Ordering number : ENA1818A

LV8860V

Bi-CMOS IC

Fan Motor Driver

Single-Phase Full-Wave Driver

ON Semiconductor®

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Overview

LV8860V is a driver IC used for single-phase fan motor. High-efficiency and low-noise are realized by reducing reactive power using Silent PWM.
The operating range of LV8860V is wide. LV8860V also corresponds to 24V. Therefore, it is optimal for office automation equipment and factory automation equipment.

Functions

- Single-phase full wave operation by Silent PWM drive.
- Speed is controllable by PWM input.
- Hall bias output pin.
- Integrated Quick Start Circuit.
- FG (rotation detection) / RD (lock detection) output pin (open drain output)
- Integrated current limiter circuit (limit at I_O=450mA with Rf=0.5Ω connection, limit value is determined based on Rf.)
- Integrated lock protector circuit and automatic recovery circuit.
- Integrated thermal shut-down (TSD) circuit.

Specifications

Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	V_{CC} max		36	V
OUT pin output current	I_{OUT} max		0.7	A
Output withstand	V_{OUT} max		36	V
RD/FG output pin withstand	$V_{RD/FG}$ max		36	V
RD/FG output maximum current	$I_{RD/FG}$ max		10	mA
RGL output maximum current	I_{RGL} max		5	mA
HB output maximum current	I_{HB} max		10	mA
PWM input pin withstand	V_{PWM} max		6	V
Allowable power dissipation	Pd max	* On a specified board	0.8	W
Operating temperature	Topr		-40 to +95	˚C
Storage temperature	Tstg		-55 to +150	˚C

*Specified board: 114.3mm × 76.1mm × 1.6mm fiberglass epoxy printed circuit board

Caution 1) Absolute maximum ratings represent the value which cannot be exceeded for any length of time.
Caution 2) Even when the device is used within the range of absolute maximum ratings, as a result of continuous usage under high temperature, high current, high voltage, or drastic temperature change, the reliability of the IC may be degraded. Please contact us for the further details.

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

Recommended Operating Conditions at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Operating supply voltage range	V_{CC} op1	Recommended supply voltage range	7 to 34	V
	V_{CC} op2	Boot guarantee supply voltage range	6 to 34	V
Hall input common phase input voltage range	V_{ICM}		0.3 to VRGL-2.0	V
SSW pin input voltage range	SSW		1.0 to 3.0	V
Input PWM frequency range	PWMF		20 to 50	kHz

Electrical Characteristics at Ta = 25°C, V_{CC} = 24V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Circuit consumption current	I_{CC}	Active		2.2	3.5	mA
	I_{CC}o	Stand-by		1.7	2.7	mA
RGL pin output voltage	VRGL		4.7	5.0	5.3	V
RGH pin output voltage	VRGH		V_{CC}-4.3	V_{CC}-4.8	V_{CC}-5.3	V
HB pin output voltage	VHB	IHB=5mA	1.16	1.25	1.28	V
Output ON resistance	Ron	I_O=0.3A, upper and lower ON resistance		1.4	2.0	Ω
Hall input bias current	IHIN				1.0	μA
Current limiter	VRF		200	225	250	mV
PWM pin input Low level	VPWML		0		1.0	V
PWM pin input High level	VPWMH		2.5		VRGL	V
PWM input minimum pulse width	TPWM			2		μs
RD/FG output pin Low voltage	VRD/FG	$I_{RD/FG}$=3mA		0.22	0.3	V
FG output leakage current	IRDL/FGL	$V_{RD/FG}$=24V			10	μA
FG comparator hysteresis width	ΔVHYS	including offset	±5	±12	±18	mV
Output ON time in Lock-detection	TACT		0.74	0.95	1.16	sec
Output OFF time in Lock-detection	TDET		7.0	9.0	11.0	sec
Output ON/OFF ratio in Lock-detection	TRTO	TRTO=TDET/TACT	7.5	9.0	11.0	
Thermal shutdown operating temperature	TSD	* Design guarantee		180		°C
Thermal shutdown hysteresis width	ΔTSD	* Design guarantee		40		°C

* Design guarantee: Signifies target value in design. These parameters are not tested in an independent IC.

