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

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

SSOP-16

Figure 1. Package Type of AM4967

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

Pin Configuration

GS Package
(SSOP-16)

OUT2	1	16 OUT1
OUT2B	2	15 OUT1B
VCC	3	14 GND
CS	4	13 VREF
VMIN	5	12 LS
VPWM	6	11 CT
COSC	7	10 HIN+
FG/RD	8	9 HIN-
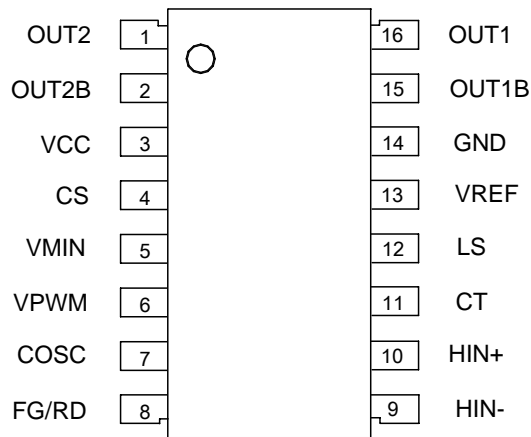
Figure 2. Pin Configuration of AM4967

ADJUSTABLE-SPEED SINGLE-PHASE FULL-WAVE PRE-DRIVER FOR MOTOR   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 0.47μF 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

Functional Block Diagram
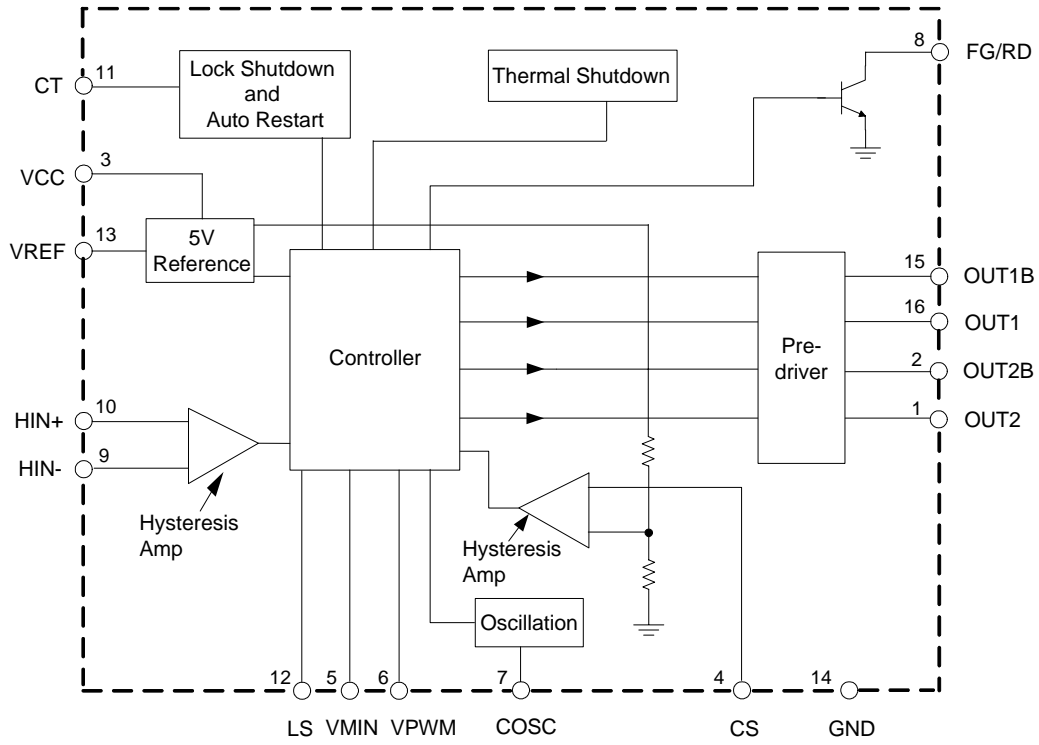
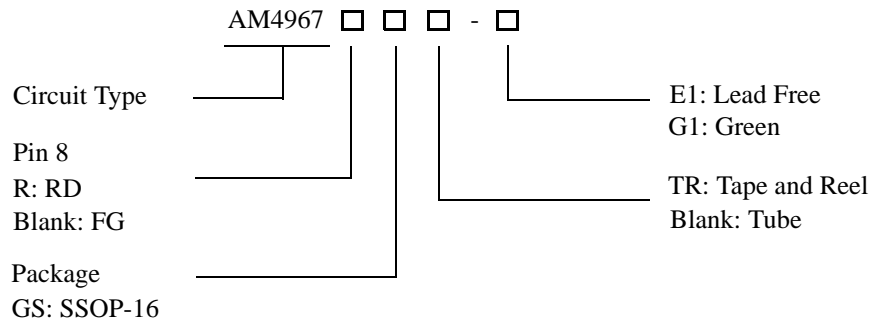Figure 3. Functional Block Diagram of AM4967

