



## 1A Low Drop-out Positive Voltage Regulators

### Features

- Low dropout voltage (500mV at 1A load)
- Voltage reference accuracy of 1%
- Low ground current
- Maximum quiescent current in shutdown of 1 $\mu$ A (APU1207M-3, APU1208M-3)
- Fast transient response
- Current limit and thermal shutdown
- Error flag signal for "output out of regulation" (APU1207M-3, APU1208M-3)
- RoHS-compliant, halogen-free package

### Applications

- Supplying 2.5V output from 3.3V input for the new generation of ICs
- Computer motherboard and add-on cards
- High efficiency post-regulator in switched-mode power supplies (SMPS)

### Description

The APU1206 family of devices are ultra-low dropout 1A linear regulators using a PNP transistor as the pass element. These products are ideal when only a single input supply is available and the required dropout voltage is less than 1V, exceeding the minimum dropout characteristics of NPN/PNP hybrid regulators. One common application of these regulators is where the input is 3.3V and a 2.5V output is needed.

Along with the low dropout voltage of less than 0.5V, other features of this family of parts are micro-power shutdown capability and output UVLO detection where the Flag pin is switched low when the output falls below 5% of its nominal point.

### Typical Application

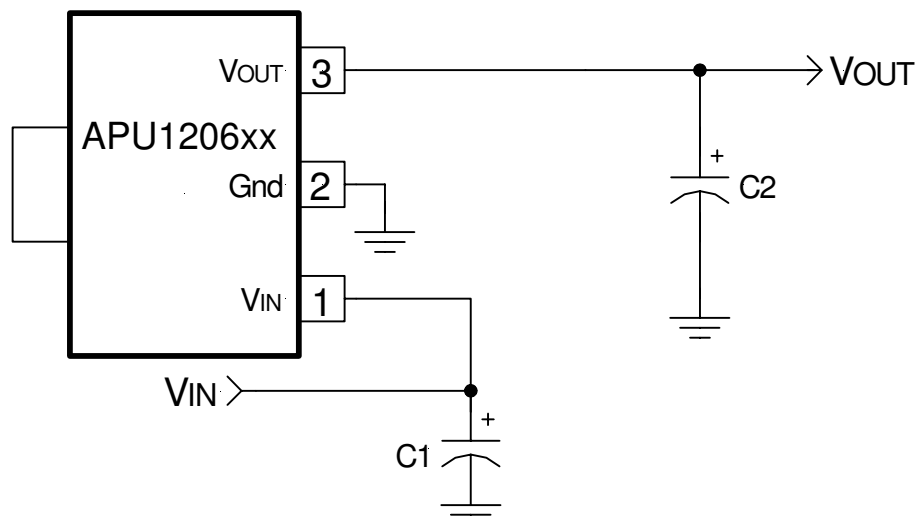


Figure 1 - Typical application for the APU1206XX in a 3-pin SOT-223 package.

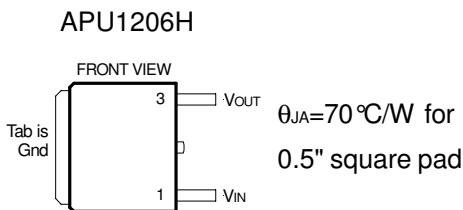


**Ordering Information**

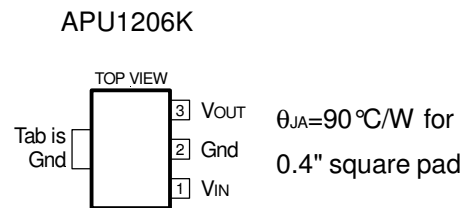
| T <sub>J</sub> (°C) | 2-PIN TO-252 (H)   | 3-PIN SOT-223 (K)  | 8-PIN PLASTIC SOIC (M) | OUTPUT VOLTAGE | PIN FUNCTIONS  |
|---------------------|--------------------|--------------------|------------------------|----------------|--|
| 0 to 125            | APU1206H-18-HF-3TR | APU1206K-18-HF-3TR | NA                     | 1.8V           | V <sub>IN</sub> , V <sub>OUT</sub> , Gnd               |
| 0 to 125            | APU1206H-25-HF-3TR | APU1206K-25-HF-3TR | NA                     | 2.5V           | V <sub>IN</sub> , V <sub>OUT</sub> , Gnd               |
| 0 to 125            | APU1206H-33-HF-3TR | APU1206K-33-HF-3TR | NA                     | 3.3V           | V <sub>IN</sub> , V <sub>OUT</sub> , Gnd               |
| 0 to 125            | N/A                | N/A                | APU1207M-18-HF-3TR     | 1.8V           | V <sub>IN</sub> , V <sub>OUT</sub> , Gnd, Enable, Flag |
| 0 to 125            | N/A                | N/A                | APU1207M-25-HF-3TR     | 2.5V           | V <sub>IN</sub> , V <sub>OUT</sub> , Gnd, Enable, Flag |
| 0 to 125            | N/A                | N/A                | APU1207M-33-HF-3TR     | 3.3V           | V <sub>IN</sub> , V <sub>OUT</sub> , Gnd, Enable, Flag |
| 0 to 125            | N/A                | N/A                | APU1208M-HF-3TR        | Adj            | V <sub>IN</sub> , V <sub>OUT</sub> , Gnd, Flag, Adj    |
| 0 to 125            | N/A                | N/A                | APU1209M-HF-3TR        | Adj            | V <sub>IN</sub> , V <sub>OUT</sub> , Gnd, Enable, Adj  |

