

## N-Channel Enhancement Mode Power MOSFET

### Description

SMIRF12N65 is an N-channel enhancement mode power MOS field effect transistor. The improved planar stripe cell and the improved guard ring terminal 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 suppliers, DCDC converters and H-bridge PWM motor drivers.

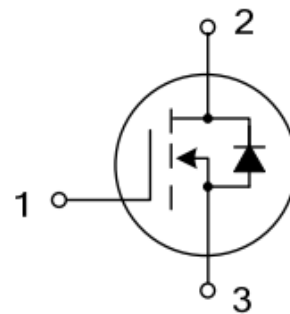
### General Features

- 12A,650V, $R_{DS(on)(typ.)} = 0.6\Omega @ V_{GS}=10V$
- Low Gate charge
- Low Crss
- Fast Switching
- Improved dv/dt Capability

### Application

- Power switching application
- Hard switched and high frequency circuits
- Uninterruptible power supply

|                  |                                   |
|------------------|-----------------------------------|
| $I_D$            | 12A                               |
| $V_{DSS}$        | 650V                              |
| $R_{dson (max)}$ | $0.75\Omega (V_{GS}=10V, I_D=6A)$ |
| $Q_g$            | 45nC                              |



1.Gate 2.Drain 3.Source



TO-220



TO-220F

**Order Information**

| Order Information | Marking ID | Package   | Packing Type Supplied As                |
|-------------------|------------|-----------|---|
| SMIRF12N65T2TL    | IRF12N65   | TO220F-3L | 1000 units on Box, 5000 units on Carton |
| SMIRF12N65T1TL    | IRF12N65   | TO220-3L  | 1000 units on Box, 5000 units on Carton |

**Absolute Maximum Ratings Ta=25 °C unless otherwise noted**

| Parameter                         | Symbol    | Value       | Unit |
|-----------------------------------|-----------|-------------|------|
| Drain-source Voltage              | $V_{DS}$  | 650         | V    |
| Gate-source Voltage               | $V_{GS}$  | $\pm 30$    | V    |
| Continuous Drain Current(Ta=25°C) | $I_D$     | 12          | A    |
| Drain Current-Pulsed              | $I_{DM}$  | 48          | A    |
| Total Dissipation(Ta=25°C)        | TO220     | 225         | W    |
|                                   | TO220F    | 56          |      |
| Junction Temperature              | $T_J$     | 150         | °C   |
| Storage Temperature               | $T_{STG}$ | -55 to 150  | °C   |
| Single Pulse Avalanche Energy     | $E_{AS}$  | 820         | mJ   |
| ESD HBM(Human Body Mode)          |           | $\geq 2000$ | V    |
| ESD MM(Machine Mode)              |           | $\geq 200$  | V    |

**Electrical Characteristics Ta = 25°C**

| PARAMETER                                  | Symbol       | Test Condition                | MIN | TYP | MAX       | UNIT     |
|--|--------------|-------------------------------|-----|-----|-----------|----------|
| Drain-source Breakdown Voltage             | $BV_{DSS}$   | $V_{GS}=0V, I_D=250\mu A$     | 650 |     |           | V        |
| Gate Threshold Voltage                     | $V_{GS(TH)}$ | $V_{GS}=V_{DS}, I_D=250\mu A$ | 2.0 |     | 4.0       | V        |
| Drain-source Leakage Current               | $I_{DSS}$    | $V_{DS}=650V, V_{GS}=0V$      |     |     | 10        | $\mu A$  |
| Drain-Source Diode Forward Voltage         | $V_{SD}$     | $V_{GS}=0V, I_S=12A$          |     |     | 1.5       | V        |
| Gate-body Leakage Current ( $V_{DS} = 0$ ) | $I_{GSS}$    | $V_{GS}=\pm 30V$              |     |     | $\pm 100$ | nA       |
| Static Drain-source On Resistance          | $R_{DS(ON)}$ | $V_{GS}=10V, I_D=6A$          |     | 0.6 | 0.75      | $\Omega$ |

**Note:** Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant in temperature etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings

## Thermal Characteristics Ta=25°C

| PARAMETER                   |               | Symbol           | TYP | MAX  | UNIT |
|-----------------------------|---------------|------------------|-----|------|------|
| Maximum Junction-to-case    | TO220F, TO220 | R <sub>QJC</sub> |     | 2.4  | °C/W |
| Maximum Junction-to-Ambient | TO220F, TO220 | R <sub>QJA</sub> |     | 62.5 | °C/W |

