PAG7661QN: Multi-finger Gesture Recognition Processing Chip

General Description

The PAG7661QN is a Multi-finger Gesture Recognition processing chip. It receives the IR images' raw output from the sensor and uses PixArt's proprietary human hand shape recognition algorithm to generate the respective fingertip's position, size, brightness, and palm immediately. The chip leverages fingertips and palm recognition information and compares it with pre-defined gestures for gesture identification.

The instant gesture output is generated independently and can be used to wake up the system, which helps to reduce the whole system's power consumption significantly. The communication interfaces are I^2C, 4-wire SPI, and USB 1.1.

Key Features

- Real-time output of palm's and fingertips' position, size and brightness
- Multi-finger gestures: N-finger push, pinch, tap, grab, rotation, thumb up, thumb down, static gesture (1 to 5 fingers) and swipe
- Communication interface options:
  - I^2C, SPI and USB 1.1 for Gesture mode
  - USB 1.1 for Image mode (support up to Image Size 80 x 60)
- I^2C interface up to 1Mbit/s

Applications

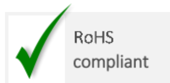
- VR/AR
- Interactive device
- IoT connected home device

Key Parameters

Parameter	Value
Sensor Interface	Parallel/Half-parallel
Interfaces	I^2C, SPI, USB 1.1
Supply Voltage	VDDMA: 3 to 3.6V VDDOSC: 3 to 3.6V VDDUSB: 3 to 3.6V VDDIO: 1.62 to 3.6V
Supply Current Average (typical)	Operation(I^2C/SPI):<8mA Suspend: 160μA
Package Size (L x W x H)	6 x 6 x 0.85 mm^3

Ordering Information

Part Number	Description	Package Type	Packing Type	MOQ
PAG7661QN	Multi-Finger Gesture Recognition Processing Chip	QFN48	JEDEC Tray	4900



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1.0 Introduction

1.1 Overview

The PAG7661QN is a Multi-finger Gesture Recognition processing chip. It receives the IR images' raw output from the sensor and uses PixArt's proprietary human hand shape recognition algorithm to generate the respective fingertip's position, size, brightness, and palm immediately. The chip leverages fingertips and palm recognition information and compares it with pre-defined gestures for gesture identification.

The instant gesture output is generated independently and can be used to wake up the system, which helps to reduce the whole system's power consumption significantly. The communication interfaces are I^2C, 4-wire SPI, and USB 1.1.

Note: Throughout this document, the PAG7661QN is referred to as the "chip".

