HY16F188

Glucose Meter Instruction Manual

Index

Notes:

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1. Content Introduction

This article introduces relevant application in measuring electrical resistance signal, such as wide application in electronic chemical signals regarding to CO concentration meter, CO2 concentration meter, blood glucose meter, and saccharimeter. This article mainly focuses on explanation in blood glucose meter.

2. Theory Explanation

Under normal circumstances, our body naturally converts ingested starch diet into glucose, which becomes an energy source for our live. Insulin is a hormone produced by our pancreas, facilitating glucose to access our cell, so as to produce thermal energy. Since diabetes sufferer’s pancreas produces insufficient or deficient insulin, glucose cannot easily enter body cells to be consumed. As a result, glucose remains in diabetes patient’s blood, further rising blood glucose concentration. Long term high concentration in blood glucose can lead to diabetic retinopathy, chronic kidney disease, neurological disorders (such as cause for amputation), cardiovascular disorders (such as stroke), high blood pressure, weakened physiological function, or sometimes even death. Diabetes incidence has a positive correlation with heredity. Other factors such as obesity, emotional pressure, drug, or physiological nutrition disorder can also result in diabetes.

Diabetes has become one of the major global chronic diseases. “Early diagnosis and treatment” as well as “patient cooperation” have become the golden rule for diabetic control. In addition to long term insulin injection for severe diabetes patients, daily blood glucose testing is also very important for diabetes sufferers. With a combination of drug administration, diet control, and constant monitoring, various diabetes complications can be postponed, further contributing to a healthy live for diabetes patients.

Testing strip is applied here as a sampling source for glucose signals. Through fixture and biasing approaches, electrochemical reaction between testing strip and blood can be stimulated, further transforming into electrical resistance signal output. Through Hycon Technology 32-bit HY16F188, measurement in electrical resistance signal, calculation, digital output and display, as presented in illustration 1. With minimum components, measurement in biasing electrical resistance can be conducted.

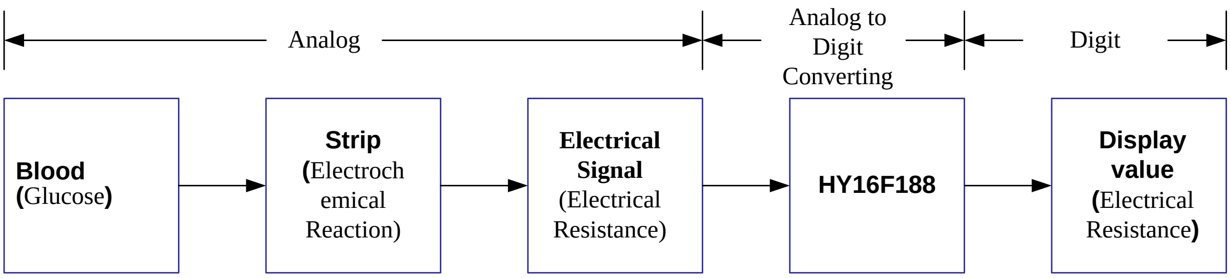


Illustration 1: Converting between Analog and Digit

2.1 Testing Strip Explanation

Since different testing strips are made of distinctive components, this article has adopted equivalent circuit as an investigation subject. Before program development, we must understand some specifications in advance, including equivalent circuit (illustration 2), electrochemical reaction time (illustration 3), and electrical current converting formula,etc.

Equivalent Electrical Circuit

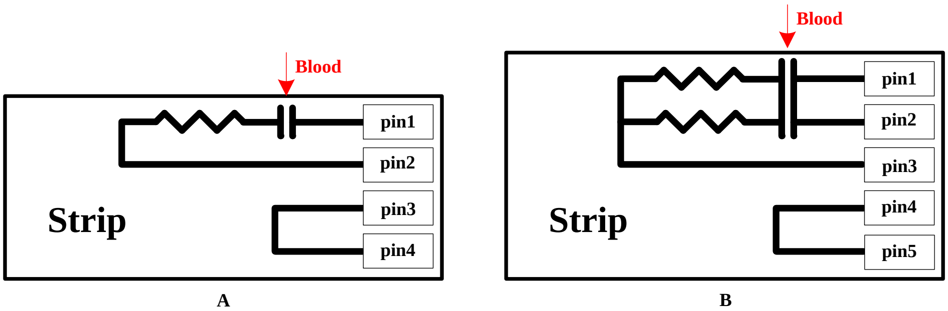


Illustration 2: Testing Strip Equivalent Circuit
A: Single Channel Electrical Resistance
B: Double Channel Electrical Resistance

Electrochemical Reaction Time

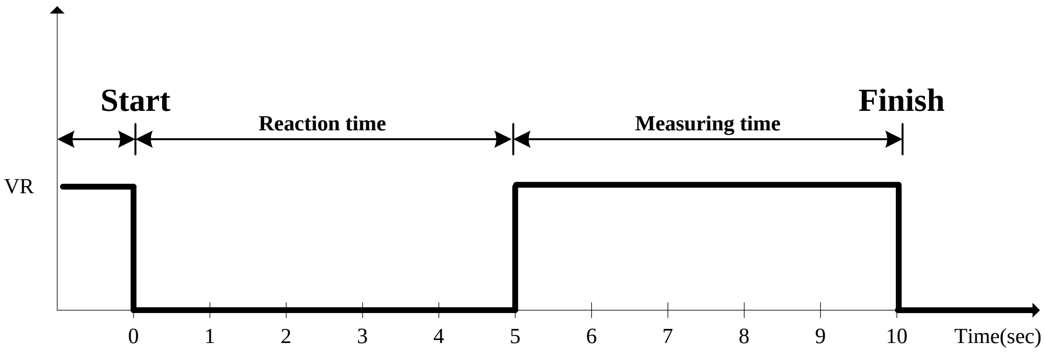


Illustration 3 Electrochemical Reaction Time

VR： Fixed Bias
Reaction time：Testing Strip Responding Time
Measuring time：Testing Strip Measurement Time

Example for Current Converting Formula:

$$Glu\cos e = I \times F(code) \times T(t)$$

I： Electrical Current (μA)
F(code)： Different testing strips yield different values.
T(t): Temperature Coefficient

2.2 Control Chip

Single Chip Microcomputer Introduction: HY16F Series 32-Bit High Performance Flash Single Chip Microcomputer (HY16F188)

