HYCON TECHNOLOGY

HY11P13
Application Note
Wide Temperature Range Measurement

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1 Brief Introduction

In real world applications, temperature is often a measured parameter. Temperature is the key factor to complete many production procedures from iron and steel industry to semiconductor manufactures. Temperature sensors bridge the application system to the real world. A miscellaneous collection of temperature applications not only includes temperature control of the manufacturing procedures but also electrical products' internal temperature measurement. For example, computers must monitor CPU temperature, motor controller needs the temperature information on driver IC…etc. This article mainly focuses on the illustration of high precision temperature module that composed by thermistors and single chip.

2 Theory

2.1 Sensor Components

Thermistors are utilized to capture temperature signals. The obtained signals will then be transformed to resistance signal output. HYCON single chip, HY11P13 is applied to measure signal, to operate data and to display the value digitally, as shown in Figure 1. It is a solution that only requires minimum components to complete high precision temperature measurement.

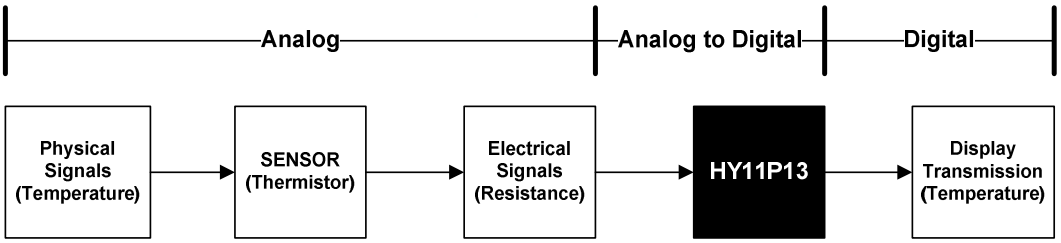

Figure 1 Analog and Digital Signal Conversion

Brief Introduction of Sensors

There is a wide variety of sensors to measure temperature; the thermistor is one of them. Many thermistors equip the characteristic of NTC (Negative Temperature Coefficient), which means the resistance is rising when the temperature is descending. Among all passive temperature sensors, thermistors are relatively high sensitivity (resistance changes with every temperature degree). However, the thermistor characteristics curve which compares resistance against the temperature is non-linearity. The major application of thermistors is to monitor ambient temperature. Its output signals indicate the changes of temperature and resistance.

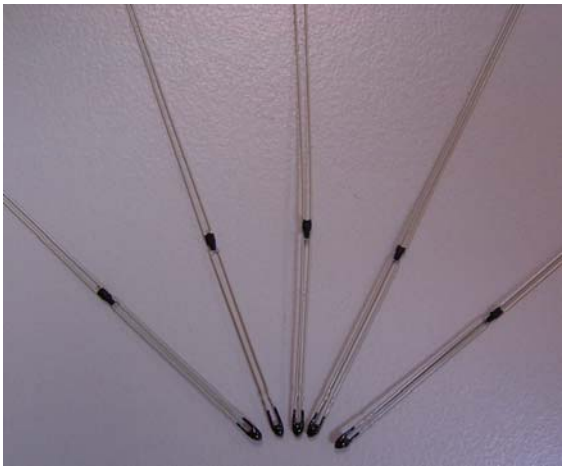

Figure 2 Thermistor

Thermistor：

The resistance will be different according to temperature changes where it is located (Figure 3). It is used to monitor the internal temperature of IR sensor, also being called the ambient temperature while measuring. It is suggested to configure measure error and repeativity less than 0.05°C.

Mathematical formula is listed as below:

$$R_{th}(T) = R_{25} \times e^{\{B\times[(\frac{1}{T+273.13})-(\frac{1}{25+273.13})]\}} \quad \text{…… Equation(2)}$$

