**DATASHEET**

# AR7643

## TOUCH PANEL CONTROLLER


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**May 27, 2001**
**Preliminary**

## 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
- PROGRAMMABLE 8- OR 12-BIT RESOLUTION
- UP TO 125KHz CONVERSION RATE
- 2 AUXILIARY ANALOG INPUTS
- FULL POWER-DOWN CONTROL
- 16 PIN SSOP PACKAGE

## APPLICATIONS

- TOUCH PANELS
- PERSONAL DIGITAL ASSISTANTS (PDA)
- POINT-OF-SALES TERMINALS
- PAGES
- HIGH SPEED DATA ACQUISTION
- PORTABLE INSTRUMENTS
- LOW POWER INSTRUMENTS

## DESCRIPTION

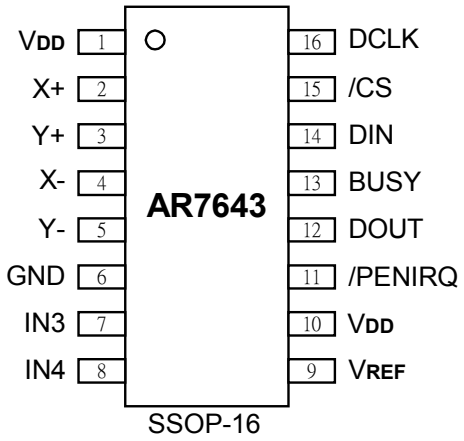
The AR7643 Touch Panel Controller IC is a 12-bit analog-to-digital (ADC) converter with SPI serial interface and low on-resistance drivers for 4-wire resistive touch panels.

The AR7643 is a highly integrated controller for portable applications with 4-wire resistive touch panel such as, PDA, portable instruments, cellular phone, etc.

The AR7643 consumes only 800μW at a 125kHz sample rate and a 2.7V supply and consumes only 0.3μW at shutdown mode. The AR7643 is guaranteed down to 2.7V supply.

The AR7643 is provided in a very small 16-lead SSOP package and is guaranteed over the temperature range.

## Pin Configuration



SSOP-16

## Ordering Information

| PART | TEMP. RANGE | PACKAGE |
|---|---|---|
| AR7643 | -40℃ to +85℃ | SSOP-16 |

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## 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.

