

Features

- VIN Input Voltage Range: 4.0 to 5.5V.
- 25V Absolute Ratings at VBUS Pin.
- 3A Output Current Capability
- Adjustable Current limit from 1A to 3.3A
- Fast Over Current Protection Response Time
- Fault Report on /FLT Pin.
- Built in Thermal Shutdown Protection
- Built in Fast Turn On function by FO pin if needing quick hot-swap.
- Built in True Reverse-Current Blocking (TRCB)
- Built in Enable/ Shutdown Control by EN Pin
- Integrated Internal Charge Pump
- Built in Programmable Over Current Setting
- Surge Protection:
 - IEC61000-4-5 exceeds $\pm 80V$ on VBUS
- Safety Approvals :
 - UL Approved-File No. E328191
 - UL-CB Scheme IEC/EN62368-1 Certified, No. DK-82160-UL
 - TUV IEC/EN62368-1 Certified, No. 44 780 19 40674 8-002
- ESD Protection :
 - EC61000-4-2 contact discharge over with 8kV
 - HBM with over 2kV
 - CDM with over 500V at VBUS pin
- WLCSP2.05x2.05-16 Package
- Lead Free and Green Devices Available (RoHS Compliant)

Applications

- Notebook and Desktop Computers
- USB PD Type C Ports/Hubs
- High-side Power Protection Switches

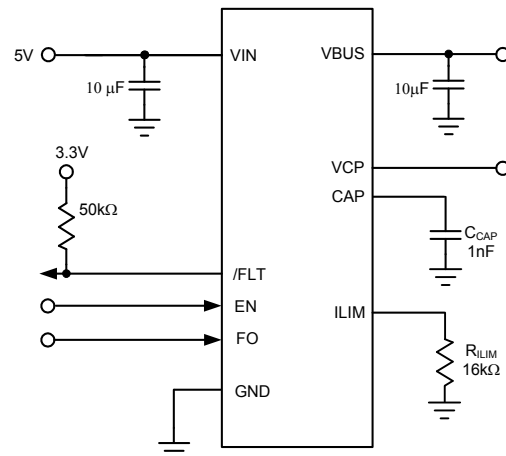
General Description

The APL3563 is designed for USB PD Type C applications. The low on resistance N-channel MOSFET power switch can satisfy the voltage drop requirements of USB specification.

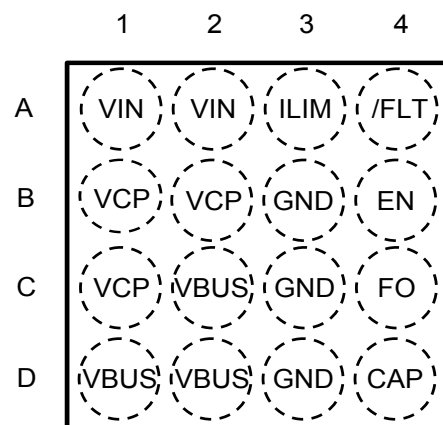
The protection features include current limit protection, short circuit protection, over-temperature protection, input over voltage protection output over voltage protection, output surge protection and reverse current blocking.

Other features include a deglitched /FLT output to indicate the fault condition and an enable input to enable or disable the device.

Simplified Application Circuit



Pin Configuration



WLCSP2.05x2.05-16
(Top View)
APL3563

Ordering and Marking Information

APL3563□□-□□□□ Assembly Material Handling Code Temperature Range Package Code	Package Code HA : WLCSP2.05x2.05-16 Operating Ambient Temperature Range I : -40 to 85°C Handling Code TR : Tape & Reel Assembly Material G : Halogen and Lead Free Device
APL3563HA: 3563 X X - Date Code	

Note : ANPEC lead-free products contain molding compounds/die attach materials and 100% matte tin plate termination finish; which are fully compliant with RoHS. ANPEC lead-free products meet or exceed the lead-free requirements of IPC/JEDEC J-STD-020C for MSL classification at lead-free peak reflow temperature. ANPEC defines "Green" to mean lead-free (RoHS compliant) and halogen free (Br or Cl does not exceed 900ppm by weight in homogeneous material and total of Br and Cl does not exceed 1500ppm by weight).

Absolute Maximum Ratings (Note 1)

Symbol	Parameter		Rating	Unit
V_{IN}	VIN to GND Voltage		-0.3 ~ 7	V
V_{BUS}	VBUS to GND Voltage	>20ns pulse width	-0.3 ~ 25	V
		<20ns pulse width	-0.3 ~ 30	V
	EN, FO, /FLT, ILIM to GND Voltage		-0.3 ~ 7	V
T_J	Maximum Junction Temperature		-40 ~ 150	°C
T_{STG}	Storage Temperature		-65 ~ 150	°C
T_{SDR}	Maximum Lead Soldering Temperature (10 Seconds)		260	°C

Note 1: 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 rating conditions for extended periods may affect device reliability.

