

## Embedding SHT2x in 5V Supply

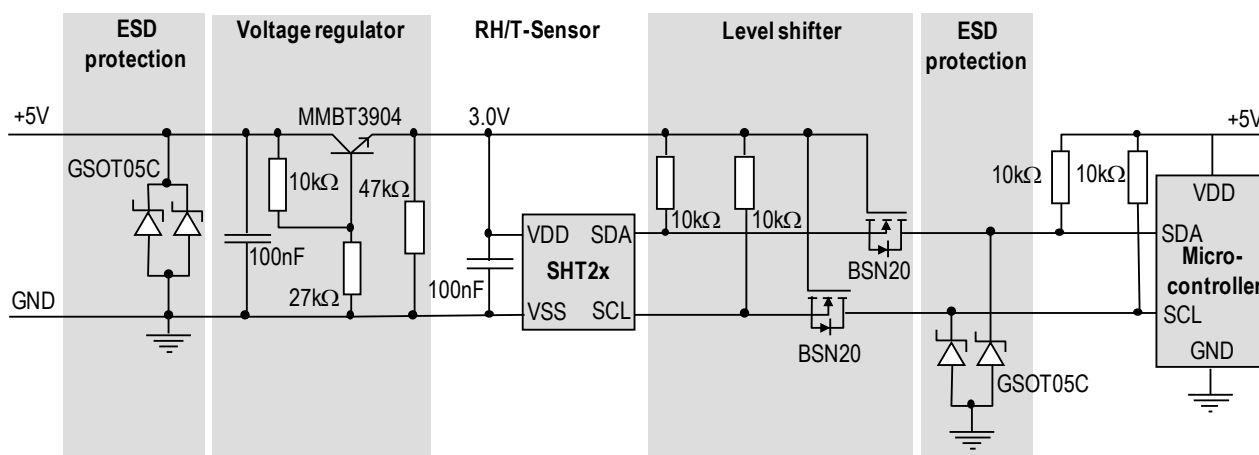
### Sample Schemes, ESD Protection and Material List

The digital SHT2x humidity and temperature sensor series integrates multi-functionality on a small footprint. Due to the underlying physics of the highly integrated on-chip CMOS circuitry the supply voltage of the SHT2x is restricted to 2.2 - 3.6V. This application note provides sample schemes for embedding SHT2x sensors with I<sup>2</sup>C-bus, PWM interface, and SDM interface into 5V power supply environment.

Samples schemes for I<sup>2</sup>C bus, pulse-width modulation (PWM) and sigma-delta modulation (SDM) signal are presented using Sensirion SHT2x, SHT2xP, and SHT2xS humidity and temperature sensors, respectively.

### I<sup>2</sup>C Interface

Low-cost implementation of SHT2x by voltage regulator and bi-directional FET level shifter for I<sup>2</sup>C-bus. ESD protection is recommended but not mandatory if adequate ESD precaution in production is considered.



For more details on bidirectional level shifter for I<sup>2</sup>C-bus please refer to US 5,689,196 and Application Note AN97055 by NXP: <http://www.standardics.nxp.com/support/documents/i2c/pdf/an97055.pdf> Please note that this level shifter design is covered by patents of NXP.

### Bill of materials – I<sup>2</sup>C interface

Component	Type	FET level shifter SDA & SCL, ESD protection	FET level shifter SDA & SCL, without ESD protection
Resistor	Several 0603	5	5
Capacitor	100nF, 0603	2	2
Transistor	MMBT3904	1	1
FET level shifter	BSN20	2	2
Diodes	GSOT05C	2	0

