

4825898 INTEGRATED POWER

82D 00316 D

T-58-1/13

# 1 Amp, 3-Terminal Positive Regulators

# INTEGRATED POWER SEMICONDUCTORS, LTD.

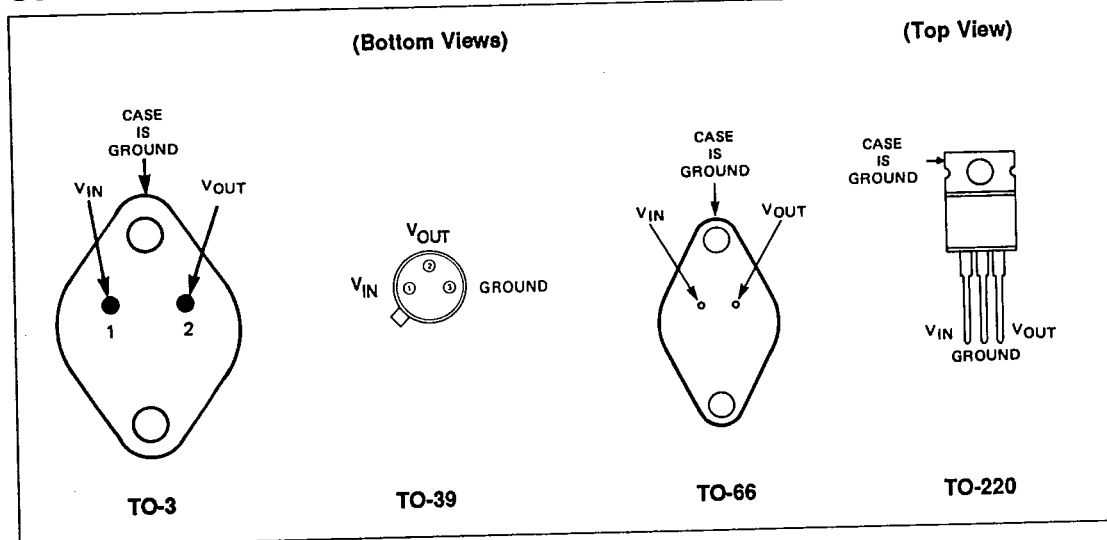
## Description

The IP140A/ LM140/ IP240A/ LM240/ IP340A/ LM340/ IP7800A/ IP7800/ IP7800AC/ IP7800C series of three-terminal regulators is available with several fixed output voltages making them useful in a wide range of applications. The A-suffix devices are fully specified at 1.0A, provide 0.01%/V line regulation, 0.3%/A load regulation, and  $\pm 1\%$  output voltage tolerance at room temperature. Protection features include safe operating area current limiting and thermal shutdown. The entire series of regulators is available in the metal TO-3 and TO-66 power packages. The IP340A/ LM340/ IP7800AC/ IP7800C series is available in the TO-220 plastic power package and the IP140A/ LM140/ IP7800A/ IP7800 series is now available in a new hermetic TO-220 style power package, as well as the TO-39 metal can.

## Features

- 1% Tolerance
- 5, 12, and 15V fixed output voltages available
- 0.01%/V line regulation
- 0.3%/A load regulation
- Thermal overload protection
- Short-circuit current limit protection
- Safe area protection
- 100% thermal limit burn-in
- Start-up with negative voltage ( $\pm$  supplies) on output

## Connections



Section 5 - Voltage Regulators  
IP140A, IP240A, IP340A, IP7800A Series, IP7800AC Series  
LM140, LM240, LM340, IP7800 Series, IP7800C Series



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**Absolute Maximum Ratings**

|  |                    |                                       |                 |
|--|--------------------|---------------------------------------|-----------------|
| Input Voltage ( $V_O = 5V, 12V, 15V$ ) | 35V                | Maximum Junction Temperature          |                 |
| Internal Power Dissipation<br>(Note 1) | Internally Limited | TO-3 Package K                        | 150°C           |
| Operating Temperature Range ( $T_j$ )  |                    | TO-39 Package H                       | 150°C           |
| IP140A, LM140                          | -55°C to +150°C    | TO-66 Package R                       | 150°C           |
| IP7800A, IP7800                        | -55°C to +150°C    | Hermetic TO-220 Package G             | 150°C           |
| IP240A, LM240                          | -25°C to +150°C    | TO-220 Package T                      | 125°C           |
| IP340A, LM340                          | 0°C to +125°C      | Storage Temperature Range             | -65°C to +150°C |
| IP7800AC, IP7800C                      | 0°C to +125°C      | Lead Temperature (Soldering, 10 sec.) | 300°C           |