1.2 Block Diagram

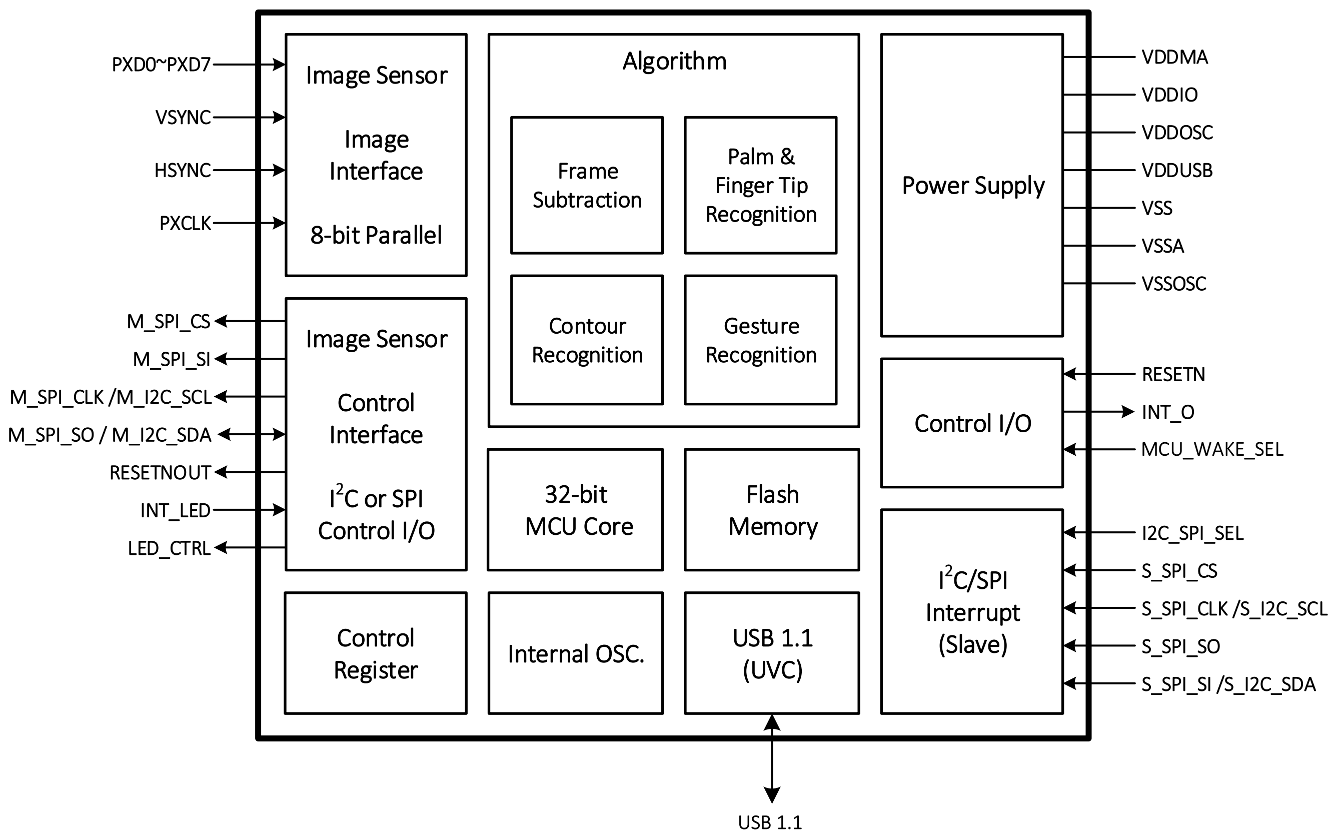

Figure 1. Functional Block Diagram

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1.3 Terminology

Term	Description
CMOS	Complementary Metal-Oxide-Semiconductor
DSP	Digital Signal Processor
SPI	Serial Peripheral Interface
I^2C	Inter-Integrated Circuit
IR	Infrared
LED	Light-Emitting Diode
FPS	Frame Per Second
FOV	Field of View
I/O	Input/ Output
GPIO	General Purpose Input/ Output
DC	Direct Current
SMT	Surface-Mount Technology
LSB	Least Significant Bit
PCB	Printed-Circuit Board
ESD	Electrostatic discharge

1.4 Pin Assignment and Signal Description

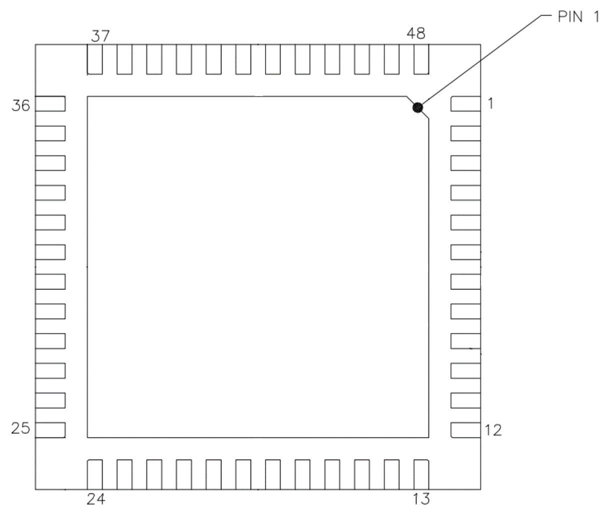

Figure 2. Pin Configuration (Bottom View)

Table 1. Signal Pins Description

Function	Pin No.	Signal Name	Type	Description
Power Supplies	38	VDDMA	Power	Main power supply
	1,12,20,32	VDDIO	Power	I/O power input
	40	VDDUSB	Power	Power supply for USB block
	43	VDDOSC	Power	Internal Oscillator. Power input
	9,21,34	VDD12	Power	Power supply for Core
	33	VSS	Ground	Digital ground

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Function	Pin No.	Signal Name	Type	Description
	45,46	VSS	Ground	Ground
	39	VSSA	Ground	Analog ground
	44	VSSOSC	Ground	Internal oscillator ground
Regulator Output	37	VDD12_O	Power	Internal 1.2V Regulator Output
Control Interface	7	S_SPI_CS	Input	SPI CS signal
	6	S_SPI_CLK/ S_I^{2}C_SCL	Input	SPI Slave: SPI CLK signal I^{2}C Slave: I^{2}C clock pin (Open Drain)
	8	S_SPI_SI/ S_I^{2}C_SDA	I/O	SPI Slave: SPI data in I^{2}C Slave: I^{2}C data pin (Open Drain)
	10	S_SPI_SO	Output	SPI data out
	41	USB_DN	I/O	USB 1.1, D-
	42	USB_DP	I/O	USB 1.1, D+
Sensor Interface	5	M_SPI_CS	Output	SPI CS signal
	4	M_SPI_CLK/ M_I2C_SCL	Output	SPI Master: SPI CLK signal I^{2}C Master: I^{2}C clock pin (Open Drain)
	2	M_SPI_SI	Output	SPI data out
	3	M_SPI_SO/ M_I2C_SDA	I/O	SPI Master: SPI data in I^{2}C Master: I^{2}C data pin (Open Drain)
	27	VSYNC	Input	Vsync signal of parallel interface
	26	HSYNC	Input	Hsync signal of parallel interface
	31	PXCLK	Input	Pixel clock of parallel interface
	11	PXD7	Input	Pixel data bit[7] of parallel interface
	13	PXD6	Input	Pixel data bit[6] of parallel interface
	14	PXD5	Input	Pixel data bit[5] of parallel interface
	15	PXD4	Input	Pixel data bit[4] of parallel interface
	16	PXD3	Input	Pixel data bit[3] of parallel interface
	23	PXD2	Input	Pixel data bit[2] of parallel interface
	24	PXD1	Input	Pixel data bit[1] of parallel interface
	25	PXD0	Input	Pixel data bit[0] of parallel interface
Functional I/O	17	INT_O	Output	Interrupt pin-Active low (Open Drain)
	18	RESETN	Input	Reset pin-Active low
	28	MCU_WAKE_SEL	Input	Hardware strapping: Pull High : USB Interface Pull Low : I^{2}C or SPI Interface
	29	I^{2}C_SPI_SEL	Input	Hardware strapping: Pull High : I^{2}C Interface Pull Low : SPI Interface
	30	RESETNOUT	Output	Reset pin for Sensor
	35	INT_LED	Input	LED timing control from sensor
	36	LED CTRL	I/O	External LED timing control pin.
	22	TX	I/O	UART TX for debug
Other	19,47,48	NC	-	-

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2.0 Operating Specification

2.1 Absolute Maximum Rating

Table 2. Absolute Maximum Rating

Parameter	Symbol	Min.	Max.	Unit	Note
Storage Temperature	T_{st}	-40	125	°C	
Relative Humidity	RH	0	85	%	Non-condensing, Non-biased
Supply Voltage	VDDMA	-0.3	VDDMA+0.3	V	
OSC Supply Voltage	VDDOSC	-0.3	VDDOSC+0.3	V	
USB Supply Voltage	VDDUSB	-0.3	VDDUSB+0.3	V	
I/O power Voltage	VDDIO	-0.3	VDDIO+0.3	V	
ESD	ESD_{HBM}	-	2	kV	Human body model
	ESD_{CDM}	-	750	V	Charged device model 750V for corner pins 500V for all other pins
		-	500		

Notes:

1. At room temperature (T_A = 25°C).
2. Maximum Ratings are those values beyond which damage to the device may occur.
3. Exposure to these conditions or conditions beyond those indicated may adversely affect device reliability. Functional operation under absolute maximum-rated conditions is not implied.

