

150mA CMOS Low Dropout Regulator With Power OK

Features

- Ultra low ground current : 60μA
- Low Dropout Voltage Regulator, 1.5V
- 150mA Load Current Capability
- Output Voltage Accuracy : ±2% Over Temp.
- Input Voltage Range of 2.7V to 6.0V
- Power Good (POK) Function
- Current Limit Protection
- Thermal Shutdown Protection
- Fast Transient Response
- Stability with low-ESR capacitors
- TTL Logic controlled enable input
- SOT-23-5 Package

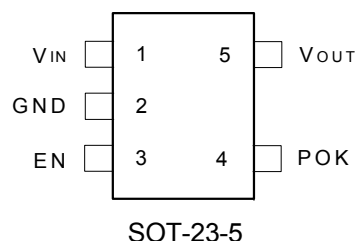
General Description

The APL5158 is a precise CMOS LDO with power ok function. The APL5158 offers 2% output accuracy over temp, and an ultra low ground current 60μA. The power good function monitors the output voltage and indicates when an error occurs in the system (active low). In the event of an output fault such as over current, thermal shutdown, the power ok output is pulled low. The APL5158 also works with low-ESR output capacitors, reducing the amount of board space for power applications, critical in hand-held wireless devices. Key features include current-limit, thermal shutdown, fast transient response. A compact package SOT-23-5 is available for space saving purpose.

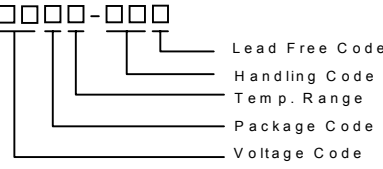
Applications

- Processor power up sequencing
- Laptop, notebook, and palmtop computers
- Wireless LAN

Pin Configuration



Ordering and Marking Information

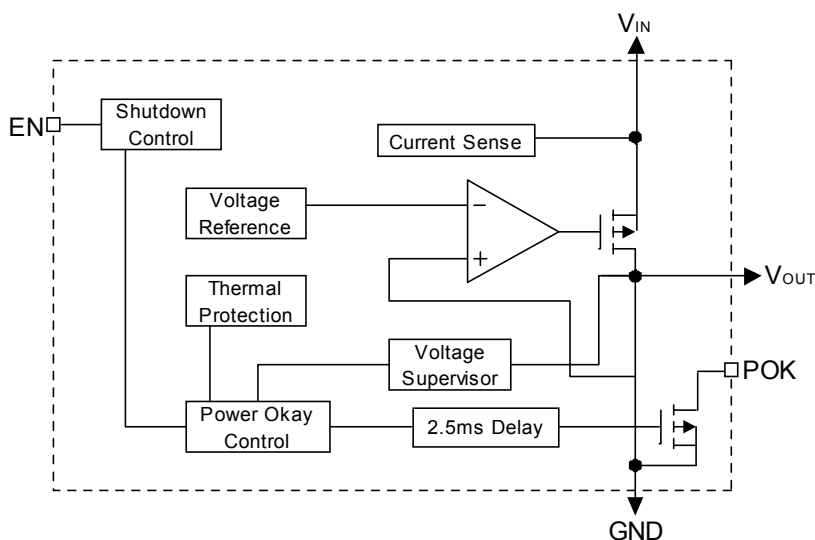
| | |
|--|--|
| <p>APL5158 - □□□□-□□□□</p>  <p>Lead Free Code Handling Code Temp. Range Package Code Voltage Code</p> | <p>Package Code B : SOT-23-5 Temp. Range C : 0 to 70°C Handling Code TR : Tape & Reel Voltage Code : 12 : 1.2V Lead Free Code L : Lead Free Device Blank : Original Device</p> |
| <div style="border: 1px solid black; display: inline-block; padding: 2px;">185X</div> | <p>5 - 1.2V X - Date Code</p> |

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.

Pin Description

| PIN | | I/O | Description |
|-----|------------------|-----|---|
| No. | Name | | |
| 1 | V _{IN} | I | Input supply voltage. |
| 2 | GND | | Ground pin for signal ground and power ground. |
| 3 | EN | I | Enable/shutdown input (active high). Do not leave open. |
| 4 | POK | O | Power OK indicator. |
| 5 | V _{OUT} | O | Regulator output voltage. |

Block Diagram



Absolute Maximum Ratings

| Symbol | Parameter | Rating | Unit |
|------------------|------------------------------------|--------------------|------|
| V _{IN} | Input Voltage | 7 | V |
| V _{EN} | Enable Input Voltage | 7 | V |
| P _D | Power Dissipation | Internally Limited | W |
| T _J | Junction Temperature | 150 | °C |
| T _{STG} | Storage Temperature | -65 to +150 | °C |
| T _s | Soldering Temperature (10 seconds) | 300 | °C |
| ESD | ESD Classification | 2 | kV |

Thermal Characteristics

| Symbol | Parameter | Rating | Unit |
|---------------|--|--------|-----------------------------|
| θ_{JA} | Thermal Resistance in Free Air SOT-23-5 | 260 | $^{\circ}\text{C}/\text{W}$ |

