Single-phase DC Brushless Motor Driver IC

◆ GENERAL DESCRIPTION

The NJU7349 is single-phase DC brushless motor driver IC. It features MOS-FET driver circuit for better output characteristics.

The driver includes PWM_IN INPUT for Rotation Speed Control.

Maximum output current is 1000mA and Continuance output current is 500mA.

It is suitable for variable speed FAN required Low Noise & Good Efficiency characteristics.
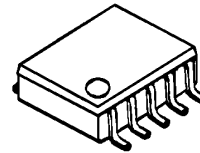
◆ FEATURES

- Speed Control with PWM Signal Input
- Operating Voltage   2.2 to 5.5V
- Internal Lock Detect / Auto Release Circuit
- Half-FG Output
- Thermal Shutdown Circuit
- Low Operating Current
  I_{DD}=2mA
- Low Saturation Output Voltage
  Vsat= $\pm$0.25V @Io=$\pm$500mA
- CMOS Technology
- Package Outline   VSP10

◆ PACKAGE OUTLINE

NJU7349R

◆ BLOCK DIAGLAM
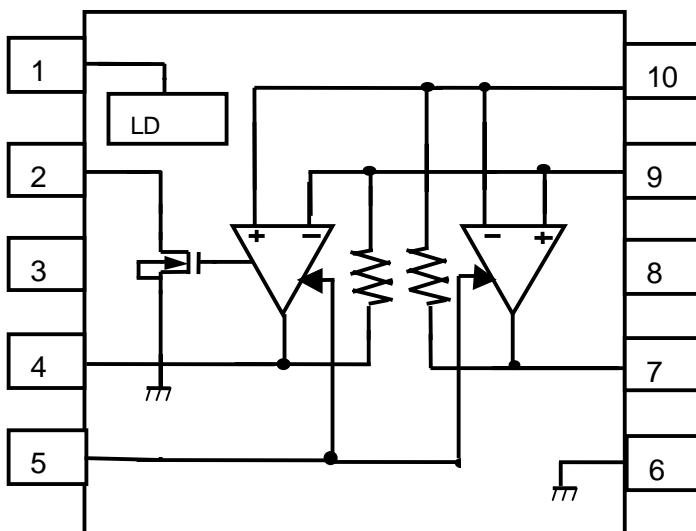
◆ PIN FUNCTION

1: Ct
2: Half-FG
3: V_{DD}
4: OUT B
5: PWM_IN
6: Vss
7: OUT A
8: V_{DD}
9: IN-
10: IN+

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

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NJU7349

♦ **ABSOLUTE MAXIMUM RATINGS**   (Ta=25°C)

PARAMETER	RATINGS	SYMBOL (unit)	NOTE
Supply Voltage	+7.0	V_{DD} (V)	
Input Voltage	$-0.3 \sim V_{DD}+0.3$	V_{ID}(V)	
Output Current (Continuance)	500	I_O (mA)	
Output Current (Peak)	1000	$I_{O\,PEAK}$ (mA)	
Operating Temperature Range	$-40 \sim +85$	Topr (°C)	
Storage Temperature Range	$-50 \sim +150$	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

NJU7349

♦ ELECTRICAL CHARACTERISTICS

(V_{DD} =5V, Ta=25°C)

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
General						
Operating Current	I_{DD}	-	-	2.0	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
Output						
Maximum Output Voltage Range	V_{OH}	Io=+350mA	4.65	4.80	-	V
	V_{OL}	Io=-350mA	-	0.20	0.35	
Output Resistance	R_{ONH}	Io=+500mA	-	0.5	-	Ω
	R_{ONL}	Io=-500mA	-	0.5	-	
FG L Output Voltage	V_{FG}	9pin=0V, 10pin=5V, R_L=10kΩ	-	-	0.3	V
FG H Leak Current	$I_{FG-LEAK}$	9pin=5V, 10pin=0V, R_L=10kΩ	-	-	1.0	µA
Lock Detect Circuit*						
Lock Protect Operation Voltage	V_{LOP}	-	4.0	-	-	V
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
PWM_IN Input						
Input HIGH voltage	V_{IHP}		0.7 V_{DD}	-	V_{DD}	V
Input LOW voltage	V_{ILP}		0	-	0.3V_{DD}	V

