

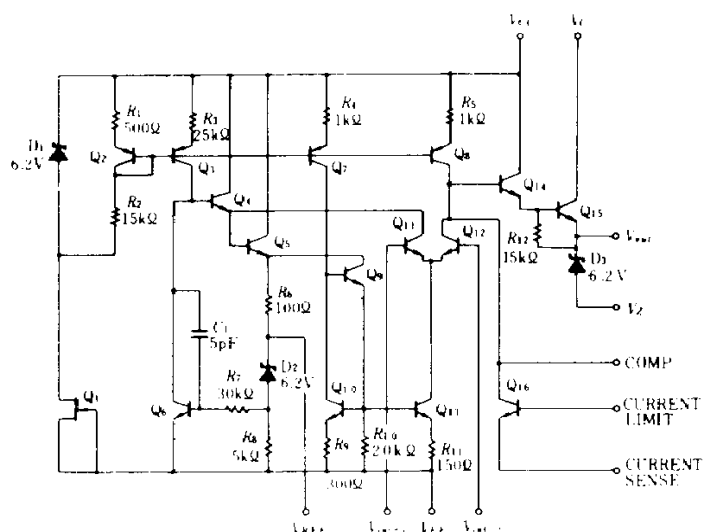
# HA17723G, HA17723 ● Voltage Regulator

HA17723, high accuracy voltage regulator for general purposes, features low stand-by current — quiescent current, low temperature drift and high ripple rejection ratio.

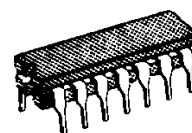
Output current above 150mA is also available by adding PNP or NPN transistors externally. This voltage regulator finds wide application, using in series, parallel and as switches.

Industrial Use . . . . . HA17723G  
Commercial Use . . . . . HA17723

## ■ CIRCUIT SCHEMATIC

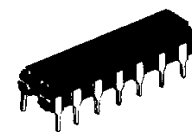


HA17723G



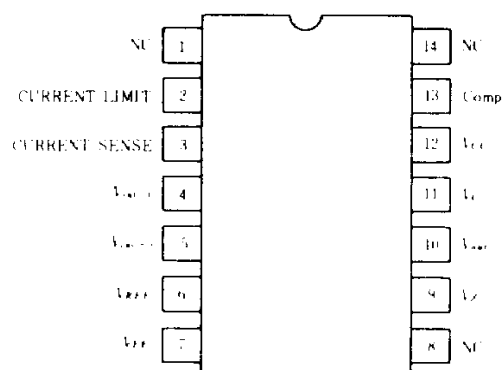
(DG-14)

HA17723



(DP-14)

## ■ PIN ARRANGEMENT



(Top View)

# **■ ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)**

Item	Symbol	HA17723G	HA17723	Unit
Supply Voltage	$V_{CC}$	40	40	V
Input/Output Voltage Differential	$V_{DIFF(1X/0)}$	40	40	V
Differential Input Voltage	$V_{in\_diff}$	$\pm 5$	$\pm 5$	V
Maximum Output Current	$I_{out}$	150	150	mA
Current from $V_{REF}$	$I_{REF}$	15	15	mA
Power Dissipation*	$P_D$	950*	830**	mW
Operating Temperature	$T_{OP}$	-20 to +75	0 to +70	°C
Storage Temperature	$T_{stg}$	-65 to +150	-55 to +125	°C

\* Derating above 25°C will be 7.6mW/°C

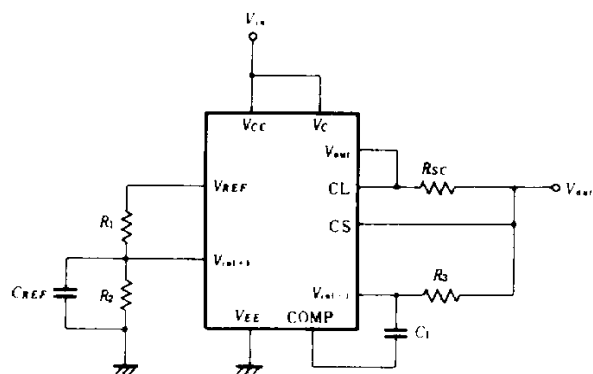
\*\* Derating above 25°C will be 8.3mW/°C

