DC Brushless Motor Hall Driver IC

# PT3935/3936
# 24V Single coil Hall Driver IC with RD/FG output

**Package: DFN-10**

## Applications

- Single coil DC brushless motor
- Support pre-driver application

## Features

- Built-in hall sensor
- Single phase full wave driver
- Soft switching output driver
- Motor locked protection and automatic restart
- RD output (PT3935)
- FG output (PT3936)
- 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
- Rohs 2.0

3 : VDD/DC power supply
4 : O1/First output pin
5 : GND/DC ground
6 : O2/Second output pin
7 : RD/FG

## Specifications

### Absolute Maximum Ratings (Ta=25℃)

| Parameter | Symbol | Conditions | Rating | Units |
|---|---|---|---|---|
| Maximum supply voltage | VDDmax | 10u sec | 34.5 | V |
| Allowable power dissipation | Pd | | 800*1 | mW |
| Operating temperature | Ta | | -40~+105 | ℃ |
| Storage temperature | Ts | | -50~+150 | ℃ |
| Max. output current | $I_{OMAX}$ | 0.5sec | 800*2 | mA |
| RD/FG output current | $I_{RD/FGMAX}$ | | 20 | mA |
| RD/FG output voltage | $V_{RD/FGMAX}$ | | 32 | V |
| Maximum Junction temperature | Tjmax | | 150 | ℃ |

*1: Reduced by 4.54mW 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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## Electrical Characteristics ($T_A$=+25°C, $V_{DD}$=24V)

| Characteristic | Symbol | Test Condition | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Supply Voltage | $V_{DD}$ | | 4.5 | | 30 | V |
| Output High Voltage | $V_{OH(ON)}$ | @ $I_{OUT}$ =200mA | $V_{DD}$-0.6 | $V_{DD}$-0.4 | | V |
| Output Low Voltage | $V_{OL(ON)}$ | @ $I_{OUT}$ =200mA | | 0.4 | 0.6 | V |
| Output Voltage Clamp | $V_{BV}$ | | 32 | | 42 | V |
| Supply Current | $I_{DD}$ | Output open | | 8 | 10 | mA |
| RD/FG output voltage | $V_{RD/FG}$ | | | | 30 | V |
| RD/FG sink voltage | $V_{DSRD/FG}$ | $I_{RD/FG}$=5mA | | 0.2 | 0.3 | V |
| Shutdown Time | $T_{SD}$ | | 2.8 | 3.5 | 4.2 | S |
| Restart Time | $T_{RS}$ | | 0.4 | 0.5 | 0.6 | S |
| **Magnetic Characteristics ($T_A$=+25°C, $V_{DD}$=24V)** | | | | | | |
| Operate Point | $B_{OP}$ | | 5 | 15 | 35 | G |
| Release Point | $B_{RP}$ | | -35 | -15 | -5 | G |
| Hysteresis | $B_{HYS}$ | | 20 | 30 | 50 | G |

## General Specifications

The PT3935/36 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 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 2.8 seconds. Figure 1 shows the timing diagram between the hall input signal and driver's output state.

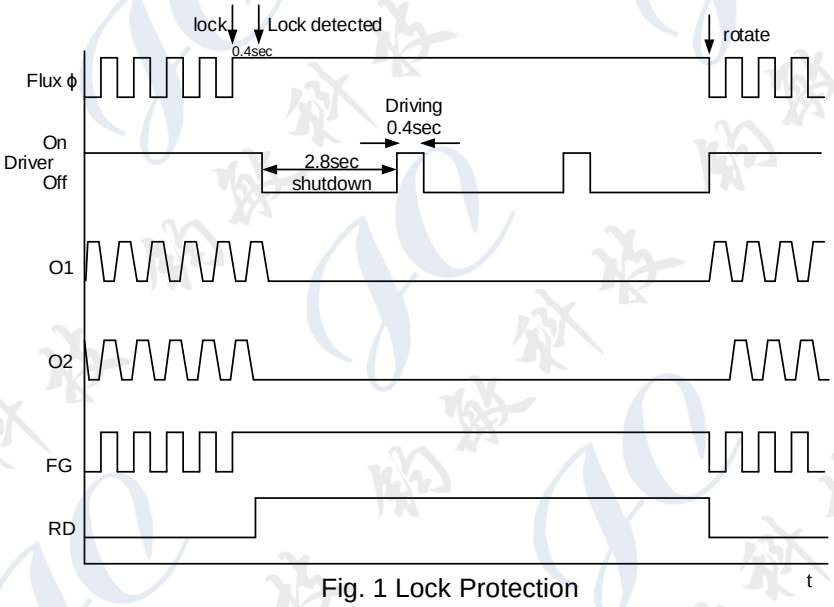



Fig. 1 Lock Protection

## 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 +-15 Gauss.

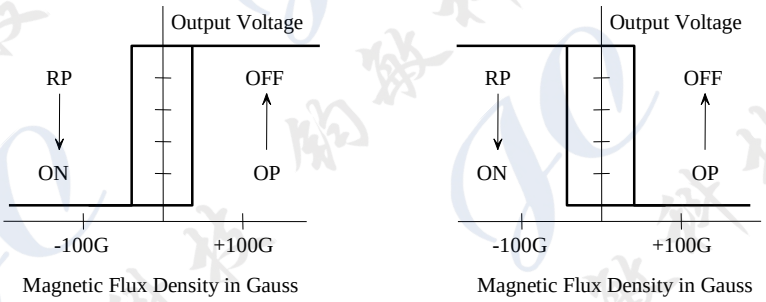



Fig 2. Magnetic Hysteresis Characteristics

## Thermal Protection

The thermal protection of PT3935/PT3936 is to utilize the internal Hall element signal variation over temperature to achieve. Once the junction temperature of PT3935/PT3936 is over 150℃, Hall element signal amplitude will be decreased to make sensitivity weaker. That will make PT3935/PT3936 to operate in shutdown and auto-restart mode. This will turn off output driver to ensure safety.

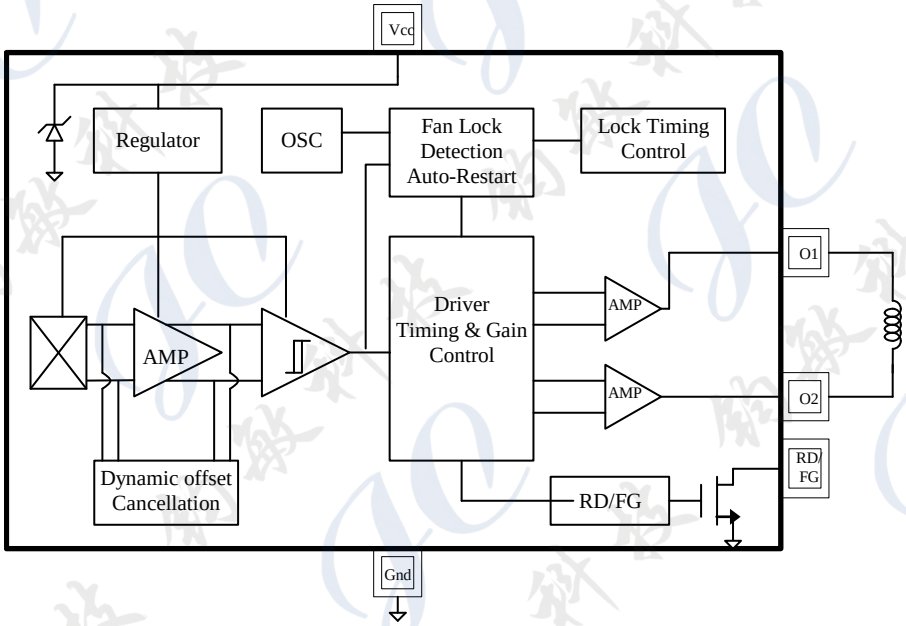
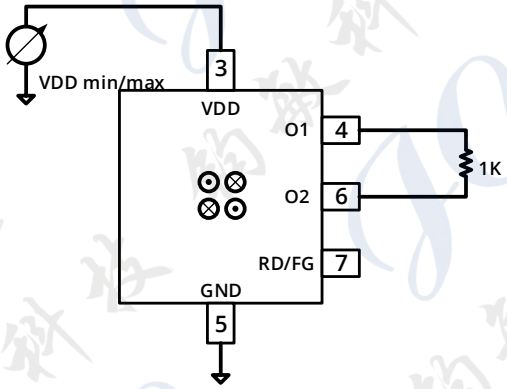


