
HA17451AP/HA17451AFP

Switching Regulator Controllers for DC/DC Converters

HITACHI

Description

The HA17451 is a dual-channel switching regulator controller IC. Each channel contains the basic circuits for controlling a PWM-type switching-regulator power supply. Both channels are integrated onto the same chip. Both channels can be completely synchronized, using the same oscillator output waveform. Each channel can provide output voltages for step-up, step-down, inverting, and other converter topologies.

These controllers operate at voltages from 3.3 V to 40 V, making them suitable for a wide range of applications. They are ideal for chopper-type DC/DC converters. They are similar to the TL1451, but note that the HA17451A differs from the TL1451A.

Functions

- Low-dropout 2.5V voltage reference
- Undervoltage lockout
- Triangle-wave oscillator
- Adjustable dead-time control
- Error amplifier
- Output driver (open-collector transistor type)
- PWM comparator

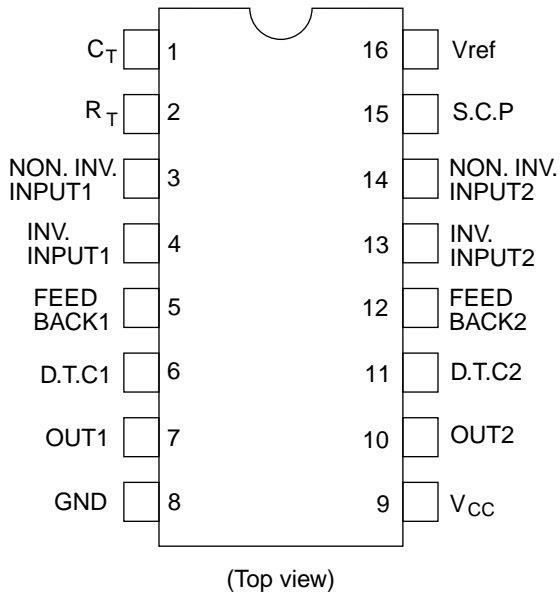
Features

- Low dropout voltage of on-chip 2.5V voltage reference: $V_{drop} = 0.2 \text{ V}$ (typ)
- Operates throughout wide supply voltage range: 3.3 V to 40 V
- Large maximum output current: 50 mA (max)
- Undervoltage lockout circuit
 - High threshold voltage: 3.15 V (typ)
 - Low threshold voltage: 2.98 V (typ)
- Low current drain: 1.5 mA (typ)
- Operates at wide range of oscillator frequencies: $f_{osc} = 1 \text{ kHz}$ to 300 kHz
- Dead time adjustable through full duty cycle range
- Surface-mount package (SOP16) for saving space (HA17451AFP)

