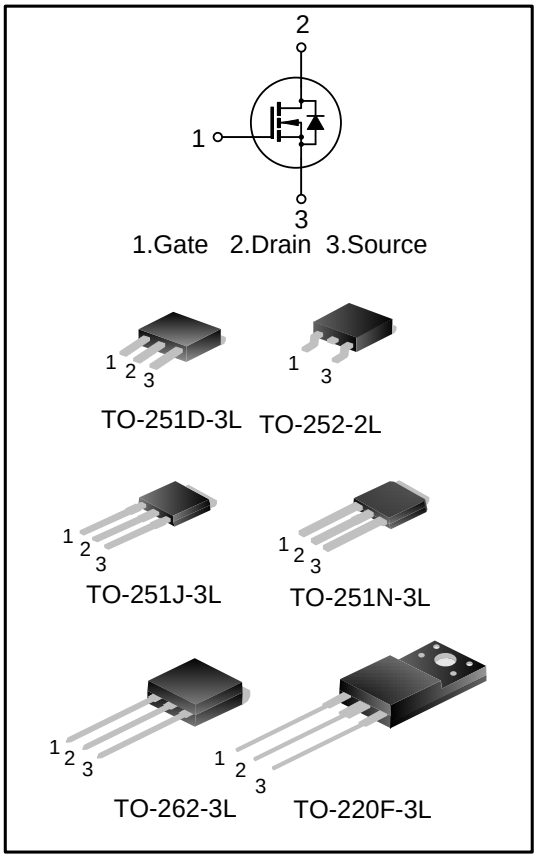
# 4A, 650V N-CHANNEL MOSFET




## GENERAL DESCRIPTION

SVF4N65CAF/D/M/MJ/MN/K is an N-channel enhancement mode power MOS field effect transistor which is produced using Silan proprietary F-Cell™ high-voltage planar VDMOS technology. The improved process and cell structure have been especially tailored to minimize on-state resistance, provide superior switching performance, and withstand high energy pulse in the avalanche and commutation mode.

These devices are widely used in AC-DC power supplies, DC-DC converters and H-bridge PWM motor drivers.

## FEATURES

- 4A, 650V, $R_{DS(on)(typ.)}$=2.3Ω@$V_{GS}$=10V
- Low gate charge
- Low Crss
- Fast switching
- Improved dv/dt capability

## ORDERING INFORMATION

| Part No. | Package | Marking | Hazardous Substance Control | Packing Type |
|---|---|---|---|---|
| SVF4N65CAF | TO-220F-3L | SVF4N65CAF | Halogen free | Tube |
| SVF4N65CADTR | TO-252-2L | 4N65CAD | Halogen free | Tape & Reel |
| SVF4N65CAM | TO-251D-3L | 4N65CAM | Halogen free | Tube |
| SVF4N65CAMJ | TO-251J-3L | 4N65CAMJ | Halogen free | Tube |
| SVF4N65CAMN | TO-251N-3L | 4N65CAMN | Halogen free | Tube |
| SVF4N65CAK | TO-262-3L | 4N65CAK | Halogen free | Tube |

## ABSOLUTE MAXIMUM RATINGS ($T_A$=25°C, UNLESS OTHERWISE NOTED)

| Characteristics | | Symbol | Ratings | | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | SVF4N65 CAF | SVF4N65 CAM/D | SVF4N65 CAMJ/MN | SVF4N65 CAK | |
| Drain-Source Voltage | | $V_{DS}$ | 650 | | | | V |
| Gate-Source Voltage | | $V_{GS}$ | ±30 | | | | V |
| Drain Current | $T_C$=25°C | $I_D$ | 4.0 | | | | A |
| | $T_C$=100°C | | 2.5 | | | | |
| Drain Current Pulsed | | $I_{DM}$ | 16 | | | | A |
| Power Dissipation($T_C$=25°C) | | $P_D$ | 30 | 77 | 79 | 90 | W |
| -Derate above 25°C | | | 0.24 | 0.62 | 0.63 | 0.72 | W/°C |
| Single Pulsed Avalanche Energy (Note 1) | | $E_{AS}$ | 215 | | | | mJ |
| Operation Junction Temperature Range | | $T_J$ | -55～+150 | | | | °C |
| Storage Temperature Range | | $T_{stg}$ | -55～+150 | | | | °C |

## THERMAL CHARACTERISTICS

| Characteristics | Symbol | Ratings | | | | Unit |
|---|---|---|---|---|---|---|
| | | SVF4N65 CAF | SVF4N65 CAM/D | SVF4N65 CAMJ/MN | SVF4N65 CAK | |
| Thermal Resistance, Junction-to-Case | $R_{\theta JC}$ | 4.17 | 1.62 | 1.58 | 1.39 | °C/W |
| Thermal Resistance, Junction-to-Ambient | $R_{\theta JA}$ | 62.5 | 62.0 | 62.0 | 62.5 | °C/W |

