GSL6186LMSCM1

DATASHEET

Contents

1 FEATURES

Fingerprint Collection

- High Sensitivity, High SNR, High quality image. 256 true gray scale values, 8 bits per pixel.
- Support Standard SPI Bus Interface.
- Resolution：508 DPI（Dot Per Inch）

Fingerprint Identification

- Adaptive Calibration: automatically adjusts the sensor configuration according to the different types of fingerprints.
- Adaptive for many kinds of algorithm include finger pattern and feature points.
- obtain high-resolution fingerprint images without metal rings
- it can quickly wake up the cold screen when the whole machine is dormant

Electrical Properties

- Supply Voltage：2.8V~3.6V
- Power Consumption：

  Active Mode: 45mA (Typically)

  Idle Mode (Before awaken)： 0.5mA (Typically)

  Sleep Mode：0.48mA (Typically)

Reliability

- Sensor ESD Performance[1]
  - Air discharge：± 15.0 kV
  - Direct discharge：± 8.0 kV
- Sensor Latch-upPerformance：±400.0mA

[1] Parameter（Air discharge）is correlation with module craft，see also chapter 4.5；

2 GSL6186LMSCM1 Introduction

GSL6186LMSCM1 is a full-board fingerprint recognition sensor chip packaged with the LGA.A full board package (GSL6186LMSCM1) can cut out a single fingerprint identification chip. According to their actual needs, customers can cut the whole plate fingerprint sensor chip into a single fingerprint chip of any size within the allowed range of free cutting, so as to meet the increasingly diverse needs.

GSL6186LMSCM1 pressing fingerprint solution is implemented in the form of active capacitance. The principle is to use semiconductor capacitance array to inductively measure the capacitance change of each pixel. Each pixel is a capacitive electrode.

GSL6186LMSCM1 is highly sensitive, leaving enough space for the protective layer of the chip to effectively protect the chip from mechanical, physical and chemical damage and extend the service life of the entire module.

GSL6186LMSCM1 is a planar structure with a medium fingerprint acquisition area and adaptive capability. Software and algorithms can automatically adjust the chip configuration according to different types of fingers to optimize the original fingerprint collection. Subsequent image processing will further optimize the fingerprint image and greatly improve the fingerprint identification rate and accuracy. Fingerprint recognition algorithm is efficient, occupies less CPU resources, high recognition rate, can cover a wide range of people.

GSL6186LMSCM1 is characterized by simple structure, ultra-low power consumption and platform wildcard. Simple structure is conducive to mobile phone, tablet and other mobile terminal ID design; Its press-type induction mode enables users to complete the whole recognition process by placing their finger gently. Identification accuracy up to 508 DPI; The integrated circuit design using ultra-low power consumption meets the needs of mobile terminals; Wildcard mainstream platform solution.

GSL6186LMSCM1 Fingerprint Sensor Crucial Parameters		
AA (Active Area)	4.0×3.2	mm
Pixel Array	80×64	Pixel
Resolution	508	DPI
Grayscale	256	Level
Bezel	Unnecessary	
Coating	≤45	μm

3 Hardware Description

3.1 Fingerprint Sensor Architecture Diagram

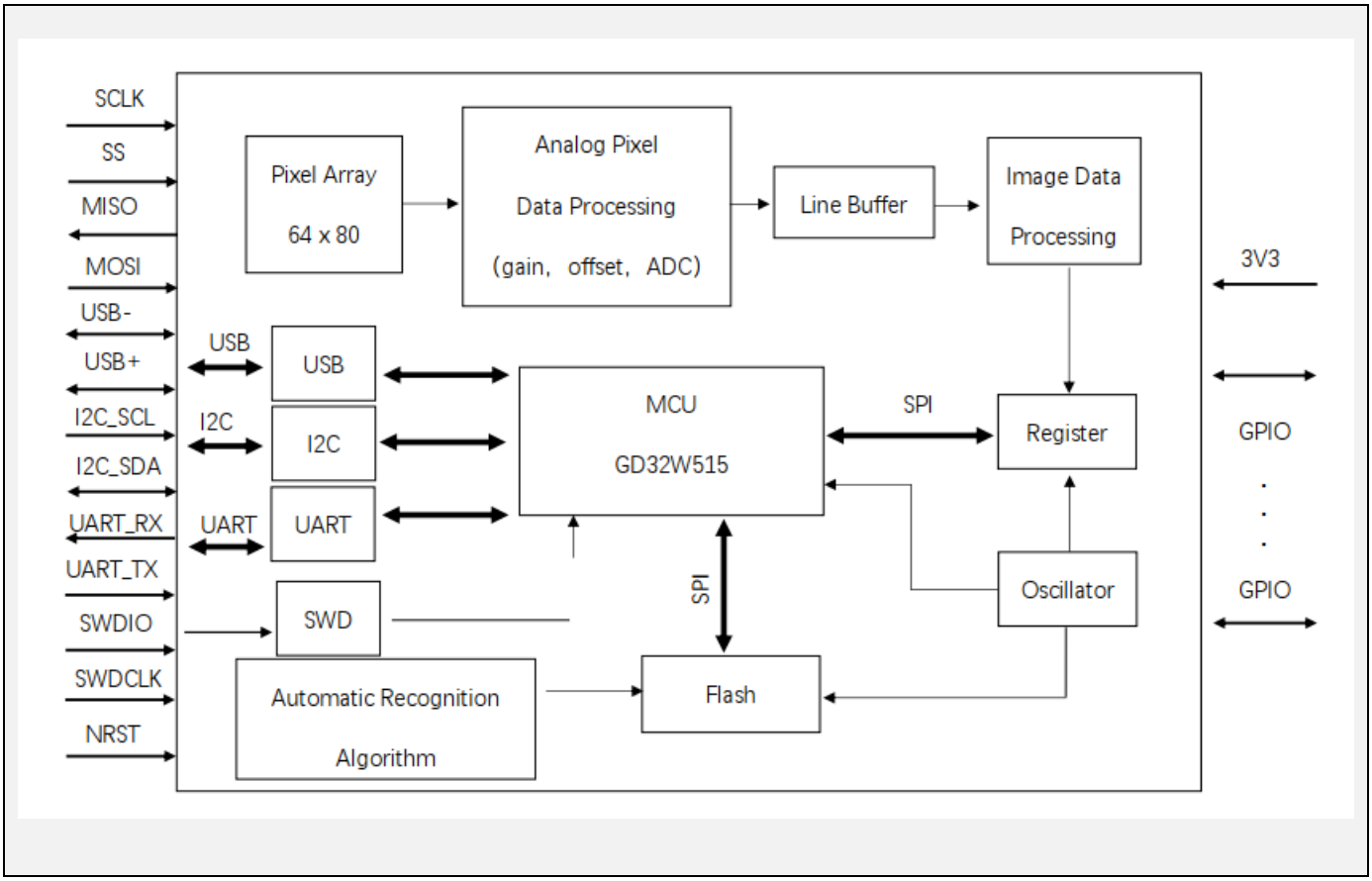
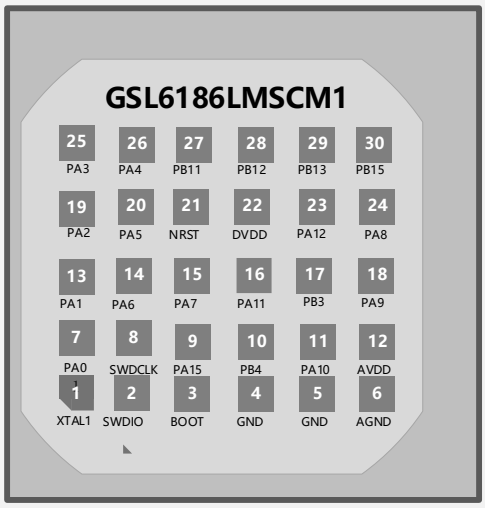