Electrical Characteristics

$T_A=25^{\circ}\text{C}$, $V_I=5\text{V}$, $V_{(EN)}=V_I$, $I_O=100\mu\text{A}$, $C_L=1\mu\text{F}$, unless otherwise specified.

| Symbol | Parameter | Test Conditions | APL5158 | | | Unit |
|----------------------------------|------------------------------------|--|--------------|------|--------------|--------------------|
| | | | Min. | Typ. | Max. | |
| V_{IN} | Input Voltage | | 2.7 | | 6 | V |
| V_{OUT} | Output Voltage | $I_O=25\text{mA}$ | | 1.2 | | V |
| | Output Voltage Accuracy | $I_O=0\text{mA}$ $I_O=1\sim 150\text{mA}$, $T_A=0^{\circ}\text{C}$ to 70°C | -1.0 -2.0 | | +1.0 +2.0 | % % |
| I_Q | Quiescent Current | $V_{(EN)}\leq 0.8\text{V}$ | | 0.45 | 1 | μA |
| I_{GND} | Ground Terminal Current | $I_O=0\text{mA}$ | | 60 | | μA |
| | | $I_O=150\text{mA}$ | | 370 | | μA |
| I_L | Output Load Current | | 150 | | | mA |
| I_{LIMIT} | Output Current Limit | | 300 | 600 | | mA |
| ΔV_{LNR} | Line Regulation | $V_{IN}=2.7\text{V}$ to 6V | -0.1 | | +0.1 | % |
| ΔV_{LDR} | Load Regulation | $I_O=10\text{mA}$ to 150mA | | 0.2 | 1 | % |
| $V_{IN}-V_{OUT}$ | Dropout Voltage | $I_O=100\mu\text{A}$ | | 1.5 | | V |
| | | $I_O=150\text{mA}$ | | 1.5 | | V |
| C_L | Load Capacitance | ESR and Capacitance Tradeoffs | | 1 | | μF |
| I_{REV} | Reverse Output Current on V_{IN} | $V_{IN}=\text{GND}$, $V_{OUT}=\text{Regulated Voltage}$ | | | 4 | mA |
| Enable Input | | | | | | |
| V_{IL} | Enable Input Logic-Low Voltage | $V_{IN}=2.7\text{V}$ to 6V Regulated Shutdown | | | 0.4 | V |
| V_{IH} | Enable Input Logic-High Voltage | $V_{IN}=2.7\text{V}$ to 6V Regulated Enabled | 1.6 | | | V |
| I_{EN} | Enable Input Current | Shutdown, $V_{IL}\leq 0.8\text{V}$ | | 0.01 | | μA |
| | | Enabled, $V_{IH}\geq 2\text{V}$ | | 0.01 | | μA |
| | Resistance Discharge | $V_{EN}\leq 0.8\text{V}$ | | 500 | | Ω |
| Thermal Protection | | | | | | |
| T_{SD} | Thermal Shutdown | | | 150 | | $^{\circ}\text{C}$ |
| T_{SDHYS} | Hysteresis | | | 15 | | $^{\circ}\text{C}$ |
| Power Good | | | | | | |
| V_{POK} | Low Threshold | Output Falls % of V_{OUT} (Power not OK) | | | 83 | % |
| | High Threshold | Output Reaches % of V_O , Starts Delay Timer(Power OK) | 90 | | | % |
| V_{OL} | V_O Out of Regulation | Fault Condition, $I_{OL}=2\text{mA}$, $V_{IN}=3.3\text{V}$ | | 0.13 | 0.15 | V |
| I_{POK} | POK Leakage Current | Power good off, $V_{IN}=5\text{V}$ | | | 1 | μA |
| Switching Characteristics | | | | | | |
| | Power Up Overshoot | Max Voltage Overshoot Allowed on Output During Power Up | | 1 | | % |
| t_{STEP} | Output Transient Time Limit | Time for Output to Return within Specified Regulation Range | | 5 | | μs |
| | Output Transient Voltage Limit | Voltage that Load Step can Affect the Nominal Output Voltage | | 1 | | % |

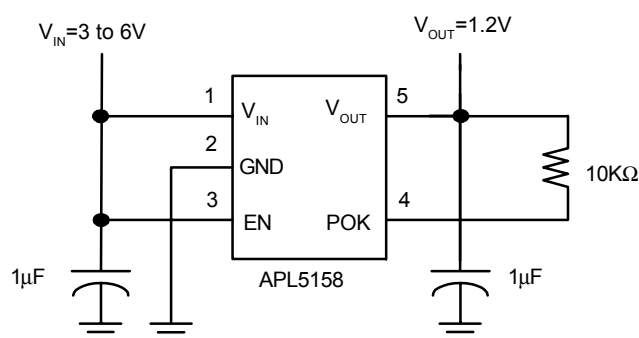
Electrical Characteristics Cont.

