

# HMW60N120E7

## N-Channel MOS E7 Power MOSFET

600 V, 27 A, 120 mΩ

### Description

The 600V MOS E7 is an advanced Power Master Semiconductor's Super Junction MOSFET family by utilizing charge balance technology for excellent low on-resistance and gate charge.

This technology combines the benefits of a fast switching performance with ease of usage and robustness. Consequently, the MOS E7 family is suitable for application requiring high power density and superior efficiency.

### Applications

- PFC, Hard & Soft Switching Topologies
- Industrial & Consumer Power Supplies

### Features

| $BV_{DSS} @ T_{J,max}$ | $I_D$ | $R_{DS(on),max}$ | $Q_{g,typ}$ |
|------------------------|-------|------------------|-------------|
| 650 V                  | 27 A  | 120 mΩ           | 43.6 nC     |

- Reduced Switching & Conduction Losses
- Lower Gate Resistance
- 100% Avalanche Tested
- Pb-free, Halogen Free, and RoHS Compliant



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

| Symbol         | Parameter                                                             |                                            | Value      | Unit                  |
|----------------|-----------------------------------------------------------------------|--------------------------------------------|------------|-----------------------|
| $V_{DSS}$      | Drain to Source Voltage                                               |                                            | 600        | V                     |
| $V_{GSS}$      | Gate to Source Voltage                                                |                                            | $\pm 30$   | V                     |
| $I_D$          | Drain Current                                                         | Continuous ( $T_C = 25^{\circ}\text{C}$ )  | 27         | A                     |
|                |                                                                       | Continuous ( $T_C = 100^{\circ}\text{C}$ ) | 17.3       |                       |
| $I_{DM}$       | Drain Current                                                         | Pulsed (Note1)                             | 81         | A                     |
| $E_{AS}$       | Single Pulsed Avalanche Energy (Note2)                                |                                            | 164        | mJ                    |
| $I_{AS}$       | Avalanche Current (Note2)                                             |                                            | 5.1        | A                     |
| $E_{AR}$       | Repetitive Avalanche Energy (Note1)                                   |                                            | 2.23       | mJ                    |
| dv/dt          | MOSFET dv/dt                                                          |                                            | 100        | V/ns                  |
|                | Peak Diode Recovery dv/dt (Note3)                                     |                                            | 20         |                       |
| $P_D$          | Power Dissipation                                                     | ( $T_C = 25^{\circ}\text{C}$ )             | 223        | W                     |
|                |                                                                       | Derate Above $25^{\circ}\text{C}$          | 1.79       | W/ $^{\circ}\text{C}$ |
| $T_J, T_{STG}$ | Operating and Storage Temperature Range                               |                                            | -55 to 150 | $^{\circ}\text{C}$    |
| $T_L$          | Maximum Lead Temperature for Soldering, 1/8" from Case for 10 Seconds |                                            | 260        | $^{\circ}\text{C}$    |

### Thermal Characteristics

| Symbol          | Parameter                                     | Value | Unit                 |
|-----------------|-----------------------------------------------|-------|----------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case, Max.    | 0.56  | $^{\circ}\text{C/W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient, Max. | 40    |                      |

## Package Marking and Ordering Information

| Part Number | Top Marking | Package | Packing Method | Quantity |
|-------------|-------------|---------|----------------|----------|
| HMW60N120E7 | HMW60N120E7 | TO-247  | Tube           | 30 units |

Electrical Characteristics ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Unit |
|--------|-----------|-----------------|-----|-----|-----|------|
|--------|-----------|-----------------|-----|-----|-----|------|

## Off Characteristics

|            |                                   |                                                                       |     |   |           |               |
|------------|-----------------------------------|-----------------------------------------------------------------------|-----|---|-----------|---------------|
| $BV_{DSS}$ | Drain to Source Breakdown Voltage | $V_{GS} = 0\text{ V}, I_D = 1\text{ mA}$                              | 600 |   |           | V             |
|            |                                   | $V_{GS} = 0\text{ V}, I_D = 1\text{ mA}, T_J = 150^\circ\text{C}$     | 650 |   |           |               |
| $I_{DSS}$  | Zero Gate Voltage Drain Current   | $V_{DS} = 600\text{ V}, V_{GS} = 0\text{ V}$                          |     |   | 1         | $\mu\text{A}$ |
|            |                                   | $V_{DS} = 480\text{ V}, V_{GS} = 0\text{ V}, T_J = 125^\circ\text{C}$ |     | 2 |           |               |
| $I_{GSS}$  | Gate-Source Leakage Current       | $V_{GS} = \pm 30\text{ V}, V_{DS} = 0\text{ V}$                       |     |   | $\pm 100$ | nA            |

