



Thin Film Pyroelectric IR Line Sensor Array Demonstrator Kit

For use with Pyreos packaged line arrays
with resolution of

1 x 128

2 x 128

1 x 510

4 x 20

User Guide

Version 02

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Contents

1	Introduction	4
1.1	Kit contents.....	4
1.2	Requirements.....	4
2	Installation.....	5
2.1	Device driver installation	5
2.2	Software installation	6
2.3	Quick start guide	7
3	Software user guide	8
3.1	Getting started.....	8
3.1.1	Connecting the software to the demonstration kit.....	8
3.2	Using and understanding the main display	9
3.3	Detector properties.....	10
3.3.1	Selecting the correct number of channels and IC to read from the line sensor	11
3.3.2	Selecting how to synchronise the line sensor to an IR light source.....	12
3.3.3	Selecting the correct timings for operating the line sensor	13
3.4	Display show rendering options dialog box.....	13
3.4.1	Demonstration kit data reader software object sub-system.....	14
3.4.2	Low pass filter sub-system.....	14
3.4.3	Normalisation sub-system.....	14
3.4.4	Range calculation sub-system	15
3.4.5	Main histogram display	15
3.5	Using oscilloscope view:	16
3.5.1	Oscilloscope display range	16
3.5.2	Oscilloscope menu.....	17
3.6	Saving data to a CSV file from the kit	17
4	Synchronisation of line sensor and IR LIGHT SOURCE	19
5	PC to Demonstration kit communications.....	22
5.1	Communications used.....	22
5.2	Data format.....	22
5.3	Kit commands.....	23
5.3.1	Start sending data	23
5.3.2	Stop sending data	23
5.3.3	Get the firmware version	23
5.3.4	Read the temperature from the demonstration kit	23
5.3.5	Change the baud rate	24

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5.3.6	Set a new operating frequency	24
5.3.7	Read the operating frequency.....	25
5.3.8	Change the operating settings	25
5.3.9	Read the operating settings	26
5.3.10	Set the VVR delay time	26
5.3.11	Set the VDR delay time.....	27
6	Line sensor kit hardware and jumper settings	28
6.1.1	Connector 3 – DC power supply	28
6.1.2	Connector 4 – Synchronisation connection	29
6.1.3	Connector 6 – RS-232 serial communications.....	29
6.1.4	Connector 7 – USB mini connector.....	29
6.2	Jumpers.....	30
6.2.1	Jumper 1 – LED 1 (Yellow) function.....	30
6.2.2	Jumper 2 – Microcontroller RX source.....	30
6.2.3	Jumper 3 – RTS input	30
6.2.4	Jumper 5 – USB power supply.....	30
7	Line sensor demonstration kit schematic.....	31
8	Appendix A data conversion equations	32
8.1	A-D voltage measurements.....	32
8.2	Temperature measurements.....	32
8.2.1	C8051F530 temperature measurements	32
8.2.2	Line sensor thermistor measurements.....	33
9	FURTHER INFORMATION AND SUPPORT	34
10	BUG FIXES	35



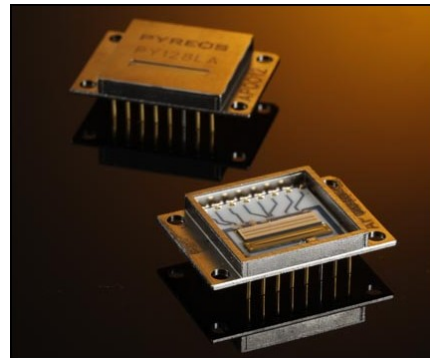
1 INTRODUCTION

This user guide describes the software, hardware and installation process for the PYREOS IR line sensor family PY-LA-S-XXX demonstration kit. It is intended to be used by electronics and software engineers who are familiar with IR sensor components and products. The guide is split up into several sections:

- installation and set up of the kit,
- software user guide,
- description of integrating electronics and sampling theory,
- description of the data produced by the demonstration kit ,
- hardware guide.



Sensor pcb board



Line Sensor

1.1 Kit contents

- Sensor pcb board PYB_001 V2
- CD with the demonstrator software
- USB cable
- 9 volt DC power supply

1.2 Requirements

- Computer (PC) running Microsoft Windows XP or Vista and has a CD Rom drive and one USB port available for use
- The .net framework version 3.5 or above
 - If you do not have it you can download it from www.microsoft.com
- Local administrator authority to install software and hardware drivers on a PC.



2 INSTALLATION

There are two software components required to use the demonstration kit. These are; the device drivers for the UART to USB Bridge which form part of the sensor pcb board, and the windows application software supplied with the kit.

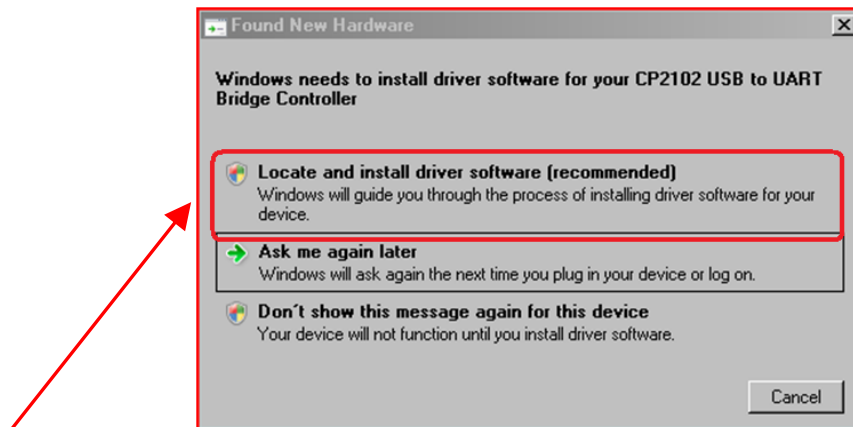
2.1 Device driver installation

This step is only required when the kit is first connected to your USB port, re-connections should work without requiring driver re-installation.

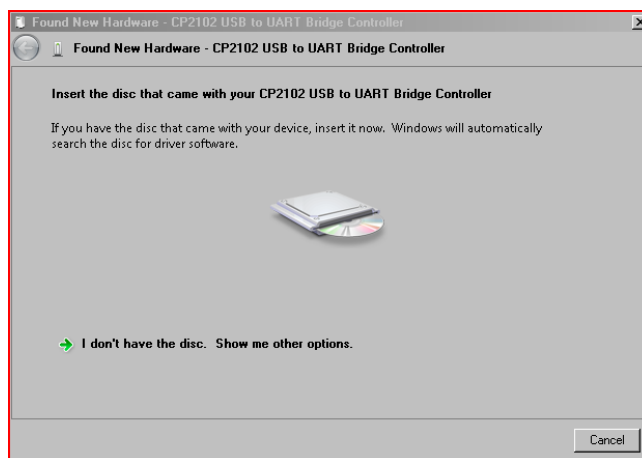
- 1) Connect the demonstration kit to the PC using the USB cable supplied.

Your computer will either connect to the Microsoft web site to download the correct drivers, or

You should see a pop up box like the one below appear.



- 2) Select "locate and install driver software"



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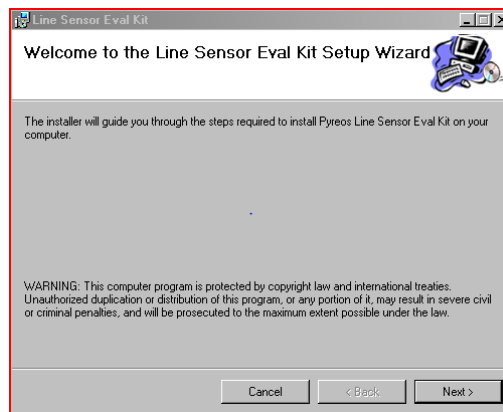


- 3) Either Insert the Pyreos CD that came with the development kit, or download new drivers for the CP2102 USB to UART chip from:

<https://www.silabs.com/products/mcu/Pages/USBtoUARTBridgeVCPDrivers.aspx>

2.2 Software installation

Run the file named setup.exe contained on the Pyreos CD included with the kit (or supplied by email). This will start a windows installer (shown below) which will guide you through the step-by-step installation procedure,



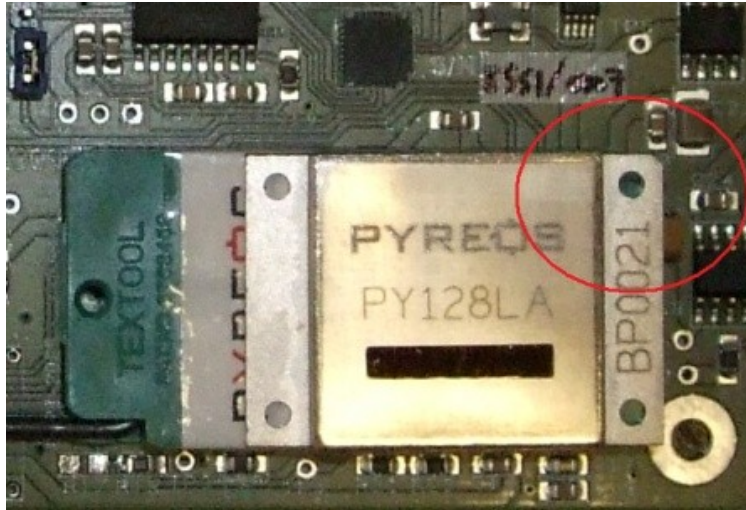
Follow the on screen instructions until the installer completes the installation. If you encounter problems installing please contact Pyreos and we will try to help you through the installation process.

