

# HCP2D-3V

Advanced Humidity & Temperature Solution

## Enhanced Features

- ♦ Improved Temperature Accuracy & Range  
( $\pm 0.2^{\circ}\text{C}$  for  $-20 \sim 60^{\circ}\text{C}$ )
- ♦ Extremely Low Current Consumption  
( $13\mu\text{A}$  operating)
- ♦ I<sup>2</sup>C with Alarm Function
- ♦ Enhanced Accuracy of RH% ( $\pm 2\% \text{RH}$ , 14bit )
- ♦ Pin-to-Pin match with existing HumiChip<sup>®</sup>
- ♦ Fast Natural Recovery after Reflow Soldering
- ♦ Enhanced Reliability against Chemical



## Product Summary

**HCP2D-3V** is an improved version of **HumiChip<sup>®</sup>**, the most advanced and cost effective humidity and temperature sensing solution for virtually any type of applications.

Capacitive polymer sensor chip developed and fabricated in-house and CMOS integrated circuit with EEPROM are integrated into one embedded system in a reflow solder-able SMD package.

Individually calibrated and tested, **HCP2D-3V** performs  $\pm 2\%$  from 20% to 80%RH ( $\pm 4\%$  over entire humidity range), and yet, is simple and ready to use without further calibration or temperature compensation.

**HCP2D-3V** provides linear output signals in various interfaces to customer requirements - the **standard I<sup>2</sup>C interface** and an **Alarm function** for preset control at min/max humidity.

Designed and manufactured by industry leading humidity and temperature sensing technology of **SAMYOUNG S&C** – field proven in HVAC and Auto industry for over 15 years, **HCP2D-3V** offers another smart sensing solution for excellent reliability, high accuracy, and cost effective sensing applications.

## Application

### Energy Saving HVAC Control

Air Conditioning, Refrigeration, IAQ monitoring, Vent Fans, Home Appliances, Humi/Dehumidifiers

### Automobile & Transportation

Cabin Climate Control, Defogging Control  
Condensing Preventive Device ...,

### Process Control & Instrumentations

Medical Instruments, Handheld Devices, Weather Stations, Food Processing, Printers, RFIDs ...

### Mass Quantity Application

OEM custom specification available

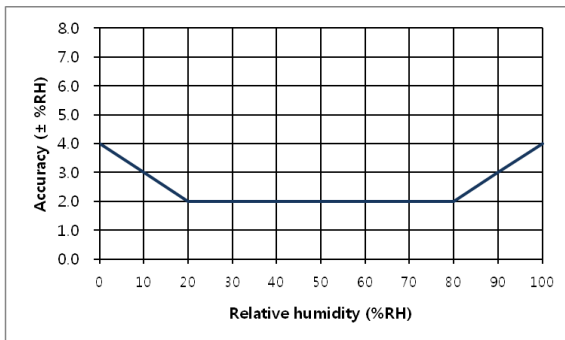
## Sensor Performance

### Relative Humidity (%RH)

\* Custom Accuracy Tolerance Available

Resolution	<b>14 bit</b> (0.01%RH)
Accuracy <sup>1</sup>	<b>±2.0</b> %RH (Figure 1)*
Repeatability	<b>±0.2</b> %RH
Hysteresis	<b>±1.5</b> %RH
Linearity	<b>&lt;2.0</b> %RH
Response time <sup>2</sup>	<b>Max 8.0</b> sec ( $\tau$ 63%)
Operating range	<b>0 ~ 100</b> %RH (Non-Condensing)
Long term drift	<b>&lt;0.5</b> %RH/yr (Normal condition)

1. Accuracies measured at 25 °C, 3.3V.
2. Measured at 25 °C, 1m/sec airflow for achieving 63% of step from 10%RH to 90%RH

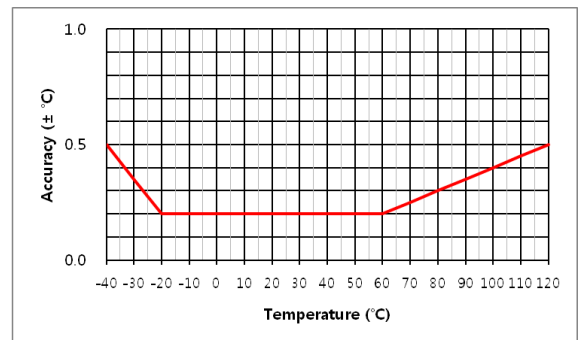


Typical %RH Accuracy at 25 °C

### Temperature (°C)

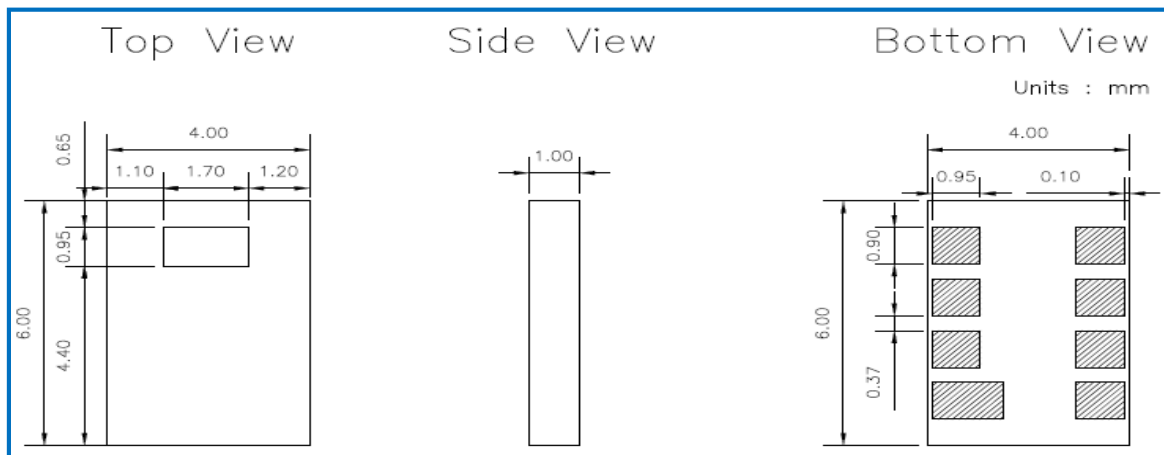
Resolution	<b>14 bit</b> (0.01 °C)
Accuracy <sup>3</sup>	<b>±0.2</b> °C (Figure 2)
Repeatability	<b>±0.1</b> °C
Response time <sup>4</sup>	<b>10.0</b> sec ( $\tau$ 63%)
Operating range	<b>- 40 ~ 125</b> °C
Long term drift	<b>&lt;0.05</b> °C/yr (Normal condition)

3. Accuracies measured at 25 °C, 3.3V.
4. Min 5.0 sec, Max 20 sec



Typical Temperature Accuracy

## Dimensions



## Electrical Specification

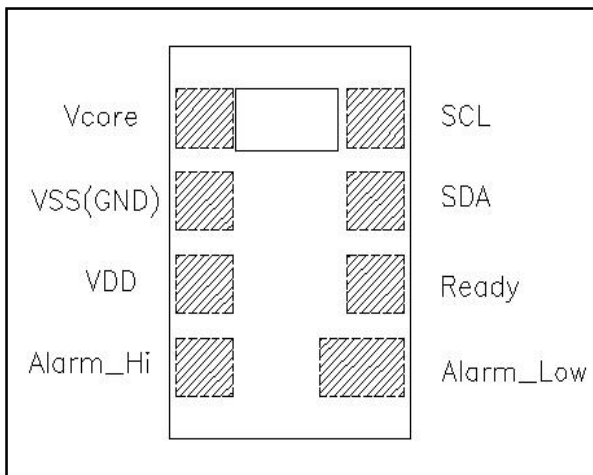
Supply Voltage	min 2.1V ~ max 3.6V
Supply Current (I <sub>DD</sub> )*1	13 $\mu$ A (typical)

\*1. at room temperature

## Environmental

Operating Temperature	- 40 ~ 125 $^{\circ}$ C
Operating Humidity	0~100%RH (non condensing)

## Pin Connection



## Absolute Maximum Rating

Parameter	Min	Max
Supply Voltage (VDD)	-0.3V	4.0V
Storage Temp	-40 $^{\circ}$ C	125 $^{\circ}$ C
Junction Temp (T <sub>j</sub> )	-40 $^{\circ}$ C	125 $^{\circ}$ C

## Soldering Information

Standard or IR Solder Reflow.  
IPC/JEDEC standard  
T<sub>P</sub>  $\leq$  250 $^{\circ}$ C, t<sub>P</sub> < 10sec, T<sub>L</sub> < 220 $^{\circ}$ C, t<sub>L</sub> < 60sec.  
T<sub>P</sub>(Peak Temperature), t<sub>P</sub>(Peak Time),  
T<sub>L</sub>(Critical Zone Temperature), t<sub>L</sub>(Critical Zone Time)  
Ramp-up/down speed < 6 $^{\circ}$ C/sec

## Package Contents

Capacitive polymer RH Sensor,  
Poly Silicon Temperature sensor integrated ASIC  
chip in LCC (Leadless Chip Carrier) package,  
SMD.

