Data Sheet

Three Phase Direct PWM Sensorless Motor Driver   AM9800

General Description

The AM9800 is a direct PWM driver IC designed for three-phase brushless motors. Also, by using highly silent PWM drive, switching current of the phase with a smooth slope reduces the sound of slewing motor, and makes high-efficiency drive a reality by a synchronous commutation.

The device is build-in lock protection. When the fan is locked, the device will enter the lockup protection mode. It is also equipped with thermal shutdown function and forward or reverse rotation selection. In normal operation, supply current is less than 2mA, but in PWM=0 mode it is just around 20µA.

The AM9800 is available in SSOP-16 package.

Features

- Speed Controllable by PWM Input Signal
- Sensorless Drive
- Soft Switched Drive
- Build-in Forward/Reverse Switching Circuit
- Power Saving Function in a Stopped State: 2mA and PWM=0 State: 20µA
- Build-in Current Limiter Circuit
- Build-in Lock Protection and Auto-restart
- Built-in Over Current Protection
- Built-in Thermal Shutdown Circuit
- ESD Rating: 4000V (Human Body Model)
  300V (Machine Model)

Applications

- CPU Cooler Fan in Notebook Personal Computers

SSOP-16

Figure 1. Package Type of AM9800

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Data Sheet

Three Phase Direct PWM Sensorless Motor Driver	AM9800

Pin Configuration

GS Package
(SSOP-16)

```
        VO  ┌1        16┐  WO
        UO  ┌2        15┐  RF
       VCC  ┌3        14┐  CPC
       COM  ┌4        13┐  CP
     COMIN  ┌5        12┐  VG
       FIL  ┌6        11┐  PWM
       OSC  ┌7        10┐  FG
      SGND  ┌8         9┐  F/R
```
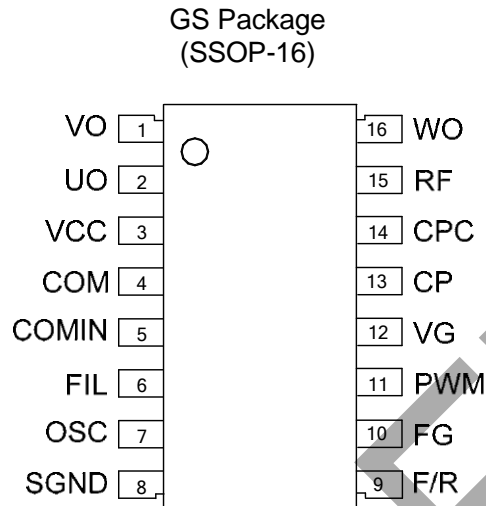
Figure 2. Pin Configuration of AM9800 (Top View)

Pin Description

Pin Number	Pin Name	Function
1	VO	Output pin (V), connected to the motor coil
2	UO	Output pin (U), connected to the motor coil
3	VCC	Supply voltage
4	COM	Motor middle-point connection
5	COMIN	Motor position detection comparator filter pin 1
6	FIL	Motor position detection comparator filter pin 2
7	OSC	OSC startup frequency setting
8	SGND	Ground for IC
9	F/R	Rotation direction switching
10	FG	FG pulse output
11	PWM	PWM signal input
12	VG	Charge pump step-up output
13	CP	Charge pump step-up pulse output pin
14	CPC	Charge pump step-up pin
15	RF	Output current detection
16	WO	Output pin (W), connected to the motor coil

