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MODULE/MANUAL

SMTIRIN06 INFRARED INTERFACE BOARD

SMARTEC INFRARED INTERFACE BOARD

SMTIRIN06

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Important note:

**This Interface board can not be used in combination with Pyro-electric
FET based thermo detectors, often used in alarm systems.
It is advised when the Infrared sensor is connected to the board with a 4-wire cable to use the
4-pole connector. From experience it is known the solder of the wires can cause leakage
currents on the inputs which can cause wrong measurement results.
Of course this is not the case when connection the Smartec temperature sensor via a longer
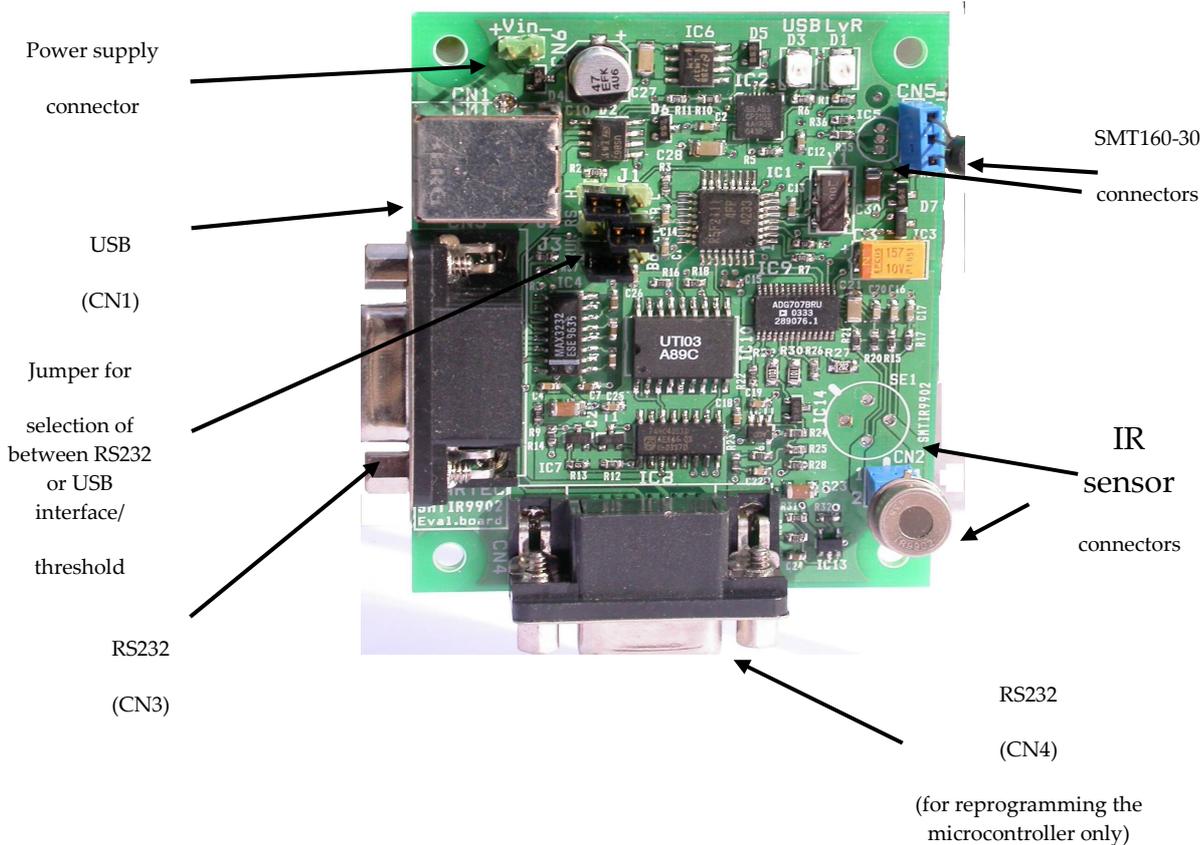cable.**

SMTIRIN06

1. Introduction

This document describes the SMTIRIN06 (SMarTec InfraRed INterface) board. The SMTIRIN06 is an interface board designed for Smartec SMTIR9902 infrared sensor, as well as for other infrared sensors. The Smartec SMTIR9902 infrared sensor is a device that can make temperature measurements of distant objects. The net captured infrared radiation heats up the black top of the internal thermopile (stacked thermocouples) related to the sensor housing. This temperature difference between the respective junctions of the thermopile results in a DC voltage (in the micro- to millivolt range).

If a Smartec SMT160-30 digital temperature sensor is in contact with the remote body and the sensor is connected to its corresponding input on the SMTIRIN06 board, this sensor can be used to measure the temperature of that body without making physical contact. The results can not only be used to verify the IR temperature measurements, but also to calibrate the system when objects have to be measured of which the emission factor is not known.

Power supply connector

USB (CN1)

Jumper for selection of between RS232 or USB interface/ threshold

RS232 (CN3)

SMT160-30 connectors

IR sensor connectors

RS232 (CN4)

(for reprogramming the microcontroller only)

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2. Quick start and functional check

This document assumes that the SMTIRIN06 board will be connected to a Personal Computer or Laptop. However, any other device capable of handling RS232 or USB data could do the job just as well (the USB bus voltage has to be 5 V).