## On Characteristics

|              |                                      |                                             |     |     |     |            |
|--------------|--------------------------------------|---------------------------------------------|-----|-----|-----|------------|
| $V_{GS(th)}$ | Gate Threshold Voltage               | $V_{GS} = V_{DS}, I_D = 1.8\text{ mA}$      | 2.5 |     | 4.5 | V          |
| $R_{DS(on)}$ | Static Drain to Source On Resistance | $V_{GS} = 10\text{ V}, I_D = 12.6\text{ A}$ |     | 103 | 120 | m $\Omega$ |

## Dynamic Characteristics

|              |                                   |                                                                         |  |      |  |          |
|--------------|-----------------------------------|-------------------------------------------------------------------------|--|------|--|----------|
| $C_{iss}$    | Input Capacitance                 | $V_{DS} = 400\text{ V}, V_{GS} = 0\text{ V},$<br>$f = 250\text{ kHz}$   |  | 1827 |  | pF       |
| $C_{oss}$    | Output Capacitance                |                                                                         |  | 48.9 |  | pF       |
| $C_{o(tr)}$  | Time Related Output Capacitance   | $V_{DS} = 0\text{ V to } 400\text{ V}, V_{GS} = 0\text{ V}$             |  | 500  |  | pF       |
| $C_{o(er)}$  | Energy Related Output Capacitance |                                                                         |  | 78   |  | pF       |
| $Q_{g(tot)}$ | Total Gate Charge at 10 V         | $V_{DS} = 400\text{ V}, I_D = 12.6\text{ A},$<br>$V_{GS} = 10\text{ V}$ |  | 43.6 |  | nC       |
| $Q_{gs}$     | Gate to Source Charge             |                                                                         |  | 9.6  |  | nC       |
| $Q_{gd}$     | Gate to Drain "Miller" Charge     |                                                                         |  | 20.2 |  | nC       |
| $R_G$        | Gate Resistance                   | $f = 1\text{ MHz}$                                                      |  | 1    |  | $\Omega$ |

## Switching Characteristics

|              |                     |                                                                                                                  |  |    |  |    |
|--------------|---------------------|------------------------------------------------------------------------------------------------------------------|--|----|--|----|
| $t_{d(on)}$  | Turn-On Delay Time  | $V_{DS} = 400\text{ V}, I_D = 12.6\text{ A},$<br>$V_{GS} = 10\text{ V}, R_G = 10\text{ }\Omega$<br>See Figure 13 |  | 15 |  | ns |
| $t_r$        | Turn-On Rise Time   |                                                                                                                  |  | 9  |  | ns |
| $t_{d(off)}$ | Turn-Off Delay Time |                                                                                                                  |  | 76 |  | ns |
| $t_f$        | Turn-Off Fall Time  |                                                                                                                  |  | 10 |  | ns |

## Source-Drain Diode Characteristics

|          |                                          |                                                                                          |  |     |               |
|----------|------------------------------------------|------------------------------------------------------------------------------------------|--|-----|---------------|
| $I_S$    | Maximum Continuous Diode Forward Current |                                                                                          |  | 27  | A             |
| $I_{SM}$ | Maximum Pulsed Diode Forward Current     |                                                                                          |  | 81  | A             |
| $V_{SD}$ | Diode Forward Voltage                    | $V_{GS} = 0\text{ V}, I_{SD} = 12.6\text{ A}$                                            |  | 1.2 | V             |
| $t_{rr}$ | Reverse Recovery Time                    | $V_{DD} = 400\text{ V}, I_{SD} = 12.6\text{ A},$<br>$di_F/dt = 100\text{ A}/\mu\text{s}$ |  | 300 | ns            |
| $Q_{rr}$ | Reverse Recovery Charge                  |                                                                                          |  | 4.1 | $\mu\text{C}$ |

※Notes:

1. Repetitive rating: pulse-width limited by maximum junction temperature.
2.  $I_{AS} = 5.1\text{ A}, R_G = 25\text{ }\Omega$ , starting  $T_J = 25^\circ\text{C}$ .
3.  $I_{SD} \leq 12.6\text{ A}, di/dt \leq 100\text{ A}/\mu\text{s}, V_{DD} \leq 400\text{ V}$ , starting  $T_J = 25^\circ\text{C}$ .

