

# **FD178A/FD178B/FD178C**

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*Single Coil Brushless DC Motor Drivers with  
Soft-Switching and PWM control  
( 2 to 6.5 Volts )*



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## General Specifications

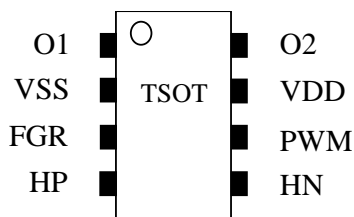
Designed for rotation speed control of single coil DC brushless fans, the FD178 series motor drivers minimize external component count and integrate all the key features required for high efficiency and low noise fans. Specifically PWM control and soft switching are provided to control the rotation speed and reduce the audible noise. Internal circuit protection includes thermal shutdown with hysteresis, rotor lock protection, and reverse power polarity protection. Three frequency generation (FGR pin) options are provided for different fan configurations - FG (FGR signal following Hall sensor output frequency), FG/2 (divided by two version of FG), and RD (rotation detection) for FD178A, FD178B, and FD178C respectively.

## Features and Benefits

- Support single-phase full wave Brushless DC Motor Driver
- Built-in Hall sensor input signal amplifier
- PWM control circuit
- Low voltage startup (VDD=2V)
- High driving capability
- Lock detection and automatic self-restart
- Power polarity reverse protection
- Thermal shut down protection circuit
- Thin, compact, highly reliable package (TSOT-28)

## Pin Description

FD178A/FD178B/FD178C : TSOT-28



Package : TSOT-28

| NO. | NAME | DESCRIPTION  |
|-----|------|--|
| 1   | O1   | Output driving & sinking pin 1   |
| 2   | VSS  | Ground pin   |
| 3   | FGR  | Frequency generator or rotating detector<br>FD178 : FG<br>FD178B : FG/2<br>FD178C : RD |
| 4   | HP   | Hall sensor in+  |
| 5   | HN   | Hall sensor in-  |
| 6   | PWM  | PWM control pin  |
| 7   | VDD  | Power supply pin   |
| 8   | O2   | Output driving & sinking pin 2   |

## Absolute Maximum Ratings

( Unless otherwise noted, VDD=5V, T<sub>A</sub> = 25 °C )

| Characteristic                          | Symbol                 | Rating    | Unit  |
|---|------------------------|-----------|-------|
| Supply Voltage                          | V <sub>DDM</sub>       | 6.5       | V     |
| Operation Current                       | I <sub>OUT</sub>       | 500       | mA    |
| Output Current at Locked (TSOT-28)      | I <sub>OL1</sub>       | 1         | A     |
| Maximum FGR Output Current              | I <sub>FGR_MAX</sub>   | 10        | mA    |
| Maximum FGR Output Voltage              | V <sub>FGR_MAX</sub>   | 6.5       | V     |
| Operating Temperature Range             | T <sub>OPR</sub>       | -30 ~ 85  | °C    |
| Storage Temperature Range               | T <sub>STG</sub>       | -65 ~ 150 | °C    |
| Power Dissipation (TSOT-28)             | P <sub>D</sub>         | 568       | mW    |
| Thermal Resistance, Junction to Ambient | θ <sub>JA_TSOT28</sub> | 220       | °C/ W |
| Thermal Resistance, Junction to Case    | θ <sub>JC_TSOT28</sub> | 92        | °C/ W |
| Maximum Junction Temperature            | T <sub>j(max)</sub>    | 150       | °C    |

## Electrical Characteristics

( Unless otherwise noted, VDD=5V, T<sub>A</sub> = 25 °C )

