Digital Contact Controller

ATA2501 Datasheet

Version 2.4

ATLab

Digital Contact Controller
ATA2501 Data Sheet

INTRODUCTION

Description

Digital contact controller (ATA2501), using ATLab's proprietary impedance matching technology, not only enables an easy realization of navigation and access to contents in portable devices such as mobile phones, MP3 players and PDA's, but also is able to replace many mechanical buttons on electronic products. One controller detects 12 sensor inputs of human finger contact and transmits the result to MCU through serial interface at the speed of up to 500 times per second. For computer mouse scroll application, ATLab's patented navigation engine is included to calculate direction and magnitude of finger gesture.

Since impedance matching is very difficult to cope with user's various applications, ATA2501 provides automatic impedance calibration (AIC) function that will automatically adjust contact sensitivity for maximum design flexibility.

Another benefit of using ATA2501 is its low power consumption capability. It only consumes less than 120uA during normal operation. It can also be suspended when device is in the idle state in order to save more power.

There are 2 package types available: 48 TQFP and 40 QFN

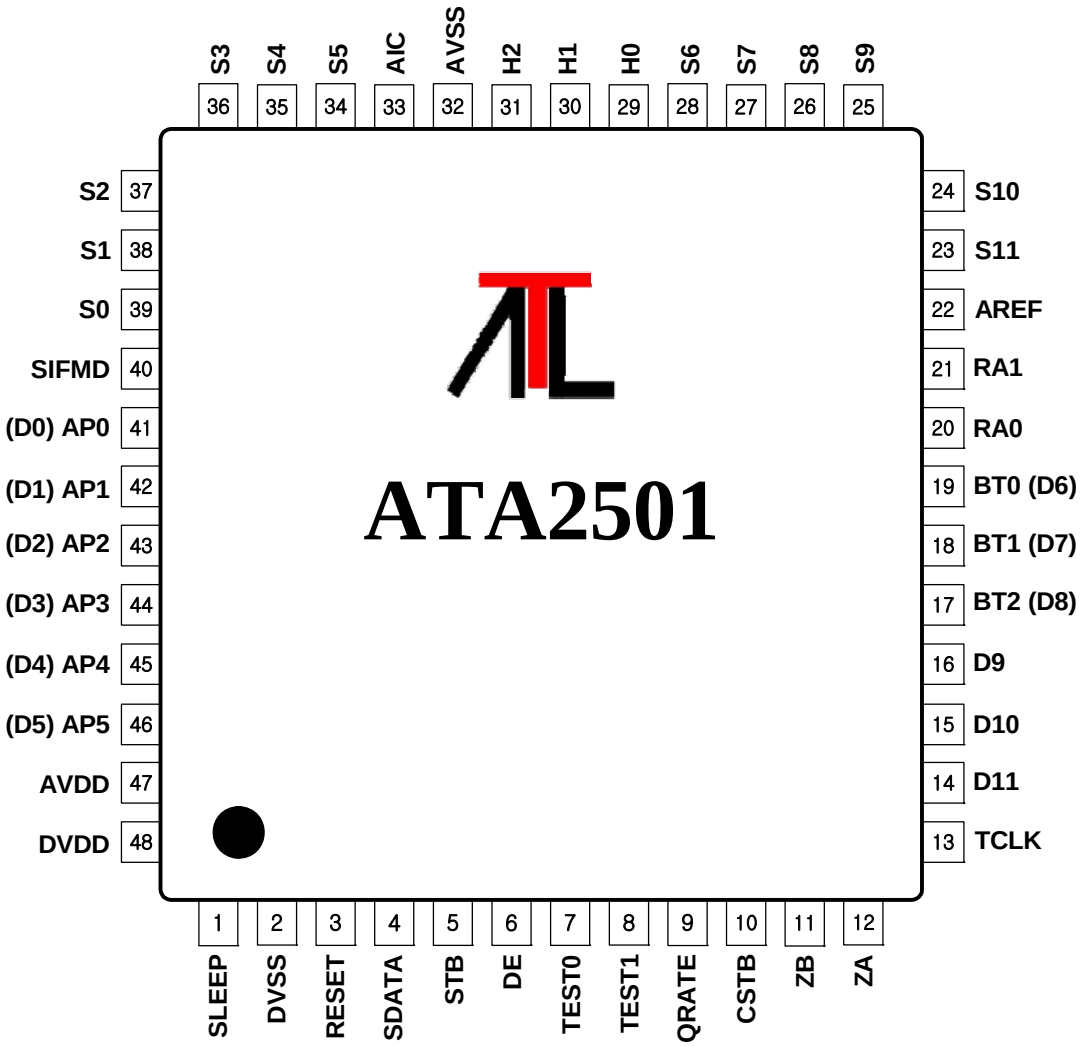
Features and Benefits

- Up to twelve contact sensor inputs used for scroll, navigation and selection
- Versatile interfaces available: Serial Interface, Direct I/O Interface and Quadrature interface
- Proprietary navigation engine included for mouse scroll application
- Supports user's own sensor layout for maximum design flexibility
- Automatically adjusts sensor sensitivity to cope with various operating environment
- No external clock source is required
- Supports Idle and sleep mode for power saving
- High reliable ESD input pads
- Lead free package

