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%

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- 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

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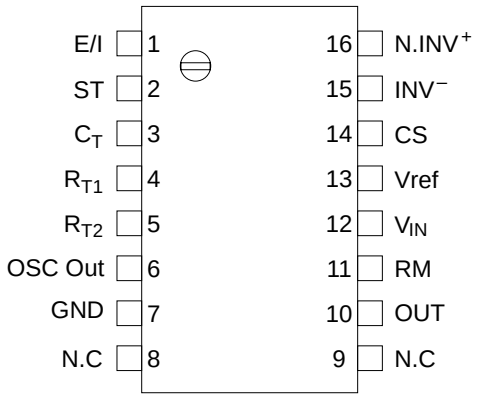
Pin Arrangement



(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

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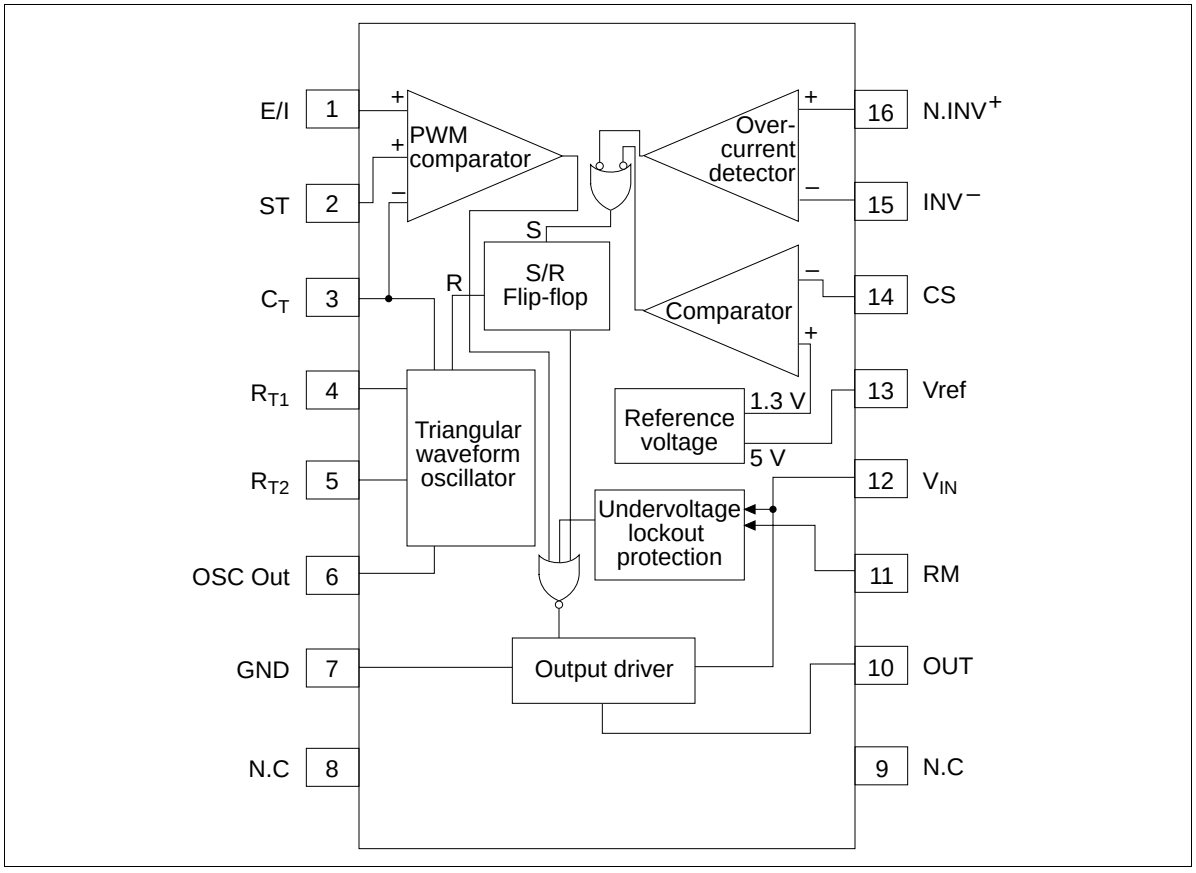
Block Diagram



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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

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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.

