LAMPIRAN
LAMPIRAN A

RANGKAIAN KESELURUHAN
#include <at89x51.h>
#include <intrins.h>
#include <math.h>
#include <stdio.h>

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

enum {TEMP,HUMI};

#define datalcd P2
#define datalampu_ka P0_0
#define datalampu_ki P0_1
#define definekipas_in P0_2
#define definekipas_out P0_3
#define definepemanas P0_6
#define defineDATA P3_0
#define SCK

// program sensor dimulai dari sini

#define noACK 0
#define ACK 1

#define STATUS_REG_W 0x06
#define STATUS_REG_R 0x07
#define MEASURE_TEMP 0x03
#define MEASURE_HUMI 0x05
#define RESET 0x1e

char s_write_byte(unsigned char value)
{
    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;
        SCK = 1; // clk for SENSI-BUS
        _nop_(); _nop_(); _nop_(); // puls with approx. 5 us
        SCK = 0;
    }
    DATA = 1; // release DATA-line
    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)
{
    unsigned char i, val = 0;
    DATA = 1; // release DATA-line
    for (i = 0x80; i > 0; i >>= 1) // shift bit for masking
    {
        SCK = 1; // clk for SENSE-BUS
        if (DATA) val |= (val | i); // read bit
        SCK = 0;
    }
    DATA = !ack; // in case of "ack==1" pull down DATA-Line
    SCK = 1; // clk #9 for ack
    _nop_(); _nop_(); _nop_(); // pulse with approx. 5 us
    SCK = 0;
    DATA = 1; // release DATA-line
    return val;
}

void s_transstart(void)
{
    DATA = 1; SCK = 0; // Initial state
    _nop_(); SCK = 1;
    _nop_(); DATA = 0;
    _nop_(); SCK = 0;
    _nop_(); _nop_(); _nop_();
    SCK = 1; _nop_();
    DATA = 1; _nop_();
void s_connectionreset (void)
{
    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)
{
    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)
{
    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 from the sensor

}

char s_write_statusreg(unsigned char *p_value)
{
    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 from the sensor
}

char s_measure(unsigned char *p_value, unsigned char *p_checksum,unsigned char mode)
{
    unsigned 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 calc_sth11(float *p_humidity, float *p_temperature)
{
const float C1=-4.0;    // for 12 Bit
const float C2=+0.0405;  // for 12 Bit
const float C3=-0.0000028;   // for 12 Bit

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 t_C;                // t_C : Temperature [°C]

t_C=*0.01 - 40;           //calc. temperature from ticks to [°C]
rh_lin=C3*rh*rh + C2*16191;  //calc. humidity from ticks to [%RH]

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

//program sensor sampai disini
//program sensor sampai disini
//program sensor sampai disini

void tunda()
{
int a;
for (a=0;a<=500;a++);
}
void tunda2(int loop2)
{
    int loop;
    loop=0;
    while (loop<=loop2)
    {
        loop++;
        TH1=((-50000/256)-1);
        TL1=((-50000%256);
        TF1=0;
        TR1=1;
        while (!TF1);
    }
}

void kirim_p(int dat)
{
    rs=0;
    datalcd=dat;
    e=1;
    e=0;
    tunda();
}

void initlcd()
{
    tunda();
    kirim_p(56);kirim_p(56);
    kirim_p(56);kirim_p(56);
    kirim_p(6);kirim_p(12);
void kirim_k(int dat2)
{
    rs=1;
    datalcd=dat2;
    e=1;
    e=0;
    tunda();
}

void clear()
{
    rs=0;
    kirim_p(1);
}

void cursorhome()
{
    rs=0;
    kirim_p(2);
}

void tampil_suhu_input()
{
    kirim_k('M');  kirim_k('A');  kirim_k('S');
    kirim_k('U');  kirim_k('K');  kirim_k('K');
    kirim_k('A');  kirim_k('N');  kirim_k(' ');  kirim_k('S');  kirim_k('K');
    kirim_k('H');  kirim_k(':');
```c
void tampilan_suhu_awal()
{
kirim_p(192); kirim_k('2'); kirim_k('6');
}

void tampil_suhu()
{
kirim_p(2); kirim_k('S'); kirim_k('U'); kirim_k('H');
kirim_k('U'); kirim_k(':'); kirim_k('');
}

void tampil_rh()
{
kirim_k('K'); kirim_k('E'); kirim_k('L');
kirim_k('E'); kirim_k('M'); kirim_k('B');
kirim_k('A'); kirim_k('B'); kirim_k('A');
kirim_k('N'); kirim_k(':'); kirim_k('');
}

void delay_2 ()
     // prosedure delay_2
{
    int x,y=0;
    ulang8kali:
y++;    
    for (x=0; x<30000; x++);
    if (y<15) goto ulang8kali;
}
```
int cek_keypad(int *cekker)
{
    int suhu_satuan,suhu_puluhan,boleh;
    lbh_dr_38:

    kirim_p(2);
    tampil_suhu_input();
    kirim_p(192);
    tampilan_suhu_awal();