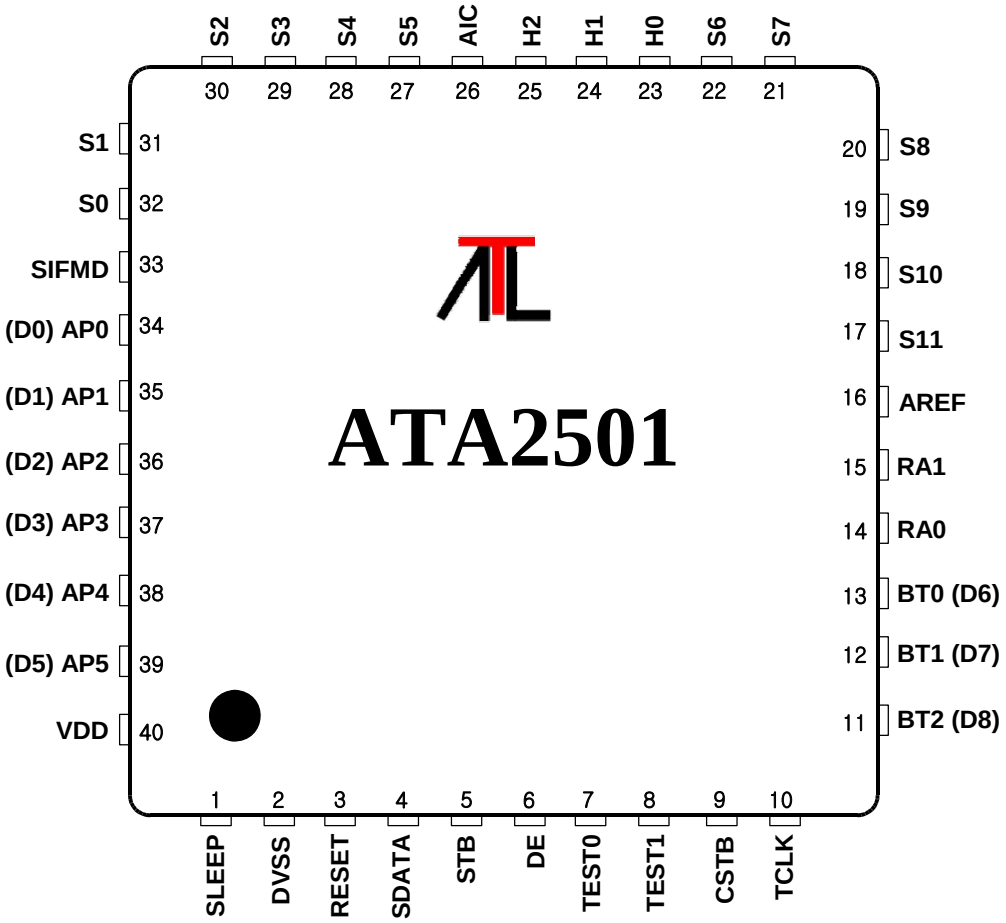
Applications

- Portable devices such as PDA's, cellular phones, MP3 players, remote controllers, and other Integrated input devices
- Home appliances and consumer electronic products.
- Mice for desktop PC's, workstations, and notebook PC's

48TQFP Pin Configuration



40 QFN Pin Configuration



Package Types (Lead free packages)

Package Type	Product Code	Package Dimension	Pin Pitch	Digital Output	Quad. Output	No. of Sensor Inputs	View
48TQFP	ATA2501DB	9mm X 9mm	0.5mm	3ea	Available	12ea	
40QFN	ATA2501DB-40N	5mm X 5mm	0.4mm	Not Available	Not Available	12ea	

Pin Description for 48 TQFP

Pin No.	Name	IO	Description
1	SLEEP	I	Power down, active low
2	DVSS	G	Ground of digital
3	RESET	I	Reset, active low
4	SDATA	O	Serial data
5	STB	I	Data strobe for SDATA
6	DE	IO	Data enable for serial data in SIF1 (In SIF2 mode, must be connected to GND)
7	TEST0	I	Low: For normal operation mode, High: for test mode.
8	TEST1	I	Low: For normal operation mode, High: for test mode.
9	QRATE	I	To change quadrate output form Low : Normal quadrate output , High : Microsoft mouse quadrate output
10	CSTB	I	External AIC strobe input
11	ZB	O	Quadrate output of wheel
12	ZA	O	Quadrate output of wheel
13	TCLK	I	Test clock input
14~19 41~46	AP[5:0]/ BT[2:0] Or D[11:0]	IO	When AIC pin is high, D[8:0] are configured as input to receive AIC Parameter. . D[5:0] are replaced to AP[5:0] for sensitivity adjustment, . D[8:6] are replaced to BT[2:0] as AIC function parameters . D[11:9] are configured as digital output of inverted S[11:9] When AIC is low, D[11:0] are configured as digital output of inverted S[11:0]
20,21	RA[1:0]	IO	AREF adjustment pins (In non AIC mode, must open RA pins)
22	AREF	I	Reference data from external reference pin
23~28 34~39	S[11:0]	I	Captured sensor data from external touch pads [No.11 ~ 0]
29~31	H[2:0]	IO	AIC function parameters (In non AIC mode, must open H pins)
32	AVSS	G	Ground of analog core
33	AIC	I	AIC Function Low : AIC OFF, High : AIC ON
40	SIFMD	I	To Select serial interface mode, High: 2 wire serial interface, Low: 3 wire serial interface.
47	AVDD	P	Power of analog core
48	DVDD	P	Power of digital core

Pin Description for 40 QFN

Pin No.	Name	IO	Description
1	SLEEP	I	Power down, active low
2	DVSS	G	Ground of digital
3	RESET	I	Reset, active low
4	SDATA	O	Serial data
5	STB	I	Data strobe for SDATA
6	DE	IO	Data enable for serial data in SIF1 (In SIF2 mode, must be connected to GND)
7	TEST0	I	Low: For normal operation mode, High: for test mode.
8	TEST1	I	Low: For normal operation mode, High: for test mode.
9	CSTB	I	External AIC strobe input
10	TCLK	I	Test clock input
11~13	BT[2:0]	I	AIC input parameter, Recommended value is 4.
14,15	RA[1:0]	I	AREF adjustment pins
16	AREF	I	Reference capacitance from external reference pin
17~22 27~32	S[11:0]	I	Captured sensor data from external touch pads [No.11 ~ 0]
23~25	H[2:0]	I	AIC input parameter, Recommended value is 7.
26	AIC	I	AIC Function, MUST set to HIGH to activate AIC function. Low : AIC OFF, High : AIC ON
33	SIFMD	I	To Select serial interface mode, High: 2 wire serial interface, Low: 3 wire serial interface.
34~39	AP[5:0]	I	AIC input parameter to adjust sensitivity
40	VDD	P	Power of digital core

