Advanced Energy

®

**® WaveCapture**

Sense 20/20 Software - FBGA

User Manual

June 2023   57010250-00AA

# COPYRIGHT

# DISCLAIMER AND LIMITATION OF LIABILITY

# PRODUCT USAGE STATEMENT

⚠ **WARNING:**

Read this entire manual and all other publications pertaining to the work to be performed before you install, operate, or maintain this equipment. Practice all plant and product safety instructions and precautions. Failure to follow instructions can cause personal injury and/or property damage. If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment might be impaired. All personnel who work with or who are exposed to this equipment must take precautions to protect themselves against serious or possibly fatal bodily injury.

Advanced Energy Industries, Inc. (AE) provides information on its products and associated hazards, but it assumes no responsibility for the after-sale operation of the equipment or the safety practices of the owner or user. NEVER DEFEAT INTERLOCKS OR GROUNDS.

**For Release 6/21/2023**

# TRADEMARKS

All Advanced Energy trademarks are the property of Advanced Energy Industries, Inc. For the list of Advanced Energy trademarks, visit: https://www.advancedenergy.com/legal/. Any unauthorized use of Advanced Energy trademarks is prohibited.

All other trademarks are the property of their respective owners.

# CUSTOMER FEEDBACK

Advanced Energy's technical writing staff has carefully developed this manual using research-based document design principles. However, improvement is ongoing, and the writing staff welcomes and appreciates customer feedback. Please send any comments on the content, organization, or format of this user manual to:

- tech.writing@aei.com

To order a manual, please contact Technical Support:

- technical.support@aei.com

**For Release 6/21/2023**

# Table of Contents

# Chapter 5. Troubleshooting and Technical Support

For Release 6/21/2023

# List of Tables

For Release 6/21/2023

# List of Figures

For Release 6/21/2023

**Chapter**

**1**

# Safety and Product Compliance Guidelines

## IMPORTANT SAFETY INFORMATION

To ensure safe installation and operation of the Advanced Energy WaveCapture unit, read and understand this manual before attempting to install and operate this unit. At a minimum, read and follow the safety guidelines, instructions, and practices.

## DANGER, WARNING, AND CAUTION BOXES

This symbol represents important notes concerning potential harm to people, this unit, or associated equipment. Advanced Energy includes this symbol in danger, warning, and caution boxes to identify specific levels of hazard seriousness.

> **⚠ DANGER:**
> DANGER indicates an imminently hazardous situation that, if not avoided, will result in death or serious injury. DANGER is limited to the most extreme situations.

> **⚠ WARNING:**
> WARNING indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury, and/or property damage.

> **⚠ CAUTION:**
> CAUTION indicates a potentially hazardous situation that, if not avoided, could result in minor or moderate injury, and/or property damage. CAUTION is also used for property-damage-only accidents.

## PRODUCT COMPLIANCE

The following sections include information about unit compliance and certification, including the conditions of use required to be in compliance with the standards and directives.

**For Release 6/21/2023**

# Product Overview

## FBG SYSTEM OVERVIEW

### Fiber Bragg Grating Technologies

The WaveCapture FBGA (Fiber Bragg Grating Analyzer) system is based upon a high-speed spectral engine simultaneously covering multiple wavelengths for precise and rapid Fiber Bragg Grating (FBG) sensor system measurements. It can integrate with an internal reference source (IRS) to achieve high end of life wavelength accuracy at high frequency response time. With an integrated superluminescent light-emitting diode (SLED) and multiple channel optical switch, it can interrogate the fiber-optic sensing network.

The FBGA system covers a wide wavelength range and provides simultaneous measurements at very fast response rates and excellent wavelength resolution. High reliability (MIL STD 810F shock and vibration) is achieved through a rugged mechanical design with no moving parts. The wavelength can be calibrated with an internal reference source.

The Sense 20/20 software is a Microsoft Windows based program for interfacing with the FBGA system via a USB 2.0 connection, displaying and processing the spectral data. This application program is designed to run with Windows 7 or above operating systems. This user manual is for the Sense 20/20 application software version 2.3.0.4.

**For Release 6/21/2023**

# SERIES OF FBGA SYSTEMS

The FBG analyzer series includes a single fiber-optic cable connected to the analyzer; the light source is supplied by the customer.
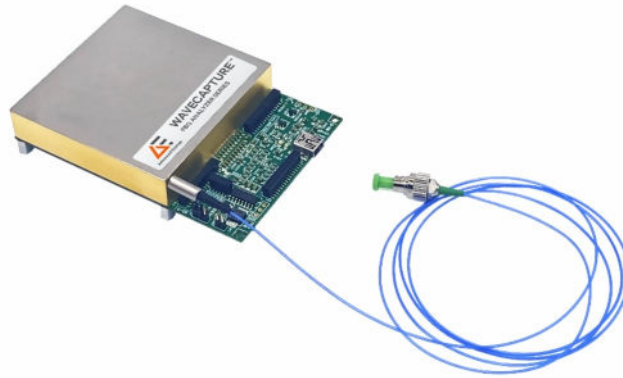


*Figure 2-1.*   *FBG analyzer series*

The FBGA-IRS is a spectral analyzer with an internal reference source (IRS), an optical switch inside, one fiber-optic cable, and a customer-supplied light source.



*Figure 2-2.*   *FBG analyzer with internal reference source*

For Release 6/21/2023

The FBG Interrogator includes an integrated light source and an optical port, and can accommodate up to16 channels.

Optical port
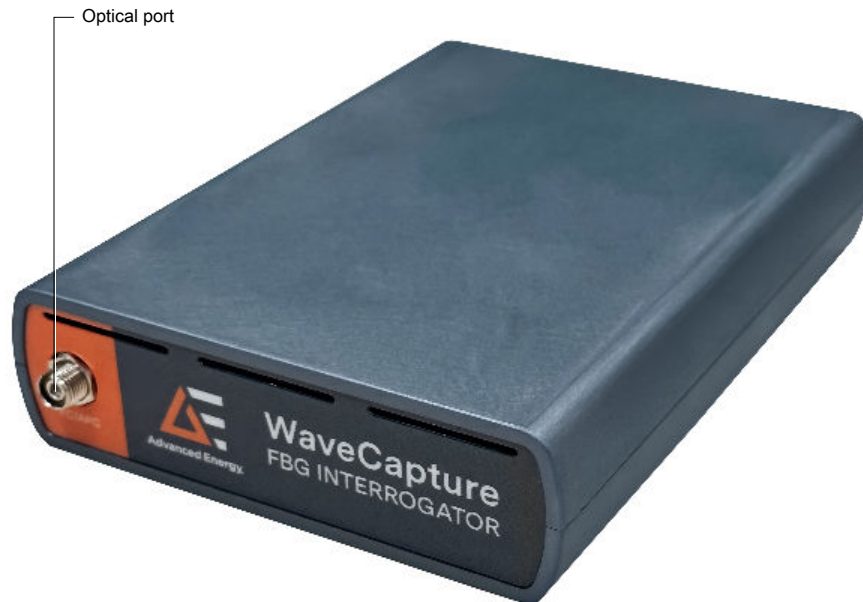


*Figure 2-3.*    *FBG Interrogator - front view*

Power switch with indicator light

Power input                                          USB port
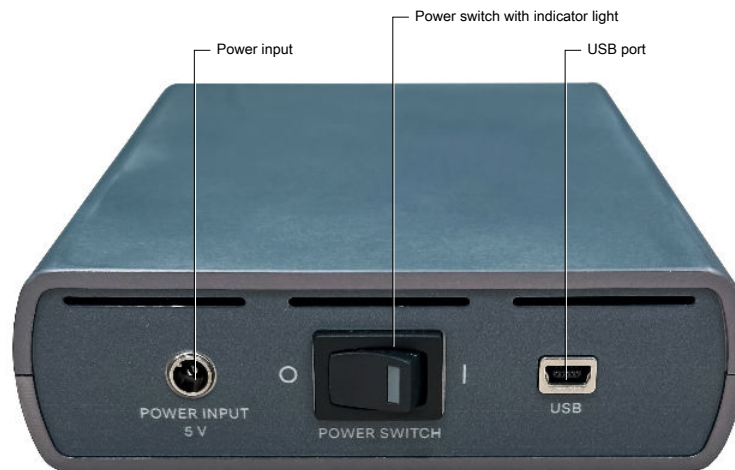


*Figure 2-4.*    *FBG Interrogator - rear view*

For Release 6/21/2023

An FBGA system includes the previously described components plus a fiber-optic array system that is application dependent.
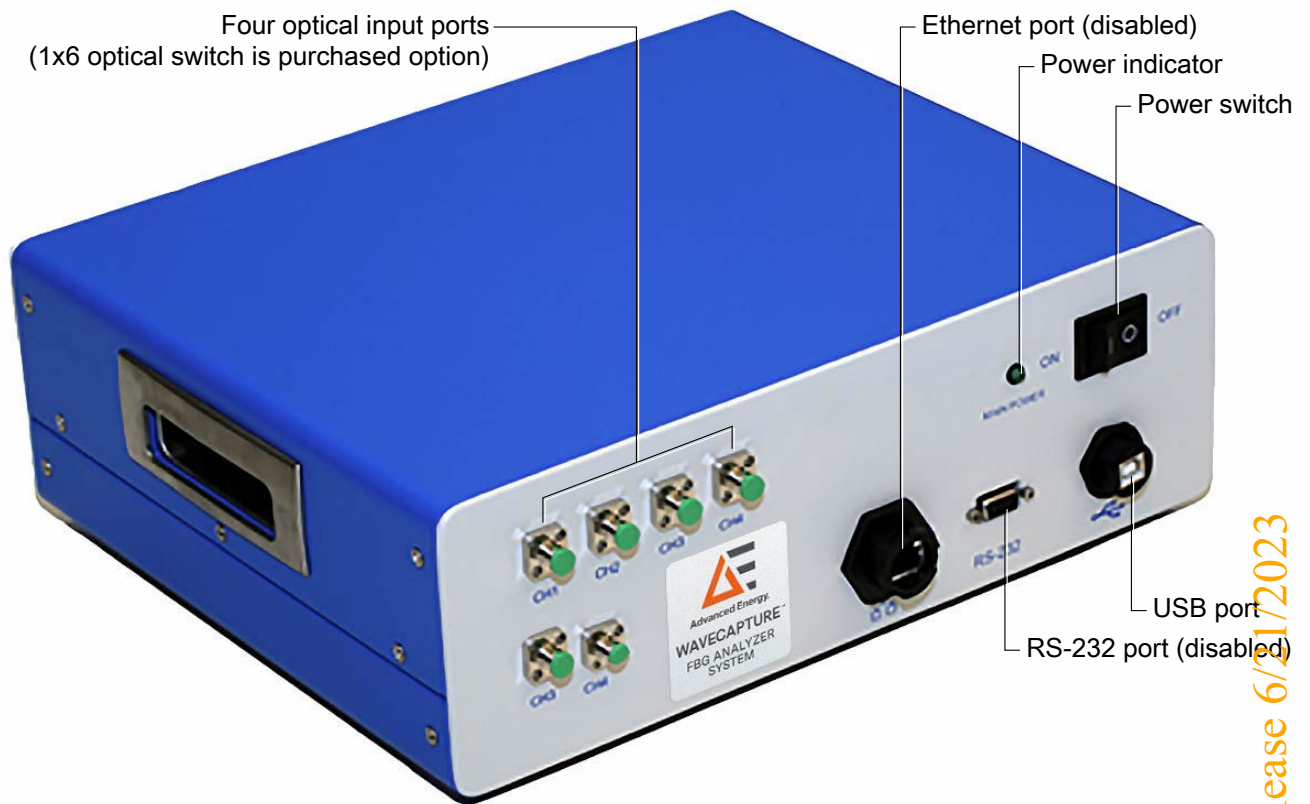


Figure 2-5.    FBGA system with fiber-optic array

For Release 6/21/2023

# Installation, Setup, and Operation

## ACCESSING THE SOFTWARE PACKAGE

The installation of WaveCapture ™ FBGA System includes: Sense 20/20 software, USB driver for spectral engine, USB driver for SLED, and Microsoft Visual C++ 2005 SP1 Redistributable Packages.

AE will send a secure file transfer link to download the entire software package needed for new FBG system users. The software package download includes both .zip and .7z files. You are encouraged to have 7-Zip already installed on your system to extract the files.

The email and downloads are time sensitive and cannot be forwarded to anyone other than the original recipient.

### To Install the Software Package

1. In the email you received, click the secure file transfer link below the list of files.

2. Login or create an account with Advanced Energy Secure File Transfer.

3. Download the listed files, approximately 115 MB.

4. Extract zip folders: USB Drivers, F2096224, FBG00001.

## TO INSTALL THE SLED USB DRIVER - OPTIONAL

If your FBGA system includes the integration of superluminescent light-emitting diode (SLED), follow the steps below to install the SLED USB driver.

