HA16666P/FP

600kHz PWM Controlled Switching Regulator

HITACHI

Description

The HA16666P/FP is a voltage mode PWM (pulse width modulation) control IC for switching regulator control. It can drive a power MOS FET efficiently on 600 kHz. Its stanby current is 0.3 mA (max), and it is used as the primary control power supply.

Functions

- +5 V reference voltage circuit
- Triangular waveform oscillator
- PWM comparator
- Output circuit (Totem pole output)
- Overcurrent protection circuit (with one-pulselatch mode)
- Undervoltage lockout protectoin circuit
- Soft start and quick shutdown function
- Remote control function
- Comparator with internal 1.3 V reference voltage

Features

- High-speed switching;
  tr = 80 ns (15 V amplitude)
  tf = 40 ns (15 V amplitude)
- Low power dissipation;
  0.3 mA max in standby state
  12 mA max in operation state (V_{IN} = 15 V)
- Dual-slope highly accurate dead-band duty setup circuit; Setup accuracy Du = ±3% (max)
- Wide output pulse width control range; 0 to 75%

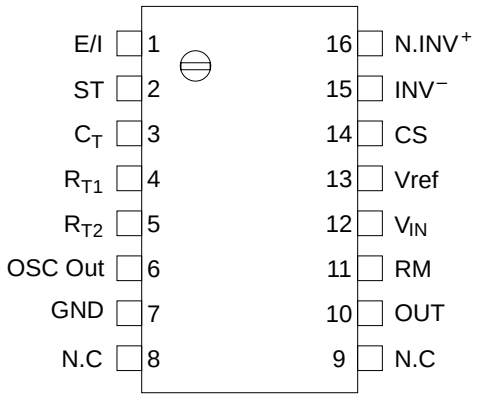
Hitachi semiconductor

- Undervoltage lockout protection;
  V_{IN} high threshold voltage 10 V typ
  V_{IN} low threshold voltage 8 V typ
- Two input threshold voltage for overcurrent protection cmparator;
  fixed voltage (1.3 V)
  variable voltage
- Double pulse output protection by overcurrent protection circuit with one-pulse latch mode
- Wide input supply voltage range; V_{CC} = 11 to 40 V

