



# FAN8412M/FAN8413M

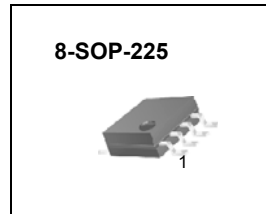
## 2 Phase Half Wave BLDC Motor Predriver

### Features

- A wide range of operation voltage: 4V to 28V
- Locked motor protection with open collector alarm out or speed out and auto retry
- Compact package: 8-SOP-225

### Description

The FAN8412M/FAN8413M is a monolithic integrated circuit, and suitable for DC cooling fan motors predriver.



### Typical Applications

- DC cooling fan motor

### Ordering Information

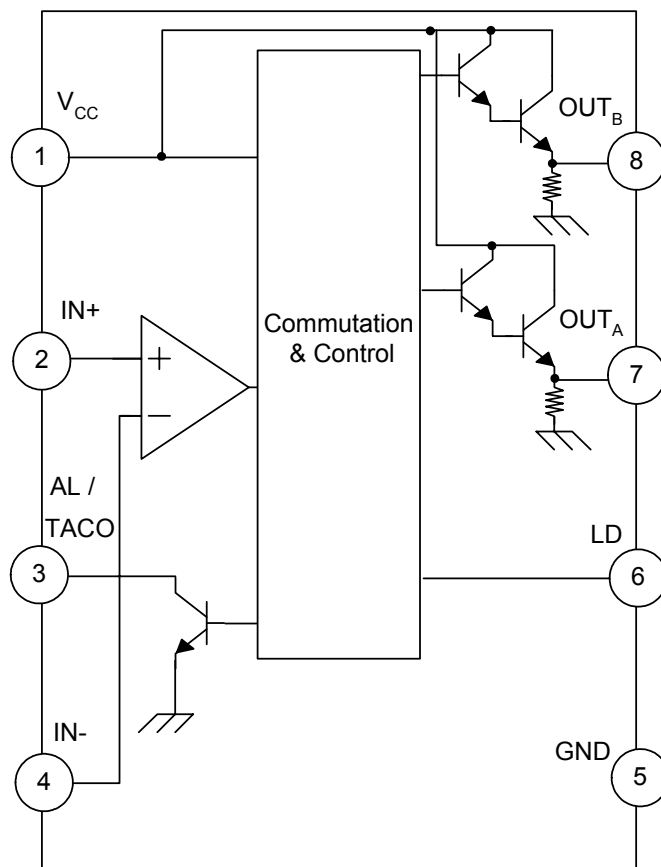
| Device       | Package   | Operating Temp. |
|--------------|-----------|-----------------|
| FAN8412M     | 8-SOP-225 | -40°C ~ 95°C    |
| FAN8412MX    | 8-SOP-225 | -40°C ~ 95°C    |
| FAN8413M     | 8-SOP-225 | -40°C ~ 95°C    |
| FAN8413MX    | 8-SOP-225 | -40°C ~ 95°C    |
| FAN8412M_NL  | 8-SOP-225 | -40°C ~ 95°C    |
| FAN8412MX_NL | 8-SOP-225 | -40°C ~ 95°C    |
| FAN8413M_NL  | 8-SOP-225 | -40°C ~ 95°C    |
| FAN8413MX_NL | 8-SOP-225 | -40°C ~ 95°C    |

#### Note

X : Tape & Reel

NL : Lead Free

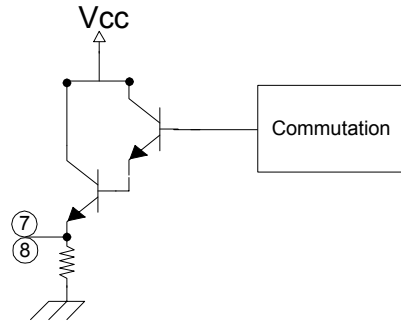
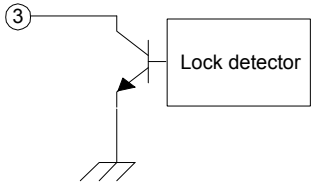
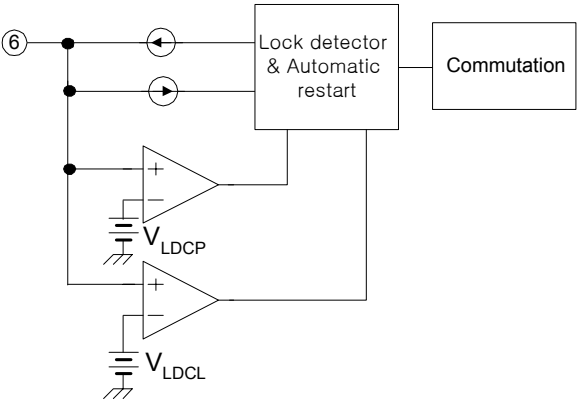
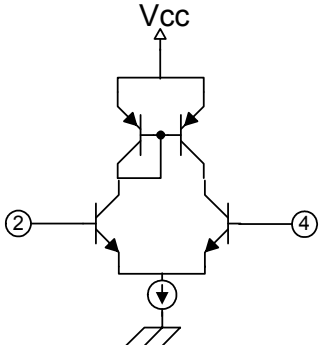
## Block Diagram



