

GENERAL DESCRIPTION

The LM104, LM204, and LM304 are precision voltage regulators which provide programmable output voltage levels. With an external resistor the voltage levels can be programmed from 40V down to 0V.

These devices are primarily designed for systems requiring regulated negative voltages which have a common ground with the unregulated supply. They are complements of the LM105/LM305 positive regulators.

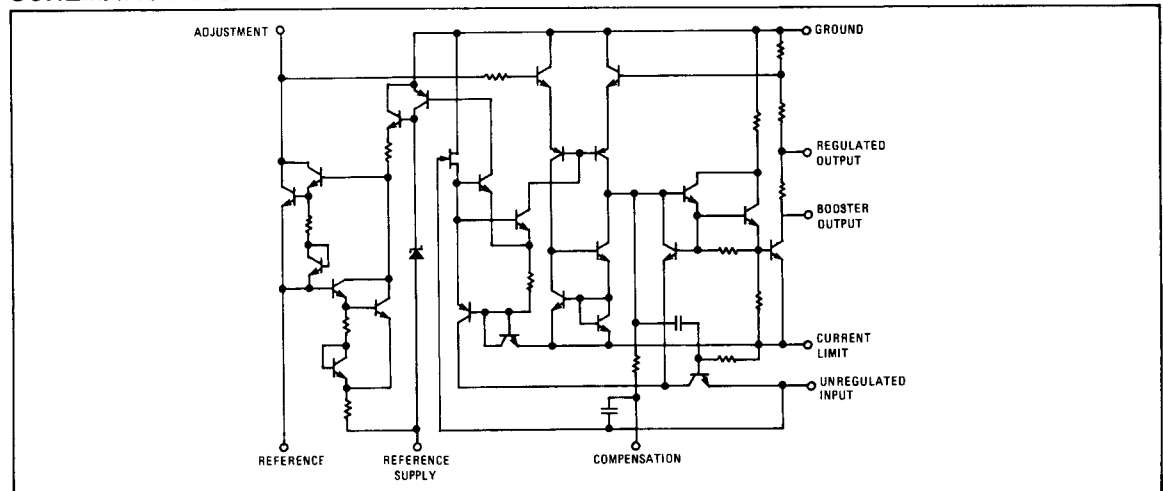
The LM104 series can also be used as switching or current regulators, or in a variety of control applications. Both constant and foldback current limiting are available.

The LM104 operates over the military temperature range of -55°C to $+125^{\circ}\text{C}$. The LM304 is the commercial version which operates from 0°C to $+70^{\circ}\text{C}$. The LM204 is the same as the LM104 except its performance is guaranteed from -25°C to $+85^{\circ}\text{C}$.

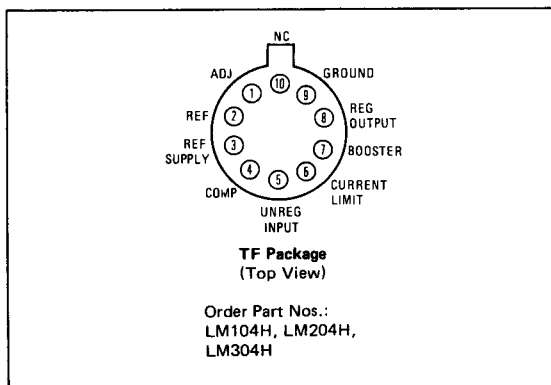
DESIGN FEATURES

- No-Load to Full-Load Regulation 1mV
- Line Regulation 0.01%/V
- Ripple Rejection 0.2mV/V
- Temperature Stability 0.3% from -55°C to $+125^{\circ}\text{C}$

