HA13571FR

Combo (Spindle & VCM) Driver for HDD

HITACHI

ADE-207-269 (Z)
1st Edition
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Description

The HA13571FR is combination of Spindle and VCM Driver designed for HDD and have following functions and features.

Functions

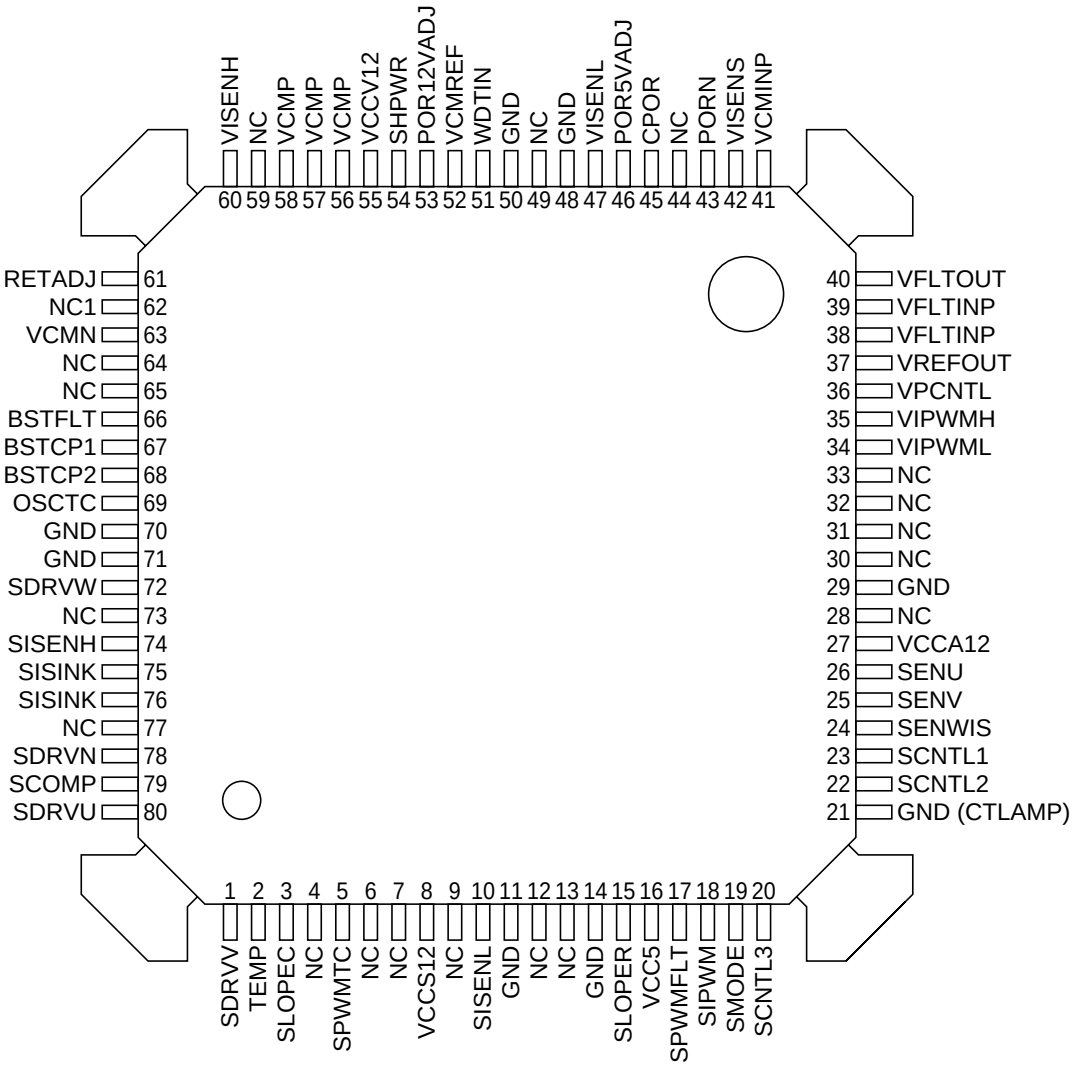
- 2.2 A/phase spindle motor driver
- 1.5 A VCM driver
- Soft switching control circuit
- B-EMF detection circuit
- Selectable PWM or linear drive (spindle motor driver)
- Power down brake & retract
- PWM DAC & filter (VCM driver)
- 5 V, 12 V power supply monitor
- Watch dog timer

Features

- Low thermal resistance package ($\theta j\text{-}a \leq 25°C/W$)
- Full programable commutation structure
- Low output saturation voltage
  - — Spindle motor driver
  - — VCM driver
- Built-in PWM DAC with filter
- Low noise drive by soft switching