**Note1:** Ensure that the channel temperature does not exceed 150°C

**Note2:** V<sub>DD</sub>=50V, T<sub>ch</sub>=25 °C(initial), I<sub>AS</sub>=12A, R<sub>g</sub>=25Ω

**Note3:** This transistor is sensitive to electrostatic and should be handled with care

## Dynamic Characteristics Ta = 25 °C

| PARAMETER                    | Symbol           | Test Condition   | MIN | TYP  | MAX  | UNIT |
|------------------------------|------------------|--|-----|------|------|------|
| Input Capacitance            | C <sub>iss</sub> | V <sub>DS</sub> =25V, V <sub>GS</sub> =0V,<br>f=1.0MHZ |     | 1810 | 2300 | pF   |
| output Capacitance           | C <sub>oss</sub> |  |     | 150  | 250  | pF   |
| Reverse Transfer Capacitance | C <sub>rss</sub> |  |     | 16   | 32   | pF   |

## Switching Characteristics Ta=25 °C

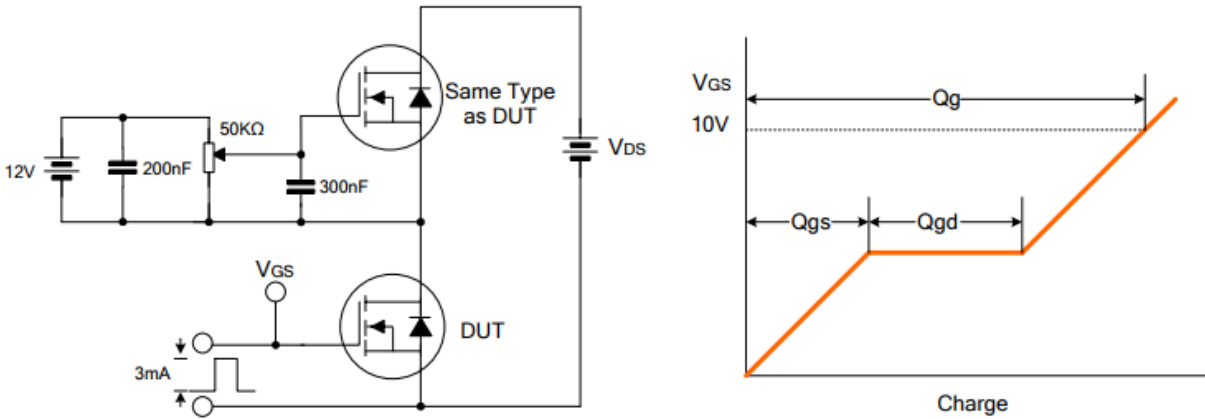
| PARAMETER           | Symbol              | Test Condition   | MIN | TYP | MAX | UNIT |
|---------------------|---------------------|--|-----|-----|-----|------|
| Turn-On Delay Time  | T <sub>d(on)</sub>  | V <sub>DS</sub> =325V, I <sub>D</sub> =12A,<br>V <sub>GS</sub> =10V, R <sub>G</sub> =25Ω |     | 32  | 65  | nS   |
| Turn-On Rise Time   | T <sub>r</sub>      |  |     | 105 | 245 | nS   |
| Turn-Off Delay Time | T <sub>d(off)</sub> |  |     | 90  | 170 | nS   |
| Turn-Off Rise Time  | T <sub>f</sub>      |  |     | 85  | 160 | nS   |
| Total Gate Charge   | Q <sub>g</sub>      | V <sub>DS</sub> =520V, I <sub>D</sub> =12A,<br>V <sub>GS</sub> =10V                      |     | 45  | 55  | nC   |
| Gate-Source Charge  | Q <sub>gs</sub>     |  |     | 8.2 |     | nC   |
| Gate-Drain Charge   | Q <sub>gd</sub>     |  |     | 25  |     | nC   |