Thermal Characteristics (Note 2)

Symbol	Parameter	Typical Value	Unit
θ_{JA}	Junction-to-Ambient Resistance in free air	58	°C/W

Note 2: θ_{JA} is measured with the component mounted on a high effective thermal conductivity test board in free air.

Recommended Operating Conditions (Note 3)

Symbol	Parameter	Range	Unit
V_{IN}	VIN Input Voltage	4.0 ~ 5.5	V
I_{OUT}	OUT Output Current	0~3	A
C_{OUT}	VBUS Pin External Capacitor Range	10 ~ 100	μF
R_{ILIM}	ILIM Pin External Resistor Range	16 ~ 54	kΩ
T_A	Ambient Temperature	-40 ~ 85	°C
T_J	Junction Temperature	-40 ~ 125	°C

Note 3: Refer to the typical application circuit.

Electrical Characteristics

Unless otherwise specified, these specifications apply over $V_{IN}=5V$, $V_{EN}=5V$ and $T_A=-40 \sim 85^\circ C$. Typical values are at $T_A=25^\circ C$.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit	
BASIC OPERATION							
V _{VIN}	VIN Input Voltage		4.0	–	5.5	V	
I _Q	VCC Supply Current	V _{VIN} =5V, No load, V _{EN} =0V	–	2	55	μA	
		V _{VIN} =5V, No load, V _{EN} =5V, RILIM =33kΩ	–	1.3	1.65	mA	
		V _{VIN} =5V, No load, V _{EN} =5V, RILIM =16kΩ	–	1.3	1.65	mA	
	VBUS Off State Leakage Current	V _{VIN} =5V, VBUS=GND, V _{EN} =0V	–	–	4	μA	
	VIN Reverse Leakage Current	V _{VIN} =GND, V _{VBUS} =5V, V _{EN} =0V	–	–	10	μA	
		V _{VIN} =GND, V _{VBUS} =20V, V _{EN} =0V	–	–	50	μA	
POWER SWITCH							
R _{DS(ON)}	Power Switch On Resistance	V _{VIN} = 4.0 to 5.5V, I _{OUT} =3A, resistance between VIN and VBUS	T _A = 25 °C	–	35	42	mΩ
			T _A = -40 ~ 85°C	–	–	49	mΩ
UNDER-VOLTAGE LOCKOUT							
V _{UVLO_H}	VIN UVLO Threshold Voltage	V _{VIN} rising, T _A = -40 ~ 85 °C	3.6	3.8	4.0	V	
	VIN UVLO Hysteresis		–	0.2	–	V	
OVER-CURRENT AND SHORT CIRCUIT PROTECTIONS							
I _{OCP}	Over Current Protection	V _{VIN} = 5V, V _{VBUS} = 5V	R _{ILIM} =54K	515	615	800	mA
			R _{ILIM} =33K	1100	1300	1580	mA
			R _{ILIM} =24.9K	1600	1800	2200	mA
			R _{ILIM} =20K	2050	2250	2700	mA
			R _{ILIM} =16K	2700	2900	3500	mA
t _{FLTB_Degl}	Fault pin deglitch time	V _{VIN} = 5V, T _A =25 °C	–	8	–	ms	
	Fault pin deglitch time Hystersis	V _{VIN} = 5V, T _A =25 °C	–	8	–	ms	
I _{TRIP_SC}	Short Circuit Trip Threshold	VBUS short circuit to ground	7	8	9	A	
	Short Circuit Response Time	C _L =1μF, VBUS short circuit to ground	–	–	1	μs	
/FLT OUTPUT PIN							
	/FLT Output Low Voltage	I _{/FLT} =5mA	–	0.2	0.4	V	
	/FLT Leakage Current	V _{/FLT} =5V	–	–	1	μA	
EN, FO, DISEN INPUT PIN							
V _{IH}	Input Logic HIGH	V _{VIN} =4.0V to 5.5V, T _A = -40 ~ 85 °C	1.2	–	–	V	
V _{IL}	Input Logic LOW	V _{VIN} =4.0V to 5.5V, T _A = -40 ~ 85 °C	–	–	0.4	V	
	Input Current	V _{EN} = 5V, T _A = -40 ~ 85 °C	–	–	1	μA	
Rpd	Pull-down resistance	V _{VIN} =5V,		1		MΩ	
DISCHARGE AND SOFTSTART							
t _{D(ON)}	Turn on Delay Time	C _{OUT} =10μF, V _{VIN} =5V, FO=low	–	200	–	μs	
		C _{OUT} =10μF, V _{VIN} =5V, FO=high	–	200	–	μs	
t _{D(OFF)}	Turn off Delay Time	C _{OUT} =10μF, V _{VIN} =5V,	–	50	–	μs	
t _{SS}	Soft-Start Time	No load, COUT=10μF, VVIN=5V, FO=low,	–	2	–	ms	
		No load, COUT=10μF, VVIN=5V, FO=high	–	50	150	μs	

Electrical Characteristics (Cont.)

