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

Description

The DIODES™ 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 makes it suitable for use in great air volume, large current and high-voltage applications.

The AM4967 is available in SSOP-16 package.

Pin Assignments

GS Package
(SSOP-16)

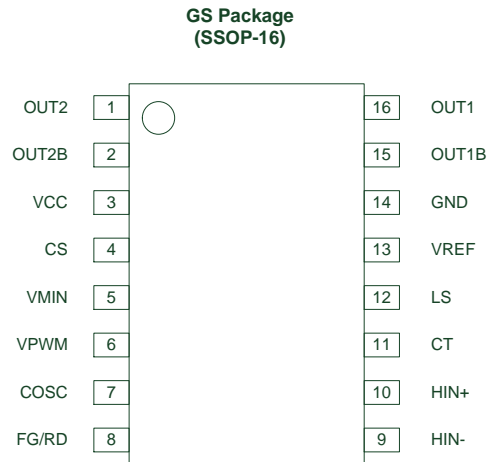| Pin	Name		Pin	Name
1	OUT2		16	OUT1
2	OUT2B		15	OUT1B
3	VCC		14	GND
4	CS		13	VREF
5	VMIN		12	LS
6	VPWM		11	CT
7	COSC		10	HIN+
8	FG/RD		9	HIN-

Figure 1. Pin Assignment of AM4967

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
- Overtemperature Protection
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **For automotive applications requiring specific change control (i.e. parts qualified to AEC-Q100/101/104/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please contact us or your local Diodes representative. https://www.diodes.com/quality/product-definitions/**

Applications

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

SSOP-16

Figure 2. Package Type of AM4967

Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

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Pin Descriptions

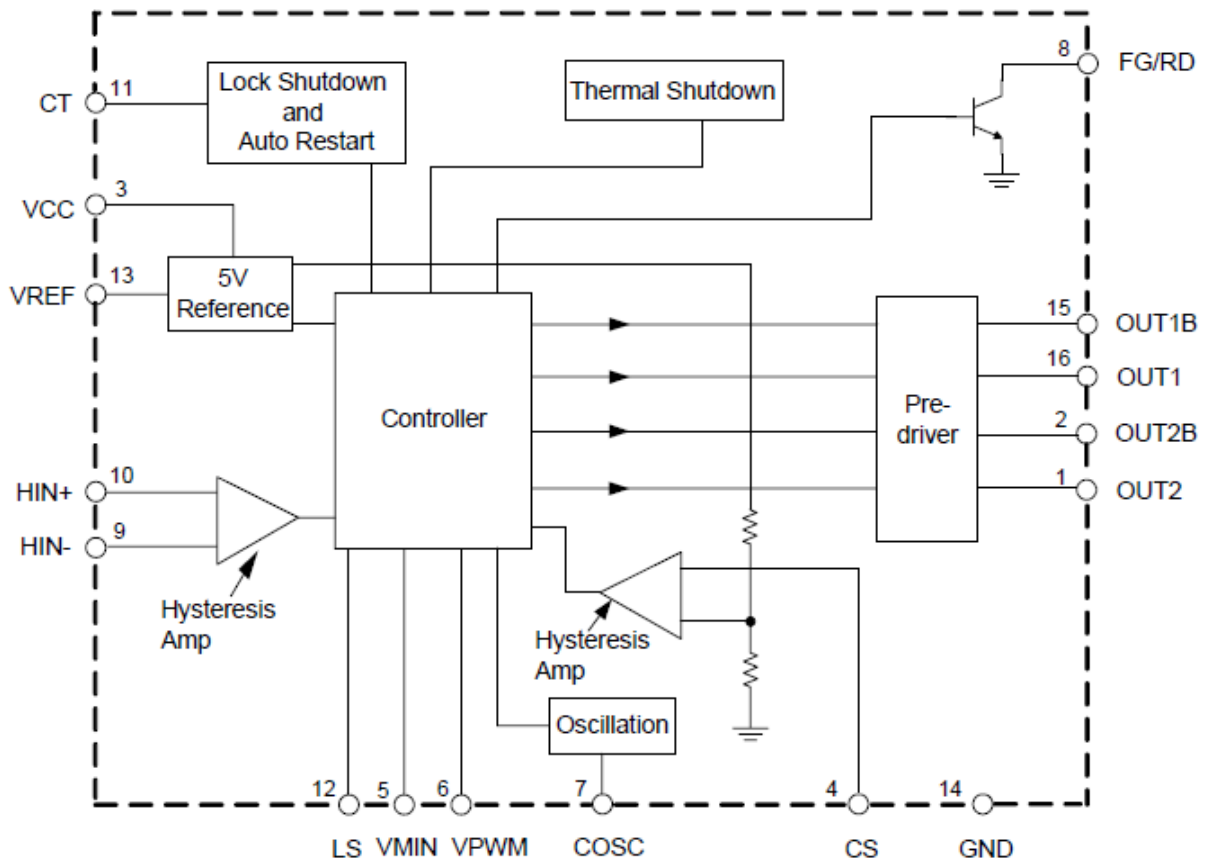| Pin Number	Pin Name	Function
1	OUT2	Second channel P-type driver output. Open-drain output, must be connected with pull-up resistor to drive external power devices in operation
2	OUT2B	Second channel N-type driver output. Push-pull output to drive external power devices
3	VCC	Power supply
4	CS	Current 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 0.47µF 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 0.47µF to 1µF 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

