Ordering number:EN3782A

Monolithic Digital IC

LB1810M

FDD Spindle Motor Driver

Overview

The LB1810M is a 3-phase DD motor driver IC and is an ideal FDD spindle motor driver for 3.5 inch applications.

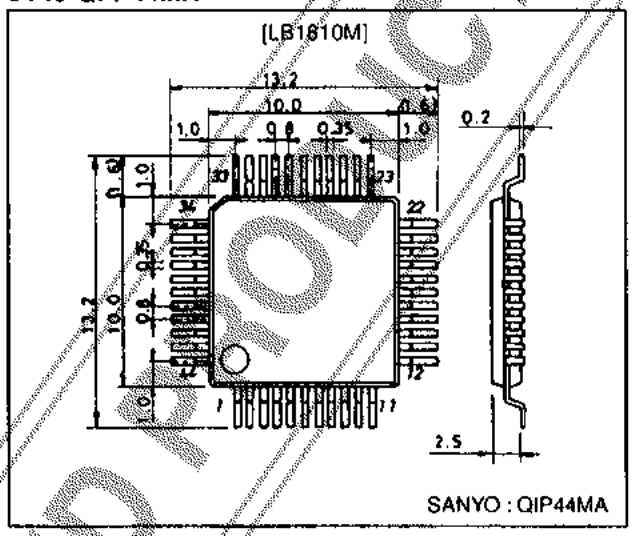
Functions and Features

- Three phase total wave linear driver.
- Eliminates need for output electrolytic capacitor (however, depending on the motor, this may not apply)
- On-chip digital speed control : $f_{OSC}=(1024\times f_{FG})/D$
  When SL1=high D=5/8,
  SL1=low D=6/8
- Start/Stop circuit. S/S1 : high active. S/S2 : low active.
- Rotation speed switching.
- Current limiter circuit.
- On-chip index comparator (single HYS).
- On-chip index delay circuit.
- AGC circuit.
- Thermal protection circuit.

Package Dimensions

unit:mm

3148-QFP44MA



Specifications

Absolute Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	V_{CC} max		14.5	V
Maximum output current	I_O max1	t≤0.5s	1.0	A
Steady maximum output current	I_O max2		0.7	A
Allowable power dissipation	Pd max	Independent IC	1	W
Operating temperature	Topr		-20 to +80	°C
Storage temperature	Tstg		-40 to +125	°C