## Drain-Source Diode Maximum Ratings and Characteristics Ta=25 °C

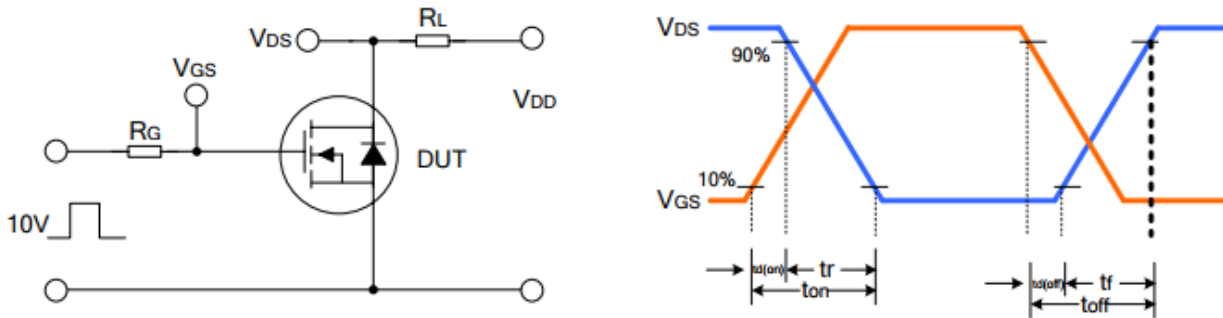
| PARAMETER                  | Symbol          | Test Condition  | MIN | TYP | MAX | UNIT |
|----------------------------|-----------------|---|-----|-----|-----|------|
| Max. Diode Forward Current | I <sub>s</sub>  | Integral Reverse P-N Junction<br>Diode in the MOSFET        |     |     | 12  | A    |
| Pulsed Source Current      | I <sub>sm</sub> |   |     |     | 48  | A    |
| Diode Forward Voltage      | V <sub>SD</sub> | V <sub>GS</sub> =0V, I <sub>s</sub> =12A                    |     |     | 1.5 | V    |
| Reverse Recovery Time      | t <sub>rr</sub> | V <sub>GS</sub> =0V, I <sub>s</sub> =12A,<br>dIF/dt=100A/μs |     | 385 |     | nS   |
| Reverse Recovery Charge    | Q <sub>rr</sub> |   |     |     | 3   | μC   |

