

HA17723/F/P

Precision Voltage Regulator

HITACHI

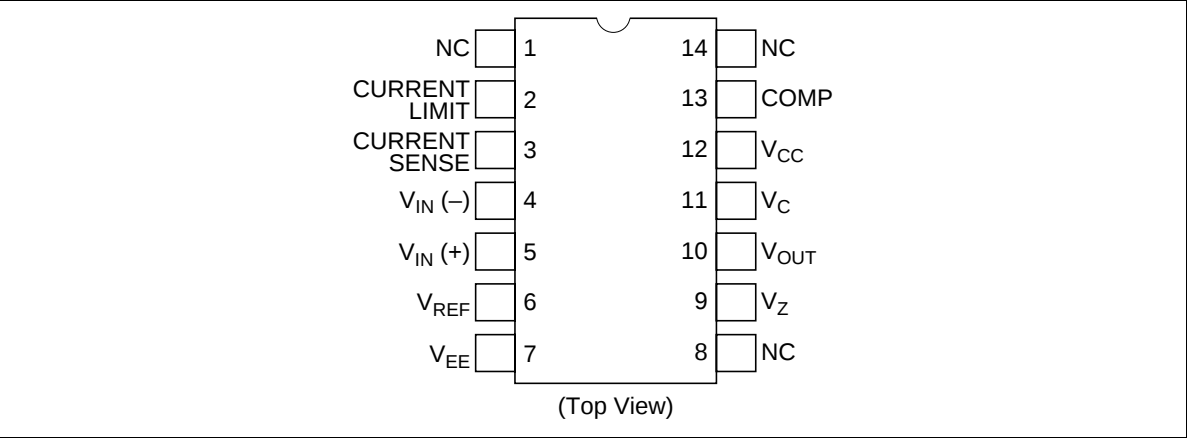
Description

The HA17723 high-accuracy general-purpose voltage regulator features a very low stand-by current, (quiescent current) a low temperature drift, and high ripple rejection ratio. If you need over than 150mA output current, adding external PNP or NPN transistor. This voltage regulator is suitable for various applications, for example, series or parallel regulator, switching regulator.

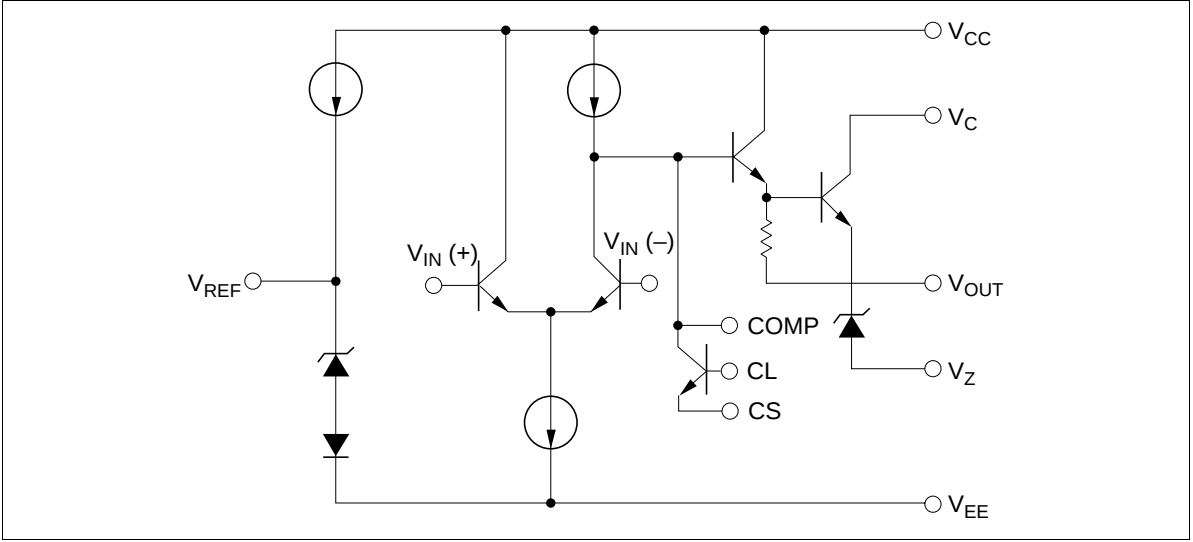
Ordering Information

Type No.	Application	Package
HA17723	Commercial use	DP-14
HA17723F		FP-14DA
HA17723P	Industrial use	DP-14