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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	$\rightarrow$ OUT2 (Driver)
L	H		OFF	H	L	L	OFF	OUT2	$\rightarrow$ 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	$\rightarrow$ OUT2 (Driver)
		L	H	OFF	H	L	L	OUT2	$\rightarrow$ OUT1 (Driver)
H	L	H	L	OFF	L	OFF	H	Regenerative	
		L	H	OFF	H	OFF	L		

Ordering Information (Note 4)

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Circuit Type

Pin 8
R: RD
Blank: FG

Package
GS: SSOP-16

E1: Lead Free
G1: Green

TR: Tape and Reel
Blank: Tube
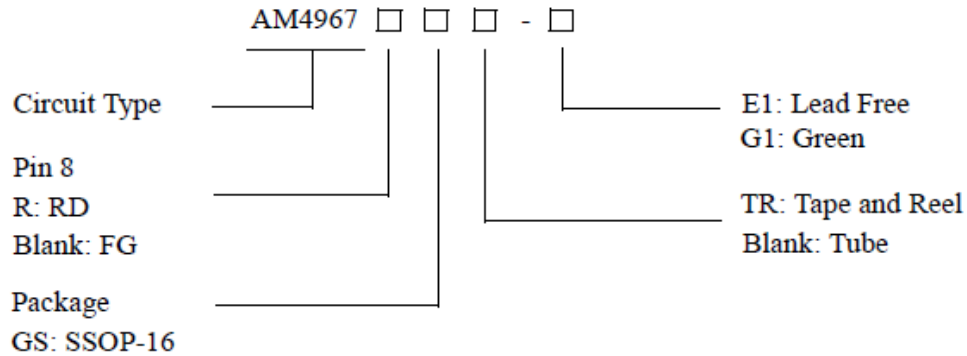
Package	Temperature	Part Number		Marking ID		Packing Type
		Lead Free	Green	Lead Free	Green	
SSOP-16	-30 to 105℃	AM4967GS-E1	AM4967GS-G1	AM4967GS	AM4967GS-G1	Tube
		AM4967GSTR-E1	AM4967GSTR-G1	AM4967GS	AM4967GS-G1	Tape & Reel
		AM4967RGS-E1	AM4967RGS-G1	AM4967RGS	AM4967RGS-G1	Tube
		AM4967RGSTR-E1	AM4967RGSTR-G1	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.

Note: 4.For packaging details, go to our website at https://www.diodes.com/design/support/packaging/diodes-packaging/ .

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Absolute Maximum Ratings (Note 5)

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 6)	P_D	800	mW
Storage Temperature Range	T_{STG}	-55 to 150	°C
ESD (Human Body Model)	ESD	2000	V

Notes: 5. 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.

6. When mounted on the specified printed circuit board (114.3mmX76.1mmX1.6mm, 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	TA	-30		105	°C

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Electrical Characteristics (V_{CC}=12V, T_A=25°C, unless otherwise specified.)

