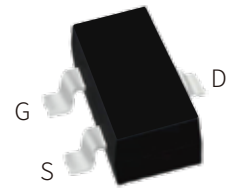


## FEATURES

Ultra low on-resistance:  $V_{DS}=20V, R_{DS(ON)} \leq 0.25\Omega$

@  $V_{GS}=4.5V, I_D=1.2A$

Surface Mount device



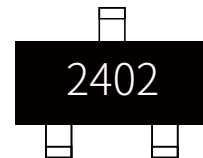
SOT-23

## APPLICATION

Case: SOT-23

Case Material: Molded Plastic. UL flammability

Classification Rating: 94V-0

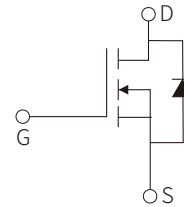


Marking

## APPROVALS

**RoHS** Compliance with 2011/65/EU

**HF** Compliance with IEC61249-2-21:2003

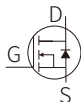


Schematic Symbol

## ABSOLUTE MAXIMUM RATINGS( $T_A=25^\circ\text{C}$ )

| Parameter                         |                        | Symbol          | Value      | Unit                      |
|-----------------------------------|------------------------|-----------------|------------|---------------------------|
| Drain-Source Voltage              |                        | $V_{DS}$        | 20         | V                         |
| Drain Current-Continuous          | $T_A=25^\circ\text{C}$ | $I_D$           | 1.2        | A                         |
| Drain Current-Continuous          | $T_A=70^\circ\text{C}$ | $I_D$           | 0.95       | A                         |
| Pulsed Drain Current              |                        | $I_{DM}$        | 7.4        | A                         |
| Gate-Source Voltage               |                        | $V_{GS}$        | $\pm 12$   | V                         |
| Total Power Dissipation           | $T_A=25^\circ\text{C}$ | $P_D$           | 540        | mW                        |
| Peak Dipde Recovery dv/dt(note 2) |                        | dv/dt           | 5.0        | V/ns                      |
| Linear Derating Factor            |                        |                 | 4.3        | mW/ $^\circ\text{C}$      |
| Junction-to-Ambient(note 4)       |                        | $R_{\theta JA}$ | 230        | $^\circ\text{C}/\text{W}$ |
| Storage temperature               |                        | $T_{STG}$       | -55 to 150 | $^\circ\text{C}$          |