    //memberi nilai awal register
    suhu_satuan=6;
    suhu_puluhan=2;
    boleh=0;
    do
    {
        // tombol up ditekan
        //
        if (tb_up==0)
        {
            delay_2();
            kirim_p(2);
            tampil_suhu_input();
            kirim_p(192);

            suhu_satuan++;
            // cek apakah satuan sdh lebih dari 10
            if (suhu_satuan>=10)
            {
                suhu_puluhan++;
                suhu_satuan=0;
            }
        }
    } while (1);
// tampilkan satuan dan puluhan ke LCD
kirim_k(suhu_puluan+48);
kirim_k(suhu_satuan+48);
}

// tombol down ditekan
if (tb_down==0)
{
    delay_2();
kirim_p(2);
tampil_suhu_input();
kirim_p(192);
suhu_satuan--;
    // cek apakah satuan sdh kurang lebih dari 0
    if (suhu_satuan<0)
    {
        suhu_puluan--;
suhu_satuan=9;
    }
    //tampilkan satuan dan puluhan ke LCD
    kirim_k(suhu_puluan+48);
kirim_k(suhu_satuan+48);
}

// tombol enter ditekan
if (tb_enter==0)
{
    *cekker=(suhu_puluan*10)+suhu_satuan;
boleh=1;
delay_2();
//jika suhu lebih 39 dan kurang dari 25 lompat ke tampilan awal
if (*cekker >:39) goto lbh_dr_38;
else if (*cekker <=25) goto lbh_dr_38;
//jika kondisi terpenuhi program jalan
else
{
    clear0; kirim_p(2);
kirim_k('S'); kirim_k('U'); kirim_k('H');
kirim_k('U'); kirim_k(' '); kirim_k(' '); kirim_k(' '); kirim_k(suhu_puluhan+48);
kirim_k(suhu_satuan+48);
}
}
while (boleh==0);
}

void cek_kondisi(int *suhu_inputan, float *suhu_data, float *rh_data)
{
    int satuan_suhu,puluhan_suhu,satuan_rh,puluhan_rh,koma_suhu,koma_rh;
    if (*suhu_data < 32)
    {
        *suhu_data= *suhu_data - 2 ;
    }
    if (*suhu_inputan > *suhu_data)
    {
        lampu_ka=0;
lampu_ki=0;
kipas_in=1;
kipas_out=0;
if (*rh_data<=50) pemanas=0;
else pemanas=1;
}
else if (*suhu_inputan == *suhu_data)
{
lampu_ka=1;
lampu_ki=1;
kipas_in=1;
kipas_out=0;
pemanas=1;
}
else if (*suhu_inputan < *suhu_data)
{
lampu_ka=1;
lampu_ki=1;
kipas_in=1;
kipas_out=1;
pemanas=1;
}
clear();
tampil_suhu();
if (*suhu_data>=10)
{
puluhan_suhu=*suhu_data/10;
satuan_suhu=*suhu_data-(puluhan_suhu*10);
koma_suhu=(*suhu_data-((puluhan_suhu*10)+satuan_suhu))*10;
kirim_k(puluhan_suhu+48); kirim_k(satuan_suhu+48);
kirim_k(','); kirim_k(koma_suhu+48);
else
{
    satuan_suhu=*sujuh_data;
    koma_suhu=(sujuh_data-satuan_suhu)*10;
    kirim_k(satuun_suhu+48); kirim_k(''); kirim_k(koma_suhu+48);
}
kirim_k(''); kirim_k('0'); kirim_k('C');
kirim_p(192);

tampil_rh();
if ( (*rh_data>=10) || (*rh_data<=99) )
{
    puluhan_rh=*rh_data/10;
    satuan_rh=*rh_data-(puluhan_rh*10);
    kirim_k(puluhan_rh+48); kirim_k(satuan_rh+48);
}
else
{
    satuan_rh=*rh_data;
    kirim_k(satuan_rh+48);
}
kirim_k('%');
}

void main()
{
    value humi_val,temp_val;
    unsigned char error,checksum;
    unsigned int i;
    int suhu_input,red,data_suhu,data_rh;

start:
P0=0x0FF;
P1=0x0FF;
kips_in=0;
kips_out=0;
data_rh=0;
data_suhu=0;
initlcd();
clear();
tampil_suhu_input();
tampilan_suhu_awal();
cek_keypad(&suhu_input);

s_connectionreset();

while (1)
{
    error=0;
    error+=s_measure((unsigned char*) &humi_val.i,&checksum,HUMI);
    error+=s_measure((unsigned char*) &temp_val.i,&checksum,TEMP);
    if(error!=0) s_connectionreset();
    else
    {
        humi_val.f=(float)humi_val.i;
        temp_val.f=(float)temp_val.i;
        calc_sth11(&humi_val.f,&temp_val.f);
    }
}
clear();

cek_kondisi(&suhu_input,&temp_val.f,&humi_val.f);

for (i=0; i<40000; i++)
{
    if (tb_reset==0) goto start;
}

start:

}
SHT1x / SHT7x
Humidity & Temperature Sensor

Evaluation Kit Available

- Relative humidity and temperature sensors
- Dew point
- Fully calibrated, digital output
- Excellent long-term stability
- No external components required
- Ultra low power consumption
- Surface mountable or 4-pin fully interchangeable
- Small size
- Automatic power down