## PWM Interface

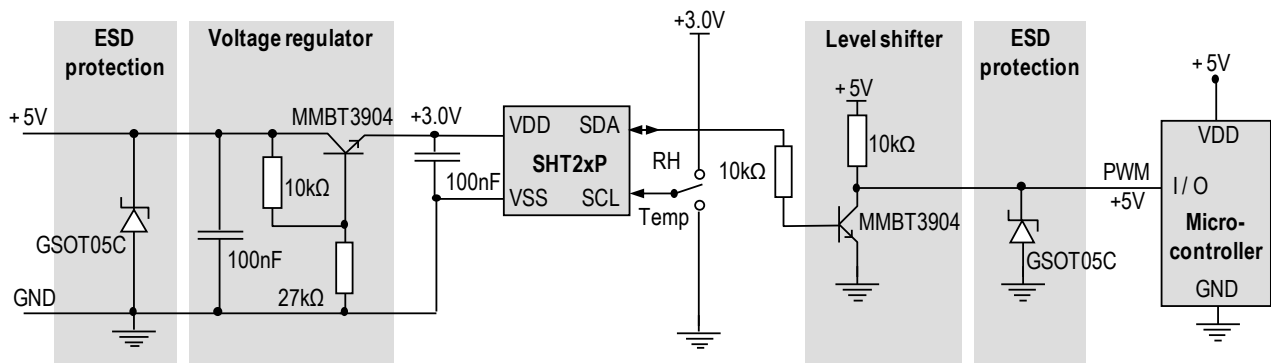
For SHT2xP RH/T-sensors with PWM output, there are 2 possible samples schemes: open-collector output and push-pull output.

### Sample scheme – PWM interface, open-collector output

The level shifter set-up for PWM signal with open-collector output is optimized for low cost. The following sample scheme implements an open collector output with a bipolar transistor.

Important note: The level shifter transistor at the signal output inverts the PWM sensor signal.

According to the PWM interface specifications of SHT2xP series, the SCL line must be drawn high for relative humidity read-out or grounded for temperature read-out. ESD protection is recommended but not mandatory if adequate ESD precaution in production is considered.



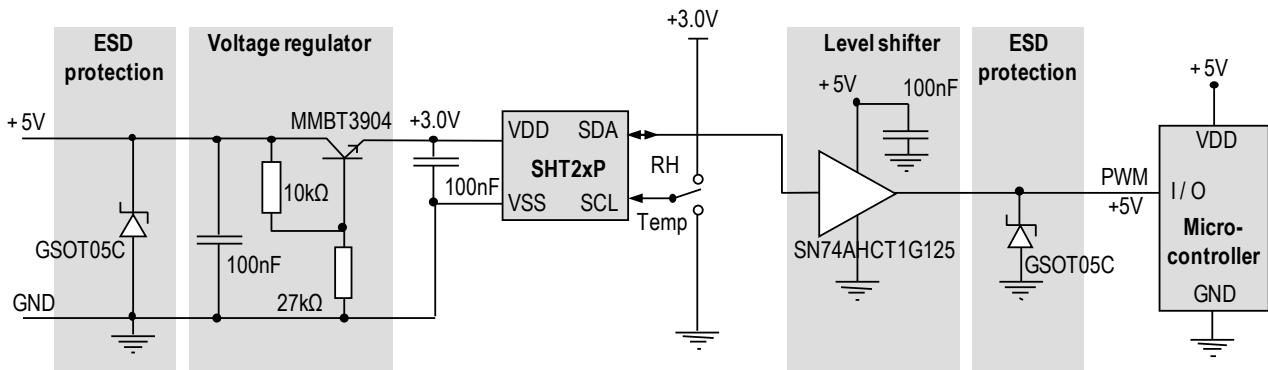
### Bill of materials – PWM interface, open-collector output

Component	Type	Transistor level shifter SDA, ESD protection	Transistor level shifter SDA, without ESD protection
Resistor	Several 0603	4	4
Capacitor	100nF, 0603	2	2
Transistor	MMBT3904	2	2
Diodes	GSOT05C	1	0

### Sample scheme – PWM interface, push-pull output

For a 5V push-pull output, the single line driver of type 74AHCT1G125 can be used as a level shifter instead of the transistor driver used for the open-collector output. In contrary to the open-collector output, the PWM signal in case of push-pull output is not inverted.

