

## ILI2510

# Single Chip Capacitive Touch Sensor Controller

## Specification

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## Revision History

Version	Date	Page	Description
V1.01	2016/5/27	All	Draft specification released.
V1.02	2016/8/2	All	Preliminary released
V1.03	2016/8/5	All	Modify the BGA-147 ball assignment; Add new BGA-147 ball description, QFN-88 pin assignment & description, QFN-88 package dimension, I2C AC characteristics, application circuit for USB & I2C.
V1.04	2016/8/9	All	Add power-on sequence, power-off to power-on sequence.
V1.05	2016/8/9	All	Modify the capacitance of VGH to 1uF.
V1.06	2016/8/10	All	Remove ILI2511 data
V1.07	2017/2/9	4,7,10,11	Modify VDDIO operation voltage
V1.08	2017/3/28	14,15	Modify Power Sequence
V1.09	2017/5/18	9,10,11,13	Modify Recommended Operating Conditions, DC Characteristics, I2C DC Characteristics
V1.1	2017/9/7	All	Final Specification released
V1.2	2017/10/13	All	Change VDDIO From 5V into 3.3V
V1.3	2017/12/20	All	Add VDDIO 3.3V or 1.8V Input Power Supply Characteristics Add Marking Information

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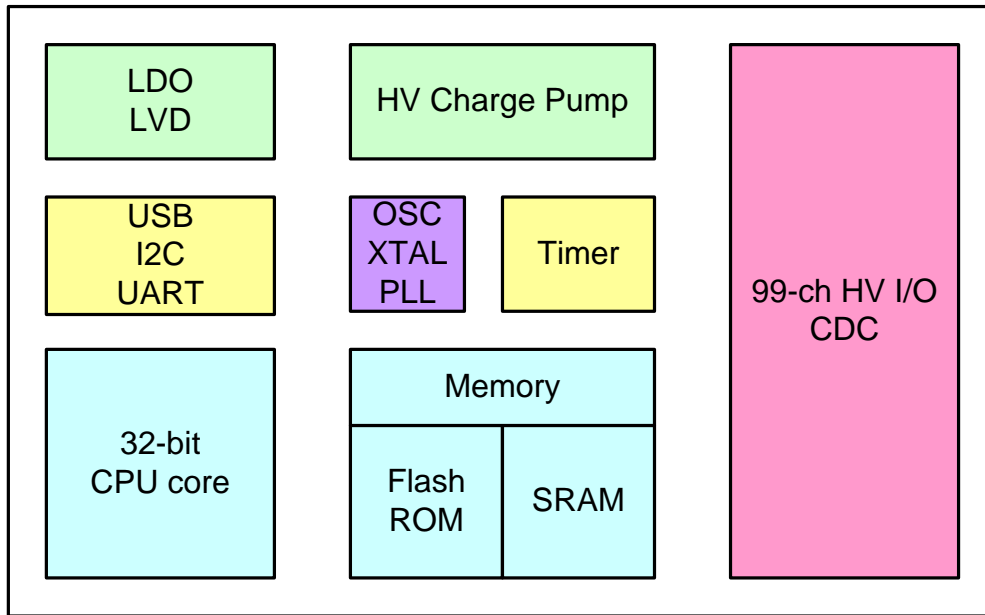
## 1. Description

The ILI2510 is a single chip capacitive touch sensor controller optimized for POS, ATM and Industry Capacitive Touch Panel applications. It integrates high speed Capacitance to Digital Converter (CDC), total 99 channels including high voltage Driving and Sensing channels, high voltage Charge Pump Controller, high voltage regulator and 32-bit high performance Micro-controller (MCU). With compact BGA-147 package, its package size is 7mm\*7mm\*1mm and ball pitch is 0.5mm. ILI2510 meets all Windows 8.1 and Windows 10 requirements with best user touch experience and highest noise immunity performance.

## 2. Features

- 99 channels for capacitive touch panel
- Flexible driving or sensing channel assignment
- Max TX channel number is 54
- Max RX channel number is 63
- Programmable driving voltage for driving channels
- High voltage charge pump controller with programmable high voltage regulator
- High speed ADC converter
- Support baseline calibration function
- Support mutual-capacitance sensing
- Support self-capacitance sensing
- Built-in noise processing function
- Support IEC 61000-4-6 (CS test), Level 3: 10Vrms
- Built-in 1.8V LDO for 1.8V operation of VDDIO for I2C and GPIO
- Built-in 32-bit high performance Micro-controller (MCU)
- Input voltage low level detection circuit
- Input voltage power on reset circuit
- Driving to Sensing mutual capacitance: 1pF to 4pF