$T_A = 25^\circ\text{C}$, $V_I = 5\text{V}$, $V_{(EN)} = V_I$, $I_O = 100\mu\text{A}$, $C_L = 1\mu\text{F}$, unless otherwise specified.

| Symbol | Parameter | Test Conditions | APL5158 | | | Unit |
|-----------------|-----------------------------|--|---------|------|------|-------------------------|
| | | | Min. | Typ. | Max. | |
| I_{SR} | Load Step Current Slew Rate | $I_L = 10\text{mA to } 150\text{mA}$ | | 10 | | $\text{mA}/\mu\text{s}$ |
| t_r | Power Up Rise Time | | | 3 | | ms |
| t_f | Power Down Fall Time | Discharge resistance = 500Ω , $V_O < 1.08\text{V}$ | | 60 | | μs |
| V_{POK} Delay | Delay Time to Power Good | | 1 | 2.5 | 5 | ms |

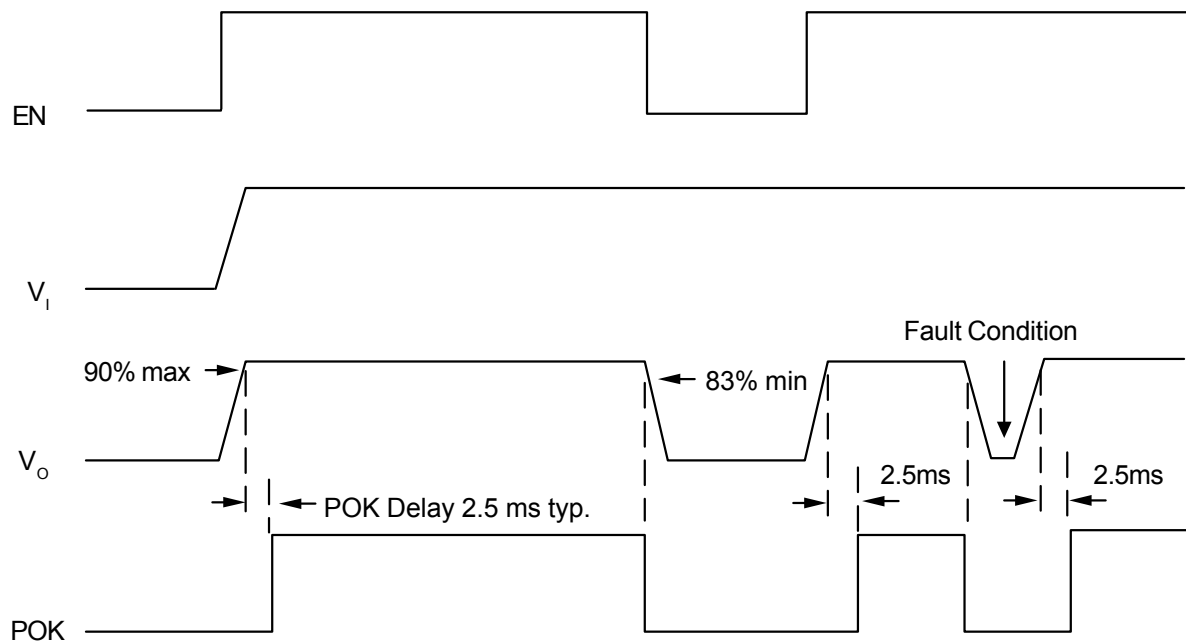
Note 1 : Positive output current means the regulator is sourcing load current, and negative one is sinking load current.

Application Circuit



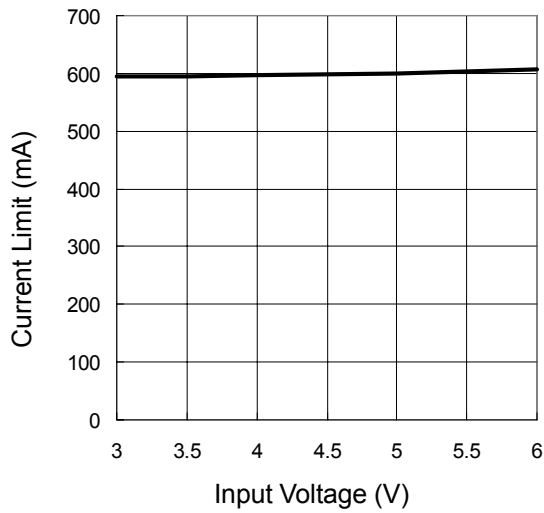
Typical Application For Processor VID Code Power Sequencing Schematic

