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Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832

Email & Skype: info@chipsmall.com Web: www.chipsmall.com

Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China



General Description

The AM4967 is a single-coil, single-phase motor pre-driver designed by bipolar process. Its rotation speed can be controlled through an external PWM. This IC requires few external components and has the merit of high efficiency which make it suitable for use in great air volume, large current and high voltage applications.

The AM4967 is available in SSOP-16 package.

Features

- Single-phase Full-wave Pre-drive
- Rotation Speed Control via External PWM
- Maximum Operating Current Limit
- Linear Start Function for Reducing Large Current Impulse at the Moment of Turn-on
- Minimum Rotation Speed Setting
- Lock Protection and Auto Start Function
- Rotation Speed Indication
- Over Temperature Protection

Application

- CPU and OA (Office Automation) Cooler Fan
- Brushless DC Motor



Figure 1. Package Type of AM4967

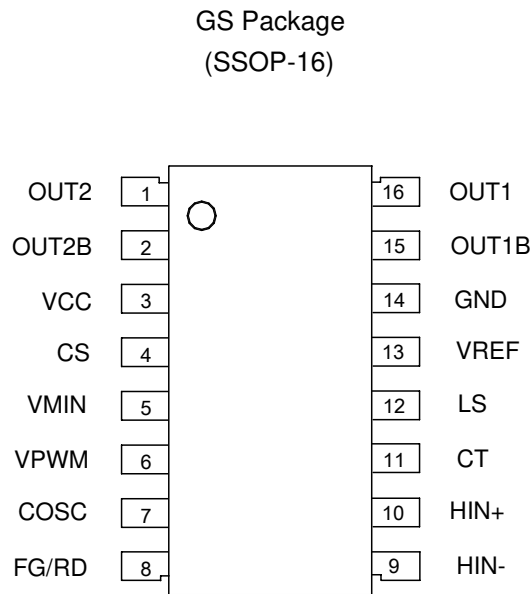
Pin Configuration

Figure 2. Pin Configuration of AM4967

**Pin Description**

Pin Number	Pin Name	Function
1	OUT2	Second channel P-type driver output. Open-drain output, must be connected with pull-up resistor to drive external power devices in operation
2	OUT2B	Second channel N-type driver output. Push-pull output to drive external power devices
3	VCC	Power supply
4	CS	Current limiter indicator. Fixed to 0.2V internally. Maximum allowable current is decided by external sample resistance. When the voltage of this pin exceeds 0.2V, the output will be shut down by current limit. If this function is not used, connect this pin to ground directly
5	VMIN	Minimum speed setting terminal. Connect it to VREF when disused. In case it is tied to other power supply for controlling, an isolated resistor is necessary
6	VPWM	Speed control terminal. It is full speed mode when connected to ground. If the speed is controlled by PWM mode, the frequency of control signal is 20kHz to 100kHz. Moreover, a low pass network is necessary to transfer PWM to DC level
7	COSC	PWM basic oscillation frequency generator when connected with a capacitor of 220pF. 30kHz frequency is available.
8	FG/RD	"FG" means pin 8 is an output pin of FG signal which is used for detecting rotation speed. "RD" means pin 8 is an output pin of RD signal, and is used for detecting fan rotate-stop state. "FG" and "RD" can be selected according to the requirement. This pin need to be connected with pull-up resistor when used. A new pulse will be generated once input signal changed. Keep this pin open when it is not to be used
9	HIN-	Hall sensor negative input. To prevent noise, this pin is recommended to be placed as close as possible to Hall circuit. If necessary, a capacitor may be added between HIN+ and HIN- to reduce the influence caused by noise
10	HIN+	Hall sensor positive input. To avoid noise, this pin is recommended to be placed as close as possible to Hall circuit
11	CT	Lock protection and auto start frequency generator. It is connected with an external 0.47 μ F capacitor which decides lock-rotate time and start time. If lock-rotate protection function is disused, please connect this pin to GND
12	LS	Linear start terminal. This pin is connected to VREF externally via a capacitor of 0.47 μ F to 1 μ F which enables fan start steadily. Start time is dependent to the capacitance. If linear start function is not used, connect this pin to ground
13	VREF	5V voltage reference
14	GND	Ground for circuit control
15	OUT1B	First channel N-type driver output. Push-pull output to drive external power devices
16	OUT1	First channel P-type driver output. Open-drain output, must be connected with pull-up resistor to drive external power devices in operation