Pin Configuration Table by Package Type

Pin No.	Name	IO	48TQFP	40QFN
1	SLEEP	I	○	○ (1)
2	DVSS	G	○	○ (2)
3	RESET	I	○	○ (3)
4	SDATA	O	○	○ (4)
5	STB	I	○	○ (5)
6	DE	IO	○	○ (6)
7	TEST0	I	○	○ (7)
8	TEST1	I	○	○ (8)
9	QRATE	I	○	X
10	CSTB	I	○	○ (9)
11	ZB	O	○	X
12	ZA	O	○	X
13	TCLK	I	○	○ (10)
14	D11	O	○	X
15	D10	O	○	X
16	D9	O	○	X
17	BT2(D8)	IO	○	○ (11)
18	BT1(D7)	IO	○	○ (12)
19	BT0(D6)	IO	○	○ (13)
20	RA0	I	○	○ (14)
21	RA1	I	○	○ (15)
22	AREF	I	○	○ (16)
23	S11	I	○	○ (17)
24	S10	I	○	○ (18)
25	S9	I	○	○ (19)
26	S8	I	○	○ (20)
27	S7	I	○	○ (21)
28	S6	I	○	○ (22)
29	H0	I	○	○ (23)
30	H1	I	○	○ (24)
31	H2	I	○	○ (25)
32	AVSS	G	○	X
33	AIC	I	○	○ (26)
34	S5	I	○	○ (27)
35	S4	I	○	○ (28)
36	S3	I	○	○ (29)
37	S2	I	○	○ (30)
38	S1	I	○	○ (31)
39	S0	I	○	○ (32)
40	SIFMD	I	○	○ (33)
41	AP0(D0)	I/O	○	○ (34)
42	AP1(D1)	I/O	○	○ (35)
43	AP2(D2)	I/O	○	○ (36)
44	AP3(D3)	I/O	○	○ (37)
45	AP4(D4)	I/O	○	○ (38)
46	AP5(D5)	I/O	○	○ (39)
47	AVDD	P	○	X
48	DVDD	P	○	○ (40)

ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Unit	Min.	Typ.	Max.	Note
Absolute Maximum Ratings						
Storage Temperature	Tstg	°C	-45		95	
Operating Temperature	Topr	°C	-40		90	
Operating Humidity	Hopr	%	5		95	
Power Supply Voltage	Vdda	V	2.0		3.6	
Input Voltage	Vin	V	Vss-0.3		Vdd+0.3	
ESD	HBM	V	8000			**Input Pins**
	Set		15000			
Recommended Operating Conditions						
Operating Temperature	Toprr	°C	-35	25	85	
Power Supply Voltage	Vdd	V	2.5		3.5	
Digital Input Rising Time	Tr_i	ns	-	-	5	
Digital Input Falling Time	Tf_i	ns	-	-	5	
AC Electrical Specifications (Typical values at Ta=25°C and Vdd=3.3V)						
Internal OSC frequency	fosc	MHz	0.9	1	1.1	
Sample frequency	fsmp	KHz	0.45	0.5	0.55	
Touch Sensitivity	Stch	pF		0.1		
Reset to Active Conversion Time	Treac	ms	530	540	550	
Active to Sleep Conversion Time	Tacsl	us		5	10	
Active to Idle Conversion Time	Tacid	sec	3.5	4	4.5	
Idle to Active Conversion Time	Tidac	ms	35	40	45	
Idle to Sleep Conversion Time	Tidsl	us	550	600	650	
Sleep to Active Conversion Time	Tslac	us	120	130	140	
Output Rising Time	Tr_o	ns	-	50	60	Load = 100pF
Output Falling Time	Tf_o	ns	-	50	60	Load = 100pF
DC Electrical Specifications (Typical values at Ta=25°C and Vdd=3.3V)						
Supply Current (Active mode)	Idd_o	μA	100	110	120	
Supply Current (Idle mode)	Idd_i	μA	55	60	65	
Supply Current (Sleep mode)	Idd_s	μA		0.5	1	
Digital Input Low Voltage	Vil	V		0.5	1.0	
Digital Input High Voltage	Vih	V	0.7xVdd			
Digital Output Low Voltage	Vol	V		0.5	1.0	
Digital Output High Voltage	Voh	V	Vdd-0.5			

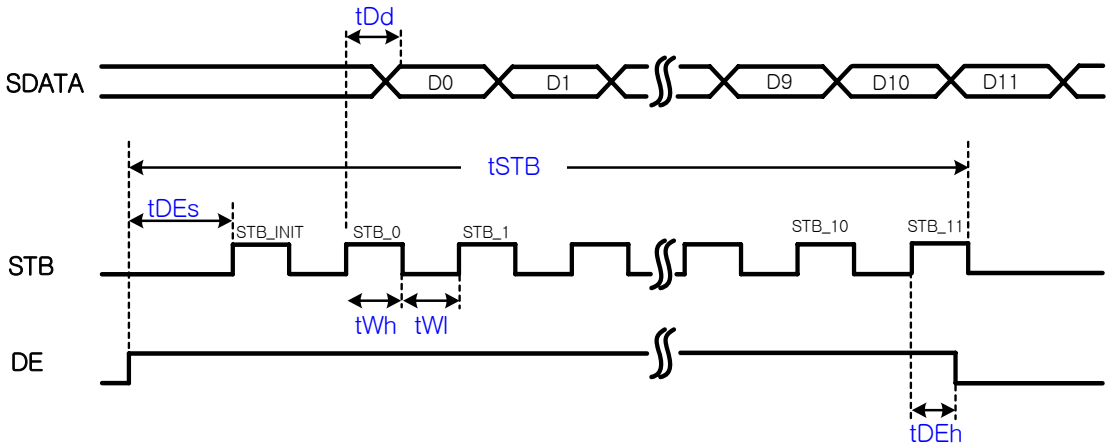
Timing Diagram

SIF (SERIAL INTERFACE)

SIF provides two kinds of interface protocol. And it can be configured by the pin SIFMD.

