PRODUCT HIGHLIGHTS

- High Accuracy up to ±0.1°C
- Very Small Size
- Ready for SMT Assembly
- Multiple Interfaces I2C, SPI
- Adjustment of High Accuracy Temperature Range on Request
- Low Current Consumption
- Low Self Heating
- Additional Input for External Temperature Sensor Component

DESCRIPTION

The TSYS01 is a single chip, versatile, new technology temperature sensor. The TSYS01 provides factory calibrated temperature information. It includes a temperature sensing chip and a 24 bit ΔΣ-ADC. The essence of the digital 24 bit temperature value and the internal factory set calibration values lead to highly accurate temperature information accompanied by high measurement resolution.

The TSYS01 can be interfaced to any microcontroller by an I2C or SPI interface. This microcontroller has to calculate the temperature result based on the ADC values and the calibration parameters.

The basic working principle is:
- Converting temperature into digital 16/24 bit ADC value
- Providing calibration coefficients
- Providing ADC value and calibration coefficients by SPI or I2C interface.
## Specifcation Overview

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Supply Voltage</td>
<td>VDD</td>
<td>stabilized</td>
<td>2.2</td>
<td>3.6</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>High Accuracy Supply Voltage</td>
<td>VDD</td>
<td>To achieve Acc1</td>
<td>3.2</td>
<td>3.4</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Supply Current</td>
<td>IDD</td>
<td>1 sample per second</td>
<td></td>
<td></td>
<td>12.5</td>
<td>µA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.02</td>
<td>µA</td>
</tr>
<tr>
<td>Standby current</td>
<td>IS</td>
<td>No conversion, VDD = 3V</td>
<td></td>
<td></td>
<td>0.14</td>
<td>µA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T = 25°C</td>
<td></td>
<td></td>
<td>1.40</td>
<td>µA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T = 85°C</td>
<td></td>
<td></td>
<td>0.70</td>
<td>µA</td>
</tr>
<tr>
<td>Peak Supply Current</td>
<td>IDD</td>
<td>During conversion</td>
<td></td>
<td></td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>Conversion time</td>
<td>TCONV</td>
<td></td>
<td>7.40</td>
<td>8.22</td>
<td>9.04</td>
<td>ms</td>
</tr>
<tr>
<td>Serial Data Clock SPI</td>
<td>F_SCLK</td>
<td></td>
<td>20</td>
<td></td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td>Serial Data Clock TC</td>
<td>F_SCL</td>
<td></td>
<td>400</td>
<td></td>
<td></td>
<td>kHz</td>
</tr>
<tr>
<td>VDD Capacitor</td>
<td></td>
<td>Place close to the chip</td>
<td></td>
<td></td>
<td>100nF</td>
<td></td>
</tr>
<tr>
<td>Temperature Measurement Range</td>
<td>TRANG</td>
<td></td>
<td>-40</td>
<td>125</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Accuracy 1</td>
<td>T_ACC1</td>
<td>VDD = 2.2…3.6V</td>
<td></td>
<td></td>
<td>-0.1</td>
<td>°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T = 25°C</td>
<td></td>
<td></td>
<td>+0.1</td>
<td>°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T = 85°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accuracy 2</td>
<td>T_ACC2</td>
<td>VDD = 2.7 – 3.6</td>
<td></td>
<td></td>
<td>-0.5</td>
<td>°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T = 25°C, C = 100nF</td>
<td></td>
<td></td>
<td>+0.5</td>
<td>°C</td>
</tr>
<tr>
<td>PSSR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.2</td>
<td>°C</td>
</tr>
<tr>
<td>Temperature Resolution</td>
<td>T_RES</td>
<td></td>
<td></td>
<td></td>
<td>0.01</td>
<td>°C</td>
</tr>
<tr>
<td>Time Constant</td>
<td>T</td>
<td>t110-90</td>
<td></td>
<td>9</td>
<td></td>
<td>s</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PCB=25°C T2=75°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C=100nF, FR4=900mm² x 1.5mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self Heating</td>
<td>SH</td>
<td>10 samples/s, 60s, still air</td>
<td></td>
<td>0.02</td>
<td></td>
<td>°C</td>
</tr>
</tbody>
</table>