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

Note 1. Although power dissipation is internally limited, these specifications are applicable for maximum power dissipation  $P_{MAX}$  of 2W for the TO-39 and 20W for the TO-3, TO-66 and TO-220.  $I_{MAX}$  is 1.0A for the TO-3, TO-66 and TO-220 packages and 500mA for the TO-39 package.

Section 5 - Voltage Regulators  
 IP140A, IP240A, IP340A, IP7800A Series, IP7800AC Series  
 LM140, LM240, LM340, IP7800 Series, IP7800C Series



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Electrical Characteristics (See Note 2)

| Parameter  | Test Conditions   | IP7803A<br>IP7805AC<br>IP140A-S<br>IP240A-S<br>IP340A-S                                      |     |      | IP7805<br>IP7805C<br>LM140-S<br>LM240-S<br>LM340-S |     |      | Units      |                |
|--|---|--|-----|------|--|-----|------|------------|----------------|
|  |   | Min  | Typ | Max  | Min  | Typ | Max  |            |                |
| Output Voltage, $V_O$  | K, R, T Pkg, $I_O = 1A$ , $V_{IN} = 10V$                                      | 4.95   | 5   | 5.05 | 4.8  | 5   | 5.2  | V          |                |
|  | $P_D \leq P_{MAX}$ , $5mA \leq I_O < I_{MAX}$<br>$7.5V \leq V_{IN} \leq 20V$  | • 4.85   |     | 5.15 | 4.75   |     | 5.25 | V          |                |
| Low Supply, $V_O$  | $P_D \leq P_{MAX}$ , $5mA \leq I_O \leq I_{MAX}$<br>$7V \leq V_{IN} \leq 20V$ | 4.75   |     | 5.15 | 4.75   |     | 5.25 | V          |                |
| Line Regulation, $\Delta V_O$                                | $I_O = 0.5 I_{MAX}$   | $7V \leq V_{IN} \leq 25V$  |     | 3    | 10   |     | 50   | mV         |                |
|  |   | $7.5V \leq V_{IN} \leq 20V$  | •   | 3    | 10   |     | 50   | mV         |                |
|  | $I_O \leq I_{MAX}$  | $7.3V \leq V_{IN} \leq 20V$  |     | 3    | 10   |     | 50   | mV         |                |
|  |   | $8V \leq V_{IN} \leq 12V$  |     | 1    | 4  |     | 20   | mV         |                |
|  |   |  | •   | 2    | 12   |     | 25   | mV         |                |
| Load Regulation, $\Delta V_O$                                | K, R, T Pkg.,<br>$V_{IN} = 10V$   | $5mA \leq I_O \leq 1.5A$   |     | 10   | 25   |     | 50   | mV         |                |
|  |   | $250mA \leq I_O \leq 750mA$  |     | 4    | 15   |     | 25   | mV         |                |
|  | $5mA \leq I_O \leq I_{MAX}$ , $V_{IN} = 10V$                                  | •  | 7   | 25   |  | 50  | mV   |            |                |
| Quiescent Current, $I_Q$                                     | $I_O \leq I_{MAX}$<br>$V_{IN} = 10V$  |  |     | 4    | 6  |     | 6    | mA         |                |
|  |   | •  |     | 4    | 6.5  |     | 7    | mA         |                |
| Quiescent Current Change, $\Delta I_Q$                       | $5mA \leq I_O \leq I_{MAX}$ , $V_{IN} = 10V$                                  | $I_O \leq I_{MAX}$ , $7.5V \leq V_{IN} \leq 20V$   |     | 0.2  | 0.5  |     | 0.5  | mA         |                |
|  |   | $I_O \leq I_{MAX}$ , $7.5V \leq V_{IN} \leq 20V$   |     | 0.1  | 0.8  |     | 0.8  | mA         |                |
|  |   | $I_O \leq 0.5 I_{MAX}$ , $8V \leq V_{IN} \leq 25V$   | •   | 0.1  | 0.8  |     | 0.8  | mA         |                |
|  |   | $I_O \leq 0.5 I_{MAX}$ , $0^\circ C \leq T_j \leq +125^\circ C$<br>$7V \leq V_{IN} \leq 25V$ |     | 0.2  | 1.0  |     | 1.0  | mA         |                |
| Output Noise Voltage, $V_N$                                  | $10Hz \leq f \leq 100kHz$ , $V_{IN} = 10V$                                    |  | 40  | 200  |  | 40  |      | $\mu V$    |                |
| Ripple Rejection, $\Delta V_{IN}/\Delta V_{OUT}$             | $f = 120Hz$<br>$8V \leq V_{IN} \leq 18V$                                      | $I_O \leq I_{MAX}$   |     | 68   | 80   |     | 68   |            | dB             |
|  |   | $I_O \leq 0.5 I_{MAX}$   | •   | 68   | 80   |     | 68   |            | dB             |
| Dropout Voltage  | $I_{OUT} = I_{MAX}$   |  | 2.0 | 2.5  |  | 2.0 |      | V          |                |
| Output Resistance, $R_O$                                     | $f = 1kHz$  |  | 5   |      |  | 5   |      | m $\Omega$ |                |
| Short-Circuit Current, $I_{SC}$                              | $V_{IN} = 35V$  | K, R, T Package  |     | 0.6  | 1.2  |     | 0.6  | 1.2        | A              |
|  |   | H Package  |     | 0.4  | 0.6  |     | 0.4  | 0.6        | A              |
| Peak Output Current, $I_{pk}$                                | $V_{IN} = 10V$  | K, R, T Package  |     | 2.4  | 3.3  |     | 2.4  | 3.3        | A              |
|  |   | H Package  |     | 1.2  | 1.7  |     | 1.2  | 1.7        | A              |
| Average TC of $V_{OUT}$                                      | $I_O = 5mA$   |  |     | 0.2  | 2  |     | 0.6  |            | mV/ $^\circ C$ |
| Input Voltage Required to Maintain Line Regulation, $V_{IN}$ | $I_O \leq I_{MAX}$  |  | 7.3 |      |  | 7.3 |      |            | V              |