Pin Name	Status	Description
SIFMD	Low	SIF configuration-1 (3 wire)
	High	SIF configuration-2 (2 wire)

- ***SIF configuration-1***

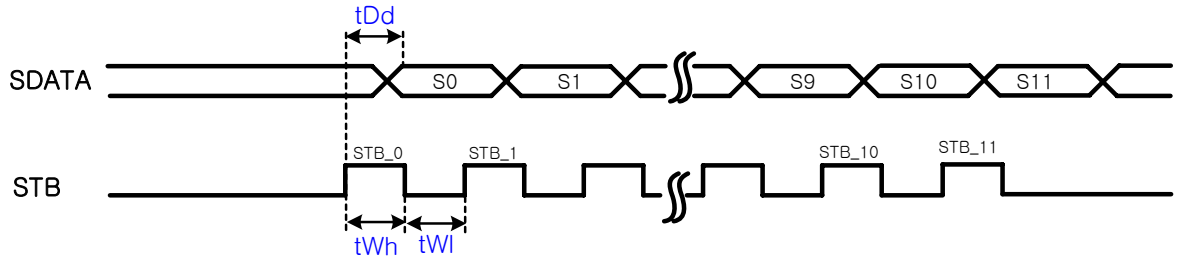


Parameter	Definition	Value (ns)		
		Min	Typ	Max
tDEs	DE setup time to ACK	200	-	-
tDd	Data delay time from ACK rising	20	-	-
tWh	ACK High width	100	-	-
tWl	ACK Low width	100	-	-
tDEh	DE hold time from STB rising	0.1	-	-
tSTB	ACK Maximum Hold time	-	-	2mS

<Fig.1> SIF configuration-1 Timing Diagram

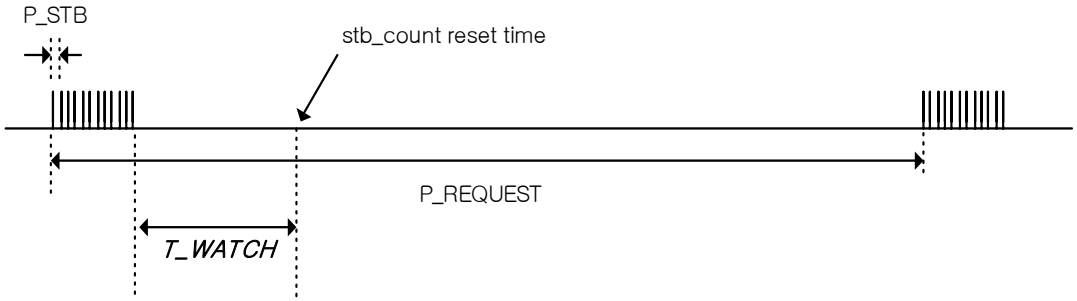
SIF1 is an interrupt-driven interface, which means system MCU does not need to monitor sensor data periodically. Instead, ATA2501 asserts DE to high whenever the status of any touch pad is changed. As shown in the figure1 when ATA2501 is ready to transfer 12-bit packet data, it asserts DE to high. While DE is high and at every STB input received, ATA2501 outputs sensor data with LSB first through SDATA pin. The STB_INIT is required at the start of data transmission as shown in the timing diagram. After ATA2501 receives 13 STB inputs, DE automatically goes back to low. In order to receive sensor data properly in SIF1 mode, tSTB must be shorter than 2 msec.

- ***SIF configuration-2***



Parameter	Definition	Value (ns)		
		Min	Typ	Max
tDd	Data delay time from ACK rising	20	-	-
tWh	ACK High width	100	-	40000
tWl	ACK Low width	100	-	40000

<Fig.2 > SIF configuration-2 Timing Diagram



Minimum P_STB = 200ns(min)
Minimum (P_STB X 12) = 200ns X 12 = 2.4us(min)
Minimum P_REQUEST = 1/(2kHz) = 0.5ms = 500us
T_WATCH = 62 cycles of 800kHz system clock
= 62 X 1.25us = 77.5us

Parameter	Definition	Value (us)		
		Min	Typ	Max
P_REQUEST	Request Period	500	-	**2000**
T_WATCH	stb_count reset time	78	-	-

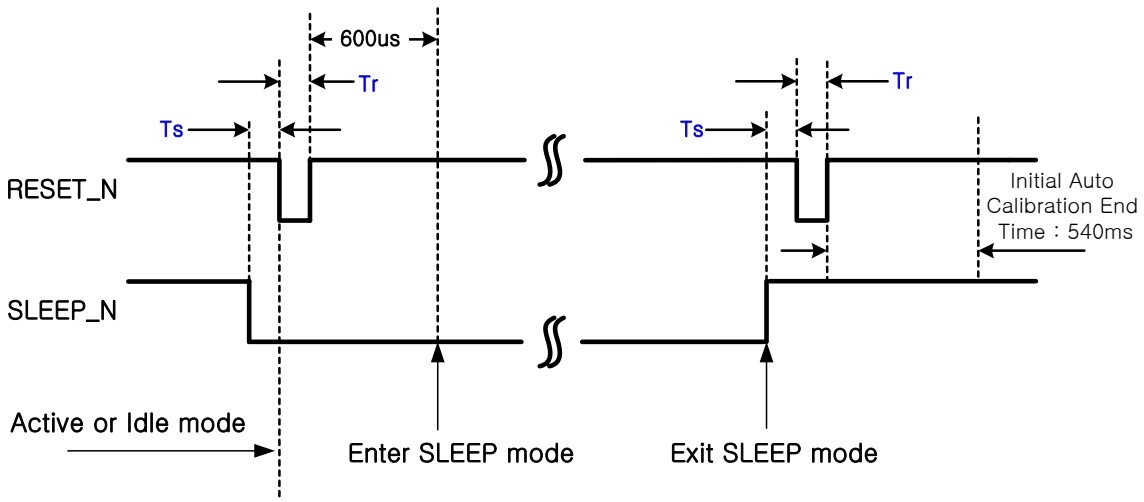
< Fig.3 >Request Interval Constraint for SIF configuration-2

SIF2 is a polling style interface, which means system MCU must check sensor data periodically. Whenever ATA2501 receives 12 STB signals from system MCU, it sends the current status of 12 touch pads to system MCU.

In order to achieve the synchronization of STB counter used internally in ATA2501, T-WATCH time must be guaranteed which is longer than 77.5 usec as shown in the Figure. 3.

SLEEP Mode Timing Diagram

Especially, when ATA2501 enters SLEEP mode, has to receive RESET_N signal.



