M51785P,SP

3-PHASE BRUSHLESS MOTOR CONTROL

DESCRIPTION

The M51785P/SP is a semiconductor integrated circuit designed for a single-chip controller for FDD spindle motor, consisting of power amplifier, Hall ajplifier, FG amplifier, oscillator and speed discriminator and various protection circuits.

The device shows superiority in speed switching function of 1 : 1.2 which enables miniaturization of motor sets and cost reduction.

FEATURES

- High-accuracy, high-stability, and adjustment-free controller is possible by digital servo
- Speed switch of 1 : 1.2 possible ..... MOD
- $I_{O(peak)}$=1.2A
- 2 ENABLE systems ..... EN, $\overline{EN}$

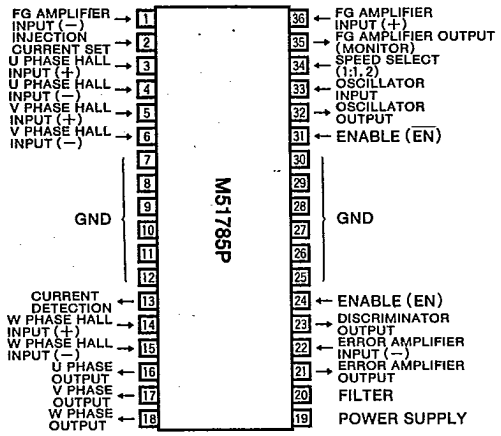
APPLICATION

FDD spindle motor (5″, 3.5″)

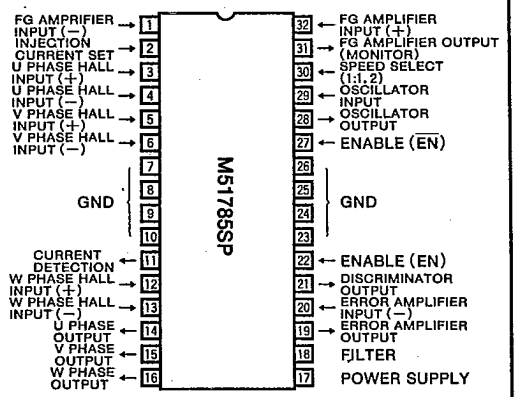
RECOMMENDED OPERATING CONDITIONS

Supply voltage 10.8-12-13.2V
Oscillating frequency 400-650kHz
Ingector current 2.5-3-7mA
Maximum output current 800mA
FG OUT Load resistance 100kΩ
FG amplifier input signal level ..... 5 or above mV_{P-P}
Hall amplifier input signal level ..... 50-100-150 mV_{P-P}

PIN CONFIGURATION (TOP VIEW)



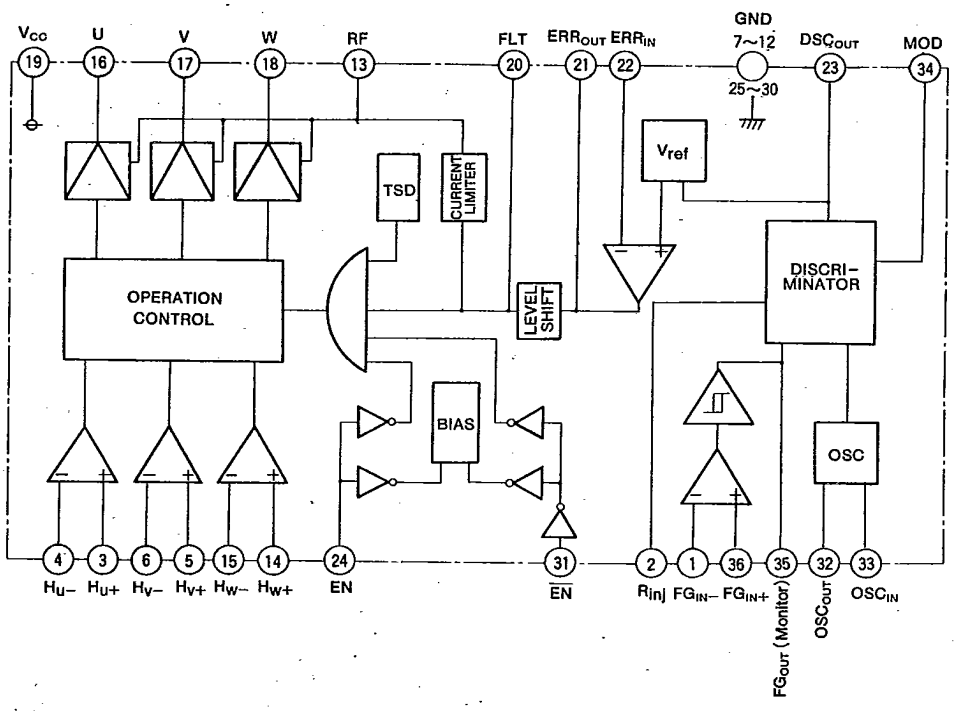
36-pin molded plastic FLAT (shrink)



