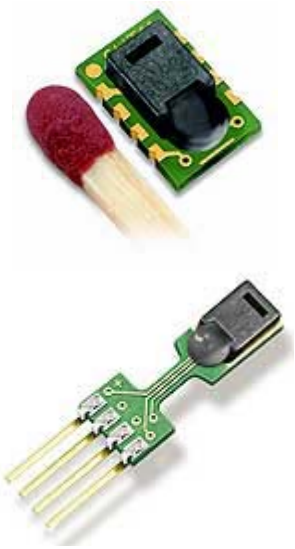
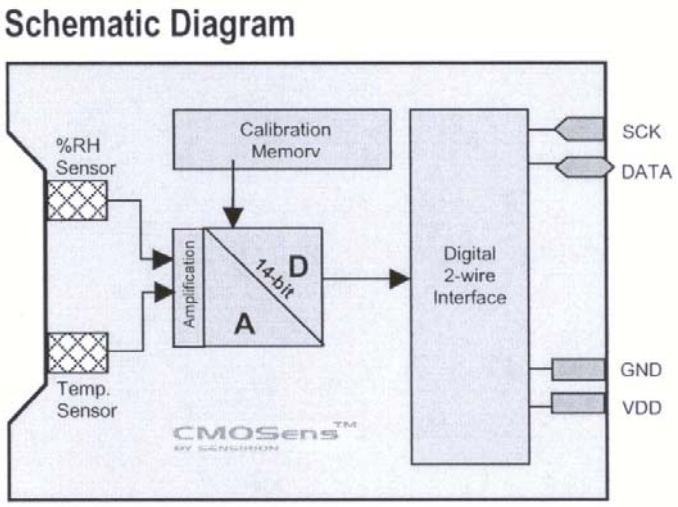
Sensirion
Humidity & Temperature Sensmitter
SHT1x/SHT7x

For more information, search at the following websites.

http://www.onsetcomp.com/Products/Product_Pages/Tattletale_pages/sensirion html

http://www.sensirion.com/en/sensors/humidity/default.htm





A new generation of integrated relative humidity and temperature sensor systems with outstanding performance. Based on intelligent CMOSens® technology, the SHTxx family of RH/Temp modules offers you maximum ease-of-use and excellent long-term stability.

Features

Combined relative humidity and temperature measurement
Precise dewpoint calculation possible
Fully calibrated, interchangeable without recalibration
Ultra-fast response time (<3 or <4 seconds)
High reliability
Optimized for long-term stability
Fully immersible
Low power due to measurement on demand
Self test capability of sensor elements
Heatable sensor elements for excellent precision and stability

SHT1x Product Summary

The SHT1x / SHT7x is a single chip relative humidity and temperature multi sensor module comprising a calibrated digital output. Application of industrial CMOS processes with customized post processing (CMOSens technology) ensures highest reliability and excellent long term stability. The device includes two calibrated microsensors for relative humidity and temperature which 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 sensor is calibrated in a precision humidity chamber and 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 including automotive, instrumentation, medical equipment, heating, ventilation and air conditioning systems (HVAC), portable consumer electronics and battery-operated controllers. The device is supplied in either a surface mountable LCC (SHT1x) or as a 4-pin single-in-line type package (SHT7x). Customer specific packaging options may be available on request.

Ordering Information

To place an order or get a quote for larger quantities email OEM Sales or call 1-800-564-4377 or 508-759-9500.

Description	Part No.	Price Qty 1-9	Price 10-24	Price 25-49	Price 50-99
Surface Mount Humidity/Temperature Module ±3.5% RH	SHT11	$18.61	$16.43	$15.53	$14.70
Surface Mount Humidity/Temperature Module ±2% RH	SHT15	$22.35	$19.75	$18.61	$17.64
4-pin single-in-line Humidity/temperature Module	SHT71	$22.35	$19.75	$18.61	$17.64
4-pin single-in-line Humidity/temperature Module	SHT75	$26.01	$22.99	$21.71	$20.58
Evaluation Kit for SHT11/SHT15	EK-H2	$373.00	n/a	n/a	n/a

Shipping costs will be added to order.