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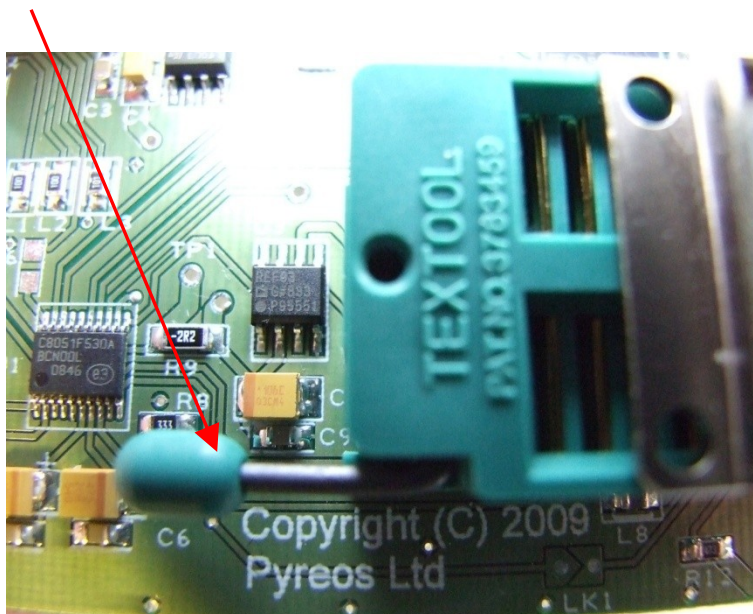


2.3 Quick start guide

- Install the software and device driver as detailed above.
- Place the line sensor in the socket with pin 1 (highlighted by the cut corner shown below) aligned with pin 1 of the socket (diagonally opposite corner from the lever).



- Push down to close the lever on the socket to secure the line sensor



- Connect the USB cable to your PC
- Connect the power to the demonstration kit
- Start the software (see user guide below)

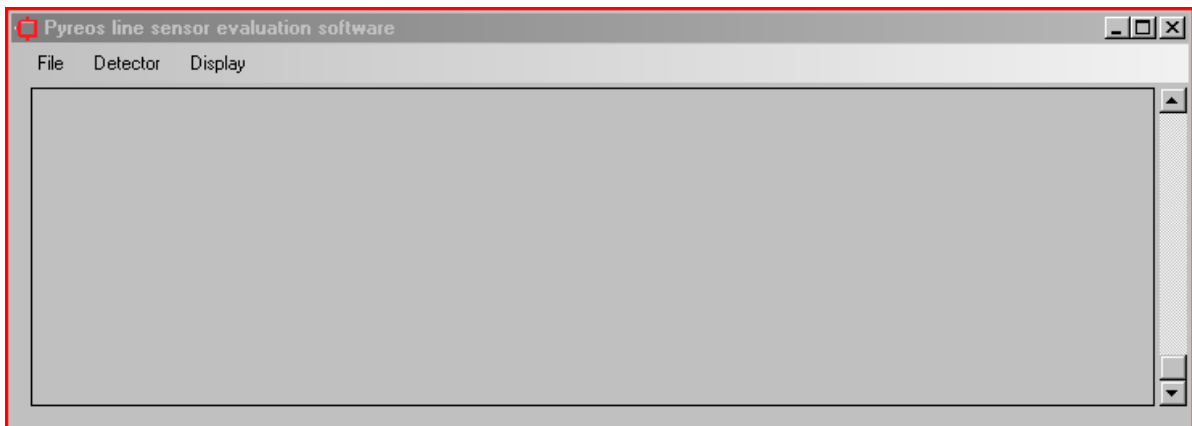
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3 SOFTWARE USER GUIDE

This section describes the software and how to use it with your line sensor and demonstration kit.

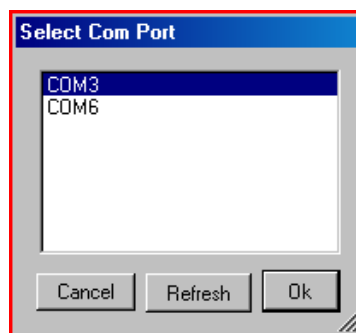
3.1 Getting started

This section describes how to start the software and get it communicating with your sensor pcb board. After completing the software installation you will find a link in your windows Programs menu to “Pyreos \ Line sensor evaluation kit”. Clicking this link will load the software, as shown below.



3.1.1 Connecting the software to the demonstration kit

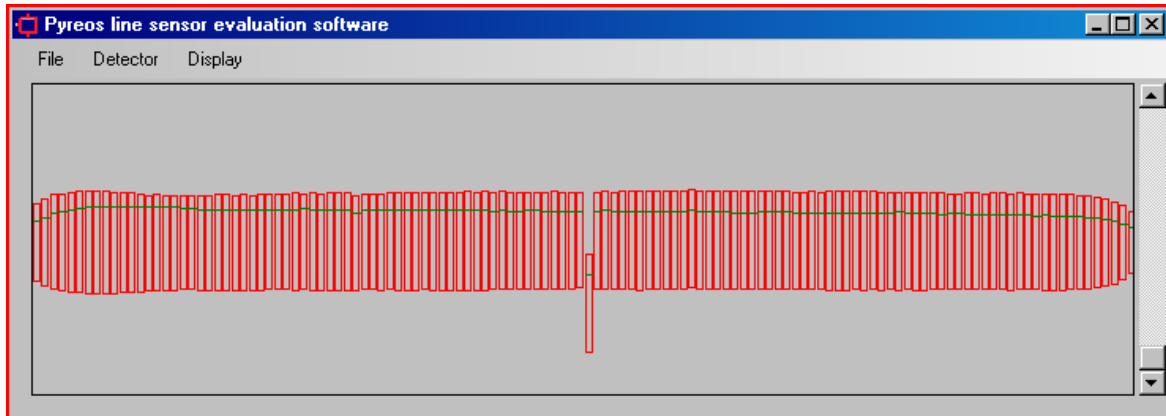
Having successfully installed the software, now connect the line sensor pcb to your computer and click “Connect” in the “Detector” menu. The software will display a dialog box (shown below) asking you to “Select Com Port” to use with the line sensor.



Select the relevant Com Port and click “Ok”. If you are unsure which Port belongs to the kit, try unplugging the USB cable from the computer and clicking “Refresh” (as shown above). Then reconnect the USB cable to the computer kit and click “Refresh” once again. This process should add a new Com Port to the dialog box list and the new Port is the correct one to use.

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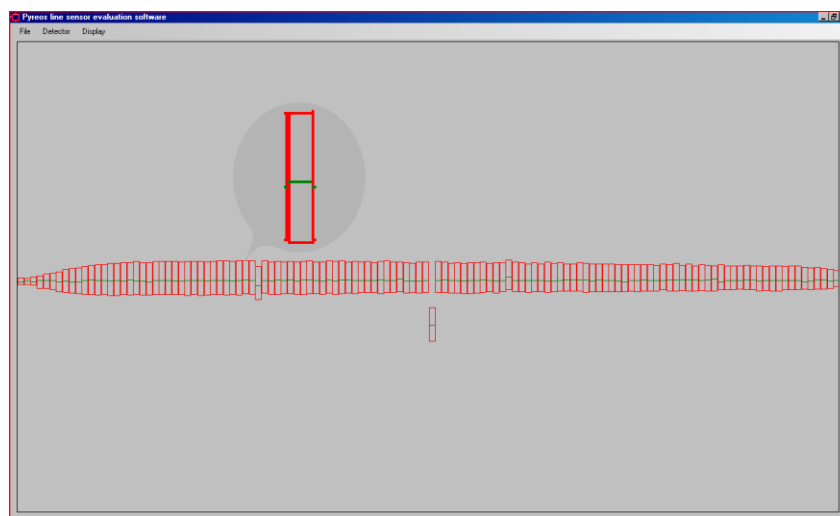
The software should now be connected and should start reading data from the line sensor. The data will be shown in the dialog box (as shown below) and will continuously update to display a changing histogram of data from all sensor elements (pixels) in the line sensor under evaluation.



