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# M5231TL

## VARIABLE OUTPUT VOLTAGE REGULATOR

### DESCRIPTION

The M5231TL is a semiconductor integrated circuit which is designed for variable output voltage regulator and is housed in a small 5-pin SIP.

The input range 8~70V, and the output voltage range 3~50V can be optionally adjusted by the external resistors. In addition, by attaching power transistors, high current gains can be achieved, making the device suitable for used in the power supplies of a wide variety of equipment.

### FEATURES

- High input voltage .....  $V_i=70V$
- Wide range of output voltages .....  $V_o=3V\sim 50V$
- Low output noise voltage .....  $V_{NO}=6\mu V_{rms}(typ.)$
- Built-in current limiting and thermal shutdown circuits
- Capability of adjusting the output voltage rise time constant of the coefficients by the external capacitor
- Capability of the operating control by the external signal

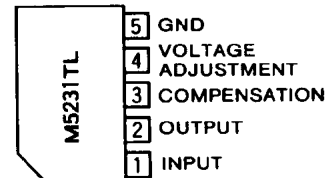
### APPLICATION

Audio, VTR equipment, and a variety of electronic musical instruments.

### RECOMMENDED OPERATING CONDITIONS

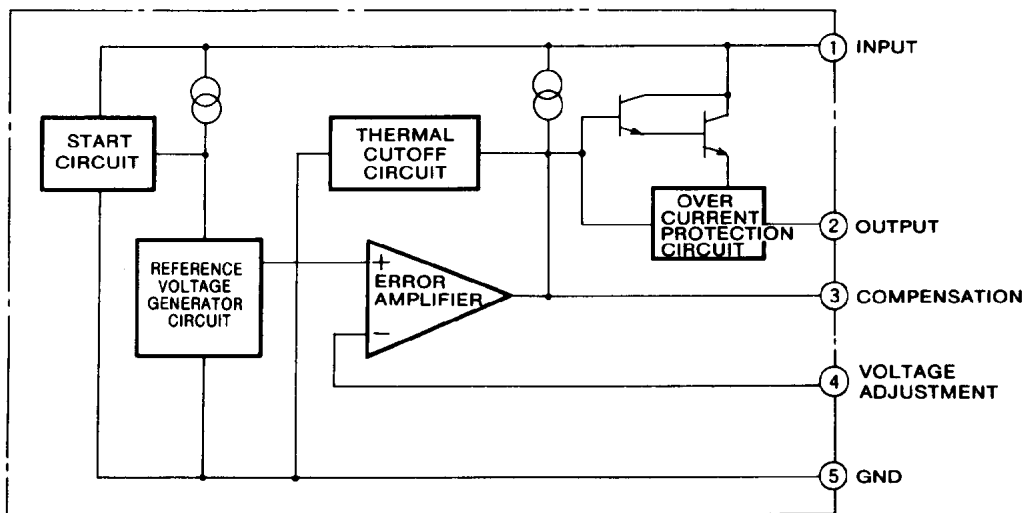
- Supply voltage range ..... 8~70V
- Rated supply voltage ..... 35V

### PIN CONFIGURATION (TOP VIEW)



Outline 5P5T

### BLOCK DIAGRAM



**VARIABLE OUTPUT VOLTAGE REGULATOR**

**ABSOLUTE MAXIMUM RATINGS** (T<sub>a</sub>=25°C)

Symbol	Parameter	Ratings	Unit
V <sub>I</sub>	Input voltage	70	V
I <sub>L</sub>	Load current	30	mA
V <sub>I</sub> -V <sub>O</sub>	Input-output voltage difference	67	V
P <sub>d</sub>	Power dissipation	450	mW
T <sub>opr</sub>	Operating temperature	-20~+75	°C
T <sub>stg</sub>	Storage temperature	-55~+125	°C