Typical Performance Characteristics

Figure 1. On-Region Characteristics

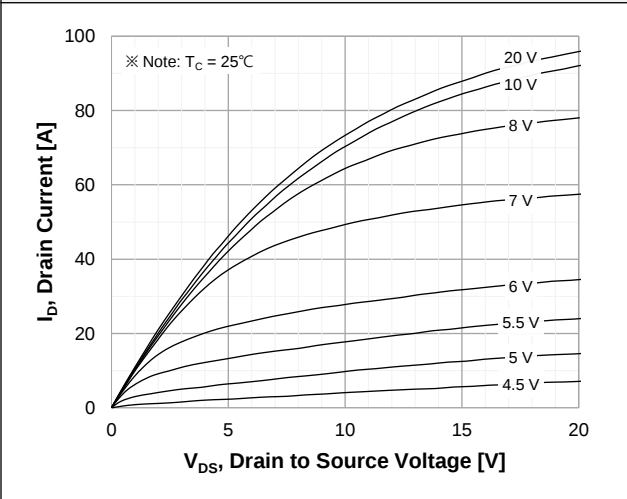


Figure 2. Transfer Characteristics

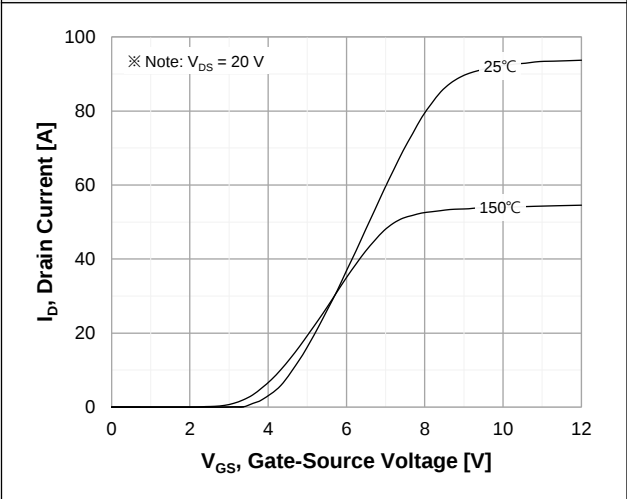


Figure 3. On-Resistance Characteristics vs. Drain Current and Gate Voltage

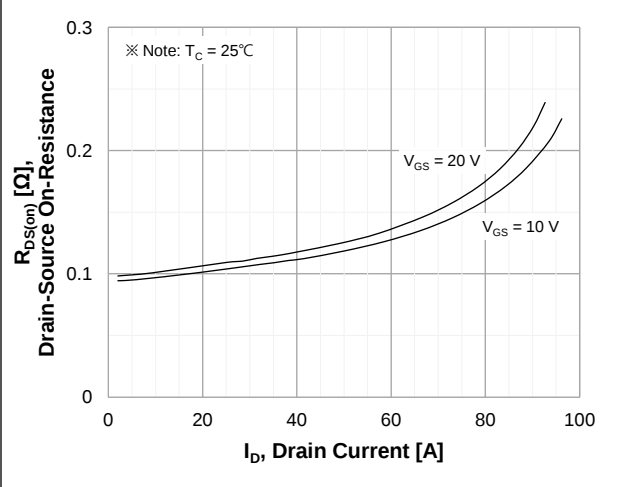


Figure 4. Diode Forward Voltage Characteristics vs. Source-Drain Current and Temperature

