



# PT3937-A 24V Automotive Single Coil Motor Driver

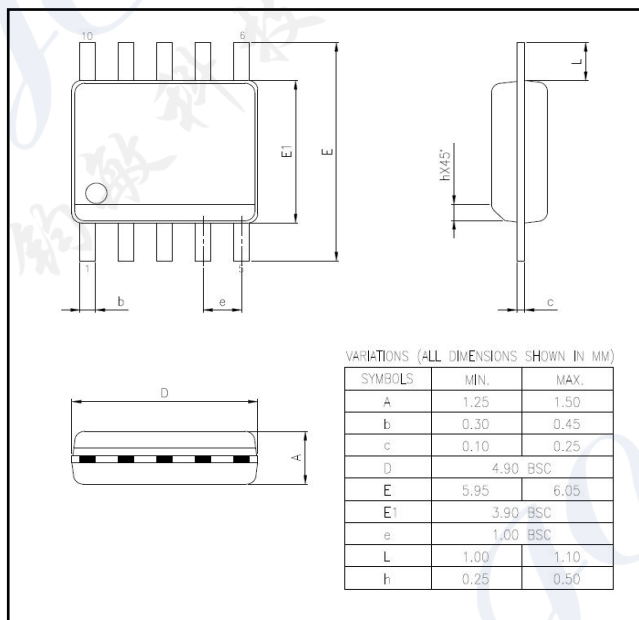
## Package: SOP-10F (Strait-Pin)

### Applications

- Single coil DC brushless motor
- Automotive fan motor

### Features

- Built-in high sensitivity hall sensor
- Single phase full wave driver
- Soft switching output driver
- Motor locked protection and automatic restart
- RD output
- Built-in hysteresis comparator
- Built-in zener diode
- High balance and low thermal drift magnetic sensing
- Low power consumption and high driving efficiency
- Thermal protection
- AEC-Q100 qualified



### Specifications

#### Absolute Maximum Ratings

Parameter	Symbol	Conditions	Rating	Units
Maximum supply voltage	VDDmax	10u sec	42	V
Allowable power dissipation	Pd		833 <sup>*1</sup>	mW
Storage temperature	Ts		-50~150	°C
Operating temperature range	Tj		-40~150	°C
Max. output current	I <sub>OMAX</sub>	0.5sec	1200 <sup>*2</sup>	mA
RD output current	I <sub>RDMAX</sub>		20	mA
RD output voltage	V <sub>RDMAX</sub>		32	V
Electrostatic discharge	V <sub>ESD-HBM</sub>	Human-body model (HBM), AEC Q100-002 qualified	±8000	V
	V <sub>ESD-CDM</sub>	Charged-device model (CDM), per AEC Q100-011 qualified	±1500	V

\*1: Reduced by 6.67mW for each increase in Ta of 1°C over 25°C When mounted on 50mm x 50mm x 1.6mm glass epoxy board

\*2: Should not exceed Pd

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**PROLIFIC TECHNOLOGY INC.**

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**Electrical Characteristics (T<sub>J</sub>=-40~150°C, V<sub>DD</sub>=4.5~30V)**

Characteristic	Symbol	Test Condition	Min.	Typ.	Max.	Units
Supply Voltage	V <sub>DD</sub>		4.5		30	V
Output High Voltage	V <sub>OH(ON)</sub>	I <sub>O</sub> =300mA	V <sub>DD</sub> -0.5	V <sub>DD</sub> -0.3		V
Output Low Voltage	V <sub>OL(ON)</sub>	I <sub>O</sub> =300mA		0.15	0.25	V
Output Voltage Clamp	V <sub>BV</sub>		32		42	V
Supply Current	I <sub>DD</sub>	Output open		6	8	mA
RD output voltage	V <sub>RD</sub>				30	V
RD sink voltage	V <sub>DSRD</sub>	I <sub>RD</sub> =3mA		0.2	0.3	V
Shutdown Time	T <sub>SD</sub>		4.2	5.6	7	S
Restart Time	T <sub>RS</sub>		0.3	0.4	0.5	S

**Magnetic Characteristics (T<sub>J</sub>=-40~150°C, V<sub>DD</sub>=4.5~30V)**

Operate Point	B <sub>OP</sub>		5	10	20	G
Release Point	B <sub>RP</sub>		-20	-10	-5	G
Hysteresis	B <sub>HYS</sub>		10	20	40	G
Symmetry	B <sub>OP</sub>  - B <sub>RP</sub>				15	G

**General Specifications**

The PT3937-A is designed for magnetic actuating using a bipolar magnetic field. The built-in dynamic offset cancellation of pre-amplifier stage achieves optimal symmetrical magnetic sensing. The output driver provides a linear drive to eliminate switching noise. This Hall-effect IC is optimal for DC brushless fan motor application. The supply voltage range is from 4.5V to 30V.

**Lock Protection**

In order to protect the motor, the driver IC will be shutdown to drive the coil when the motor is locked over 0.4 seconds. Then, it restarts to drive the motor after 5.6 seconds. Figure 1 shows the timing diagram between the hall input signal and driver's output state.