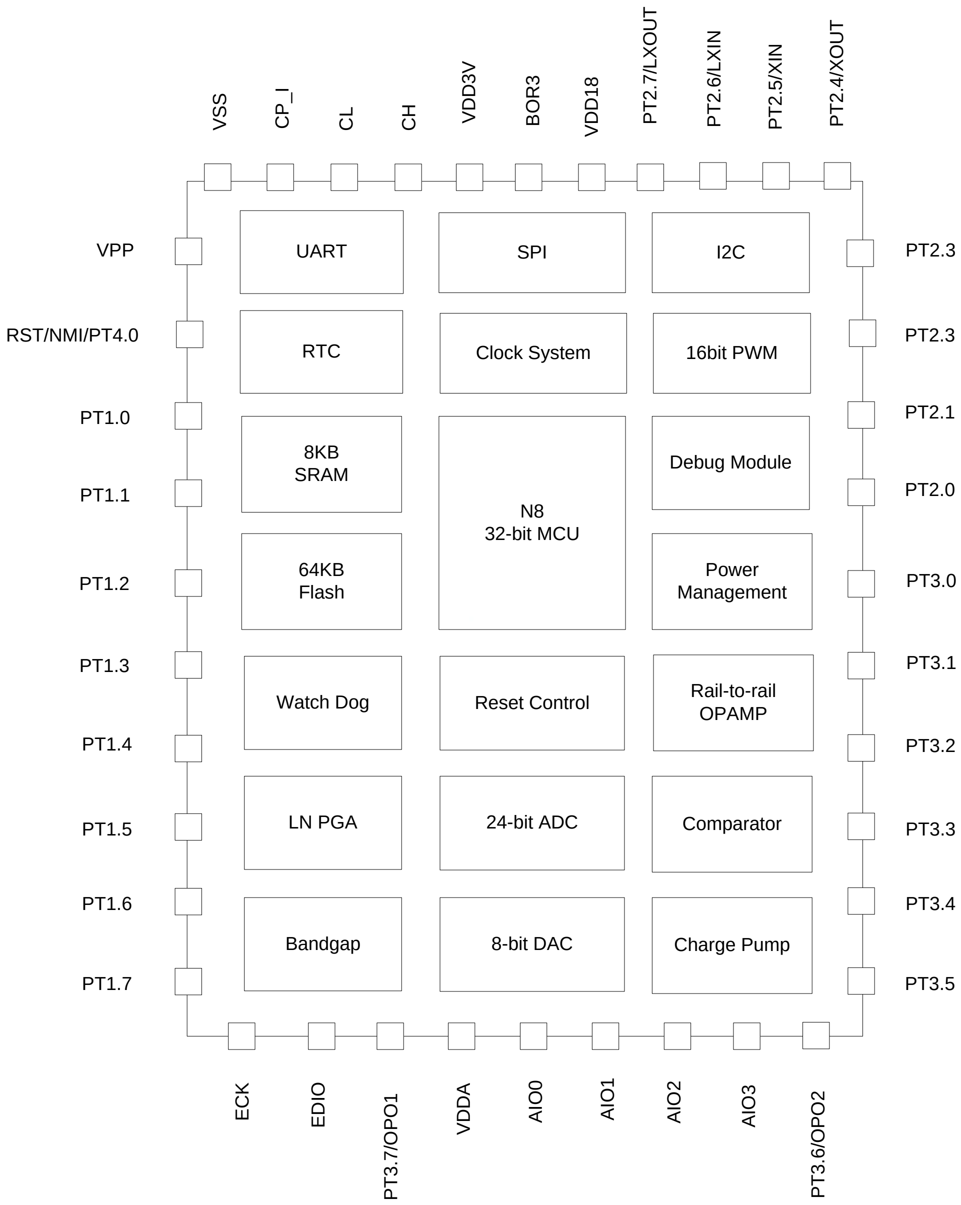


Illustration 4: HYCON HY16F Series 32-Bit High Performance Flash Single Chip Microcomputer (HY16F188)

(1) Adopt the most advanced Andes 32 Bit CPU core N801 processor.
(2) Voltage operation range is 2.0-3.6V, while working temperature range is -40℃-85℃.
(3) Support for external 20MHz quartz crystal resonator or internal 20MHz accurate RC oscillator.

With various CPU working clock converters, users can achieve an optimum power saving program.

(3.1) Operation Mode 350uA＠2MHz/2

(3.2) Idle Mode 10uA@32KHz/2

(3.3) Sleep Mode 2.5uA

(4) Program Memory 64KBytes Flash ROM

(5) Data Memory 8Kbytes SRAM

(6) Through BOR and WDT function, CPU crash can be avoided.

(7) 24-bit Highly Accurate ΣΔADC Analog to Digit Converter

(7.1) Inbuilt PGA (Programmable Gain Amplifier) can make magnification up to 128 times.

(7.2) Inbuilt Temperature Sensor

(8) Ultralow Input Noise Operational Amplifier

(9) 16-bit Timer A

(10) 16-bit Timer B mode is equipped with PWM wave producing function.

(11) 16-bit Timer C mode is equipped with Capture / Compare function.

