Description

The WH4535V is a light to digital converter which combines an advanced proximity sensor and a high efficiency infra VCSEL light. The WH4535V is a miniature optical land grid array module integrated with a proximity sensor and a 940nm IR VCSEL.

The tiny package size is 2.0mm x 1.0mm x 0.5mm.

Proximity sensor (PS) built-in an 940nm optical filter for ambient light immunity, so PS can detect reflected IR light with high precision and excellent rejection into the sensor.

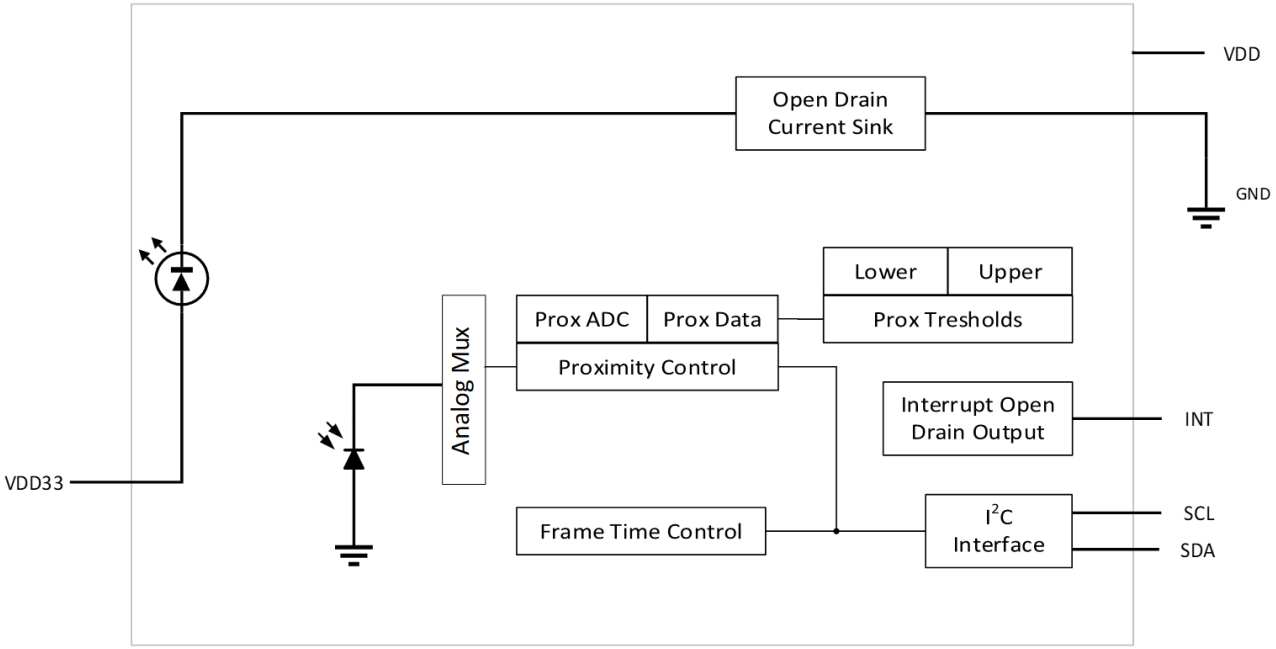
Features

- Tiny Package L2.0mm x W1.0mm x H0.5mm.
- Small pitch designed for 1.7mm circular sensor aperture size.
- 1.8V power supply with 1.8V I^2C bus.
- Total active current under 10uA@100ms and 10bits (VCSEL current included).
- Idle mode current 0.7uA.
- Sleep mode current 0.7uA.
- 940nm VCSEL IR emitter is driven 12mA.
- High crosstalk and ambient light cancellation equivalent to 2^{20} resolution.
- ADC resolution selectable for 10/12/14/16 bits.