Pin Arrangement



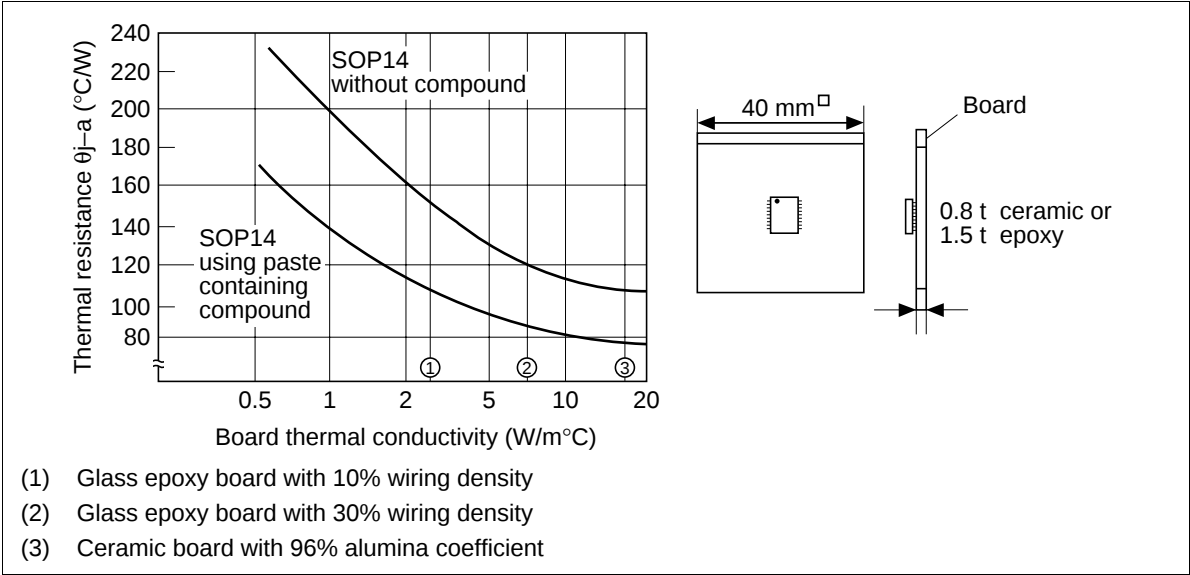
Circuit Schematic



Absolute Maximum Ratings (Ta = 25°C)

Item	Symbol	HA17723/P	HA17723F	Unit
Supply voltage	VCC	40	40	V
Input/Output voltage differential	Vdiff (IN-O)	40	40	V
Differential input voltage	V _{IN} (diff)	±5	±5	V
Maximum output current	I _{OUT}	150	150	mA
Current from VREF	I _{REF}	15	15	mA
Power dissipation	P _T	830 (Note 1)	625 (Note 2)	mW
Operating temperature	Topr	0 to +70 / -20 to +75	0 to +70	°C
Storage temperature	Tstg	-55 to +125	-55 to +125	°C

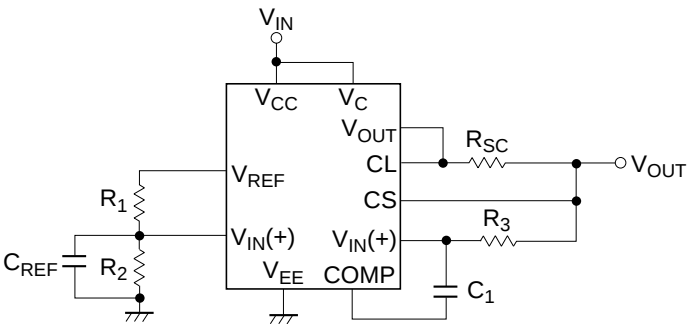
- Notes: 1. Above 25°C derate by 8.3mW/°C
2. Allowable temperature of IC junction part, Tj (max), is as shown below.
- Tj (max) = $\theta_j - a \cdot P_c$ (max)+Ta
- ($\theta_j - a$ is thermal resistance value during mounting, and Pc (max) is the maximum value of IC power dissipation.)
- Therefore, to keep Tj (max) ≤ 125°C, wiring density and board material must be selected according to the board thermal conductivity ratio shown below.
- Be careful that the value of Pc (max) does not exceed that P_T.



Electrical Characteristics (Ta = 25°C)

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Line regulation	δV_O Line	—	0.01	0.1	%	$V_{IN} = 12$ to $15V$
		—	0.1	0.5	%	$V_{IN} = 12$ to $40V$
		—	—	0.4	%	$V_{IN} = 12$ to $15V$, $T_A = -20$ to $+75^{\circ}C$
		—	—	0.3	%	$V_{IN} = 12$ to $15V$, $T_a = 0$ to $+70^{\circ}C$
Load regulation	δV_O Load	—	0.03	0.2	%	$I_{OUT} = 1$ to $50mA$
		—	—	0.7	%	$V_{IN} = 12$ to $15V$, $T_A = -20$ to $+75^{\circ}C$
		—	—	0.6	%	$I_{OUT} = 1$ to $50mA$, $T_a = 0$ to $+70^{\circ}C$
Ripple rejection	R_{REJ}	—	74	—	dB	$f = 50Hz$ to $10kHz$ $C_{REF} = 0$
		—	86	—		$C_{REF} = 5\mu F$
Average temperature coefficient of output voltage	$\delta V_O / \delta T$	—	0.003	0.018	%/ $^{\circ}C$	$T_A = -20$ to $+75^{\circ}C$
		—	0.003	0.015	%/ $^{\circ}C$	$T_a = 0$ to $+70^{\circ}C$
Reference voltage	V_{REF}	6.80	7.15	7.50	V	$V_{IN} = V_{CC} = V_C = 12V$, $V_{EE} = 0$
Standby current	I_{ST}	—	—	4.0	mA	$V_{IN} = 30V$, $I_L = 0$
Short circuit current limit	I_{SC}	—	65	—	mA	$R_{SC} = 10\Omega$, $V_{OUT} = 0$

Electrical Characteristics Measuring Circuit



$V_{IN} = V_{CC} = V_C = 12V$, $V_{EE} = 0$, $V_{OUT} = 5.0V$, $I_L = 1mA$,
 $R_{SC} = 0$, $C_1 = 100pF$, $C_{REF} = 0$, $R_2 \approx 5k\Omega$, $R_3 = R_1 R_2 / (R_1 + R_2)$