Allowable Operating Conditions at Ta = 25°C

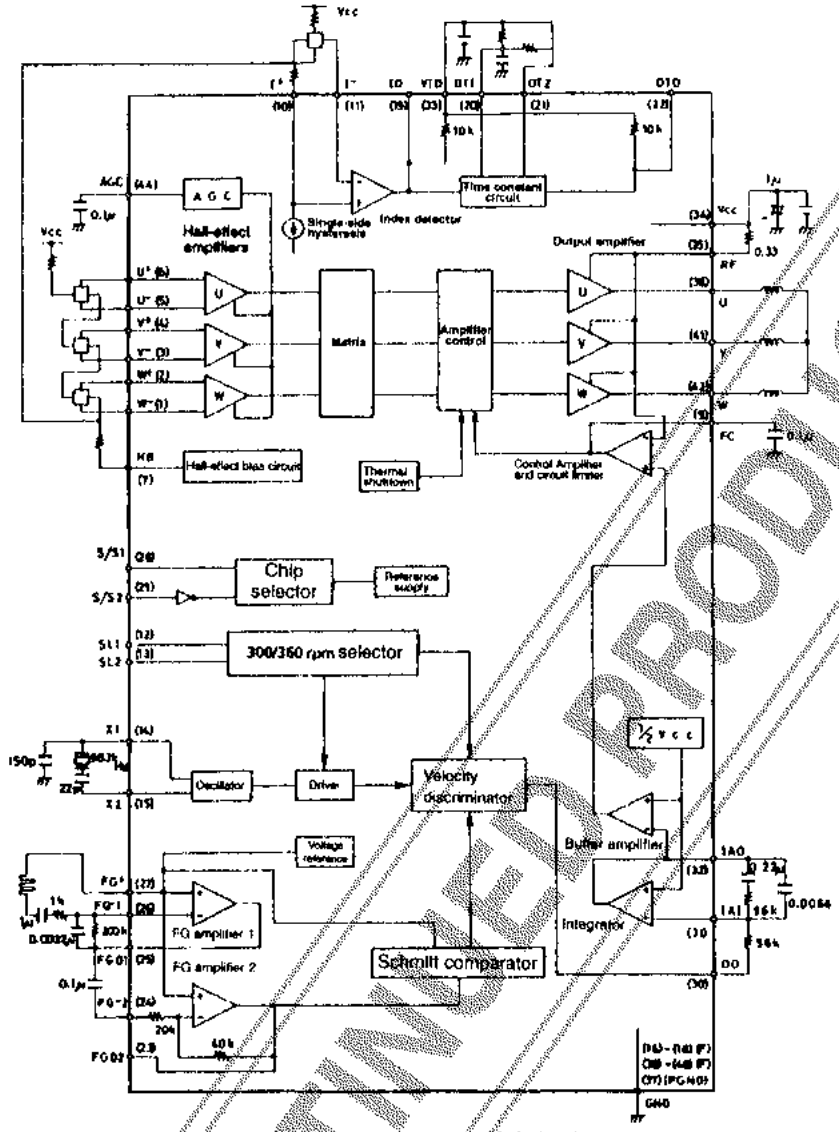
Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage	V_{CC}		4.2 to 6.5	V

