

# FAN8039BD3

## 5-CH Motor Driver

### Features

- 1 Phase, Full-wave, Linear DC Motor Driver
- Built-in 5-CH Balanced TransFormerless (BTL) Driver
- Built-in thermal shut down circuit (TSD)
- Built-in Variable Regulator With Power Tr.
- Built-in Power Save Circuit
- Built-in stand by mode circuit
- Wide Operating Supply Voltage : 4.5 ~ 13.2V

### Description

The FAN8039BD3 is a monolithic integrated circuit suitable for a 5-CH motor driver which drives the tracking actuator, focus actuator, sled motor, tray motor, spindle motor of the DVDP/CAR-CD systems.



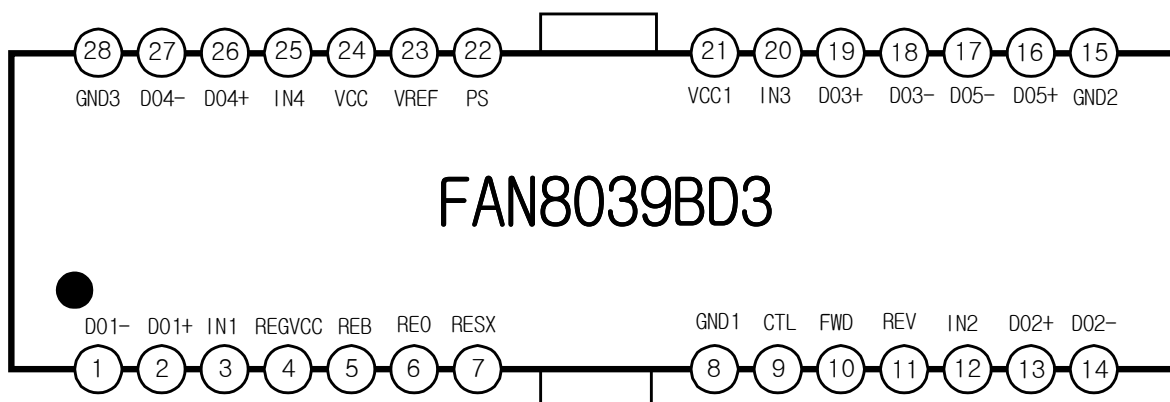
### Typical Applications

- Compact disk player
- Video compact disk player
- Car compact disk player
- Mixing with compact disk player and mini disk player
- DVDP

### Ordering Information

| Device       | Package         | Operating Temp |
|--------------|-----------------|----------------|
| FAN8039BD3   | 28-SSOPH-375SG2 | -35°C ~ 85°C   |
| FAN8039BD3TF | 28-SSOPH-375SG2 | -35°C ~ 85°C   |

