Digital Humidity & Temperature Sensor

With Two-Wire Interface

Description

The SYM series are serial output relative humidity and temperature multi sensor module comprising a calibrated digital output.

The device includes a resistive polymer sensing element (SYH-2R) for relative humidity and a NTC thermister temperature sensor.

Both are seamlessly coupled to an 8 bit high performance microcontroller with 15-bit analog to digital converter and a serial interface circuit on the same chip.

This results in superior signal quality, insensitivity to external disturbances (EMC) at a very competitive price.

Features

Relative humidity and temperature BCD output

Two-wire serial interface digital output

Small Size

Wide operation voltage

Calibrated temperature and input voltage, digital output

Automatic power down

Low power consumption

Cable length up to 10m

Temperature °C or °F output

Applications

Air-conditioners

Humidifiers

Dehumidifiers

Controllers and transmitters

Consumer goods

Weather stations

Data Loggers

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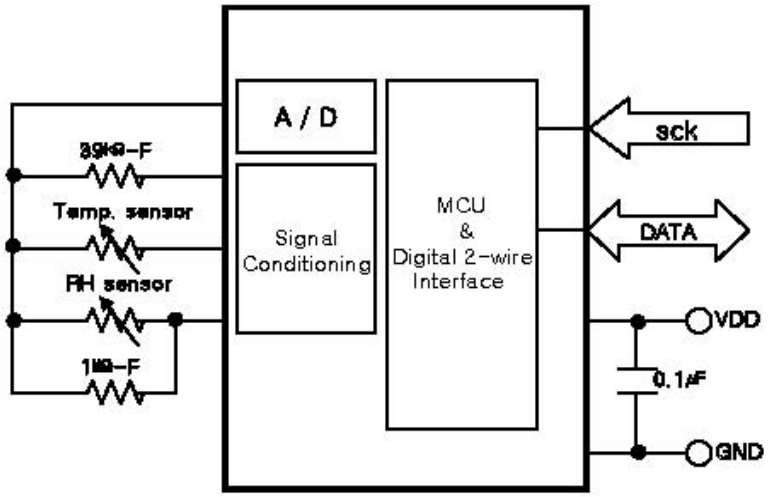
Block Diagram



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Sensor Specifications

Relative Humidity

Sensor	: SYH-2R
Working range output (temperature compensated)	: 10.0 ..... 95.0%RH
Resolution	: 15-bit
Working temperature range	: -20 ..... 85℃
Accuracy (at 25℃)	: see figure 1
Temperature Coefficient	: 0.05%RH/℃
Sampling rate	: 1sec.
Response time (1/e)	: < 60sec.
Linearity	: < ±2%RH

Temperature

Sensor	: NTC thermister
Working range	: -50.0 ..... 70.0℃
Resolution	: 15-bit
Accuracy (at 25℃)	: see figure 2
Sampling rate	: 1sec.

Electrical Characteristics

Supply voltage	: 2.4V DC – 5.5V DC
Current consumption (3.3V)	: 0.8㎃
Standby current(3V)	: 2㎂
Working temperature range	: -40 ..... 85℃
Storage temperature range	: -50 ..... 125℃
Low level input voltage	: 2.0V .....VDD
High level input voltage	: 0.8V
Maximum cable length	: 10m
Internal pull-high resistance(3V/5V)	: 100㏀/50㏀