Ordering Information

Type	Package
HA16666P	DP-16
HA16666FP	FP-16DA

Pin Arrangement

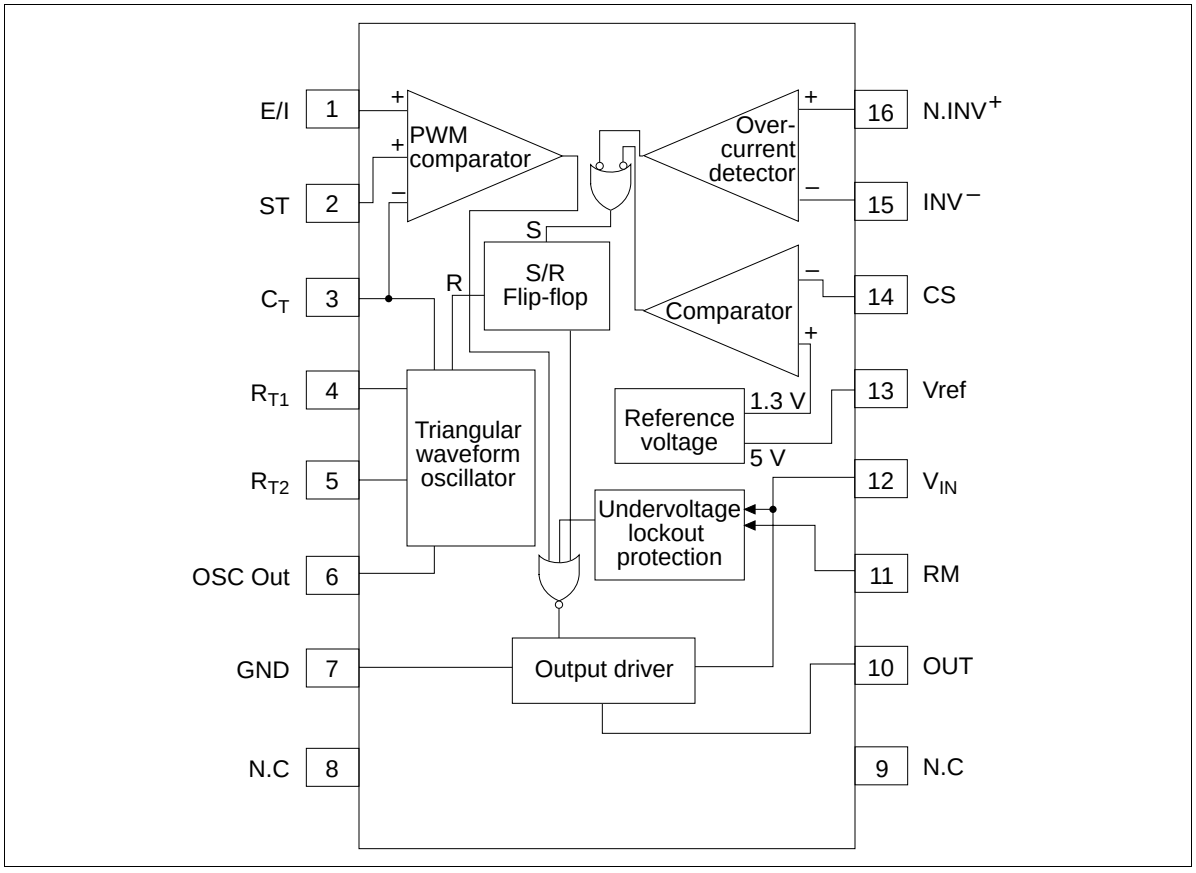


(Top View)

Pin Functions

Pin No.	Symbol	Descreption
1	E/I	Error input
2	ST	Soft start
3	C_T	Timing capacitance
4	R_{T1}	Timing resistor (rise section)
5	R_{T2}	Timing resistor (fall section)
6	OSC Out	Triangular waveform oscillator
7	GND	Ground
8	N.C	No connect
9	N.C	No connect
10	OUT	Pulse output
11	RM	Remote control
12	V_{IN}	Power supply voltage
13	Vref	Reference voltage (5 V) output
14	CS	Comparator input (–) with reference voltage (1.3 V)
15	INV^-	Comparator input (–) for overcurrent protection
16	$N.INV^+$	Comparator input (+) for overcurrent protection

Block Diagram



Absolute Maximum Ratings (Ta = 25°C)

Item		Symbol	Rating HA16666P	Rating HA16666FP	Unit
Power supply voltage		V_{IN}	+40	+40	V
Output current (Push-pull)	DC	$I_{O(DC)}$	100	100	mA
	Peak	$I_{O(peak)}$	500*1	500*[1]	mA
Error input		V_{EI}	Vref	Vref	V
OSC input voltage		V_{OSC}	$V_{IN} - 3V_{BE}$	$V_{IN} - 3V_{BE}$	V
CS input voltage		V_{CS}	Vref	Vref	V
RM input voltage		V_{RM}	V_{IN}	V_{IN}	V
RT2 input current		I_{R2}	1	1	mA
RT1 input current		I_{R1}	1	1	mA
Power dissipation		P_T	680*[2]	680*[3]	mW
Operation temperature		Topr	–20 to +85	–20 to +85	°C
Storage temperature		Tstg	–55 to +125	–55 to +125	°C

Notes: 1. Value at 300 ns of switiching time
2. Value at Ta ≤ 45°C. If Ta > 45°C, derated by 8.3 mW/°C
3. Value under the condition of 40 mm × 40 mm × 0.8 t ceramics board epoxy board

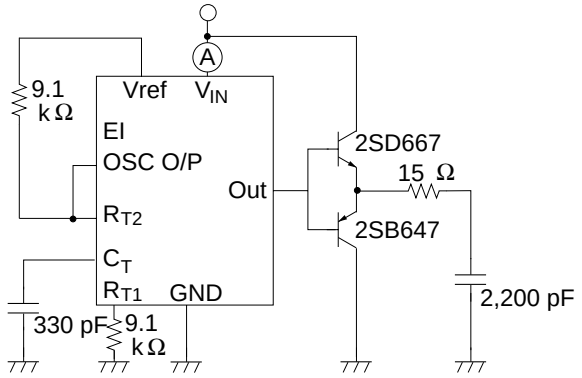
Electrical Characteristics (V_{IN} = 15 V, Ta = 25°C, fosc = 300 kHz)

Item		Symbol	Min	Typ	Max	Unit	Test Condition
Voltage reference	Output voltage	Vref	4.75	5.00	5.25	V	no load
	Line regulation	Line	—	50	100	mV	V_{IN} = 11 to 40 V
	Load regulation	Load	—	9	20	mV	I_O = 0 to 10 mA
	Temperature stability	V_{RTC}	—	+60	—	ppm/°C	no load
	Short circuit current	I_{OS}	10	35	—	mA	Vref = 0 V
Triangular waveform oscillator	Maximum frequency	f_{max}	600	—	—	kHz	C_T = 150 pF
	Minimum frequency	f_{min}	—	—	1	kHz	C_T = 0.15 µF
	Frequency accuracy	f_{der}	–10	0	+10	%	
	Voltage stability	f_T	—	1	—	%	11 V≤ V_{IN} ≤40 V
	Temperature coefficient of frequency	f_i	—	2	—	%	–20°C ≤ Ta ≤ +85°C

Electrical Characteristics (V_{IN} = 15 V, Ta = 25°C, fosc = 300 kHz) (cont)

