Single Phase Full-Wave Motor Driver for Fan Motor AM3929

The AM3929 is a single phase DC fan motor Combo driver IC. Rotation speed can be controlled by PWM input signal and voltage. The drivers include Lock Detection, Thermal Shutdown, and Over-current Protection. Maximum output current is 0.8A. Package is PB-free and Halogen-Free.

● Applications

Single Phase DC Fan Motor.

● Features

1) Operation voltage 1.8 to 8.0V.
2) Lock detection/Automatic restart circuit.
3) Control output terminal. (FG)
4) Thermal shutdown circuit.
5) Over current protection.
6) Combo PWM and Voltage controllable
7) Low cross-over noise.

● Absolute Maximum Ratings (Ta = 25℃)

Parameter	Symbol	Limits	Unit
Supply voltage	V_{CC}	8	V
Output current	Iomax	800	mA
FG single output current	$I_{FG(SINK)}$	10	mA
FG single output voltage	V_{FG}	8	V
HB output current	I_{HB}	10	mA
Power dissipation (2Layer PCB)	Pd	3078*	mW
Operate temperature range	T_{opr}	-40～+125	℃
Storage temperature range	T_{stg}	-40～+150	℃
Junction temperature	Tjmax	150	℃

* Pd de-rated by 24.62mW/°C over 25℃ (based on JEDEC 2S2P board)

Those are stress rating only and functional operating at those conditions for extended periods may damage to the device.

● Recommended operating conditions

(Set the power supply voltage taking allowable dissipation into considering)

Parameter	Symbol	Min	Typ	Max	Unit
Operating supply voltage range	Vcc	1.8～8.0			V
Hall input voltage range	V_H	0.4～Vcc-1.1			V

Electrical Characteristics

(Unless otherwise specified, Ta = 25℃, VCC = 5V)

Parameter	Symbol	Limit			Unit	Conditions
		Min	Typ	Max		
Supply current	I_{CC}	—	3	6	mA	
Hall input						
Input offset voltage	V_{HOFS}	—	—	±6	mV	
PWM input						
Input H level	V_{PWMH}	2.5	—	V_{CC}	V	
Input L level	V_{PWML}	0	—	0.8	V	
Input frequency	F_{PWM}	0.02	—	50	kHz	
Output						
Output voltage	V_0	—	0.3	0.5	V	I_0=250mA (Upper + Lower)
Input-output Gain	G_{IO}	45	48	51	dB	
FG low voltage	V_{FGL}	—	0.2	0.3	V	$I_{FG(sink)}$ = 5mA
FG leakage current	I_{FGL}	—	—	10.0	μA	V_{FG} = 5V
Input hysteresis voltage	V_{HYS}	±7	±12	±17	mV	
Hall bias voltage	V_{HB}	0.8	1.0	1.2	V	I_{HB}=-5mA
Lock protection						
Lock detection ON time	T_{ON}	0.35	0.50	0.65	sec	
Lock detection OFF time	T_{OFF}	3.5	5.0	6.5	sec	

