

To all our customers

Regarding the change of names mentioned in the document, such as Mitsubishi Electric and Mitsubishi XX, to Renesas Technology Corp.

The semiconductor operations of Hitachi and Mitsubishi Electric were transferred to Renesas Technology Corporation on April 1st 2003. These operations include microcomputer, logic, analog and discrete devices, and memory chips other than DRAMs (flash memory, SRAMs etc.) Accordingly, although Mitsubishi Electric, Mitsubishi Electric Corporation, Mitsubishi Semiconductors, and other Mitsubishi brand names are mentioned in the document, these names have in fact all been changed to Renesas Technology Corp. Thank you for your understanding. Except for our corporate trademark, logo and corporate statement, no changes whatsoever have been made to the contents of the document, and these changes do not constitute any alteration to the contents of the document itself.

Note : Mitsubishi Electric will continue the business operations of high frequency & optical devices and power devices.

Renesas Technology Corp.
Customer Support Dept.
April 1, 2003

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

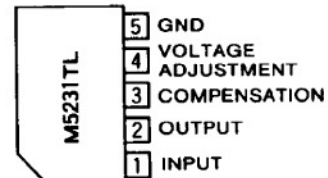
- High input voltage $V_I=70V$
- Wide range of output voltages $V_O=3V\sim 50V$
- Low output noise voltage $V_{NO}=6\mu V_{rms}(typ.)$
- Built-in current limiting and thermal shutdown circuits
- Capability of adjusting the output voltage rise time constant of the coefficients by the external capacitor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

APPLICATION

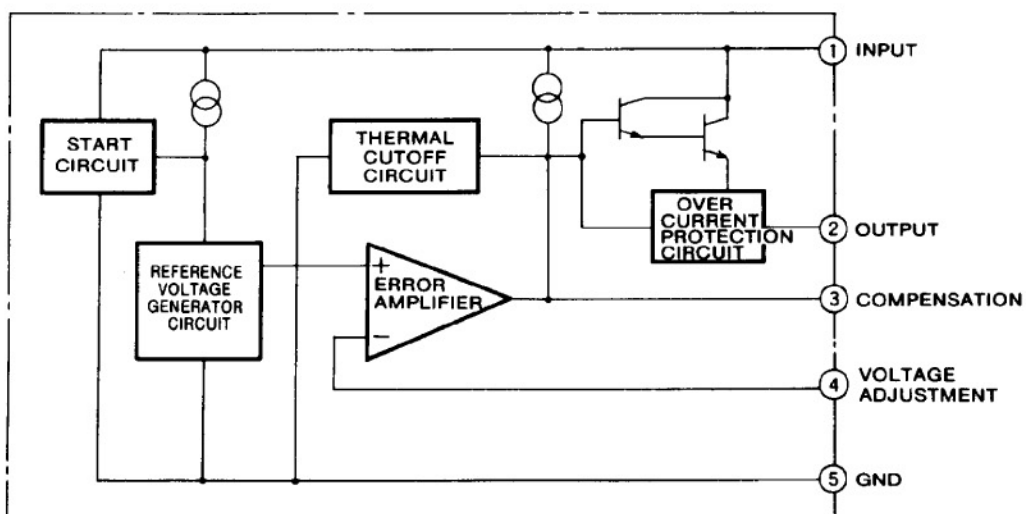
Audio, VTR equipment, and a variety of electronic musical instruments.