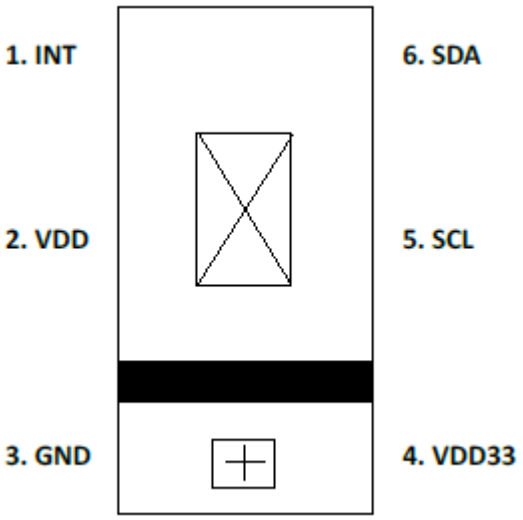
Applications

- True-wireless stereo earbuds
- Glasses
- Watches

Block Diagram



Pin Definition



I/O Pins Configuration

PIN	NAME	TYPE	DESCRIPTION
1	INT	O	Interrupt – Open drain
2	VDD		Supply voltage for sensor. Connect to V_{DD}
3	GND		Ground. All voltages are referenced to GND
4	VDD33	I	VCSEL Anode, connect to V_{DD33}
5	SCL	I	I^2C serial clock input terminal
6	SDA	I/O	I^2C serial data I/O terminal

Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Units	Conditions
Supply voltage to GND	V_{DD}	-0.3	2.1	V	
IR emitter voltage to GND	V_{DD33}	-0.3	4.5	V	
Digital I/O terminal voltage	V_{IO}	-0.3	4.3	V	
Digital output terminal current	I_{IO}	-1	24	mA	
Input current (latch-up immunity)	I_{SCR}		200	mA	JEDEC/JESD78E
HBM electrostatic discharge	ESD_{HBM}		2	KV	JEDEC/ESDA JS-001-2017
CDM electrostatic discharge	ESD_{CDM}		500	V	JEDEC JS-002-2014
Storage temperature range	T_{STRG}	−40	85	°C	
Package body temperature	T_{BODY}		260	°C	IPC/JEDEC J-STD-020

All voltages are with respect to GND.
Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Units
Operating ambient temperature	T_A	-30		85	°C
Power supply voltage to sensor	V_{DD}	1.6	1.8	2.0	V
Power supply voltage to IR emitter	V_{DD33}	2.9	3.3	4.5	V

Operating Characteristics, VDD = 1.8V, VDD33 = 3.3V, TA = 25°C (unless otherwise noted)

Parameter	Symbol	Min	Typ	Max	Units	Conditions [1]
Supply current [1]	I_{DD}		10		uA	Active state
Idle current [2]	I_{DD}		0.7			Idle state
Sleep current [3]	I_{DD}		0.7			Sleep state
INT SDA output low voltage	V_{OL}	0		0.4	V	3 mA sink current
		0		0.6	V	6 mA sink current
Leakage current, SDA, SCL, INT	I_{IOLEAK}	-5		5	uA	
SCL, SDA input high voltage	V_{IH}	1.25			V	
SCL, SDA input low voltage	V_{IL}			0.54	V	

Note(s):
1. The power consumption values include IR VCSEL current.
2. Idle state occurs when proximity is enabled and not in active state.
3. Sleep state occurs when proximity is disabled and I^2C is idle.

Proximity Photodiode Optical Characteristics, VDD = 1.8V, VDD33 = 3.3V, T_A = 25° C (unless otherwise noted)

