Datasheet SHT20

Humidity and Temperature Sensor

Fully calibrated

Digital output, I2C interface

Low power consumption

Excellent long term stability

DFN type package – reflow solderable

Product Summary

SHT20, the new humidity and temperature sensor of

Sensirion is about to set new standards in terms of size

and intelligence: Embedded in a reflow solderable Dual

Flat No leads (DFN) package of 3 x 3mm foot print and

1.1mm height it provides calibrated, linearized signals in

digital, true I2C format.

With a completely new designed CMOSens® chip, a

reworked capacitive type humidity sensor and a standard

band gap temperature sensor the performance has been

lifted even beyond the outstanding level of the previous

sensor generation (SHT1x and SHT7x). For example,

measures have been taken to stabilize the behavior at

high humidity levels.

Dimensions

3.0

0.3 typ

Every sensor is individually calibrated and tested. Lot

identification is printed on the sensor and an electronic

identification code is stored on the chip – which can be

read out by command. Furthermore, the resolution of

SHT20 can be changed by command (8/12bit up to

12/14bit for RH/T), low battery can be detected and a

checksum helps to improve communication reliability.

With made improvements and the miniaturization of the

sensor the performance-to-price ratio has been improved

– and eventually, any device should benefit from the

cutting edge energy saving operation mode. For testing

SHT20 a new evaluation Kit EK-H4 is available.

Sensor Chip

SHT20 features a generation 4C CMOSens® chip.

Besides the capacitive relative humidity sensor and the

band gap temperature sensor, the chip contains an

amplifier, A/D converter, OTP memory and a digital

processing unit.

1.1

0.2

SHT20D0AC4

0.8 typ

2.0 typ1.4 typ

3.0

2.2

Material Contents

While the sensor itself is made of Silicon the sensors’

housing consists of a plated Cu lead-frame and green

epoxy-based mold compound. The device is fully RoHS

and WEEE compliant, e.g. free of Pb, Cd and Hg.

Additional Information and Evaluation Kits

Additional information such as Application Notes is

available from the web page www.sensirion.com/SHT20.

For more information please contact Sensirion via

info@sensirion.com.

Bottom View

NC

VDD

SCL

0.4

0.75

0.3

0.4

1.5

2.4

1.0

1.0

NC

VSS

SDA

Figure 1: Drawing of SHT20 sensor package, dimensions are

given in mm (1mm = 0.039inch), tolerances are ±0.1mm. Die

pad (centre pad) is internally connected to VSS. NC are floating.

VSS = GND, SDA = DATA.

For SHT20 two Evaluation Kits are available: EK-H4, a

four-channel device with viewer software, which also

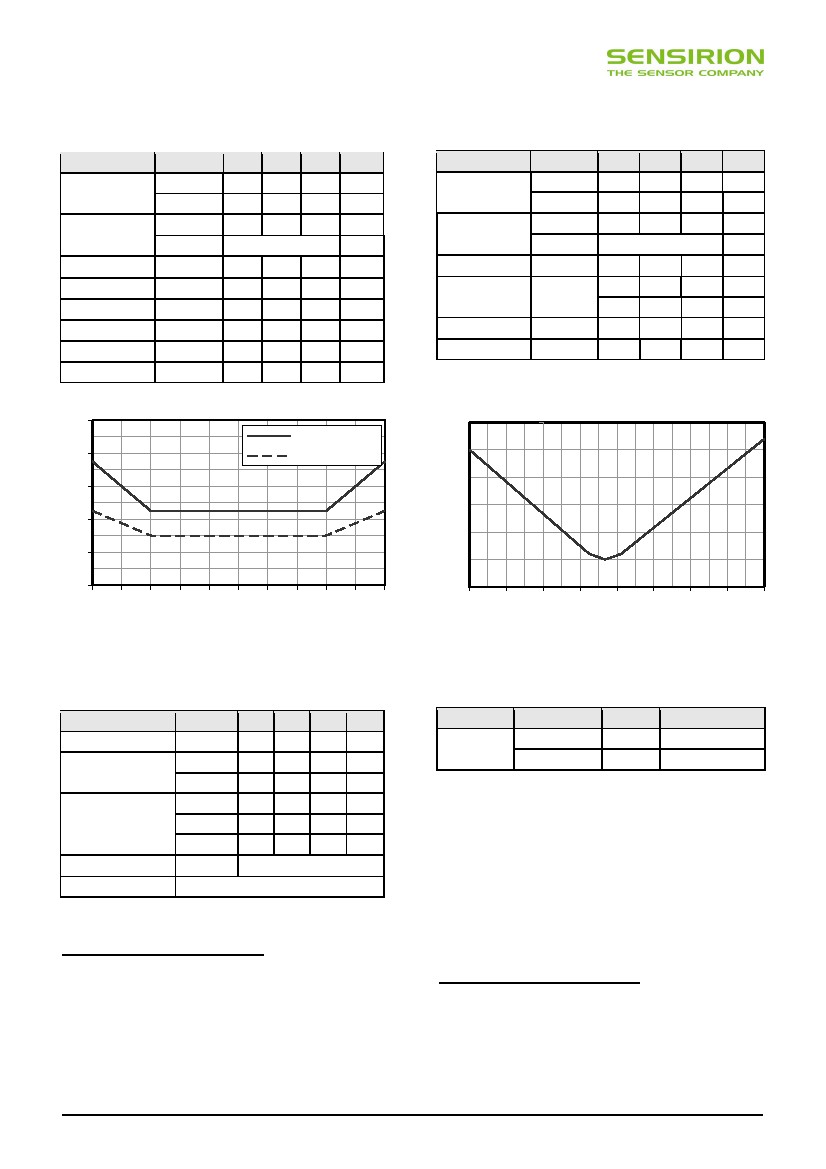
serves for data-logging, and a simple EK-H5 directly

connecting one sensor via USB port to a computer.

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Sensor Performance

Relative Humidity1234

Parameter

Temperature567

min

Resolution 1

Condition

12 bit

8 bit

typ

0.04

0.7

max

Units

%RH

%RH

Parameter

Resolution 1

Condition

14 bit

12 bit

min

typ

0.01

0.04

max

Units

°C

°C

Accuracy

tolerance 2

typ

max



see Figure 2

%RH

%RH

Accuracy

tolerance 2

typ

max



see Figure 3

°C

°C

Repeatability



%RH

Repeatability



°C

Hysteresis

Nonlinearity



<0.1

%RH

Operating Range extended 4

%RH

-40

-40

125

257

°C

°F

Response time 3

63%

Operating Range extended 4

Long Term Drift 5normal

8

s

Response Time 7

63%

5

30

s

0

100

< 0.5

%RH

%RH/yr

Long Term Drift

< 0.04

°C/yr

∆RH (%RH)

± 10

∆T (°C)

± 3.0

maximal tolerance

±8

±6

±4

typical tolerance

± 2.5

± 2.0

± 1.5

± 1.0

±2

±0

0

10

20

30

40

50

60 70 80 90 100

Relative Humidity (%RH)

± 0.5

± 0.0

-40

-20

0

20

40

60

80100120

Temperature (°C)

Figure 2 Typical and maximal tolerance at 25°C for relative

humidity. For extensive information see Users Guide, Sect. 1.2.

Figure 3 Maximal tolerance for temperature sensor in °C.

Electrical Specification

Conditions minParameter

Supply Voltage, VDD2.1

sleep mode-

Supply Current, IDD 6

measuring270

sleep mode-

6Power Dissipationmeasuring0.8

average 8bit-

Packaging Information

typ

3.0

0.15

300

0.5

0.9

1.5

max Units

3.6V

0.4A

330A

1.2W

1.0 mW

-W

Sensor Type

SHT20

Packaging

Tape & Reel

Tape & Reel

Quantity

1500

5000

Order Number

1-100706-01

1-100704-01

Heater

VDD = 3.0 V

Communication

5.5mW, ∆= + 0.5-1.5°C

digital 2-wire interface, true I2C protocol

Table 1 Electrical specification. For absolute maximum

values see Chapter 3 of Users Guide.

1

This datasheet is subject to change and may be amended

without prior notice.

Default measurement resolution is 14bit (temperature) / 12bit (humidity). It can

be reduced to 12/8bit, 11/11bit or 13/10bit by command to user register.

2 Accuracies are tested at Outgoing Quality Control at 25°C (77°F) and 3.0V.

Values exclude hysteresis and non-linearity and are applicable to non-

condensing environments only.