HA17723 Applications

Fixed Voltage Source in Series

Low Voltage (2 to 7 V) Regulator: Figure 1 shows the construction of a basic low voltage regulator. The divider (resistors R_1 and R_2) from V_{REF} makes the reference voltage, which will be provided to the noninverted input of the error amplifier, 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 figure 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:

$$V_{OUT} = nV_{REF}, \quad n = \frac{R_2}{R_1 + R_2}$$

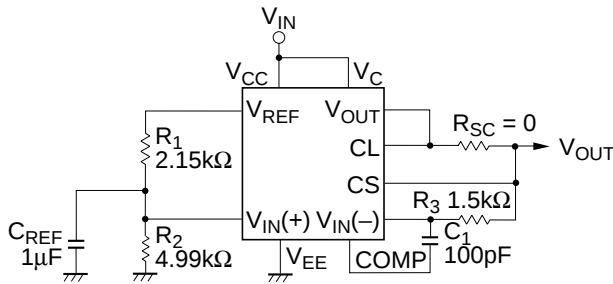


Figure 1 Low Voltage (2 to 7 V) Regulator

High Voltage (7 to 37 V) Regulator: Figure 2 shows the construction of a regulator whose output voltage is higher than the reference voltage, V_{REF} . V_{REF} is added to the non-inverted input of the error amplifier via a resistor, R_3 . The feedback voltage is produced by dividing the output voltage with resistors R_1 and R_2 .

Thus, the output voltage V_{OUT} is:

$$V_{OUT} = \frac{V_{REF}}{n}, \quad n = \frac{R_2}{R_1 + R_2}$$

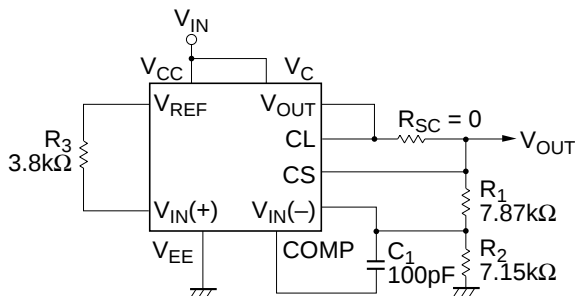


Figure 2 High Voltage (7 to 37 V) Regulator

Negative Voltage Regulator: Figure 3 shows the construction of a so-called negative voltage regulator, which generates a negative output voltage with regard to GND. Assume that the output voltage, $-V_{OUT}$, increases in the negative direction. As the voltage across the R_1 is larger than that across the R_3 , which provides the reference voltage, the output current of the error amplifier increases. In the control circuit, the impedance decreases with the increase of input current, which makes the base current of the external transistor Q approach GND. As a result, the output voltage returns to the established value and output voltage is stable.

The output voltage $-V_{OUT}$ of this circuit is:

$$\begin{aligned} -V_{OUT} &= -\left(\frac{R_1 + R_2}{R_3 + R_4} \times \frac{R_3}{R_1}\right) V_{REF} \\ &= -\frac{(R_1 + R_2) \cdot (R_3 + R_4)}{R_2 \cdot (R_3 + R_4) - R_4 \cdot (R_1 + R_2)} \times \frac{R_3}{R_3 + R_4} V_{REF} \end{aligned}$$

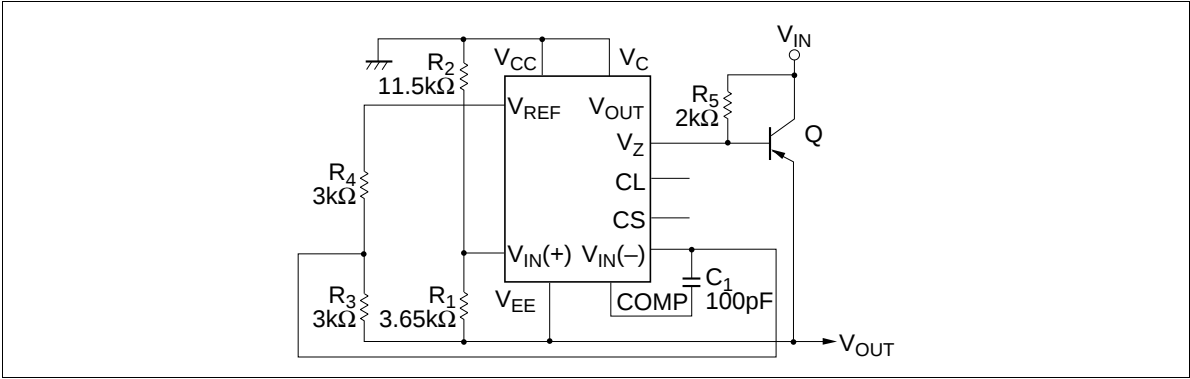


Figure 3 Negative Voltage Regulator

How to Increase the Output Current: To increase the output current, you must increase the current capacity of the control circuit. Figures 4 and 5 show examples with external transistors.

