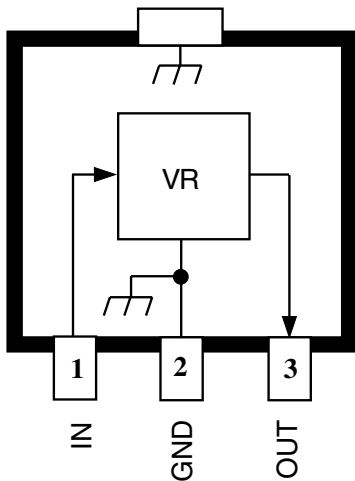


# 8188

**PRELIMINARY INFORMATION**  
(subject to change without notice)  
July 13, 1999

## **LOW-DROPOUT REGULATORS — HIGH EFFICIENCY**

**A8188SLT-xx**



Dwg. PS-022-2

where “-xx” is the required output voltage in tenths

### **ABSOLUTE MAXIMUM RATINGS**

|   |                 |
|---|-----------------|
| Input Voltage, $V_I$ .....                  | 10 V            |
| Peak Output Current,<br>$I_{OM}$ .....      | 250 mA*         |
| Enable Input Voltage, $V_E$ .....           | $V_I$           |
| Operating Temperature Range,<br>$T_A$ ..... | -20°C to +85°C  |
| Junction Temperature, $T_J$ .....           | +150°C†         |
| Storage Temperature Range,<br>$T_S$ .....   | -40°C to +150°C |

\* Output current rating is limited by input voltage, duty cycle, and ambient temperature. Under any set of conditions, do not exceed a junction temperature of +150°C. See following pages.

† Fault conditions that produce excessive junction temperature will activate device thermal shutdown circuitry. These conditions can be tolerated but should be avoided.

Designed specifically to meet the requirement for extended operation of battery-powered equipment such as cordless and cellular telephones, the A8188S— voltage regulators offer the reduced dropout voltage and quiescent current essential for maximum battery life. Applicable also to palmtop computers and personal data assistants, these devices deliver a regulated output at up to 250 mA (transient), which is limited only by package power dissipation. Regulated output voltages between 2.5 V and 3.3 V are trimmed at wafer probe.

A PMOS pass element provides a typical dropout voltage of only 90 mV at 60 mA of load current. The low dropout voltage permits deeper battery discharge before output regulation is lost. Quiescent current does not increase significantly as the dropout voltage is approached, an ideal feature in standby/resume power systems where data integrity is crucial. Regulator accuracy and excellent temperature characteristics are provided by a bandgap reference. The A8188SL-xx includes ENABLE inputs to give the designer complete control over power up, standby, or power down.

These devices are supplied, without the ENABLE function, in a standard 3-lead SOT-89/TO-243AA small-outline plastic transistor package (suffix ‘LT’). Dual regulators (A8188SL-xx) are provided in an 8-lead SOIC package. All devices are rated for operation over a temperature range of -20°C to +85°C.

### **FEATURES AND BENEFITS**

- High Efficiency Provides Extended Battery Life
- 90 mV Typical Dropout Voltage at  $I_O = 60$  mA
- 55  $\mu$ A Typical Quiescent Current  
Less Than 1  $\mu$ A “Sleep” Current
- 250 mA Peak Output Current
- Improved PSRR and Transient Performance
- Internal Thermal Protection

