

MITSUBISHI LINEAR ICs  
**M5236L, ML**

**GENERAL PURPOSE 3-TERMINAL VARIABLE VOLTAGE OUTPUT REGULATOR  
 (FOR DRIVER)**

**DESCRIPTION**

The M5236 is a semiconductor integrated circuit designed for general-purpose output voltage regulator.

A high-performance variable output voltage regulator with small input-output voltage differences can be made in combination with externally connected PNP transistors.

It is housed in a small 3-pin package, including a reference voltage circuit, error amplifier, and driver, and the output voltage can be set freely by externally connected resistors, and a small, compact power supply circuit can be achieved, making the device suitable for use in small electronic equipment, such as car stereo, radio cassette recorder and portable stereo equipment.

**FEATURES**

- Wide operating voltage range  
 .....  $V_{IN}=3.5V\sim 36V$ ,  $V_O=1.5V\sim 33V$
- Capable of operating at low input-output voltage for driver by externally connected power transistors  
 [ $V_{CE(sat)}$  state of TR] .....  $V_{I-O(min)}\cong 0.2V$
- Output voltage can be set freely by externally connected resistors
- Built-in ASO protection and thermal cutoff circuits
- Capable of taping (automated insertion) and lead forming

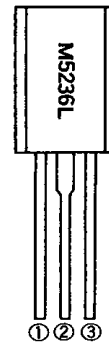
**APPLICATION**

For car stereo equipment, radio cassette recorder, portable stereo and other general electronic equipment.

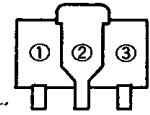
**RECOMMENDED OPERATING CONDITIONS**

- Supply voltage range .....  $V_{IN}=3.5V\sim 30V$
- Rated supply voltage .....  $V_O=1.5V\sim 25V$

**PIN CONFIGURATION**



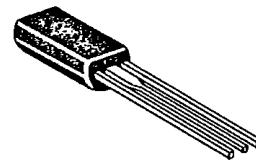
TO-92L



SOT-89

**PIN CONNECTION**

- ① INPUT
- ② GND
- ③ VOLTAGE ADJUSTMENT

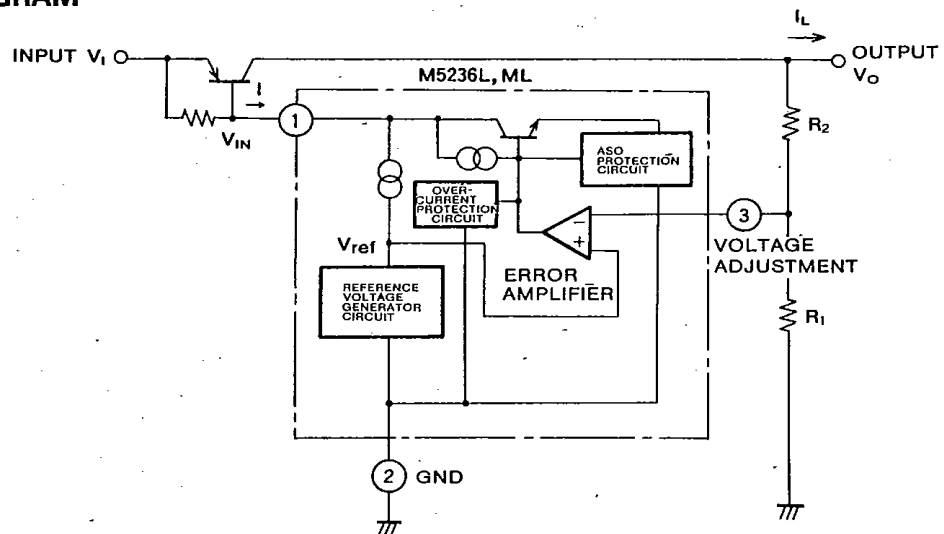


TO-92L package



SOT-89 package

**BLOCK DIAGRAM**



GENERAL PURPOSE 3-TERMINAL VARIABLE VOLTAGE OUTPUT REGULATOR

ABSOLUTE MAXIMUM RATINGS ( $T_a=25^\circ\text{C}$ )

