



### Features

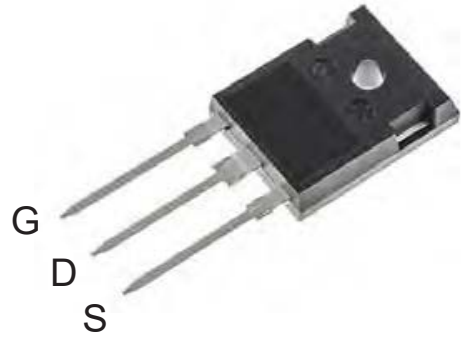
- 3rd generation SiC MOSFET technology
- Optimized package with separate driver source pin
- High blocking voltage with low on-resistance
- High-speed switching with low capacitances
- Fast intrinsic diode with low reverse recovery ( $Q_{rr}$ )
- Halogen free, RoHS compliant

### Benefits

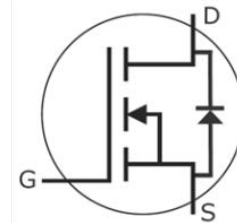
- Reduce switching losses and minimize gate ringing
- Higher system efficiency
- Reduce cooling requirements
- Increase power density
- Increase system switching frequency

### Applications

- Renewable energy
- EV battery chargers
- High voltage DC/DC converters
- Switch Mode Power Supplies



TO-247  
Package



| Ordering Part Number | Package | Marking    |
|----------------------|---------|------------|
| HC1M60120D           | TO-247  | HC1M60120D |

### Maximum Ratings ( $T_C = 25^\circ\text{C}$ unless otherwise specified)

| Parameter   | Symbol         | Value      | Unit             |
|---|----------------|------------|------------------|
| Drain-source voltage  | $V_{DS}$       | 1200       | V                |
| Continuous drain current  | $I_D$          | 40         | A                |
| $T_C = 25^\circ\text{C}$  |                | 28         |                  |
| $T_C = 100^\circ\text{C}$   |                |            |                  |
| Pulsed drain current ( $T_C = 25^\circ\text{C}$ , $t_p$ limited by $T_{jmax}$ ) | $I_{D\ pulse}$ | 80         | A                |
| Avalanche energy, single pulse ( $L=10\text{mH}$ )                              | $E_{AS}$       | 600        | mJ               |
| Gate-Source voltage   | $V_{GS}$       | -4/+18     | V                |
| Gate-Source voltage (Absolute maximum values)                                   | $V_{GSmax}$    | -8/+22     | V                |
| Power dissipation ( $T_C = 25^\circ\text{C}$ )                                  | $P_{tot}$      | 214        | W                |
| Operating junction and storage temperature                                      | $T_j, T_{stg}$ | -55...+175 | $^\circ\text{C}$ |

• Example of acceptable  $V_{GS}$  waveform





**Thermal Resistance**

| Parameter                                   | Symbol     | Value | Unit |
|---|------------|-------|------|
| Thermal resistance, junction – case. Max    | $R_{thJC}$ | 0.70  | °C/W |
| Thermal resistance, junction – ambient. Max | $R_{thJA}$ | 40    |      |

**Electrical Characteristic** (at  $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise specified)

| Parameter | Symbol | Value |      |      | Unit | Test Condition |
|-----------|--------|-------|------|------|------|----------------|
|           |        | min.  | typ. | max. |      |                |

**Static Characteristic**

|                                  |              |      |     |     |            |   |
|----------------------------------|--------------|------|-----|-----|------------|---|
| Drain-source breakdown voltage   | $BV_{DSS}$   | 1200 | -   | -   | V          | $V_{GS}=0V, I_D=100\mu A$                     |
| Gate threshold voltage           | $V_{GS(th)}$ | 2.3  | 2.8 | 3.6 | V          | $V_{DS}=V_{GS}, I_D=5mA$                      |
| Zero gate voltage drain current  | $I_{DSS}$    | -    | 1   | 10  | $\mu A$    | $V_{DS}=1200V, V_{GS}=0V$<br>$T_C=25^\circ C$ |
|                                  |              | -    | 5   | -   |            | $T_C=175^\circ C$                             |
| Gate-source leakage current      | $I_{GSS}$    | -    | -   | 100 | nA         | $V_{GS}=18V, V_{DS}=0V$                       |
| Drain-source on-state resistance | $R_{DS(on)}$ | -    | 60  | 75  | m $\Omega$ | $V_{GS}=18V, I_D=20A,$<br>$T_J=25^\circ C$    |
|                                  |              | -    | 120 | -   |            | $T_J=175^\circ C$                             |
| Transconductance                 | $g_{fs}$     | -    | 10  | -   | S          | $V_{DS}=20V, I_D=20A$                         |