Functional Block Diagram

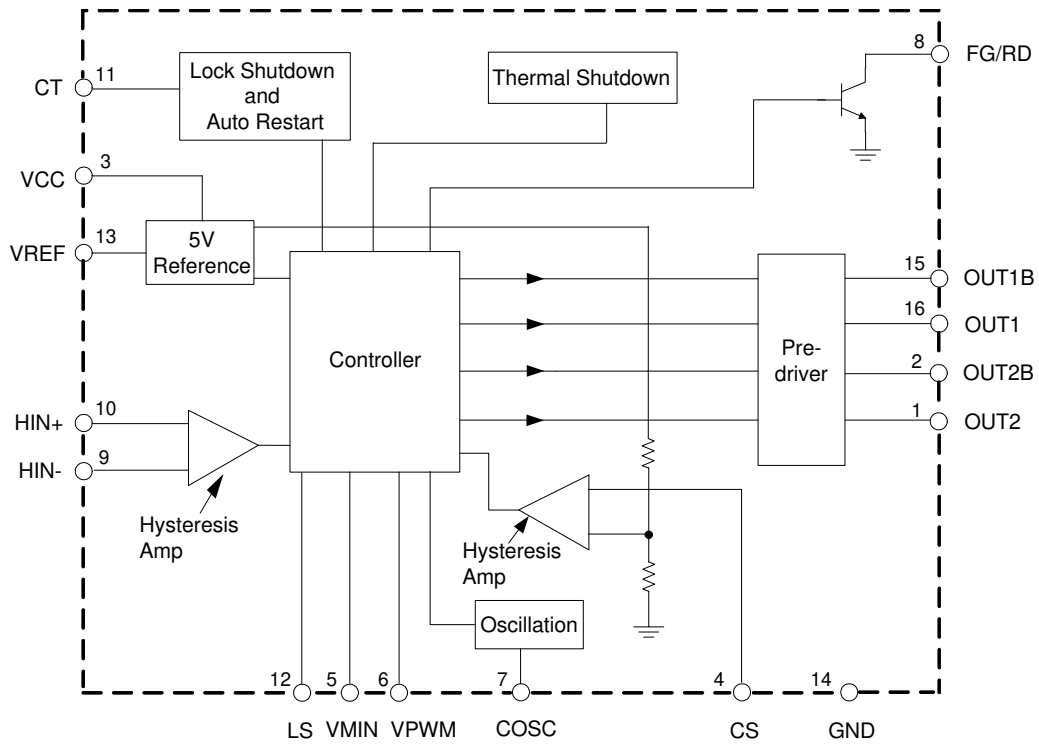


Figure 3. Functional Block Diagram of AM4967



ADJUSTABLE-SPEED SINGLE-PHASE FULL-WAVE PRE-DRIVER FOR MOTOR **AM4967**

Truth Table

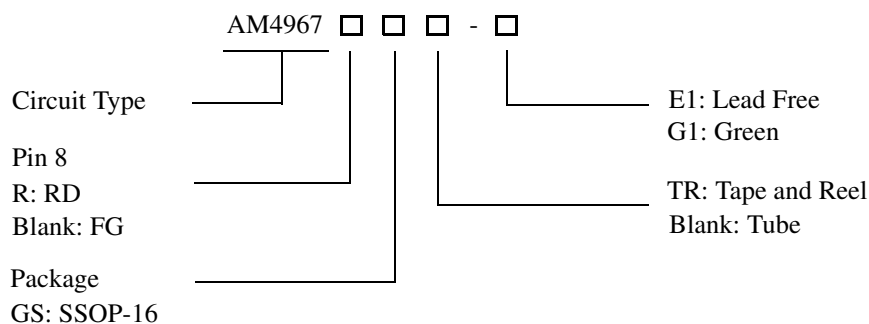
1. Driver-lock. V_{OSC} is High, V_{PWM} , V_{VMIN} and V_{LS} are low.

HIN-	HIN+	CT	OUT1	OUT1B	OUT2	OUT2B	FG/RD	Mode
H	L	L	L	L	OFF	H	L	OUT1 → OUT2 (Driver)
L	H		OFF	H	L	L	OFF	OUT2 → OUT1 (Driver)
H	L	H	OFF	L	OFF	H	L	Lock Protection
L	H		OFF	H	OFF	L	OFF	

2. Speed control. V_{CT} , V_{LS} are low.

VPWM, VMIN	COSC	HIN-	HIN+	OUT1	OUT1B	OUT2	OUT2B	Mode
L	H	H	L	L	L	OFF	H	OUT1 → OUT2 (Driver)
		L	H	OFF	H	L	L	OUT2 → OUT1 (Driver)
H	L	H	L	OFF	L	OFF	H	Regenerative
		L	H	OFF	H	OFF	L	

Ordering Information



Package	Temperature Range	Part Number		Marking ID		Packing Type
		Lead Free	Green	Lead Free	Green	
SSOP-16	-30 to 105°C	AM4967GS-E1	AM4967GS-G1	AM4967GS	AM4967GS-G1	Tube
		AM4967GSTR-E1	AM4967GSTR-G1	AM4967GS	AM4967GS-G1	Tape & Reel
		AM4967RGS-E1	AM4967RGS-G1	AM4967RGS	AM4967RGS-G1	Tube
		AM4967RGSTR-E1	AM4967RGSTR-G1	AM4967RGS	AM4967RGS-G1	Tape & Reel

BCD Semiconductor's Pb-free products, as designated with "E1" suffix in the part number, are RoHS compliant. Products with "G1" suffix are available in green package.