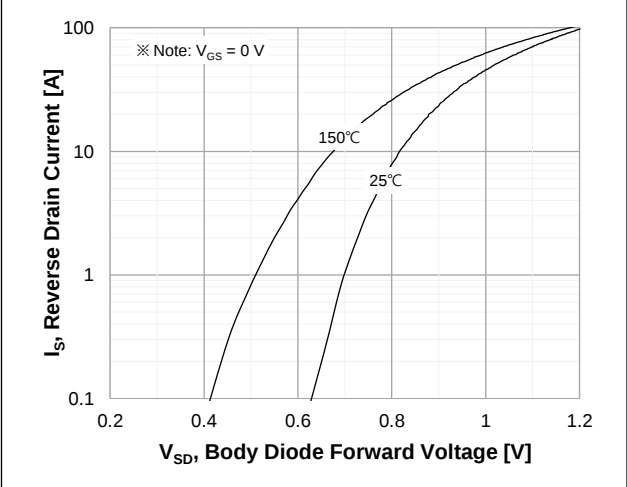


Figure 5. Capacitance Characteristics

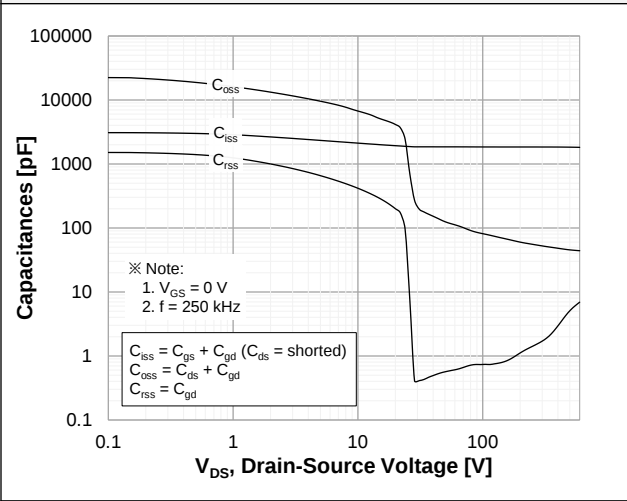
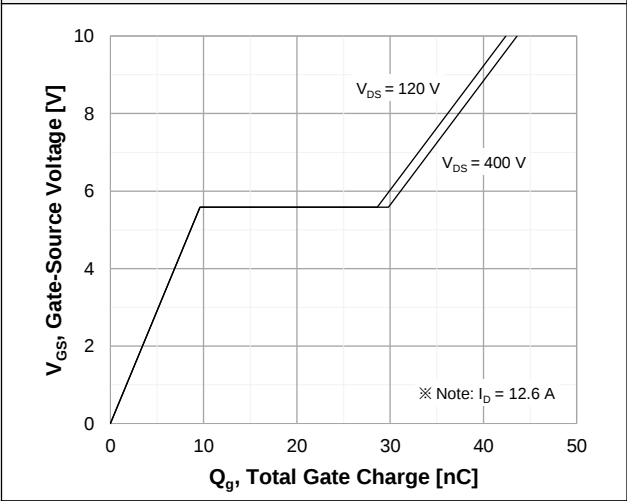


