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# HA17451AP/HA17451AFP

Switching Regulator Controllers for DC/DC Converters

# HITACHI

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## 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

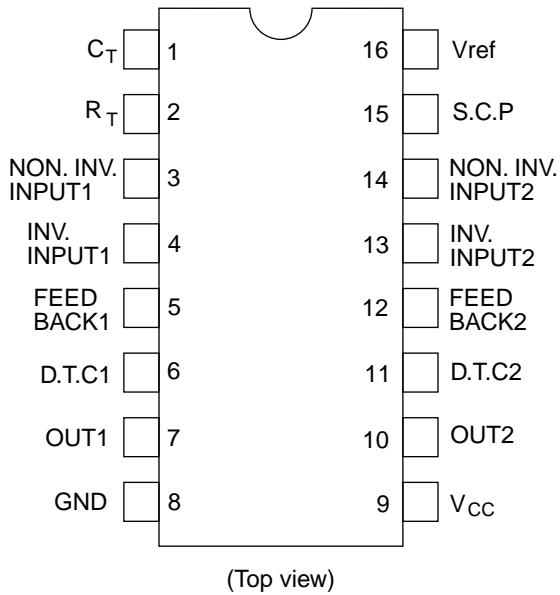
## Features

- 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

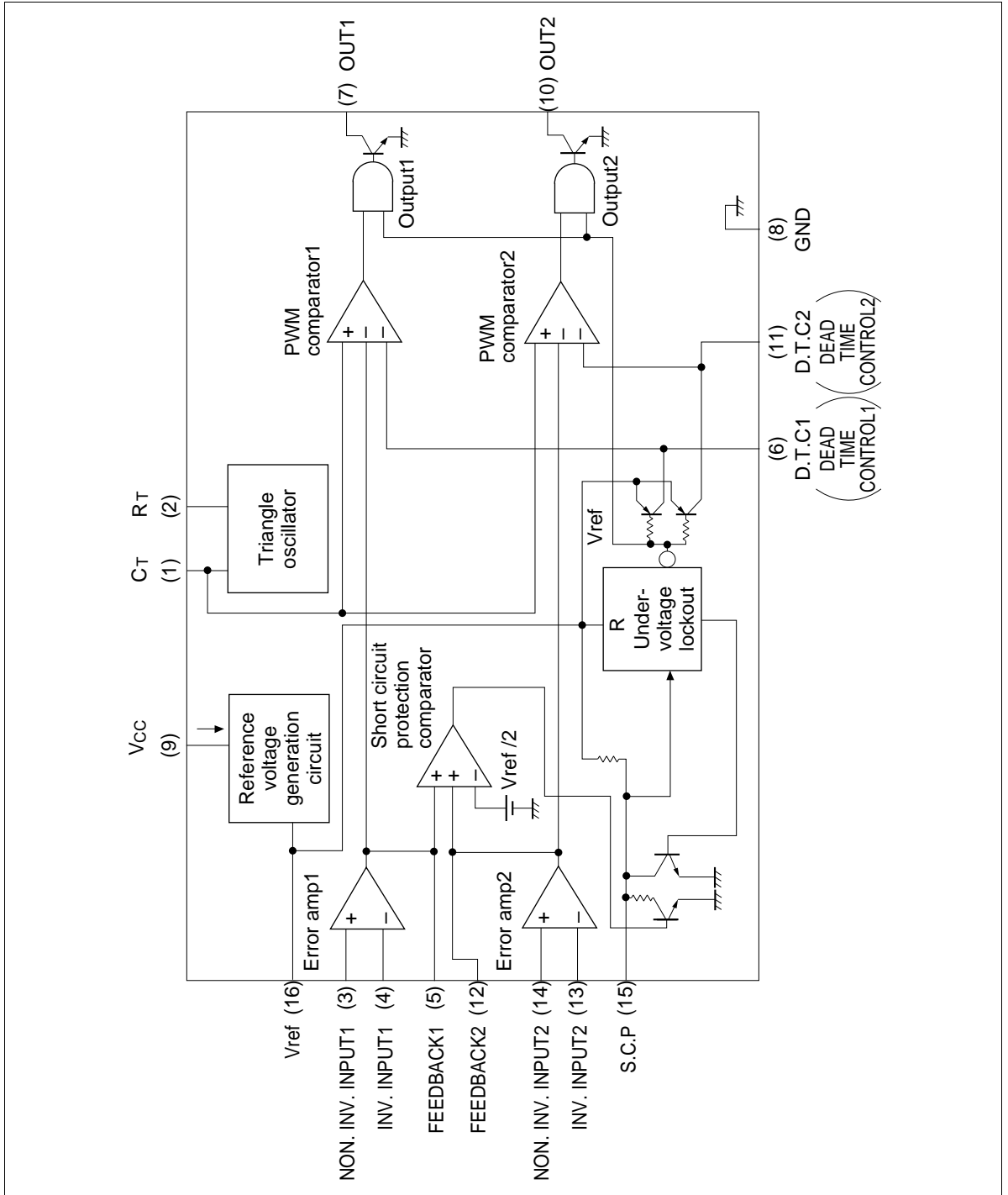
## Pin Arrangement



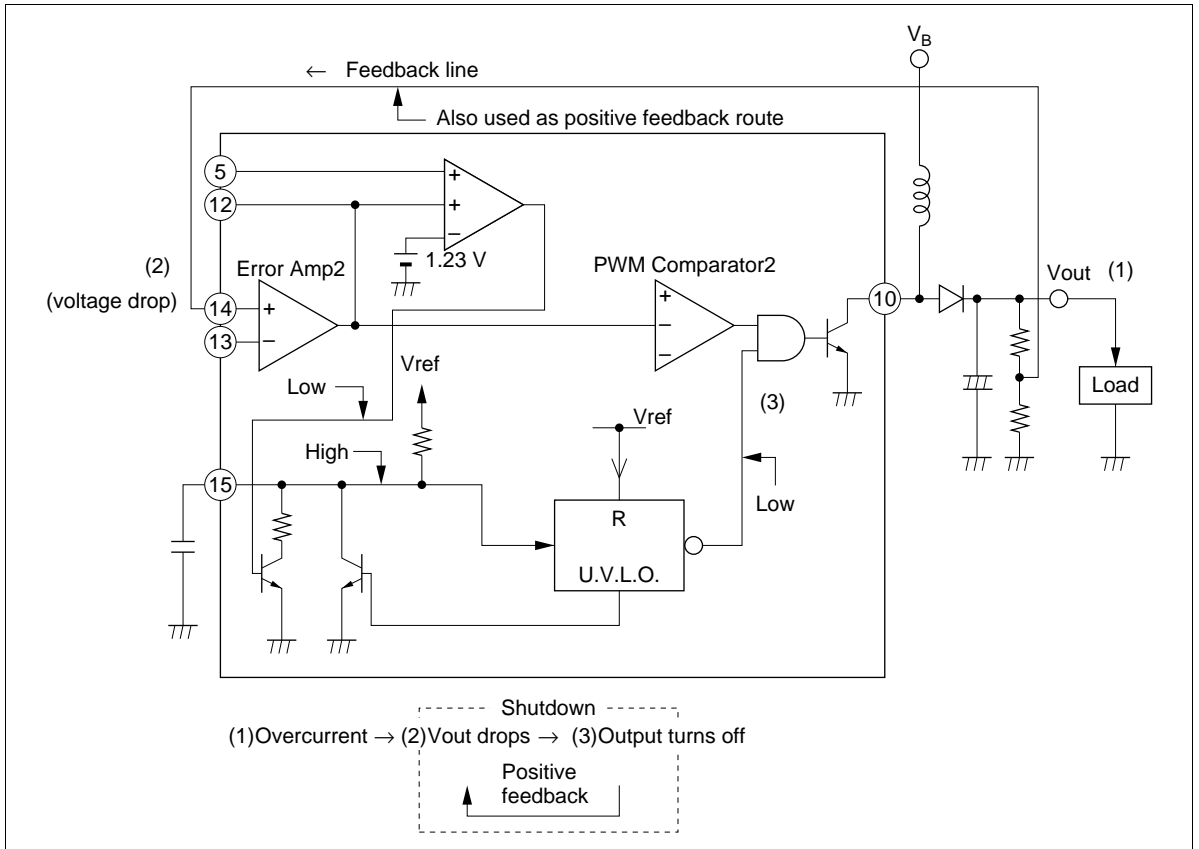
## Pin Functions

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 (Ta = 25°C)

