To all our customers

Regarding the change of names mentioned in the document, such as Hitachi Electric and Hitachi XX, to Renesas Technology Corp.

The semiconductor operations of Mitsubishi Electric and Hitachi were transferred to Renesas Technology Corporation on April 1st 2003. These operations include microcomputer, logic, analog and discrete devices, and memory chips other than DRAMs (flash memory, SRAMs etc.) Accordingly, although Hitachi, Hitachi, Ltd., Hitachi Semiconductors, and other Hitachi brand names are mentioned in the document, these names have in fact all been changed to Renesas Technology Corp. Thank you for your understanding. Except for our corporate trademark, logo and corporate statement, no changes whatsoever have been made to the contents of the document, and these changes do not constitute any alteration to the contents of the document itself.

Renesas Technology Home Page: http://www.renesas.com

Renesas Technology Corp.
Customer Support Dept.
April 1, 2003

Cautions

Keep safety first in your circuit designs!

1. Renesas Technology Corporation puts the maximum effort into making semiconductor products better and more reliable, but there is always the possibility that trouble may occur with them. Trouble with semiconductors may lead to personal injury, fire or property damage.
   Remember to give due consideration to safety when making your circuit designs, with appropriate measures such as (i) placement of substitutive, auxiliary circuits, (ii) use of nonflammable material or (iii) prevention against any malfunction or mishap.

Notes regarding these materials

1. These materials are intended as a reference to assist our customers in the selection of the Renesas Technology Corporation product best suited to the customer's application; they do not convey any license under any intellectual property rights, or any other rights, belonging to Renesas Technology Corporation or a third party.
2. Renesas Technology Corporation assumes no responsibility for any damage, or infringement of any third-party's rights, originating in the use of any product data, diagrams, charts, programs, algorithms, or circuit application examples contained in these materials.
3. All information contained in these materials, including product data, diagrams, charts, programs and algorithms represents information on products at the time of publication of these materials, and are subject to change by Renesas Technology Corporation without notice due to product improvements or other reasons. It is therefore recommended that customers contact Renesas Technology Corporation or an authorized Renesas Technology Corporation product distributor for the latest product information before purchasing a product listed herein.
   The information described here may contain technical inaccuracies or typographical errors.
   Renesas Technology Corporation assumes no responsibility for any damage, liability, or other loss rising from these inaccuracies or errors.
   Please also pay attention to information published by Renesas Technology Corporation by various means, including the Renesas Technology Corporation Semiconductor home page (http://www.renesas.com).
4. When using any or all of the information contained in these materials, including product data, diagrams, charts, programs, and algorithms, please be sure to evaluate all information as a total system before making a final decision on the applicability of the information and products. Renesas Technology Corporation assumes no responsibility for any damage, liability or other loss resulting from the information contained herein.
5. Renesas Technology Corporation semiconductors are not designed or manufactured for use in a device or system that is used under circumstances in which human life is potentially at stake. Please contact Renesas Technology Corporation or an authorized Renesas Technology Corporation product distributor when considering the use of a product contained herein for any specific purposes, such as apparatus or systems for transportation, vehicular, medical, aerospace, nuclear, or undersea repeater use.
6. The prior written approval of Renesas Technology Corporation is necessary to reprint or reproduce in whole or in part these materials.
7. If these products or technologies are subject to the Japanese export control restrictions, they must be exported under a license from the Japanese government and cannot be imported into a country other than the approved destination.
   Any diversion or reexport contrary to the export control laws and regulations of Japan and/or the country of destination is prohibited.
8. Please contact Renesas Technology Corporation for further details on these materials or the products contained therein.

HA16341NT/FP, HA16342NT/FP

Redundant Secondary Switching Power Supply Controller

ADE-204-035C (Z)

Rev.3
Apr. 2001

Description

The HA16341NT/FP and the HA16342NT/FP are switching regulator control ICs for the off-line converters of redundant power supplies.

The HA16342NT/FP is reverse current detection less version of the HA16341NT/FP.

The HA16341NT/FP have the functions of current sharing and hot swap control for redundancy. These functions enable high efficiency and high reliability for switching power supplies.

Combination the HA16341 with the HA16141 is suitable for the redundant AC to DC converters.

Features

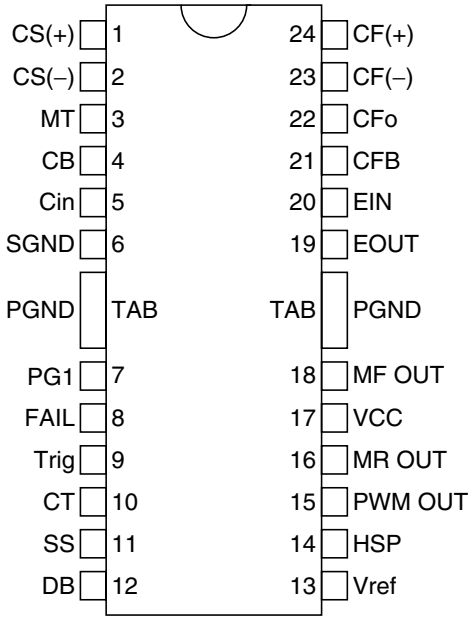
- Secondary-side synchronous rectification control
- Main switching controller
- Dead-time adjustment for synchronous rectification MOS
- Current share function with line resistance compensation
- Hot swap power MOS FET control
- Remote on/off function, FAIL output function
- Synchronized switching with primary side
- Soft start function
- Maximum duty adjustment
- Overcurrent limiting, overcurrent shutdown functions
- Reverse current detection (only the HA16341NT/FP)
- Light load detection
- OVP function
- VCC pin UVL function

Ordering Information

Type No.	Package
HA16341NT	DP-24TS
HA16342NT	
HA16341FP	FP-26DT
HA16342FP	

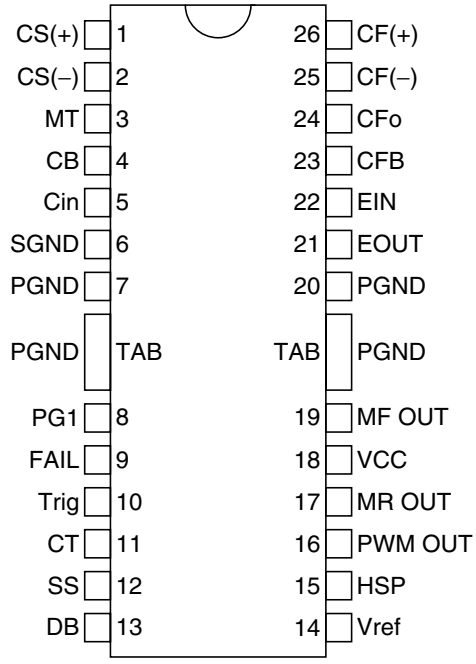
Pin Arrangement

HA16341NT, HA16342NT
(DP-24TS)



(Top view)

HA16341FP, HA16342FP
(FP-26DT)

