
HA13570T

MODD Combo Driver

HITACHI

ADE-207-255B (Z)
3rd Edition
January 1999

Description

The HA13570T is combination of Spindle, Focus, Tracking, Voice coil, Bias magnet designed for MODD and have following function and features.

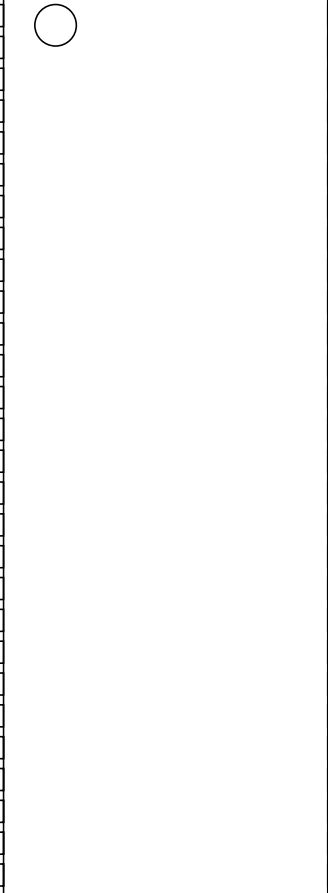
Functions

- 1.0 A spindle driver (SPN: Linear drive)
- 1.0 A focus driver (FCS: Linear drive)
- 1.0 A tracking driver (TRK: Linear drive)
- 1.5 A voice coil motor driver (VCM: PWM drive)
- 1.0 A bias magnet driver (BMG: PWM drive)
- FLL speed control circuit
- Over temperature shut down (OTSD)

Features

- Sensorless driver with self start (SPN)
- Soft switching drive (SPN)
- Output low saturation voltage
- With current limiter (All driver)
- With through current protection (VCM, BMG)
- Low thermal resistance thin surface mount package: TTP-56DT

Pin Arrangement



SUBGND	1		56	SUBGND
VBMG	2		55	BMGIN
BMGDTC	3		54	VREF1
RS4	4		53	VCMIN
BMGN	5		52	VCM DTC
BMGP	6		51	BMGR
VVCM	7		50	BMGF
VCMN	8		49	VCMR
RS3	9		48	VCMF
VCMP	10		47	CLK
SUBGND	11		46	BRAKE
BSTGND	12		45	SGND
B2	13		44	ACTEN
B1	14		43	SPNEN
VBST	15		42	PC
FGND	16		41	VSS
FCSN	17		40	CP
FCSP	18		39	FGOUT
TRKN	19		38	READY
TRKP	20		37	CT1
VFCS	21		36	RT
U	22		35	FCSIN
RNF	23		34	TRKIN
V	24		33	FCSRS
W	25		32	TRKRS
CT	26		31	VREF2
VSPN	27		30	SGND
SUBGND	28		29	SUBGND

(Top view)

Pin Description

Pin No.	Pin Name	Function	Note
1	SUBGND	Sub straight GND	
2	VBMG	BMG driver power supply	
3	BMGDTC	BMG current detection comparator output	
4	RS4	BMG current detection	
5	BMGN	BMG driver N output	
6	BMGP	BMG driver P output	
7	VVCM	VCM driver power supply	
8	VCMN	VCM driver N output	
9	RS3	VCM current detection	
10	VCMP	VCM driver P output	
11	SUBGND	Sub straight GND	
12	BSTGND	Booster GND	
13	B2	Booster pumping capacitor connection	
14	B1	Booster pumping capacitor connection	
15	VBST	Booster output pin. This circuit generates a voltage about 1.5 V above that of the VPS pin.	
16	FGND	FCS & TRK output GND	
17	FCSN	FCS driver N output	
18	FCSP	FCS driver P output	
19	TRKN	TRK driver N output	
20	TRKP	TRK driver P output	
21	VFCS	FCS & TRK driver power supply	
22	U	U phase output	
23	RNF	SPN current detection	
24	V	V phase output	
25	W	W phase output	
26	CT	SPN center tap	
27	VSPN	SPN driver power supply	
28	SUBGND	Sub straight GND	
29	SUBGND	Sub straight GND	
30	SGND	Small signal GND	
31	VREF2	Reference voltage of FCS & TRK control analog input	
32	TRKRS	TRK current detection	
33	FCSRS	FCS current detection	

Pin Description (cont)

Pin No.	Pin Name	Function	Note
34	TRKIN	TRK control analog input	
35	FCSIN	FCS control analog input	
36	RT	Reference voltage. The IC's internal reference current is determined by this voltage and the external resistor Rt.	
37	CT1	Time constant for start-up oscillator. The clock oscillator frequency is determined by the external capacitor and resistor Ct1 and Rt. Use a capacitor with good temperature characteristics.	
38	$\overline{\text{READY}}$	SPN ready output. Low output at running	
39	FGOUT	Outputs the B-EMF zero cross phase. (See the timing chart)	
40	CP	SPN servo loop phase compensation	
41	VSS	Control block power supply	
42	PC	SPN current control phase compensation	
43	SPNEN	SPN enable. (See the truth table)	
44	ACTEN	Actuator enable. (See the truth table)	
45	SGND	Small signal GND	
46	BRAKE	Brake control input. (See the truth table)	
47	CLK	External clock input. The rotation speed of SPN is determined by the clock frequency.	1
48	VCMF	VCM control logic input. (See the truth table)	
49	VCMR	VCM control logic input. (See the truth table)	
50	BMGF	BMG control logic input. (See the truth table)	
51	BMGR	BMG control logic input. (See the truth table)	
52	$\overline{\text{VCMDTC}}$	VCM current detection comparator output	
53	VCMIN	VCM control analog input	
54	VREF1	Reference voltage of VCM & BMG control analog input	
55	BMGIN	BMG control analog input	
56	SUBGND	Sub straight GND	