Ordering Information

Type Name	Package
HA17451AP	DP-16
HA17451AFP	FP-16DA

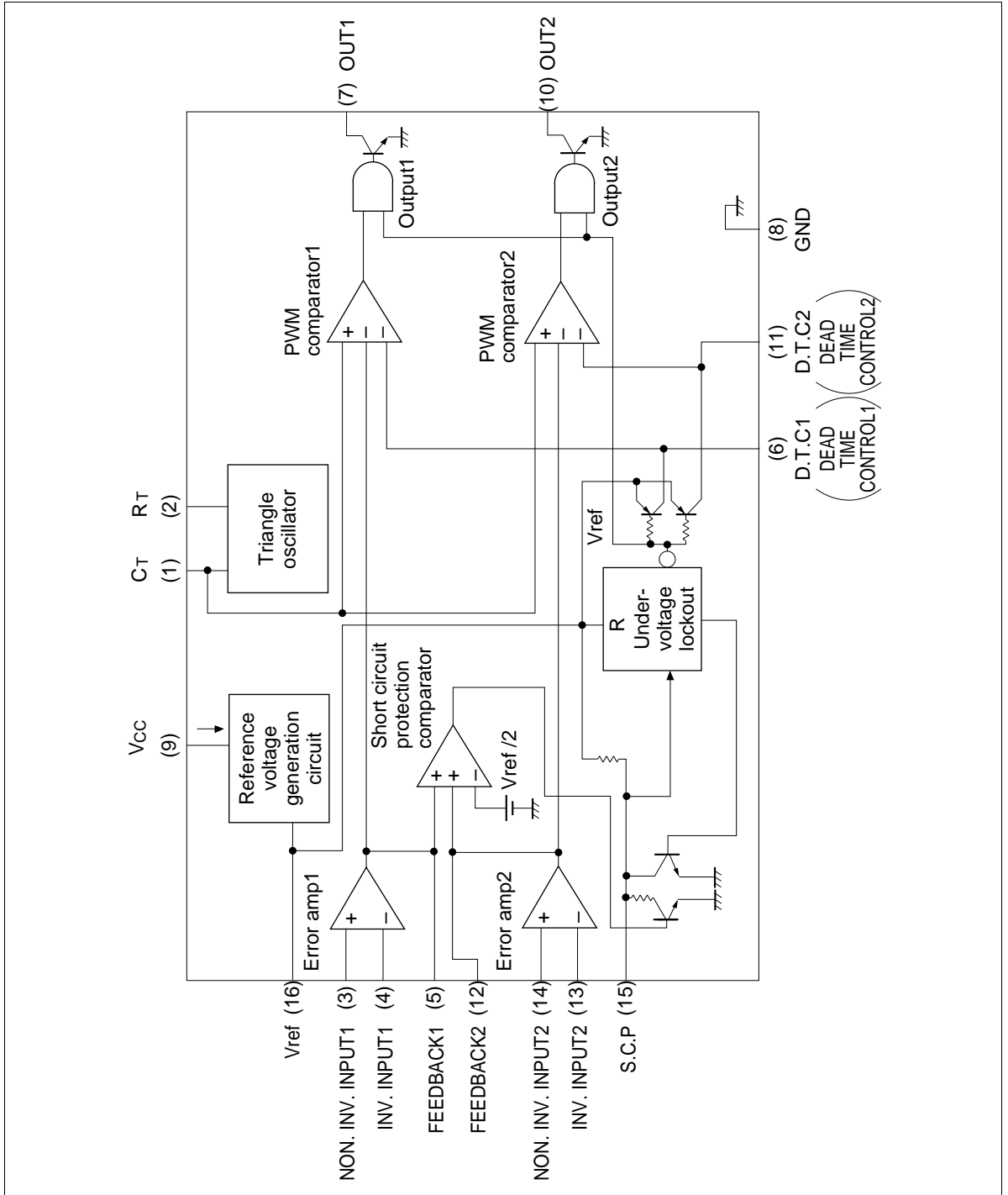
Pin Arrangement



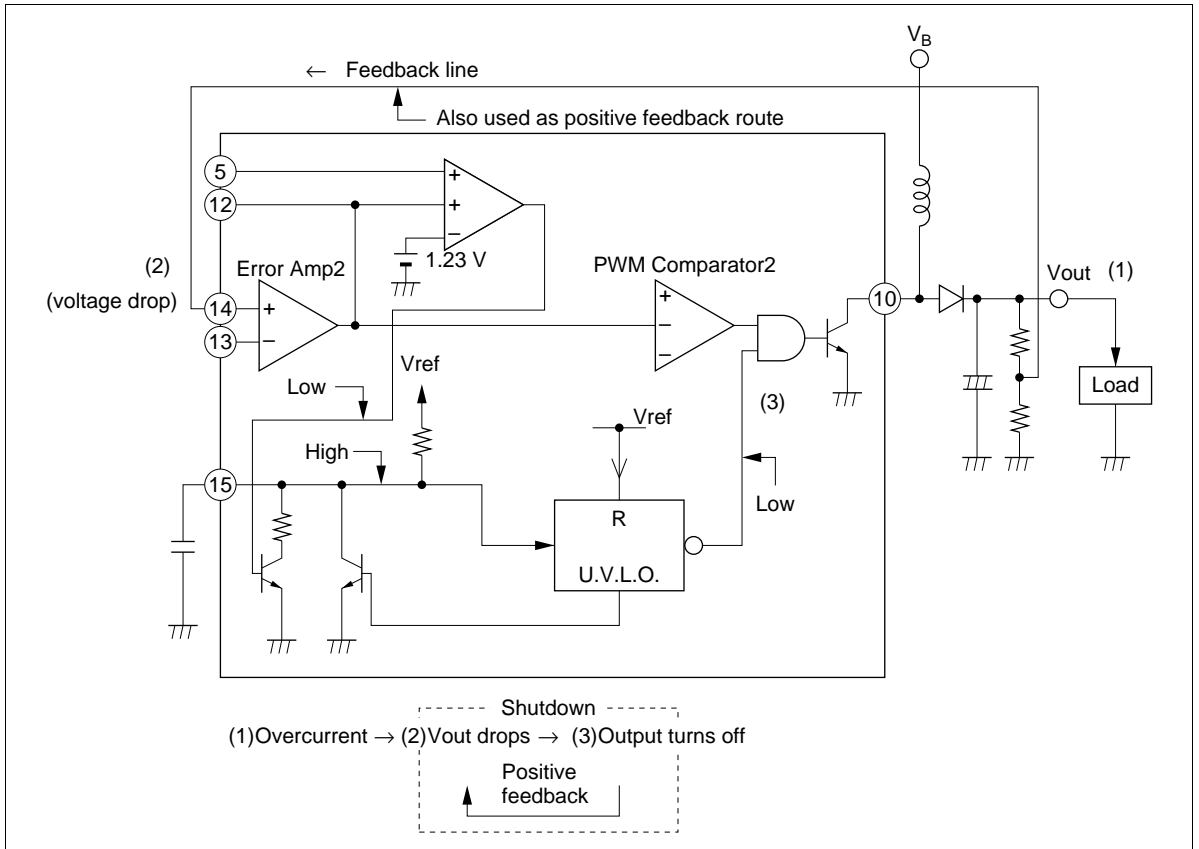
Pin Functions

Pin No.	Symbols	Functions
1	C_T	Timing capacitor
2	R_T	Timing resistor
3, 14	NON. INV. INPUT	Non-inverting input of error amp
4, 13	INV. INPUT	Inverting input of error amp
5, 12	FEEDBACK	Output of error amp
6, 11	D.T.C	Dead time control
7, 10	OUT	Output
8	GND	Ground
9	V_{CC}	Input voltage
15	S.C.P	Short circuit protection
16	Vref	Reference voltage output

Block Diagram



Short-circuit Protection in HA17451A



Absolute Maximum Ratings (T_a = 25°C)

Item	Symbol	Rating	Unit	Note
Power supply voltage	V _{CC}	40	V	
Error amplifier input voltage	V _I	20	V	
Collector output voltage	V _O	40	V	
Collector output current	I _O	50	mA	
Power dissipation	P _T	680	mW	*
Operating temperature	T _{opr}	- 20 to +85	°C	
Storage temperature	T _{stg}	- 55 to +125	°C	

Note: This value applies to the HA17451AP at ambient temperatures up to T_a = 45°C. Derate by 8.3 mW/°C above that point.