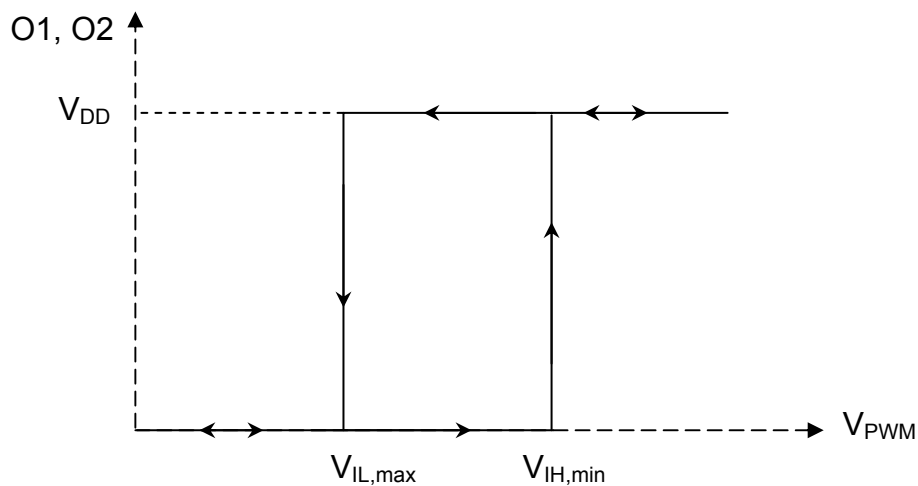
| Characteristic                             | Sym.                | Condition                 | Limit   |      |         | Unit |
|--|---------------------|---------------------------|---------|------|---------|------|
|  |                     |                           | Min.    | Typ. | Max.    |      |
| Operation Voltage                          | V <sub>DD</sub>     | -                         | 2       | 5    | 6.5     | V    |
| Supply Current                             | I <sub>CC</sub>     | -                         |         | 3    | 5       | mA   |
| Maximum Output Voltage Range               | V <sub>OH</sub>     | I <sub>OUT</sub> = 250 mA | 4.5     | 4.65 | -       | V    |
| Minimum Output Voltage Range               | V <sub>OL</sub>     | I <sub>OUT</sub> = 250 mA | -       | 0.35 | 0.5     | V    |
| FG Output Low Voltage                      | V <sub>FGROL</sub>  | I <sub>FGR</sub> = 5 mA   | -       | 0.25 | 0.4     | V    |
| Hall Amplifier Offset                      | V <sub>Offset</sub> | -                         | -9      | 0    | 9       | mV   |
| Input-Output Gain                          | G <sub>IO</sub>     | -                         | 45      | 48   | 51      | dB   |
| Automatic self-restart                     |                     |                           |         |      |         |      |
| Lock detection on Time                     | T <sub>ON</sub>     | -                         | 110     | 150  | 190     | ms   |
| Lock detection off Time                    | T <sub>OFF</sub>    | -                         | 0.75    | 1.05 | 1.35    | Sec  |
| PWM signal control                         |                     |                           |         |      |         |      |
| PWM input frequency                        | V <sub>PWM</sub>    | -                         | -       | 25   | 50      | KHZ  |
| PWM input high level voltage <sup>*1</sup> | V <sub>IH</sub>     | -                         | 0.55VDD | VDD  | VDD+0.4 | V    |
| PWM input low level voltage <sup>*1</sup>  | V <sub>IL</sub>     | -                         | -0.3    | 0    | 0.2VDD  | V    |
| Hall signal output                         |                     |                           |         |      |         |      |
| Hall average output DC voltage             | V <sub>DC</sub>     | -                         | 400     | -    | -       | mV   |
| Hall amplitude of waveform voltage         | V <sub>Am</sub>     | -                         | 150     | -    | -       | mV   |

<sup>\*1</sup> Description in the page4 "PWM input high and low level voltage"

| Thermal shut down protection circuit |  |   |     |     |     |    |
|--------------------------------------|--|---|-----|-----|-----|----|
| Shut down temperature                |  | - | 160 | 180 | 200 | °C |
| Release temperature                  |  | - | 120 | 140 | 160 | °C |

### Truth Table

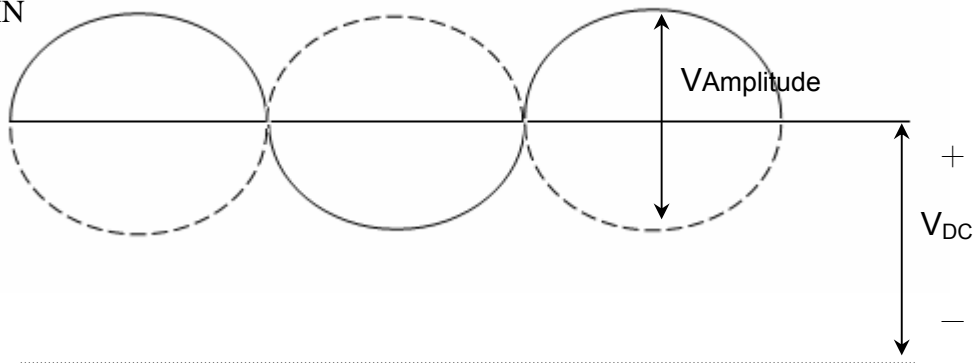
| PWM | Hall input | O1 | O2 |
|-----|------------|----|----|
| L   | X          | L  | L  |
| H   | HP > HN    | H  | L  |
| H   | HP < HN    | L  | H  |