## ELECTRICAL CHARACTERISTICS ($T_J$=25°C, UNLESS OTHERWISE NOTED)

| Characteristics | Symbol | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Drain -Source Breakdown Voltage | $BV_{DSS}$ | $V_{GS}$=0V, $I_D$=250μA | 650 | -- | -- | V |
| Drain-Source Leakage Current | $I_{DSS}$ | $V_{DS}$=650V, $V_{GS}$=0V | -- | -- | 1.0 | μA |
| Gate-Source Leakage Current | $I_{GSS}$ | $V_{GS}$=±30V, $V_{DS}$=0V | -- | -- | ±100 | nA |
| Gate Threshold Voltage | $V_{GS(th)}$ | $V_{GS}$= $V_{DS}$, $I_D$=250μA | 2.0 | -- | 4.0 | V |
| Static Drain- Source On State Resistance | $R_{DS(on)}$ | $V_{GS}$=10V, $I_D$=2A | -- | 2.3 | 2.7 | Ω |
| Input Capacitance | $C_{iss}$ | $V_{DS}$=25V,$V_{GS}$=0V,f=1.0MHz | -- | 430 | -- | pF |
| Output Capacitance | $C_{oss}$ | | -- | 55 | -- | |
| Reverse Transfer Capacitance | $C_{rss}$ | | -- | 4.1 | -- | |
| Turn-on Delay Time | $t_{d(on)}$ | $V_{DD}$=325V, $V_{GS}$=10V, $R_G$=25Ω, $I_D$=4A (Note2,3) | -- | 9.9 | -- | ns |
| Turn-on Rise Time | $t_r$ | | -- | 26 | -- | |
| Turn-off Delay Time | $t_{d(off)}$ | | -- | 28 | -- | |
| Turn-off Fall Time | $t_f$ | | -- | 26 | -- | |
| Total Gate Charge | $Q_g$ | $V_{DD}$=520V, $V_{GS}$=10V, $I_D$=4A (Note 2,3) | -- | 13 | -- | nC |
| Gate-Source Charge | $Q_{gs}$ | | -- | 2.7 | -- | |
| Gate-Drain Charge | $Q_{gd}$ | | -- | 6.3 | -- | |

## SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

| Characteristics | Symbol | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Continuous Source Current | $I_S$ | Integral Reverse P-N Junction Diode in the MOSFET | -- | -- | 4.0 | A |
| Pulsed Source Current | $I_{SM}$ | | -- | -- | 16 | |
| Diode Forward Voltage | $V_{SD}$ | $I_S$=4.0A,$V_{GS}$=0V | -- | -- | 1.4 | V |
| Reverse Recovery Time | $T_{rr}$ | $I_S$=4.0A,$V_{GS}$=0V, $dI_F/dt$=100A/μs (Note 2) | -- | 450 | -- | ns |
| Reverse Recovery Charge | $Q_{rr}$ | | -- | 1.9 | -- | μC |

**Notes:**

1. L=30mH, $I_{AS}$=3.6A, $V_{DD}$=100V, $R_G$=25Ω, starting $TB_{JB}$=25°C;
2. Pulse Test: Pulse width ≤300μs,Duty cycle≤2%;
3. Essentially independent of operating temperature.