Figure 6. Gate Charge Characteristics



Typical Performance Characteristics

Figure 7. Breakdown Voltage Characteristics vs. Temperature

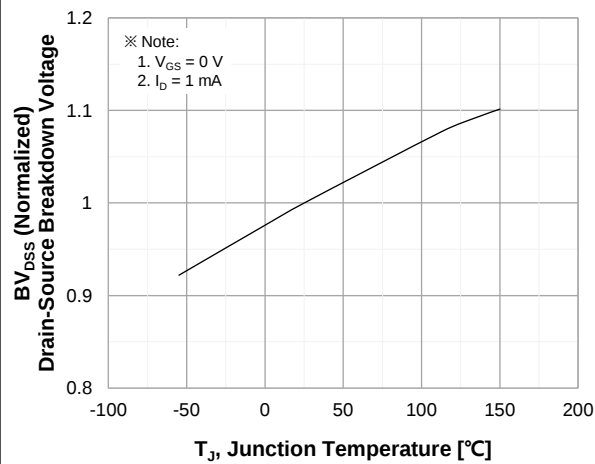


Figure 8. On-Resistance Characteristics vs. Temperature

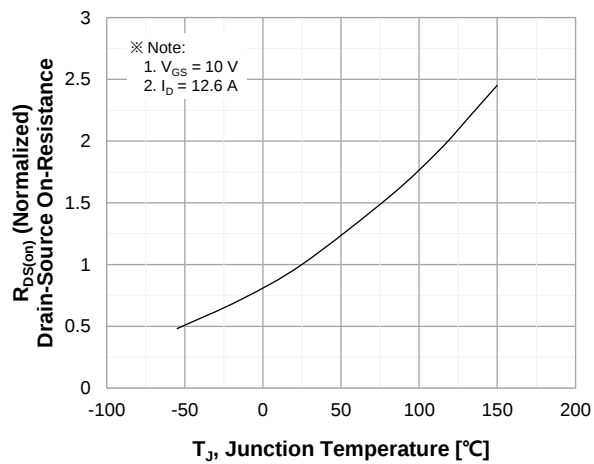


Figure 9. Maximum Safe Operating Area

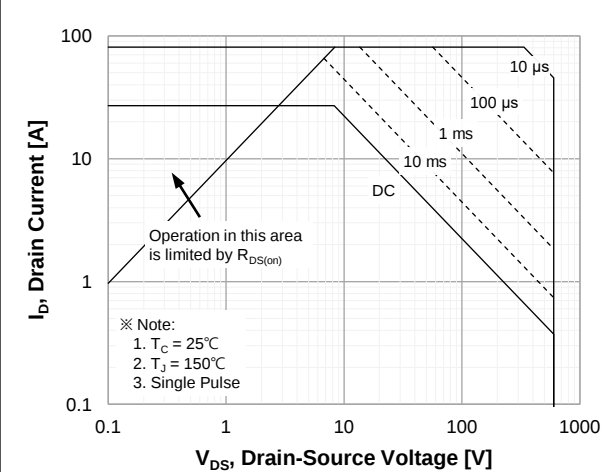


Figure 10. Maximum Drain Current vs. Case Temperature

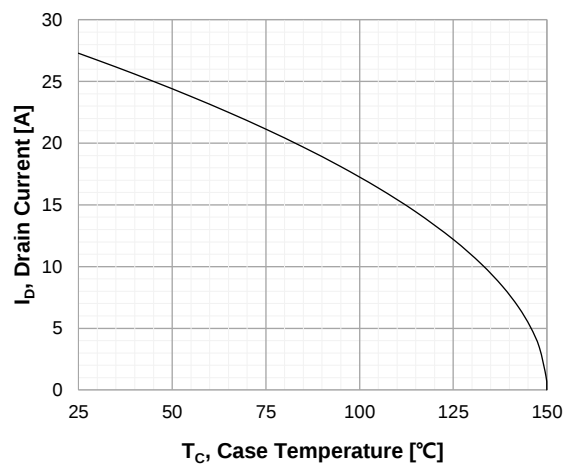


Figure 11.  $E_{oss}$  vs. Drain to Source Voltage

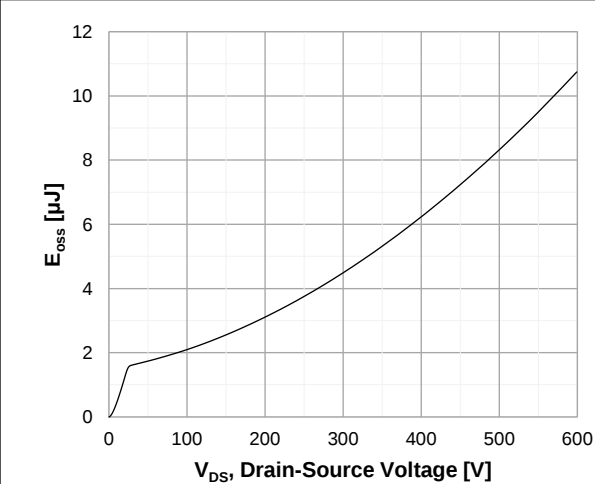
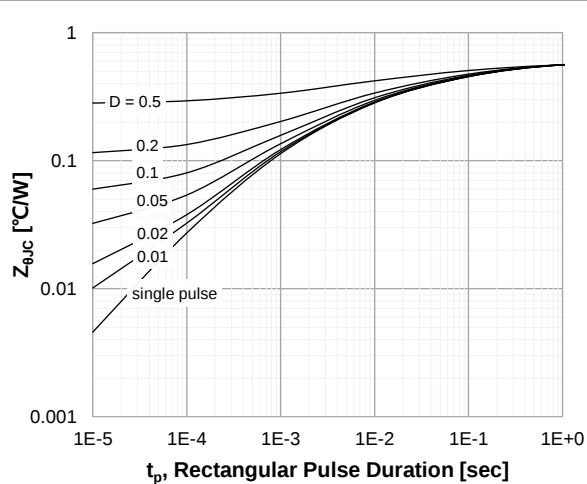