The • denotes the specifications which apply over the full operating temperature range, all others apply at  $T_j = 25^\circ C$  unless otherwise specified.

Section 5 - Voltage Regulators  
 IP140A, IP240A, IP340A, IP7800A Series, IP7800AC Series  
 LM140, LM240, LM340, IP7800 Series, IP7800C Series



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**Electrical Characteristics (Cont.)**

| Parameter  | Test Conditions   | IP7812A<br>IP7812AC<br>IP140A-12<br>IP240A-12<br>IP340A-12 |     |       | IP7812<br>IP7812C<br>LM140-12<br>LM240-12<br>LM340-12 |     |      | Units         |    |
|--|---|--|-----|-------|---|-----|------|---------------|----|
|  |   | Min  | Typ | Max   | Min   | Typ | Max  |               |    |
| Output Voltage, $V_O$  | K, R, T Package, $I_O \leq 1A$ , $V_{IN} = 19V$   | 11.88  | 12  | 12.12 | 11.5  | 12  | 12.5 | V             |    |
|  | $P_D \leq P_{MAX}$ , $5 mA \leq I_O \leq I_{MAX}$<br>$14.8V \leq V_{IN} \leq 27V$               | • 11.64  |     | 12.36 | 11.4  |     | 12.6 | V             |    |
| Low Supply, $V_O$  | $P_D \leq P_{MAX}$ , $5 mA \leq I_O \leq I_{MAX}$<br>$14.5V \leq V_{IN} \leq 27V$               | 11.40  |     | 12.36 | 11.4  |     | 12.6 | V             |    |
| Line Regulation, $\Delta V_O$                                | $I_O = 0.5 I_{MAX}$   | $14.5V \leq V_{IN} \leq 30V$                               |     | 4     | 18  |     | 120  | mV            |    |
|  |   | $14.8V \leq V_{IN} \leq 27V$                               | •   | 4     | 18  |     | 120  | mV            |    |
|  | $I_O \leq I_{MAX}$  | $14.5V \leq V_{IN} \leq 27V$                               |     | 4     | 18  |     | 120  | mV            |    |
|  |   | $16V \leq V_{IN} \leq 22V$                                 |     | 2     | 9   |     | 50   | mV            |    |
|  |   | •  | 4   | 30    |   | 60  | mV   |               |    |
| Load Regulation, $\Delta V_O$                                | K, R, T Pkg.,<br>$V_{IN} = 19V$   | $5 mA \leq I_O \leq 1.5A$                                  |     | 12    | 32  |     | 120  | mV            |    |
|  |   | $250mA \leq I_O \leq 750mA$                                |     | 4     | 19  |     | 60   | mV            |    |
|  | $5 mA \leq I_O \leq I_{MAX}$ , $V_{IN} = 19V$   | •  | 8   | 60    |   | 120 | mV   |               |    |
| Quiescent Current, $I_Q$                                     | $I_O \leq I_{MAX}$<br>$V_{IN} = 19V$  |  |     | 4     | 6   |     | 6    | mA            |    |
|  |   | •  |     | 4     | 6.5   |     | 7    | mA            |    |
| Quiescent Current Change, $\Delta I_Q$                       | $5 mA \leq I_O \leq I_{MAX}$ , $V_{IN} = 19V$   |  |     | 0.2   | 0.5   |     | 0.5  | mA            |    |
|  |   | •  |     | 0.1   | 0.8   |     | 0.8  | mA            |    |
|  | $I_O \leq 0.5 I_{MAX}$ , $15V \leq V_{IN} \leq 30V$   |  |     | 0.1   | 0.8   |     | 0.8  | mA            |    |
|  |   | •  |     | 0.2   | 1.0   |     | 1.0  | mA            |    |
|  | $I_O \leq 0.5 I_{MAX}$ , $0^\circ C \leq T_J \leq +125^\circ C$<br>$14.5V \leq V_{IN} \leq 30V$ |  |     | 0.2   | 1.0   |     | 1.0  | mA            |    |
| Output Noise Voltage, $V_N$                                  | $10 Hz \leq f \leq 100 kHz$ , $V_{IN} = 19V$  |  | 75  | 480   |   | 75  |      | $\mu V$       |    |
| Ripple Rejection, $\Delta V_{IN}/\Delta V_{OUT}$             | $f = 120Hz$<br>$15V \leq V_{IN} \leq 25V$   | $I_O \leq I_{MAX}$   |     | 61    | 72  |     | 61   |               | dB |
|  |   | $I_O \leq 0.5 I_{MAX}$                                     | •   | 61    | 72  |     | 61   |               | dB |
| Dropout Voltage  | $I_{OUT} = I_{MAX}$   |  | 2.0 | 2.5   |   | 2.0 |      | V             |    |
| Output Resistance, $R_O$                                     | $f = 1 kHz$   |  | 8   |       |   | 8   |      | $m\Omega$     |    |
| Short-Circuit Current, $I_{sc}$                              | $V_{IN} = 35V$  | K, R, T Package  |     | 0.6   | 1.2   |     | 0.6  | 1.2           | A  |
|  |   | H Package  |     | 0.4   | 0.6   |     | 0.4  | 0.6           | A  |
| Peak Output Current, $I_{pk}$                                | $V_{IN} = 19V$  | K, R, T Package  |     | 2.4   | 3.3   |     | 2.4  | 3.3           | A  |
|  |   | H Package  |     | 1.2   | 1.7   |     | 1.2  | 1.7           | A  |
| Average TC of $V_{OUT}$                                      | $I_O = 5 mA$  |  | 0.5 | 4.8   |   | 1.5 |      | $mV/^\circ C$ |    |
| Input Voltage Required to Maintain Line Regulation, $V_{IN}$ | $I_O \leq I_{MAX}$  | 14.5   |     |       | 14.6  |     |      | V             |    |

Section 5 - Voltage Regulators  
 IP140A, IP240A, IP340A, IP7800A Series, IP7800AC Series  
 LM140, LM240, LM340, IP7800 Series, IP7800C Series



Electrical Characteristics (Cont.)