**Dynamic Characteristic**

|                              |              |   |     |   |          |   |                         |
|------------------------------|--------------|---|-----|---|----------|---|-------------------------|
| Input Capacitance            | $C_{iss}$    | - | 940 | - | pF       | $V_{DS} = 1000V$<br>$V_{GS} = 0V$<br>$T_J = 25^\circ C$<br>$V_{AC} = 25mV$<br>$f = 1MHz$  |                         |
| Output Capacitance           | $C_{oss}$    | - | 59  | - |          |   |                         |
| Reverse Transfer Capacitance | $C_{riss}$   | - | 4.1 | - |          |   |                         |
| Gate Total Charge            | $Q_G$        | - | 42  | - | nC       | $V_{DS} = 800V$<br>$V_{GS} = -4/+18V$<br>$I_D = 20A$                                      |                         |
| Gate-Source charge           | $Q_{gs}$     | - | 8   | - |          |   |                         |
| Gate-Drain charge            | $Q_{gd}$     | - | 20  | - |          |   |                         |
| Turn-On Switching Energy     | $E_{ON}$     | - | 330 | - | $\mu J$  | $V_{DD} = 800V$<br>$V_{GS} = -4/+15V$<br>$I_D = 20A$<br>$R_G = 0\Omega$<br>$L = 120\mu H$ |                         |
| Turn-Off Switching Energy    | $E_{OFF}$    | - | 51  | - |          |   |                         |
| Turn-on delay time           | $t_{d(on)}$  | - | 21  | - | ns       |   |                         |
| Rise time                    | $t_r$        | - | 23  | - |          |   |                         |
| Turn-off delay time          | $t_{d(off)}$ | - | 16  | - |          |   |                         |
| Fall time                    | $t_f$        | - | 19  | - |          |   |                         |
| Gate resistance              | $R_G$        | - | 1.7 | - | $\Omega$ |   | $V_{AC} = 25mV, f=1MHz$ |



Body Diode Characteristic

| Parameter                          | Symbol   | Value |      |      | Unit | Test Condition  |
|------------------------------------|----------|-------|------|------|------|---|
|                                    |          | min.  | typ. | max. |      |   |
| Body Diode Forward Voltage         | $V_{SD}$ |       | 4.3  |      | V    | $V_{GS}=-4V, I_{SD}=10A, T_J=25^{\circ}C$   |
|                                    |          |       | 3.8  |      |      | $V_{GS}=-4V, I_{SD}=10A, T_J=175^{\circ}C$  |
| Body Diode Reverse Recovery Time   | $t_{rr}$ | -     | 43   | -    | ns   | $V_R = 800V, V_{GS} = -4V$<br>$I_D = 20A$<br>$di/dt = 700A/\mu S$<br>$T_J = 150^{\circ}C$ |
| Body Diode Reverse Recovery Charge | $Q_{rr}$ | -     | 413  | -    | nC   |   |

Typical Performance Characteristics

Fig 1. Output Characteristic ( $T_J=-40^{\circ}C$ )

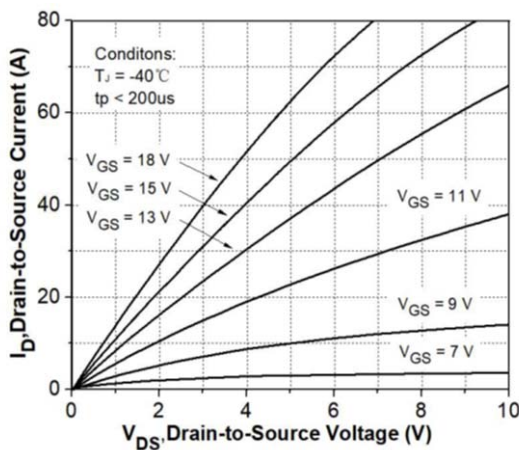


Fig 2. Output Characteristic ( $T_J=25^{\circ}C$ )

