



# USER GUIDE

## Integrated & Smart IR Evaluation Software

(Applies to Version 3.0.0.0 & above)



**Version 2.0**

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**DOCUMENT REVISION RECORD**

| <b>Version</b> | <b>Issue Date</b> | <b>Change</b>   |
|----------------|-------------------|---|
| 0.0            | 10/06/2014        | Original Version Released. DRAFT Version.   |
| 1.0            | 25/07/2014        | DRAFT Beta released with the software for customers to evaluate.  |
| 2.0            | 11/11/2015        | Officially Issue User Guide for the Evaluation Software of INIR and SMIR.<br>(Applies to Version 3.0.0.0 & above) |
|                |                   |   |
|                |                   |   |
|                |                   |   |

**DOCUMENT ERRATA RECORD**

| <b>Version</b> | <b>Issue Date</b> | <b>ERRATA</b> |
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|                |                   |               |
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## Abstract

Both the Smart IR module and the Integrated IR have been designed with the latest technology, using a microcontroller unit with an ARM7TDMI core and via software design the necessary techniques have been implemented to increase the reliability of the device therefore minimize the probability of faults. The Smart IR and the Integrated IR are user friendly electronic modules and are designed to fit directly on to SGX Sensortech's existing Series 2 gas sensor product types like IR12GM\_1 or IR11GM\_1. The electronic module is designed to decrease the implementation time therefore increase productivity. The modules module incorporates the necessary electronics and embedded software to operate the infrared sensors from a low voltage DC power supply. The modules will sample the raw signals to output a linear, temperature compensated signal proportional to the gas concentration applied. The output signal is available in digital and analogue forms. Both the Smart IR module and the Integrated IR provide users with a simple method of incorporating an SGX Sensortech Infrared Sensor into their gas detection instrument which will significantly reduce the development time and expertise required during the design and implementation phases. The Smart IR and the Integrated IR can also be factory calibrated with the gas sensor to allow installation without the need for recalibration. The Integrated IR is by default calibrated in the factory unless otherwise required or ordered. The Evaluation Software designed to work with both the Integrated IR Digital Sensor and Smart IR Module.



# Introduction

The Smart IR has been designed to fit directly to SGX Sensortech's 7-pin single gas products like the IR11GM\_1 (Carbon Dioxide) and IR12GM\_1 (Methane), which both contain a supported lamp for additional shock protection. Containing the necessary electronics and embedded software to send the linearized and temperature compensated concentration via Digital (32-bit) and Analog (14-bits) outputs, the Smart IR Configuration Unit can be used to configure, calibrate and evaluate the Smart IR and the Integrated IR via the USB interface with an easy-to-use PC software interface.

Alternatively, control of the Smart IR and the Integrated IR via UART is available for communicating with an external microprocessor as well. The device itself contains full fault diagnostics, which are sent via the digital string along with the temperature output of the sensor and the linearized concentration.

## Summary of Contents

In the first chapter we can find a tutorial including the guidelines for using the Evaluation Software, included within the Evaluation Kit, is being presented. Many examples and screenshots are embedded into the document for further understanding of the software's tools as well as the installation process. The procedure is the same if we are using the Smart IR or the Integrated IR Sensor.

At the end of this document we can find attached a table of coefficients for all the SGX's Infrared Sensors that potentially can be used with the Evaluation Software or a custom made Evaluation Kit or instrument.

Please find attached also in the end an index table for quick reference to the important part of this document.

## Included in the Box

The Evaluation Kits were designed for easy testing and experimental measurements as well as for production use. We can see below in the Figure a screenshot of the Evaluation Kit and what is included inside the package. Obviously depending on the application and the ordering code the Gas Sensor type or other components may vary.



### Included in the Box :

- 1 x Smart IR Module or the Integrated IR Digital Sensor if ordered
- 1 x Gas Sensor ( IR12GM\_1/ IR11GM\_1 etc... ) if ordered with the Smart IR *Only*
- 1 x Configuration Unit with USB TTL Cable
- 1 x CD/DVD, containing the Smart IR Evaluation Software
  - 1 x Electronic Version of the Smart IR Datasheet
  - 1 x Electronic Version of any Smart IR Application Notes
  - 1 x Electronic Version of the Integrated IR Datasheet
  - 1 x Electronic Version of any Integrated IR Application Notes
  - 1 x Electronic Version of this Integrated & Smart IR Evaluation Software User Guide



# 1 | Integrated & Smart IR Evaluation Software

## 1.1 EVALUATION SOFTWARE INSTALLATION GUIDE

In the Table 1.1 we can find the minimum and recommended system requirements for the computer on which the Evaluation Software will be installed. Windows is the only Operating System (OS) that the Evaluation Software Currently is working.

**Table 1.1 - Evaluation Software Minimum System Requirements**

|                   | Minimum Requirements  | Recommended Requirements         |
|-------------------|---|----------------------------------|
| Processor         | Pentium III/Celeron 866 MHz   | Pentium core 2 duo or better     |
| RAM               | 1 Gb  | 3 Gb                             |
| Screen Resolution | 1024 x 768 pixels minimum   | 1280 x 768 Pixels minimum        |
| Operating System  | Windows XP/7/Vista (32- and 64-bit)<br>Windows Server 2003 R2 (32-bit)<br>Windows Server 2008 R2 (64-bit) | Windows 7/Vista (32- and 64-bit) |
| Disk Space        | 1 Gb  | 3 Gb                             |

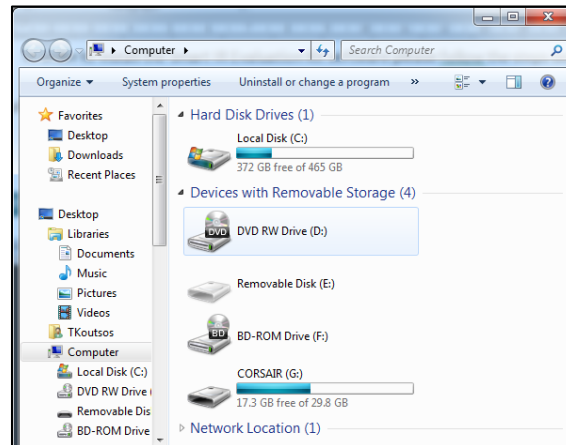
In order to use the Evaluation Software the TTL USB cable drivers should be installed in your PC. If you are using other operating system than Windows 7 or 8 with internet connection that can automatically find the drivers on the internet, please visit <http://www.ftdichip.com/Products/Cables/USBTTLSerial.htm> ,FTDi web site to download and install the appropriate driver for your operating system.