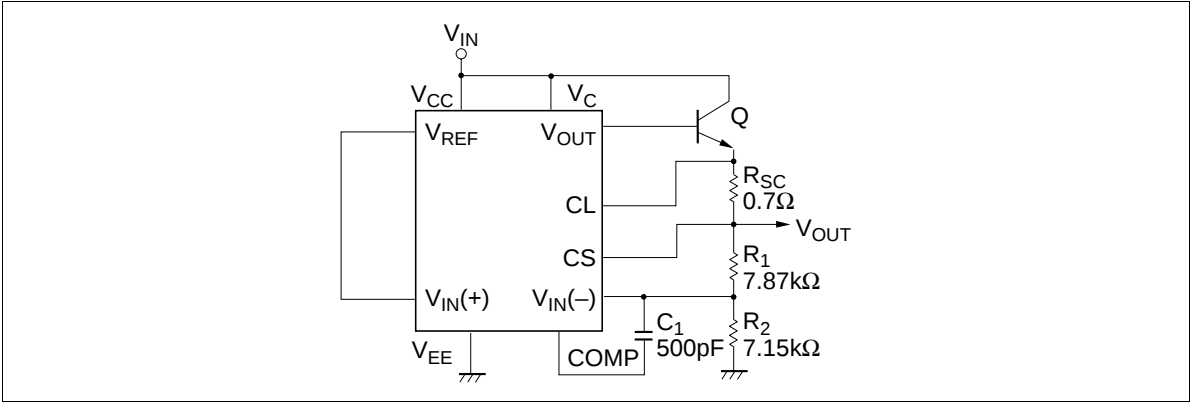


Figure 4 Increasing Output Current (1)

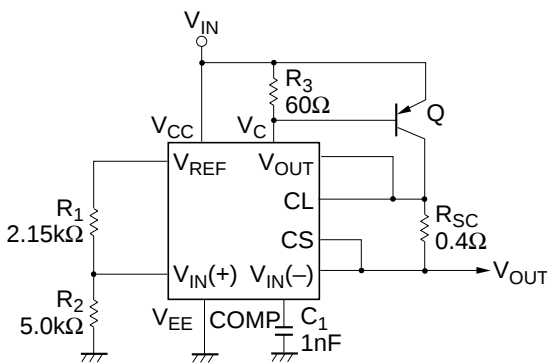


Figure 5 Increasing Output Current (2)

Fixed Voltage Source in Parallel Control

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

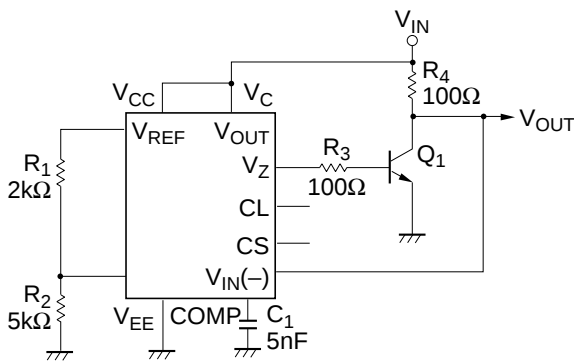


Figure 6 Fixed Voltage Source in Shunt Regulator

Switching Regulator

Figure 7 shows a switching regulator circuit. The error amplifier, control circuit, and forward feedback circuit R_4 and R_3 operate in together as a comparator, and make the external transistors Q_1 and Q_2 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 the switches conducting period.

Figures 8 and 9 show a negative voltage switching regulator circuit and its characteristics.