Block Diagram

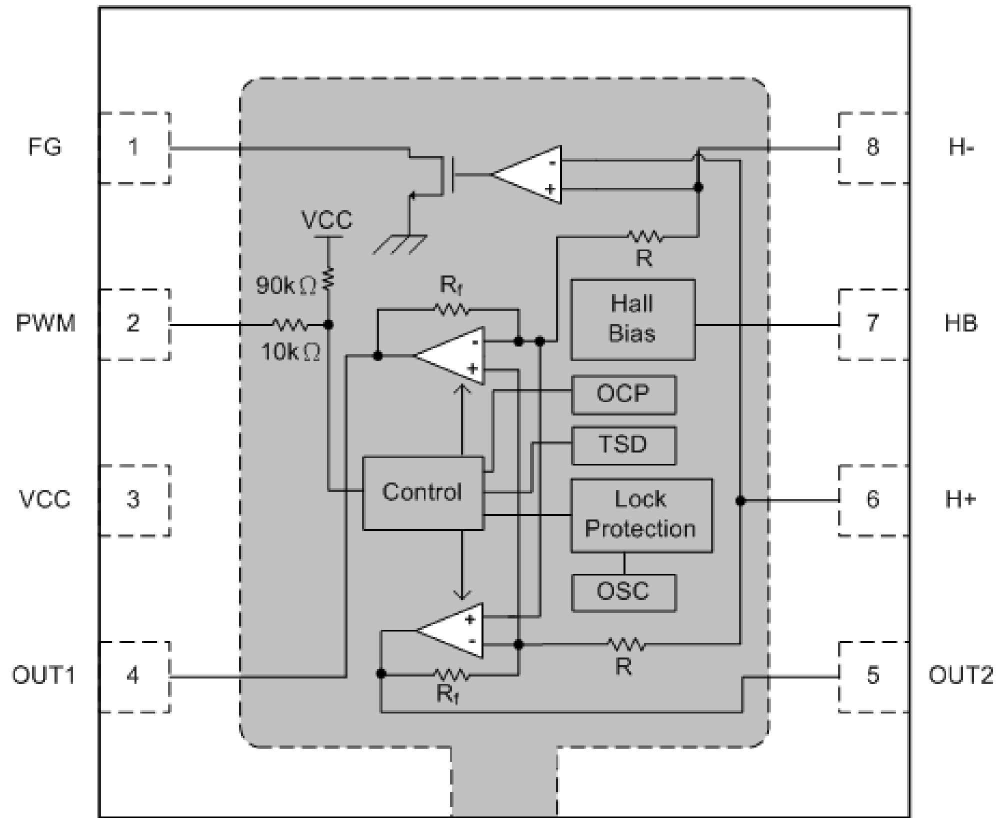


Fig.1 Block diagram

Pin Description

PIN No	Pin Name	Function
1	FG	FG signal output terminal
2	PWM	PWM signal input terminal
3	VCC	Power supply terminal
4	OUT1	Motor output terminal
5	OUT2	Motor output terminal
6	H+	Hall input terminal
7	HB	Hall Bias
8	H-	Hall input terminal
E-pad	GND	Ground terminal

Truth Table

H+	H-	PWM	OUT1	OUT2	FG	Mode
H	L	H	H	L	L (Output Tr : ON)	Operation mode
L	H		L	H	Z (Output Tr : OFF)	
H	L	L	L	L	L (Output Tr : ON)	
L	H		L	L	Z (Output Tr : OFF)	
H	L	-	L	L	L (Output Tr : ON)	Lock mode
L	H		L	L	Z (Output Tr : OFF)	

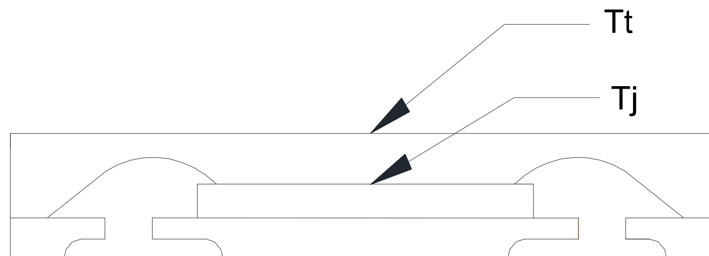
Z：Open drain output (High impedance)

- **Thermal Information**

Θja	junction-to-ambient thermal resistance	40.61℃/W
Ψjt	junction-to-top characterization parameter	0.36℃/W

- **Θja** is obtained in a simulation on a JEDEC-standard 2s2p board as specified inJESD-51.
- The **Θja** number listed above gives an estimate of how much temperature rise is expected if the device was mounted on a standard JEDEC board.
- When mounted on the actual PCB, the **Θja** value of JEDEC board is totally different than the **Θja** value of actual PCB.
- **Ψjt** is extracted from the simulation data to obtain **Θja** using a procedure described in JESD-51, which estimates the junction temperature of a device in an actual PCB.

- The thermal characterization parameter, **Ψjt**, is proportional to the temperature difference between the top of the package and the junction temperature. Hence, it is useful value for an engineer verifying device temperature in an actual PCB environment as described in JEDEC JESD-51-12.
- When Greek letters are not available, **Ψjt** is written Psi-jt.
- Definition:



$$\text{DFEINITION:}\psi_{jt} = (T_j - T_t) / P_d$$

Where :

Ψjt (Psi-jt) = Junction-to-Top(of the package) °C/W
Tj= Die Junction Temp. °C
Tt= Top of package Temp at center. °C
Pd= Power dissipation. Watts

- Practically, most of the device heat goes into the PCB, there is a very low heat flow through top of the package, So the temperature difference between **Tj** and **Tt** shall be small, that is any error caused by PCB variation is small.