Figure.3.1 Sensor Architecture

3.2 Pin Define



PKG – **LGA**30

GSL6186LMSCM1 Sensor Package Pad Define		
Pad Type	**Description**	
I	Input Only	
O	Output Only	
I/O	Level: 2.8V-3.6V	
A	Analog	
P	Power or Ground	

Num.	Pad Name	Pad Type	I/O Level	Pad Description	Num.	Pad Name	Pad Type	I/O Level	Pad Description
1	XTAL1	AI		XTAL1	**16**	PA11	**I/O**	2.8V-3.6V	USBFS_ID/USART2_RX
2	SWDIO	**I/O**	2.8V-3.6V	SWDIO	**17**	PB3	**I/O**	2.8V-3.6V	SPI0_SCK/USART0_RX
3	BOOT	**I/O**	2.8V-3.6V	I2C0_SDA/USART0_TX/I2C1_SDA	**18**	PA9	**I/O**	2.8V-3.6V	SPI0_MOSI/SPI1_SCK/USART0_TX
4	GND	**P**	-	Ground	**19**	PA2	**I/O**	2.8V-3.6V	USART1_TX
5	GND	**P**	-	Ground	**20**	PA5	**I/O**	2.8V-3.6V	SPI0_MISO/USART1_RX/SPI0_SCK
6	AGND	**P**	-	Ground	**21**	NRST	**I/O**	2.8V-3.6V	NRST
7	PA0	**I/O**	2.8V-3.6V	USART0_TX	**22**	DVDD	**P**	2.8V-3.6V	Power Source
8	SWDCLK	**I/O**	2.8V-3.6V	SWDCLK	**23**	PA12	**I/O**	2.8V-3.6V	SPI0_NSS
9	PA15	**I/O**	2.8V-3.6V	JTDI/PA15/I2C0_SCL/USART0_RX/I2C1_SCL/SPI0_NSS	**24**	PA8	**I/O**	2.8V-3.6V	USART1_RX/USART0_RX/I2C0_SDA/I2C1_SDA/USBFS_SOF
10	PB4	**I/O**	2.8V-3.6V	NJTRST/SPI0_MISO	**25**	PA3	**I/O**	2.8V-3.6V	USART1_RX
11	PA10	**I/O**	2.8V-3.6V	SPI0_MISO	**26**	PA4	**I/O**	2.8V-3.6V	SPI0_MOSI/USART1_TX/SPI0_NSS
12	AVDD	**P**	2.8V-3.6V	Power Source	**27**	PB11	**I/O**	2.8V-3.6V	USBFS_ID/USART2_RX
13	PA1	**I/O**	2.8V-3.6V	USART0_RX	**28**	PB12	**I/O**	2.8V-3.6V	USBFS_DP
14	PA6	**I/O**	2.8V-3.6V	SPI0_SCK/SPI0_MISO	**29**	PB13	**I/O**	2.8V-3.6V	USBFS_DM/SPI1_SCK
15	PA7	**I/O**	2.8V-3.6V	SPI1_NSS/SPI0_NSS/USART2_RX	**30**	PB15	**I/O**	2.8V-3.6V	USART1_TX/USART0_TX/I2C0_SCL/I2C1_SCL/SPI1_MOSI

4 Sensor Operating Principle

4.1 Power-on and Reset

GSL6186LMSCM1 is available on a single power supply, ranging from 2.8v to 3.6v. GSL6186LMSCM1 has an on-chip reset (POR) circuit. GSL6186LMSCM1 also has a Shutdown pin. The Shutdown pin is set low at least 100ns and the device returns to the reset state. After releasing Shutdown, GSL6186LMSCM1 goes into normal mode. The Shutdown pin should be connected to the GPIO pin of the host. Pulling the pin down and then pulling it up again indicates that hardware reset has been completed. The Shutdown pin cannot be suspended.

4.2 SPI Interface

4.2.1 Pin Notes

Table.4.2.1 Detail Description about Pins

Pin Notes			
Interface	**Function and Performance**	**Default**	**I/O Property**
SS	**CHIP SELECT**: Asserting the SS pin selects the device. When the SS pin is deasserted, the device will be deselected. When the device is deselected, data will not be accepted on the MOSI pin. A high-to-low transition on the SS pin is required to start an operation, and a low-to-high transition is required to end an operation.	**High**	**Input**
SCLK	**SERIAL CLOCK**: This pin is used to provide a clock to the device and is used to control the flow of data to and from the device.		**Input**
MOSI	**SERIAL INPUT**: The MOSI pin is used to shift data into the device. The MOSI pin is used for all data input including command and address sequences.		**Input**
MISO	**SERIAL OUTPUT**: The MISO pin is used to shift data out from the device.		**Output**
IRQ	**INTERRUPT SIGNAL**: This pin is used to indicate a new frame's generation. An appropriate configuration thorough SPI can drive down IRQ pin.	**Low**	**Output**
SHUTDOWN	**SHTD SIGNAL**: This pin used as standby signal for whole chip. Chip sleep in a low power mode when Shutdown was pull down. Re-configuration for chip is necessary if this pin have been pull high after pull down.	**High**	**Input**

4.2.2 SPI Communication

A valid instruction or operation must always be started by first deasserting the SS pin. After the SS pin has been deasserted, the SPI Master must then clock in a valid 8-bit address on the SPI bus.

Following the address, an 8-bits instruction include write/read information following the 8bits address. The number of bytes after address and instruction can be 0 to N. (N is positive integer). Data latch from MISO was known as read data. Data latch from MOSI was known as write data. All address, Instruction, and data bytes was transferred with the least significant bit (LSB) first. An operation is ended by deasserting the SS pin.

SPI bus support multiple operating modes from “Mode0” to “Mode3”, and these modes are configurable. Except that, LSB (Last Significant Bit) and MSB (Most Significant Bit) also can be configured. The default mode is “Mode0”.