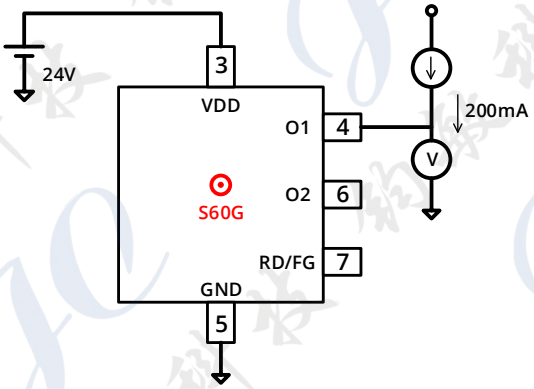

Fig. 3 Hall IC Architecture

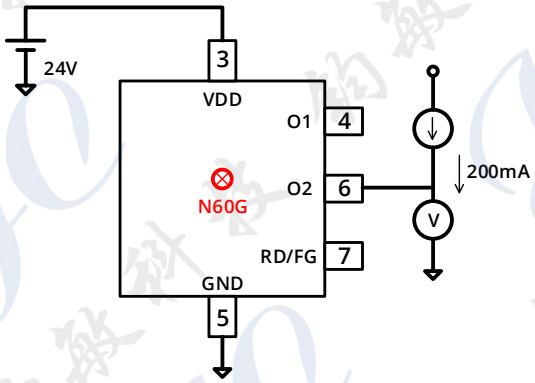
## Test circuit

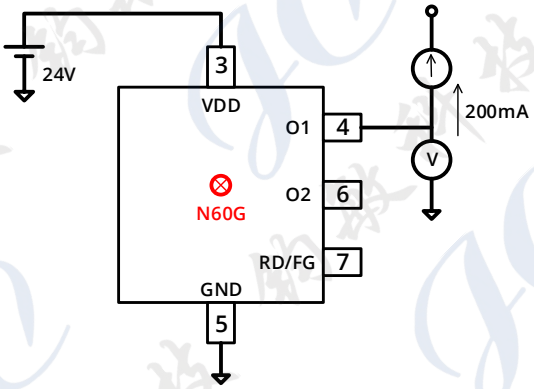
### VDD Min./Max.