In order to get the board running you will need:

- the SMTIRIN06 board
- one or more SMTIR9902 sensors
- a DB9 RS232 cable (straight) **and**
- a power supply delivering between 8 and 15 Volts (min 30 mA) **or**
- a USB cable (bus voltage has to be 5 Volts)
- a PC or laptop computer running a terminal program, for example Windows Hyper terminal (9600,8,n,1,n)
- optional: a Smartec SMT160-30 temperature sensor

After connecting the parts together, the radiation temperatures can be measured. Make sure the settings of the com port are as given and the port number itself is chosen correctly.

Type "?" and the help information appears on screen. This means that the SMTIRIN06 board is functioning correctly. At the same time LED D1 should flash, indicating the measuring cycle.

The position of Jumper J2 determines whether the board will be controlled by the physical com port (CN3) or the USB virtual com port (CN1). Please refer to chapter "1.Introduction" for the layout of the board and to chapter "5. Connecting the board to a PC" for the jumper settings.

More information about the possibilities of the board will be given later. Please refer to chapter 9 for the layout of the board and to the relevant datasheets of the used Smartec products.

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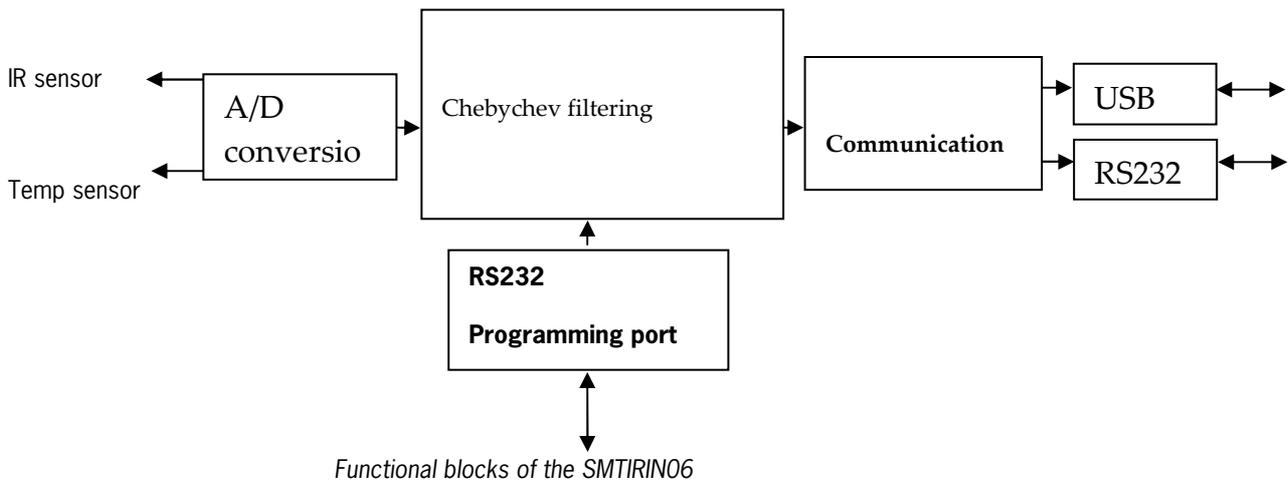December 1, 2010

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3. Hardware inside the SMTIRIN06 system

3.1 General

The SMTIRIN06 can be used to measure the radiation (infrared) temperature of an object within the angle of view of the Smartec SMTIR9902 infrared sensor.

As explained in the introduction, the temperature difference between the respective junctions of the thermopile results in a DC voltage over the connecting wires (in the micro- to millivolt range).

In order to calculate the temperature of the radiating body, the board has to measure the output voltage of the sensor, as well as the temperature of the sensor housing (by means of its built in NI1000 element). The board is pre-programmed with the NI1000 R/T curve parameters, but different curves for other temperature sensors (like thermistors) can be loaded.

```
IR sensor  ←→  A/D          →  Chebychev filtering  →  Communication  →  USB  ←→
               conversio                                                 RS232 ←→
Temp sensor ←→

                              RS232
                              Programming port
```

Functional blocks of the SMTIRIN06

The SMTIRIN06 is built up around five functional blocks. The features of the respective blocks are described here.

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3.2 Input stage

The input stage is a sophisticated A/D converter that digitizes the output voltage of the thermopile sensor as well as the resistance value of the built-in temperature sensor.

The high output resistance of the thermopile makes any first stage amplifier extremely sensitive to bias currents, especially when output voltages in the µV to mV range have to be measured precisely (within tenths of a percent). Multiple Smart sensor techniques are used to solve this problem, such as the Smartec three variable technique, the key element of the Smartec Universal Transducer Interface UTI (see our website) and hardware switching techniques.

Measuring the resistance value of the built-in NI1000 element is a standard UTI function is well documented in the UTI datasheet. Measuring the output duty cycle of the Smartec SMT160-30 temperature sensor is well documented in a number of application notes available on the Smartec website Supportshop. See our site for the latest information.