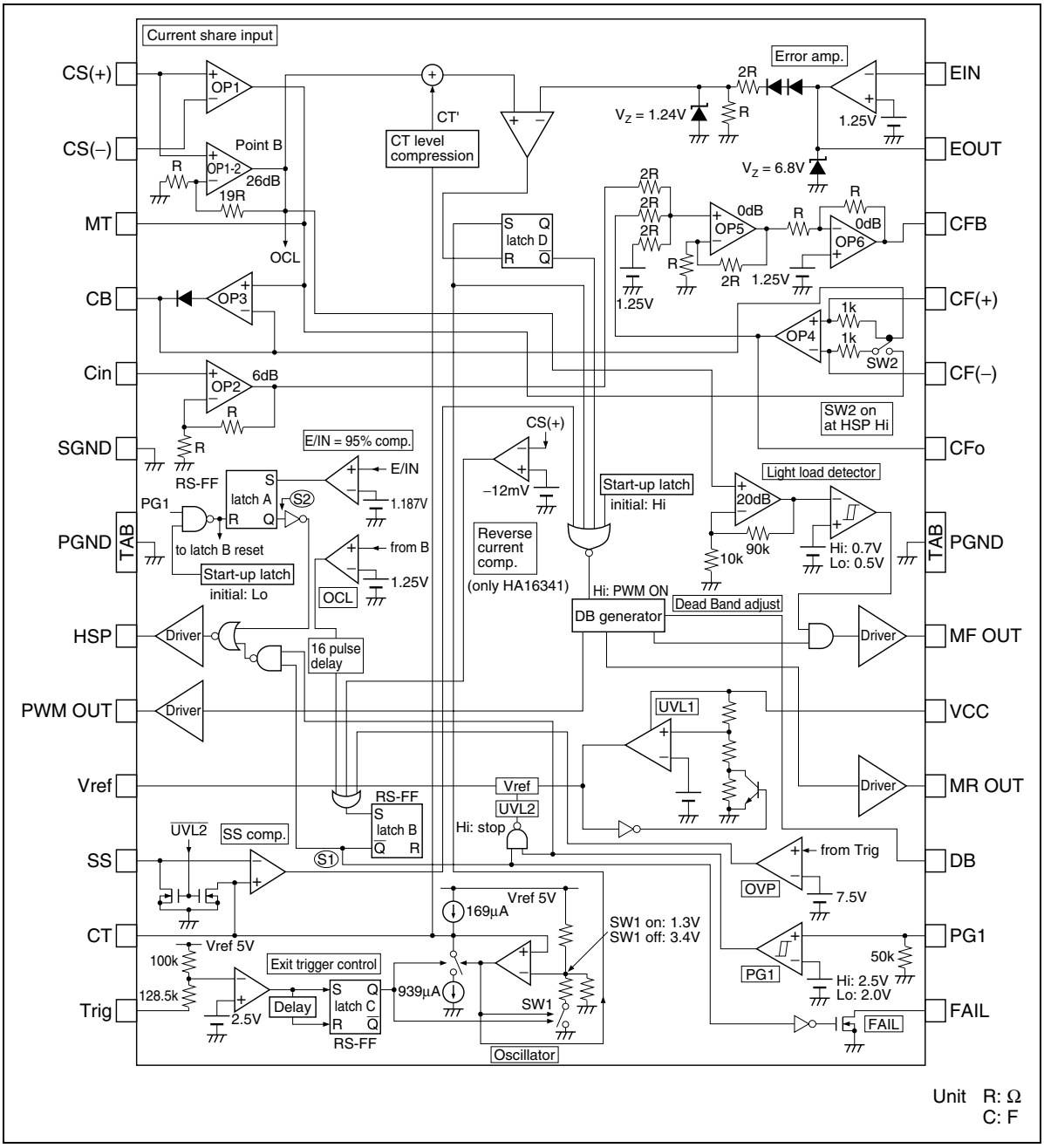


(Top view)

Pin Functions

Pin No.			
DP-24TS	**FP-26DT**	**Symbol**	**Pin Name**
1	1	CS(+)	Current sense amp input (+)
2	2	CS(–)	Current sense amp input (–)
3	3	MT	Current sense amp output
4	4	CB	Current bus output
5	5	Cin	Line resistance compensation input
6	6	SGND	Signal ground
7	8	PG1	Remote on/off
8	9	FAIL	FAIL output (open-drain)
9	10	Trig	External synchronization input
10	11	CT	Timing capacitance
11	12	SS	Soft start
12	13	DB	Dead band
13	14	Vref	Vref (5 V)
14	15	HSP	Hot swap output
15	16	PWM OUT	PWM output
16	17	MR OUT	MR output
17	18	VCC	Power supply voltage
18	19	MF OUT	MF output
19	21	EOUT	Error amp output
20	22	EIN	Error amp input
21	23	CFB	Current share feedback output
22	24	CFo	Current share differential amp output
23	25	CF(–)	Current share differential amp input (–)
24	26	CF(+)	Current share differential amp input (+)
TAB	TAB, 7, 20	PGND	Power ground

Block Diagram



Unit R: Ω
C: F

Absolute Maximum Ratings

(Ta = 25°C)

Item	Symbol	Rating	Unit	Note
Supply Voltage	VCC	18	V	
DC output current1	Io1	±0.1	A	PWM OUT *1
Peak output current1	Iopeak1	±1.0	A	PWM OUT *2
DC output current2	Io2	±0.2	A	MF OUT *1
Peak output current2	Iopeak2	±2.0	A	MF OUT *2
DC output current3	Io3	±0.1	A	MR OUT *1
Peak output current3	Iopeak3	±1.0	A	MR OUT *2
DC output current4	Io4	–5	mA	CB OUT
DC output current5	Io5	±500	µA	CFB OUT
DC output current6	Io6	20	mA	FAIL OUT
DC output current7	Io7	–5.0	mA	Vref OUT
Peak output current4	Iopeak4	0.5	A	HSP sink
DC output current8	Io8	±500	µA	MT OUT
DC output current9	Io9	±500	µA	CFo OUT
DC output current10	Io10	6	mA	EOUT sink
TRIG terminal voltage	Vtrigmax	–1.5 to V_{CC}	V	
CT terminal voltage	VCTmax	–0.3 to Vref	V	
Vref terminal voltage	Vrefmax	–0.3 to Vref	V	
SS terminal voltage	Vssmax	–0.3 to Vref	V	
EIN terminal voltage	VEINmax	–0.3 to Vref	V	
EOUT terminal voltage	VEOUTmax	–0.3 to V_{CC}	V	
PG1 terminal voltage	VPG1max	–0.3 to Vref	V	
FAIL terminal voltage	VFAILmax	–0.3 to V_{CC}	V	
PWM OUT terminal voltage	VoPWMmax	–0.3 to V_{CC}	V	
MR OUT terminal voltage	VoMRmax	–0.3 to V_{CC}	V	
MF OUT terminal voltage	VoMFmax	–0.3 to V_{CC}	V	
HSP terminal voltage	VoHSPmax	–0.3 to V_{CC}	V	
CFB terminal voltage	VCFBmax	–0.3 to Vref	V	
CS(+) terminal voltage	VCS(+)max	–0.3 to Vref	V	
CS(–) terminal voltage	VCS(–)max	–0.3 to Vref	V	
MT terminal voltage	VMTmax	–0.3 to Vref	V	
Cin terminal voltage	VCinmax	–0.3 to Vref	V	

Notes: 1. V_{DS} = 10 V max. Therefore test condition must be $V_{OH} = V_{CC} - 10$ V or over , V_{OL} = 10 V or under.
2. V_{DS} = 10 V max. Pulse duration ≤ 10 ms

Absolute Maximum Ratings (cont.)

(Ta = 25°C)

Item	Symbol	Rating	Unit	Note
CF(+) terminal voltage	VCF(+)max	–0.3 to Vref	V	
CF(–) terminal voltage	VCF(–)max	–0.3 to Vref	V	
CFo terminal voltage	VCFomax	–0.3 to Vref	V	
CB terminal voltage	VCBmax	–0.3 to Vref	V	
DB terminal voltage	VDBmax	–0.3 to Vref	V	
Maximum power dissipation	P_T	4.17	W	1
Operating temperature	Topr	–40 to +105	°C	
Storage temperature	Tstg	–55 to +150	°C	
Junction temperature	Tj	150	°C	

Note: 1. This is allowable value up to Ta = 25°C.
Derate by θj-a = 30°C/W above that temperature.
θj-a = 30°C/W is the case that HA16341NT is mounted on 30% wiring density glass epoxy board (105 mm × 76.2 mm × 1.6 mmt) and HA16341FP is mounted on a board which thermal resistance is 23°C/W because of θj-pin (SOP) = 7°C/W typ.

