HY11P Series

Auto Wake up and Reset Zero without On/Off Switch

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1. Brief Introduction

The high accuracy measuring products working by battery usually enter the sleep status after measuring a long-term unchanged signal to save the consumption of the battery capacity and lengthen the battery service life. It needs generally to use the digital switch to awaken the system when restarts measuring. If it can carry out to awaken the CPU to restart measuring when the measuring signal is slightly changed, and the average of the current consumption is small enough during the sleep mode, the battery service life may surpass above one year. This let many products that need a long-term monitoring to the measuring signals can work by batteries and increases the convenience on the utility of products.

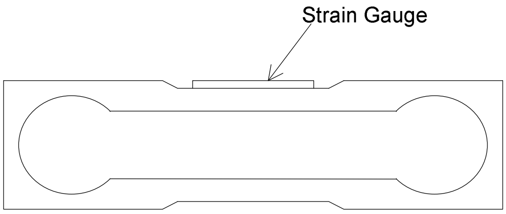
This article introduces the electronic scale that uses the HY11P13 chip produced by HYCON to accomplish the auto-start without switches and fast measurement. When the electronic scale is in the sleep mode, if we put the weight over 1% full scale, the electronic scale will awaken automatically, and display the measuring result in 2~3 seconds. The average current consumption of the whole system in the sleep mode is approximately 20uA, even if uses the CR2032 button battery; it can also be used over than one year.

HYCON's HY11P series chips are built-in high resolution ΣΔADC, Programmable Gain Amplifier (PGA) and LCD Driver 8 bit MCU. The built-in 2.4V linear voltage regulator, low analogical working voltage, programmable ADC measuring speed (1KHz~8Hz) and the fast MCU start function let us may achieve easily what we need without the external connection driving components.

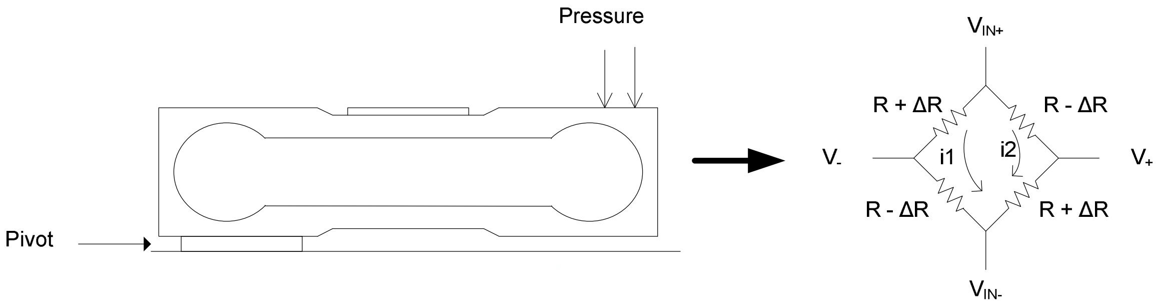
2. Theory

2.1. The Measuring Theory of The Electronic Scale

The theory of Load Cell is to paste one piece of Strain Gauge, which is composed of the bridge resistance on the aluminum-made stick.



When the aluminum stick receives the pressure and distortion will cause Strain Gauge resistance to produce ΔR change.



Therefore the voltage produced by ΔR change in both ends of the signals is

$V+ - V- = \Delta R/R \times (Vin+ - Vin-)$

Convert the physical quantity of this voltage change to the digital signals through ADC and show them up via the display.

But because this voltage change is approximately the mV signal (because ΔR change is much smaller than R), to make a high accuracy scale, the processing signal will approach to 0.1uV. Generally, the R of Load Cell used in the kitchen scale is approximately 1KΩ, but the greatest full-scale ΔR change is also only 1Ω. If V_{IN+}-V_{IN-} voltage is 3V, then the output signal V_+ - V_- voltage is also only 3mV. For 5000 Count kitchen scales, 1 cell stands for only 0.6uV.

