2000 Counts Solar Energy Weighing Scale HY13P56 Application Instruction Manual

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1 Introduction

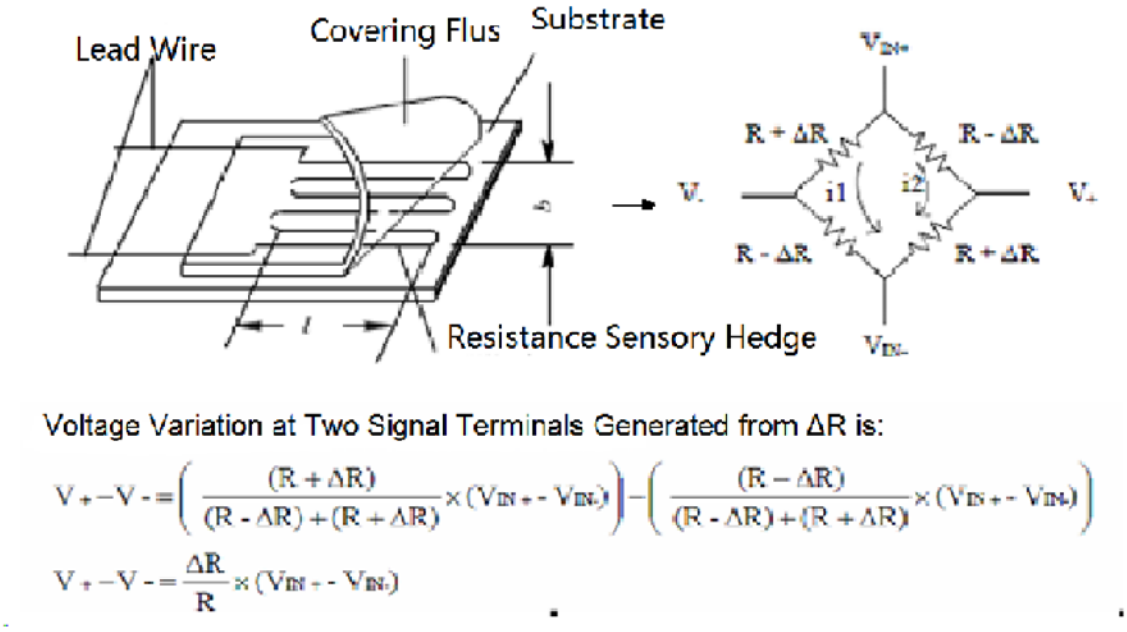
With carbon reduction ideal on the rise, electronic solar weighing scale should become a mainstream in future electronic scale market. However, power consumption remains a main difficulty in applying solar energy to household portable electronic weighing scale now. Even though great amount of solar energy reaches earth every day, this energy is extremely dispersed, with too low density to be served as energy. If electronic scale consumes too much energy, solar energy application device must possess extremely large area, so as to collect enough solar power. However, large area inevitably leads to higher cost, with great inconvenience to be moved around. Only when power consumption of electronic weighing scale suffices reasonably-sized solar energy device can it be economically applied. According to current market prospect in solar weighing scale, numerous companies have been devoted to this specific market.

HYCON SOC series MCU is equipped with low power consumption and simple peripheral circuit. In this article, HY13P56 is applied to design 2000 counts solar weighing scale. Highly precision ∑△ADC is built within this IC, with ADC maximum output speed reaching 31.25KHZ. Even under 4K output speed, the device can suffice 2000 counts solar weighing scale resolution, with both LCD drive module and internal LDO output module being internally built. As a result, internal resource can be applied to realize 2000 count solar weighing scale.

2 Theory Introduction

2.1 Sensory Component

Resistance weighing sensor is composed of an aluminum chip with a bridge strain gauge attached. Its working theory is it will generate deformation and △R variation under the effect of external weight, and it can recover deformation absolutely once pressure is removed. Weighing scale sensor is a full bridge composed of 4 half bridge sensors, as presented in illustration 1.



