low voltageI/OTouch screen control circuit

overview

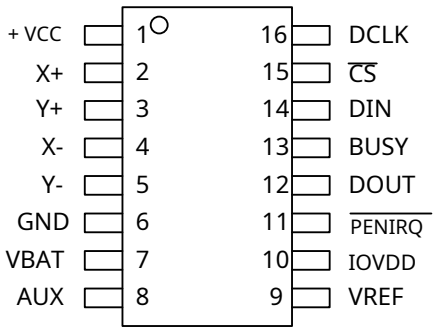
HR2046yes4line touch screen controller, supports1.5V~5.5Vlow pressureI/Ointerface.HR2046has built-in2.5VVoltage source for measurements in auxiliary input, battery monitoring, and temperature sensing modes. When not in use, the built-in voltage source can also be turned off to save power. The built-in voltage source can work at least2.7Vsupply voltage can be detected while0V~6Vthe battery voltage.

becauseHR2046with low power consumption (at supply voltages of2.7Vless than0.75mW), high speed (the highest sampling rate can reach 125KHz) and built-in chip drivers, making it a personal digital assistant with a resistive touch screen (PDAs),BPIdeal for mobile phones, mobile phones and other portable devices.HR2046Can work on-40℃～85℃.

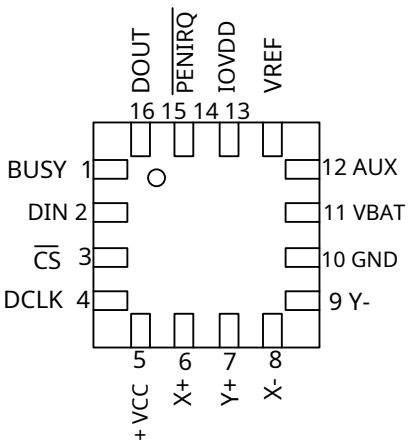
Features

- pin withADS7846compatible
- Operating Voltage:2.2V~5.25V 1.5V
- arrive5.25VnumberI/OInterface built-
- in2.5Vpower source
- The battery voltage can be directly measured (0V~6V) on-chip
- built-in temperature measurement
- touch pressure measurement
- QSPI™andSPI™3Line interface automatic
- power saving
- Package form:SSOP16 QFN16

Pin Arrangement



SSOP16(S)

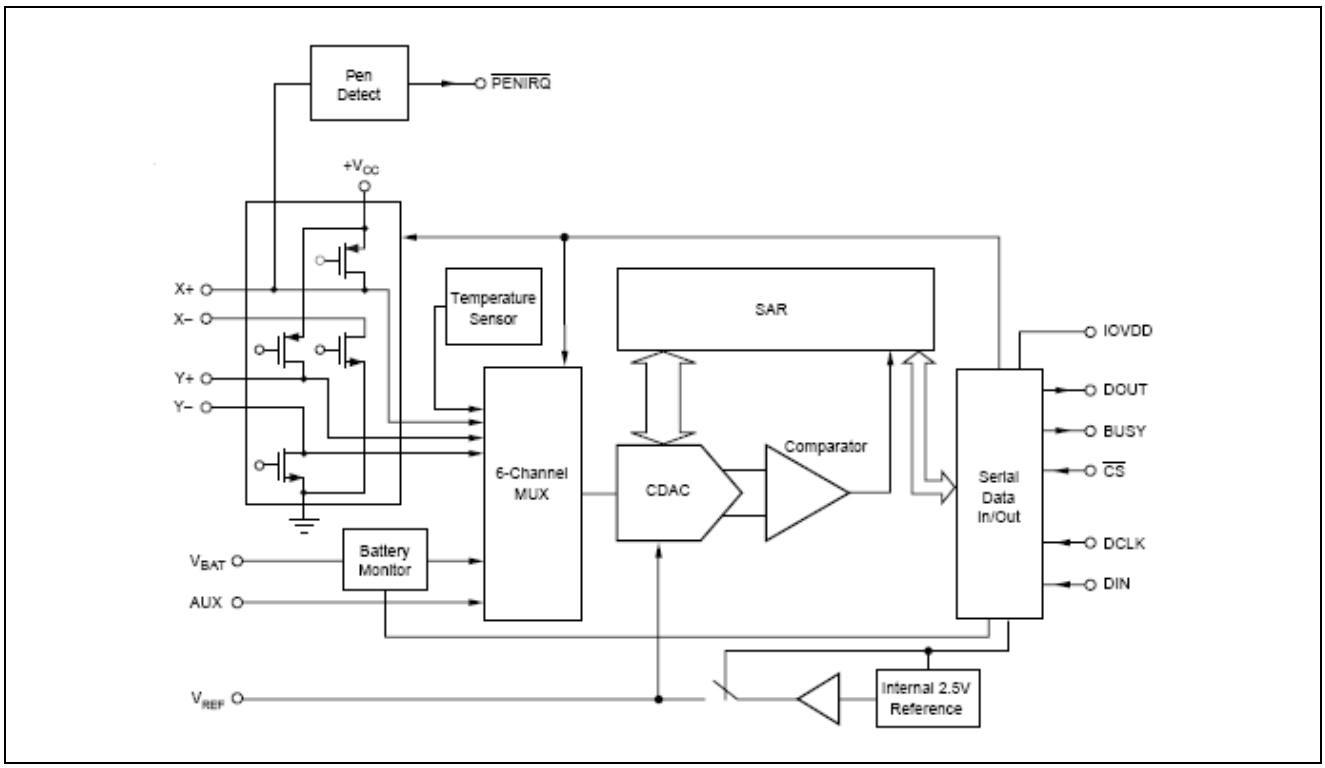


QFN16(HR2046)

Pin description

serial number		Pin name	Function Description
SSOP16	QFN16		
1	5	+ VCC	power supply.
2	6	X+	X+enter.
3	7	Y+	Y+enter.
4	8	X-	X-enter.
5	9	Y-	Y-enter.
6	10	GND	land.
7	11	VBAT	Battery Monitor Input.
8	12	AUX	arriveADCauxiliary input.
9	13	VREF	Voltage Reference Source Input/Output.
10	14	IOVDD	numberI/Opower input.
11	15	$\overline{\text{PENIRQ}}$	The stylus is interrupted.
12	16	DOUT	Serial data output. data inDCLKThe falling edge shifts out. when$\overline{\text{CS}}$When high, this output is high impedance.
13	1	BUSY	BUSYoutput. when$\overline{\text{CS}}$When high, this output is high impedance.
14	2	DIN	Serial data input. like$\overline{\text{CS}}$is low, the data in theDCLKThe rising edge of is latched into the register.
15	3	$\overline{\text{CS}}$	Chip select input. Control conversion time and enable serial input/output register$\overline{\text{CS}}$for high =Power-Downmodel(ADC only).
16	4	DCLK	External clock input. This clock is used forSARConversion process and synchronous serial dataI/O.