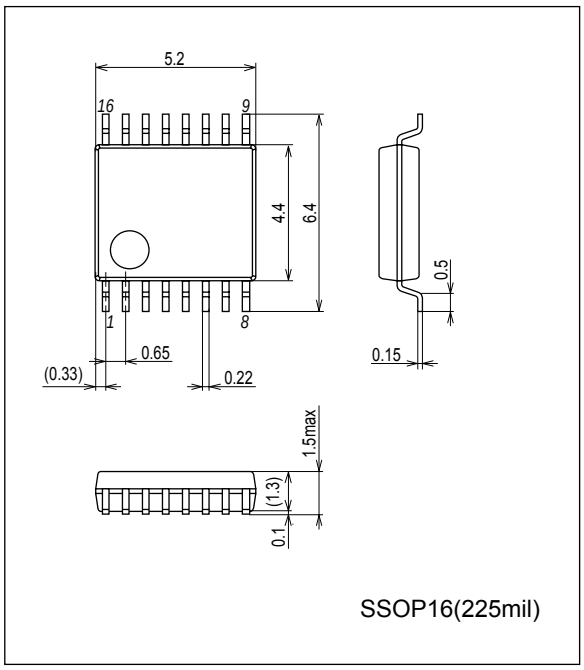
Truth table

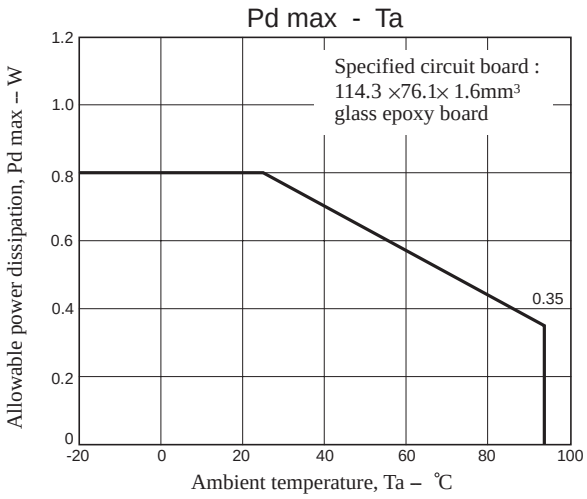
Operating state	IN1	IN2	PWM	OUT1	OUT2	FG	RD
Rotation – drive mode	H	L	H	H	L	L	L
	L	H		L	H	OFF	L
Rotation – regeneration mode	H	L	L	L	L	L	L
	L	H		L	L	OFF	L
Stand-by mode	-	-	L	L	OFF	OFF	L
Lock protector	H	L	-	OFF	L	L	OFF
	L	H		L	OFF	OFF	OFF

Package Dimensions

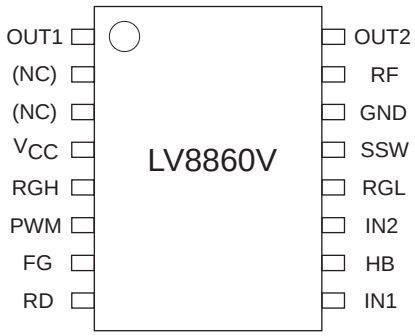
unit : mm (typ)

