Low-Voltage I/O Touch Panel Controller

■ Description

The LN2046 touch panel controller IC is a 12-bit ADC converter with SPI serial interface and low on-resistance drivers for 4-wire resistive touch panels.

The LN2046 is a highly integrated controller for portable applications with 4-wire resistive touch panel such as, PDA, portable instruments, cellular phone, etc.

The LN2046 consumes only 800μW at a 125kHz sample rate and a 2.7V supply and consumes only 0.3μW at shutdown mode. The LN2046 is guaranteed down to 2.7V supply.

The LN2046 is provided in a very small 16-lead TSSOP and QFNWB4×4 package and is guaranteed over the temperature range.

■ Package

- TSSOP-16
- QFNWB4×4-16L

■ Applications

- Touch panel
- PDA
- Point-of-sales terminals
- Pagers
- High speed data acquisition
- Portable instruments
- Low power instruments

■ Features

- Serial interface
- 4-wire touch panel interface
- Embedded touch panel drivers
- 2.7V to 5.5V supply voltage
- 12-bit analog to digital converter
- Programable 8-or 12-bit resolution
- Up to 125KHz conversion rate
- 2 auxiliary analog input
- Full power-down control
- 16 pin package

■Typical Operating Circuit

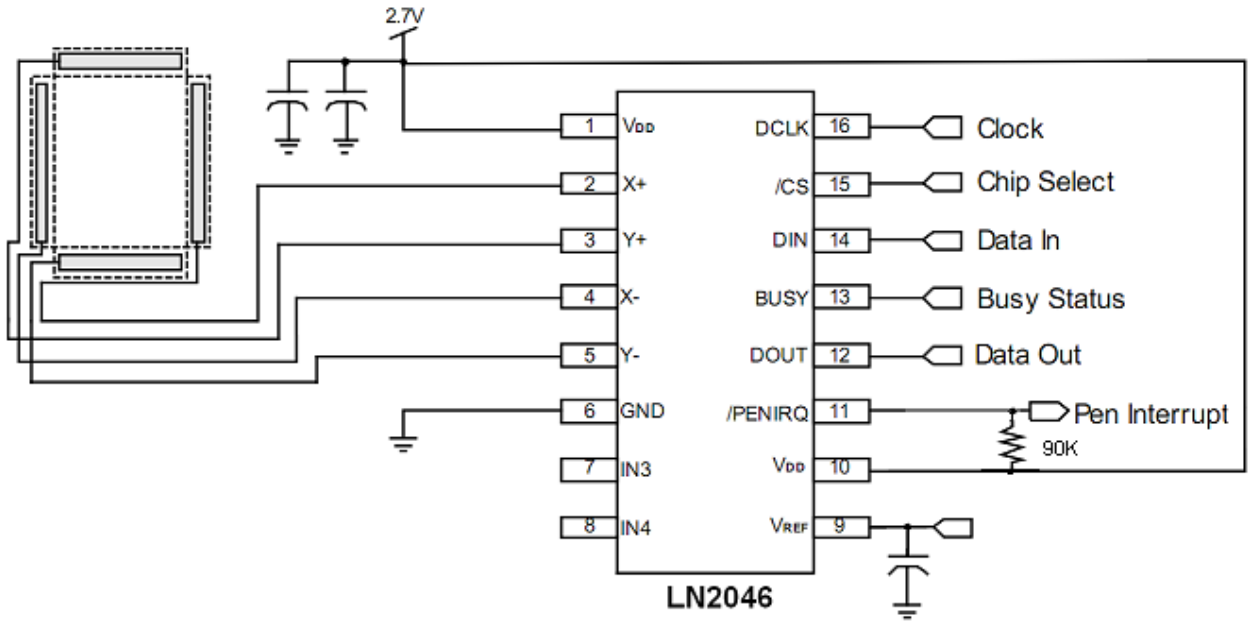


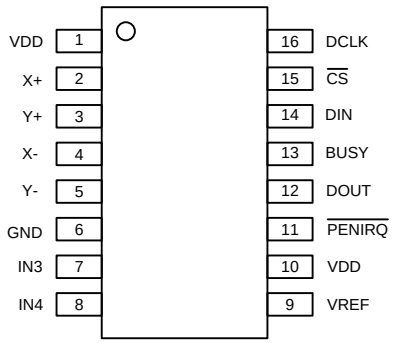
Figure 1. Typical operation of the LN2046

■ Ordering Information

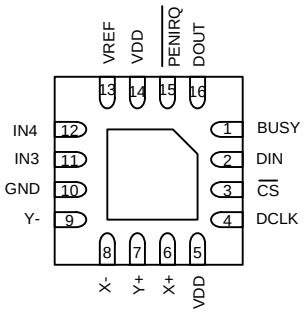
LN2046 ①②

Designator	Symbol	Description
①		Reference voltage
	U	External reference voltage
	R	Built-in reference voltage of 2.5 V
②		Package
	T	TSSOP-16
	Q	QFNWB4×4-16L