**Pin Configuration**

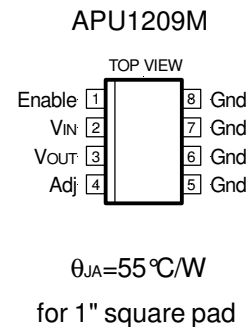
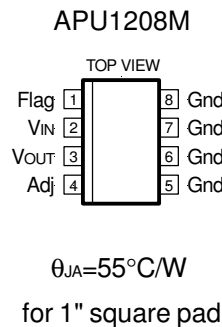
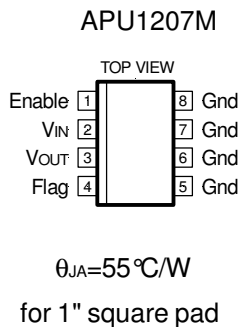
2-PIN PLASTIC TO-252 (D-Pak)



3-PIN PLASTIC SOT-223



8-PIN PLASTIC SOIC



THIS PRODUCT IS SENSITIVE TO ELECTROSTATIC DISCHARGE, PLEASE HANDLE WITH CAUTION.

USE OF THIS PRODUCT AS A CRITICAL COMPONENT IN LIFE SUPPORT OR OTHER SIMILAR SYSTEMS IS NOT AUTHORIZED.

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## Absolute Maximum Ratings

|                                      |                |
|--------------------------------------|----------------|
| Input Voltage ( $V_{IN}$ )           | 10V            |
| Enable Input Voltage                 | 10V            |
| Storage Temperature Range            | -65°C To 150°C |
| Operating Junction Temperature Range | 0°C To 135°C   |

## Electrical Specifications

Unless otherwise indicated, these specifications apply for  $C_{IN}=C_{OUT}=10\mu F$ ,  $V_{IN}=V_O+1V$ ,  $V_{OUT}=V_{FB}$  (for adjustable version only), and  $T_A=25^\circ C$ . Typical values refer to  $T_A=25^\circ C$ . Low duty-cycle pulse testing is used which keeps junction and case temperatures equal to the ambient temperature.

| PARAMETER  | SYM               | TEST CONDITION   | MIN        | TYP               | MAX               | UNITS   |
|--|-------------------|--|------------|-------------------|-------------------|---------|
| Initial Voltage Accuracy<br>(see Table 1 for nominal values) | $V_O$             | $I_O=10mA$ , $T_A=25^\circ C$<br>(Note 4)  | -1<br>-1.3 |                   | 1<br>1.3          | %       |
| Line Regulation  | $\Delta V_I$      | $V_O + 1V < V_{IN} < 10$   |            | 0.5               | 1                 | %       |
| Load Regulation (Note 1)                                     | $\Delta V_L$      | $10mA < I_O < 1A$<br>$1mA < I_O < 150mA$   |            | 0.5               | 0.7<br>0.5        | %       |
| Output Voltage Temp Coef.                                    | $\Delta V_{O(T)}$ |  |            | 20                | 100               | ppm/°C  |
| Dropout Voltage (Note 2)                                     | $\Delta V_{I(O)}$ | $I_O=100mA$ (Note 4)<br>$I_O=500mA$ (Note 4)<br>$I_O=1000mA$ (Note 4)  |            | 100<br>300<br>500 | 200<br>400<br>650 | mV      |
| Ground Current (Note 3)                                      | $I_Q$             | $V_{IN}=V_O + 1V$ for all conditions:<br>$I_O=100mA$ (Note 4)<br>$I_O=500mA$ (Note 4)<br>$I_O=1000mA$ (Note 4) |            |                   | 3<br>15<br>50     | mA      |
| Current Limit  | $I_{CL}$          | $V_O=5\%$ below regulation point   | 1.1        | 1.4               |                   | A       |
| Minimum Input Voltage  | $V_{IN(min)}$     |  |            | 2.1               | 2.3               | V       |
| <b>APU1208, APU1209</b>                                      |                   |  |            |                   |                   |         |
| Adjust Pin Current   | $I_{ADJ}$         | $V_{IN}=2.5V$ , $V_O=V_{ADJ}$ (Note 4)   |            |                   | 0.1               | $\mu A$ |
| Minimum Load Current   | $I_{O(min)}$      |  | 1          |                   |                   | mA      |
| <b>APU1207, APU1209</b>                                      |                   |  |            |                   |                   |         |
| Ground Current - SD Activated                                | $I_{Q(SD)}$       | Enable=Open  |            | 0.01              | 1                 | $\mu A$ |
| Enable Pin Input LO Voltage                                  | $V_{EN(L)}$       | Regulator OFF (Note 4)   |            |                   | 0.8               | V       |
| Enable Pin Input HI Voltage                                  | $V_{EN(L)}$       | Regulator ON (Note 4)  | 2          |                   |                   | V       |
| Enable Pin Input LO Current                                  |                   | $V_{EN(L)}=0V$ to $0.8V$ (Note 4)  |            | 0.1               | 2                 | $\mu A$ |
| Enable Pin Input HI Current                                  |                   | $V_{EN(L)}=2V$ to $V_{IN}$ (Note 4)  |            | 100               | 600               | $\mu A$ |
| <b>APU1207, APU1208</b>                                      |                   |  |            |                   |                   |         |
| Flag Output Threshold Voltage                                | $V_{TH(FG)}$      |  |            | 5                 |                   | % $V_O$ |
| Flag Output Hysteresis Voltage                               | $V_{HYS}$         | Output Ramping Up  |            | 0.8               |                   | % $V_O$ |
| Flag Output Saturation Voltage                               | $V_{F(SAT)}$      | $I_O=5mA$<br>$I_O=500\mu A$  |            | 400<br>230        |                   | mV      |