**Absolute Maximum Ratings (Note 1)**

Parameter	Symbol	Value	Unit
Supply Voltage	V_{CC}	18	V
OUT1B/OUT2B Output Current	I_{OUTB}	20	mA
OUT1/OUT2 Sink Current	I_{OUT}	20	mA
OUT1B/OUT2B/OUT1/OUT2 Withstand Voltage	V_{OUT}	18	V
VPWM/VMIN Withstand Voltage	V_{PWM}/V_{VMIN}	7	V
LS Withstand Voltage	V_{LS}	7	V
FG/RD Withstand Voltage	V_{FG}/V_{RD}	V_{CC}	V
FG/RD Output Current	I_{FG}/I_{RD}	10	mA
VREF Output Current	I_{REF}	20	mA
Power Dissipation (Note 2)	P_D	800	mW
Storage Temperature Range	T_{STG}	-55 to 150	°C
ESD (Human Body Model)	ESD	2000	V

Note 1: Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "Recommended Operating Conditions" is not implied. Exposure to "Absolute Maximum Ratings" for extended periods may affect device reliability.

Note 2: When mounted on the specified printed circuit board (114.3mm×76.1mm×1.6mm, glass epoxy).

Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Unit
Supply Voltage	V_{CC}	5.5		16	V
VPWM/VMIN Input Voltage		0		5	V
Hall Input Voltage		0.2		3	V
Ambient Temperature	T_A	-30		105	°C



ADJUSTABLE-SPEED SINGLE-PHASE FULL-WAVE PRE-DRIVER FOR MOTOR **AM4967**

Electrical Characteristics

($V_{CC}=12V$, $T_A=25^{\circ}C$, unless otherwise specified.)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Quiescent Current	I_{Q1}	Lock off	8	10	12	mA
	I_{Q2}	Lock on	8	10	12	
VREF Reference Voltage	V_{REF}	$I_{OUT}=5mA$	4.5	5.0	5.5	V
Current Limit Voltage	V_{LIM}		186	200	215	mV
COSC High Level Voltage	V_{OSCH}		3.0	3.4	3.8	V
COSC Low Level Voltage	V_{OSCL}		0.9	1.1	1.3	V
COSC Frequency	f_{OSC}	$C_L=220pF$	25.4	30	35.5	kHz
CT High Level Voltage	V_{CTH}		2.4	3.3	3.6	V
CT Low Level Voltage	V_{CTL}		1.0	1.3	1.6	V
CT Charge Current	I_{CHG}	$V_{CT}=0.5V$	1.5	2	2.5	μA
CT Discharge Current	I_{DHG}	$V_{CT}=3.5V$	0.13	0.2	0.25	μA
CT Charge and Discharge Ratio	R_{CD}	I_{CHG}/I_{DHG}	8.5	10	14.5	
Linear Start Charge Current	I_{LS}	$V_{LS}=1V$		0.5	0.7	μA
OUT1B/OUT2B High Level Voltage	V_{OBH}	$I_{OUT}=10mA$	$V_{CC}-1.8$	$V_{CC}-0.9$	V_{CC}	V
OUT1B/OUT2B Low Level Voltage	V_{OBL}	$I_{OUT}=10mA$		0.9	1.5	V
OUT1/OUT2 Low Level Voltage	V_{OL}	$I_{OUT}=10mA$		0.45	0.8	V
FG Signal Hall Input Sensitivity	V_{HN}	I_{HIN+} , I_{HIN-} difference voltage (include offset and hysteresis)		± 10		mV
FG Saturation Voltage	V_{SAT}	$I_{SINK}=5mA$		200	500	mV
FG Leakage Current	I_{LFG}	$V_{FG}=V_{CC}$			30	μA
VPWM/VMIN Bias Current	I_{PWMB}/I_{VMINB}	$V_{OSC}=V_{PWM}/V_{VMIN}=2V$		0.1	3	μA



