# M5230L,FP

## VARIABLE OUTPUT VOLTAGE REGULATOR(DUAL TRACKING TYPE)

## DESCRIPTION

The M5230 is a semiconductor integrated circuit which is designed for variable output voltage regulator of dual tracking type.

It is housed in an 8-pin SIP and SOP. The output voltage can be adjusted over a wide range from ±3~±30V by adjusting the value of the voltage setting external resistors. By adjusting the resistance of the external balance setting resistors the positive/negative output voltage ratio can also be set freely. Again by attaching power transistors high current gains can be achieved, making the device suitable for use in the power supplies of a wide variety of equipment.

## FEATURES

- High input voltage ························ $V_I$=±35V
- Wide range of output voltage ················ $V_O$=±3~±30V
- Low output noise voltage ················ $V_{NO}$=12μVrms(typ.)
- Built-in current limiting and thermal shutdown circuit
- The output voltage rise time constant of the coefficients can be adjusted by the value of the external capacitor.
- Capability of operation control by the external control signal (Pin ⑧).

## APPLICATION

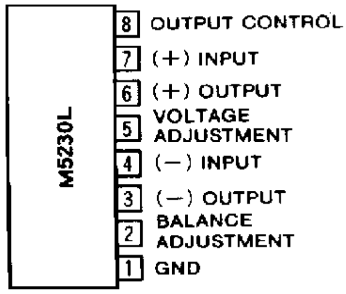
Dual voltage power supplies for stereo preamplifiers, for the power supplies of other equipment, including operational amplifiers.

## RECOMMENDED OPERATING CONDITIONS

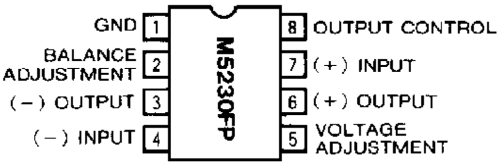
Supply voltage range ························ ±8~±35V