Figure 12. Transient Thermal Response Curve



Test Circuits

Figure 13. Inductive Load Switching Test Circuit and Waveforms

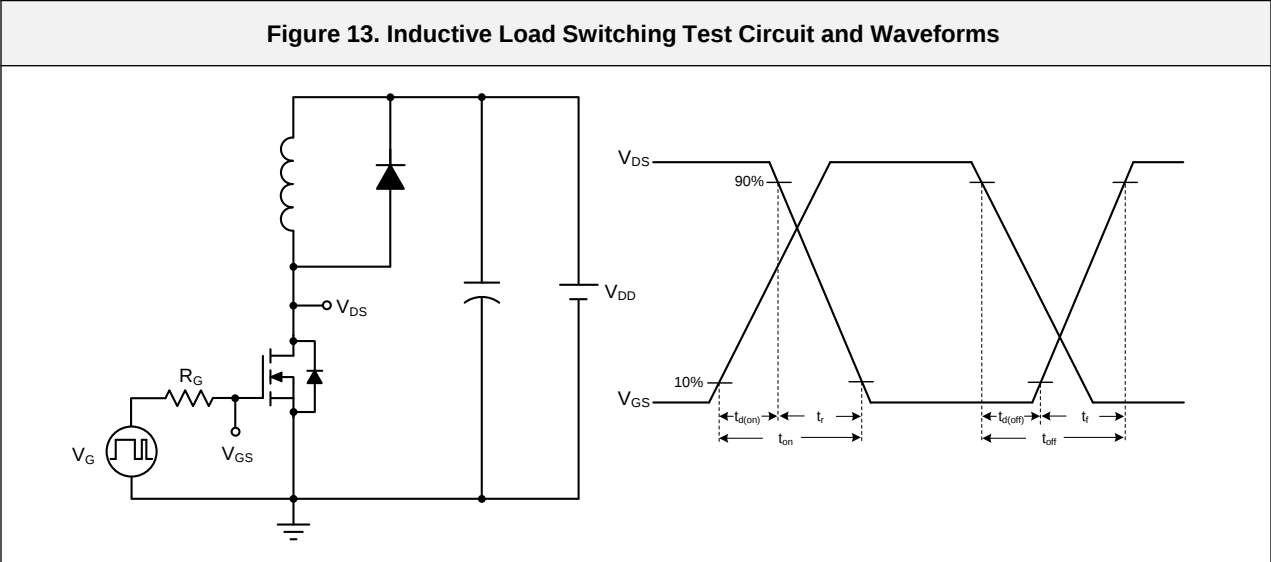


