

# SHT1x and SHT7x Sample Code

## Humidity & Temperature Sensor

### Introduction

This application note presents an example of a code in C to achieve the following:

- Readout of Humidity (RH) and Temperature (T) from SHT1x and SHT7x sensors with basic error handling
- Calculation of RH linearization and temperature compensation
- Access to status register
- Dewpoint calculation from RH and T values
- UART handling (communication with an external device such as a PC)

### 1. Sample Code

```

/*****
Project:          SHT1x/7x demo program (V2.4)
Filename:         SHT1x_sample_code.c

Prozessor:        80C51 family
Compiler:         Keil Version 6.23a

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*****/
// Revisions:
// V2.4  calc_sht11()      Coefficients for humidity and temperature conversion
//                               changed (for V4 sensors)
//      calc_dewpoint()   New formula for dew point calculation

#include <AT89s53.h> //Microcontroller specific library, e.g. port definitions
#include <intrins.h> //Keil library (is used for _nop()_ operation)
#include <math.h>    //Keil library
#include <stdio.h>   //Keil library

typedef union
{ unsigned int i;
  float f;
} value;
  
```

```

//-----
// modul-var
//-----
enum {TEMP,HUMI};

#define DATA    P1_1
#define SCK      P1_0

#define noACK 0
#define ACK     1

#define STATUS_REG_W 0x06 //adr  command  r/w
#define STATUS_REG_R 0x07 //000    0011    0
#define MEASURE_TEMP 0x03 //000    0001    1
#define MEASURE_HUMI 0x05 //000    0010    1
#define RESET        0x1e //000    1111    0

//-----
char s_write_byte(unsigned char value)
//-----
// writes a byte on the Sensibus and checks the acknowledge
{
    unsigned char i,error=0;
    for (i=0x80;i>0;i/=2) //shift bit for masking
    { if (i & value) DATA=1; //masking value with i , write to SENSI-BUS
      else DATA=0;
      _nop(); //observe setup time
      SCK=1; //clk for SENSI-BUS
      _nop();_nop();_nop(); //pulswith approx. 5 us
      SCK=0;
      _nop(); //observe hold time
    }
    DATA=1; //release DATA-line
    _nop(); //observe setup time
    SCK=1; //clk #9 for ack
    error=DATA; //check ack (DATA will be pulled down by SHT11)
    SCK=0;
    return error; //error=1 in case of no acknowledge
}

//-----
char s_read_byte(unsigned char ack)
//-----
// reads a byte form the Sensibus and gives an acknowledge in case of "ack=1"
{
    unsigned char i,val=0;
    DATA=1; //release DATA-line
    for (i=0x80;i>0;i/=2) //shift bit for masking
    { SCK=1; //clk for SENSI-BUS
      if (DATA) val=(val | i); //read bit
      SCK=0;
    }
    DATA=!ack; //in case of "ack==1" pull down DATA-Line
    _nop(); //observe setup time
    SCK=1; //clk #9 for ack
    _nop();_nop();_nop(); //pulswith approx. 5 us
    SCK=0;
    _nop(); //observe hold time
    DATA=1; //release DATA-line
    return val;
}

```

```
//-----  
void s_transstart(void)  
//-----  
// generates a transmission start  
//  
// DATA: _____|_____|_____   
//  
// SCK : ____|__|____|__|_____  
{  
    DATA=1; SCK=0; //Initial state  
    _nop_();  
    SCK=1;  
    _nop_();  
    DATA=0;  
    _nop_();  
    SCK=0;  
    _nop_();_nop_();_nop_();  
    SCK=1;  
    _nop_();  
    DATA=1;  
    _nop_();  
    SCK=0;  
}  
  
//-----  
void s_connectionreset(void)  
//-----  
// communication reset: DATA-line=1 and at least 9 SCK cycles followed by transstart  
//  
// DATA: _____|_____|_____   
//  
// SCK : ____|__|____|__|____|__|____|__|____|__|____|__|____|____|____|____|____|____|____|____|____  
{  
    unsigned char i;  
    DATA=1; SCK=0; //Initial state  
    for(i=0;i<9;i++) //9 SCK cycles  
    {  
        SCK=1;  
        SCK=0;  
    }  
    s_transstart(); //transmission start  
}  
  
//-----  
char s_softreset(void)  
//-----  
// resets the sensor by a softreset  
{  
    unsigned char error=0;  
    s_connectionreset(); //reset communication  
    error+=s_write_byte(RESET); //send RESET-command to sensor  
    return error; //error=1 in case of no response form the sensor  
}
```

```

//-----
char s_read_statusreg(unsigned char *p_value, unsigned char *p_checksum)
//-----
// reads the status register with checksum (8-bit)
{
    unsigned char error=0;
    s_transstart();           //transmission start
    error=s_write_byte(STATUS_REG_R); //send command to sensor
    *p_value=s_read_byte(ACK); //read status register (8-bit)
    *p_checksum=s_read_byte(noACK); //read checksum (8-bit)
    return error;             //error=1 in case of no response form the sensor
}

//-----
char s_write_statusreg(unsigned char *p_value)
//-----
// writes the status register with checksum (8-bit)
{
    unsigned char error=0;
    s_transstart();           //transmission start
    error+=s_write_byte(STATUS_REG_W); //send command to sensor
    error+=s_write_byte(*p_value);    //send value of status register
    return error;             //error>=1 in case of no response form the sensor
}

//-----
char s_measure(unsigned char *p_value, unsigned char *p_checksum, unsigned char
mode)
//-----
// makes a measurement (humidity/temperature) with checksum
{
    unsigned char error=0;
    unsigned int i;

    s_transstart();           //transmission start
    switch(mode){             //send command to sensor
        case TEMP : error+=s_write_byte(MEASURE_TEMP); break;
        case HUMI : error+=s_write_byte(MEASURE_HUMI); break;
        default   : break;
    }
    for (i=0;i<65535;i++) if(DATA==0) break; //wait until sensor has finished the
measurement
    if(DATA) error+=1;        // or timeout (~2 sec.) is reached
    *(p_value) =s_read_byte(ACK); //read the first byte (MSB)
    *(p_value+1)=s_read_byte(ACK); //read the second byte (LSB)
    *p_checksum =s_read_byte(noACK); //read checksum
    return error;
}