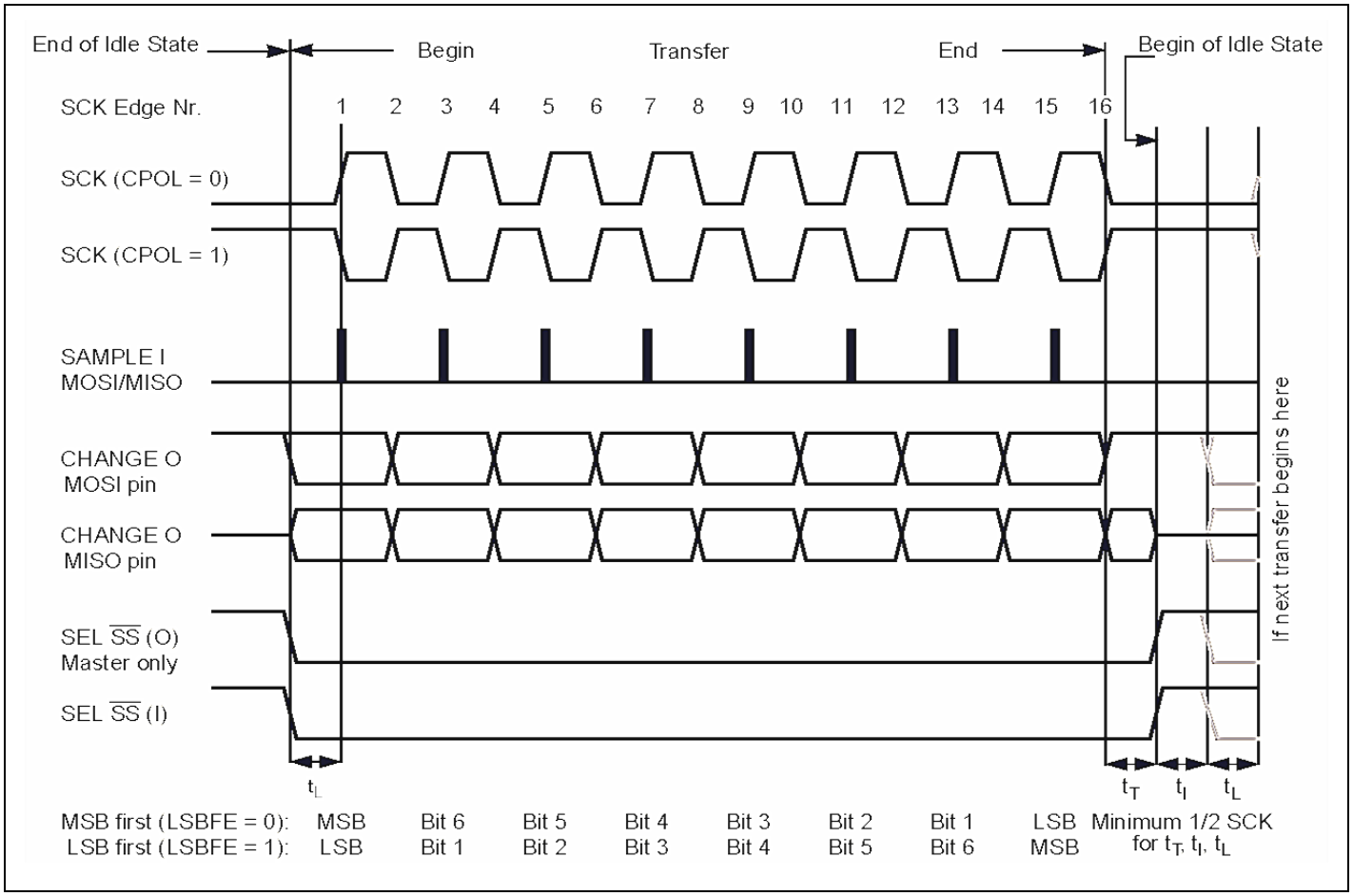


Figure.4.2.2 SPI Bus“Mode 0”（CPHA=0；CPOL=0；LSBFE=0）

SPI Communication Mode			
Order	**Description**		**Value（Mode 0）**
1	CPHA	Clock Phase	0
2	CPOL	Clock Polarity	0
3	LSBFE	Last Significant Bit Enable	0

4.2.3 SPI Characteristics

Table4.2.3 Standard SPI characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
f_{SCK}	SCK clock frequency	V_{DD} = V_{DDA} = 3.3 V	—	8	—	MHz
$t_{sck(H)}$	SCK clock high time		—	22.22	—	ns
$t_{sck\ (L)}$	SCK clock low time		—	22.22	—	ns
SPI master mode						
$t_{V(MO)}$	Data output valid time	V_{DD} = V_{DDA} = 3.3 V	—	—	7	ns
$t_{SU(MI)}$	Data input setup time		2	—	—	ns
$t_{H(MI)}$	Data input hold time		0	—	—	ns
SPI slave mode						
$t_{SU(NSS)}$	NSS enable setup time	V_{DD} = V_{DDA} = 3.3 V, f $_{PCLK}$ = 90 MHz	0	—	—	ns
$t_{H(NSS)}$	NSS enable hold time		2	—	—	ns
$t_{A(SO)}$	Data output access time		—	6	—	ns
$t_{DIS(SO)}$	Data output disable time	V_{DD} = V_{DDA} = 3.3 V	—	9	—	ns
$t_{V(SO)}$	Data output valid time		—	9	—	ns
$t_{SU(SI)}$	Data input setup time		0	—	—	ns
$t_{H(SI)}$	Data input hold time		1	—	—	ns