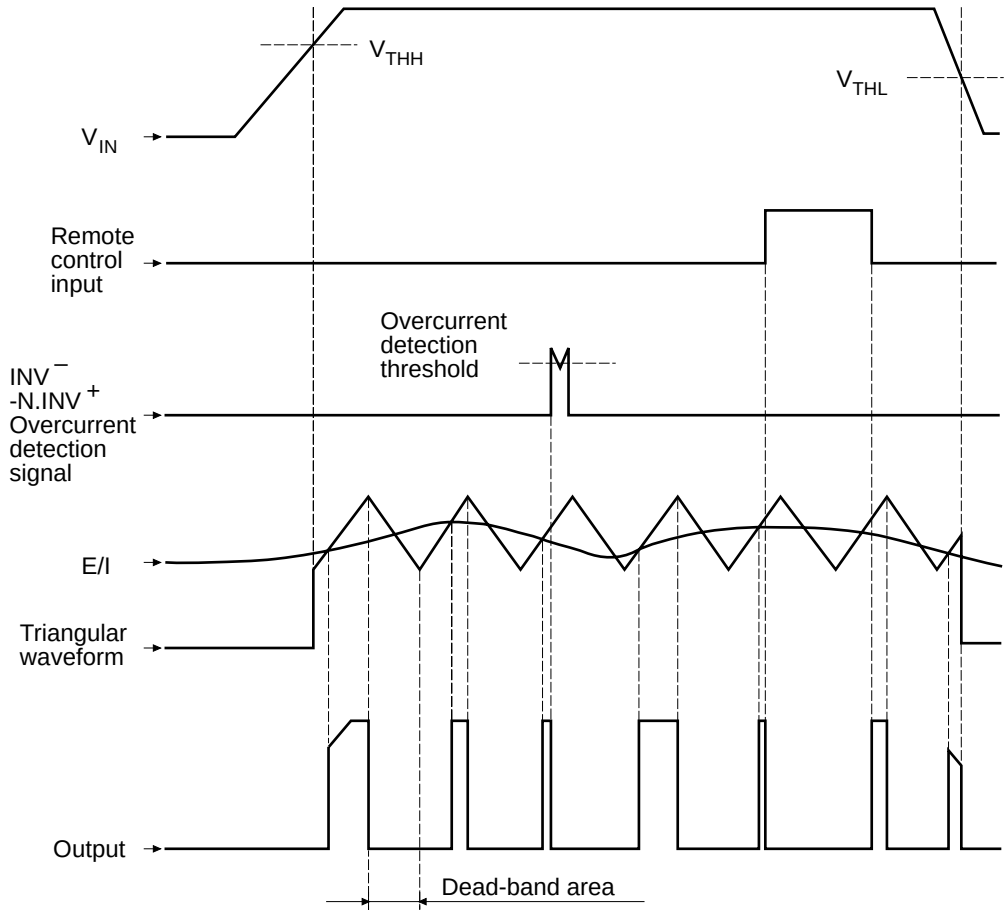
Item		Symbol	Min	Typ	Max	Unit	Test Condition
PWM comparator	Maximum duty cycle	Du	75	—	—	%	
	Input bias current	I_B	–2	—	—	µA	Pin 1
	Low-level threshold voltage	V_{OSCL}	—	1.5	—	V	Pin 1
	High-level threshold voltage	V_{OSCH}	—	2.5	—	V	Pin 1
	Dead-band duty accuracy	Δ Du	—	±1	±3	%	
	Dead-band duty input voltage stability	D_T	—	1	—	%	11 V≤ V_{IN} ≤ 40 V
	Temperature coefficient of dead-band duty	D_{uT}	—	1	—	%	–20°C ≤ Ta ≤ +85°C
Overcurrent detector	Input bias current	I_{B1}	–2	—	—	µA	Pin 15, 16
	Common-mode input voltage range	V_{CM1}	0 to V_{IN} – 3	—	—	V	Pin 15, 16
Comparator	Input bias current	I_{B2}	—	5	13	µA	V_{CS} = 5 V
	Input threshold voltage	Vth	1.2	1.3	1.4	V	
	Input voltage range	V_{CS}	0	—	Vref	V	
Remote controller	Input current to remote control pin	I_{RM}	—	—	1.5	mA	V_{RM} = 5 V
	Input high-voltage	V_{INH}	1	—	—	V	
	Input low-voltage	V_{INL}	—	—	0.4	V	
Undervoltage lockout protector	High-level threshold voltage	V_{THH}	9	10	11	V	
	Low-level threshold voltage	V_{THL}	7	8	9	V	
	Hysteresis width	Hys	1.5	2.0	2.8	V	
Output driver	Output low-level	V_L	—	0.7	1.4	V	$I_{O\ (SINK)}$ = 10 mA
	Output high-level	V_H	V_{IN} – 2.2	—	—	V	$I_{O\ (SOURCE)}$ = 10 mA
	Output rise time	t_r	—	80	150	ns	Note 1
	Output fall time	t_f	—	40	100	ns	Note 1
Total current	Standby current	I_{CS}	—	0.15	0.3	mA	Note 1
	Operation current	I_{CL}	—	8	12	mA	Note 1

Note: 1. Measurement conditions of I_{CS}, I_{CL}, t_r, t_f are defined as following diagram.



