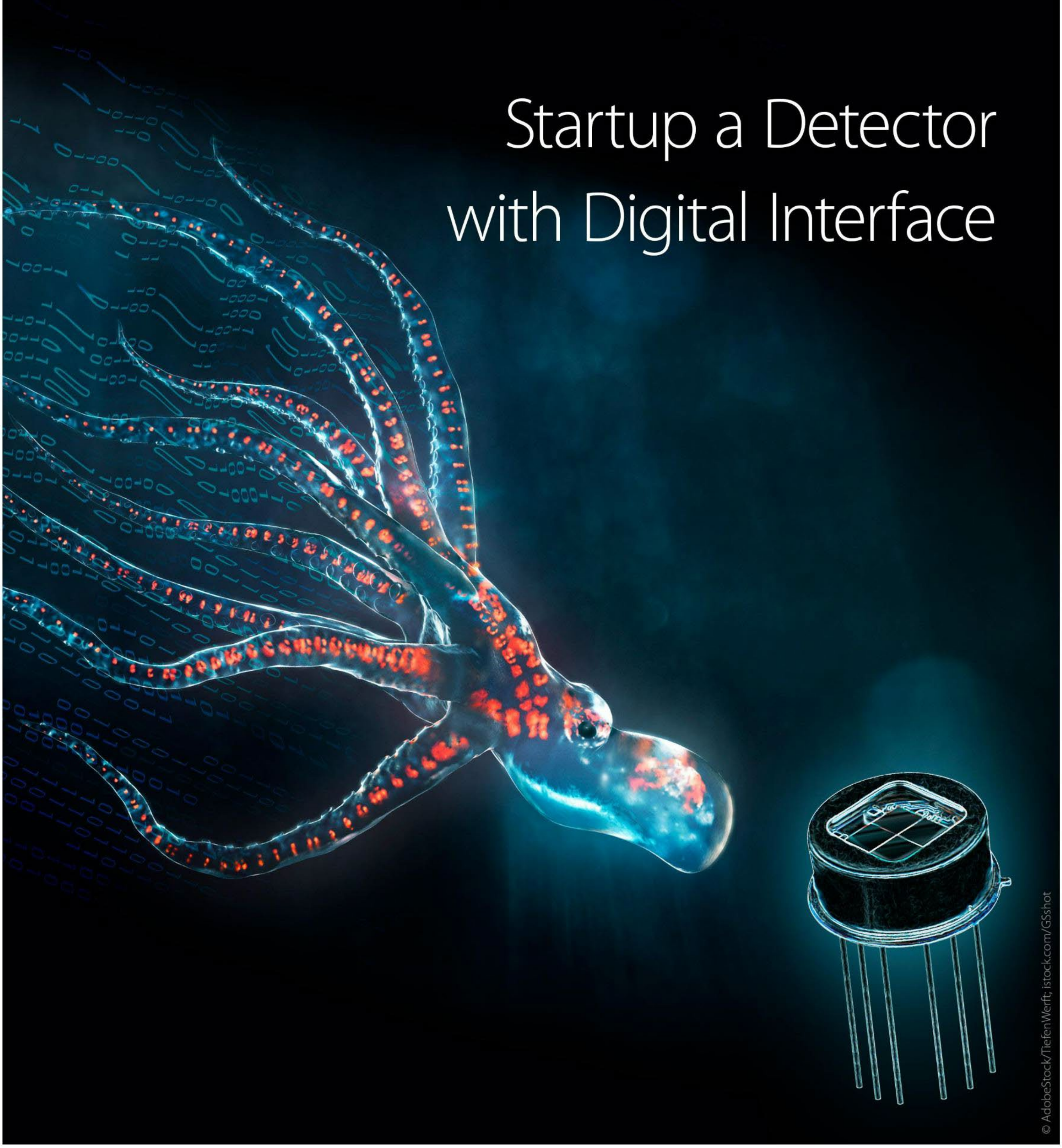
PyrIQ

Digital Infrared Sensor Intelligence

Startup a Detector with Digital Interface



InfraTec.

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Pyroelectric infrared detectors are particularly suitable for flame detection and gas analysis due to their robustness and excellent performance. Analogue pyroelectric detectors from InfraTec have been used in a number of different customer applications for over 30 years. These have now been joined by a new range of detectors with a digital communication interface.