Electrical Characteristics ($T_a = 25^\circ\text{C}$, $V_{CC} = 6\text{ V}$, $f_{OSC} = 200\text{ kHz}$)**Reference Section**

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Output voltage	V_{ref}	2.40	2.50	2.60	V	$I_o = 1\text{ mA}$
Voltage drop	V_{drop}	—	0.2	0.35	V	$I_o = 1\text{ mA}$
Line regulation	Line	—	2	12.5	mV	$V_{CC} = 3.0\text{ to }40\text{ V}$
Load regulation	Load	—	1	7.5	mV	$I_o = 0.1\text{ to }1\text{ mA}$
Maximum output current	I_{OMAX}	3	10	30	mA	$V_{ref} = 0.5\text{ V}$
Reverse voltage state minimum current	I_{OR}	18	—	—	μA	$-0.2\text{ V} < V_{ref} < 0\text{ V}$

Undervoltage Lockout Protection Section

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
High level threshold	V_{th}	2.90	3.15	3.30	V	$I_o = 0.1\text{ mA}$
Low level threshold	V_{tl}	2.75	2.98	3.15	V	$I_o = 0.1\text{ mA}$
Hysteresis width	V_{HYS}	100	170	—	mV	$I_o = 0.1\text{ mA}$
Reset voltage	V_R	1.5	1.9	—	V	$I_o = 0.1\text{ mA}$

Protection Section

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Input threshold	V_{TPC}	0.56	0.61	0.66	V	
Input standby voltage	V_{STBY}	140	185	230	mV	No pull up
Input source current	I_{bpc}	10	15	20	μA	
Comparator threshold voltage	V_{tc}	—	1.23	—	V	Pins 5 and 12

Oscillator Section

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Frequency	f_{OSC}	—	200	—	kHz	$C_T = 330\text{ pF}$, $R_T = 10\text{ k}\Omega$
Initial accuracy	f_{dev}	—	10	—	%	
Voltage stability	f_{dv}	—	1	—	%	

Electrical Characteristics ($T_a = 25^\circ\text{C}$, $V_{CC} = 6\text{ V}$, $f_{OSC} = 200\text{ kHz}$) (cont)

Dead Time Control Section

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Input threshold voltage	Vt0	—	2.05	2.25	V	$f_{OSC} = 10\text{ kHz}$ Duty cycle = 0%
Input threshold voltage	Vt100	1.20	1.45	—	V	$f_{OSC} = 10\text{ kHz}$ Duty cycle = 100%

Error Amp Section

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Input offset voltage	V_{IO}	-6	—	6	mV	V_O (pin 5, 12) = 1.25 V
Input offset current	I_{IO}	-100	—	100	nA	V_O (pin 5, 12) = 1.25 V
Input bias current	I_B	—	160	500	nA	V_O (pin 5, 12) = 1.25 V
Common mode input voltage range	V_{ICR}	1.0	—	1.45	V	$V_{CC} = 3.3\text{ to }40\text{ V}$
Open loop gain	A_V	70	80	—	dB	$R_{NF} = 200\text{ k}\Omega^*$
Band width	GB	—	2.5	—	MHz	
Common mode rejection ratio	CMRR	40	60	—	dB	
Maximum output voltage	V_{OM+}	$V_{ref} - 0.15$	—	—	V	
	V_{OM-}	—	—	1.0		
Output sink current	I_{OM+}	0.5	1.6	—	mA	$V_O = 1.25\text{ V}$
Output source current	I_{OM-}	—	-70	-45	μA	$V_O = 1.25\text{ V}$

Note: R_{NF} is connected between pin 4 and 5 for channel 1, pin 12 and 13 for channel 2.

Output Section

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Collector off-state current (1)	$I_{Leak} (1)$	—	—	10	μA	$V_O = 40\text{ V}$
Collector off-state current (2)	$I_{Leak} (2)$	—	—	10	μA	$V_O = 40\text{ V}$ $V_{CC} = \text{Open}$
Saturation voltage	Vsat	—	1.2	2	V	$I_O = 10\text{ mA}$