32-pin molded plastic DIP (shrink) with fin

MITSUBISHI ELECTRIC

BLOCK DIAGRAM



Note Pin No.=M51785P.

ABSOLUTE MAXIMUM RATINGS (T_a=25℃)

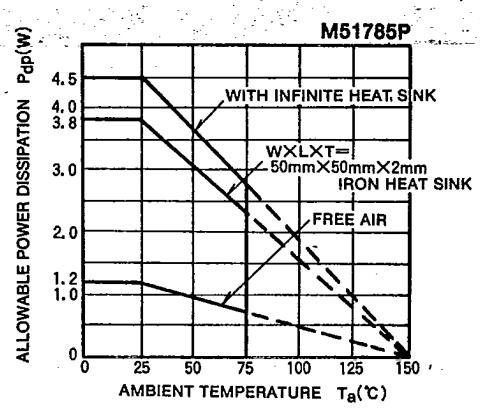
Symbol	Parameter	Conditions	Ratings	Unit
V_{CCA}	Operating supply voltage		15	V
I_O	Output current		1.2	A
V_{HD}	Hall amplifier differential input voltage	3—4, 5—6, 14—15(Pin no).	5	V
I_{SS}	Source/sink current	20, 21, 23, 32, 33, 36(Pin no.)	±3	mA
V_{IN}	Pin applied voltage	1, 3, 4, 5, 6, 14, 15, 22, 24, 31, 34(Pin no.)	0～V_{CC}	V
Iinj	Injection current		20	mA
V_{RF}	⑬ pin applied voltage		1	V
P_t	Power dissipation	Heatsink of infinite size used	4.5(8)	W
$K\theta$	Thermal derating	Heatsink of infinite size used	27.8(15.6)	℃/W
Tj	Junction temperature		150	℃
Topr	Operating temperature		−20～+75	℃
Tstg	Storage temperature		−40～+125	℃
V_{CCB}	Quiescent supply voltage	EN-Lo, EN-Hi.	16	V