(12) Hardware Series Communication SPI Mode

(13) Hardware Series Communication I2C Mode

(14) Hardware Series Communication UART Mode

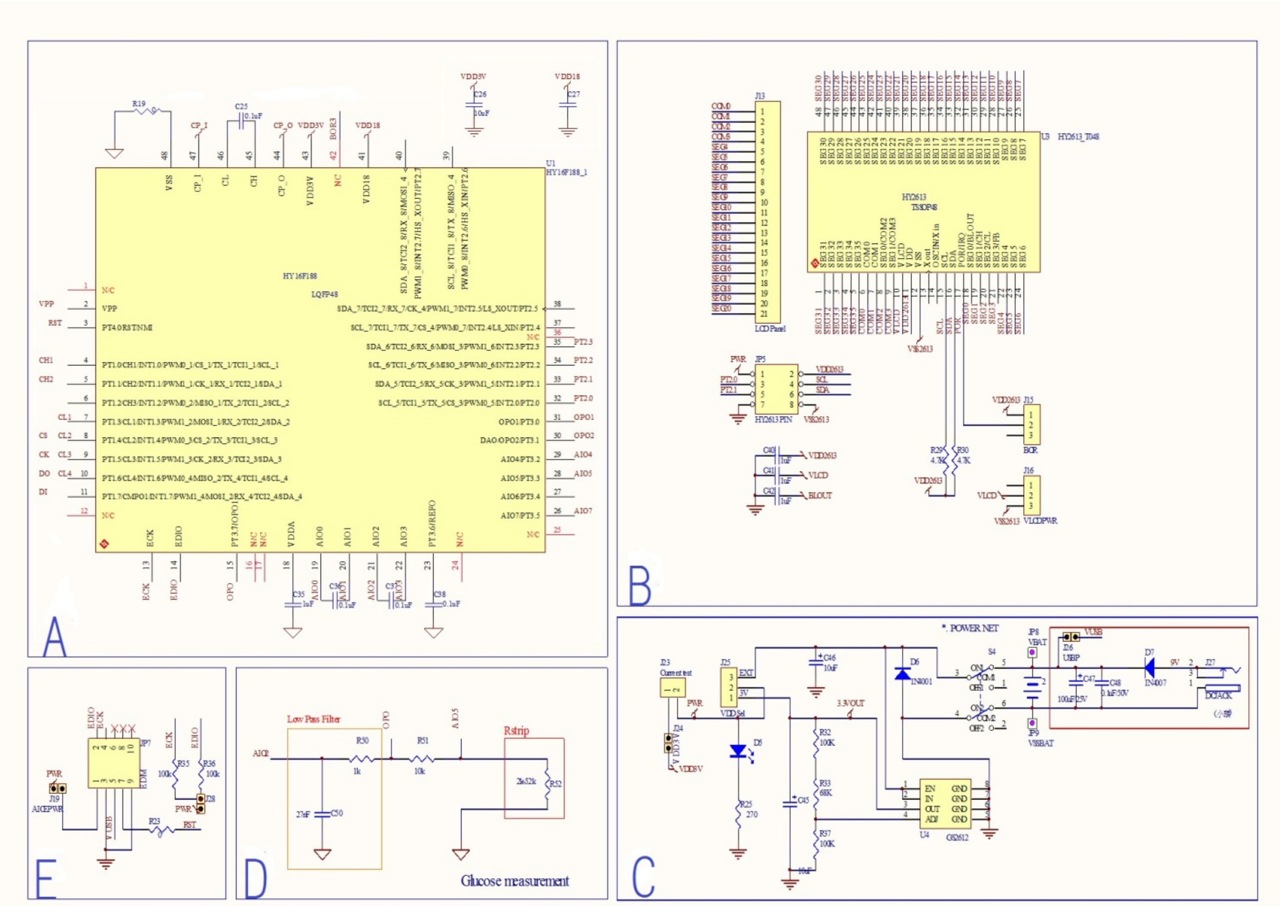
(15) Hardware RTC Clock Function Mode

(16) Hardware Touch KEY Function Mode

3 · System Design

3.1 Hardware Explanation

PCB Electrical Circuit Explanation



(A) Central Processing Unit：

HY16F188 (Andes 32-bit MCU Core + HYCON 24-bit ΣΔADC + UMC 64K Flash)

(B) Display Chip：HY2613 (HYCON LCD Driver LCD Segment 4X36)

(C) Power Supply Electrical Circuit： Power Supply System which Convert 9V to 3.3V

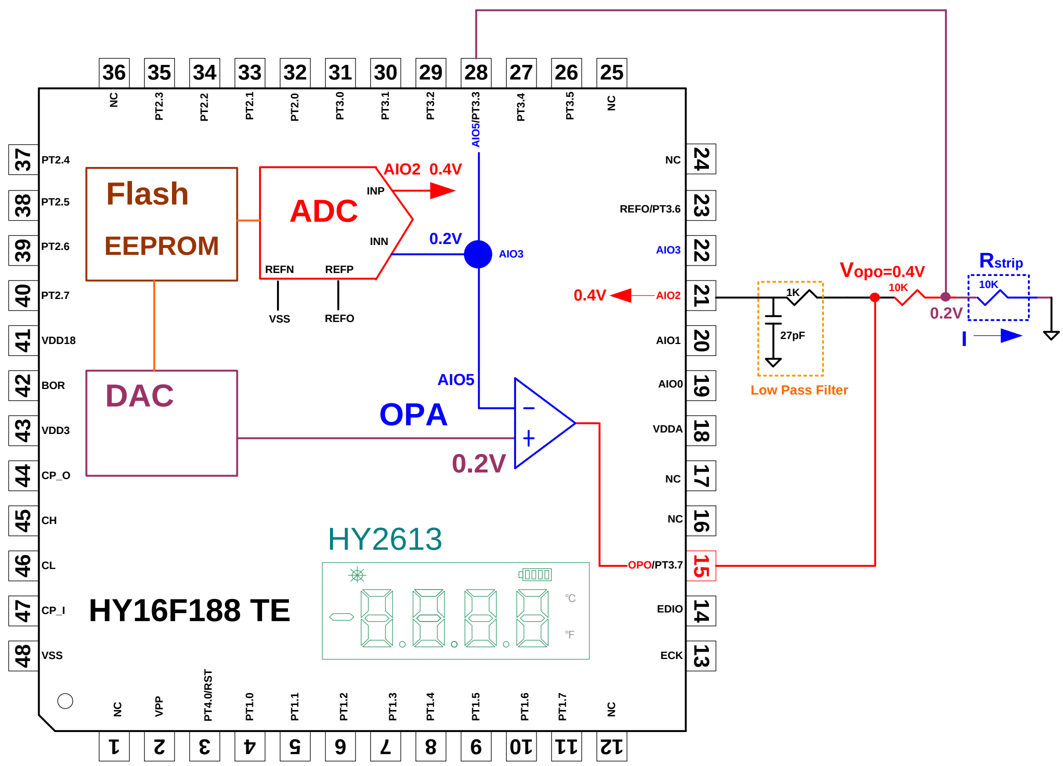
(D) Analog Sensor Mode：

Through one 10 KΩ Electrical Resistance + Low Pass Filter (1KΩ Electrical Resistance + 27nF Electrical Capacity)

The device is able to detect externally inserted testing strip (replaced by electrical resistance approach).

(E) Online Burning and ICE Connection Circuit

Through EDM connection, online burning simulation can be supported. It is also equipped with strong C platform IDE, HYCON analog software analysis and GUI support.



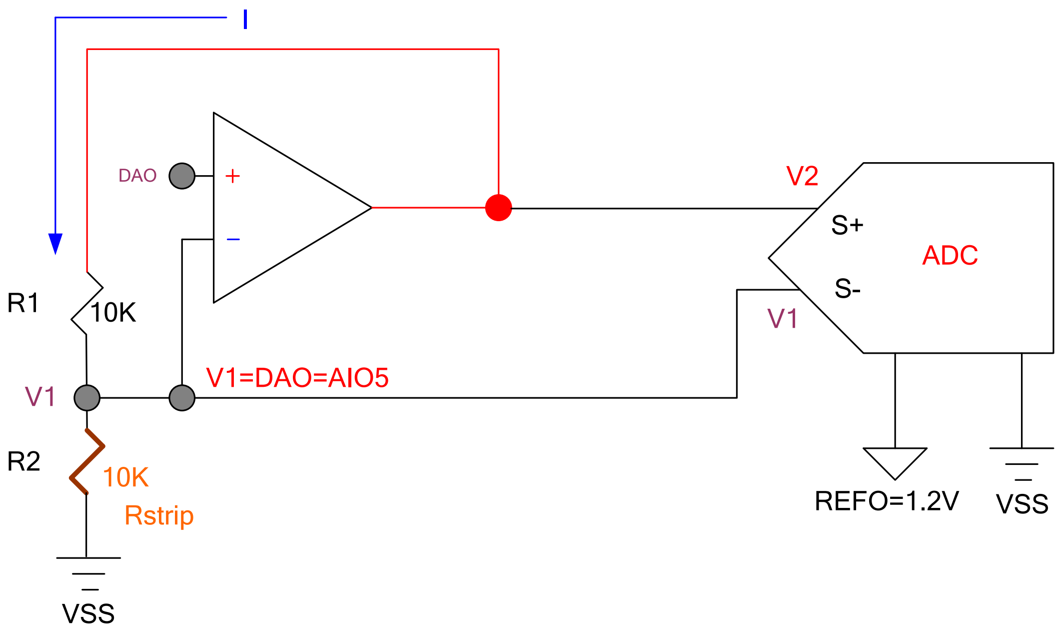
Main Component Introduction

(1) MCU: HY16F188, with a main function of electrical message measurement, controlling, and calculation for saved correction parameters.