HA17451AP/HA17451AFP

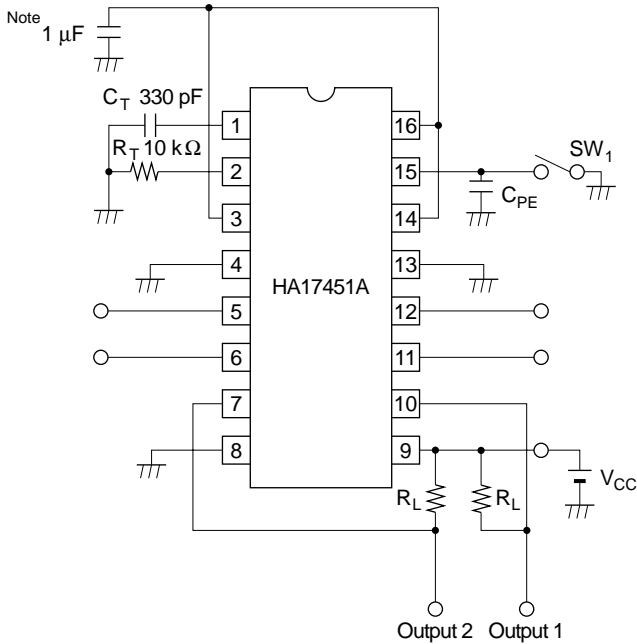
PWM Comparator Section

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Input threshold voltage	Vt0	—	2.05	2.25	V	$f_{osc} = 10 \text{ kHz}$ Duty cycle = 0%
Input threshold voltage	Vt100	1.20	1.45	—	V	$f_{osc} = 10 \text{ kHz}$ Duty cycle = 100%
Input sink current	I _{sink}	0.5	1.6	—	mA	V _O (pin 5, 12) = 1.25 V
Input source current	I _{source}	—	-70	-45	μA	V _O (pin 5, 12) = 1.25 V

Total Current

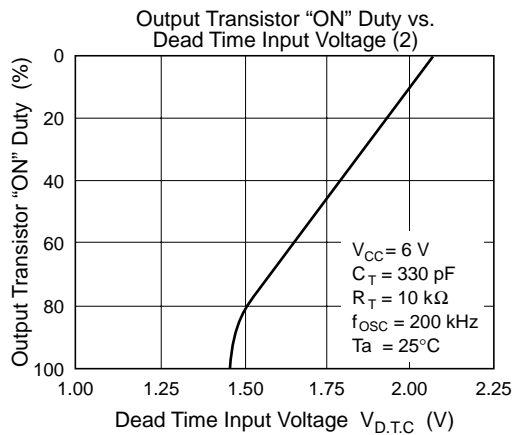
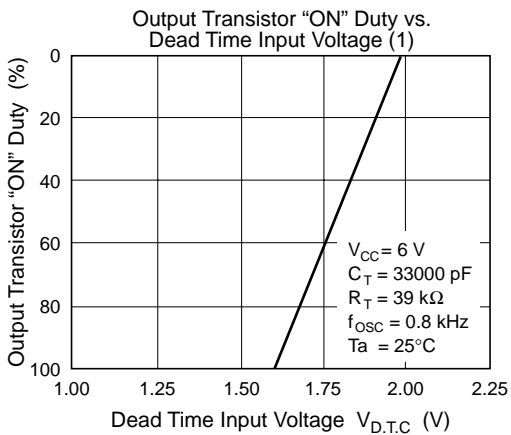
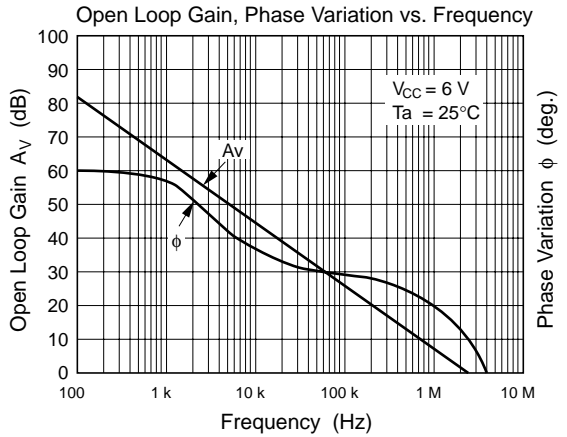
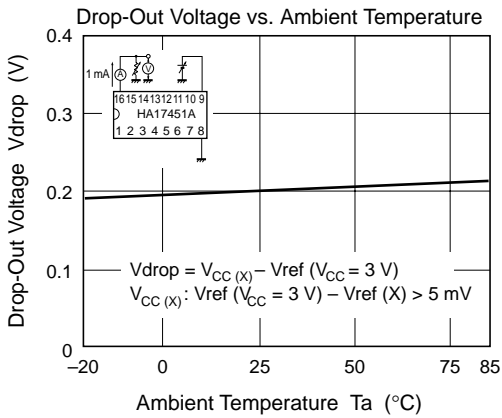
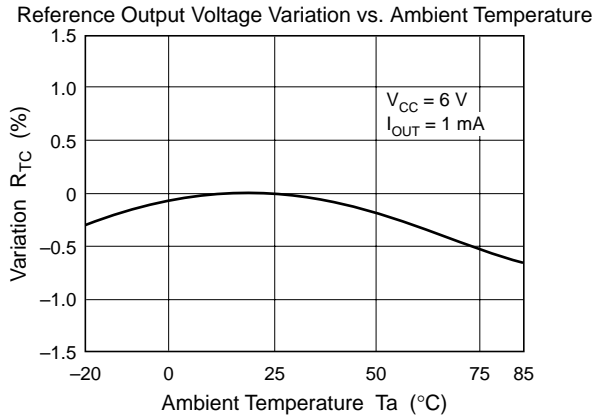
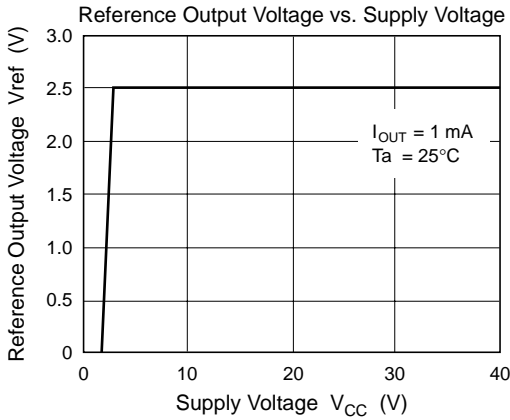
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Standby current	I _{ccs}	—	1.5	2.0	mA	Output off-state
Average supply current	I _{cca}	—	1.9	2.6	mA	R _T = 10 kΩ S _{CP} (pin 15) = 0 V