3.3 Calculation and filtering

The two signals needed for measuring the radiation temperature of an object are the output signal of the thermopile (mV) and the temperature of the sensor housing itself. The thermopile can be considered as a series of thermocouples of which the temperature difference between the cold junctions (= sensor body) and the hot junctions (= sensor end heated by incoming radiation) has to be determined. The output voltage represents this temperature difference.

The relation between the incoming radiation, the output voltage and the sensor body temperature is complex. Radiation of a body is in accordance with the Planck's law and this radiation is filtered by the high pass wavelength filter mounted on the sensor (See the SMTIR99xx datasheet).

Complicated integral calculus has to be performed on the raw data to obtain the temperature of the object from the two signals and the filter characteristics.

The optical filtering characteristics of the SMTIR9902 for example, is a high pass (wavelength) filter, with a steep drop off at 5,5 µm. Such filters are conveniently described by Chebychevs method. Fifteen parameter values are needed to describe the filter characteristic with adequate accuracy.

The default values of these parameters are the ones that apply to the SMTIR99xx sensors, but can be (re)programmed via the USB/RS232 port (further on in this manual). This means that the SMTIRIN06 can be used in conjunction with other types of filters and that IR sensors of other manufacturers may be connected to and measured with the SMTIRIN06 board.

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4. SOFTWARE inside the SMTIRIN06 system

4.1 Command overview

The following commands are available on the interface board:

Table 1: Commands

Command	Description
?	send help screen
N	get next value
B	start of continuous measurement
D	get next diagnostic value
g <code>	lists a parameter value
G	lists all parameters
s <code> <value>	set a parameter value
r	resets parameters to factory default values
t <value>	set / read threshold

4.2 Explanation of the commands

? - help screen

When "?" or ENTER is sent to the board, the following help screen is shown:

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<div align="center">

Smartec IR V1.0:

n : next values

b : start/stop continuous measurement

g ? : get variable

s ? ? : set variable

r : reset variables

d : next diagnostic values

t : threshold value

</div>

n - get next value

The "n" command results in an ASCII record consisting of the temperatures for respectively sensor temperature (NI1000 element), the thermopile, object temperature and temperature of the digital temperature sensor SMTxx. All values are formatted in scientific format with 3 decimals after the decimal point. The fields are separated by a tab character and the record ends with a CR and LF character.

Example record:

        2.012+E01   1.176-E01   3.188+E01   2.213+E01

b - continuous measurement

The "b" command will start measuring in continuous mode and repeatedly send out data in the format as explained under "n". The transmission of data will stop after sending another "b".

d - diagnostic values

The "d" command results in a diagnostic record. The fields of this record are: Leakage Current, Voltage on Thermopile caused by Leakage and the Corrected Voltage on the Thermopile (which can be used to determine Thermopile Normalize factor). The record has the same format as the regular data. These values are normally used for evaluation and testing purposes.

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g <blank><code> - reads and displays one Chebychev variable

When the user wants to change the Chebychev parameters, the "g" command can be used to read out the actual values of the interface board. Between the "g" and the code (0 – 15) a space must be typed. In case the "g" command is given without an index all the Chebychev parameters are read out.

Below the codes and their functions are listed:

Code	Description
0	Chebychev table for G-function for Thermopile entry 0
1	Chebychev table for G-function for Thermopile entry 1
2	Chebychev table for G-function for Thermopile entry 2
3	Chebychev table for F-function for Thermopile entry 0
4	Chebychev table for F-function for Thermopile entry 1
5	Chebychev table for F-function for Thermopile entry 2
6	Chebychev table for F-function for Thermopile entry 3
7	Chebychev table for F-function for Thermopile entry 4
8	Chebychev table for F-function for Thermopile entry 5
9	Chebychev table for Finv-function for Thermopile entry 0
10	Chebychev table for Finv-function for Thermopile entry 1
11	Chebychev table for Finv-function for Thermopile entry 2
12	Chebychev table for Finv-function for Thermopile entry 3
13	Chebychev table for Finv-function for Thermopile entry 4
14	Chebychev table for Finv-function for Thermopile entry 5
15	Thermopile Normalization Factor

When retrieving or setting these variables floating point numbers are used. Internally the variables are stored as 4 byte floats (IEEE-754).

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The variable nr 15, the Thermopile Normalization factor is default set to 0.0035. This value is set for an emission factor of 1. In case another emission factor is needed this factor has to be changed.

s <blank><code><blank><value>

The "s" command sets a value of a Chebychev variable. In case another infrared sensor or another filter is used the Chebychev variables have to be changed. **The "G" command displays all the actual parameter values.**

r - reset variables

The "r" commands resets the interface board to the factory settings which means the Chebychev coefficients of the SMTIR99xx are loaded as well as the NI1000 element R/T curve parameters.

t <value> sets threshold

The "t" command sets and reads the threshold value. In case no <value> is given, the threshold value is shown. When the measured object temperature is higher than the threshold value given pin 2 of jumper J1 is going to "1" 'high' and in case the object temperature is lower than the threshold temperature pin2 of jumper J1 will go to "0" 'zero'.

