

## MOSFET

-24A, -60V, 31.2 mΩ, P-CHANNEL MOSFET

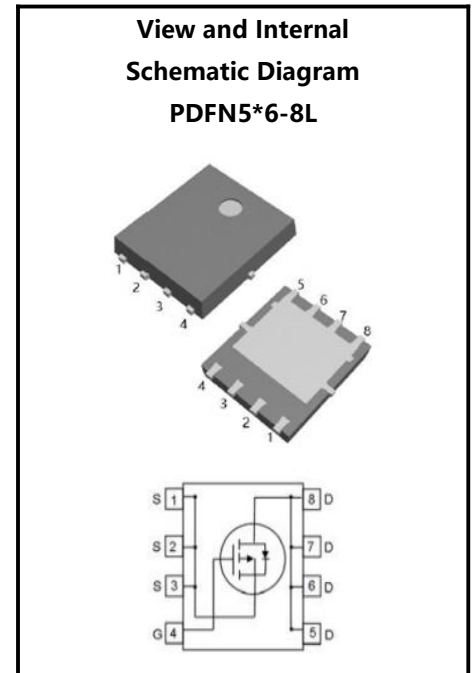
### Features

- ◆ Low gate charge
- ◆ High Power and current handing capability
- ◆ Lead free product is acquired

### Applications

- ◆ Load switch
- ◆ DC/DC converter for LCD display

| Parameter         | Values | Unit |
|-------------------|--------|------|
| $BV_{DSS}$        | -60    | V    |
| $I_D$             | -24    | A    |
| $R_{Dson(max)}$   | 31.2   | mΩ   |
| $V_{GS(th)}(Typ)$ | -1.7   | V    |



| Ordering Code | Marking       | Package    | Packaging   |
|---------------|---------------|------------|-------------|
| X31P2P060TLV8 | X31P2P060TLV8 | PDFN5*6-8L | Tape & Reel |

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

| Parameter                                        | Symbol           | Values |     |      | Unit               | Note/Test Conditions                                      |
|--------------------------------------------------|------------------|--------|-----|------|--------------------|-----------------------------------------------------------|
|                                                  |                  | Min    | Typ | Max  |                    |                                                           |
| Drain-Source Voltage                             | $V_{DSS}$        | -      | -   | -60  | V                  | -                                                         |
| Gate-Source Voltage                              | $V_{GS}$         | -20    | -   | 20   | V                  | -                                                         |
| Continuous Drain Current(Note 1)                 | $I_D$            | -      | -   | -24  | A                  | $T_C=25^{\circ}\text{C}$                                  |
|                                                  |                  | -      | -   | -15  | A                  | $T_C=100^{\circ}\text{C}$                                 |
| Pulsed Drain Current(Note 2)                     | $I_{DM}$         | -      | -   | -96  | A                  | -                                                         |
| Single Pulse Avalanche Energy                    | $E_{AS}$         | -      | -   | 272  | mJ                 | $L=0.5\text{mH}, V_D=-40\text{V}, T_C=25^{\circ}\text{C}$ |
| Maximum Power Dissipation                        | $P_D$            | -      | -   | 33   | W                  | $T_C=25^{\circ}\text{C}$                                  |
|                                                  |                  | -      | -   | 13.5 | W                  | $T_C=100^{\circ}\text{C}$                                 |
| Operating Junction and Storage Temperature Range | $T_{j}, T_{STG}$ | -55    | -   | 150  | $^{\circ}\text{C}$ | -                                                         |

### Thermal Characteristics

| Parameter                             | Symbol        | Values |     |     | Unit                 | Note/Test Conditions |
|---------------------------------------|---------------|--------|-----|-----|----------------------|----------------------|
|                                       |               | Min    | Typ | Max |                      |                      |
| Thermal resistance , Junction to Case | $R_{th(J-C)}$ | -      | -   | 3.7 | $^{\circ}\text{C/W}$ | -                    |

