USB Power-Distribution Switches

Features

- **70mΩ (MSOP-8) High Side MOSFET**
- **Wide Supply Voltage Range: 2.7V to 5.5V**
- **Current-Limit and Short-Circuit Protections**
- **Over-Temperature Protection**
- **Fault Indication Output**
- **Enable Input**
- **UL Approved-File No. E328191**
- **Nemko IEC 60950-1:2005(2nd Edition)+Am 1:2009 EN 60950-1:2006+A11:2009+A1:2010+A12:2011 CB_Scheme Certified, No.67404**
- **TUV IEC 60950-1: 2005+A1:2009 and EN 60950-1: 2006+A11:2009+A1:2010 Certified, No.44 780 11 393954**
- **Lead Free and Green Devices Available (RoHS Compliant)**

Applications

- **Notebook and Desktop Computers**
- **USB Ports**
- **High-Side Power Protection Switchs**

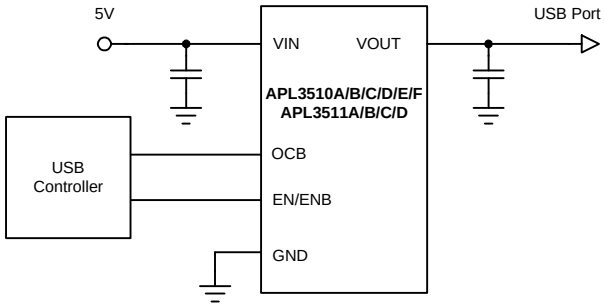
General Description

The APL3510/1 series of power switches are designed for USB applications. The 70mΩ N-channel MOSFET power switch satisfies the voltage drop requirements of USB specification.

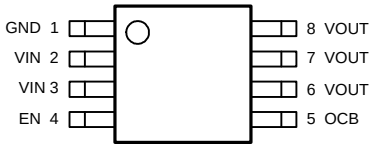
The protection features include current-limit protection, short-circuit protection, and over-temperature protection. The device limits the output current at current limit threshold level. When V_{OUT} drops below V_{IN}-1V, the devices limit the current to a lower and safe level. The over-temperature protection limits the junction temperature below 140°C in case of short circuit or over load conditions.

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

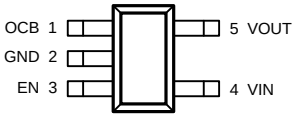
Simplified Application Circuit



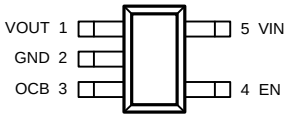
Pin Configurations



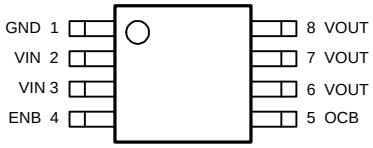
SOP-8/MSOP-8
APL3510A/C
(Top View)



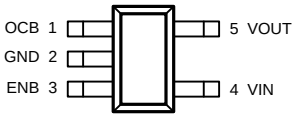
SOT-23-5
APL3510A/C/E
(Top View)



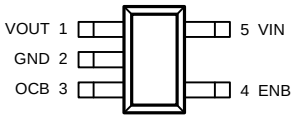
SOT-23-5
APL3511A/C
(Top View)



SOP-8/MSOP-8
APL3510B/D
(Top View)



SOT-23-5
APL3510B/D/F
(Top View)



SOT-23-5
APL3511B/D
(Top View)

ANPEC reserves the right to make changes to improve reliability or manufacturability without notice, and advise customers to obtain the latest version of relevant information to verify before placing orders.

Ordering and Marking Information

APL3510 □□□-□□□
APL3511

- Assembly Material
- Handling Code
- Temperature Range
- Package Code
- Output Current/EN Function

Package Code
K : SOP-8 X : MSOP-8 B : SOT-23-5
Operating Ambient Temperature Range
I : -40 to 85 °C
Handling Code
TR : Tape & Reel
Output Current/EN Function
A : 2A/Active High B : 2A/Active Low C : 1A/Active High
D : 1A/Active Low E : 0.3A/Active High F : 0.3A/Active Low
Assembly Material
G : Halogen and Lead Free Device

APL3510A K:	APL3510A XXXXX ●	XXXXX - Date Code
APL3510A X:	L510A XXX ● XX	XXXXX - Date Code
APL3510A B:	L0AX	X - Date Code
APL3511A B:	L1AX	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-020D 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 Input Voltage (VIN to GND)	-0.3 ~ 7	V
V_{OUT}	VOUT to GND Voltage	-0.3 ~ 7	V
V_{ENB}, V_{EN}	EN, ENB to GND Voltage	-0.3 ~ 7	V
V_{OCB}	OCB to GND Voltage	-0.3 ~ 7	V
T_J	Maximum Junction Temperature	150	°C
T_{STG}	Storage Temperature	-65 ~ 150	°C
T_{SDR}	Maximum Lead Soldering Temperature, 10 Seconds	260	°C

Note1: 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

Symbol	Parameter	Typical Value	Unit
θ_{JA}	Junction-to-Ambient Resistance in Free Air (Note 2) SOP-8 MSOP-8 SOT-23-5	 160 160 235	°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	2.7 ~ 5.5	V
I_{OUT}	OUT Output Current (APL3510A/B, APL3511A/B)	0 ~2	A
	OUT Output Current (APL3510C/D, APL3511C/D)	0 ~1	
	OUT Output Current (APL3510E/F)	0 ~0.3	
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 or V_{ENB}=0V and T_A= -40 ~ 85 °C. Typical values are at T_A=25°C.

Symbol	Parameter	Test Conditions		APL3510/1			Unit
				Min.	Typ.	Max.	
SUPPLY CURRENT							
	VIN Supply Current	No load, V_{EN}=0V or V_{ENB}=5V		-	-	1	µA
		No load, V_{EN}=5V or V_{ENB}=0V		-	65	100	µA
	Leakage Current	VOUT=GND, V_{EN}=0V or V_{ENB}=5V		-	-	1	µA
	Reverse Leakage Current	VIN=GND, V_{OUT}=5V, V_{EN}=0V or V_{ENB}=5V		-	-	1	µA
POWER SWITCH							
$R_{DS(ON)}$	Power Switch On Resistance	I_{OUT}=1.5A, T_A= 25 °C	SOP-8 Package	-	80	90	mΩ
			SOT-23-5 Package	-	75	90	
			MSOP-8 Package	-	70	90	
UNDER-VOLTAGE LOCKOUT (UVLO)							
	VIN UVLO Threshold Voltage	V_{IN} rising, T_A= -40 ~ 85 °C		1.7	-	2.65	V
	VIN UVLO Hysteresis			-	0.2	-	V
CURRENT-LIMIT AND SHORT-CIRCUIT PROTECTIONS							
I_{LIM}	Current Limit Threshold	APL3510A/B, APL3511A/B, V_{IN}=2.7V to 5.5V, T_A= -40 ~ 85 °C		2.1	2.5	2.9	A
		APL3510C/D, APL3511C/D, V_{IN}=2.7V to 5.5V, T_A= -40 ~ 85 °C		1.1	1.5	1.9	A
		APL3510E/F, V_{IN}=2.7V to 5.5V, T_A= -40 ~ 85 °C		0.35	-	0.7	A
I_{SHORT}	Short-Circuit Output Current	APL3510A/B, APL3511A/B, V_{IN}=2.7V to 5.5V		-	0.8	-	A
		APL3510C/D, APL3511C/D, V_{IN}=2.7V to 5.5V		-	0.8	-	A
		APL3510E/F, V_{IN}=2.7V to 5.5V		0.35	-	0.7	A

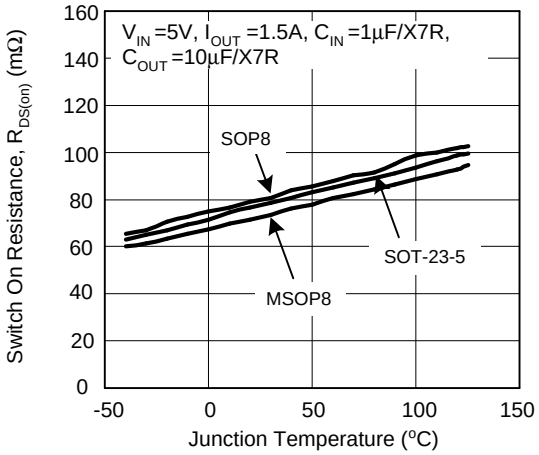
Electrical Characteristics (Cont.)