## RoHS Compliant

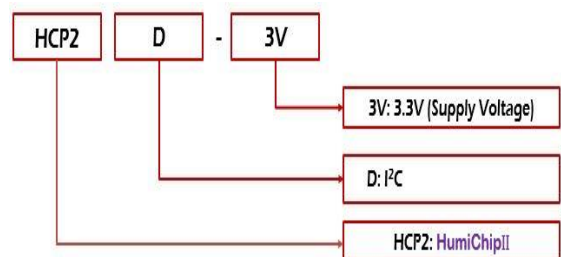
## Shipping

Reel & Tape: 500 or 2,500 ea

### To order

I<sup>2</sup>C output **HCP2D-3V**  
 **$\pm$ 2%RH Accuracy** (20%~80%RH)  
**Reel & Tape** shipping package

### Ordering Part Number



# Application Guide

## CONTENTS

<b>1. GENERAL INFORMATION .....</b>	<b>7</b>
1.1 PRELIMINARY CONSIDERATION .....	7
1.2 OPERATING CONDITIONS .....	7
1.3 HEATING .....	7
1.4 SOLDERING INSTRUCTION .....	7
1.5 STORAGE AND HANDLING INFORMATION .....	8
1.6 RECONDITIONING PROCEDURE.....	8
1.7 MATERIAL CONTENTS.....	8
1.8 TRACEABILITY INFORMATION .....	8
1.9 SHIPPING PACKAGE.....	9
<b>2. INTERFACE SPECIFICATION .....</b>	<b>10</b>
2.1 POWER PADS (VDD, VSS, V <sub>CORE</sub> ).....	10
2.2 I <sup>2</sup> C CLOCK & DATA PADS (SDA, SCL) .....	10
2.3 ALARM PADS (ALARM_LOW, ALARM_HIGH).....	10
2.4 READY PAD (READY) .....	11
<b>3. ELECTRICAL SPECIFICATION .....</b>	<b>12</b>
3.1 ABSOLUTE MAXIMUM RATING .....	12
3.2 ELECTRICAL SPECIFICATION AND RECOMMENDED OPERATING CONDITIONS .....	12
3.3 OUTPUT PAD DRIVE STRENGTH .....	12
3.4 ESD.....	12
<b>4. COMMUNICATING WITH HCP2D-3V.....</b>	<b>14</b>
4.1 POWER-ON SEQUENCE.....	14
4.2 I <sup>2</sup> C COMPATIBLE INTERFACE .....	14
4.2.1 I <sup>2</sup> C Write.....	15
4.2.2 I <sup>2</sup> C Read.....	15
4.2.3 I <sup>2</sup> C Timing.....	15
4.3 OPCODE.....	17
4.4 DATA FETCH .....	17
4.5 READY PIN .....	19
4.6 EEPROM.....	19
4.7 CONFIGURATIONS .....	20
4.7.1 RunBit.....	20

4.7.2 Status Register.....	20
<b>5. ALARM FUNCTION (OPTIONAL).....</b>	<b>23</b>
5.1 ALARM OUTPUT.....	23
5.2 ALARM REGISTERS.....	23
5.3 ALARM OPERATION.....	23
<b>6. REVISION HISTORY.....</b>	<b>25</b>

## List of Tables and Figures

### Tables

Table 1	Pin Descriptions	10
Table 2	Absolute Maximum Rating	12
Table 3	Recommended Operating Conditions	12
Table 4	Electrical Characteristics Specifications	13
Table 5	Characteristics of the SDA and SCL bus lines	12
Table 6	Opcode	13
Table 7	Humidity & Temperature Conversion Formula	14
Table 8	Result Register	15
Table 9	EEPROM Timings	20
Table 10	Commands for configurations	20
Table 11	Status Register Details	20
Table 12	EEPROM Assignments	22

### Figures

Figure 1	Operating Conditions	7
Figure 2	Soldering Profile	8
Figure 3	Land Pattern	8
Figure 4	Packing Reel & Tape	9
Figure 5	Packing (Box)	9
Figure 6	Typical Application Circuit	11
Figure 7	Power-On Sequence	10
Figure 8	Address Byte	10
Figure 9	START and STOP condition	10
Figure 10	I <sup>2</sup> C principle sequence	11
Figure 11	I <sup>2</sup> C Write procedure	11
Figure 12	I <sup>2</sup> C Read procedure	11
Figure 13	Definition of timing for device on the I <sup>2</sup> C-bus	12
Figure 14	I <sup>2</sup> C Measurement Packet Reads	13
Figure 15	Example : Temperature and Humidity data fetch	14
Figure 16	EEPROM communication	15
Figure 17	EEPROM power controlled by user : Write / Erase	21
Figure 18	EEPROM power controlled by user : Read	21
Figure 19	EEPROM power controlled automatically : Write / Erase	21
Figure 20	EEPROM power controlled automatically : Read	21
Figure 21	Example of Alarm Function	23
Figure 22	Alarm Output Flow Chart	20
Figure 23	Bang-Bang Humidity Control (Digital Output)	204

## 1. General Information

### 1.1 Preliminary Consideration

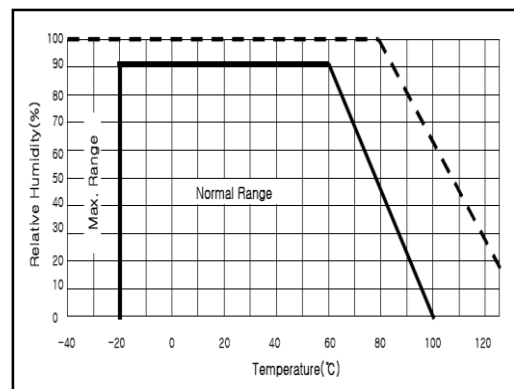
To maximize the performance of **HCP2D-3V**, it is important to plan an appropriate location of the sensor at the design stage. Airflow and proper exposure to ambient air must be secured for **HCP2D-3V** to ensure expected performance. Airflow holes must NOT be blocked. Any heat

generating parts near **HCP2D-3V** will distort the proper measurement of relative humidity and temperature reading, and either should be avoided or measures should be taken to prevent heat transfer.

### 1.2 Operating Conditions

**HCP2D-3V**'s maximum and recommended normal operating condition is shown in **Figure 1**. Within the Normal Range, **HCP2D-3V** performs stably. Prolonged exposures to conditions outside normal range, especially at humidity over 90%RH, may temporarily offset the RH signal up to  $\pm 3\%$ RH. When return to Normal Range, it will gradually recover back to the calibration state.

Re-Conditioning Procedure in **Section 1.6** will help reduce this recovery time. Long term exposure to extreme conditions may also accelerate aging of the sensor.



**Figure 1** Operating Conditions

### 1.3 Heating

Heat sources such as power electronics, microcontrollers, and display near the sensor may affect the accurate measurement. The location of Sensor near such heat sources should be

avoided by maintaining distance or thermal buffer. Thin metal pattern, or even better, 'milling slits' around the sensor also may help reduce the error.

### 1.4 Soldering Instruction

**HCP2D-3V** is designed for mass production reflow soldering process. It is qualified for soldering profile according to IPC/JEDEC J-STD-020D (see **Figure 2**) for Pb-free assembly in standard reflow soldering ovens or IR/Convection reflow ovens to withstand peak temperature at 250°C and peak time up to 10 sec. For soldering in Vapor Phase Reflow (VPR) ovens the peak conditions are limited to  $T_P < 250^\circ\text{C}$  with  $t_P < 10\text{sec}$  and ramp-up/down speeds shall be limited to 6°C/sec.

*For most of the standard reflow soldering, allow 12 hours of stabilization under room environment ( $23\pm 3^\circ\text{C}$ ,  $55\pm 5\%$ RH).*

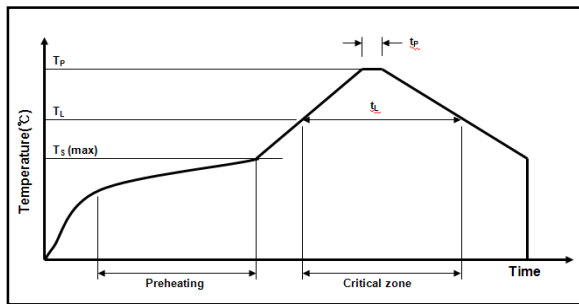
**NO extra rehydration process is required** after reflow soldering for **HCP2D-3V**.

Contact our **customer support** for optimal reflow soldering process. [[sales@samyoungsnc.com](mailto:sales@samyoungsnc.com)]

For **Land Pattern** dimensions, see **Figure 3**.

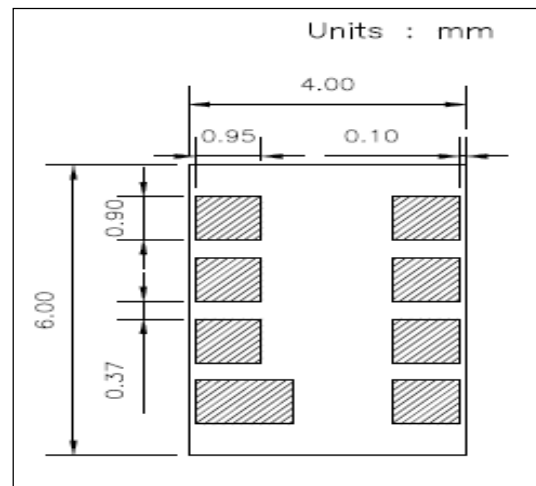
**Note :** The distance between the Vcore capacitor and pad has to be within the 10mm and the tracks of the Power and GND have to be more than 12 mil.

