HY13P56

8*5 Matrix Touch Key

Instruction Manual

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1 Introduction

This article is to introduce HYCON HY13P56 application in capacity touch key. Capacity touch key and traditional machine capacity touch key are attractive, durable, and long serving life. Matrix capacity touch key is an application design which combines HY13P56 internal comparator module with timer counting module through PCB layout to realize RC charging and discharging.

2 Theory Explanation

2.1 Touch Key Inspection

Basic theory in capacity touch key is to impact electrical charges or electrical level on electrode or capacity through user's finger touch. Sensory electrode or electrical capacity can be placed behind any insulating layer (usually glass or plastic materials). In addition, it is easy to form a hermetical keypad with surrounding environment. In designing touch sensory key, the first thing is to do is to inspect charge or electrical level capacity on the touch key, as well as some relevant transformation relationships, that is to say calibration on system. Second, change in electrical charge or level can be influenced by external surrounding. Static electrical discharging and electromagnetic noise can also lead to error action. In addition, environmental change such as temperature variation can affect system calibration. At the same time, its accumulated pollutant on the surface can influence its accuracy and repetitiveness. As a result, anti-influence and reliability is an important key in designing touch sensory key.

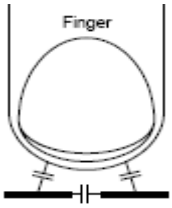

Illustration 1

Capacitance touch theory is presented in illustration 1. A fixed parasitic capacitance Cp exists between two nearby copper pours on the electrical

board. When user's finger (or other electrical conductor) approaches it, new capacitance can be generated between user's finger and two copper pours. These capacitances are equivalent to the parallel connection to Cp. Through variation of capacitance charging time, it can be inspected whether there are fingers getting into contact. While designing, the variational signal can be connected to relevant HY13P56 pin. Through HY13P56 internal related module processing, touch motion on the key can be sensed.

2.2 Control Chip

HY13P56 inspection on touch key is through internal multi-channels input comparator. By combining internal network, periodical charging to comparator positive capacitance can be conducted. When capacitance voltage is higher than negative terminal, comparator output changes, with charging time being recorded by internal timer B1.It can be determined whether touch key has been touched through the record time.

HY13P56 Characteristics:

- System Working Voltage 2.4-3.6V
- 8-Bit RISC-Like Controller
- 24-Bit ∑△ADC Analog to Digital Converter
  - ◆ Comb filter adopts three-stage design, with maximum frequence output of 31.25 Ksps.
  - ◆ Signal can be magnified up to 128 times.
  - ◆ Low Temperature Drift Coefficient and Internal Absolute Temperature Sensor
- Internal Power Supply System
  - ◆ Inbuilt LDO Linear Regulated Power Supply VDDA, with 2.4V/2.6V/3.0V/3.3V Available for Output Setting
  - ◆ Inbuilt Referential Voltage Source: REFO = 1.2 V Output
- Multi-functional Comparator
  - ◆ Output Filter, Inverse, and Low Power Design
  - ◆ Interruption Incident
  - ◆ Voltage Inspection & Capacitance Measurement Application etc.
- Timer
  - ◆ Watch Dog Reset or Interruption Incident
  - ◆ 8-Bit Timer A Counting Interruption

- ◆ 16-Bit Timer B Counting Interruption, with Different PWM Output Mode Available for Arrangement
- ◆ By combining Timer C and Timer B, signal capture function can be realized.

- LCD Drive Display Device
  - ◆ Support 4*32seg, with 1/2 or 1/3 biasing mode.
  - ◆ Low Power Design, with Operation Current 3uA
- Working Frequency
  - ◆ Internal High Speed RC Oscillator ,2M/4M/8M Options
  - ◆ 14KhZ Internal Low Power Consumption LPO Oscillator
  - ◆ Simultaneously support for external high and low speed quartz crystal resonator.
- 4KW OPT Program Memory and 64 word Build-In EPROM
- –40°C to +85°C Operation Temperature Range