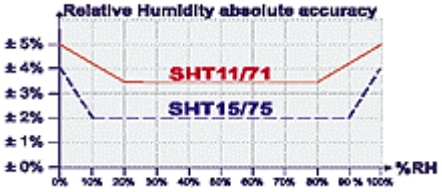
Sensirion Humidity & Temperature Sensmitter SHT11 & SHT15

For lowest cost: SHT11 (±3.5% RH)
For best RH accuracy: SHT15 (±2% RH)

Specifications

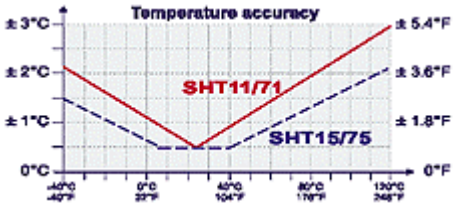
Relative Humidity (RH)

Range:	0 to 100% RH
Accuracy: (see graph at right)	±3.5% RH (20 to 80% RH) SHT11 ±2% RH (10 to 90% RH) SHT15
Response time:	4 sec. typical (to 63% in slowly moving air)
Reproducibility:	±0.1% RH
Resolution:	0.03% RH
Operating temperature:	-40° to 120°C (-40° to 249°F)



Temperature (T)

Range:	-40° to 123.8°C
Accuracy: (see graph at right)	± 0.5°C @ 25°C, ±0.9°C (7° to 40°C) SHT11 ± 0.9°F @ 77°F, ±1.8°F (45° to 104°F) ± 0.5°C @ 5° to 40°C, ±0.9°C (-15° to 60°C) SHT15 ± 0.9°F @ 41°F to 104°F, ±1.8°F (5° to 140°F)
Response time:	5 to 30 seconds (to 63% in slowly moving air)
Reproducibility:	±0.1°C (±0.2°F)
Resolution:	0.01°C (0.02°F)



Physical Dimensions and Mounting Information

Package type

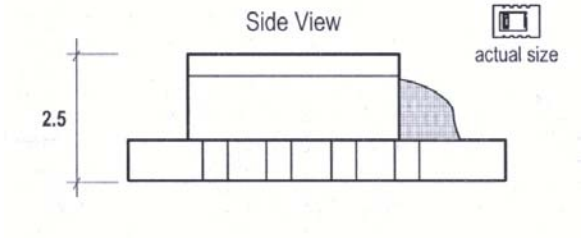
The SHT1x is supplied in a surface-mountable LCC type package. The sensors housing consists of a Liquid Crystal Polymer (LCP) cap with epoxy glob top on a standard 0.8mm FR4 substrate. Device size is 7.62 x 5.08 x 2.5 mm. Weight 100mg

Soldering Information

The SHT1x can be soldered using standard reflow ovens at maximum 225°C for 20 seconds. For manual soldering contact time must be limited to 5 seconds at up to 350°C. After soldering the devices must be stored at >74%RH for at least 24h to allow the polymer to recover. Please consult the application note "Soldering procedure" for detailed instructions.

Delivery Conditions

The SHT1x will be delivered in standard IC tubes by 80 pieces per tube. Other delivery options may be available on request.



4.1 SHT1x (surface mountable)

Pin	Name	Comment
1	GND	Ground
2	DATA	Serial data bidirectional
3	SCK	Serial clock input
4	VDD	Supply 2.4 – 5.5V
5-8	nc	Do not connect pins on right side