Rated supply voltage ························ ±20V

## PIN CONFIGURATION (TOP VIEW)

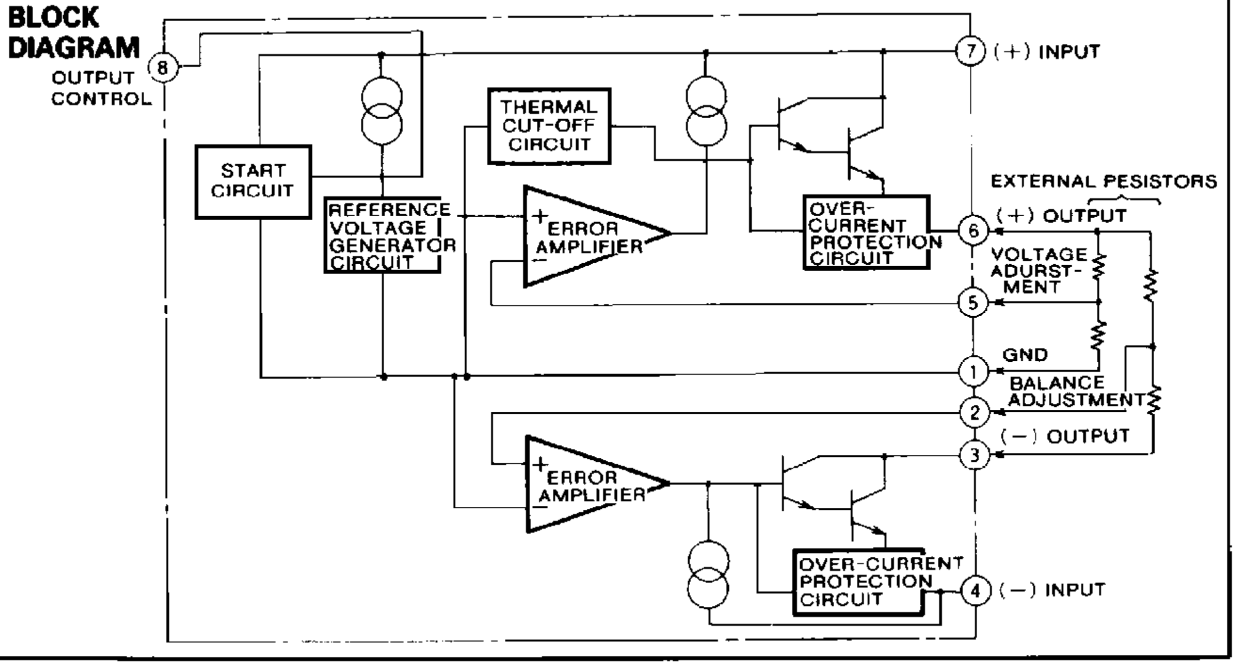



Outline 8P5




Outline 8P2S-A

## BLOCK DIAGRAM



**VARIABLE OUTPUT VOLTAGE REGULATOR(DUAL TRACKING TYPE)**

## ABSOLUTE MAXIMUM RATINGS ($T_a$=25℃)

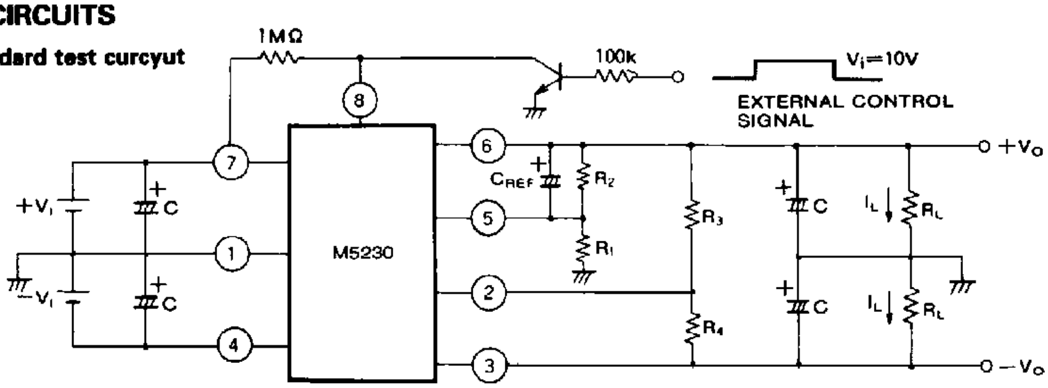
| Symbol | Parameter | Ratings | Unit |
|---|---|---|---|
| $V_i$ | Input voltage | ±35 | V |
| $I_L$ | Load current | ±30 | mA |
| $V_i-V_O$ | Input-output voltage difference | ±32 | V |
| $P_d$ | Power dissipation | 800(L)/440(FP) | mW |
| $T_{opr}$ | Ambient temperature | −20∼+75 | ℃ |
| $T_{stg}$ | Storage temperature | −55∼+125 | ℃ |

## ELECTTICAL CHARACTERISTICS (measurement circuit (a) is used with, $T_a$=25℃, $V_i$=±20V, $V_O$=±15V, $I_L$=10mA, C=10μF, $C_{REF}$=1μF, $R_1$=3.3kΩ)

| Symbol | Parameter | Test conditions | Limits | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| $V_i$ | Input voltage | | ±8 | | ±35 | V |
| $V_O$ | Output voltage | $R_2$≈1.5∼55kΩ | ±3 | | ±30 | V |
| $V_{REF}$ | Reference voltage | (between pin ⑤ and pin ①) | 1.66 | 1.8 | 1.95 | V |
| $V_i-V_O$ | Minimum input-output voltage difference | | | 2.5 | 3 | V |
| $\Delta V_O\pm$ | Dual voltage tracking | | | | 1 | % |
| $R_{eg\text{-}in}$ | Input regulation | $V_i$=±18∼±30V | | 0.02 | 0.1 | %/V |
| $R_{eg\text{-}L}$ | Load regulation | $I_L$=0∼20mA | | 0.02 | 0.1 | % |
| $I_B$ | Bias current | $I_L$=0 (disregarding the current in resistors $R_1$, $R_2$, $R_3$, $R_4$) | | 1.3 | 3.0 | mA |
| $TC_{VO}$ | Temperature coefficient of output voltage | $T_a$=0∼75℃, $V_O$=±3∼±30V | | 0.01 | | %/℃ |
| RR | Ripple rejection | f=120Hz(measured with circuit (b)) | | 68 | | dB |
| $V_{NO}$ | Output noise voltage | f=20Hz∼100kHz (between the output terminal and ground) | | 12 | | μVrms |
| $V_{O(OFF)}$ | Output cut-off voltage | $V_i$=10V | | | ±0.1 | V |

