

# Sensirion SHT11 Sensor Module (#28018)

## Precision Temperature and Humidity Measurement

### Introduction

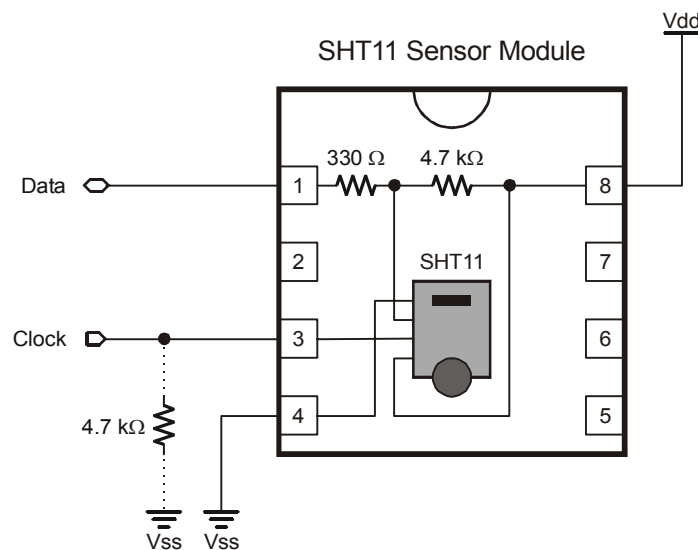
When it comes to precision temperature and humidity measurement, Sensirion ([www.sensirion.com](http://www.sensirion.com)) has simplified the process their SHT1x sensor series. Through a two-wire serial interface, both temperature and humidity can be read with excellent response time and accuracy. Parallax has simplified the use of the SHT11 by mounting it in a user-friendly 8-pin DIP module. The module includes a data-line pull-up and series limiter making it possible to connect directly to the BASIC or Javelin Stamp.

### Features

- Temperature range: -40 °F (-40 °C) to +254.9 °F (+123.8 °C)
- Temp. accuracy: +/- 0.5 °C @ 25 °C
- Humidity range: 0 to 100% RH
- Absolute RH accuracy: +/- 3.5% RH
- Low power consumption (typically 30 µW)

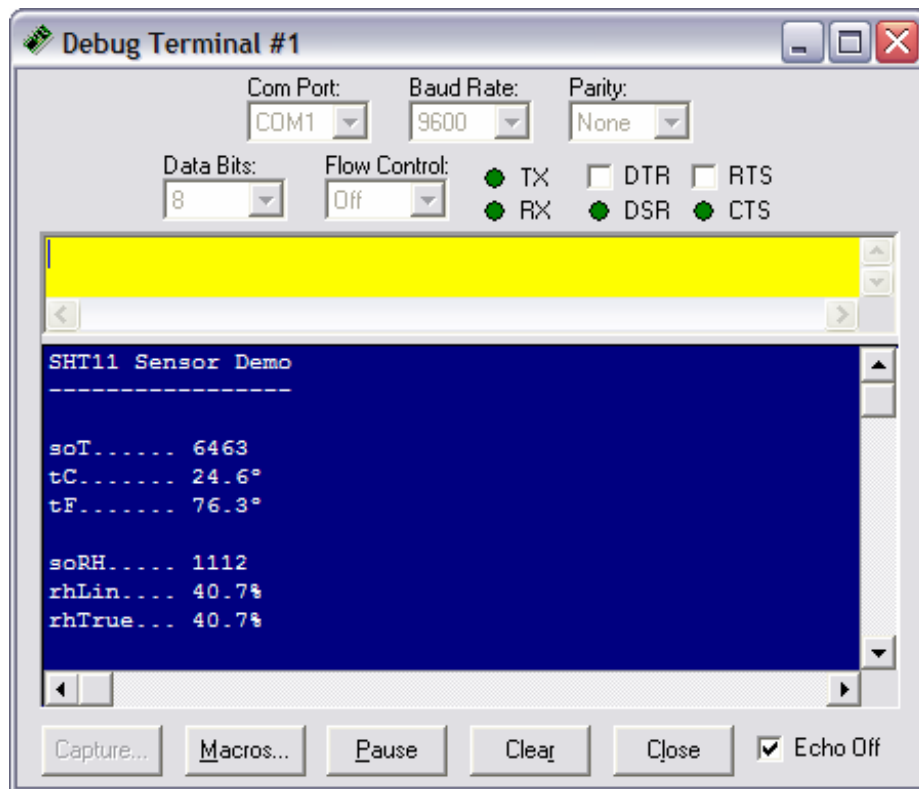
### Connections

The SHT11 is interfaced to the Stamp over two I/O pins. The 4.7 kΩ pull-down resistor on the clock is optional but may be required if your application experiences sensor lock-up.