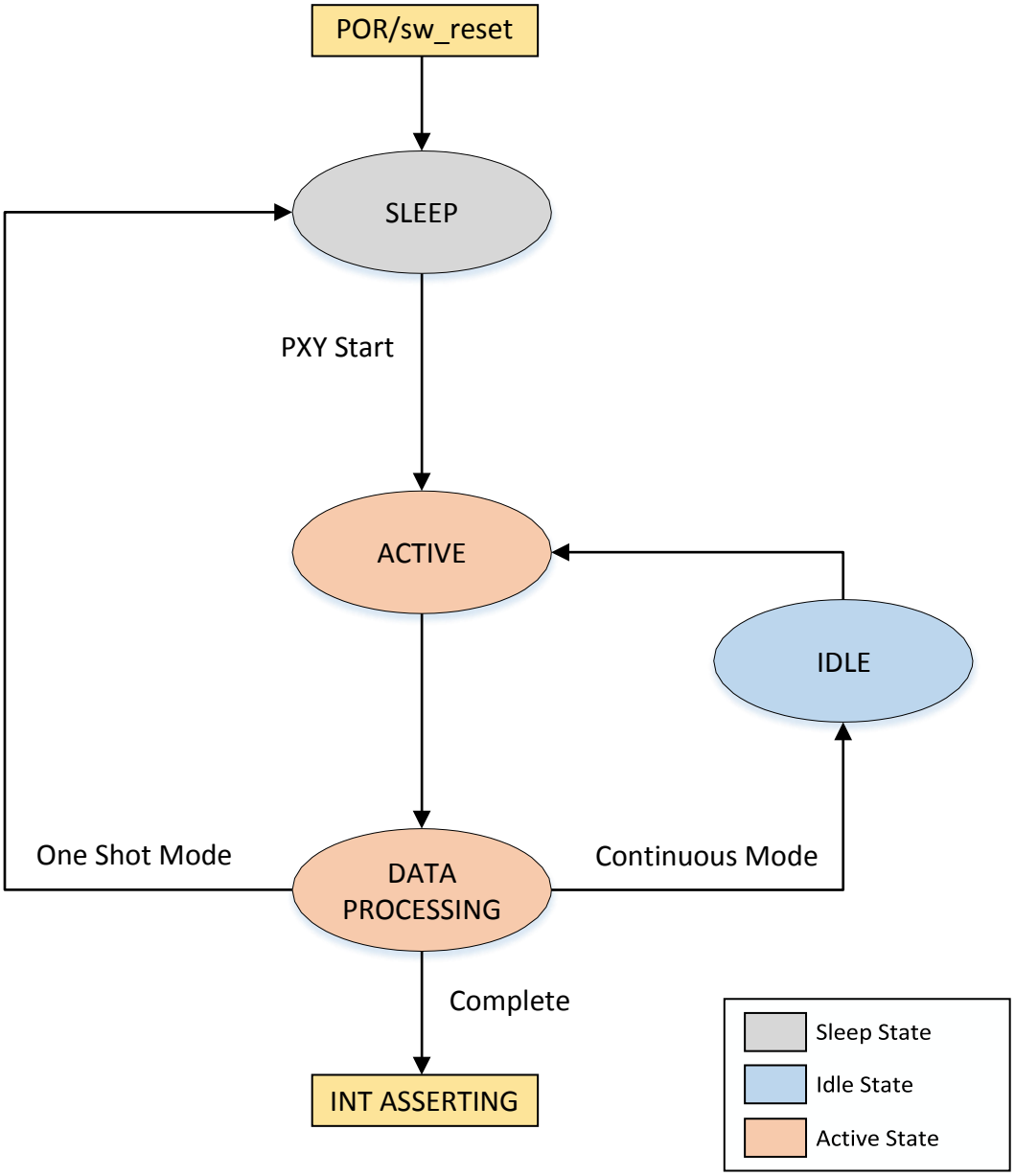
Parameter	Min	Typ	Max	Units
Proximity ADC count value [1][3] Object@10mm [2]		630		counts
Noise [1][4]			±2	%
Part to Part Variation [1][4]			±25	%

Note(s):
1. Pulse count = 1x; Pulse width=32us; LED drive = 12mA; No glass above module.
2. Object = 18% reflective surface (Gray card); Object Size = 100mm x 100mm.
3. Response with no target varies with power supply characteristics and system noise.
4. 3 sigma (σ) variation.

Frame Time Characteristics, V_{DD} = 1.8 V, VDD33 = 3.3V, T_A = 25 ℃ (unless otherwise noted)

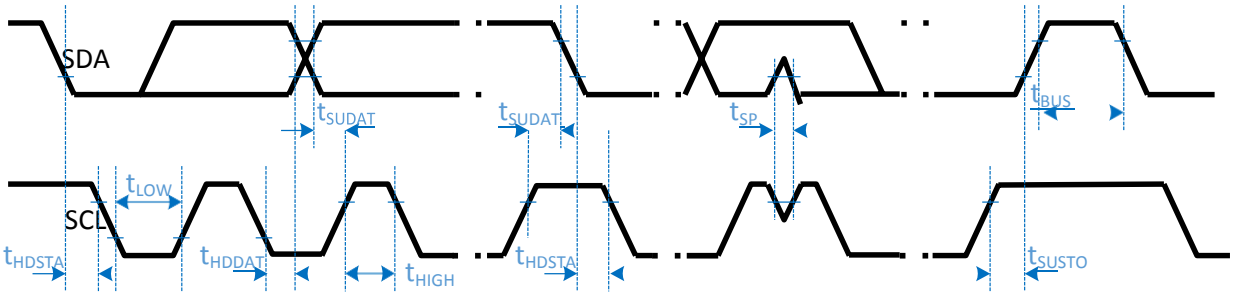
Parameter	Min	Typ	Max	Units	Conditions
Frame Time Step Size		1		ms	
Frame Time Number of Step	0		4095	steps	

System state machine



I²C Interface Timing Characteristics

This section will describe the protocol of the I²C bus. For more details and timing diagrams please refer to the I²C specification.