Functional block diagram



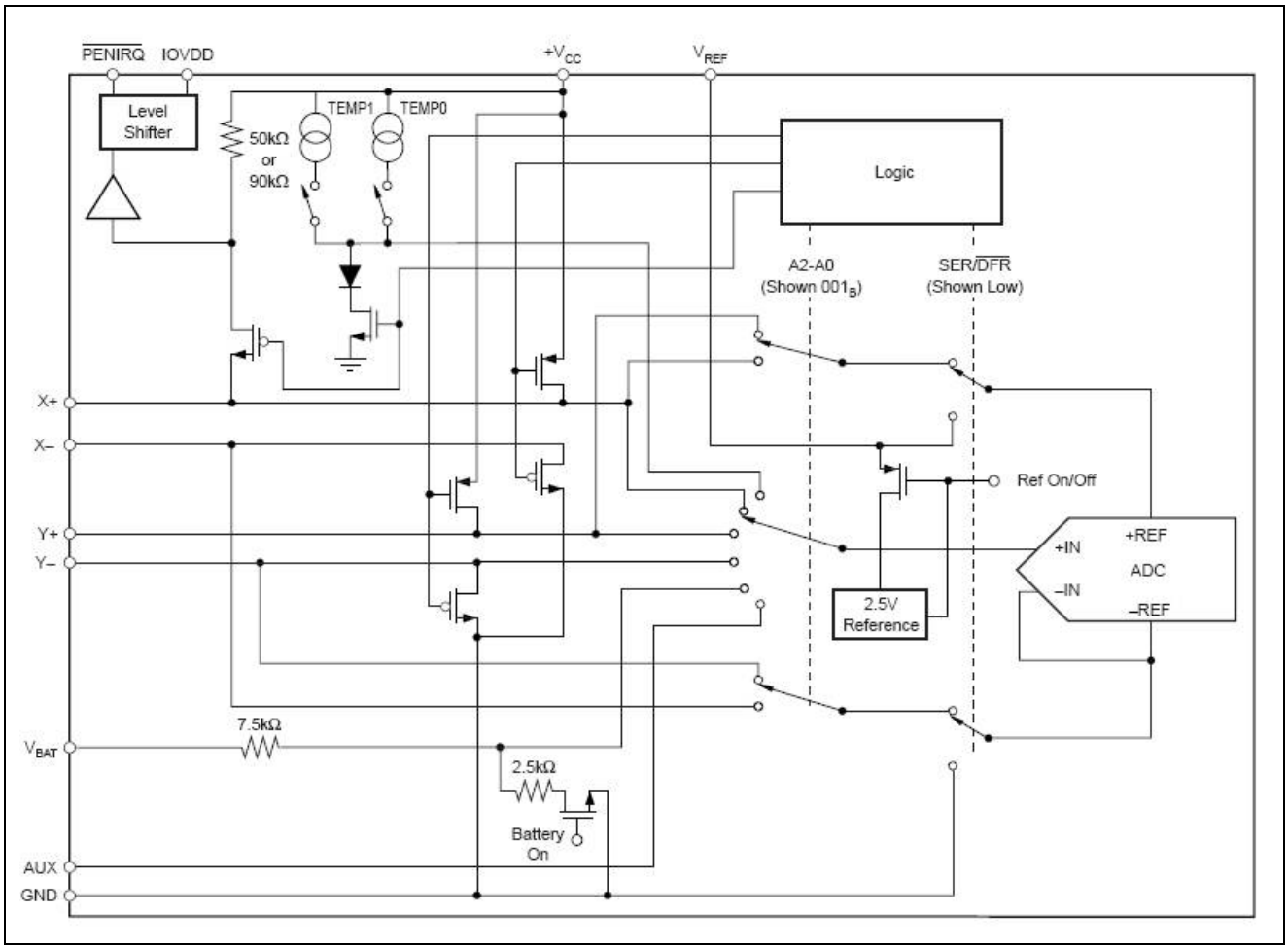
Function Description

HR2046is a classic successive approximation register ADC (SAR ADC). This architecture is based on the principle of charge redistribution with an inherent sample-and-hold function.

HR2046The basic working principle is shown in the figure below. This device incorporates a2.5VThe voltage source, using an external clock, is available2.7Varrive 5.25Vpower supply. The internal source can be externally low impedance1Vto +VCCdriven by a voltage source. The value of the source voltage directly determines the input range of the converter.

converter's analog input (X-,Y-andZcoordinates, auxiliary input, battery voltage and die temperature) are provided through a multiplexer. A unique low on-resistance touchscreen drive switch allows an unselectedADCThe input channel provides power to external devices, and another adjacent channel provides ground, such as a touch screen. By maintaining a differential input and differential reference structure for the converter, errors due to the on-resistance of the touchscreen drive switch (if this is a source of error under certain measurement conditions) are reduced.

analog input



picture1analog input

The picture above showsHR2046on the demultiplexer,ADCThe differential input and the differential reference mode of the converter. surface1and table2shownA2,A1,A0andSER/DFRThe relationship between control words andHR2046Configuration. This control word is controlled by the serial portDINsupply. When the converter enters holdover mode, the +INand-INThe input voltage difference is captured by an internal capacitor array. The current drawn by the analog input is determined by the slew rate of the device. During the sampling period, the source must apply an internal sampling capacitor (typically25pF)Charge. After the capacitor is fully charged there will be no more input current. The transfer rate from the analog source to the converter is a function of the conversion rate.

A2	A1	A0	V_{BAT}	AUX_{IN}	TEMP	Y–	X+	Y+	Y-POSITION	X-POSITION	Z_1-POSITION	Z_2-POSITION	X-DRIVERS	Y-DRIVERS
0	0	0			+IN (TEMP0)								Off	Off
0	0	1					+IN		Measure				Off	On
0	1	0	+IN										Off	Off
0	1	1					+IN				Measure		X–, On	Y+, On
1	0	0				+IN						Measure	X–, On	Y+, On
1	0	1						+IN		Measure			On	Off
1	1	0		+IN									Off	Off
1	1	1			+IN (TEMP1)								Off	Off

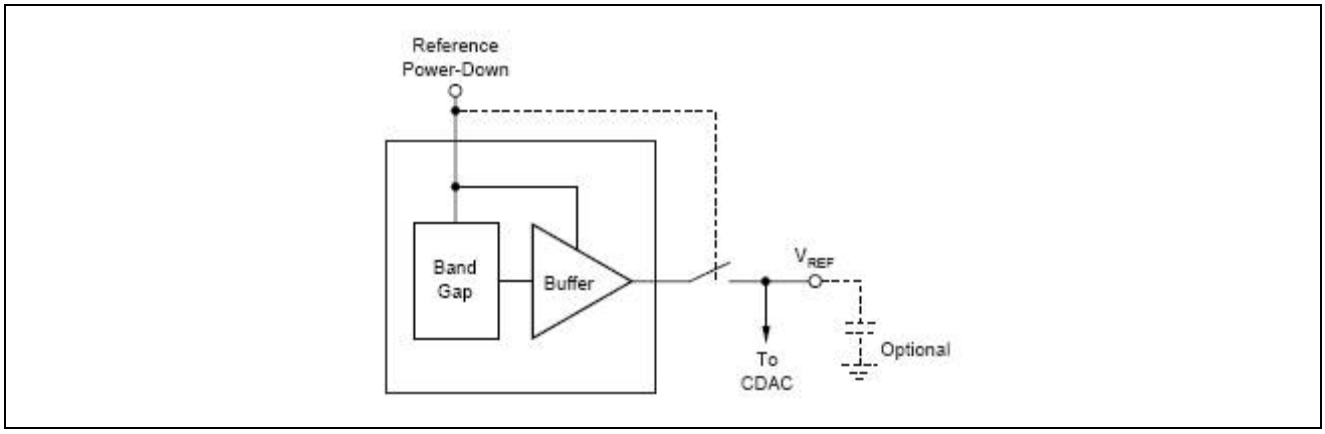
surface1input configuration (DIN),single-ended reference source mode (SER/DFRfor high)

A2	A1	A0	+REF	–REF	Y–	X+	Y+	Y-POSITION	X-POSITION	Z_1-POSITION	Z_2-POSITION	DRIVERS ON
0	0	1	Y+	Y–		+IN		Measure				Y+, Y–
0	1	1	Y+	X–		+IN				Measure		Y+, X–
1	0	0	Y+	X–	+IN						Measure	Y+, X–
1	0	1	X+	X–			+IN		Measure			X+, X–

surface2input configuration (DIN),differential reference source mode (SER/DFRfor low)

internal reference

HR2046built in one2.5VThe voltage reference source can be controlled by the wordPD1On and off. Generally, this reference source is only used for battery monitoring, temperature measurement and auxiliary input measurement in single-ended mode. In the differential mode, the measurement of the touch screen can be optimized. in order to be withADS7843compatible, the internal reference voltage source must be turned off. Therefore, after power-up, it is necessary to write aPD1=0to ensure that the source is closed.



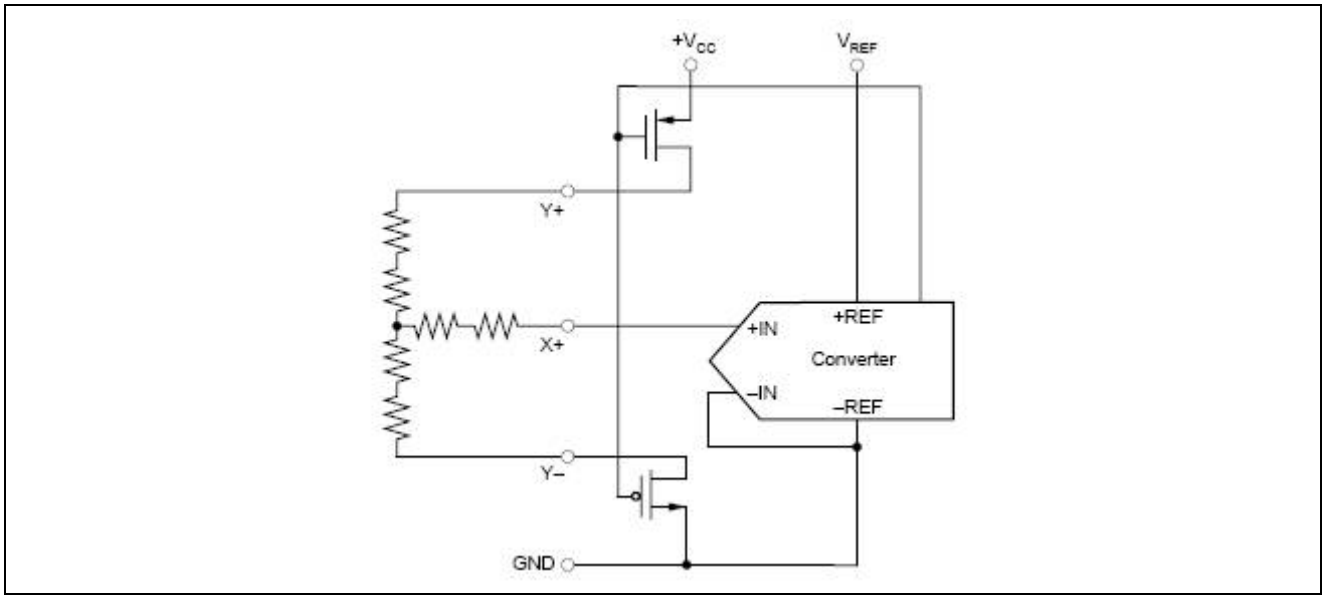
picture2Simplified diagram of internal sources