## TYPICAL CHARACTERISTICS

Figure 1. On-Region Characteristics

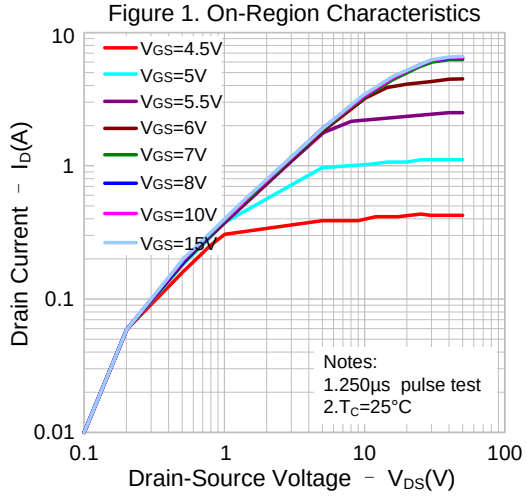



Figure 2. Transfer Characteristics

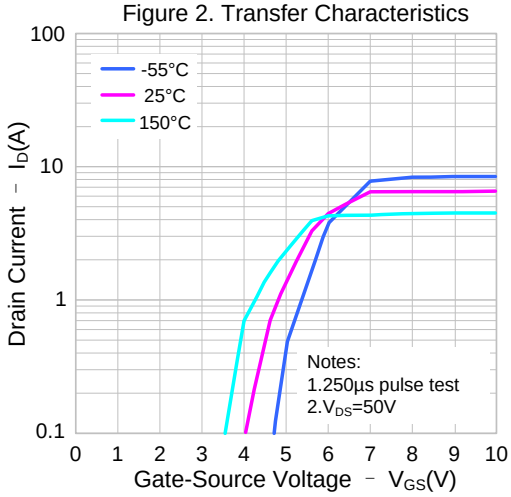



Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

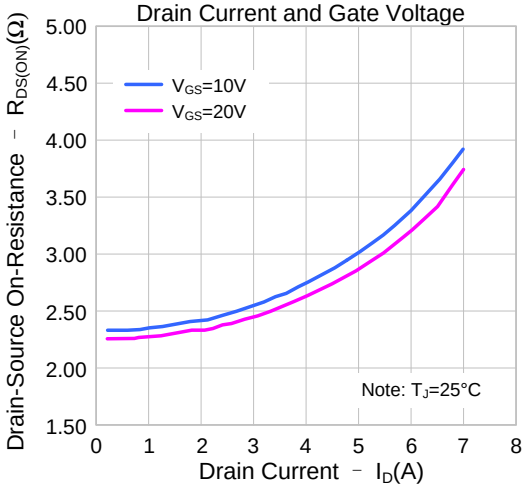



Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

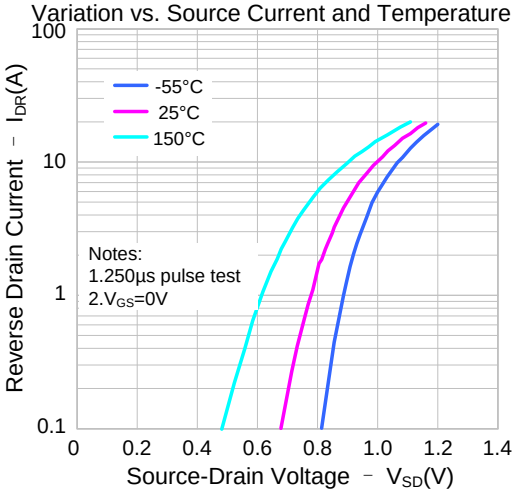



Figure 5. Capacitance Characteristics

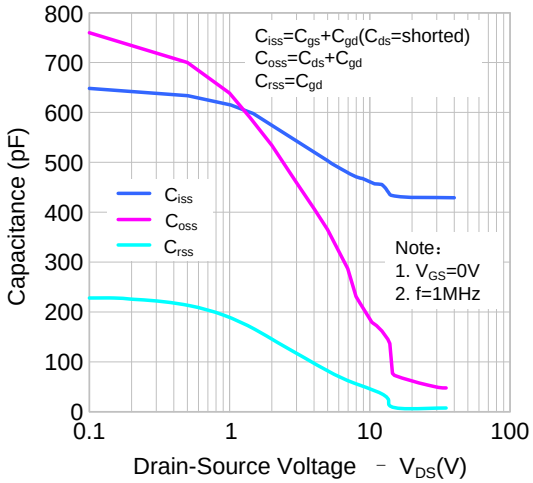
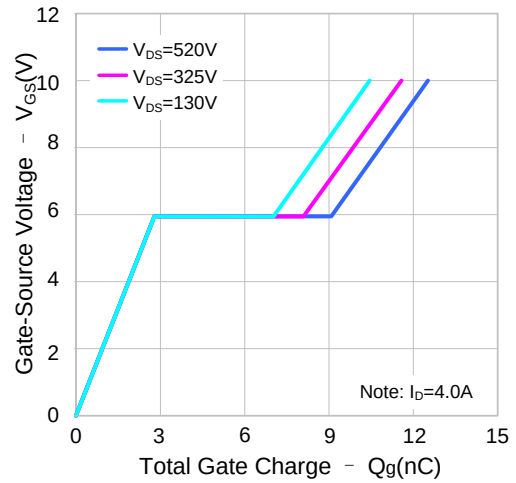



Figure 6. Gate Charge Characteristics



## TYPICAL CHARACTERISTICS(CONTINUED)

Figure 7. Breakdown Voltage Variation vs. Temperature

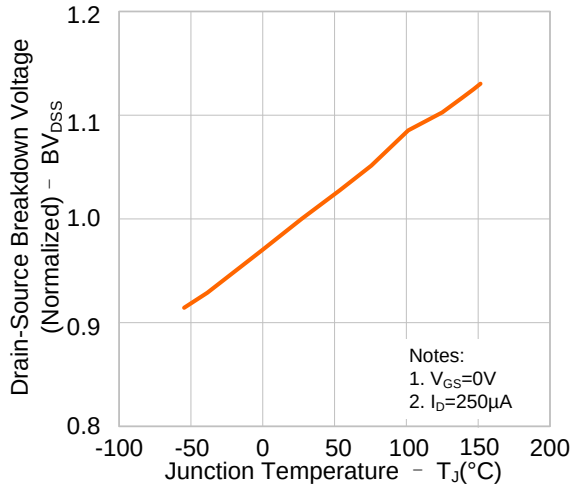



Figure 8. On-resistance vs. Temperature

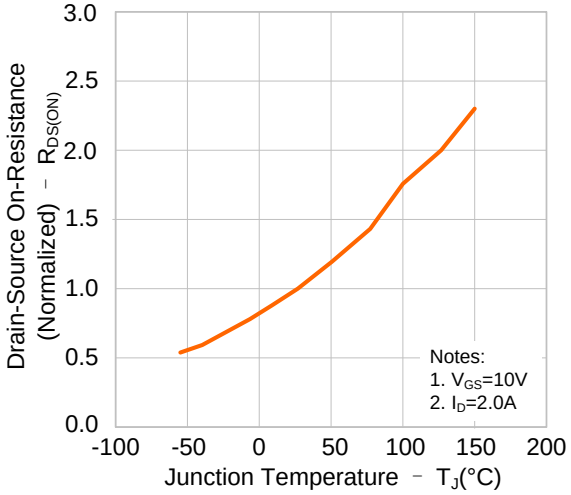



Figure 9-1. Max. Safe Operating Area(SVF4N65CAF)

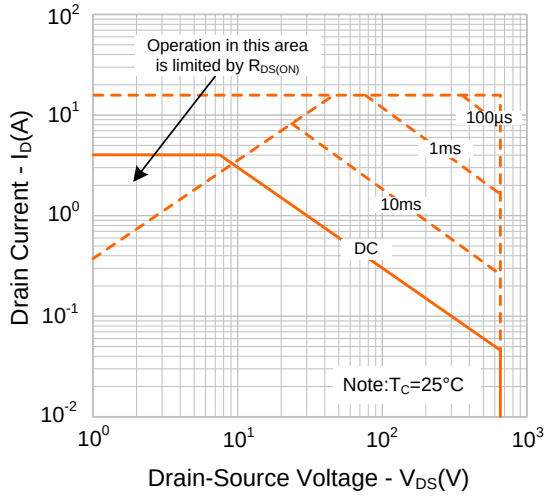



Figure 9-2. Max. Safe Operating Area(SVF4N65CAM/D)