SHT1x / SHT7x Product Summary

The SHTxx is a single chip relative humidity and temperature multi sensor module comprising a calibrated digital output. Application of industrial CMOS processes with patented micro-machining (CMOSens® technology) ensures highest reliability and excellent long term stability. The device includes a capacitive polymer sensing element for relative humidity and a bandgap temperature sensor. Both are seamlessly coupled to a 14bit analog to digital converter and a serial interface circuit on the same chip. This results in superior signal quality, a fast response time and insensitivity to external disturbances (EMC) at a very competitive price. Each SHTxx is individually calibrated in a precision humidity chamber. The calibration coefficients are programmed into the OTP memory. These coefficients are used internally during measurements to calibrate the signals from the sensors.

The 2-wire serial interface and internal voltage regulation allows easy and fast system integration. Its tiny size and low power consumption makes it the ultimate choice for even the most demanding applications.

The device is supplied in either a surface-mountable LCC (Leadless Chip Carrier) or as a pluggable 4-pin single-in-line type package. Customer specific packaging options may be available on request.

Applications
- HVAC
- Automotive
- Consumer Goods
- Weather Stations
- Humidifiers
- Dehumidifiers
- Test & Measurement
- Data Logging
- Automation
- White Goods
- Medical

Ordering Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Humidity accuracy [%RH]</th>
<th>Temperature accuracy [K] @ 25 °C</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHT10</td>
<td>+4.5</td>
<td>+0.5</td>
<td>SMD (LCC)</td>
</tr>
<tr>
<td>SHT11</td>
<td>+3.0</td>
<td>+0.4</td>
<td>SMD (LCC)</td>
</tr>
<tr>
<td>SHT15</td>
<td>+2.0</td>
<td>+0.3</td>
<td>SMD (LCC)</td>
</tr>
<tr>
<td>SHT71</td>
<td>+3.0</td>
<td>+0.4</td>
<td>4-pin single-in-line</td>
</tr>
<tr>
<td>SHT75</td>
<td>+1.8</td>
<td>+0.3</td>
<td>4-pin single-in-line</td>
</tr>
</tbody>
</table>

www.sensirion.com Sensirion AG, Laubisrüti str. 50, CH-8712 Stäfa ZH, Switzerland, Tel: +41 44 306 40 00, Fax: +41 1 306 40 30 v2.04
1 Sensor Performance Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humidity Resolution</td>
<td></td>
<td>0.5</td>
<td>0.03</td>
<td>0.03</td>
<td>%RH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>12</td>
<td>12</td>
<td>bit</td>
</tr>
<tr>
<td>Repeatability</td>
<td></td>
<td>±0.1</td>
<td>±0.1</td>
<td>±0.1</td>
<td>%RH</td>
</tr>
<tr>
<td>Accuracy (1)</td>
<td>linearized</td>
<td>-0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>%RH</td>
</tr>
<tr>
<td>Uncertainty</td>
<td></td>
<td>±1</td>
<td>±1</td>
<td>±1</td>
<td>%RH</td>
</tr>
<tr>
<td>Interchangeability</td>
<td></td>
<td>Fully interchangeable</td>
<td>Fully interchangeable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonlinearity</td>
<td>raw data</td>
<td>±3</td>
<td>±3</td>
<td>±3</td>
<td>%RH</td>
</tr>
<tr>
<td></td>
<td>linearized</td>
<td>&lt;=1</td>
<td>&lt;=1</td>
<td>&lt;=1</td>
<td>%RH</td>
</tr>
<tr>
<td>Range</td>
<td></td>
<td>0</td>
<td>100</td>
<td>100</td>
<td>%RH</td>
</tr>
<tr>
<td>Response time</td>
<td>1/e (63%)</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>s</td>
</tr>
<tr>
<td></td>
<td>slowly moving air</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>s</td>
</tr>
<tr>
<td>Hysteresis</td>
<td></td>
<td>±1</td>
<td>±1</td>
<td>±1</td>
<td>%RH</td>
</tr>
<tr>
<td>Long term stability</td>
<td>typical</td>
<td>&lt;0.5</td>
<td>&lt;0.5</td>
<td>&lt;0.5</td>
<td>%RH/yr</td>
</tr>
</tbody>
</table>

Table 1 Sensor Performance Specifications

2 Interface Specifications

2.1 Power Pins

The SHTxx requires a voltage supply between 2.4 and 5.5 V. After powerup the device needs 11 ms to reach its "sleep" state. No commands should be sent before that time.

Power supply pins (VDD, GND) may be decoupled with a 0.1 nF capacitor.

2.2 Serial Interface (Bidirectional 2-wire)

The serial interface of the SHTxx is optimized for sensor readout and power consumption and is not compatible with I2C interfaces, see FAQ for details.

2.2.1 Serial clock input (SCK)

The SCK is used to synchronize the communication between a microcontroller and the SHTxx. Since the interface consists of fully static logic there is no minimum SCK frequency.