**ELECTRICAL CHARACTERISTICS** (measurement circuit (a) is used with, T<sub>a</sub>=25°C, V<sub>I</sub>=40V, V<sub>O</sub>=35V, I<sub>L</sub>=10mA, C=10μF, C<sub>REF</sub>=1μF, R<sub>1</sub>=3.3kΩ, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V <sub>I</sub>	Input voltage		8		70	V
V <sub>O</sub>	Output voltage	R <sub>2</sub> ≐1.5~88kΩ	3		50	V
V <sub>I</sub> -V <sub>O</sub>	Minimum input-output voltage differential			2.5	3.0	V
V <sub>REF</sub>	Reference voltage	(between pin ④ and pin ⑤)	(1.66)	1.8	(1.90)	V
Reg.in	Input regulation	V <sub>I</sub> =38~60V		0.04	0.1	%/V
R <sub>ge-L</sub>	Load regulation	I <sub>L</sub> =0~20mA		0.03	0.1	%
I <sub>B</sub>	Bias current	I <sub>L</sub> =0 (disregarding the current in resistors R <sub>1</sub> , R <sub>2</sub> )		1.2	2.5	mA
TC <sub>VO</sub>	Temperature coefficient of output voltage	T <sub>a</sub> =0~75°C, V <sub>O</sub> =3~50V		0.02		%/°C
RR	Ripple rejection	f=120Hz (measured with circuit (b))		62		dB
V <sub>NO</sub>	Output noise voltage	f=20Hz~100kHz		6		μVrms

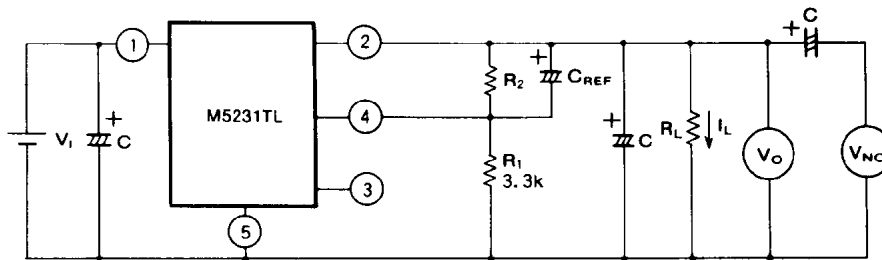
**TEST CIRCUITS**

**(a) Standard test circuit**

$$V_O = V_{REF} \left(1 + \frac{R_2}{R_1}\right) \approx 1.8 \times \left(1 + \frac{R_2}{3.3}\right) \text{ (V)}$$

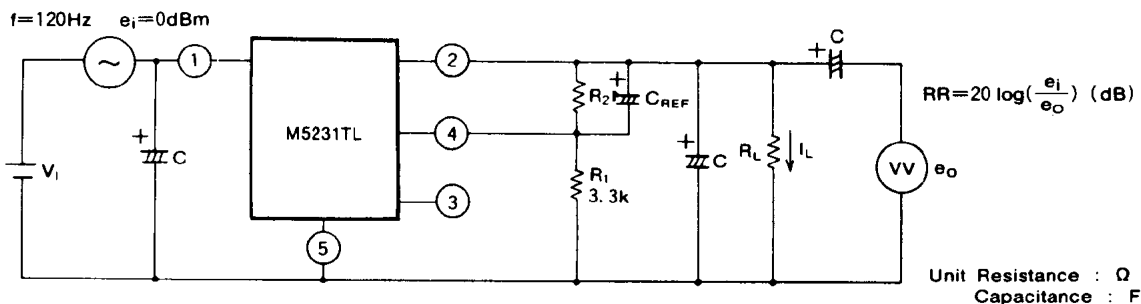
$$R_2 = R_1 \left(\frac{V_O}{V_{REF}} - 1\right) \approx 3.3 \times \left(\frac{V_O}{1.8} - 1\right) \text{ (k}\Omega\text{)}$$