Electrical Characteristics at Ta = 25°C

Parameter	Symbol	Conditions	Ratings			Unit	Note
			min	typ	max		
Current drain	$I_{CCO}1$	V_{CC}=5.0V (Stop)			0.2	mA	
	$I_{CCO}2$	V_{CC}=12V (Stop)			0.5	mA	
	$I_{CC}1$	V_{CC}=5.0V (Steady)		20	30	mA	
	$I_{CC}2$	V_{CC}=12V (Steady)		22	33	mA	
Time changeover bias current	I_{SL}				0.4	mA	
Time changeover input voltage 1	V_{SLL}		0		0.8	V	
Time changeover input voltage 2	V_{SLH}		2.0		V_{CC}	V	
S/S1 bias current	$I_{S/S}1$				0.4	mA	
S/S1 start voltage	$V_{S/S}1$		2.0		V_{CC}	V	
S/S1 stop voltage	$V_{S/S}1$		0		0.8	V	
S/S2 bias current	$I_{S/S}2$				0.1	mA	
S/S2 start voltage	$V_{S/S}2$		0		0.8	V	
S/S2 stop voltage	$V_{S/S}2$		2.0		V_{CC}	V	
Hall-effect bias amplifier input current	I_{HB}				20	μA	
In-phase input voltage range	Vh		2.2		V_{CC}-0.7	V	
Differntial input voltage range	Vdif		70		200	mVp-p	*
Input offset voltage	Vho				±1.0	mV	*
Hall-Effect output voltage	V_H	I_H=5mA		1.5	1.8	V	
Leak current	I_{HL}	Stop			±10	μA	
Output saturation voltage (sink plus source)	Vsat1	I_O=0.35A, V_{CC}=4.2V		1.2	1.4	V	
	Vsat2	I_O=0.70A, V_{CC}=4.2V		1.5	2.0	V	
Output leak current	I_{OL}				±1.0	mA	
Current limiter	Vref1		0.27	0.30	0.33	V	
Control amplifier voltage gain	G_C			-6		dB	
Voltage gain phase differntial	ΔG_C				±1	dB	
Integrated amplifier internal reference voltage	Vref2			V_{CC}/2		V	
Integrated amplifier bias current	Iib				±1	μA	
Integrated output voltage amplitude	V_i^+	Ii=-0.5mA with reference of Vref2		0.75		V	
	V_i^-	Ii=0.5mA with reference of Vref2		-1.4		V	
Gain band width				1000		kHz	*
FG amplifier1 input voltage	$V_{FG}1$		2		40	mVp-p	
FG amplifier1 voltage gain	$G_{FG}1$	Open loop		60		dB	*
FG amplifier1 input offset	$V_{FG}10$				±10	mV	
FG amplifier2 input voltage range	$V_{FG}2$		1		V_{CC}-1	V	
FG amplifier2 voltage gain	$G_{FG}2$			6.0		dB	
FG amplifier2 input offset	$V_{FG}20$				±10	mV	
FG amplifier internal reference voltage	V_{FGB}		5.30	5.90	6.50	V	
			(2.20)	(2.50)	(2.80)	V	
Schmitt hysteresis width	ΔVsh1	High→Low		25		mV	*
	ΔVsh2	Low→High		25		mV	*
Schmitt input operation level	Vsh		1		V_{CC}-1	V	
Speed disk recount number	N			1024			
Disk recount out low level voltage	V_{DL}	I_D=-0.5mA			0.3	V	
Disk recount out high level voltage	V_{DH}	I_D=0.5mA	V_{CC}-0.4			V	
Disk recount out leak current	I_D				±1.0	μA	
Disk recount operation frequency	F_D				1.0	MHz	*
Oscillation range	F_{OSC}				1.0	MHz	*
Index bias current	I_{IDB}				±10	μA	
In-phase input voltage range	V_{ID}		1.5		V_{CC}-0.5	V	
Hysteresis setting current range	I_{IDO}		5	10	15	μA	
Index output low level voltage	V_{IDL}	V_{ID}=5V			0.4	V	
Index output high level voltage	V_{IDH}	V_{ID}=5V	4.5			V	
Brak-down voltage	V_{DLDC}	V_{ID}=5V		2.50		V	
Delay output low level voltage	V_{DLL}	V_{ID}=5V			0.4	V	
Delay output high level voltage	V_{DLH}	V_{ID}=5V	4.5			V	
Thermal Shutdown operating temperature	TSD		150	180		°C	*
Hysteresis width	ΔTSD			40		°C	*

Note : *) Marked values are guaranteed by the design itself and therefore do not require measurement.

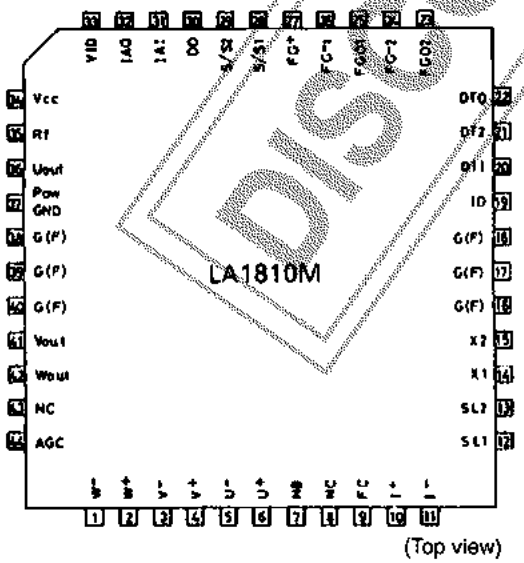
Equivalent Circuit Block Diagram



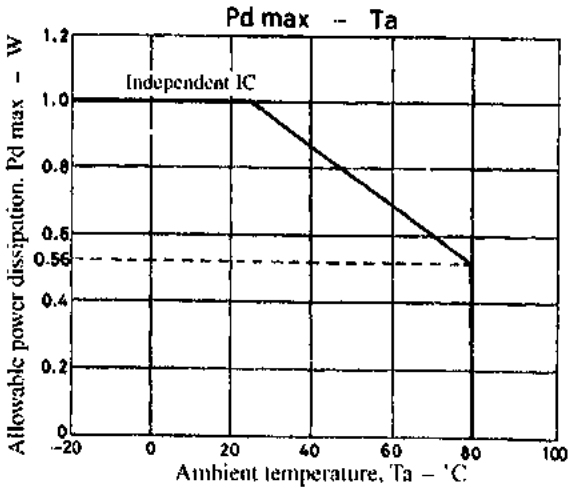
Unit (resistance : Ω, capacitance : F)

