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SmartScan FBG Interrogator
Product Manual



D01816559 Rev B
28/05/2020

1. Introduction 3
Product Description 3
Packing List 4
2. Safety Information 4
Safety Symbols 4
Laser Safety 4
CE Compliance 4
3. Specifications 5
4. Installation 6
Mounting Details 6
Optical Connections 6
Electrical Connections 6
Interrogator Status LED 6
SmartSoft for SmartScan Software Installation 7
Switching on the Interrogator 7
Switching off the Interrogator 7
5. Maintenance 7
Appendix A - SmartSoft for SmartScan User Manual 8
Installation 8
Preparing For Use 8
Basic Acquisition 10
Instrument Set-Up 13
Enhanced Acquisition 20
Appendix B - IP Address Settings of Host PC 30
Appendix C – SmartScan HTTP Interface and On-Board Storage 31
http interface 31
Network 32
Transferring data from On-board Storage to PC 37
Appendix D - Optical Connector Cleaning 41
Appendix E – CE Compliance Testing Information 45

1. Introduction

Product Description

SmartScan is an ultra-compact and robust interrogator for dynamic measurement of Fibre Bragg Grating, (FBG) sensors. This Wavelength Division Multiplexing (WDM) instrument is based on an agile, tuneable laser source that enables high-resolution interrogation at multi-kHz frequencies.

SmartScan is available with 1, 2, 3 or 4 optical channels; multiple sensors can be multiplexed on each fibre without reducing acquisition speed or performance.

SmartScan_CAN has an additional CANopen interface.
SmartSCan_USB has a feature to log raw measurement data to a USB storage device.

SmartScan connects to a host PC using standard Ethernet. Optionally SmartScan can integrate directly with a PLC or other supervisory system.

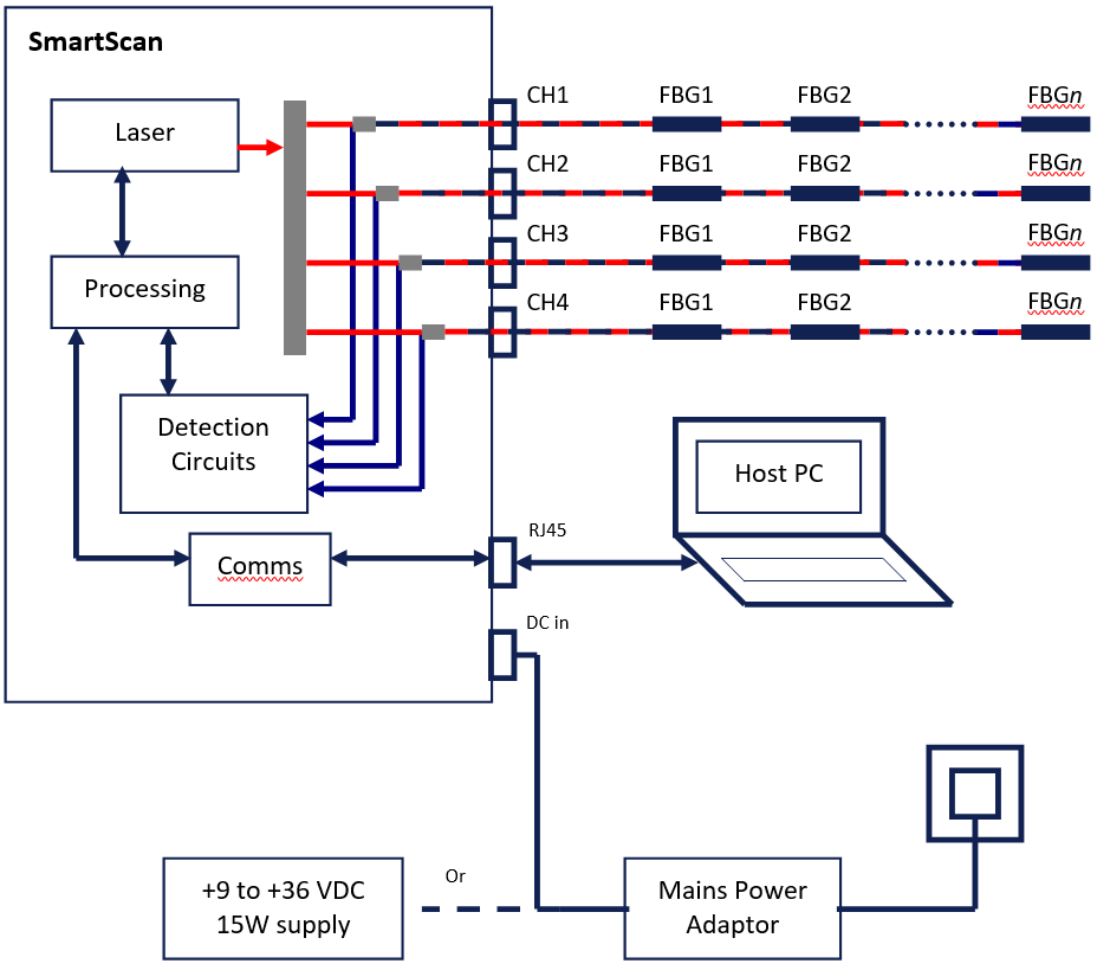


Figure 1 - SmartScan System Diagram

Packing List

The SmartScan package should contain the following items as standard:

- SmartScan Interrogator
- Rugged carry case
- Quick start guide
- Ethernet Cross-over cable
- Mains power adaptor and regional mains cable or DC power cable
- Cletop-S Fibre Optic Connector Cleaner

If any items are missing please contact Smart Fibres or your local representative immediately.

2. Safety Information

Safety Symbols

The following symbols may be present on the unit:

Symbol	Description
	Laser Safety. Refer to user manual for safety instructions for use.
	Refer to user manual for safety instructions for use and handling.

Laser Safety

Applicable Standard:	EN60825-1 (Safety of Laser Products)
Laser Type:	cw
Laser Class:	1M
Max power:	2.5 mW
Wavelength:	1528-1568 nm



The optical outputs for the interrogator are safe to view with the naked eye but should not be viewed through optical instruments such as microscopes and telescopes. If viewing optical connector faces using optical instruments the interrogator must first be powered off.

Refer servicing only to qualified and authorised personnel.

WARNING: Use of controls or adjustment of performance or procedures other than those specified for the laser source may result in hazardous radiation exposure.

CE Compliance

Applicable Standards:
EN61326-1 (Electrical equipment for measurement, control and laboratory use. EMC requirements)
Details of the CE compliance testing are provided at Appendix E

3. Specifications

Below are the Performance Specifications of the Instrument at the time of publishing this document. Specification may be subject to change. The latest specifications are available at https://www.smartfibres.com/files/pdf/SmartScan.pdf

Measurement and Processing	SmartScan	SmartScan Lite
Wavelength Range	40 nm (1528 – 1568 nm)	
Number of Optical Channels[1]	1, 2, 3, 4	
Maximum Number of Sensors/Channel	16	
Scan Frequency (all sensors simultaneously)	2.5 kHz	250 Hz
Maximum Scan Frequency (with reduced wavelength range)	25 kHz	-
Repeatability[2,3,4]	< 1 pm	
Wavelength Stability	< ±5 pm over operating temperature range, ± 20 pm over 25 years	
Dynamic Range (total tolerable optical attenuation without loss of performance)	27 dB	
Dynamic Range (laser launch power minus detection noise floor)	37 dB	
Gain Control	9 levels, per channel or per sensor, automatic or user controlled	
Onboard Processing	For conversion of measuring units and interfacing to client systems	
Bragg Grating Full Width Half Maximum (FWHM)	Minimum > 0.2 nm, > 0.5 nm recommended	

Mechanical, Environmental and Electrical	
SmartScan, SmartScan_USB Dimensions	140 x 115 x 85 mm / 5.5 x 4.5 x 3.3”
SmartScan_CAN Dimensions	140 x 115 x 105 mm / 5.5 x 4.5 x 4.1”
Weight	0.9 kg / 2 lb
Operating Temperature	-15 to +55 °C / +5 to 131 °F
Optional Increased Temperature Range	-20 to +60 °C / -4 to 140 °F
Comms Interface	Ethernet (UDP-IP), CAN bus and others on request
Data Connector	RJ45 standard
Data Logging (optional)	To USB memory device (no need for connected PC)
Power Connector	via mains adapter supplied
Optical Connector[5]	FC/APC
Input Voltage	+9 to +36 VDC
Power Consumption	typ 7.5 W, max 8.5 W
EMC Certification	Per BS EN 61326-1 edition 2006
Hazardous Area Certification (optional)	Per ATEX for hazardous zones 0, 1 or 2 with gas groups IIA, IIB or IIC Link to certification

1. 4, 8, 12 and 16 channel Modular SmartScan also available.
2. Measured over 1 minute, standard uncertainty (1 σ distribution).
3. Averaging allows 2, 4, or 8 times data reduction, improving repeatability.
4. Using FBG profile as shown.
5. Connector required to be fitted on cable to mate with unit.

Specifications may change without notice

4. Installation

Mounting Details

Currently SmartScan is for bench top use; other mounting arrangements, including DIN Rail, are available on request.

Optical Connections

SmartScan may have 1, 2, 3 or 4 FC/APC connectors for connecting Single Mode Fibres. These are numbered from the left as CH1, CH2, CH3 and CH4. Observe the recommended connector cleaning practice described in Section 5. Connectors should only be fastened finger tight, take care to correctly align the key-way when mating the connectors.



Figure 2 – SmartScan Connections

Electrical Connections

Refer to the labels in yellow on the above image
A = On/Off Switch
B = DC power Input
C = Power and Status light
D = RJ45 Ethernet Connector with built-in network status lights
E = Serial connector for diagnostics/servicing
F = USB (for use with models with USB functionality enabled only)
G = CANbus connector as per CiA standard 303 v1.7 (SmartScan CAN models only)

Interrogator Status LED

OFF	Interrogator not powered or boot-up not complete
RED	System error or power up sequence in progress
GREEN	Interrogator booted and operational
FLASHING GREEN	Storage session in progress (models with USB functionality enabled only)

Note, during power up the sequence is as follows:

1. LED Off
2. Power applied to Interrogator, LED remains off for approximately 10 seconds
3. LED Red briefly, Interrogator not ready
4. CANopen interface enabled (SmartScan CAN models only)*
5. LED Green, Interrogator ready

* CANopen sequence:

- CANopen interface initialisation starts, NMT state reported as BOOTUP
- After a further 5 seconds CANopen interface initialisation completed.
- NMT state reported as PREOPERATIONAL
- CANopen Master must send NMT command to change state to OPERATIONAL
- CANopen Master sends SYNC messages, SmartScan_CAN responds with TPDO messages
- The CANopen protocol has been implemented as per CiA standard 301 v4.02

SmartSoft for SmartScan Software Installation

SmartScan is configured and controlled using ***SmartSoft*** application software. This software also allows data to be acquired from the interrogator. ***SmartSoft*** can be downloaded via the URL shown for each model:
SmartScan = http://download.smartfibres.com/SmartSoft-for-SmartScan.zip
SmartScan_CAN = http://download.smartfibres.com/SmartSoft-for-SmartScan(CAN).zip
SmartScan_USB = http://download.smartfibres.com/SmartSoft-for-SmartScan(USB).zip

An instruction manual for the installation and operation of ***SmartSoft*** is provided at Appendix A.

Switching on the Interrogator

Once the equipment has been connected as shown in Figure 1 and SmartSoft has been installed on the host PC the SmartScan Interrogator is ready to be switched on using the power switch on the front panel. Move the power switch to the down position and observe the LED sequence above.

The SmartSoft PC application should now be used to configure and acquire data from the interrogator.

Switching off the Interrogator

Prior to switching off the interrogator it is best practice to stop SmartSoft following the instructions in the SmartSoft user manual, after which the interrogator may be switched off by moving the power switch to the up position.

5. Maintenance

The SmartScan interrogator contains no user serviceable parts. Many reported issues are as a result of poor optical connector cleanliness. You are recommended to refer to Appendix D, where best practices for optical connector cleaning are provided.

In the event that you are having problems with your SmartScan, please contact your local representative or Smart Fibres technical support at +44 1344 484111 or Smartfiber@Halliburton.com . In the event that technical support are unable to resolve your issues remotely, you will be given a Return Material Authorisation (RMA) number under which you can return the instrument for maintenance or repair.

Appendix A - SmartSoft for SmartScan User Manual

Installation

SmartSoft can be downloaded via the URL shown for each model:
SmartScan = http://download.smartfibres.com/SmartSoft-for-SmartScan.zip
SmartScan_CAN = http://download.smartfibres.com/SmartSoft-for-SmartScan(CAN).zip
SmartScan_USB = http://download.smartfibres.com/SmartSoft-for-SmartScan(USB).zip
SmartSoft is then installed on a host PC. The host PC must run a suitable Operating System, this manual covers installation on a PC running Windows operating systems.

After downloading, extract the zip files to a suitable location on the PC. To install the software, run "setup.exe" and follow the instructions that appear during the install process. The installer will place a shortcut in the Windows Start Menu under the Smart Fibres program group and on the Desktop.

If not already installed on the host PC, the National Instruments' LabVIEW™ Run Time Engine (RTE) must be downloaded and installed. At the time of writing, the RTE is available at www.ni.com/en-us/support/downloads/software-products/download.labview.html#305508. Make the following selections on the download page: Supported OS = Windows, Version = 2015, Bitness = 32-bit, Editions = Runtime

Preparing For Use

After installing SmartSoft, connect the supplied Ethernet cross-over cable between the host PC and SmartScan. The PC's network connection must be configured to a suitable subnet; by default SmartScan's IP address is 10.0.0.150 and its Net mask is 255.255.255.0. The Net mask for the PC must also be set to 255.255.255.0, suitable ranges for the PC's IP address are 10.0.0.1 to 10.0.0.149 or to 10.0.0.151 to 10.0.0.250. (see Appendix B for further details or contact your network administrator for assistance).

SmartScan can also be connected to a network instead of a direct connection to a host PC. Further details are given in section A4/ Instrument Setup – Network Tab.

Connect the Power adaptor to the main AC supply and connect its DC output to the DC input of SmartScan. Alternatively SmartScan can be powered directly from a DC supply, in which case the DC supply must be in the range +9 to +36V and capable of supplying 15W of power and a DC power cable should have been ordered with the SmartScan.

SmartScan is now ready to be powered. Switch on the supply and observe the Power/Status light next to the DC power connector, it should first light red to indicate the presence of supply voltage and then change to green after a few seconds to indicate that the SmartScan is ready for a host PC connection. FBG sensors can be connected to the SmartScan at any time.

On the host PC Navigate to the Smart Fibres > SmartSoft short-cut on the Windows Start Menu and start the program. **Note** that the first time SmartSoft is run a message from the PC's firewall may be displayed requesting permission to allow SmartSoft through the firewall, it is important to check the tick boxes for all domains that appear





Figure 3 - Connecting SmartScan to Network

The program requests the IP address of the SmartScan. As shipped from the factory this will be 10.0.0.150. An Ethernet connection is attempted and the dialogue box changes to indicate progress. If a connection can be made successfully the dialogue box will close after a few seconds and the SmartSoft main screen appears.

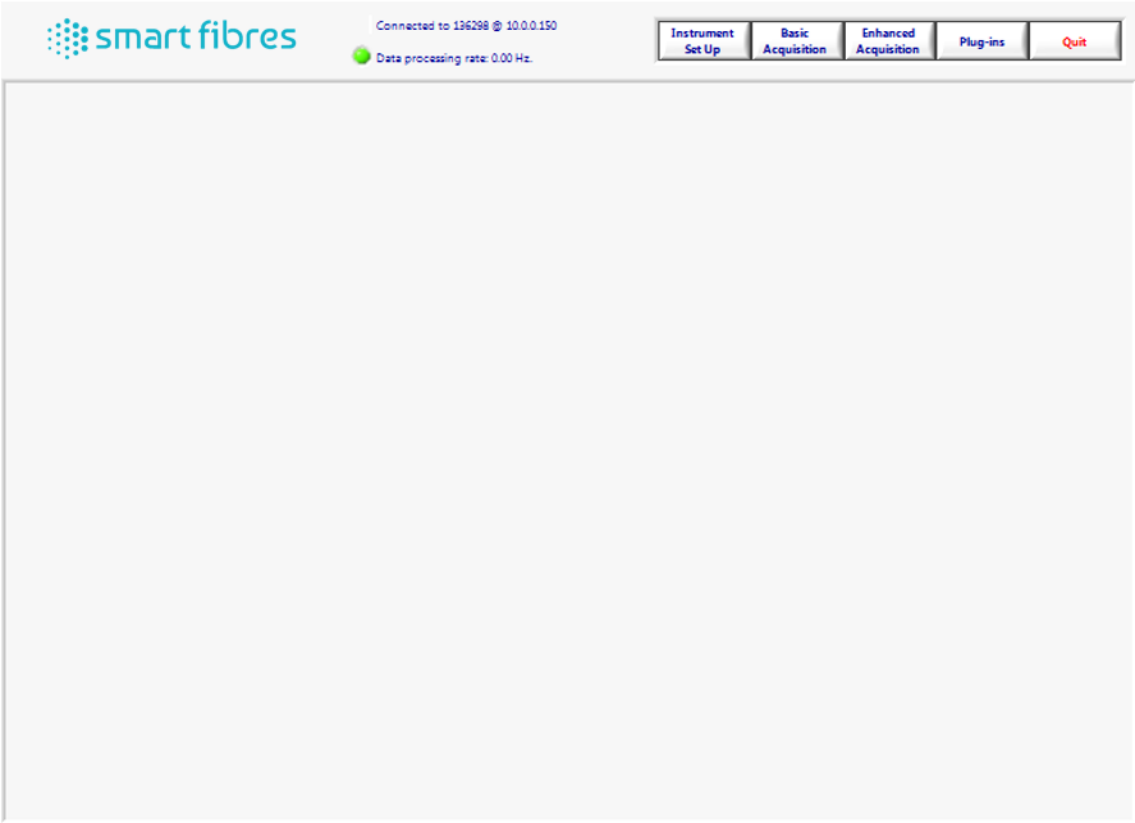


Figure 4 - SmartSoft for SmartScan Main Screen

A number of function buttons are shown top right. Inactive functions are greyed out.

