

Single-phase DC Brushless Motor Driver IC

GENERAL DESCRIPTION

The NJU7343/ 44/ 45 is a single-phase DC brushless motor driver IC developed for a small fan motor. Adopting the CMOS process, it can provide a low saturation output voltage that is effective in high current conditions.

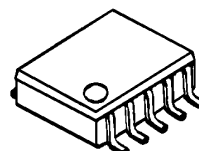
This driver includes Lock Detect / Auto Reset and Thermal Shutdown Circuit for safety fan operation. Each of the drivers has FG output (NJU7343), Half FG output (NJU7344), and RD output (NJU7345).

It adopts small VSP10 package for downsizing and slimming motors. It is suitable for applications for small and high output fan motors.

FEATURES

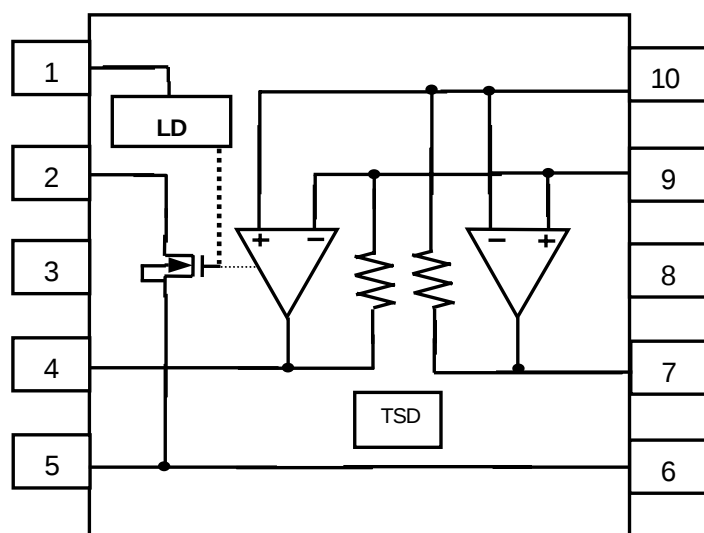
- Operating Voltage 2.2 to 5.5V
- Lock Detect / Auto Release
- Control Output Terminal
NJU7343:FG(Frequency Generator)
NJU7344:Half FG
NJU7345:RD(Rotation Detect)
- Thermal Shutdown Circuit
- Low Operating Current
- Low Saturation Output Voltage
- $V_{sat} = \pm 0.25V$ @ $I_o = \pm 500mA$
- Input offset voltage $\pm 5mV$
- CMOS Technology
- Package Outline VSP10

PACKAGE OUTLINE



NJU7343R/44R/45R

BLOCK DIAGRAM



..... NJU7343(FG), NJU7344(Half FG)

..... NJU7345(RD)

PIN FUNCTION

- 1: Ct
- 2: FG(NJU7343), Half FG(NJU7344), RD(NJU7345)
- 3: V_{DD}
- 4: OUT B
- 5: V_{SS}
- 6: V_{SS}
- 7: OUT A
- 8: V_{DD}
- 9: IN-
- 10: IN+

(Note)

All V_{DD} and V_{SS} pins should be connected the power supply and the ground respectively. Otherwise, the electrical characteristic may not satisfy specifications

■ 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)	1000	$I_{O\ PEAK}$ (mA)	
Operating Temperature Range	-40 ~ +85	Topr (°C)	
Junction Temperature Range	-40 ~ +150	Toj (°C)	
Storage Temperature Range	-40 ~ +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}	Ct=0	2.2	5.0	5.5	V
Junction Temperature Range	Tj	-	-40	-	125	°C
Input Common Mode Voltage Range	V_{ICM}	-	0.4	-	4.0	V
Output Current	I_O	-	-	-	500	mA