- This constant represents that **Ψjt** is completely PCB independent and could be used to predict the **Tj** in the environment of the actual PCB if **Tt** is measured properly.

How to predict Tj in the environment of the actual PCB

Step 1 : Used the simulated **Ψjt** value listed above.

Step 2 : Measure **Tt** value by using

- **Thermocouple Method**
  We recommend use of a small ~40 gauge(3.15mil diameter) thermocouple. The bead and thermocouples wires should touch the top of the package and be covered with a minimal amount of thermally conductive epoxy. The wires should be heat-insulated to prevent cooling of the bead due to heat loss into wires. This is important towards preventing "too cool" **Tt** measurements, which would lead to the calculated **Tj** also being too cool.

- **IR Spot Method**
  An IR Spot method should be utilized only when using a tool with a small enough spot area to acquire the true top center "hot spot".
  Many so-called "small spot size" tools still have a measurement area of 0~100+mils at "zero" distance of the tool from the surface. This spot area is too big for many smaller packages and likely would result in cooler readings than the small thermocouple method. Consequently, to match between spot area and package surface size is important while measuring **Tt** with IR sport method.

Step 3 : calculating power dissipation by

$$P \cong (VCC - |Vo_{_Hi} - Vo_{_Lo}|) \times I_{out} + VCC \times Icc$$

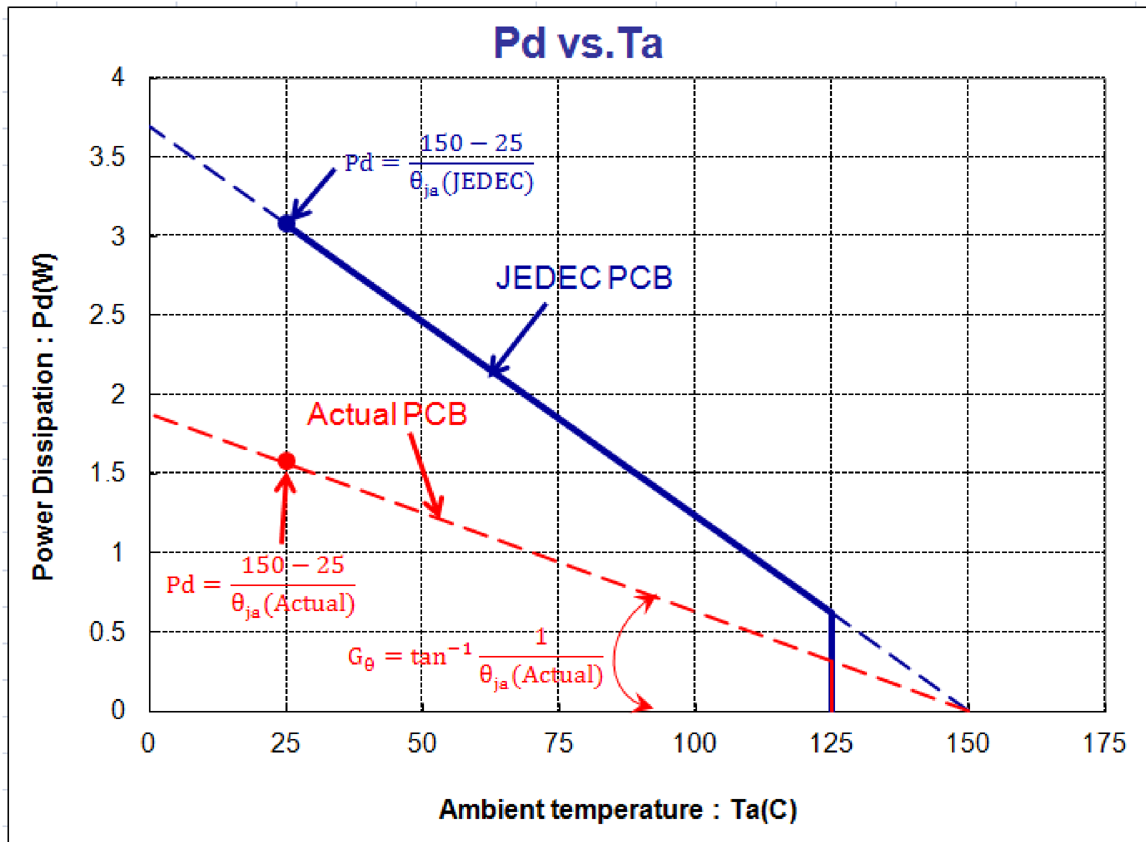
Step 4 : Estimate **Tj** value by

$$Tj = \Psi jt \times P + Tt$$

Step 5: Calculated Θja value of actual PCB by the known **Tj**

$$\Theta ja(actual) = (Tj - Ta)/P$$

Maximum Power Dissipation (de-rating curve) under JEDEC PCB & actual PCB



Application circuit

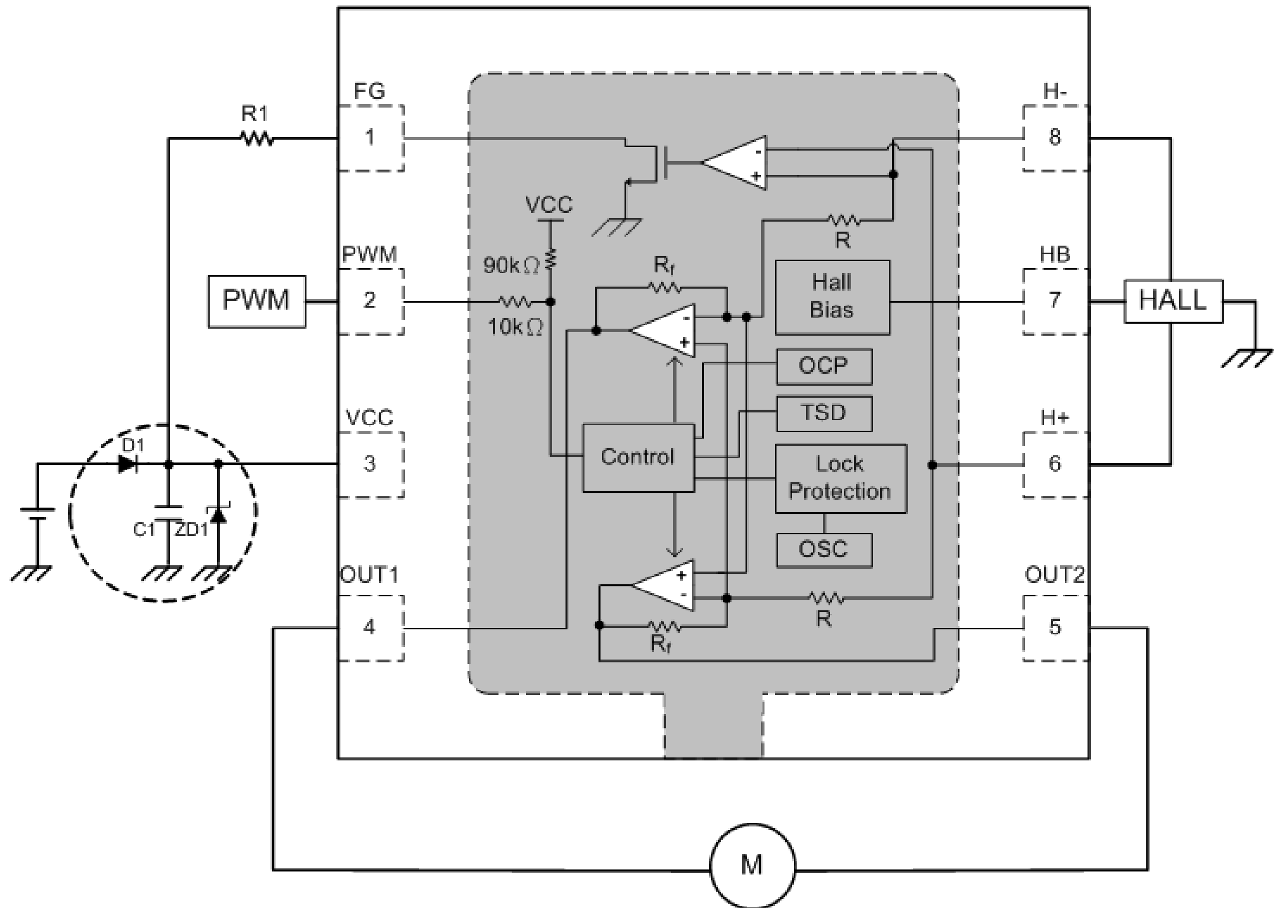


Fig.2 Application circuit

Reverse connection of power supply may break the device. A countermeasure is needed such as using reverse current protection diode (D1) between power supply and V_{CC} terminal.