reference input

at +REFand-REFThe voltage difference between determines the operating range of the analog input.HR2046exist1V~+V_{CC}work with a voltage source. There are several key points to note related to the voltage source input and its wide voltage range. When the source voltage drops, the analog input value corresponding to each digital output code also drops accordingly. This is the same as the least significant bit (LSB) related,1LSBcorresponds to the12Bitmode in which the source voltage is divided by the4096 value. When the source voltage drops, due toLSBThe value of is also reduced, resulting in thisADCInherent offset error and gain error will rise. For example, in 2.5VThe offset error of the voltage source down converter is2LSBs, while in1VUnder the voltage source, its error can reach5LSBs. But in both cases, the absolute value of the device offset error is the same as1.22mV. At lower reference voltages, the layout must be carefully designed, with sufficient filter capacitors added, and low noise, lowripple If you use an external voltage reference source, you must use a low-noise reference source and use a low-noise input signal.

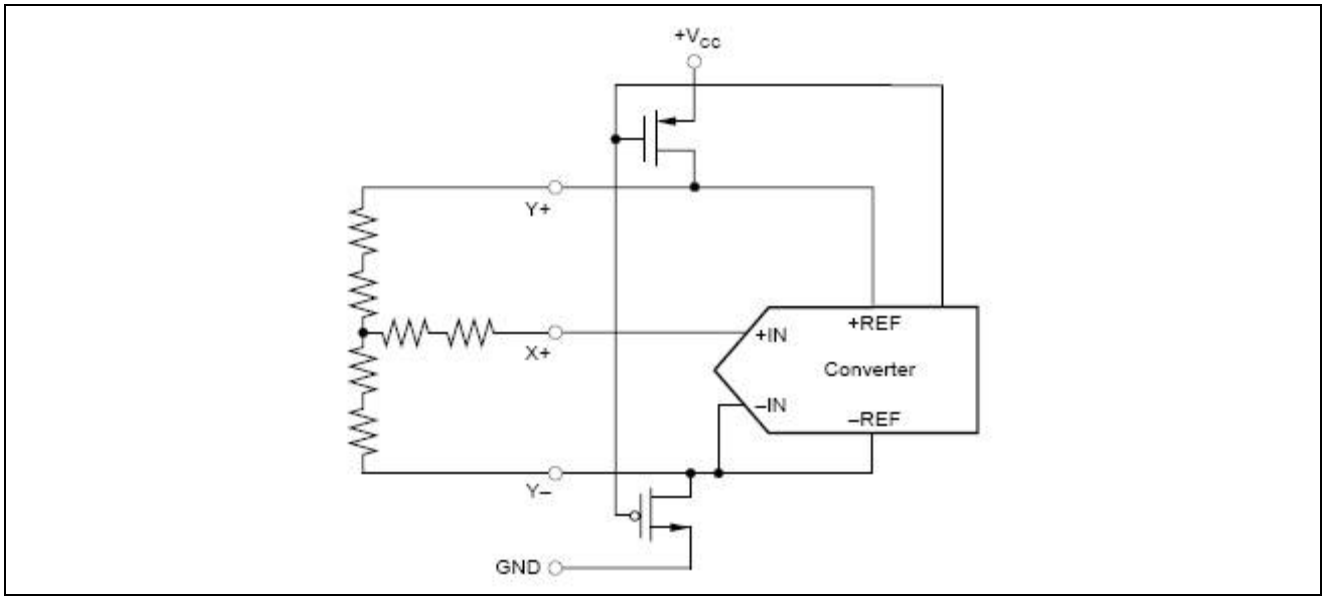
enterV_{REF}port voltage directly drives the DAC (CDAC) of the capacitive portion. Therefore, the input current is very low (typical value <13μA). There are a few key points to note here about the reference source when the shield is measured but the switch is driven on. For illustration, see Fig.1. This application diagram represents the HR2046For measuring resistive touch screens. for measuring equipment inYcurrent value in direction, need toX+input connected toADC, OpenY+andY-drive, quantifyX+on the voltage (see Fig.3block diagram shown). For this measurement,X+Lead resistance does not affect conversion (it affects settling time, but this resistance is generally small and its effect is negligible) . But due toY+andY-The resistance between them is quite low,Ydrive conduction Resistors will have some effect. To sum up, no matter where the contact device on the touch screen is pointed, the input cannot be0Vor full scale because some voltage has been lost across the internal switch. In addition, the internal switch resistance does not link with the resistance of the touch screen, so an additional

external sources of error.



picture3Simplified block diagram of a single-ended reference source (SER/DFR=1,Yswitch enable,X+analog input) This situation can be shown by Fig.5

Shown to remedy. in positionSER/DFR=0After, +REFand-REFdirectly connected toY+andX+On, the analog-to-digital converter enters the ratio conversion state accordingly. The result of the conversion will be a percentage of the external resistance regardless of the change in the ratio of the external resistance to the internal switch on-resistance. Note that power consumption must be considered when using ratiometric mode.



picture4Simplified block diagram of a differential reference source (SER/DFR=0,Yswitch enable,X+analog input) A final point to note in differential mode is that the +Vccinstead ofVREFas +REFsource. When ratiometric mode is not required, a high-precision reference source and single-ended mode can be used for measurement. In certain cases, the converter can be started from a high-precision reference source. Most reference sources can beHR2046Provides enough power, but may not provide enough power for external loads such as resistive touch screens.

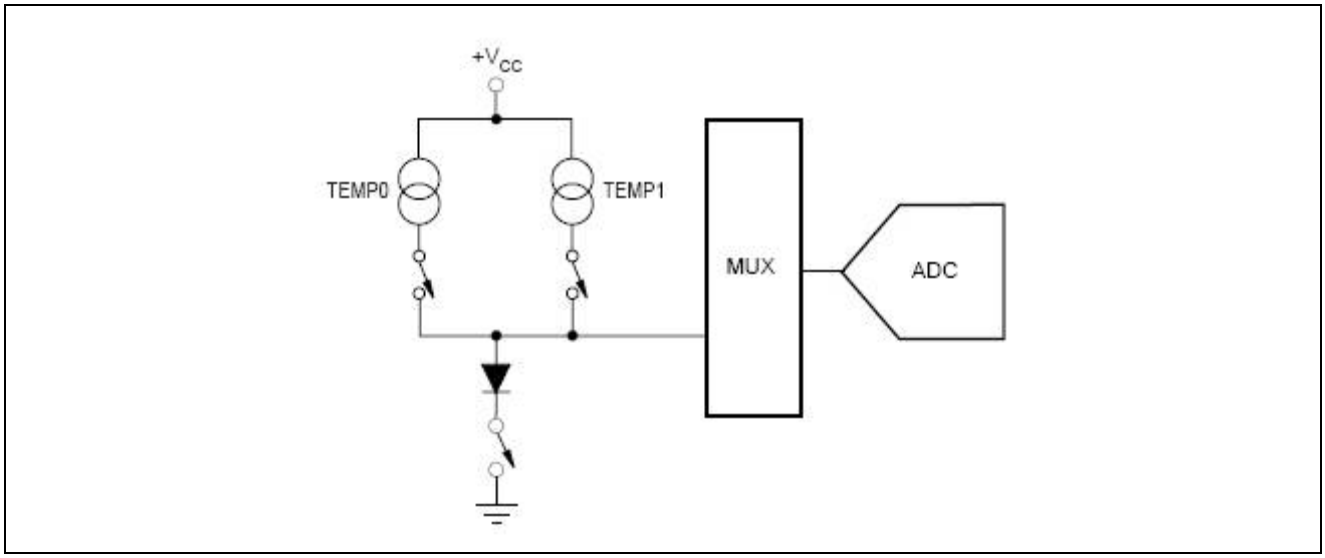
Build the touch screen

In some cases, it may be necessary to connect a capacitor across the touch screen to eliminate noise generated by the touch screen operation (for example, from the backlight circuit or LCDnoise generated on the panel) . These capacitors provide a low-pass filter to reduce noise, but cause settling time when the screen is touched The problem usually manifests itself as a gain error. There are several ways to eliminate or mitigate this effect. The crux of the problem is that the input and/or reference sources are inADCThe final stable value is not reached when the input is sampled and the digital output is provided. In addition, the reference source may still be