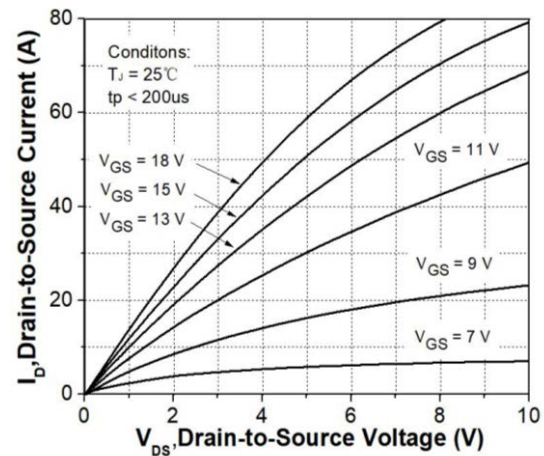


Fig 3. Output Characteristic ( $T_J=175^{\circ}C$ )

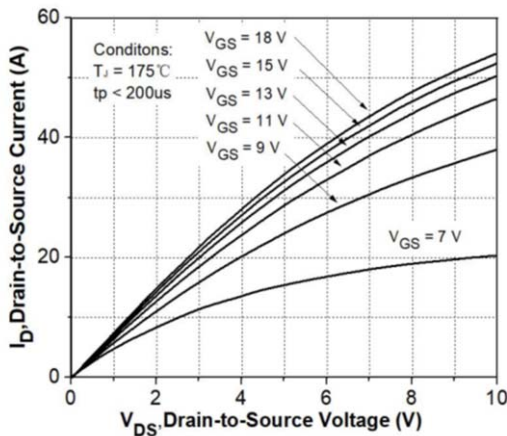


Fig 4:  $R_{ds(on)}$  Vs  $I_{ds}$  Characteristic

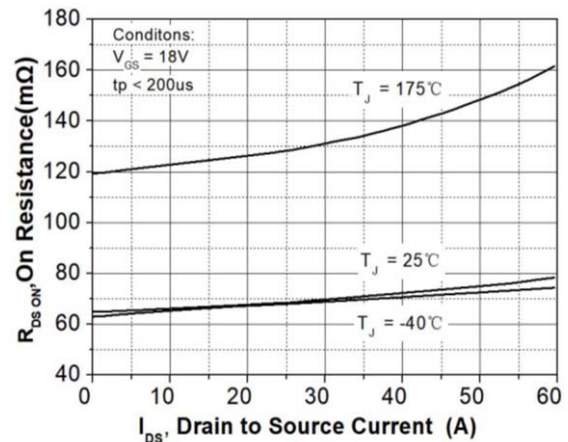




Fig 5: Rds(on) vs. Temperature

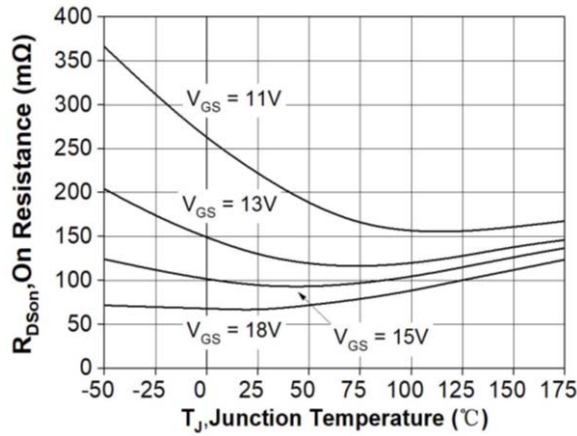


Fig 6: Transfer Characteristic

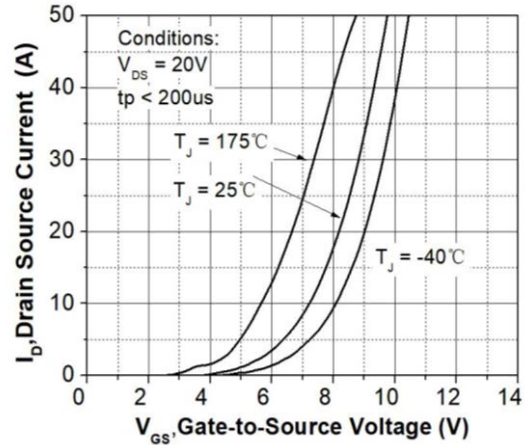


Fig 7: Body-diode Characteristic ( $T_J = -40^\circ C$ )