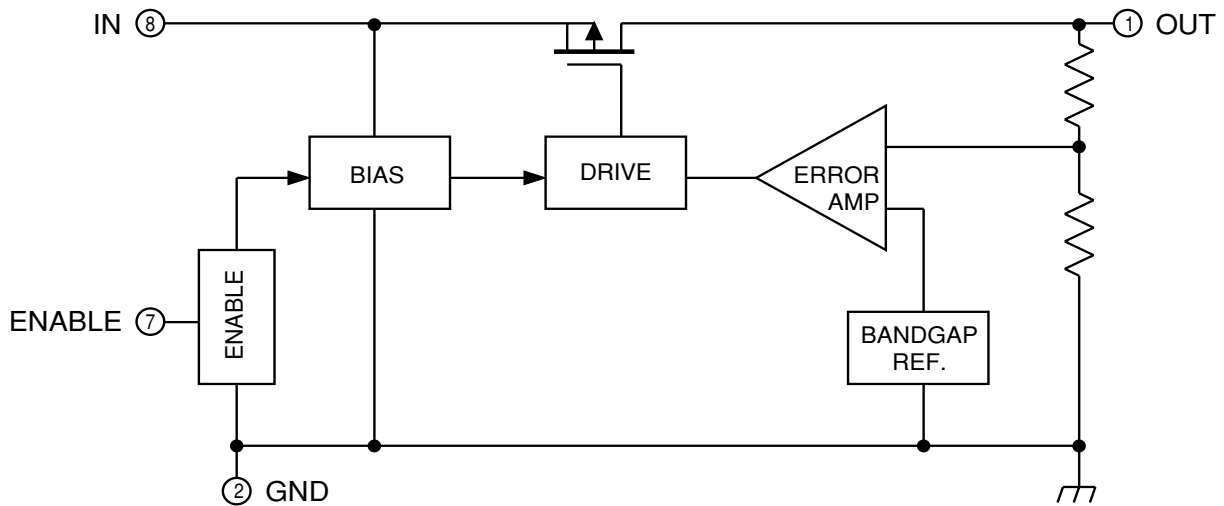
### **APPLICATIONS**

- Cordless and Cellular Telephones
- Personal Data Assistants
- Personal Communicators
- Palmtop Computers

Always order by complete part number, e.g., **A8188SLT-30**.

# 8188 LOW-DROPOUT REGULATORS

**FUNCTIONAL BLOCK DIAGRAM**  
(1/2 of A8188SL-xx shown)



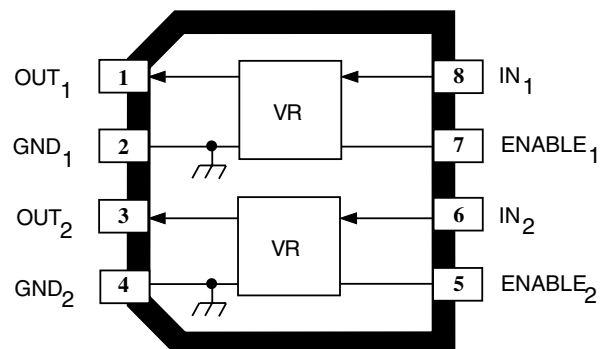
Dwg. FS-012-8

Always order by complete part number:

| Part Number | Package                | $R_{\theta JA}$ |
|-------------|------------------------|-----------------|
| A8188SL-xx  | 8-Lead SOIC            | 108°C/W         |
| A8188SLT-xx | 3-Lead SOT-89/TO-243AA | 258°C/W         |

where “-xx” is the required output voltage ( $V_{O(nom)}$ ) in tenths (25 through 33), e.g., -30 = 3.0 volts.

**A8188SL-xx**



Dwg. PS-023

NOTE — There is an indeterminate resistance between terminals 2 and 4. For proper operation, terminals 2 and 4 must be externally connected together.



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# 8188 LOW-DROPOUT REGULATORS

**A8188SL-xx Maximum Allowable Total Average Output Current\*** with device mounted on 2.24" x 2.24" (56.9 mm x 56.9 mm) solder-coated copper-clad board in still air.

| T <sub>A</sub> | Allowable Total Average (10 ms) Output Current in Milliamperes with T <sub>J</sub> = 150°C, Duty Cycle = 100%† |     |     |     |  |     |     |     |      |
|----------------|--|-----|-----|-----|--|-----|-----|-----|------|
|                | 1.0  | 1.5 | 2.0 | 2.5 | V <sub>I</sub> - V <sub>O</sub><br>3.0 | 4.0 | 5.0 | 6.0 | 7.0* |
| 25°C           | 500  | 500 | 500 | 460 | 385                                    | 285 | 230 | 190 | 165  |
| 50°C           | 500  | 500 | 460 | 370 | 305                                    | 230 | 185 | 150 | 130  |
| 70°C           | 500  | 490 | 370 | 295 | 245                                    | 185 | 145 | 120 | 105  |
| 85°C           | 500  | 400 | 300 | 240 | 200                                    | 150 | 120 | 100 | 85   |

\* Absolute maximum peak output current rating for either output is 250 mA; absolute maximum input voltage is 10 V.

$$† I_O = (T_J - T_A) / ([V_I - V_O] R_{\theta JA} \times dc) = (150 - T_A) / ([V_I - V_O] \times 108 \times 1.00)$$

Output current rating can be increased (to 250 mA maximum per output) by additional heat sinking or reducing the duty cycle. Conditions that produce excessive junction temperature will activate device thermal shutdown circuitry. These conditions can be tolerated but should be avoided.

