

# M51785P,SP

6249826 MITSUBISHI ELEK (LINEAR)

80C 09032 D

T-52-13-25

## 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 amplifier, 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,  $\overline{EN}$

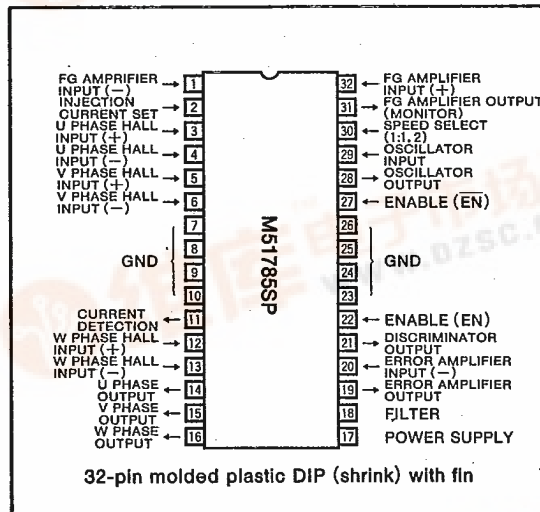
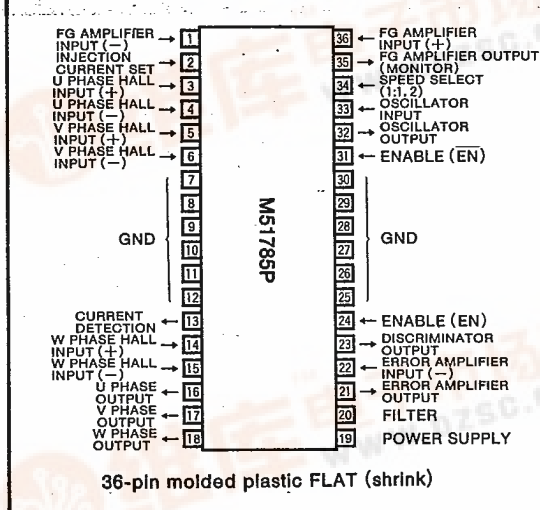
### APPLICATION

FDD spindle motor (5", 3.5")

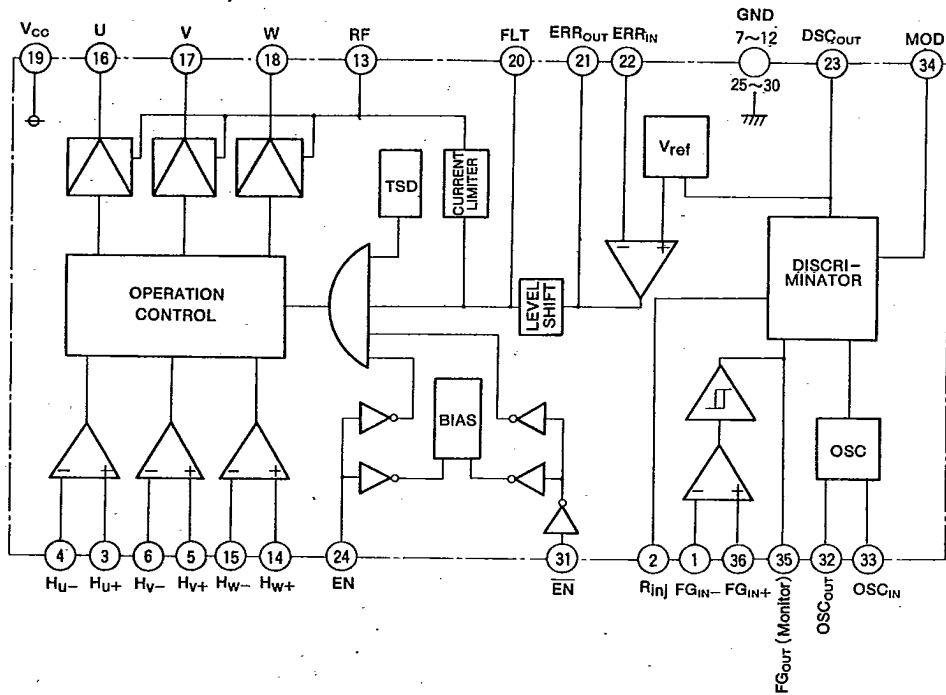
### RECOMMENDED OPERATING CONDITIONS

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.....	100k $\Omega$
FG-amplifier input signal level.....	5 or above mV <sub>p-p</sub>
Hall amplifier input signal level.....	50-100-150 mV <sub>p-p</sub>

### PIN CONFIGURATION (TOP VIEW)



**BLOCK DIAGRAM**



Note Pin No.=M51785P.