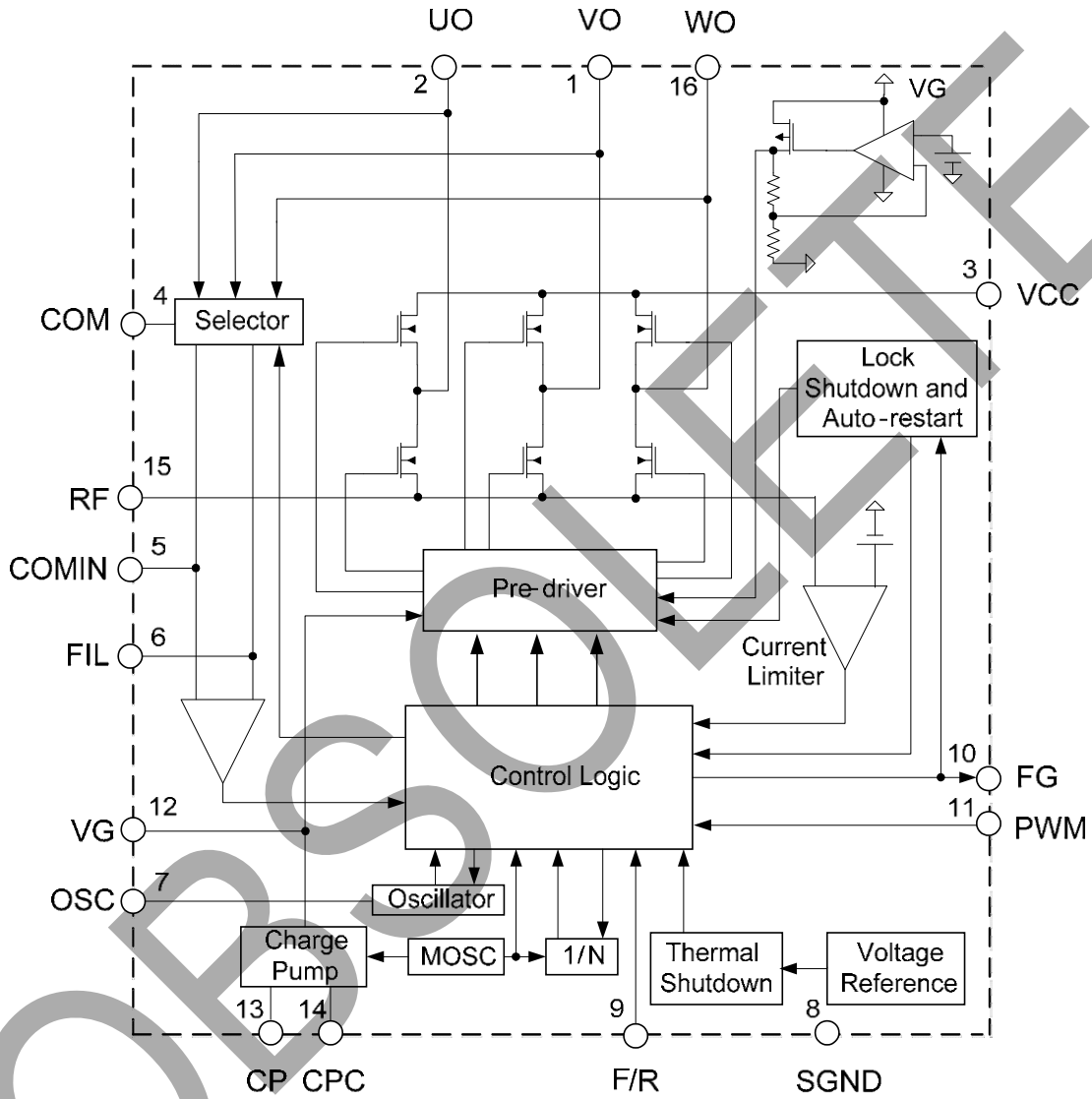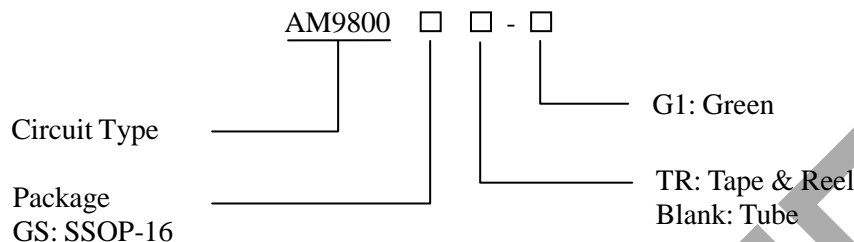## Three Phase Direct PWM Sensorless Motor Driver | AM9800