## Digital Inputs (SCLK, SDI, CSB, PS)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input High Voltage</td>
<td>VH</td>
<td>VDD = 2.2…3.6V</td>
<td>0.7</td>
<td>VDD</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input Low Voltage</td>
<td>VL</td>
<td>VDD = 2.2…3.6V</td>
<td>0.0</td>
<td>0.3</td>
<td>VDD</td>
<td>V</td>
</tr>
<tr>
<td>CS low to first SCLK rising</td>
<td>t_CSL</td>
<td></td>
<td>21</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>CS high to first SCLK rising</td>
<td>t_CSH</td>
<td></td>
<td>21</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>SDI setup to first SCLK rising</td>
<td>t_DSO</td>
<td></td>
<td>6</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>SDI hold to first SCLK rising</td>
<td>t_DO</td>
<td></td>
<td>6</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
</tbody>
</table>

## Digital Outputs (SDA, SDO)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output High Voltage</td>
<td>VOH</td>
<td>I_Source = 1mA</td>
<td>0.8</td>
<td>VDD</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Output Low Voltage</td>
<td>VOL</td>
<td>I_Sink = 1mA</td>
<td>0.0</td>
<td>0.2</td>
<td>VDD</td>
<td>V</td>
</tr>
<tr>
<td>SDO setup to first SCLK rising</td>
<td>t_SQ</td>
<td></td>
<td>10</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>SDO hold to first SCLK rising</td>
<td>t_QH</td>
<td></td>
<td>0</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
</tbody>
</table>
CONNECTION DIAGRAMS

USING INTEGRATED SENSOR COMPONENT

The TSYS01 is factory calibrated for usage of the internal temperature sensor component. Short pin 10 and pin 11 in order to activate the internal sensor component.

USING EXTERNAL SENSOR COMPONENT

The TSYS01 can be used for remote temperature measurement. A RTD like the NI1000SOT (LINK) has to be wired to the pins 10 and 12 while pin 11 is unconnected. The factory-set calibration parameters are not valid for external sensor application.
### PIN FUNCTION TABLE

<table>
<thead>
<tr>
<th>Pin</th>
<th>Name</th>
<th>Type</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VSS</td>
<td>G</td>
<td>Ground</td>
</tr>
<tr>
<td>2</td>
<td>CSB</td>
<td>DI</td>
<td>SPI: Chip Select (active low) I²C: Address Selection</td>
</tr>
<tr>
<td>3</td>
<td>SCLK/SCL</td>
<td>DI</td>
<td>SPI: Serial Data Clock I²C: Serial Data Clock</td>
</tr>
<tr>
<td>4</td>
<td>SDI/SDA</td>
<td>DIO</td>
<td>SPI: Serial Data Input I²C: Data Input / Output</td>
</tr>
<tr>
<td>5</td>
<td>SDO</td>
<td>DO</td>
<td>SPI: Serial Data Output</td>
</tr>
<tr>
<td>6–9</td>
<td>NC</td>
<td>---</td>
<td>Not connected / Do not connect</td>
</tr>
<tr>
<td>10</td>
<td>INT / EXT</td>
<td>DI/AI</td>
<td>Internal / External Sensor Selection</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Internal Sensor: Connect Pin10 with Pin11</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>External Sensor: Connect external Sensor</td>
</tr>
<tr>
<td>11</td>
<td>INT</td>
<td>DI/AI</td>
<td>Internal / External Sensor Selection</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Internal Sensor: Connect Pin11 with Pin10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>External Sensor: Leave Unconnected</td>
</tr>
<tr>
<td>12</td>
<td>EXT</td>
<td>DI/AI</td>
<td>Internal / External Sensor Selection</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Internal Sensor: Leave Unconnected</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>External Sensor: Connect external Sensor</td>
</tr>
<tr>
<td>13–14</td>
<td>NC</td>
<td>---</td>
<td>Not connected / Do not connect</td>
</tr>
<tr>
<td>15</td>
<td>VDD</td>
<td>P</td>
<td>Supply Voltage</td>
</tr>
<tr>
<td>16</td>
<td>PS</td>
<td>DI</td>
<td>Communication protocol select (0=SPI, 1=I²C)</td>
</tr>
</tbody>
</table>

### SOLDER RECOMMENDATION

Solder reflow process according to IPC/JEDEC J-STD-020D (Pb-Free Process) is recommended.
MEASUREMENT GUIDELINES

GENERAL

In order to achieve the most accurate temperature measurement results, please notice these advices

- Use a stabilized and noise free supply voltage
- Place a ceramic capacitor close to the supply pins
- Keep supply lines as short as possible
- Separate TSYS01 from any heat source which is not meant to be measured.
- Avoid air streams if the PCB temperature is meant to be measured.