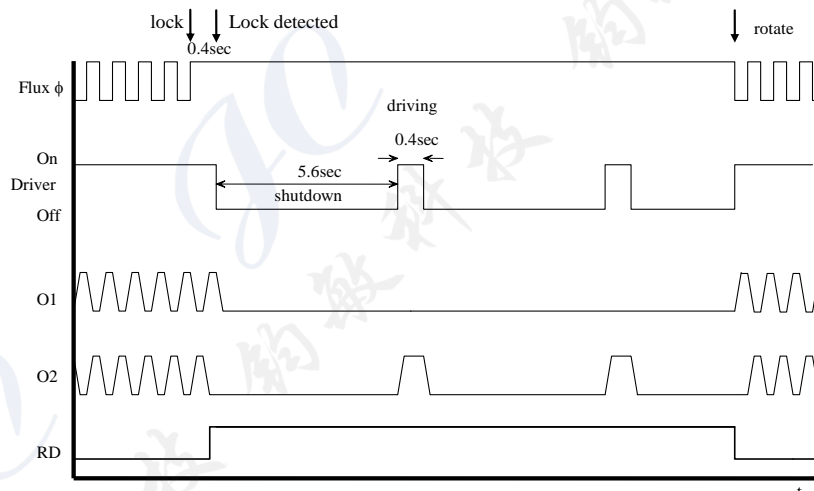


Fig 1. Lock Protection

### Hall Sensor

This Hall effect sensor IC integrates the sensor, pre-amplifier with dynamic offset cancellation and the hysteresis comparator in single chip. The hysteresis characteristic is illustrated in Fig. 2 and the threshold of the magnetic flux density is  $\pm 10$  Gauss.

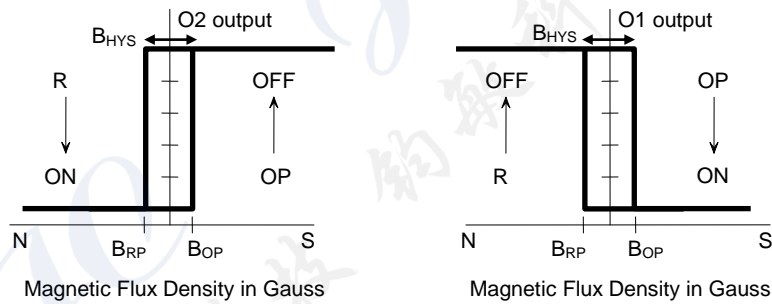
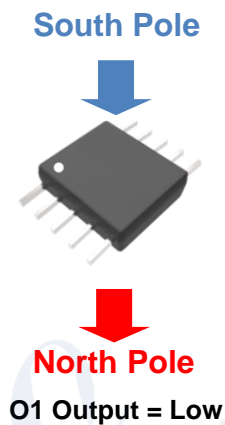


Fig 2. Magnetic Hysteresis Characteristics

### Truth Table

Parameter	Test Condition	O1	O2	RD	Mode
South Pole	$B > B_{OP}$	L	H	L	During rotation
North Pole	$B < B_{RP}$	H	L	L	



### Thermal Protection

The thermal protection of PT3937-A is to utilize the internal Hall element signal variation over temperature to achieve. Once the junction temperature of PT3937-A is over  $150^{\circ}\text{C}$ , Hall element signal amplitude will be decreased to make sensitivity weaker. That will make PT3937-A to operate in shutdown and auto-restart mode. This will turn off output driver to ensure safety.

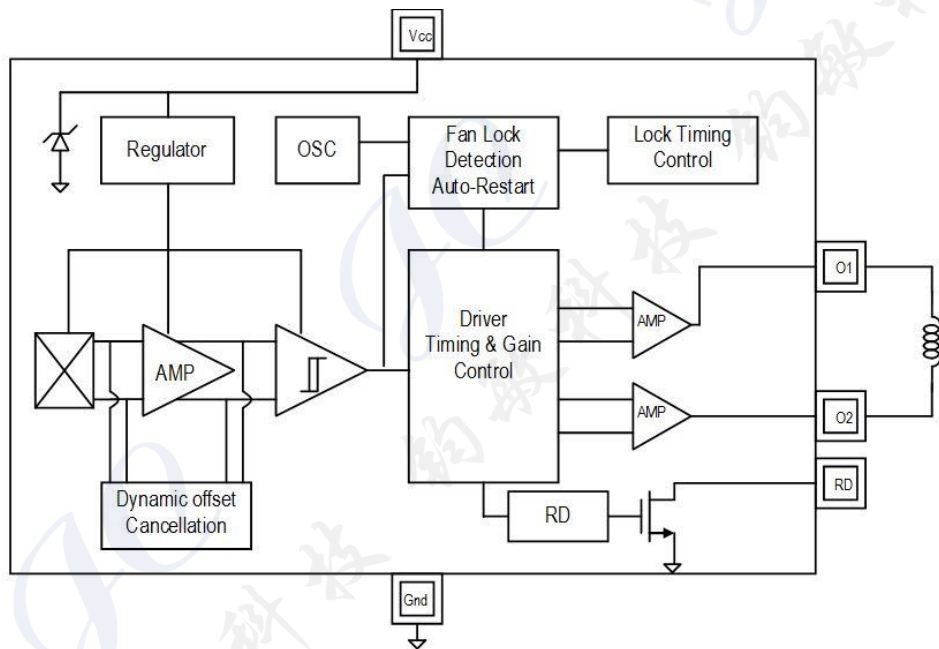
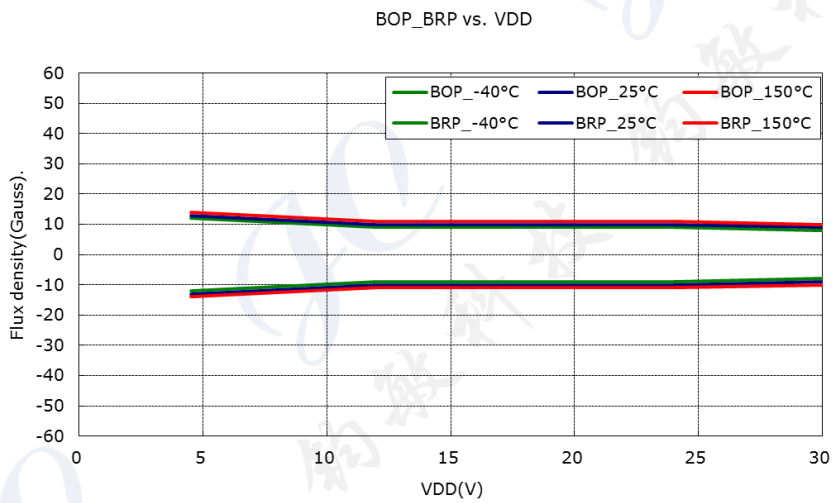
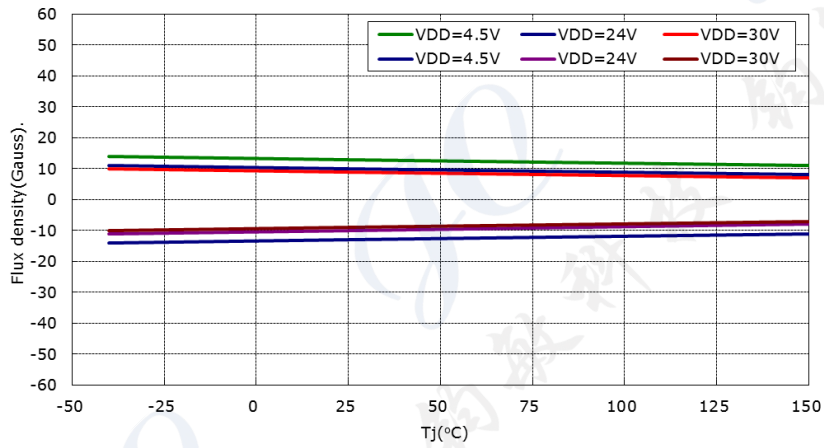