## TEST CIRCUITS

**(a) Stabdard test curcyut**



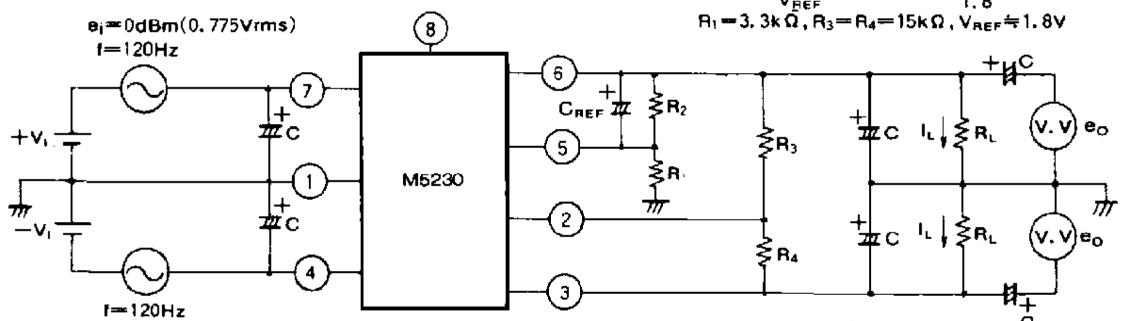

$$+V_O=V_{REF}(1+\frac{R_2}{R_1})\fallingdotseq 1.8\times(1+\frac{R_2}{3.3})\ (V)$$

$$-V_O=+V_O\cdot\frac{R_4}{R_3}(V)$$

$$R_2=R_1(\frac{V_O}{V_{REF}}-1)\fallingdotseq 3.3\times(\frac{+V_O}{1.8}-1)\ (k\Omega)$$