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Quiescent Current	IQ1	Lock off	8	10	12	mA
	IQ2	Lock on	8	10	12	
VREF Reference Voltage	VREF	IOUT=5mA	4.5	5.0	5.5	V
Current Limit Voltage	VLIM		186	200	215	mV
COSC High Level Voltage	VOSCH		3.0	3.4	3.8	V
COSC Low Level Voltage	VOSCL		0.9	1.1	1.3	V
COSC Frequency	fOSC	CL=220pF	25.4	30	35.5	kHz
CT High Level Voltage	VCTH		2.4	3.3	3.6	V
CT Low Level Voltage	VCTL		1.0	1.3	1.6	V
CT Charge Current	ICHG	VCT=0.5V	1.5	2	2.5	μA
CT Discharge Current	IDHG	VCT=3.5V	0.13	0.2	0.25	μA
CT Charge and Discharge Ratio	RCD	ICHG/IDHG	8.5	10	14.5	
Linear Start Charge Current	ILS	VLS=1V		0.5	0.7	μA
OUT1B/OUT2B High Level Voltage	VOBH	IOUT=10mA	Vcc ~1.8	Vcc ~0.9	Vcc	V
OUT1B/OUT2B Low Level Voltage	VOBL	IOUT=10mA		0.9	1.5	V
OUT1/OUT2 Low Level Voltage	VOL	IOUT=10mA		0.45	0.8	V
FG Signal Hall Input Sensitivity	VHN	IHIN+,IHIN- difference voltage (include offset and hysteresis)		±10		mV
FG Saturation Voltage	VSAT	ISINK=5mA		200	500	mV
FG Leakage Current	ILFG	VFG=VCC			30	μA
VPWM/VMIN Bias Current	IPWMB/IVMINB	VOSC=VPWM/VVMIN=2V		0.1	3	μA

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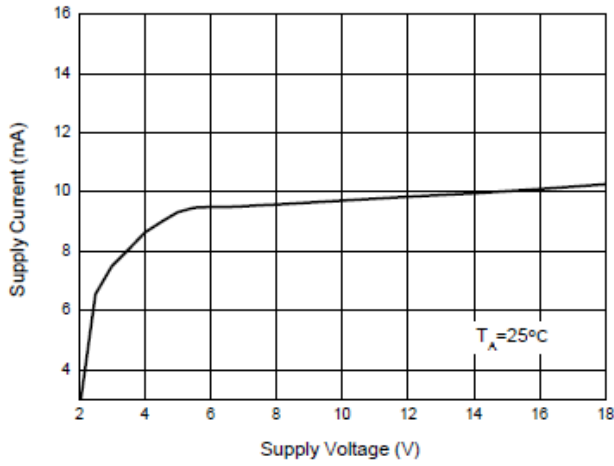
Typical Performance Characteristics

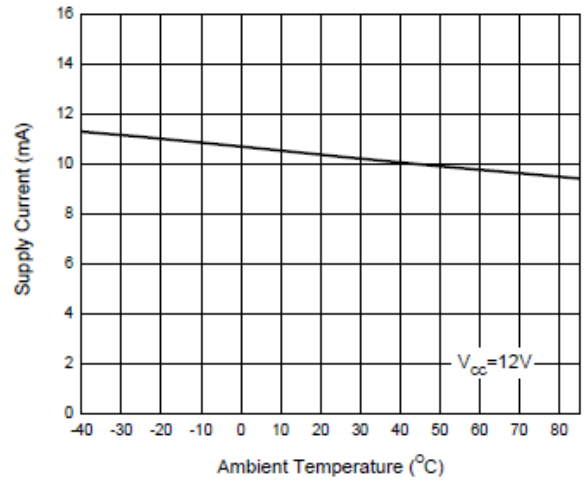Figure 4. Supply Current vs. Supply Voltage

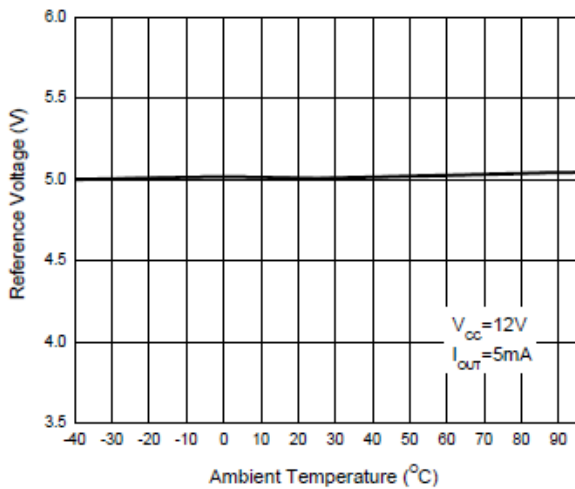Figure 5. Supply Current vs. Ambient Temperature
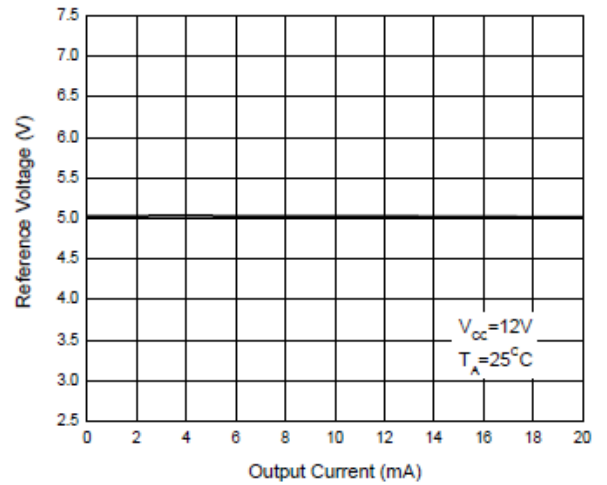