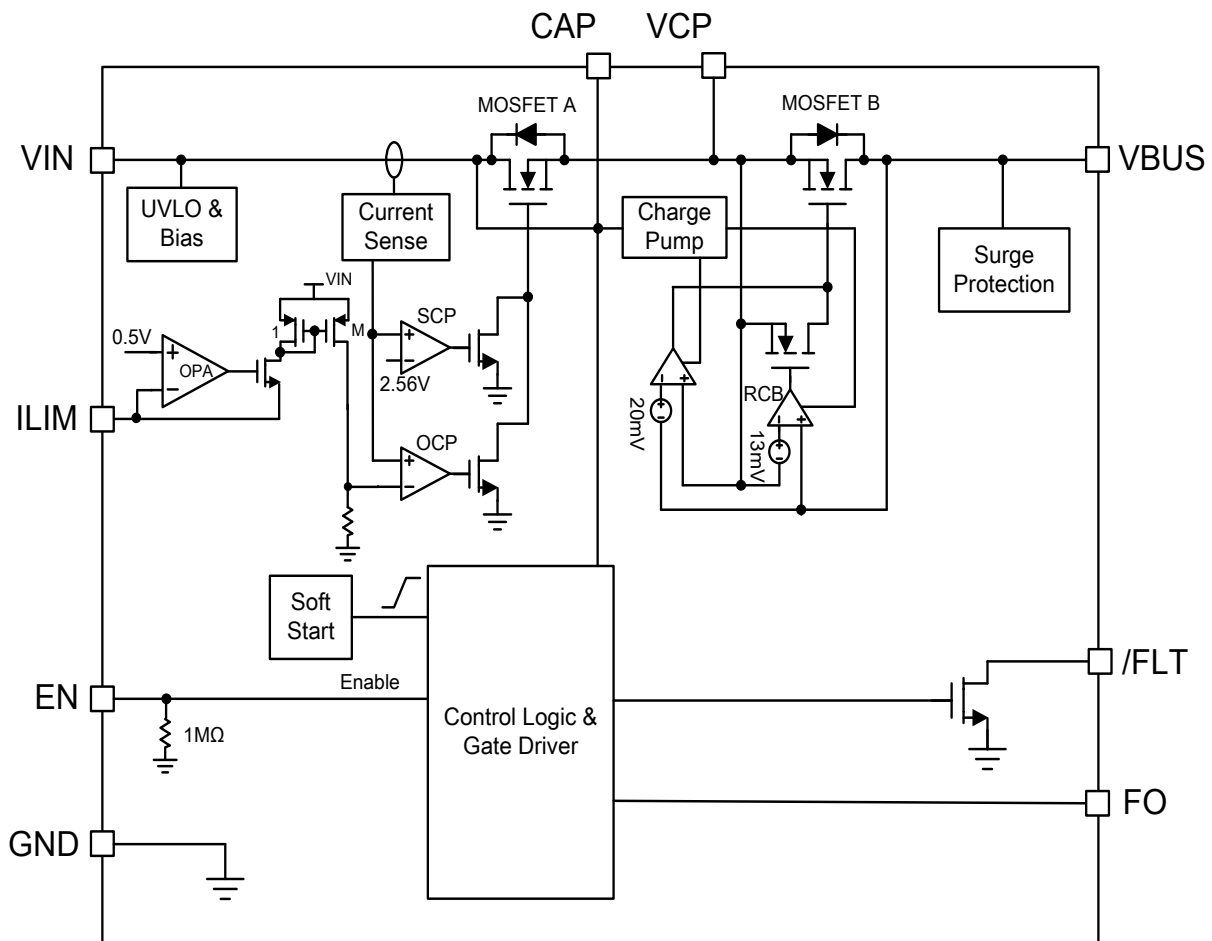
Unless otherwise specified, these specifications apply over $V_{IN}=5V$, $V_{EN}=5V$ and $T_A=-40 \sim 85^\circ C$. Typical values are at $T_A=25^\circ C$.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
OVER-TEMPERATURE PROTECTION (OTP)						
T_{OTP}	Over-Temperature Threshold	T_J rising	–	150	–	$^\circ C$
	Over-Temperature Hysteresis		–	50	–	$^\circ C$
SURGE PROTECTION						
	Output Surge Protection Threshold		–	27	–	V
REVERSE CURRENT BLOCK						
	Reverse Current Block Threshold	$V_{VBUS} - V_{VCP}$	–	13	–	mV
	Reverse Current Protection recovery time	$V_{VIN}=5V$, EN=high, from VBUS drops below VIN to MOS-B ON.	–	15	50	μs
	Reverse Current trun off time	MOS-B turn off time	–	0.3	–	μs
	VCP to VBUS Regulation Voltage	$V_{VCP} - V_{VBUS}$	–	20	–	mV