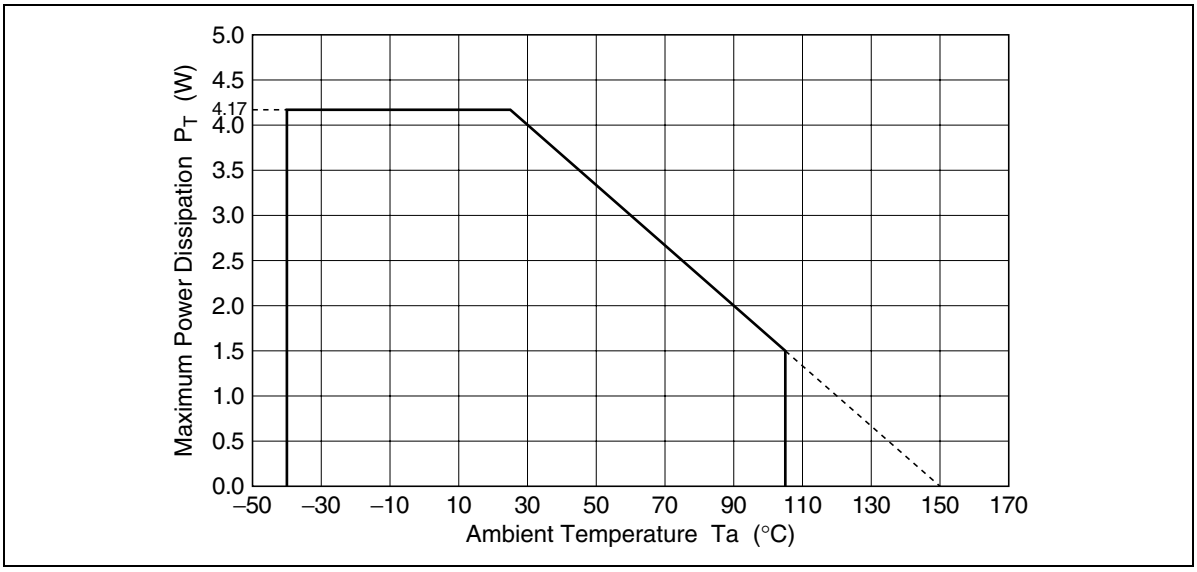


Figure 1 Derating Curve

Electrical Characteristics

(Ta = 25°C, V_{cc} = 12V, PG1 = 3V, Vtrig = 0V, VCS(+) = 0V, VCin = 0V, CCT = 330pF, GvOP1 = 26dB, GvOP4 = 40dB, RDB = 1.8kΩ)

- Current share

Item	Symbol	Min	Typ	Max	Unit	Test Conditions	Note
CB output Hi voltage	VCBH	2.5	—	—	V	Iosource = 300μA VCS(+) = 1V	
CB output Lo voltage	VCBL	—	—	25	mV	VCS(+) = 0V, RCB = 10kΩ	
CFB output Lo voltage	VCFBL	—	—	100	mV	Iosink = 100μA, HSP ON VCS(+) = 0V, VCB = 0.1V	
CFB output typ voltage	VCFBtyp	1.19	1.25	1.31	V	VCS(+) = 0V, VCB = 0V RfOP4 = 1kΩ, HSP ON	
OP1 input offset voltage	VioOP1	—	—	(1)	mV		1
CS(+) input bias current	IibCS(+)	—	–20	–30	μA	VCS(+) = 0V, VCS(–) = 0V	
CS(–) input bias current	IibCS(–)	—	0.2	1.0	μA	VCS(+) = 0V, VCS(–) = 0V	
Cin input bias current	IibCin	—	0.2	1.0	μA	Vcin = 0V	
OP4 input resistance	Rsin	0.75	1.00	1.25	kΩ		1, 2
Open loop gain OP1–OP6	Avo	(70)	80	—	dB		1
Band width OP1–OP6	BWCS	—	700	—	kHz		1
OCL detector threshold voltage	VthOCL	59.5	62.5	65.5	mV	CS(+) terminal voltage sensing	
Light load detector threshold Hi voltage	VthHLL	(2.0)	3.5	(5.0)	mV	CS(+) terminal voltage sensing	1
Light load detector threshold Lo voltage	VthLLL	(1.0)	2.5	(4.0)	mV	CS(+) terminal voltage sensing	1
VthLL hysteresis	dVthLL	(0.5)	1.0	(1.5)	mV		1
Reverse current detector threshold Hi voltage	VthRC	–6	–12	–18	mV	CS(+) terminal voltage sensing	3

Notes: 1. Design spec.
2. Temperature coefficient is 5400ppm/°C.
3. Only HA16341NT/FP.

- Hot swap

Item	Symbol	Min	Typ	Max	Unit	Test Conditions	Note
HSP ON threshold voltage	VthHSP	1.14	1.19	1.23	V	95% typ of reference 1.25V	
HSP charge current	IcHSP	–7	–10	–13	μA	VHSP = 5V, VEIN = 2V	
HSP output Lo voltage	VOLHSP	—	0.3	0.6	V	VEIN = 1V, Iosink = 50mA	

Electrical Characteristics (cont.)

(Ta = 25°C, V_{cc} = 12V, PG1 = 3V, Vtrig = 0V, VCS(+) = 0V, VCin = 0V, CCT = 330pF, GvOP1 = 26dB, GvOP4 = 40dB, RDB = 1.8kΩ)

- Oscillator

Item	Symbol	Min	Typ	Max	Unit	Test Conditions	Note
Typical oscillating frequency	fosctyp	180	200	220	kHz		±10%
Maximum oscillating frequency	foscmax	400	—	—	kHz		
Typical oscillating temperature stability	dfosc	—	±5	—	%	–20°C < Ta < 85°C	1
CT charge current	Ici	–135	–169	–203	µA		±20%
CT discharge current	Icd	616	770	924	µA		±20%
Upper trip point	VthCTH	—	3.4	—	V		2
Lower trip point	VthCTL	—	1.3	—	V		
Amplitude	dVCT	—	2.1	—	V		
Exit trigger Vth	Vthtrig	–0.3	–0.5	–0.7	V		

Notes: 1. Design spec.
2. In case of external trigger control, CCT should be changed from 330 pF to 430 pF. At this synchronous and 430 pF CCT condition VthCTH becomes about 2.9 V.

- Vref

Item	Symbol	Min	Typ	Max	Unit	Test Conditions	Note
Reference voltage	Vref	4.9	5.0	5.1	V	Iosource = 1mA	±2%
Line regulation	Vref-line	—	5	20	mV	Iosource = 1mA 12V < V_{cc} < 18V	
Load regulation	Vref-load	—	5	20	mV	0 < Iosource < 3mA	
Temperature stability	dVref	—	80	—	ppm/°C	–20°C < Ta < 85°C	1

Note: 1. Design spec.

- UVL

Item	Symbol	Min	Typ	Max	Unit	Test Conditions	Note
Hi threshold voltage	VH	9.5	10.0	10.5	V		
Lo threshold voltage	VL	8.5	9.0	9.5	V		
Hysteresis	dVUVL	0.6	1.0	1.4	V		

Electrical Characteristics (cont.)

(Ta = 25°C, V_{cc} = 12V, PG1 = 3V, Vtrig = 0V, VCS(+) = 0V, VCin = 0V, CCT = 330pF, GvOP1 = 26dB, GvOP4 = 40dB, RDB = 1.8kΩ)

- PG1

Item	Symbol	Min	Typ	Max	Unit	Test Conditions	Note
PG1 threshold Hi voltage	VthHPG1	2.4	2.5	2.6	V		
PG1 threshold Lo voltage	VthLPG1	1.9	2.0	2.1	V		
Input impedance	RinPG1	(37.5)	50.0	(62.5)	kΩ		1

Note: 1. Design spec.

- FAIL

Item	Symbol	Min	Typ	Max	Unit	Test Conditions	Note
Leak current	IleakFAIL	—	—	−10	μA	VFAIL = 5V	
Output Lo voltage	VOLFAIL	—	—	0.5	V	Iosink = 10mA	

- Error amp.

Item	Symbol	Min	Typ	Max	Unit	Test Conditions	Note
Input threshold voltage	VthEIN	1.23	1.25	1.27	V	VEOUT = 1.25V	±1.6%
Input bias current	IibEIN	—	−0.2	−2.0	μA	VEIN = 2V	
Open loop gain	AvoEA	60	80	—	dB		
Band width	BWEA	(0.7)	1.4	—	MHz		1
EOUT sink current	IosinkEA	0.5	5.0	—	mA	VEIN = 1.5V, EOUT = 1.1V	
EOUT source current	IosourceEA	−100	−250	—	μA	VEIN = 1.0V, EOUT = 5V	
EOUT clamp voltage	VOHEA	5.8	6.8	7.8	V	VEIN = 1.0V	
EOUT Lo voltage	VOLEA	—	—	1.0	V	VEIN = 1.5V, Iosink = 200μA	

Note: 1. Design spec.