The novel approach integrates the signal conditioning and analogue-to-digital conversion into the detector housing. This leads to a simplified system integration and consequently improves the electromagnetic compatibility of the detector. Furthermore, the signal conditioning in terms of electrical amplification and filtering can be adjusted flexibly at any time for the respective application and is not fixed by discrete components.

This white paper is intended to show how to put the digital detector into operation with a basic microcontroller board like the Arduino Uno. You will also learn how to configure the detector and retrieve data.

InfraTec

The Dresden-based company InfraTec GmbH Infrarotsensorik und Messtechnik is a specialist for products and services in the field of infrared technology. Since 1991, it is a fully integrated company with its own departments of development, production, service and distribution. In order to coordinate activities in the chief markets Europe, North America and Asia InfraTec has established several international subsidiaries and business partners.

The business unit of the infrared sensor division produces custom-made components on more than 1.600 m² of clean room space – especially pyroelectric infrared detectors – for clients worldwide. Based on a broad range of detector types, customized measurement tasks can be realized. Longstanding experience of R&D colleagues, technologists and constructors provides high-quality customer support. Spectrally single and multi-channel infrared detectors count among the products of the infrared sensor division. These detectors can be used in gas analysis, flame detection and spectroscopy.

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Integration of Digital Detector into Measurement System

A key element of InfraTec detectors with digital interface is an application-specific integrated circuit (ASIC). This ASIC enables complete flexibility in the configuration of the detector parameters and thus variable signal processing.

One main advantage of the novel detector design is the user-friendly communication interface. It allows the customer to connect the detector with a microcontroller and directly read out the digitalized data with the standard communication interface I^2C. This allows an easy and fast integration into the overall measurement system. Furthermore, the same interface can be used to adjust elementary detector parameters like e.g., the sampling frequency, electrical amplification and filtering frequencies to the customer specific application.
The whitepaper is based on the structure outlined in Figure 1.

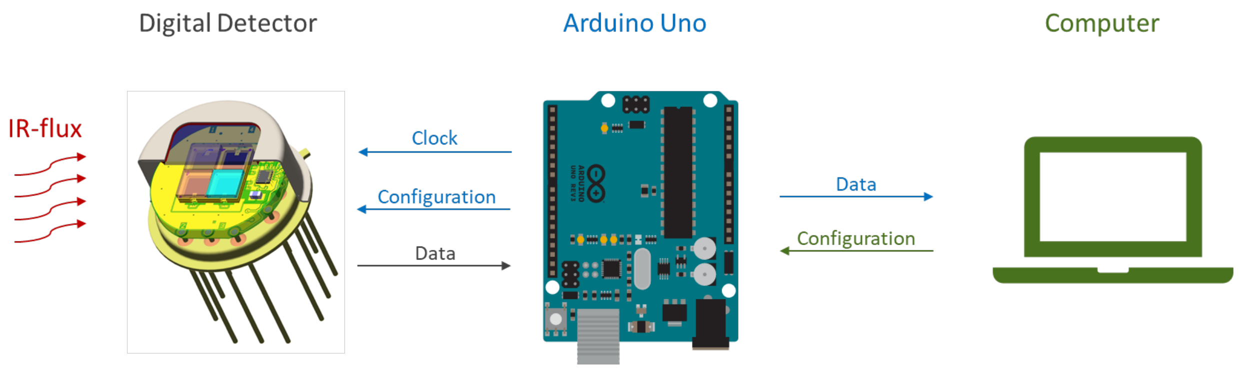

Figure 1: Exemplary structure to integrate the detector with digital interface into a measurement system