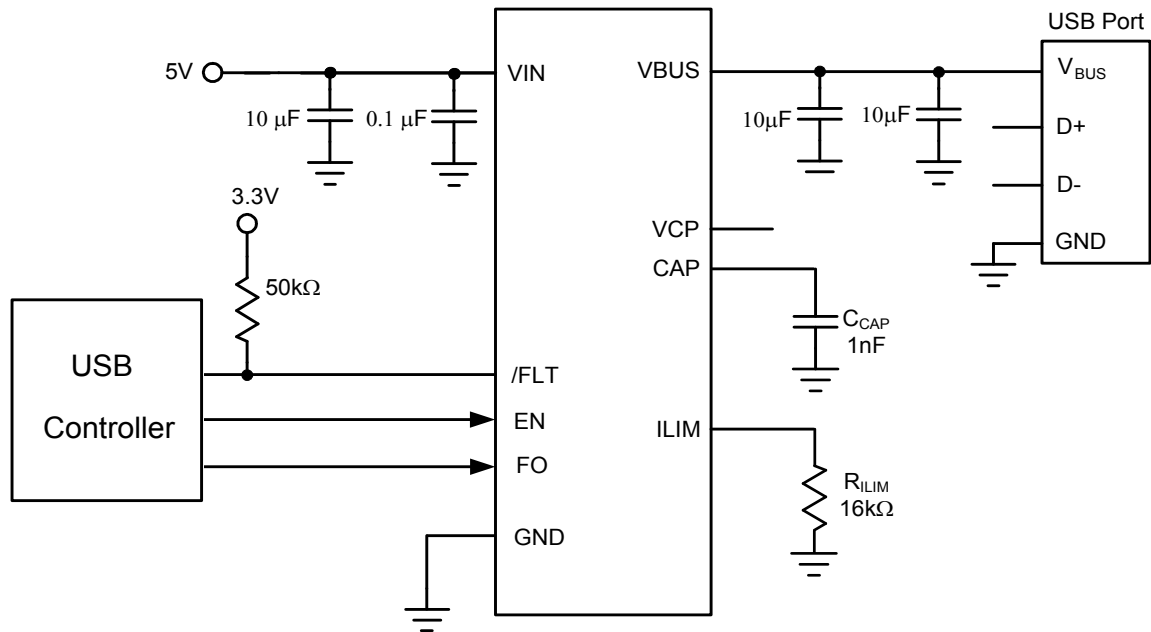
Pin Descriptions

PIN		FUNCTION
NO.	NAME	
A1,A2	VIN	Power Supply Input. Connect this pin to an external DC power supply.
B1,B2,C1	VCP	Central point of internal two power MOSFETs.
C2,D1,D2	VBUS	Output Voltage Pin. The output voltage follows the input voltage. When EN is low the output voltage is disconnected from input.
A3	ILIM	Over Current Threshold Setting Pin. A resistor connected form this pin to ground can set an over current threshold.
A4	/FLT	Fault Indication Pin. This pin goes low when a current limit, or an over-temperature condition is detected after a 8ms deglitch time.
B4	EN	Enable Input. Pulling this pin to high enables the device while pulling low disables the device. The EN pin have Pull-down resistance 1M Ω .
B3,C3,D3	GND	Ground.
C4	FO	Fast turn on control pin. Pulling this pin high can disable CAP slew rate control. This pin has an internal pull low resistor and then can be left open if not used.
D4	CAP	Charge pump charge storage pin.

Block Diagram



Typical Application Circuit



Function Descriptions

VCC Under-voltage Lockout (UVLO)

The APL3563 is built-in an under-voltage lockout circuit to keep the output shut off until internal circuitry is operating properly. The UVLO circuit has hysteresis and a de-glitch feature so that it will typically ignore undershoot transients on the input. When input voltage exceeds the UVLO threshold, the output voltage starts a soft-start to reduce the inrush current.

Power Switch

The power switches are N-channel MOSFETs with a low $R_{DS(ON)}$. Their body diodes are reversely connected in polarity with each other that can prevent a current flowing from the VBUS back to VIN and VIN to VBUS when IC is off.

Soft start

The APL3563 has a 2ms rising time for normal startup. Fast turn-on when USB PD is applied. The customer uses the FO pin to pull high and the rise time can be reduced to 100us level.

