

## Dual Channel 300mA Regulator + Reset IC

### Features

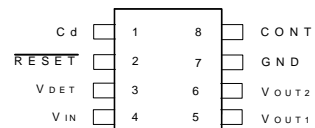
- Low Quiescent Current : 110 $\mu$ A (No load)
- Low Dropout Voltage :  
 $V_{DRO P1}=350mV@300mA$   
 $V_{DRO P2}=350mV@300mA$
- Fixed Output Voltage :  
 $V_{OUT1}=3.3V/300mA$   
 $V_{OUT2}=3.3V/300mA$
- Stable with 2.2 $\mu$ F Output Capacitor
- Stable with Aluminum, Tantalum or Ceramic Capacitors
- Built in Thermal Protection
- Fast Transient Response
- Short Setting Time
- SOP-8, SOP-8-P with Thermal Pad Packages
- Adjustment-free Reset Detection Voltage :  
 3.9V or 4.2V typ
- Easy to Set Delay Time from Voltage Detection to Reset Release

### General Description

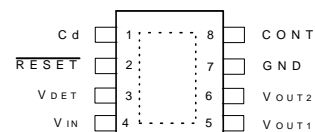
The APL5538 is a dual-channel regulator with reset function (specific voltage monitoring), and internal delay circuit, set to detect 3.9V or 4.2V. Maximum input voltage is 6V, output1 and output2 deliver up to 300mA.  $V_{OUT1}$  typical dropout voltage is 350mV at 300mA loading and  $V_{OUT2}$  typical dropout voltage is 350mV at 300mA loading. Design with an internal P-channel MOSFET pass transistor, the APL5538 maintains a low supply current. Other features include, thermal-shutdown protection, current limit protection to ensure specified output current. The APL5538 come in miniature SOP-8 and SOP-8-P packages.

### Pinouts


SOP-8 Top View



SOP-8-P Top View



APL5538

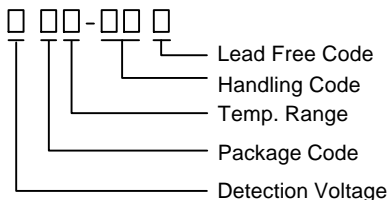
 = Thermal Pad  
 (connected to GND plane for better heat dissipation)

### Applications

- CD-ROM drive.

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

<p>APL5538 - </p>	<p>Package Code                  K : SOP-8      KA : SOP-8-P                  Temp. Range                  C : 0 to 70 °C    I : -40 to 85 °C                  Handling Code                  TR : Tape &amp; Reel                  Detection Voltage :                  A : 3.9V          B : 4.2V                  Lead Free Code                  L : Lead Free Device    Blank : Original Device</p>	
<p>APL5538 K / KA :</p>	<table border="1" style="display: inline-table; margin-right: 20px;"> <tr> <td style="padding: 2px;">APL5538X XXXXX</td> </tr> </table> <p>X            - Detection Voltage                  XXXXX - Date Code</p>	APL5538X XXXXX
APL5538X XXXXX		

## Pin Description

PIN		I/O	Description
No.	Name		
1	Cd		Delay time capacitor pin, RESET pin output delay time can be set by the capacitor connected to the Cd pin. $t_{PLH} = 130000 * C$ , $t_{PLH}$ : transmission delay time (s), C:capacitor value (F)
2	RESET	O	Input voltage detection output pin , low = $V_{DET} < V_S$ , high = $V_{DET} > V_S$
3	$V_{DET}$	I	Input pin of voltage detection.
4	$V_{IN}$	I	Voltage supply input pin.
5	$V_{OUT1}$	O	Regulator output pin.
6	$V_{OUT2}$	O	Regulator output pin.
7	GND		GND pin
8	CONT	I	$V_{OUT1}$ on/off-control pin, $V_{OUT1}$ will be turn off when CONT pull to low.

## Absolute Maximum Ratings

Symbol	Parameter	Rating	Unit	
$V_{IN}, V_{OUT}$	Input Voltage or Out Voltage	6.5	V	
CONT	$V_{OUT1}$ Shutdown Control Pin	6.5	V	
$V_{DET}$	RESET Pin Supply Voltage	6.5	V	
$R_{TH,JA}$	Thermal Resistance – Junction to Ambient	SOP-8	130	°C/W
		SOP-8-P	80	
$R_{TH,JC}$	Thermal Resistance – Junction to Case	SOP-8	30	°C/W
		SOP-8-P	5	
$P_D$	Power Dissipation	Internally Limited	W	
$T_J$	Operating Junction Temperature	Control Section	0 to 125	°C
		Power Transistor	0 to 150	
$T_{STG}$	Storage Temperature Range	-65 to +150	°C	
$T_L$	Lead Temperature (Soldering, 10 second)	260	°C	

## Electrical Characteristics

Unless otherwise noted these specifications apply over full temperature ,  $V_{IN}=5V$ ,  $C_{IN}=1\mu F$ ,  $C_{OUT1}=2.2\mu F$ ,  $C_{OUT2}=2.2\mu F$ ,  $CONT=V_{IN}$ ,  $T_J=0$  to  $125^\circ C$  . Typical values refer to  $T_J=25^\circ C$  .