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

### Static characteristics

| Parameter                          | Symbol       | Values |      |      | Unit       | Note/Test Conditions           |
|------------------------------------|--------------|--------|------|------|------------|--------------------------------|
|                                    |              | Min    | Typ  | Max  |            |                                |
| Drain-Source Breakdown Voltage     | $BV_{DSS}$   | -60    | -    | -    | V          | $V_{GS}=0V, I_D=-250\mu A$     |
| Zero Gate Voltage Drain Current    | $I_{DSS}$    | -      | -    | 1    | $\mu A$    | $V_{DS}=-60V, V_{GS}=0V$       |
| Gate-Body Leakage Current, Forward | $I_{GSSF}$   | -      | -    | 100  | nA         | $V_{GS}=20V, V_{DS}=0V$        |
| Gate-Body Leakage Current, Reverse | $I_{GSSR}$   | -      | -    | -100 | nA         | $V_{GS}=-20V, V_{DS}=0V$       |
| Gate-Source Threshold Voltage      | $V_{GS(th)}$ | -1     | -    | -2.5 | V          | $V_{DS}=V_{GS}, I_D=-250\mu A$ |
| Drain-Source On-State Resistance   | $R_{DS(on)}$ | -      | 24   | 31.2 | m $\Omega$ | $V_{GS}=-10V, I_D=-15A$        |
|                                    |              | -      | 30.4 | 40.4 | m $\Omega$ | $V_{GS}=-4.5V, I_D=-10A$       |
| Forward Transconductance           | $g_{fs}$     | -      | 30.5 | -    | S          | $V_{DS}=-5V, I_D=-10A$         |

### Dynamic characteristics

| Parameter                    | Symbol       | Values |      |     | Unit | Note/Test Conditions                                 |
|------------------------------|--------------|--------|------|-----|------|------------------------------------------------------|
|                              |              | Min    | Typ  | Max |      |                                                      |
| Input Capacitance            | $C_{iss}$    | -      | 4026 | -   | pF   | $V_{DS}=-30V, V_{GS}=0V, f=1.0\text{MHz}$            |
| Output Capacitance           | $C_{oss}$    | -      | 134  | -   | pF   |                                                      |
| Reverse Transfer Capacitance | $C_{rss}$    | -      | 98   | -   | pF   |                                                      |
| Turn-On Delay Time           | $t_{d(on)}$  | -      | 12.2 | -   | ns   | $V_{DD}=-30V, R_G=3\Omega, V_{GS}=-10V, R_L=2\Omega$ |
| Turn-On Rise Time            | $t_r$        | -      | 10   | -   | ns   |                                                      |
| Turn-Off Delay Time          | $t_{d(off)}$ | -      | 64   | -   | ns   |                                                      |
| Turn-Off Fall Time           | $t_f$        | -      | 14   | -   | ns   |                                                      |

### Gate charge characteristics

| Parameter          | Symbol   | Values |      |     | Unit | Note/Test Conditions                 |
|--------------------|----------|--------|------|-----|------|--------------------------------------|
|                    |          | Min    | Typ  | Max |      |                                      |
| Total Gate Charge  | $Q_g$    | -      | 68   | -   | nC   | $V_{DS}=-30V, I_D=-10A, V_{GS}=-10V$ |
| Gate-Source Charge | $Q_{gs}$ | -      | 10.5 | -   | nC   |                                      |
| Gate-Drain Charge  | $Q_{gd}$ | -      | 13   | -   | nC   |                                      |