Over Current Protection

The APL3563 provides OCP protection against over load or short circuit conditions. The OCP threshold can be adjusted by the resistor on ILIM pin, RILIM. When the load current exceeds the OCP threshold, IOCP, the MOS-A will clamp the OCP threshold and VBUS will go down. In the current limit mode, the output periodically executes soft start process until the fault event has disappeared.

Short-circuit Protection

The APL3563 shuts off output current immediately when output current exceeds short circuit trip threshold in an instant short circuit event.

After the trip of short circuit threshold, MOS-A turn off immediately and the output is shut off. In this mode, the output periodically executes soft start process until the fault event has disappeared.

When using the following conditions for short circuit test, VIN must be greater than 4.5V.

- $C_{VIN} = 44\mu F$, VBUS short to gnd by metal tweezer.
- VIN connect to customer DC-DC converter.

/FLT Output

The APL3563 provides an open-drain output to indicate that a fault has occurred. When any of current limit or over-temperature protection occurs the /FLT goes low. When over current protection occurs, there will be 8ms deglitch time before entering the condition of fault. There is no 8ms deglitch time when over temperature protection occurs. Since the /FLT pin is an open-drain output, connecting a resistor to a pull high voltage is necessary. Normally the pull high resistor is suggested between $2k\Omega$ to 200Ω .

Enable/Disable

Pulling the EN below 0.4V disables the device while pulling EN above 1.2V enables the device. When the IC is disabled the supply current is reduced to less than $2\mu A$. The enable input is compatible with both TTL and CMOS logic levels. The EN pin cannot be left floating.

Over-temperature Protection

When the junction temperature exceeds $150^{\circ}C$, the internal thermal sense circuit turns off the power FET and allows the device to cool down. When the device's junction temperature cools by $50^{\circ}C$, the internal thermal sense circuit will enable the device, resulting in a pulsed output during continuous thermal protection. Thermal protection is designed to protect the IC in the event of over temperature conditions. For normal operation, the junction temperature cannot exceed $T_J = +125^{\circ}C$.

Reverse Current Block

The APL3563 provides reverse current block function or RCB to prevent current flowing from VBUS to VIN. This function can emulate the internal MOSFET B as an ideal diode. In other words, the current is only allowed to flow from VIN to VBUS but forbidden from VBUS to VIN. During normal operation, if a voltage higher than VVIN appears at VBUS, the reverse current could generate a voltage drop between VBUS and VCP. When $V_{VBUS} - V_{VCP} > 13mV$ is triggered, the RCB function is activated then. There is another scenario when RCB can be activated. In normal operation if a short circuit happens at VIN, the RCB function can stop current flowing from VBUS to VIN, too. In light load or no load conditions, The VVBUS is regulated at $V_{VIN} - 20mV$ until load current is large enough to produce a voltage drop $(= I_{LOAD} * R_{DS(ON)})$ across VBUS to VIN higher than 20mV.

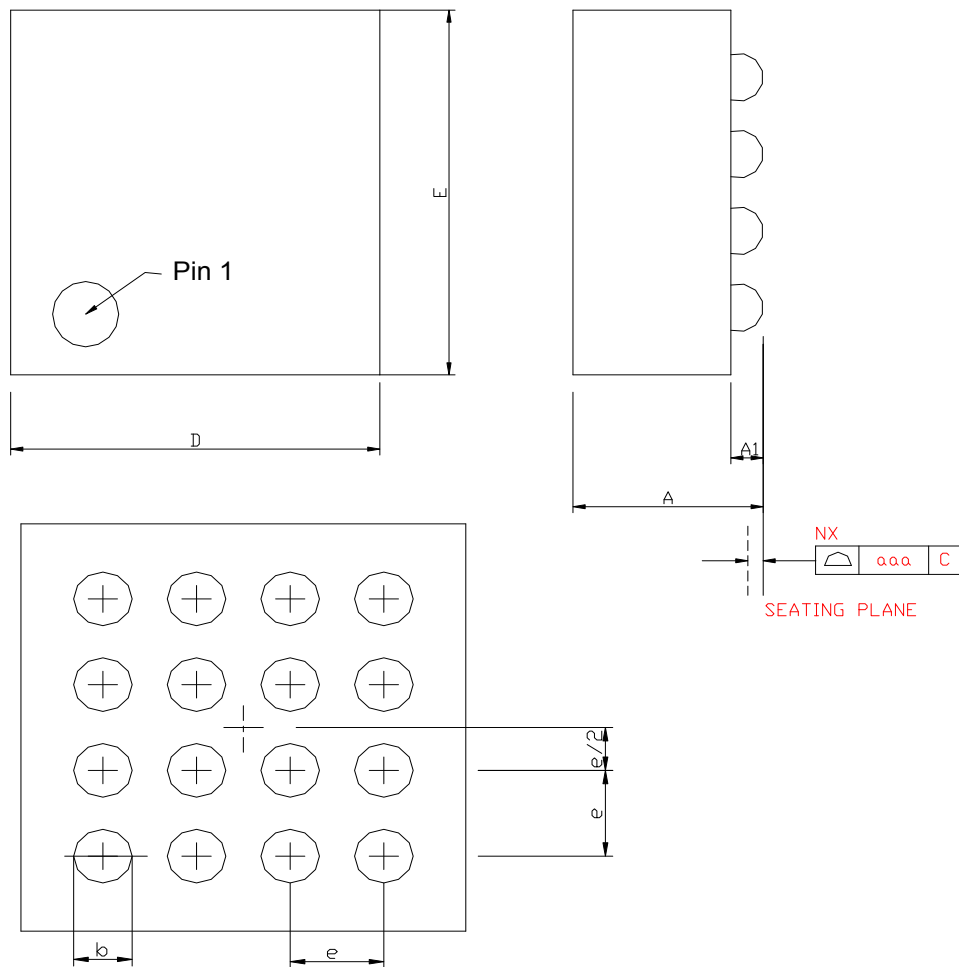
When VBUS drop below VIN in RCB mode, the device immediately leaves the RCB mode and turns on MOS-B in 50us. When the VBUS greater than VIN, the device turn off MOS_B within 1us.