R_{th} (T)：Thermistor resistance change value

B：Sensitivity of Thermistor

R_{25}：25℃ Resistor value

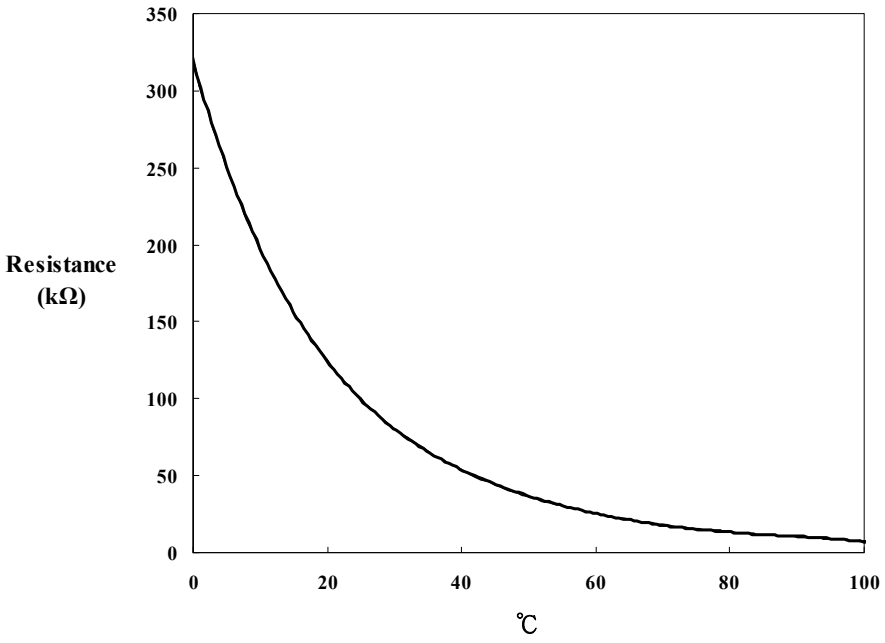

Figure 3：Curve of Thermistor Characteristic

2.2 Control IC

Single Chip Introduction

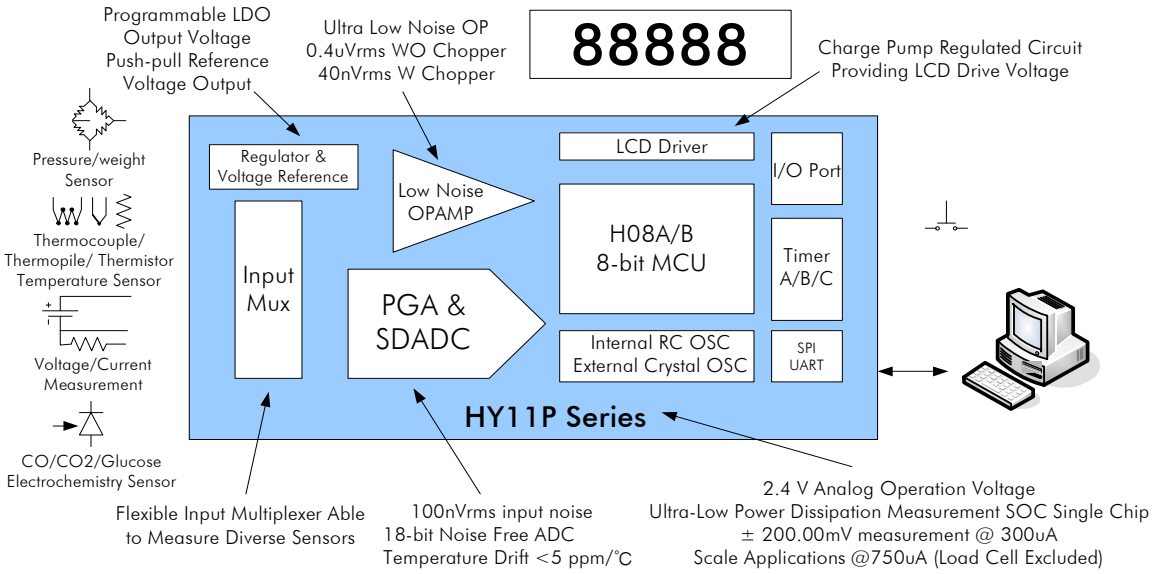

Figure 4 HY11P Series 8-Bit High Performance OTP Single Chip (HY11P13) 5[3]