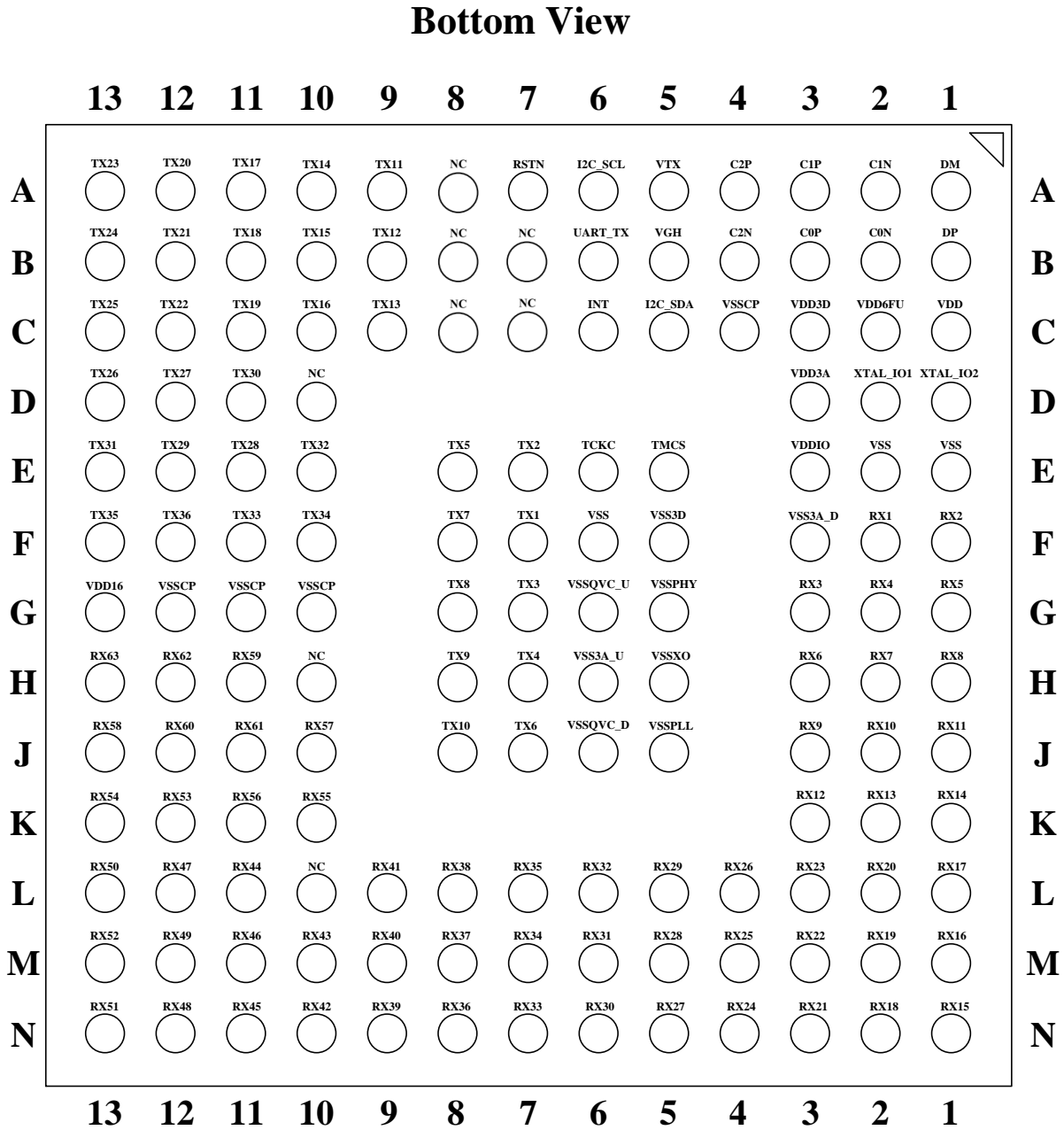
### 3. Block Diagram



**Figure 3-1: ILI2510 Block Diagram**

## 4. Pin Definition

### 4.1 BGA-147 Ball Assignment



**Figure 4-1: ILI2510 BGA-147 Ball Map**

## 4.2 BGA-147 Ball Description

**Table 4-1 Ball Type Define**

Symbol	Description
P	Power pad
CLK	Clock
I	Input only
O	Output only (Push-pull)
I/O	input / output pad

**Table 4-2 ILI2510 Ball Description**

Name	Type	Description
VDD	P	3.3V input power supply, connect 1uF capacitor to system ground
VDD3D	P	3.3V input power supply, connect 1uF capacitor to system ground
VDD3A	P	3.3V input power supply, connect 1uF capacitor to system ground
VDDIO	P	1.8V or 3.3V input power supply for I2C, SPI, UART, INT, RSTN, connect 2.2uF capacitor to system ground
VDD16	P	1.6V regulator output, connect 1uF capacitor to system ground
VDD6FU	P	6V input power supply for E-fuse programming, connect 1uF capacitor to system ground
VTX	P	HV regulator output, connect 1uF capacitor to system ground
VGH	P	Charge pump HV output, connect 1uF capacitor to system ground
VSS3D	P	Digital ground of chip, connect to system ground
VSS3A_D	P	Analog ground of chip, connect to system ground
VSS3A_U	P	Analog ground of chip, connect to system ground
VSSQVC_U	P	QVC ground of chip, connect to system ground
VSSQVC_D	P	QVC ground of chip, connect to system ground
VSS3XO	P	XTAL ground of chip, connect to system ground
VSSPLL	P	PLL ground of chip, connect to system ground
VSSPHY	P	USB PHY ground of chip, connect to system ground
VSS	P	connect to system ground
VSSCP	P	connect to system ground
C2N	P	Cathode of charge pump capacitor, connect 1uF capacitor to C2P
C2P	P	Anode of charge pump capacitor, connect 1uF capacitor to C2N
C1N	P	Cathode of charge pump capacitor, connect 1uF capacitor to C1P