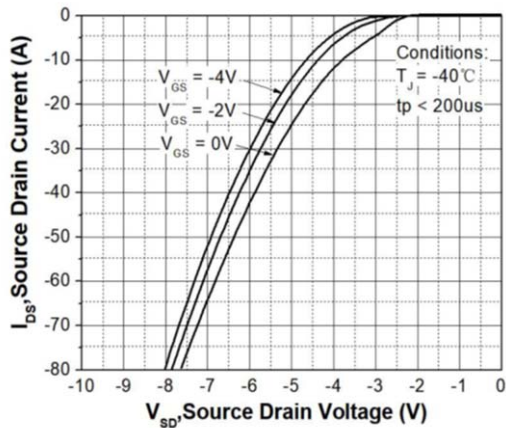


Fig 8: Body-diode Characteristic ( $T_J = 25^\circ C$ )

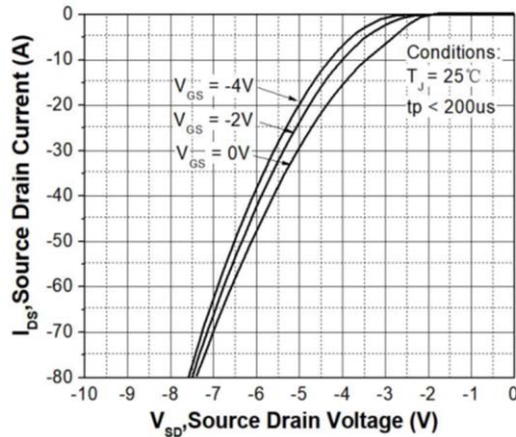


Fig 9: Body-diode Characteristic ( $T_J = 175^\circ C$ )

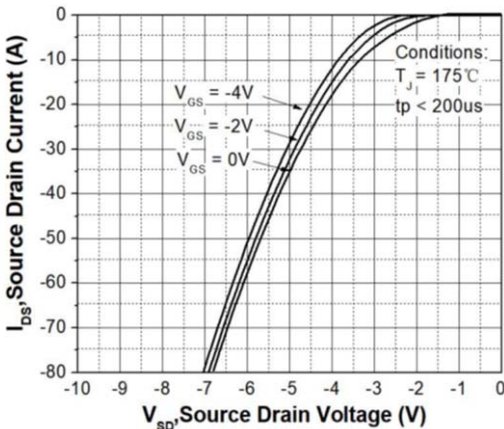


Fig 10:  $V_{TH}$  Vs  $T_J$  Temperature Characteristic

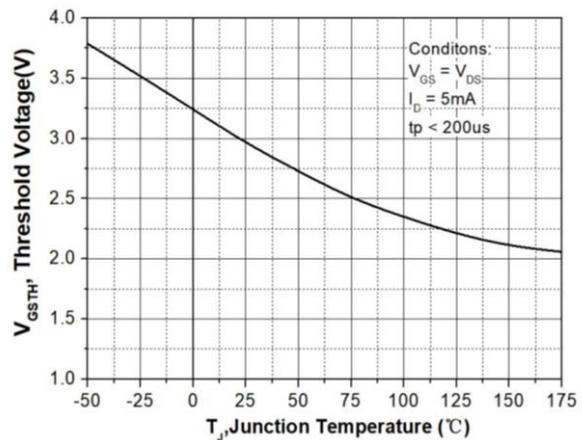




Fig 11: Gate Charge Characteristics

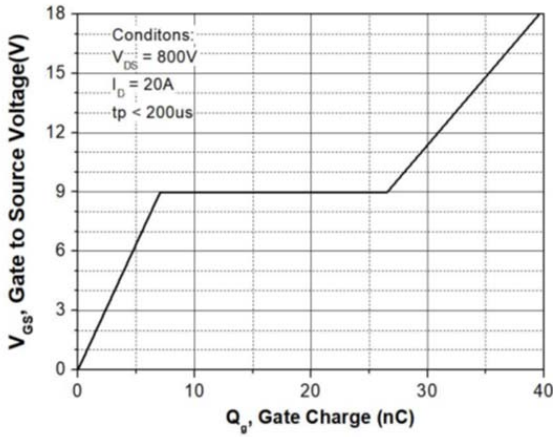


Fig 12: 3rd Quadrant Characteristic( $T_J = -40^\circ C$ )