Hitachi semiconductor

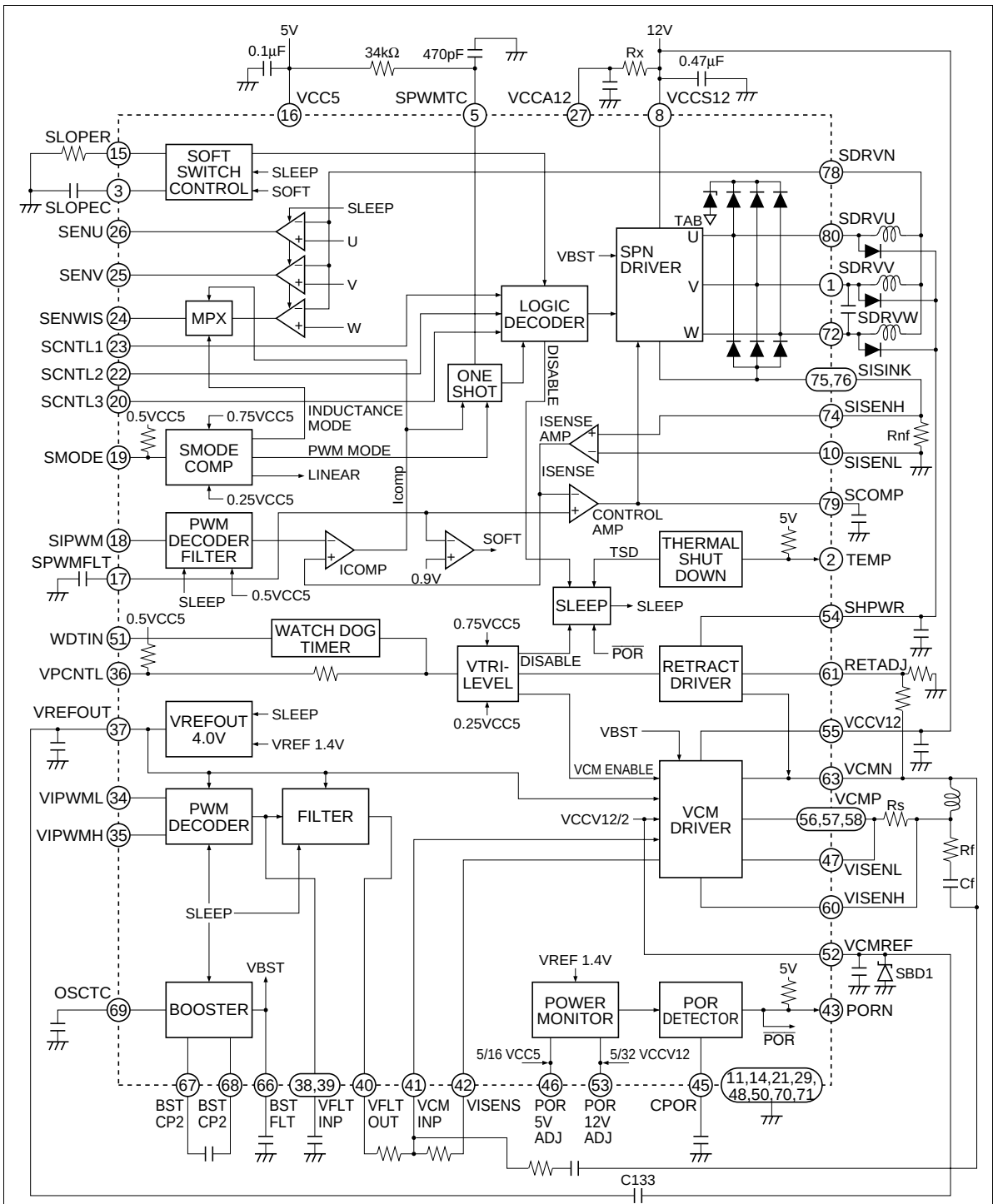
Pin Arrangement



(Top view)

Notes: 1. All same name pins must be connected together.
2. "NC" and "NC1" denotes no connection pins.
3. ALL "NC" pins must be connected to GND or opened.
4. "NC1" pin must be connected to VCMN or opened.

Block Diagram



Truth Table

Table 1 Input to Output Drivers

SCNTL1	SCNTL2	SCNTL3	SDRVU	SDRVV	SDRVW
H	H	L	L	Z	H
H	L	L	Z	L	H
H	L	H	H	L	Z
L	L	H	H	Z	L
L	H	H	Z	H	L
L	H	L	L	H	Z
L	L	L	Z	Z	Z
H	H	H	L	L	L

Note: Z = High impedance

Table 2 Spindle Driver Mode Control

SMODE	SIPWM	Spindle Driver Mode
H	Duty ≥ 50%	Linear Mode (High slew rate) *[2]
H	Duty ≤ 40%	Linear Mode (Low slew rate) *[2]
M	X	Inductive Sense Mode
L	X	B-EMF Sense in PWM Drive Mode

Note: 1. X = Don't care
2. Slew rate mode is commutated at synchronized with the up edge of SLOPEC.

Table 3 VCM Control

WDTIN	VPCNTL	VCM Mode
H or L	X	Park
M	H	Enable
M	M	Disable
M	L	Park

Table 4 Temp Output

TEMP	Status
H	Warning or TSD
L	Normal

Table 5 Output Status

	PORN		TSD		SLEEP *3		TEMP	
Driver	**L**	**H**	**Inactive**	**Active**	**L**	**H**	**L**	**H**
SPN Output	Brake for Retract	Enable	X	Z	X	Z	X	
VCM Output	Retract (Power off)	Enable	X	Z	X	Z	X	

Notes: 1. X = Don't care
2. Z = High impedance
3. SLEEP SCNTL1 = SCNTL2 = SCNTL3 = Low
WDTIN = VPCNTL = Middle

Table 6 SCNTL, WDTIN and VPCNTL Mode

SCNTL Input States			WDTIN Input State	VPCNTL Input State	Modes of Operation at Power Good (PORN = H)
SCNTL1	SCNTL2	SCNTL3			Spindle Driver
See Table 1	See Table 1	See Table 1	X	X	Enable
L	L	L	X	X	Disable
H	H	H	X	X	Brake

SCNTL Input States			WDTIN Input State	VPCNTL Input State	Modes of Operation at Power Good (PORN = H)
SCNTL1	SCNTL2	SCNTL3			VCM Driver
X	X	X	L or H	X	Park
X	X	X	Middle	H	Enable
X	X	X	Middle	Z	Disable
X	X	X	Middle	L	Park

SCNTL Input States			WDTIN Input State	VPCNTL Input State	Modes of Operation at Power Good (PORN = H)
SCNTL1	SCNTL2	SCNTL3			Spindle & VCM Driver
L	L	L	Middle	Z	Sleep Mode *

Note: Sleep signal is generated by SCNTL and VPCNTL.
TEMP output is depend on internal TSD and internal TEMP. (see figure 1)

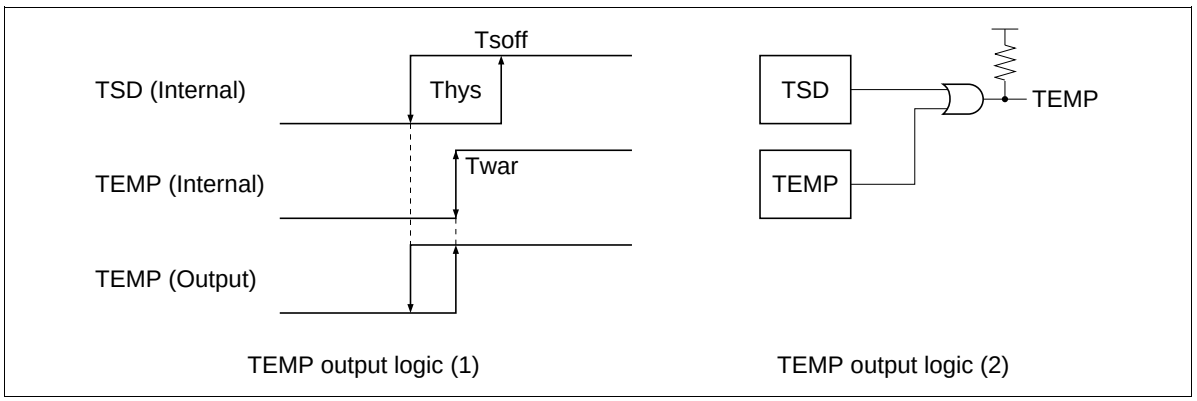


Figure 1 TEMP Output Logic

Table 7 Function Powered on Vs Mode Operation

Function	UPPER BOOSTER	UPPER DRIVERS	LOWER DRIVERS	COMP	CONTROL AMP
Spindle enable	ON	ON	ON	ON	ON
Spindle disable	ON	OFF	OFF	ON	OFF
PORN low	OFF	OFF	ON	OFF	OFF
Park *[1]	ON	ON/OFF	ON/OFF	ON	ON/OFF
Sleep *[2]	OFF	OFF	OFF	OFF	OFF

