



# LB1913

## FDD Spindle Motor Driver

### Overview

The LB1913 is a three-phase disk drive motor driver IC that is optimal for use as a 3.5-inch floppy disk drive spindle motor driver.

### Functions and Features

- Three-phase full-wave linear drive
- On-chip digital speed control
- Start and stop circuits (active low)
- Speed switching  
High: 300 rpm, Low: 360 rpm
- Current limiter circuit
- Index comparator circuit
- Index delay circuit
- Thermal protection circuit

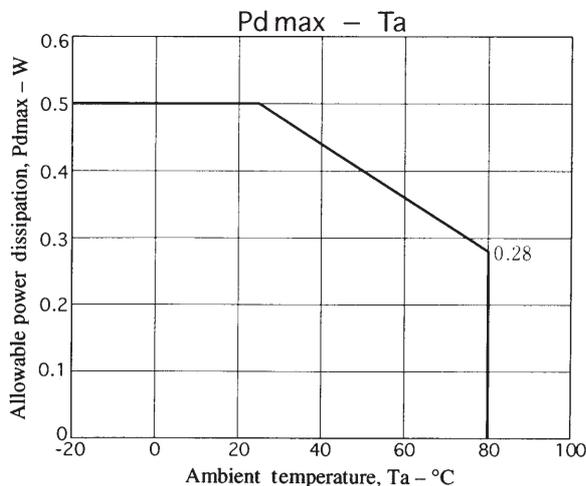
### Specifications

#### Absolute Maximum Ratings at Ta = 25°C

| Parameter                           | Symbol        | Conditions      | Ratings     | Unit |
|-------------------------------------|---------------|-----------------|-------------|------|
| Maximum supply voltage              | $V_{CC\ max}$ |                 | 7.0         | V    |
| Maximum output current              | $I_O\ max1$   | $t \leq 0.5\ s$ | 1.0         | A    |
| Maximum steady-state output current | $I_O\ max2$   |                 | 0.7         | A    |
| Allowable power dissipation         | $Pd\ max$     | Independent IC  | 0.5         | W    |
| Operating temperature               | $T_{opr}$     |                 | -20 to +80  | °C   |
| Storage temperature                 | $T_{stg}$     |                 | -40 to +150 | °C   |

#### Allowable Operating Ranges at Ta = 25°C

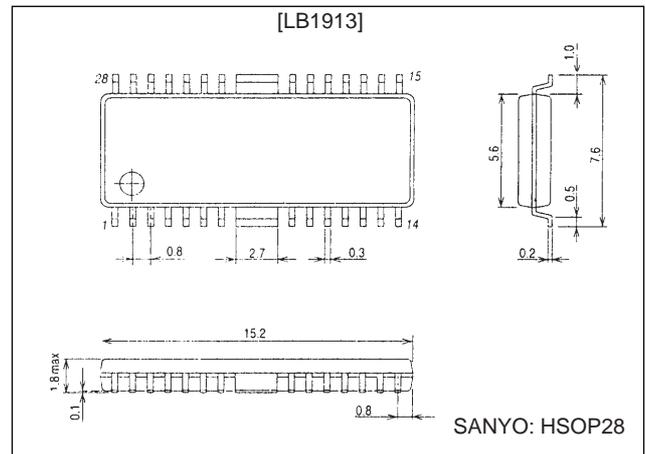
| Parameter                  | Symbol   | Conditions | Ratings    | Unit |
|----------------------------|----------|------------|------------|------|
| Recommended supply voltage | $V_{CC}$ |            | 4.2 to 6.5 | V    |