Item	Symbol	Rating	Unit	Note
Power supply voltage	V <sub>CC</sub>	40	V	
Error amplifier input voltage	V <sub>I</sub>	20	V	
Collector output voltage	V <sub>O</sub>	40	V	
Collector output current	I <sub>O</sub>	50	mA	
Power dissipation	P <sub>T</sub>	680	mW	*
Operating temperature	T <sub>opr</sub>	- 20 to +85	°C	
Storage temperature	T <sub>stg</sub>	- 55 to +125	°C	

Note: This value applies to the HA17451AP at ambient temperatures up to Ta = 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	—	—	$\mu\text{A}$	$-0.2\text{ V} < V_{ref} < 0\text{ V}$

**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	$\mu\text{A}$	
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	$V_{t0}$	—	2.05	2.25	V	$f_{OSC} = 10\text{ kHz}$ Duty cycle = 0%
Input threshold voltage	$V_{t100}$	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	$\mu\text{A}$	$V_O = 1.25\text{ V}$

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	$\mu\text{A}$	$V_O = 40\text{ V}$
Collector off-state current (2)	$I_{Leak} (2)$	—	—	10	$\mu\text{A}$	$V_O = 40\text{ V}$ $V_{CC} = \text{Open}$
Saturation voltage	$V_{sat}$	—	1.2	2	V	$I_O = 10\text{ mA}$

# HA17451AP/HA17451AFP

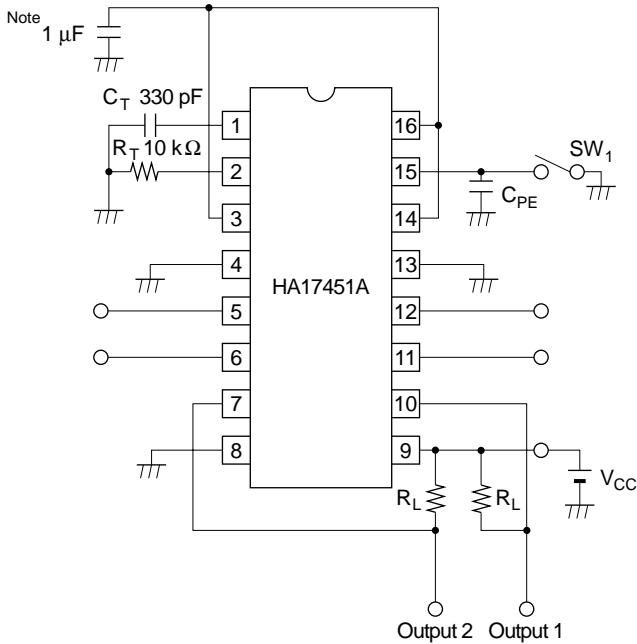
## PWM Comparator Section

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 <sub>sink</sub>	0.5	1.6	—	mA	V <sub>O</sub> (pin 5, 12) = 1.25 V
Input source current	I <sub>source</sub>	—	-70	-45	μA	V <sub>O</sub> (pin 5, 12) = 1.25 V

