Datasheet for ChipsemiCHSC5816

Ver1.1.5

CHIPSEMI

CHIPSEMISEMICONDUCTOR

Features:

- Capacitive touch panel controller, highly integrated with analog transceivers and digital Processor (SOC)
- Support mutual-capacitance, self-capacitance, hybrid sense also with noise detect
- 16 programmable TRX pin, typical with (8 TX, 8 RX) channels or (4 TX,12 RX) channels, with displays size up to 2 inches,
- Report rate up to 250Hz
- Supports moisture detection
- Strong filtering for noise from AC charger/ common mode noise or LCD/OLED
- Low power consumption for battery application
- 32bits MCU and Software Developing Environment
- I2C interface to host
- In-system re-programmability(re-flash) support
- High ESD endurance :
  HBM>+-7KV
  CDM>+-1.5kV
- Supports advanced sensor/display architecture with:
  - On-cell metal mesh and ITO sensor designs
  -Curved lens designs
  -Sensor ITO pattern on lens
  - Touch controller IC on sensor Flexible Printed Circuit (FPC) tail
  - Touch controller IC on main board
  - Very narrow bezel sensor designs
  - Notched, trenched, or beveled sensors

Package: WLCSP 2.01mmx1.99mmx0.44mm；0.4mm ball pitch

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Revision History

Version	Major Changes	Date	Author
1.0.0	Initial release	2020/6	Yuan qiu chun
1.0.1	Initial release	2020/7	Yao guo
1.1.4	Initial release	2020/9	WX
1.1.5	Idle current	2020/10	WX

目录

一、Introduction

1.1. General description

CHSC5816 is highly integrated single-chip mutual-capacitive touch panel controller Soc developed by CHIPSEMI, which is designed to work with mutual-capacitance type sensor and supports user-friendly gesture control and up to two-point touch with a capacitive touch panel.

Single-chip CHSC5816 supports up to 2'' touch panel.

With built-in 32-bit RISC processor and CDSP module, the CHSC5816 is featured with outstanding noise immunity, fast response, low power consumption, excellent accuracy and linearity, as well as perfect waterproof performance.

CHSC5816, which operates in the -40℃~+85℃ industrial temperature range, can be applied to a diverse group of portable devices, such as cellular phones, tablets, and GPS navigator.

CHSC5816 offers high-volume-assembly and high integration level. Few external components are needed to satisfy customers' ultra-low cost requirement. It's completely RoHS-compliant and 100% lead (Pb)-free.

1.2. Key features

Table 1- 1 Key features of CHSC5816

Features	CHSC5816
Package	**WLCSP 2.01mmx1.99mmx0.44mm； 0.4mm ball pitch**
Touch sensor	G/G, G/F,P/F,OGS,Ultra-thin G/F, On cell **(Support ITO traces; support direct bonding; support frame-less TP)**
Touch panel size	2’’
Response time	Power-on time: <75ms; Latency time for first touch: <12ms. Scanning speed up to 250Hz
Operating voltage	2.6V~3.6V
Operating temperature	-40℃~+85℃
Supported channel number	16
Power consumption	Current-active: 2mA@200Hz FPS, 1.1mA@100Hz FPS Idle : type. 25uA@30Hz FPS, max. 32uA@30Hz FPS Wake up-key :Type. 24uA @100Hz, max. 28uA@100hz Sleep mode:<1uA
ESD/latch up	HBM 7000V (min.), CDM 1500V (min.),latch up 200mA(min.)
Multi-point touch	Up to 2points
Glove mode	Support
Anti-interference performance	Immune to noise from RF, LCD and power supply

1.3. Sensor pin characteristics

Table 1-2 sensor pin characteristics

Parameter	Symbol	Condition	Min	Type	Max	Unit
Mutual capacitance	Ct	Mutual capacitance Per node		1.5	4	pF
Self-capacitance	Cb	Self-capacitance Per TX or RX node		10	40	pF
RX impedance	Rs	trace +pattern resistance for RX sensor		20		Kohm
TX impedance	Rt			20		Kohm

Note1: For large self-capacitance, recommend combine with low TRX impedance.

Note2: For better performance, RC constant for TRX sensor is suggest below 500nS.

1.4. Key benefits

(1) Anti-Interference and excellent noise-cancellation performance:

Immune to RF interferences, robust operation in noisy RF environment;

Insensitive to capacitance and environmental variety via auto calibration function;

Chipsemi's innovative adaptive-noise-cancellation technology and specially designed data processing unit can detect and silence the two noise sources which capacitive touch screen usually suffers from: display noise and charger noise.

With the powerful 32bit MCU and specific built-in hardware, both the periodic and broadband noise can be eliminated to obtain unmatched noise immunity.

(2) Fast response time:

The power-on time for the CHSC5816 is less than 75ms;

When it is powered up, the latency time for first touch is less than 12ms;

Scanning rate up to250Hz makes fast response available, which is especially useful for the highly demanding applications for the responding speed, such as handwriting and game.

(3) Low power consumption:

The average current in typical case is 1.1mA@100Hz at active state,

25uA@30Hz at idle mode , and <1uA in deep sleep mode.

(4) Excellent waterproof performance:

Water mist even droplets the surface will not influence normal operation of touch panel based on the CHSC5816. When water mist or droplets are wiped off, the touch screen can also be operated normally without extra delays. No malfunction or dummy points will be reported during water spurting and wiping process.