## BASIC Stamp Application

The following BASIC Stamp application will read the SHT11 sensor module and display sensor counts, converted temperature and calibrated humidity. When running, the program output will appear as shown below:



```
' -----
'
' File..... SHT11_Demo.BS2
' Purpose... Interface to Sensirion SHT11 temperature/humidity sensor
' Author.... Parallax
' E-mail.... support@parallax.com
' Started...
' Updated... 19 JUL 2003
'
' {$STAMP BS2}
' {$PBASIC 2.5}
'
' -----
'
' -----
' Program Description
' -----
'
```

```

' This program demonstrates the interface and conversion of SHT11/15 data
' to usable program values.  This program uses advanced math features of
' PBASIC, specifically the ** operator.
'
' For detailed application information on the use and application of the
' ** operator, see Dr. Tracy Allen's web page at this link:
'
' -- http://www.emesystems.com/BS2math1.htm
'
' For SHT11/15 documentation and app notes, visit:
'
' -- http://www.sensirion.com
'
' -----
' Revision History
' -----
'
' -----
' I/O Definitions
' -----

ShtData      PIN      1          ' bi-directional data
Clock        PIN      0

' -----
' Constants
' -----

ShtTemp      CON      %00011    ' read temperature
ShtHumi      CON      %00101    ' read humidity
ShtStatW     CON      %00110    ' status register write
ShtStatR     CON      %00111    ' status register read
ShtReset     CON      %11110    ' soft reset

Ack          CON      0
NoAck        CON      1

No           CON      0
Yes          CON      1

DegSym       CON      186        ' degrees symbol for DEBUG

' -----
' Variables
' -----

```

```

ioByte          VAR      Byte          ' data from/to SHT11
ackBit          VAR      Bit           ' ack/nak from/to SHT11
toDelay         VAR      Byte          ' timeout delay timer
timeOut         VAR      Bit           ' timeout status

soT             VAR      Word           ' temp counts from SHT11
tC              VAR      Word           ' temp - Celcius
tF              VAR      Word           ' temp - Fahrenheit

soRH            VAR      Word           ' humidity counts
rhLin           VAR      Word           ' humidity; linearized
rhTrue          VAR      Word           ' humidity; compensated

status         VAR      Byte           ' status byte

' -----
' EEPROM Data
' -----

' -----
' Initialization
' -----

Initialize:
  GOSUB SHT_Connection_Reset          ' reset device connection
  PAUSE 250                            ' let DEBUG window open
  DEBUG CLS,
    "SHT11 Sensor Demo", CR,
    "-----", CR

' -----
' Program Code
' -----

Main:
  DO
    GOSUB SHT_Measure_Temp
    DEBUG CRSRXY, 0, 3,
      "soT..... ", DEC soT, CR,
      "tC..... ", DEC (tC / 10), ".", DEC1 tC, DegSym, " ", CR,
      "tF..... ", DEC (tF / 10), ".", DEC1 tF, DegSym, " "

    GOSUB SHT_Measure_Humidity
    DEBUG CRSRXY, 0, 7,
      "soRH..... ", DEC soRH, CR,

```

```

        "rhLin.... ", DEC (rhLin / 10), ".", DEC1 rhLin, "% ", CR,
        "rhTrue... ", DEC (rhTrue / 10), ".", DEC1 rhTrue, "% "

    PAUSE 1000
LOOP
END

' -----
' Subroutines
' -----

' connection reset: 9 clock cycles with ShtData high, then start sequence
'
SHT_Connection_Reset:
    SHIFTOUT ShtData, Clock, LSBFirst, [ $FFF\9 ]

' generates SHT11 "start" sequence
'
' ShtData  _____|_____|_____
'
' Clock    ___|___|___|___|___
'
SHT_Start:
    INPUT ShtData           ' let pull-up take high
    LOW Clock
    HIGH Clock
    LOW ShtData
    LOW Clock
    HIGH Clock
    INPUT ShtData
    LOW Clock
    RETURN

' measure temperature
' -- celcius = raw * 0.01 - 40
' -- fahrenheit = raw * 0.018 - 40
'
SHT_Measure_Temp:
    GOSUB SHT_Start         ' alert device
    ioByte = ShtTemp        ' temperature command
    GOSUB SHT_Write_Byte    ' send command
    GOSUB SHT_Wait          ' wait for measurement
    ackBit = Ack            ' another read follows
    GOSUB SHT_Read_Byte     ' get MSB
    soT.HighByte = ioByte
    ackBit = NoAck          ' last read
    GOSUB SHT_Read_Byte     ' get LSB