2.2.2 Serial data (DATA)

The DATA tristate pin is used to transfer data in and out of the device. DATA changes after the falling edge and is valid on the rising edge of the serial clock SCK. During transmission the DATA line must remain stable while SCK is high. To avoid signal contention the microcontroller should only drive DATA low. An external pull-up resistor (e.g. 10 kΩ) is required to pull the signal high. (See Figure 2) Pull-up resistors are often included in I/O circuits of microcontrollers. See Table 5 for detailed I/O characteristics.

Each SHTxx is tested to be fully within RH accuracy specifications at 25 °C (77 °F) and 48 °C (118.4 °F)

The default measurement resolution of 14 bit (temperature) and 12 bit (humidity) can be reduced to 12 and 8 bit through the status register.
2.2.3 Sending a command

To initiate a transmission, a "Transmission Start" sequence has to be issued. It consists of a lowering of the DATA line while SCK is high, followed by a low pulse on SCK and raising DATA again while SCK is still high.

![Figure 3 "Transmission Start" sequence](image)

The subsequent command consists of three address bits (only "000" is currently supported) and five command bits. The SHTxx indicates the proper reception of a command by pulling the DATA pin low (ACK bit) after the falling edge of the 8th SCK clock. The DATA line is released (and goes high) after the falling edge of the 9th SCK clock.

![Table 2 SHTxx list of commands](image)

### Table 2 SHTxx list of commands

<table>
<thead>
<tr>
<th>Command</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reserved</td>
<td>0000x</td>
</tr>
<tr>
<td>Measure Temperature</td>
<td>00011</td>
</tr>
<tr>
<td>Measure Humidity</td>
<td>00101</td>
</tr>
<tr>
<td>Read Status Register</td>
<td>00111</td>
</tr>
<tr>
<td>Write Status Register</td>
<td>00110</td>
</tr>
<tr>
<td>Reserved</td>
<td>00110</td>
</tr>
</tbody>
</table>

- **Soft reset**, resets the interface, clears the status register to default values
- wait minimum 11 ms before next command

2.2.4 Measurement sequence (RH and T)

After issuing a measurement command ("00000101" for RH, "00000111" for Temperature) the controller has to wait for the measurement to complete. This takes approximately 11.55/210 ms for a 8/12/14 bit measurement. The exact time varies by up to ±15% with the speed of the internal oscillator.

To signal the completion of a measurement, the SHTxx pulls down the data line and enters idle mode. The controller must wait for this "data ready" signal before restarting SCK to readout the data. Measurement data is stored until readout, therefore the controller can continue with other tasks and readout as convenient.

Two bytes of measurement data and one byte of CRC checksum will then be transmitted. The uC must acknowledge each byte by pulling the DATA line low. All values are MSB first, right justified. (e.g. the 5th SCK is MSB for a 12bit value, for a 8bit result the first byte is not used).

Communication terminates after the acknowledge bit of the CRC data. If CRC-8 checksum is not used the controller may terminate the communication after the measurement data LSB by keeping ack high.

The device automatically returns to sleep mode after the measurement and communication have ended.

**Warning**: To keep self heating below 0.1 °C the SHTxx should not be active for more than 10% of the time (e.g. max. 2 measurements / second for 12bit accuracy).

2.2.5 Connection reset sequence

If communication with the device is lost the following signal sequence will reset its serial interface:

While leaving DATA high, toggle SCK 9 or more times. This must be followed by a "Transmission Start" sequence preceding the next command. This sequence resets the interface only. The status register preserves its content.

![Figure 4 Connection reset sequence](image)

2.2.6 CRC-8 Checksum calculation

The whole digital transmission is secured by a 8 bit checksum. It ensures that any wrong data can be detected and eliminated.

Please consult application note "CRC-8 Checksum Calculation" for information on how to calculate the CRC.

![Figure 5 Example RH measurement sequence for value "0000'1001' 0011'0001" = 2353 = 75.79 %RH (without temperature compensation)](image)
2.3 Status Register

Some of the advanced functions of the SHTxx are available through the status register. The following section gives a brief overview of these features. A more detailed description is available in the application note "Status Register".

2.3.1 Measurement resolution

The default measurement resolution of 14bit (temperature) and 12bit (humidity) can be reduced to 12 and 8bit. This is especially useful in high speed or extreme low power applications.

2.3.2 End of Battery

The "End of Battery" function detects VDD voltages below 2.47 V. Accuracy is ±0.05 V.

2.3.3 Heater

An on-chip heating element can be switched on. It will increase the temperature of the sensor by 5-15 °C (9-27 °F). Power consumption will increase by ~8 mA @ 5 V.

Applications:

- By comparing temperature and humidity values before and after switching on the heater, proper functionality of both sensors can be verified.
- In high (>95 %RH) RH environments heating the sensor element will prevent condensation, improve response time and accuracy.

Warning: While heated the SHTxx will show higher temperatures and a lower relative humidity than with no heating.