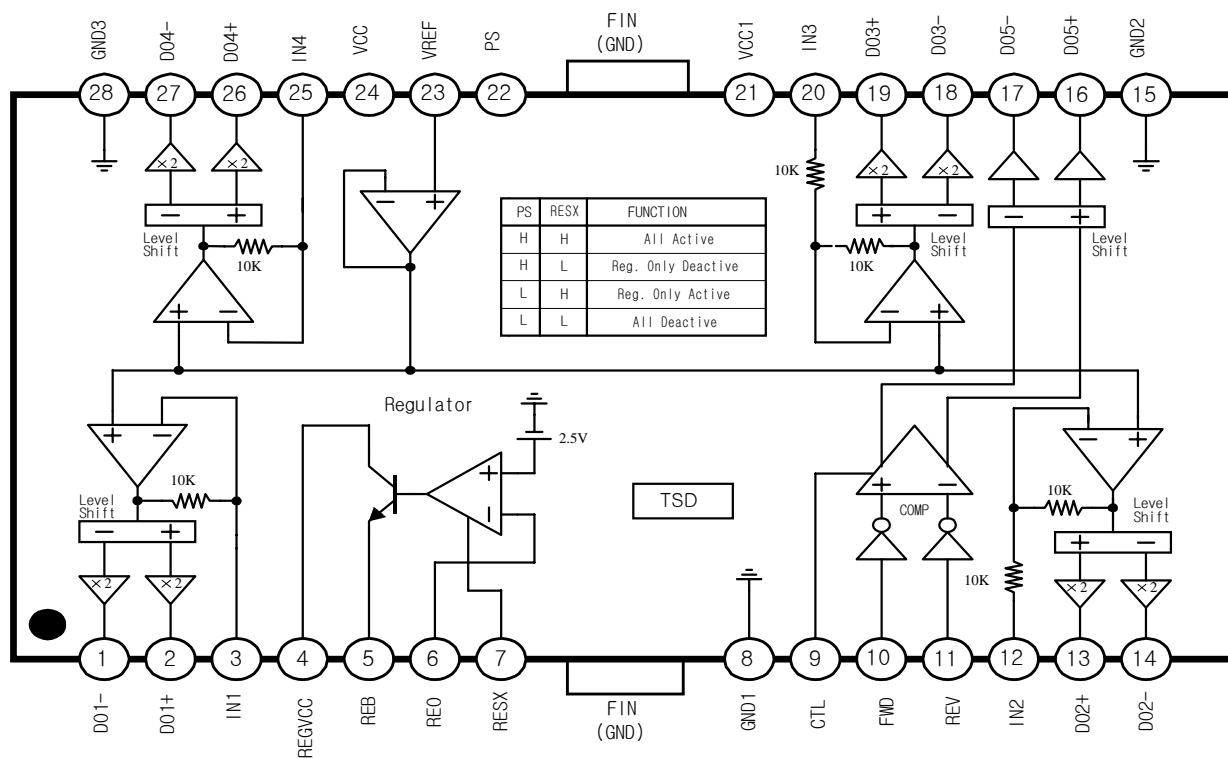
## Pin Assignments



## Pin Definitions

| NO | Symbol | Description              | NO | Symbol | Description                  |
|----|--------|--------------------------|----|--------|------------------------------|
| 1  | DO1-   | CH1 Drive Output (-)     | 15 | GND2   | Power Ground1 (CH 2,3,5)     |
| 2  | DO1+   | CH1 Drive Output (+)     | 16 | DO5+   | CH5 Drive Output (+)         |
| 3  | IN1    | CH1 Drive Input          | 17 | DO5-   | CH5 Drive Output(-)          |
| 4  | REGVCC | Regulator Supply Voltage | 18 | DO3-   | CH3 Drive Output(-)          |
| 5  | REB    | Regulator Output         | 19 | DO3+   | CH3 Drive Output (+)         |
| 6  | REO    | Regulator Feedback Input | 20 | IN3    | CH3 Drive Input              |
| 7  | RESX   | Regulator Reset          | 21 | VCC1   | Supply Voltage1(CH2,CH3,CH5) |
| 8  | GND1   | Signal Ground            | 22 | PS     | Power Save                   |
| 9  | CTL    | CH5 Motor Speed Control  | 23 | VREF   | Bias Voltage                 |
| 10 | FWD    | CH5 Forward Input        | 24 | VCC    | Supply Voltage(CH1,CH4)      |
| 11 | REV    | CH5 Reverse Input        | 25 | IN4    | CH4 Drive Input              |
| 12 | IN2    | CH2 Drive Input          | 26 | DO4+   | CH4 Drive Output (+)         |
| 13 | DO2+   | CH2 Drive Output (+)     | 27 | DO4-   | CH4 Drive Output (-)         |
| 14 | DO2-   | CH2 Drive Output (-)     | 28 | GND3   | Power Ground2 (CH 1,4)       |

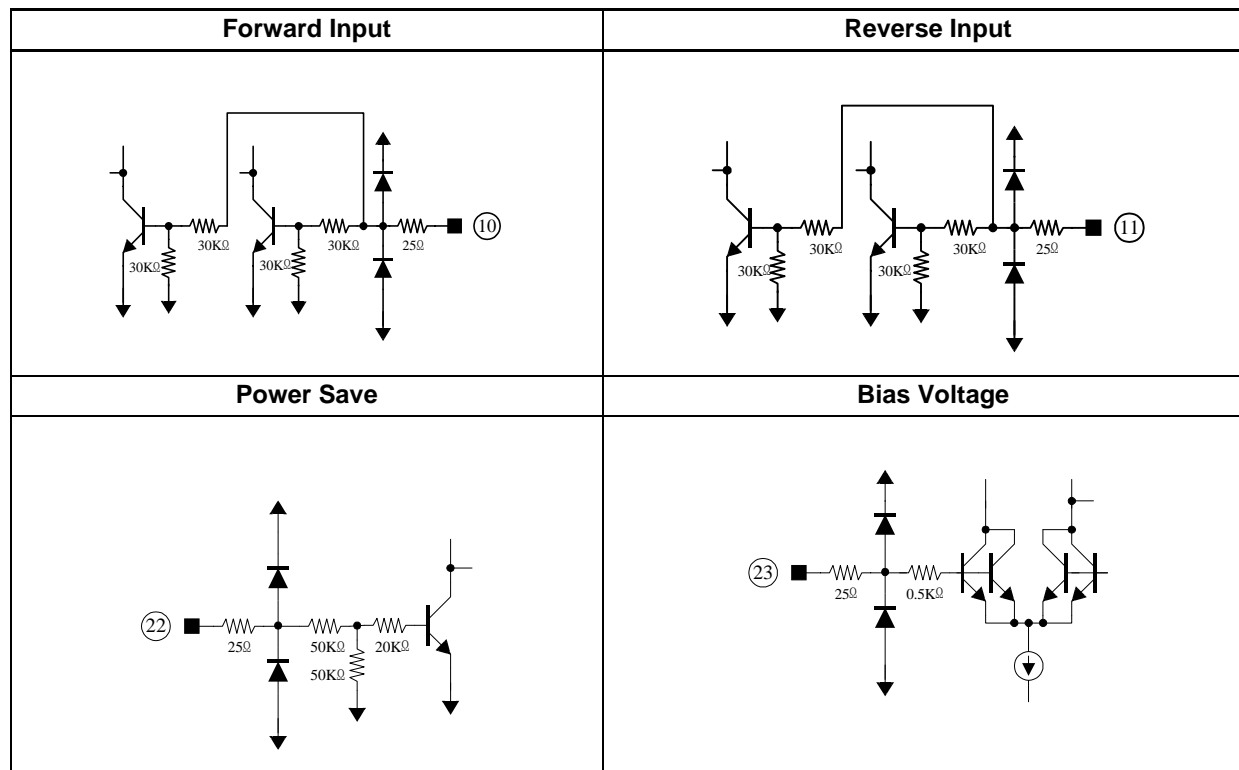
# Internal Block Diagram



# Equivalent Circuits

|   |  |
|---|--|
| <p style="text-align: center;"><b>Btl Driver Output</b></p> | <p style="text-align: center;"><b>Btl Drive Input</b></p>          |
| <p style="text-align: center;"><b>Regulator Output</b></p>  | <p style="text-align: center;"><b>Regulator Feedback Input</b></p> |
| <p style="text-align: center;"><b>Regulator Reset</b></p>   | <p style="text-align: center;"><b>Motor Speed Control</b></p>      |