1. Uninstall any previous version of the Silicon Laboratories USB driver through the control panel.

**For Release 6/21/2023**
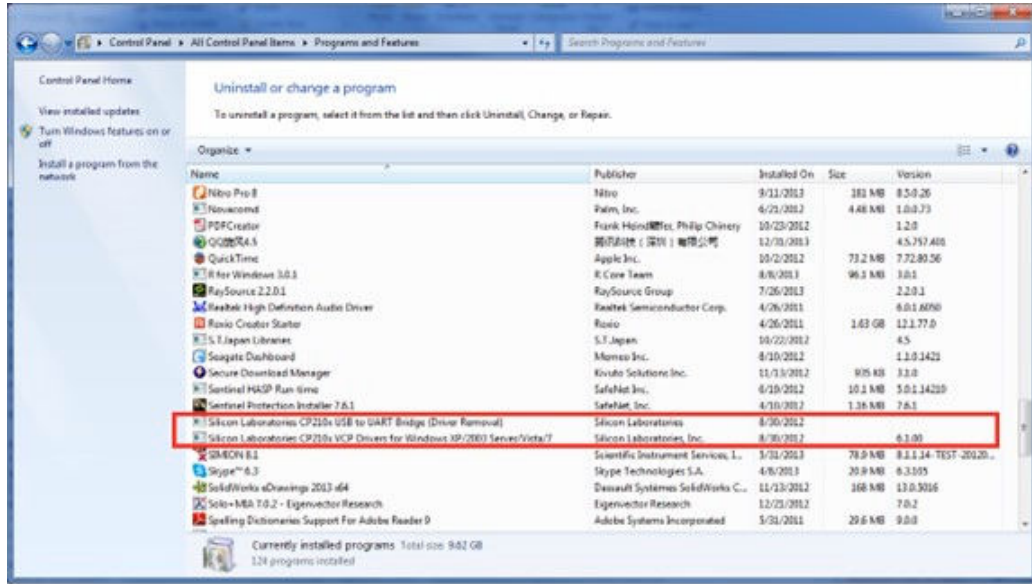
*Figure 3-1.*    *Control Panel window*

2.  Navigate to folder `C:\Sense 2020\USB Drivers\CP2101 DRIVER` and double-click file `CP210x_VCP_Win_XP_S2K3_Vista_7.exe,` click **Yes** on the resulting **User Account Control** window to continue.
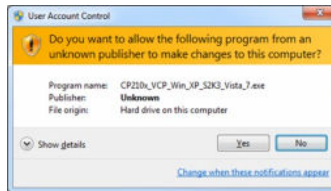


*Figure 3-2.*    *User Account Control window*

3.  Click **Next** to begin.
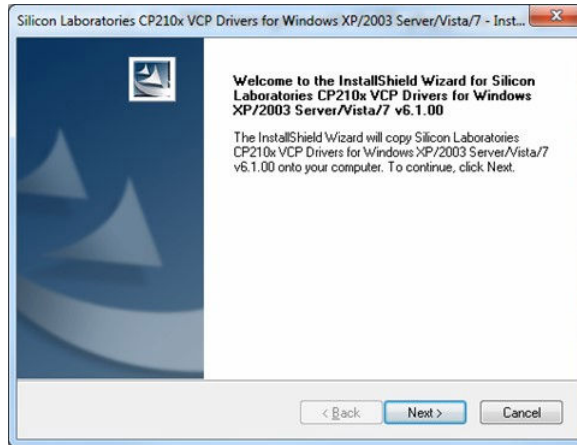


*Figure 3-3.*    *InstallShield wizard*

4.  Click **I accept the terms of the license agreement**, then click **Next** to continue.

For Release 6/21/2023
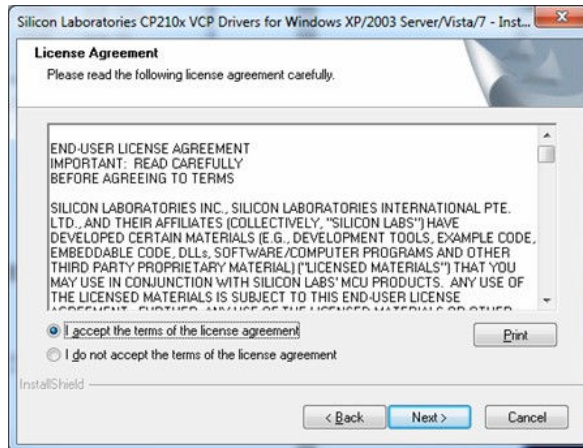
***Figure 3-4.***    *License agreement*

5. Choose **Destination Location** to verify where to store the files, or click **Browse** to browse to another location. Click **Next** to proceed.
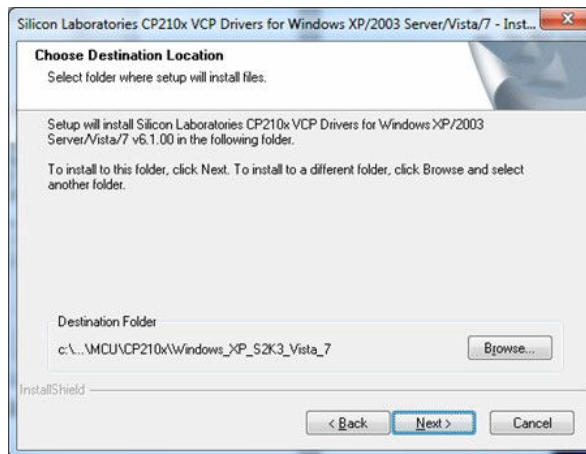


***Figure 3-5.***    *Destination location*

6. Click **Install** to proceed.
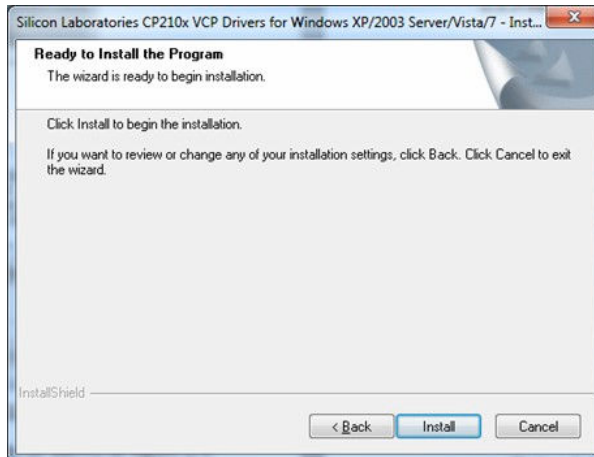


***Figure 3-6.***    *Ready to Install the Program*

For Release 6/21/2023

7. Once the driver is installed click **Finish**.

8. On the resulting window, click **Install** to install the Silicon Laboratories CP210x USB to UART Bridge.
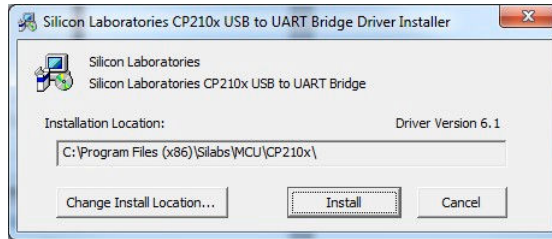


***Figure 3-7.*** *Bridge Driver Installer*

9. Once the driver is installed, click **OK** to finish the installation.
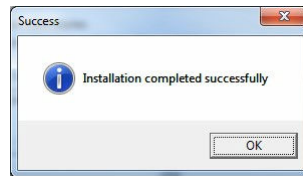


***Figure 3-8.*** *Installation complete*

# INSTALLING THE SPECTRAL ENGINE USB DRIVER

Complete the following steps to install the spectral engine USB driver.

1. Connect the FBGA system to a USB 2.0 port of the host computer using the USB cable provided.

2. For the FBGA system with SLED option, plug the power cord into the line power socket and turn the power switch on.

   Windows attempts to automatically install the spectral engine USB from its default system file folder.

3. Go to **Window Start→ Computer**, then right-click **Manage**to display the **Computer Management** window. Under **System Tools** click **Device Manager** to expand its contents. **BS2BASE** is listed and marked as an unknown device under **Other devices**.

For Release 6/21/2023
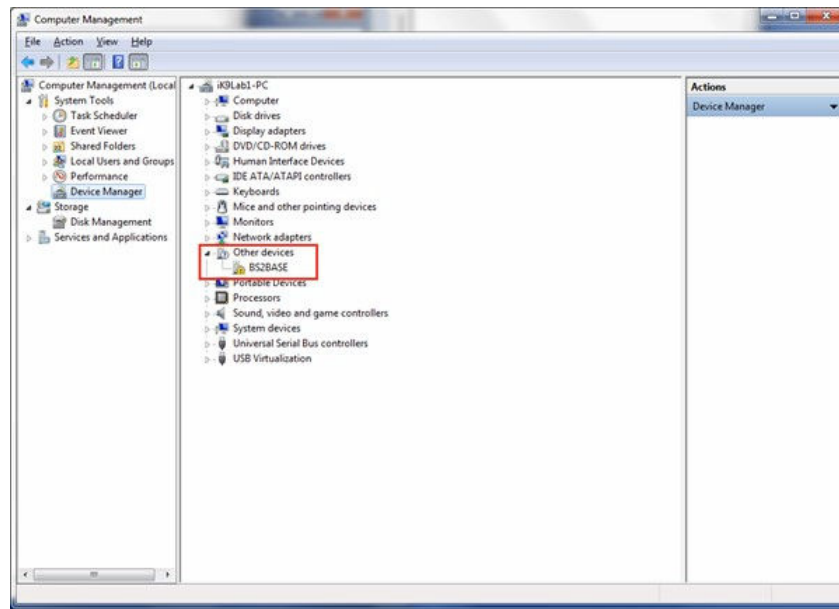
*Figure 3-9.* *Computer Management window*

4. Right-click **BS2BASE** and select **Update Driver Software.**

5. In the **Update Driver Software** window select **Browse my computer for driver software**.
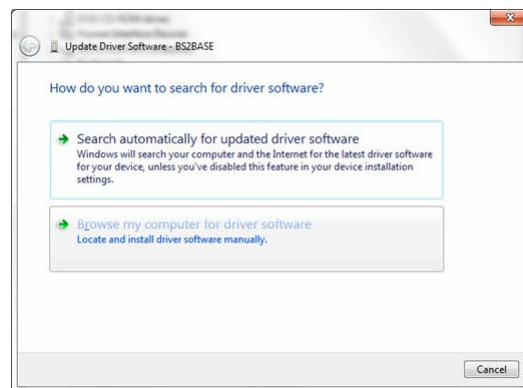


*Figure 3-10.* *Update Driver Software*

6. In the next window, click **Browse** to select the file location of the spectral engine USB driver. The default location is `C:\Sense 2020\USB Drivers\USB20BS Drivers\64 bits.`

For Release 6/21/2023
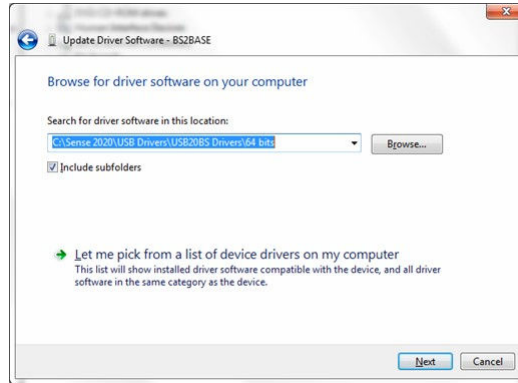
**Figure 3-11.**    *Select driver location*

7.  In the resulting **Window Security** confirmation window, click **Always trust software from BaySpec, Inc** then click **Install**.



**Figure 3-12.**    *Windows Security window*

8.  Wait for Windows to install the spectral engine USB driver, then click **Close**.
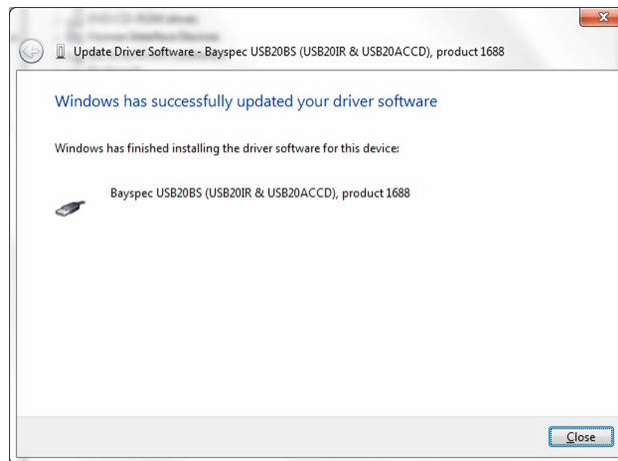


**Figure 3-13.**    *Installation complete*

# VERIFYING SOFTWARE INSTALLATION

## To Verify Software Installation

1.  Navigate to **Window Start→ Computer**, then right click and select **Manage** item to bring up the **Computer Management** window.

For Release 6/21/2023

2. Under the **System Tools**, click **Device Manager** to expand its contents.

3. For the system with SLED option, under **Ports (COM & LPT)**, a **Silicon Labs CP210x USB to UART Bridge (COMxx)** should be listed there, where `xx` is the COM port number.

