HA17723/F/P

Precision Voltage Regulator

HITACHI

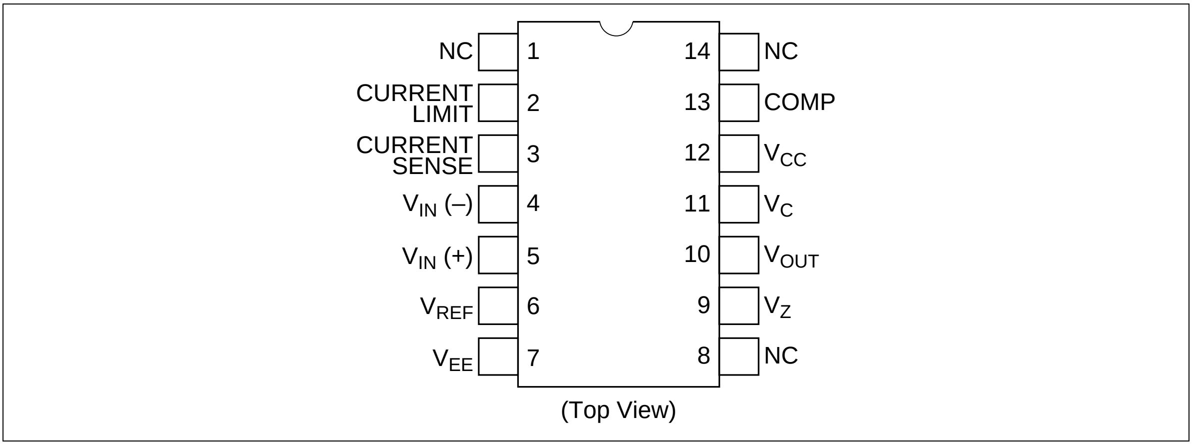
Description

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

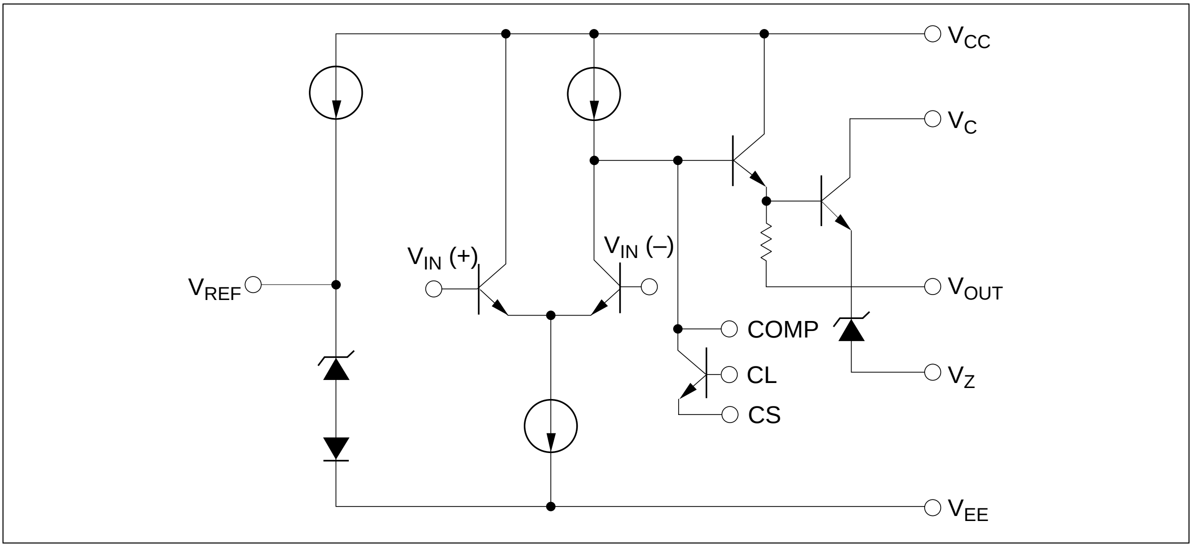
Type No.	Application	Package
HA17723	Commercial use	DP-14
HA17723F		FP-14DA
HA17723P	Industrial use	DP-14

Pin Arrangement



Hitachi semiconductor

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

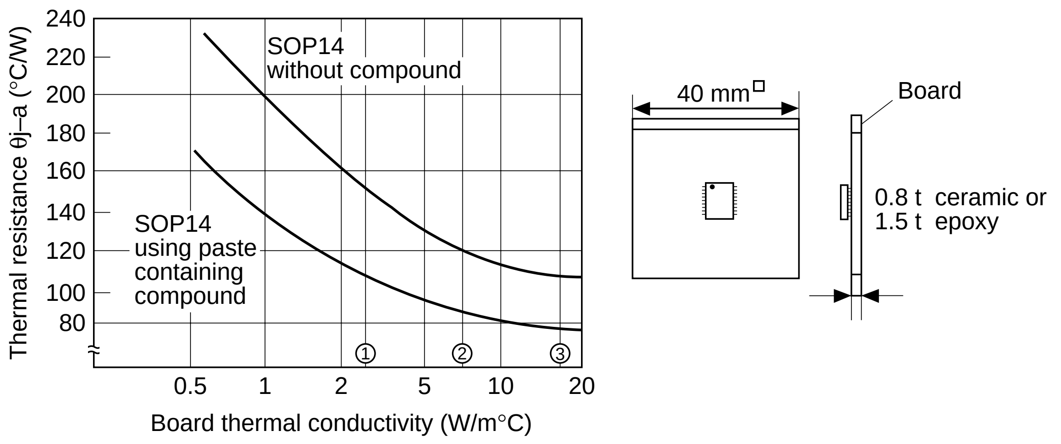
2. Allowable temperature of IC junction part, Tj (max), is as shown below.