Symbol	Parameter	Ratings	Unit
$V_{IN}$	Input voltage	36	V
$I_D$	Drive current	30	mA
$V_I-V_O$	Input-output voltage difference	30	V
$P_d$	Power dissipation	900(SIP)/500(ML)	mW
$T_{opr}$	Operating temperature	$-20\sim+75$	$^\circ\text{C}$
$T_{stg}$	Storage temperature	$-55\sim+150$	$^\circ\text{C}$

ELECTRICAL CHARACTERISTICS (measurement circuit (a) is used with,  $T_a=25^\circ\text{C}$ ,  $V_I=15\text{V}$ ,  $V_O=12\text{V}$ ,  $I_L=200\text{mA}$ ,  $C_{REF}=1\mu\text{F}$ ,  $R_1=4.3\text{k}\Omega$ , unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
$V_{IN}$	Input voltage	(between pin ① and pin ②)	3.5		36	V
$V_O$	Output voltage	$R_2 \approx 0.82\text{k}\Omega \sim 108\text{k}\Omega$	1.5		33	V
$V_I-V_O$	Minimum input-output voltage difference			0.2		V
$V_{REF}$	Reference voltage	(between pin ③ and pin ②)	1.20	1.26	1.32	V
Reg-In	Input regulation	$V_I=15\sim 20\text{V}$		0.02	0.1	%/V
Reg-L	Load regulation	$I_L=10\sim 200\text{mA}$		0.02	0.1	%
$I_B$	Bias current	$I_L=0$ (disregarding the current in resistors $R_1, R_2$ )		1.7	3.0	mA
$TC_{VO}$	Temperature coefficient of output voltage	$T_a=0\sim 75^\circ\text{C}$		0.02		%/ $^\circ\text{C}$
RR	Ripple rejection ratio	$f=120\text{Hz}$ (measured with circuit (b))		68		dB
$V_{NO}$	Output noise voltage	$f=20\text{Hz}\sim 100\text{kHz}$		33		$\mu\text{Vrms}$

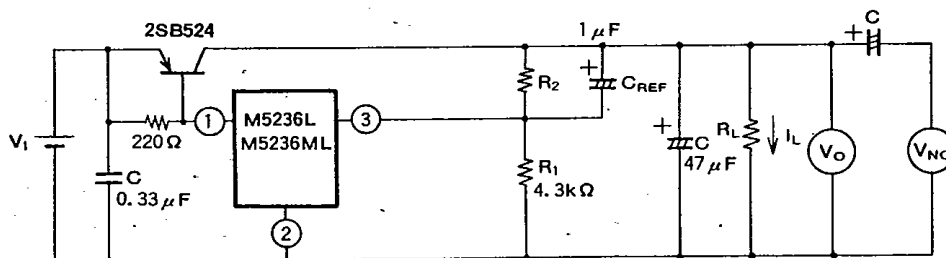
TEST CIRCUITS

(a) Standard test circuit

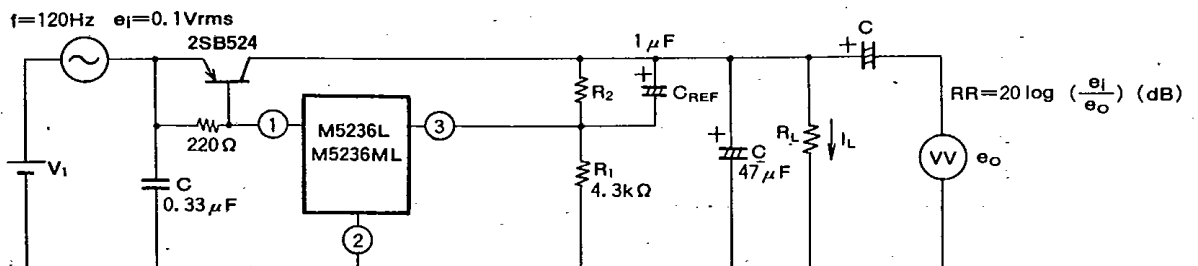
$$V_O = V_{REF} \left(1 + \frac{R_2}{R_1}\right) \approx 1.26 \times \left(1 + \frac{R_2}{4.3}\right) \text{ (V)}$$