The BEMF causes re-circulate current to power supply, when power-on or output changes. It may cause V_{CC} terminal to raise voltage, especially using reverse current protection diode (D1) because there is no way to return current back to power supply. In such case, please take necessary measures like below.

Connect a Zener diode (ZD1) between V_{CC} and GND terminal not to exceed the absolute maximum rating voltage.

Connect a capacitor (C1) between V_{CC} and GND terminal to make a path of return current to power supply.

Lock detection, automatic restart circuit

This IC detect the rotation of the motor by hall signal, and adjust lock detection ON time (Ton) and lock detection OFF time (Toff) by the internal counter. These time (Ton, Toff) are showed below.

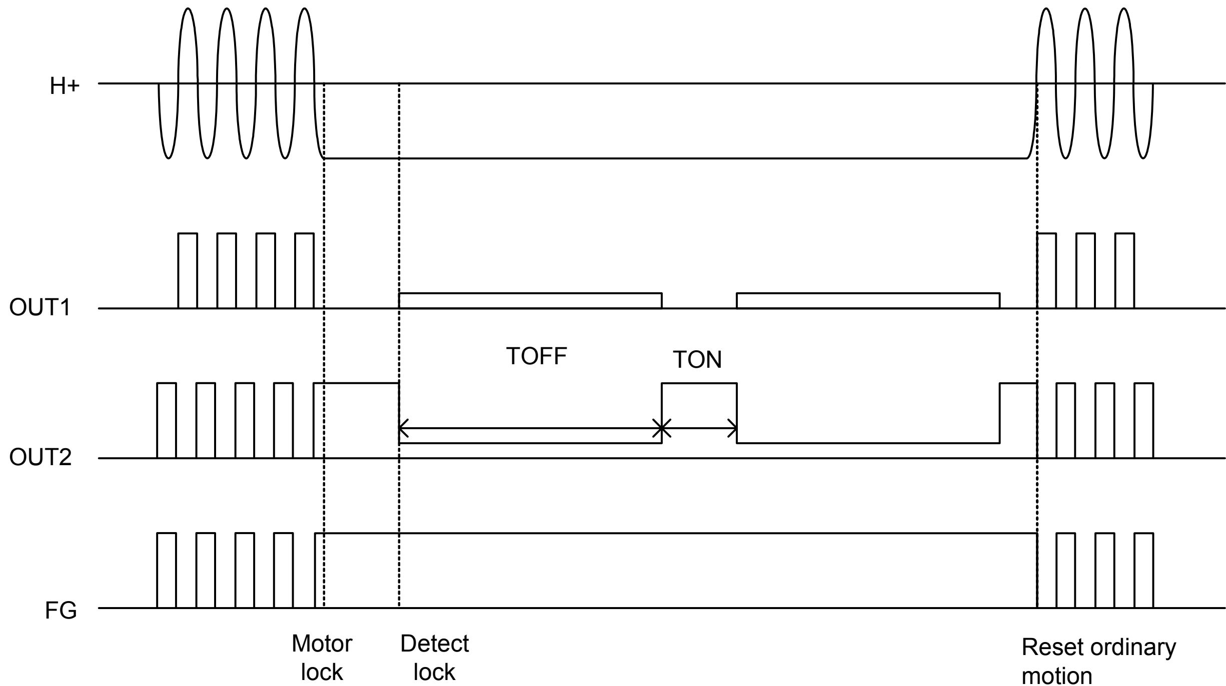


Fig.3 Lock detect and auto restart motion

Only in Lock detection ON Time (Ton), motor will be rest ordinary motion by switching over of hall signal.

This IC make the lock protection function off, when the PWM input keeps low level for more than 70ms (typ.)