   Tj (max) = θj - a • Pc (max)+Ta

   (θj - 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.



(1) Glass epoxy board with 10% wiring density

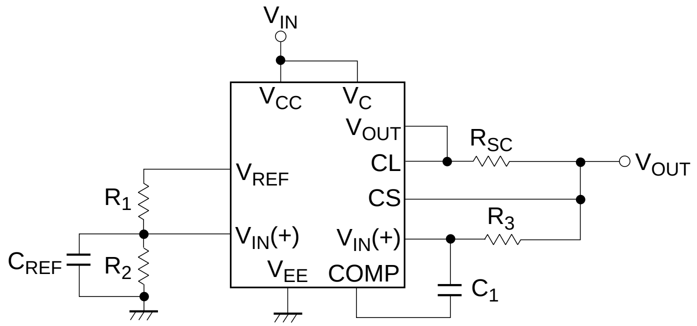
(2) Glass epoxy board with 30% wiring density

(3) Ceramic board with 96% alumina coefficient

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, TA = –20 to +75°C	
		—	—	0.3	%	V_{IN} = 12 to 15V, Ta = 0 to +70°C	
Load regulation	δV_O Load	—	0.03	0.2	%	I_{OUT} = 1 to 50mA	
		—	—	0.7	%	V_{IN} = 12 to 15V, TA = –20 to +75°C	
		—	—	0.6	%	I_{OUT} = 1 to 50mA, Ta = 0 to +70°C	
Ripple rejection	R_{REJ}	—	74	—	dB	f = 50Hz to 10kHz	C_{REF} = 0
		—	86	—			C_{REF} = 5µF
Average temperature coefficient of output voltage	$\delta V_O/\delta T$	—	0.003	0.018	%/°C	TA = –20 to +75°C	
		—	0.003	0.015	%/°C	Ta = 0 to +70°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} = 10Ω, 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, $R_2 \approx 5k\Omega$, $R_3 = R_1R_2/(R_1+R_2)$

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 VREF since the output voltage is equal to the reference voltage.

Thus, the output voltage V_{OUT} is:

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

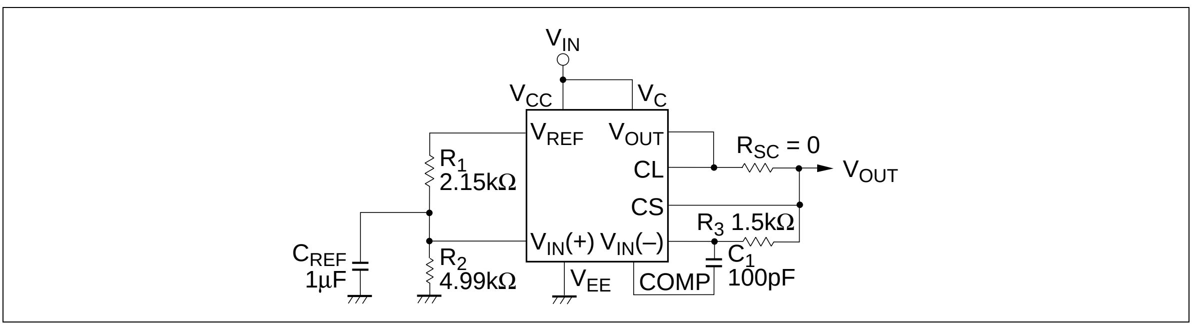


Figure 1 Low Voltage (2 to 7 V) Regulator

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:

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

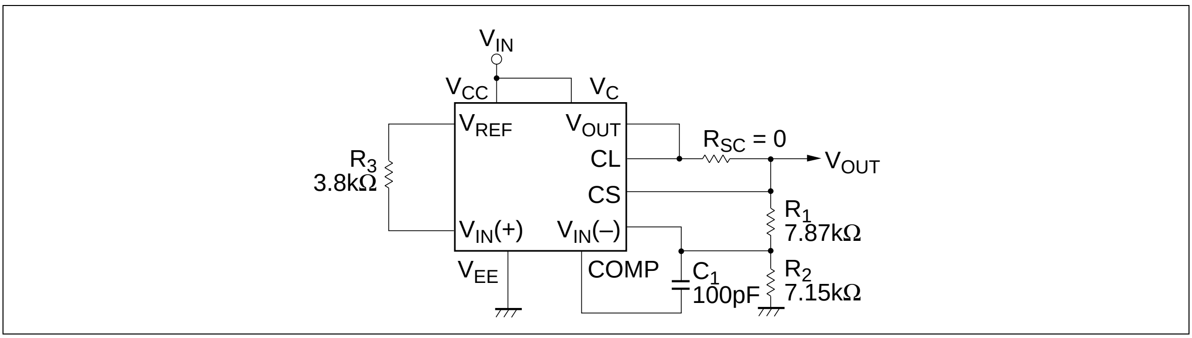


Figure 2 High Voltage (7 to 37 V) Regulator

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 –VOUT of this circuit is:

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

$$= -\frac{(R_1 + R_2) \cdot (R_3 + R_4)}{R_2 \cdot (R_3 + R_4) - R_4 \cdot (R_1 + R_2)} \times \frac{R_3}{R_3 + R_4} V_{REF}$$

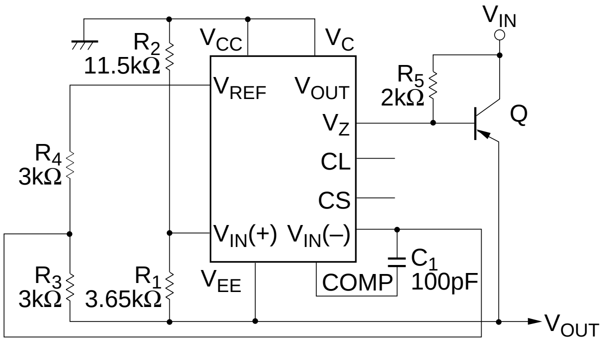


Figure 3 Negative Voltage Regulator

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.

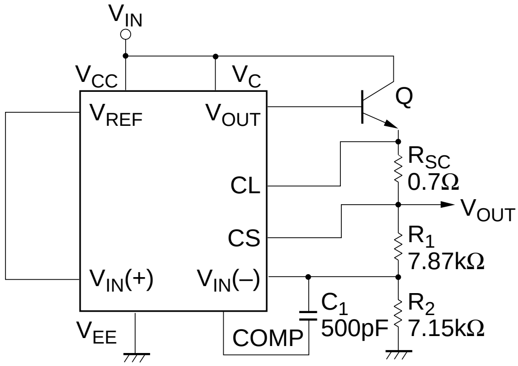


Figure 4 Increasing Output Current (1)

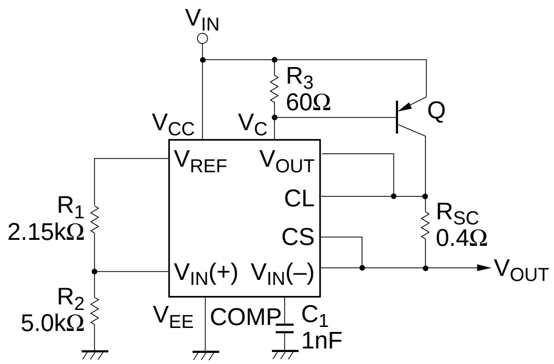


Figure 5 Increasing Output Current (2)

Fixed Voltage Source in Parallel Control

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

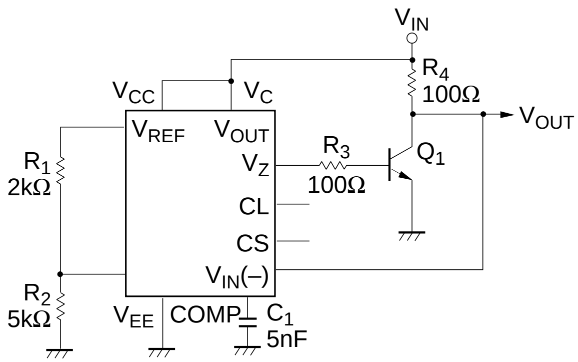


Figure 6 Fixed Voltage Source in Shunt Regulator

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.