$$R_1 = 3.3 \text{ k}\Omega, V_{REF} \approx 1.8 \text{ V}$$



Unit Resistance : Ω  
Capacitance : F

**(b) Ripple rejection test circuit**

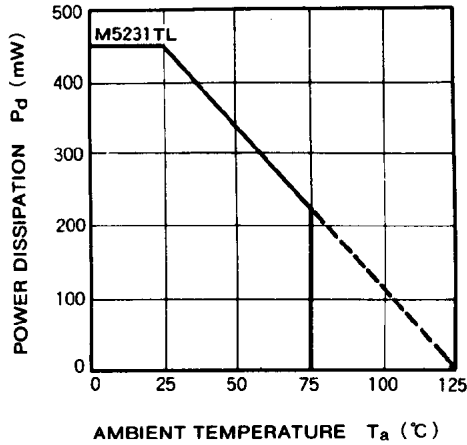


Unit Resistance : Ω  
Capacitance : F

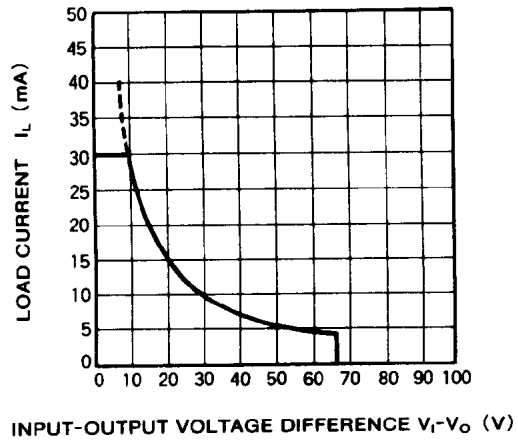
**VARIABLE OUTPUT VOLTAGE REGULATOR**

**TYPICAL CHARACTERISTICS** ( $T_a=25^\circ\text{C}$ , unless otherwise noted)

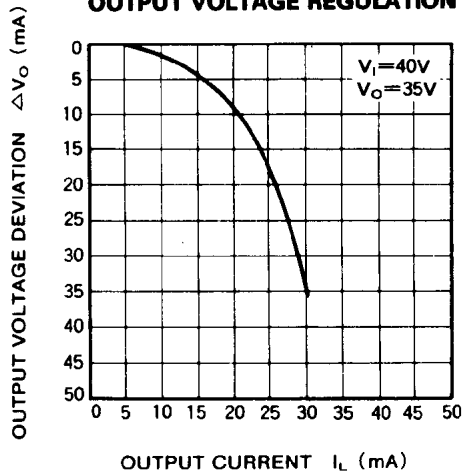
**THERMAL DERATING (MAXIMUM RATINGS)**



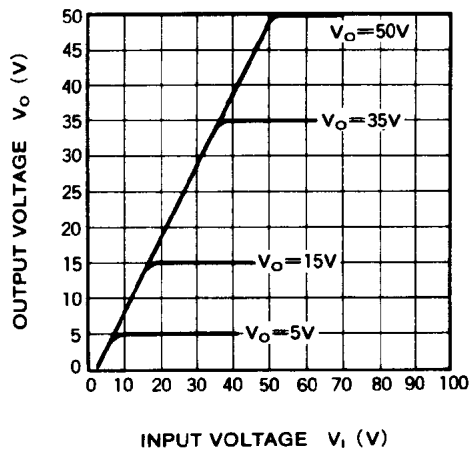
**LOAD CURRENT VS. INPUT-OUTPUT VOLTAGE DIFFERENCE**