**A8188SLT-xx Maximum Allowable Output Current** with device mounted on 2.24" x 2.24" (56.9 mm x 56.9 mm) solder-coated copper-clad board in still air.

| T <sub>A</sub> | Allowable Average (10 ms) Output Current in Milliamperes with T <sub>J</sub> = 150°C, Duty Cycle = 100%† |     |     |     |  |     |     |     |      |
|----------------|--|-----|-----|-----|--|-----|-----|-----|------|
|                | 1.0  | 1.5 | 2.0 | 2.5 | V <sub>I</sub> - V <sub>O</sub><br>3.0 | 4.0 | 5.0 | 6.0 | 7.0* |
| 25°C           | 250  | 250 | 240 | 190 | 160                                    | 120 | 95  | 80  | 65   |
| 50°C           | 250  | 250 | 190 | 155 | 125                                    | 95  | 75  | 65  | 55   |
| 70°C           | 250  | 205 | 155 | 120 | 100                                    | 75  | 60  | 50  | 40   |
| 85°C           | 250  | 165 | 125 | 100 | 80                                     | 60  | 50  | 40  | 35   |

\* Absolute maximum input voltage is 10 V.

$$† I_O = (T_J - T_A) / ([V_I - V_O] R_{\theta JA} \times dc) = (150 - T_A) / ([V_I - V_O] \times 258 \times 1.00)$$

Output current rating can be increased (to 250 mA maximum) by additional heat sinking or reducing the duty cycle. Conditions that produce excessive junction temperature will activate device thermal shutdown circuitry. These conditions can be tolerated but should be avoided.

# 8188

## LOW-DROPOUT REGULATORS

### ELECTRICAL CHARACTERISTICS at $T_A = +25^\circ\text{C}$ (unless otherwise noted).

| Characteristic   | Symbol                     | Test Conditions  | Limits |       |           |                                |
|--|----------------------------|--|--------|-------|-----------|--------------------------------|
|  |                            |  | Min.   | Typ.  | Max.      | Units                          |
| Output Voltage<br>(reference specified $V_{O(\text{nom})}$ ) | $V_O$                      | $4\text{ V} \leq V_I \leq 8\text{ V}$ , $10\ \mu\text{A} \leq I_O \leq 100\text{ mA}^*$    | -0.05  | 0.00  | +0.05     | V                              |
|  |                            | $V_I = V_{O(\text{nom})}$ , $I_O = 60\text{ mA}$   | -0.30  | —     | —         | V                              |
| Output Volt. Temp. Coeff.                                    | $a_{V_O}$                  | $V_I = 6\text{ V}$ , $I_O = 10\text{ mA}$ , $T_J \leq 125^\circ\text{C}$                   | —      | -0.30 | —         | mV/°C                          |
| Line Regulation  | $\Delta V_{O(\Delta V_I)}$ | $4\text{ V} \leq V_I \leq 8\text{ V}$ , $I_O = 1\text{ mA}$                                | —      | —     | 10        | mV                             |
| Load Regulation  | $\Delta V_{O(\Delta I_O)}$ | $1\text{ mA} \leq I_O \leq 100\text{ mA}^*$ , $V_I = 8\text{ V}$                           | —      | —     | 40        | mV                             |
|  |                            | $1\text{ mA} \leq I_O \leq 100\text{ mA}^*$ , $V_I = 6\text{ V}$                           | —      | —     | 40        | mV                             |
|  |                            | $1\text{ mA} \leq I_O \leq 100\text{ mA}^*$ , $V_I = 4\text{ V}$                           | —      | —     | 40        | mV                             |
| Dropout Voltage  | $V_{I\text{min}} - V_O$    | $I_O = 60\text{ mA}$   | —      | 90    | 150       | mV                             |
|  |                            | $I_O = 125\text{ mA}^*$  | —      | 190   | 300       | mV                             |
| Quiescent Current<br>(GND terminal current)                  | $I_Q$                      | $V_I = 8\text{ V}$ , $I_O \leq 1\text{ mA}$ , $V_E \geq 2.0\text{ V}$                      | —      | 55    | 70        | $\mu\text{A}$                  |
|  |                            | $V_I = 8\text{ V}$ , $I_O \leq 100\text{ mA}^*$ , $V_E \geq 2.0\text{ V}$                  | —      | 70    | 85        | $\mu\text{A}$                  |
|  |                            | $V_I = V_{O(\text{nom})}$ , $I_O = 60\text{ mA}$   | —      | 200   | —         | $\mu\text{A}$                  |
|  | $I_{Q(\text{off})}$        | $4\text{ V} \leq V_I \leq 8\text{ V}$ , $V_E \leq 0.8\text{ V}$                            | —      | —     | 1.0       | $\mu\text{A}$                  |
| ENABLE Input Voltage   | $V_{EH}$                   | $4\text{ V} \leq V_I \leq 8\text{ V}$ , Output ON  | 2.0    | —     | —         | V                              |
|  | $V_{EL}$                   | $4\text{ V} \leq V_I \leq 8\text{ V}$ , Output OFF   | —      | —     | 0.8       | V                              |
| ENABLE Input Current   | $I_E$                      | $V_E = V_I = 8\text{ V}$   | —      | —     | $\pm 1.0$ | $\mu\text{A}$                  |
| Thermal Shutdown Temp.                                       | $T_J$                      |  | 150    | —     | —         | °C                             |
| Rejection Ratio  | PSRR                       | $V_I = V_{O(\text{nom})} + 1.5\text{ V}$ , $V_I = 100\text{ mV}$ , $I_O = 10\text{ mA}$ :  |        |       |           |                                |
|  |                            | $f = 1\text{ kHz}$   | —      | 60    | —         | dB                             |
|  |                            | $f = 10\text{ kHz}$  | —      | 50    | —         | dB                             |
| Noise  | $e_n$                      | $10\text{ Hz} \leq f \leq 100\text{ kHz}$ , $I_O = 10\text{ mA}$ , $C_O = 10\ \mu\text{F}$ | —      | 2.0   | —         | $\mu\text{V}/\sqrt{\text{Hz}}$ |