Voltage Variation at Two Signal Terminals Generated from ΔR is:

$$V_+ - V_- = \left(\frac{(R + \Delta R)}{(R - \Delta R) + (R + \Delta R)} \times (V_{IN+} - V_{IN-}) \right) - \left(\frac{(R - \Delta R)}{(R - \Delta R) + (R + \Delta R)} \times (V_{IN+} - V_{IN-}) \right)$$

$$V_+ - V_- = \frac{\Delta R}{R} \times (V_{IN+} - V_{IN-})$$

Illustration 1: Equivalence Sensor Illustration

Therefore use the physical quantity of voltage variation to convert to digital signal through ADC, it can be displayed after computing processing. Load cell internal R in solar energy weighing scale is approximately 2KΩ, while ΔR full range variation is 2Ω. If voltage is 2.4V at two load cell terminals, its output signal V+ to V- voltage is only 2.4mV. If 2000 counts must be achieved, minimum processing signal is $\frac{2.4mV}{2000*2}$ =0.6uV for a weighing scale with internal and external ratio being 1:2.

2.2 Control Chip

HY13P56 Characteristic:

- System Working Voltage: 2.2-3.6V.
- 8-Bit RISC-Like Controller
- 24-Bit ∑△ADC Analog to Digital Converter
  - A three-stage design is applied to the comb filter, with maximum output frequency reaching 31.25Ksps.
  - Maximum signal amplification can be magnified for 128 times.
  - Low Temperature Drift Coefficient and Inbuilt Absolute Temperature Sensor
- Internal Power Supply System
  - Inbuilt LDO Linear Voltage Stabilization Power Supply VDDA, with 2.4V/2.6V/3.0V/3.3V Available for Output Settings
  - Inbuilt Referential Voltage Source REFO=1.2V Output
- Multifunctional Comparator
  - Output Filter and Inverse Low Power Design

- Interruption Incident
- Voltage Inspection,Capacitance Measurement Application,etc

- Timer
  - Watch Dog Reset or Interruption Incident
  - 8-Bit Timer A Timing Interruption
  - 16bit TimerB Timing interruption,and can set different mode PWM output.
  - Realize signal capturing function once timer C and timer B are combined.
- LCD Drive Display
  - Support 4*32 seg, with 1/2 or 1/3 biasing mode.
  - Low Current Design; Operation Current 3uA
- Working Frequency
  - Internal high speed RC oscillator 2M/4M/8M can be selected.
  - Internal Low Power Consumption LPO oscillator 14KhZ
  - Support External High Speed and Low Speed Crystal Oscillator
- 4KW OTP Program Memory and 64 Word Build-In EPROM
  - –40°C to +85°C Operational Temperature Range

2.3 Solar Energy Battery

Crystalline Silicon material (including polycrystalline silicon and single crystalline silicon) is the main photovoltaic material, with market share being more than 90%. It will also be main materials of solar battery during a long time in the days to come. Expert has predicted that solar photovoltaics industry would surpass nuclear power and become one of the most important basic power supply in the first half of 21th century.

Solar battery is a component which applies photovoltaic effect to convert solar energy into power supply directly. It's a semiconductor optoelectronic diodes, once solar light shines onto the optoelectronic diodes, optoelectronic diodes automatically transform solar light into electrical power, so as to generate electrical current. When numerous batteries are arranged in series or parallels, solar battery matrix with greater output power can be formed. Solar power battery is a new power supply with great prospect, which is equipped with three advantages of eternity, cleanness, and flexibility. Solar battery possess long lifetime. As long as sun exists, just one investment,solar battery can be put into use for a long time. Compared to thermal power and nuclear power, solar battery won't lead to any environmental pollution. Solar battery of different sizes can be developed simultaneously, from medium power station with a million kilowatt to solar battery set used to provide for one household, unachievable by other power supply.

Solar panel is the core part, as well as the most valuable part, in solar power system. Its function is to convert solar power into power supply to drive electrical load.