Symbol	Parameter	Test Conditions	APL5538			Unit
			Min.	Typ.	Max.	
$V_{IN}$	Input Voltage				6	V
$I_Q$	Quiescent Current	$I_{OUT1}=0mA, I_{OUT2}=0mA$		110	220	$\mu A$
	Shutdown Supply Current	$CONT = low, I_{OUT2}=0mA$		70	140	$\mu A$
$I_{CONT}$	Shutdown Input Bias current	$V_{CONT}=V_{IN}$			0.1	$\mu A$
$V_{CONT}$	High Threshold Voltage		1.6		$V_{IN}+0.3$	V
	Low Threshold Voltage		-0.3		0.4	
$I_{CCQ}$	$V_{DET}$ Input Current	$V_{DET}=5V$		20	40	$\mu A$
<b>Regulator1</b>						
$V_{OUT1}$	Output Voltage	$V_{IN}=5V$	3.234	3.3	3.366	V
$I_{LIMIT}$	Circuit Current Limit	$V_{IN}=5V$		800		mA
$I_{OUT}$	Load Current		300			mA
$REG_{LINE}$	Line Regulation	$V_{OUT}+0.5V < V_{IN} < 6.0V, I_{OUT}=10mA$		4	6	mV
$REG_{LOAD}$	Load Regulation	$V_{IN}=5V, 0mA < I_{OUT} < I_{MAX}$		20	60	mV
$V_{DROP}$	Dropout Voltage <sup>(Note)</sup> ( $V_{OUT}(\text{Nominal})=3.3V$ Version)	$I_{OUT}=300mA$		350	450	mV
PSRR	Ripple Rejection	$F \leq 1kHz, 1V_{pp}$ at $I_{OUT}=50mA$	45	50		dB
OTS	Over Temperature Shutdown			150		$^\circ C$
	Over Temperature Shutdown Hysteresis	Hysteresis		10		$^\circ C$
TC	Output Voltage Temperature Coefficient	$T_a = -20 \sim 80^\circ C$		100		ppm/ $^\circ C$
$C_{OUT}$	Output Capacitor			2.2		$\mu F$
	ESR		0.01		1	Ohm
<b>Regulator2</b>						
$V_{OUT2}$	Output Voltage	$V_{IN}=5V$	3.234	3.3	3.366	V
$I_{LIMIT}$	Circuit Current Limit	$V_{IN}=5V$		800		mA
$I_{OUT}$	Load Current		300			mA

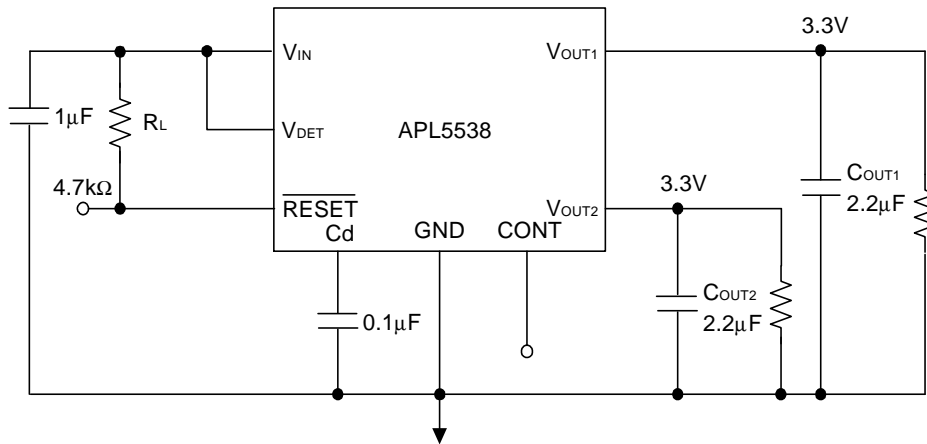
## Electrical Characteristics (Cont.)

Unless otherwise noted these specifications apply over full temperature ,  $V_{IN}=5V$ ,  $C_{IN}=1\mu F$ ,  $C_{OUT1}=2.2\mu F$ ,  $C_{OUT2}=2.2\mu F$ ,  $C_{OUT}=V_{IN}$ ,  $T_J=0$  to  $125^\circ C$  . Typical values refer to  $T_J=25^\circ C$  .

Symbol	Parameter	Test Conditions	APL5538			Unit
			Min.	Typ.	Max.	
REG <sub>LINE</sub>	Line Regulation	$V_{OUT}+0.5V < V_{IN} < 6.0V$ , $I_{OUT}=10mA$		4	6	mV
REG <sub>LOAD</sub>	Load Regulation	$V_{IN} = 5V$ , $0mA < I_{OUT} < I_{MAX}$		20	60	mV
V <sub>DROP</sub>	Dropout Voltage <sup>(Note)</sup> ( $V_{OUT}(\text{Nominal})=3.3V$ Version)	$I_{OUT} = 300mA$		350	450	mV
PSRR	Ripple Rejection	$F \leq 1kHz$ , $1V_{pp}$ at $I_{OUT}=50mA$	45	50		dB
OTS	Over Temperature Shutdown			150		$^\circ C$
	Over Temperature Shutdown Hysteresis	Hysteresis		10		$^\circ C$
TC	Output Voltage Temperature Coefficient	$T_a = -20 \sim 80^\circ C$		100		ppm/ $^\circ C$
C <sub>OUT</sub>	Output Capacitor			2.2		$\mu F$
	ESR		0.01		1	Ohm
<b>RESET / RESET</b>						
VS	Detection Voltage	$V_{DET}=H \rightarrow L$ (APL5538A)	3.822	3.9	3.978	V
		$V_{DET}=H \rightarrow L$ (APL5538B)	4.116	4.2	4.284	
$\Delta VS/\Delta T$	Vs Temperature Coefficient	$T_a = -20 \sim +80^\circ C$		100		ppm/ $^\circ C$
$\Delta VS$	Hysteresis Voltage	$V_{DET} = H \rightarrow L \rightarrow H$	100	150	200	mV
V <sub>OL</sub>	Low-level Output Voltage	$V_{DET} = 3.9V$ , $R_L = 4.7k\Omega$		12	60	mV
I <sub>OH</sub>	Output Leakage Current	$V_{DET} = 5V$		0.5	1	$\mu A$
I <sub>OL1</sub>	Output Current1	$V_{DET} = 3.9V$ , $V_{RESET} = 0.4V$	25	30		mA
I <sub>OL2</sub>	Output Current2	$V_{DET} = 3.9V$ , $V_{RESET} = 0.4V$ $T_a = -20 \sim +80^\circ C$	20	25		mA
t <sub>PLH</sub>	"H" Transmission Delay Time	$C_d = 0\mu F$		42	90	$\mu s$
t <sub>PLH1</sub>	Reset Delay Time	$V_{DET} = 3.7V \rightarrow 5V$ , $C_d = 0.1\mu F$	8	13	18	ms
t <sub>PHL</sub>	"L" Transmission Delay Time	$C_d = 0\mu F$		4	90	$\mu s$
V <sub>OPL</sub>	Threshold Operating Voltage	$V_{RESET} = 0.4V$		0.95	1.25	V