Unless otherwise specified, these specifications apply over V_{IN}=5V, V_{EN} =5V or V_{ENB}=0V and T_A= -40 ~ 85 °C. Typical values are at T_A=25°C.

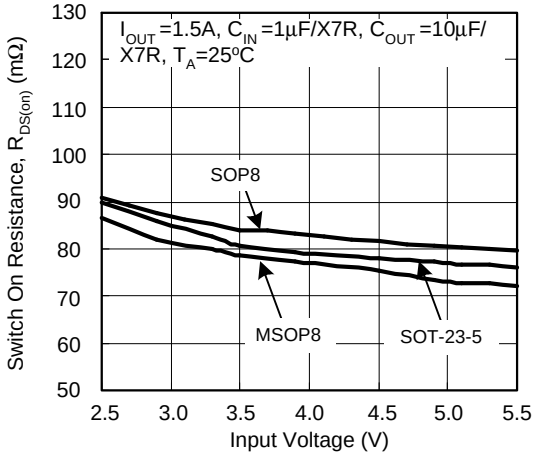
Symbol	Parameter	Test Conditions	APL3510/1			Unit
			Min.	Typ.	Max.	
OCB OUTPUT PIN						
	OCB Output Low Voltage	I_{OCB}=5mA	-	0.2	0.4	V
	OCB Leakage Current	V_{OCB}=5V	-	-	1	μA
$t_{D(OCB)}$	OCB Deglitch Time	OCB assertion, T_A= -40 ~ 85 °C	5	12	20	ms
EN OR ENB INPUT PIN						
V_{IH}	Input Logic HIGH	V_{IN}=2.7V to 5V	2	-	-	V
V_{IL}	Input Logic LOW	V_{IN}=2.7V to 5V	-	-	0.8	V
	Input Current		-	-	1	μA
	VOUT Discharge Resistance	V_{EN}=0V or V_{ENB}=5V	-	150	-	Ω
$t_{D(ON)}$	Turn On Delay Time		-	30	-	μs
$t_{D(OFF)}$	Turn Off Delay Time		-	30	-	μs
t_{SS}	Soft-Start Time	No load, C_{OUT}=1μF, V_{IN}=5V	-	400	-	μs
OVER-TEMPERATURE PROTECTION (OTP)						
T_{OTP}	Over-Temperature Threshold	T_J rising	-	140	-	°C
	Over-Temperature Hysteresis		-	20	-	°C

Typical Operating Characteristics

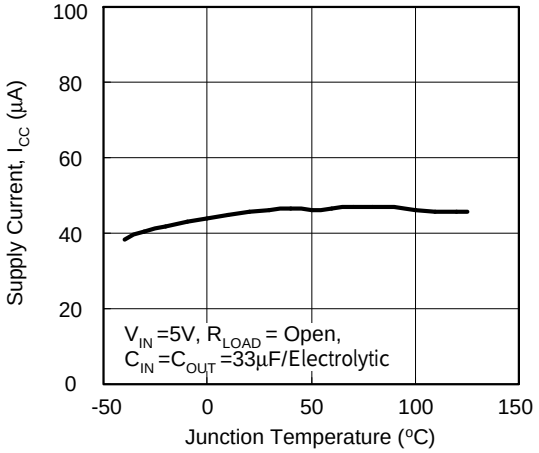
Switch On Resistance vs. Junction Temperature



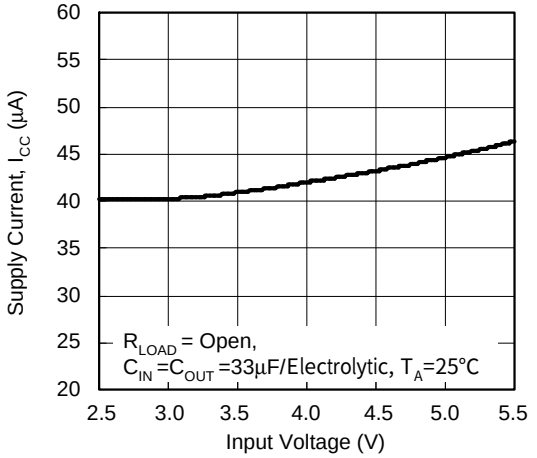
Switch On Resistance vs. Input Voltage



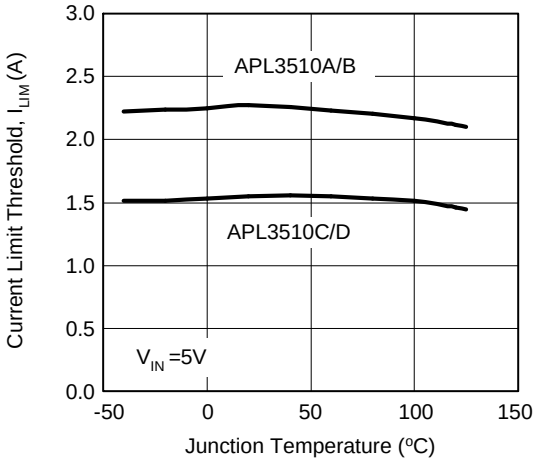
Supply Current vs. Junction Temperature



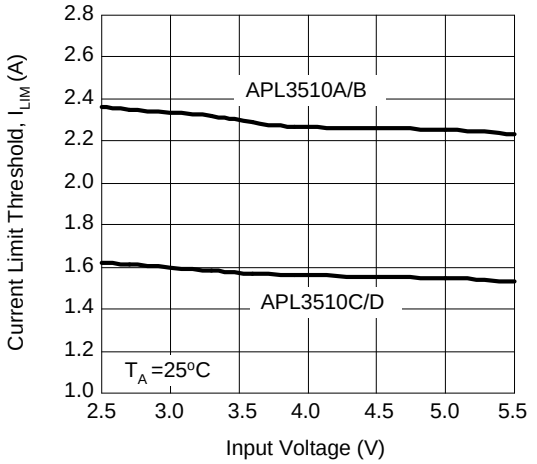
Supply Current vs. Input Voltage



Current Limit Threshold vs. Junction Temperature

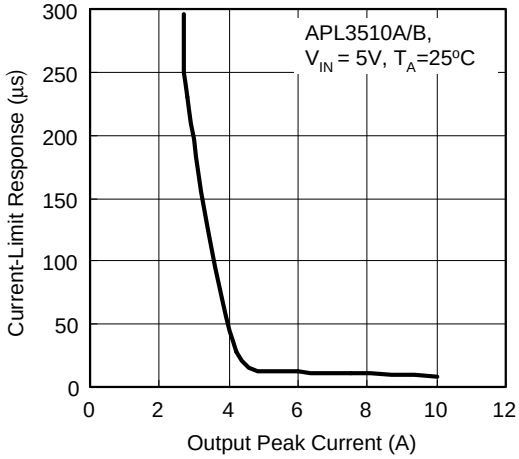


Current Limit Threshold vs. Input Voltage

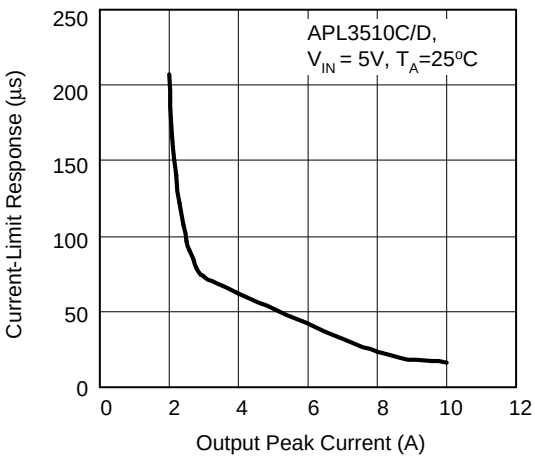


Typical Operating Characteristics (Cont.)