3 Time for achieving 63% of a step function, valid at 25°C and 1 m/s airflow.

4 Normal operating range: 0-80%RH, beyond this limit sensor may read a

reversible offset with slow kinetics (<3%RH after 200hours at 90%RH). For more

details please see Section 1.1 of the Users Guide.

Value may be higher in environments with vaporized solvents, out-gassing

tapes, adhesives, packaging materials, etc. For more details please refer to

Handling Instructions.

6 Min and max values of Supply Current and Power Dissipation are based on

fixed VDD = 3.0V and T<60°C. The average value is based on one 8bit

measurement per second.

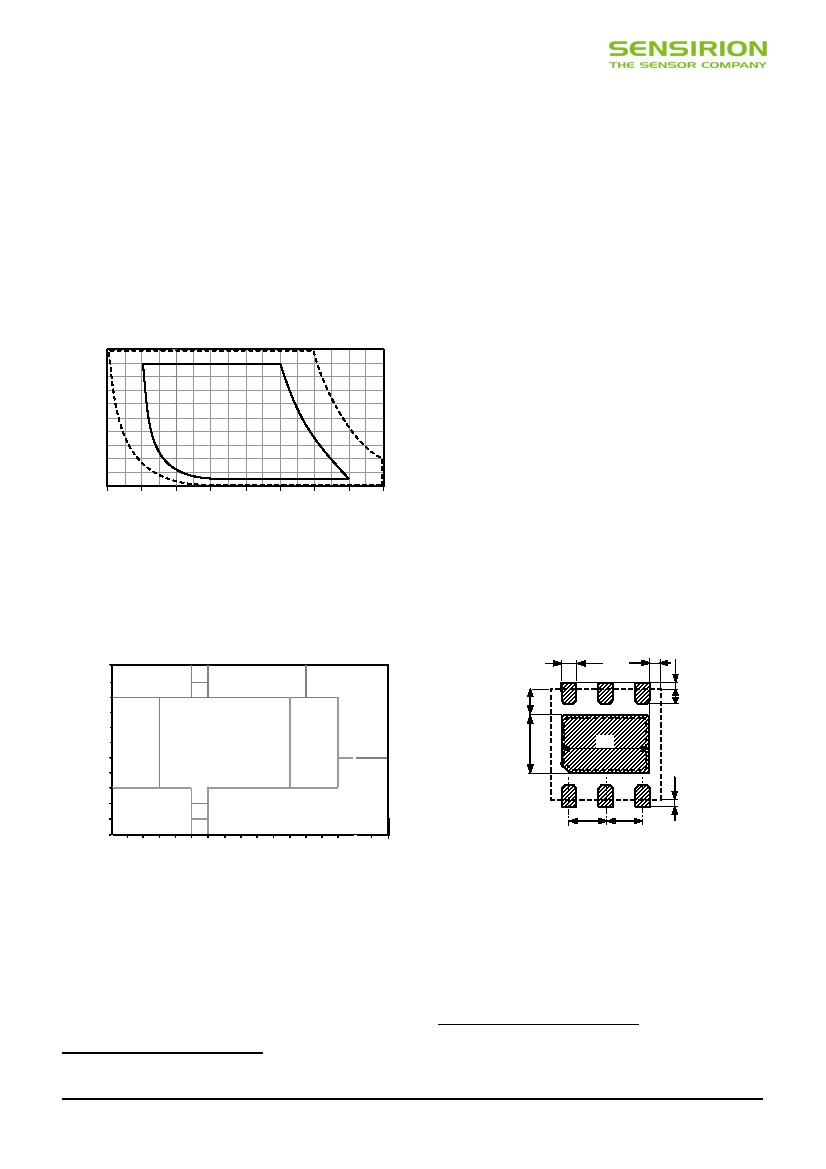
7 Response time depends on heat conductivity of sensor substrate.

5

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Users Guide SHT2x

1 Extended Specifications

1.1 Operating Range

The sensor works stable within recommended Normal

Range – see Figure 4. Long term exposure to conditions

outside Normal Range, especially at humidity >80%RH,

may temporarily offset the RH signal (+3%RH after 60h).

After return into the Normal Range it will slowly return

towards calibration state by itself. See Section 2.3 “Recon-

ditioning Procedure” for eliminating the offset. Prolonged

exposure to extreme conditions may accelerate ageing.

Relative Humidity (%)

2 Application Information

2.1 Soldering Instructions

The DFN’s die pad (centre pad) and perimeter I/O pads

are fabricated from a planar copper lead-frame by over-

molding leaving the die pad and I/O pads exposed for

mechanical and electrical connection. Both the I/O pads

and die pad should be soldered to the PCB. In order to

prevent oxidation and optimize soldering, the bottom side

of the sensor pads is plated with Ni/Pd/Au.

On the PCB the I/O lands9 should be 0.2mm longer than

the package I/O pads. Inward corners may be rounded to

match the I/O pad shape. The I/O land width should match

the DFN-package I/O-pads width 1:1 and the land for the

die pad should match 1:1 with the DFN package – see

Figure 6.

The solder mask10 design for the land pattern preferably is

of type Non-Solder Mask Defined (NSMD) with solder

mask openings larger than metal pads. For NSMD pads,

the solder mask opening should be about 120µm to

150µm larger than the pad size, providing a 60µm to 75µm

design clearance between the copper pad and solder

mask. Rounded portions of package pads should have a

matching rounded solder mask-opening shape to minimize

the risk of solder bridging. For the actual pad dimensions,

each pad on the PCB should have its own solder mask

opening with a web of solder mask between adjacent

pads.

0.4

0.3

100

80

60

40

20

0

-40

-20

0

20

40

60

80100 120

Temperature (°C)

Normal

Range

Max.

Range

Figure 4 Operating Conditions

1.2 RH accuracy at various temperatures

Maximal tolerance for RH accuracy at 25°C is defined in

Figure 2. For other temperatures maximal tolerance has

been evaluated to be within limits displayed in Figure 58.

100

90

80

70

60

50

40

30

20

10

0

Relative Humidity (%RH)

±7

±8

0.7

±6

±4.5

±6

1.6

2.4

±7

±5

±7

±7

1.0

1.0

0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80

Temperature (°C)

Figure 6 Recommended metal land pattern for SHT2x. Values

in mm. Die pad (centre pad) and NC pads may be left floating or

be connected to ground. The outer dotted line represents the

outer dimension of the DFN package.

Figure 5 Maximal tolerance of relative humidity measurements

given in %RH for temperatures 0 – 80°C.

Please note that above values are maximal tolerances (not

including hysteresis) against a high precision reference

such as a dew point mirror. Typical deviations are at

±3%RH where maximal tolerance is ±4.5%RH and about

half the maximal tolerance at other values.

8

For solder paste printing a laser-cut, stainless steel stencil

with electro-polished trapezoidal walls and with 0.125mm

stencil thickness is recommended. For the I/O pads the

stencil apertures should be 0.1mm longer than PCB pads

and positioned with 0.1mm offset away from the centre of

The land pattern is understood to be the metal layer on the PCB, onto which

the DFN pads are soldered to.

10 The solder mask is understood to be the insulating layer on top of the PCB

covering the connecting lines.

9

Details on how Sensirion is specifying and testing accuracy performance are

planned to be published on the Sensirion web page.