Fig. 3 Hall IC Architecture

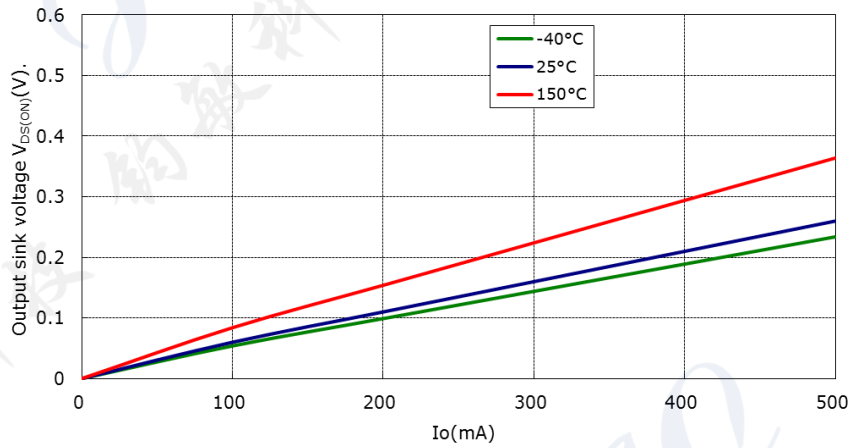
**Performance curve**



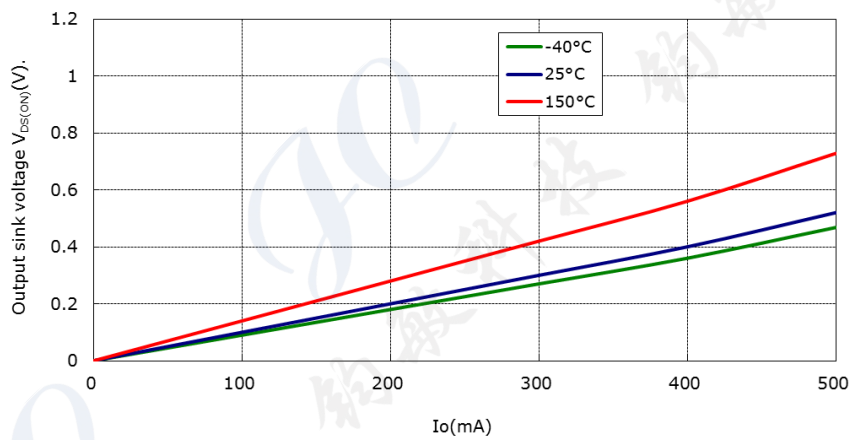
BOP\_BRP vs. Tj

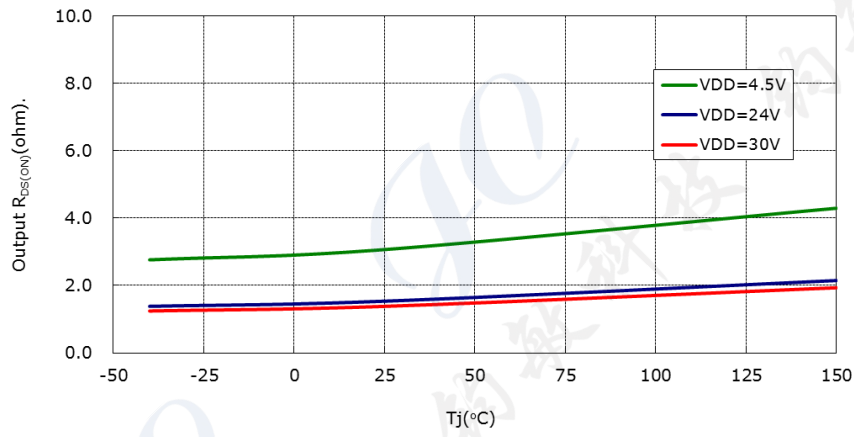
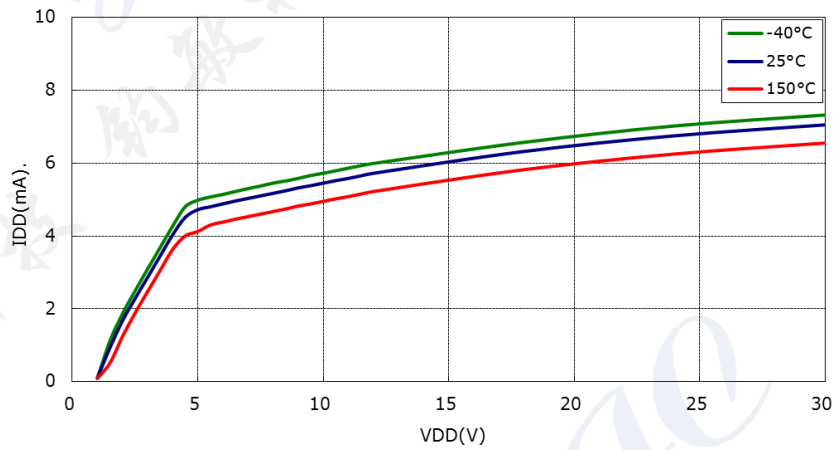
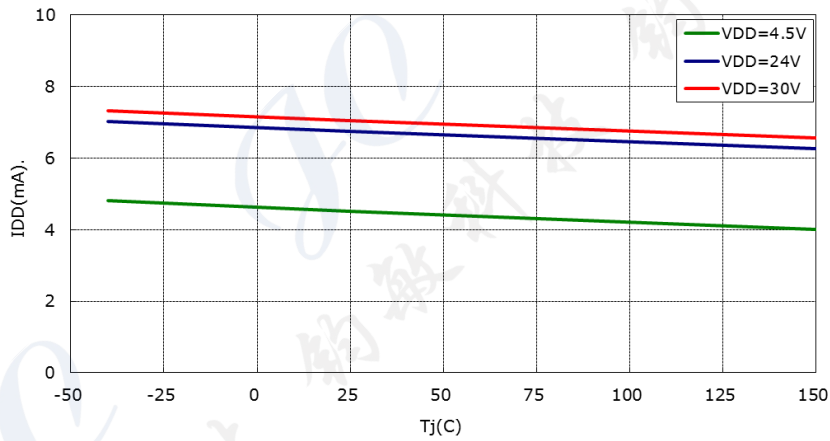


Output sink voltage VOL(ON) vs. Io (VDD=24V)

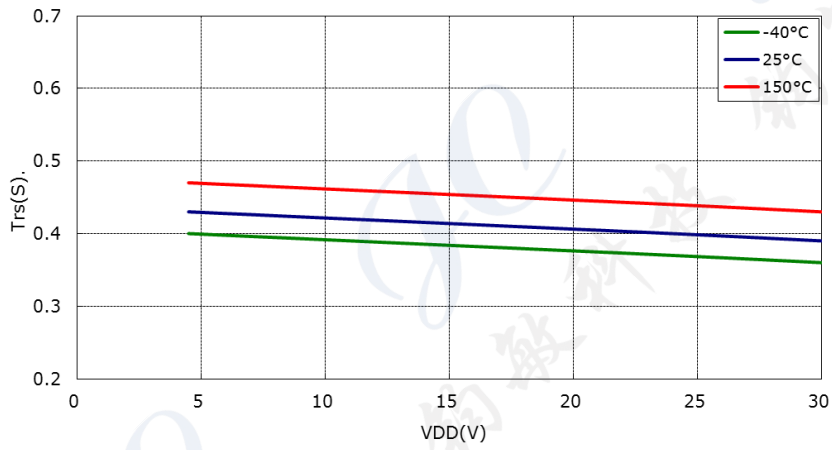


Output sink voltage VOH(ON) vs. Io (VDD=24V)