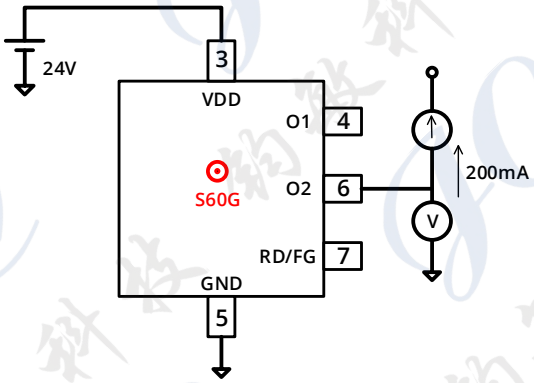



### VOH(ON)/VOL(ON)

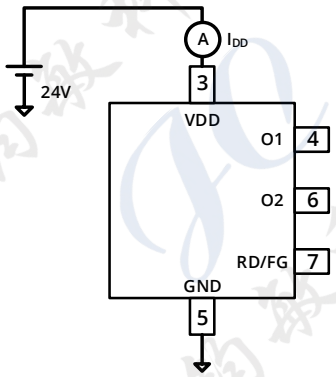


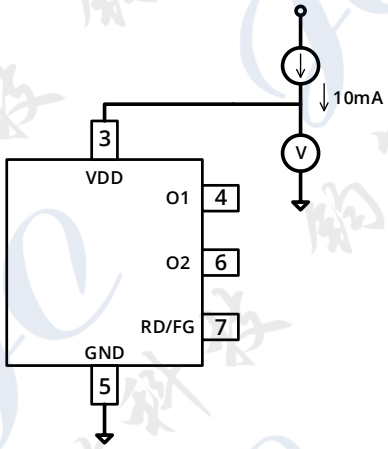



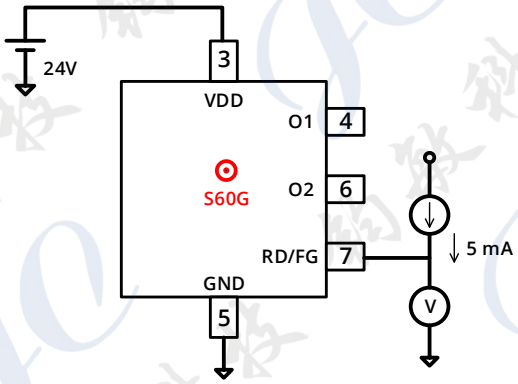
## Supply Current IDD



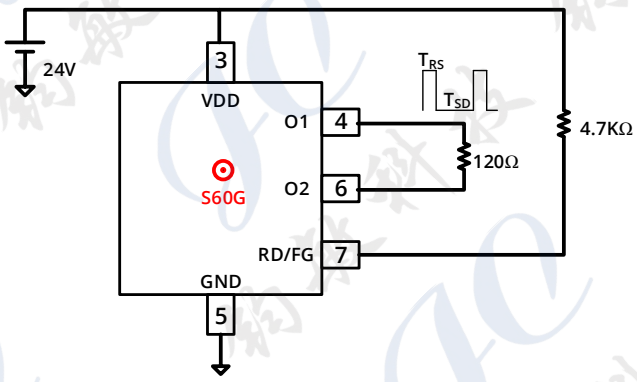

## Voltage Clamp Vz




## RD/FG Sink Voltage $V_{DSRD/FG}$




## Lock Time $T_{RS}/T_{SD}$

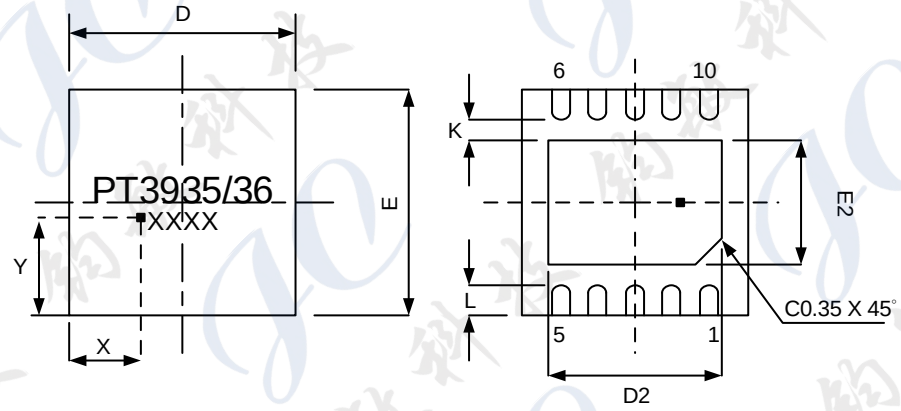


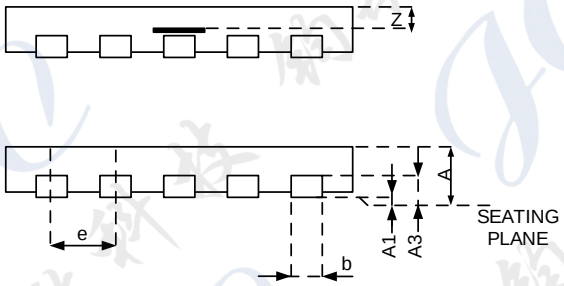
## Pin Description

| NAME | Pin | Description | Type | HBM (V) | MM (V) | Sustained Voltage (V) |
|---|---|---|---|---|---|---|
| Vdd | 3 | DC power supply | P | ±8000 | ±1000 | 34 |
| GND | 5 | DC ground | P | ±8000 | ±1000 | 34 |
| O1 | 4 | First output pin | O | ±8000 | ±1000 | 34 |
| O2 | 6 | Second output pin | O | ±8000 | ±1000 | 34 |
| RD/FG | 7 | Rotation Detection /Frequency Generation | O | ±4000 | ±450 | 30 |

## Package Outline

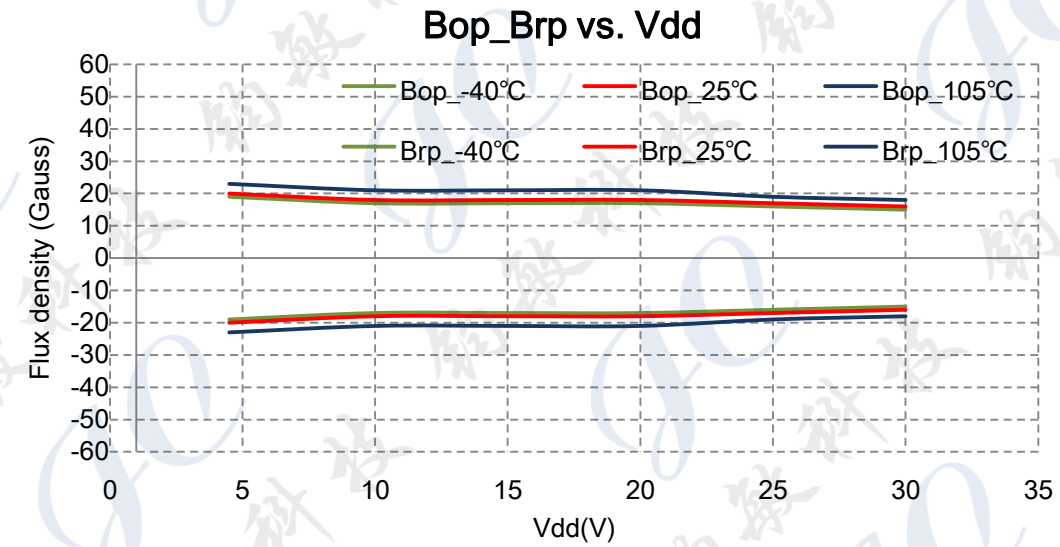
Datecode : xx(years)xx(weeks)