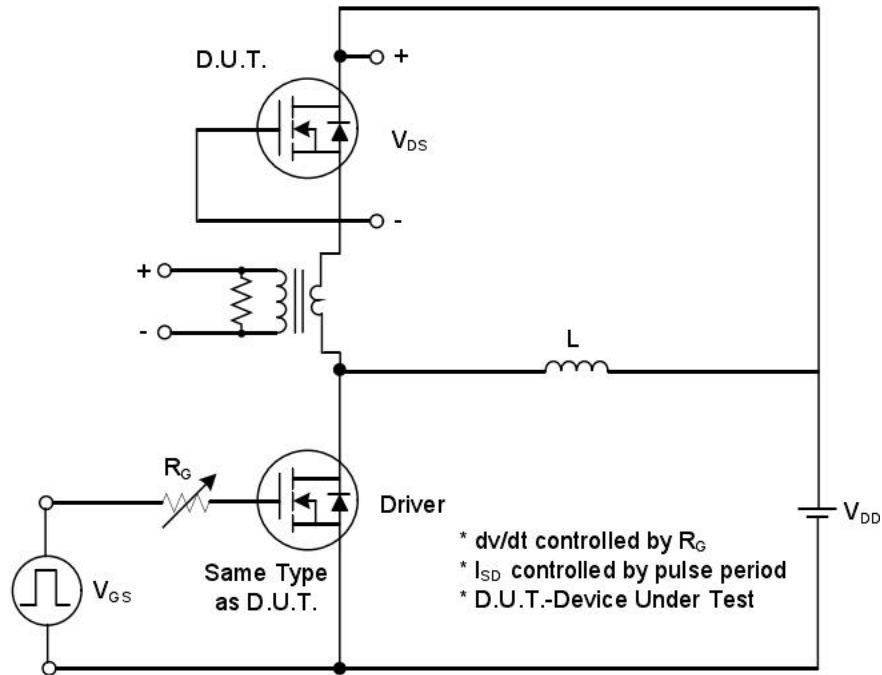
### Reverse diode

| Parameter                        | Symbol   | Values |     |      | Unit | Note/Test Conditions                     |
|----------------------------------|----------|--------|-----|------|------|------------------------------------------|
|                                  |          | Min    | Typ | Max  |      |                                          |
| Continuous Diode Forward Current | $I_{SD}$ | -      | -   | -24  | A    | -                                        |
| Diode Forward Voltage(Note 3)    | $V_{SD}$ | -      | -   | -1.2 | V    | $I_S=-10A, V_{GS}=0V$                    |
| Reverse Recovery Time            | $t_{rr}$ | -      | 26  | -    | ns   | $V_{GS}=0V, I_S=-10A, di/dt=-100A/\mu s$ |
| Reverse Recovery Charge          | $Q_{rr}$ | -      | 29  | -    | nC   |                                          |

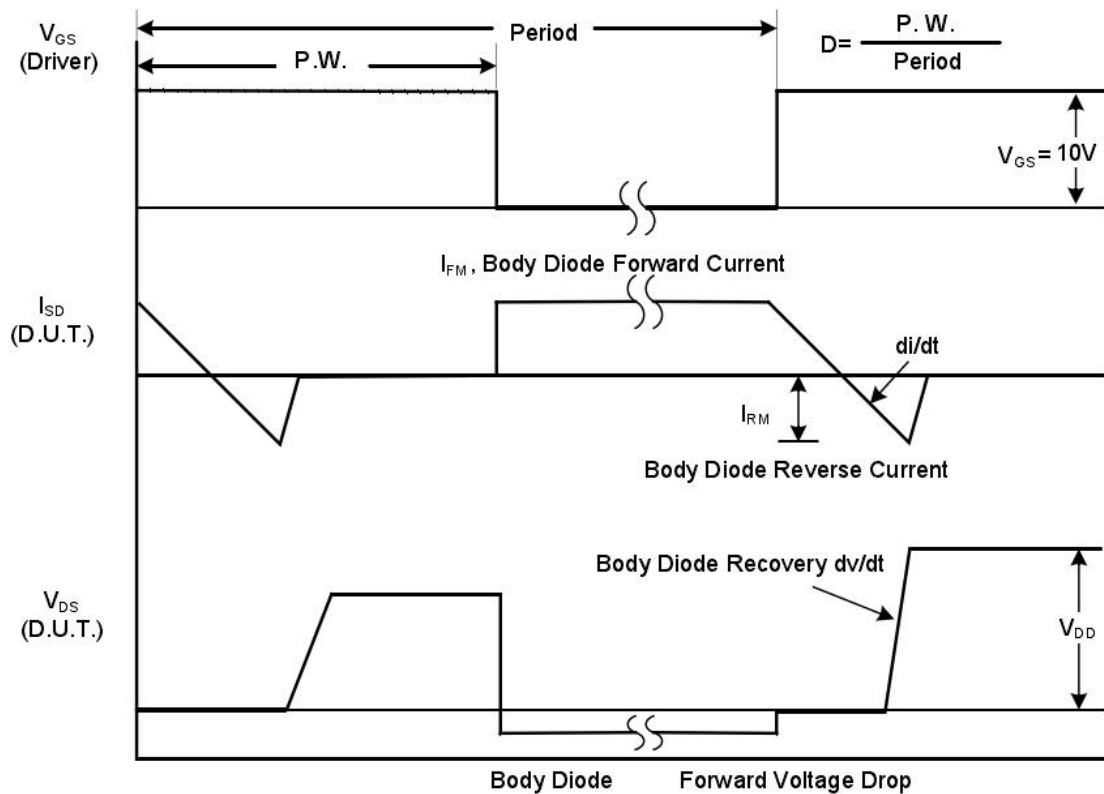
### Notes

1. Computed continuous current assumes the condition of  $T_{j\_Max}$  while the actual continuous current depends on the thermal & electro-mechanical application board design.
2. This single-pulse measurement was taken under  $T_{j\_Max} = 150^{\circ}\text{C}$ .