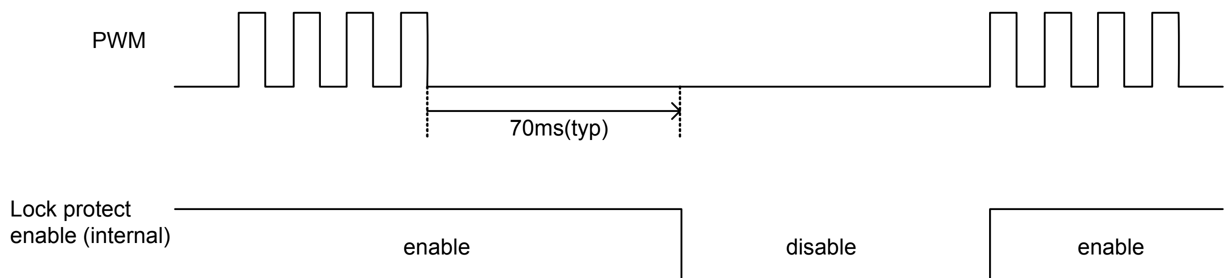
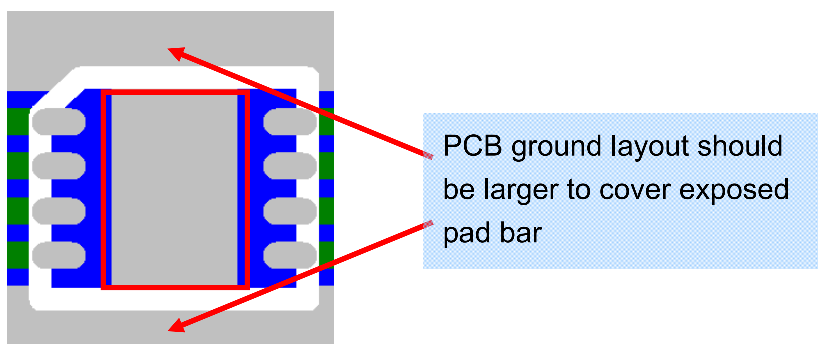


Fig.4 PWM input signal and lock protect function

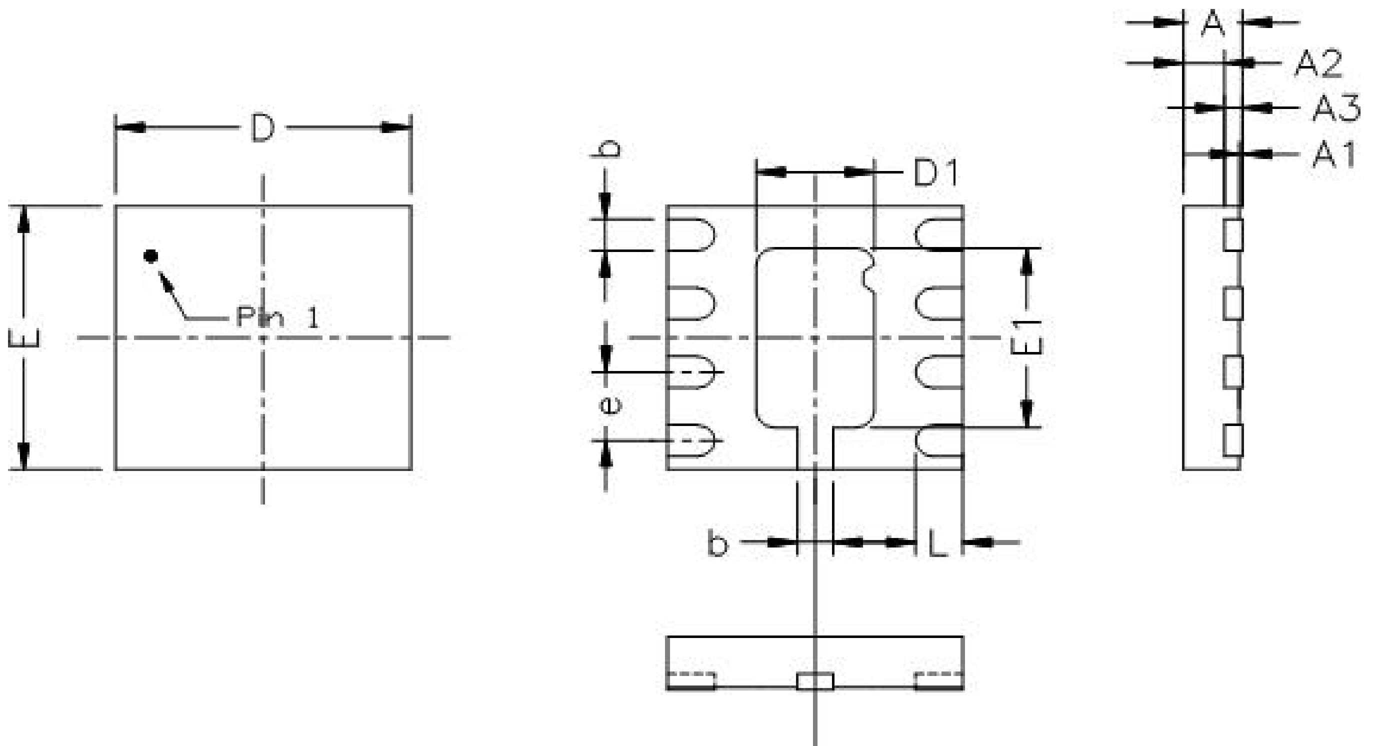
Lock protect function does not work if PWM input frequency is slower than 15Hz (typ.)
So, please input faster frequency more than 20Hz