Basic Acquisition is recommended for first time users and is designed to enable basic measurements to be taken with simplified settings. Acquisition will be fixed at 2.5kHz (250Hz for SmartScan lite), with per-channel auto-gain. The data processing rate can be varied by averaging a user defined number of samples (1-1000).

Enhanced Acquisition is recommended for advanced users and is rich in features but requires more detailed settings. Attempting to use enhanced mode without first reading this manual is not recommended.

Instrument Set-up is largely used in conjunction with Enhanced Acquisition.

Plug-ins allows the user to run custom LabVIEW source code modules. Contact Smart Fibres technical support for details.

Quit is used to close the entire application. Always use the Quit button to exit the SmartSoft application; using other methods to close the application may cause unexpected behaviour.

Basic Acquisition

Press the Basic Acquisition Button and then select the Spectrum Tab.

Basic acquisition – spectrum tab

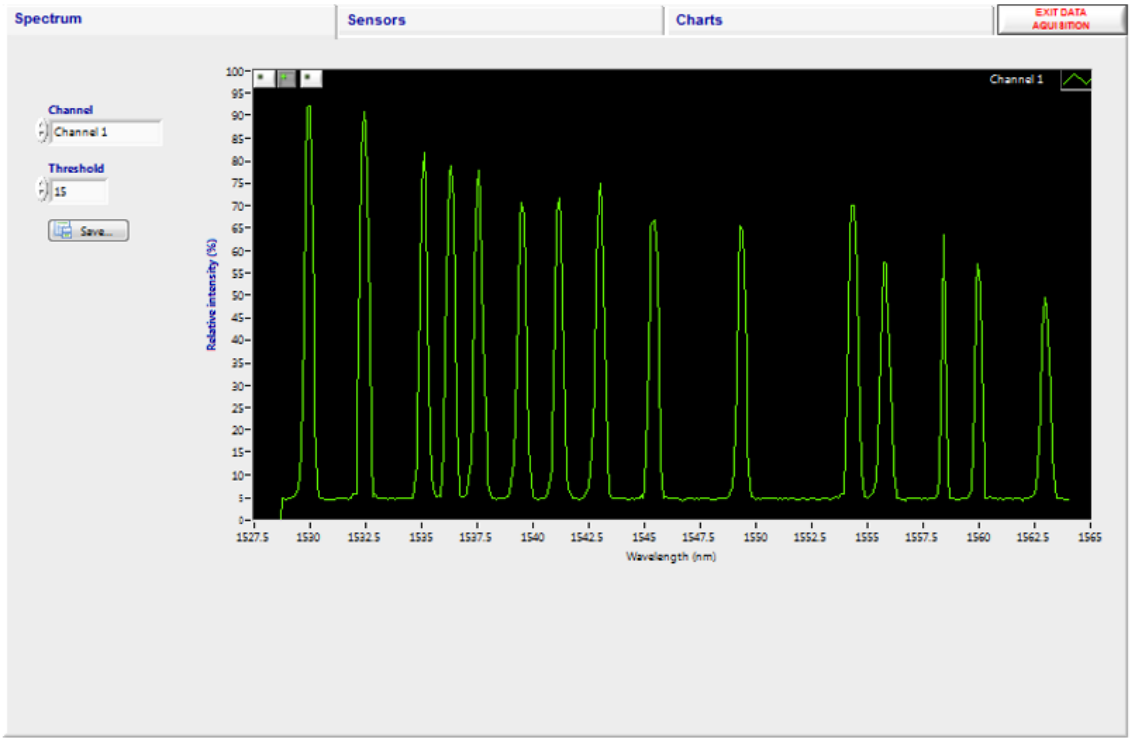


Figure 5 - Basic acquisition – Spectrum tab

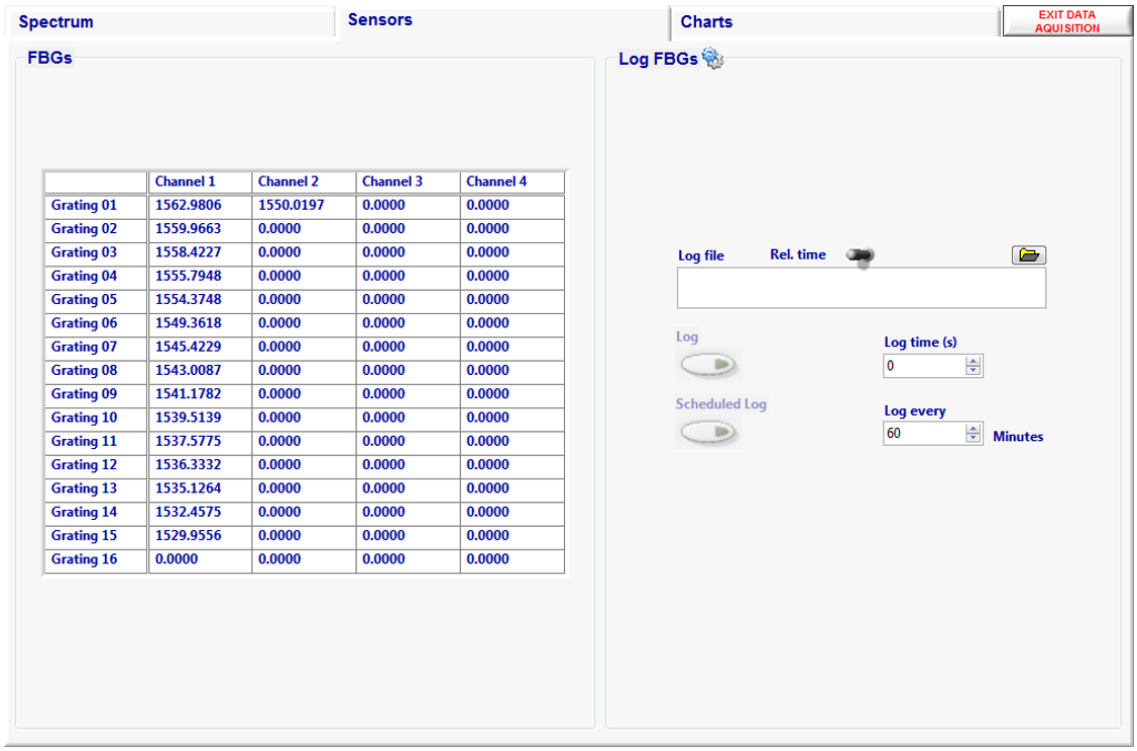
The spectrum tab is intended as a tool to aid setting up of sensors and/or SmartScan parameters. The sensors on one channel at a time can be viewed with the reflected signal intensity displayed over the wavelength range. Each peak represents the reflected light from one FBG. In basic Acquisition mode the gain is applied on a per channel basis. Automatic gain control ensures that the largest signal is not saturated.

If there are large differences in the signal intensity of FBGs on the same channel then per-FBG gain can be used with the enhanced acquisition panel, see the Instrument Set Up section for more details. Step through all the channels that have FBGs connected and ensure that the background noise is below 10% and that the FBG signal peaks are above 25%.

If desired, the instantaneous spectrum can be saved to file, press the save button whilst the channel of interest is being viewed. A file of 400 points is generated, with relative intensity of reflection vs wavelength at 100 pm intervals.

Next move to the Sensors tab.

Basic acquisition – sensors tab



	Channel 1	Channel 2	Channel 3	Channel 4
Grating 01	1562.9806	1550.0197	0.0000	0.0000
Grating 02	1559.9663	0.0000	0.0000	0.0000
Grating 03	1558.4227	0.0000	0.0000	0.0000
Grating 04	1555.7948	0.0000	0.0000	0.0000
Grating 05	1554.3748	0.0000	0.0000	0.0000
Grating 06	1549.3618	0.0000	0.0000	0.0000
Grating 07	1545.4229	0.0000	0.0000	0.0000
Grating 08	1543.0087	0.0000	0.0000	0.0000
Grating 09	1541.1782	0.0000	0.0000	0.0000
Grating 10	1539.5139	0.0000	0.0000	0.0000
Grating 11	1537.5775	0.0000	0.0000	0.0000
Grating 12	1536.3332	0.0000	0.0000	0.0000
Grating 13	1535.1264	0.0000	0.0000	0.0000
Grating 14	1532.4575	0.0000	0.0000	0.0000
Grating 15	1529.9556	0.0000	0.0000	0.0000
Grating 16	0.0000	0.0000	0.0000	0.0000

Figure 6 - Basic acquisition – Spectrum tab

All FBG locations are shown in the table on the left of the screen. The number of FBGs per channel can be programmed using Instrument Set Up.

The SmartScan calculates the centre wavelength of each FBG peak and these are displayed in the table.

The user may record the table wavelengths to a log file. First set the target location and name of the log file by typing it in the box, or by clicking the folder icon. Then set the duration of the logging period (log time) and then press the log button. The button lights up and the elapsed time is indicated by a progress bar and a numeric indicator. The recording will automatically stop when the Log time is reached or the user may stop the recording by pressing the Log button again.

A log file can be scheduled to take place at regular intervals. The file name will be appended with a date/time string of the format “YYYYMMDD-HHMM_” where YYYY is the year, MM is the month, DD is the day, HH is the hour of day and MM is the minutes in the hour. The scheduled log button will only be enabled when a valid log file name is selected and a log time shorter than the logging period is chosen.

A logging session can be split over many files in order to avoid large log files if logging for long periods at high rates. The number of lines per log file and the time/date format to append or prepend to the file-name may be set by clicking the icon next to the “Log FBGs” heading. If both prefix and postfix strings are empty the log file name will be exactly as selected in the log file control, unless the selected log time would exceed the selected number of lines per log file. In which case the log file name will be prepended with the default time-stamp format of %Y%m%d-%H%M%S_. To cancel Log file rotation set the number of lines to 0.

Now move on to the Charts tab.

Basic Acquisition – Charts Tab

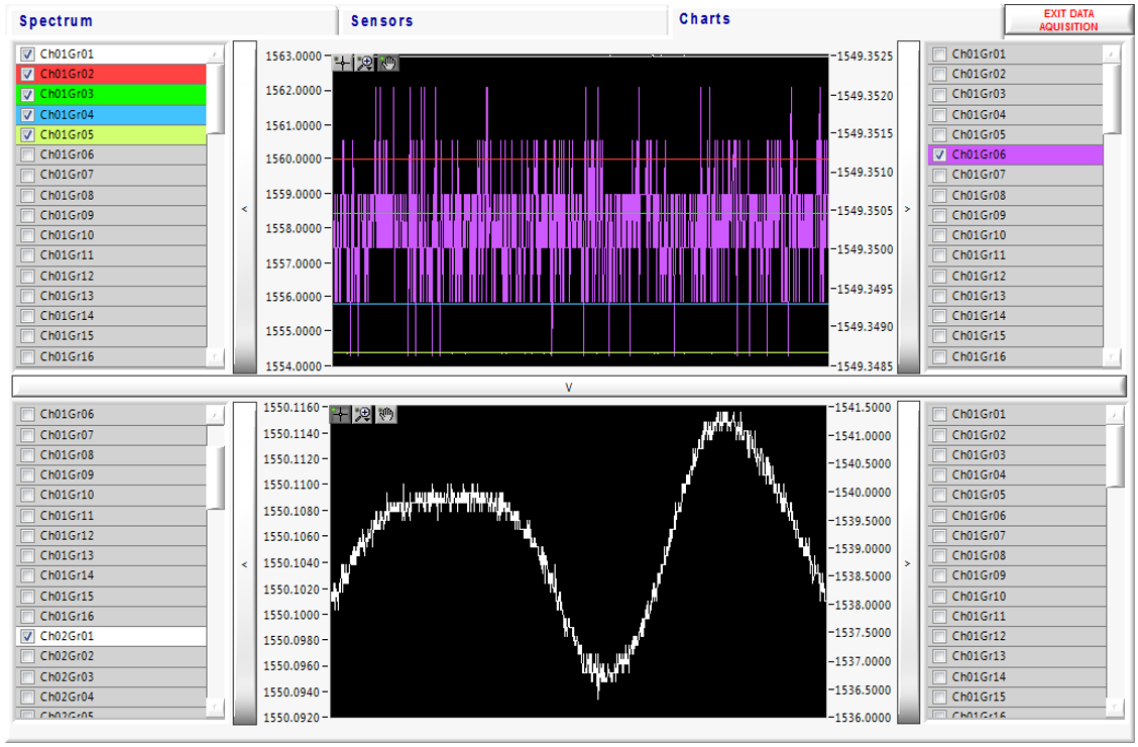


Figure 7 - Basic acquisition – Charts tab

Two wavelength graphs are displayed simultaneously and any of the available FBGs (16 per channel) can be selected for display. FBGs can be added to the left or right y-axes and each one is assigned a colour-coded trace.

To increase the displayed graph area one or both of the y-axes can be hidden by pressing the appropriate < or > button. Similarly the lower graph can be hidden using the “V” button between the two graphs, allowing the upper graph to extend to fill the screen.

The Y axes of the graphs are set to auto-scale. If required, they can be locked by right clicking on the desired scale axis and de-selecting “AutoScale Y”. The upper and lower limits of the locked axis can then be selected and adjusted.

Instrument Set-Up

Instrument Set Up is used to enable Enhanced Acquisition and allows the powerful features of SmartScan and SmartSoft to be utilised fully.

A number of set up tabs are available, they will be described from left to right.

Instrument Set-Up - Acquisition Rate Tab

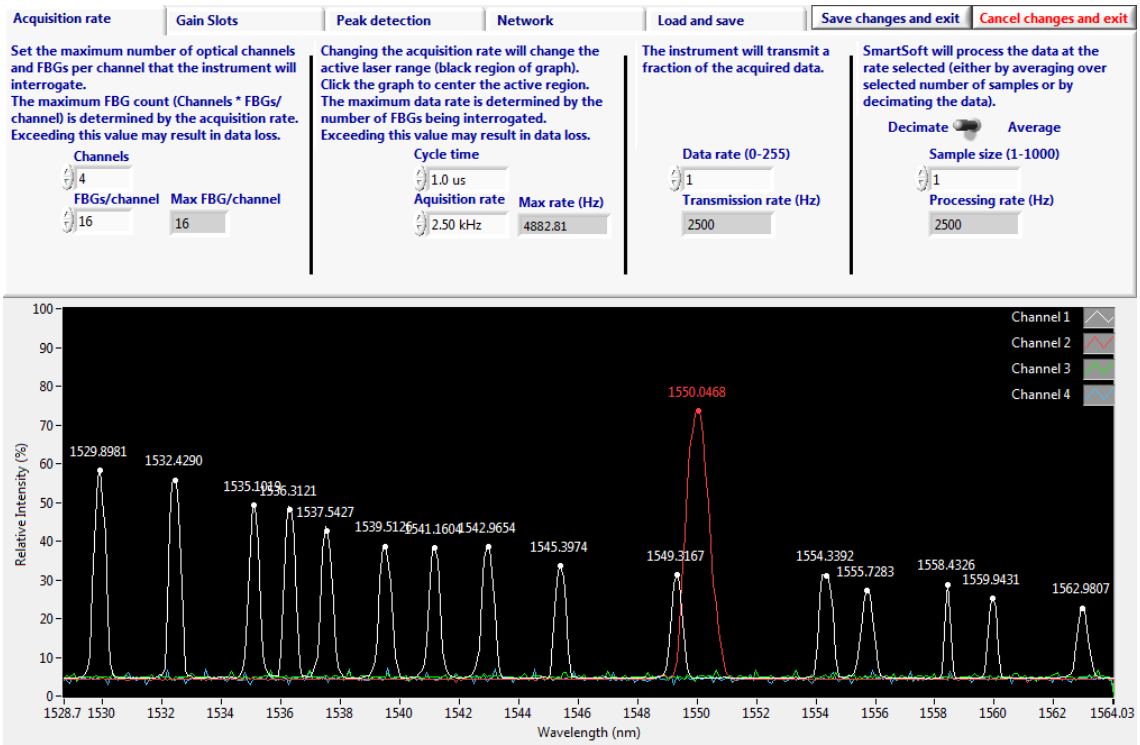


Figure 8 – Instrument setup - Acquisition rate tab

Here the user can adjust various parameters that affect the acquisition rate of the SmartScan and the data processing rate of the SmartSoft software.

The lower half of the screen shows spectra from all operational channels, together with the current wavelengths of any detected FBG peaks.

Starting on the left the user may configure the number of active optical channels. The limit depends on the maximum number of optical channels the instrument supports.

The user may configure the number of FBGs per channel. Reducing the number of FBGs per channel enables the faster acquisition rates in the drop down menu to be used.