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0.2

0.4

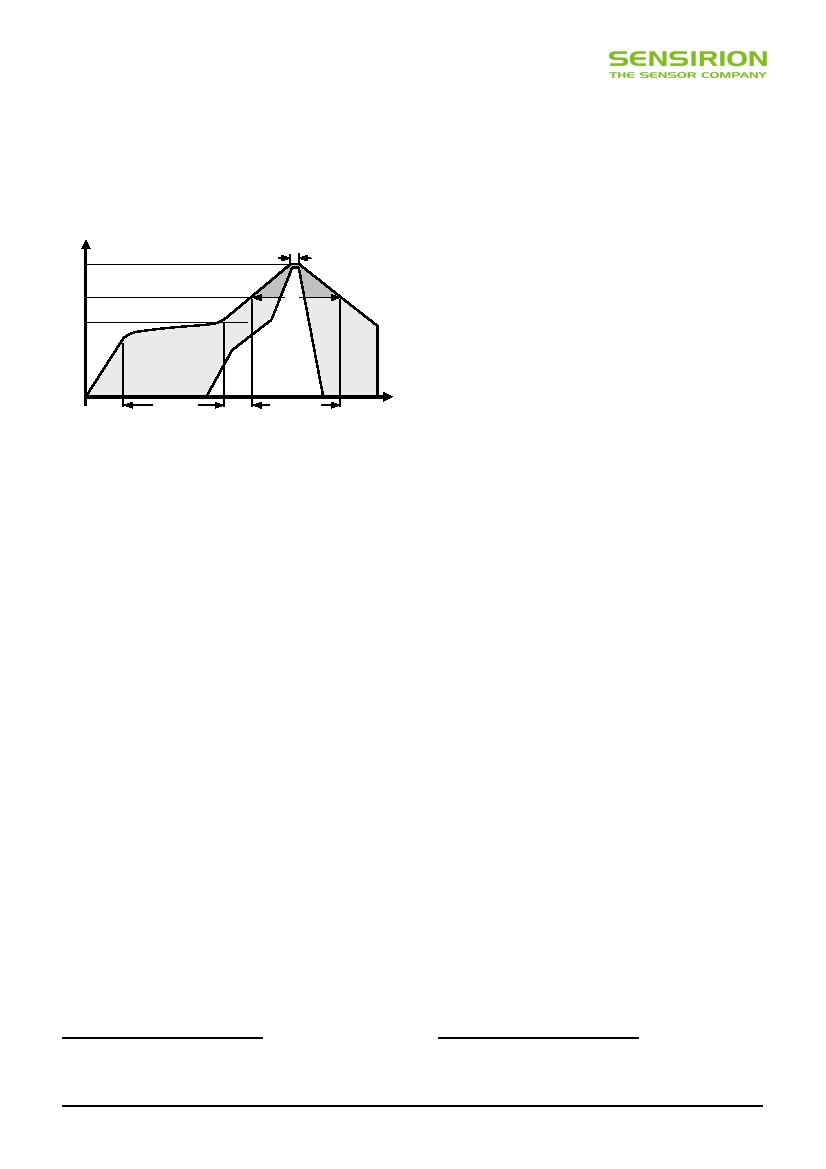
±7

±5

±7

0.2

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the package. The die pad aperture should cover about 70

– 90% of the pad area – say up to 1.4mm x 2.3mm

centered on the thermal land area. It can also be split in

two openings.

Due to the low mounted height of the DFN, “no clean”

type 3 solder paste11 is recommended as well as Nitrogen

purge during reflow.

TP

tP

It is of great importance to understand that a humidity

sensor is not a normal electronic component and needs to

be handled with care. Chemical vapors at high

concentration in combination with long exposure times

may offset the sensor reading.

For this reason it is recommended to store the sensors in

original packaging including the sealed ESD bag at

following conditions: Temperature shall be in the range of

10°C – 50°C and humidity at 20 – 60%RH (sensors that

are not stored in ESD bags). For sensors that have been

removed from the original packaging we recommend to

store them in ESD bags made of PE-HD13.

In manufacturing and transport the sensors shall be

prevented of high concentration of chemical solvents and

long exposure times. Out-gassing of glues, adhesive tapes

and stickers or out-gassing packaging material such as

bubble foils, foams, etc. shall be avoided. Manufacturing

area shall be well ventilated.

For more detailed information please consult the

document “Handling Instructions” or contact Sensirion.

2.3 Reconditioning Procedure

As stated above extreme conditions or exposure to solvent

vapors may offset the sensor. The following reconditioning

procedure may bring the sensor back to calibration state:

Baking:

Re-Hydration:

100 – 105°C at < 5%RH for 10h

20 – 30°C at ~ 75%RH for 12h 14.

Temperature

TL

TS (max)

tL

preheating

critical zone

Time

Figure 7 Soldering profile according to JEDEC standard. TP <=

260°C and tP < 40sec for Pb-free assembly. TL < 220°C and tL <

150sec. Ramp-up/down speeds shall be < 5°C/sec.

It is important to note that the diced edge or side faces of

the I/O pads may oxidise over time, therefore a solder fillet

may or may not form. Hence there is no guarantee for

solder joint fillet heights of any kind.

For soldering SHT2x, standard reflow soldering ovens may

be used. The sensor is qualified to withstand soldering

profile according to IPC/JEDEC J-STD-020D with peak

temperatures at 260°C during up to 40sec for Pb-free

assembly in IR/Convection reflow ovens (see Figure 7).

For manual soldering contact time must be limited to 5

seconds at up to 350°C12.

IMPORTANT: After soldering, the devices should be

stored at >75%RH for at least 12h to allow the sensor

element to re-hydrate. Otherwise the sensor may read an

offset that slowly disappears if exposed to ambient

conditions. Alternatively the re-hydration process may be

performed at ambient conditions (>40%RH) during more

than 5 days.

In no case, neither after manual nor reflow soldering, a

board wash shall be applied. Therefore, and as mentioned

above, it is strongly recommended to use “no-clean” solder

paste. In case of applications with exposure of the sensor

to corrosive gases the soldering pads shall be sealed to

prevent loose contacts or short cuts.

2.2 Storage Conditions and Handling Instructions

Moisture Sensitivity Level (MSL) is 2; hence storage time

is limited to one year.

Solder types are related to the solder particle size in the paste: Type 3 covers

the size range of 25 – 45 m (powder type 42).

12 260°C = 500°F, 350°C = 662°F

11

2.4 Temperature Effects

Relative humidity reading strongly depends on

temperature. Therefore, it is essential to keep humidity

sensors at the same temperature as the air of which the

relative humidity is to be measured. In case of testing or

qualification the reference sensor and test sensor must

show equal temperature to allow for comparing humidity

readings.

If the sensor shares a PCB with electronic components

that produce heat it should be mounted in a way that

prevents heat transfer or keeps it as low as possible.

Measures to reduce heat transfer can be ventilation,

reduction of copper layers between the sensor and the

rest of the PCB or milling a slit into the PCB around the

sensor – see Figure 8.

Furthermore, there are self-heating effects in case the

measurement frequency is too high. To keep self heating

below 0.1°C, SHT2x should not be active for more than

10% of the time – e.g. maximum two measurements per

second at 12bit accuracy shall be made.

13

14

For example, 3M antistatic bag, product “1910” with zipper.

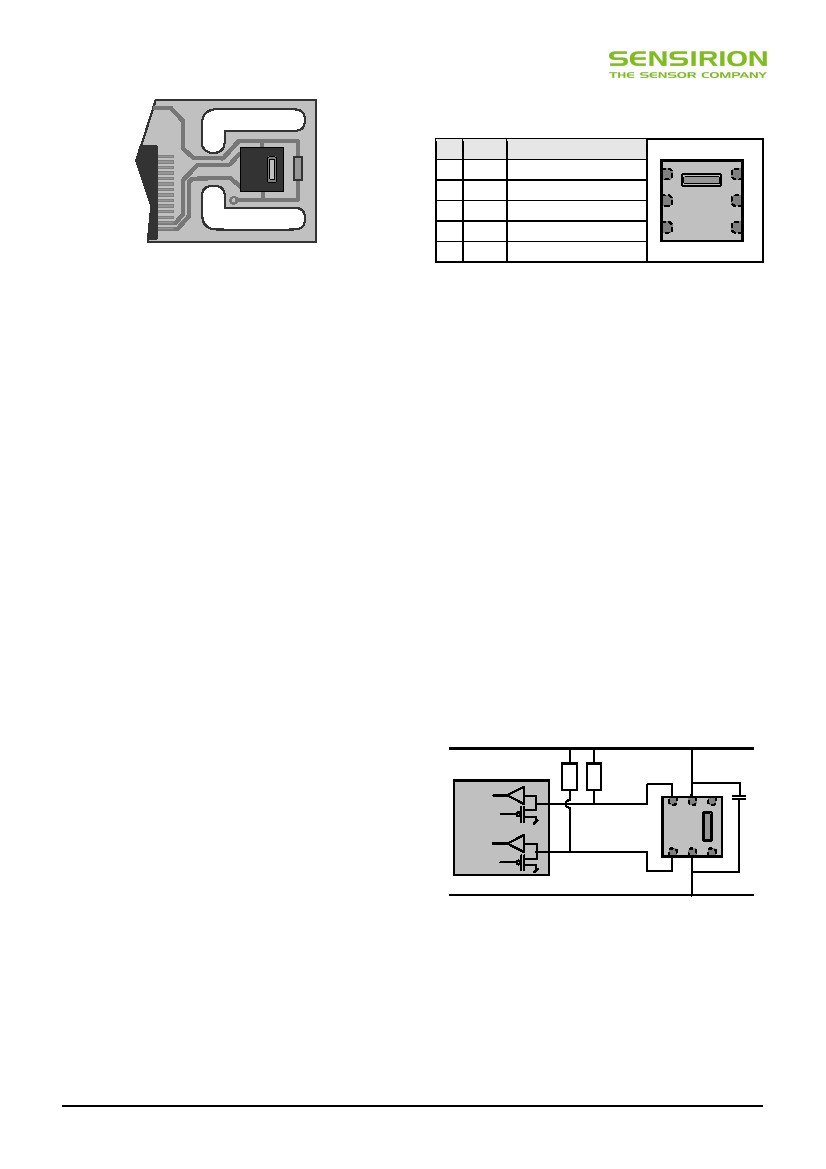
75%RH can conveniently be generated with saturated NaCl solution.