Figure 6. Reference Voltage vs. Ambient Temperature Current

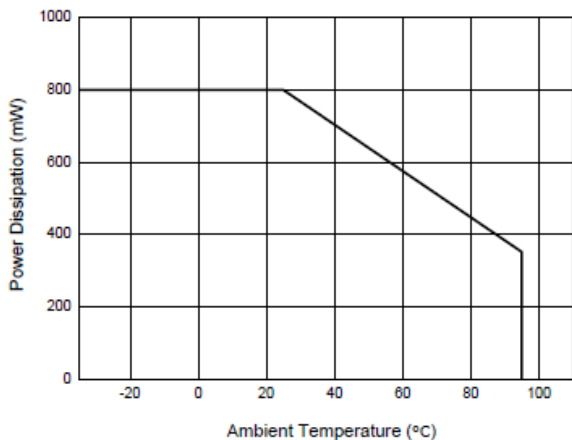Figure 7. Reference Voltage vs. Output
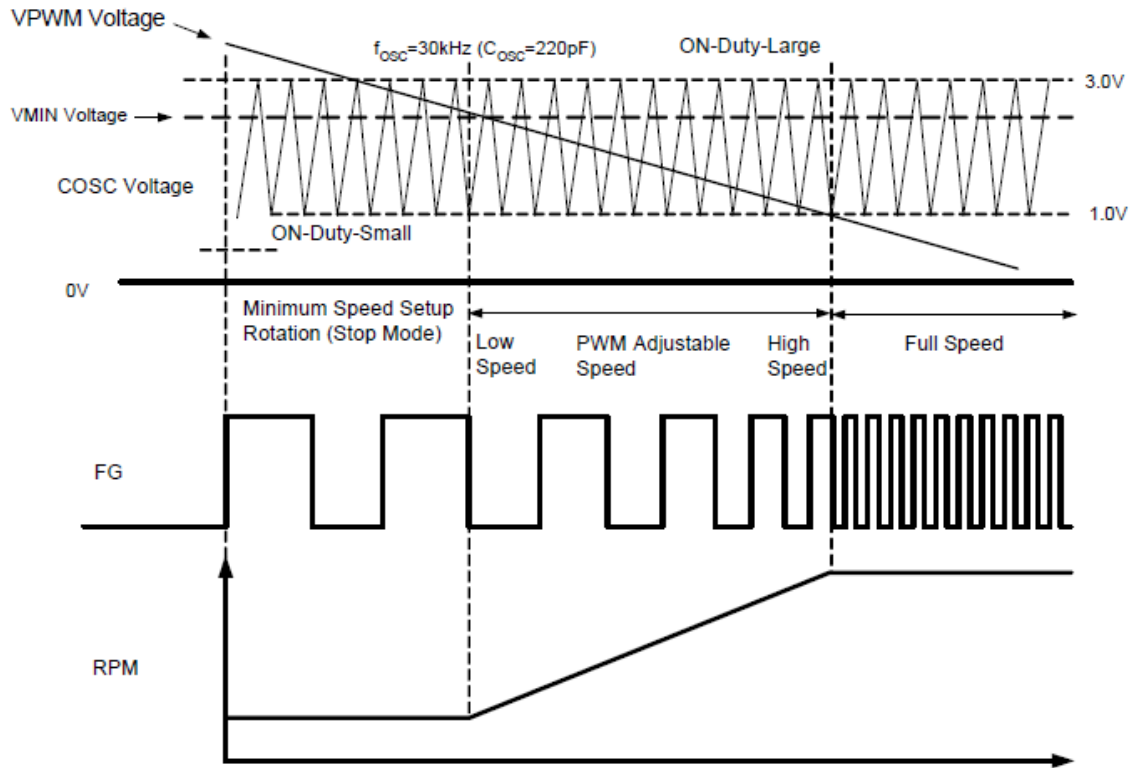

Figure 8. Power Dissipation vs. Ambient Temperature

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Operating Diagram

Figure 9. Operating Diagram 1 of AM4967 (Speed Control, Note 7)

Note: 7.

a. 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.

b. 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.