## Total Current

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

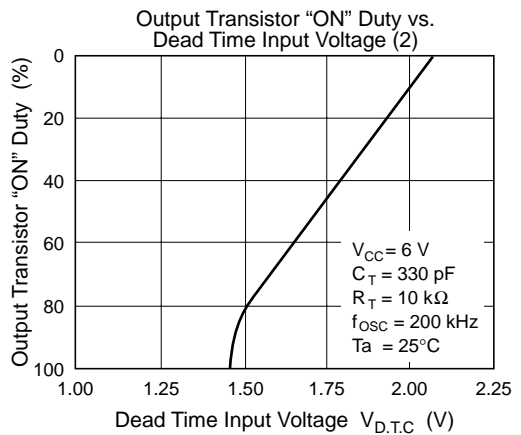
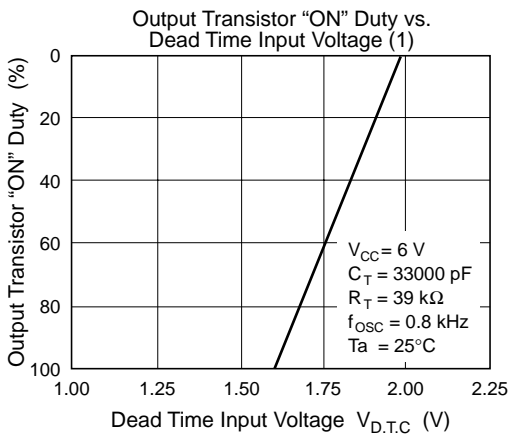
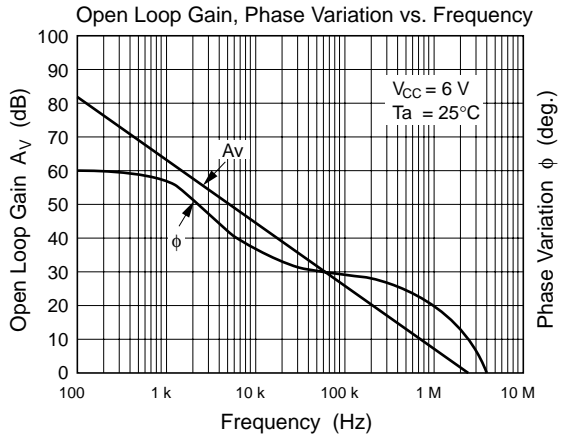
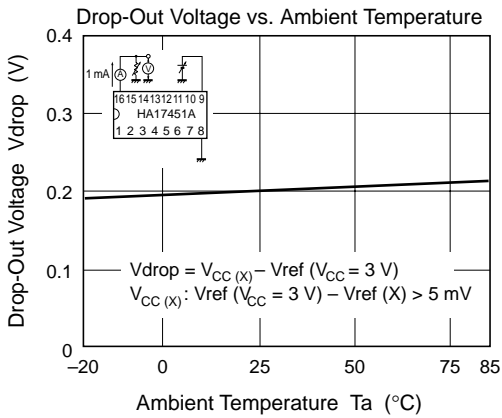
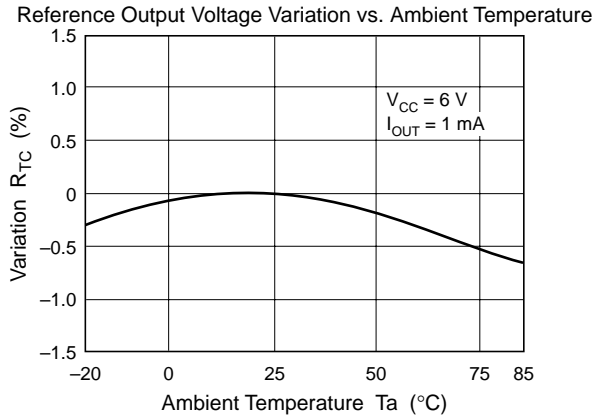
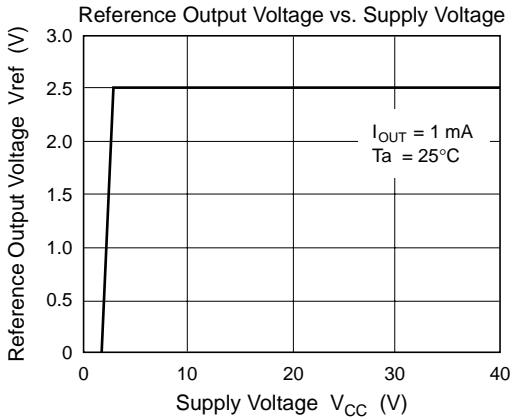
## Test Circuit



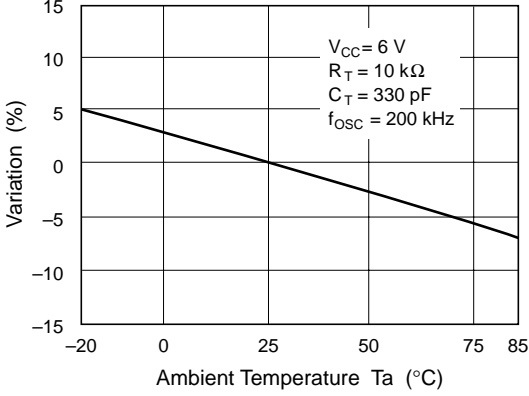
Note: Connect a phase compensating capacitor (at least 1 μF) to Vref.