二、Pin Information

2.1. Pin layout

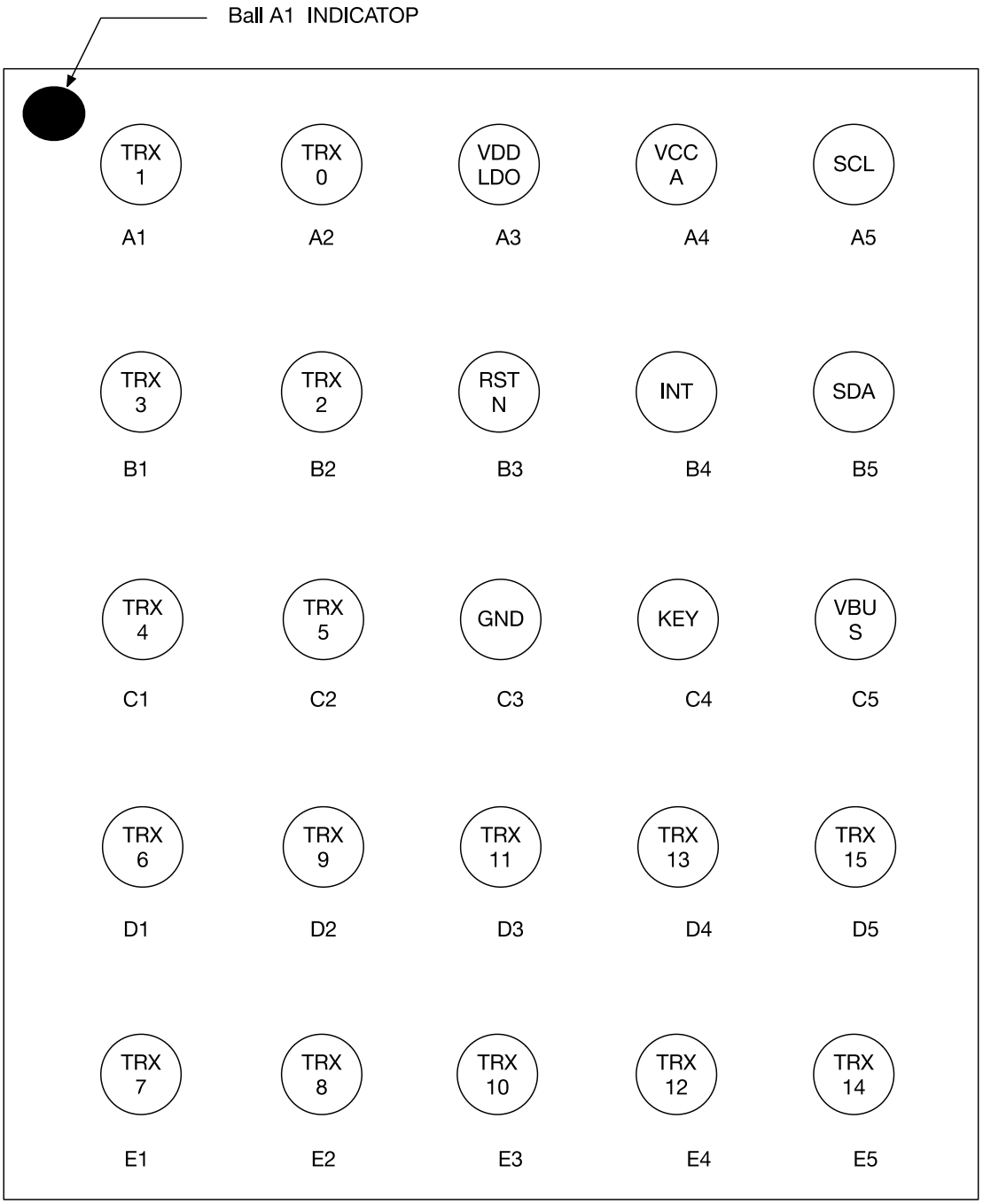


Figure 2-1 25 Ball WLCSP (TOP VIEW) assignments

2.2. Pin list

Table 2- 1 Pin functions for the CHSC5816

Pin Name	X	Y	Pin No.	Type	Description
TRX1	1795.39	1786.39	A1	I/O	Sense input ,Drive output
TRX0	1395.40	1786.39	A2	I/O	Sense input ,Drive output
VDDLDO	995.40	1786.39	A3	PWR	Digital power 1.2V supply, 1uF capacitor to ground is required.
VCCA	595.40	1786.39	A4	PWR	Chip power supply,2.6V or 3.6V. A 1uF ceramic capacitor to ground is required.
SCL	195.41	1786.39	A5	I	I2C clock
TRX3	1795.39	1386.40	B1	I/O	Sense input ,Drive output
TRX2	1395.40	1386.40	B2	I/O	Sense input ,Drive output
RSTN	995.40	1386.40	B3	I	Reset Pin, zero voltage active, A 0.1uF capacitor to ground is required.
INT	595.40	1386.40	B4	I/O	External interrupt to the host
SDA	195.41	1386.40	B5	I/O	I2C data
TRX4	1795.39	986.40	C1	I/O	Sense input ,Drive output
TRX5	1395.40	986.40	C2	I/O	Sense input ,Drive output
GND	995.40	986.40	C3	G	Ground
KEY	595.40	986.40	C4	I	Wake up key
VBUS	195.41	986.40	C5	PWR	Interface power, 1.8V or 3.6V. A 1uF ceramic capacitor to ground is required.
TRX6	1795.39	586.40	D1	I/O	Sense input ,Drive output
TRX9	1395.40	586.40	D2	I/O	Sense input ,Drive output
TRX11	995.40	586.40	D3	I/O	Sense input ,Drive output
TRX13	595.40	586.40	D4	I/O	Sense input ,Drive output
TRX15	195.41	586.40	D5	I/O	Sense input ,Drive output
TRX7	1795.39	186.41	E1	I/O	Sense input ,Drive output
TRX8	1395.40	186.41	E2	I/O	Sense input ,Drive output
TRX10	995.40	186.41	E3	I/O	Sense input ,Drive output
TRX12	595.40	186.41	E4	I/O	Sense input ,Drive output
TRX14	195.41	186.41	E5	I/O	Sense input ,Drive output