**IMPORTANT!**

The operating system that the Evaluation Software is targeting is Windows; there is no Evaluation solution for other operating systems at the moment.

In order to install the Evaluation Software please follow the steps below:

1. Insert the CD/DVD into the drive in the targeted computer.
2. If the autorun is not working open the CD/DVD Drive, found inside the **Computer** place that contains the Installation CD. See the Figure below:



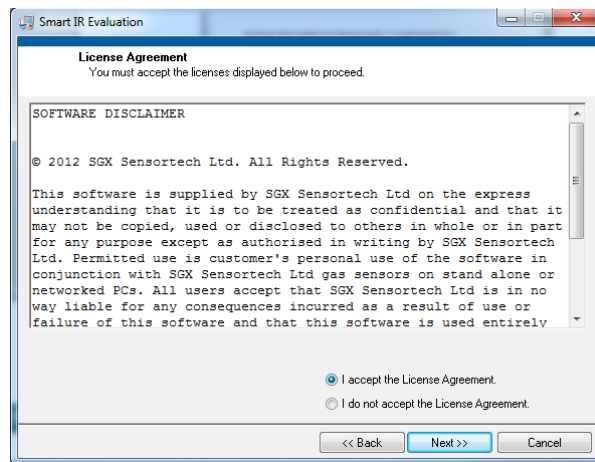
**Figure 1.1 – Open the CD/DVD in your Computer places**

3. Inside the CD/DVD find **setup.exe**, double click in order to start the installation.
4. See below the installation screenshots for more details on the installation process:
  - (a) **Choose the installation folder**, default is recommended



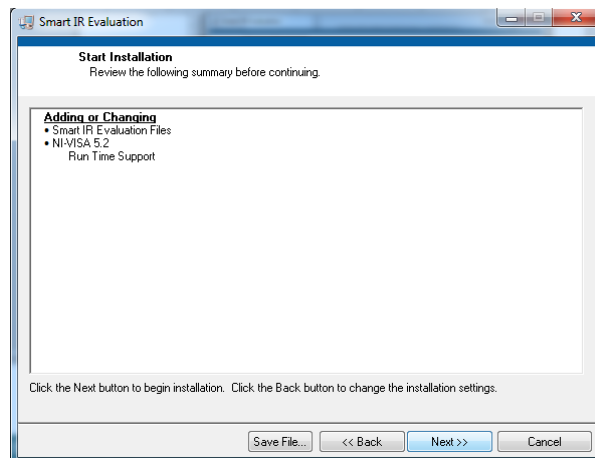
**Figure 1.2 – Choosing the installation folder for Evaluation Software**

(b) **Accept the License Agreement(s)**, press the next button.



**Figure 1.3 – Accept the License Agreement**

(b) **Start Installation**, press the next button.



**Figure 1.4 – Press next to start Installation Process**

(c) **Wait for the Installation to finish**, only takes a couple of minutes.

The installation will only take a few minutes depending on the processing power of the computer being used. Along with the appropriate files that the Evaluation Kit needs to install there are some Run Time machines for the NI Labview software. These files are required for the application to run independently inside any computer without the need for the full NI Labview Software to be installed. Please see the Figure 1.5 including a screenshot taken during and after the installation has finished.

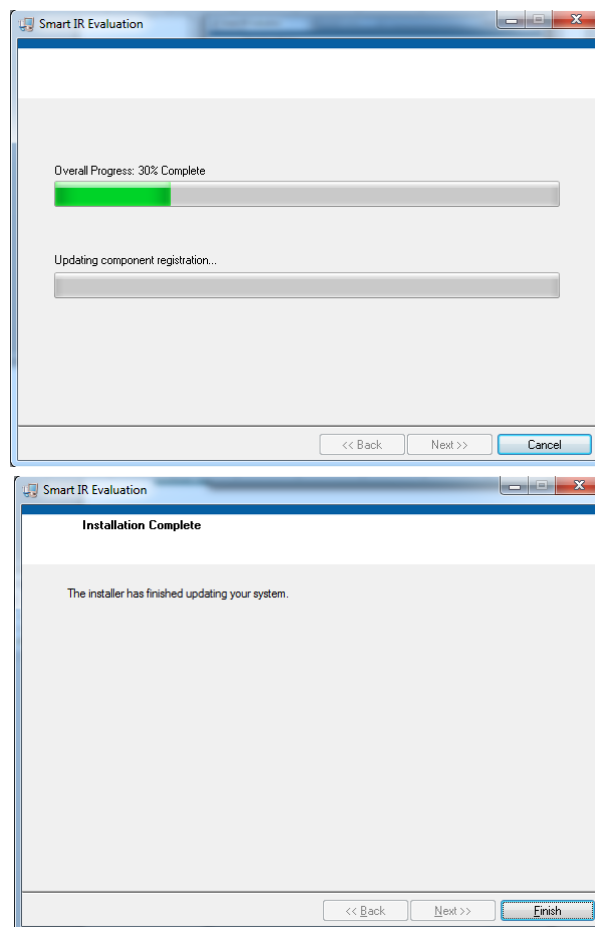


Figure 1.5 – Waiting for the installation to finish

(c) **Left Click on SGX Sensortech (Smart IR) -> Run as Administrator**, from the Start Menu -> All Programs -> SGX Sensortech (Smart IR) or desktop shortcut (see below).