The SmartScan cycle time in microseconds (μs) can be adjusted. The cycle time is defined as the time to complete one laser tuning step and measure the light received by the detector circuits. This can speed up or slow down the overall acquisition time. The minimum cycle time is 1 μs.

The SmartScan's acquisition rate is a function of cycle time and wavelength range. The acquisition rate can be adjusted by choosing a value from the selection box. This trades the instruments wavelength range for acquisition speed, e.g. 2.5 kHz over 40 nm, 5 kHz over 20 nm, 25 kHz over 4 nm. For some rates it may be necessary to reduce the number of FBGs per channel as described above.

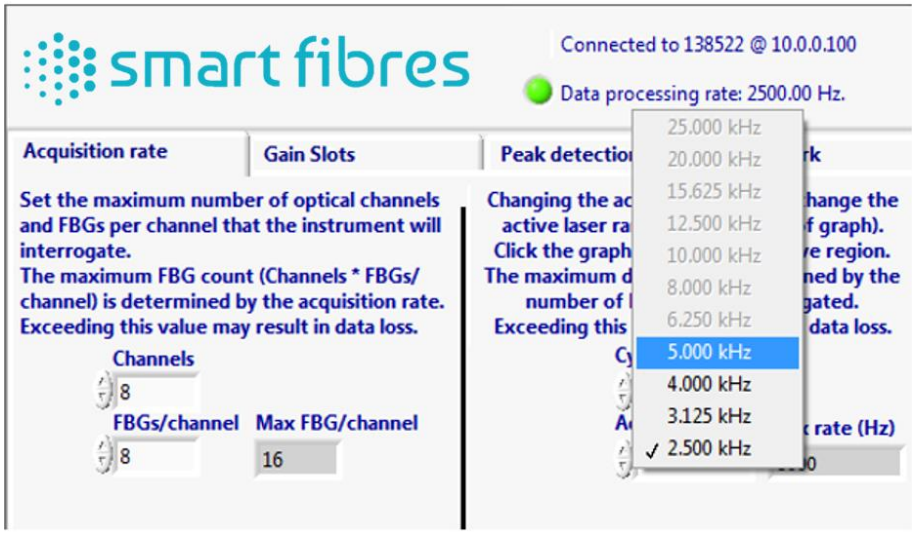


Figure 9- Instrument setup - Acquisition rate selection

The active laser range will be reduced according to the selected acquisition rate. The inactive range will be greyed out in the graph. Left click on the graph with the mouse to centre the active region in the desired location. Select the lowest acquisition rate in the list to reset the active region to its full range.

Consideration should be given to the expected wavelength excursions of each FBG peak to ensure that they will not move outside the laser tuning range.

The rate at which data are transmitted to the host PC can be reduced by sampling the data. Setting the Data Rate to 1 means that the SmartScan will transmit all available data to the PC and the transmission rate will be equal to the acquisition rate. Setting the Data Rate to a number N greater than 1 will result in data from every N^{th} scan being transmitted. It may be desirable to slow down the transmission rate because, for example the data are transmitted over a slow network connection or because the host PC cannot process the data packets fast enough.

Finally, the user may further reduce the amount of data stored in a log file by applying averaging or decimating the data. This is applied by the SmartSoft application so will not reduce the Ethernet traffic but will reduce the data presented by SmartSoft and optionally saved to file. The extent of data reduction is controlled by the Sample size box. Setting this to a number N will result in every Nth transmitted data point being presented or stored, either by averaging N points together or by keeping every Nth point and discarding the rest. Averaging N data points together will also improve the signal to noise ratio by up to a factor of √N.

The data processing rate is displayed at the top of the screen when acquisition is in progress. The acquisition and transmission rates are shown as a tool tip when hovering the mouse over the data processing rate indicator.

Instrument Setup - Gain Slots Tab

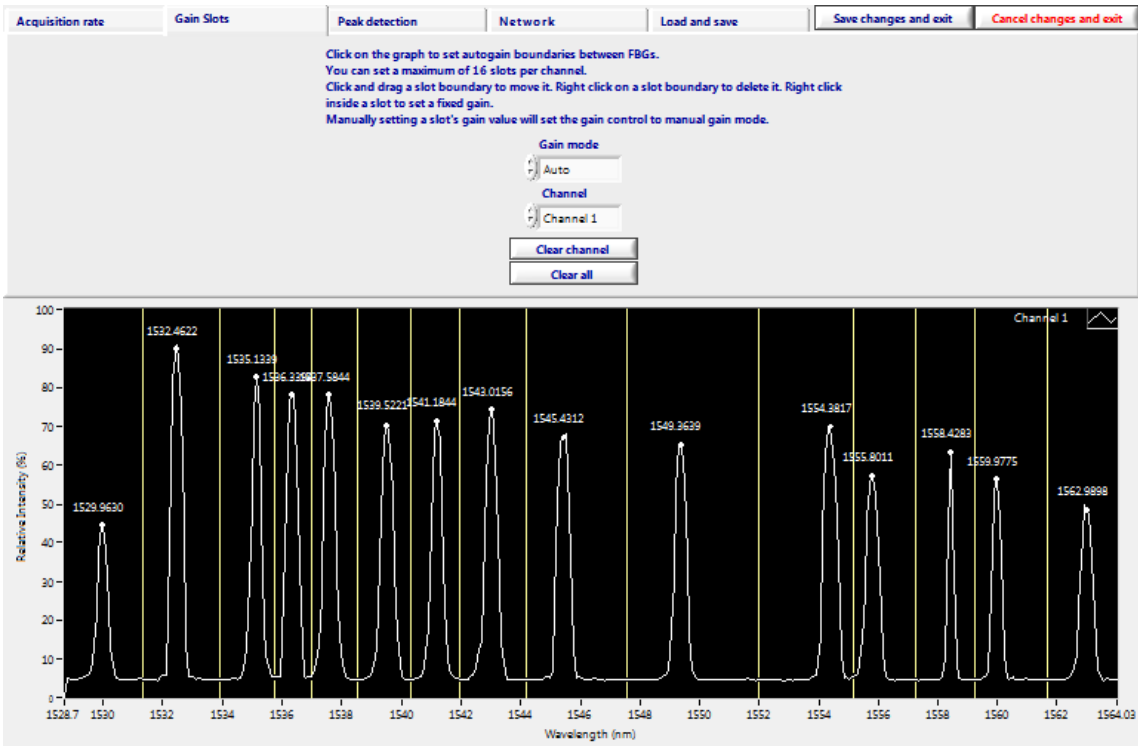


Figure 10 - Instrument setup - Gain slots tab

An advantage of Enhanced Acquisition is that it enables the use of Wavelength Gain slots, whereby each FBG operates within its own wavelength window that is assigned its own set of properties. Each slot can use a different gain level so large variations in signal intensity can be accommodated on one channel without loss of measurement resolution.

The Gain slots are set up on a channel-by-channel basis. The spectrum for the Channel in question is displayed. The wavelength limits on the graph's x-axis have already been determined according to the laser tuning range that was set up on the Acquisition Rate tab. The user then clicks between the spectral peaks to add slot boundaries. Only one FBG peak should be present in each slot. The start and end points of the wavelength tuning range are slot boundaries, so be sure not to add slot boundaries before the first FBG or after the last FBG. Care should be taken that during operation the FBG peak will not cross a slot boundary and that FBG peaks remain separated by at least 1.6 nm from each other and 0.8 nm from the end of the active laser range. Do not set up more slots than the number of sensors per channel that was configured on the Acquisition Rate tab. Slot boundaries can be adjusted by dragging them to their desired position using the mouse. Right click on a boundary to delete it.

Once the slots are established the Gain Mode can be set. There are two modes, in auto mode the gain for each slot adjusts automatically so that the intensity of each FBG peak is maximised but does not saturate. The peak intensity will be maintained between 50 and 100% and will only reduce below 50% on the highest gain level if the signal is still too small.

In Manual gain mode a fixed gain is applied to each slot. To set the gain, right click on the graph between the slot boundaries and set the gain level between 0 and 8, repeating this process for each slot on all channels. The optimum gain level is above 50% but without saturating; a saturated FBG peak will have a flat top at around 100% intensity. The gain applied to each slot is displayed on the graph. Selecting a manual gain for a slot will automatically change the gain setting from auto to manual. It is recommended that in manual mode the gain be set as high as possible without risk of the FBG peak saturating. Peaks below 25% relative intensity may suffer reduced measurement performance.

Instrument Setup - Peak Detection Tab

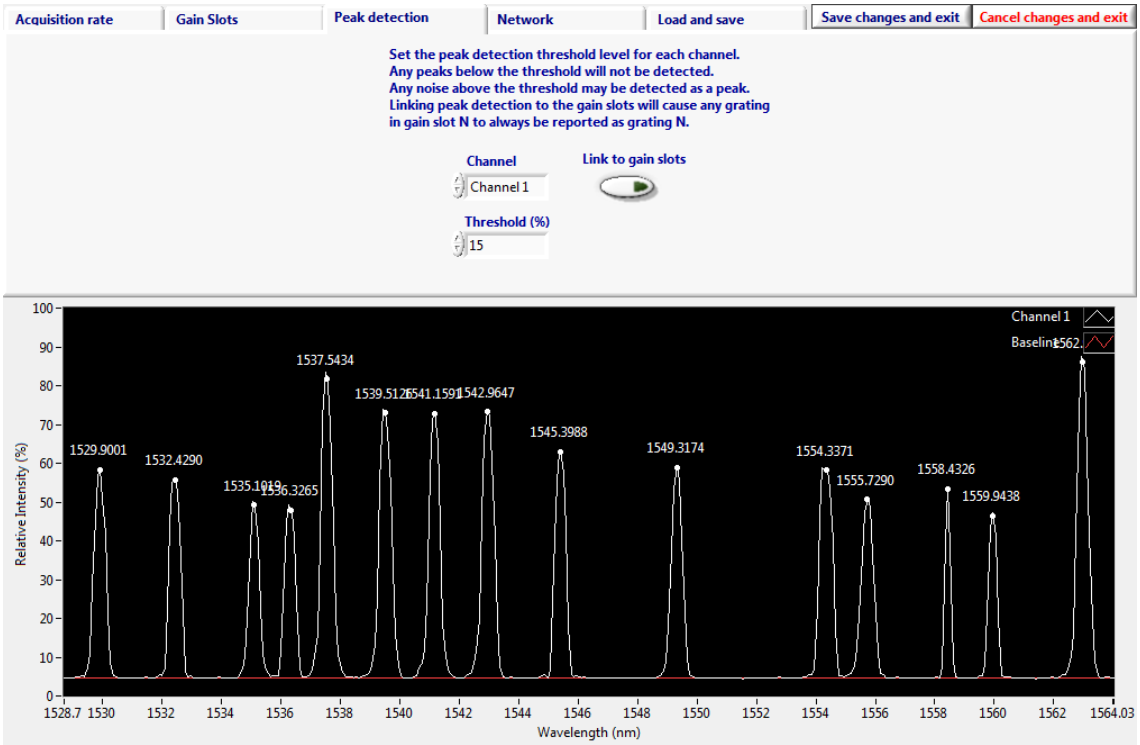


Figure 11 - Instrument setup - Peak detection tab

SmartScan performs a baseline calibration of the photo-detectors during power up. This compensates for any back-reflection in the fibres. The calibrated baseline value is shown as a red trace on the graph. If the fibres are changed or disturbed and the baseline changes, calibration can be performed by either power-cycling the instrument or pressing the “Calibrate baseline” button.

The peak detection threshold may be adjusted for each channel on this tab. Ensure the threshold level is above the background reflection level but not above any true FBG peaks. In most cases a value of around 15% is optimal. The threshold is relative to the signal baseline, the red trace on the graph, not zero relative intensity.

The location of detected peaks can be linked to the auto-gain slots by selecting the ‘link to gain slots button’. This way, a peak at wavelength X will always be reported as grating N, where N is the slot number containing wavelength X. This feature avoids the software becoming confused if, for instance, one FBG within an array drops below its threshold.

Instrument Setup - Time of Flight Tab

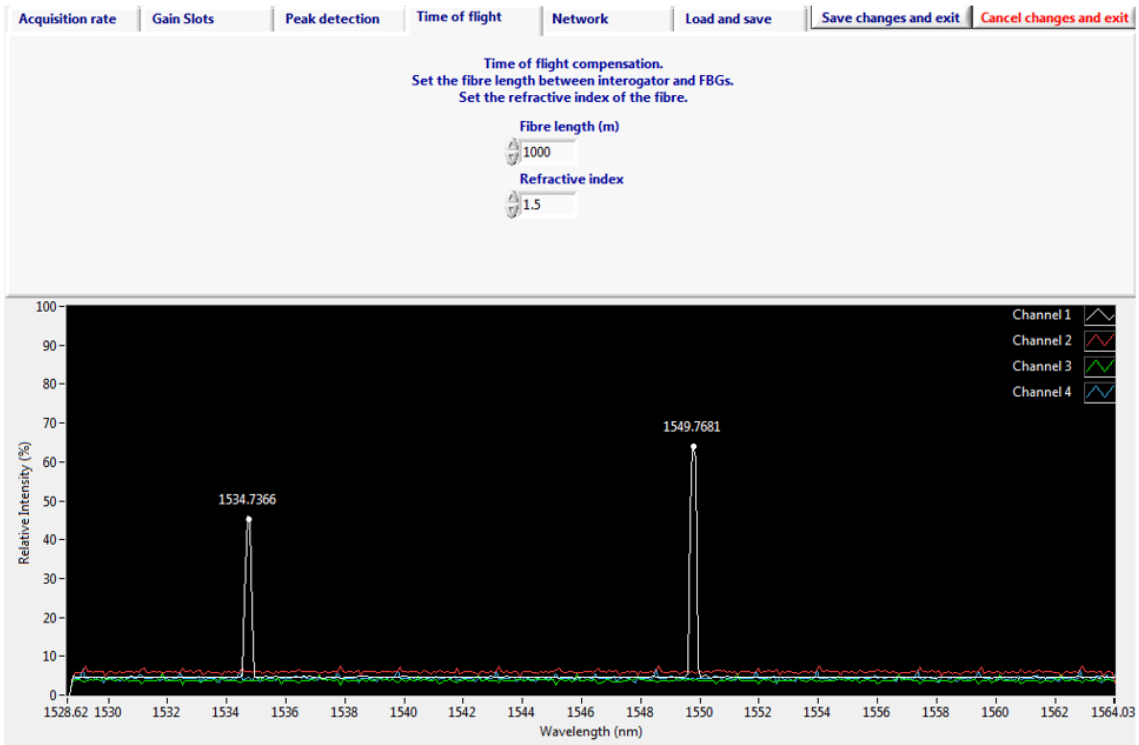


Figure 12 - Instrument setup - Time of flight tab

If the interrogator supports time of flight compensation in hardware, the user can enter a fibre length and refractive index in order to compensate for the time it takes light to travel from the interrogator to the gratings and back. The compensation is applied to all gratings on all channels.

The refractive index of the fibre can be requested from the fibre manufacturer or supplier if not known.

Fibre length is entered to the nearest whole metre, the length entered should be accurate to within 5 metres for best results.

Instrument Setup – Network Tab

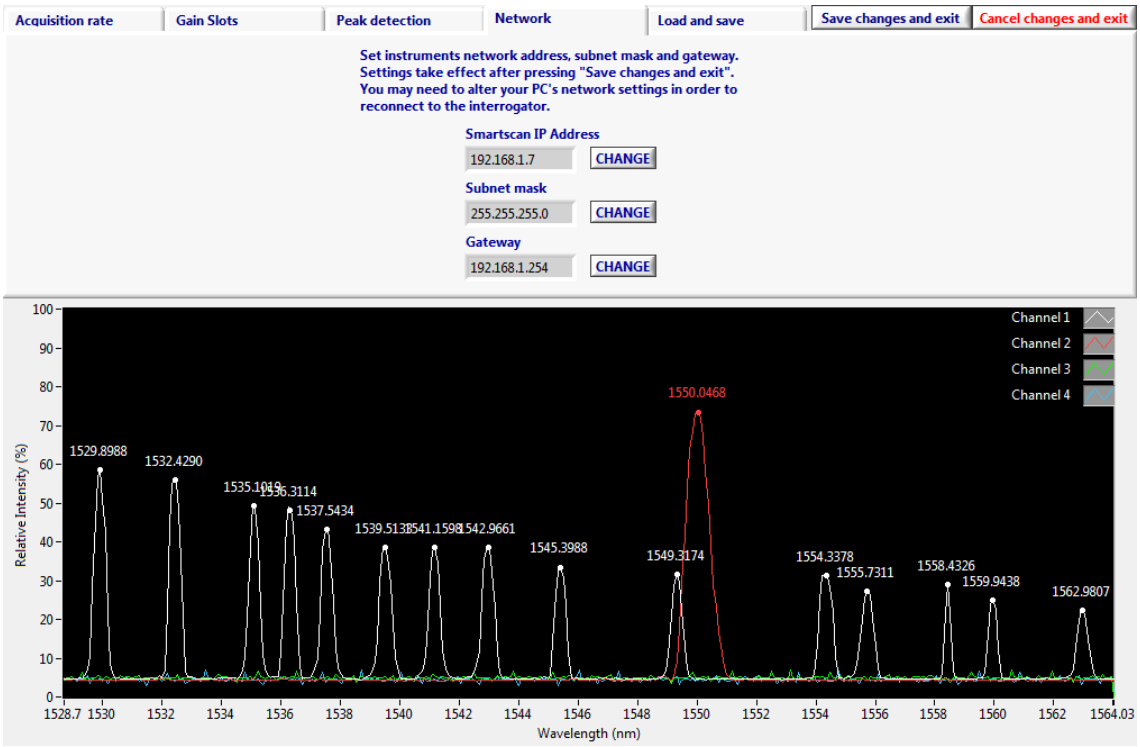


Figure 13 - Instrument Setup – Network Tab

On the Network tab the user can change the IP settings of the SmartScan. This is usually only necessary when a SmartScan is to be used on a Local Area Network. Be aware that the IP settings of the host PC may need to change in order to maintain connectivity.

