

**AK4161****6-channel Capacitive Touch Sensor IC****GENERAL DESCRIPTION**

The AK4161 is a low operating voltage and low power consumption 6-channel capacitive touch sensor. Maximum 6 input channels can be configured to LED drive or GPIO. 2 channels out of 6-channel can also be configured to interrupt output. The AK4161 has a channel independent automatic correct function of environmental drifts for each sense input. It reduces false detection by continuous calibration of the internal reference value in the situation when the input capacitance of the touch switch is changed by the external factors such as hydrothermal conditions. The automatic initial setting function sets the charge current and charge time according to the size and the shape of a touch switch. Even more, a noise filter and a false protection filter are integrated. The AK4161 can be configured via serial interfaces, it is suitable for mobile phones, PCs and home electric applications.

FEATURE

- Up to 6 capacitive sensor inputs
- Up to 6 general purpose inputs/outputs with PWM control for LED
- Selectable 2 interrupt outputs
- Automatic initial setting function for the charge current and time
- Independent automatic environmental drifts correct function for each sense terminal
- Independent threshold configuration for each sense terminal
- Selectable multi touch feature
- Integrated Median Averaging Filter
- Data Update Stop Function for Noisy Environment
- Reset Input pin
- I²C Serial Interface
- 10 bit SAR A/D Converter with S/H circuit
- Integrated Regulator
- Low Power Consumption:
 - Typ. 4.1uA (Sampling rate=512ms, 6ch Sensor input, VDD=3.3V, N1S=20)
 - Typ. 177uA (Sampling rate=1ms, 6ch Sensor input, VDD=3.3V, N1S=6)
- Power Down Current: Typ. 1.2uA
- Low Power Operation: VDD = 1.6V ~ 3.6V
- Operating Temperature: Ta = -40 ~ 85 °C
- Package: 16pin QFN (3mm x 3mm, pitch 0.5mm)

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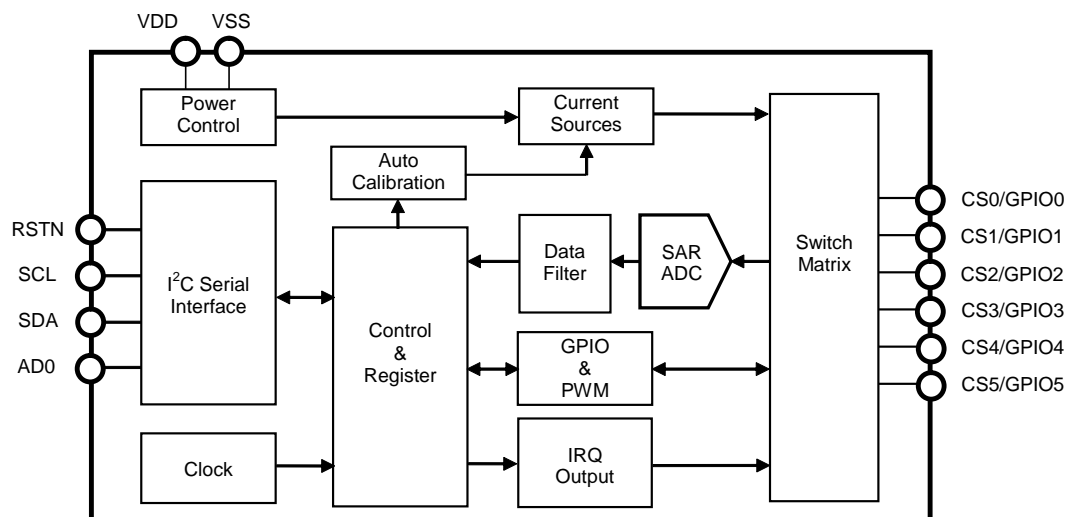
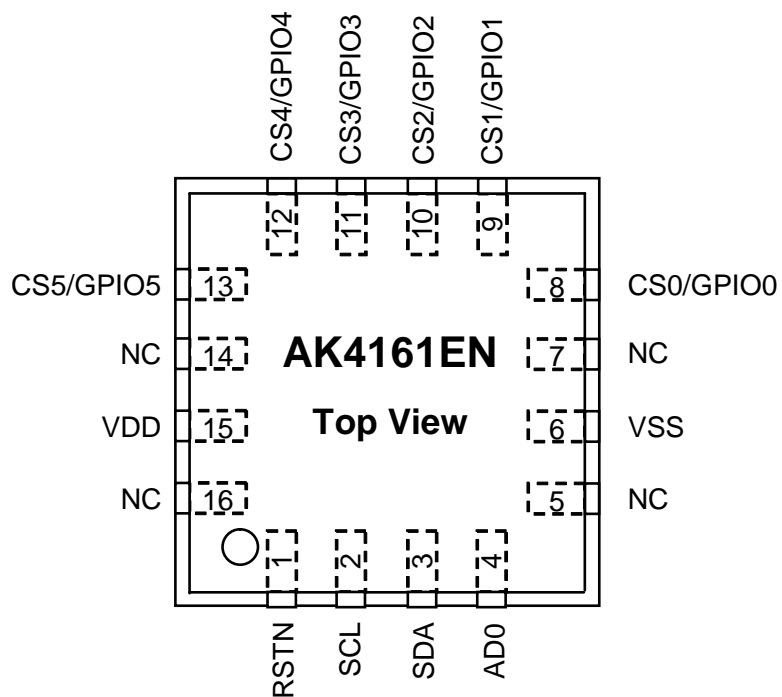