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

Ordering Information

AM4967 ☐ ☐ ☐ - ☐

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 Range	Part Number		Marking ID		Packing Type
		Lead Free	**Green**	**Lead Free**	**Green**	
SSOP-16	-30 to 105ºC	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.

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

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	^{o}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	^{o}C

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

Electrical Characteristics

(V_{CC}=12V, T_A=25°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
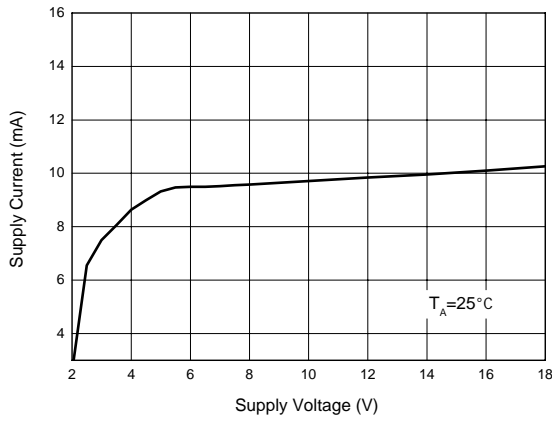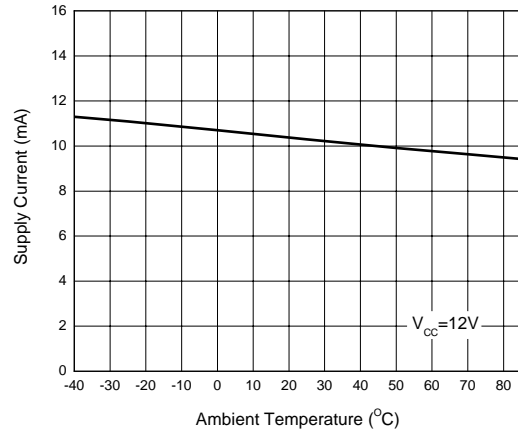

Figure 4. Supply Current vs. Supply Voltage

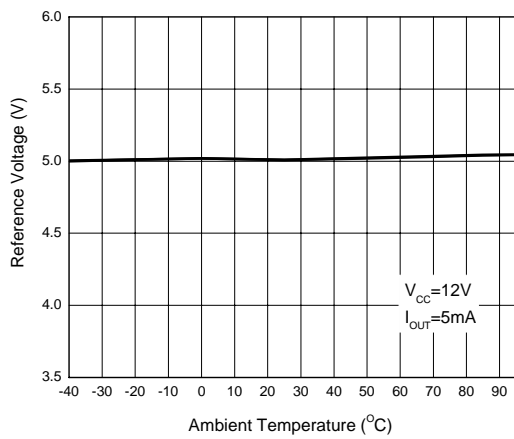Figure 5. Supply Current vs. Ambient Temperature
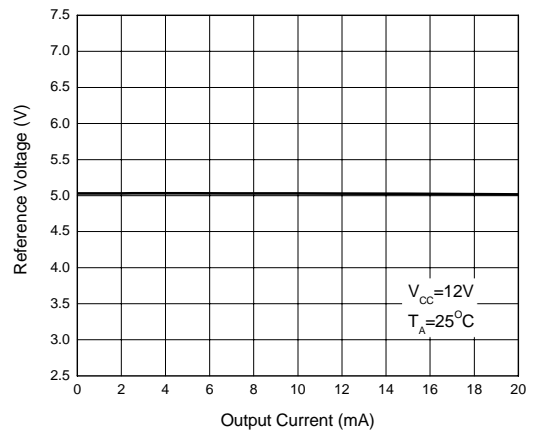