Test Circuit

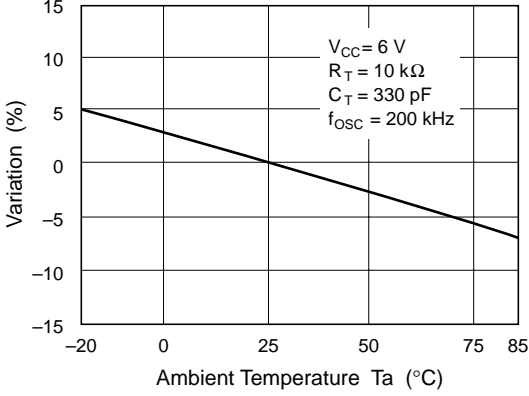


Note: Connect a phase compensating capacitor (at least 1 μF) to Vref.

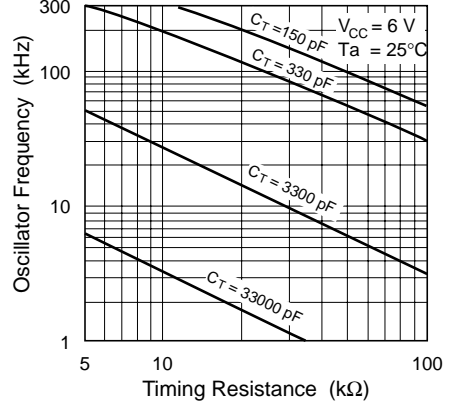
Characteristic Curves



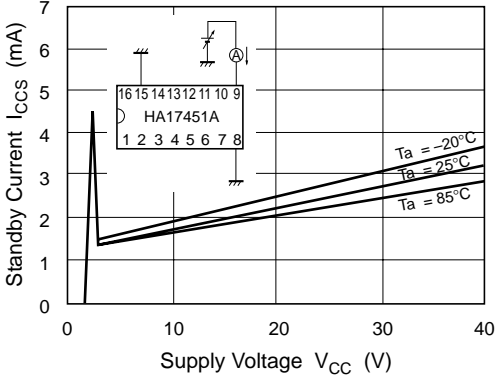
Oscillator Frequency Variation vs. Ambient Temperature



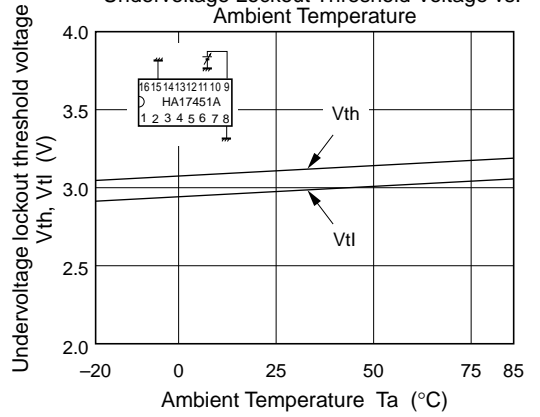
Oscillator Frequency vs. Timing Resistance