Figure 1. Block Diagram

■ Ordering Guide

AK4161EN	−40 ~ +85°C	16pin QFN (3mm x 3mm, 0.5mm pitch)
AKD4161	AK4161EN Evaluation Board	

■ Pin Layout

PIN/FUNCTION

Pin No.	Pin Name	Type (Note 1)	I/O (Note 2)	Function	Reset State RSTN = "L"
1	RSTN	D	I	Reset Pin (Active Low)	-
2	SCL	D	I	I ² C Serial Clock Input	-
3	SDA	D	I/O	I ² C Serial Data Input/ Output	Hi-z
4	AD0	D	I	I ² C Slave Address Bit 0	-
6	VSS	GND	-	Ground	-
8	CS0 / GPIO0	A/D	I/O	Cap Sense / GPIO Pin0	Hi-z
9	CS1 / GPIO1	A/D	I/O	Cap Sense / GPIO Pin1	Hi-z
10	CS2 / GPIO2	A/D	I/O	Cap Sense / GPIO Pin2	Hi-z
11	CS3 / GPIO3	A/D	I/O	Cap Sense / GPIO Pin3	Hi-z
12	CS4 / GPIO4	A/D	I/O	Cap Sense / GPIO Pin4 with IRQN	Hi-z
13	CS5 / GPIO5	A/D	I/O	Cap Sense / GPIO Pin5 with IRQN	Hi-z
15	VDD	PWR	-	Power Supply : 1.6V ~ 3.6V	-
5 7 14 16	NC	-	-	No Connection No internal bonding. This pin must be connected to VSS.	-

Note 1. A (Analog terminal), D (Digital terminal), GND (Ground), PWR (Power)

Note 2. I (Input terminal), O (Output terminal)

Note 3. All digital input pins (SCL, SDA, AD0, RSTN) must not be allowed to float.

■ Handling of Unused Pins

The unused I/O pins must be connected appropriately.

Classification	Pin Name	Setting
Analog/Digital	CS0 / GPIO0 ~ CS5/ GPIO5	Pin Connection: Connect to VSS. Register Setting: FUNC (Addr: 0x1F-0x20) = "00"

ABSOLUTE MAXIMUM RATINGS

(VSS = 0V (Note 4))

Parameter	Symbol	min	max	Unit
Power Supply	VDD	-0.3	4.3	V
Input Current Any Pins except for supply	IIN	-	±10	mA
GPIO Source Current per Pin	Isource	-	12	mA
GPIO Sink Current per Pin	Isink	-	1.2	mA
Input Voltage (Note 5)	VIN	-0.3	VDD+0.3 or 4.3	V
Ambient Temperature (power applied)	Ta	-40	85	°C
Storage Temperature	Tstg	-65	150	°C

Note 4. All voltages with respect to ground.