2.3 Touch Key Internal Control Charging Theory

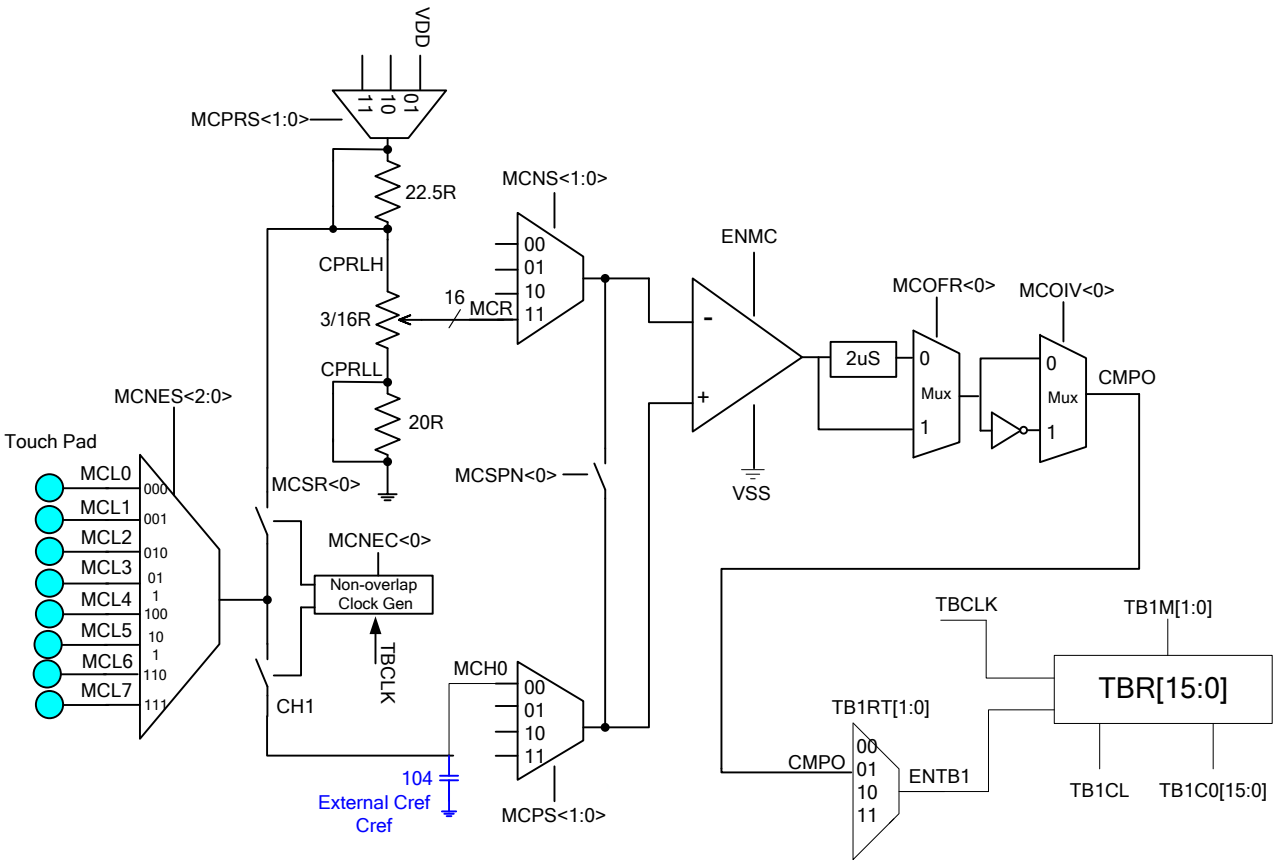

Illustration 2

Concrete internal arrangement of Touch key in inspecting multifunctional comparator is presented in illustration 2. Touch key inspection control includes two process: with first being capacitance discharging, and second being capacitance charging. Regard to capacitance discharging, since HY13P56 internal comparator input terminal MCH0 and PT1.0 IO port are multiplexing ports, For capacitance discharging,just set PT1.0 to outputing low. Considering capacitance charging aspect, comparator and timer B must be started at first, with MCH0 (PT1.0) being set for comparator positive input terminal and MCR being set for negative input terminal. MCR resistance network at negative terminal can be set as 7/16R, with VDD selected for resistance network power supply. Before controlling capacitance charging, timer B value must be cleaned before setting 1 for MCSR bit, so as to control capacitance charging switch,turn on and off to execute capacitance charging. When capacitance voltage is greater than MCR terminal voltage, comparator turns and timer B stop counting, and record timer B count value to determine whether below critical value to determine there is touch action.