Typical Performance Characteristics

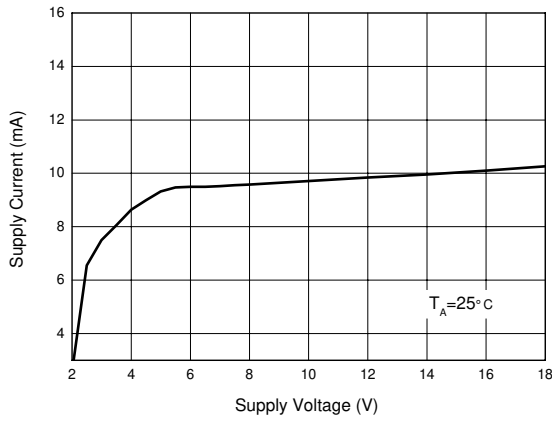


Figure 4. Supply Current vs. Supply Voltage

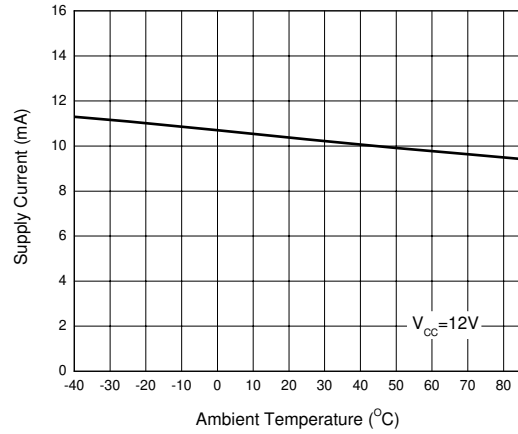


Figure 5. Supply Current vs. Ambient Temperature

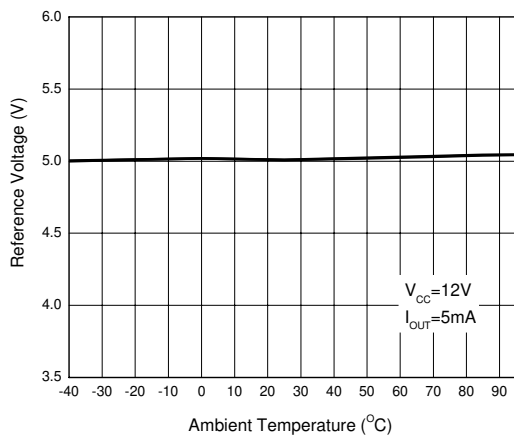


Figure 6. Reference Voltage vs. Ambient Temperature

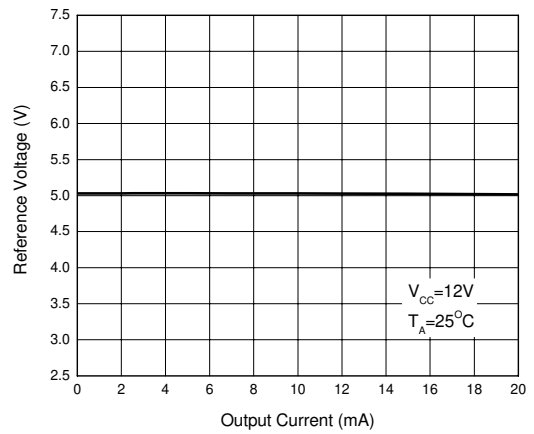


Figure 7. Reference Voltage vs. Output Current



Typical Performance Characteristics (Continued)