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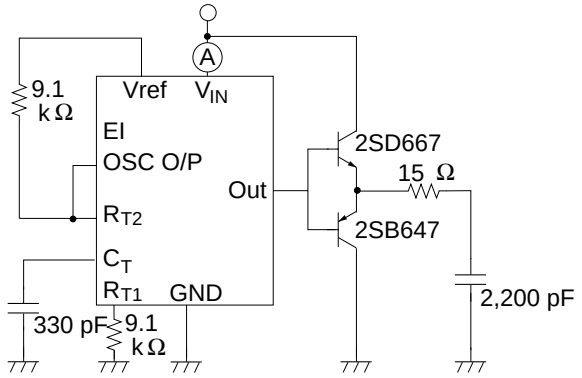
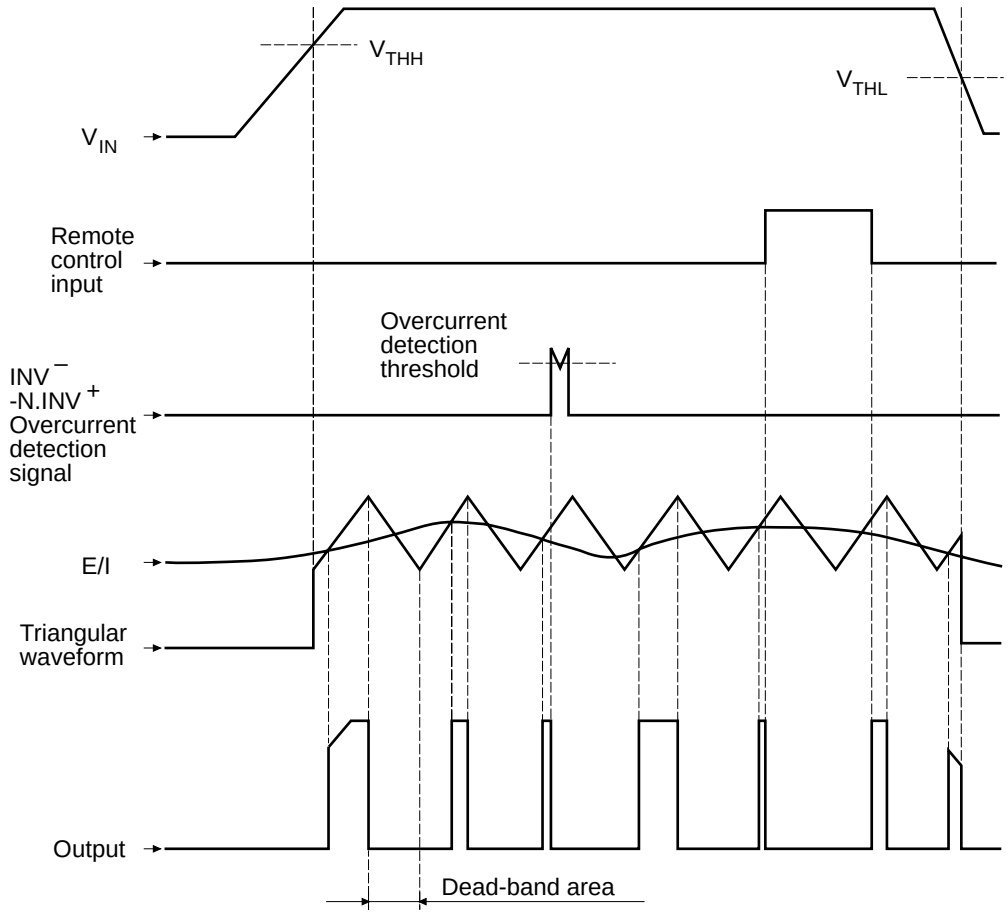


h_{FE} of 2SD667 is defined as 60 min and 200 max.