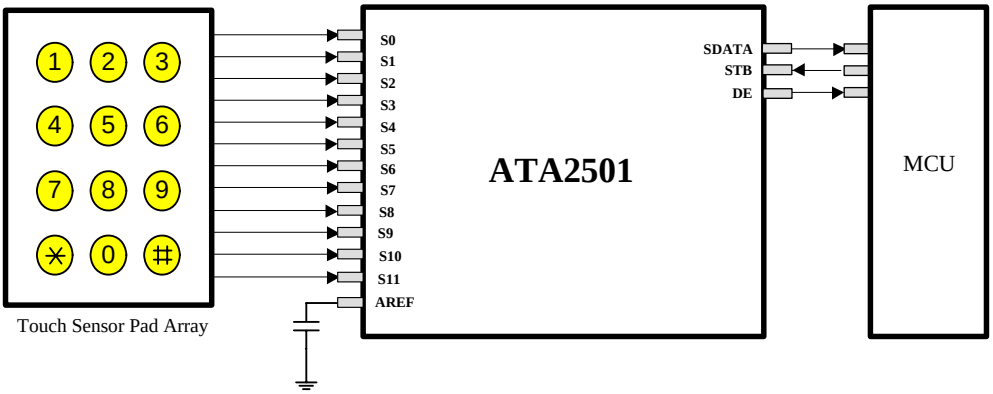
Parameter	Definition	Value (ns)		
		Min	Typ	Max
Ts	SLEEP_N Set Time	0	-	-
Tr	RESET_N Hold Time	100	-	-

TYPICAL APPLICATIONS

The following diagrams show typical applications of ATLab's Digital Contact Controller.

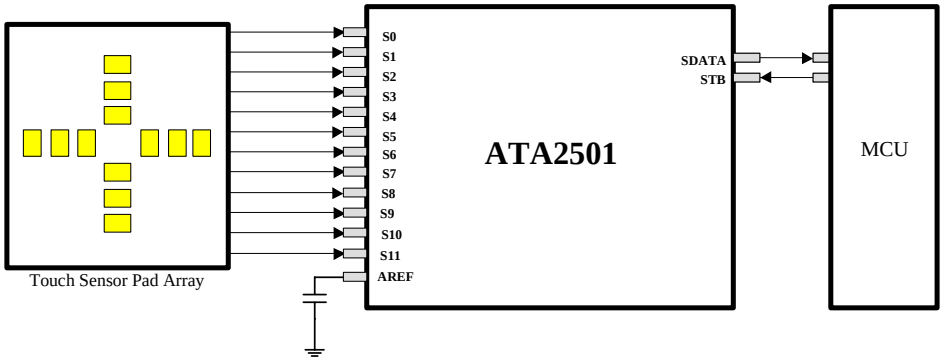
Application for Switch Button

3 wire serial interface is used.



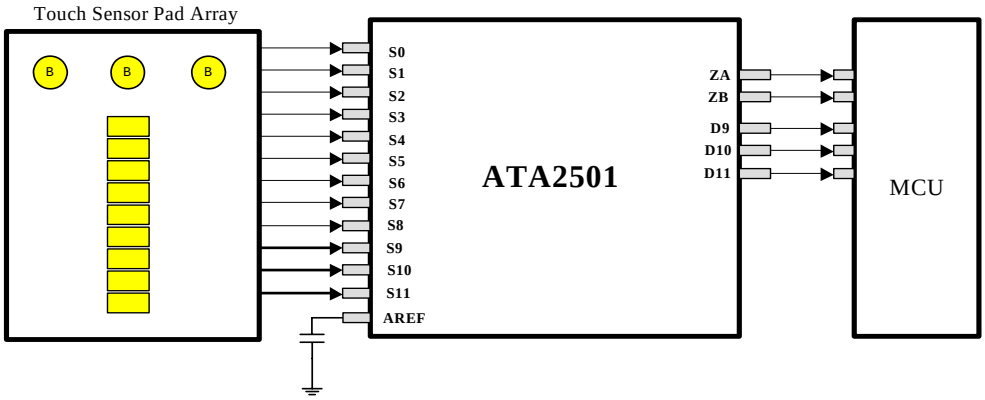
Application for 2 Dimensional Navigation

2 wire serial interface is used.



Application for Mouse

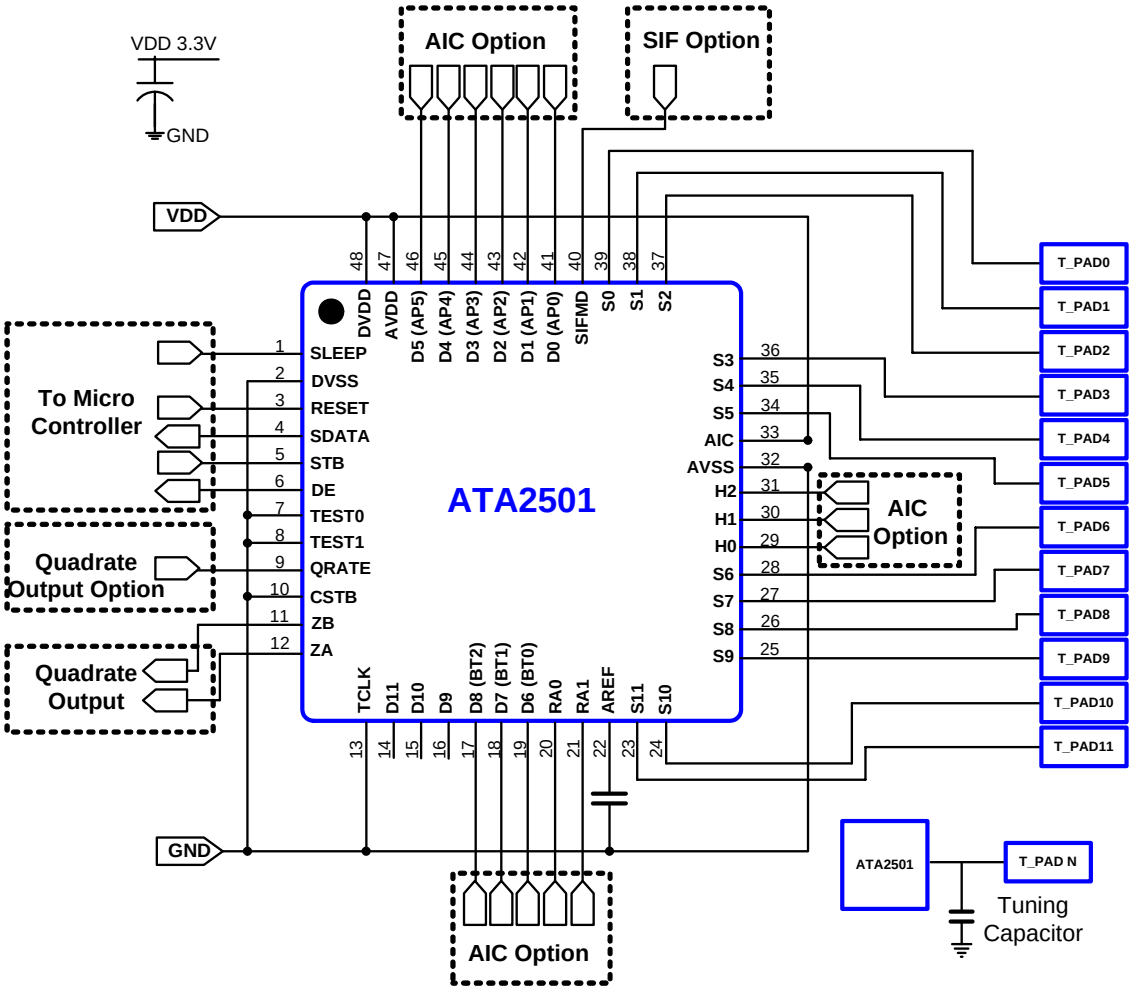
9 sensors for scroll wheel and 3 sensors for left/right/middle buttons.



