

# Sensorless BLDC Motor Driver for Optical Storage AM9293Q

The AM9293Q is developed to drive Brush-less spindle motor. This IC has braking select. Forward rotation mode and braking mode are able to be selected by two control terminals. Package material is Pb free.

## ● Applications

DVD-ROM, DVD-RW , BD-ROM, DVD-player, BD-player

## ● Features

- 1) Direct-PWM-driving system
- 2) Current limit circuit
- 3) Built in FG-output
- 4) Over-voltage protection
- 5) Low consumption
- 6) Short brake
- 7) Built-in thermal-shut-down circuit

## ● Absolute Maximum Ratings (Ta = 25°C)

Parameter	Symbol	Limits	Unit
5V voltage Supply	VDD1/VDD2	7	V
Motor power supply	VCCB/VM	15	V
Spindle output current	Io	1.6	A
Power dissipation	Pd	*2.26	W
Operating temperature	Topr	-35 to +85	°C
Storage temperature	Tstg	** -40 to +150	°C

\* When mounted on a 76.2mmx114.6mmx1.6mm 2 layers FR4 board.

\*Reduced by 18.1mW for each increase in Ta of 1°C over 25°C.

\*\*Do not exceed Pd ASO and Tj = 150°C.

## ● Recommended operating conditions

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

Parameter	Symbol	Min	Typ	Max	Unit
5V Power supply	VDD1/VDD2	4	5	6	V
Motor power supply	VM/VCCB	9	12	13.2	V
Spindle output current	Io	-	1	1.5	A
PWM carrier frequency	Fosc	-	85	-	KHz

