



## 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

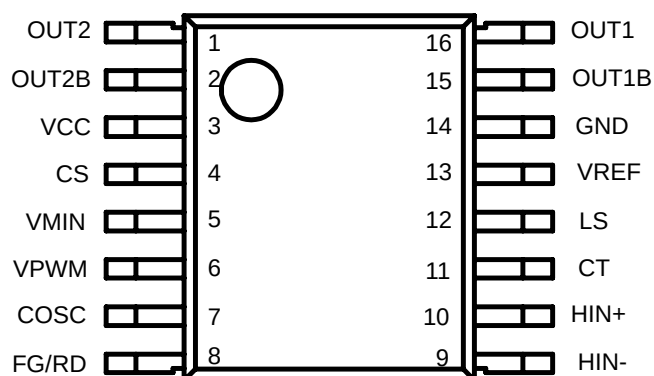
**Pin Configuration**GS Package  
(SSOP-16)

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 $\mu$ 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 $\mu$ F to 1 $\mu$ 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                                                                                                                                                                                                                                                                                  |

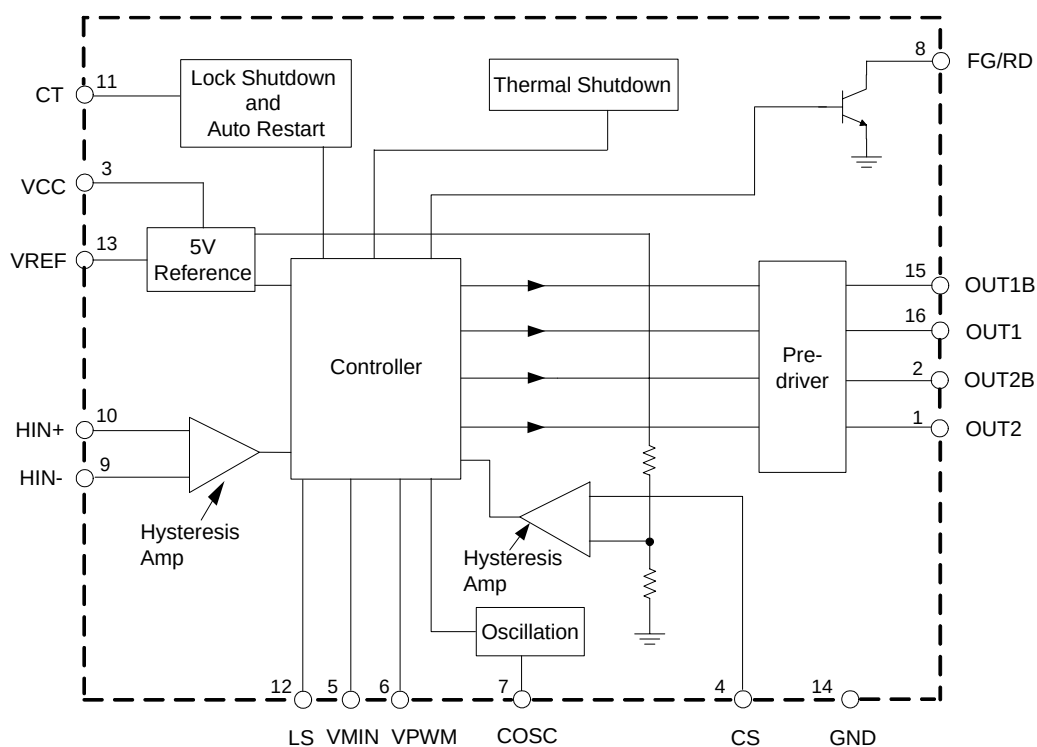
**Functional Block Diagram**

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**

|              |   |   |   |   |                            |
|--------------|---|---|---|---|----------------------------|
| AM4967       | □ | □ | □ | - | □                          |
| Circuit Type |   |   |   |   | E1: Lead Free<br>G1: Green |
| Pin 8        |   |   |   |   |                            |
| R: RD        |   |   |   |   | TR: Tape and Reel          |
| Blank: FG    |   |   |   |   | Blank: Tube                |
| Package      |   |   |   |   |                            |
| GS: SSOP-16  |   |   |   |   |                            |

| 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.