Figure 6. Reference Voltage vs. Ambient Temperature

Figure 7. Reference Voltage vs. Output Current

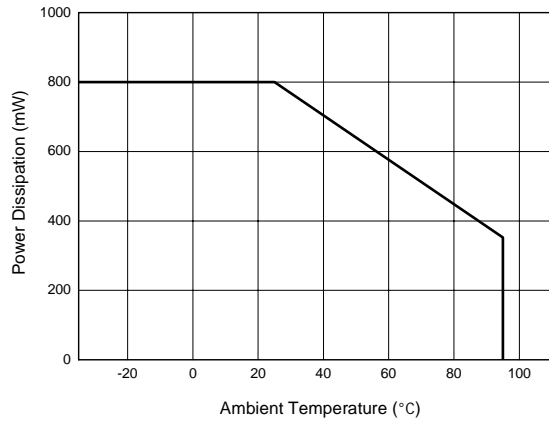## Typical Performance Characteristics (Continued)

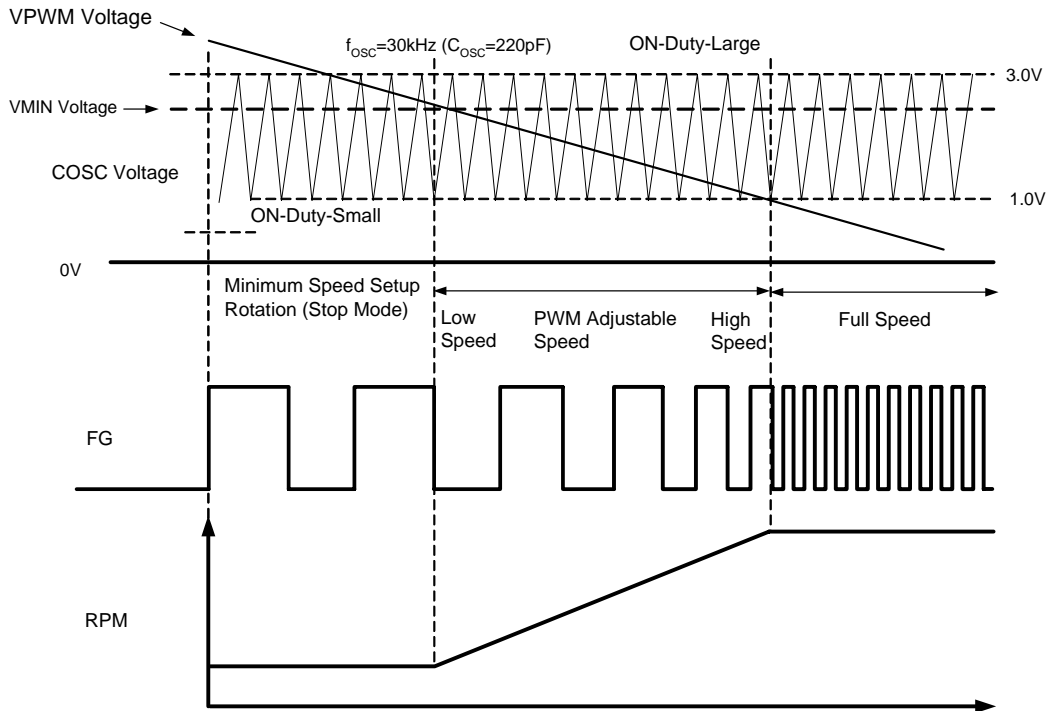Figure 8. Power Dissipation vs. Ambient Temperature

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)
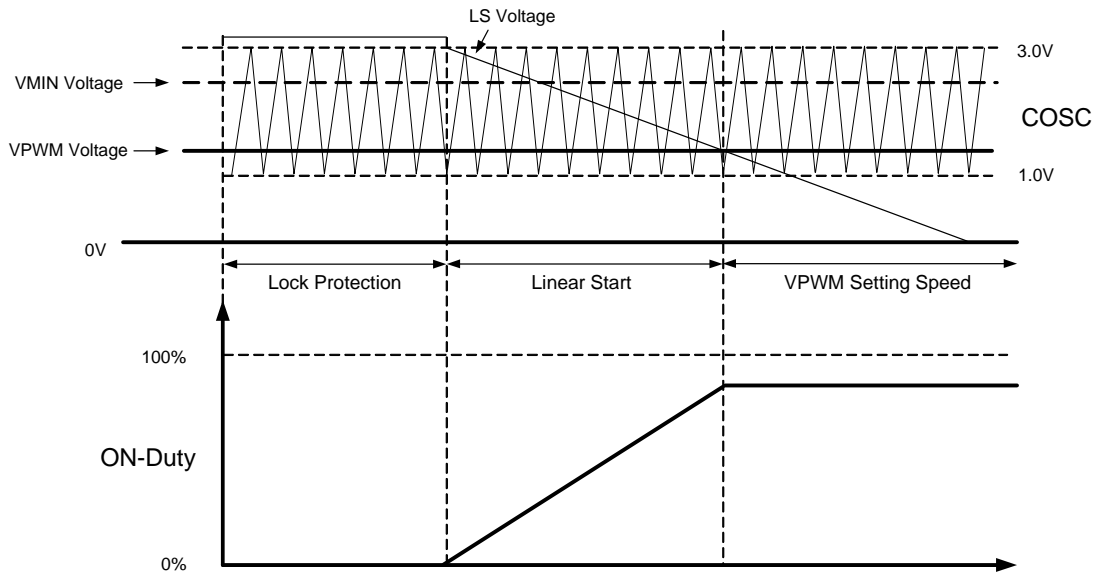
Operating Diagram (Continued)

