

WT5701
Low Power
Capacitive Touch Key Sensor

Data Sheet

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WT5701 v1.00

Low Power Capacitive Touch Key Sensor

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Preliminary data sheet.
V0.91 6/29/09
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V1.00 12/17/09
For MP version

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1. General Description

WT5701 is a 12-key capacitive touch key sensor. It is designed for replacing button and also can be configured as matrix scan function. WT5701 has low power consumption, so it is suitable for consumer products and portable applications.

1.1. Features

- 1-12 channel input sensor
- Auto sensitivity calibration
- 3 sensitivity option pins
- Anti-noise circuit embedded
- 3 output modes
 - ◆ Direct output: 12 output pad (open drain output)
 - ◆ Serial output(I2C) and include interrupt pin
 - ◆ PWM output
- Output polarity option: active high or active low
- 12 output expander(maximum)
- Open-drain digital output with maximum drain current 8mA
- Wide operating voltage: 2.2V ~ 5.5V
- 3 operation modes: Normal mode, Slow mode and Sleep mode
- Low operating current
 - ◆ Normal mode
 - 3.0V: Typical 30uA
 - 5.0V: Typical 60uA
 - ◆ Slow mode
 - 3.0V: Typical 3uA
 - 5.0V: Typical 7uA
 - ◆ Sleep mode
 - 3.0V: < 1uA
 - 5.0V: < 1uA
- Package type
 - LQFP48
 - QFN32
 - QFN16
- 4 I2C ID(2 external output option pins)
- Calibration function can be set enable/disable
- Each sensor sensitivity is individually programmable by 3 bits
- 2 sensors(SI[0]/SI[1]) can work at slow mode, response time is 100~150ms(max. @3.0V)

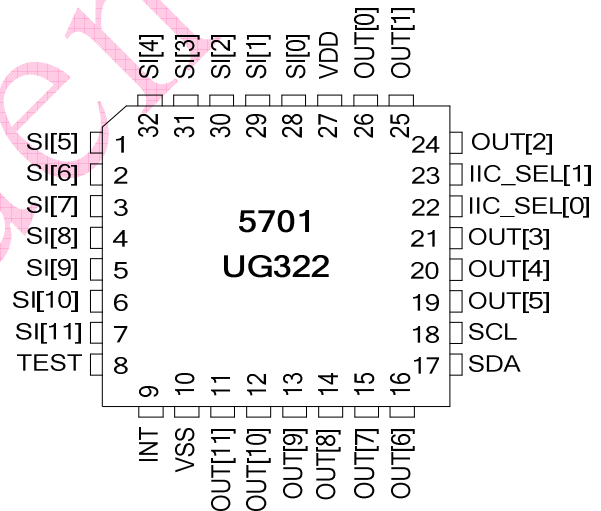
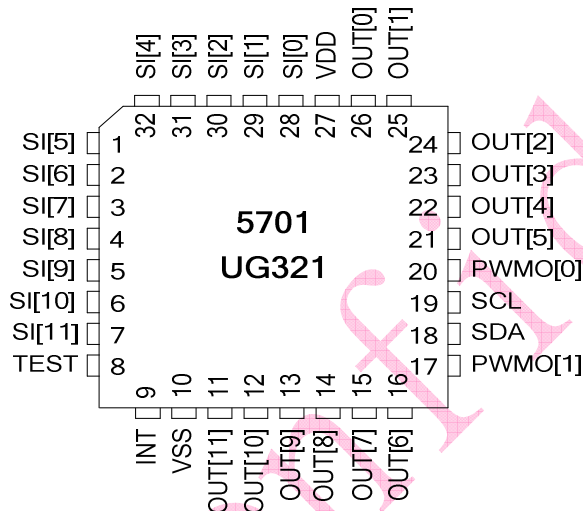
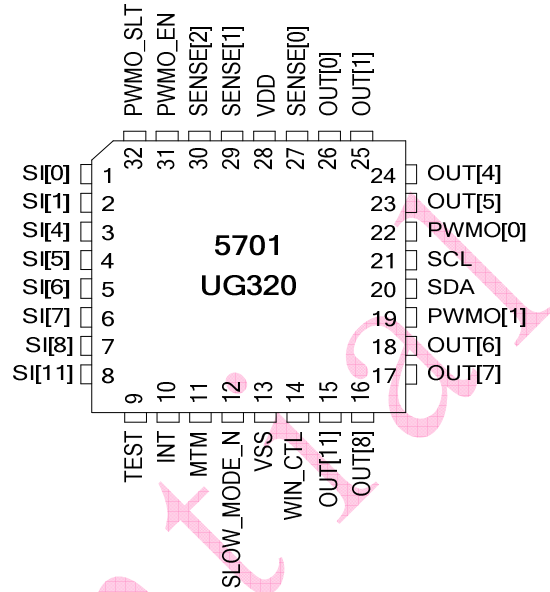
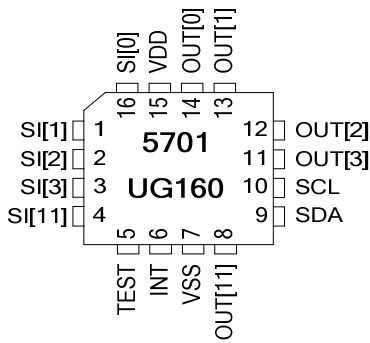


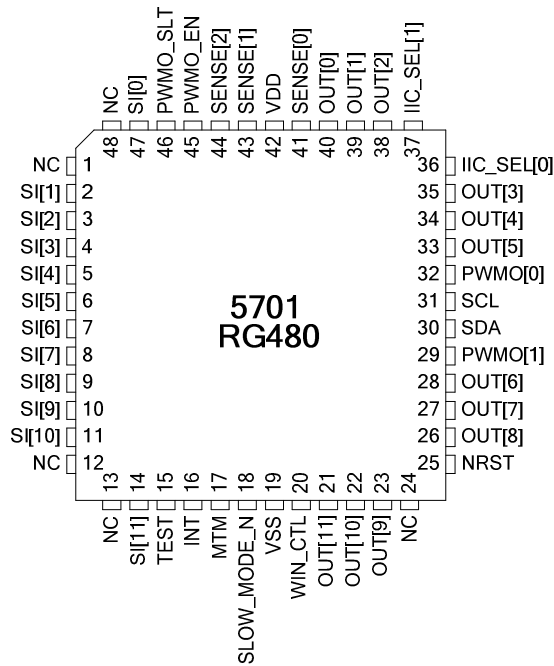
- One PWM could output via OUT[11:0]
- Add external reset pin, active low
- Auto-reset(calibration) function(default disable). If key touch over 190sec, chip will auto reset calibration function automatic.