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** ($T_a=25^\circ\text{C}$)

Symbol	Parameter	Ratings	Unit
V_i	Input voltage	70	V
I_L	Load current	30	mA
$V_i - V_o$	Input-output voltage difference	67	V
P_d	Power dissipation	450	mW
T_{opr}	Operating temperature	$-20 \sim +75$	$^\circ\text{C}$
T_{stg}	Storage temperature	$-55 \sim +125$	$^\circ\text{C}$

ELECTRICAL CHARACTERISTICS (measurement circuit (a) is used with, $T_a=25^\circ\text{C}$, $V_i=40\text{V}$, $V_o=35\text{V}$, $I_L=10\text{mA}$, $C=10\mu\text{F}$, $C_{REF}=1\mu\text{F}$, $R_1=3.3\text{k}\Omega$, unless otherwise noted)

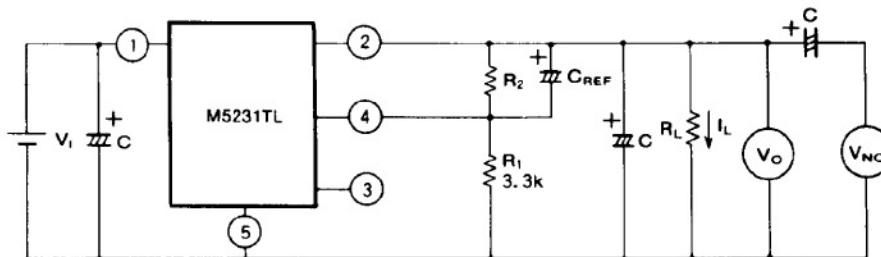
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_i	Input voltage		8		70	V
V_o	Output voltage	$R_2 \approx 1.5 \sim 88\text{k}\Omega$	3		50	V
$V_i - V_o$	Minimum input-output voltage differential			2.5	3.0	V
V_{REF}	Reference voltage	(between pin ④ and pin ⑤)	(1.66)	1.8	(1.90)	V
Reg_{in}	Input regulation	$V_i=38 \sim 60\text{V}$		0.04	0.1	%/V
Reg_{L}	Load regulation	$I_L=0 \sim 20\text{mA}$		0.03	0.1	%
I_B	Bias current	$I_L=0$ (disregarding the current in resistors R_1, R_2)		1.2	2.5	mA
TC_{V_o}	Temperature coefficient of output voltage	$T_a=0 \sim 75^\circ\text{C}$, $V_o=3 \sim 50\text{V}$		0.02		%/ $^\circ\text{C}$
RR	Ripple rejection	$f=120\text{Hz}$ (measured with circuit (b))		62		dB
V_{NO}	Output noise voltage	$f=20\text{Hz} \sim 100\text{kHz}$		6		μV_{rms}

TEST CIRCUITS**(a) Standard test circuit**

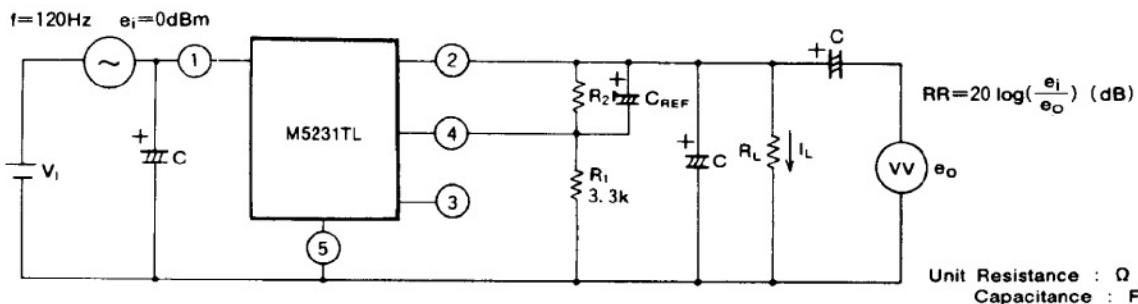
$$V_o = V_{REF} \left(1 + \frac{R_2}{R_1}\right) \approx 1.8 \times \left(1 + \frac{R_2}{3.3}\right) \text{ (V)}$$