The measuring system usually indicated by its input RMS Noise or Peak to Peak Noise (Vpp noise) to see if it can satisfy the small signal measurement. Vpp =6.6 Vrms (±3.3s). To achieve displaying not rolling completely, the Vpp must be smaller than the voltage of 1 cell. For the above example, Vrms must be smaller than 90nV.

2.2. Theory of Auto-start Without Switches

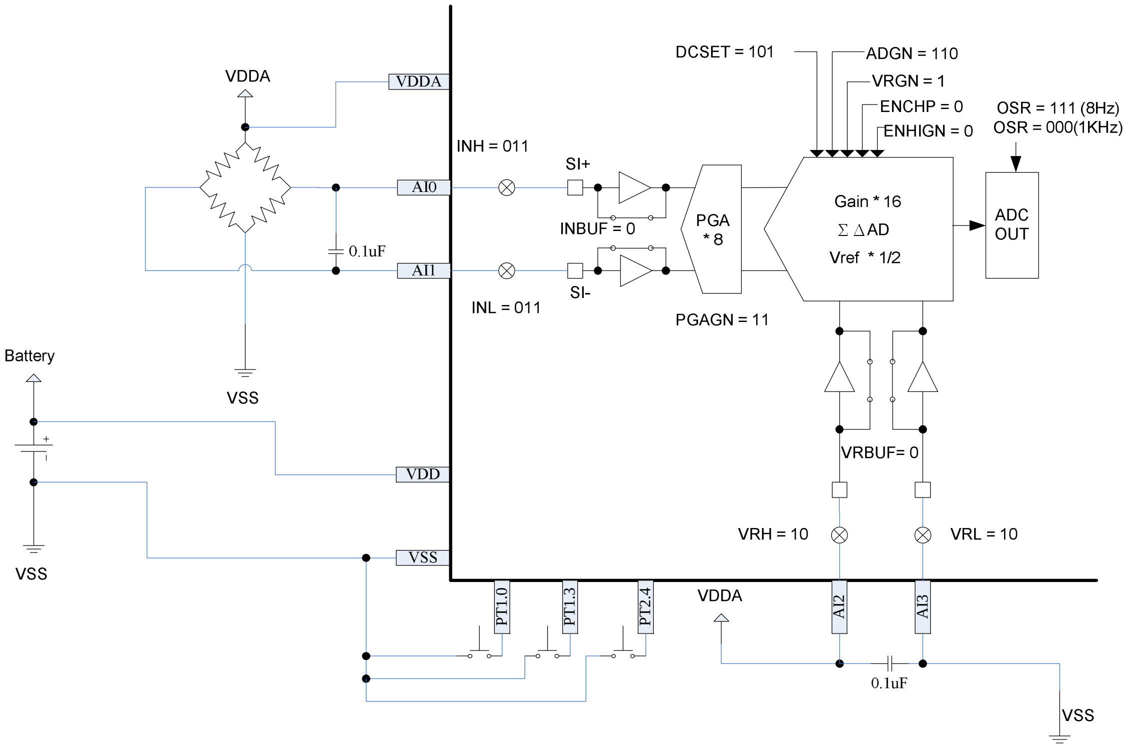
For the products powered by batteries, we usually guaranteed that the battery service life is bigger than 1 year at least, that is, if use the 200mAhr battery, its average current consumption must be smaller than 200mA/(365 x 24) = 22.8uA. 2.4V voltage supplied by Load Cell plus the current consumption of ADC and MCU, the total current consumption is approximately 3mA. If measure one time by each second, we need to measure the stable data within about 6mS. Therefore it is the most essential to provide fast, stable and time-saving measurement.

2.3. Load Cell Creep Phenomenon and Fixed Time Auto-zero

The zero point of the Load Cell itself will drift along with the time, which is generally called the Creep Phenomenon. In order to solve this problem, it usually has the zero reset procedure to start the system in design for the electronic scale products. For the electronic scale without the auto start switches, it cannot operate the zero reset in starting when the weight is already put on it, so except the zero reset procedure to start the system, we also design the procedure of fixed time zero reset to reduce the error caused by the creep phenomenon of Load Cell.