$R_1$=3.3kΩ, $R_3$=$R_4$=15kΩ, $V_{REF}$≒1.8V

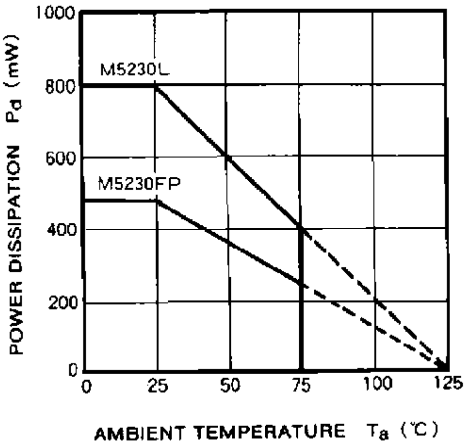
**(b) Ripple rejection test circuit**



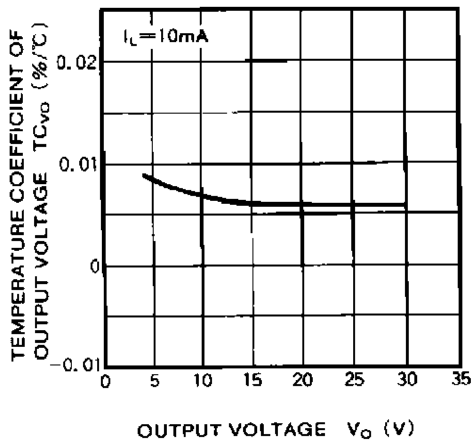

$$RR=20\log_{10}(\frac{e_i}{e_O})\ (dB)$$

## TYPICAL CHARACTERISTICS

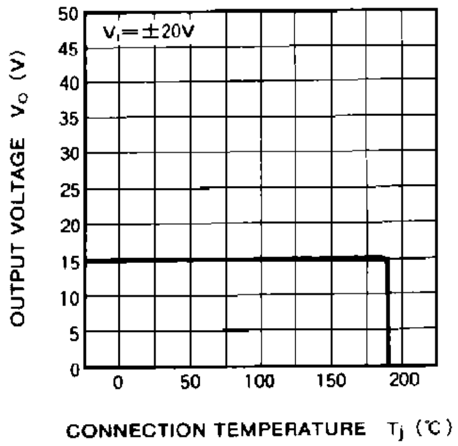
**THERMAL DERATING (MAXIMUM RATING)**



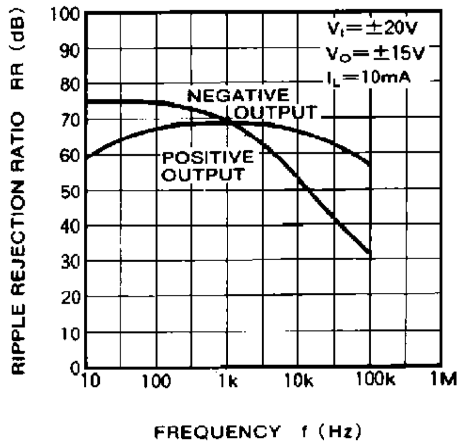

**TEMPERATURE COEFFICIENT OF OUTPUT VOLTAGE VS. OUTPUT VOLTAGE CHARACTERISTICS**



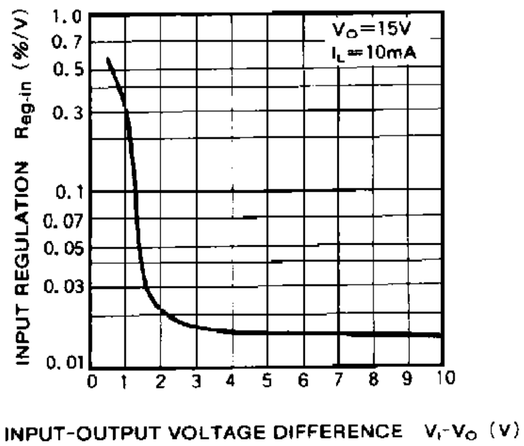

**THERMAL CUTOFF**



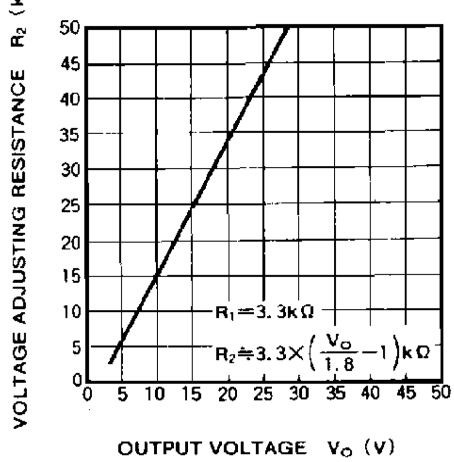

**RIPPLE ERJECTION**




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

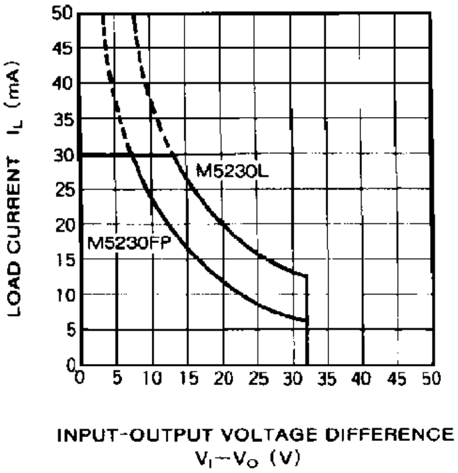