**Note :** Test or measurement right after reflow soldering may read an offset as the sensor needs time for stabilization from the soldering heat. The recovery time may vary depending on reflow soldering profile and ambient storage condition.



**Figure 2 Soldering Profile**

IPC/JEDEC standard  
 $T_P \leq 250^\circ\text{C}$ ,  $t_P < 10\text{sec}$ ,  $T_L < 220^\circ\text{C}$ ,  $t_L < 60\text{sec}$ .  
 Ramp-up/down speed  $< 6^\circ\text{C}/\text{sec}$ .



**Figure 3 Land Pattern**

### 1.5 Storage and Handling Information

**HCP2D-3V** contains polymer based capacitive humidity sensor sensitive to environment, and should NOT be handled as an ordinary electronic component.

Chemical vapors at high concentration may interface with the polymer layers, and coupled with long exposure time, may cause a shift in both offset and sensitivity of the sensor.

Despite the sensor endures the extreme conditions of  $-40^\circ\text{C} \sim 125^\circ\text{C}$ ,  $0\%RH \sim 100\%RH$  (non condensing), long term exposure in such

environment may also offset the sensor reading. Hence, once the package is opened, it is recommended to store in clean environment of temperature at  $5^\circ\text{C} \sim 55^\circ\text{C}$  and humidity at  $10\% \sim 70\%RH$ .

**HCP2D-3V** is protected of ESD up to 2000V and Latch-up in the range of  $\pm 150\text{mA}$  to  $\pm 200\text{mA}$  and also packed in ESD protected shipping material. Normal ESD precaution is required when handling in assembly process.

### 1.6 Reconditioning Procedure

If **HCP2D-3V** is exposed or contaminated with chemical vapors, the following reconditioning procedure will recover the sensor back to calibration state.

Baking: **120°C for 6 hrs** and  
 Re-Hydration: **30°C at > 80%RH for 24 hrs**

### 1.7 Material Contents

**HCP2D-3V** consists of sensor cell and IC (polymer / glass & silicon substrate) packaged in a surface mountable LCC (Leadless Chip Carrier) type package. The sensor housing consists of a PPS (Poly Phenylene Sulfide) cap with epoxy glob top on a standard FR4 substrate. Pads are

made of Au plated Cu. The device is free of Pb, Cd and Hg.

**RoHS compliant / REACH report available**

### 1.8 Traceability Information

**HCP2D-3V** is laser marked with product type and lot identification.

The first line denotes the sensor type: **HCP2D** for **IC** output.

Lot identification is printed on the second line with

5 digit alphanumeric code.

Further information about individual sensor is electronically stored on the chip.



### 1.9 Shipping Package

**HCP2D-3V** is provided in a tape & reel shipment packaging, sealed into antistatic ESD trays. Standard packaging sizes are 2,500 or 500 units per reel. The drawing of the packaging tapes with sensor orientation and packing box dimensions are shown in [Figure 4](#) and [Figure 5](#).

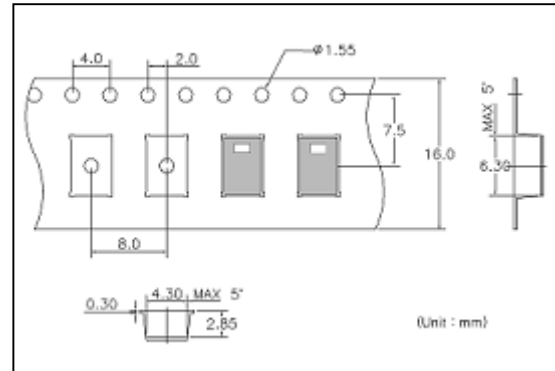


Figure 4 Packing Reel & Tape

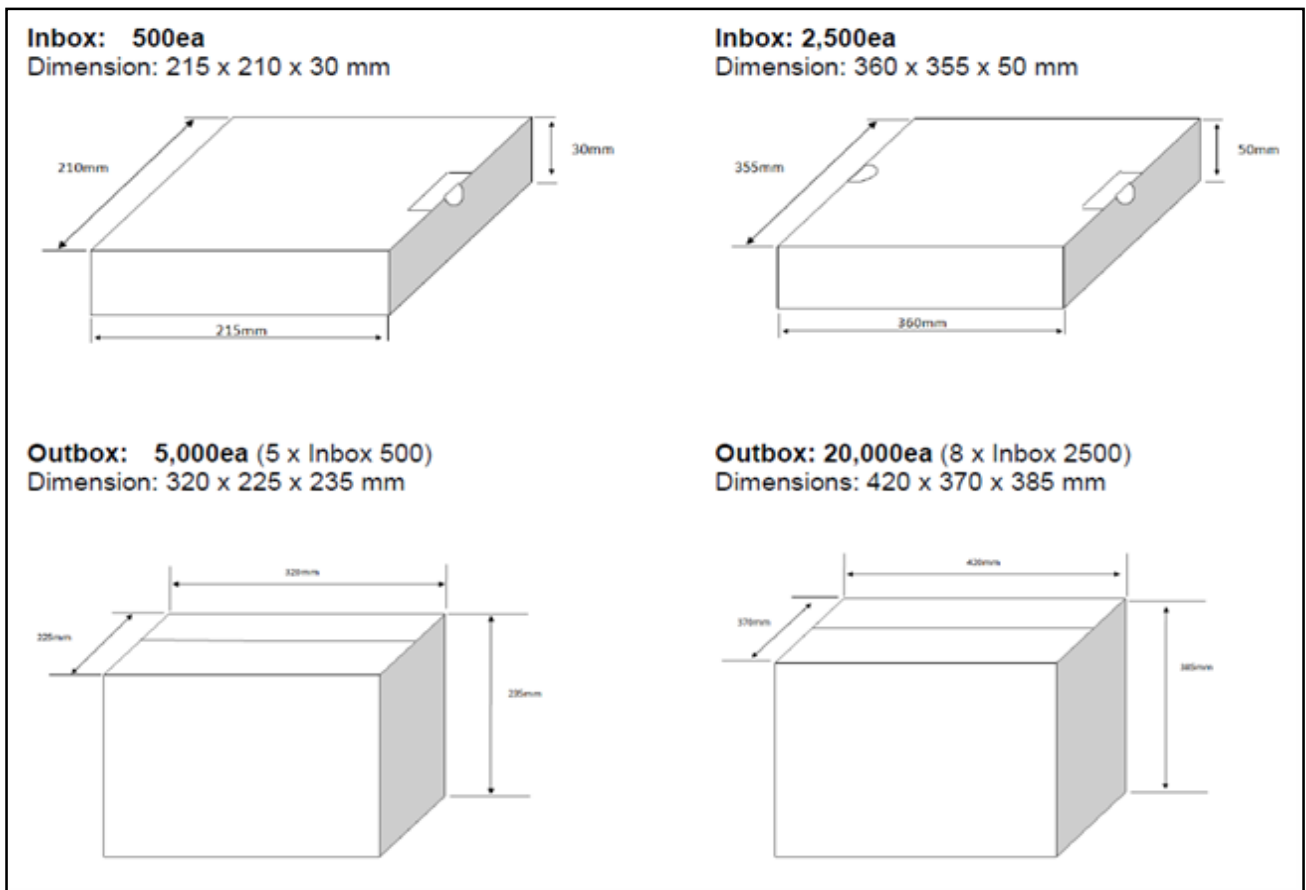
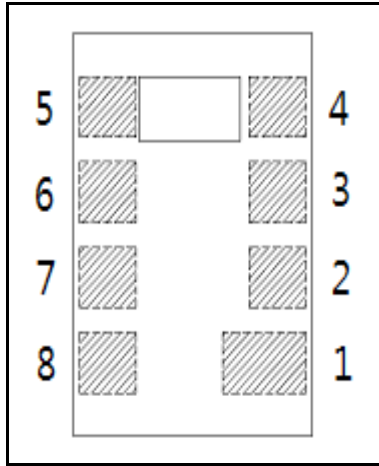


Figure 5 Packing (Box)

## 2. Interface Specification



Pin No	Digital Output (I <sup>2</sup> C Interface)
1	Alarm_Low
2	Ready
3	SDA
4	SCL
5	V <sub>CORE</sub>
6	VSS
7	VDD
8	Alarm_High

Table 1 Pin Descriptions

### 2.1 Power Pads (VDD, VSS, V<sub>CORE</sub>)

**HCP2D-3V** is capable of operating on range of power supply voltage from 2.1V to 3.6V. Power supply should be connected to VDD(pad7). VDD and VSS(pad6) should be decoupled with a 10 $\mu$ F capacitor.

**Note :** Vcore must not be connected to VDD, and it must always be connected to an external 4.7 $\mu$ F capacitor to ground. (see [Figure 6](#))

### 2.2 I<sup>2</sup>C Clock & Data Pads (SDA, SCL)

The sensor's data is transferred in and out through the SDA pad while the communication between **HCP2D-3V** and microcontroller (MCU) is synchronized through the SCL pad.