- PWM OUT

Item	Symbol	Min	Typ	Max	Unit	Test Conditions	Note
Output Lo voltage	VOLPWM	—	0.2	0.4	V	Iosink = 100mA	
Output Hi voltage	VOHPWM	V_{cc}−0.4	V_{cc}−0.2	—	V	Iosource = 100mA	
Rise time	trPWM	20	50	100	ns	CL = 3300pF	
Fall time	tfPWM	20	50	100	ns	CL = 3300pF	
Maximum duty	Dmax	58	65	72	%	VSS = 4V, VEIN = 1.0V	
Minimum duty	Dmin	—	—	0	%	VSS = 4V, VEIN = 1.5V	

Note: 1. Design spec.

Electrical Characteristics (cont.)

(Ta = 25°C, V_{cc} = 12V, PG1 = 3V, Vtrig = 0V, VCS(+) = 0V, VCin = 0V, CCT = 330pF, GvOP1 = 26dB, GvOP4 = 40dB, RDB = 1.8kΩ)

- MR OUT

Item	Symbol	Min	Typ	Max	Unit	Test Conditions	Note
Output Lo voltage	VOLMR	—	0.2	0.4	V	Iosink = 100mA	
Output Hi voltage	VOHMR	V_{cc}–0.4	V_{cc}–0.2	—	V	Iosource = 100mA	
Rise time	trMR	20	50	100	ns	CL = 3300pF	
Fall time	tfMR	20	50	100	ns	CL = 3300pF	

- MF OUT

Item	Symbol	Min	Typ	Max	Unit	Test Conditions	Note
Output Lo voltage	VOLMF	—	0.2	0.4	V	Iosink = 200mA	
Output Hi voltage	VOHMF	V_{cc}–0.4	V_{cc}–0.2	—	V	Iosource = 200mA	
Rise time	trMF	20	50	100	ns	CL = 6000pF	
Fall time	tfMF	20	50	100	ns	CL = 6000pF	

- Dead band time

Item	Symbol	Min	Typ	Max	Unit	Test Conditions	Note
Dead band time1	Td1typ	0	50	100	ns	RDB = 1.8kΩ	
Dead band time2	Td2typ	0	100	200	ns	RDB = 1.8kΩ	
MR to MF delay time	t1	(–20)	—	(50)	ns	t1 = MF off – MR on	1
PWM to MR delay time	t2	(–20)	—	(50)	ns	t2 = MR off – PWM off	1
MR delay time	t3	—	1	—	µs	t3 = CT low trip point – MR on	1
Maximum Dead band adjust time1	Tdadj1	—	Td1typ +300	—	ns	RDB = 47kΩ	1
Maximum Dead band adjust time2	Tdadj2	—	Td2typ +600	—	ns	RDB = 47kΩ	1

Note: 1. Design spec.
Measurement is 50% slice point.

Electrical Characteristics (cont.)

(Ta = 25°C, V_{CC} = 12V, PG1 = 3V, Vtrig = 0V, VCS(+) = 0V, VCin = 0V, CCT = 330pF, GvOP1 = 26dB, GvOP4 = 40dB, RDB = 1.8kΩ)

- SS

Item	Symbol	Min	Typ	Max	Unit	Test Conditions	Note
SS sink current	Idss	500	—	—	µA	PG1 = 2V, VSS = 2V	

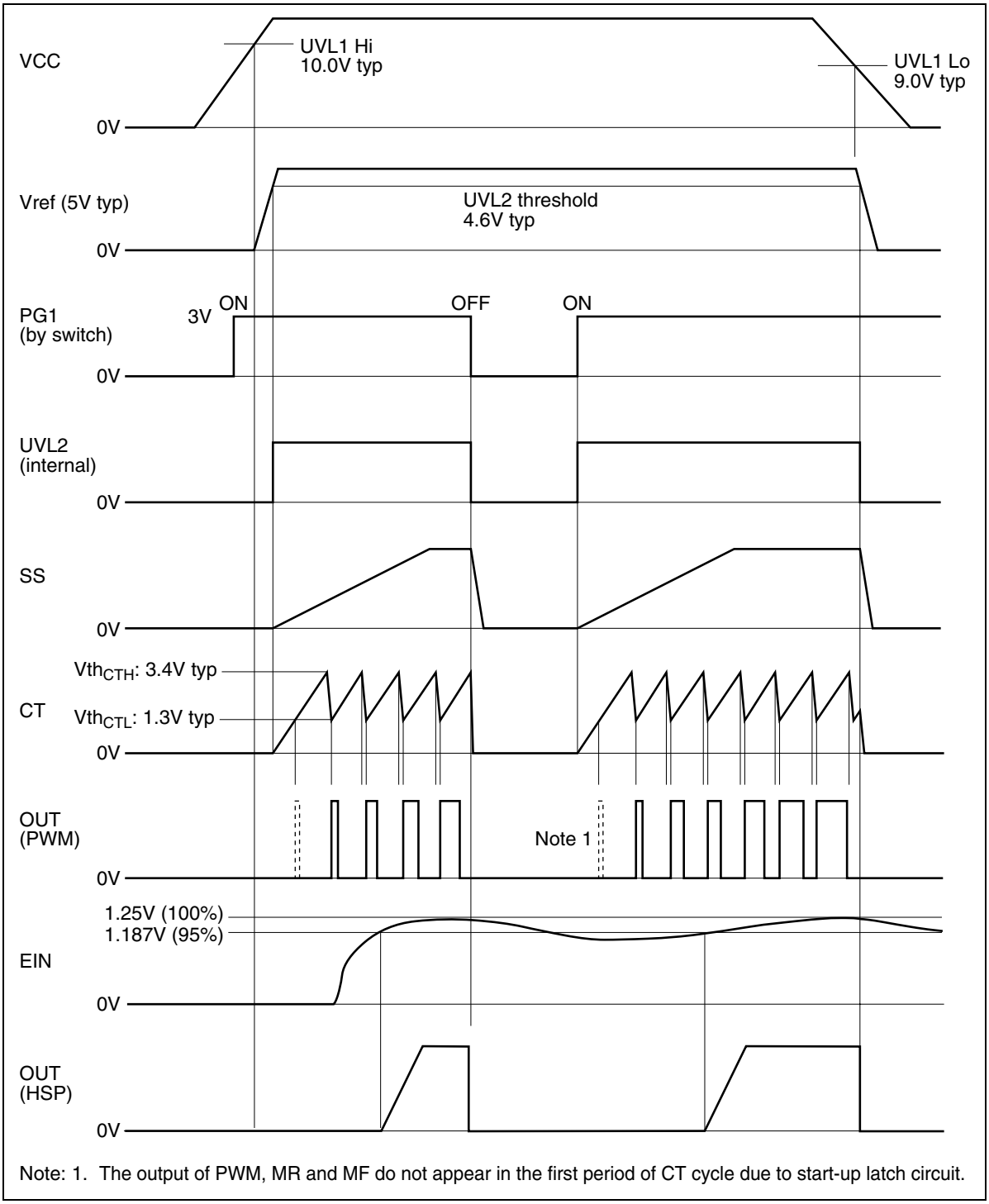
- OVP

Item	Symbol	Min	Typ	Max	Unit	Test Conditions	Note
OVP latch voltage	VOVP	6.5	7.5	8.5	V		

