

4825898 INTEGRATED POWER

82D 00290 D

T-58-11-13

**1.5 Amp, 3-Terminal  
Negative Regulators**

**INTEGRATED  
POWER  
SEMICONDUCTORS, LTD.**

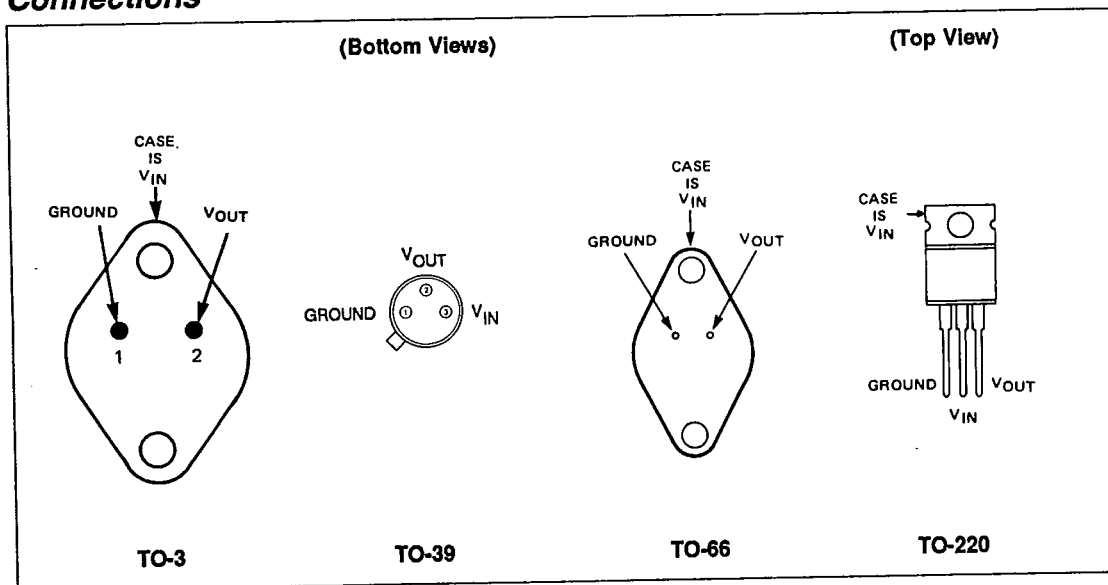
**Description**

The IP120A/ IP220A/ IP320A/ IP7900A/ IP7900/ IP7900AC/ IP7900C 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 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 IP320A/ IP7900AC/ IP7900C series is also available in the TO-220 plastic power package. The IP120A/ LM120/ IP7900A/ IP7900 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 positive voltage ( $\pm$  supplies) on output

**Connections**



Section 5 - Voltage Regulators  
 IP120A, IP220A, IP320A, IP7900A Series,  
 IP7900AC Series, IP7900 Series, IP7900C Series



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**Absolute Maximum Ratings**

<b>Input Voltage</b> ( $V_O = -5V, -12V, -15V$ )	35V	<b>Maximum Junction Temperature</b>	
<b>Internal Power Dissipation</b> (Note 1)	Internally Limited	TO-3 Package K	150°C
<b>Operating Temperature Range</b> ( $T_j$ )		TO-39 Package H	150°C
IP120A, LM120,	-55°C to +150°C	TO-66 Package R	150°C
IP7900A, IP7900	-55°C to +150°C	TO-220 Hermetic G	150°C
IP220A, LM220	-25°C to +150°C	TO-220 Package T	125°C
IP320A, LM320,	0°C to +125°C	<b>Storage Temperature Range</b>	-65°C to 150°C
IP7900AC, IP7900C	0°C to +125°C	<b>Lead Temperature</b> (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  
 IP120A, IP220A, IP320A, IP7900A Series,  
 IP7900AC Series, IP7900 Series, IP7900C Series



Electrical Characteristics (Note 2)