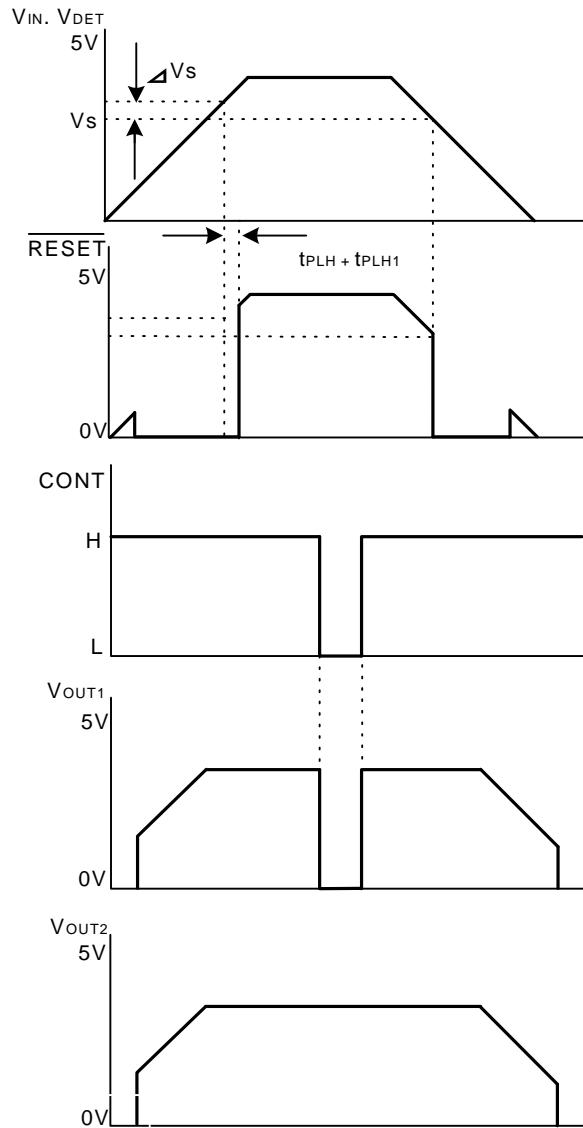
Note : Dropout voltage definition :  $V_{IN} - V_{OUT}$  when  $V_{OUT}$  is 2% below the value of  $V_{OUT}$  for  $V_{IN}=5V$

Application Circuit

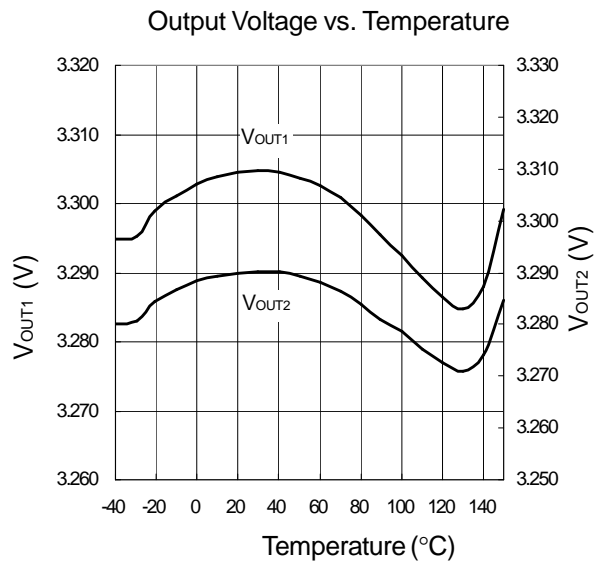
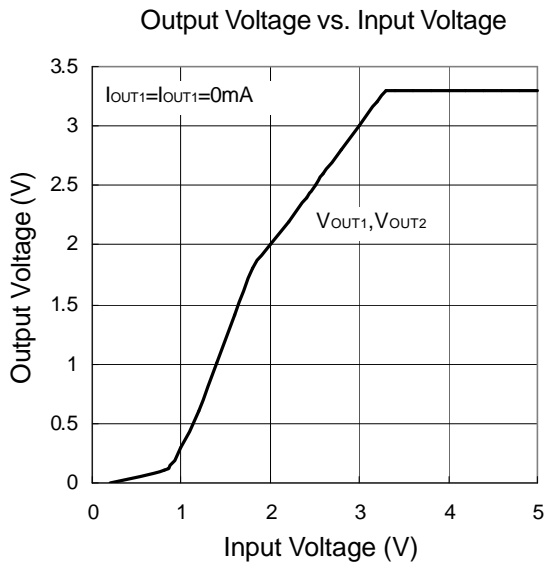
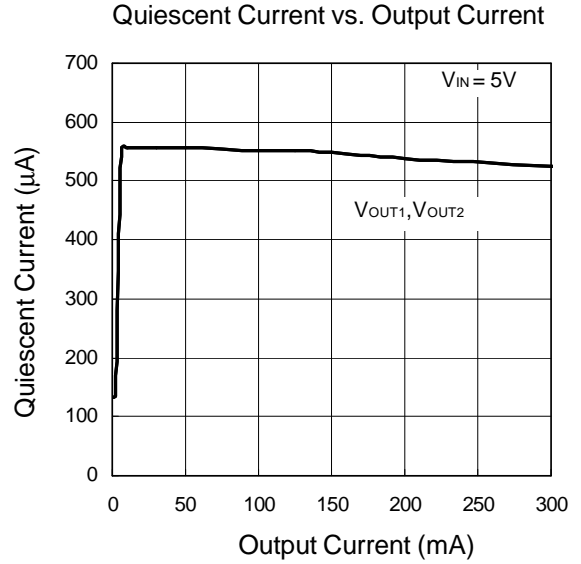
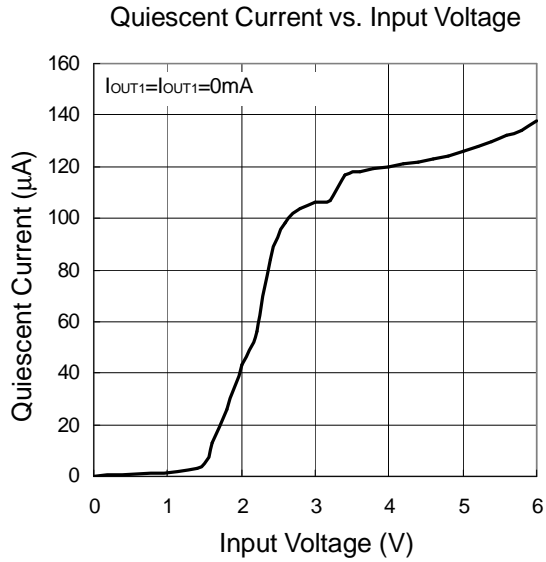