Table 6 SHT1x Pin Description

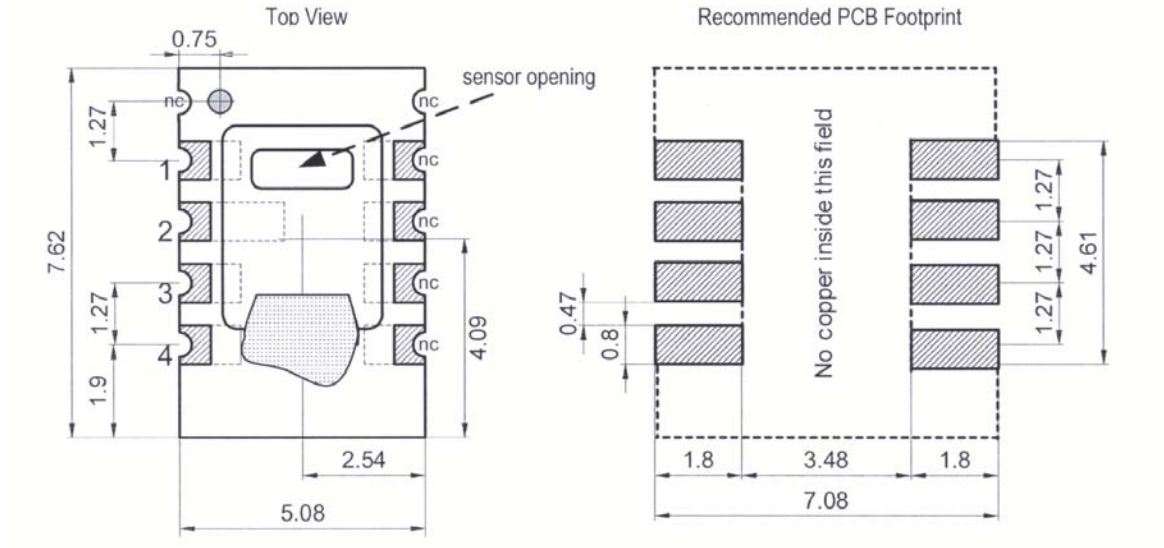


Figure 9 SHT1x drawing and footprint dimensions in mm

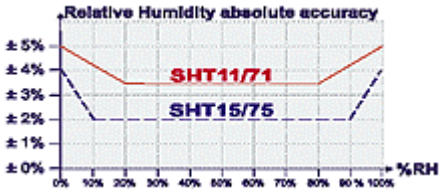
Sensirion Humidity & Temperature Sensmitter SHT71/SHT75

For fast response and interchangeability without recalibration: SHT71 (±3.5% RH)
For fast response, interchangeability, and best RH accuracy: SHT75 (±2% RH)

Specifications

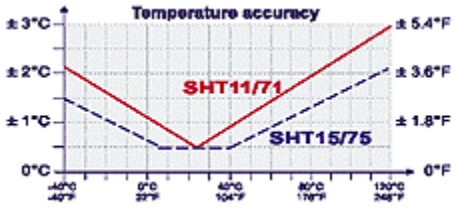
Relative Humidity (RH)

Range:	0 to 100% RH
Accuracy: (see graph at right)	±3.5% RH (20 to 80% RH), SHT71 ±2% RH (10 to 90% RH), SHT75
Response time:	3 seconds typical (to 63% in slowly moving air)
Reproducibility:	±0.1% RH
Resolution:	0.03% RH
Operating temperature:	-40° to 120°C (-40° to 248°F)



Temperature (T)

Range:	-40° to 123.8°C
Accuracy: (see graph at right)	±0.5°C @ 25°C, ±0.9°C (7° to 40°C), SHT71 ±0.9°F @ 77°F, ±1.8°F (45° to 104°F) ±0.5°C @ 5° to 40°C, ±0.9°C (-15° to 60°C), SHT75 ±0.9°F @ 41°F to 104°F, ±1.8°F (5° to 140°F)
Response time:	5 to 30 seconds (to 63% in slowly moving air)
Reproducibility:	±0.1°C (±0.2°F)
Resolution:	0.01°C (0.02°F)



Physical Dimensions and Mounting Information

Package type

The device is supplied in a single-in-line pin type package. The sensors housing consists of a Liquid Crystal Polymer (LCP) cap with epoxy glob top on a standard0.6mm FR4 substrate. The sensor head is connected to the pins by a small bridge to minimize heat conduction and response times. A 100nF capacitor is mounted on the back side between VDD and GND. Weight 168mg, Weight of sensor head 73mg All pins are gold plated to avoid corrosion.

Pins mate with most 1.27mm (0.05") sockets e.g.: Preci-dip / Mill-Max 851-93 004-20-001 or similar

Soldering Information (Preliminary)

The SHT7x may be soldered using standard wave soldering systems at maximum 225°C for 20 seconds. For manual soldering contact time must be limited to 5 seconds at up to 350°C. After soldering the devices must be stored at >74%RH for at least 24h to allow the polymer to recover. Please consult the application note "Soldering procedure" for detailed instructions.

Delivery Conditions

The SHT7x will be delivered in trays by xx pieces per tray. Other delivery options may be available on request.