**Note 1:** Low duty-cycle pulse testing with Kelvin connections is required in order to maintain accurate data.

**Note 2:** Dropout voltage is defined as the minimum differential voltage between  $V_{IN}$  and  $V_{OUT}$  required to maintain regulation at  $V_{OUT}$ . It is measured when the output voltage drops 1% below its nominal value.

**Note 3:** Ground current is the regulator quiescent current plus the pass transistor current. The total current from the supply is the sum of the load current plus the ground pin current.

**Note 4:** The specification applies for junction temperatures from 0 to +125°C.



## Pin Descriptions

| PIN SYMBOL                        | PIN DESCRIPTION   |
|-----------------------------------|---|
| V <sub>IN</sub><br>(All devices)  | The input pin of the regulator. Typically a large storage capacitor is connected from this pin to ground to ensure that the input voltage does not sag below the minimum drop-out voltage during the load transient response. This pin must always be 0.6V higher than V <sub>OUT</sub> in order for the device to regulate properly. |
| V <sub>OUT</sub><br>(All devices) | The output of the regulator. A capacitor of at least 2.2μF must be connected from this pin to ground.   |
| Gnd<br>(All devices)              | Ground pin. This pin must be connected to the lowest potential in the system and all other pins must be at higher potential with respect to this pin.   |
| Enable<br>(APU1207, APU1209)      | Enable pin. A low signal or left open on this pin shuts down the output. This pin must be tied HI or to V <sub>IN</sub> for normal operation.   |
| Flag<br>(APU1207, APU1208)        | An open collector output that switches low when the output voltage drops about 4% below its expected regulated voltage.   |
| Adj<br>(APU1208, APU1209)         | A resistor divider from this pin to the V <sub>OUT</sub> pin and ground sets the output voltage.  |

## Application Information

### Stability

The APU120X series of regulators requires the use of an output capacitor as part of the frequency compensation in order to make the regulator stable. A capacitor of at least 2.2μF and ESR in the range of 0.5 to 2Ω will ensure the stability of the system.

## Typical Applications

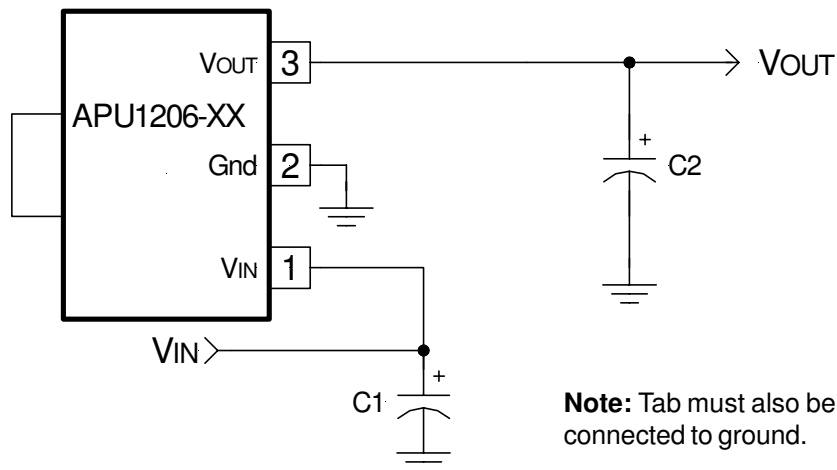


Figure 2 - Typical application of APU1206.

| Ref Desig | Description | Qty | Part #         | Manuf |
|-----------|-------------|-----|----------------|-------|
| C1        | Capacitor   | 1   | 10μF, Tantalum | AVX   |
| C2        | Capacitor   | 1   | 10μF, Tantalum | AVX   |