All constants are reference value and integrated constants may vary depending on the motor.

Pin Assignment



(Top view)

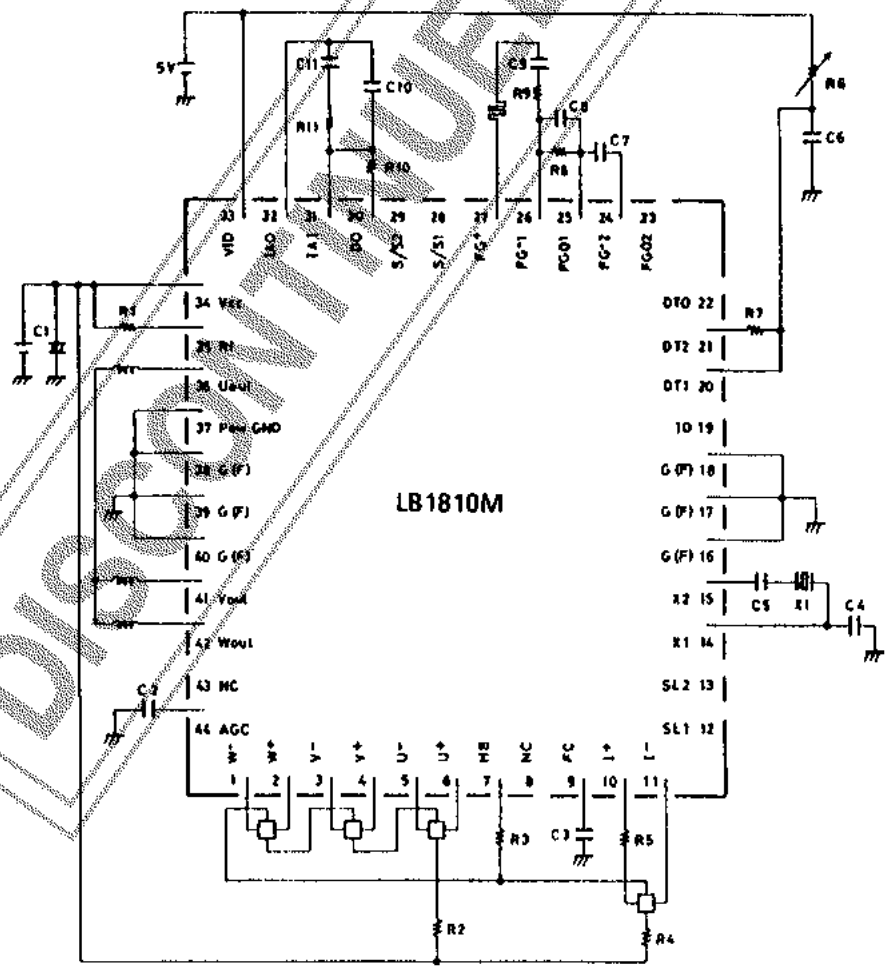


Truth Table

	Source→Sink	Hall-Effect Input		
		U	V	W
1	V-phase →W-phase	H	H	L
2	V-phase →U-phase	L	H	L
3	W-phase →U-phase	L	H	H
4	W-phase →V-phase	L	L	H
5	U-phase →V-phase	H	L	H
6	U-phase →W-phase	H	L	L