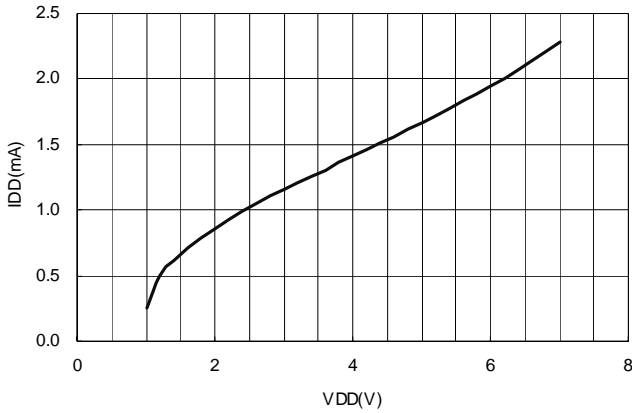# NJU7349

♦ **TIME CHART**

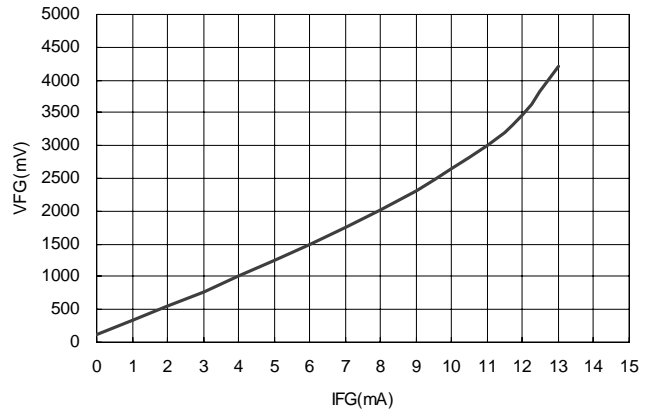PWM timing
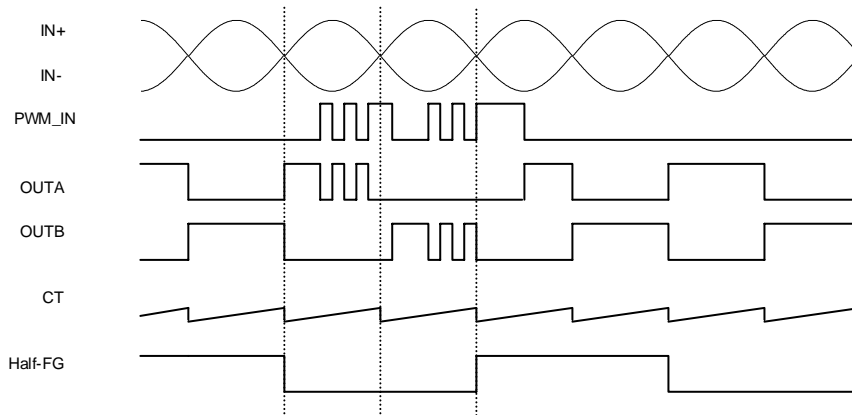
Lock protection timing
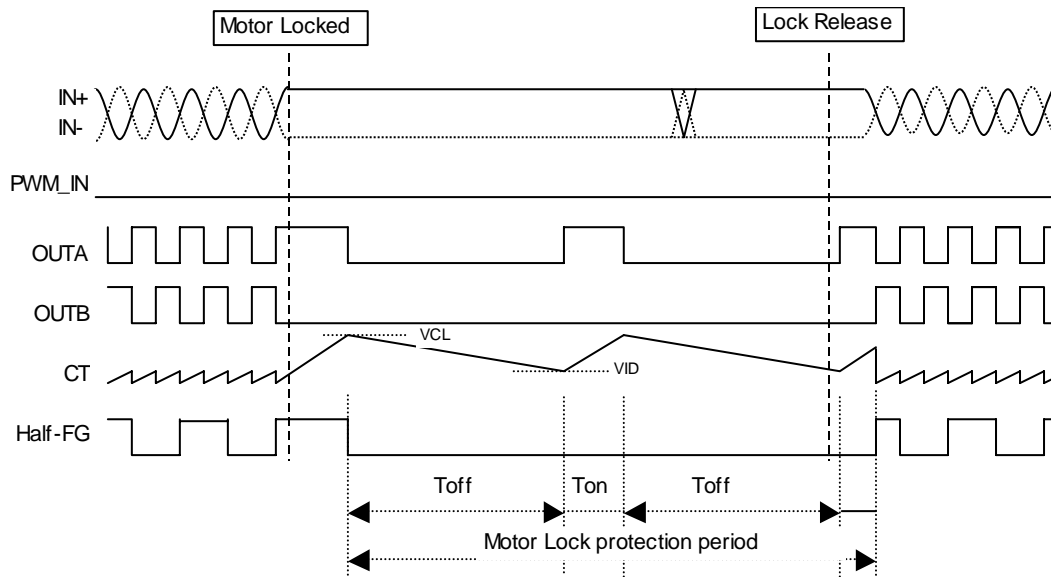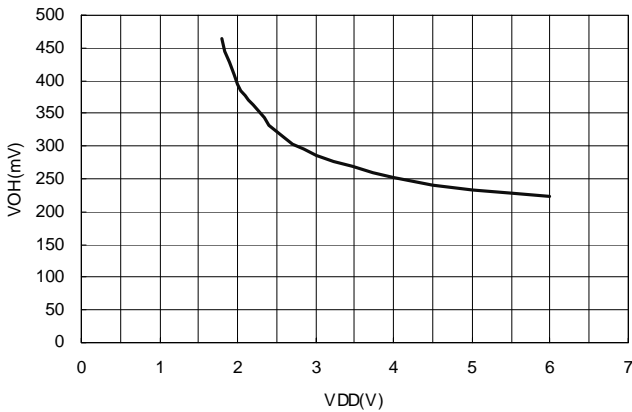
♦TYPICAL CHARACTERISTICS