## Equivalent Circuits

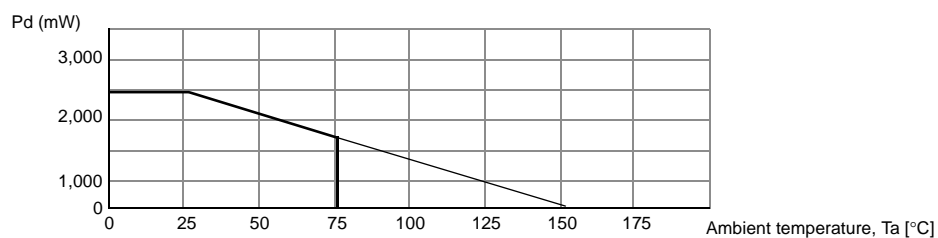


## Absolute Maximum Ratings (Ta = 25°C)

| Parameter                        | Symbol | Value               | Unit |
|----------------------------------|--------|---------------------|------|
| Maximum Supply Voltage           | VCC    | 18                  | V    |
| Power Dissipation                | PD     | 2.5 <sup>note</sup> | W    |
| Operating Temperature            | TOPR   | -35 ~ +85           | °C   |
| Storage Temperature              | TSTG   | -55 ~ +150          | °C   |
| Maximum output current           | IOMAX  | 1                   | A    |
| Regulator Maximum output current | IROMAX | 400                 | mA   |

### Notes:

- When mounted on 70mm × 70mm × 1.6mm PCB
- Power dissipation reduces 20mW/°C for using above TA = 25°C
- Do not exceed PD and SOA (Safe Operating Area)



## Recommended Operating Conditions (Ta = 25°C)

| Parameter                       | Symbol | Min. | Typ. | Max. | Unit |
|---------------------------------|--------|------|------|------|------|
| Operating Supply Voltage        | Vcc    | 4.5  | -    | 13.2 | V    |
| Vctl(pin9) Voltage(Vcc=Vcc1=8V) | Vctl   | 0    | -    | 3.0  | V    |
| Vctl(pin9) Voltage(Vcc=Vcc1=5V) | Vctl   | 0    | -    | 1.6  | V    |

## Electrical Characteristics

(VCC = VCC1 = 8V, TA = 25°C, unless otherwise specified)

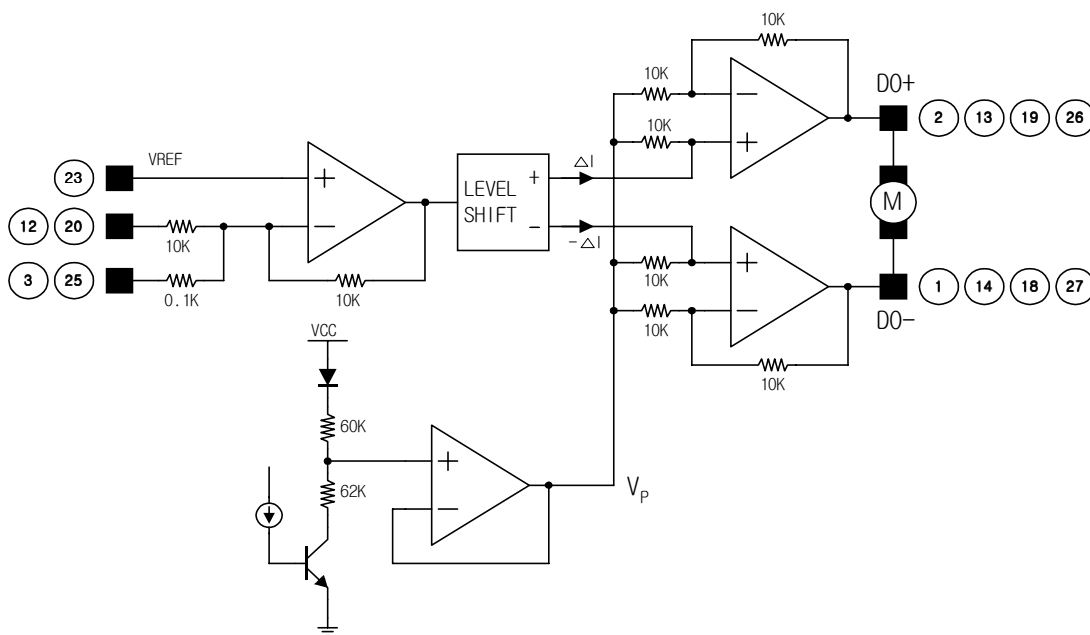
| Characteristics                       | Symbol           | Condition   | Min.  | Typ. | Max.  | Unit       |
|---------------------------------------|------------------|---|-------|------|-------|------------|
| Quiescent Circuit Current             | ICCQ             | Under no - load                                   | -     | 20   | -     | mA         |
| Power Save On Current                 | IPS              | Pin7=GND  | -     | 1    | 2     | mA         |
| Power Save On Voltage                 | VPSON            | Pin7=Variation                                    | -     | -    | 0.5   | V          |
| Power Save Off Voltage                | VPSOFF           | Pin7=Variation                                    | 2     | -    | -     | V          |
| <b>VARIABLE REGULATOR PART</b>        |                  |   |       |      |       |            |
| Load Regulation                       | $\Delta V_{RL}$  | $I_L = 0mA \rightarrow 200mA$                     | -40   | 0    | 10    | mV         |
| Line Regulation                       | $\Delta V_{CC}$  | $I_L = 200mA, V_{CC}=6V \rightarrow 9V$           | -20   | 0    | 30    | mV         |
| Regulator Output Voltage 1            | VREG1            | $I_L = 100mA$                                     | 4.75  | 5    | 5.25  | V          |
| Regulator Output Voltage 2            | VREG2            | $I_L = 100mA$                                     | 3.135 | 3.3  | 3.465 | V          |
| Regulator Output Peak Current (Note1) | IPK              | $T_j = 25^\circ C$                                |       | 700  |       | mA         |
| <b>BLT DRIVER PART</b>                |                  |   |       |      |       |            |
| Output Offset Voltage                 | VOO              | $V_{IN}=2.5V$                                     | -40   | 0    | 40    | mV         |
| Maximum Output Voltage1               | VOM1             | $V_{CC}=V_{CC1}=8V, R_L = 12\Omega$               | 5.5   | 6.5  | -     | V          |
| Maximum Output Voltage2               | VOM2             | $V_{CC}=V_{CC1}=13V, R_L = 24\Omega$              | 10.5  | 11.5 | -     | V          |
| Close Loop Voltage Gain               | AVF              | $V_{IN}=0V, 1V_{rms}, f = 1KHz$                   | 10.5  | 12   | 13.5  | dB         |
| Slew rate                             | SR               | $V_{OUT}=4VP-P, f = 120KHz, Square$               | -     | 2    | -     | V/ $\mu s$ |
| <b>LOADING MOTOR DRIVER PART</b>      |                  |   |       |      |       |            |
| Input High Level Voltage              | V <sub>IH</sub>  | -   | 2     | -    | -     | V          |
| Input Low Level Voltage               | V <sub>IL</sub>  | -   | -     | -    | 0.5   | V          |
| Output Voltage1                       | V <sub>O1</sub>  | $V_{CC}=V_{CC1}=5V, V_{ctl}=1.8V, R_L = 12\Omega$ | 2.6   | 3.6  |       |            |
| Output Voltage2                       | V <sub>O2</sub>  | $V_{CC}=V_{CC1}=8V, V_{ctl}=3.2V, R_L = 12\Omega$ | 5.5   | 6.5  | -     | V          |
| Output Offset Voltage1                | V <sub>OO1</sub> | $V_{IN}=5V, 5V$                                   | -40   | -    | 40    | mV         |
| Output Offset Voltage2                | V <sub>OO2</sub> | $V_{IN}=0V, 0V$                                   | -40   | -    | 40    | mV         |