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5. Connecting the board to a PC (USB/RS232)

The SMTIRIN06 can communicate with a computer by means of three connectors CN1, CN3 and CN4. If dedicated software is needed, reprogramming of the micro controller can be done through CN4.

The physical RS232 serial (com) port (CN3) and the USB (CN1) virtual com port are similar in functionality.

The RS232 com port can be connected to a PC serial port with a straight cable and port settings 9600,8,1,n.

When the USB connector is used for communication, the USB virtual com port driver needs to be installed (CP2102 USB to UART Bridge Controller). This virtual com port can be found on the internet.

See also USB interface note in the Smartec website Supportshop.

Selection between CN1 and CN3 takes place by setting jumper J2. J1 and J3 are always on the connector side (position "1"). When J2 is in-line with J1 and J3, then the board is in standard RS232 mode (CN3). When J2 is not in-line ((position "0"), the board is in USB virtual com port mode (CN1).

Please refer to section 1."Introduction", for the layout of the board and to section 9.2 "PCB layout and connections".

In case the board is controlled from the USB virtual com port, LED D3 will be lit and the device manager (XP: computer properties, hardware, device manager) can be consulted to find out which COM port the USB virtual com port has been mapped to (see also the USB interface note in the Smartec website Supportshop).

Note 1.   When the serial port connector is used to control the board from the PC, the board can still be powered by the USB port. (LED D3 will not be lit until the driver has been installed).

Note 2.   The board can even be **controlled** by the RS232 com port and be **powered** by the USB cable, without installing the virtual com port driver. In that case LED D3 will NOT be lit.

Note 3.   Caution: the USB port voltage must be 5 V. This is not always the case with laptop computers. In that case an external power supply is needed.

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6. Demonstration program in Visual Basic

To learn more about infrared radiation in general and the SMTIRIN06 interface board we have developed an application. Note this software of the application is free to copy and also, as all the other information we have available, downloadable from the Supportshop of our website. The application is described in detail below.

6.1 Visual basic

This chapter describes the Visual Basic demonstration application which can be found in the supportshop of the Smartec website. This demonstration program is developed in a **Windows XP** environment so we cannot guarantee good working in older versions of Windows.

Display

The application displays:

- a graph (plot) of the selected value(s)
- the number of samples received
- the average of the selected value
- the standard deviation of the selected value
- some Diagnostic functions

Features

This utility allows you to:

- Start/Stop capturing data.
- Clear the graph.
- Show the About box
- Choose the Value(s) to show in the graph.
- Show Average and Standard deviation in the graph.

If the application receives a "NaN" value for one of it is requested variables an error label shows up. A "NaN" value is probably caused by an incorrectly connected sensor.

Installation

In order for this application to work you need to connect the evaluation board to your COM port or to your USB port. In case of an USB port you need to install the appropriate drivers that provides a COM port interface to the connected evaluation board.

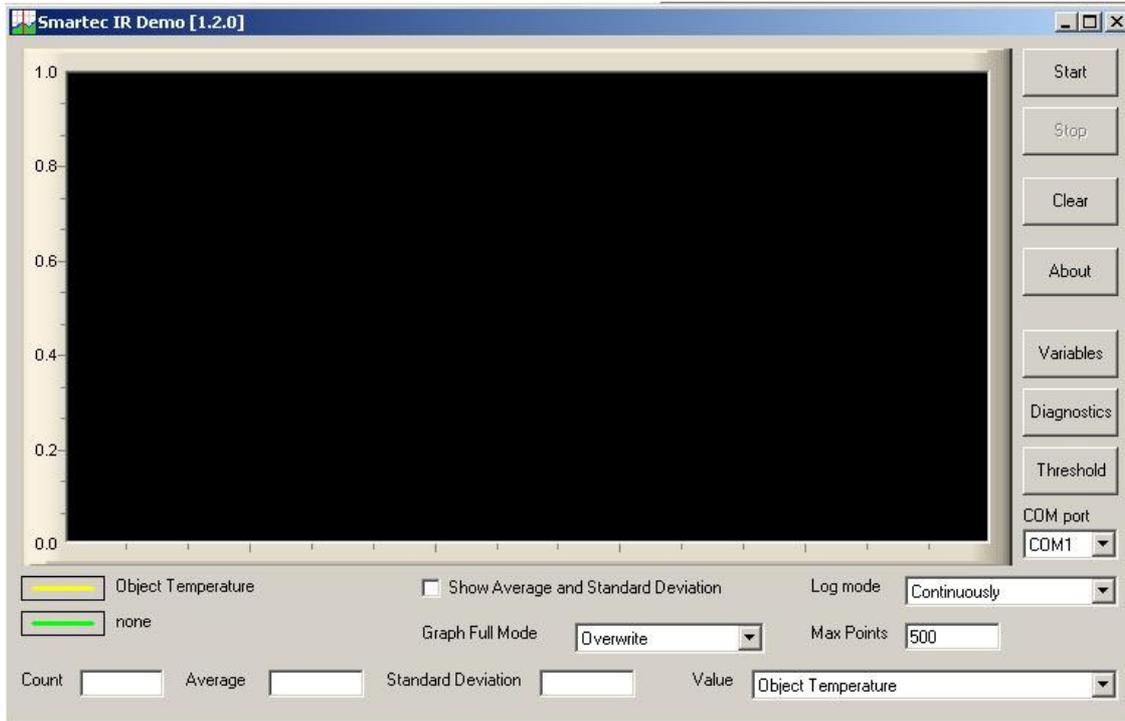To uninstall the application use Add/Remove Programs in the Control Panel.