Figure4.2.3 SPI timing diagram - master mode

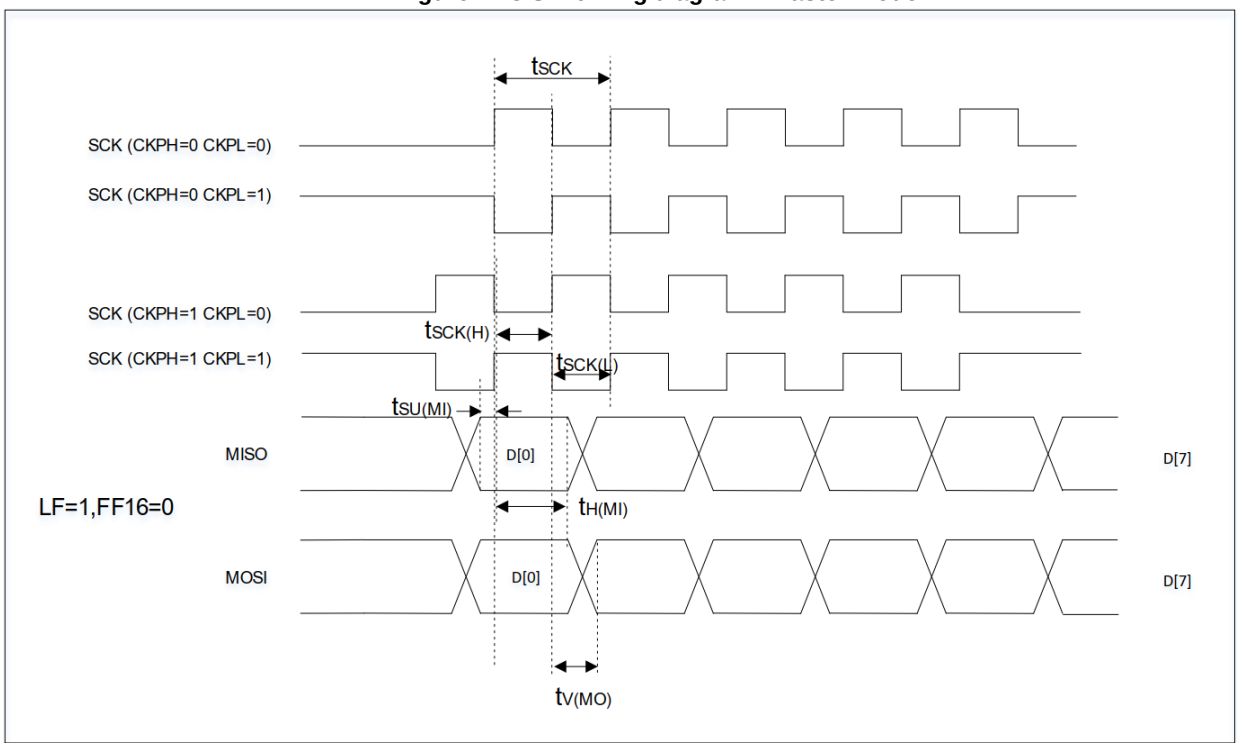
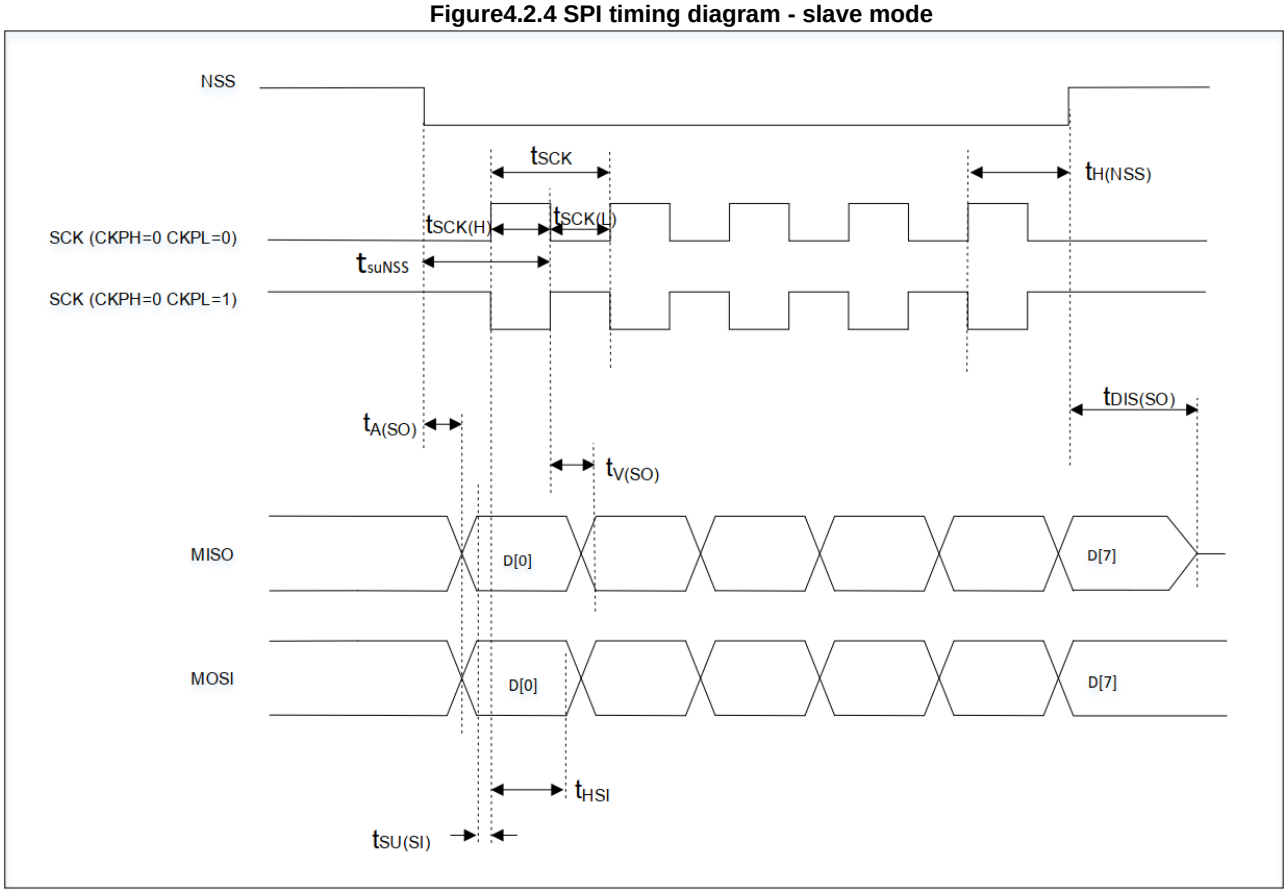


Figure4.2.4 SPI timing diagram - slave mode



4.3 USB Interface

USBFS start up time			
Symbol	**Parameter**	**Max**	**Unit**
$t_{STARTUP}$(1)	USBFS startup time	1	μs

（1）0Guaranteed by design, not tested in production.

USBFS DC electrical characteristics							
Symbol		**Parameter**	**Conditions**	**Min**	**Typ**	**Max**	**Unit**
Input levels(1)	V_{DD}	USBFS operating voltage	—	3	—	3.6	V
	V_{DI}	Differential input sensitivity	—	0.2	—	—	
	V_{CM}	Differential common mode range	Includes V_{DI} range	0.8	—	2.5	
	V_{SE}	Single ended receiver threshold	—	1.3	—	2.0	
Output levels (2)	V_{OL}	Static output level low	R_L of 1.0 kΩ to 3.6 V	—	0.002	0.3	V
	V_{OH}	Static output level high	R_L of 15 kΩ to GND	2.8	3.48	3.6	
R_{PD}(2)		PB13, PB12(USBFS_DM/DP)	V_{IN} = V_{DD}	17	19.02	24	kΩ
		PB14(USBFS_VBUS)		0.65	—	2.0	
R_{PU}(2)		PB13, PB12(USBFS_DM/DP)	V_{IN} = GND	1.5	1.589	2.1	
		PB14(USBFS_VBUS)		0.25	—	0.55	

(1) Guaranteed by design, not tested in production.

(2) Based on characterization, not tested in production.

USBFS full speed-electrical characteristics						
Symbol	**Parameter**	**Conditions**	**Min**	**Typ**	**Max**	**Unit**
t_R	Rise time	CL = 50 pF	4	—	20	ns
t_F	Fall time	CL = 50 pF	4	—	20	ns
t_{RFM}	Rise / fall time matching	t_R / t_F	90	—	110	%
v_{CRS}	Output signal crossover voltage	—	1.3	—	2.0	V

(1) Guaranteed by design, not tested in production.

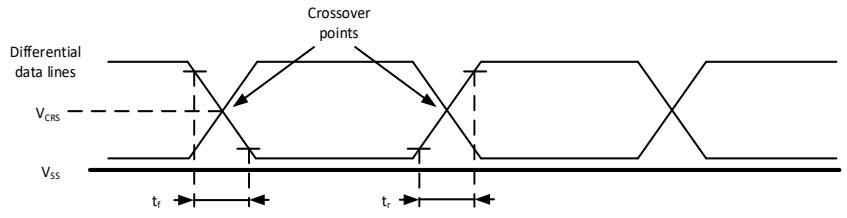


Figure 4.3.1 USBFS timings: definition of data signal rise and fall time

4.4 UART

The UART baud rate generator is configurable up to 115200bps.

Table 4.4. UART characteristics (1)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
f_{SCK}	SCK clock frequency	f_{PCLKx} = 45 MHz	—	—	22.5	MHz
$t_{SCK(H)}$	SCK clock high time	f_{PCLKx} = 45 MHz	22.22	—	—	ns
$t_{SCK(L)}$	SCK clock low time	f_{PCLKx} = 45 MHz	22.22	—	—	ns

(1) Guaranteed by design, not tested in production.

4.5 I2C

Support master and slave mode

The I2C interface is general serial interface. the I2C module provides different data transfer rates: up to 100 KHz in standard mode, up to 400 KHz in the fast mode.

