

24V SINGLE PHASE BRUSHLESS DC MOTOR DRIVER

■ GENERAL DESCRIPTION

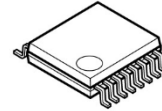
The NJW4320 is a single phase motor driver IC for 24V FAN Motor.

It features a PWM Soft-Switching that provides low vibration and high efficiency motor driving.

Built-in protection circuits: Lock Protection, Over Current Detection and Thermal Shutdown contribute to enhance safety.

The speed control is available to direct PWM signal input.

■ PACKAGE OUTLINE

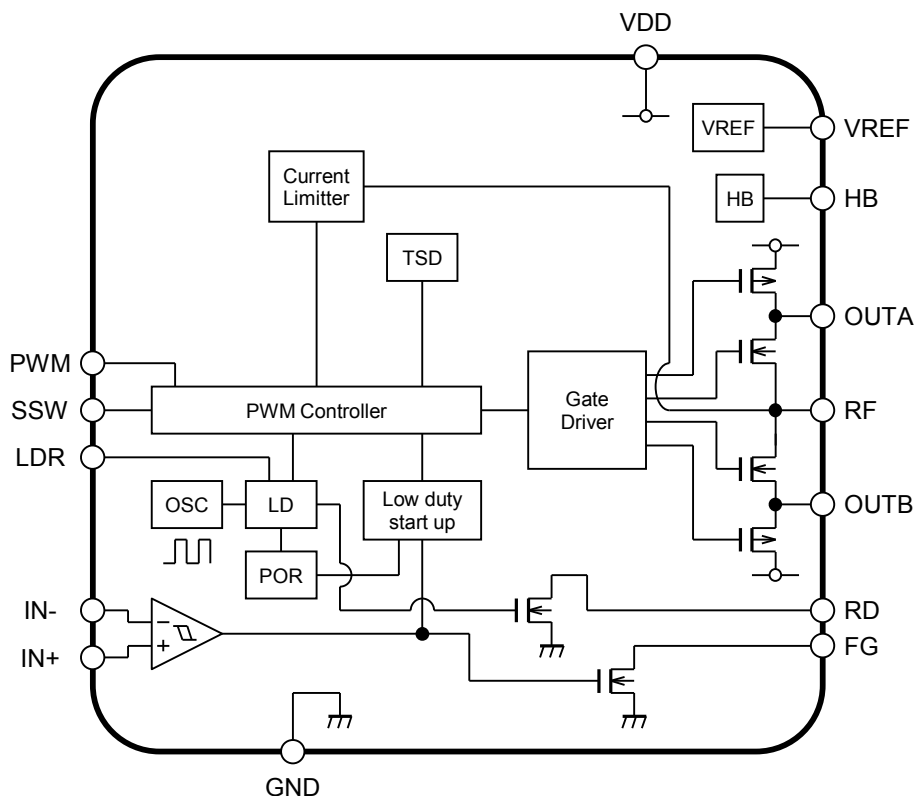


NJW4320V

■ FEATURES

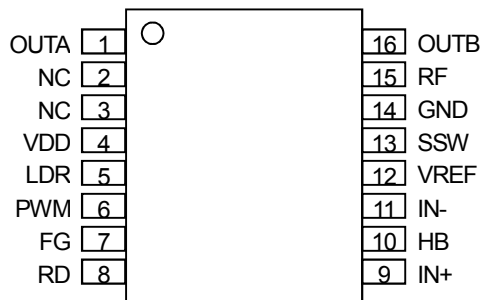
- Supply Voltage Range $V_{DD}=6$ to 36V
- Low Quiescent Current $I_{DD}=1.7\text{mA}$ typ. at $V_{DD}=24\text{V}$
- Output ON Resistance $R_{ON(H+L)}=1.0\Omega$ typ.
- PWM Soft-Switching
- Direct PWM Input(5V/3.3V-IF)
- Quick Start, Start up Assist
- Lock Protection (Auto Recovery)
- Over Current Detection
- FG, RD Output
- Thermal Shutdown
- Package SSOP16

■ BLOCK DIAGRAM



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■ PIN CONFIGURATION



SSOP16

■ PIN DESCRIPTION

PIN No. SSOP16	PIN NAME	FUNCTION	NOTES
1	OUTA	Motor Output Pin A	-
2,3	NC	No Connection	Not Internally Connected
4	VDD	Power Supply Pin	-
5	LDR	Lock Protection Setting Pin	The LDR determines ON:OFF ratio at lock protection. H or OPEN = 1 : 10 L = 1 : 15
6	PWM	PWM Input Pin	PWM Signal Input When not using, it should be set to open.
7	FG	FG Output Pin	Rotation Signal Output When not using, it should be set to open.
8	RD	RD Signal Output Pin	Lock Alarm Signal Output When not using, it should be set to open.
9	IN+	Hall Input + Pin	Hall Signal Input When $V_{IN+} > V_{IN-}$, OUTA=H
10	HB	Hall Bias Output Pin	Hall Bias Output for Hall element When not using, it should be set to open.
11	IN-	Hall Input - Pin	Hall Signal Input When $V_{IN+} < V_{IN-}$, OUTB=H
12	VREF	VREF Output Pin	Reference Voltage Output A capacitor should be connected between VREF and GND, even if not using.
13	SSW	Soft Switching Setting Pin	Setting Soft Switching Width When using default, it should be set to open.
14	GND	Ground Pin	-
15	RF	Over Current Detect Pin	Setting Current Limit When not using, it should be connected to GND.
16	OUTB	Motor Output Pin B	-

■ ABSOLUTE MAXIMUM RATINGS

(Ta=25°C)