Waveform Timing



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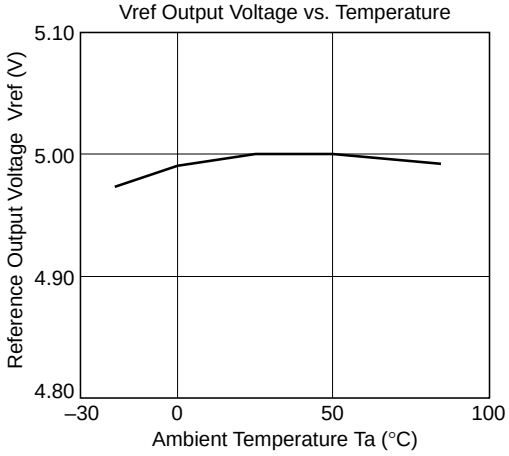
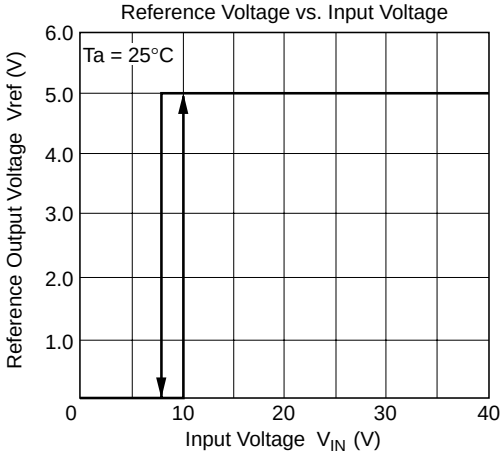
Characteristic Curves

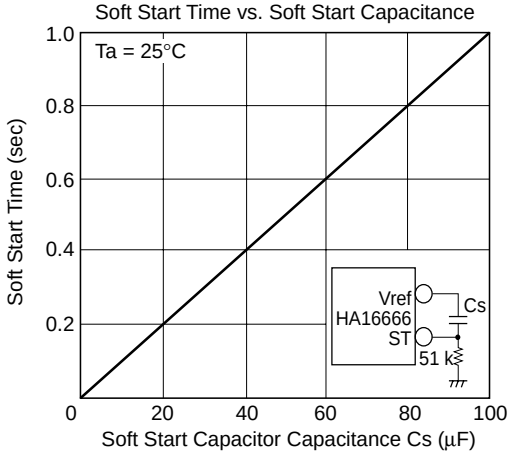
Vref Output Voltage vs. Temperature



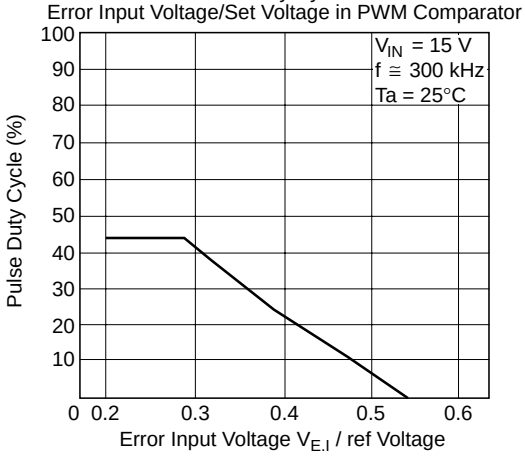
Reference Voltage vs. Input Voltage



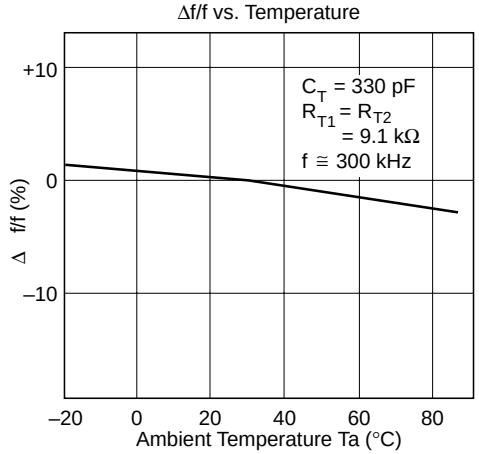
Soft Start Time vs. Soft Start Capacitance