## Pin Definitions

| Pin Number | Pin Name | I/O | Pin Function Description   | Remark         |
|------------|----------|-----|--|----------------|
| 1          | VCC      | P   | Supply voltage   | -              |
| 2          | IN+      | A   | Hall input +   | -              |
| 3          | AL       | O   | Alarm output (For FAN8412M)                                      | Open Collector |
|            | TACO     | O   | Speed output (For FAN8413M)                                      | Open Collector |
| 4          | IN-      | A   | Hall input -   | -              |
| 5          | GND      | P   | Ground   | -              |
| 6          | LD       | A   | Triangle pulse generator for lock detector and automatic restart | -              |
| 7          | OUTA     | A   | Motor output A   | -              |
| 8          | OUTB     | A   | Motor output B   | -              |

### Equivalent Circuits

| Description | Pin No. | Internal Circuit   |
|-------------|---------|--|
| OUTA        | 7       |    |
| OUTB        | 8       |  |
| AL / TACO   | 3       |    |
| LD          | 6       |   |
| IN+         | 2       |  |
| IN-         | 4       |  |

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

| Parameter                                  | Symbol            | Value     | Unit |
|--|-------------------|-----------|------|
| Maximum Power Supply Voltage               | VCCMAX            | 32        | V    |
| Maximum Power Dissipation <sup>note1</sup> | PDMAX             | 600       | mW   |
| Thermal Resistance <sup>note1</sup>        | θJA               | 208       | °C/W |
| Maximum Output Voltage                     | VOMAX             | 36        | V    |
| Maximum Output Current                     | IOMAX             | 0.07      | A    |
| Alarm Output Current                       | I <sub>AL</sub>   | 10        | mA   |
| Alarm Output Withstanding Voltage          | V <sub>AL</sub>   | 36        | V    |
| TACO Output Current                        | I <sub>TACO</sub> | 10        | mA   |
| TACO Output Withstanding Voltage           | V <sub>TACO</sub> | 36        | V    |
| Operating Temperature                      | T <sub>OPR</sub>  | -40 ~ 95  | °C   |
| Storage Temperature                        | T <sub>STG</sub>  | -55 ~ 150 | °C   |

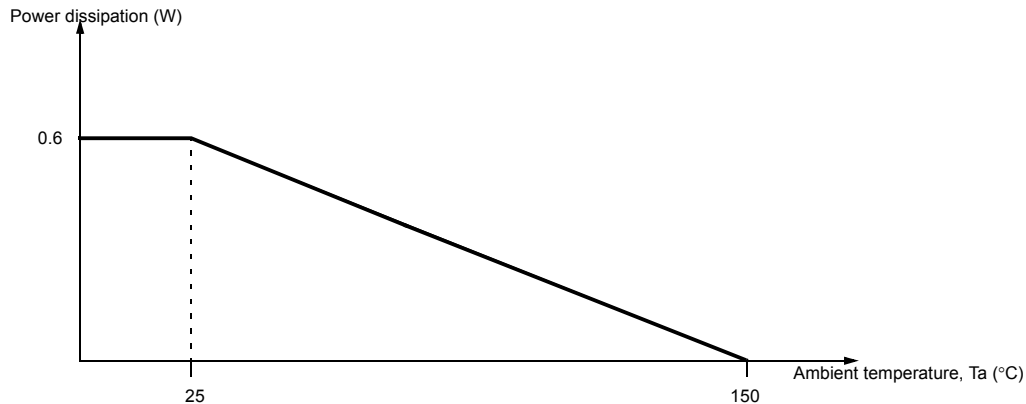
### Note1:

PCB Condition: Thickness (1.6mm), Dimension (76.2mm \* 114.3mm)

Refer: EIA/J SED 51-2 & EIA/J SED 51-3

Should not exceed PD or ASO value

## Power Dissipation Curve (Air condition = 0m/s)



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

| Parameter                               | Symbol | Min. | Typ. | Max. | Unit |
|---|--------|------|------|------|------|
| Function Compensation Operating Voltage | VCC    | 4.0  | –    | 28.0 | V    |