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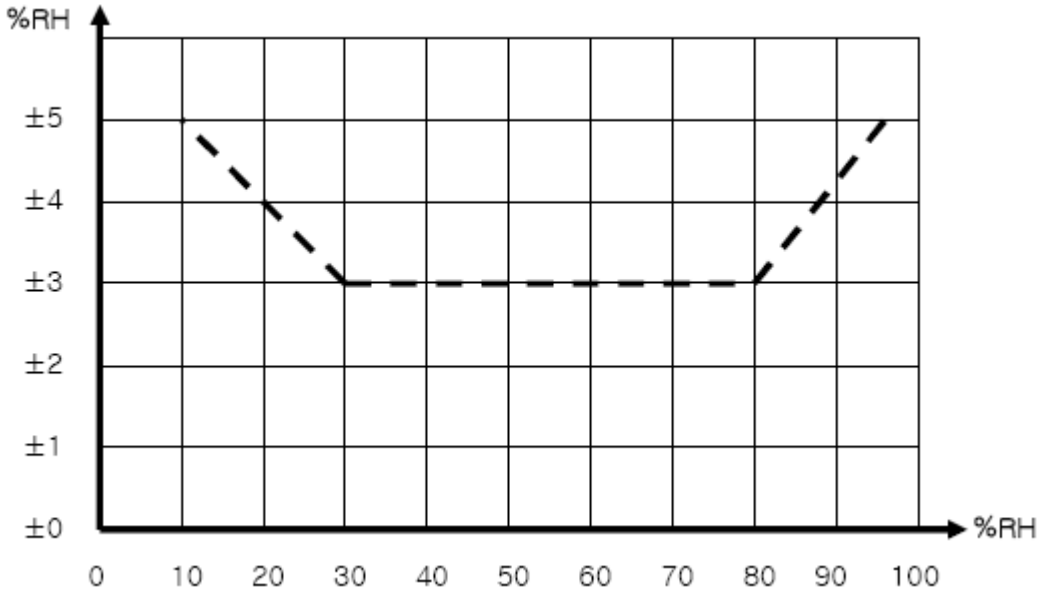