According to the PWM interface specifications of SHT2xP series, the SCL line must be drawn high for relative humidity read-out or grounded for temperature read-out. ESD protection is recommended but not mandatory if adequate ESD precaution in production is considered.



**Bill of materials – PWM interface, push-pull output**

Component	Type	Single line driver level shifter SDA, ESD protection	Single line driver level shifter SDA, without ESD protection
Resistor	Several 0603	2	2
Capacitor	100nF, 0603	3	3
Transistor	MMBT3904	1	1
Driver	SN74AHCT1G125	1	1
Diodes	GSOT05C	1	0

**Analog Voltage Output**

With an SHT2x with SDM interface it is possible to generate an analog signal using a low pass filter.

Please note: Aout is ratioetric to supply voltage (+5V)

According to the SDM interface specifications of SHT2xS series, the SCL line must be drawn high for relative humidity read-out or grounded for temperature read-out. ESD protection is recommended but not mandatory if adequate ESD precaution in production is considered.

For the example scheme shown in the following graph, it is assumed that R2, R3, and R4 are not used. In that case, the analog output signal Aout is converted to relative humidity and temperature values according to

Relative humidity RH  
 $RH = -6 + 125 * Aout/VDD$

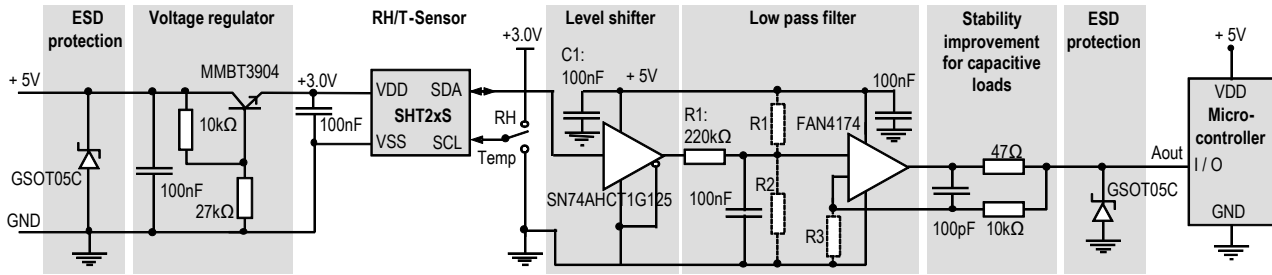
Temperature T  
 $T = -46.65 + 175.72 * Aout/VDD$

For supply voltage of +5V  
 RH = 0%      Aout = 0.24 V  
 RH = 100%    Aout = 4.24 V

For supply voltage of +5V  
 T = 0°C    Aout = 1.33V  
 T = 100 °C: Aout = 4.18 V

With the optional resistors R2, R3, and R4, analog output Aout can be adjusted (gain and offset) to meet customer-specific requirements and yield other voltage values than those shown above.

**Sample scheme – SDM interface, analog voltage output**



Important note: Capacitor C1 (100 nF) and resistor R1 (220 kΩ) should be placed as close as possible to the driver (SN74AHCT1G125) to minimize noise on analog output signal Aout.

**Bill of materials – SDM interface, analog voltage output**

Component	Type	Single line driver level shifter SDA, ESD protection	Single line driver level shifter SDA, without ESD protection
Resistor	Several 0603	5	5
Capacitor	100nF, 0603	6	6
Transistor	MMBT3904	1	1
Driver	SN74AHCT1G125	1	1
OpAmp	FAN4174	1	1
Diodes	GSOT05C	1	0

## Revision History

Date	Revision	Changes
6 March 2009	1.0	Initial version (DHA)
14. July 2009	1.1	Chapter 2, PWM interface added (CLA), Sensirion CN added
June 2012	2	Re-worked digital, PWM interface; added SDM interface

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