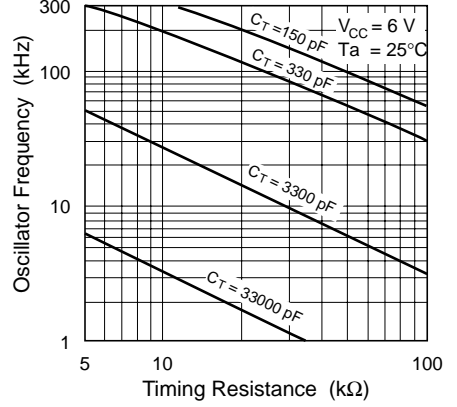
Characteristic Curves



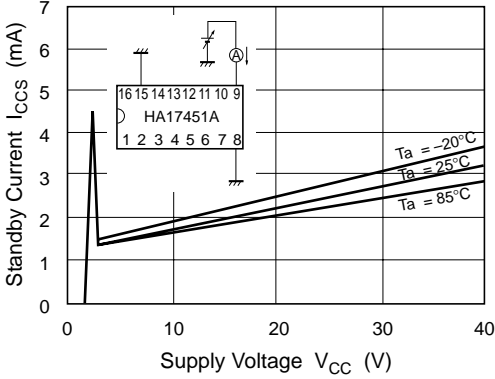
Oscillator Frequency Variation vs. Ambient Temperature



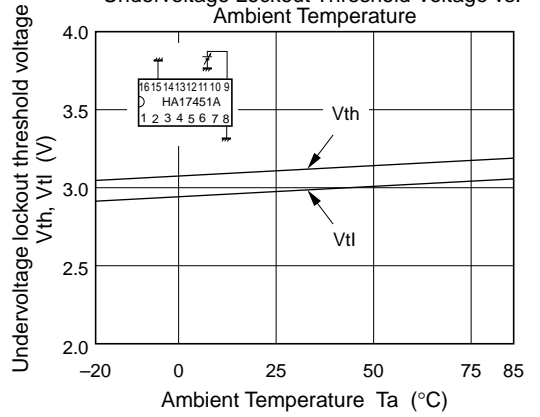
Oscillator Frequency vs. Timing Resistance



