DATA SHEET

Digital humidity sensor HYT131

Features
- On-Chip humidity & temperature sensors
- Fully calibrated, 14-bit digital output
- Excellent long-term stability
- Low power consumption
- Serial interface control.
- Small size

HYT131 product summary

The HYT-131 is a humidity & temperature sensor. The device includes a capacitive to voltage converter (C-V Converter) for relative capacitive humidity sensor elements and a band-gap temperature sensor. Both are seamlessly coupled to a 14bit analog to digital converter and a serial interface circuit on the same chip.

This results in superior signal quality, a fast response time and insensitivity to external disturbances at a very competitive price. Each HYT-131 is individually calibrated in a precision chamber. The calibration coefficients are programmed into the memory. These coefficients are used internally during measurements to calibrate the signals from the sensors. The 2-wire serial interface and internal voltage regulation allows easy and fast system integration. Its tiny size and low power consumption makes it the ultimate choice for even the most demanding applications.

Application
- HVAC -Test & Measurement
- Automotive -Data Logging
- Consumer Goods -Automation
- Weather Stations -White Goods
- Humidifiers -Medical
- Dehumidifiers

Specification

Parameter	Condition	min	typ	max	Units
Resolution			12		bit
Operating range		0		100	% RH
Accuracy	Typical		±2		% RH
	Maximal	See figure 1			
Hysteresis			<±1,5		% RH
Response time			10		s

Table 1 Specification for humidity sensor

Parameter	Condition	min	typ	max	Units
Resolution			12		bit
Operating range		-40		120	°C
Accuracy	Typical		±0,3		°C
	Maximal	See figure 2			
Response time		15		25	s

Table 2 Specification for temperature sensor

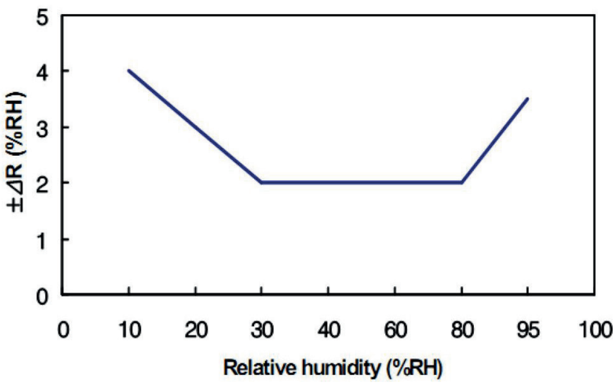

Fig. 1 Maximal RH-accuracy at 25 °C per sensor

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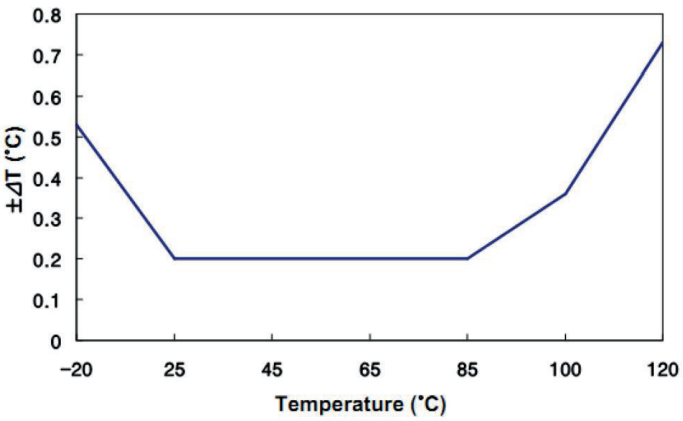