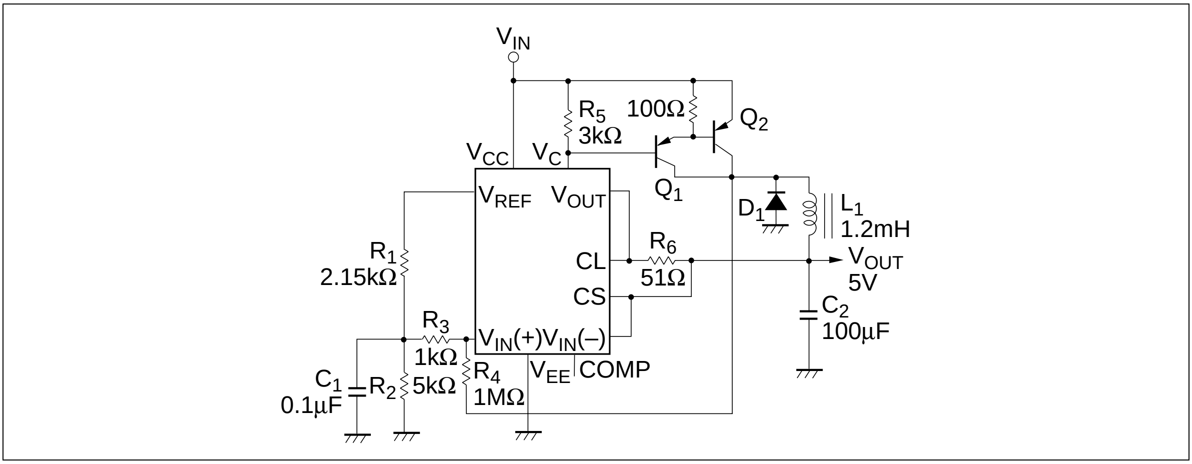


Figure 7 Positive Voltage Switching Regulator

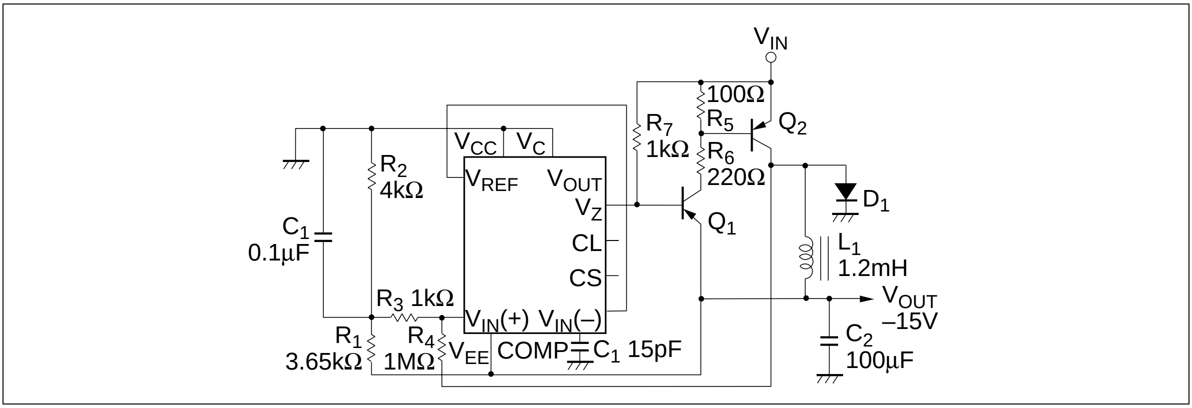


Figure 8 Negative Voltage Switching Regulator

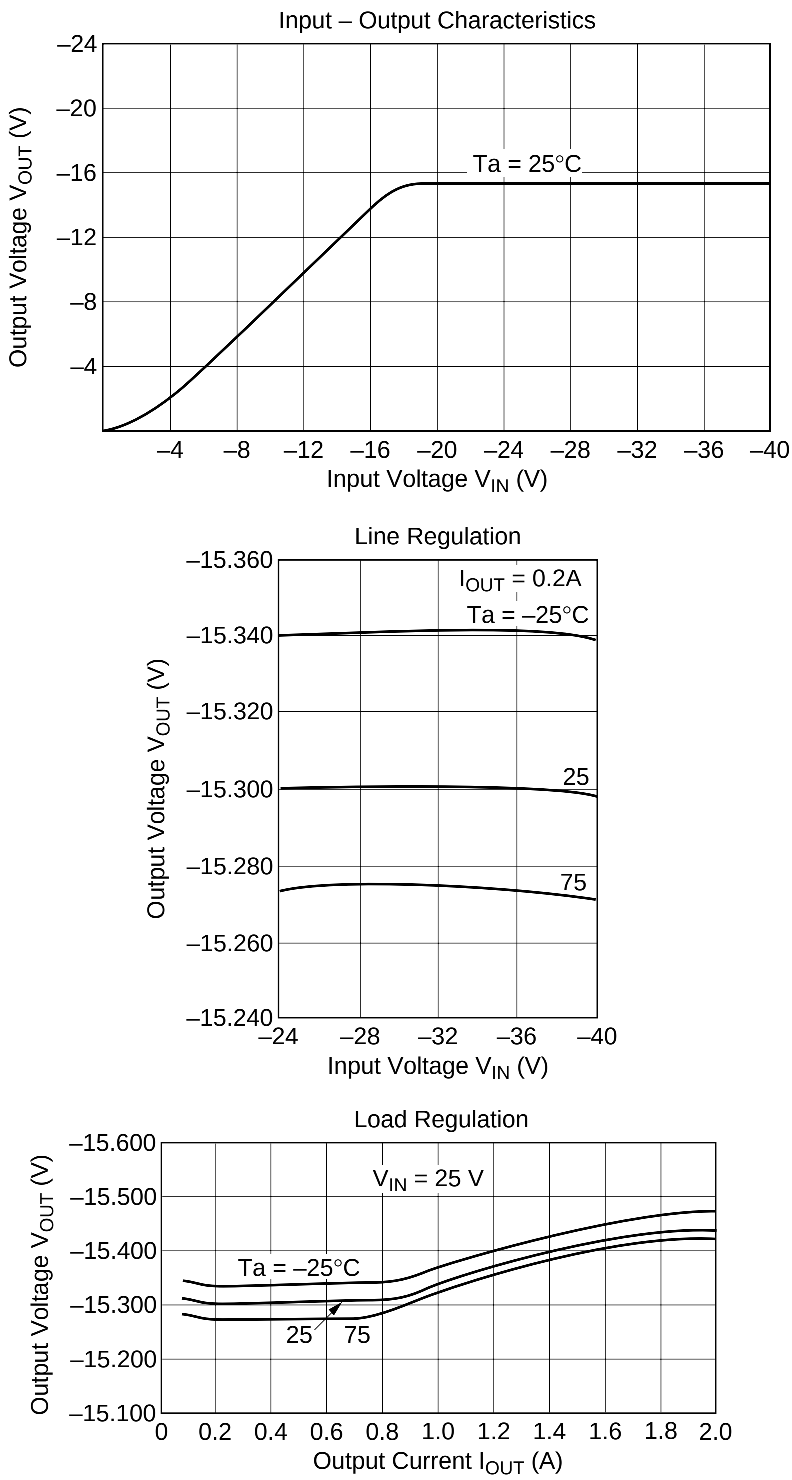


Figure 9 Negative Voltage Switching Regulator Operating Characteristics

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.