Note: 1. The relationship between the clock frequency f_c (MHz) and the spindle rotation speed N_o (rpm) is as follows. And the example is shown in table 1.

$$f_c = \frac{N_o}{60} \times \frac{P}{2} \times D_n \times D_c$$

Where, P : Number of spindle motor poles (Total number of poles)

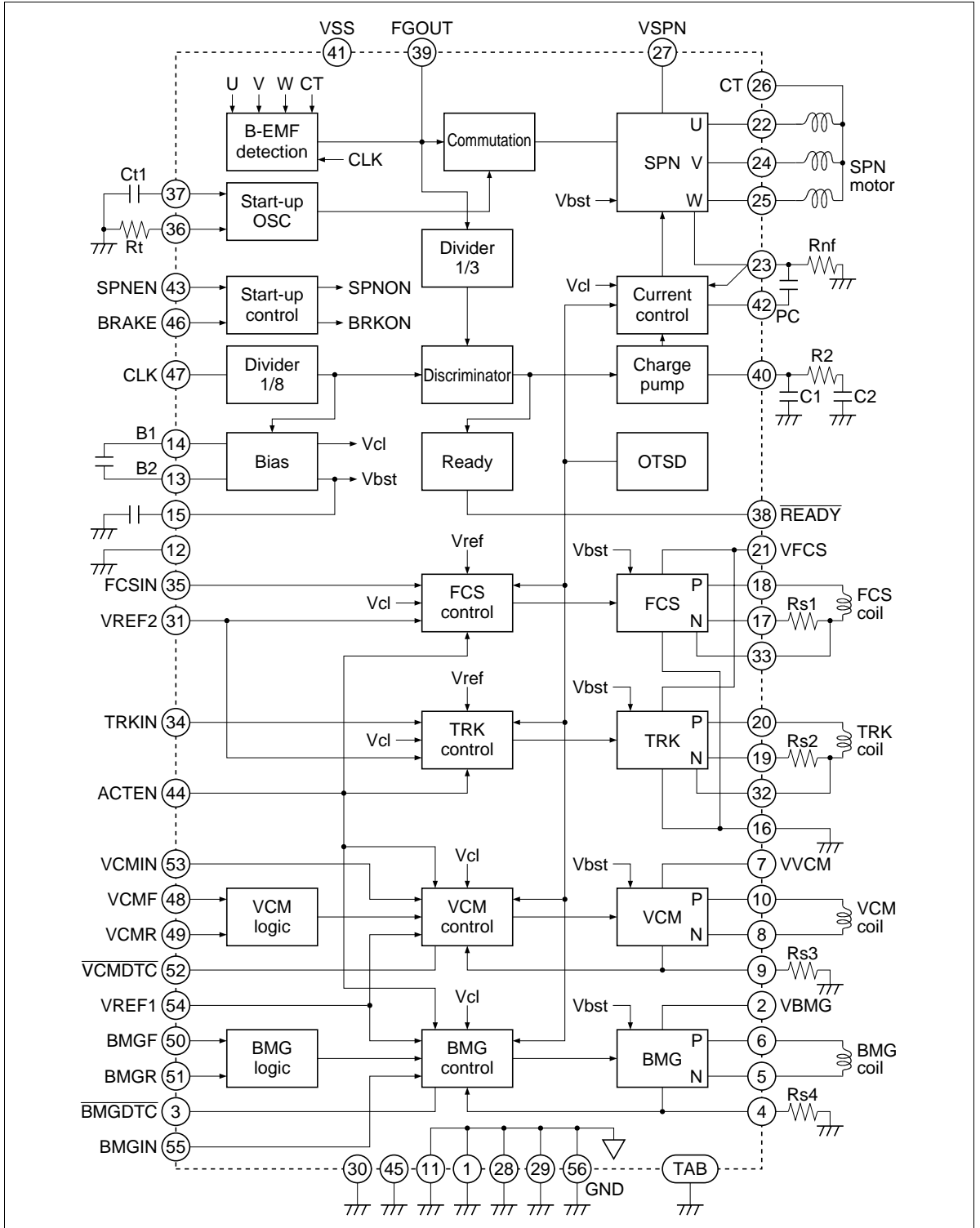
D_n : Count number on speed discriminator (See the electrical characteristics)

D_c : Number of CLK divider ($D_c = 8$)

Table 1 **Example**

No (rpm)	fc (MHz)	
	P = 8	P = 12
2700	1.49976	2.24964
3600	1.99968	2.99952
4200	2.33296	3.49944
4500	2.4996	3.7494
5400	2.99952	4.49928