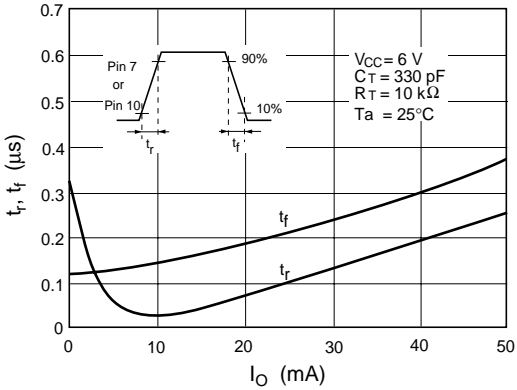
Standby Current vs. Supply Voltage



Undervoltage Lockout Threshold Voltage vs. Ambient Temperature

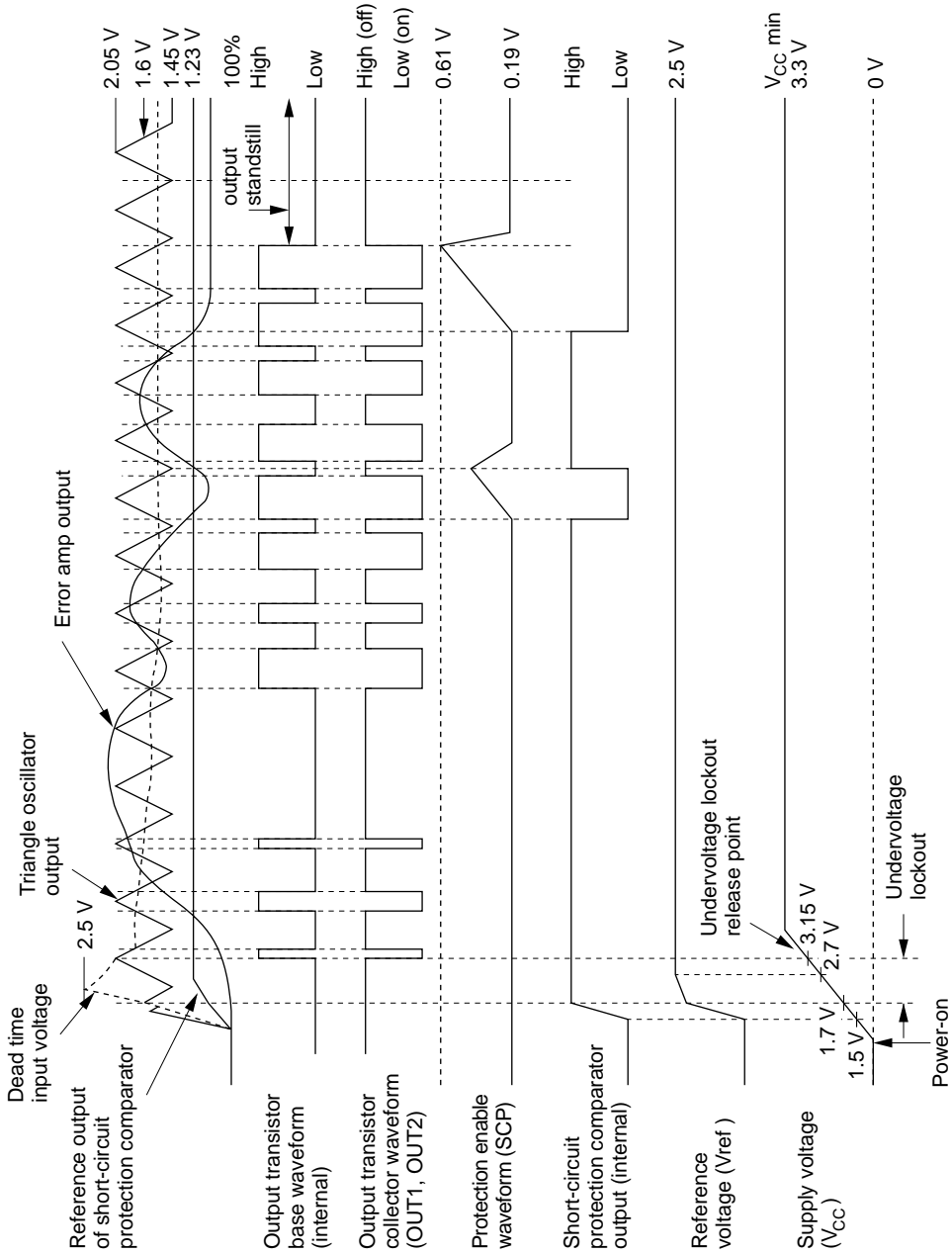


$t_r, t_f$  vs.  $I_O$