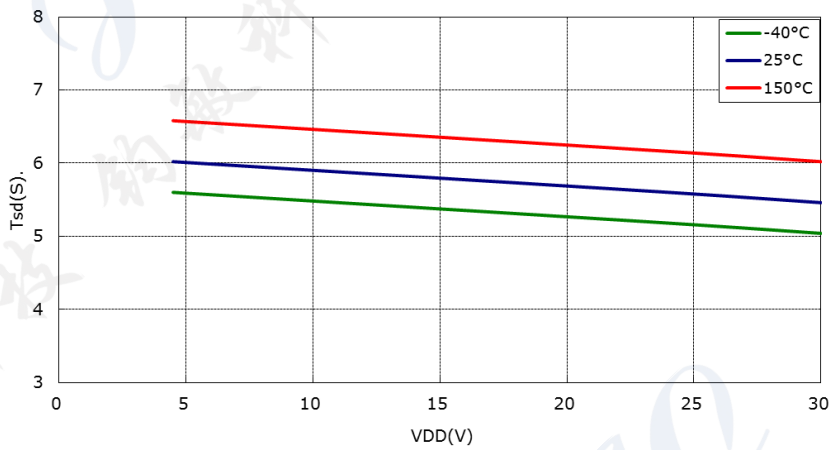


**$R_{DS(on)}$  vs.  $T_j$** 

**IDD vs. VDD**

**IDD vs.  $T_j$** 


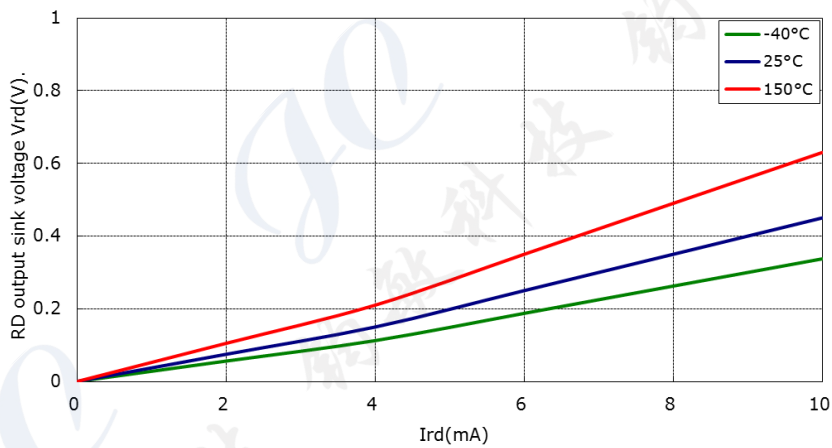
Lock Trs vs. VDD



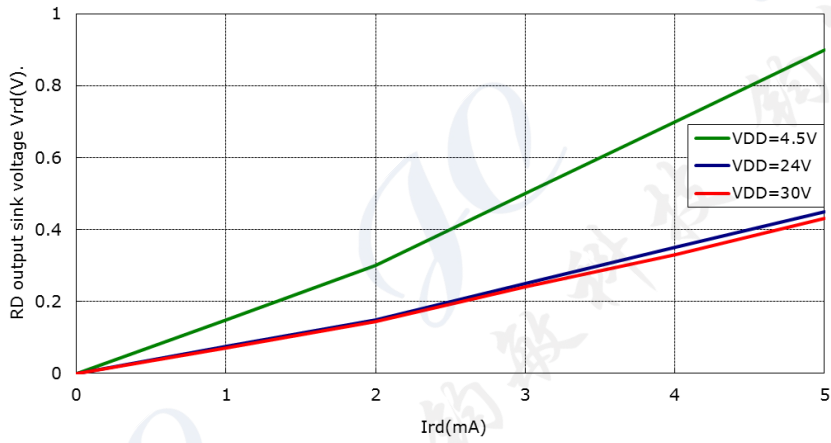
Lock Tsd vs. VDD



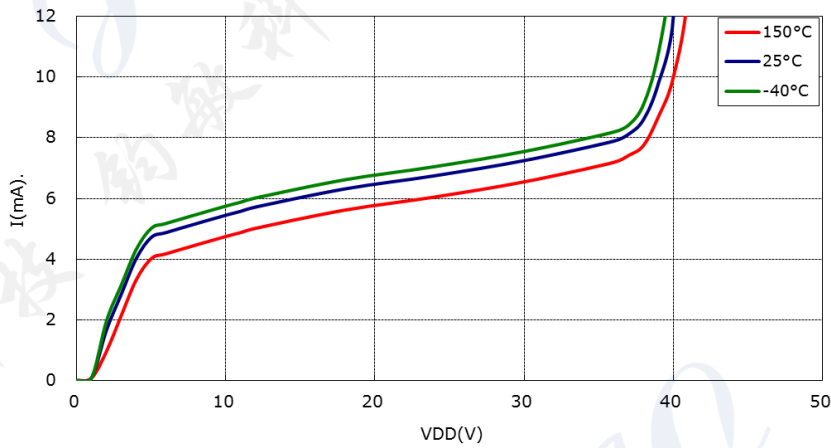
RD output sink voltage Vrd vs. Ird (VDD=24V)



RD output sink voltage vs. Ird (Ta=25C)