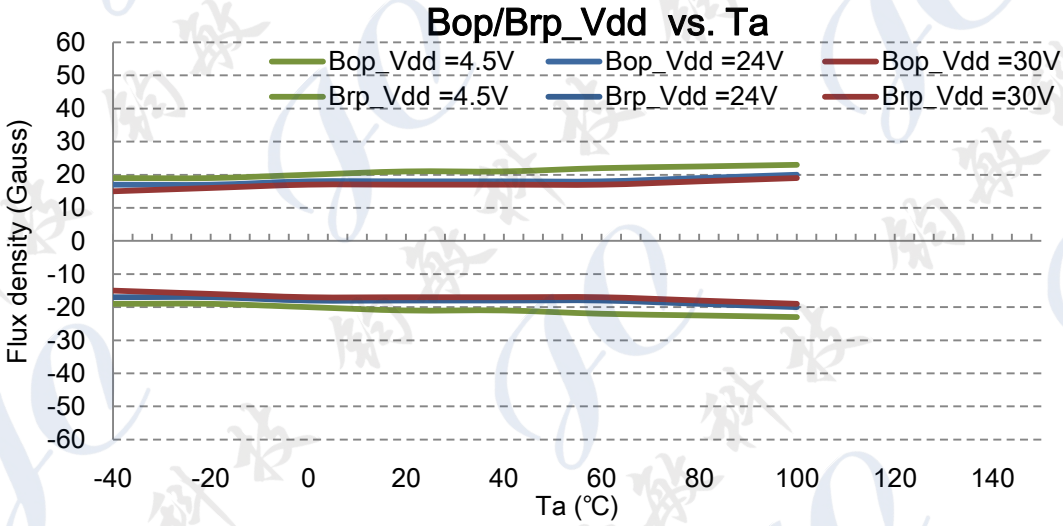


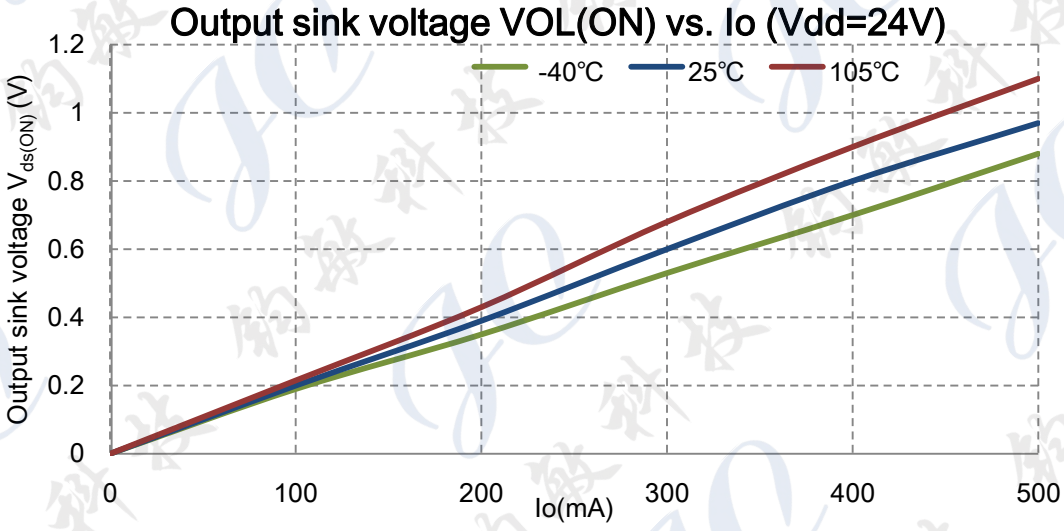



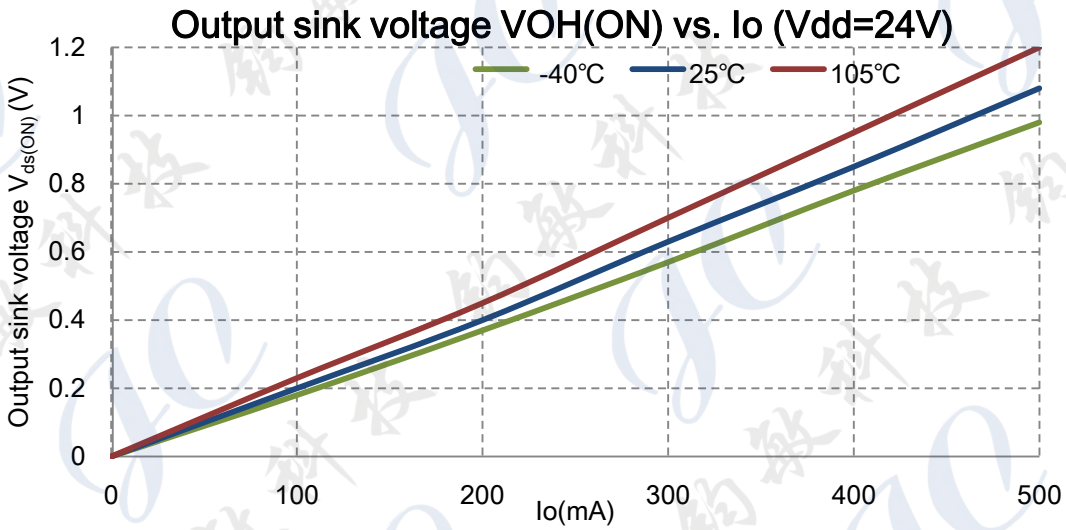

| SYMBOLS | MIN. | NOM. | MAX. |
|---|---|---|---|
| A | 0.7 | 0.75 | 0.8 |
| A1 | 0.00 | 0.02 | 0.05 |
| A3 | | 0.203 REF | |
| b | 0.18 | 0.25 | 0.3 |
| D | | 3.00 BSC | |
| E | | 3.00 BSC | |
| e | | 0.50 BSC | |
| K | 0.20 | - | - |
| Pad Size | | | |
| D2 | 2.20 | 2.30 | 2.35 |
| E2 | 1.55 | 1.65 | 1.70 |
| L | 0.30 | 0.40 | 0.50 |
| Sensor Location | | | |
| X | 0.95 | 1.05 | 1.15 |
| Y | 1.25 | 1.35 | 1.45 |
| Z | 0.35 | 0.38 | 0.42 |