Function	ONE SHOT	ICOMP (Current comparator)	PWM DECODER FILTER	SMODE COMP	ISENSE AMP	LOGIC DECODER
Spindle enable	ON	ON	ON	ON	ON	ON
Spindle disable	ON	ON	ON	ON	ON	ON
PORN low	OFF	OFF	OFF	OFF	OFF	ON
Park *[1]	ON	ON	ON	ON	ON	ON
Sleep *[2]	OFF	OFF	OFF	OFF	OFF	ON

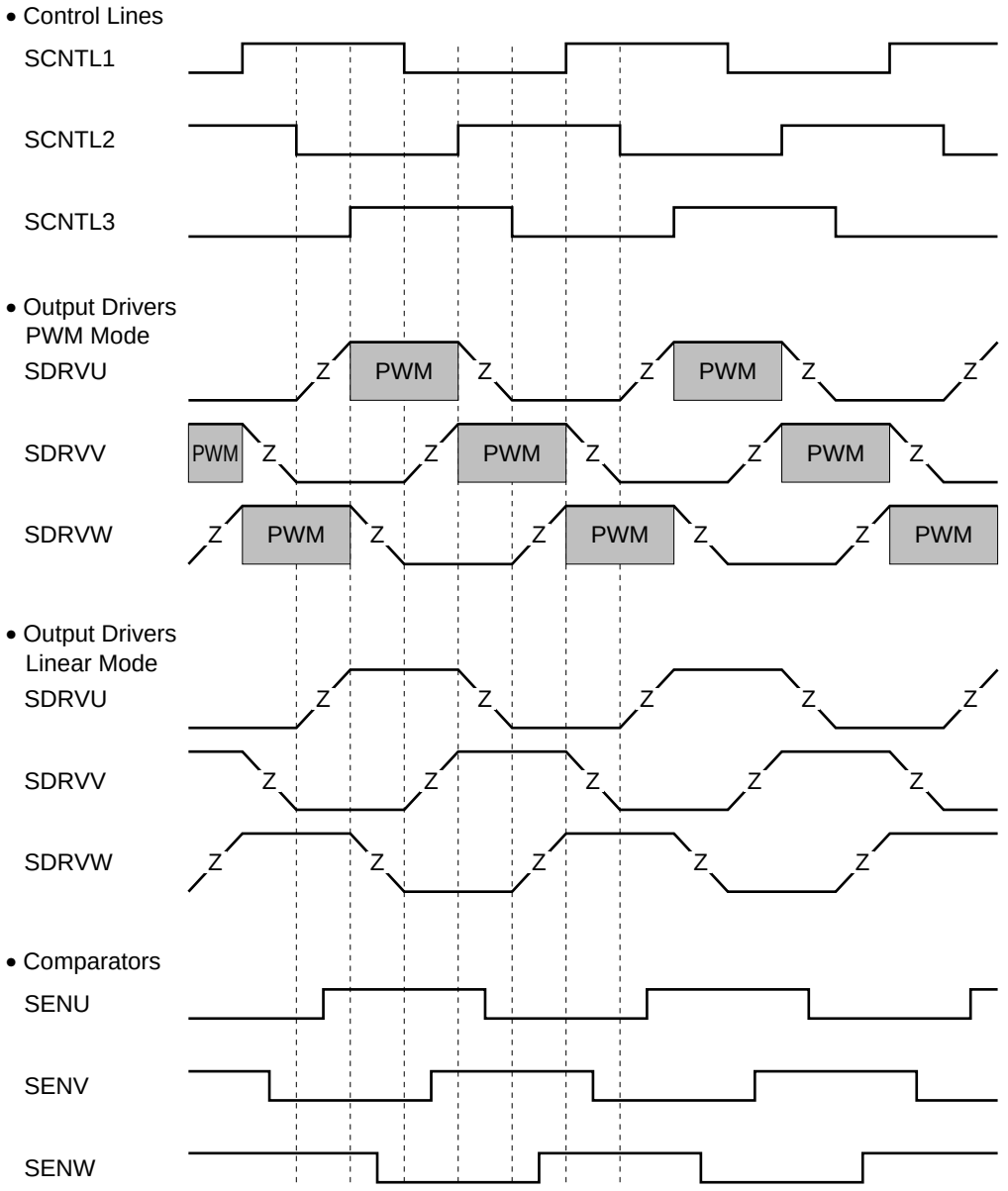
Function	PWM DECODER	12V and 5V COMP	FILTER AMP	PORN DETECTOR	RETRACT CIRCUIT	TSD
VCM enable	ON	ON	ON	ON	OFF	ON
VCM disable	ON	ON	ON	ON	OFF	ON
Park *[1]	ON	ON	ON	ON	ON	ON
Sleep *[2]	OFF	ON	OFF	ON	OFF	ON
PORN low	OFF	ON	OFF	ON	ON	ON

Function	VPCNTL	VREFOUT BUF	VREFOUT	SENSE1	VCM DRIVER	SLEEP FUNCTION
VCM enable	ON	ON	ON	ON	ON	OFF
VCM disable	ON	ON	ON	ON	OFF	OFF
Park *[1]	ON	ON	ON	ON	OFF	OFF
Sleep *[2]	ON	OFF	OFF	OFF	OFF	ON
PORN low	ON	OFF	OFF	OFF	OFF	ON

Note: 1. Park signal is generated by VPCNTL.
2. Sleep signal is generated by SCNTL and VPCNTL.