(2) HY2613: Responsible for LCD Drive

(3) R_{strip}: This application replaces testing strip with electrical resistance, so as to simulate testing strip electrochemical signals.

3.2 Electrical Circuit Explanation



Step1: $V2 = \frac{R1+R2}{R2}(V1) = (\frac{R1}{R2})(V1) + V1$

Step2: $V2 - V1 = (\frac{R1}{R2})(V1) + V1 - V1 = (\frac{R1}{R2})V1 = R1 * (\frac{V1}{R2}) = R1 * I$

Step3: $ADC = V2 - V1 = R1 * I$

Step4: $I = \frac{V2 - V1}{R1}$

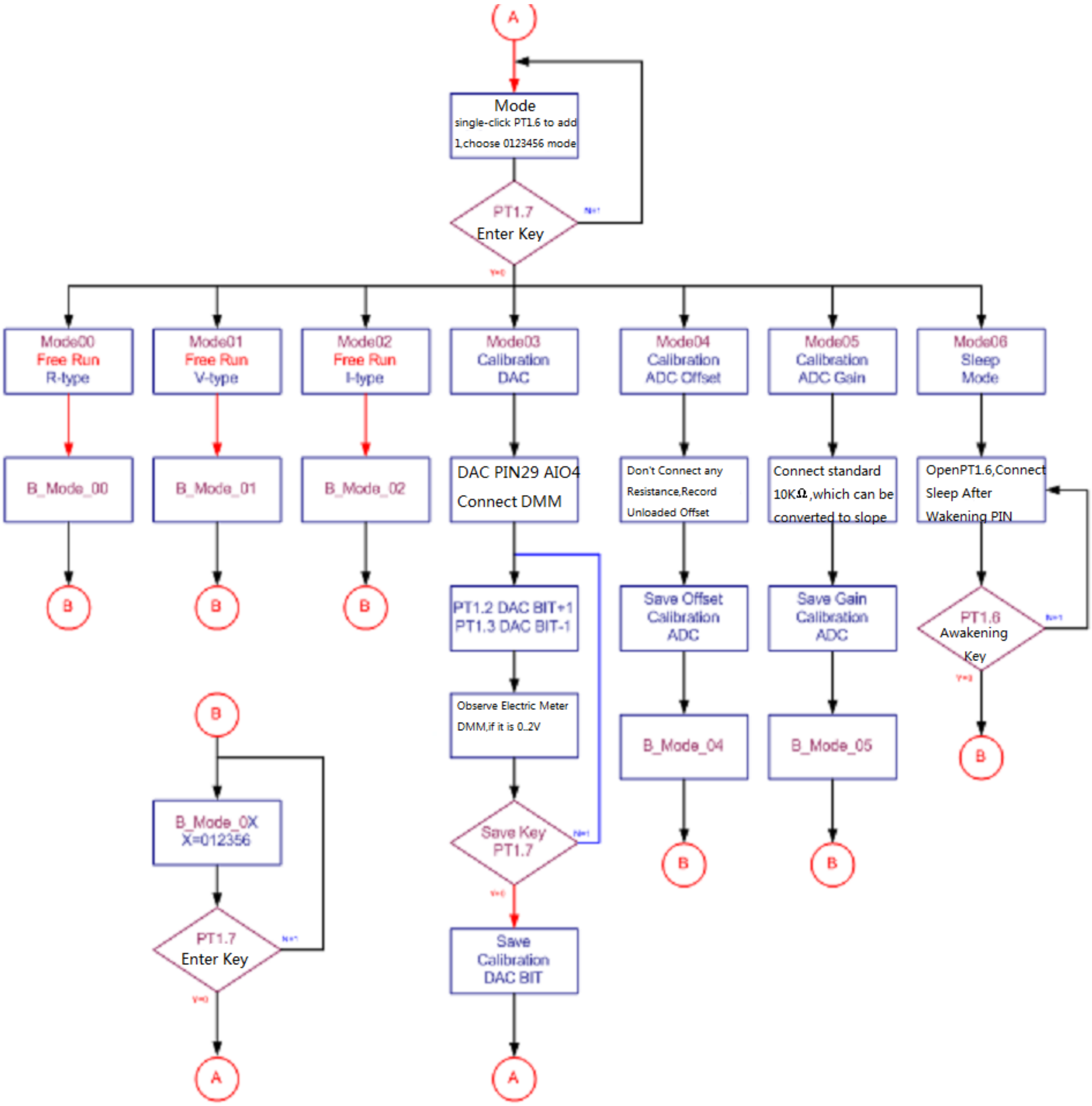
$R1 = 10K \qquad V2 - V1 = ADC \qquad V1 = 0.2V$

$ADC = (\frac{R1}{R2})V1 = (\frac{10}{R2})(0.2) = (\frac{2}{R2})$

$R2 = (\frac{2}{ADC})$

3.3 Software Explanation

Program Flow Chart



4. Operation Procedure

(1) Power ON

(2) Mode Selection (Calibration Included)

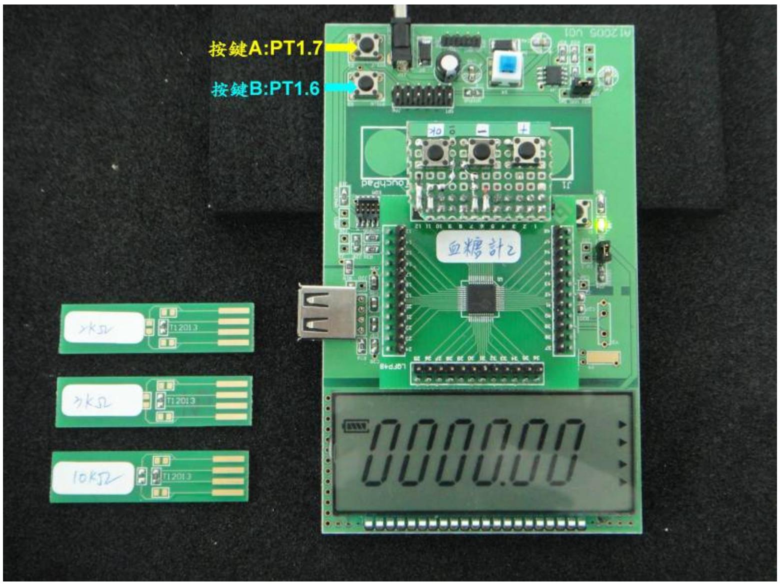
(3) Insert electrical resistance into USB port to start the measurement.