# Timing Chart

APL5538

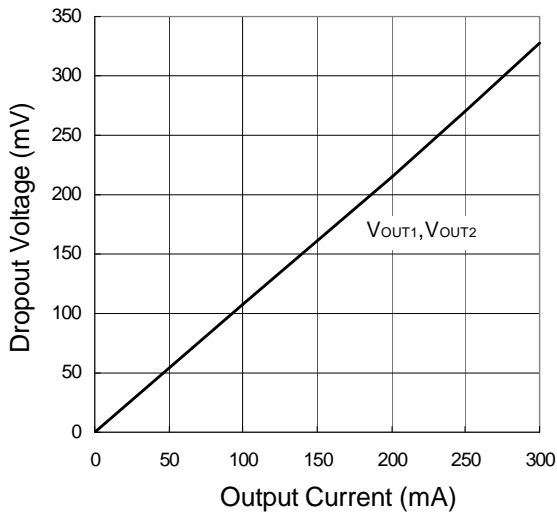


## Typical Characteristics

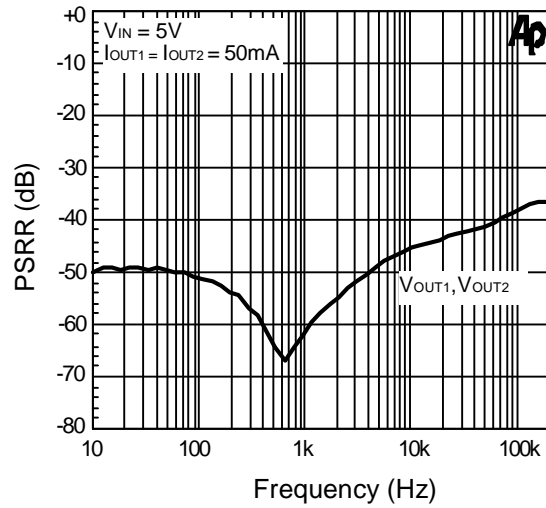


## Typical Characteristics

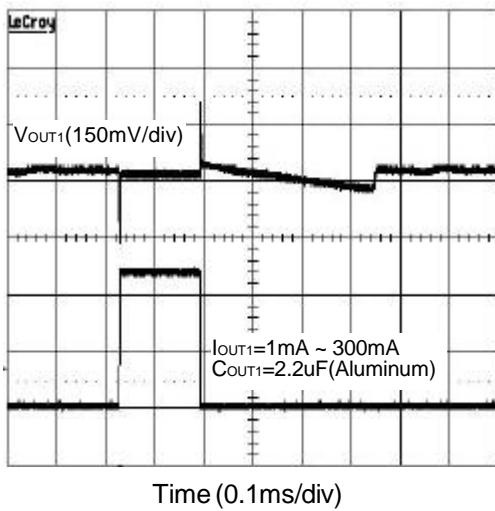
Dropout Voltage vs. Output Current



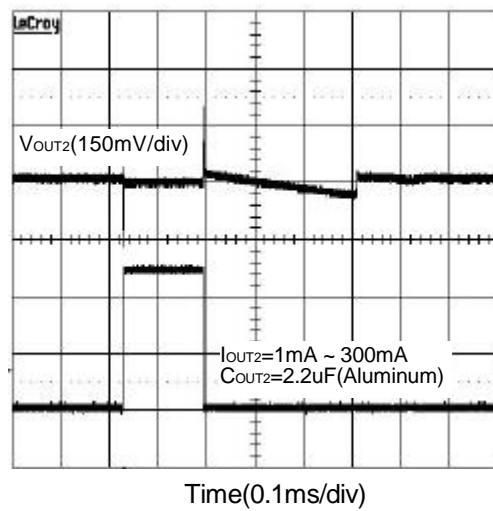
PSRR vs. Frequency



Load-Transient Response



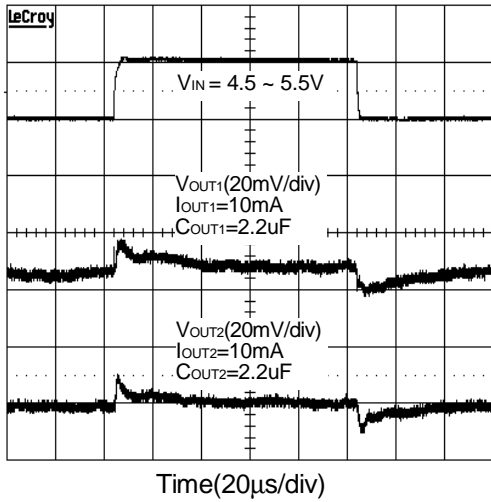
Load-Transient Response



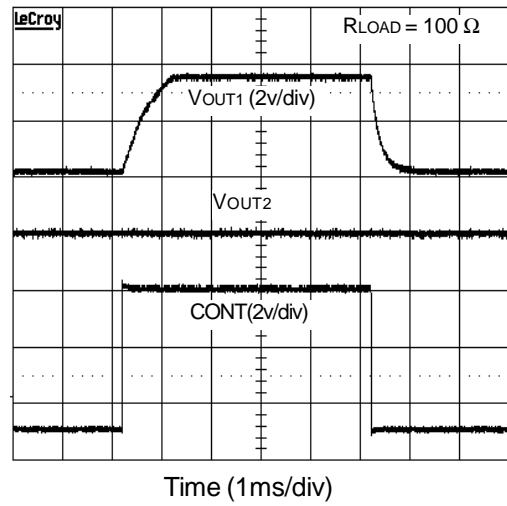


## Typical Characteristics

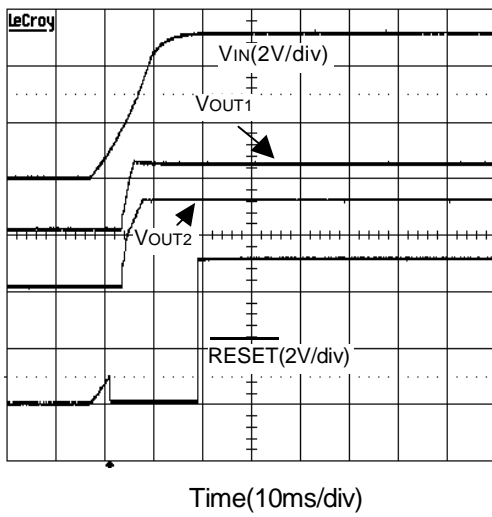
Line-Transient Response



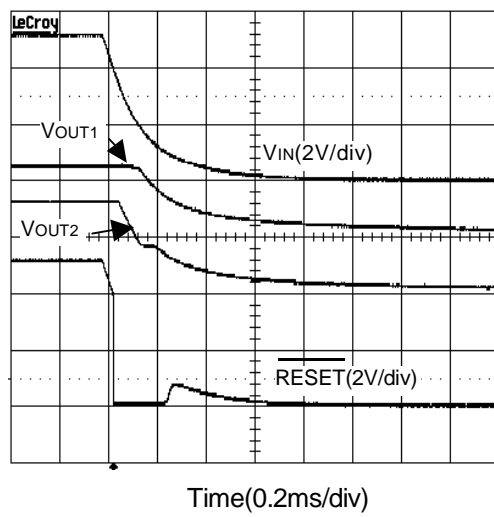
Shutdown Response



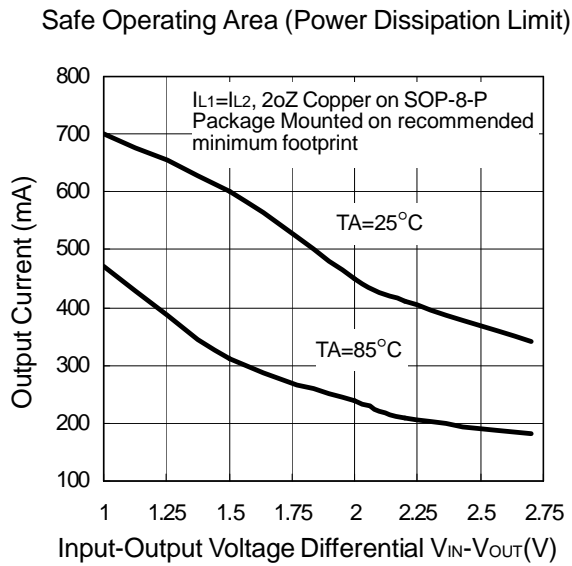
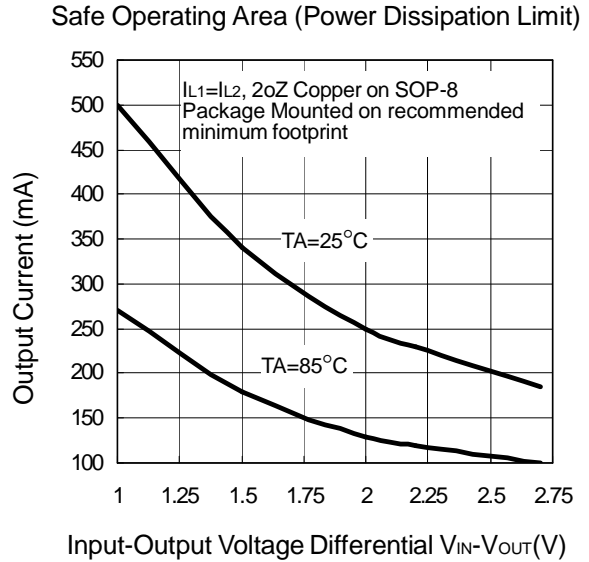
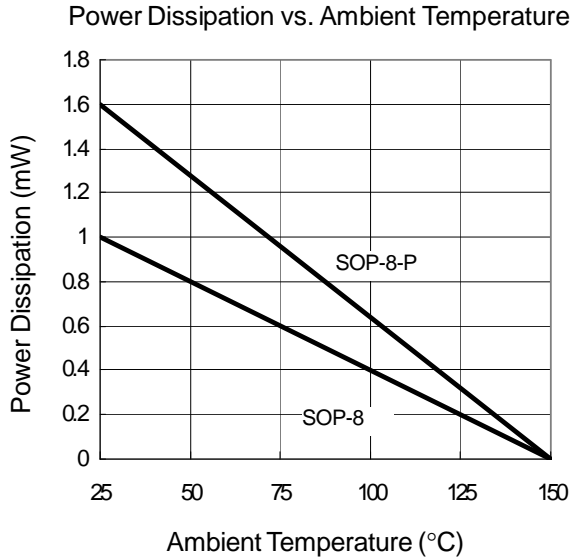
Powering On



Powering Off



## Typical Characteristics



## Application Information

### Capacitor Selection and Regulator Stability

The APL5538 uses at least a 1 $\mu$ F capacitor on the input. This capacitor can use Aluminum, Tantalum or Ceramic capacitors. Input capacitor with large value and low ESR provides better PSRR and line-transient response. The output capacitor also can use Aluminum, Tantalum or Ceramic capacitors, and its minimum values is recommended 2.2 $\mu$ F, ESR must be above 0.01 $\Omega$ . Large output capacitor values can reduce noise and improve load-transient response, stability, and PSRR. Note that some ceramic dielectrics exhibit large capacitance and ESR variation with Temperature. If use this capacitor, it may be necessary to use 2.2 $\mu$ F or more to ensure stability at temperature below -10 $^{\circ}$ C.

### Load-Transient Considerations

The APL5538 load-transient response graphs in Typical Characteristics show the transient response. A step change in the load current from 1mA to 300mA at 1 $\mu$  second will cause less than 200mV transient spike. Large output capacitor's value and low ESR can reduce transient spike.