**ABSOLUTE MAXIMUM RATINGS (Ta=25°C)**

Symbol	Parameter	Conditions	Ratings	Unit
V <sub>COA</sub>	Operating supply voltage		15	V
I <sub>O</sub>	Output current		1.2	A
V <sub>HD</sub>	Hall amplifier differential input voltage	3-4, 5-6, 14-15 (Pin no.)	5	V
I <sub>SS</sub>	Source/sink current	20, 21, 23, 32, 33, 36 (Pin no.)	±3	mA
V <sub>IN</sub>	Pin applied voltage	1, 3, 4, 5, 6, 14, 15, 22, 24, 31, 34 (Pin no.)	0~V <sub>CC</sub>	V
I <sub>inj</sub>	Injection current		20	mA
V <sub>RF</sub>	Ⓜ pin applied voltage		1	V
P <sub>t</sub>	Power dissipation	Heatsink of infinite size used	4.5(8)	W
Kθ	Thermal derating	Heatsink of infinite size used	27.8(15.6)	°C/W
T <sub>j</sub>	Junction temperature		150	°C
T <sub>opr</sub>	Operating temperature		-20~+75	°C
T <sub>stg</sub>	Storage temperature		-40~+125	°C
V <sub>CCB</sub>	Quiescent supply voltage	EN-Lo, EN-Hi.	16	V

( ) Shows the value of M51785SP

MITSUBISHI LINEAR ICs  
M51785P.SP

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3-PHASE BRUSHLESS MOTOR CONTROL

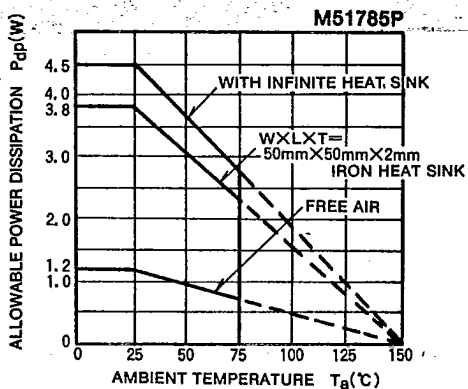
ELECTRICAL CHARACTERISTICS (V<sub>CC</sub>=12V, T<sub>a</sub>=25°C, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
I <sub>CC</sub> (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 <sub>CC</sub> (L)	Circuit current (EN OFF)	Connect injection setting pin and FG monitor pin directly to V <sub>CC</sub> . No load, EN=0.8V, EN=2.5V	—	90	300	μA
V <sub>CC</sub> (OP)	Operating supply voltage		9	12	15	V
I <sub>INHA</sub>	Hall amplifier input current		—	0.4	4	μA
V <sub>N</sub>	Phase output middle point voltage		5.3	6.5	7.3	V
ΔV <sub>N</sub>	Difference of middle point voltage between phases		—	—	0.2	V
V <sub>SAT</sub>	Output saturation voltage	Current flow U→V, V→W, W→U. Total of V <sub>SAT</sub> of T <sub>r</sub> on both sides, I <sub>o</sub> =0.7A	—	2.3	3.3	V
V <sub>TH</sub>	Control input reference voltage	FLT pin voltage producing output	1.0	1.1	1.2	V
G <sub>V</sub>	Voltage gain between control input and output	Source	16.65	18.06	26.81	dB
		Sink	20.82	23.80	26.81	
ΔG <sub>V</sub>	Difference of voltage gain between phases		—	—	2	dB
V <sub>REF</sub>	Error amplifier reference voltage	Measure middle level of discriminator output	2.0	2.2	2.4	V
I <sub>INEA</sub>	Error amplifier input current		-2.0	-0.02	—	μA
V <sub>OEAL</sub>	Error amplifier output level	Hi	2.2	2.5	3.1	V
		Lo	0.6	0.8	1.05	
V <sub>OL</sub>	Current limiter reference voltage	R <sub>F</sub> pin voltage when FLT pin voltage is reduced to less than 1.5V	0.36	0.40	0.44	V
V <sub>IN</sub>	Function input threshold value	Hi	2.5	—	—	V
		Lo	—	—	0.8	
I <sub>IN</sub>	Input current at function input pin	V <sub>IN</sub> =12V	500	700	1000	μA
		V <sub>IN</sub> =0V	-150	-100	-70	
V <sub>INJ</sub>	Injection pin voltage	I <sub>inj</sub> =6mA	0.6	0.9	1.5	V
V <sub>ODSC</sub>	Discriminator output level	Hi	4.1	4.8	5.3	V
		Lo	0.5	0.8	1.2	
ΔT	Discriminator count error	+ for deceleration, - for acceleration f <sub>osc</sub> =610.2kHz.	-6	1	6	μsec
f <sub>OSC</sub>	Oscillating frequency	f <sub>osc</sub> =610.2kHz.	-0.2	—	+8.2	%
I <sub>inj</sub> MAX	Maximum injection operating current	f <sub>osc</sub> =610.2kHz.	17	—	—	mA
I <sub>inj</sub> MIN	Minimum injection operating current	f <sub>osc</sub> =610.2kHz.	—	—	4	mA
V <sub>OL</sub> (FG)	FG amplifier output low level (monitor)	I <sub>L</sub> =200μA.	—	0.1	0.2	V
I <sub>L</sub> (FG)	Leak current at FG amplifier output (monitor) pin	12V is applied	—	—	1.0	μA
V <sub>CC</sub> (SD)	Over-voltage protection operating voltage		—	16.3	—	V
T <sub>(SD)</sub>	Thermal shutdown protection operating temperature		—	150	—	°C
ΔT <sub>(SD)</sub>	Thermal shutdown protection hysteresis		—	25	—	°C
V <sub>IN(FG)MIN</sub>	FG amplifier operating minimum input voltage	Measure at FG monitor pin	—	2.5	—	mV <sub>P-P</sub>
V <sub>FG</sub> (NM)	FG amplifier input noise margin		—	1.0	—	mV <sub>P-P</sub>
N <sub>CLK</sub>	Discriminator count no.	MOD=Lo	Count error is specified in section 19 of ELECTRICAL CHARACTERISTICS.		1695	—
		MOD=Hi			2034	
f <sub>FL1</sub>	Synchronous frequency 1	MOD=Hi, f <sub>osc</sub> =610.2kHz.	—	300.0	—	Hz
f <sub>FL2</sub>	Synchronous frequency 2	MOD=Lo, f <sub>osc</sub> =610.2kHz.	—	360.0	—	Hz