**Typical Applications**

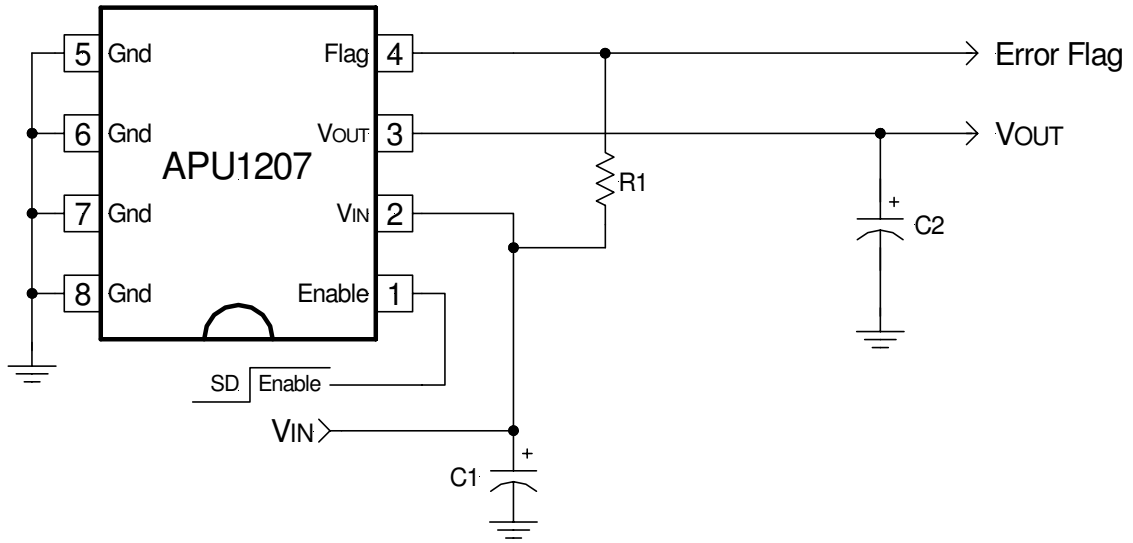


Figure 3 - Typical application of APU1207.

| Ref Desig | Description | Qty | Part #         | Manuf     |
|-----------|-------------|-----|----------------|-----------|
| C1        | Capacitor   | 1   | 10μF, Tantalum | AVX       |
| C2        | Capacitor   | 1   | 10μF, Tantalum | AVX       |
| R1        | Resistor    | 1   | 10kΩ, 5%       | Panasonic |

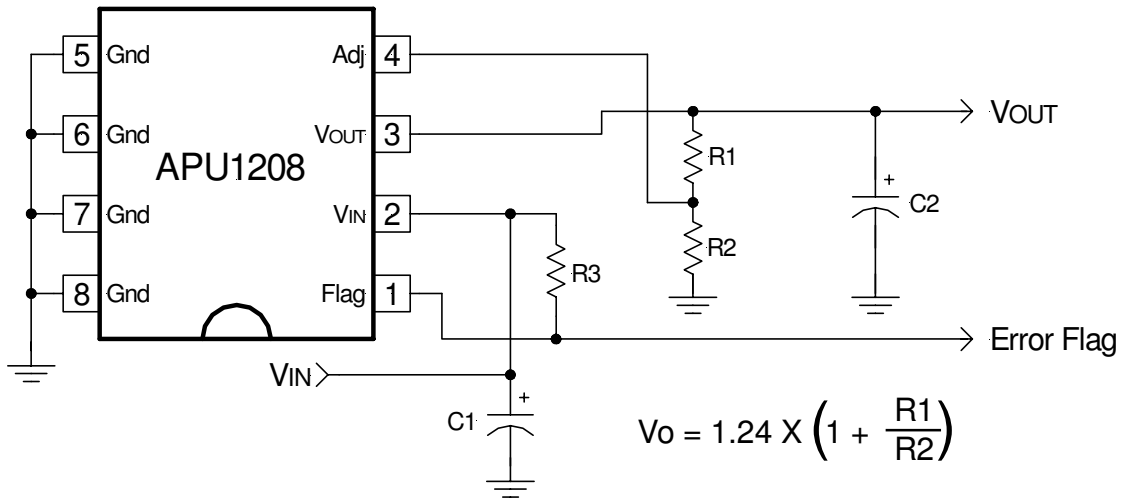


Figure 4 - Typical application of APU1208 in 3.3V to 2.5V regulator.

| Ref Desig | Description | Qty | Part #         | Manuf |
|-----------|-------------|-----|----------------|-------|
| C1        | Capacitor   | 1   | 10μF, Tantalum | AVX   |
| C2        | Capacitor   | 1   | 10μF, Tantalum | AVX   |
| R1        | Resistor    | 1   | 127Ω, 1%       |       |
| R2        | Resistor    | 1   | 124Ω, 1%       |       |
| R3        | Resistor    | 1   | 10kΩ, 5%       |       |