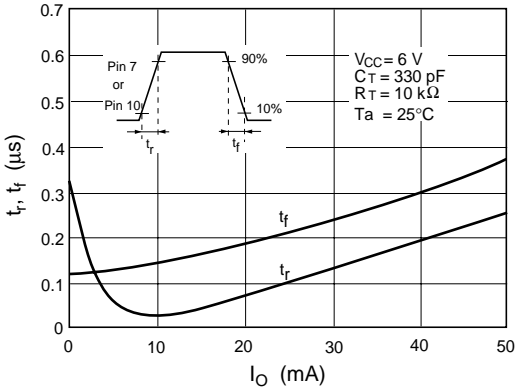
Standby Current vs. Supply Voltage



Undervoltage Lockout Threshold Voltage vs. Ambient Temperature

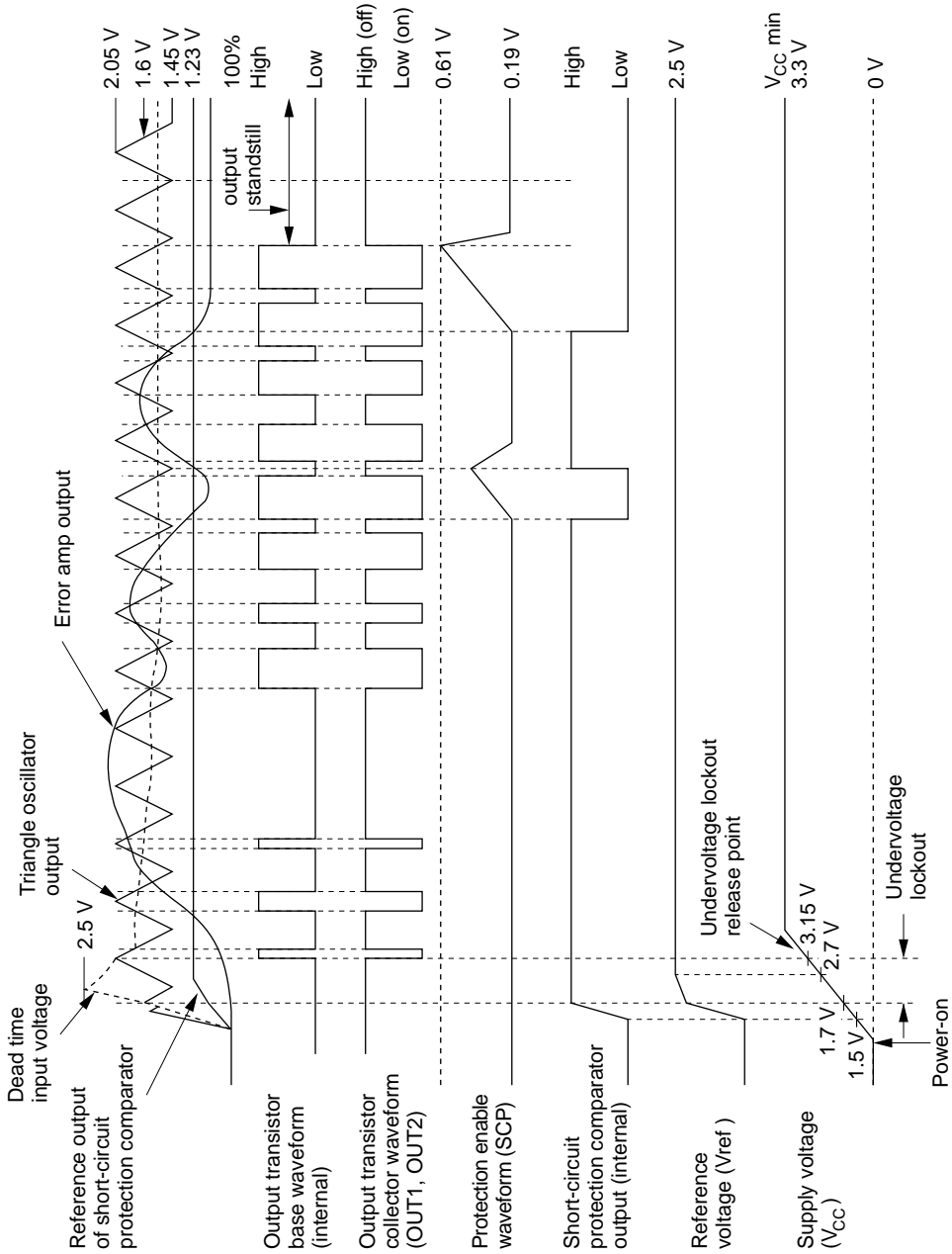


t_r, t_f vs. I_O



Timing Waveforms

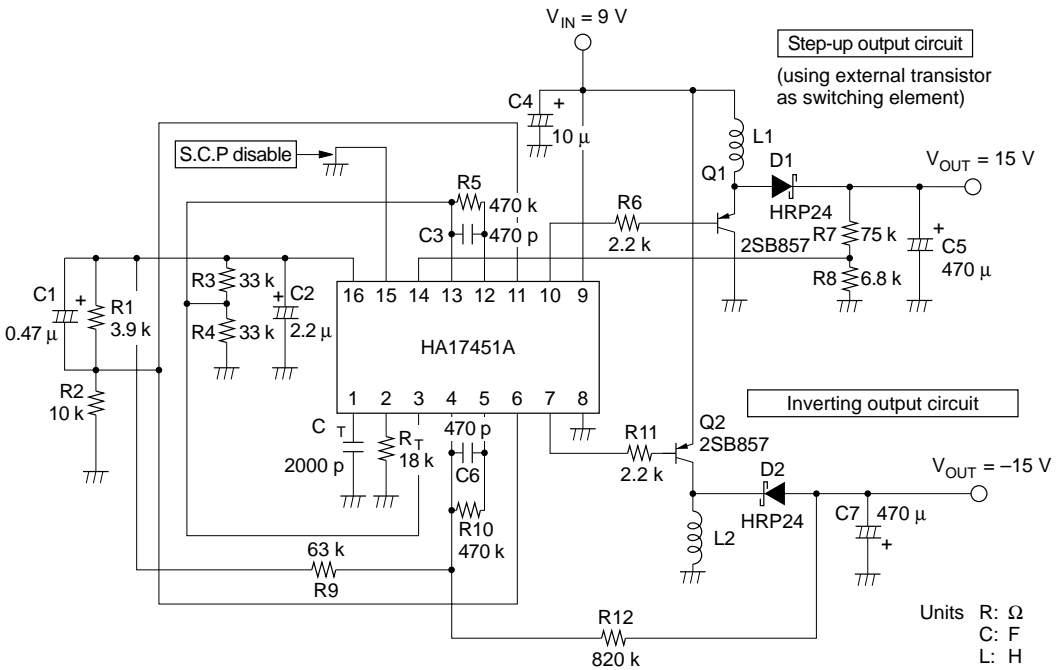
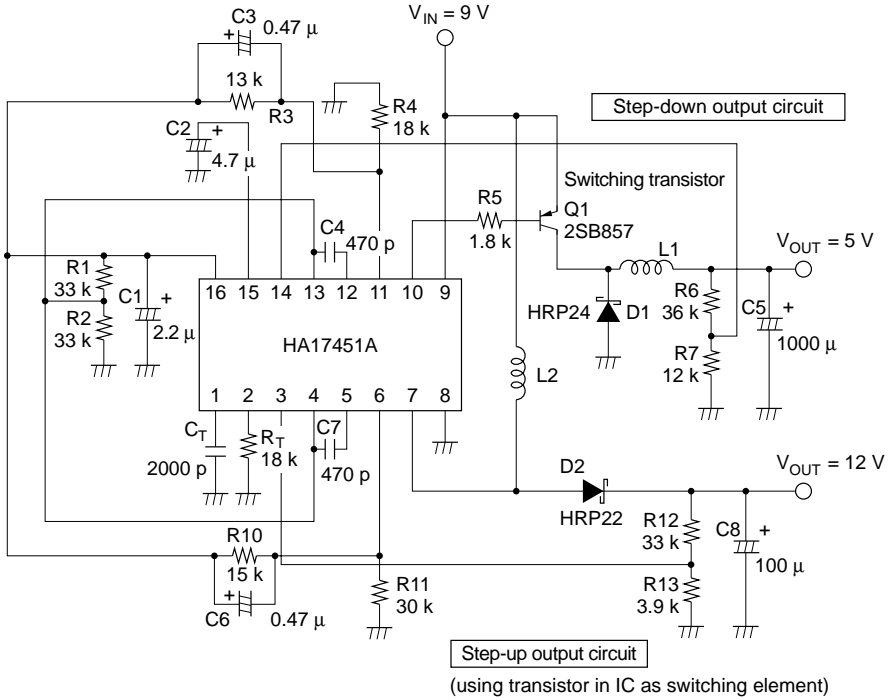
• Internal waveform timing diagram



Notes: Voltages shown in diagram are typical values.

