# NSE34050Q-Q1

## 50mΩ, 40V, Automotive Quad Channel High-side Switch

Preliminary specifications subject to change without notice Datasheet (EN) 0V1

## Product Overview

NSE34050Q-Q1 is a quad channel 50mΩ high-side switch with protection and diagnostics for 12V automotive system applications. It's designed for driving all types automotive resistive, inductive or capacitive loads.

This device provides advanced protective functions in fault conditions, such as overvoltage clamp, current limitation, thermal shutdown and off-state diagnosis.

A FaultRST pin can be used to latch or retry the output in case of fault.

A sense enable pin allows lower power dissipation when it is disabled.

## Key Features

- AEC-Q100 qualified
  - Temperature grade 1: -40℃ to 125℃
- Protections
  - Current limitation: 27A
  - 48V overvoltage clamp
  - Thermal shutdown protection
  - Thermal swing protection when ΔT exceeds 60℃
  - Loss of ground and loss of Vcc protection
  - Undervoltage shutdown
  - Reverse battery protection with turning the power MOS on
  - ESD protection
- Fault diagnostic block
  - Thermal shutdown diagnosis
  - Off-state open-load diagnosis
  - Output short to Vcc diagnosis
  - Current limitation or output short to ground diagnosis
- Very low standby current
- Very low electromagnetic susceptibility

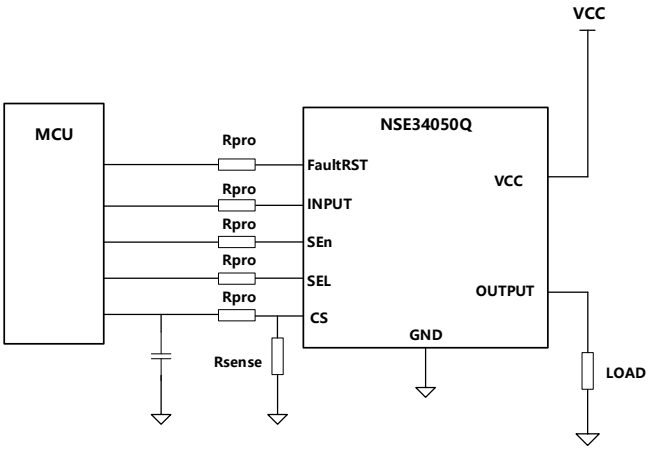
## Applications

- All types automotive resistive, inductive or capacitive loads
- Driving high inrush current loads

## Device Information

| *Part Number* | *Package* | *Body Size* |
|---|---|---|
| NSE34050Q-Q1 | PowerSSO-16 | 4.9mm x 3.9mm |

## Typical Application



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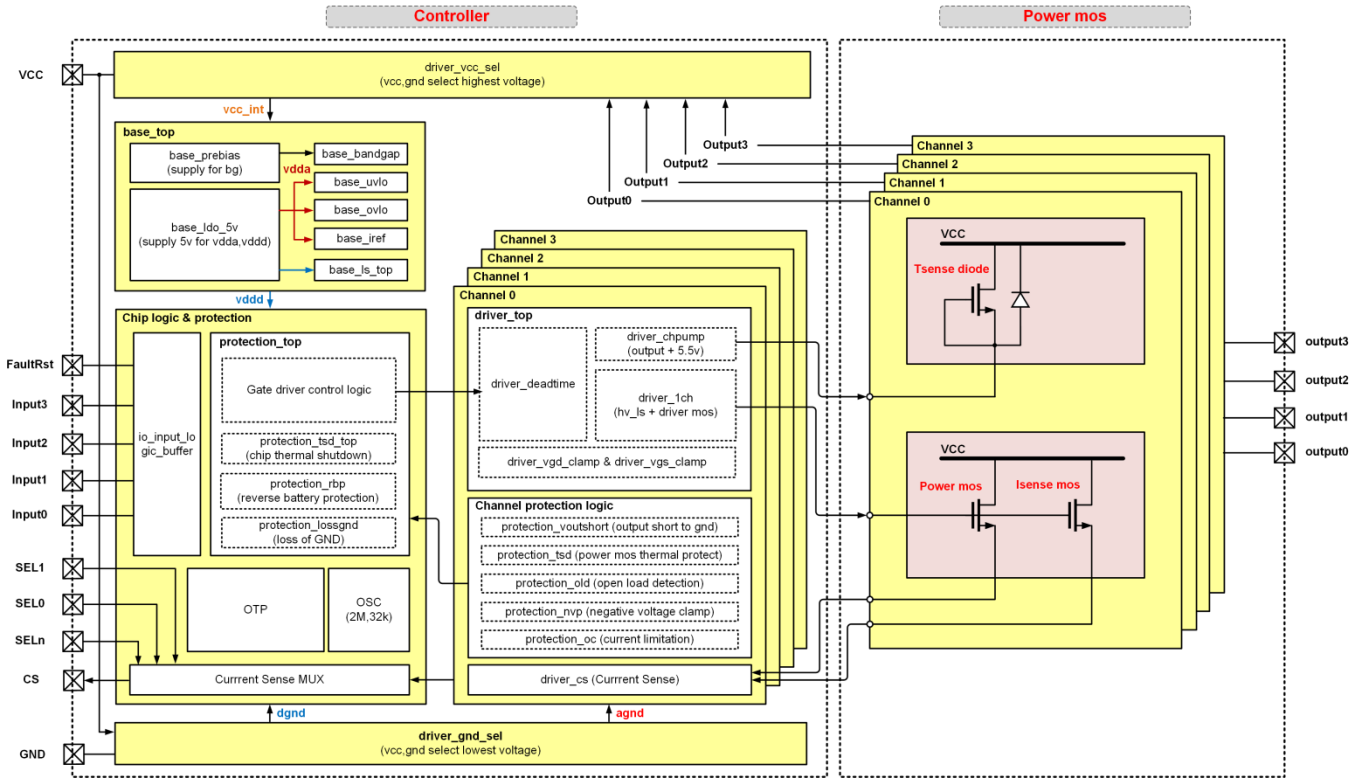
# 1. Block diagram