Regard to HY13P56 touch key inspection theory, distribution capacitance between touch pad and ground will increase when there is finger touch.Once upper switch is closed and lower switch is opened, touch facilitate an increase for touch pad to grounding capacitance so that the charge will increase. Once upper switch is opened and lower switch is closed, touch pad electrical charge will transfer to capacitance of MCH0 to earth. As a result, when there is touch action available, capacitance charge time will be reduced to facilitate comparator overturn.

3 Design Planning

3.1 Hardware Explanation

Regard to HY13P56 application in matrix key, integral electrical circuit is extremely simple with only one charge capacitance externally required, since internal resource is sufficient for touch key application. LCD drive module is provided within HY13P56 itself for display part. As a result, only external-attached LCD panel is required.

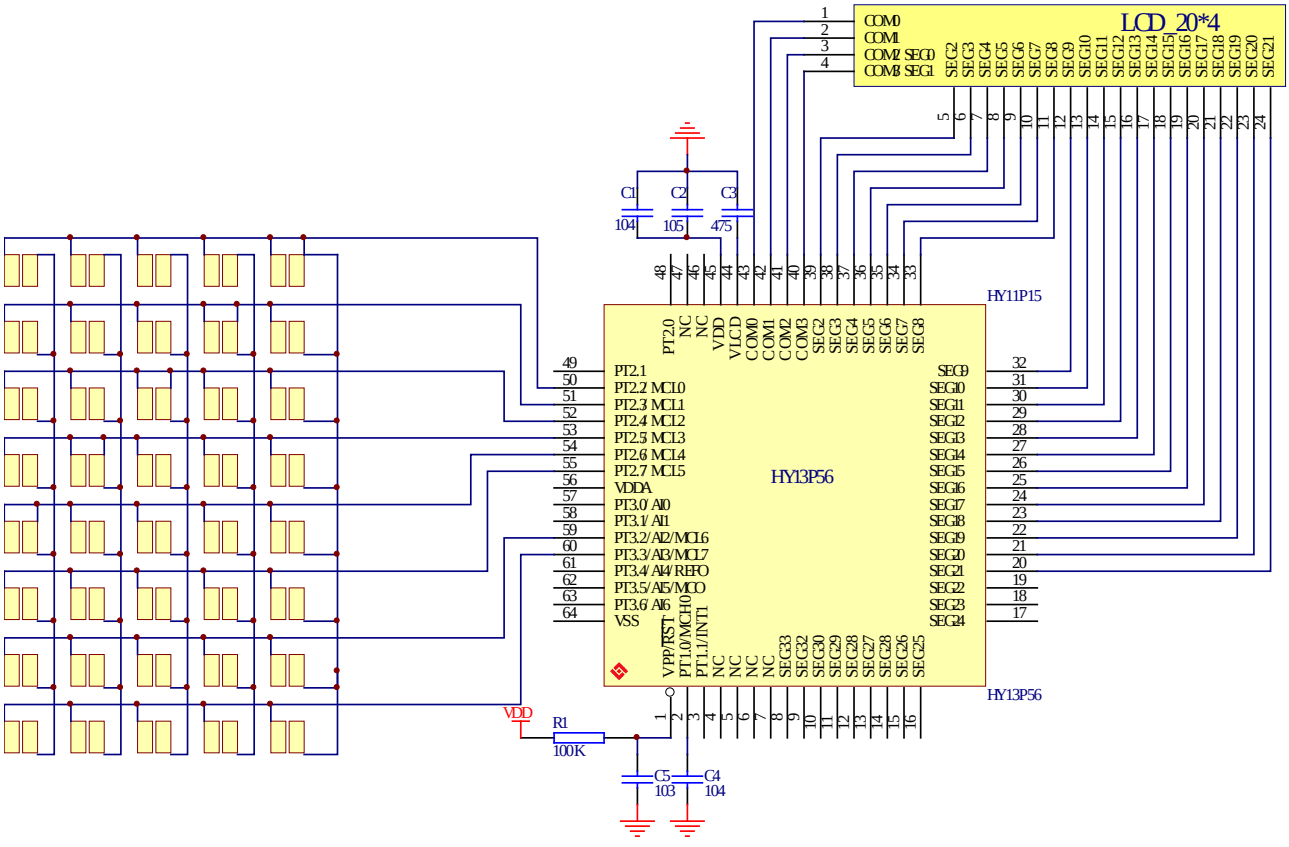

Illustration 3

HY13P56 possesses 8 touch key inspection channels. Through matrix touch key formulation, 8 inspection channel can make 36 different combination touch key. This article applies 8*5 matrix method to make relevant application explanation, with integral electrical circuit presented in illustration 3. 8*5 matrix key arrange 40 pads totally. Through pair combination, 30 different touch key can be made maximumly. In order to increase touch key reliability, only pad under different channel combination can serve as effective touch key. By processing in this way, 8*5 matrix touch key combinations can make 25 touch key design.

Display part is applied to exhibit different key messages. Since 8*5 matrix keys can form 25 touch keys in different pads, so LCD panel can display key message corresponding to 1-25.

3.2 Touch Key Software Explanation

Rotational scanning is applied to process touch key. Upon power on, referential time of each channel charge capacitance to overturn comparator need be measured. Under subsequent touch key scanning, the time of each channel charge to overturn comparator must also be recorded.It can be decided whether there is an existence of touch action by comparing with referential timespan upon power on.It indicate effective touch occur when two different lines determine the existence of touching,with procedural flow chart presented in illustration 4.