Block Diagram



Truth Table

Table 2 **SPN**

SPNEN	BRAKE	SPN
L	X	Z
H	L	Enable
	H	Brake

Note: X: Option, Z: Hi impedance

Table 3 **FCS & TRK**

ACTEN	FCS	TRK
L	Z	Z
H	Enable	Enable

Note: Z: Hi impedance

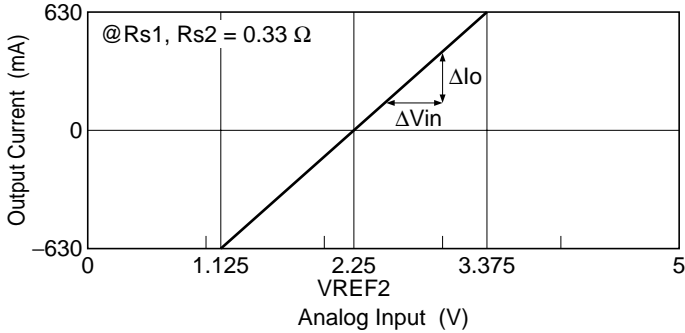
Table 4 **VCM & BMG**

ACTEN	F	R	P Output	N Output
L	X	X	Z	Z
H	L	L	L	L
		H	L	H
	H	L	H	L
		H	Z	Z

Note: X: Option, Z: Hi impedance

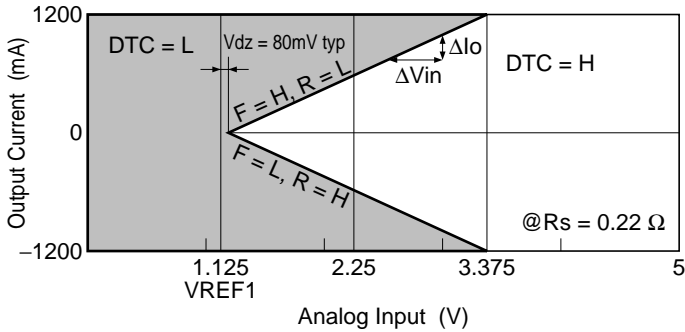
Transfer Characteristics

1. FCS & TRK



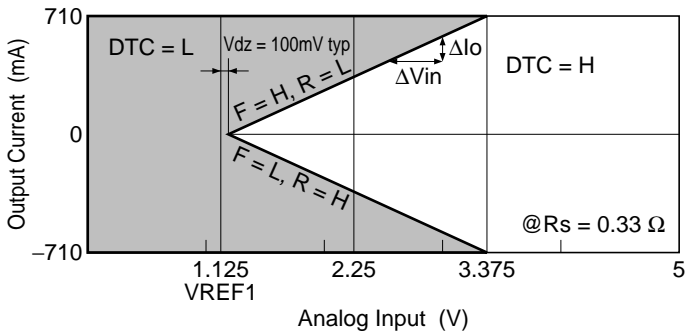
Note: Assuming output current polarity is positive for P output → N output and negative for N output → P output.

2. VCM



Note: Assuming output current polarity is positive for P output → N output and negative for N output → P output.