■ Pin Configuration



TSSOP-16
(Top View)



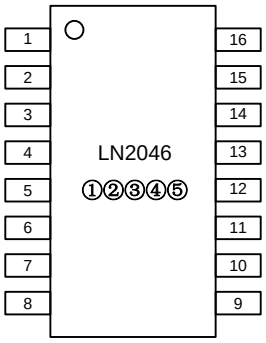
QFNWB4*4-16L
(Bottom View)

■ Pin Assignment

Pin number		Name	Description
TSSOP-16	QFNWB4*4-16L		
1	5	VDD	Power supply, 2.7V to 5.5V.
2	6	X+	X+ Input; ADC input channel 1.
3	7	Y+	Y+ Input; ADC input channel 2.
4	8	X-	X- Input.
5	9	Y-	Y- Input.
6	10	GND	Ground.
7	11	IN3	Auxiliary input 1;ADC input channel 3.
8	12	IN4	Auxiliary input 2;ADC input channel 4.
9	13	VREF	Reference voltage input.
10	14	VDD	Power supply, 2.7V to 5.5V.
11	15	/PENIRQ	Pen interrupt. requires 10KΩ to 100KΩ external pull-up resistor.
12	16	DOUT	Serial data output. This output pin is high impedance when /CS is high.
13	1	BUSY	Busy output. This output pin is high impedance when /CS is high.
14	2	DIN	Serial data input.
15	3	/CS	Chip select input. This input is active low.
16	4	DCLK	External clock input.

■ Marking Rule

- TSSOP-16, QFNWB4×4-16L



TSSOP-16
(Top View)

QFNWB4*4-16L
(Top View)

① Represents the reference voltage

Symbol	Description
U	External reference voltage
R	Built-in reference voltage of 2.5 V

② Represents the type of package

Symbol	Description
T	TSSOP-16
Q	QFNWB4×4-16L

③ ④ ⑤ Represents the assembly lot no.

■ Absolute Maximum Rating

Parameter	Absolute Maximum Rating
V_{DD} to GND	-0.3V to +6V
Analog input to GND	-0.3V to V_{DD} +0.3V
Digital input to GND	-0.3V to V_{DD} +0.3V
Operating temperature range	-40°C to +85°C
Maximum junction temperature	+150°C
Storage temperature range	-60°C to +150°C
Lead temperature (Soldering, 10s)	+300°C