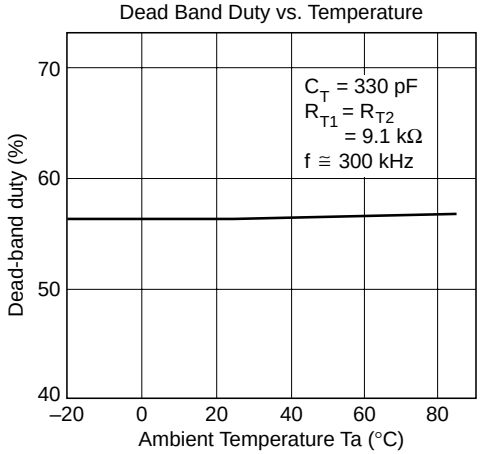
Pulse Duty Cycle vs.
Error Input Voltage/Set Voltage in PWM Comparator



Δf/f vs. Temperature



Dead Band Duty vs. Temperature



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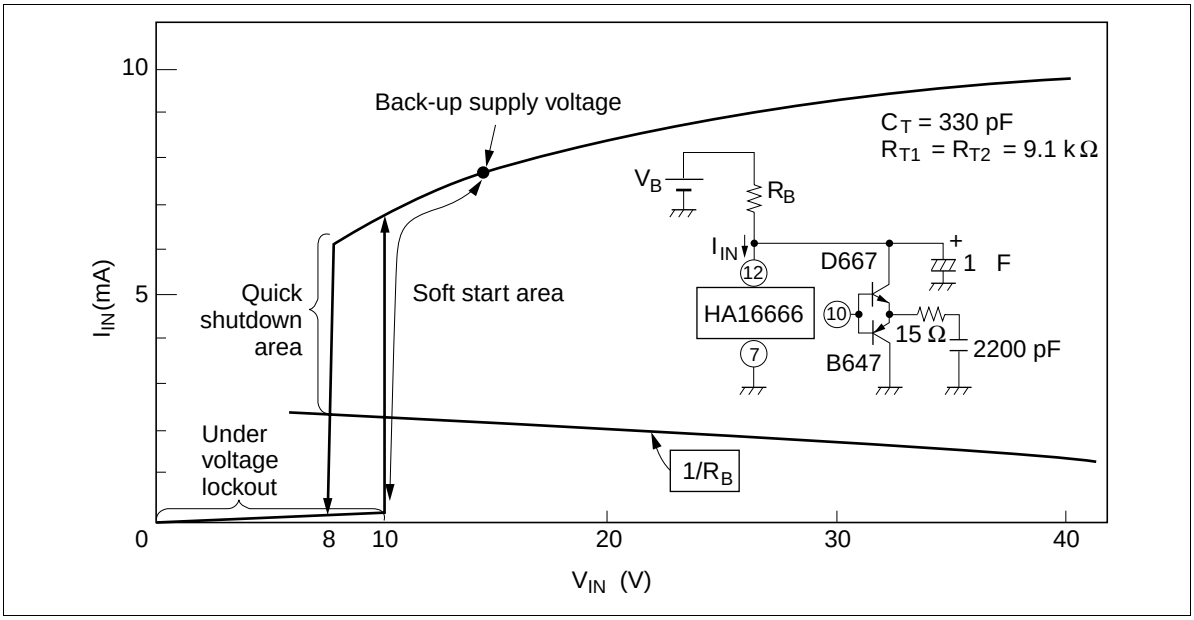
V_{IN} Bias Point



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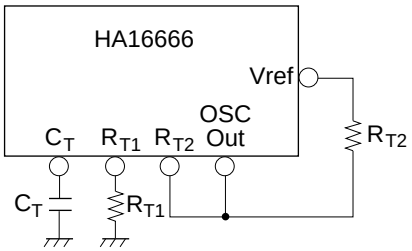
Formula for the oscillation frequency