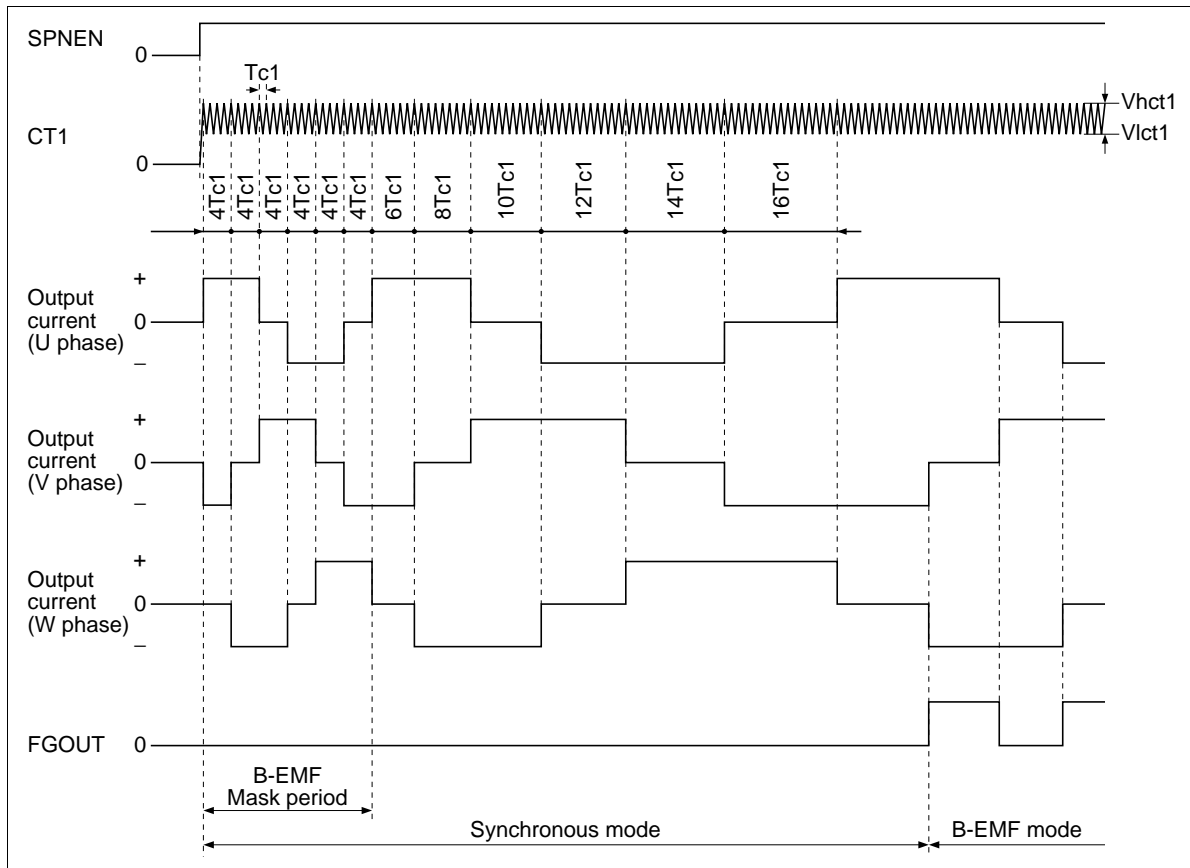
3. BMG



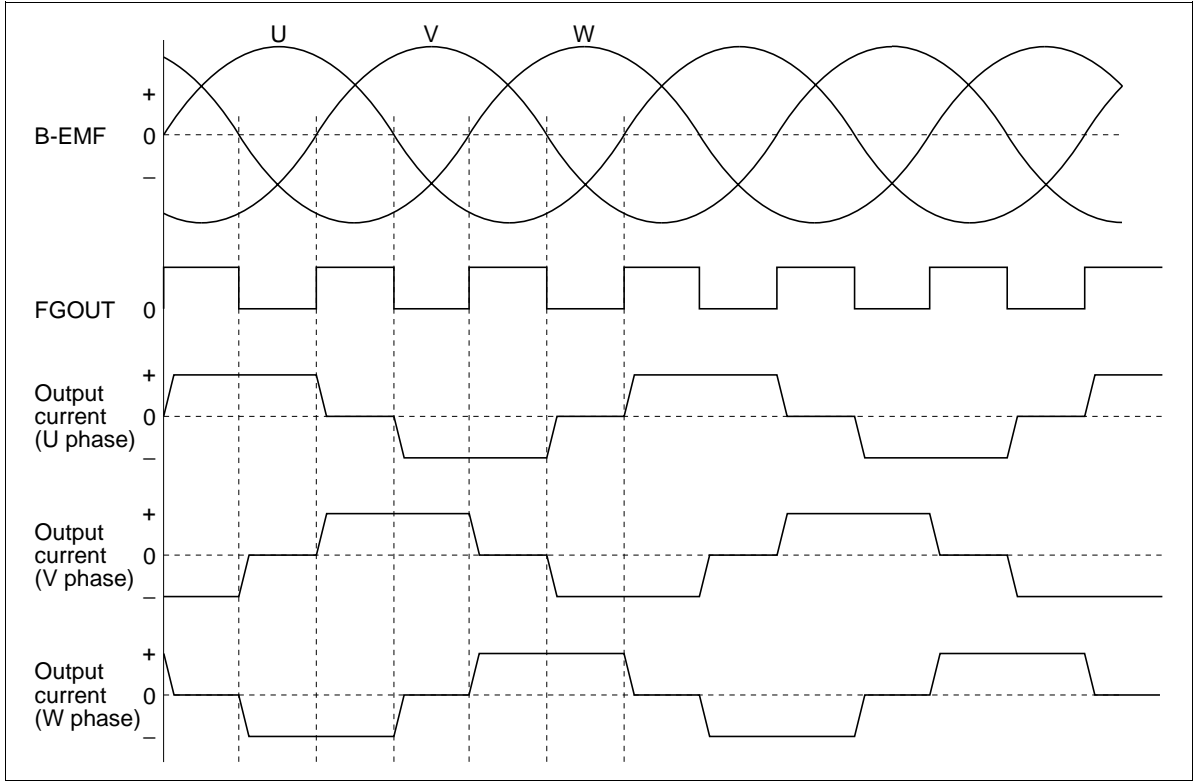
Note: Assuming output current polarity is positive for P output → N output and negative for N output → P output.