Step 01(Selection Mode)

Insert power supply, mode 0-6 can be displayed on LCD screen.

Button B (PT1.6) is a selection key. Value 1 will be added with each click, ranging from integer 0 to 6.

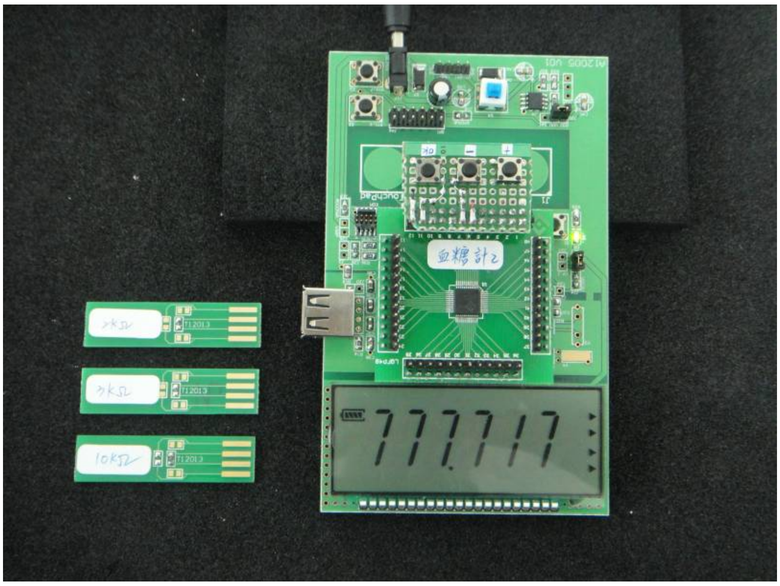
Button A (PT1.7) is a confirmation key.



Step 02 (Confirming DAC)

Button B(PT1.6) is the selection key. By selecting 3, DAC will be adjusted before outputting to 0.2V. Under this moment, electrical meter must be attached to conduct observation.

Through clicking confirmation button A, LCD screen will display 777.717, representing that DAC BIT is equivalent to 17.

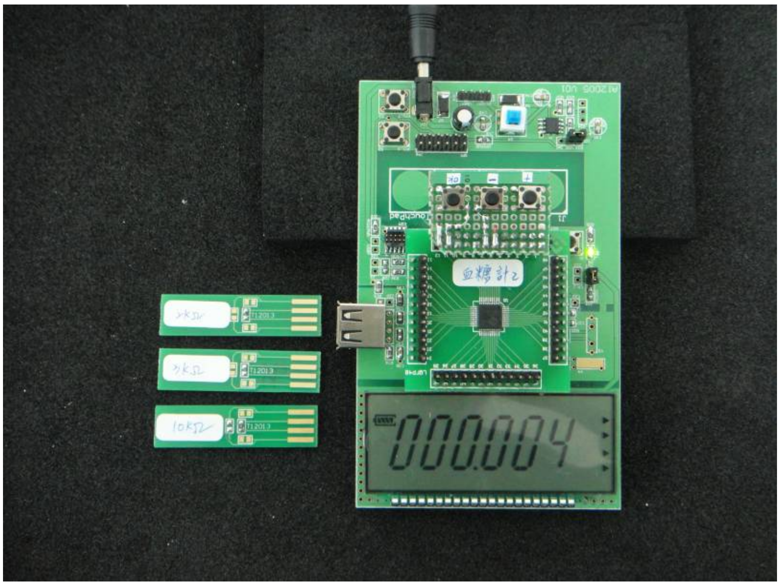


By clicking (+), 1 to 18 can be added to 17. Upon reaching 255, the device will automatically return to its zero setting.

By clicking (-), 1 to 16 can be deducted from 17. Upon reaching a value below 0, the device will automatically return to its zero setting.

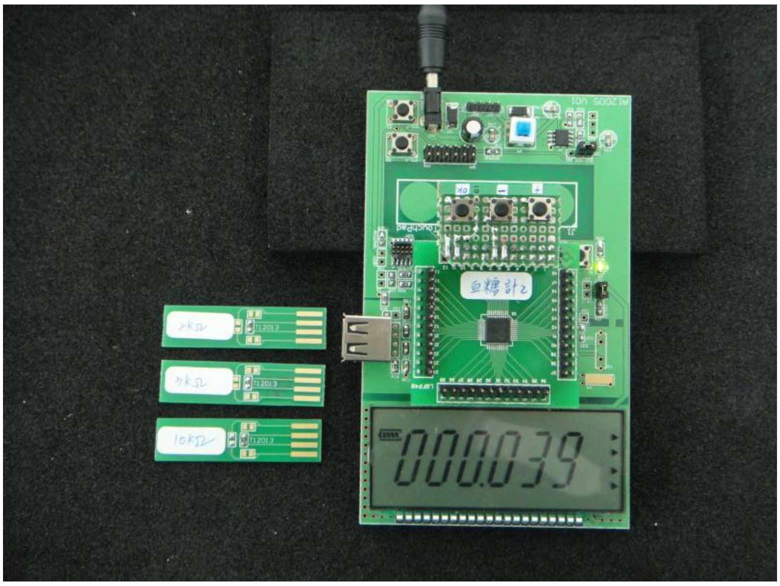
Step 03 (Confirm OFFSET in ADC)

Mode 4: Please click confirmation button A to enter ADC OFFSET for measurement. (Under this moment, terminal to be tested must be idle contact).



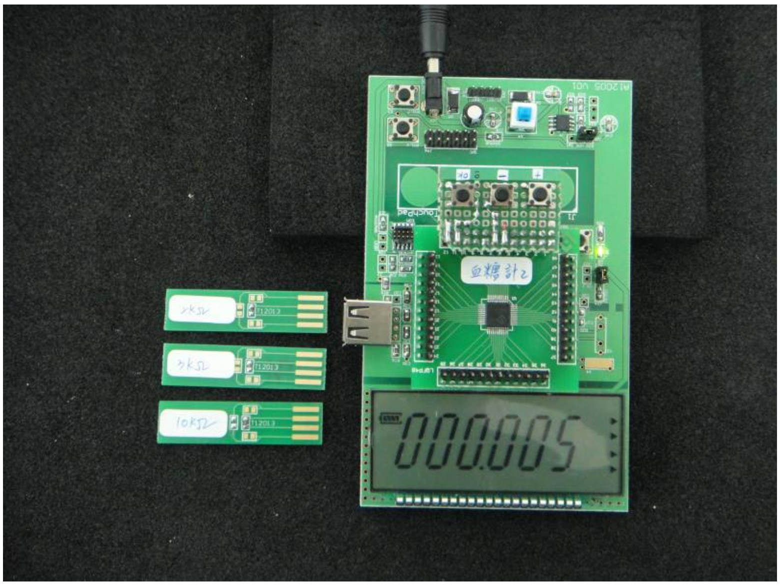
After entering mode 4, LCD will present ADC OFFSET value (39).

