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ELECTRA-CT

Datasheet

EPC C1G2 COMPLIANT BATTERYLESS CONTACT TEMPERATURE SENSOR

Check for samples: ELECTRA-CT

DESCRIPTION

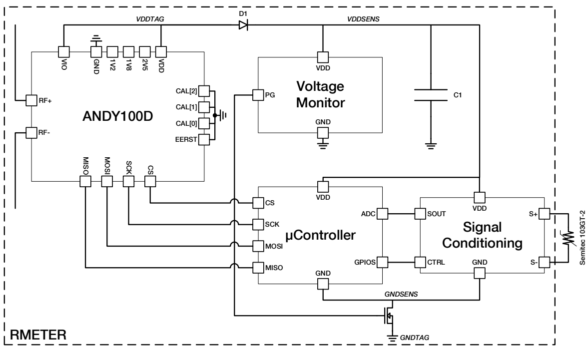
ELECTRA-CT is an EPC Class-1 Generation-2 (C1G2) RFID tag based on Farsens' batteryless sensor technology. Built in a compact PCB format, the tag includes a resistance meter and a temperature dependent NTC thermistor.

These RFID sensor tags are compatible with commercial UHF RFID readers (EPC C1G2). With a 2W ERP setup the battery-free contact temperature sensor can communicate to over one meter and a half - 5 feet.

The ELECTRA-CT is available in a variety of antenna design and sizes, depending on the specific application. It can be encapsulated in an IP67 or IP68 casing for usage in harsh environments.

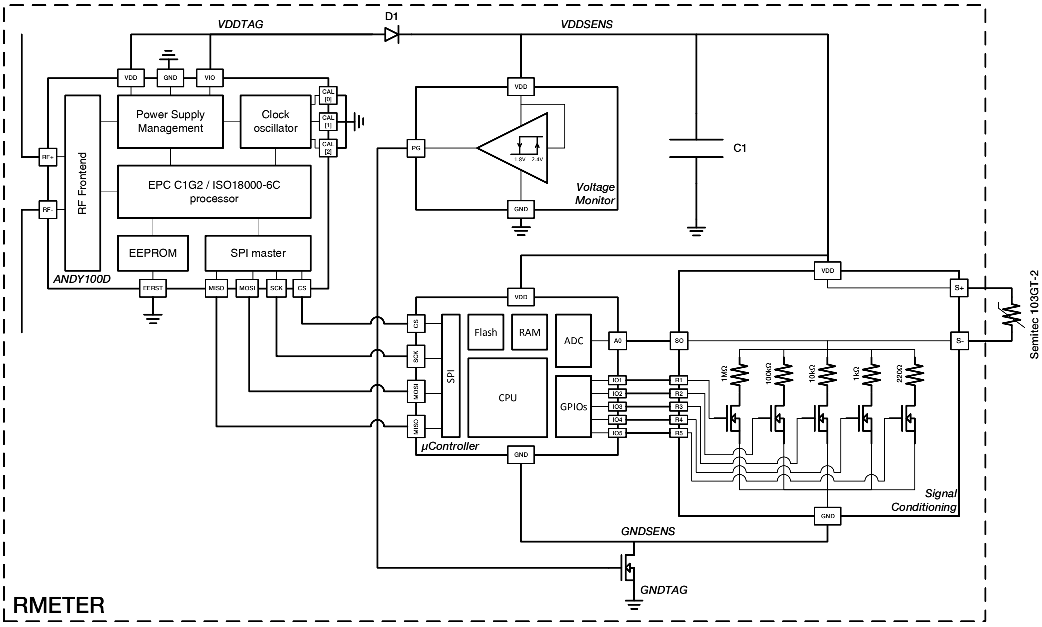
BLOCK DIAGRAM

The ELECTRA-CT tag consists of a RMETER tag and a Semitec 103GT-2 NTC thermistor. The RMETER includes an ANDY100 IC for energy harvesting and wireless communication, a start-up circuitry based on a voltage monitor, a microcontroler with integrated ADC (10 bits) and signal conditioning circuitry for measuring resistive sensors.