3178B

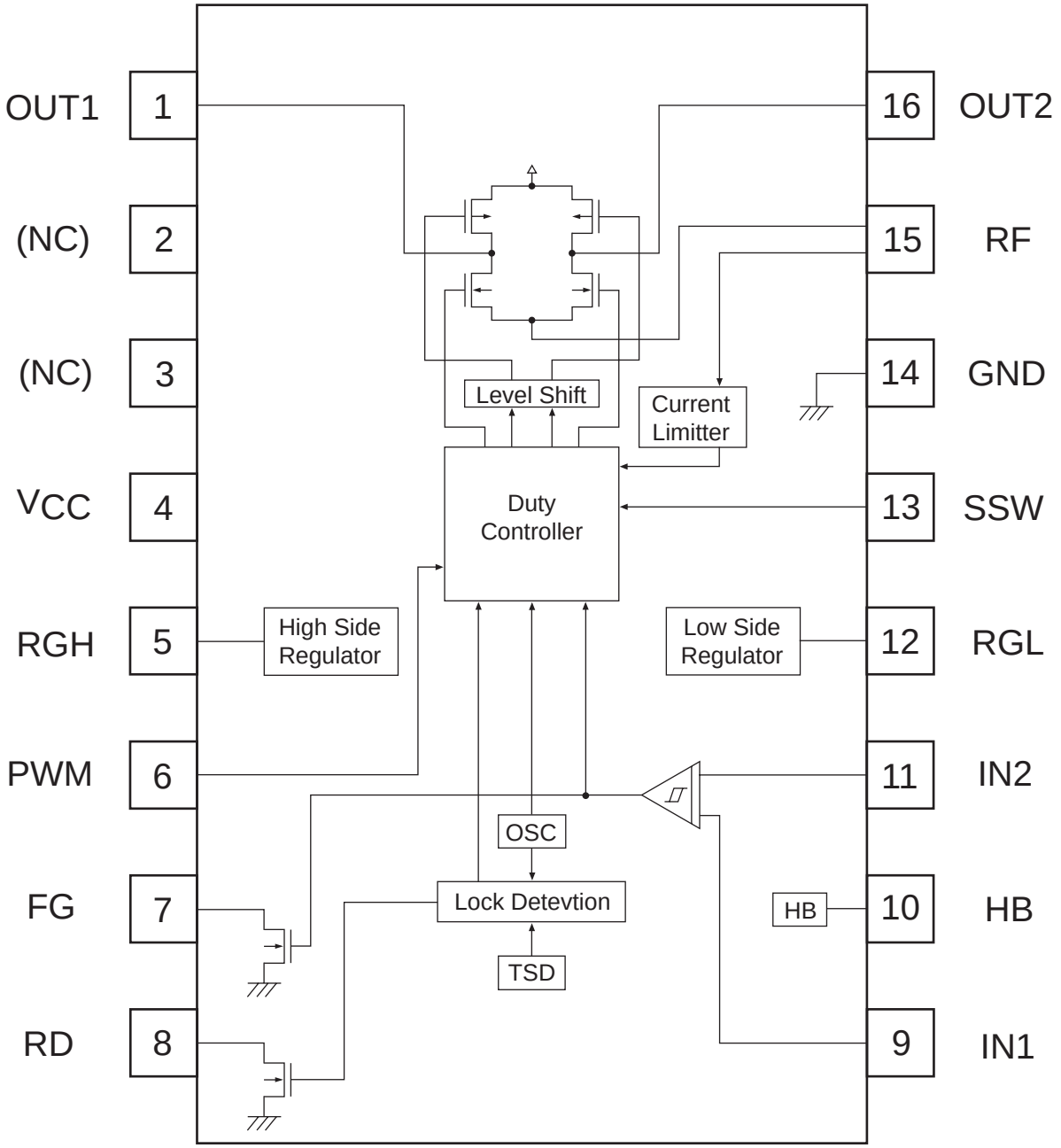




Pin Assignment

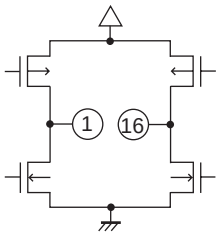
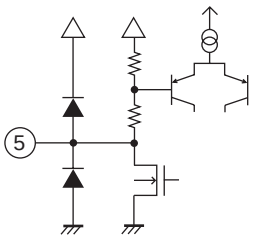
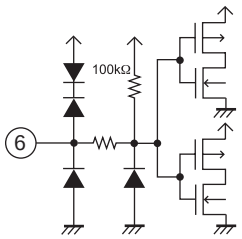
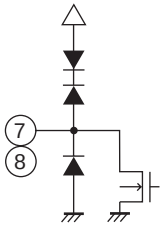
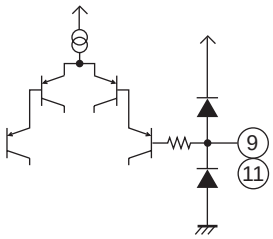
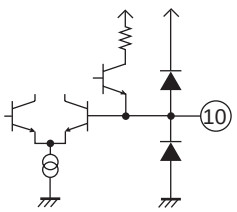


Block Diagram



PIN function

*On circuit bord, ⏚ means V_{CC}, ↑ means RGL.

NO.	Pin name	Function	Equivalent circuit
1	OUT1	Output pin for motor driver	
16	OUT2		
2	NC	No connect pin	
3	NC	No connect pin	
4	V_{CC}	Power supply pin	
5	RGH	Regulator voltage output pin for the upper output Tr driver	
6	PWM	Input pin for PWM control * OPEN: pull up to High * When input is High → output is High When input is Low → output is Low	
7	FG	FG (rotation detection) pulse output pin	
8	RD	RD (lock detection) signal output pin * During rotation → output is Low During lock → output is High	
9	IN1	Hall input + pin	
11	IN2	Hall input - pin	
10	HB	Hall bias output pin	