2.2 Recommended Operating Condition

Table 3. Recommended Operating Condition

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Ambient Temperature	T_A	-20	-	70	°C	
Supply Voltage	VDDMA	3	3.3	3.6	V	
OSC Supply Voltage	VDDOSC	3	3.3	3.6	V	
USB Supply Voltage	VDDUSB	3	3.3	3.6	V	
I/O power Voltage	VDDIO	1.62	-	3.6	V	
I/O Pin Current	I_{DDIO}	-	-	8	mA	At VDDIO = 3.3V

Note: At room temperature (T_A = 25°C).

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2.3 DC Characteristic

Table 4. DC Electrical Specification

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Operation Current for I^2C/SPI mode	I_{DD}	-	-	8	mA	At VDDMA= 3.3V, VDDOSC= 3.3V, VDDUSB = 3.3V Excluded VDDIO
Operation Current for USB mode	I_{usb}	-	-	20	mA	At VDDMA= 3.3V, VDDOSC= 3.3V, VDDUSB = 3.3V Excluded VDDIO
Suspend Current	I_{DD_SUS}	-	160	-	µA	At VDDMA = 3.3V, VDDOSC = 3.3V, VDDUSB= 3.3V; Excluded VDDIO
I/O Input High Voltage	V_{IH}	0.7 x VDDIO	-	-	V	
I/O Input Low Voltage	V_{IL}	-	-	0.3 x VDDIO	V	
I/O Output High Voltage	V_{OH}	0.8 x VDDIO	-	-	V	
I/O Output Low Voltage	V_{OL}	-	-	0.2 x VDDIO	V	VDDIO ≤ 2V
		-	-	0.4		VDDIO > 2V

Note: At room temperature (T_A = 25°C).

2.4 AC Characteristic

Table 5. AC Electrical Specification

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
I^2C interface speed for Host	-	-	-	1	Mbit/s	
SPI interface speed for Host	-	-	-	20	MHz	
I^2C interface speed for Sensor	-	-	-	400	kbit/s	
SPI interface speed for Sensor	-		-	66	MHz	

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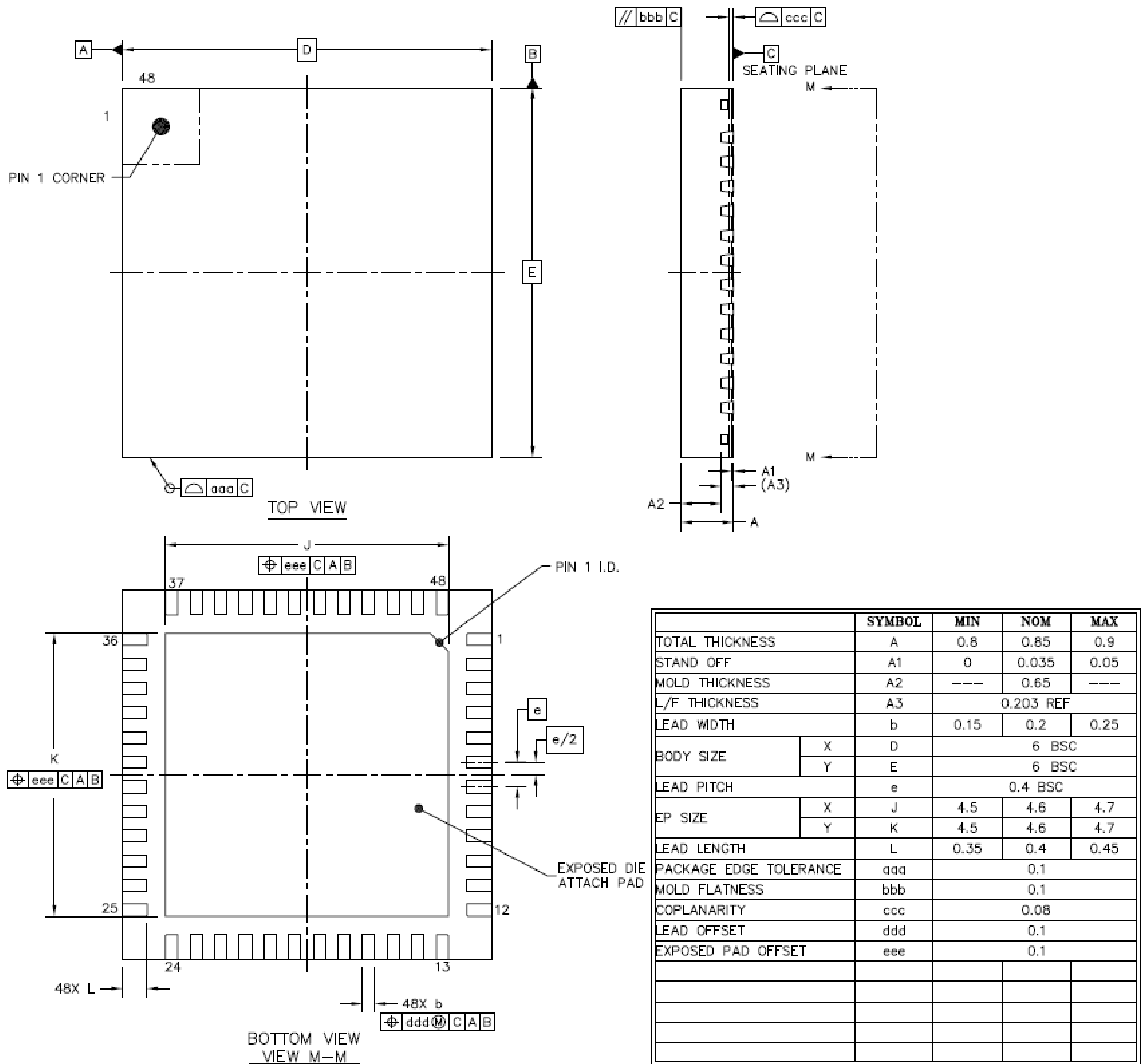
3.0 Mechanical Specifications

