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Nyfea product specification

PRODUCT SPECIFICATION

Customer: _____

Product Name: Temperature and Humidity Sensor

Part NO: FSHTC3-P

Issue Date: _____

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Prepared	Checked	Customer Check
ChenTT	Zelig	

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1 Features

- Ultra-low power consumption
- I²C protocol compatibility
- Wide supply voltage range（1.6V-5.5V）
- Small DFN6 package (2×2×0.75mm³)
- Typical accuracy: ±3 %RH and ±0.3 °C
- Factory calibrated and reflow solderable

2 Applications

- Consumer electronics
- Cold chain transportation
- Smart home
- Smart agriculture
- Communication equipment
- Photovoltaic energy storage

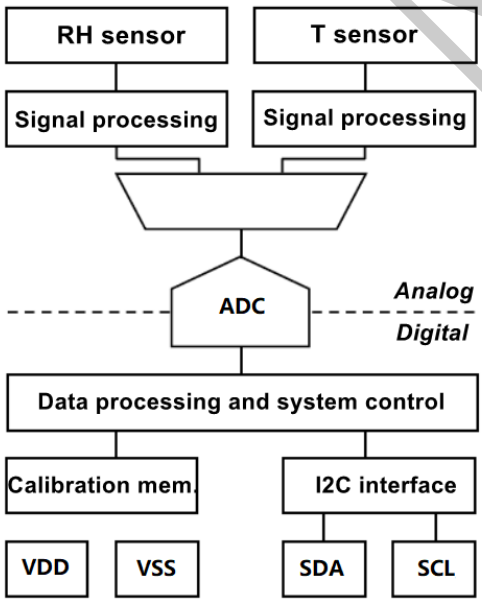
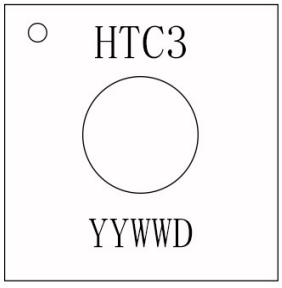


Figure 1. Functional block diagram of the FSHTC3-P

3 Description

The FSHTC3-P is a temperature and humidity sensing device tailored to the needs of consumer electronics applications. It satisfies the industry's stringent demands with respect to package footprint, operational power consumption, supply voltage flexibility, and overall value proposition. The device integrates a complete sensor subsystem on a single die, encompassing a capacitive humidity sensing element, a PN-junction- based temperature sensor, a 16- bit analog- to- digital converter, digital signal processing logic, non- volatile calibration data memory, and an I²C digital communication interface.

The FSHTC3-P is offered in a miniature DFN6 package with dimensions of 2×2×0.75 mm³, enabling deployment in extremely space- limited applications. The device supports a humidity measurement range of 0 to 100% RH and a temperature range of -45° C to +135° C. Operating from a supply voltage of 1.60 V to 5.5 V and requiring only 2 µJ per conversion cycle, the FSHTC3-P is particularly well suited for battery- operated mobile and wireless communication equipment. Each device undergoes full factory calibration before delivery to guarantee unit- to- unit consistency and measurement precision. The product is provided in tape- and- reel packaging and is designed to meet the requirements of standard surface- mount device (SMD) production lines.



FSHTC3-P
FS=Nyfea sensor
H=Humidity,T=Temperatuer
C3=Code name
P=protective cover
N=No protective cover

Figure 2. Chip Rendering

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4 Sensor Performance

Each sensor is individually calibrated, and the calibrated instrument has passed the metrological calibration of ISO/IEC17025 accredited laboratory.

Table 1. Humidity Sensor Specifications.

PARAMETER	CONDITION	VALUE	UNIT
Accuracy	Typ.	±3.0	% RH
	Max.	See Figure 3	% RH
Resolution	_	0.01	% RH
Hysteresis	_	±1.0	% RH
Specified range	_	0-100	% RH
Response time	τ 63%	8	s
Long-term drift	Typ.	<0.5	%RH/y

Table 2. Temperature Sensor Specifications.

PARAMETER	CONDITION	VALUE	UNIT
Accuracy	Typ.	±0.3	℃
	Max.	See Figure 5	_
Resolution	_	0.01	℃
Hysteresis	_	±1.0	℃
Specified range	_	-45 to +130	℃
Response time	τ 63%	< 5-30	s
Long-term drift	Typ.	<0.02	° C /y

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Temperature and Humidity sensor performance diagram