**The parasitic diode of UVW output BEMF current endurance spec is 1.20A.**

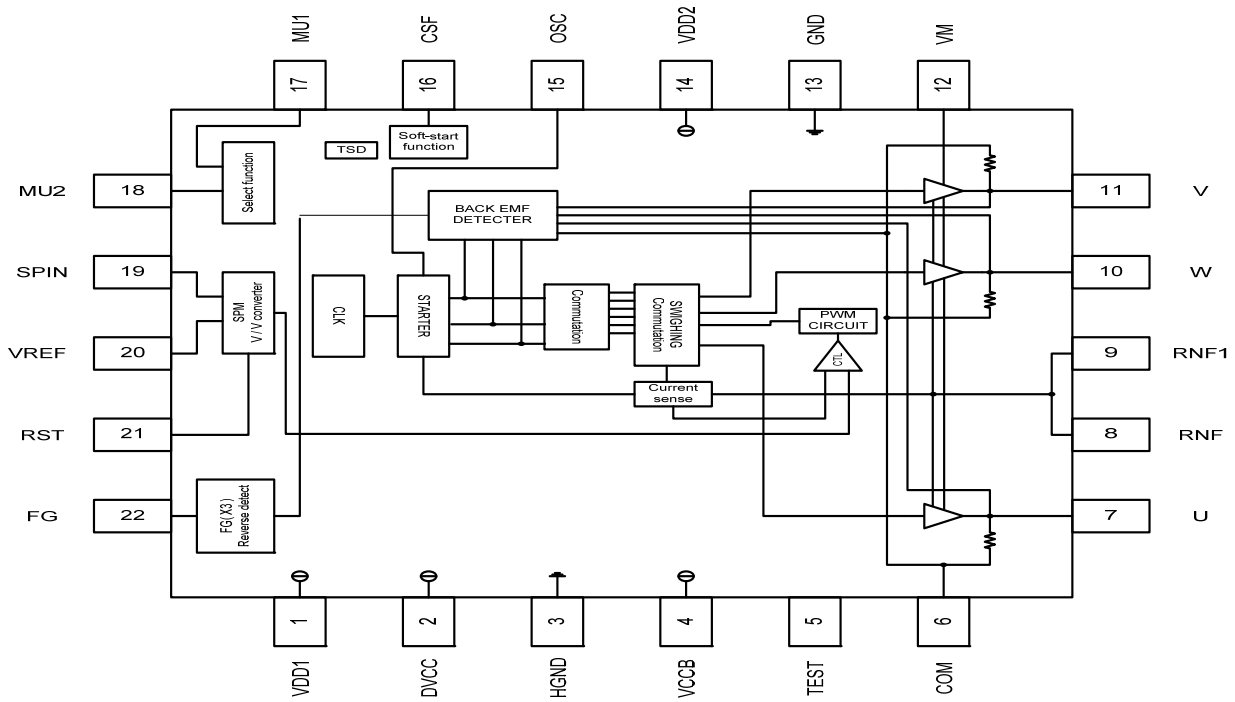
● **Electrical Characteristics**

(Unless otherwise specified, Ta = 25°C, VDD1=VDD2= 5V, VCCB=VM=12V, RNF=0.66Ω, VREF=1.65V)

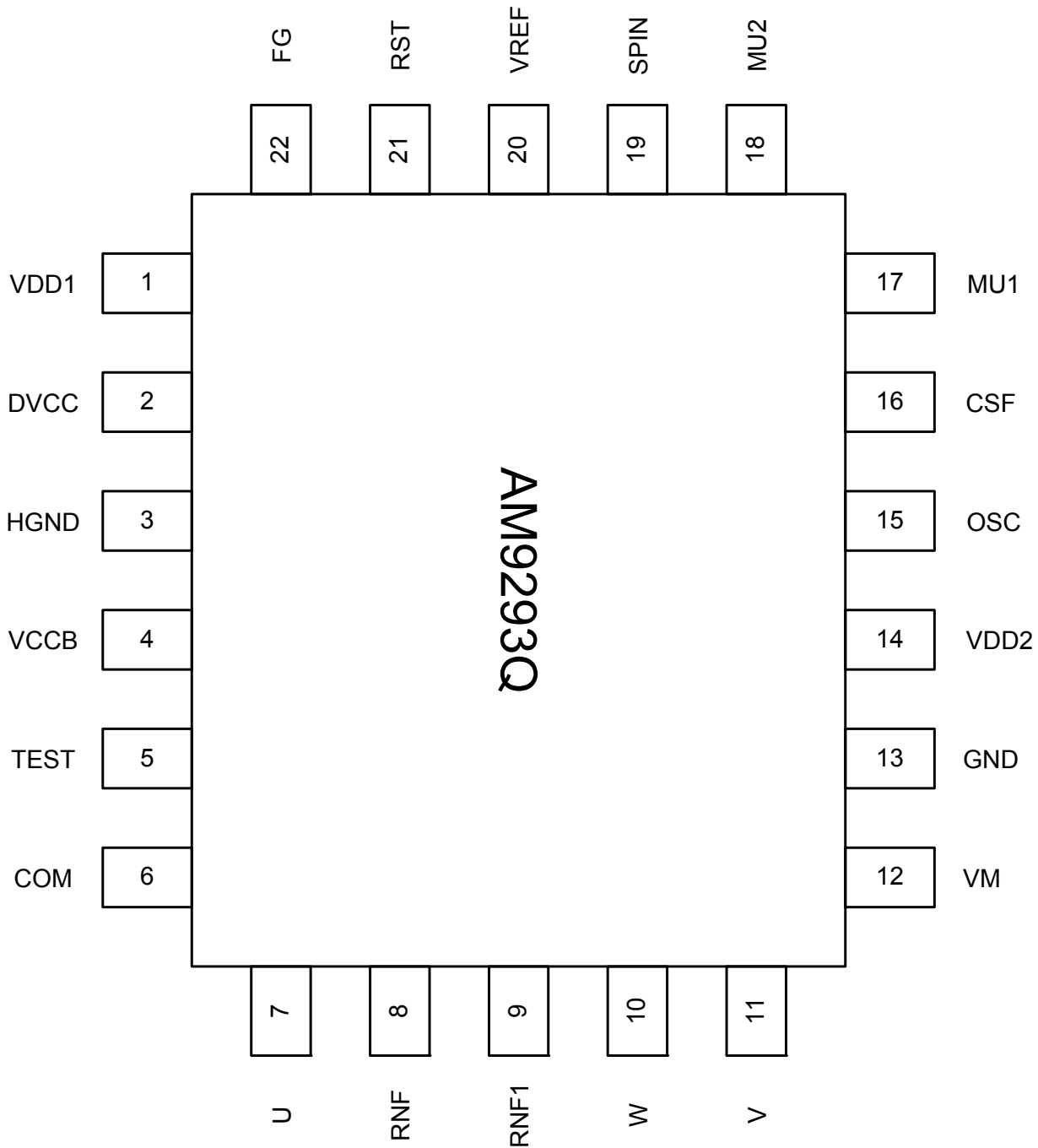
Parameter	Symbol	Limit			Unit	Conditions
		Min	Typ	Max		
<b>Common</b>						
Sleep current	I <sub>sc</sub>	-	700	-	uA	MU1=0V
Quiescent current	I <sub>cc</sub>	-	3	-	mA	MU1=5V, MU2=5V
MUTE1/MUTE2 terminal low voltage	VMU1L/ VMU2L	0	-	0.8	V	MU1/MU2
MUTE1/MUTE2 terminal high voltage	VMU1H/ VMU2H	2.5	-	5	V	MU1/MU2
MUTE1/MUTE2 terminal input current	IMU1/ IMU2	-	-	500	uA	MU1/MU2=5V
PWM carrier frequency	Fosc	-	85	-	KHz	
VREF input voltage range	VinREF	1.0	-	3.0	V	
VREF terminal input current	IinREF	-	50	-	uA	VREF=1.65V
<b>Spindle driver block &lt; FG output&gt;</b>						
High voltage	VFGH		4.9		V	100 kΩ pull up to VDD
Low voltage	VFGL	-	0.1		V	
<b>Spindle driver block &lt;Torque control&gt;</b>						
Output on resistance	RDSON		2		Ω	I <sub>o</sub> =0.5[A]
Control voltage dead zone-	VDZ-	-80	-40	0	mV	SPIN<VREF [REVERSE]
Control voltage dead zone+	VDZ+	0	+40	+80	mV	VREF<SPIN [FORWARD]
Control gain	Gvo	0.85	1.0	1.15	V/V	G <sub>io</sub> =G <sub>vo</sub> /RNF[A/V]
Control limit 1F	Vlim1F		0.55		V	Ilim1F=Vlim1F/RNF [FORWARD]
Control limit 1R	Vlim1R		0.32		V	Ilim1R=Vlim1R/RNF [REVERSE]