**HCP2D-3V** has an internal temperature compensated oscillator that provides time base for all operation, and uses an I<sup>2</sup>C-compatible communication protocol with support up to 100kHz bit rates.

External pull-up resistors are required to pull the

drive signal high, that can be included in I/O circuits of microcontroller. (see [Figure 6](#))

If pads(SDA and SCL) are not used, SCL should be connected to VDD and SDA should be connected GND.

Further information about timing and communication between the sensor and microcontroller is explained in **Section 4. Communicating with HCP2D-3V.**

### 2.3 Alarm Pads (Alarm\_Low, Alarm\_High)

The alarm output can be used to monitor whether the sensor reading has exceeded or fallen below pre-programmed values. The alarm outputs are full push-pull driver type. If a high voltage application is required, external devices can be

controlled with the Alarm pins.

The two alarm outputs can be used simultaneously, and these alarms can be used in combination with the I<sup>2</sup>C. Further information about Alarm control is explained in **Section 6.**

## 2.4 Ready Pad (Ready)

The signal on Ready pad indicates whether the output data is valid or not. It can be used connecting to interrupt pin or GPIO in

microcontroller. If it is not used, it can be left unconnected.

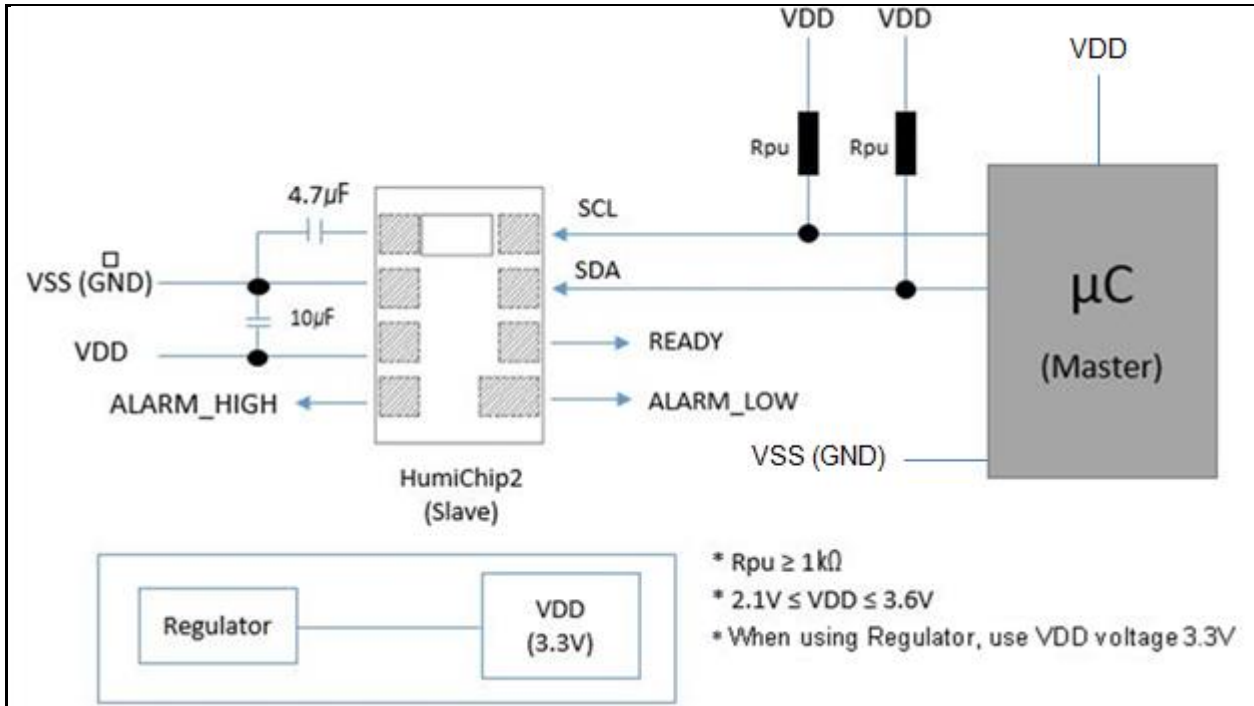


Figure 6 Typical Application Circuit

### 3. Electrical Specification

#### 3.1 Absolute Maximum Rating

**Table 2** shows the Absolute Maximum Ratings for **HCP2D-3V**. Exposure to these extreme condition for extended period may deteriorate the sensor

performance and accelerate aging. Functional operation is not implied at these conditions.

#### 3.2 Electrical Specification and Recommended Operating Conditions

The operating conditions recommended for **HCP2D-3V** is given in the electrical specification is shown in **Table 4**.

#### 3.3 Output Pad Drive Strength

Output pad drive strength is 4mA.

#### 3.4 ESD

All pins have an ESD rating of up to 2kV. The ESD test follows the Human Body Model with C=150pF

and R=330Ω based on IEC61000-4-2

**Table 2 Absolute Maximum Rating**

PARAMETER	SYMBOL	MIN	MAX	Unit
Supply Voltage (VDD to GND)	V <sub>SUPPLY</sub>	-0.3	4.0	V
Storage Temperature Range	T <sub>STG</sub>	-40	125	°C
Junction Temperature	T <sub>j</sub>	-40	125	°C

**Table 3 Recommended Operating Conditions**

PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT
Supply Voltage	V <sub>DD</sub>	2.1		3.6	V
Ambient Temperature Range	T <sub>AMB</sub>	-40		125	°C
External Capacitance between V <sub>DD</sub> pin and Gnd	C <sub>V<sub>SUPPLY</sub></sub>		10		μF
External Capacitance between V <sub>core</sub> and Gnd	C <sub>V<sub>CORE</sub></sub>		4.7		μF
Pull-up on SDA and SCL*1	R <sub>PU</sub>	1			kΩ

\*1 : The SDA and SCL should not be left in the open state..

\*2 : For the capacitor, the X7R or C0G is recommended.

**Table 4 Electrical Characteristics Specifications**

PARAMETER	SYMBOL	REMARKS	MIN	TYP	MAX	UNIT
Current consumption	$I_{DD}$	At 3V, 1Hz		13		$\mu A$
Digital port voltage	$V_{IO\_DIGITAL}$	Relative to ground	-0.6	3.3	$V_{DD}+0.6$ $\leq 3.6$	V
Digital ports switching level		HIGH $\rightarrow$ LOW LOW $\rightarrow$ HIGH		$0.3 \cdot V_{DD}$ $0.7 \cdot V_{DD}$		V
Start-Up-Time Power-on (POR) to data ready	$t_{STA}$				10	ms
Measuring Rate				5		Hz
EEPROM Data Retention Period		at 95°C temperature			10	Year
OTP Data Retention Period		at 95°C temperature			10	Year

## 4. Communicating with HCP2D-3V

### 4.1 Power-On Sequence

On system Power-On-Reset, the **HCP2D-3V** wakes as an I<sup>2</sup>C device. After power-on-reset, start-up-time is required 10ms. The CDC is triggered by the conversion timer. After the CDC is completed, the RDC will be

performed sequentially. Then the DSP calculate and update the humidity and temperature to Result Register. The measurement rate is 5Hz (200ms) by conversion timer. See the [Figure 7](#) Power-on Sequence.

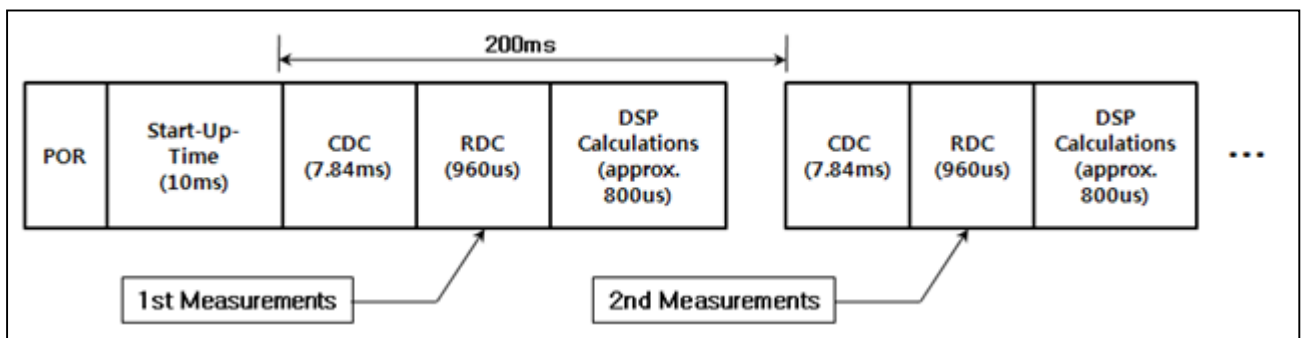


Figure 7 Power-On Sequence

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

The present paragraph outlines the **HCP2D-3V** device specific use of the I<sup>2</sup>C interface. The external master (**HCP2D-3V** cannot be master) begins the communication by creating a start condition, falling edge on the SDA line while SCL is HIGH. It stops the communication by a stop condition, a rising edge on the SDA line while SCK is high. Data bits are transferred with the rising edge of SCK.

On I<sup>2</sup>C buses, every slave holds an individual 7-bit device address (0x28 fixed). This address always has to be sent as the first byte after the start condition. The eighth bit indicating the direction of the following data transfer (Read : 1 and Write : 0). The address byte is followed by the opcode and eventually the payload. Each byte is followed by an acknowledge bit (0 : when a slave acknowledges).