2.3. Absolute maxim rating & ESD

Table 2-2 Absolute maxim rating & ESD

VDD28 to GND	-0.3V to +3.6V
VDD18 to GND	-0.3V to +3.6V
VDD12 to GND	-0.3V to +1.32V
INT/SDA/SCL to GND	-0.3V to +3.6V
TRX0~TRX11 to GND	-0.3V to +3.6V
Maxim Power dissipation	250mW
Maxim Junction Temperature	150℃
Operating Temperature	-40℃ to 85 ℃
Storage Temperature	-60℃ to 150 ℃
HBM	+/-7000V (min.)
CDM	+/-1500V (min.)

三、System Description

3.1. Block diagram

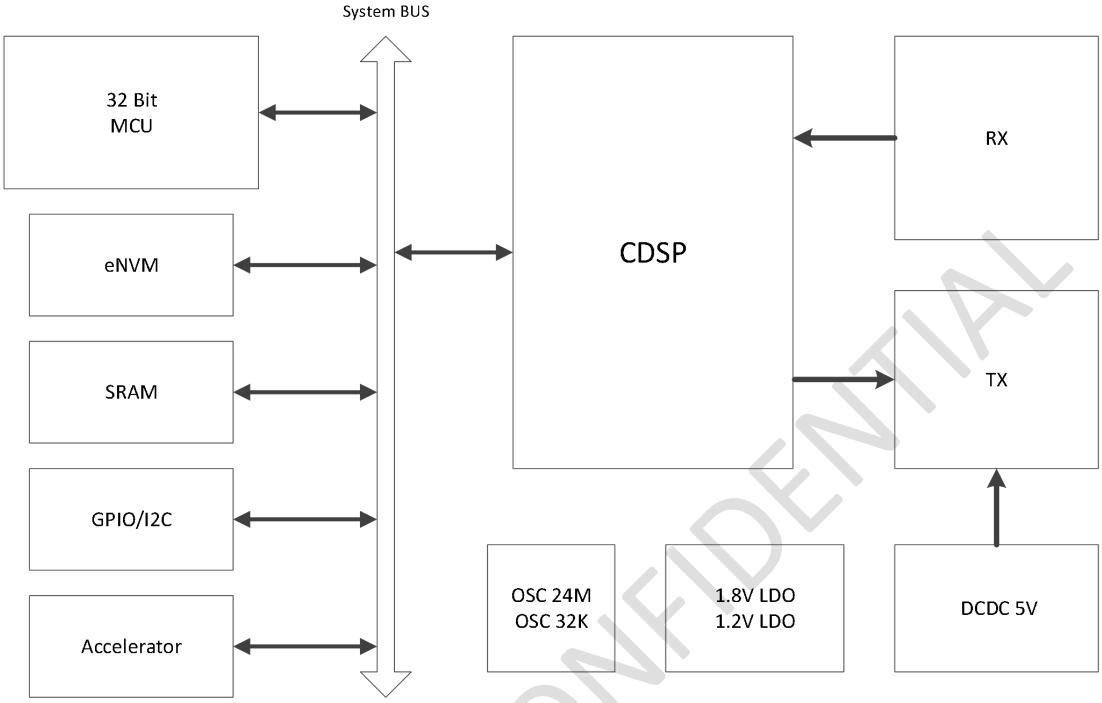


Figure 3-1 Block diagram

3.2. Block description

- **32bit MCU**

  CHSC5816 integrates a 32bit high performance, low Power CPU.

  It's Harvard structure CPU core, with a 32×32 multiplier and a 32/32 divider.

- **Memory**

  16KB RAM and 40KB MTP ROM.

- **GPIO/I2C interface**

  INT PIN can be used as GPIO for user define, also it can generate interrupt signal.

  SCL/SDA are I2C interface pins, open drain outputs.

- **Accelerator**

  Hardware accelerates CTP computing.

- **CDSP**

The CHSC5816 embeds CDSP.

The CDSP configures analog front-end parameters, control analog-to-digital conversion and channel switch for flexible scanning time and sensor usage. The collected sampling data from ADC will be stored into internal SRAM and will be translated into accurate touch position information using advanced algorithms.

The CDSP integrates four control modes: mutual capacitance detection, self capacitance detection, noise detection and short detection, also it has temperature following technique.

- **TRX0~15**

CHSC5816 has 16-TRX channels that can be programmed as sensing lines or driving lines.

CHSC5816 has 12 channels for CTP sensing. The RX module is capacitive sensing channels, it includes high performance capacitive-sense amplifier and ADC that makes the capacitor quantized.

CHSC5816 has 8 channels for CTP driving. The TX module is capacitive driving channels. TX generates ordered serial signals to drive mutual capacitance panel.

CHSC5816 supports up to 64 patterns in mutual capacitive screen used 8-tx & 8-rx. It also can support 16 patterns in self capacitive screen.(Although CHSC5816 has only 12 channels for CTP sensing, but the TRX channels are programmable, so it can scan twice to finish scanning the 16 patterns).

- **Oscillator**

The CHSC5816 embeds a 24MHz RC oscillator and 32K RC oscillator.

The 24M oscillator is the clock source for MCU and CTP driving, the oscillator clock has a wide adjustment; by tuning frequency, CTP will avoid the frequency of the noise interference. The 32K oscillator is the clock source for working mode conversion timer and watch-dog monitor.