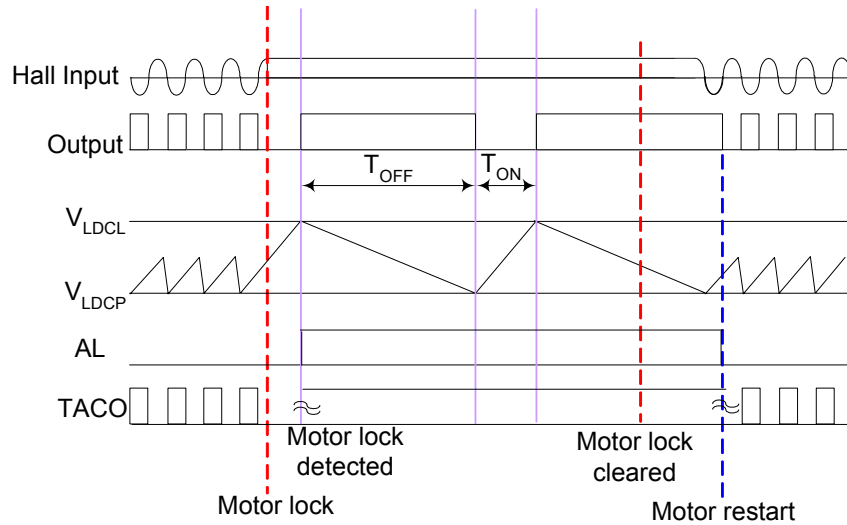
## Electrical Characteristics

(Ta=25°C, VCC=12V unless otherwise specified)

| Parameter                                       | Symbol             | Conditions              | Min. | Typ. | Max.  | Unit |
|---|--------------------|-------------------------|------|------|-------|------|
| <b>TOTAL</b>                                    |                    |                         |      |      |       |      |
| Supply Current                                  | ICC                | When output is off.     | -    | 3.2  | 5.0   | mA   |
| <b>HALL AMPLIFIER INPUT RANGE</b>               |                    |                         |      |      |       |      |
| Pin2,4 Hall Input Range                         | VHDC               | -                       | 1    | -    | Vcc-2 | V    |
| Pin2,4 Hall Input Offset                        | VHOF               | -                       | 15   | -    | -     | mV   |
| <b>LOCK DETECTOR &amp; AUTO RESTART</b>         |                    |                         |      |      |       |      |
| Pin6 Lock Detector Charging Current             | ILDC               | VLD=1.5V                | 2.2  | 3.8  | 5.7   | μA   |
| Pin6 Lock Detector Discharging Current          | ILDD               | VLD=1.5V                | 0.4  | 0.88 | 1.6   | μA   |
| Pin6 Lock Detector Charging/Discharging Ratio   | RCD                | RCD=ILDC/ILDD           | 3    | 5    | 7     | -    |
| Pin6 Lock Detector Capacitor Clamp Voltage      | VLDC               | -                       | 2.54 | 2.94 | 3.34  | V    |
| Pin6 Lock Detector Capacitor Comparator Voltage | VLDCP              | -                       | 0.54 | 0.74 | 0.94  | V    |
| <b>OUTPUT STAGE</b>                             |                    |                         |      |      |       |      |
| Pin7, 8 Output High Level Voltage               | VOH                | IO=10mA                 | 10   | 10.5 | -     | V    |
| Pin7, 8 Output Low Level Voltage                | VOL                | IO=10mA                 | -    | -    | 0.5   | V    |
| <b>AL / TACO OUTPUT</b>                         |                    |                         |      |      |       |      |
| Pin3 Alarm Output Low Level Voltage             | VALL               | IO=10mA                 | -    | 0.2  | 0.5   | V    |
| Pin3 Alarm Output Current Capacity              | I <sub>AL</sub>    | V <sub>AL</sub> =2.0V   | 8    | -    | -     | mA   |
| Pin3 Taco Output Low Level Voltage              | VTACOL             | IO=10mA                 | -    | 0.2  | 0.5   | V    |
| Pin3 Taco Output Current Capacity               | I <sub>TACOL</sub> | V <sub>TACO</sub> =2.0V | 8    | -    | -     | mA   |

## Application Information

### 1. Lock Detection & Automatic Restart



FAN8412M/FAN8413M features a lock detection and an automatic restart. The functions can be operated as follows.

When the rotor is locked, there is no change in input signal of hall amplifier.

A capacitor( $C_{LD}$ ) connected LD pin is continually charged by internal current source ( $I_{LDC}$ ) to internal threshold( $V_{LDCL}$ ).

When the voltage,  $V_{CLD}$  on LD pin, reaches  $V_{LDCL}$ , output power  $T_R$  is turned-off to protect motor during  $T_{OFF}$  and alarm output( $AL$ ) becomes floating high and taco output( $TACO$ ) becomes remain high or low. When the  $V_{CLD}$  reaches upper threshold,  $V_{LDCL}$ ,  $V_{CLD}$  starts to decrease with internal current sink ( $I_{LDD}$ ) to the low threshold,  $V_{LDCLP}$ . At that time, the  $V_{CLD}$  charging repeat until locked condition is removed, or FAN8412M/FAN8413M is power down.