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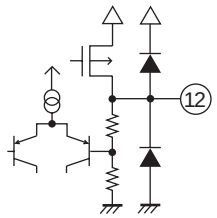
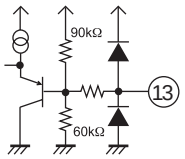
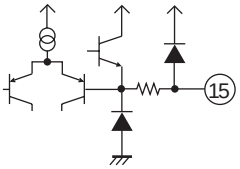
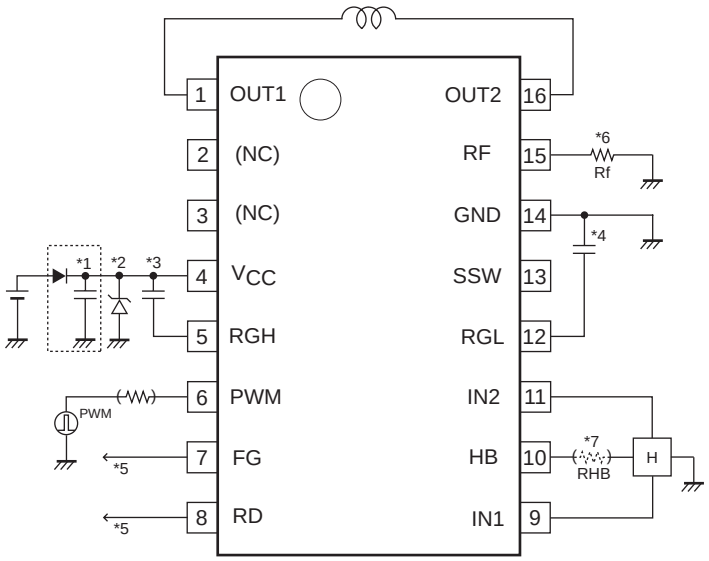
NO.	Pin name	Function	Equivalent circuit
12	RGL	Regulator voltage output pin for internal circuit and lower output Tr driver	
13	SSW	Voltage input pin for control between soft switches * OPEN: pin voltage is 2V * Soft switch zone is changed by connecting a resistance to RGL or GND to adjust pin voltage.	
14	GND	Ground pin	
15	RF	Resistive connection pin for current limiter	

Sample Application Circuit



*1 When diode Di is used to prevent destruction of IC from reverse connection, make sure to implement capacitor Cr to secure regenerative current route.

*2 If kickback at a phase change is greater, insert zener diode between GND and V_{CC} or implement the larger capacitor between GND and V_{CC} mentioned in *1

*3 Make sure to implement enough capacitance 0.1μF or greater between RGH pin and V_{CC} pin for stable performance.