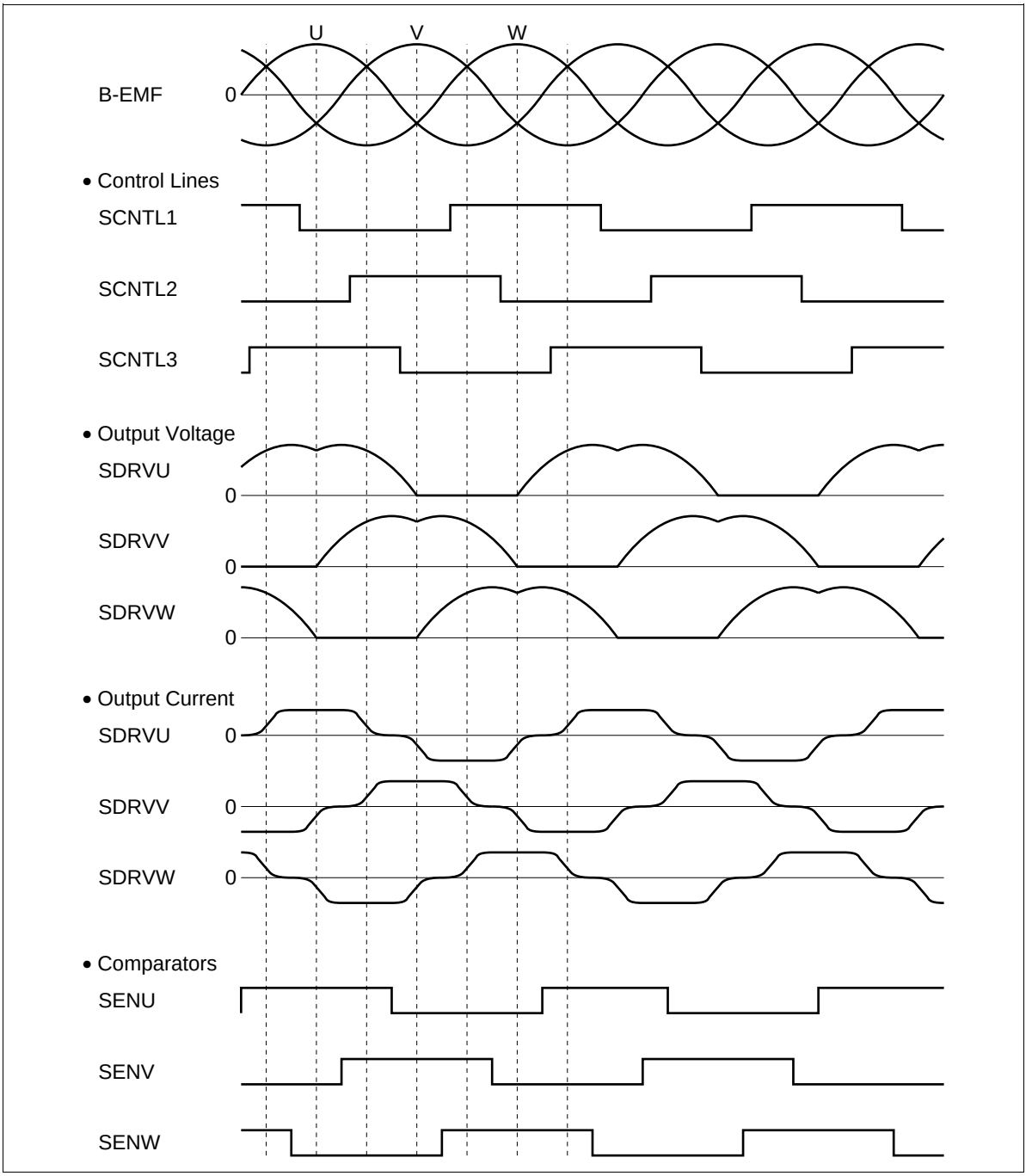
Timing Chart

1. SPN Input to Output Drivers

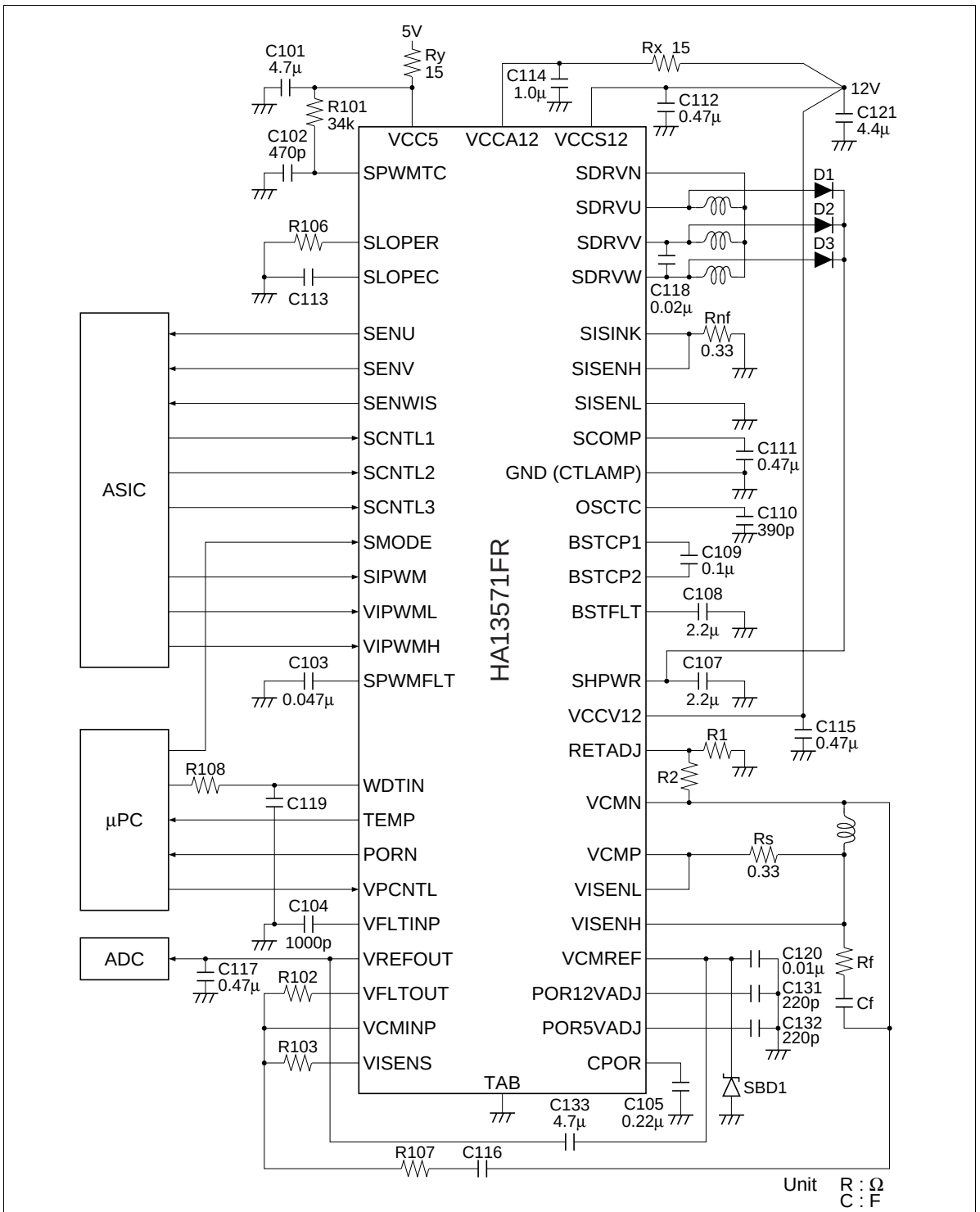


Note: "Z" = High impedance

2. Soft Switching



Application



External Components

Parts No.	Reccomended Value	Purpose
R1, R2	—	Setting of Retract voltage
R101	34 kΩ	PWM time off for Spindle driver
R102, R103	—	Setting of VCM driver gain
R106	100 kΩ	Time constant for Soft switching
R107	—	Phase compensation for VCM driver
R108	TBD	for Watch dog timer
Rnf	0.33 Ω	Current sensing for Spindle driver
Rs	0.33 Ω	Current sensing for VCM driver
Rx, Ry	15 Ω	for Filter VCCA12 and VCC5
Rf	—	Snubber for VCM driver
C101	4.7 µF	5V power supply by passing
C102	470 pF	PWM time off for Spindle driver
C103	0.047 µF	PWM filter for Spindle driver
C104	1000 pF	PWM filter for VCM driver
C105	0.22 µF	Delay for POR
C107	2.2 µF	Capacitor for Retract voltage supply
C108	2.2 µF	for Booster
C109	0.1 µF	for Booster
C110	390 pF	Time constant for Oscillation
C111	0.47 µF	Phase compensation for Spindle driver
C112	0.47 µF	12V power supply by passing
C113	0.003 µF	Time constant for Soft switching
C114	1.0 µF	12V power supply by passing
C115	0.47 µF	12V power supply by passing
C116	—	Phase compensation for VCM driver
C117	0.47 µF	Reference output by passing
C118	0.02 µF	Prevent from oscillation during PWM drive
C119	TBD	for Watch dog timer
C120	0.01 µF	Reduction of noise from 12V power supply for VCM driver
C121	4.4 µF	Reduction of noise from 12V power supply for VCM driver
C131	220 pF	(Option) Filter for POR12VADJ
C132	220 pF	(Option) Filter for POR5VADJ
C133 *	4.7 µF	Reduction of noise from 12V power supply for VCM driver

External Components (cont)

Parts No.	Reccomended Value	Purpose