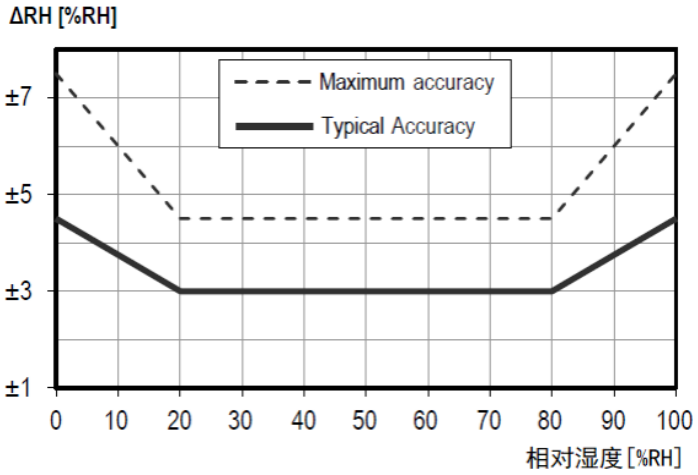

Figure 3. Tolerance of RH at 25° C for FSHTC3-P

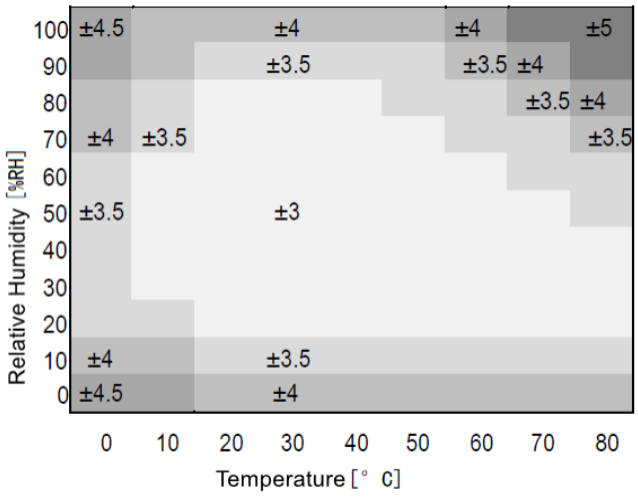

Figure 4. Typical accuracy of relative humidity measurements for different temperatures.

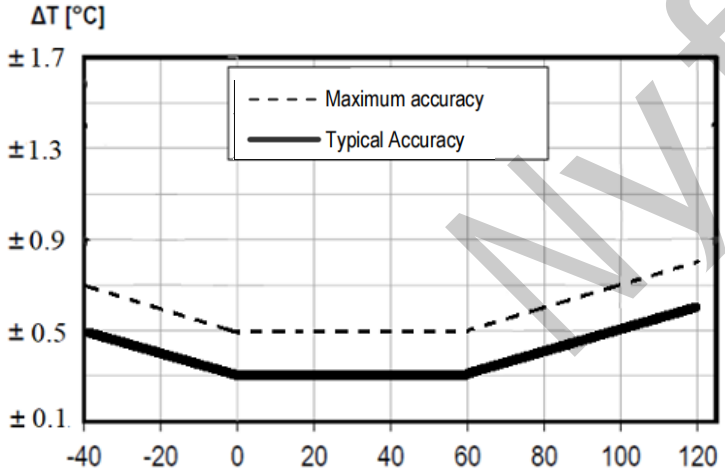

Figure 5. Temperature accuracy of FSHTC3-P

Recommended Operating Condition

The sensor exhibits optimal performance when maintained within the recommended normal operating intervals of 5° C to 60° C for temperature and 20% RH to 80% RH for humidity. Extended periods of operation outside these boundaries—particularly in high- humidity environments—may induce a temporary offset in the relative humidity output. Upon re- establishment of normal ambient conditions, the sensor will progressively self- correct and revert to its calibrated state.

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5 Specifications

5.1 Electrical Characteristic Parameters

Table 3. Electrical characteristic parameters (@25℃, 3.3V)

PARAMETER	SYMBOL	CONDITIONS		MIN.	TYP.	MAX.	UNIT	COMMENTS
Supply voltage	V_{DD}	-		1.6	3.3	5.5	V	-
Power-up level	V_{POR}	Static power supply		1.3	1.4	1.5	V	-
Supply current	I_{DD}	Idle state		-	45	80	μA	After power-up the sensor remains in idle state unless a sleep or measurement command is sent
		Sleep mode			0.2	0.3	μA	When in sleep mode, the sensor requires a wake-up command to enable other commands
		Measurement	Normal	-	500	860	μA	Average current consumption while the sensor is measuring
			Low power		320	620	μA	
		Average	Normal		3		μA	Average current consumption (continuous operation with one measurement per second)
			Low power	-	1	-	μA	
Low level input voltage	V_{IL}	-		-	-	$0.4V_{DD}$	V	
High level input voltage	V_{IH}	-		-	$0.7V_{DD}$	-	V	
Low level output voltage	V_{OL}	3mA sink current		-	-	$0.2V_{DD}$	V	

5.2 Absolute Maximum Ratings

Table 4. Absolute Maximum Ratings.

PARAMETER	RATING	UNIT
Supply voltage	-0.3 to +6	V
Operating temperature range	-45 to 130	℃
Storage temperature range	-45 to 130	℃
ESD HBM (human body mode)	-4 to +4	kV
ESD CDM (charge device mode)	-500 to +500	V
Latch up , JESD78 Class Ⅱ, 125° C	-100 to +100	mA

NOTE: The stress levels defined in Table 4 represent absolute extremes that, if applied to the device, may lead to permanent and unrecoverable damage. Sensor performance is not warranted under any of these listed extreme conditions.