Typical values are at  $T_A = +25^\circ\text{C}$  and are given for circuit design information only.

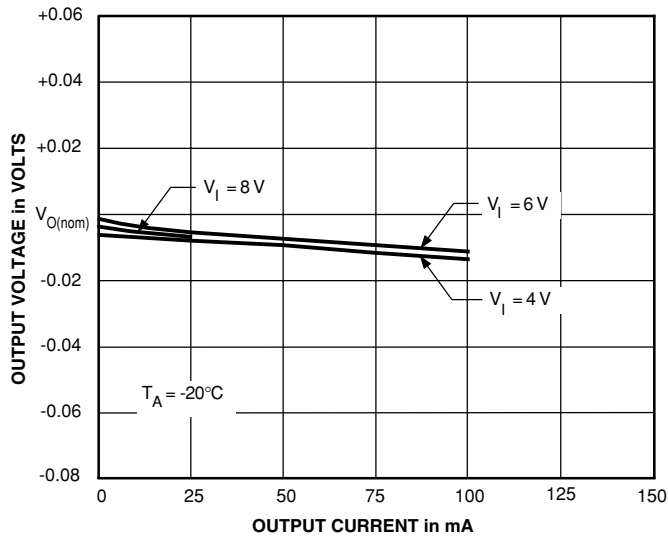
\* Pulse test ( $\leq 20\text{ ms}$ ). See previous page for duty cycle limitations.



