

## Product Summary

| $V_{(BR)DSS}$ | $R_{DS(on)TYP}$ | $I_D$ |
|---------------|-----------------|-------|
| 60V           | 13.0mΩ@10V      | 18A   |
|               | 21.0mΩ@4.5V     |       |



**合肥矽普半导体**

Siliup Semiconductor Technology Co., Ltd

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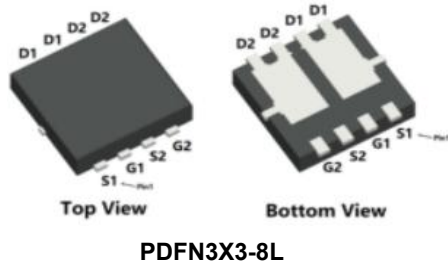
## Feature

- Fast switching speed
- Surface mount package
- Advanced Split Gate Trench Technology
- 100% Single Pulse avalanche energy Test

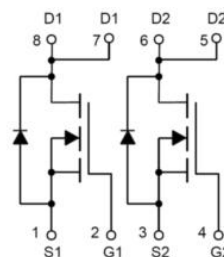
## Applications

- DC-DC Converters.
- Motor Control.

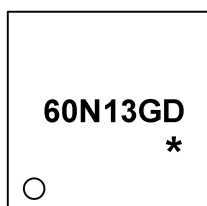
## Package



## Circuit diagram



## Marking



60N13GD :Device Code  
\* :Month Code

## Order Information

| Device      | Package    | Unit/Tape |
|-------------|------------|-----------|
| SP60N13GDNJ | PDFN3X3-8L | 5000      |

**Absolute maximum ratings (Ta=25°C, unless otherwise noted)**

| Parameter                                  | Symbol          | Rating     | Unit |
|--------------------------------------------|-----------------|------------|------|
| Drain-Source Voltage                       | $V_{DS}$        | 60         | V    |
| Gate-Source Voltage                        | $V_{GS}$        | $\pm 20$   | V    |
| Continuous Drain Current (Tc=25°C)         | $I_D$           | 18         | A    |
| Continuous Drain Current (Tc=100°C)        | $I_D$           | 12         | A    |
| Pulse Drain Current Tested                 | $I_{DM}$        | 72         | A    |
| Single Pulse Avalanche Energy <sup>1</sup> | $E_{AS}$        | 64         | mJ   |
| Power Dissipation (Tc=25°C)                | $P_D$           | 30         | W    |
| Power Dissipation (Tc=100°C)               | $P_D$           | 12         | W    |
| Thermal Resistance Junction-to-Case        | $R_{\theta JC}$ | 4.17       | °C/W |
| Maximum Junction Temperature               | $T_J$           | -55 to 150 | °C   |
| Storage Temperature Range                  | $T_{STG}$       | -55 to 150 | °C   |

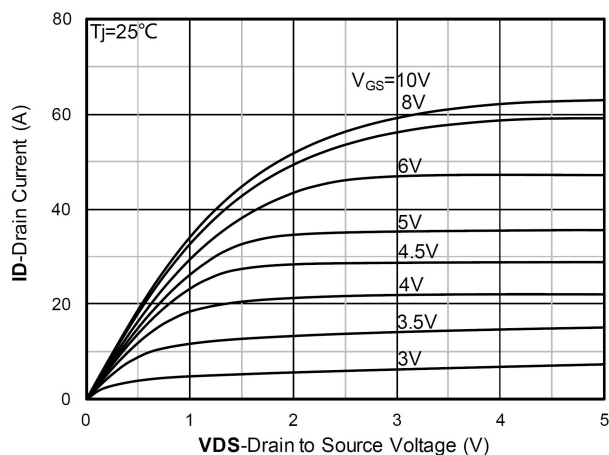
**Electrical characteristics (Ta=25°C, unless otherwise noted)**