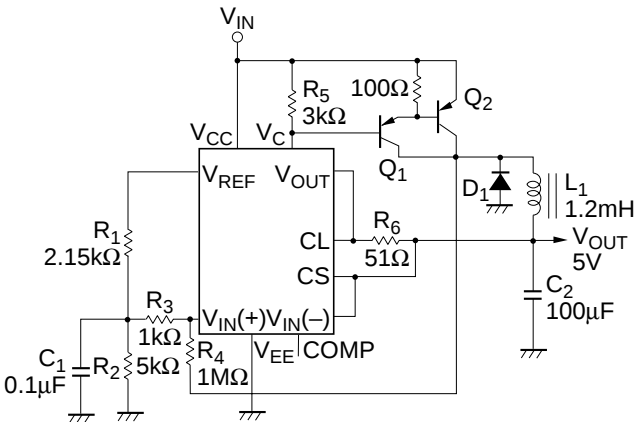


Figure 7 Positive Voltage Switching Regulator

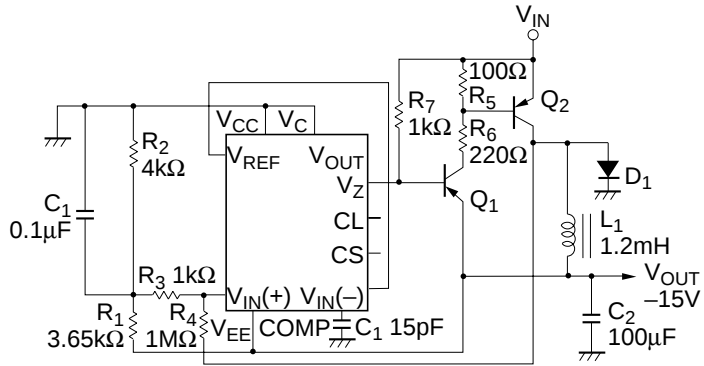


Figure 8 Negative Voltage Switching Regulator

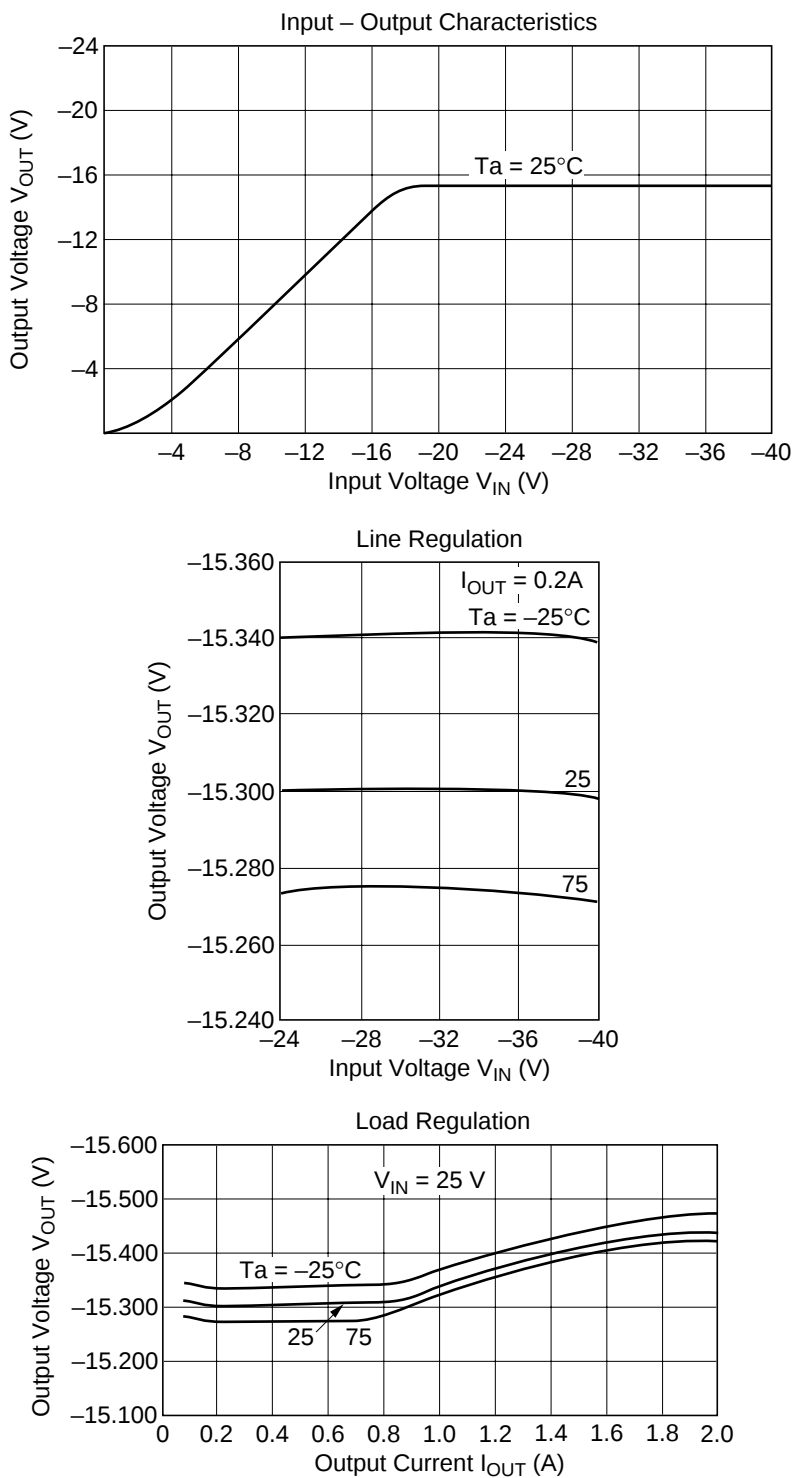


Figure 9 Negative Voltage Switching Regulator Operating Characteristics

Floating-Type Fixed Voltage Source

Voltage sources of the floating type or boost type are typically employed when high voltage output is required. Figure 10 shows the circuit of a floating-type fixed voltage source. Considering the stabilization in this circuit, assume that the output voltage increases. At the input terminal of the error amplifier the non-inverted input will become low compared with the inverted input, and the output current of the error amplifier decreases. Then, the current from the terminal V_Z in the control circuit decreases. As a result the base current of the external resistor Q_1 will decrease and collector current will decrease, controlling increase of the output voltage.

The output voltage V_{OUT} in the circuit in figure 10

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

Figure 11 is the circuit diagram of a negative fixed voltage source in floating type.