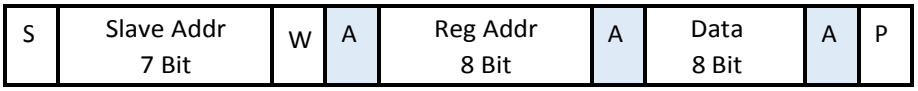


Parameter (*)	Symbol	Fast mode		Unit
		Min	Max	
SCL clock frequency	f_{SCL}	100	400	kHz
Bus free time between STOP condition and START condition	t_{BUS}	1.3	--	µs
LOW period of the SCL clock	t_{LOW}	1.3	--	µs
HIGH period of the SCL clock	t_{HIGH}	0.6	--	µs
Hold time (repeated) START condition	t_{HDSTA}	0.6	--	µs
Set-up time (repeated) START condition	t_{SUSTA}	0.6	--	µs
Set-up time for STOP condition	t_{SUSTO}	0.6	--	µs
Data hold time	t_{HDDAT}	50	--	ns
Data set-up time	t_{SUDAT}	100	--	ns
Pulse width of spikes which must be suppressed by the input filter	t_{SP}	0	50	ns
Rise time of both SDA and SCL signals		20 x VDD/5.5	300	ns
Fall time of both SDA and SCL signals		20 x VDD/5.5	300	ns

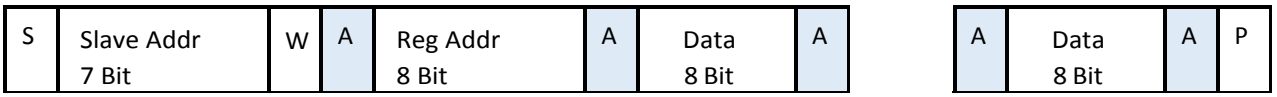
(*) Specified by design and characterization; not production tested.

(**) All specifications are at V_{Bus} = 3.3V, T_{ope}=25°C, unless otherwise noted.