- Current consumption

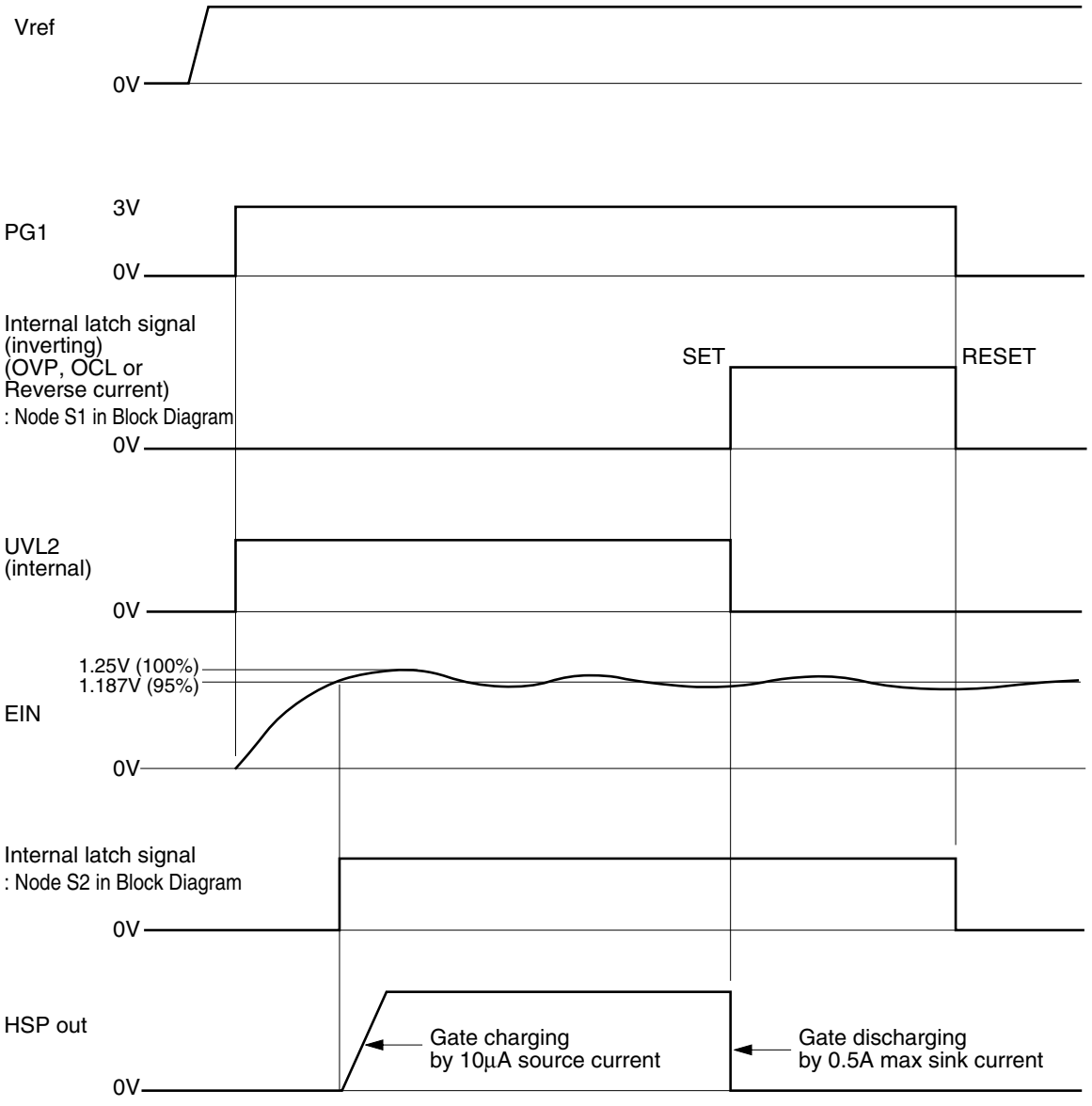
Item	Symbol	Min	Typ	Max	Unit	Test Conditions	Note
Operating current	ICC	5.4	7.4	9.4	mA	VCT = 1V	
Standby current	ISTBY	—	200	600	µA	VCC = 8V, PG1 = 0V	

Timing Chart 1 (Total)



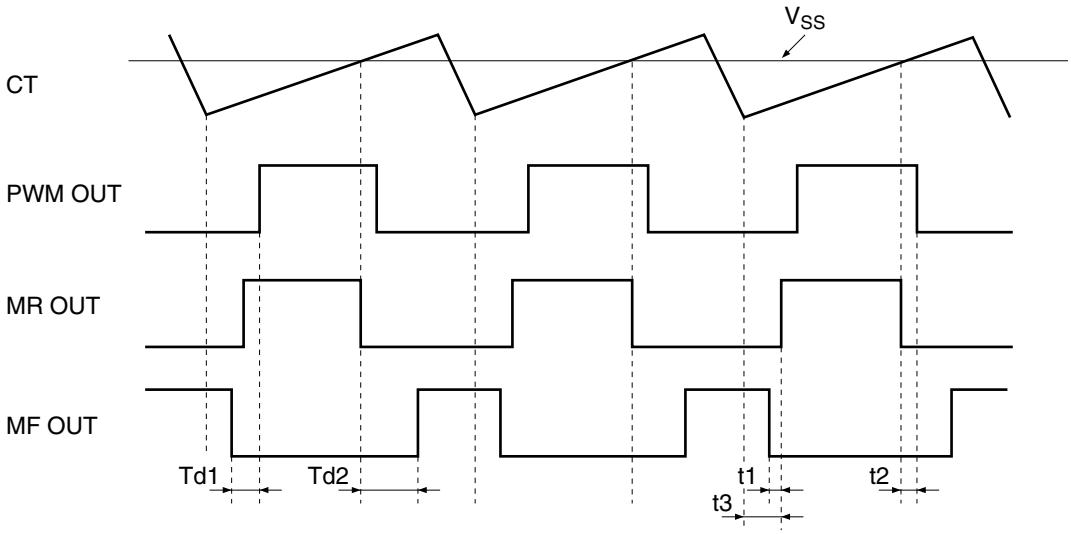
Note: 1. The output of PWM, MR and MF do not appear in the first period of CT cycle due to start-up latch circuit.

Timing Chart 2 (Hot Swap)

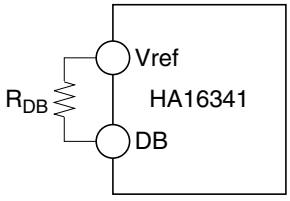


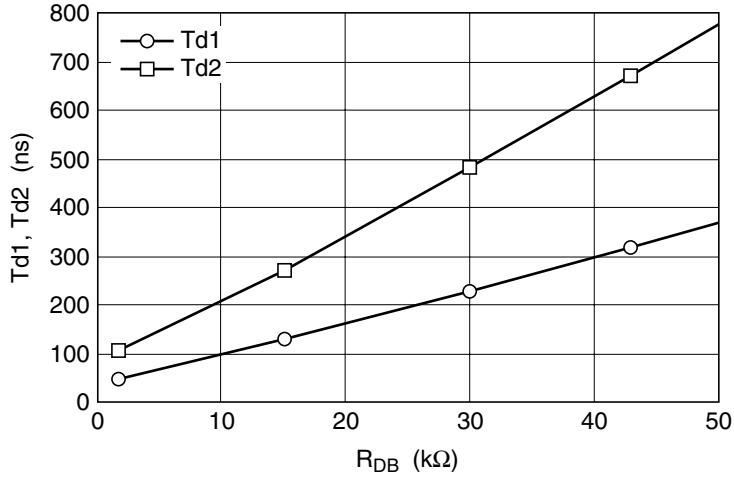
Note: Reverse current is HA16341NT/FP only.