Note 5. For SDA, SCL, AD0, RSTN, CS0/GPIO0 ~ CS5/GPIO5 pins. The maximum value is smaller value between (VDD+0.3)V and 4.3V.

WARNING: Operation at or beyond these limits may result in permanent damage to the device.
Normal operation is not guaranteed at these extremes.

RECOMMEND OPERATING CONDITIONS

(VSS = 0V (Note 4))

Parameter	Symbol	min	typ	max	Unit
Power Supply	VDD	1.6	3.3	3.6	V

Note 4. All voltages with respect to ground.

WARNING: AKM assumes no responsibility for the usage beyond the conditions in this datasheet.

ANALOG CHARACTERISTICS

(Ta = -40°C ~ 85°C, VDD = 3.3V; unless otherwise specified)

Parameter	Symbol	min	typ	max	Unit
A/D Converter					
Resolution	RESO	-	10	-	Bits
Touch Sensor					
Charge Current Variation Against Nominal Value (Note 6)	ICHG	-30	-	30	%
Power Supply Current					
Measurement Current (All function in active)	IMEAS	-	0.765	-	mA
Idle Current	IIDLE	-	3.15	-	uA
Average Supply Current (Note 7)	IDD				
TSR= 0.25ms		-	687	-	uA
TSR= 0.5ms		-	351	-	uA
TSR= 1ms		-	177	-	uA
TSR= 2ms		-	90	-	uA
TSR= 4ms		-	47	-	uA
TSR=8ms		-	25	-	uA
TSR=16ms		-	14	-	uA
TSR=32ms		-	9	-	uA
TSR=2ms, 20 samplings at 1st order Filter		-	489	-	uA
TSR=32ms, 20 samplings at 1st order Filter		-	18	-	uA
TSR=512ms, 20 samplings at 1st order Filter		-	4.1	-	uA
Shutdown Current, ACT= "0" (Shutdown Mode)	ISHUT	-	1.2	8.0	uA

Note 6. Sense terminal voltage condition: The AD conversion value should be less or equal to VDD-0.2[V]. (It should be less or equal to VDD-0.3[V] when CC2Xn bit= "1") The charge current is dependent on the operating voltage, and is configured by register settings in the range of "0.556 x VDD [uA]" to "70.056 x VDD [uA]".

Note 7. Measurement Condition: 6 active sense terminals, 2us charge period, 6 samplings at 1st order filter for noise cancelling, using sense terminal with 22pF capacitance.

DC CHARACTERISTICS (Logic I/O)

(Ta = -40°C ~ 85°C, VDD = 1.6V ~ 3.6V; unless otherwise specified)

Parameter	Symbol	min	typ	max	Unit
Input Leakage Current (Note 8)	IILH	-5	-	5	uA
Tri-state Leakage Current (Note 9)	IOLK	-5	-	5	uA
Input High Voltage (Note 10)	VIH	0.7×VDD	-	-	V
Input Low Voltage (Note 10)	VIL	-	-	0.3×VDD	V
Output High Voltage (Note 11) (Note 12) Io=-10mA	VOHF	VDD-0.5	-	-	V
Output High Voltage (Note 11) (Note 13) Io=-1mA	VOH	VDD-0.3	-	-	V
Output Low Voltage (Note 10) (Note 13) Io=1mA	VOL	-	-	0.3	V
Output Low Voltage (Note 14) Io=3mA	VOLI2C	-	-	0.3	V

Note 8. RSTN pin

Note 9. AD0, SCL, SDA, GPIO0~GPIO5 pins

Note 10. GPIO0 ~ GPIO5 pins (FUNCn 1-0 bits = "01", GPIO input setting)

Note 11. GPIO0 ~ GPIO5 pins (FUNCn 1-0 bits = "10", GPIO output setting)

Note 12. Full Drive Operation (Output Driver Setting: DRVn1-0 bits = "11")

Note 13. Normal Drive Operation (Output Driver Setting: DRVn1-0 bits = "00", "01", "10")