# **■ ELECTRICAL CHARACTERISTICS (Ta = 25°C)**

Item	Symbol	Test Conditions	min	typ	max	Unit
Line Regulation	$\delta V_{OL\_line}$	$V_{in} = 12$ to 15V	—	0.01	0.1	%
		$V_{in} = 12$ to 40V	—	0.1	0.5	%
		$V_{in} = 12$ to 15V, $T_a = -20$ to +75°C	—	—	0.4	%
		$V_{in} = 12$ to 15V, $T_a = 0$ to +70°C	—	—	0.3	%
Load Regulation	$\delta V_{OL\_load}$	$I_{out} = 1$ to 50mA	—	0.03	0.2	%
		$I_{out} = 1$ to 50mA $T_a = -20$ to +75°C	—	—	0.7	%
		$I_{out} = 1$ to 50mA $T_a = 0$ to +70°C	—	—	0.6	%
Ripple Rejection	$R_{REF}$	$f = 50\text{Hz}$ to 1kHz	—	74	—	dB
		$C_{REF} = 0$ $C_{REF} = 5\mu\text{F}$		86	—	dB
Average Temperature Coefficient of Output Voltage	$\delta V_{OL}/\delta T$	$T_a = -20$ to +75°C	—	0.003	0.018	%/°C
		$T_a = 0$ to +70°C	—	0.003	0.015	%/°C
Reference Voltage	$V_{REF}$	$V_{in} = V_{CC} = V_C = 12\text{V}$ , $V_{EE} = 0$	6.80	7.15	7.50	V
Standby Current	$I_{ST}$	$V_{in} = 30\text{V}$ , $I_L = 0$	—	—	4.0	mA
Short Circuit Current Limit	$I_{SC}$	$R_{SC} = 10\Omega$ , $V_{out} = 0$	—	65	—	mA

\*HA17723G Only

## ELECTRICAL CHARACTERISTICS MEASURING CIRCUIT



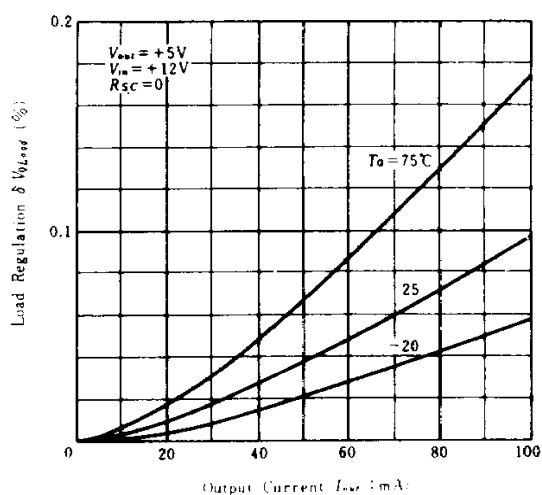
$$V_{in} = V_{CC} - V_F = 12V, V_{EE} = 0$$

$$V_{out} = 5.0V, I_L = 1mA$$

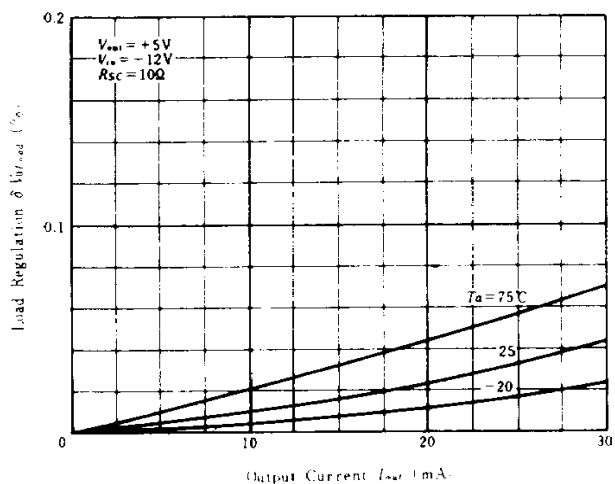
$$R_{SC} = 0, C_1 = 100pF, C_{REF} = 0$$