Table 4.5. I2C characteristics (1)(2)(3)

Symbol	Parameter	Conditions	Standard mode		Fast mode		Fast mode plus		Unit
			Min	Max	Min	Max	Min	Max	
$t_{SCL(H)}$	SCL clock high time	—	4.0	—	0.6	—	0.2	—	μs
$t_{SCL(L)}$	SCL clock low time	—	4.7	—	1.3	—	0.5	—	μs
$t_{su(SDA)}$	SDA setup time	—	250	—	100	—	50	—	ns
$t_{h(SDA)}$	SDA data hold time	—	0(3)	3450	0	900	0	450	ns
$t_{r(SDA/SCL)}$	SDA and SCL rise time	—	—	1000	—	300	—	120	ns
$t_{f(SDA/SCL)}$	SDA and SCL fall time	—	—	300	3(4)(5)	300	3(4)(6)	120	ns
$t_{h(STA)}$	Start condition hold time	—	4.0	—	0.6	—	0.26	—	μs

(1) Guaranteed by design, not tested in production.

(2) To ensure the standard mode I2C frequency, f_{PCLK1} must be at least 2 MHz To ensure the fast mode I2C frequency, f_{PCLK1} must be at least 4 MHz To ensure the fast mode plus I2C frequency, f_{PCLK1} must be at least a multiple of 10 MHz.

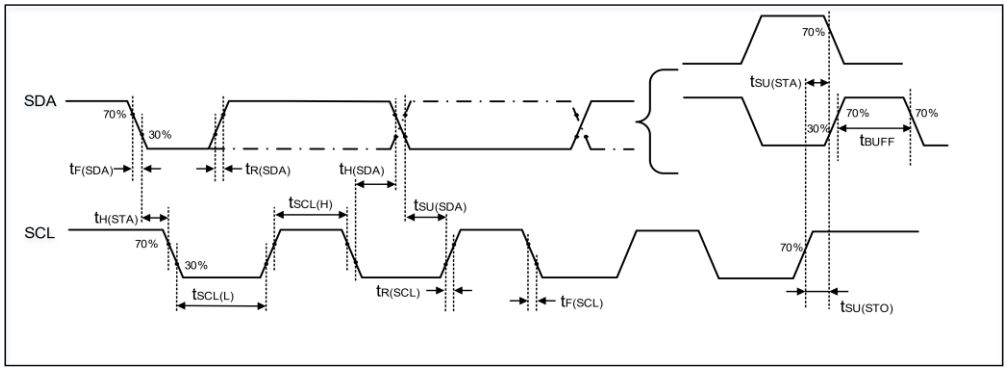
(3) The external device should provide a data hold time of 300 ns at least in order to bridge the undefined region of the falling edge of SCL.

(4) Based on characterization, not tested in production.

(5) In the condition of I2C frequency = 400 kHz, IO_Speed = 50 MHz and Pull-up resistor = 1 kΩ.

(6) In the condition of I2C frequency = 1 MHz, IO_Speed = 50 MHz and Pull -up resistor = 1 kΩ.

Figure4.5. I2C bus timing diagram



4.6 No Bezel Structure

The GSL6186LMSCM1 fingerprint recognition module does not require a metal outer ring to obtain a clear fingerprint image.

In the fingerprint identification module of conventional structure, the metal ring integrated around the module is used as the transmitter of the scanning signal to send out the excitation signal to scan the fingerprint image. The whole pixel array of the fingerprint module serves as the receiving end of the signal, receiving the scanning signal sent by the metal ring and presenting the fingerprint image.

In the GSL6186LMSCM1 fingerprint module without metal ring, the pixel array emits and receives signals by itself to collect the whole fingerprint image and obtain the high-resolution fingerprint image.

4.7 Connection with Host [2]

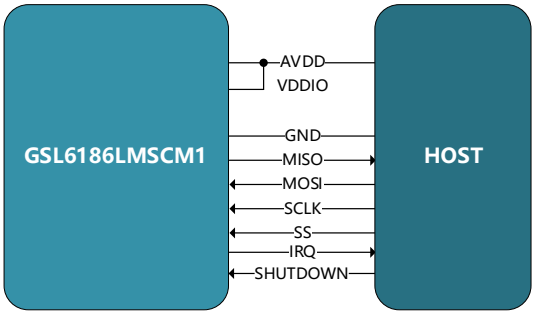
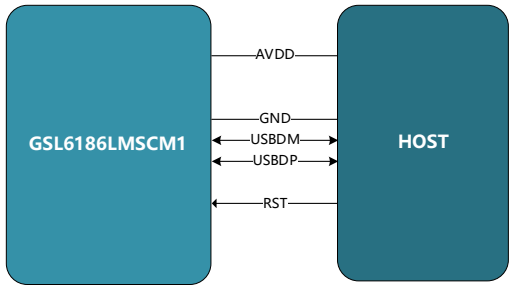
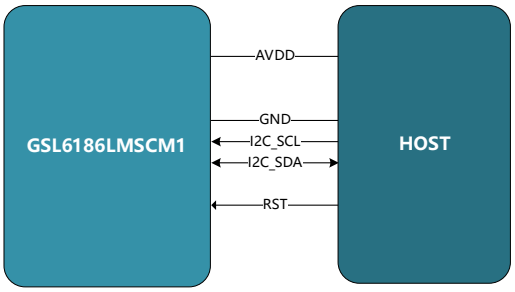
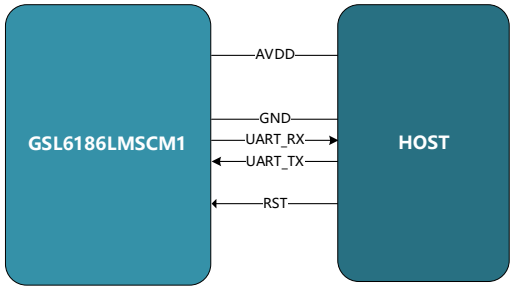


Figure.4.7. Main engine connection, single power supply mode: VDDIO and AVDD short connection (VOUT_1V8 suspended)







[3] In this place, The "host connection" here represents a single chip cut from the GSL6186LMSCM1

In addition to the power supply, GSL6186LMSCM1 is connected to four SPI signals, a Shutdown signal, and an IRQ signal. The voltage ranges from 2.8v to 3.6v.

It is recommended that Shutdown be connected to the host's GPIO.If the host pulls Shutdown down, GSL6186LMSCM1 goes into sleep mode. To wake up GSL6186LMSCM1, the host releases Shutdown and sends a Start_Command to start GSL6186LMSCM1.The Shutdown pin cannot be suspended.

An IRQ is an interrupt signal to the host.