VDD-IDD
GND=0V, IN-=5V, IN+=Ct=0V
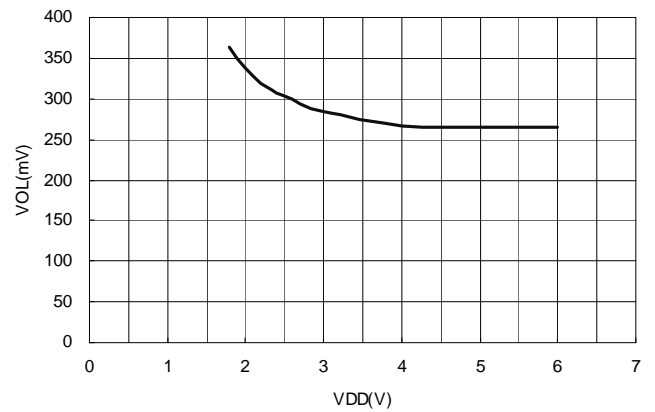MEAS:VDD

IFG-VFG
VDD=5V, GND=0V, IN-=2.5V, IN+=Ct=0V
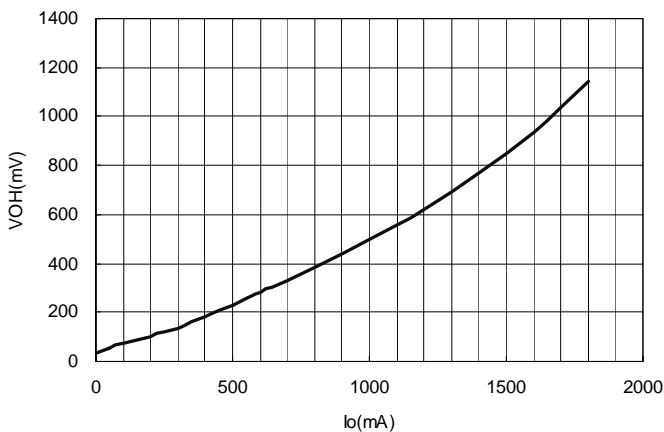MEAS:FG