| Parameter  | Test Conditions  | IP7815A<br>IP7815AC<br>IP140A-15<br>IP240A-15<br>IP340A-15 |      |       | IP7815<br>IP7815C<br>LM140-15<br>LM240-15<br>LM340-15 |      |       | Units           |    |
|--|--|--|------|-------|---|------|-------|-----------------|----|
|  |  | Min  | Typ  | Max   | Min   | Typ  | Max   |                 |    |
| Output Voltage, $V_O$  | K, R, T Pkg., $I_O \leq 1A$ , $V_{IN} = 23V$                                     | 14.85  | 15   | 15.15 | 14.4  | 15   | 15.6  | V               |    |
|  | $P_D \leq P_{MAX}$ , $5mA \leq I_O \leq I_{MAX}$<br>$17.9V \leq V_{IN} \leq 30V$ | • 14.55  |      | 15.45 | 14.25   |      | 15.75 | V               |    |
| Low Supply, $V_O$  | $P_D \leq P_{MAX}$ , $5mA \leq I_O \leq I_{MAX}$<br>$17.5V \leq V_{IN} \leq 30V$ |  |      | 15.45 | 14.25   |      | 15.75 | V               |    |
| Line Regulation, $\Delta V_O$                                | $I_O = 0.5 I_{MAX}$  | $17.5V \leq V_{IN} \leq 30V$                               |      | 4     | 22  |      | 150   | mV              |    |
|  |  | $17.9V \leq V_{IN} \leq 30V$ , •                           |      | 4     | 22  |      | 150   | mV              |    |
|  | $I_O \leq I_{MAX}$   | $17.5V \leq V_{IN} \leq 30V$                               |      |       | 4   | 22   |       | 150             | mV |
|  |  | $20V \leq V_{IN} \leq 26V$                                 |      |       | 2   | 10   |       | 60              | mV |
| Load Regulation, $\Delta V_O$                                | K, R, T Pkg.,<br>$V_{IN} = 23V$  | $5mA \leq I_O \leq 1.5A$                                   |      | 12    | 35  |      | 150   | mV              |    |
|  |  | $250mA \leq I_O \leq 750mA$                                |      | 4     | 21  |      | 75    | mV              |    |
|  | $5mA \leq I_O \leq I_{MAX}$ , $V_{IN} = 23V$                                     | •  |      | 9     | 75  |      | 150   | mV              |    |
| Quiescent Current, $I_Q$                                     | $I_O \leq I_{MAX}$<br>$V_{IN} = 23V$   |  |      | 4     | 6   |      | 6     | mA              |    |
|  |  | •  |      | 4     | 6.5   |      | 7     | mA              |    |
| Quiescent Current Change, $\Delta I_Q$                       | $5mA \leq I_O \leq I_{MAX}$ , $V_{IN} = 23V$                                     |  |      | 0.2   | 0.5   |      | 0.5   | mA              |    |
|  |  | •  |      | 0.1   | 0.8   |      | 0.8   | mA              |    |
|  | $I_O \leq 0.5 I_{MAX}$ , $17.9V \leq V_{IN} \leq 30V$                            |  |      |       | 0.1   | 0.8  |       | 0.8             | mA |
|  |  | •  |      |       | 0.1   | 0.8  |       | 0.8             | mA |
| Output Noise Voltage, $V_N$                                  | $10Hz \leq f \leq 100kHz$ , $V_{IN} = 23V$                                       |  |      | 90    | 600   |      | 90    | $\mu V$         |    |
|  |  | •  |      | 60    | 70  |      | 60    | dB              |    |
| Ripple Rejection, $\Delta V_{IN}/\Delta V_{OUT}$             | $f = 120Hz$ ,<br>$18.5V \leq V_{IN} \leq 28.5V$                                  | $I_O \leq I_{MAX}$   |      | 60    | 70  |      | 60    | dB              |    |
|  |  | $I_O \leq 0.5 I_{MAX}$ , •                                 |      | 60    | 70  |      | 60    | dB              |    |
| Dropout Voltage  | $I_{OUT} = I_{MAX}$  |  |      | 2.0   | 2.5   |      | 2.0   | V               |    |
| Output Resistance, $R_O$                                     | $f = 1kHz$   |  |      | 9     |   |      | 9     | m $\Omega$      |    |
| Short-Circuit Current, $I_{SC}$                              | $V_{IN} = 35V$   | K, R, T Package  |      | 0.6   | 1.2   |      | 0.6   | 1.2             | A  |
|  |  | H Package  |      | 0.4   | 0.6   |      | 0.4   | 0.6             | A  |
| Peak Output Current, $I_{pk}$                                | $V_{IN} = 23V$   | K, R, T Package  |      | 2.4   | 3.3   |      | 2.4   | 3.3             | A  |
|  |  | H Package  |      | 1.2   | 1.7   |      | 1.2   | 1.7             | A  |
| Average TC of $V_{OUT}$                                      | $I_O = 5mA$  |  |      | 0.6   | 6.0   |      | 1.8   | mV/ $^{\circ}C$ |    |
| Input Voltage Required to Maintain Line Regulation, $V_{IN}$ | $I_O \leq I_{MAX}$   |  | 17.5 |       |   | 17.7 |       | V               |    |

