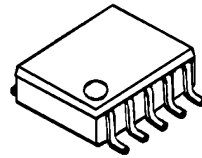


# Single-phase DC Brushless Motor Driver IC

## ■ GENERAL DESCRIPTION

The NJU7333 is a single-phase DC brushless motor driver IC for small fan-motor and high power applications. It features MOS-FET driver circuit for better saturation characteristics. Slew rate of amplifiers and feedback resistors are optimized to achieve low-noise motor operation. Maximum output current is 500mA. The NJU7333 includes frequency generator (FG) output, lock detect (with auto recovery circuit), and a thermal shutdown circuit.

## ■ PACKAGE OUTLINE

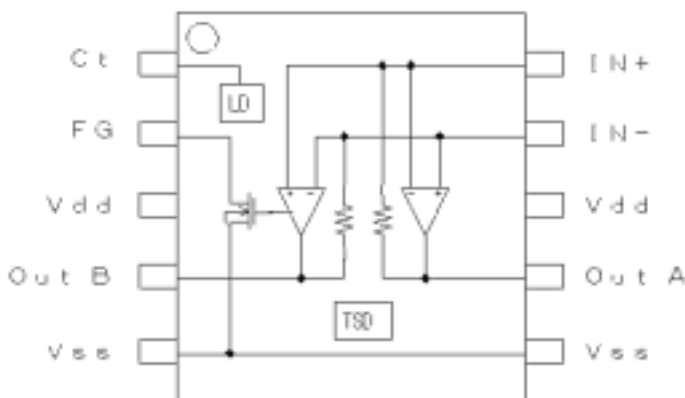


NJU7333R

## ■ FEATURES

- Operating Voltage  $V_{DD}=2.4 \sim 5.5V$
- FG Output
- Internal Lock Detect / Auto Recovery Circuit
- Internal Thermal Shutdown Circuit
- Low Operating Current  $I_{DD}=3mA$  (Typ.)
- Low Saturation Output Voltage  
 $V_{sat}=\pm 0.35V$  @  $I_o=\pm 500mA$
- C-MOS Technology
- Package Outline VSP10

## ■ BLOCK DIAGRAM



## ■ PIN FUNCTION

- 1: Ct
- 2: FG
- 3: Vdd
- 4: OUT B
- 5: Vss
- 6: Vss
- 7: OUT A
- 8: Vdd
- 9: IN-
- 10: IN+

# NJU7333

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## ■ ABSOLUTE MAXIMUM RATINGS

(Ta=25°C)

PARAMETER	RATINGS	SYMBOL (unit)	NOTE
Supply Voltage	+7.0	V <sub>DD</sub> (V)	
Input Voltage	-0.3 ~ V <sub>DD</sub> +0.3	V <sub>ID</sub> (V)	
Output Current (Peak)	1.0	I <sub>O PEAK</sub> (A)	
Operating Temperature Range	-40 ~ +85	T <sub>opr</sub> (°C)	
Storage Temperature Range	-50 ~ +150	T <sub>stg</sub> (°C)	
Power Dissipation	400	P <sub>D</sub> (mW)	Device itself

## ■ RECOMMENDED OPERATING CONDITIONS

(V<sub>DD</sub>=5V, Ta=25°C)

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V <sub>DD</sub>	-	2.4	5.0	5.5	V
Operating Temperature Range	T <sub>j</sub>	-	-40	-	85	°C
Input Common Mode Voltage Range	V <sub>ICM</sub>	-	0.4	-	4.0	V
Output Current	I <sub>o</sub>	-	-	-	0.5	A

## ■ ELECTRICAL CHARACTERISTICS

(V<sub>DD</sub>=5V, T<sub>a</sub>=25°C)