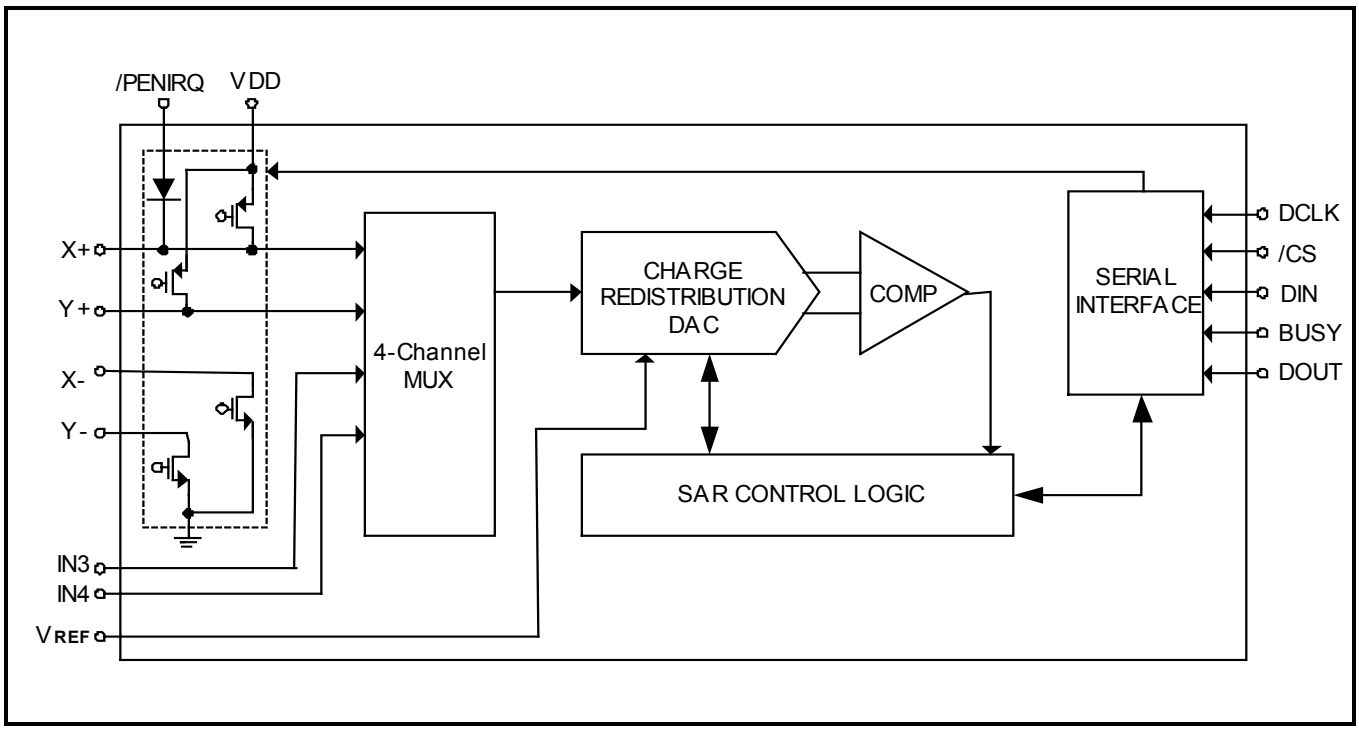
## Electrostatic Discharge Sensitivity

This integrated circuit can be damaged by ESD. ARTi recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure.

## Pin Description

| Pin | Name | Description |
|---|---|---|
| 1 | $V_{DD}$ | Power Supply, 2.7V to 5.5V. |
| 2 | X+ | X+ Input; ADC Input Channel 1. |
| 3 | Y+ | Y+ Input; ADC Input Channel 2. |
| 4 | X- | X- Input. |
| 5 | Y- | Y- Input. |
| 6 | GND | Ground. |
| 7 | IN3 | Auxiliary Input 1; ADC Input Channel 3. |
| 8 | IN4 | Auxiliary Input 2; ADC Input Channel 4. |
| 9 | $V_{REF}$ | Reference Voltage Input. |
| 10 | $V_{DD}$ | Power Supply, 2.7V to 5.5V. |
| 11 | /PENIRQ | Pen Interrupt. Requires 10KΩ to 100KΩ external pull-up resistor. |
| 12 | DOUT | Serial Data Output. This output pin is high impedance when /CS is high. |
| 13 | BUSY | Busy Output. This output pin is high impedance when /CS is high. |
| 14 | DIN | Serial Data Input. |
| 15 | /CS | Chip Select Input. This input is active low. |
| 16 | DCLK | External Clock Input. |

## Block Diagram



## 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 | | 3.6 | V |
| Nominal Supply Current | | | 300 | | µA |
| | Shut Down Mode | | | 3 | µA |
| Power Dissipation | | | 800 | | µW |
| **System Performance** | | | | | |
| Resolution | | | 12 | | Bits |
| INL | | | +/-2 | | LSB |
| DNL | | | +/-1 | | LSB |
| Gain Error | | | +/-4 | | LSB |
| Offset Error | | | +/-6 | | LSB |
| **Digital Input/Output** | | | | | |
| **Logic Family** | CMOS | | | | |
| $V_{OH}$ | | $V_{DD}$ · 0.8 | | | V |
| $V_{OL}$ | | | | 0.4 | V |
| $V_{IH}$ | | $V_{DD}$ · 0.7 | | $V_{DD}$ + 0.3 | V |
| $V_{IL}$ | | -0.3 | | 0.8 | V |
| **/PENIRQ** | 100KΩ Pull-Up | | | | |
| $V_{OL}$ | | | 0. 6 | | V |
| **Analog Input** | | | | | |
| Input Span | | 0 | | $V_{REF}$ | V |
| Input Range | | -0.2 | | $V_{DD}$ + 0.2 | |
| Capacitance | | | 25 | | PF |
| **Reference Input** | | | | | |
| Range | | 1 | | $V_{DD}$ | V |
| Input Current | 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:

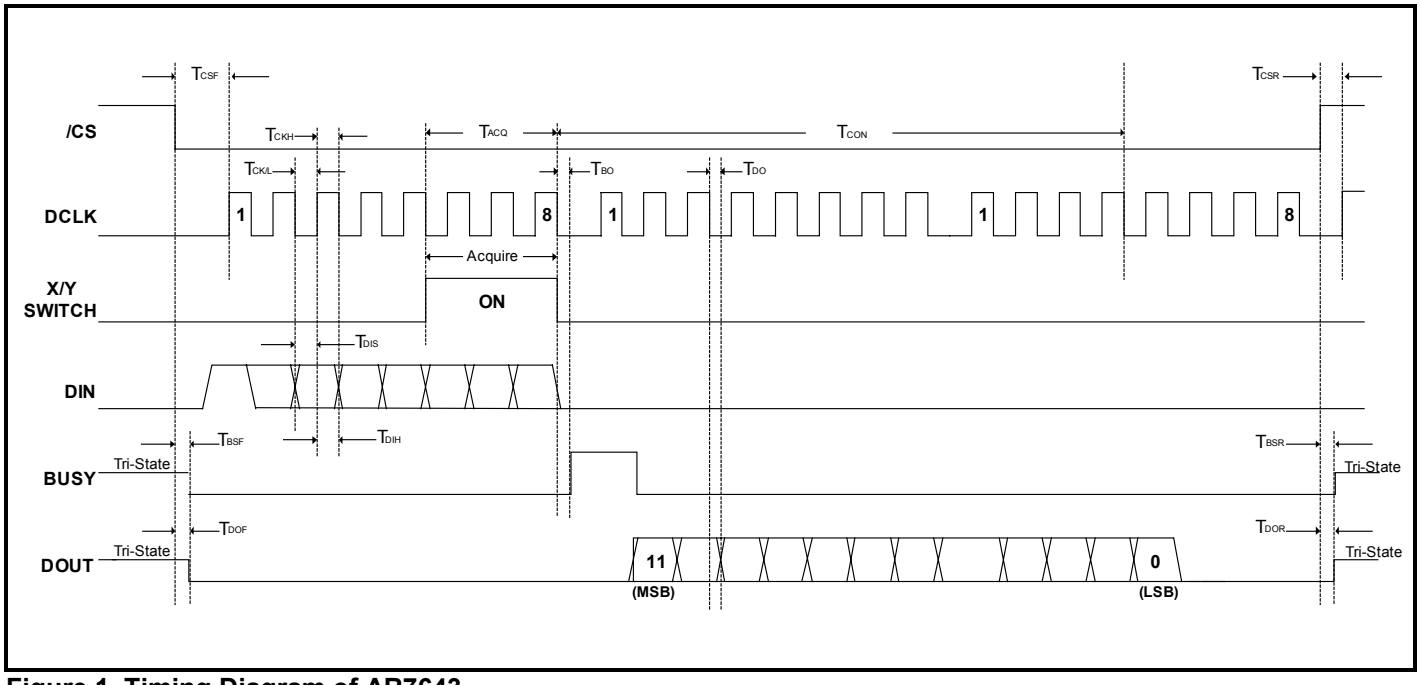



**Figure 1. Timing Diagram of AR7643**

# FUNCTIONAL DESCRIPTION

## OVERVIEW

The AR7643 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 AR7643 is shown in Figure 6. The AR7643 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 AR7643 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 Figure 5.

## OPERATION OF 24-CLOCKS

The typical operation of AR7643's serial interface is shown in Figure 2. The AR7643 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 AR7643 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 AR7643.