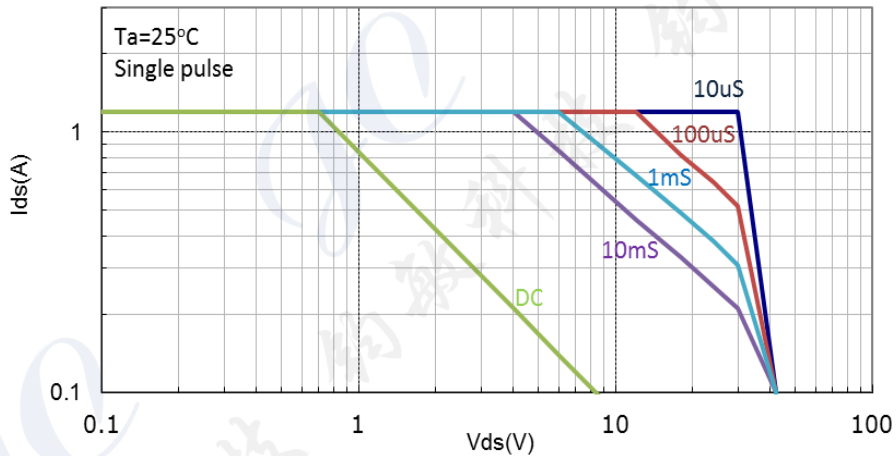


Vz vs. I



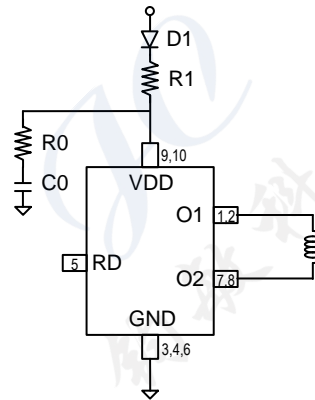
**A.S.O.**

**A.S.O (Area of Safe Operation)**



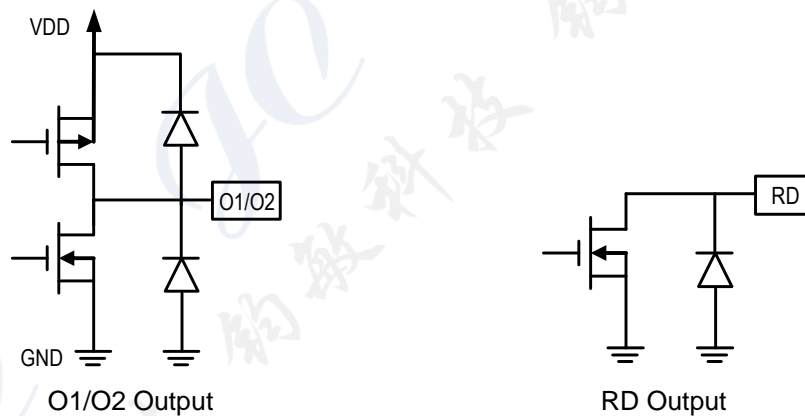


**Application circuits**



R1: 0~12ohm  
 R0: RC Snubber resistor 0ohm~12ohm  
 C0: decoupling capacitor 1nF ~ 0.1uF  
 dv/dt recommendation value of Vdd: 400V/uS max  
 All electrical characteristics shall be satisfied at this application

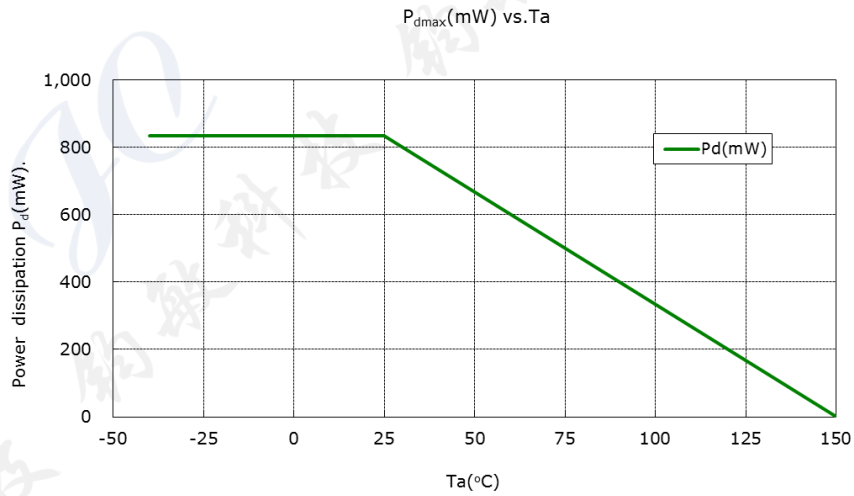
**I/O Equivalent circuits**



**Thermal resistance**

Parameter	Symbol	Conditions	Rating	Units
Allowable power dissipation	$P_d$		$833^{*1}$	mW
Junction to ambient thermal resistance	$\theta_{JA}$		150	$^{\circ}C/W$
Junction to case thermal resistance	$\theta_{JC}$		50	$^{\circ}C/W$
Maximum junction temperature	$T_J$		150	$^{\circ}C$

\*1: Reduced by 6.67mW for each increase in  $T_a$  of  $1^{\circ}C$  over  $25^{\circ}C$  When mounted on 50mm x 50mm x 1.6mm glass epoxy board