This product is not designed for protection against radioactive rays.

● Block Diagram



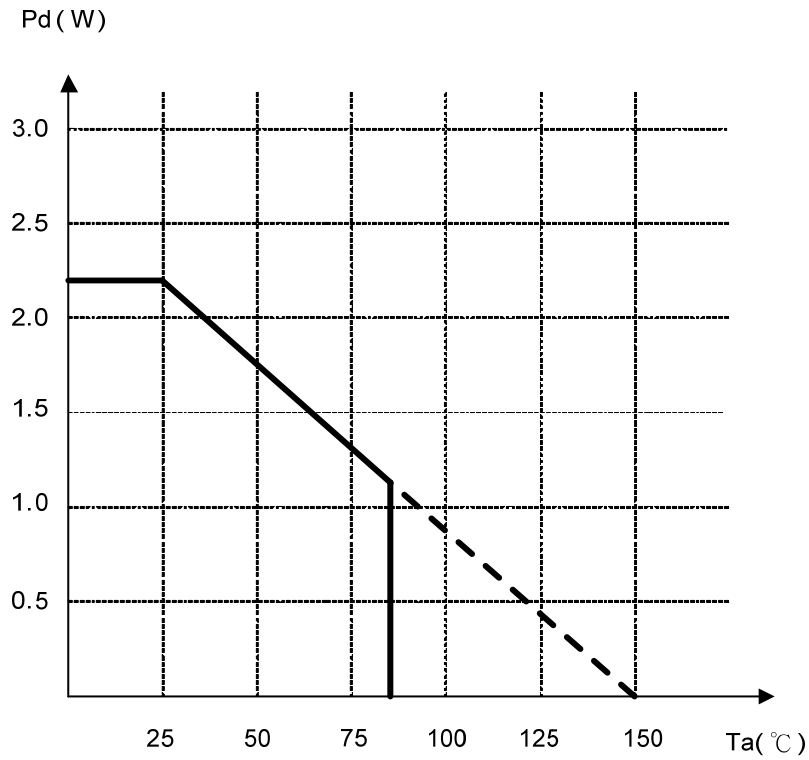
● Pin configuration



● Pin Description

PIN No	Pin Name	Function
1	VDD1	5V power supply
2	DVCC	Internal power supply
3	HGND	HGND
4	VCCB	12 power supply
5	TEST	Test pin
6	COM	Motor coil center point input
7	U	Motor drive output U
8	RNF	Spindle current sense
9	RNF1	Spindle current sense1
10	W	Motor drive output W
11	V	Motor drive output V
12	VM	Motor power supply
13	GND	GND
14	VDD2	5V power supply
15	OSC	Oscillator timing setting
16	CSF	Soft-start setting input
17	MU1	Mute/Brake select terminal 1
18	MU2	Mute/Brake select terminal 2
19	SPIN	Spindle driver input
20	VREF	Reference voltage input
21	RST	Start setting input
22	FG	Frequency generator output

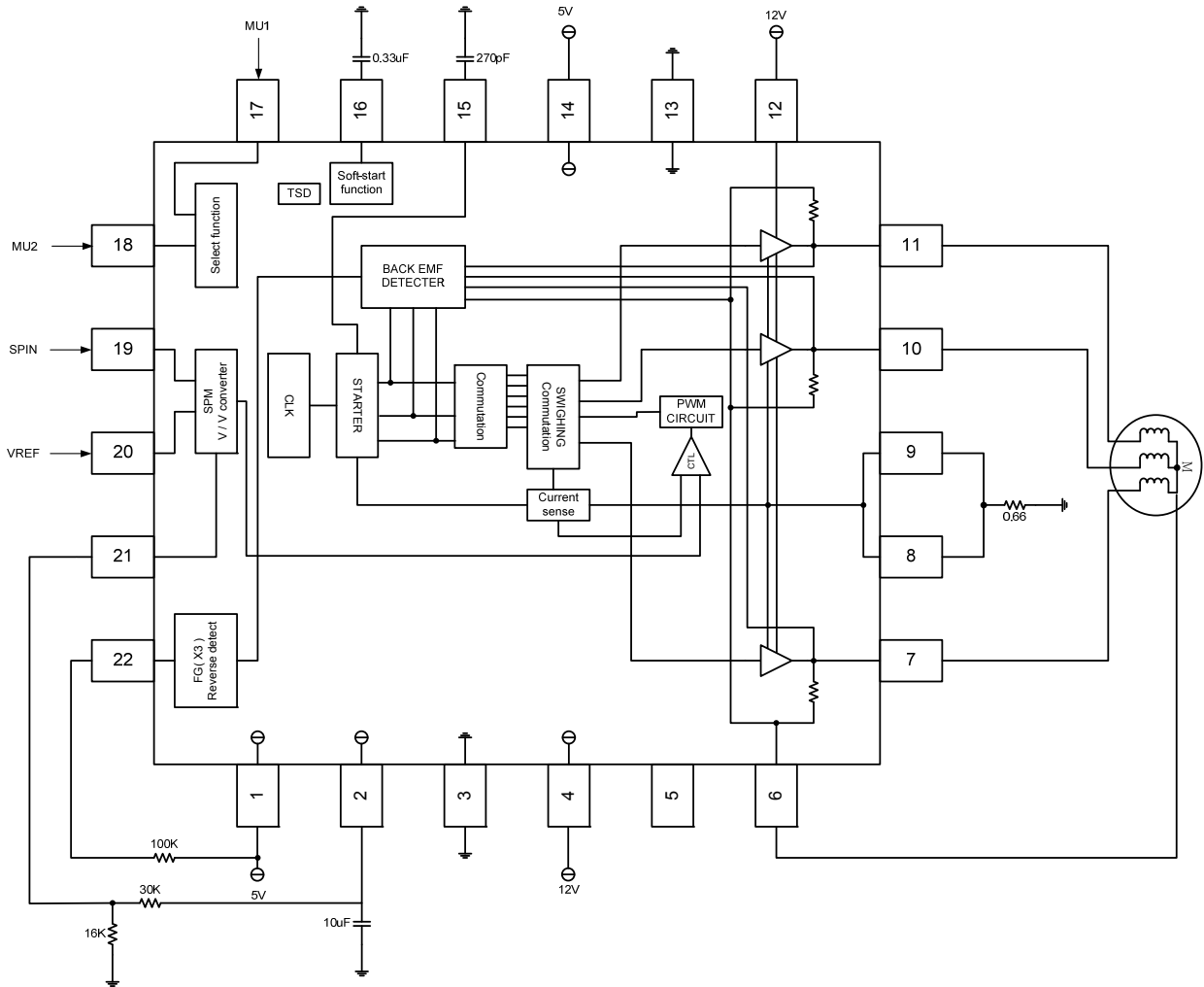
● Power dissipation curve:



\*76.2mm×114.6mm×1.6mm 2layers FR4 board.

\*De-rating is done at 18.1mW/°C for operating above  $T_a=25^{\circ}\text{C}$

● Application circuit



● **Function description**

1. The short brake is switched by MU1 and MU2 pin, the operation is shown in the table as below.

MU1 (pin17)	MU2 (pin18)	Spindle	VREF < SPIN	SPIN < VREF
L	L	X	--	--
L	H	X	--	--
H	L	O	Rotating forward (100%)	Short circuit brake ♦1
H	H	O	Rotating forward (100%)	PWM brake (56%) ♦2

♦1 Short-circuit braking mode

All the spindle driver outputs are shorted out to GND when SPIN < VREF.

♦2 PWM Reverse-rotation braking mode

When SPIN < VREF, all output is shorted to GND at 4000rpm(Typ.) or more, in less than 4000rpm (Typ.) the output become reverse-rotation braking mode

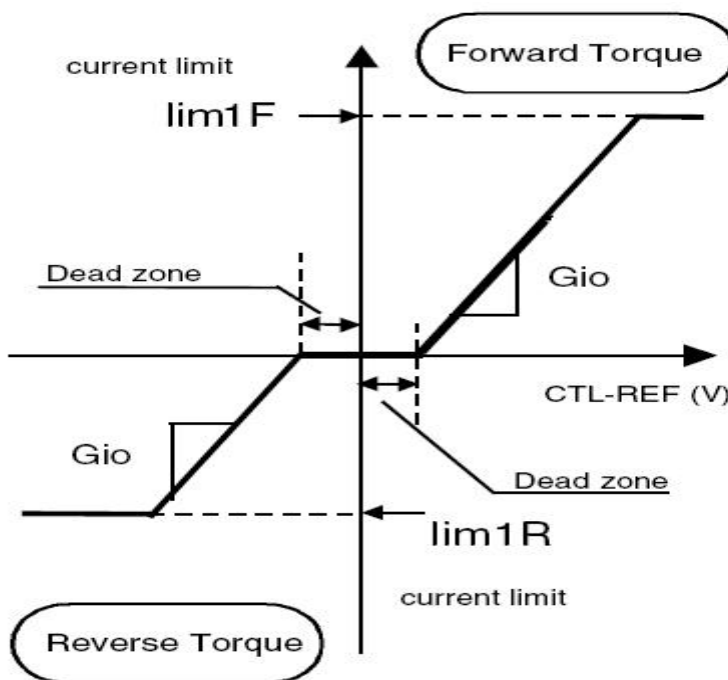
Rotation speed is less than 300rpm when SPIN < VREF, all output is shorted to GND.

2. Torque command (SPIN: pin 19)/ output current detection terminals (RNF: pin 8 and 9)

The relationship between the differential voltage between SPIN and VREF and the torque is shown in following Figure. The voltage gain [Gvo] is 1[V/V].