The • denotes the specifications which apply over the full operating temperature range, all others apply at  $T_j = 25^{\circ}C$  unless otherwise specified.

Note 2. All characteristics are measured with a capacitor across the input of  $0.22 \mu F$  and a capacitor across the output of  $0.1 \mu F$ . All characteristics except noise voltage and ripple rejection ratio are measured using pulse techniques ( $t_{W} \leq 10ms$ , duty cycle  $\leq 5\%$ ). Output voltage changes due to changes in internal temperature must be taken into account separately.

Section 5 - Voltage Regulators  
IP140A, IP240A, IP340A, IP7800A Series, IP7800AC Series  
LM140, LM240, LM340, IP7800 Series, IP7800C Series

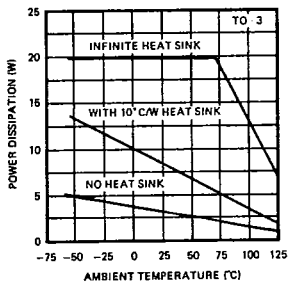


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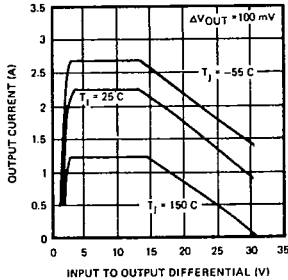
Typical Performance Characteristics

Section 5 - Voltage Regulators  
 IP140A, IP240A, IP340A, IP7800A Series, IP7800AC Series  
 LM140, LM240, LM340, IP7800 Series, IP7800C Series