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Starting the Program

The startup can be performed via a link on the desktop. After starting the program the figure below appears on the screen of the PC.

Below the features of the demonstration program will be given in detail.

COM port, serial communication

Before you can communicate with the SMTIRIN06, configure the COM port (default is COM1). In case the RS232 interface is used the port has connected with a straight cable and port settings 9600, 8, 1, n. In case the USB port is used the port has to be chosen from the system list (see relevant application note in the support shop of our website).

After setting the port there is a connection between the interface board and the PC. This can be tested by pressing **START** at the upper right part of the screen. On the screen the graph is shown. The graph screen can be cleaned by pressing **STOP** and **CLEAR.**

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Log Mode

All data captured is sent to the graph and written to the log file as well. The time interval between the samples can be selected by the user. In the log files also the time and date is stored for later analysis.

The log file is called smartec_ir.log&date&time.CSV and is located in the installation directory. The log files can be read by standard Windows programs like EXCEL.

The values are logged as:

Date, time, sensor temperature, difference between sensor and object temperature and SMT

temperature. The values are separated by a comma and a line ends with $\n\r$.

Max points

Here the user can select the maximum of points to be displayed on the screen. After filling the screen it can be selected to **clean**, to **scroll** or to **overwrite** the screen by using the **Graph full mode** button.

Value

The displayed value of the graph can be selected. The possibilities are depicted below:
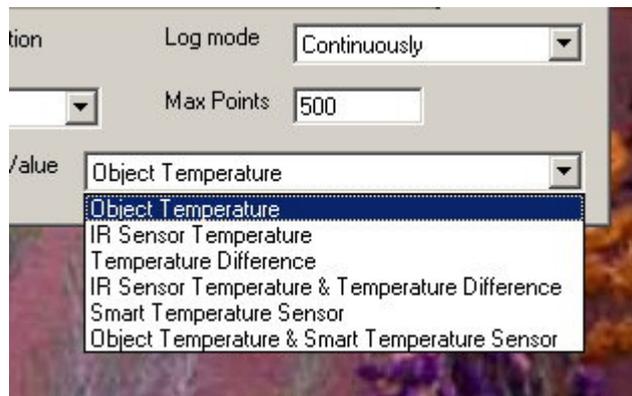
Object temperature

is the corrected temperature of the object seen by the total opening of the sensor.

The **IR sensor temperature** is the temperature calculated from the Nickel temperature sensor built-in the thermopile (SMTIR9902). The **Temperature difference** is the difference between the object temperature and the temperature of the thermopile sensor.

The temperature of the Smartec SMT16030 is for calibration purposes. Also an option is the combined graph of the **object temperature** & **the Smartec sensor temperature**. Independent of the selection above the filed data is always the same.
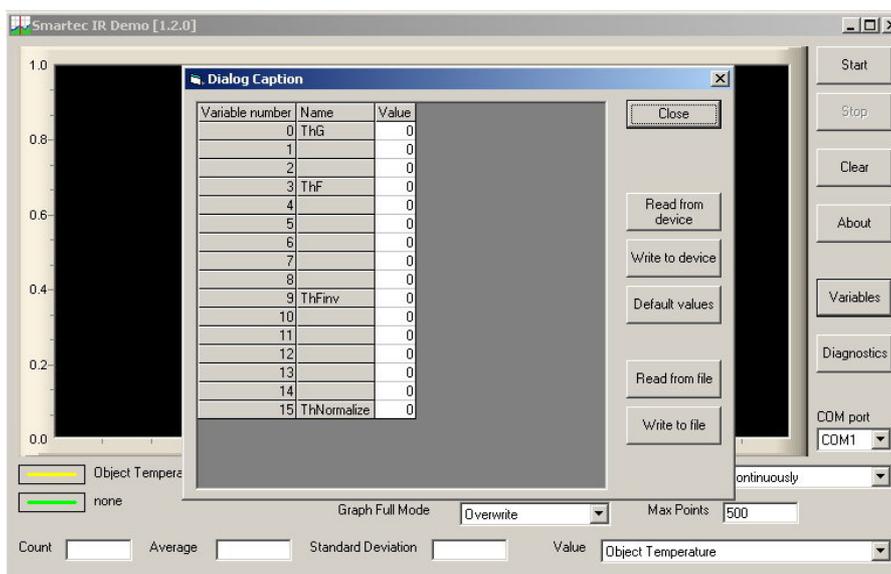
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Variables

Activating the button **Variables** will generate a screen as depicted in the figure. A complete list of the Chebychev variables is given (see therefore also Section 4).

These variables can be loaded form the interface board (**Read from device**) modified by the user and written into the Interface board (**Write device**). It is also possible to write these to a file for future use.