Figure 14. Unclamped Inductive Switching Test Circuit and Waveforms

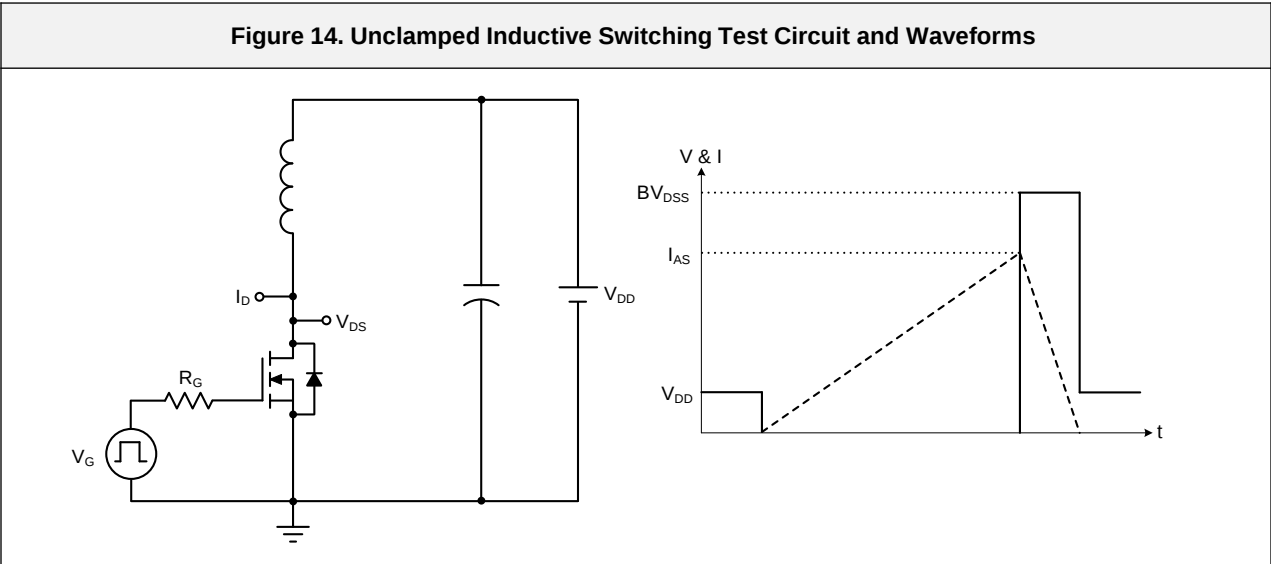
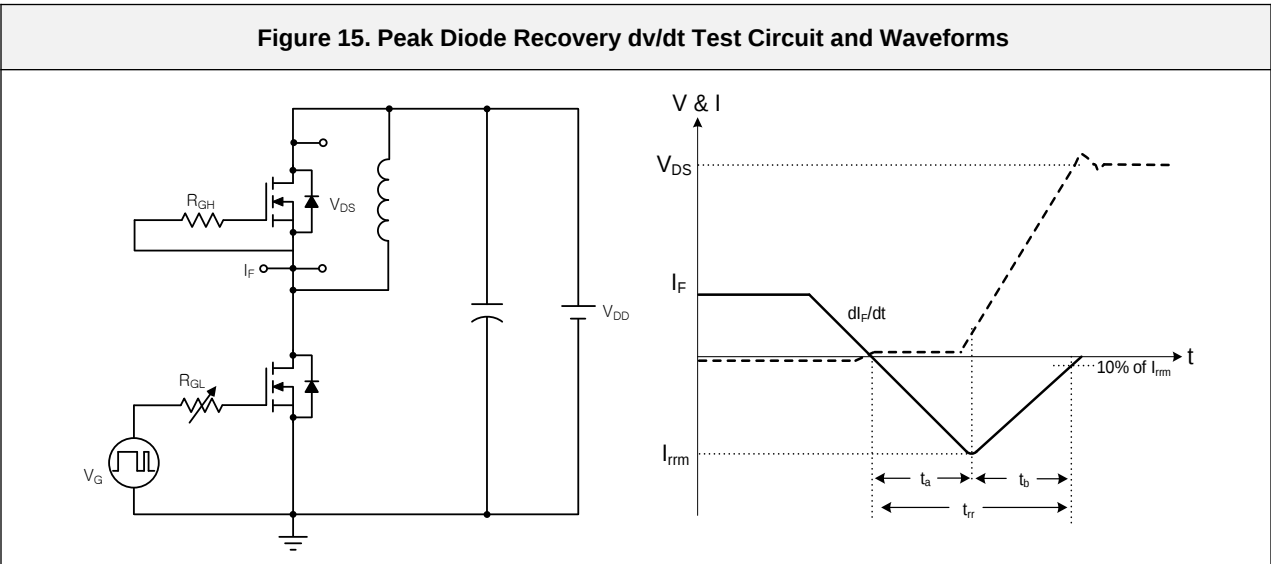
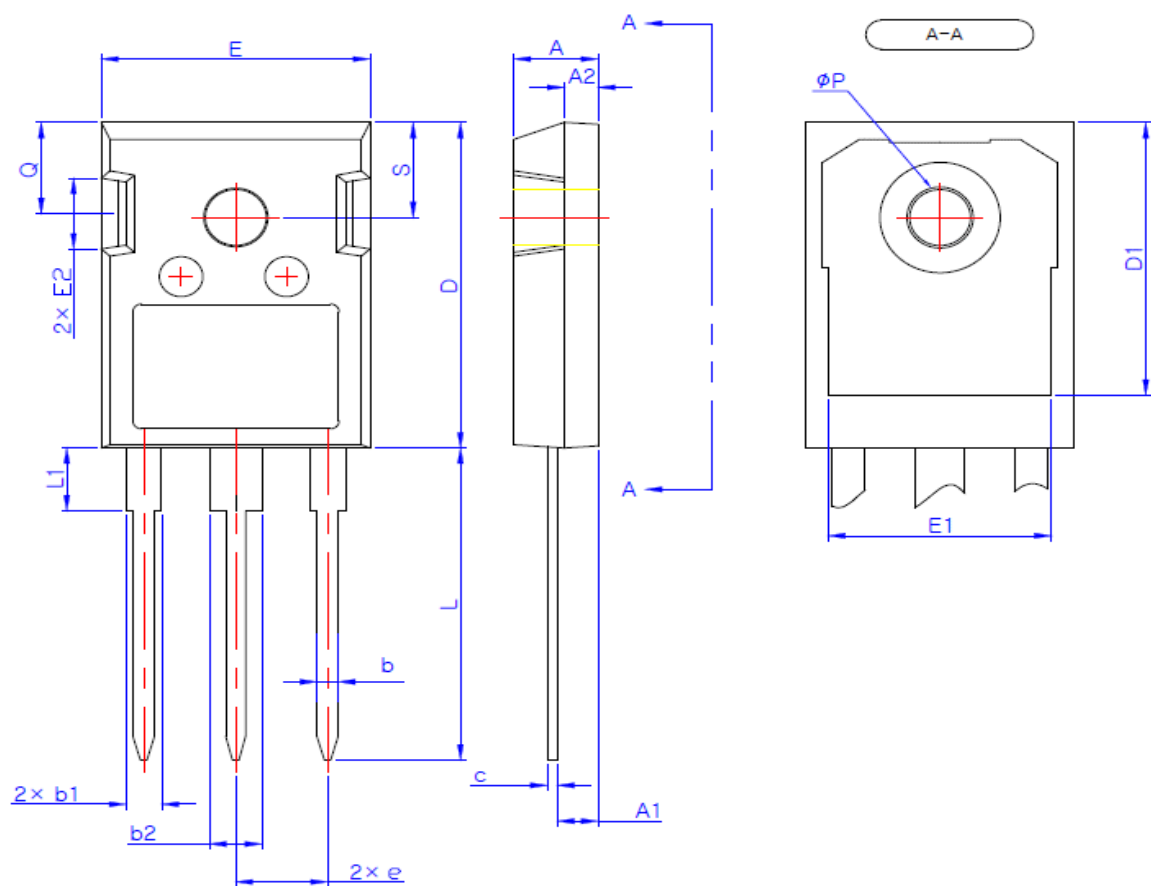