Figure 1. Relative humidity accuracy

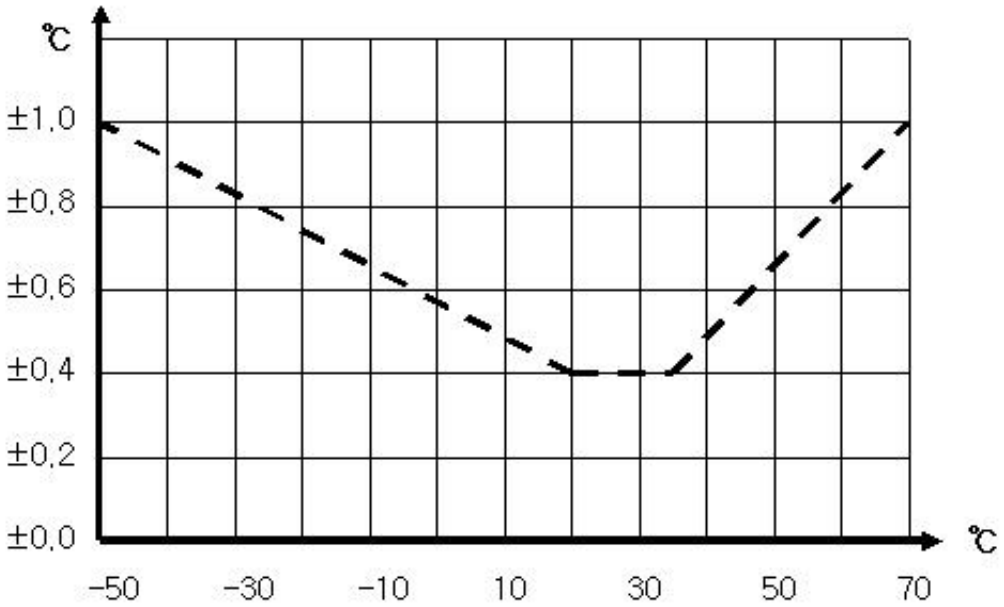

Figure 2. Temperature accuracy

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1. Interface Specifications

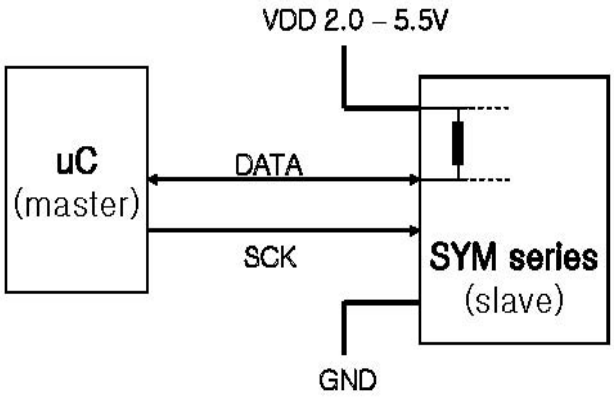

Figure 3. Typical application circuit

1.1 Power pin

The SYM series require a voltage between 2.4V to 5.5V bases on mass option setting.

1.2 Clock pin (SCK)

The SCK is used to synchronize the communication between a microcontroller and the SYM series. The frequency requires is from 1㎐ up to 10㎑.

1.3 Data pin (DATA)

The DATA pin is used to transfer data in and out of the device. DATA changes after the falling edge and is valid on the rising of the serial clock SCK. During transmission the DATA line must remain stable while SCK is high. To avoid signal contention the microcontroller should only drive DATA low. An internal pull-up resistor(50kΩ~100kΩ depends on operating voltage) will pull the signal high (Fig. 3)

2. Start up / Reset acknowledgement

After turn on the SYM series, it should pull low the DATA ~30㎳(T_A) for reset acknowledgement. After releasing the DATA, the SYM series will go into sleep mode if the communication pins met the requirement and wait for command. In order to go into stop mode, **the DATA must be release (naturally pulled high) and the SCK should output low by the uC.**

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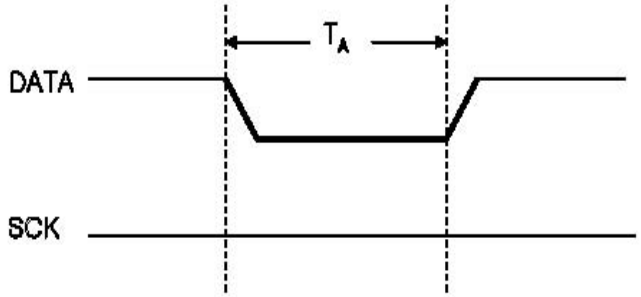

Figure 4. Reset respond

3. Communication proto-code

To initiate a transmission, the uC needs to bring up a sequence of polling transition. First the uC should pull high the SCK pin and pull low DATA pin about 1㎳ to generate a pulse. After the SYM series wake up. it will pull low the DATA pin and wait for the uC pull low the SCK pin. When the SYM series will release the DATA pin indicating ready after the SCK become low. The u C should keep T_B ~10㎲ and T_C will take ~10㎲. Another 50㎲ waiting should be place after T_C before sending command to the SYM series.

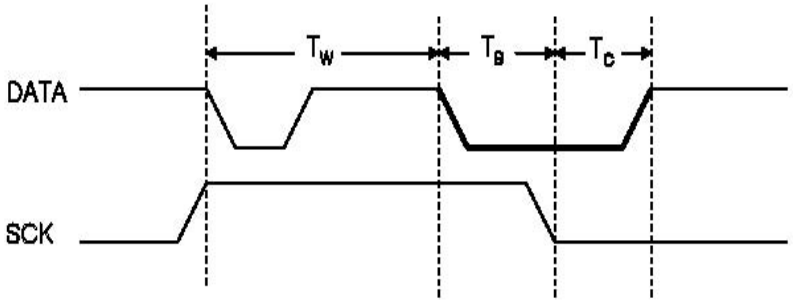

Figure 5. Transmission start polling sequence

The subsequent command consists of four address bits (only “0000” is currently supported), three command bits and one read / write bit. The SYM series indicates the Proper reception of a command by pulling the DATA low (ACK bit) after the falling edge of the 8th SCK clock. The DATA line is

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released (and goes high) after the falling edge of the 9th SCK clock.

