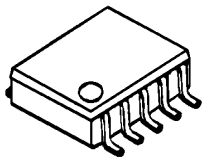
Single-phaseDC Brushless Motor Driver IC

■ 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 late 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

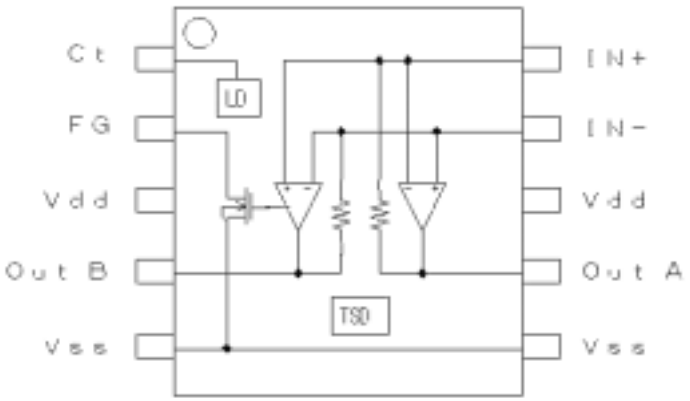


NJU7333R

■ FEATURES

- Operating Voltage V_{DD}=2.4 ~ 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
  Vsat=±0.35V @Io=±500mA
- C-MOS Technology
- Package Outline VSP10

■ BLOCK DIAGLAM



■ PIN FUNCTION

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

Preliminary

■ ABSOLUTE MAXIMUM RATINGS

(Ta=25°C)

PARAMETER	RATINGS	SYMBOL (unit)	NOTE
Supply Voltage	+7.0	V_{DD} (V)	
Input Voltage	-0.3 ~ V_{DD}+0.3	V_{ID}(V)	
Output Current (Peak)	1.0	$I_{O\,PEAK}$ (A)	
Operating Temperature Range	-40 ~ +85	Topr (°C)	
Storage Temperature Range	-50 ~ +150	Tstg (°C)	
Power Dissipation	400	P_D (mW)	Device itself

■ RECOMMENDED OPERATING CONDITIONS

(V_{DD}=5V, Ta=25°C)

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V_{DD}	-	2.4	5.0	5.5	V
Operating Temperature Range	Tj	-	-40	-	85	°C
Input Common Mode Voltage Range	V_{ICM}	-	0.4	-	4.0	V
Output Current	Io	-	-	-	0.5	A

■ **ELECTRICAL CHARACTERISTICS** (V_{DD}=5V, Ta=25°C)

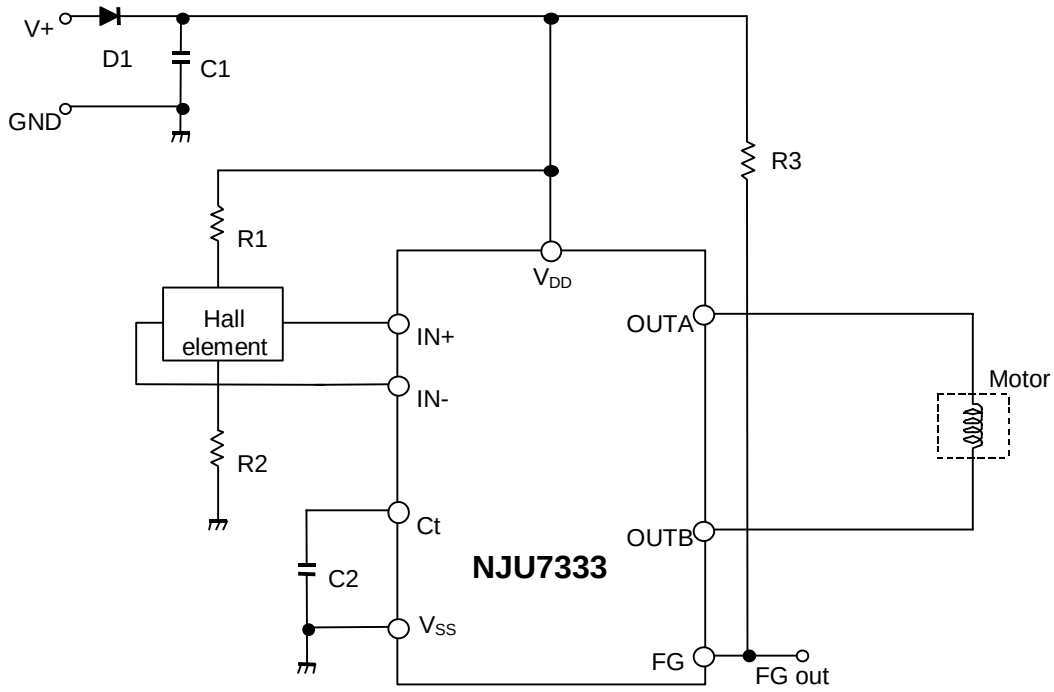
PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
General						
Operating Current	I_{DD}	-	-	3.0	4.0	mA
Thermal Shutdown Temperature	T_{TSD}	-	-	180	-	°C
Thermal Shutdown Hysteresis	T_{HYS}	-	-	50	-	°C
Hall Amplifier						
Input Offset Voltage	V_{IO}	-	-7	-	7	mV
Feedback Resistance	R_F	-	22.0	27.5	33.0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