$$R_2 = R_1 \left(\frac{V_O}{V_{REF}} - 1\right) \approx 4.3 \times \left(\frac{V_O}{1.26} - 1\right) \text{ (k}\Omega\text{)}$$

( $R_1=4.3\text{k}\Omega$ ,  $V_{REF}\approx 1.26\text{V}$ )



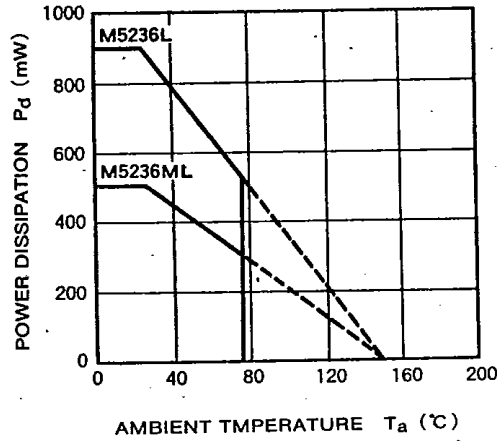
(b) Ripple rejection test circuit



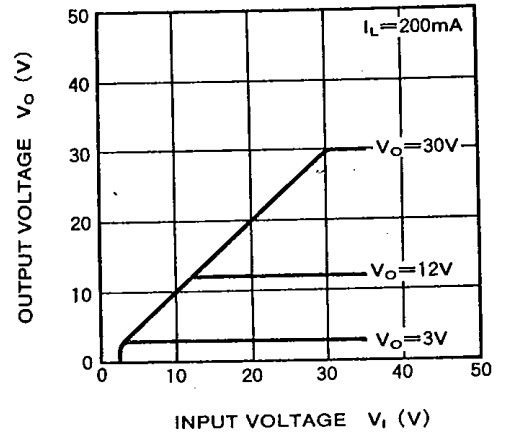
**GENERAL PURPOSE 3-TERMINAL VARIABLE VOLTAGE OUTPUT REGULATOR  
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**TYPICAL CHARACTERISTICS**

