

## 1A Low Dropout Fast Response Positive Adjustable Regulator and Fixed 3.3V

### Features

- Guaranteed Output Voltage Accuracy within 2%
- Fast Transient Response
- Guaranteed Dropout Voltage at Multiple Currents
- Load Regulation : 0.1% Typ.
- Line Regulation : 0.03% Typ.
- Low Dropout Voltage : 1.1V Typ. at  $I_{OUT}=1A$
- Current Limit : 1A Typ. at  $T_J=125^\circ C$
- On-Chip Thermal Limiting :  $150^\circ C$  Typ.
- Adjustable Output : 1.25~7.75V
- Standard 8-pin SO Power Package

### Applications

- Peripheral Cards
- Active SCSI Terminators
- Low Voltage Logic Supplies
- Post Regulator for Switching Power Supply

### General Description

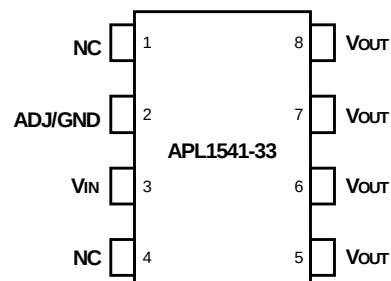
The APL1541 is a low dropout three-terminal adjustable regulators with 1A output current capability. In order to obtain lower dropout voltage and faster transient response, which is critical for low voltage applications, the APL1541 has been optimized.

The device is available in an adjustable version and fixed output voltages of 3.3V, the output available voltage range is from 1.25~7.75V with an input supply below 12V. Dropout voltage is guaranteed at a maximum of 1.3V at 1A.

Current limit is trimmed to ensure specified output current and controlled short-circuit current. On-chip thermal limiting provides protection against any combination of overload that would create excessive junction temperatures.

The APL1541 is available in the industry standard 8-pin SO power package which can be used in applications where space is limited.

### Pin Description



Front View for SO - 8

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>APL1541- <span style="border: 1px solid black; padding: 2px;">□□□□</span> - <span style="border: 1px solid black; padding: 2px;">□□□</span> □</p> <p style="margin-left: 150px;"> <span style="border: 1px solid black; padding: 2px;">□□□□</span> Lead Free Code<br/> <span style="border: 1px solid black; padding: 2px;">□□□</span> Handling Code<br/> <span style="border: 1px solid black; padding: 2px;">□□</span> Temp. Range<br/> <span style="border: 1px solid black; padding: 2px;">□</span> Package Code<br/> <span style="border: 1px solid black; padding: 2px;">□</span> Voltage Code         </p> | <p>Package Code<br/>K : SOP-8<br/>Temp. Range<br/>C : 0 to 70 °C<br/>Handling Code<br/>TU : Tube<br/>Voltage Code<br/>33: 3.3V<br/>Lead Free Code<br/>L : Lead Free Device</p> <p>TR : Tape &amp; Reel<br/>Blank : Adjustable Version<br/>Blank : Original Device</p> |
| <p>APL1541- <span style="border: 1px solid black; padding: 2px;">APL1541<br/>XXXXX</span>      XXXXX - Date Code</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <p>APL1541- 33 : <span style="border: 1px solid black; padding: 2px;">APL1541<br/>XXXXX33</span>      XXXXX - Date Code</p>                                                                                                                                           |

## Absolute Maximum Ratings

| Symbol    | Parameter                                                                   | Rating               | Unit |
|-----------|-----------------------------------------------------------------------------|----------------------|------|
| $V_I$     | Input Voltage                                                               | 13.2                 | V    |
| $T_J$     | Operating Junction Temperature Range<br>Control Section<br>Power Transistor | 0 to 125<br>0 to 150 | °C   |
| $T_{STG}$ | Storage Temperature Range                                                   | -65 to +150          | °C   |
| $T_L$     | Lead Temperature (Soldering, 10 second)                                     | 260                  | °C   |