Cf	—	Snubber for VCM Driver
D1 to D3	TBD	Power rectification for Retract driver
SBD1 *	HRU0302A	Prevent of malfunction for Retract driver

Note: Retract circuit sometime will be malfunctioning by means of negative voltage on the terminal VCMREF (pin 52) in the following sequence.

If you want to countermeasure this, you need to avoid the following sequence or to attach the Schottky Barrier Diode (SBD1) between terminal VCMREF and GND. (see figure 2)

1. Spindle motor driver is active and VCM driver is disable by (VPCNTL = Middle).
2. Power supply goes to low level after above condition 1 and retract circuit becomes active by (POR = L).

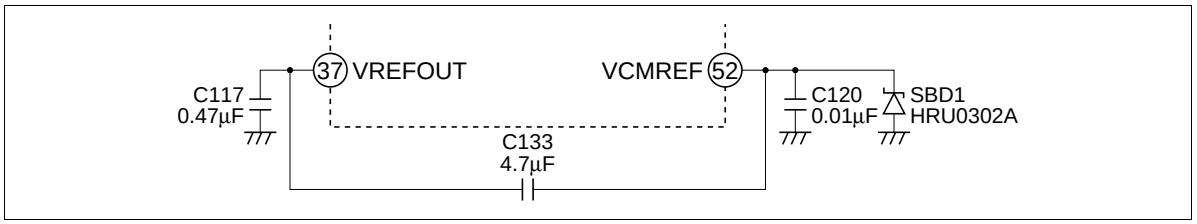


Figure 2

Absolute Maximum Ratings (Ta = 25°C)

Item	Symbol	Rating	Unit	Notes
Supply voltage +12V	Vcc12	–0.3 to 13.5	V	1
Supply voltage +5V	Vcc5	–0.3 to 6	V	1
Output voltage +12V (DC)	Vsdrv (DC)	–0.3 to 15	V	5
Output voltage +12V (PEAK)	Vsdrv (PEAK)	–2.0 to 17	V	5, 6
Output voltage +5V	Vout	–0.3 to 6	V	7
Output current spindle driver	Iospn (DC)	2.2	A	2
Output current VCM driver	Iovcm (DC)	1.5	A	2
Input voltage	Vi	–0.3 to Vcc5	V	3
Power dissipation	P_T	5	W	4
Junction temperature	Tj	160	°C	1
Storage temperature	Tstg	–55 to +125	°C	

Notes: 1. Operating range are as follows.
Vcc12 = 10.8 to 13.2 V
VccA12 = 10.4 to 13.2 V
Vcc5 = 4.3 to 5.5 V
Tjopr = 0 to 130°C
2. Refer to ASO shown below. Operating locus must be within the ASO.
3. Applied to pin SCNTL1, SCNTL2, SCNTL3, SMODE, SIPWM, VPCNTL, VIPWML and VIPWMH.
4. Thermal resistance θj-a ≤ 25°C/W with 4 layer multi glass-epoxy board.
5. Applied to pin SDRVN, SDRVU, SDRVV, SDRVW, VCMN and VCMP.
6. PEAK time must be shorter than 1 ms.
7. Applied to pin PORN and TEMP.