If you are connecting the SmartScan to a network instead of a direct connection to a host PC, make sure to set the gateway address to match the network router or gateway PC's LAN address and that the SmartScan's IP address is unique on the network and not in the pool of addresses assigned to any DHCP servers on the network.

If there is a firewall or NAT router between the SmartScan and the host PC you may need to open TCP port 80 and UDP ports 30001 to 30003, 30070 to 30072 and 30075 to allow SmartSoft to communicate with the interrogator.

See Preparing for Use section and Appendix B for further details and if necessary consult your Network Administrator.

Instrument Setup - Load and Save Tab

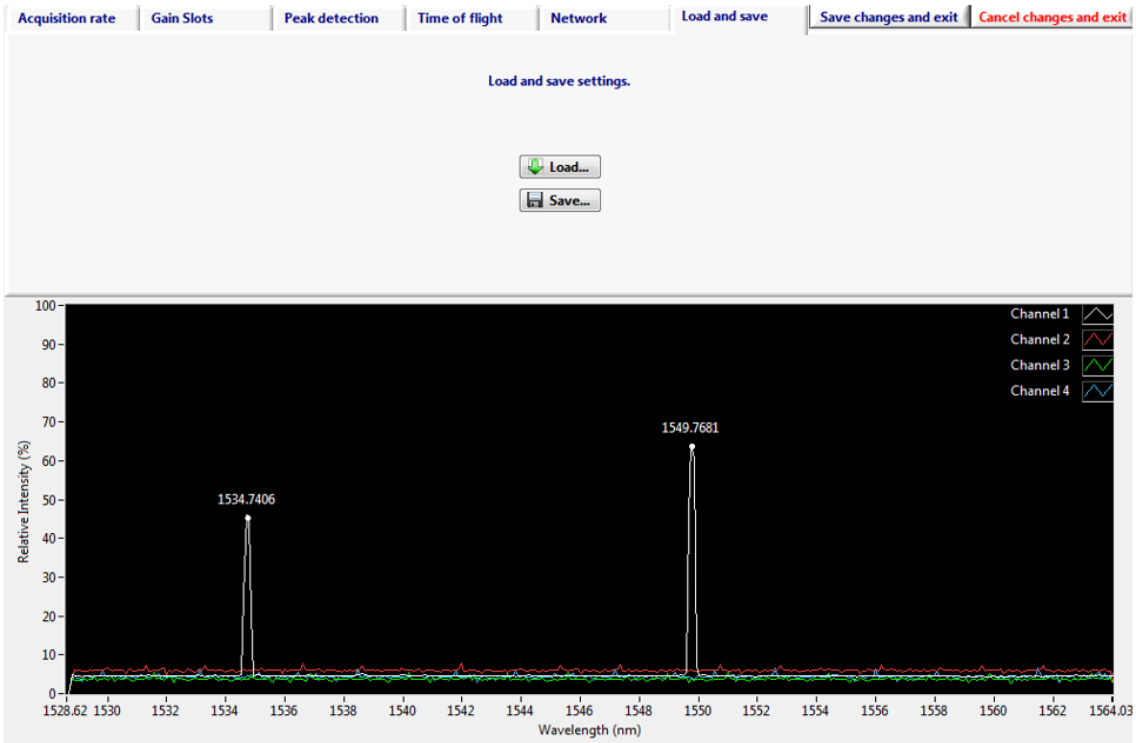


Figure 14 - Instrument Setup - Load and Save Tab

The user can use this tab to save all the Instrument Setup parameters to a file. The file can be recalled later using the Load button. This is particularly useful when SmartScan is used to interrogate multiple sensor systems, as a configuration for each system can be saved.

Instrument Setup - Exiting Instrument Set-Up

There are three options for exiting Instrument Set Up, pressing “Save changes and exit” will transfer all parameters to SmartScan and the instrument is ready to begin an Acquisition session. Alternatively, pressing “Cancel changes and Exit” will discard any changes and SmartScan will revert to its previous configuration. You can also just select a new panel from the main controls, if any settings have been changed SmartSoft will ask if you want to save them.

Enhanced Acquisition

Before entering Enhanced Acquisition, first configure the instrument in the Instrument Set Up section.

Enhanced Acquisition - Spectrum Tab

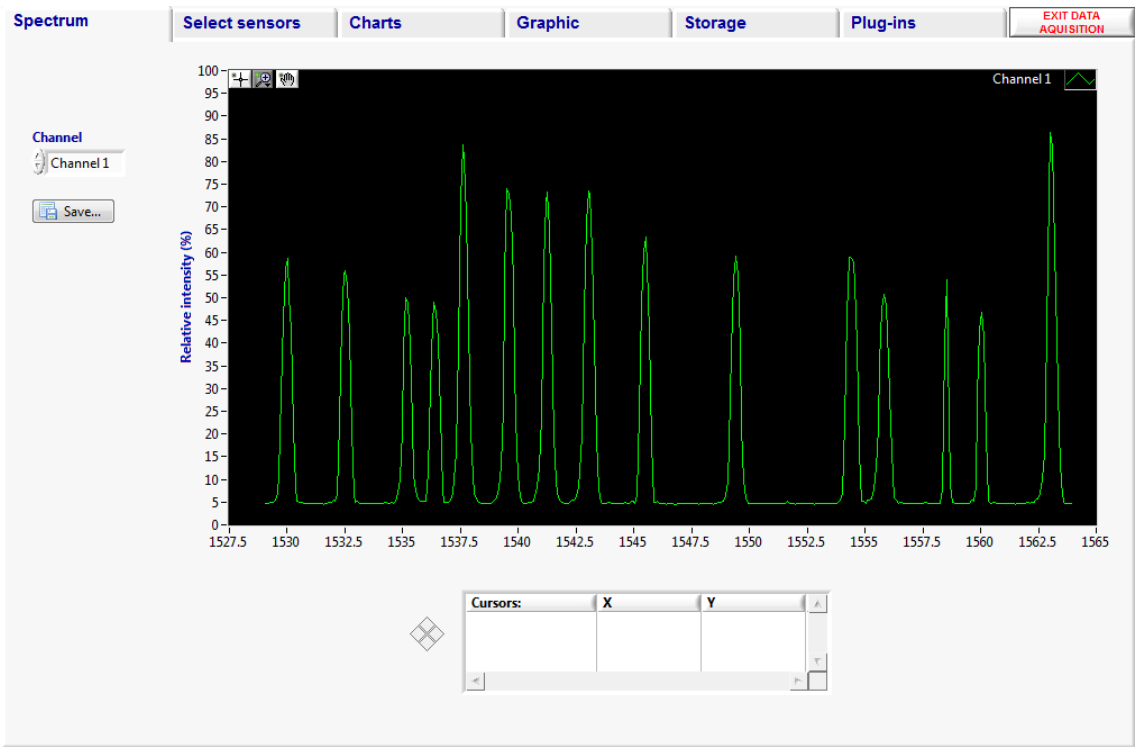


Figure 15 - Enhanced Acquisition - Spectrum Tab

The spectrum tab is intended as a tool to aid setting up of sensors and/or SmartScan parameters. The sensors on one channel at a time can be viewed with the reflected signal intensity displayed over the wavelength range. Each peak represents the reflected light from one FBG. The appearance of the FBG Peaks will be influenced by the Gain scheme selected during Instrument Set Up.

If desired the instantaneous spectrum can be saved to file, press the save button whilst the channel of interest is being viewed. An image of the spectrum can be exported to the clipboard or a file by right clicking in the graph area. Note that the data rate for spectral data is much slower than for sensor data.

The graph palette in the top left corner of the graph provides options for navigating around the screen. The cross icon is the selection tool and is used for selecting and moving graph cursors, the magnifying glass icon allows the user to zoom in on the graph to examine particular spectral features in more detail and the hand icon is used to drag a magnified region around the plot.

The plot legend in the top right of the graph can used to change the plot properties, e.g. line style/colour, point style/colour, etc.

Extra functionality is made available by right clicking in the graph and selecting from the pop-up menu. The scale legend can be used to gain quick access to the graphs auto-scale options and for changing scale indicator parameters such as numeric format, precision, etc. The cursor legend is used for creating cursors on the graph and reading the position of those cursors. Cursors can be created by right clicking inside the cursor legend and can be dragged with the selection tool (see graph palette section). The cursor can be configured by right clicking on its name in the cursor list.

Enhanced Acquisition - Select Sensors Tab

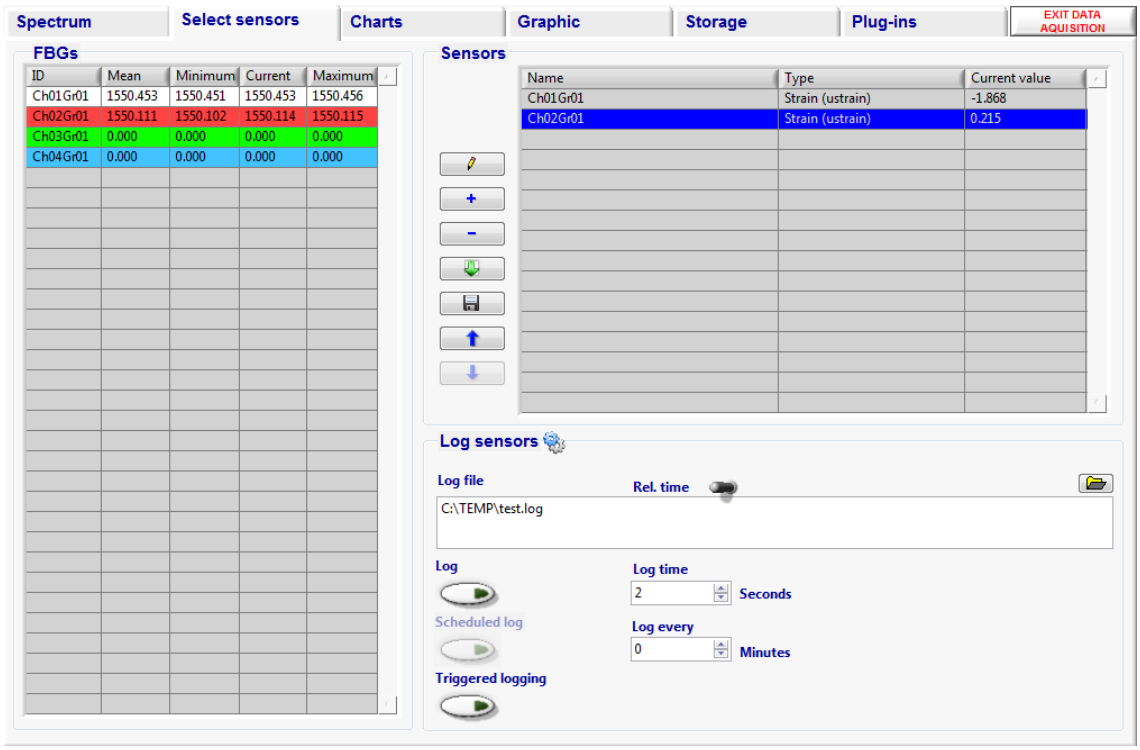


Figure 16 - Enhanced Acquisition - Select Sensors Tab

The Select Sensors tab has two tables. The left hand table displays all available FBGs, the number being determined during the Instrument Set Up by the Sensors per Channel setting and the number of gain slots. If there are more FBG Peaks on the Spectrum tab than available FBGs in the table then revisit the Instrument Set Up and either add more Gain Slots or increase the Sensors per channel setting. If a gain slot is set up without an FBG reflection within it, a sensor wavelength of zero is returned in the table.

The FBG table displays all the FBGs on channel 1 in descending wavelength order followed by those on channel 2 and so on. The channels are colour coded for ease of identification. For each FBG there are columns for its current wavelength as well as average, minimum and maximum.

The right hand table displays the selected Sensors; this table will be empty to start with. Sensors are added to the table using the + button or by right clicking on a grating in the FBG table. This brings up the add sensor dialogue box.

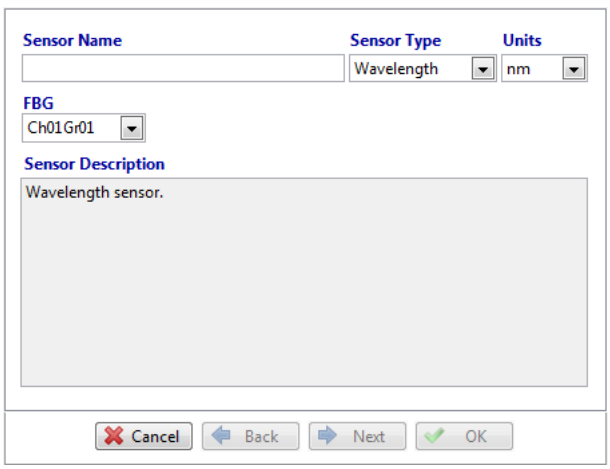


Figure 17 - Sensor dialog box - Sensor page

The user can select one of the FBGs from a drop down list of all available FBGs. The user may now give the sensor a meaningful name and change the measurement units. In the case of a wavelength sensor (as shown above), there is only one page to fill out and once a sensor name has been entered the OK button will become active.

For measurements other than Wavelength the user must enter a number of parameters so that SmartSoft can make the conversion. The next button will become active allowing the definition of multiple gratings, sensors and coefficients as determined by the sensor type. Selecting a strain sensor type and clicking next leads to the following dialog box page.

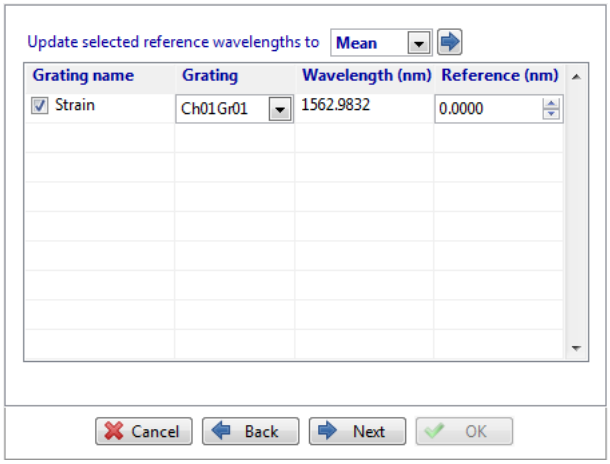


Figure 18 - Sensor dialog box - Gratings page

The reference wavelength is the wavelength against which the grating will be compared. For some sensor types, SmartSoft needs to measure a change in the wavelength of an FBG in order to convert to engineering units such as strain, temperature and pressure. The reference wavelength may be supplied by the sensor manufacturer or it can be entered by selecting one or more gratings, choosing the mean, minimum, maximum or current value in the reference wavelength selection box and pressing the blue arrow button to update al selected gratings. It may be necessary to set the type to wavelength and then log and analyse some data in order to determine the required reference wavelength. The grating selection page will not be available if the sensor type selected does not require it.

Press next to advance to the next dialog box page.

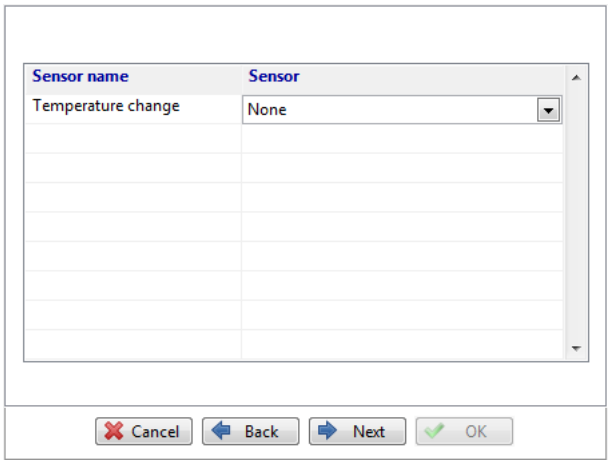


Figure 19 - Sensor dialog box - Sensors page

A sensor can use the values of other, previously defined sensors. In the case of a strain sensor, a temperature sensor can be selected to perform temperature compensation. Temperature sensors must be defined before they are available for use. Notice that the sensor name refers to temperature change. The temperature sensor must be configured to show relative rather than absolute temperature (i.e. relative to the temperature at the reference wavelength).

The types of sensors available to choose from is determined by the sensor type selected. The sensor selection page will not be available if the sensor type selected does not require it.

Press next to advance to the next dialog box page

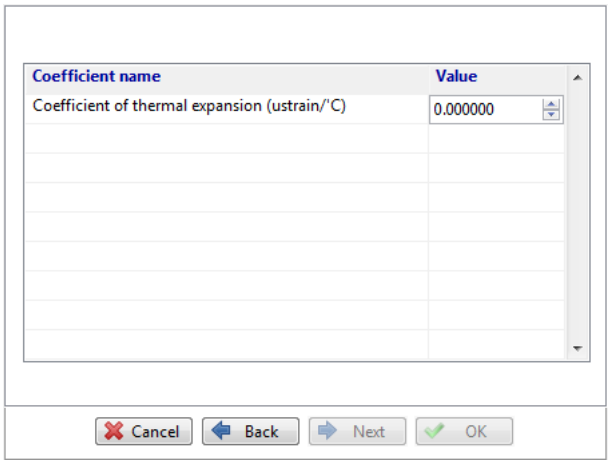


Figure 20 - Sensor dialog box - Coefficients page

If the sensor requires constant coefficients, enter them here. They should be provided with the sensor.