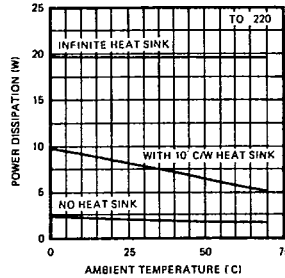
Maximum Average Power Dissipation



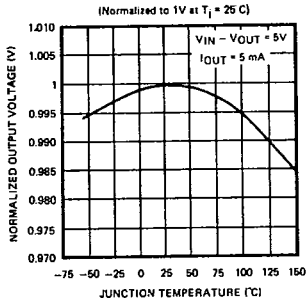
Peak Output Current



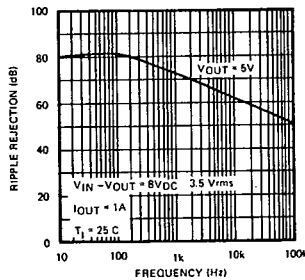
Maximum Average Power Dissipation



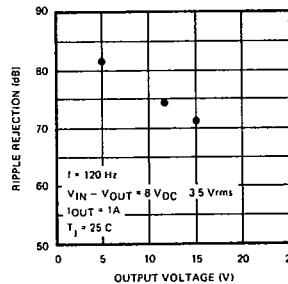
Output Voltage



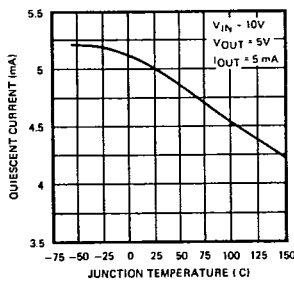
Ripple Rejection



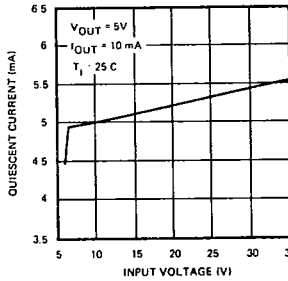
Ripple Rejection



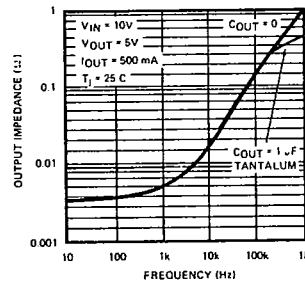
Quiescent Current



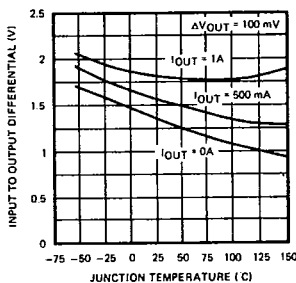
Quiescent Current



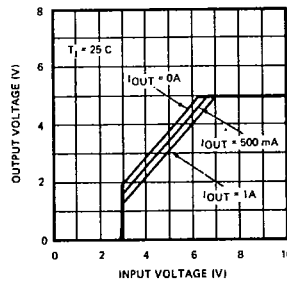
Output Impedance



Dropout Voltage

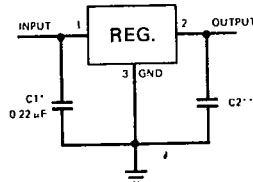


Dropout Characteristics



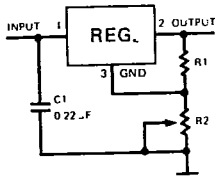
**Applications Information**

**Fixed Output Regulator**



\*Required if the regulator is located far from the power supply filter.  
 \*\*Although no output capacitor is needed for stability, it does help transient response. If needed, use 0.1 μF, ceramic disc!

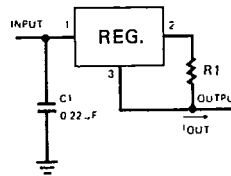
**Adjustable Output Regulator**



$$V_{OUT} = 5V + (5V/R1) \cdot I_Q/R2$$

$$5V/R1 > 3 I_Q, \text{ load regulation } (L_r) \approx \left[ \frac{(R1+R2)}{R1} \right] (L_r \text{ of Regulator})$$

**Current Regulator**



$$I_{OUT} = \frac{V_2 - V_3}{R1} + I_Q$$

$$\Delta I_Q = 1.3 \text{ mA over line and load changes}$$

Section 5 - Voltage Regulators  
 IP140A, IP240A, IP340A, IP7800A Series, IP7800AC Series  