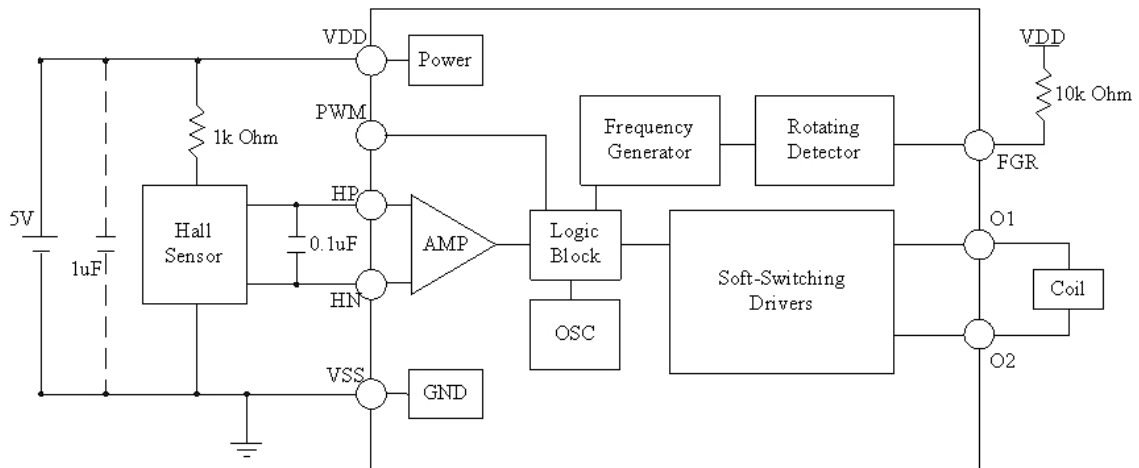
## Hall Signal

- For a stable operation, the Hall sensor output is required to meet the following conditions.
  - (a) The DC level of Hall signal is greater than 400 mV
  - (b) The amplitude of Hall signal is greater than 150mV