Figure 15. Peak Diode Recovery  $dv/dt$  Test Circuit and Waveforms



Package Outlines

TO-247



| SYMBOL | MIN      | NOM   | MAX   |
|--------|----------|-------|-------|
| A      | 4.80     | 5.00  | 5.20  |
| A1     | 2.29     | 2.42  | 2.54  |
| A2     | 1.90     | 2.00  | 2.10  |
| b      | 1.10     | 1.20  | 1.30  |
| b1     | 1.91     | 2.06  | 2.20  |
| b2     | 2.92     | 3.06  | 3.20  |
| c      | 0.50     | 0.60  | 0.70  |
| D      | 20.80    | 21.07 | 21.34 |
| D1     | 17.43    | 17.63 | 17.83 |
| E      | 15.75    | 15.94 | 16.13 |
| E1     | 13.06    | 13.26 | 13.46 |
| E2     | 4.32     | 4.58  | 4.83  |
| e      | 5.45 BSC |       |       |
| L      | 19.85    | 20.05 | 20.25 |
| L1     | 4.05     | 4.27  | 4.49  |
| ΦP     | 3.55     | 3.60  | 3.65  |
| Q      | 5.59     | 5.89  | 6.19  |
| S      | 6.15 BSC |       |       |

\* Dimensions in millimeters