Quality and cost of power panel directly decides the quality and cost of the entire system. Currently, watt is applied as a fundamental unit in the price of solar battery. As a result, entire system power consumption directly decides system cost.

3 Design Plan

3.1 Hardware Explanation

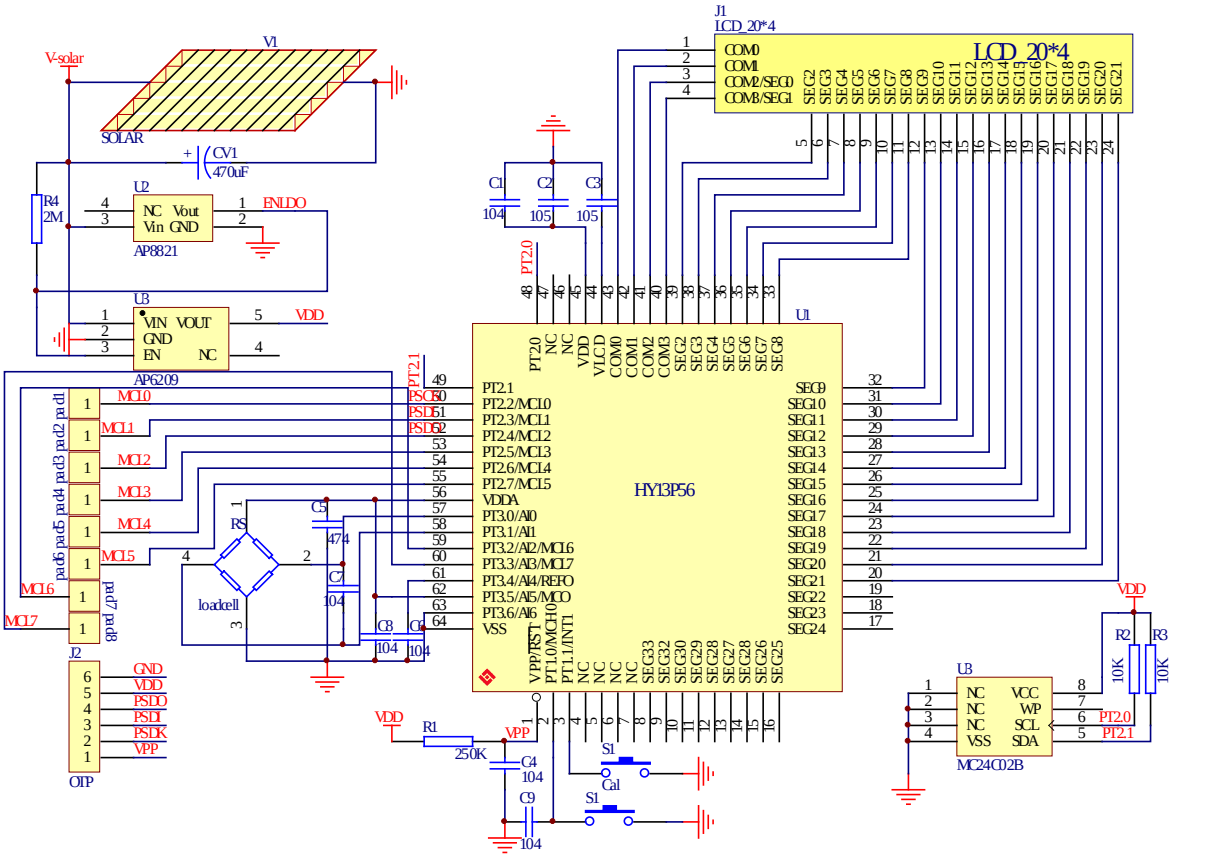


Illustration 2: Integral Electrical Circuit in Solar Weighing Scale

Integral solar kitchen scale is comprised of three components below.

- ADC measuration;
- Solar panel power supply circuit;
- Other peripheral circuit.