- The sensors for substituting three mechanical buttons should be located apart from the other sensors for scrolling in order to avoid malfunction caused by touching simultaneously.
- Only 3 digital outputs are available when AIC Function is turned ON and 12 full digital outputs are available when AIC is turned OFF. But, we do not recommend AIC function OFF.

Recommended Application Circuit

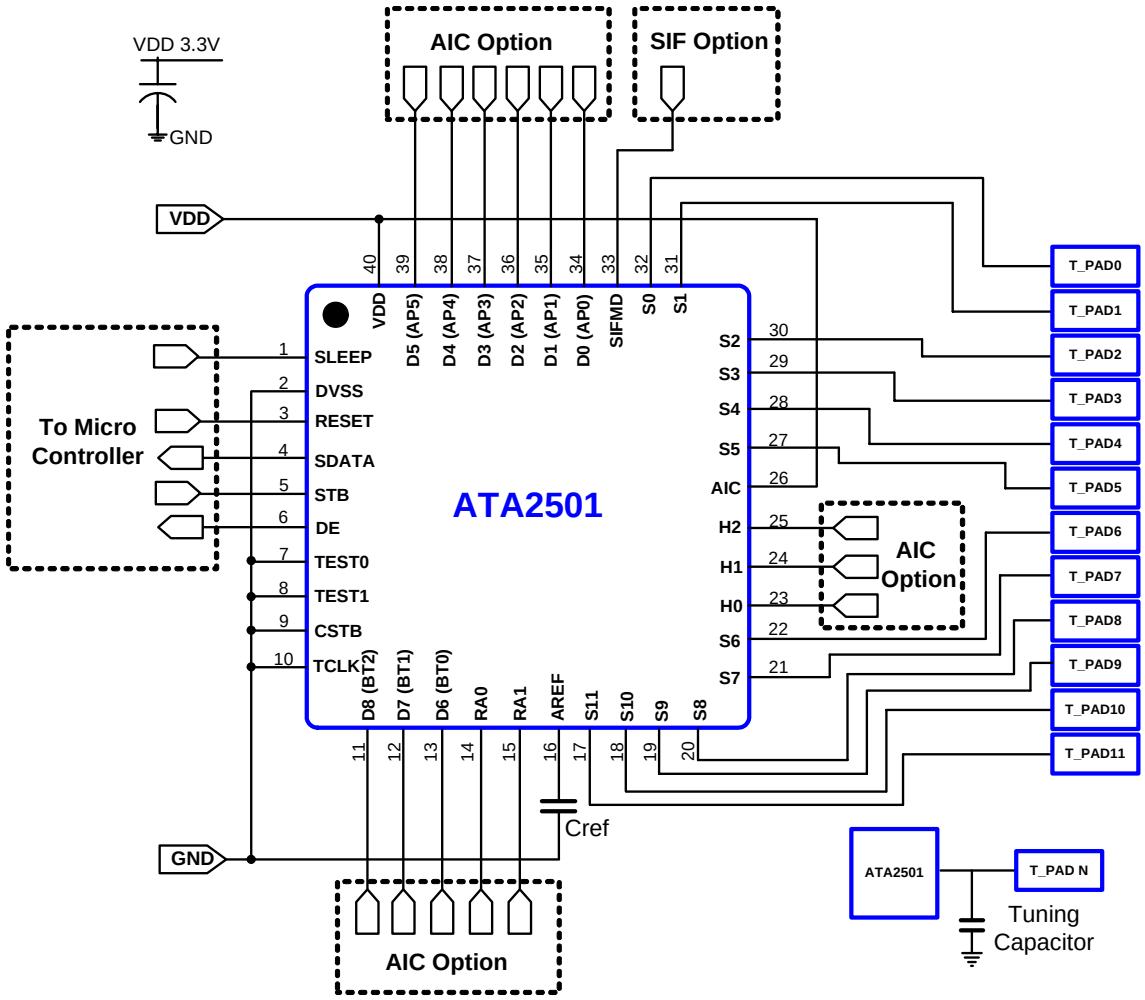
48TQFP - Typical Application Circuit at AIC Mode and SIF1 (3wire)



In SIF2 (2wire) mode, you have to connect DE (#6) to GND and SIFMD(#40) to VDD.