3. Design Plan

3.1. Hardware Construction

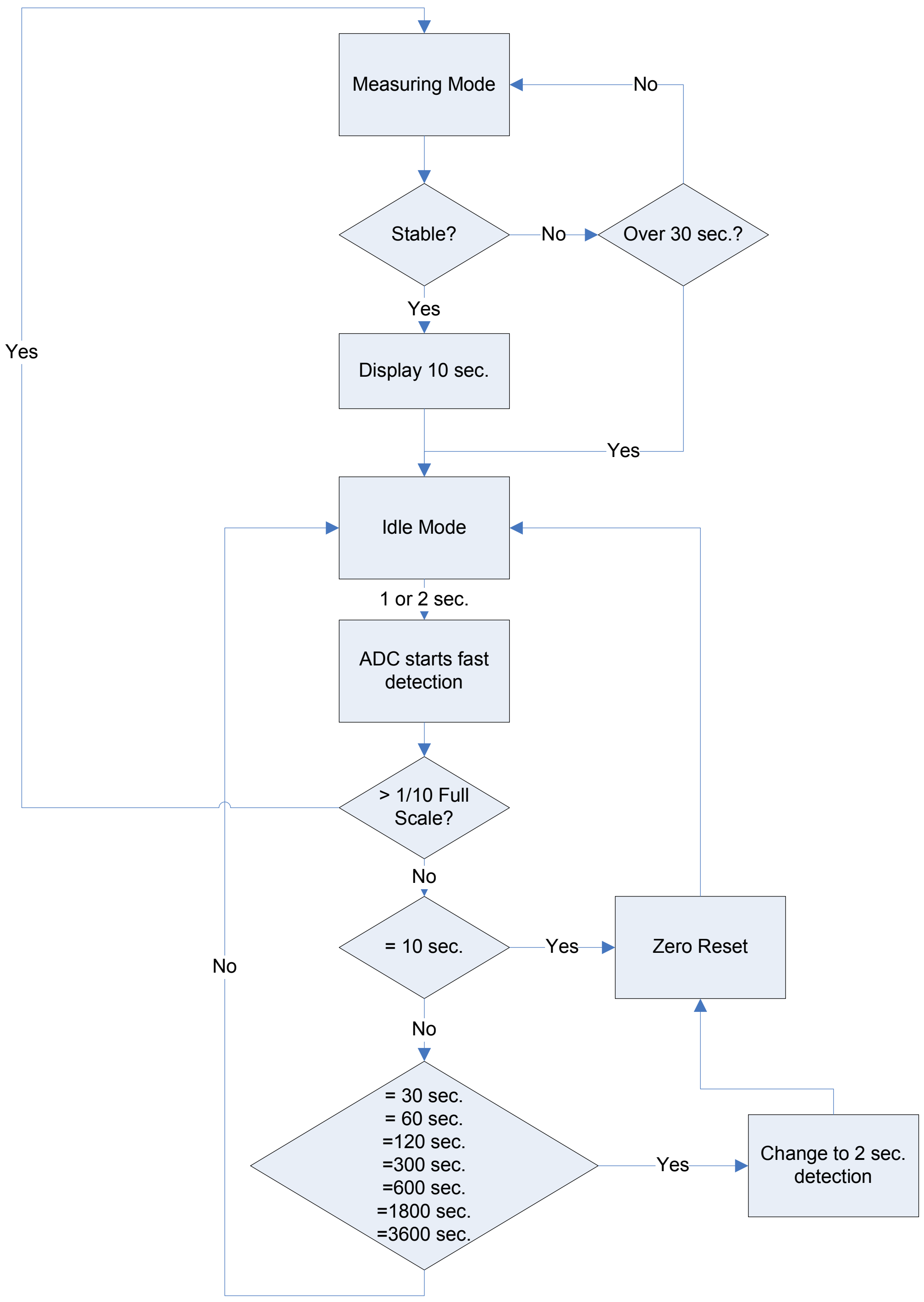


The above figure is the reference circuit diagram to use HY11P13 in the electronic scale. The Load Cell input voltage is supplied by built-in Regulator 2.4V output, Load Cell output signal is 1mV/V, Full Scale output voltage is 2.4mV, ADC internal PGA is enlarged by 8 times, Gain is enlarged by 16 times, and the reference voltage is supplied to VRGN by VDDA-VSS to set 1 (VREF multiply 1/2) that it is equal to input reference voltage 1.2V. Under such setups, RMS Noise input by ADC in 8 Hz output speed is approximately 110nV. If we take 8 records again and average their input RMS Noise, it can be reduced to 40nV approximately that can satisfy completely the demand of making 5000 Counts kitchen scales.

In sleep mode, using the internal Watch Dog to awaken one time per second. In the meantime, start internal power system first and wait for the power being stable, then start ADC. Set ADC output rate as 1KHz, then take the second record of ADC output to adjust if the weight is change. If it is over the critical weight, then start automatically to enter the normal continuous measuring mode, otherwise continues to return to the sleep mode.