```

```
//-----
void init_uart()
//-----
//9600 bps @ 11.059 MHz
{SCON  = 0x52;
  TMOD  = 0x20;
  TCON  = 0x69;
  TH1   = 0xfd;
}

//-----
void calc_sth11(float *p_humidity ,float *p_temperature)
//-----
// calculates temperature [°C] and humidity [%RH]
// input :  humi [Ticks] (12 bit)
//          temp [Ticks] (14 bit)
// output:  humi [%RH]
//          temp [°C]
{ const float C1=-2.0468;           // for 12 Bit RH
  const float C2=+0.0367;           // for 12 Bit RH
  const float C3=-0.0000015955;     // for 12 Bit RH
  const float T1=+0.01;             // for 12 Bit RH
  const float T2=+0.00008;          // for 12 Bit RH

  float rh=*p_humidity;             // rh:      Humidity [Ticks] 12 Bit
  float t=*p_temperature;           // t:      Temperature [Ticks] 14 Bit
  float rh_lin;                     // rh_lin: Humidity linear
  float rh_true;                    // rh_true: Temperature compensated humidity
  float t_C;                        // t_C     : Temperature [°C]

  t_C=t*0.01 - 40.1;                //calc. temperature[°C]from 14 bit temp.ticks @5V
  rh_lin=C3*rh*rh + C2*rh + C1;      //calc. humidity from ticks to [%RH]
  rh_true=(t_C-25)*(T1+T2*rh)+rh_lin; //calc. temperature compensated humidity
[%RH]
  if(rh_true>100)rh_true=100;        //cut if the value is outside of
  if(rh_true<0.1)rh_true=0.1;       //the physical possible range

  *p_temperature=t_C;               //return temperature [°C]
  *p_humidity=rh_true;              //return humidity[%RH]
}

//-----
float calc_dewpoint(float h,float t)
//-----
// calculates dew point
// input:  humidity [%RH], temperature [°C]
// output: dew point [°C]
{ float k,dew_point ;

  k = (log10(h)-2)/0.4343 + (17.62*t)/(243.12+t);
  dew_point = 243.12*k/(17.62-k);
  return dew_point;
}
```

```

//-----
void main()
//-----
// sample program that shows how to use SHT11 functions
// 1. connection reset
// 2. measure humidity [ticks](12 bit) and temperature [ticks](14 bit)
// 3. calculate humidity [%RH] and temperature [°C]
// 4. calculate dew point [°C]
// 5. print temperature, humidity, dew point

{ value humi_val,temp_val;
  float dew_point;
  unsigned char error,checksum;
  unsigned int i;

  init_uart();
  s_connectionreset();
  while(1)
  { error=0;
    error+=s_measure((unsigned char*) &humi_val.i,&checksum,HUMI); //measure
humidity
    error+=s_measure((unsigned char*) &temp_val.i,&checksum,TEMP); //measure
temperature
    if(error!=0) s_connectionreset(); //in case of an error: connection reset
    else
    { humi_val.f=(float)humi_val.i; //converts integer to float
      temp_val.f=(float)temp_val.i; //converts integer to float
      calc_sth11(&humi_val.f,&temp_val.f); //calculate humidity,
temperature
      dew_point=calc_dewpoint(humi_val.f,temp_val.f); //calculate dew point
      printf("temp:%5.1fC humi:%5.1f%% dew
point:%5.1fC\n",temp_val.f,humi_val.f,dew_point);
    }
  }
//-----wait approx. 0.8s to avoid heating up SHTxx-----
  for (i=0;i<40000;i++); //(be sure that the compiler doesn't eliminate this line!)
//-----
}
}

```

## 2. Revision History

Date	Revision	Changes
November 20, 2001	0.9 (Preliminary)	Initial revision
February 19, 2001	1.00	
July 10, 2002	2.00	Added delay of 0.8s between measurements to prevent selfheating Connection reset only after error during transmission Checks for RH<0% and >100%
October 23, 2002	2.01	Changed sign of Temperature coefficient T1 to match datasheet.
Oct. 17, 2003	2.02	Changed download link
July 15, 2004	2.03	Added comments about UART function
May 25, 2005	2.04	Changed company address
April, 28, 2006	2.05	The function calc_dewpoint is updated with the new Magnus parameters. This improves slightly the accuracy at low humidity and low temperature.
Oct 3, 2006	2.06	Sensirion Inc. address added
November 24, 2010	2.07	Coefficients for humidity and temperature conversion changed (for V4 sensors) and addresses of new sales offices added.

The latest version of this document and all application notes can be found at: [www.sensirion.com/humidity](http://www.sensirion.com/humidity)

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