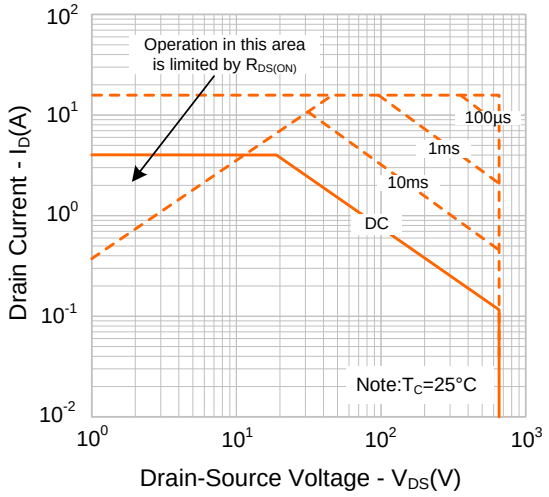



Figure 9-3. Max. Safe Operating Area(SVF4N65CAMJ/MN)

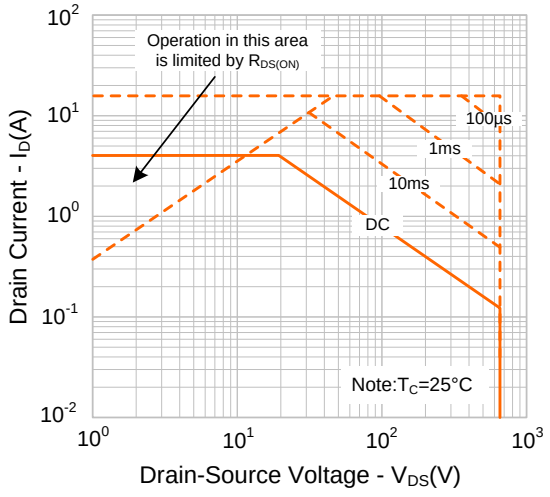
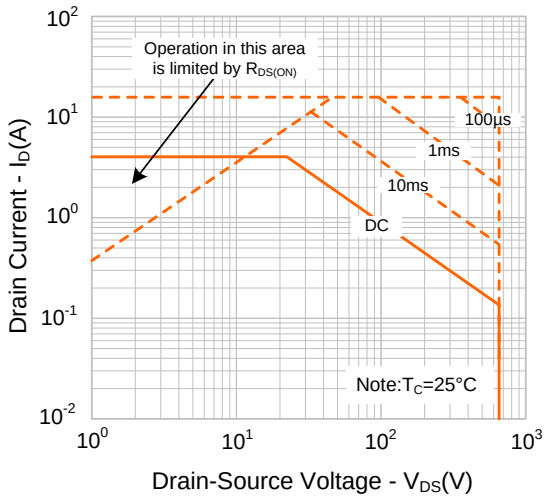
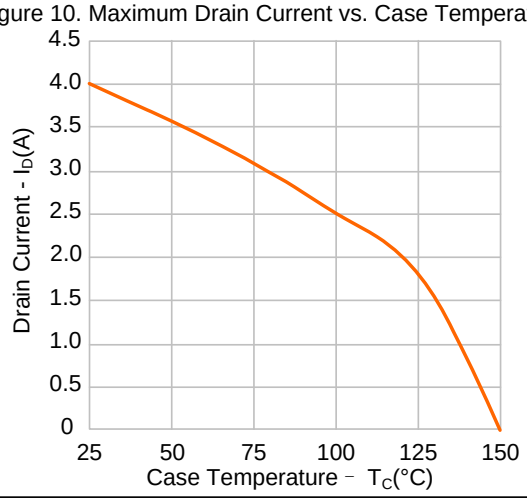



Figure 9-4. Max. Safe Operating Area(SVF4N65CAK)



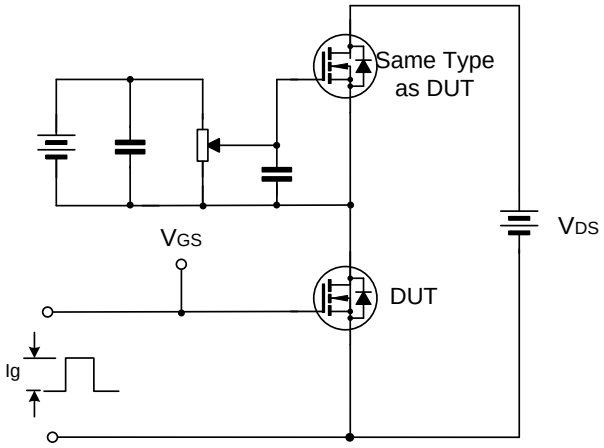
## TYPICAL CHARACTERISTICS(CONTINUED)