Please note the software must be connected to and communicating with a demonstration kit as detailed in section 3.1 before any of the software functionality described in the following sections can be accessed. It is also important to disconnect the software from the demonstration kit BEFORE unplugging the USB cable from the PC, as failure to do this may result in the application ceasing to function correctly.

3.2 Using and understanding the main display

The main display of the software shows live data from the line sensor when connected correctly. When the default configuration is used, each sensor element (pixel) that is being read out from the line sensor under test, is shown as an individual red rectangle with a green line within, as shown below,.



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The lower and upper sides of the red rectangle represent the minimum and maximum values read from that pixel over a set number of recent samples, and the green line displays the present value. . The position of these values on the screen indicates the voltage read from the corresponding pixel, with 2.5V in the middle of the screen, 0V* at the bottom and 5V* at the top. Pixel 0 is located on the left hand side. **The values stated above only apply when the scroll bar at the right hand side is in the default configuration (at the bottom of the window).*

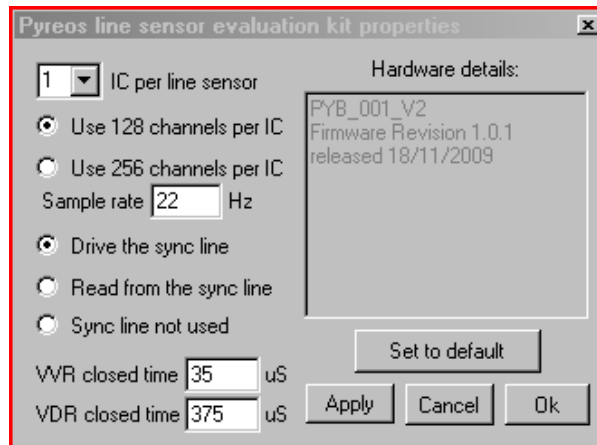
It is possible to change the voltage range which will be displayed on the screen by clicking or dragging the position of the vertical scroll bar up or down. When the scroll bar is at the bottom of the screen the display shows the full 0 to 5V range, and as it is moved up the range is reduced to 10mV, providing a zoom in function by moving the vertical scroll bar.

To examine the data from a single pixel, a virtual oscilloscope window can be opened by double clicking on any specific pixel(s), or by selecting the “Oscilloscope view” from the Display menu and then entering the desired pixel number in the dialog box. A further explanation of “Oscilloscope view” is provided in section 3.5.

Data from the line sensor under test can be displayed in several different ways using the demonstration kit software. The following sections describe how to select and use these options

3.3 Detector properties

The demonstration kit software is designed to support several Pyreos products and provide flexibility to the user during evaluation. This section details the different options available and what affect they have on the data available from the line sensor. Below is a picture of the dialog box that opens when the **Properties** option is selected from the **Detector** drop-down menu in the main window. Please note any changes selected from this dialog box will not take effect until the “**Apply**” or “**Ok**” button is pressed.



It is important to correctly enter the number of channels and the number of ICs for the line sensor under test in this dialog box,

3.3.1 Selecting the correct number of channels and IC to read from the line sensor

Pyreos produces several different line sensor products for example 1 x 128, 2 x 128 and 1 x 510 channel line sensors. Each line sensor product has either one or two integrated circuits (ICs) within the product package. The ICs provide all the necessary front end amplification circuits for each pixel in the sensor array. . For some products (for example PY-LA-S 128 channel line sensor), every second channel on the IC is missed out. The options on this page allow the user to specify the number of IC's to be read from the number of channels connected. The table below shows the correct configuration for the following Pyreos products when selecting from the **Properties** box above:

Product sensor resolution	Pyreos product code	Number of IC per line sensor	Number of channels per IC
1 x 128	PY-LA-S-128	1	128
2 x 128	PY LA-S-2x128	1	256
1 x 510	PL-LA-S-510	2	256
4 by 20	PY-LA 4 by 20	1	256

It should be noted that by design, the first channel of all IC's (only applicable when all 256 channels per IC are connected) will not provide real data, it is however included in the display software so as to replicate the end product integration requirements.



3.3.2 Selecting how to synchronise the line sensor to an IR light source

There are three different options available for synchronisation between an IR light source and the sample of the line sensor under test. The radio buttons in the **Properties** dialog box detail which option is being used by the demonstration kit and can be selected by the user. Section 4 of this user guide further details why IR light source and sample synchronisation is useful.

- **Drive the Sync line** *Synchronised with the demonstration kit driving the IR light source*
 - This option is typically used in spectrometer application where an electrically controlled IR light source is used to generate a pulsed signal for use with the line array.
 - When this option is selected the demonstration kit will drive a 5V square wave signal with a 50% duty cycle to pin 3 of Connector 4 on the PYB_001 V2 PCB.
- **Read from the sync line** *Synchronised with the IR light source driving the demonstration kit sample process*
 - This option is typically used when the IR source cannot be pulsed or is externally controlled. In these circumstances it is common to mechanically chop the incoming IR light with a rotating disk or shutter. This option allows an external square wave to trigger the sample timings.
 - Selecting this option configures the demonstration kit to read the TTL (5V) voltage level applied to pin 3 on Connector 4 of the PYB_001 V2 PCB. When an edge is detected the previous sample is taken and a new sample is started. After the new sample has been started the kit reads out data from all the pixels before starting to look for a new edge from the synchronisation line. The time this takes is dependent on how many channels of data are being read and the baud rate of the kit. The table below shows the minimum* times required for each of the 4 different settings available.

Number of channels	No IC's	Min (ms)	Max (ms)
128	1	3.88	1027
256	1	6.73	1027
128	2	6.96	1027
256	2	12.73	1027

*These timings assume that the software is able to connect to the demonstration kit at 921600 baud, which requires your PC to have sufficient hardware and memory resources.

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- **Sync line not used** Not synchronised
 - This option would typically be used if the line sensor is intended for use in an application where there is no a priori knowledge of the incoming signal, for example a thermal difference imager.
 - The demonstration kit will take samples from the line sensor at the frequency entered in the sample rate box on the dialog.

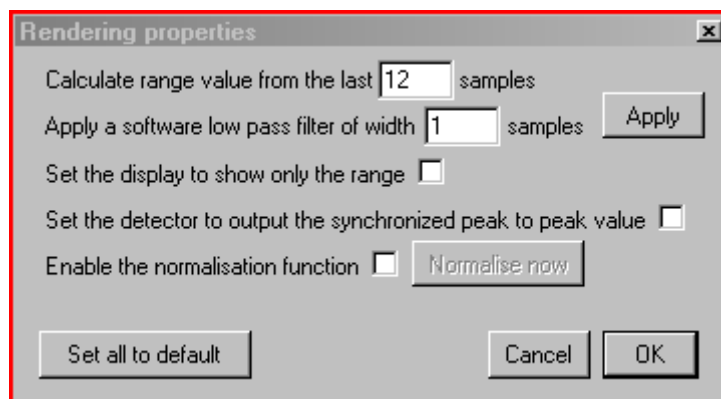
3.3.3 Selecting the correct timings for operating the line sensor

There are three different options available to select the timing of the line sensor electronics, VVR, VDR and sample rate. The VVR and VDR high timings are used to start a sample, further information on these can be found in your product datasheet. It is rare for these timings to be changed from the default values. The sample rate value dictates the sample rate measured in Hz, changing this value will alter the integration time used by the demonstration kit to collect data (This is only used when the kit is configured to either “Drive the sync line” or “sync line not used”).

Remember to click “**Apply**” or “**OK**” for changes selected from the Properties dialog box to take effect.