C1P	P	Anode of charge pump capacitor, connect 1uF capacitor to C1N
C0N	P	Cathode of charge pump capacitor, connect 1uF capacitor to C0P
C0P	P	Anode of charge pump capacitor, connect 1uF capacitor to C0N
DM	I/O	USB interface, D- signal.
DP	I/O	USB interface, D+ signal.
XTAL_IO1	I/O	External crystal input, connect 12Mhz crystal for USB application
XTAL_IO2	I/O	External crystal output, connect 12Mhz crystal for USB application
RSTN	I/O	External hardware reset input, internal pull high to VDDIO, pull high resistance is about 4.7k $\Omega$ .
INT	I/O	Interrupt output, internal pull high to VDDIO, pull high resistance is about 4.7k $\Omega$ .
UART_TX	I/O	UART TXD output, internal pull high to VDDIO, pull high resistance is about 4.7k $\Omega$ .
I2C_SCL	I/O	I2C interface, clock input, internal pull high to VDDIO, pull high resistance is about 4.7k $\Omega$ .
I2C_SDA	I/O	I2C interface, data input, internal pull high to VDDIO, pull high resistance is about 4.7k $\Omega$ .
TCKC	I/O	JTAG interface, clock input
TMCS	I/O	JTAG interface, data input
RX[1:45]	I/O	Typical touch panel sensing channels
TRX[46:63]	I/O	Typical touch panel sensing channels and can be configured to driving channels
TX[1:36]	I/O	Typical touch panel driving channels

## 5. Electrical Characteristics

### 5.1 Absolute Maximum Ratings

Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may remain possibility to affect device reliability.

**Table 5-1: Absolute Maximum Ratings**

Parameter	Symbol	Min	Max	Unit
Chip power input	$V_{DD}$	-0.3	3.6	V
$V_{DD3A}$ to GND	$V_{DD3A}$	-0.3	3.6	V
$V_{DD3D}$ to GND	$V_{DD3D}$	-0.3	3.6	V
$V_{DDIO}$ to GND	$V_{DDIO}$	-0.3	3.6	V
$V_{DD16}$ to GND	$V_{DD16}$	-0.3	1.65	V
$V_{GH}$ to GND	$V_{GH}$	-0.3	32	V
$V_{TX}$ to GND	$V_{TX}$	-0.3	32	V
ESD Susceptibility HBM (Human Body Mode)( <b>Note 1</b> )	HBM		4000	V
ESD Susceptibility MM (Machine Mode) ( <b>Note 1</b> )	MM		400	V
Operating Ambient Temperature Range	$T_A$	-40	85	°C
Operating Junction Temperature Range	$T_J$	-40	125	°C
Storage Ambient Temperature Range	$T_{ST}$	-40	150	°C

**Note 1:** Devices are ESD sensitive. Handling precaution is recommended.

## 5.2 Recommended Operating Conditions

**Table 5-2: Recommended Operating Conditions**

Parameter	Symbol	Min	Max	Unit
V <sub>DD</sub> to GND input power supply voltage	V <sub>DD</sub>	3.14	3.46	V
V <sub>DD3A</sub> to GND	V <sub>DD3A</sub>	3.14	3.46	V
V <sub>DD3D</sub> to GND	V <sub>DD3D</sub>	3.14	3.46	V
V <sub>DDIO</sub> (3.3V) to GND	V <sub>DDIO</sub>	3.14	3.46	V
V <sub>DDIO</sub> (1.8V) to GND	V <sub>DDIO</sub>	1.7	1.9	V
V <sub>DD16</sub> to GND	V <sub>DD16</sub>	1.55	1.65	V
V <sub>GH</sub> to GND	V <sub>GH</sub>	23	32	V
V <sub>TX</sub> to GND	V <sub>TX</sub>	19	21	V
Operating Ambient Temperature Range	T <sub>A</sub>	-40	85	°C
Operating Junction Temperature Range	T <sub>J</sub>	-40	125	°C
Storage Ambient Temperature Range	T <sub>ST</sub>	-40	150	°C

**Note:** The device is not guaranteed to function outside its operating conditions.

### 5.3 DC Characteristics

**Table 5-3: Input Power Supply**

(VDD3A=VDD3D=3.3V, Room Temperature)

Item	Symbol	Min	Typ.	Max	Unit	Condition
Digital input power supply voltage*	V <sub>DD3D</sub>	3.14	3.3	3.46	V	
Analog input power supply voltage	V <sub>DD3A</sub>	3.14	3.3	3.46	V	
3.3V I/O input power supply voltage*	V <sub>DDIO</sub>	3.14	3.3	3.46	V	
1.8V I/O input power supply voltage*	V <sub>DDIO</sub>	1.7	1.8	1.9	V	

\*If VDDIO & VDD3D is not supplied power, there is risk of I/O pin with current leakage

**Table 5-4: DC Characteristics**

(VDD3A=VDD3D=3.3V, Room Temperature)