All commands are 8bits in length and start with “0000”

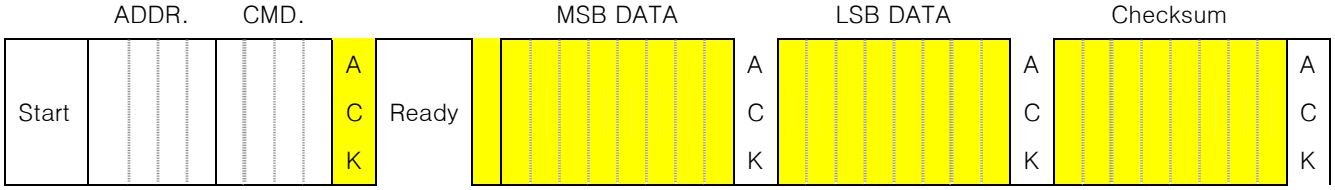
Command	Code	
Measure Temperature in ℃	0000	0001
Measure Temperature in °F	0000	0011
Measure calculated Humidity	0000	0111
Reserved	Other	

Table 1. Command

3.1. Measurement sequence (RH and Temp)

As the SYM series need temperature data for relative humidity calibration, **a measure temperature request should be conducted BEFORE requesting for RH data or invalid data (0xAAA) will be outputted..** After issuing a measurement command (‘00000111’ for RH, ‘00000001’ for Temperature) the controller has to wait for the measurement to complete. This takes approximately 80ms. To signal the completion of a measurement, the SYM series pulls down the data line and enters idle mode. The controller must wait for this “data ready” signal before restarting SCK to readout the data. Measurement data is stored for ~640ms for readout, therefore the controller can continue with other tasks and readout as convenient. If the uC does not readout the data within 640ms after data ready, the SYM series will reset automatically.

Two bytes of measurement data and one byte of checksum will then be transmitted.
The uC must acknowledge each byte by pulling the DATA line low. All values are MSB first, right justified.(e.g. while requesting temperature in degree F, the 4th SCK is MSB for a 13bit value). Communication terminates after the acknowledge bit of the checksum data. If checksum is not used the controller may terminate the communication after the measurement data LSB by keeping ack high.
The device automatically returns to sleep mode after the measurement and communication have ended.



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*Shadow place is controlled by Master.