## ELECTRICAL CHARACTERISTICS( $T_a=25^{\circ}\text{C}$ )

| Parameter                                 | Symbol                          | Test Conditions                                                                                                                                     | Min. | Typ.  | Max.      | Unit                  |
|-------------------------------------------|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|------|-------|-----------|-----------------------|
| Drain-source Breakdown Voltage            | $BV_{DSS}$                      | $V_{GS}=0V, I_D=250\mu A$                                                                                                                           | 20   |       |           | V                     |
| Breakdown Voltage Temp. Coefficient       | $\Delta V_{(BR)DSS}/\Delta T_J$ | Reference to 25, $I_D=1mA$                                                                                                                          |      | 0.024 |           | V/ $^{\circ}\text{C}$ |
| Zero Gate Voltage Drain Current           | $I_{DSS}$                       | $V_{DS}=16V, V_{GS}=0V$                                                                                                                             |      |       | 1.0       | $\mu A$               |
| Gate-to-Source Forward Leakag             | $I_{GSS}$                       | $V_{GS}=\pm 12V, V_{DS}=0V$                                                                                                                         |      |       | $\pm 100$ | nA                    |
| Gate Threshold Voltage                    | $V_{GS(th)}$                    | $V_{DS}=V_{GS}, I_D=250\mu A$                                                                                                                       | 0.70 |       |           | V                     |
| Static Drain-Source On-Resistance(Note3)  | $R_{DS(on)}$                    | $V_{GS}=4.5V, I_D=0.93A$                                                                                                                            |      |       | 0.25      | $\Omega$              |
|                                           |                                 | $V_{GS}=2.7V, I_D=0.47A$                                                                                                                            |      |       | 0.35      |                       |
| Input Capacitance                         | $C_{iss}$                       | $V_{DS}=15V, V_{GS}=0V, f=1.0MHz, \text{See Fig.5}$                                                                                                 |      | 110   |           | pF                    |
| Output Capacitance                        | $C_{oss}$                       |                                                                                                                                                     |      | 51    |           |                       |
| Reverse Transfer Capacitance              | $C_{rss}$                       |                                                                                                                                                     |      | 25    |           |                       |
| Turn-On Delay Time                        | $t_{d(on)}$                     | $R_D=11\Omega, R_G=6.2\Omega$<br>$V_{DD}=10V, I_D=0.93A$                                                                                            |      | 2.5   |           | ns                    |
| Turn-On Rise Time                         | $t_r$                           |                                                                                                                                                     |      | 9.5   |           |                       |
| Turn-Off Delay Time                       | $t_{d(off)}$                    |                                                                                                                                                     |      | 9.7   |           |                       |
| Turn-Off Fall Time                        | $t_f$                           |                                                                                                                                                     |      | 4.8   |           |                       |
| Diode forward voltage (note 2)            | $V_{SD}$                        | $I_S=0.93A, V_{GS}=0V, T_J=25^{\circ}\text{C}$                                                                                                      |      |       | 1.2       | V                     |
| Total Gate Charge                         | $Q_g$                           | $V_{GS}=4.5V, V_{DS}=16V, I_D=0.93A$                                                                                                                |      | 2.6   | 3.9       | nC                    |
| Gate Source Charge                        | $Q_{gs}$                        |                                                                                                                                                     |      | 0.41  | 0.62      |                       |
| Gate Drain Charge(note 2)                 | $Q_{gd}$                        |                                                                                                                                                     |      | 1.1   | 1.7       |                       |
| Diode forward current(Body Diode)         | $I_S$                           | MOSFET symbol showing the<br>integral rever p-n junction diod  |      |       | 0.54      | A                     |
| Pulsed Source Curren (Body Diode)(note 1) | $I_{SM}$                        |                                                                                                                                                     |      |       | 7.4       |                       |
| Reverse Recovery Time                     | $t_{rr}$                        | $I_F=0.93A$<br>$di/dt=100A/\mu s, T_J=25^{\circ}\text{C}$                                                                                           |      | 25    | 38        | ns                    |
| Reverse Recovery Charge(note 3)           | $Q_{rr}$                        |                                                                                                                                                     |      | 16    | 24        | nC                    |

Note:1. Repetitive rating; pulse width limited by max. junction temperature

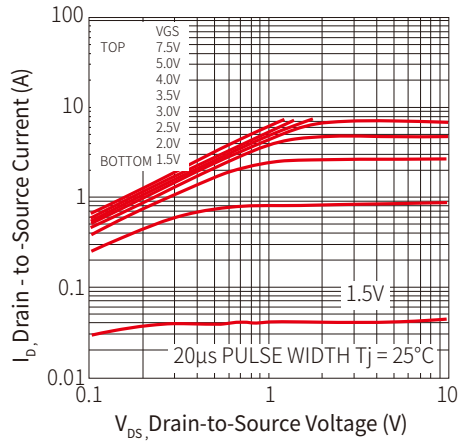
Note:2.  $I_{SD} \leq 0.93A, di/dt \leq 90A/\mu s, V_{DD} \leq V_{(BR)DSS}, T_J \leq 150^{\circ}\text{C}$