Item	Symbol	Min	Typ.	Max	Unit	Condition
Operation current	I <sub>op</sub>		100		mA	Active Mode / 21.5"
Input Low Voltage	V <sub>IL1</sub>	0		0.3V <sub>DDIO</sub>	V	
Input High Voltage	V <sub>IH1</sub>	0.6V <sub>DDIO</sub>		V <sub>DDIO</sub> +0.5	V	
Hysteresis voltage	V <sub>HY</sub>		0.2V <sub>DDIO</sub>		V	
Input Low Voltage, XT_In	V <sub>IL2</sub>	0		0.6	V	V <sub>DDIO</sub> =3.3V
Input High Voltage, XT_In	V <sub>IH2</sub>	2.6		V <sub>DDIO</sub> +0.2	V	V <sub>DDIO</sub> =3.3V
Negative going threshold, /Reset	V <sub>ILS</sub>	0		0.2V <sub>DDIO</sub>	V	
Positive going threshold, /Reset	V <sub>IHS</sub>	0.6V <sub>DDIO</sub>		V <sub>DDIO</sub> +0.5	V	
Output High Voltage	V <sub>OH</sub>	0.7V <sub>DDIO</sub>			V	V <sub>DDIO</sub> =3.3V, I <sub>OH</sub> =8mA
Output Low Voltage	V <sub>OL</sub>			0.3V <sub>DDIO</sub>	V	V <sub>DDIO</sub> =3.3V, I <sub>OL</sub> =10mA

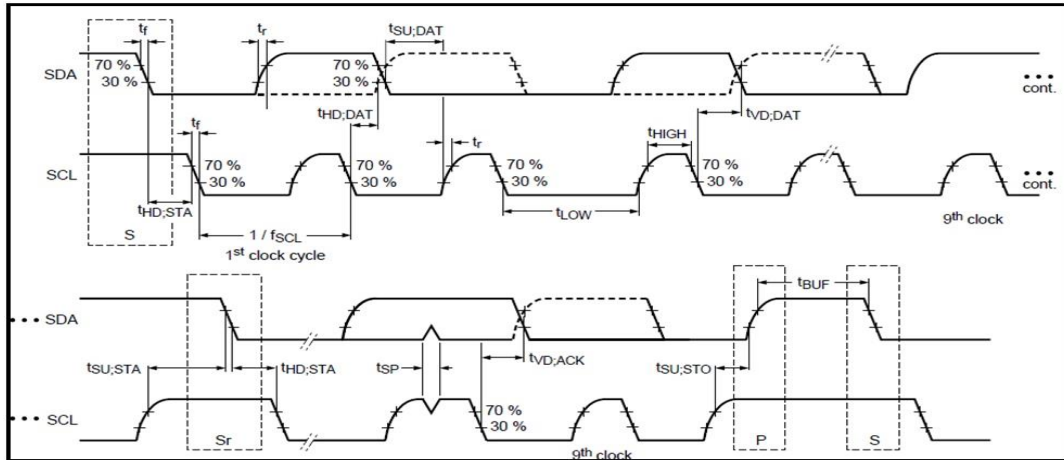
**Table 5-5: USB DC Characteristics**

Item	Symbol	Min	Typ.	Max	Unit	Condition
Input Low	$V_{IL}$			0.8	V	
Input High (driven)	$V_{IH}$	2.0			V	
Differential input sensitivity	$V_{DI}$	0.2			V	(D+) – (D-)
Differential common-mode range	$V_{CM}$	0.8		2.5	V	Includes $V_{DI}$ range
Single-ended receiver threshold	$V_{SE}$	0.8		2.0	V	
Receiver hysteresis	$V_{RH}$		200		mV	
Output low (driven)	$V_{OL}$	0		0.3	V	
Output high (driven)	$V_{OH}$	2.8		3.6	V	
Output signal cross voltage	$V_{CRS}$	1.3		2.0	V	
Pull-up resistor	$R_{PU}$	1.425		1.575	$k\Omega$	
Pull-down resistor	$R_{PD}$	14.25		15.75	$k\Omega$	
Termination Voltage for upstream port pull up (RPU)	$V_{TRM}$	3.0		3.6	V	

**Table 5-6: Crystal Characteristics**

Item	Symbol	Min	Typ.	Max	Unit	Condition
Input clock frequency	$f_{XIN}$		12		MHz	External crystal