# 8188 LOW-DROPOUT REGULATORS

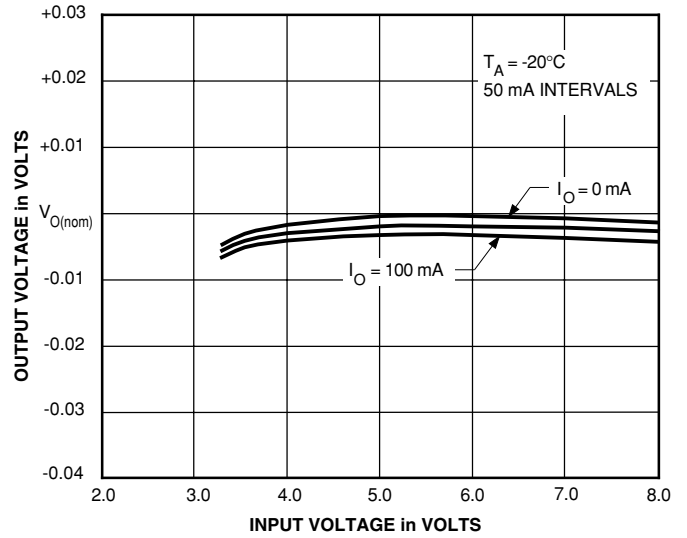
## TYPICAL CHARACTERISTICS

### LOAD REGULATION

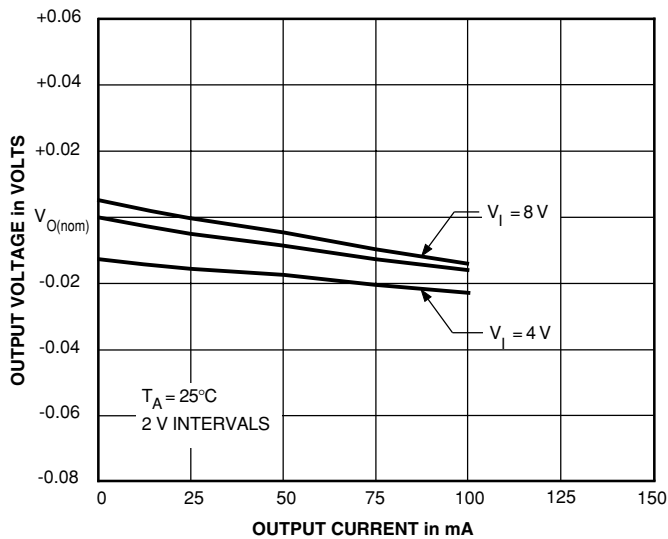


Dwg. GP-052-13

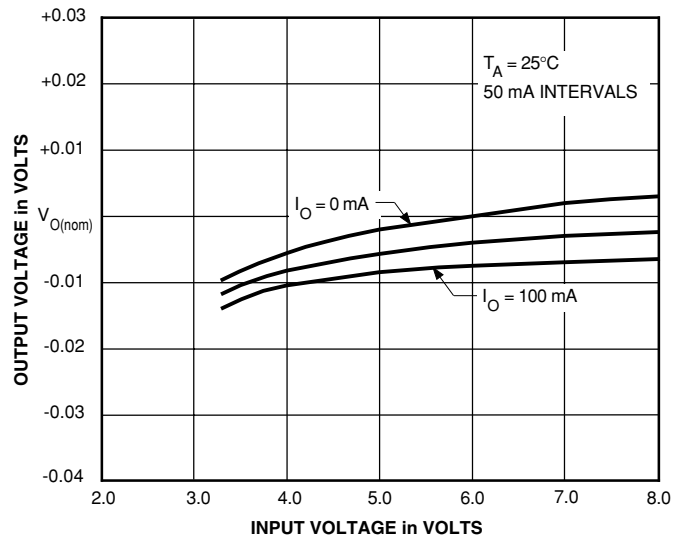
### LINE REGULATION



Dwg. GP-053-13



Dwg. GP-052-14



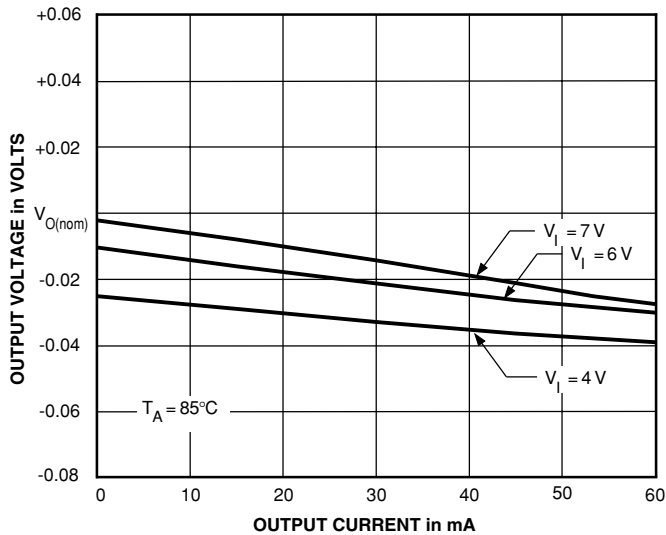
Dwg. GP-053-14

**CAUTION:** Maximum allowable duty cycle will be significantly less than 100% at high temperatures, at high input voltages, or at high output currents. See appropriate Maximum Allowable Output Current table.

# 8188 LOW-DROPOUT REGULATORS

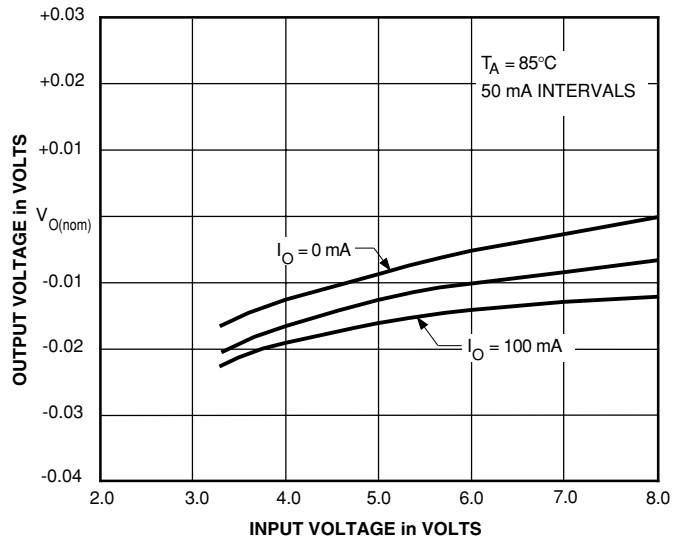
## TYPICAL CHARACTERISTICS (cont'd)