4.2 SHT7x (4-pin single-in-line)

Pin	Name	Comment
1	SCK	Serial clock input
2	VDD	Supply 2.4 – 5.5V
3	GND	Ground
4	DATA	Serial data bidirectional

Table 7 SHT7x Pin Description

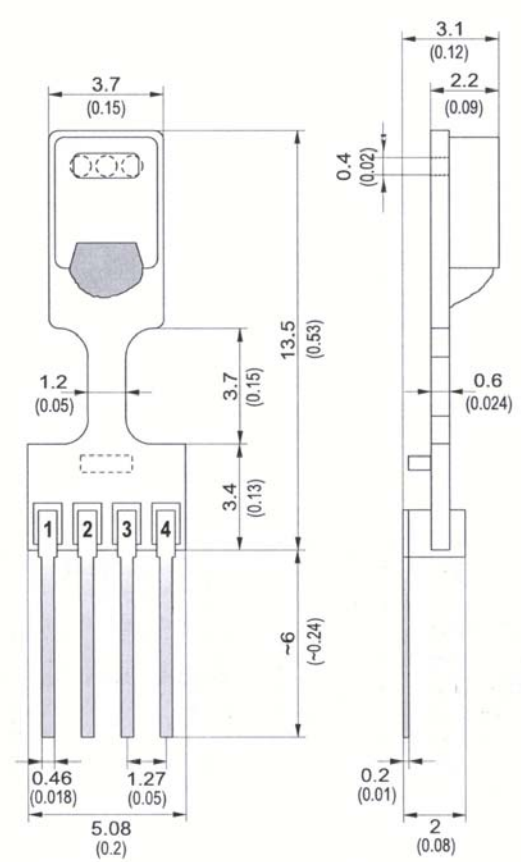
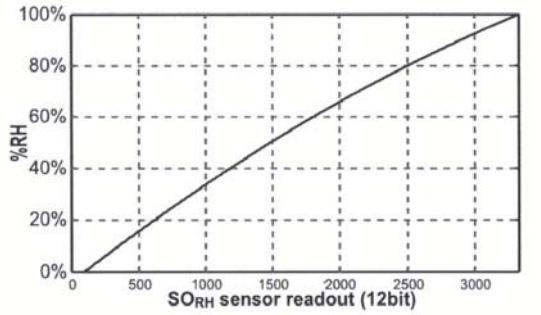


Figure 10 SHT7x dimensions in mm (inch), preliminary

Converting the digital output to physical values

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:
$RH_{linear} = c_1+c_2*SO_{RH}+SO_{RH}^2$
c1= -4 c2= 0.0405 c3= -2.8 *10 -6 for 12bit SORH
c1= -4 c2= 0.648 c3= -7.2 *10 -4 for 8bit SORH
For simplified, less computation intense conversion formulas see application note “RH Non-Linearity Compensation”.



For temperatures significantly different from 25°C (~77°F) the temperature coefficient of the RH sensor should be considered:
$RH_{true}=(T_{°C}-25)*(t_1+t_2*SO_{RH})+RH_{linear}$
with t1 = 0.01; t2 = 0.00008 for 12bit SORH ; t2 = 0.00128 for 8bit SORH
This equals ~0.12%RH / °C @ 50%RH

Temperature
The temperature sensor is very linear by design. Use the following formula to convert from digital readout to temperature: Temperature = d1+ d2*SOT
Use the appropriate table entries for 5V or 3V.

	Celsius		Fahrenheit	
SO_T	d_1	d_2	d_1	d_2
14bit 5V	-40	0.01	-40	0.018
12bit 5V	-40	0.04	-40	0.072
14bit 3V	-38.4	0.0098	-37.1	0.0176
12bit 3V	-38.4	0.0392	-37.1	0.0704

This equals a voltage dependency of ~ -0.2°C/V @ 25°C

Serial Interface

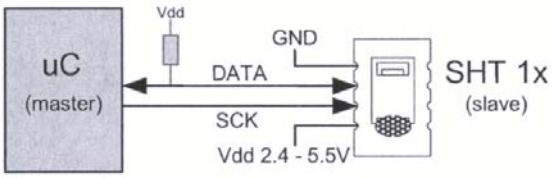


Figure 2 Typical application circuit

Power Pins
The device requires a voltage supply between 2.4V and 5.5V. After powerup the device requires 11ms to reach its ‘sleep’ state. No commands should be sent before that time. Power supply pins (VDD, GND) may be decoupled with a 100 nF capacitor.

I/O Pins
(Bidirectional 2-wire Interface)
See Table 5 for a detailed I/O characteristics.

Serial clock input (SCK)
The SCK is used to synchronize the communication

between a master and the SHT1x/SHT7x. Since the device contains fully static logic there is no minimum SCK frequency.

Serial data (DATA)

The DATA tristate pin is used to transfer data in and out of the device. DATA **changes at the falling edge** and is **valid on the rising edge** of the serial clock SCK. An external pull- up resistor is required to pull the signal high. (See Figure 2). Pull-up resistors are often included in I/O circuits of microcontrollers.