Timing Waveforms

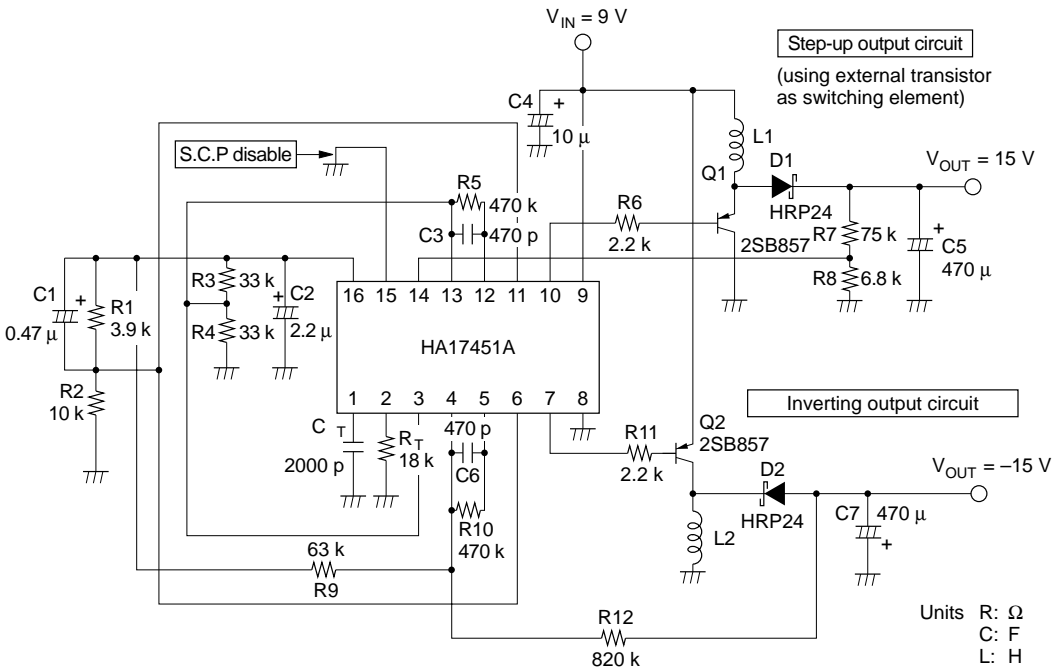
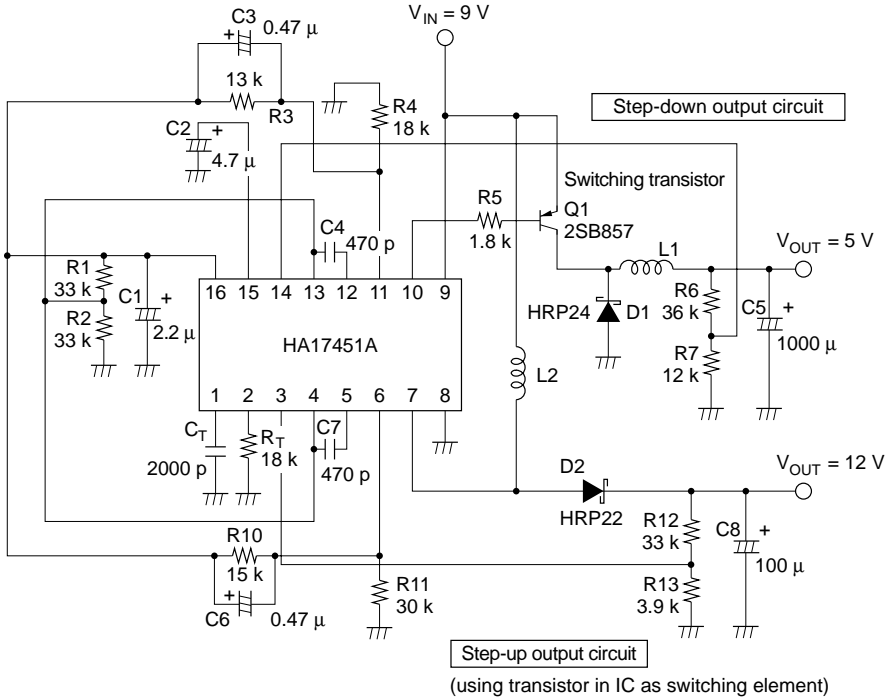
• Internal waveform timing diagram



Notes: Voltages shown in diagram are typical values.