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

■ Block Diagram

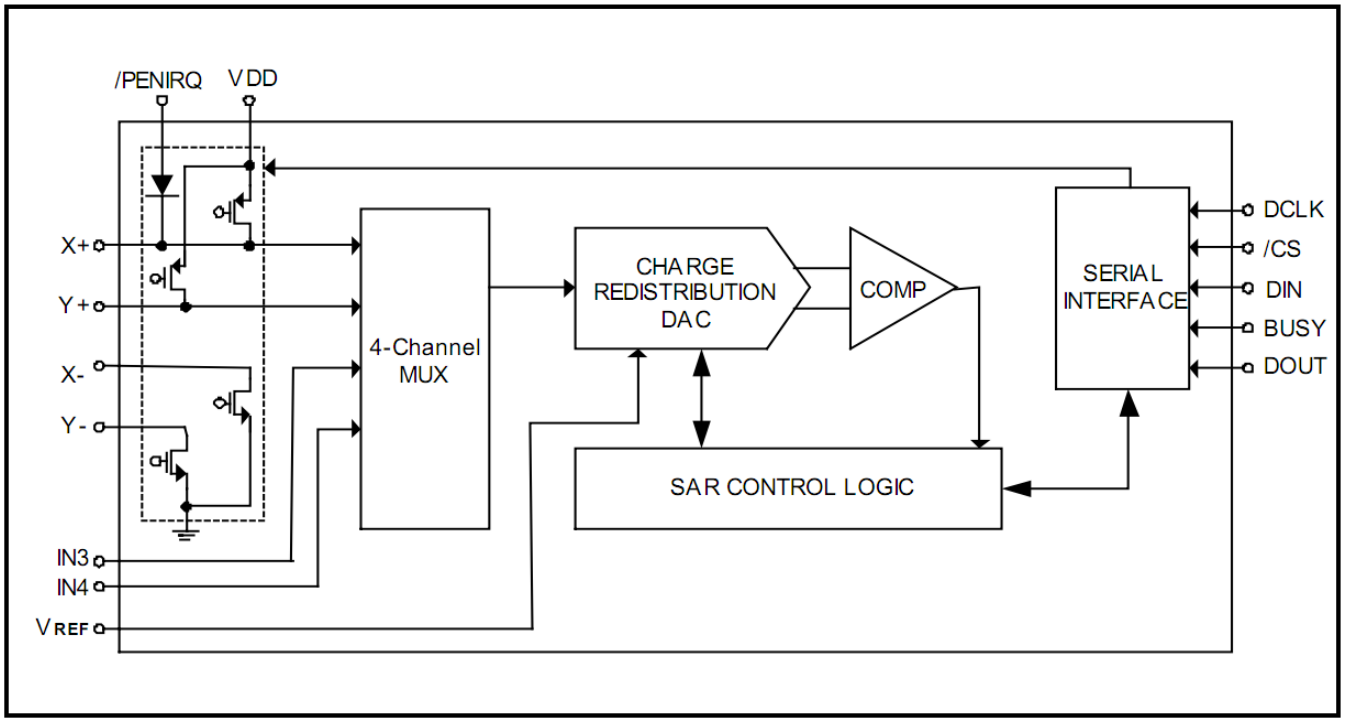


Figure 2. Block Diagram of The LN2046

■ ELECTRICAL SPECIFICATIONS

(T_A = -40°C to +85°C, V_{DD}=+2.7V, V_{REF}=+2.7V, f_{Sample}=125KHz, f_{CLK}=24 · f_{Sample}, 12-bit mode, Digital Inputs= GND or +V_{DD}. Typical values are at T_A = +25°C, unless otherwise noted.)

Parameter	Test Conditions	Min.	Typ.	Max.	Units
Power Supply Requirements					
V_{DD}	Specified performance	2.7		5.5	V
Nominal supply current			300		µA
	Shut down mode			3	µA
Power dissipation			800		µW
System Performance					
Resolution			12		Bits
INL			+/-2		LSB
DNL			+/-4		LSB
Gain error			+/-1		LSB
Offset error			+/-6		LSB
Digital Input/Output					
Logic family	CMOS				
VOH		V_{DD}×0.8			V
VOL				0.4	V
VIH		V_{DD}×0.7		V_{DD} + 0.3	V
VIL		-0.3		0.8	V
/PENIRQ	100KΩ Pull-Up				
V_{OL}			0. 6		V
Analog Input					
Input span input		0		V_{REF}	V
Range		-0.2		V_{DD}+0.2	V
Capacitance			25		PF
Reference Input					
Range					
Input current		1		V_{DD}	V
	Specified performance		15		µA
X / Y Switches					
X+, Y+	Switch On-Resistance		5		Ω
X-, Y-	Switch On-Resistance		5		Ω
Temperature Range					
Operating temperature range	Specified performance	-40		+85	°C

■ Timing Specifications

(T_A = -40°C to +85°C, V_{DD}≧+2.7V, C_{LOAD}=50pF. Typical values are at T_A = +25°C, unless otherwise noted.)

Symbol	Description	Min	Typ	Max	Units
T_{ACQ}	ADC acquisition time	500			ns
T_{CON}	ADC conversion time	6.5			µs
T_{CSF}	/CS falling to first DCLK rising	100			ns
T_{CSR}	/CS rising to DCLK ignored	0			ns
T_{DOF}	/CS falling to DOUT enable			200	ns
T_{DOR}	/CS rising to DOUT disable			200	ns
T_{BSF}	/CS falling to BUSY enable			200	ns
T_{BSR}	/CS rising to BUSY disable			200	ns
T_{CKH}	DCLK High Period	200			ns
T_{CKL}	DCLK LOW Period	200			ns
T_{DIS}	DIN valid before DCLK rising	100			ns
T_{DIH}	DIN hold time after DCLK going high	15			ns
T_{DO}	DCLK falling to DOUT valid			200	ns
T_{BO}	DCLK falling to BUSY rising			200	ns