## Electrical Characteristics

| Symbol       | Parameter                                | Test Conditions                                                                                                                                                                | APL1541 |                  |                   | Unit    |
|--------------|------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|------------------|-------------------|---------|
|              |                                          |                                                                                                                                                                                | Min.    | Typ.             | Max.              |         |
| $V_{REF}$    | Reference Voltage<br>APL1541             | $10mA \leq I_{OUT} \leq 1A$ , $1.4V \leq (V_{IN} - V_{OUT}) \leq 9.75V$ ,<br>$T_J = 0 \sim 125^\circ C$                                                                        | 1.225   | 1.250            | 1.275             | V       |
| $V_{OUT}$    | Output Voltage<br>APL1541-33             | $T_J = 0 \sim 125^\circ C$ ,<br>$0 \leq I_{OUT} \leq 1A$ , $4.75V \leq V_{IN} \leq 12V$ ,                                                                                      | 3.235   | 3.300            | 3.365             | V       |
| $REG_{LINE}$ | Line Regulation<br>APL1541<br>APL1541-33 | $T_J = 0 \sim 125^\circ C$<br>$I_{OUT} = 10mA$ , $1.5V \leq (V_{IN} - V_{OUT}) \leq 9.75V$ , (note1)<br>$I_{OUT} = 0A$ , $4.75V \leq (V_{IN} - V_{OUT}) \leq 7.75V$ , (note 1) |         | 0.03<br>1        | 0.2<br>6          | %<br>mV |
| $REG_{LOAD}$ | Load Regulation<br>APL1541<br>APL1541-33 | $T_J = 0 \sim 125^\circ C$<br>$(V_{IN} - V_{OUT}) = 3V$ , $0 \leq I_{OUT} \leq 1A$ , (note 1)<br>$V_{IN} = 4.75V$ , $0 \leq I_{OUT} \leq 1A$ , (note 1)                        |         | 0.1<br>1         | 0.4<br>10         | %<br>mV |
| $V_D$        | Dropout Voltage                          | $I_{OUT} = 100mA$ , $T_J = 0 \sim 125^\circ C$<br>$I_{OUT} = 500mA$ , $T_J = 0 \sim 125^\circ C$<br>$I_{OUT} = 1A$ , $T_J = 0 \sim 125^\circ C$                                |         | 1<br>1.05<br>1.1 | 1.1<br>1.2<br>1.3 | V       |

## Electrical Characteristics Cont.

| Symbol           | Parameter                               | Test Conditions                                                                                    | APL1541 |          |      | Unit           |
|------------------|-----------------------------------------|----------------------------------------------------------------------------------------------------|---------|----------|------|----------------|
|                  |                                         |                                                                                                    | Min.    | Typ.     | Max. |                |
| $I_{LIMIT}$      | Current Limit                           | $(V_{IN}-V_{OUT})=5V$ , $T_J=25^{\circ}C$                                                          | 1       |          |      | A              |
| $I_{ADJ}$        | Adjust Pin Current<br>APL1541           | $(V_{IN}-V_{OUT})=3V$ , $I_{OUT}=10mA$ , $T_J=0\sim125^{\circ}C$                                   |         | 60       | 120  | $\mu A$        |
| $\Delta I_{ADJ}$ | Adjust Pin Current<br>Change<br>APL1541 | $T_J=0\sim125^{\circ}C$ , $10mA \leq I_{OUT} \leq 1A$ ,<br>$1.4V \leq (V_{IN}-V_{OUT}) \leq 9.75V$ |         | 0.2      | 5    | $\mu A$        |
| $I_O$            | Minimum Load<br>Current<br>APL1541      | $T_J=0\sim125^{\circ}C$ , $(V_{IN}-V_{OUT})=9.75V$ , (note 3)                                      |         | 1.7      |      | mA             |
| PSRR             | Ripple Rejection                        | $F_{RIPPLE}=120Hz$ , $V_{RIPPLE}=1V_{P-P}$ ,<br>$(V_{IN}-V_{OUT})=3V$ , $T_J=0\sim125^{\circ}C$    | 60      | 75       |      | dB             |
| $T_R$            | Thermal<br>Regulation                   | $T_J=25^{\circ}C$ , 30ms Pulse                                                                     |         | 0.01     | 0.02 | %/ W           |
| $T_S$            | Temperature<br>Stability                |                                                                                                    |         | 0.5      |      | %              |
| $L_S$            | Long -Term<br>Stability                 | $T_J=125^{\circ}C$ , 1000Hrs.                                                                      |         | 0.3      |      | %              |
| $V_N$            | RMS Output<br>Noise                     | $T_J=25^{\circ}C$ , $10Hz \leq F \leq 10kHz$ ,<br>(% of $V_{OUT}$ )                                |         | 0.003    |      | %              |
| $\theta_{th}$    | Thermal<br>Resistance                   | Junction to Case, at Tab<br>Junction to ambient                                                    |         | 15<br>50 |      | $^{\circ}C/ W$ |
| $I_q$            | Quiescent Current<br>APL1541-33         | $T_J=0\sim125^{\circ}C$ ,<br>$V_{IN} \leq 12V$                                                     |         | 5.5      | 10   | mA             |

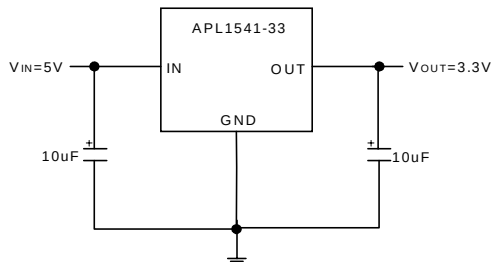
Note 1: See thermal regulation specifications for changes in output voltage due to heating effects. Load line regulations are measured at a constant junction temperature by low duty cycle pulse testing.