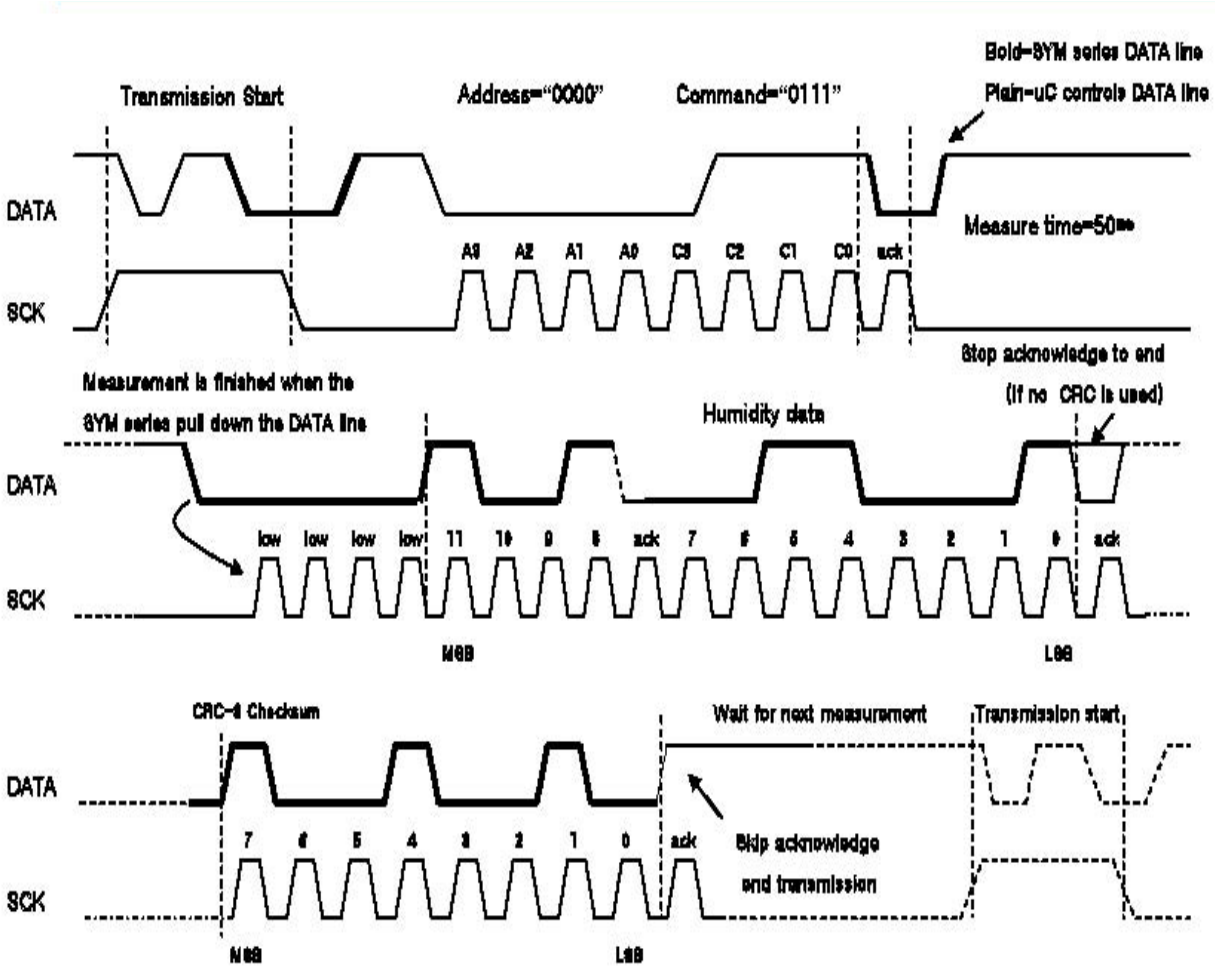

Figure 6. Measure sequence example (RH)

The SYM series will output the BCD data directly.

For the above example (Fig. 6), the data is 0931h and this mean the recorded humidity is 93.1%, As the SYM series will use the temperature data to correct the relative humidity error, so a measure temperature command must be sent before reading relative humidity or the data may not be accurate.

For temperature, bit1 of the first nibble data indicating the sign of the data

MSB of first nibble	Bit 2	Bit 1	Bit 0
Must be "0"	0: in C 1: in F	0: + ve 1: -ve	MSB of temp. data

Table 2. Temperature 1st nibble

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3.2 Data range

The SYM series has several data boundary. For temperature, the range is from -50C to 70C. For RH is from 15% to 95%. As RH need to compensate with temperature data, a temperature bounding (-20C~70C) will apply to the RH data output too. If the temperature is out of the bounding, invalid RH data (0xAAA) will be outputted.

	Temperature	Humidity
<-50℃	0xEEE(low error)	0℃ RH data
-50℃ ~ 0℃	Temperature data	
0℃ ~ 70℃		RH data
>70℃	0xFFF(high error)	70℃ RH data
Sensor open	0xEEE	0xEFF
Sensor short	0xFFF	0xDDD

Table 3 – Data range

3.2 Checksum

The 8-bit checksum is the result of the low byte of adding the high byte and low byte of the output data. Carry are ignored in this case.

Ex) If Humidity output data is 0931h (0000 1001 0011 0001b), 0 XOR 9 = 9, 3 XOR 1 = 2

Therefore checksum value is 92h (1001 0010)

4. Bonding option

The SYM series have several bonding option to adjust RH offset.