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

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



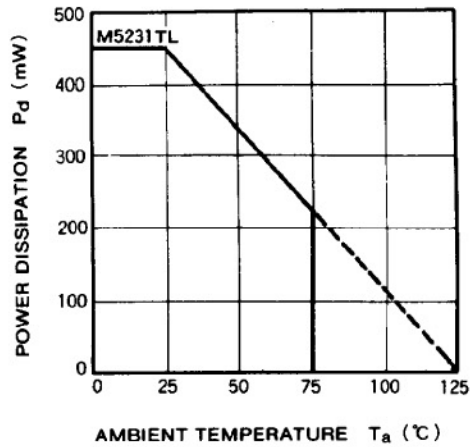
Unit Resistance : Ω
Capacitance : F

(b) Ripple rejection test circuit

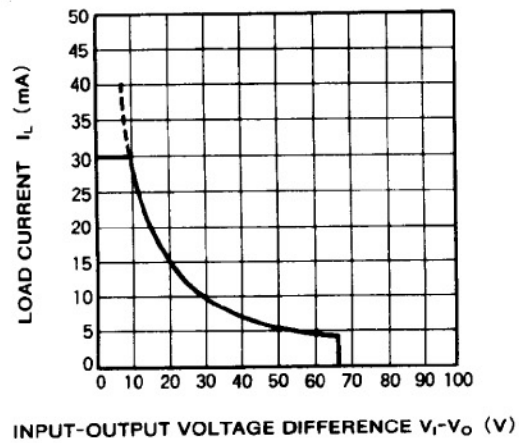
VARIABLE OUTPUT VOLTAGE REGULATOR

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

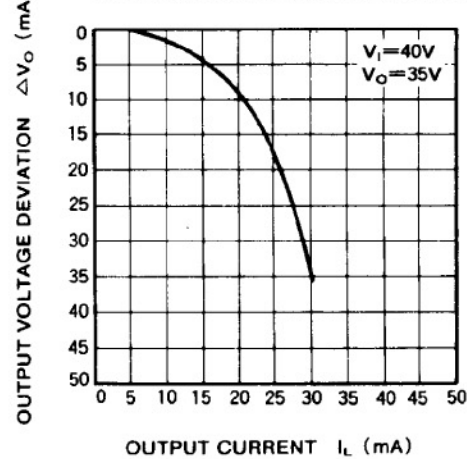
THERMAL DERATING (MAXIMUM RATINGS)



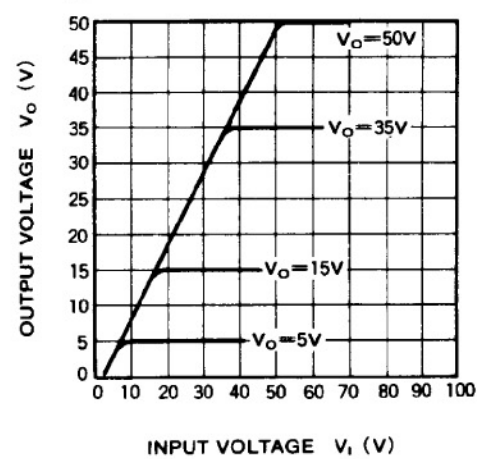
LOAD CURRENT VS. INPUT-OUTPUT VOLTAGE DIFFERENCE