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Parameter	Test Conditions	IP7905A IP7905AC IP120A-5 IP220A-5 IP320A-5			IP7905 IP7905C			Units
		Min	Typ	Max	Min	Typ	Max	
Output Voltage, $V_O$	K, R, T Pkg., $I_O = 500\text{mA}$ , $V_{IN} = -10\text{V}$	-4.95	-5	-5.05	-4.8	-5	-5.2	V
	$P_D \leq P_{MAX}$ , $5\text{mA} \leq I_O \leq I_{MAX}$ $-7.5\text{V} \geq V_{IN} \geq -20\text{V}$	• -4.85		-5.15	-4.75		-5.25	V
Low Supply, $V_O$	$P_D \leq P_{MAX}$ , $5\text{mA} \leq I_O \leq I_{MAX}$ $-7\text{V} \geq V_{IN} \geq -20\text{V}$	-4.75		-5.15	-4.75		-5.25	V
Line Regulation, $\Delta V_O$	$I_O = 0.5 I_{MAX}$	$-7\text{V} \geq V_{IN} \geq -25\text{V}$		3	10		50	mV
		$-7.5\text{V} \geq V_{IN} \geq -20\text{V}$	•	3	10			mV
	$I_O \leq I_{MAX}$	$-8\text{V} \geq V_{IN} \geq -12\text{V}$		1	4		25	mV
			•	2	12			mV
Load Regulation, $\Delta V_O$	K, R, T Pkg., $V_{IN} = -10\text{V}$	$5\text{mA} \leq I_O \leq 1.5\text{A}$		10	25		100	mV
		$250\text{mA} \leq I_O \leq 750\text{mA}$		4	15		50	mV
	$5\text{mA} \leq I_O \leq I_{MAX}$ , $V_{IN} = -10\text{V}$	•	7	25			mV	
Quiescent Current, $I_Q$	$I_O \leq 0.5 I_{MAX}$ , $V_{IN} = -10\text{V}$			1	1.9		8	mA
		•		1	2			mA
Quiescent Current Change, $\Delta I_Q$	$5\text{mA} \leq I_O \leq I_{MAX}$ $V_{IN} = -10\text{V}$			0.2	0.4		0.5	mA
		•		0.2	0.5			mA
	$I_O \leq 0.5 I_{MAX}$ , $-7\text{V} \geq V_{IN} \geq -25\text{V}$			0.1	0.4		1.0	mA
		•		0.1	0.5			mA
Output Noise Voltage, $V_N$	$10\text{Hz} \leq f \leq 100\text{kHz}$ , $V_{IN} = -10\text{V}$		40	400	40			$\mu\text{V}$
Ripple Rejection, $\Delta V_{IN}/\Delta V_{OUT}$	$f = 120\text{Hz}$	$I_O \leq I_{MAX}$		66	80		80	dB
		$I_O \leq 0.5 I_{MAX}$	•	66	80		80	dB
Dropout Voltage	$I_{OUT} = I_{MAX}$		1.1	2.3	1.1			V
Output Resistance, $R_O$	$f = 1\text{kHz}$		5		5			$\text{m}\Omega$
Short-Circuit Current, $I_{SC}$	$V_{IN} = -35\text{V}$	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, $I_{pk}$	$V_{IN} = -10\text{V}$	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 $V_{OUT}$	$I_O = 5\text{mA}$		0.2	2.0	0.6			$\text{mV}/^\circ\text{C}$
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  $T_j = 25^\circ\text{C}$  unless otherwise specified.

Section 5 - Voltage Regulators  
IP120A, IP220A, IP320A, IP7900A Series,  
IP7900AC Series, IP7900 Series, IP7900C Series



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**Electrical Characteristics (Cont.)**