changing. The first option is to stop or slow down the required touchscreen settling timeHR2046ofDCLKSignal. This allows the input and reference sources to be in the validation cycle (HR2046in the3clock cycle, see Fig.8) can reach a stable value. This works in both single-ended and differential modes. The second option is to makeHR2046Only work in differential mode when measuring touch screens and configureHR2046Make it always in working state (touch screen driver on) without enteringPower-Downstate(PD0=1). According to the requirements of the establishment time andHR2046Convert several times at the rate. Once the required number of conversions has been reached, the processor commandsHR2046Enter after the last conversionPower-Down state. This process can bexdirection,Ydirection andZIt is implemented in the measurement of direction. A third option is to operate the device at15clock-per-conversion mode, which enablesADCKeep working continuously and keep the touch screen driver always on until a stop command is received from the processor.

temperature measurement

In some applications, such as when charging a battery, it is necessary to measure absolute temperature.HR2046The temperature measurement technique is derived from the properties of a semiconductor junction operating at a constant current. The forward voltage of the diode junction (V_{BE}) has a good correlation with temperature. In practical applications, known25°CV_{BE}value and monitorV_{BE}The absolute temperature at this time can be obtained by the offset value when changing with temperature. HR2046Two working methods are provided. The first mode requires a voltage value at a known temperature as a standard, but requires only one measurement to obtain an absolute temperature value. A diode is used (turned on) during this measurement. exist20℃ and have20μAWhen a current flows through the diode, this voltage is typically 600mV. The absolute value of this diode voltage will havemVlevel deviation. However, the temperature coefficient of this voltage (TC) is very fixed, for 2.1mV/℃. In final production testing, the devices are stored in a room with a known room temperature in order to memorize this specific voltage used as a standard. In this way, the accuracy of the measurement results can reach0.3°C/LSB(exist12-Bitmode).



picture5Schematic diagram of temperature test mode

The second measurement method does not need to test the temperature standard, but uses two temperature measurement processes to eliminate the influence of no temperature standard, which can reach2°C accuracy. In this mode, a second conversion is required, at which time the current flowing through the diode will be the first91times. The pressure difference between the first and second transitions is given by the following formula (1)means:

$$\frac{KT}{q}\ln(N) \qquad (1)$$

in:

Nis the current ratio =91

K=Boltzmann constant (1.38054·10^{-23}Electron volts/Kelvin temperature)

q=Electron power (1.602189 10^{-19}C) T =Kelvin temperature

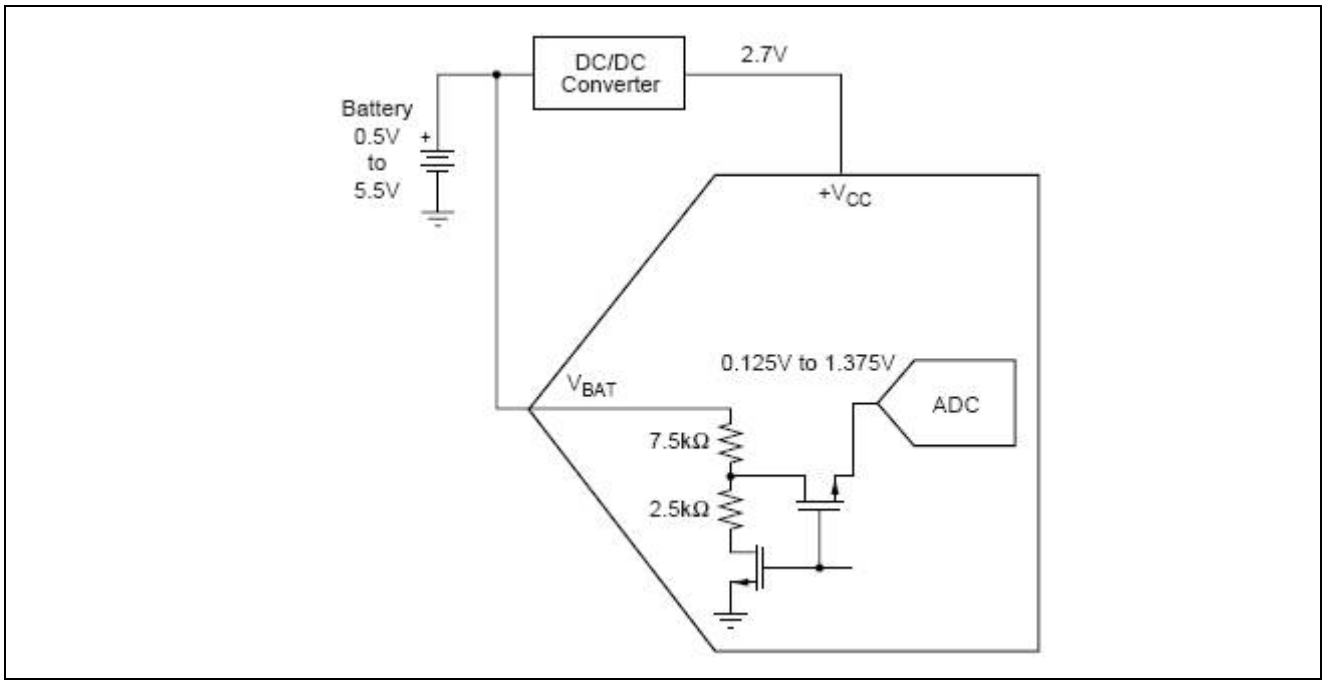
This mode provides an improved method of measuring temperature at the cost of reduced accuracy. The equation to solve for the temperature in Kelvin is:

$$Kelvin = q \cdot \frac{-V}{(k * \ln(N))} \qquad (2)$$

in:

△V=V(I_{91})-V(I_1)(Unit ismV) Kelvin = 2.573Kelvin/mV ·△V ° C =2.573·△V(mV)-273Kelvin **Measurement of battery voltage**

HR2046With the regulator (DC/DCconverter) side to monitor the battery voltage capability, see Fig.6. The battery voltage is available from0Vchange to 6V, while maintaining the supplyHR2046The voltage is2.7Vor3.3VWait. The input voltage is divided by4so5.5VThe battery voltage input to theADC middle is 1.375V. This simplifies the multiplexer and control logic. To minimize power dissipation, this divider is onlyA2=0,A1=1 andA0=0It only works during the sampling period of time.