Note 2: Dropout voltage is specified over the full output current range of the device. Dropout voltage is defined as the minimum input/output differential measured at the specified output current. Test points and limits are also shown on the Dropout Voltage curve.

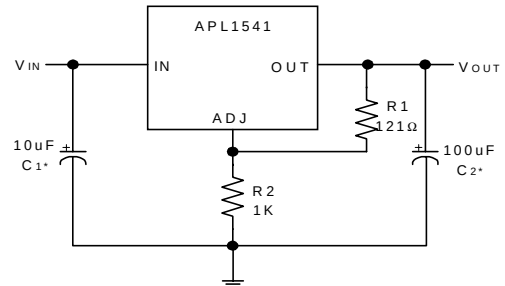
Note 3: Minimum load current is defined as the minimum output current required to maintain regulation.

## Application Circuits

Simple 5V to 3.3V Regulation



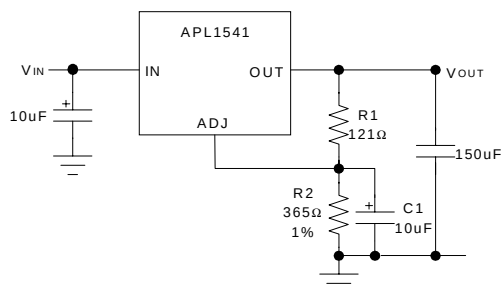
1.25V to 7.75V Adjustable Regulator



\*Needed if device is far from filter capacitors

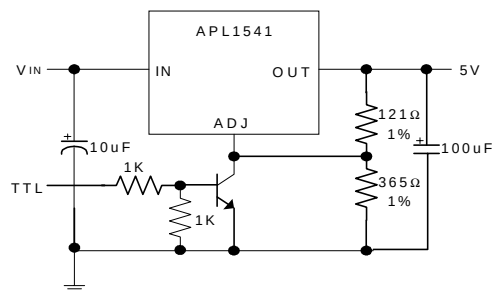
$$V_{OUT} = 1.250V \times \frac{R1 + R2}{R1}$$

Improving Ripple Rejection



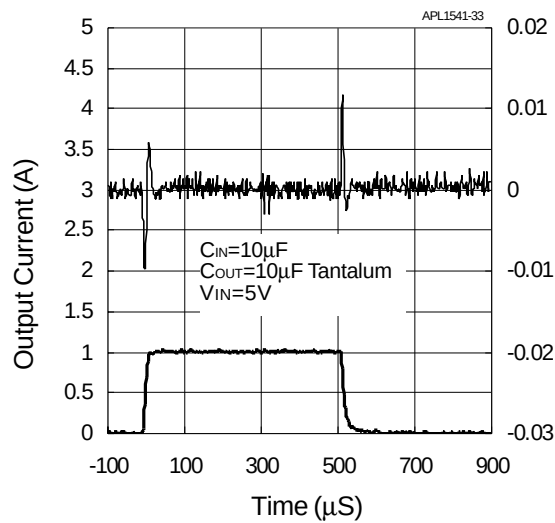
\*C1 improves ripple rejection. XC should be approximately equal to R1 at ripple frequency