**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 | °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   |



## 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      | $\mu A$ |
| CT Discharge Current             | $I_{DHG}$            | $V_{CT}=3.5V$                                                              | 0.13         | 0.2          | 0.25     | $\mu A$ |
| 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      | $\mu A$ |
| 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) |              | $\pm 10$     |          | mV      |
| FG Saturation Voltage            | $V_{SAT}$            | $I_{SINK}=5mA$                                                             |              | 200          | 500      | mV      |
| FG Leakage Current               | $I_{LFG}$            | $V_{FG}=V_{CC}$                                                            |              |              | 30       | $\mu A$ |
| VPWM/VMIN Bias Current           | $I_{PWMB}/I_{VMINB}$ | $V_{OSC}=V_{PWM}/V_{VMIN}=2V$                                              |              | 0.1          | 3        | $\mu A$ |



## Typical Performance Characteristics

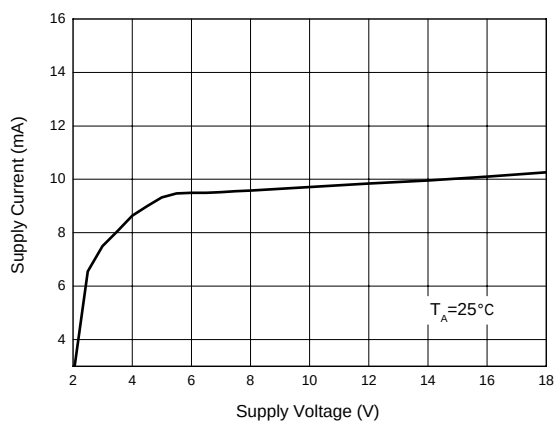


Figure 4. Supply Current vs. Supply Voltage

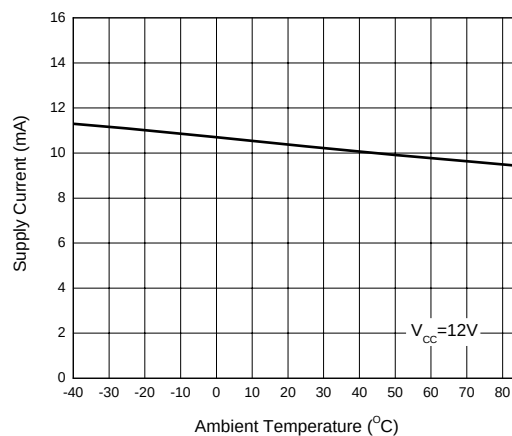


Figure 5. Supply Current vs. Ambient Temperature

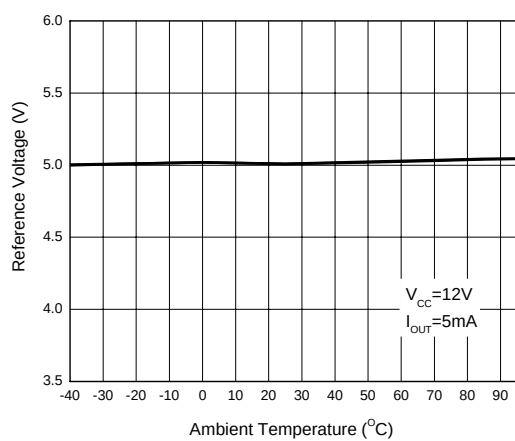


Figure 6. Reference Voltage vs. Ambient Temperature

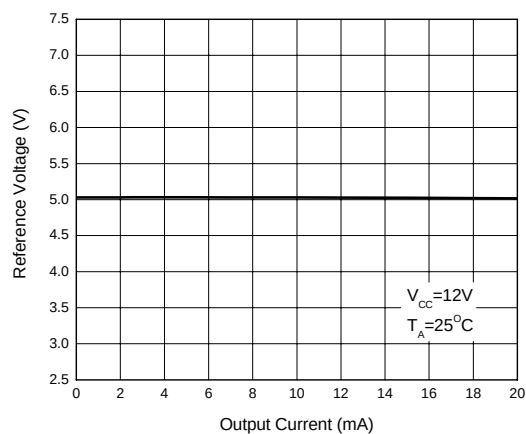


Figure 7. Reference Voltage vs. Output Current

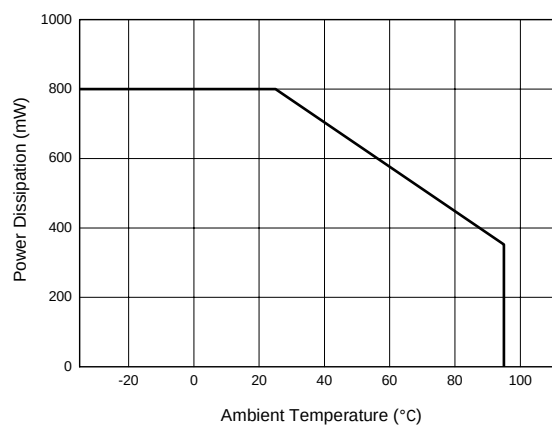
**Typical Performance Characteristics (Continued)**