- **Regulator**

The CHSC5816 embeds two groups LDO (Low Dropout) regulators to provide lower voltage power. One is for digital core supply, and the other one is for 1.8V IO driving. Each group has two LDOs, large current driving for active mode and weak current driving for suspend and sleep mode.

- **DCDC**

The DCDC generates high voltage over supply power for TX driving, higher voltage can provide higher dynamic range for RX sensing, gets better SNR. The DCDC is recommended setting to 3V.

3.3. Power management

The CHSC5816 is optimized for power consumption, inside the chip it embedded PMU (power management unit) to reduce power consumption at off working state. The CHSC5816 has three working states: active/idle/deep sleep mode.

Program would control the system enter suspend or deep sleep mode, and return to active mode by interrupt signal.

Table 3-1 CHSC5816 nominal power consumption

Operation mode	**Total current(VDD28)**
Active	1.1mA@100Hz
Idle	Type:25uA@30Hz，max:32uA@30Hz
Wake up-key	Type:24uA@100Hz，max:28uA@100Hz
Sleep	<1uA

Note: the power consumption only show as reference. actual power consumption depend on system design requirement and the real application case.

3.4. Chip operation modes

For the CHSC5816, there are three operation modes available as follows: active mode, idle mode and deep sleep mode.

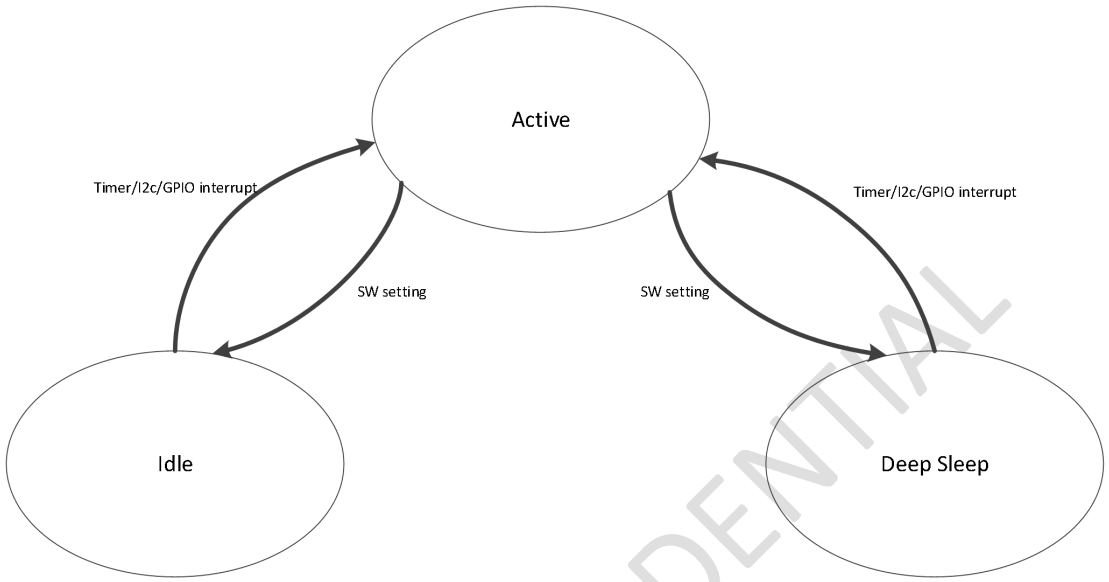


Figure 3-2 Operation mode conversion

- **Active mode**

Active mode, all module will power on, the system work at full speed with high frame report rate.

- **Idle mode**

At this mode, system detect the touch event with fast response ability, Once Touch event is detected, the system recover to active mode. The responding time can be program from 10mS~100mS by firmware.

- **Deep Sleep mode**

At deep sleep mode, the CHSC5816 will power down MCU and CTP functions and provide minimum current maintain necessary state without loss. At this mode, the CHSC5816 will consume less then 1uA current at 2.8V power supply.

I2C, INT, or inner timer can be used to wake up the system.

四、CTP function

The CTP is the core of capacitance detection, with high accuracy analog front end (RX, TX) and powerful computation of CDSP. The CTP provides mutual capacitance detection, self capacitance detection, noise detection and short detection mode. Also the CTP has temperature following technology to fit temperature variation.

4.1. Mutual capacitance mode

At mutual capacitance detection mode, the TX module outputs pulse signal, and the RX module receive it via mutual capacitance on the panel. When user touches the screen, mutual capacitance will increase, the CTP will detect capacitance changing, and mark it as contract.

Mutual capacitance detection supports large range up to 4pF, it has enough sensitive circuit to ensure the detection accuracy. It also integrate smooth filter to reduce random noise.

4.2. Self capacitance mode

CHSC5816 has high performance self -cap detect technique, the self cap detect with 4 sub-mode can adaptive numerous application, with strong noise immunity and high sensitivity. Also can support large self -capacitance range

4.3. Noise detection

The CTP can scan large frequency range and get noise power density of touch screen, and then system can choose a working frequency with less noise.

4.4 Short detection

At short detection mode, the CTP will sense the resistance of RX Pin, and it is very helpful to factory production.

五、Communication interface

5.1. I2C communication description

I2C module of the CHSC5816 acts as slave. Its related registers are as follows:

Be default, I2C Master can read any internal register and RAM space of the CHSC5816 via I2C.