## Typical System Configurations

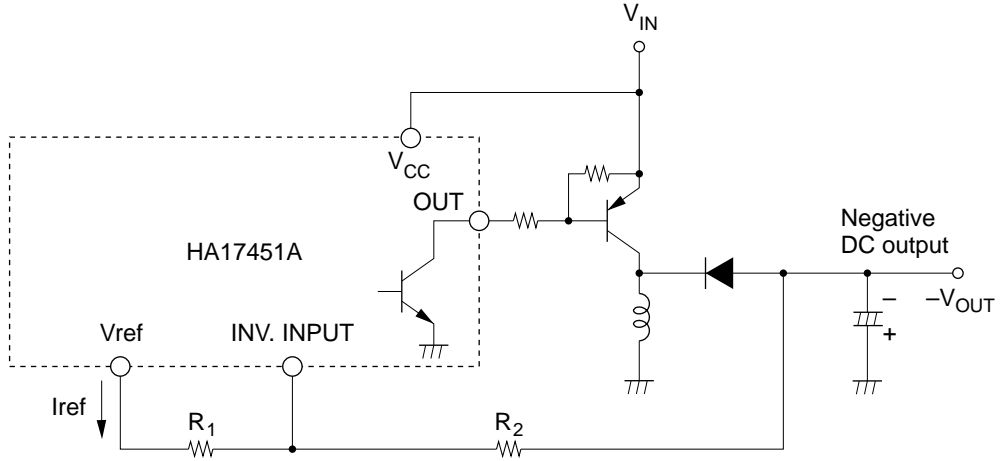
- Dual-output DC/DC converter



**Precautions**

Precaution concerning inverting (negative voltage) output

Circuit diagram

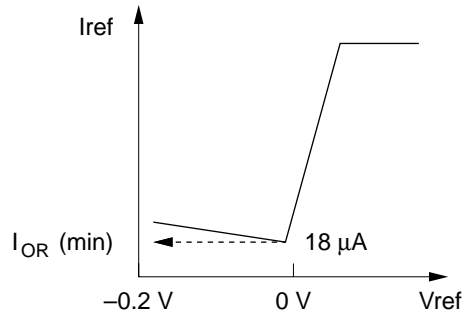


Conditions

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:

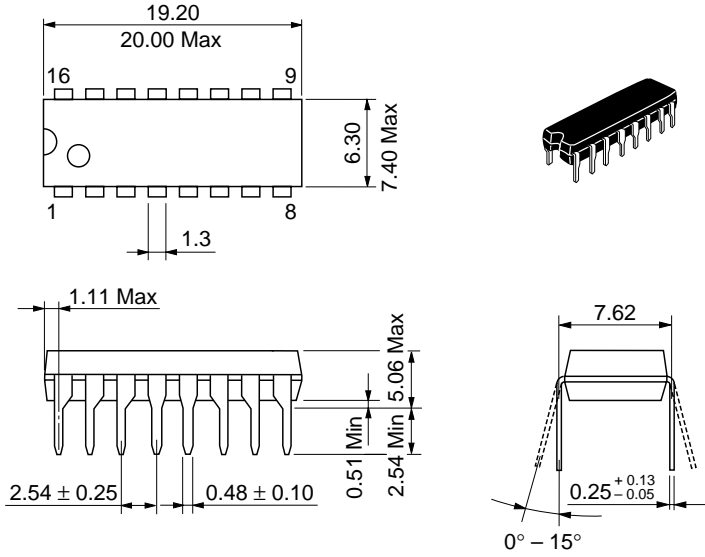
$$R_1 + R_2 > \frac{|V_{OUT}| V}{18 \mu A}$$

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;  $I_{OR}(\min)$



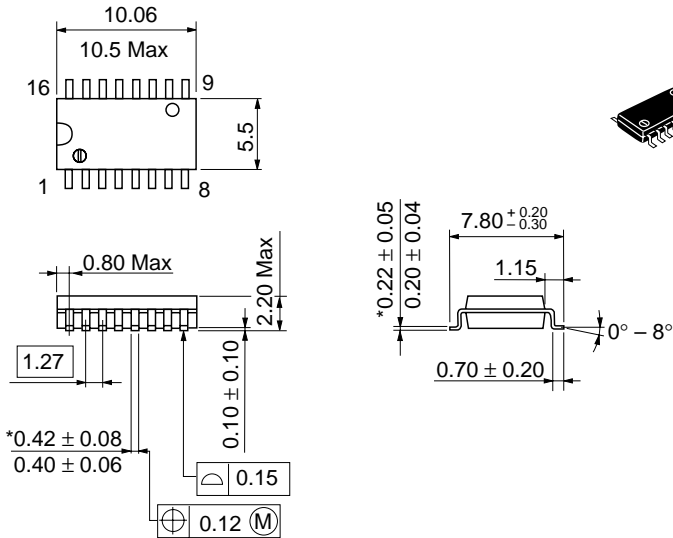
## Package Dimensions

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

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