Functional Block Diagram

Figure 3. Functional Block Diagram of AM9800

Data Sheet

Three Phase Direct PWM Sensorless Motor Driver	AM9800

Ordering Information

AM9800 ☐ ☐ - ☐

- Circuit Type
- Package
  GS: SSOP-16
- TR: Tape & Reel
  Blank: Tube
- G1: Green

Package	Temperature Range	Part Number	Marking ID	Packing Type
SSOP-16	-30 to 95°C	AM9800GS-G1	AM9800GS-G1	Tube
		AM9800GSTR-G1	AM9800GS-G1	Tape & Reel

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

Absolute Maximum Ratings (T_A=25°C, Note 1)

Parameter	Symbol	Value	Unit
Supply Voltage	V_{CC}	6.5	V
Pre-drive Voltage (Gate Voltage)	V_G	10	V
Output Current	I_{OUT}	0.7	A
PWM Input Withstand Voltage	V_{PWM}	V_{CC}	V
FG Output Withstand Voltage	V_{FG}	6	V
FG Output Current	I_{FG}	5	mA
Power Dissipation1 (Independent IC)	P_{D1}	0.3	W
Power Dissipation2 (Note 2)	P_{D2}	0.8	W
Ambient Temperature (Note 3)	T_A	-40 to 105	°C
Storage Temperature	T_{STG}	-55 to 150	°C
ESD (Human Body Model)		4000	V
ESD (Machine Model)		300	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 76.1mm×114.3mm×1.6mm glass epoxy board.

Note 3: T_J=150°C. Use the IC in the range where the temperature of the chip does not exceed T_J=150°C during operation.

Data Sheet

| Three Phase Direct PWM Sensorless Motor Driver | AM9800 |

Recommended Operating Conditions (T$_A$=25°C)

Parameter	Symbol	Min	Max	Unit
Supply Voltage	V$_{CC}$	2.2	6	V
Operating Temperature	T$_{OP}$	-30	95	°C

Electrical Characteristics

V$_{CC}$=5V, T$_A$=25°C, unless otherwise specified.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Supply Current 1	I$_{CC1}$	V$_{PWM}$=V$_{CC}$		2	2.5	mA
Supply Current 2	I$_{CC2}$	V$_{PWM}$=0V		20	50	µA
VG Output Voltage	V$_G$			9.7		V
Upper Transistor Resistance	R$_{ONH}$	I$_{OUT}$=0.5A		1	1.5	Ω
Lower Transistor Resistance	R$_{ONL}$	I$_{OUT}$=0.5A		1	1.5	Ω
Upper & Lower Transistor Resistance Total	R$_{ON(H+L)}$	I$_{OUT}$=0.5A		2	3	Ω
OSC Frequency	f$_{OSC}$	C$_{OSC}$=2200pF		1.0		kHz
PWM Pin High-level Input Voltage	V$_{PWMH}$		V$_{CC}$×0.8		V$_{CC}$	V
PWM Pin Low-level Input Voltage	V$_{PWML}$		0		V$_{CC}$×0.2	V
PWM Pin Input Current	I$_{PWM}$	V$_{PWM}$=0V	-50	-20		µA
PWM Input Frequency	f$_{PWM}$		20	25	50	kHz
FG Low Level Voltage	V$_{FG}$	I$_{FG}$=0.5mA		0.2		V
RF Limiter Voltage	V$_{RF}$	R$_F$=0.5Ω	0.225	0.25	0.275	V
Lock Detection ON Time	t$_{ON}$			2		s
Lock Detection OFF Time	t$_{OFF}$			4		s
Thermal Protection Temperature	T$_{SD}$			175		°C
Temperature Hysteresis Width	ΔT$_{SD}$			25		°C