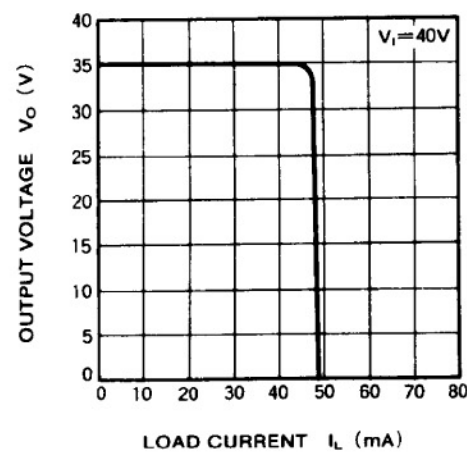
OUTPUT VOLTAGE REGULATION



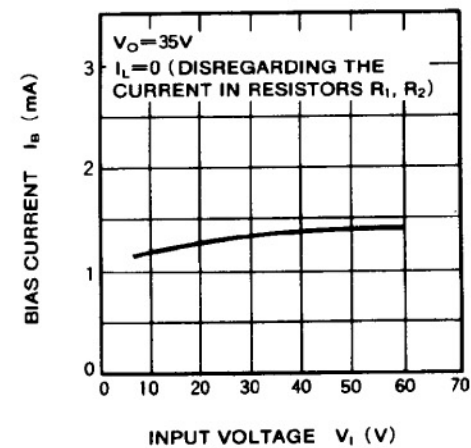
OUTPUT VOLTAGE CHARACTERISTICS



LOAD CHARACTERISTICS

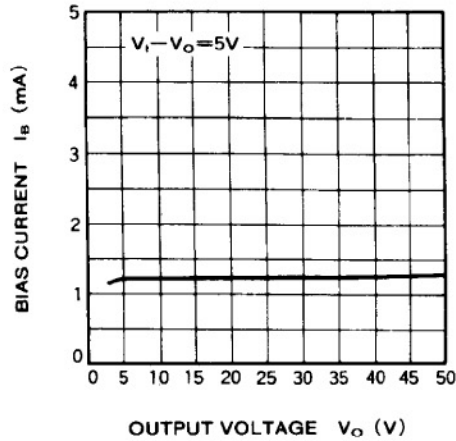


BIAS CURRENT VS. INPUT VOLTAGE

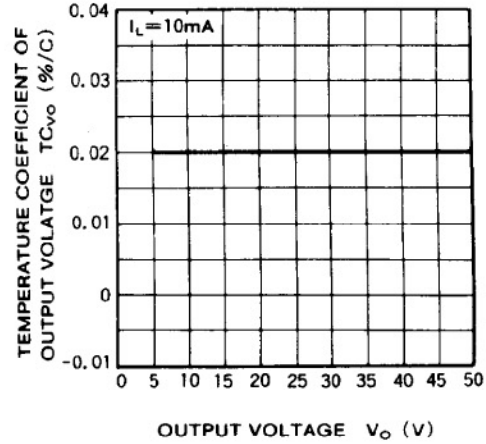


VARIABLE OUTPUT VOLTAGE REGULATOR

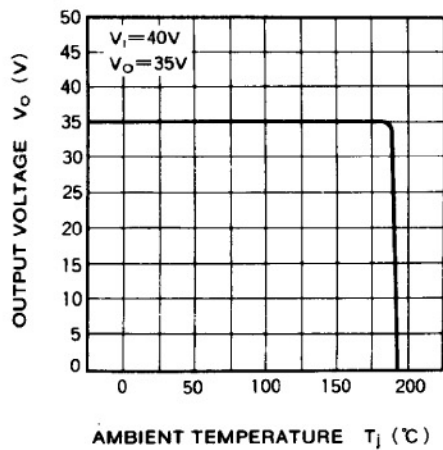
BIAS CURRENT VS. OUTPUT VOLTAGE



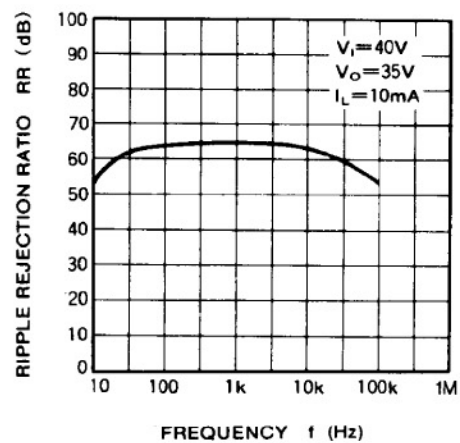
TEMPERATURE COEFFICIENT OF OUTPUT VOLTAGE VS. OUTPUT VOLTAGE CHARACTERISTICS