( ) Shows the value of M51785SP

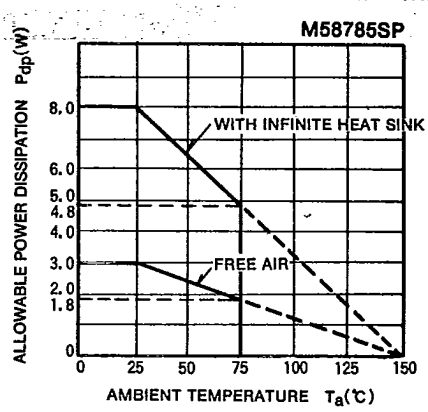
ELECTRICAL CHARACTERISTICS (V_{CC}=12V, T_a=25℃, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits Min	Limits Typ	Limits Max	Unit
$I_{CC}(H)$	Circuit current (EN ON)	EN=2.5V, MOD=EN=0.8V, excluding injection current and FG monitor pin current. No load	9	18	28	mA
$I_{CC}(L)$	Circuit current (EN OFF)	Connect injection setting pin and FG monitor pin directly to V_{CC}. No load, EN=0.8V, EN=2.5V	—	90	300	μA
$V_{CC}(OP)$	Operating supply voltage		9	12	15	V
I_{INHA}	Hall amplifier input current		—	0.4	4	μA
V_N	Phase output middle point voltage		5.3	6.5	7.3	V
$\triangle V_N$	Difference of middle point voltage between phases		—	—	0.2	V
V_{sat}	Output saturation voltage	Current flow U→V, V→W, W→U. Total of V_{sat} of T_r on both sides, Io=0.7A	—	2.3	3.3	V
V_{TH}	Control input reference voltage	FLT pin voltage producing output	1.0	1.1	1.2	V
G_V	Voltage gain between contol input and output	Source	16.65	18.06	26.81	dB
		Sink	20.82	23.80	26.81	
$\triangle G_V$	Difference of voltage gain between phases		—	—	2	dB
V_{ref}	Error amplifier recerence voltage	Measure middle level of discriminator output	2.0	2.2	2.4	V
I_{INEA}	Error amplifier input current		−2.0	−0.02	—	μA
V_{OEA}	Error amplifier output level	Hi	2.2	2.5	3.1	V
		Lo	0.6	0.8	1.05	
V_{CL}	Current limiter reference voltage	R_F pin voltage when FLT pin voltage is reduced to less than 1.5V	0.36	0.40	0.44	V
V_{IN}	Function input threshold value	Hi 24, 31, 34	2.5	—	—	V
		Lo	—	—	0.8	
I_{IN}	Input current at function input pin	V_{IN}=12V 24, 34	500	700	1000	μA
		V_{IN}=0V 31	−150	−100	−70	
VInj	Injection pin voltage	Iinj=6mA.	0.6	0.9	1.5	V
V_{ODSC}	Discriminator output level	Hi	4.1	4.8	5.3	V
		Lo	0.5	0.8	1.2	
$\triangle T$	Discriminator count error	+ for deceleration, −for acceleration f_{OSC}=610.2kHz.	−6	1	6	μsec
f_{OSC}	Oscillating frequency	f_{OSC}=610.2kHz.	−0.2	—	+8.2	%
IinjMAX	Maximum injection operationg current	f_{OSC}=610.2kHz.	17	—	—	mA
IinjMIN	Minimum injection operating current	f_{OSC}=610.2kHz.	—	—	4	mA
$V_{OL}(FG)$	FG amplifier output low level (monitor)	I_L=200μA.	—	0.1	0.2	V
II(FG)	Leak current at FG amplifier output (monitor) pin	12V is applied	—	—	1.0	μA
$V_{OC(SD)}$	Over-voltage protection operating voltage			16.3		V
$T_{(SD)}$	Thermal shutdown protection operating temperature			150		℃
$\triangle T_{(SD)}$	Thermal shutdown protection hysteresis			25		℃
$V_{in(FG)}$MIN	FG amplifier operating minimum input voltage	Measure at FG monitor pin		2.5		mV_{P-P}
$V_{FG(NM)}$	FG amplifier input noise margin			1.0		mV_{P-P}
N_{CLK}	Discriminator count no.	MOD=Lo Count error is specified in section		1695		—
		MOD=HI 19 of ELECTRICAL CHARACTERISTICS.		2034		
f_{FGL1}	Synchronous frequency 1	MOD=HI, fosc=610.2kHz.		300.0		Hz
f_{FGL2}	Synchronous frequency 2	MOD=Lo, fosc=610.2kHz.		360.0		Hz