4. Under **Universal Serial Bus Controllers**, if the `BaySpec USB20BS (USB20IR & USB20ACCD), product 1688` is listed, software installation was successful.
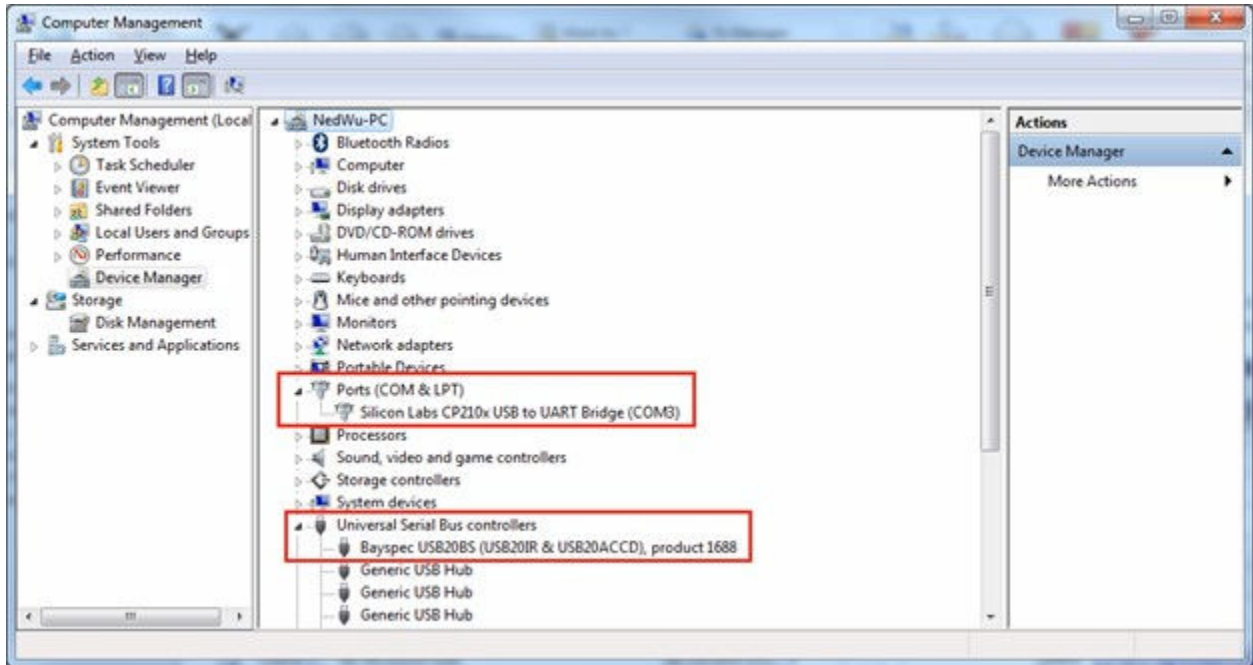


*Figure 3-14.*    *Computer management*

# VERIFYING SYSTEM COMMUNICATION

The first action initiates a short series of automatic file loads that verify the system communications.

## To Verify System Communication

1. Double-click `Sense 2020 V1652 xxxxxxxx.exe` in the folder `C:\Sense 2020` where `xxxxxxxx` is the built-in time stamp of the Sense 20/20 software. A folder `C:\Sense 2020\Spectrum_Data` is created automatically to hold saved or recorded spectrum files.

The Sense 20/20 software checks the connection between the WaveCapture FBGA system and the host computer and initializes the spectral engine first. Only a single spectral engine can be connected.

a. Next, the Sense 20/20 software loads the system configuration from the file `BaySpec_System.ini` in the folder `C:\Sense2020`.

b. Then the Sense 20/20 software loads the calibration data file `Calib_LT_########.dat`, the `########` is the system serial number.

If the calibration file cannot be found or the serial number does not correlate with the connected system, a **Load Calibration Data File** dialog displays.
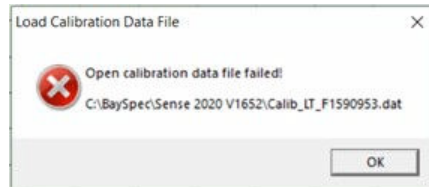


*Figure 3-15.* *Load calibration data file dialog*

Click **OK** to acknowledge and exit the window.

# TROUBLESHOOTING INITIALIZATION FAILURES

If the system initialization failed, most features of the Sense 20/20 software are disabled until the problems are remedied.

If you launch the Sense 20/20 software the following error displays "side-by-side configuration is incorrect" the host computer is missing the Visual C++ Runtime application.



*Figure 3-16.* *Failed to start*

Installing the Microsoft Visual C++ 2005 SP1 Redistributable package on the host computer will remedy the issue.

## To Install the VC 2005 SP1 Redistributable Package

1. Navigate to `C:\Sense2020\USB Drivers\VC2005 SP1 Redistributable Package`, then double-click **vcredist_x64.EXE**

2. In the resulting window click **Yes** to accept the license agreement.

For Release 6/21/2023
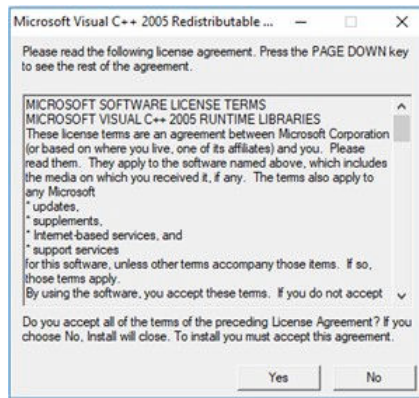
***Figure 3-17.***    *Visual C++ 2005 license agreement*

3. Wait for Windows to configure the redistributable package and click **Yes** to allow the application to make changes.
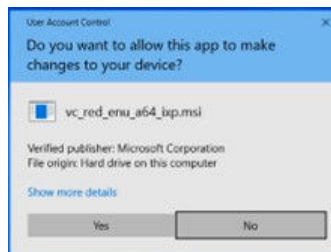


***Figure 3-18.***    *Confirm install*

For Release 6/21/2023

# Communication Controls

## MAIN USER INTERFACE (UI) - FUNCTIONAL AREA FEATURES

The following figure shows the four main components in the user interface: the device information tree viewer, spectrum viewer, data viewer, and menu and toolbars area.
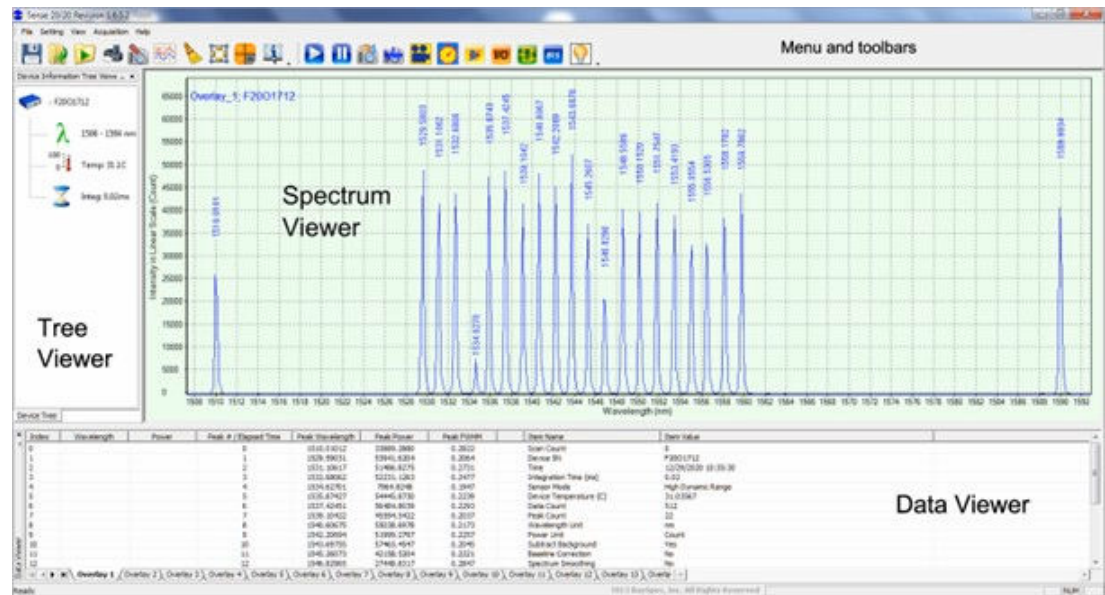


*Figure 4-1.* *Main user interface*

## Device Information Tree Viewer

The device information tree viewer displays the connected FBGA system serial number, the wavelength range, real-time device temperatures, and the integration time currently used.
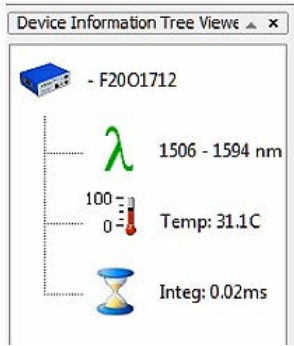
*Figure 4-2.* Tree viewer close up

- If there is no FBGA connected, the device tree viewer will be empty.
- If there is an FBGA connected but the calibration file is not successfully loaded when initializing the system, only the system serial number will be shown under the device tree viewer and the wavelength unit will be switched to pixel.

Click **X** on the top right corner of this pane to close this viewer.

## Spectrum Viewer

This area displays all measured spectra captured by snapshot or continuously acquired. The spectra are coded with user-selectable colors. You can adjust spectrum displays and colors associated with overlays in two ways.

- Click 📈 or use the **VIEW** dropdown menu and select **Set Spectrum Display and Color**.
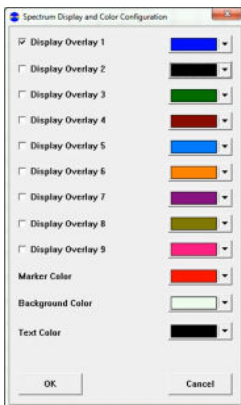


*Figure 4-3.* Spectrum Display and Color Configuration window

- Check or uncheck the boxes on the left side of each overlay to enable or disable the spectrum and data of this overlay in both the spectrum viewer and data viewer. You can customize the color of each spectrum, text, marker, and background view using the right side color palette shown in the next figure.
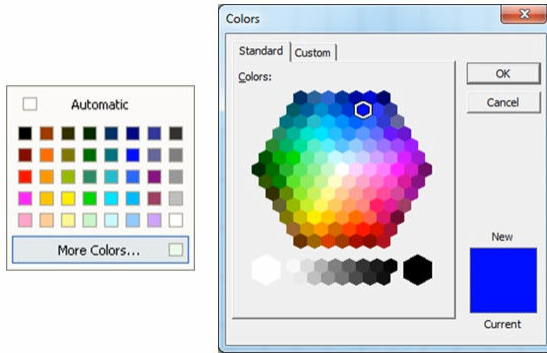
*Figure 4-4.* *More Colors window*

To zoom in on a specific area in the spectrum viewer, left-click and hold, then drag the mouse to select the desired area.
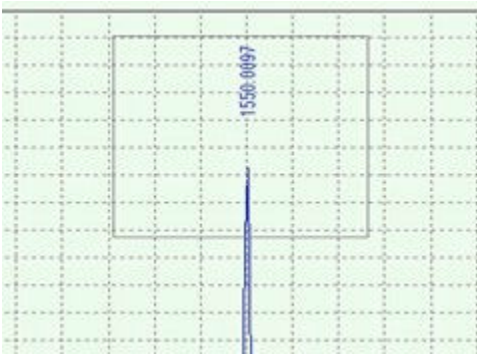


*Figure 4-5.* *Zoom in on single spectra*

Double-click the right mouse button to access graph control.
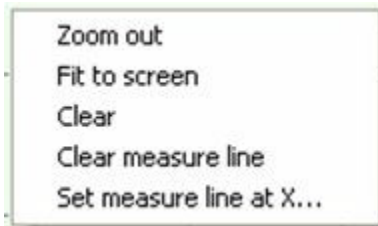


*Figure 4-7.* *Graph Control window*

- Click **Zoom out** to zoom out the displayed spectra into previous fitting or original status in the spectrum viewer.

- Click **Fit to screen** to fit the displayed spectra into the spectrum viewer without top and bottom margins.

- Click **Clear** to clear spectra from the spectrum viewer.

- Click **Clear measure line** to remove the measurement marker and label.

- Click **Set measure line at X ...** to set the measure line at a specific X-axis value.

For Release 6/21/2023
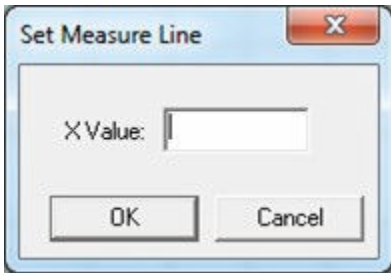
*Figure 4-8.*     *Set Measure Line window*

# Data Viewer - Overlay Tabs

The data viewer displays a list of spectral wavelength/pixel and intensity data, a list of detected peaks (if peak detection is activated), and all test parameters.

Each overlay tab would display acquired spectrum and test parameters. Click an overlay tab at the bottom of the data viewer to display the overlay.



*Figure 4-9.*     *Close-up of single overlay tab*

After spectrum acquisition, the overlay name with device serial number is displayed in the top left corner of the spectrum viewer.
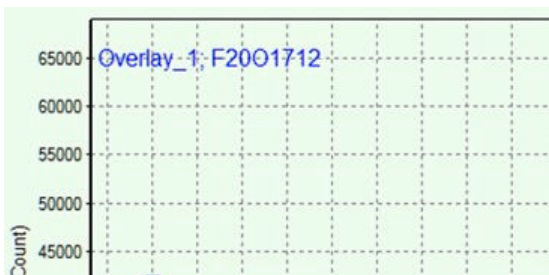


*Figure 4-10.*     *Spectrum acquisition successful*

Click **X** in the top left corner of this pane to close the viewer.