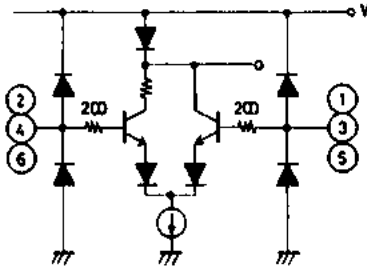
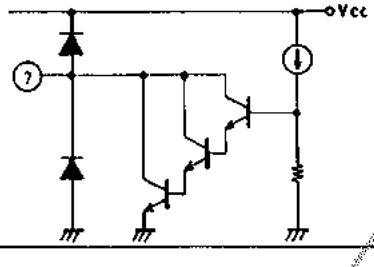
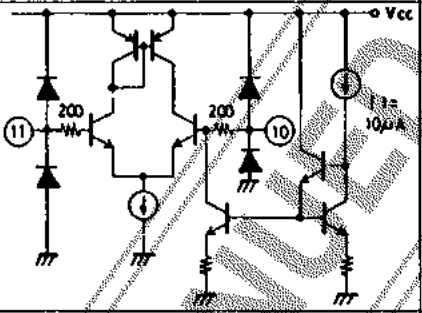
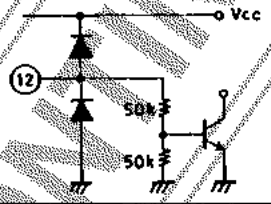
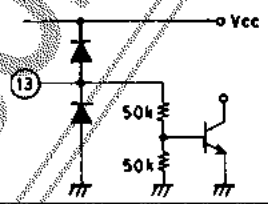
When an high level exists for Hall-effect input.
U⁺>U⁻
V⁺>V⁻
W⁺>W⁻

Sample Application Circuit



Pin Description

Unit (resistance : Ω)

Pin No	Symbol	Pin voltage	Equivalent circuit	Pin function
1 2 3 4 5 6	W⁻ W⁺ V⁻ V⁺ U⁻ U⁺	2.2V min V_{CC}–0.7V max		• W-phase Hall-element input pin W⁺ > W⁻ is established when logic is at an high level. • V-phase Hall effect input pin. V⁺ > V⁻ is established when logic is at an high level • U-phase Hall-effect input pin. U⁺ > U⁻ is established when logic is at an high level.
7	HB	1.5V typ (I_H=5mA)		• Minus pin for Hall-effect bias. When stopped, switches open and Hall-effect bias severs.
9	FC			• Frequency characteristics revision pin. By installing a capacitor between this pin and GND, close-loop oscillation for the current control system
10 11	I⁺ I⁻	1.5V min V_{CC}–0.5V max		• Index input pin. When the I⁺ pin is at an low level, I1 operates with the fixed current of I1=10μA and when at an high level, I1 does not flow. Hysteresis width is determined by the resistor attached externally to the I⁺ pin.
12	SL1	H : 2.0V min L : 0.8V max		• Time changeover pin. fosc=983kHz SL1 \ SL2: H / L H: 600rpm / 300rpm L: 720rpm / 360rpm fosc=491kHz SL1 \ SL2: H / L H: 300rpm / – L: 360rpm / –
13	SL2	H : 2.0V min L : 0.8V max		FG : 60pulse/round