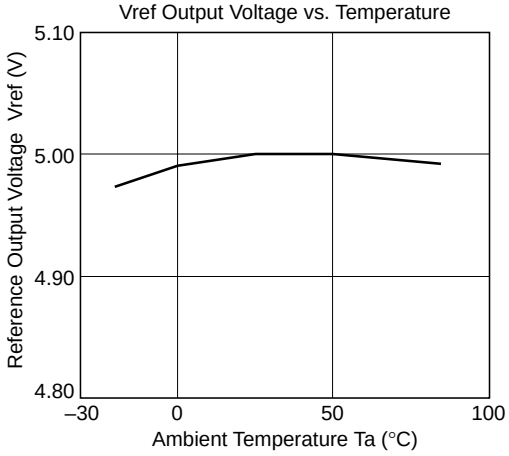
h_{FE} of 2SD667 is defined as 60 min and 200 max.

Waveform Timing

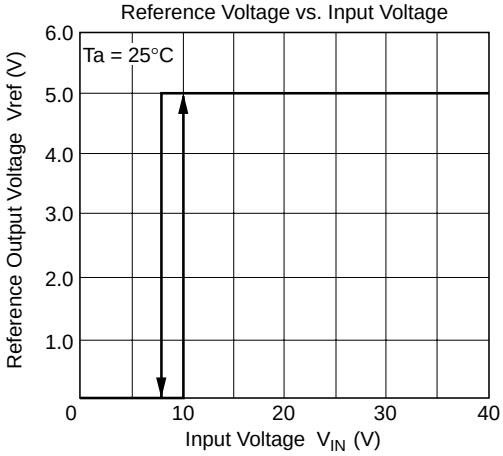


Characteristic Curves

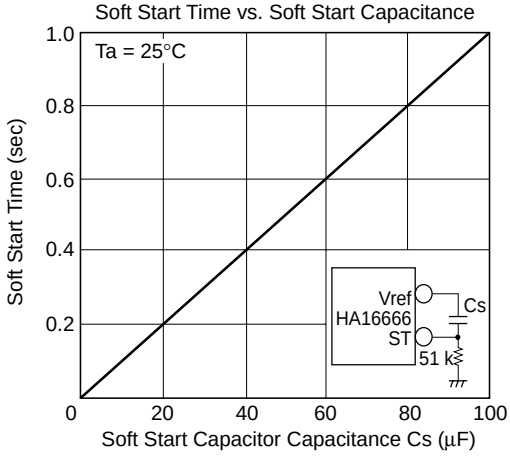
Vref Output Voltage vs. Temperature



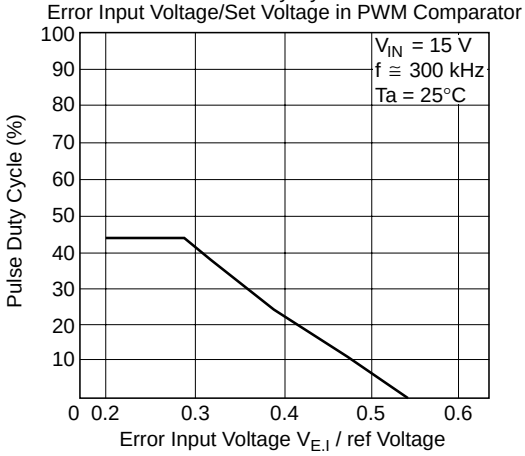
Reference Voltage vs. Input Voltage



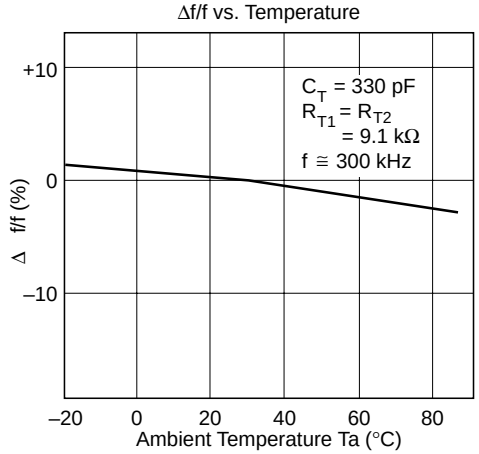
Soft Start Time vs. Soft Start Capacitance



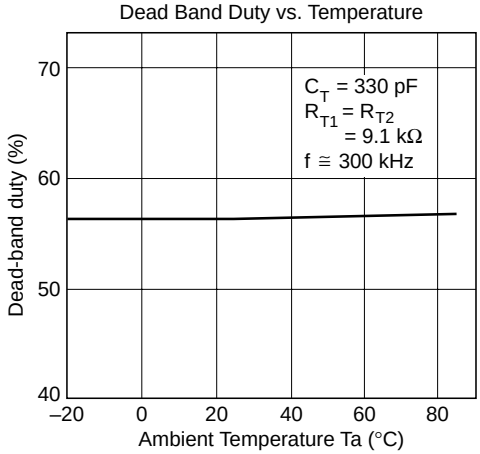
Pulse Duty Cycle vs.
Error Input Voltage/Set Voltage in PWM Comparator