**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 AR7643 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<br>Mode0 | 12-Bit / 8-Bit Conversion Configuration Bit. |
| 1, 0 | PD1,PD0 | Power Down Control Bits |

**Table II. Description of the Control Bits**

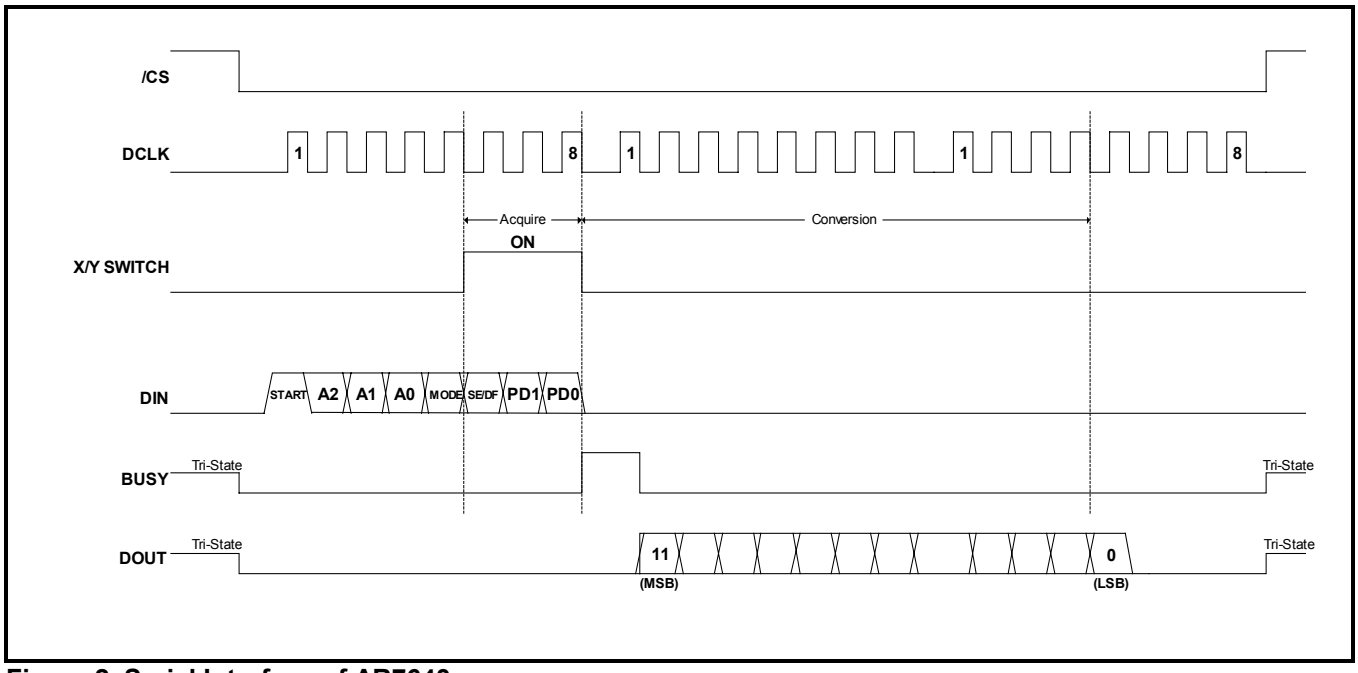



**Figure 2. Serial Interface of AR7643**

### 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 5), and touch panel drivers.

### Mode Bits – Conversion Resolution Configuration

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 AR7643. 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 AR7643 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 3 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**