5V Regulator with Shutdown

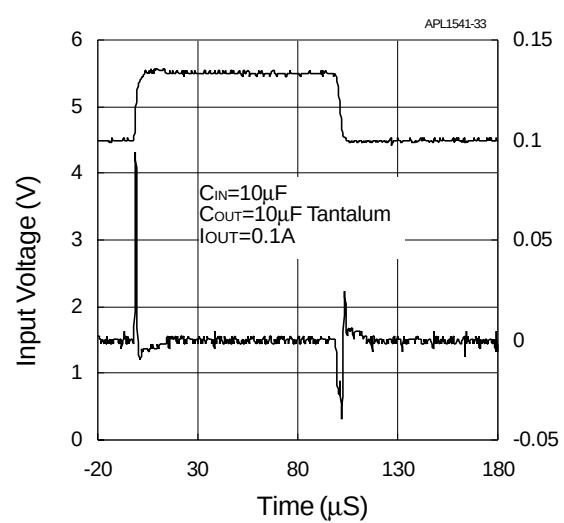


## Typical Characteristics

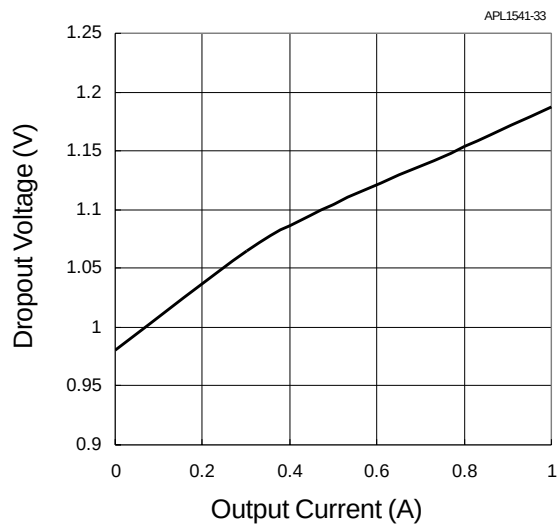
Load Transient Response



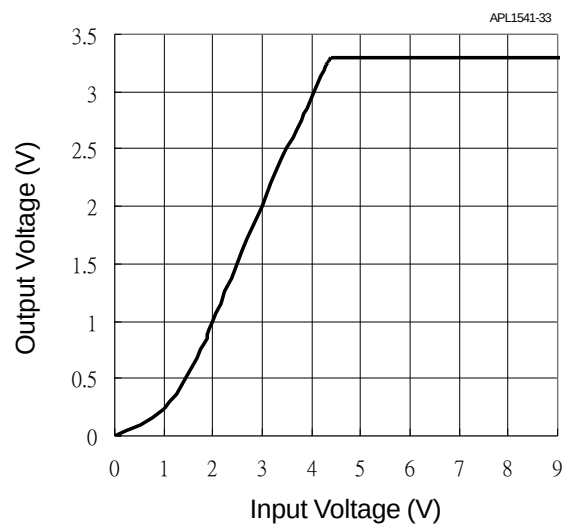
Line Transient Response



Dropout Voltage vs. Output Current

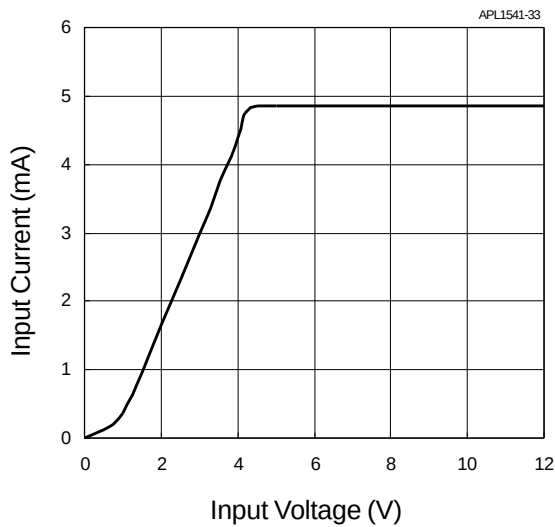


Output Voltage vs. Input Voltage

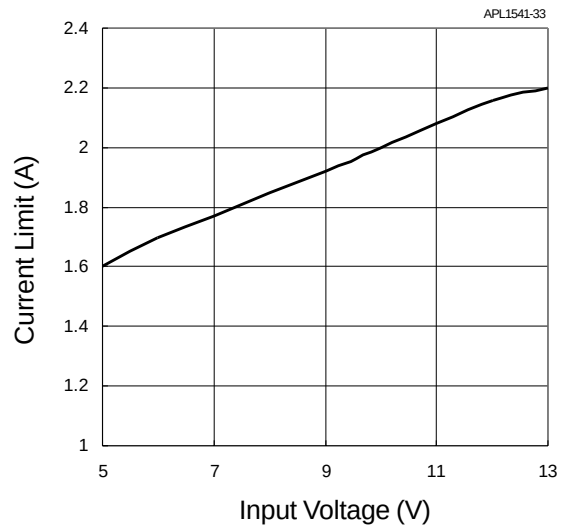


## Typical Characteristics Cont.

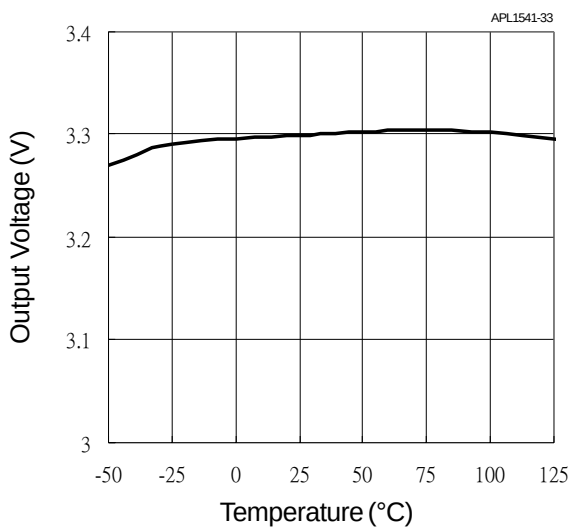
Input Current vs. Input Voltage



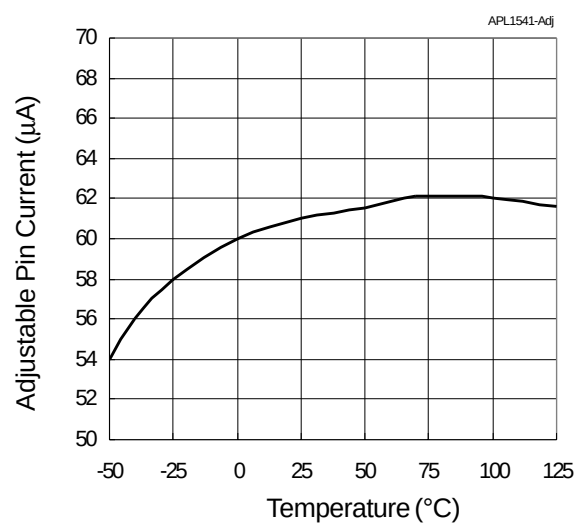
Current Limit vs. Input Voltage



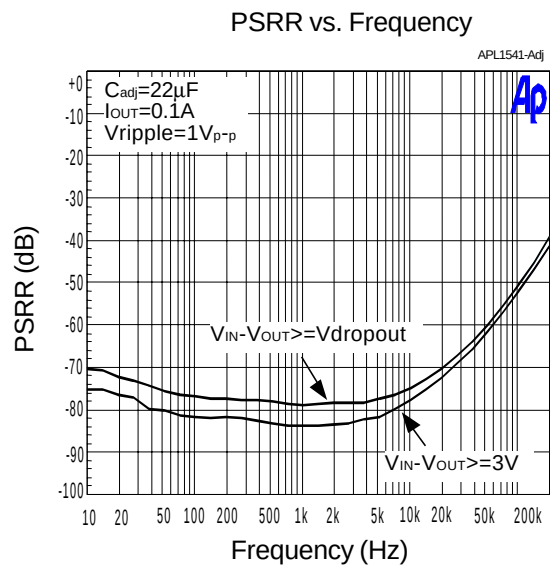