Parameter	Test Conditions	IP7912A IP7912AC IP120A-12 IP220A-12 IP320A-12			IP7912 IP7912C			Units	
		Min	Typ	Max	Min	Typ	Max		
Output Voltage, $V_O$	K, R, T Pkg., $I_O = 500\text{mA}$ , $V_{IN} = -19\text{V}$	-11.88	-12	-12.12	-11.5	-12	-12.5	V	
	$P_D \leq P_{MAX}$ , $5\text{mA} \leq I_O \leq I_{MAX}$ , $-14.8\text{V} \geq V_{IN} \geq -27\text{V}$	-11.64		-12.36	-11.4		-12.6	V	
Low Supply, $V_O$	$P_D \leq P_{MAX}$ , $5\text{mA} \leq I_O \leq I_{MAX}$ , $-14.5\text{V} \geq V_{IN} \geq -27\text{V}$	11.40		-12.36	-11.4		-12.6	V	
Line Regulation, $\Delta V_O$	$I_O = 0.5 I_{MAX}$	$-14.5\text{V} \geq V_{IN} \geq -30\text{V}$		4	18		120	mV	
		$-14.8\text{V} \geq V_{IN} \geq -27\text{V}$		4	18			mV	
	$I_O \leq I_{MAX}$	$-16\text{V} \geq V_{IN} \geq -22\text{V}$		2	9		60	mV	
Load Regulation, $\Delta V_O$	K, R, T Package $V_{IN} = -19\text{V}$	$5\text{mA} \leq I_O \leq 1.5\text{A}$		12	32		240	mV	
		$250\text{mA} \leq I_O \leq 750\text{mA}$		4	19		120	mV	
	$5\text{mA} \leq I_O \leq I_{MAX}$ , $V_{IN} = -19\text{V}$		8	60				mV	
Quiescent Current, $I_Q$	$I_O \leq 0.5 I_{MAX}$ $V_{IN} = -19\text{V}$			1	1.9		8	mA	
				1	2			mA	
Quiescent Current Change, $\Delta I_Q$	$5\text{mA} \leq I_O \leq I_{MAX}$ $V_{IN} = -19\text{V}$			0.2	0.4		0.5	mA	
				0.2	0.5			mA	
	$I_O \leq 0.5 I_{MAX}$ , $-14.5\text{V} \geq V_{IN} \geq -30\text{V}$			0.1	0.4		1.0	mA	
	$I_O \leq 0.5 I_{MAX}$ , $-15\text{V} \geq V_{IN} \geq -30\text{V}$			0.1	0.5			mA	
Output Noise Voltage, $V_N$	$10\text{Hz} \leq f \leq 100\text{kHz}$ , $V_{IN} = -19\text{V}$			75	960		75	$\mu\text{V}$	
Ripple Rejection, $\Delta V_{IN}/\Delta V_{OUT}$	$f = 120\text{Hz}$ $-15\text{V} \geq V_{IN} \geq -25\text{V}$	$I_O \leq I_{MAX}$		58	72		72	dB	
		$I_O \leq 0.5 I_{MAX}$		58	72		72	dB	
Dropout Voltage	$I_{OUT} = I_{MAX}$			1.1	2.3		1.1	V	
Output Resistance, $R_O$	$f = 1\text{kHz}$			8			8	$\text{m}\Omega$	
Short-Circuit Current, $I_{sc}$	$V_{IN} = -35\text{V}$	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, $I_{pk}$	$V_{IN} = -19\text{V}$	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 $V_{OUT}$	$I_O = 5\text{mA}$			0.5	4.8		1.5	$\text{mV}/^\circ\text{C}$	
Input Voltage Required to Maintain Line Regulation, $V_{IN}$	$I_O \leq I_{MAX}$		-14.5			-14.6		V	

Section 5 - Voltage Regulators  
 IP120A, IP220A, IP320A, IP7900A Series,  
 IP7900AC Series, IP7900 Series, IP7900C Series