Timing Chart

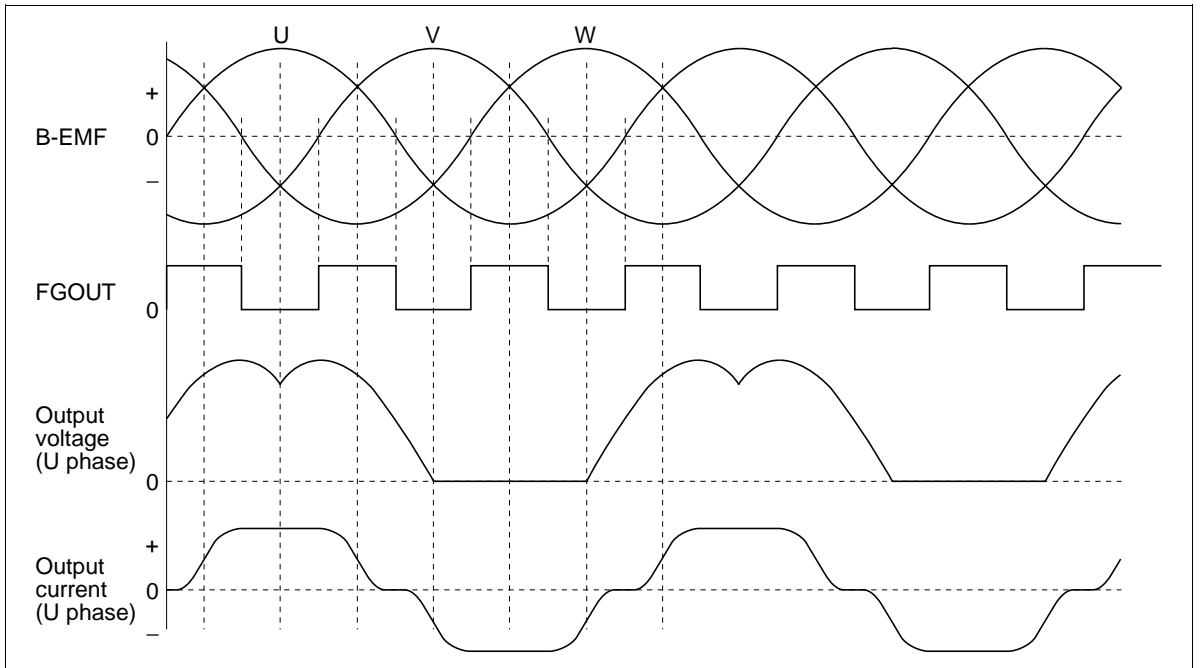
1. Start-up



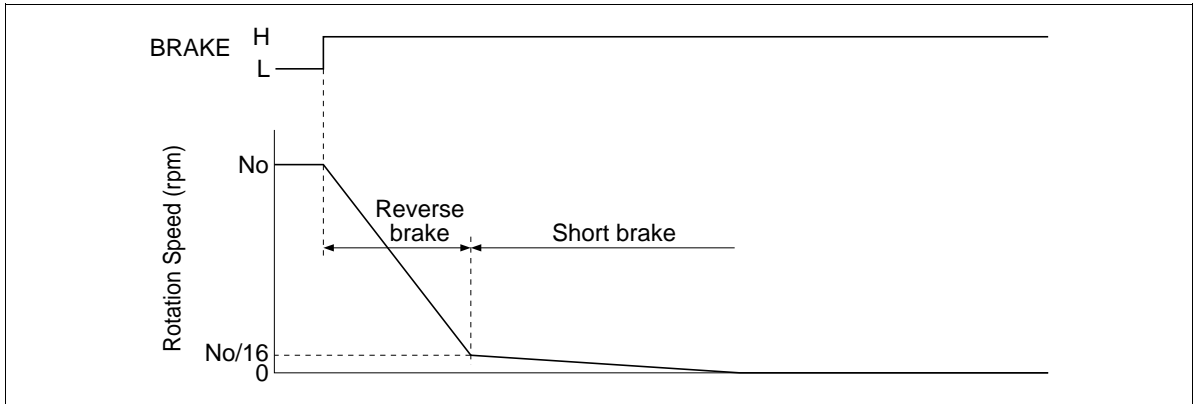
2. Acceleration (switching mode)



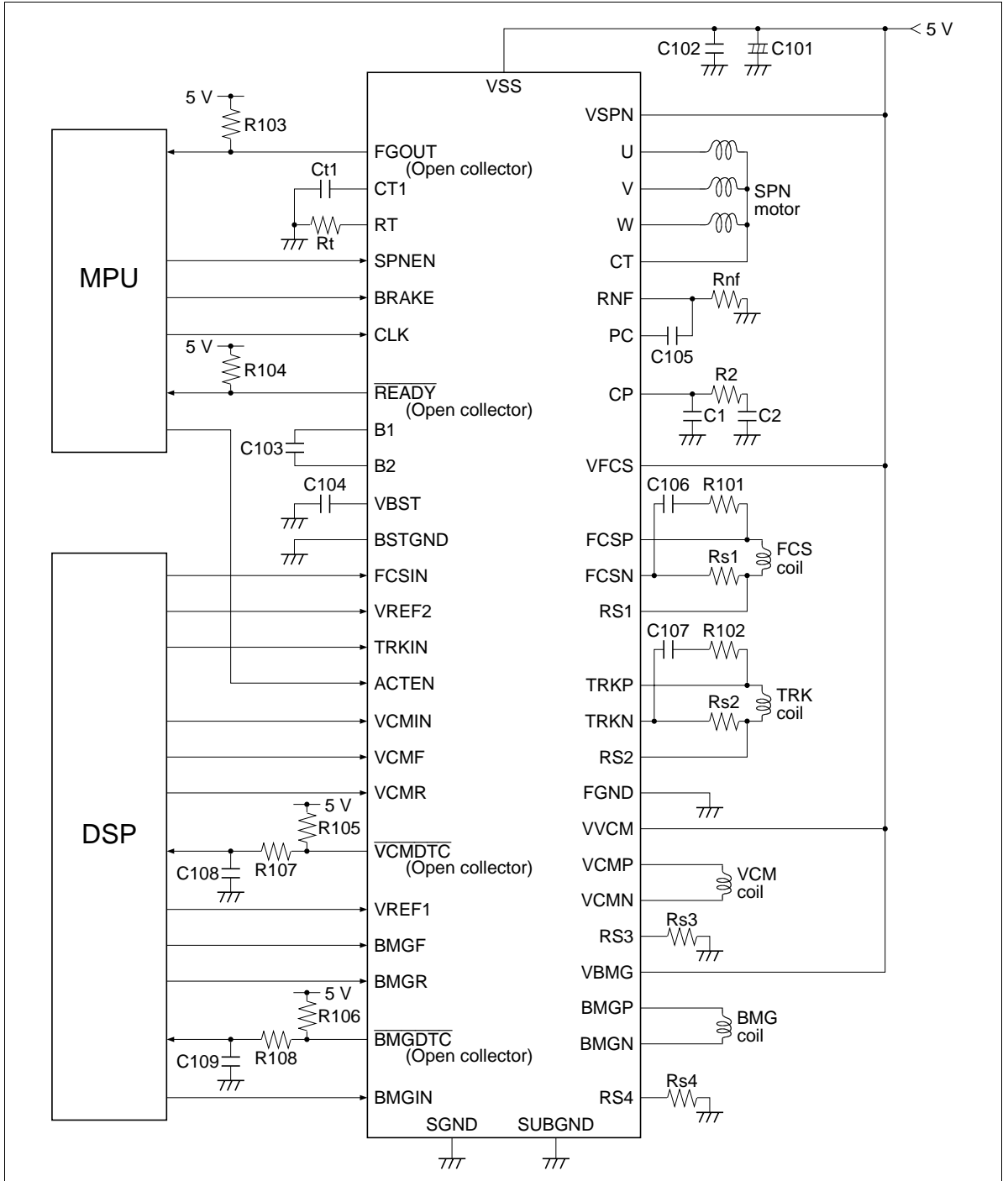
3. Running (soft switching mode)