$$R_2 \approx 5k\Omega, R_3 = R_1 R_2 / (R_1 + R_2)$$

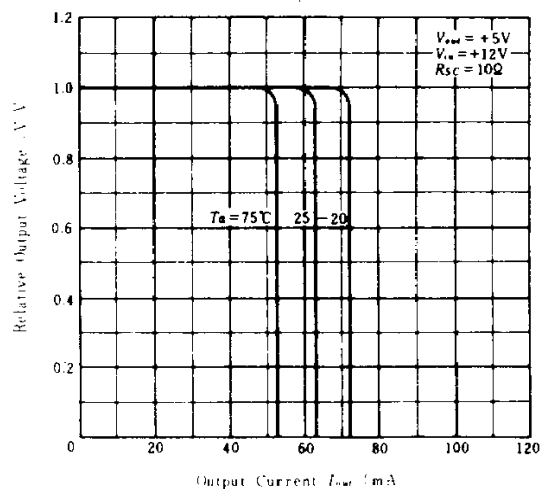
### LOAD REGULATION VS. OUTPUT CURRENT-1



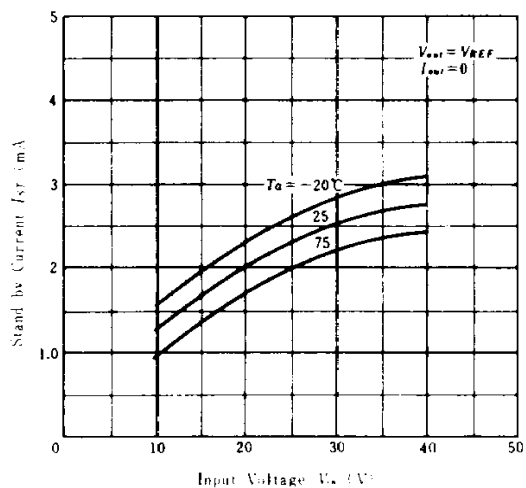
### LOAD REGULATION VS. OUTPUT CURRENT-2



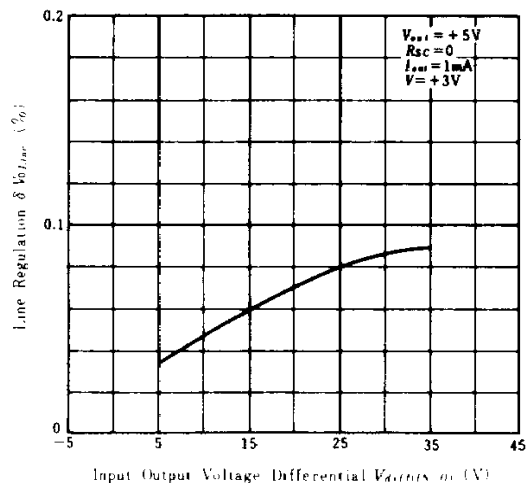
### RELATIVE OUTPUT VS. OUTPUT CURRENT VOLTAGE