### Note:

1. Pulse Testing with Low Duty.

## Application Information

### 1. Driver (Except For Loading Motor Driver)



A voltage,  $V_{REF}$  is the reference voltage driven by the external bias voltage on pin#23. The input signal( $V_{in}$ ) on pin#12 and #20 is uplifted by 10K/10K times and then fed to the level shift. The level shift provides a current as  $+\Delta I$  and  $-\Delta I$  due to the difference between the input signal and the arbitrary reference signal. The current can be fed into the driver Amp, so it drives the power TR on the output stage. The output can be shown 2 times as much as the input signal. (gain =  $1 + 10K/10K$ ).

$$V_{IN} = V_{REF} + \Delta V \Delta I = \frac{\Delta V}{10K}$$

$$DO+ = V_P + \Delta I \cdot 10K \cdot \left(1 + \frac{10K}{10K}\right) = V_P + 2\Delta V$$

$$DO- = V_P - \Delta I \cdot 10K \cdot \left(1 + \frac{10K}{10K}\right) = V_P - 2\Delta V$$

$$V_{OUT} = (DO+) - (DO-) = 4\Delta V$$

$$GAIN = 20\log\left(\frac{V_{OUT}}{\Delta V}\right) = 12dB$$

Pin#3 or #25 can be used to modify the gain. The output stage is the balanced transformerless(BTL) driver. The bias voltage  $V_P$  is described as follows.

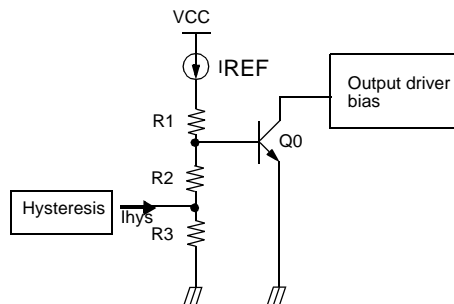
$$\begin{aligned} V_P &= (V_{CC} - V_{BE} - V_{CE(SAT)}) \times \frac{62K}{60K + 62K} + V_{CE(SAT)} \\ &= \frac{V_{CC} - V_{BE} - V_{CE(SAT)}}{1.97} + V_{CE(SAT)} \end{aligned}$$

## 2. Thermal Shutdown

The TSD circuit turns activated when the junction temperature becomes over 175°C.

It cuts off the bias current on the output driver and keeps all the output drivers off. Meanwhile, the junction temperature begins to decrease.

The TSD circuit can be deactivated when the junction temperature falls under 150°C, so the output driver begins operating in normal condition. The TSD circuit has the hysteresis temperature of 25°C.

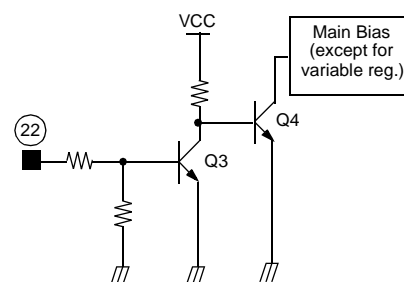


## 3. Power Save Function

When the pin22 is high, the TR Q3 is turned on and Q4 is off, so the bias circuit is enabled. On the other hand, when the pin22 is Low (GND), the TR Q3 is turned off and Q4 is on, so the bias circuit is disabled.

that is, it will make all the circuit blocks except for variable regulator off, so low power quiescent state can be established. Truth table is as follows.

| Pin#22 | FAN8039BD3     |
|--------|----------------|
| High   | Power Save Off |
| Low    | Power Save On  |



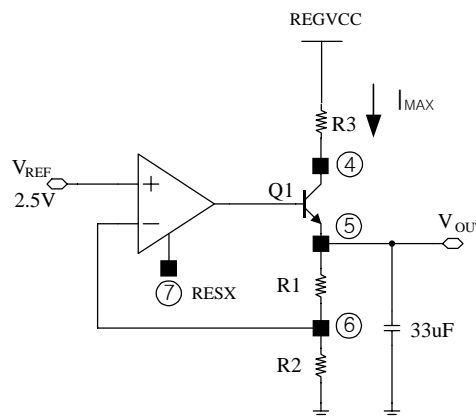
## 4. Variable Regulator

A 33uF capacitor is used as a ripple eliminator in the external circuit. Therefore, output voltage, V<sub>out</sub> can be calculated as follows.