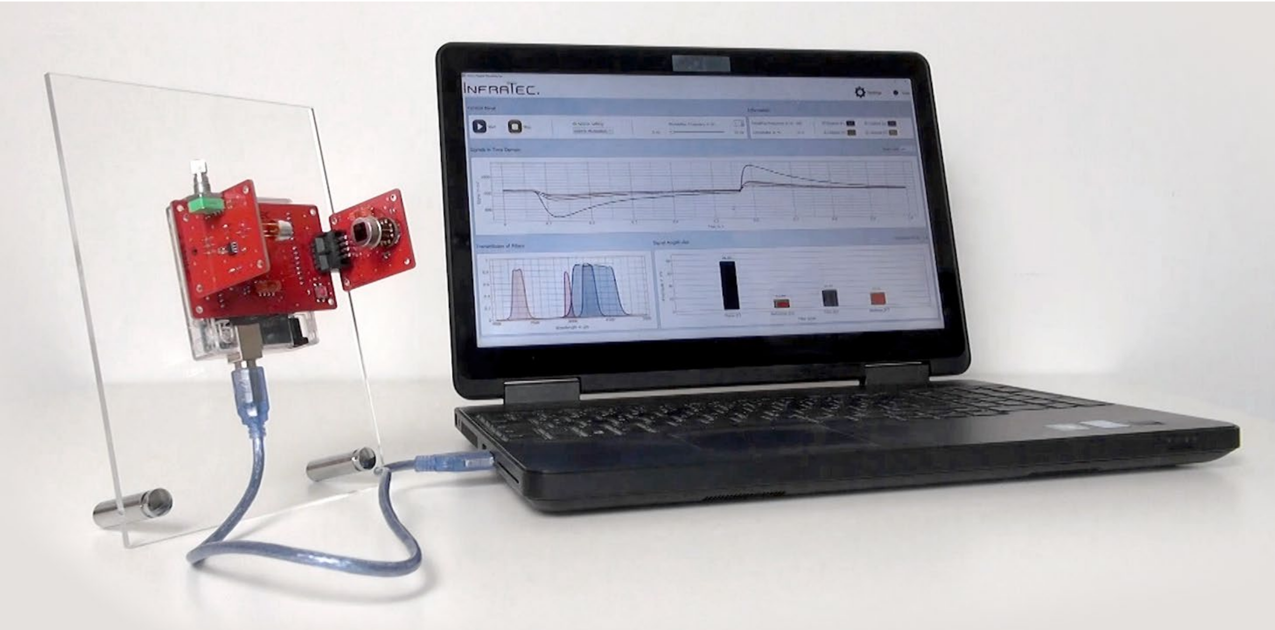

Figure 2: Example for structure with demonstrator

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For the first steps with InfraTecs digital detectors, InfraTec provides an open-source library for Arduino. Depending on the detector type, different function pins of the ASIC are routed to the detector pins. To get your specific detector pin configuration refer to the data sheet of the detector. This white paper is based on the four-channel detector LRD-3824. If you use a different detector or you have any questions, do not hesitate to ask us!

Any Questions? Contact Us.

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Request your download link for Arduino and PyrIQ library here: https://bit.ly/3s6qILt

Quick Setup

To receive sensor data from the detector with digital interface go through the following steps:

Set up the Hardware:

- Connect the detector pins SDA / SCL / V+ with the SDA / SCL / +3.3 V pins of the Arduino Uno
- Implement the pull-up resistors for the SDA / SCL lines
- Connect the detector pins Case / GND / PD with the GND pin of the Arduino Uno
- Connect the Arduino pin D11 with Arduino pin D2
- Connect the detector pin CLK to a voltage divider (to reduce Arduinos +5 V to ~+3 V) and connect this node to the Arduino pin D11

Set up the Firmware:

- Download the Arduino IDE and the InfraTec library PyrIQ via requested link
- Upload the example script IT_digital_detector.ino from the library to the Arduino Uno
- Open the Serial Monitor inside the Arduino IDE and set the baud rate to 1,000,000
- You should receive the system configuration of the detector and the configuration of each channel. Additionally, 500 data lines are sent whereby one line consists of the status byte, four sensor values and the temperature value.
- Check out the high-level functions provided by the PyrIQ library. E.g., you can modify the detector parameters and check how the read values change

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Hardware

Figure 3 shows how to connect the detector with the Arduino Uno. The description of the detector pins can be found in the datasheet. In this white paper, the microcontroller is going to provide the 32 kHz working clock of the detector. The detector can not handle voltages above +3.6 V; therefore, a resistor network is needed to reduce the +5 V clock signal from the microcontroller board.