Note 14. SDA pin

SWITCHING CHARACTERISTICS

(Ta = -40°C ~ 85°C, VDD = 1.6V ~ 3.6V; unless otherwise specified)

Parameter	Symbol	min	typ	max	Unit
Internal Oscillator					
Fast Oscillator Period	FPRD	75	125	175	ns
Slow Oscillator Period	SPRD	21	32	43	us
Reset Timing					
Reset Pulse Width (Note 15)	tRW	10	-	-	us
Reset Pin Pulse Width of Spike Noise Suppressed by Input Filter (Note 16)	tRS	0.5	-	-	us
I²C					
SCL clock frequency	f _{SCL}	-	-	400	kHz
Bus Free Time Between Transmissions	tBUF	1.3	-	-	us
Start Condition Hold Time (prior to first Clock pulse)	tHD:STA	0.6	-	-	us
Clock Low Time	tLOW	1.3	-	-	us
Clock High Time	tHIGH	0.6	-	-	us
Setup Time for Repeated Start Condition	tSU:STA	0.6	-	-	us
SDA Hold Time from SCL Falling (Note 17)	tHD:DAT	0	-	-	us
SDA Setup Time from SCL Rising	tSU:DAT	0.1	-	-	us
Rise Time of Both SDA and SCL Lines	tR	-	-	0.3	us
Fall Time of Both SDA and SCL Lines	tF	-	-	0.3	us
Setup Time for Stop Condition	tSU:STO	0.6	-	-	us
Pulse Width of Spike Noise Suppressed By Input Filter	tSP	50	-	-	ns
Capacitive load on bus	Cb	-	-	400	pF

Note 15. The AK4161 can be reset by the RSTN pin = "L". Keep "L" period for 10us or more for a certain reset.

Note 16. Pulse width of spike noise suppressed by input filter of the RSTN pin.

Note 17. Data must be held for sufficient time to bridge the 300ns transition time of SCL.