100 – 105°C correspond to 212 – 221°F, 20 – 30°C correspond to 68 – 86°F

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3 Interface Specifications

CommentPin Name

2VSS Ground

4

1SDA Serial Data, bidirectional

5

6SCL Serial Clock, bidirectional

65 VDD Supply Voltage

3,4 NC Not Connected, floating

3

2

1

Figure 8 Top view of example of mounted SHT2x with slits

milled into PCB to minimize heat transfer.

Table 2 SHT2x pin assignment, NC remain floating

2.5 Light

The SHT2x is not light sensitive. Prolonged direct

exposure to sunshine or strong UV radiation may age the

sensor.

2.6 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: Any metals, LCP, POM

(Delrin), PTFE (Teflon), PEEK, PP, PB, PPS, PSU, PVDF,

PVF.

For sealing and gluing (use sparingly): Use high filled

epoxy for electronic packaging (e.g. glob top, underfill),

and Silicone. Out-gassing of these materials may also

contaminate the sensor (see Section 1.3). Therefore try to

add the sensor as a last manufacturing step to the

assembly, store the assembly well ventilated after

manufacturing or bake at >50°C for 24h to outgas

contaminants before packing.

2.7 Wiring Considerations and Signal Integrity

Carrying the SCL and SDA 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 VSS between the two

SDA signals and/or using shielded cables. Furthermore,

slowing down SCL frequency will possibly improve signal

integrity. Power supply pins (VDD, VSS) must be

decoupled with a 100nF capacitor – see next Section.

3.1 Power Pins (VDD, VSS)

The supply voltage of SHT2x must be in the range of 2.1 –

3.6V, recommended supply voltage is 3.0V. Power supply

pins Supply Voltage (VDD) and Ground (VSS) must be

decoupled with a 100nF capacitor, that shall be placed as

close to the sensor as possible – see Figure 9.

3.2 Serial clock (SCL)

SCL is used to synchronize the communication between

microcontroller (MCU) and the sensor. Since the interface

consists of fully static logic there is no minimum SCL

frequency.

3.3 Serial SDA (SDA)

The SDA pin is used to transfer data in and out of the

sensor. For sending a command to the sensor, SDA is

valid on the rising edge of SCL and must remain stable

while SCL is high. After the falling edge of SCL the SDA

value may be changed. For safe communication SDA shall

be valid tSU and tHD before the rising and after the falling

edge of SCL, respectively – see Figure 10. For reading

data from the sensor, SDA is valid tVD after SCL has gone

low and remains valid until the next falling edge of SCL.

VDD

MCU (master)

RP

RP

SCL

SCL IN

SCL OUT

SDA IN

SDA OUT

C = 100nF

SHT2x

(slave)

SDA

GND

Figure 9 Typical application circuit, including pull-up resistors

RP and decoupling of VDD and VSS by a capacitor.

To avoid signal contention the micro-controller unit (MCU)

must only drive SDA and SCL low. External pull-up

resistors (e.g. 10k ), are required to pull the signal high.

For the choice of resistor size please take bus capacity

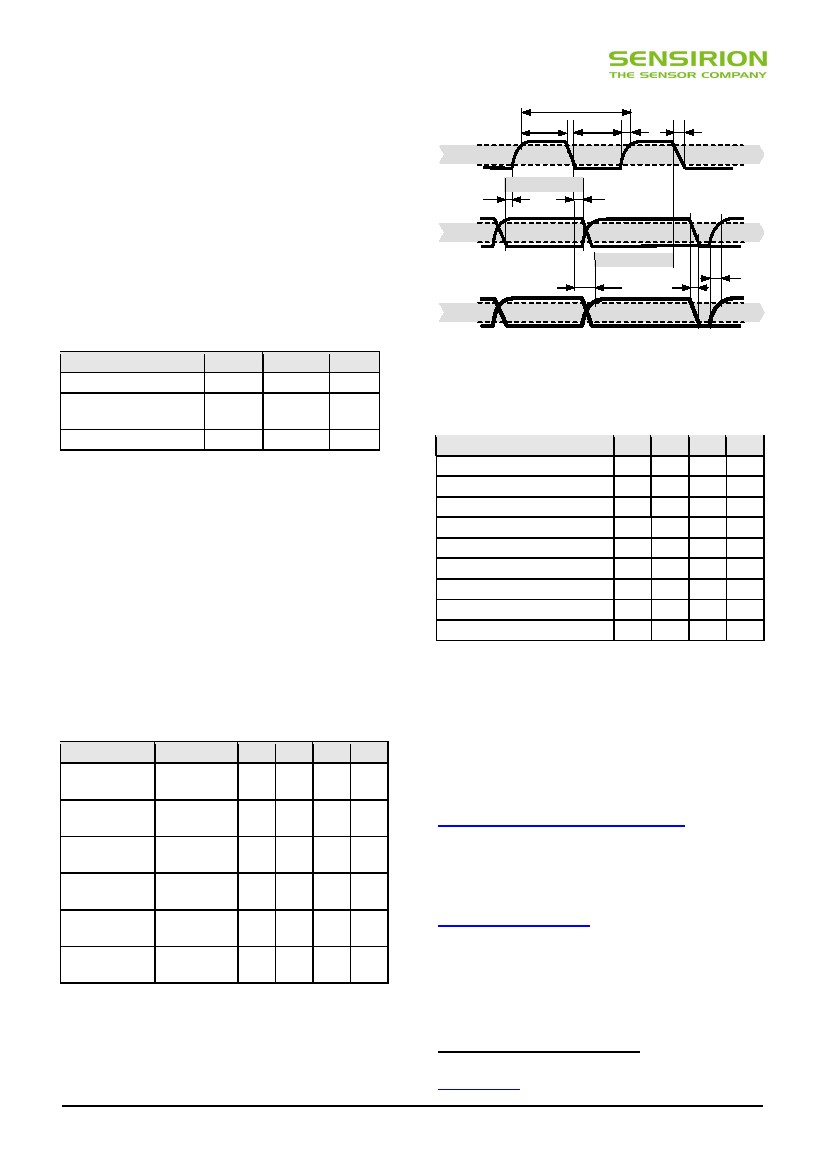
requirements into account (compare Table 5). It should be

noted that pull-up resistors may be included in I/O circuits

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of MCUs. See Table 4 and Table 5 for detailed I/O

characteristic of the sensor.

1/fSCK

tSCKH

tSCKL

tR

tF

70%

4 Electrical Characteristics

4.1 Absolute Maximum Ratings

The electrical characteristics of SHT2x are defined in

Table 1. The absolute maximum ratings as given in Table

3 are stress ratings only and give additional information.

Functional operation of the device at these conditions is

not implied. Exposure to absolute maximum rating

conditions for extended periods may affect the sensor

reliability (e.g. hot carrier degradation, oxide breakdown).

Parameter

VDD to VSS

Digital IO Pins (SDA, SCL)

to VSS

Input Current on any Pin

SCL

tSU

DATA IN

30%

SDA valid write

tHD

70%

SDA

SDA valid read

30%

tVD

DATA OUT

tF

tR

SDA

70%

30%

min

-0.3

max

5

Units

V

-0.3

VDD + 0.3

V

Figure 10 Timing Diagram for Digital Input/Output Pads,

abbreviations are explained in Table 5. SDA directions are seen

from the sensor. Bold SDA line is controlled by the sensor, plain

SDA line is controlled by the micro-controller. Both valid times

(SDA read and SDA write) refer to the left SCL toggle.