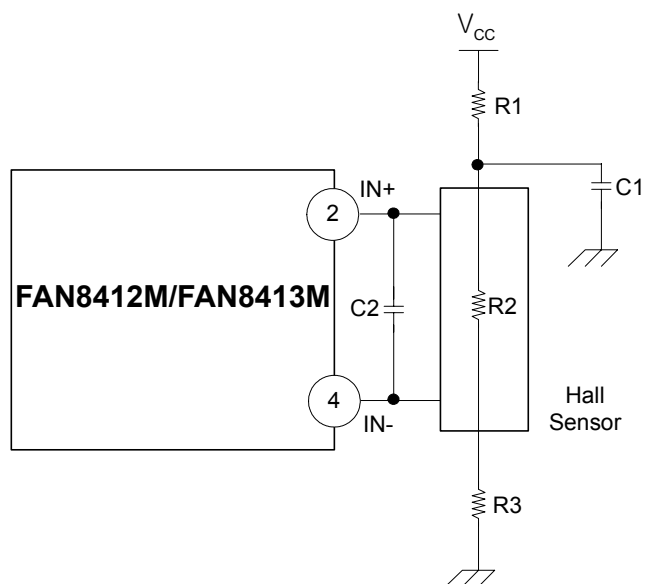
The auto-restart time ( $T_{ON}$ ), the motor protection time( $T_{OFF}$ ) are proportional to external capacitor,  $C_{LD}$  and each value can be calculated as follow;

$$T_{ON} = \frac{C_{LD} \times (V_{LDCL} - V_{LDCLP})}{I_{LDC}}$$

$$T_{OFF} = \frac{C_{LD} \times (V_{LDCL} - V_{LDCLP})}{I_{LDD}}$$

For example,  $C_{LD}=1\mu F$ , then  $T_{ON}=0.57\text{Sec}$ ,  $T_{OFF}=2.2\text{Sec}$ . This  $AL$  or  $TACO$  output can be used to inform a locked rotor condition or speed information to super IO or system controller. Because the  $AL$  or  $TACO$  output is open collector type, end user can pull up this pin with a external resistor to the supply voltage of their choice(that is 5 or 3.3V).

## 2. Hall Amplifier Input Block



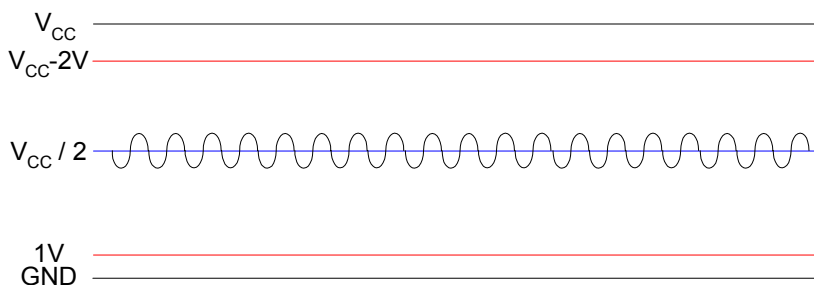
The hall current ( $I_H$ ) is determined by R1, R2 and R3.

$$I_H = \frac{V_{CC}}{R1 + R2 + R3}$$

Where, the R2 is the impedance of hall sensor.

An external capacitor, C1, can be used to reduce a power supply noise. In addition, C2 is to remove a noise which is caused in case the line is long from the hall sensor output to the hall input (pin 2 / 4) of the device.

The input bias voltage of hall amplifier is between 1V and  $V_{CC}-2V$  as following figure.

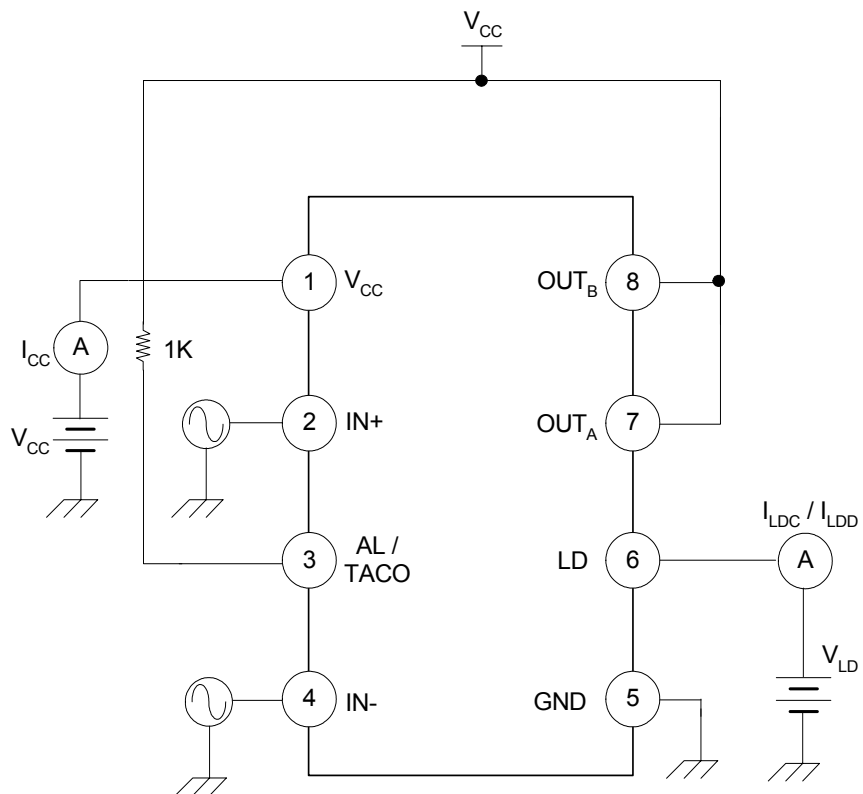


It is recommended that R1 and R3 should have the same value to make the output signal of hall sensor centered as  $V_{CC}/2$ .