### Shutdown/Enable

The APL5538 has an active high enable function. Force CONT high (>1.6V) enables the  $V_{OUT1}$ , CONT low (<0.4V) disables the  $V_{OUT1}$  and  $V_{OUT2}$  can not be affected by CONT. Enter the shutdown mode, it also causes the output voltage to discharge through a 500 $\Omega$  resistance to ground. In shutdown mode, the quiescent current can reduce to 100 $\mu$ A. The CONT pin cannot be floating, a floating CONT pin may cause an indeterminate state on the output. If it is no use, connect to  $V_{IN}$  for normal operation.

### $\overline{\text{RESET}}$

The  $\overline{\text{RESET}}$  pin is asserted whenever  $V_{DET}$  falls below the reset threshold voltage or if CONT is forced low at some special IC (refer timing chart and pin description). The reset function ensures the microprocessor is properly reset and powers up into a known condition after a power failure.  $\overline{\text{RESET}}$  will remain valid with  $V_{IN}$  as low as 0.95V. The  $\overline{\text{RESET}}$  output is a simple open-drain N channel MOSFET structure. A pull-up resistor must be used to pull this output up to some voltage. For most application, this voltage will be the same power supply that supplies  $V_{IN}$  to the APL5538. The APL5538 is relatively immune to negative-going glitches below the reset threshold. Typically reset delay time is 13ms while using 0.1 $\mu$ F at Cd pin. If more transient immunity is needed, a Cd capacitor can be placed as larger as possible.

### Input-Output (Dropout) Voltage

The minimum input-output voltage differential (dropout) determines the lowest usable supply voltage. The dropout voltage is a function of drain-to-source on resistance multiplied by the load current.

### Current Limit

APL5538 includes two separate current-limit circuitry for each linear regulator. The current limit protection, which sense the current flows the P-channel MOSFET, and controls the output voltage. The point where limiting occurs is  $I_{OUT}=950\text{mA}$ . The output can be shorted to ground for an indefinite amount of time without damaging to the part.

## Application Information

### Thermal Protection

Thermal protection limits total power dissipation in the APL5538. When the junction temperature exceeds  $T_{j}=+150^{\circ}\text{C}$ , the thermal sensor generate a logic signal to turn off the pass transistor and let IC to cool. When the IC's junction temperature cools by  $10^{\circ}\text{C}$ , the thermal sensor will turn the pass transistor on again, resulting in a pulsed output during continuous thermal protection. Thermal protection is designed to protect the IC in the event of fault conditions. For continual operation, do not exceed the absolute maximum junction temperature rating of  $T_{j}=+150^{\circ}\text{C}$ .

### Operating Region and Power Dissipation

The thermal resistance of the case and circuit board, ambient and junction air temperature, and the rate of air flow all control the APL5538 maximum power dissipation. The power dissipation across the device is  $P = I_{OUT}(V_{IN} - V_{OUT})$ . The maximum power dissipation is:

$$P_{MAX} = (T_J - T_A) / (\theta_{JB} + \theta_{BA})$$

where  $T_J - T_A$  is the temperature difference between the junction and ambient air.

$\theta_{JB}$  is the thermal resistance of the package,  $\theta_{BA}$  is the thermal resistance through the printed circuit board, copper traces, and other materials to the surrounding air. The GND pin provides an electrical connection to ground and channeling heat away. Connect the GND pin to ground using a large pad or ground plane as a heat sink, it can improve maximize thermal dissipation.

See figure 1. The SOP-8-P utilizes a bottom thermal pad to minimize the thermal resistance of the package, making the package suitable for high current applications. The thermal pad is soldered to the top ground pad and is connected to the internal or bottom ground plane by several vias. The printed circuit board (PCB) forms a heat sink and dissipates most of the

heat into ambient air. The vias are recommended to have proper size to retain solder, helping heat conduction.

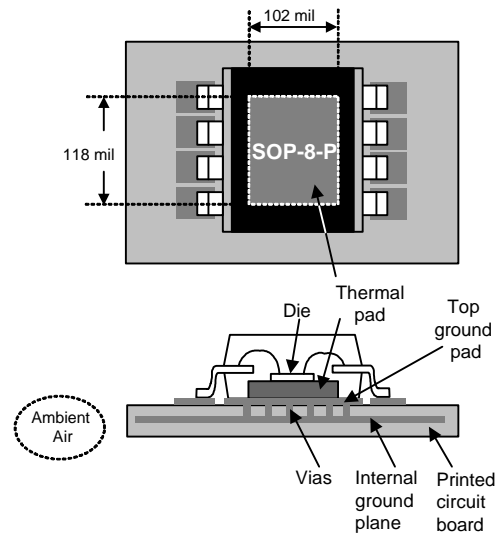
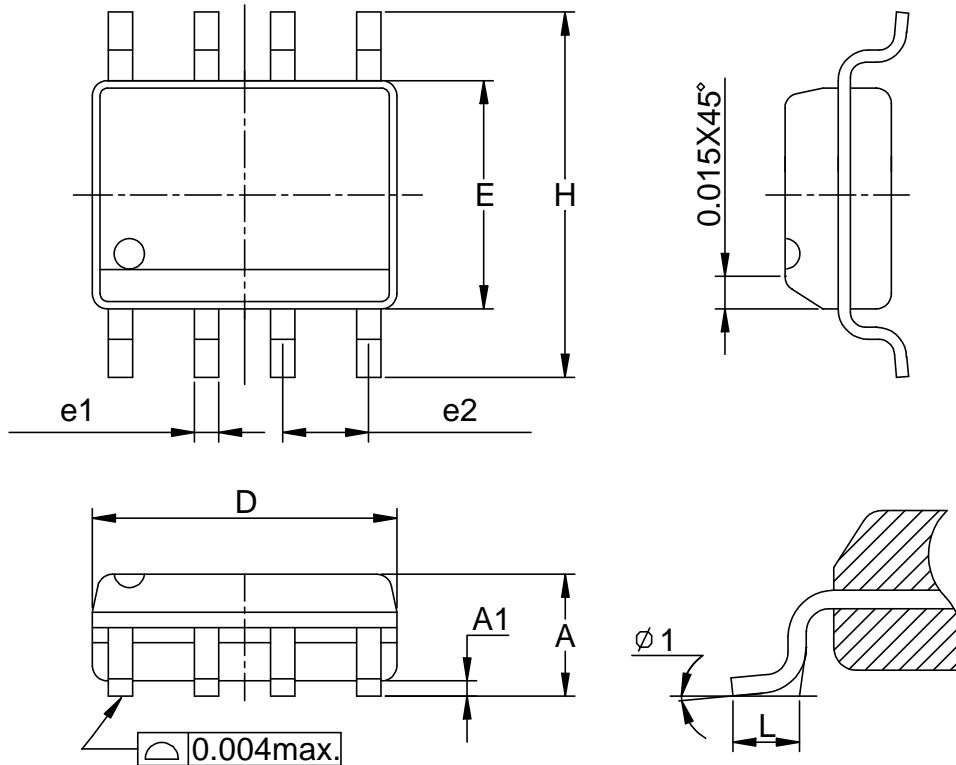