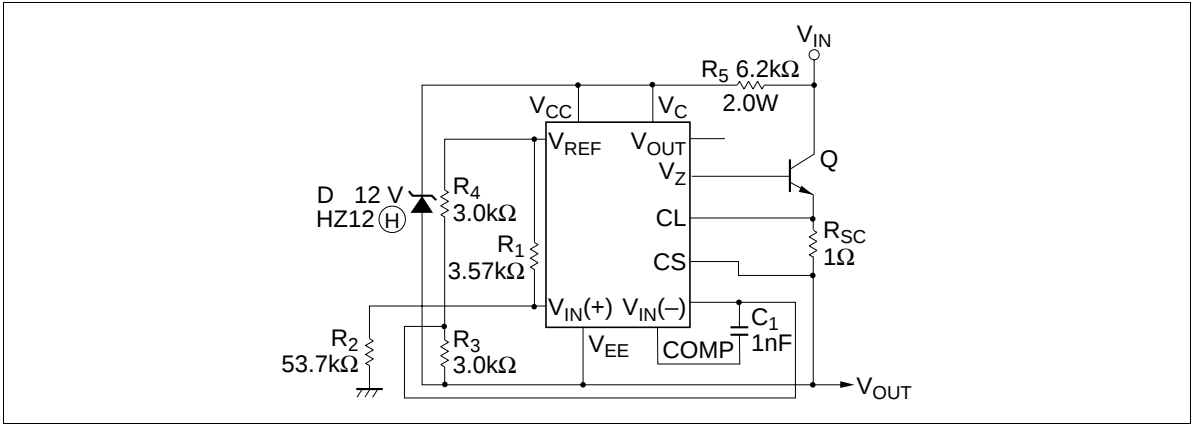


Figure 10 Positive Voltage Floating Regulator

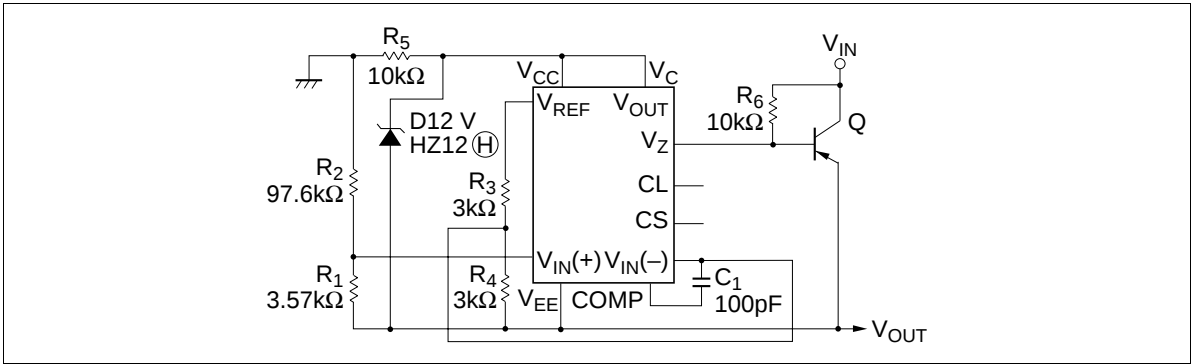
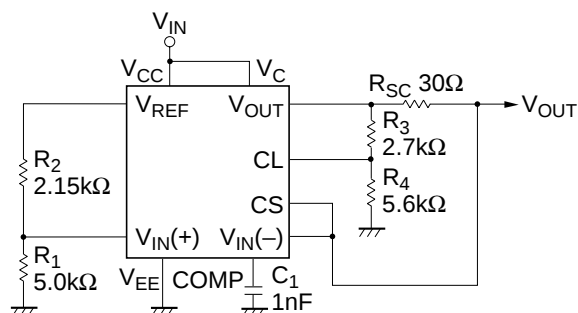


Figure 11 Negative Voltage Floating Regulator

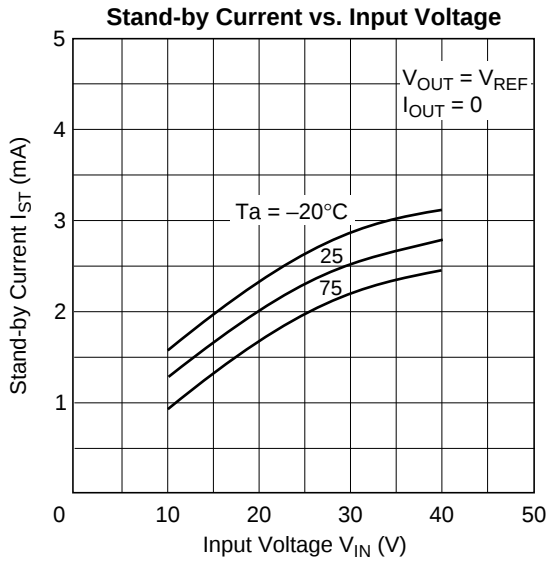
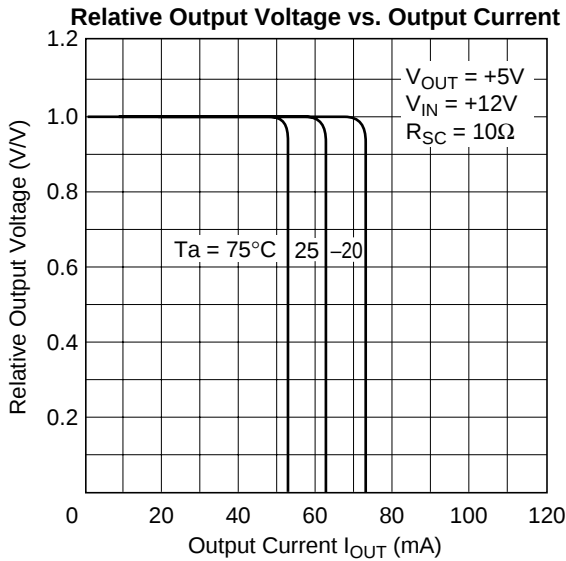
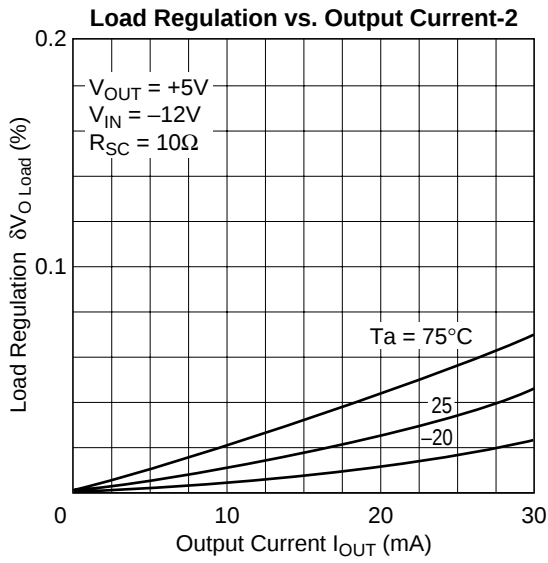
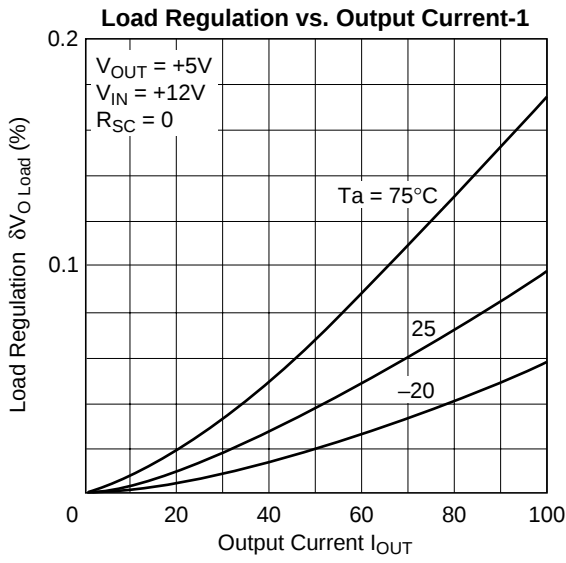