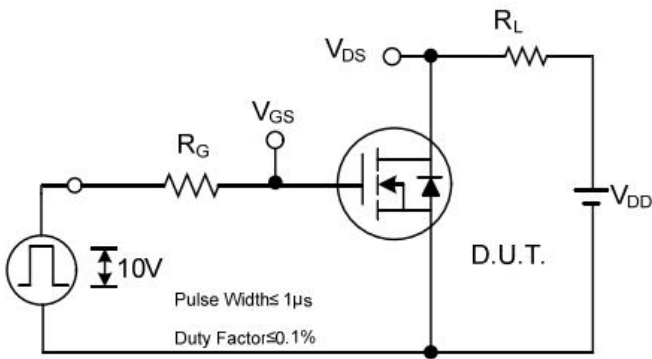
## RATING AND CHARACTERISTIC CURVES



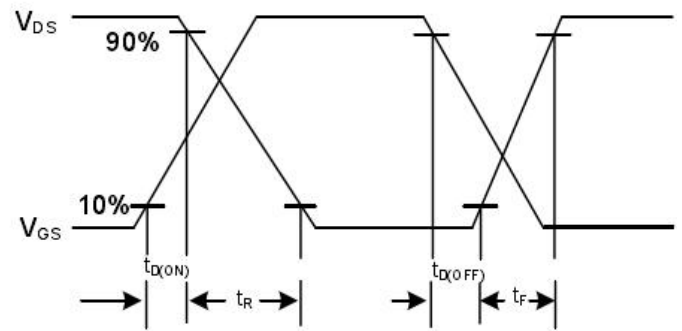
Peak Diode Recovery  $dv/dt$  Test Circuit