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5.3 Sensor System Timings

Table 5. Sensor SystemTiming Specifications (@ 25℃ , 3.3V)

PARAMETER	SYMBOL	CONDITIONS		MIN.	TYP.	MAX.	UNIT	COMMENTS
Power-up time	t_{PU}	After hard reset V_{DD} > V_{POR}		_	180	500	μs	Time from power-up to the voltage reaches V_{POR}
Soft reset time	t_{SR}	After soft reset.		_	180	500	μs	Time between ACK of soft reset command and sensor entering the idle state
Measurement duration	t_{MEAS}	Average	Normal	_	10	11	ms	Duration for a humidity and temperature measurement
			Low power	_	1.5	2	ms	

5.4 Communication Timings

Table 6. Communication Timing Specifications (@ 25℃ , 3.3V)

PARAMETER	SYMBOL	CONDITIONS	NORMAL		LOW POWER		UNIT
			Min.	Max.	Min.	Max.	
SCL clock frequency	f_{SCL}	_	0	100	0	1000	KHz
Hold time START condition	$t_{HD;STA}$	After this period, the first SCL pulse is generated	4.0	_	0.6	_	us
Low period of the SCL clock	t_{LOW}	_	4.5	_	0.5	_	us
High period of the SCL clock	t_{HIGH}	_	4.0	_	0.26	_	us
Set-up time for a repeated START condition	$t_{SU;STA}$	_	4.7	_	0.5	_	us
SDA hold time	$t_{HD;DAT}$	_	0	_	0	_	us
SDA set-up time	$t_{SU;DAT}$	_	250	_	50	_	ns
SCL/SDA rise time	t_R	_	_	1000	_	120	ns
SCL/SDA fall time	t_F	_	_	300	_	120	ns
SDA valid time	$t_{VD;\ DAT}$	_	_	3.5	_	0.5	us
Set-up time for STOP condition	$t_{SU:STO}$	_	4	_	0.26	_	us
Capacitive load on bus line	C_B	_	_	500	_	400	pF

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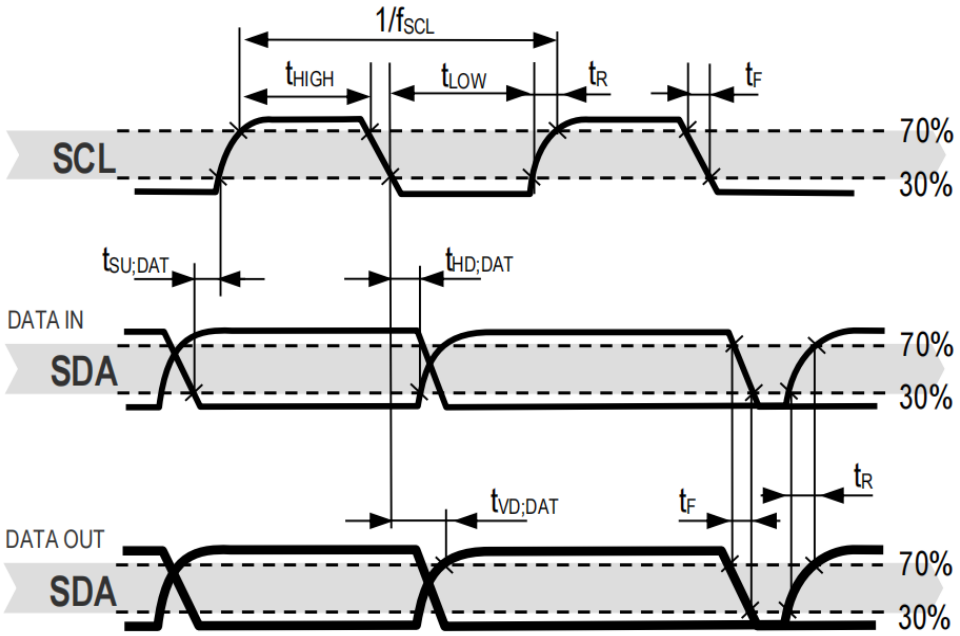

Figure 6. Timing diagram for digital input/output pads.

NOTE: The direction of SDA is specified with respect to the sensor device. In the timing diagram, bold- style SDA waveforms indicate signals driven by the sensor, whereas standard- style SDA waveforms are driven by the host controller. It should be noted that the valid data window for SDA is referenced to the falling edge of the SCL clock signal.

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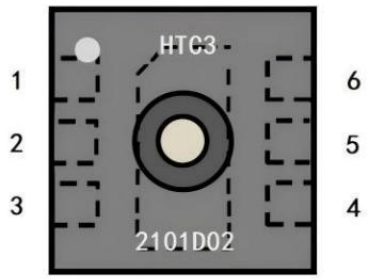
6 Pin Assignment

The FSHTC3-P supports I²C Normal,Fast Mode and Fast Mode Plus (SCL clock frequency up to 1MHz) with clock stretching. Users can choose the mode according to actual needs.

The FSHTC3-P comes in DFN6 package, see Table 7 for detailed description.

Table 7. Pin Assignment (the center pad is grounded).

PIN	NAME	DESCRIPTION
1	V_{DD}	Supply voltage
3	SCL	erial clock
4	SDA	Serial data
6	GND	Ground
2，5	NO USE	



Power supply decoupling shall be provided by a 100nF capacitor connected between VDD and GND, with the component positioned in close proximity to the sensor package. Recommended placement is illustrated in Figure7.