■ Timing Diagram

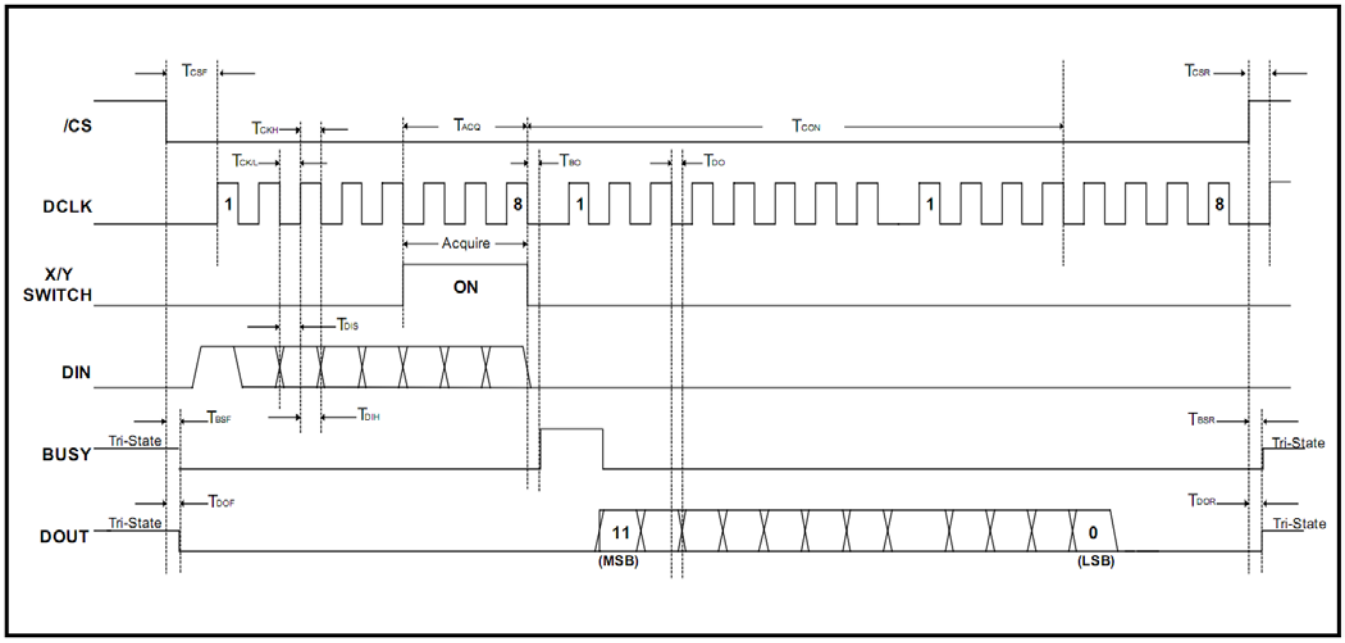


Figure 3. Timing Diagram of LN2046

■ Functional Description

- **Overview**

The LN2046 is a 12-bit switched-capacitor Analog-to-Digital (A/D) converter. The converter is fabricated on a 0.6μm CMOS process and packaged in the very small 16-pin SSOP package.

The typical operation of the LN2046 is shown in Figure1. The LN2046 operates on a single supply ranging from +2.7V to +5.5V. It requires an external reference and an external clock. The reference voltage directly sets the input range of the converter.

The LN2046 contains four channel inputs, a serial interface, and low on-resistance switches for touch panel (see Block Diagram). The input to the converter is selected via the four-channel multiplexer as shown in Figure7.

- **Operation of 24-clocks**

The typical operation of LN2046's serial interface is shown in Figure1. The LN2046 communicate with microprocessors or digital signal processors via a synchronous serial interface. One complete conversion can be accomplished with three serial communications for a total 24 clock cycles on the DCLK input.

- **Serial interface**

The operation is initiated by a falling signal on Chip Select (/CS) input. After /CS falls the LN2046 look for a start bit on the DIN input. The first eight clock cycles are used to provide the control byte. At the end of the operation the /CS pin should be brought high. Bringing /CS high after the conversion also minimizes supply current if DCLK is left running.

- **Control Byte**

Table I and Table II are detailed information of the control byte (on DIN). The control byte provides the start operation, addressing, resolution, and power down information of the LN2046.

- **Start Bit – Initiate Start**

The control byte starts with the first high bit on DIN. The first bit must always be HIGH (1) to initiate the start of the conversion. The LN2046 will ignore any inputs on the DIN until the start bit is detected.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Start	A2	A1	A0	Mode1	Mode0	PD1	PD0

Table I. Control Bits in the Control Byte

BIT	Name	Description
7	Start	Start Bit.
6, 5, 4	A2,A1,A0	Input Channel Select Bits.
3, 2	Mode1 Mode0	12-bit/8-bit Conversion Configuration bit.
1, 0	PD1,PD0	Power Down Control Bits