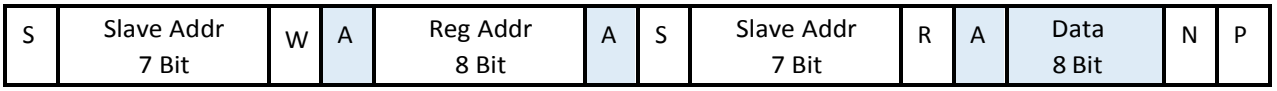
I²C Write Format



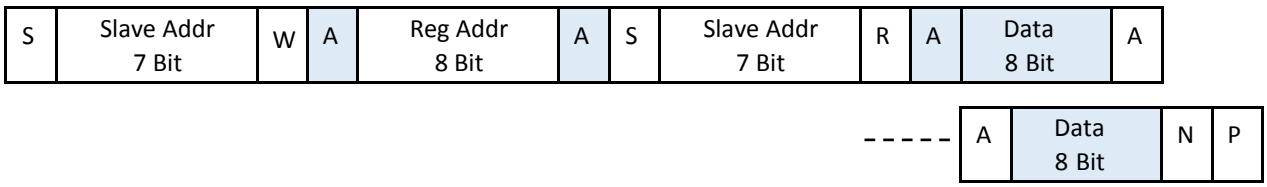
I²C Block Write Format



I²C Read Format



I²C Block Read Format



Master to Slave

Slave to Master

S Start Condition,1Bit

P Stop Condition,1Bit

W Write,Set 0 for write,1Bit

R Read, Set 1 for read, 1 Bit

A Acknowledge(ACK), Set 0, 1 Bit

N Non acknowledge(NACK), Set 1, 1 Bit

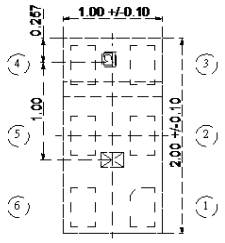
Register Map

Address	Default	Name	Function	R/W
0x00	0xC0	InterruptFlag	Interrupt Flag	R/W
0x01	0x00	ErrorFlag	PS Error Flag	R
0x02	0x00	PDAT_L	PS low data	R
0x03	0x00	PDAT_H	PS high data	R
0x1E	0x01	PID	Product ID	R
0x1F	0x01 or 0x02	VID	Revision ID	R
0x40	0x00	PsCtrl	PS bits and average number control	R/W
0x42	0x01	PsPulseWidth	PS pulse width control	R/W
0x43	0x01	PsBurstCount	PS burst count control	R/W
0x44	0x20	LedDriverCtrl	LED driver control	R/W
0x45	0x01	PsIntCtrl	PS interrupt control	R/W
0x46	0x11	CTC(1)_Gain	CTC(1) gain control	R/W
0x47	0x00	CTC(1)_Ctrl	CTC(1) control	R/W
0x4A	0x00	PsBaseLine_L	PS base line low byte	R/W
0x4B	0x00	PsBaseLine_H	PS base line high byte	R/W
0x4C	0x00	PsThresholdLow_L	PS low threshold low byte	R/W
0x4D	0x00	PsThresholdLow_H	PS low threshold high byte	R/W
0x4E	0xFF	PsThresholdHigh_L	PS high threshold low byte	R/W
0x4F	0xFF	PsThresholdHigh_H	PS high threshold high byte	R/W
0x80	0x00	SensorCtrl	Sensor control	R/W
0x81	0x81	InterruptCtrl	Interrupt control	R/W
0x84	0x00	SoftwareReset	Software reset	R/W
0x88	0x1E	FrameTime_L	Frame time low byte	R/W
0x89	0x00	FrameTime_H	Frame time high byte	R/W
0xD9	0x00 to 0x3F	CTC(1)_Step	CTC(1) step control	R/W