### Soldering recommendations

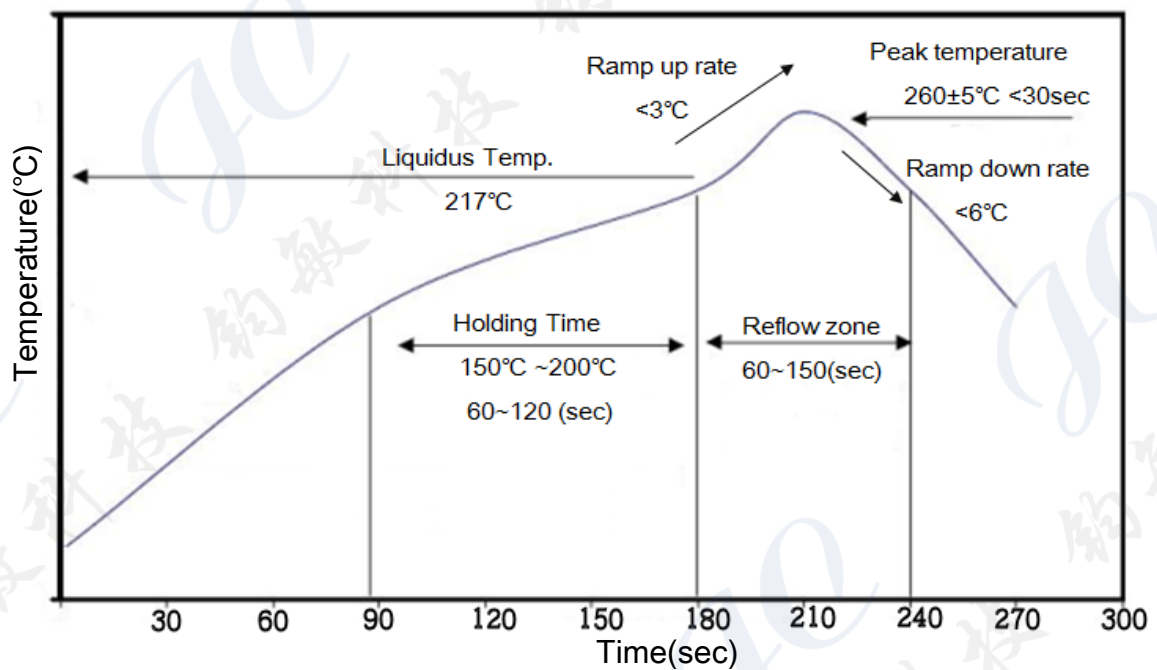
1. JEDEC J-STD-020

2. Iron Soldering

Temperature and Time: 350°C, 3S

3. Reflow

Temperature profile should conform to described in JEDEC-020 standard



## Reliability test conditions

### Solderability

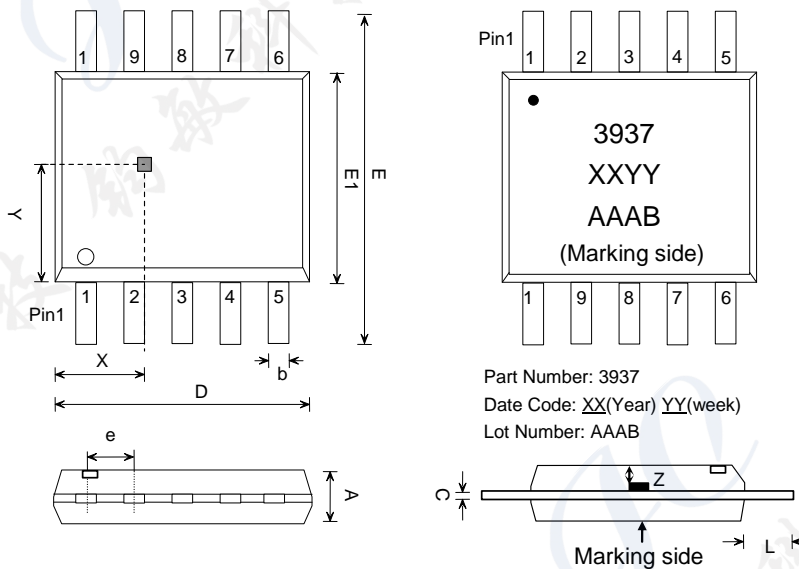
1. Reference document : AEC-Q005 PB-FREE TEST REQUIREMENTS
2. Method 2 : Pb-free solderability test

### AEC Q100 Reliability qualification requirements

Stress	Abv.	Ref. No.	Test Method	Conditions	Sample Size/lot	Numbers of lot	Accept Criteria
Preconditioning	PC	A1	JEDEC J-STD-020 JESD22-A113	30°C/60%RH, 192hrs	231	3	0 Fails
Temperature-Humidity-Bias	THB	A2	JEDEC JESD22-A101	85°C/85%RH,1000hrs	77	3	0 Fails
Autoclave	AC	A3	JEDEC JESD22-A102	121°C, 2atm,168hrs	77	3	0 Fails