The type of conversion coefficients requested by the sensor set-up dialogue box is determined by the sensor type selected. The coefficient selection page will not be available if the sensor type selected does not require it.

If all required information has been entered the “OK” button should become active. Press “OK” to save the sensor. Press cancel at any time to exit the dialog box.

When the sensor dialogue box is closed the new sensor will now appear in the sensor table.

Further FBGs can then be selected to add more sensors to the table and the Sensor order can be adjusted using the “UP” and “DOWN” buttons. Sensor parameters can be amended using the “EDIT” button.

When the sensor table is complete, press the “SAVE” button so that the sensor parameters can be re-loaded during future acquisition sessions. Multiple sensor selections can be saved with different file-names. SmartSoft loads the last used sensor set-up when starting the enhanced acquisition panel. If gratings have been removed or changed, you can change the sensor set-up with the “DELETE” and “EDIT” buttons.

The logging feature on this tab can be used to save all the sensors present in the Sensor table. Sensors will be logged at the Data Processing Rate displayed at the top of the screen.

Set the target location and name of the log file by typing it in the box, or by clicking the folder icon. Then set the duration of the logging period (log time) and then press the log button. The button lights up and the

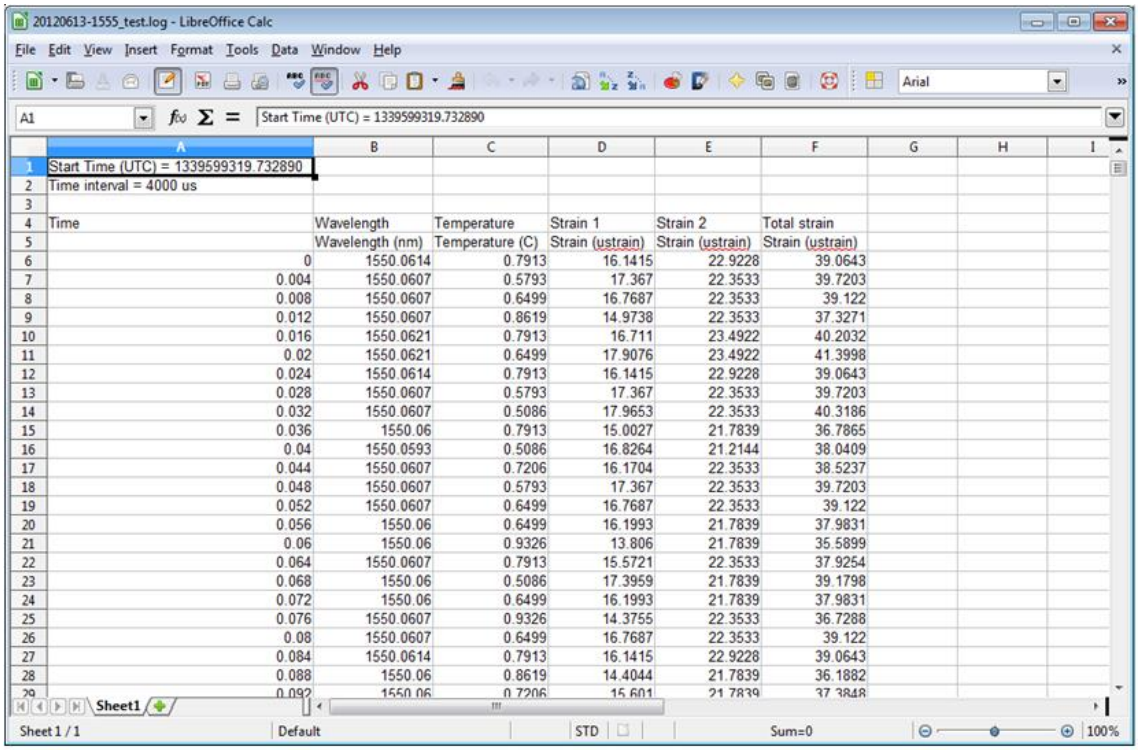
elapsed time will be indicated by a progress bar and a numeric indicator. The recording will automatically stop when the log time is reached or the user may stop the recording by pressing the log button again.

The number of lines per log file and the time/date format to append or prepend to the file-name may be set by clicking the icon next to the “Log sensors” heading.

A log file can be scheduled to take place at regular intervals. The file name will be appended with a date/time string of the format “YYYYMMDD-HHMM_” where YYYY is the year, MM is the month, DD is the day, HH is the hour of day and MM is the minutes in the hour.

Data are saved in tab separated format suitable for opening with common spreadsheet applications such as Microsoft Excel and OpenOffice Calc.

The Start Time is given in standard UTC format, which is the number of seconds since 00:00 on 1st January 1970.



	A	B	C	D	E	F
1	Start Time (UTC) = 1339599319.732890					
2	Time interval = 4000 us					
3						
4	Time	Wavelength	Temperature	Strain 1	Strain 2	Total strain
5		Wavelength (nm)	Temperature (C)	Strain (ustrain)	Strain (ustrain)	Strain (ustrain)
6	0	1550.0614	0.7913	16.1415	22.9228	39.0643
7	0.004	1550.0607	0.5793	17.367	22.3533	39.7203
8	0.008	1550.0607	0.6499	16.7687	22.3533	39.122
9	0.012	1550.0607	0.8619	14.9738	22.3533	37.3271
10	0.016	1550.0621	0.7913	16.711	23.4922	40.2032
11	0.02	1550.0621	0.6499	17.9076	23.4922	41.3998
12	0.024	1550.0614	0.7913	16.1415	22.9228	39.0643
13	0.028	1550.0607	0.5793	17.367	22.3533	39.7203
14	0.032	1550.0607	0.5086	17.9653	22.3533	40.3186
15	0.036	1550.06	0.7913	15.0027	21.7839	36.7865
16	0.04	1550.0593	0.5086	16.8264	21.2144	38.0409
17	0.044	1550.0607	0.7206	16.1704	22.3533	38.5237
18	0.048	1550.0607	0.5793	17.367	22.3533	39.7203
19	0.052	1550.0607	0.6499	16.7687	22.3533	39.122
20	0.056	1550.06	0.6499	16.1993	21.7839	37.9831
21	0.06	1550.06	0.9326	13.806	21.7839	35.5899
22	0.064	1550.0607	0.7913	15.5721	22.3533	37.9254
23	0.068	1550.06	0.5086	17.3959	21.7839	39.1798
24	0.072	1550.06	0.6499	16.1993	21.7839	37.9831
25	0.076	1550.0607	0.9326	14.3755	22.3533	36.7288
26	0.08	1550.0607	0.6499	16.7687	22.3533	39.122
27	0.084	1550.0614	0.7913	16.1415	22.9228	39.0643
28	0.088	1550.06	0.8619	14.4044	21.7839	36.1882
29	0.092	1550.06	0.7206	15.601	21.7839	37.3848

Figure 21 - Example log file

Enhanced acquisition - charts tab

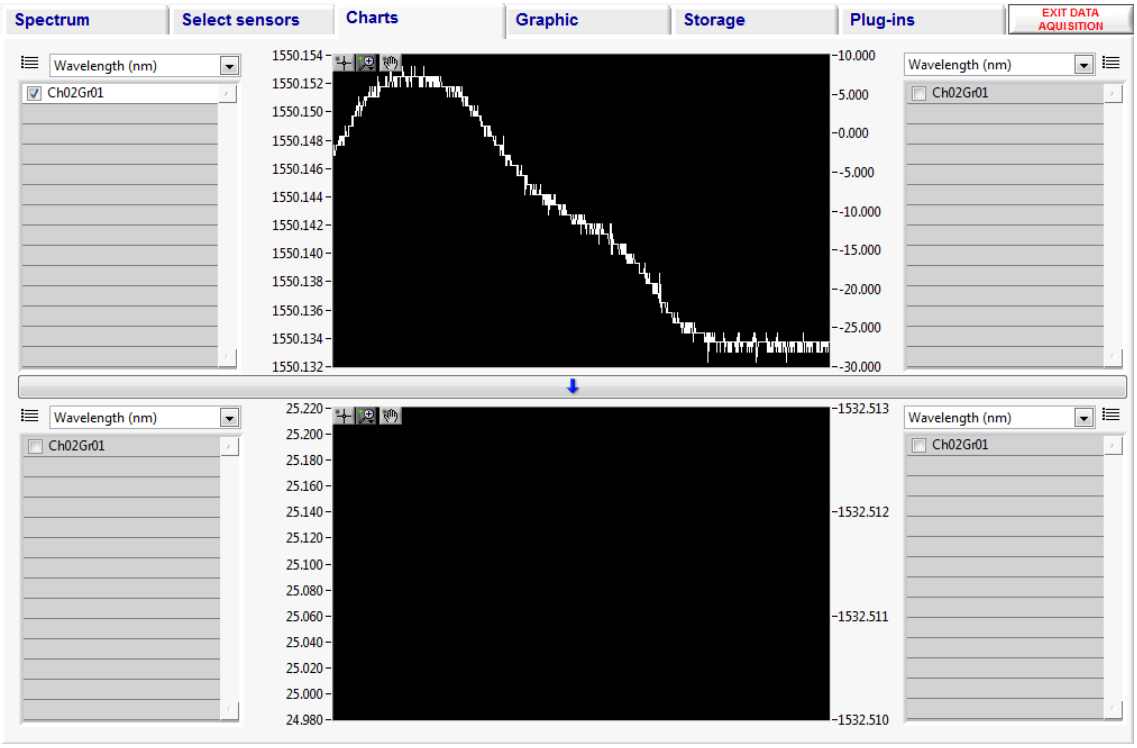


Figure 22 - Enhanced acquisition – Charts tab

By default two charts are shown, each with dual y-axes. All the Sensors present in the Sensor table are available for adding to the charts, this is achieved by selecting the tick box next to each sensor.

The left and right y-axes of each chart can be set to different measurement units. The chart can be expanded by hiding one of the y-axes using the appropriate “X” button. The entire lower chart can also be hidden by pressing the “V” button, whereby the upper chart expands to fill the whole tab.

The y-axes of the charts auto-scale by default but by right clicking on the charts the user may disable auto-scaling and may then edit the maximum and minimum y-axis limits to display the desired amplitude range.

An image of the chart can be exported to the clipboard or saved to a file by right clicking on the graph and selecting “Export simplified image...”.

Enhanced acquisition - graphic tab

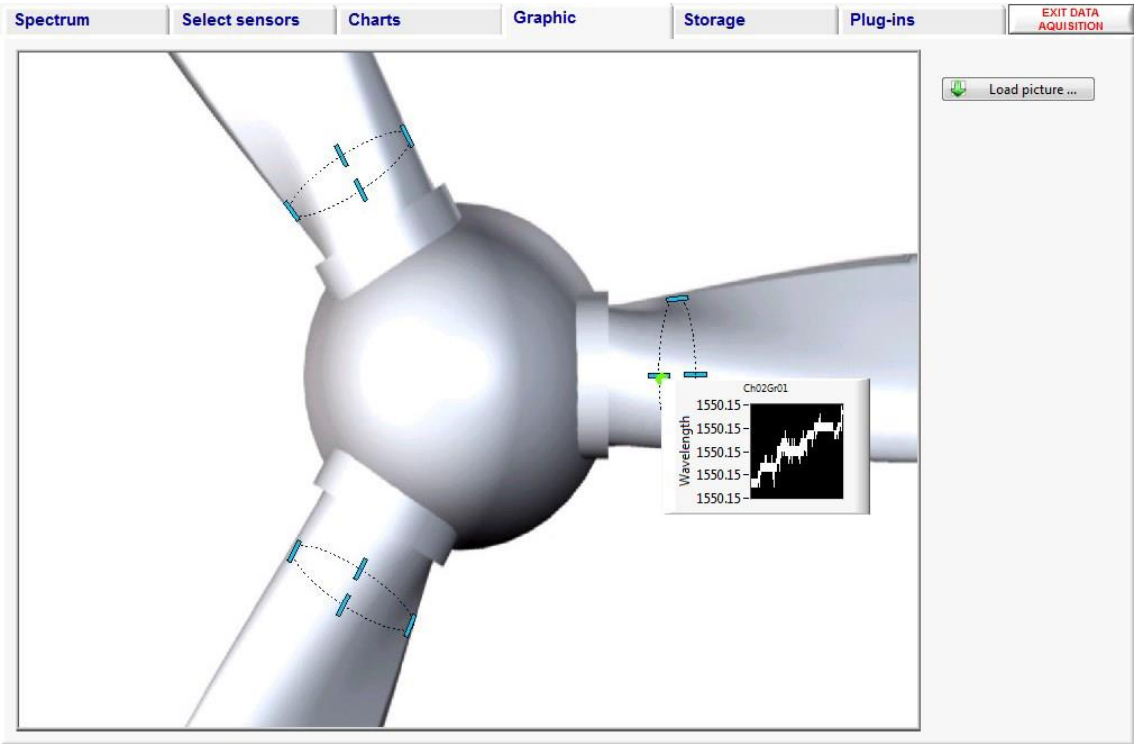


Figure 23 - Enhanced acquisition - Graphic tab

On the graphic tab the user may load a photograph or diagram of the structure being monitored. The file must be in JPG format and 800 x 600 pixels. Some example pictures are installed with the application and are located in the common application data directory e.g. “C:\Documents and Settings\All Users\Application Data\Smart Fibres\SmartSoft SSI\Graphics”. The location of the common application data folder is dependent on your version of Windows, the example shown is for Windows XP.

By right clicking on the graphic the user may add sensors from the sensor table and display their current values in numeric or mini-graph form. By right clicking on an existing sensor it may be deleted or modified in type.

Enhanced acquisition – storage tab (models with USB functionality enabled only)

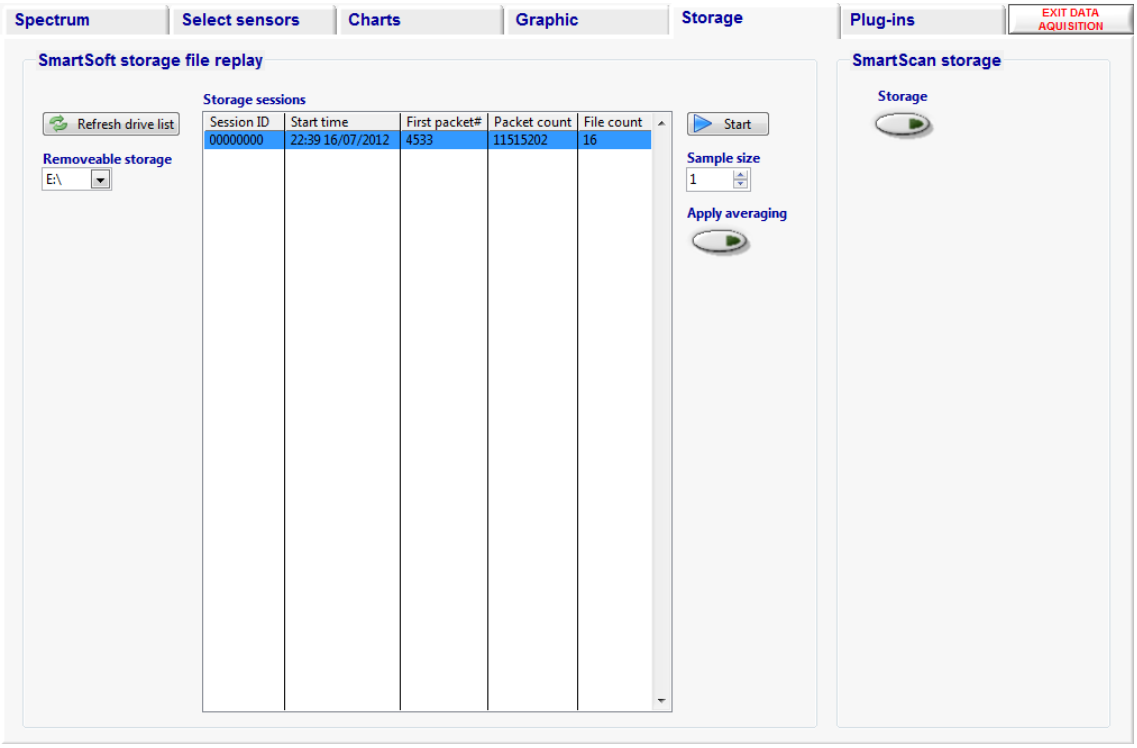


Figure 24 - Enhanced acquisition - storage tab

The storage tab is used to replay storage sessions from a USB storage device or to start and stop storage sessions on a connected instrument.

For further information about how to store data from the SmartScan to a USB device, refer to Appendix C, section Storage

When replaying storage sessions it is not necessary to be connected to a SmartScan interrogator. Cancel the connection dialogue box and open the enhanced acquisition panel.

Warning Wait at least 10 seconds after the storage session has ended before removing the USB storage device from SmartScan or data may be corrupted or lost

Storage file replay

Select the path of the storage file. If the storage file is on a USB device, first connect the USB drive to the computer, wait for the operating system to recognise the device and click “Refresh drive list”. The “Removable storage” drop down box will be updated with the currently detected removable storage devices. Select the appropriate device from the list and the “Storage sessions” list-box will show the detected storage sessions on the drive. There is also a “Storage path...” option in which allows the selection of a folder on the local file-system.