 LM140, LM240, LM340, IP7800 Series, IP7800C Series



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**Order Information**

| Part Number          | Temperature Range | Package         |
|----------------------|-------------------|-----------------|
| IP140AK-XX/LM140K-XX | -55°C to +150°C   | TO-3            |
| IP7800AK/IP7800K     | -55°C to +150°C   | TO-3            |
| IP140AR-XX/IP140R-XX | -55°C to +150°C   | TO-66           |
| IP7800AR/IP7800R     | -55°C to +150°C   | TO-66           |
| IP140AG-XX/IP140G-XX | -55°C to +150°C   | Hermetic TO-220 |
| IP7800AG/IP7800G     | -55°C to +150°C   | Hermetic TO-220 |
| IP140AH-XX/LM140H-XX | -55°C to +150°C   | TO-39           |
| IP7800AH/IP7800H     | -55°C to +150°C   | TO-39           |
| IP240AK-XX/LM240K-XX | -25°C to +150°C   | TO-3            |
| IP240AR-XX/IP240R-XX | -25°C to +150°C   | TO-66           |
| IP340AK-XX/LM340K-XX | 0°C to +125°C     | TO-3            |
| IP7800ACK/IP7800CK   | 0°C to +125°C     | TO-3            |
| IP340AR-XX/IP340R-XX | 0°C to +125°C     | TO-66           |
| IP7800ACR/IP7800CR   | 0°C to +125°C     | TO-66           |
| IP340AT-XX/LM340T-XX | 0°C to +125°C     | TO-220          |
| IP7800ACT/IP7800CT   | 0°C to +125°C     | TO-220          |

Section 5 - Voltage Regulators  
 IP140A, IP240A, IP340A, IP7800A Series, IP7800AC Series  
 LM140, LM240, LM340, IP7800 Series, IP7800C Series

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