Temperature Cycling	TC	A4	JEDEC JESD22-A104 and Appendix 3	-65°C~+150C, 500cycles (Grade 1)	77	3	0 Fails
Power Temperature Cycling	PTC	A5	JEDEC JESD22-A105	-40°C~+125C, 1000cycles (Grade 1)	45	1	0 Fails
High Temperature Storage Life	HTSL	A6	JEDEC JESD22-A103	150°C,1000hrs (Grade 1)	45	1	0 Fails
High Temperature Operating Life	HTOL	B1	JEDEC JESD22-A108	125°C,1000hrs (Grade 1)	77	1	0 Fails
Early Life Failure Rate	ELFR	B2	AEC Q100-008	125°C,48hrs (Grade 1)	800	3	0 Fails
Electrostatic Discharge Human Body Model	HBM	E2	AEC Q100-002	±8KV HBM (Classification 3B)	See Test Method	1	0 Fails
Electrostatic Discharge Charged Device Model	CDM	E3	AEC Q100-011	±1.5KV CDM (Classification C6)	See Test Method	1	0 Fails
Latch-Up	LU	E4	AEC Q100-004	±200mA	6	1	0 Fails

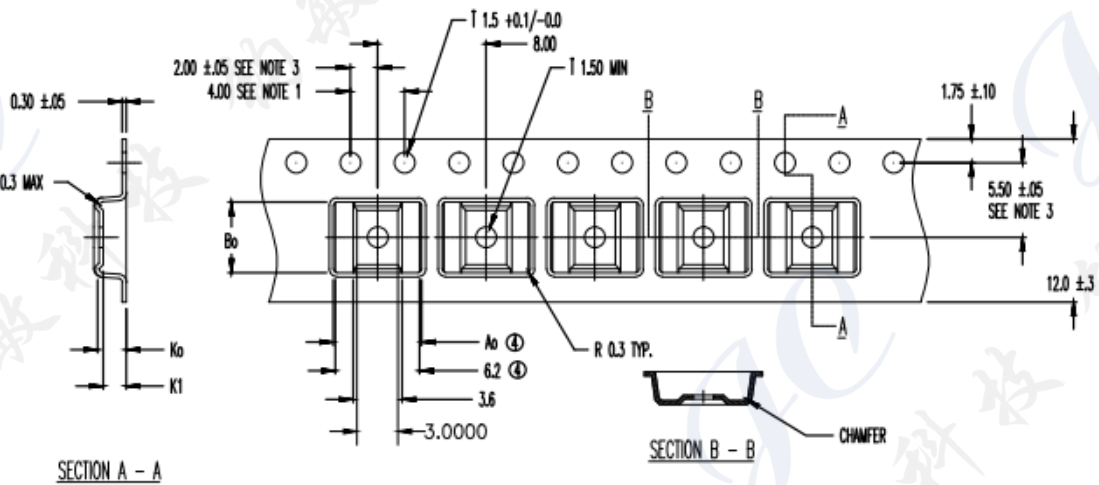
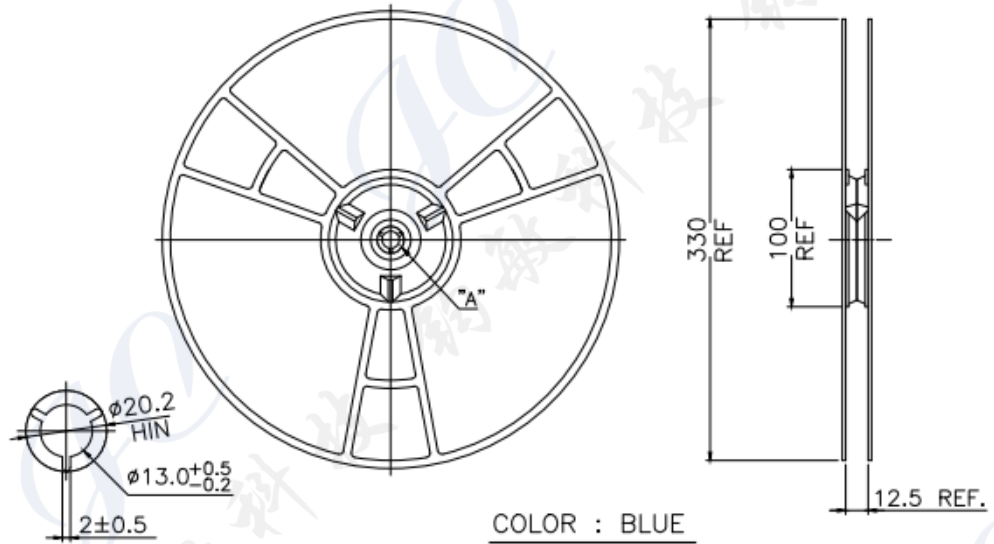
**Pin Description**  
**SOP-10F**