Fig. 2 Maximal temperature accuracy per sensor

Package

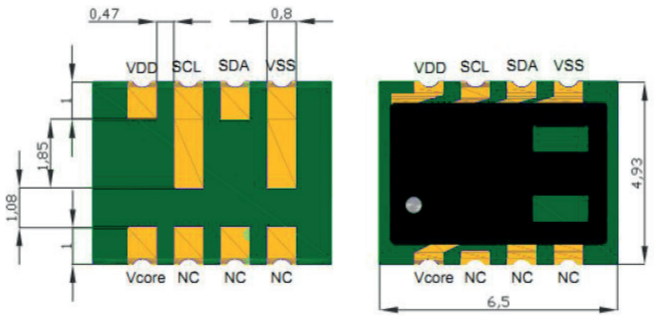

Fig. 3 HYT131 dimensions (mm) & pin assignment

Name (Pin No.)	Pin function
Vcode (#1)	
VSS (#5)	Ground
SDA (#6)	Serial data
SCL (#7)	Serial clock
VDD (#8)	DC power

Table 3 Pin description

Block diagram

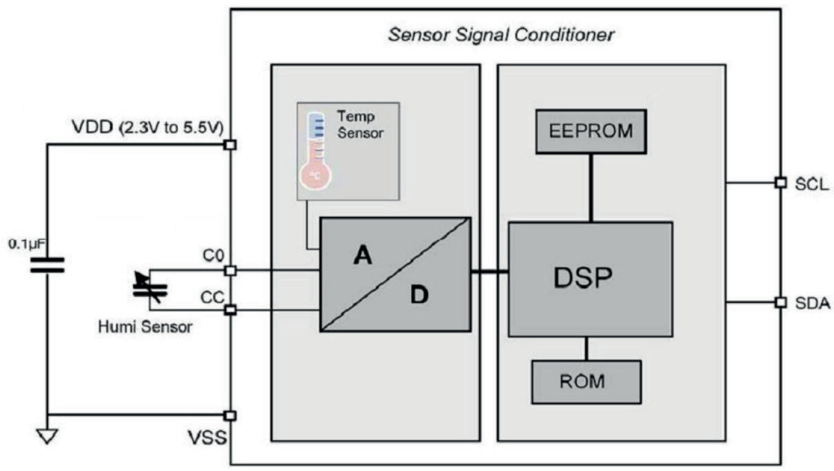

Fig. 4 HYT131 block diagram

Operating conditions

1) Absolute maximum ratings

Parameter	Symbol	min	typ	max	Units
Analog supply voltage	V_{DD}	-0,3		6,0	V

Voltages at analog I/O in pin	V_{INA}	-0,3		V_{DD}+0,3	V
Voltages at analog I/O pit pin	V_{OUTA}	-0,3		V_{DD}+0,3	V
Storage temperature range	T_{STOR}	-55		150	°C

2) Operating conditions

Parameter	Symbol	min	typ	max	Units
Supply voltage to GND	C_{SUPPLY}	2,3		5,5	V
Ambient temperature range	T_{AMP}	-40		125	°C
External capacitace between V_{DD} pin and GND	$C_{VSUPPLY}$	100	220	470	nF
External capacitance between V_{CORE} pin and GND	C_{VCORE}	10		100	nF
I2C pull-up resistor	R_{PU}	1	2,2		kΩ
SDA load capacitance	C_{SDA}			0,2	nF