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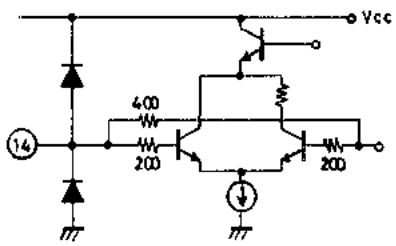
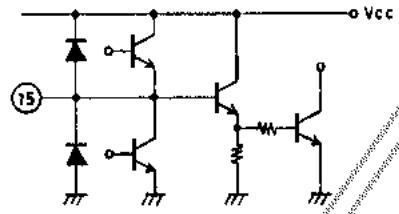
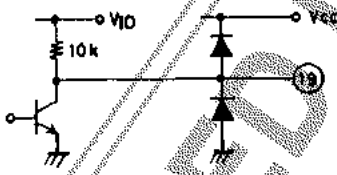
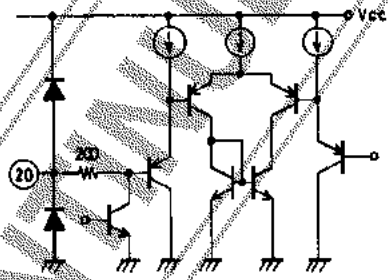
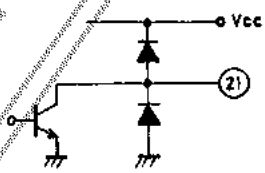
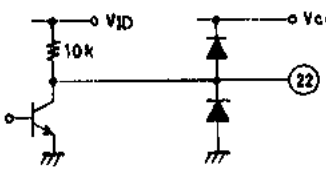
Unit (resistance : Ω)

Pin No.	Symbol	Pin voltage	Equivalent circuit	Pin function
14	X1			• Reference clock generating pin.
15	X2			
16 17 18	G(F) G(F) G(F)			• Frame GND pin. Grounded as with pins 37, 38, 39, 40.
19	ID	H : 4.5V min L : 0.4V max (V_{IO}=5V)		• Index pulse output pin.
20	DT1			• Pin connecting the external CR for the delay time constant circuit.
21	DT2			• Break-down current setting pin for the delay time constant circuit.
22	DTO	H : 4.5V min L : 0.4V max (V_{IO}=5V)		• Index delay pulse output pin.

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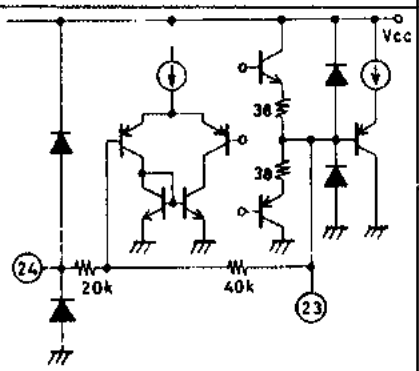
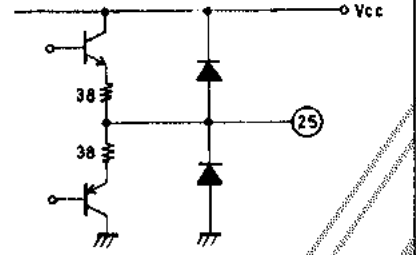
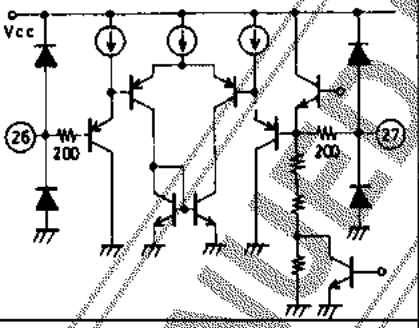
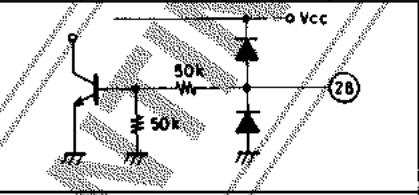
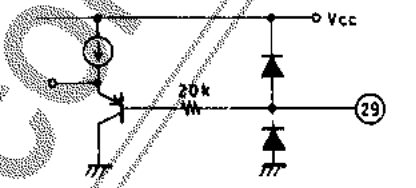
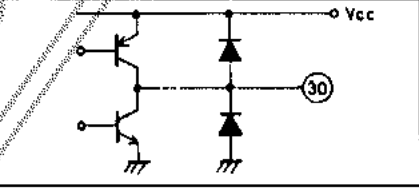
Unit (resistance : Ω)