## Test Circuit

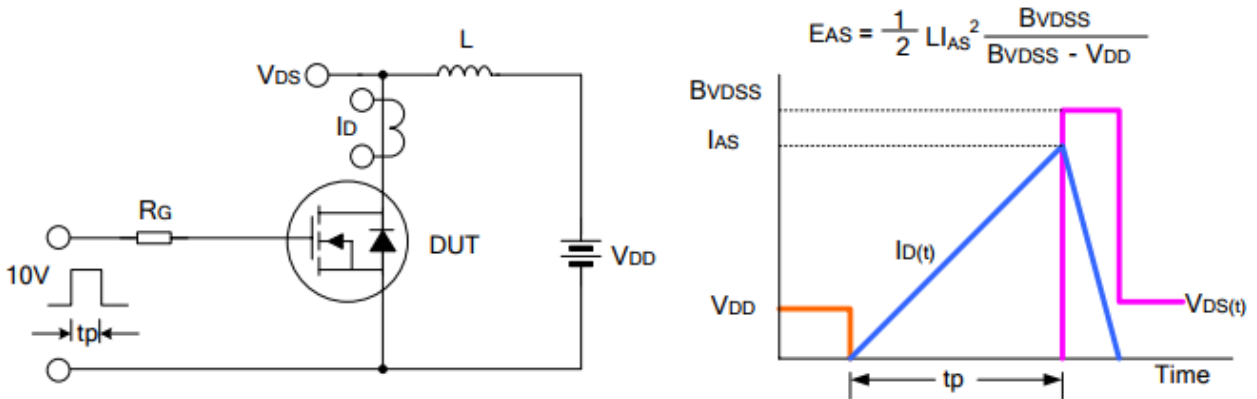
### Gate Charge Test Circuit & Waveform



### Resistive Switching Test Circuit & Waveform



### Unclamped Inductive Switching Test Circuit & Waveform



## Typical Characteristics Curve

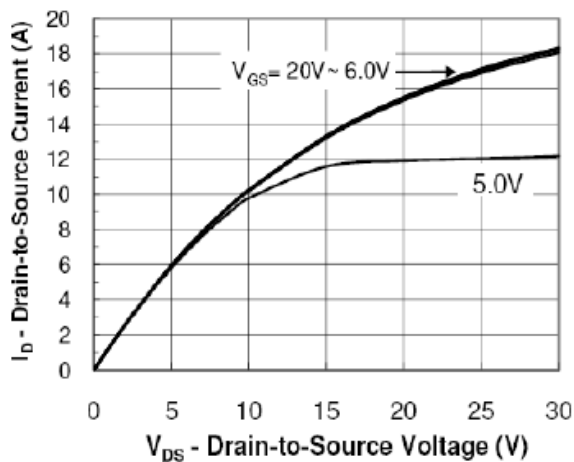


Figure 1: Output Characteristics

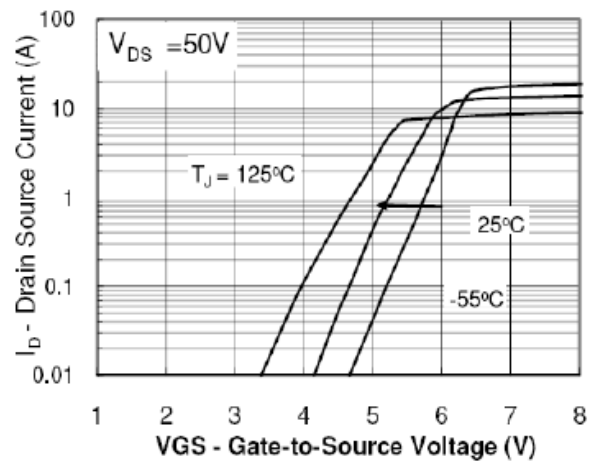


Figure 2: Transfer Characteristics

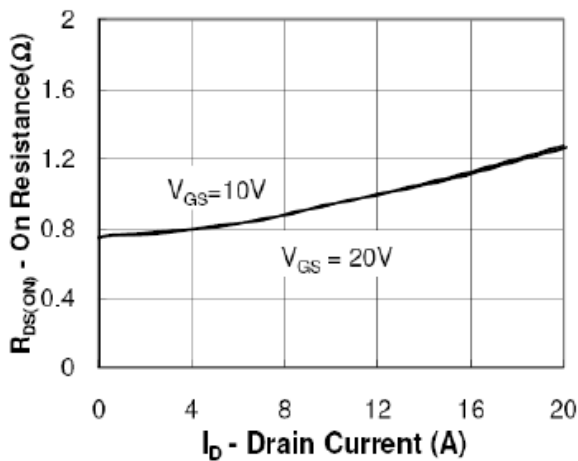


Figure 3: On Resistance Vs Drain Current Source Voltage