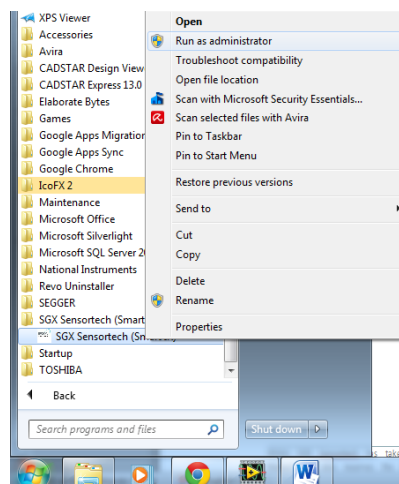


Figure 1.6 – Inside All Programs in Start menu

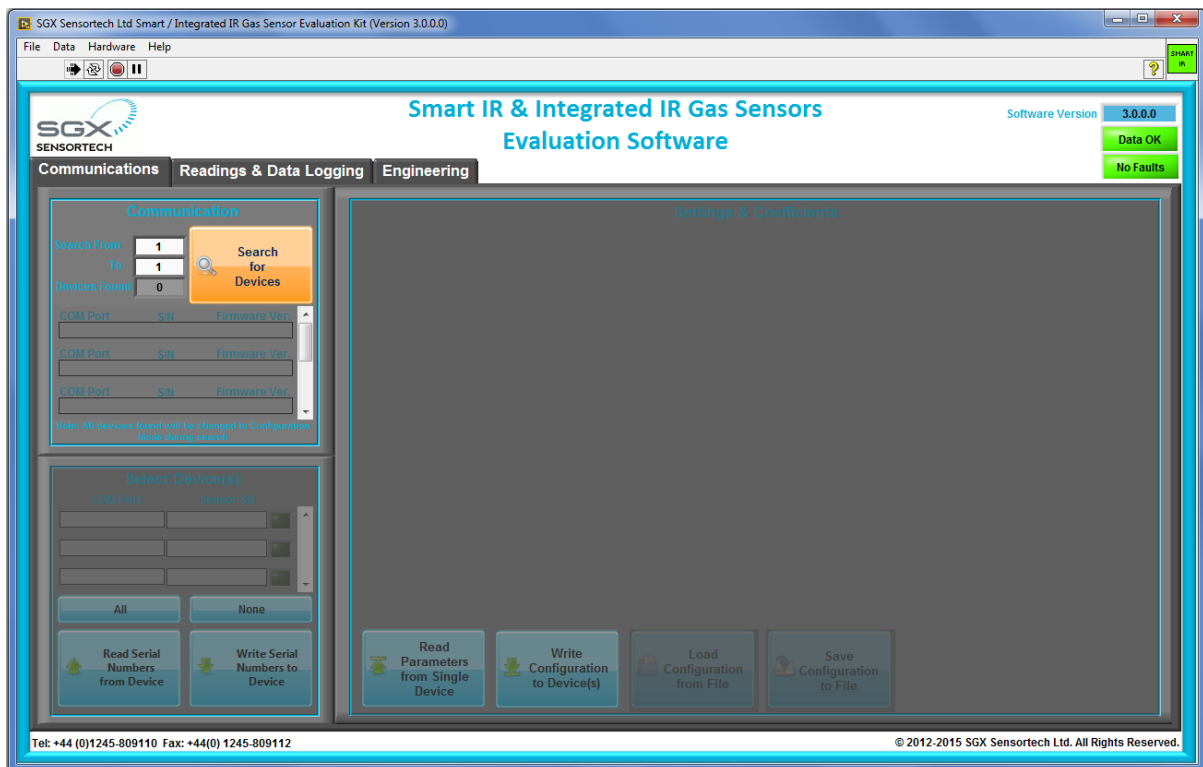
**1.2 USER INTERFACE of the EVALUATION SOFTWARE**

At the moment the current version of the Evaluation Software doesn't have a Production Tab but in the final release it will be possible to calibrate the Zero and the Span simultaneously to all the connected devices. The Graphical User Interface (GUI) is simple and has been designed to increase productivity and solve engineering problems quickly.

From the GUI it is possible to change the type of the values like the Temperature, in Celsius or Fahrenheit. There is the possibility to connect more than one Smart IR or Integrated IR Sensor and to read and change the settings to all of them at once. Moreover changing the coefficients can be done simultaneously by using a text file that contains the saved coefficients.

The readings can also be logged and saved into a specific file. For the beta version of the Software there is no option for logging the data coming from all the connected devices at present time, although there is a Table View where the data coming from all the connected Smart IR or Integrated IR Devices can be observed.

After running the application from the start menu or from the shortcut on our desktop we must be able to see the following window in the Figure 1.7 below. The window can be resized and fit most screen resolutions but a minimum of 1280 x 768 Pixels is recommended.



**Figure 1.7 – Screenshot from Evaluation Software**

## Menu Bar

On the top left hand side we can find a menu bar File|Data|Hardware|Help. In the Table 1.2 below we can find the functionality of each menu item or submenu items that exist on that bar.

**Table 1.2 – Menu Bar Items on the Evaluation Software**

| Menu Bar  | Submenu1                | Submenu2      | Description   |
|-----------|-------------------------|---------------|---|
| File →    | Show Scroll Bars        |               | Show the scroll bars in the window  |
|           | Print Window...(Ctrl+P) |               | Print dialog for the current window   |
|           | Exit (Ctrl+Q)           |               | Exit the evaluation software  |
| Data→     | Temperature Units →     | Celsius       | Shows the Temperature in Degrees Celsius (°C)   |
|           |                         | Fahrenheit    | Shows the Temperature in Degrees Fahrenheit (°F)  |
|           | Concentration Units →   | Percent       | Concentration in %vol of gas  |
|           |                         | PPM           | Concentration in ppm = 10000* %vol  |
|           | CSV File Delimiter      | Comma(,)      | The saved coefficient file will use comma (,) to separate values.                                 |
|           |                         | Semicolon(,;) | The saved coefficient file will use semicolon (;) to separate values.                             |
| Hardware→ | Update Firmware         |               | Perform update of the firmware to the connected device. (Currently Disabled for the Beta Version) |
| Help→     | Software Disclaimer     |               | Displays a software disclaimer statement.   |
|           | About                   |               | Displays the splash screen, with details about the software.                                      |

### 1.2.1 COMMUNICATIONS TAB

#### Configuration Unit (Connecting a device)

In order to connect with a device we must first correctly connect the Smart IR or Integrated IR Configuration Unit with the computer running Windows and installed the

drivers for the TTL USB cable. Make sure the Smart IR and the Gas Sensor is plugged onto the Board too, before powering up the Configuration Unit.