Pin No.	Symbol	Pin voltage	Equivalent circuit	Pin function
23	FG02			• FG amplifier2 output pin.
24	FG⁻2			• FG amplifier2 negative input pin.
25	FG01			• FG amplifier1 output pin.
26	FG⁻1			• FG amplifier1 negative input pin.
27	FG⁺1	2.48V (V_{CC}=5V) 5.8V (V_{CC}=12V)		• FG amplifier1 positive input pin. Generates reference voltage within IC.
28	S/S1	H : 2.0V min L : 0.8V max		• Start/Stop changeover pin. high level active.
29	S/S2	H : 2.0V min L : 0.8V max		• Start/Stop changeover pin. low level active.
30	DO			• Speed discriminator output pin.

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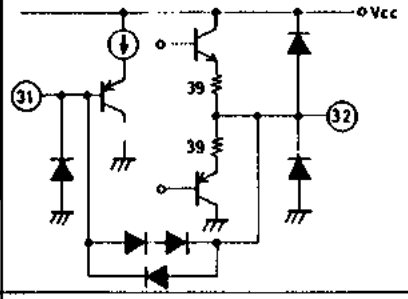
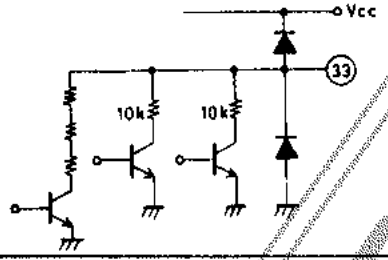
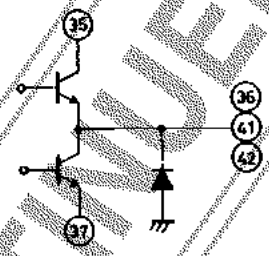
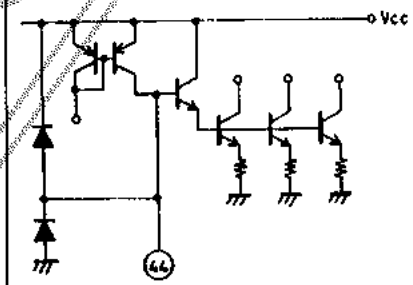
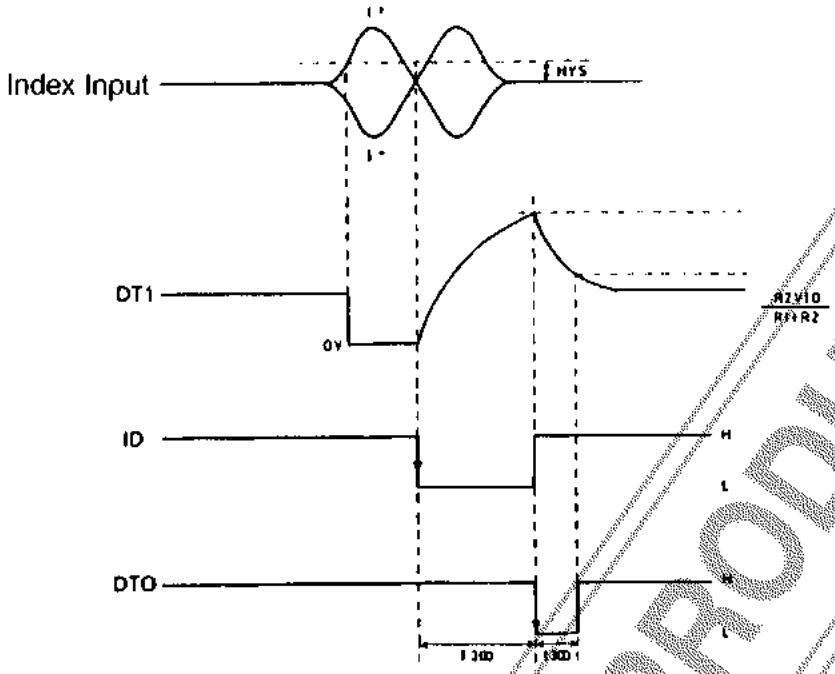
Unit (resistance : Ω)