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2. Pin Assignment

2.1. Package





2.2. Ordering information

Package Type	outline	Part Number
48-pin LQFP	7x7mm	5701-RG480WT
32-pin QFN	5x5mm	5701-UG320WT
32-pin QFN	5x5mm	5701-UG321WT
32-pin QFN	5x5mm	5701-UG322WT
16-pin QFN	4x4mm	5701-UG160WT

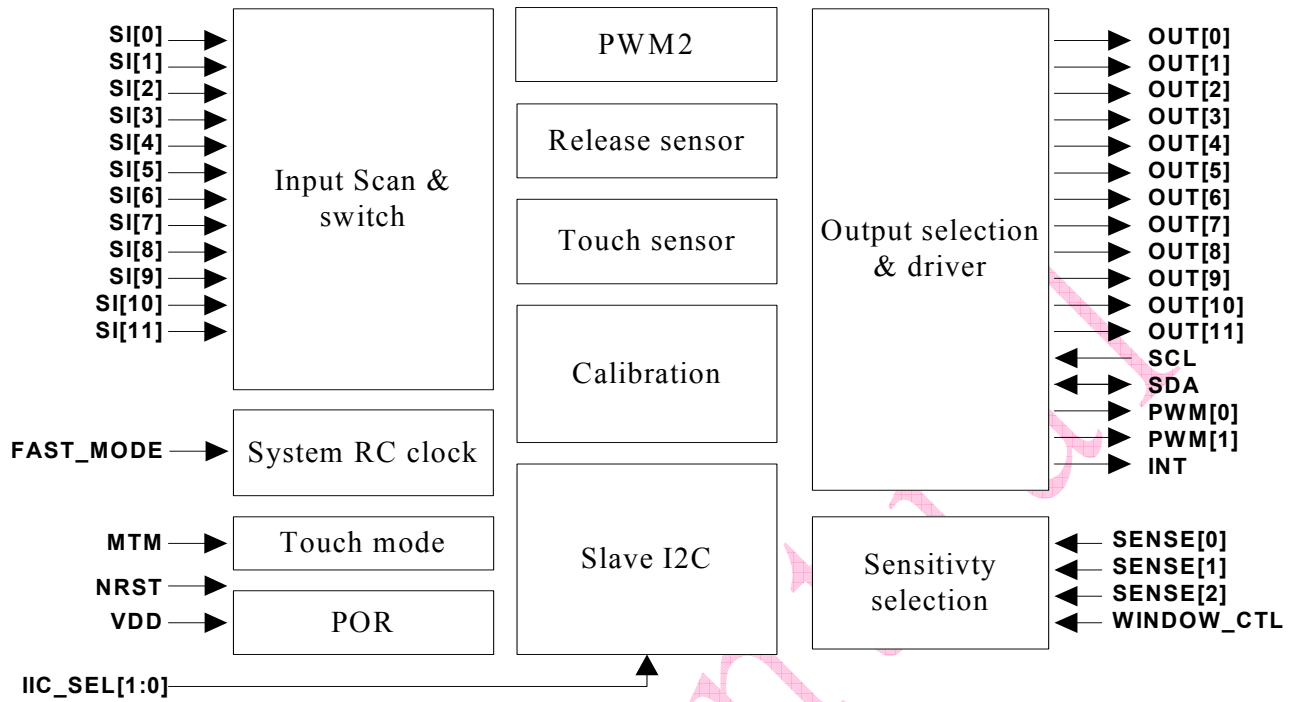
2.3. Pin description

RG480	UG320	UG321	UG322	UG160	Pin Name	Function Description
47	1	28	28	16	SI[0]	Capacitive sensor input[0]
2	2	29	29	1	SI[1]	Capacitive sensor input[1]
3		30	30	2	SI[2]	Capacitive sensor input[2]
4		31	31	3	SI[3]	Capacitive sensor input[3]
5	3	32	32		SI[4]	Capacitive sensor input[4]
6	4	1	1		SI[5]	Capacitive sensor input[5]
7	5	2	2		SI[6]	Capacitive sensor input[6]
8	6	3	3		SI[7]	Capacitive sensor input[7]
9	7	4	4		SI[8]	Capacitive sensor input[8]
10		5	5		SI[9]	Capacitive sensor input[9]
11		6	6		SI[10]	Capacitive sensor input[10]
14	8	7	7	4	SI[11]	Capacitive sensor input[11]
15	9	8	8	5	TEST	Test mode (internal pull high)
16	10	9	9	6	INT	Interruption output
17	11				MTM	Multi touch mode (internal pull high)
18	12				SLOW_MODE_N	Slow down mode (internal pull high)
19	13	10	10	7	VSS	ground
20	14				WIN_CTL	Sensitivity window control(internal pull high)