First choose the COM port for the program to search in order to find the device, then press the “Search for devices” button on the Communications Tab to search for new devices connected to the PC. If we don’t know the exact port, we could use a range from 1 to 6 for example but do not overdo it by using a range from 1 to 25 because the Evaluation Software will search all the COMs for a device even if there is none connected which will take some time. By pressing the “Search for devices” button the process will be initialized and all the devices found will be displayed in the “Found Devices” field on the right hand side. We will be able to also see the COM Port that the device is connected the Serial Number of the Device and the Firmware version installed in the Smart IR module or the Integrated IR.

Below we can see a screenshot of the Communications Tab and the process of searching of a new Smart IR or Integrated IR device.

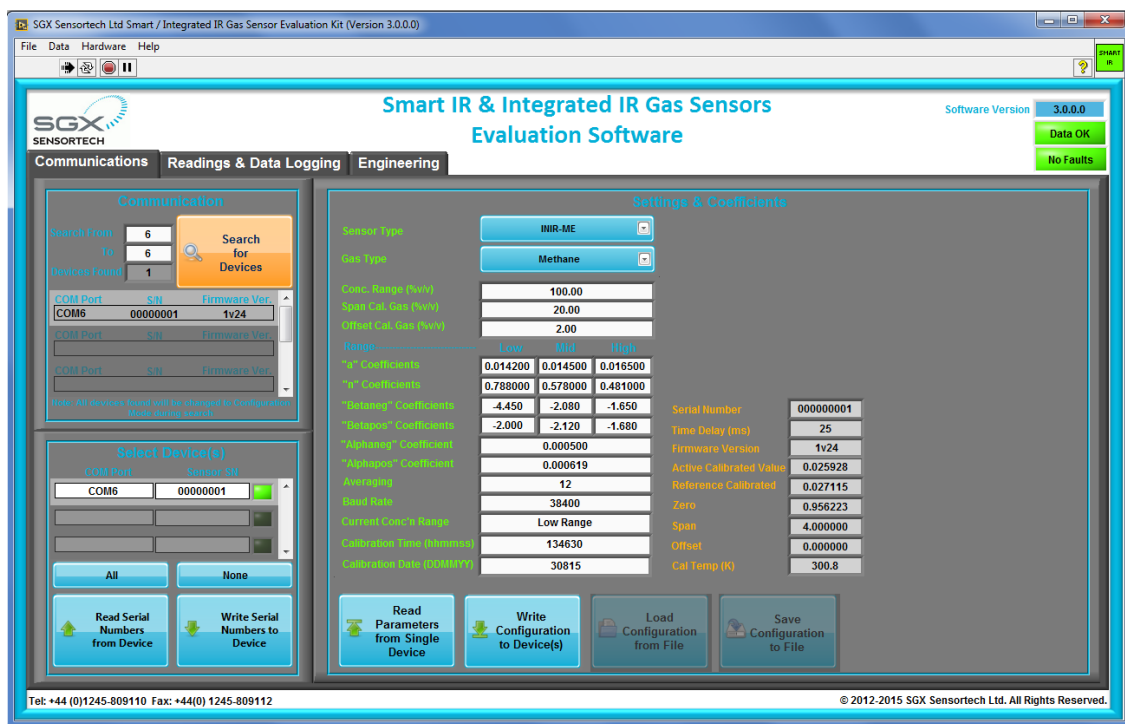


Figure 1.8 – Evaluation Software, “Communications Tab”

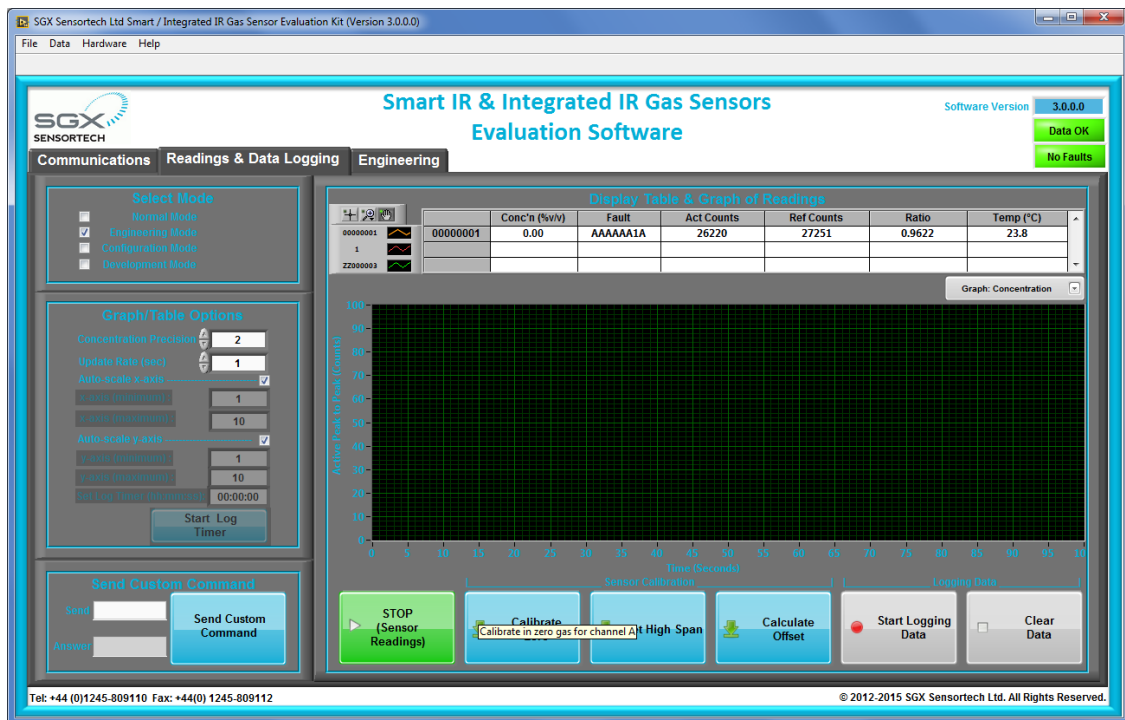
In the same Tab we can configure the devices that we have found under the “Settings & Coefficients” section. By default the connected devices should be initially in Configuration Mode, where we could be able to read and write the coefficients of each device. We can Read the coefficients from a Single Device with the ability to “Write” new coefficients to all the devices that are connected to the computer.