Data Sheet

Three Phase Direct PWM Sensorless Motor Driver | AM9800

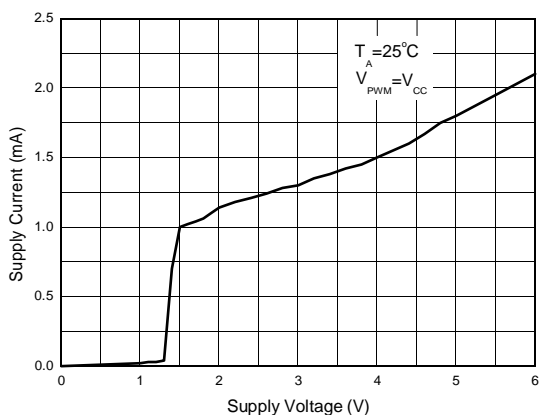## Typical Performance Characteristics
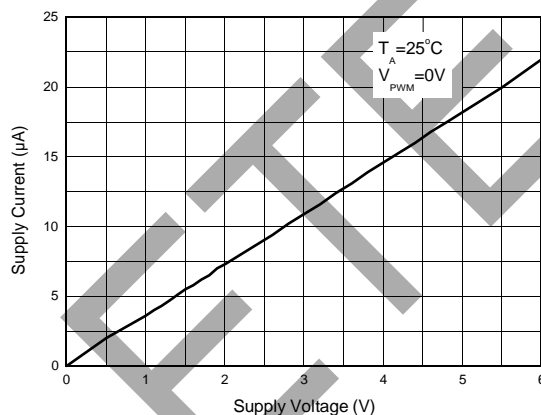

Figure 4. Supply Current vs. Supply Voltage
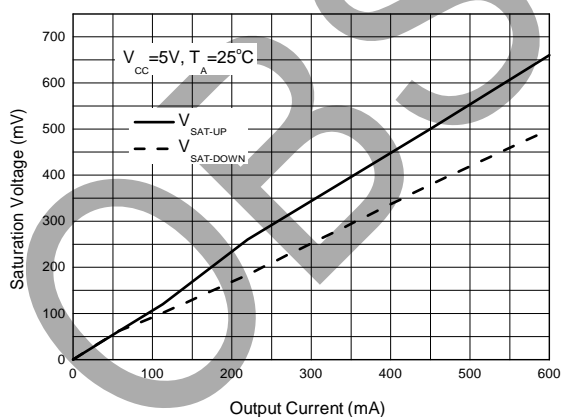

Figure 5. Supply Current vs. Supply Voltage

Figure 6. Saturation Voltage vs. Output Current

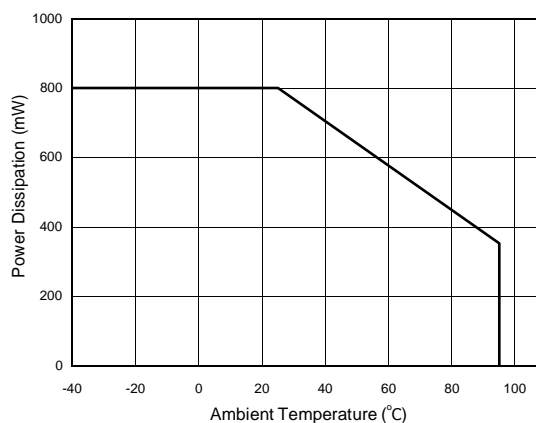Figure 7. Power Dissipation vs. Temperature (Note 2)

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Three Phase Direct PWM Sensorless Motor Driver   **AM9800**