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
<b>General</b>						
Operating Current	I <sub>DD</sub>	-	-	3.0	4.0	mA
Thermal Shutdown Temperature	T <sub>TSD</sub>	-	-	180	-	°C
Thermal Shutdown Hysteresis	T <sub>HYS</sub>	-	-	50	-	°C
<b>Hall Amplifier</b>						
Input Offset Voltage	V <sub>IO</sub>	-	-7	-	7	mV
Feedback Resistance	R <sub>F</sub>	-	22.0	27.5	33.0	kΩ
Open loop gain	A <sub>V</sub>	-	-	80	-	dB
Input Common Mode Voltage Range	V <sub>ICM</sub>	-	0.4-4.0	-	-	V
<b>Outputs</b>						
Maximum Output Voltage Range	V <sub>OH</sub>	I <sub>o</sub> =+350mA	4.65	4.75	-	V
	V <sub>OL</sub>	I <sub>o</sub> = -350mA	-	0.25	0.35	
Output Resistance	R <sub>ONH</sub>	I <sub>o</sub> =+500mA	-	0.5	-	Ω
	R <sub>ONL</sub>	I <sub>o</sub> = -500mA	-	0.5	-	
FG L Output Voltage	V <sub>FG</sub>	4pin=5V,3pin=0V, R <sub>P</sub> =10kΩ	-	-	0.3	V
FG H Leak Current	I <sub>FG-LEAK</sub>	4pin=0V,3pin=5V, R <sub>P</sub> =10kΩ	-	-	1.0	μA
<b>Lock Detect Circuits</b>						
Lock Protect Operating Voltage	V <sub>LOP</sub>	-	4.0	-	-	V
Lock Detect Discharge Current	I <sub>DCHG</sub>	-	-	1.5	-	μA
Lock Detect Discharge Current	I <sub>DCHG</sub>	-	-	0.5	-	μA
Clamp Voltage	V <sub>CL</sub>	-	-	2.6	-	V
Detect Voltage	V <sub>ID</sub>	-	-	0.6	-	V

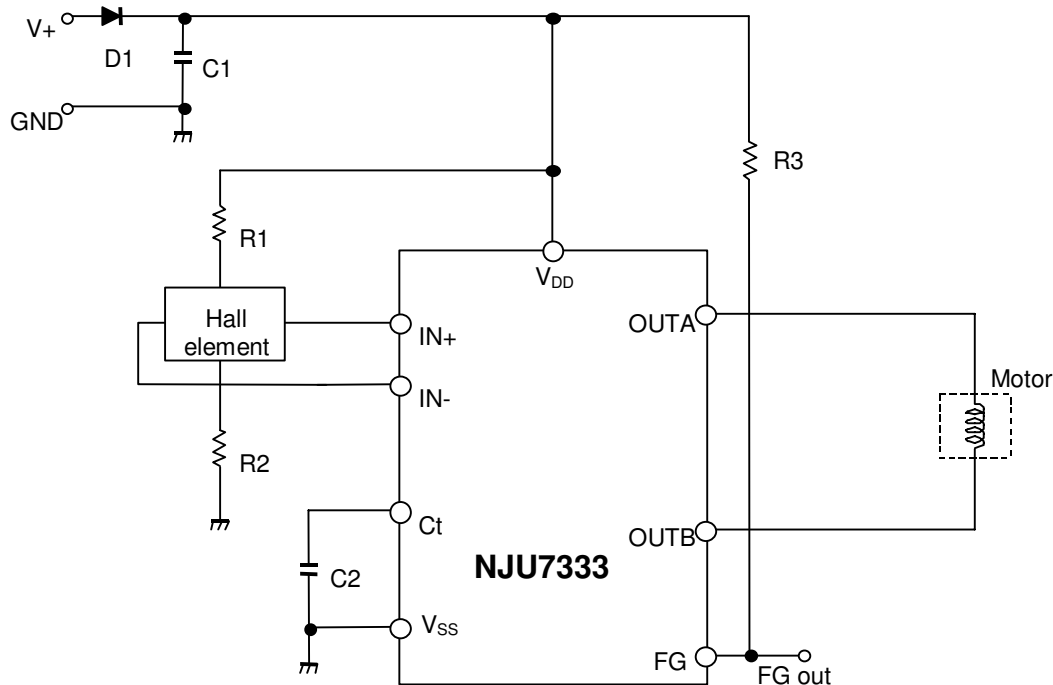
# NJU7333

## Preliminary

### APPLICATION NOTE

The NJU7333 is a single-phase DC brushless motor driver IC featuring CMOS process. It is suitable for fan motor drivers for a small equipment such as the note personal computers.

[Application Circuit Example]



[Design Notes]

Above application example is designed for 5V operation with motor current of 500mA. It uses the following components:

Hall Elements: HW101A (AKE)

#### 1. Selection of C1 and D1:

C1 is used for a noise reduction purpose. A typical value is 0.1 $\mu$ F.

Optimize the value in actual operating conditions if necessary. D1 is a diode for protection against reverse voltage supply. Silicon rectifier diode (WO3C, 10D1 and equivalent) is appropriate.

#### 2. Lock Protection Function (Design of C2 value):

Lock Protection Function, consists of Motor Lock Detection and Auto Resume Function, is a safety feature to protect a motor and a driver circuit from fatal destruction in case of motor halt.

Motor Lock Detection detects motor halt due to irregular load conditions and then cuts motor driving current for safety operation. A value of C2 determines Lock detection time ( $T_{on}$ ) and Auto Resume Time ( $T_{off}$ ).