FEATURES

- **860MHz-960MHz operation**
- **EPC Class-1 Generation-2 compliant**
- **ISO 18000-6 Type C compliant**
- **96-bit EPC & 32-bit TID**
- **Contact temperature**
- **Temperature range: -30 °C to 85 °C**
- **Temperature accuracy: 0.5 °C**



The ANDY100 IC includes a RF frontend for UHF RFID power harvesting and communication, a power supply module to generate the required voltage levels, a EPC C1G2/ISO18000-6C digital processor including a trimmed clock oscillator, a non volatile memory and a SPI master module. The SPI master module can be controlled via EPC C1G2 standard memory access commands.

In order to isolate the supply of the RFID tag from the supply of the rest of the system, the diode D1 is included. The capacitor C1 acts as an energy storage unit to support current peaks of the system during active operation, such as initialization and measurement.

A voltage monitor is included to connect the sensor system only after the energy storage capacitor has been charged. The voltage monitor connects the sensor system when the voltage in the capacitor is over 2.4V and disconnects the sensor system when the voltage falls below 1.8V. This architecture avoids oscillation of the system during initialization.

The operation of measuring resistive values is controlled with a microcontroller. Besides the CPU, the flash memory and the RAM memory the microcontroller includes a SPI module, GPIOs and a 10 bit SAR ADC.

Finally, the signal conditioning includes a set of resistors that can be connected in a resistive divider configuration with the resistive sensor. The GPIOs of the microcontroller command the gates of the NMOS transistor to select if any of the available resistors is connected to the resistive sensor, or if the sensor is left floating.

Upon receiving a SPI directed read request from the UHF RFID reader, the ANDY100 generates SPI signaling towards the microcontroller. Given that the RFID communication protocol specifies timing restrictions for answer, the microcontroller returns the measurement value stored in a buffer and triggers a new measurement. Thus, the answer of the tag to the reader includes the value of the previous measurement.

In order to execute a new measurement, the microcontroller activates different resistors sequentially and reads the output voltage of the divider bridge. After evaluating the different configurations, the best reading is selected according to the order of magnitude of the value of the connected sensor. Finally, the index of the selected resistor and the ADC reading are allocated in the SPI buffer for the next transaction.

CHARACTERISTICS

SYMBOL	PARAMETER	MIN	TYP	MAX	UNIT
RFID					
RF_{SENS}	RF sensitivity fully passive	-4	-2	0	dBm
OPERATING CONDITIONS					
T_{OP_TOP}	Operating temperature range	-30		85	°C
CONTACT TEMPERATURE PROBE					
T_{range}	Temperature range	-30		85	°C
T_{acc}	Temperature accuracy			±0.5	°C
$t_{response}$	Response time to 63.2%		7		s

Given the characteristics of the RMETER tag and the specifications of the Semitec 103GT-2 NTC thermistor, the following graph shows the expected precision of the temperature measurements:

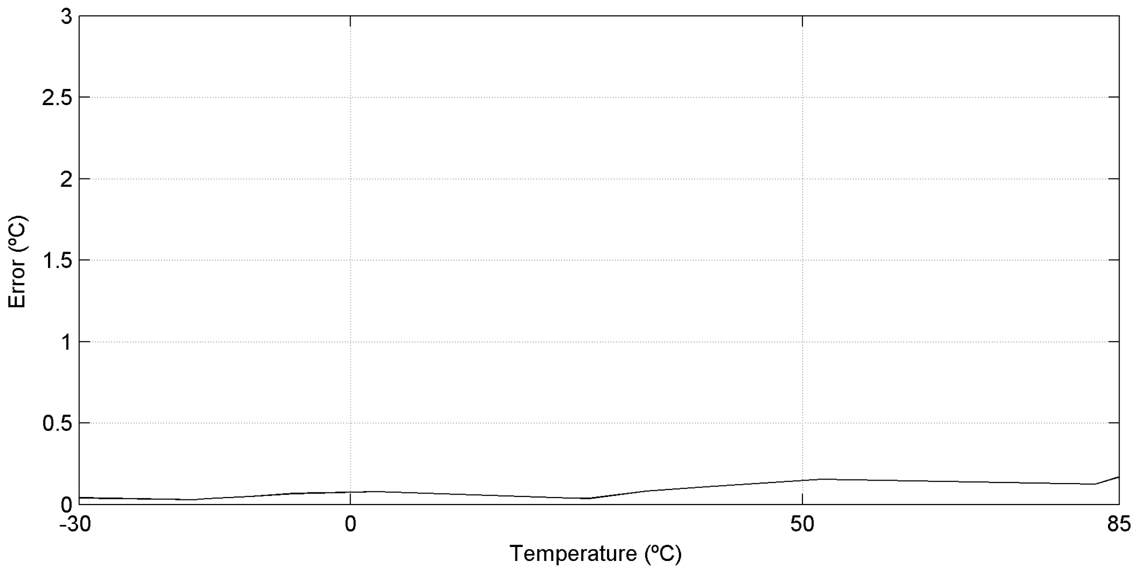


Figure 1: Measurement accuracy vs contact temperature

OPERATION

EPC reading

In order to read the EPC of the tag, commercial EPC C1G2 readers can be used. However, some considerations have to be taken into account.

As the tag has a significant supply capacitor connected to VDD, the power-up of the system will be slow. It can last several seconds. In order to speed up the charge process, the reader shall be configured to send power as continuously as possible. Refer to the application note *External capacitor on VDD of ANDY100* for detailed instructions on how to set up the reader for best performance.

Once the supply capacitor is charged, the tag will respond with its EPC. From this point on, memory access commands can be used to control additional functionalities via the SPI bridge.

Contact temperature reading

The contact temperature of the sensor can be read using standard EPC read commands. It is important to take into account that the value returned to such a request contains the reading of the previous measurement. As the measurement process takes longer than the communication, upon receiving a temperature reading request the tag answers with the value of the previous measurements and triggers a new one. In order to get a up to date measurement, it is mandatory to perform at least two readings.

Read Temperature
Operation: Read
Memory bank: User Memory
Word Pointer: 0x06
Word Count: 4

The answer from the tag to such a request will contain 8 bytes of data. The EPC word size is 16bits and the SPI word size is 8bits. The answer received from the SPI interface is right aligned in the EPC words. Assuming that the reader returns the received data in the buffer of bytes *rawdata*, the content of the answer is defined as follows:

rawdata	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
content	0x00	FW_VER	0x00	R_IDX	0x00	ADC_H	0x00	ADC_L

- FW_VER: firmware version included in the micro-controller.
- R_IDX: index of the resistor used to measure the resistive value of the sensor in the optimum range.
- ADC_H: MSB of the ADC reading.
- ADC_L: LSB of the ADC reading.

The conversion from the ADC reading to the actual temperature value has to be done by software in the reader side. From R_IDX and ADC_VAL the resistance value of the sensor can be calculated. Finally, from the resistive value of the sensor, the actual contact temperature value is obtained using the specifications of the thermistor. In this case, the β parameter equation is used for the conversion.