**Typical Applications**

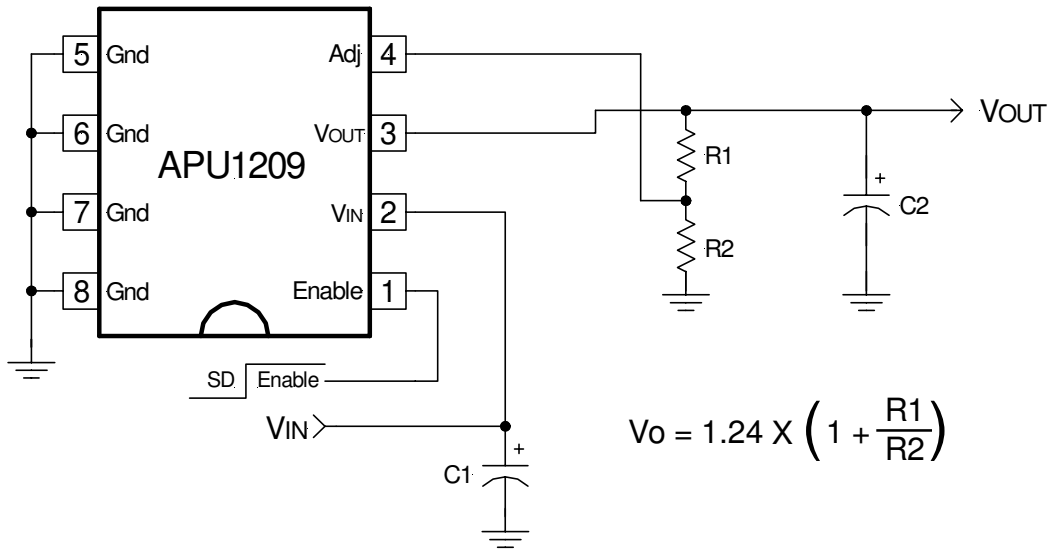


Figure 5 - Typical application of APU1209 in 3.3V to 2.5V regulator.

| Ref Desig | Description | Qty | Part #               | Manuf |
|-----------|-------------|-----|----------------------|-------|
| C1        | Capacitor   | 1   | 10 $\mu$ F, Tantalum | AVX   |
| C2        | Capacitor   | 1   | 10 $\mu$ F, Tantalum | AVX   |
| R1        | Resistor    | 1   | 127 $\Omega$ , 1%    |       |
| R2        | Resistor    | 1   | 124 $\Omega$ , 1%    |       |