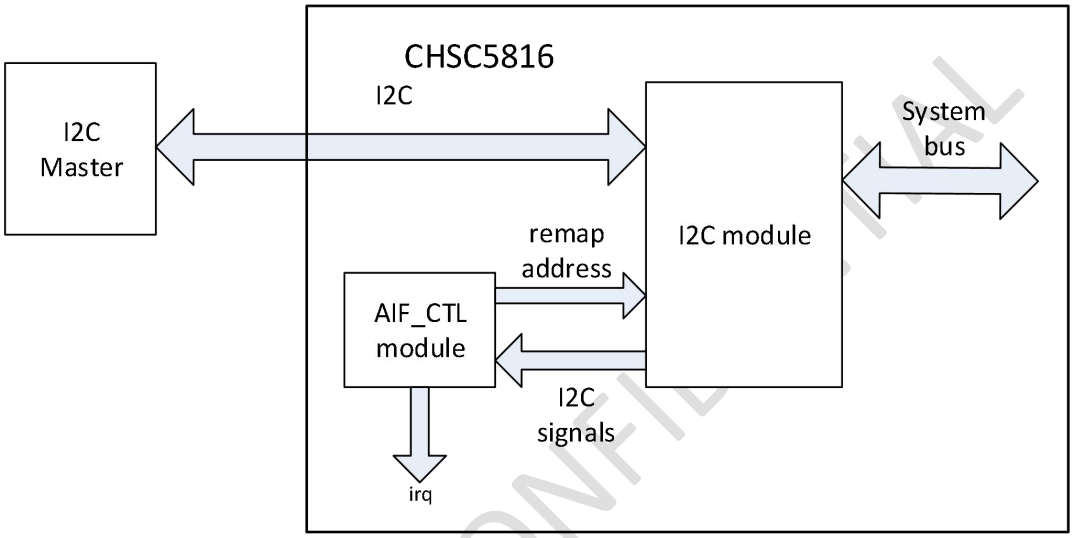


Figure 5-1 Connection schematic between I2C and AIF_CTL module

The AIF_CTL module embedded in the CHSC5816 serves to implement I2C address mapping, and provide command register to generate interrupt signal for I2C communication.

5.2 I2C timing

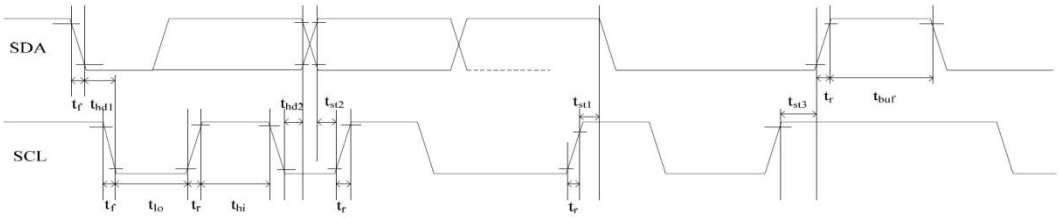


Figure 5-2 I2C timing sequence

Table 5-1 I2C timing parameter

parameter	symbol	MIN	MAX	unit
SCL low period	t_{lo}	1.3		us
SCL high period	t_{hi}	0.6		us
SCL setup time for START condition	t_{st1}	0.6		us
SCL setup time for STOP condition	t_{st3}	0.6		us
SCL hold time for START condition	t_{hd1}	0.6		us
SDA setup time	t_{st2}	0.1		us
SDA hold time	t_{hd2}	0		us

5.3 AC characteristics

Table5-2 AC Characteristics

Parameter	Sym.	Min	Typ.	Max	Unit	Condition
Digital inputs/outputs						
IO voltage(*)	VDDIO	1.6	1.8	2	V	
IO voltage(**)	VDDIO	3.0	3.3	3.6	V	
Input high voltage	VIH	0.7VDDIO		VDDIO	V	
Input low voltage	VIL	VSS		0.3VDDIO	V	
Output high voltage	VOH	VDDIO-0.3		VDD	V	
Output low voltage	VOL	VSS		0.3	V	

(*)VDDIO = 1.8V @ VDD28 = 2.8V

(*)VDDIO =1.8V/3.3V @ VDD28=3.3V

六、Power on reset sequence

Reset should be pulled down to be low before powering on and powering down. I2C shouldn't be used by other devices during Reset time after VDD powering on (Trtp). INT signal will be sent to the host after ini- tializing all parameters and then start to report points to the host. If Power is down, the voltage of supply must be below 0.3V and Tpdt is more than 1ms.