### 5.4 I2C AC Characteristics



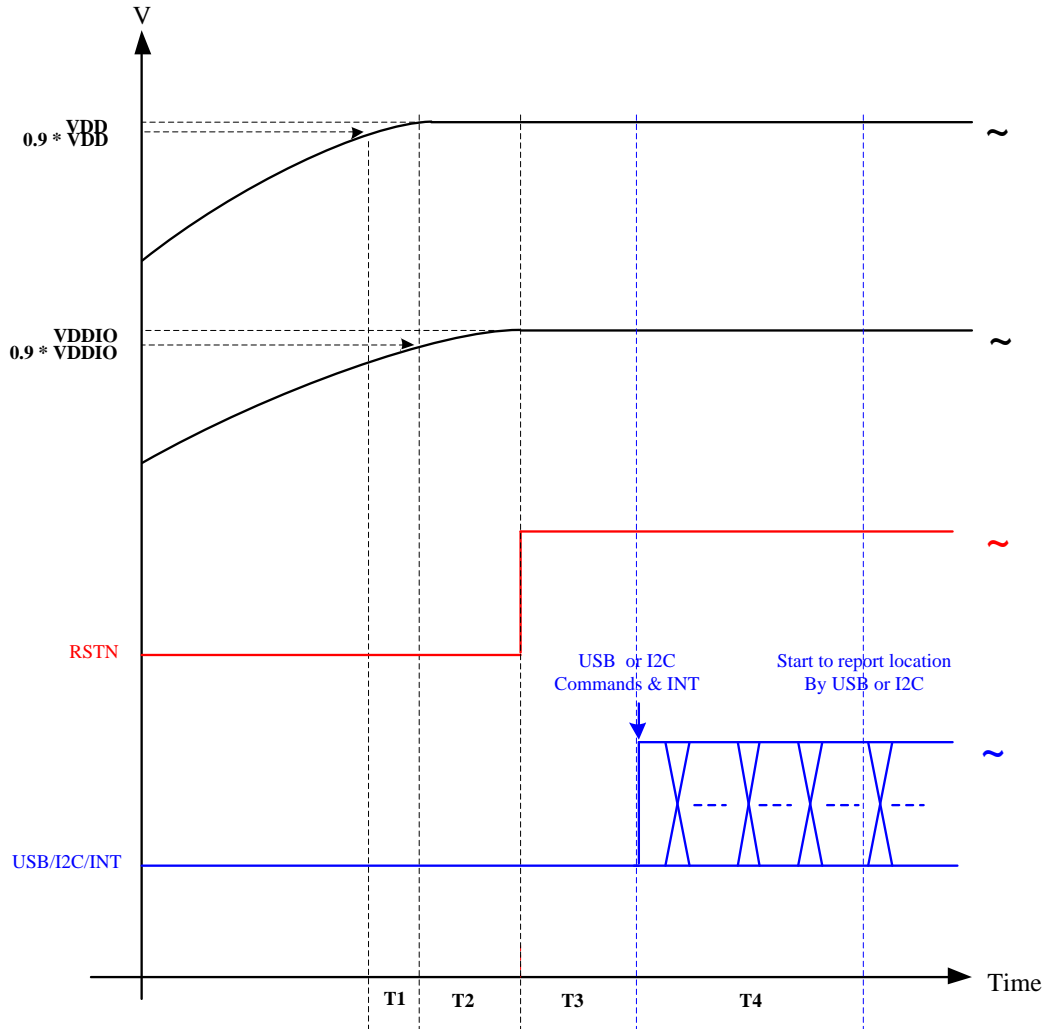
**Table 5-7: I2C DC Characteristics**

Parameter	Symbol	Standard-mode		Fast-mode		Unit
		Min	Max	Min	Max	
SCL clock frequency	$f_{SCL}$	0	100	0	400	kHz
Hold time START condition	$t_{HD;STA}$	4.0	-	0.6	-	us
LOW period of the SCL clock	$t_{Low}$	4.7	-	1.3	-	us
HIGH period of the SCL clock	$t_{High}$	4.0	-	0.6	-	us
Set-up time for a repeated START condition	$t_{SU;STA}$	4.7	-	0.6	-	us
Data hold time	$t_{HD;DAT}$	300	-	300	-	ns
Data set-up time	$t_{SU;DAT}$	250	-	100	-	ns
Rise time of both SDA and SCL signals (30% to 70%)	$t_r$	-	1000	20	300	ns
Fall time of both SDA and SCL signals (70% to 30%)	$t_f$	-	300	20	300	ns
Set-up time for STOP condition	$t_{SU;STO}$	4.0	-	0.6	-	us
Bus free time between a STOP and START condition	$t_{BUF}$	4.7	-	1.3	-	us
Capacitive load for each bus line	$C_b$	-	400	-	400	pF
Noise margin at the LOW level for each connected device	$V_{nL}$	$0.1V_{DD}$	-	$0.1V_{DD}$	-	V
Noise margin at the HIGH level for each connected device	$V_{nH}$	$0.2V_{DD}$	-	$0.2V_{DD}$	-	V

\*SCL = I2C Host must to support clock stretching mode for using 400 kHz.