Table II. Description of the Control Bits

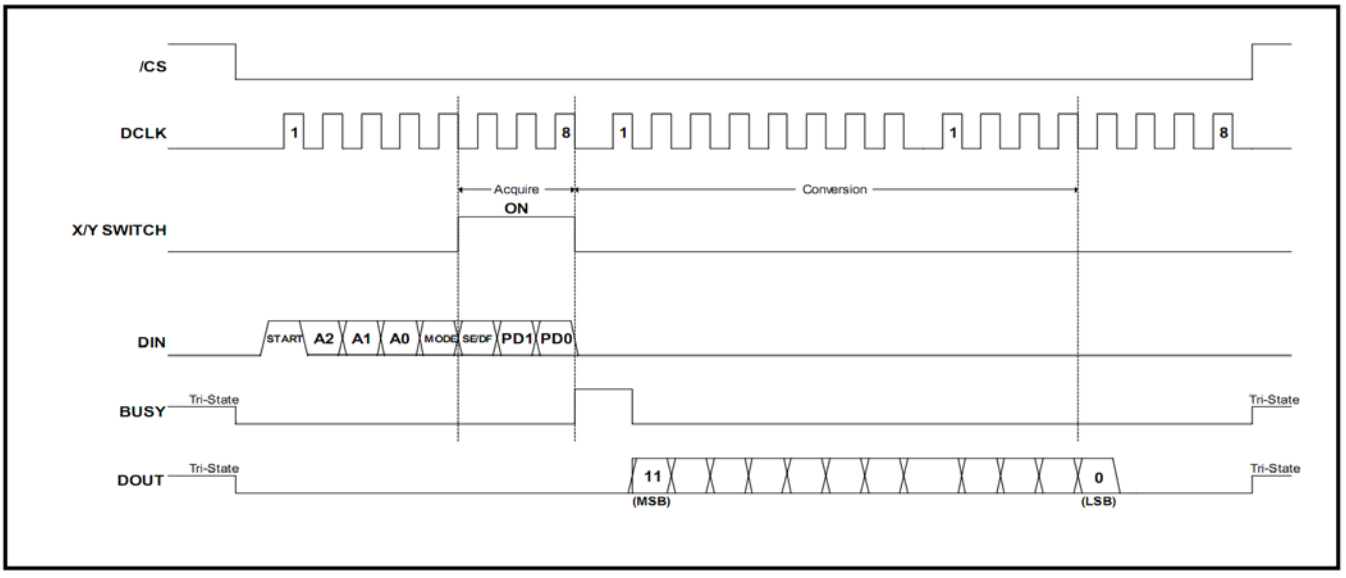


Figure 4. Serial Interface of LN2046

- **Addressing Bits – Input Channel Selection**

The next three bits on control byte (A2, A1, A0) select the active input channel of the input multiplexer (see Table V, and Figure 7), and touch panel drivers.

- **Mode Bits – Conversion Resolution on figuration**

The Mode bits (Mode1, Mode0) set the resolution of the analog-to-digital (ADC) converter. With the Mode1 bit LOW (0) the following conversion will have 12 bits of resolution. With the Mode1 bit HIGH (1) the following conversion will have 8 bits of resolution.See Table III for more information.

- **PD0 and PD1 Bits - Power Down Control**

The last two bits (PD1, PD0) control the power-down mode of LN2046. If both bits are HIGH (1), the device is always powered up. If both bits are LOW (0), the device enters a power-down mode between conversions. See Table IV for more information.

- **Operation of 16-clocks**

The typical operation of LN2046 is 24-clocks (three control bytes) per conversion. However the control bits for the next conversion can be overlapped with current conversion for a faster conversion. Figure 5 shows the timing of 16-Clocks per conversion.

Mode1	Mode0	DESCRIPTION
0	1	12bits Resolution
0	0	12bits Resolution
1	1	8bits Resolution
1	0	8bits Resolution

Table III. Resolution Configuration

PD1	PD0	PENIRQ	DESCRIPTION
0	0	Enable	Power-Down between conversions. Y- switch is on.
0	1	Disable	Power-Down between conversions. Y- switch is off. /PENIRQ is disabled
1	0	Disable	No used.
1	1	Disable	No Power-Down between conversions.