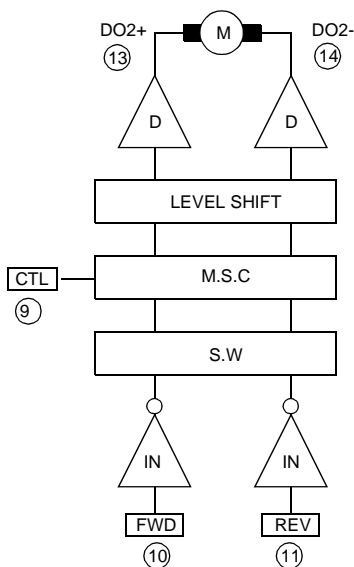
$$V_{OUT} = V_{REF} \cdot \left(1 + \frac{R_1}{R_2}\right) = 2.5 \times 2 = 5V (R_1 = R_2)$$

In order to reduce the heating problem on regulator output TR, Q1, a resistor R3 can be used and calculated as follows.

$$R_3 = \frac{(REGVCC - (V_{out} + 1.5))}{I_{MAX}}$$



## 5. Loading Motor Driver



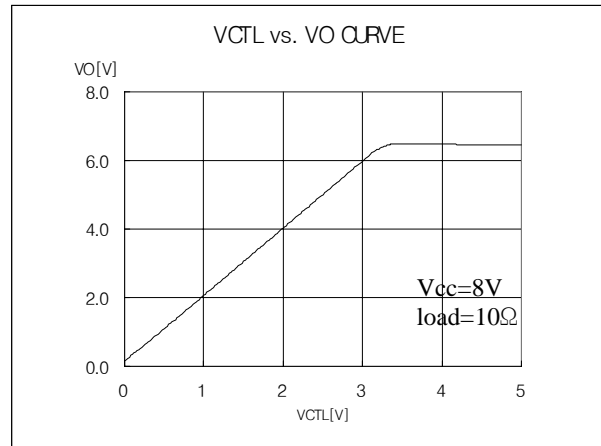
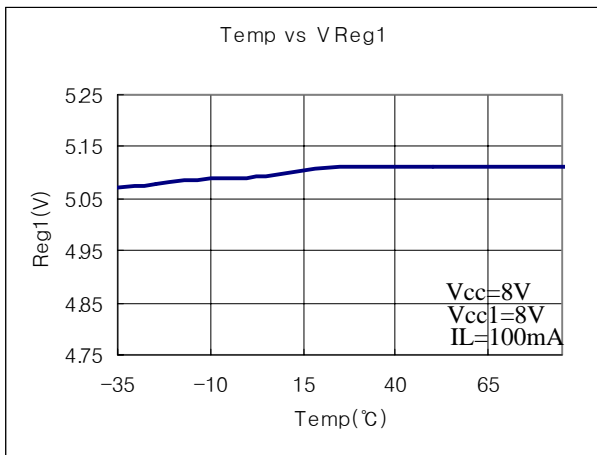
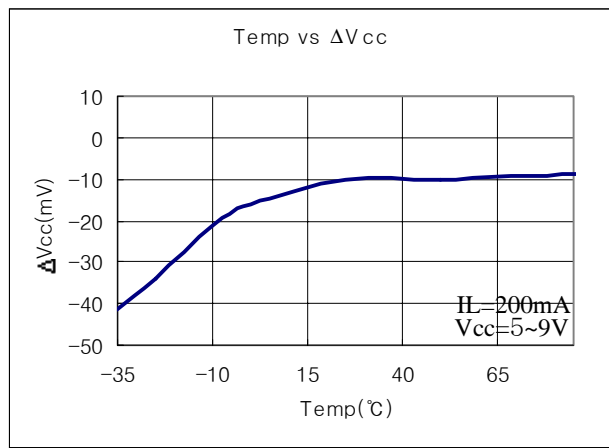
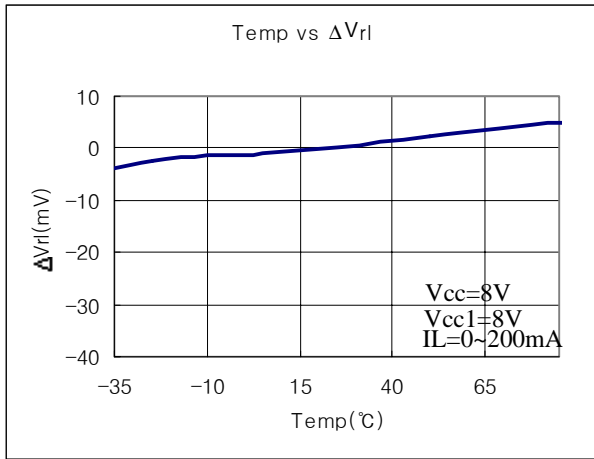
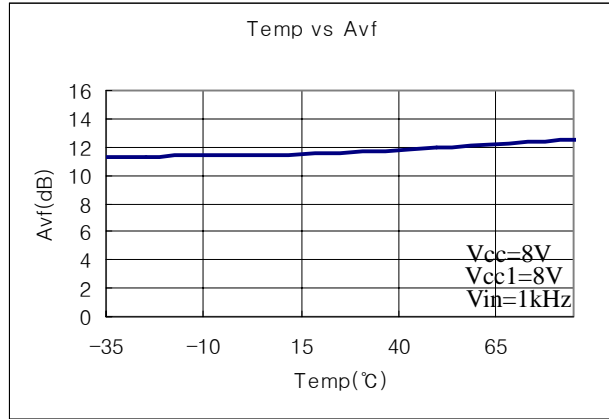
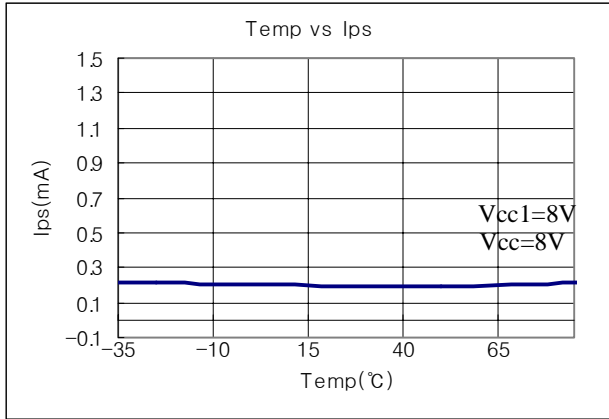
- Rotational direction control

The forward and reverse rotational direction is controlled by FWD (pin10) and REV (pin11) , so the conditions are as follows.