# 2. Pin Configuration and Functions

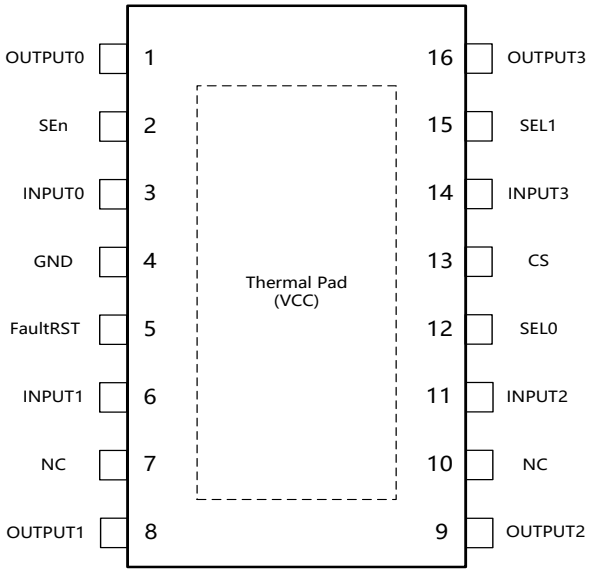



Table 1 PowerSSO-16 Pin Configuration and Description

| PIN NO. | SYMBOL | FUNCTION |
|---|---|---|
| 1, 8, 9, 16 | $OUTPUT_{0,1,2,3}$ | Power output. |
| 2 | SEn | Digital signal enables the CS diagnostic pin, active high. |
| 3, 6, 11, 14 | $INPUT_{0,1,2,3}$ | Digital signal to control the channel n on/off, active high. |
| 4 | GND | Ground connection. |
| 5 | FaultRST | Digital signal to control the device auto-retry or latch-off in case of fault. The device works in auto-retry mode when it keeps low. |
| 7, 10 | N.C. | Not connect. |
| 12, 15 | $SEL_{0,1}$ | Current sense channel select. |
| 13 | CS | Current sense output. |

## 3. Recommended Connections for Unused Pins

Table 2 Recommended connections for unused pins

| PIN NAME | CONNECTIONS FOR UNUSED PINS | IMPACT IF NOT USED |
|---|---|---|
| $OUTPUT_{0,1,2,3}$ | Floating | No output. |
| SEn | Floating or ground through 15kΩ resister | Current sense is not available. |
| $INPUT_{0,1,2,3}$ | Floating or ground through 15kΩ resister | All channel is off. |
| FaultRST | Floating or ground through 15kΩ resister | Default auto-retry mode. |
| $SEL_{0,1}$ | Floating or ground through 15kΩ resister | Can not select current sense channel. |
| CS | To ground through 1kΩ resister, floating is not allowed | Current sense is not available. |

## 4. Absolute Maximum Ratings

| Parameters | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| DC supply voltage | $V_{cc}$ | | | 40 | V |
| Reverse DC supply voltage | $-V_{cc}$ | -0.3 | | | V |
| Maximum jump start voltage | $V_{ccjs}$ | | | 28 | V |

| Parameters | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Reverse ground pin current | $-I_{GND}$ | -200 | | | mA |
| OUTPUT DC current | $I_{out}$ | | | Internally limited | A |
| Reverse OUTPUT DC current | $-I_{out}$ | Load limited | | | A |
| INPUT DC input current | $I_{IN}$ | -1 | | 10 | mA |
| SEn DC input current | $I_{SEn}$ | | | | |
| SEL DC input current | $I_{SEL}$ | | | | |
| FaultRST DC input current | $I_{FR}$ | | | | |
| FaultRST DC input voltage | $V_{FR}$ | | | 7.5 | V |
| CS pin DC output current | $I_{snese}$ | -20 | | 10 | mA |
| Single pulse avalanche energy(L = 1mH, $T_j$ = 150°C) | $E_{AS}$ | | | 24 | mJ |
| Electrostatic discharge, Human-body model | HBM | -4000 | | 4000 | V |
| Electrostatic discharge, Charged-device model | CDM | -750 | | 750 | V |
| Junction Temperature | $T_J$ | -40 | | 150 | °C |
| Storage Temperature | $T_{stg}$ | -55 | | 150 | °C |

# 5. Thermal Information

| Parameters | Symbol | Value | Unit |
|---|---|---|---|
| IC Junction-to-ambient Thermal Resistance[1),3)] | $\theta_{JA}$ | 57.3 | °C/W |
| IC Junction-to-ambient Thermal Resistance[1),2)] | $\theta_{JA}$ | 23.5 | °C/W |
| IC Junction-to-board Thermal Resistance[1),2)] | $\theta_{JB}$ | 6.3 | °C/W |

**Notes:**

1). One channel ON.

2). Four layers 2s2p PCB JEDEC JESD 51-7

3). Two layers 2s0p PCB JEDEC JESD 51-5

# 6. Specifications

## 6.1. Electrical Characteristics

(VCC = 7 V to 28 V, Tj =-40°C to 150°C, unless otherwise noted, All typical value refer to VCC = 13 V, Tj = 25°C, unless otherwise noted.)

| Parameters | Symbol | Min | Typ | Max | Unit | Comments |
|---|---|---|---|---|---|---|
| Power Section | | | | | | |

| *Parameters* | *Symbol* | *Min* | *Typ* | *Max* | *Unit* | *Comments* |
|---|---|---|---|---|---|---|
| Operating supply voltage | $V_{cc}$ | 4 | 13 | 28 | V | |
| Undervoltage lockdown falling voltage | $V_{UVLOF}$ | | 3.3 | | V | |
| Undervoltage lockdown rising voltage | $V_{UVLOR}$ | | 3.6 | | V | |
| Undervoltage lockdown hysteresis | $V_{UVhys}$ | | 300 | | mV | |
| ON-state resistance | $R_{ON}$ | | 50 | | mΩ | Iout = 2 A; Tj = 25°C |
| | | | | 100 | mΩ | Iout = 2 A; Tj = 150°C |
| | | | | 75 | mΩ | Iout = 2 A; Tj = 25°C; Vcc = 4V |
| Vcc-output clamp voltage | $V_{CLAMP}$ | 41 | 46 | 52 | V | Is = 20mA; Tj =-40°C to 150°C |
| Supply current in standby mode | $I_{SB}$ | | | 0.5 | µA | Vcc = 13 V; $V_{IN}$ = $V_{OUT}$ = $V_{FR}$ = $V_{SEn}$ = $V_{SEL0,1}$ = 0V; Tj = 25°C |
| | | | | 3 | µA | Vcc = 13 V; $V_{IN}$ = $V_{OUT}$ = $V_{FR}$ = $V_{SEn}$ = $V_{SEL0,1}$ = 0V; Tj = 125°C |
| Standby mode blanking time | $t_{D\_SB}$ | 60 | 300 | 550 | µs | Vcc = 13 V; $V_{IN}$ = $V_{OUT}$ = $V_{FR}$ = $V_{SEL0,1}$ = 0V; $V_{SEn}$ = 5V to 0V |
| Supply current in onstate mode without Iout | $I_{S(ON)}$ | | 10 | 16 | mA | Vcc = 13 V; $V_{OUT}$ = $V_{FR}$ = $V_{SEn}$ = $V_{SEL0,1}$ = 0V; $V_{IN0,1,2,3}$ = 5V; $I_{OUT0,1,2,3}$ = 0A |
| GND current in onstate mode with Iout | $I_{GND(ON)}$ | | | 20 | mA | Vcc = 13 V; $V_{OUT}$ = $V_{FR}$ = $V_{SEL0,1}$ = 0V; $V_{IN0,1,2,3}$ = $V_{SEn}$ = 5V; $I_{OUT0,1,2,3}$ = 1A |
| Bode diode forward voltage | $V_{BD}$ | | | 0.7 | V | Iout =-2 A; Tj = 150°C |
| **$Input_{0,1,2,3}$ section** | | | | | | |
| Low-level input voltage | $V_{IL}$ | | | 0.9 | V | |
| Low-level input current | $I_{IL}$ | 1 | | | µA | VIN = 0.9V |
| High-level input voltage | $V_{IH}$ | 2.1 | | | V | |
| High-level input current | $I_{IH}$ | | | 10 | µA | VIN = 2.1V |
| Input hysteresis voltage | $V_{I(hyst)}$ | 0.2 | | | V | |
| Input clamp voltage | $V_{ICL}$ | 5.3 | | 7.5 | V | IIN = 1 mA |
| | | | -0.7 | | | IIN = -1 mA |
| **FaultRST section** | | | | | | |