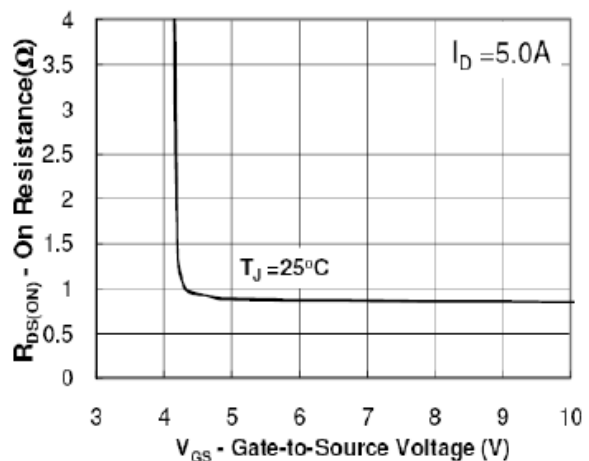


Figure 4: On Resistance Vs Gate Source Voltage

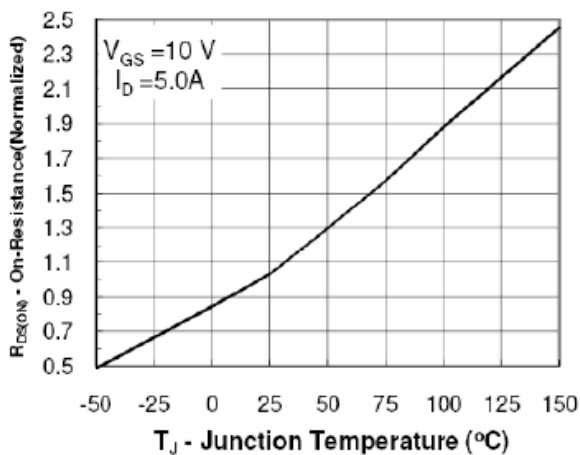


Figure 5: On Resistance Vs Junction Temperature Characteristics

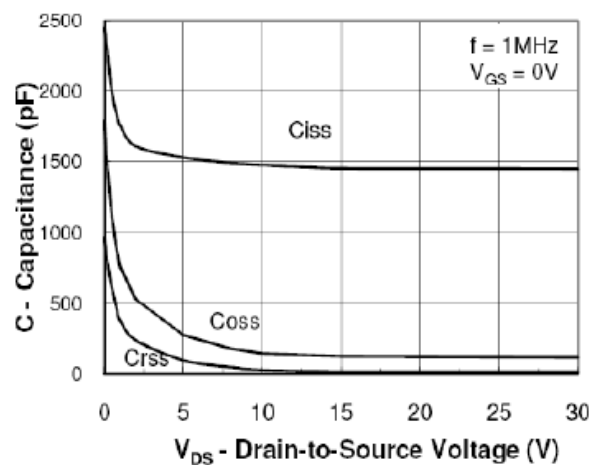


Figure 6: Capacitance

## Typical Characteristics Curve

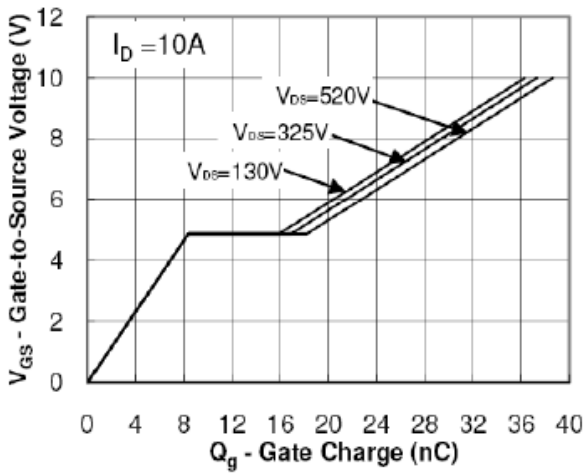


Figure7: Gate Charge Waveform Forward Voltage

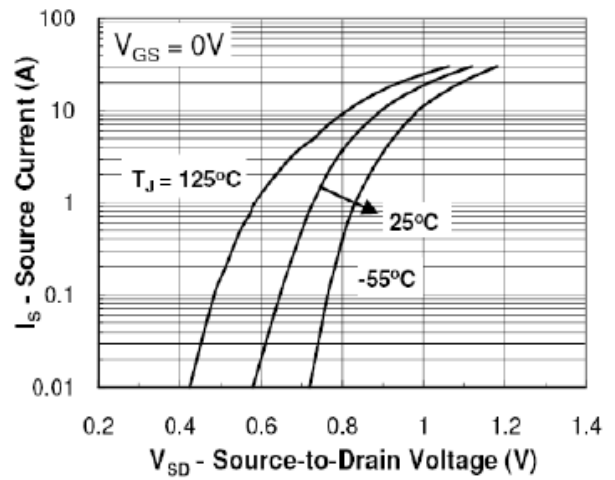


Figure8: Source-Drain Diode

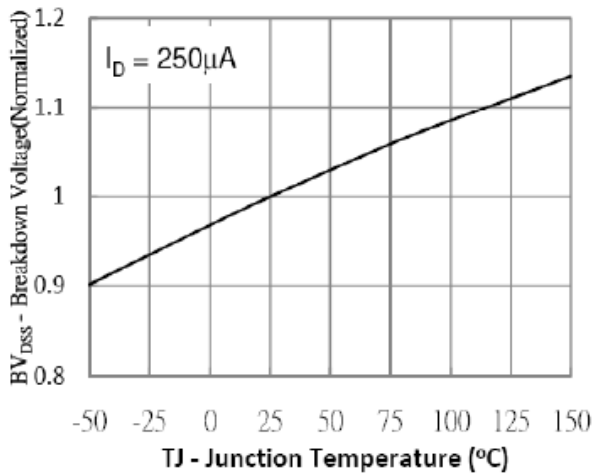
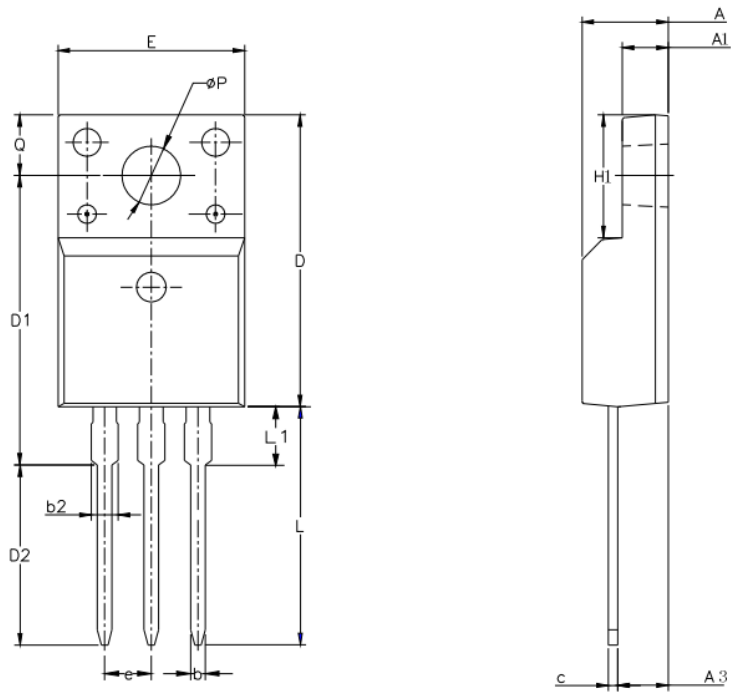