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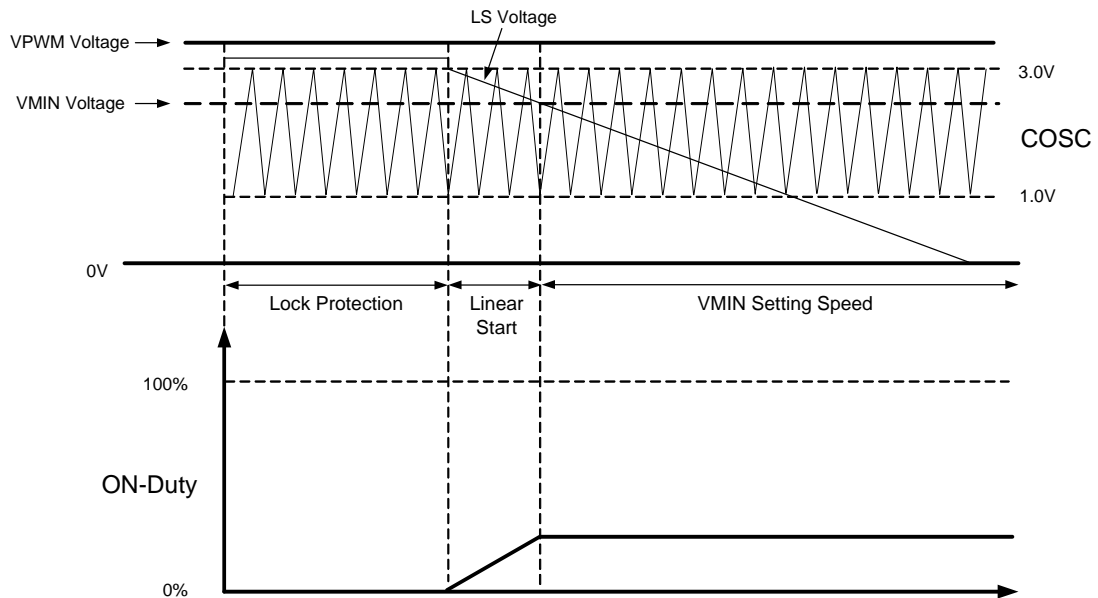

Figure 11. Operating Diagram 3 of AM4967 (Linear Start, VPWM Voltage>VMIN Voltage, Note 4)
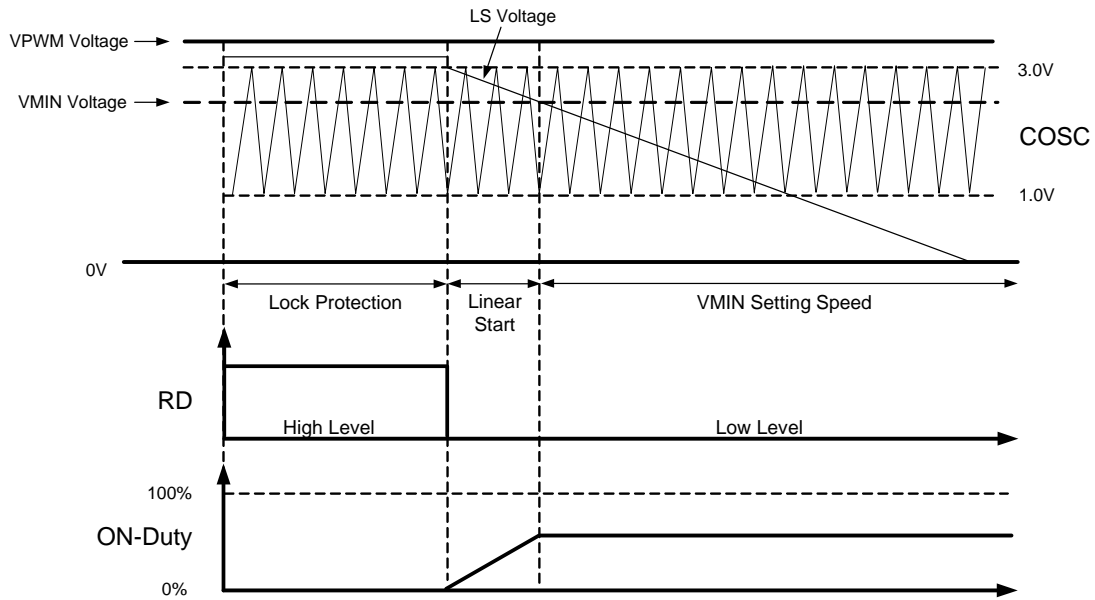
Operating Diagram (Continued)