By clicking confirmation button A, ADC OFFSET will be saved.



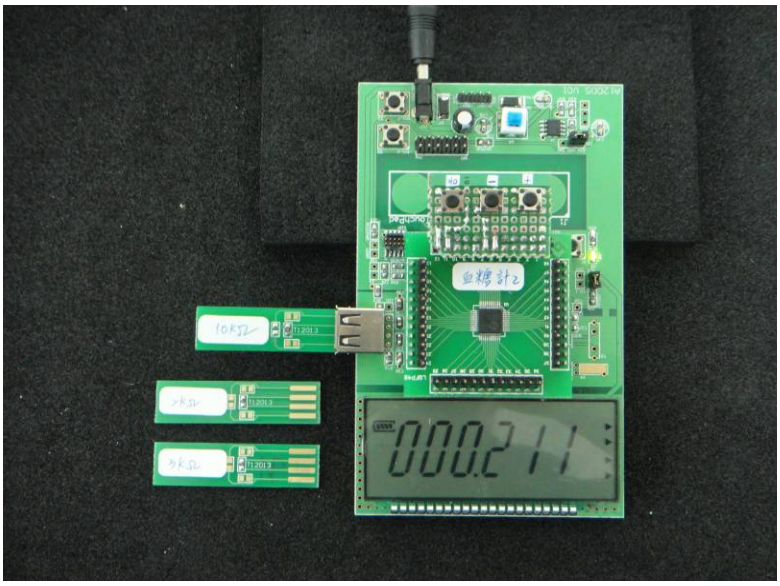
Step 04 (Please confirm ADC Gain)

Mode 5: Click confirmation key A to access ADC Gain measurement (Under this moment, terminal to be tested must be connected to 10KΩ electrical resistance).



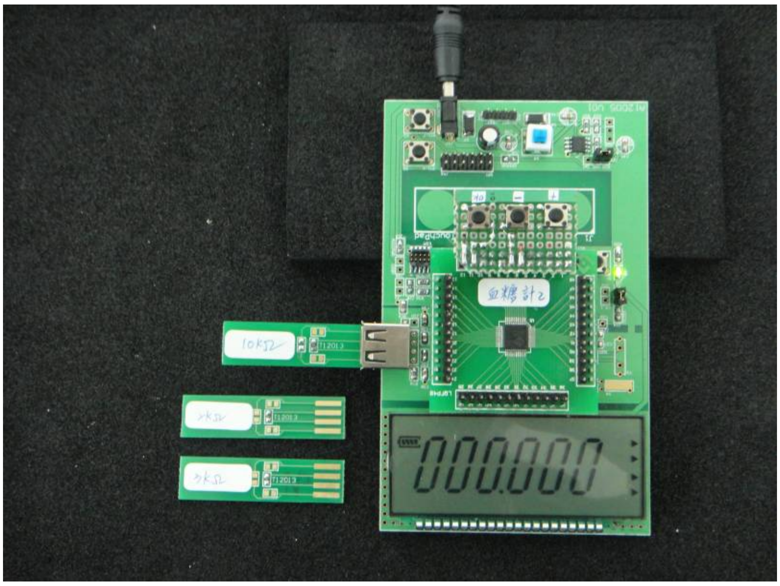
After accessing mode 5, LCD will display ADC slope (211).

Once clicking confirmation button A, ADC slope will be saved.

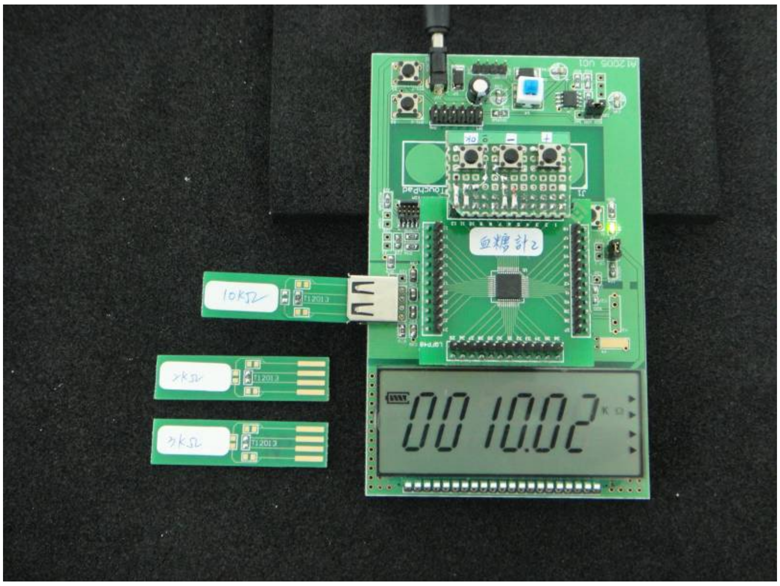


Step 05 (Accessing continuous measurement mode.)

By clicking button B, mode 0 will be selected.



Click confirmation key A to access continuous measurement mode (10KΩ electrical resistance)



5. Technical Specification

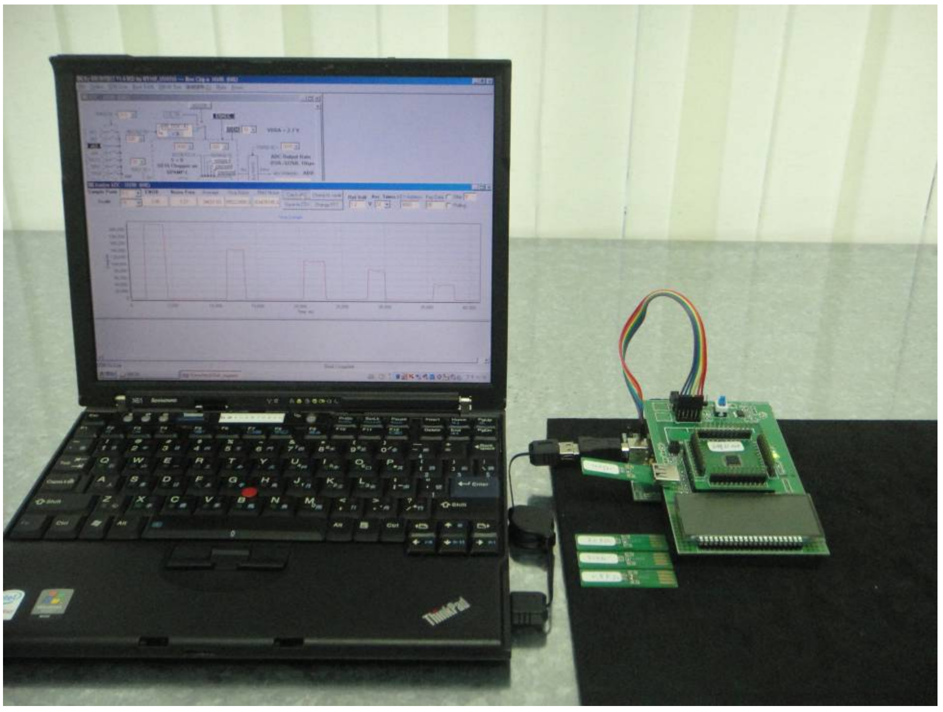
(1)Operation voltage：2.4~3.6V
(2)Operation current：1.5mA@HSRC=2MHz/2(3.3V)
(3)Sleep mode current：2.5uA
(4)Environment Temperature:25℃
(5)Resolution: 0.01KΩ
(6)Testing Range：2KΩ~47KΩ
(7) Error is approximately 0.5%.