Timing Chart 3 (Dead Band Control)

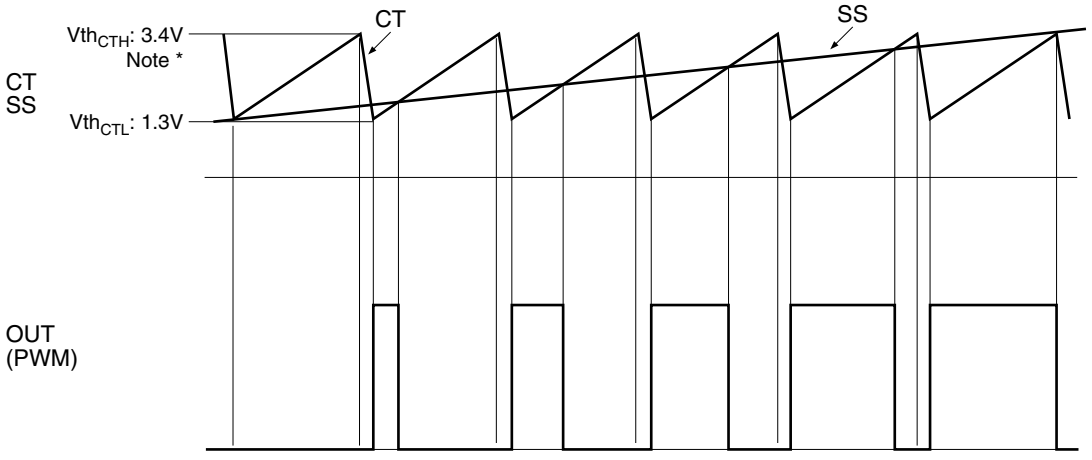


Note: V_{SS} determines maximum duty. This waveform example shows the case of EIN = Lo.
V_{SS}: Voltage of SS pin





Timing Chart 4 (Soft Start)



Note: Self-oscillation: Vth_{CTH} = 3.4V typ
Synchronized operation: Vth_{CTH} = 2.9V typ

Case $V_{HSS} \geq Vth_{CTH}$
Maximum duty would be the value specified in page 9.

Case $V_{HSS} < Vth_{CTH}$
Maximum duty decrease to the corresponding value.

Please refer to formula 1 as design value of maximum duty.

Max duty = (tss – 0.63µs – Td1) × Operating frequency · · · · · Formula 1

$$tss = \frac{C_{CT}}{Ici} (V_{HSS} - Vth_{CTL})$$

Ici : CT charge current
C_{CT} : CT terminal capacitor
Vth_{CTH} : CT upper trip point
Vth_{CTL} : CT lower trip point

Select values R1, R2 and C1 for suitable maximum duty and SS time constant.

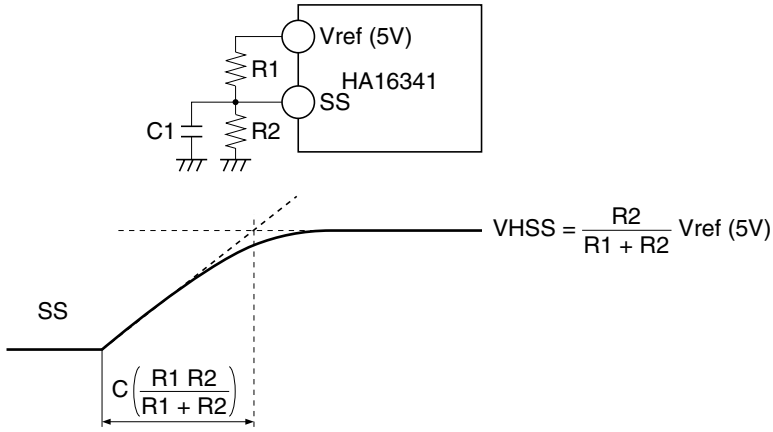
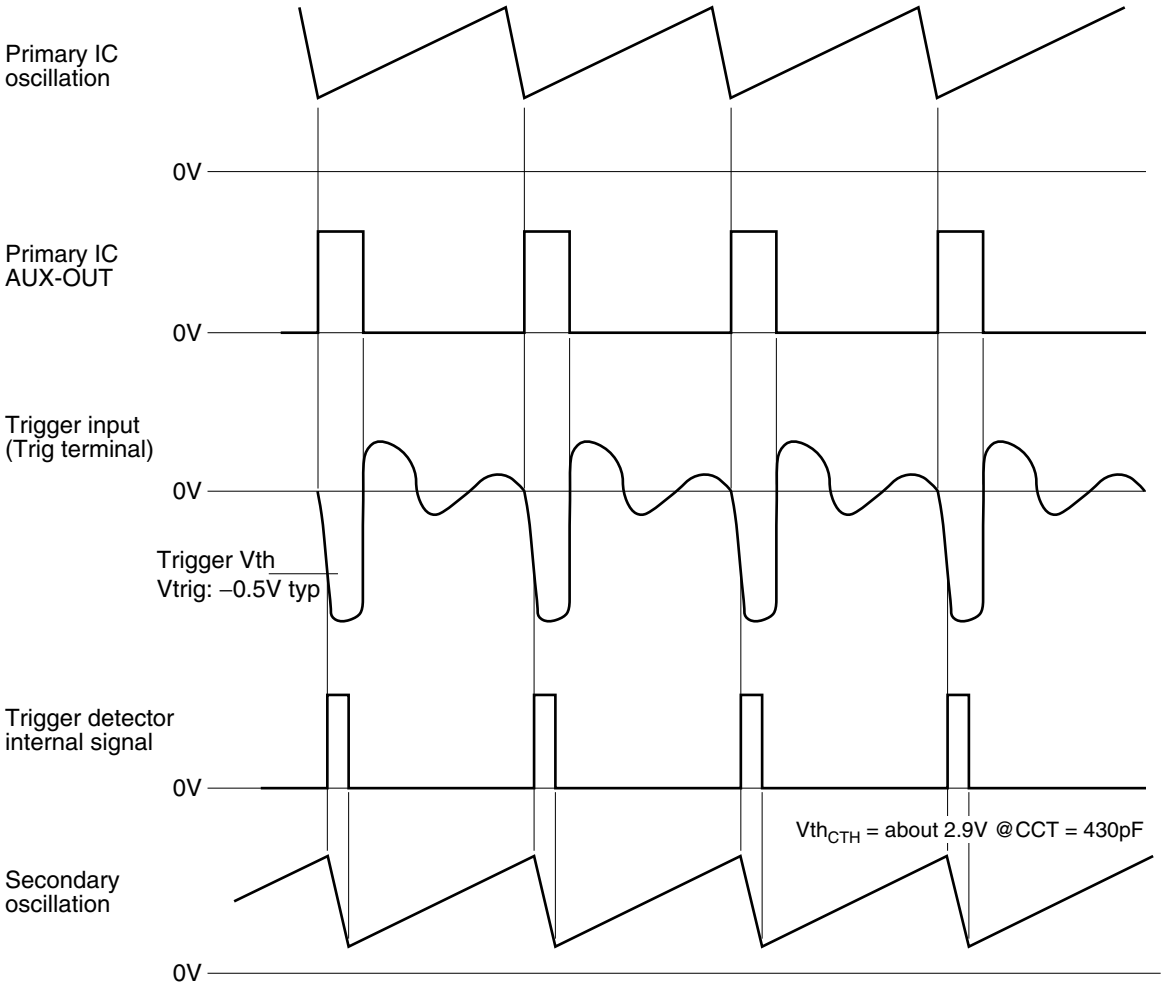


Figure A. SS Terminal Application

Timing Chart 5 (External Trigger Control)



This IC is triggered by negative pulse.
R1 and R2 must be calculated including internal impedance of 230kΩ.

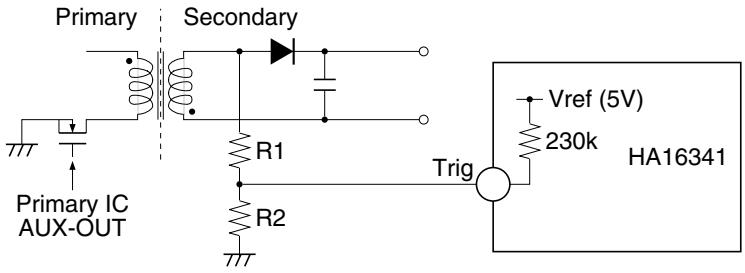
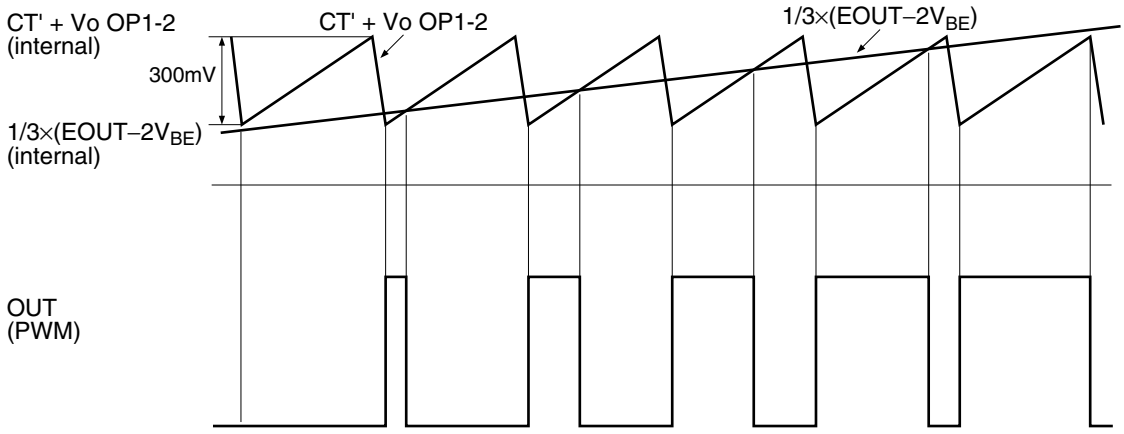