(**Read from File / Write to File**). The default values are stored in the memory of the Interface board and are downloadable via the button **Default values**.

Each time the SMTIRIN06 is switched on the default values (applicable to the SMT IR9902) are used for calculations of the object temperature. In case another Infrared Sensor is connected and other Chebychev coefficients are used the user needs to upload the Chebychev variables first.
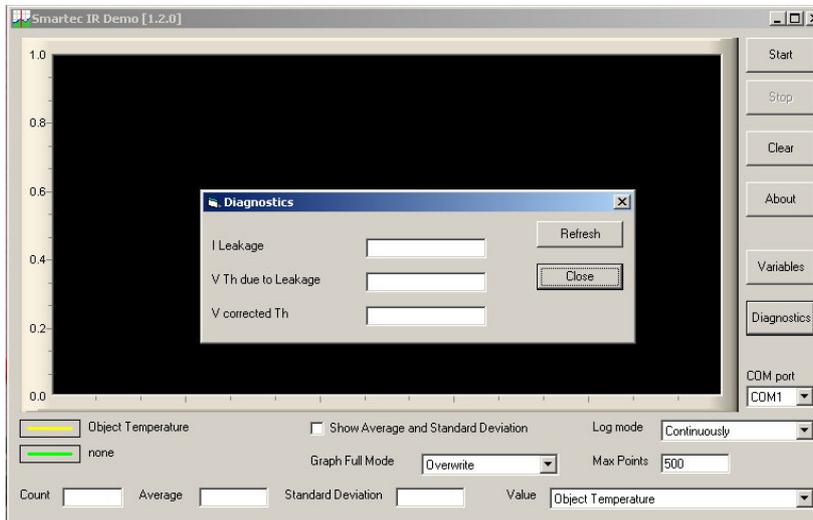
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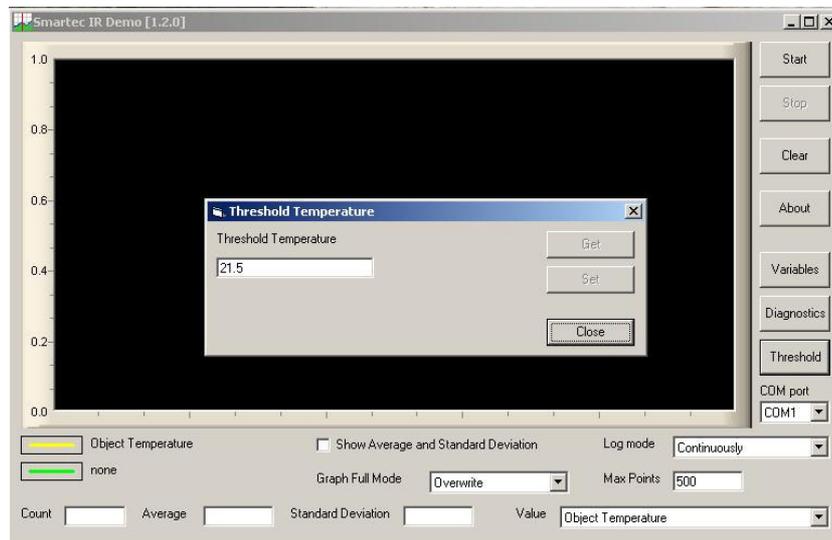SMTIRIN06

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Diagnostic

With the diagnostic function the leakage current of the Thermopile sensor can be displayed. This function is only for service use.

Threshold

By means of the Threshold button a threshold value of the object temperature can be set.

When the object temperature is higher than the one set point 2 of jumper J1 goes to "1" and in case the temperature of the object is lower as the one set the output pin 2 of jumper J1 goes to "0"

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The software above is intended to be an example how to interface a PC to most types of Thermopile sensors. This Interface board cannot be used in combination with Pyro-electric FET based thermo detectors as used in all kind of alarm systems.

It will be clear that all variables of the SMTIRIN06 interface board and the Visual Basic program above can be read out also with a standard terminal program, like **hyper terminal (windows standard).**

The software of the SMTIRIN06 interface board can be modified also (via the CN3 service port). The complexity of this software and way to do this is beside the scope of this manual.

The complexity of this software is not explained in this manual, please ask the nearest representative or contact Smartec headquarters.

7. Connecting other infrared sensors

It is possible to use this interface board in combination with another type of thermopile sensor.

In case the thermopile sensor is equipped with a same kind of Ni sensor for measuring the temperature of the sensor the Chebychev coefficients **has to be changed** only in accordance to the filter of the thermopile sensor used. Working with the Chebychev coefficients is not simple and beyond the scope of this manual. We therefore advise you to contact the factory in these cases.

This Interface board cannot be used in combination with Pyro-electric FET based thermo detectors as used in all kind of alarm systems.

8. System calibration for objects

For calibration purposes the SMTIRIN06 interface board has an input for a Smartec SMT temperature sensor. This input can be used to calibrate a radiation measurement system. Due to the emission factor and the physical setup small deviations of the radiation temperature can occur. By means of connecting the Smartec temperature sensor to the object the exact temperature of the object can be compared with the measurement of the radiation temperature. The differences can be fi. stored in a lookup table for further processing. This correction setup is no part of the VB demonstration program.