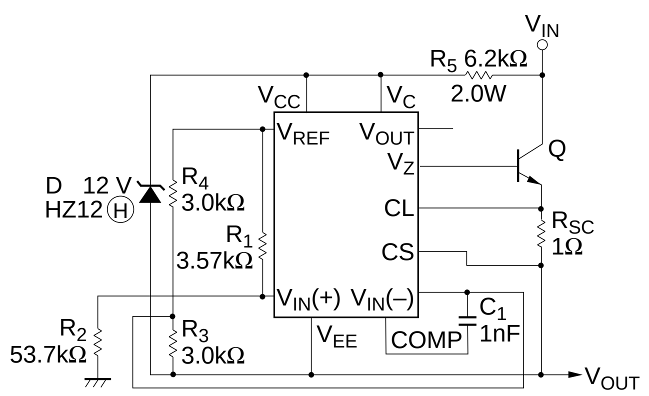


Figure 10 Positive Voltage Floating Regulator

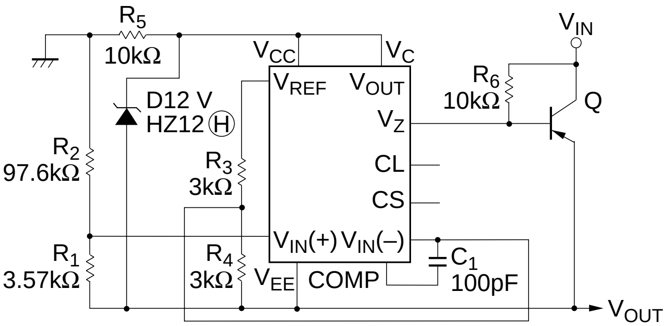


Figure 11 Negative Voltage Floating Regulator

Fixed Voltage Source with Reduction Type Current Limiter

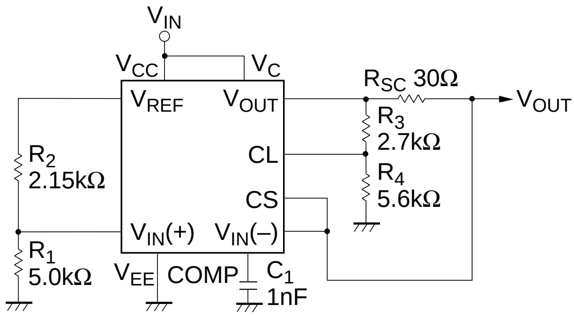
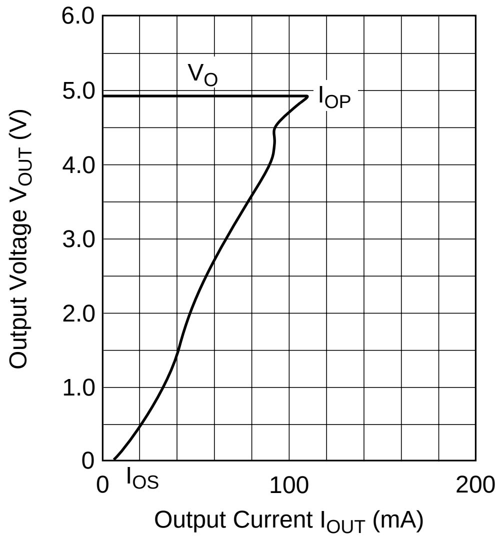