Under the normal continuous measuring mode, if the weight is measured not changes over 30 seconds, the system enters the sleep mode. In sleep mode, the system will start operating auto-zero per 10 seconds and expand until one time per hour.

3.2. Software Flow



4. Computing Average Current

Start ADC measurement one time per second. The starting time is approximately 4mS for each time (1mS for starting MCU, 1mS for VDDA power stabilizing and 2mS for ADC measuring). The current consumed during measuring needs approximately 3.15mA (2.4mA for Load Cell, approximately 0.75mA for HY11P12). So, the average current is 3.15mA x 4mA /1s = 12.6uA.

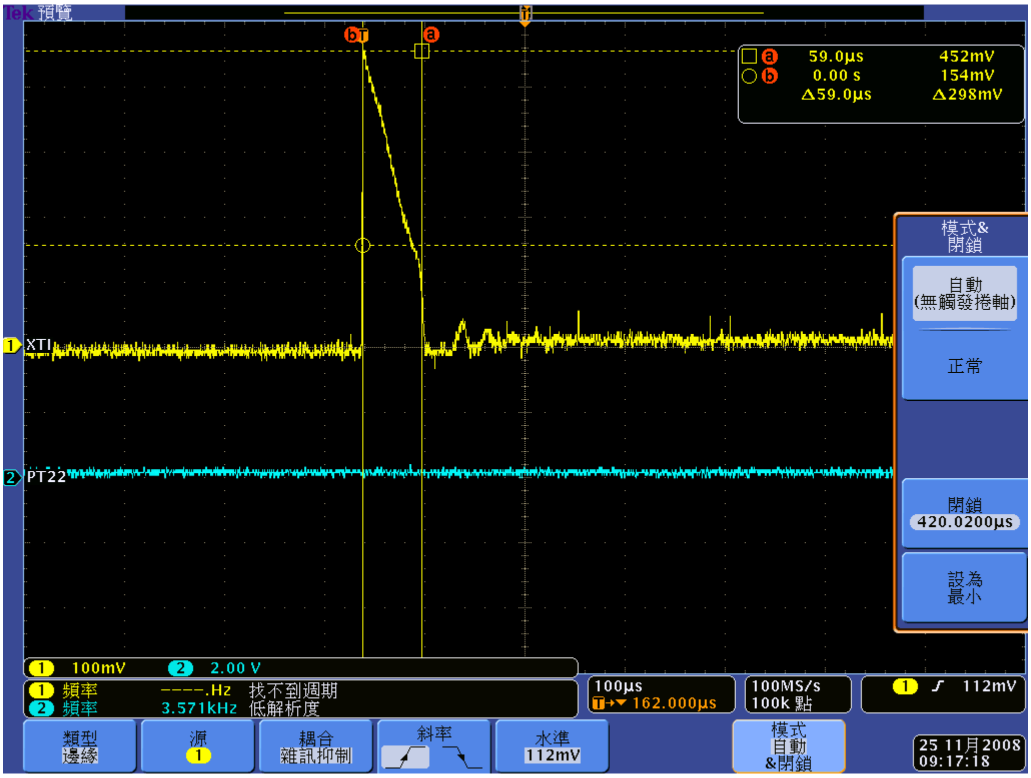
Starting the watchdog in sleep mode needs to consume current approximately 1.65uA. On average auto-zero one time each hour (approximately 1s) needs to consume current approximately 3.15mA/3600s = 0.88uA. To use one time everyday and one minute each time, the average of the current consumption is 3.15mA/1440= 2.19uA.