**VOLTAGE ADJUSTION RESISTANCE VS. OUTPUT VOLTAGE**

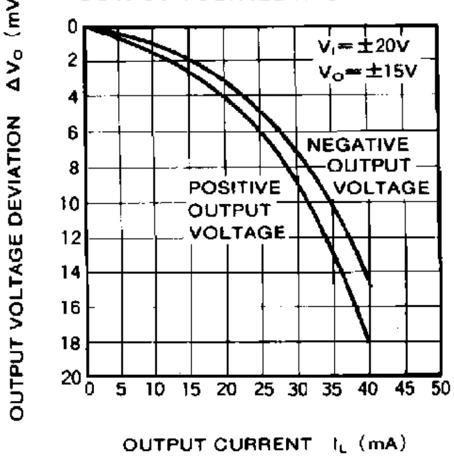


## VARIABLE OUTPUT VOLTAGE REGULATOR(DUAL TRACKING TYPE)

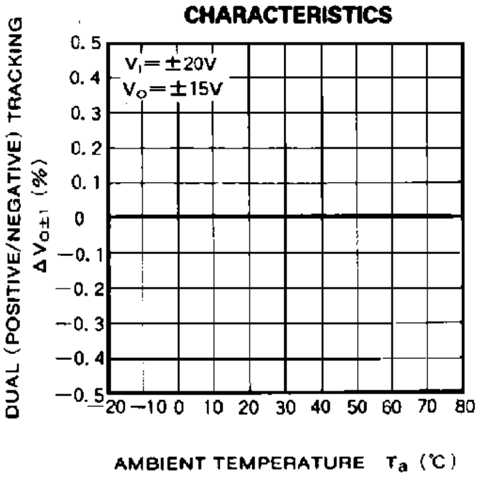
### LOAD CURRENT VS. INPUT-OUTPUT VOLTAGE DIFFERENCE



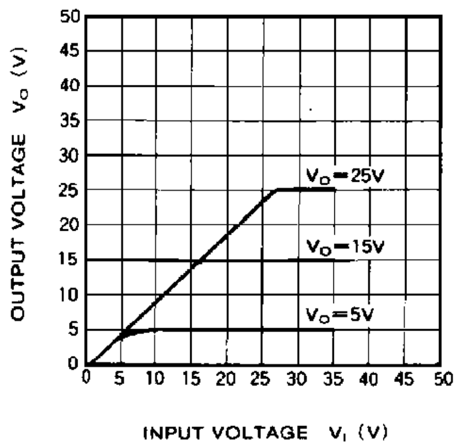

### OUTPUT VOLTAGE REGULATION



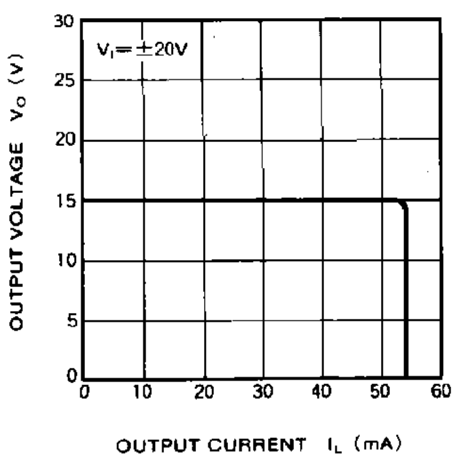

### DUAL-TRACKING TEMPERATURE CHARACTERISTICS



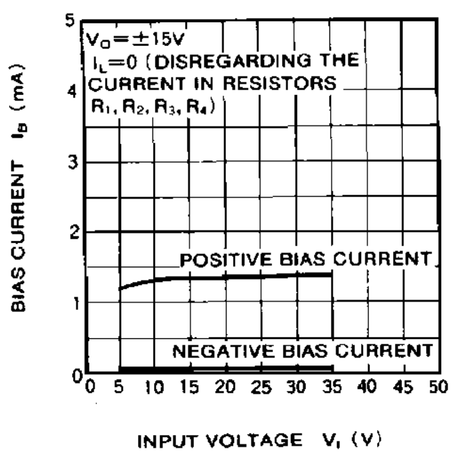

### OUTPUT VOLTAGE CHARACTERISTICS




### LOAD CHARACTERISTICS




### BIAS CURRENT VS. INPUT VOLTAGE



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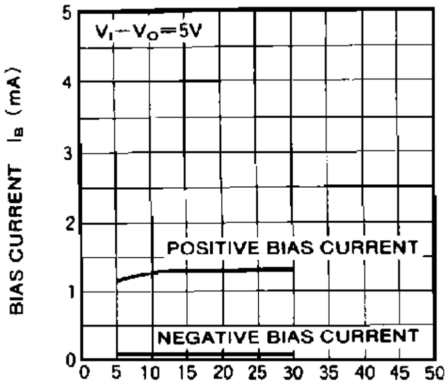
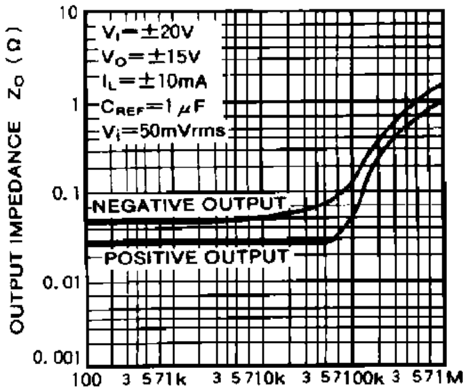
BIAS CURRENT VS. OUTPUT VOLTAGE