Surge Protection

The APL3563 has surge protection on VBUS pin. Any voltage surge surpasses 27V will be clamped to a safe level.

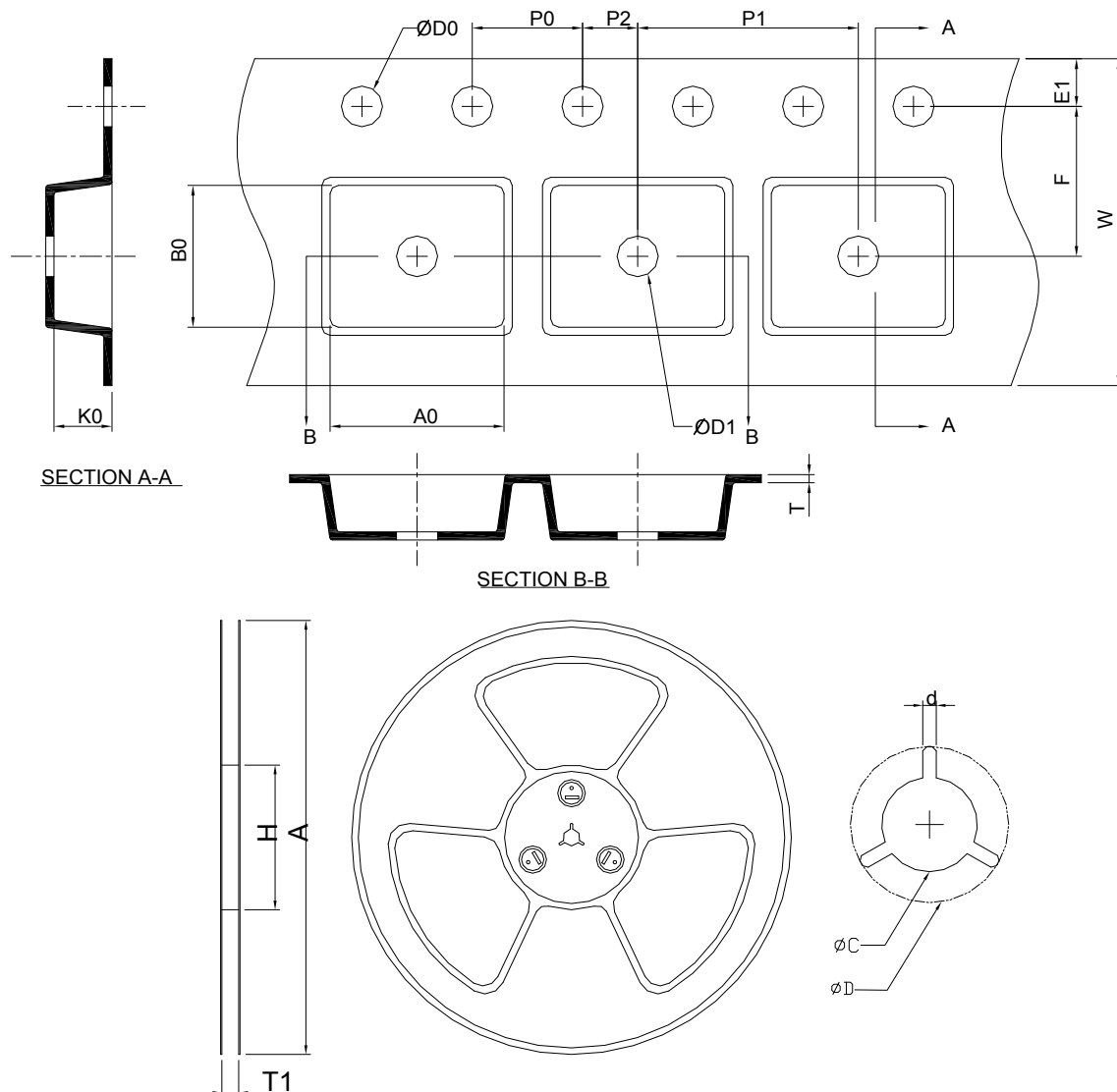
Package Information

WLCSP2.05x2.05-16



SYMBOL	WLCSP2.05x2.05-16			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A		0.60		0.024
A1	0.20	0.26	0.008	0.010
b	0.25	0.35	0.010	0.014
D	2.05	2.13	0.081	0.084
E	2.05	2.13	0.081	0.084
e	0.50 BSC		0.020 BSC	
aaa	0.08		0.003	

Carrier Tape & Reel Dimensions



Application	A	H	T1	C	d	D	W	E1	F
WLCSP 2.05x2.05	178.0±2.00	50 MIN.	8.4+2.00 -0.00	13.0+0.50 -0.20	1.5 MIN.	20.2 MIN.	8.0±0.30	1.75±0.10	3.5±0.05
	P0	P1	P2	D0	D1	T	A0	B0	K0
	4.0±0.10	4.0±0.10	2.0±0.05	1.5+0.10 -0.00	1.0 MIN.	0.6+0.00 -0.40	2.33±0.20	2.33±0.20	0.70±0.20

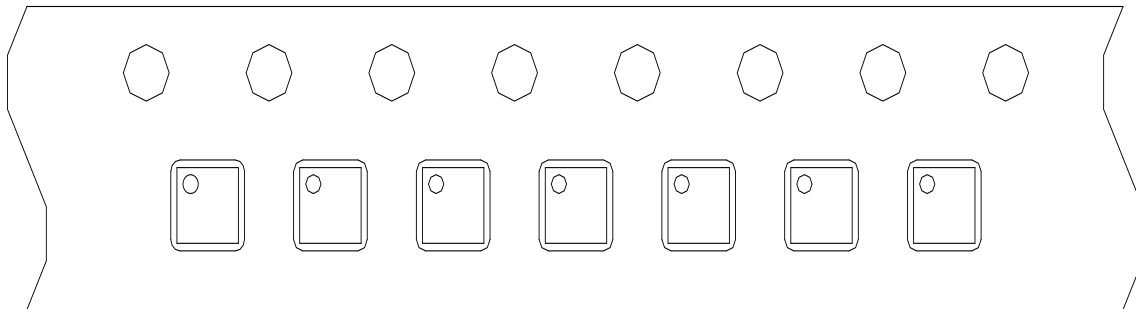
(mm)