Warning USB log files from different USB storage devices should not be copied into the same local folder. Create a separate folder for each USB drive.

Select a storage session and click “Start” to begin replaying the session through SmartSoft's data processing system instead of live data from a connected interrogator. The data will be sub-sampled by either averaging the number of samples selected in the “sample size” control or decimating them depending on the state of the “apply averaging” control.

The storage data can be converted to engineering units, logged to file and displayed on charts and graphics in the same manner as for live data.

If SmartSoft is connected to an interrogator, the top line of the “Storage sessions” list-box will read “live”. Select “live” and click “Start” to return to live data acquisition from the connected interrogator.

When the “Start” button is pressed a floating control box will pop up to allow the user to pause the replay, change the replay speed and stop the replay while using any of the other enhanced acquisition panel tabs. At speed 5 the data will be processed at the highest speed the computer can handle. At lower speeds, time delays are introduced to enable data to be viewed on graphs or to prevent SmartSoft from monopolising the computer's processor.

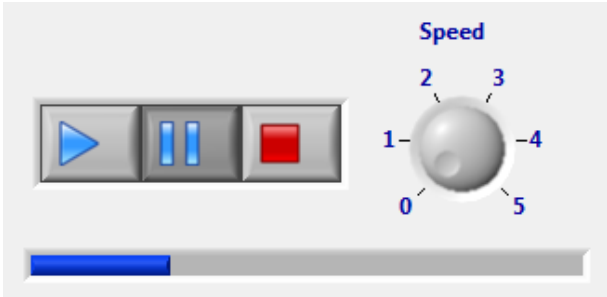


Figure 25 - Storage file playback controls

SmartScan storage

The storage button will display the current state of the connected interrogator's storage system. It can also be used to start or stop storing data on the connected interrogator. The storage button will be disabled and greyed out if storage is not possible.

The logging LED on the interrogator displays the current state of the storage system.

OFF	Storage system ready
RED	No storage device attached
GREEN	Storage session in progress

Enhanced acquisition – plug-ins tab

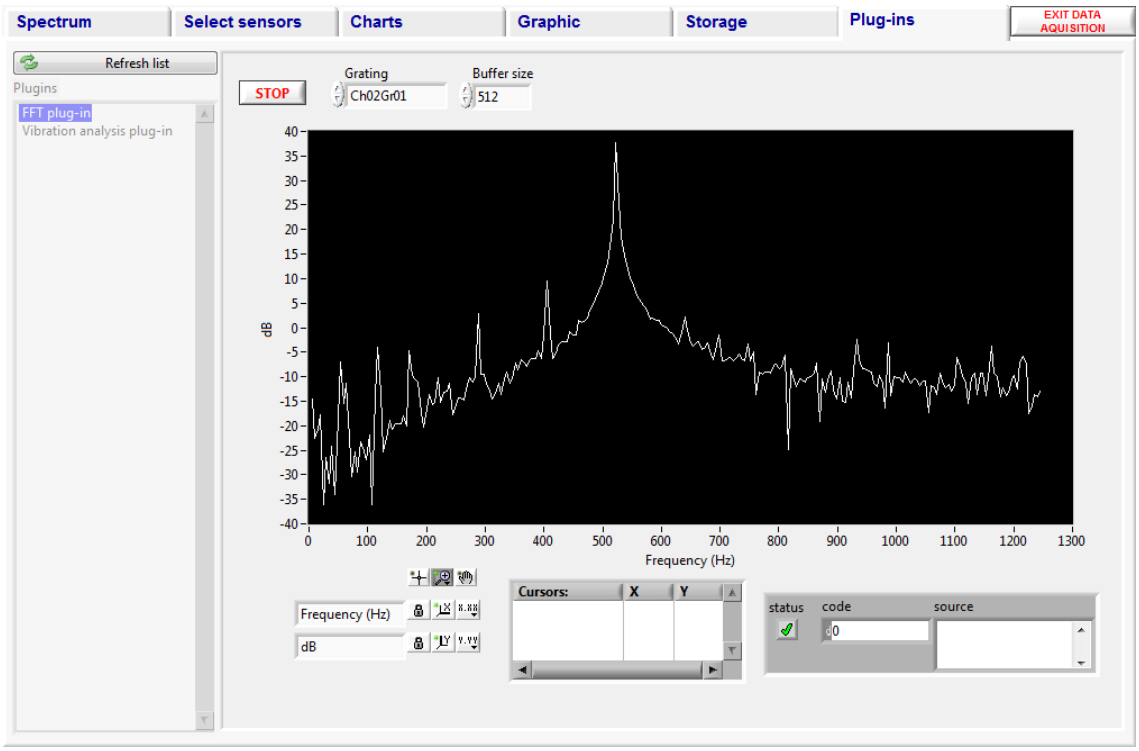


Figure 26 - Enhanced acquisition - Plug-ins tab

The plug-ins tab is used for running LabVIEW source code, these can be written by the end user to increase and customise the functionality of the SmartSoft user interface. SmartSoft may be supplied with a variety of plug-ins, including one for performing FFT analysis on a selected grating. Here, a Fast Fourier Transform (FFT) of live wavelength data can be viewed allowing the user to observe the frequency content of signals. Each FBG can be viewed on the graph using the "FFT Grating" drop-down menu. By selecting the Magnifying glass icon the user may zoom in to view a particular area of the frequency spectrum, select the cross-hair icon zoom out again. The frequency scale on the x-axis will be determined by the Acquisition frequency. FFT theory dictates that the frequency scale will be half the sample frequency. The sample frequency is the transmission rate as set up during Instrument Set Up and can be viewed by hovering the mouse over the Data Processing value at the top of the screen.

SmartSoft searches for plug-ins in the "Plug-ins" folder under the SmartSoft installation folder. This will be C:\Program Files (x86)\Smart Fibres\SmartSoftSSIv3.2\Plug-ins if the default installation folder was used.

Details on how to write plug-ins can be obtained on request from Smart Fibres.

Enhanced acquisition - exit data acquisition

Press "Exit Data Acquisition" to leave this area of the application.

Appendix B - IP Address Settings of Host PC

The process is slightly different based on which version of Windows is being used.

Below are some examples

Windows 7

Click on the Start Bar and select Control Panel, select “Network and Sharing Centre”.

Select “Change adapter settings”, Right Click on the Local Area Connection and select “Properties”

Select “Internet Protocol Version 4” and click the “Properties” button. Select “Use the following IP address” and enter the desired IP address and Subnet Mask to suit SmartScan. Click OK to save settings.

Windows 10

Select Start, then select Settings > Network & Internet .
For an Ethernet network, select Ethernet , then select the Ethernet network you’re connected to.
Under IP assignment, select Edit.
Under Edit IP settings, select Automatic (DHCP) or Manual.
Under Edit IP settings, choose Manual, then turn on IPv4.
To specify an IP address, in the IP address, Subnet prefix length, and Gateway boxes, type Set your IP address settings and DNS server address.
When you’re done, select Save.

In each case, the network settings should look similar to those below

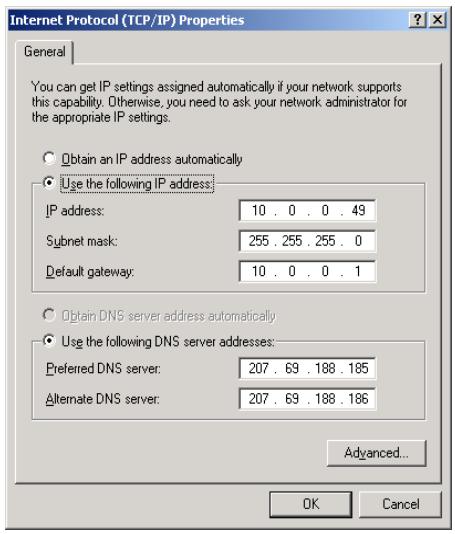


Figure 27 – example SmartScan network settings

After using SmartScan, to reconnect to a Local Area Network follow the same process and select “Obtain an IP address automatically”.

Appendix C – SmartScan HTTP Interface and On-Board Storage
(Applicable to Models with USB Storage only)

Whilst the user can use SmartSoft for SmartScan (Appendix A) for configuration and data display, it can be useful to make use of an auxiliary interface that is available via a web browser using the http protocol. This Appendix describes the operation of this http interface.

One such feature that is managed by this http interface is the recording of data to a USB storage device, available as an option on certain SmartScan models.

All the pages displayed via the http interface are briefly described with more detailed instructions on using the Storage features. The final section describes how to transfer the storage files from the interrogator to a host PC where they may be played back or post-processed.

http interface

The existing interface is implemented as pages on a webserver that is hosted on the interrogator as part of the Linux operating system. Pages are coded using html. The user just needs a PC with a web browser to access the pages.

The interrogator must be connected via LAN to the host PC, details of this can be found in the SmartSoft for SmartScan user guide (Appendix A).

Once the interrogator is connected via LAN simply open a web browser and enter the interrogator's IP address as the URL.

On all pages with user configurable parameters, changes are made by overwritting the existing settings and then pressing a submit button.

Home Page

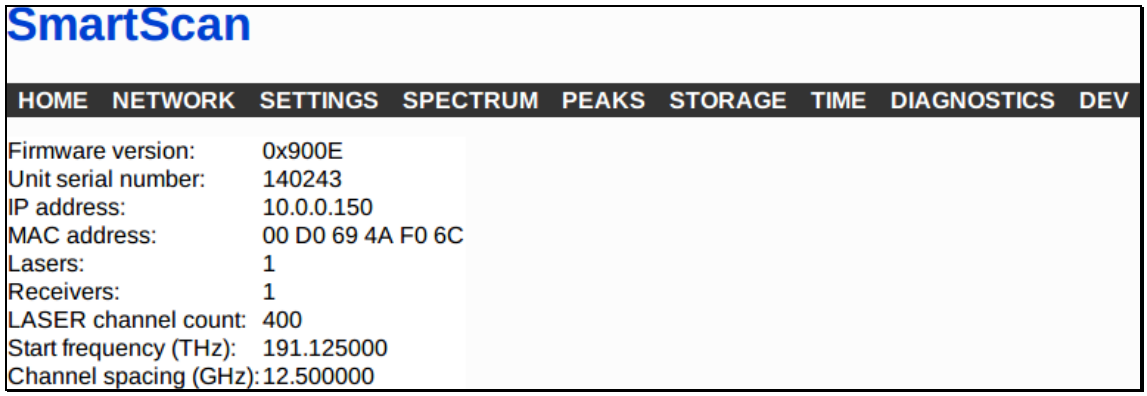


Figure 28 - http interface / home page

Some basic identity information is displayed here, there are no user configurable fields.

Network

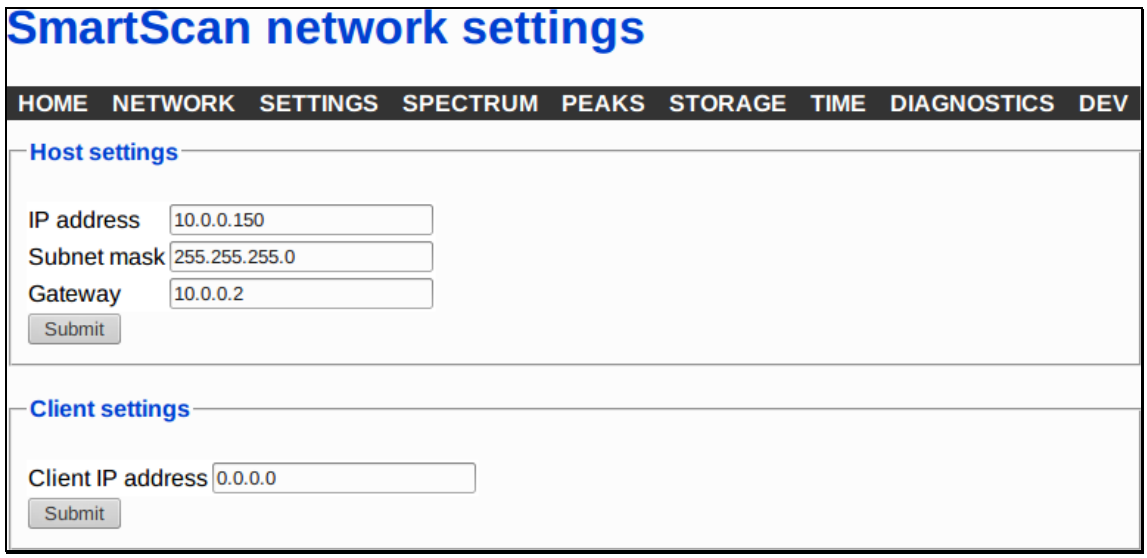


Figure 29 - http interface / network page

The user may view and change the IP settings on this page. Care should be taken to avoid losing track of the IP settings of the interrogator which might result in not being able to communicate with the instrument. There are further details of IP address settings in the SmartSoft User manual under the section “Preparing for Use” and in the Appendices.

Settings

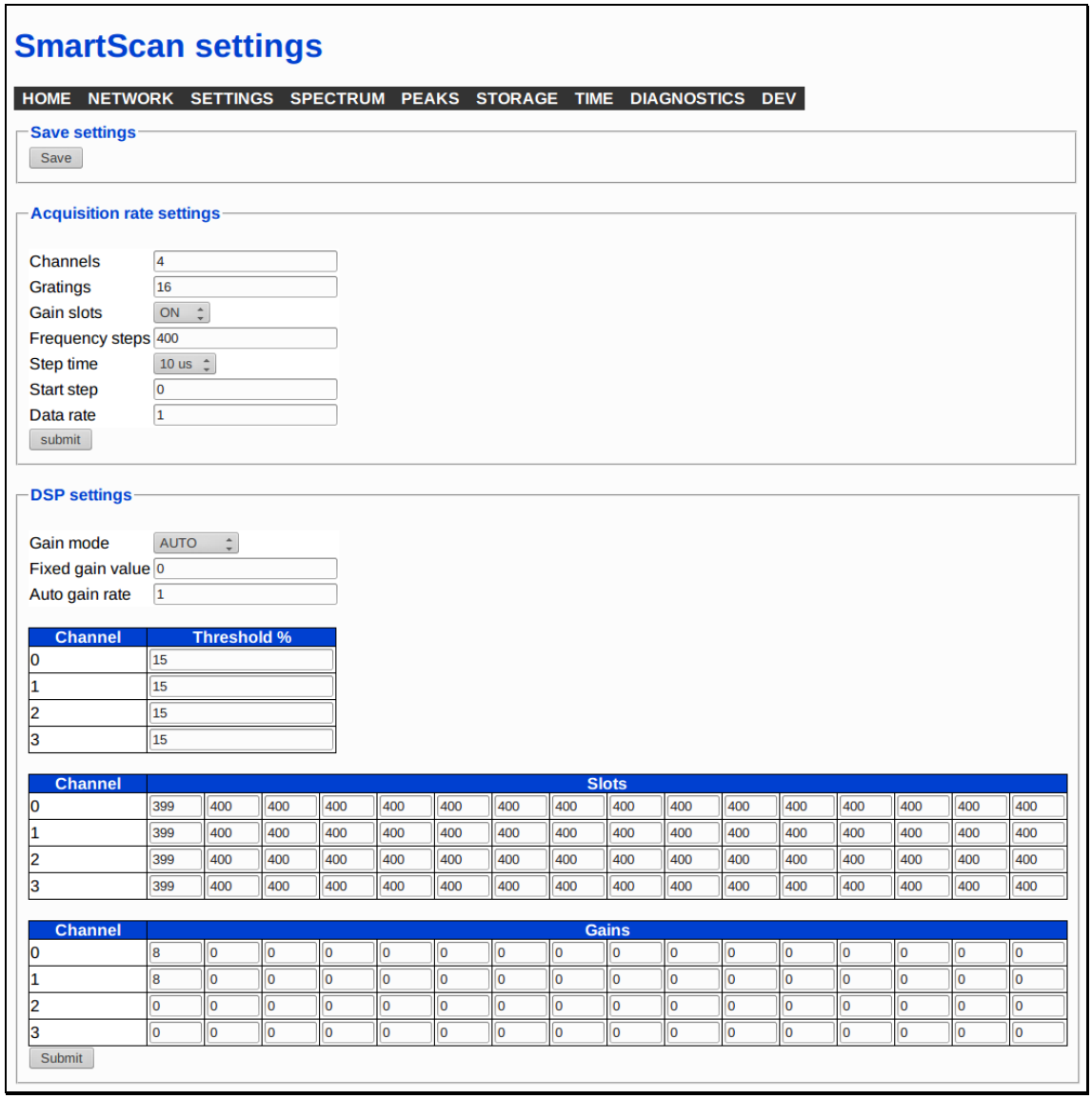


Figure 30 - http interface / settings page

This page contains most of the settings that one would find in the Set-up screens of SmartSoft. Although wavelength related settings are entered in units of “Laser tuning steps” these are integers usually with a value between 0 and 399 representing the wavelength range 1568.7 to 1528.7 . It is recommended to use the SmartSoft interface when changing these parameters.