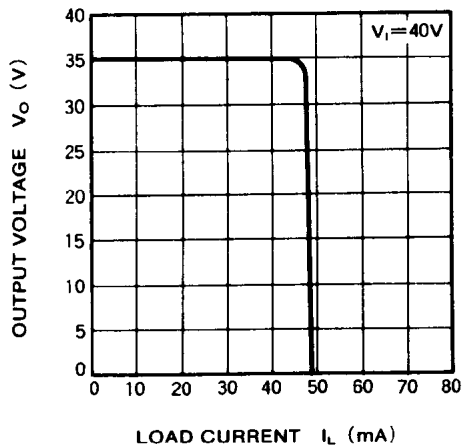
**OUTPUT VOLTAGE REGULATION**



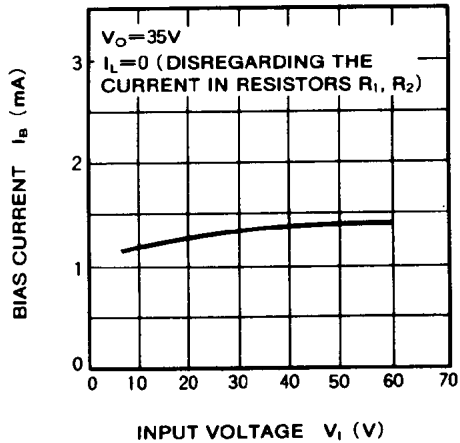
**OUTPUT VOLTAGE CHARACTERISTICS**



**LOAD CHARACTERISTICS**

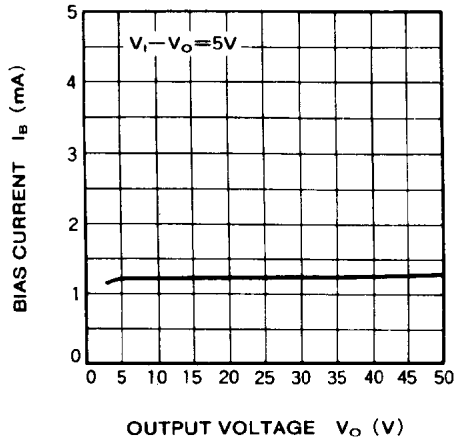


**BIAS CURRENT VS. INPUT VOLTAGE**

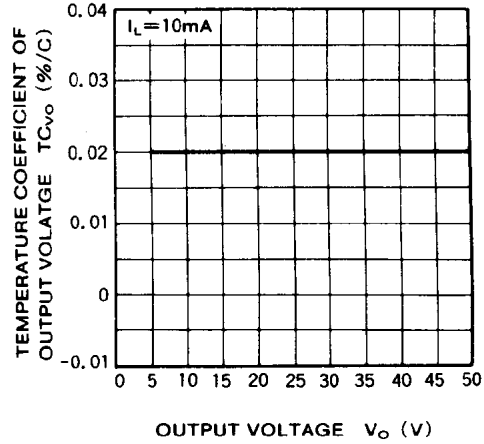


**VARIABLE OUTPUT VOLTAGE REGULATOR**

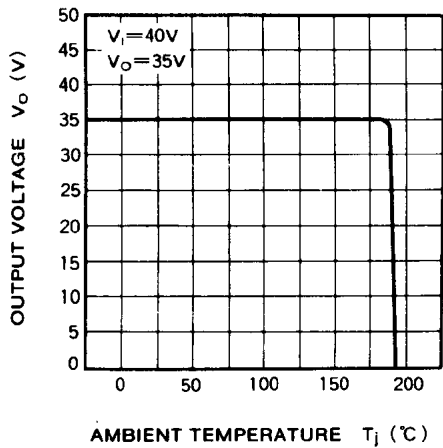
**BIAS CURRENT VS. OUTPUT VOLTAGE**



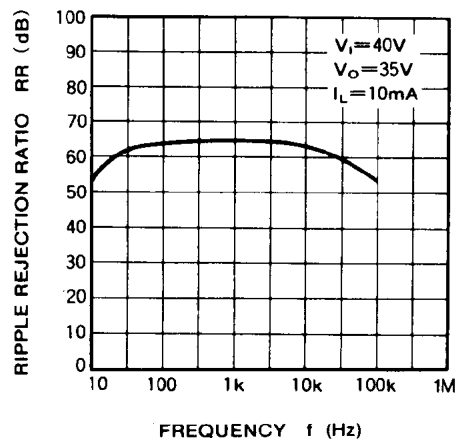
**TEMPERATURE COEFFICIENT OF OUTPUT VOLTAGE VS. OUTPUT VOLTAGE CHARACTERISTICS**