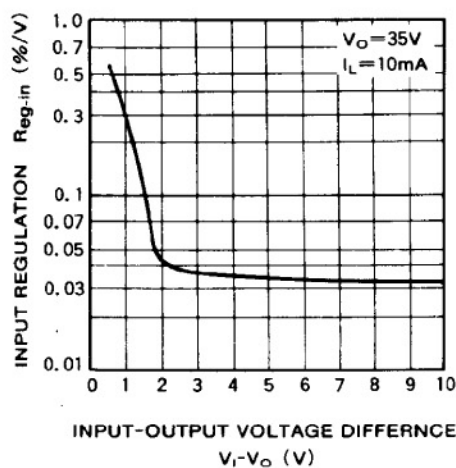
THERMAL CUTOFF



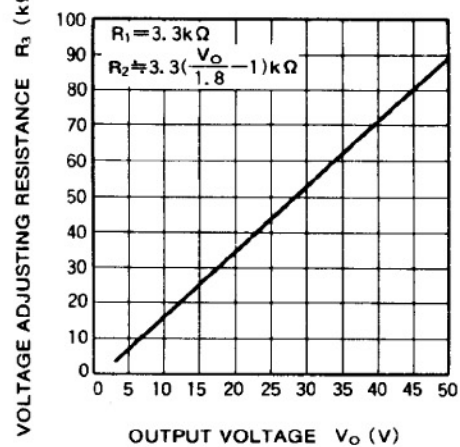
RIPPLE REJECTION



INPUT REGULATION VS. INPUT-OUTPUT VOLTAGE DIFFERENCE



VOLTAGE ADJUSTING RESISTANCE VS. OUTPUT VOLTAGE

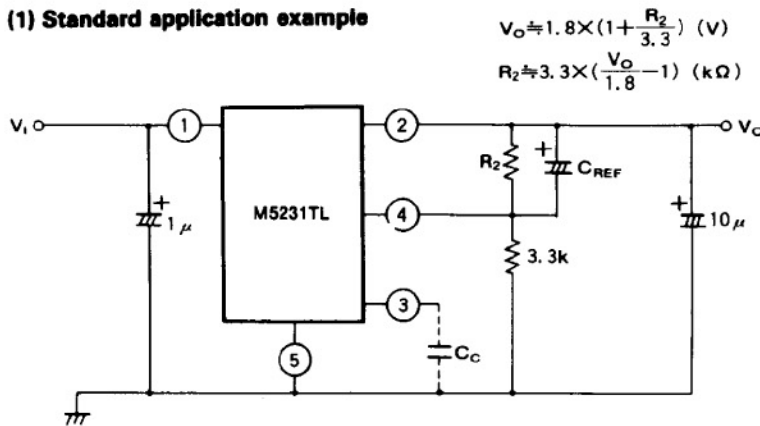


M5231TL

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_{REF}

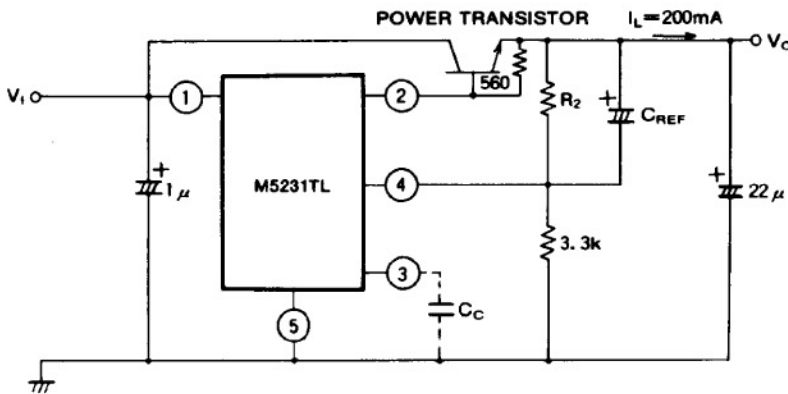
Connection of this capacitor gives the following characteristics.