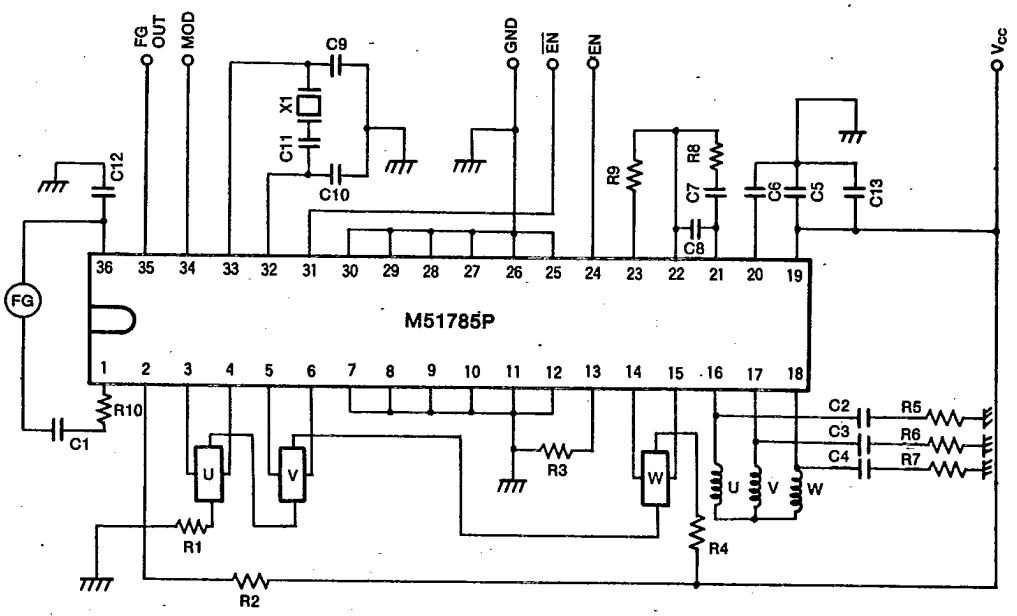
THERMAL DERATING (MAXIMUM RATING)



THERMAL DERATING (MAXIMUM RATING)