Interface specifications

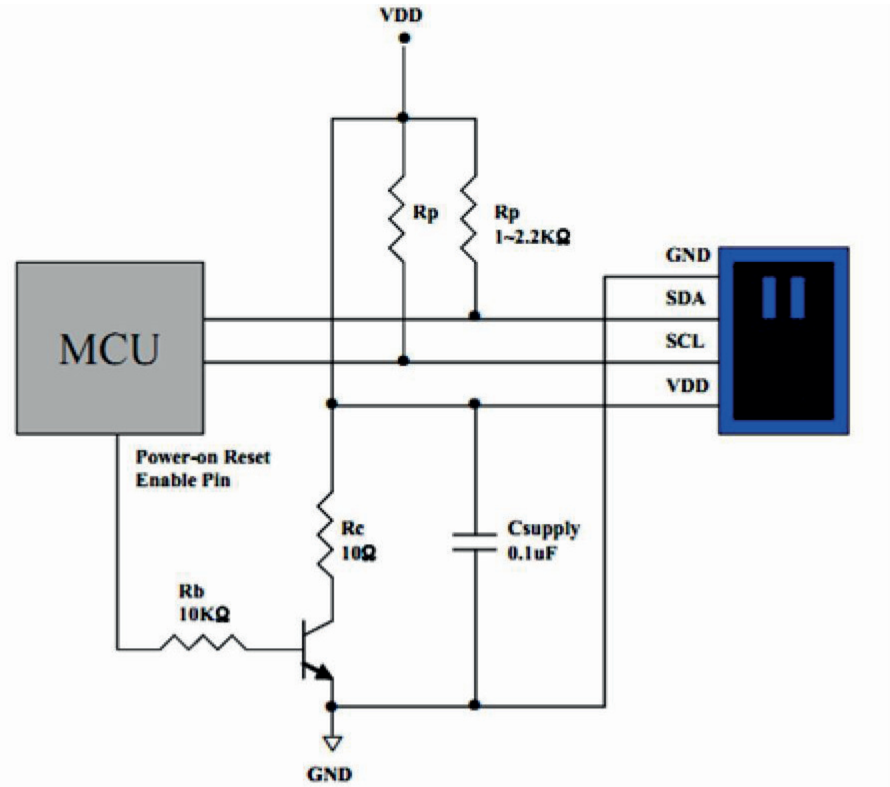

Fig. 5 HYT131 I²C-interface

1) Power
The HYT131 requires a voltage supply between 2.3 and 5.5V. After power up, the device needs 10ms to reach its "stand-by" state. No commands should be sent before that time. Power supply pins (VDD, GND) may be decoupled with a 0.1uF capacitor.
2) Serial Clock (SCL)
The SCLK is used to synchronize the communication between a microcontroller and the HYT131 Since the interface consists of fully static logic there is no minimum SCL frequency.
3) Serial Data (SDAT)
The SDAT pin is used to transfer data in and out of the device. Data changes after the falling edge and is valid on the rising edge of the serial clock SCL. During transmission the SDAT line must remain stable while SCL is high. An external pull-up resistor is required to pull the signal high.
4) Power-on Reset Enable
On system power-on reset, the HYT-131 wakes as an I2C device regardless of the output protocol programmed in EEPROM. After power-on reset, HYT131 enters the

command window. It then waits for a Start_CM command for 3ms if the fast_Startup EEPROM bit is set or 10ms otherwise. Command Mode is primarily used in the EEPROM writing.

I²C-interface and timing
For integration with the micro-controller, the HYT-131 has a I2C-compatible interface which supports both 100 kHz and 400 kHz bit rate. The I2C slave address is programmed by default on 28H and can be adjusted in the entire address range of (00H to 7FH).