c. 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, VPWM=GND)
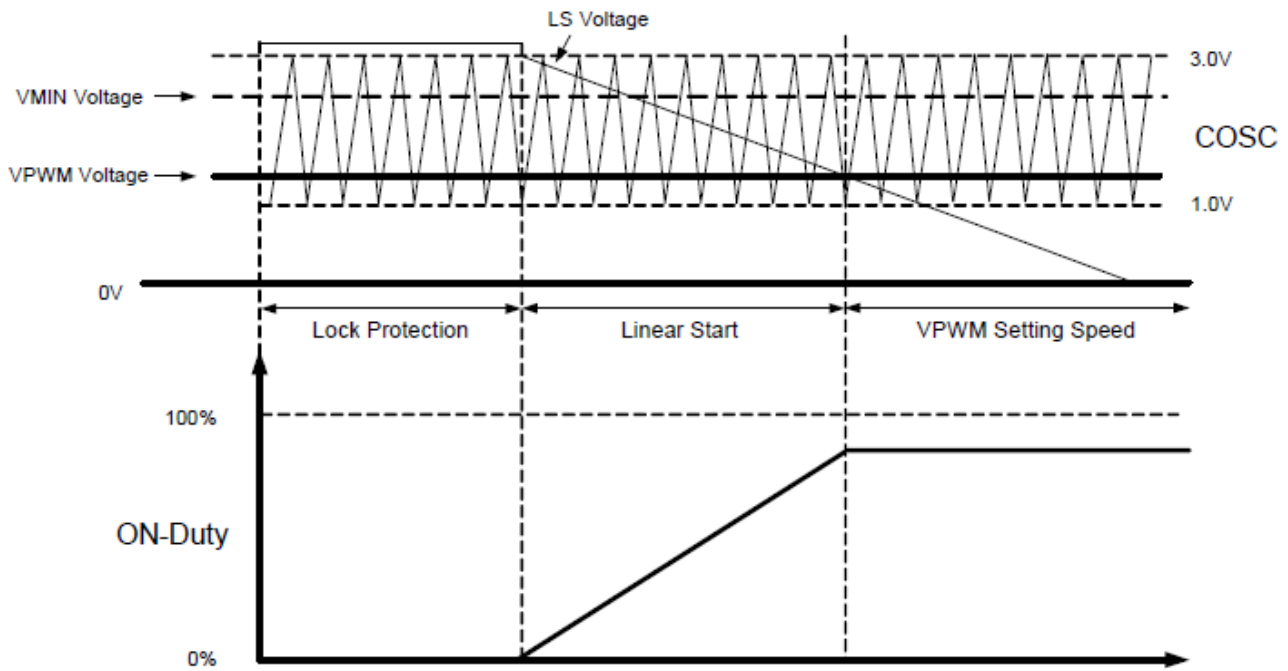
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Operating Diagram (Continued)

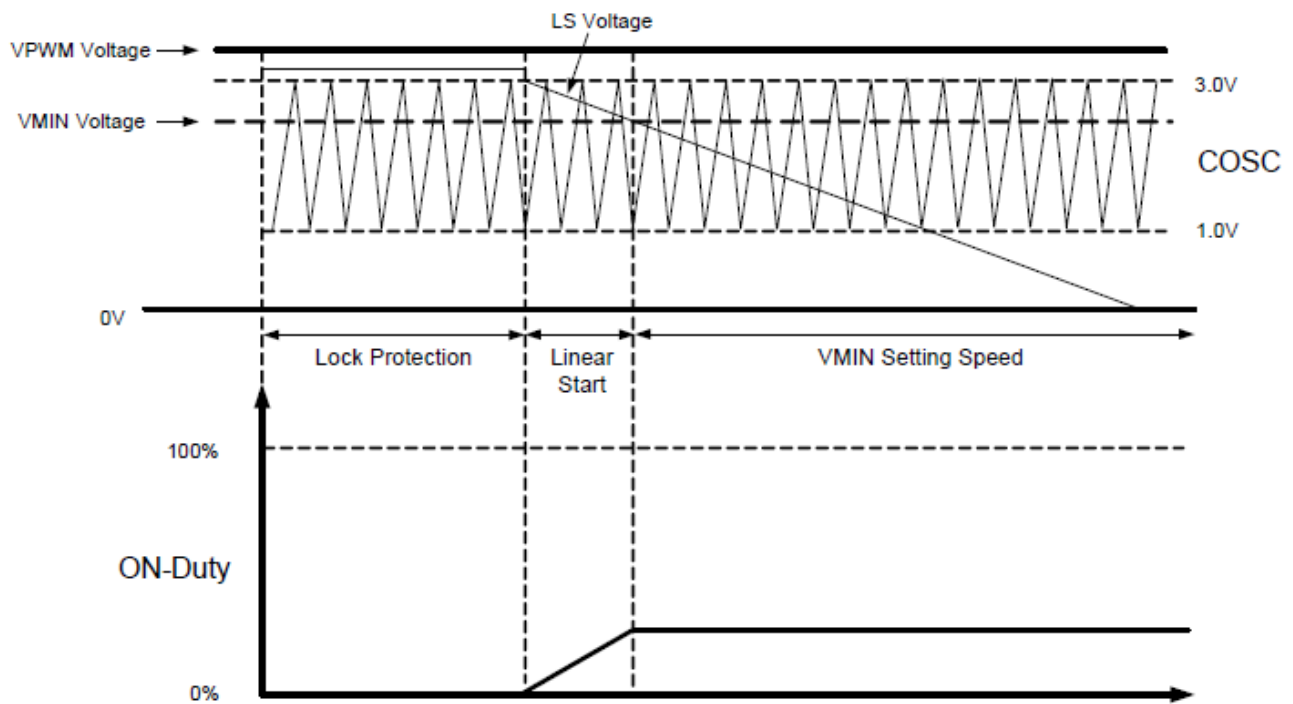Figure 10. Operating Diagram 2 of AM4967 (Linear Start, VPWM Voltage<VMIN Voltage, Note 4)