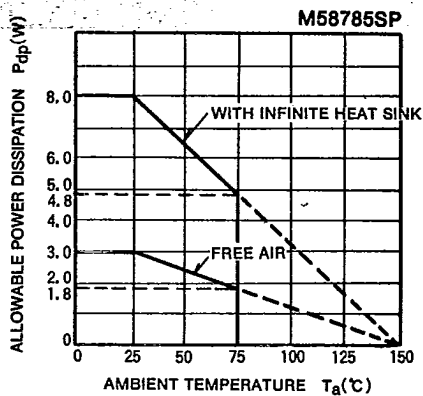
**M51785P, SP**

**3-PHASE BRUSHLESS MOTOR CONTROL**

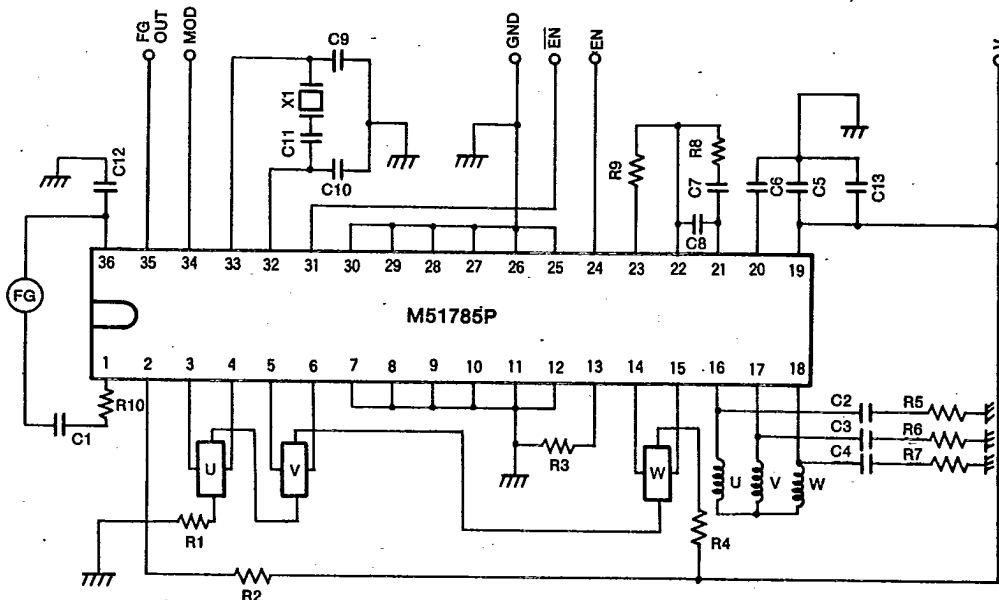
THERMAL DERATING (MAXIMUM RATING)