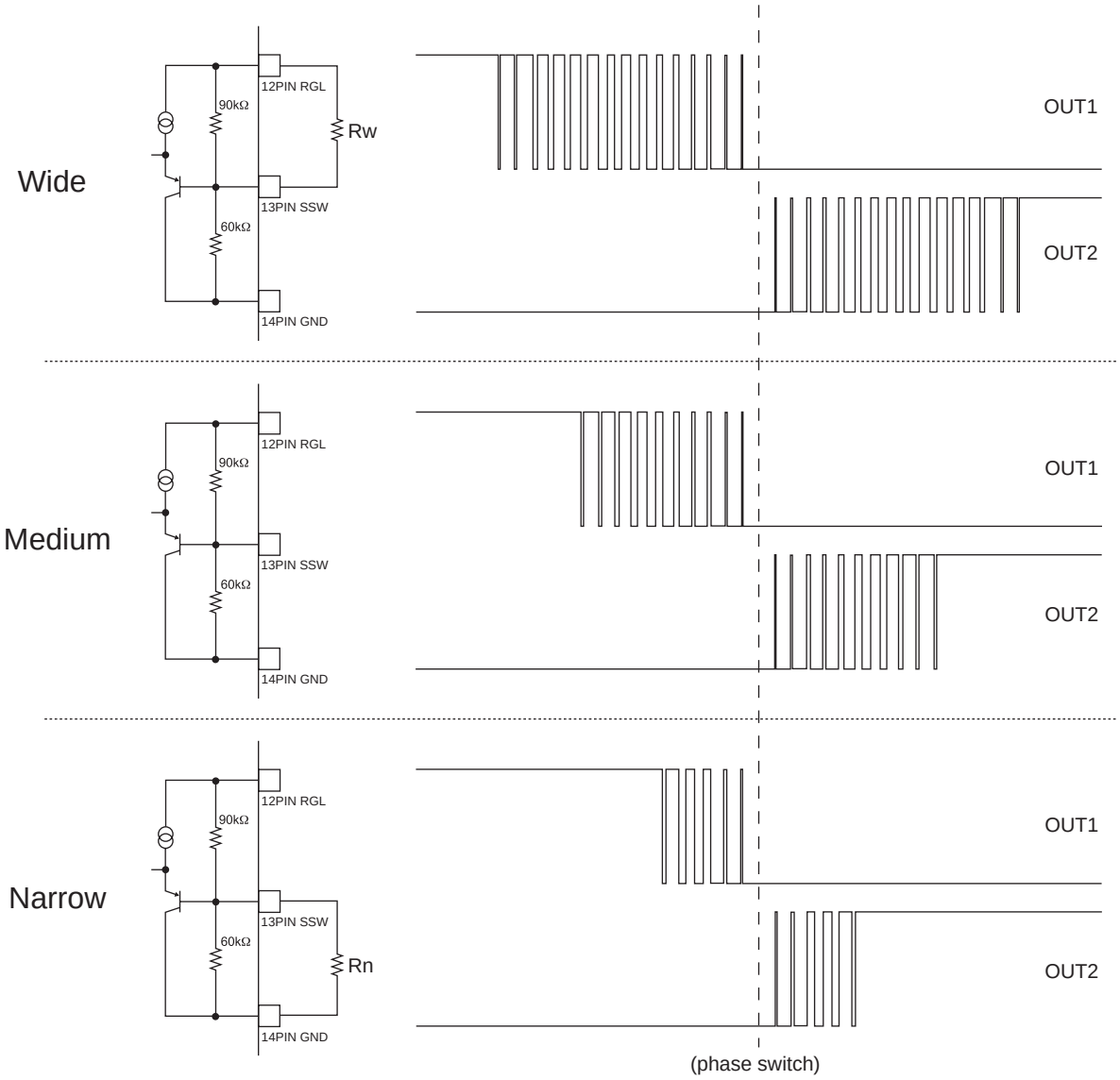
*4 Make sure to implement enough capacitance 0.1μF or greater between RGL pin and GND pin for stable performance.

*5 FG pin and RD pin are open drain output. Keep the pins open when unused.

*6 The current limiter is activated when the current detection resistor voltage exceeds 225mV between RF and GND. Where Rf=0.5Ω, current limiter is activated at I_O=450mA. Setting is made using Rf resistance.

*7 Hall element outputs stable hall signal with good temperature characteristic when it is biased with constant voltage from HB pin. If you wish to alleviate heating of IC, do not use HB pin. When you do not use this Pin (Pin HB), pull down with resistor of around 10kΩ (recommended).

Adjustment of a direction between soft switches



LV8860V realizes high efficiency and low noise by controlling reactive power using soft switch before and after phase switch by variable PWM-duty.
The width of soft switch before and after switching is controlled by SSW pin voltage. Therefore, it is adjustable by connecting an external resistance to SSW. Adjustment voltage range is between 1V and 3V.

* Without adjustment (SSW is open * this is a reference width of soft switch)
  … with IC's internal resistance: VSSW = 5 × 60k / (90k + 60k) = 2V

* To widen width of soft switch (connect Rw (resistance) between RGL and SSW.)
  … VSSW = 5 × 60k / (60k + 1 / (1/Rw + 1/90k))

  ex.) Connect Rw = 75kΩ
  VSSW = 5 × 60k / (60k + 1 / (1/75k + 1/90k)) = 2.97V

* To narrow soft switch width (connect Rn (resistance) between SSW and GND.)
  … VSSW = 5 × ((1 / (1/Rn + 1/60k)) / (90k + 1 / (1/Rn + 1/60k)))
  ex.) Connect Rn = 39kΩ
  VSSW = 5 × ((1/(1/39k + 1/60k)) / (90k + 1 / (1/39k + 1/60k))) = 1.04V

Setting value of input signal amplitude

The width of soft switch in LV8860V is controlled by input signal, IN1/IN2. The difference of input voltage (V_{IN}p-p) that creates width of soft switch is adjustable by SSW voltage (VSSW) of an external pin. The range of SSW input voltage is between 1V and 3V.

Difference of input signal amplitude in VSSW range:

- When VSSW = 1V (min), V_{IN}p-p = 30mV → make sure to input Hall signal with amplitude difference greater than 30mV.
- When VSSW = 2V (open), V_{IN}p-p = 90mV → make sure to input Hall signal with amplitude difference greater than 90mV.
- When VSSW = 3V (max), V_{IN}p-p = 150mV → make sure to input Hall signal with amplitude difference greater than 150mV.