SIF Mode	SIFMD	DE
SIF1 (3 wire)	Low	To MCU
SIF2 (2 wire)	High	**Low**

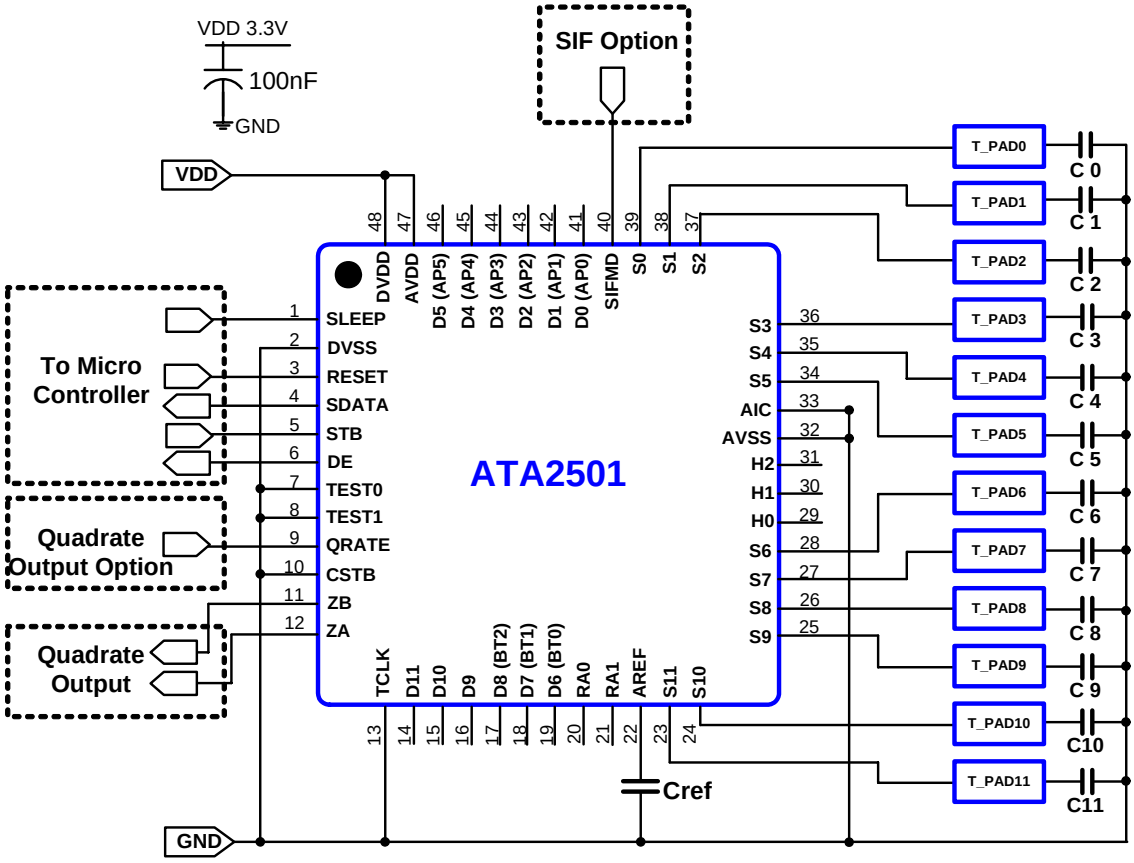
40QFN - Typical Application Circuit at AIC Mode and SIF1 (3wire)



In SIF2 (2wire) mode, you have to connect DE (#6) to GND and SIFMD(#40) to VDD.

SIF Mode	SIFMD	DE
SIF1 (3 wire)	Low	To MCU
SIF2 (2 wire)	High	**Low**

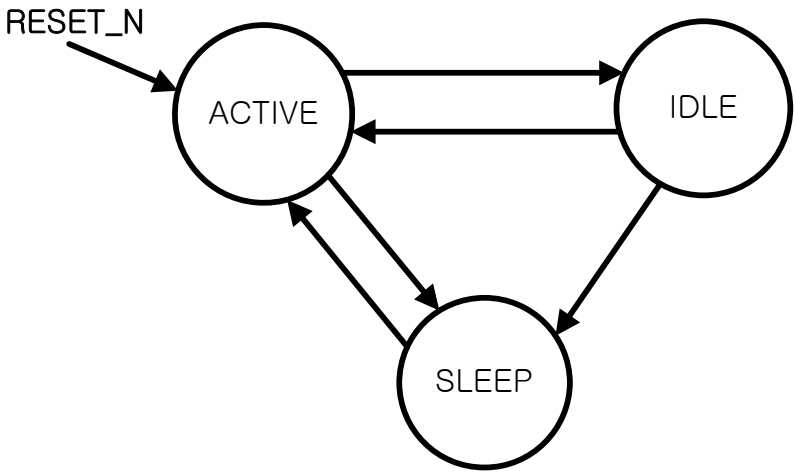
Typical Application Circuit at NON-AIC mode (48TQFP)



This application circuit is strongly recommended to be used under less sensitive environment such as consumer electronic products and home appliances with big sensor input pads without mobility.
In this application, 12 Digital Outputs are available.

Power Save Mode

ATA2501 has three kinds of operation modes, Active, Idle, Sleep. In active mode power consumption is around 110uA. If ATA2501 is not aware of human contact during 4 seconds, it goes into idle mode where power consumption is around 60uA. If it detects human contact, it goes back to active mode immediately. For maximum power saving ATA2501 enters sleep mode by asserting Low to SLEEP_N pin. At sleep mode only 1uA is consumed. To recover from Sleep and become active MCU should assert High to SLEEP_N pin.