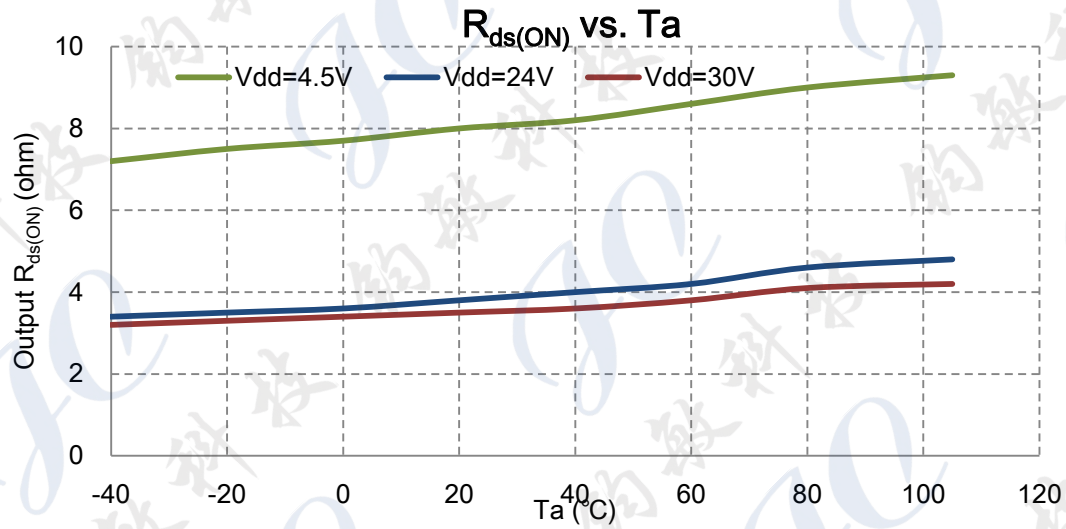
## Performance curve

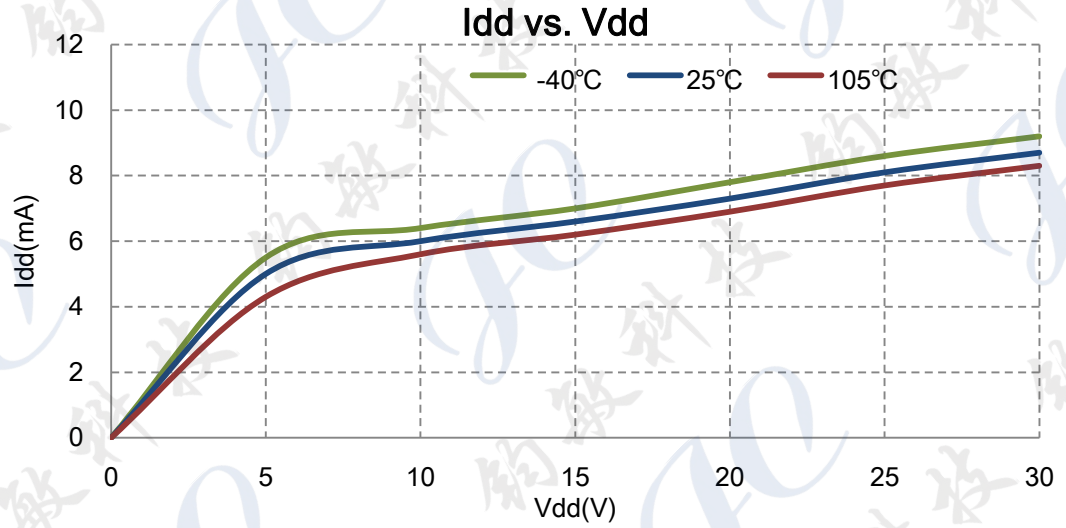


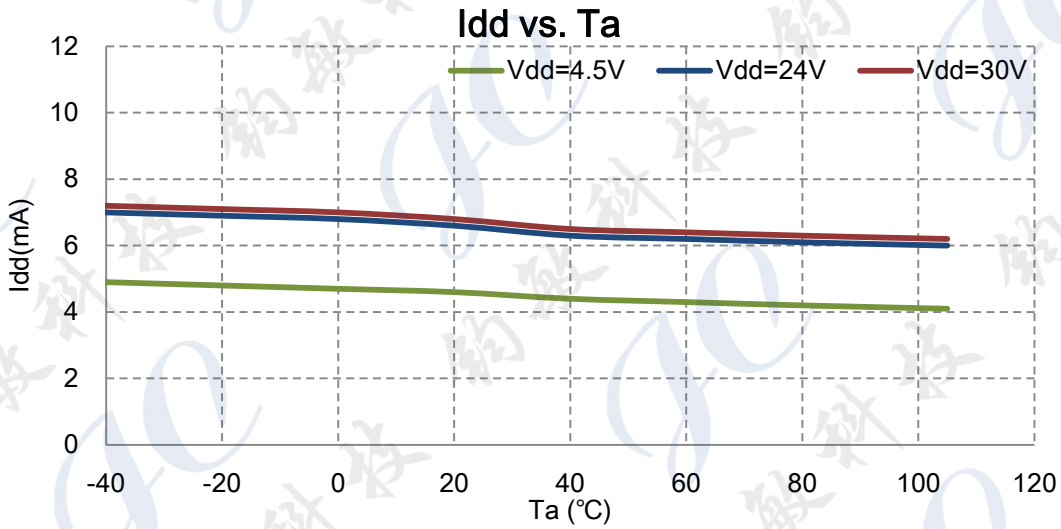



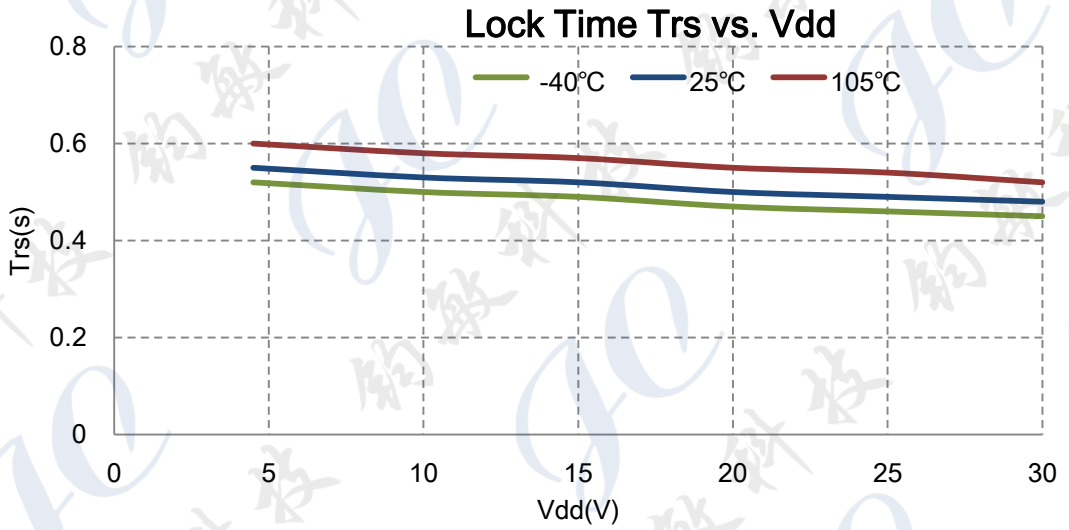



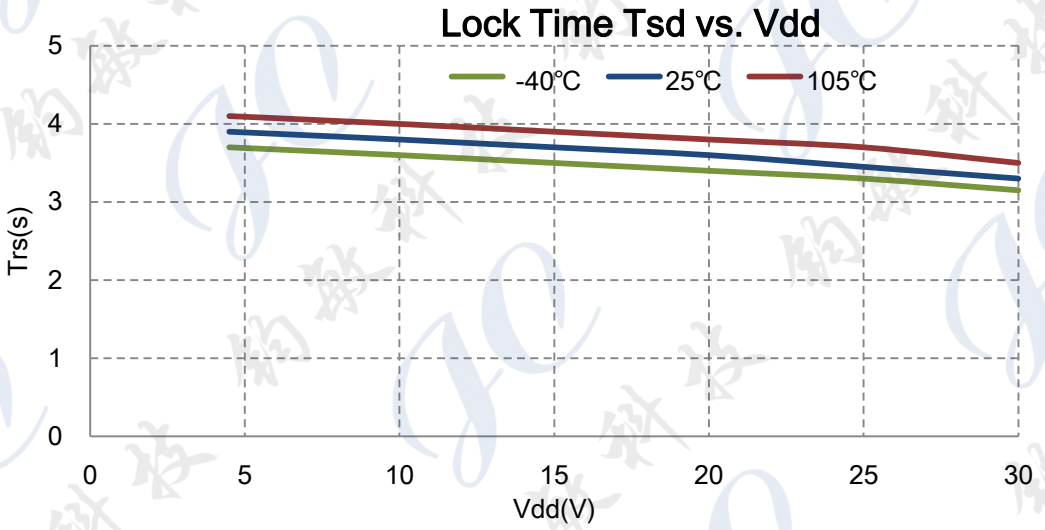

Output sink voltage VOH(ON) vs. Io (Vdd=24V)
-40℃
25℃
105℃
Output sink voltage Vds(ON) (V)
1.2
1
0.8
0.6
0.4
0.2
0
0
100
200
300
400
500
Io(mA)

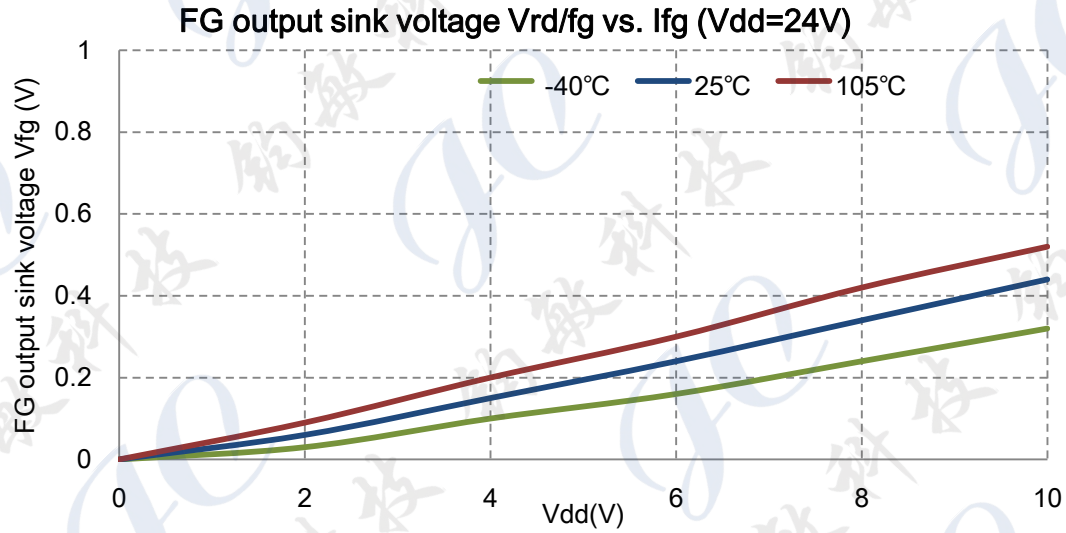

Rds(ON) vs. Ta
Vdd=4.5V
Vdd=24V
Vdd=30V
Output Rds(ON) (ohm)
10
8
6
4
2
0
-40
-20
0
20
40
60
80
100
120
Ta (°C)