MSB							LSB
0	1	0	1	0	0	0	R/W

Figure 8 Address Byte

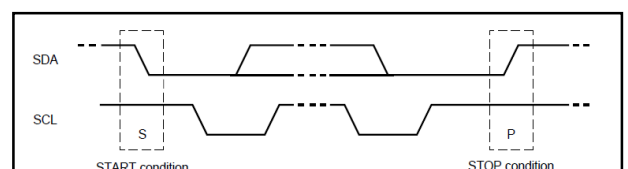
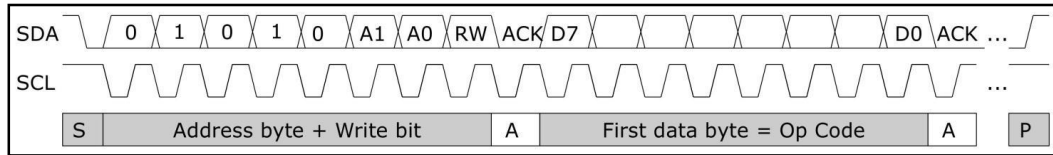


Figure 9 START and STOP condition

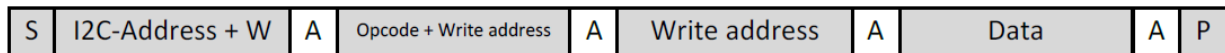


**Figure 10 I<sup>2</sup>C principle sequence**

#### 4.2.1 I<sup>2</sup>C Write

During write transactions, the master alone sends data, the addressed slave just sends the acknowledge bit. The master first sends the slave address plus the write bit. Then it sends the

**HCP2D-3V** specific opcode including the register address in the slave. Finally it sends the payload (“Data”).

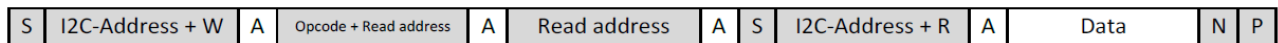


**Figure 11 I<sup>2</sup>C Write procedure**

#### 4.2.2 I<sup>2</sup>C Read

During read transactions, the direction of communication has to be commuted. Therefore, the master creates again a start condition and

sends the slave address plus the read bit (instead of the write bit) to switch into read mode. [Figure 12](#) shows.



**Figure 12 I<sup>2</sup>C Read procedure**

After arrival of the first (or any) data byte, the master may be either signal Not-Acknowledge or Acknowledge. Not-Acknowledge (=N=1) indicate “end of read” and “stop sending” to the slave.

Acknowledge (=A=0) indicate “continue in automatic address-increment mode” and thus receive many bytes in a row. As one can see, automatic address increment is particularly useful and efficient with the I<sup>2</sup>C interface.

#### 4.2.3 I<sup>2</sup>C Timing

The **HCP2D-3V** uses I<sup>2</sup>C-compatible communication protocol with support for Max 100 kHz bit rates. See [Figure 13](#) and [Table 5](#).

**Note :** Please refer to the I<sup>2</sup>C-bus specification for Detailed Timing Chart. And Reference Programming Code are available upon request.

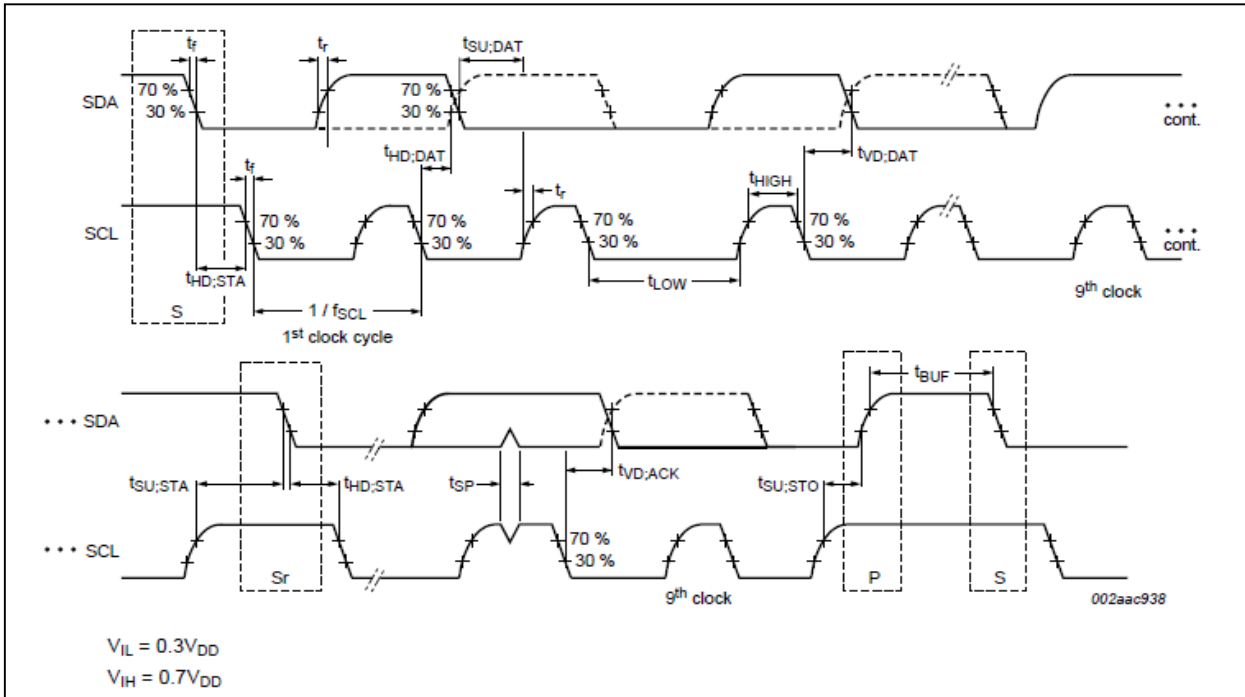


Figure 13 Definition of timing for device on the I<sup>2</sup>C-bus

Table 5 Characteristics of the SDA and SCL bus lines

PARAMETER	SYMBOL	MIN	MAX	UNIT
SCL clock frequency <sup>1</sup>	$f_{SCL}$	0	100	kHz
hold time (repeated) START condition	$t_{HD:STA}$	4.0		$\mu s$
LOW period of the SCL clock	$t_{LOW}$	4.7		
HIGH period of the SCL clock	$t_{HIGH}$	4.0		
set-up time for a repeated START condition	$t_{SU:STA}$	4.7		
data hold time <sup>2</sup>	$t_{HD:DAT}$	0		
data set-up time	$t_{SU:DAT}$	250		ns
rise time of both SDA and SCL signals	$t_r$		1000	ns
Fall time of both SDA and SCL signals	$t_f$		300	ns
set-up time for STOP condition	$t_{SU:STO}$	4.0		$\mu s$
Bus free time between a STOP and START condition	$t_{BUF}$	4.7		$\mu s$
capacitive load for each bus line	$C_b$		400	pF
data valid time	$t_{VD:DAT}$		3.45	$\mu s$
data valid acknowledge time	$t_{VD:ACK}$		3.45	$\mu s$

1. Overclocking is technically possible but within the sole responsibility of the customer (a license may be necessary)  
 2. The data hold time that is measured from the falling edge of SCL, applies to data in transmission and the acknowledge.  
 A device must internally provide a hold time of at least 300 ns for the SDA signal to bridge the undefined region of the falling edge of SCL.



### 4.3 Opcode

All commands for write or read to memory or configuration or result registers may use explicit addressing or address auto-increment.

**Note :** Besides the case of reading the result registers, it is recommended to deactivate the

converter for any communication to configuration registers or EEPROM. This is done by setting the RunBit to '0'. After the communication process the RunBit needs to be set back to '1'. For more details, see the **Section 4.7**.