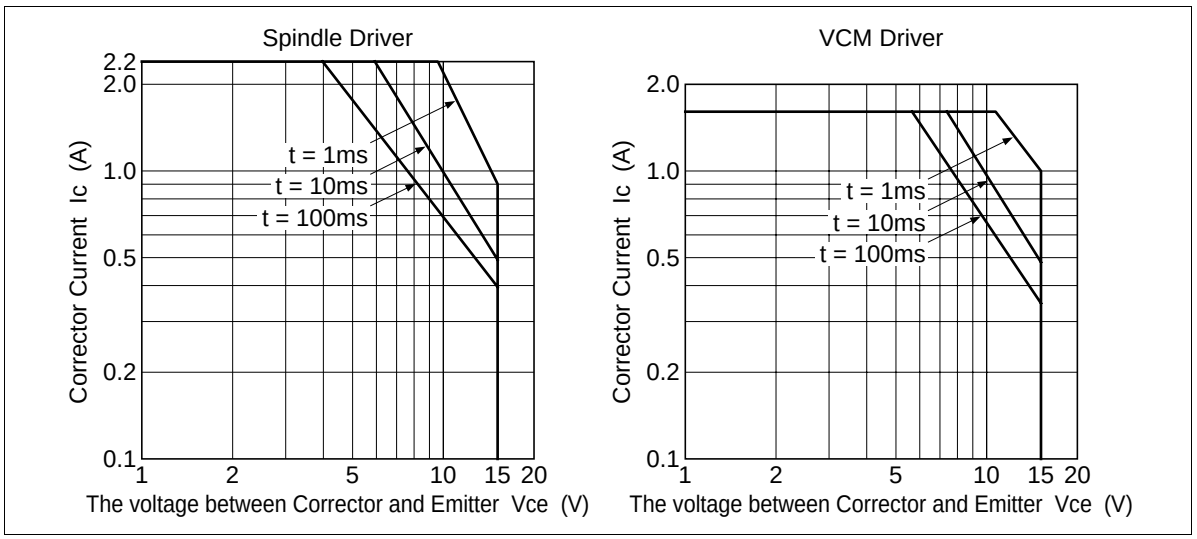


Figure 3 ASO

Electrical Characteristics (Ta = 25°C, Vcc5 = 5.0 V, Vcc12 = 12 V)

Item		Symbol	Min	Typ	Max	Unit	Test Conditions		Applicable pins	Note
+5V supply current		Icc5s	—	9.0	11.5	mA	Sleep mode		VCC5	
		Icc5	—	15	18.5	mA				
+12V supply current		Icc12s	—	3.0	4.5	mA	Sleep mode		VCCS12 VCCV12 VCCA12	
		Icc12	—	40	50	mA	SMODE = High			
		IccA12	—	12.5	16	mA	SMODE = High		VCCA12	1
Total power dissipation		Pdiss	—	81	110	mW	Sleep mode Vcc5 = 5.0V, Vcc12 = 12.0V		VCC5 VCCS12 VCCV12 VCCA12	
Logic inputs1	Input current	Iin	—	—	±10	µA	Vin = 0 to Vcc5		SCNTL1 SCNTL2 SCNTL3	
	High level voltage	Vih	3.5	—	—	V				
	Low level voltage	Vil	—	—	1.5	V				
Logic inputs2	High level voltage	Vih	3.9	—	—	V			SMODE	
	Middle level voltage	Vim	1.4	—	3.6	V				
	Low level voltage	Vil	—	—	1.1	V				
	High level current	Iih	80	100	133	µA	VIN = 5V			
	Low level current	Iil	–80	–100	–133	µA	VIN = 0V			
Logic inputs3	High level voltage	Vih	3.9	—	—	V			VPCNTL	
	Middle level voltage	Vim	1.4	—	3.6	V				
	Low level voltage	Vil	—	—	1.1	V				
	High level current	Iih	80	100	133	µA	VIN = 5V	WDTIN = Middle		
	Low level current	Iil	–80	–100	–133	µA	VIN = 0V			
	High level current	Iih	480	600	800	µA	VIN = 5V	WDTIN = High or Low		
	Low level current	Iil	–80	–100	–133	µA	VIN = 0V			
Logic inputs4	High level voltage	Vih	3.8	—	—	V			WDTIN	
	Middle level voltage	Vim	1.3	—	3.5	V				
	Low level voltage	Vil	—	—	1.0	V				
	Input current	Iin	—	—	±20	µA	Vin = 0 to Vcc5			

Electrical Characteristics (cont)

Item		Symbol	Min	Typ	Max	Unit	Test Conditions	Applicable pins	Note
SPN output drivers	Total output saturation voltage	Vsatspn	—	1.1	1.4	V	Iout = 1.2A, Tj = 25°C	SDRVU SDRVV SDRVW	
			—	2.0	2.6	V	Iout = 2.2A Tj = 25°C		
			—	2.6	3.74	V	Tj = 125°C		1
	Leakage current	Icex1	—	—	0.1	mA	VIN = 14V	SDRVU SDRVV SDRVW	
		Icex2	—	0.6	1.2	mA	Test source current from middle phase R_L = 11Ω/phase		
		Ifrdu	—	—	20	mA	Vfrdu = 2.0V, Vcc12 = 0V		
	Recirculating diode forward voltage	Vfrdl1	—	1.25	1.4	V	If = –1.0A		1
		Vfrdl2	—	1.75	2.2	V	If = –2.2A		
	Overvoltage protection clamp	Vclp	14.4	15.4	17	V	Iclp = 100mA		
SPN PWM DAC & filter	Input current	Iin	—	—	±300	µA	Vin = –0.3 to Vcc5	SIPWM	
	High level voltage	Vh	3.5	—	—	V			
	Low level voltage	Vts	—	—	1.5	V			
	PWM pulse width	Tpwm	23	—	—	ns			
	Output resistance at Spwmflt	Rsout	—	34	±20%	kΩ		SPWMFLT	
	Output voltage	Vflt100	—	1.79	±10%	V	Duty = 100%		
		Vflt50	—	0.93	±10%	V	Duty = 50%		
		Vflt0	—	50	100	mV	Duty = 0%		
PWM one shot	Sink current	Isk	410	580	750	µA	Spwmtg = 3.0V	SPWMTC	
	Low clamp voltage	Vclmp	1.33	1.53	1.73	V	for discharging		
	Threshold voltage	Vthst	3.0	3.3	3.6	V	for discharging		
		Vthend	1.47	1.67	1.87	V	for charging		

Electrical Characteristics (cont)