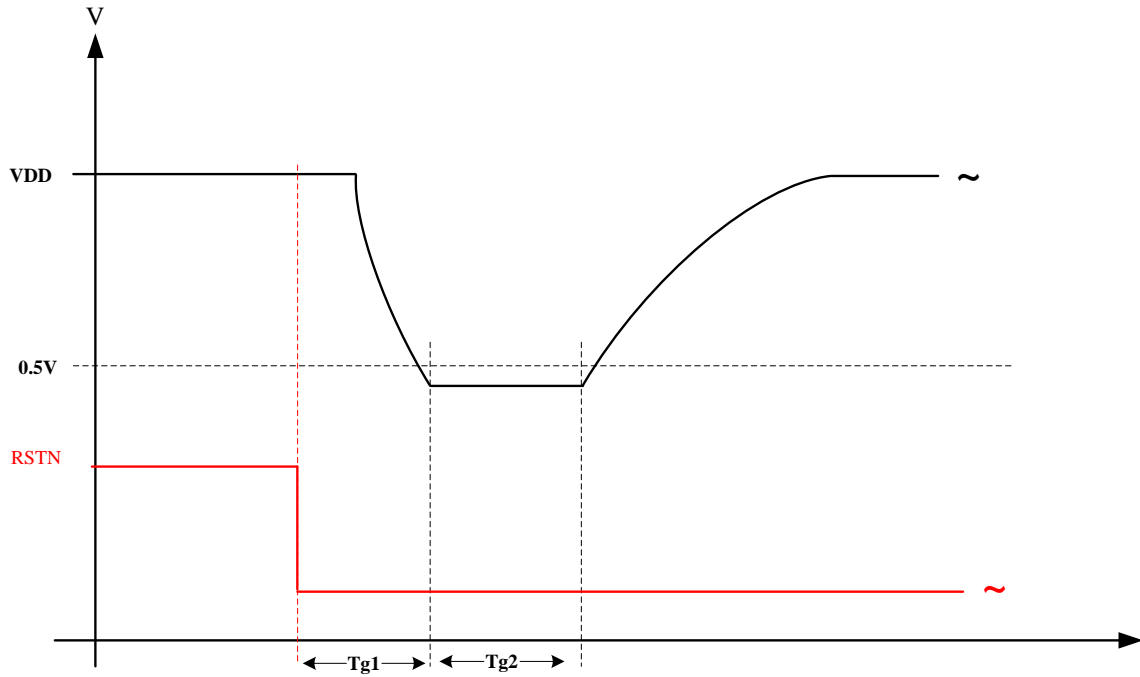
## 6. Power Sequence

### 6.1 Power-on Sequence



1. T1: the time difference between 0.9\*VDD and 0.9\*VDDIO. T1 must be  $\geq 0$  sec.
2. T2: the time difference between 0.9\*VDDIO and RSTN. T2 must be  $\geq 200$  us.
3. T3: the time difference between RSTN and Commands. T3 must be  $\geq 150$  ms.
4. T4: IC start to report point location to host. T4 must be  $\geq 300$  ms.

## 6.2 Power-off to Power-on Sequence



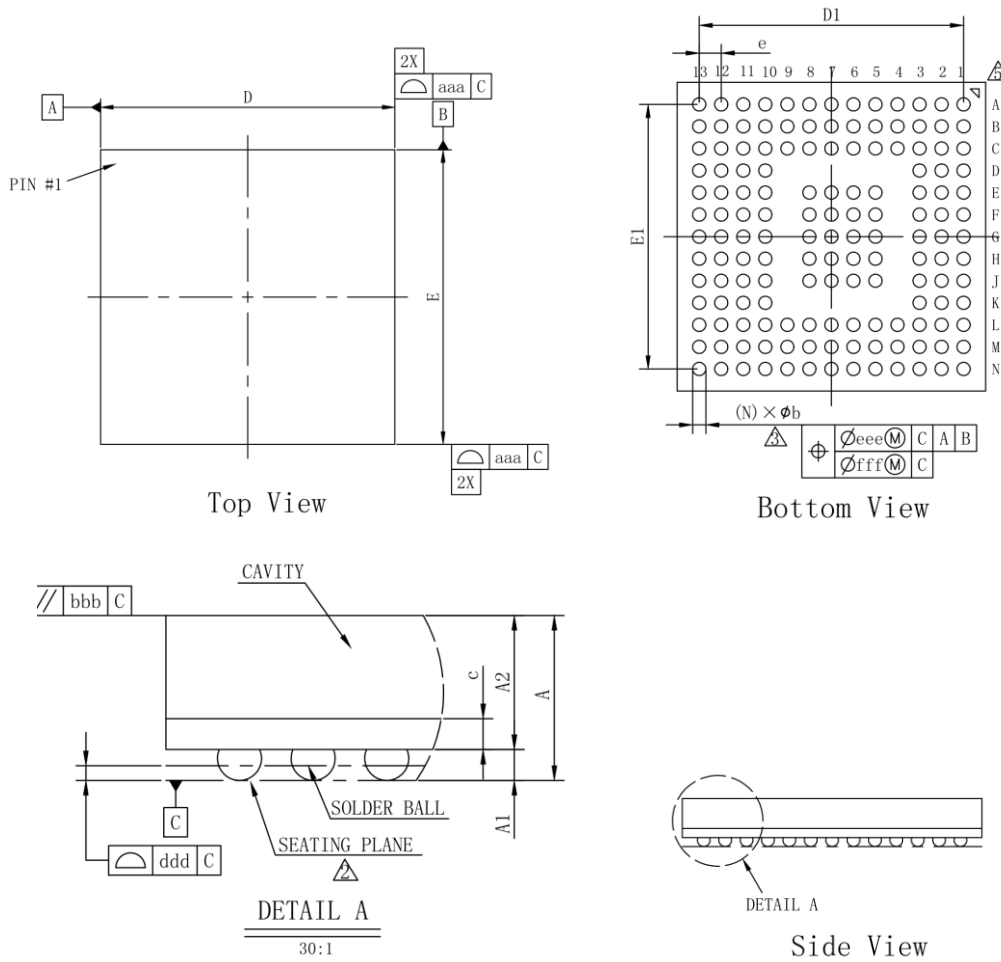
Tg1 : the time difference between power-off and power-on. Tg1 must be > 10us.