21	15	11	11	8	OUT[11]	Channel of output[11] (Open drain)
22		12	12		OUT[10]	Channel of output[10] (Open drain)
23		13	13		OUT[9]	Channel of output[9] (Open drain)
25					NRST	External reset pin(internal pull high)
26	16	14	14		OUT[8]	Channel of output[8] (Open drain)
27	17	15	15		OUT[7]	Channel of output[7] (Open drain)
28	18	16	16		OUT[6]	Channel of output[6] (Open drain)
29	19	17			PWMO[1]	PWMO[1] output
30	20	18	17	9	SDA	I2C SDA
31	21	19	18	10	SCL	I2C SCL
32	22	20			PWMO[0]	PWMO[0] output
33	23	21	19		OUT[5]	Channel of output[5] (Open drain)
34	24	22	20		OUT[4]	Channel of output[4] (Open drain)
35		23	21	11	OUT[3]	Channel of output[3] (Open drain)
36			22		IIC_SEL[0]	Device address select bit 0(pull high)
37			23		IIC_SEL[1]	Device address select bit 1(pull high)
38		24	24	12	OUT[2]	Channel of output[2] (Open drain)
39	25	25	25	13	OUT[1]	Channel of output[1] (Open drain)
40	26	26	26	14	OUT[0]	Channel of output[0] (Open drain)
41	27				SENSE[0]	Sensitivity control [0] (internal pull high)
42	28	27	27	15	VDD	VDD
43	29				SENSE[1]	Sensitivity control [1] (internal pull high)
44	30				SENSE[2]	Sensitivity control [2] (internal pull high)
45	31				PWMO_EN	PWM output enable (internal pull high)
46	32				PWMO_SLT	PWM mode selection (internal pull high)

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3. Functional Block Diagram

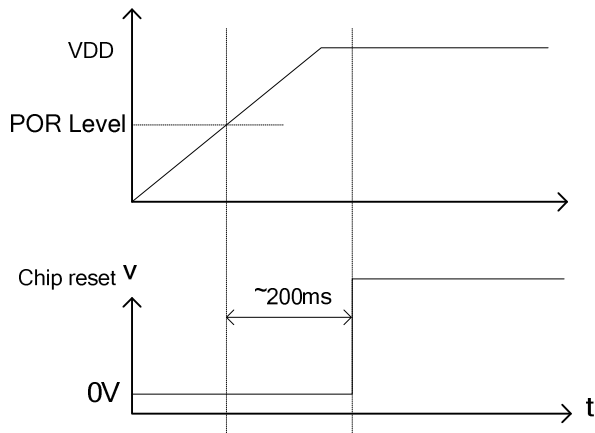


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4. Functional Description

4.1. Chip initialization

- (A) One on chip power on reset circuit
- (1) VDD POR level: $\sim 1.8V$
 - (2) Reset signal will delay $\sim 200ms$



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4.2. System control register

Index	Default	R/W	Bit	Name	Description
00	20	R/W	7-6	Reserved	
			5	SLOW_MODE_N	RC oscillator frequency adjust 1: Normal mode 0: Slow down mode
		W	4	RST_CALB	1: Reset calibration block 0: normal mode
			3	ACT_INT_LVL	Active interrupt level 1: High active 0: Low active
			2	ACT_OUT_LVL	Active output level 1: High active 0: Low active
			1	CTL_SLT	Control signal selection 1: From register setting 0: From input pin
			0	PWR_DN	1: Power down oscillator 0: Normal mode

- (a) If MUC sends I2C command to set CTL_SLT, the function of control input pin will be disable.
Control signals include: SENSEn[2:0], WIN_CTL, MTM, PWMO_EN, PWMO_SLT, SLOW_MODE_N
- (b) PWR_DN: MCU sends I2C command to enable/disable power down mode(sleep mode).
- (c) After wake up, MCU must set RST_CALB=1 to reset calibration block and get new & correct calibration data.

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4.3. Output expander share with OUT[11:0]

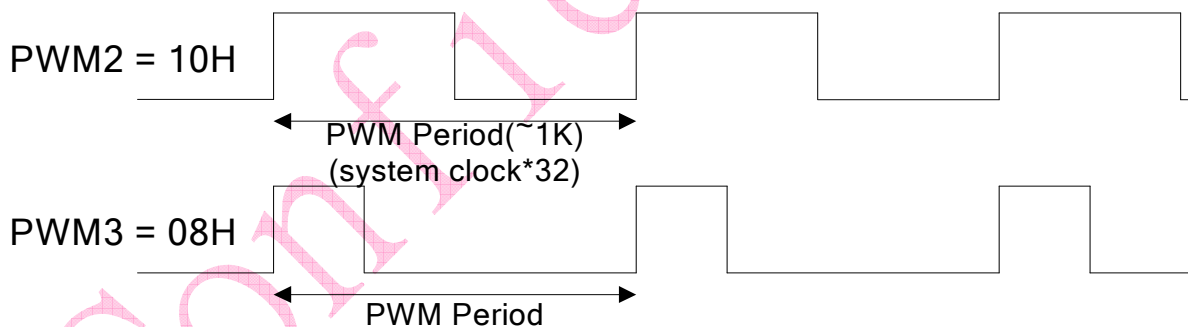
The GPO[11:0] are the general purpose output shared with KEY output pads. When GPO_OE is enable, it is a general purpose output port and it could source /sink 4mA. Else if GPO_PWM_OE is enable, it will output the PWM2 signal.(Please enable the PWM2 first) If both GPO_OE and GPO_PWM_OE are enable at same time, the output pin is set as a general purpose output port.

Index	Default	R/W	Bit	Name	Description
04	00	W	7-4	Reserved	
			3-0	GPO_OE[11:8]	Output pin[11:8] output enable, active high
05	00	W	7-4	Reserved	
			3-0	GPO_D[11:8]	Output pin[11:8] output data
06	00	W	7-0	GPO_OE[7:0]	Output pin[7:0] output enable, active high
07	00	W	7-0	GPO_D[7:0]	Output pin[7:0] output data

Index	Default	R/W	Bit	Name	Description
0A	00	W	7-4	Reserved	
			3-0	GPO_PWM_OE[11:8]	Output pin[11:8] PWM2 output enable, active high
0B	00	W	7-0	GPO_PWM_OE[7:0]	Output pin[7:0] PWM2 output enable, active high

4.3.1. PWM2

Index	Default	R/W	Bit	Name	Description
03	00	W	7	EN_PWM2	
			6-5	Reserved	
			4-0	PWM2[4:0]	PWM2 data