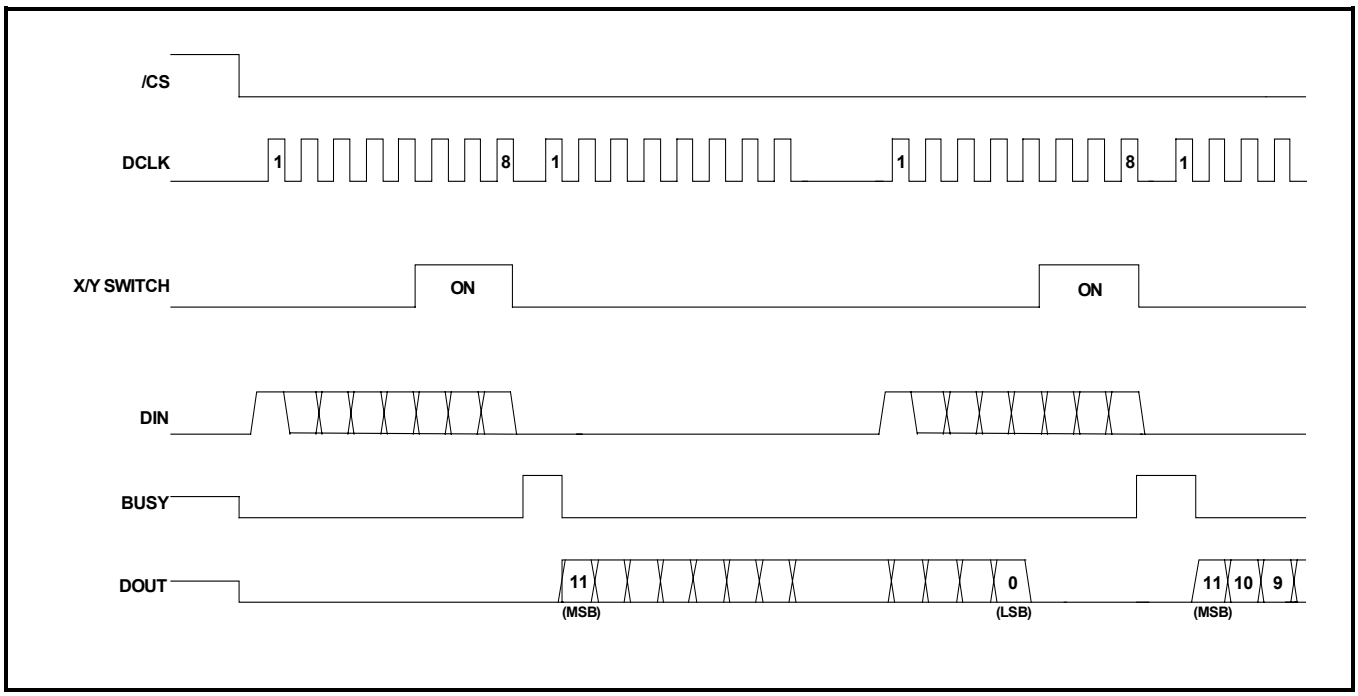



**Figure 3. Timing of 16-clocks per Conversion**

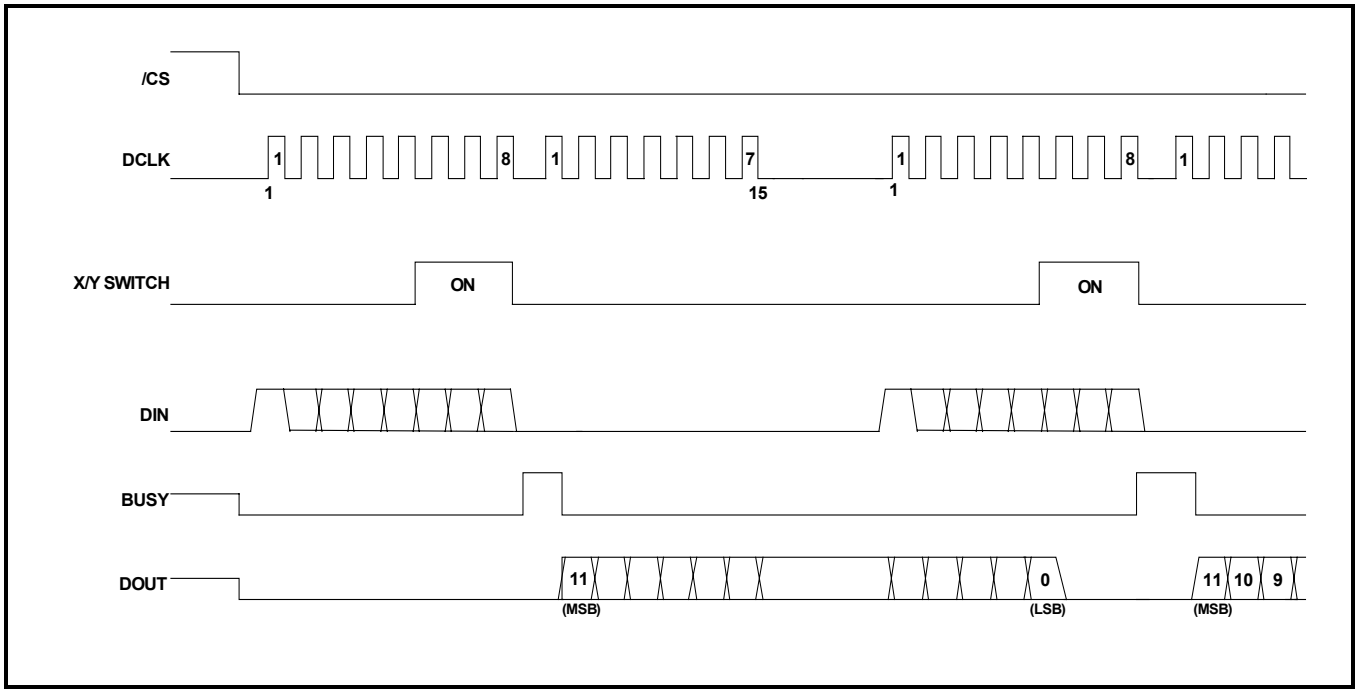



**Figure 4. Timing of 15-clocks per Conversion**

## OPERATION OF 15-CLOCKS

The fastest operation (15-clocks per conversion) of AR7643 is shown on Figure 4. 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 AR7643 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 5.)

### Input Channel

Table V shown the input channel configuration of the AR7643. 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 AR7643 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**