APPLICATION EXAMPLE

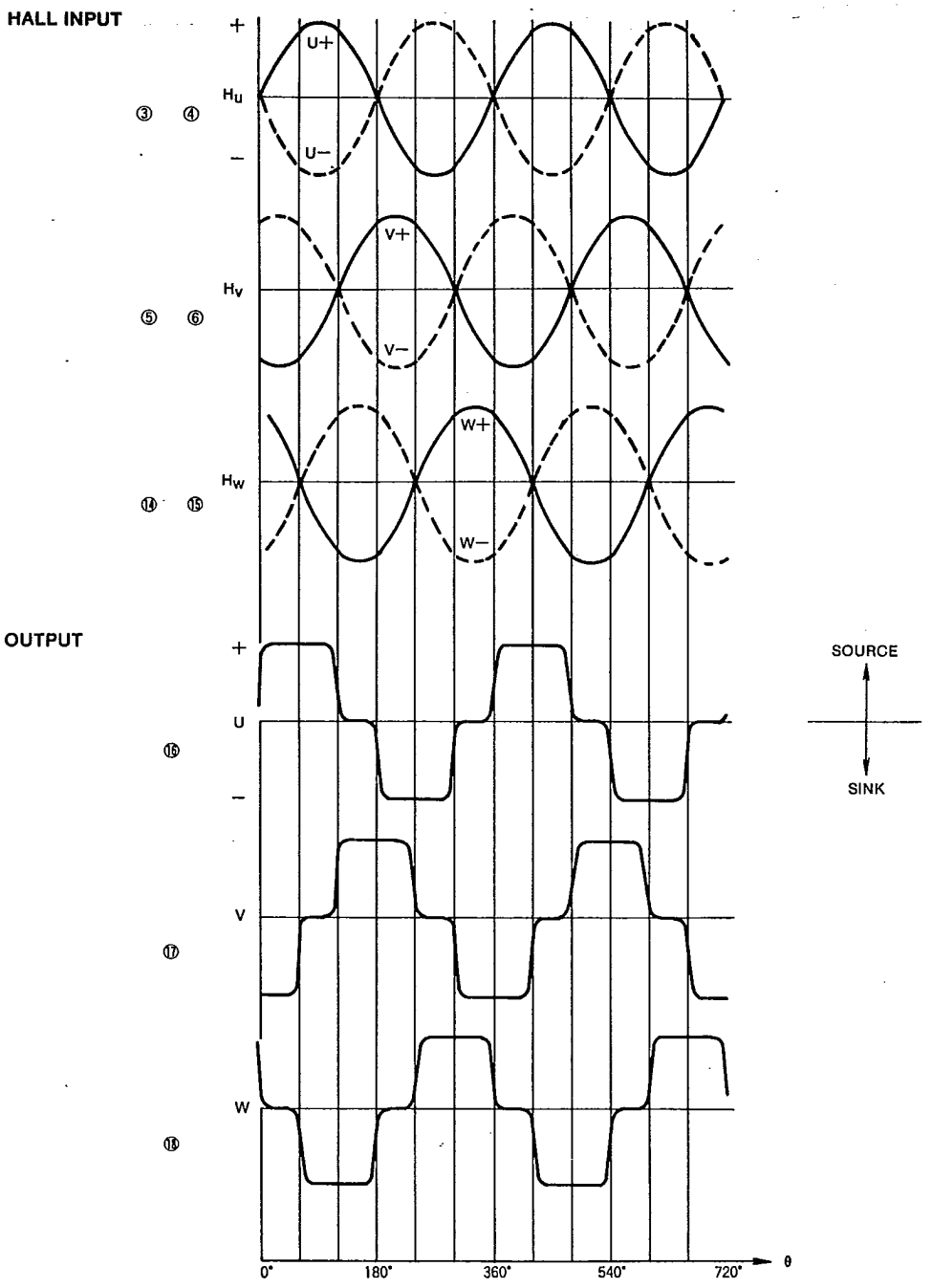


CONSTANTS

R1	330Ω	C1	4.7μF	X1	610.2kHz
R2	3.6kΩ	C2	0.1μF		
R3	0.5Ω	C3	0.1μF		
R4	330Ω	C4	0.1μF		
R5	4.7Ω	C5	0.1μF		
R6	4.7Ω	C6	0.22μF		
R7	4.7Ω	C7	0.33μF		
R8	75kΩ	C8	0.033pF		
R9	22kΩ	C9	220pF		
R10	330Ω	C10	220pF		
		C11	100pF		
		C12	0.1μF		
		C13	33μF		

Note : Open collector output at FG OUT pin

TIMING CHART



Note 1. The waveforms shown above are different from those at actual motor operation.
Note 2. Pin. No. =M51785P

TEST DESCRIPTION

Phase output middle point voltage
→①

Difference of middle point voltage between phase
; Measure voltage 1 for each phase and $\triangle V_N$ is given in,

$$\triangle V_N = \triangle V_{UV} = V_U - V_V$$
$$= \triangle V_{VW} = V_V - V_W$$
$$= \triangle V_{VU} = V_W - V_U$$

Output saturation voltage
→⑦+⑧ Load current 0.7A
Control input voltage 2.2V

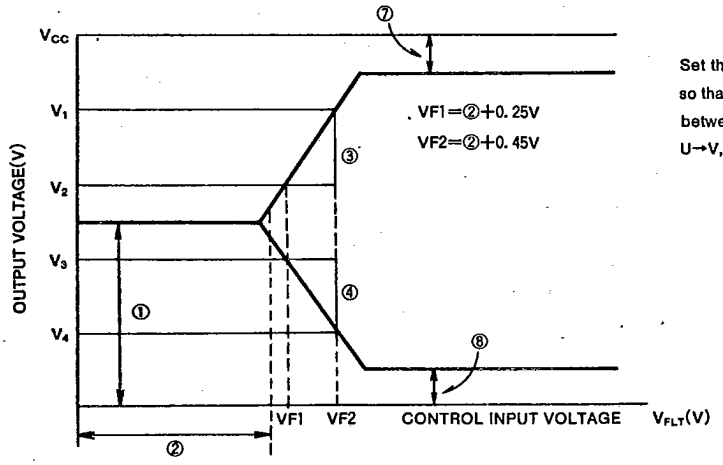
Control input reference voltage
→② Control input voltage value (V_{FLT}) when the output voltage is ①+100mV.