4.4. Calibration

4.4.1. Calibration time

Index	Default	R/W	Bit	Name	Description
01	01	R/W	7	HOLD_CALB	Hold calibration
			6-5	Reserved	
			4-3	RST_CAL_TIME	Auto reset calibration time when touch 11: ~200s 10: ~100s 01: ~50s 00: disable (default)
			2	CAL_AVGE	Calibration average mode 0: 1/2 1: 3/4
			1-0	CAL_TIME	00: ~0.8s 01: ~1.6s(default) 10: ~3.2s 11: ~6.4s

4.4.2. Calibration reference(MAX) counter

Index	Default	R/W	Bit	Name	Description
18	00	R	7-0	CAB0_CNT[7:0]	Sensor input 0 calibration reference counter[10:3]
19	00	R	7-0	CAB1_CNT[7:0]	Sensor input 1 calibration reference counter[10:3]
1A	00	R	7-0	CAB2_CNT[7:0]	Sensor input 2 calibration reference counter[10:3]
1B	00	R	7-0	CAB3_CNT[7:0]	Sensor input 3 calibration reference counter[10:3]
1C	00	R	7-0	CAB4_CNT[7:0]	Sensor input 4 calibration reference counter[10:3]
1D	00	R	7-0	CAB5_CNT[7:0]	Sensor input 5 calibration reference counter[10:3]
1E	00	R	7-0	CAB6_CNT[7:0]	Sensor input 6 calibration reference counter[10:3]
1F	00	R	7-0	CAB7_CNT[7:0]	Sensor input 7 calibration reference counter[10:3]
20	00	R	7-0	CAB8_CNT[7:0]	Sensor input 8 calibration reference counter[10:3]
21	00	R	7-0	CAB9_CNT[7:0]	Sensor input 9 calibration reference counter[10:3]
22	00	R	7-0	CAB10_CNT[7:0]	Sensor input 10 calibration reference counter[10:3]
23	00	R	7-0	CAB11_CNT[7:0]	Sensor input 11 calibration reference counter[10:3]



4.5. I2C control interface

If MUC sends command to set CTL_SLT(index:00H,bit1), the function of control input pin will be disable.
Control signals include: SENSE[2:0], WIN_CTL, MTM.

4.5.1. Slave I2C address(for muti-chip use)

IIC_SEL[1:0] = 11(default) : E0/E1
 10 : E4/E5
 01 : E8/E9
 00 : EC/ED

4.5.2. Slave I2C Control

(A) Slave I2C write mode:

Start + saddr(E0)+A+00+A+addr+A+data_1+A+ - - - +data_n+A+Stop

(B) Slave I2C read mode:

Start + saddr(E0)+A+00+A+addr+Stop+re-start+saddr(E1)+A+data_1+A+ - - - + data_n+A+Stop

4.5.3. Control register

Index	Default	R/W	Bit	Name	Description
02	F0	R/W	7	PWMO_EN	Enable PWM output
			6	PWMO_SLT	PWM output selection 1: PWM[0] output SI[0]/SI[2]/SI[4]/SI[6]/SI[8]/SI[10] PWM[1] output SI[1]/SI[3]/SI[5]/SI[7]/SI[9]/SI[11] 0: PWM[0] output SI[0]/SI[1]...../SI[10]/SI[11]
			5	MTM	Default =1 1: Multi touch mode 0: Single touch mode
			4	WIN_CTL	Window of sensitivity selector 1: No-windows 0: 1/2-windows
			3	SYNC_EN	Sync output enable 1: Sync output via INT pin 0: INT output
			2	READY	MCU ready to read sample counter 1: MCU ready(auto clear after sample counter update) 0: MCU could read the data
			1-0	Reserved	

When MCU set "Ready" bit and if WT5701 fill the buffer ready the "Ready" bit will be clear automatic.

* SI sensitivity level selection

	CTL_SLT=0	CTL_SLT=1
SI[11:0]	Pin SENSE[2:0]	Register SENSEn[2:0] (n=11~0)

4.6. Sensitivity

Index	Default	R/W	Bit	Name	Description
10	77	W	7	Reserved	
			6-4	SENSE1[2:0]	Sensitivity level selection for channel 1 000: 4 clock 001: 8 clock 010: 12 clock 011: 20 clock 100: 32 clock 101: 48 clock 110: 72 clock 111: 96 clock
			3	Reserved	
			2-0	SENSE0[2:0]	Sensitivity level selection for channel 0 000: 4 clock 001: 8 clock 010: 12 clock 011: 20 clock 100: 32 clock 101: 48 clock 110: 72 clock 111: 96 clock
11	77	W	7	Reserved	
			6-4	SENSE3[2:0]	Sensitivity level selection for channel 3
			3	Reserved	
			2-0	SENSE2[2:0]	Sensitivity level selection for channel 2
12	77	W	7	Reserved	
			6-4	SENSE5[2:0]	Sensitivity level selection for channel 5
			3	Reserved	
			2-0	SENSE4[2:0]	Sensitivity level selection for channel 4
13	77	W	7	Reserved	
			6-4	SENSE7[2:0]	Sensitivity level selection for channel 7
			3	Reserved	
			2-0	SENSE6[2:0]	Sensitivity level selection for channel 6
14	77	W	7	Reserved	
			6-4	SENSE9[2:0]	Sensitivity level selection for channel 9
			3	Reserved	
			2-0	SENSE8[2:0]	Sensitivity level selection for channel 8
15	77	W	7	Reserved	
			6-4	SENSE11[2:0]	Sensitivity level selection for channel 11
			3	Reserved	
			2-0	SENSE10[2:0]	Sensitivity level selection for channel 10

4.6.1. Sensitivity control: SENSEn[2:0]

(A) The key detector is the value (different clock numbers) of clock difference for detecting from no-touching to touching.