Tg2 : the time difference between power-off and power-on. Tg2 must be > 10us.

**Note.** During the power off time, the VDD must be lower than 0.5V that make sure the touch controller have been correctly reset.

## 7. Package Information

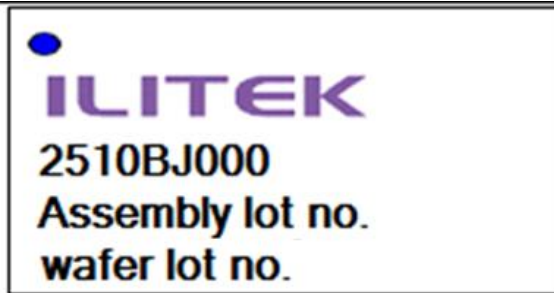
### 7.1 BGA-147 Package Dimension



symbol	Dimension in mm			Dimension in inch		
	MIN	NOM	MAX	MIN	NOM	MAX
A	---	---	1.220	---	---	0.048
A1	0.160	0.210	0.260	0.006	0.008	0.010
A2	0.860	0.910	0.960	0.034	0.036	0.038
c	0.170	0.210	0.250	0.007	0.008	0.010
D	6.900	7.000	7.100	0.272	0.276	0.280
E	6.900	7.000	7.100	0.272	0.276	0.280
D1	---	6.000	---	---	0.236	---
E1	---	6.000	---	---	0.236	---
e	---	0.500	---	---	0.020	---
b	0.250	0.300	0.350	0.010	0.012	0.014
aaa		0.100			0.004	
bbb		0.100			0.004	
ddd		0.080			0.003	
eee		0.150			0.006	
fff		0.050			0.002	
Ball Diam		0.300			0.012	
N		147			147	
MD/ME		13/13			13/13	