4.8 Peripheral Circuit (Recommend)

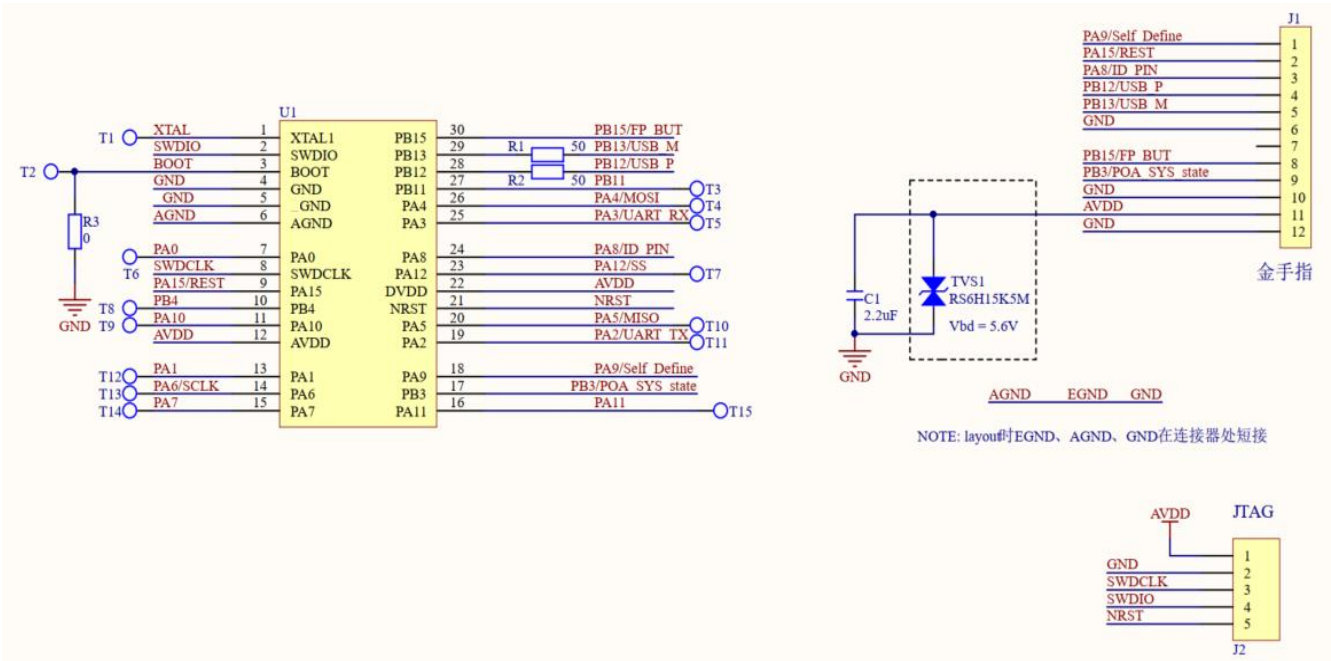


Figure.4.8.1 GSL6186LMSCM1 Peripheral Circui

The recommended bill of materials (BOM) is shown in the following table. Related components can be replaced by other components with the same specifications and parameters.

Figure.4.8.2 List of recommended materials for peripheral circuits

Peripheral Circuit Bill Of Materials							
Device	Device Specification		Device Recommended Model/Manufacturer	Device	Device Specification		Device Recommended Model/Manufacturer
	Parameters	Size			Parameters	Size	
C1	2.2μF	0201	SMT Capacitor	TVS1	5.6V	0201	(RS Industry Ltd.) **RS6H15K5M TVS** 二极管
R1	50Ω	0201	SMT Capacitor	J1	---	---	
R2	50Ω	0201	SMT Capacitor	LGA	---	---	Silead® GSL6186LMSCM1 Fingerprint Sensor Chip
R3	0Ω		SMT Capacitor				

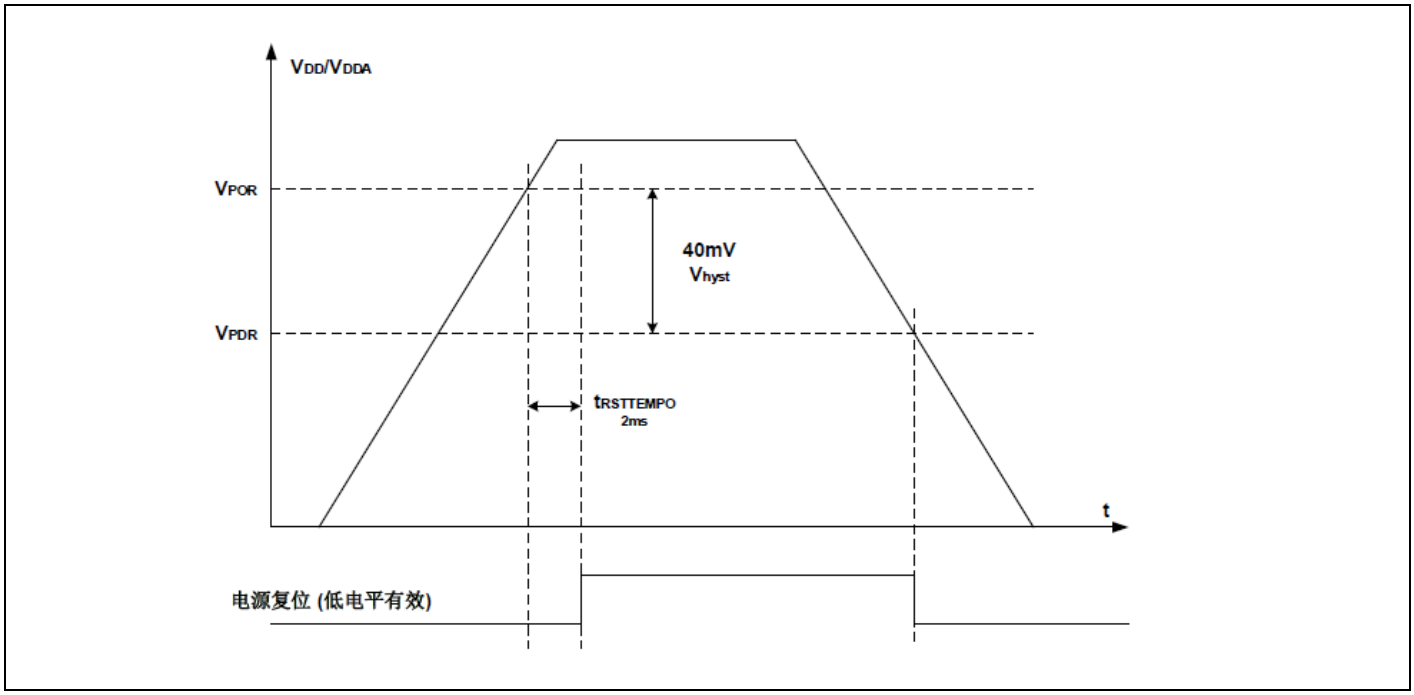
[3]The size specification of the peripheral components is illustrated by the "EIA" industry standard, and please refer to Appendix 2 for the detailed parameter list;

5 Sensor Working Parameters

5.1 Power-Up/Down State

Power-up/Down State			
Parametters	**Description**	**Recommended Value**	**Unit**
t_{RST}	Reset Time	>5.0	**ms**

Figure.4.1.1，Single Power Supply Sequence Diagram



Power-Up/Down State			
参数	**Description**	**Recommended Value**	**Unit**
t_{AVR}	AVDD-VDDIO Rising Interval Time	>10.0	**ms**
t_{RST}	Reset Time	>5.0	**ms**
t_{VF}	VDDIO Falling Time	-	**ms**

5.2 Operating Condition

Operating Condition				
Parameter	**Min**	**Typical**	**Max**	**Unit**
Supply Voltage	2.8	3.3	3.6	**V**
Operating Temperature	-40	+25	+85	℃
Storage Temperature	Constant temperature storage (Recommended): 22±2			℃