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

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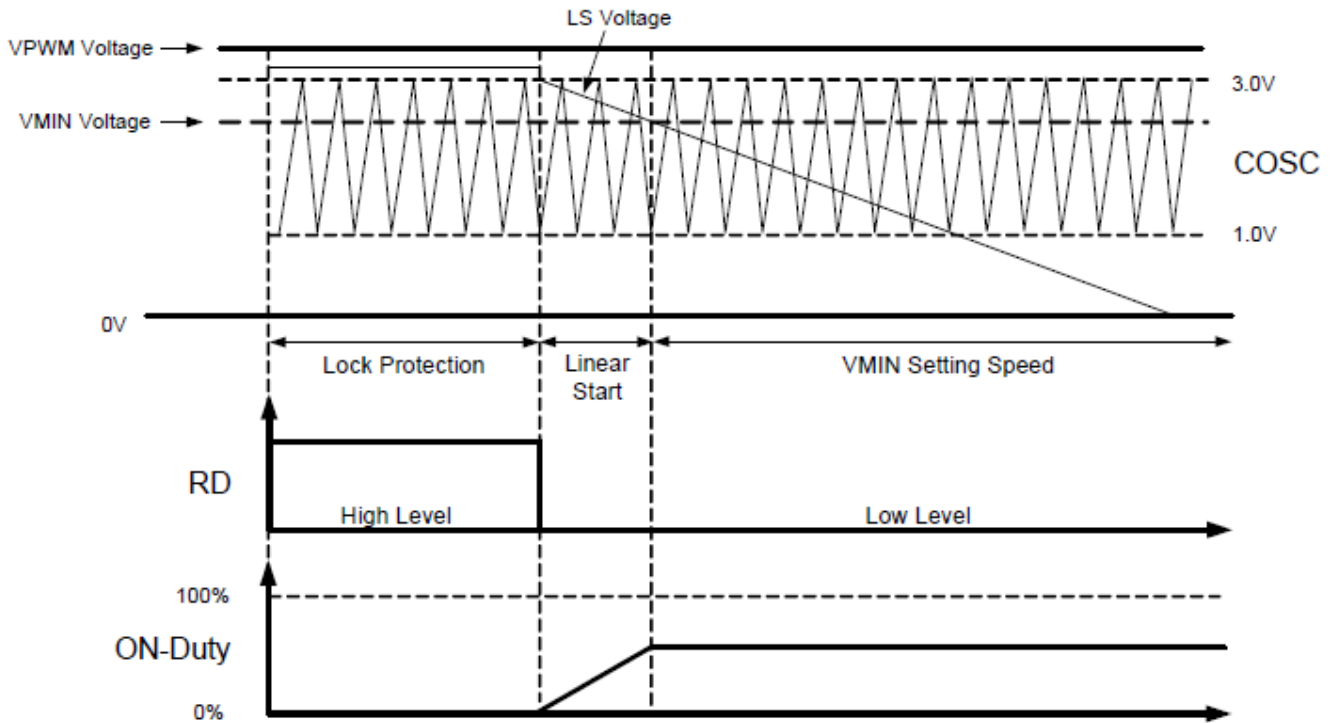
Operating Diagram (Continued)

Figure 12. Operating Diagram 4 of AM4967 (Note 8)