Application Note

1) Absolute maximum ratings
   This product is produced with strict quality control, but destroyed in using beyond absolute maximum ratings. Once IC destroyed, a failure mode cannot be defined (like short-mode or open-mode).Therefore, physical security counter measure, like fuse, is to be given when a specific mode to be beyond absolute maximum rating is considered.
2) Reverse connection of power supply
   Reverse connection of the power supply may break the device. A countermeasure is needed such as using reverse current protection diodes between the power supply and the V_{CC} terminal.
3) Power supply line
   The BEMF causes re-circulate current to power supply, Please connect a capacitor between power supply and GND as a route of re-circulate current. And please determine the capacitance after confirmation that the capacitance does not causes any problems.
4) GND potential
   The GND terminal should be the location of the lowest voltage on the chip.
5) Thermal design
   The thermal design should allow enough margin for actual power dissipation.
6) Mounting failures
   Mounting failures, such as misdirection or miss-mounts, may destroy the device.
   The electrical short caused by falling particle, between outputs; power supply and output; or output and ground, may damage the device.
7) Layout guide
   <a> There are a Bars on AM3929 exposed pad, the advantage of these a bars is to detect if exposed pad is well mounted on PCB ground.
   <b> The PCB ground layout should be larger enough to cover exposed pad bar in order to detect exposed pad is well mounted on PCB.
   PLS refer to following drawing



- **Packaging outline --- DFN 2.5X2.5L** **Unit : mm**



SYMBOL	MILLIMETERS		INCHES	
	Min.	Max.	Min.	Max.
A	-	0.50	-	0.020
A1	-	0.05	-	0.002
A2	-	0.35	-	0.014
A3	0.15 REF		0.006 REF	
b	0.25	0.35	0.010	0.014
D/E	2.50 BSC		0.098 BSC	
D1	1.34	1.54	0.053	0.061
E1	1.95	2.15	0.077	0.085
L	0.25	0.35	0.010	0.014
e	0.65 BSC		0.026 BSC	