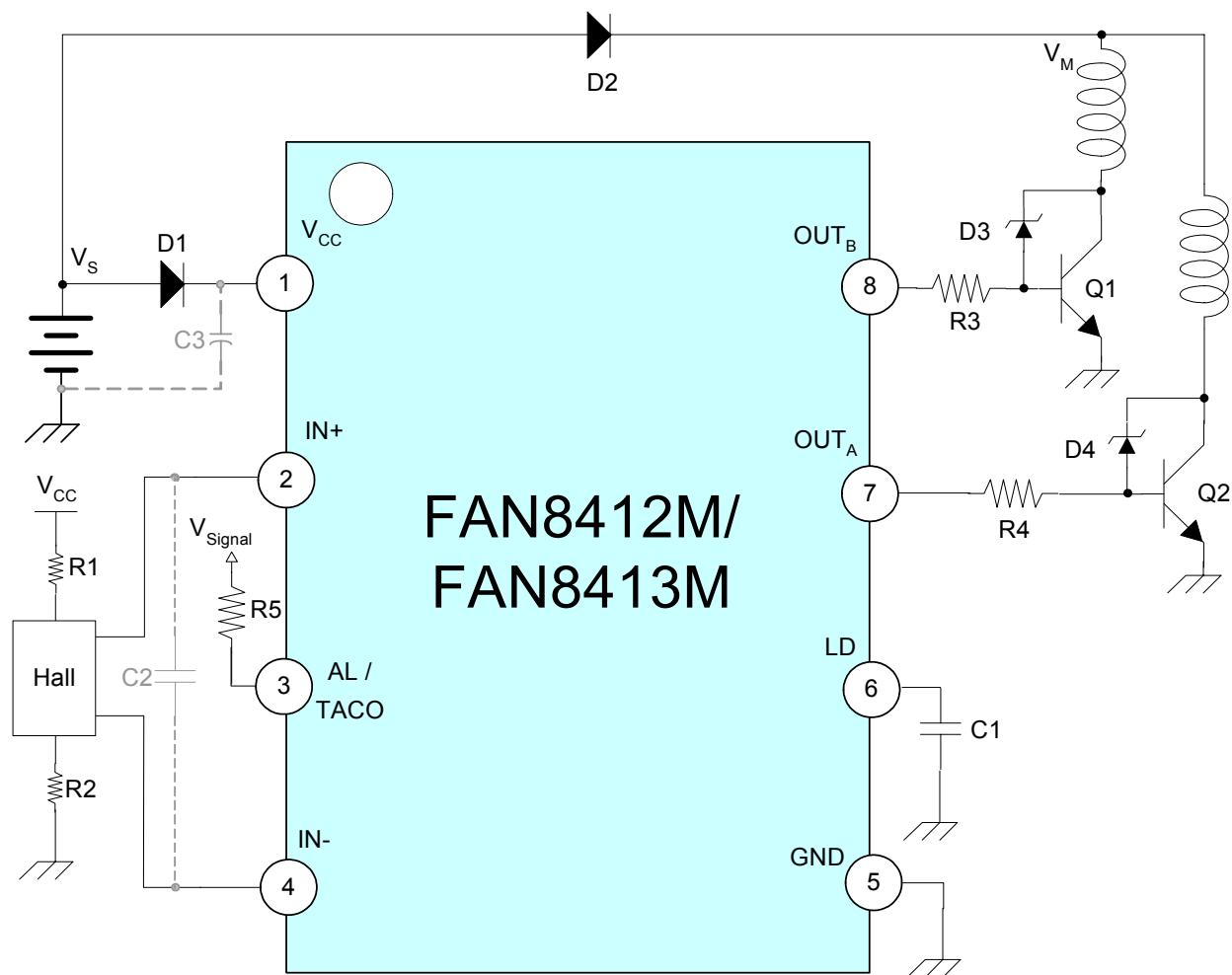
### Operation Truth Table

| IN+         | IN-         | OUT <sub>A</sub> | OUT <sub>B</sub> | AL   | TACO        | Remark   |
|-------------|-------------|------------------|------------------|------|-------------|----------|
| High        | Low         | High             | Low              | Low  | High        | Rotating |
| Low         | High        | Low              | High             | Low  | Low         |          |
| Low or High | Low or High | Low or High      | Low or High      | High | Low or High | Lock     |