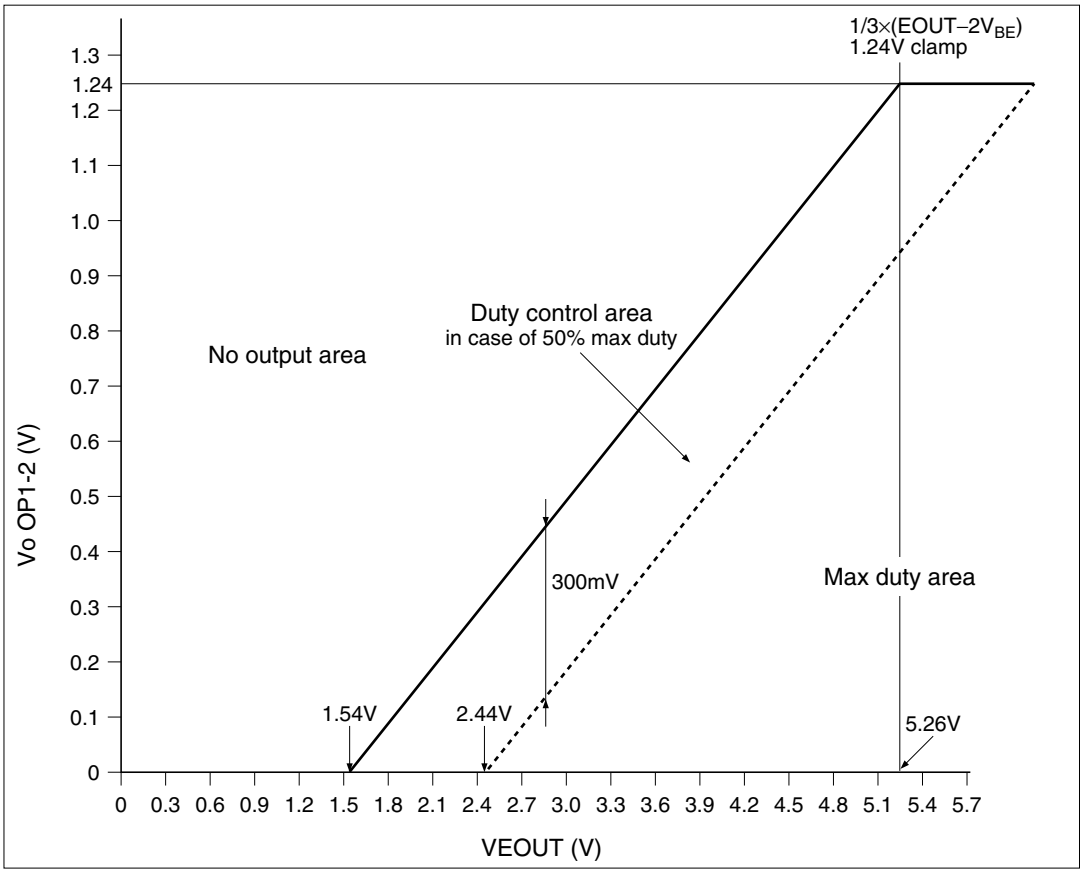
Figure B. External Trigger Application

Timing Chart 6 (Duty Control)

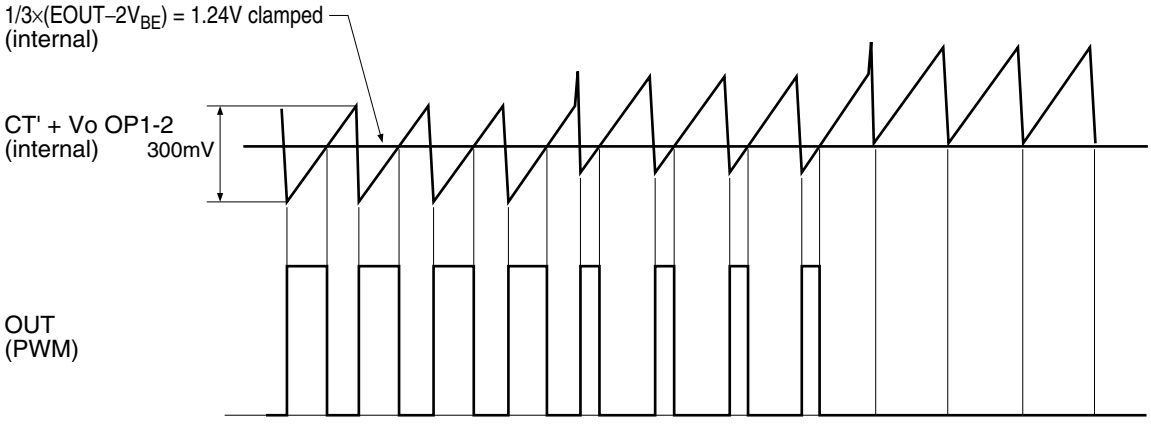


$$CT' = \frac{CT}{5.33}$$

The amplitude of CT' is 300mV typ at synchronous operation with trigger frequency as 200kHz and C_{CT} = 430pF.

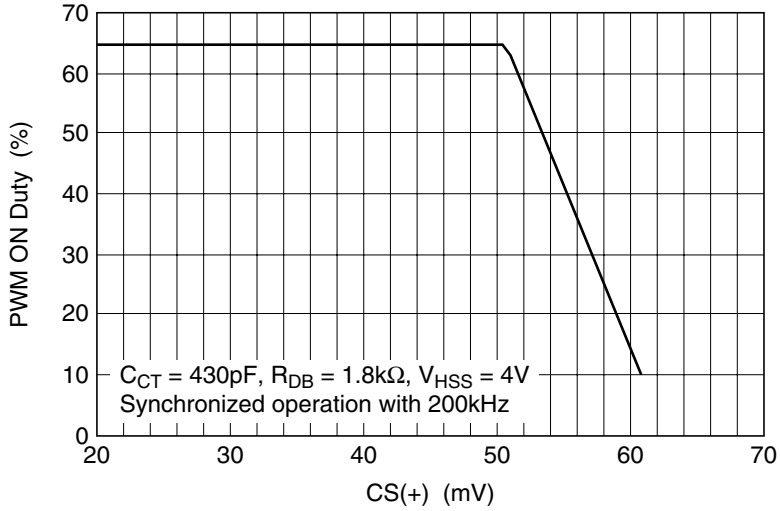


Timing Chart 7 (Current Limitting)