| *Parameters* | *Symbol* | *Min* | *Typ* | *Max* | *Unit* | *Comments* |
|---|---|---|---|---|---|---|
| Low-level input voltage | $V_{FRL}$ | | | 0.9 | V | |
| Low-level input current | $I_{FRL}$ | 1 | | | µA | VIN = 0.9V |
| High-level input voltage | $V_{FRH}$ | 2.1 | | | V | |
| High-level input current | $I_{FRH}$ | | | 10 | µA | VIN = 2.1V |
| Input hysteresis voltage | $V_{FR(hyst)}$ | 0.13 | | | V | |
| Input clamp voltage | $V_{FRCL}$ | 5.3 | | 7.5 | V | IIN = 1 mA |
| | | | -0.7 | | | IIN = -1 mA |
| **$SEL_{0,1}$ section** | | | | | | |
| Low-level input voltage | $V_{SELL}$ | | | 0.9 | V | |
| Low-level input current | $I_{SELL}$ | 1 | | | µA | VIN = 0.9V |
| High-level input voltage | $V_{SELH}$ | 2.1 | | | V | |
| High-level input current | $I_{SELH}$ | | | 10 | µA | VIN = 2.1V |
| Input hysteresis voltage | $V_{SEL(hyst)}$ | 0.13 | | | V | |
| Input clamp voltage | $V_{SELCL}$ | 5.3 | | 7.5 | V | IIN = 1 mA |
| | | | -0.7 | | | IIN = -1 mA |
| **SEn section** | | | | | | |
| Low-level input voltage | $V_{SEnL}$ | | | 0.9 | V | |
| Low-level input current | $I_{SEnL}$ | 1 | | | µA | VIN = 0.9V |
| High-level input voltage | $V_{SEnH}$ | 2.1 | | | V | |
| High-level input current | $I_{SEnH}$ | | | 10 | µA | VIN = 2.1V |
| Input hysteresis voltage | $V_{SEn(hyst)}$ | 0.13 | | | V | |
| Input clamp voltage | $V_{SEnCL}$ | 5.3 | | 7.5 | V | IIN = 1 mA |
| | | | -0.7 | | | IIN = -1 mA |
| **Switching characteristics ( VCC = 13V, Tj =-40°C to 150°C)** | | | | | | |
| Turn-on delay time | $t_{d(ON)}$ | 10 | 25 | 70 | µs | RL = 6.5 Ω, VCC = 13 V, Tj = 25°C |
| Turn-off delay time | $t_{d(OFF)}$ | 10 | 25 | 70 | µs | RL = 6.5 Ω, VCC = 13 V, Tj = 25°C |
| Turn-on slew rate | $dv/dt_{on}$ | 0.2 | 0.25 | 0.65 | V/µs | RL = 6.5 Ω, VCC = 13 V, Tj = 25°C |

| *Parameters* | *Symbol* | *Min* | *Typ* | *Max* | *Unit* | *Comments* |
|---|---|---|---|---|---|---|
| Turn-off slew rate | $dv/dt_{off}$ | 0.2 | 0.35 | 0.65 | V/µs | RL = 6.5 Ω, VCC = 13 V, Tj = 25°C |
| Switching energy losses at turn-on | $W_{ON}$ | 0.1 | 0.2 | 0.3 | mJ | RL = 6.5 Ω, VCC = 13 V |
| Switching energy losses at turn-off | $W_{OFF}$ | 0.1 | 0.2 | 0.3 | mJ | RL = 6.5 Ω, VCC = 13 V |
| Pulse skew time ($t_{PHL}$- $t_{PLH}$ ) | $t_{SKEW}$ | -30 | 10 | 40 | µs | RL = 6.5 Ω, VCC = 13 V |
| **Protections** | | | | | | |
| DC short-circuit current | $I_{limit}$ | 21 | 27 | 38 | A | VCC = 13 V, VIN = 5V |
| Deglitch time | | | 3 | | µs | |
| Auto-retry times in case of fault after the Counter reset | $n_{RETRY(CR)}$ | - | 5 | - | | See Figure |
| Auto-retry times in case of fault after the first $t_{RETRY}$ activation | $n_{RETRY(NT)}$ | - | 1 | - | | |
| Retry cycles allowed before channel latch off | $n_{RETRY(CYC)}$ | - | 2 | - | | |
| Auto-retry time after fault condition | $t_{RETRY}$ | 40 | 70 | 100 | ms | |
| Counter reset delay time after fault condition | $t_{DELAY(CR)}$ | 40 | 70 | 100 | ms | |
| | ~~$t_{DEN(CR)}$~~ | ~~50~~ | ~~100~~ | ~~150~~ | ~~µs~~ | |
| Shutdown temperature | $T_{TSD}$ | 150 | 175 | 200 | °C | |
| Reset temperature | $T_R$ | $T_{RS}$ + 1 | $T_{RS}$ + 7 | | | |
| Thermal reset of diagnostic indication | $T_{RS}$ | 135 | | | | $V_{FR}$ = 0V, $V_{SEn}$ = 5V |
| Thermal hysteresis (TTSD- TR) | $T_{HYST}$ | | 7 | | | |
| Dynamic temperature | ΔTj | | 60 | | K | Tj =-40°C, VCC = 13V |
| Dynamic temperature hysteresis | ΔTj(HYS) | | 20? | | K | |
| Fault reset time for output unlatch | $t_{LATCH\_RST}$ | 3 | 10 | 20 | µs | $V_{FR}$ = 5V to 0V, $V_{SEn}$ = 5V |
| Turn off output voltage clamp | $V_{DEMAG}$ | $V_{CC}$-41 | $V_{CC}$-46 | $V_{CC}$-52 | V | Tj =-40°C to 150°C |
| CS pin to ground clamp voltage | $V_{CSG\_CL}$ | | 7 | | V | $I_{SENSE}$ =-1mA, VCC = 13V |
| **Current Sense** | | | | | | |
| $K_0$ | | -30% | 1200 | 30% | | $I_{OUT}$ = 0.01A to 0.05A, $V_{sense}$ = 0.5V |