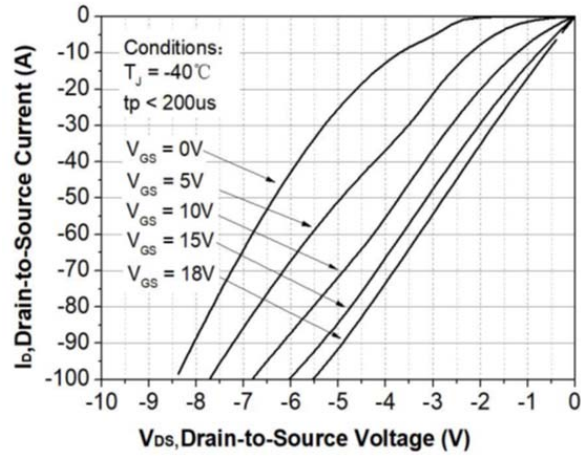


Fig 13: 3rd Quadrant Characteristic( $T_J = 25^\circ C$ )

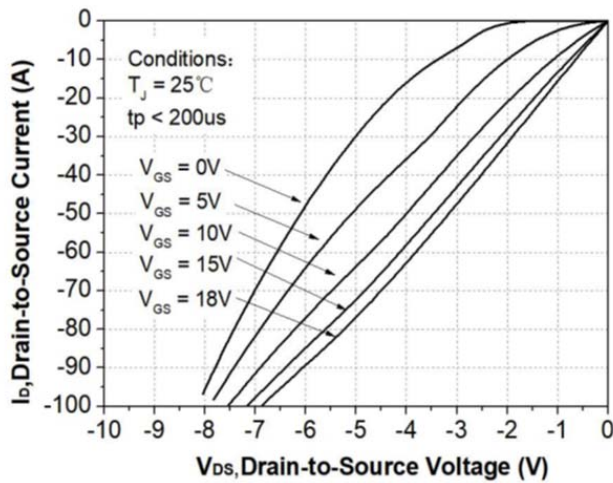


Fig 14: 3rd Quadrant Characteristic( $T_J = 175^\circ C$ )