The current gain [Gio] is 1.52[A/V](at RNF=0.66Ω) in forward torque directions, and the dead zone is from 0mV to 80mV

Current-gain-control and current-limit of this IC are determined with sensing resistor value.





**● Notice**

## 1) Wiring for RNF

Considering the wiring resistance, connect each detecting resistor as close as possible to the current detection terminals for the spindle drive RNF (pin 8, 9) of the IC.

## 2) Reverse-rotation braking

In the case of reverse-rotation braking from high speed rotation, pay good attention to reverse electromotive force. Furthermore, fully check the voltage to be applied to the output terminal and consider the revolutions applied to the reverse-rotation brake.

## 3) Bypass capacitor

Please connect a bypass capacitor (0.1uF) across the supply voltage lines close to the IC pins.

Supply fault, ground fault, and short-circuit between output terminals.

Do not short-circuit between any output pin and supply pin (supply fault) or ground (ground fault), or between any output pins (load short-circuit). When mounting the IC on the circuit board, be extremely cautious about the orientation of the IC. If the orientation is mistaken, the IC may break down, and produce smoke in some cases.

## 4) Heat dissipation fins

Heat dissipation fins are attached to the GND on the inside of the package. Make sure to connect them to the external GND.

## 5) Thermal shutdown function

The built-in thermal shutdown circuit mutes the output current when the chip temperature reaches 150°C (typ.). The hysteresis is set to 25°C (typ.), so the circuit will start up again when the chip temperature falling to 125°C (typ.).

## 6) 3 phase spindle motor start function

- a. When SPIN(pin19) > VREF(pin20) (OSC capacitor=270pF), the IC start to work after delay 150ms.

● **Condition of Soldering**

**1).Manual Soldering**

Pb-free: Time / Temperature  $\leq 3 \text{ sec} / 400 \pm 10^\circ\text{C}$  ( 2 Times )