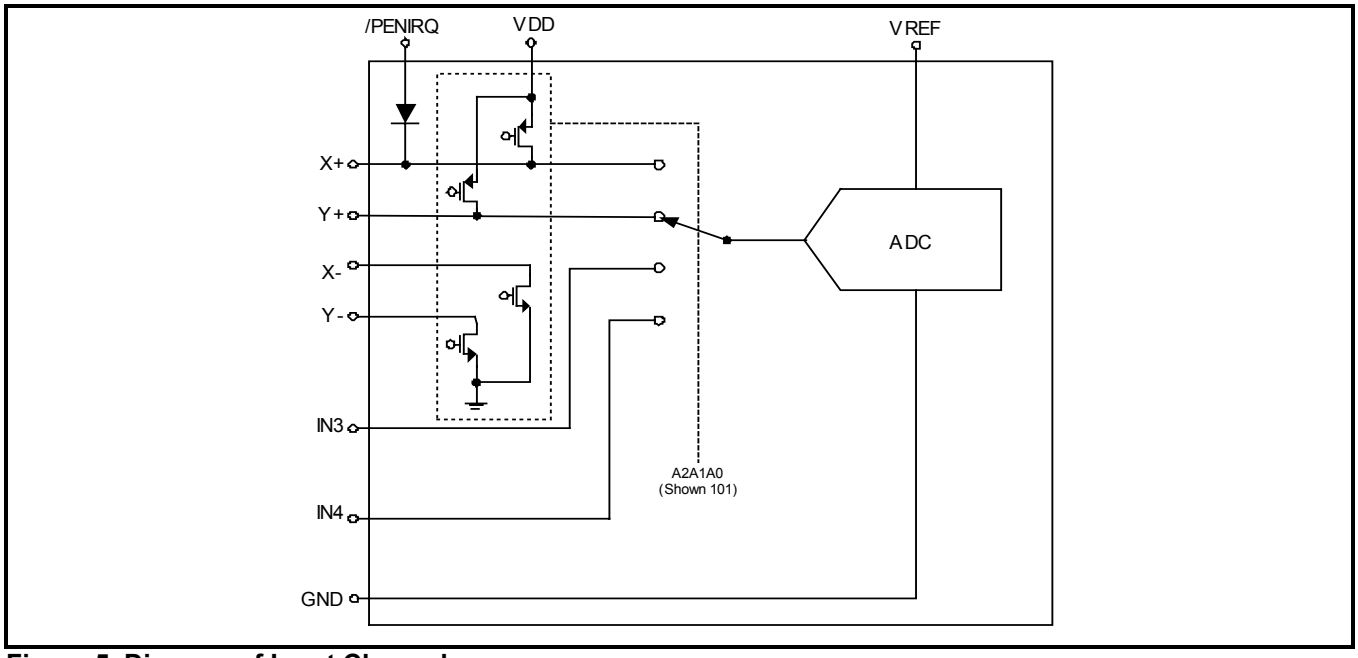



**Figure 5. Diagram of Input Channel**

## Typical Operating Circuit

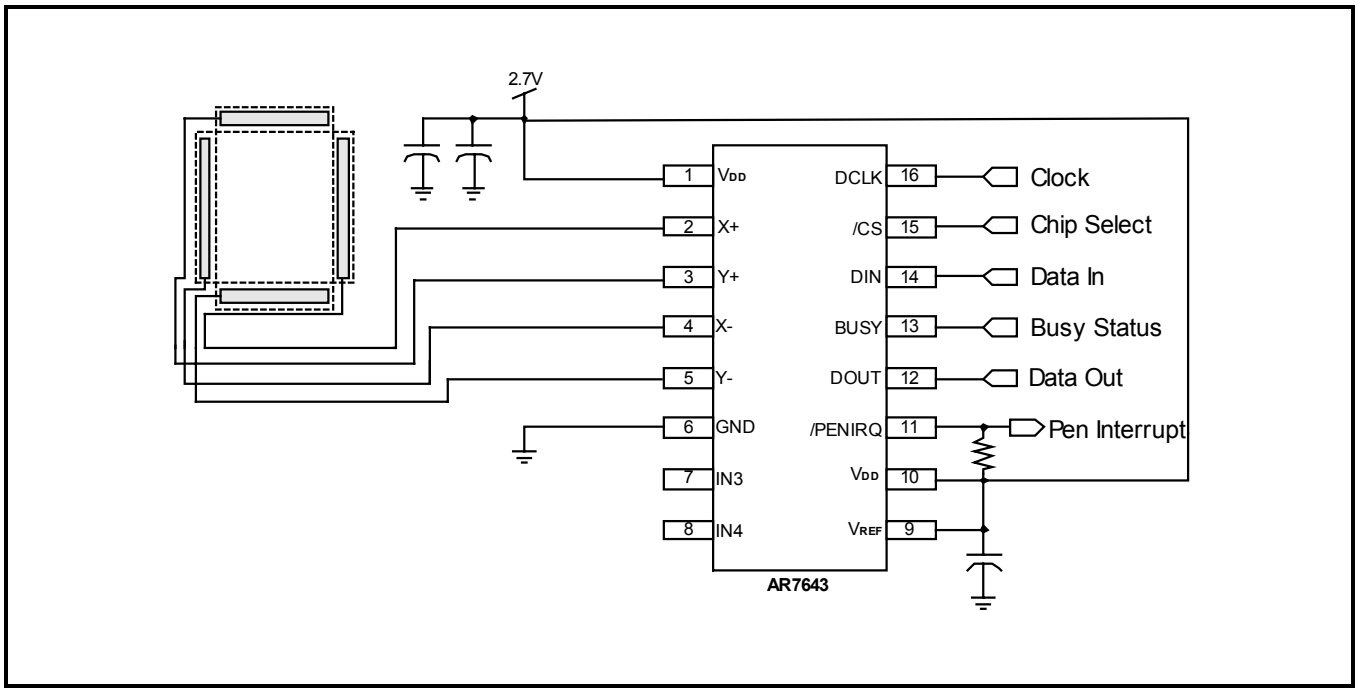



**Figure 6.** Typical Operation of The AR7643

# 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.

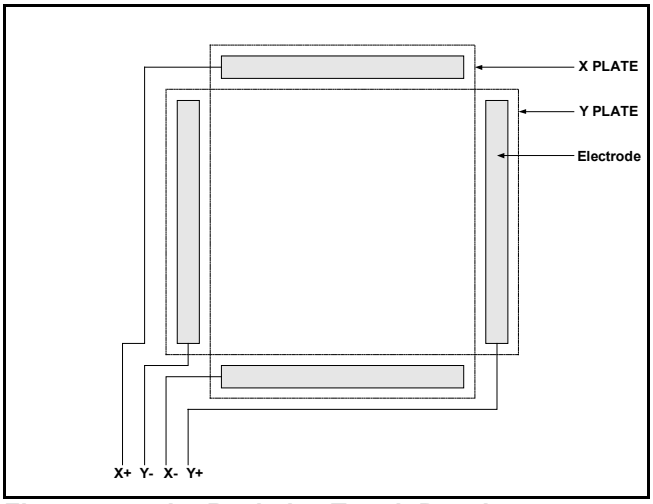
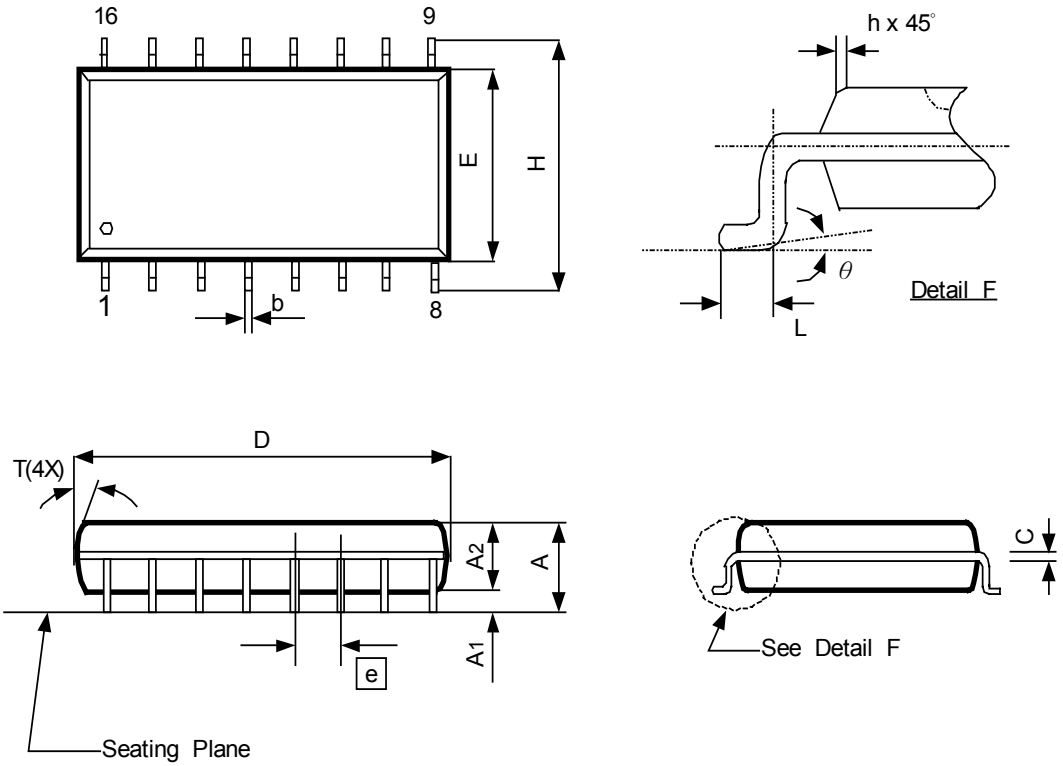



**Figure 7. 