Spectrum

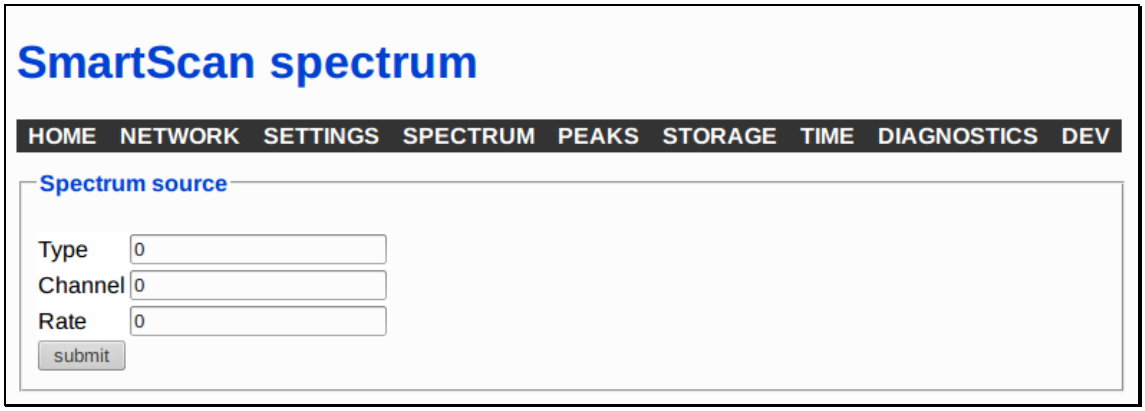


Figure 31 - http interface / spectrum page

This is a rather simple page where the user can set the source of the data contained in the spectrum UDP message, this message is sent to SmartSoft and displayed in the form of an X-Y graph. The data that forms this graph is listed in table form. Optical channels are number 0 to 3 rather than 1 to 4.

Time

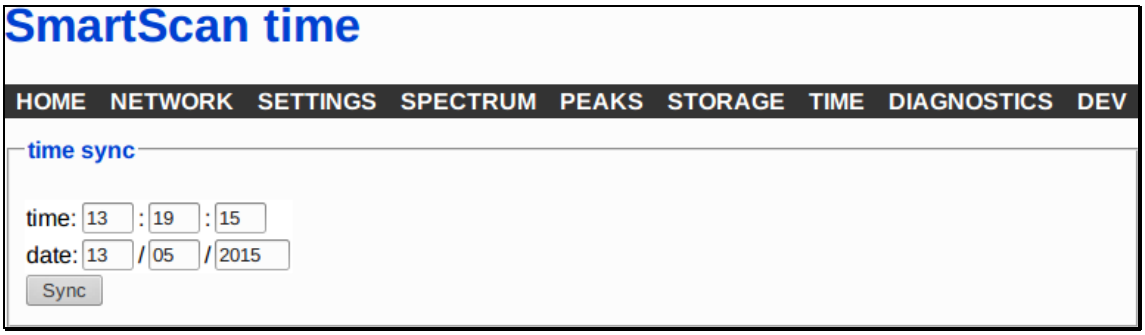


Figure 32 - http interface / time page

A page where the user may set the time used by the interrogator's internal clock. The user should type in the current date and time and then press the "Sync" button to upload this to the interrogator's internal clock.

Note, SmartScan interrgoators do not have a battery backed clock so the time setting will be lost when the interrogator is powered down.

Diagnostics

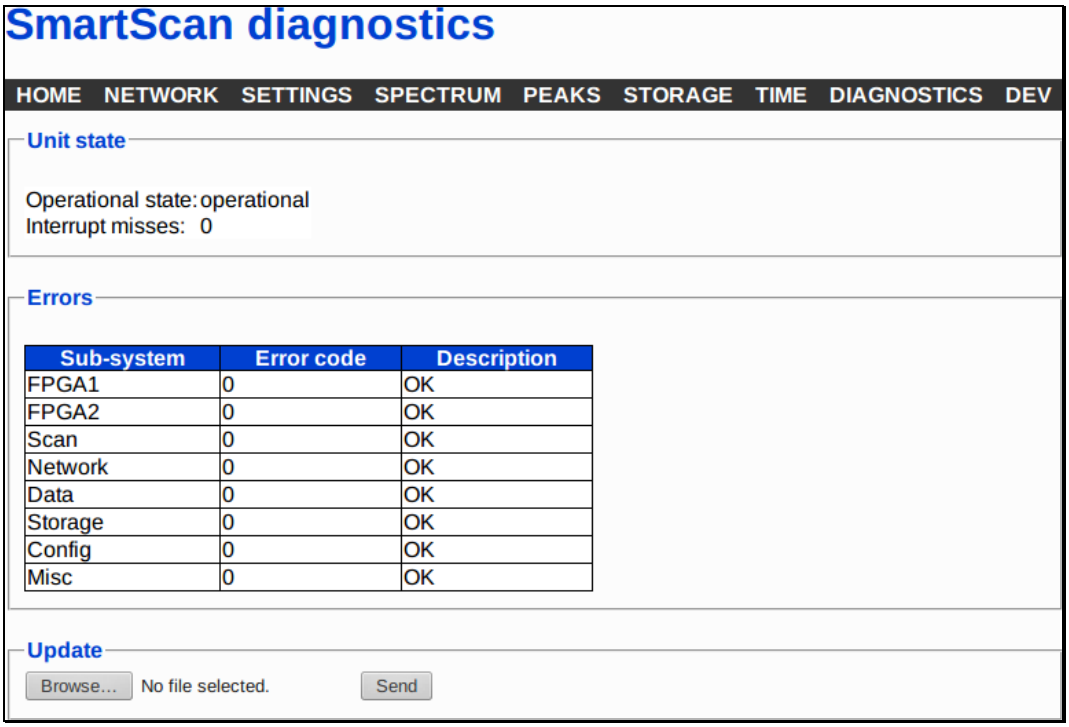


Figure 33 - http interface / diagnostics page

This page dispays status information and error codes should a problem occur.

The Update section allows the user to upgrade the embedded firmware using a script file that would be supplied by Smart Fibres.

Storage

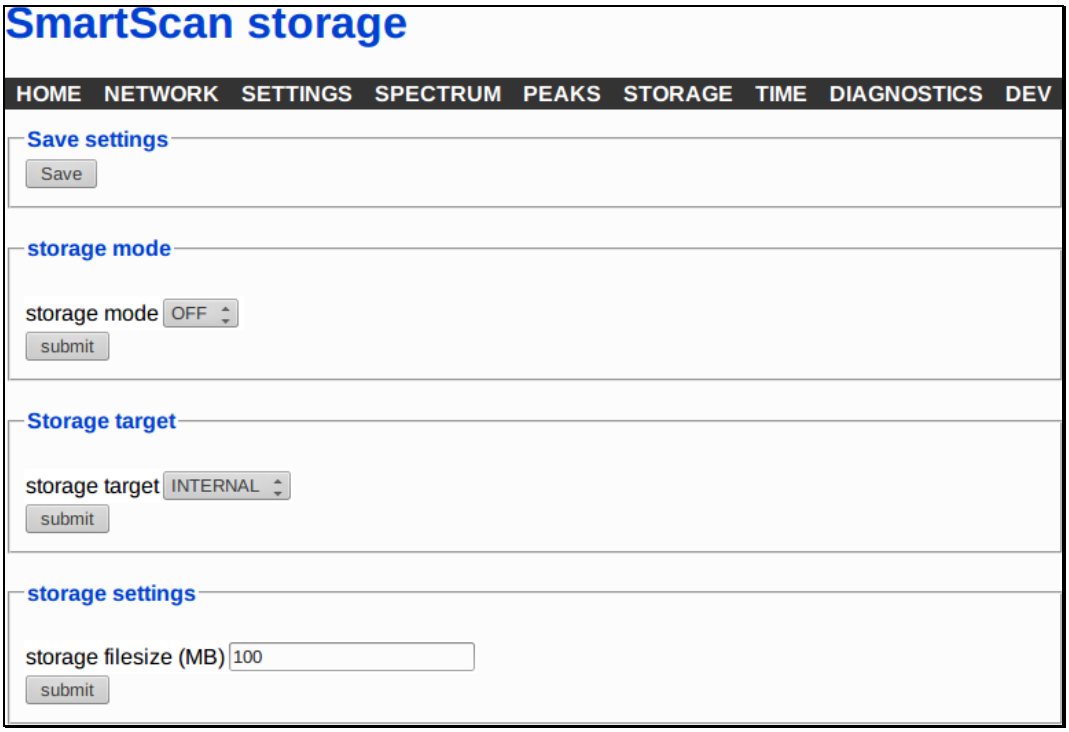


Figure 34 - http interface / storage page

Storage Mode
The storage mode will be “OFF” and greyed out unless a USB storage device is plugged into SmartScan. When a USB storage device is plugged in the Storge Target will show this and a message will confirm the device has been mounted to the interrogator’s file system.

Changing the mode from “ON” to “OFF” stops the current storage session. Changing from “OFF” to “ON” starts another on-board storage session, the peak wavelengths of any FBGs attached to the instrument are written to file with timestamps on the selected storage target. When on-board storage is active there is an LED indication on the front panel of the interrogator. (Note SBI does not have this LED fitted).

The default storage mode is “ON” if the selected storage target exists and has space available, which means the interrogator will automatically start on-board storage whenever it is powered. This means the interrogator can operate independently of any host PC and store data for later retrieval.

Storage target
The user may select between “INTERNAL”, “EXTERNAL” or “NONE”. Press the “Save” button to store changes. Currently SmartScan-USB and SmartScan Aero have only front panel USB receptacles for connecting external storage devices, whilst SmartScan Aero Mini has only internal storage in the form of a compact flash card. SmartScan SBI+PM can have both internal and external storage.

If the selected storage target is full or not present then no storage will take place and an error message “No storage media or no space on mounted media” will be reported on this page. If the selected media device is full the user must delete storage sessions before further storage can take place.

Setting the storage target to “NONE” prevents the interrogator from automatically starting an on-board storage session at power on. This is the only way to prevent automatic storage at power on.

Storage Filesize
The nature of Flash storage is that the current file that is being written to can be corrupted if power is lost or if the storage media is removed without first unmounting the device from the operating system. SmartScan stores data in a series of files that are automatically created in sequence, thus if power is lost or the device removed there is a good chance that only the currently open file is at risk of being corrupted. 1 MB is the minimum file size that can be configured, equivalent to a few seconds of data with a typical set up of 32 FBGs acquired at 2500 Hz. The user may set the file size, keeping the amount data at risk of corruption to a minimum whilst keeping the file size convenient for data processing. 100 MB is recommended , this is equivalent to around 10 minutes of data with a typical set up.
Press the ‘Save’ button to store changes when interrogator is powered off.

Save Settings
Press ‘Save’ to store changes to the settings on this page so that the configuration is saved when the interrogator is powered off.

Storage > Media

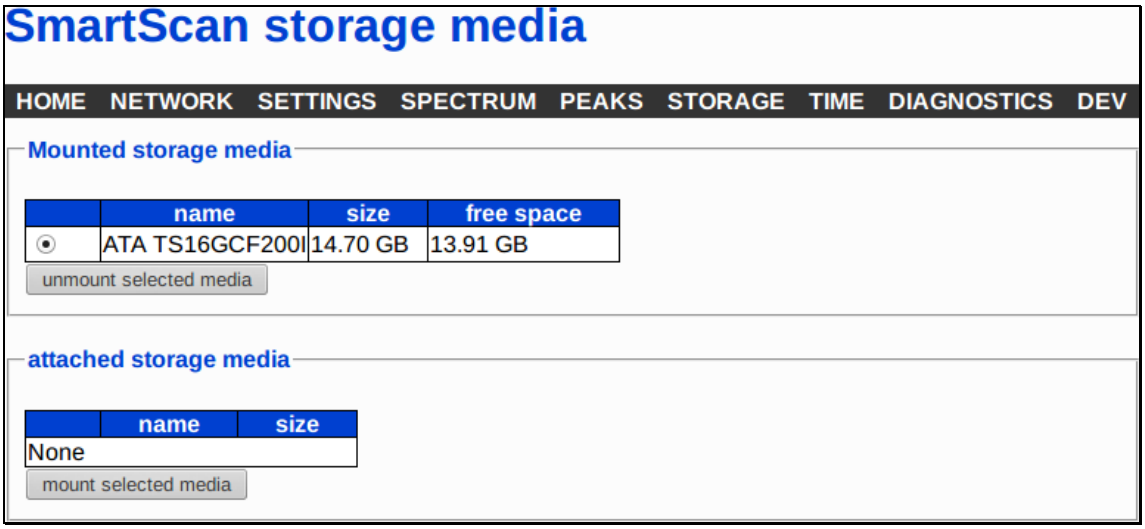


Figure 35 - http interface / storage media page

Any storage device that has been mounted and recognised by the operating system will be displayed here.

Storage > Sessions

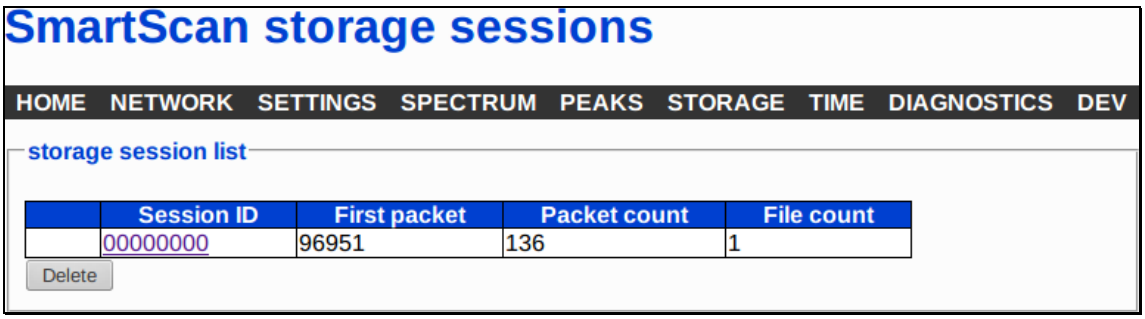


Figure 36 - http interface / storage sessions page

This page displays the current storage sessions saved on the storage media, each has a session ID number. A new session is a started each time Storage is switched on, either by setting the Storage mode via the http interface or using the “Start” control from SmartSoft or if the storage target was not set to “NONE” and the interrogator has been switched on. The session will end when storage is stopped via http or SmartSoft or when the storage device is full. There could be one or many files in the session depending on the data length specified and the duration of the storage session.

Storage sessions can be deleted from the media by selecting session IDs for deletion and pressing Delete.

Transferring data from On-board Storage to PC

There are two ways to get the data off the interrogator depending on the type of storage media used.
For either method first ensure that no storage session is still in progress to avoid the risk of corrupting data.

If the media is external simply remove the USB device from the interrogator and plug it into the USB port on the host PC.

If the media is internal data simply click on the Session ID - one or more files may be present, each will have a .ssf filename. Right click on each filename and select “Save Target As” and browse to a folder on the host PC. Note Windows will automatically rename the file “.txt”, the files must be renamed as .ssf files again in order to be recognised by SmartSoft for playback.

An alternative method for transferring larger quantities of files is to use a third party file manager software. One such program is described in the next section. The files reside in the directory /var/tmp/ssi_storage/ssi on the interrogator’s file system. In due course a file transfer facility will be integrated into SmartSoft.

In either case, the most convenient way to view and post process the storage files is to use the playback facility in SmartSoft, see SmartSoft user guide for details.

File Transfer using WinSCP

A facility for transferring storage files between interrogator and host PC has yet to be integrated into SmartSoft. For the time being third party file manager software can be used. One such application is WinSCP.
WinSCP is available as a free download from http://winscp.net/download/winscp573setup.exe

Some instructions on using this particular application are detailed in the remainder of this chapter.

Install the WinSCP program

Follow the on-screen installation instructions.
When requested select “Typical” Installation and choose the “Commander” style.

Run WinSCP

Use the settings shown below,
File Protocol = SCP
Host name = the IP address of the interrogator, the default IP address is shown below
Port number = 22
User name = root
Password = *[leave blank]*

You can optionally save these settings for later use by pressing the Save button,

To open the connection press “Login”

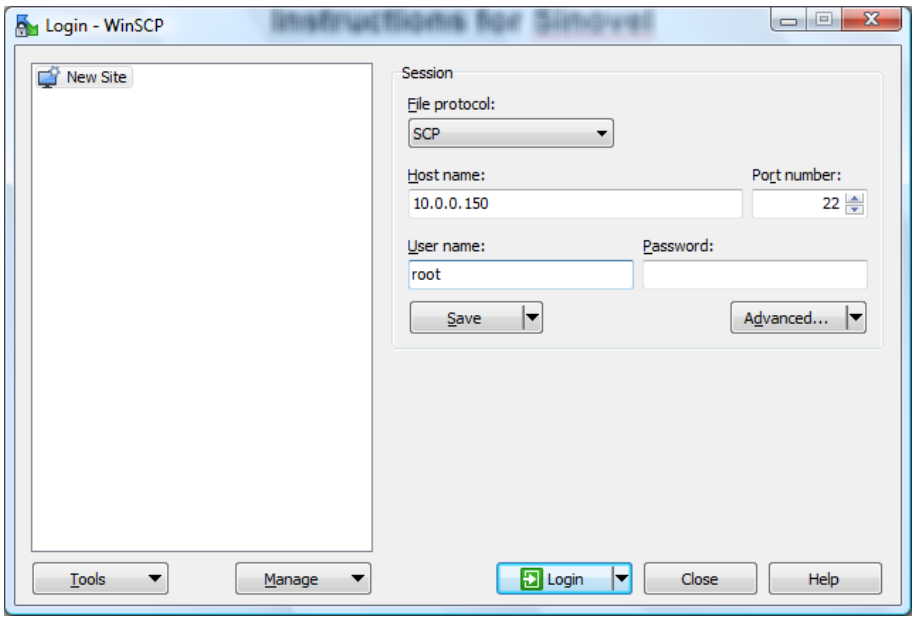


Figure 37 - WinSCP login page

If a password is requested, leave it blank and continue.