Command sequence

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

The subsequent command sequence consists of three address bits (only "000" is currently supported) and five command bits. The SHT1x/SHT7x indicates the proper reception of a command by pulling the DATA pin low (ACK bit) after the falling edge of the 8th SCK clock and the DATA line is released (and goes high) after the falling edge of the 9th SCK clock.

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.

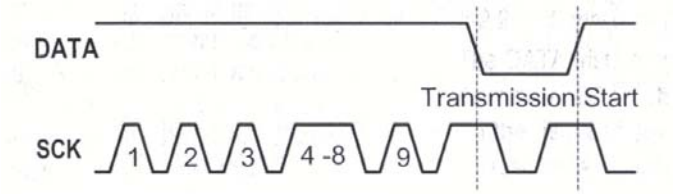


Figure 4 Connection reset sequence

Command	Code	Description
Reserved	0000x	Reserved
Measure Temperature	**00011**	**Temperature measurement**
Measure Humidity	**00101**	**Humidity measurement**
Status Register Read	00111	Read access to the status register (see application note)
Status Register Write	00110	Write access to the status register (see application note)
Reserved	0101x-1110x	Reserved
Soft reset	**11110**	**resets the chip, clears the status register to default values** wait 11ms before next command

Table 2 SHT1x/SHT7x list of commands

Measurement sequence (T and RH)
After issuing a measurement command ('00000101' for RH, '00000011' for Temperature) the controller has to wait for the measurement to complete. This takes approximately 11/55/210ms for a 8/12/14bit measurement. The exact time varies by up to ±15% with the speed of the internal oscillator. To signal the completion of a measurement, the SHT1x pulls down the data line 2 and the controller must restart SCK. 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 finished.

Warning:
To keep heat up of the SHT1x/SHT7x below 0.1°C it should not be active for more than 15% of the time (e.g. max. 3 measurements / second for 12bit accuracy).

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

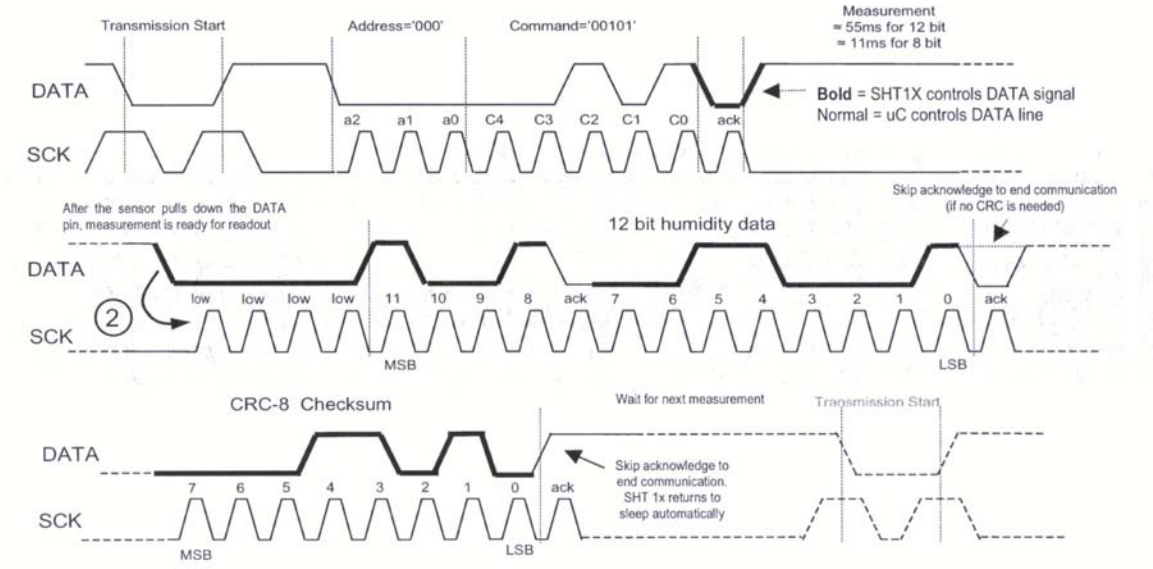


Figure 5 Example RH measurement sequence for value "0000'1001 ' 0011'0001"= 2353 = 75.79%RH

Status Register
Some of the advanced functions of the SHT1x/SHT7x are available through the status register. The following section gives a brief overview of these features. Please consult application note "Status Register" for more information.