SENSEn[2:0]			Clock difference
0	0	0	4
0	0	1	8
0	1	0	12
0	1	1	20
1	0	0	32

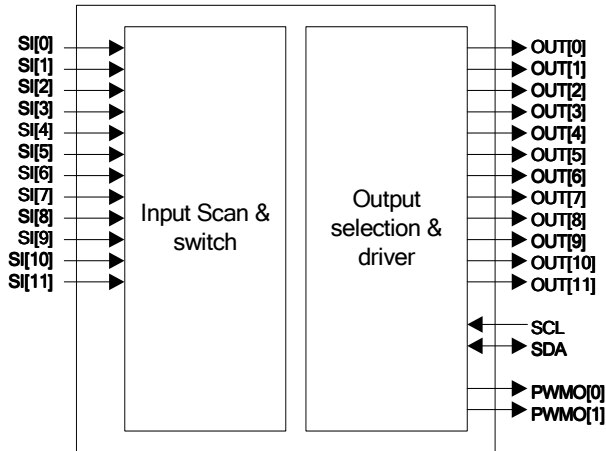
1	0	1	48
1	1	0	72
1	1	1	96

(B) The key from touching to release detect by WIN_CTL.

SENSE n[2:0]			WIN_CTL	
			1 No-W	0 1/2-W
0	0	0	4	2
0	0	1	8 (4)	4
0	1	0	12 (4)	6
0	1	1	20 (8)	10
1	0	0	32 (12)	16
1	0	1	48 (16)	24
1	1	0	72 (24)	36
1	1	1	96 (24)	48

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4.7. Output interface



4.7.1. Direct output : OUT[11:0]

Direct mode : IN pad (SI[0]-SI[11]) => output pad(OUT[0]-OUT[11]))

- (1) Multi touch mode(MTM=1, (index:20H,bit5))
- (2) Single touch mode(MTM=0, (index:20H,bit5))

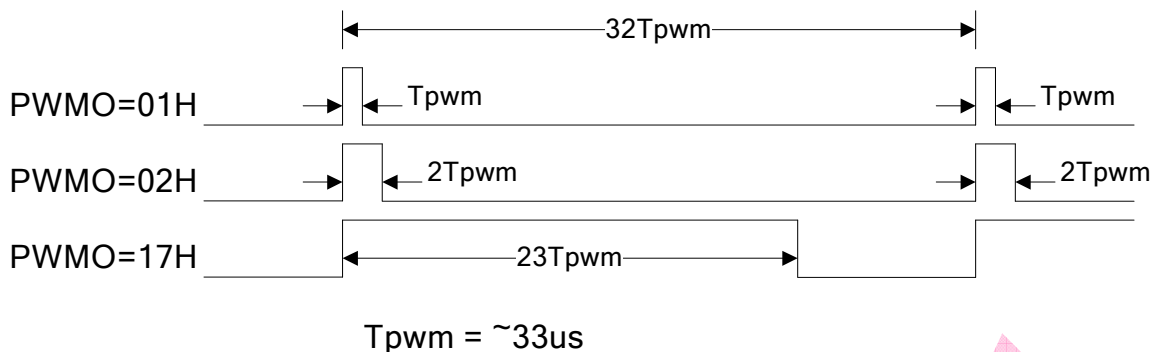
4.7.2. PWMO output: PWMO[1:0]

(1) PWMO_SLT register :

- (a) PWMO_SLT=1 : PWMO[0] outputs the detection of SI[0]/SI[2]/SI[4]/SI[6]/SI[8]/SI[10]
PWMO[1] outputs the detection of SI[1]/SI[3]/SI[5]/SI[7]/SI[9]/SI[11]
- (b) PWMO_SLT=0 : PWMO[0] outputs the detection of SI[0]/SI[1]...../SI[10]/SI[11]
PWMO[1] is no use.

Touched PAD	PWMO SLT=0	PWMO SLT=1	
	PWMO[0] output	PWMO[0] output	PWMO[1] output
SI[0]	01H	02H	
SI[1]	03H		02H
SI[2]	05H	06H	
SI[3]	07H		06H
SI[4]	09H	0AH	
SI[5]	0BH		0AH
SI[6]	0DH	0EH	
SI[7]	0FH		0EH
SI[8]	11H	12H	
SI[9]	13H		12H
SI[10]	15H	16H	
SI[11]	17H		16H

- (2) PWMO base clock = system clock => PWMO period ~1kHz
- (3) PWMO-outputs only support single-touch mode



4.7.3. I2C interface

Sensor data(KEY_TOUCH[11:0]) always supports multi-touch mode.

Index	Default	R/W	Bit	Name	Description
08	00	R	7	CHIP_RST	After Power on reset or external reset finish
			6	CAL_RST	F/W reset calibration of auto reset calibration
			5-4	Reserved	
			3-0	KEY_TOUCH[11:8]	0000: No key of SI[11:8] has been touch 0001: SI[8] key has been touch 0010: SI[9] key has been touch 0011: SI[9:8] keys have been touch 1111: SI[11:8] keys have been touch
09	00	R	7-0	KEY_TOUCH[7:0]	0000_0000: No key of SI[7:0] has been touch 0000_0001: SI[0] key has been touch 0000_0010: SI[1] key has been touch 0000_0011: SI[1:0] keys have been touch 1111_1111: SI[7:0] keys have been touch