* When input signal amplitude is greater than V_{IN}p-p (as shown in Fig. A below).
Width of soft switch is defined as shown in Fig. A

* When input signal amplitude is less than V_{IN}p-p (as shown in Fig. B below).
Since input signal is within the range of V_{IN}p-p in all rotations, the entire zone is the soft switch zone. Consequently, IC does not operate properly.

For such reason, make sure to input Hall signal with enough amplitude difference to SSW setting value so that IC operates properly.

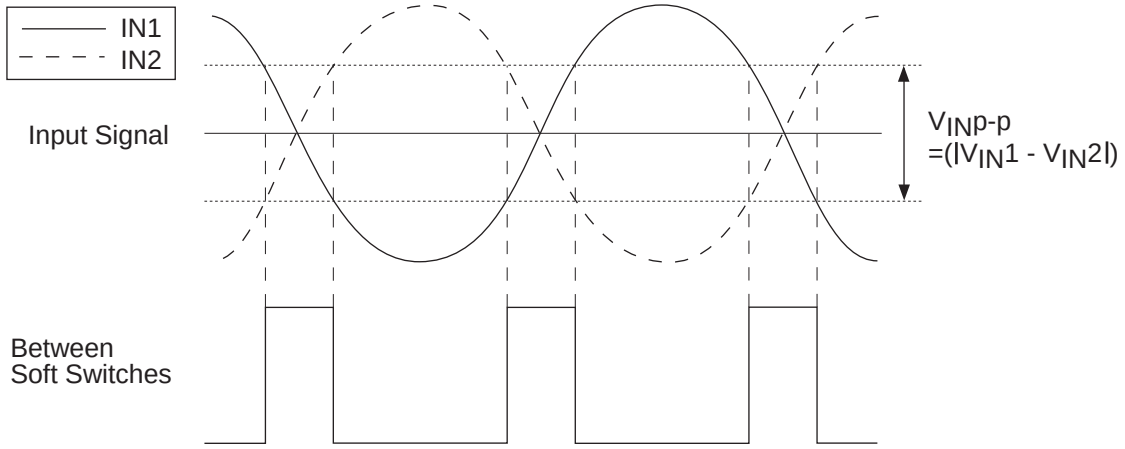


Fig.A

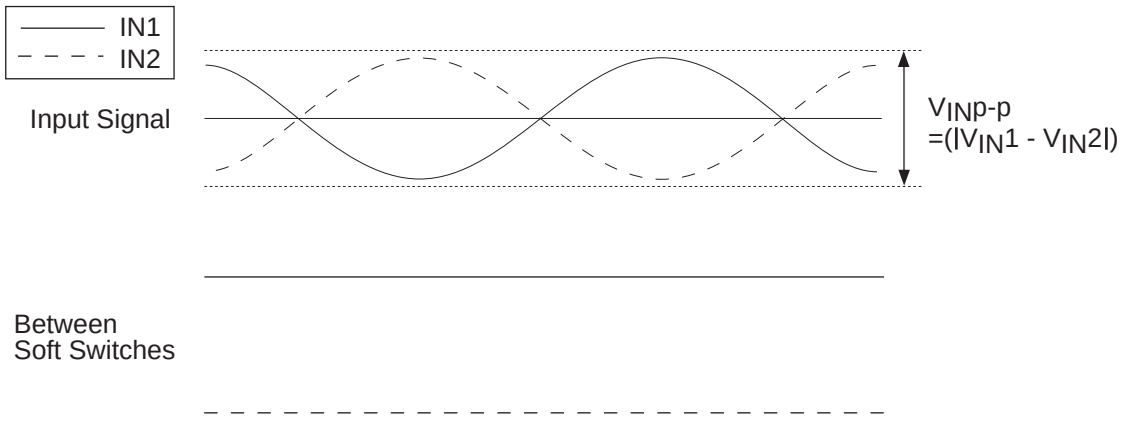
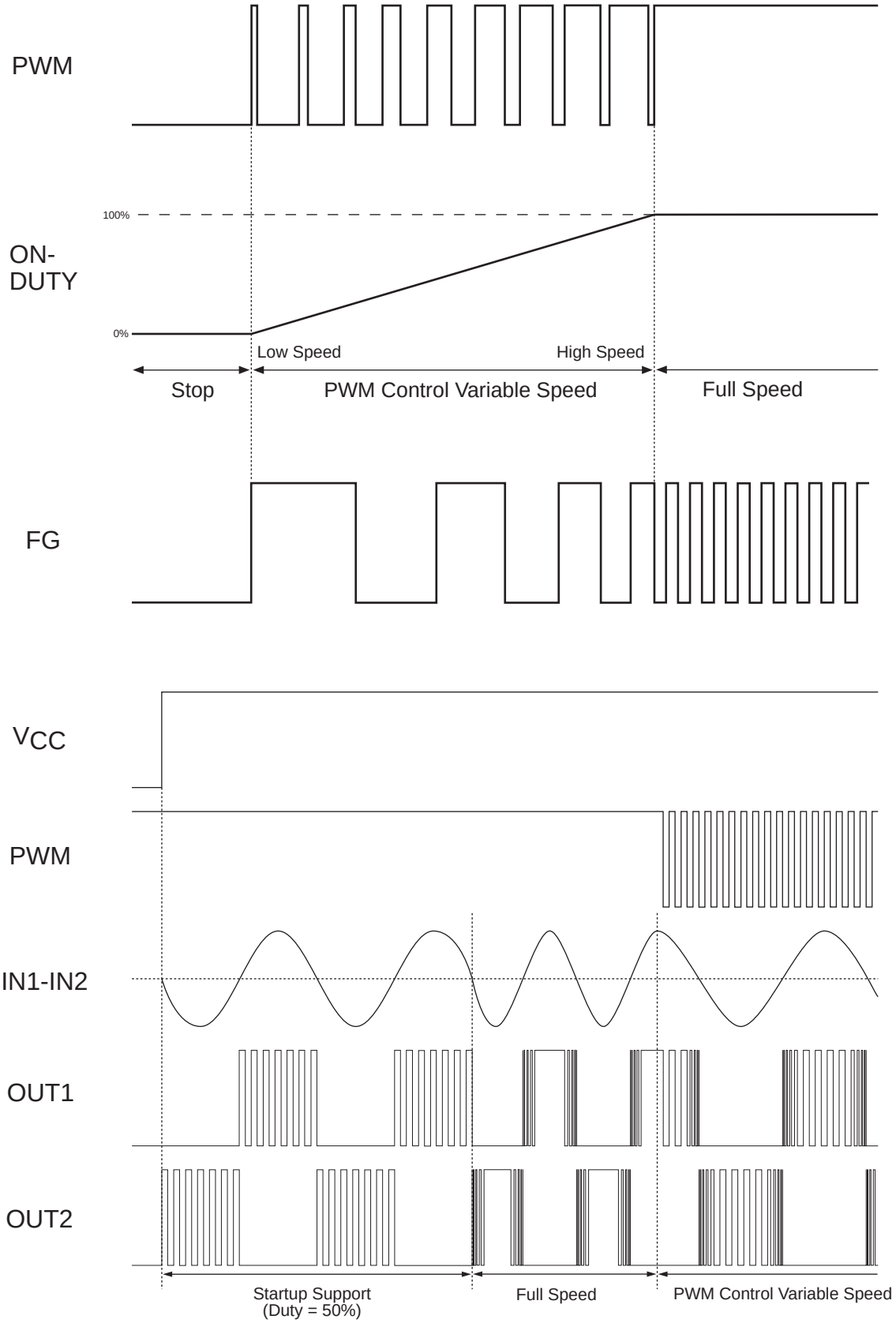


