HCH20DP temperature and humidity sensor

Features

· Fully interchangeable, no recalibration required

· Rapid recovery after long-term saturation

· Low power consumption

· Small size, waterproof and sealed structure, strong environmental adaptability

· Temperature range: -40°C - +125°C

· Humidity range: 0 - 100 %RH

· Separate identification, meeting strict traceability requirements

Applications

· Home appliances, medical, agriculture, car
· Intelligent environment monitoring
· Industrial precision control field
· Replace traditional NTC and PTC boxes
· HVAC, air conditioning
· Intelligent building monitoring
· Computer room data center

Product description

HCH20DP digital temperature and humidity composite sensor sets an intelligent model of the new temperature and humidity sensor and provides a corrected linear I2C digital signal output. As a plug-and-play humidity and temperature sensor, the humidity and temperature signals output can be directly connected to the microcontroller. Through continuous improvement and miniaturization, HCH20DP has many advantages such as low power consumption, waterproof, cost-effective, small size, and energy saving.

Performance specification

Parameter	Symbol	l value	unit
stored temperature	Tstg	-40—+125	℃
Supply voltage (peak)	Vcc	3.8	Vdc
Humidity measurement range	RH	0—100	%RH
Temperature measurement range	Ta	-40—+125	℃
VDD to GND		-0.3—3.6V	V
Digital I/O port pin (DATA/SCK) toVDD		-0.3—VDD+0.3	V
Current per input and output		-10—+10	mA

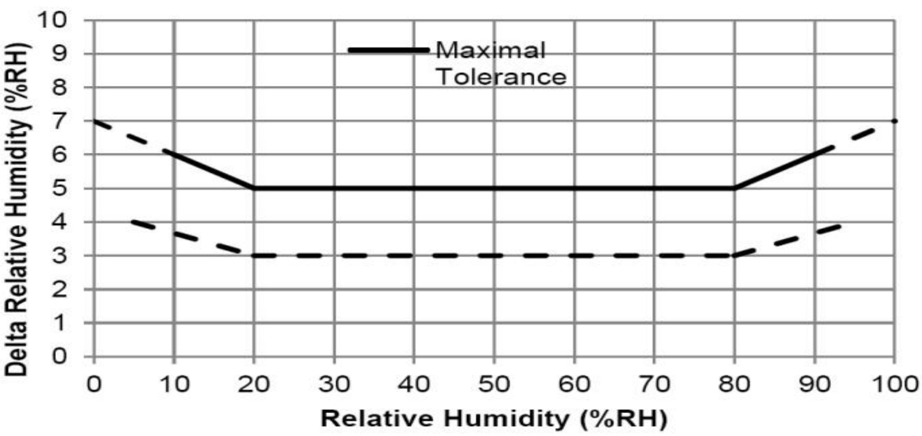
Electrical characteristics (at T=25°C, Vdd=3.3V)

characteristic		Symbol	Min	Typ	Max	Unit
Supply voltage		VDD	1.5	3	3.6	V
Current consumption	Sleep mode	idd		0.02	0.14	μA
	Measuring		300	450	500	μA
Power consumption	Sleep mode			0.06	0.5	μW
	8-bit mode			2.7		μW
communication		Digital (two-wire interface) I2C				
Heater	VDD=3V	5.5mW/ΔT = + 0.5 - 1.5 ℃				
Storage environment		-40℃—125℃				

Humidity performance (at T=25°C, Vdd=3.3V)

characteristic		Symbol	Min	Typ	Max	Unit
Resolution	12 digits			0.04		%RH
	8 digits			0.7		%RH
Temperature measurement range		RH	0		100	%RH
Relative humidity accuracy @25°C (20%-80%RH)	typ			±3		%RH
	max		see graph			%RH
Replacement		fullyinterchangeable				
Temperature coefficient (from 0°C-°C)		T_{cc}		-0.1	-0.15	%RH/℃
Humidity tape				±1		%RH
measure time	12 digits			14	16	ms
	11 digits			7	8	ms
	10 digits			4	5	ms
	8 digits			2	3	ms
Power control ratio					±10	LSB
Condensation 150 hours recovery time		t		10		S
Long-term drift				0.5		%RH/yr
Response time (from 33 - 75 %RH)		T_{RH}		5	10	s