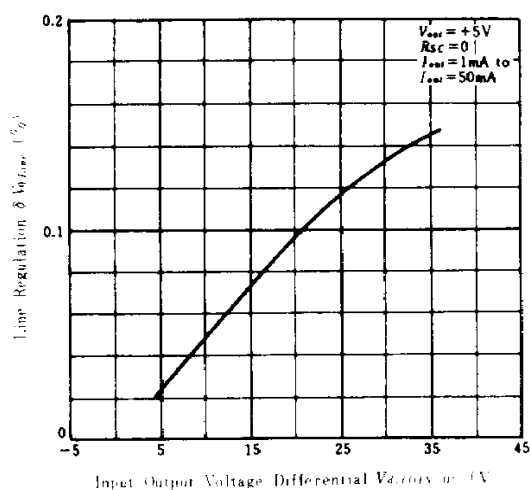
## STAND-BY CURRENT VS. INPUT VOLTAGE



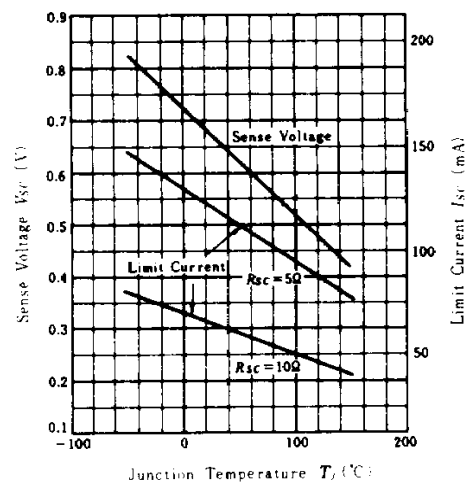
## LINE REGULATION VS. INPUT/OUTPUT VOLTAGE DIFFERENTIAL



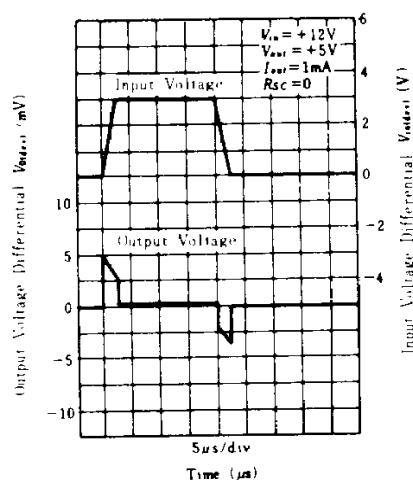
## LINE REGULATION VS. INPUT/OUTPUT VOLTAGE DIFFERENTIAL



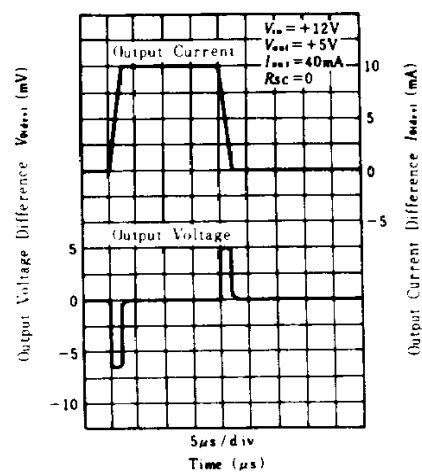
## CURRENT LIMITING CHARACTERISTICS



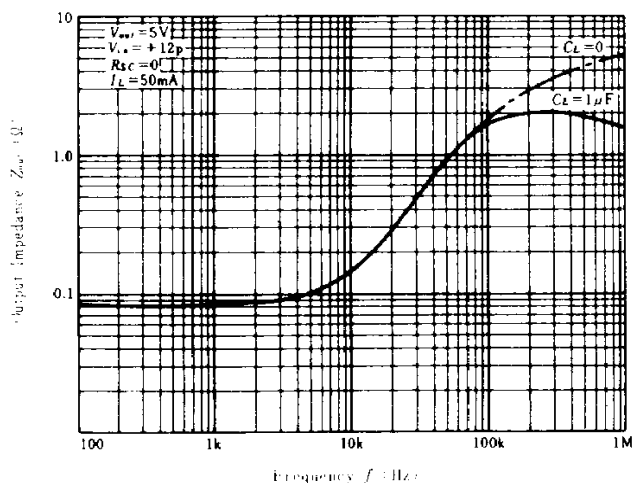
## LINE TRANSIENT RESPONSE



## LOAD TRANSIENT RESPONSE



### OUTPUT IMPEDANCE VS. FREQUENCY



Thus output voltage  $V_{out}$  is:

$$V_{out} = \frac{V_{REF}}{n} \quad n = \frac{R_2}{R_1 + R_2} \quad \dots \dots \dots (2)$$

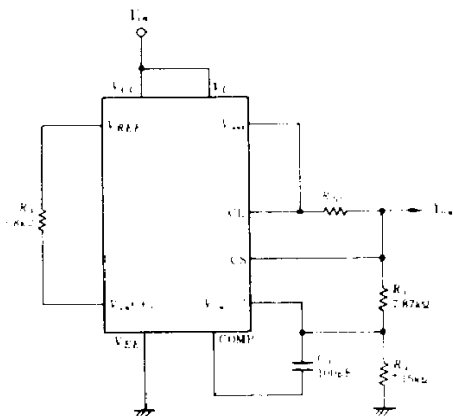


Fig.2 High Voltage (7 to 37V) Regulator

## HA17723, APPLICATIONS

HA17723 is high accuracy voltage regulator for general purposes and may be used as voltage sources in various types.