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

End of Battery

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

Heater

An on chip heating element can be switched on. It will increase the temperature of the sensor by approximately 5°C. Power consumption will increase by 8mA @ 5V.

Applications:

- By comparing temperature and humidity values before and after switching on the heater, proper functionality of both sensors can be verified.
- In high RH environments heating the sensor element will avoid condensation.

Warning: The built-in calibration is not correct while the sensmitter is heated!

Please consult application note "Status Register" for more information on how to access and use these features.

Specifications SHT1x/SHT7x

Absolute Maximum Ratings

Ambient Storage Temperature: -40°C to 120°C

Operating Conditions

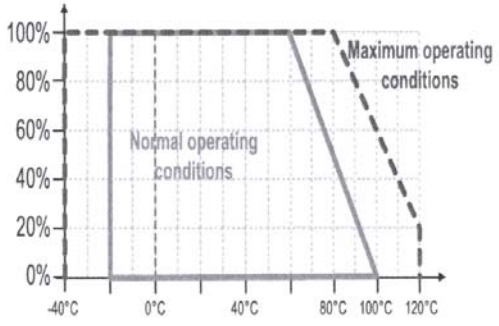


Figure 6 Recommended operating conditions

Conditions outside the recommended range may temporarily offset the RH signal up to ±3%RH. After return to normal conditions it will slowly return close to calibration state by itself. To accelerate this process we recommend the following reconditioning procedure:
90°C at <5%RH for 24h followed by
20-30°C at >74%RH for 48h
Prolonged exposure to extreme conditions may accelerate ageing.

Special Conditions

Extensive tests were performed in various environments.

Environment	Norm	Results[4]
Temperature Cycles	JESD22-A104-A -40 +125°C, 1000cy	Within Specifications
Pressure Cooker	JESD22-A110-B 2.3bar 125°C 85%RH	Reversible shift by +2% RH
Salt Atmosphere	DIN-50021ss	Within Specifications
Freezing cycles fully submerged	-20 +90°C, 100cy 30min dwell time	Reversible shift by +2% RH

Table 3 Qualification tests

Electrical Specifications

ESD (Electrostatic Discharge)

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

DC Characteristics

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

Parameter	Conditions	Min.	Typ.	Max.	Units
Power supply DC		2.4	5	5.5	V
Supply current	measuring		550		µA
	average	2[2]	28[3]		µA
	sleep		0.3	1	µA
Low level output voltage		0		20%	Vdd
High level output voltage		75%		100%	Vdd
Low level input voltage	Negative going	0		20%	Vdd
High level input voltage	Positive going	80%		100%	Vdd
Input current on pads				1	µA
Output peak current	on			4	mA
	Tristated (off)		10		µA

Table 4 SHT1x/SHT7x DC Characteristics

I/O Characteristics

Sck and DATA frequencies

	Parameter	Conditions	Min	Typ.	Max.	Unit
F_{SCK}	SCK frequency	VDD > 4.5 V			10	MHz
		VDD < 4.5 V			1	MHz
T_{RFO}	DATA fall time	Output load 5 pF	3.5	10	20	ns
		Output load 100 pF	30	40	200	ns
T_{CLH}	SCK high time		100			ns
T_{CLL}	SCK low time		100			ns
T_V	DATA valid time			250		ns
T_{SU}	DATA set up time		100			ns
T_{HO}	DATA hold time		0	10		ns
T_R/T_F	SCK rise/fall time				200	ns

Table 5 SHT1x/SHT7x I/O Signals Characteristics

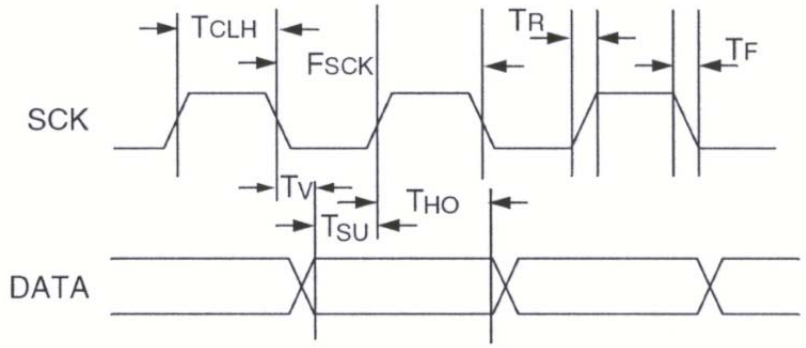


Figure 7 Timing Diagram