Condition of Soldering

1).Manual Soldering

Time / Temperature ≤ 3 sec / 400 ± 10 °C （2 Times）

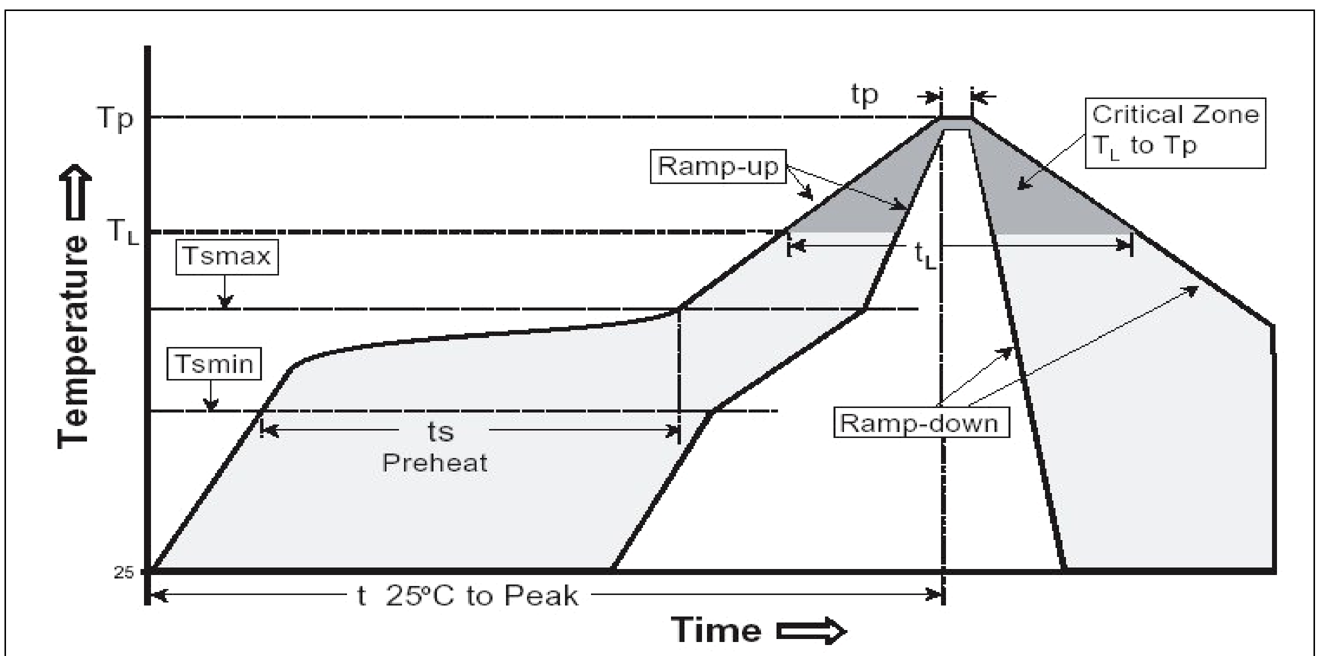
Test Results：0 fail/ 22 tested

Manual Soldering count：2 Times

2).Re-flow Soldering (follow IPC/JEDEC J-STD-020D)

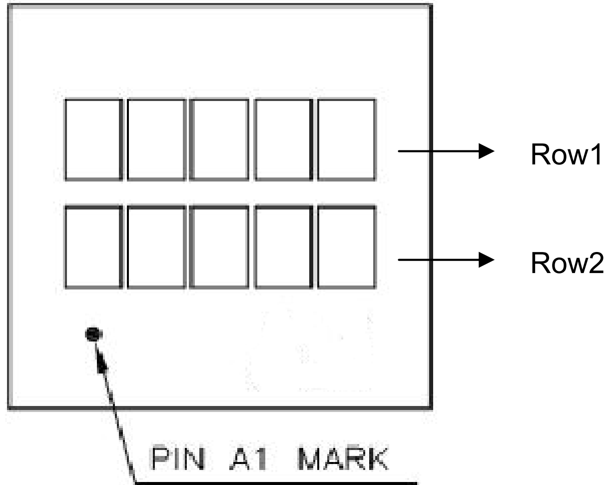
Classification Reflow Profile

Profile Feature	Pb-Free Assembly
Average ramp-up rate (T_L to T_P)	3°C/second max.
Preheat - Temperature Min (Ts min) - Temperature Max (Ts max) - Time (ts) from (Tsmin to Tsmax)	 150°C 200°C 60-120 seconds
Ts max to T_L - Temperature Min (Ts min)	 3°C/second max.
Time maintained above: - Liquid us temperature (T_L) - Time (t_L) maintained above TL	 217°C 60-150 seconds
Peak package body temperature (Tp)	260 +0/-5°C
Time with 5°C of actual Peak - Temperature (tp)	30 seconds
Ramp-down Rate	6°C/second max.
Time 25°C to Peak Temperature	8 minutes max.



Test Results：0 fail/ 32 tested Reflow count：3 cycles

Marking Identification



Row 1
A3929

Row 2
Date & Lot number