Item		Symbol	Min	Typ	Max	Unit	Test Conditions		Applicable pins	Note
PWM one shot	One-shot off time	Toff	9	11	13	µs	Ext. R = 34kΩ, C = 470pF		SPWMTC	1
	One-shot minimum on time	Ton	2.1	2.8	3.5	µs				
B-EMF comparators	Common mode input voltage	Vcm	–0.4	—	VCC12 –2.0	V			SDRVU SDRVV SDRVW SDRVN	
	Common mode clamp resistor	Rclp	7	10	13	kΩ	Sdrvn = 6V			
	Offset voltage	Vcos	—	—	±5	mV	Sdrvn = 1.0V to Vcc12-2V			
		ΔVosc	—	—	±7	mV	Variation in U, V, W			
	Output low voltage	Vsink	—	—	0.5	V	Isink = 1.0mA		SENU SENV SENWIS	
	Output high voltage	Vsource	2.7	—	—	V	Isource = 0.04mA			
	Center tap voltage	VCT	1.0	—	VCC12 –2.0	V	SCNTL1, 2, 3 = "L" R_L = 2Ω/phase VPCNTL = "H" or "M"		SDRVN	
Control amp & sense amp	Isense input current	Isen	–10	—	24	µA	SISENH = 0 to 0.4V		SISENH SISENL	
	Isense amp voltage gain	Ksp	—	4.9	±4.6%	V/V	Ksp = Spwmflt/Sisenh Rs = 0.33Ω		SISENH SPWMFLT	
	SISENH voltage	V100	—	348	±18	mV	Rnf = 0.33Ω	D = 100% Tj = 125°C	SISINK	1
			—	348	±18	mV		D = 100%		
		V50	—	170	±18	mV		D = 50%		
		V5	—	7	17	mV		D = 5%		
		V0	0.0	0.0	5	mV		D = 0%		
	Current loop bandwidth	Bwd	1.8	3.0	—	kHz	Rnf = 0.33W, Rm = 12Ω Lm = 1.0mH, C111 = 0.47µF			1
	ICOMP threshold voltage	Vth	—	180	±15	mV	No Load No Rnf	Spwmflt = 1.0V	SENWIS	
			—	80	±11	mV	Smode = 2.5V, Sisenh = 0 to 5V	Spwmflt = 0.5V		

Electrical Characteristics (cont)

Item		Symbol	Min	Typ	Max	Unit	Test Conditions	Applicable pins	Note
Soft Switch	SLOPER Output voltage	Vsoftr	1.45	1.90	2.35	V	R106 = 100kΩ	SLOPER	
	SLOPEC Source current	Isource	7	9	12	µA	R106 = 100kΩ	SLOPEC	
	SLOPEC Sink current	Isink	7	9	12	µA	R106 = 100kΩ		
	SLOPEC High voltage	Vhsoft	3.5	4.4	5.5	V	High SR		
			2.0	2.4	2.8	V	Low SR		
	SLOPEC Low voltage	Vlsoft	0.9	1.1	1.3	V			
VCM PWM DAC	Input current	Iin	—	—	±200	µA	Vin = 0V to 5V	VIPWML VIPWMH	
	Input high voltage	Vhi	3.5	—	—	V			
	Input low voltage	Vli	—	—	1.5	V			
	Input PWM frequency	Fpwm	—	625	—	kHz			1
	PWM pulse width	Tpwm	23	—	—	ns			
	PWM DAC resolution		—	14	—	bits			1
	Positive full scale voltage	Vflp	—	Vrefout +1.0	—	V		VFLTINP	1
	Negative full scale voltage	Vfln	—	Vrefout –1.0	—	V			1
	Current ratio		–0.5	32	+1.0	A/A	MSB/LSB		
	Output impedance	Rout	—	3.75	±17%	kΩ			
Filter	Output impedance	Rout	—	—	40	Ω	ΔVout = 10mV	VFLTOUT	
	Phase shift		—	—	1.2	deg.	f = 500Hz, Vfltinp to Vfltout		1
	Cutoff frequency	Fc	33	50	75	kHz	ΔGv = –3dB		1
	Attenuation		—	24	±10	dB	f = 200kHz		

Electrical Characteristics (cont)

Item		Symbol	Min	Typ	Max	Unit	Test Conditions	Applicable pins	Note
Filter	Output voltage	Vflt0	—	Vrefout –2.03	±0.1	V	Vipwml & Vipwmh Duty = 0%	VFLTOUT	
		Vflt50	—	Vrefout	±0.05	V	Vipwml & Vipwmh Duty = 50%		
		Vflt100	—	Vrefout +2.03	±0.1	V	Vipwml & Vipwmh Duty = 100%		
	Output voltage symmetry	Vfltsym	—	—	±140	mV	| Vflt100 – Vrefout | – | Vfit0 – Vrefout |		
Current sense amp	Input current	Iin	–200	—	400	µA		VISENS VISENH VISENL	
	Output offset voltage	Vos	—	10	±20	mV	Visenh – Visenl = 0V at 1/2 Vcc		
	Output resistance	Rout	—	—	25	Ω	Sink and Source		
	Visenl, Visenh operating range	Vr1	0	—	12	V	Gain and Offset Valid		
	Unity gain bandwidth	BW1	2.0	3.0	4.0	MHz			1
	Gain	G10	3.8	4.0	4.2	V/V	VISENH/L = 0V		
		G16	3.8	4.0	4.2	V/V	VISENH/L = 6V		
		G112	3.8	4.0	4.2	V/V	VISENH/L = 12V		
		ΔG1	—	0	±2%	V/V	(G112 – G16)/G16 (G10 – G16)/G16		
	Power supply rejection ratio	PSRR	40	52	—	dB	F ≤ 20kHz		1
VCM output driver	Total output saturation voltage	Vsatvcm	—	1.5	1.875	V	Iout = 1.5A Tj = 25°C	VCMN VCMP	
			—	1.95	2.85	V	Tj = 125°C		1
	Output leakage	Ilk	—	—	0.5	mA	Tj = 25°C BSTFLT = VCCV12 = 14V		
	Output quiescent voltage	Vq	—	Vcc12/2	±5%	V			
	Recircurate diode voltage	VRD	—	2.0	2.5	V	Io = –1.5A		1

Electrical Characteristics (cont)