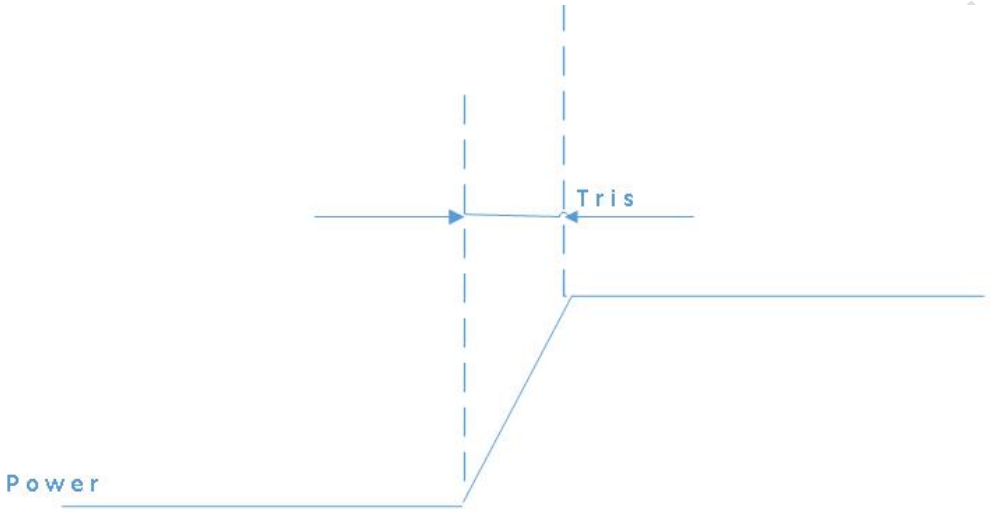


Figure 6-1 power on time

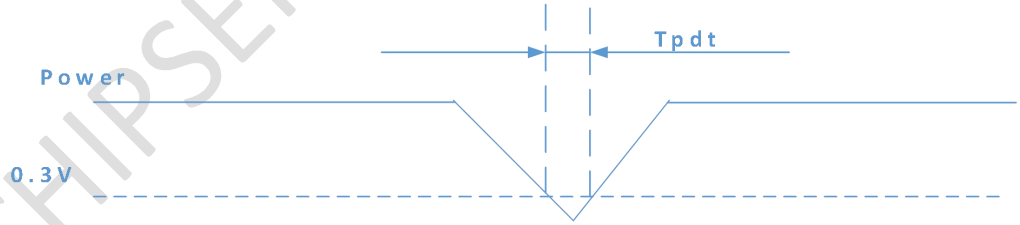


Figure 6-2 Power Cycle requirement

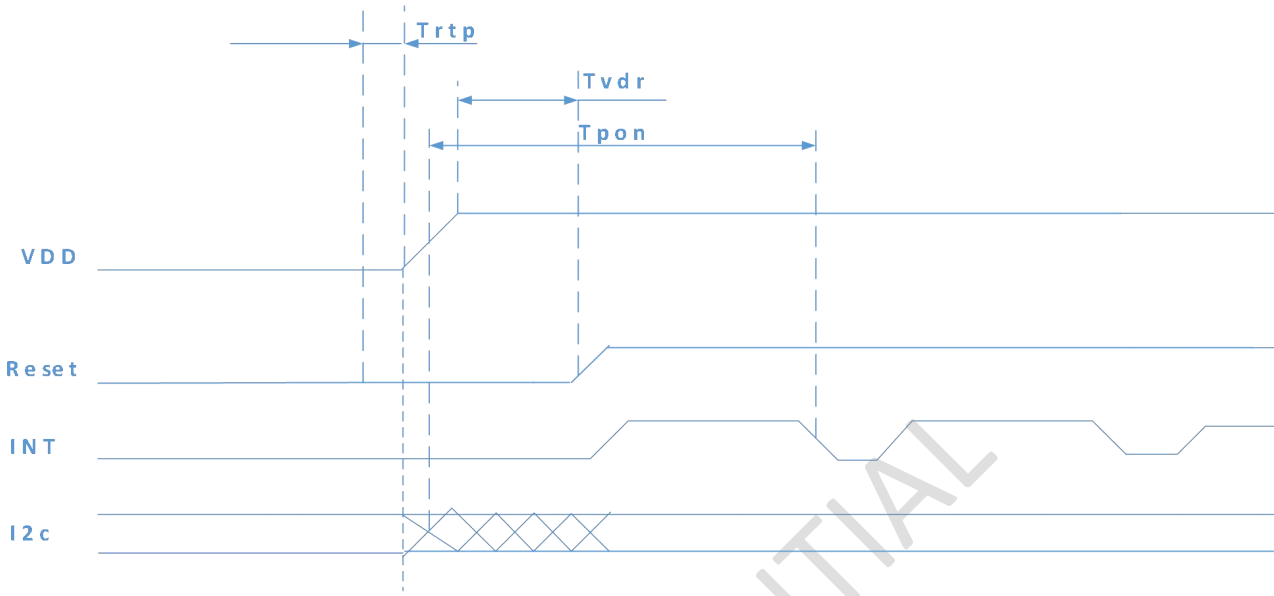


Figure 6-3 Power on Sequence

Reset time must be enough to guarantee reliable reset, the time of starting to report point after resetting approach to the time of starting to report point after powering on.

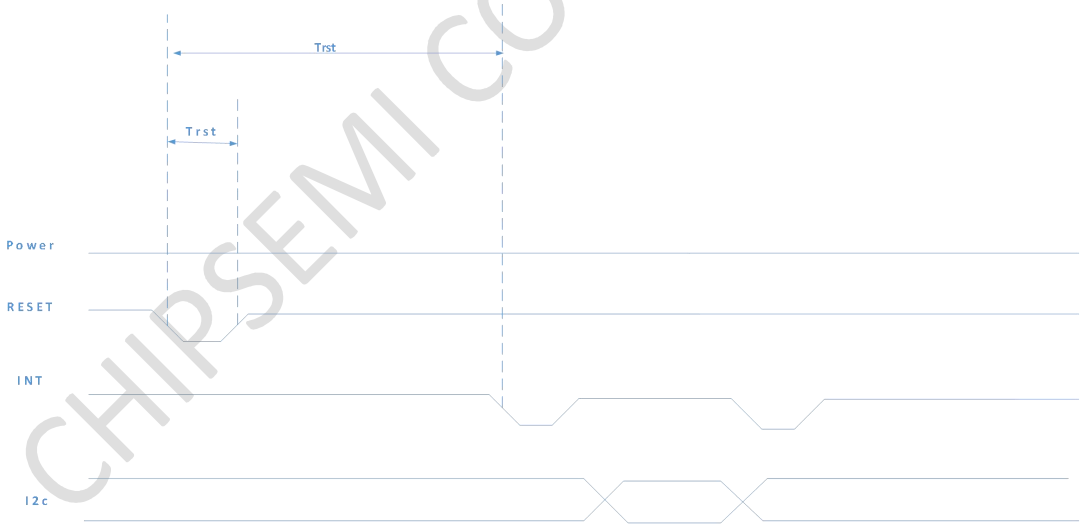


Figure 6-4 Reset Sequence

Table 6-1 Power on/Reset Sequence Parameters

Parameter	Description	Min	Max	Units
Tris	Rise time from 0.1VDD to 0.9VDD	--	5	ms
Tpdt	Time of the voltage of supply being below 0.3V	2	--	ms
Trtp	Time of resetting to be low before powering on	100	--	μs
Tpon	Time of starting to report point after powering on	--	200	ms
Tvdr	Reset time after VDD powering on	1	--	ms
Trsi	Time of starting to report point after resetting	--	200	ms
Trst	Reset time	500	--	us