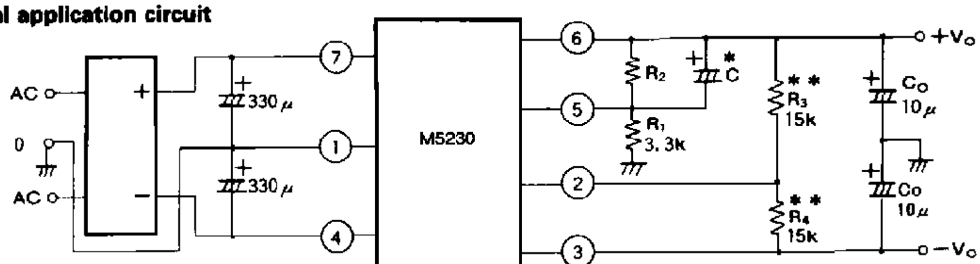



OUTPUT IMPEDANCE VS. FREQUENCY




## APPLICATION EXAMPLES

### (1) Typical application circuit




$+V_O \fallingdotseq 1.8 \times (1 + \frac{R_2}{3.3})$ (V)

$R_2 \fallingdotseq 3.3 \times (\frac{V_O}{1.8} - 1)$ (kΩ) $\quad -V_O = (+V_O) \cdot \frac{R_4}{R_3}$ (V)

Note: When the input power supply lines become long, a 0.1 μF capacitor should be connected between input power supply pins ⑦ and ④ and ground.

Unit Resistance : Ω
Capacitance : F

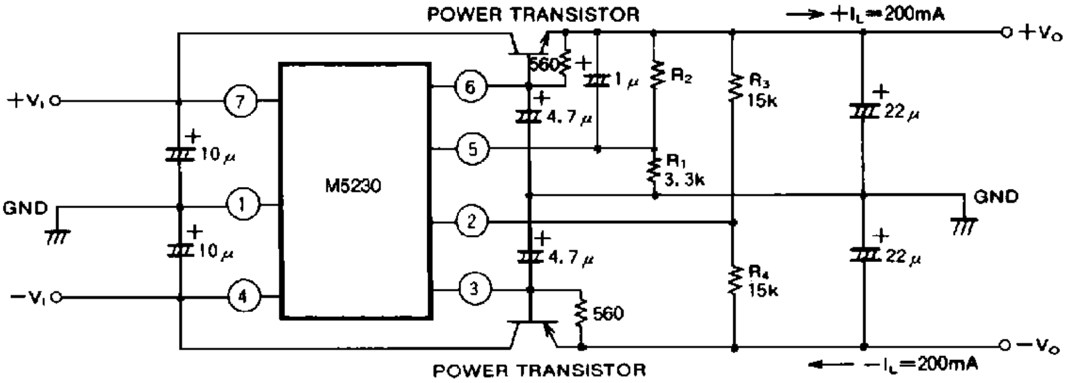
***C**

Connection of this capacitor gives the following characteristics.
1) The rise time constant of the output voltage can be adjusted (slowed) (See Fig. 1)
2) The ripple rejection ration is improved.
3) Noise output voltage is reduced.

****$R_3$, $R_4$**

By changing the ratio of these two resistances the positive/negative voltage ratio can also be set freely. (See Fig. 2)