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 0.1uF.

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 f or safety operation. A value of C2 determines Lock detection time (T_{on}) and Auto Resume Time (Toff).

Lock detection time (Ton) is given by:

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

Where C2 is 0.47uF:

$$T_{ON} = 0.47\times10^{-6}\times\frac{2.6-0.6}{1.5\times10^{-6}} = 0.62[\text{sec}]$$

Auto Resume Time (Toff) is given by:

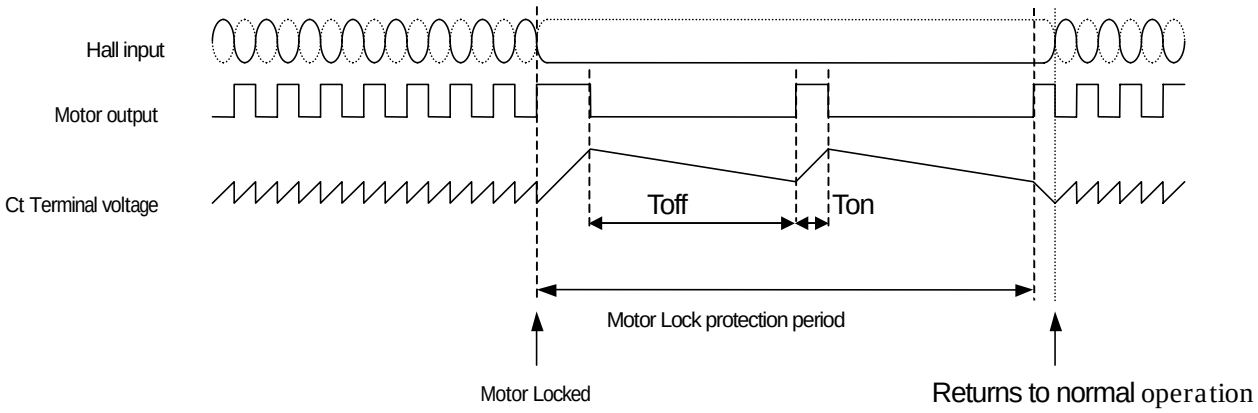
$$T_{OFF} = C2\frac{V_{CL} - V_{ID}}{I_{DCHG}}[\text{sec}]$$

Where C2 is 0.47uF:

$$T_{OFF} = 0.47\times10^{-6}\times\frac{2.6-0.6}{0.5\times10^{-6}} = 1.88[\text{sec}]$$

In actual application, Lock detection time (Ton) 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.

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

$$R1 + R2 + Rin = \frac{V_{DD}}{Ihbias} = \frac{5}{5 \times 10^{-3}} = 1k\Omega$$

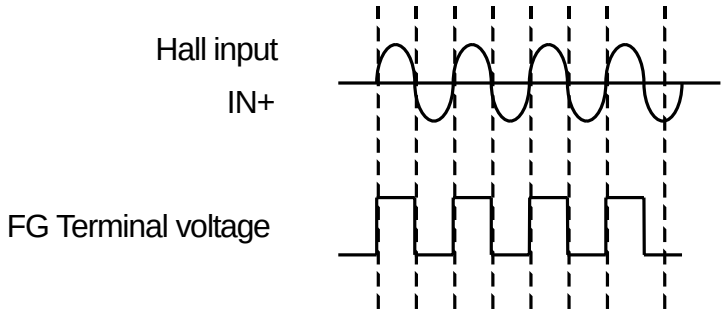
$$R1 = R2 = 300\Omega$$

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 resistsnce (**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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