-100

100

mA

Table 3 Electrical absolute maximum ratings

ESD immunity is qualified according to MIL STD 883E,

method 3015 (Human Body Model at kV). Latch-up

immunity is provided at a force current of with

Tamb = 80°C according to JEDEC78A. For exposure

beyond named limits the sensor needs additional

protection circuit.

4.2 Input / Output Characteristics

The electrical characteristics such as power consumption,

low and high level input and output voltages depend on

the supply voltage. For proper communication with the

sensor it is essential to make sure that signal design is

strictly within the limits given in Table 4 & 5 and Figure 10.

Parameter

Parameter

SCL frequency, fSCL

SCL High Time, tSCLH

SCL Low Time, tSCLL

SDA Set-Up Time, tSU

SDA Hold Time, tHD

SDA Valid Time, tVD

SCL/SDA Fall Time, tF

SCL/SDA Rise Time, tR

Capacitive Load on Bus Line, CB

min

0

0.6

1.3

100

0

0

0

0

0

typ

-

-

-

-

-

-

-

-

-

max

0.4

-

-

-

900

400

100

300

400

Units

MHz

s

s

ns

ns

ns

ns

ns

pF

Table 5 Timing specifications of digital input/output pads for I2C

fast mode. Entities are displayed in Figure 10. VDD = 2.1V to

3.6V, T = -40°C to 125°C, unless otherwise noted.

5 Communication with Sensor

Conditions

VDD = 3.0 V,

-4 mA < IOL < 0mA

min

typ

max

Units

Output Low

Voltage, VOL

0

-

0.4

V

Output High

Voltage, VOH

70%

VDD

-

VDD

V

Output Sink

Current, IOL

-

-

-4

mA

SHT20 communicates with true I2C protocol. For

information on I2C beyond the information in the following

Sections please refer to the following website:

http://www.standardics.nxp.com/support/i2c/.

Please note that all sensors are set to the same I2C

address, as defined in Section 5.3. 15

Input Low

Voltage, VIL

0

-

30%

VDD

V

Input High

Voltage, VIH

70%

VDD

VDD = 3.6 V,

VIN = 0 V to 3.6 V

-

VDD

V

Furthermore, please note, that Sensirion provides a

sample code on its home page – compare

www.sensirion.com/SHT20.

Input Current

-

-

±1

uA

Table 4 DC characteristics of digital input/output pads. VDD =

2.1 V to 3.6 V, T = -40 °C to 125 °C, unless otherwise noted.

5.1 Start Up Sensor

As a first step, the sensor is powered up to the chosen

supply voltage VDD (between 2.1 V and 3.6 V). After

power-up, the sensor needs at most 15 ms, while SCL is

high, for reaching idle state, i.e. to be ready accepting

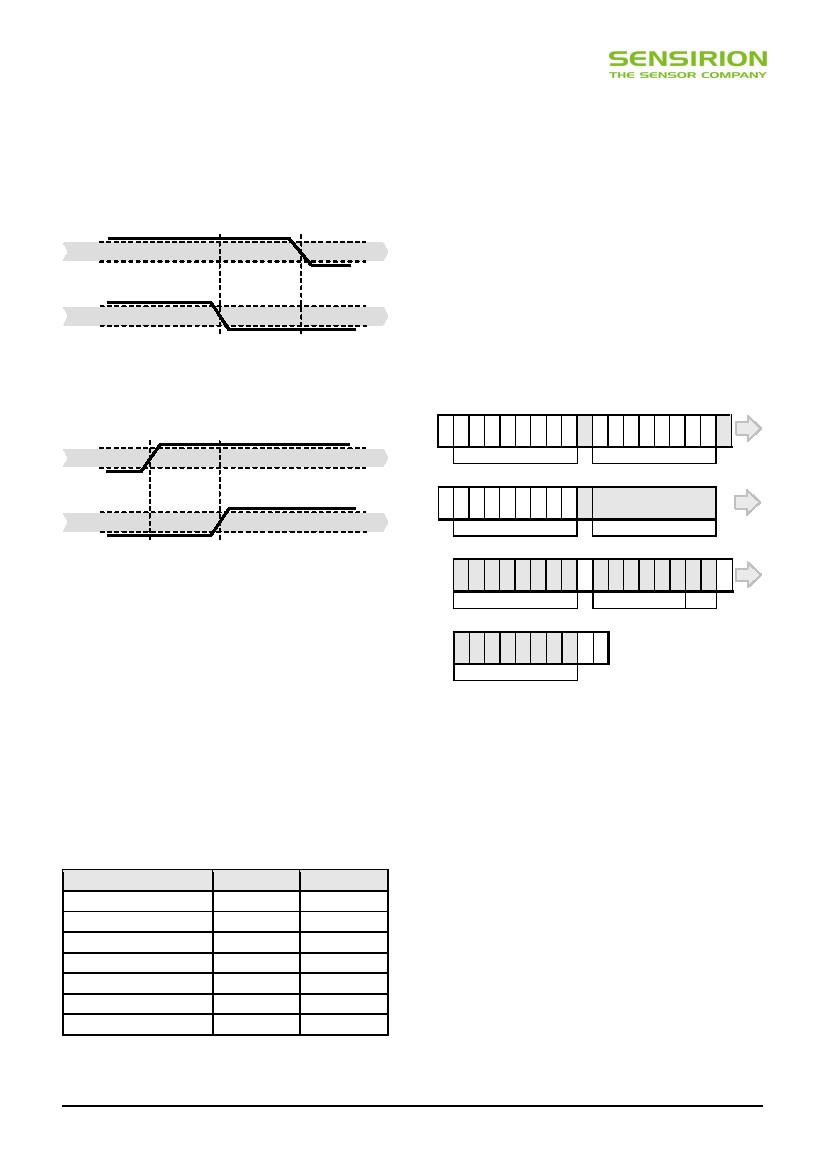
15 For sensors with alternative I2C address please contact Sensirion via

info@sensirion.com.

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commands from the master (MCU). Current consumption

during start up is 350 A maximum.

5.2 Start / Stop Sequence

Each transmission sequence begins with Start condition

(S) and ends with Stop condition (P) as displayed in Figure

11 and Figure 12.

SCL

70%

30%

5.4 Hold / No Hold Master Mode

There are two different operation modes to communicate

with the sensor: Hold Master mode or No Hold Master

mode. In the first case the SCL line is blocked (controlled

by sensor) during measurement process while in the latter

case the SCL line remains open for other communication

while the sensor is processing the measurement. No hold

master mode allows for processing other I2C

communication tasks on a bus while the sensor is

measuring. A communication sequence of the two modes

is displayed in Figure 13 and Figure 14, respectively.

In the hold master mode, the SHT2x pulls down the SCL

line while measuring to force the master into a wait state.

By releasing the SCL line the sensor indicates that internal

processing is terminated and that transmission may be

continued.

1

2

3

4

5

6

7

8

9

10 11 12 13 14 15 16 17 18

SDA

70%

30%

ACK

S10000000

11100101

Command (see Table 6)

SCL

70%

I2C address + write

19 20 21 22 23 24 25 26 27

30%

ACK

SDA

70%

S10000001

I2C address + read

Measurement

Hold during measurement

30%

Figure 12 Transmission Stop Condition (P) - a low to high

transition on the SDA line while SCL is high. The Stop condition

is a unique state on the bus created by the master, indicating to

the slaves the end of a transmission sequence (bus is

considered free after a Stop).

28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45

ACK

01100011

Data (MSB)

01010010

Data (LSB) Stat.

46 47 48 49 50 51 52 53 54

5.3 Sending a Command

After sending the Start condition, the subsequent I2C

header consists of the 7-bit I2C device address ‘1000’000’

and an SDA direction bit (Read R: ‘1’, Write W: ‘0’). The

sensor indicates the proper reception of a byte by pulling

the SDA pin low (ACK bit) after the falling edge of the 8th

SCL clock. After the issue of a measurement command

(‘1110’0011’ for temperature, ‘1110’0101’ for relative

humidity’), the MCU must wait for the measurement to

complete. The basic commands are summarized in Table

6. Hold master or no hold master modes are explained in

next Section.