Table IV. Power-Down Selection

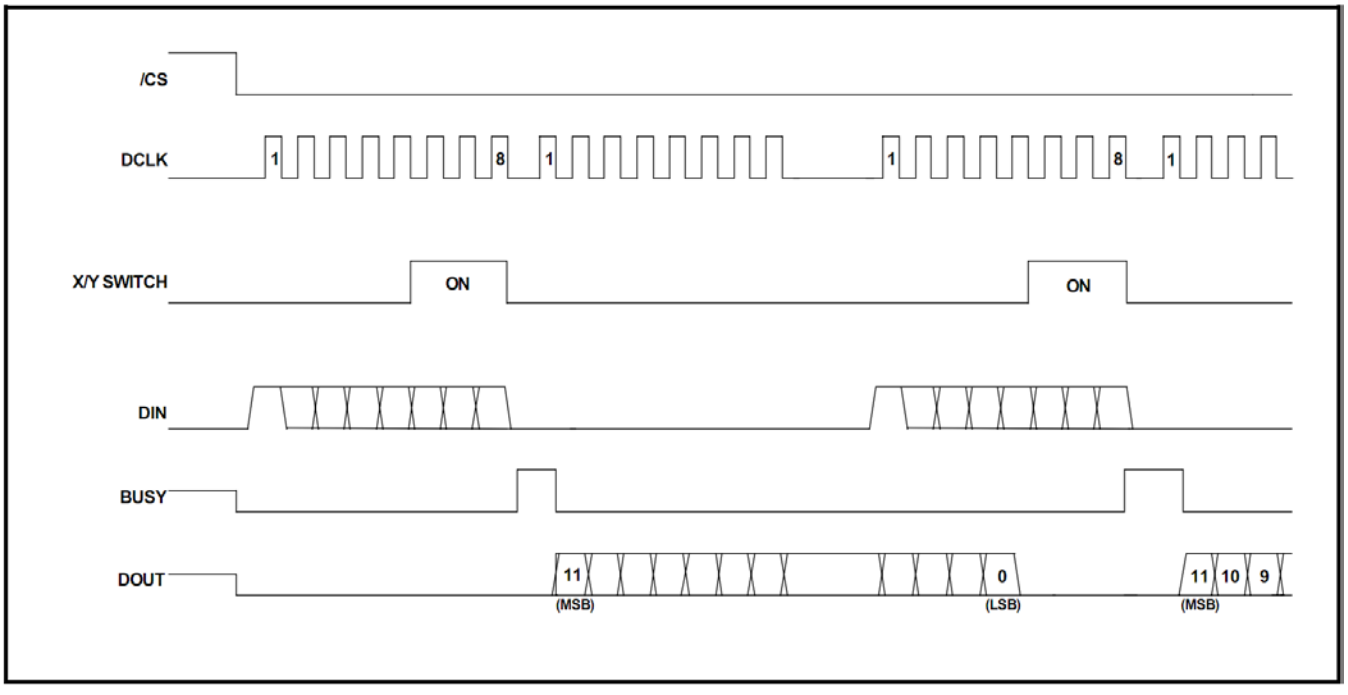


Figure 5. Timing of 16-clocks per Conversion

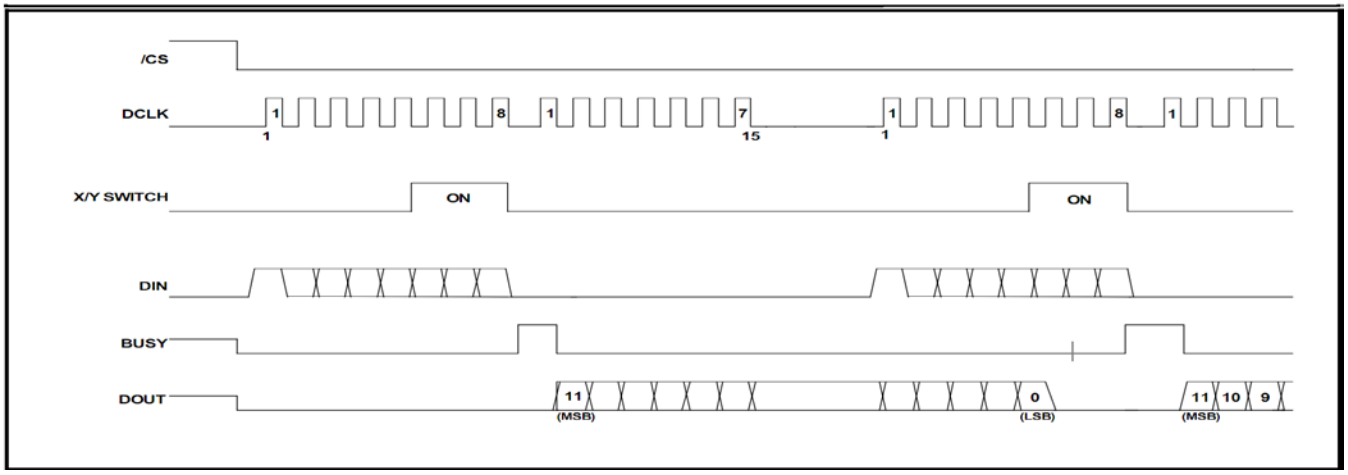


Figure 6. Timing of 15-clocks per Conversion

- **Operation of 15-clocks**

The fastest operation (15-clocks per conversion) of LN2046 is shown on Figure 6. This operation will NOT work with the serial interface of most microcontrollers and digital signal processors, as they are not capable of providing 15 clocks cycles per serial transfer.

- **Analog Input**

The LN2046 contains four channel inputs. X+ and Y+ inputs are for touch panel measurement, 2 auxiliary inputs are IN3 and IN4. The input to the A/D converter is selected via the four-channel multiplexer. (see Block Diagram section and Figure 7.)

- **Input Channel**

Table V shown the input channel configuration of the LN2046. The control bits are set via the DIN pin. (see Control Byte section). The selected channel is for A/D converter input. Please refer to Figure 5 for detailed input channel multiplexer. For measuring X+ and Y+, Y switches and X switches are turned onrespectively.