Note:3. Pulse width  $\leq 300\mu s$ , Duty cycle  $\leq 2\%$

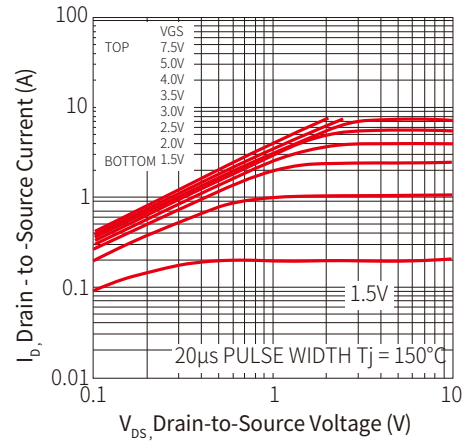
Note:4. Surface mounted on FR-4 board  $t \leq 5\text{sec}$

# PARAMETER CHARACTERISTIC CURVE

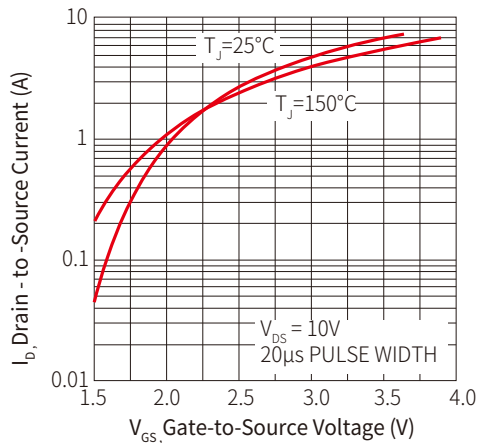
**Fig 1: Typical Output Characteristics**



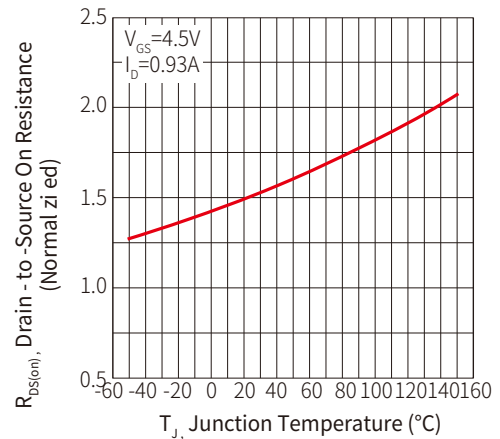
**Figure 2: Typical Output Characteristics**



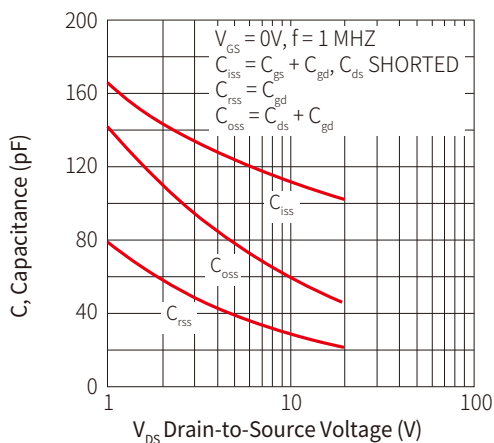
**Figure 3: Typical Transfer Characteristics**



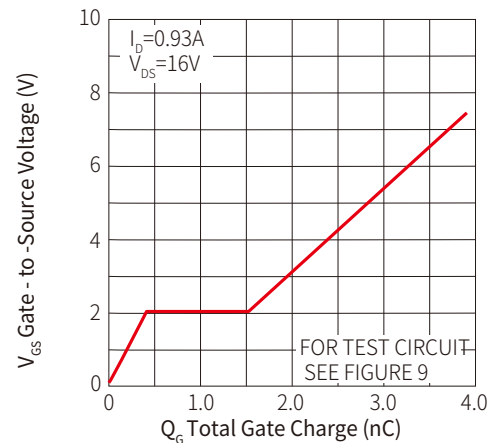
**Figure 4: Normalized On-Resistance Vs. Temperature**