Figure9: Breakdown Voltage Vs Junction Temperature

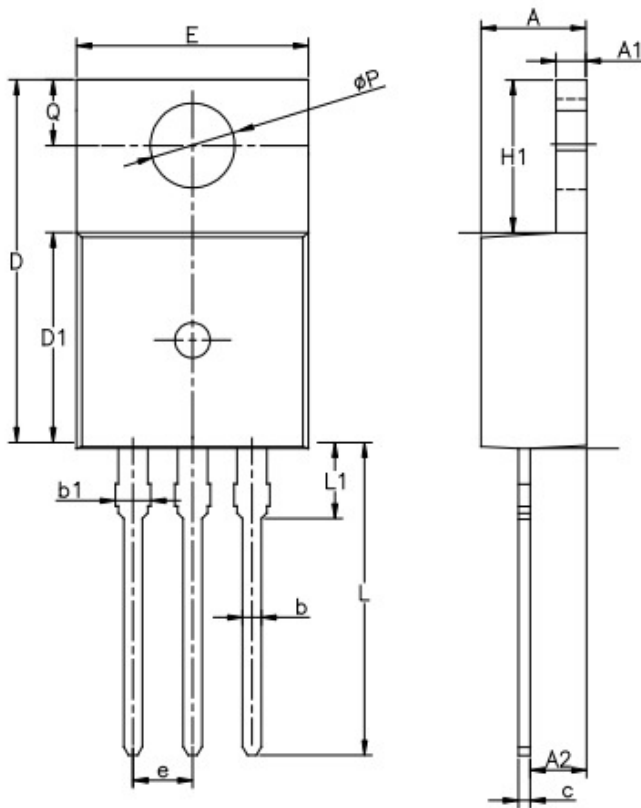
**Note:** The above characteristics curves are presented for reference only and not guaranteed by production test unless otherwise noted

## Outline Information (TO220F-3L)



| SYMBOL   | 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        | 2.54BCS |       |       |
| H1       | 6.40    | 6.68  | 7.00  |
| L        | 12.48   | 12.98 | 13.48 |
| L1       | /       | /     | 3.50  |
| $\phi P$ | 3.00    | 3.18  | 3.40  |
| Q        | 3.05    | 3.30  | 3.55  |

## Outline Information (TO220-3L)



| SYMBOL   | MIN     | NOM   | MAX   |
|----------|---------|-------|-------|
| A        | 4.30    | 4.50  | 4.70  |
| A1       | 1.00    | 1.30  | 1.50  |
| A2       | 1.80    | 2.40  | 2.80  |
| b        | 0.60    | 0.80  | 1.00  |
| b1       | 1.00    | —     | 1.60  |
| c        | 0.30    | —     | 0.70  |
| D        | 15.10   | 15.70 | 16.10 |
| D1       | 8.10    | 9.20  | 10.00 |
| E        | 9.60    | 9.90  | 10.40 |
| e        | 2.54BSC |       |       |
| H1       | 6.10    | 6.50  | 7.00  |
| L        | 12.60   | 13.08 | 13.60 |
| L1       | —       | —     | 3.95  |
| $\phi P$ | 3.40    | 3.70  | 3.90  |
| Q        | 2.60    | —     | 3.20  |