5.1 Testing Data

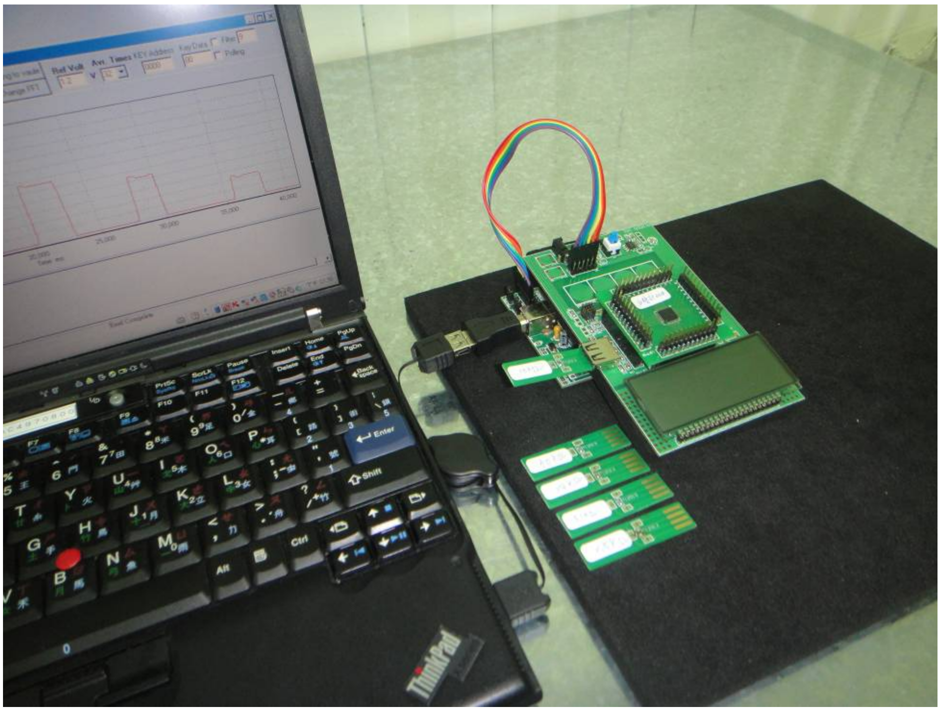
SMD Resistance	A	B	(A-B)/A
Rstrip Resistance Label Value (Theoretical KΩ)	Connect to DMM electrical chart measurement (Practical KΩ)	HY16F Display (Practical KΩ)	A and B error %
2	2.00	1.99	0.50
3	3.00	2.99	0.33
3.92	3.91	3.89	0.51
4.32	4.31	4.30	0.23
5.11	5.10	5.09	0.20
5.62	5.63	5.62	0.18
6.04	6.05	6.04	0.17
10	10.05	10.02	0.30
11	10.99	10.97	0.18
12	12.09	12.06	0.25
17.4	17.54	17.51	0.17
20	19.98	19.96	0.10
24	24.13	24.08	0.21
30	29.94	29.91	0.10
47	47.54	47.78	-0.50

6. Experiment Record

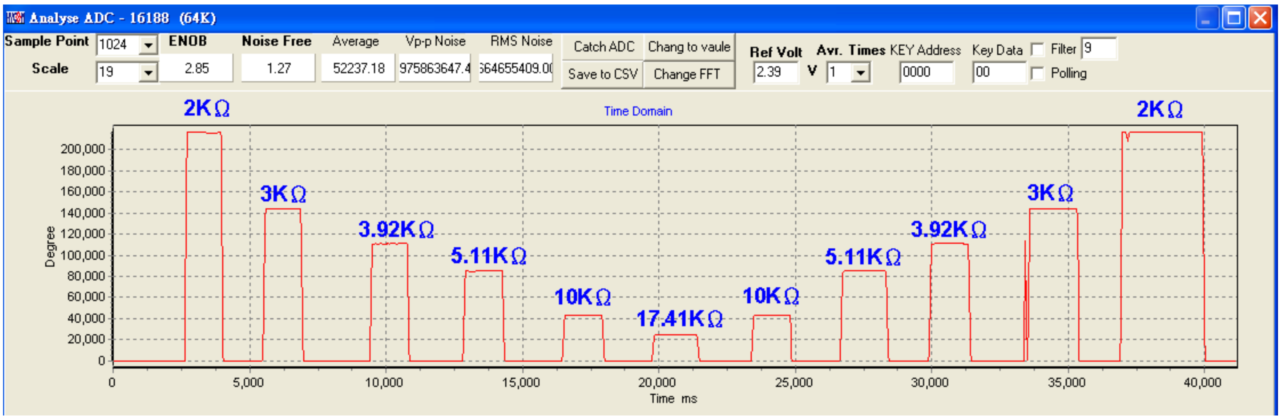
Through connecting ENOB TOOL, tests corresponding to different electrical resistances can be conducted. (Integral Graph)