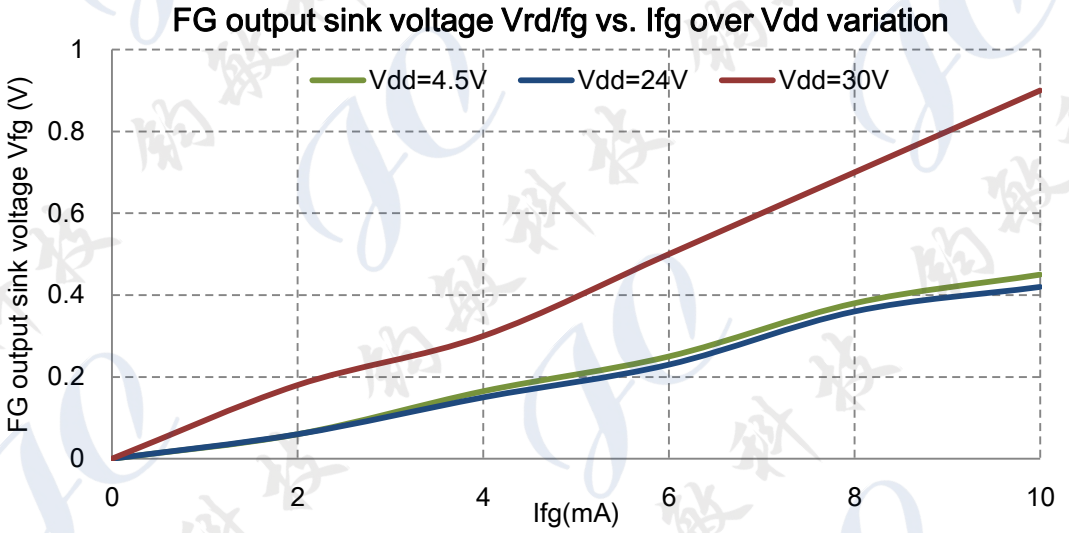

Idd vs. Vdd
-40℃
25℃
105℃
Idd(mA)
12
10
8
6
4
2
0
0
5
10
15
20
25
30
Vdd(V)

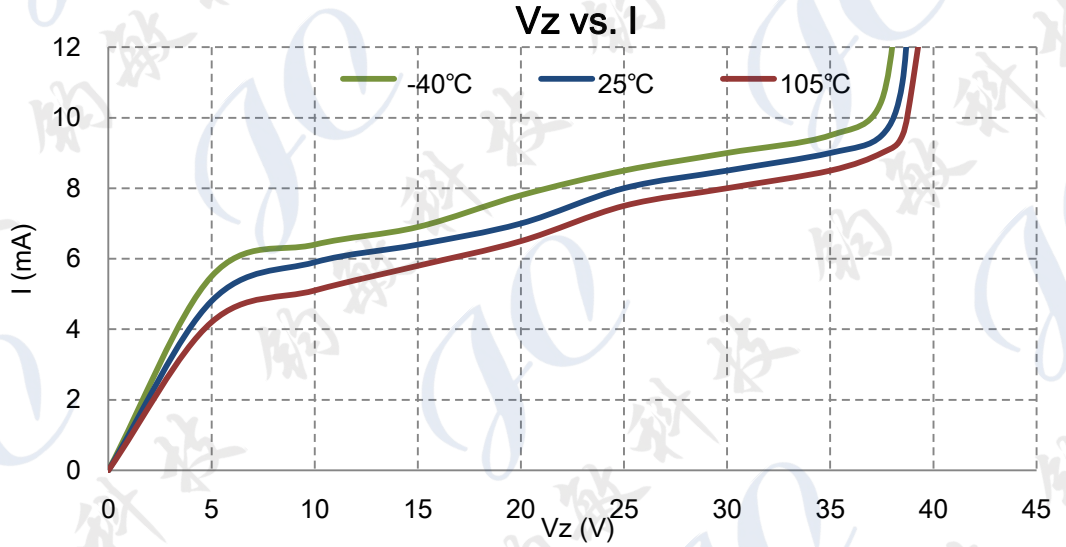

Idd vs. Ta
Vdd=4.5V
Vdd=24V
Vdd=30V
Idd(mA)
12
10
8
6
4
2
0
-40
-20
0
20
40
60
80
100
120
Ta (℃)


Lock Time Trs vs. Vdd
-40℃
25℃
105℃
Trs(s)
0.8
0.6
0.4
0.2
0
0
5
10
15
20
25
30
Vdd(V)

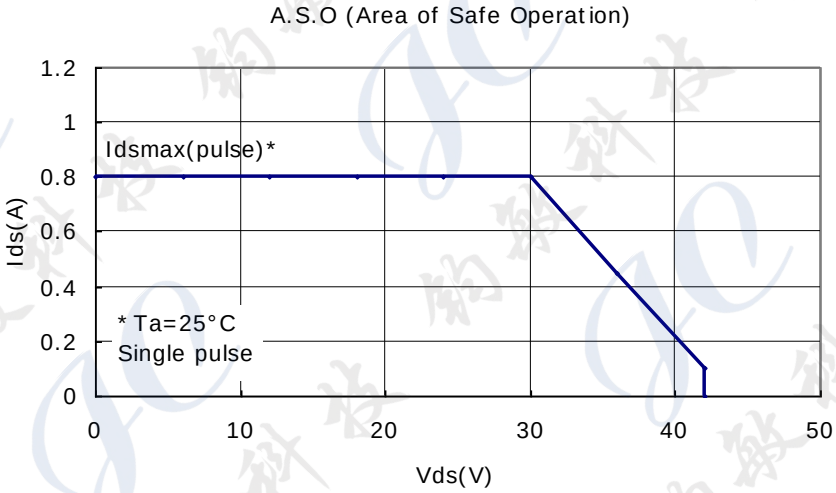

Lock Time Tsd vs. Vdd
-40℃
25℃
105℃
Trs(s)
5
4
3
2
1
0
0
5
10
15
20
25
30
Vdd(V)


FG output sink voltage Vrd/fg vs. Ifg (Vdd=24V)
-40℃
25℃
105℃
FG output sink voltage Vfg (V)
Vdd(V)
0
0.2
0.4
0.6
0.8
1
0
2
4
6
8
10

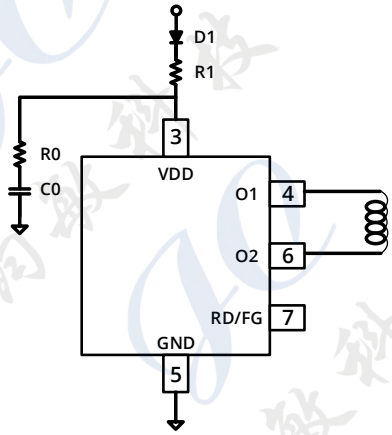

FG output sink voltage Vrd/fg vs. Ifg over Vdd variation
Vdd=4.5V
Vdd=24V
Vdd=30V
FG output sink voltage Vfg (V)
Ifg(mA)
0
0.2
0.4
0.6
0.8
1
0
2
4
6
8
10


Vz vs. I
-40℃
25℃
105℃
I (mA)
Vz (V)
0
2
4
6
8
10
12
0
5
10
15
20
25
30
35
40
45

## A.S.O.



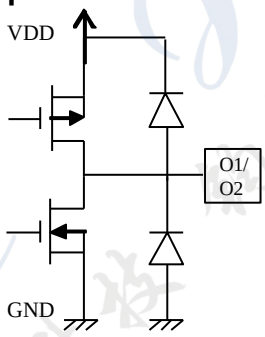

## Application circuits



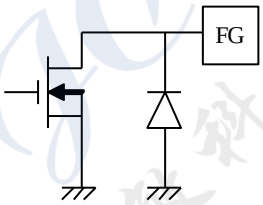

R1: 0~ 12ohm
R0: RC Snubber resistor 0ohm~12ohm
C0: decoupling capacitor 1nF ~ 0.1uF
dv/dt recommendation value of Vdd: 300V/usec max

All electrical characteristics shall be satisfied at this application.