Estimation of relative temperature error at 25 ° C



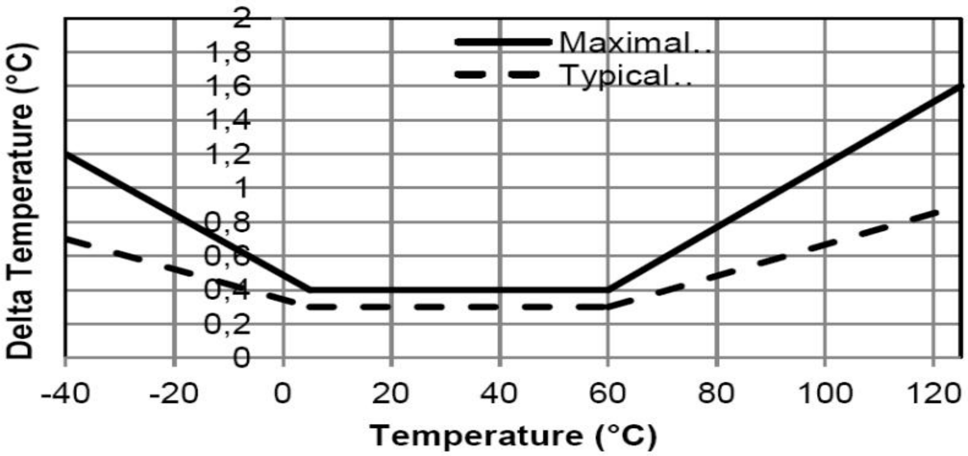
· The optimal measurement range specified by the HCH20DP sensor module is 5% RH—95% RH

· In other humidity ranges (<5%RH or >95%RH, or condensation), it does not affect its stability and reliability.

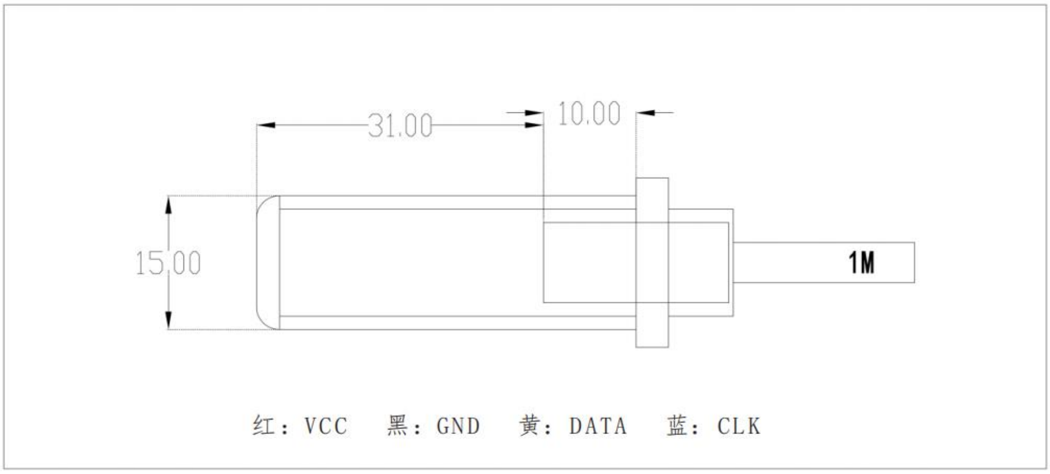
Temperature performance (at Vdd=3.3V)

characteristic		Symbol	Min	Typ	Max	Unit
Resolution	14 digits			0.01		℃
	12 digits			0.04		℃
Temperature measurement range		T	-40		125	℃
Temperature measurement accuracy (25 ° C)	typ			±0.3		℃
	max		see graph			℃
Replacement		fullyinterchangeable				
measure time	12 digits			44	50	ms
	11 digits			22	25	ms
	10 digits			11	13	ms
	8 digits			6	7	ms
Power control ratio					±25	LSB
Long-term drift				0.04		℃/yr
Response time (from 15°C to 45°C)		T_T		10		s

Temperature error estimation



Dimensions



I2C communication protocol

Start sensor

The sensor requires a voltage of 1.5V to 3.6V. After power-on, the device needs most of the 15ms, and the SCK high reaches the idle state (sleep mode), that is, ready to accept the command MCU. No commands should be sent until then. A soft reset is recommended at the beginning.

Start signal (S)

To initiate a transfer, a start condition must be issued, which includes pulling the DATA line low and a low transition during SCK high.