Timing Chart

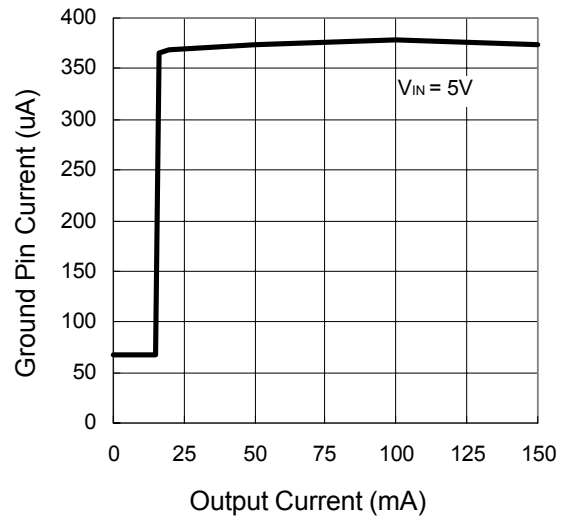


Typical Characteristics

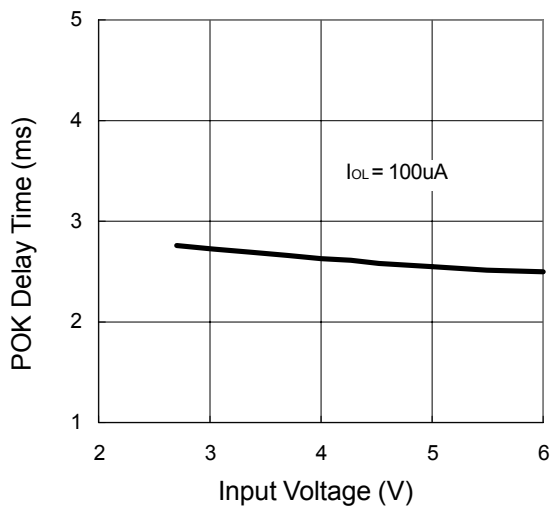
Current Limit vs. Input Voltage



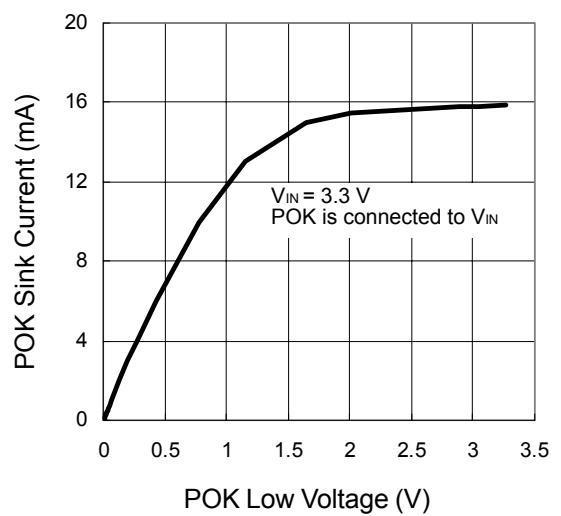
Ground Pin Current vs. Output Current



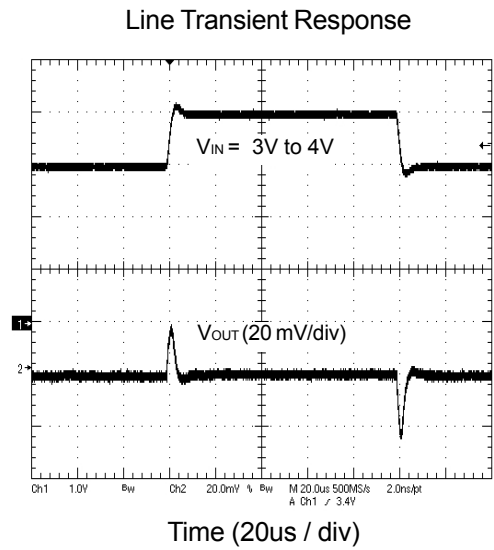
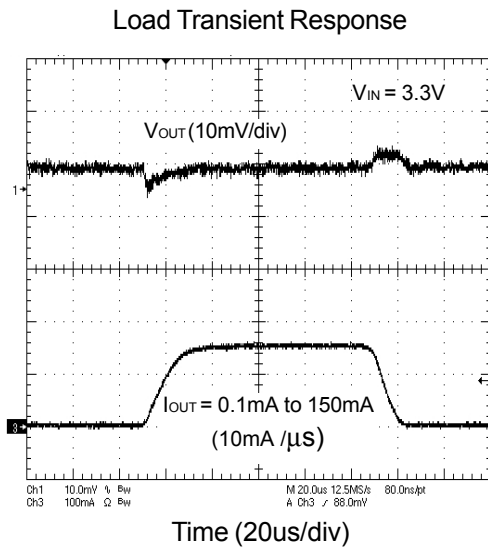
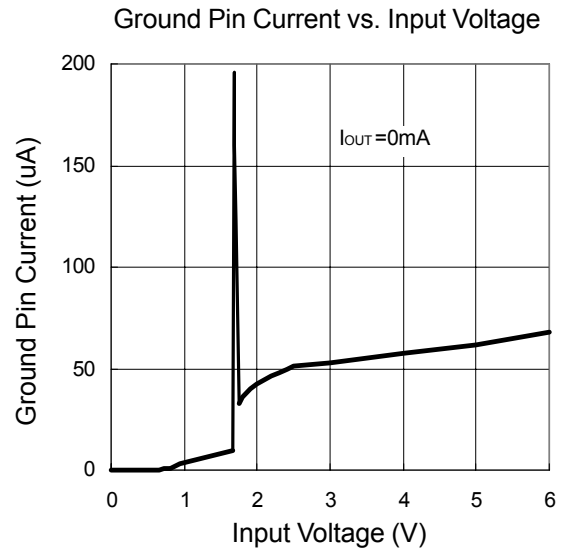
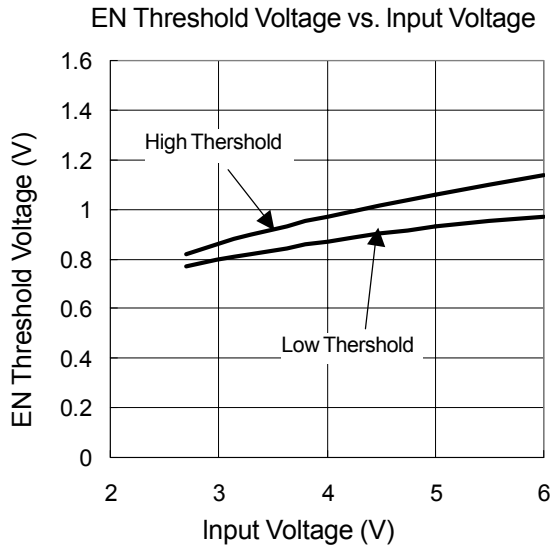
POK Delay Time vs. Input Voltage