The SCL line carries the clock signal that synchronizes data transfers between the host controller and the sensor. The clock frequency applied by the master must be maintained below 1 MHz. The FSHTC3-P may assert clock-stretching by driving the SCL line to a low state.

The SDA line functions as the bidirectional data path for both input and output operations. Proper timing parameters—as specified in the I²C bus specification—must be observed to ensure error- free communication.

To avoid signal contention, the microcontroller can only pull down the SDA and SCL buses, and the high level of the bus is realized by the pull-up resistor. The selection of the pull-up resistor needs to be determined according to the bus capacity requirements . Note that some microcontroller I/O circuits may include pull-up resistors.

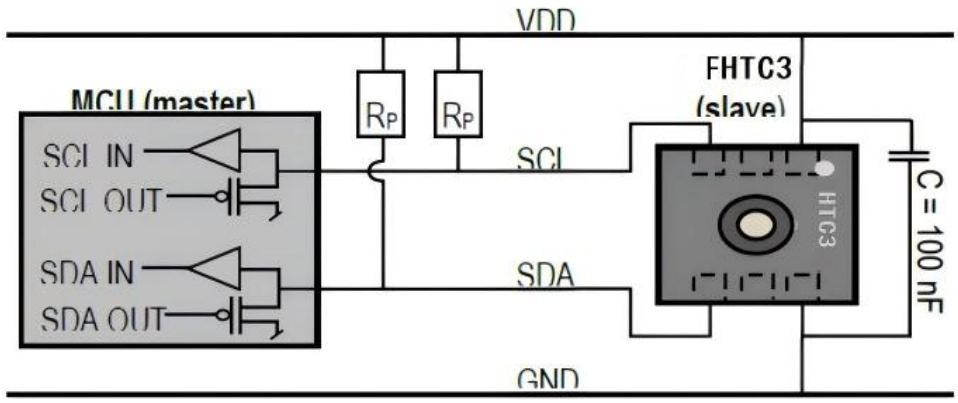


Figure 7. Typical application circuit for FSHTC3-P(including pull-up resistors and decoupling capacitors)

NOTE:For mechanical stress considerations, the center pad must be soldered to ground

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7 Communication and Operation

All commands and memory locations of the FSHTC3-P are mapped to a 16-bit address space which can be accessed via the I²C protocol.

7.1 I2C Address

Table 8. FSHTC3-P I²C device address.

FSHTC3-P	HEX	BINARY
I²C address	0x70	111’ 0000

According to the I²C protocol, each communication starts with a START signal and ends with a STOP signal.

7.2 Power-Up, Sleep, Wake up

When the power supply voltage V_{DD} reaches the power-up voltage level V_{POR}, the FSHTC3-P enters the idle state. Then the sensor should be set to sleep mode to reduce the power consumption. The format of the sleep command is shown in Table 9:

Table 9. Sleep command of the sensor.

COMMAND	HEX	BINARY
Sleep	0xB098	1011’ 0000’ 1001’ 1000

When the sensor is in sleep mode, it requires the following wake-up command before other operations, see Table 10.

Table 10. Wake-up command of the sensor.

COMMAND	HEX	BINARY
Wake up	0x3517	0011’ 0101’ 0001’ 0111

7.3 Measurement Commands

The FSHTC3-P provides a user-selectable clock-stretching feature, as well as the ability to define the transmission order of temperature and humidity data. These operational parameters are configured through the distinct commands enumerated in Table 11. Each issued command initiates a full conversion cycle, yielding both temperature and humidity measurement results.

Table 11. Measurement commands.

Mode	Clock stretching on		Clock stretching off	
	T first	RH first	T first	RH first
Normal	0x7CA2	0x5C24	0x7866	0x58E0
Low power	0x6458	0x44DE	0x609C	0x401A

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7.4 Measuring and Reading the Signals

Each measurement session is composed of four distinct commands, initiated by a START condition and terminated by a STOP condition. The required command sequence is:

1) Issue the wake- up command to activate the device from standby.
2) Send the measurement command to trigger a conversion cycle.
3) Transmit the read command to retrieve the measurement results.
4) Issue the sleep command to return the device to low- power mode.

The specific typical command sequence is shown in Figure 8:

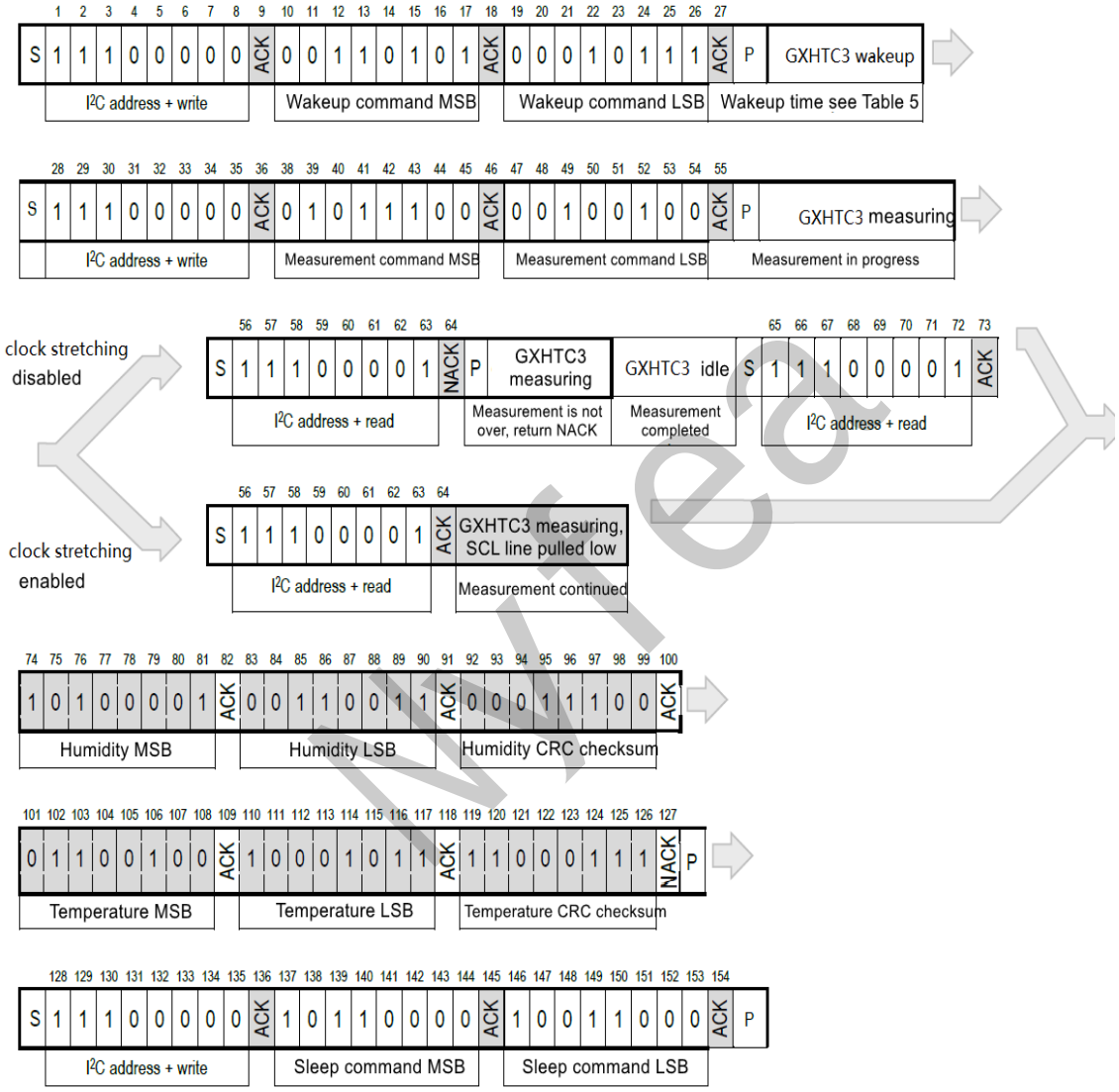

Figure 8. Wake-up, start temperature and humidity measurement, temperature and humidity conversion and sleep command execution sequence diagram.

NOTE: This example shows that the humidity data is sent first. The actual humidity data is 63% and the temperature is 23.7° C. The white box is controlled by the microcontroller and the gray box is controlled by the sensor.

7.5 Measurement Process

In general, the sensor does not respond to any I²C communication requests during the temperature and humidity measurement process. For example, the microcontroller will receive a NACK signal when attempting to send read or write commands while a conversion is in progress.

However, when the clock- stretching mode is enabled, the sensor behaves differently: it responds to a read command from the microcontroller with an ACK signal and pulls the SCL line low until the measurement is complete. At that point, the sensor begins transmitting the measurement results.

The power consumption during measurement is specified in Table 3. To ensure repeatability of temperature and humidity measurements, it is recommended to avoid any I²C communication on the bus during the conversion period.

7.6 Readout of Measurement Results

After the microcontroller sends the temperature and humidity measurement command, the sensor begins the conversion process. The conversion time is specified in Table 5. Once the conversion is complete, the microcontroller can retrieve the results by issuing a START condition followed by an I²C read header. The sensor will acknowledge the read header and then transmit two bytes of temperature or humidity data along with a one- byte CRC checksum, followed by two bytes of the remaining measurement (humidity or temperature) and its accompanying CRC byte. The microcontroller must generate an ACK signal after each received byte. If the sensor does not detect an ACK from the master, it will abort further data transmission.

If the I²C master does not require the remaining data, it may terminate the transmission early by sending a NACK signal.

For applications where CRC validation is not needed, it is recommended to read the first two data bytes along with their CRC byte, and then issue a NACK after receiving the second two data bytes to abort the transmission..

7.7 Soft Reset

The FSHTC3-P provides a soft reset mechanism to force the system into an idle state without power loss. It acts the same as power-on reset.

The send command for soft reset is shown in Table 12 :

Table 12. Soft reset command.