VDD-VOH
GND=0V, IN-=VDD/2, IN+=Ct=0V
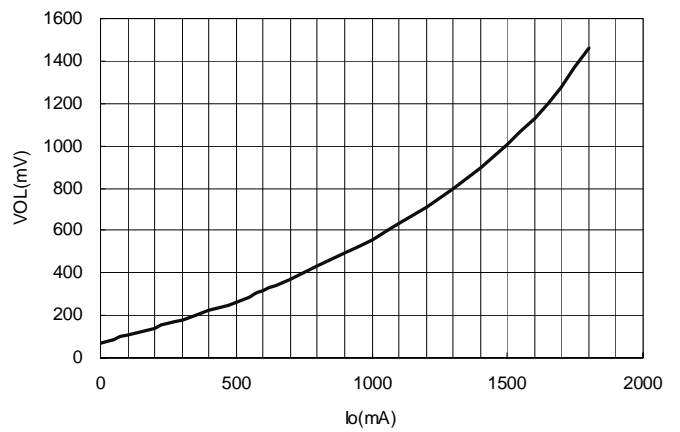MEAS:OUTB (Io=500mA)

VDD-VOL
GND=0V, IN+=VDD/2, IN-=Ct=0V
MEAS:OUTB (Io=500mA)

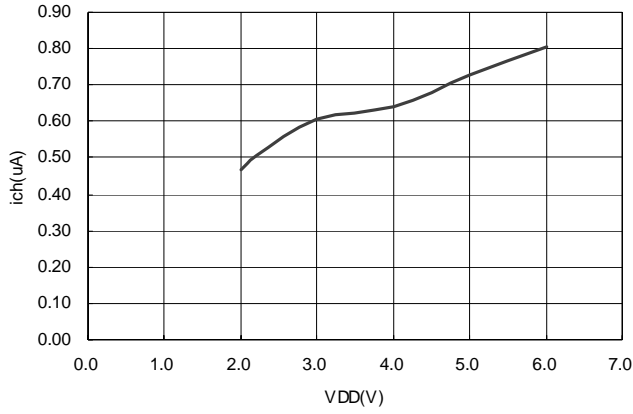**Io-VOH**
VDD=5V, GND=0V, IN-=2.5V, IN+=Ct=0V
MEAS:OUTB

Io-VOL
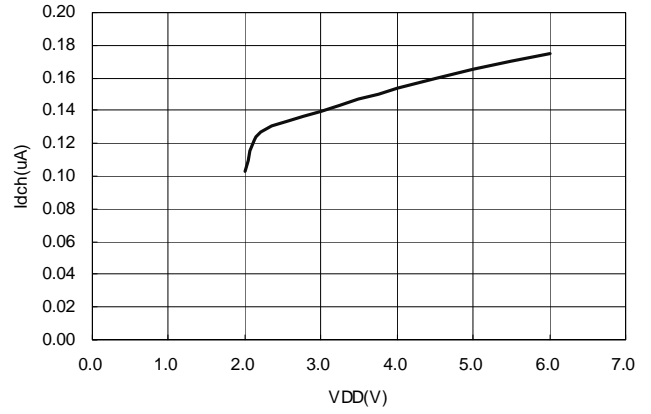VDD=5V, GND=0V, IN+=2.5V, IN-=Ct=0V
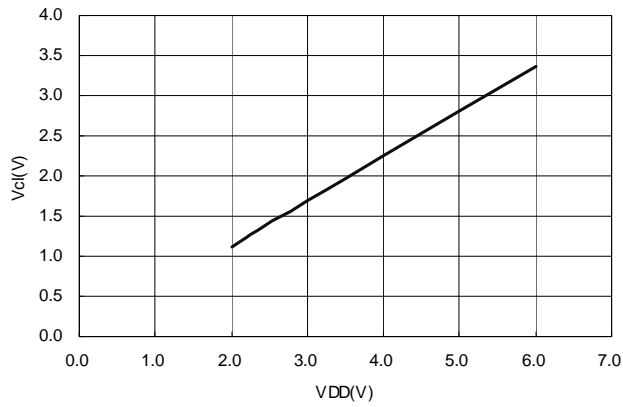MEAS:OUTB