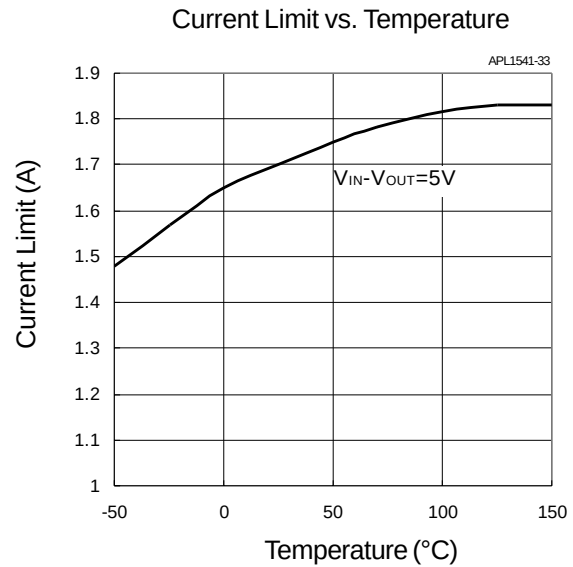
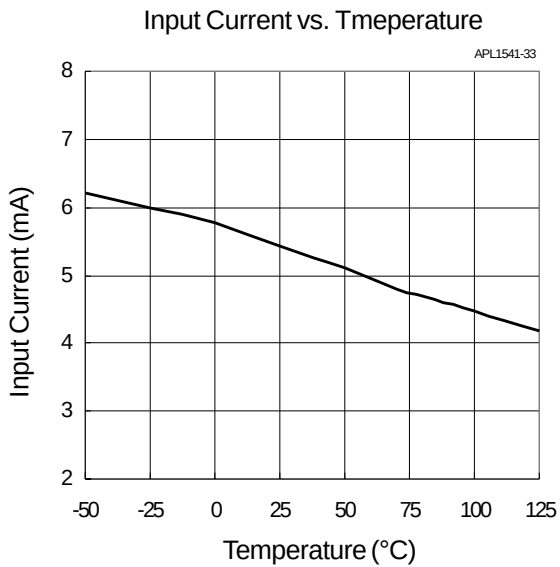
Output Voltage vs. Temperature



Adjustable Pin Current vs. Temperature



## Typical Characteristics Cont.



## Application Information

### Output Voltage

The APL1541 develops a 1.25V reference voltage between the output and the adjust terminal. By placing a resistor between these two terminals, a constant Current is caused to flow through R1 and down through R2 to set the overall output voltage. Normally this current is chosen to be the specified minimum load current of 10mA. For fixed voltage devices R1 and R2 are included in the device.