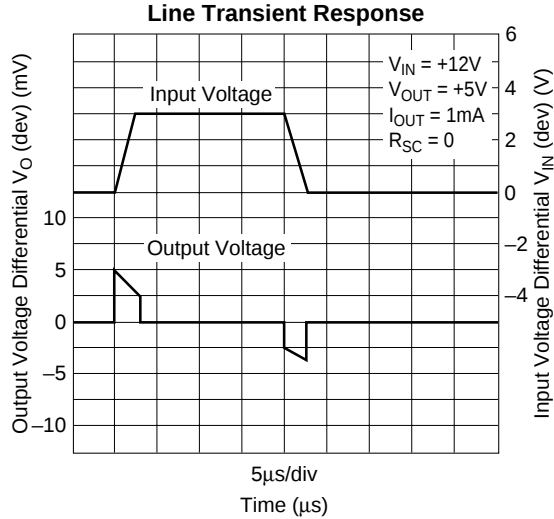
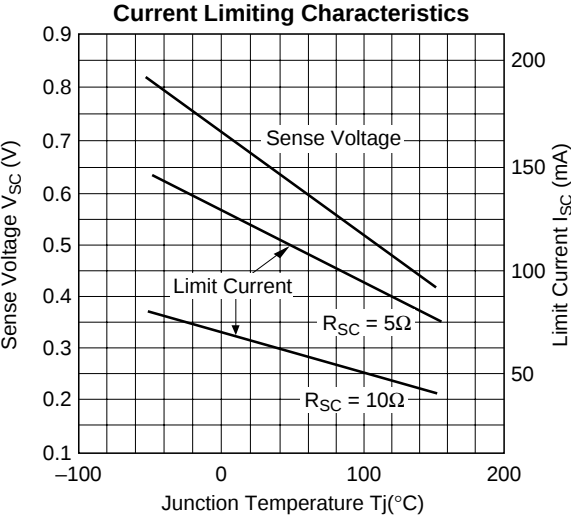
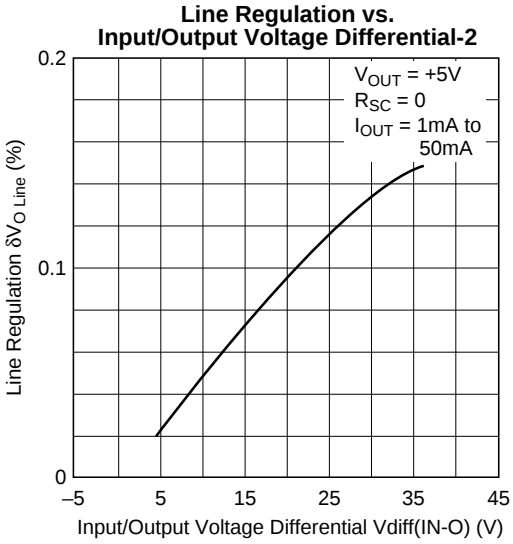
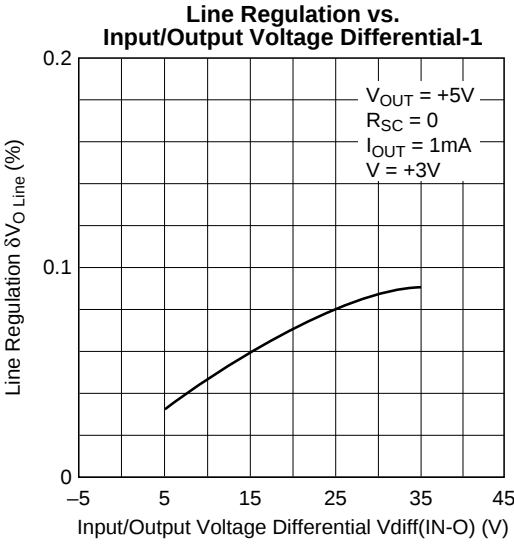
The graph shows the output voltage V_{OUT} in Volts (V) on the y-axis (0 to 6.0) versus the output current I_{OUT} in milliamperes (mA) on the x-axis (0 to 200). The curve is a constant voltage source at $V_O = 5.0V$ up to the maximum load current $I_{OP} = 100mA$. Beyond I_{OP} , the voltage drops linearly to 0V at the short-circuit current $I_{OS} = 0mA$.