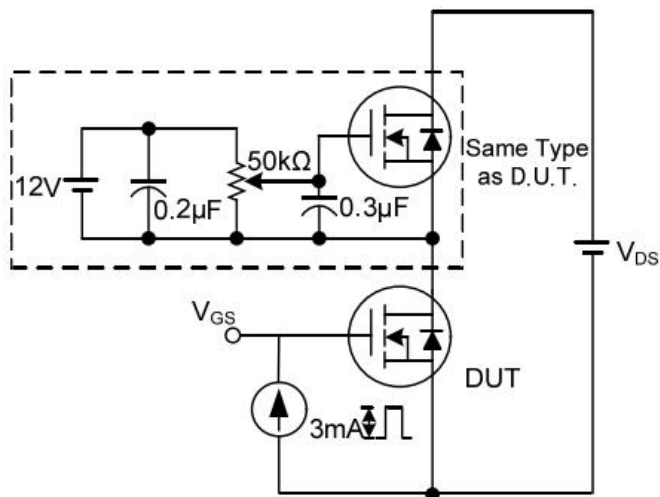
Peak Diode Recovery  $dv/dt$  Waveforms



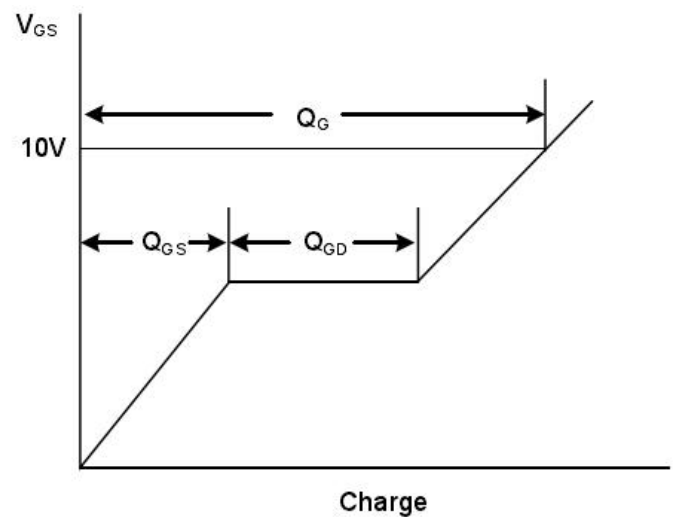
Switching Test Circuit



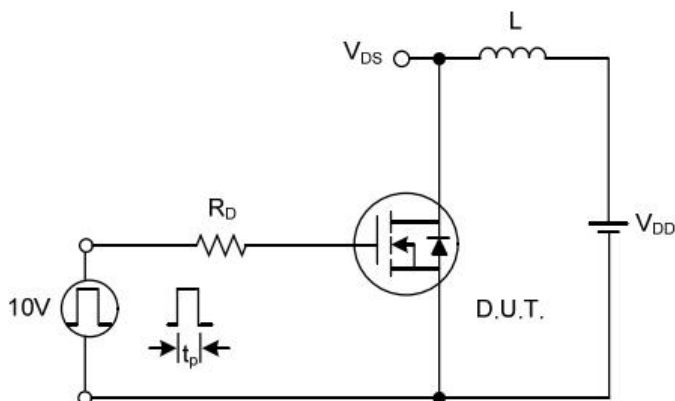
Switching Waveforms



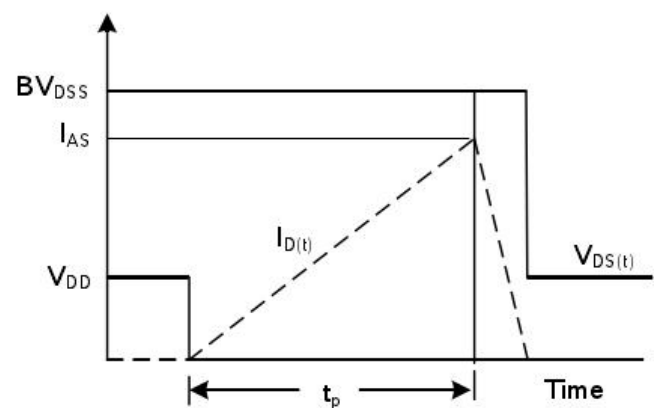
Gate Charge Test Circuit



Gate Charge Waveform



Unclamped Inductive Switching Test Circuit



Unclamped Inductive Switching Waveforms