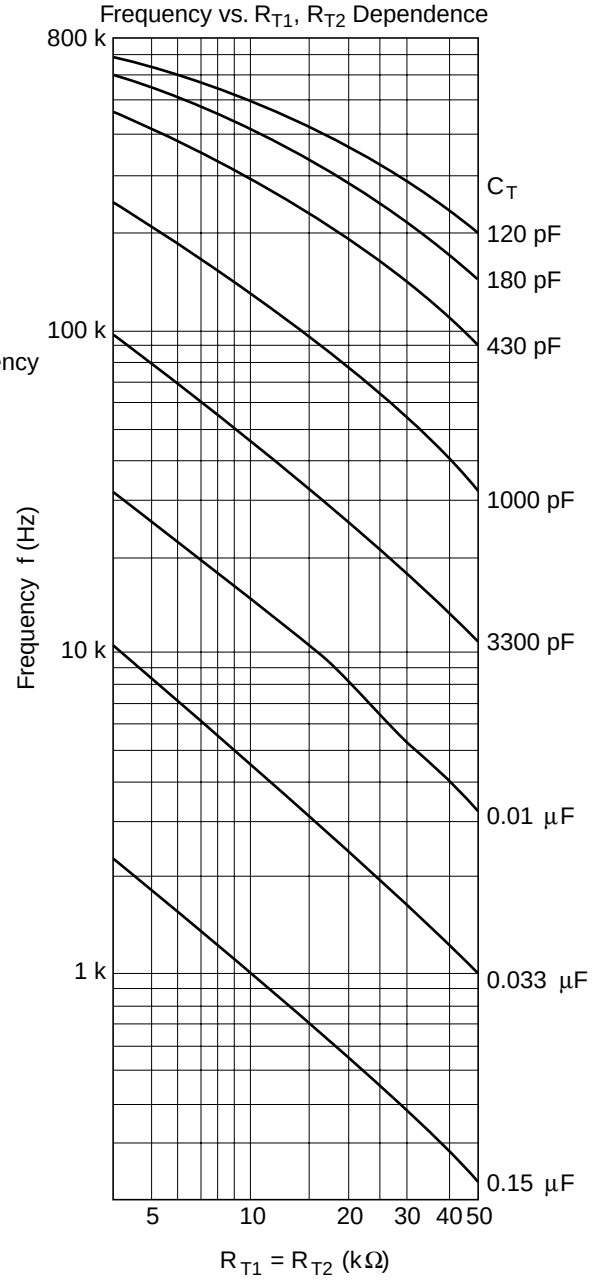
HA16666 summary formula of the oscillation ferquency