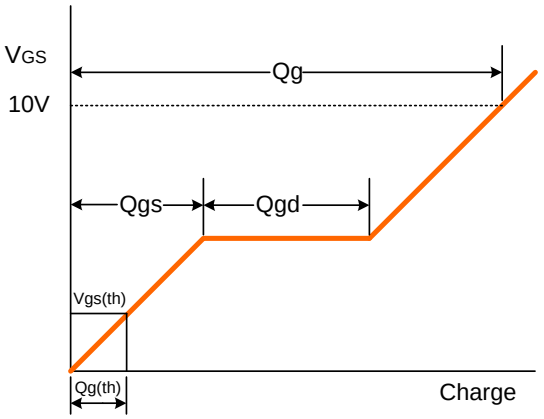
Figure 10. Maximum Drain Current vs. Case Temperature



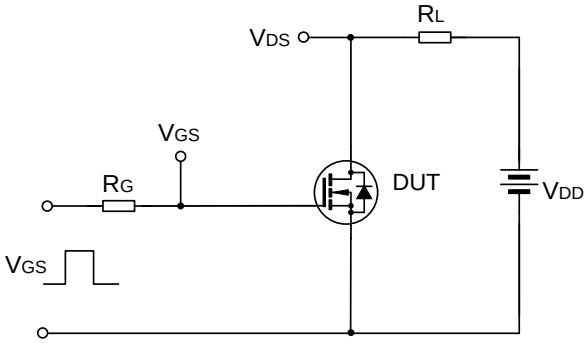
## TYPICAL TEST CIRCUIT

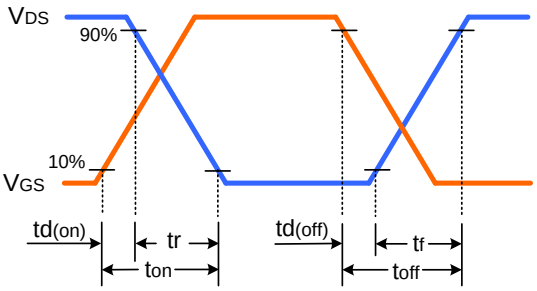
Gate Charge Test Circuit & Waveform



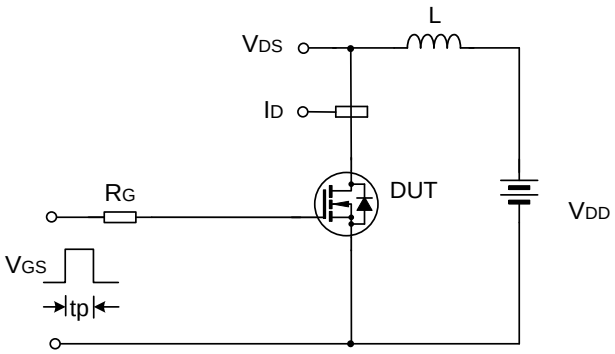




Resistive Switching Test Circuit & Waveform

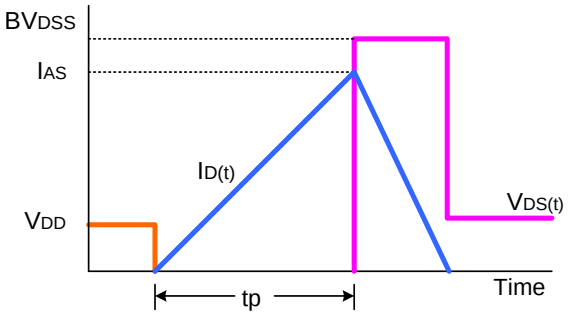



Unclamped Inductive Switching Test Circuit & Waveform

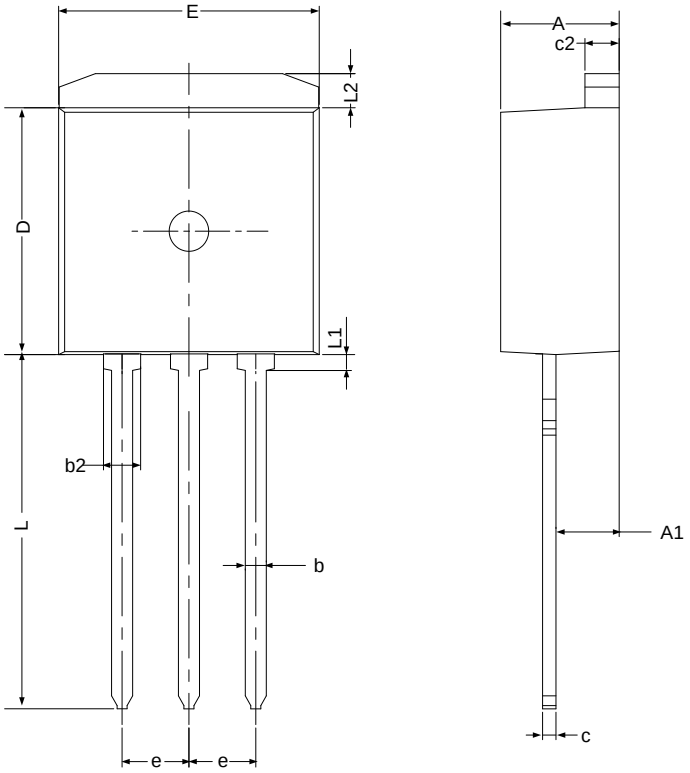



$$E_{AS} = \frac{1}{2} LI_{AS}^2 \frac{BV_{DSS}}{BV_{DSS} - V_{DD}}$$



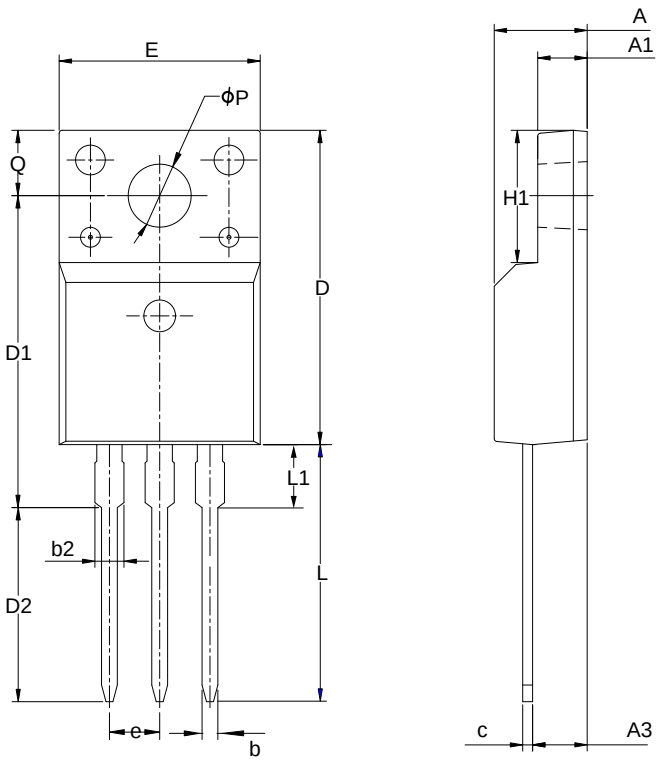
## PACKAGE OUTLINE

**TO-262-3L** **UNIT: mm**




| SYMBOL | MILLIMETER | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 4.30 | 4.50 | 4.70 |
| A1 | 2.20 | — | 2.92 |
| b | 0.71 | 0.80 | 0.90 |