The configuration settings/coefficients can be saved to a text file to be used in the future and in the same way we can load settings/coefficients from a single text file. Therefore by having different text files for different sensors we can load and write the

configuration settings/coefficients effectively in all the devices that are connected to the computer. In addition to the above there are two ranges of coefficients that we can load, save, write or read, usually depending on the Concentration Ranges. For example we can have or create a text file that will include the coefficients for the low range of 5% Methane and the high range of 100% Methane. So each time we can choose a different range of coefficient depending on the application by clicking the Range 1 or Range 2 buttons at the bottom of the coefficients.

## 1.2.2 READINGS & DATA LOGGING TAB

In order to start evaluating the sensors we must set the device into “Engineering Mode” by setting the tick box, same think can happen by setting the device into Normal Mode but we won’t be able to see the Active and Reference counts. See below in Figure 1.9 the screenshot of the software solution in the Readings & Data Logging Tab.

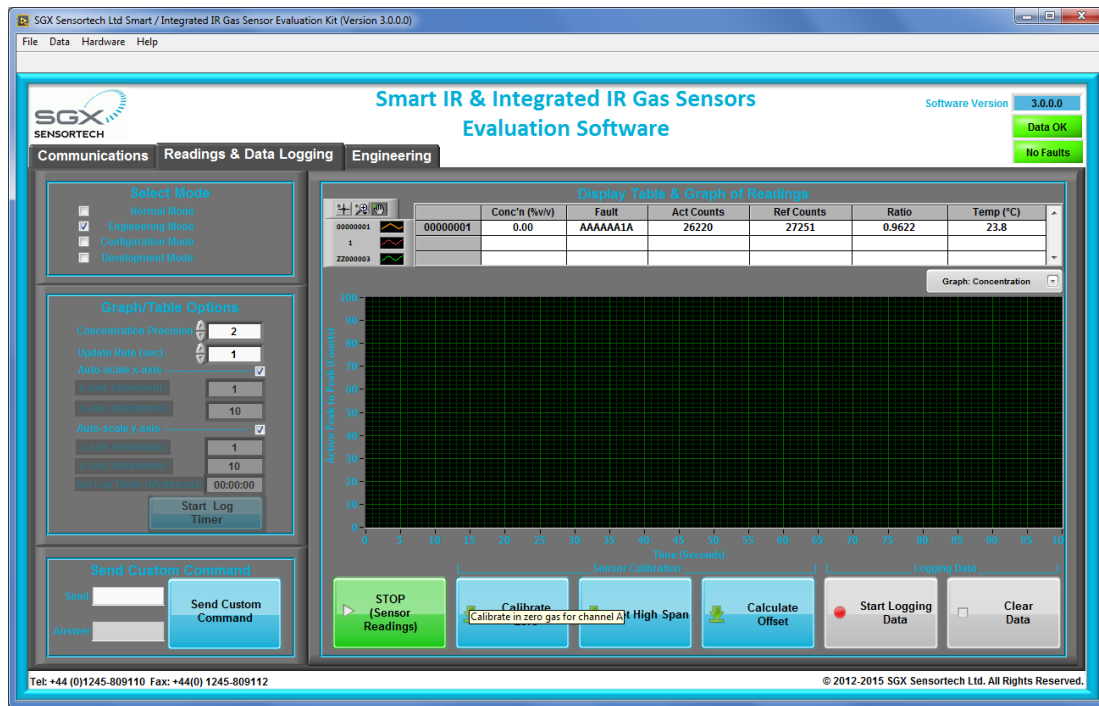


**Figure 1.9 – Evaluation Software, “Readings & Data Logging Tab”**

The Evaluation Software gives the ability to log the data coming from the Smart IR Module or the Integrated IR Sensor and to save it to a .csv type file.



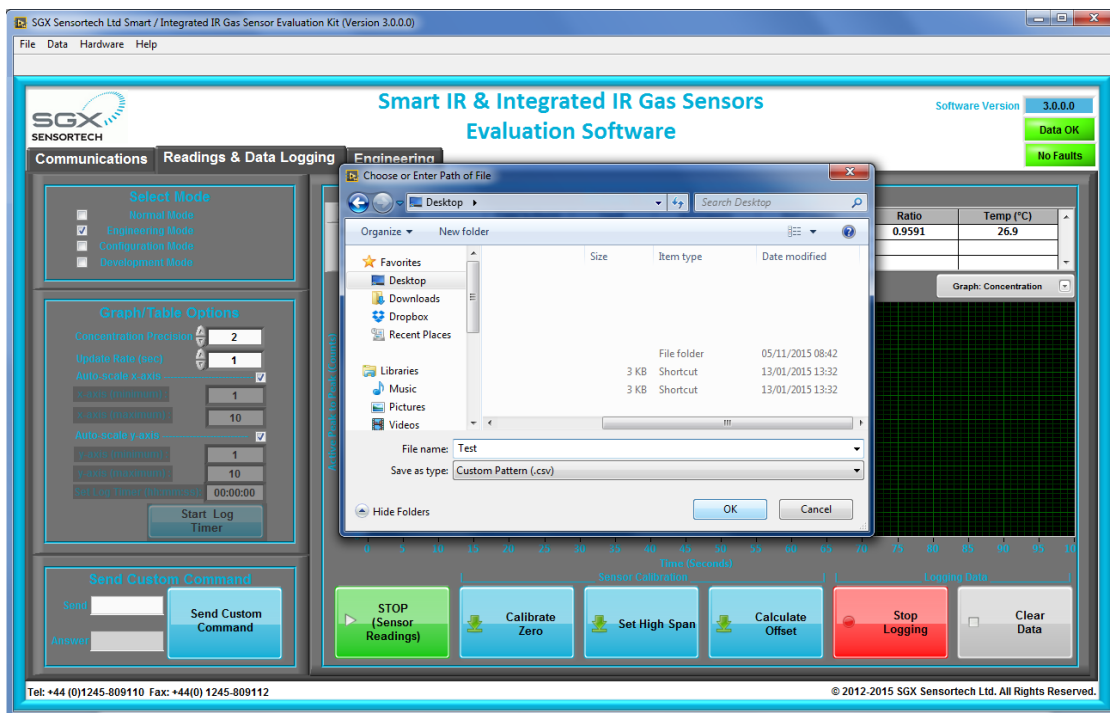
**Readings in Table View**



**Figure 1.10 – “Start” Button to be clicked in Engineering Mode, Table View**

**Data Logging the Readings & Graph View**

In order for us to be able to monitor the Sensor’s Readings we have to enable the data logging by pressing the “Start Logging” button. Doing so a new folder dialog will appear asking to choose the folder that the .csv file will be saved, see Figure 1.11.