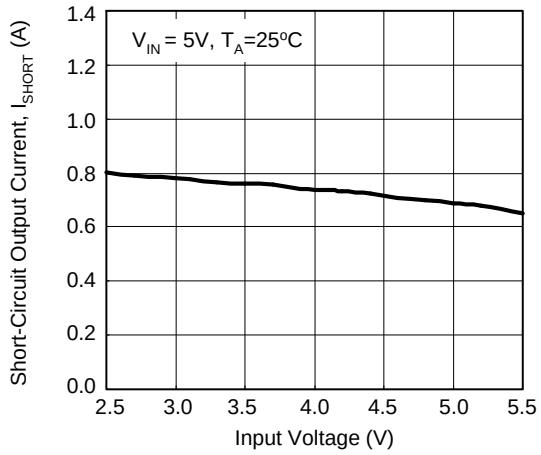
Current-Limit Response vs. Output Peak Current



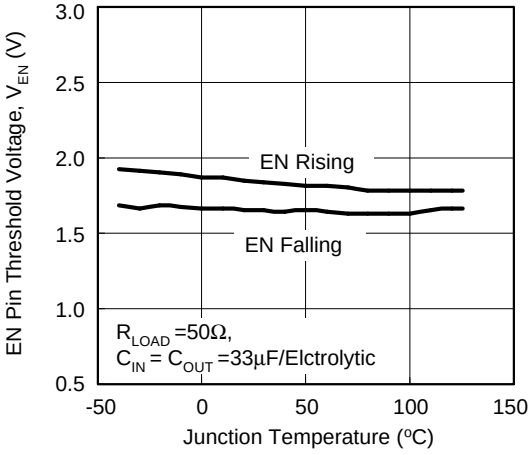
Current-Limit Response vs. Output Peak Current



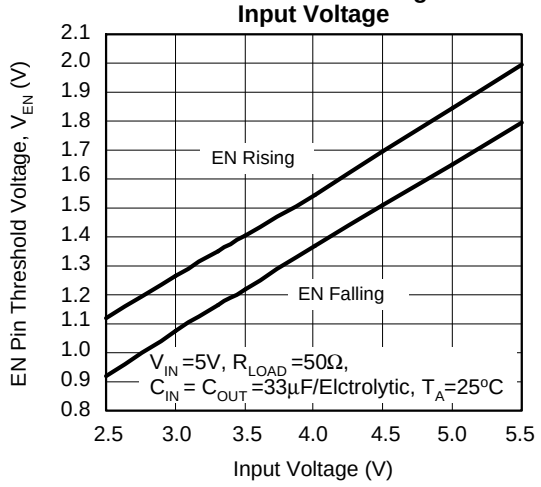
Short-Circuit Output Current vs. Input Voltage



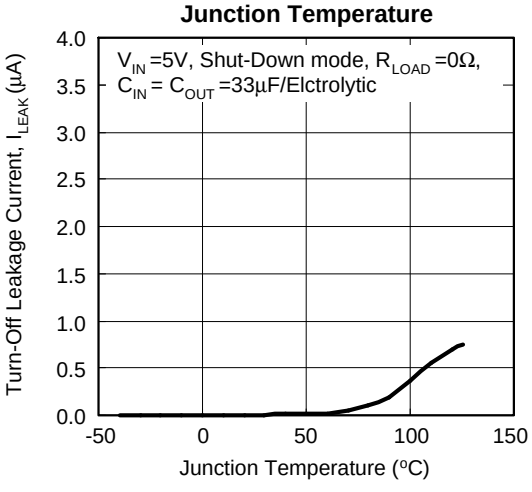
EN Pin Threshold Voltage vs. Junction Temperature



EN Pin Threshold Voltage vs. Input Voltage

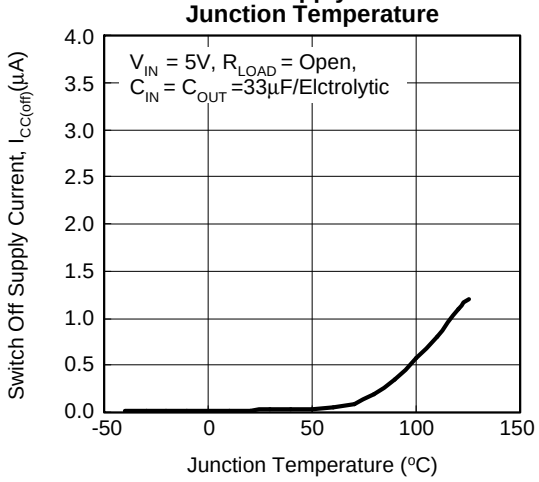


Turn-Off Leakage Current vs. Junction Temperature

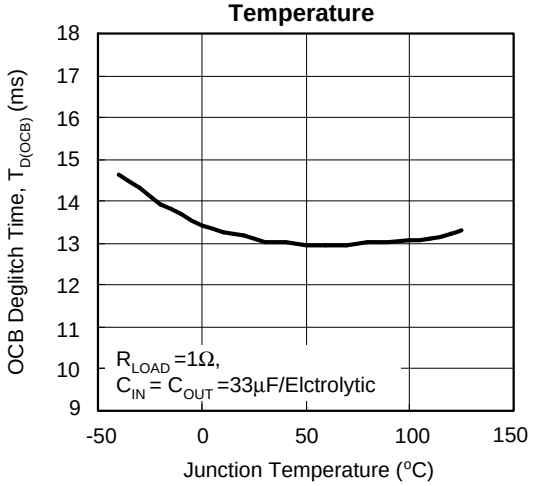


Typical Operating Characteristics (Cont.)

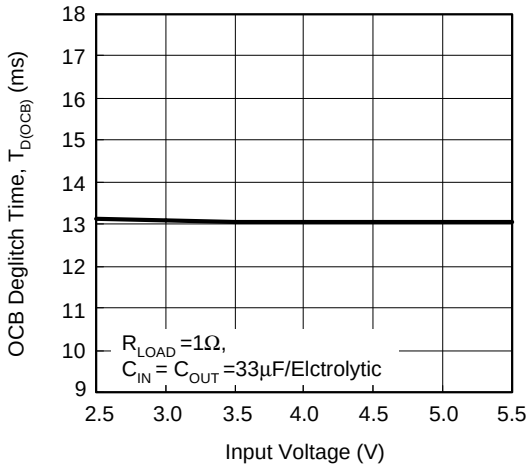
Switch Off Supply Current vs. Junction Temperature



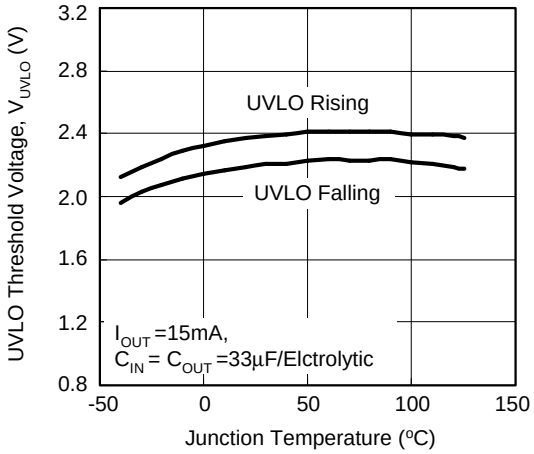
OCB Deglitch Time vs. Junction Temperature