Another computation what could be possibly neglected is the current that is needed to charge the VDDA external capacitor. Theoretically, it needs at least the average current (by charging and discharging one time each second) I= C x V/t = 2.4V x 1uF /1s = 2.4uA. The below figure indicates the observation from the oscilloscope of connecting VDDA to1uF capacitor. To start the VDDA voltage differential instantly (the sense resistance of the current is 6Ω), the average current to start ADC each second is approximately 17uA, and approximately 8.5uA for every 2 seconds. The current of zero reset each time (approximately 1 second) is 3.15mA/S. The average current within 3600 seconds not entering the Normal Mode is:

$$[(17uA\times10S)+(3150uA\times8S)+(8.5uA\times3590S)]\div3600S \fallingdotseq 15.5uA$$

4.1. VDDA Starting Instant Current

The below figure indicates the observation from the oscilloscope of connecting VDDA to1uF capacitor. To start the VDDA voltage differential instantly (the sense resistance of the current is 6Ω)



VDDA average current ≒((51mA × 59uS)÷2)+(23mA×59uS)

= 2881.2 mA · uS ≒2.8812uA/S

To analyze from above, the total of the average consuming current is approximately 12.6uA + 1.65uA + 0.88uA + 2.19uA+ 2.88uA= 20.2uA

5. Conclusion

This article introduced how to use HYCON's HY11P13 to accomplish the development of the electronic scales that are with auto start without switch. By HY11P13 that is built-in the high resolution ADC, the programmable gain amplifier (PGA), the regulator and the LCD Driver, we need only several constant voltage capacities and EEPROM by external connection to complete the development of the electronic scale. At the same time, its ADC has fast start and provides stable and fast output data that enables us to monitor whether the weight changes by the way of saving the electricity much to accomplish the function of auto start without switches. By the same theory, it may also be suitable for other different sensor's applications, like the tire pressure monitoring, the temperature monitoring, the current monitoring and so on.

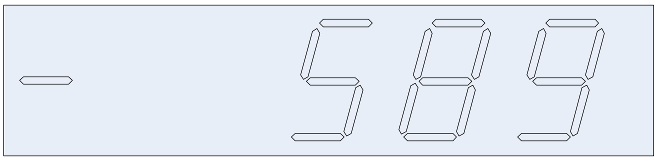
Taking advantage of BIE (Build-In EPROM) function of HY11P32 of HYCON Technology can easily complete electronic scales of auto on without switch development. It only takes some external regulated capacitors to finish the total development. Also, base on the features of ADC fast start and stable data output, we can monitor weight change in an energy-saving way to implement auto start without switch function.

6. Operation Description of The Example Program

6.1. Calibration Description

If there is no calibrating value in EEPROM, the program will enter the calibration mode automatically. To recalibrate, press and hold PT1.7* first, and press Power ON, then release PT1.7.

In calibration mode, the program shows the inner code first.

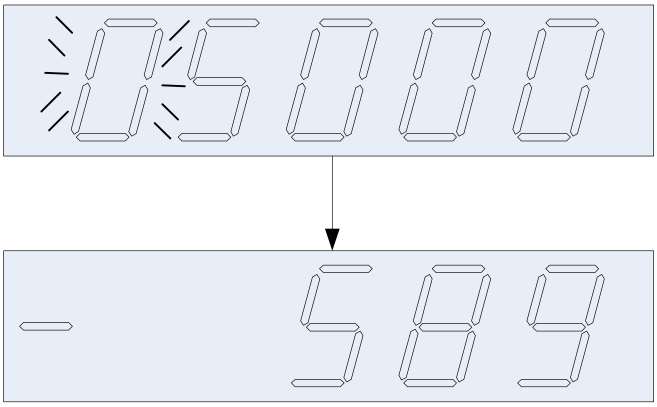


Press PT1.7 to show the fully weight (the largest scale scope).