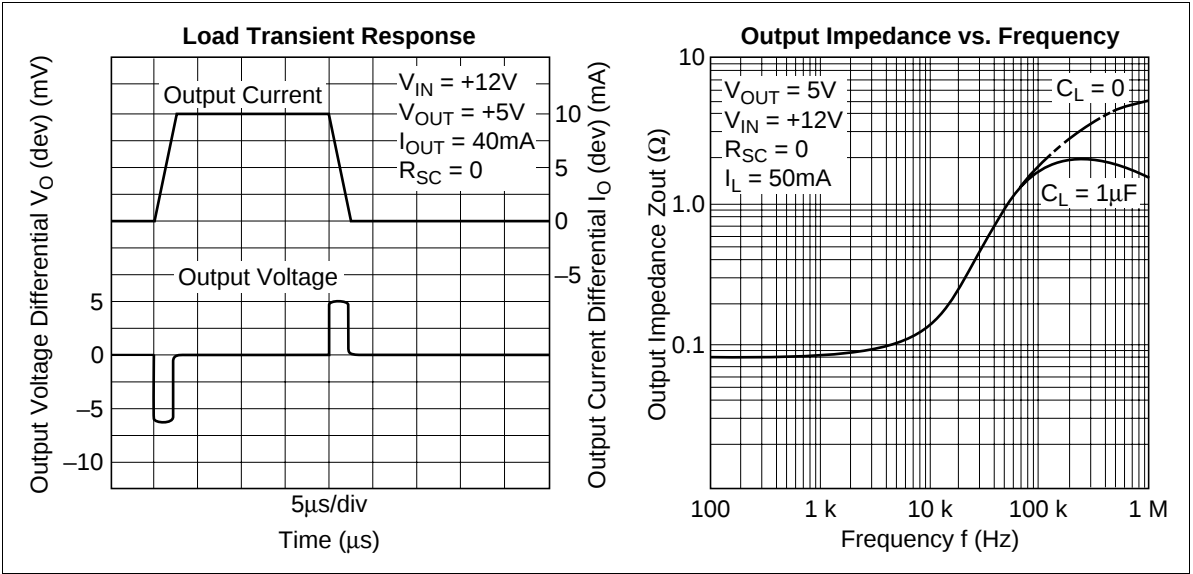
$$I_{OS} = \frac{R_3 + R_4}{R_4 \cdot R_{SC}} \cdot V_{BE}$$
$$I_{OP} = I_{OS} + \frac{R_3}{R_4 \cdot R_{SC}} \cdot V_O$$

Figure 13 Current Control Characteristics of Fixed Voltage Source with Reduction Type Current Limiter

Characteristic Curves

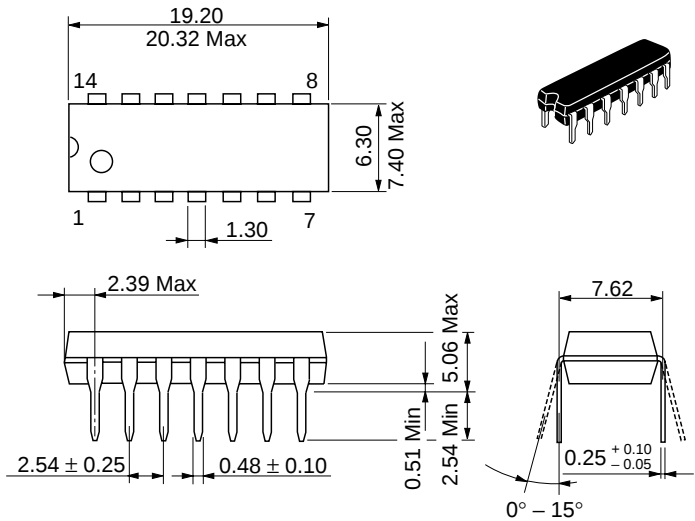






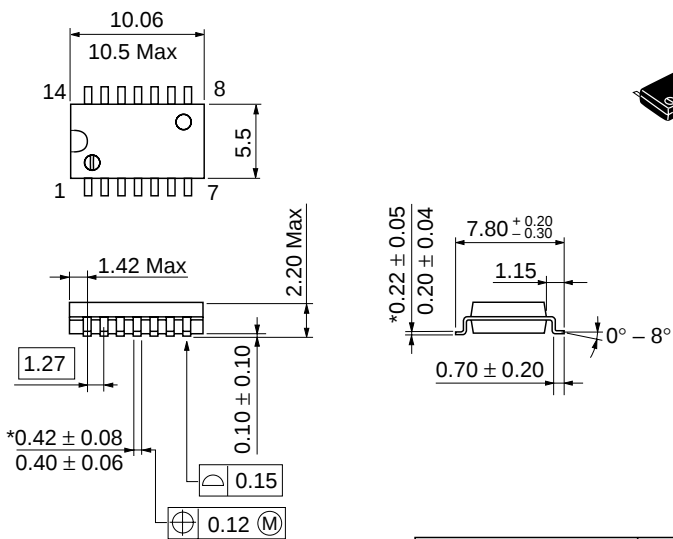
Package Dimensions

Unit: mm



Hitachi Code	DP-14
JEDEC	Conforms
EIAJ	Conforms
Mass (reference value)	0.97 g

Unit: mm



*Dimension including the plating thickness
Base material dimension

Hitachi Code	FP-14DA
JEDEC	—
EIAJ	Conforms
Mass (reference value)	0.23 g

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