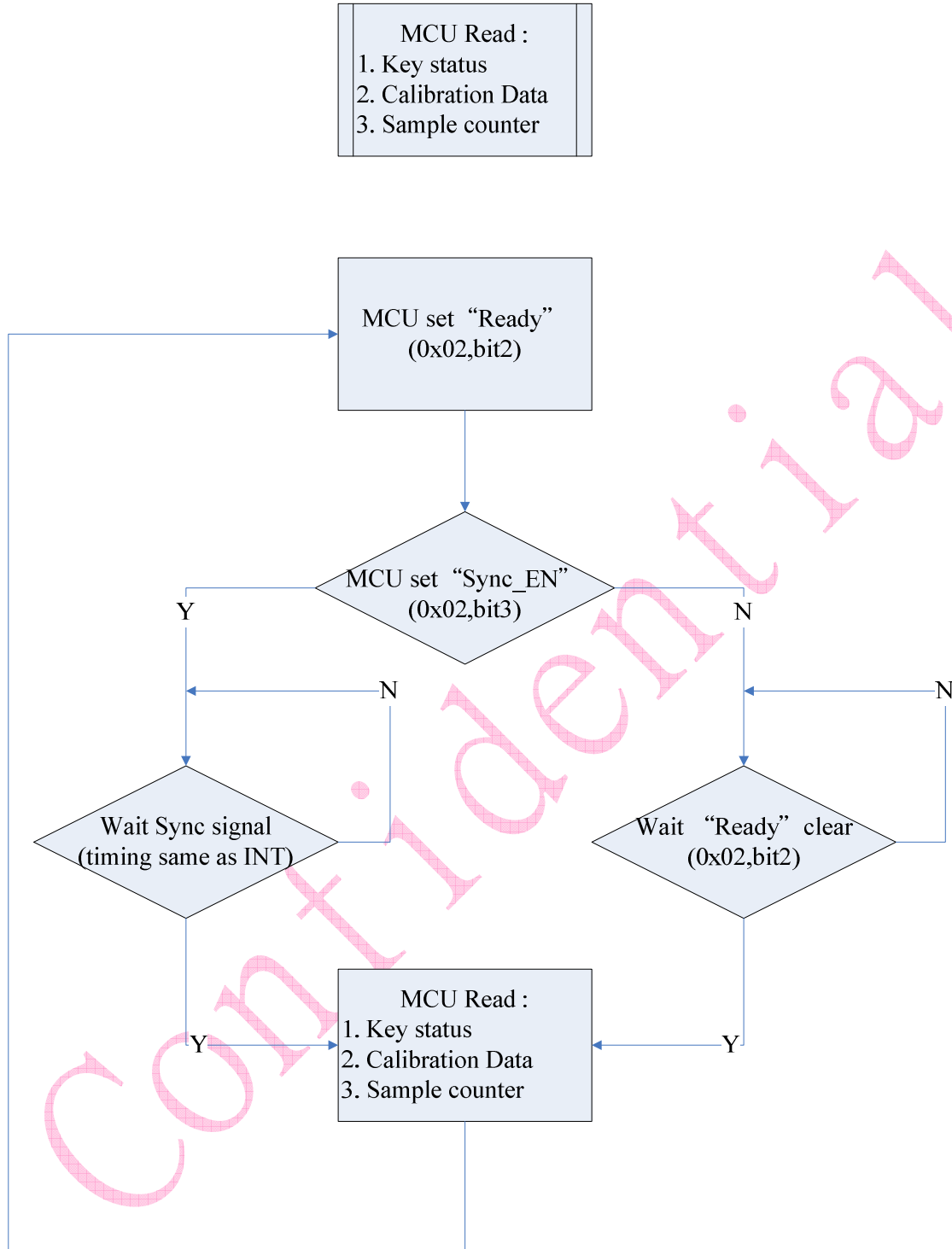
SI[11:0] Sample counter

Index	Default	R/W	Bit	Name	Description
24	00	R	7-0	SMP0_CNT[10:3]	Sensor input 0 sample counter[10:3]
25	00	R	7-0	SMP1_CNT[10:3]	Sensor input 1 sample counter[10:3]
26	00	R	7-0	SMP2_CNT[10:3]	Sensor input 2 sample counter[10:3]
27	00	R	7-0	SMP3_CNT[10:3]	Sensor input 3 sample counter[10:3]
28	00	R	7-0	SMP4_CNT[10:3]	Sensor input 4 sample counter[10:3]
29	00	R	7-0	SMP5_CNT[10:3]	Sensor input 5 sample counter[10:3]
2A	00	R	7-0	SMP6_CNT[10:3]	Sensor input 6 sample counter[10:3]
2B	00	R	7-0	SMP7_CNT[10:3]	Sensor input 7 sample counter[10:3]
2C	00	R	7-0	SMP8_CNT[10:3]	Sensor input 8 sample counter[10:3]
2D	00	R	7-0	SMP9_CNT[10:3]	Sensor input 9 sample counter[10:3]
2E	00	R	7-0	SMP10_CNT[10:3]	Sensor input 10 sample counter[10:3]
2F	00	R	7-0	SMP11_CNT[10:3]	Sensor input 11 sample counter[10:3]
30	00	R	7	Reserve	
			6-4	SMP1_CNT[2:0]	Sensor input 1 sample counter[2:0]
			3	Reserve	
			2-0	SMP0_CNT[2:0]	Sensor input 0 sample counter[2:0]
31	00	R	7	Reserve	
			6-4	SMP3_CNT[2:0]	Sensor input 3 sample counter[2:0]
			3	Reserve	
			2-0	SMP2_CNT[2:0]	Sensor input 2 sample counter[2:0]

32	00	R	7	Reserve	
			6-4	SMP5_CNT[2:0]	Sensor input 5 sample counter[2:0]
			3	Reserve	
			2-0	SMP4_CNT[2:0]	Sensor input 4 sample counter[2:0]
33	00	R	7	Reserve	
			6-4	SMP7_CNT[2:0]	Sensor input 7 sample counter[2:0]
			3	Reserve	
			2-0	SMP6_CNT[2:0]	Sensor input 6 sample counter[2:0]
34	00	R	7	Reserve	
			6-4	SMP9_CNT[2:0]	Sensor input 9 sample counter[2:0]
			3	Reserve	
			2-0	SMP8_CNT[2:0]	Sensor input 8 sample counter[2:0]
35	00	R	7	Reserve	
			6-4	SMP11_CNT[2:0]	Sensor input 11 sample counter[2:0]
			3	Reserve	
			2-0	SMP10_CNT[2:0]	Sensor input 10 sample counter[2:0]

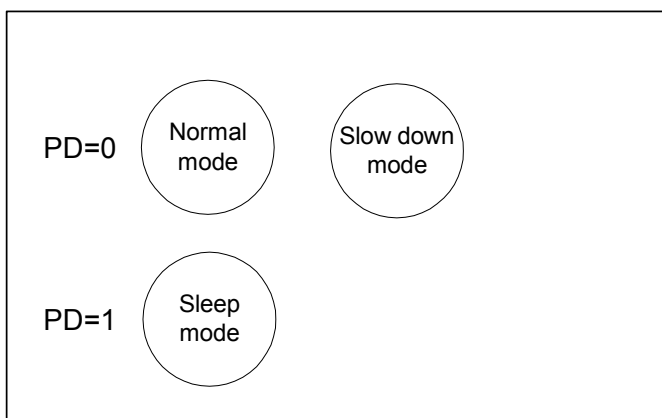
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4.7.4. IIC READ DATA FLOW CHART:



If "ready" bit not set. MCU will read the previous data(w/o update).