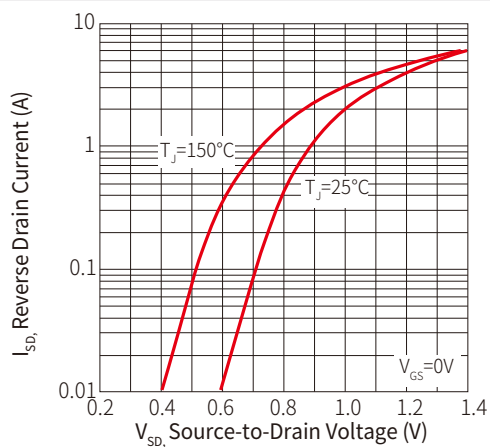
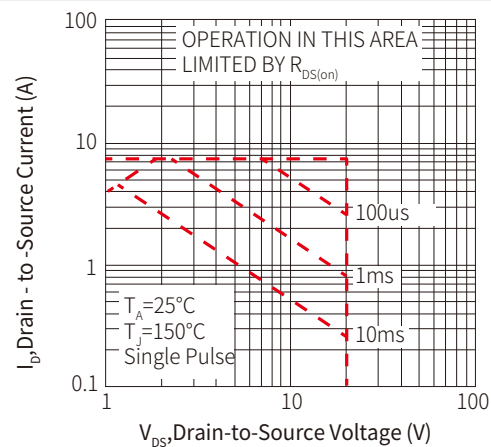
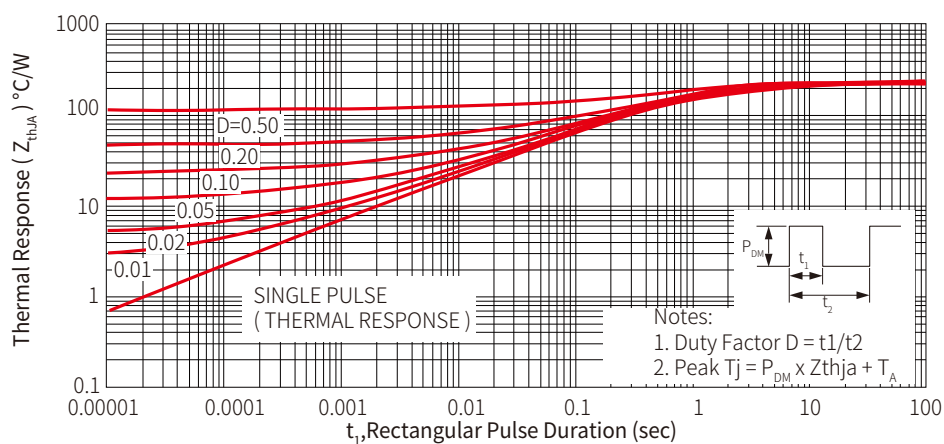
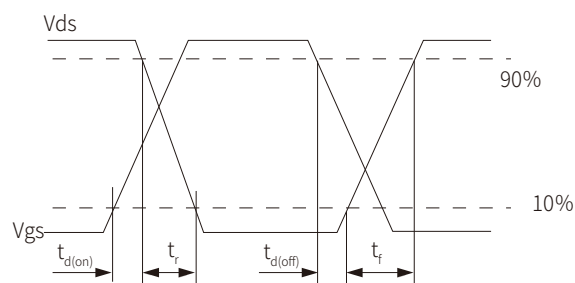
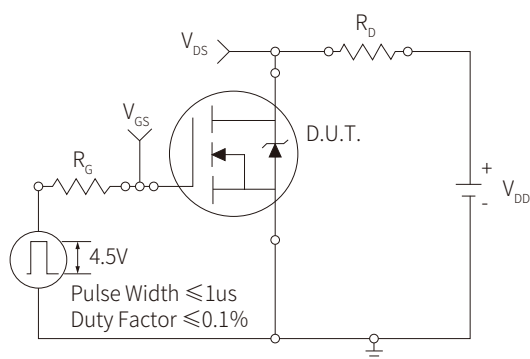