3.1.1 ADC Module Circuit

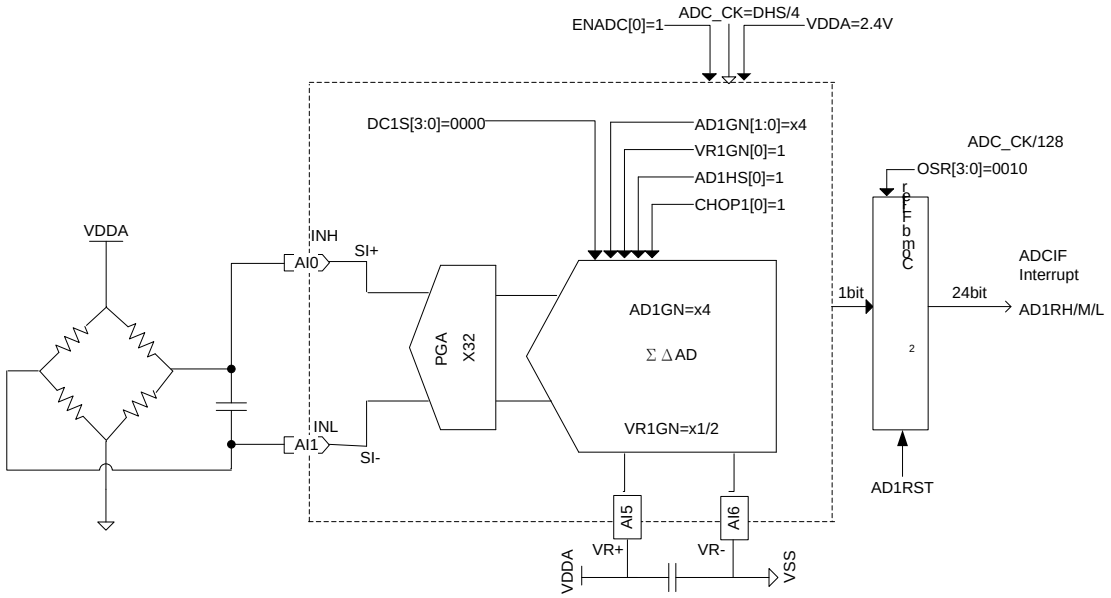


Illustration 3 ADC Network Setting

Load cell input voltage is provided by VDDA output 2.4V from internal chip LDO module, with weighing scale load cell being 1mV/V output signal, or full scale output voltage 2.4mV. According to this small signal, amplification number is 32*4 for internal ADC settings. Referential voltage is provided to AI5-AI6 from VDDA-VSS, with VRGN being set as 1 (VREF times 1/2), or equivalent to input referential voltage 1.2 V that can suffice ADC to output minimum resolution voltage. Second, 13P56 ADC is equipped with excellent temperature characteristics, with integral temperature curve being approximately ±10ppm. With low temperature drift coefficient load cell being selected, temperature drift demand can be achieved. AI0-AI1 and AI5-AI6 input capacitance must be connected so that ADC can acquire sufficient maintaining time during temperature variation.

In order to reduce integral power consumption in solar weighing scale application, it must suffice signal resolution under speed as fast as possible for ADC. Current ADC output speed is ADC_CK/128, with 1M being set for ADC_CK sampling frequency.

3.1.2 Solar Panel Electrical Circuit

Voltage circuit in solar panel is composed of a 4.5V solar panel, connecting parallelly with a 470uF capacitance, reset IC and LDO. Reset IC is applied here since IC leads to immediate great current when COMS switch voltage is approximately 0.8V. This tensile load maintains solar panel output voltage at approximately 0.8V. Reset IC AP8821 is applied here to prevent system startup incapability once solar panel voltage drops below 0.8V. Once solar battery voltage is above 2.2V, Reset IC can manipulate the entire system power supply through enabled LDO pin.