4.8. Power Down and Slow Down mode



(A) Normal mode :

(1) Normal mode throughput with ~20Hz output

(B) Slow down mode :

(1) Slow down mode by pin(tie low) => Only two key(S0/S1)work(direct output and INT pin).

	SLOW_MODE N = 1	SLOW_MODE N =0
Operating mode	Normal mode	Slow down mode

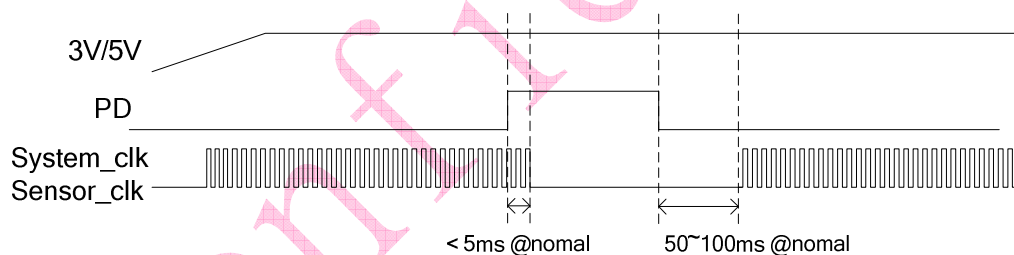
(2) Slow down mode by I2C => Only two key(S0/S1)work. After wakeup WT5701 will go back to normal mode and MUC need reset the calibration block again.

(C) Sleep mode : (must with IIC)

(1) MCU sends I2C command to enable sleep mode and wake up system.

(PWR_DN register, (index:00H,bit0))

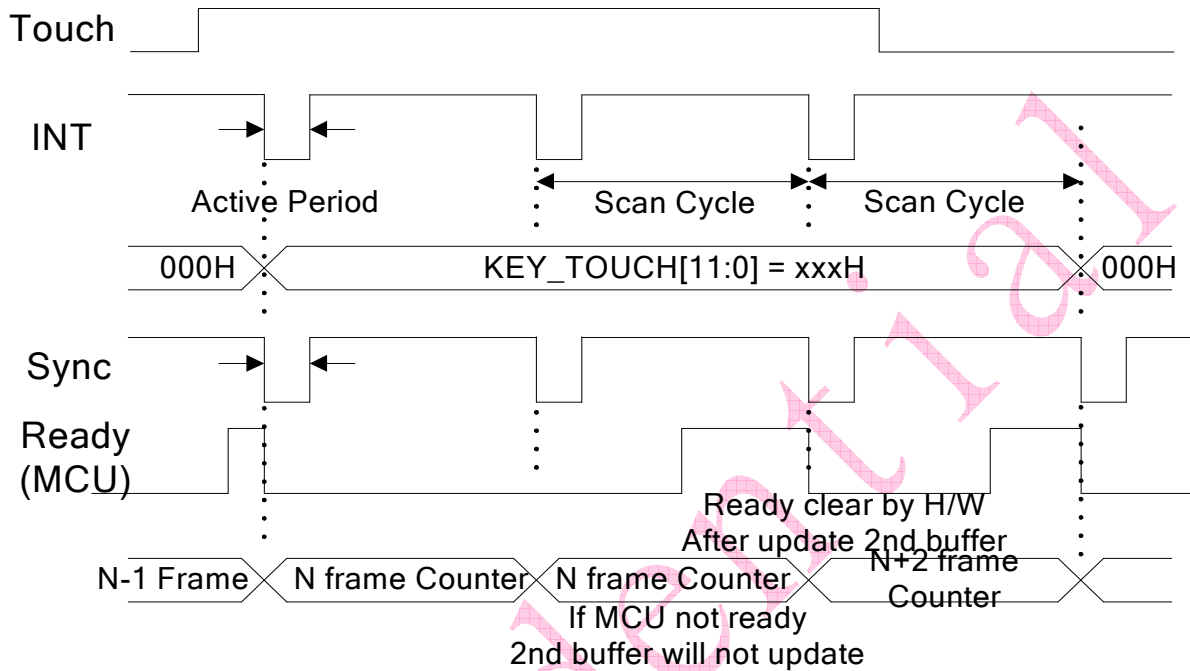
(2) After PWR_DN =0, System waits 50~100ms to stable clock



4.9. Interrupt

(A) Active interrupt level : To set/clear ACT_INT_LVL(index:00H,bit3) is to program H/L active level
(Initial : low active)(only used in I2C mode)

(B) WT5701 ↔ MCU interruption timing



- (1) "INT" pulse low time ~4ms
- (2) If pad keeps to be touched, INT is periodic pulse and period is ~50 ms
- (3) INT pin share with "SYNC" function output.(by setting 0x02 bit3). When "SYNC" falling(active low) MCU could read the previous frame's sample counter stable. After read F/W have to set "ready" bit again before read the next frame data.



4.10. System & Sample clock adjust register

Index	Default	R/W	Bit	Name	Description
0F	66	W	7	Reserved	
			6-4	CNT_SEL[2:0]	Sample counter adjust register 000:The most sample counter 111:The less sample counter
			3	Reserved	
			2-0	SCAN_SEL[2:0]	Scan time adjust register 000:The fastest scan time 111:The slower scan time

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5. Electrical Characteristics

5.1. Absolute Maximum Ratings

Parameter	Value	Unit
Power Supply Voltage	5.5V	V
Storage Temperature	-60 ~ +125	°C

5.2. Recommended Operating Condition

Parameter	Min.	Typ.	Max.	Unit
Power supply	2.2	3.0	5.5	V
Operating Temperature	-40	-	85	°C

5.3. Power Supply

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
I _{VDD5v}	Normal operation current at 5V operating	No load on output		60		uA
I _{VDD3v}	Normal operation current at 3V operating	No load on output		30		uA
I _{SLOW}	Slow down mode current at 3V operating	No load on output		3		uA
I _{SLEEP}	Sleep mode current	No load on output			1	uA