# Electrical Characteristics

APU1209 Line Regulation from 5mA to 100mA

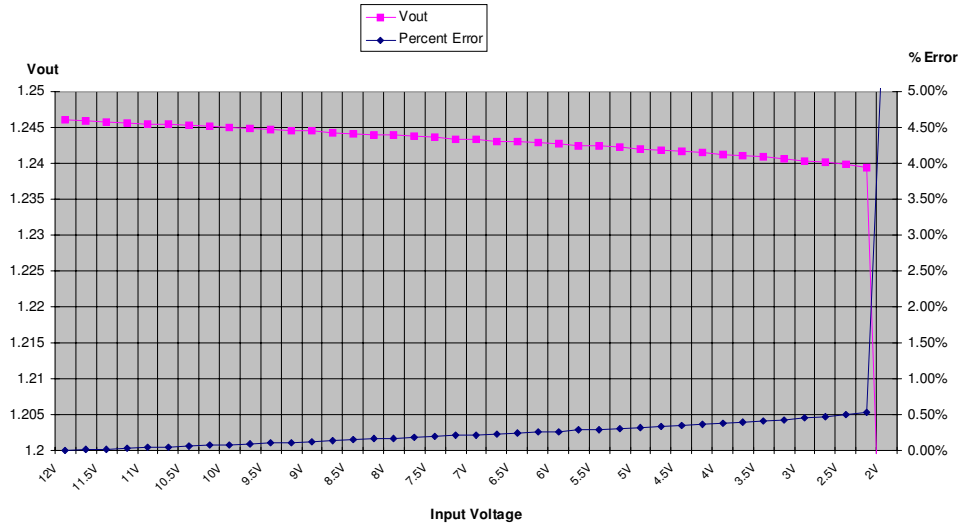


Figure 6

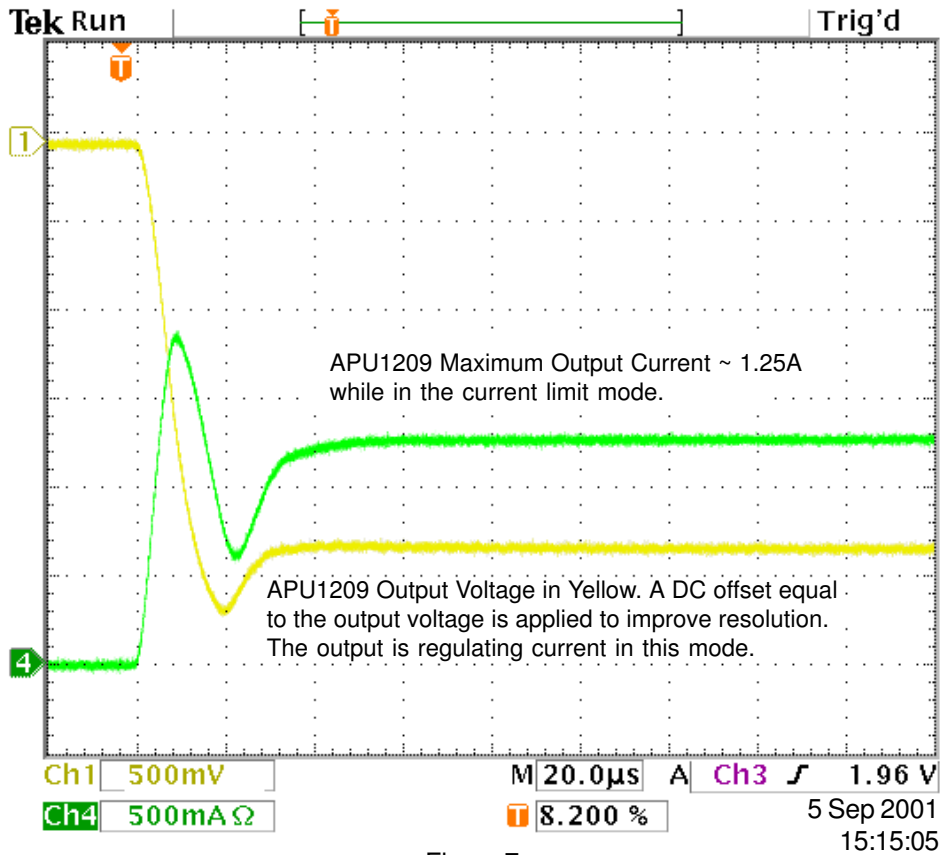


Figure 7



### Electrical Characteristics (cont.)

APU1209 Voltage Drop-out Variation with Ambient Temperature  
with various load currents

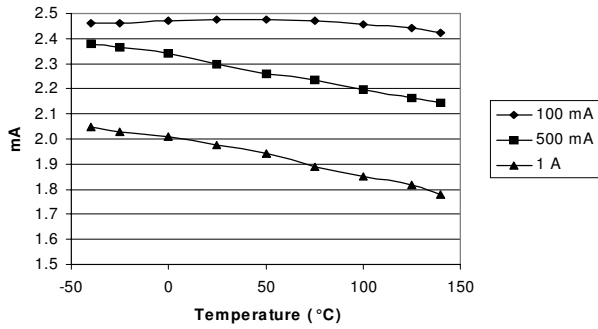


Figure 8

APU1209 Vout Variation with Ambient Temperature  
with Vin at 3.5V and 12V

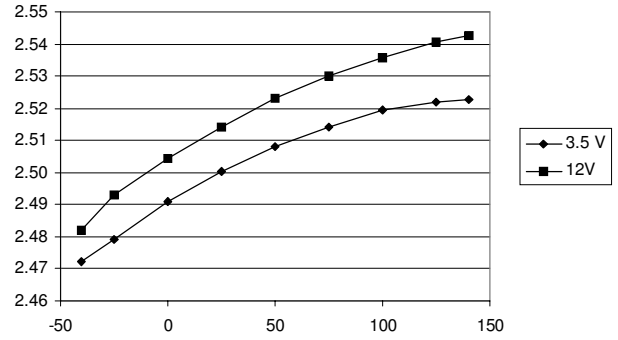


Figure 9

APU1209 Ground Current Variation with Ambient Temperature

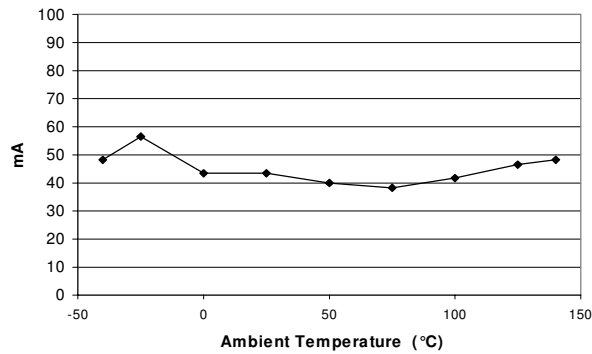
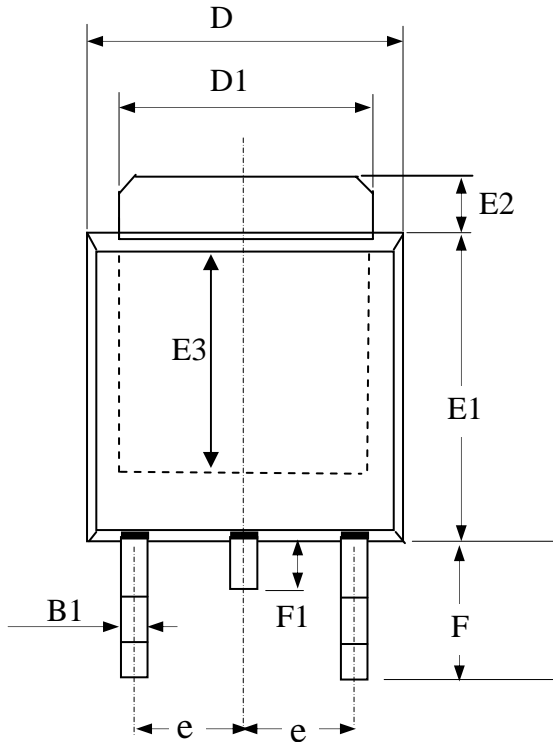