| Characteristics                         | Symbol            | Test Condition                    | Min | Typ  | Max  | Unit |
|-----------------------------------------|-------------------|-----------------------------------|-----|------|------|------|
| Static Characteristics                  |                   |                                   |     |      |      |      |
| Drain-Source Breakdown Voltage          | BV <sub>DSS</sub> | VGS=0V, ID=250uA                  | 60  | -    | -    | V    |
| Zero Gate Voltage Drain Current         | IDSS              | VDS=48V, VGS=0V                   | -   | -    | 1    | uA   |
| Gate Leakage Current                    | IGSS              | VGS=±20V, VDS=0V                  | -   | -    | ±100 | nA   |
| Gate Threshold Voltage                  | VGS(th)           | VDS=VGS, ID=250uA                 | 1.3 | 1.7  | 2.3  | V    |
| Drain-Source On-state Resistance        | RDS(ON)           | VGS=10V, ID=15A                   | -   | 13.0 | 18.0 | mΩ   |
|                                         |                   | VGS=4.5V, ID=10A                  | -   | 21.0 | 28.0 |      |
| Gate Resistance                         | RG                | f=1MHz                            | -   | 2.4  | -    | Ω    |
| Dynamic Characteristics                 |                   |                                   |     |      |      |      |
| Input Capacitance                       | Ciss              | VGS=0V, VDS=30V, F=1MHz           | -   | 709  | -    | pF   |
| Output Capacitance                      | Coss              |                                   | -   | 203  | -    |      |
| Reverse Transfer Capacitance            | Crss              |                                   | -   | 12   | -    |      |
| Total Gate Charge                       | Qg                | VDS=30V, VGS=10V, ID=10A          | -   | 10   | -    | nC   |
| Gate-Source Charge                      | Qgs               |                                   | -   | 2.6  | -    |      |
| Gate-Drain Charge                       | Qgd               |                                   | -   | 1.9  | -    |      |
| Gate Plateau Voltage                    | Vplateau          |                                   | -   | 3.3  | -    | V    |
| Switching Characteristics               |                   |                                   |     |      |      |      |
| Turn-On Delay Time                      | td(on)            | VDD=30V, ID=10A, VGS=10V, RG=4.7Ω | -   | 3    | -    | nS   |
| Rise Time                               | tr                |                                   | -   | 4.5  | -    |      |
| Turn-Off Delay Time                     | td(off)           |                                   | -   | 13.2 | -    |      |
| Fall Time                               | tf                |                                   | -   | 4.8  | -    |      |
| Drain-Source Body Diode Characteristics |                   |                                   |     |      |      |      |
| Source-Drain Diode Forward Voltage      | VSD               | VGS=0V , IS=1A , TJ=25℃           | -   | -    | 1.2  | V    |
| Maximum Body-Diode Continuous Current   | IS                |                                   | -   | -    | 18   | A    |
| Reverse Recovery Time                   | Trr               | IS=10A , di/dt=100A/μs , TJ=25℃   | -   | 14   | -    | nS   |
| Reverse Recovery Charge                 | Qrr               |                                   | -   | 9    | -    | nC   |