**Figure 7-1: Package Information of BGA-147**

## 7.2 Marking Information



Column 1: ILITEK Logo

Column 2: Product Code

Code 1~4: Model Name

Code 5: Package Type, B: BGA

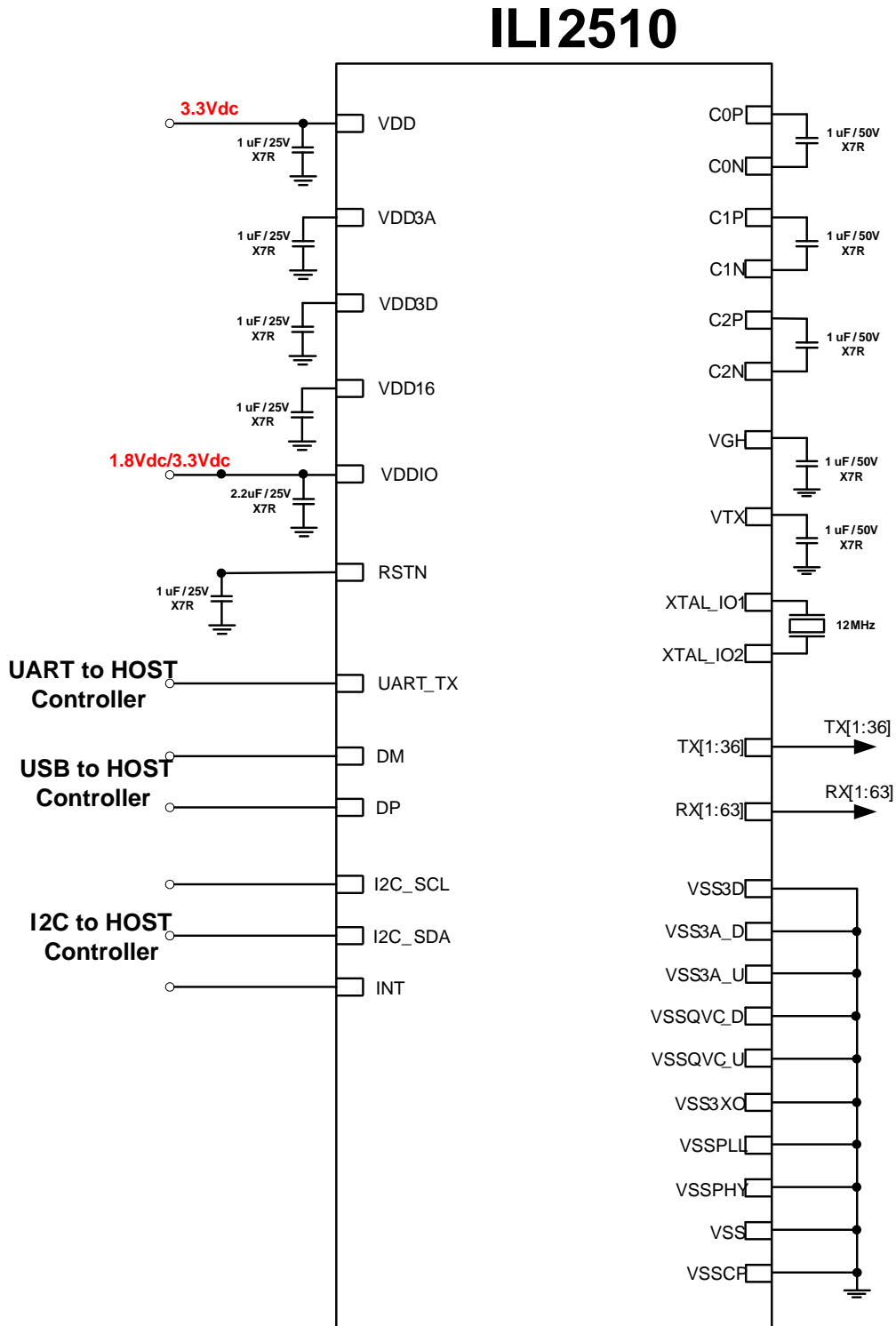
Code 6~9: Package Fab Control Number

Column 3: Package Assembly Lot No

Column 4: Wafer Lot No

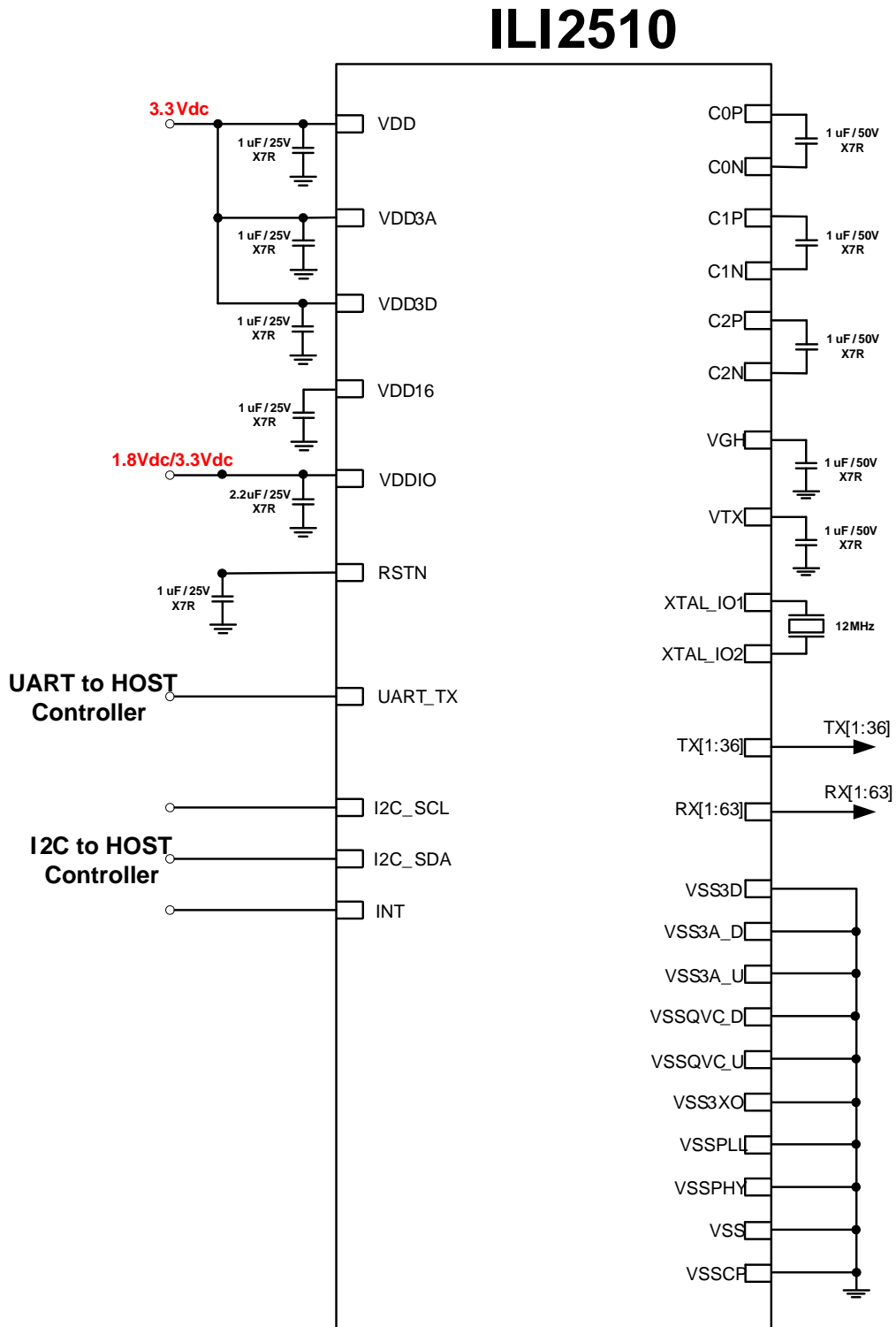
## 8. Typical Application Circuit

### 8.1 USB Application Circuit



**Figure 8-1: ILI2510 USB Application Circuit**

## 8.2 I2C Application Circuit



**Figure 8-2: ILI2510 I2C Application Circuit**