HP or HN

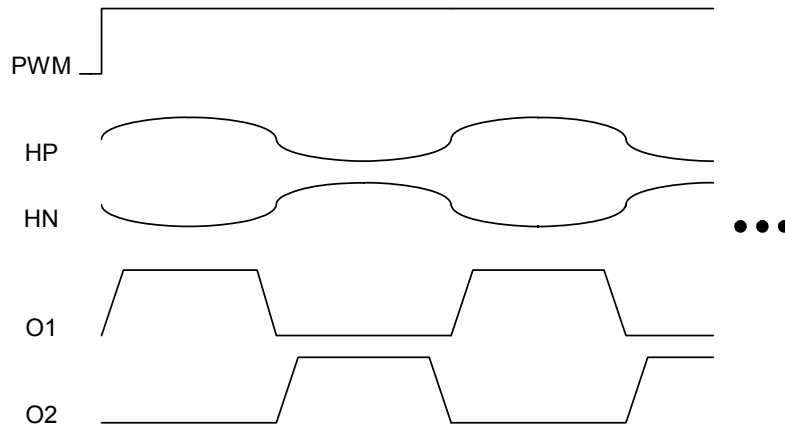


## Application Circuit

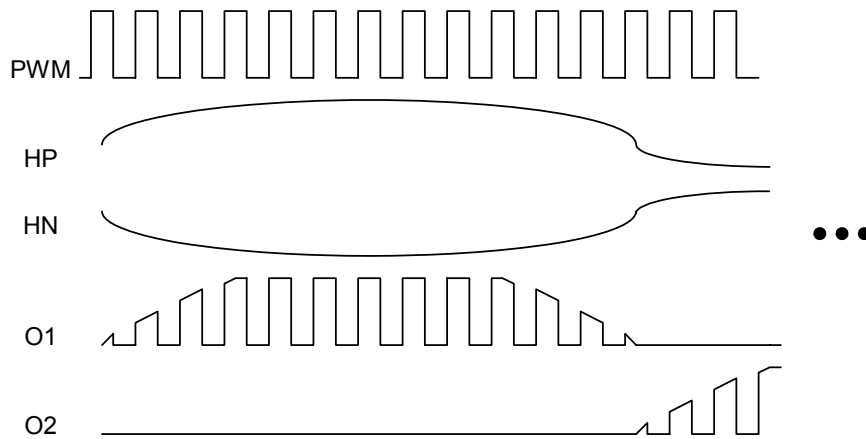


- The connection of the capacitor between VDD and GND will increase stability of operation, if required.

## Output Waveform



## PWM control

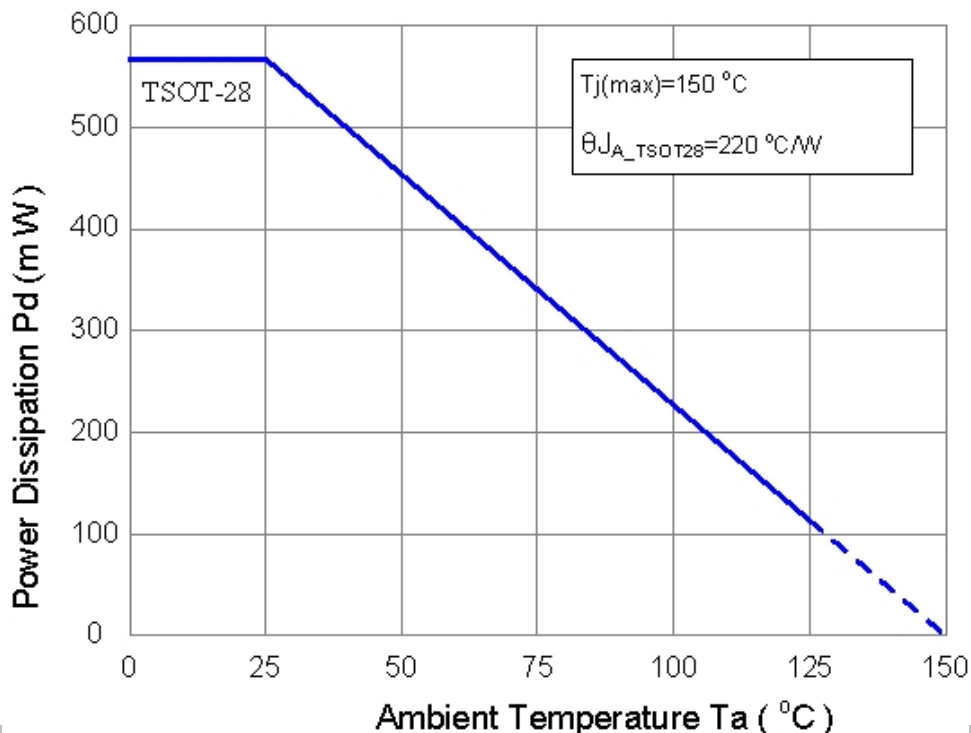


## Application Notes

- The device can be operated with a wide supply voltage ranging from 2 to 6.5 Volts. However, the design, specifications, and performance have been optimized for 5V brushless dc motor applications.
- The output driver node O1/O2 are in drive/sink state when V(HP) > V(HN) and vice versa
- The lock and auto-restart do not require an external capacitor for a timing counting purpose. The driver will be shutdown approximately 1 second after the motor is lock and the auto-restart is activated every one second until the lock is released.
- Eliminating an external protection diode, a power polarity reverse circuit is integrated on the chip.
- A 1uF capacitor between VDD and GND as well as a 0.1uF between HP and HN are strongly recommended for a reliable and noise immune operation.
- The power dissipated by the chip varies with the supply voltage. It is advisable to ensure the power dissipation by the chip does not exceed the thermal requirement dictated by the package. The maximum allowable power consumption can be calculated by the following equation:

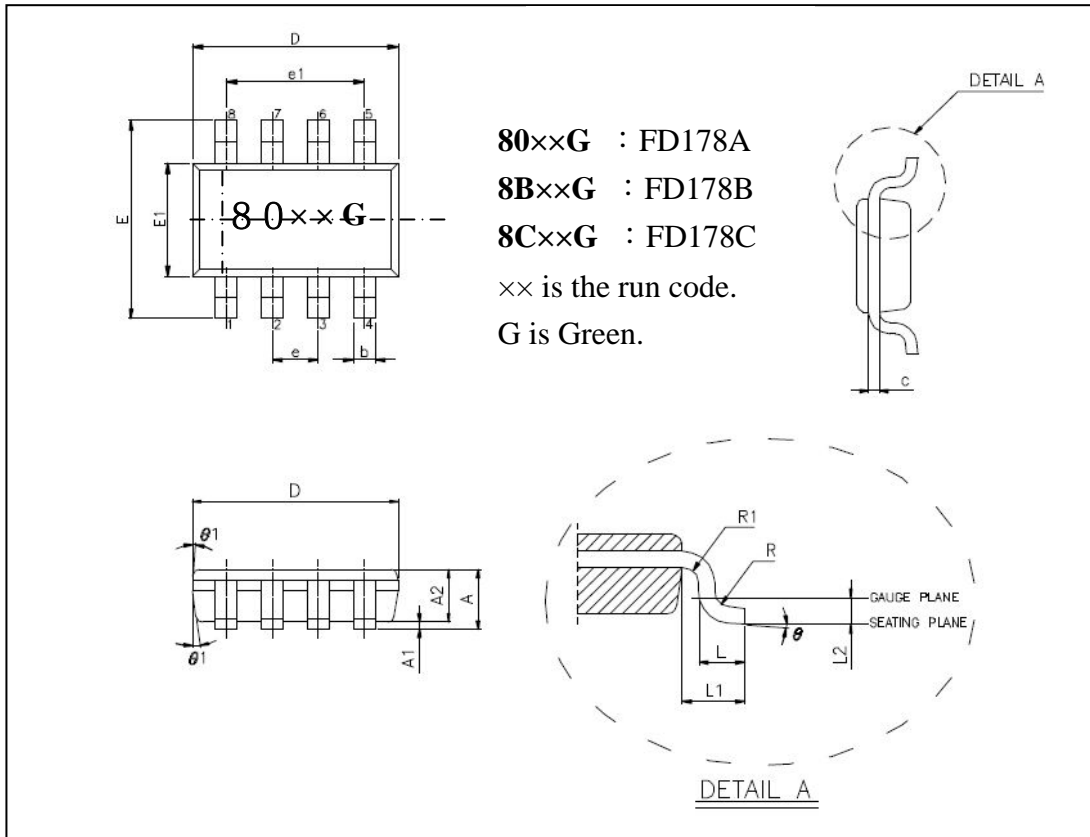
$$Pd(\text{Power Dissipation})(\text{Watt}) = \frac{Tj(\text{Junction Temperature})(\text{max})(^{\circ}\text{C}) - Ta(\text{Ambient Temperature})(^{\circ}\text{C})}{\theta_{JA}(\text{Thermal Resistance, Junction to Ambient})(^{\circ}\text{C}/\text{Watt})}$$

The relationship between power dissipation and operating temperature can refer to the figure below:





**Package Specifications**  
**FD178 : TSOT-28**



**VARIATION (ALL DIMENSIONS SHOWN IN MM)**

| SYMBOL | MIN.      | NOM.  | MAX.  |
|--------|-----------|-------|-------|
| A      | 0.750     | -     | 0.800 |
| A1     | 0         | -     | 0.050 |
| A2     | 0.700     | 0.750 | 0.775 |
| b      | 0.220     | -     | 0.380 |
| c      | 0.100     | -     | 0.200 |
| D      | 2.800     | 2.900 | 3.000 |
| E      | 2.600     | 2.800 | 3.000 |
| E1     | 1.500     | 1.600 | 1.700 |
| e      | 0.650 BSC |       |       |
| e1     | 1.950 BSC |       |       |
| L      | 0.370     | 0.450 | 0.600 |
| L1     | 0.600 REF |       |       |
| L2     | 0.250 BSC |       |       |
| R      | 0.100     | -     | -     |
| R1     | 0.100     | -     | 0.250 |
| θ      | 0°        | 4°    | 8°    |
| θ1     | 4°        | 10°   | 12°   |

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