picture6Functional Block Diagram of Battery Monitoring

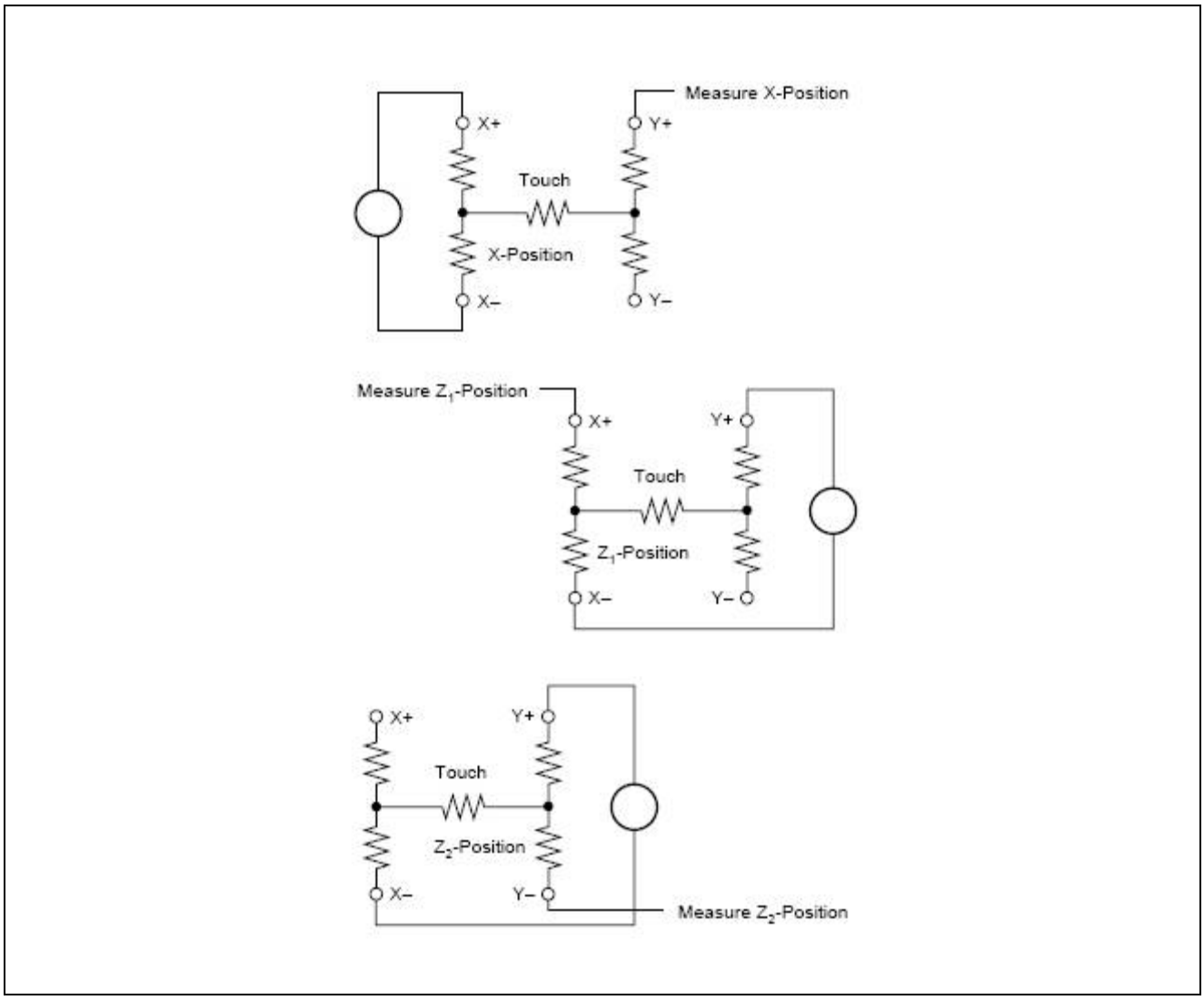
pressure monitoring

useHR2046The pressure of the touch can also be monitored. In order to distinguish whether to touch the screen with a hand or a pen, it is necessary to measure the force of the touch. In general, this measurement does not require high precision, so it is recommended to use8-Bitprecision mode (but the calculations shown now start with12-Bitprecision mode as an example). There are various ways to measure pressure.HR2046Two of these methods are supported. The first method requires a knownxThe resistance of the plane, measuredx position and measure two additional flat positions on the touch screen (Z1andZ2), as shown in the figure7shown. Using the equation (3)The touch resistance can be calculated:

$$R_{TOUCH} = R_{X\text{-}Plate} \cdot \frac{X\text{-}Position}{4096} \left(\frac{Z_2}{Z_1} - 1\right) \qquad (3)$$

The second method requires a knownxplane andYThe resistance of the plane, measuredxdirection,Ydirection of position andZ1. Using the equation (4)Also get touch resistance:

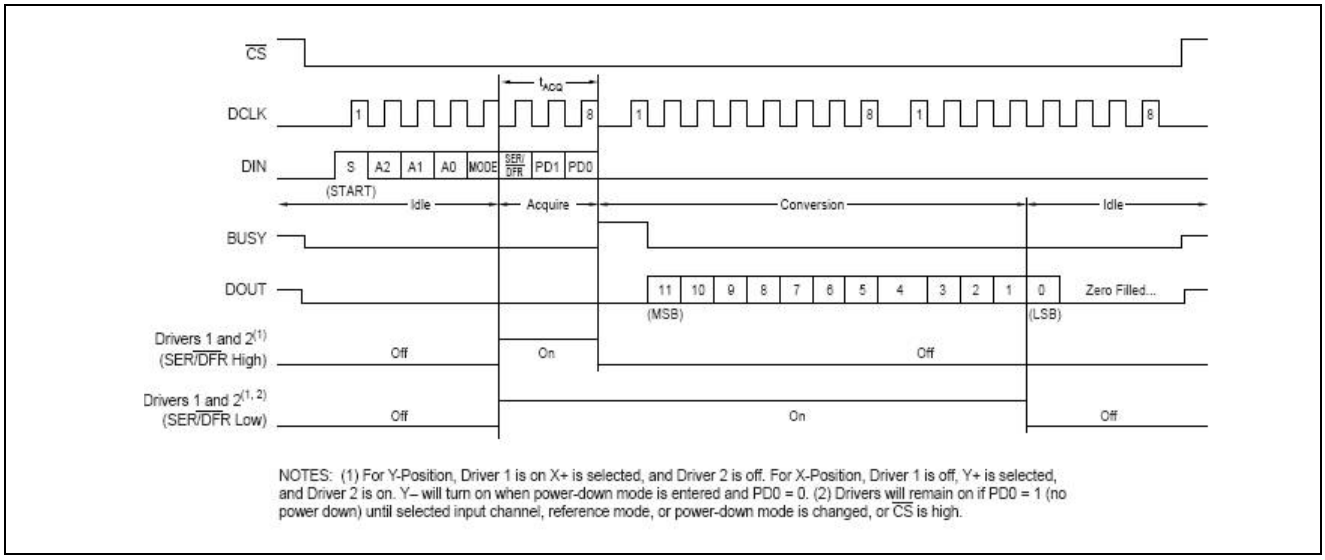
$$R_{TOUCH} = R_{X\text{-}Plate} \frac{X\text{-}Position}{4096} \left(\frac{4096}{Z_1} - 1\right) - R_{Y\text{-}Plate} \left(1 - \frac{Y\text{-}Position}{4096}\right) \qquad (4)$$



picture7Block Diagram of Pressure Measurement

digital interface

HR2046The typical working mode of the digital interface is shown in the figure8.



NOTES: (1) For Y-Position, Driver 1 is on X+ is selected, and Driver 2 is off. For X-Position, Driver 1 is off, Y+ is selected, and Driver 2 is on. Y– will turn on when power-down mode is entered and PD0 = 0. (2) Drivers will remain on if PD0 = 1 (no power down) until selected input channel, reference mode, or power-down mode is changed, or $\overline{CS}$ is high.

picture8Conversion Timing Diagram, Each Conversion Cycletwenty foura clock,8bit bus interface.

This diagram assumes that the digital signal originates from a microcontroller or digital signal processor with a serial port. Every communication between the processor and converter, such asSPI,SSIorMicrowire™synchronous serial interface, both by8consists of clock cycles. A complete conversion can be done by3The second serial port communication is completed, inDCLKCo-inputtwenty fourclock cycle.

forward8clock cycles for passing throughDINThe port provides the control word. When the converter has enough information to configure the multiplexer and reference source inputs, the device enters acknowledge (sampling) mode, opening the touchscreen driver port if necessary. later3After two clock cycles, the transmission of the control word is completed and the converter enters the conversion mode. At this time, the input sample-hold enters the hold mode and the touch screen driver port is closed (in single-ended mode). Next12cycle to complete the actual analog-to-digital conversion. If converted to ratio mode (SER/$\overline{DFR}$=0), the drive port remains open during the transition and requires the first13clock cycles to complete the final1Bitconversion. need additional3cycles to complete the last byte (DOUT will be low), these three cycles are ignored by the converter.

control word

control word (added to theDINport) providesHR2046The following information: start conversion flag, address,ADCthe accuracy, configuration andPower-Downmode selection, see table3. picture8,surface3and table4Details are given.

Start bit—the first bit (ieSbit) must remain high to indicate the start of a control word transfer. When no start bit is detectedHR2046will ignoreDINAll inputs on foot.

address bits—the next3bits (A2,A1,A0) determines the input multiplexer (see table1,surface2and diagram2) input channel, touch screen driver and reference source input.

Mode Bits—Mode bits are setADCaccuracy. When this bit is low, subsequent conversions start with12-Bitmode; if this bit is high, the next conversion will be8-Bitmode is performed.

SER/$\overline{DFR}$bits—SER/$\overline{DFR}$bit controls the mode of the reference source, whether to use single-ended mode (this bit is high) or differential mode (this bit is low). Differential mode is also known as ratiometric mode and when used to measurexdirection,YOrientation and touch pressure will outperform single-ended mode. The reference source voltage comes from the switch driver voltage, which is almost as large as the voltage applied to the touch screen. In this situation,ADCThe reference voltage is the voltage across the touch screen, so there is no need for an independent reference source voltage. In single-ended mode, the reference voltage of the converter is always equal toV_{REF}

feet andGNDVoltage difference between pins (see table1-2,picture1-4) . If measured in single-ended modexdirection,YOrientation and touch pressure require External reference sources.HR2046It must also be powered by an external reference source. Care must be taken when using single-ended modeADCThe input voltage cannot exceed the voltage value of the internal reference source. Especially at supply voltages greater than2.7VTime.