# Menu and Toolbars

You can access all of the Sense 20/20 functions and features (for example, system settings and spectrum acquisitions and processing information) from the menu and toolbars. To access features and functions, right-click the left portion of the menu or

toolbar to display a dropdown list. Check options to view them; uncheck options to close the view.
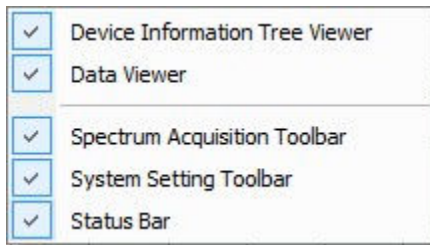


***Figure 4-11.***  *View Preferences menu*

# USER INTERFACE - TOOLBARS

To customize the location of icons in any toolbar, click the downward arrow at the lower right end of either toolbar, then click **Customize** to display the **Customize Toolbar** window.
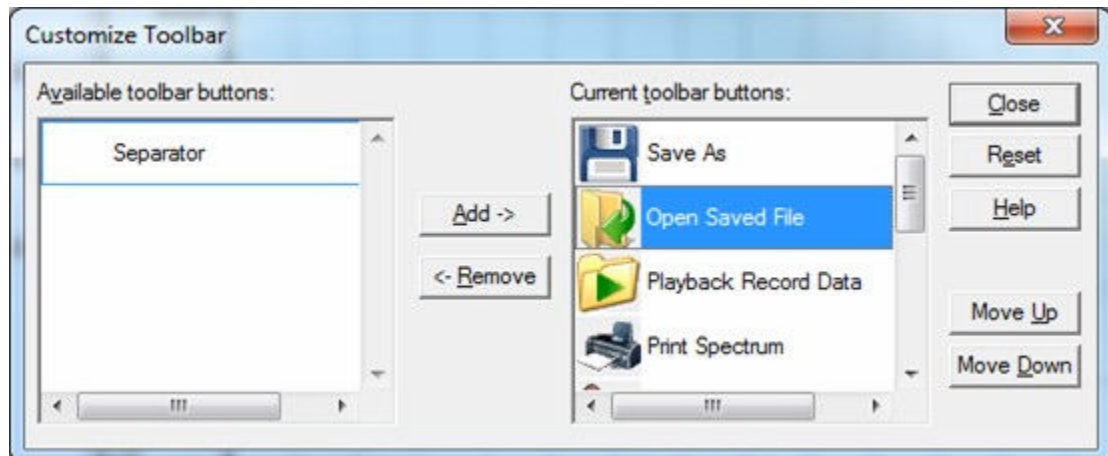


***Figure 4-12.***  *Customize Toolbar window*

- Select an icon that you want to move. Click **Add** to move an icon to the **Current toolbar buttons**; click **Remove** to move an icon to the **Available toolbar buttons**.

- Use the **Move Up** and **Move Down** buttons to change the position of the selected icon on the toolbar.

- Click **Reset** to reset all buttons to the default setting.

- Click **Close** to exit the customize toolbar window.

## System Setting Toolbar

The system setting toolbar is located on the left side of the menu and toolbar area.

For Release 6/21/2023

***Figure 4-13.***   *System setting toolbar*

| | |
|---|---|
| 🖫 | Save - **File → Save As** |
| 📂 | Open - **File → Open** |
| 📂 | Playback Record Data - **File→ Playback Record Data** |
| 🖨 | Print Spectrum - **File→ Print Spectrum** |
| 🔍 | Data Processing - **Setting→ System Settings** |
| 📈 | Set Spectrum Display and Color Configuration - **View→ Spectrum Display and Color Configuration** |
| 🖌 | Clear - **Setting → Clear All Spectra and Overlays** |
| ⬚ | Adjust View - **View→ Spectrum Fit to Window** |
| ⊞ | Calculator - **Setting→ Spectrum Calculator** |
| ℹ | Version Information - **Help→ About Sense 20/20** |

# Spectrum Acquisition Toolbar

The spectrum acquisition toolbar located on the right side of the menu and toolbar area.



***Figure 4-14.***   *Spectrum acquisition toolbar*

| | |
|---|---|
| ▶ | Start - **Acquisition→ Start Continuous Acquisition** |
| ⏸ | Stop - **Acquisition → Stop Continuous/Triggering Acquisition** |
| 📷 | Snapshot - **Acquisition → Snapshot One Spectrum** |
| 📊 | Background - **Acquisition → Acquire Background** |
| 🎥 | Fast Record - **Acquisition → Start Fast Recording** |
| ⏱ | Peak Tracking - **Acquisition → Start Peak Tracking vs. Time** |
| 📶 | Triggering - **Acquisition → Start Triggering Acquisition** |
| I/O | GPIO - **Setting → GPIO Settings** |

|  | Optical - **Setting → Optical Switch Settings** |
| --- | --- |
|  | IRS - **Acquisition → IRS Calibration** |
|  | (SLED Off) **- Setting→ Turn On SLED** |
|  | (SLED On) **- Setting → Turn Off SLED** |

# POST PROCESSING TOOLS

## Save Spectra

Click ⊟ in the system setting toolbar, or select **Menu→ Save As** to display the file explorer window. The default file folder is `Sense 2020/Spectrum_Data`.
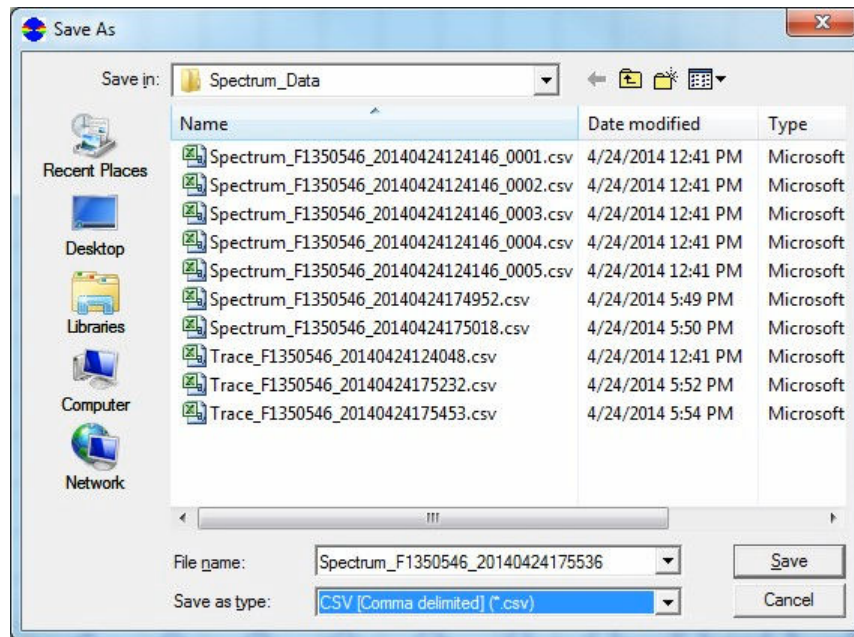


*Figure 4-15.*     *Save As window*

You can save spectrum data as either a tab-delimited text `Text [Tab delimited].txt` or comma-delimited `CSV [Comma delimited].csv`. The automatically-generated file name is in the format `Spectrum_SN-YYYYMMDDhhmmss.xxx` for acquired spectra or `Trace_SN-YYYYMMDDhhmmss.xxx` for acquired peak trace data, where:

- `SN` is the FBGA serial number
- `YYYYMMDDhhmmss` is the time stamp (year, month, day, hour, minute, second)
- `xxx` is the file extension (.txt or .csv)

For Release 6/21/2023

Click **Save** to save current spectra in all overlays (including the measurement information) into the selected directory.

The contents of a saved spectrum data file is slightly different than the contents of a saved trace data file. See the following tables for examples.

*Table 4-1. Contents of saved spectrum data file*

| Attribute | Value 1 | Value 2 (If Applicable) |
|---|---|---|
| Device_SN | F1350546 | |
| Test_Time | 4/24/2014 11:53:03 | |
| Integration_Time (ms) | 0.08 | |
| Device_Temperature | 24 | |
| Sensor_Mode | High Dynamic Range | |
| WL_Unit | nm | |
| Pwr_Unit | Count | |
| Subtract_Background | Yes | |
| Baseline_Correction | No | |
| Smoothing | No | |
| Average_Number | 1 | |
| Peak_Search_Mode | Uniform | |
| Threshold | 8000 | |
| Data_Count | 512 | |
| WL | Power | |
| 1507.6390 | 3097.521 | |
| 1507.9938 | 3097.325 | |
| 1507.9938 | 3097.118 | |
| ... | ... | |
| 1592.0281 | 3196.412 | |
| Peak_Count | 2 | |
| Peak_WL | Peak_Power | Peak_FWHM |
| 1552.6586 | 8757.768 | 0.6375 |
| 1555.6325 | 9960.831 | 0.5677 |

*Table 4-2. Contents of saved trace data file*

| Attribute | Value 1 | Value 2 (If Applicable) |
|---|---|---|
| Device_SN | F1350546 | |
| Test_Time | 4/24/2014 11:53 | |

<span style="color:orange">For Release 6/21/2023</span>

*Table 4-2.* Contents of saved trace data file  (Continued)

| Attribute | Value 1 | Value 2 (If Applicable) |
|---|---|---|
| Integration_Time (ms) | 0.08 | |
| Device_Temperature | 24 | |
| Sensor_Mode | High Dynamic Range | |
| WL_Unit | nm | |
| Pwr_Unit | Count | |
| Subtract_Background | Yes | |
| Baseline_Correction | No | |
| Smoothing | No | |
| Average_Number | 1 | |
| Peak_Search_Mode | Uniform | |
| Threshold | 8000 | |
| Trace_Sample_Count | 300 | |
| Trace_Peak_Count | 2 | |
| Elapsed_Time (sec) | WL1 | WL2 |
| 1.022 | 1539.9206 | 1559.844 |
| 1.053 | 1539.9207 | 1559.845 |
| 1.085 | 1539.9203 | 1559.844 |
| ... | ... | |
| 10.443 | 1539.9193 | 1559.820 |

## Open Saved Spectra

Click ![icon] in the system setting toolbar, or select **File→ Open** to access the file explorer window. The default file folder is `Sense 2020\Spectrum_Data.`

Use the **Files of type** drop-down menu to select file type.
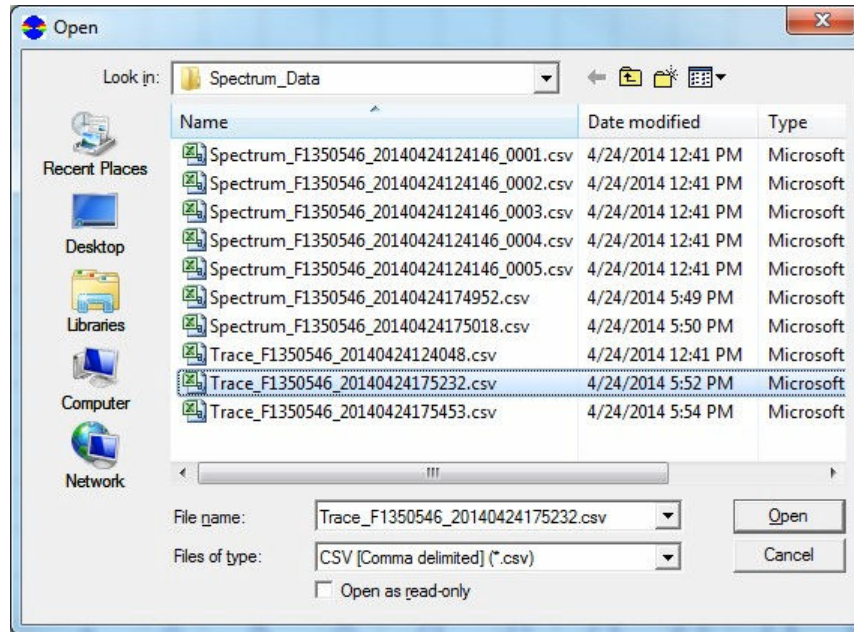
*Figure 4-16.*    *Open saved trace files*

Select saved spectrum or trace file and click **Open** to load spectrum data or peak trace data into the system. The spectrum or peak trace populates the current overlay selected in spectrum viewer and all data displays in the data viewer. The file name is shown in the top left corner of the spectrum viewer.

☞    **Important**

This software can also open saved spectra files when there is no FBGA device connected.

## Print Spectra

Click  in the system setting toolbar, or select **File→ Print Spectrum** to send the spectrum viewer display to a connected printer.

## Spectra Calculator

Click  in the system setting toolbar, or select **Setting → Spectrum Calculator** to invoke the calculator window.