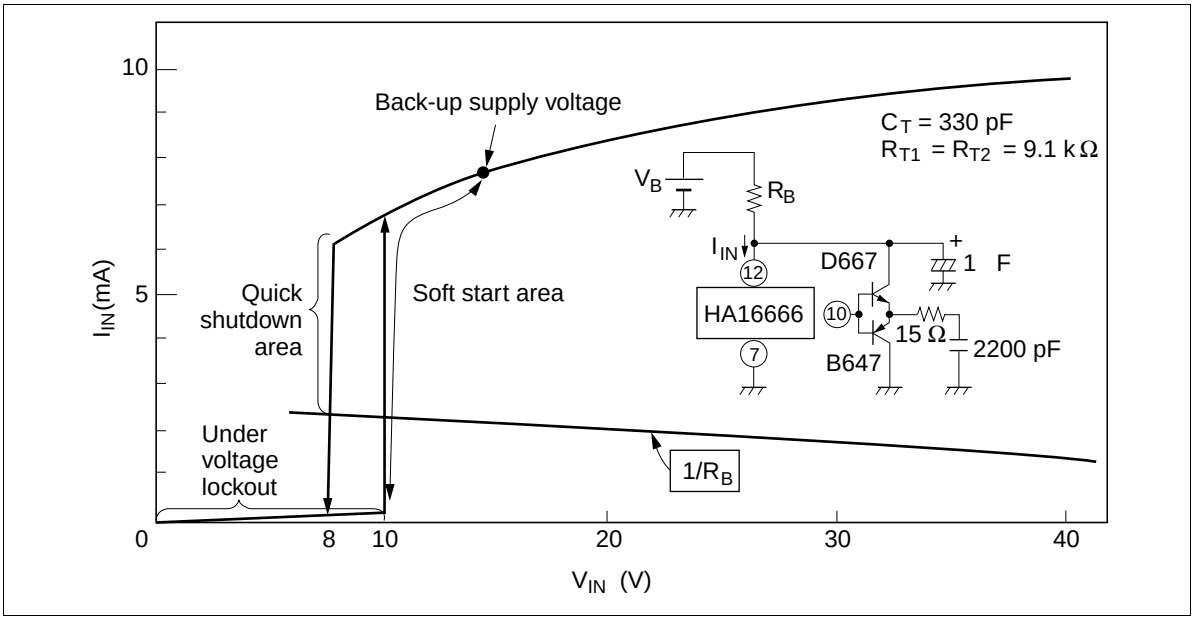
Δf/f vs. Temperature



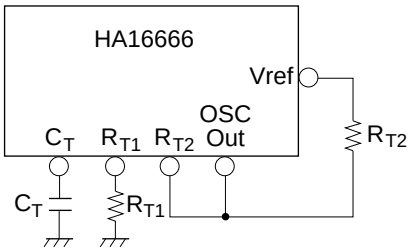
Dead Band Duty vs. Temperature



V_{IN} Bias Point



Formula for the oscillation frequency



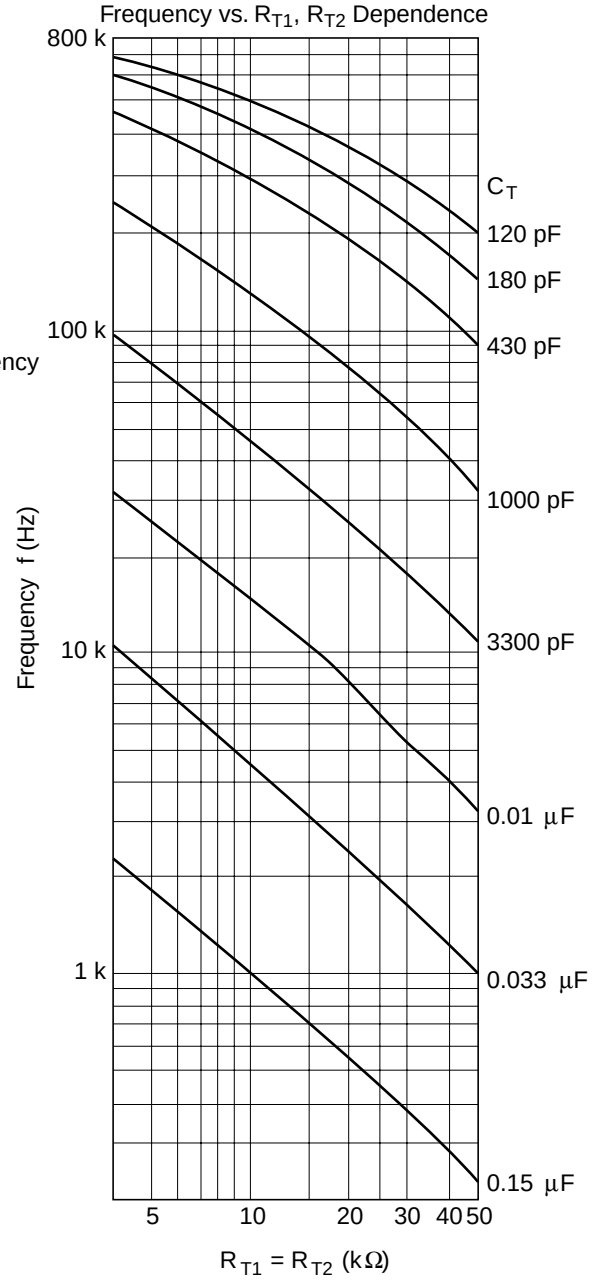
HA16666 summary formula of the oscillation ferquency