3.1.3 Other Peripheral Circuit

HY13P56 internal resource can be applied to realize application design in solar weighing scale, further allowing extremely simple peripherals. Peripheral circuit is equipped with only one spare EEPROM24C02 to save calibrated data and a LCD display panel,

3.2 Software Explanation

3.2.1 System Procedure

Solar weighing scale is separated into two working mode, shutdown mode and startup weighing mode. Under shutdown mode, weighing mode can be spontaneously accessed if detected object is greater than 5Kg through periodical object detection on the weighing scale. Under weighing scale mode, LCD panel can be startup to display weight number. In order to save system power consumption,ADC weight measurement can be startup through periodicity under ADC speedy output mode. After stabilizing successively weight on the scale, shutdown mode can be automatically accessed.

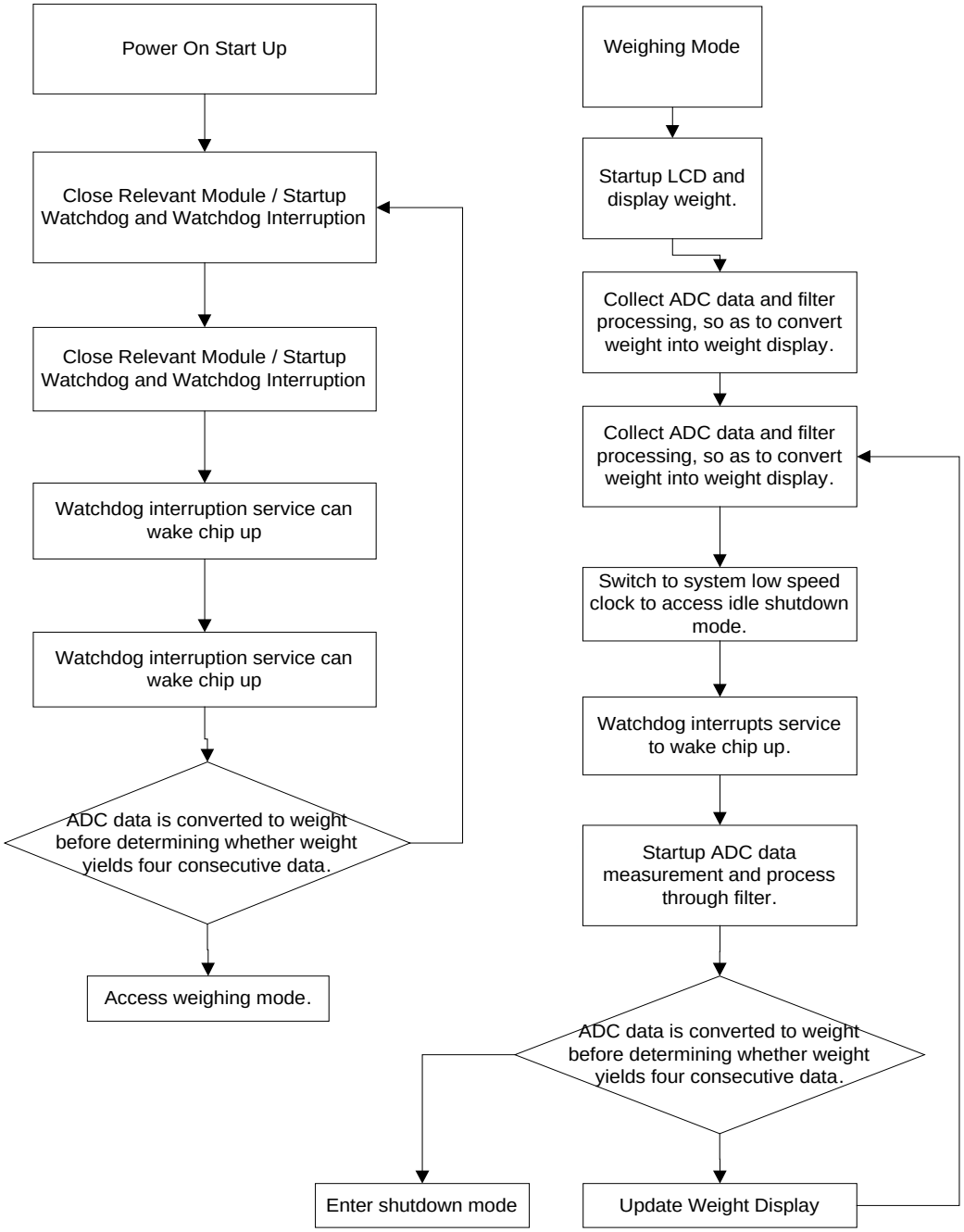


Illustration 4 System Flow Chart

3.2.2 Power Saving Control

Under boot weighing mode, in order to reduce integral system power consumption while performance is sufficed, 13P56 watchdog chip is applied to wake startup at 0.8s in software to conduct interval ADC measurement. In order to reduce startup time, ADC output frequency must be ADC_CK/128, so as to suffice resolution rate through software filter method. After consecutive weights have been stabilized, shutdown mode can be automatically accessed to save power consumption.

Solar weighing scale automatically starts up and conducts measurement when pressure is exerted on it. By applying interval measurement method under shutdown mode, it can be decided whether there is pressure being exerted on weighing scale to start up. In order to save power consumption under shutdown mode, watchdog wakes ADC up to implement measurement every 1.3s. If current scale weight is greater than startup weight, weighing scale mode can be accessed. Otherwise, shutdown mode would be accessed.

3.2.3 Software Filtering

Software filtering is for that Once interval method is applied to conduct measurement in solar scale startup mode, ADC converted data can be computed once ADC is started up. Under speedy ADC output method, ADC data filter mode reaches weighing stabilization through two-stage filtering. Through second-stage data processing, first-stage filtering output data can be converted into practical weight.