Typical Application
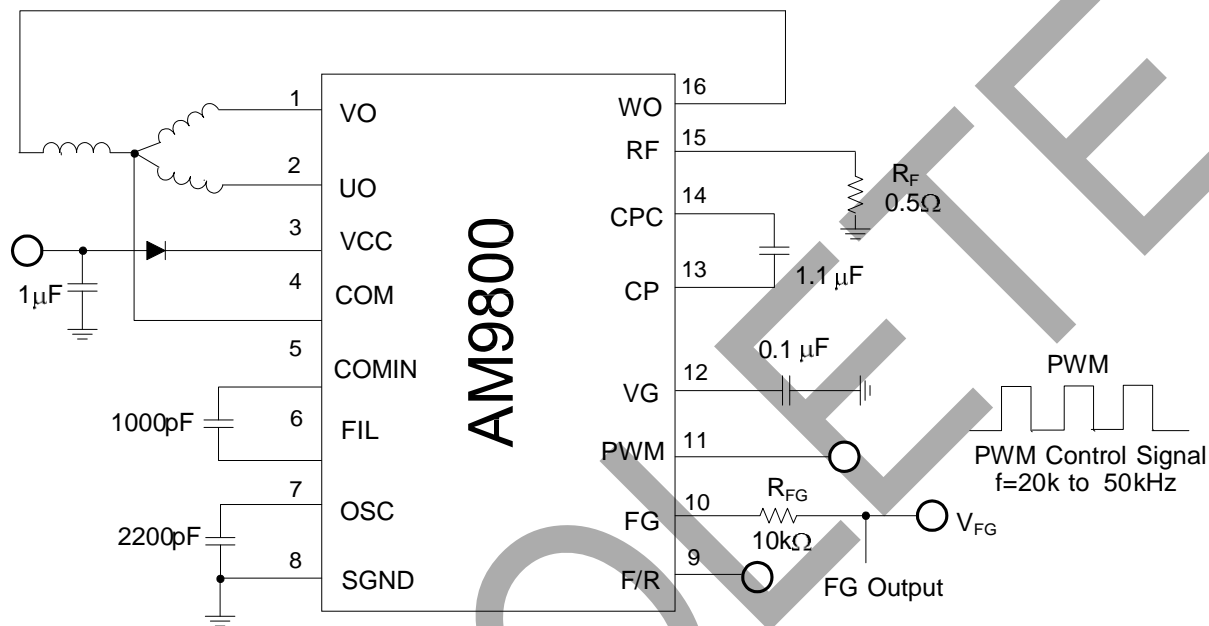
Figure 8. Typical Application of AM9800

Three Phase Direct PWM Sensorless Motor Driver   AM9800

Application Information

1. Reverse Connection of Power Supply Connector

Reverse connection of power supply connector may break IC. Some methods such as inserting a diode between power supply and VCC terminal can be taken to avoid the reverse connection destruction.

2. Power Supply Line

Back electromotive force (EMF) causes regenerated current to the power supply line, so insert a capacitor (recommended value: 1μF or larger) as close as possible to the space between the power supply pin (VCC pin) and ground pin (SGND pin) for routing regenerated current.

3. GND Potential and External Components

Ensure that the potential of GND terminal is the minimum potential in any operating condition. External components connected to the ground must be connected with lines that are as short as possible and external components connected between IC pins must be placed as close to the pins as possible.

4. Mounting Failures

In the process of attaching IC to the printed board, more attention must be paid to the direction and location of the IC, since mounting failures may also break IC. In addition, destruction is also possible when the circuit is shorted by foreign substance between outputs or between output and power supply or between output and GND.

5. Thermal Shutdown Circuit

Considering the power dissipation under actual operating condition, the thermal design must be applied with sufficient margin.