| Parameters | Symbol | Min | Typ | Max | Unit | Comments |
|---|---|---|---|---|---|---|
| $K_1$ | $I_{OUT}/I_{SEN}$ | -25% | 1200 | 25% | | $I_{OUT}$ = 0.2A, $V_{sense}$ = 0.5V |
| $K_2$ | | -20% | 1200 | 20% | | $I_{OUT}$ = 0.4A, $V_{sense}$ = 4V |
| $K_3$ | | -15% | 1200 | 15% | | $I_{OUT}$ = 1.5A, $V_{sense}$ = 4V |
| $K_4$ | | -10% | 1200 | 10% | | $I_{OUT}$ = 4.5A, $V_{sense}$ = 4V |
| CS pin leakage current | $I_{SENSE0}$ | | | 0.5 | µA | $V_{SEn}$ = 0V |
| | | -0.5 | | 0.5 | | $V_{SEn}$ = 0V,-1V < $V_{SENSE}$ < 5V |
| | | | | 2 | | $V_{SEn}$ = 5V, $I_{OUTx}$ = 0A, $V_{INPUT0,1,2,3}$ = 5V, channel diagnostic selected |
| | | | | 2 | | $V_{SEn}$ = 5V, $I_{OUTx}$ = 0A, $V_{INPUT0,1,2,3}$ = 0V, channel diagnostic selected |
| Output voltage for CS shutdown | $V_{OUT\_MSD}$ | | 5 | | V | $V_{SEn}$ = 5V, $R_{SENSE}$ = 2.7kΩ, $I_{OUT}$ = 2A |
| CS saturation voltage | $V_{SENSE\_SAT}$ | | 5.5 | | V | VCC = 7V, $V_{SEn}$ = 5V, $R_{SENSE}$ = 2.7kΩ, $I_{OUT}$ = 4.5A |
| CS saturation current | $I_{SENSE\_SAT}$ | 4 | | | mA | VCC = 7V, $V_{SEn}$ = 5V, $V_{SENSE}$ = 4V, $V_{INPUT}$ = 5V, Tj = 150°C |
| Output saturation current | $I_{OUT\_SAT}$ | 4.8 | | | A | VCC = 7V, $V_{SEn}$ = 5V, $V_{SENSE}$ = 4V, $V_{INPUT}$ = 5V, Tj = 150°C |
| **Off-state diagnostic** | | | | | | |
| Off-state open-load voltage detection threshold | $V_{OL}$ | 2 | 3 | 4 | V | $V_{SEn}$ = 5V, $V_{INPUT}$ = 0V |
| Off-state output sink current | $I_{L(off)}$ | -100 | | -15 | µA | $V_{INPUT}$ = 0V, $V_{OUT}$ = $V_{OL}$ |
| Off-state diagnostic delay time from falling edge of INPUT | $t_{DSTKON}$ | 100 | 350 | 700 | µs | $V_{SEn}$ = 5V, $V_{INPUT}$ = 5V to 0V |
| Setting time for valid Off-state open-load diagnostic indication from rising edge of SEn | $t_{D\_OL\_V}$ | | | 60 | µs | $V_{SEn}$ = 0V to 5V |
| Off-state diagnostic delay time from rising edge of $V_{OUT}$ | $t_{D\_VOL}$ | | 5 | 30 | µs | $V_{SEn}$ = 5V, $V_{INPUT}$ = 0V, $V_{OUT}$ = 0V to 4V |
| **Fault diagnostic** | | | | | | |
| CS pin output voltage in fault condition | $V_{SENSEH}$ | 5 | | 6.6 | V | |
| CS pin output current in fault condition | $I_{SENSEH}$ | 7 | 20 | 30 | mA | |

| *Parameters* | *Symbol* | *Min* | *Typ* | *Max* | *Unit* | *Comments* |
|---|---|---|---|---|---|---|
| **Current sense timings** | | | | | | |
| CS setting time from rising edge of SEn | $t_{DSENSE1H}$ | | | 60 | μs | $V_{SEn}$ = 0V to 5V, $V_{INPUT}$ = 5V, $R_{SENSE}$ = 1kΩ, $R_L$ = 6.5Ω |
| CS disable time delay from falling edge of SEn | $t_{DSENSE1L}$ | | 5 | 20 | μs | $V_{SEn}$ = 5V to 0V, $R_{SENSE}$ = 1kΩ, $R_L$ = 6.5Ω |
| CS setting time from rising edge of INPUT | $t_{DSENSE2H}$ | | 100 | 250 | μs | $V_{SEn}$ = 5V, $V_{INPUT}$ = 0V to 5V, $R_{SENSE}$ = 1kΩ, $R_L$ = 6.5Ω |
| CS setting time from rising edge of $I_{OUT}$ (dynamic response to a step change of $I_{OUT}$) | $\Delta t_{DSENSE2H}$ | | | 100 | μs | $V_{SEn}$ = 5V, $V_{INPUT}$ = 5V, $R_{SENSE}$ = 1kΩ, $R_L$ = 6.5Ω |
| CS turn off delay time from falling edge of INPUT | $t_{DSENSE2L}$ | | 50 | 250 | μs | $V_{SEn}$ = 5V, $V_{INPUT}$ = 5V to 0V, $R_{SENSE}$ = 1kΩ, $R_L$ = 6.5Ω |