- **Reference Input**

The LN2046 requires an external reference voltage source. The reference input sets the Analog-to-Digital converter (ADC) input range. If the reference input is from the power supply directly, special care must be taken to avoid noise from power supply.

A2	A1	A0	Input Channel.	X Switch	Y Switch	Reference
0	0	1	X+	OFF	ON	V_{REF}
1	0	1	Y+	ON	OFF	V_{REF}
0	1	0	IN3	OFF	OFF	V_{REF}
1	1	0	IN4	OFF	OFF	V_{REF}

Table V. Input Channel Configuration

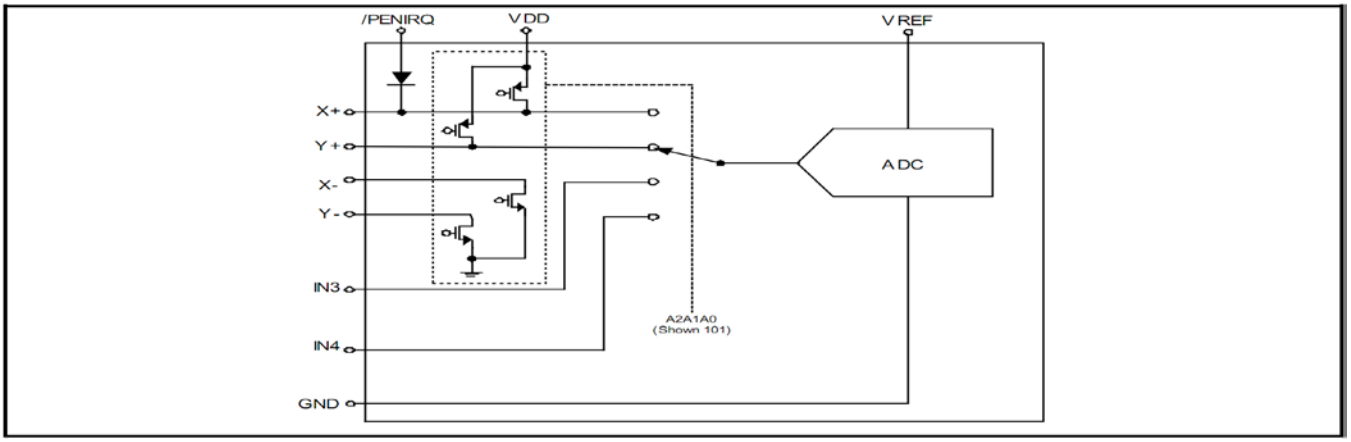


Figure 7. Diagram of Input Channel

■APPLICATION CONSIDERATIONS

- **Resistive Touch Panel (4-Wire)**

The 4-wire resistive touch panel consists of 2 resistive plates that are separated by a small gap. Each of the panel has a resistance in the range from 200 to 2000 ohms.

The panel works by applying a voltage across the X plate or Y plate resistive networks. If a voltage is applied, for example, between X+ and X- then a voltage divider is formed on the X plate. When the Y plate is touched to the X plate, a voltage will be developed on the Y plate. By accurately measuring this voltage, the position of the panel can be determined. The connection of LN2046 to the touch panel should be as short as possible.