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 0.1μF to 1.0μF.
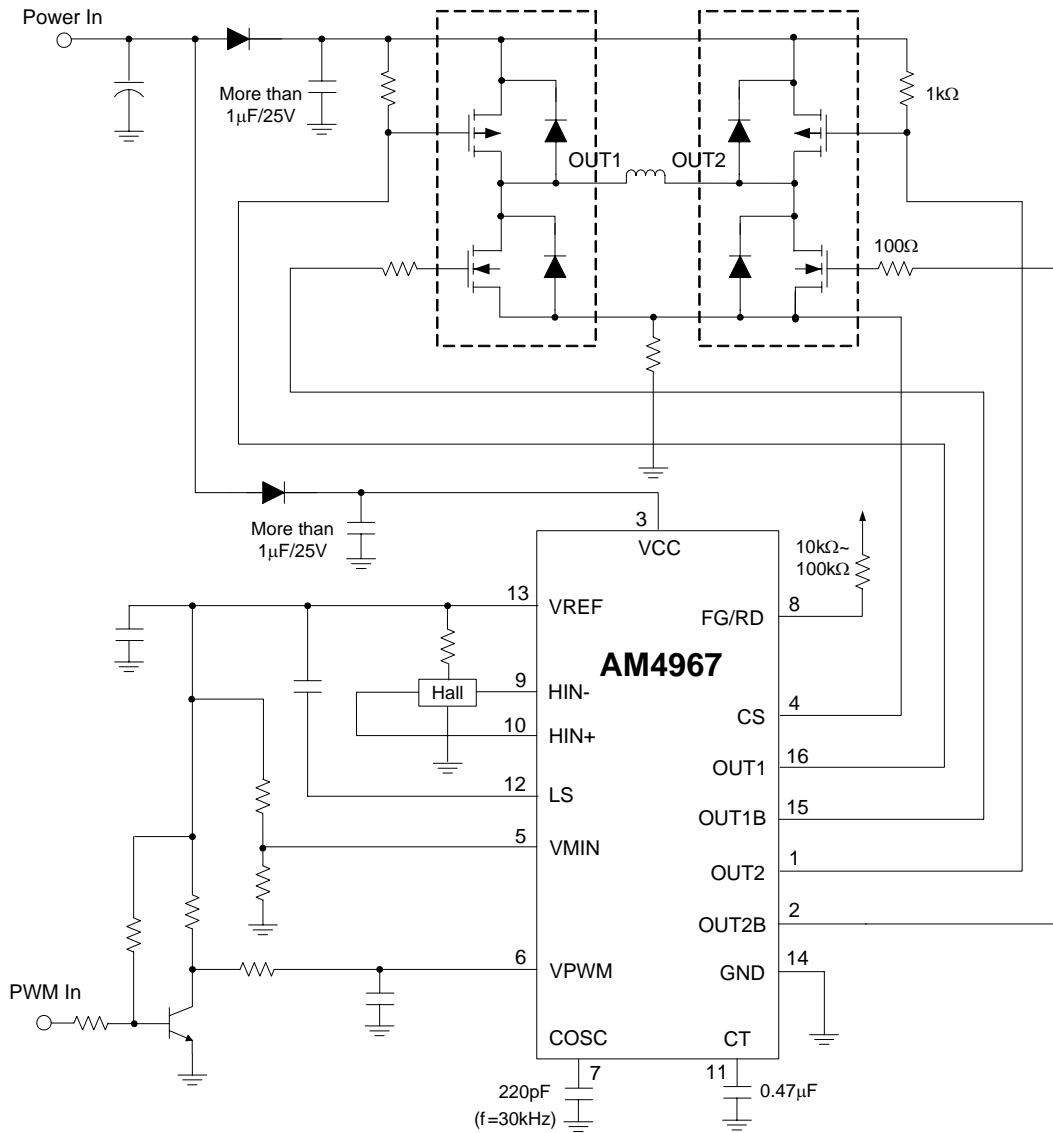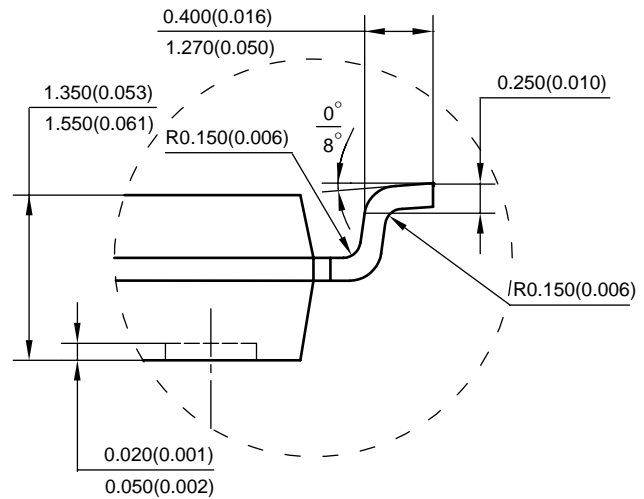
Typical Application