**Table 6 Opcode**

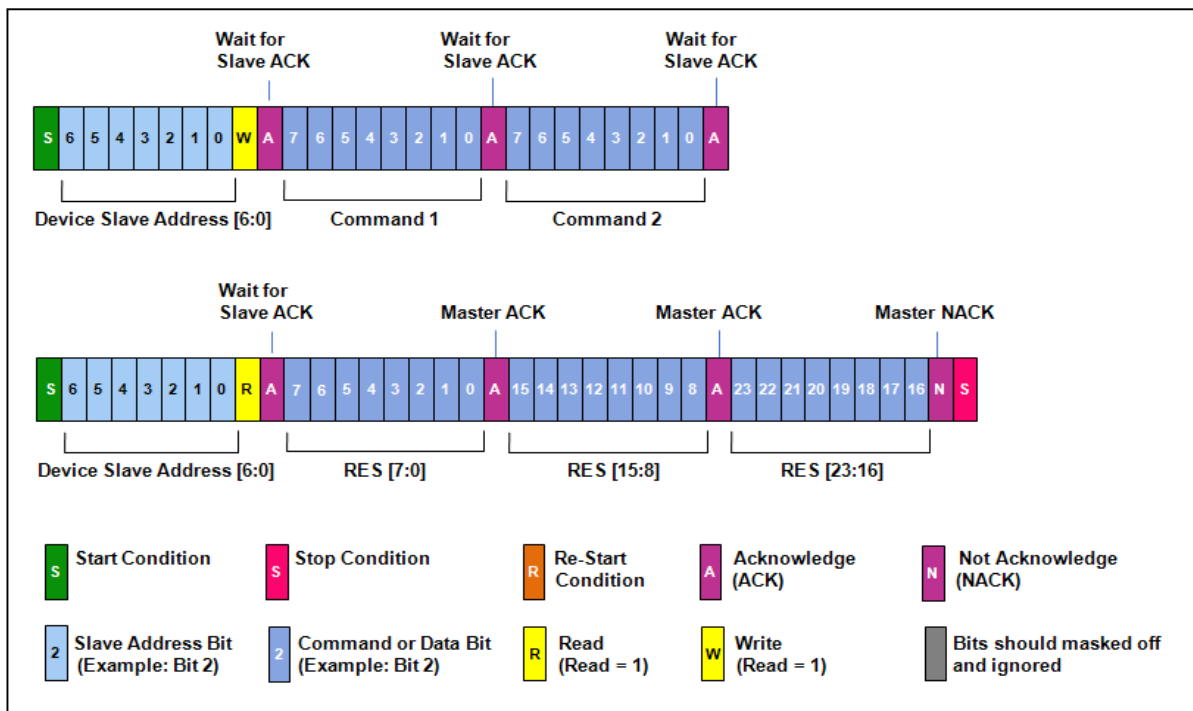
Description	BYTE 2								BYTE 1								BYTE 0	
Read Result	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Addr <6..0>	
Write configuration	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Addr <6..0>	Data <7..0>
Write EEPROM	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	Addr <6..0>	Data <7..0>
Read EEPROM	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	Addr <6..0>	
Erase EEPROM	1	1	1	0	0	0	1	0	0	0	1	0	0	0	0	0	Addr <6..0>	[ Dummy Byte ]
Power-on Reset*1	1	0	0	0	1	0	0	0										

1. It takes about 280us until the first(cdc) measurement starts.

### 4.4 Data Fetch

The Data Fetch (DF) command is used to fetch data from HCP2D-3V. An I<sup>2</sup>C Data Fetch command starts with the 7-bit slave address and the 8<sup>th</sup> bit 1(Read). The HCP2D-3V as the slave sends an acknowledgement (ACK) indicating success.

The number of data bytes returned by the HCP2D-3V is determined by when the master sends the NACK and stop condition. **Figure 14** shows examples of fetching three bytes respectively.



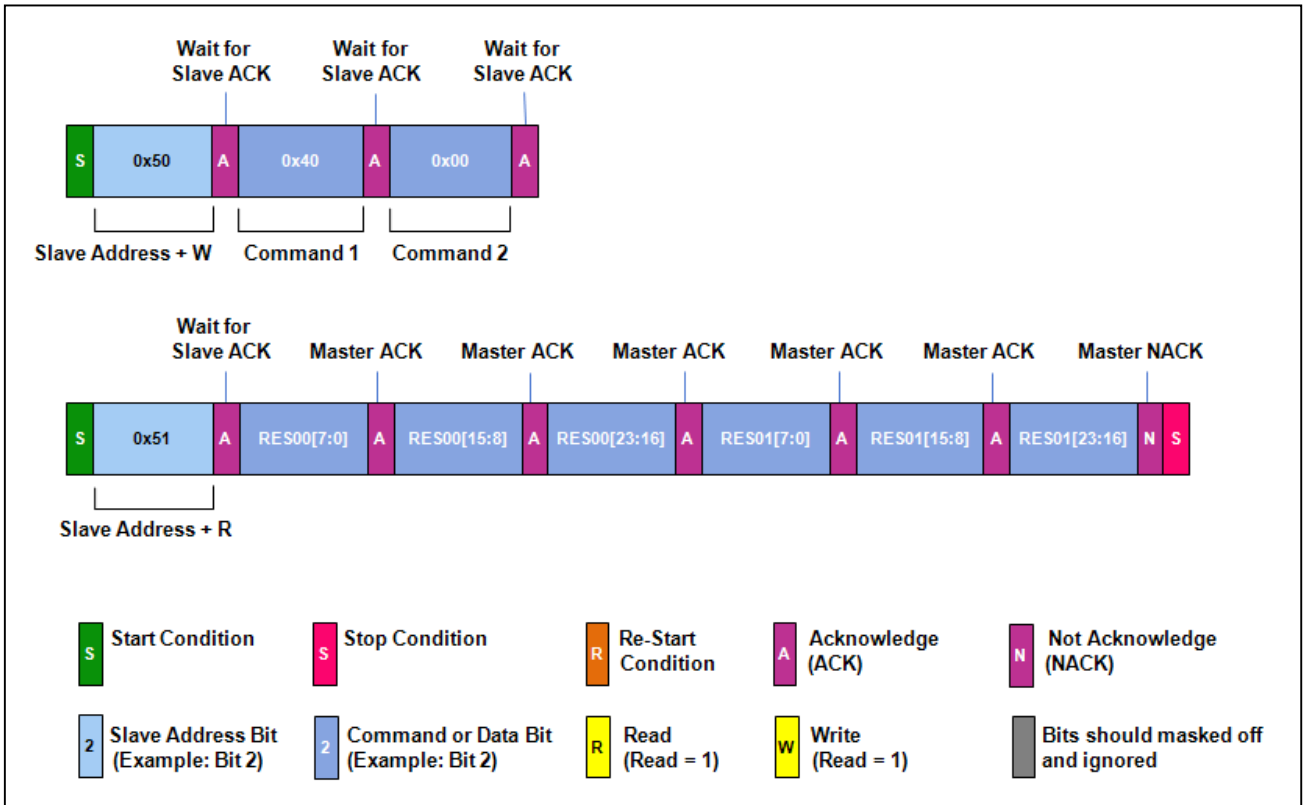
**Figure 14 I<sup>2</sup>C Measurement Packet Reads**

The data has to be read from Result Register (see [Table 8](#)) using the Read Result command in order to fetch the humidity and temperature. Read Result command consists of 0x40 and 7-bit address. 7-bit address is 0x00(for temperature) or 0x03(for humidity). After commands are transferred, 3-bytes data is read from **HCP2D-3V**. First 2-bytes are humidity or temperature. They are signed integer, two's complement fixed-point. The lower byte is fractional digits and the higher

byte is integer values. Third byte is Checksum. If it is not used, only 2-bytes can be read. The checksum and output data are calculated as

**Table 7:**

To read temperature and humidity at a time, data of 6-Bytes can be fetched from **HCP2D-3V** after commands (0x40+0x00) are sent. The first 3-bytes are temperature and the next 3-bytes are humidity.



**Figure 15 Example : Temperature and Humidity data fetch**

**Table 7 Humidity & Temperature Conversion Formula**

Humidity & Temperature Conversion Formula	
Humidity Output (%RH)	$RES01[15:0] / 256$
Temperature Output (°C)	$RES00[15:0] / 256$
Checksum	$RES[23..16] = (RES[15..8] + RES[7:0]) \% 256$

**Note :** '%' symbol in Checksum Formula means mod operation.

**Table 8 Result Register**

Name	Res	Address	fpp	Description
Temperature (°C)	00	0..2	8	Determined temperature in °C (-40 ~ 125°C)
Humidity (%RH)	01	3..5	8	Determined relative humidity in %RH (0 ~ 100%RH) (Temperature compensated)

### 4.5 Ready Pin

The READY signal is intended to show that measurement data is processed and ready to fetch. After power-up, the READY is 0. When the measure data is processed and ready to fetch, the READY is set to 0. **HCP2D-3V** is able to detect interface activity. When interface activity (reading of measure data) is detected, READY is

set back to 1.

The Ready pin's output driver type is full push-pull. Point-to-point communication most likely uses the full push-pull driver.

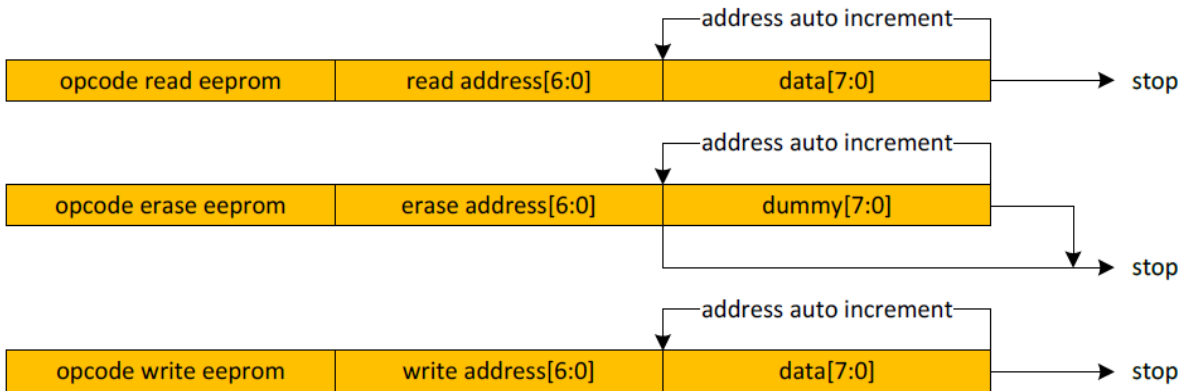
**Note :** If the output mode is Analog, the ready signal cannot be used.