### Package Dimensions

unit: mm

#### 3222-HSOP28



## LB1913

### Electrical Characteristics at $T_a = 25^\circ\text{C}$ , $V_{CC} = 5.0\text{ V}$

| Parameter                                      | Symbol          | Conditions                           | Ratings |        |              | Unit              |
|--|-----------------|--------------------------------------|---------|--------|--------------|-------------------|
|  |                 |                                      | min     | typ    | max          |                   |
| Current drain                                  | $I_{CCO}$       | S/S = 5 V (standby mode)             |         |        | 10           | $\mu\text{A}$     |
|  | $I_{CC}$        | S/S = 0 V (normal mode)              |         | 12     | 18           | $\text{mA}$       |
| SL bias current                                | $I_{SL}$        | $V_{SL} = 0\text{ V}$                |         |        | 10           | $\mu\text{A}$     |
| SL input low-level voltage                     | $V_{SLL}$       |                                      | 0       |        | 1.0          | V                 |
| SL input high-level voltage                    | $V_{SLH}$       |                                      | 3.5     |        | $V_{CC}$     | V                 |
| S/S bias current                               | $I_{S/S}$       |                                      |         | 180    | 270          | $\mu\text{A}$     |
| S/S low-level voltage                          | $V_{S/SL}$      |                                      | 0       |        | 0.8          | V                 |
| S/S high-level voltage                         | $V_{S/SH}$      |                                      | 3.5     |        | $V_{CC}$     | V                 |
| Hall amplifier input bias current              | $I_{HB}$        |                                      |         |        | 10           | $\mu\text{A}$     |
| Common-mode input voltage range                | $V_h$           |                                      | 1.5     |        | $V_{CC}-1.0$ | V                 |
| Differential-mode input voltage range          | $V_{dif}$       |                                      | 50      |        | 200          | $\text{mV}_{p-p}$ |
| Hall bias output voltage                       | $V_H$           | $I_H = 5\text{ mA}$                  |         | 0.8    |              | V                 |
| Leakage current                                | $I_{HL}$        | S/S = 5 V                            |         |        | $\pm 10$     | $\mu\text{A}$     |
| Output saturation voltage                      | $V_{sat}$       | $I_O = 0.7\text{ A}$ , sink + source |         | 1.3    | 1.8          | V                 |
| Output leakage current                         | $I_{OL}$        |                                      |         |        | 1.0          | $\text{mA}$       |
| Current limiter                                | $V_{lim}$       |                                      | 0.27    | 0.3    | 0.33         | V                 |
| Control amplifier voltage gain                 | $G_C$           |                                      |         | -7     |              | $\text{dB}$       |
| Interphase voltage gain difference             | $\Delta G_C$    |                                      |         |        | $\pm 1$      | $\text{dB}$       |
| V/I converter source current                   | $I^+$           |                                      | 9       | 14     | 19           | $\mu\text{A}$     |
| V/I converter sink current                     | $I^-$           |                                      | -9      | -14    | -19          | $\mu\text{A}$     |
| V/I converter current ratio                    | $I^+/I^-$       |                                      | 0.8     | 1.0    | 1.2          |                   |
| DSC buffer input current                       | $I_{DSC}$       |                                      |         |        | 1.0          | $\mu\text{A}$     |
| FG Schmitt hysteresis                          | $\Delta V_{sh}$ | *                                    |         | 50     |              | $\text{mV}$       |
| Number of speed discriminator counts           | $N$             |                                      |         | 1041.5 |              |                   |
| Discriminator operating frequency              | $F_D$           | *                                    |         |        | 1.1          | $\text{MHz}$      |
| Oscillator frequency range                     | $F_{OSC}$       | *                                    |         |        | 1.1          | $\text{MHz}$      |
| Index output low-level voltage                 | $V_{IDL}$       | $I_O = 2\text{ mA}$                  |         |        | 0.4          | V                 |
| Index output leakage current                   | $I_{IDL}$       |                                      |         |        | $\pm 10$     | $\mu\text{A}$     |
| FG amplifier voltage gain                      | $G_{FG}$        | *                                    |         | 48     |              | $\text{dB}$       |
| FG amplifier input offset                      | $V_{FGO}$       |                                      |         |        | $\pm 10$     | $\text{mV}$       |
| FG amplifier internal reference voltage        | $V_{FGB}$       |                                      | 2.2     | 2.5    | 2.8          | V                 |
| Schmitt hysteresis                             | $\Delta V_{SH}$ | *                                    |         | 50     |              | $\text{mV}$       |
| Index input hysteresis                         | $\Delta V_{ID}$ | *                                    |         | 20     |              | $\text{mV}$       |
| Index common-mode input voltage range          | $V_{ID}$        |                                      | 1.0     |        | $V_{CC}-1.0$ | V                 |
| Thermal shutdown circuit operating temperature | $TSD$           | *                                    | 150     | 180    |              | $^\circ\text{C}$  |
| Hysteresis                                     | $\Delta TSD$    | *                                    |         | 40     |              | $^\circ\text{C}$  |

Note: \* These items are design target values and are not tested.