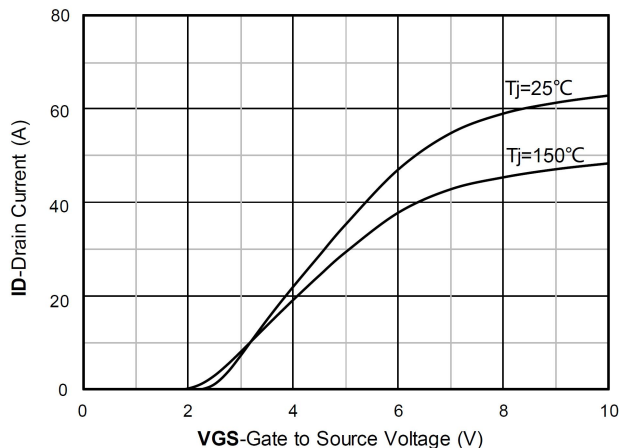
**Note :**

1. The test condition is  $V_{DD}=30V, V_{GS}=10V, L=0.5mH, R_G=25\Omega$ ;

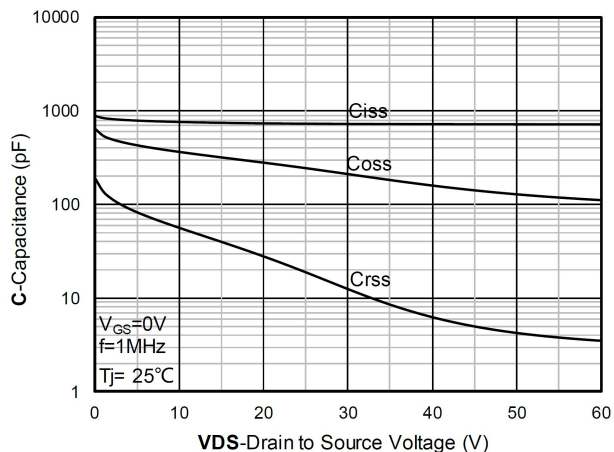
## Typical Characteristics



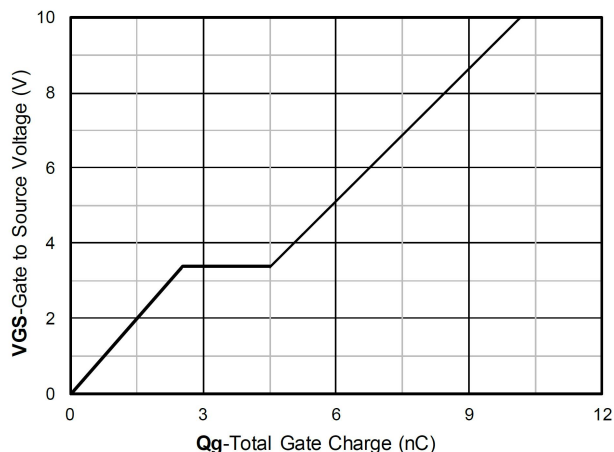
Output Characteristics



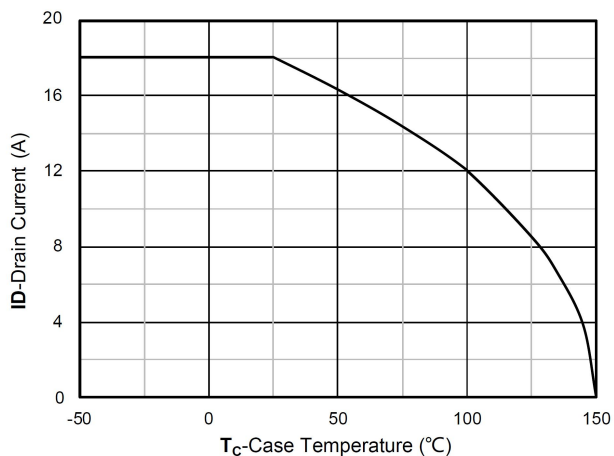