| b2 | 1.20 | — | 1.50 |
| c | 0.34 | — | 0.65 |
| c2 | 1.22 | 1.30 | 1.35 |
| D | 8.38 | — | 9.30 |
| E | 9.80 | 10.16 | 10.54 |
| e | 2.54 BSC | | |
| L | 12.80 | — | 14.10 |
| L1 | — | — | 0.75 |
| L2 | 1.12 | — | 1.42 |

**TO-220F-3L** **UNIT: mm**

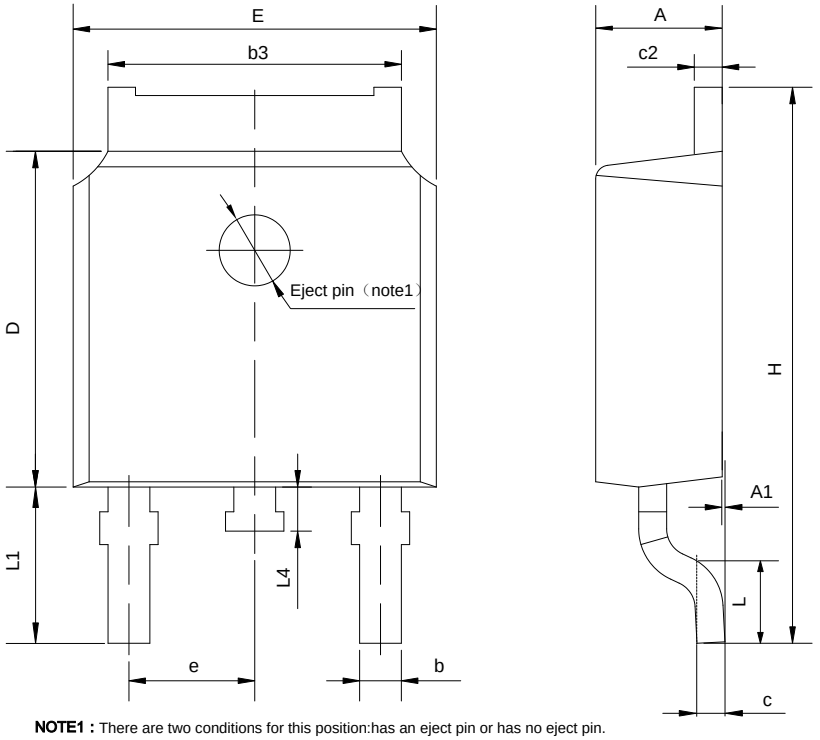



| SYMBOL | MILLIMETER | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 4.42 | 4.70 | 5.02 |
| A1 | 2.30 | 2.54 | 2.80 |
| A3 | 2.50 | 2.76 | 3.10 |
| b | 0.70 | 0.80 | 0.90 |
| b2 | – | – | 1.47 |
| c | 0.35 | 0.50 | 0.65 |
| D | 15.25 | 15.87 | 16.25 |
| D1 | 15.30 | 15.75 | 16.30 |
| D2 | 9.30 | 9.80 | 10.30 |
| E | 9.73 | 10.16 | 10.36 |
| e | 2.54BSC | | |
| H1 | 6.40 | 6.68 | 7.00 |
| L | 12.48 | 12.98 | 13.48 |
| L1 | – | – | 3.50 |
| ϕP | 3.00 | 3.18 | 3.40 |
| Q | 3.05 | 3.30 | 3.55 |