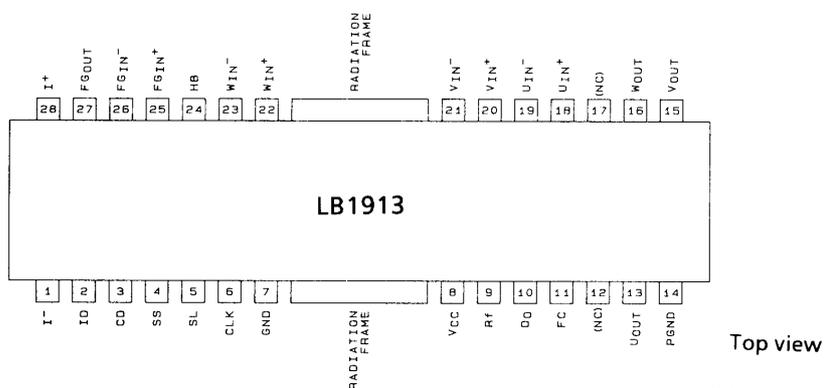
### Truth Table

|   | Source → Sink     | Hall 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 |

A "high-level" (H) Hall amplifier input means:  
 $U_{IN+} > U_{IN-}$   
 $V_{IN+} > V_{IN-}$   
 $W_{IN+} > W_{IN-}$

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## Pin Assignment



A06066

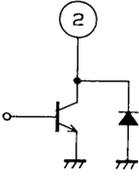
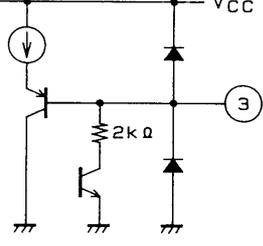
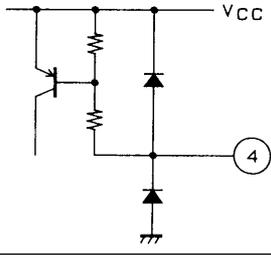
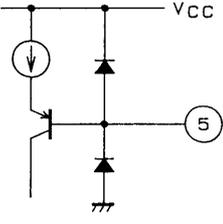
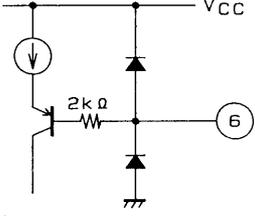
## Pin Functions

| Pin no.                          | Pin  | Pin voltage                     | Equivalent circuit | Function   |
|----------------------------------|--|---------------------------------|--------------------|--|
| 18<br>19<br>20<br>21<br>22<br>23 | $U_{IN+}$<br>$U_{IN-}$<br>$V_{IN+}$<br>$V_{IN-}$<br>$W_{IN+}$<br>$W_{IN-}$ | 1.5 V min<br>$V_{CC}-1.0$ V max | <p>A06069</p>      | <ul style="list-style-type: none"> <li>• U-phase Hall element input</li> <li>• V-phase Hall element input</li> <li>• W-phase Hall element input</li> </ul>   |
| 24                               | HB   | 0.8 V typ<br>( $I_H = 5$ mA)    | <p>A06070</p>      | <ul style="list-style-type: none"> <li>• Minus-side pin for applying the Hall bias current<br/>This pin goes to the open state in the stopped state and the Hall bias is cut off.</li> </ul>                           |
| 25<br>26<br>27                   | $FG_{IN+}$<br>$FG_{IN-}$<br>$FG_{OUT}$                                     |                                 | <p>A06071</p>      | <ul style="list-style-type: none"> <li>• FG amplifier plus input<br/>A reference voltage of 2.5 V is generated by the IC internally.</li> <li>• FG amplifier minus input</li> <li>• FG amplifier output pin</li> </ul> |
| 28<br>1                          | $I^+$<br>$I^-$   |                                 | <p>A06072</p>      | <ul style="list-style-type: none"> <li>• Index input</li> </ul>  |