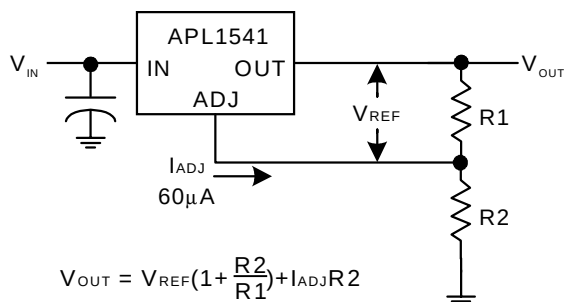


Figure 1. Basic Adjustable Regulator

### Load Regulation

When the adjustable regulator is used. Load regulation will be limited by the resistance of the wire connecting the regulator to the load. The data sheet specification for load regulation is measured at the output pin of the device. Best load regulation is obtained when the top of the resistor divider (R1) is tied directly to the output pin of the device, not to the load. For fixed voltage devices the top of R1 is internally connected to the output, and the ground pin can be connected to low side of the load. If R1 were connected to the load,  $R_p$  is multiplied by the divider ratio, the effective resistance between the regulator and the load would be:

$$R_p \times \left(1 + \frac{R_2}{R_1}\right), R_p = \text{Parasitic Line Resistance}$$

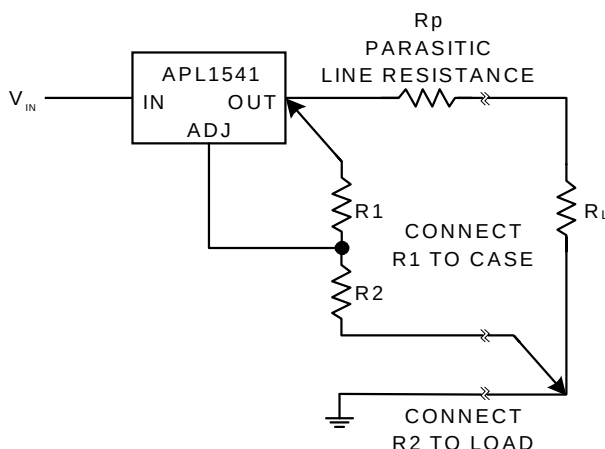


Figure 2. Connections for Best Load Regulation

### Input Capacitor

An input capacitor of 10µF or greater is recommended. Tantalum, or aluminum electrolytic capacitors can be used for bypassing. Larger Values will improve ripple rejection by bypassing the input to the regulator.

### Output Capacitor

The APL1541 requires an output capacitor to maintain stability and improve transient response. Proper capacitor selection is important to ensure proper operation. The APL1541 output capacitor selection is dependent upon the ESR (equivalent series resistance) of the output capacitor to maintain stability. When the output capacitor is 10uF or greater, the output capacitor should have an ESR less than 1Ω. This will improve transient response as well as promote stability. A low-ESR solid tantalum capacitor works extremely well and provides good transient response and stability over temperature.



## **Application Information (Cont.)**

### **Output Capacitor (Cont.)**

Aluminum electrolytics can also be used, as long as the ESR of the capacitor is  $<1\Omega$ . The value of the output capacitor can be increased without limit. Higher capacitance values help to improve transient response and ripple rejection and reduce output noise.

$$P_D = (V_{IN} - V_{OUT}) \times I_{OUT}$$

Maximum junction temperature is equal to :