Stop signal (P)

To stop the transfer, a stop condition must be issued, which includes pulling the DATA line high and a high transition during the SCK high period.

send command

After the start condition is transmitted, the subsequent I2C header consists of the 7-bit I2C device address 0x40 and the DATA direction bit (write access "0": 0x80). The temperature and humidity sensor indicates the correct reception of the byte by pulling the DATA pin low (ACK bit) after the falling edge of the eighth SCK clock. After issuing a measurement command (temperature 0xE3, relative humidity 0xE5), the MCU must wait for the measurement to complete.

The basic commands are shown in the following table:

command	Code	description
Trigger temperature measurement	0xE3	Host
Trigger humidity measurement	0xE5	Host
Trigger temperature measurement	0xF3	Slave
Trigger humidity measurement	0xF5	Slave
Write user registration	0xE6	
Read user registration	0xE7	
Soft reset	0xFE	

Master/slave mode

There are two different modes of operation to communicate with the temperature and humidity sensor: master mode and slave mode

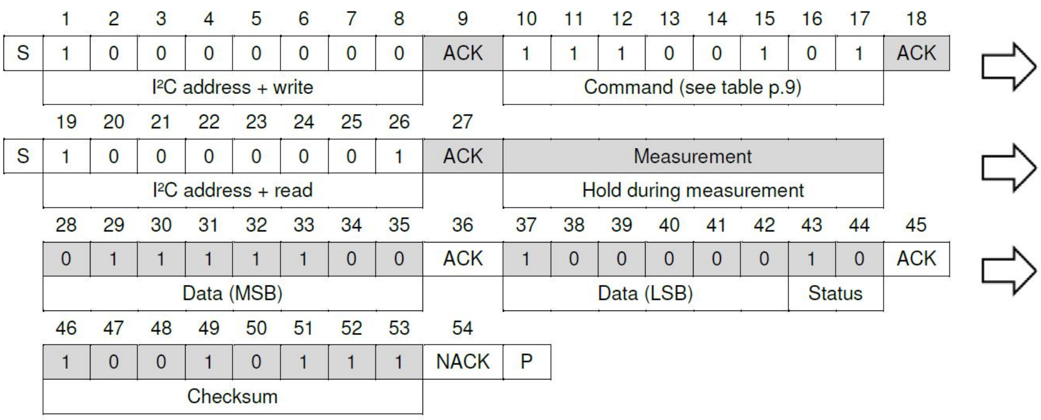
In the first case, the SCK line is stopped during the measurement (controlled by the sensor), and in the second case, when the sensor is processing the measurement, the SCK line remains open for other communication.

Slave mode allows other I2C communication tasks on the bus to be processed while the sensor is measuring. The communication sequence for the two modes is provided below.

In master mode, the sensor pulls down the SCK line while measuring to force the host to wait. By releasing the SCK line, the sensor indicates that the internal processing has completed the transfer can continue.

In slave mode, the MCU must poll the internal processing of the terminating sensor. By sending a start condition, (read access to "1": 0x81), as shown below. If the internal processing is completed, the sensor will confirm that the polling of the MCU and data is read by the MCU. If the measurement process is not completed, the sensor does not acknowledge the ACK bit and must issue the start condition again.

For both modes, since the maximum resolution of the measurement is 14 bits, the last two least significant bits (LSB, bits 43 and 44) are used to transmit status information. The first bit of the two LSBs indicates the type of measurement ('0': temperature, '1': humidity). Bit 0 is currently not assigned.



Host mode

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
S	1	0	0	0	0	0	0	0	ACK	1	1	1	1	0	1	0	1	ACK
	I²C address + write									Command (see table p.9)								

Measurement	19	20	21	22	23	24	25	26	27
Measurement	S	1	0	0	0	0	0	0	1	NACK
measuring		I²C address + read								

Measurement		19	20	21	22	23	24	25	26	27
Measurement	S	1	0	0	0	0	0	0	1	ACK
continue measuring		I²C address + read								

28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
0	1	1	1	1	1	0	0	ACK	1	0	0	0	0	0	1	0	ACK
Data (MSB)									Data (LSB)						Status		

46	47	48	49	50	51	52	53	54	
1	0	0	1	0	1	1	1	NACK	P
Checksum									

Slave mode

The gray block is controlled by the sensor.

In host mode, bit 45 can be changed to NACK followed by a stop condition to omit checksum transmission.
In slave mode, if the measurement is not completed at the "read" command, the sensor does not provide an ACK at bit 27 (possibly more of these iterations). If bit 45 becomes NACK and then a stop condition, the checksum transfer is omitted.
In these examples, the sensor output is SRH = '0111'1100'1000'0000 (0x7C80). For the calculation of physical values, the status bit must be set to "0".
The maximum duration of the measurement depends on the type and resolution of the selected measurement. The maximum value should be selected for the MCU's communication plan.