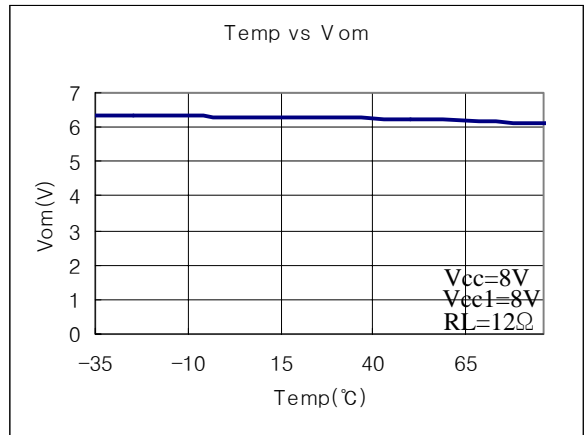
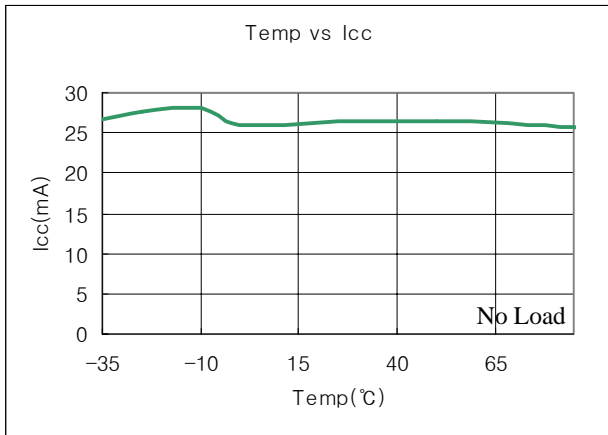
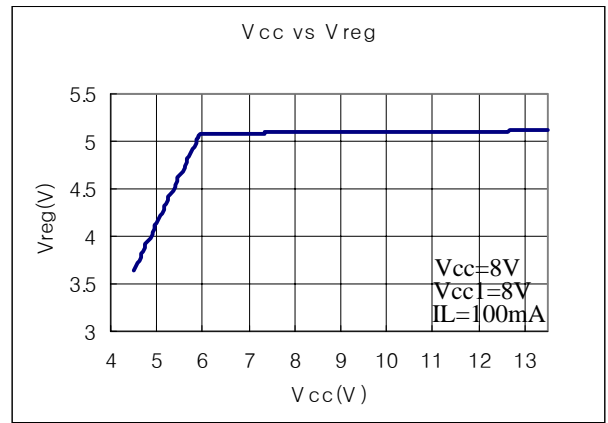
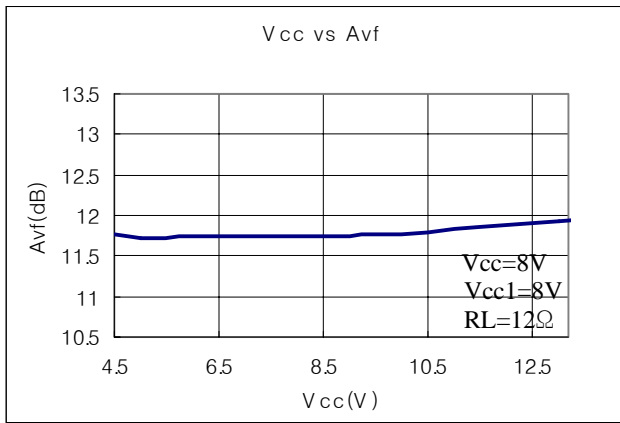
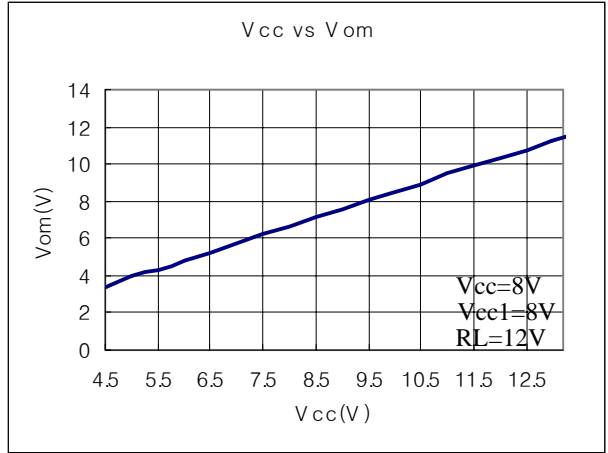
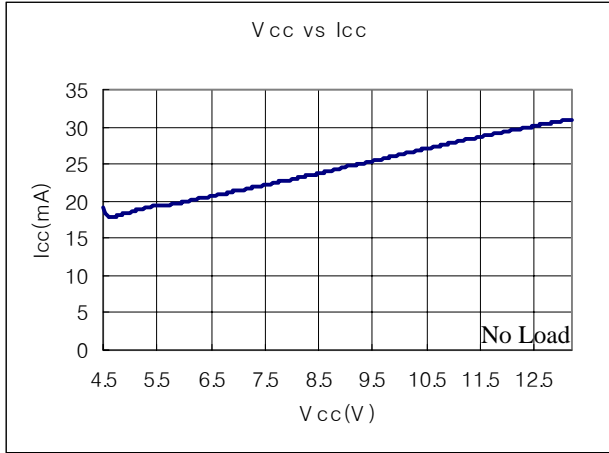
| INPUT |     | OUTPUT |       |                |
|-------|-----|--------|-------|----------------|
| FWD   | REV | OUT 1  | OUT 2 | State          |
| H     | H   | Vp     | Vp    | Short Brake.   |
| H     | L   | H      | L     | Forward        |
| L     | H   | L      | H     | Reverse        |
| L     | L   | Vb     | Vb    | High Impedance |

- Vp(Power Bias voltage) can be approximately 3.75V where Vcc1 and Vcc are 8V.
- Vb(Brake Bias voltage) can be approximately 1.7V where Vcc1 and Vcc are 8V.
- Motor speed control (Where VCC=VCC1=8V)
  - The maximum torque can be obtained when the pin 9(CTL) is open.
  - If the voltage on pin 9(CTL) is 0V, the motor will not be operating.