The drop-down menu for **Spectrum 1** and **Spectrum 2** provide all available spectra for calculation.
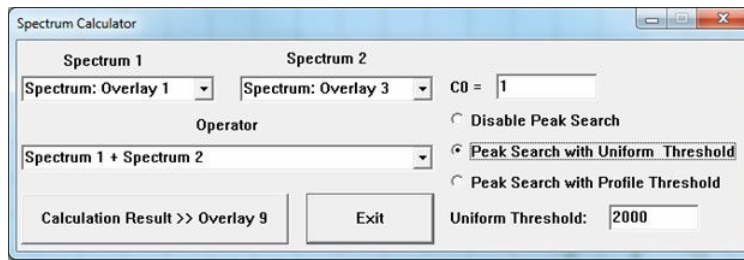
*Figure 4-17.    Spectrum Calculator window*

The drop-down menu of mathematical formulas shown in the **Operator** menu consists of the following:
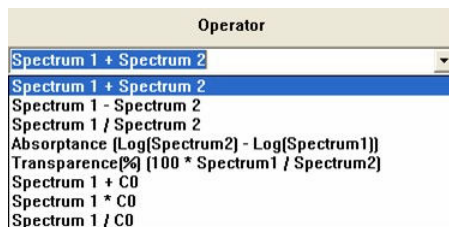


*Figure 4-18.    Operator drop down list*

Take the following steps to utilize the calculator.

1. Select an overlay to assign to **Spectrum 1** and **Spectrum 2**.

2. Choose an equation operator from the dropdown list.

3. If selecting one of the lower three formulas, set the value of **C0**.

4. Click **Calculation Result (Overlay {#})** (where {#} is the numbered tab overlay).

   The calculation results show in the spectrum viewer and in the data viewer.

   The peaks of the spectrum for **Overlay {#}: Calculation Result** shown in the data viewer are searchable if the **Peak Search with Uniform Threshold** or **Peak Search with Profile Threshold** has been selected and the value of **Uniform Threshold** or **Threshold Profile** has been loaded into the system.

Click **Exit** to close the **Spectrum Calculator** window.

## Playback Recorded Spectra

Click ▶ in the system setting toolbar, or select **File→ Playback Record Data**. This will invoke the playback window.
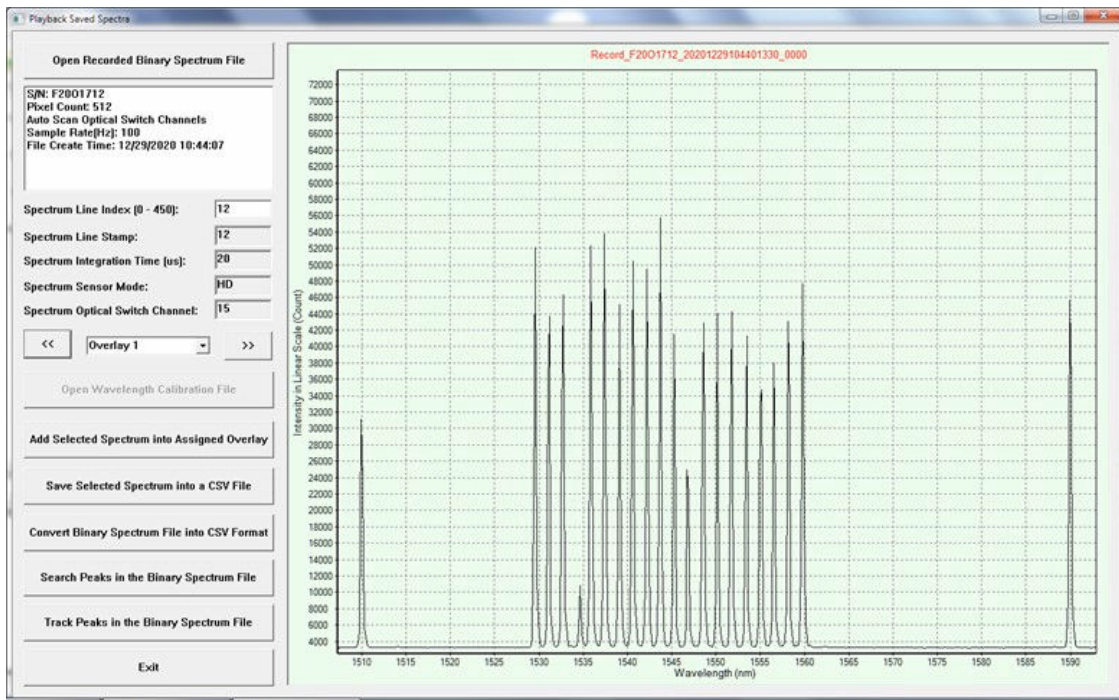
*Figure 4-19.*  *Playback Saved Spectra window*

The list below describe the functions of each button shown in the playback window.

**Open Recorded Binary Spectrum File**

Click **Open Recorded Binary Spectrum File** to open the file explorer window. The default file folder is `Sense 2020\Spectrum_Data`. There are two types of files in the drop-down menu, `Record File (*.dat)` and `All Files`. Select the binary `Record File (*.dat)` and click **Open**. The system information, test parameters, channel information {if optical switch is enabled and has been set to auto scan (fast record only)}, and the total number of spectra in this file and the first spectrum will be displayed in this window.

**Forward** `>>` **and Backward** `<<`

Use the forward or backward buttons to maneuver the spectrum in the record file. The current spectrum line number and line stamp will be updated in the playback window. Changing the number in the **Spectrum Line Index** edit box will set the start spectrum when clicking the backward or forward button.

**Open Wavelength Calibration File**

Sense 20/20 software can open a record file with or without connecting to an FBGA device. If the FBGA device is connected and the calibration data is loaded successfully when initializing the system, the **Open Wavelength Calibration File** box is disabled and shown in gray color.

Under this situation, only the record files with the same serial number as the connected FBGA device can be opened. If you attempt to open a recorded file with

For Release 6/21/2023

a different serial number, an error message displays, and you cannot open the file. Click **OK** to exit.
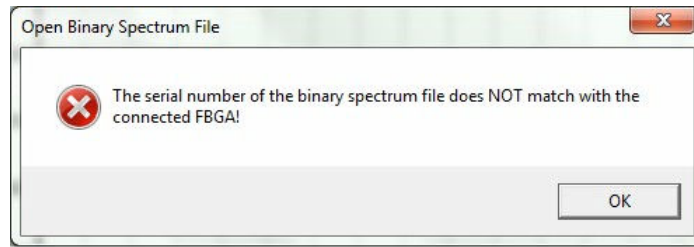


*Figure 4-20.* *Open Binary Spectrum File error message - device serial number does not match file*

When the FBGA device is not connected or the FBGA device is connected without having loaded its calibration data successfully, you can still open the file using the playback record file window. After opening one record file, the horizontal axis shows wavelength as pixel; click **Open Wavelength Calibration File** and choose the correct calibration file. The horizontal axis then shows wavelength in nm.

If the chosen wavelength calibration file does not match the opened record file, an error message displays and you cannot load the calibration file. After successfully loading the calibration file, you can open different record files with the same serial number without exiting the current playback record file window. If the record files have a different serial number, an error message displays.
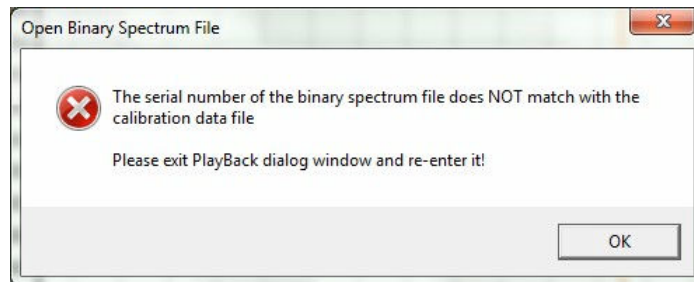


*Figure 4-21.* *Open Binary Spectrum File - error message - calibration and spectrum file serial numbers do not match*

Click **OK** to exit, then exit the current playback record file window and re-enter it.

**Add Selected Spectrum into Assigned Overlay**

Select the overlay from the drop-down menu and click **Add Selected Spectrum into Assigned Overlay** to add current spectrum into the selected overlay.

**Save Selected Spectrum into a CSV File**

Click **Save Selected Spectrum into a CSV File** to save current opened binary record file into a .csv format file. The file name and location can also be selected in the `Save As` file explorer dialog window. The default file name will be `TheName_Spectrum_####.csv` where `TheName` matches the open binary record file and `####` is the line stamp of current displayed spectrum.

For Release 6/21/2023

**Convert Binary Spectrum File into a CSV Format**

Click **Convert Binary Spectrum File into a CSV Format** to convert current opened binary record file into a .csv format file. The file name and location can also be selected from the **Save As** file explorer window. The default file name will match the open record binary file.

The following table shows an example of the contents of a converted text format spectrum data file.

*Table 4-3. Contents of a converted text format spectrum data file*

| Attribute | Value |
|---|---|
| Device_SN | F1350546 |
| Pixel_Count | 512 |
| Integration_Time (ms) | 0.08 |
| Sample_Rate (Hz) | 1000 |
| Sensor_Mode | High Dynamic Range |
| WL_Unit | nm |
| Pwr_Unit | Count |
| Subtract_Background | No |
| Baseline_Correction | No |
| Smoothing | No |
| Average_Number | 1 |
| Total_Spectrum_Line | 5291 |
| Line_Index | 1 |
| Line_Stamp | 2 |
| Device_Temperature | 28.86 |
| Wavelength | Power |
| 1507.6390 | 3097.521 |
| 1507.9938 | 3097.325 |
| 1507.9938 | 3007.118 |
| ... | ... |
| 1592.0281 | 3196.412 |
| Line_Index | 2 |
| Line_Stamp | 3 |
| Device_Temperature | 28.86 |
| Wavelength | Power |
| 1507.6390 | 3097.521 |
| 1507.9938 | 3097.325 |

*Table 4-3.* Contents of a converted text format spectrum data file  (Continued)

| Attribute | Value |
| --- | --- |
| 1507.9938 | 3007.118 |
| ... | ... |
| 1592.0281 | 3196.412 |
| ... | ... |

**Search Peaks in the Binary Spectrum File**

Click **Search Peaks in the Binary Spectrum File** to find peaks in all spectra with pre-defined uniformity or profile threshold and save search results into a .csv format file. If the subtract option is enabled, the current acquired background will be used in the data process. The file name and location can also be selected from the **Save As** file explorer window. The default file name will be `TheName_Peak.csv` where `TheName` matches the open binary record file.

The following table shows an example of a spectrum peak file.

*Table 4-4.* Contents of spectrum peak file

| Attribute | Value |
| --- | --- |
| Device_SN | F1350546 |
| Pixel_Count | 512 |
| Integration_Time (ms) | 0.08 |
| Sample_Rate (Hz) | 1000 |
| Sensor Mode | High Dynamic Rate |
| WL_Unit | nm |
| Pwr_Unit | Count |
| Subtract_Background | No |
| Baseline_Correction | No |
| Spectrum_Smoothing | No |
| Average_Number | 1 |
| Peak_Search | Uniform |
| Peak_Uniform_Threshold | 3500 |
| Total_Spectrum_Line | 4852 |

For Release 6/21/2023

*Table 4-5.* *Contents of spectrum peak file (continued)*

| Line Index | Line Stamp | Device Temp | Peak Count | Peak WL1 | Peak Pwr1 | Peak WL2 | Peak Pwr2 |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 28.86 | 1 | 1555.7067 | 6845 | | |
| 1 | 1 | 28.86 | 2 | 1555.7067 | 6834.5 | 1558.7117 | 7237 |

**Track Peaks in the Binary Spectrum File**

Click **Track Peaks in the Binary Spectrum File** to track peaks in all saved spectra. You need to have enabled the peak search and set threshold in the **System Setting** window.
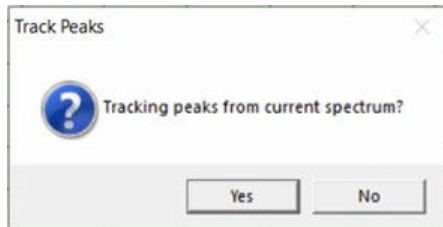


*Figure 4-22.* *Confirmation to Track Peaks*

Click **No** to abort, or **Yes** to invoke the peak wavelength tracking setting window.
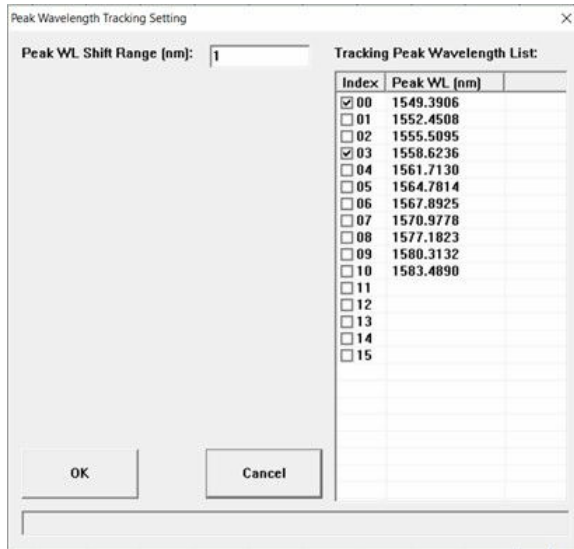


*Figure 4-23.* *Peak Wavelength Tracking Setting window*

- Define the peak wavelength shift range in and select desired peaks to track.