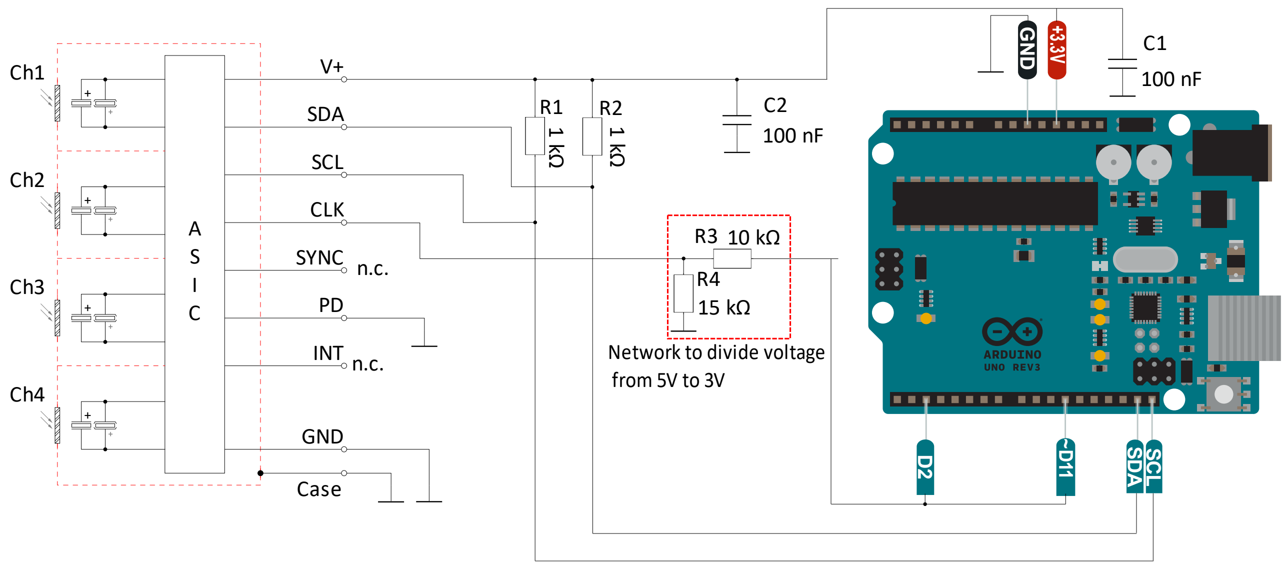

Figure 3: LRD-3824 connected with Arduino Uno

To retrieve the sensor data the controller counts the clock cycles of the ASIC clock. With a 32 kHz clock and a desired sampling frequency of e.g., 500 Hz the sampling process finishes every 64 cycles. By counting the cycles of the working clock, the controller can evaluate when new sensor data are available. To provide a clock rate the digital pin D11 is used. This pin is connected with the 8-bit Timer 2 of the ATmega328P which allows the implementation of the clock without CPU intervention. Figure 3 shows that the clock is fed back into pin D2 of the Arduino. This pin is an interrupt capable pin and will allow us to count the clock cycles of the detector.

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Firmware

It is recommended to use the Arduino IDE 1.8.13 or newer. Furthermore, you need to download the opensource library PyrIQ. You will receive the link on request. Copy the PyrIQ library into your Arduino libraries directory. The PyrIQ library also contains an examples folder with the script IT_digital_detector.ino which has to be uploaded to the Arduino Uno. Figure 4 shows the structure of the implemented firmware.

