

Monolithic Digital IC

<b>SANYO</b>	No. 4183A	LB1813M
	Spindle Motor Driver for Floppy-disk Drives	

### Overview

The LB1813M is a three-phase, full-wave spindle motor driver IC that features digital speed control, making it ideal for use in 3.5-inch floppy disk drives. It can be used in most disk drives without requiring any output electrolytic capacitors.

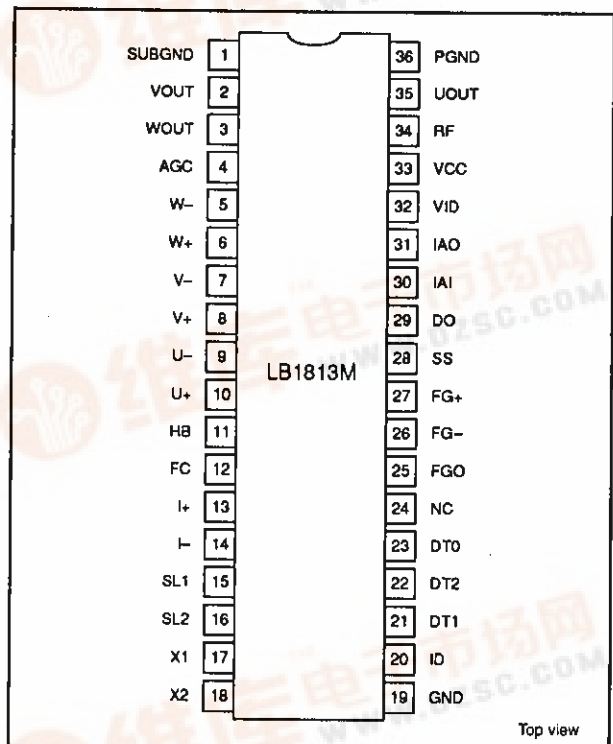
The LB1813M incorporates a start/stop control input, a revolution detector, Hall-effect transducer amplifiers with AGC, thermal protection and index delay circuits, and a single-sided hysteresis index comparator.

The LB1813M operates from a 4.2 to 6.5 V supply and is available in 36-pin MFPs.

### Features

- Three-phase, full-wave motor driver
- Digital speed control
- Start/stop control input
- Revolution detector
- Hall-effect transducer amplifiers with AGC
- Thermal protection circuit
- Current limiter circuit
- Single-sided hysteresis index comparator
- Index delay circuit
- 4.2 to 6.5 V supply
- 36-pin MFP