**Figure 1.11 – Enabling Data Logging Function**

By enabling the data logging we are now able to see the Graphical representation of the data coming via UART against time in seconds while the readings are being saved second by second to the file that we have identified before. When enough logged data has been collected press the “Stop Logging” button. The process can be started again in the same way and the data saved to the same file by overwriting it or to a different file. The .csv files generated above can be opened by using Microsoft Excel or any application that can handle spreadsheets and therefore we can produce Graphs from the data and even plot different sets of measurements comparing the results from different settings.

In the “Readings & Data Logging Tab” it is possible to have at the same time a Table View and a Graph View of the elements that we are actually monitoring. By changing the “Graph View” roll down menu we can choose which Graph we want to observe but it is possible to see only one graph at a time and only from one Smart IR device or one Integrated IR Sensor. In case multiple devices are connected to the Evaluation Software solution then only the first one will be monitored in the Graph View although all of them will be visible to the Table View. In the Figure 1.11 we can see the Graph: Concentration while the Data logging is enabled in the “Readings & Data Logging” Tab.

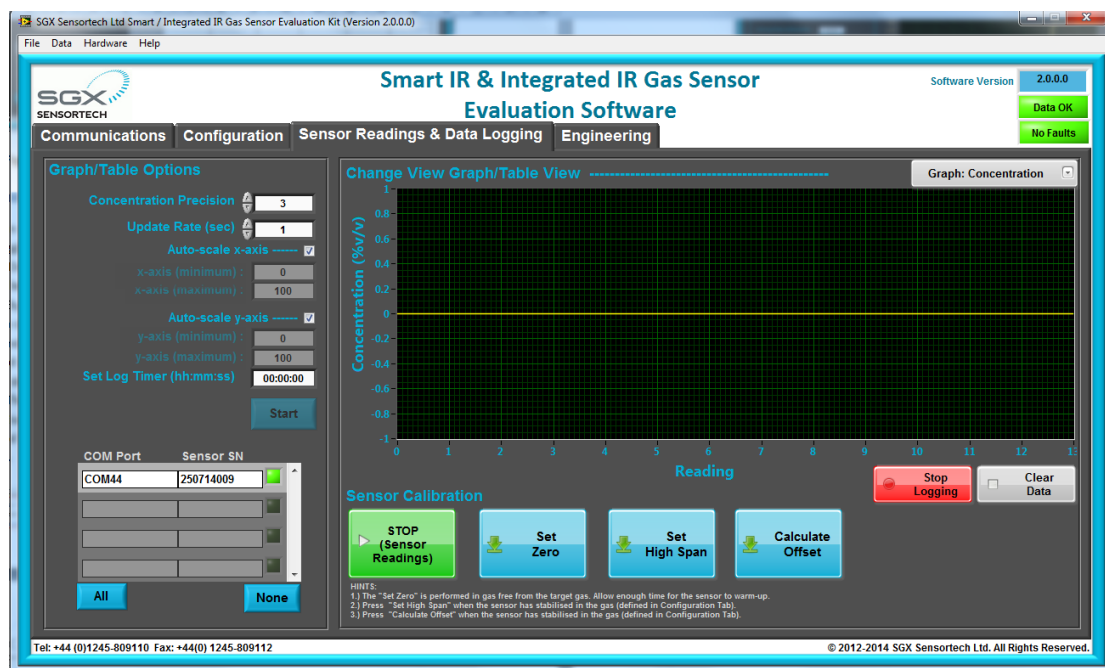


Figure 1.12 - Readings Send via the UART in Engineering Mode, Graph: Temperature

### Translating the “Faults” Code

The Fault is a 32-bit unsigned integer number that is representing all the errors either code or hardware related. The Fault is transmitted via the UART second in place after the Concentration in ppm. Each 4-bits of the Fault variable can represent different levels of errors so we can simultaneously monitor 8 different errors from 8 different parts in terms of

hardware or software. The association between the Fault variable and the different states of errors can be found below in the Table 1.3 – Faults/Errors Interpretation.

To interpret the Fault variable, first identify the Assigned Digit that we want to translate then the function/error that is representing from the column Associated Part and finally the Meaning of the error depending on the value of the digit.