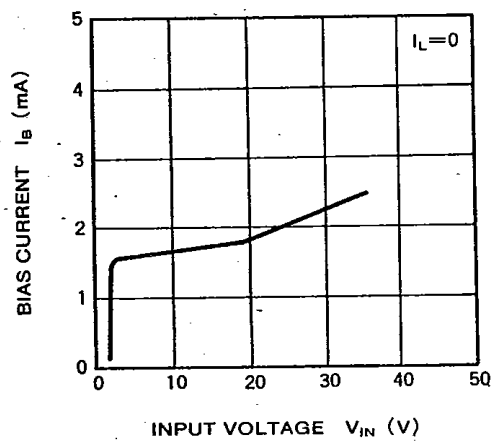
**THERMAL DERATING (MAXIMUM RATINGS)**



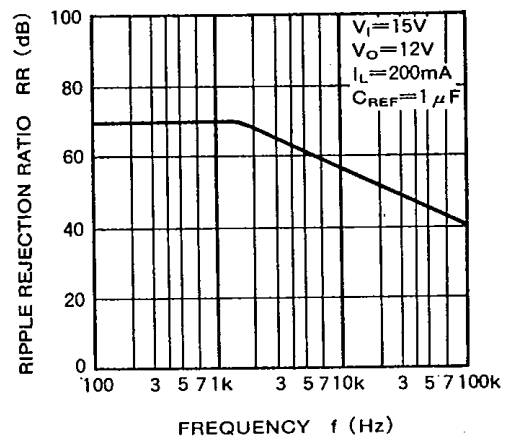
**OUTPUT VOLTAGE CHARACTERISTICS**



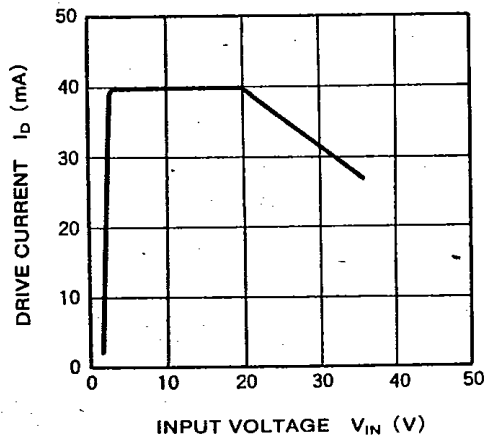
**BIAS CURRENT VS. INPUT VOLTAGE**



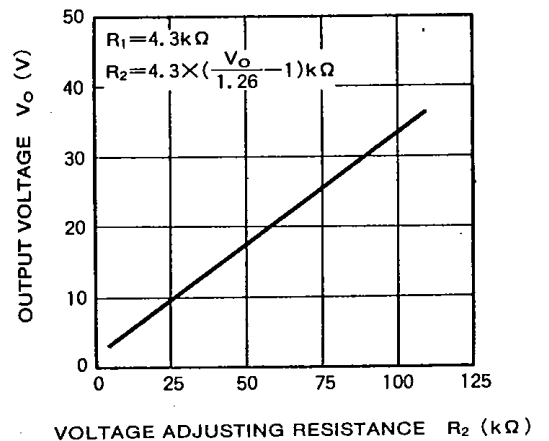
**RIPPLE REJECTION**



**DRIVE CURRENT VS. INPUT VOLTAGE**



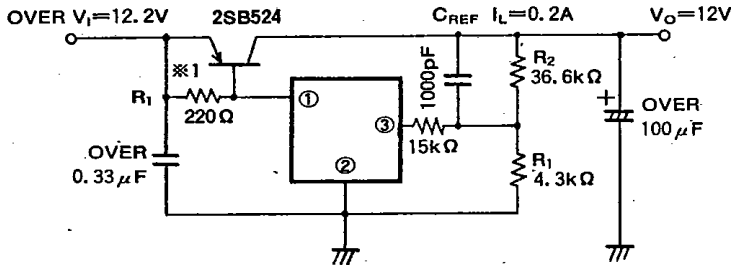
**OUTPUT VOLTAGE VS. VOLTAGE ADJUSTING RESISTANCE**



**GENERAL PURPOSE 3-TERMINAL VARIABLE VOLTAGE OUTPUT REGULATOR  
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**APPLICATION EXAMPLES**

**1. Standard application circuit**

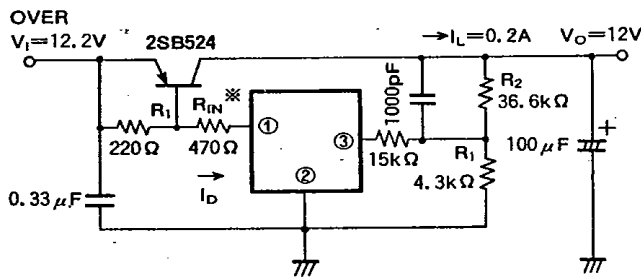


$$V_o = V_{REF} \times \left( 1 + \frac{R_2}{R_1} \right) V$$

$V_{REF} = 1.26V(\text{typ.})$   
 ※1.  $R_1$  of 180~220 Ω should be used.

Note) Capacitors displaying small capacity change with temperature should be used.