3.1 Package Mechanical Dimension



		SYMBOL	MIN	NOM	MAX
TOTAL THICKNESS		A	0.8	0.85	0.9
STAND OFF		A1	0	0.035	0.05
MOLD THICKNESS		A2	---	0.65	---
L/F THICKNESS		A3		0.203 REF	
LEAD WIDTH		b	0.15	0.2	0.25
BODY SIZE	X	D		6 BSC	
	Y	E		6 BSC	
LEAD PITCH		e		0.4 BSC	
EP SIZE	X	J	4.5	4.6	4.7
	Y	K	4.5	4.6	4.7
LEAD LENGTH		L	0.35	0.4	0.45
PACKAGE EDGE TOLERANCE		aaa		0.1	
MOLD FLATNESS		bbb		0.1	
COPLANARITY		ccc		0.08	
LEAD OFFSET		ddd		0.1	
EXPOSED PAD OFFSET		eee		0.1	

Figure 3. Package Outline Diagram (Unit in mm)

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3.2 Package Marking Identification

Figure 4 is the code marking location on the chip package.

Table 6. Code Identification

Laser Mark	Description
AAAAAA	PXI Lot code
BBB	Assembly Trace Code

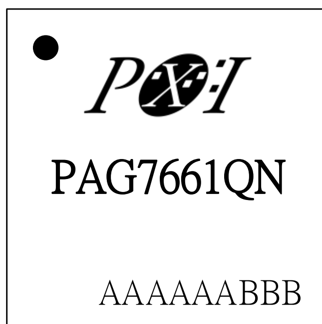

Figure 4. Package Marking Outline

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4.0 Design Reference

4.1 Reference Schematic

As circuit complexity, the circuit diagram split into multiple block or figure for explanation.