Figure 1

## Packaging Information

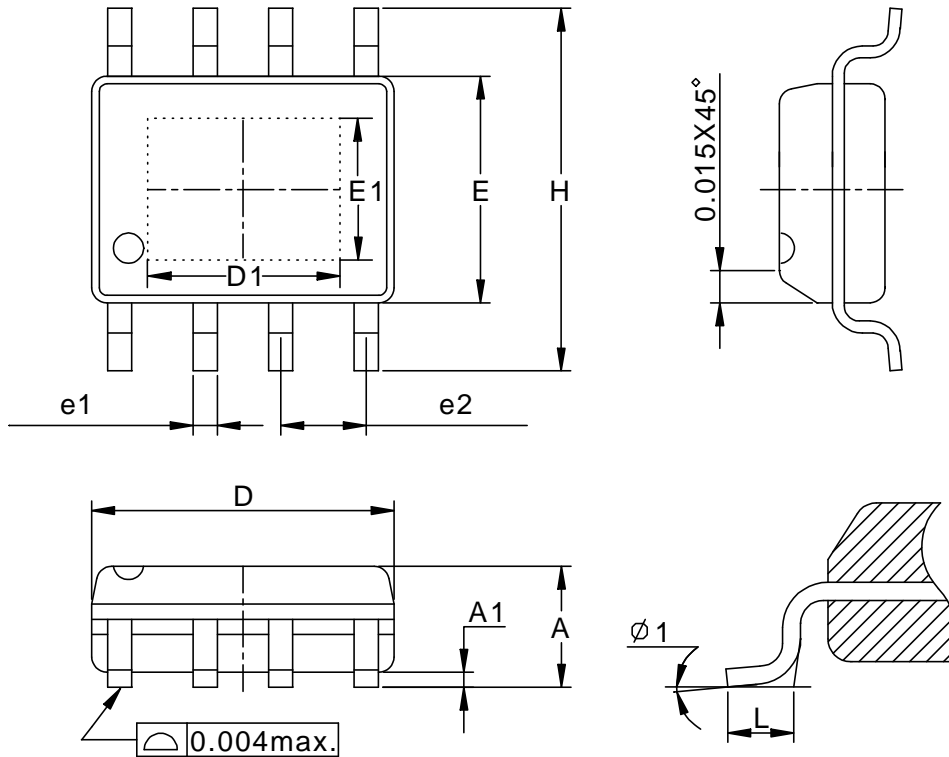
SOP-8 pin ( Reference JEDEC Registration MS-012)



Dim	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	1.35	1.75	0.053	0.069
A1	0.10	0.25	0.004	0.010
D	4.80	5.00	0.189	0.197
E	3.80	4.00	0.150	0.157
H	5.80	6.20	0.228	0.244
L	0.40	1.27	0.016	0.050
e1	0.33	0.51	0.013	0.020
e2	1.27BSC		0.50BSC	
φ 1	8°		8°	

## Packaging Information

SOP-8-P pin ( Reference JEDEC Registration MS-012)

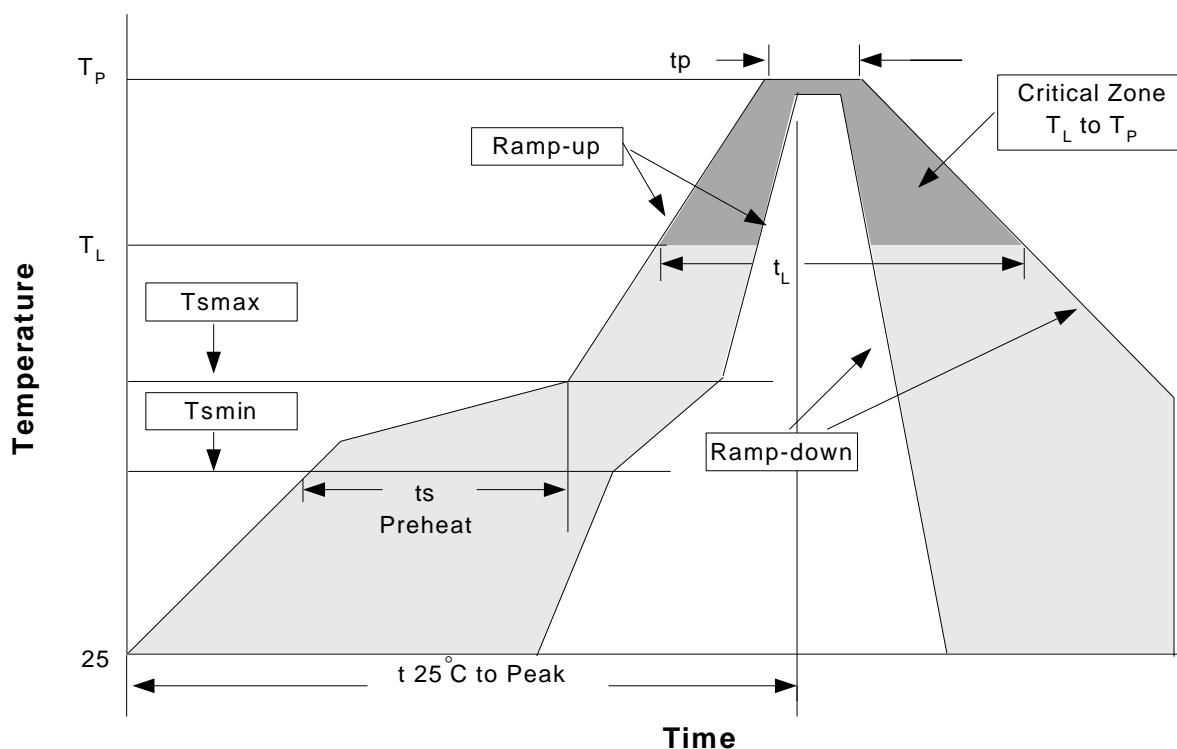


Dim	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	1.35	1.75	0.053	0.069
A1	0	0.15	0	0.006
D	4.80	5.00	0.189	0.197
D1	3.00REF		0.118REF	
E	3.80	4.00	0.150	0.157
E1	2.60REF		0.102REF	
H	5.80	6.20	0.228	0.244
L	0.40	1.27	0.016	0.050
e1	0.33	0.51	0.013	0.020
e2	1.27BSC		0.50BSC	
φ 1	8°		8°	