七、System application guide

The CHSC5816 supply voltage can use 2.8V or 3.3V, support 1.8V or 3.3V IO voltage to system. This circuit has a 1.8V LDO internally, user can use it to pull up I2C resister or not.

If VDD18 pin connect to VDD28, the 1.8V LDO will be disabled automatically.

7.1. Application

There are two applications for connections.

Application 1: VCCA = 2.8V/3.3V, I2C communication voltage = VBUS

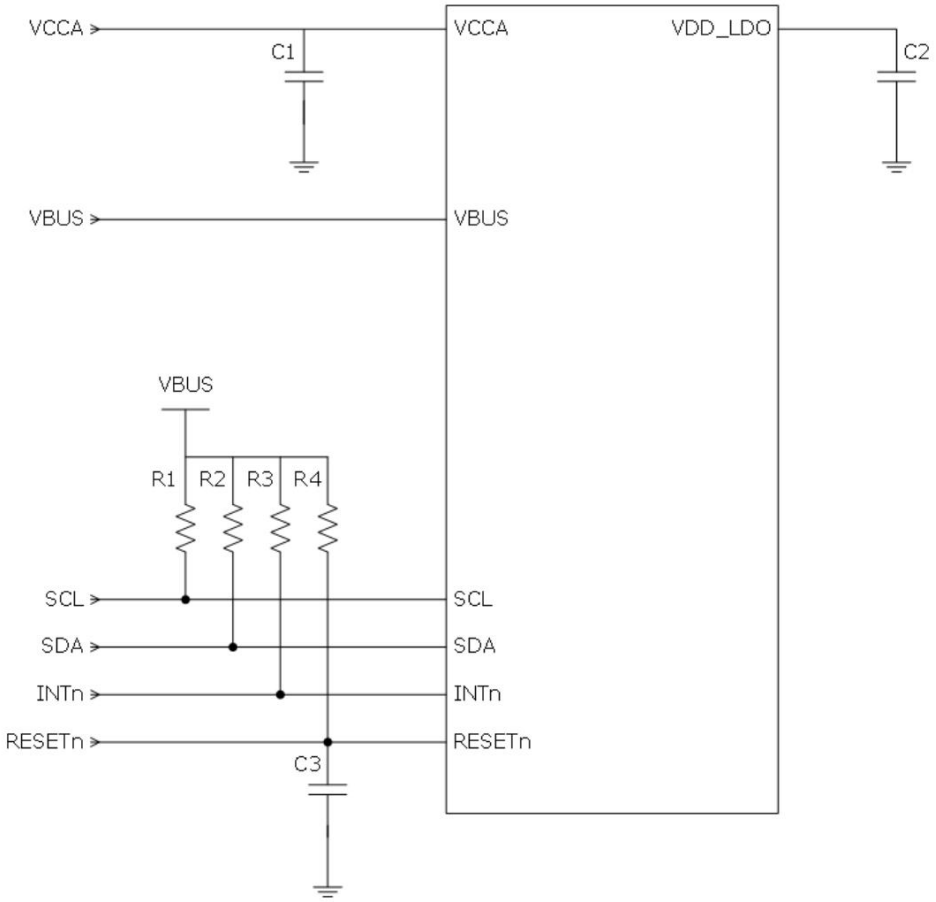


Figure 7-1 I2C host interface

Note : the C3 at RSTN pin can be removed if no serious noise couple to RSTN pin.