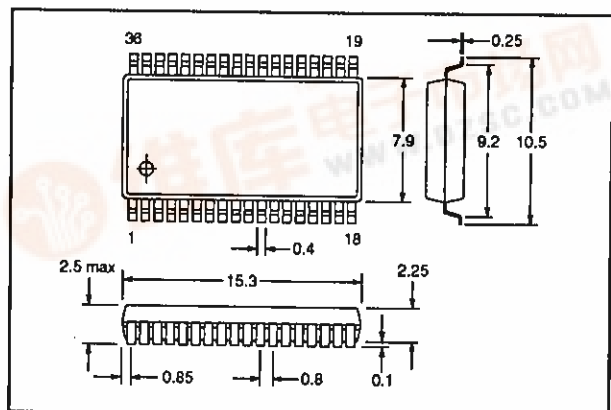
### Pin Assignment



### Package Dimensions

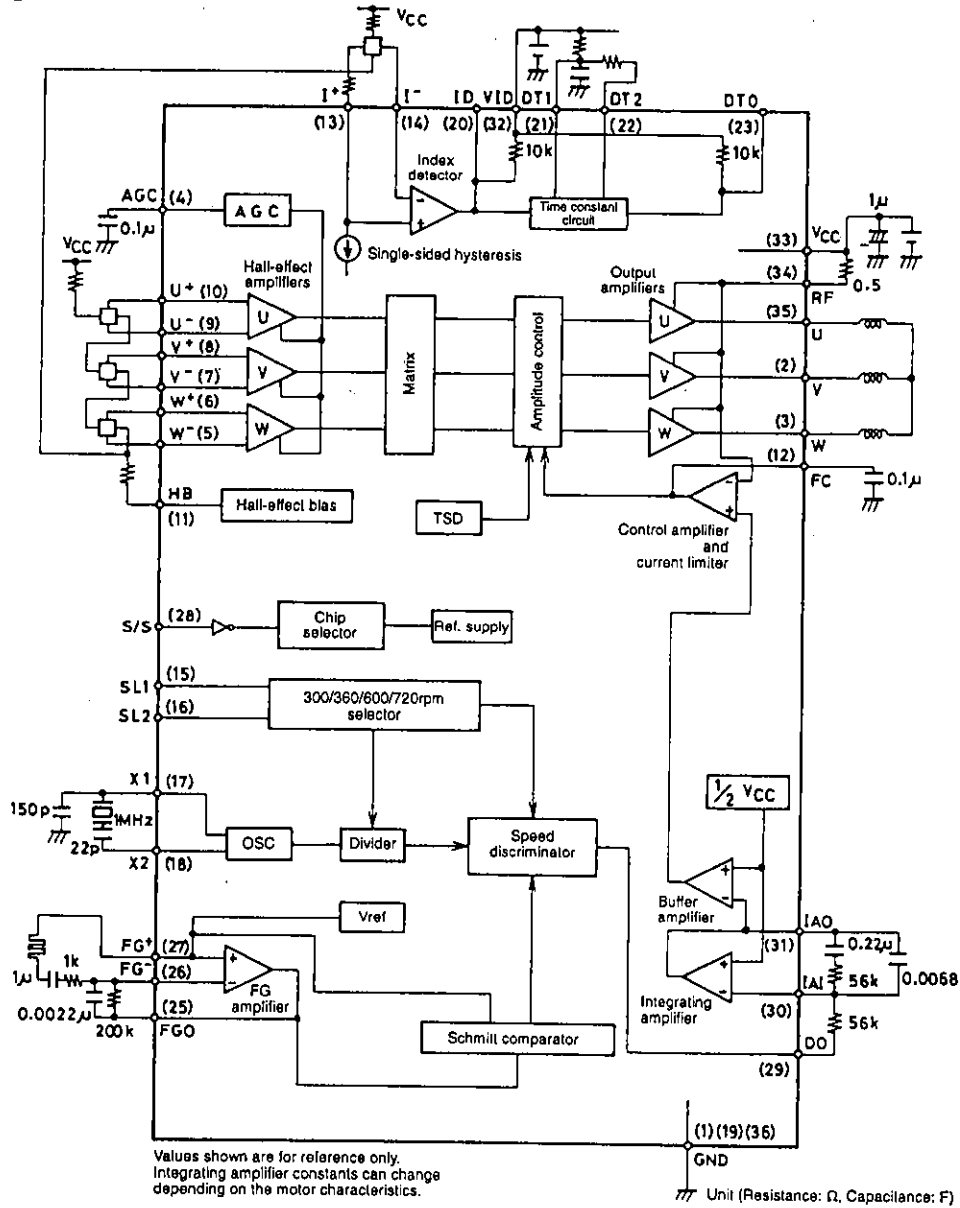
Unit: mm

3129-MFP36S



# LB1813M

## Block Diagram



## Pin Functions

Number	Name	Equivalent circuit	Function
1	SGND		Sub-ground
2	VOUT		V-phase output
3	WOUT		W-phase output
4	AGC		Automatic gain control circuit capacitor connection

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Number	Name	Equivalent circuit	Function :
5	W-		W-phase Hall-effect transducer amplifier inputs. HIGH when $W+ > W-$ .
6	W+		V-phase Hall-effect transducer amplifier inputs. HIGH when $V+ > V-$ .
7	V-		U-phase Hall-effect transducer amplifier inputs. HIGH when $U+ > U-$ .
8	V+		
9	U-		
10	U+		
11	HB		Hall-effect transducer bias voltage output. When in stop mode, HB is open.
12	FC		Frequency compensation capacitor connection
13	I+		Index detector Hall-effect transducer amplifier inputs. When $I+$ is HIGH, $I_1 = 10 \mu A$ . When $I+$ is LOW, $I_1 = 0 \mu A$ . The hysteresis width is determined by the external resistor connected to $I+$ .
14	I-		
15	SL1		RPM select input 1
16	SL2		RPM select input 2