### LOAD REGULATION



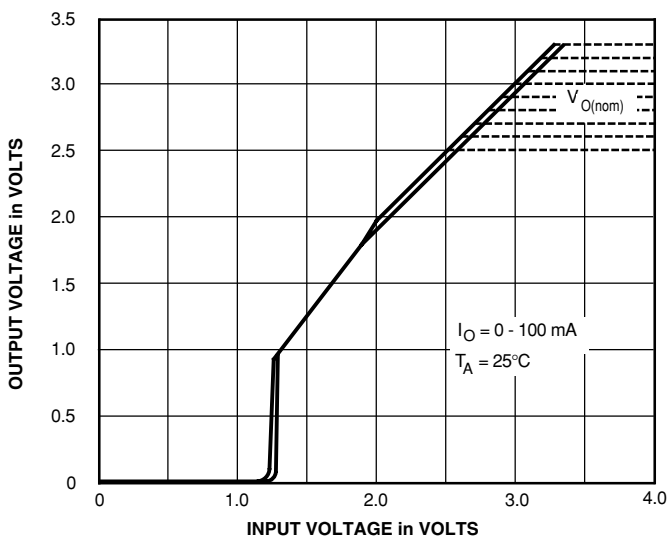
Dwg. GP-052-15

### LINE REGULATION

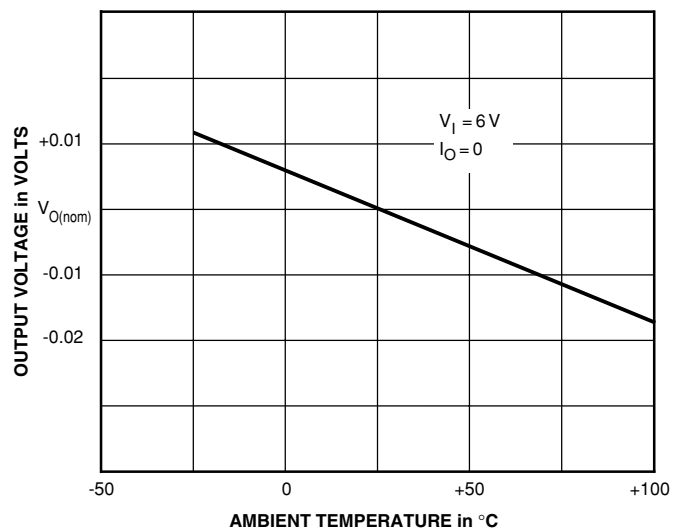


Dwg. GP-053-15

## OUTPUT VOLTAGE



Dwg. GP-059-2



Dwg. GP-050-3

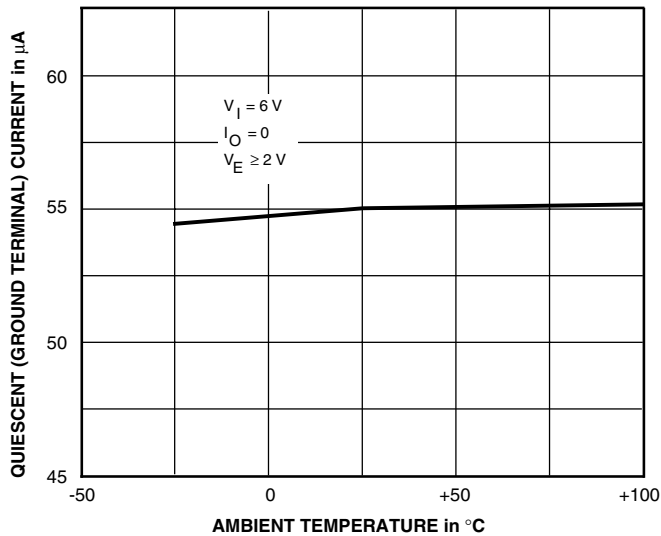
**CAUTION:** Maximum allowable duty cycle will be significantly less than 100% at high temperatures, at high input voltages, or at high output currents. See appropriate Maximum Allowable Output Current table.



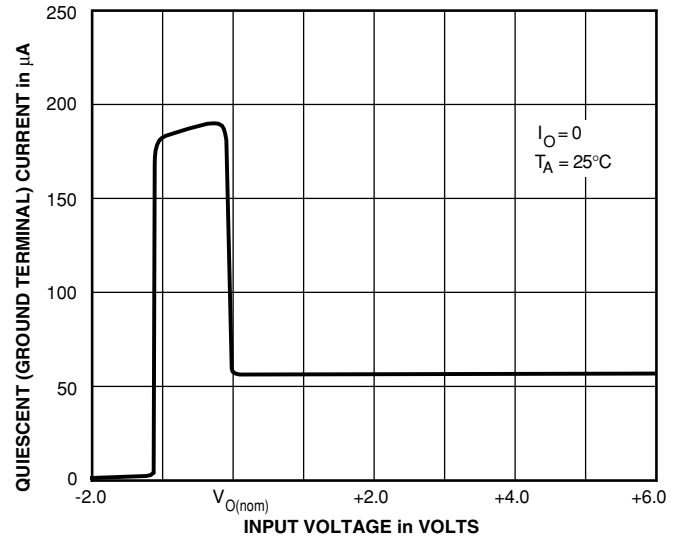
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**TYPICAL CHARACTERISTICS (cont'd)**