MEASUREMENT OF AIR TEMPERATURE

- Separate TSYS01 from the remaining electronics by PCB layout.

MEASUREMENT PCB TEMPERATURE

- Connect DAP (die attach pad) to copper layer of the PCB.
INTERFACE DESCRIPTION

PROTOCOL SELECTION

PS pin input level has to be defined in dependence to protocol selection.

- PS = 0 activates SPI.
- PS = 1 activates I²C.

I²C INTERFACE

A I²C communication message starts with a start condition and it is ended by a stop condition. Each command consists of two bytes: the address byte and command byte.

I²C ADDRESS SELECTION

The I²C address can be selected by CSB pin.

- CSB=1 then the address is 1110110x.
- CSB=0 the address is 1110111x.

Therefore, two TSYS01 can be interfaced on the same I²C bus.

SPI INTERFACE

The serial interface is a 4-wire SPI bus, operating as a slave. CS (chip select), SCLK (serial clock), SDI (serial data in), and SDO (serial data out) are used to interact with the SPI master. Communication with the chip starts when CS is pulled to low and ends when CS is pulled to high. SCLK is controlled by the SPI master and idles low (SCLK low on CS transitions, mode 0). A mode where the clock alternatively idles high is also supported (mode 3).

COMMANDS

The commands are the same for SPI and I²C interface. There are four commands:

- Reset
- Read PROM (calibration parameters)
- Start ADC Temperature conversion
- Read ADC Temperature result

<table>
<thead>
<tr>
<th>Command</th>
<th>Hex Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reset</td>
<td>0x1E</td>
</tr>
<tr>
<td>Start ADC Temperature Conversion</td>
<td>0x48</td>
</tr>
<tr>
<td>Read ADC Temperature Result</td>
<td>0x00</td>
</tr>
<tr>
<td>PROM Read Address 0</td>
<td>0xA0</td>
</tr>
<tr>
<td>PROM Read Address 1</td>
<td>0xA2</td>
</tr>
<tr>
<td>PROM Read Address 2</td>
<td>0xA4</td>
</tr>
<tr>
<td>PROM Read Address 3</td>
<td>0xA6</td>
</tr>
<tr>
<td>PROM Read Address 4</td>
<td>0xA8</td>
</tr>
<tr>
<td>PROM Read Address 5</td>
<td>0xAA</td>
</tr>
<tr>
<td>PROM Read Address 6</td>
<td>0xAC</td>
</tr>
<tr>
<td>PROM Read Address 7</td>
<td>0xAE</td>
</tr>
</tbody>
</table>
INTERFACE CODE EXAMPLES

SPI INTERFACE

The code examples shown are meant to be understood as exemplary. The code has to be adjusted with respect to the used microcontroller in order to work correctly.

```c
// Function: TSYS01_SPI_INIT
void TSYS01_SPI_INIT(void)
{
    // Configure I/Os
    SDI_DIR = IN;  // SDI = Input
    SDO_DIR = OUT; // SDO = Output
    SCL_DIR = OUT; // SCL = Output
    CSB_DIR = OUT; // CSB = Output
}

// Function: TSYS01_SPI_TRANSFER
char TSYS01_SPI_TRANSFER(char cTransmit)
{
    char cReceive = 0;
    char cBit = 0;
    SDO = 0;  SCL = 0;  // Reset SPI Lines
    for (cBit = 0; cBit < 8; cBit++)
    {
        cReceive = cReceive << 1; // Shift Receive Register
        SCL = 0;  // SCL = 0
        SDO = (cTransmit >> (7 - cBit)); // Output next Bit on SDO
        SCL = 1;  // SCL = 1
        cReceive = cReceive | SDI; // Input next Bit on SDI
    }
    RC3 = 0;  RC5 = 0;  // Reset SPI Lines
    return cReceive;
}
```
Function: TSYS01_SPI_READ_ADC
Input: ---
Description: Reads four bytes of ADC result (24bit)

```c
void TSYS01_SPI_READ_ADC(char *cADC)
{
    char cByte;
    CSB = 1;
    CSB = 0;   // Enable Chip Select
    cADC(0) = TSYS01_TRANSFER(0x48);   // Start Conversion
    while (SDI == 0);   // Wait for Conversion done
    CSB = 1;
    CSB = 0;   // Enable Chip Select
    for (cByte = 0; cByte < 4; cByte++)
    {
        cADC[cByte] = TSYS01_TRANSFER(0x00);   // READ ADC
    }
    CSB = 1;
}
```