$$T_{JUNCTION} = T_{AMBIENT} + (P_D \times \theta_{JA})$$

Note:  $T_{JUNCTION}$  must not exceed  $125^\circ\text{C}$

### **Ripple Rejection**

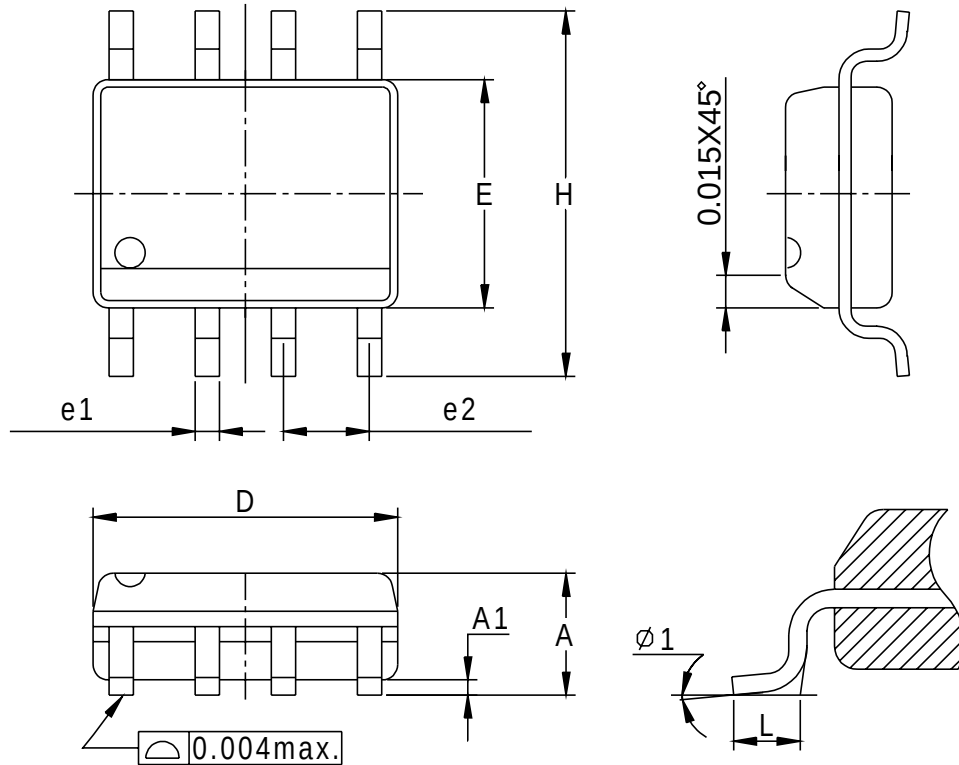
The curves for Ripple Rejection were generated using an adjustable device with the adjust pin bypassed. With a  $22\mu\text{F}$  bypassing capacitor 75dB ripple rejection is obtainable at any output level. The impedance of the adjust pin capacitor, at the ripple frequency, should be  $< R1$ .  $R1$  is normally in the range of  $100\Omega$ - $200\Omega$ . The size of the required adjust pin capacitor is a function of the input ripple frequency. At 120Hz, with  $R1=100\Omega$ , the adjust pin capacitor should be  $13\mu\text{F}$ . For fixed voltage devices, and adjustable devices without an adjust pin capacitor, the output ripple will increase as the ratio of the output voltage to the reference voltage ( $V_{OUT}/V_{REF}$ ).

### **Thermal Considerations**

APL1541 has thermal protection which limits junction temperature to  $150^\circ\text{C}$ . However, device functionality is only guaranteed to a maximum junction temperature of  $+125^\circ\text{C}$ . The thermal resistance for each application will be affected by thermal interactions with other components on the board. Some experimentation will be necessary to determine the actual value. The power dissipation of APL1541 is equal to :