Voltage gain between control input and output
→③(source)
④(sink)

$$③ = 20 \log |(V_1 - V_2)/0.2|$$
$$④ = 20 \log |(V_3 - V_4)/0.2|$$

Difference of voltage gain between phase
; Measure ③ and ④ for each phase, and $\triangle G_V$ is given in, (source and sink)

$$\triangle G = \triangle G_{UV} = G_{V(U)} - G_{V(V)}$$
$$= \triangle G_{VW} = G_{V(V)} - G_{V(W)}$$
$$= \triangle G_{WU} = G_{V(W)} - G_{V(U)}$$



Set the values of ② to ⑧ so that the output current flows between phases U→V, V→W, W→U.

DISCRIMINATOR COUNT ERROR

Measure the pulsewidth at 23 pin DSC OUT. The test value is negative for accelerating pulse.

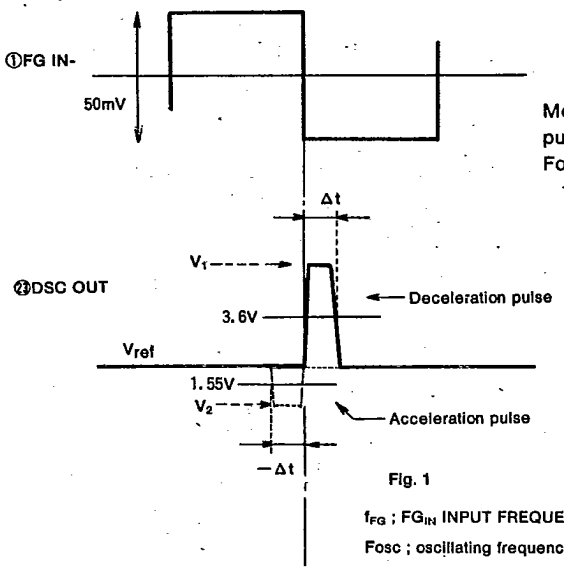


Fig. 1

f_{FG} ; FG_{IN} INPUT FREQUENCY

Fosc ; oscillating frequency

Measure acceleration or deceleration pulse at DOS_{OUT} output, applying pulse (synchronous with Fosc) divided by Fosc to FG_{IN}-in each mode.

☆Refer to table 1 for the frequency given to FG_{IN}.

Table 1

㉒MOD	①FG_{IN} input frequency
L 1665 division	$F_{OSC}/1695$
H 2034 division	$F_{OSC}/2034$

DISCRIMINATOR OUTPUT LEVEL

Measure V_1 and V_2 in Fig. 1. Vo_{DSC}(Hi)→V_1
(Lo)→V_2

But, for Low(V_2)level, measure Lo level of f_{FG}=250Hz(acceleration pulse),
and for High(V_1)level, measure Hi level of f_{FG}=400Hz (deceleration pulse).

ENABLE FUNCTION

Table 2

$\overline{EN}$ \ EN	Lo	HI
Lo	DISABLE	ENABLE
HI	DISABLE	DISABLE

☆EN pin=circuit is operated only when EN pin=Hi and $\overline{EN}$ pin=Lo

☆EN pin→open=Lo

$\overline{EN}$ pin→open=Hi

(But anti-noise characteristics may deteriorate if used with EN. • $\overline{EN}$=open after mounting on the equipment.)