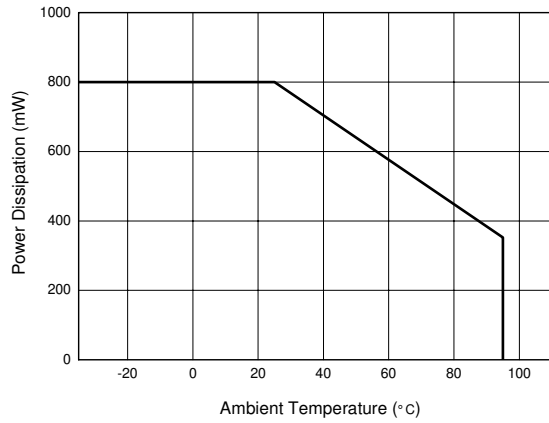


Figure 8. Power Dissipation vs. Ambient Temperature

Operating Diagram

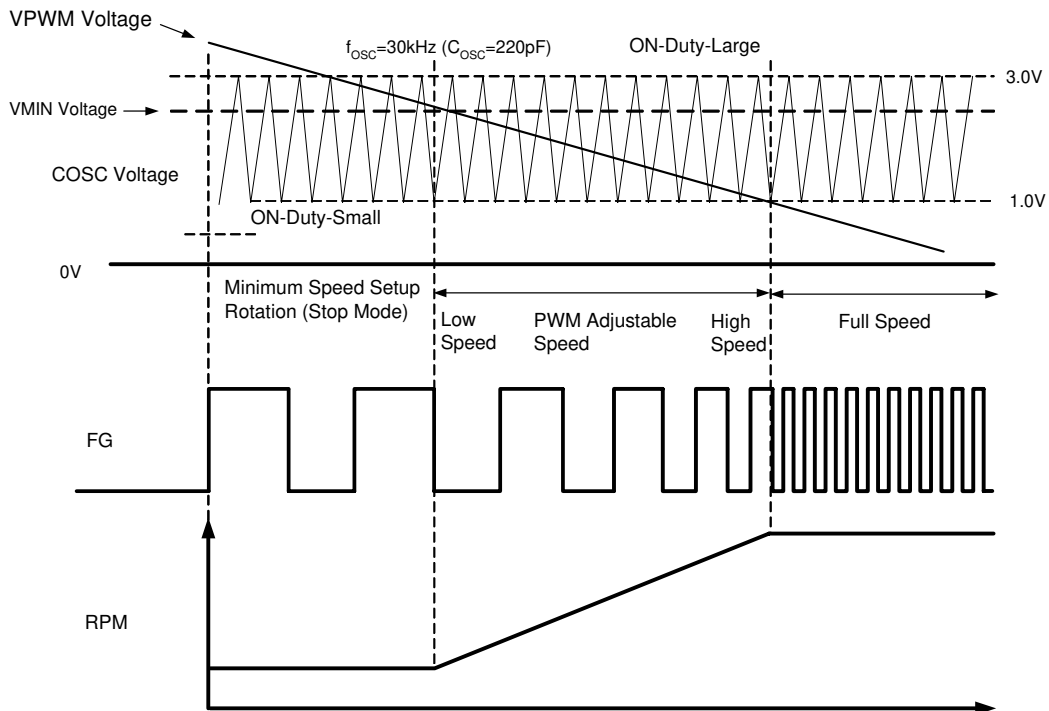


Figure 9. Operating Diagram 1 of AM4967 (Speed Control, Note 3)

Note 3:

1. Minimum Speed Setting Mode (Stop Mode)

When fan rotate at low speed, its lowest speed is settable by VMIN pin voltage. If not, fan motor stops.

2. Low Speed to High Speed Setting Mode

PWM control system works by comparing the voltage of VPWM and COSC (1.0V to 3.0V). When VPWM voltage is low, the transistors of the upper and lower side outputs are ON. On contrary, when VPWM voltage is high, the upper side transistors are OFF. And coil current re-circulates in a lower side transistor. Therefore, as the VPWM

voltage becomes lower, output ON duty becomes large. Sequentially, coil current increases and the motor runs at high speed which is monitored by FG output while rotation-stop state is monitored by RD output.

3. Full Speed Rotation Mode

When VPWM voltage drops to 1.0V or lower, motor fan will run at full speed. (If the speed is not controlled, $V_{PWM}=GND$)



Operating Diagram (Continued)

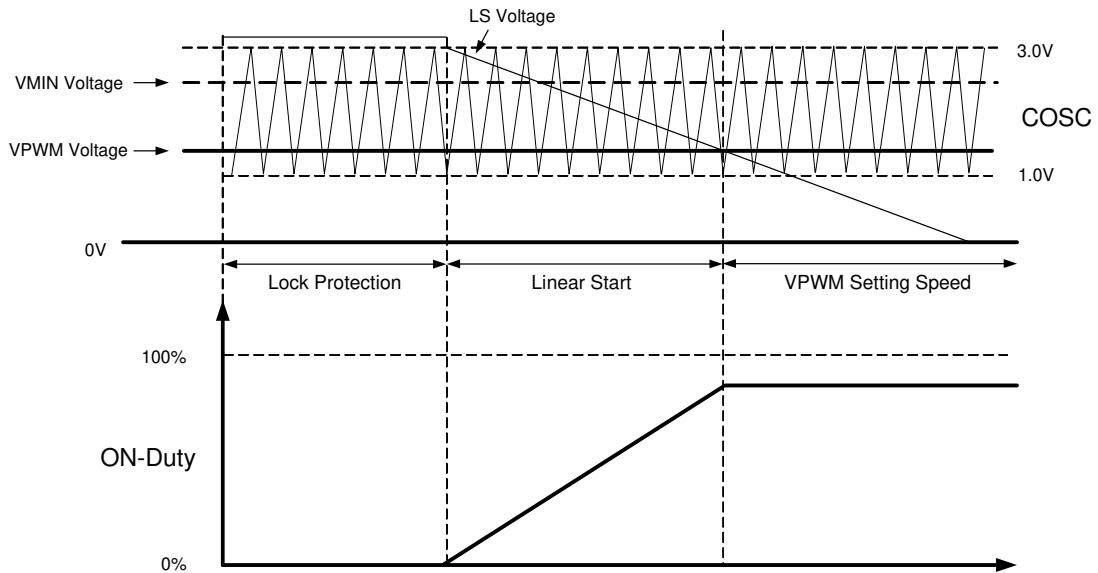


Figure 10. Operating Diagram 2 of AM4967 (Linear Start, VPWM Voltage < VMIN Voltage, Note 4)