4-wire Resistive Touch Panel**

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 AR7643 to the touch panel should be as short as possible.

## Package Information

**The Package of AR7643 is 16-pin SSOP.**




| SYMBOLS | DIMENSIONS (MM) | | | DIMENSIONS (MIL) | | |
|---|---|---|---|---|---|---|
| | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. |
| **A** | 1.35 | 1.60 | 1.75 | 53 | 63 | 68 |
| **A1** | 0.10 | 0.15 | 0.25 | 4 | 6 | 10 |
| **A2** | | | 1.50 | | | 59 |
| **b** | 0.20 | 0.254 | 0.30 | 8 | 10 | 12 |
| **C** | 0.18 | 0.203 | 0.25 | 7 | 8 | 10 |
| **D** | 4.80 | 4.90 | 5.00 | 189 | 193 | 197 |
| **E** | 3.80 | 3.90 | 4.00 | 150 | 154 | 157 |
| **H** | 5.80 | 6.00 | 6.80 | 228 | 236 | 244 |
| **e** | 0.6358 BSC | | | 25 BSC | | |
| **L** | 0.40 | 0.635 | 1.27 | 16 | 25 | 50 |
| **h** | 0.25 | 0.42 | 0.50 | 10 | 17 | 20 |
| **θ** | 0° | | 8° | 0° | | 8° |

**Notes:**