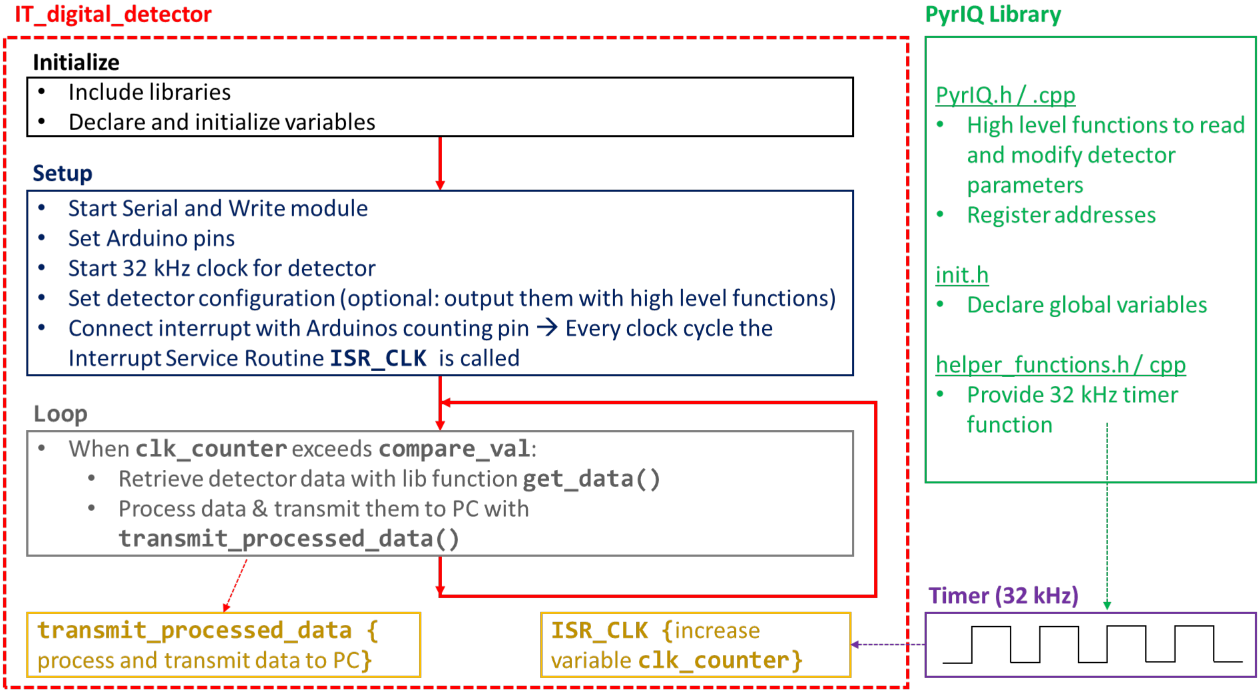

Figure 4: Overview firmware structure

Firstly, the necessary libraries are included in the **Initialize Block**. Additional to the PyrIQ library, the user needs to include the Wire library for the I²C communication.

Secondly, the **Setup Block** is executed. In this block the Serial module is started with a baud rate of 1,000,000. This module takes care of the communication with the computer via the UART interface. Furthermore, the Wire module is started for the I²C communication between the Arduino and the detector with a speed of 400 kHz[1]. To change the sampling frequency, you can adjust the variable sample_freq. The user can also specify the different detector parameters as feedback-resistance, feedback-capacitance, cuton- and cutoff-frequencies and gain factors with the corresponding variables in the example script.

[1] The detector supports a clock rate of 1 MHz but the Arudino Uno is only capable of 400 kHz.

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The function print_sys_cfg_PyrIQ() prints the system configuration of the detector to the serial monitor (Figure 5).

```
----------------------------------
System Configuration digITEC Detector
Sampling frequency in Hz: 500
Interrupt: enable
Sleep: disable
Clock source: external
Sync source: external
Clock output: disable
```

Figure 5: Output in the serial monitor from the function print_sys_cfg_PyrIQ()

To display the individual configuration of the four different sensor channels you can use the function print_ch_cfg(). This will lead to the displayed output in the serial monitor shown in Figure 6.

```
----------------------------------
Channel Configuration digITEC Detector
Channel, fb-resistance in GOhm, fb-capacitance in fF, lp-cutoff in Hz, hp-cuton in Hz, adc-gain in dB, bp-gain in dB
1, 128, 100, 100.0, 0.5, 0, 0.0
2, 128, 100, 100.0, 0.5, 0, 0.0
3, 128, 100, 100.0, 0.5, 0, 0.0
4, 128, 100, 100.0, 0.5, 0, 0.0
```

Figure 6: Output in the serial monitor from the function print_ch_cfg()

Note
The displayed channel configuration refers to the order of the channels according to the register map of the ASIC and not the optical channel as shown in the datasheet.

In the **Loop Block** the counter clk_counter gets permanently checked. This counter variable is increased in the Interrupt Service Routine ISR_CLK. When clk_counter exceeds the value compare_val, the data from the detector is collected and stored into an array with the function get_data().The counter_debug variable ensures that only a limited (e.g., 500) number of data chunks is sent to the computer.

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After the data is retrieved with get_data() the function transmit_processed_data() is called. This function processes the read bytes to actual integer values and outputs the data to the serial monitor. The output is shown in Figure 7 whereas one line represents the values from one sampling process.

The data order is:
status byte, ASIC channel 1, ASIC channel 2, ASIC channel 3, ASIC channel 4, temperature value.

```
14,35911,36497,35366,32711,45133,
12,35617,36030,35060,32795,45132,
12,35300,35604,34768,32852,45130,
12,35035,35282,34516,32917,45131,
12,34820,34992,34371,32969,45130,
12,34664,34735,34193,33023,45130,
12,34479,34530,34015,33099,45130,
12,34321,34349,33902,33180,45130,
12,34212,34177,33787,33232,45130,
12,34112,34021,33662,33237,45131,
```

Figure 7: Example of received data in the serial monitor

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Request your download link for Arduino and PyrIQ library here: https://bit.ly/3s6qILt

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