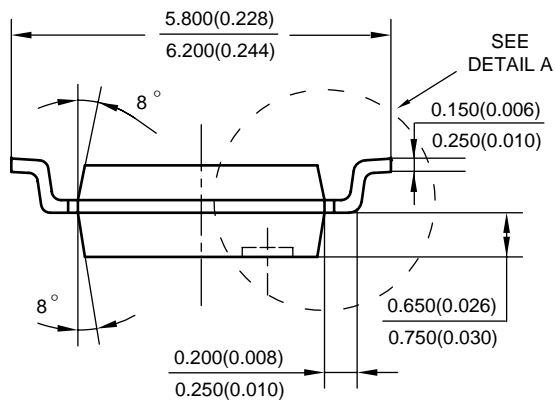Figure 13. Typical Application of AM4967 (V_{CC}=12V)

Mechanical Dimensions

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°

7°

0.635(0.025)
BSC

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

8°

0.150(0.006)
0.250(0.010)

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)
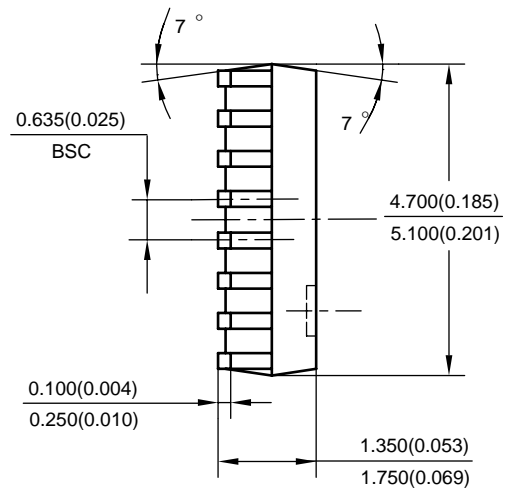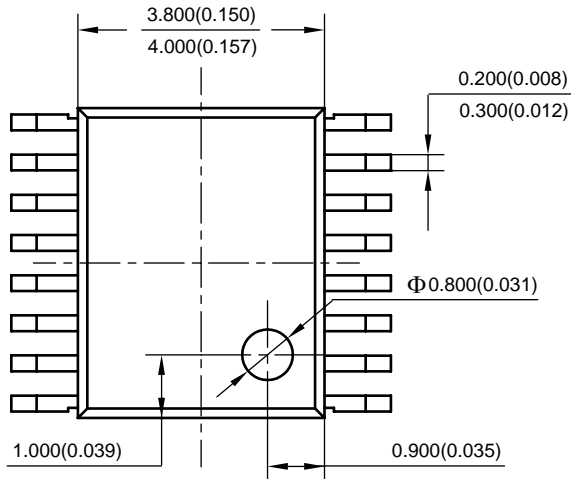
DETAIL A

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