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

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



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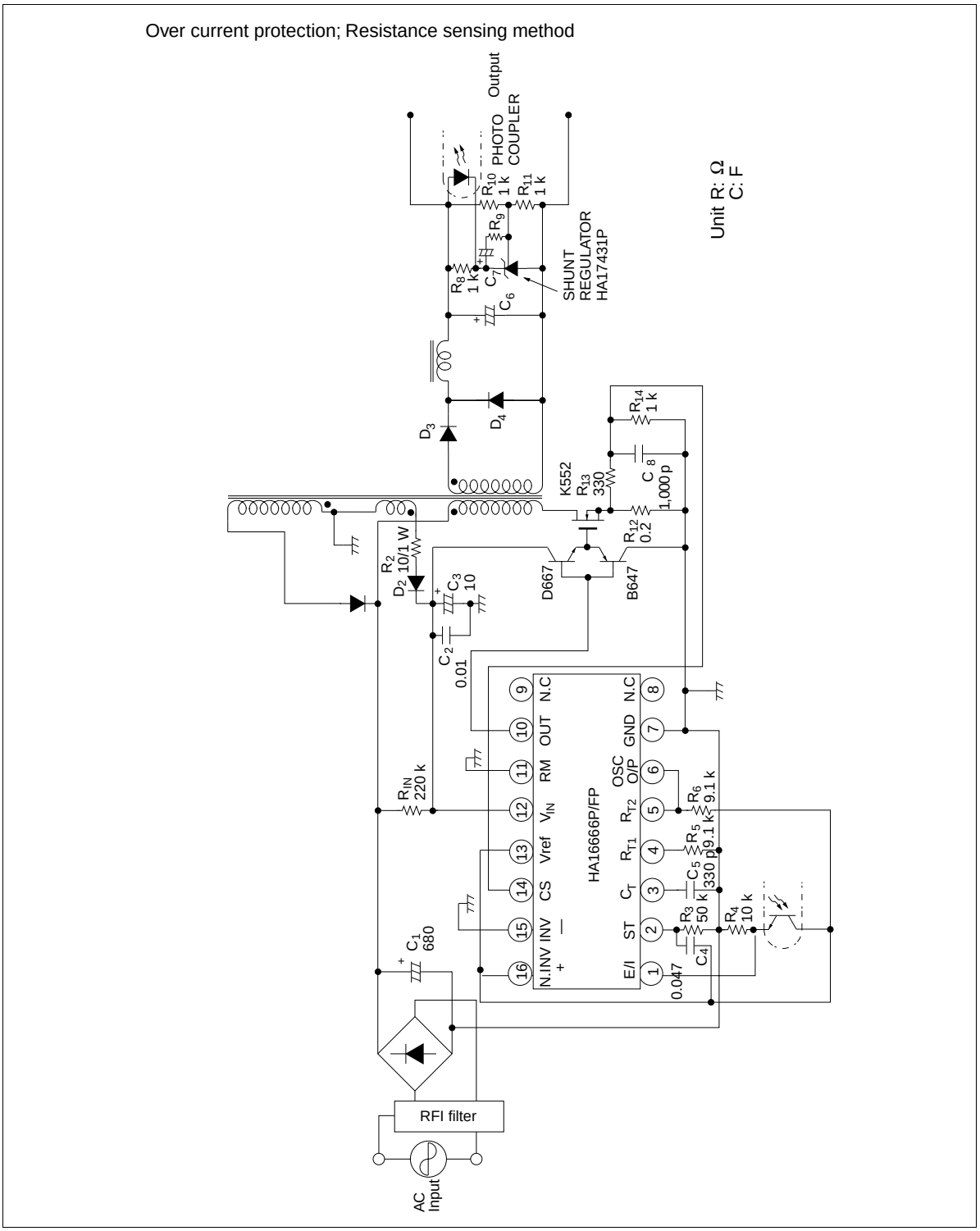
System Connection Example



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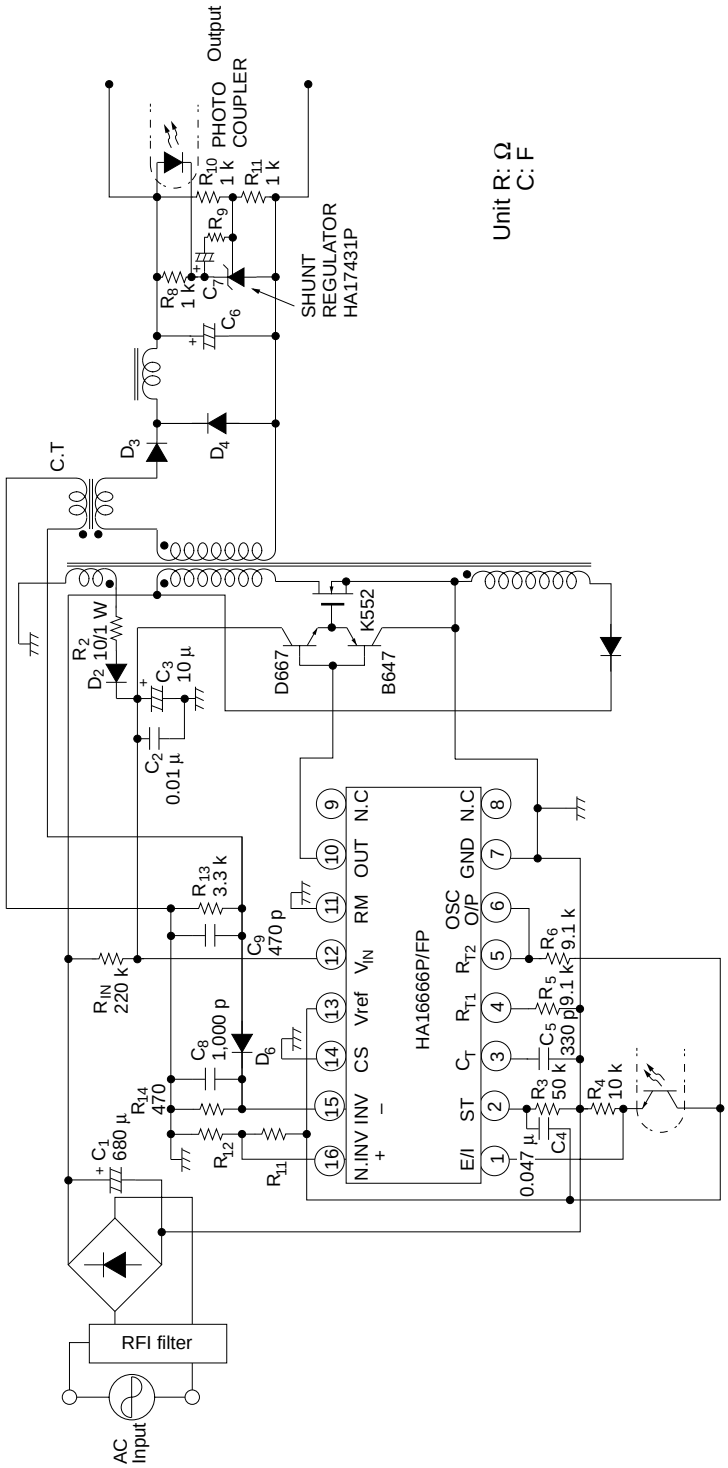
Over current protection; Current transformer method