COMMAND	HEX	BINARY
Soft reset	0x805D	1000’ 0000’ 0101’ 1101

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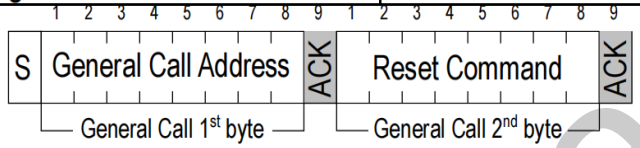
7.8 General Call Reset

The sensor can also be reset via the General Call command defined in the I²C specification, which functions as a power- on reset equivalent. It is important to note that this reset is not specific to the FSHTC3-P it resets all slave devices on the I²C bus, provided that they support and respond to this command. The specific reset commands are listed in Table 13:

Table 13. General call reset command.

Command	Code
Address byte	0x00
Second byte	0x06
Reset command using the general call address	0x0006



7.9 Readout of ID Register

The FSHTC3-P includes an ID register that stores the product code specific to this device. Reading the ID register can be used as a means to verify proper communication between the sensor and the host microcontroller. The commands for accessing the ID register are provided in Table 14:

Table 14. Readout command of ID register.

COMMAND	HEX	BINARY
Read ID	0xEFC8	1110’ 1111’ 1100’ 1000

This command needs to be followed by I²C write header, then the microcontroller can send the I²C read header to read the 16-bit ID and one byte CRC check data.

7.10 CRC Checksum

The CRC check algorithm for data transfer is shown in Table 15. The CRC check object is the two bytes of data transferred before it.

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Table 15. CRC check algorithm.

PROPERTY	VALUE
Name	CRC-8
Width	8 位
Polynomial	0x31($x^8+x^5+x^4+1$)
Initialization	0xFF
Reflect input	false
Reflect output	false
Example	CRC (0xBEEF) = 0x92

7.11 Conversion of Sensor Output

The temperature and humidity measurement results are provided as 16- bit unsigned binary values. These raw outputs are already linearized and temperature- compensated internally by the sensor. The following formulas are required to convert these original data values into actual temperature and humidity readings:

Relative Humidity Conversion (% RH) :

$$RH = 100 \cdot \frac{S_{RH}}{2^{16}}$$

Temperature Conversion Formula (℃) :

$$T = -45 + 175 \cdot \frac{S_T}{2^{16}}$$

S_{RH} and S_T denote the raw sensor output for humidity and temperature output, respectively. It is important to note that the raw output is converted to decimal in formula calculation.

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8 Quality Control

8.1 Environmental Stability

The qualification of the FSHTC3-P is based on the JEDEC JESD47 qualification test method.

8.2 Material Contents

The FSHTC3-P is fully RoHS, REACH and Halogen compliant, free of Pb, Cd and Hg.

9 Packaging Information

The FSHTC3-P is offered in a miniature DFN6 package with outline dimensions of 2 × 2 × 0.75 mm^3 and a pin pitch of 0.5 mm. DFN denotes a dual- flat no- lead package configuration.

The device is fabricated from silicon wafers and mounted onto a lead frame composed of copper with a Ni/Pd/Au plating. The assembled device and lead frame are encapsulated in an epoxy resin compound.

The package complies with the Small Outline Plastic Leadless specification as defined in Section 4.22 of JEDEC95, as well as the Small Outline (QFN/SON) Specification D.01.2009. Additionally, the FSHTC3-P meets the moisture sensitivity requirements of IPC/JEDEC J- STD- 020 Class 1.

9.1 Product Traceability

All FSHTC3-P devices are laser- marked on the front face for identification and traceability purposes. As illustrated in Figure 8, the upper- left corner of the sensor front carries the pin- 1 indicator along with the sensor model designation. The marking at the bottom consists of seven characters. The first four characters (YYWW) encode the production date—YY represents the year, and WW represents the week. The final character D denotes the product identification code. Decoding of the batch mark is handled by NYFEA, which enables tracking of production, calibration, and test information for each product.

Upon reasonable request, customers may apply to NYFEA to have the batch mark decoded for product source tracing.



Figure 9. FSHTC3-P front laser marking

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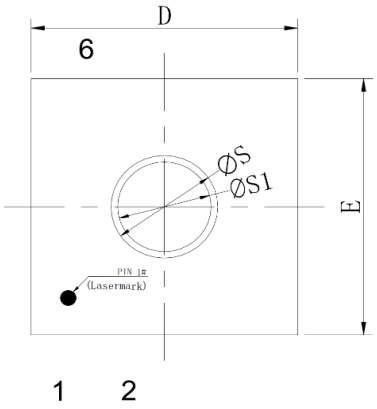
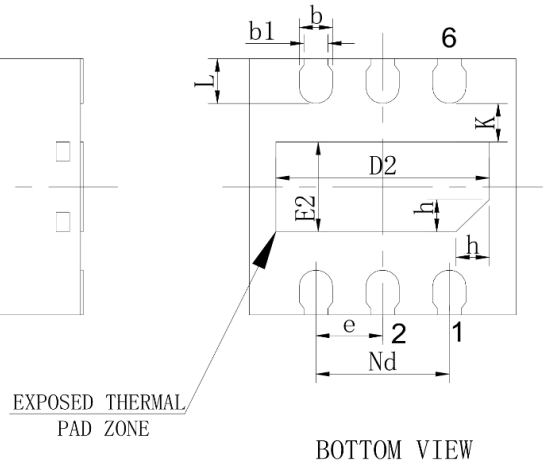
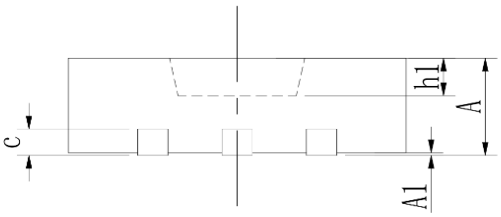
9.2 Technical Drawings