4. Brake



Application



External Components

Parts No.	Reccomended Value	Reccomended Range	Purpose	Note
R2	—		Integral constant for SPN driver speed control	1
R101	4.7 Ω		for FCS driver stability	
R102	4.7 Ω		for TRK driver stability	
R103 to R106	10 kΩ	≥ 5.1 kΩ	Pull-up resistor	
R107	—		for VCM block mask time setting	
R108	—		for BMG block mask time setting	
Rnf	0.33 Ω	≥ 0.33 Ω	SPN driver current detection resistor	2
Rs1	0.33 Ω	≥ 0.33 Ω	FCS driver current detection resistor	
Rs2	0.33 Ω	≥ 0.33 Ω	TRK driver current detection resistor	
Rs3	0.22 Ω	≥ 0.22 Ω	VCM driver current detection resistor	
Rs4	0.33 Ω	≥ 0.33 Ω	BMG driver current detection resistor	
Rt	3.3 kΩ		for Reference current setting	
C1	—		Integral constant for SPN driver speed control	1
C2	—		Integral constant for SPN driver speed control	1
C101	≥ 100 μF		for Power supply by passing	
C102	≥ 0.22 μF		for Power supply by passing	
C103	0.22 μF		for Booster pumping	
C104	2.2 μF		for Booster output smoothing	
C105	0.1 μF		for SPN driver phase compensation	
C106	0.01 μF		for FCS driver stability	
C107	0.01 μF		for TRK driver stability	
C108	51 pF		for VCM block mask time setting	
C109	51 pF		for BMG block mask time setting	
Ct1	—		Time constant for start-up oscillation. Use a capacitor with good temperature characteristics.	3

Note: 1. The integral constant is determined by the following equation.

$$F_{fg} = \frac{N_o}{60} \frac{P}{2}$$

$$\omega_o \leq \frac{2\pi F_{fg}}{20}$$

$$R2 = \frac{1}{9.55} \frac{J}{Kt} \frac{\omega_o N_o R_{nf}}{G_m S I_{cp}}$$

$$C1 = \frac{1}{\sqrt{10}} \frac{1}{\omega_o R2}$$

$$C2 = 10 C1$$

Where, Ffg : FG frequency (Hz)
ωo : Servo loop time constant
No : Rotation speed (rpm)
J : Moment of inertia (kg cm s²)
Kt : Torque constant (kg cm / A)
Rnf : Current sense resistance (Ω)
GmS : Voltage current change gain (See the electrical characteristics)
Icp : Charge pump output current (See the electrical characteristics)

2. The output current maximum value of SPN driver Iomax is controlled according to the following equation. However, Vcls is current limiter voltage (See the electrical characteristics).

$$I_{omax} = \frac{V_{cls}}{R_{nf}}$$

3. The start-up oscillation Ct1 is determined by the following equation.

$$T_{c1} = \frac{1}{6} \sqrt{\frac{J}{P K_t I_{spnmax}}}$$

$$C_{t1} = \frac{T_{c1} V_{rt}}{8 R_t (V_{hct1} - V_{lct1})}$$

Where, J : Spindle motor inertia (kg cm s²)
P : Number of spindle motor poles (Total number of S poles and N poles)
Kt : Spindle motor torque constant (kg cm / A)
Vhct1 : CT1 pin high voltage (See the electrical characteristics)
Vlct1 : CT1 pin low voltage (See the electrical characteristics)

Absolute Maximum Ratings ($T_a = 25^\circ\text{C}$)

Item	Symbol	Rating	Unit	Note
Supply voltage	Vps	7	V	1
Input voltage	Vin	-0.3 to Vcc +0.3	V	2
SPN output current	Ispn	1.0	A	
FCS output current	Ifcs	1.0	A	
TRK output current	Itrk	1.0	A	
VCM output current	Ivcm	1.5	A	
BMG output current	Ibmg	1.0	A	
Power dissipation	P_T	2.5	W	3
Junction temperature	Tj	150	$^\circ\text{C}$	1
Storage temperature range	Tstg	-55 to +125	$^\circ\text{C}$	

Note: 1. Applied to VSS, VSPN, VFCS, VVCM and VBMG. Operating range is shown below.

Vss = 4.5 to 5.5 V

Vspn = 4.5 to 5.5 V

Vfcs = 4.5 to 5.5 V

Vvcm = 4.5 to 5.5 V

Vbmg = 4.5 to 5.5 V

Tjopr = 0 to +125 $^\circ\text{C}$

2. Applied to all analog input and logic input.

3. However, the case temperature Tc is 135 $^\circ\text{C}$. Thermal resistance is shown below.

$\theta_{j-c} \leq 6^\circ\text{C} / \text{W}$

$\theta_{j-a} \leq 30^\circ\text{C} / \text{W}$ (when mounted on 4 layer multi glass-epoxy board)

Electrical Characteristics

($T_a = 25^\circ\text{C}$, $V_{ss} = V_{spn} = V_{fcs} = V_{trk} = V_{vcm} = V_{bmg} = 5\text{ V}$)