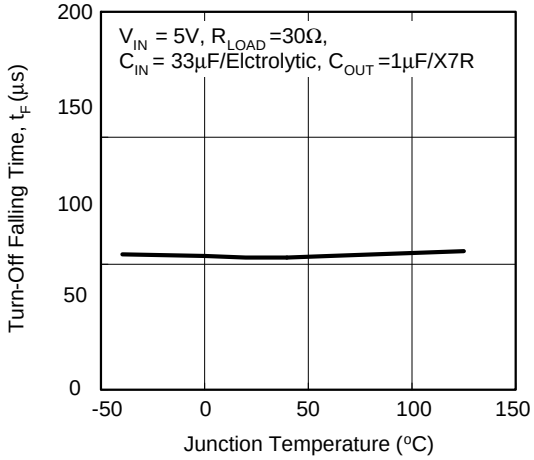
OCB Deglitch Time vs. Input Voltage



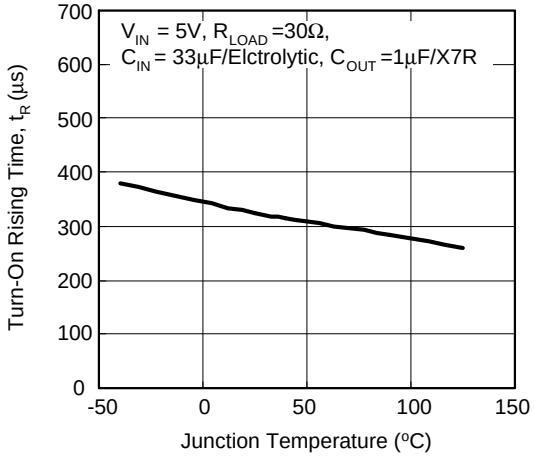
UVLO Threshold Voltage vs. Junction Temperature



Turn-Off Falling Time vs. Junction Temperature

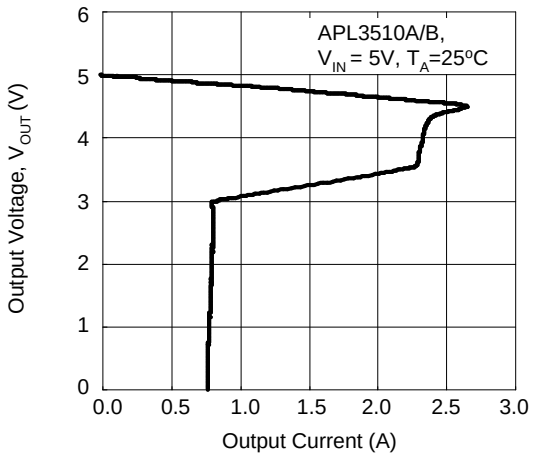


Turn-On Rising Time vs. Junction Temperature

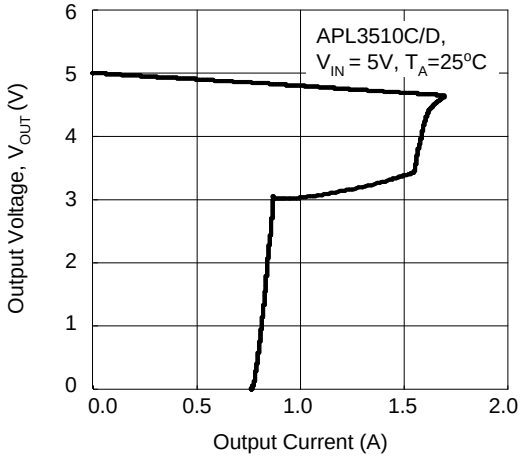


Typical Operating Characteristics (Cont.)

Output Voltage vs. Output Current



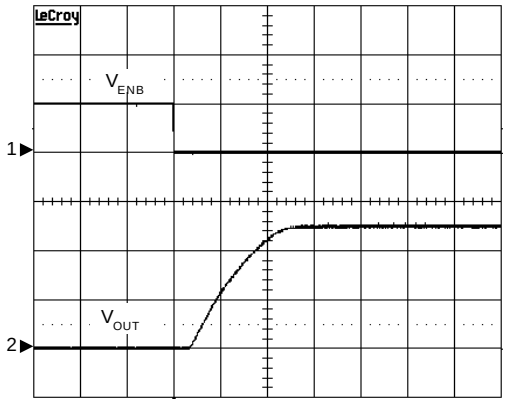
Output Voltage vs. Output Current



Operating Waveforms

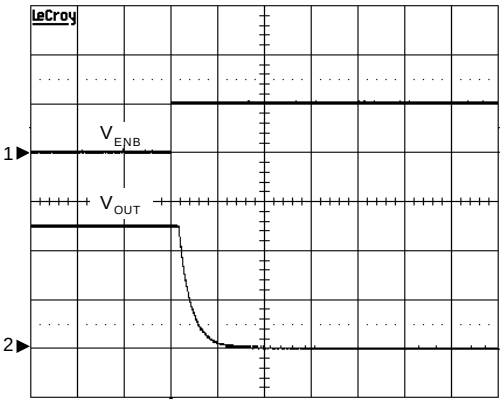
The test condition is V_{IN}=5V, T_A= 25°C unless otherwise specified.

Turn On Response



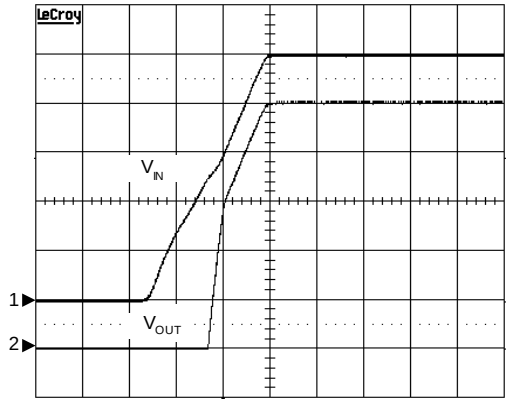
V_{IN} =5V, R_{LOAD} =30Ω, C_{IN} =33µF/Electrolytic,
C_{OUT} =1µF/Electrolytic
CH1: V_{ENB}, 5V/Div, DC
CH2: V_{OUT}, 2V/Div, DC
TIME: 200µs/Div

Turn Off Response



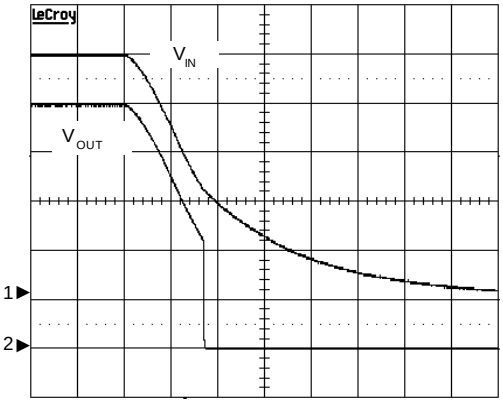
V_{IN} =5V, R_{LOAD} =30Ω, C_{IN} =33µF/Electrolytic,
C_{OUT} =1µF/Electrolytic
CH1: V_{ENB}, 5V/Div, DC
CH2: V_{OUT}, 2V/Div, DC
TIME: 100µs/Div

UVLO at Rising



V_{IN} =5V, R_{LOAD} =30Ω, C_{IN} =33µF/Electrolytic,
C_{OUT} =1µF/Electrolytic
CH1: V_{IN}, 1V/Div, DC
CH2: V_{OUT}, 1V/Div, DC
TIME:2ms/Div

UVLO at Falling

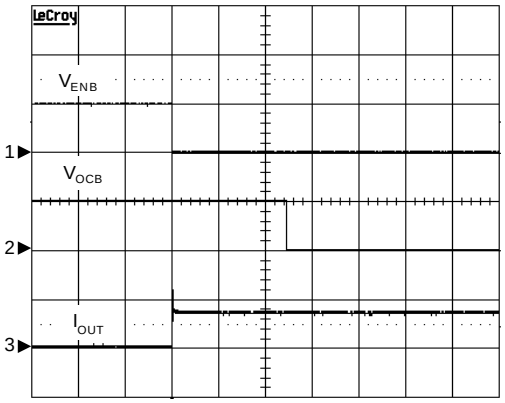


V_{IN} =5V, R_{LOAD} =30Ω, C_{IN} =33µF/Electrolytic,
C_{OUT} =1µF/Electrolytic
CH1: V_{IN}, 1V/Div, DC
CH2: V_{OUT}, 1V/Div, DC
TIME:5ms/Div

Operating Waveforms (Cont.)