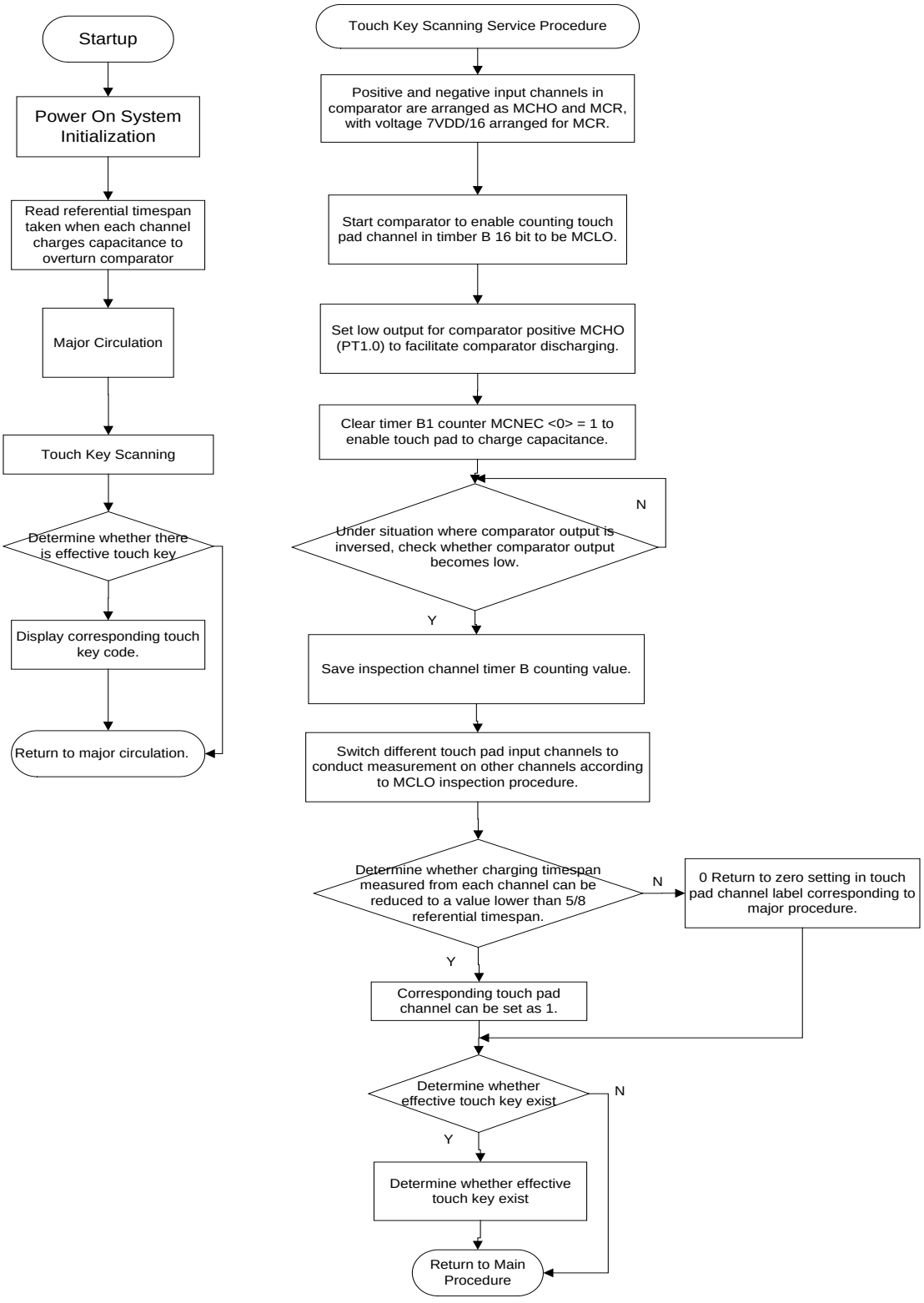

Illustration 4

4 *Testing Data*

4.1 Touch Key Performance Testing

By analyzing 256 data collected consecutively from each touch pad, data in the chart below is formed. Under no touch and touch condition, each channel respectively collects timer B1 counting value when capacitance charging facilitates comparator overturning. Compute respective average value through collected 256 data, with “TouchStrength=Average_Untouch-Average_touch，Average_Untouch” representing 256 data average under no touch condition, and “Average touch” representing 256 data average under touch condition.

SNR(dB)(Signal Noise Ratio)= 20Log(TouchStrength / NoiseTouchedRMS)

	no acrylic plate placed							
MCR=7/16*VDD	MCL 0	MCL 1	MCL 2	MCL 3	MCL 4	MCL 5	MCL 6	MCL 7
TouchStrength	2541	2408	2373	2844	2610	2881	3577	3342
NoiseTouched_RMS 256	3	2	3	2	2	2	3	2
Average_Touch256	1288	1499	1483	1401	1473	1419	1525	1209
Average_Untouch256	3829	3907	3855	4245	4083	4300	5102	4632
SNR(db)	59	60	58	62	62	62	61	63
	Add 2mm acrylic plate placed							
MCR=7/16*VDD	MCL 0	MCL 1	MCL 2	MCL 3	MCL 4	MCL 5	MCL 6	MCL 7
TouchStrength	461	76	71	314	294	316	548	60
NoiseTouched_RMS 256	2	2	3	3	3	3	4	2
Average_Touch256	3368	3830	3784	3930	3789	3984	4554	4574
Average_Untouch256	3829	3907	3855	4245	4083	4300	5102	4632
SNR(db)	49	33	28	41	41	40	43	29

Illustration 5 below represents a condition where there is no acrylic plate placed. When touched, touch key counting value will prominently decrease as shown in illustration 5 below.It can be determined whether there is a touch action through this variation.

Illustration 5

4.2 Specification Parameter

- Working Temperature Range: -40°C - 85°C
- Working Voltage Range: 2.2-3.6V
- Set appropriate voltage 7/16VDD for comparator with each touch key scanning timespan approximately 10ms.
- Touch Key Consecutive Scanning Mode with Internal 4M HAO System Frequency Power Consumption Approximately: 780uA

5 Conclusion

By comparing application in HY13P56 matrix key with traditional RC charging or discharging comparator, this article application can eliminate R resistance, with internal strengthen comparator capable of realizing numerous touch key application. Compared to traditional RC electrical circuit, it is more immune to interference. In addition, HY13 P56 is equipped with highly precision ∑△ADC internally which combines with touch key have great prospect in measurement domain and its exterior is more beautiful fashionable.

6 Referential Data

Datasheet file：HY13P56datasheet

Datasheet file: HY13P00 user's guide

7 Appendix

Democode:


Ttouch25.rar

8 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