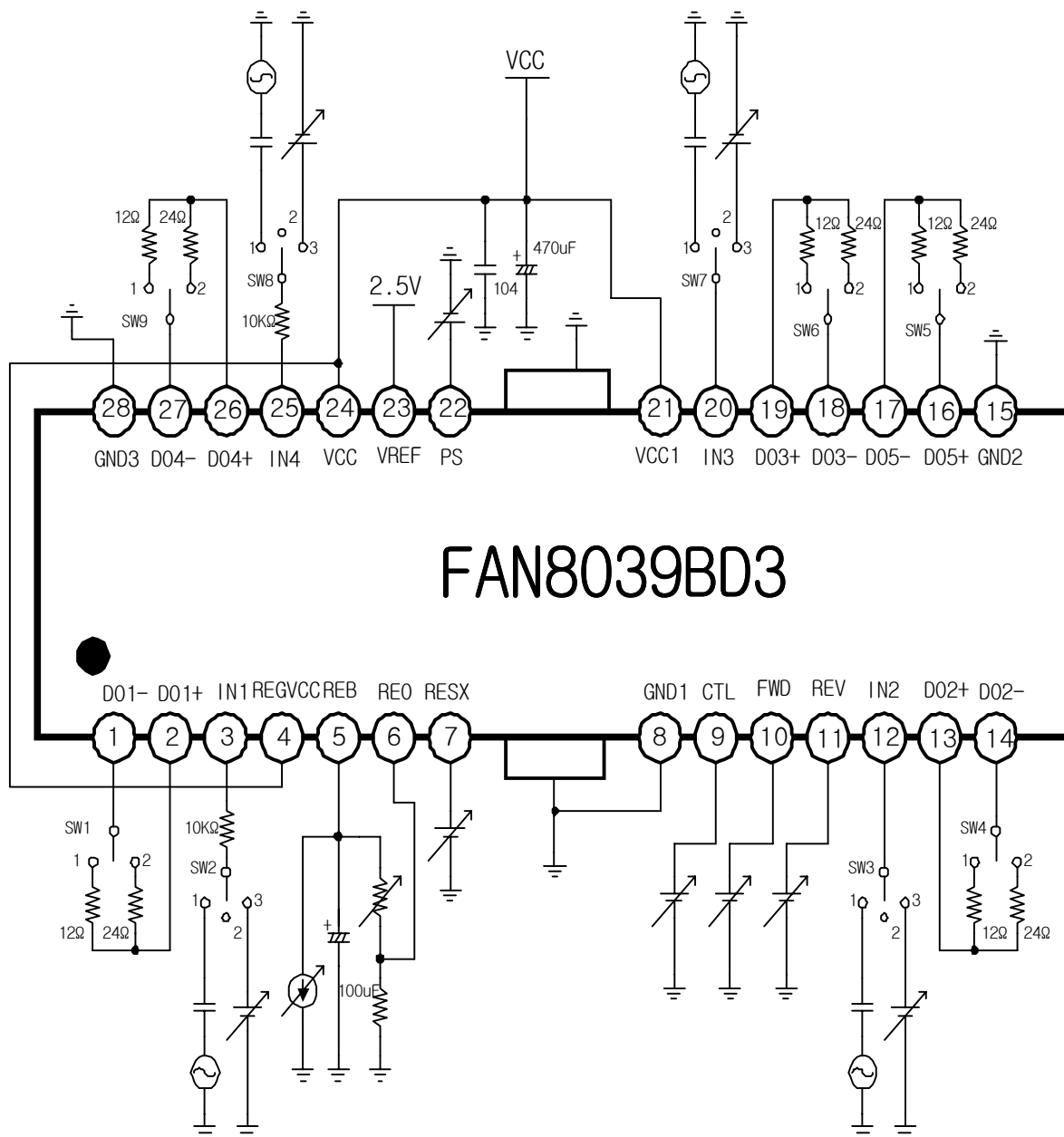
## Typical Performance Characteristics



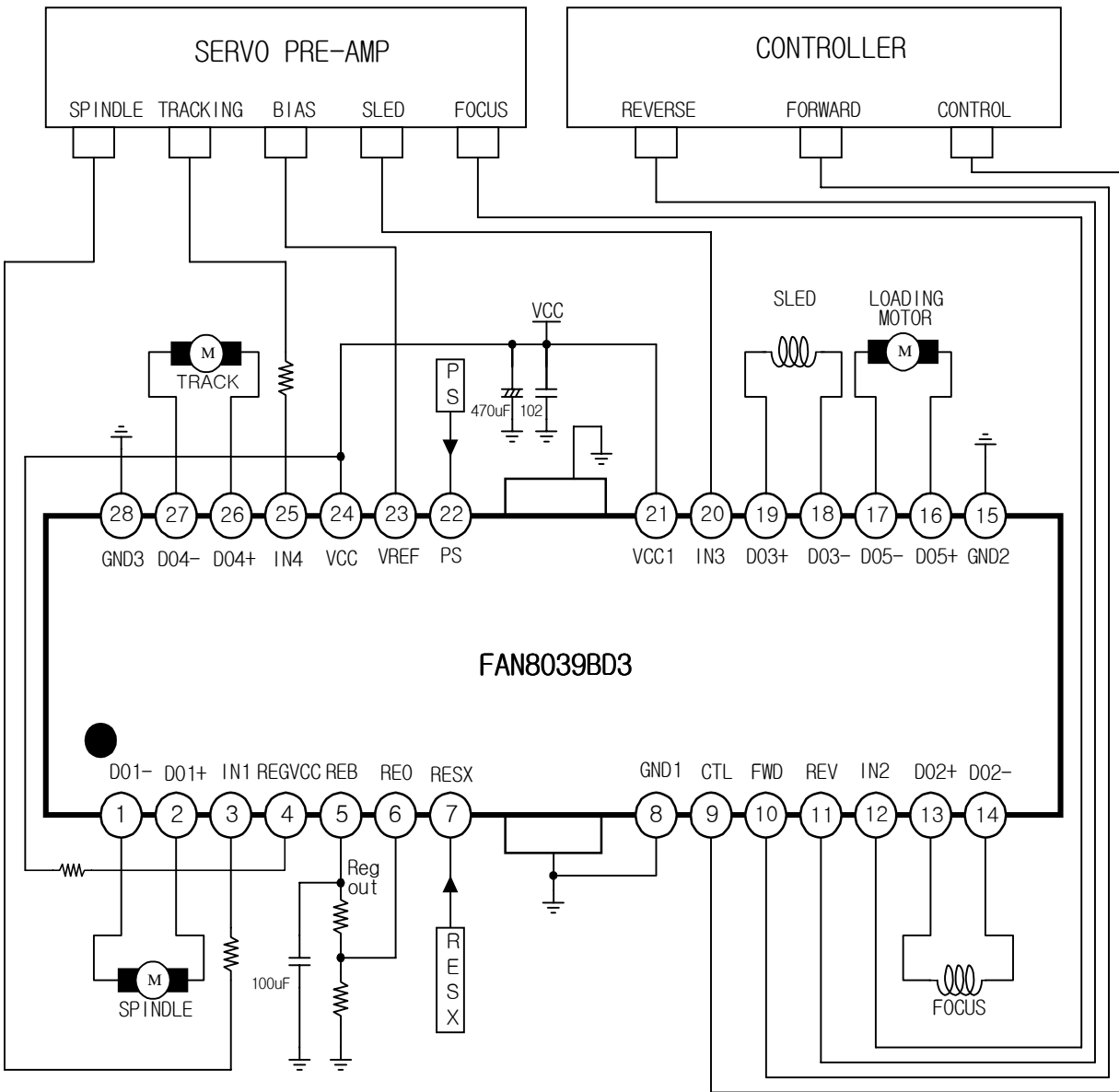
Typical Performance Characteristics(Continued)