AM9800 features thermal shutdown (TSD) circuit (protection temperature is 175°C typical and hysteresis width is 25°C typical). When the chip temperature reaches the TSD circuit temperature, the output terminal becomes an open state. TSD circuit is designed simply for the purpose of intercepting IC from overheating. Make sure that the IC should not be used again after this circuit operating. Figure 9 shows a fan rotates normally first and then enter into OTP mode since the chip temperature reaches 175°C. Finally the chip temperature decreases below 150°C, then OTP mode is canceled and the fan rotates normally again.
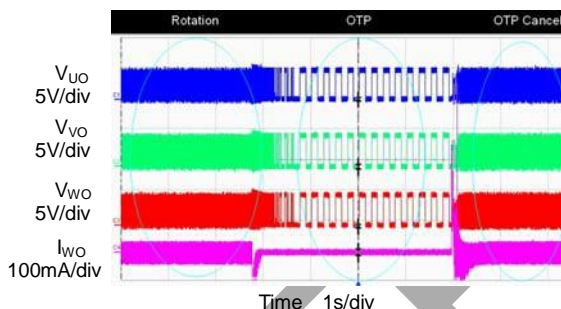

Figure 9. OTP Function

6. F/R Function

A high level input causes the current to flow into the motor in the order of U, V, and W and a low level input in the order of U, W, and V. When the motor is used with the F/R pin open, the built-in resistor enables the F/R pin to GND. Changing the order of current application turns the motor to rotate in the opposite direction. Switching H/L of F/R (pin 9) terminal should not be done during the motor rotation. It should be done once the motor stops. F/R terminal should be connected to VCC or GND for reducing PWM noise. Figure 10 shows a rotating fan's waveform at forward mode (F/R pin is connected to SGND pin).
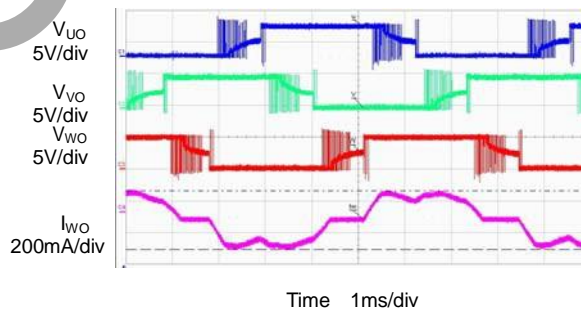

Figure 10. Rotation Mode Waveform (Forward Mode)

7. PWM Mode

The output transistor is on when a high-level voltage is input to the PWM pin (pin 11), and is off when a low-level voltage is input. PWM controls the speed of the motor by inputting the pulse in accordance with the duty cycle to the PWM pin. When the motor is operated with the PWM pin open, the built-in resistor enables the PWM pin to change to high-level voltage and the motor speed rises to full speed. When the PWM pin is fixed at low-level voltage, the motor decelerates, and after the motor stops, it enters "Power Saving Mode". Figure 11 shows a rotating fan's waveform at PWM Mode.

Three Phase Direct PWM Sensorless Motor Driver   AM9800
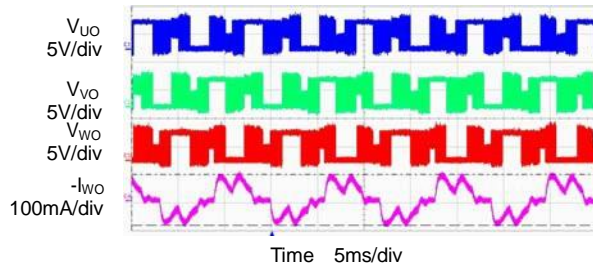
Application Information (Continued)

Figure 11. Rotation Mode Waveform (PWM Mode)
(f=25kHz, V_H=5V, V_L=0V, Duty Cycle=50%)