It is always important to take the angle of the radiation sensor in account. This means the radiation coming in from an object is not disturbed by the surrounding radiating area. Calculation on the SMTIR9902 gives an opening angle of about 77° but it is advised to consider an angle of about minimal 100°.

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9. Board Specifications

9.1 General

Inputs

IR-sensor

Type	: SMTIR9902 (Smartec)
11Connection	: via 2x2-pole header/ direct soldering on PCB
Maximal cable length	: 5 meter (4-wire shielded)

Thermopile δT measurement:

Accuracy (interface)   :   0,5% x δT °C

(δT = difference between Ni1000
temperature and thermopile temperature)

Resolution   : <0,1 °C (without software averaging)

Input voltage range   : ± 4 mV

Reference temperature sensor

Type   : SMT16030-18

Mounting   : Direct on PCB or via connector 1 x 3-pole header

Measurement range   : 0 - 50°C

Outputs

Communication

Host communication   : USB2.0 or RS232 (selectable by jumper J2)

Connectors   : Sub-D 9-pole/RS232, USB type D

Service port (optional)   : RS232, for programming purpose only.

Power supply
RS232 mode

External power supply   : 8 - 15Vdc (polarity protected)

Power current   : 50mA

Connection   : 2-pole header on PCB

USB mode   : Via USB 5V bus

ESD protection

SMTIR9902 inputs	: 2kV + 10Ω/10nF 10 µs.
RS232/USB	: 15kV

Storage/Operating temperature   : 0 - 50°C

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9.2 PCB layout and connections

Printsize: 60 x 70mm

Jumper settings

USB

Jumper settings

1   0

J1   pin 2 threshold output

J2   RS232   USB

Vin
8-15Vdc
+ -

USB
CN1

RS232
CN3

SMT160
CN5

CN5 SMT16030
1 Gnd
2 Vcc
3 Out

IR

CN2 SMTIR9902
1 det+
2 det-
3 Ni 1000
4 Ni1000/GND

RS232
CN4

Optional

Service port

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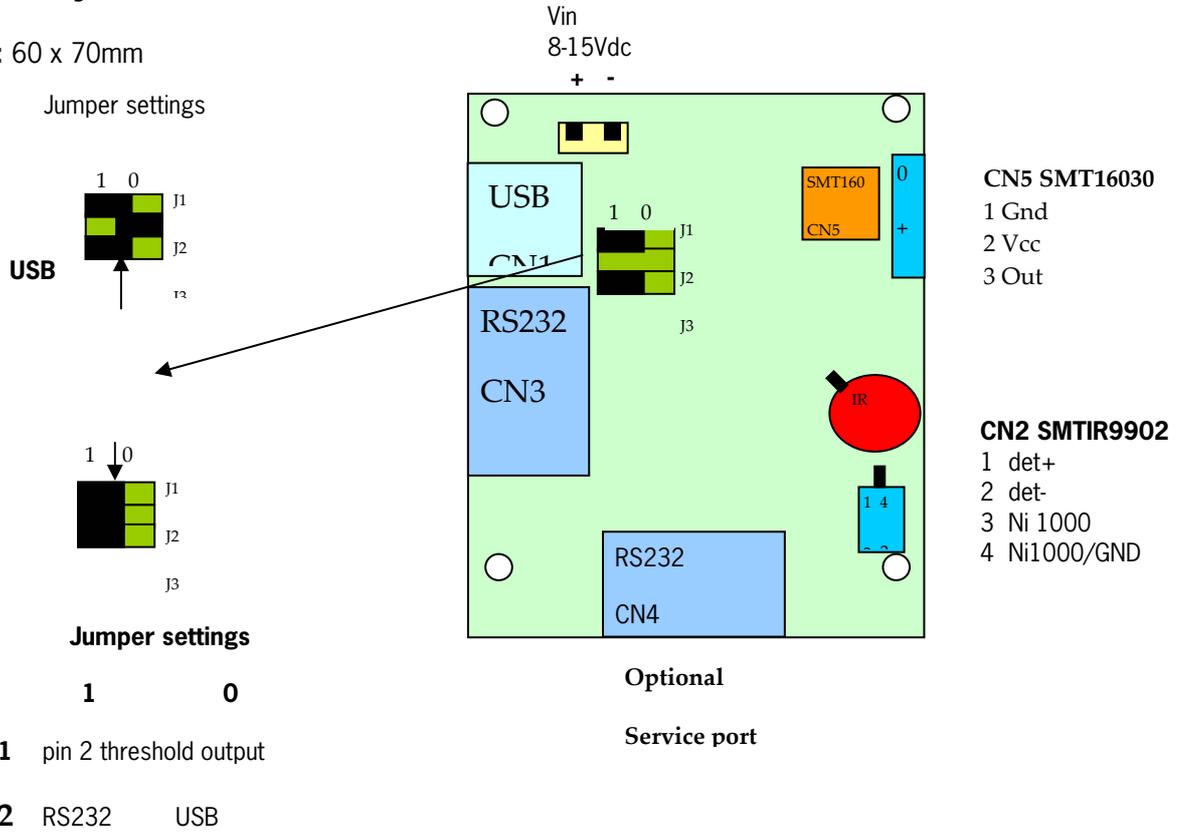
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9.3 Circuit diagram