## Test Circuit



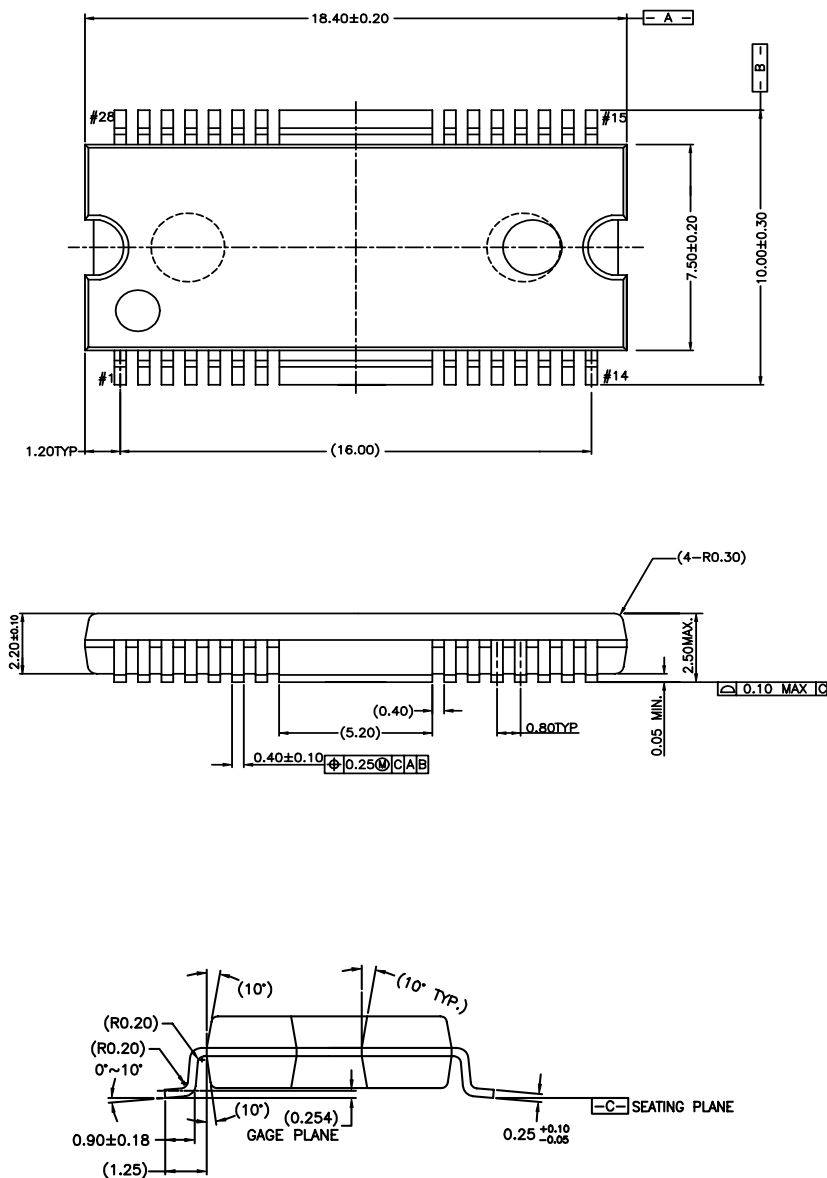
# Application Circuit



# Mechanical Dimensions

## Package

### 28-SSOPH-375-SG2



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