**Table 1.3 – Faults/Errors Interpretation**

| Variable | Associated Part              | Assigned DIGIT | Error Meaning  | Value UART |
|----------|------------------------------|----------------|--|------------|
| Fault    | ALL Parts                    | <b>7 to 0</b>  | NO ERROR IN ALL PARTS (EVERYTHING OK ) <sup>*1</sup>   | 0xAAAAAAAA |
| ENABLED  | Gas Sensor                   | <b>0</b>       | NO ERROR   | 0x0000000A |
|          |                              |                | 01-Sensor not Present  | 0x00000001 |
|          |                              |                | 02-Temperature sensor not working <b>OR</b><br>Device Temperature Out of the Operating Range | 0x00000002 |
|          |                              |                | 03-Active or Reference are weak  | 0x00000003 |
|          |                              |                | 04-First Time Configuration Mode, no settings present  | 0x00000004 |
| ENABLED  | Power Related                | <b>1</b>       | NO ERROR   | 0x000000A0 |
|          |                              |                | 01-Last Reset was because of a Power on Reset  | 0x00000010 |
|          |                              |                | 02-Last Reset was because of a Watchdog Timer  | 0x00000020 |
|          |                              |                | 03-Last Reset was because of a Software Reset  | 0x00000030 |
|          |                              |                | 04-Last Reset was because of an External Interrupt   | 0x00000040 |
|          |                              |                | 05-Not assigned yet  | 0x00000050 |
| DISABLED | ADC Related                  | <b>2</b>       | NO ERROR   | 0x00000A00 |
|          |                              |                | 01-ADC is switched off   | 0x00000100 |
|          |                              |                | 02-Weak Signals Received   | 0x00000200 |
|          |                              |                | 03-Not assigned yet  | 0x00000300 |
| ENABLED  | DAC Related                  | <b>3</b>       | NO ERROR   | 0x0000A000 |
|          |                              |                | 01-DAC is switched off   | 0x00001000 |
|          |                              |                | 02-DAC output disable in Configuration mode  | 0x00002000 |
| ENABLED  | UART Related <sup>*2</sup>   | <b>4</b>       | NO ERROR   | 0x000A0000 |
|          |                              |                | 01-Break Indicator P1.0 set LOW for more than the maximum word length                        | 0x00010000 |
|          |                              |                | 02-Framing Error, stop bit was invalid   | 0x00020000 |
|          |                              |                | 03-Parity Error, stop bit was invalid  | 0x00030000 |
|          |                              |                | 04-Overrun Error, data overwrite before being read   | 0x00040000 |
| DISABLED | TIMERS Related               | <b>5</b>       | NO ERROR   | 0x00A00000 |
|          |                              |                | 01-Timer1 Error  | 0x00100000 |
|          |                              |                | 02-Timer2/Watchdog Error   | 0x00200000 |
|          |                              |                | 03-Not assigned yet  | 0x00300000 |
| DISABLED | General Error                | <b>6</b>       | NO ERROR   | 0x0A000000 |
|          |                              |                | 01-Main loop is not executed   | 0x01000000 |
|          |                              |                | 02-Not assigned yet  | 0x02000000 |
| ENABLED  | MEMORY Related <sup>*3</sup> | <b>7</b>       | NO ERROR   | 0xA0000000 |
|          |                              |                | 01-Unable to store Data, to the Device   | 0x10000000 |
|          |                              |                | 02-Unable to read Data from the Device   | 0x20000000 |
|          |                              |                | 03-Not assigned yet  | 0x30000000 |

\*1: It normal to get a Fault = 0xAAAAAA1A because the “1” in the second digit representing the Power on Reset process of the MCU which is a normal operation when we turn on the Smart IR or the Integrated IR

\*2: This is the function that will check the UART Status (COMSTA0) register, to produce a fault depending on the

previous experience. Obviously if the error is serious we will not be able to receive the message via UART, but we can check it later to find out what caused it.

\*3: The Memory will work correctly as long as the MCU is working but it will not be able to store the data in the flash upon reset, if the Error 01 is present. If we cannot read the Memory then check the Mode you are working, the memory cannot be read other than CONFIGURATION MODE.

### 1.2.3 CALIBRATION in “Readings & Data Logging”

In the same tab Readings & Data Logging we can perform the Zero Calibration Routine, the Span Calibration Routine and the Offset Calculation on the Device(s) we have selected on a left hand side (see Figure 1.12.)

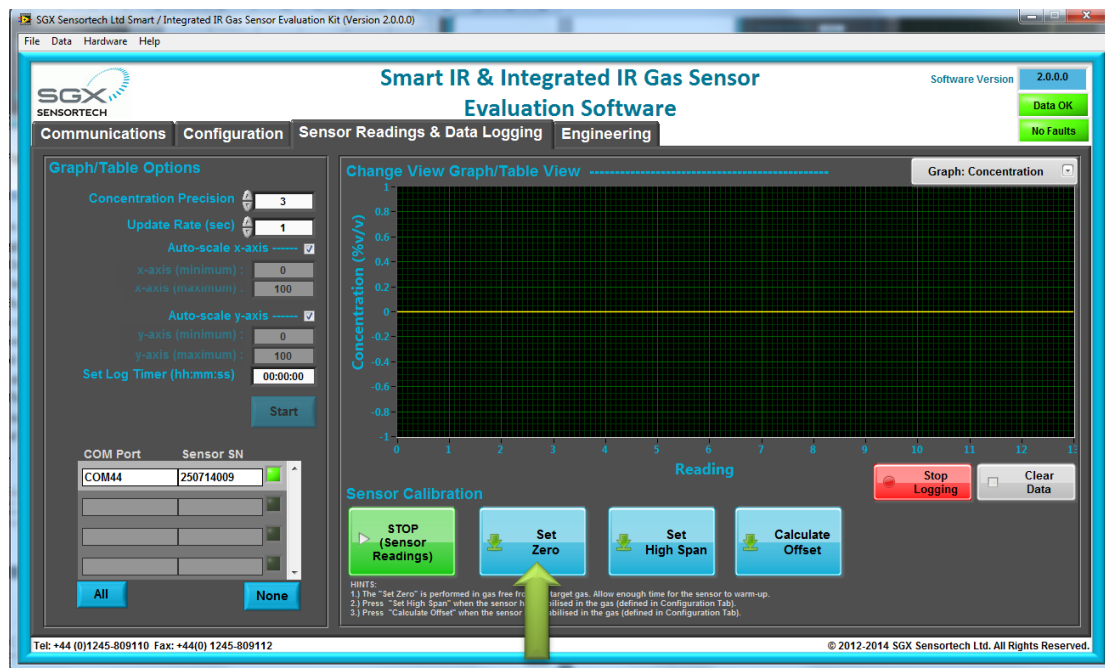


Figure 1.13 – Evaluation Software, Calibration Routine

### ZERO CALIBRATION

We can perform the “Zero” calibration routine by sending the correct command while the Smart IR or Integrated IR is in NORMAL or ENGINEERING mode. Please make sure that the value we have set in the configuration Tab matches the percentage of concentration of the gas used. Performing the Zero calibration with different percentage of concentration as default value comparing with the Gas Sensor type will result unstable readings and may cause false alarms as well.

### SPAN CALIBRATION

We can perform the “Span” calibration routine by sending the correct command while the Smart IR or the Integrated IR is in NORMAL or ENGINEERING mode, see

Application Note 1 and 2. Please make sure that the value we have set in the configuration Tab matches the percentage of concentration of the gas used. Performing the Span calibration with different percentage of concentration as default value comparing with the Gas Sensor type will result unstable readings and may cause false alarms as well.

**IMPORTANT!**

It is advisable to do the Span and Zero Calibration after we have left the sensor for 35-40 minutes to warm up.

It is important to perform both zero and span calibration routines in the same controlled environmental conditions of ambient temperature, humidity and pressure without strengthening the components above the maximum ratings presented into the technical specifications table.