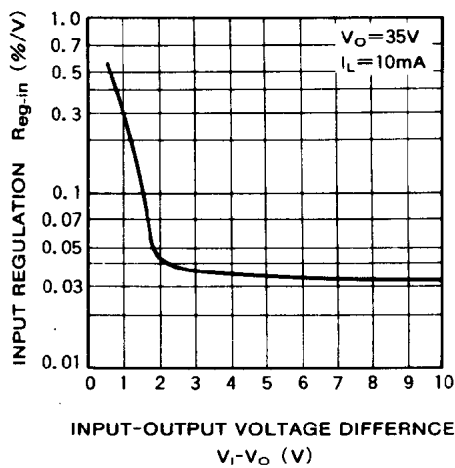
**THERMAL CUTOFF**



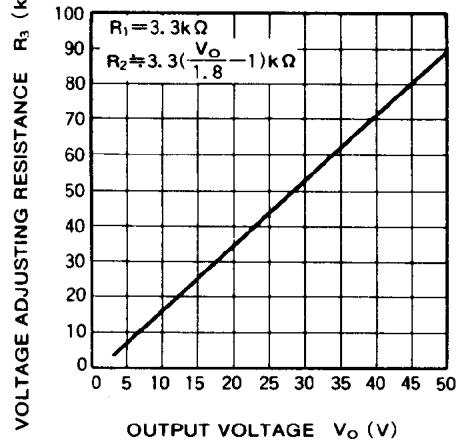
**RIPPLE REJECTION**



**INPUT REGULATION VS. INPUT-OUTPUT VOLTAGE DIFFERENCE**



**VOLTAGE ADJUSTING RESISTANCE VS. OUTPUT VOLTAGE**



# M5231TL

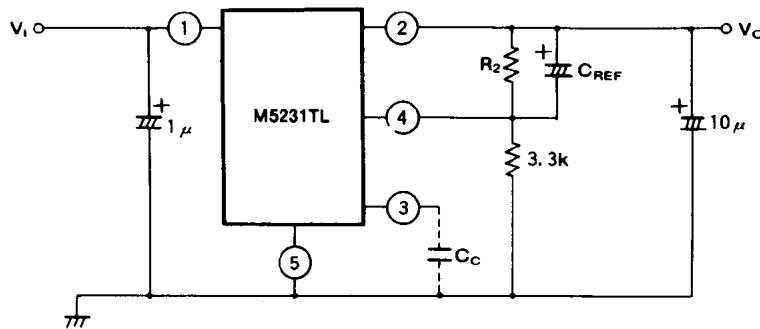
## VARIABLE OUTPUT VOLTAGE REGULATOR

### APPLICATION EXAMPLES

#### (1) Standard application example

$$V_O \approx 1.8 \times \left(1 + \frac{R_2}{3.3}\right) \text{ (V)}$$

$$R_2 \approx 3.3 \times \left(\frac{V_O}{1.8} - 1\right) \text{ (k}\Omega\text{)}$$



**C<sub>REF</sub>**

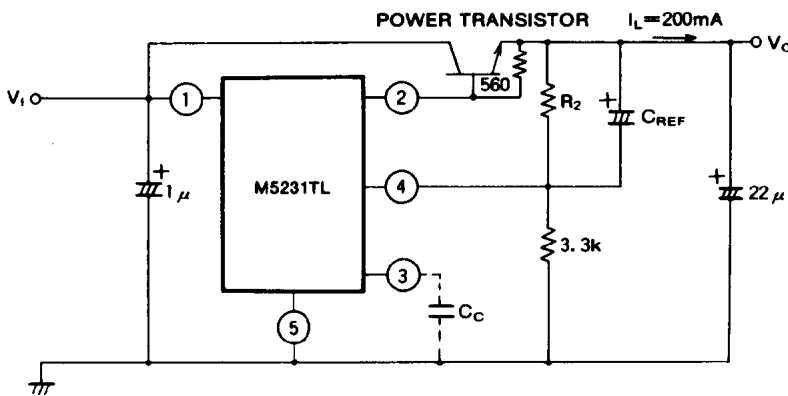
Connection of this capacitor gives the following characteristics.

- 1) The rise time of the output voltage can be adjusted (slowed).
- 2) The ripple rejection ratio is improved.
- 3) Output noise voltage is reduced down to 1/10 of three terminal regulator IC.