## Physical Specifications

Terminal Material	Solder-Plated Copper (Solder Material : 90/10 or 63/37 SnPb), 100%Sn
Lead Solderability	Meets EIA Specification RSI86-91, ANSI/J-STD-002 Category 3.

### Reflow Condition (IR/Convection or VPR Reflow)



### Classification of Reflow Profiles

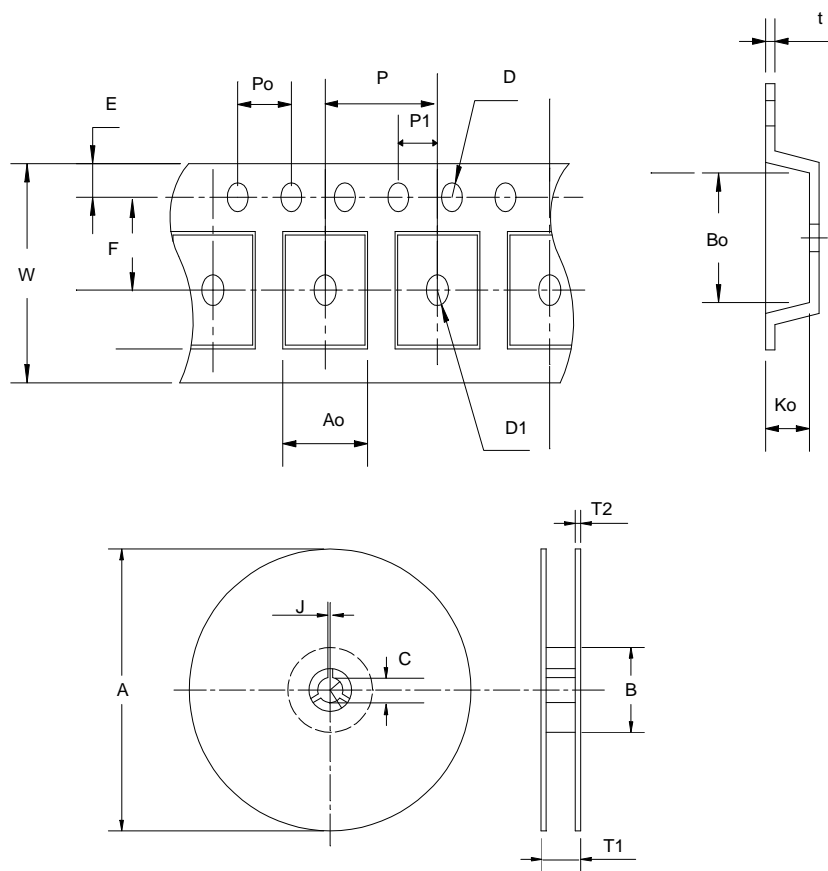
Profile Feature	Sn-Pb Eutectic Assembly		Pb-Free Assembly	
	Large Body	Small Body	Large Body	Small Body
Average ramp-up rate ( $T_L$ to $T_P$ )	3°C/second max.		3°C/second max.	
Preheat				
- Temperature Min ( $T_{smin}$ )	100°C		150°C	
- Temperature Mix ( $T_{smax}$ )	150°C		200°C	
- Time (min to max)( $t_s$ )	60-120 seconds		60-180 seconds	
$T_{smax}$ to $T_L$				
- Ramp-up Rate			3°C/second max	
$T_{smax}$ to $T_L$				
- Temperature( $T_L$ )	183°C		217°C	
- Time ( $t_L$ )	60-150 seconds		60-150 seconds	
Peak Temperature( $T_p$ )	225 +0/-5°C	240 +0/-5°C	245 +0/-5°C	250 +0/-5°C
Time within 5°C of actual Peak Temperature( $t_p$ )	10-30 seconds	10-30 seconds	10-30 seconds	20-40 seconds
Ramp-down Rate	6°C/second max.		6°C/second max.	
Time 25°C to Peak Temperature	6 minutes max.		8 minutes max.	

Note: All temperatures refer to topside of the package. Measured on the body surface.

## Reliability test program

Test item	Method	Description
SOLDERABILITY	MIL-STD-883D-2003	245°C , 5 SEC
HOLT	MIL-STD-883D-1005.7	1000 Hrs Bias @ 125 °C
PCT	JESD-22-B, A102	168 Hrs, 100 % RH , 121°C
TST	MIL-STD-883D-1011.9	-65°C ~ 150°C, 200 Cycles
ESD	MIL-STD-883D-3015.7	VHBM > 2KV, VMM > 200V
Latch-Up	JESD 78	10ms , I <sub>tr</sub> > 100mA

## Carrier Tape



Application	A	B	C	J	T1	T2	W	P	E
SOP- 8/-P	330 ± 1	62 +1.5	12.75+ 0.15	2 ± 0.5	12.4 ± 0.2	2 ± 0.2	12± 0.3	8± 0.1	1.75±0.1
	F	D	D1	Po	P1	Ao	Bo	Ko	t
	5.5± 1	1.55 +0.1	1.55+ 0.25	4.0 ± 0.1	2.0 ± 0.1	6.4 ± 0.1	5.2± 0.1	2.1± 0.1	0.3±0.013

(mm)



## Cover Tape Dimensions

Application	Carrier Width	Cover Tape Width	Devices Per Reel
SOP- 8/-P	12	9.3	2500

## Customer Service

### **Anpec Electronics Corp.**

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