Function: TSYS01_SPI_READ_PROM_WORD
Input: char cAddress Address of Prom to be read
Description: Reads two byte (on word) of Prom memory

```c
void TSYS01_SPI_READ_PROM_WORD(char cAddress, char *cPROM)
{
    cAdress = 0xA0 | (cAddress << 1);
    CSB = 1;
    CSB = 0;   // Enable Chip Select
    cPPROM[0] = TSYS01_TRANSFER (cAdress);   // Command Read PROM
    cPPROM[0] = TSYS01_TRANSFER(0x00);   // Read high byte
    cPPROM[1] = TSYS01_TRANSFER(0x00);   // Read low byte
    CSB = 1;
}
```
I²C INTERFACE

The code examples shown are meant to be understood as exemplary. The code has to be adjusted with respect to the used microcontroller in order to work.

```
//*****************************/
/* Function: TSYS01_I2C_INIT */
/* Input:  ---                */
/* Return: ---                */
/* Description: Initialization of I2C Port */
**************************************************************************/
void TSYS01_I2C_INIT(void)
{
    I2C_SCK_DIR = OUT; // SCK = Output
    I2C_SDA_DIR = OUT; // SDA = Output
}

//*****************************/
/* Function: TSYS01_I2C_READ_PROM_WORD */
/* Input:  char cAddress Address of Prom to be read */
/* Description: Reads two byte (on word) of Prom memory */
**************************************************************************/
void TSYS01_I2C_READ_PROM_WORD(char cAddress, char *cPROM)
{
    cAdress = 0xA0 | (cAddress << 1);
    TSYS01_I2C_START(); // Send Start Condition
    TSYS01_I2C_TRANSMIT_BYTE(I2C_ADRESS | I2C_W); // Send I2C-Address, Write
       // Mode
    TSYS01_I2C_GET_ACK(); // Get ACK
    TSYS01_I2C_SEND_BYTE(cAdress); // Send Read PROM command
       // including address to read
    TSYS01_I2C_GET_ACK(); // Get ACK
    TSYS01_I2C_STOP(); // Send Stop Condition
    TSYS01_I2C_START(); // Send Start Condition
    TSYS01_I2C_TRANSMIT_BYTE(I2C_ADRESS | I2C_R); // Send I2C-Address, Read Mode
    TSYS01_I2C_GET_ACK(); // Get ACK
    cPPROM[0] = TSYS01_I2C_RECEIVE_BYTE(void) // Read high byte
    I2C_SET_ACK(TRUE); // Set ACK
    cPPROM[1] = TSYS01_I2C_RECEIVE_BYTE(void) // Read low byte
    I2C_SET_ACK(FALSE); // Set NACK
    TSYS01_I2C_STOP(); // Send Stop Condition
```
Function: TSYS01_I2C_READ_ADC
Input: ---
Description: Reads four bytes of ADC result (24bit)

void TSYS01_I2C_READ_ADC(char *cADC)
{
    char cByte;

    // Send command to start ADC conversion
    TSYS01_I2C_START(); // Send Start Condition
    TSYS01_I2C_TRANSMIT_BYTE(I2C_ADDRESS | I2C_W); // Send I2C-Address, Write
                                               // Mode
    TSYS01_I2C_GET_ACK(); // Get ACK
    TSYS01_I2C_SEND_BYTE(0x48); // Start Conversion
    TSYS01_I2C_GET_ACK(); // Get ACK
    TSYS01_I2C_STOP(); // Send Stop Condition