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| Pin no. | Pin      | Pin voltage                                   | Equivalent circuit   | Function  |
|---------|----------|---|--|---|
| 2       | ID       | Low: 0.4 V max<br>High: 4.5 V min             |  <p style="text-align: right;">A06073</p>   | <ul style="list-style-type: none"> <li>Index output</li> </ul>  |
| 3       | CD       |   |  <p style="text-align: right;">A06074</p>   | <ul style="list-style-type: none"> <li>Connection for external RC time constant circuit.</li> </ul>   |
| 4       | SS       | Low: 0.8 V max<br>High: 3.5 V min             |  <p style="text-align: right;">A06075</p>  | <ul style="list-style-type: none"> <li>Start/stop switching input<br/>This is an active-low input.</li> </ul>   |
| 5       | SL       | Low: 1.0 V max<br>High: 3.5 V min             |  <p style="text-align: right;">A06076</p> | <ul style="list-style-type: none"> <li>Speed switching input</li> </ul>   |
| 6       | CLK      | Low: 1.0 V max<br>High:<br>$V_{CC}-1.0$ V min |  <p style="text-align: right;">A06077</p> | <ul style="list-style-type: none"> <li>Reference clock input<br/>Use a clock rate of 1 MHz for 300 and 360 rpm speeds.</li> </ul>   |
| 7       | GND      |   |  | <ul style="list-style-type: none"> <li>Ground connection<br/>Connect this pin, pin 14, and the frame to ground.</li> </ul>  |
| 8       | $V_{CC}$ |   |  | <ul style="list-style-type: none"> <li>Power supply<br/>Provide a well-stabilized power supply so that ripple and noise do not enter the LB1913 from this pin.</li> </ul>   |
| 9       | Rf       |   |  | <ul style="list-style-type: none"> <li>Used for output current detection.<br/>The output current is converted to a voltage and detected by connecting a resistor (Rf) between this pin and <math>V_{CC}</math>. The current limiter operates by detecting the voltage on this pin.</li> </ul> |

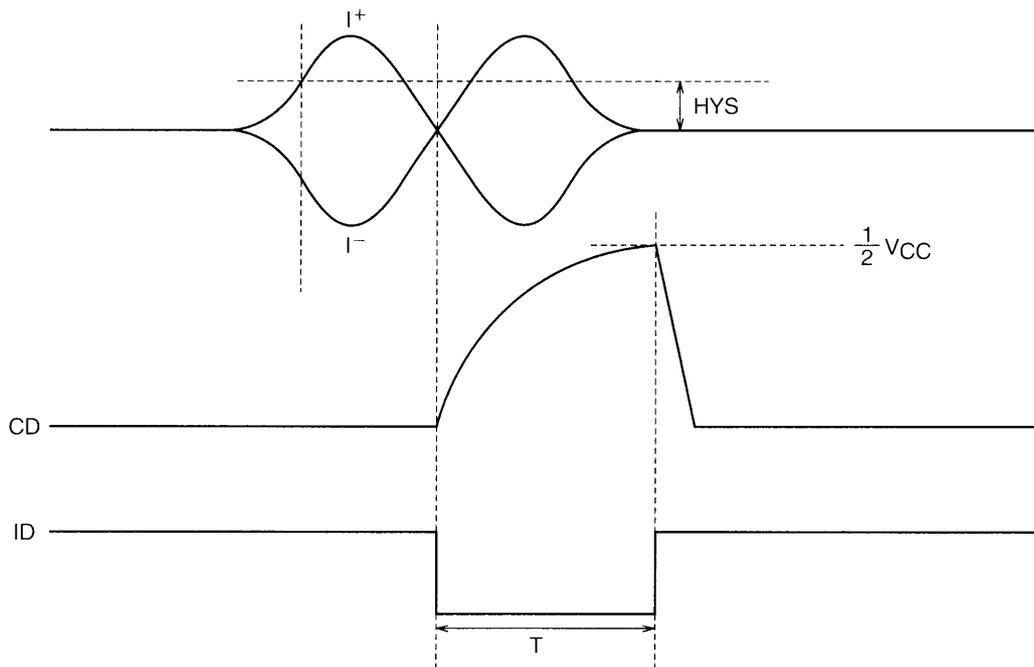
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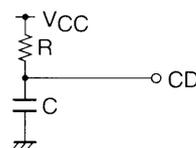
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| Pin no.        | Pin  | Pin voltage | Equivalent circuit | Function   |
|----------------|--|-------------|--------------------|--|
| 10             | D <sub>O</sub>   |             |                    | <ul style="list-style-type: none"> <li>• Speed discriminator</li> </ul>  |
| 11             | F <sub>C</sub>   |             |                    | <ul style="list-style-type: none"> <li>• Frequency characteristics correction<br/>Current control system open loop oscillation can be prevented by inserting a capacitor between this pin and ground.</li> </ul> |
| 13<br>15<br>16 | U <sub>OUT</sub><br>V <sub>OUT</sub><br>W <sub>OUT</sub> |             |                    | <ul style="list-style-type: none"> <li>• U-phase output</li> <li>• V-phase output</li> <li>• W-phase output</li> </ul>   |
| 14             | PGND   |             |                    | <ul style="list-style-type: none"> <li>• Output transistor ground connection</li> </ul>  |