```

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soT.LowByte = ioByte

' Note: Conversion factors are multiplied by 10 to return the
'       temperature values in tenths of degrees

tC = soT ** $1999 - 400           ' convert to tenths C
tF = soT ** $2E14 - 400         ' convert to tenths F
RETURN

' measure humidity
'
SHT_Measure_Humidity:
GOSUB SHT_Start                   ' alert device
ioByte = ShtHumi                  ' humidity command
GOSUB SHT_Write_Byte              ' send command
GOSUB SHT_Wait                    ' wait for measurement
ackBit = Ack                      ' another read follows
GOSUB SHT_Read_Byte               ' get MSB
soRH.HighByte = ioByte
ackBit = NoAck                    ' last read
GOSUB SHT_Read_Byte               ' get LSB
soRH.LowByte = ioByte

' linearize humidity
'   rhLin = (soRH * 0.0405) - (soRH^2 * 0.0000028) - 4
'
' for the BASIC Stamp:
'   rhLin = (soRH * 0.0405) - (soRH * 0.002 * soRH * 0.0014) - 4
'
' Conversion factors are multiplied by 10 to return tenths
'
rhLin = (soRH ** $67AE) - (soRH ** $83 * soRH ** $5B) - 40

' temperature compensated humidity
'   rhTrue = (tc - 25) * (soRH * 0.00008 + 0.01) + rhLin
'
' Conversion factors are multiplied by 10 to return tenths
' -- simplified
'
rhTrue = (tC - 250) * (soRH ** $34) + rhLin
RETURN

' sends "status"
'
SHT_Write_Status:
GOSUB SHT_Start                   ' alert device
ioByte = ShtStatW                 ' write to status reg cmd

```

```

GOSUB SHT_Write_Byte          ' send command
ioByte = status
GOSUB SHT_Write_Byte
RETURN

' returns "status"
'
SHT_Read_Status:
  GOSUB SHT_Start            ' alert device
  ioByte = ShtStatW         ' write to status reg cmd
  GOSUB SHT_Read_Byte       ' send command
  ackBit = NoAck           ' only one byte to read
  GOSUB SHT_Read_Byte
  RETURN

' sends "ioByte"
' returns "ackBit"
'
SHT_Write_Byte:
  SHIFTOUT ShtData, Clock, MSBFirst, [ioByte]  ' send byte
  SHIFTTIN  ShtData, Clock, LSBPre, [ackBit\1]  ' get ack bit
  RETURN

' returns "ioByte"
' sends "ackBit"
'
SHT_Read_Byte:
  SHIFTTIN  ShtData, Clock, MSBPre, [ioByte]    ' get byte
  SHIFTOUT ShtData, Clock, LSBFirst, [ackBit\1] ' send ack bit
  INPUT ShtData                                 ' release data line
  RETURN

' wait for device to finish measurement (pulls data line low)
' -- timeout after ~1/4 second
'
SHT_Wait:
  INPUT ShtData                                ' data line is input
  timeOut = No                                 ' assume no timeout
  FOR toDelay = 1 TO 250                       ' wait ~1/4 second
    IF (ShtData = 0) THEN EXIT
    PAUSE 1
  NEXT
  IF (toDelay = 250) THEN timeOut = Yes        ' loop completed = timeout
  RETURN

```

```

' reset SHT11/15 with soft reset
'
SHT_Soft_Reset:
  GOSUB SHT_Connection_Reset           ' reset the connection
  ioByte = ShtReset                   ' reset command
  ackBit = NoAck                      ' only one byte to send
  GOSUB SHT_Write_Byte                ' send it
  PAUSE 11                            ' wait at least 11 ms
  RETURN

```

In high humidity applications, the SHT11 heater can be switched on briefly to prevent condensation. Another use of the heater is to test the operation of the sensor: by reading before enabling the heater and immediately after the sensor can be verified by noting a higher temperature and lower humidity. The following subroutines can be used to switch the SHT11 heater on and off.

```

Heater_On:
  status = %00000100                 ' heater bit = On
  GOSUB SHT_Write_Status
  RETURN

Heater_Off:
  status = %00000000                 ' heater bit = Off
  GOSUB SHT_Write_Status
  RETURN

```