## PACKAGE OUTLINE(CONTINUED)

### TO-252-2L

UNIT: mm

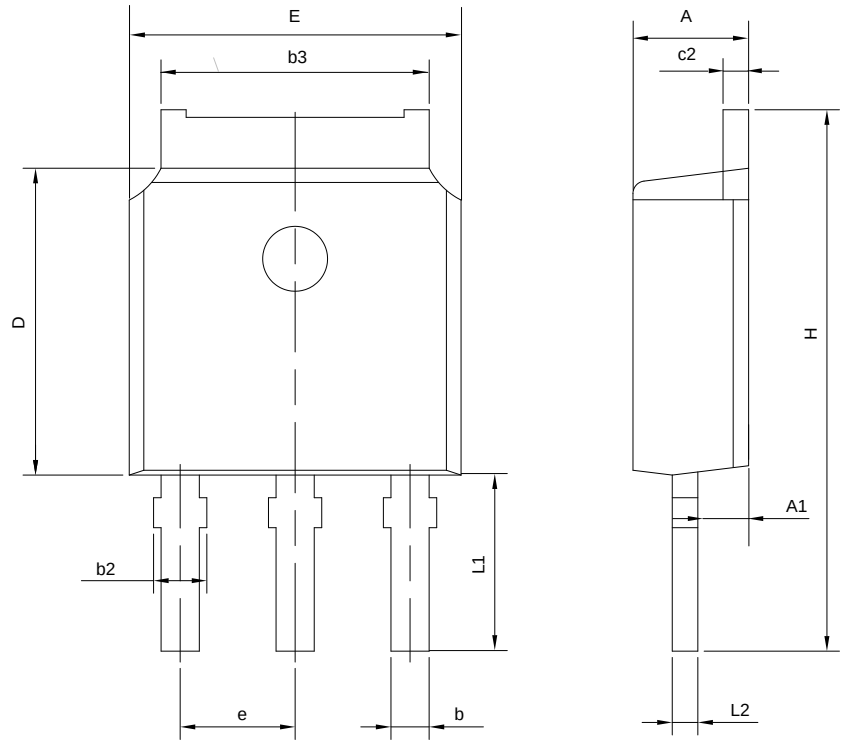



NOTE1 : There are two conditions for this position:has an eject pin or has no eject pin.

| SYMBOL | MILLIMETER | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 2.10 | 2.30 | 2.50 |
| A1 | 0 | — | 0.127 |
| b | 0.66 | 0.76 | 0.89 |
| b3 | 5.10 | 5.33 | 5.46 |
| c | 0.45 | — | 0.65 |
| c2 | 0.45 | — | 0.65 |
| D | 5.80 | 6.10 | 6.40 |
| E | 6.30 | 6.60 | 6.90 |
| e | 2.30TYP | | |
| H | 9.60 | 10.10 | 10.60 |
| L | 1.40 | 1.50 | 1.70 |
| L1 | 2.90REF | | |
| L4 | 0.60 | 0.80 | 1.00 |

### TO-251D-3L

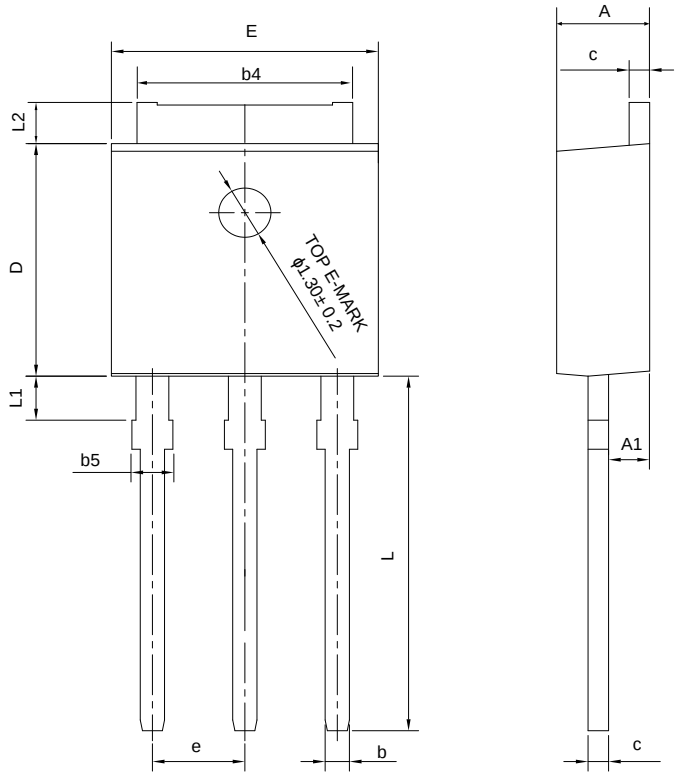
UNIT: mm




| SYMBOL | MILLIMETER | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 2.20 | 2.30 | 2.40 |
| b | 0.66 | – | 0.86 |
| b2 | 0.72 | – | 0.90 |
| b3 | 5.10 | 5.33 | 5.46 |
| c2 | 0.46 | – | 0.60 |
| D | 6.00 | 6.10 | 6.20 |
| E | 6.50 | 6.60 | 6.70 |
| e | 2.186 | 2.286 | 2.386 |
| H | 10.40 | 10.70 | 11.00 |
| L1 | 3.50 REF | | |
| L2 | 0.508 BSC | | |