4.1.1 PAG7661QN

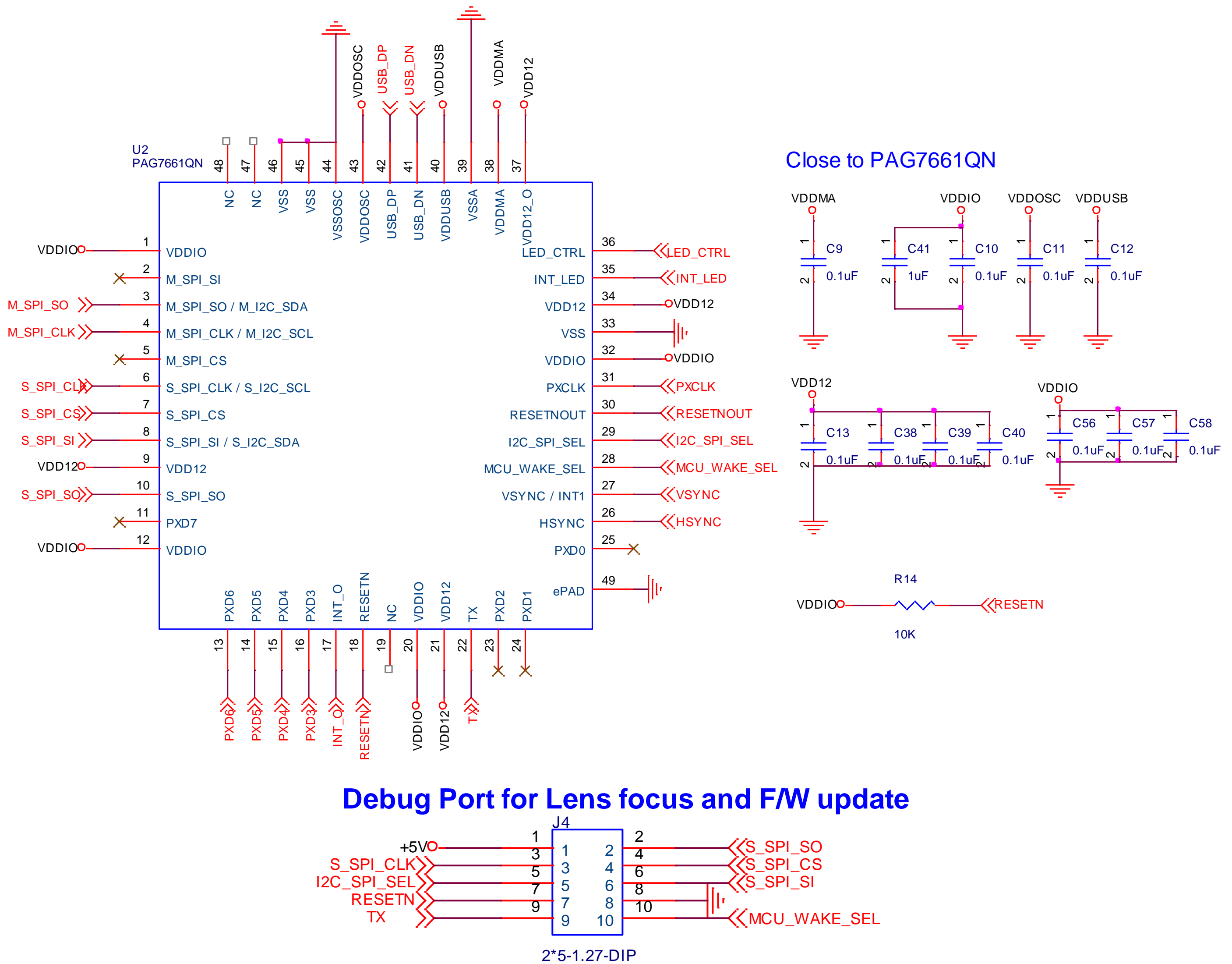

Figure 5. Schematic of PAG7661QN

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4.1.2 PAG7646J1 and Power

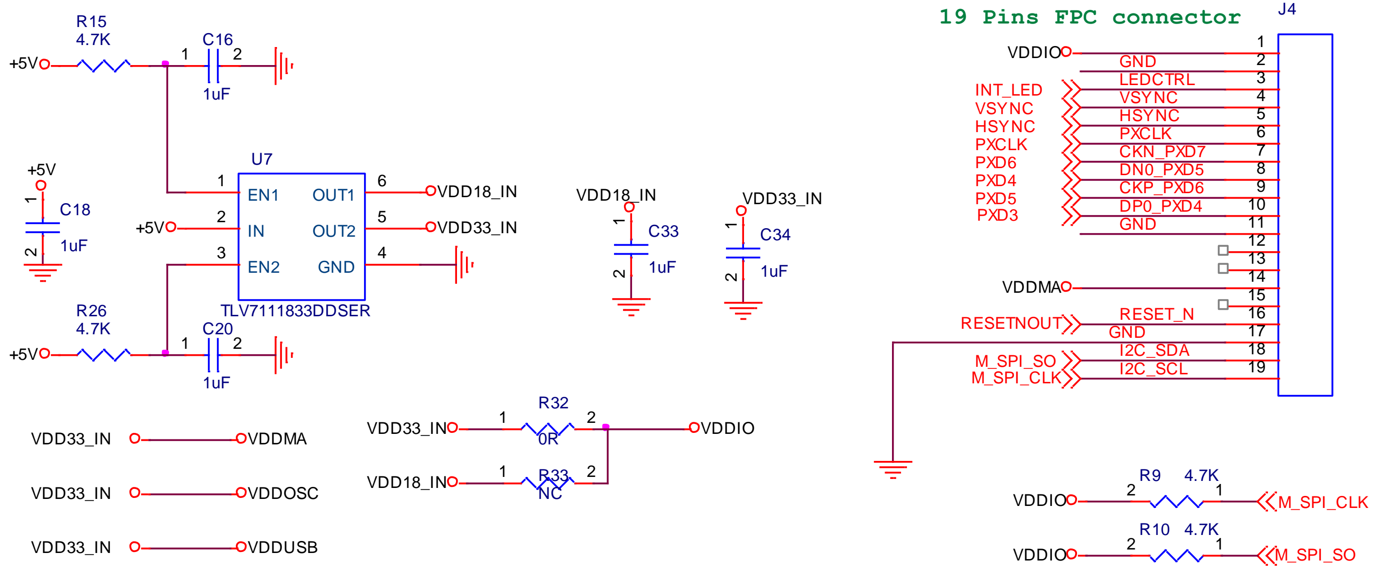

Figure 6. Schematic of PAG7646J1 and Power

4.1.3 LED

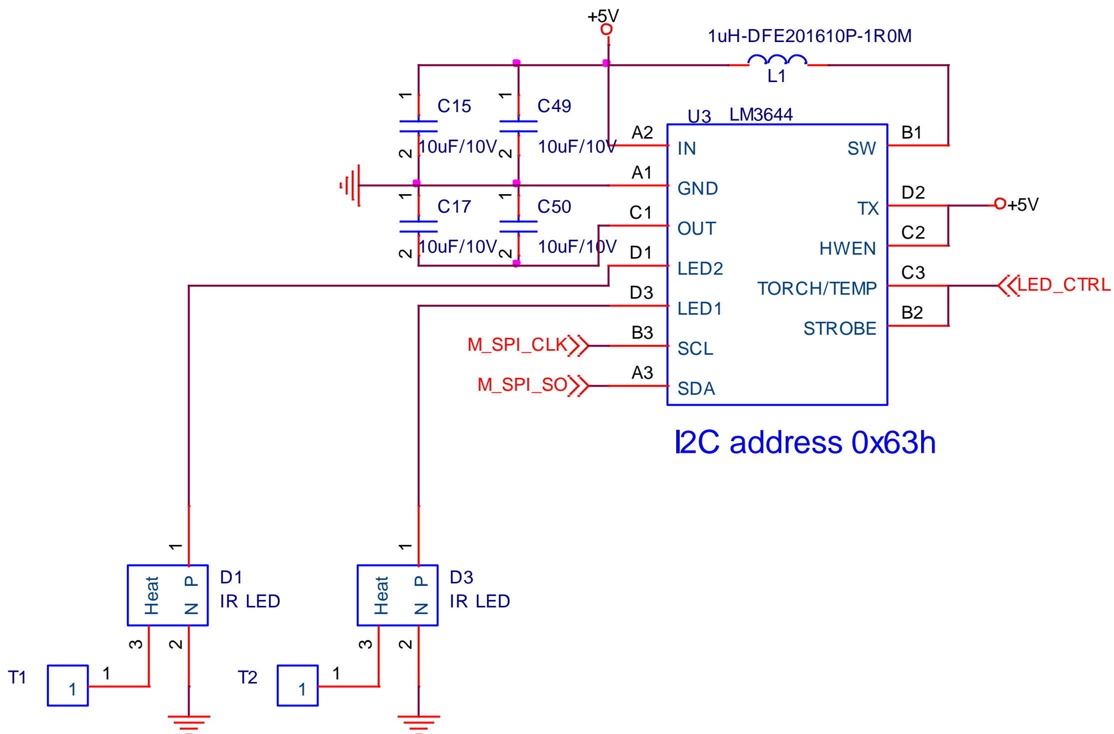

Figure 7. Schematic of LED

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4.1.4 Interface

The chip supports 3 types interface (I²C, SPI, and USB), select one interface at a time through I/O strapping configuration.

- I²C