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Number	Name	Equivalent circuit	Function
17	X1		Crystal oscillator connection 1
18	X2		Crystal oscillator connection 2
19	GND		Ground
20	ID		Index pulse output
21	DT1		Delay time constant setting external network connection 1
22	DT2		Delay time constant setting external network connection 2
23	DTO		Index delay pulse output
24	NC		No connection

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Number	Name	Equivalent circuit	Function :
25	FGO		FG amplifier output
26	FG-		FG amplifier inverting input
27	FG+		FG amplifier non-inverting input
28	S/S		Active LOW start/stop circuit control input.
29	DO		Discriminator output
30	IAI		Integrating amplifier input
31	IAO		Integrating amplifier output
32	VID		5 V index delay circuit supply
33	VCC		4.2 to 6.5 V supply
34	RF		Output supply voltage detection input. Connecting a resistor between RF and VCC enables current limiting.

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Number	Name	Equivalent circuit	Function
35	UOUT		U-phase output
36	PGND		Power ground

## Specifications

### Absolute Maximum Ratings

Parameter	Symbol	Ratings	Unit
Supply voltage	$V_{CC}$	7.0	V
Output current	$I_o$	1 ( $t \leq 0.5$ s)	A
		0.7	
Power dissipation	$P_D$	1000	mW
Operating temperature range	$T_{opr}$	-20 to 80	°C
Storage temperature range	$T_{stg}$	-40 to 150	°C

### Allowable Operating Ranges

$T_a = 25$  °C

Parameter	Symbol	Ratings	Unit
Supply voltage	$V_{CC}$	5	V
Supply voltage range	$V_{CC}$	4.2 to 6.5	V

### Electrical Characteristics

$V_{CC} = 5$  V,  $T_a = 25$  °C unless otherwise noted

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Quiescent supply current	$I_{CCO}$	Motor stopped	-	-	0.4	mA
Supply current	$I_{CC}$	Motor running	-	20	30	mA
SL1 and SL2 360-rpm select input voltage	$V_{SLL}$		0	-	0.8	V
SL1 and SL2 300-rpm select input voltage	$V_{SLH}$		2	-	$V_{CC}$	V
SL1 and SL2 input bias current	$I_{SL}$		-	-	0.4	mA
S/S start voltage	$V_{S/SL}$		0	-	0.8	V
S/S stop voltage	$V_{S/SH}$		2	-	$V_{CC}$	V
S/S input bias current	$I_{S/S}$		-	-	0.1	mA
Hall-effect transducer amplifier common-mode input voltage	$V_h$		2.2	-	$V_{CC} - 0.7$	V
Hall-effect transducer amplifier differential input voltage	$V_{\Delta I}$		70	-	200	mV <sub>PP</sub>