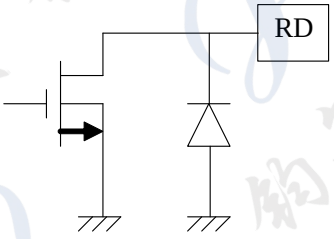
## I/O Equivalent circuits




O1/O2 Output




FG Output

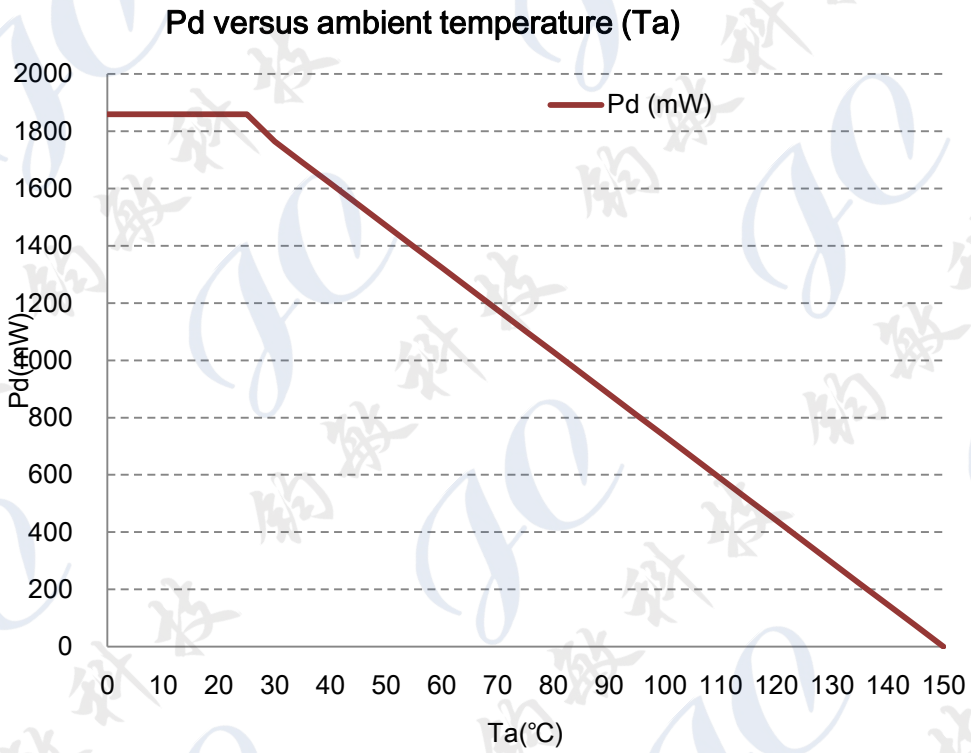



RD output

## Thermal resistance

| Parameter | Symbol | Conditions | Rating | Units |
|---|---|---|---|---|
| Allowable power dissipation | $P_d$ | | 1860*1 | mW |
| Junction to ambient thermal resistance | $\theta_{JA}$ | | 68 | ℃/W |
| Junction to case thermal resistance | $\theta_{JC}$ | | 12 | ℃/W |
| Maximum junction temperature | $T_J$ | | 150 | ℃ |

*1: Reduced by 6.4mW for each increase in Ta of 1°C over 25°C When mounted on 50mm x 50mm x 1.6mm glass epoxy board



## Power dissipation calculation

Power Dissipation Total = Static power dissipation (Pd_static) + Driving power dissipation (Pd_drv) + Switching loss (Pd_sw)

Static power dissipation (Pd_static) : Vdd * Idd

Driving power dissipation (Pd_drv) : Io * Vsat

Switching loss (Pd_sw) : duration of switching * period of per rotation * Io * Vdd

Note. $V_{OH}$ = Vdd-Va. $V_{OL}$ = Vb-Gnd Vsat = $V_{OH}$ + $V_{OL}$

Example :

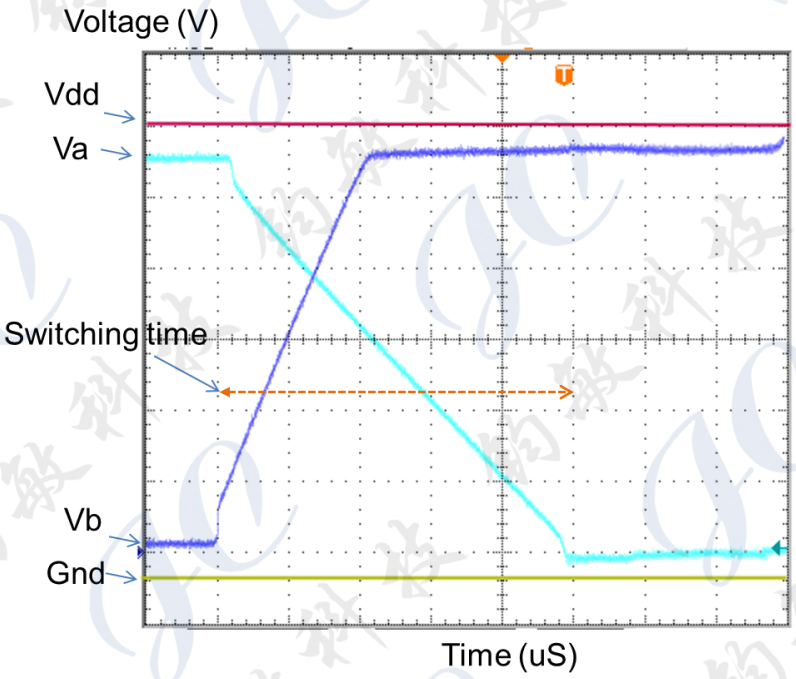
When Vdd = 12V , Idd = 8mA , Io = 430mA , RPM = 4000, Switching time = 100uS , 4-pole fan motor

Pd_static : 12 * 8 = 96mW

Pd_drv : 430 * Vsat (e.g. 1V) = 430mW

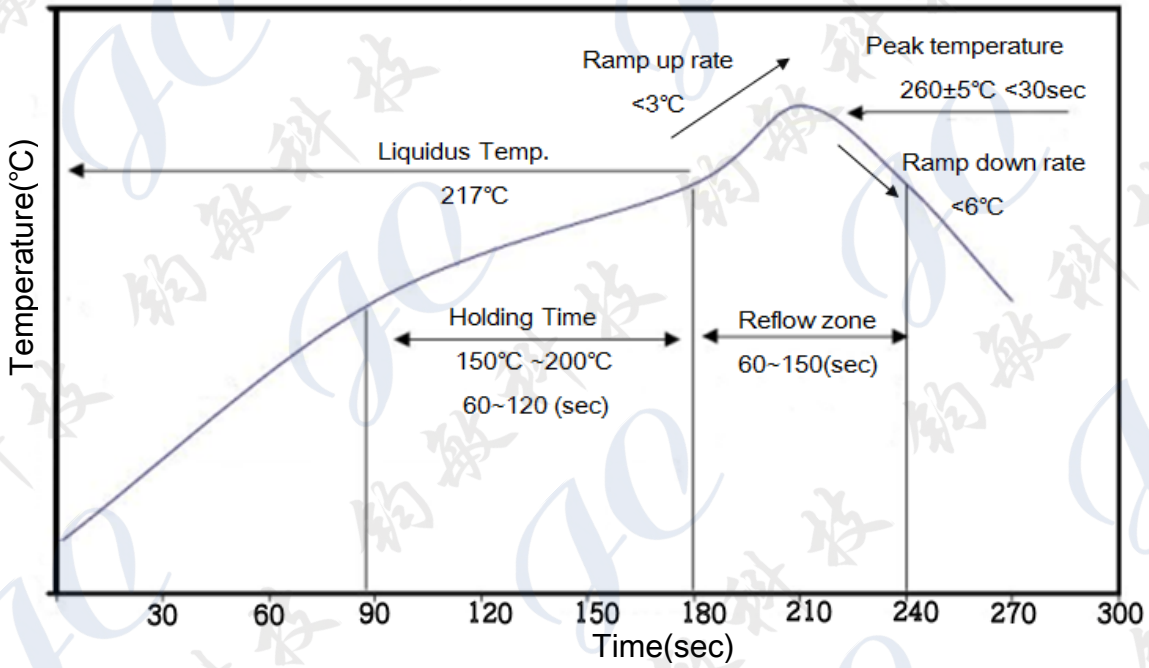
Pd_sw : 100 / 30 * 4000 * $10^{-6}$ * 430 * 12 = 69 mW