    // Repeat this block until Acknowledge is true
    // or wait 10ms for conversion to be done
    TSYS01_I2C_START(); // Send Start Condition
    TSYS01_I2C_TRANSMIT_BYTE(I2C_ADDRESS | I2C_W); // Send I2C-Address, Write Mode
    TSYS01_I2C_GET_ACK(); // Get ACK
    TSYS01_I2C_STOP(); // Send Stop Condition

    TSYS01_I2C_START(); // Send Start Condition
    TSYS01_I2C_TRANSMIT_BYTE(I2C_ADDRESS | I2C_W); // Send I2C-Address, Write Mode
    TSYS01_I2C_GET_ACK(); // Get ACK
    TSYS01_I2C_SEND_BYTE(0x00); // Send Read ADC command
    TSYS01_I2C_GET_ACK(); // Get ACK
    TSYS01_I2C_STOP(); // Send Stop Condition

    TSYS01_I2C_START(); // Send Start Condition
    TSYS01_I2C_TRANSMIT_BYTE(I2C_ADDRESS | I2C_R); // Send I2C-Address, Read Mode
    TSYS01_I2C_GET_ACK(); // Get ACK
cADC[0] = TSYS01_I2C_RECEIVE_BYTE(void) // Read first byte
           I2C_SET_ACK(TRUE); // Set ACK
    cADC[1] = TSYS01_I2C_RECEIVE_BYTE(void) // Read next byte
           I2C_SET_ACK(TRUE); // Set ACK
    cADC[2] = TSYS01_I2C_RECEIVE_BYTE(void) // Read next byte
           I2C_SET_ACK(TRUE); // Set ACK
    cADC[3] = TSYS01_I2C_RECEIVE_BYTE(void) // Read last byte
           I2C_SET_ACK(FALSE); // Set NACK
    TSYS01_I2C_STOP(); // Send Stop Condition
}
void TSYS01_I2C_START(void)
{
    I2C_SCK_DIR = OUT; // SCK = Output
    I2C_SDA_DIR = OUT; // SDA = Output
    I2C_SCK = 1;
    I2C_SDA = 1;
    I2C_SDA = 0;
}

void TSYS01_I2C_STOP(void)
{
    I2C_SCK_DIR = OUT; // SCK is Output
    I2C_SDA_DIR = OUT; // SDA is Output
    I2C_SCK = 1;
    I2C_SDA = 0;
    I2C_SDA = 1;
}
/****************************************************************** *
* Function:   TSYS01_I2C_TRANSMIT_BYTE                           *
* Input:      char cTransmit        Byte to be send to TSYS01    *
* Return:     ---                      *
* Description: Sends one byte to TSYS01                        *
*******************************************************************/
void TSYS01_I2C_TRANSMIT_BYTE(char cTransmit)
{
    char cBit, cMask;
    cMask = 0x80;

    I2C_SCK_DIR = OUT; // SCK is Output
    I2C_SDA_DIR = OUT; // SDA is Output

    I2C_SCK = 0;
    for (cBit = 0; cBit < 8; cBit++)
    {
        I2C_SDA = 0;
        if ((cTransmit & cMask) != 0) I2C_SDA = 1;
        I2C_SCK = 1;
        I2C_SCK = 0;
        cMask = cMask >> 1;
    }
}

/***************************************************************************/
Function:   TSYS01_I2C_RECEIVE_BYTE
Input:      ---                      
Return:     char cReceive Byte received from TSYS01                  
Description: Reads one byte from TSYS01                             
***************************************************************************/
char TSYS01_I2C_RECEIVE_BYTE(void)
{
    char cReceive, cBit;

    I2C_SCK_DIR = IN; // SCK is Input
    I2C_SDA_DIR = IN; // SDA is Input

    while (I2C_SCK == 0); // Wait for SCL release

    I2C_SCK_DIR = OUT; // SCK is Output

    I2C_SCK = 0;
    I2C_SCK = 1;
    for (cBit = 0; cBit < 8; cBit++)
    {
        cReceive = cReceive << 1;
        I2C_SCK = 1;
        if (I2C_SDA == 1) cReceive = cReceive + 1;
        I2C_SCK = 0;
    }
    return cReceive;
}
Function: TSYS01_I2C_GET_ACK
Input: ---
Return: bit bACK Bit represents ACK status
Description: Reads Acknowledge from TSYS01

bit TSYS01_I2C_GET_ACK(void)
{
    bit bACK;
    I2C_SCK_DIR = OUT;   // SCK is Output
    I2C_SDA_DIR = IN;    // SDA is Input
    I2C_SCK = 0;
    I2C_SCK = 1;
    bACK = I2C_SDA;
    I2C_SCK = 0;
    return bACK;
}