Figure 12   Fixed Voltage Source with Reduction Type Current Limiter



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

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

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

Fixed Voltage Source Switching External Control

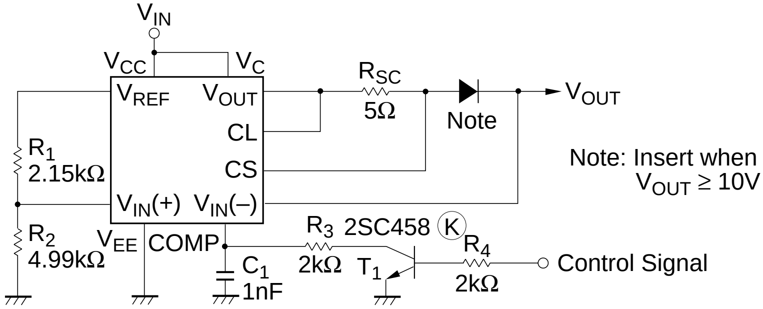


Figure 14 Fixed Voltage Source Switching External Control

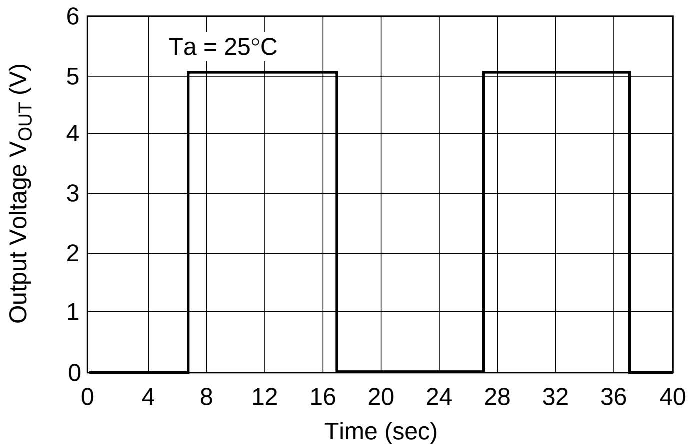
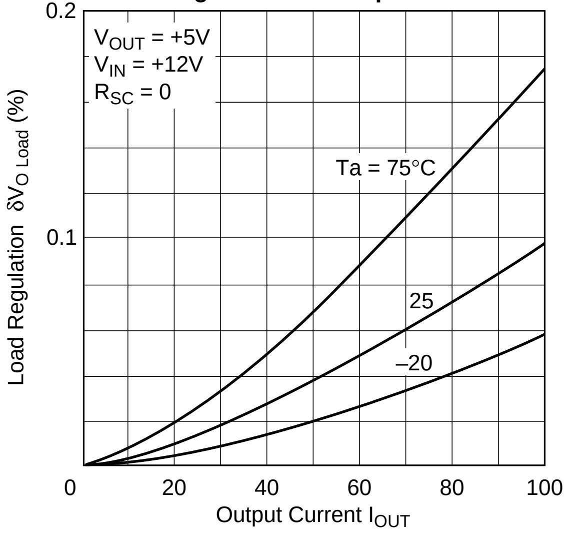


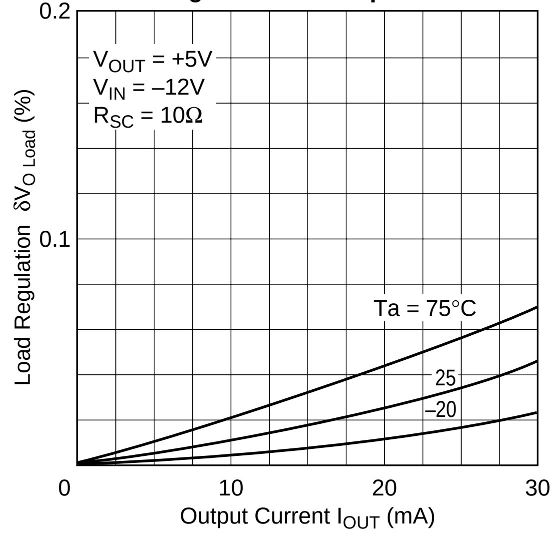
Figure 15 Operating Characteristics of Fixed Voltage Source Switching External Control