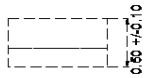
Note: 1. CTC = Crosstalk Cancellation

Package Outline Dimensions

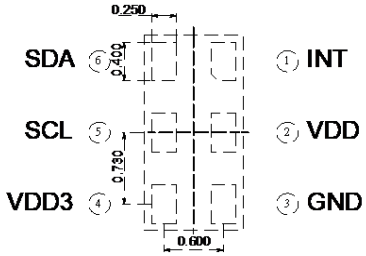
PACKAGE DIMENSIONS



Top View

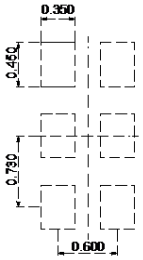


Front View

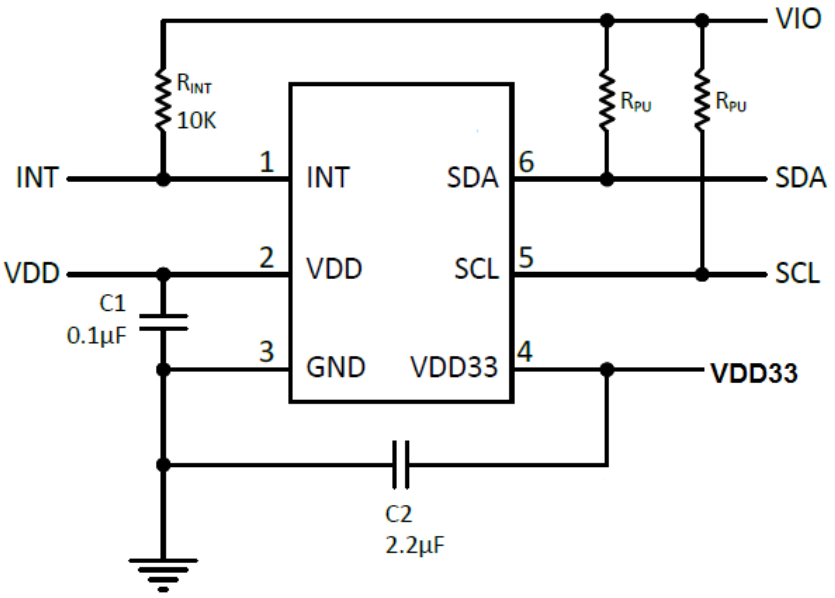


Bottom View

PCBLAND PATTERN



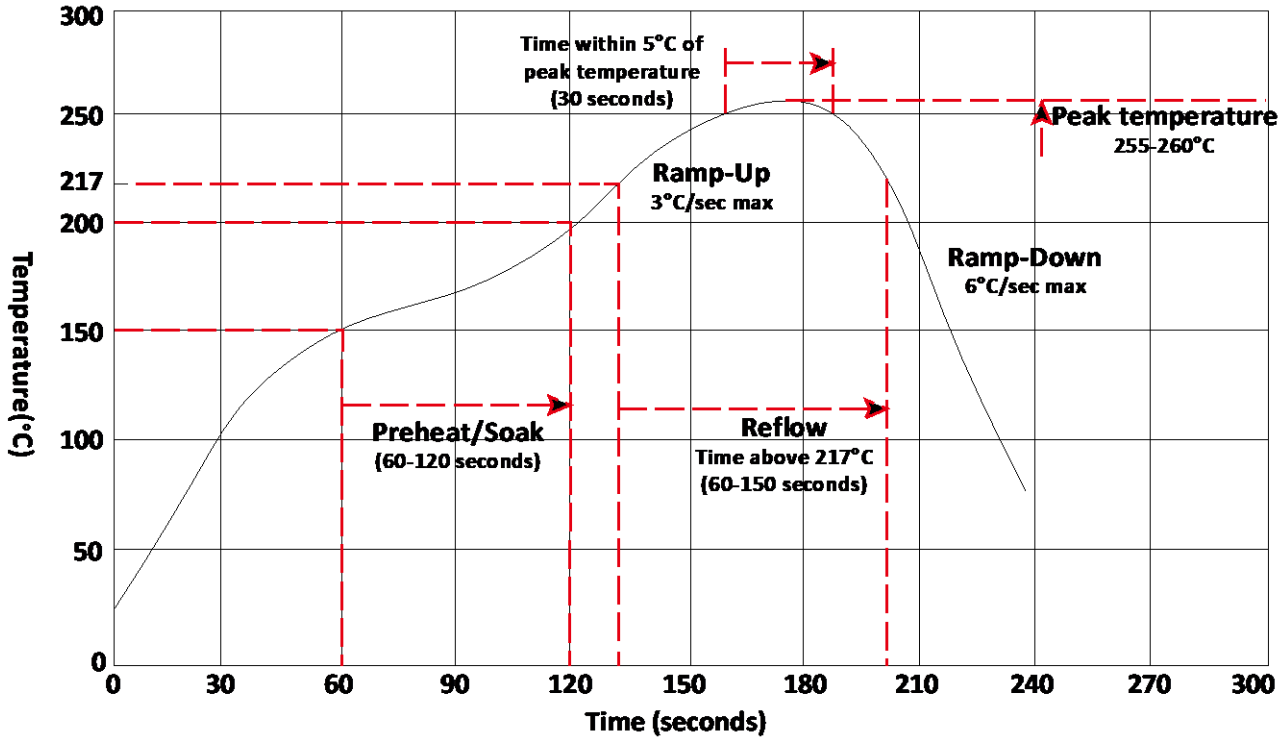
Application Circuit



Note(s):

1. Power supply decoupling capacitors (C1, C2) should be placed as near as possible to the device (common design practice).
2. The I^2C lines are open-drain and pull up resisters required.
3. The value of the I^2C pull up resistors R_{PU} should be based on the V_{IO} (1.8V) bus voltage, system bus speed and trace capacitance.
4. Recommended to connect VDD to a host GPIO pin to allow the device to be independently power cycled.

Recommended Reflow Profile



Complies with IEC/EN 60825-1:2014 and 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No.50, dated June 24, 2007

CLASS 1
LASER PRODUCT
IEC / EN 60825-1:2014

The WH4535V is designed to meet the Class 1 laser safety limits including single faults in compliance with IEC/EN
60825-1:2014. In an end application system environment, the system may need to be tested to ensure it remains compliant. The system must not include any additional
lens to concentrate the laser light or parameters set outside of the recommended operating conditions or any physical modification to the module during development could result in hazardous levels of radiation exposure.