Function: TSYS01_I2C_Set_ACK
Input: bit bACK Bit represents ACK status to be send
Return: ---
Description: Reads Acknowledge from TSYS01

void I2C_SET_ACK(bit bACK)
{
    I2C_SCK_DIR = OUT;   // SCK is Output
    I2C_SDA_DIR = OUT;   // SDA is Output
    I2C_SCK = 0;
    I2C_SCK = 1;
    I2C_SCK = 0;
    I2C_SDA = bACK;
}
INTERFACE TRANSMISSIONS

RESET SEQUENCE

The Reset sequence has to be sent once after power-on. It can be also used to reset the device ROM from an unknown condition.

**SPI**

![SPI Diagram]

**I²C**

![I²C Diagram]

PROM READ SEQUENCE

The PROM Read command consists of two parts. First command sets up the system into PROM read mode. The second part gets the data from the system. Below examples are sequences to read address 3 (command 0xA6).

**SPI**

![SPI Diagram]

**I²C**

![I²C Diagram]
CONVERSION SEQUENCE

A conversion has to be started by sending this command. The sensor stays busy until conversion is done. When conversion is finished the data can be accessed by using ADC read command

SPI

The last clock will start the conversion which TSYS01 indicates by pulling SDO low. SDO goes high when conversion is completed.

I²C

When the command is sent the TSYS01 stays busy until the conversion is done. All other commands except the reset command will not be executed during this time. When the conversion is finished the data can be accessed by sending a ADC read command, when an acknowledge appears from TSYS01.

READ ADC RESULT

After the conversion command the ADC result is read using ADC read command. Repeated ADC read commands, or command executed without prior conversion will return all 0 as result.

SPI

I²C
TEMPERATURE CALCULATION

CALIBRATION PARAMETER

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Command</th>
<th>Size / bit</th>
<th>Min</th>
<th>Max</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>k₄</td>
<td>Coefficient k₄ of polynomial</td>
<td>0xA2</td>
<td>16</td>
<td>0</td>
<td>65535</td>
<td>28446</td>
</tr>
<tr>
<td>k₃</td>
<td>Coefficient k₃ of polynomial</td>
<td>0xA4</td>
<td>16</td>
<td>0</td>
<td>65535</td>
<td>24926</td>
</tr>
<tr>
<td>k₂</td>
<td>Coefficient k₂ of polynomial</td>
<td>0xA6</td>
<td>16</td>
<td>0</td>
<td>65535</td>
<td>36016</td>
</tr>
<tr>
<td>k₁</td>
<td>Coefficient k₁ of polynomial</td>
<td>0xA8</td>
<td>16</td>
<td>0</td>
<td>65535</td>
<td>32791</td>
</tr>
<tr>
<td>k₀</td>
<td>Coefficient k₀ of polynomial</td>
<td>0xAA</td>
<td>16</td>
<td>0</td>
<td>65535</td>
<td>40781</td>
</tr>
</tbody>
</table>

TEMPERATURE POLYNOMIAL

ADC24: ADC value
ADC16: ADC24 / 256

\[
T / ^\circ C = (-2) * k_4 * 10^{-21} * \text{ADC16}^4 + \\
4 * k_3 * 10^{-16} * \text{ADC16}^3 + \\
(-2) * k_2 * 10^{-11} * \text{ADC16}^2 + \\
1 * k_1 * 10^{-6} * \text{ADC16} + \\
(-1.5) * k_0 * 10^{-2}
\]

EXAMPLE

ADC24: 9378708
ADC16: 9378708 / 256 = 36636

\[
T / ^\circ C = (-2) * 28446 * 10^{-21} * 36636^4 + \\
4 * 24926 * 10^{-16} * 36636^3 + \\
(-2) * 36016 * 10^{-11} * 36636^2 + \\
1 * 32791 * 10^{-6} * 36636 + \\
(-1.5) * 40781 * 10^{-2}
\]