Devices Per Unit

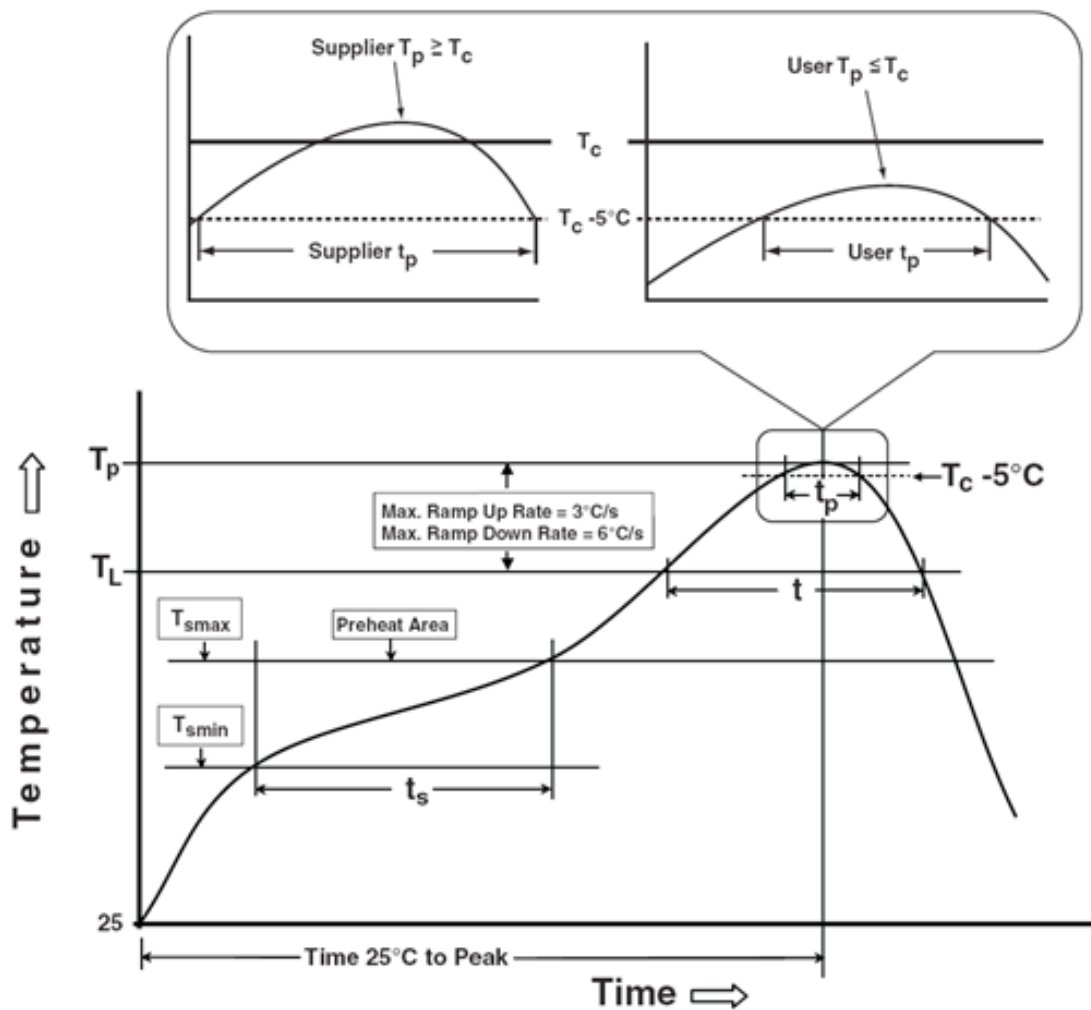
Package type	Packing	Quantity
WLCSP(2.05x2.05)	Tape & Reel	3000

Taping Direction Information

WLCSP2.05x2.05-16



Classification Profile



Classification Reflow Profiles

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Preheat & Soak		
Temperature min (T_{smin})	100 °C	150 °C
Temperature max (T_{smax})	150 °C	200 °C
Time (T_{smin} to T_{smax}) (t_s)	60-120 seconds	60-120 seconds
Average ramp-up rate (T_{smax} to T_p)	3 °C/second max.	3°C/second max.
Liquidous temperature (T_L)	183 °C	217 °C
Time at liquidous (t_L)	60-150 seconds	60-150 seconds
Peak package body Temperature (T_p)*	See Classification Temp in table 1	See Classification Temp in table 2
Time (t_p)** within 5°C of the specified classification temperature (T_c)	20** seconds	30** seconds
Average ramp-down rate (T_p to T_{smax})	6 °C/second max.	6 °C/second max.
Time 25°C to peak temperature	6 minutes max.	8 minutes max.
* Tolerance for peak profile Temperature (T_p) is defined as a supplier minimum and a user maximum.		