### 1. Fixed Voltage Source in Series

#### 1.1 Low Voltage, 2 to 7 volts, Regulator

Fig. 1 shows the construction of a basic low voltage regulator. The divider by resistors  $R_1$  and  $R_2$  from  $V_{REF}$  is to make the reference voltage which will be provided to non-inverted input of the error amplifier, be less than output voltage. In the fixed voltage source where the output voltage will be fed back to the error amplifier directly as shown in Fig. 1. Output voltage will be divided  $V_{REF}$  since the output voltage is equal to the reference voltage.

Thus, the output voltage  $V_{out}$  is;

$$V_{out} = nV_{REF}, \quad n = \frac{R_2}{R_1 + R_2} \quad \dots \dots \dots (1)$$

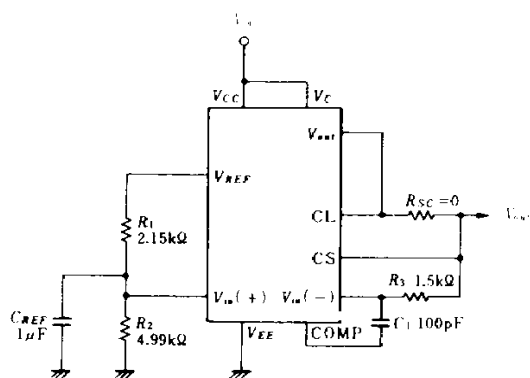


Fig.1 Low Voltage (2 to 7V) Regulator

#### 1.2 High Voltage, 7 to 37V, Regulator

Fig. 2 shows the construction of a regulator when output voltage is higher than the reference voltage,  $V_{REF}$ . The  $V_{REF}$  shall be added to the non-inverted input of the error amplifier via a resistor,  $R_3$ . The feedback voltage is available by dividing the output voltage with resistors  $R_1$  and  $R_2$ .

### 1.3 Negative Voltage Regulator

Fig. 3 shows the construction of a so-called negative voltage regulator which generates negative output voltage with regard to the GND. Assuming that the output voltage,  $-V_{OUT}$  increased in the negative directions. As the voltage across the  $R_1$  is larger than that across the  $R_3$  which provides the reference voltage, output current of the error amplifier increases. In the control circuit, the impedance decreases with increase of input current, which makes the base current of the external transistor Q approach to the potential at GND. As the results, the output voltage returns to the established value and stable output voltage is available.

The output voltage  $-V_{OUT}$  in this circuit is;

$$-V_{out} = - \left( \frac{R_1 + R_2}{R_3 + R_4} \times \frac{R_3}{R_1} \right) V_{REF} \\ = - \frac{(R_1 + R_2) \cdot (R_3 + R_4)}{R_2 \cdot (R_3 + R_4)} \times \frac{R_3}{R_1 \cdot (R_1 + R_2)} \times \frac{R_4}{R_3 + R_4} V_{REF} \quad \dots \dots \dots (2)$$

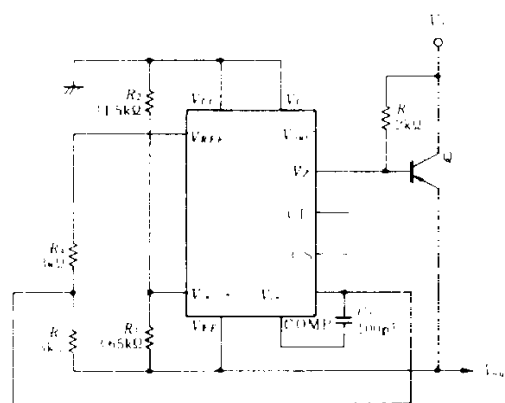


Fig.3 Negative Voltage Regulator

### 1.4 How to Increase the Output Current

It is necessary for increase of output current to increase the current capacitance in the control-circuit. Fig. 4 and Fig. 5 show examples, where transistors are externally added.