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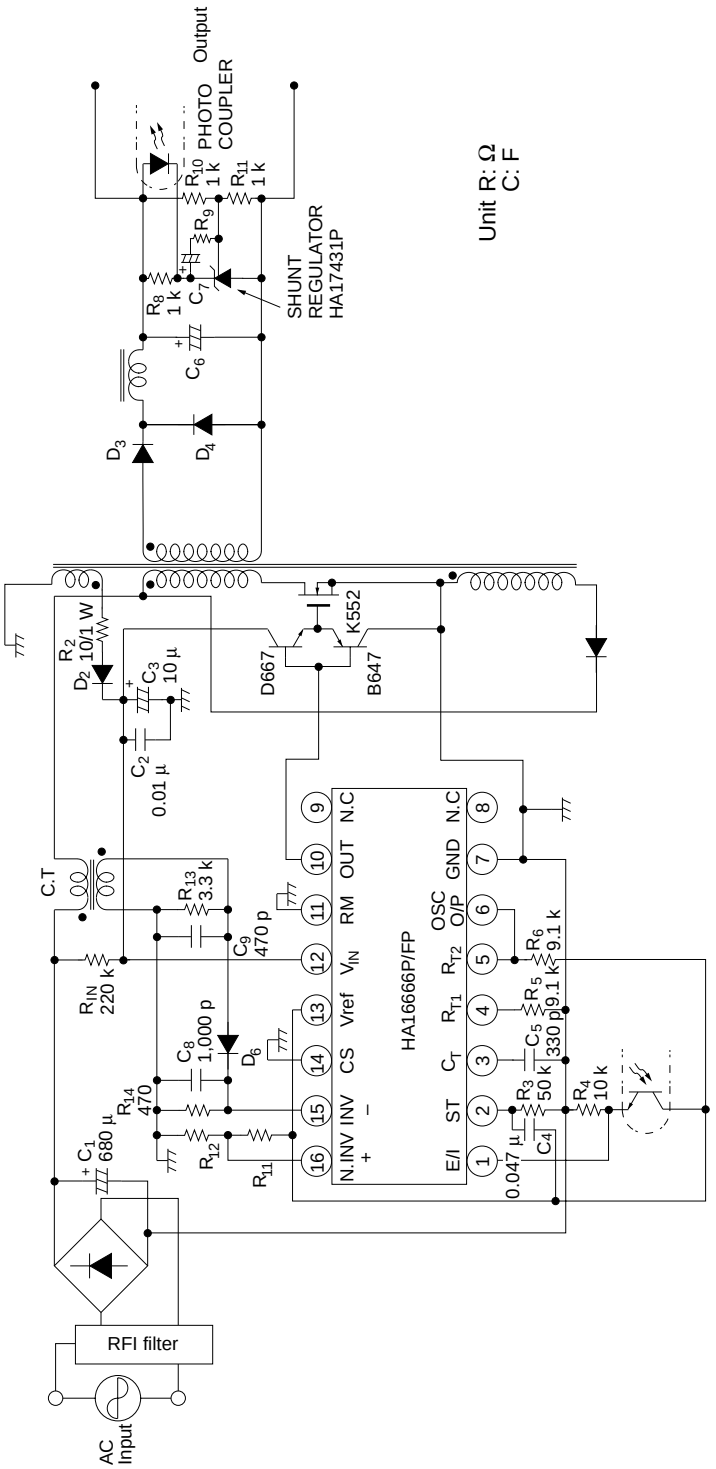