- 8 bit enhanced RISC. 69 instructions including Hardware Multiplier Instruction and Look-up Table Instruction
- Operating voltage range: 2.0V to 3.6V, Operating temperature range: -40℃~85℃
- External Crystal Oscillator, 6 CPU clock rate enable users to have the most power-saving plan
  - Run Mode 300uA@2MHz
  - Standby Mode 3uA@28KHz
  - Sleep Mode 1uA
- 4K Word OTP (One Time Programmable) Type program memory, 256 Byte data memory
- Brownout Detector and Watch dog Timer prevents CPU from crash
- 18-Bit fully differential input Sigma-Delta Analog-to-Digital Converter(A/D)
  - Build-in PGA (Programmable Gain Amplifier). 1/4x, 1/2x, 1x…128x, 10 input signal gain selection
  - Build-in Input zero point adjustment can increase measurement range according to different application
  - Build-in high impedance input buffer(Not suitable for 32x or upwards input gain)
  - Build-in absolute temperature sensor
- Ultra-Low Input Noise(<1uVpp) OP provides High Output Impedance, small signal amplification and low current voltage transformation
- 1.2 low temperatures drift parameter internal analog circuit common ground that

equips with Push-Pull drive ability to provide sensor driving voltage

- 10mA Low dropout Regulator and low temperatures drift parameter has 4 different output voltage selections.
- 4x20 LCD driver
  - Static, 1/2, 1/3, 1/4 Duty and 1/2, 1/3 Bias Programmable Option
  - Embedded Charge Pump Regulated Circuit with 4 LCD Bias Voltage
- 8-bit Timer A
- 16-bit Timer B With Capture/Compare Function
- 16-bit Timer C Module Generates PWN/PFD waveform
- Serial Communication SPI Module

3 Design Scheme

3.1 Hardware Illustration

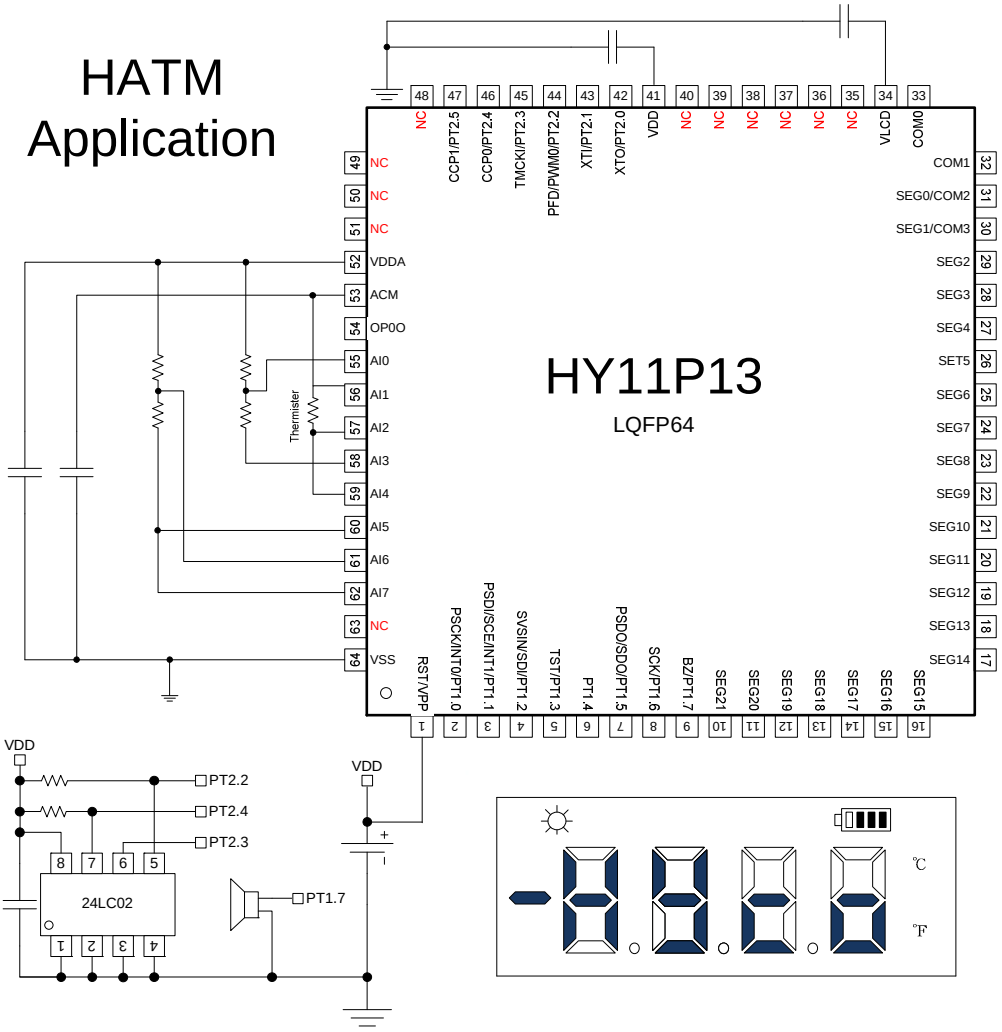

Figure 5 High precision Application Circuit of Temperature Module

Main Components Introduction

MCU：HY11P13, the function is to measure electrical signal, control, operate, and display.