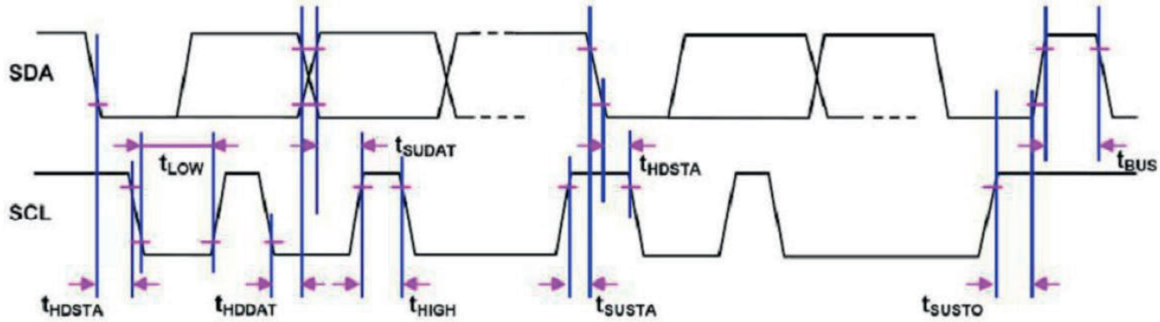

Fig. 6 I²C timing diagram

1) I²C parameters

Parameter	Symbol	min	max	Units
SCL clock frequency	f_{SCL}	100	400	kHz
Start condition hold time relative to SCL edge	t_{HDSTA}	0,1		µs
Minimum SCL clock low width	t_{LOW}	0,6		µs
Minimum SCL clock high width	t_{HIGH}	0,6		µs
Start condition setup time relative to SCL edge	t_{SUSTA}	0,1		µs
Data hold time on SDA relative to SCL edge	t_{HDDAT}	0		µs
Data setup time on SDA relative to SCL edge	t_{SUDAT}	0,1		µs
Stop condition setup time on SCL	t_{SUSTO}	0,1		µs
Bus free time between stop and start condition	t_{BUS}	1		µs

2) I²C commands
As detailed in below table, there are two types of commands for user operating a HYT131.

I2C command types

Type	Description
Data fetch (DF)	Fetch the last measured value of humidity and temperature
Measurement request (MR)	Start measuring cycle

In the initial condition, the humidity module is in the Sleep mode to minimise on the current consumption. A new measurement is carried out only after the command measuring request (MR) is received. Access to the status bits and measured values is made by the data fetch command. After the measuring cycle has been completely processed, the ready status bit is set and the current measured values are available. If the measuring cycle has been already finished, the output registers may be cyclically polled.

3) Measurement Requests(MR)
By a measurement request command, the sleep mode is terminated and the HYT131 executes a measuring cycle. The measuring cycle begins with the temperature measurement, followed by humidity measurement, digital signal processing and finally writing the processed measured values into the output register. The MR command consists of the address of the HYT-131, with which the R/W bit is transferred as 0(= write). After the humidity module is answered with ACK (= mesurement started), the master finalized the transfer with NACK (=stop condition).

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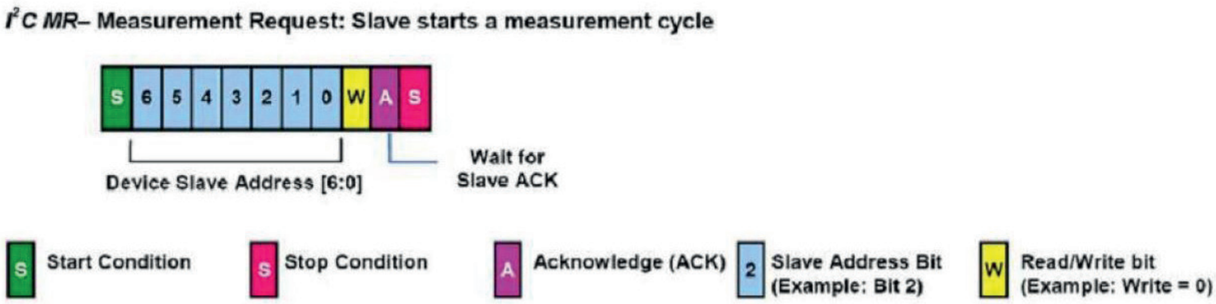

Fig. 7 Measurement request command

4) Data Fetch(DF)
The data fetch command serves to finish reading the output register. The Data Fetch command is sent by the master to the Humidity module (Slave) and begins with the 7 Bit slave 8 bit as 1 (= read). The Humidity module sends back an acknowledgement (ACK) in case of incorrect addressing The number of bits, that the humidity module sends back, is distiguished when the master sends a NACK (= stop condition). The first two bytes of measurement data
contain the two status bits as MSB, then followed by the humidity value with 14 bits. If the temperature data is also needed, then these can be read after the humidity value. The most significant 8 bits of the temperature value will be transferred as third byte. Then the least significant 6 bits of the temperature value can be read as the fourth byte. The last two bits are not used and should be masked away.
The master has the possibility to terminate the reading after each read byte through an NACK. Hence, it is possible to finish reading even after the first byte and evaluate only the status/stale bit and the master can terminate the transfer without completing the whole cycle. If only the upper 8-bits of the temperature value are to be transferred (8 bit resolution), the transfer can be aborted after the third byte by a NACK.