## RATING AND CHARACTERISTIC CURVES

Figure.1 Output Characteristics

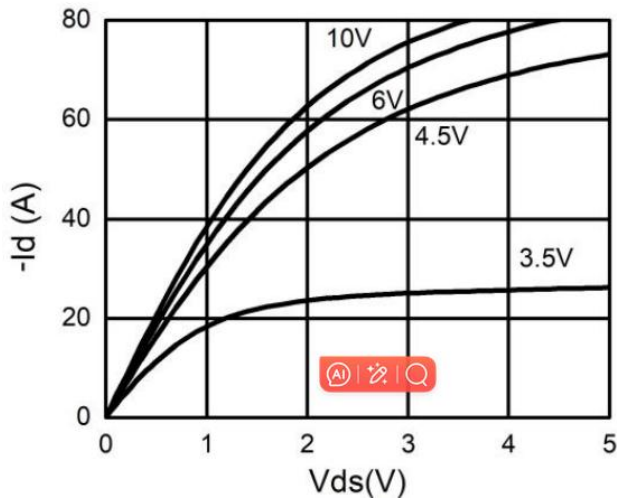


Figure.2 Transfer Characteristics

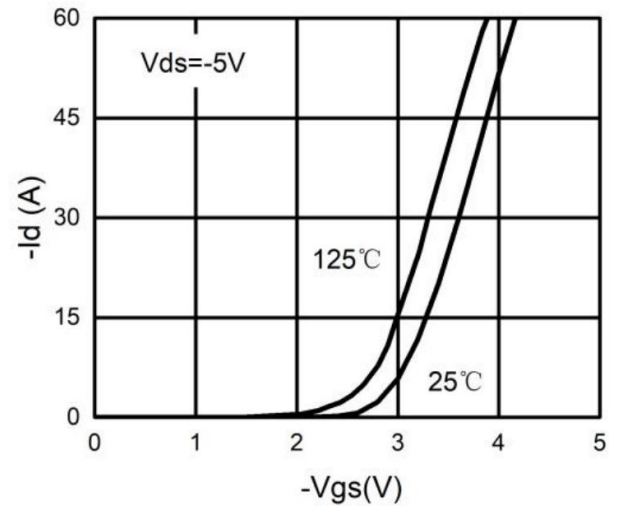


Figure.3 Power Dissipation

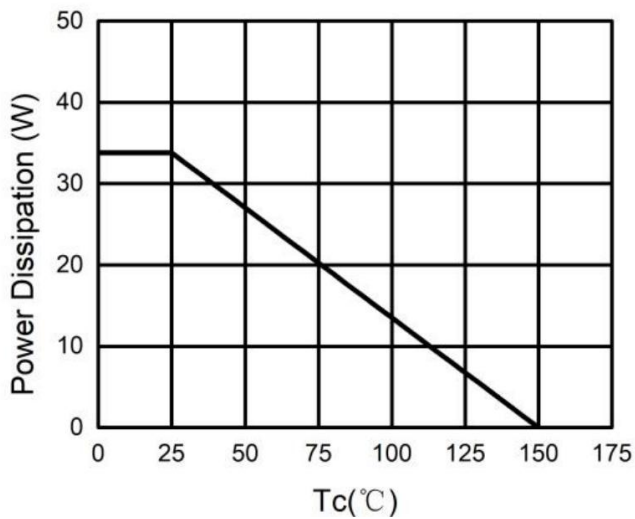


Figure.4 Drain Current

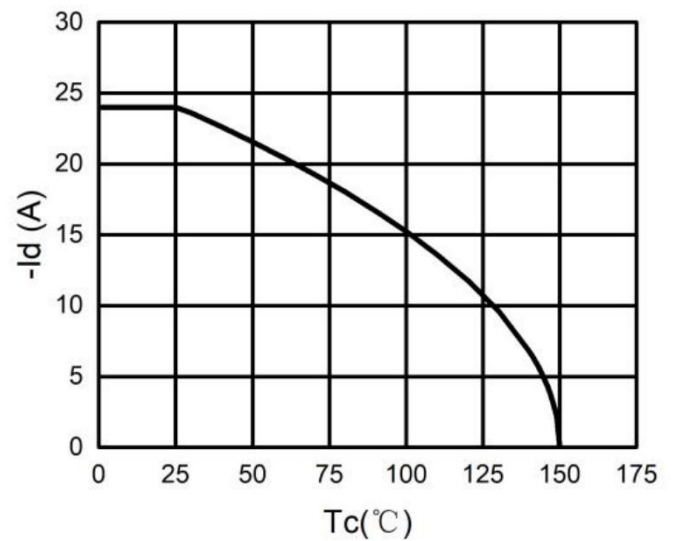


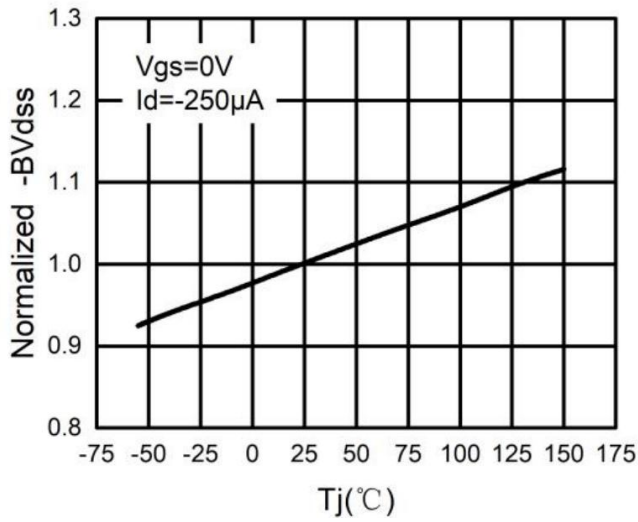
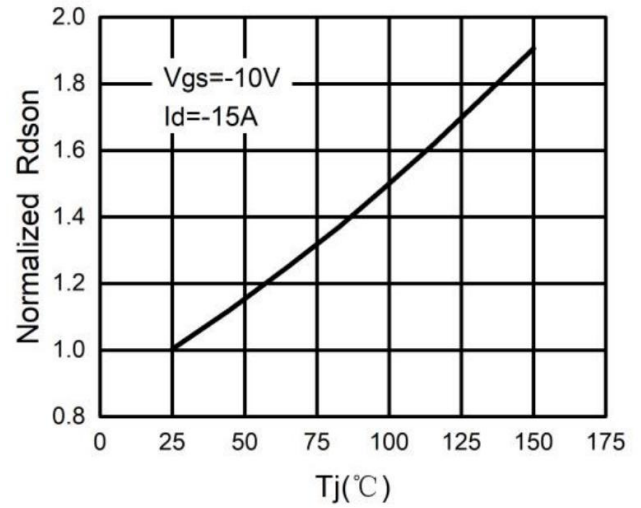
Figure.5  $BV_{DSS}$  vs Junction Temperature