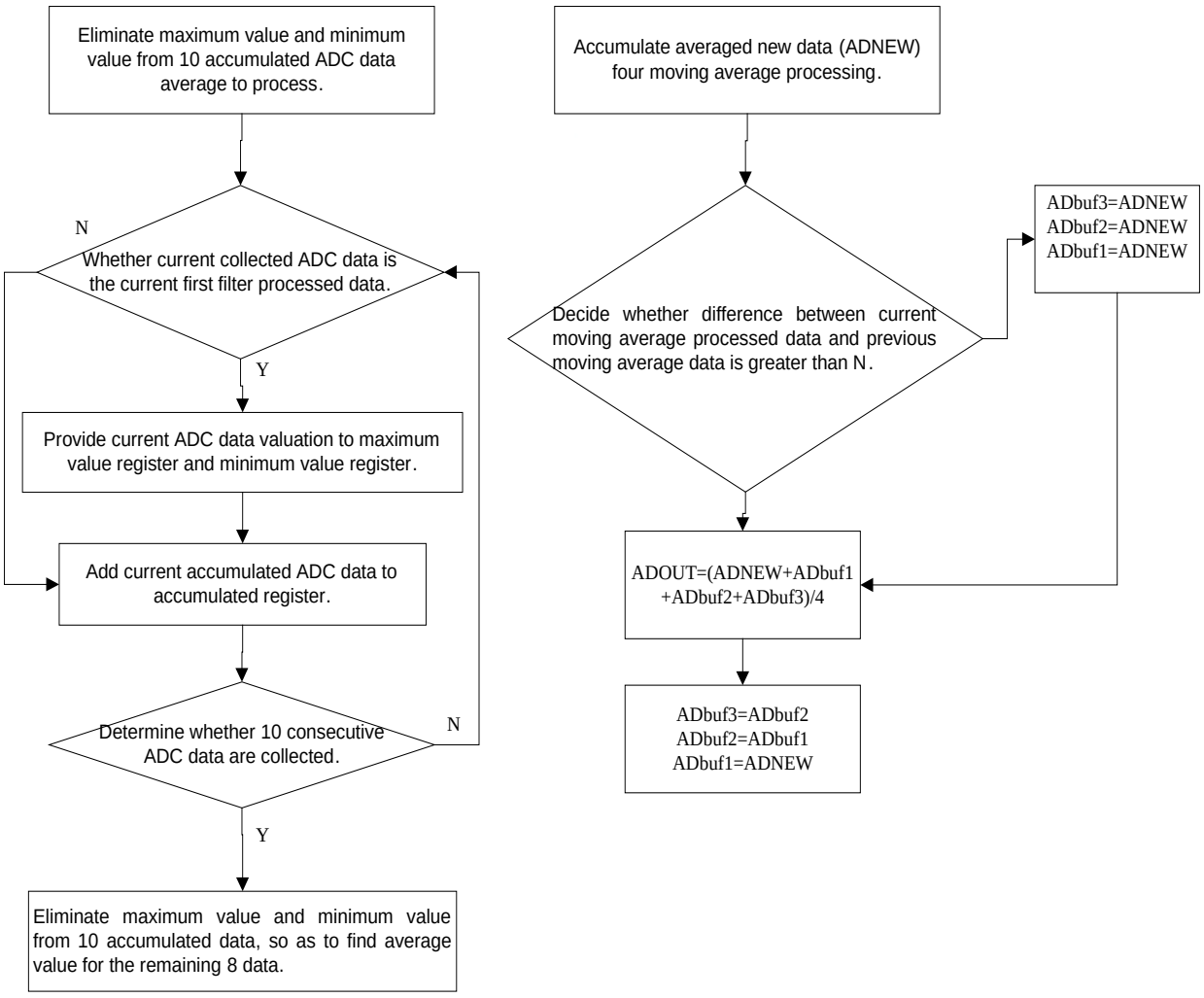


Illustration 5 ADC Data Filter Processing

4 Operation Explanation

4.1 Calibration Explanation

- Click PT1.0 calibration key before power on, while enter calibration mode after power on.
- Display internal code after entering calibration mode.
- LCD panel displays “00” after calibration key PT1.0 is clicked.
- Click PT1.0 to enter zero calibration after ensuring no weight is presented on the weighing scale.
- After zero calibration, 120 will be automatically displayed to notify accessing 60kg calibration.
- Place 60kg weight on the scale before pressing PT1.0 to conduct 60kg calibration.
- After 60kg calibration, weighing mode will be automatically accessed.

4.2 Weighing Explanation

- Under shutdown mode, scale will be automatically started up to process weight measurement if weight above 5kg is placed on the weighing scale.
- Upon weighing mode, shutdown mode will be automatically accessed if weight on the scale is stabilized for approximately 5s.

5 Specification Parameter

- Working Temperature Range: -40°C-85°C
- Working Voltage Range: 2.2-3.6V
- Power consumption is 5uA under shutdown mode.
- Power consumption is less than 40uA under weighing mode, while internal sensor resistance is 1.5K.