### Test Circuits

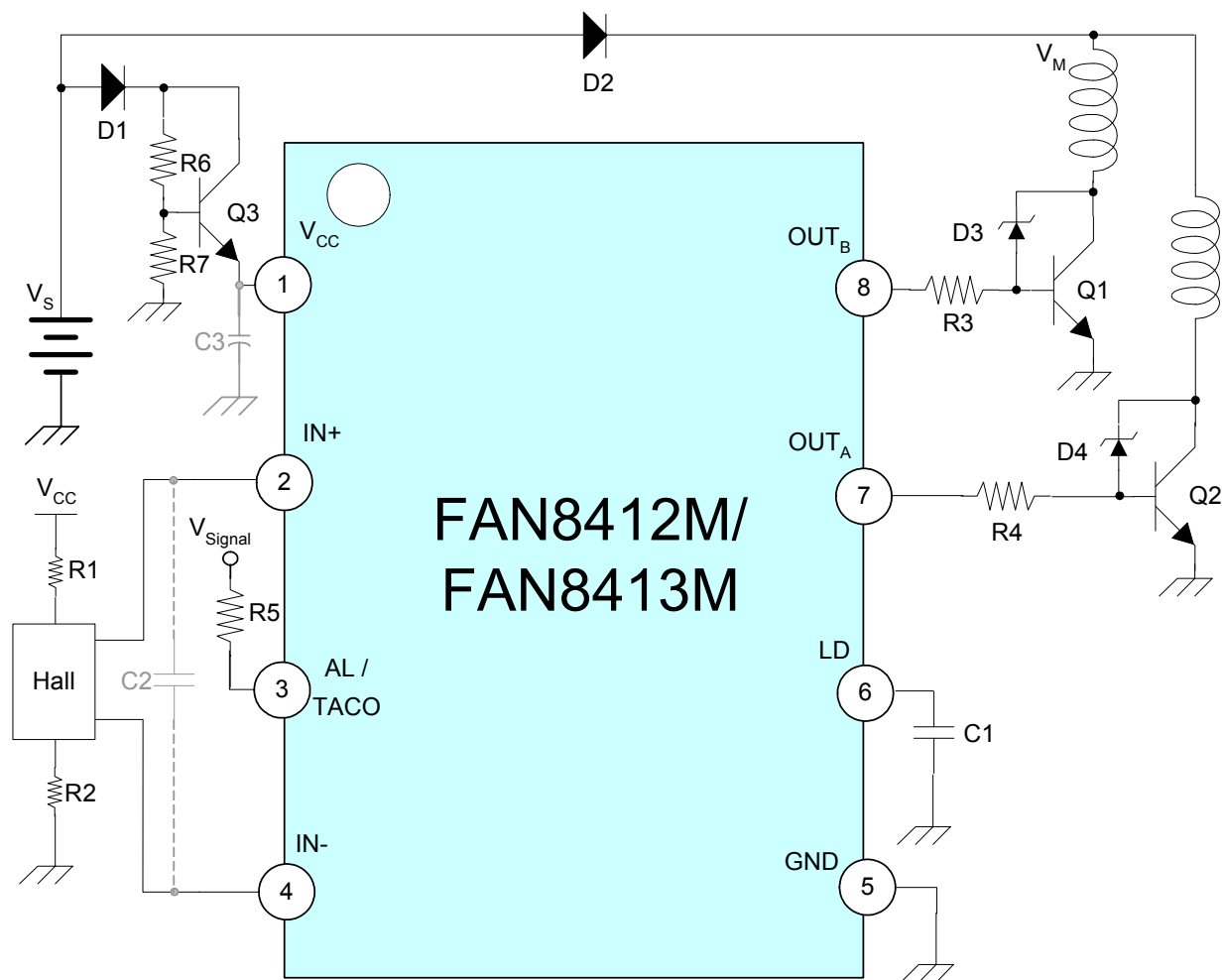


## Typical Application Circuits1 (12V / 24V)



- 1.D1 : A reverse protection diode for IC.
  - 2.D2 : A reverse protection diode for motor coil.
  - 3.D3/D4 : Zener diode for freewheeling.
  - 4.R1/R2 : A resistor to set DC hall bias level.
  - 5.R3/R4 : A resistor to limit a base current of external power TR.
  6. R5 : A pull-up resistor for taco output signal when a fan motor is locked.
  7. C1 : A Capacitor for lock protection and detection of a fan motor.
- If lock protection and detection functions are not necessary , LD pin should be connect ground.
- 8.C2 : A capacitor to reduce a noise in hall input stage. This is not necessary in case of no noise.
  - 9.C3 : This is not necessary in case the stable input on V<sub>CC</sub> is provided.
  - 10.Q1/Q2 : An external power TR .