**2. Control circuit for maximum drive current ( $I_{DM}$ )**

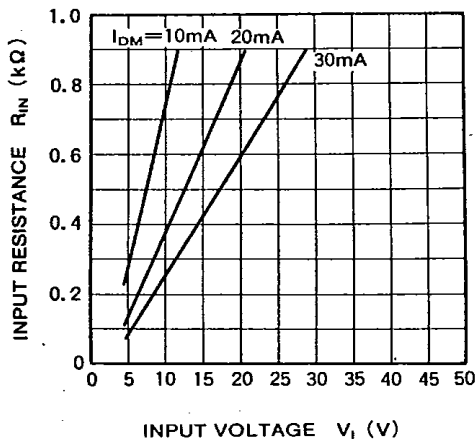


When the input voltage ( $V_i$ ) is lower than the set output voltage ( $V_o$ ), drive current of approximately 30mA to 45mA runs in Pin ① of the integrated circuit. (Refer to TYPICAL CHARACTERISTICS DRIVE CURRENT VS INPUT VOLTAGE. For example, when the input voltage  $V_i$  of 20V is higher than the fixed output voltage of 20V or above, and input and output are inverted, power dissipation in the circuit is  $P_D = 20V \times 45mA = 900mW$ , and reaches the maximum rating, making it necessary to control the drive current.) When the input power supply is supplied by batteries and the current needs to be controlled, a resistor  $R_{IN}$  can be inserted to control the drive current. (Fig. 1 shows input voltage dependency of the control current and input resistor  $R_{IN}$ .)

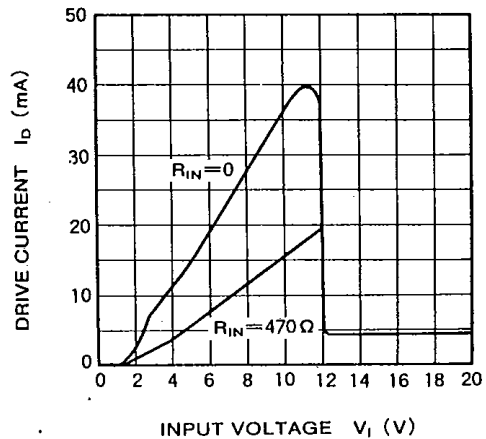
When the input voltage reaches 12V ( $=V_o$ ), the current at Pin ① is limited to approximately to 20mA.

Fig. 2 shows  $I_D - V_i$  characteristics of the circuit.

**Fig. 1 MAXIMUM DRIVE CURRENT CONTROL CHARACTERISTICS ( $I_{DM}$ )**

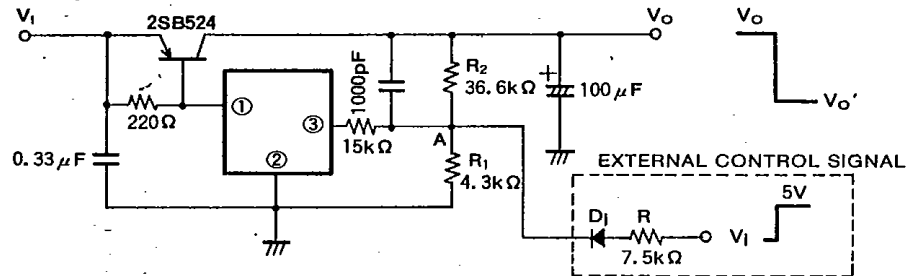


**Fig. 2  $I_D - V_i$  CHARACTERISTICS IN APPLICATION EXAMPLE 2**



**GENERAL PURPOSE 3-TERMINAL VARIABLE VOLTAGE OUTPUT REGULATOR**

**3. ON/OFF control of output voltage circuit**



Resistor R in the control circuit is determined by the following equation.

$$R = \frac{V_i - V_F - V_{REF'}}{V_{REF'} + \frac{V_{REF'} - V_{O'}}{R_1}}$$

where,  $V_i$ : External control voltage

$V_F$ : Forward voltage of diode ( $D_i$ )

$V_{REF'}$ : 1.4V Pin ③ voltage when  $V_{REF'}$  is  $V_{O(OFF)}$

$V_{O'}$ : 0V output voltage when  $V_{O'}$  is  $V_{O(OFF)}$