The conversion to contact temperature can be done as shown in the following sample code:

```
// Define 103GT-2 thermistor constants
#define T0 25
#define R0 10000
#define B  4126

short Rdown, ADCval, Rsens;

// Get Rdown
switch (rawdata[3])
{
  case 1:
    Rdown = 1000000;
    break;
  case 2:
    Rdown = 100000;
    break;
  case 3:
    Rdown = 10000;
    break;
  case 4:
    Rdown = 1000;
    break;
  case 5:
    Rdown = 250;
    break;
}
// Get ADC measurement
ADCval = (UInt16)((rawdata[5] << 8) | rawdata[7]);
// Calculate measured R
Rsens = (1023.0 / ADCval - 1) * Rdown;

// Operate temperature
double T0_K = T0 + 273.15;
double Rinf = R0 * Math.Exp(-(B / T0_K));
double temp = B / (Math.Log(Rsens / Rinf)) - 273.15;
```

DEMO SOFTWARE

Demonstration software to read and control the ELECTRA-CT is available in the web. Download the latest software and user guide at: http://www.farsens.com/software.php. Currently, the software is compatible with the following UHF RFID readers:

Fixed readers

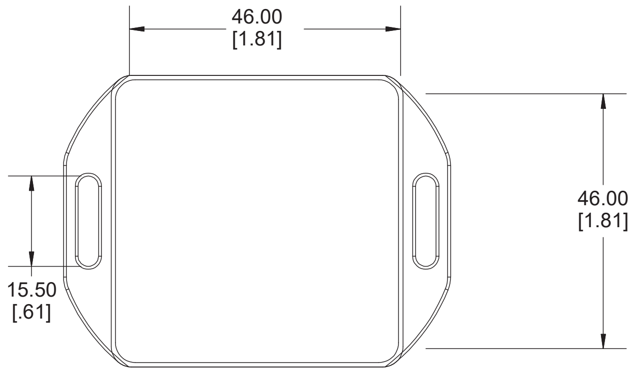
- Alien ALR9900
- AMS Radon
- Caen Muon DevKit - RS232
- CSL CS203
- Impinj R420
- Thingmagic M6
- Thingmagic M6e DevKit6
- Motorola FX9500
- Motorola FX7400/FX7500
- Nordic ID Sampo
- Nordic ID Stix
- RF-Embedded PUR500U
- Sirit IN610

Handheld readers

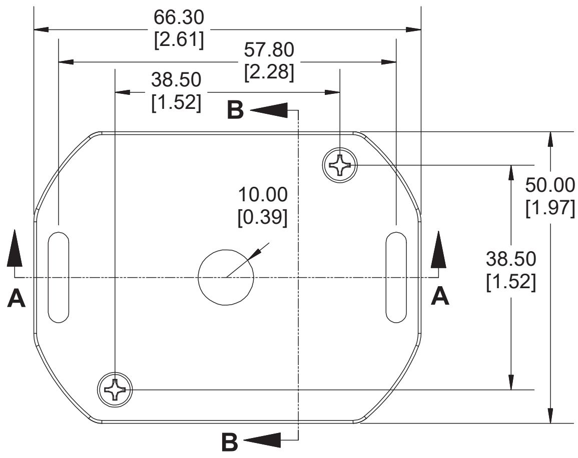
- Nordic ID Merlin
- Nordic ID Morphic
- Motorola MC9090G
- Motorola MC9190Z

MECHANICAL DIMENSIONS

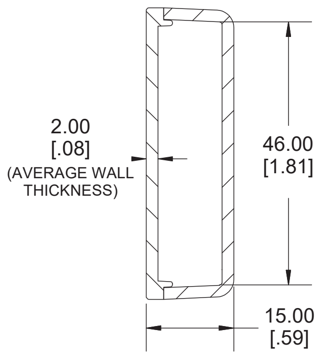
All dimensions are in millimeters [inches].



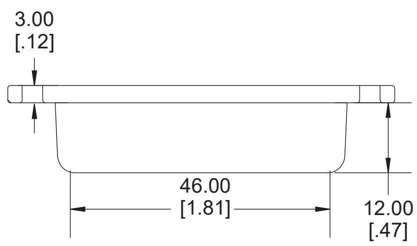
TOP VIEW



BOTTOM VIEW



SECTION B-B



SECTION A-A