NJU7349

♦TYPICAL CHARACTERISTICS

VDD-Ich
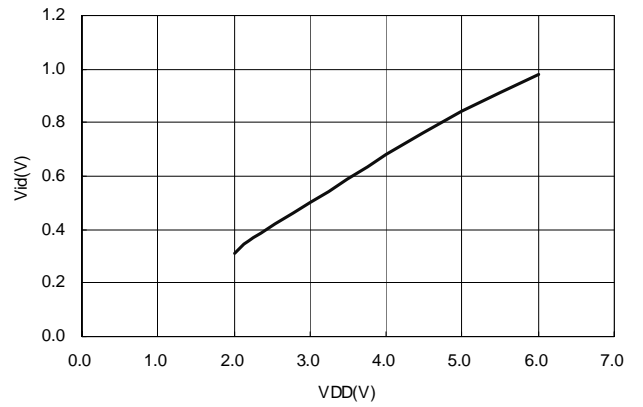GND=0V, IN-=VDD/2, IN+=Ct=0V
MEAS:Ct

VDD-Idch
GND=0V, IN-=VDD/2, IN+=0V, Ct=VDD
MEAS:Ct

VDD-Vcl
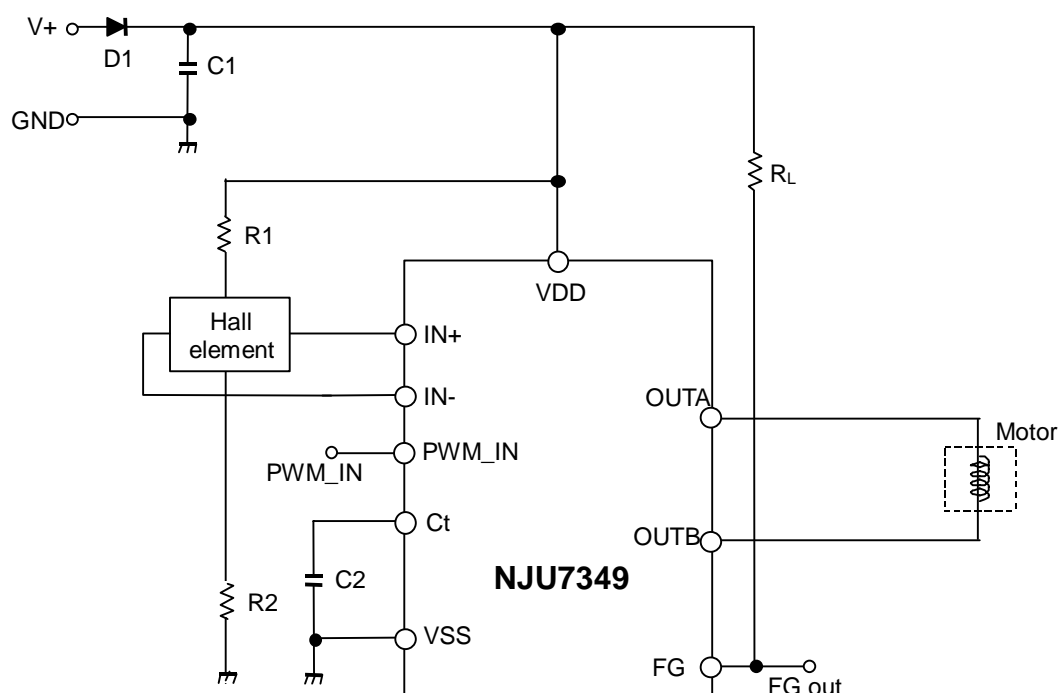GND=0V, IN-=VDD/2, IN+=Ct=0V
MEAS:OUTB

VDD-Vid
GND=0V, IN-=VDD/2, IN+=0V, Ct=VDD
MEAS:OUTB

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♦**APPLICATION NOTE**

The NJU7349 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 f or safety operation. A value of C2 determines Lock detection time (Ton) and Auto Resume Time (Toff).