T / ^\circ C = 10.55
DIMENSIONS

**BOTTOM VIEW**

**SIDE VIEW**

**MARKING**

<table>
<thead>
<tr>
<th>Line</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Manufacturer</td>
<td>MEAS</td>
</tr>
<tr>
<td>2</td>
<td>Product Name</td>
<td>TSYS01</td>
</tr>
<tr>
<td>3</td>
<td>Pin 1 Dot, Date Code YYWW</td>
<td>1141</td>
</tr>
</tbody>
</table>
ORDER INFORMATION

Please order this product using following:

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Part Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>G-NICO-018</td>
<td>TSYS01 Digital Temperature Sensor</td>
</tr>
</tbody>
</table>

EMC

Due to the use of these modules for OEM application no CE declaration is done. Especially line coupled disturbances like surge, burst, HF etc. cannot be removed by the module due to the small board area and low price feature. There is no protection circuit against reverse polarity or over voltage implemented.

The module will be designed using capacitors for blocking and ground plane areas in order to prevent wireless coupled disturbances as good as possible.

DEFINITIONS AND DISCLAIMERS

- Application information – Applications that are described herein for any of these products are for illustrative purpose only. MEAS Deutschland GmbH makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.
- Life support applications – These products are not designed for use in life support appliances, devices, or systems where malfunctions of these products can reasonably be expected to result in personal injury. MEAS Deutschland GmbH customers using or selling this product for use in such applications do so at their own risk and agree to fully indemnify MEAS Deutschland GmbH for any damages resulting from such improper use or sale.

TECHNICAL CONTACT INFORMATION

<table>
<thead>
<tr>
<th>NORTH AMERICA</th>
<th>EUROPE</th>
<th>ASIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement Specialties, Inc.</td>
<td>MEAS Deutschland GmbH</td>
<td>Measurement Specialties China Ltd.</td>
</tr>
<tr>
<td>1000 Lucas Way</td>
<td>Hauert 13</td>
<td>No. 26, Langshan Road</td>
</tr>
<tr>
<td>Hampton, VA 23666</td>
<td>D-44227 Dortmund</td>
<td>High-tech Park (North)</td>
</tr>
<tr>
<td>United States</td>
<td>Germany</td>
<td>Nanshan District, Shenzhen 518057</td>
</tr>
<tr>
<td>Phone: +1-800-745-8008</td>
<td>Phone: +49-(0)231-9740-0</td>
<td>China</td>
</tr>
<tr>
<td>Fax: +1-757-766-4297</td>
<td>Fax: +49-(0)231-9740-20</td>
<td>Phone: +86-755-33305088</td>
</tr>
<tr>
<td>Email: <a href="mailto:sales@meas-spec.com">sales@meas-spec.com</a></td>
<td>Email: <a href="mailto:info.de@meas-spec.com">info.de@meas-spec.com</a></td>
<td>Fax: +86-755-33305099</td>
</tr>
<tr>
<td>Web: <a href="http://www.meas-spec.com">www.meas-spec.com</a></td>
<td>Web: <a href="http://www.meas-spec.com">www.meas-spec.com</a></td>
<td>Email: <a href="mailto:info.cn@meas-spec.com">info.cn@meas-spec.com</a></td>
</tr>
</tbody>
</table>

The information in this sheet has been carefully reviewed and is believed to be accurate; however, no responsibility is assumed for inaccuracies. Furthermore, this information does not convey to the purchaser of such devices any license under the patent rights to the manufacturer. Measurement Specialties, Inc. reserves the right to make changes without further notice to any product herein. Measurement Specialties, Inc. makes no warranty, representation or guarantee regarding the suitability of its product for any particular purpose, nor does Measurement Specialties, Inc. assume any liability arising out of the application or use of any product or circuit and specifically disclaims any and all liability, including without limitation consequential or incidental damages. Typical parameters can and do vary in different applications. All operating parameters must be validated for each customer application by customer’s technical experts. Measurement Specialties, Inc. does not convey any license under its patent rights nor the rights of others.