[**Note**]: In the image Scanning mode, the ripple <50mV

5.3 Operating Mode Parameters

Operating Mode Parameters								
Operating Mode		**Frame Rate**（Unit: Frame/Second）			**Power Consumption**			**Description**
		Min	**Typical**	**Max**	**Min**	**Typical**	**Max**	
Active State	AVDD	-	-	-	-	45mA	-	Fingerprint Normally Scanned
Idle State	AVDD		-		-	0.5mA	-	SLEEP Mode, Waiting For The Cold Screen To Wakeup
Sleep State	AVDD				-	0.48mA	-	Shutdown Pull Down

5.4 Reliability Parameters

Reliability Parameters						
Symbol	**Technical Indicator**		**Industrial Standard**	**Min**	**Max**	**Unit**
V_{esd}	Electrostatic Discharge	Charge Device Mode	JESD22-C101	-500	+500	**V**
		Human Body Mode	JESD22-A114F	-8	+8	**kV**
		Air contact[4]	IEC61000-4-2	-15	+15	
		Direct contact[5]		-8	+8	
I_{lu}	Latch-up Current		JESD78B	-400	+400	**mA**

[4] Parameter（Air discharge）correlate with module manufacturing craft;

[5] Parameter（Direct discharge）correlate with module manufacturing craft;

6 Mechanical Drawing and Storage Conditions

6.1 GSL6186LMSCM1 Mechanical Drawing

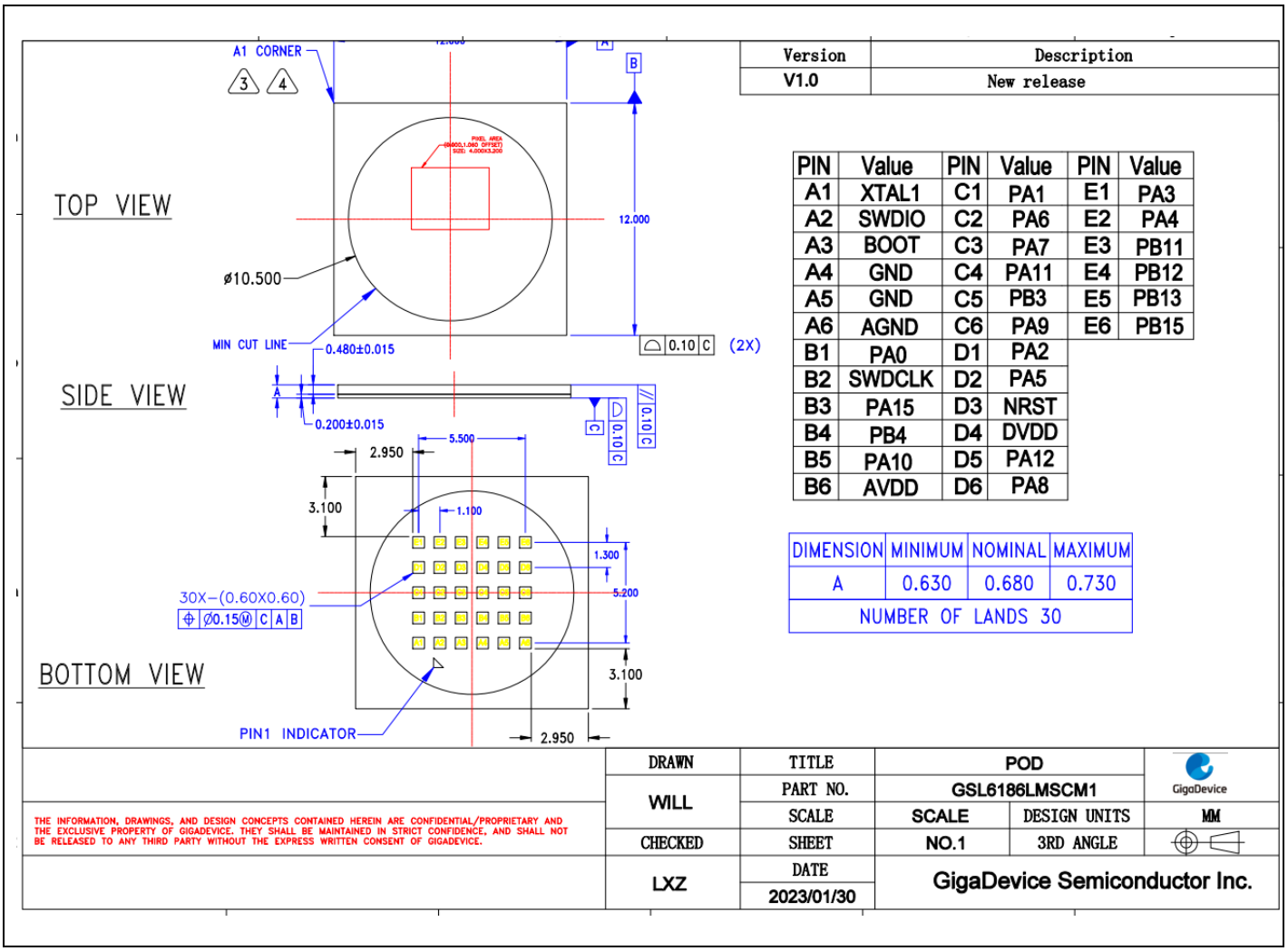


Figure.6.2.1 GSL6186LMSCM1 Mechanical Drawing [6]

[6] The design drawing uses GSL6186LMSCM1_POD_V1.0 version

6.2 GSL6186LMSCM1 Save and Use Conditions

This product is Grade 3 moisture-proof, and the requirements are:

(1) Effective storage time in vacuum packaging: 12 months under normal storage conditions of electronic components; The storage environment requires temperature <40℃ and relative humidity <90%R.H.

(2) After the vacuum package is opened, if the device is used for infrared reflux equipment or equivalent treatment (temperature not exceeding 260℃), the following conditions must be met:

a) Production within 168 hours (30℃/60%R.H);

b) stored at 10%R.H (e. g. in drying cabinet)

(3) The device is dried before online production under the following conditions:

a) At 23 ± 5℃, the humidity indicator card displays> 20%;

b) Does not comply with either 2a or 2b

(4) If the device needs drying treatment, the drying time is:

a) If the sealed packaging is low-temperature packaging devices (e. g. tape packaging products), dry in 40℃+5℃/-0℃<5%R.H conditions for 192 hours.