8. Soft Switching Circuit

AM9800 adopts variable duty soft switching to minimize the motor drive noise. Figure 12 shows how soft switching circuit works during the fan rotation.
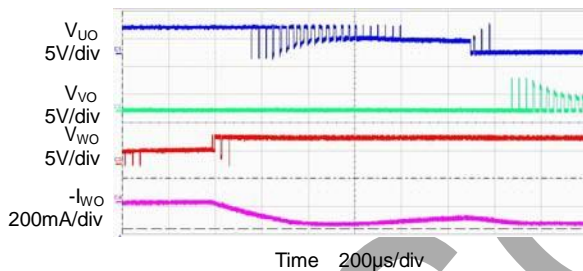

Figure 12. Soft Switching Waveform

9. Current Limiter Circuit

The driver current is detected by connecting a resistor between RF pin (pin 15) and ground. The current limiter circuit limits the output current peak value to a level determined by the equation $I=V_{RF}/R_F$ (V_{RF}=0.25V typical).

10. OSC Circuit

A capacitor must be connected between OSC pin (Pin 7) and ground. When a capacitor is connected, the OSC pin starts self-oscillation, and its frequency becomes the startup frequency. Figure 13 shows a fan system's OSC Waveform.
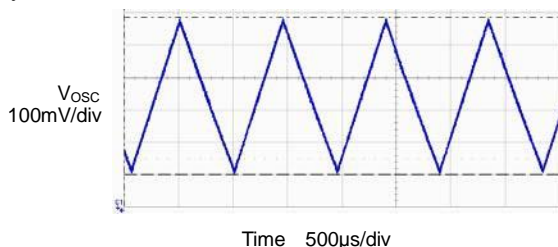

Figure 13. OSC Waveform (C_{OSC}=2200pF)

11．Position Detector Comparator Circuit for Rotor

The position detector comparator circuit for the rotor is a comparator for detecting rotor positional information with the back EMF signal generated when the motor rotates. The IC determines the timing at which the output block applies current to the motor based on the position information obtained here. A capacitor (between 1000 and 10000pF) must be connected between COMIN pin (pin 5) and the FIL pin (pin 6) to prevent any motor startup misoperation that is caused by the comparator input noise.

12．FG Output Circuit

FG output pin (pin 10) provides a pulse signal equivalent to what provided by systems using a Hall-effect sensor. A pull-up resistor (10kΩ is recommended) must be connected between FG pin and the power supply. Figure 14 shows the FG output signal when the fan rotates.
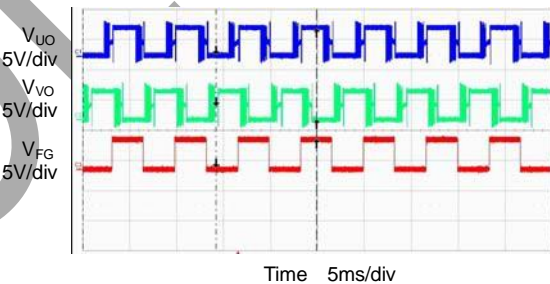