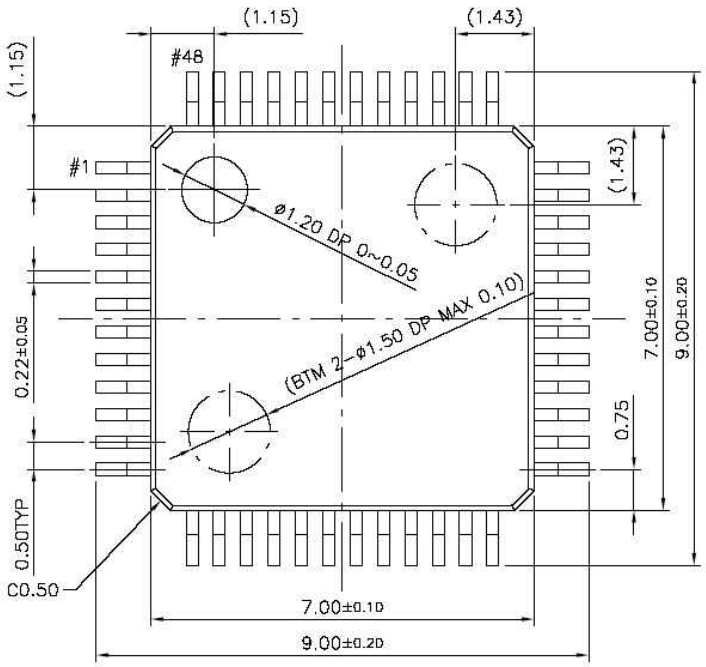
< Power management state diagram >

Ordering Information

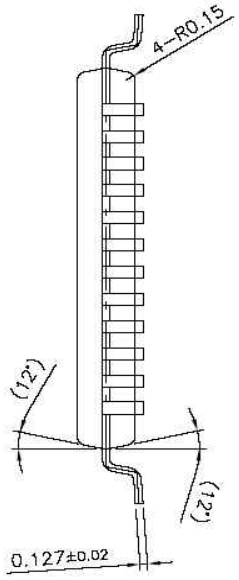
Order Code	Pin	Package	Package Size	Packing
ATA2501DB	48	TQFP	9mm X 9mm	Tray
ATA2501DB-40N	40	QFN	5mm X 5mm	Tape & Reel

48TQFP Dimension (Unit: mm)

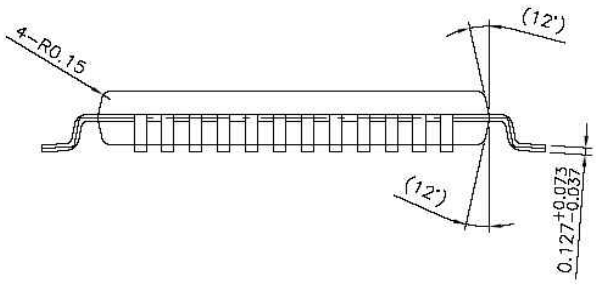
Package Outline Drawing

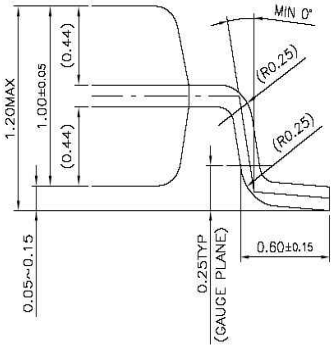


Top View



Side View (1)

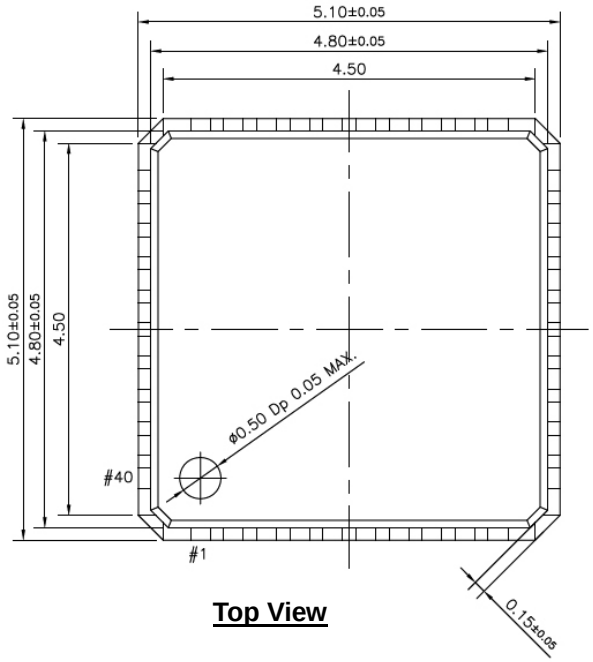




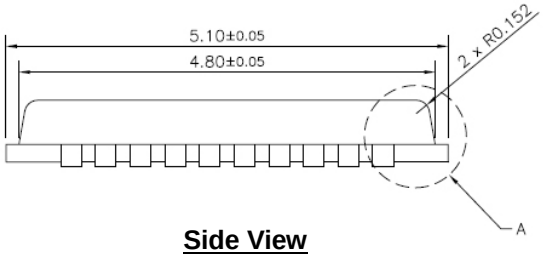
Side View (2)

40QFN Dimension (Unit: mm)

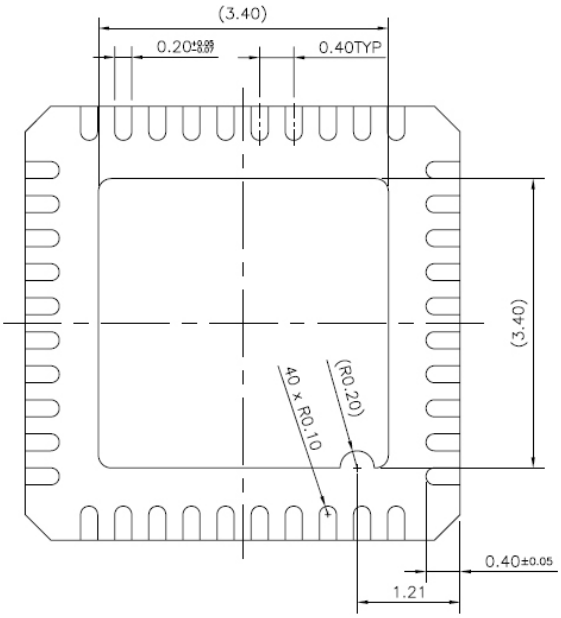
Package Outline Drawing



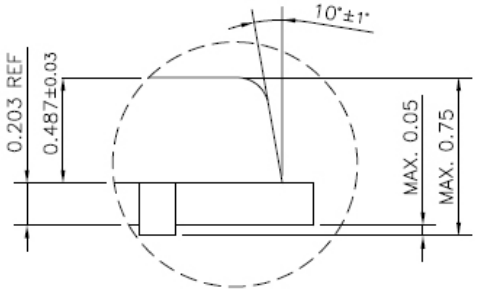
Top View



Side View



Bottom View



Detail "A"