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Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Hall-effect transducer amplifier input offset voltage	$V_{ho}$	See Note.	-	-	$\pm 10$	mV
Hall-effect transducer amplifier input bias current	$I_{HB}$		-	-	20	$\mu A$
HB output voltage	$V_H$	$I_H = 5 \text{ mA}$	-	1.5	1.8	V
HB output leakage current	$I_{HL}$	Motor stopped	-	-	$\pm 10$	$\mu A$
UOUT, VOUT and WOUT source or sink output saturation voltage	$V_{sat}$	$I_o = 0.35 \text{ A}, V_{CC} = 4.2 \text{ V}$	-	1.2	1.4	V
		$I_o = 0.7 \text{ A}, V_{CC} = 4.2 \text{ V}$	-	1.5	2.0	V
UOUT, VOUT and WOUT output leakage current	$I_{OL}$		-	-	$\pm 1$	mA
Current limiter reference voltage	$V_{ref1}$		0.27	0.30	0.33	V
Control amplifier voltage gain	$G_C$		-	-6	-	dB
Control amplifier interphase voltage gain differential	$\Delta G_C$		-	-	$\pm 1$	dB
Integrating amplifier reference voltage	$V_{ref2}$		-	$0.5V_{CC}$	-	V
Integrating amplifier bias current	$I_b$		-	-	$\pm 1$	$\mu A$
Integrating amplifier output voltages	$V_i^+$	Referenced to $V_{ref2}$ , $I_i = -0.5 \text{ mA}$	-	0.75	-	V
	$V_i^-$	Referenced to $V_{ref2}$ , $I_i = 0.5 \text{ mA}$	-	-1.4	-	V
Amplifier gain bandwidth	BW	See Note.	-	1	-	MHz
FG amplifier input voltage	$V_{FG}$		5	-	100	mV <sub>pp</sub>
FG amplifier voltage gain	$G_{FG}$	Output open. See Note.	-	60	-	dB
FG amplifier input offset voltage	$V_{FGO}$		-	-	$\pm 10$	mV
FG amplifier internal reference voltage	$V_{FGB}$		2.2	2.5	2.8	V
Schmitt trigger voltage hysteresis	$\Delta V_{sh}$	LOW-to-HIGH and HIGH-to-LOW. See Note.	-	25	-	mV
Schmitt trigger input voltage	$V_{sh}$		1	-	$V_{CC} - 1$	V
Discriminator levels	N		-	1042	-	levels
Discriminator LOW-level voltage	$V_{DL}$	$I_D = -0.5 \text{ mA}$	-	-	0.3	V
Discriminator HIGH-level voltage	$V_{DH}$	$I_D = 0.5 \text{ mA}$	$V_{CC} - 0.4$	-	-	V
Discriminator leakage current	$I_{D1}$		-	-	$\pm 1$	$\mu A$
Discriminator operating frequency	$f_D$	See Note.	-	-	1	MHz
Oscillator frequency	$f_{osc}$	See Note.	-	-	1	MHz
Index detector Hall-effect transducer amplifier phase input voltage	$V_{ID}$		1.5	-	$V_{CC} - 0.5$	V
Index detector Hall-effect transducer amplifier input bias current	$I_{IDB}$		-	-	$\pm 10$	$\mu A$
Induction current for hysteresis	$I_{IDO}$		5	10	15	$\mu A$
Index detector LOW-level output voltage	$V_{IDL}$	$V_{ID} = 5 \text{ V}$	-	-	0.4	V
Index detector HIGH-level output voltage	$V_{IDH}$	$V_{ID} = 5 \text{ V}$	4.5	-	-	V

## LB1813M

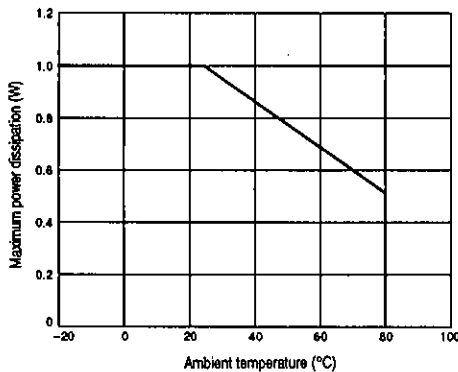
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Index delay circuit discharge voltage	V <sub>DLDC</sub>	V <sub>ID</sub> = 5 V	-	2.5	-	V
Index delay circuit LOW-level output voltage	V <sub>DLL</sub>	V <sub>ID</sub> = 5 V	-	-	0.4	V
Index delay circuit HIGH-level output voltage	V <sub>DLH</sub>	V <sub>ID</sub> = 5 V	4.5	-	-	V
Thermal shutdown temperature	TSD	See note.	150	180	-	°C
Thermal shutdown temperature hysteresis	ΔTSD	See note.	-	40	-	°C

### Note

These values are calculated ratings only and are not measured.