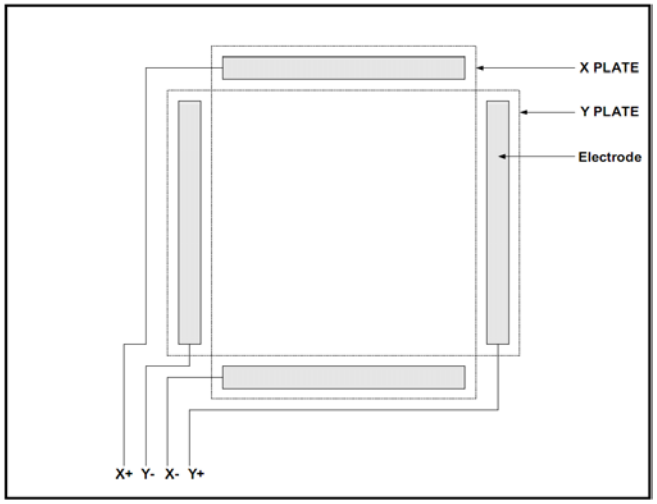
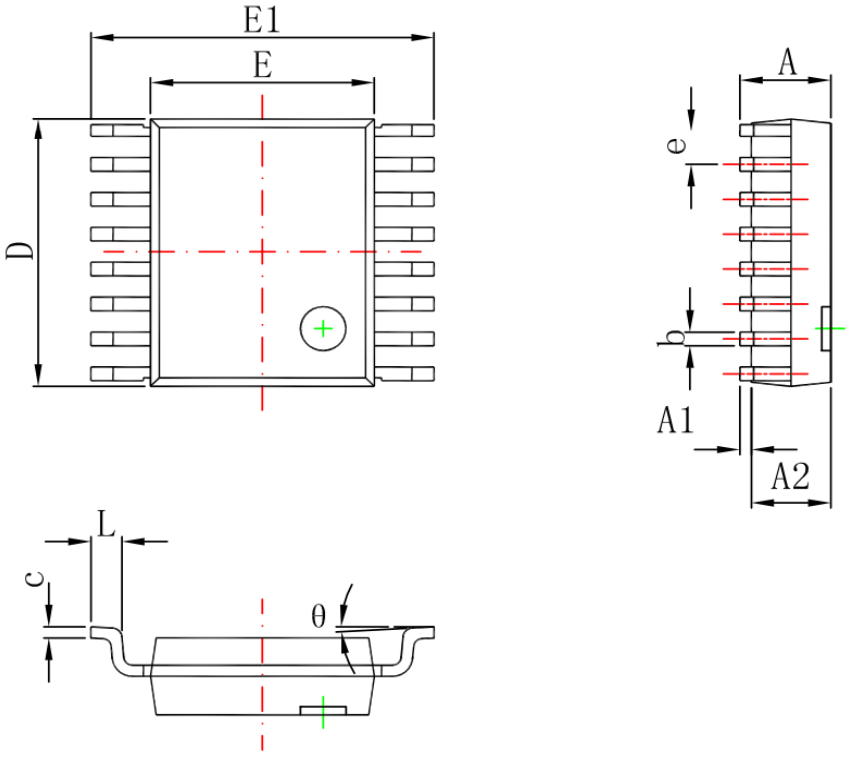


Figure 8. 4-wire Resistive Touch Panel

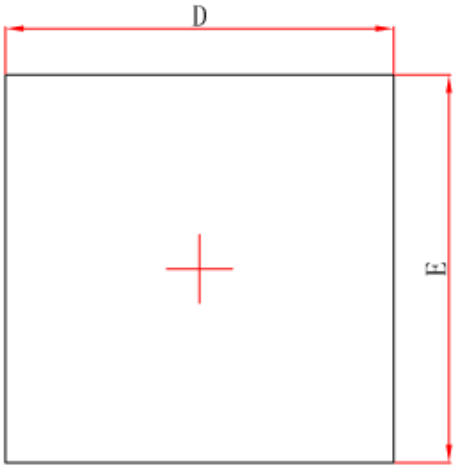
■ Package Information

- **SSOP-16**

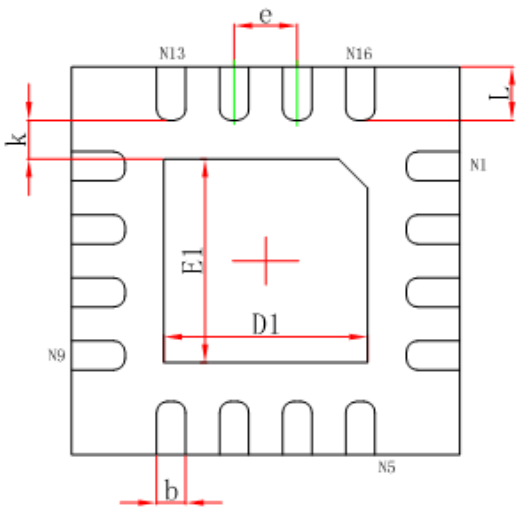


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	**Max**	**Min**	**Max**
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.200	0.300	0.008	0.012
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	0.635(BSC)		0.025(BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

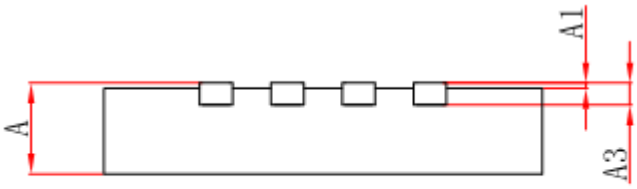
- **QFNWB4×4-16L**



Top View



Bottom View



Side View

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	0.700/0.800	0.800/0.900	0.028/0.031	0.031/0.035
A1	0.000	0.050	0.000	0.002
A3	0.203REF.		0.008REF.	
D	3.900	4.100	0.154	0.161
E	3.900	4.100	0.154	0.161
D1	2.000	2.200	0.079	0.087
E1	2.000	2.200	0.079	0.087
k	0.200MIN.		0.008MIN.	
b	0.250	0.350	0.010	0.014
e	0.650TYP.		0.026TYP.	
L	0.450	0.650	0.018	0.026