The test condition is V_{IN}=5V, T_A= 25°C unless otherwise specified.

OCB Response During Short Circuit



V_{IN} =5V, R_{LOAD} =0Ω, C_{IN} =C_{OUT}=33µF/ Electrolytic

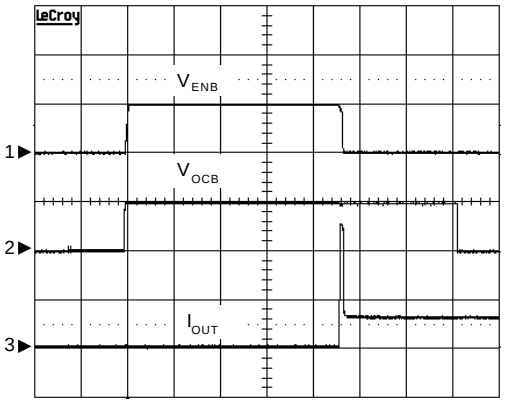
CH1: V_{ENB}, 5V/Div, DC

CH2: V_{OCB}, 5V/Div, DC

CH3: I_{OUT}, 1A/Div, DC

TIME: 5ms/Div

OCB Response During Over Load



V_{IN} =5V, R_{LOAD} =2Ω, C_{IN} =C_{OUT}=33µF/ Electrolytic

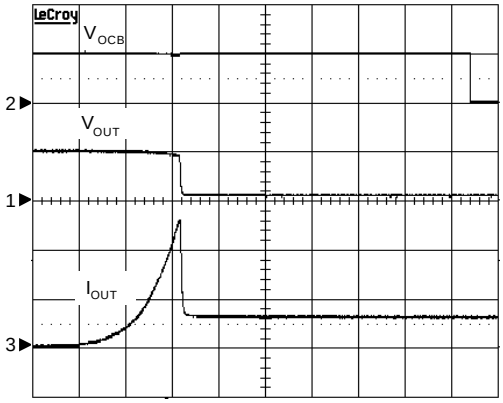
CH1: V_{ENB}, 5V/Div, DC

CH2: V_{OCB}, 5V/Div, DC

CH3: I_{OUT}, 1A/Div, DC

TIME: 5ms/Div

OCB Response with Ramped Load



V_{IN} =5V, C_{IN} =C_{OUT}=33µF/Electrolytic

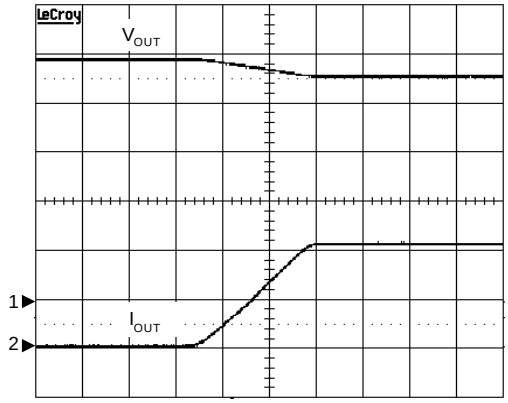
CH1: V_{OUT}, 5V/Div, DC

CH2: V_{OCB}, 5V/Div, DC

CH3: I_{OUT}, 1A/Div, DC

TIME: 2ms/Div

Load-Transient Response



V_{IN} =5V, R_{LOAD} =1kΩ to 2.2Ω, C_{IN} =C_{OUT}=33µF/ Electrolytic

CH1: V_{OUT}, 1V/Div, DC

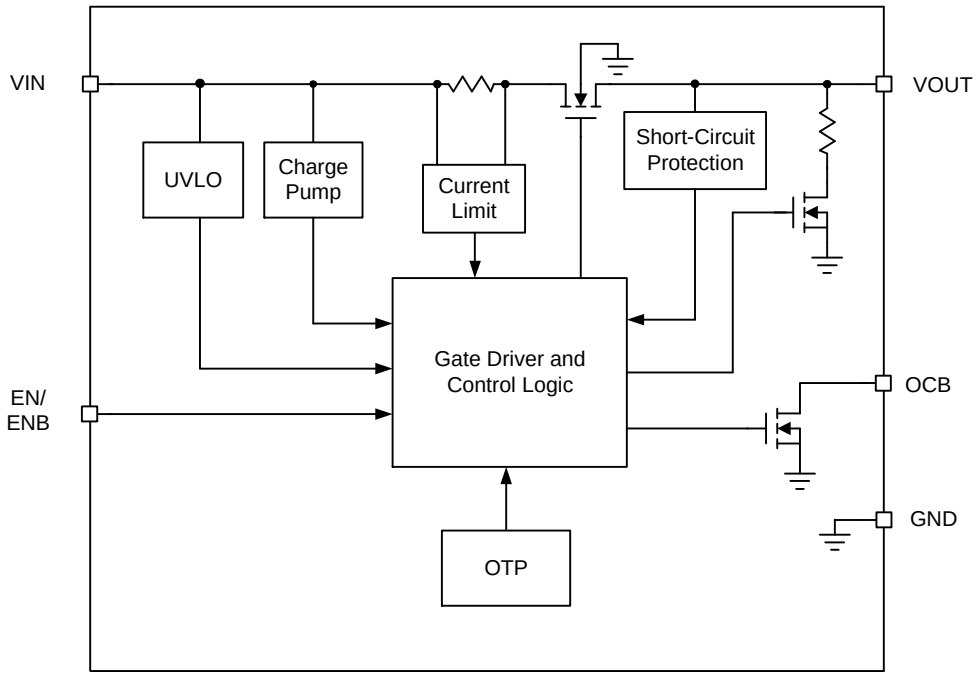
CH2: I_{OUT}, 1A/Div, DC

TIME: 1ms/Div

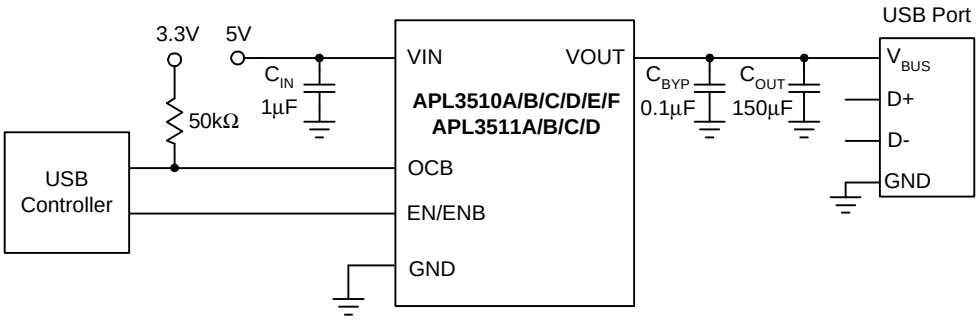
Pin Description

PIN				FUNCTION
NO.			NAME	
SOP-8/ MSOP-8	SOT-23-5			
	APL3510	APL3511		
1	2	2	GND	Ground.
2	4	5	VIN	Power Supply Input. Connect this pin to external DC supply.
3				
4	3	4	EN (A/C/E)	Enable Input. Pulling this pin to high will enable the device and pulling this pin to low will disable device. The EN pin cannot be left floating.
			ENB (B/D/F)	Enable Input. Pulling this pin to high will disable the device and pulling this pin to low will enable device. The ENB pin cannot be left floating.
5	1	3	OCB	Fault Indication Pin. This pin goes low when a current limit or an over-temperature condition is detected after a 12ms deglitch time.
6	5	1	VOUT	Output Voltage Pin. The output voltage follows the input voltage. When ENB is high or EN is low, the output voltage is discharged by an internal resistor.
7				
8				

Block Diagram



Typical Application Circuit



Function Description

VIN Under-Voltage Lockout (UVLO)

The APL3510/1 series of power switches have a built-in under-voltage lockout circuit to keep the output shutting 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 switch is an N-channel MOSFET with a low $R_{DS(ON)}$. The internal power MOSFET does not have the body diode. When IC is off, the MOSFET prevents a current flowing from the VOUT back to VIN and VIN to VOUT.