I2C communication allows repeated start conditions without having to close the previous order with a stop condition.

Soft reset

This command is used to restart the sensor, turn off the power and turn it on again. At the time of reception, the sensor system re-initializes according to the default settings and starts operating the header bits in the user register. Soft reset is less than 15ms.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
S	1	0	0	0	0	0	0	0	ACK	1	1	1	1	1	1	1	0	ACK	P
	I²C address + write									Soft Reset Command									

The gray block is controlled by the sensor.

User register

The contents of the user register are shown in the table below. Data that cannot be changed for reserved bits and default values may change over time without notice. Therefore, for any write to the user registry, The default value of the reserved bit must first be read.

When the battery charge is below 2.25V, the "Battery End" alarm/status will be activated.

The heater is used for functional diagnosis: the relative humidity drops when the temperature rises. The heater consumes about 5.5 mW and the temperature rises by about 0.5-1.5 °C.

OTP reload is a security feature that loads the entire OTP settings into the registers, except for the heater bits.

Before each measurement. This feature is disabled by default and is not recommended. Please use soft Reset because it contains an OTP reload.

Bit	#Bit	Description / coding				default
7.0	2	Measurement resolution				'00'
		Bit 7	Bit 0	RH	temperature	
		0	0	12 digits	14 bits	
		0	1	8 digits	12 digits	
		1	0	10 digits	13 people	
		1	1	11 digits	11 digits	
6	1	Status: Battery End (1)				'0'
3,4,5	3	'0': VDD>2.25V '1': VDD<2.25V				'0'
2	1	reserved				'0'
1	1	Enable on-chip heater				'1'

(1) Update the status bit after each measurement

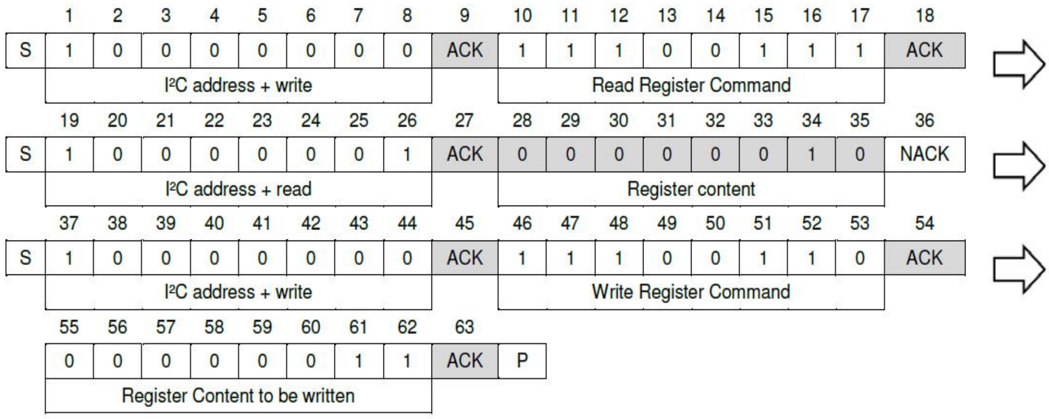
The cutoff value of the "Battery End" signal may vary by ±0.1V.

Do not change the reserved bits.

The OTP reload activity loads the default settings each time a measurement command is issued.

I2C communication read and write user register

In this example, by default, the resolution is set to 8 bits / 12 bits (for RH / Temp)



The gray block is controlled by the sensor.

CRC checksum

The sensor provides a CRC-8 checksum for error detection. The polynomial used is X8 + X5 + X4 + 1.

Basic considerations

The CRC stands for cyclic redundancy check. It is one of the most effective error detection schemes and requires a minimum amount of resources.

The types of CRC detectable errors implemented in the sensor include:

1. Any odd error anywhere in the data transfer
2. All double bit errors anywhere in the transfer
3. Any error cluster that can be included in an 8-bit window (1-8 bits are incorrect)
4. Most large error clusters

CRC is an error detection code commonly used in digital networks and storage devices to detect unexpected changes to raw data.

The data blocks entering these systems get additional short check values based on the remainder of the polynomial division of their contents; when retrieving, the calculations are repeated, and if the check values do not match, corrective action can be taken on the assumed data corruption.