Characteristic Curves

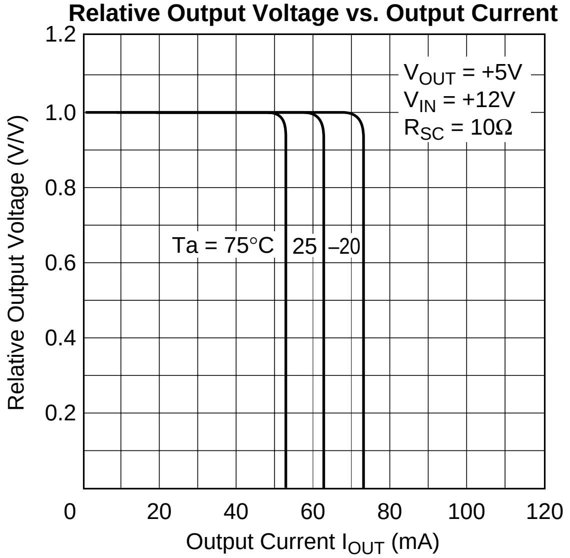
Load Regulation vs. Output Current-1



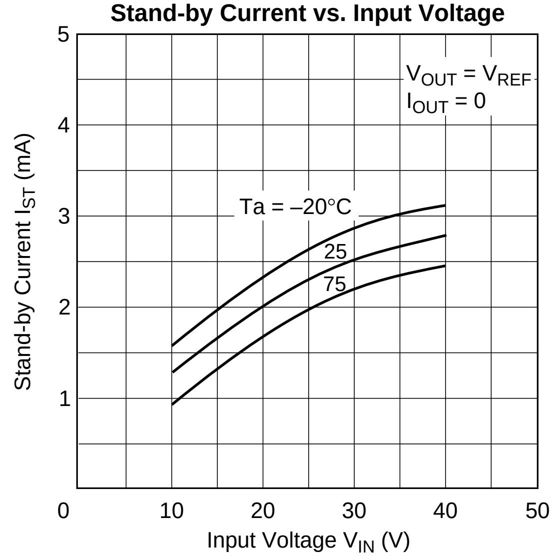
Load Regulation vs. Output Current-2



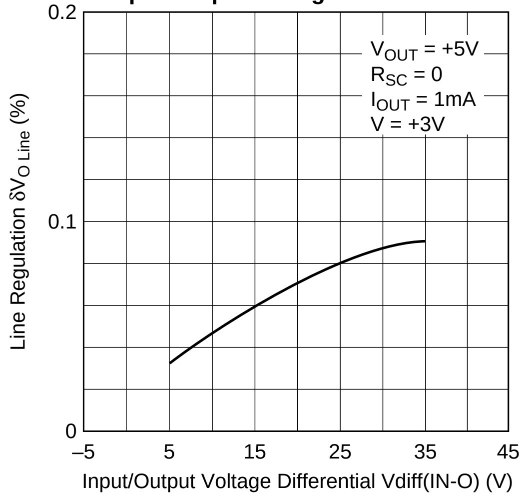
Relative Output Voltage vs. Output Current



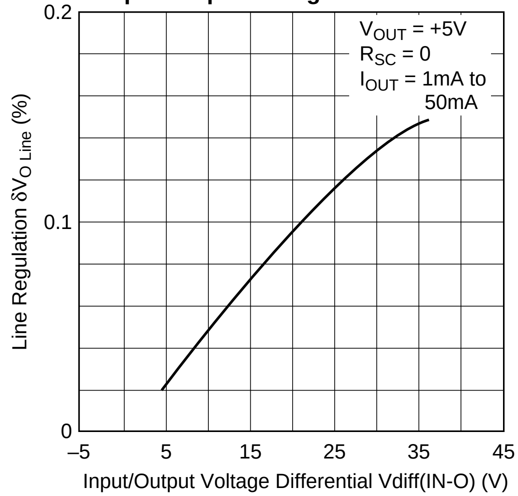
Stand-by Current vs. Input Voltage



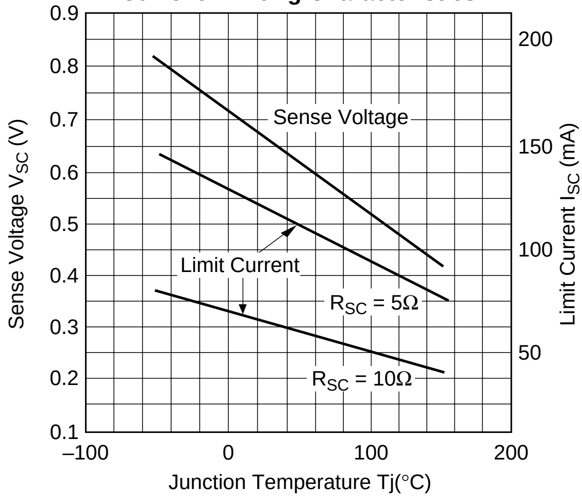
Line Regulation vs. Input/Output Voltage Differential-1



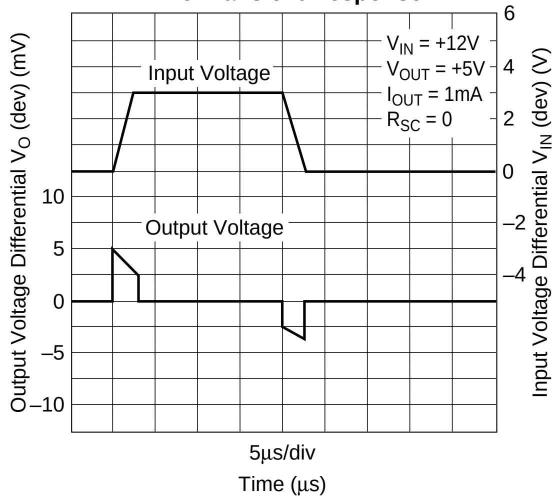
Line Regulation vs. Input/Output Voltage Differential-2