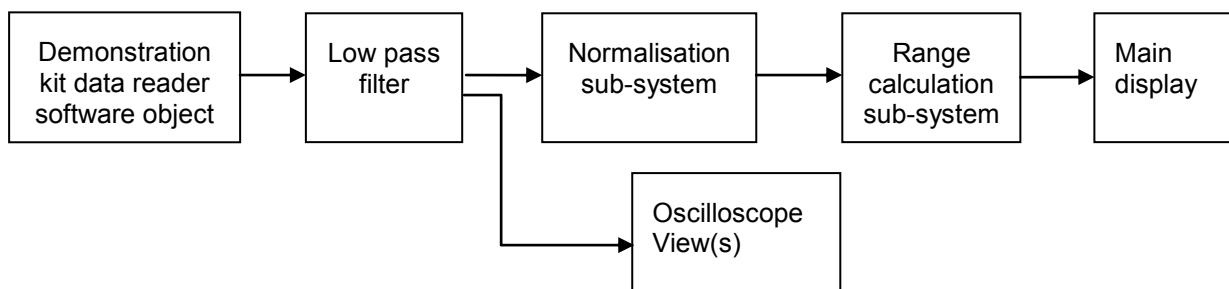
3.4 Display show rendering options dialog box

Pyreos software has several different options for displaying the data generated by the line sensor. These can be set using the “**Rendering properties**” dialog box (shown below). There are five options available in this dialog box each of which alters how the software processes and displays data from the line sensor.



To understand each of these options it is best to understand how the line sensor kit software functions. The flow chart below shows the processing steps conducted by the system when handling data from a Pyreos line sensor. Each section is further described below in sections 3.4.1-5

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3.4.1 Demonstration kit data reader software object sub-system

The software reads data from the line sensor via a virtual serial port. This data includes a value which tells the software whether the data originated from a high or a low pulse on the synchronisation pin (pin 3 connector 4). The software can be set to calculate the peak to peak value at this stage with the low value subtracted from the high value. This allows a peak to peak value to be found and filtered post magnitude calculation for applications which require this (for example spectroscopy).

3.4.2 Low pass filter sub-system

A software low pass filter is available to smooth data produced by the line sensor. This software feature stores a rolling buffer of data for each pixel in the line array. Each time it obtains a new value the oldest value is overwritten with the newest value, the new average is passed on to the software pixel normalisation and oscilloscope view sub-system(s). There is one software low pass sub-system for each pixel in the line array.

3.4.3 Normalisation sub-system

Pyreos software contains a normalisation function which is useful for evaluations aimed at analytical applications such as spectroscopy. Several features can affect the readings obtained from the different pixels including the selection of optical filter configurations. This can easily lead to one part (or group of pixels) of the line sensor array consistently producing stronger signals than other parts. The normalisation system can address these issues by applying a multiplication to the value of every pixel in the line array before displaying the result. By checking the “**Enable normalisation function**” box in the **Rendering Properties** dialog box this feature becomes enabled. The value used to multiply each pixel by can be reset by running the line sensor until it produces a stable reading and clicking normalise now button. This calculates a product for each pixel which will scale its value to 1000 based on the sample take directly after it is pressed.

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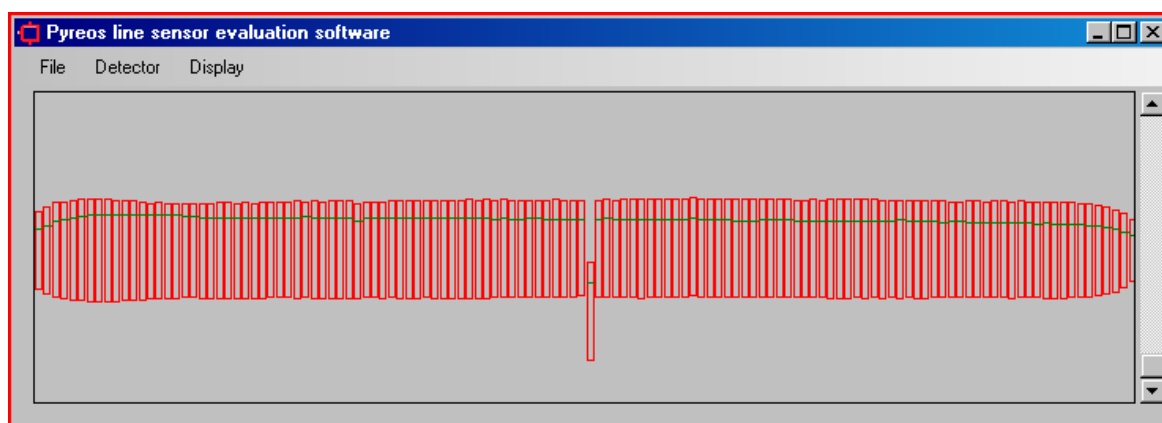
3.4.4 Range calculation sub-system

In order to display a histogram showing the magnitude (peak to peak) of each pixel it is necessary to establish over what time period this peak to peak should be calculated. It is not always the case that the line sensor sample is synchronised with the IR light source in customer evaluations. In these cases it is necessary to store a buffer of readings and scan this buffer to find the maximum and minimum values. The width of the buffers scanned to calculate these values can be set by entering a value in the “**Calculate range value from the last [] sample**” box. There is one range calculation sub-system for each pixel in the line array.

If the range is set to “1” then the software will assume that the maximum is the greater of 0 or the current value and the minimum value is the lesser of the current value or 0.

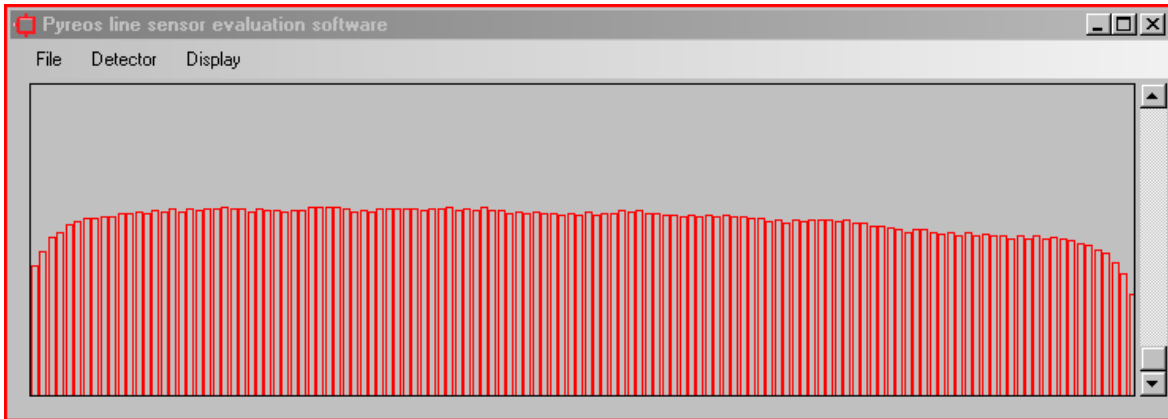
3.4.5 Main histogram display

The histogram display has two different display options firstly the default display which described in section 3.2 of this document, secondly the option to display only the range of values seen. The desired display option can be chosen by either checking or un-checking the “**Set display to show only the range**” in the dialog box. If the box is checked then the display will show the values without the green lines and will reference all the values to the minimum for each pixel. This allows an even signal to be displayed after accounting for pixels where a consistent offset is noted. The figure below shows the actual data from a line sensor.



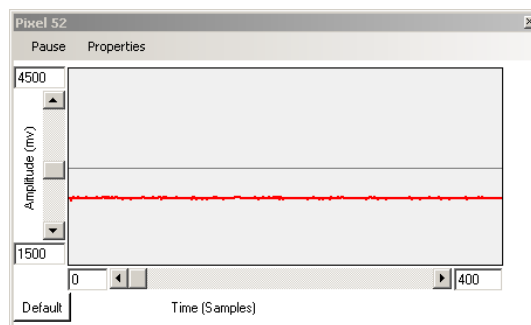
The figure below shows the same data when viewed with a range only display.

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3.5 Using oscilloscope view:

The Oscilloscope view software component (shown below) has several different features which aim to emulate a basic oscilloscope for viewing live sampled data from an individual channel of the line sensor. It is possible to open several individual oscilloscope views at one time on your pc.



The oscilloscope view component can be adjusted to enable the desired operation, on both the y-axis (amplitude) and the x-axis (time domain) maximum and minimum values can be entered in the appropriate boxes.

3.5.1 Oscilloscope display range

The amplitude and range of the signal being viewed can be changed in two different ways, first the max and min values can be entered in the boxes on the control (for both the x and y axis) or these can be set using the pc mouse control:

- 1) Entering the values in the text boxes
 - a. When entering the values the colour of the box will change to signify that the value in the box is not currently being displayed. When you have set the text value to the desired number press enter and the display will update (the text box changes back to white to signify that the value in the box is being used). If the new value is not

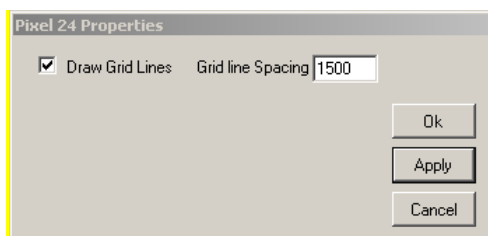
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accepted (for example if the minimum value is greater than the maximum value or text has been entered instead of a number) then the previous value will automatically re-load.