Figure 8. Power Dissipation vs. Ambient Temperature



## Operating Diagram

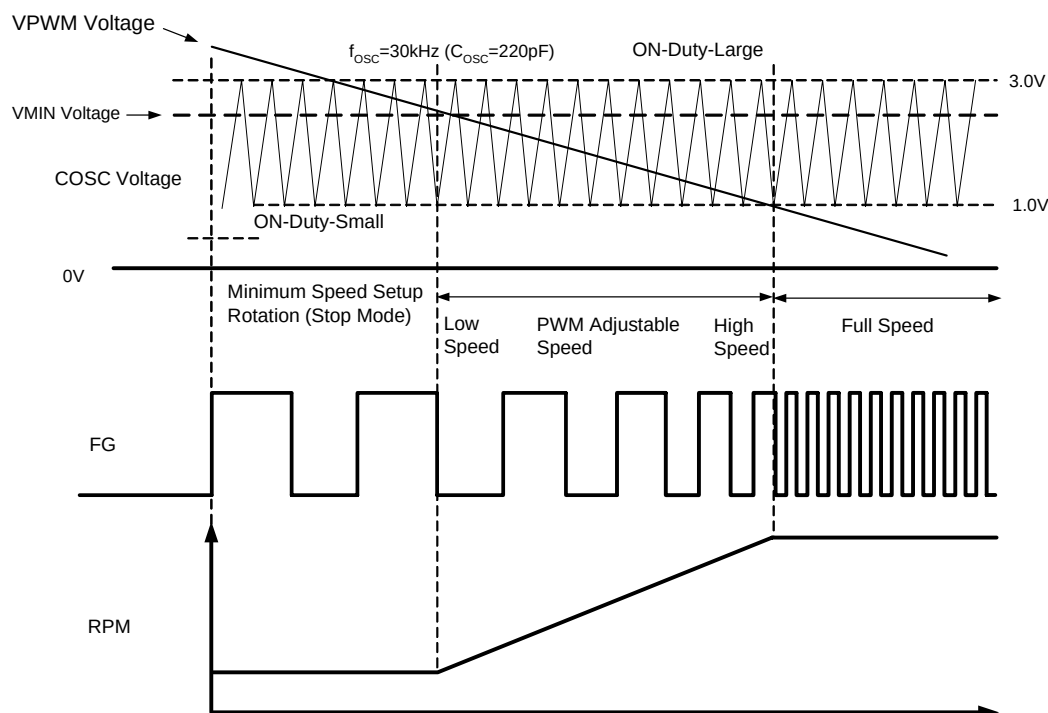


Figure 9. Operating Diagram 1 of AM4967 (Speed Control, Note 3)

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)