Figure 1 Switching times and switching loss

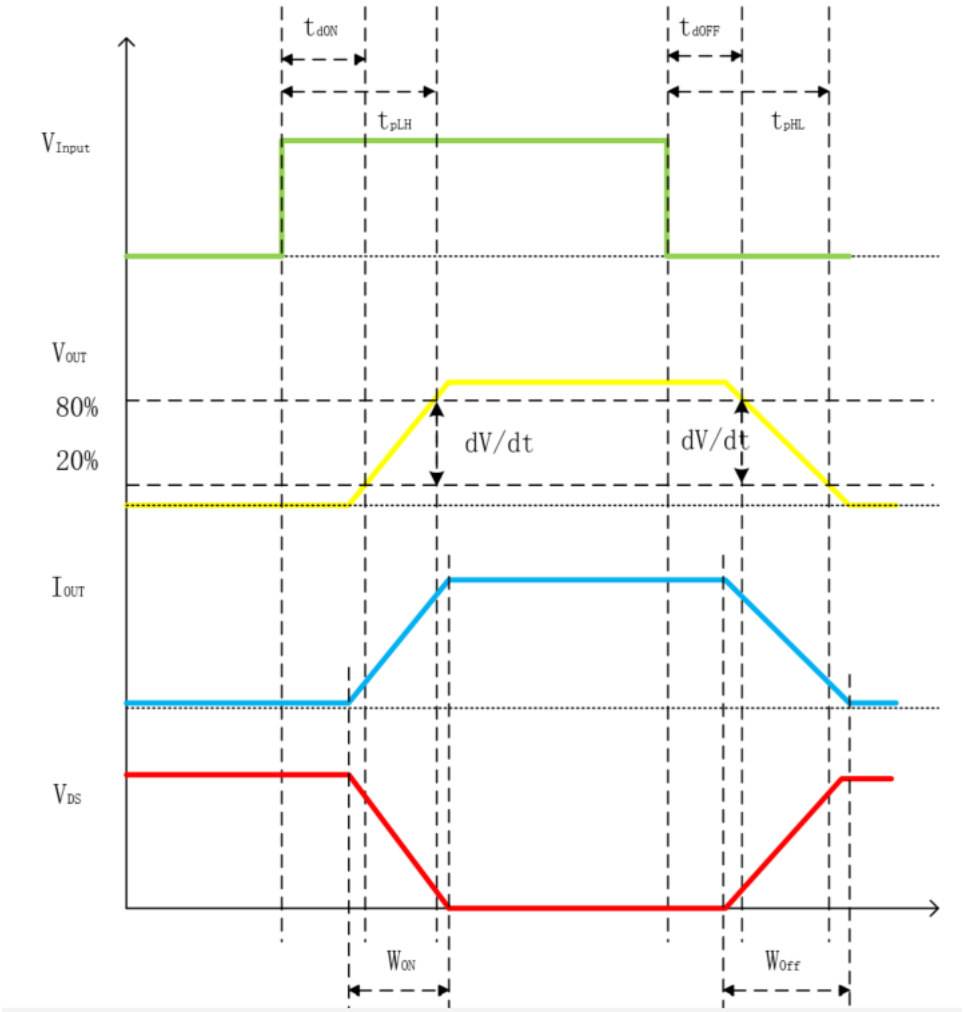



Figure 2 Off-state diagnostic delay time from falling edge of INPUT

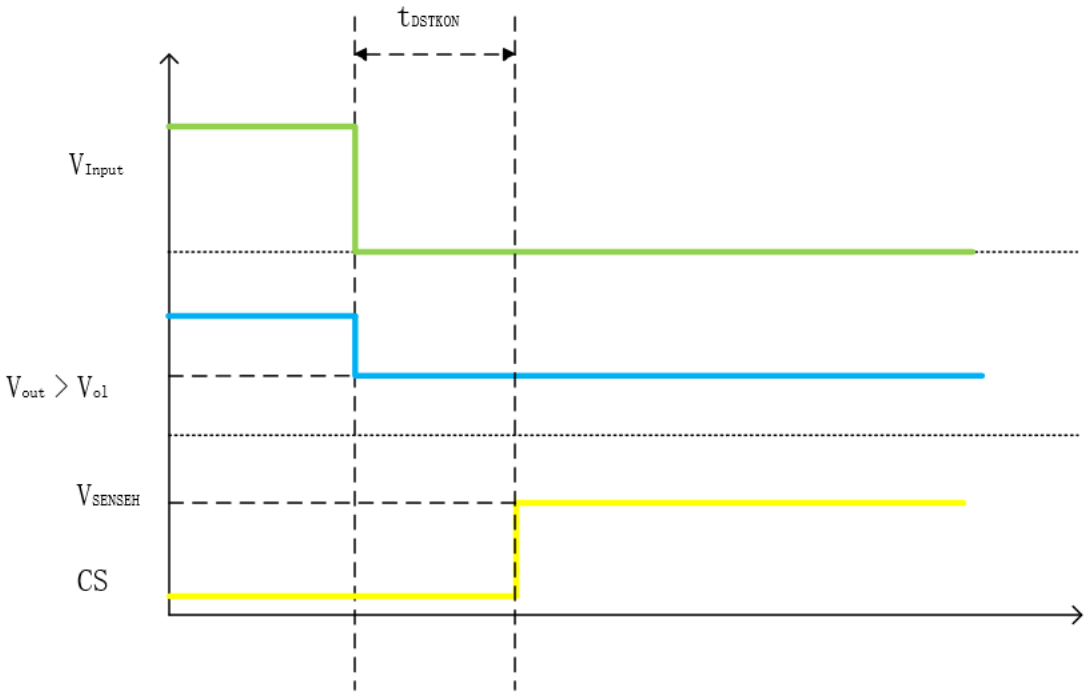



Figure 3 Off-state diagnostic delay time from rising edge of VOUT

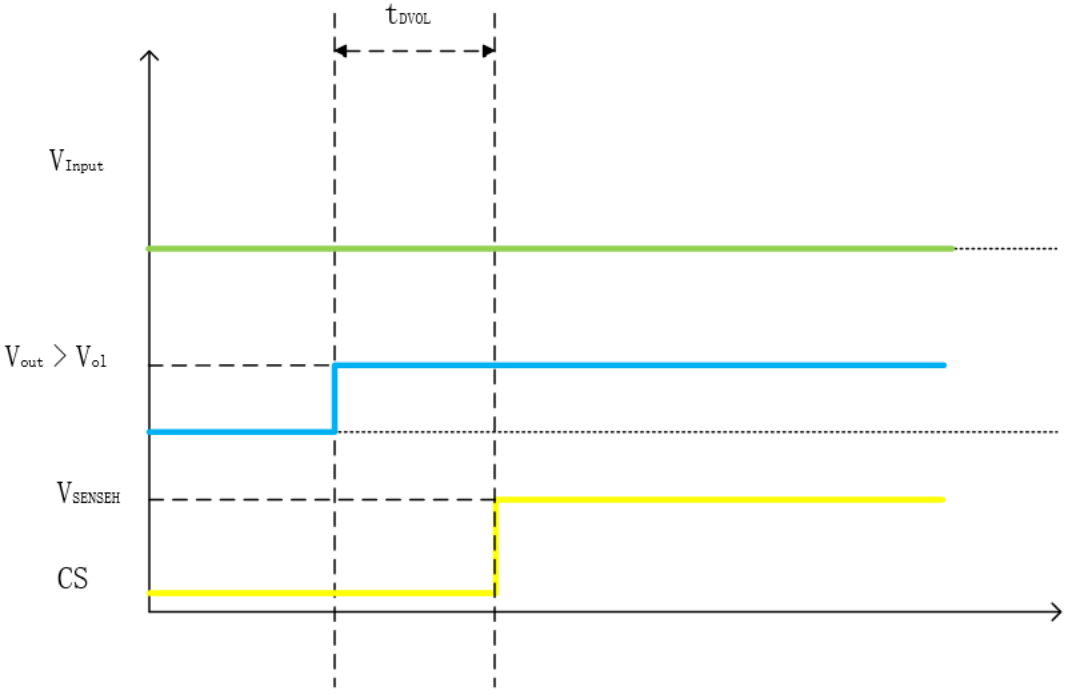
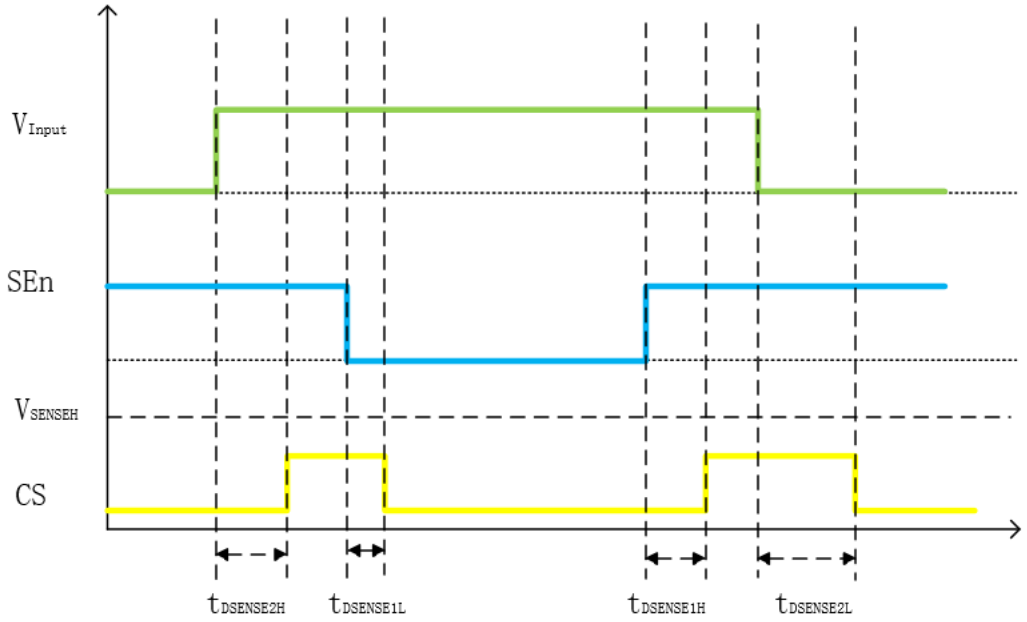