Lock detection time ( $T_{on}$ ) is given by:

$$T_{ON} = C2 \frac{V_{CL} - V_{ID}}{I_{CHG}} [\text{sec}]$$

Where C2 is 0.47uF:

$$T_{ON} = 0.47 \times 10^{-6} \times \frac{2.6 - 0.6}{1.5 \times 10^{-6}} = 0.62 [\text{sec}]$$

Auto Resume Time ( $T_{off}$ ) is given by:

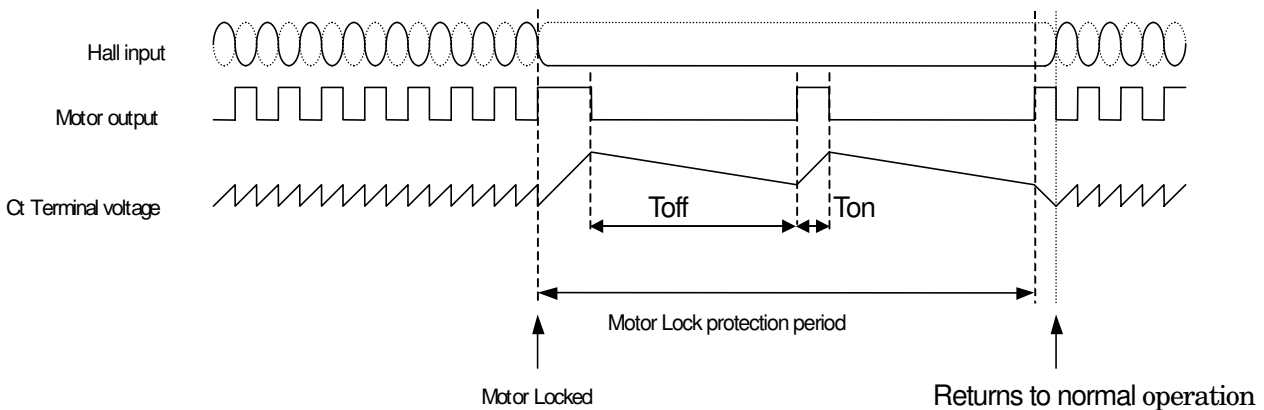
$$T_{OFF} = C2 \frac{V_{CL} - V_{ID}}{I_{DCHG}} [\text{sec}]$$

Where C2 is 0.47uF:

$$T_{OFF} = 0.47 \times 10^{-6} \times \frac{2.6 - 0.6}{0.5 \times 10^{-6}} = 1.88 [\text{sec}]$$

In actual application, Lock detection time ( $T_{on}$ ) is affected by the mechanical time constant of a motor. Therefore, constant start up must be confirmed in actual evaluation taking operating variations (i.e. Temperature, Voltage change and so on) in consideration.

A typical value of C2 is either 0.47uF or 1uF depending on a motor.



### 3. Design of hall element bias resistance (**R1 and R2**)

Hall amplifier is a differential amplifier with hysteresis characteristics (24mV typical).

The common-mode input voltage is between 0.4V and  $V_{DD}-1V$  and the input signal must be within the range. Non-excitation hall bias voltage is to be set at a half of  $V_{DD}$  for effective use of common-mode input voltage range. Therefore the same value of hall bias resistors is selected for R1 and R2.

## Preliminary

Given that the bias current is set to be 5mA by HW101A datasheet, R1 and R2 can be determined as follows:

$$R1 + R2 + R_{in} = \frac{V_{DD}}{I_{bias}} = \frac{5}{5 \times 10^{-3}} = 1k\Omega$$

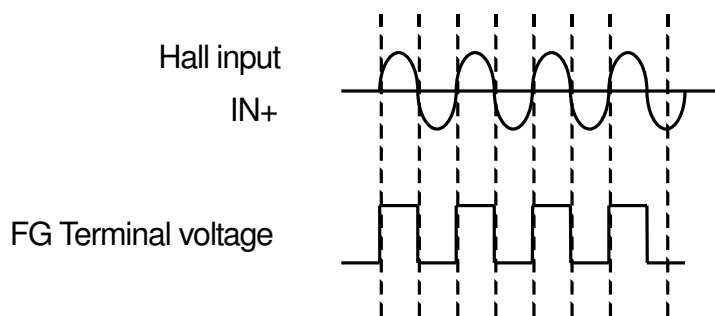
$$R1 = R2 = 300\Omega$$

The output voltage of hall elements is influenced by the bias current and magnetic flux density of hall elements.

The optimum input voltage of NJU7333 is 100mVp-p and higher. With such input voltage, the highest efficiency can be obtained.

#### 4. Design of FG output resistance (**R3**)

FG Out(FG:Pin2) is a open drain output and R3 is a pull up register. A typical value of R3 is 10kΩ. The timing chart of FG Out is as follows.



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