- Weighing full load is 200kg, with 100g precision.
- Weighing time available regard to different illumination current.

Illumination Lumen	Available weighing time with 5s interval	Available Weighing Time with 10s Interval	Weighing Mode System Average Current	Weighing Precision
30-40lux	2	4	35	±0.1kg
40-50lux	2	4	35	±0.1kg
50-60lux	3	8	35	±0.1kg
60-70lux	5	Continuous	36	±0.1kg
70-80lux	9	Continuous	36	±0.1kg
80-90lux	Continuous	Continuous	36	±0.1kg

6 Conclusion

HY13P56 low power consumption characteristics and maximum output speed can achieve 31.25KHZ highly precision ∑△ADC. Power consumption under measurement mode can achieve less than 40uA current, realizing weight measurement under low illumination. In addition, internal device is equipped with LDO output and LCD drive module. Regard to 2000 counts solar weighing scale, peripheral can be extremely simple. To sum up, HY13P56 have high performance and high price-performance ratio for 2000 counts solar weighing scale application.

7 Appendix


code V03.rar

8 Referential Data

1.HY11P56 DataSheet；
2.HY13P00 User’s Guide；
3.AP8821 datasheet；

9 Amendment Record

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

Version	Page Number	Amendment Summary
V01	All	Initial Version Publication