THERMAL DERATING (MAXIMUM RATING)



**APPLICATION EXAMPLE**



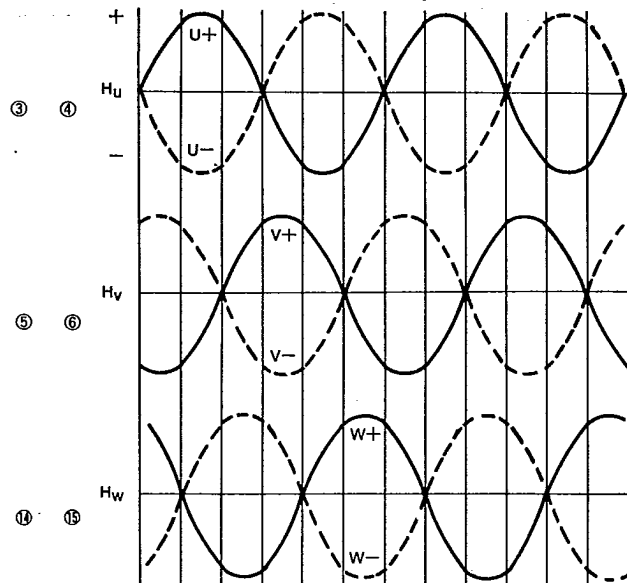
CONSTANTS

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		

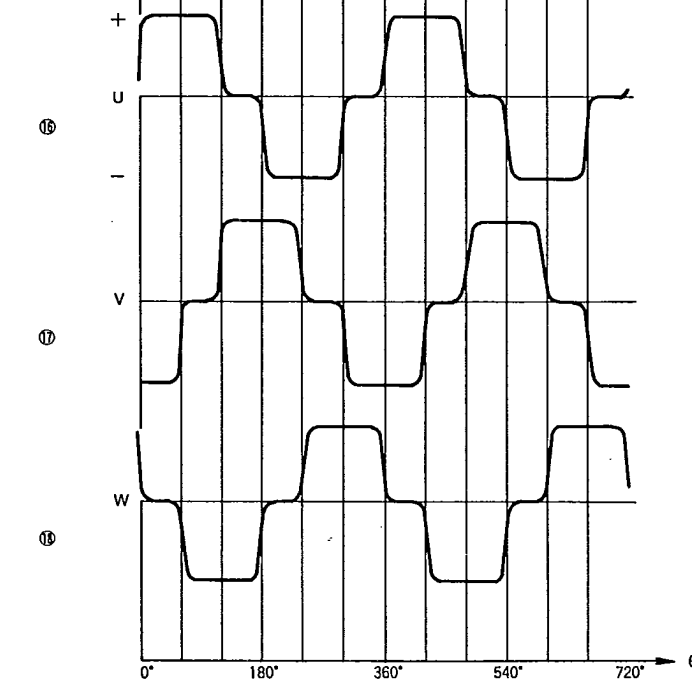
Note : Open collector output at FG OUT pin