$$\log (f) \approx a \times \log \left(\frac{R_{T1}}{(= R_{T2})}\right) + b$$

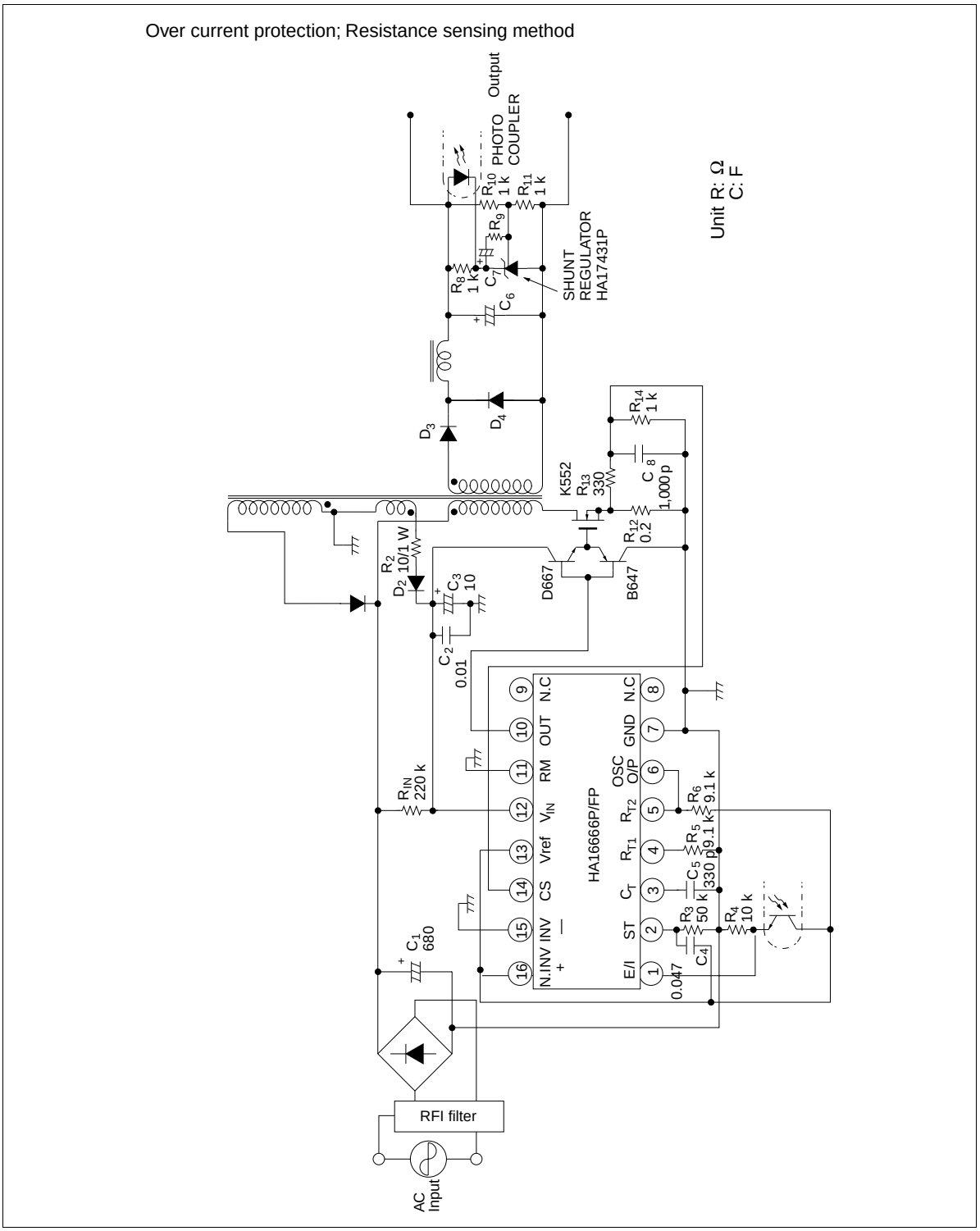
The following table show empirical values of a and b for different values of C_T.