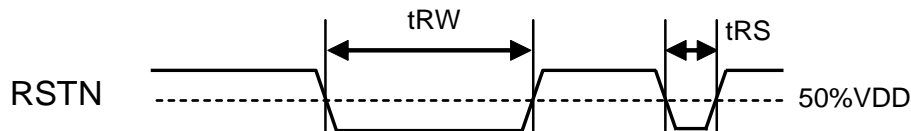


Figure 2. Reset Timing Diagram

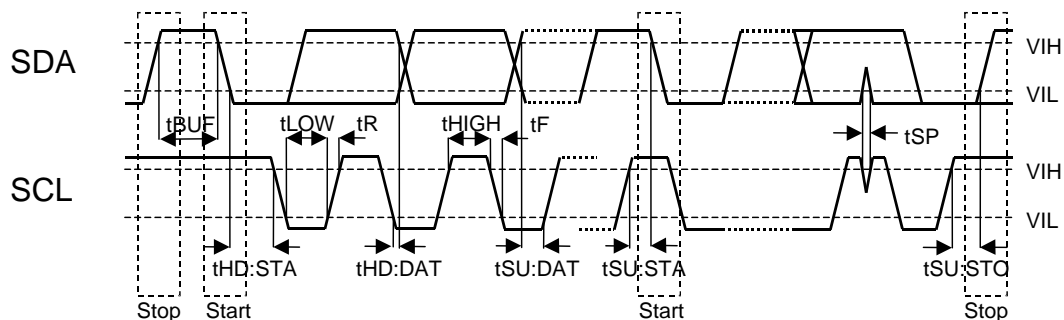
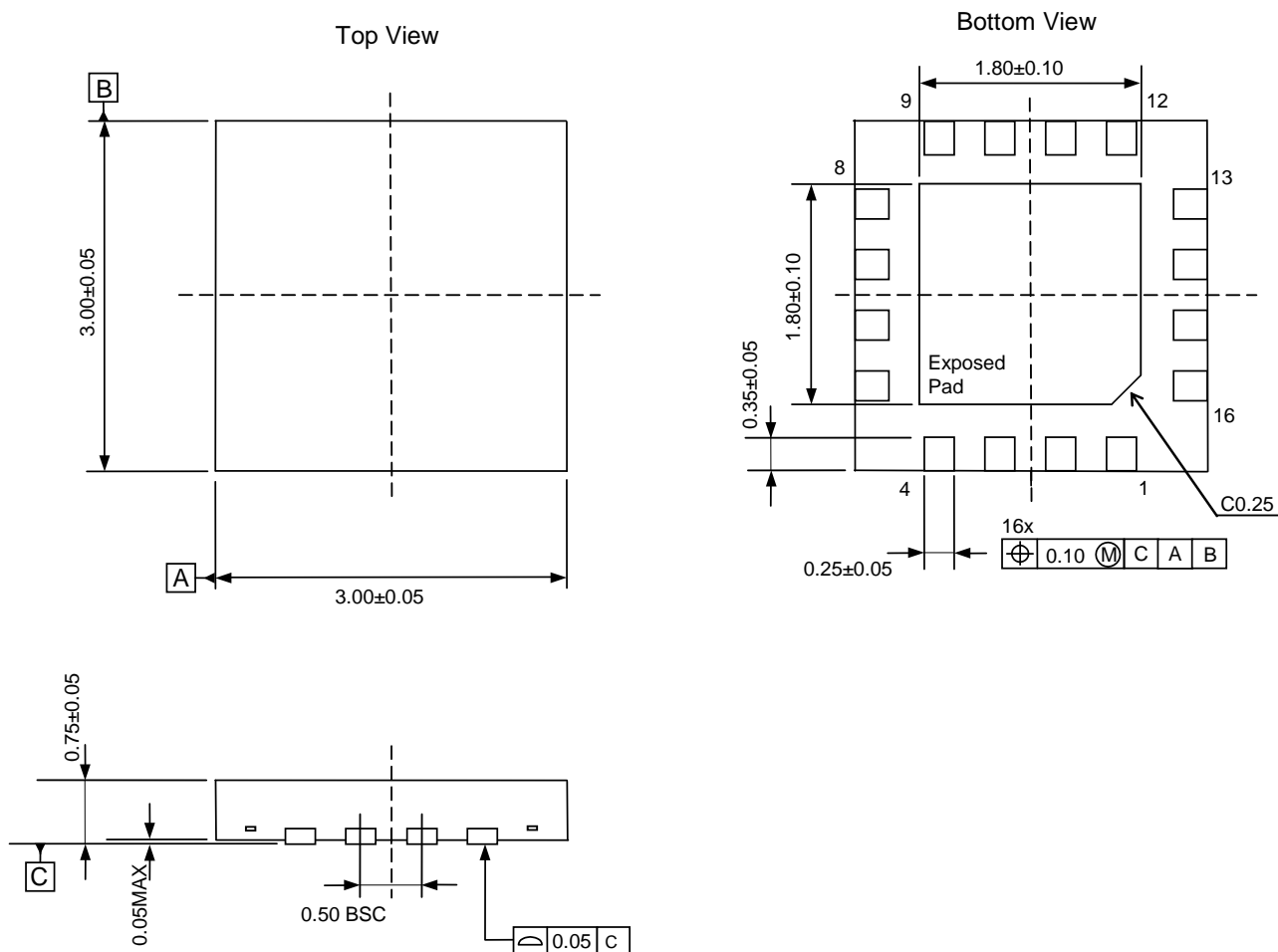


Figure 3. I²C Interface Timing Diagram

PACKAGE

16pin QFN (Unit: mm)



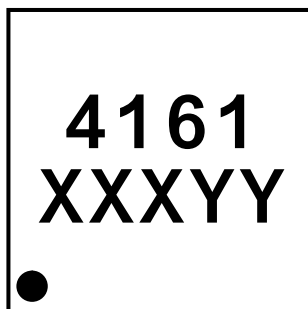
Note: The thermal die pad must be connected to open node.

■ Package & Lead frame material

Package molding compound: Epoxy Resin, Halogen (Br, Cl) Free

Lead frame material: Cu Alloy

Lead frame surface treatment: Solder (Pb free) Plate

MARKING

Contents of XXXY

XXX: Date Code

YY: Internal Control Code

Pin #1 indication

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