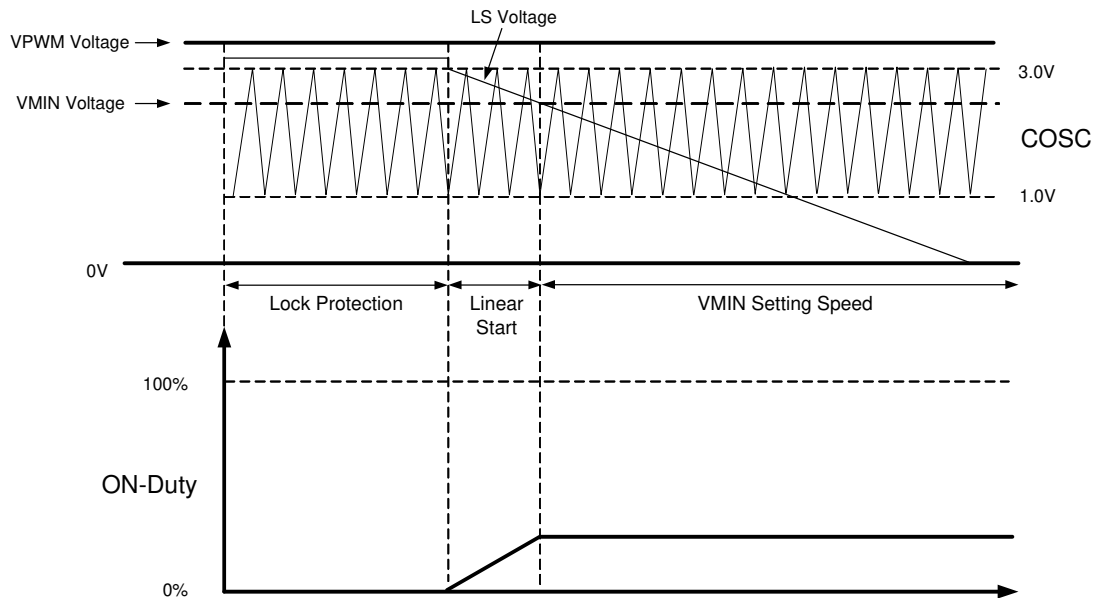


Figure 11. Operating Diagram 3 of AM4967 (Linear Start, VPWM Voltage > VMIN Voltage, Note 4)

Operating Diagram (Continued)

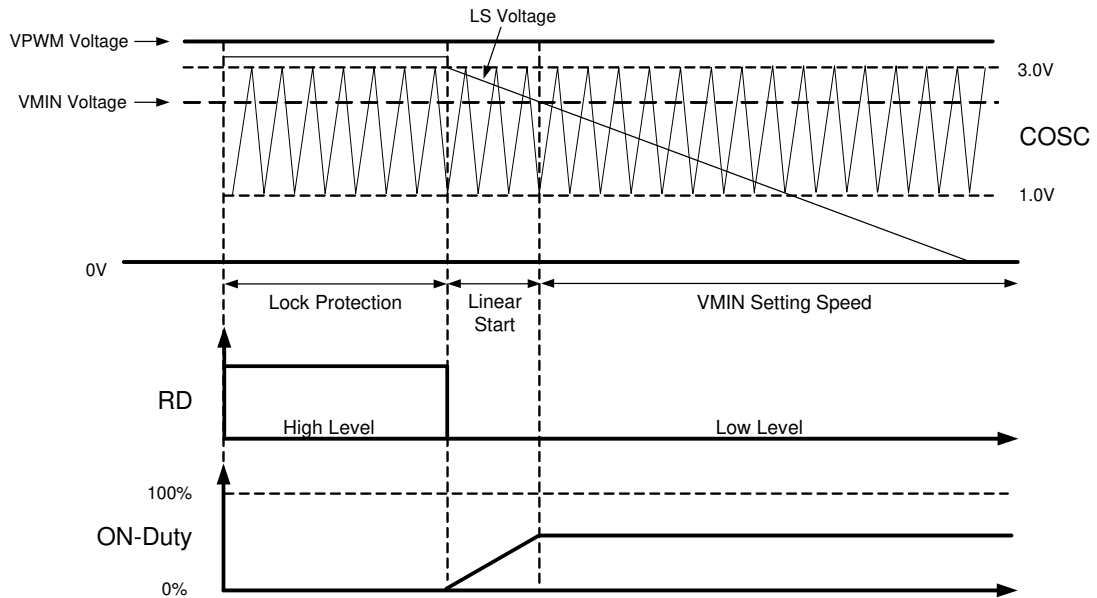


Figure 12. Operating Diagram 4 of AM4967 (Note 4)

Note 4: The inclination of LS voltage is adjusted between V_{LS} and V_{REF} according to the capacitance which is recommended to be 0.1 μ F to 1.0 μ F.