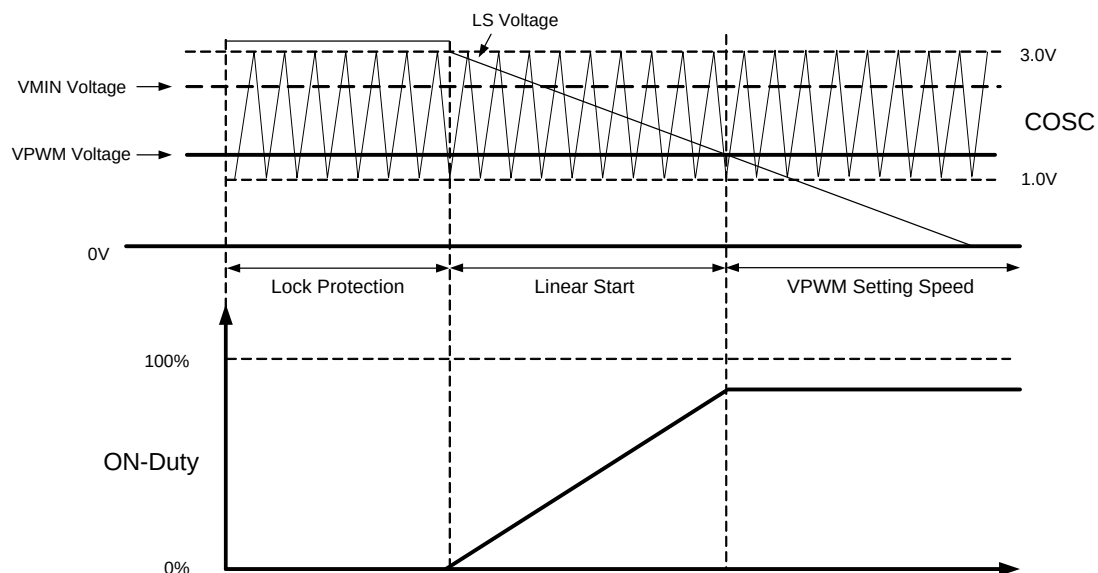


Figure 10. Operating Diagram 2 of AM4967 (Linear Start, VPWM Voltage &lt; VMIN Voltage, Note 4)

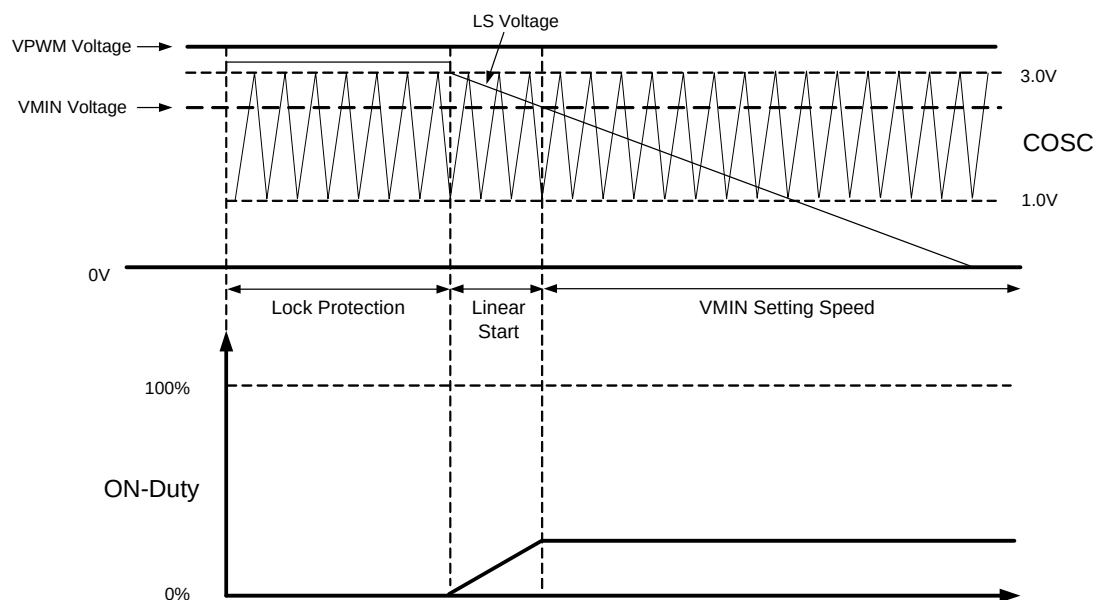


Figure 11. Operating Diagram 3 of AM4967 (Linear Start, VPWM Voltage &gt; VMIN Voltage, Note 4)