PARAMETER	SYMBOL	RATINGS	UNIT	NOTES
Supply Voltage	V _{DD}	40	V	VDD Pin
Motor Output Current	I _{OPEAK}	700	mA	OUTA, OUTB Pin
Motor Output Pin Voltage	V _O	40	V	OUTA, OUTB Pin
Analog Input Pin Voltage	V _{IN}	7	V	IN+, IN-, SSW, LDR, RF Pin
PWM Pin Input Voltage	V _{PWM}	40	V	PWM Pin
VREF Pin Output Current	I _{REF}	3	mA	VREF Pin (*1)
HB Pin Output Current	I _{HB}	10	mA	HB Pin (*1)
FG Pin Output Current	I _{FG}	10	mA	FG Pin
FG Pin Output Voltage	V _{FG}	40	V	FG Pin
RD Pin Output Current	I _{RD}	10	mA	RD Pin
RD Pin Output Voltage	V _{RD}	40	V	RD Pin
Operating Temperature Range	Topr	-40 to +105	°C	I _O ≤ 250mA, not using HB Pin
		-40 to +90		I _O ≤ 300mA, not using HB Pin
		-40 to +85		I _O ≤ 230mA, I _{HB} ≤ 5mA, V _{DD} ≤ 24V
Junction Temperature Range	T _j	-40 to +150	°C	-
Storage Temperature Range	T _{stg}	-50 to +150	°C	-
Power Dissipation	P _D	300	mW	Device itself
		610		(*2)

(*1): Don't apply a voltage to VREF pin and HB pin from external source.

(*2): Mounted on glass epoxy board based on EIA/JEDEC. (76.2×114.3×1.6mm, FR-4, 2Layers)

■ RECOMMENDED OPERATING CONDITIONS

(Ta=25°C)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V _{DD}		6	24	36	V

■ PIN OPERATING CONDITIONS

(V_{DD}=24V, Ta=25°C)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
■ HALL INPUT PIN						
Common Mode Input Voltage Range	V _{ICM}		0.3	-	3.0	V
Hall Input Sensitivity	ΔV _{MIH}	V _{SSW} = 1V	0.04	-	-	V
■ PWM INPUT PIN						
H Level Input Voltage	V _{HPWM}		2.3	-	5	V
L Level Input Voltage	V _{LPWM}		0	-	0.8	V
PWM Input Frequency Range	f _{PWM}		1	-	50	kHz
■ SSW INPUT PIN						
SSW Input Voltage Range	V _{SSW}		1	-	3	V

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■ ELECTRICAL CHARACTERISTICS

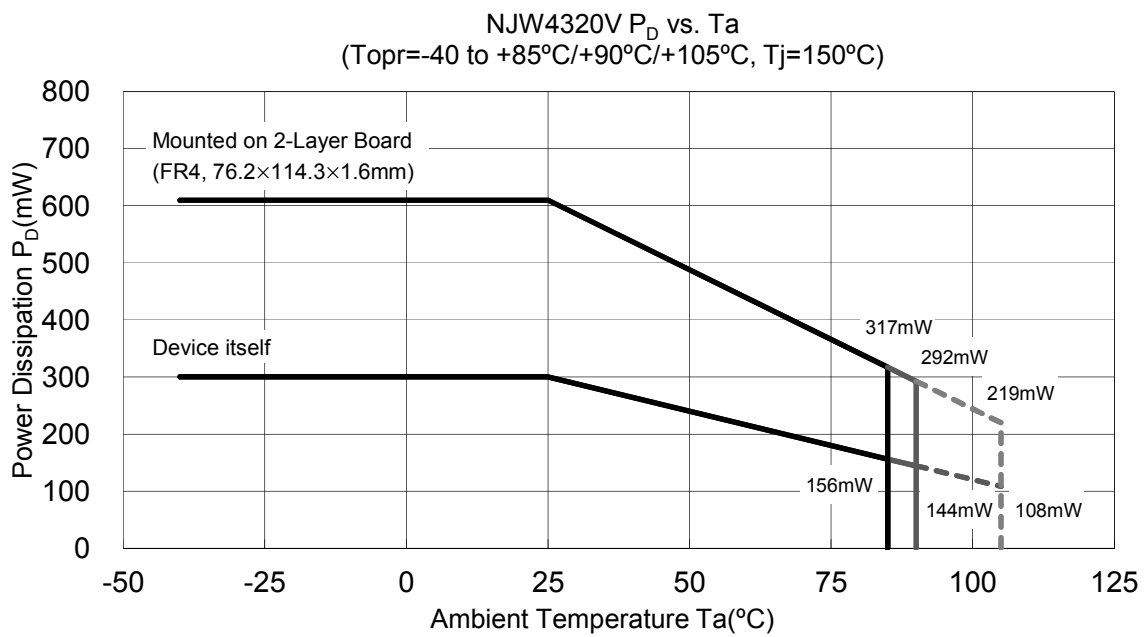
(V_{DD}=24V, Ta=25°C)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
■ GENERAL						
Quiescent Current	I _{DD}		-	1.7	2.2	mA
■ MOTOR OUTPUT BLOCK						
Output ON Resistance	R _{ON}	I _O = 300mA, high side and low side	-	1.0	1.1	Ω
■ HALL INPUT BLOCK						
FG Comparator Hysteresis Width	ΔV _{HYS}	V _{ICM} = 0.6V, include offset	±4	±12	±20	mV
Soft Switching Input Difference Voltage	ΔV _{IH}	V _{ICM} = 0.6V, SSW = OPEN	-	62	75	mV
■ PWM INPUT BLOCK						
PWM Input Minimum Pulse Width	t _{PWM}		2	-	-	μs
PWM Pull-up Voltage	V _{UPWM}		2.5	2.7	2.9	V
PWM Pull-up Resistance	R _{UPWM}		80	100	125	kΩ
■ OSCILLATOR BLOCK						
Oscillation Frequency	f _{OSC}		19	30	50	kHz
■ VREF OUTPUT BLOCK						
VREF Output Voltage	V _{REF}	I _{REF} = 0.5mA	3.8	4.0	4.2	V
■ HB OUTPUT BLOCK						
HB Output Voltage	V _{HB}	I _{HB} = 5mA	1.12	1.25	1.35	V
■ FG OUTPUT BLOCK						
L Output Voltage	V _{FGL}	I _{FG} = 3mA	-	0.1	0.2	V
Leak Current	I _{FGLEAK}	V _{FG} = 36V	-	-	1	μA
■ RD OUTPUT BLOCK						
L Output Voltage	V _{RDL}	I _{RD} = 3mA	-	0.1	0.2	V
Leak Current	I _{RDLEAK}	V _{RD} = 36V	-	-	1	μA
■ LOCK PROTECTION BLOCK						
Lock Protection ON Time	t _{ON}		0.35	0.5	0.70	s
Lock Protection OFF Time 1	t _{OFF1}	LDR = GND	5.25	7.5	10.5	s
Lock Protection OFF Time 2	t _{OFF2}	LDR = OPEN	3.5	5.0	7.0	s
■ OVER CURRENT DETECT BLOCK						
Current Limiter Detection Voltage	V _{DETRF}		0.22	0.25	0.28	V
■ THERMAL SHUTDOWN BLOCK						
Thermal Protection Operating Temperature	T _{DTSD}		-	170	-	°C
Thermal Protection Recovery Temperature	T _{RTSD}		-	140	-	°C
Thermal Protection Hysteresis	T _{HYS}		-	30	-	°C