Name	Pin	Description
O1	1	First output pin
O1	2	First output pin
GND	3	DC ground
GND	4	DC ground
RD	5	RD output
GND	6	DC ground
O2	7	Second output pin
O2	8	Second output pin
VDD	9	DC power supply
VDD	10	DC power supply

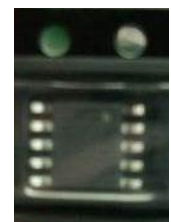
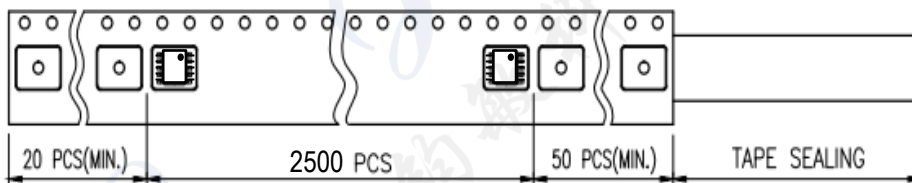


SYMBOLS	DIMENSIONS IN MILLIMETERS(mm)		
	MIN	NOM	MAX
A	1.25		1.50
b	0.30		0.45
C	0.10		0.25
D		4.90	
E	5.95		6.05
E1		3.90	
e	-	1.00	-
L	1.00	-	1.10
SENSOR LOCATION			
X	1.55	1.75	1.95
Y	2.20	2.40	2.60
Z	0.31	0.35	0.39

**Packing specification**



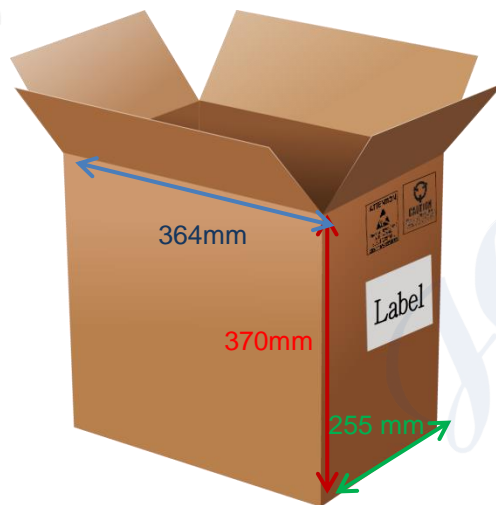
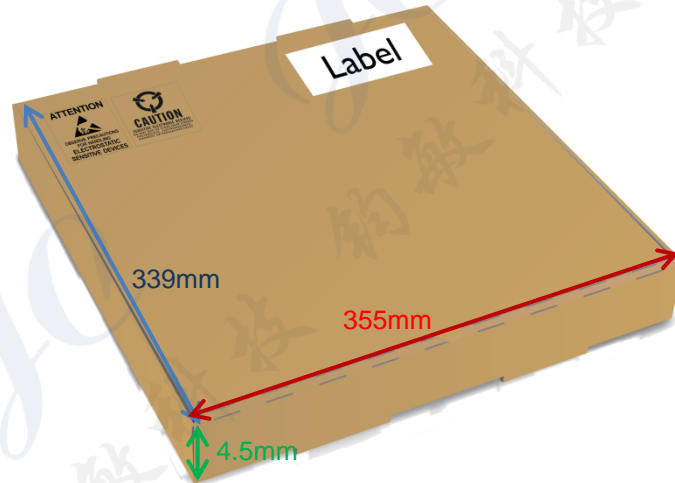
- ①  $A_0 = 6.50$
- $B_0 = 5.20$
- $K_0 = 2.10$
- $K_1 = 1.70$



USER DIRECTION OF FEED →

### Packing specification

1. Reference document: PD-3-75-010
2. Dimension:



3. Quantity:

Type	Package	Amount Per Reel(EA)	Amount Carton(EA)
SOP-10F	Reel	2500	12500

**Order information**

Part Number	Temperature Range	Package Type	Delivery	MOQ
PT3937D1PRG8PA	-40°C~+150°C	SOP-10F	Reel	12.5K

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