Current-Limit Protection

The APL3510/1 series of power switches provide the current-limit protection function. During current limit, the devices limit output current at current limit threshold. For reliable operation, the device should not be operated in current limit for extended period.

Short-Circuit Protection

When the output voltage drops below V_{IN}-1V, which is caused by an over-load or a short-circuit, the devices limit the output current down to a safe level. The short-circuit current limit is used to reduce the power dissipation during short-circuit conditions. If the junction temperature reaches over-temperature threshold, the device will enter the thermal shutdown.

OCB Output

The APL3510/1 series of power switches provide an open-drain output to indicate that a fault has occurred. When any of current-limit or over-temperature protection occurs for a deglitch time of $t_{D(OCB)}$, the OCB goes low. Since the OCB pin is an open-drain output, connecting a resistor to a pull high voltage is necessary.

Enable/Disable

Pull the ENB above 2V or EN below 0.8V will disable the device, and pull ENB pin below 0.8V or EN above 2V will enable the device. When the IC is disabled, the supply current is reduced to less than 1μA. The enable input is compatible with both TTL and CMOS logic levels. The EN/ENB pin cannot be left floating.

Over-Temperature Protection

When the junction temperature exceeds 140°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 20°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°C.

Application Information

Input Capacitor

A 1μF ceramic bypass capacitor from V_{IN} to GND, located near the APL3510, is strongly recommended to suppress the ringing during short circuit fault event. Without the bypass capacitor, the output short may cause sufficient ringing on the input (from supply lead inductance) to damage internal control circuitry.

Output Capacitor

A low-ESR 150μF aluminum electrolytic or tantalum between V_{OUT} and GND is strongly recommended to reduce the voltage droop during hot-attachment of downstream peripheral. (Per USB 2.0, output ports must have a minimum 120μF of low-ESR bulk capacitance per hub). Higher-value output capacitor is better when the output load is heavy. Additionally, bypassing the output with a 0.1μF ceramic capacitor improves the immunity of the device to short-circuit transients.

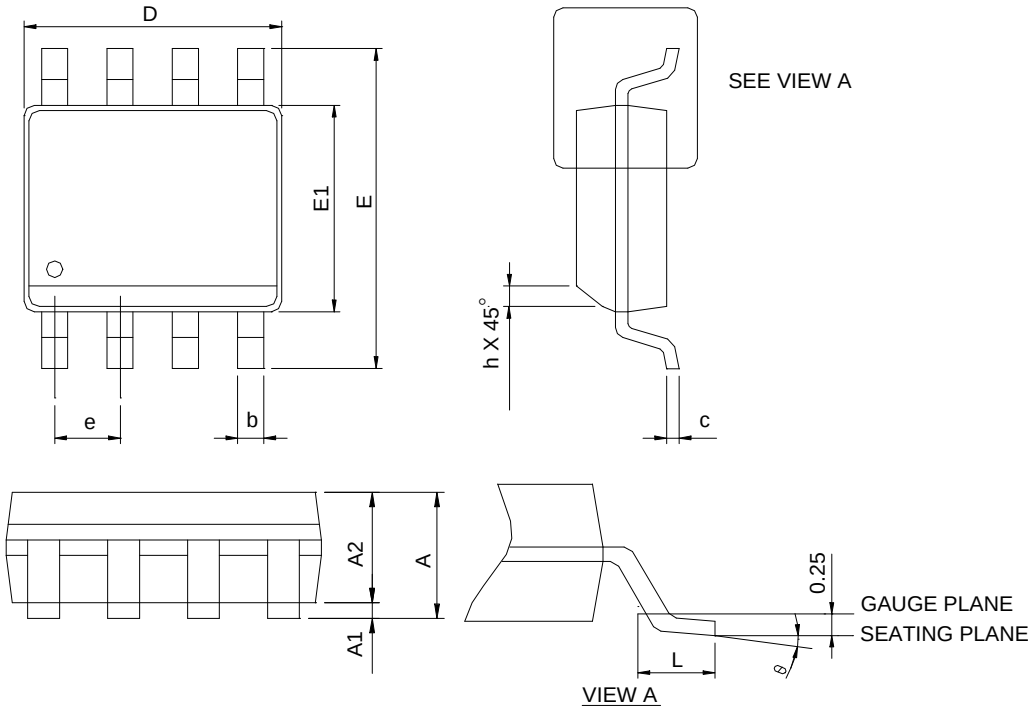
Layout Consideration

The PCB layout should be carefully performed to maximize thermal dissipation and to minimize voltage drop, droop and EMI. The following guidelines must be considered:

1. Please place the input capacitors near the VIN pin as close as possible.
2. Output decoupling capacitors for load must be placed near the load as close as possible for decoupling high-frequency ripples.
3. Locate APL3510 and output capacitors near the load to reduce parasitic resistance and inductance for excellent load transient performance.
4. The negative pins of the input and output capacitors and the GND pin must be connected to the ground plane of the load.
5. Keep V_{IN} and V_{OUT} traces as wide and short as possible.

Package Information

SOP-8

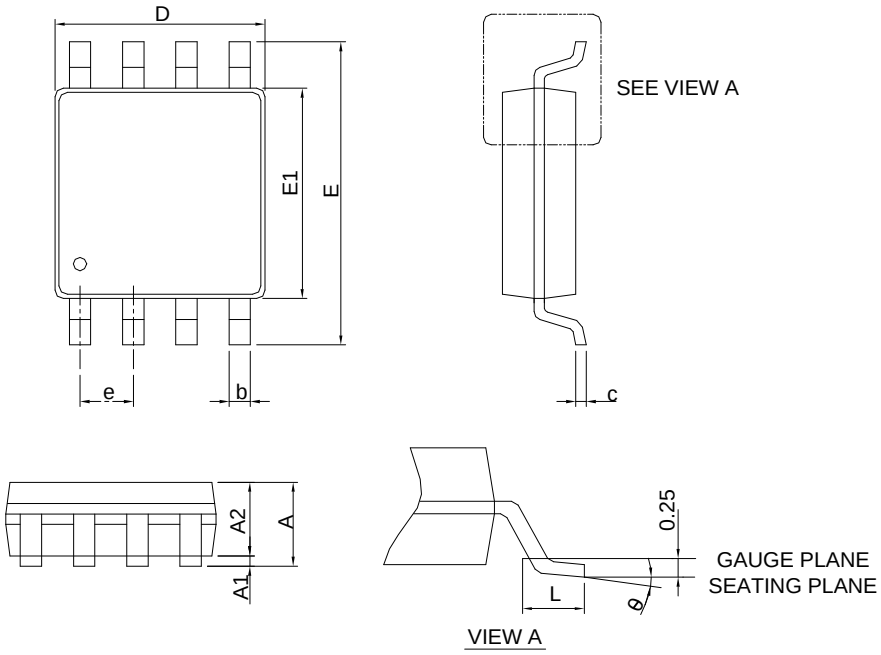


SYMBOL	SOP-8			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A		1.75		0.069
A1	0.10	0.25	0.004	0.010
A2	1.25		0.049	
b	0.31	0.51	0.012	0.020
c	0.17	0.25	0.007	0.010
D	4.80	5.00	0.189	0.197
E	5.80	6.20	0.228	0.244
E1	3.80	4.00	0.150	0.157
e	1.27 BSC		0.050 BSC	
h	0.25	0.50	0.010	0.020
L	0.40	1.27	0.016	0.050
θ	0°	8°	0°	8°

Note: 1. Follow JEDEC MS-012 AA.
2. Dimension “D” does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 6 mil per side.
3. Dimension “E” does not include inter-lead flash or protrusions. Inter-lead flash and protrusions shall not exceed 10 mil per side.