ELECTRICAL CHARACTERISTICS

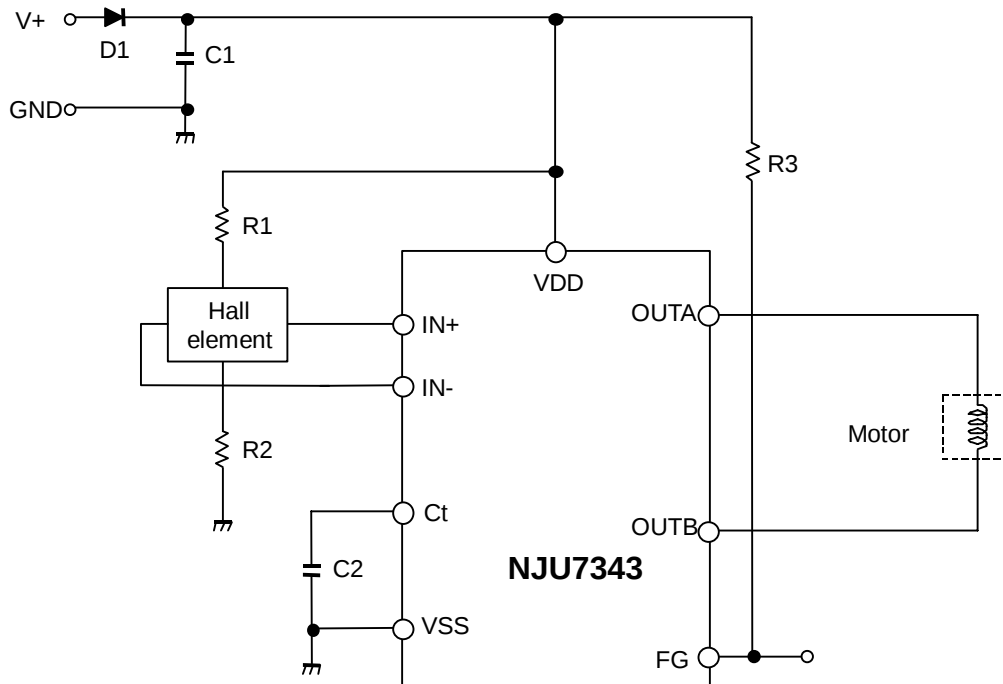
($V_{DD}=5V$, $T_a=25^{\circ}C$)

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}	-	-5	-	5	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	
Motor Output							
Maximum Output Voltage Range	V _{OH}	I _o =+350mA	4.65	4.75	-	V	
	V _{OL}	I _o =-350mA	-	0.25	0.35		
Output Resistance	R _{ONH}	I _o =+500mA	-	0.5	-	Ω	
	R _{ONL}	I _o =-500mA	-	0.5	-		
Lock Detect Circuit							
Lock Detect Charge Current	I _{CHG}	-	-	0.6	-	μA	
Lock Detect Discharge Current	I _{DCHG}	-	-	0.1	-	μA	
Clamp Voltage	V _{CL}	-	-	2.8	-	V	
Detect Voltage	V _{ID}	-	-	0.8	-	V	
Rotation Detect Output							
NJU 7343	FG L Output Voltage	V _{FG}	IN+(10pin)=0V,IN-(9pin)=5V, R _P =10kΩ	—	—	0.3	V
	FG H Leak Current	I _{FG-LEAK}	IN+(10pin)=5V,IN-(9pin)=0V, R _P =10kΩ	—	—	1.0	μA
NJU 7344	Half-FG L Output Voltage	V _{FG}	R _P =10kΩ	—	—	0.3	V
	Half-FG H Leak Current	I _{FG-LEAK}		—	—	1.0	μA
NJU 7345	RD L Output Voltage		V _{CL} =3V, R _P =10kΩ	—	—	0.3	V
	RD H Leak Current		V _{CL} =0V, R _P =10kΩ	—	—	1.0	μA

APPLICATION NOTE

The NJU7343/44/45 are single-phase DC brushless motor driver IC in small VSP-10 package.
With minimal external components, that can drive up to 500mA of motor current for small fan application.

[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 for safety operation. A value of C2 determines Lock detection time (Ton) and Auto Resume Time (Toff).