Figure.6  $R_{DS(ON)}$  vs Junction Temperature


Figure.7 Gate Charge Waveforms

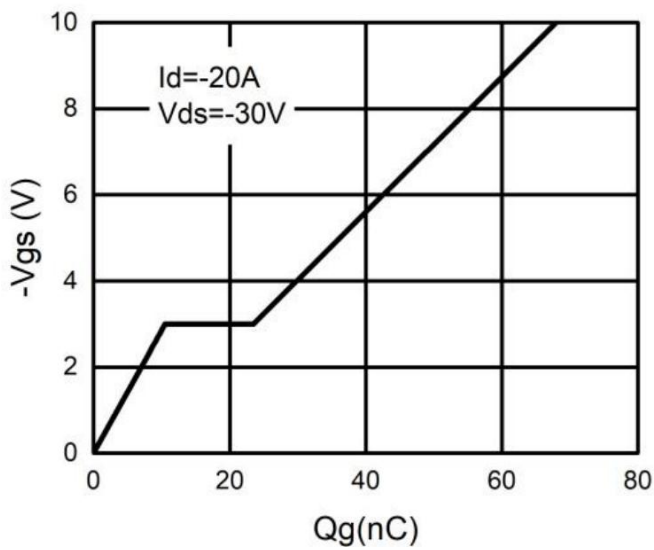


Figure.8 Capacitance

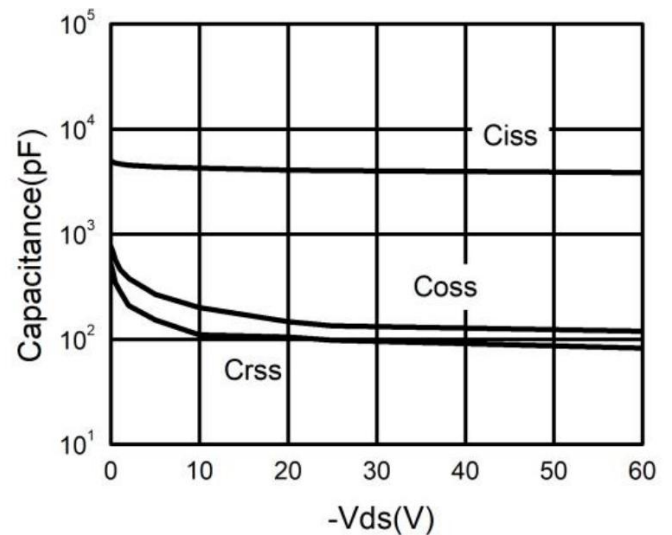


Figure.9 Body-Diode Characteristics

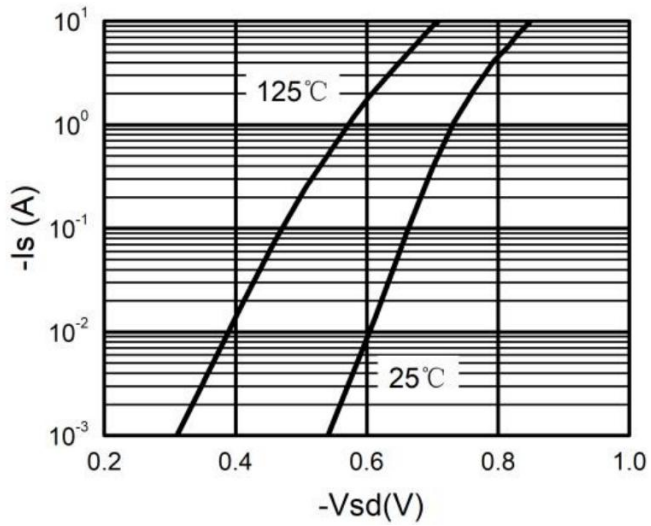
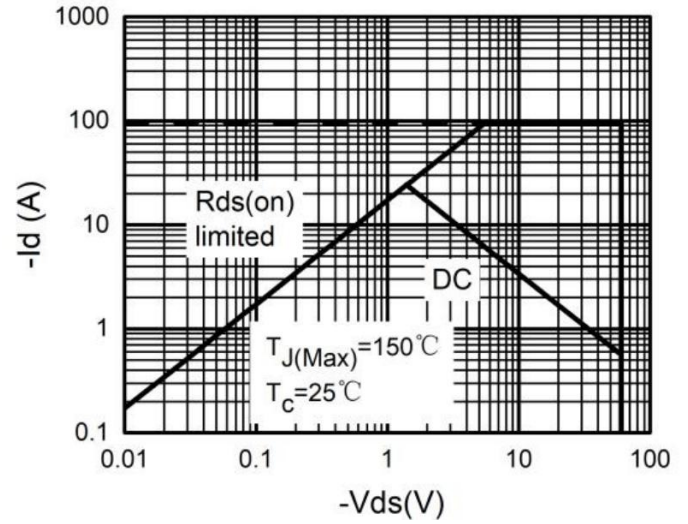
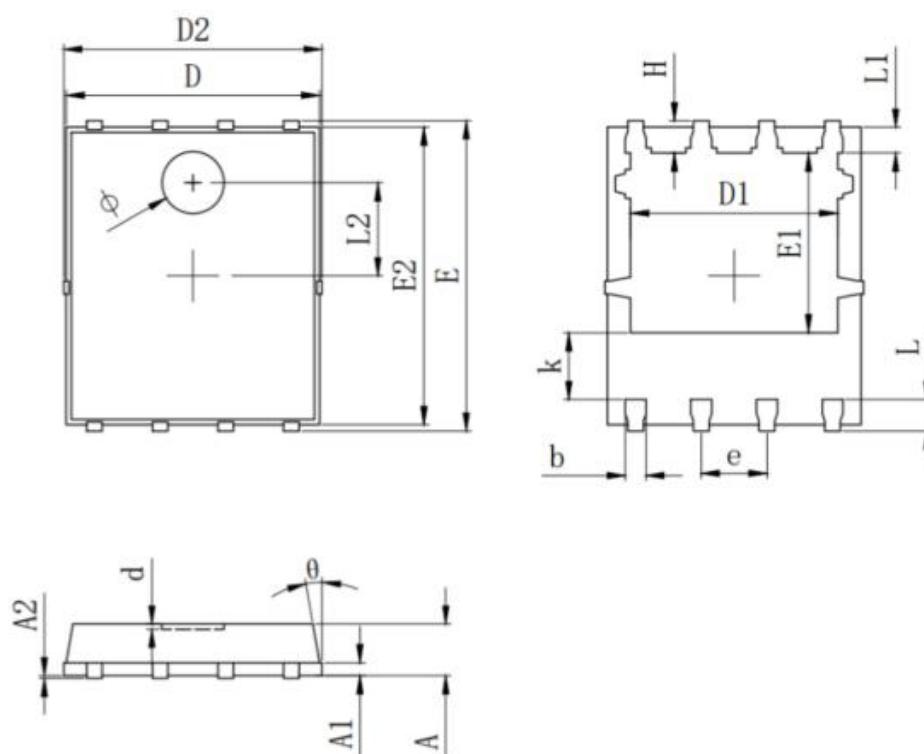


Figure.10 Maximum Safe Operating Area



## Package Outline: PDFN5\*6-8L



| SMBOL | MILLIMETER |       |       |
|-------|------------|-------|-------|
|       | MIN        | Typ   | MAX   |
| A     | 0.900      | 1.000 | 1.100 |
| A1    | 0.254ref   |       |       |
| A2    | 0~0.05     |       |       |
| D     | 4.824      | 4.900 | 4.976 |
| D1    | 3.910      | 4.010 | 4.110 |
| D2    | 4.924      | 5.000 | 5.076 |
| E     | 5.924      | 6.000 | 6.076 |
| E1    | 3.375      | 3.475 | 3.575 |
| E2    | 5.674      | 5.75  | 5.826 |
| b     | 0.350      | 0.400 | 0.450 |
| e     | 1.270TYP   |       |       |
| L     | 0.534      | 0.610 | 0.686 |
| L1    | 0.424      | 0.500 | 0.576 |
| L2    | 1.800REF   |       |       |
| k     | 1.190      | 1.290 | 1.390 |
| H     | 0.549      | 0.625 | 0.701 |
| θ     | 8°         | 10°   | 12°   |
| Φ     | 1.100      | 1.200 | 1.300 |
| d     |            |       | 0.100 |