## Typical Performance Characteristics

### Power dissipation vs. ambient temperature



## Functional Description

### Digital Speed Control

The motor speed is given by the equation

$$f_{PG} = \frac{f_{osc} \times D}{1024}$$

where  $f_{PG}$  is the revolution detector frequency,  $f_{osc}$  is the crystal oscillator frequency and  $D$  is the frequency-divider constant. When SL1 is HIGH,  $D$  is 5/8, and when LOW,  $D$  is 6/8.

$f_{osc} = 1$  MHz,  $FG = 60$  pulses/revolution

SL1/SL2	H	L
H	600 rpm	300 rpm
L	720 rpm	360 rpm

When SL1 is HIGH,

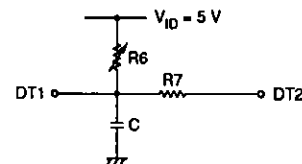
$$T_{300} \approx 0.693C \times R6$$

$$t_{300} \approx \frac{C \times R6 \times R7}{R6 + R7} \left[ 0.405 + \ln \left( \frac{0.781R6 - R7}{R6 - 2R7} \right) \right]$$

When SL1 is LOW,

$$T_{360} \approx 0.577C \times R6$$

$$t_{360} \approx \frac{C \times R6 \times R7}{R6 + R7} \left[ 0.522 + \ln \left( \frac{0.781R6 - R7}{R6 - 2R7} \right) \right]$$



If the index pulse output only is to be used, DT1 and DT2 should be short circuited.



### Output Phase Control

The motor driver output source and sink phases are selected by the voltages on the Hall-effect transducer amplifier inputs for each phase as shown in Table 1. Note that a Hall-effect transducer amplifier input is HIGH when the voltage on the positive input exceeds the voltage on the negative input.

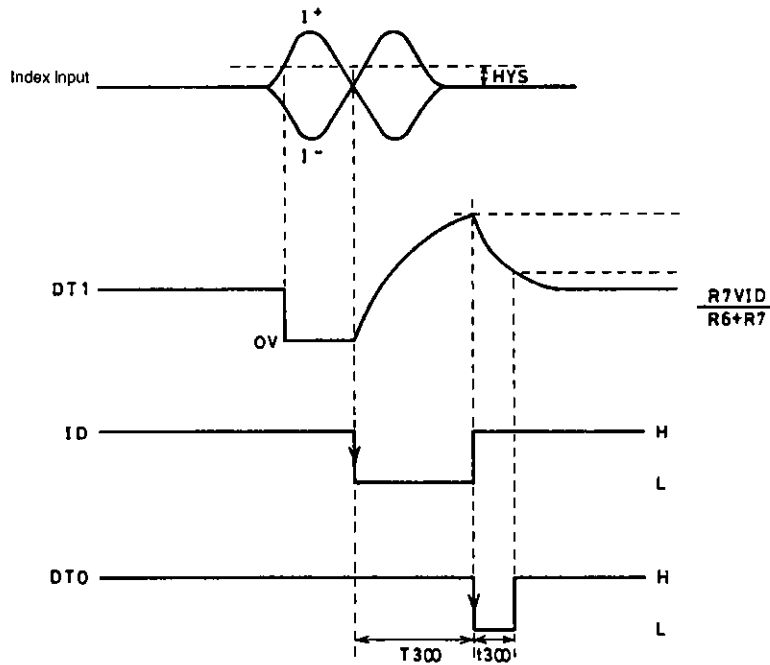
Table 1. Source and sink phase selection

Source phase	Sink phase	Hall-effect transducer amplifier inputs		
		U	V	W
V	W	HIGH	HIGH	LOW
V	U	LOW	HIGH	LOW

Table 1. Source and sink phase selection—continued

Source phase	Sink phase	Hall-effect transducer amplifier inputs		
		U	V	W
W	U	LOW	HIGH	HIGH
W	V	LOW	LOW	HIGH
U	V	HIGH	LOW	HIGH
U	W	HIGH	LOW	LOW

### Index Detector Timing



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