Figure 14. FG Output Signal

13. Lock Shutdown and Auto Restart

This IC detects the rotation of the motor by internal circuit block, and adjusts lock detection ON time (t_{ON}) and lock detection OFF time (t_{OFF}) by internal counter. t_{ON} and t_{OFF} are shown as below:
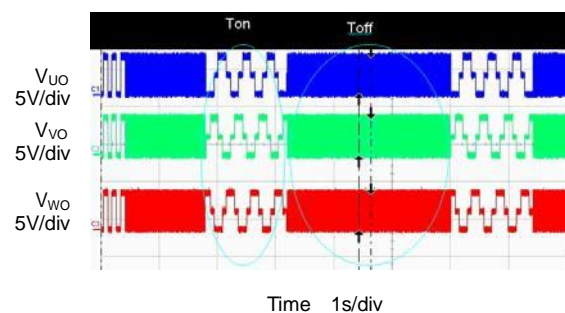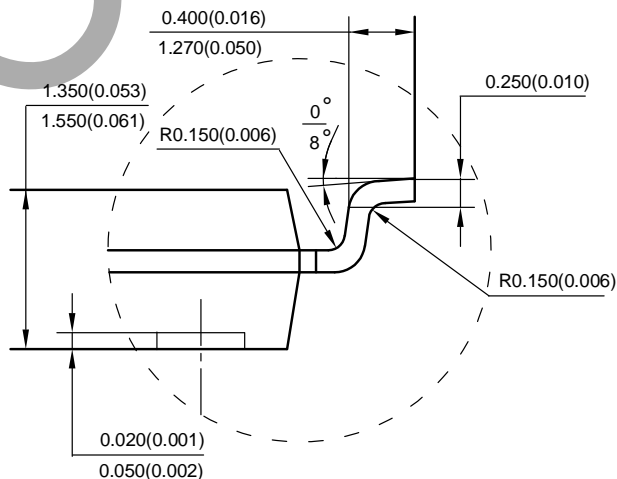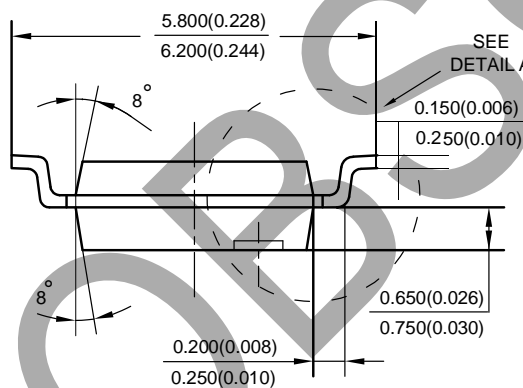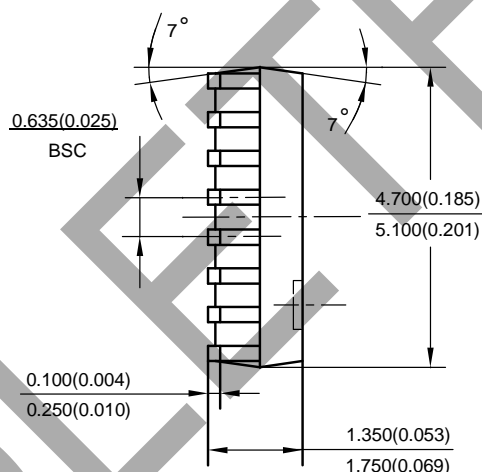

Figure 15. Lock Mode

Data Sheet

Three Phase Direct PWM Sensorless Motor Driver AM9800

Mechanical Dimensions

SSOP-16   Unit: mm(inch)

3.800(0.150)
4.000(0.157)

0.200(0.008)
0.300(0.012)

0.635(0.025)
BSC

7°

7°

4.700(0.185)
5.100(0.201)

Φ 0.800(0.031)

0.100(0.004)
0.250(0.010)

1.000(0.039)   0.900(0.035)

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°

0.200(0.008)
0.250(0.010)

0.650(0.026)
0.750(0.030)

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)
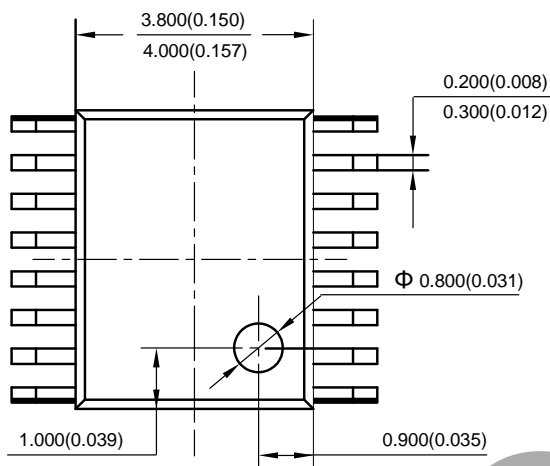
Note: Eject hole, oriented hole and mold mark is optional.   DETAIL A

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http://www.bcdsemi.com

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