NOTE: Differential measurement mode is only available forxdirection,YMeasurement of orientation and touch pressure. Measurements of other values require single-ended mode.

Bit7(MSB)	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0 (LSB)
S	A2	A1	A0	MODE	SER/$\overline{DFR}$	PD1	PD0

surface3Sequence of control bits in the control word

bit	name	describe
7	S	Start bit. Control byte starts with first high bit on DIN. A new control byte can start every 15th clock cycle in 12-bit conversion mode or every 11th clock cycle in 8-bit conversion mode (see Figure 13).
6-4	A2-A0	Channel Select bits. Along with the SER/DFR bit, these bits control the setting of the multiplexer input, touch drivers witches, and reference inputs (see Tables I and II).
3	MODE	12-Bit/8-Bit Conversion Select bit. This bit controls the number of bits for the next conversion: 12-bits(low) or 8-bits (high).
2	SER/$\overline{DFR}$	Single-Ended/Differential Reference Select bit. Along with bits A2-A0, this bit controls the setting of the multiplexer input, touch driver switches, and reference inputs (see Tables I and II).
1-0	PD1-PD0	Power-Down Mode Select bits. Refer to Table V for details.

surface4Description of the control bits in the control word

PD0andPD1bit-table5Describedpower-downmode and how the internal reference is configured. The internal reference source can be used without affecting theADC turned on and off in case of This gives the internal reference additional time to settle to its voltage value before the conversion takes place.ADCWorks immediately with no additional build time. In order to turn off the internal reference source, after the conversion of the channel is completed, theHR2046Write an additional instruction.

PD1	PD0	$\overline{\text{PENIRQ}}$	describe
0	0	Enabled	Power-Down Between Conversions. When each conversion is finished, the converter enters a low-power mode. At the start of the next conversion, the device instantly powers up to full power. There is no need for additional delays to ensure full operation, and the very first conversion is valid. The Y– switch is on when in power-down.
0	1	Disabled	Reference is off and ADC is on.
1	0	Enabled	Reference is on and ADC is off.
1	1	Disabled	Device is always powered. Reference is on and ADC is ON.

surface5 Power-DownSelection of modes and internal reference sources

$\overline{\text{PENIRQ}}$output

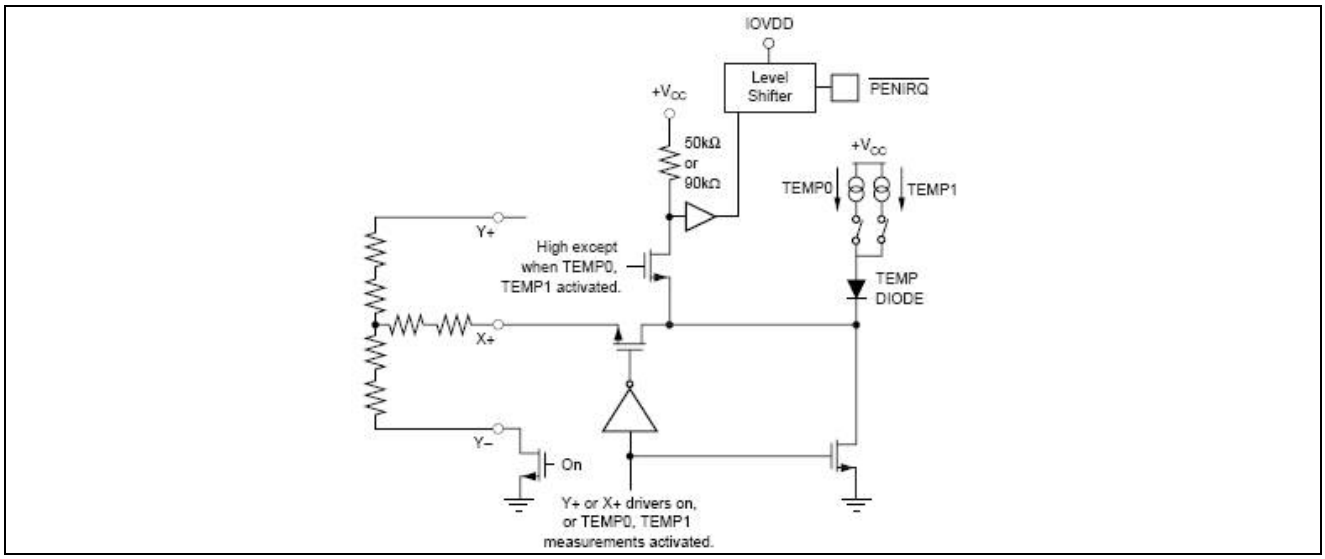
picture9Indicates the output function of the pen interrupt. when inPower-Downmode andPD0=0hour,Ydrive conduction will touch the screen'sYDirection to ground. $\overline{\text{PENIRQ}}$The output is connected through two transmission gates toX+enter. When the screen is touched,X+Inputs are pulled to ground via the touch screen.

existHR2046, the internal pull-up resistor is typically50kΩ, but this value varies with temperature and process in36kΩand67kΩchange between. to make sure$\overline{\text{PENIRQ}}$able to achieve0.35*(+Vcc)logic low level, connected to theX+andY-The total resistance between the21kΩ.

$\overline{\text{PENIRQ}}$Generates an interrupt to the processor by sinking current through the path from the touch screen to ground to go low. existX+, Y+andZThe measurement period of the direction,X+input with$\overline{\text{PENIRQ}}$The internal pull-up resistor on is disconnected. This eliminates leakage current from the internal pull-up resistor through the touch screen to ground (this current can cause measurement errors) .

in addition,$\overline{\text{PENIRQ}}$signal is measuringX+,Y+andZdirection is disabled and held low.$\overline{\text{PENIRQ}}$The signal is inhibited and held high while measuring battery, auxiliary input and temperature. If writeHR2046In the last byte of the instruction thePD0=1, the pen interrupt output function is disabled, so it cannot detect whether the touch screen is touched. In this case, to re-enable this signal must beHR2046write a tape PD0=0control word. If writeHR2046The last control word of containsPD0=0, then the pen interrupt function is enabled after this conversion. The end of the conversion is at the end of the converted dataBit1send outHR2046the clockDCLKafter the falling edge of .

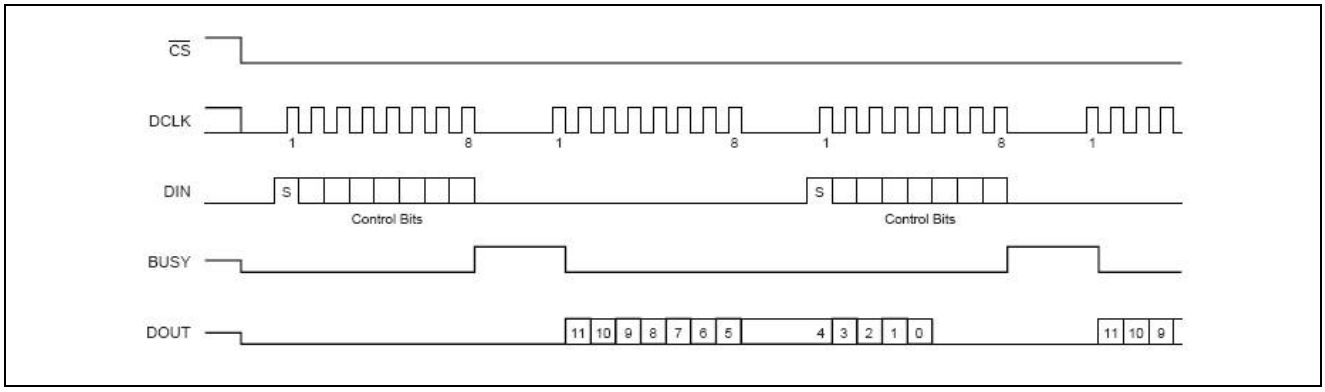
We recommend that the processor send the control word toHR2046time shield$\overline{\text{PENIRQ}}$interruption. In this way, in the cases discussed in this section, the$\overline{\text{PENIRQ}}$ The output will not false trigger.



picture9 $\overline{\text{PENIRQ}}$Functional block diagram

16clocks per conversion cycle

as shown in the picture10shown, convertn+1The control word can be converted immediately after thenoinput to achieve16clocks per conversion cycle. This figure also shows the format of the serial communication between the processor and the converter. There is this diagram to know that every transition can be started after1.6msFinish. Otherwise, the voltage on the sample and hold capacitor will drop significantly and affect the conversion result.