■ THERMAL CHARACTERISTICS

PARAMETER	SYMBOL	TEST CONDITIONS	TYP.	MAX.	UNIT
Junction - Ambient Thermal Resistance	θ_{ja}	Mounted on glass epoxy board based on EIA/JEDEC. (76.2×114.3×1.6mm, FR-4, 2Layers)	-	204	°CW
Junction - Top of package Characterization Parameter	ψ_{jt}		35	-	°CW

■ POWER DISSIPATION vs. AMBIENT TEMPERATURE

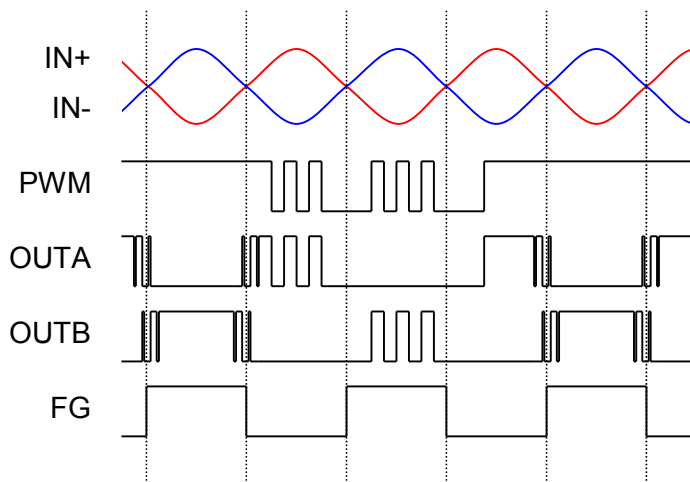


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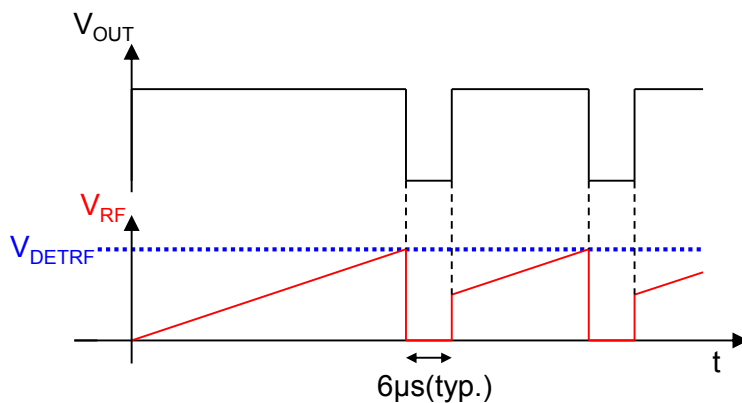
■ TRUTH TABLE

No.	IN+	IN-	PWM	TSD	LD	OUTA	OUTB	FG	RD
1	H	L	H	OFF	OFF	H	L	L	L
2	L	H	H	OFF	OFF	L	H	Hi-Z	L
3	H	L	L	OFF	OFF	L	L	L	L
4	L	H	L	OFF	OFF	L	L	Hi-Z	L
5	H	L	H	ON	OFF	L	L	L	L
6	L	H	H	ON	OFF	L	L	Hi-Z	L
7	H	L	L	ON	OFF	L	L	L	L
8	L	H	L	ON	OFF	L	L	Hi-Z	L
9	H	L	H	OFF	ON	L	L	L	Hi-Z
10	L	H	H	OFF	ON	L	L	Hi-Z	Hi-Z
11	H	L	L	OFF	ON	L	L	L	Hi-Z
12	L	H	L	OFF	ON	L	L	Hi-Z	Hi-Z
13	H	L	H	ON	ON	L	L	L	Hi-Z
14	L	H	H	ON	ON	L	L	Hi-Z	Hi-Z
15	H	L	L	ON	ON	L	L	L	Hi-Z
16	L	H	L	ON	ON	L	L	Hi-Z	Hi-Z