**C<sub>C</sub>**

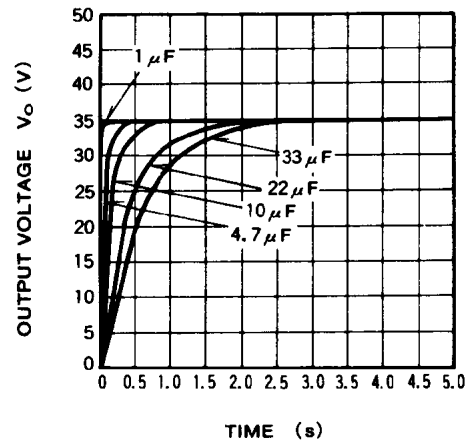
Compensation capability by connection of a capacitor.

#### (2) Current boost circuit with NPN external power TR

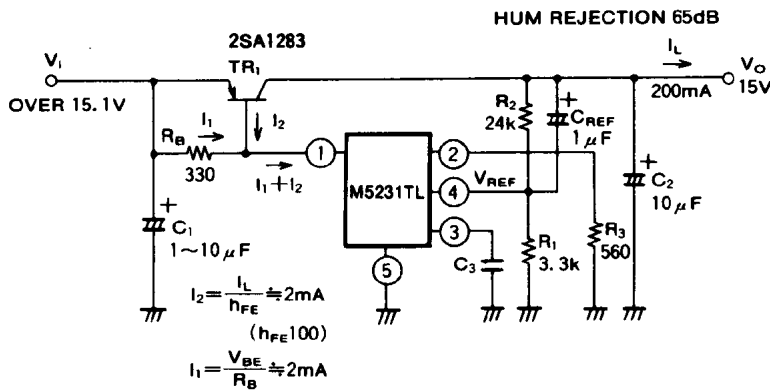


### EXAMPLE 1 OF CHARACTERISTIC ACHIEVED

#### OUTPUT VOLTAGE CHARACTERISTICS FOR EXTERNAL CAPACITORS (C<sub>REF</sub>)



#### (3) Supper low dropout regulator circuits (V<sub>IO</sub>=100mW)

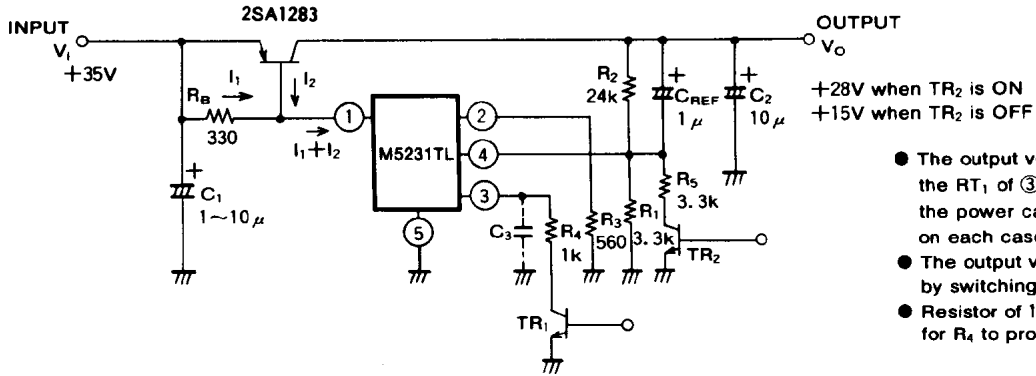


- Stable operation is expected even if the input-output voltage differences are as low as 0.1V.
- The heat sink of power TR can become small in size owing to low dissipation. The R<sub>3</sub> is a load current limit resistor and the input-output voltage differences between ① and ② pins must be over 3V.
- $$V_i - V_{RE} - (I_1 + I_2 - I_B)R_3 > 3V$$

# M5231TL

## VARIABLE OUTPUT VOLTAGE REGULATOR

### (4) Output voltage ON/OFF controller, Step UP/DOWN controller



(Note) The load current can be over 1A by connection the external power TR.