- 2) Using the mouse
 - a. When the Oscilloscope window has control focus (it can be selected by clicking on the title bar) the scroll bars at the side can be used to move the display position and zoom in or out. Zooming in or out is achieved by positioning the mouse over the scroll bar (horizontal or vertical) and using the mouse wheel. Moving the position is achieved by dragging the bar position.
 - b. The position viewed can also be adjusted in both x and y directions by holding down the right mouse button when over the viewing area and moving the mouse pointer (up, down, left or right).

3.5.2 Oscilloscope menu

- Pause/ Play
 - This allows the user to pause (or resume) the display update
- Properties
 - This allows the user to open a box (shown below) which controls the spacing of the horizontal grid lines (in mV).



3.6 Saving data to a CSV file from the kit

In the **File** menu there are two options to save data from the demonstration kit to a Comma Separated Value (CSV) file which can be opened by Microsoft Excel or similar software packages. Selecting the menu option **“Save to CSV”** will show two further options, **“Capture 200 samples”** and **“Capture until stopped”**. Selecting either will open a dialog box prompting you to enter a file name into which the data will be saved. After the file name is selected the demonstration kit software will automatically save data to this file. If the **“Capture 200 samples”** option was chosen the next 200 readings from the detector will be stored in this file and the software will then stop capturing data. If the **“Capture**

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until stopped” option was chosen then the software will store data to the file until the user opts to stop the data capture or the operating system maximum file size is reached. When the readings have been captured the software will display a dialog box stating that the software has finished recording the data. This function can be used to run a series of tests or optimizations.

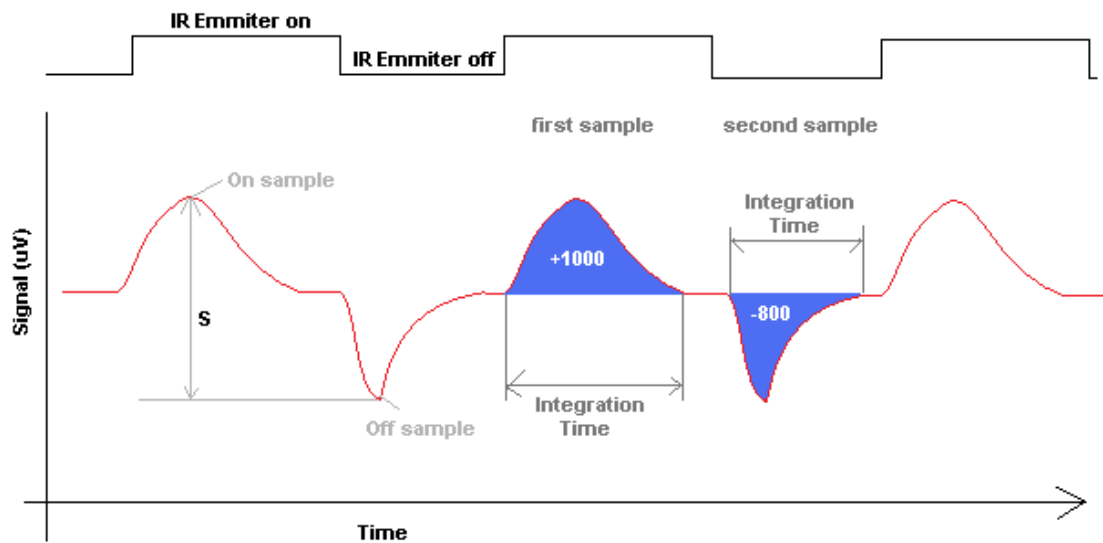
The data transfer can be stopped during the data capture by selecting the appropriate option from the **File** menu “**Stop capture**” which is only available when the software is capturing data to a file.



4 SYNCHRONISATION OF LINE SENSOR AND IR LIGHT SOURCE

The Pyreos line sensor is a pyroelectric detector and it detects a **change** in IR (temperature) not an actual temperature. In most line sensor applications the aim is to measure the maximum change in the IR signal. To do this we must synchronize the IR light source (emitter) and the detector.

Below is a signal/time plot of the signal produced by *one single sensor element* in the line sensor, in response to a synchronised IR light source. The diagram shows the IR light source pulse (square wave signal at the top) and the response of the sensor element (red signal below).

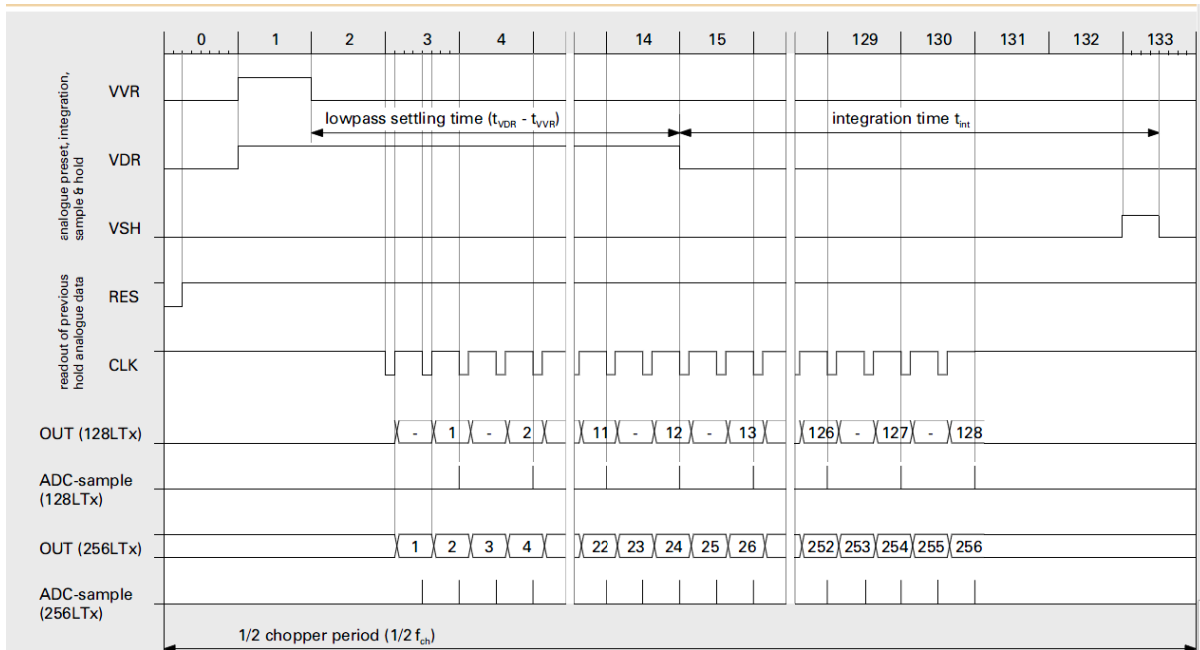


To calculate the maximum change in the IR signal it is necessary to measure the peak to peak signal size (depicted as S in the diagram). To achieve this, the signal is measured when the IR light source is on, and when the IR light source is off. The sensor response is the difference between the first sample (IR light source on), and the second sample (IR light source off).

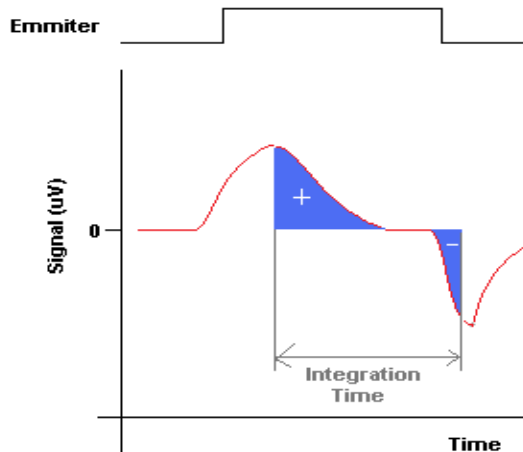
The blue coloured area illustrates how the integrating amplifier works in the line sensor package. The signal is summed during the integration amplification time. The voltage output is directly proportional to the area highlighted in blue. In order to achieve the maximum signal the integration time must coincide with the IR light source on and off pulses.

When the IR light source and detector sample measurement are synchronised the maximum signal is always measured and nyquist noise removed. The integrating amplifier electronics in the line sensor enable any small signals to be measured successfully. This is why the light source and detector must have their timing controlled accurately (synchronized) as described in the clocking diagram.