Lock detection time (Ton) is given by:

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

Where C2 is 0.15uF:

$$T_{ON} = 0.15 \times 10^{-6} \times \frac{2.8 - 0.8}{0.6 \times 10^{-6}} = 0.49[\text{sec}]$$

Auto Resume Time (Toff) is given by:

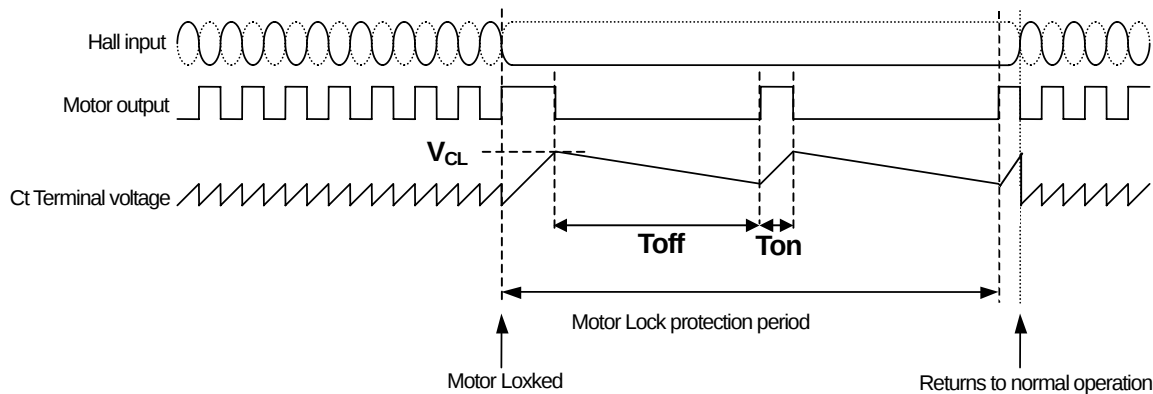
$$T_{OFF} = C2 \frac{V_{CL} - V_{ID}}{I_{dis}} [\text{sec}]$$

Where C2 is 0.15uF:

$$T_{OFF} = 0.15 \times 10^{-6} \times \frac{2.8 - 0.8}{0.1 \times 10^{-6}} = 3.00[\text{sec}]$$

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 from 0.1uF to 0.47uF depending on a motor.



*Remarks : When V_{DD} becomes lower than 4V, the Clamp Voltage (V_{CL}) becomes lower accordingly. This makes T_{on} and T_{off} shorter and may cause issues associated with the restarting of the motor from the lock protection state. Therefore, careful evaluation is necessary with actual motors.

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

Hall amplifier is a differential amplifier.

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:

$$R1 + R2 + R_{in} = \frac{V_{DD}}{I_{hbias}} = \frac{5}{5 \times 10^{-3}} = 1.0\text{k}\Omega$$

$$R1 = R2 = 300\Omega$$

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

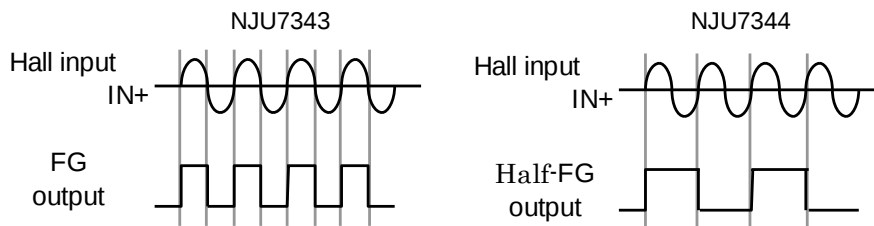
The optimum input voltage of NJU7343/44/45 are 100mVp-p and higher. With such input voltage, the highest efficiency can be obtained.

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

FG Out (FG: Pin2) is an open drain output and R3 is a pull up register. A typical value of R3 is 10k Ω .

The timing chart of FG Out for NJU7343/NJU7344 is as follows.

Note that the pull up resistance shall be connected to below supply voltage.



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