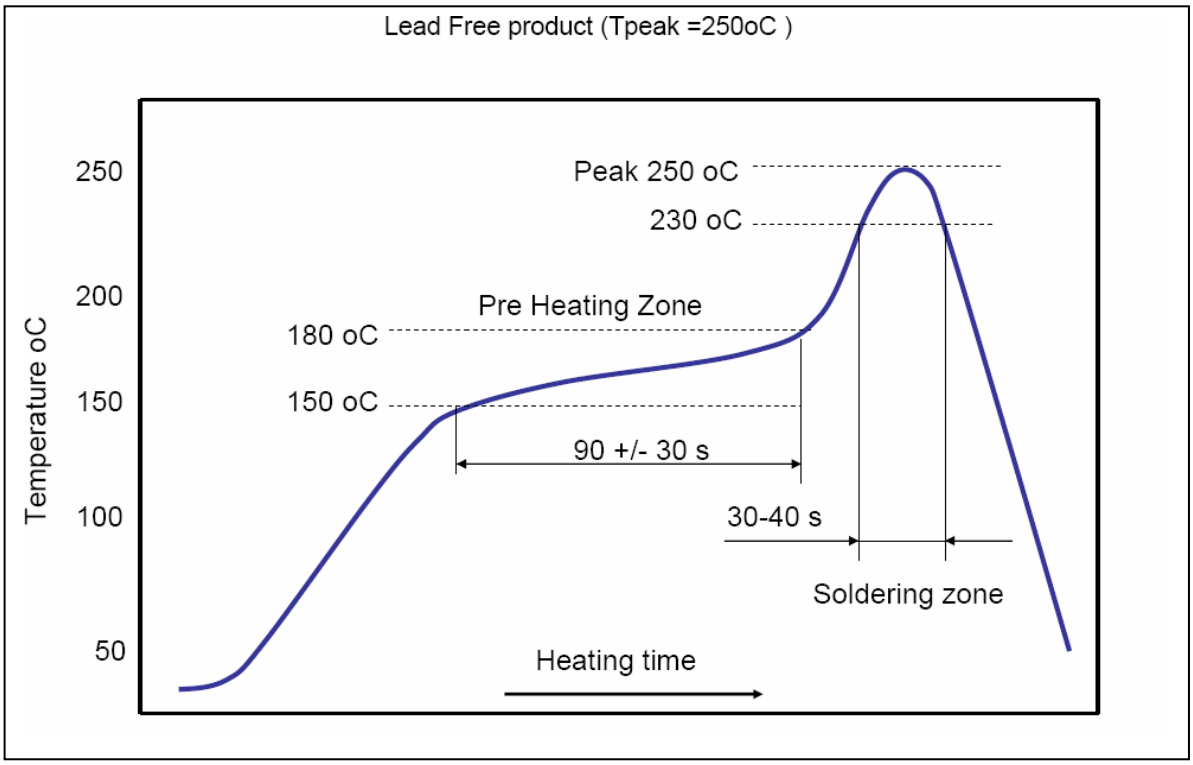
b) If the sealed package is a high-temperature packaging device (e. g., tray packaging products), dry at 125℃ + 5 / -0℃ for 24 hours.

c) After the product is baked, it should be loaded into a vacuum bag immediately after cooling. Belt vacuum bag package with no less than 5 grams of desiccant and a 6-point humidity indicator card and vacuum sealed; tray vacuum bag package with no less than 10 grams of desiccant and a 6-point humidity indicator card and keep with vacuum sealing.

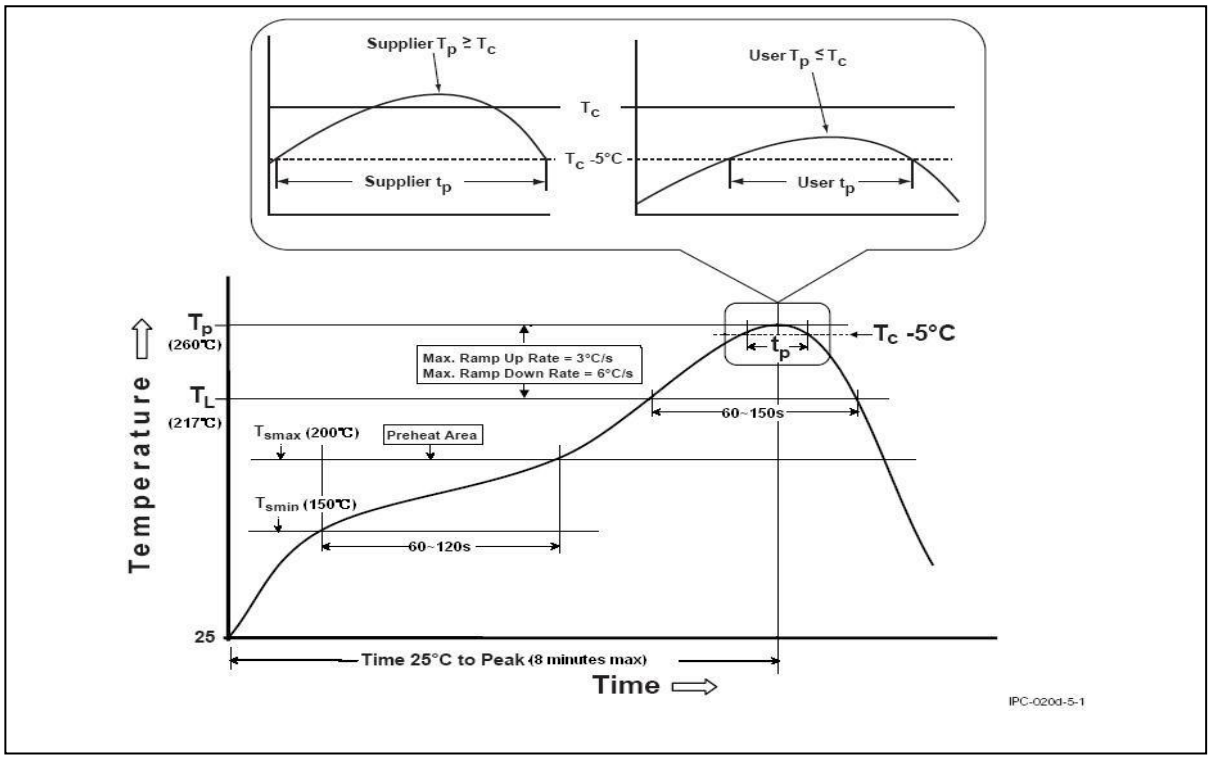
(5) Reflow welding times 3 times.

6.3 GSL6186LMSCM1 Recommends SMT Profile

Recommended for Reflow Profile and JEDEC standards



JEDEC Standard



7 Product Naming Rules

G S L	6	1	86	LMS	CM1	Product Naming Rule of Fingerprint Sensor
						Product Package — **L**: LGA; **M:** mobile; **S:** strip
						Product Series — **86**: 86 Series
						Surface Material — **1**: Coating; **2**: Glass/Ceramic; **3**: UnderGlass
						Product Type — **6**: Capacitive Fingerprint Sensor
						Company abbreviation — **GigaDevice - SiLead Inc.**

8 REVISION HISTORY

Version No	Description	Page	Date
1.0	Initial release	All	2023-09-13
1.1	update Power Consumption	3、14	2023-12-01
1.2	update POD	17	2023-12-21
1.3	update	15	2025-03-24
1.4	update		2025-04-09

[Appendix.1]: Document Convention

Acronym	Description	Acronym	Description
AA	Active Area	**LSBFE**	Last Significant Bit Enable
AGC	Automatic Gain Control	**MISO**	Master Input Slave Output
AVDD	Analog Voltage Drain-Drain	**MM**	Machine Model
BGA	Ball Grid Array	**MOSI**	Master Output Slave Input
BOM	Bill of Materials	**NVM**	Non-Volatile Memory
CPHA	Clock Phase	**POR**	Power On Reset
CPOL	Clock Polarity	**OSC**	Oscillator
DC	Direct Current	**OTP**	One-Time Programmable
DPI	Dot Per Inch	**RoHS**	Restriction of Hazardous Substances
EIA	Electrical Industrial Association	**SCLK**	Serial Clock
ESD	Electro-Static Discharge	**SIP**	System In Package
HBM	Human Body Model	**SPI**	Serial Peripheral Interface
IRQ	Interrupt Request	**SS/CS**	Slave Selected/Chip Selected
LGA	Land Grid Array		

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