## Operating Diagram (Continued)

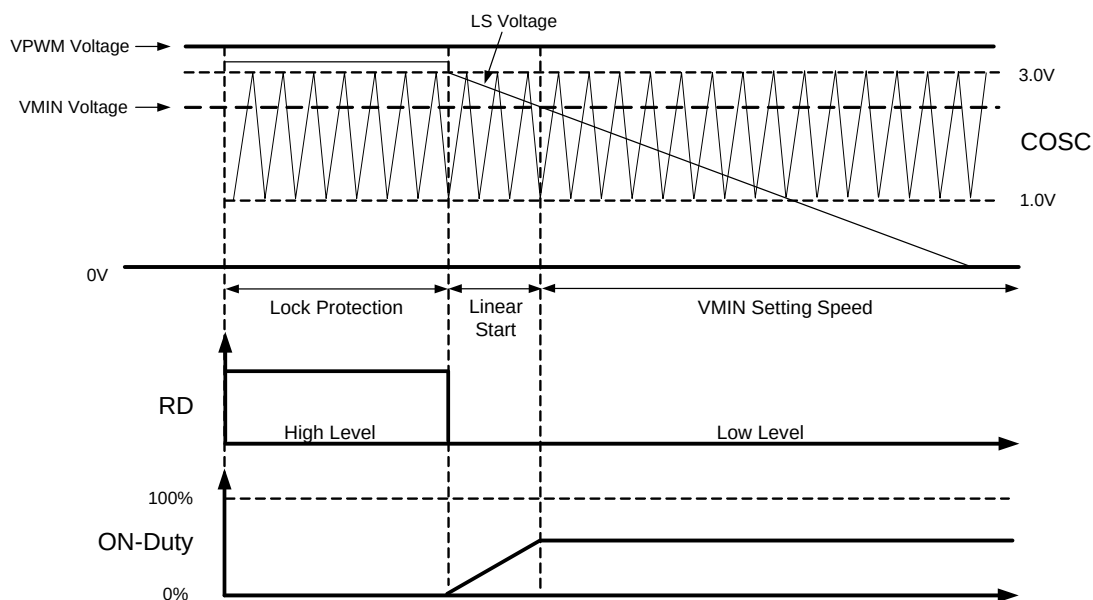
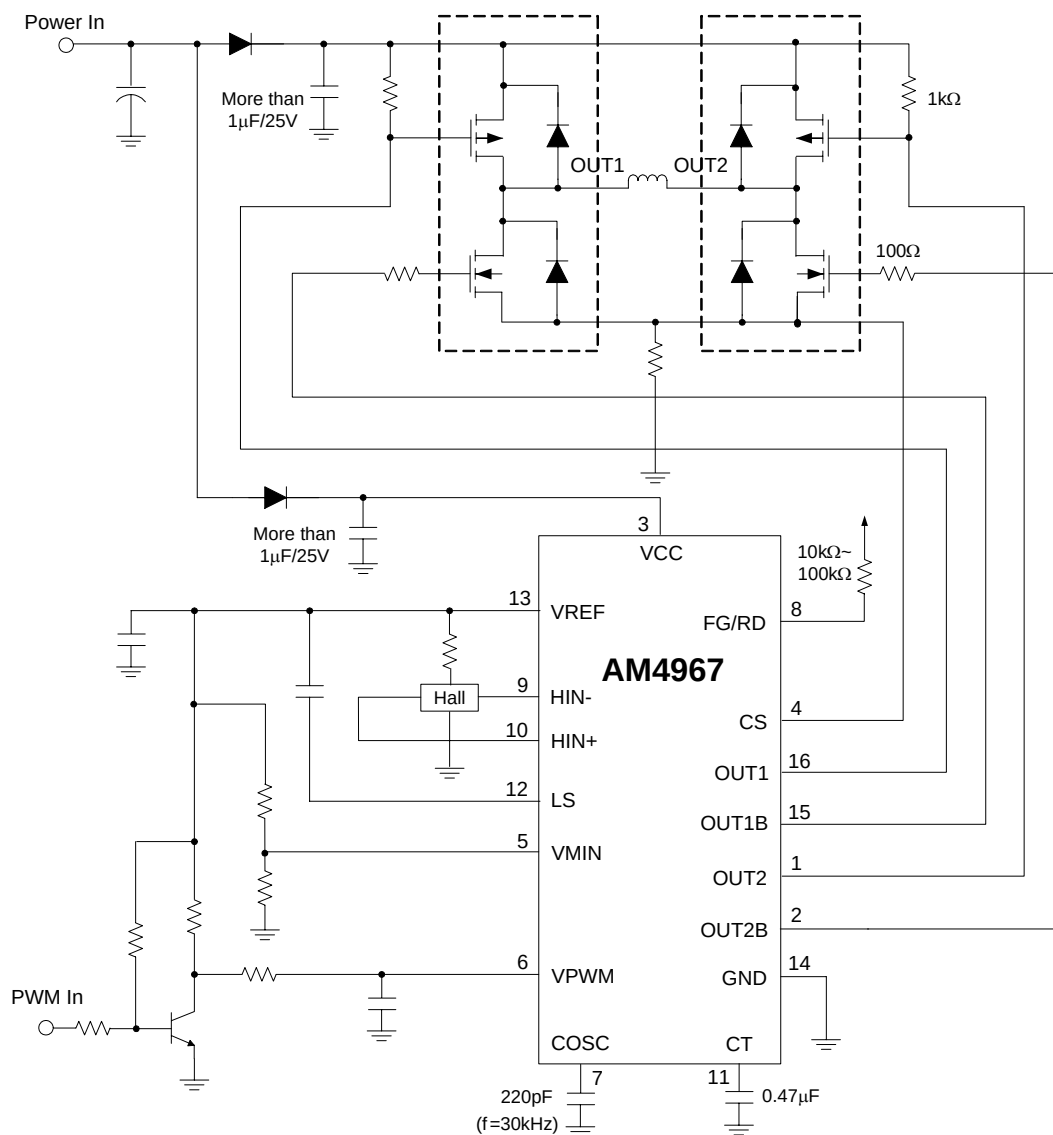