JP1	JP2	JP3	RH offset
0	0	0	+ 0%
0	0	1	+ 1
0	1	0	+ 2
0	1	1	+ 3
1	0	0	-0%
1	0	1	-1
1	1	0	-2
1	1	1	-3

"1" is connected to ground

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Table 4. Bonding option

5. Packaging option

The SYM series can be packaged in three types.

DIP CONNECTOR TYPE(SYM-001)

SMD CONNECTOR TYPE(SYM-002)

SIP TYPE(SYM-003)

(Units : mm)

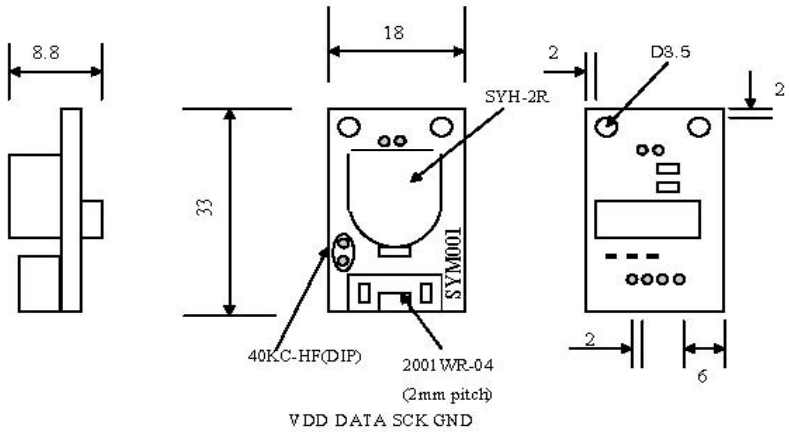

Figure 7. SYM-001

(Units : mm)

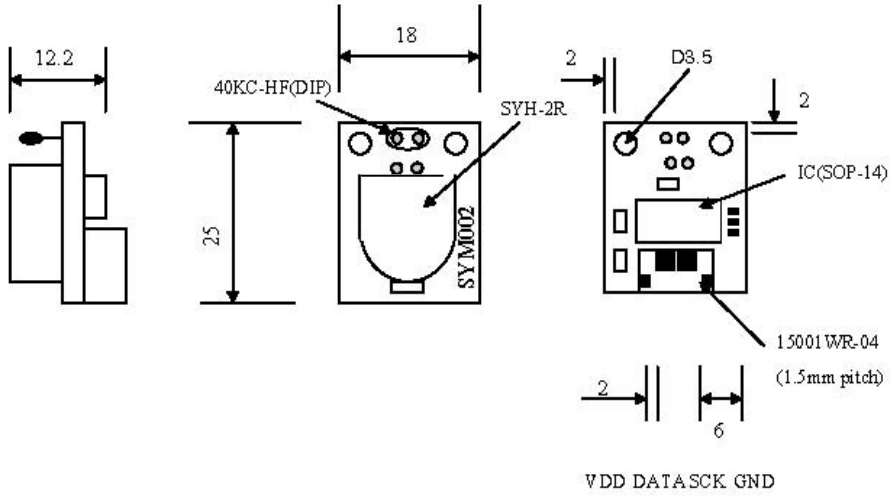

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Figure 8. SYM-002

(Units : mm)