POK Sink Current vs. POK Low Voltage

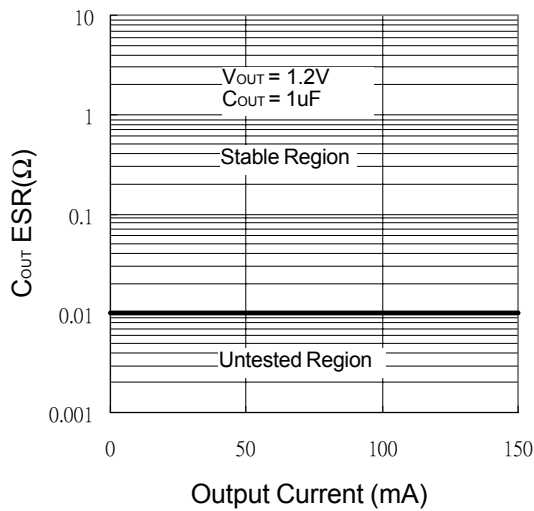


Typical Characteristics

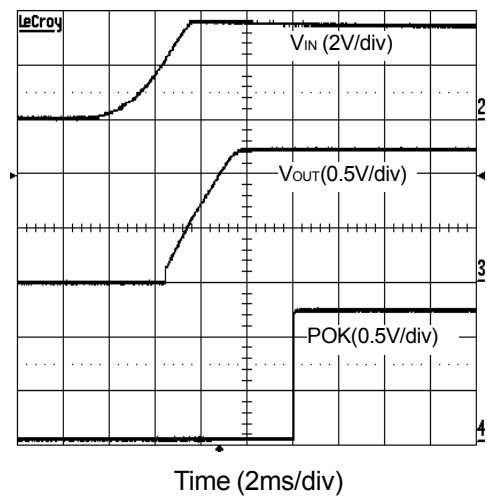


Typical Characteristics

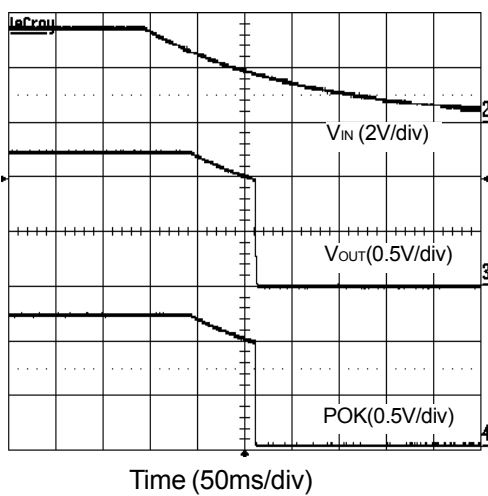
Region of Stable C_{OUT} ESR vs. Output Current