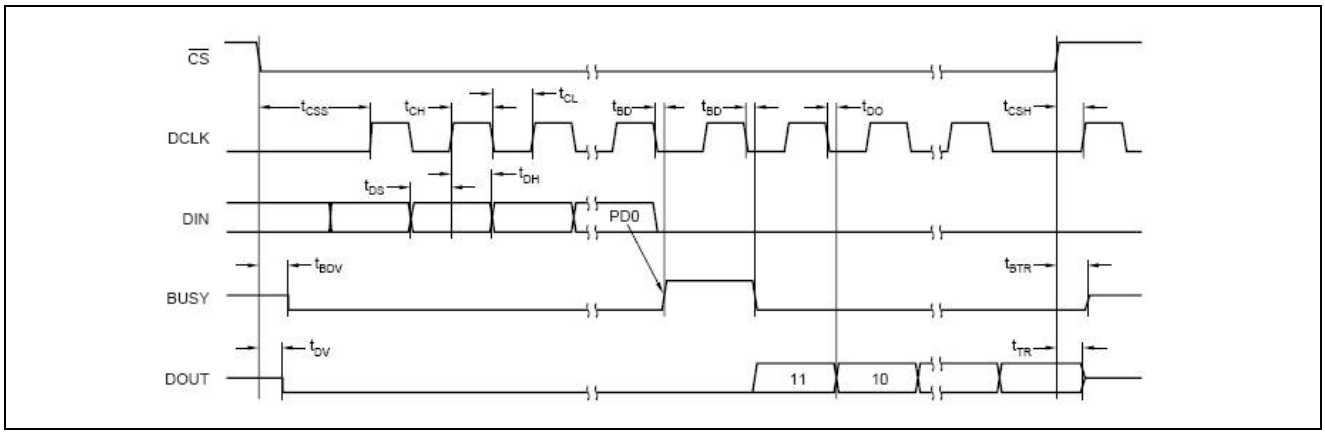


picture10conversion timing diagram,16clocks per conversion cycle,8bit bus mode.

No need for a specific serial portDCLKDelay

digital timing

picture



picture11Detailed Timing Diagram

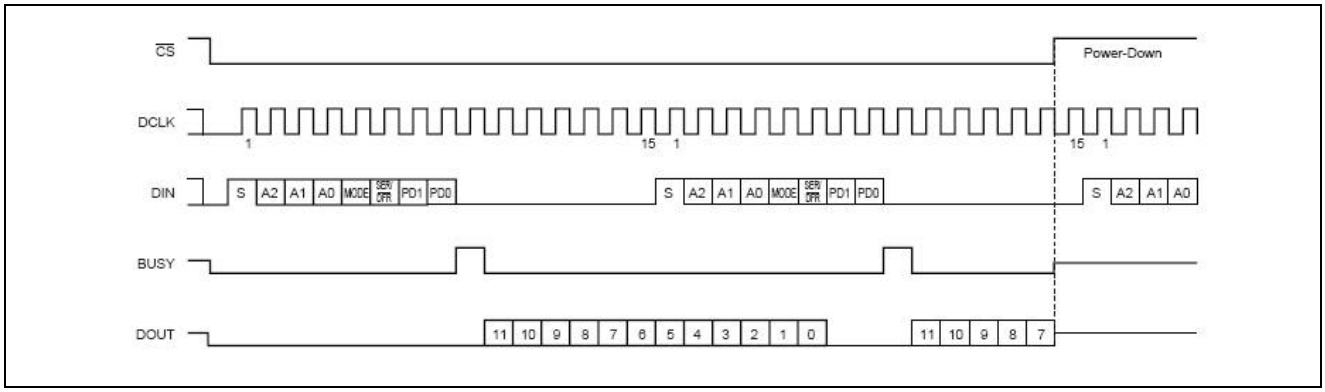
symbol	describe	+V_{CC} * 2.7V, +V_{CC}*IOV_{DD}*1.5V,C_{LOAD}=50pF			unit
		minimum value	typical value	maximum value	
t_{ACQ}	Acquisition Time	1.5			μs
t_{DS}	DIN Valid Prior to DCLK Rising	100			ns
t_{DH}	DIN Hold After DCLK High	50			ns
t_{do}	DCLK Falling to DOUT Valid			200	ns
t_{DV}	$\overline{CS}$ Falling to DOUT Enabled			200	ns
t_{TR}	$\overline{CS}$ Rising to DOUT Disabled			200	ns
t_{css}	$\overline{CS}$ Falling to First DCLK Rising	100			ns
t_{CSH}	$\overline{CS}$ Rising to DCLK Ignored	10			ns
t_{CH}	DCLK High	200			ns
t_{CL}	DCLK Low	200			ns
t_{BD}	DCLK Falling to BUSY Rising/Falling			200	ns

t_{BDV}	$\overline{CS}$ Falling to BUSY Enabled			200	ns
t_{BTR}	$\overline{CS}$ Rising to BUSY Disabled			200	ns

surface6timing value,Ta=-40℃ to +85℃

15clocks per conversion cycle

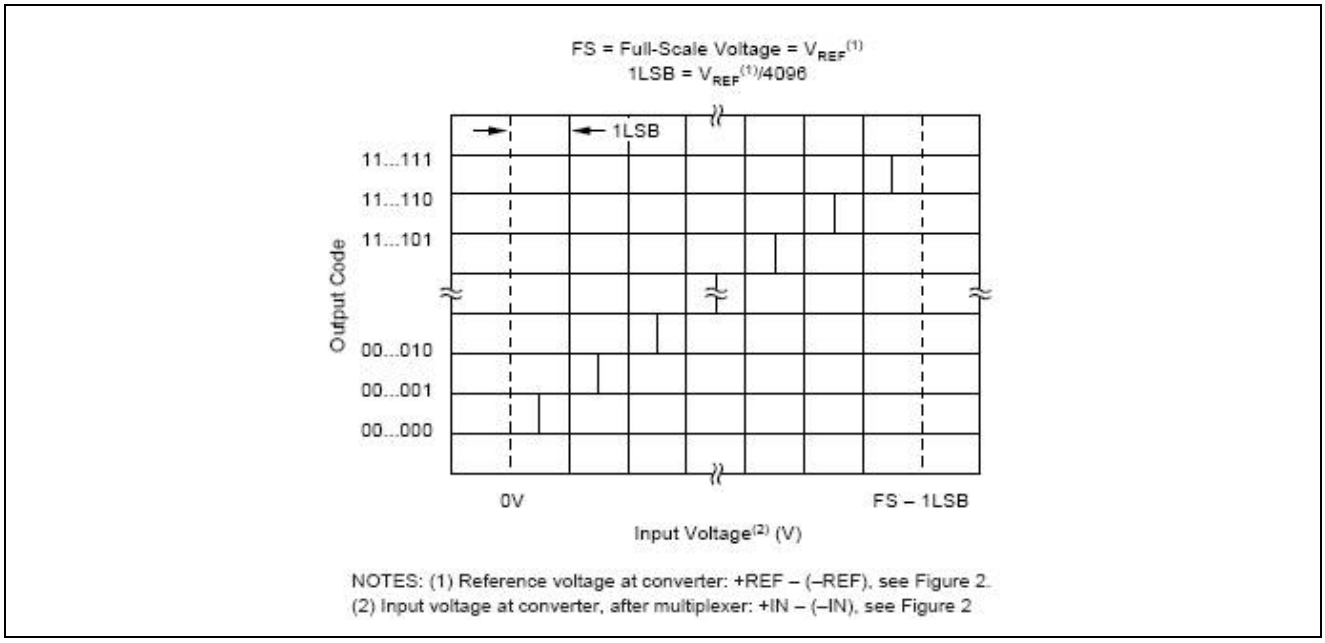
picture11providedHR2046Fastest way to clock. This method is not suitable for most microcontrollers and digital signal processors, because they do not have the15clock capability. However, this approach can be applied to Field Programmable Gate Arrays (FPGAs) or ASIC (ASICs). Note that this method greatly increases the maximum conversion rate of the converter.



picture12Maximum transfer rate,15clocks per conversion cycle

Data Format

HR2046Output data directly in binary format, as shown in the figure13shown. This graph shows the ideal output code for a given input voltage, excluding the effects of offset, gain error, and noise.



picture13Ideal Input Voltage and Output Code

conversion mode

HR2046provides a8BitConversion mode, used for occasions that require high-speed conversion but do not require high precision of digital results. switch to8Bitmode, each conversion can be advanced4clock cycle is completed. This not only reduces each conversion4bit (speed up25%), while each conversion can occur at a faster rate. This is becauseHR2046The internal settling time of the8 The precision value in digits. Clock rates can be accelerated up to50%. Faster clocks and fewer clock cycles will increase conversion rates up to1times.