2.4 Electrical Characteristics(1)

VDD=5V, Temperature = 25 °C unless otherwise noted

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply DC</td>
<td>measuring</td>
<td>2.4</td>
<td>5</td>
<td>5.5</td>
<td>V</td>
</tr>
<tr>
<td>Supply current</td>
<td>average</td>
<td>2(2)</td>
<td>28(3)</td>
<td>μA</td>
<td></td>
</tr>
<tr>
<td>Sleep</td>
<td>0.3</td>
<td>1</td>
<td>μA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low level output voltage</td>
<td>0</td>
<td>20%</td>
<td>Vdd</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High level output voltage</td>
<td>75%</td>
<td>100%</td>
<td>Vdd</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low level input voltage</td>
<td>Negative going</td>
<td>0</td>
<td>20%</td>
<td>Vdd</td>
<td></td>
</tr>
<tr>
<td>High level input voltage</td>
<td>Positive going</td>
<td>80%</td>
<td>100%</td>
<td>Vdd</td>
<td></td>
</tr>
<tr>
<td>Input current on pads</td>
<td>1</td>
<td>μA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output peak current</td>
<td>on</td>
<td>4</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4 SHTxx DC Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>F_SCK</td>
<td>SCK frequency</td>
<td>VDD &gt; 4.5 V</td>
<td>10</td>
<td>MHz</td>
<td></td>
</tr>
<tr>
<td>T_FIO</td>
<td>DATA fall time</td>
<td>Output load 5 pF</td>
<td>3.5</td>
<td>20</td>
<td>ns</td>
</tr>
<tr>
<td>T_SH</td>
<td>DATA valid time</td>
<td>Output load 100 pF</td>
<td>30</td>
<td>200</td>
<td>ns</td>
</tr>
<tr>
<td>T_HC</td>
<td>SCK hi/low time</td>
<td>100</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T_V</td>
<td>DATA valid time</td>
<td>250</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T_S</td>
<td>DATA set up time</td>
<td>100</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T_TD</td>
<td>DATA hold time</td>
<td>0</td>
<td>10</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>T_HS</td>
<td>SCK rise/fall time</td>
<td>200</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5 SHTxx I/O Signals Characteristics

---

(1) Parameters are periodically sampled and not 100% tested
(2) With one measurement of 8 bit accuracy without OTP reload per second
(3) With one measurement of 12 bit accuracy per second
3 Converting Output to Physical Values

3.1 Relative Humidity

To compensate for the non-linearity of the humidity sensor and to obtain the full accuracy it is recommended to convert the readout with the following formula:

\[ RH_{\text{linear}} = c_1 + c_2 \cdot \text{SO}_{RH} + c_3 \cdot \text{SO}_{RH}^2 \]

<table>
<thead>
<tr>
<th>SO_{RH}</th>
<th>c_1</th>
<th>c_2</th>
<th>c_3</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 bit</td>
<td>-4</td>
<td>0.0405</td>
<td>-2.8 \times 10^{-6}</td>
</tr>
<tr>
<td>8 bit</td>
<td>-4</td>
<td>0.648</td>
<td>-7.2 \times 10^{-4}</td>
</tr>
</tbody>
</table>

Table 6 Humidity conversion coefficients

For simplified, less computation intense conversion formulas see application note “RH and Temperature Non-Linearity Compensation”. Values higher than 99% RH indicate fully saturated air and must be processed and displayed as 100% RH.

The humidity sensor has no significant voltage dependency.

Figure 10 Conversion from SO_{RH} to relative humidity

3.2 Temperature

The bandgap PTAT (Proportional To Absolute Temperature) temperature sensor is very linear by design. Use the following formula to convert from digital readout to temperature:

\[ \text{Temperature} = d_1 + d_2 \cdot \text{SO}_T \]

<table>
<thead>
<tr>
<th>VDD</th>
<th>d_1[^\circ C]</th>
<th>d_1[^\circ F]</th>
<th>d_2[^\circ C]</th>
<th>d_2[^\circ F]</th>
</tr>
</thead>
<tbody>
<tr>
<td>5V</td>
<td>-40.00</td>
<td>-40.00</td>
<td>14bit 0.01</td>
<td>14bit 0.018</td>
</tr>
<tr>
<td>4V</td>
<td>-39.75</td>
<td>-39.50</td>
<td>12bit 0.04</td>
<td>12bit 0.072</td>
</tr>
<tr>
<td>3.5V</td>
<td>-39.66</td>
<td>-39.35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3V</td>
<td>-39.60</td>
<td>-39.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5V</td>
<td>-39.55</td>
<td>-39.23</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8 Temperature conversion coefficients

For improved accuracies in extreme temperatures with more computation intense conversion formulas see application note “RH and Temperature Non-Linearity Compensation”.

3.3 Dewpoint

Since humidity and temperature are both measured on the same monolithic chip, the SHTxx allows superb dewpoint measurements. See application note “Dewpoint calculation” for more.

Where SO_{RH} is the sensor output for relative humidity

www.sensirion.com v2.04 May 2005
4 Applications Information

4.1 Operating and Storage Conditions

Figure 11 Recommended operating conditions
Conditions outside the recommended range may temporarily offset the RH signal up to ±3 %RH. After return to normal conditions it will slowly return towards calibration state by itself. See 4.3 "Reconditioning Procedure" to accelerate this process. Prolonged exposure to extreme conditions may accelerate ageing.