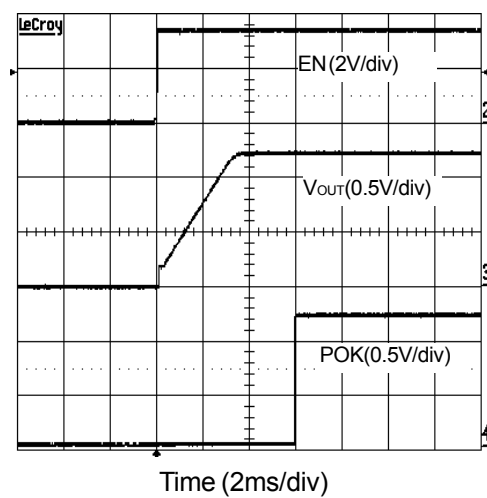
Power Up



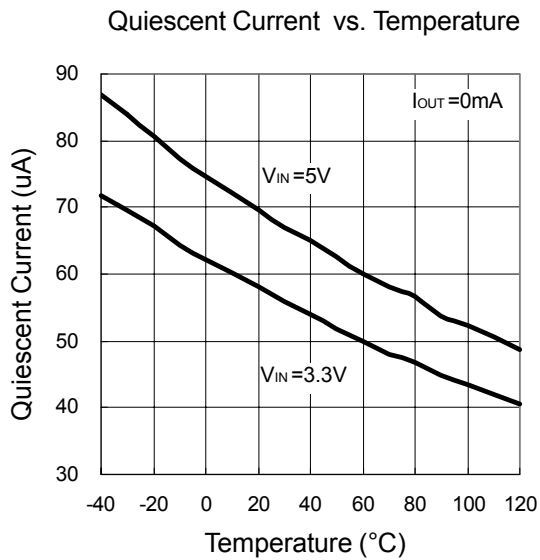
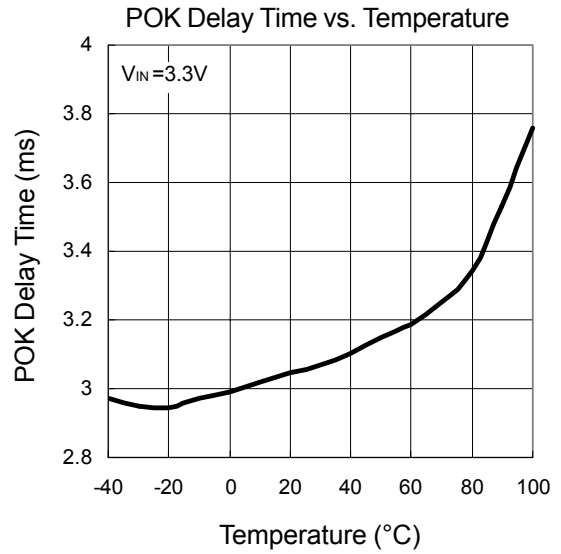
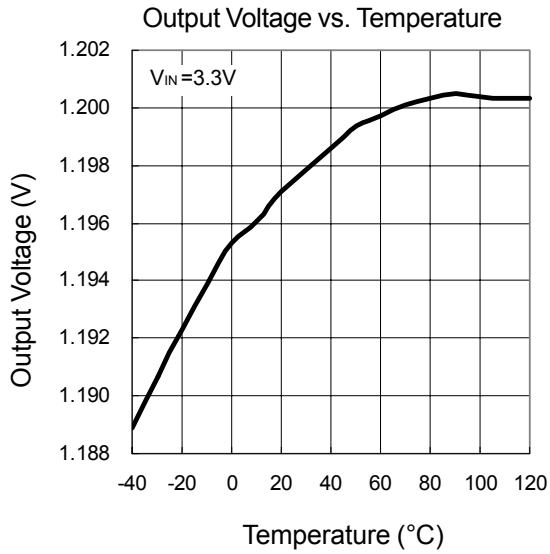
Power Down



Exiting Shutdown



Typical Characteristics



Application Information

Capacitor Selection and Regulator Stability

The APL5158 use at least a 1 μ 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 it's minimum values is recommended 1 μ F, ESR must be above 0.01 Ω . The Curve of the region of stable C_{OUT} ESR vs. load current in Typical Characteristics shows the output capacitor ESR and load current range for APL5158 stability. 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 μ F or more to ensure stability at temperature below -10 $^{\circ}$ C.

Load-Transient Considerations

The APL5158 Load-transient response graphs in Typical Characteristics show the transient response. A step change in the load current from 0.1mA to 150mA at 15 μ second will cause less than 10mV transient spike. Large output capacitor's value and low ESR can reduce transient spike.

Shutdown/Enable

The APL5158 has an active high enable function. Force EN high (>1.6V) enables the regulator, EN low (<0.4V) disables the regulator and enter the shutdown mode, it also causes the output voltage to discharge through a 500 Ω resistance to ground. In shutdown mode, the quiescent current can reduce below 1 μ A. The EN pin cannot be floating, a floating EN pin may cause an indeterminate state on the output. If it is no use, connect to V_{IN} for normal operation.

Power Ok

The power ok function monitors the output voltage and drives high or low to indicate a fault. When a fault condition such as overcurrent, undervoltage, thermal shutdown., or dropout occurs, the power ok output is pulled low. The power ok output comes back when the output voltage has reached 90% of it's nominal value and with a typ. 2.5ms delay time. The power ok is an open-drain output, connect a 10k Ω resistance to V_{OUT} for typical application

Input-Output (Dropout)Voltage

The minimum input-output voltage differential (dropout) determines the lowest usable supply voltage. The minimum input voltage is 2.7V and output voltage is 1.2V, so the dropout voltage is 1.5V.

Reverse Protection

The APL5158 has a internal reverse protection, it doesn't need a external schottky diode to connect the regulator input and output. If the output voltage is forced above the input voltage, the IC will be shutdown and the reverse output current is below 4mA , it will increase with the output voltage. The maximum allowable output voltage is 7V (see Absolute Maximum Ratings).

Current Limit

The APL5158 has a current limit protection, which senses the current flows the P-channel MOSFET, and controls the output voltage. The point where limiting occurs is $I_{OUT}=600$ mA and the output voltage will be shutdown. The output can be shorted to ground for an indefinite amount of time without damaging the part.