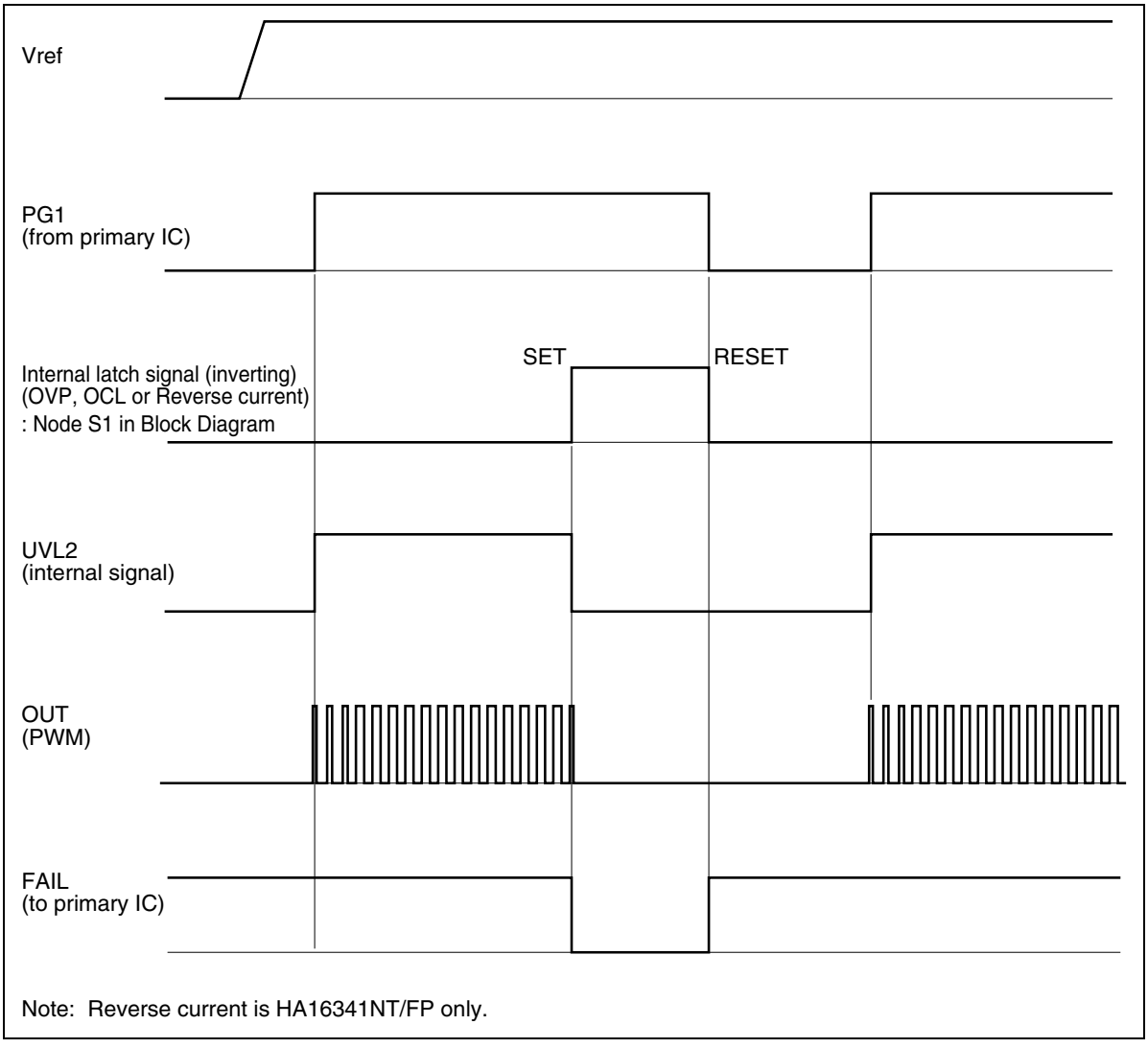


$$CT' = \frac{CT}{5.33}$$

The amplitude of CT' is 300mV typ at synchronous operation with trigger frequency as 200kHz and C_{CT} = 430pF.



Timing Chart 8 (Interface with Primary Control IC)

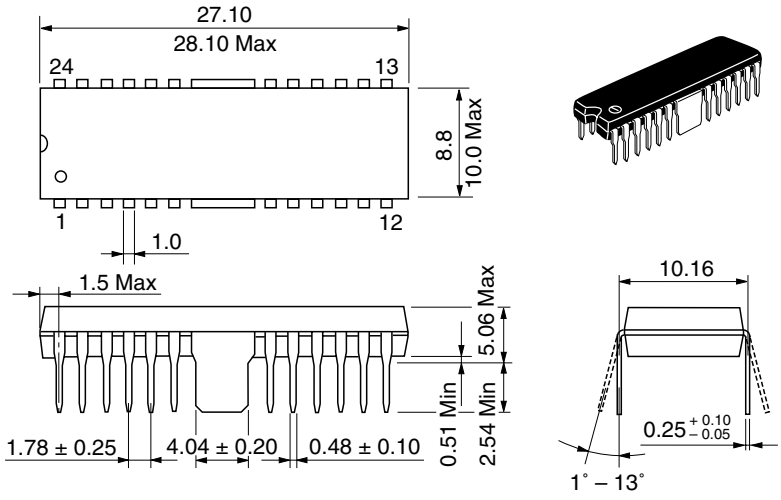


Note: Reverse current is HA16341NT/FP only.

Package Dimensions

As of January, 2002

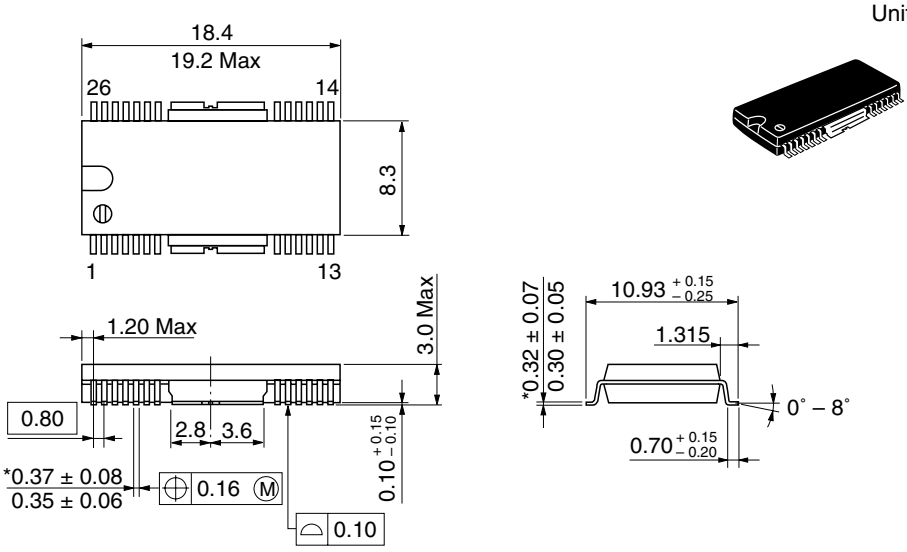
Unit: mm



Hitachi Code	DP-24TS
JEDEC	—
JEITA	—
Mass (reference value)	2.04 g

As of January, 2002

Unit: mm



Hitachi Code	FP-26DT
JEDEC	—
JEITA	—
Mass (reference value)	0.98 g

*Dimension including the plating thickness

Base material dimension

Disclaimer

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.

Sales Offices <heading sales offices,hso>

HITACHI

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

URL http://www.hitachisemiconductor.com/

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 Ltd.
Electronic Components Group
Whitebrook Park
Lower Cookham Road
Maidenhead
Berkshire SL6 8YA, United Kingdom
Tel: <44> (1628) 585000
Fax: <44> (1628) 585200

Hitachi Europe GmbH
Electronic Components Group
Dornacher Straße 3
D-85622 Feldkirchen
Postfach 201, D-85619 Feldkirchen
Germany
Tel: <49> (89) 9 9180-0
Fax: <49> (89) 9 29 30 00

Hitachi Asia Ltd.
Hitachi Tower
16 Collyer Quay #20-00
Singapore 049318
Tel : <65>-6538-6533/6538-8577
Fax : <65>-6538-6933/6538-3877
URL : http://semiconductor.hitachi.com.sg

Hitachi Asia Ltd.
(Taipei Branch Office)
4/F, No. 167, Tun Hwa North Road
Hung-Kuo Building
Taipei (105), Taiwan
Tel : <886>-(2)-2718-3666
Fax : <886>-(2)-2718-8180
Telex : 23222 HAS-TP
URL : http://www.hitachi.com.tw

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>-2735-9218
Fax : <852>-2730-0281
URL : http://semiconductor.hitachi.com.hk

Colophon 6.0

RENESAS