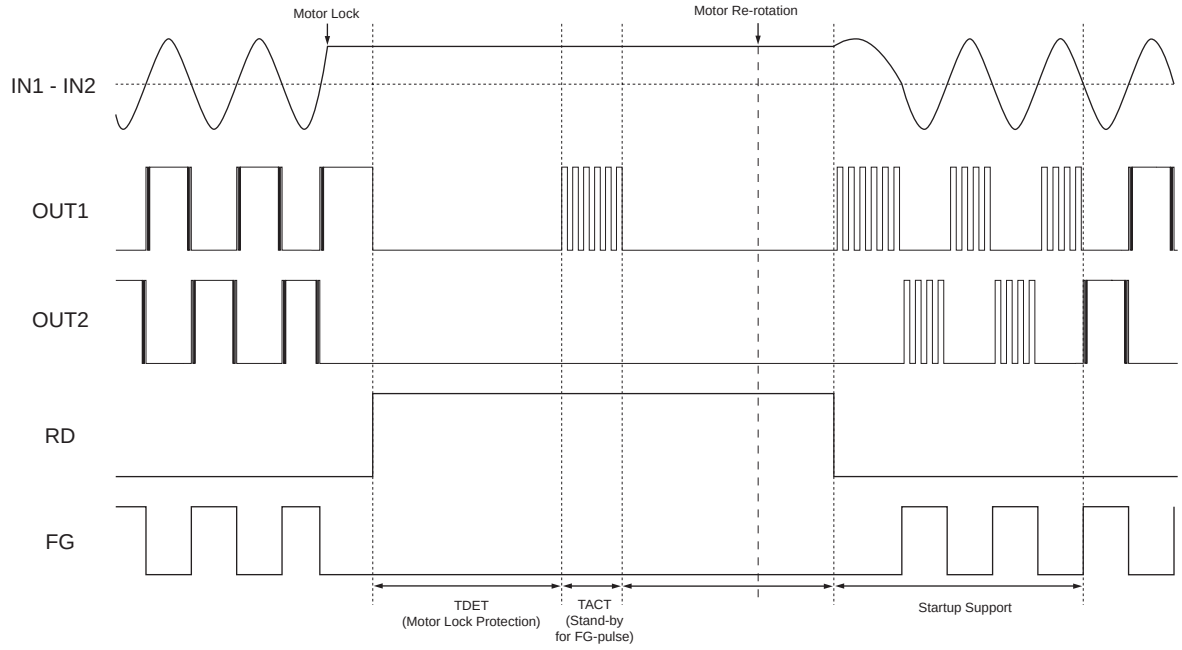
Fig.B

Description of operation

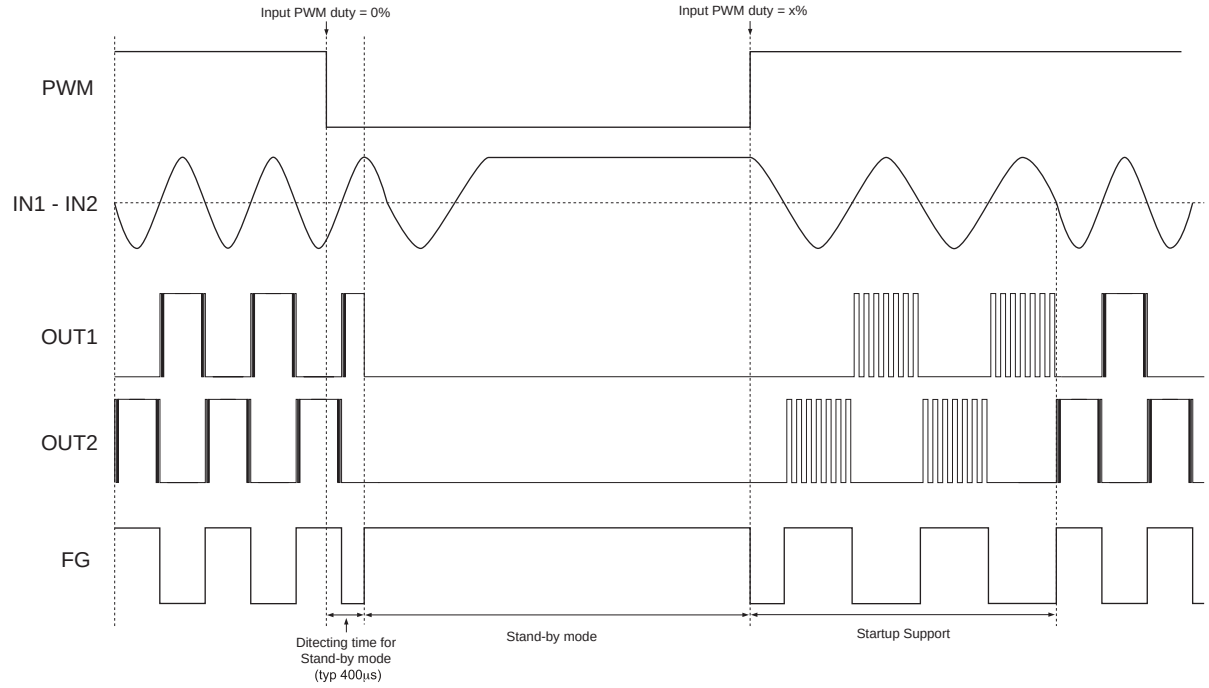
- PWM speed control waveform



• Lock protection operation waveform



• Stand-by mode operation waveform



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