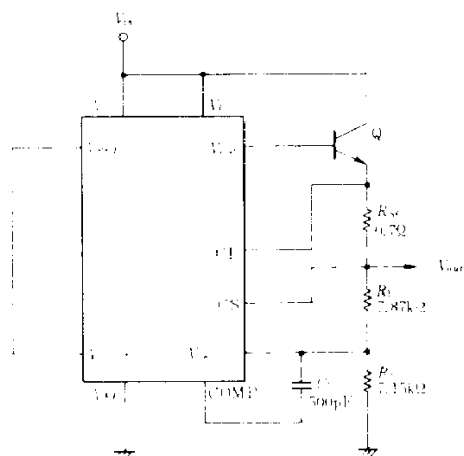


Fig.4 Method to Increase Output Current (1)

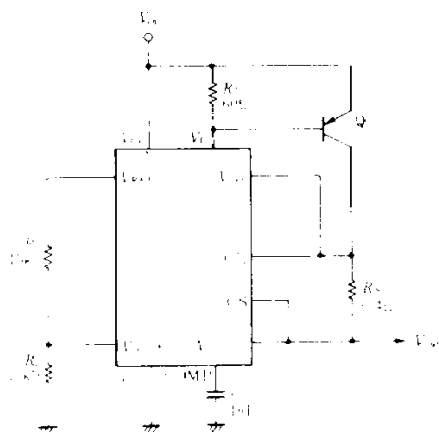


Fig.5 Method to Increase Output Current (2)

### 2. Fixed Voltage Source in Parallel Control

Fig. 6 shows the circuit of fixed voltage source in parallel control.

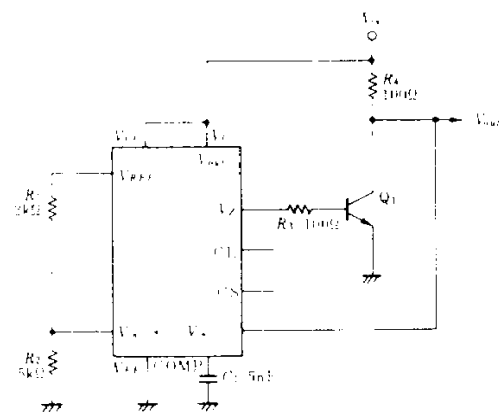


Fig.6 Fixed Voltage Source in Parallel Control

### 3. Switching Regulator

Fig. 7 shows the circuit of a switching regulator. The error amplifier, control circuit and forward feedback circuit  $R_4$  and  $R_5$  operate in together as a comparator, and make the external transistors  $Q_1$  and  $Q_2$  operate as switching elements to turn ON/OFF. In this circuit, the self-oscillation stabilizes the output voltage and the change in output is absorbed by the changes of conducted period of switches.

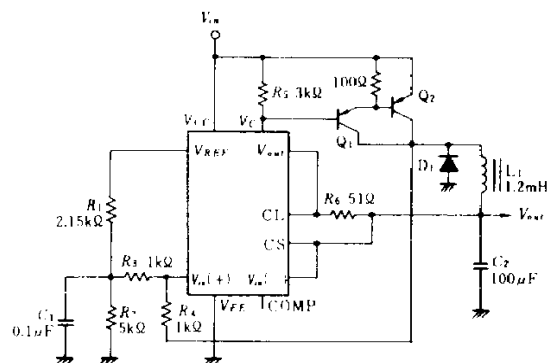


Fig.7 Positive Voltage Switching Regulator

Fig. 8 and Fig. 9 show the circuit of negative voltage switching regulator and its characteristics.