4.2 Exposure to Chemicals

Chemical vapors may interfere with the polymer layers used for capacitive humidity sensors. The diffusion of chemicals into the polymer may cause a shift in both offset and sensitivity. In a clean environment the contaminants will slowly outgas. The reconditioning procedure described below will accelerate this process. High levels of pollutants may cause permanent damage to the sensing polymer.

4.3 Reconditioning Procedure

The following reconditioning procedure will bring the sensor back to calibration state after exposure to extreme conditions or chemical vapors.

- 80-90 °C (176-194°F) at < 5 %RH for 24h (baking) followed by 20-30 °C (70-90°F) at > 74 %RH for 48h (re-hydration)

4.4 Temperature Effects

The relative humidity of a gas strongly depends on its temperature. It is therefore essential to keep humidity sensors at the same temperature as the air of which the relative humidity is to be measured. If the SHTxx shares a PCB with electronic components that give off heat it should be mounted far away and below the heat source and the housing must remain well ventilated. To reduce heat conduction copper layers between the SHTxx and the rest of the PCB should be minimized and a slit may be milled in between (see figure 13).

4.5 Membranes

A membrane may be used to prevent dirt from entering the housing and to protect the sensor. It will also reduce peak concentrations of chemical vapors. For optimal response times air volume behind the membrane must be kept to a minimum. For the SHTxx package Sensirion recommends the SF1 filter cap for optimal IP67 protection.

Table 9 Qualification tests (excerpt)

| Environment                | Norm       | Results
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature Cycles</td>
<td>JESD22-A104-B</td>
<td>Within Specifications</td>
</tr>
<tr>
<td>HAST</td>
<td>JESD22-A110-B</td>
<td>Reversible shift by +2 %RH</td>
</tr>
<tr>
<td>Pressure Cooker</td>
<td>2.3 bar 125 °C 85 %RH</td>
<td>Reversible shift by +2 %RH</td>
</tr>
<tr>
<td>High Temperature and Humidity</td>
<td>JESD22-A101-B</td>
<td>Reversible shift by +2 %RH</td>
</tr>
<tr>
<td>Condensing Air</td>
<td>DIN-50021ss</td>
<td>Within Spec.</td>
</tr>
<tr>
<td>Freezing cycles fully submerged</td>
<td>-20 / +90 °C, 100 cy</td>
<td>Reversible shift by +2 %RH</td>
</tr>
<tr>
<td>Various Automotive Chemicals</td>
<td>DIN 72300-5</td>
<td>Within Specifications</td>
</tr>
</tbody>
</table>

4.6 Light

The SHTxx is not light sensitive. Prolonged direct exposure to sunshine or strong UV radiation may age the housing.

4.7 Materials Used for Sealing / Mounting

Many materials absorb humidity and will act as a buffer, increasing response times and hysteresis. Materials in the vicinity of the sensor must therefore be carefully chosen. Recommended materials are: All Metals, LCP, POM (Delrin), PTFE (Teflon), PE, PEEK, PP, PS, PSU, PVDF, PVF. For sealing and gluing (use sparingly): High filled epoxy for electronic packaging (e.g. glob top, underfill), and Silicone. Outgassing of these materials may also contaminate the SHTxx (cf. 4.2). Store well ventilated after manufacturing or bake at 50°C for 24h to outgas contaminants before packing.

4.8 Wiring Considerations and Signal Integrity

Carrying the SCK and DATA signal parallel and in close proximity (e.g. in wires) for more than 10cm may result in cross talk and loss of communication. This may be resolved by routing VDD and/or GND between the two data signals. Please see the application note "ESD, Latchup and EMC" for more information.

Power supply pins (VDD, GND) should be decoupled with a 100 nF capacitor if wires are used.

4.9 Qualifications

Extensive tests were performed in various environments. Please contact SENSIRION for detailed information.

4.10 ESD (Electrostatic Discharge)

ESD immunity is qualified according to MIL STD 883E, method 3015 (Human Body Model at ±2 kV). Latch-up immunity is provided at a force current of ±100 mA with Tambient = 80 °C according to JEDEC 17. See application note "ESD, Latchup and EMC" for more information.
5 Package Information

5.1 SHTlx (surface mountable)

<table>
<thead>
<tr>
<th>Pin</th>
<th>Name</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>2</td>
<td>DATA</td>
<td>Serial data, bidirectional</td>
</tr>
<tr>
<td>3</td>
<td>SCK</td>
<td>Serial clock, input</td>
</tr>
<tr>
<td>4</td>
<td>VDD</td>
<td>Supply 2.4 - 5.5 V</td>
</tr>
<tr>
<td>NC</td>
<td></td>
<td>Remaining pins must be left unconnected</td>
</tr>
</tbody>
</table>

Table 10 SHTlx Pin Description

5.1.1 Package type

The SHTlx is supplied in a surface-mountable LCC (Leadless Chip Carrier) type package. The sensors housing consists of a Liquid Crystal Polymer (LCP) cap with epoxy glob top on a standard 0.8 mm FR4 substrate. The device is free of Pb, Cd and Hg. (Fully ROHS, WEEE compliant)

The production date is printed onto the cap in white numbers in the form wwy. e.g. "351" = week 35, 2001.