Package Information

MSOP-8

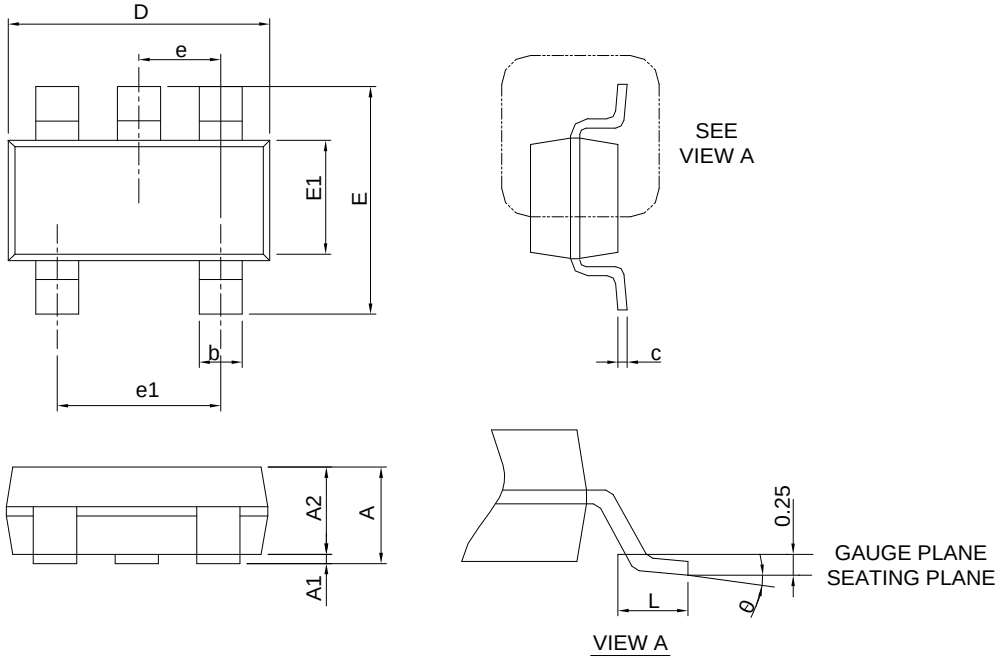


SYMBOL	MSOP-8			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A		1.10		0.043
A1	0.00	0.15	0.000	0.006
A2	0.75	0.95	0.030	0.037
b	0.22	0.38	0.009	0.015
c	0.08	0.23	0.003	0.009
D	2.90	3.10	0.114	0.122
E	4.70	5.10	0.185	0.201
E1	2.90	3.10	0.114	0.122
e	0.65 BSC		0.026 BSC	
L	0.40	0.80	0.016	0.031
θ	0°	8°	0°	8°

Note: 1. Follow JEDEC MO-187 AA.
2. Dimension " D " does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 6 mil per side.
3. Dimension " E1 " does not include inter-lead flash or protrusions. Inter-lead flash and protrusions shall not exceed 5 mil per side.

Package Information

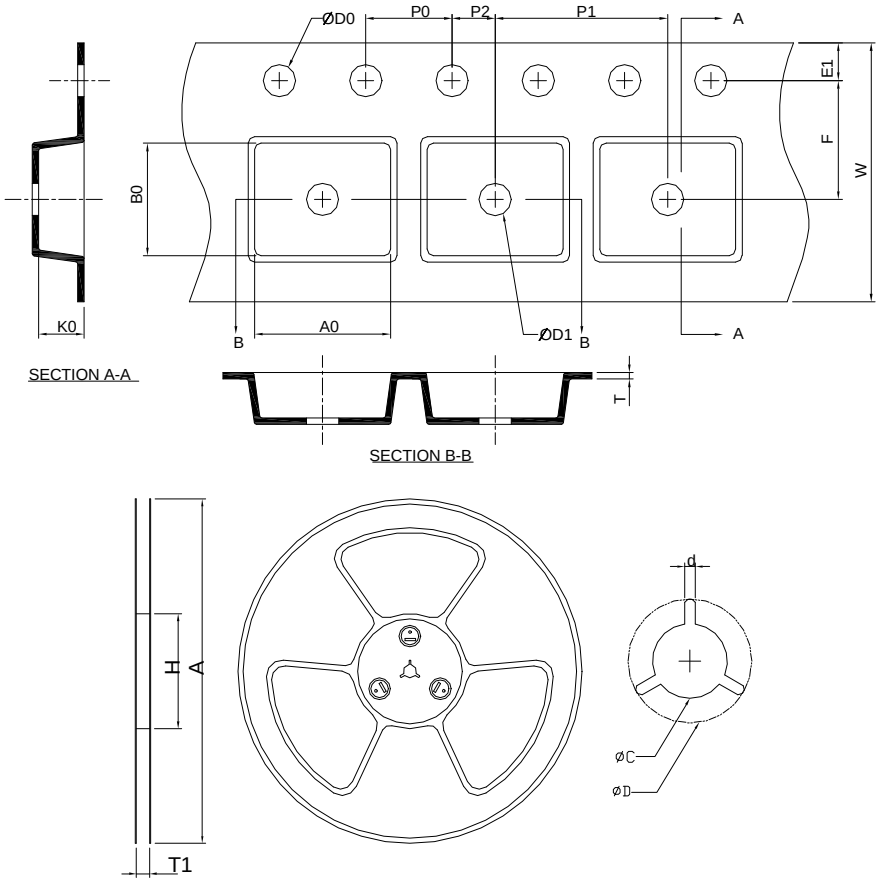
SOT-23-5



SYMBOL	SOT-23-5			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A		1.45		0.057
A1	0.00	0.15	0.000	0.006
A2	0.90	1.30	0.035	0.051
b	0.30	0.50	0.012	0.020
c	0.08	0.22	0.003	0.009
D	2.70	3.10	0.106	0.122
E	2.60	3.00	0.102	0.118
E1	1.40	1.80	0.055	0.071
e	0.95 BSC		0.037 BSC	
e1	1.90 BSC		0.075 BSC	
L	0.30	0.60	0.012	0.024
θ	0°	8°	0°	8°

Note : 1. Follow JEDEC TO-178 AA.
2. Dimension D and E1 do not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 10 mil per side.