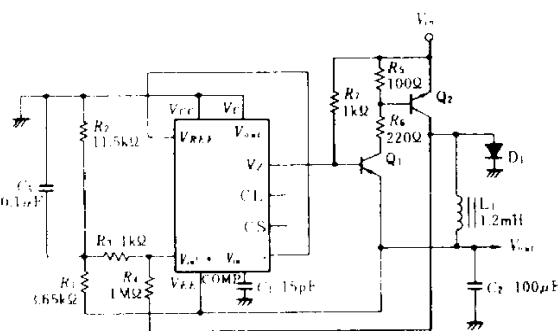


Fig.8 Negative Voltage Switching Regulator

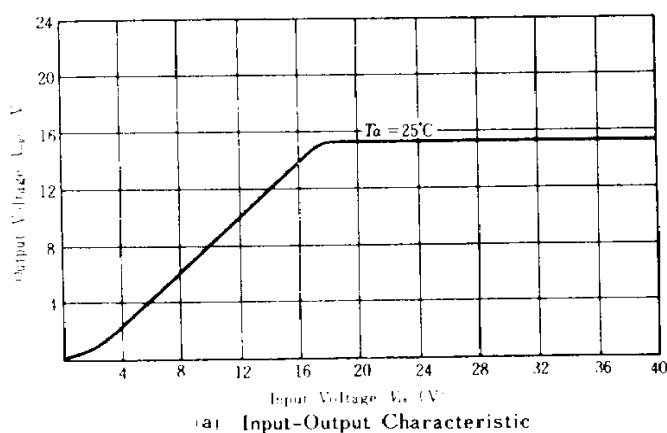
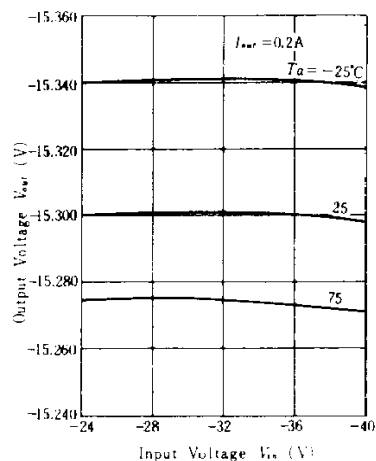
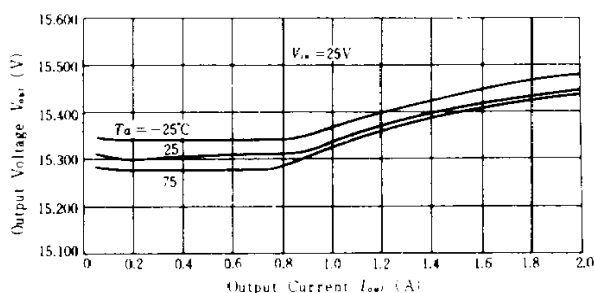


Fig.9 Operating Characteristics of Negative Voltage Switching Regulator



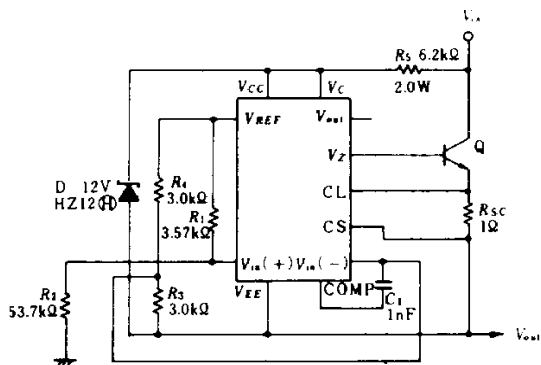
(b) Line Regulation



(c) Load Regulation

**Fig.9 Operating Characteristics of Negative Voltage Switching Regulator****4. Fixed Voltage Source in Floating Type**

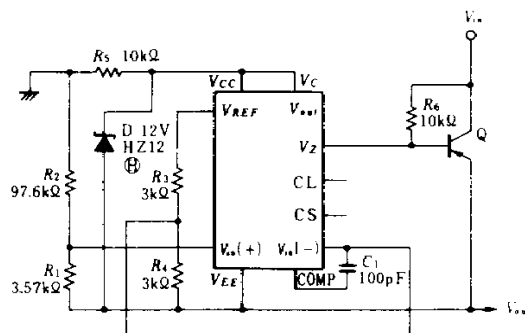
Voltage sources in floating type or boost type are typically employed when high voltage output is required. Fig. 10 shows the circuit of a fixed voltage source in the floating type. For considering the stabilization in this circuit, assuming that the output voltage increased. At the input terminal of the error amplifier, non-inverted input will become low compared with inverted input, and the output current of the error amplifier decrease. Then, the current from the terminal  $V_2$  in the control circuit decrease. As the results, the base current of the external resistor  $Q_1$  will decrease and collector current will decrease, resulting to control increase-ment of the output voltage.