## Packaging Information

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

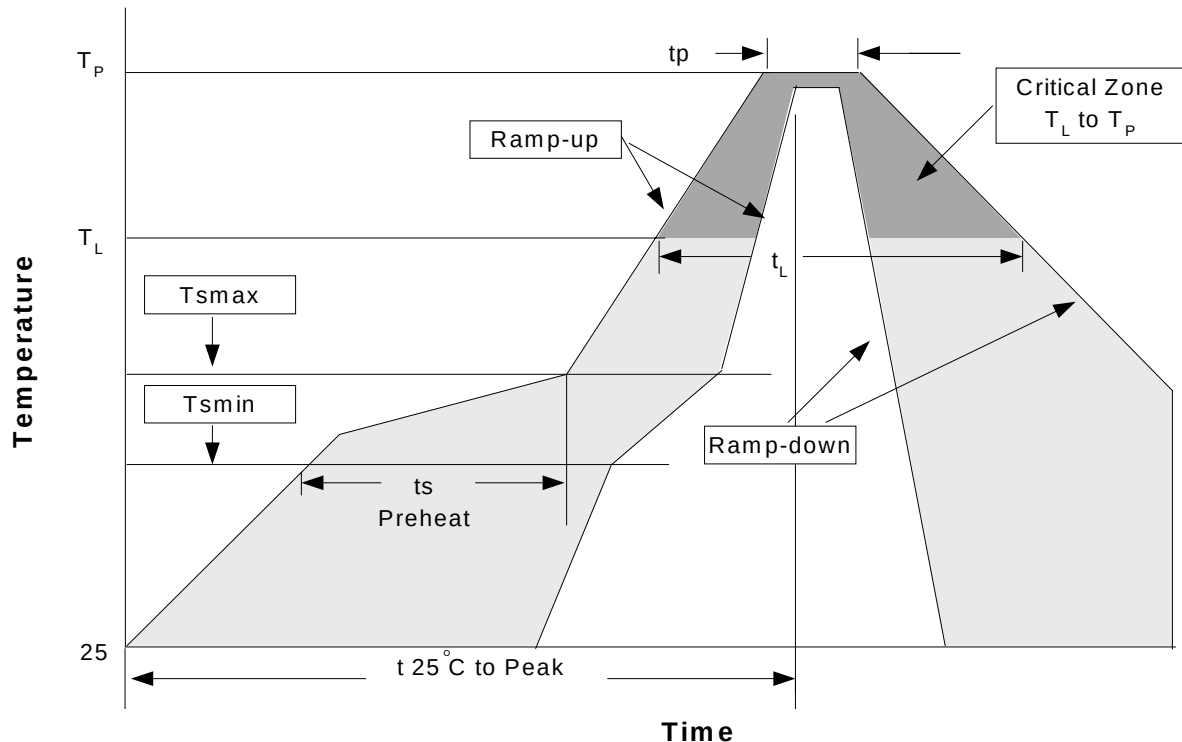


| Dim | Millimeters |      | Inches  |       |
|-----|-------------|------|---------|-------|
|     | Min.        | Max. | Min.    | Max.  |
| A   | 1.35        | 1.75 | 0.053   | 0.069 |
| A1  | 0.10        | 0.25 | 0.004   | 0.010 |
| D   | 4.80        | 5.00 | 0.189   | 0.197 |
| E   | 3.80        | 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 |       |
| Ø 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 Reflow Profiles

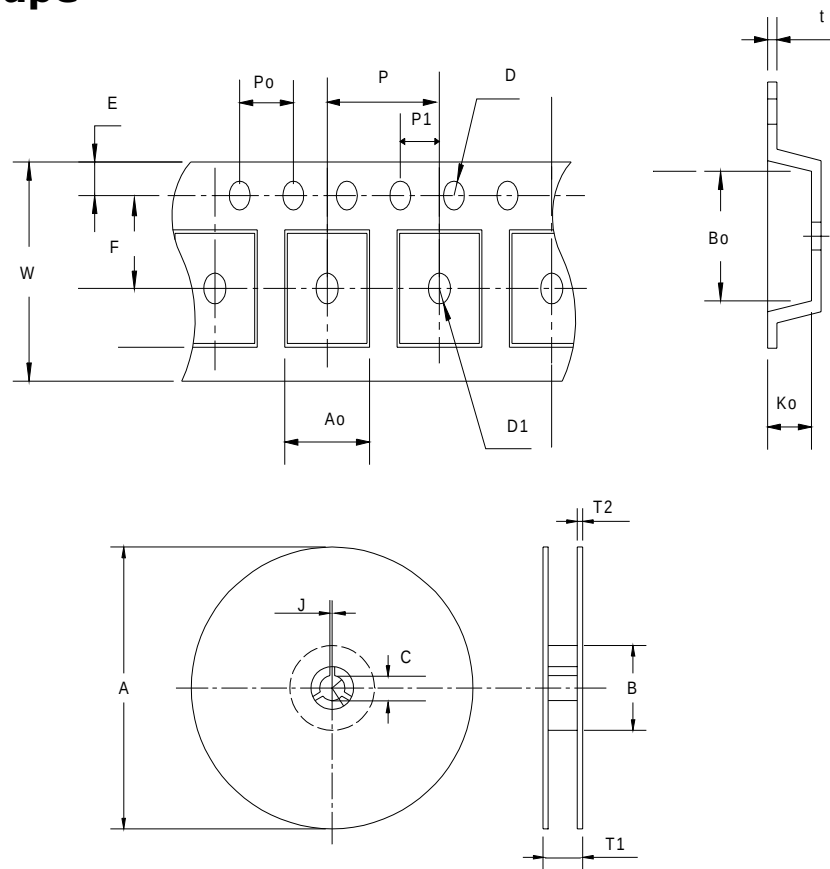
| Profile Feature                                     | Sn-Pb Eutectic Assembly |               | Pb-Free Assembly |               |
|-----------------------------------------------------|-------------------------|---------------|------------------|---------------|
|                                                     | 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 $T_L$                                 |                         |               | 3°C/second max   |               |
| - Ramp-up Rate                                      |                         |               |                  |               |
| $T_{smax}$ 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 , $I_{tr} > 100mA$   |

## Carrier Tape



| Application | A       | B         | C              | J         | T1         | T2        | W         | P        | E        |
|-------------|---------|-----------|----------------|-----------|------------|-----------|-----------|----------|----------|
| SOP- 8      | 330 ± 1 | 62 +1.5   | 12.75+<br>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 | .3±0.013 |

(mm)

## Cover Tape Dimensions

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

## Customer Service

### Anpec Electronics Corp.

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