TOP VIEW



BOTTOM VIEW



SIDE VIEW

SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	0	0.02	0.05
b	0.20	0.25	0.30
b1		0.18REF	
c		0.203REF	
D	1.90	2.00	2.10
D2	1.50	1.60	1.70
Nd		1.00BSC	
E	1.90	2.00	2.10
E2	0.60	0.70	0.80
e		0.50BSC	
K		0.30REF	
L	0.30	0.35	0.40
h	0.20	0.25	0.30
ØS		0.80BSC	
ØS1		0.70BSC	
h1	-	0.29	-

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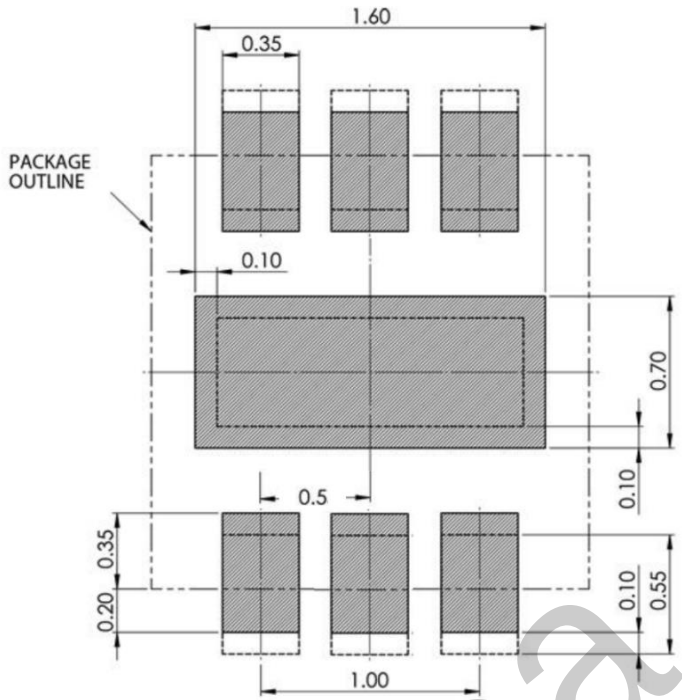
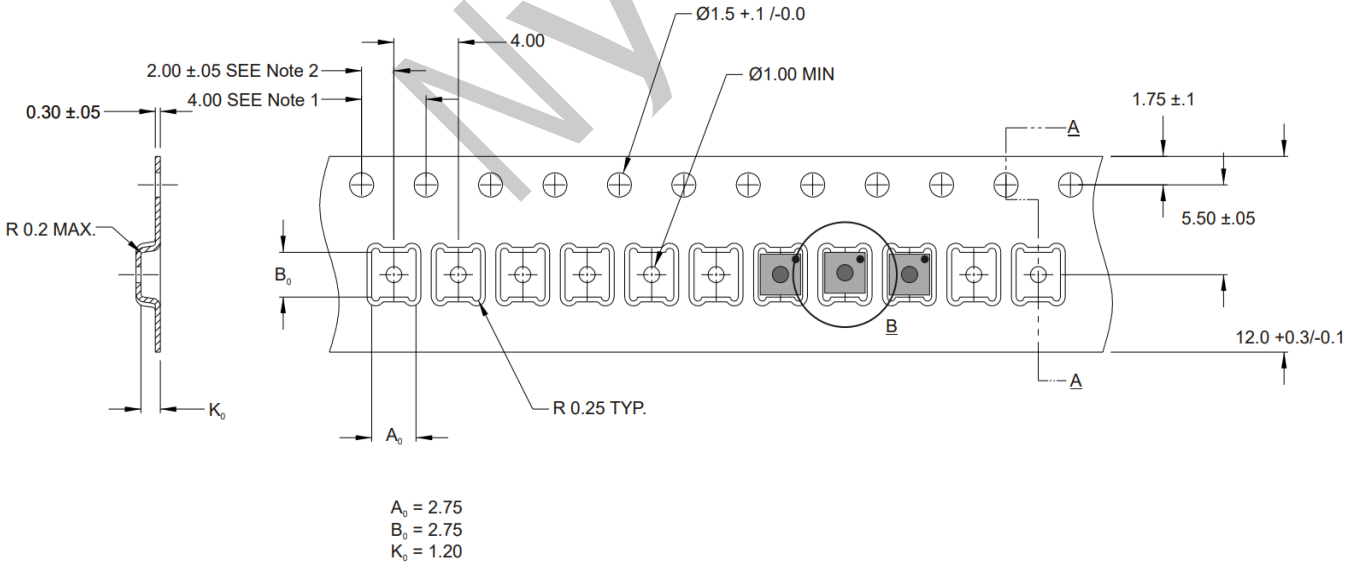
9.3 Metal Land Pattern