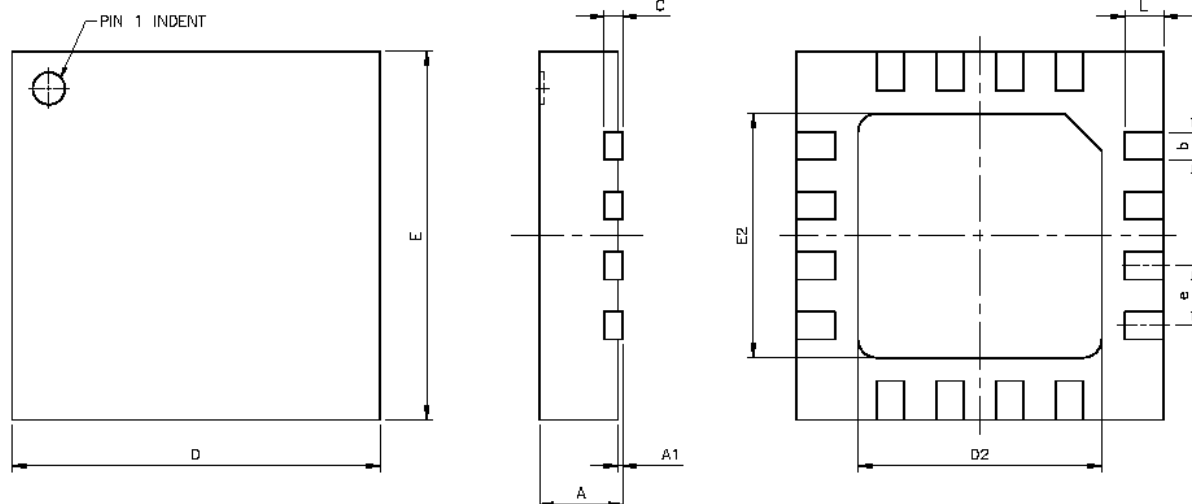
5.4. Digital I/O

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
V _{IH}	Input High Voltage		0.7V _{DD}		V _{DD} +0.3	V
V _{IL}	Input Low Voltage		-0.3		0.2V _{DD}	V
V _{OH}	Output high voltage	I _{OH} = 4mA at VDD= 3.3V	2.4			V
		I _{OH} = 4mA at VDD= 5V	4			
V _{OL}	Output low voltage (PWMO[1:0], INT, SDA)	I _{OL} = 4mA			0.4	V
V _{OL}	Output low voltage (OUT[11:0])	I _{OL} = 8mA			0.4	V
I _{OZ}	Tri-state leakage current	V _O = 0 or 3.3V		±0.01	±1	μA
R _{PD}	Pull up resistor			10 *		MΩ

* Pull high current= 0.5uA, pull high resistor = 5/0.5uA = 10MΩ

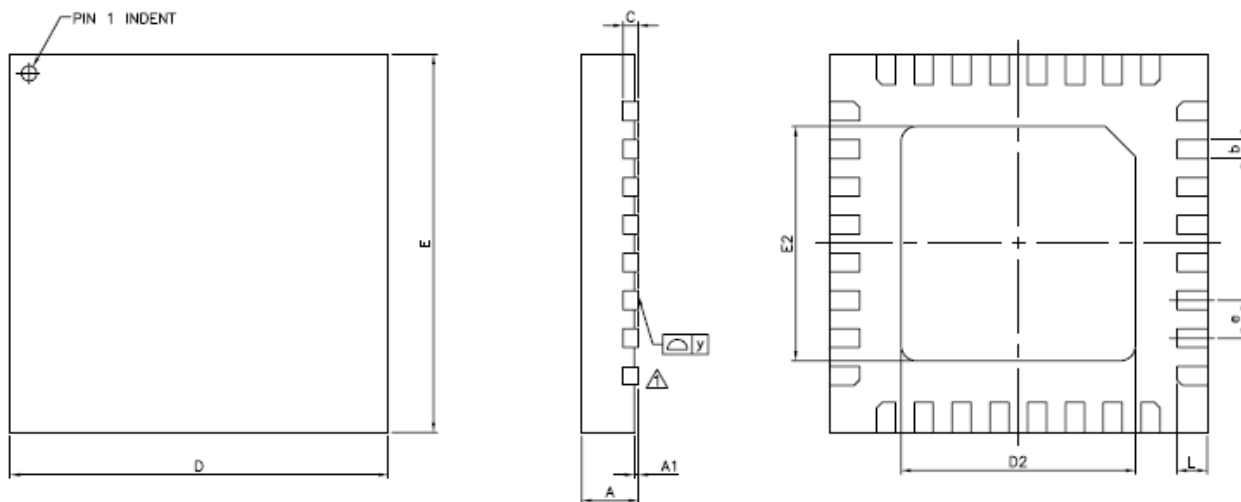
6. Package Dimension

6.1. 16pin QFN



SYMBOLS	DIMENSIONS IN MILLIMETERS		
	MIN	NOM	MAX
A	0.80	0.90	1.00
A1	0.00	0.02	0.05
b	0.25	0.30	0.35
C	—	0.20 REF.	—
D	3.90	4.00	4.10
D2	2.50	2.65	2.80
E	3.90	4.00	4.10
E2	2.50	2.65	2.80
e	—	0.65	—
L	0.30	0.425	0.50
y	0.00	—	0.076

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6.2. 32pin QFN


NOTE:

1. THE TERMINAL #1 IDENTIFIER IS A LASER MARKED FEATURE

SYMBOLS	DIMENSIONS IN MILLIMETERS		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	0.00	0.02	0.05
b	0.18	0.25	0.30
C	—	0.20 REF.	—
D	4.90	5.00	5.10
D2	3.05	3.10	3.15
E	4.90	5.00	5.10
E2	3.05	3.10	3.15
e	—	0.50	—
L	0.35	0.40	0.45
y	0.00	—	0.075

Cont.

6.3. 48pin LQFP