Pd_total = 96 + 430 +69 = 595 mW



## Soldering recommendations

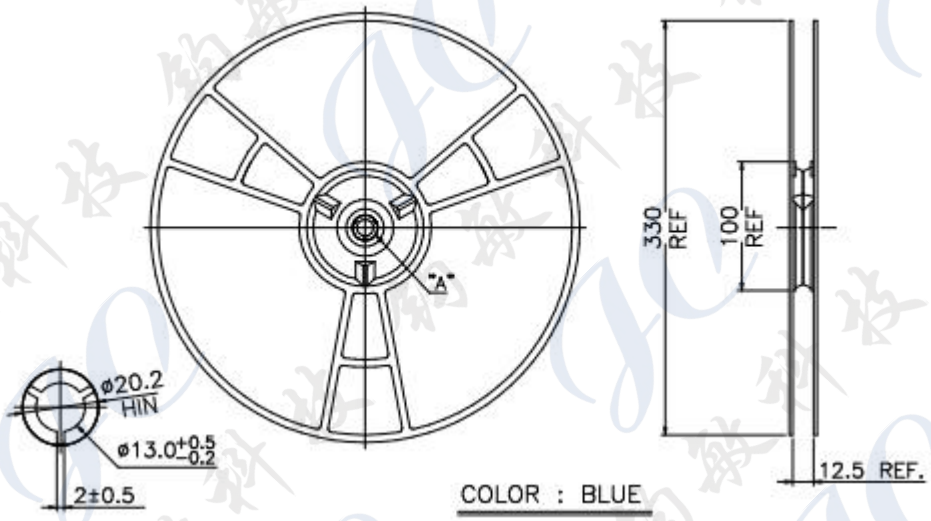
1. JEDEC J-STD-20
2. Iron Soldering
   Temperature and Time: 350°C, 3S
3. Reflow
   Temperature profile should conform to described in JEDEC-020 standard

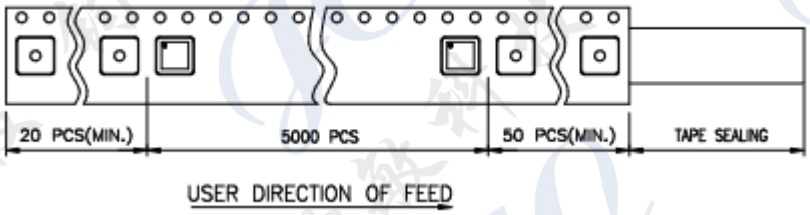


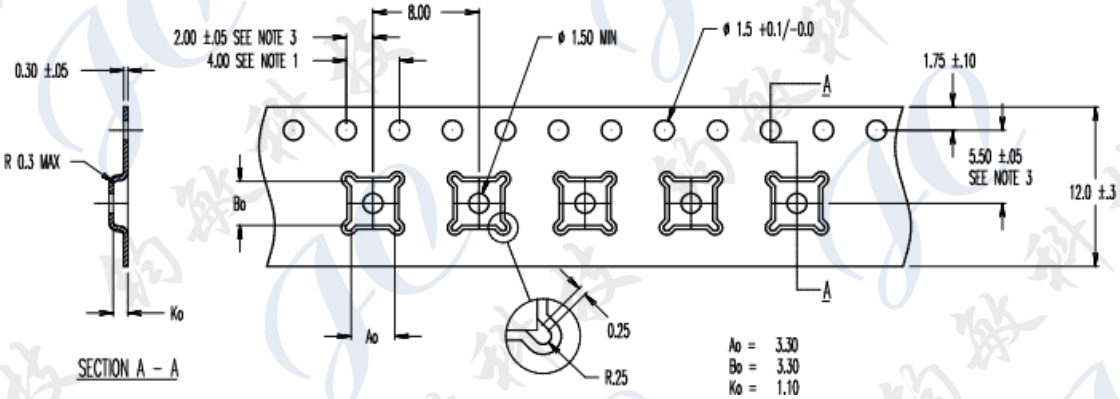

## ESD Sensitivity level

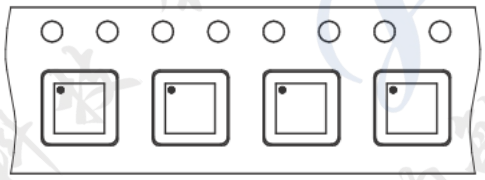
| Immunity test | Standard | Class | Sensitivity Range |
|---|---|---|---|
| HBM | MIL-STD-883H / Method 3015.8 | 3A | 4000V |
| MM | ANSI/ESD S5.2-2009 | M4 | 450V |

## Carrier Tape & Reel specifications



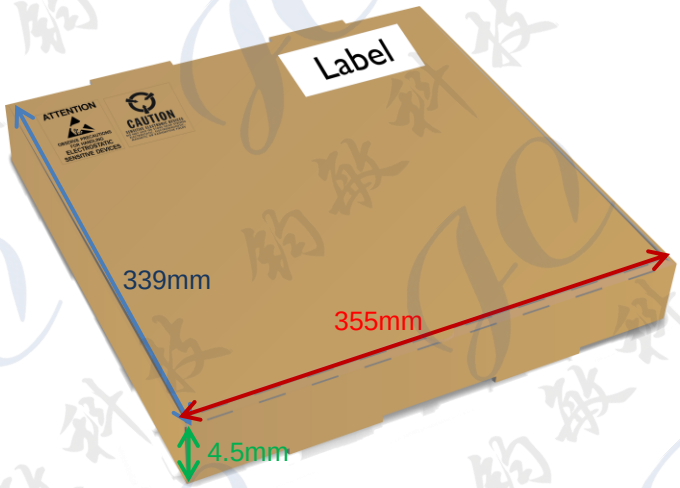



WSON(DFN) 3X3

QUANITITY : 5000 EA/PER REEL 1 REEL/BOX

## Packing specification

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





3. Quantity:

| Type | Package | Amount Per Reel (EA) | Amount Carton (EA) |
|---|---|---|---|
| DFN10 | Reel | 5000 | 25000 |

## Order information

| Part Number | Temperature Range | Package Type | Delivery | MOQ |
|---|---|---|---|---|
| PT3936I1HFG8P1 | -40°C~+105°C | DFN10 | Reel | 25000 |