Note: 8. The inclination of LS voltage is adjusted between VLS and VREF according to the capacitance which is recommended to be 0.1µF to 1.0µF
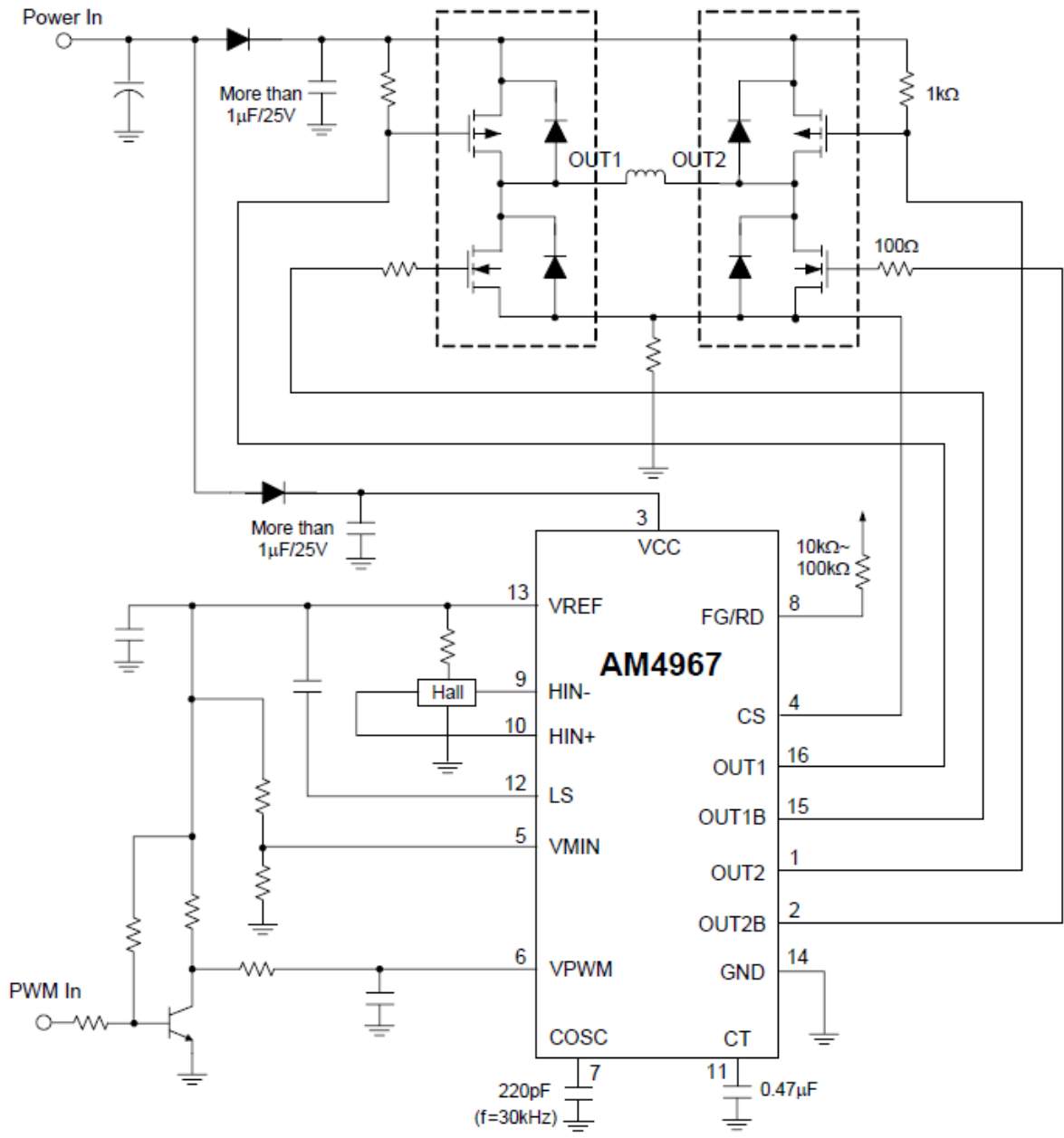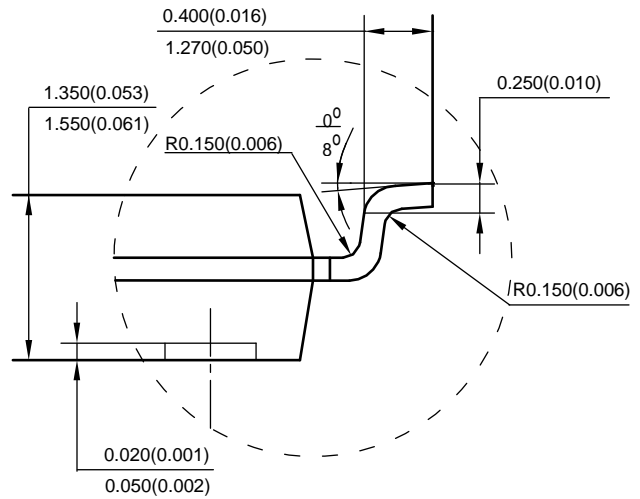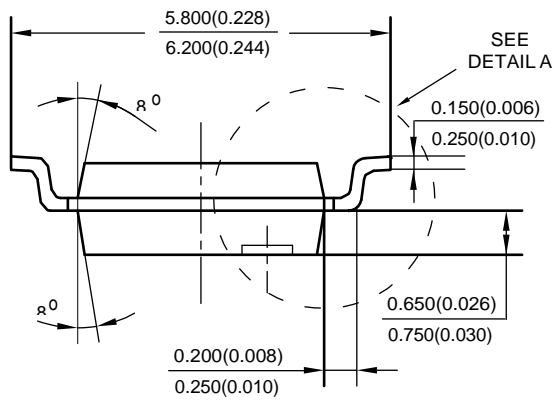
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Typical Application