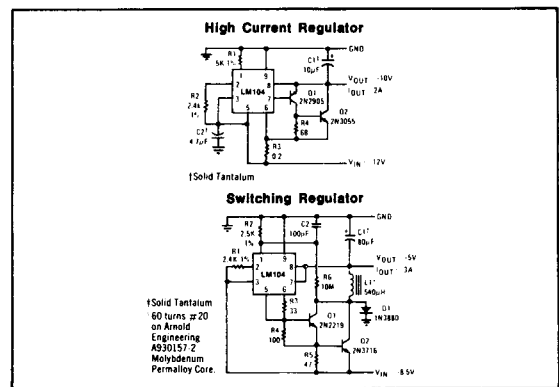
SCHEMATIC DIAGRAM



CONNECTION INFORMATION



TYPICAL APPLICATIONS



ABSOLUTE MAXIMUM RATINGS

Input Voltage	LM104/LM204: 50V LM304: 40V	Operating Temperature Range LM104	-55°C to +125°C
Input-Output Voltage Differential	LM104/LM204: 50V LM304: 40V	LM204	-25°C to +85°C
Power Dissipation (Note 1)	500mW	LM304	0°C to +70°C
		Storage Temperature Range	-65°C to +150°C
		Lead Temperature (Soldering, 10s)	300°C

ELECTRICAL CHARACTERISTICS (Note 2)

PARAMETER	CONDITIONS	LM104/LM204			LM304			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
Input Voltage Range		-50		-8	-40		-8	V
Output Voltage Range		-40		-0.015	-30		-0.035	V
Output-Input Voltage Differential (Note 3)	$I_O = 20\text{mA}$	2.0		50	2.0		40	V
	$I_O = 5\text{mA}$	0.5		50	0.5		40	V
Load Regulation (Note 4)	$0 \leq I_O \leq 20\text{mA}$ $R_{SC} = 15\Omega$		1	5		1	5	mV
Line Regulation (Note 5)	$V_{OUT} \leq -5\text{V}$ $\Delta V_{IN} = 0.1 V_{IN}$		0.056	0.1		0.056	0.1	%
Ripple Rejection	$C_{19} = 10\mu\text{F}$, $f = 120\text{Hz}$ $V_{IN} < -15\text{V}$		0.2	0.5		0.2	0.5	mV/V
	$-7\text{V} \geq V_{IN} \geq -15\text{V}$		0.5	1.0		0.5	1.0	mV/V
Output Voltage Scale Factor	$R_{23} = 2.4\text{k}$	1.8	2.0	2.2	1.8	2.0	2.2	V/k Ω
Temperature Stability	$V_O \leq -1\text{V}$		0.3	1.0				%
	$V_O \leq -1\text{V}$, $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$					0.3	1.0	
Output Noise Voltage	$10\text{Hz} \leq f \leq 10\text{kHz}$ $V_O \leq -5\text{V}$, $C_{19} = 0$		0.007			0.007		%
	$C_{19} = 10\mu\text{F}$		15			15		μV
Standby Current Drain	$I_L = 5\text{mA}$, $V_O = 0$		1.7	2.5		1.7	2.5	mA
	$V_O = -40\text{V}$		3.6	5.0				
	$V_O = -30\text{V}$					3.6	5.0	
Long Term Stability	$V_O \leq -1\text{V}$		0.1	1.0		0.1	1.0	%

NOTES:

- The maximum junction temperature of the LM104 is 150°C and the LM304 +85°C. For operating at elevated temperatures, devices in the TO-5 package must be derated based on a thermal resistance of +150°C/W, junction to ambient, or +45°C, junction to case. For the flat package, the derating is based on a thermal resistance of +185°C/W when mounted on a 1/16-inch-thick epoxy glass board with ten, 0.03-inch-wide, 2-ounce copper conductors.
- These specifications apply for junction temperatures between -55°C and +150°C (between 0°C and +85°C for the LM304) and for input and output voltages within the ranges given, unless otherwise specified. The load and line regulation specifications are for constant junction temperature. Temperature drift effects must be taken into

account separately when the unit is operating under conditions of high dissipation.

- When external booster transistors are used, the minimum output-input voltage differential is increased, in the worst case, by approximately 1V.
- The output currents given, as well as the load regulation, can be increased by the addition of external transistors. The improvement factor will be roughly equal to the composite current gain of the added transistors.
- With zero output, the dc line regulation is determined from the ripple rejection. Hence, with output voltages between 0V and -5V, a dc output variation, determined from the ripple rejection, must be added to find the worst case line regulation.

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