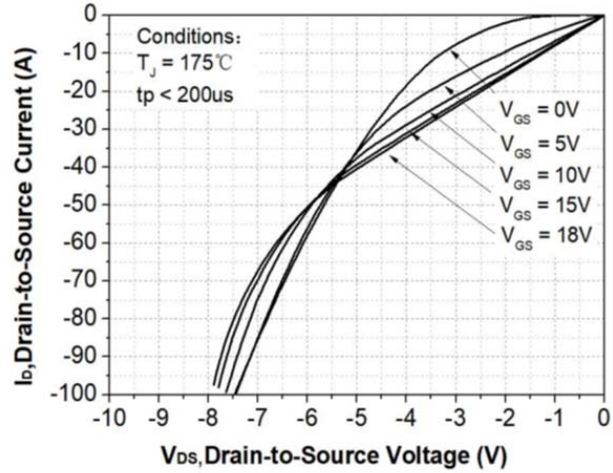


Fig 15: Capacitance Characteristic

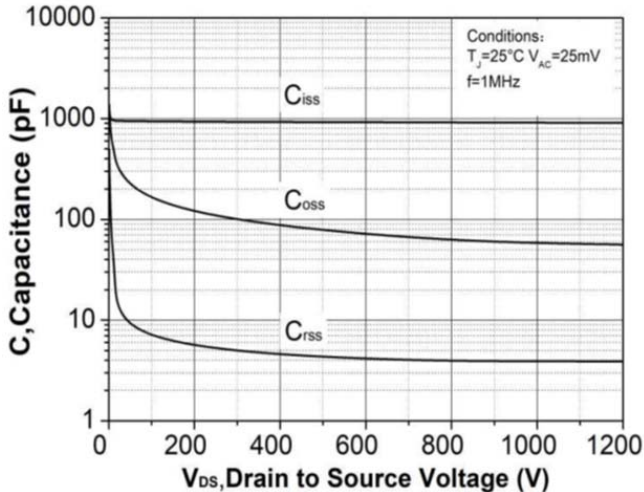


Fig 16: Safe Operating Area

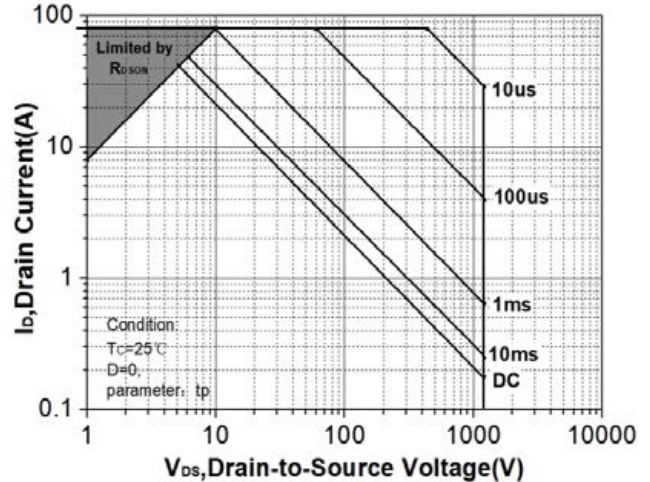
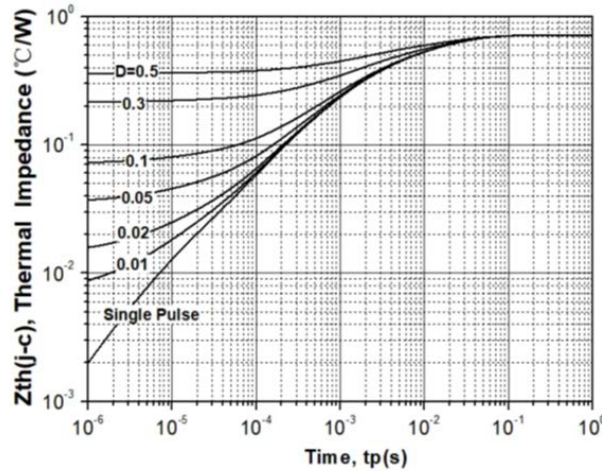