## Typical Application Circuits2 (48V)

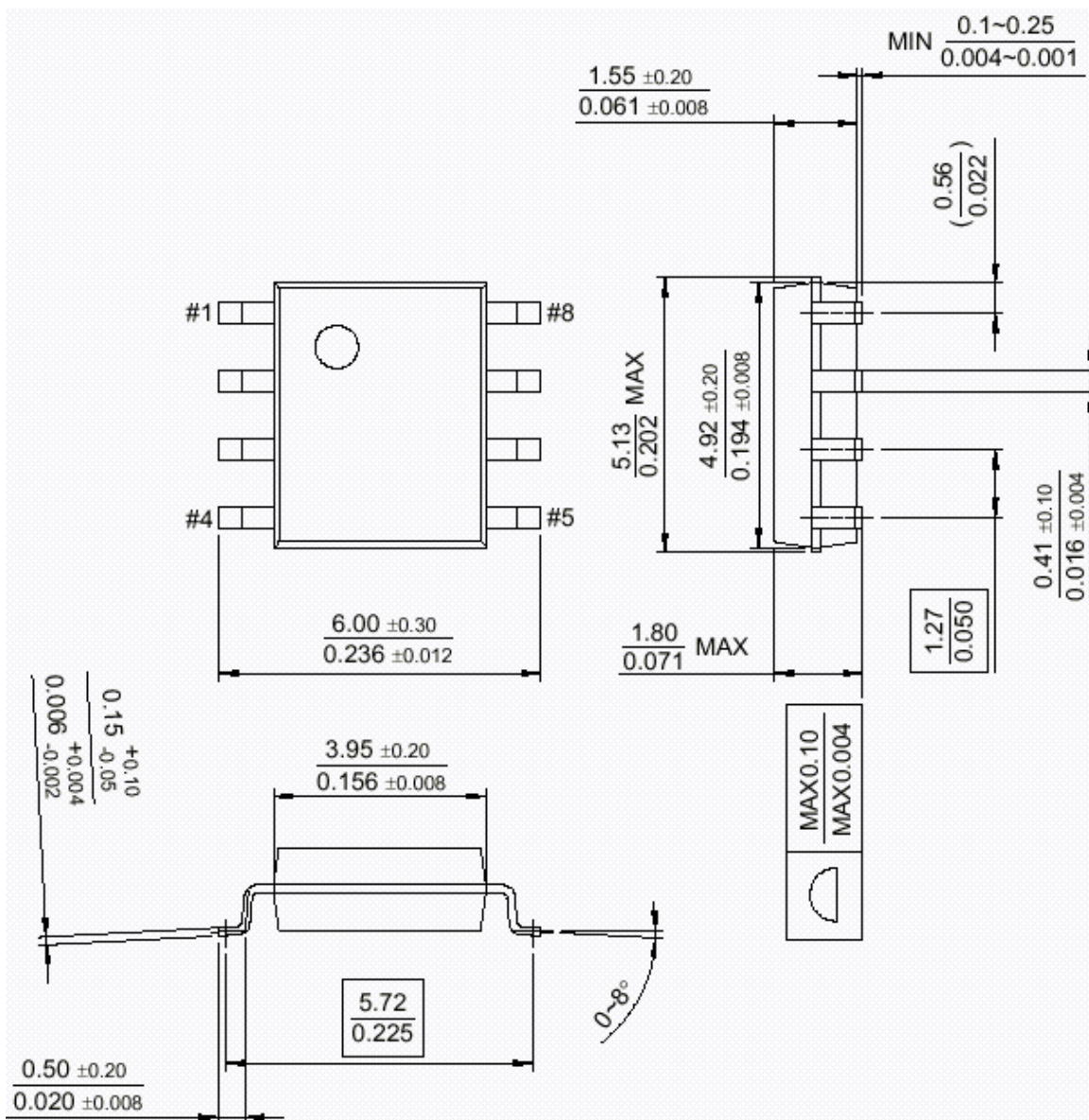


- 1.D1 : A reverse protection diode for IC.
  - 2.D2 : A reverse protection diode for motor coil.
  - 3.D3/D4 : Zener diode for freewheeling.
  - 4.R1/R2 : A resistor to set DC hall bias level.
  - 5.R3/R4 : A resistor to limit a base current of external power TR.
  - 6.R5 : A pull-up resistor for taco output signal when a fan motor is locked.
  - 7.R6/R7 : A resistor to set a output voltage of TR(Q3).
  - 8.C1 : A Capacitor for lock protection and detection of a fan motor.
- If lock protection and detection functions are not necessary , LD pin should be connect ground.
- 9.C2 : A capacitor to reduce a noise in hall input stage. This is not necessary in case of no noise.
  - 10.C3 : This is not necessary in case the stable input on VCC is provided.
  - 11.Q1/Q2 : An external power TR .
  - 12.Q3 : An external power TR to control output voltage.