Application Information

Thermal Protection

Thermal protection limits total power dissipation in the APL5158. 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 15°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 APL5158's maximum power dissipation. The power dissipation across the device is $P = I_{\text{OUT}}(V_{\text{IN}} - V_{\text{OUT}})$. The maximum power dissipation is:

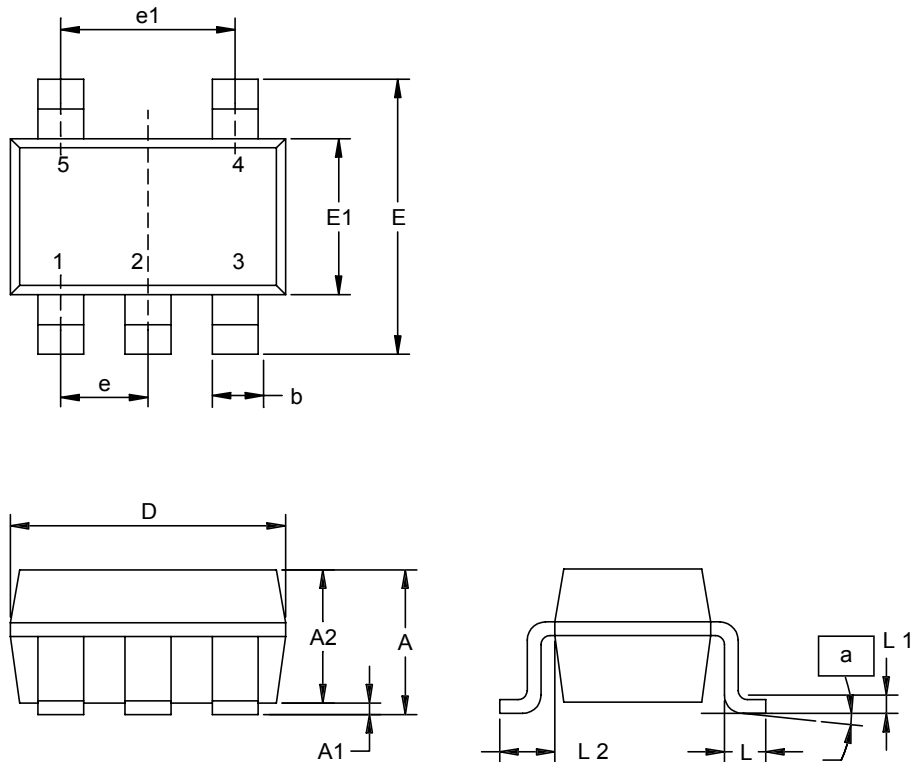
$$P_{\text{MAX}} = (T_J - T_A) / (\theta_{\text{JB}} + \theta_{\text{BA}})$$

where $T_J - T_A$ is the temperature difference between the junction and ambient air. θ_{JB} (or θ_{JA}) is the thermal resistance of the package, θ_{BA} is the thermal resistance through the printed circuit board, copper traces, and other materials to the surrounding air.

The GND pin of the APL5158 provide an electrical connection to ground and channeling heat away. Connect the GND pin to ground using a large pad or ground plane as a heatsink, it can improve maximize thermal dissipation.