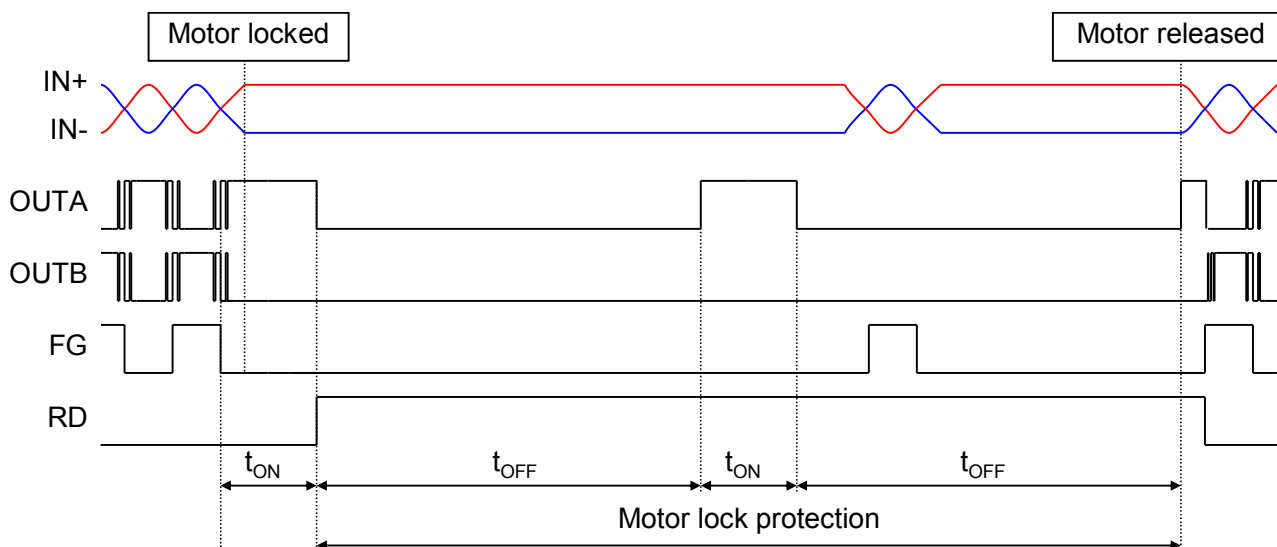
■ PWM TIMING CHART



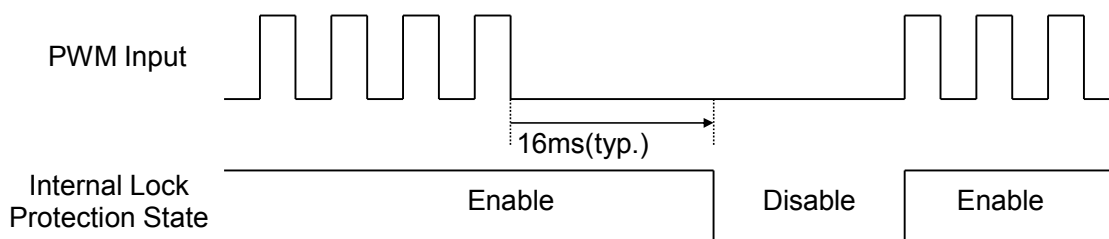
■ CURRENT LIMIT TIMING CHART



■ LOCK PROTECTION TIMING CHART

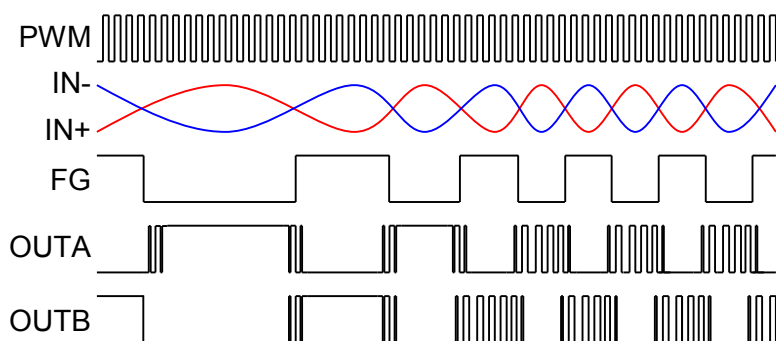


■ QUICK START TIMING CHART



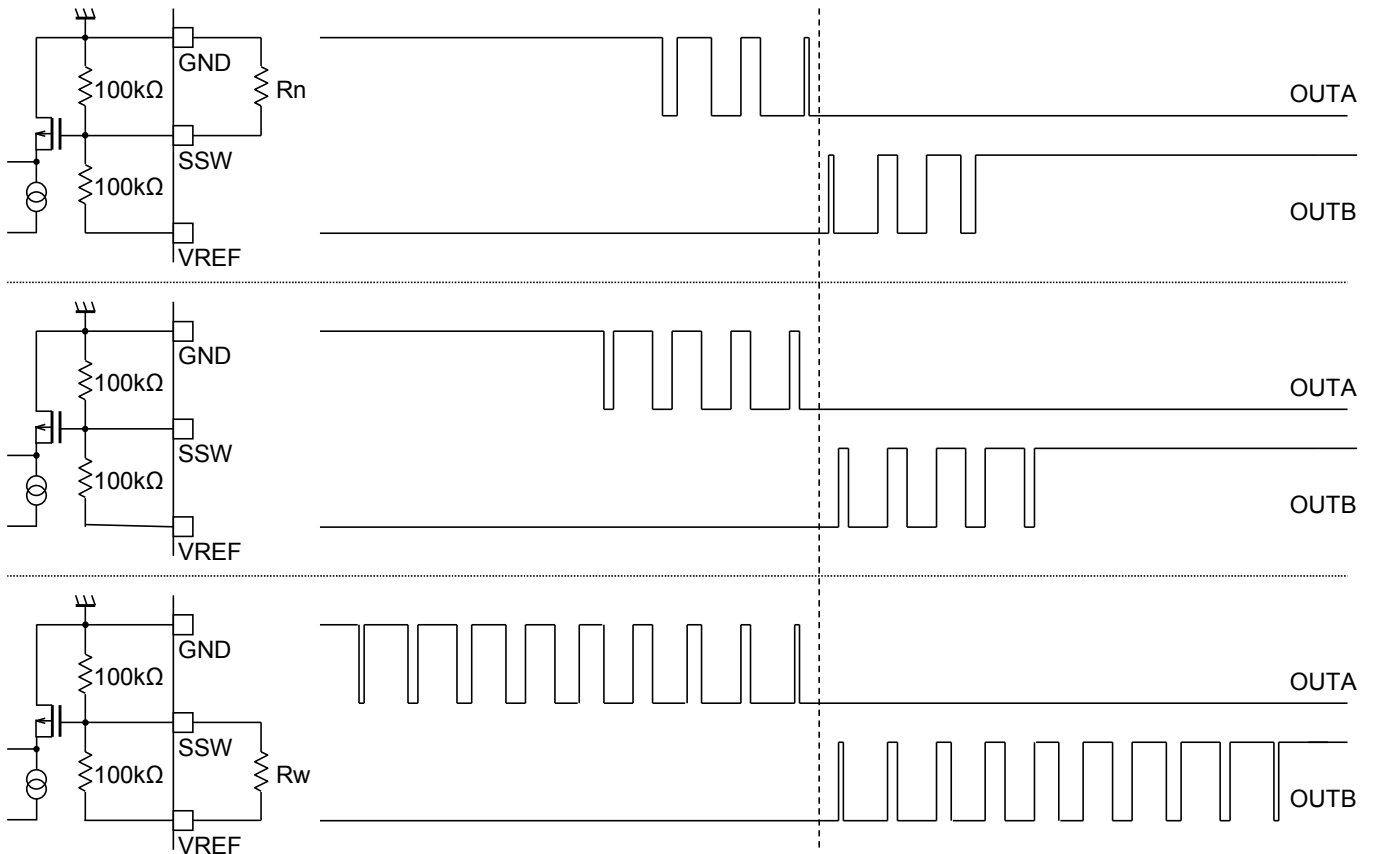
When the PWM signal isn't input while a fixed period (16ms typ.), internal Lock Protection function is disabled. Therefore, in normal start-stop operation, the output delay by Lock Protection function is evaded.

■ START UP ASSIST TIMING CHART



For the assistance when start up a motor, the PWM control is enabled after 4 times phase-shift of Hall signal.

■SOFT SWITCHING WIDTH ADJUSTMENT



The NJW4320 provides high efficiency and low noise by Soft Switching operation before and after phase-shift.
 Soft Switching Width is controlled by SSW pin voltage, so it is adjustable by connecting an external resistor to SSW.
 Adjustment voltage range is 1V to 3V.