- 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_C

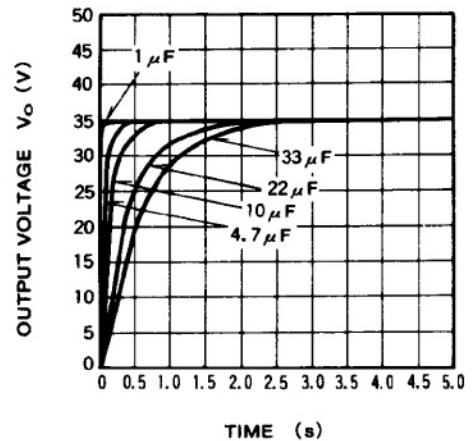
Compensation capability by connection of a capacitor.

(2) Current boost circuit with NPN external power TR

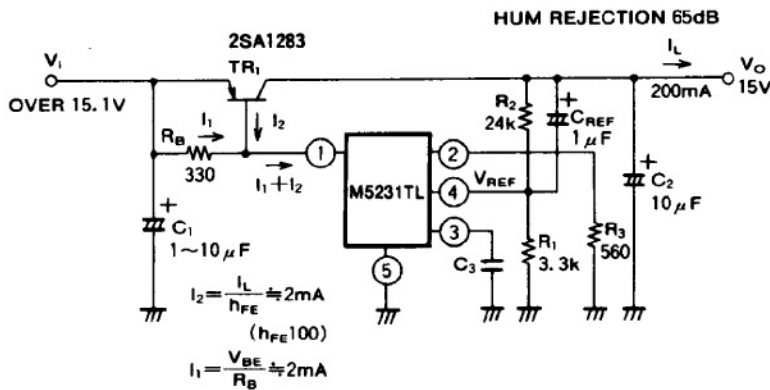


EXAMPLE 1 OF CHARACTERISTIC ACHIEVED

OUTPUT VOLTAGE CHARACTERISTICS FOR EXTERNAL CAPACITORS (C_{REF})



(3) Supper low dropout regulator circuits ($V_{IO}=100\text{mW}$)

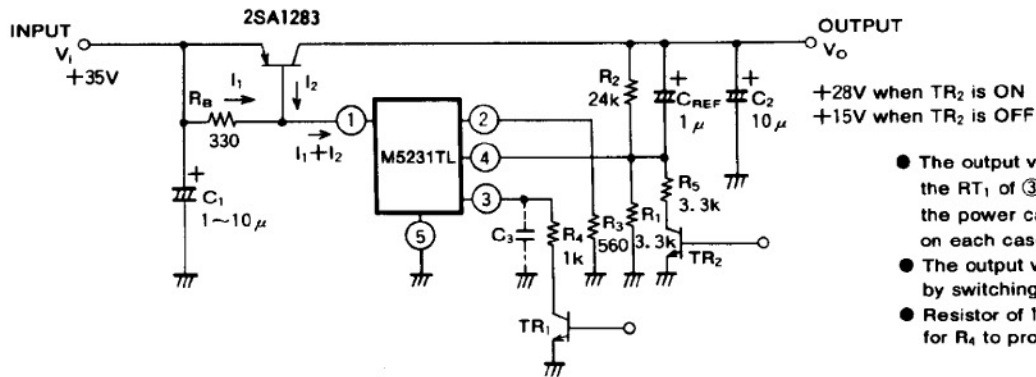


- Stable operation is expected even if the input-output voltage differences are as low as 0.1V. The heat sink of power TR can become small in size owing to low dissipation. The R_3 is a load current limit resistor and the input-output voltage differences between ① and ② pins must be over 3V. $V_I - V_{RE}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

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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.