EEPROM：24LC02, the function is to save calibration parameters.

Sensor：104GT, the function is to convert temperature and electrical signal.

3.2 Software Illustration

3.2.1 Program Flow

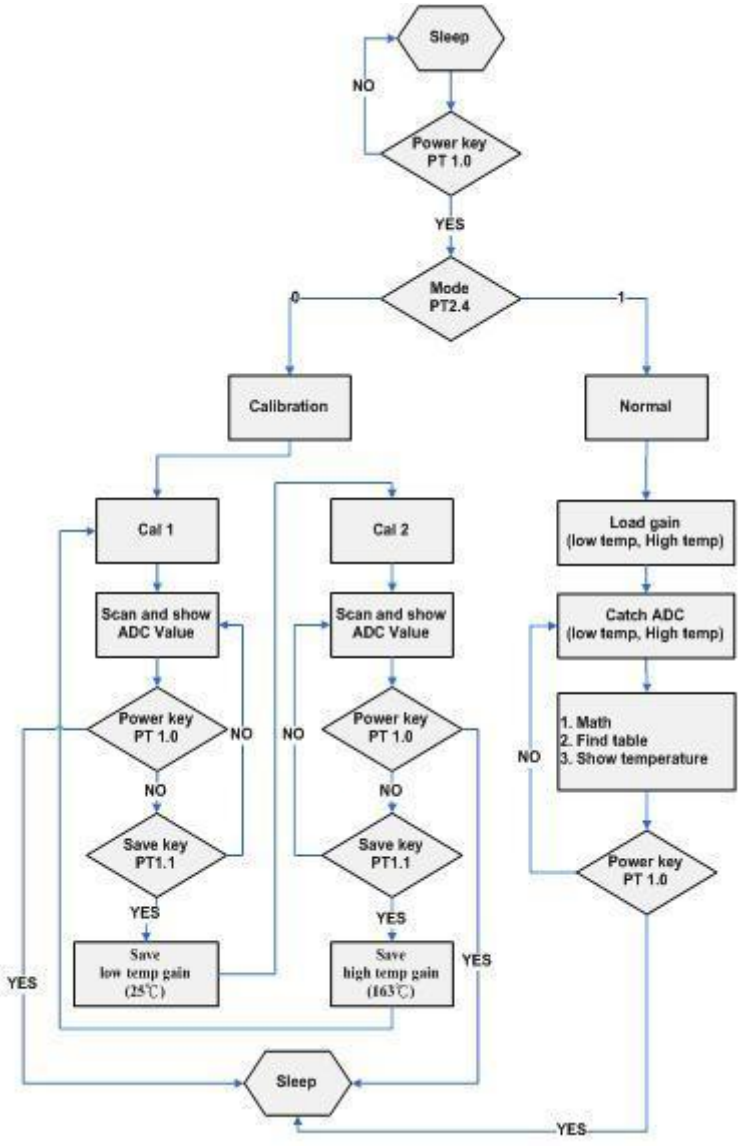

Figure 6 Program Flow

3.2.2 Calibration Flow

Connect PT2.4 to VSS, enter the calibration mode.

Power on (PT1.0)

Cal 1 mode：

The Thermistor calibration @25℃

Push down PT1.1 to save Thermistor Gain in EEPROM

Cal 2 mode：

The Thermistor calibration @163℃

Push down PT1.1 to save Thermistor Gain in EEPROM

4 Technical Specification

Operating voltage：2.4~3.6V
Sleep mode current：0.69uA
Run mode current：0.366mA
Temperature range: 0~300℃
Resolution: 0.01℃

5 References

[1] Global Sources EETimes http://www.eettaiwan.com
[2] ISHIZUKA ELECTRONICS CORPORATION http://www.semitec.co.jp/
[3] HYCON TECHNOLOGY CORPORATION http://www.hycontek.com/

6 Attachment

HATM-02
APD-SD18010 demo

7 Revision Record

Major differences are stated thereinafter:

Version	Page	Revision Summary
V01	All	First Edition
V02	6	Update the description and illustration of Single Chip
	8	Update Figure 5 (revise the pin name)
	10	Add the attachment, Demo Code