 The PWM cycle of the Soft Switching operation synchronizes with the speed control.

- Default (SSW Pin = OPEN)

$$V_{SSW} = 4 \times \frac{100k\Omega}{100k\Omega + 100k\Omega} = 2V$$

- When expand the Soft Switching Width (Connecting resistor (Rw) between SSW pin and VREF pin)

$$V_{SSW} = 4 \times \frac{100k\Omega}{100k\Omega + 1/(1/Rw + 1/100k\Omega)}$$

e.g.) Rw=56kΩ : $V_{SSW} = 4 \times \frac{100k\Omega}{100k\Omega + 1/(1/56k\Omega + 1/100k\Omega)} = 2.94V$

- When reduce the Soft Switching Width (Connecting resistor (Rn) between SSW pin and GND pin)

$$V_{SSW} = 4 \times \frac{1/(1/Rn + 1/100k\Omega)}{100k\Omega + 1/(1/Rn + 1/100k\Omega)}$$

e.g.) Rn=56kΩ : $V_{SSW} = 4 \times \frac{1/(1/56k\Omega + 1/100k\Omega)}{100k\Omega + 1/(1/56k\Omega + 1/100k\Omega)} = 1.06V$

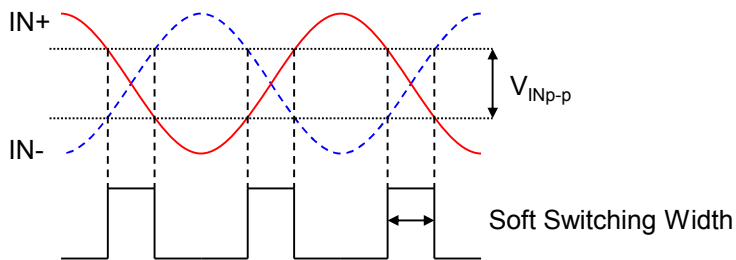
<SETTING HALL INPUT WIDTH>

The Soft Switching Width is controlled by SSW pin voltage and V_{INp-p} (Difference voltage between IN+ pin and IN- pin).