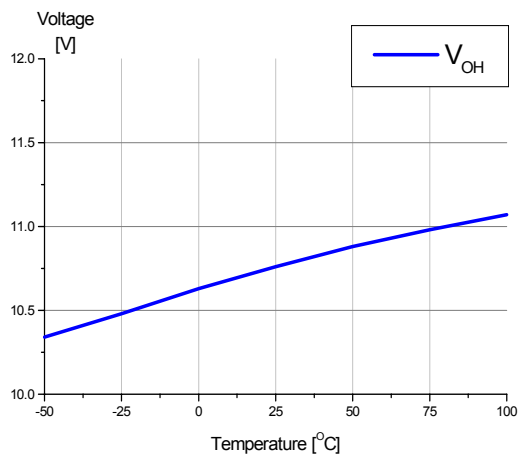
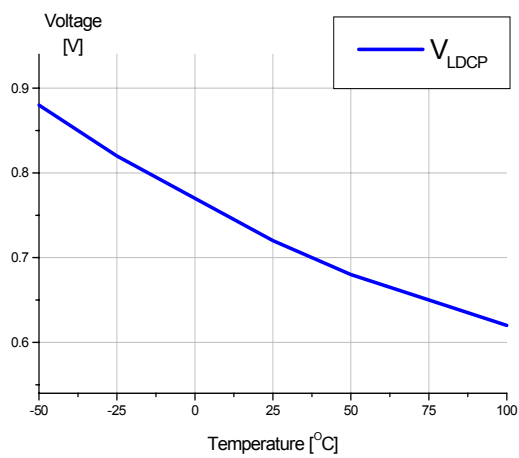
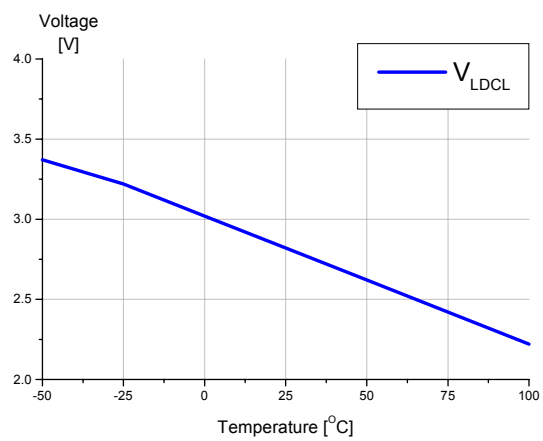
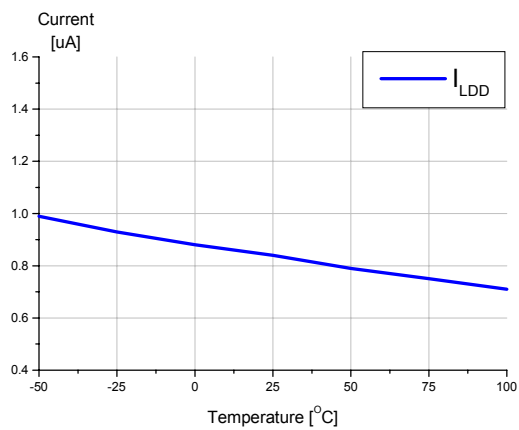
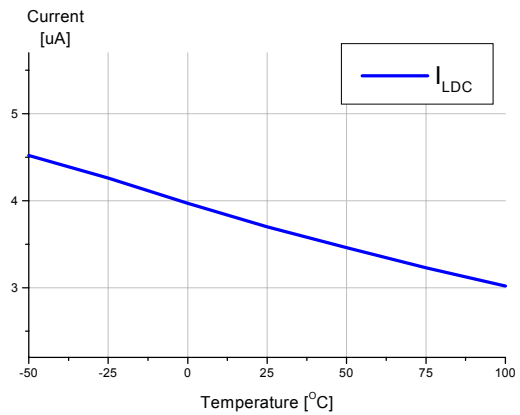
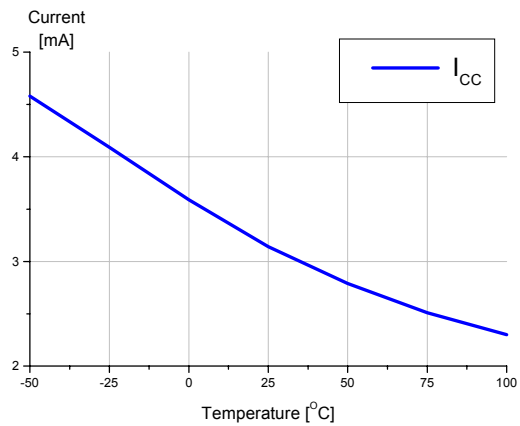


Package Dimensions (Unit: mm)

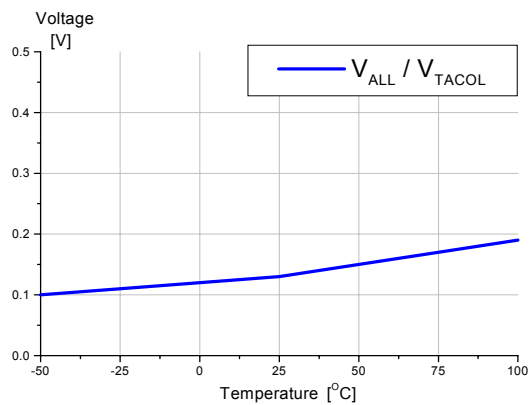
8-SOP Lead Free



## Typical Performance characteristics



## Typical Performance characteristics(Continued)





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