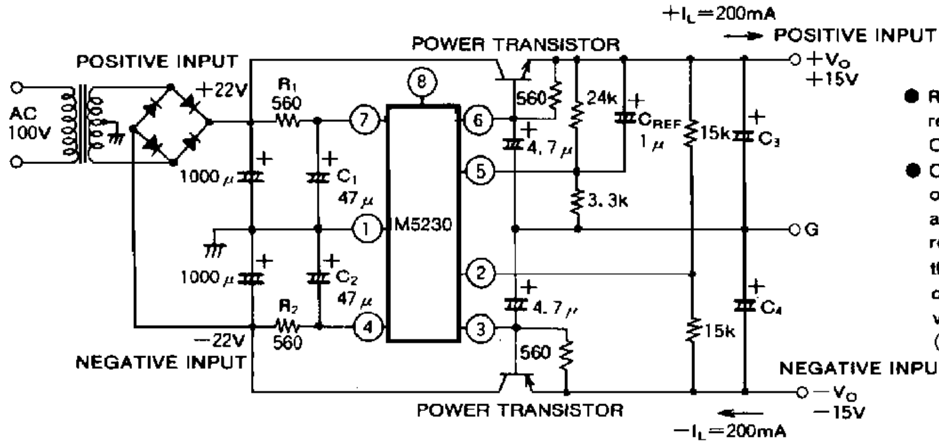
### (2) Typical application circuit with power transistors connected




Unit Resistance : Ω
Capacitance : F

## VARIABLE OUTPUT VOLTAGE REGULATOR(DUAL TRACKING TYPE)

**(3) High ripple rejection circuit (80dB)**

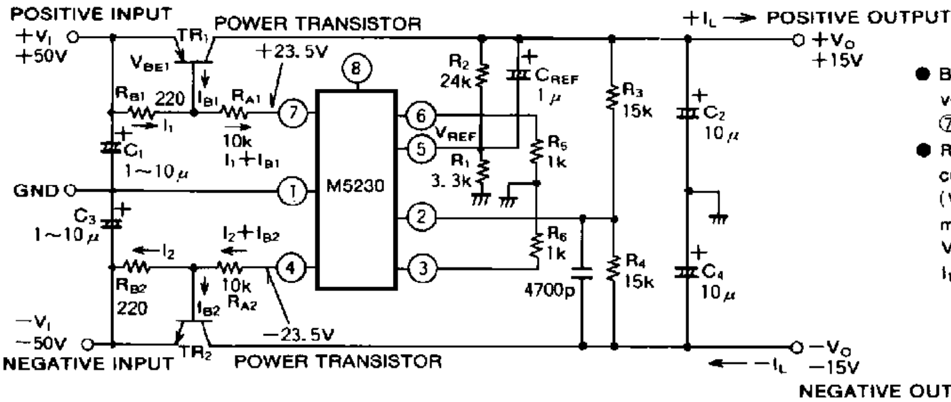



- Ripple regained by the input resistance $R_1$, ($R_2$), and capacitor $C_1$, ($C_2$).
- $C_{REF}$ can reduce noise to the 1/10 of that of 3 Terminal regulator IC, and also can inprove the ripple rejection. In addition, by increasing the capacitance of the $C_{REF}$, the constant at set-up of the output voltage $V_O$ can be adjusted. (Soft set-up enable).

Unit Resistance : Ω
Capacitance : F

**(4) High input voltage ($V_I = \pm 50V$)**

RIPPLE REJECTION 65dB

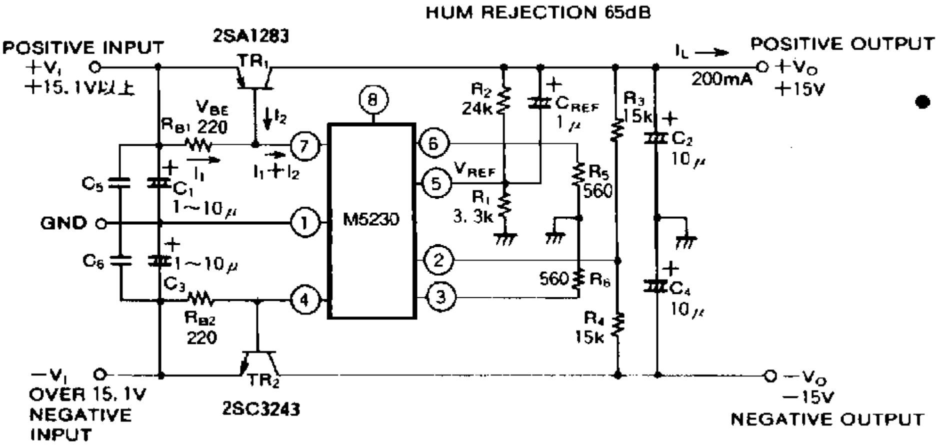



- By the resistance $R_{A1}$, ($R_{A2}$), the voltage that will be supplied to pins ⑦, ④ can be lower.
- Resistanves $R_5$ and $R_6$ are for load current limit. Keep the I/O voltage ($V_{IO}$) difference between ⑦-⑥ more than 6V.
  $V_I - V_{BE} - (I_1 + I_{B1} - I_B)R_5 > 3V$
  $I_1 = V_{BE}/R_{B1}$, $I_{B1} = I_L/h_{FE}$