### 4.6 EEPROM

The EEPROM array contains the calibration coefficients for gain and offset, etc., and the configuration bits for the output modes, measuring rate, etc.. The **HCP2D-3V** EEPROM is arranged as 127 Bytes (see [Table 12](#)).

See **Section 4.3** for instructions on reading and writing to the EEPROM via the I<sup>2</sup>C interface. When programming the EEPROM, an internal charge pump voltage is used; therefore a high voltage supply is not needed.

Only 1's can be written to the EEPROM. Therefore, it is necessary to erase the EEPROM cells before writing new data. EEPROM communication may use address auto-increment. In case of "Erase EEPROM" the incremental write is achieved by sending additional dummy bytes.



**Figure 16 EEPROM communication**

It is necessary to wake up the EEPROM before each write access. Therefore, enable EEPROM after clear RunBit. The EEPROM wakeup can be done

explicitly or automatically. It is mandatory to take care of the setup timings, for each individual byte

**Table 9 EEPROM Timings**

Symbol	Description	Typ.
$t_{rdsu}$	Set-up Time for reading	300 $\mu$ s
$t_{rd}$	Read Time from EEPROM	600ns
$t_{wrsu}$	Set-up Time for Writing	200 $\mu$ s
$t_{wr}$	Write Time to EEPROM	6.8ms

## 4.7 Configurations

### 4.7.1 RunBit

The RunBit enables or disables the front-end and the DSP. It is indicated in the Status Register bit0. When the Configuration Register or EEPROM is accessed, the Runbit should be '0'. Then, as a last

step, RunBit should be set to '1' again. Use the POR command in order to re-start the measurement after access is completed.

**Table 10 Commands for configurations**

Command	CMD1	CMD2	CMD3
Set RunBit	0xC0	0x4D	0x01
Clear RunBit	0xC0	0x4D	0x00
Enable EEPROM	0xC0	0x1C	0xC4
Disable EEPROM	0xC0	0x1C	0x44

### 4.7.2 Status Register

Address 24 in the Result Register is the Status Register. The EEPROM state and the RunBit are displayed in the Status Register.

For more information, see **Section 4.6 EEPROM** and **Section 4.7.1 RunBit**.

**Table 11 Status Register Details**

Bit#	Name	Description
0	RunBit	Run Bit (0: Disable, 1: Enable)
2:1	Reserved	
3	EE_BUSY	EEPROM busy
7:4	Reserved	

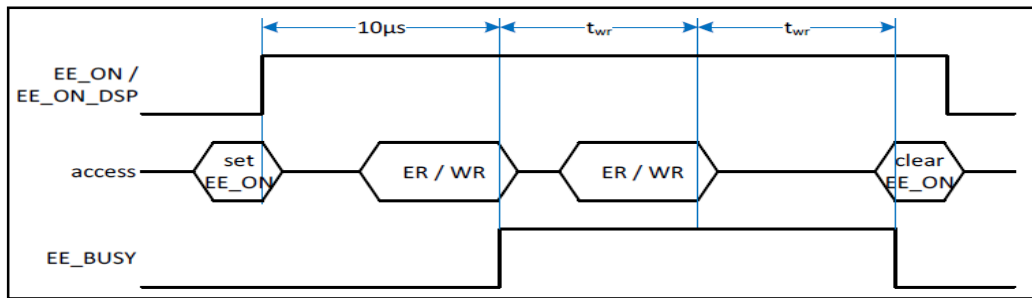


Figure 17 EEPROM power controlled by user : Write / Erase

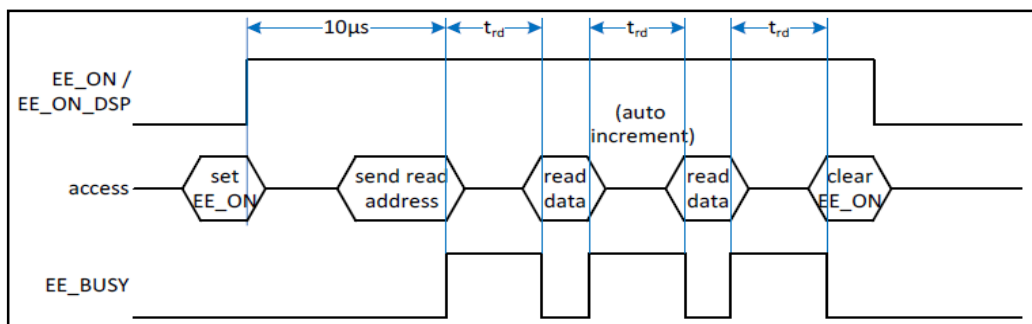


Figure 18 EEPROM power controlled by user : Read

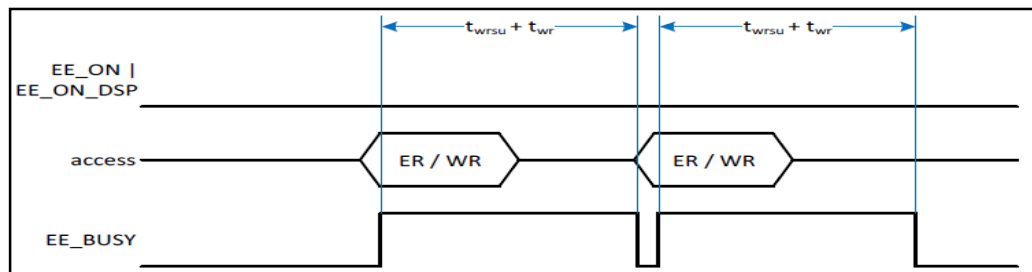


Figure 19 EEPROM power controlled automatically : Write / Erase

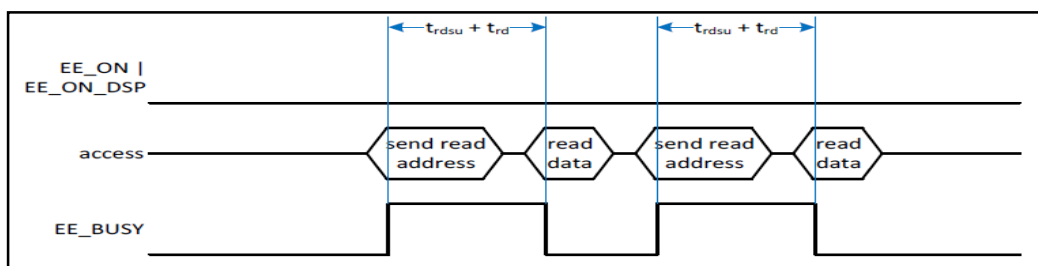


Figure 20 EEPROM power controlled automatically : Read

**Table 12 EEPROM Assignments**

Address (HEX)	Bit Range	Default	Name	Description and Notes
84(54h)	15:8	0x00	Alarm_High_On	High alarm on trip point (16bits signed integer, two's complement, fixed point with 8fpp)
85(55h)	7:0	0x00		
86(56h)	15:8	0x00	Alarm_High_Off	High alarm off trip point (16bits signed integer, two's complement, fixed point with 8fpp)
87(57h)	7:0	0x00		
88(58h)	15:8	0x00	Alarm_Low_Off	Low alarm off trip point (16bits signed integer, two's complement, fixed point with 8fpp)
89(59h)	7:0	0x00		
90(5Ah)	15:8	0x00	Alarm_Low_On	Low alarm on trip point (16bits signed integer, two's complement, fixed point with 8fpp)
91(5Bh)	7:0	0x00		

## 5. Alarm Function (Optional)

### 5.1 Alarm Output

The alarm output can be used to monitor whether Humidity reading has exceeded or fallen below pre-programmed values. The alarm is functioned as a full push-pull driver. If a high voltage application is required, external devices can be

controlled with the Alarm pads, as demonstrated in [Figure 23](#).

In standard **HCP2D-3V** Analog Output mode, only the High Alarm can be used.

### 5.2 Alarm Registers

Four registers (Alarm\_High\_On, Alarm\_High\_Off, Alarm\_Low\_On, and Alarm\_Low\_Off) are associated with the alarm functions. (see

[Table 12](#)) Each of these four registers is a 2-byte value that determines where the alarms turn on or off. The two high alarm registers form the

output with hysteresis for the Alarm\_High pin, and the two low alarm registers form the output with hysteresis for the Alarm\_Low pin.

### 5.3 Alarm Operation

As shown in [Figure 21](#) the Alarm\_High\_On register determines where the high alarm trip point is and the Alarm\_High\_Off register determines where the high alarm turns off if the high alarm has been activated. The high alarm hysteresis value is equal to Alarm\_High\_On – Alarm\_High\_Off. The same is true for the low

alarm where Alarm\_Low\_On is the low alarm trip point with Alarm\_Low\_Off determining the alarm shut off point. The low alarm hysteresis value is equal to Alarm\_Low\_Off – Alarm\_Low\_On.

[Figure 22](#) shows output operation flowcharts for both the Alarm\_High and Alarm\_Low pins.