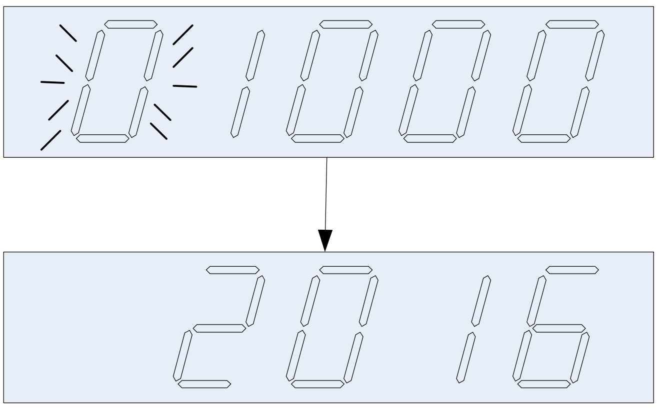
The twinkle number stands for the number waiting for input.

Press PT1.3 to increase the number, 0→9.

Press PT1.7 to shift one right until the last number to enter the zero calibration. It shows the inner code at the mean time, then press PT1.7 again to save zero and go to next process.



After zero calibration is finished, it enters the standard weight calibration.



Press PT1.3 to increase the number, 0→9.

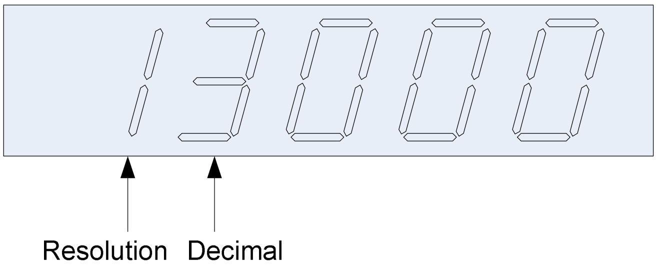
Press PT1.7, digit shifts right. It enters standard weight calibration until the last digit.

Press PT1.7 again, saves the calibration value and enters into the next flow.

After standard weight calibration accomplished, it enters into resolution and decimal bit selection

Press PT1.3, digit ascends from 0→9.

Press PT1.7 to shift one right until the last number to save all values into EEPROM, and then enters the scale mode.



For HY11P13 to enter calibration mode and button is PT1.7. For HY11P32 to enter calibration more and button is PT1.0

6.2. Scale Description

If there is no calibrating value in EEPROM, the program will enter the calibration mode automatically.

Button PT1.7 → Zero or Tare

When the weight is smaller than 1/10 of the fully weight, the button is for Zero function.

When the weight is bigger than 1/10 of the fully weight, the button is for Tare function.

Button PT1.3 → Switch of inner code and weight.

40div is defaulted as the determination of auto start.

About 5 seconds after scale stabilized, the program enters to sleep mode.

After 30 seconds of successive scale instability, the program enters into sleep mode.

For HY11P32

If there is no calibration value of BIE of the chip, the program will automatically enter into calibration mode.

Press PT1.0→Zero or Tare

This product has no internal resolution digit and weight switch display function.

6.3. Auto Zero

When the weight is within zero +/- 1 div, and maintains steady state 1 second, the program will be Auto Zero. The function of Auto Zero will be not available if the weight is bigger than 1/10 fully weight.

When the weight lowers than 40div and lasts for 30 seconds, it is deemed as zero action.

It will take about 7 seconds for stabilization after zero, the program enters into sleep mode.

6.4. Example Program


HY11P13 AutoON.rar


Auto_ON_HY11P32.rar