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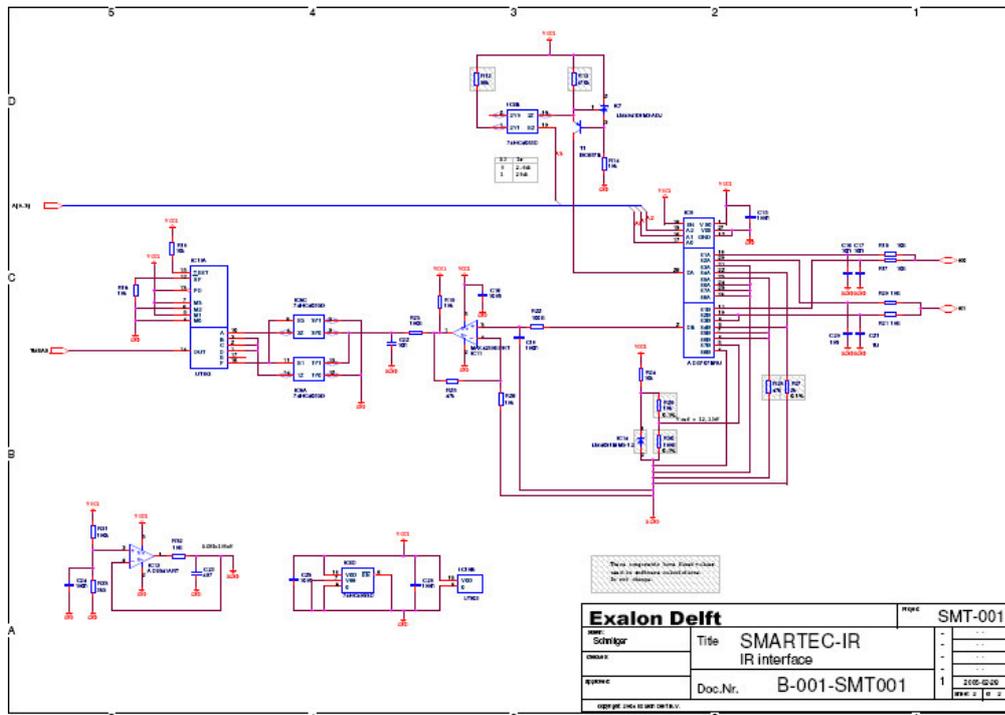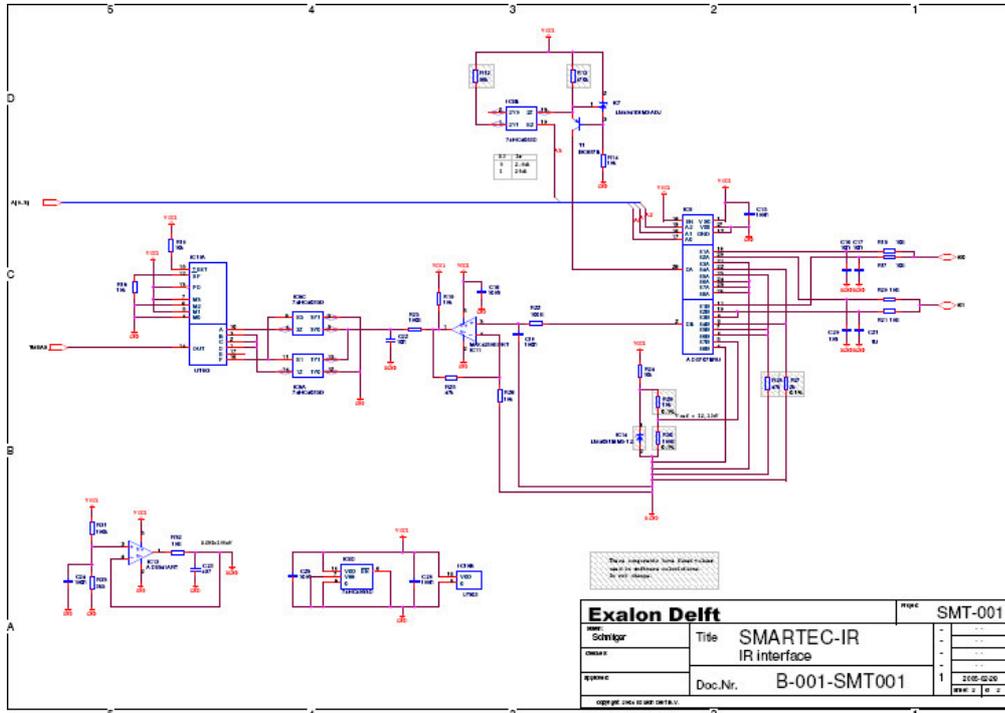
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10. Ordering information

SMTIRIN06　　Smartec Infrared interface board (filterfunction for SMTIR99xx)

SMTIR9902　　Smartec infrared sensor with built-in Ni1000 reference sensor.