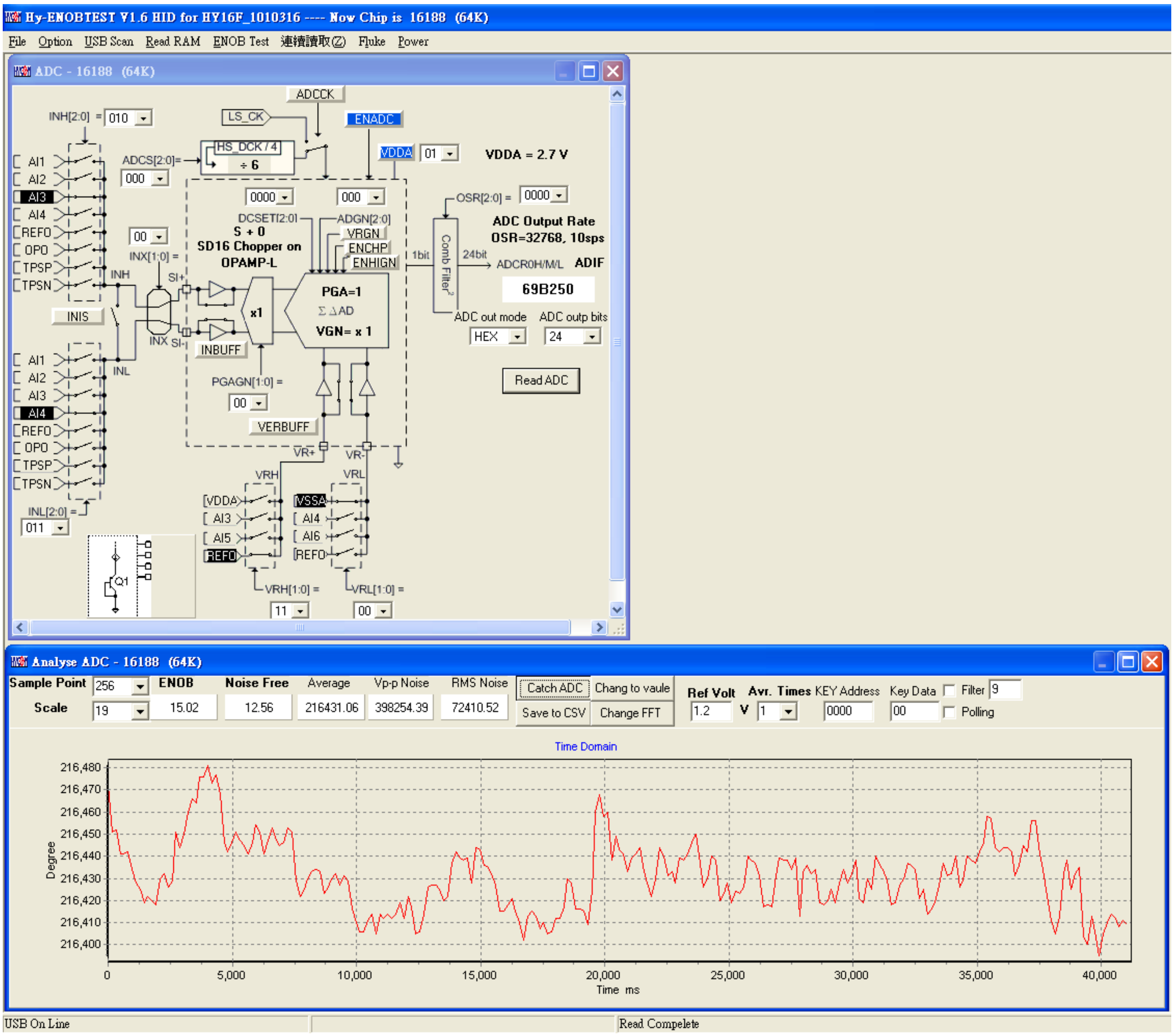
Through connecting ENOB TOOL, tests corresponding to different electrical resistances can be conducted. (Connection Approach)



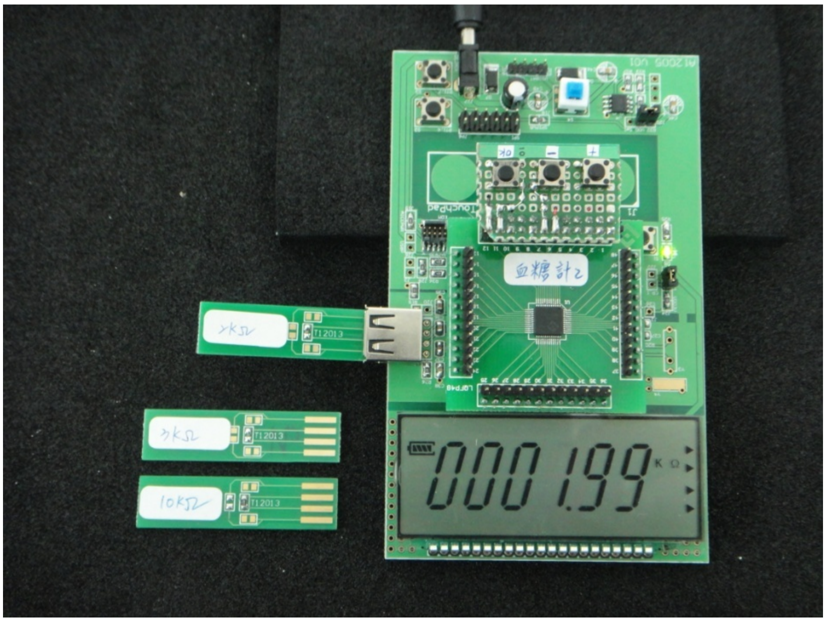
Through connecting ENOB TOOL, tests corresponding to different electrical resistances can be conducted. (Software Display)



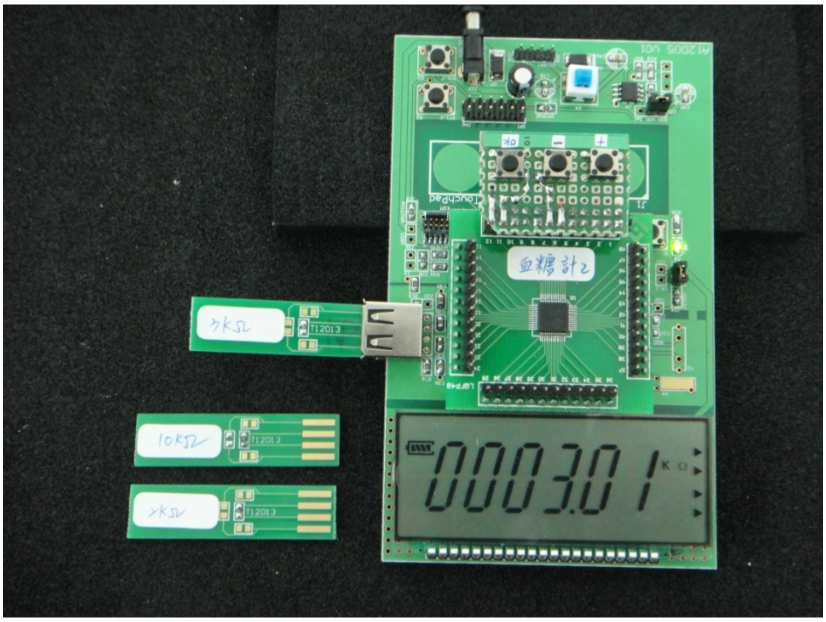
By connecting to ENOB TOOL (software display) (2KΩ), average value will be (216431.06).



Test with different electrical resistances (2KΩ) under 9V power supply.



Test with different electrical resistances (3KΩ) under 9V power supply.



7. Attached Document

HY16F002V03.rar

8. Referential Literature

(1) Chien-Nen Liao “Research and Implement on the Intelligent Glucose Meter” master's thesis, Department of Bioengineering of Datong University, 2002

(2) Freescale Semiconductor Application Note AN4364(Glucose Meter Design)

9. Amendment Record

Greater differences in the document are presented below, with variation in punctuation and font excluded.

Version	Page Number	Amendment Summary	Date
V1.0	ALL	Initial Version	11/23
V2.0	ALL	Changes in PIN Name: VDD->VDD18	12/13
V3.0	Page21	Amendment Procedure	2014/12/17