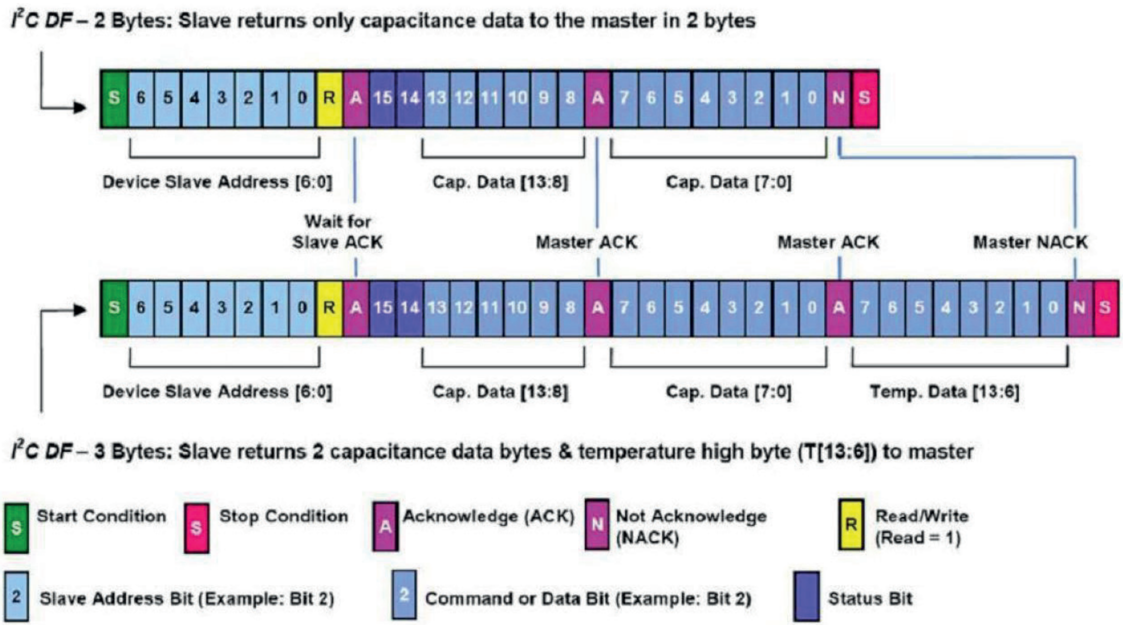

Fig. 8 Measurement packet reads

Reliability of humidity sensor
1) Operating condition
The sensor works stable within recommended normal range – see Figure. 9 Long term exposures to conditions outside normal range, especially at humidity >80%RH, may temporarily offset the RH signal. After return to normal range it will slowly return towards calibration state by itself.