Unit Resistance : Ω
Capacitance : F

**(5) Supper low dropout regulator circuit ($V_{IO}$=100mW)**

HUM REJECTION 65dB




- Stable operations are expected even if the input-output voltage differinces are quite low as 0.1V. The heat sink of power TR can become small in size owing to the low dissipation.

Unit Resistance : Ω
Capacitance : F

(Note) The load current can be over 1A by connecting the external power TR.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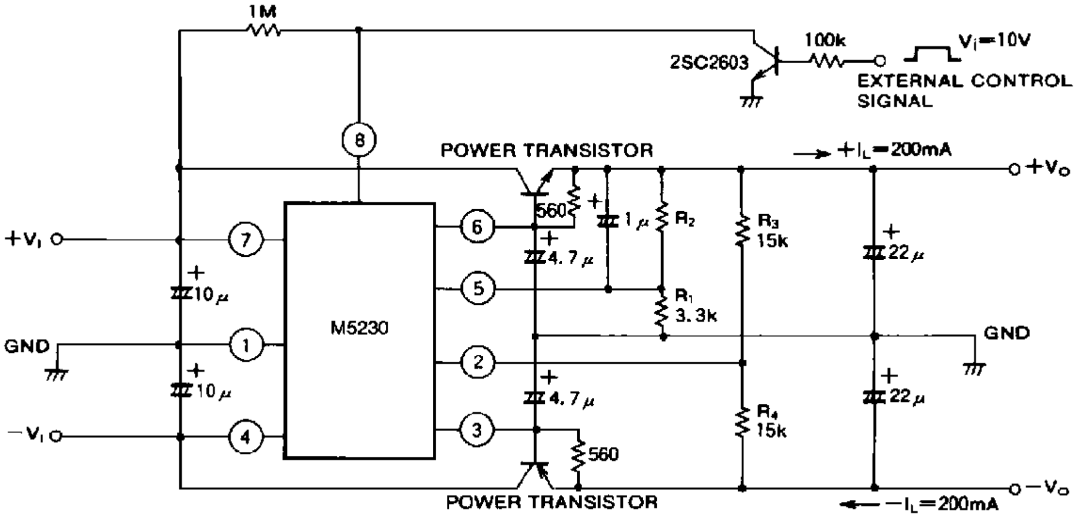
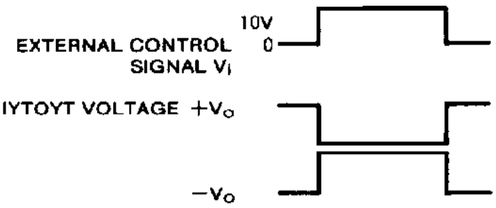
**(6) ON/OFF control of output voltage circuit**




Unit Resistance : Ω
Capacitance : F

## EXAMPLES OF THE CHARACTERISTICS ACHIEVED

**Fig. 1 OUPUT VOLTAGE CHARACTERISTICS FOR EXTERNAL CAPACITORS (*C)**

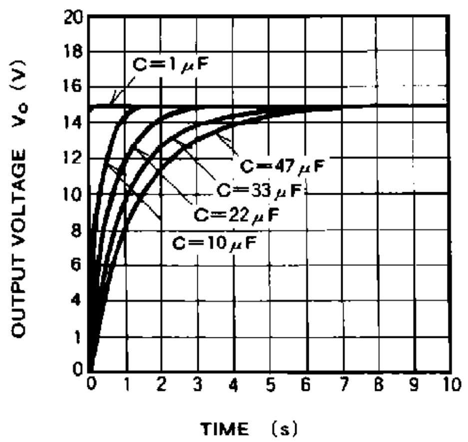



**Fig. 2 OUTPUT VOLTAGE RATIO VS. BALNCE VOLTAGE ADJUSTING RESISTANCE CHARACTERISTICS**