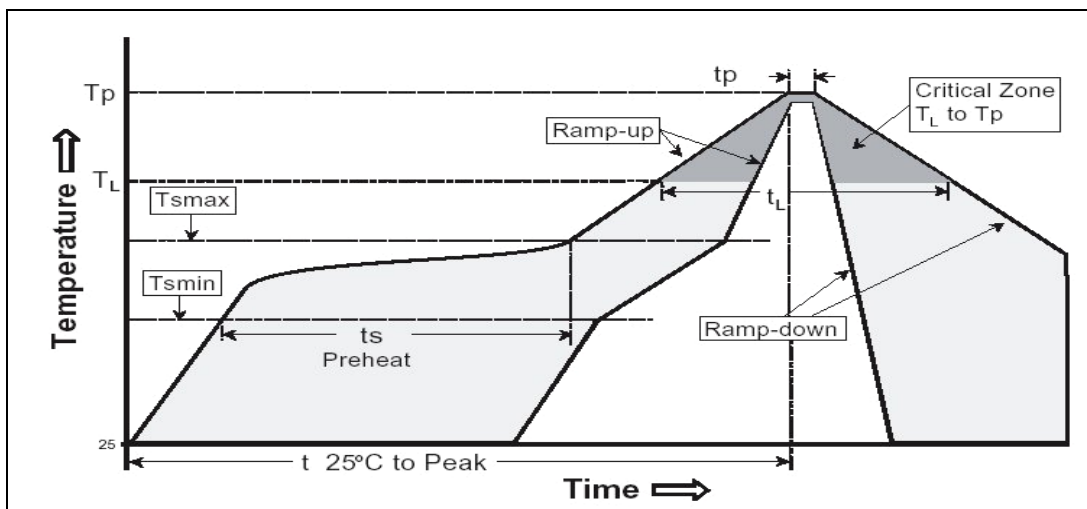
Test Results : 0 fail/ 22 tested

Manual Soldering count : 2 Times

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

Classification Reflow Profile

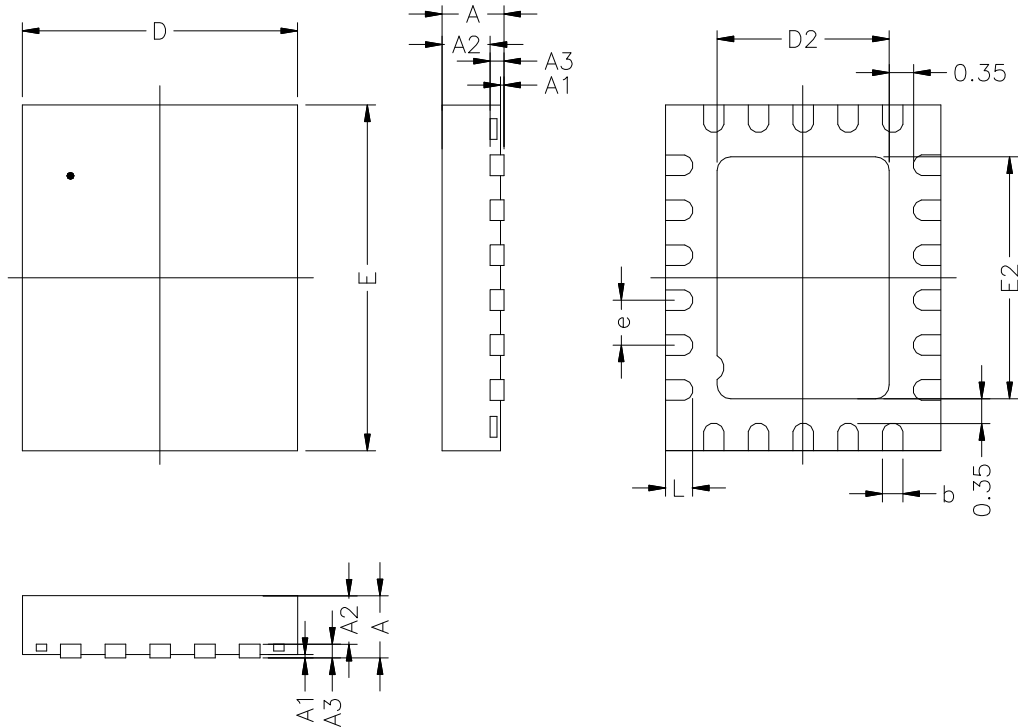
Profile Feature	Pb-Free Assembly
Average ramp-up rate ( $T_L$ to $T_P$ )	3°C/second max.
Preheat	
- Temperature Min ( $T_s \text{ min}$ )	150°C
- Temperature Max ( $T_s \text{ max}$ )	200°C
- Time (min to max) ( $t_s$ )	60-180 seconds
$T_s \text{ max}$ to $T_L$	
- Temperature Min ( $T_s \text{ min}$ )	3°C/second max.
Time maintained above:	
- Temperature ( $T_L$ )	217°C
- Time ( $t_L$ )	60-150 seconds
Peak Temperature ( $T_P$ )	260 +0/-5°C
Time with 5°C of actual Peak	20-40 seconds
- Temperature ( $t_p$ )	
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

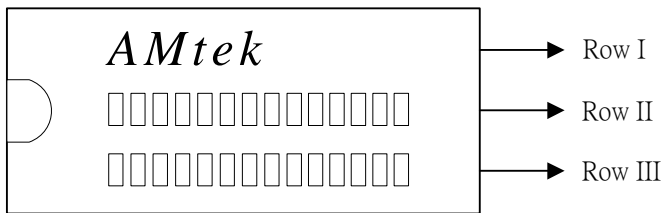
● Packaging outline --- QFN 5X4

Unit : mm



SYMBOL	MILLIMETERS		INCHES	
	Min.	Max.	Min.	Max.
A	-	0.90	-	0.035
A1	-	0.05	-	0.002
A2	-	0.70	-	0.028
A3	0.20 REF		0.008 REF	
b	0.25	0.35	0.009	0.013
D	4.00 BSC		0.157 BSC	
E	5.00 BSC		0.196 BSC	
D2	2.40	2.60	0.094	0.102
E2	3.40	3.60	0.133	0.141
L	0.30	0.50	0.014	0.018
e	0.65 BSC		0.025 BSC	

● **Marking Identification**



Row I

AMtek

Row II

AM9293Q

Row III

Lot number