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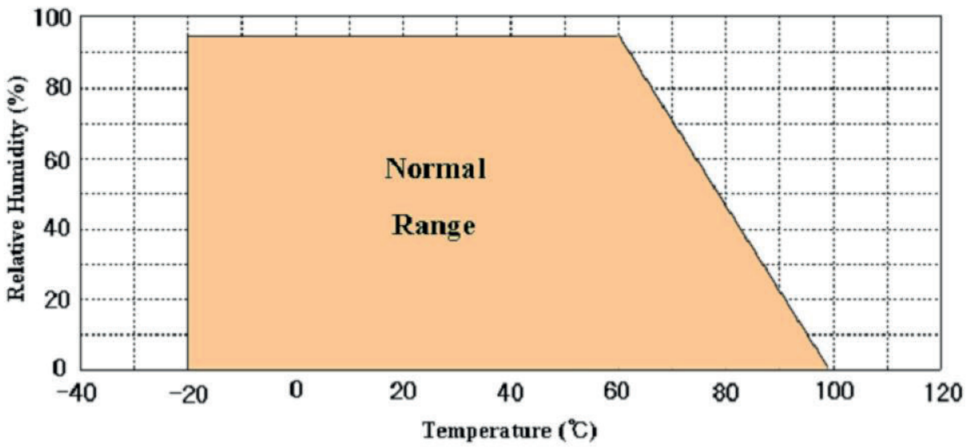

Fig. 9 Operating conditions

2) Reconditioning Procedure
As stated above extreme conditions or exposure to solvent vapors may offset the sensor. The following reconditioning procedure may bring the sensor back to calibration state:
Baking: 100 – 105°C at < 5%RH for 10h
Re-Hydration: 20 – 30°C at ~ 85%RH for 13h

3) Hysteresis of Characteristics
The graph shows the hysteresis curve of HYT-131 sensor. Considering the relative humidity of the sensor, the hysteresis formula is give by
Hysteresis Value = H(10%RH → 90%RH) – H(90%RH → 10%RH)

The hysteresis variety of samples indicate ΔH <±1.5%RH at each humidity point. This result shows that the sensor satisfies our specification. The meter is set to measure humidity value at VDD=5V. For the precise measurement, we used the hygrometer and compared with the humidity of temperature-humidity chamber.

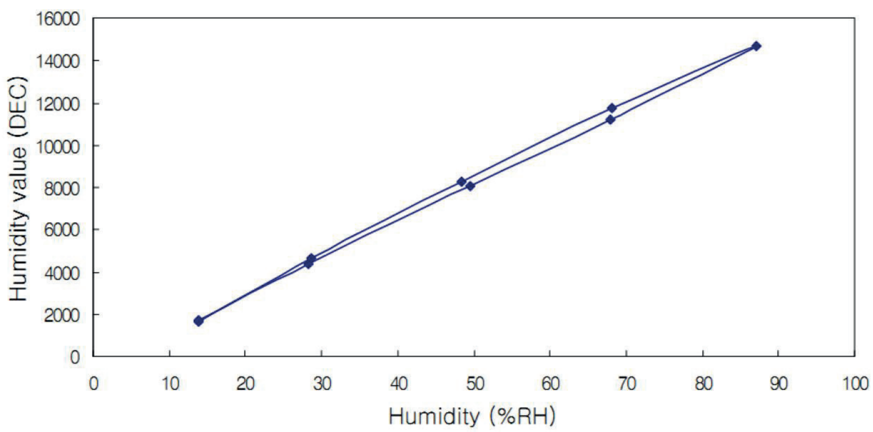

Fig. 10 Hysteresis of humidity sensor

HYT131 code
1) Command List and Encodings

Command byte 8 command bite (Hex)	Third and fourth bytes 16 data bite (Hex)	Description	Response time
00_H to $1F_H$	0000H	EEPROM read of adresses 00H to 1FH after this command has been sent and executed, a data fetch must be performed.	100 µs
40_H to $5F_H$	YYYYH (Y=data=	Write to EEPROM addresses 00H to 1FH The 2 bytes of data sent will be written to the address specified in the 6 LSBs of the command byte.	12 ms

80_H	0000H	Start_NOM Ends Command Mode and transitions to Normal Operation Mode.	
A0H	0000H	Star_CM Start Command Mode: used to enter the command interpreting mode. Start_CM is only valid during the power-on command window.	100 µs
B0H	0000H	Get Revision Get the revision of the part.After this command has been sent and executed, a data fetch must be performed.	100 µs