Command

01100011

Checksum

NACK

P

Figure 13 Hold master communication sequence – grey blocks

are controlled by SHT2x. Bit 45 may be changed to NACK

followed by Stop condition (P) to omit checksum transmission.

Comment

Code

Trigger T measurement

Trigger RH measurement

Trigger T measurement

Trigger RH measurement

Write user register

Read user register

Soft reset

hold master

hold master

no hold master

no hold master

1110’0011

1110’0101

1111’0011

1111’0101

1110’0110

1110’0111

1111’1110

In no hold master mode, the MCU has to poll for the

termination of the internal processing of the sensor. This is

done by sending a Start condition followed by the I2C

header (1000’0001) as shown in Figure 14. If the internal

processing is finished, the sensor acknowledges the poll of

the MCU and data can be read by the MCU. If the

measurement processing is not finished the sensor

answers no ACK bit and the Start condition must be

issued once more.

For both modes, since the maximum resolution of a

measurement is 14 bit, the two last LSBs (bits 43 and 44)

are used for transmitting status information. Bit 1 of the

two LSBs indicates the measurement type (‘0’:

temperature, ‘1’ humidity). Bit 0 is currently not assigned.

Table 6 Basic command set, RH stands for relative humidity,

and T stands for temperature

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ACK

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ACK

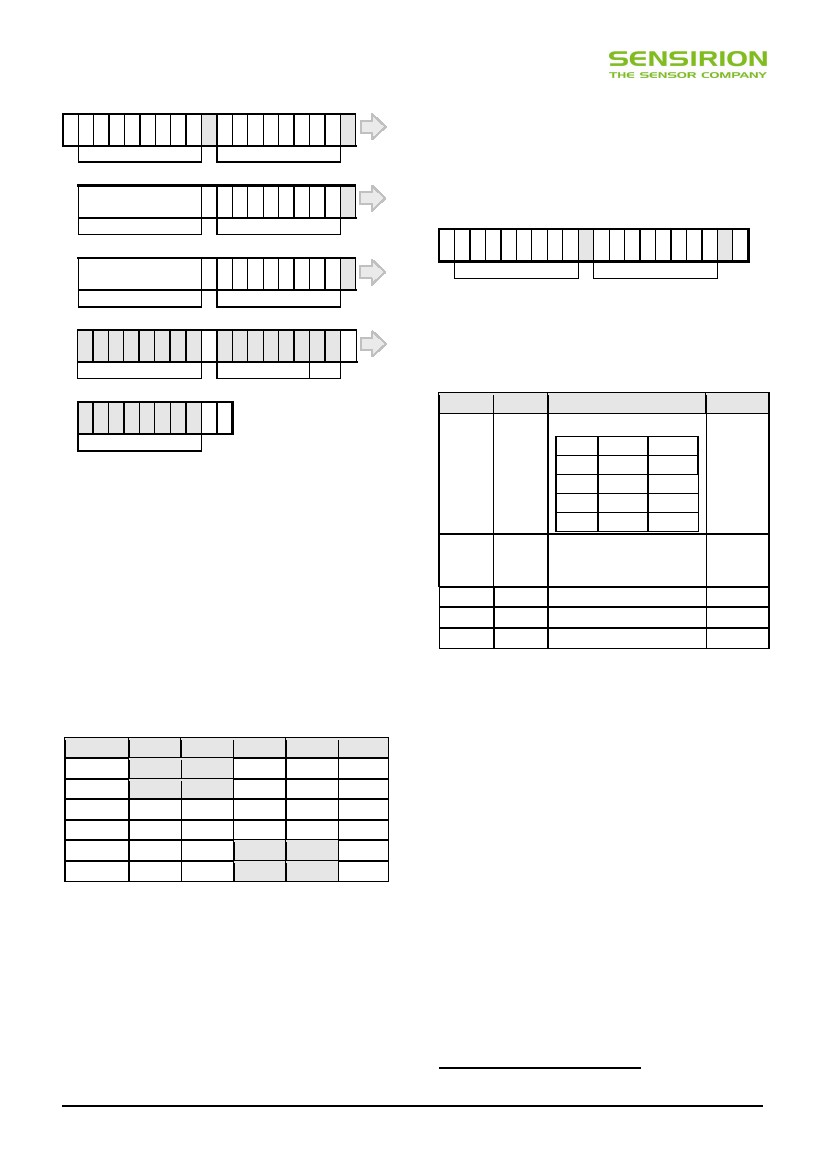
Figure 11 Transmission Start Condition (S) - a high to low

transition on the SDA line while SCL is high. The Start condition

is a unique state on the bus created by the master, indicating to

the slaves the beginning of a transmission sequence (bus is

considered busy after a Start).

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1

2

3

4

5

6

7

8

9

10 11 12 13 14 15 16 17 18

S10000000

I2C address + write

11110101

Command (see Table 6)

19 20 21 22 23 24 25 26 27

Measurement

measuring

S10000001

I2C address + read

NACK

5.5 Soft Reset

This command (see Table 6) is used for rebooting the

sensor system without switching the power off and on

again. Upon reception of this command, the sensor

system reinitializes and starts operation according to the

default settings. The soft reset takes less than 15 ms.

1

2

3

4

5

6

7

8

9

10 11 12 13 14 15 16 17 18

ACK

ACK

ACK

ACK

19 20 21 22 23 24 25 26 27

S10000000

I2C address + write

11111110

Soft Reset

P

Measurement

continue measuring

S10000001

I2C address + read

ACK

Figure 15 Soft Reset – grey blocks are controlled by SHT2x.

28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45

01100011

Data (MSB)

01010010

Data (LSB) Stat.

5.6 User Register

The content of user register is described in Table 8.

Please note that reserved bits must not be changed.

Bit

7, 0

46 47 48 49 50 51 52 53 54

ACK

ACK

01100011

Checksum

NACK

P

# Bits

2

Description / Coding

Measurement resolution

Default

‘00’

Figure 14 No Hold master communication sequence – grey

blocks are controlled by SHT2x. If measurement is not

completed upon “read” command, sensor does not provide ACK

on bit 27 (more of these iterations are possible). If bit 45 is

changed to NACK followed by Stop condition (P) checksum

transmission is omitted.

‘00’

‘01’

‘10’

‘11’

RH

12 bit

8 bit

10 bit

11 bit

T

14 bit

12 bit

13 bit

11 bit

6

1

In the examples given in Figure 13 and Figure 14 the

sensor output is SRH = ‘0110’0011’0101’0000’. For the

calculation of physical values Status Bits must be set to ‘0’

– see Chapter 6.

The maximum duration for measurements depends on the

type of measurement and resolution chosen – values are

displayed in Table 7. Maximum values shall be chosen for

the communication planning of the MCU.

Resolution

14 bit

13 bit

12 Bit

11 bit

10 bit

8 bit

3, 4, 5

2

1

3

1

1

Status: End of battery16

‘0’: VDD > 2.25 V

‘1’: VDD < 2.25 V

Reserved

Enable on-chip heater

Disable OTP reload

‘0’

‘0’

‘1’

Table 8 User Register. Cut-off value for End of Battery signal

may vary by ±0.05V. Reserved bits must not be changed. “OTP

reload” = ‘0’ loads default settings after each time a

measurement command is issued.

RH typ

RH max

22

12

7

3

29

15

9

4

T typ

66

33

17

9

T max

85

43

22

11

Units

ms

ms

ms

ms

ms

ms

The End of Battery alert is activated when the battery

power falls below 2.25V.

The heater is intended to be used for functionality

diagnosis – relative humidity drops upon rising

temperature. The heater consumes about 5.5mW and

provides a temperature increase of about 0.5 – 1.5°C.

OTP Reload is a safety feature and loads the entire OTP

settings to the register before every measurement. This

feature is disabled per default and is not recommended for

use. Please use Soft Reset instead – it contains OTP

Reload.

An example for I2C communication reading and writing the

User Register is given in Figure 16. It is important that first

the content of the register is read in order getting the

default values. Hereafter, the resolution is changed by

configuring register. Please note that the reserved user-

register bits must not be changed.

16

Table 7 Measurement times for RH and T measurements at

different resolutions. Typical values are recommended for

calculating energy consumption while maximum values shall be

applied for calculating waiting times in communication.