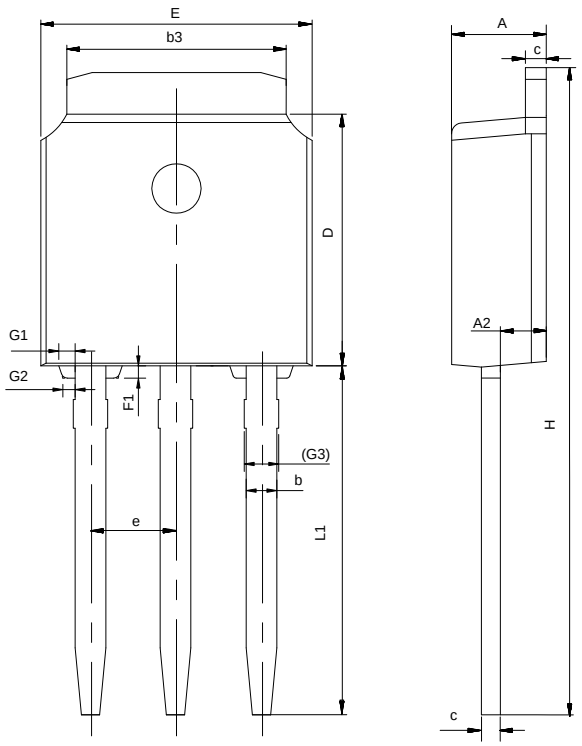
## PACKAGE OUTLINE(CONTINUED)

**TO-251J-3L** **UNIT: mm**




| SYMBOL | MILLIMETER | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 2.18 | 2.30 | 2.39 |
| A1 | 0.89 | 1.00 | 1.14 |
| b | 0.56 | — | 0.89 |
| b4 | 4.95 | 5.33 | 5.46 |
| b5 | — | — | 1.05 |
| c | 0.46 | — | 0.61 |
| D | 5.97 | 6.10 | 6.27 |
| E | 6.35 | 6.60 | 6.73 |
| e | 2.29 BCS | | |
| L | 8.89 | 9.30 | 9.65 |
| L1 | 0.95 | — | 1.50 |
| L2 | 0.89 | — | 1.27 |

**TO-251N-3L** **UNIT: mm**




| SYMBOL | MILLIMETER | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 2.20 | 2.30 | 2.40 |
| A2 | 0.97 | 1.07 | 1.17 |
| b | 0.58 | 0.68 | 0.80 |
| b3 | 5.20 | 5.33 | 5.50 |
| c | 0.43 | 0.53 | 0.63 |
| D | 5.80 | 6.10 | 6.40 |
| E | 6.30 | 6.60 | 6.90 |
| e | 2.286 BSC | | |
| F1 | 0.20 | 0.30 | 0.40 |
| G1 | 0.30 | 0.40 | 0.50 |
| G2 | 0.20 | 0.30 | 0.40 |
| G3 | 0.60 | 0.74 | 0.88 |
| H | 16.02 | 16.52 | 17.02 |
| L1 | 9.10 | 9.40 | 9.70 |

**Important notice :**

1. **The instructions are subject to change without notice!**
2. **Customers should obtain the latest relevant information before placing orders and should verify that such information is complete and current. Please read the instructions carefully before using our products, including the circuit operation precautions.**
3. **Our products are consumer electronic products or the other civil electronic products.**
4. **When using our products, please do not exceed the maximum rating of the products, otherwise the reliability of the whole machine will be affected. There is a certain possibility of failure or malfunction of any semiconductor product under specific conditions. The buyer is responsible for complying with safety standards and taking safety measures when using our products for system design, sample and whole machine manufacturing, so as to avoid potential failure risk that may cause personal injury or property loss.**
5. **It is strongly recommended to identify the trademark when buying our products. Please contact us if there is any question.**
6. **Product promotion is endless, our company will wholeheartedly provide customers with better products!**
7. **Website: http: //www.silan.com.cn**

| | | | |
|---|---|---|---|
| Part No.: | SVF4N65CAF/D/M/MJ/MN/K | Document Type: | Datasheet |
| Copyright: | HANGZHOU SILAN MICROELECTRONICS CO.,LTD | Website: | http: //www.silan.com.cn |

Rev.: 2.3

Revision History:

1. Update electrical drawings and typical circuit diagrams
2. Update important notice

Rev.: 2.2

Revision History:

1. Deleted NOMENCLATURE
2. Modify Important notice

Rev.: 2.1

Revision History:

1. Delete the package outline of TO-262L-3L

Rev.: 2.0

Revision History:

1. Update package outline of TO-262-3L

Rev.: 1.9

Revision History:

1. Delete the package outline of TO-220F-3L(2)
2. Update package outline of TO-251J-3L

Rev.: 1.8

Revision History:

1. Update Crss of Figure 5
2. Update package outline of TO-251N-3L(1.1version)

Rev.: 1.7

Revision History:

1. Add the package of TO-262L-3L

Rev.: 1.6

Revision History:

1. Modify the Typical Characteristics

Rev.: 1.5

Revision History:

1. Modify the typical characteristics

Rev.: 1.4

Revision History:

1. Modify the package information of TO-220F-3L
2. Modify the package information of TO-252-2L

Rev.: 1.3

Revision History:

1. Add the package of TO-262-3L
2. Modify the parameters

Rev.: 1.2

Revision History:

1. Add the package of TO-251N-3L

Rev.: 1.1

Revision History:

1. Modify the ordering information
2. Modify the thermal characteristics

Rev.: 1.0

Revision History:

1. First release