Figure 4 Current sense timing




## 6.2. Typical Performance Characteristics

### 6.2.1. True table

| *Mode* | *Conditions* | *$IN_X$* | *FR* | *SEn* | *$SEL_X$* | *$OUT_X$* | *CS* | *Comments* |
|---|---|---|---|---|---|---|---|---|
| Standby | All logic inputs low | L | L | L | L | L | Hi-Z | |
| Normal | Nominal load connected, Tj < 150°C | L | X | Refer to CS address | | L | Refer to CS address | |
| | | H | L | | | H | Refer to CS address | Outputs for auto-retry |
| | | H | H | | | H | Refer to CS address | Outputs for latch-off |
| Overload | Overload or short to GND, Tj > 175 °C or ΔTj > 60k | L | X | Refer to CS address | | L | Refer to CS address | |
| | | H | L | | | H | Refer to CS address | |
| | | H | H | | | L | Refer to CS address | |
| Under voltage | VCC < UVLO (falling) | X | X | X | X | L | Hi-Z | |
| Off-state diagnostics | Short to VCC | L | X | Refer to CS address | | H | Refer to CS address | |

| Mode | Conditions | $IN_X$ | FR | SEn | $SEL_X$ | $OUT_X$ | CS | Comments |
|---|---|---|---|---|---|---|---|---|
| | Open-load | L | X | | | H | Refer to CS address | External pull-up |
| Negative output voltage | Inductive load turn off | L | X | Refer to CS address | | < 0V | Refer to CS address | |

### 6.2.2. Current sense MUX address

| SEn | SEL0 | SEL1 | MUX channel | Normal mode | Overload | Off-state diag | Negative output |
|---|---|---|---|---|---|---|---|
| L | X | X | | Hi-Z | | | |
| H | L | L | Channel 0 | $I_{SENSE} = 1/K * I_{OUT0}$ | $V_{SENSE} = V_{SENSEH}$ | $V_{SENSE} = V_{SENSEH}$ | Hi-Z |
| H | L | H | Channel 1 | $I_{SENSE} = 1/K * I_{OUT1}$ | $V_{SENSE} = V_{SENSEH}$ | $V_{SENSE} = V_{SENSEH}$ | Hi-Z |
| H | H | L | Channel 2 | $I_{SENSE} = 1/K * I_{OUT2}$ | $V_{SENSE} = V_{SENSEH}$ | $V_{SENSE} = V_{SENSEH}$ | Hi-Z |
| H | H | H | Channel 3 | $I_{SENSE} = 1/K * I_{OUT3}$ | $V_{SENSE} = V_{SENSEH}$ | $V_{SENSE} = V_{SENSEH}$ | Hi-Z |

# 7. Protections

## 7.1. Current limitation

NSE34050Q-Q1 has current limitation to protect the silicon and bonding wire in case of overload or short circuit to ground. In order to allow a higher load inrush at low ambient temperature, Overload threshold is related with VDS and temperature.

Figure 5 Overload current threshold VS VDS

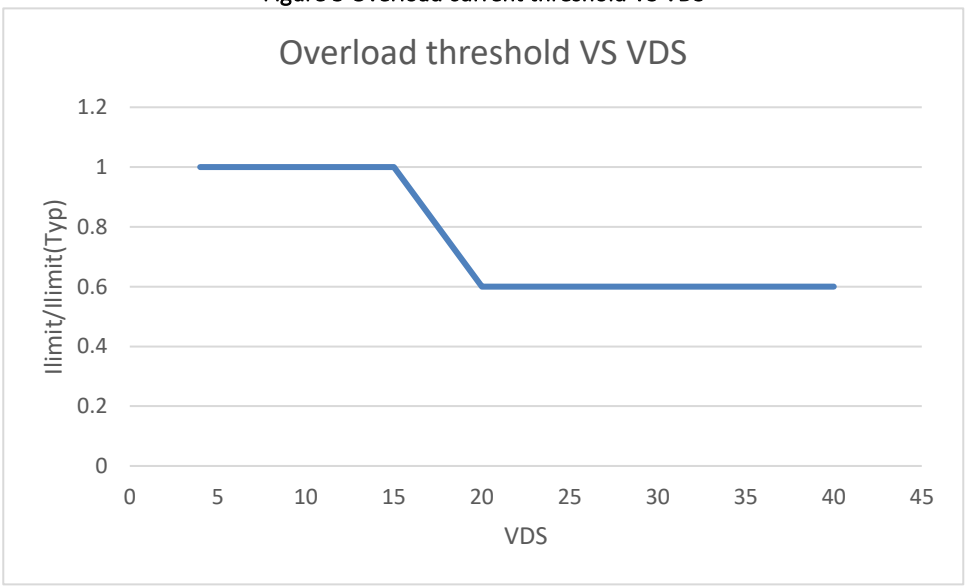
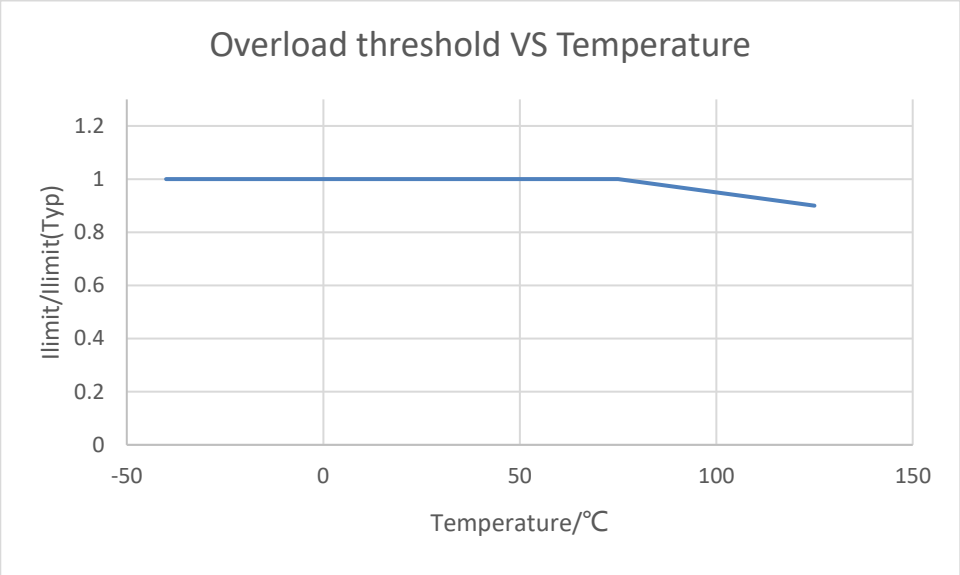