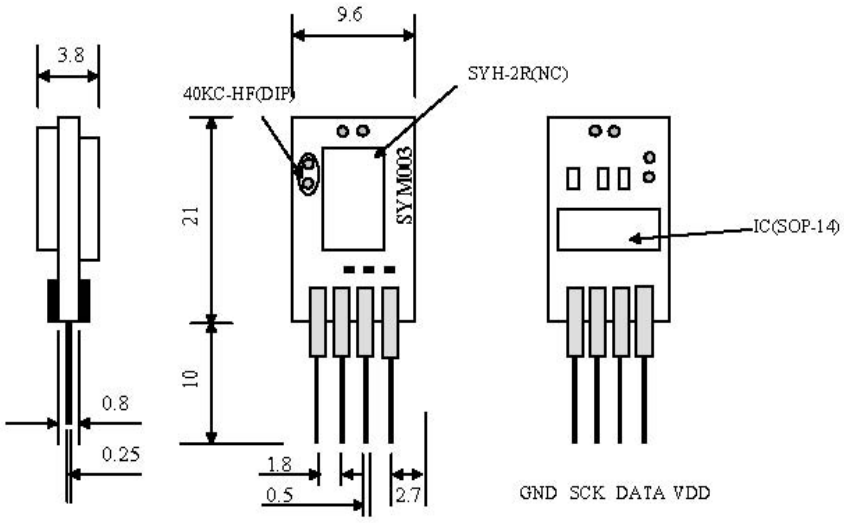

Figure 9. SYM-003

6. Application note

6.1 Water condensing

If the water(water-drop, moisture.. etc) is **condensed on the humidity sensor surface** (over 6 hrs), the sensor (humidity sensitive) membrane will be melt in the water. It become resistance quality defective.

6.2 Drenching (water, solvent .. etc.)

If the humidity sensor is **soaked in the liquid material** (water, solvent .. etc)(over 30 min), the sensor (humidity sensitive) membrane will be melt in the water. It become resistance quality defective.

6.3 Ionic atmosphere

SYH series humidity sensor is made by using ionic polymer membrane. Therefore if the humidity sensor is exposed **ionic atmosphere**(salty air, anionic ionizer.. etc) for a long time, **the resistance-drop characteristics** will occur in the sensor

6.4 Organic / Inorganic gas

If the humidity sensor is exposed **organic / inorganic gases** for a long time that have reactive polymer membrane, the sensor (humidity sensitive) membrane will be damaged. It become

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resistance quality defective. (For example : SOx, NOx, Ammonia, Alcohol, Glycol .. etc.)

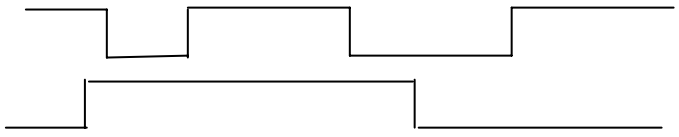
6.5 Breakdown / Scratch / Membrane touching

If the humidity sensor is received physical external pressure such as **breakdown of sensor substrate, sensor scratch, touching sensor membrane**, the sensor (humidity sensitive) membrane and electrode will be damaged. It become resistance quality defective.

7. SYM_PROTO_CODE

```
// SYM series Power on
DATA pin set to input float ;       // Or input Pull high
SCK pin = 0 ;
while(DATA pin == 1)
        wait ;
while(DATA pin == 0)
        wait ;
// SYM series into sleep mode

//**********************************************************//
// To start a transition
//
// DATA :
//
// SCK :
SCK pin = 1 ;
DATA pin = 0 ;
Delay 1ms
DATA pin set to input float ;       //        Or input Pull high
while (DATA pin == 1)
        wait ;
SCK pin = 0 ;
Delay 10us
while (DATA pin == 0)
        wait ;
Delay 50us
```



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```
// SYM series woke up and ready for command
// Send command routine
Send 1-byte command with SCK pulse ;
DATA pin set to input float ; //    Or input Pull high
Read 1-bit Acknowledgement ;
if Acknowledge = false
        Reset SYM series and Quit ; // Hardware reset or wait 640ms for watchdog reset
else
        while(DATA pin == 1)
                wait ;
// Read measured value
Read 2-byte data with SCK pulse ;
if Sent Acknowledgement
        Read 1-byte Checksum ;
Send SCK pulse without Acknowledge ; // End transition
// Transition end. SYM series back to sleep mode
```


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