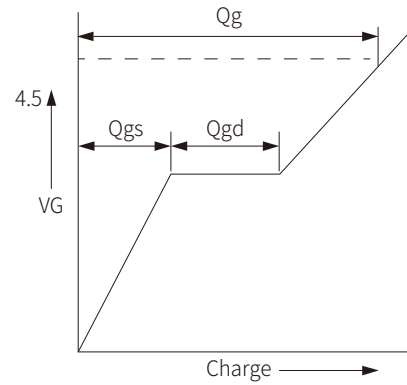
**Figure 5: Typical Capacitance Vs. Drain-to-Source Voltage**



**Figure 6: Typical Gate Charge Vs. Gate-to-Source Voltage**



**Figure 7: Typical Source-Drain Diode Forward Voltage**

**Figure 8: Maximum Safe Operating Area**

**Figure 9: Maximum Effective Transient Thermal Impedance, Junction-to-Ambient**

**Figure 10: Switching Time Test Circuit & Waveforms**


[illegible]

Circuit Layout Considerations

- Low Stray Inductance
- Ground Plane
- Low Leakage Inductance
- Current Transformer

•  $dv/dt$  controlled by  $R_G$

• Driver same type as D.U.T.

•  $I_{GD}$  controlled by Duty Factor "D"

• D.U.T.-Device Under Test

① Driver Gate Drive

Period

P.W.