Item	Symbol	Min	Typ	Max	Unit	Test Conditions	Applicable Pins	Note	
Quiescent current	I _{ss0}	—	0.2	0.6	mA	SPNEN = ACTEN = L	41		
	I _{s_{pn}0}	—	0.05	0.1	mA		27		
	I _{f_{cs}0}	—	0.05	0.1	mA		21		
	I _{v_{cm}0}	—	0.05	0.1	mA		7		
	I _{b_{mg}0}	—	0.05	0.1	mA		2		
	I _{ss}	30	50	65	mA	SPNEN = ACTEN = H,	41		
	I _{s_{pn}}	—	0.05	0.1	mA	CP = 0 V,	27		
	I _{f_{cs}}	—	5	10	mA	FCSIN = TRKIN =	21		
	I _{v_{cm}}	—	0.05	0.1	mA	VREF2 = 2.25 V,	7		
	I _{b_{mg}}	—	0.05	0.1	mA	VCMF = VCMR = H BMGF = BMGR = H	2		
Logic input	Input current	I _{inacten}	-10	—	100	μA	V _{in} = 0 to 5 V	44	
		I _{inclk}	-10	—	200	μA	V _{clk} = 0 to 5 V	47	
		I _{in}	—	—	±10	μA	V _{in} = 0 to 5 V	43, 46, 48 to 51	
	Input low voltage	V _{il}	—	—	0.8	V		43, 44, 46 to 51	
	Input high voltage	V _{ih}	2.0	—	—	V			
Logic output	Output low voltage	V _{ol}	—	—	0.4	V	I _{ol} = 1.0 mA	3, 38, 39, 52	
	Output high current	I _{oh}	—	—	±1.0	μA	V _{oh} = 7 V		
	Transient response time	t _{plh}	40	180	400	ns	R _I = 5.1 kΩ	3, 52	
t _{phl}		10	50	150	ns				
SPN driver	Output saturation voltage	V _{satS}	0.3	1.0	1.4	V	I _o = 0.7 A	22, 24, 25	1
	Leakage current	I _{offS}	0.3	1.0	2.5	mA	V _{spn} = 7 V, V _o = 7 V		
—			—	±100	μA	V _{spn} = 7 V, V _o = 0 V			
FCS& TRK driver	Output quiescent voltage	V _{qF&T}	2.44	2.56	2.68	V	V _{fcs} = 5 V	17, 18, 19, 20	
	Output saturation voltage	V _{satF&T}	0.4	1.4	2.0	V	I _o = 0.7 A		1
	Leakage current	I _{offF&T}	—	—	±100	μA	V _{ce} = 7 V		

Electrical Characteristics

($T_a = 25^\circ\text{C}$, $V_{ss} = V_{ddc} = V_{spn} = V_{fcs} = V_{trk} = V_{vcm} = V_{bmg} = 5\text{ V}$) (cont)

Item		Symbol	Min	Typ	Max	Unit	Test Conditions	Applicable Pins	Note
VCM driver	Output saturation voltage	VsatV	0.3	1.1	1.54	V	$I_o = 1.0\text{ A}$	8, 10	1
	Leakage current	IoffV	—	—	± 100	μA	$V_{ce} = 7\text{ V}$		
	Transient response time	tphV	50	250	500	ns	Resistance load		
		tphIV	50	250	500	ns	($R_I = 10\ \Omega$)		
	Regenerative diode forward voltage	VfV	—	1.4	1.7	V	$I_f = 1.0\text{ A}$		4
	Regenerative diode parasitic current	IsubV	—	0.1	1.0	mA			
Through current	IthrV	—	200	500	mAp	H to L & L to H	7		
BMG driver	Output saturation voltage	VsatM	0.3	0.7	1.0	V	$I_o = 0.7\text{ A}$	5, 6	1
	Leakage current	IoffM	—	—	± 100	μA	$V_{ce} = 7\text{ V}$		
	Transient response time	tphM	50	250	500	ns	Resistance load		
		tphIM	50	250	500	ns	($R_I = 10\ \Omega$)		
	Regenerative diode forward voltage	VfM	—	1.1	1.4	V	$I_f = 0.7\text{ A}$		4
	Regenerative diode parasitic current	IsubM	—	0.1	1.0	mA			
Through current	IthrM	—	200	500	mAp	H to L & L to H	2		
SPN current control	Threshold voltage	VthS	1.08	1.20	1.32	V	$V_{rnf} = 10\text{ mV}$	40	
	Voltage current change gain	GmS	0.8	1.0	1.2	A/V	$R_{nf} = 0.33\ \Omega$	23	2
	Current limiter voltage	VclS	202	225	248	mV			
Charge pump	Output current	Icp+	17	20	23	μA	$R_t = 3.3\text{ k}\Omega$, $V_{cp} = 1.5\text{ V}$	40	
		Icp-	-23	-20	-17	μA			
	Leakage current	Ioffcp	—	—	± 50	nA			
	Clamp voltage	Vclmp	2.43	2.70	2.97	V			

Electrical Characteristics

($T_a = 25^\circ\text{C}$, $V_{ss} = V_{ddc} = V_{spn} = V_{fcs} = V_{trk} = V_{vcm} = V_{bmg} = 5\text{ V}$) (cont)