Figure 6 Overload current threshold VS temperature




### 7.1.1. Retry strategy

While the FaultRST pin is set to low, NSE34050 works in auto-retry mode. Then the channel can be allowed to restart only if all retry conditions have been fulfilled in case of fault condition.

In the fault condition, the channel will switched on for $n_{RETRY(CR)}$ times then switch off, after a time $t_{RETRY}$, the channel will switch on for $n_{RETRY(CYC)}$ retry cycles then latch off. It is necessary to set the input pin to low for a time longer than $t_{DELAY(CR)}$ to reset the internal counter to unlatch the channel. The auto-retry timing is shown in Figure 7 and the latch-up timing is shown in Figure 8.

Figure 7 Auto-retry timing

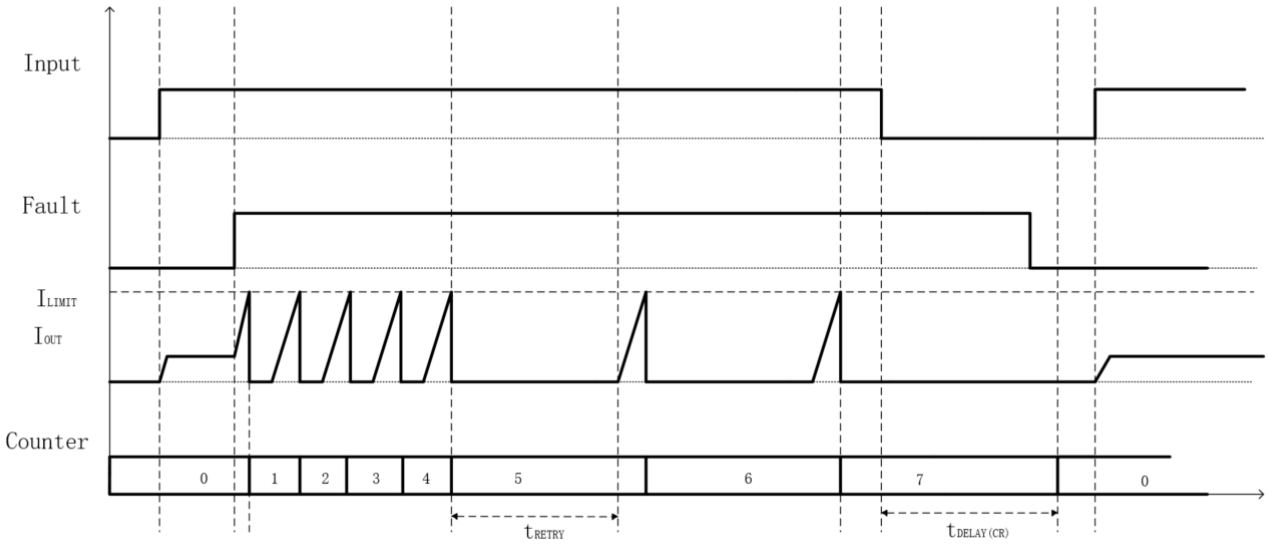



Figure 8 Latch-up timing

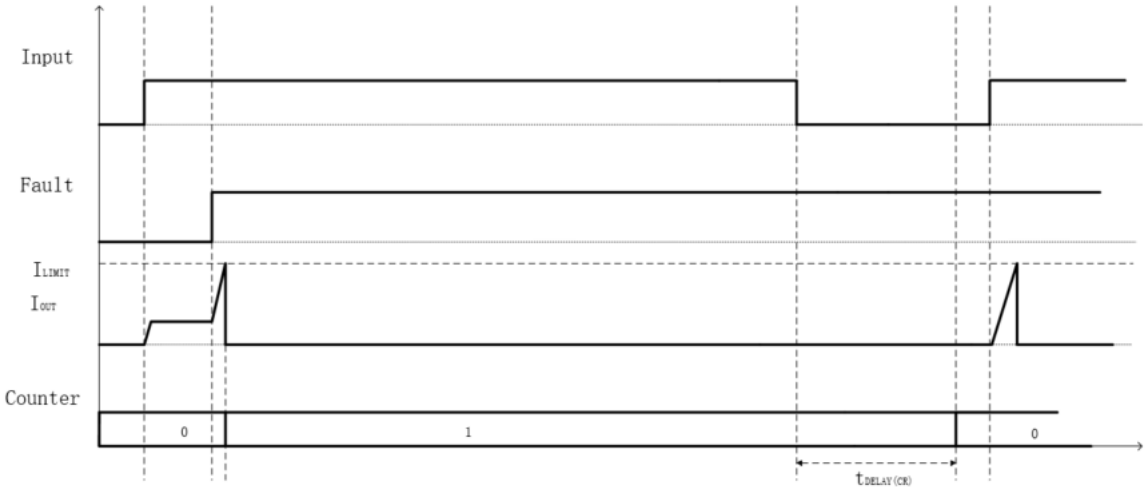
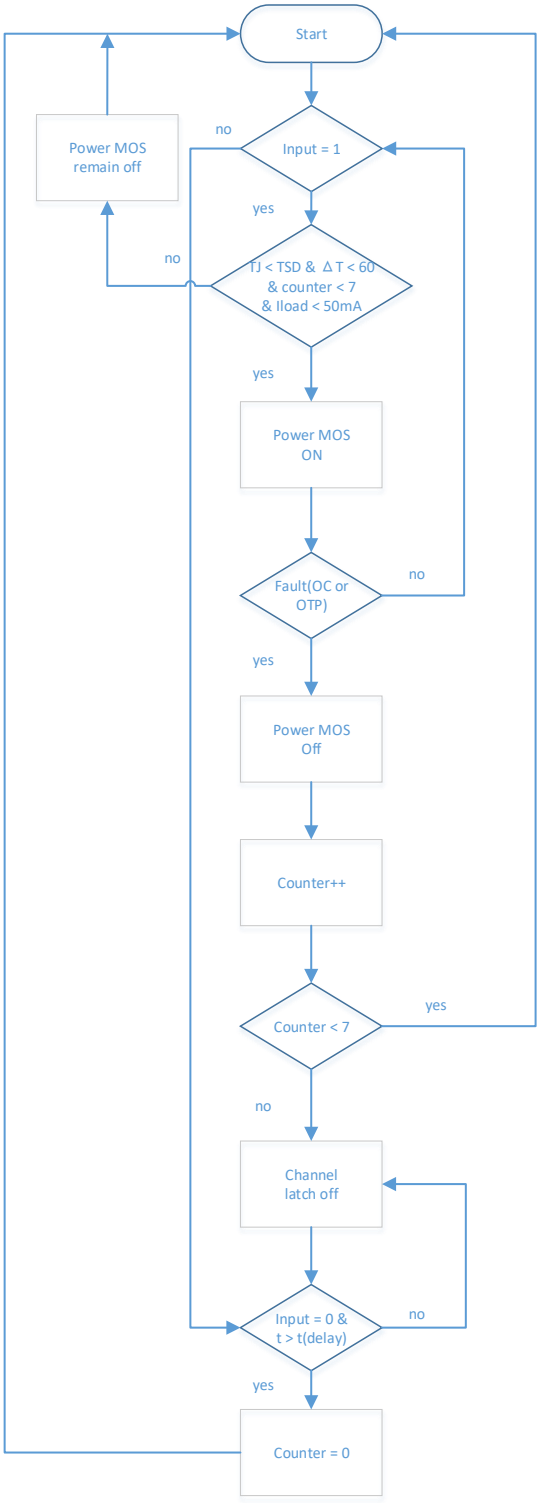