C_T	a	b
180pF	–0.50	7.58
330pF	–0.61	7.86
1000pF	–0.75	8.09
0.01µF	–0.86	7.57
0.15µF	–0.86	6.45

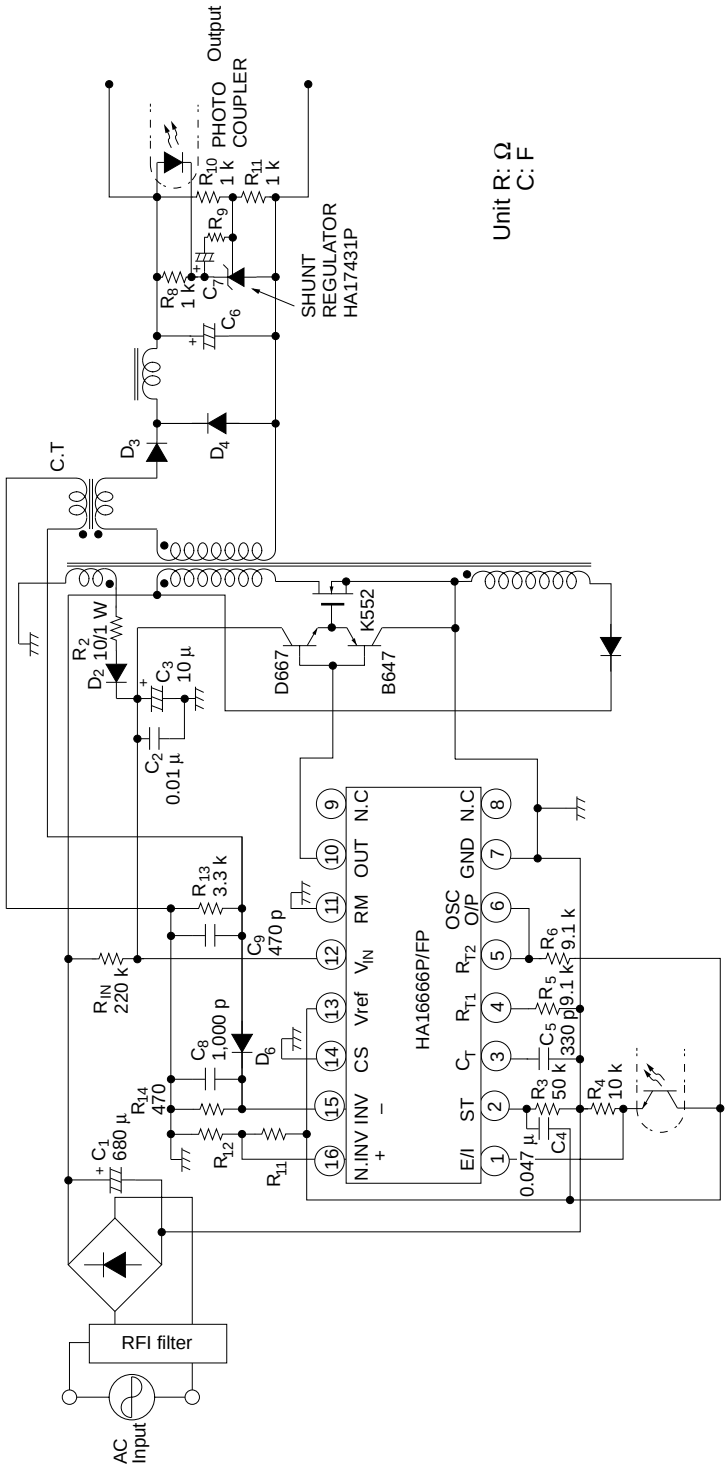
Frequency vs. R_{T1}, R_{T2} Dependence



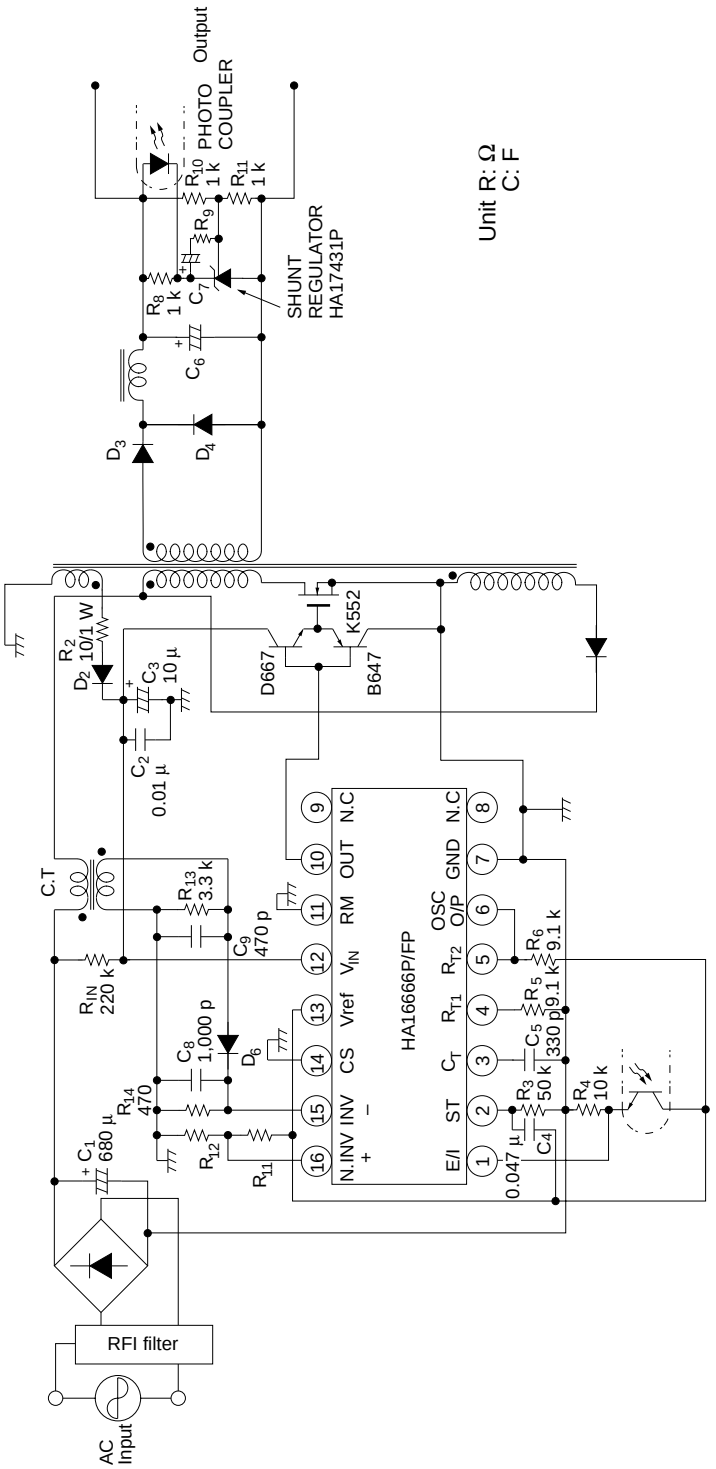
System Connection Example



Over current protection; Current transformer method

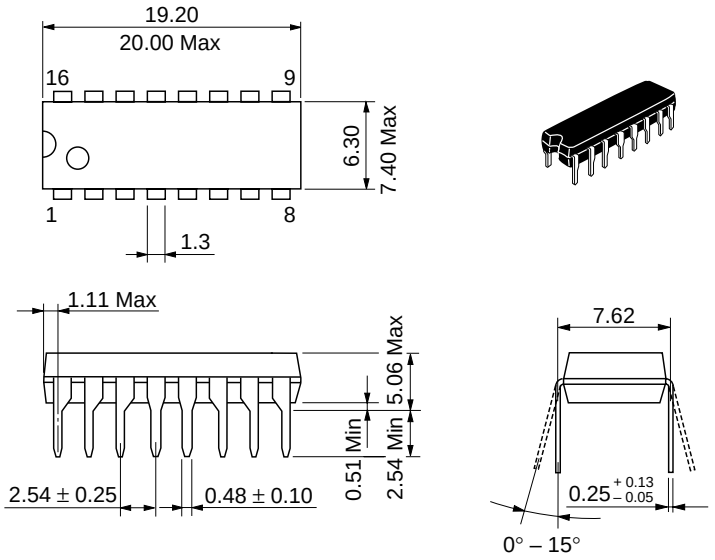


Over current protection; Current transformer method