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The diagram below illustrates what would happen if the timings were not synchronized (bad arrangement). The integrated amplified response signal would not be correct, as half of the signal is +Ve and half -Ve and the sum of blue areas will be close to 0 (therefore no signal would be measured):

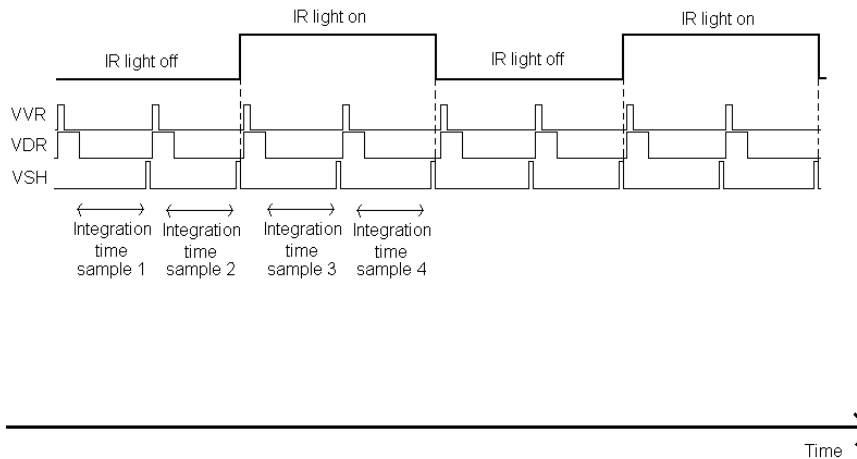


Connector 4, pin 3 of the Pyreos sensor pcb board PYB_001 V2 provides a software configured, input or output, synchronisation signal line for IR light source (see the sections on software and hardware for details).

For some applications operating the line sensor with only one sample in each of the IR light source “ON” and “OFF” periods may saturate the Pyreos sensor causing a reading error. When this occurs

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further optimisation by the User should be undertaken so that the peak to peak output rests at 3 Volts or less. If saturation is occurring it is beneficial to take multiple samples from both the IR light source ON and IR light OFF periods as shown in the diagram below.



In this case the peak to peak signal would be calculated as:

$$Result = sample\ 1 + sample\ 2 - (sample\ 3 + sample\ 4)$$

To maintain a useful sampling system it is important that the Pyreos sensor integration time stays within the range of 1ms to 100ms at all times. If saturation of the Pyreos sensor occurs the integration time should be reduced until no saturation occurs. By optimising the integration time and the sampling regime it is often possible to further improve the overall signal to noise ratio.

To find more information about sampling theory see link below.

http://en.wikipedia.org/wiki/Nyquist%E2%80%93Shannon_sampling_theorem



5 PC TO DEMONSTRATION KIT COMMUNICATIONS

It is possible to write software to communicate with the demonstration kit electronics directly without using the Pyreos software. This section describes the communications system and commands recognised by the kit. It also details the expected response from the kit.

5.1 Communications used

The kit communicates using UART; this is converted to USB using a silicon labs CP2102 UART to USB bridge and virtual com port drivers. The default settings for the demonstration kit are 115200 baud, 8 data bits, 1 stop bit, no parity, no handshaking. If the kit receives a command other than those detailed in this section it will return to the default baud rate settings. All commands and data sent to the kit are single byte commands, where a setting requires more than one byte of data the kit will request the data one byte at a time. It is necessary to wait for the kit to respond before sending the next byte of data or command.

5.2 Data format

When the demonstration kit is sending data it will continually send frames of data containing a two byte start of frame code and a 16 byte integer from each pixel being read (*when reading from a 128 channel single IC device there will be 2 bytes frame code followed by 256 bytes of data*). The framing code sent by the kit at the start of each frame will either be 0xFFFF* or 0xFFFE*. Which code is sent details the state of the sync input/output pin on the kit at the time of the sample, 0xFFFF* = 0V and 0xFFFE* = 5V. The remaining data is sent as (two byte) 16 bit unsigned integers, however the values are read directly from the 12 bit analogue to digital converter and as such will never rise above 0x0FFF* (decimal 4095). By this fact the data values can never be confused with the framing codes as it is impossible for a data value to have the same value.

When the kit is configured to read from one IC (for example when reading data from a 1 x 128 channel line sensor) the first value sent in will correspond to the first channel of the line sensor (the pixel nearest pin 1 of the device). Each subsequent pixel will correspond to the next pixel from the sensor.

When the kit is configured to read data from devices with two IC's the values read will not come in the same order. The first value read will come from the first pixel (next to pin 1), the second value read will come from the last pixel (furthest away from pin 1). For the remaining values the values read will alternate between odd pixels counting up and even pixels counting down as shown below.



The data integers are all in the range 0 to $(2^{12} - 1) = 4095$ and are generated directly from the a-d converter in the microcontroller. Each count from the a-d converter represents $\approx 1.2\text{mV}$ and is calculated by the equation below:

$$voltage = \frac{value * 5}{4095}$$

* All values preceded by "0x" are represented in hexadecimal notation.

5.3 Kit commands

This section details the commands which the demonstration kit responds to. All commands stated in single quotes (e.g. 'g') are case sensitive, encoded using ASCII and sent to the demonstration kit as 8 bit bytes. Text responses from the kit are encoded expressed in double quotes (e.g. "ok") they are encoded using ASCII and are terminated with a carriage return, followed by a new line character. All values preceded by the notation 0x are hexadecimal numbers encoded to 8 bit unsigned bytes.

The kit will also accept ASCII characters 'r' and 'w' which included to conformance with earlier revisions of the kit. The functionality of these commands is now managed through the operating settings detailed below.

5.3.1 Start sending data

Command to send from PC to kit = 'g'

After receiving this command the kit will start streaming data in accordance with its settings.

5.3.2 Stop sending data

Command to send from PC to kit = 's'

The will stop sending data after the current frame and integration cycle completes. It will then send the response "ok"

5.3.3 Get the firmware version

Command to send from PC to kit = 'v'

The kit will respond with a firmware description string for example "PYB_001_V2, Firmware Revision 1.0.1, released 18/11/2009"

5.3.4 Read the temperature from the demonstration kit

Command to send from PC to kit = 't'



The kit will respond with 4 bytes of data containing two 16 bit unsigned integers (most significant byte first). The first value represents the temperature reading from the thermistor on the Silicon labs C8051f530 microcontroller. The second value represents the temperature from the thermistor inside the line sensor package. Appendix A details the formulas required to convert these values into temperatures.

5.3.5 Change the baud rate

Command to send from PC to kit = 'b'

The kit will respond with

"Send baud multiplier i.e. baud rate = 115200 * x"

The PC should send a single byte from the table below indicating which baud rate the kit should change to.

Value to send	baud rate
1	115200
2	230400
4	460800
8	921600

The kit responds with "ok" and the kit then calculates if a reduction in sample frequency is required to stay within allowable operating parameters. If so the kit will then reduce the frame rate to the maximum allowable and send "*" however the sample frequency has been reset max allowable rate".

After sending this response the kit will re configure the UART to the new baud rate, and the same must be done by the PC. If any value not supported is sent then the kit will reply with "Unsupported baud rate" and its baud rate will remain unchanged.

5.3.6 Set a new operating frequency

Command to send from PC to kit = 'f'

The kit will respond with the string

"Send desired sample frequency in range 0-255 (0=1Hz, 255=256Hz)"

The PC should then send a single byte representing the desired sample frequency, the value sent will have 1 added to it by the kit, so sending the value 0 will set a sample rate of 1Hz and sending the value 255 will set a sample rate of 256 Hz.

The kit will either respond with

"ok" or "Insufficient UART bandwidth, the sample frequency has been reset max allowable rate" depending on the settings in place



5.3.7 Read the operating frequency

Command to send from PC to kit = 'F'

The kit will respond with a single 8 bit unsigned integer representing the sample rate -1 (so a value of 0 indicates a sample rate of 1Hz).

5.3.8 Change the operating settings

Command to send from PC to kit = 'S'

The kit will respond with the string "Send state byte"

The PC should then send a single byte representing the required operating state as described below.

The kit will then respond with "ok" or "state set ok, however the sample frequency has been reset max allowable rate" depending what the other operating parameters are set to.

Definition of demonstration kit operating state

Read all Channels	Read from two IC's	Not used	Not used	Is writing to the sync line	Is sending data	Is reading from the sync line	Not used
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0 (least significant bit)

Bit 7, Read All 256 Channels

If this bit is set to 1 then the kit will read all 256 channels from each IC, if it is set to 0 then the kit will only read every second channel from each IC starting with the second channel.