**QUIESCENT (GROUND TERMINAL) CURRENT**

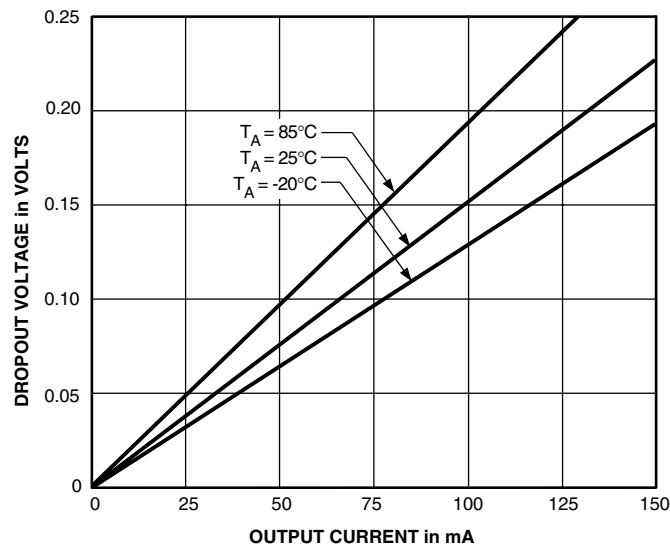


Dwg. GP-051-3



Dwg. GP-058-1

**DROPOUT VOLTAGE**



Dwg. GP-054-2

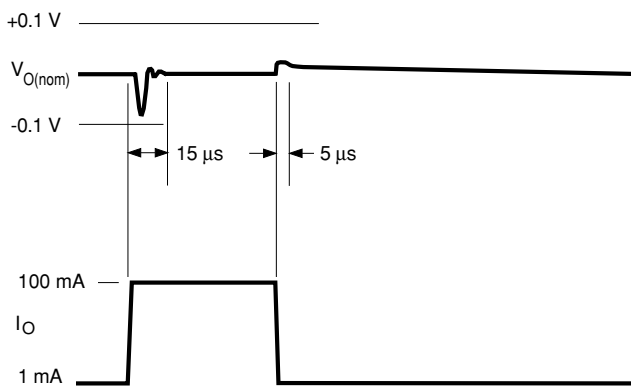
**CAUTION:** Maximum allowable duty cycle will be significantly less than 100% at high temperatures, at high input voltages, or at high output currents. See appropriate Maximum Allowable Output Current table.

# 8188 LOW-DROPOUT REGULATORS

## TYPICAL CHARACTERISTICS (concluded)

### LOAD TRANSIENT PERFORMANCE

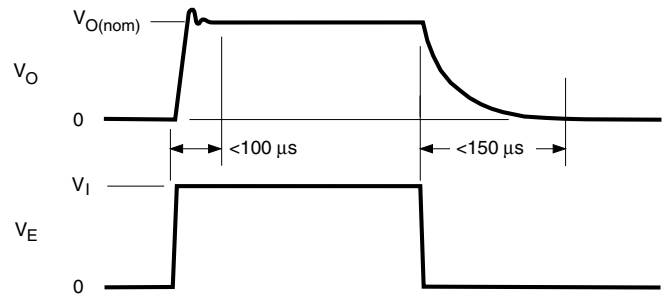
$V_I = 3.2\text{ V to }6.2\text{ V}$ ,  $C_O = 4.7\text{ }\mu\text{F}$ ,  $T_A = 25^\circ\text{C}$



Dwg. WP-028-2

### ENABLE TRANSIENT PERFORMANCE

$V_I = 3.2\text{ V to }6.2\text{ V}$ ,  $C_O = 1\text{ }\mu\text{F}$ ,  $T_A = 25^\circ\text{C}$