** Tolerance for time at peak profile temperature (t_p) is defined as a supplier minimum and a user maximum.		

Table 1. SnPb Eutectic Process – Classification Temperatures (T_c)

Package Thickness	Volume mm ³ <350	Volume mm ³ >350
<2.5 mm	235 °C	220 °C
≥2.5 mm	220 °C	220 °C

Table 2. Pb-free Process – Classification Temperatures (T_c)

Package Thickness	Volume mm ³ <350	Volume mm ³ 350-2000	Volume mm ³ >2000
<1.6 mm	260 °C	260 °C	260 °C
1.6 mm – 2.5 mm	260 °C	250 °C	245 °C
≥2.5 mm	250 °C	245 °C	245 °C

Reliability Test Program

Test item	Method	Description
SOLDERABILITY	JESD-22, B102	5 Sec, 245°C
HOLT	JESD-22, A108	1000 Hrs, Bias @ $T_j=125^{\circ}\text{C}$
PCT	JESD-22, A102	168 Hrs, 100%RH, 2atm, 121°C
TCT	JESD-22, A104	500 Cycles, -65°C~150°C
HBM	MIL-STD-883-3015.7	VHBM ≥ 2KV
MM	JESD-22, A115	VMM ≥ 200V
Latch-Up	JESD 78	10ms, $1_{tr} \geq 100\text{mA}$

Customer Service

Anpec Electronics Corp.

Head Office :

No.6, Dusing 1st Road, SBIP,

Hsin-Chu, Taiwan, R.O.C.

Tel : 886-3-5642000

Fax : 886-3-5642050

Taipei Branch :

2F, No. 11, Lane 218, Sec 2 Jhongsing Rd.,

Sindian City, Taipei County 23146, Taiwan

Tel : 886-2-2910-3838

Fax : 886-2-2917-3838