9.4 Tape and Reel Package



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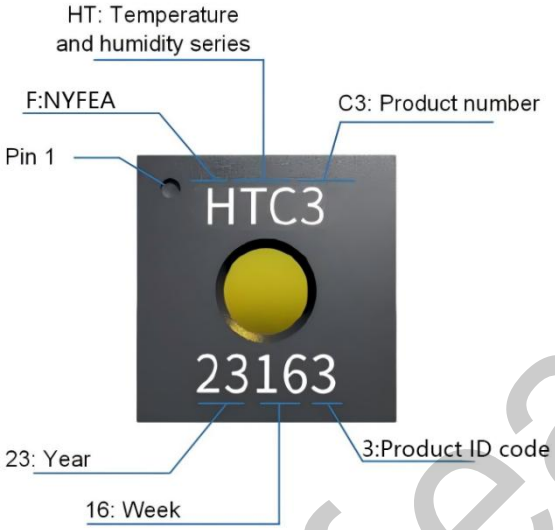
10 Chip description and Ordering information

Order number description:

FSHTC3-P: FSHTC3-P represents the product. number, TR represents packaged form is tape and reel.

FSHTC3-P LOGO description:



Ordering Information:

Purchase Number	Device	Package	SPQ	Note
FSHTC3-P-TR	FSHTC3-P	DFN6 2mm*2mm	2000	Tape and reel; covered with a dustproof breathable film

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11 Important Notices

11.1 ESD Precautions

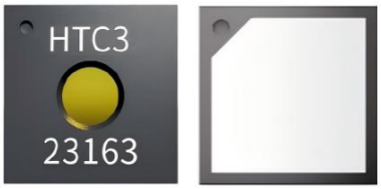
Due to its intrinsic semiconductor design, this device is highly susceptible to electrostatic discharge (ESD). To prevent performance degradation or permanent failure, the sensor must be handled exclusively within an Electrostatic Protected Area (EPA). Appropriate ESD precautions should be observed at all times: operators must be grounded via a wrist strap, and all non- insulated or conductive objects in the work area should be properly connected to ground.

11.2 Exposure to Chemicals

The temperature and humidity sensing elements from NYFEA are highly sensitive environmental transducers and should not be treated as standard electronic components. These sensors must be kept away from volatile chemicals — including but not limited to organic solvents and compounds such as (ethyl)ketene, acetone, isopropanol, ethanol, and toluene. Exposure to these substances, particularly at elevated concentrations or over extended periods, can cause permanent shifts in humidity measurement accuracy that are generally irreversible.

11.3 Dustproof Breathable Film

Temperature and humidity sensors differ from conventional sensor chips in that they are highly sensitive devices, and their exposed sensing areas are susceptible to contamination from dust and airborne particles. For customers deploying the sensor in outdoor applications, it is recommended to order the device with our optional dust- proof and breathable membrane. This protective layer helps shield the sensor from particulate ingress, resists environmental contamination, and enhances both the service life and operational reliability of the device. The membrane must not be removed after installation..



11.4 Applications in Extreme Environments

Certain applications may necessitate exposing the temperature and humidity sensor to aggressive or challenging environmental conditions. In many such cases, the compatibility of the sensor with these environments is often overlooked during system design. The following situations, however, warrant particular care and should be carefully evaluated prior to deployment..

a) The sensor needs to return to the normal environment to recover for a period of time after working under abnormal temperature and humidity conditions (> 90) .

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b) In some application environments, the sensor may be exposed to a high concentration of volatile organic solvents for a long time, which may occur in both the assembly process and the application process. Such applications require attention.

c) In some application environments, the sensor may be exposed to an acidic or alkaline environment, but only a certain concentration will cause harm to the sensor. For bases, pH > 9 will cause damage to the sensor. Etching materials, such as H2O2, NH3, etc., can also harm the sensor in high concentrations.

d) In certain application environments, corrosive gases may be present. At relatively low concentrations, these gases do not directly affect the sensor's functionality; however, they can compromise the integrity of solder joint connections over time. At higher concentrations, corrosive gases may also cause damage to the sensor itself.

11.5 Spraying of Conformal Coating

Paint itself can contaminate the temperature and humidity sensor. For customers who must spray paint on the circuit board, it is recommended to order the sensor with a conformal coating protective film. After spraying the conformal coating, the film should be removed before normal temperature and humidity testing.

When applying the conformal coating, maintain a minimum distance of thirty centimeters from the sensor and move the spray can slowly to achieve an even coating. The surface will dry in approximately thirty minutes, after which a second coat may be applied. Allow the paint to dry completely—about 24 hours—then gently remove the protective film.



11.6 Packaging and Storage

Before use, it is strongly recommended to store the sensor in its original packaging in the following environment: temperature 10° C ~ 50° C (0° C - 125 ° C for a limited time), 20% ~ 65% RH.

11.7 Assemblage

The sensor can be stored for 1 year in normal storage environment, and the sensor has a moisture resistance level of 1.