Application 2: VCCA = 2.8V/3.3V

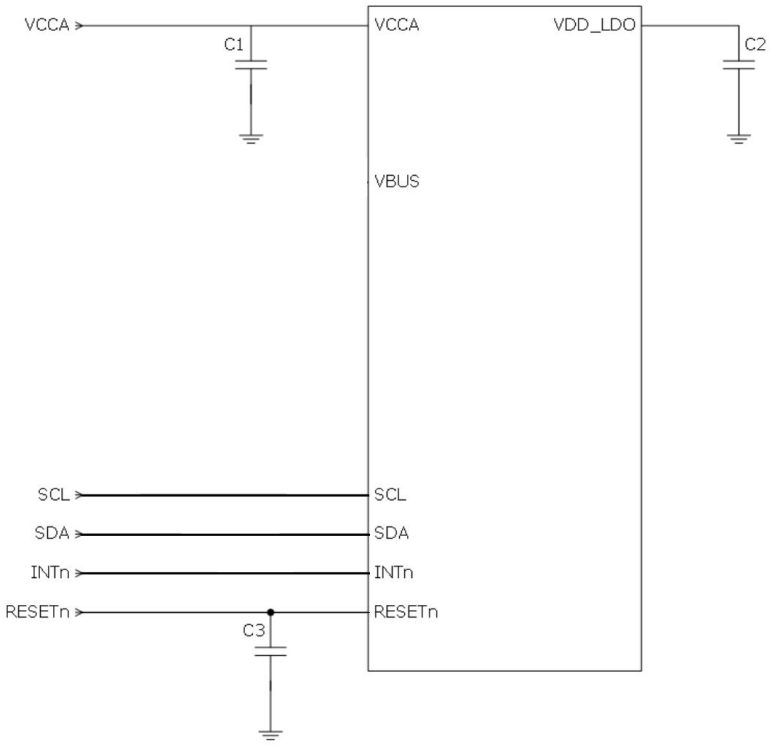


Figure 7-2 I2C host interface

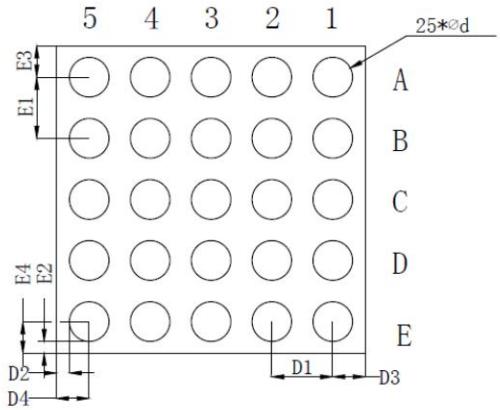
Note : the C3 at RSTN pin can be removed if no serious noise couple to RSTN pin.

7.2. Package information

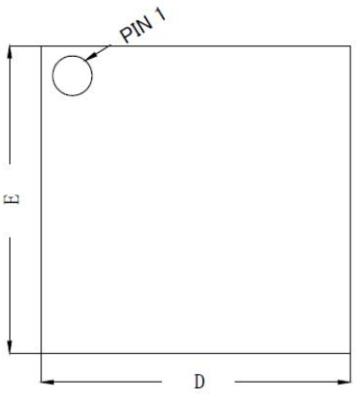
Figure 7-3 Package top view and side view

Table1: Package Dimension

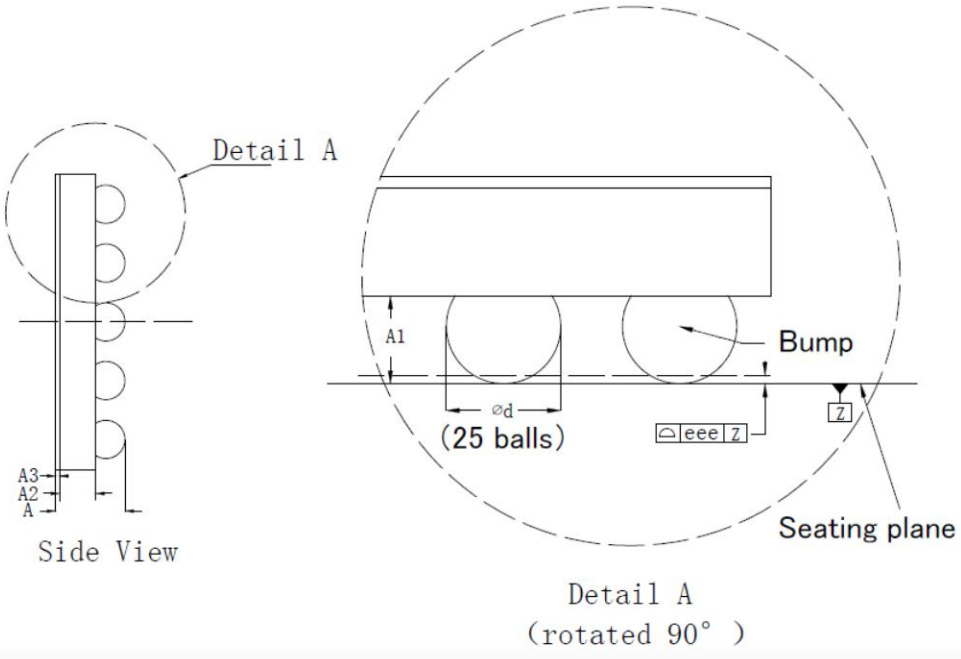
Parameter	Symbol	Nominal	Min	Max	NOTE
		Millimeters			
Package Body Dimension X	D	2.0308	2.0108	2.0508	±0.020
Package Body Dimension Y	E	2.0128	1.9928	2.0328	±0.020
Package Height	A	0.470	0.440	0.500	±0.030
Solder Bump Height	A1	0.200	0.180	0.220	±0.020
Si thickness	A2	0.245	0.2325	0.2575	±0.0125
BC thickness	A3	0.025	0.020	0.030	±0.005
Solder Bump Diameter	d	0.260	0.240	0.280	±0.020
Coplanarity	eee	0.020			/
Ball Pitch X axis (min.)	D1	0.400			/
Ball Pitch Y axis (min.)	E1	0.400			/
Ball edge to die edge	D2	0.08541			/
Ball edge to die edge	E2	0.07641			/
Ball center to die edge	D3	0.21541			/
Ball center to die edge	E3	0.20641			/
Ball center to die edge	D4	0.21541			/
Ball center to die edge	E4	0.20641			/



Bottom View(Bump side up)



Top View(Bump side down)



Side View

Detail A
(rotated 90°)

NOTES

1.REFER TO JEDEC MO-220;
2.COPLANARITY APPLIES TO LEADS, CORNER LEADS AND DIE ATTACH PAD;
3.BAN TO USE THE LEVEL 1 ENVIRONMENT-RELATED SUBSTANCES;
4.FINISH: Cu/EP •Sn8~20s

Table 7-1 Ordering information of the CHSC5816

Product Series	Package Type	Temperature Range	Product Part No.	Packing Method	Ordering Number	Minimum Order Quantity
CHSC5816	25-pin WLCSP: 2.01x1.99x0.44 mm	-40℃ ~+85℃	CHSC5816	TR	CHSC5816R	3000

*Note: Packing method “TR” means tape and reel.