Item		Symbol	Min	Typ	Max	Unit	Test Conditions	Applicable Pins	Note
Discriminator	Count	Dn	—	1041.5	—	—			
	Operating CLK frequency	fc	—	—	8.0	MHz			3
	Ready range	ΔNo	—	± 1.2	—	%			
B-EMF detection	Detection sensitivity	Vbemf	33	40	52	mVpp		22, 24, 25, 26	
	Hysteresis	Vhbemf	3	12	22	mVpp			
Start-up OSC	RT voltage	Vrt	1.16	1.26	1.36	V	$R_t = 3.3\text{ k}\Omega$	36	
	CT1 charge current	Ict1+	40	46	52	μA	$R_t = 3.3\text{ k}\Omega$, $V_{ct1} = 2.2\text{ V}$	37	
	CT1 discharge current	Ict1-	-52	-46	-40	μA			
	CT1 high voltage	Vhct2	3.18	3.36	3.54	V			
	CT1 low voltage	Vlct2	1.09	1.19	1.29	V			
FCS& TRK control	Input current	IinF&T	—	—	± 2	μA	$V_{in} = 1\text{ to }4\text{ V}$	31, 34, 35	
	Common mode input voltage range	Vref2	2.0	—	2.5	V			
	Offset voltage	VosF&T	—	—	± 10	mV		17, 18, 19,	
	Voltage current change gain	GmF&T	0.47	0.56	0.65	A/V	$R_s = 0.33\ \Omega$	20, 32, 33	
	Gain bandwidth	BF&T	—	40	—	kHz	$R_l = 6.8\ \Omega$, $R_s = 0.33\ \Omega$, $L_l = 0.12\text{ mH}$		4
VCM& BMG control	Input current	IinV&M	-10	—	150	μA	$V_{in} = 1\text{ to }3.5\text{ V}$	53, 54, 55	
	Common mode input voltage range	Vref1	1.0	—	1.5	V			
	Offset voltage	VosV	30	80	130	mV	$V_{CMF} = V_{CMR} = H$		
		VosM	0	100	200	mV	$BMGF = BMGR = H$		
	Voltage current change gain	GmV	0.47	0.55	0.63	A/V	$R_s = 0.22\ \Omega$	4, 9	
		GmM	0.30	0.35	0.40	A/V	$R_s = 0.33\ \Omega$		

Electrical Characteristics

($T_a = 25^\circ\text{C}$, $V_{ss} = V_{ddc} = V_{spn} = V_{fcs} = V_{trk} = V_{vcm} = V_{bmg} = 5\text{ V}$) (cont)

Item		Symbol	Min	Typ	Max	Unit	Test Conditions	Applicable Pins	Note
OTSD	Operating temperature	Tsd	125	155	—	°C			4
	Hysteresis	Thys	—	45	—	°C			

Notes: 1. The output saturation voltage is the sum of the upper and lower saturation voltages.

2. See figure 1. Where,

$$GmS = \frac{\Delta I_{mf}}{\Delta V_{cp}}$$

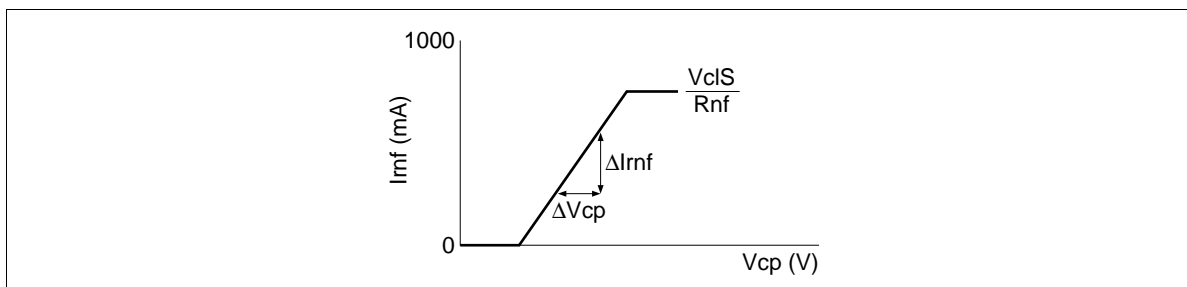


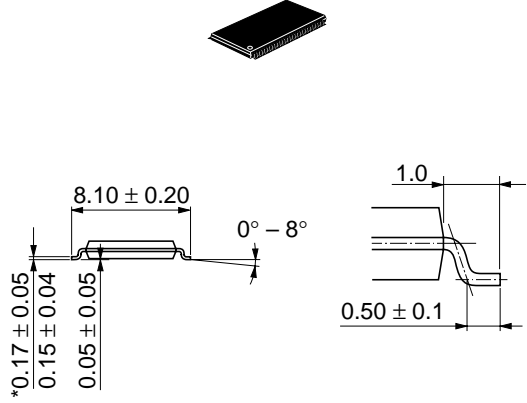
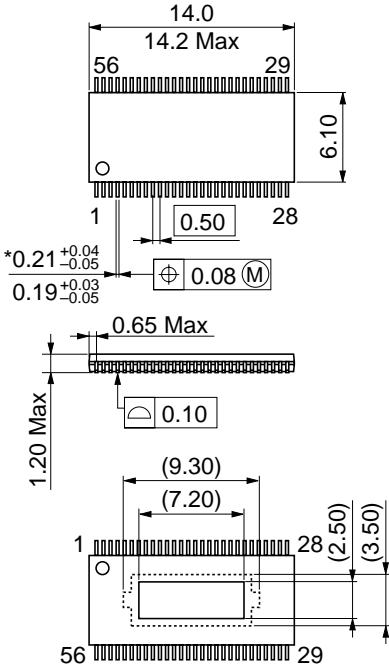
Figure 1

3. Stipulated at the CLK pin.

4. Design guide only.

Package Dimensions

Unit: mm



*Dimension including the plating thickness
Base material dimension

Hitachi Code	TTP-56DT
JEDEC	—
EIAJ	—
Weight (reference value)	0.32 g

Cautions

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