Figure 13. Typical Application of AM4967 (VCC=12V)

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Package Outline Dimensions

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SSOP-16   **Unit: mm(inch)**

3.800(0.150)
4.000(0.157)

0.200(0.008)
0.300(0.012)

Φ0.800(0.031)

1.000(0.039)

0.900(0.035)

7°

0.635(0.025)
BSC

7°

4.700(0.185)
5.100(0.201)

0.100(0.004)
0.250(0.010)

1.350(0.053)
1.750(0.069)

5.800(0.228)
6.200(0.244)

SEE DETAIL A

0.150(0.006)
0.250(0.010)

8°

8°

0.650(0.026)
0.750(0.030)

0.200(0.008)
0.250(0.010)

0.400(0.016)
1.270(0.050)

0.250(0.010)

1.350(0.053)
1.550(0.061)

R0.150(0.006)

0°
8°

R0.150(0.006)

0.020(0.001)
0.050(0.002)

DETAIL A

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Suggested Pad Layout

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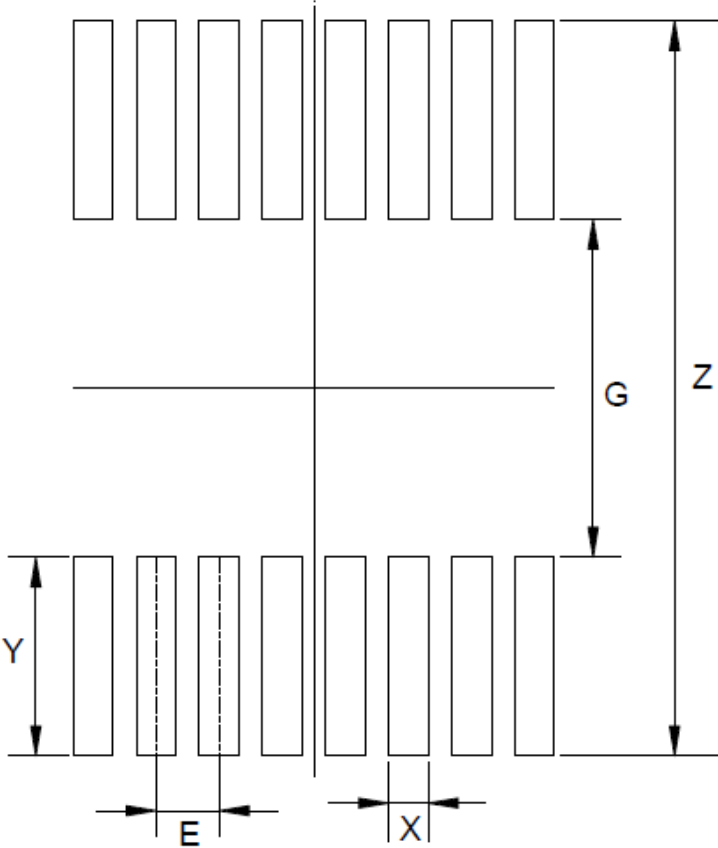
Dimensions	Z (mm)/(inch)	G (mm)/(inch)	X (mm)/(inch)	Y (mm)/(inch)	E (mm)/(inch)
Value	7.400/0.291	3.400/0.134	0.400/0.016	2.000/0.079	0.635/0.025

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