**Fig.10 Positive Voltage Floating Regulator**

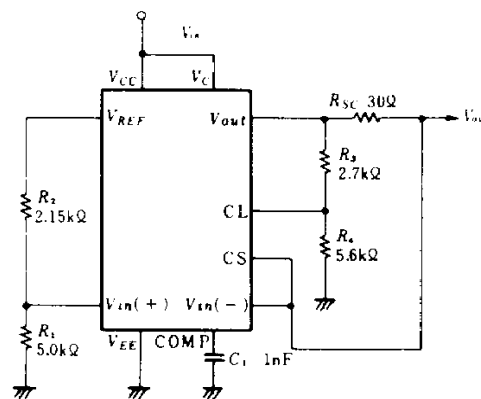
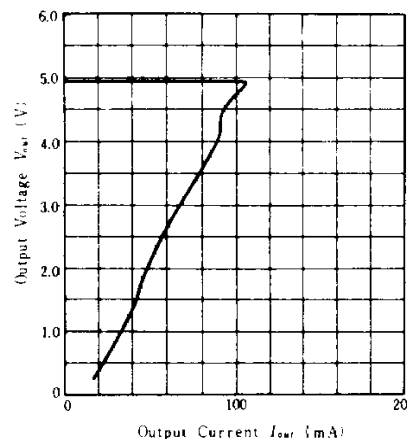
The output voltage  $V_{out}$  in the circuit, Fig. 10 is;

$$V_{out} = \left( \frac{R_1 + R_2}{R_3 + R_4} \times \frac{R_4}{R_1} - 1 \right) V_{REF} \quad \dots\dots\dots (3)$$

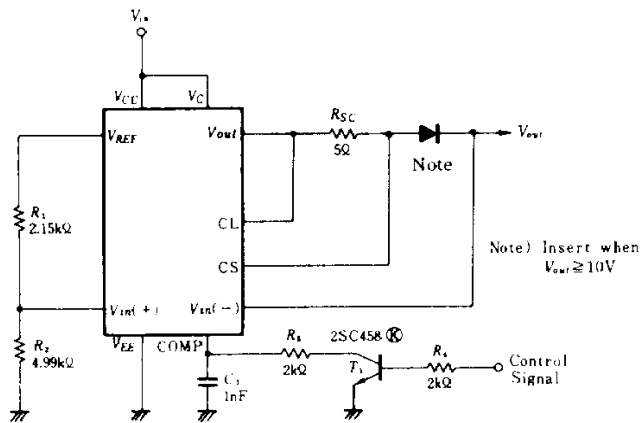
Fig. 11 shows the circuit diagram of the negative fixed voltage source in floating type.

**Fig.11 Negative Voltage Floating Regulator****5. Other Applications**

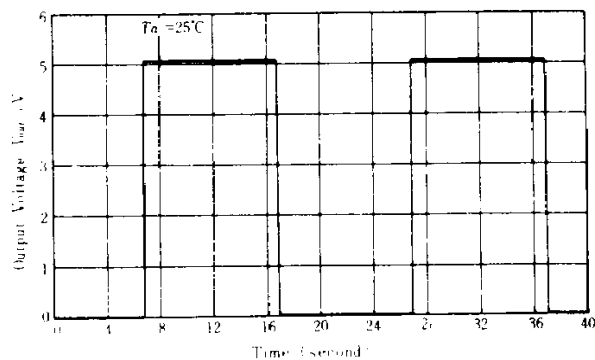
Other applications are follows.

**5.1 Fixed Voltage Source with Reduction Type Current Limiter****Fig.12 Fixed Voltage Source with Reduction Type Current Limiter****Fig.13 Current Control Characteristics of Fixed Voltage Source with Reduction Type Current Limiter**

## 5.2 Fixed Voltage Source Turning ON/OFF External Control



**Fig.14 Fixed Voltage Source Turning ON/OFF External Control**



**Fig.15 Operating Characteristics of Fixed Voltage Source Turning ON/OFF External Control**