$D = \frac{P.W.}{Period}$

$V_{GS} = 10V$

② D.U.T.  $I_{SD}$  Waveform

Reverse Recovery Current

Body Diode Forward Current

$di/dt$

③ D.U.T.  $V_{DS}$  Waveform

Diode Recovery  $dv/dt$

Body Diode

Forward Drop

$V_{BD}$

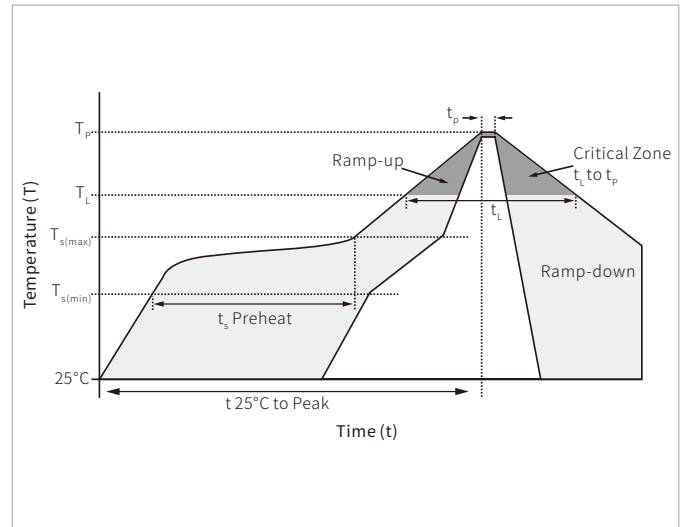
④ Inductor Current

Ripple  $\leq 5\%$

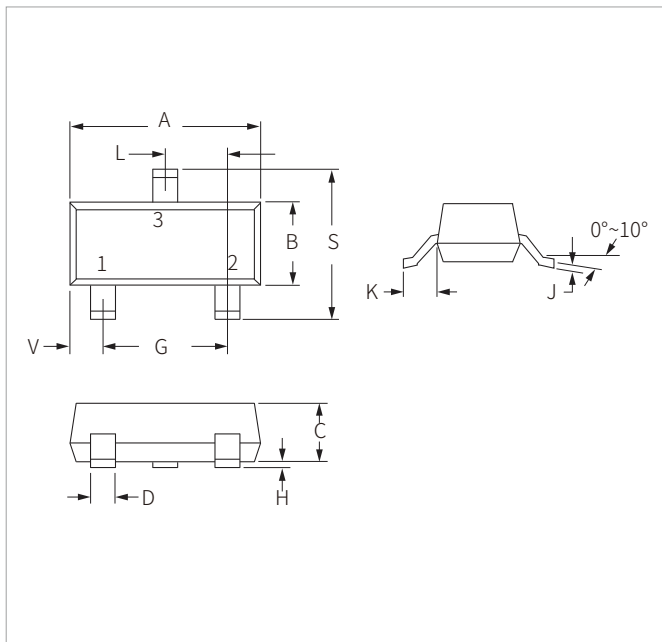
$I_{SD}$

## SOLDERING PARAMETERS

| Reflow Condition                                      |                                  | Lead-free assembly |
|-------------------------------------------------------|----------------------------------|--------------------|
| Pre Heat                                              | Temperature Max ( $T_{s(min)}$ ) | 150°C              |
|                                                       | Temperature Max ( $T_{s(max)}$ ) | 200°C              |
|                                                       | Time (min to max) ( $t_s$ )      | 60 – 180 secs      |
| Average ramp up rate (Liquidus Temp ( $T_L$ ) to peak |                                  | 3°C/second max     |
| $T_{s(max)}$ to $T_L$ - Ramp-up Rate                  |                                  | 3°C/second max     |
| Reflow                                                | Temperature ( $T_L$ ) (Liquidus) | 217°C              |
|                                                       | Time (min to max) ( $t_l$ )      | 60 – 150 seconds   |
| Peak Temperature ( $T_p$ )                            |                                  | 260°C              |
| Time within 5°C of actual peak Temperature ( $t_p$ )  |                                  | 20 – 40 seconds    |
| Ramp-down Rate                                        |                                  | 6°C/second max     |
| Time 25°C to peak Temperature ( $T_p$ )               |                                  | 8 minutes max.     |
| Do not exceed                                         |                                  | 260°C              |

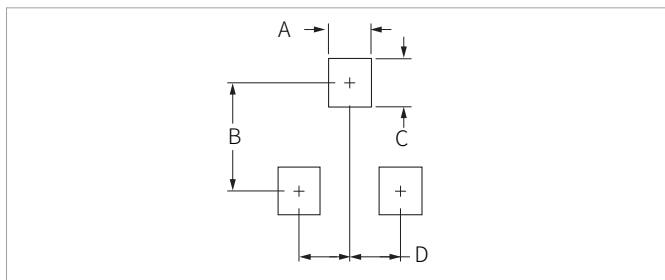


## SOT-23 PACKAGE INFORMATION



| Ref. | Millimeters |       | Inches |       |
|------|-------------|-------|--------|-------|
|      | Min.        | Max.  | Min.   | Max.  |
| A    | 2.80        | 3.05  | 0.110  | 0.120 |
| B    | 1.20        | 1.40  | 0.047  | 0.055 |
| C    | 0.90        | 1.15  | 0.035  | 0.045 |
| D    | 0.37        | 0.50  | 0.015  | 0.020 |
| G    | 1.75        | 2.05  | 0.069  | 0.081 |
| H    | 0.01        | 0.100 | 0.001  | 0.004 |
| J    | 0.085       | 0.180 | 0.003  | 0.007 |
| K    | 0.35        | 0.69  | 0.014  | 0.029 |
| L    | 0.89        | 1.02  | 0.035  | 0.040 |
| S    | 2.10        | 2.65  | 0.083  | 0.104 |
| V    | 0.45        | 0.60  | 0.018  | 0.024 |

## RECOMMENDED PAD LAYOUT DIMENSIONS



| Ref. | Millimeters |      | Inches |       |
|------|-------------|------|--------|-------|
|      | Min.        | Max. | Min.   | Max.  |
| A    | 0.71        | 0.97 | 0.028  | 0.038 |
| B    | 1.88        | 2.13 | 0.074  | 0.084 |
| C    | 0.71        | 0.97 | 0.028  | 0.038 |
| D    | 0.81        | 1.07 | 0.032  | 0.042 |

## ORDERING INFORMATION

| Part Number | Component Package | QTY/Reel | Reel Size |
|-------------|-------------------|----------|-----------|
| SNM2402S    | SOT-23            | 3000PCS  | 7"        |

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