- Click **OK** to show the trace and data of selected peaks on the spectrum viewer and data viewer.

- **Playback save spectra** window will close automatically.

- Click **No** to abort peak tracking.

When opening a record file without an FBGA device connection and you have not successfully loaded the calibration data first, the peak wavelength tracking setting window shows pixels instead of wavelength. At this point, the tracking is the pixel change instead of the wavelength changes over time. You will need to load the calibration file by opening the **Open Wavelength Calibration File** box, the peak wavelength setting window will then display wavelength and tracks changes over time.

The **Exit** button closes the playback window.

# OPTIONAL FEATURE CONTROLS

## IRS Calibration

If your FBGA system has the IRS calibration option, this [IRS] button in the spectrum acquisition toolbar and the menu path **Acquisition→ IRS Calibration** is enabled. The IRS calibration is only needed when wavelength offsets have been found.

## SLED Control

If your FBGA system has the SLED option, this [icon] button in spectrum acquisition toolbar, and the menu path **Setting → Turn On SLED** is enabled.

- Click [icon] to turn on SLED with the output power defined in **System Setting** "Measurement and Data Processing", and the icon will change to [icon].

- Click [icon] to turn off SLED and the icon reverts back to [icon].

- Check or uncheck the item from **Setting → Turn On SLED** to toggle the SLED on or off.

## GPIO Control

- If your FBGA system has the GPIO option, this icon [I/O] in the spectrum acquisition toolbar and the menu selection **Setting→ GPIO Settings** are enabled.
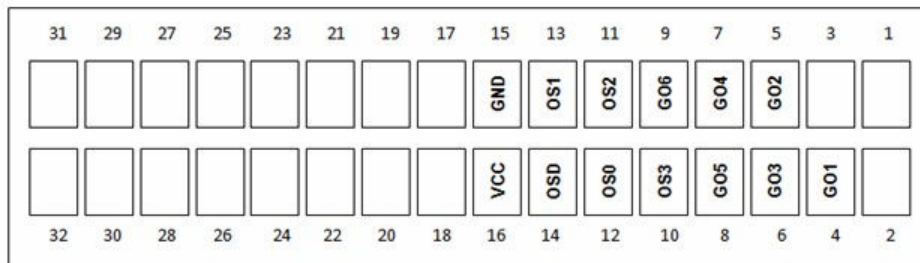


*Figure 4-24.*   *Layout of GPIO and optical switch control pins at connector JD5*

For Release 6/21/2023

• The six GPIO pins (G01 to G06) are located on connector JD5. They can output 3.3 V DC TTL signals.
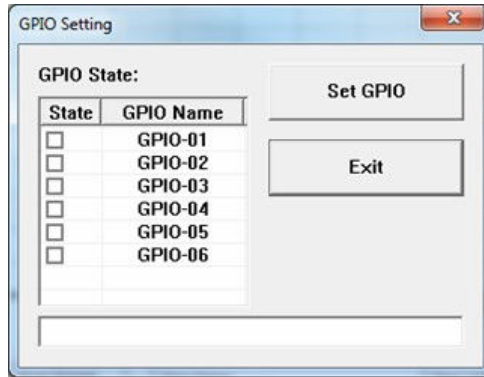


*Figure 4-25.    GPIO setting window*

• Click **Exit** to close the window.

## Optical Switch Control

•
If the FBGA system includes the optical switch option, this ⬛ button in the spectrum acquisition toolbar and the menu selection **Setting → Optical Switch Settings** are both enabled.

• The FBGA device can control optical switches using four IO pins (OS0 to OS3). This means a single optical switch can direct the light path into 2, 4, 8 or 16 separate channels. The true value of optical switch control pins are shown below.

| Channel State | OS3 | OS2 | OS1 | OS0 |
|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 1 |
| 3 | 0 | 0 | 1 | 0 |
| 4 | 0 | 0 | 1 | 1 |
| 5 | 0 | 1 | 0 | 0 |
| 6 | 0 | 1 | 0 | 1 |
| 7 | 0 | 1 | 1 | 0 |
| 8 | 0 | 1 | 1 | 1 |
| 9 | 1 | 0 | 0 | 0 |
| 10 | 1 | 0 | 0 | 1 |
| 11 | 1 | 0 | 1 | 0 |
| 12 | 1 | 0 | 1 | 1 |
| 13 | 1 | 1 | 0 | 0 |
| 14 | 1 | 1 | 0 | 1 |
| 15 | 1 | 1 | 1 | 0 |
| 16 | 1 | 1 | 1 | 1 |

*Figure 4-26.    True value table of optical switch control pins*

•
⬛ This icon in the spectrum acquisition toolbar will invoke the **Optical Switch Setting** window, or alternatively, from the menu bar select **Setting→ Optical Switch Settings** to access the **Optical Switch Setting** window. The total optical switch channel number is defined in the system configuration file. All available

optical switch options for the fixed channel selection are listed in the **Channel Selection** drop-down menu.
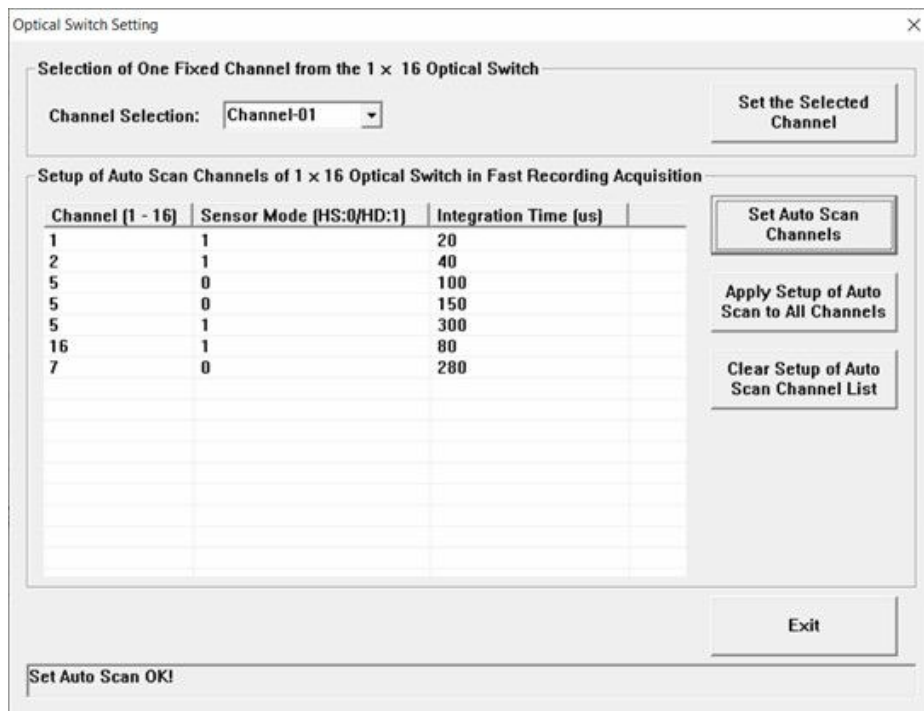


*Figure 4-27.*    *Optical Switch Setting window*

- Select one channel for the optical switch in the **Channel Selection** drop-down menu. Click **Set the Selected Channel** to select the fixed channel for the optical switch.

In the auto scan queue, channel sequence is assigned, sensor mode and integration time for each channel is defined individually in the **Setup of Auto Scan Channels** list. The pre-defined auto scan queue for the optical switch channels can be executed repeatedly during fast recording acquisition.

AE strongly recommends using snapshot or continuous acquisition to optimize the sensor mode and integration time for each optical switch channel before engaging the auto scan queue.

In the auto scan queue, the maximum number of assigned channels is the total channel count for the optical switch. In these assigned channels, the channel order can either be random, or duplicated. The sensor mode has two options:

- 0: High Sensitive

- 1: High Dynamical Range

The integration time should not be less than 20 µs, and the reciprocal of the integration time must be larger than the sample rate.

- Click **Apply Setup of Auto Scan to All Channels** to duplicate the first channel setup across all channels.

- Click **Clear Setup of Auto Scan Channel List** to clear the contents in the **Setup of Auto Scan Channels** list.

- Click **Set Auto Scan Channels** to set the auto scan queue from the **Setup of Auto Scan Channels** list.

If the auto scan channels for fast recording acquisition is enabled, the background, snapshot, continuous triggering, peak tracking and IRS acquisitions are disabled.

- Click **Exit** to close the **Optical Switch Setting** window.

# MEASUREMENT AND DATA PROCESSING

## System settings

You can manage spectrum acquisition and data processing settings using the **System Setting** window.

- To access system settings, click ![icon] in the system setting toolbar, or select **Setting → System Setting**. The FBGA system serial number, pixel count, and wavelength range displays in the top text box of the **System Setting** window. All setting parameters are read from the FBGA system and the system configuration file.

- Click **Confirm** to enable or activate all changes and close the **System Setting** window.

- Click **Cancel** to close the **System Setting** window without saving any parameters.



*Figure 4-28.*    *System setting window*

For Release 6/21/2023

# Integration Time, Sample Rate, Sensor Mode, and SLED Settings

The integration time determines the accumulating time of spectrum acquisition. The longer the integration time, the higher the collected spectrum intensity. The setting range of the integration time is from 20 μs to 60 seconds. The integration time can be set by typing desired integers into the **sec, ms,** or **μs** edit boxes. If the integration time is too long, the spectrum intensity will be saturated.

Before setting the changed integration time into the FBGA system, integration time is checked with the calibration range. If out of range, the spectral ripple correction is disabled and the following warning displays.
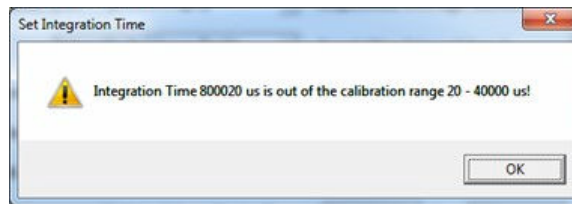


*Figure 4-29.*    *Warning message integration time out of calibration range*

- The **Sample Rate / Trigger Frequency** determines how many spectra are acquired per second. Its reciprocal is the sampling time interval of spectrum acquisitions or scans, which must be longer than the integration time. Otherwise, the software is forced to increase the time interval (and therefore decrease the sampling rate) to make it equal to the integration time.

- During the triggering acquisition mode, use **Sampling Rate / Trigger Frequency** to input the trigger signal frequency which determines the spectrum data transfer speed over the USB communication channel.

- Click **High Dynamic Range Mode** to set the sensor into high dynamic range mode for measuring a strong signal.

- Click **High Sensitive Mode** to set the sensor into high sensitive mode for measuring weak signal. The acquired spectrum intensity in high sensitive mode is about 15 dB higher than when in high dynamic range mode.

- If the SLED option is enabled, the SLED output power setting range label and output power field display in this section. Modify the number within the range as needed to change the SLED output power.

# Data Process and Display Settings

There are two wavelength units in the **Wavelength Units** drop-down menu: **Pixel** and **nm (Wavelength)**. The default unit is **nm (Wavelength).** The relationship of wavelength vs. pixel is defined in the calibration data file and dependents upon the FBGA system temperature.

There are two power units in the **Power Unit** drop-down menu: **Intensity in Linear Scale** (Count) and **Intensity in Logarithm Scale** (dB). The default power unit is **Intensity in Linear Scale.**

For Release 6/21/2023

Advanced Energy® ® WaveCapture

If the **Acquisition Average Number** is greater than one, the FBGA system makes the indicated numbers of spectrum acquisitions, then calculates the average of the acquired spectra. Averaging reduces the random noise level, but increase acquisition time.

While in continuous spectrum acquisition mode, the FBGA system acquires spectra at the indicated **Acquisition Interval**, valid values are 0.01 second to 3600 seconds. To monitor slow change activities or if you want to reduce the number of auto-saved spectrum files, AE recommends using a 3600 second acquisition interval.

- Uncheck the **Update Overlay Data** check box disables the spectrum data from updating in the data viewer during continuous spectrum acquisition, which increases the spectrum updating speed in the spectrum viewer. The last spectrum data and test parameters will be updated in the data viewer once continuous spectrum acquisition stops.

**Subtract Background**

Background subtraction removes the interferences from the system dark noise, sensor response fixed pattern, and other ambient environments.

**Baseline Correction**

When the baseline correction is enabled, the system calculates the baseline of the acquired spectrum with an auto-leveling algorithm, subtract this baseline from the spectrum, and shift the spectrum to make its minimum intensity zero.

**Spectrum Smooth**

Check this box to perform a smooth to the acquired spectrum.

**Auto Save Spectrum**

This enables the auto save feature in continuous spectrum acquisition or triggering acquisition mode. The following confirmation window displays when continuous spectrum acquisition or triggering acquisition starts.
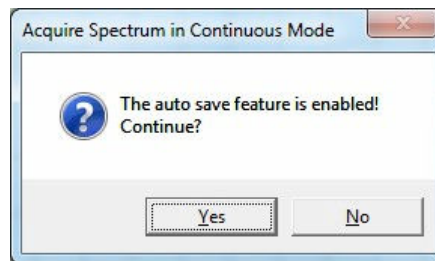


*Figure 4-30.* *Confirm continuous mode window*

Click **No** to abort the continuous spectrum acquisition or triggering acquisition. Click **Yes** to display the **Browse for Folder** window.