The I²C Salve ID is configured through S_SPI_CS and S_SPI_SO.

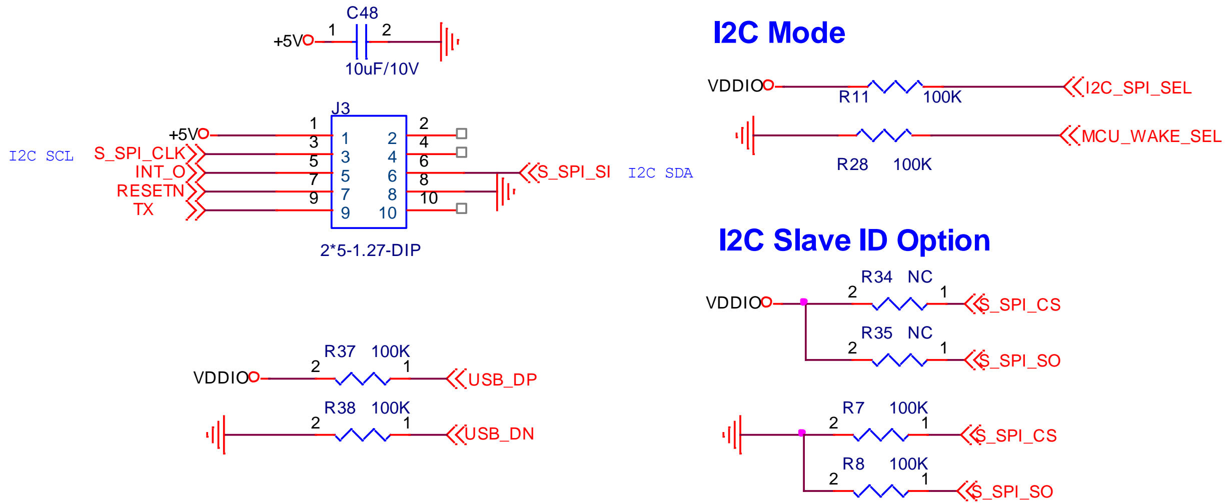

Figure 8. Schematic of I²C Interface

- SPI

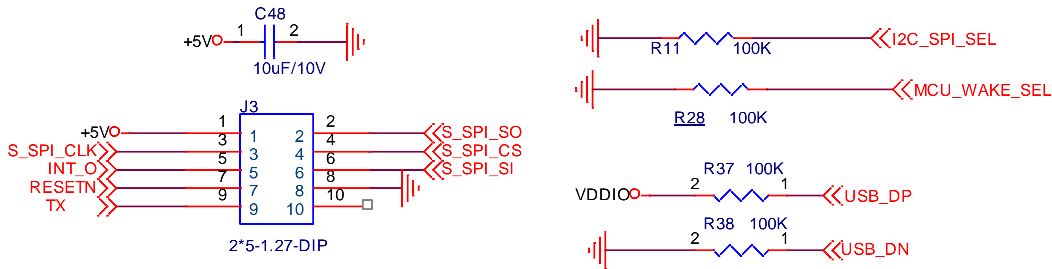

Figure 9. Schematic of SPI Interface

- USB

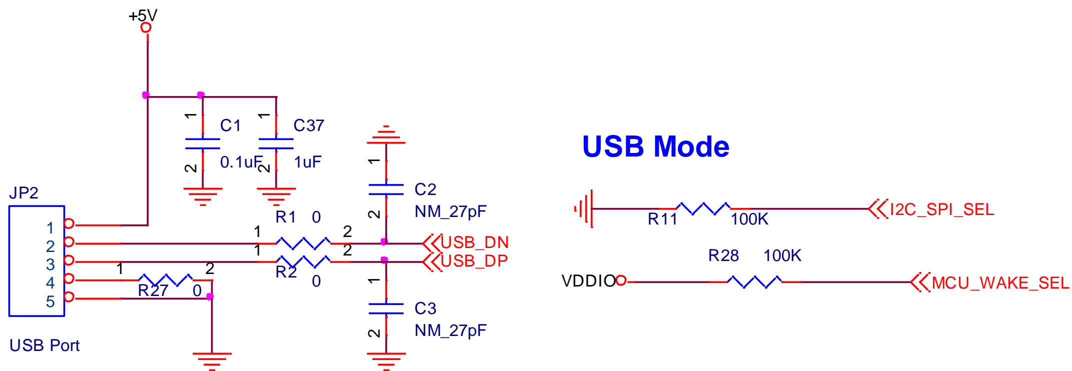

Figure 10. Schematic of USB Interface

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4.2 PCB Layout Design Guide

4.2.1 Placement

For Lens and LED placement, both LED center and Lens center need to be aligned more than 9.425mm for optimum performance.