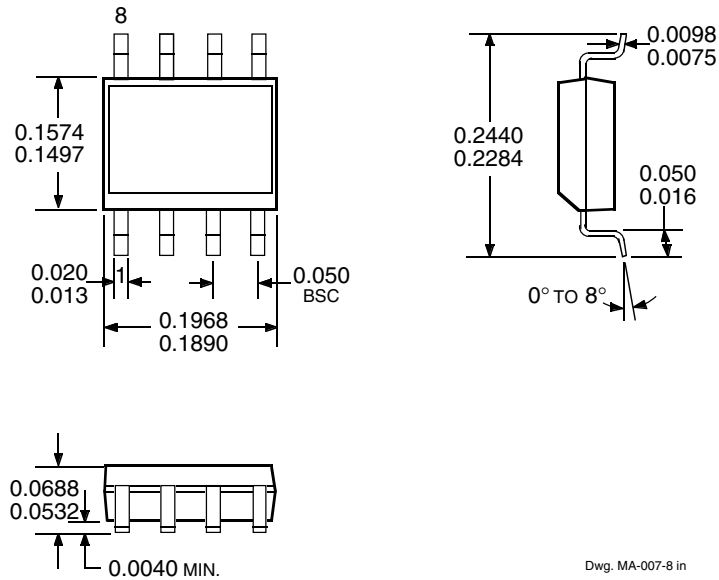
Dwg. WP-027-3



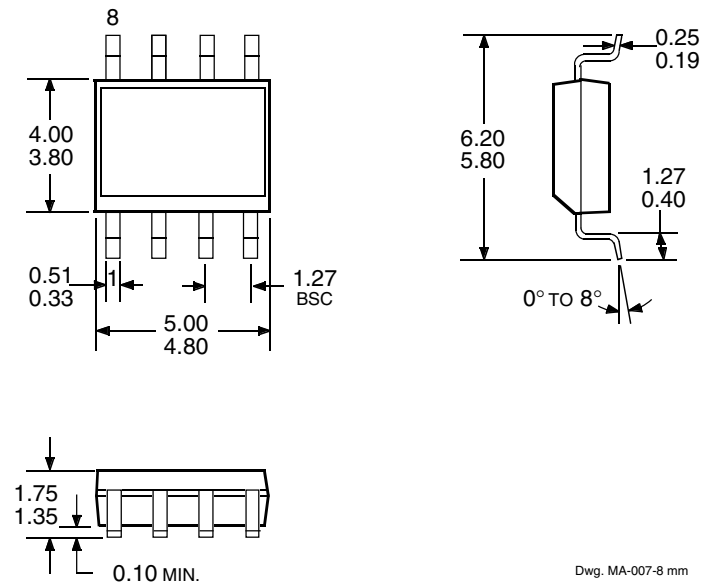
# 8188 LOW-DROPOUT REGULATORS

## A8188SL-xx

Dimensions in Inches  
(for reference only)



Dimensions in Millimeters  
(controlling dimensions)



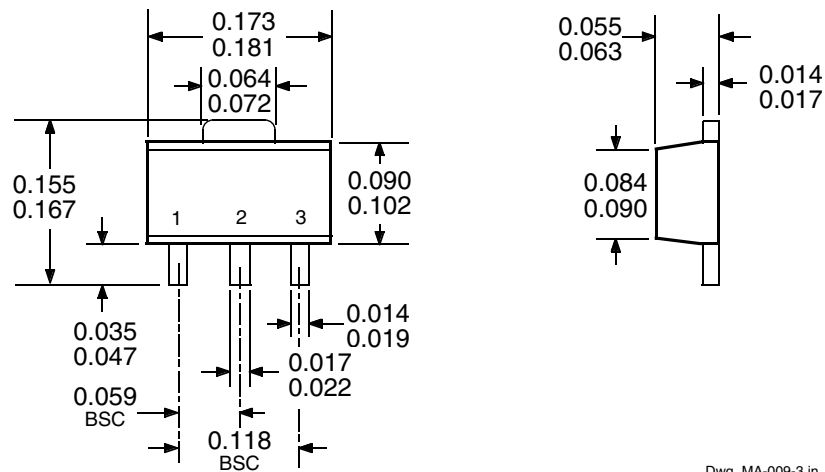
NOTES: 1. Lead spacing tolerance is non-cumulative.

2. Exact body and lead configuration at vendor's option within limits shown.

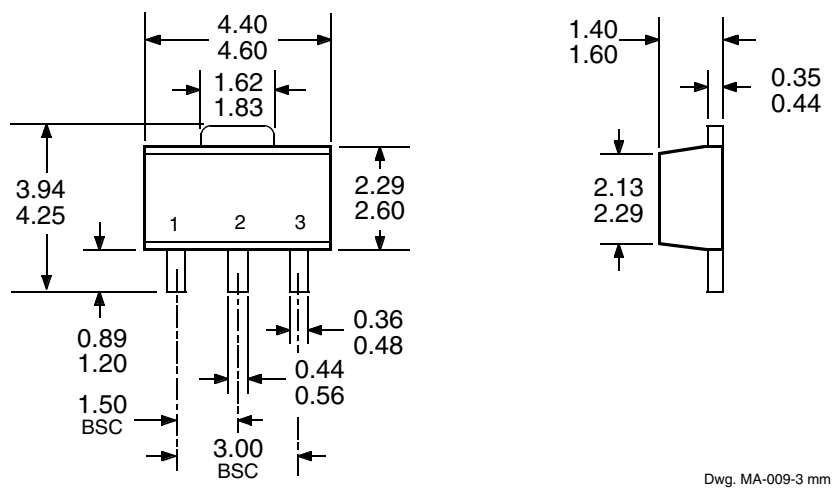
# 8188 LOW-DROPOUT REGULATORS

## A8188SLT-xx

Dimensions in Inches  
(for reference only)



Dimensions in Millimeters  
(controlling dimensions)



NOTES: 1. Lead spacing tolerance is non-cumulative.

2. Exact body and lead configuration at vendor's option within limits shown.



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