For Release 6/21/2023

57010250-00AA Communication Controls 4-22
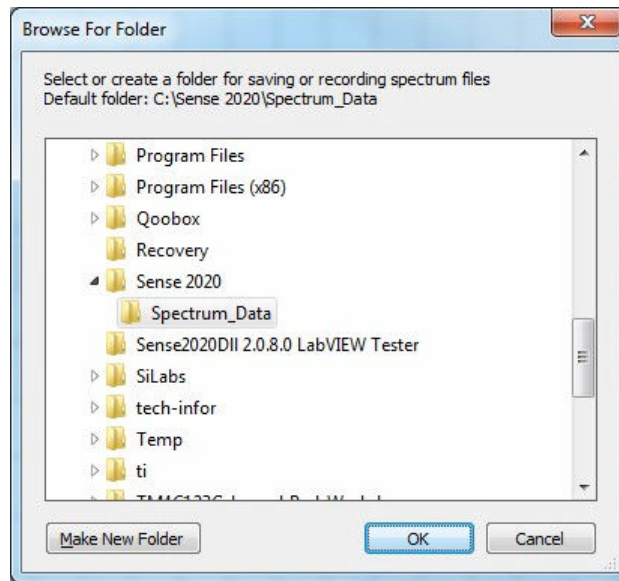
*Figure 4-31.*    *Browse For Folder window*

The default file folder is `Sense 2020\Spectrum_Data`. You can save spectrum files to a different folder; to create a new folder, click **Make New Folder** to create a new folder and follow the onscreen prompts. Click **OK** to start continuous spectrum acquisition or triggering acquisition, or click **Cancel** to abort the operation.

During continuous spectrum acquisition, each acquired spectrum and its test parameters are saved into a comma- delimited text file. The file name is formatted as `Spectrum_SN_####.csv`, where SN is the serial number of the FBGA system. During triggering acquisition, all acquired spectra will be saved into a binary file. The format of the file name is described in a later section.

Check the **Auto X Axis Scale** check box and the X axis scale sets automatically, depending upon all acquired spectra. If you uncheck the **Auto X Axis Scale** check box you will need to manually set the X axis scale using the **From** and **To** edit boxes.

Check the **Auto Y Axis Scale** check box and the Y axis scale sets automatically, depending upon all acquired spectra. If you uncheck the **Auto Y Axis Scale** check box you will need to manually set the Y axis scale using the **From** and **To** edit boxes.

## Peak Search Settings

- Select **Disable Peak Search** to disable the peak search data process.

Set the uniform threshold using the right side edit box for peak search criteria. A reported peak must satisfy the following conditions:

- The peak intensity must be higher than the given threshold.

- The intensity difference of two adjacent sensor pixels at the beginning of the rising edge of the peak must be larger than one tenth of the given threshold, which eliminates false peak detection caused by spectrum ripples and large spectral profile.

For Release 6/21/2023

- Select **Peak Search with Uniform Threshold** to perform a peak search for each acquired spectrum with the defined uniform threshold across all sensor pixels.

- Select **Peak Search with Profile Threshold** to bring up a file explorer window to pick a text format threshold profile file.

A reported peak has to meet the same two conditions mentioned above, but the threshold will also be given a threshold file for each pixel. The threshold profile will display in `Overlay 16: Calculation Results` of the data viewer and spectrum viewer. The profile file is in MS Excel comma-delimited format (*.csv).
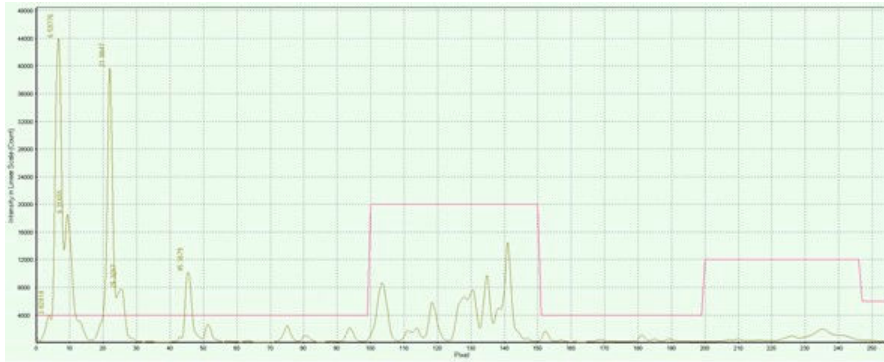


*Figure 4-32.*     *Display of the threshold profile*

| Pixel_Count: | 512 |
|---|---|
| Pixel | Threshold |
| 0 | 4000 |
| 1 | 4000 |
| 2 | 4000 |
| 3 | 4000 |
| 4 | 4000 |
| 5 | 5000 |
| 6 | 7000 |
| • | • |
| • | • |
| • | • |
| 511 | 2000 |

*Figure 4-33.*     *Threshold profile file*

The first row in the profile file is data count. If it is less than the data count of the searched spectrum, the zero profile thresholds will be used. The first column in profile is data index and the second column is the threshold.

The peak index, wavelength, power, and full width at half maximum (FWHM) of all found peaks will be listed in data view, and wavelength labels are displayed on top of each peak in spectrum view.

The Sense 20/20 software allows editing within the **Peak Search** setting if there is not a connected FBGA device, but displays the following window.
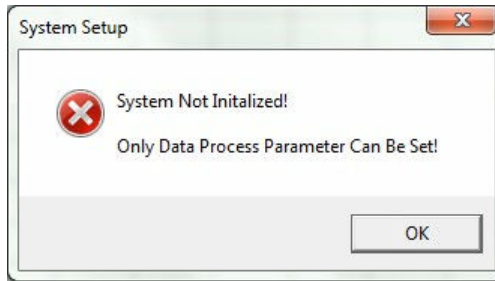
*Figure 4-34.* *System not initialized warning*

Click **OK** confirm; the **System Setting** window displays.

Since there is no FBGA device connection, most device information (for example, serial number and wavelength range) does not display. You can only adjust the **Peak Search** information.
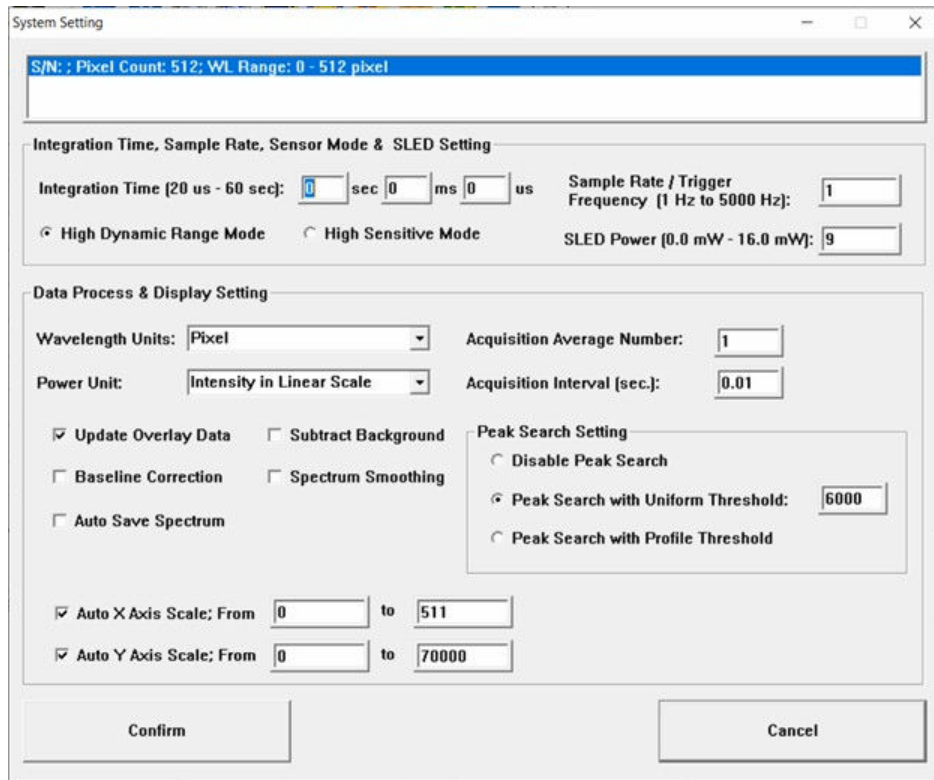


*Figure 4-35.* *System Setting window with no FBGA connection*

# SPECTRUM ACQUISITION MODES

There are different spectrum acquisition modes to meet different measurement speeds. The following sections provide descriptions of each spectrum acquisition mode.

*For Release 6/21/2023*

# Background Acquisition

Background acquisition has to be done manually. The background subtraction eliminates potential interference from the FBGA system dark noise, sensor response, fixed patterns, ambient environment, and provides a more accurate peak wavelength. When sensor modes, integration time, or environment conditions have changed, the background must be reacquired.

- ⬚ This icon in the spectrum acquisition toolbar initiates the background acquisition, or select **Acquisition→ Acquire Background** to achieve the same action.

  The acquired background spectrum updates in the spectrum viewer. The spectrum data and test parameters are listed in the active overlay of the data viewer. Background subtraction can also be enabled through the **System Setting** window as well.

# Snapshot Spectrum Acquisition

The snapshot spectrum acquisition allows a quick look at data processing parameters and the resulting measurements.

- ⬚ This icon in the spectrum acquisition toolbar takes a snapshot of the spectrum, or select from the **Acquisition → Snapshot One Spectrum** menus to achieve the same action.

  The acquired spectrum is then plotted in the spectrum viewer. The spectrum data, searched peak information, and test parameters are listed in the active overlay of the data viewer.

# Continuous Spectrum Acquisition

Use continuous spectrum acquisition to monitor slow change events. The spectrum update rate in the spectrum viewer is determined by the integration time, acquisition interval, and display settings. To increase the spectrum update rate, decrease the integration time and acquisition interval, and disable the overlay spectrum data update in the data viewer. The maximum spectrum update rate of continuous spectrum acquisition is around 10 Hz.

- ▶ The play button in the spectrum acquisition toolbar starts the continuous spectrum acquisition, or select menu **Acquisition→ Start Continuous Acquisition** to achieve the same action.

  The acquired spectra update in the spectrum viewer after each spectrum acquisition is completed.

If the **Update Overlay Data** is enabled, the searched peaks information, or the spectrum wavelength and power (if the peak search is enabled), and the test parameters are updated in the active overlay of the data viewer.

*For Release 6/21/2023*

While the continuous spectrum acquisition is running, all buttons in spectrum acquisition toolbar and the system setting toolbar are disabled. Clicking on any icon other than the pause button produces the following warning message.
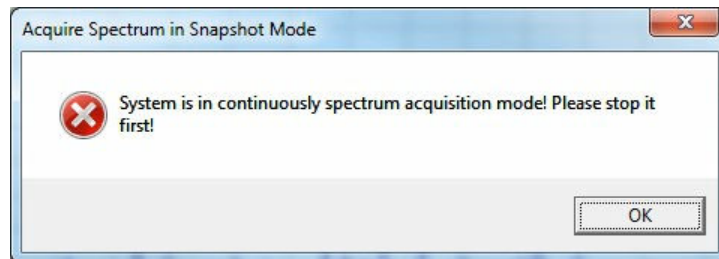


*Figure 4-36.    Warning: continuous spectrum acquisition mode is enabled*

Click **OK** to close the error message window.

- ⏸ This icon, the stop/pause button, in the spectrum acquisition toolbar pauses the continuous spectrum acquisition. Alternatively, you can select menu item **Acquisition → Stop Continuous/Triggering Acquisition** to achieve the same results.

    If the **Update Overlay Data** is disabled, the last set of spectrum data, searched peak information, and test parameters are displayed in the active overlay of the data viewer.

## Start Peak Tracking

The peak tracking vs. time function tracks the wavelength shift of selected peaks over time.

The FBGA sample rate is set in the **System Setting** dialog window, but the Sense 20/20 program can only update acquired peak wavelength shift on the spectrum viewer in about 60 Hz. Meaning the on-screen peak wavelength tracking is only suitable for slow change events (<60 Hz). To monitor the fast change events, enable the fast record mode and playback.

- 🔆 This icon in the spectrum acquisition toolbar begins peak tracking. You can also select **Acquisition → Start Peak Tracking vs. Time** to achieve the same action. A confirmation window displays, click **No** to abort the peak tracking. Click **Yes** to invoke the **Peak Wavelength Tracking Setting** window.

- The selected peaks can only be tracked in the defined peak wavelength shift range. This range should not be zero or smaller than the wavelength spacing between adjacent FBG peaks. If multiple peaks exist in this wavelength range, the peak with the highest power is tracked.

- The amount of data points that can be tracked is limited to 65535. When the data points reach the maximum number (65535), peak tracking acquisition stops automatically.

- Multiple peaks are tracked simultaneously. During peak tracking, the peak wavelength trace is continuously updated in the spectrum viewer. During peak tracking, all buttons in the spectrum acquisition toolbar and the system setting

<div style="text-align: right"><em>For Release 6/21/2023</em></div>

toolbar are disabled, except the pause/stop button. Click on any of them and an error message displays.