**Electrical Characteristics (Cont.)**

Parameter	Test Conditions	IP7915A IP7915AC IP120A-15 IP220A-15 IP320A-15			IP7915 IP7915C			Units	
		Min	Typ	Max	Min	Typ	Max		
Output Voltage, $V_O$	K, R, T Pkg., $I_O = 500\text{mA}$ , $V_{IN} = -23\text{V}$	-14.85	-15	-15.15	-14.4	-15	-15.6	V	
	$P_D \leq P_{MAX}$ , $5\text{mA} \leq I_O \leq I_{MAX}$ $-17.9\text{V} \geq V_{IN} \geq -30\text{V}$	• -14.55		-15.45	-14.25		-15.75	V	
Low Supply, $V_O$	$P_D \leq P_{MAX}$ , $5\text{mA} \leq I_O \leq I_{MAX}$ $-17.5\text{V} \geq V_{IN} \geq -30\text{V}$	-14.25		-15.45	-14.25		-15.75	V	
Line Regulation, $\Delta V_O$	$I_O = 0.5 I_{MAX}$	$-17.5\text{V} \geq V_{IN} \geq -30\text{V}$		4	22		150	mV	
		$-17.9\text{V} \geq V_{IN} \geq -30\text{V}$	•	4	22			mV	
	$I_O \leq I_{MAX}$	$-20\text{V} \geq V_{IN} \geq -26\text{V}$		2	10		75	mV	
			•	5	30			mV	
Load Regulation, $\Delta V_O$	K, R, T Pkg. $V_{IN} = -23\text{V}$	$5\text{mA} \leq I_O \leq 1.5\text{A}$		12	35		300	mV	
		$250\text{mA} \leq I_O \leq 750\text{mA}$		4	21		150	mV	
	$5\text{mA} \leq I_O \leq I_{MAX}$ , $V_{IN} = -23\text{V}$	•	9	75				mV	
Quiescent Current, $I_Q$	$I_O \leq 0.5 I_{MAX}$ $V_{IN} = -23\text{V}$		1	1.9			8	mA	
Quiescent Current Change, $\Delta I_Q$	$5\text{mA} \leq I_O \leq I_{MAX}$ $V_{IN} = -23\text{V}$			0.2	0.4		0.5	mA	
			•	0.2	0.5			mA	
	$I_O \leq 0.5 I_{MAX}$ , $-17.5\text{V} \geq V_{IN} \geq -30\text{V}$			0.1	0.4		1.0	mA	
	$I_O \leq 0.5 I_{MAX}$ , $-18.5\text{V} \geq V_{IN} \geq -30\text{V}$	•		0.1	0.5			mA	
Output Noise Voltage, $V_N$	$10\text{Hz} \leq f \leq 100\text{kHz}$ , $V_{IN} = -23\text{V}$			90	1200		90	$\mu\text{V}$	
Ripple Rejection, $\Delta V_{IN}/\Delta V_{OUT}$	$f = 120\text{Hz}$		56	70		70		dB	
	$-18.5\text{V} \geq V_{IN} \geq -28.5\text{V}$		• 56	70		70		dB	
Dropout Voltage	$I_{OUT} = I_{MAX}$			1.1	2.3		1.1	V	
Output Resistance, $R_O$	$f = 1\text{kHz}$			9			9	$\text{m}\Omega$	
Short-Circuit Current, $I_{SC}$	$V_{IN} = -35\text{V}$	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, $I_{pk}$	$V_{IN} = -23\text{V}$	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 $V_{OUT}$	$I_O = 5\text{mA}$			0.6	6.0		1.8	$\text{mV}/^\circ\text{C}$	
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  $T_j = 25^\circ\text{C}$  unless otherwise specified.

Note 2. All characteristics are measured with a capacitor across the input of  $2.2\ \mu\text{F}$  and a capacitor across the output of  $0.1\ \mu\text{F}$ . All characteristics except noise voltage and ripple rejection ratio are measured using pulse techniques ( $t_W \leq 10\text{ms}$ , duty cycle  $\leq 5\%$ ). Output voltage changes due to changes in internal temperature must be taken into account separately.

Section 5 - Voltage Regulators  
 IP120A, IP220A, IP320A, IP7900A Series,  
 IP7900AC Series, IP7900 Series, IP7900C Series

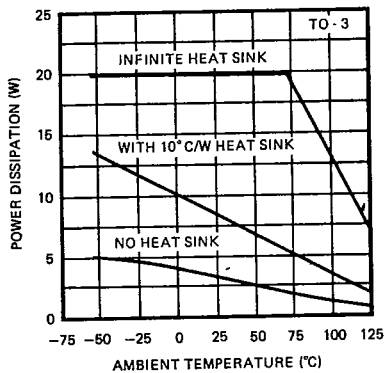


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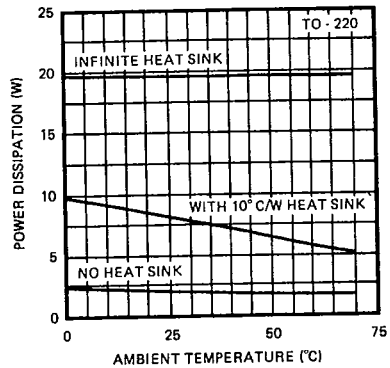
Typical Performance Characteristics