Figure 12. Operating Diagram 4 of AM4967 (Note 4)

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 $\mu$ F to 1.0 $\mu$ F.



## Typical Application

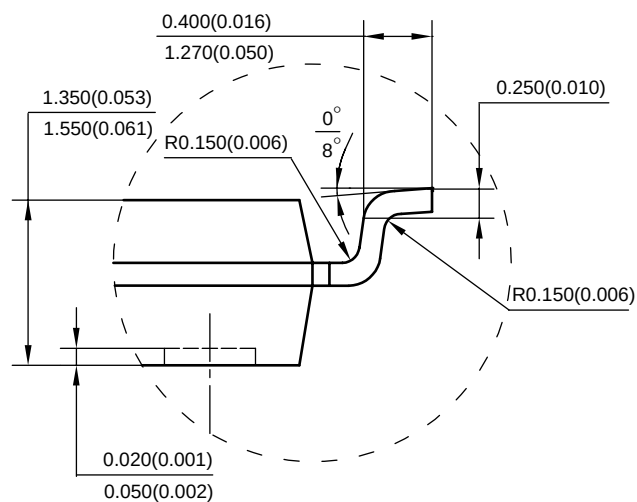
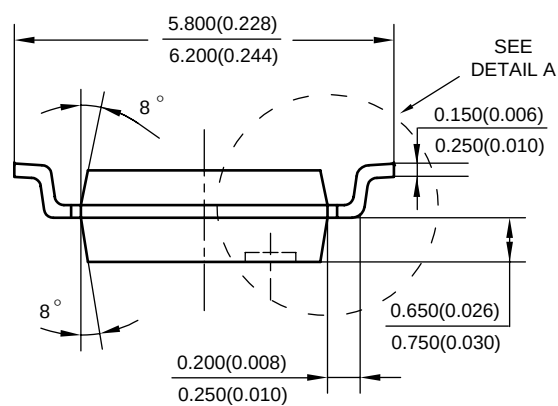
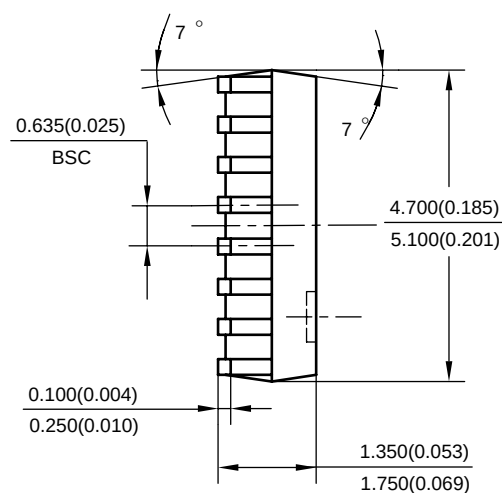
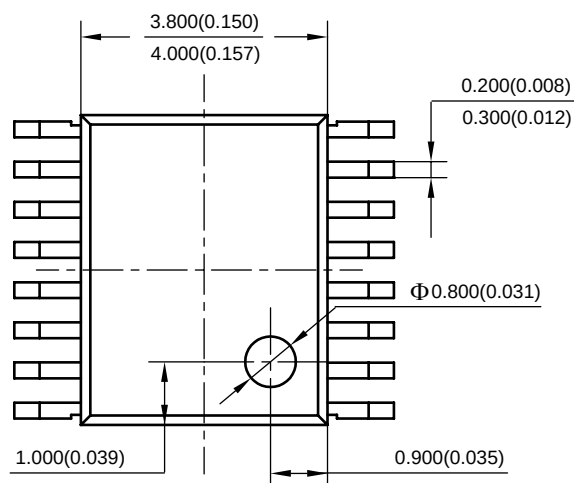
Figure 13. Typical Application of AM4967 ( $V_{CC}=12V$ )



## Mechanical Dimensions

SSOP-16

Unit: mm(inch)



DETAIL A



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