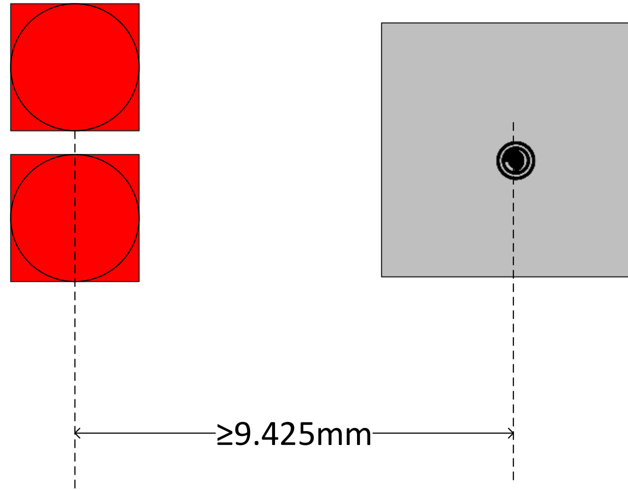

Figure 11. Distance between Sensor and LED

4.2.2 Recommended PCB Footprint

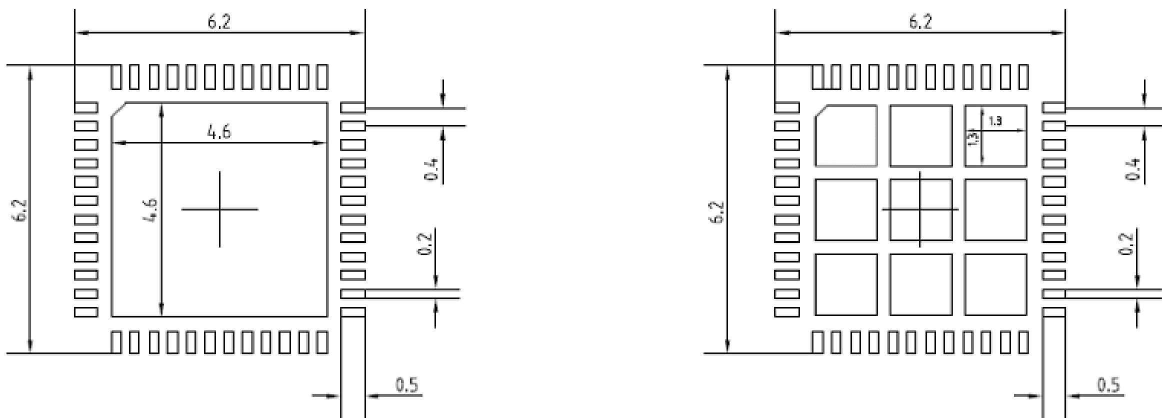

Figure 12. The Module PCB Design Guideline (unit in mm)

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4.3 Cover Material Recommendation

4.3.1 Clear Cover

1. Cover material: Glass or PC
2. Clear cover part transmittance: > 90%
3. Cover thickness ≤ 1.8mm
4. Cover and sensor distance or gap must be as close as possible. Air Gap ≤ 0.2mm

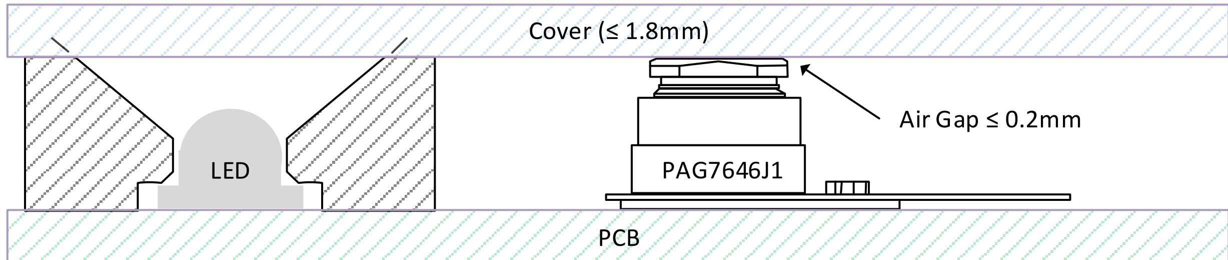

Figure 13. Cover Glass Suggestion

4.3.2 Cover Glass with IR Pass Filter

1. Cover Material: PC (PC-L1225L HF05100L, FXE121R BK1A184T, J10425PC)
2. IR pass spectrum 940nm transmittance: > 85%
3. Cover thickness ≤ 1.8mm
4. Cover and sensor distance or gap must be as close as possible. Air Gap ≤ 0.2mm

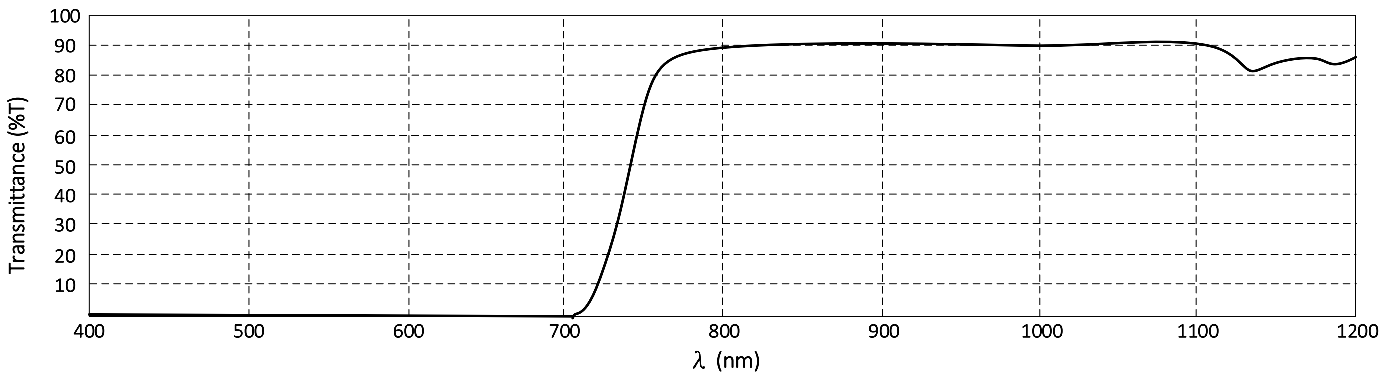

Figure 14. Cover with IR Pass Dimension

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4.3.3 Retaining Wall for Light Leakage Prevention