## Index Delay Pulse Timing Chart

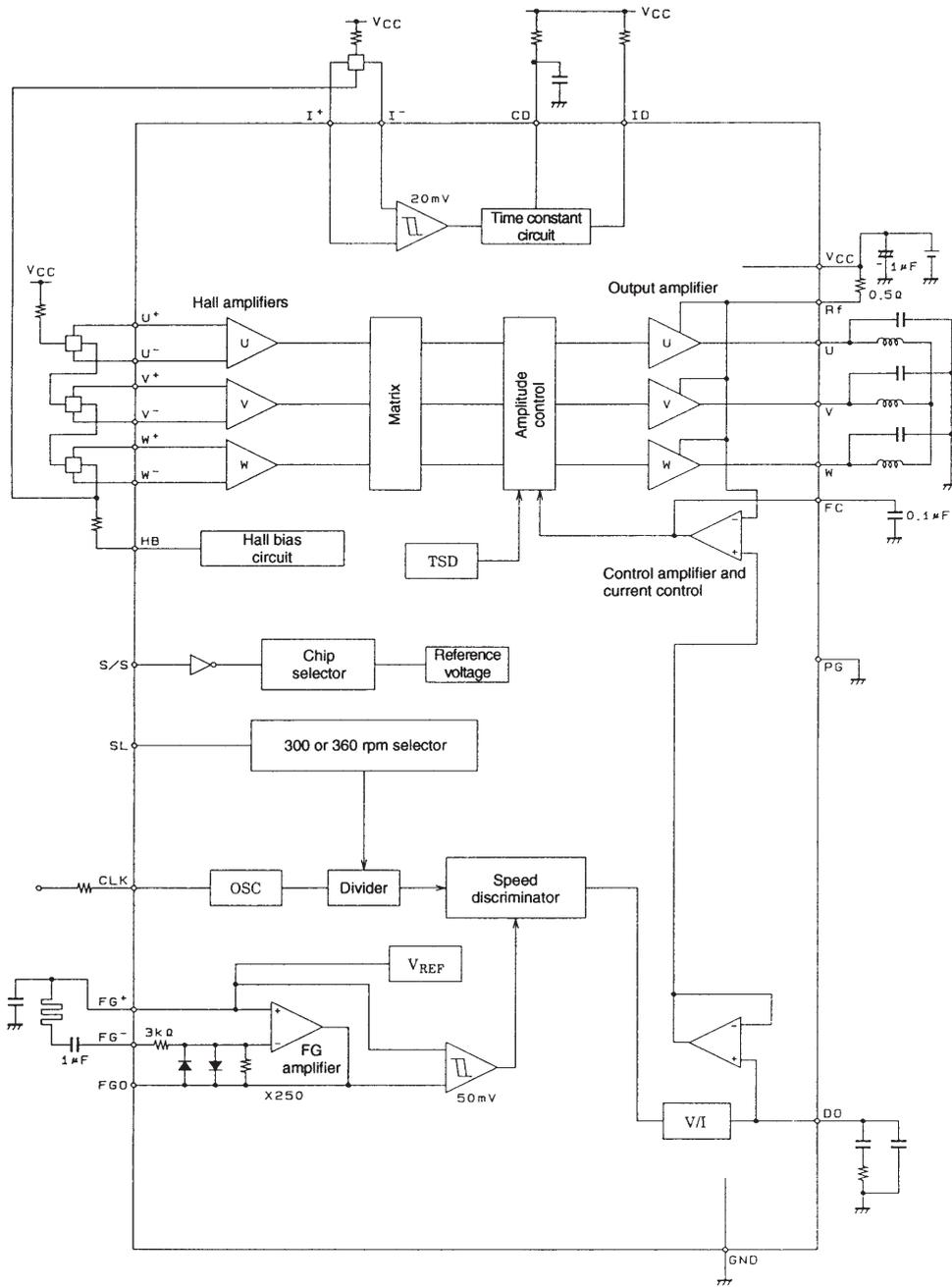


When SL = high  $T_{300} \approx 0.693CR$   
 When SL = low  $T_{360} \approx 0.577CR$



A06067

Block Diagram



A06068

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