5.1.2 Delivery Conditions

The SHTlx are shipped in 12mm tape at 100pcs or 400pcs. (SHT10 at 2000pcs only). Reels are individually labelled with barcode and human readable labels. The lot numbers allow full traceability through production, calibration and test.

5.1.3 Soldering Information

Standard reflow soldering ovens may be used. For details please see application note "soldering procedure".

For manual soldering contact time must be limited to 5 seconds at up to 350 °C.

After soldering the devices should be stored at >74 %RH for at least 24h to allow the polymer to rehydrate.

Please consult the application note "Soldering procedure" for more information.

5.1.4 Mounting Examples

![Figure 13 SHTlx PCB Mounting example](image)

Silt to minimize heat transfer from the PCB

The SF1 membrane filter cap is available for optimal IP67 protection. When mounted through a housing the interior can be protected from the environment while still allowing high quality humidity measurements (see example below).

![Figure 14 SF1 IP67 filter cap mounting example](image)

Figure 14 SF1 IP67 filter cap mounting example

www.sensirion.com | v2.04 May 2005 | 7/9
5.2 SHT7x (4-pin single-in-line)

### Table 11: SHT7x Pin Description

<table>
<thead>
<tr>
<th>Pin</th>
<th>Name</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SCK</td>
<td>Serial clock input</td>
</tr>
<tr>
<td>2</td>
<td>VDD</td>
<td>Supply 2.4 - 5.5 V</td>
</tr>
<tr>
<td>3</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>4</td>
<td>DATA</td>
<td>Serial data bidirectional</td>
</tr>
</tbody>
</table>

#### 5.2.1 Package type

The device is supplied in a single-in-line pin type package. The sensor housing consists of a Liquid Crystal Polymer (LCP) cap with epoxy glob top on a standard 0.6 mm FR4 substrate. The device is Cd and Hg free.

The sensor head is connected to the pins by a small bridge to minimize heat conduction and response times. The gold plated back side of the sensor head is connected to the GND pin.

A 100nF capacitor is mounted on the back side between VDD and GND.

All pins are gold plated to avoid corrosion. They can be soldered or mate with most 1.27 mm (0.05") sockets e.g.: Preci-dip / Mill-Max 851-93-004-20-001 or similar

Total weight: 168 mg, weight of sensor head: 73 mg

The production date is printed onto the cap in white numbers in the form wwy. e.g. "351" = week 35, 2001.

#### 5.2.2 Delivery Conditions

The SHT7x are shipped in 32 mm tape. These reel-ed parts are shipped with 500 units per 13 inch diameter reel. Reels are individually labelled with barcode and human readable labels.

#### 5.2.3 Soldering Information

Standard wave SHT7x soldering ovens may be used at maximum 235 °C for 20 seconds.

For manual soldering contact time must be limited to 5 seconds at up to 350 °C.

After wave soldering the devices should be stored at -74 %RH for at least 24 h to allow the polymer to rehydrate. Please consult the application note "Soldering procedure" for more information.

---

Other packaging options may be available on request.
For maximum accuracy do not solder SHT75!
6 Revision history

<table>
<thead>
<tr>
<th>Date</th>
<th>Version</th>
<th>Page(s)</th>
<th>Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>February 2002</td>
<td>Preliminary</td>
<td>1-9</td>
<td>First public release</td>
</tr>
<tr>
<td>June 2002</td>
<td>Preliminary</td>
<td></td>
<td>Added SHT7x information</td>
</tr>
<tr>
<td>March 2003</td>
<td>Final v2.0</td>
<td>1-9</td>
<td>Major remake, added application information etc.</td>
</tr>
<tr>
<td></td>
<td>V2.01</td>
<td>1-9</td>
<td>Typos, Graph labeling</td>
</tr>
<tr>
<td>July 2004</td>
<td>V2.02</td>
<td>1-9</td>
<td>Improved specifications, added SF1 information, improved wording</td>
</tr>
<tr>
<td>April 2005</td>
<td>V2.03</td>
<td>1-2</td>
<td>Added SHT10 information</td>
</tr>
<tr>
<td>May 2005</td>
<td>V2.04</td>
<td>1-9</td>
<td>Changed company address</td>
</tr>
</tbody>
</table>

The latest version of this document and all application notes can be found at:

7 Important Notices

7.1 Warning, personal injury
Do not use this product as safety or emergency stop devices or in any other application where failure of the product could result in personal injury. Failure to comply with these instructions could result in death or serious injury.

Should buyer purchase or use SENSIRION AG products for any such unintended or unauthorized application, Buyer shall indemnify and hold SENSIRION AG and its officers, employees, subsidiaries, affiliates and distributors harmless against all claims, costs, damages and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that SENSIRION AG was negligent regarding the design or manufacture of the part.

7.2 ESD Precautions
The inherent design of this component causes it to be sensitive to electrostatic discharge (ESD). To prevent ESD-induced damage and/or degradation, take normal ESD precautions when handling this product.
See application note “ESD, Latchup and EMC” for more information.