Figure 10



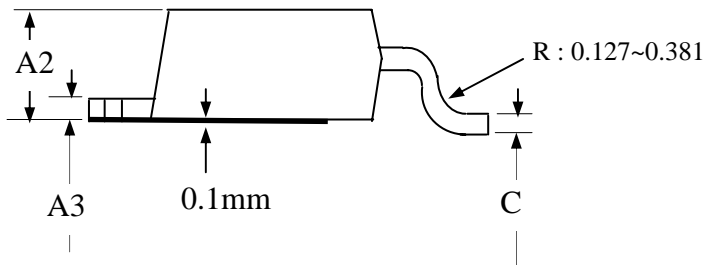


**Package Dimensions: TO-252**

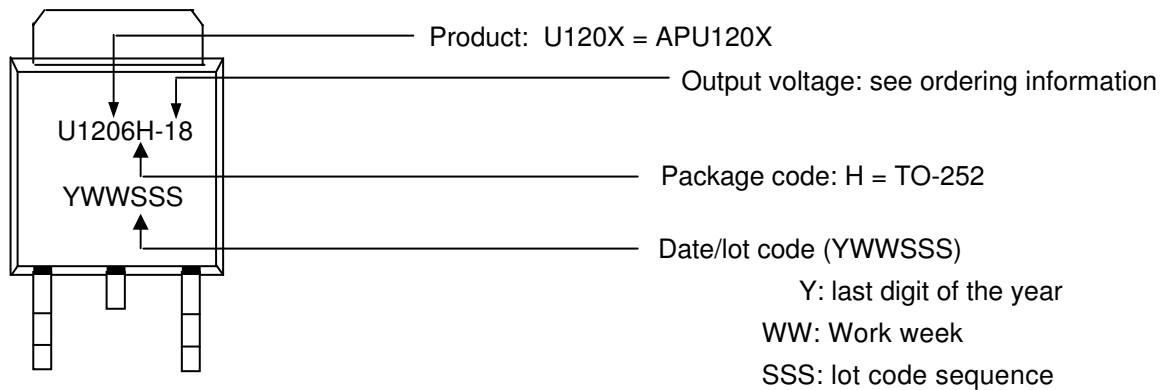


| SYMBOLS | Millimeters |      |      |
|---------|-------------|------|------|
|         | MIN         | NOM  | MAX  |
| A2      | 1.80        | 2.30 | 2.80 |
| A3      | 0.40        | 0.50 | 0.60 |
| B1      | 0.40        | 0.70 | 1.00 |
| D       | 6.00        | 6.50 | 7.00 |
| D1      | 4.80        | 5.35 | 5.90 |
| E3      | 3.50        | 4.00 | 4.50 |
| F       | 2.20        | 2.63 | 3.05 |
| F1      | 0.5         | 0.85 | 1.20 |
| E1      | 5.10        | 5.70 | 6.30 |
| E2      | 0.50        | 1.10 | 1.80 |
| e       | --          | 2.30 | --   |
| C       | 0.35        | 0.50 | 0.65 |

1. All dimensions are in millimeters.
2. Dimensions do not include mold protrusions.

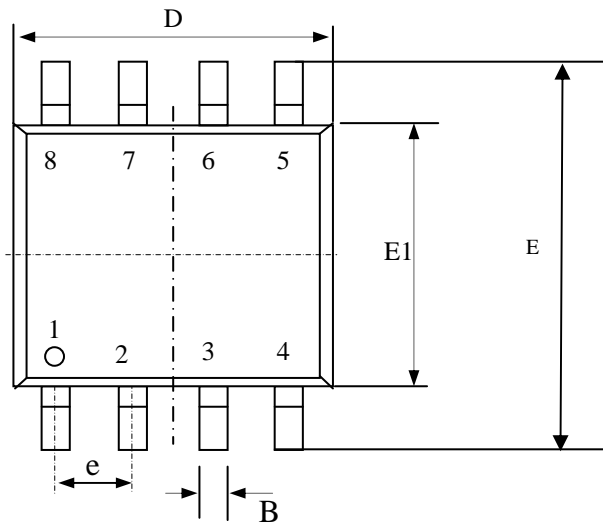


**Part Marking**

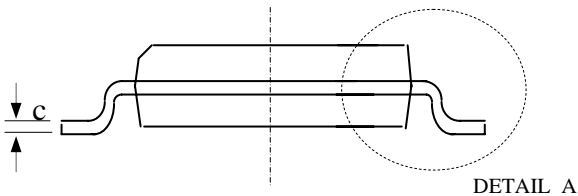
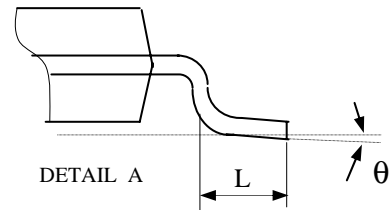
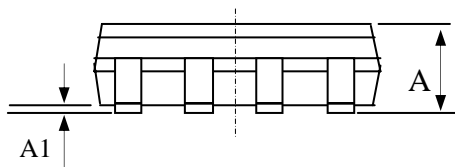