Typical Application

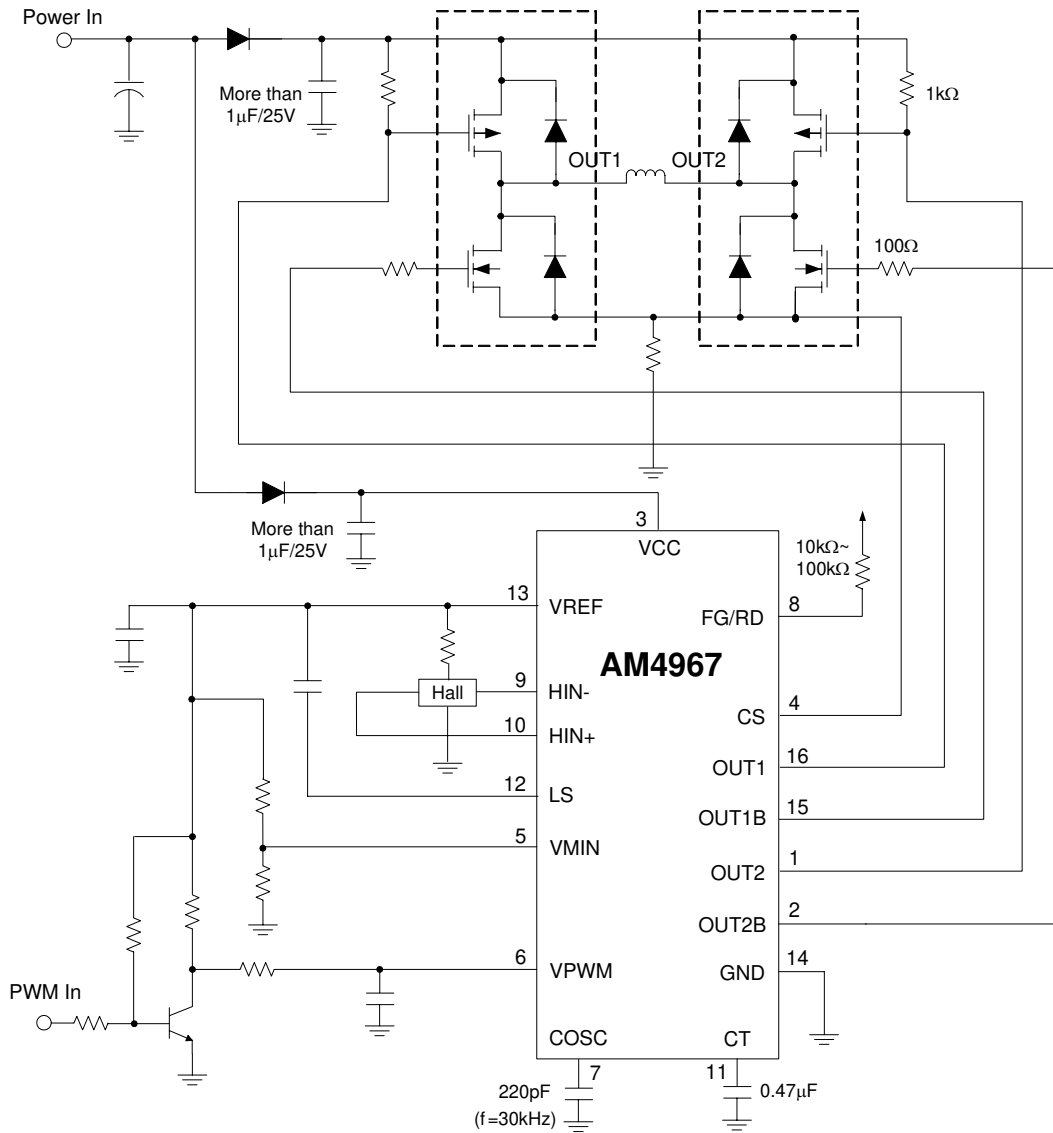


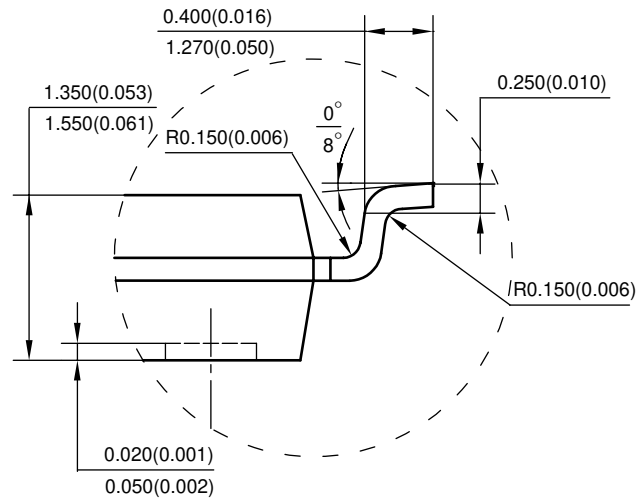
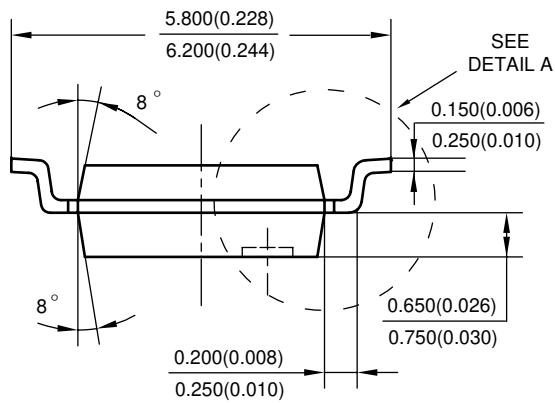
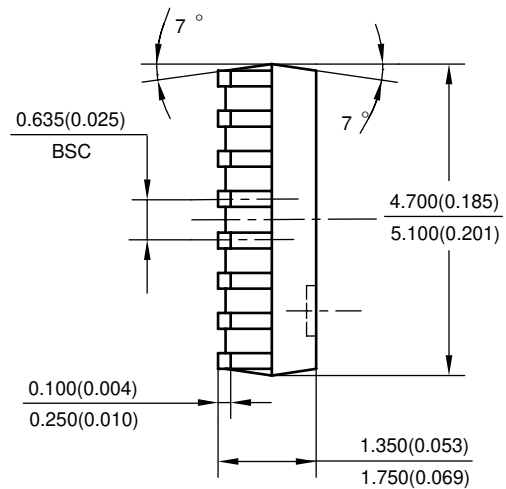
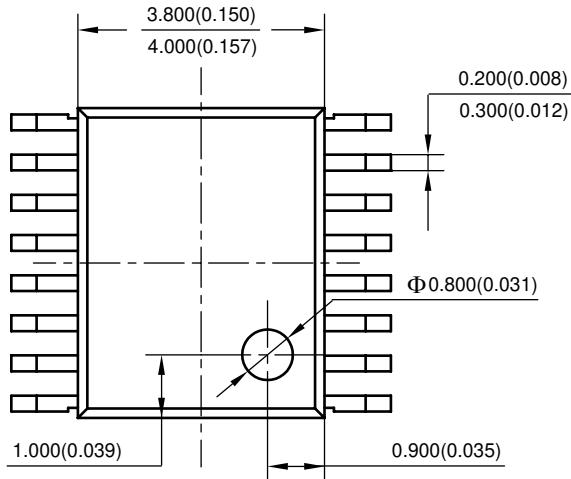
Figure 13. Typical Application of AM4967 ($V_{CC}=12V$)



Mechanical Dimensions

SSOP-16

Unit: mm(inch)



DETAIL A



BCD Semiconductor Manufacturing Limited

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MAIN SITE

- Headquarters

BCD Semiconductor Manufacturing Limited

No. 1600, Zi Xing Road, Shanghai ZiZhu Science-based Industrial Park, 200241, China
Tel: +86-21-24162266, Fax: +86-21-24162277

- Wafer Fab

Shanghai SIM-BCD Semiconductor Manufacturing Co., Ltd.

800 Yi Shan Road, Shanghai 200233, China
Tel: +86-21-6485 1491, Fax: +86-21-5450 0008

REGIONAL SALES OFFICE

Shenzhen Office

Shanghai SIM-BCD Semiconductor Manufacturing Co., Ltd., Shenzhen Office

Unit A Room 1203, Skyworth Bldg., Gaoxin Ave. 1.S., Nanshan District, Shenzhen, China
Tel: +86-755-8826 7951
Fax: +86-755-8826 7865

Taiwan Office

BCD Semiconductor (Taiwan) Company Limited

4F, 298-1, Rui Guang Road, Nei-Hu District, Taipei, Taiwan
Tel: +886-2-2656 2808
Fax: +886-2-2656 2806

USA Office

BCD Semiconductor Corp.

30920 Huntwood Ave. Hayward, CA 94544, USA
Tel : +1-510-324-2988
Fax: +1-510-324-2788