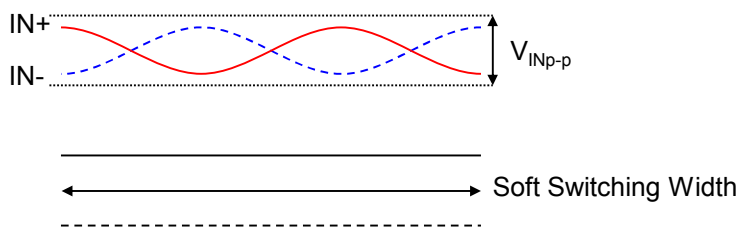
V_{INp-p} that is the basis of Soft Switching Width is calculated as follows:

$$V_{INp-p} \leq 0.039 \times V_{SSW} - 0.0147V$$

- When the amplitude of the Hall input signal is larger than V_{INp-p} , the Soft Switching Width is controlled normally.



- When the amplitude of the Hall input signal is less than V_{INp-p} , the Soft Switching Width is all period and the operation is uncontrolled.



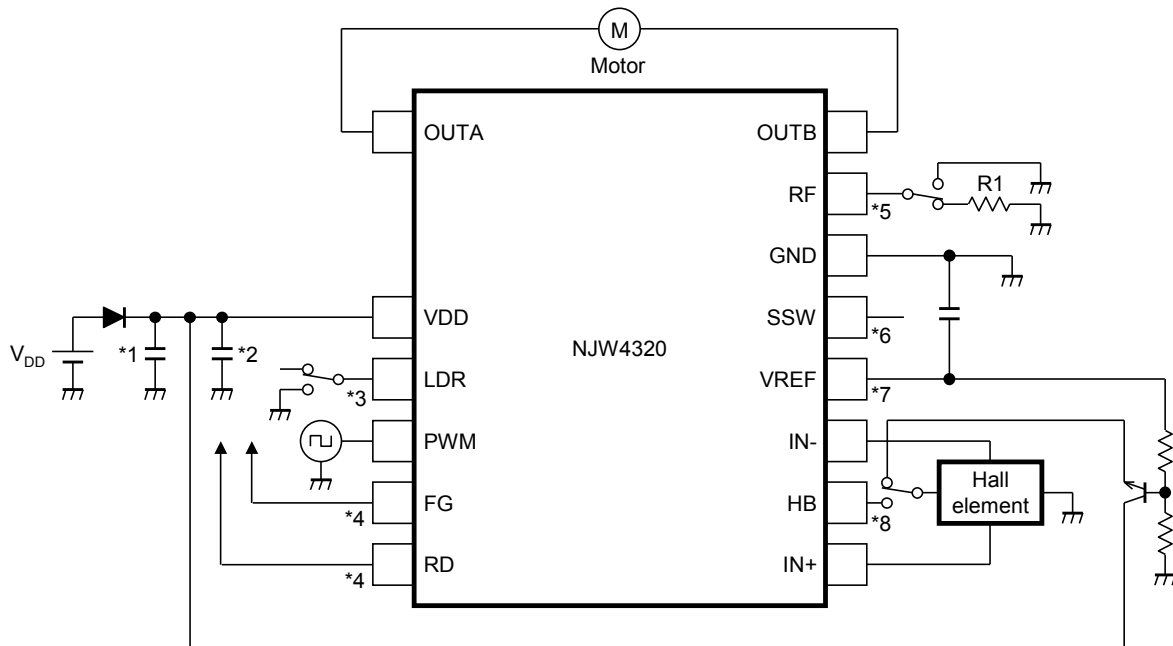
Therefore, the Hall input amplitude should have adequately margin.

Recommended value of V_{INp-p} is as follows.

- When $V_{SSW}=1V$ (min.), $V_{INp-p} > 40mVp-p$
- When $V_{SSW}=2V$ (open), $V_{INp-p} > 75mVp-p$
- When $V_{SSW}=3V$ (max.), $V_{INp-p} > 120mVp-p$