Lock detection time (Ton) is given by:

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

NJU7349

Where C2 is 0.15uF:

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

Auto Resume Time (Toff) is given by:

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

Where C2 is 0.15uF:

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

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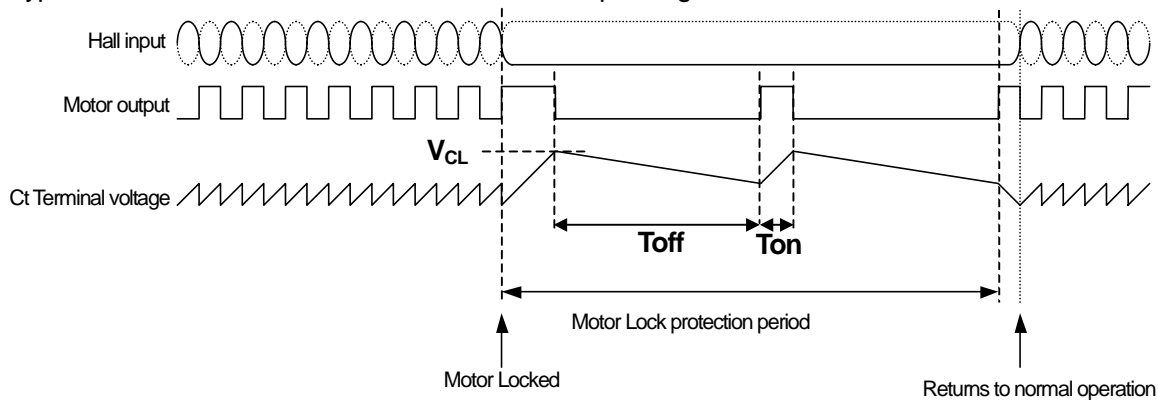
*Remarks : When V_{DD} becomes lower than 4V,the Clamp Voltage(V_{CL}) becomes lower accordingly. This makes Ton and Toff shorter and may cause issues associated with the restarting of the motor from the lock protection state. Therefore, careful evaluation is necessary with actual motors.

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 VDD-1V and the input signal must be within the range.
Non-excitation hall bias voltage is to be set at a half of VDD 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:

$$R1 + R2 + Rin = \frac{VDD}{Ihbias} = \frac{5}{5 \times 10^{-3}} = 1.0k\Omega$$
$$R1 = R2 = 300\Omega$$

The output voltage of hall elements is influenced by the bias current and magnetic flux density of hall elements.
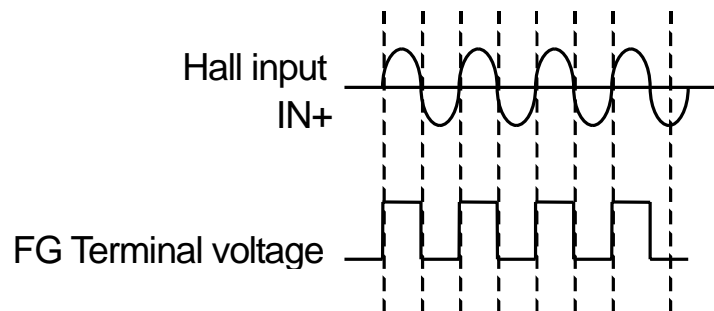
The optimum input voltage of NJU7349 are 100mVp-p and higher. With such input voltage, the highest efficiency can be obtained.

4. Design of FG output resistance (R_L)

FG Out (FG: Pin2) is an open drain output and R_L is a pull up register. A typical value of R_L is 10kΩ.
The timing chart of FG is as follows.
Note that the pull up resistance shall be connected to below supply voltage.

Hall input IN+

FG Terminal voltage