**Package Dimensions: SO-8**

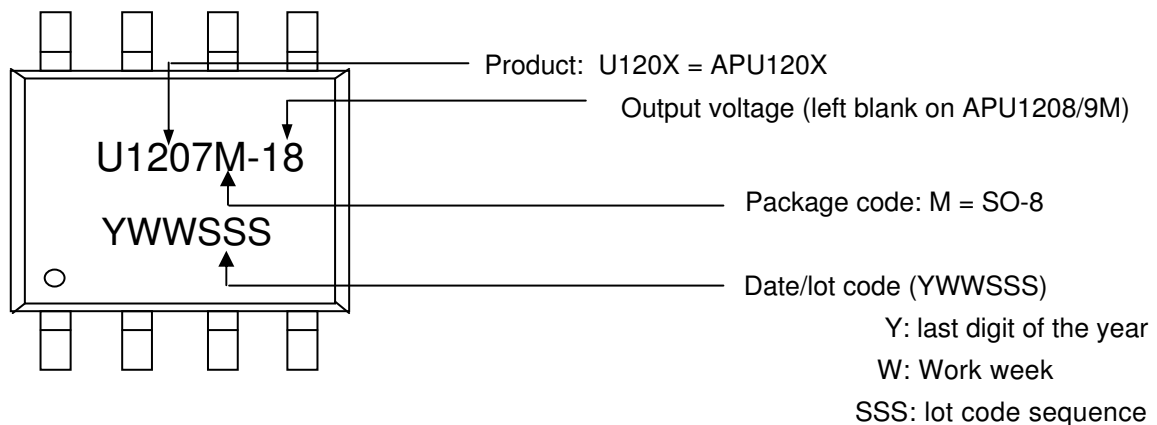


| SYMBOLS  | Millimeters |      |      |
|----------|-------------|------|------|
|          | MIN         | NOM  | MAX  |
| A        | 1.35        | 1.55 | 1.75 |
| A1       | 0.10        | 0.18 | 0.25 |
| B        | 0.33        | 0.41 | 0.51 |
| C        | 0.19        | 0.22 | 0.25 |
| D        | 4.80        | 4.90 | 5.00 |
| E1       | 3.80        | 3.90 | 4.00 |
| E        | 5.80        | 6.15 | 6.50 |
| L        | 0.38        | 0.71 | 1.27 |
| $\theta$ | 0           | 4.00 | 8.00 |
| e        | 1.27 TYP    |      |      |



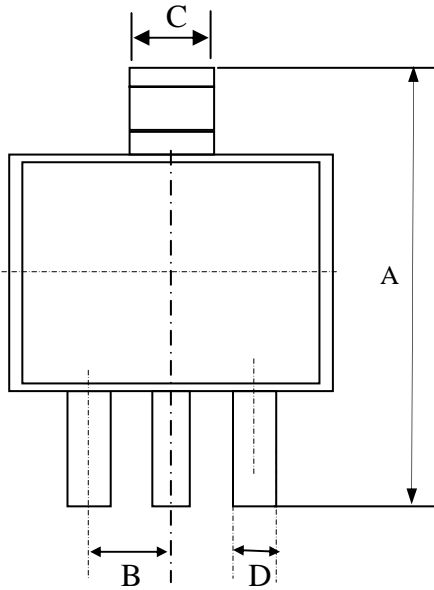
1. All dimension are in millimeters.
2. Dimensions do not include mold protrusions.

**Part Marking**

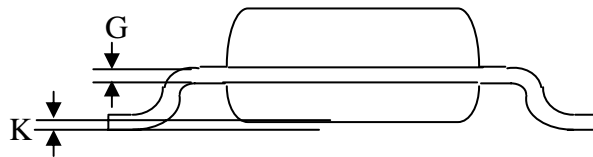
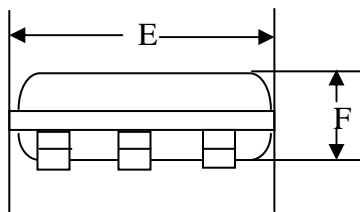




**Package Dimensions: SOT-223**



| SYMBOLS | Millimeters |      |      |
|---------|-------------|------|------|
|         | MIN         | NOM  | MAX  |
| A       | 6.70        | 7.00 | 7.30 |
| B       | ---         | 2.3  | ---  |
| C       | 2.90        | 3.00 | 3.10 |
| D       | 0.60        | 0.70 | 0.80 |
| G       | 0.25        | 0.30 | 0.35 |
| E       | 6.30        | 6.50 | 6.70 |
| F       | 1.40        | 1.60 | 1.80 |
| K       | 0.02        | 0.06 | 0.10 |



1. All dimension are in millimeters.
2. Dimensions do not include mold protrusions.

**Part Marking**