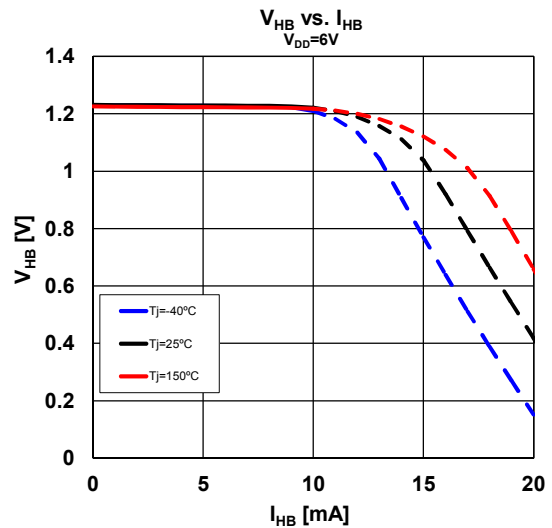
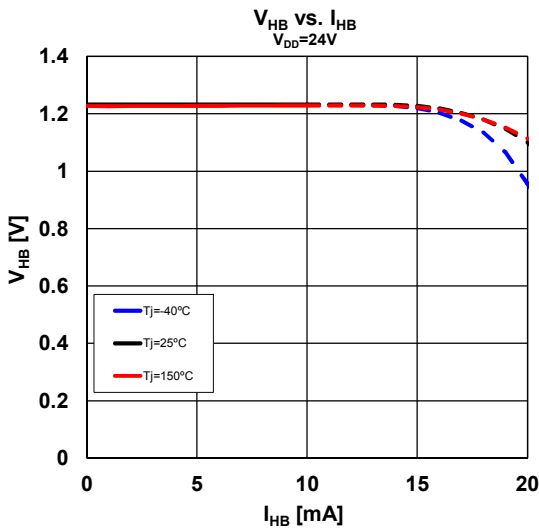
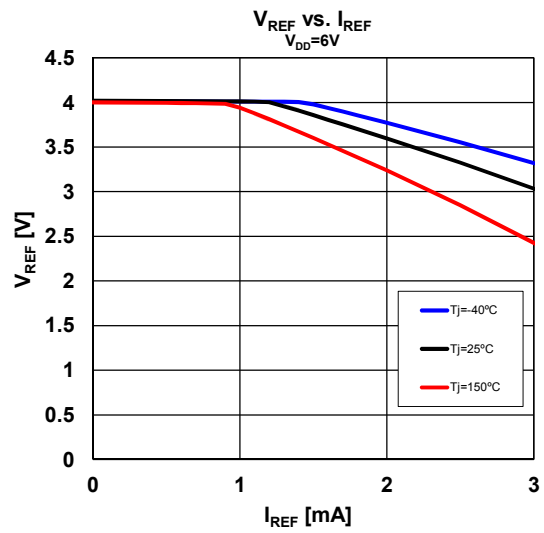
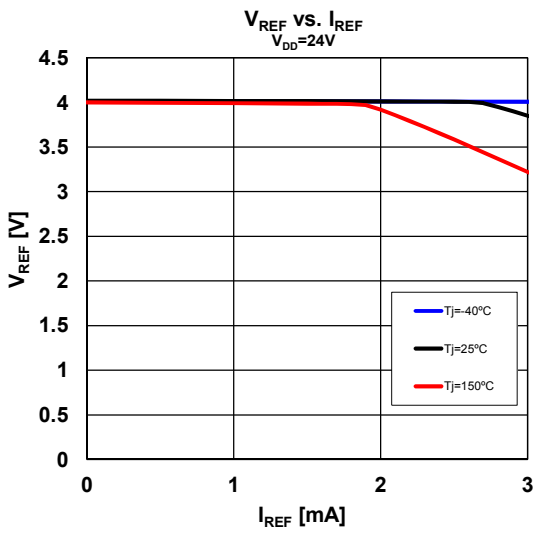
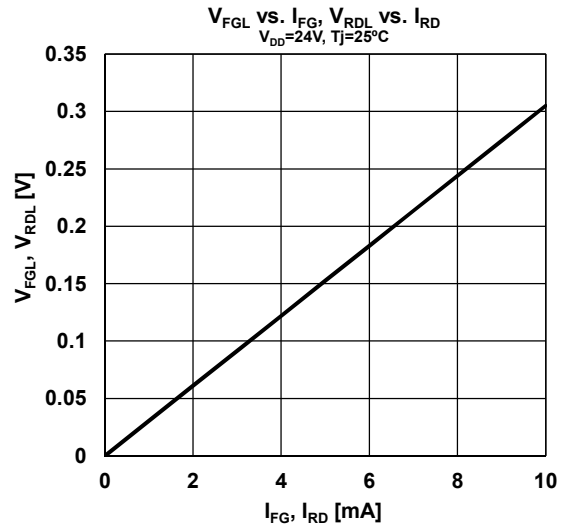
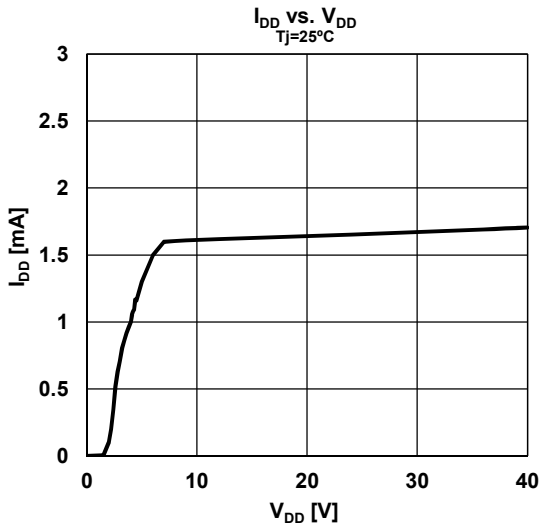
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■ TYPICAL APPLICATION CIRCUIT