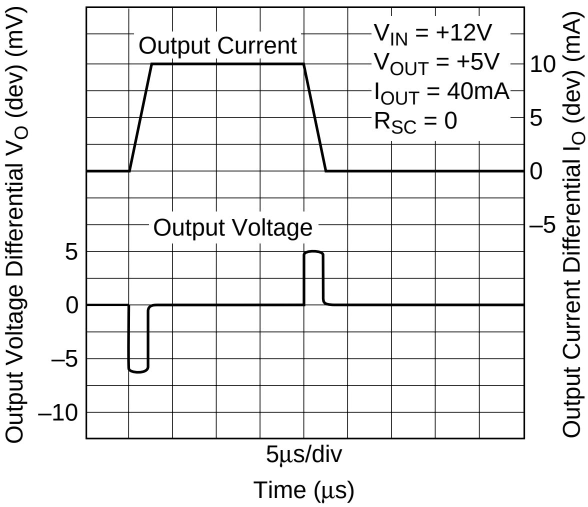
Current Limiting Characteristics



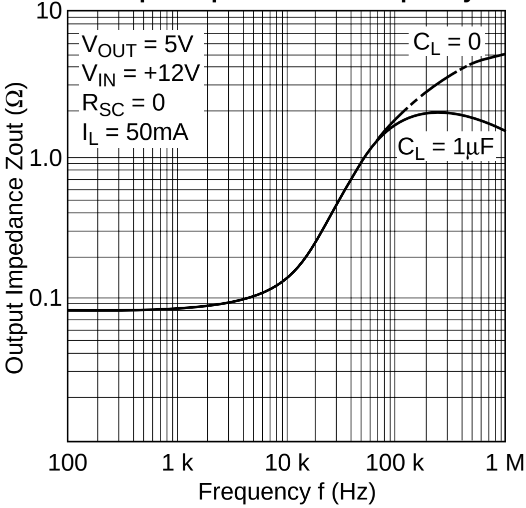
Line Transient Response



Load Transient Response

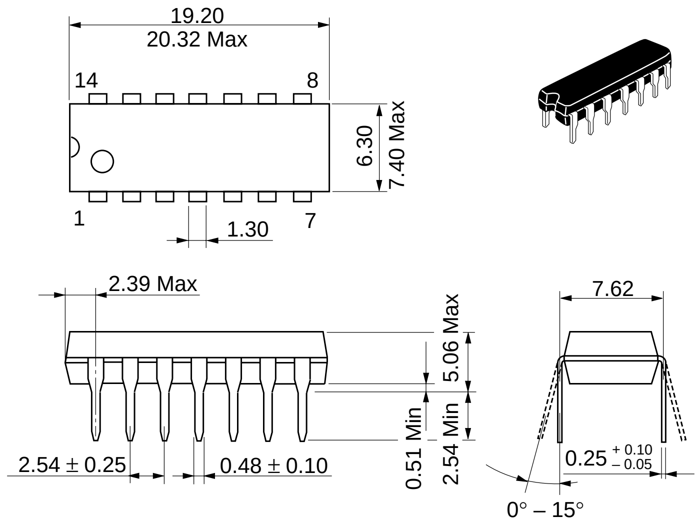


Output Impedance vs. Frequency



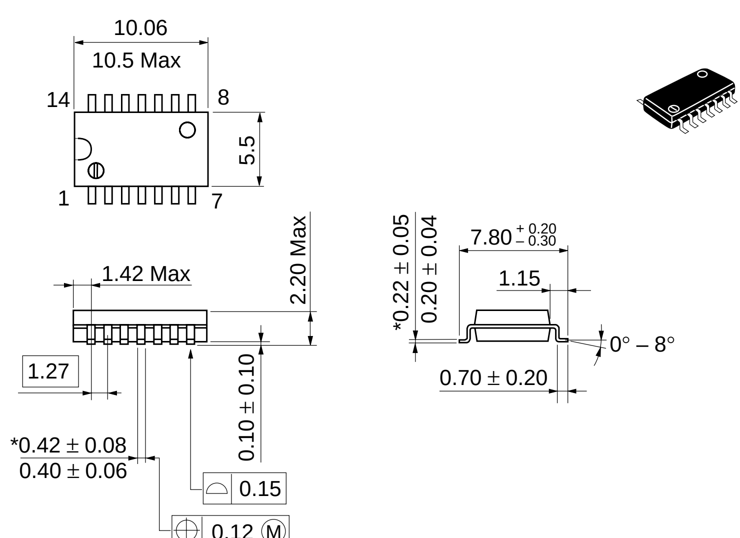
Package Dimensions

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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HITACHI

Hitachi, Ltd.
Semiconductor & Integrated Circuits.
Nippon Bldg., 2-6-2, Ohte-machi, Chiyoda-ku, Tokyo 100-0004, Japan
Tel: Tokyo (03) 3270-2111 Fax: (03) 3270-5109

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For further information write to:

Hitachi Semiconductor
(America) Inc.
179 East Tasman Drive,
San Jose,CA 95134
Tel: <1> (408) 433-1990
Fax: <1>(408) 433-0223

Hitachi Europe GmbH
Electronic components Group
Dornacher Straβe 3
D-85622 Feldkirchen, Munich
Germany
Tel: <49> (89) 9 9180-0
Fax: <49> (89) 9 29 30 00

Hitachi Europe Ltd.
Electronic Components Group.
Whitebrook Park
Lower Cookham Road
Maidenhead
Berkshire SL6 8YA, United Kingdom
Tel: <44> (1628) 585000
Fax: <44> (1628) 778322

Hitachi Asia Pte. Ltd.
16 Collyer Quay #20-00
Hitachi Tower
Singapore 049318
Tel: 535-2100
Fax: 535-1533

Hitachi Asia Ltd.
Taipei Branch Office
3F, Hung Kuo Building. No.167,
Tun-Hwa North Road, Taipei (105)
Tel: <886> (2) 2718-3666
Fax: <886> (2) 2718-8180

Hitachi Asia (Hong Kong) Ltd.
Group III (Electronic Components)
7/F., North Tower, World Finance Centre,
Harbour City, Canton Road, Tsim Sha Tsui,
Kowloon, Hong Kong
Tel: <852> (2) 735 9218
Fax: <852> (2) 730 0281
Telex: 40815 HITEC HX