Please note: I2C communication allows for repeated Start

conditions (S) without closing prior sequence with Stop

condition (P) – compare Figures 13, 14 and 16. Still, any

sequence with adjacent Start condition may alternatively

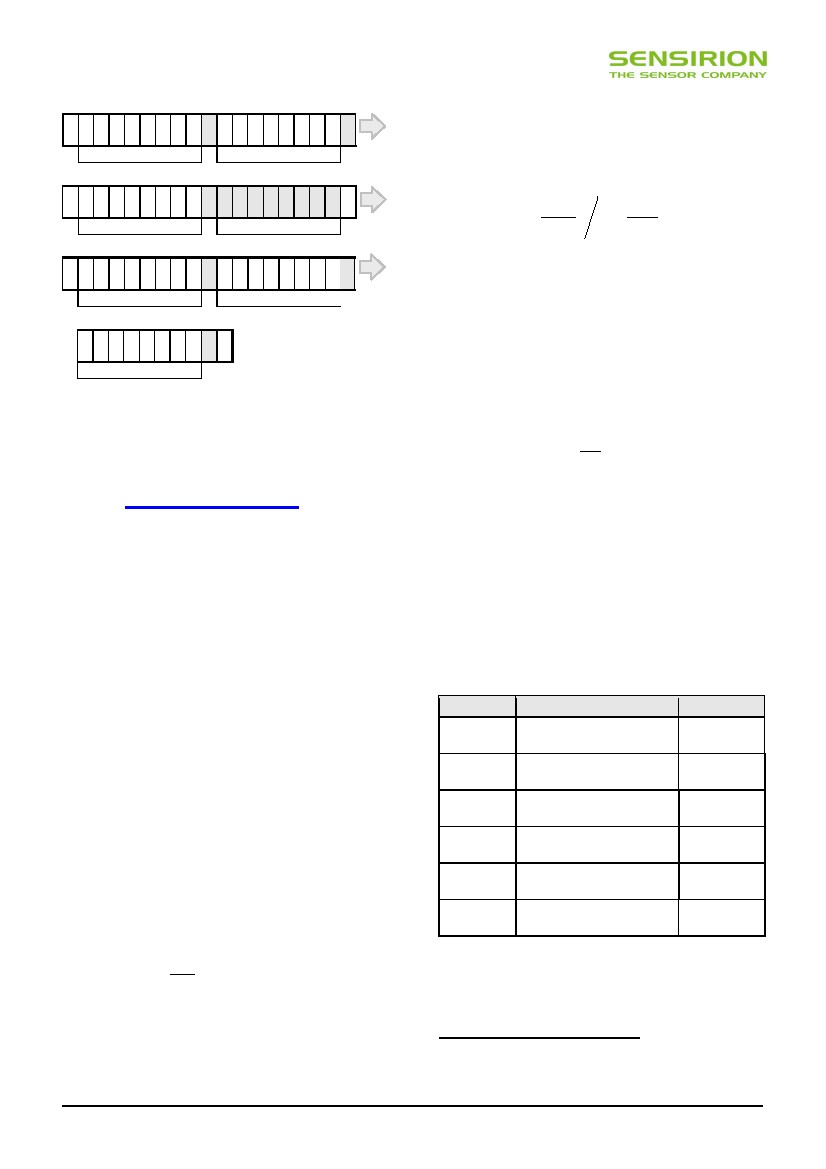
be closed with a Stop condition.

This status bit is updated after each measurement

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9

10 11 12 13 14 15 16 17 18

S10000000

I2C address + write

11100111

Read Register

19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36

Meteorological Organization (WMO). For relative humidity

above ice RHi the values need to be transformed from

relative humidity above water RHw at temperature t. The

equation is given in the following, compare also

Application Note “Introduction to Humidity:

β ⋅t 

RH i RH w ⋅expw 

λ t w

β ⋅t 

expi 

λ t i

ACK

S10000001

I2C address + read

00000010

Register content

37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54

NACK

ACK

ACK

S10000000

I2C address + write

11100110

Write Register

55 56 57 58 59 60 61 62 63

Units are %RH for relative humidity and °C for

temperature. The corresponding coefficients are defined

as follows: βw = 17.62, λw = 243.12°C, βi = 22.46, λi =

272.62°C.

ACK

ACK

00000011

Register content to be written

P

ACK

Figure 16 Read and write register sequence – grey blocks are

controlled by SHT2x. In this example, the resolution is set to 8bit

/ 12bit.

6.2 Temperature Conversion

The temperature T is calculated by inserting temperature

signal output ST into the following formula (result in °C), no

matter which resolution is chosen:

5.7 CRC Checksum

For implementing CRC8 checksum please refer to

Wikipedia (http://en.wikipedia.org/wiki/crc8).

T −46.85 175.72 ⋅

ST

216

7 Environmental Stability

The SHT2x sensor series were tested according to AEC-

Q100 Rev. F qualification test method. Sensor

specifications are tested to prevail under the AEC-Q100

temperature grade 2 test conditions listed in Table 917.

Sensor performance under other test conditions cannot be

guaranteed and is not part of the sensor specifications.

Especially, no guarantee can be given for sensor

performance in the field or for customer’s specific

application.

Environment Standard

HTSL125°C, 1000 hours

5.8 Serial Number

SHT20 provides an electronic identification code. For

instructions on how to read the identification code please

refer to the Application Note “Electronic Identification

Code” – to be downloaded from the web page

www.sensirion.com/SHT20.

6 Conversion of Signal Output

Default resolution is set to 12 bit relative humidity and 14

bit temperature reading. Measured data are transferred in

two byte packages, i.e. in frames of 8 bit length where the

most significant bit (MSB) is transferred first (left aligned).

Each byte is followed by an acknowledge bit. The two

status bits, the last bits of LSB, must be set to ‘0’ before

calculating physical values. In the example of Figure 13

and Figure 14, the transferred 16 bit relative humidity data

is ‘0110’0011’0101’0000’ = 25424.

6.1 Relative Humidity Conversion

With the relative humidity signal output SRH the relative

humidity RH is obtained by the following formula (result in

%RH), no matter which resolution is chosen:

TC

UHST

-50°C - 125°C, 1000 cycles

Acc. JESD22-A104-C

130°C / 85%RH, 96h

THU

85°C / 85%RH, 1000h

ESD immunity MIL STD 883E, method 3015

(Human Body Model at ±2kV)

Latch-upforce current of ±100mA with Qualified

Tamb = 80°C, acc. JEDEC 17

Results18

Within

specifications

Within

specifications

Within

specifications

Within

specifications

Qualified

S

RH −6 125 ⋅RH

216

In the example given in Figure 13 and Figure 14 the

relative humidity results to be 42.5%RH.

The physical value RH given above corresponds to the

relative humidity above liquid water according to World

Table 9: Qualification tests: HTSL = High Temperature Storage

Lifetime, TC = Temperature Cycles, UHST = Unbiased Highly

accelerated Stress Test, THU = Temperature Humidity

Unbiased.