It is called CRC because the check (data validation) value is redundant (it expands the message without adding information) and the algorithm is based on the cyclic code. CRCs are popular because they are easy to implement in binary hardware, easy to analyze mathematically, and are especially good at detecting common errors caused by noise in the transmission channel. Because the check value has a fixed length, the function that generated it is occasionally used as a hash function.

When running the sensor in standard I2C protocol communication, an 8-bit CRC can be used to detect transmission errors. The CRC covers all read data sent by the sensor. The CRC properties of the sensors communicating with the I2C protocol are listed in the table below.

CRC uses I2C protocol	
Generating polynomial	X8 + X5 + X4 + 1
initialization	0x00
Protected data	Reading data
Final operation	No

CRC calculation
To calculate the n-bit binary CRC, line up the bits representing the input in the line and locate the (n + 1) bit pattern.
Represents the CRC divisor below the left end of the row (called a "polynomial").

First padded with zeros corresponding to the bit length n of the CRC.

If the input bit above the leftmost divisor is 0, no action is taken. If the input bit above the leftmost divisor is 1, then The divisor is XORed with the input (in other words, the input bit above each 1 bit in the divisor is switched). The divisor then moves one bit to the right, repeating the process until the divisor reaches the end input line on the right.
Since the leftmost divisor places zero for each input location it touches, the only bit in the input line at which the end of the process can be non-zero is the n-bit at the right end of the line. These n bits are the remainder of the division and will also be the value of the CRC function.
By performing the above calculation again, it is possible to easily verify the validity of the received message by adding the check value instead of zero. If there are no detectable errors, the remainder should be equal to zero.
CRC example
Entering 11011100 (0xDC) will have the result 01111001 (0x79).
Entering 01101000 00111010 (0x683A: 24.7 °C) will produce 01111100 (0x7C).
Entering 01001110 10000101 (0x4E85: 32.3% RH) will have a result of 01101011 (0x6B).
Signal output conversion
The default resolution is set to 12-bit relative humidity and 14-bit temperature readings. The transmission measurement data is transmitted in a two-byte packet, that is, in an 8-bit-length frame, the most significant bit (MSB) (left) alignment is transmitted first. Each byte is followed by an acknowledge bit. The two status bits (the last bit of the LSB) must be set to "0" before the physical value is calculated.
To accommodate/adapt to any process variation (nominal capacitance of the moisture mold), the tolerance must account for sensors above 100% RH and below 0% RH. as a result:
118% RH corresponds to 0xFF, which is the maximum RH digital output that can be sent from the ASIC. The RH output can reach 118% RH and above this value, the RH output will be clamped to this value.

- 6% RH corresponds to 0x00, which is the minimum RH digital output that can be sent from the ASIC. The RH output can reach -6% RH and is below this value and the RH output will be clamped to this value.

Relative humidity conversion

Using the relative humidity signal output SRH, the relative humidity is obtained by the following formula (resulting in %RH), regardless of the resolution selected:

$$RH = -6 + 125 \times \frac{S_{RH}}{2^{16}}$$

In the example given, the transmitted 16-bit relative humidity data is 0x7C80:31872. The relative humidity result was 54.8% RH.

Temperature conversion

The temperature T is calculated by inserting the temperature signal output STemp into the formula below (the result is °C), regardless of the resolution selected:

$$Temp = -46.85 + 175.72 \times \frac{S_{Temp}}{2^{16}}$$

Dew point temperature measurement

The dew point is the temperature at which the water vapor in the air is saturated and begins to condense. The dew point is related to relative humidity. A high relative humidity indicates that the dew point is closer to the current temperature. A relative humidity of 100% means that the dew point is equal to the current.

Temperature (air is saturated to the maximum extent by water). When the dew point remains constant and the temperature increases, the relative humidity decreases.

Using ambient relative humidity and temperature measurements to calculate the dew point temperature of the air comes from the sensor and has the following formula:

Partial pressure (PPTamb) formula at ambient temperature:

$$PP_{Tamb} = 10^{\left[A - \frac{B}{(Tamb + C)}\right]}$$

Partial pressure (PPTamb) dew point temperature (Td) formula:

$$T_d = -\left[\frac{B}{\log_{10}\left(RH_{amb} \times \frac{PP_{Tamb}}{100}\right) - A} + C\right]$$

Partial pressure mmHg(Tamb) at PPTamb ambient temperature

RHamb ambient humidity %RH, calculated by the sensor

Tamb humidity battery temperature in °C, calculated by the sensor

Td calculates dew point in °C

A, B, C constant: A = 8.1332; B = 1762.39; C = 235.66

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