Carrier Tape & Reel Dimensions



Application	A	H	T1	C	d	D	W	E1	F
SOP-8	330.0±2.00	50 MIN.	12.4+2.00 -0.00	13.0+0.50 -0.20	1.5 MIN.	20.2 MIN.	12.0±0.30	1.75±0.10	5.5±0.05
	P0	**P1**	**P2**	**D0**	**D1**	**T**	**A0**	**B0**	**K0**
	4.0±0.10	8.0±0.10	2.0±0.05	1.5+0.10 -0.00	1.5 MIN.	0.6+0.00 -0.40	6.40±0.20	5.20±0.20	2.10±0.20
Application	**A**	**H**	**T1**	**C**	**d**	**D**	**W**	**E1**	**F**
MSOP-8	330.0±2.00	50 MIN.	12.4+2.00 -0.00	13.0+0.50 -0.20	1.5 MIN.	20.2 MIN.	12.0±0.30	1.75±0.10	5.5±0.05
	P0	**P1**	**P2**	**D0**	**D1**	**T**	**A0**	**B0**	**K0**
	4.00±0.10	8.00±0.10	2.00±0.05	1.5+0.10 -0.00	1.5 MIN.	0.6+0.00 -0.40	5.30±0.20	3.30±0.20	1.40±0.20
Application	**A**	**H**	**T1**	**C**	**d**	**D**	**W**	**E1**	**F**
SOT-23-5	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	3.20±0.20	3.10±0.20	1.50±0.20

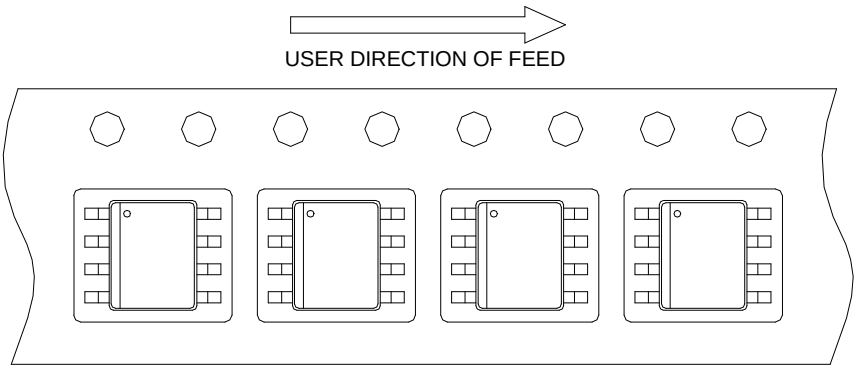
(mm)

Devices Per Unit

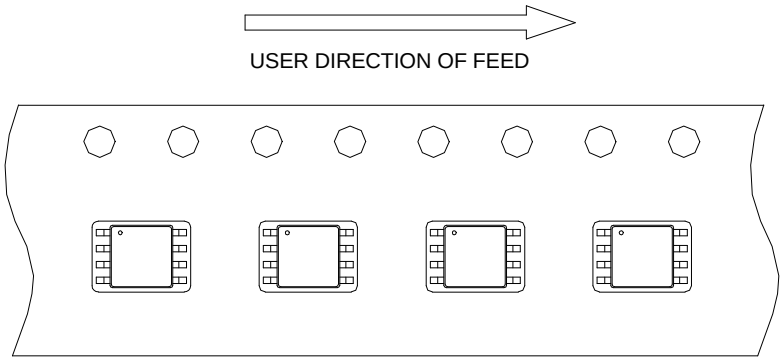
Package Type	Unit	Quantity
SOP-8	Tape & Reel	2500
MSOP-8	Tape & Reel	3000
SOT-23-5	Tape & Reel	3000

Taping Direction Information

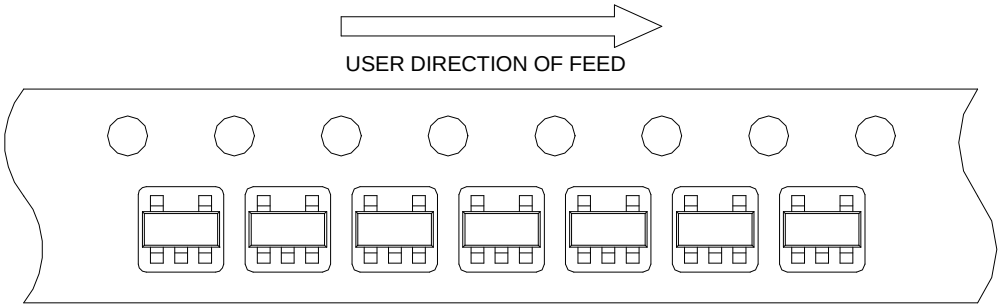
SOP-8



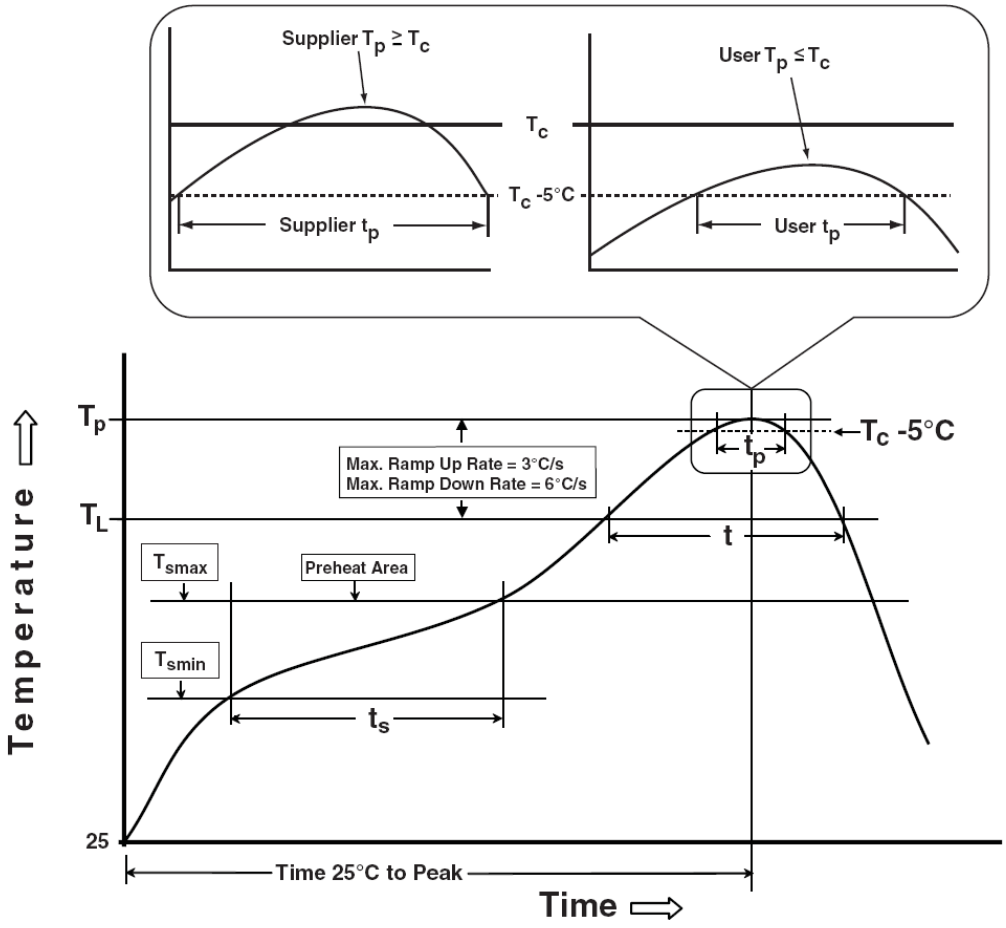
MSOP-8



SOT-23-5



Classification Profile



Classification Reflow Profiles

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Preheat & Soak Temperature min (T_{smin}) Temperature max (T_{smax}) Time (T_{smin} to T_{smax}) (t_s)	100 °C 150 °C 60-120 seconds	150 °C 200 °C 60-120 seconds
Average ramp-up rate (T_{smax} to T_P)	3 °C/second max.	3°C/second max.
Liquidous temperature (T_L) Time at liquidous (t_L)	183 °C 60-150 seconds	217 °C 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.		

Classification Reflow Profiles (Cont.)

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

Package Thickness	Volume mm^3 <350	Volume mm^3 3350
<2.5 mm	235 °C	220 °C
≥2.5 mm	220 °C	220 °C

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

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 @ Tj=125°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}≧100mA

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