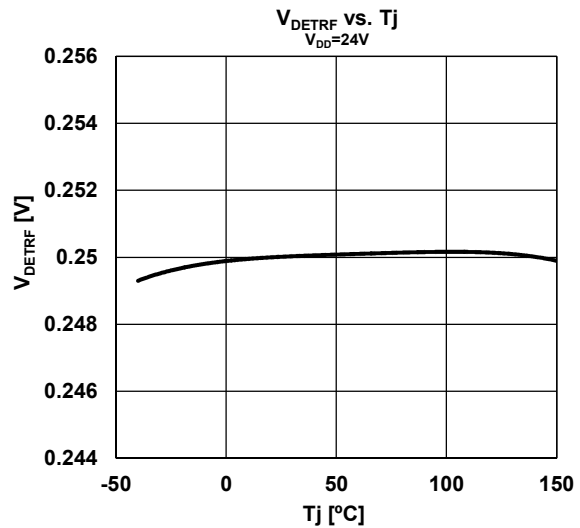
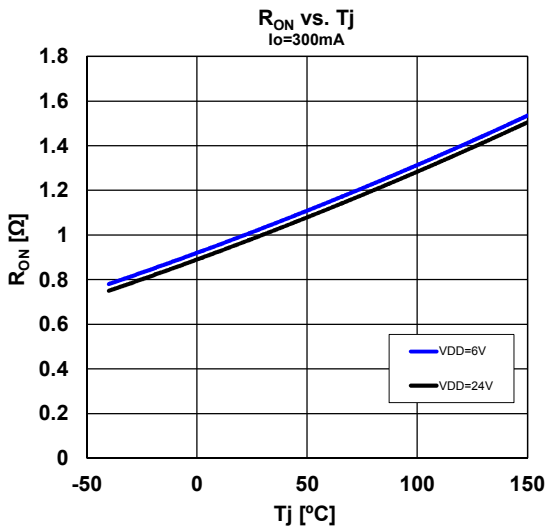
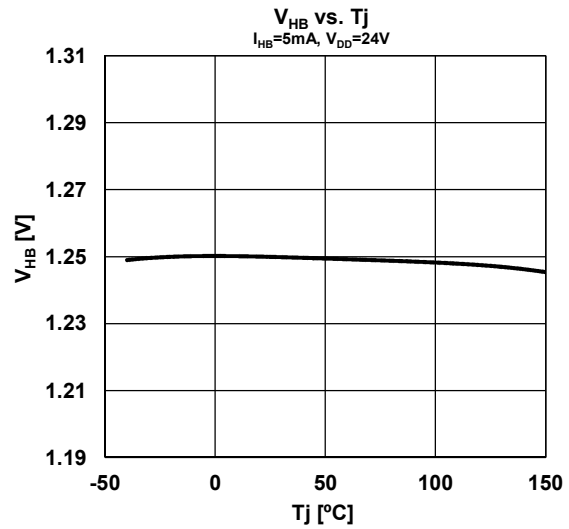
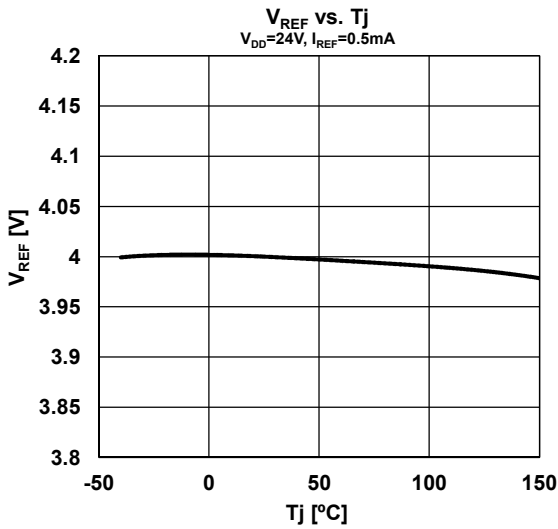
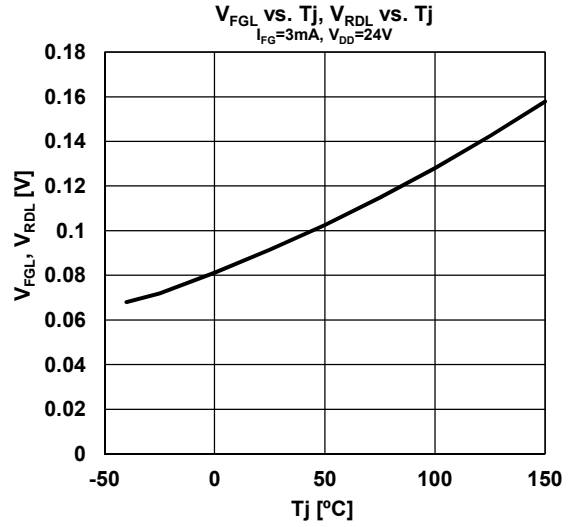
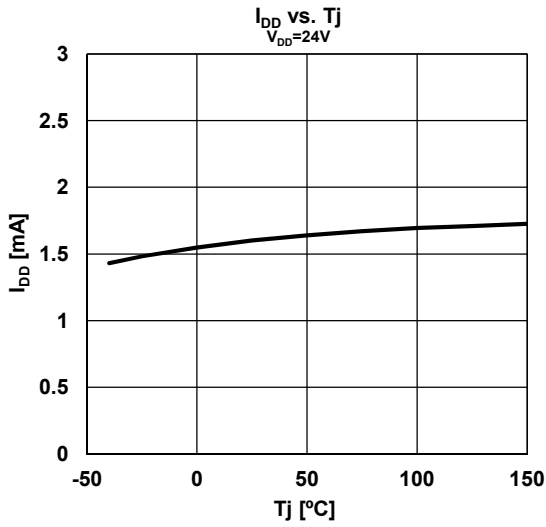
- *1. When a diode is used to prevent destruction of IC by reverse polarity, connect a capacitor and make sure to have regenerative current path.
Moreover, if large current ripple occurs, connect an optional series resistor (ESR) to the capacitor in series.
- *2. Connect a capacitor for decoupling.
- *3. When LDR pin connects to GND, $t_{ON} : t_{OFF}$ ratio of Lock Protection becomes 1 : 15.
- *4. FG pin and RD pin are open drain output. Therefore, connect external pull-up resistors when using these pins.
- *5. When the voltage between RF pin and GND pin reaches 0.25V (typ.), Over Current Protection is operated.
e.g.) when R1 is 0.5Ω, Over Current Protection is detected at $I_o=500\text{mA}$.
- *6. For the setting, refer to "SOFT SWICHING WIDTH ADJUSTMENT" on page 8.
Moreover, connect a decoupling capacitor if an EMC issue occurs.
- *7. When the VREF voltage is used for external, the VREF current can be used up to 0.5mA and a capacitor should be connected for decoupling.
- *8. When using HB pin for drive a Hall element, a power dissipation of IC should be considered.

■ TYPICAL CHARACTERISTICS



NJW4320

■ TYPICAL CHARACTERISTICS



[CAUTION]

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