Typical System Configurations

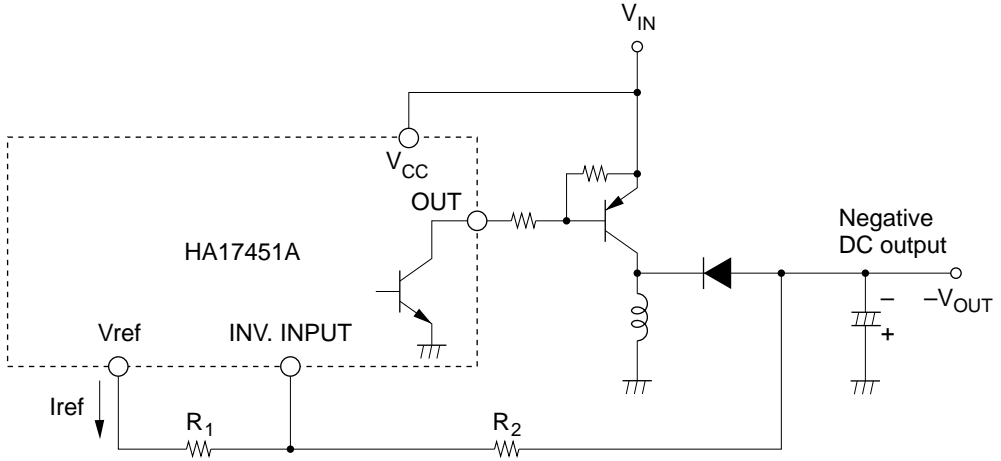
- Dual-output DC/DC converter



Precautions

Precaution concerning inverting (negative voltage) output

Circuit diagram

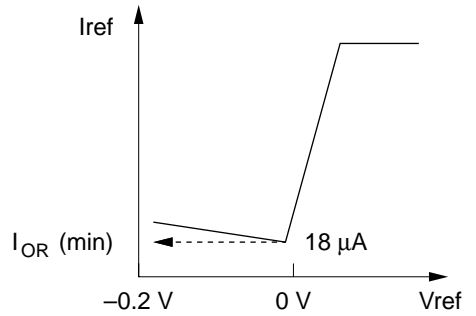


Conditions

To prevent leakage current in the IC from interfering with stable and efficient operation, choose R_1 and R_2 values that satisfy the following condition:

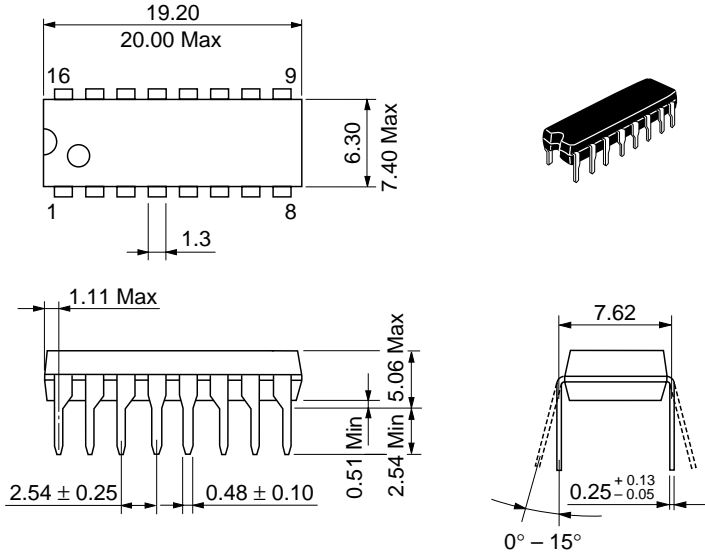
$$R_1 + R_2 > \frac{|V_{OUT}| V}{18 \mu A}$$

- where, R_1, R_2 : Feedback voltage resistors
- $|V_{OUT}|$: Absolute value of negative output voltage
- $18 \mu A$: Minimum current with negative voltage at reference voltage pin; $I_{OR}(\min)$



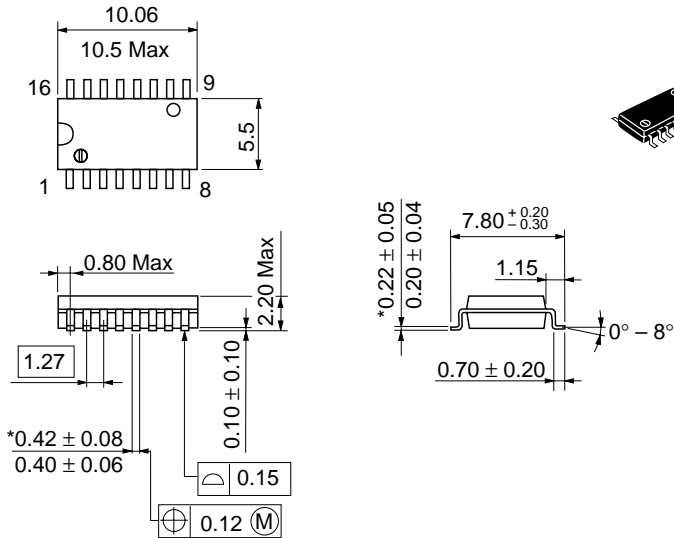
Package Dimensions

Unit: mm



Hitachi Code	DP-16
JEDEC	Conforms
EIAJ	Conforms
Mass (reference value)	1.07 g

Unit: mm



Hitachi Code	FP-16DA
JEDEC	—
EIAJ	Conforms
Mass (reference value)	0.24 g

*Dimension including the plating thickness
Base material dimension

Cautions

1. Hitachi neither warrants nor grants licenses of any rights of Hitachi's or any third party's patent, copyright, trademark, or other intellectual property rights for information contained in this document. Hitachi bears no responsibility for problems that may arise with third party's rights, including intellectual property rights, in connection with use of the information contained in this document.
2. Products and product specifications may be subject to change without notice. Confirm that you have received the latest product standards or specifications before final design, purchase or use.
3. Hitachi makes every attempt to ensure that its products are of high quality and reliability. However, contact Hitachi's sales office before using the product in an application that demands especially high quality and reliability or where its failure or malfunction may directly threaten human life or cause risk of bodily injury, such as aerospace, aeronautics, nuclear power, combustion control, transportation, traffic, safety equipment or medical equipment for life support.
4. Design your application so that the product is used within the ranges guaranteed by Hitachi particularly for maximum rating, operating supply voltage range, heat radiation characteristics, installation conditions and other characteristics. Hitachi bears no responsibility for failure or damage when used beyond the guaranteed ranges. Even within the guaranteed ranges, consider normally foreseeable failure rates or failure modes in semiconductor devices and employ systemic measures such as fail-safes, so that the equipment incorporating Hitachi product does not cause bodily injury, fire or other consequential damage due to operation of the Hitachi product.
5. This product is not designed to be radiation resistant.
6. No one is permitted to reproduce or duplicate, in any form, the whole or part of this document without written approval from Hitachi.
7. Contact Hitachi's sales office for any questions regarding this document or Hitachi semiconductor products.

HITACHI

Hitachi, Ltd.

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

URL NorthAmerica : <http://semiconductor.hitachi.com/>
 Europe : <http://www.hitachi-eu.com/hel/ecg>
 Asia (Singapore) : <http://www.has.hitachi.com.sg/grp3/sicd/index.htm>
 Asia (Taiwan) : http://www.hitachi.com.tw/E/Product/SICD_Frame.htm
 Asia (HongKong) : <http://www.hitachi.com.hk/eng/bo/grp3/index.htm>
 Japan : <http://www.hitachi.co.jp/Sicd/indx.htm>

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 Straße 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

Copyright ' Hitachi, Ltd., 1998. All rights reserved. Printed in Japan.

HITACHI