Fig 17: Transient Thermal Impedance



### Test Circuit & Waveform

Figure A. Definition of switching times

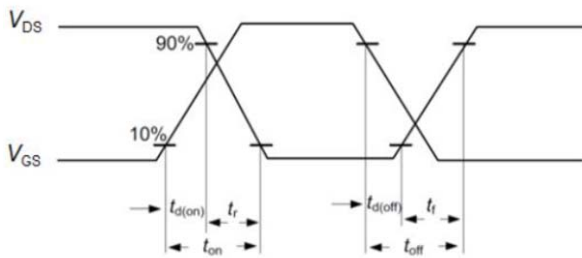


Figure B. Dynamic test circuit

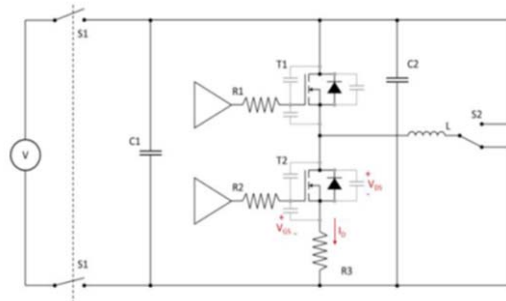


Figure C. Definition of body diodeswitching characteristics

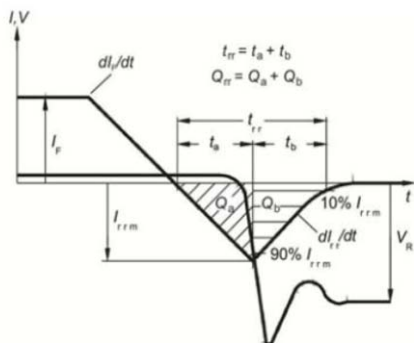
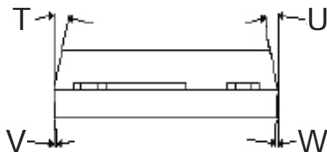
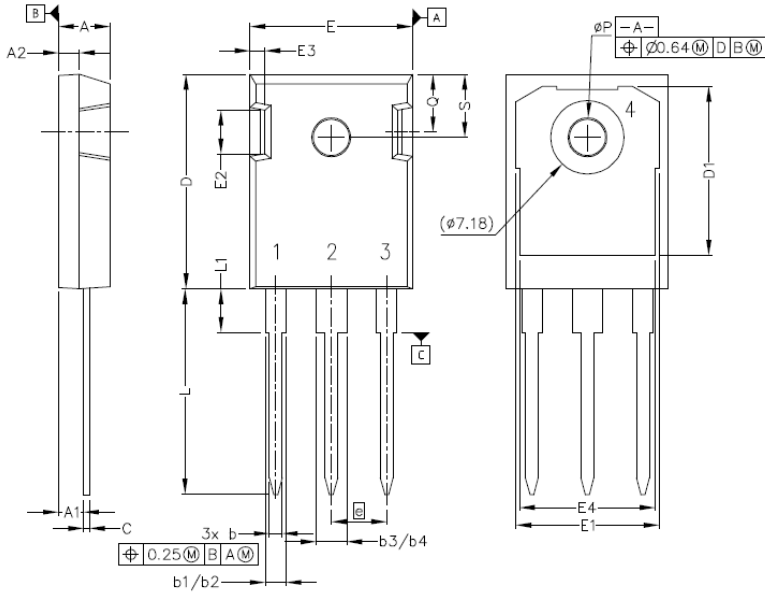


Figure C. Definition of diode switching characteristics



## Package Dimensions

### Package TO-247

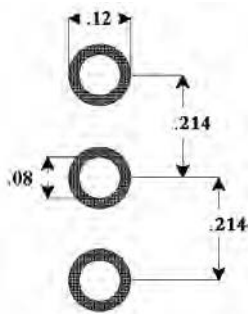


#### Pinout Information:

- Pin 1 = Gate
- Pin 2, 4 = Drain
- Pin 3 = Source

| POS | Inches   |      | Millimeters |       |
|-----|----------|------|-------------|-------|
|     | Min      | Max  | Min         | Max   |
| A   | .190     | .205 | 4.83        | 5.21  |
| A1  | .090     | .100 | 2.29        | 2.54  |
| A2  | .075     | .085 | 1.91        | 2.16  |
| b   | .042     | .052 | 1.07        | 1.33  |
| b1  | .075     | .095 | 1.91        | 2.41  |
| b2  | .075     | .085 | 1.91        | 2.16  |
| b3  | .113     | .133 | 2.87        | 3.38  |
| b4  | .113     | .123 | 2.87        | 3.13  |
| c   | .022     | .027 | 0.55        | 0.68  |
| D   | .819     | .831 | 20.80       | 21.10 |
| D1  | .640     | .695 | 16.25       | 17.65 |
| D2  | .037     | .049 | 0.95        | 1.25  |
| E   | .620     | .635 | 15.75       | 16.13 |
| E1  | .516     | .557 | 13.10       | 14.15 |
| E2  | .145     | .201 | 3.68        | 5.10  |
| E3  | .039     | .075 | 1.00        | 1.90  |
| E4  | .487     | .529 | 12.38       | 13.43 |
| e   | .214 BSC |      | 5.44 BSC    |       |
| N   | 3        |      | 3           |       |
| L   | .780     | .800 | 19.81       | 20.32 |
| L1  | .161     | .173 | 4.10        | 4.40  |
| ØP  | .138     | .144 | 3.51        | 3.65  |
| Q   | .216     | .236 | 5.49        | 6.00  |
| S   | .238     | .248 | 6.04        | 6.30  |
| T   | 9°       | 11°  | 9°          | 11°   |
| U   | 9°       | 11°  | 9°          | 11°   |
| V   | 2°       | 8°   | 2°          | 8°    |
| W   | 2°       | 8°   | 2°          | 8°    |

### Recommended Solder Pad Layout



TO-247



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