17

Sensor operation temperature range is -40 to 105°C according to AEC-Q100

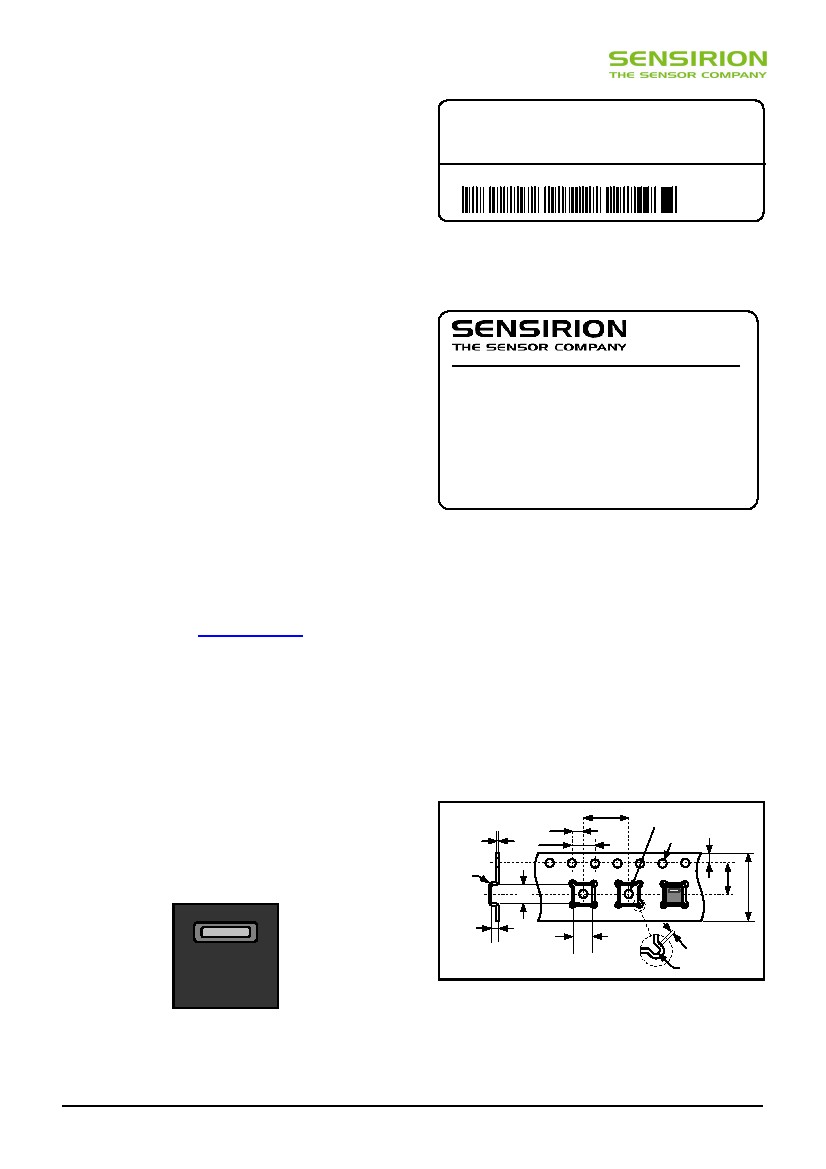
temperature grade 2.

18 According to accuracy and long term drift specification given on Page 2.

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If sensors are qualified for reliability and behavior in

extreme conditions, please make sure that they

experience same conditions as the reference sensor. It

should be taken into account that response times in

assemblies may be longer, hence enough dwell time for

the measurement shall be granted. For detailed

information please consult Application Note “Qualification

Guide”.

Lot No.:

Quantity:

RoHS:

Lot No.

XXO-NN-YRRRRTTTT

RRRR

Compliant

8 Packaging

8.1

Packaging Type

SHT2x sensors are provided in DFN packaging (in

analogy with QFN packaging). DFN stands for Dual Flat

No leads.

The sensor chip is mounted to a lead frame made of Cu

and plated with Ni/Pd/Au. Chip and lead frame are over

molded by green epoxy-based mold compound. Please

note that side walls of sensors are diced and hence lead

frame at diced edge is not covered with respective

protective coating. The total weight of the sensor is 25mg.

Figure 18: First label on reel: XX = Sensor Type (20 for SHT20),

O = Output mode (D = Digital, P = PWM, S = SDM), NN = Chip

Version, Y = last digit of year, RRRR = number of sensors on

reel, TTTT = Traceability Code.

1-100PPP-NN

Humidity & Temperature Sensor

SHTxx

Part Order No. 1-100PPP-NN or Customer Number

Date of Delivery: DD.MM.YYYY

Order Code:45CCCC / 0

Device Type:

Description:

8.2 Filter Cap and Sockets

For SHT2x a filter cap SF2 will be provided. It is designed

for fast response times and compact size. Please find the

datasheet on Sensirion’s web page by February 2010.

For testing of SHT2x sensors sockets, such as from

Plastronics, part number 10LQ50S13030 are

recommended (see e.g. www.locknest.com).

Figure 19: Second label on reel: For Device Type and Part

Order Number (See Packaging Information on page 2), Delivery

Date (also Date Code) is date of packaging of sensors (DD =

day, MM = month, YYYY = year), CCCC = Sensirion order

number.

8.3 Traceability Information

All SHT2x are laser marked with an alphanumeric, five-

digit code on the sensor – see Figure 17.

The marking on the sensor consists of two lines with five

digits each. The first line denotes the sensor type

(SHT20). The first digit of the second line defines the

output mode (D = digital, Sensibus and I2C, P = PWM, S =

SDM). The second digit defines the manufacturing year (0

= 2010, 1 = 2011, etc.). The last three digits represent an

alphanumeric tracking code. That code can be decoded by

Sensirion only and allows for tracking on batch level

through production, calibration and testing – and will be

provided upon justified request.

8.4 Shipping Package

SHT2x are provided in tape & reel shipment packaging,

sealed into antistatic ESD bags. Standard packaging sizes

are 1500 and 5000 units per reel. For SHT20, each reel

contains 440mm (55 pockets) header tape and 200mm (25

pockets) trailer tape.

The drawing of the packaging tapes with sensor

orientation is shown in Figure 20. The reels are provided in

sealed antistatic bags.

8.0

0.3

R0.3 MAX

3.3

2.0

4.0

1.75

5.5

3.3

0.25

R0.25

Ø0.15 MIN

Ø0.15 MIN

1.3

SHT20

D0AC4

Figure 17 Laser marking on SHT20. For details see text.

Figure 20 Sketch of packaging tape and sensor orientation.

Header tape is to the right and trailer tape to the left on this

sketch.

Reels are also labeled, as displayed in Figure 18 and

Figure 19, and give additional traceability information.

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9 Compatibility to SHT1x / 7x protocol

SHT2x sensors may be run by communicating with the

Sensirion specific communication protocol used for SHT1x

and SHT7x. In case such protocol is applied please refer

to the communication chapter of datasheet SHT1x or

SHT7x. Please note that reserved status bits of user

register must not be changed.

Please understand that with the SHT1x/7x communication

protocol only functions described in respective datasheets

can be used with the exception of the OTP reload function

that is not set to default on SHT2x. As an alternative to

OTP reload the soft reset may be used. Please note that

even if SHT1x/7x protocol is applied the timing values of

Table 5 and Table 7 as well as the calculation of physical

values in this SHT2x datasheet apply.

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Revision History

Date

6 May 2009

24 Sept 2009

29 January 2010

Version

0.3

0.5

1.0

Page(s)

1–9

1, 3, 6, 8-9

1 – 4, 7 – 11

Changes

Initial preliminary release

Revise Section 1.2, Figs. 1, 5 and 9, Table 5. Add Chapter 7

Complete revision. For complete revision list please require respective document from

Sensirion.

Important Notices

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. Do not use this product for applications other

than its intended and authorized use. Before installing, handling,

using or servicing this product, please consult the data sheet and

application notes. Failure to comply with these instructions could

result in death or serious injury.

If the Buyer shall purchase or use SENSIRION products for any

unintended or unauthorized application, Buyer shall defend, indemnify

and hold harmless SENSIRION and its officers, employees,

subsidiaries, affiliates and distributors 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 SENSIRION shall be

allegedly negligent with respect to the design or the manufacture of the

product.

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 customary and statutory ESD precautions when

handling this product.

See application note “ESD, Latchup and EMC” for more information.

Warranty

SENSIRION warrants solely to the original purchaser of this product for

a period of 12 months (one year) from the date of delivery that this

product shall be of the quality, material and workmanship defined in

SENSIRION’s published specifications of the product. Within such

period, if proven to be defective, SENSIRION shall repair and/or

replace this product, in SENSIRION’s discretion, free of charge to the

Buyer, provided that:

notice in writing describing the defects shall be given to

SENSIRION within fourteen (14) days after their appearance;

such defects shall be found, to SENSIRION’s reasonable

satisfaction, to have arisen from SENSIRION’s faulty design,

material, or workmanship;

the defective product shall be returned to SENSIRION’s factory at

the Buyer’s expense; and

the warranty period for any repaired or replaced product shall be

limited to the unexpired portion of the original period.

This warranty does not apply to any equipment which has not been

installed and used within the specifications recommended by

SENSIRION for the intended and proper use of the equipment.

EXCEPT FOR THE WARRANTIES EXPRESSLY SET FORTH

HEREIN, SENSIRION MAKES NO WARRANTIES, EITHER EXPRESS

OR IMPLIED, WITH RESPECT TO THE PRODUCT. ANY AND ALL

WARRANTIES, INCLUDING WITHOUT LIMITATION, WARRANTIES

OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR

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implied, for any period during which the goods are operated or stored

not in accordance with the technical specifications.

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liability, including without limitation consequential or incidental

damages. All operating parameters, including without limitation

recommended parameters, must be validated for each customer’s

applications by customer’s technical experts. Recommended

parameters can and do vary in different applications.

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