Item		Symbol	Min	Typ	Max	Unit	Test Conditions	Applicable pins	Note
VCM output driver	Output offset current	Ios	—	—	±28	mA	Rs = 0.33Ω, Rl = 10Ω, R102 = 10kΩ, R103 = 6.6kΩ C106, R107 = OPEN	VISENH	
	Transconductance	Gm	—	0.5	±5%	A/V	Vin = FLTOUT		
	–3dB bandwidth	BW	—	300	±30%	kHz	Vout = VCMN, Rl = 15Ω		
	Total harmonic distortion	THD	—	1.0	2.5	%	f = 1kHz, Vout = 1Vrms		
	Time of crossover distortion	Tcro	—	2	5	µs	Ramp input VCMINP 20µs R102 = 10kΩ, R103 = 6.6kΩ C106, R107 = OPEN		1
	Symmetry Vcm drivers VCMN VCMP	RATIO = I2/I1	0.95	1.02	1.09	Ratio	I2 = Irvcm at D = 10% I1 = Irvcm at D = 90% I0 = Irvcm at D = 50% Rs = 0.33Ω, R_L = 10Ω R103/R102 = 10k/6.6k	VCMN VCMP	
	Linearity Vcm drivers VCMN VCMP	L = | I2–I0 |/ | I1–I0 |	0.99	1.02	1.05	Ratio			
	Overvoltage protection clamp	Vclp2	14.6	15.8	17.0	V	Iclp2 = 100mA		
	Reference volatge	Vvcmref	—	Vcc12/2	±5%	V	20kΩ/20kΩ	VCMREF	
Retract (Power on)	Output voltage	Vretout	0.65	0.9	1.3	V	Rs = 0.33Ω, R_L = 15Ω R1 = 33kΩ, R2 = 10kΩ VPCNTL = “L”	VCMN	
	Saturation voltage (Lower)	VsatL	—	0.12	0.25	V		VCMP	
Retract (Power off)	Min. retract current	Iret	15	—	—	mA	VIN = VSHPWR + VF(IM10) VIN = 2.0–VFSub(@20mA)	VCMN VCMP	
	Max. retract voltage (VCMN–VCMP)	Vret	—	—	1.3	V	VIN = 8V, Rm 4Ω, R1 = 33kΩ, R2 = 10kΩ		
Brake	Brake voltage	Vbrks	—	0.5	0.8	V	Ibrk = 1.2A SCNTL1 to 3 = High	SDRVU SDRVV SDRVW	
Vrefout	Output voltage	Vref	—	4.0	±0.2	V	Io = 10.0mA, Cl = 10nF	VREFOUT	
Booster	Output voltage	Vbst	Vcc12 +0.8	—	Vcc12 +3.7	V	Ispn = 0A, Ivcm = 0A	BSTFLT	
			Vcc12 +0.8	—	Vcc12 +3.7	V	Ispn = 2.2A, Ivcm = 0A		
			Vcc12 +0.8	—	Vcc12 +3.7	V	Ispn = 0.5A, Ivcm = 1.5A		

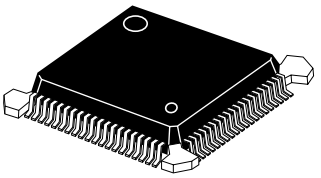
Electrical Characteristics (cont)

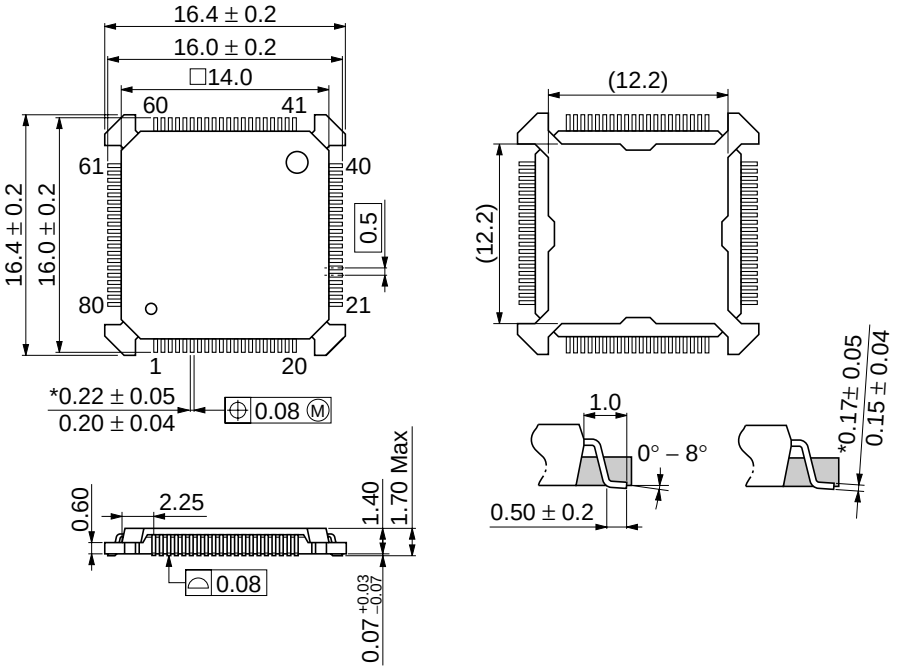
Item		Symbol	Min	Typ	Max	Unit	Test Conditions	Applicable pins	Note
Power Monitor	+12V Threshold voltage	Vt12	—	9.0	±0.3	V	Vcc5 = 5V	VCC12	
	+5V Threshold voltage	Vt5	—	4.5	±0.1	V	Vcc12 = 12V	VCC5	
	Hysteresis on Vcc12	Hv12	—	200	±60	mV		VCC12	
	Hysteresis on Vcc5	Hv5	—	50	±15	mV		VCC5	
	POR12VADJ voltage	V12adj	—	1.86	±2%	V	19.2kΩ/3.52kΩ	POR12V ADJ	
	POR5VADJ voltage	V5adj	—	1.54	±2%	V	9.6kΩ/4.27kΩ	POR5V ADJ	
POR detector	Output low level voltage	Vol	—	—	0.5	V	Iol = 2mA, Vcc5 = 4.35V Vcc12 = 8.7V	PORN	
	Output high level voltage	Voh	Vcc5 –0.15	—	—	V	Vcc5 = 4.7V, Vcc12 = 9.5V		
	PORN pull-up resistance	Rpu	—	15	±20%	kΩ			
	Charge current for CPOR	Icpor	5	8	12	µA		CPOR	
	CPOR threshold voltage	Vcpor	—	1.4	—	V			
	POR delay	Tdpor	—	40	—	ms	Cpor = 0.22µF	PORN	
	Power supply Max. pulse duration	Trpulse	5.0	—	—	µs			
Thermal shut-down	Warning temperature	Twar	130	145	160	°C			2
	Shut-down temperature	Tsoff	145	160	175	°C			2
	Difference temperature	ΔT	10	15	20	°C	Tsoff – Twar		2
	Thermal hysteresis	Thys	—	30	±10	°C			1
OSC	Frequency range	fosc	200	250	300	kHz		OSCTC	
TEMP	Output low voltage	Vol2	—	—	1.0	V	Iol = 0.1mA	TEMP	
	Pull-up resistnace	Rpu2	—	50	±20%	kΩ			
	Leakage current	Ilk2	—	—	±10	µA	Vcc5 = 6V, Vo = 6V		

Note: 1. Guaranteed by design.
2. Function test only.

Package Dimensions

Unit: mm
( ) : reference value





*Dimension including the plating thickness
Base material dimension

Hitachi Code	FP-80TA
JEDEC	—
EIAJ	—
Weight (reference value)	1.3 g

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