7.3 Warranty
SENSIRION AG makes no warranty, representation or guarantee regarding the suitability of its product for any particular purpose, nor does SENSIRION AG 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, including “Typical” must be validated for each customer applications by customer’s technical experts.

SENSIRION AG reserves the right, without further notice, to change the product specifications and/or information in this document and to improve reliability, functions and design.

Copyright© 2001-2005, SENSIRION AG. All rights reserved.

Headquarters and Sales Office

SENSIRION AG Phone: + 41 (0)44 306 40 00
Laubsrüti St. 50 Fax: + 41 (0)44 306 40 30
CH-8712 Stäfa ZH e-mail: info@sensirion.com
Switzerland

Sensirion humidity sensors are available from:
find your local representative at:

www.sensirion.com

v2.04 May 2005
RUMAH SAKIT ADI HUSADA - UNDANAN WETAN
Jln. Undaan Wetan 45 - 44 BUNURGAYA, 60261
Tel: (031) 692-1288, 631-6331, 631-6342
Fax: (031) 532-4081

Surabaya, 01 Agustus 2005

No. 246/(RSAH/Um/Un/2005)
Hal: Persetujuan pengajuan surat

Kepada Yth:

Ketua Jurusan Teknik Elektro
Universitas Katolik Widya Mandala
Jl. Kalijudan no. 37
Surabaya

Dengan hormat,


Untuk pelaksanaan dalam waktu sejak Kepada Mahasiswa diberikan surat ini, Membantu Manajer Perawatan R.S. Adi Husada, Undaan Wetan, pusatkan kepada bagian Ikhtisar, pada tanggal 01 Agustus 2005 pukul 10.00 WIB di RS Adi Husada Undaan Wetan, Undaan Wetan 45 - 44 BUNURGAYA

Semoga kembali dalam hal ini diberikan kejelasan yang cermat. Terima kasih.

[Signature]
Dr. Edhy Listyo, M.Kes.
Direktur

Tembusan kepada Yth:
1. Manager Perawatan
2. Mahasiswa Ybs.
3. Arsip

Sekretaris doc.

[Signature]

Menyusun

Dr Made Puryan
Rekan A2

RPM.01

(Rusun)
Surabaya, 12 Agustus 2005

Nomor : 028/VIII/2005
Perihal : Pemberian ijin tempat pengambilan data

Yth. Ketua Jurusan
Jurusan Teknik Elektro
Fakultas Teknik
Universitas Widya Mandala
Jalan Kalijudan 37
Surabaya 60114

Dengan hormat,


Dengan ini kami sampaikan bahwa Direksi RSK dapat memberikan ijin kepada:

Nama : Hadisuyoto Poging Yusfisia
NIM : 5103099051
Judul Proposal : Perancangan dan pembuatan prototype pengaturan suhu pada Inkubator
Unit Kerja : Sis Teknik

Untuk melaksanakan pengambilan data dan mendapatkan beberapa informasi yang berkaitan dengan inkubator di Rumah Sakit Katolik St. Vincentius a Paulo Surabaya.


Terima kasih atas kepercayaan dan perhatiannya pada rumah sakit kami.

Direktur Umum & Adm. Keu.

Maria Widjaja SSpS

Surabaya, 12 Agustus 2005
DEPARTEMEN PENDIDIKAN NASIONAL
UNIVERSITAS Airlangga
FAKULTAS KEDOKTERAN
BAGIAN ILMU KESEHATAN ANAK
Jl. Mayjen Prof. Dr. Moestopo 6-8 Surabaya Telp. 5020089-5020079-5020062 Pt. 1680 Telp. 5501681 Fax. 5501680 Kode Pos 60286

Lamp. : -
Hal : Permohonan ijin penelitian.

Kepada Yth.
Kepala Bidang Litbang
RSU Dr. Soetomo
Surabaya


Hadisuyoto Poging Yustisia
NPM : 5103099051

untuk meminjam data guna penyusunan skripsi di Bagian/SMF Ilmu Kesehatan Anak FK Unair/RSU Dr. Soetomo.
Adapun sebagai pembimbing kami adalah : Risa Etika, dr,SpA.

Demikian untuk diketahui, atas perhatian Saudara kami ucapkan terima kasih.

Ketua,

[Signature]

Prof. H. Bambang Permono, dr,SpA(K)
NIP. 1303350722

Tembusan :
1. Kepala IRNA Anak
2. Koordinator Penelitian IKA
3. Risa Etika, dr,SpA
4. Hadisuyoto Poging Yustisia
Nama Lengkap : Hadisuyoto Poging Yustisia
Temapat / TanggalLahir : Surabaya / 8 Desember 1980
Alamat : Kedurus II / 96 A Surabaya
Telepon : (031) 7664811

Riwayat Pendidikan:

1. SDK Santo Yosef Surabaya Th.1987 - 1993
2. SMPK Santo Yosef Surabaya Th.1993 - 1996
3. SMUN 4 Surabaya Th.1996 - 1999
4. UNIKA Widya Mandala Surabaya Jurusan Teknik Elektro Th.1999 - 2005