Last but not least will be also advisable to perform the zero calibration under nitrogen gas first and then the span calibration exposing the sensor into the target gas that you want to detect. In both cases the Active and Reference counts representing the Peak-to-Peak voltage of the signals accordingly along with the temperature the moment of the calibration, are stored inside the Flash/EE memory of the Smart IR or the Integrated IR Sensor and can be read back by performing the appropriate command.

**IMPORTANT!**

Beware that selecting different concentration ranges via the Evaluation Software or with the low level microcontroller implementation, the steps of the calibration routine should be performed again. By changing the concentration ranges we only changing the coefficients for that range and not the stored data of the calibration; we have to perform a recalibration process anyway.

**Offset Calculate**

We can perform the “Offset” calculation by sending the appropriate command while the Smart IR or Integrated IR is in NORMAL or ENGINEERING mode. Please make sure that the value we have set in the configuration Tab matches the percentage of concentration of the Offset Gas used. Performing the Offset calibration with different percentage of concentration as default value comparing with the Gas Sensor type will result unstable readings and may cause false alarms as well.

**1.2.4 ENGINEERING TAB**

In the Engineering Tab it is possible to observe the incoming string of data via the UART each second. In the specific Tab we can also find information about all the settings

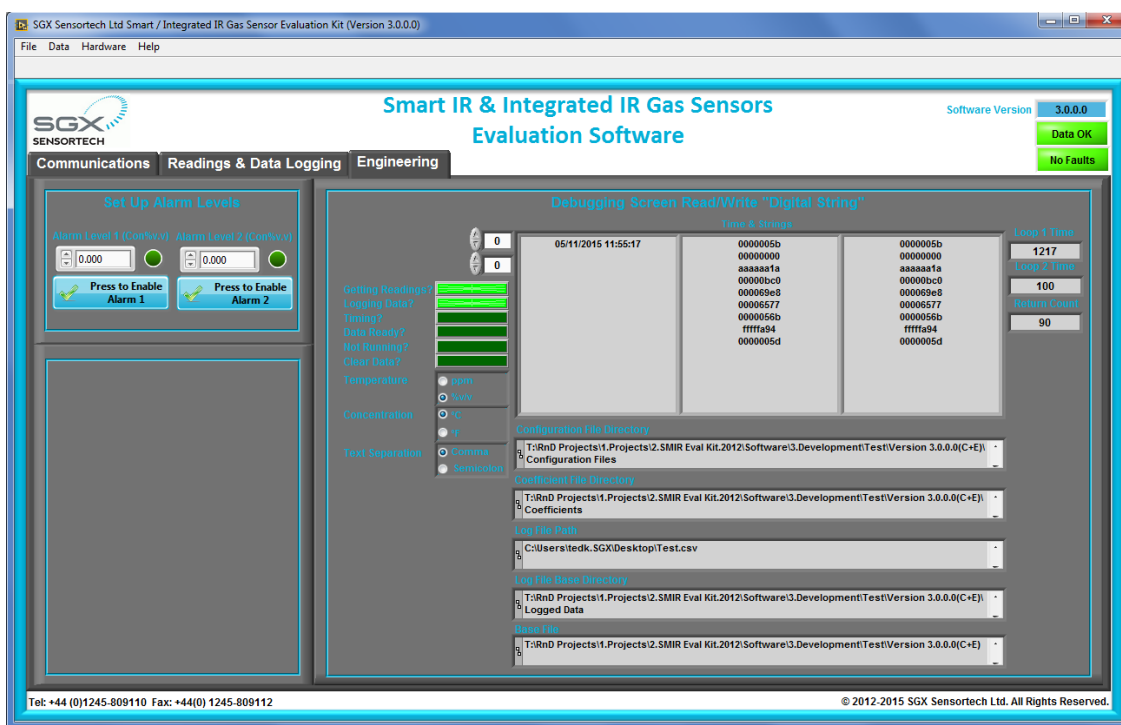
that are now valid on the Evaluation Application. Some of the information present at any given time is the Concentration, Temperature and Text Separation settings.

There are LEDs indicating the different conditions in real time of the received data, see in the Table 1.4 in the next page.

**Table 1.4 – LEDs Meaning in the Engineering Tab**

| LED Indicator      | Description - Meaning   |
|--------------------|---|
| Gettings Readings? | If the LED is on then the Readings are coming via UART                        |
| Logging Data?      | If the LED is on then the Readings are being logging in real-time             |
| Data Ready?        | Every time software receives data, LED is on, almost every 1 second           |
| Not Running?       | If data will not be updated in real time and the LED will be on.              |
| Clear Data?        | If we clear the data in the Graphs LED will be on instantly and the off again |

There are also three directories that we can see in the Engineering Tab and those are the “Coefficient File Directory”, which contains the text files of the range settings for the Smart IR Module or the Integrated IR Sensor. The “Log File Path” is the path name where the logged data is stored in the type .csv files. Final the “Log File Basic Directory” is the path, where by default the logged data is being saved. In Figure 3.13 that we can see everything that we have described before.



**Figure 1.13 – Evaluation Software, “Engineering Tab”**

In the right hand side there is a table view that includes date and time the data are being received. In addition to the above, we can see in the table the set of readings in hexadecimal format as they are being received in real time from the digital string output of the Smart IR or the Integrated IR Sensor.

# Appendix A

## Table of Coefficients

Please read the applicable Smart IR Application Note or the INIR Application Note for the correct ranges and the coefficient depending on the version of the Firmware that your Smart IR Module is utilizing. There are a few changes in coefficients from versions 1vX, 2vX, 3vX to the new version 4vX and above that. Always make sure you are using the correct coefficients as the performance of the Smart IR and the Integrated IR Sensor would be affected by those values.

**NOTE:**

1. These coefficients are based upon results measured at SGX Sensortech (IS) Ltd using standard test equipment. These coefficients may vary slightly when using different circuits. It may be required to recalculate some of these coefficients if small inaccuracies are observed during testing (refer to Infrared Sensor Application Note 5 for determination of coefficients).
2. For sensor variants with a “\_1” suffix (supported lamp versions), use the equivalent non-supported lamp version. For example for an IR11GM\_1, use coefficients for the IR11GM.

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