2) Coding Environment
- MCU: Atmega128
- Compiler: AVR Studio
- MCU Frequency: 16 MHz
- SCL: PORTD Bit0
- SDA: PORTD Bit1
- Power-on reset Enable pin: PORTB Bit0

3) Example Code

3-1) Humidity & Temperature Measurement Data Read Code

```
void Measure_TH(unsigned char Device_Address)
{
// HYT131 Measurement Mode
// 1. Update Mode: The HYT-131 will continuously measure without Measurement
// Request command (MR)
// 2. Sleep Mode: The HYT-131 will only perform conversions when The HYT-131 receives
// a Measurement Request command (MR)
// the user will not be able to change Measurement Mode.

  // Measurement Request (MR) START ---------------------------------------------
 i2c_start();
 write_i2c_byte(Device_Address);
 Delay_us(150);
 i2c_stop();
 Delay_100ms(1);    // Measurement waiting Time
// MR END ---------------------------------------------------------------------------

//Data Fetch
 i2c_start();
 write_i2c_byte(Device_Address | 0x01);
 Delay_us(150);
 DATA[0]=read_i2c_byte(0);
 Delay_us(150);
 DATA[1]=read_i2c_byte(0);
 Delay_us(150);
 DATA[2]=read_i2c_byte(0);
 Delay_us(150);
 DATA[3]=read_i2c_byte(1);
 Delay_us(200);
 i2c_stop();
 ucNack=0;
}
```

3-2) Command List and Encodings Code

```
void Command_Mode(unsigned char Device_Address, unsigned char Command_Byte,
unsigned char Hi_Data, unsigned char Low_Data)
{
 i2c_start();
write_i2c_byte(Device_Address);        // Device Address
 Delay_us(150);
 write_i2c_byte(Command_Byte);         // Command Byte
```

```
 Delay_us(150);
 write_i2c_byte(Hi_Data);           // Third Byte
 Delay_us(150);
write_i2c_byte(Low_Data);        // Fourth Byte
 Delay_us(150);
 i2c_stop();
}
```

3-3) EEPROM READ

```
void EEPROM_READ(unsigned char Device_Address, unsigned char EEPROM_Address)
{
Power_On_Reset();
  Command_Mode(Device_Address, 0xA0, 0x00, 0x00);  //Start_CM
// The I2C slave address is programmed by default on 28H
      // 0x50 => 0x28 (Slave Address[7:1] ) | 0 (Write Mode bit[0])

Command_Mode(Device_Address, EEPROM_Address, 0x00, 0x00);
// EEPROM Read of address 0x00 to 0x1F.
// Words 0x00 to 0x15 EEPROM is unlocked. Words 0x16 to 0x1F are always unlocked.
// The user only will be able to use 0x1E and 0x1F Register.
// 0x1E & 0x1F: 2Byte Customer ID byte

 i2c_start();
 write_i2c_byte(Device_Address | 0x01);  // Device Address | I2C Read Bit 1
 Delay_us(150);

 EEPROM_DATA[0] = read_i2c_byte(0);  // Status Byte
 Delay_us(150);     // DATA[0] = 0x81 Successfully Read

 EEPROM_DATA[1] = read_i2c_byte(0);  // Upper Register Byte
 Delay_us(150);

 EEPROM_DATA[2] = read_i2c_byte(1);  //Lower Register Byte
 Delay_us(200);

 i2c_stop();
 ucNack=0;
}
```

3-3) EEPROM WRITE

```
void EEPROM_WRITE(unsigned char Device_Address, unsigned char EEPROM_Addr,
unsigned char Hi_Data, unsigned char Low_Data)
Power_On_Reset();
  Command_Mode(Device_Address, 0xA0, 0x00, 0x00);  //Start_CM

EEPROM_Addr |= 0x40;
Command_Mode(Device_Address, EEPROM_Address, Hi_Data, Low_Data);
Delay_100ms(2);
}
```


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