You may see an error like:

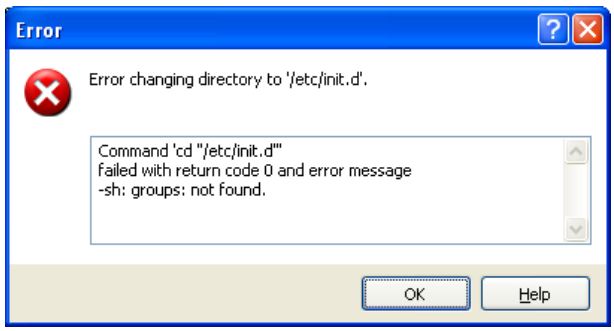


Figure 38 - WinSCP error message

Just click “OK”. You can prevent this in future by disabling “lookup user groups” in the advanced site settings and saving the site details.

WinSCP should now open

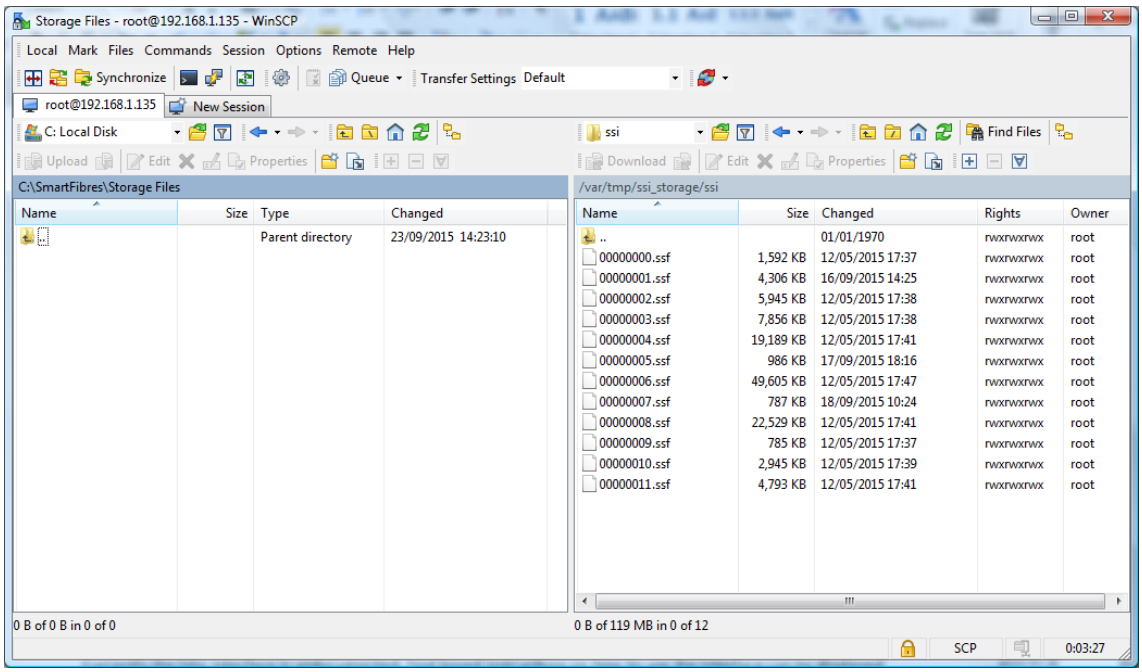


Figure 39 - WinSCP main page

The left hand pane shows the file system on the host PC and the right pane shows the file system on the interrogator.
On the left side select a folder where you want to transfer the storage files to. On the right side navigate to **/VAR/TMP/SSI_STORAGE/SSI** . The '..' folder allows you to navigate up to the parent folder. In the folder you should see any storage sessions listed with a .ssf file extension.

Right click any files you want to transfer and select 'download', they will now be copied to the selected folder on the host PC.

When using SmartSoft file replay you can select this folder as the "Storage Path" and the same storage sessions will then be listed for playback.

Appendix D - Optical Connector Cleaning

The use of optical fibre connectors requires some care if good results are to be obtained. The core of the fibre is very small, typically 8 to 9 micrometres in diameter and even the smallest dust particles, lint fibres or smears of oil can obscure it and cause optical losses. Scratches and chips in the highly-polished end face of the fibre also result in poor quality, unreliable connections. Therefore, it is important to develop good habits for handling and cleaning connectors. Ideally, both sides of a connection should be inspected and cleaned before mating.

Connector tips can easily be damaged by hitting a hard surface. This can be avoided by always keeping the plastic cover in place when not using or cleaning the connector.

A brief guide to good practise is given here. The interested reader will find further information from Industry bodies. There are also some useful proprietary standards in the public domain, for example:

- AT&T: document ID ATT-TP-76461
- Cisco: document ID 51834
- JDSU: document ID IBYC – Fiber Inspection, Cleaning & Test

Note: These documents are identified for information only. No connection between any of the named companies and Smart Fibres Ltd is intended or should be implied.

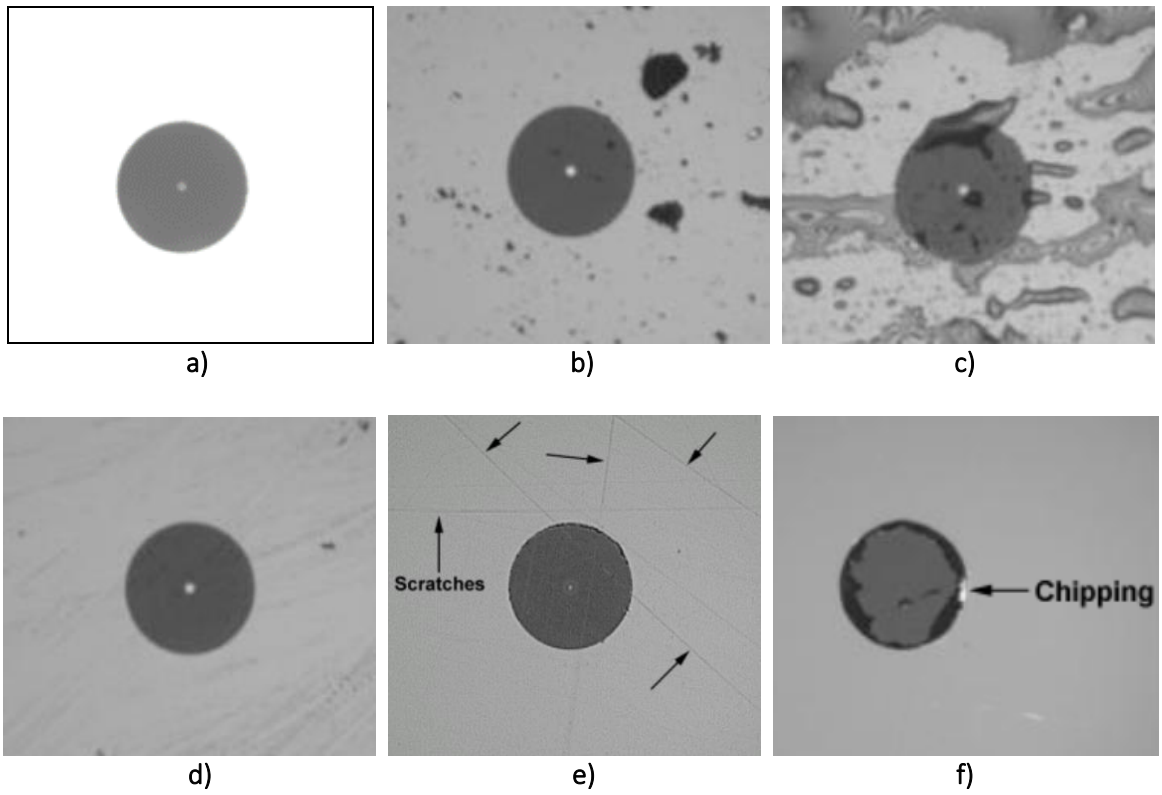
We understand that the first time user of a Smart Fibres product may not have all the correct equipment to hand but cleaning and inspection tools are relatively inexpensive and help to ensure continued correct operation of the interrogator. The regular user should make an effort to acquire them and learn how to use them effectively. The Interrogator is shipped with a Cletop-S Fibre optic connector cleaner, which facilitates dry cleaning (see sections 5.1.2 and 5.1.5).

Some or all of the operations described below may be required to ensure that the fibre-optic connection is free from contaminants. The order of operations is given in Section 0, ‘Cleaning Flowchart’.

Inspection

It is highly desirable to inspect the end-face of connector ferrules (the white ceramic part) before mating them, to ensure that they are clean and undamaged. If no inspection means is available, you may skip this stage and proceed to a dry cleaning step, but be aware of the risk of making lossy connections by mating ferrules that may be contaminated or scratched.

Remove the protective cap from the connector ferrule. Insert the connector into the fibre inspection microscope and examine the end face. If the connector is of an angle-polished type, it may be necessary to rotate it in order to see the end of the fibre clearly. Bulkhead connectors, such as those in the front face of a Smart Fibres interrogator, can only be inspected using a fibre video microscope with a suitable adapter. Typical views of a ferrule end-face are shown below:



a) Clean fibre end-face, ready for mating.
b) Dust particles on connector. Cleaning needed.
c) Liquid on connector. Cleaning needed.
d) Oily streaks on connector. Cleaning needed.
e) Connector is clean but has scratches. This is acceptable as there are no scratches on the fibre core. Ready for mating.
f) Fibre cladding is chipped. A small amount of chipping is acceptable but this connector should be replaced.

Dry cleaning

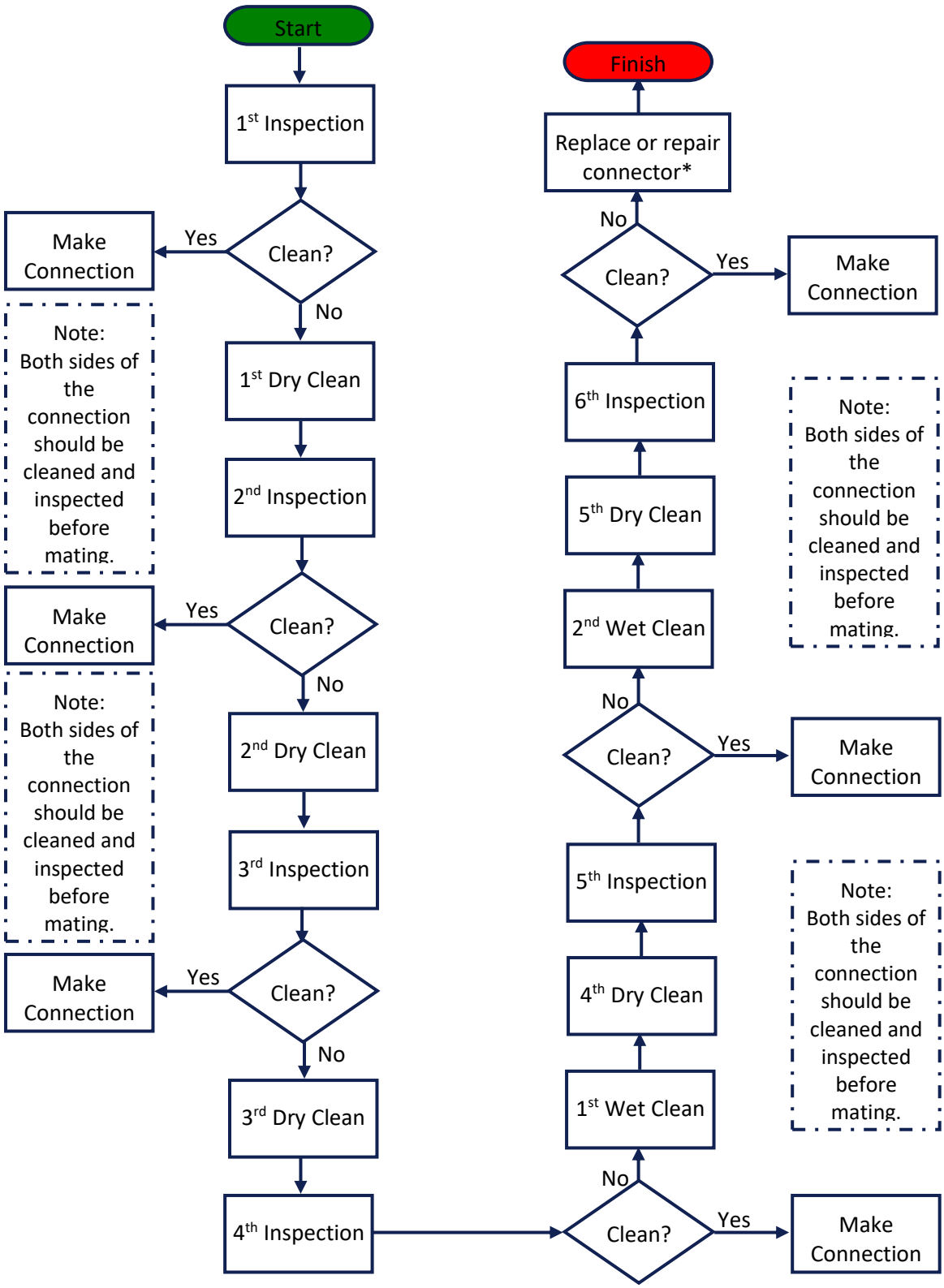
Dry cleaning involves wiping contaminants from the connector end-face using a clean, lint-free cloth. It is important to use fresh cleaning material for each wipe. Gentle but firm pressure is required, enough to depress slightly the spring-loaded ferrule. We recommend you use a 'CLETOP-S' type cleaner for free connectors and a 'One-Click' type cleaner for bulkhead or other recessed connectors.

Wet cleaning

If a contaminant resists removal by dry cleaning methods then wet cleaning may be needed. The process is similar but the cleaning material is either supplied pre-impregnated with solvent (as in some optical wipes) or a solvent is added just before use. The solvent must be of a high purity to avoid leaving a residue and a dry cleaning operation must follow immediately so that it does not have time to dry on the connector ferrule. Isopropyl alcohol is often used but there are also some good proprietary solvents.

Cleaning Flowchart

The flowchart below covers the process of cleaning and inspecting connectors before mating. It also shows the escalation of the cleaning method from dry cleaning to wet cleaning with solvents.



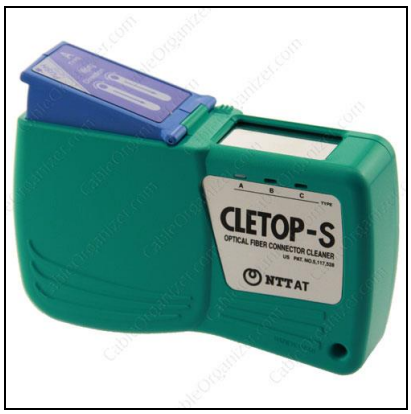
Cleaning tools

Fibre Inspection Microscope



Battery-powered microscope with 200x magnification. Requires different adapters for different connector types. Must never be used to examine 'live' fibres.

CLETOP-S Cassette cleaner



Highly effective method of cleaning a free connector ferrule. Contains a cassette of anti-static cleaning cloth. Pressing the blue lever exposes a fresh length of material. The end face of the connector is then gently wiped across the exposed cloth in the direction indicated on the tool. Not suitable for wet cleaning.

'One-click' Ferrule cleaner



Required for cleaning recessed ferrules but can also be used on free connectors. Automatically wipes the ferrule end-face when it is pushed into the connector receptacle. Can be impregnated with solvent for wet cleaning.

Appendix E – CE Compliance Information

Applicable Directives:

- Electromagnetic Compatibility 2014/30/EC
  [BS EN61326-1 *Electrical equipment for measurement, control and laboratory use. EMC requirements. 2013 edition]*
- Consumer Laser Safety 2014/59/EU
- Restriction of Hazardous Substances 2011/65/EU
- Low Voltage 2014/35/EU
- Waste Electronic and Electrical Equipment 2012/19/EU

Emissions Test	Standard	Level	Required Class	Achieved Class
Radiated Emissions	EN 55022	Industrial	B	B
Conducted Emissions	EN 55022	Industrial	B	B

EMC Emission Test Results

Immunity Test	Standard	Level	Required Criterion	Achieved Criterion
Electrostatic Discharge	EN 61000-4-2			
• Contact		±4 kV	B	B
• Air		±8 kV	B	A
• Indirect		±4 kV	B	A
Radiated RF	EN 61000-4-3	3 v/m	A	A
Fast Transients	EN 61000-4-4			
• DC power		±2 kV	B	A
• AC Power		±2 kV	B	A
• LAN		±1 kV	B	A
• CANbus		±1 kV	B	A
Surges (AC power)	EN 61000-4-5			
• Line to Earth		±2 kV	B	A
• Line to Line		±1 kV	B	A
Conducted RF	EN 61000-4-6	3 Vrms	A	A
Dips & Interruptions (AC Power)	EN 61000-4-11			
• 10ms		100 %	B	A
• 100 ms		60 %	B	A
• 500 ms		30 %	C	A
• 1000 ms		30 %	C	A
• 5000 ms		100 %	C	C

EMC Immunity Test Results

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