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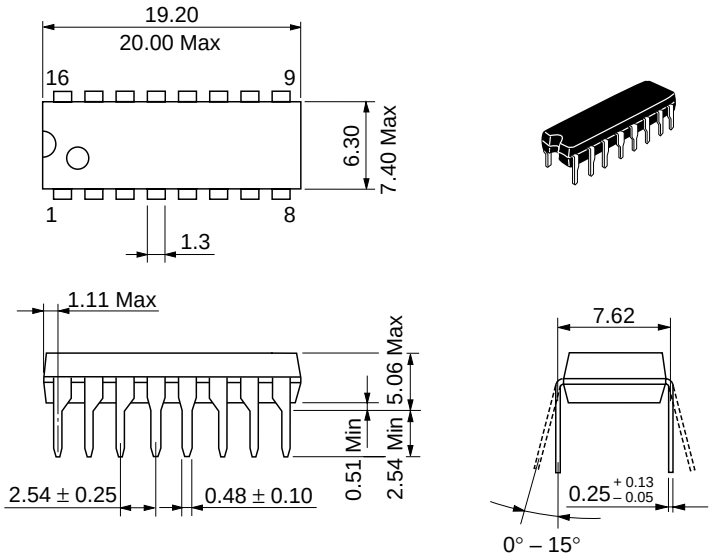
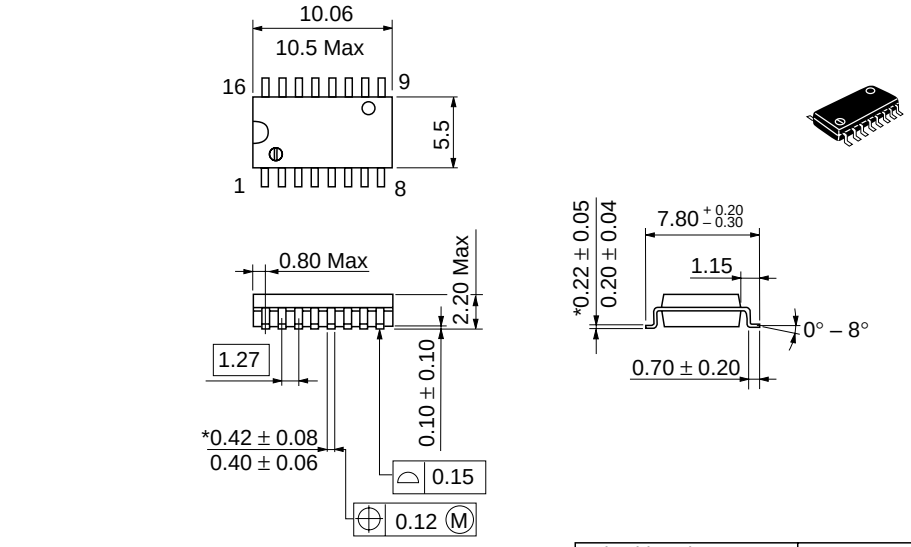
Package Dimensions

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

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