The LED surrounding is recommended to build retaining wall to prevent the internal light leakage cause by the cover. The retaining wall recommended dimension as follows.

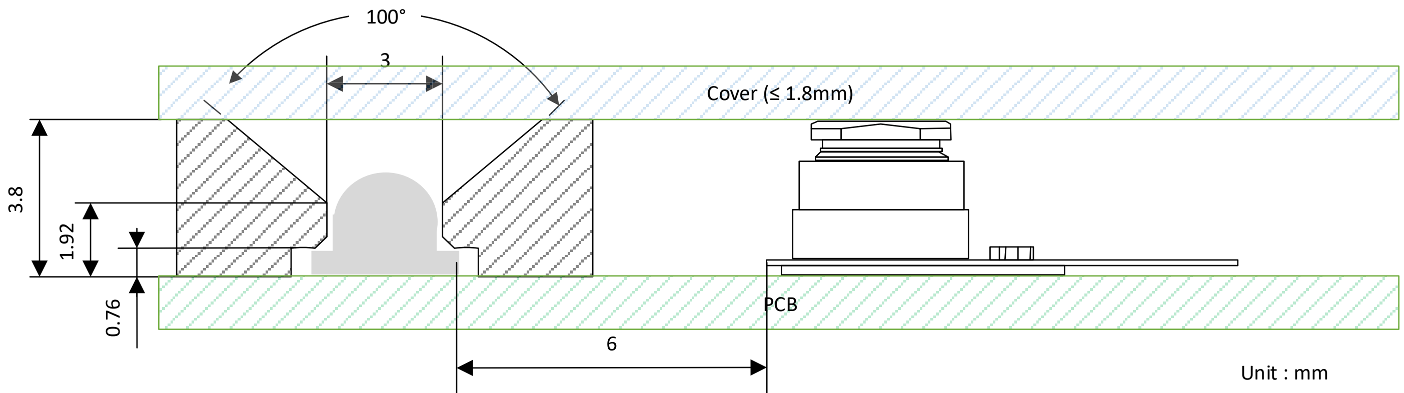

Figure 15. Retaining Wall

4.4 Assembly Guide

4.4.1 Recommended Guideline for PCB Assembly

For robust IR reflow soldering process, it is recommended to use the IR reflow profile as shown below.

The recommended Pb-free solder paste are Almit LFM-48W TM-HP and Senju M705-GRN360-K.

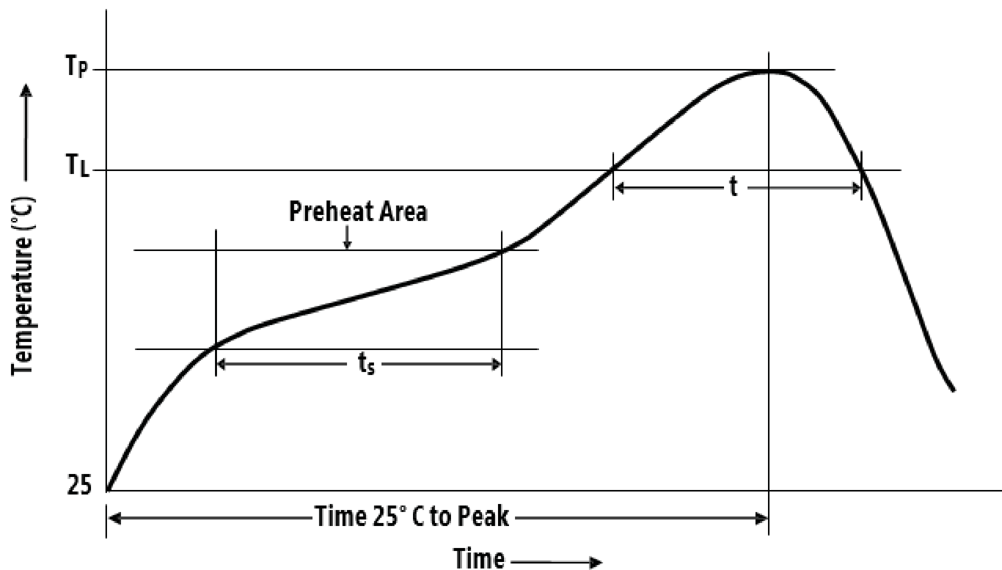

Figure 16. IR Reflow Profile

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Table 7. Reflow Profile Parameter

Parameter	Symbol	Min.	Max.	Unit	Note
Ramp-up slope to preheat area	T_{RAMP}	1.5	2.5	°C/sec	From 25 °C to preheat Area
Preheat area temperature	T_{PRE}	170	200	°C	
Preheat area duration	t_S	60	120	sec	
Melting duration	t_{MELT}	30	50	sec	T ≥220 °C
Melting Temperature	T_{MELT}	220	245	°C	

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Revision History

Revision Number	Date	Description
1.11	01 Dec 2022	Initial release.

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