Limit parameter

parameter	scope	unit
+ VccandIOVDDarriveGND	- 0.3~+6	V
Analog input to ground	- 0.3~+VCC+0.3	V
digital input to ground	- 0.3~IOVDD+0.3	V
power consumption	250	mW
maximum junction temperature	+ 150	℃
range of working temperature	- 40~+85	℃
storage temperature range	- 65~+150	℃
Wire temperature (soldering,10s)	+ 300	℃

Electrical parameters(If not specified, the test conditions are:TA=-40℃~+85℃, +VCC=+2.7V,VREF=2.5Vinternal voltage,fSAMPLE=125kHz, fCLK=16* fSAMPLE=2MHz,12-bitmode,NumberInput=GNDorIOVDD, +VCCmust be*IOVDD)

parameter	condition	minimum value	typical value	maximum value	unit
analog input					
full scale input	Positive input - negative input	0		VREF	V
absolute input range	positive input	- 0.2		+VCC+0.2	V
	negative input	- 0.2		+ 0.2	V
capacitance			25		pF
leakage current			0.1		μA
system performance					
resolution			12		Bits
missing code		11			Bits
Cumulative Linearity Error				±2	LSB(1)
Offset error				±6	LSB
gain error	externalVREF			±4	LSB
noise	including internalVREF		70		μVrms
Power Supply Rejection Ratio			70		dB
dynamic sampling					
conversion time				12	CLK Cycles
confirm the time		3			CLK Cycles
channel throughput				125	kHz
Multiplexer Setup Time			500		ns
Aperture delay			30		ns
Aperture Jitter			100		ps
Channel-to-channel isolation	VIN=2.5Vpp(50KHz)		100		dB
switch drive					
ON resistance					
Y+, X+			5		Ω
Y-, X-			6		Ω
drive current(2)	duration100ms			50	mA

Reference source output					
internal reference voltage		2.45	2.50	2.55	V
Internal Reference Drift			15		ppm/℃
Quiescent Current			500		μA
Reference source input					
scope		1.0		$+V_{CC}$	V
input resistance	SER/$\overline{DFR}$=0, PD1=0		1		GΩ
	internal source off				
	internal source on		250		Ω
battery monitoring					
Input voltage range		0.5		6.0	V
input resistance					
Sampling battery			10		kΩ
Battery monitoring off			1		GΩ
precision	V_{BAT}=0.5V~5.5V,external V_{REF}=2.5V	- 2		+ 2	%
	V_{BAT}=0.5V~5.5V, internal source	- 3		+ 3	%
temperature measurement					
temperature range		- 40		+85	℃
resolution	differential mode(3)		1.6		℃
	TEMP0(4)		0.3		℃
precision	differential mode(3)		±2		℃
	TEMP0(4)		±3		℃
digital input/output					
Digital Logic Interface			CMOS		
capacitance	All digital control input pins		5	15	pF
V_{IH}	$\lvert I_{IH} \rvert \leqslant +5\mu A$	IOVDD*0.7		IOVDD+0.3	V
V_{IL}	$\lvert I_{IL} \rvert \leqslant +5\mu A$	- 0.3		0.3*IOVDD	V
V_{Oh}	I_{Oh}=-250μA	IOVDD*0.8			V
V_{OL}	I_{OL}=250μA			0.4	V
Data Format			binary		
Power supply requirements					
$+V_{CC}$(5)	Recommended scope of work	2.7		3.6	V
	The scope of work	2.2		5.25	V
IOVDD(6)		1.5		$+V_{CC}$	V
Quiescent Current(7)	internal source off		280	650	μA
	internal source on		780		μA
	f_{SAMPLE}=12.5kHz		220		μA
	Power-Downmodel $\overline{CS}$=DCLK=DIN= IOV_{DD}			3	μA

power consumption	+V_{CC}=+2.7V			1.8	mW
temperature range					
under given working conditions		- 40		+85	℃

Note:

(1) LSBIndicates the least significant digit. existV_{REF}=2.5Vhour,1indivualLSB=610μV. Determined by design,

(2) but not tested. Exceed50mAcurrent may cause device failure. MeasurementTEMP0andTEMP1The

(3) difference of , no standard value is required. Temperature drift is -2.1mV/℃.

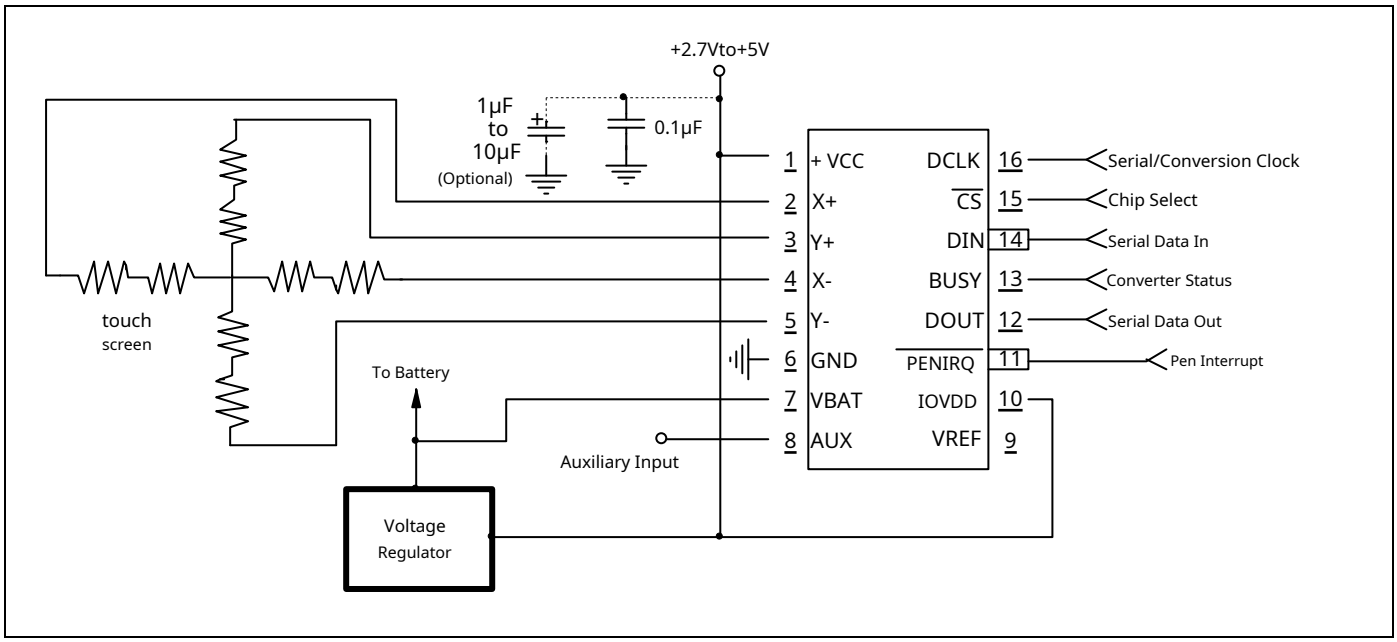
(4)

(5) HR2046Operating voltage can be as low as2.2V.

(6) IOV_{DD}Must be -(+V_{CC}).

(7) include+V_{CC}andIOV_{DD}current, typical values are fromPD0=0TimeAUXObtained from the transformation of the mouth as input.

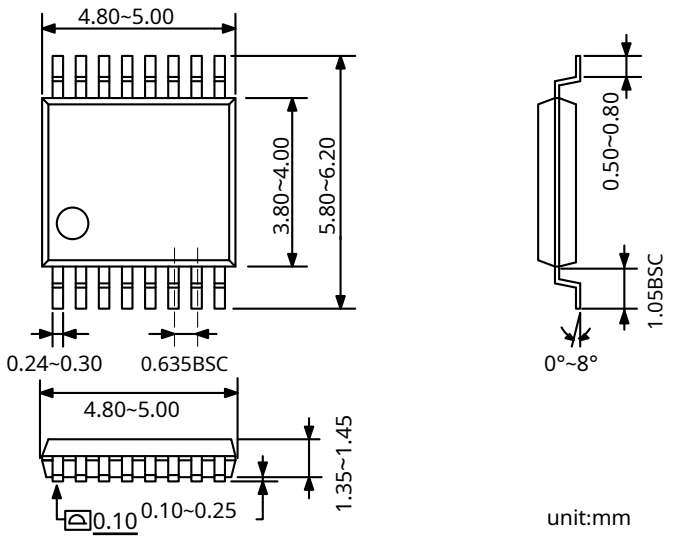
Refer to the application circuit diagram



*: This circuit is for reference only.

package size

SSOP16



QFN16