Pin No.	Symbol	Pin voltage	Equivalent circuit	Pin function
31	IAI			• Integrated amplifier input pin
32	IAO			• Integrated amplifier output pin.
33	V_{ID}			• Index pulse output and index delay pulse output power supply pin. For applications when V_{CC} =5V, V_{CC}=V_{ID}=5V For applications when V_{CC} =12V, V_{CC}=V_{ID}=5V
34	V_{CC}			• Total power supply voltage pin except for V_{ID}. Voltage must be stable and free of ripple and noise interference.
35	R_I			• Output current detection pin. By installing an RI resistor between this pin and V_{CC}, output current is detected as voltage. Voltage detection at this pin acticates the current limiter.
36	U_{OUT}			• U-phase output pin.
37	Pow GND			• Output transistor ground pin.
38 39 40	G (F) G (F) G (F)			• Ground pin. Grounded as with pins 16, 17, 18, 37
41 42	V_{OUT} W_{OUT}			• V-phase output pin. • W-phase output pin.
44	AGC			• AGC pin. Controls Hall-effect amplifier gain in response to Hall-effect input frequnecy.

Index and Timing Chart



When SL1=high level

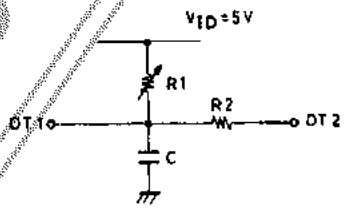
$$\cdot T300 \fallingdotseq 0.693CR1$$

$$\cdot t300 \fallingdotseq \frac{CR1R2}{R1+R2}\left\{0.405+\ln\left(\frac{R1-R2}{R1-2R2}\right)\right\}$$

When SL1=low level.

$$\cdot T360 \fallingdotseq 0.577CR1$$

$$\cdot t360 \fallingdotseq \frac{CR1R2}{R1+R2}\left\{0.522+\ln\left(\frac{0.781R1-R2}{R1-2R2}\right)\right\}$$



Using only the ID pulse involves shorting DT1 and DT2.

No.	Reference value	Objection	Note
R1	0.5Ω	Current detection, current limiter	1
R2 R3 R4		Hall bias (Hall element bias current setting)	
R5	2kΩ	Index amplifier Hysteresis width setting	2
R6	10kΩ to 100kΩ	Index output timing setting	3
R7		Index output timing setting	3
R8	200kΩ	FG amplifier feadback resistance	4
R9	1kΩ	FG amplifier input resistance	4
R10 R11		Integrator constant	5
C1	0.1μF	Supply bypass	6
C2	0.1μF	AGC filter	
C3	0.1μF	Frequency characteristics revision	
C4	150pF	Oscilator stabilization	7
C5	22pF	Oscilator connection	7
C6	0.1μF	Index output timing setting	3
C7	0.1μF	FG amplifier connection	4
C8	0.0022μF	FG amplifer filter	4
C9	1μF	FG amplifier connection	4
C10 C11		Integrator constant	5
X1	983kHz or 491kHz	Oscilator	7

Note : 1. Current limiter

$$I_{LIM}=\frac{V_{REF1}}{R1}[A]$$

Refer to the electrical characteristic for V_{REF1}.

2. Index amplifier hysterisis width

$\Delta V_{HYS}=I_{IDO}\times R5$

Refer to the electrical characteristics for I_{IDO}.

3. Refer to the timing chart of index block.

4. If the input amplifier is large enough that no noise problem will occur, C8 can be deleted and C9 can be shorted.

5. Speed discriminator gain.

$K_V=0.025[V/\%]$

Control amplifier gain.

$G_C=0.5[V/V]$

6. Connect this as close to the IC as possible.

7. Consult oscillator manufacturer to determine the values.