Bit 6, Read data from two integrated circuits

If this bit is set to 1 then the kit will read data from both output channels in the line sensor otherwise it will only read data from one output. This option should be set to 1 for all 510 devices

Bit 5, Not used

Bit 4, Not used

Bit 3, Is writing to the sync line

If this bit is set to 1 then the kit will write an output signal to the Sync line (pin 3 of connector 4), if this bit is set to 0 then the kit will hold the sync line at 0V. This bit is ignored if "Is reading from the sync line" bit is set to 1.

Bit 2, Is sending data



If this bit is set to 1, the kit will control the IC integration time, read and send frames for data to the PC. If the bit is set to 0 the kit will not control the IC or read and send data. This bit is also set by the firmware when the 'g' command is sent and cleared when any other command is sent.

Bit 1, Is reading from the sync line

If this bit is set to 0, the kit will time the integration cycle of the line sensor based on the sample rate set as described in section 5.3.6.

If the bit is set to 1 the kit will end each integration cycle when an edge is detected on the sync line (pin 3, connector 4). While the kit is operating with this bit set, the pulse width (both high and low) must be greater than period of the maximum sample time for the given demonstration kit settings*.

*This can be found by setting the operating kit to the maximum sample frequency as described in section 5.3.6 of this document and then reading the sample frequency actually set as described in section 5.3.7.

Bit 0, Not used

5.3.9 Read the operating settings

Command to send from PC to kit = 'T'

The kit will respond with a single byte representing the operating state as defined in section 5.3.8 above.

5.3.10 Set the VVR delay time

Command to send from PC to kit = 'V'

The kit will respond with the string "Send VVR delay most significant byte"

The PC should send the most significant byte of an unsigned 16 bit integer detailing the delay value as described below.

The kit will respond with "Send VVR delay least significant byte"

The PC should send the least significant byte of an unsigned 16 bit integer detailing the delay value as described below.

The value sent is converted to a delay time by the demonstration kit using the formula below. This is the duration of the high pulse on the VVR pin of the line sensor

The value must be between 0 and 16382 inclusive.

$$Delay_{\mu s} = 1.2 + 0.86 * value$$



5.3.11 Set the VDR delay time

Command to send from PC to kit = 'D'

The kit will respond with the string "Send VDR delay most significant byte"

The PC should send the most significant byte of an unsigned 16 bit integer detailing the delay value as described below.

The kit will respond with "Send VDR delay least significant byte"

The PC should send the least significant byte of an unsigned 16 bit integer detailing the delay value as described below.

The value sent is converted to a delay time by the demonstration kit using the formula below. This value is added to the VVR delay to determine the duration of the high pulse on the VDR pin of the line sensor.

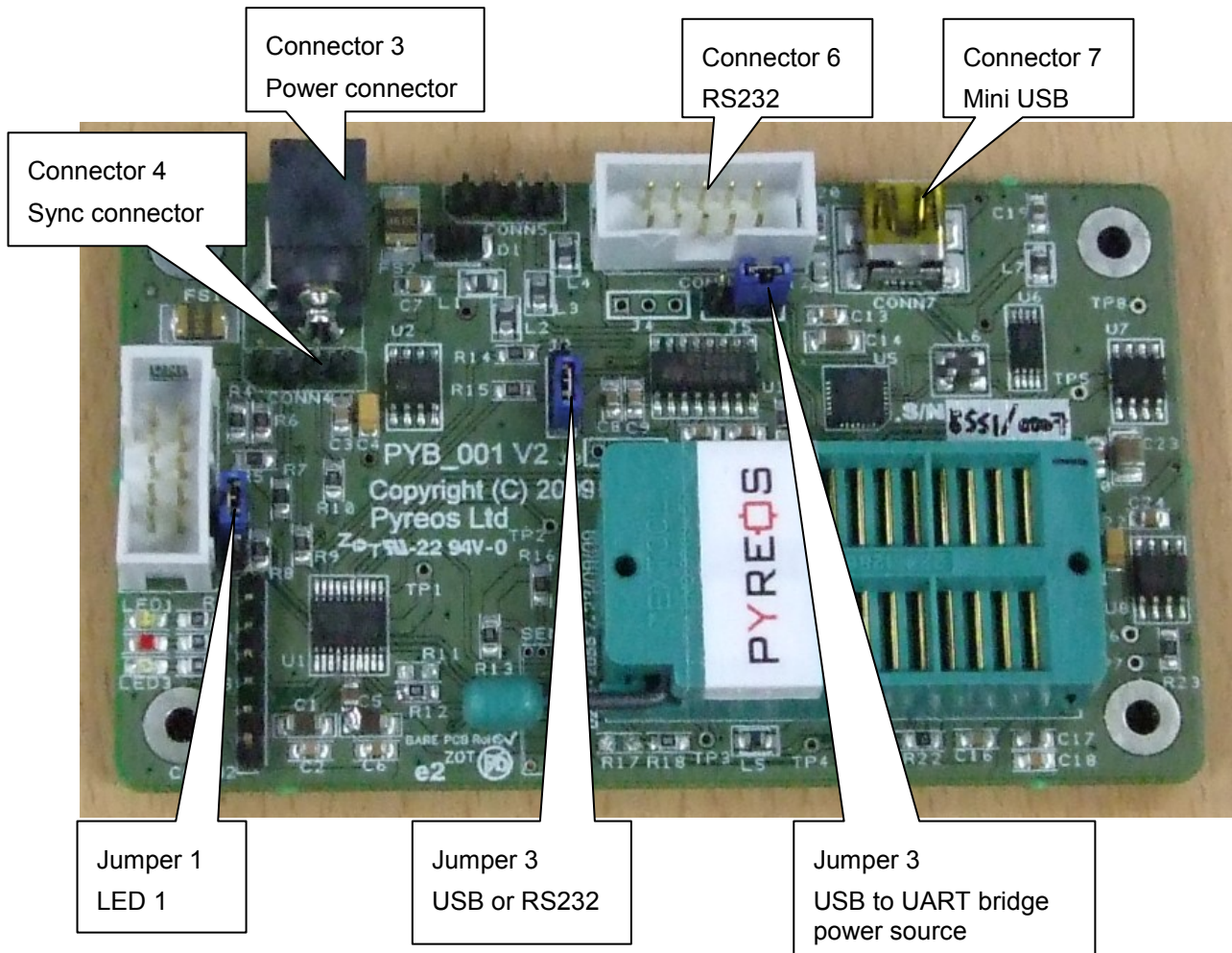
The value must be between 0 and 16382 inclusive.

$$Delay_{\mu s} = 1.2 + 0.86 * value$$



6 LINE SENSOR KIT HARDWARE AND JUMPER SETTINGS

This section describes the demonstration kit hardware; it details the use of the jumper and connectors on the PCB. It is important not to supply power to any pin detailed as **Direction “Out”** in the tables below.



6.1.1 Connector 3 – DC power supply

2.1mmØ centre pin positive.

Pin no	Signal	Direction
1	0V	In
2	No connection	
3	+9V DC	In

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6.1.2 Connector 4 – Synchronisation connection

4-pin SIL header.

Pin no	Signal	Direction
1	9v DC	In/Out
2	VDD5V	Out
3	SYNC	In/Out
4	GND	In/Out

6.1.3 Connector 6 – RS-232 serial communications

The RS232 driver included on the kit has a maximum rated speed of 230400 baud. Pyreos recommends not using it for communications with the included software.

10-pin DIL header.

Pin no	Signal	Direction
1	No connection	
2	No connection	
3	Txd	Out
4	No connection	
5	Rxd	In
6	No connection	
7	No connection	
8	No connection	
9	GND	Out
10	No connection	

6.1.4 Connector 7 – USB mini connector

Pin no	Signal	Direction
1	Vbus	In
2	D-	In/Out
3	D+	In/Out
4	No connection	
5	Ground	
6	100MΩ to Gnd	
7	100MΩ to Gnd	
8	100MΩ to Gnd	
9	100MΩ to Gnd	



6.2 Jumpers

Yellow background indicates the default jumper setting.