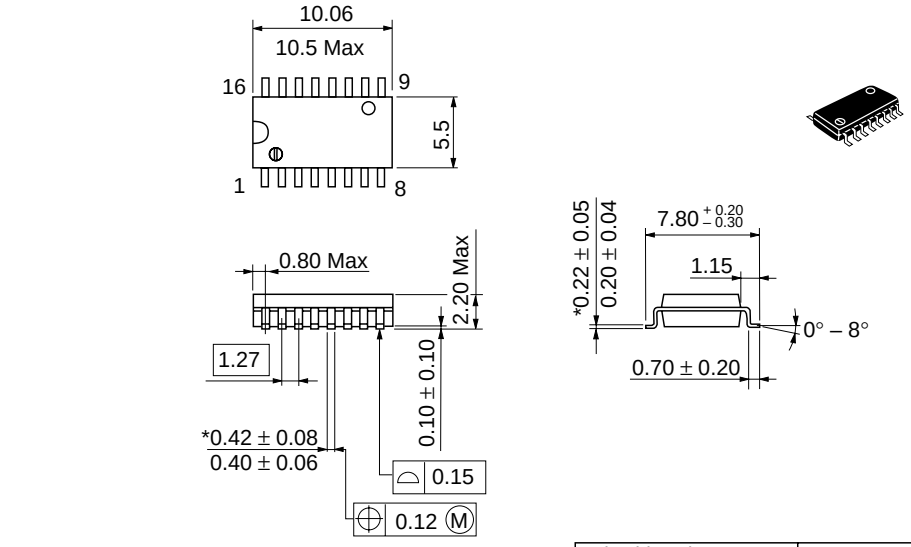
Package Dimensions

Unit: mm



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

Unit: mm



*Dimension including the plating thickness
Base material dimension

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

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, Ohte-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 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