- ⏸ This icon in the spectrum acquisition toolbar stops peak tracking. The elapsed time vs. peak wavelength shift related to the selected peak in **Peak Wavelength Tracking Setting** window is updated in the data viewer.



***Figure 4-37.*** *Peak tracking vs. time*

This image shows the updated peak trace and data after stopping peak tracking.

- 💾 This icon in the system setting toolbar saves the trace file. You can also select **File→ Save As** from the dropdown menus to save as well.

# External Triggering Spectrum Acquisition (Optional)

- Use the external trigger acquisition to synchronize external events with FBGA spectrum acquisition by TTL trigger-in and generating trigger-out signal. The frequency range of trigger-in signal is from 1 Hz to 1000 Hz. The trigger-out signal is generated when the FBGA system starts to acquire spectrum. The width of trigger-out signal is equal to the integration time. The jitter of trigger-out signal is about 100 μs.

- The trigger-in, trigger-out and ground pins are located on connector JD7, as shown below. The external trigger-in should be TTL signal. The logic low level of external triggering signal is lower than 0.8 V and logic high level is higher than 2.4 V. The maximum signal level is 5 V. If external triggering signal is higher than 5 V, the FBG PC board may be damaged.
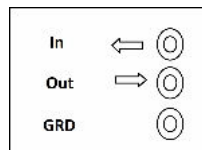


***Figure 4-38.*** *Layout of trigger-in, trigger out, and ground pins at connector JD7*

For Release 6/21/2023

If the FBGA system has the external triggering option, the ![button] button in the spectrum acquisition toolbar and menu item **Acquisition→ Start Triggering Acquisition** are enabled.

The frequency of trigger-in signals need to be set before triggering acquisition to optimize spectrum data transferring speed.

- ![icon] This icon in the spectrum acquisition toolbar to trigger acquisition. Or alternatively, select **Acquisition → Start Triggering Acquisition** from the dropdown menu to achieve the same results.

  All buttons in spectrum acquisition toolbar and the system setting toolbar are disabled, except the pause button. A warning message displays if you click on any button other than the pause button during the acquisition.
  Click **OK** to close the message.

If the **Auto Save Acquired Spectrum** option is disabled, the frequency of trigger-in signal may be very high, but the program will pick acquired spectrum at about 60 Hz and update the spectrum in the spectrum viewer and spectrum data updates in the data viewer.

If the **Auto Save Acquired Spectrum** option is enabled, acquired spectrum is saved into a binary data file at the defined sample rate.

- ![pause] The pause/stop button in the spectrum acquisition toolbar stops the triggering acquisition. Or select **Acquisition→ Stop Continuous/Triggering Acquisition** from the dropdown menu to achieve the same result.

## Fast Recording Spectrum Acquisition

Use the fast recording mode to acquire and record spectrum at very high speeds.

- ![button] This button in the spectrum acquisition toolbar starts fast record mode. Or alternatively, select **Acquisition→ Start Fast Recording** to achieve the same action. A confirmation window displays, click **No** to abort or click **Yes** to start the fast recording acquisition.
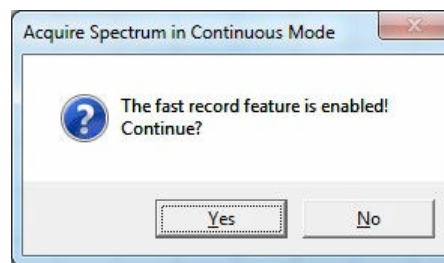


*Figure 4-39.*    *Fast record confirmation window*

- ○ The acquired spectrum raw data is saved into the binary file `Sense2020\Spectrum_Data` folder.

- ○ If the host computer CPU does not have the memory or speed available, some of the streamed out spectrum data could be missed. Free up resources to the CPU by closing other application programs. The Sense 20/20 program

For Release 6/21/2023

turns off all data process and spectrum updates automatically. The acquired spectrum data is saved into the internal memory of the host computer and a binary file is written with a huge block of spectrum data.

Same as with the continuous spectrum acquisition, all buttons in spectrum acquisition toolbar and system setting toolbar are disabled except the pause button during fast recording. If you click any of them, an error message displays. A warning message also displays on the spectrum viewer to inform updating is disabled during fast recording spectrum acquisition. The spectrum viewer and the data viewer are cleared of the warning message one fast recording mode has stopped.
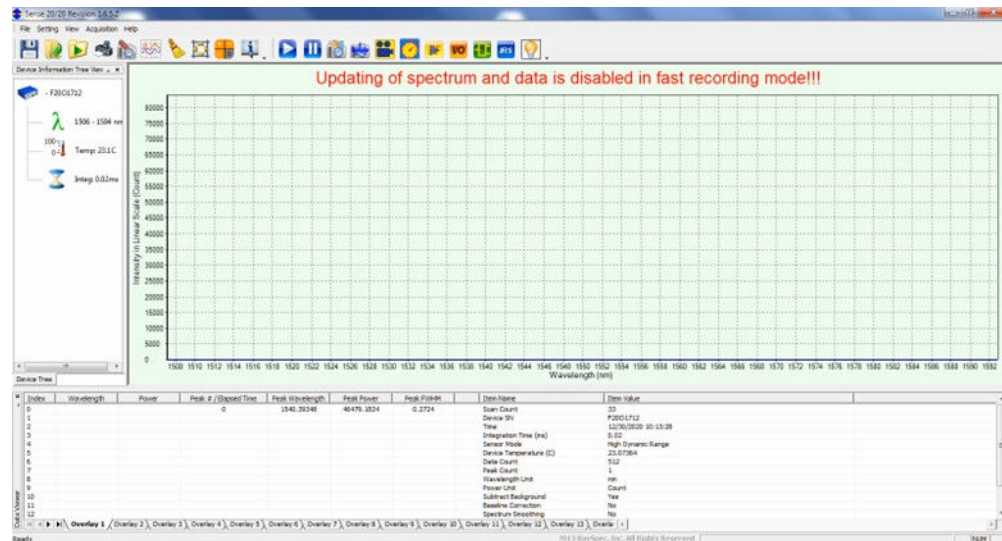


***Figure 4-40.*** *Warning message shown across spectrum viewer*

- ⏸ button in spectrum acquisition toolbar pauses fast recording. The warning message on the top of the spectrum viewer is removed.

    All acquired spectra is saved into a series of binary files with name formatted as:
    **Record_SN_YYYYMMDDhhmmssnnn_####.dat**.

    Each binary file can contain a maximum of 65534 spectrum lines of data. In the file name, SN is the FBGA serial number, **YYYYMMDDhhmmssnnn** is the time stamp of the binary file creation (YYYY: Year MM: Month, DD: Day, hh: hour, mm: minute, ss: second, nnn: microsecond) and #### is the accumulated binary file number.
    During fast record, all data processing such as subtract background, baseline correction, or smooth and peak search, are disabled.

The spectrum data in the binary file can be reviewed or post processed in the **Playback Saved Spectra**, see "Post Processing Tools" for further information.

*For Release 6/21/2023*

# FBG MEASUREMENT PARAMETERS

There are different types of Fiber Bragg Gratings (FBG) based sensors that can be used with the WaveCapture™ FBGA System to measure temperature pressure, strain, acceleration and other data parameters. These sensors are immune to electromagnetic interference, resistant to harsh environments and have a capability to perform distribution sensing.

In FBG measurements, a broadband SLED elects an input light source. By measuring the peak wavelength shift of reflected signal from FBG, temperature, pressure, or strain value are calculated. In order to achieve accurate peak wavelength, the following principles should be observed to optimize the measurement parameters:

- Multiple FBG sensors in serial configuration require all FBG peaks to maintain adequate spacing to avoid wavelength overlap during measurements.

- Set SLED to high output power range, FBGA system sensor into **High Dynamical Range Mode**, integration time at 20 µs, and the power unit as **Intensity in Linear Scale** or **Intensity in Logarithm Scale**. SLED works best in a high power level. The sensor has a quick acquisition time and lower dark noise in the short integration time.

- Turn on SLED, disable background subtraction, and then take a snapshot measurement. The optimized FBG peak intensity should be from 50000 to 60000 counts.

- If the intensity count is larger than 65000 the FBG peak intensity is saturated. Reduce SLED output power or integration time to correct this issue.

- If the detected FBG peak intensity is too low, increase the integration time, but avoid setting integration time out of calibration range (about 40 ms in high dynamical range mode), during which the spectrum ripple correction is disabled. Switching the sensor mode to a high sensitive mode will add 15 dB gains compared with a sensor being in high dynamical range mode.

- To measure FBG peak wavelength, go to **System Setting** window select **Search Peaks with Uniform Threshold** and give peak search **Threshold** a valid numerical value. The **Threshold** value depends on the **Power Unit**. Valid values can be Count or dB.

- If the intensities of FBG peaks are in wide range, go to **System Setting** window select **Search Peaks with Profile Threshold** and matched profile threshold file.

- After selecting the optimized SLED output power, integration time, and sensor mode, turn off SLED and enable background subtraction. Acquire background using the ![icon] icon. Next, turn on SLED and take a snapshot or start continuous spectrum acquisition.

- You can automatically save all acquired spectra by checking **Auto Save Acquired Spectrum** in the **System Setting** window.

- You can monitor spectrum changes at a very low speed during continuous spectrum acquisition mode by setting a longer **Acquisition Interval (sec)**.

- To track FBG peak wavelength vs. time in continuous spectrum acquisition mode, select the stopwatch icon.

    ◦  This icon in the spectrum acquisition toolbar starts tracking peaks. Or select **Acquisition→ Start Peak Tracking vs. Time** to achieve the same action.

    This feature can track multiple peaks. The trace of peak wavelength vs. elapse time (sec) is shown in the spectrum viewer, trace data and measurement parameters will be updated in the data viewer.

- To track FBG peak wavelength vs. time at high speed and accuracy, select the projector icon.

    ◦  This button in the spectrum acquisition toolbar triggers the fast record mode to continuously acquire spectrum data. Or you can select **Acquisition→ Start Fast Recording** to achieve the same action.

    Combining the time stamp in the recorded binary file name (accurate to millisecond) with each spectrum line stamp plus the acquisition sample rate, the acquisition time for each spectrum could be calculated as: {Acquisition time = time stamp in recorded file name - (Total spectrum line number - spectrum line stamp) / sample rate}.

For Release 6/21/2023

# Troubleshooting and Technical Support

Before requesting support, perform the recommended checks and the troubleshooting procedures in this chapter. If you are still unable to resolve the issue and resume normal operation of the equipment, contact Technical Support. You can find the contact information for "Technical Support" on page 5-2.

## TROUBLESHOOTING CHECKLIST

| Symptom | Problem Indicated | Suggested Action |
|---------|-------------------|------------------|
| System initialization failed in starting Sense 20/20 | The system is not powered on. | Power on the system. |
| | The USB cable between the host PC and system is not connected. | Check the USB cable connection, and verify that the host PC USB port is USB 2.0. |
| | System USB drivers are not installed successfully. | Reinstall system USB drivers. |
| | The host PC does not recognize system hardware immediately after boot-up. | Wait approximately 60 seconds after booting up for the host PC to recognize system hardware before launching the Sense 20/20 software. |
| | Missing system configuration file in Sense 20/20 folder | Contact Technical Support |
| | Missing wavelength calibration file. | Copy wavelength calibration file from delivered CD to Sense 20/20 folder |
| Cannot find FBG peaks | Peak signal too weak | Increase peak intensity |
| | Integration time is too short | Increase integration time or set sensor to high sensitivity mode |
| | The peak search threshold is too high | Adjust peak search threshold |
| FBG peak intensity too low | Output power of SLED is too low | Increase output power of SLED (see Optional Feature Controls) |
| | FBG sensor is not connected correctly | Clean FBG sensor connector and check its connection |

| Symptom | Problem Indicated | Suggested Action |
|---------|-------------------|------------------|
| Found too many peaks | Background has not be subtracted | Subtract the background (see Background Acquisition) |
| | The peak intensity is too close to noise level | Subtract background and increase peak intensity |
| | The peak search threshold is too low | Increase peak search threshold |
| The peak FWHM is 511 | Background has not be subtracted | Subtract the background |
| Cannot print test report | Host PC is not connected to a printer | • Connect a printer to host PC <br> • Print report to PDF file <br> • Print report to XPS viewer file |
| All peaks disappear during data collection | ElectroStatic Discharge interrupts SLED | Toggle SLED in software (see Optional Feature Controls) |
| Data acquisition stops and system does not respond to menu start/stop commands | Fast transient bursts on USB cable, interrupting data flow to computer | Add 'High Speed' USB isolator between USB cable and computer. |

# TECHNICAL SUPPORT

For help using or troubleshooting products, contact the Advanced Energy Technical Support Organization (TSO). Proceed as follows:

1. Make a note of the serial number (SN) and part number (PN) listed on the product label.

2. To contact the TSO by email, address your message to mailto:technical.support@aei.com. In the body of the email, include the serial number (SN) and part number (PN) of the product and a description of your problem.

3. To contact the TSO by telephone, dial +1.866.865.5180 (toll-free in the United States of America).

4. To contact the TSO at its business address, write to:
   AE World Headquarters
   1625 Sharp Point Drive
   Fort Collins, CO 80525 USA

# Index

For Release 6/21/2023

For Release 6/21/2023