**TIMING CHART**

**HALL INPUT**



**OUTPUT**



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

3-PHASE BRUSHLESS MOTOR CONTROL

TEST DESCRIPTION

Phase output middle point voltage

Difference of middle point voltage between phase

Output saturation voltage

Control input reference voltage

Voltage gain between control input and output

Difference of voltage gain between phase

- ① ; Measure voltage 1 for each phase and  $\Delta V_N$  is given in,  

$$\Delta V_N = \Delta V_{UV} = V_U - V_V$$

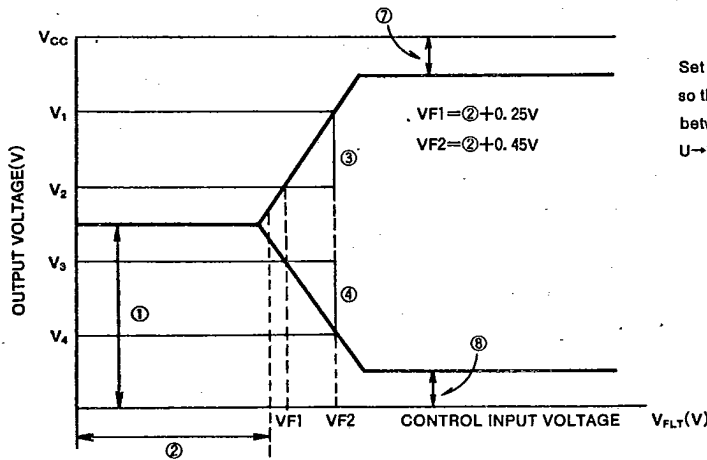
$$= \Delta V_{VW} = V_V - V_W$$

$$= \Delta V_{WU} = V_W - V_U$$
- ⑦+⑧ Load current 0.7A  
Control input voltage 2.2V
- ② Control input voltage value ( $V_{FLT}$ ) when the output voltage is ①+100mV.
- ③ (source)  
④ (sink)  
③ =  $20 \log \{(V_1 - V_2) / 0.2\}$   
④ =  $20 \log \{(V_3 - V_4) / 0.2\}$
- ; Measure ③ and ④ for each phase, and  $\Delta G_V$  is given in,  
(source and sink)  

$$\Delta G = \Delta G_{UV} = G_V(U) - G_V(V)$$

$$= \Delta G_{VW} = G_V(V) - G_V(W)$$

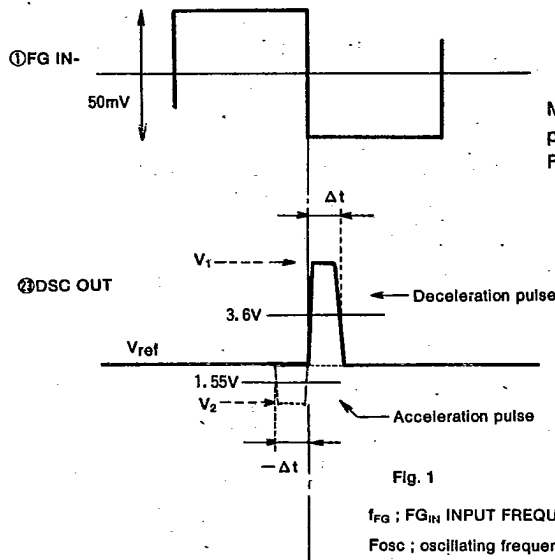
$$= \Delta G_{WU} = G_V(W) - G_V(U)$$



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.



Measure acceleration or deceleration pulse at DSC<sub>OUT</sub> output, applying pulse (synchronous with Fosc) divided by Fosc to FG<sub>IN</sub>-in each mode.

☆Refer to table 1 for the frequency given to FG<sub>IN</sub>.

Fig. 1

f<sub>FG</sub> ; FG<sub>IN</sub> INPUT FREQUENCY

F<sub>osc</sub> ; oscillating frequency

**Table 1**

MOD	FG <sub>IN</sub> Input frequency
L 1665 division	F <sub>osc</sub> /1665
H 2034 division	F <sub>osc</sub> /2034

**DISCRIMINATOR OUTPUT LEVEL**

Measure V<sub>1</sub> and V<sub>2</sub> in Fig. 1. V<sub>DSC</sub>(Hi)→V<sub>1</sub>  
(Lo)→V<sub>2</sub>

But, for Low(V<sub>2</sub>)level, measure Lo level of f<sub>FG</sub>=250Hz(acceleration pulse),  
and for High(V<sub>1</sub>)level, measure Hi level of f<sub>FG</sub>=400Hz (deceleration pulse).

**ENABLE FUNCTION**

**Table 2**

EN	EN	Lo	Hi
Lo		DISABLE	ENABLE
Hi		DISABLE	DISABLE

☆EN pin=circuit is operated only when EN pin=Hi and EN pin=Lo

☆EN pin→open=Lo

EN pin→open=Hi

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