Section 5 - Voltage Regulators  
 IP120A, IP220A, IP320A, IP7900A Series,  
 IP7900AC Series, IP7900 Series, IP7900C Series

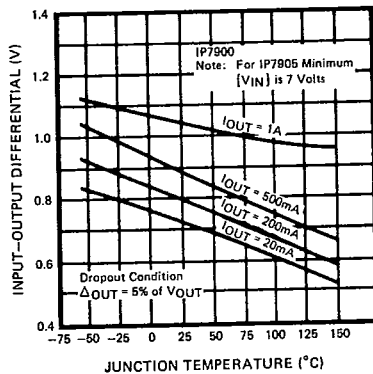
Maximum Average Power Dissipation



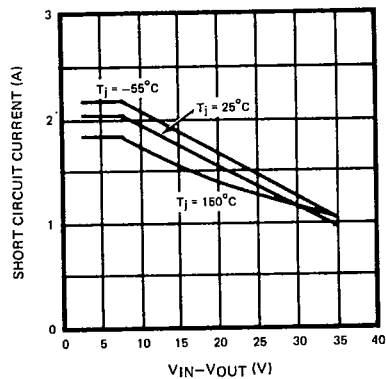
Maximum Average Power Dissipation



Dropout Voltage



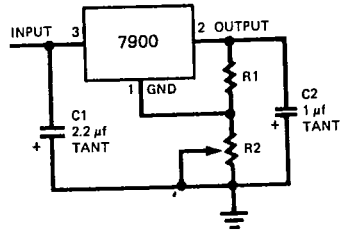
Peak Output Current



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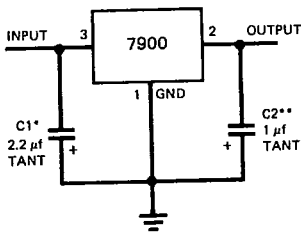
Application Information

Adjustable Output Regulator



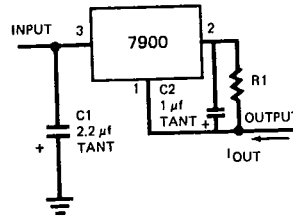
$$V_{out} \approx V_{reg} \frac{(R_1 + R_2)}{R_1}$$

Fixed Output Regulator



\* Required if the regulator is located far from the power supply filter.  
 \*\* Required for stability. 25 μf electrolytic may be substituted.

Current Regulator



$$I_{out} = \frac{V_{reg}}{R_1} + I_Q$$

Section 5 - Voltage Regulators  
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**Order Information**

Part Number	Temperature Range	Package
IP120AK-XX/LM120K-XX	-55°C to +150°C	TO-3
IP7900AK/IP7900K	-55°C to +150°C	TO-3
IP120AR-XX/IP120R-XX	-55°C to +150°C	TO-66
IP7900AR/IP7900R	-55°C to +150°C	TO-66
IP120AG-XX/IP120G-XX	-55°C to +150°C	Hermetic TO-220
IP7900AG/IP7900G	-55°C to +150°C	Hermetic TO-220
IP120AH-XX/LM120H-XX	-55°C to +150°C	TO-39
IP7900AH/IP7900H	-55°C to +150°C	TO-39
IP220AK-XX/LM220K-XX	-25°C to +150°C	TO-3
IP220AR-XX/IP220R-XX	-25°C to +150°C	TO-66
IP320AK-XX/LM320K-XX	0°C to +125°C	TO-3
IP7900ACK/IP7900CK	0°C to +125°C	TO-3
IP320AR-XX/IP320R-XX	0°C to +125°C	TO-66
IP7900ACR/IP7900CR	0°C to +125°C	TO-66
IP320AT-XX/LM320T-XX	0°C to +125°C	TO-220
IP7900ACT/IP7900CT	0°C to +125°C	TO-220

Section 5 - Voltage Regulators  
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 IP7900AC Series, IP7900 Series, IP7900C Series

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