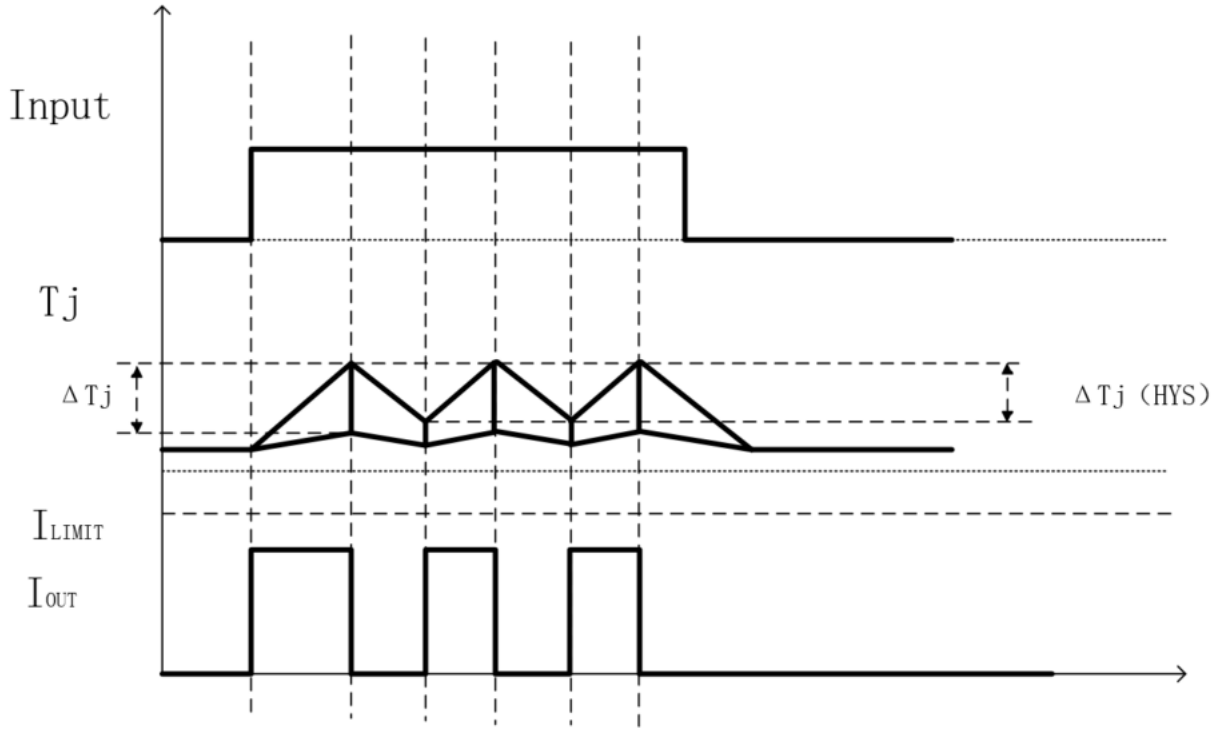

Figure 9 Retry strategy




## 7.2. Thermal shutdown and thermal swing

This device has both absolute and dynamic temperature protection. There are two thermal sensors on the controller and the MOSFET, the one on the MOSFET is the hottest and the one on the controller is the coldest. The absolute temperature protection is to shutdown the MOSFET when the hottest junction temperature exceeds the $T_{TSD}$, and the dynamic temperature protection is also to shutdown the MOSFET when the temperature difference between the hottest and the coldest exceeds ΔTj.

Figure 9 Thermal swing




### 7.3. Inductive load voltage clamp

In the case device turns off when driving inductive load, the voltage between VCC and output will exceed VCC. VDS should be clamped to limit the voltage to protect the power MOSFET from breakdown. The clamp voltage is lower than BVDSS of the MOSFET, the energy of inductor is dissipated without damaging the device.

### 7.4. Reverse polarity protection

In reverse polarity condition, the device will switch on the power MOSFET, so that to reduce the power dissipation on the power MOSFET, which is limited by the load. If power MOSFET is off, reverse current will pass through body diode and cause more power dissipation which may damage the device. What's more, the device integrate a diode in the GND, so that it is not necessary to place a diode outside the GND pin to avoid the reverse current.

### 7.5. Loss of battery and loss of ground protection

When the load is inductive, then battery is loss of connection, it is recommended to place an external diode to handle the energy of inductor when loss of battery.
In case of loss ground, the power MOSFET will be ensured to switch off to avoid MOSFET on by mistake.

## 8. Application information

## 9. Electrical characteristics curves

## 10. Immunity against transient electrical disturbances

## 11. Package and PCB thermal data

# 12. Package Information

## 12.1. PowerSSO-16

## 13. Revision history

| Revision | Description | Date |
|---|---|---|
| 0V1 | Initial version | 2021/08 |
| 0V2 | Some updates and add true table | 2021/09 |
| 0V3 | Add application information | 2021/12 |
| 0V5 | Market pre-release | 2022/04 |