6.2.1 Jumper 1 – LED 1 (Yellow) function

Jumper	Function
1-2	LED 1 indicates 5v power supply on
2-3	Port pin P0.6 (C2D) controls LED 1

6.2.2 Jumper 2 – Microcontroller RX source

Jumper	Function
1-2	Received data on SCI sourced from USB (CP2102)
2-3	Received data on SCI sourced from RS-232

6.2.3 Jumper 3 – RTS input

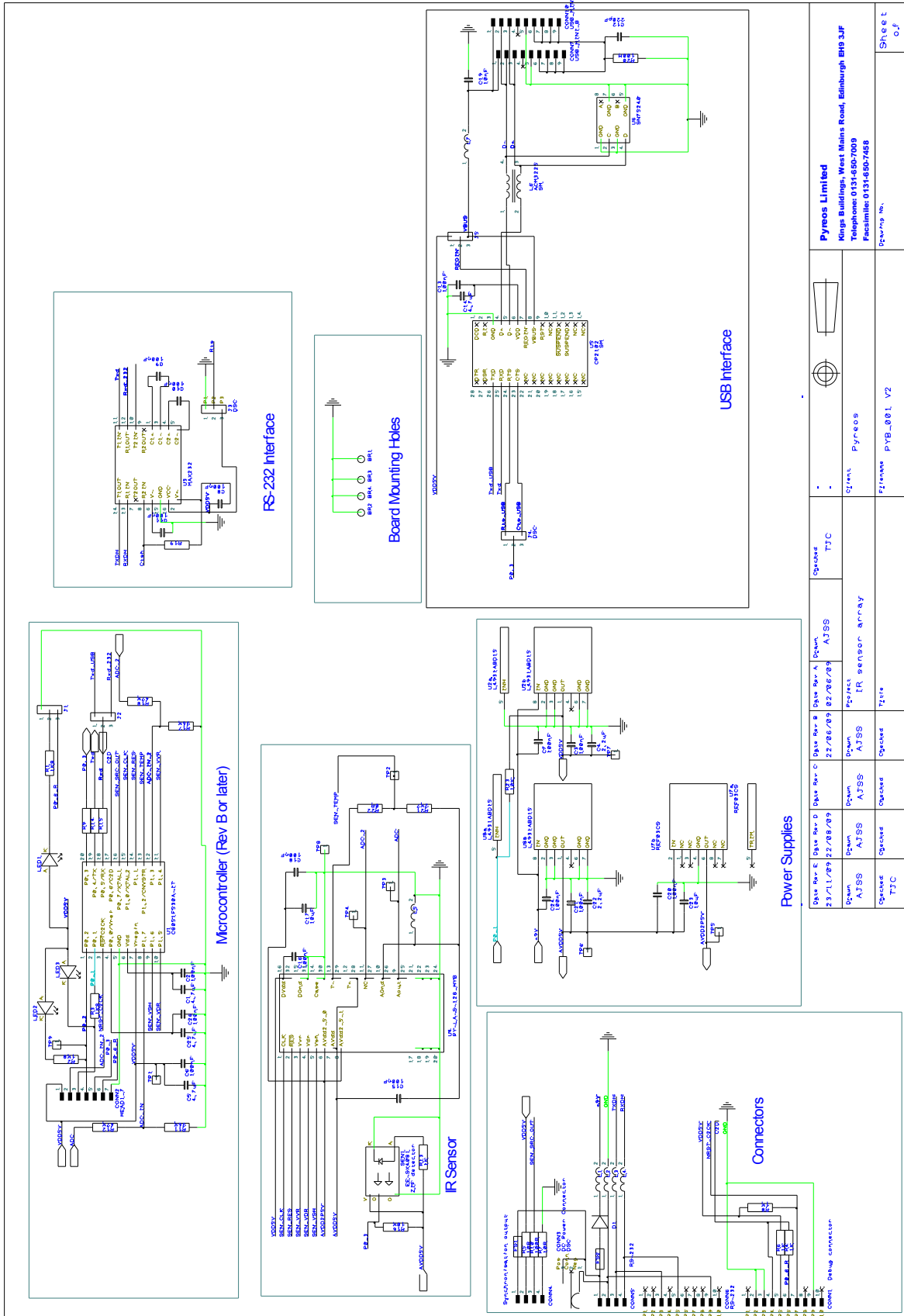
Jumper	Function
1-2	RTS input connected to ground
2-3	RTS input connected to 5v DC supply

6.2.4 Jumper 5 – USB power supply

Jumper	Function
1-2	CP2102 powered from VCC 5v board supply
2-3	CP2102 powered from external USB



7 LINE SENSOR DEMONSTRATION KIT SCHEMATIC



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8 APPENDIX A DATA CONVERSION EQUATIONS

8.1 A-D voltage measurements

Each time the demonstration kit takes a reading it uses a 12 bit analogue to digital converter. The values are sent as a 16 bit unsigned integer (two bytes) with the most significant byte first. The following equation details the conversion of A-D counts to the corresponding voltage at the A-D input.

$$\text{Volts} = \frac{\text{value} * 5}{4095}$$

8.2 Temperature measurements

The kit provides a facility to measure the voltage at its input from the line sensor thermistor. This section details the interpretation of the data set by the demonstration kit. When the temperature values are measured two 16 bit integers are sent by the demonstration kit to the PC as detailed in section 5.3.4 The first value represents the temperature as measured on the silicon labs microcontroller which operates the demonstration kit. The second value sent, details the voltage measured at the output from the line sensor thermistor.

8.2.1 C8051F530 temperature measurements

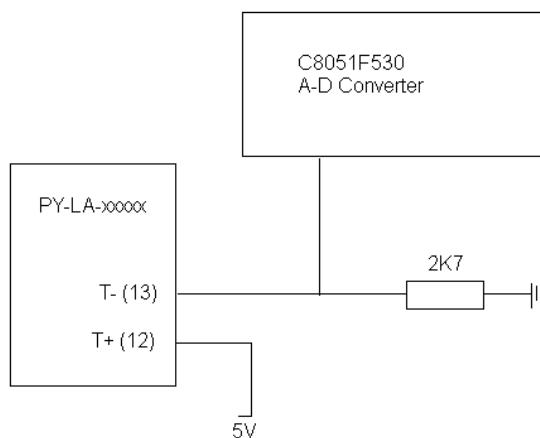
The temperature sensor in the C8051F530 provides a voltage which is linearly proportional to the actual temperature of the microcontroller as detailed by the formula below, count is the unsigned integer received from the demonstration kit.

$$\text{Temperature (centigrade)} = \left(\left(\frac{\text{count} * 5}{4095} \right) - 0.89 \right) * 0.00284$$



8.2.2 Line sensor thermistor measurements

The temperature sensor in Pyreos line sensor is connected to the A-D in the microcontroller using the circuit below. It is necessary to refer to the Pyreos line sensor datasheet to establish the voltage to temperature relationship for the product in use.





9 FURTHER INFORMATION AND SUPPORT

Pyreos can provide further information and application support to help progress a customer's development plans. Please contact us for further information or a quotation for these services.

If you encounter any difficulties with the kit please contact;

E-mail: Tim.chamberlain@pyreos.com Tel.: +44 131 650 7762

If you require a quotation for application support and development services please contact

E-mail: jeff.wright@pyreos.com Tel.: +44 131 650 7009



10 BUG FIXES

Please report any issues to Pyreos so that we can provide updated software via our web-site.

Firmware:

version 1.0.1 released 18/11/2009

Bug description: Intermittent issue when configuring the kit to read from the synchronisation line.

Symptoms: 50% of the time the evaluation kit is configured to read synchronisation signals from the synchronisation line it will fail to read the synchronisation signal correctly.

Fault diagnose: Connect a resistor (1K to 10K ohms) between pins 2 and 3 of connector 4 and measure the voltage on pin 3, if the voltage is approx 5V the evaluation kit will operate correctly, if it is near 0V then the kit will not operate correctly.

Fix options / work around:

- 1) Ensure that the evaluation kit is configured to write to sync line and streaming data, stop the kit streaming data so that the last frame received contains the frame code 0xffff, the problem will not occur.

or

- 2) If problem occurs try resetting the evaluation kit to write to the sync line then start the kit streaming data (allowing only one frame to be read before resetting it to read from the sync line) this should fix the problem.

or

- 3) Upgrade windows software to version 1.0.2.3 or later

version 1.0.2 released 22/11/2009

No reported Bugs

Windows software

version 1.0.1.2 released 22/11/2009

Bug description: User interface bug with rendering properties dialog box

Symptoms: The normalise check box fails to correctly update when it is checked and the dialog box is re-opened.

Work around: re-select the desired setting and click apply

Bug description: Detector properties dialog won't always allow the maximum possible frequency

Symptoms: If the detector was previously configured to work with a high pixel device (e.g. two IC's and 256 channels/IC) and the settings are altered to allow higher sample rate to be used the system may say it cannot set the frame rate so high.

Work around: change the no channels and no IC settings and click apply, then change the sample rate and click apply.

Windows software version 1.0.2.3 released 15/12/2009

No reported bugs