Packaging Information

SOT-23-5

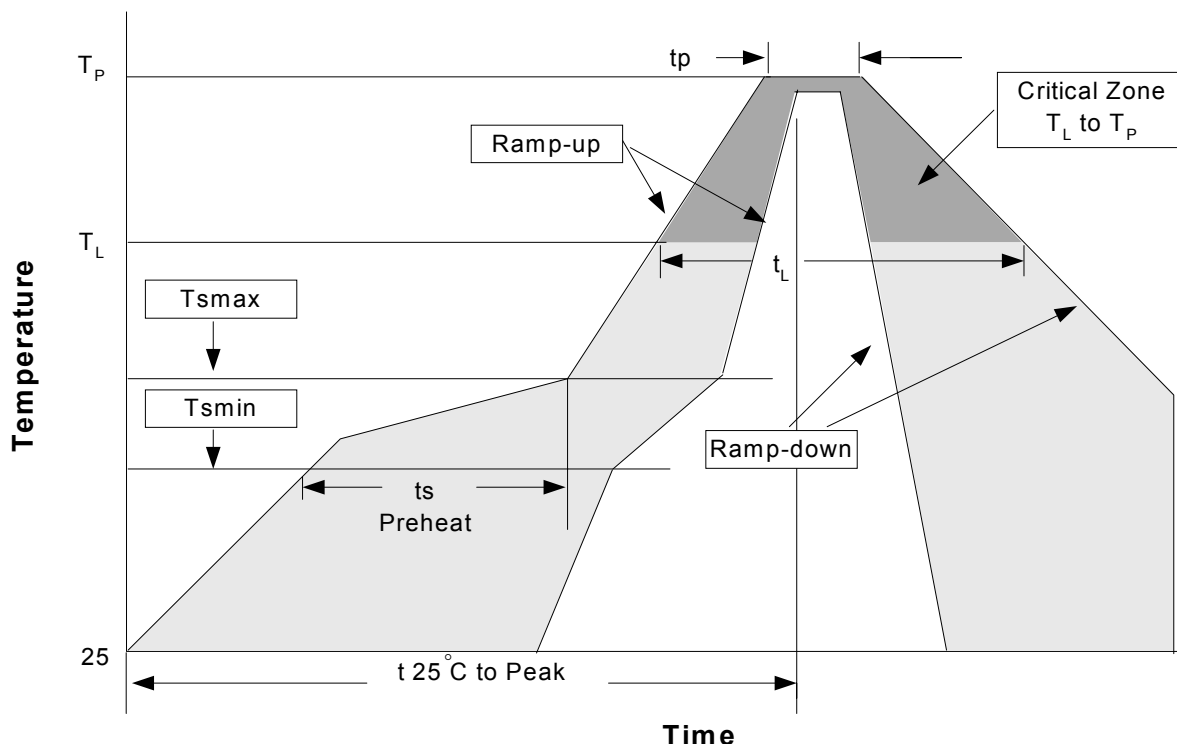


| Dim | Millimeters | | Inches | |
|----------|-------------|------|-----------|-------|
| | Min. | Max. | Min. | Max. |
| A | 0.95 | 1.45 | 0.037 | 0.057 |
| A1 | 0.05 | 0.15 | 0.002 | 0.006 |
| A2 | 0.90 | 1.30 | 0.035 | 0.051 |
| b | 0.30 | 0.50 | 0.011 | 0.019 |
| D | 2.8 | 3.00 | 0.110 | 0.118 |
| E | 2.6 | 3.00 | 0.102 | 0.118 |
| E1 | 1.5 | 1.70 | 0.059 | 0.067 |
| e | 0.95BSC | | 0.037BSC | |
| e1 | 1.90BSC | | 0.074BSC | |
| L | 0.35 | 0.55 | 0.014 | 0.022 |
| L1 | 0.20 BSC | | 0.008 BSC | |
| L2 | 0.5 | 0.7 | 0.020 | 0.028 |
| N | 5 | | 5 | |
| α | 0° | 10° | 0° | 10° |

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

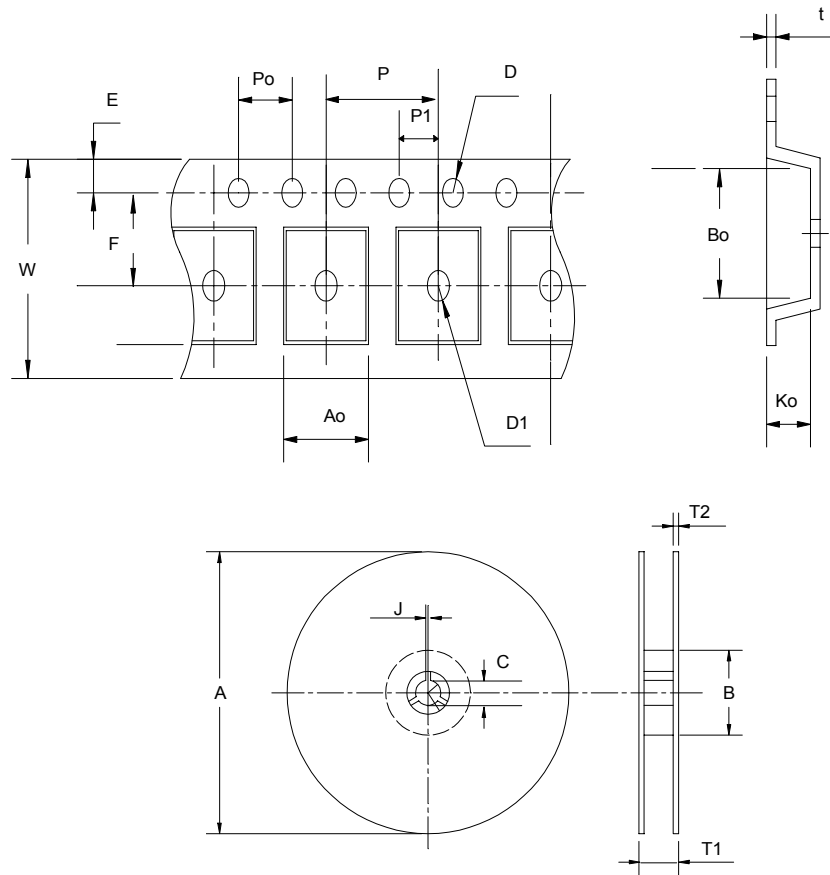
| Profile Feature | Sn-Pb Eutectic Assembly | | Pb-Free Assembly | |
|---|-------------------------|---------------|------------------|---------------|
| | Large Body | Small Body | Large Body | Small Body |
| Average ramp-up rate (T _L to T _P) | 3°C/second max. | | 3°C/second max. | |
| Preheat | | | | |
| - 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 | | | | |
| - 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, $I_{tr} > 100mA$ |

Carrier Tape



| Application | A | B | C | J | T ₁ | T ₂ | W | P | E |
|-------------|------------|-----------|----------------|----------------|----------------|----------------|-------------------|----------------|-----------|
| SOT-23-5 | 178±1 | 72 ± 1.0 | 13.0 + 0.2 | 2.5 ± 0.15 | 8.4 ± 2 | 1.5± 0.3 | 8.0+ 0.3 - 0.3 | 4 ± 0.1 | 1.75± 0.1 |
| | F | D | D ₁ | P _o | P ₁ | A _o | B _o | K _o | t |
| | 3.5 ± 0.05 | 1.5 + 0.1 | 1.5 + 0.1 | 4.0 ± 0.1 | 2.0 ± 0.1 | 3.15 ± 0.1 | 3.2± 0.1 | 1.4± 0.1 | 0.2± 0.03 |

(mm)

Cover Tape Dimensions

| Application | Carrier Width | Cover Tape Width | Devices Per Reel |
|-------------|---------------|------------------|------------------|
| SOT- 23 | 8 | 5.3 | 3000 |

Customer Service

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