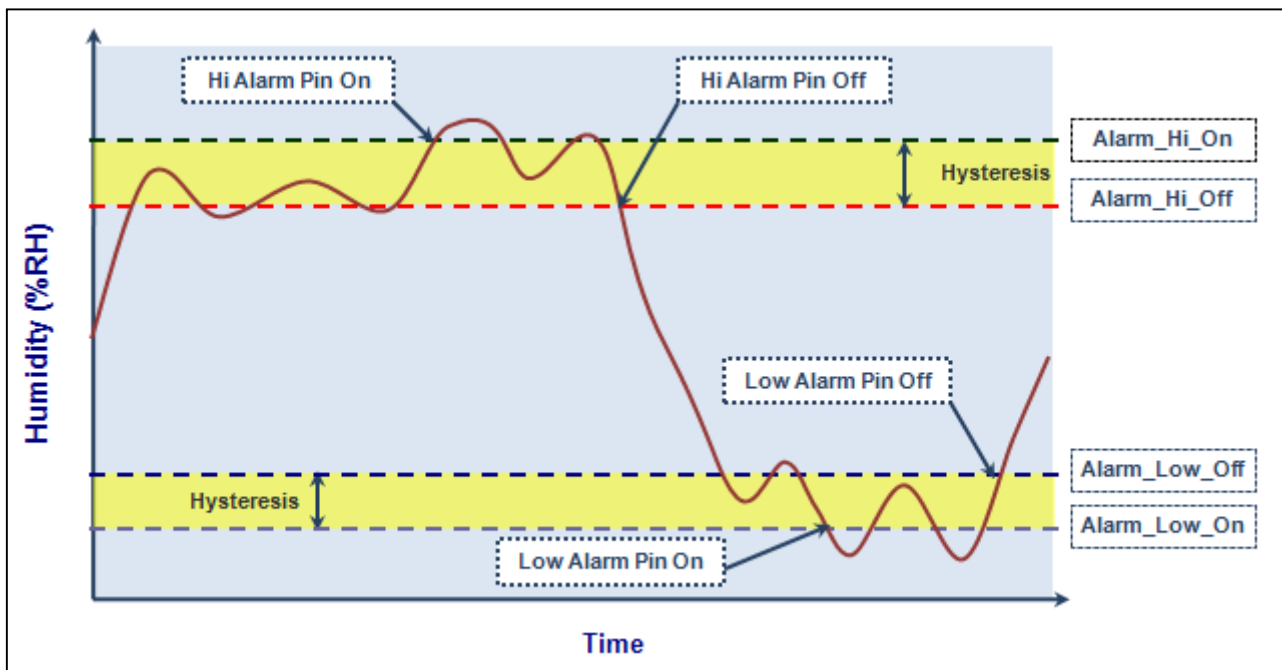


Figure 21 Example of Alarm Function

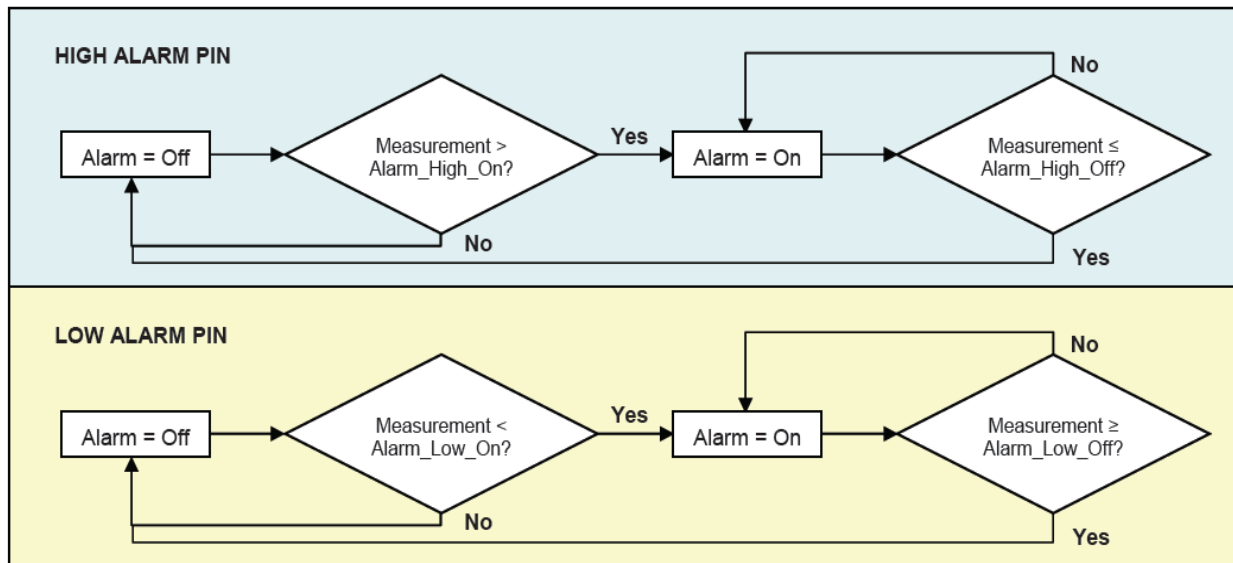


Figure 22 Alarm Output Flow Chart

**HCP2D-3V** also can be directly installed to a device without MCU interface when only a switch on/off function is required at desired

humidity level. (e.g. Bathroom Vent Fan, Humidifiers, Dehumidifiers)

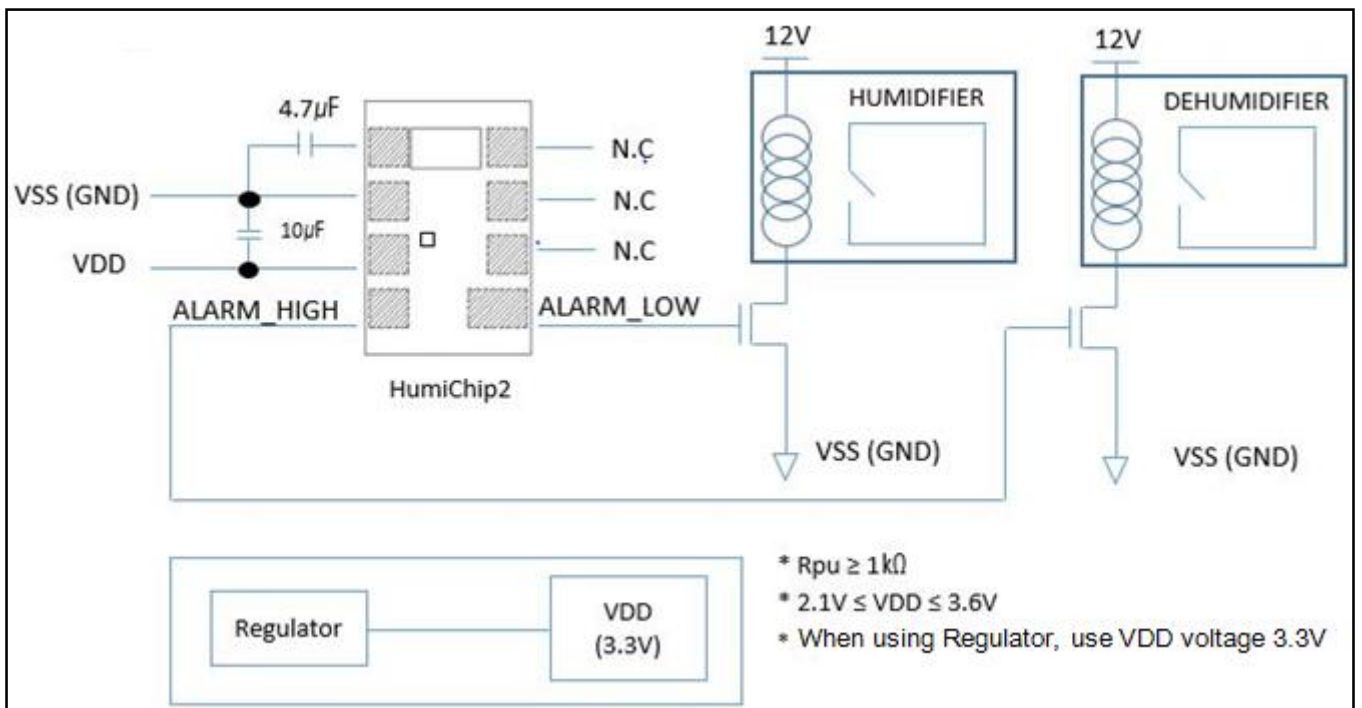


Figure 23 Bang-Bang Humidity Control (Digital Output)



## 6. Revision History

Date	Version	Page(s)	Changes
11 SEPTEMBER 2015	1.0		First Release



This publication is the proprietary product of **SAMYOUNG S&C** and is copyrighted, with all rights reserved. Under the copyright laws, no part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, for any purpose, in whole or in part, without the express written permission of **SAMYOUNG S&C**. Express written permission is also required before a third party may make any use of this publication.

技术 & 商务联系方式: 南频科技有限公司  
陈小姐 业务工程师 156 2521 4151  
rita.chen@dwintech.com www.dwintech.com  
座机0755-82565851

This Application Guide should be used only for intended and authorized application of **HCP2D-3V**.

Please consult with **SAMYOUNG S&C** for any specific application requirements and for detailed datasheet.

Copyright 2015<sup>©</sup>, **SAMYOUNG S&C**