Transfer Characteristics



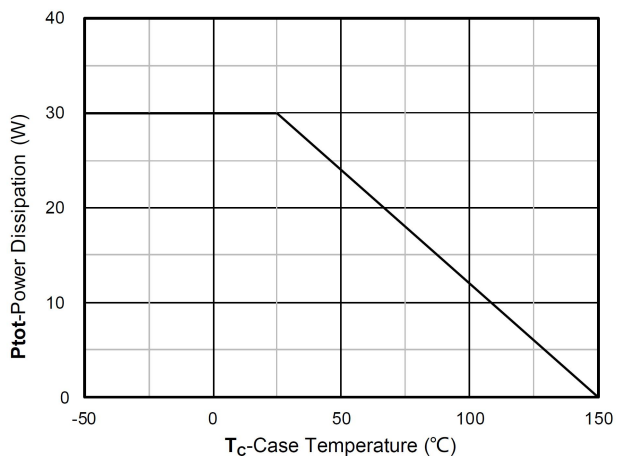
Capacitance Characteristics



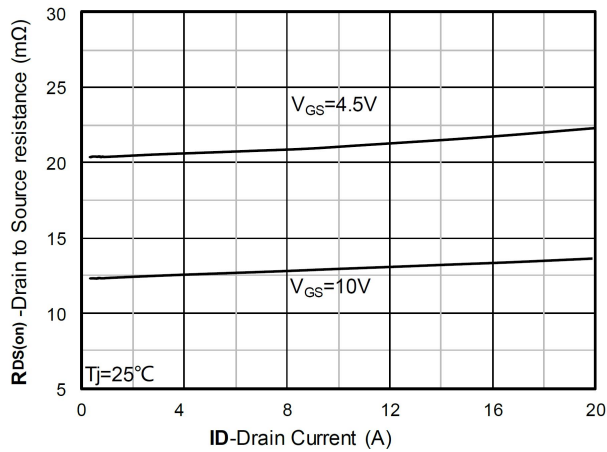
Gate Charge



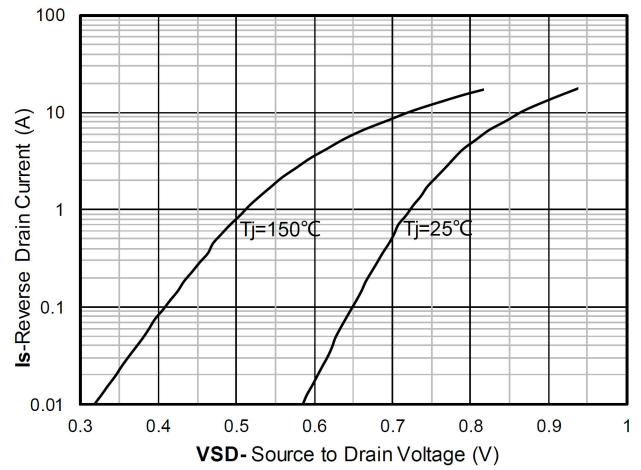
Current dissipation



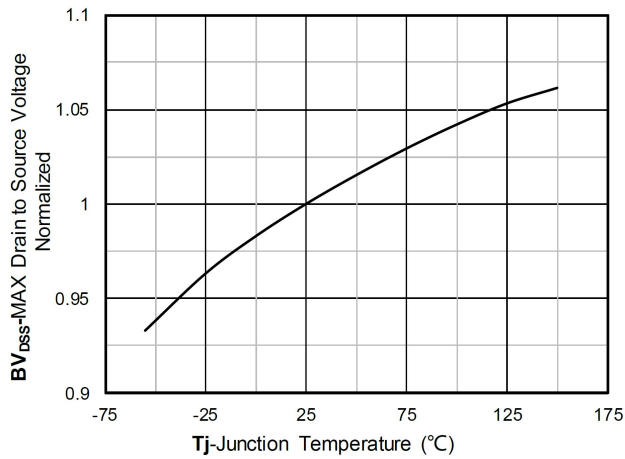
Power dissipation



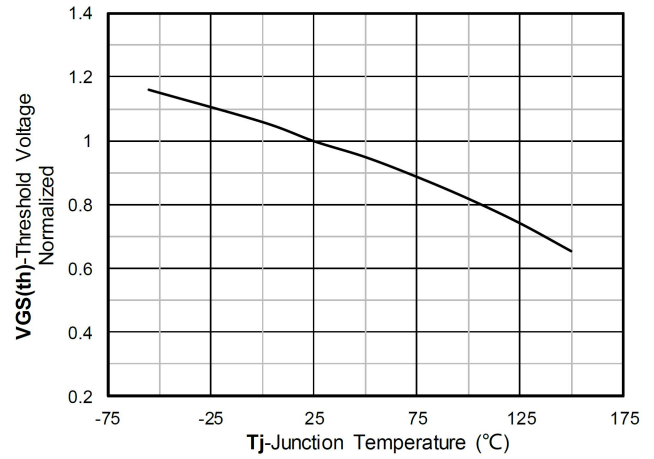
RDS(on) vs. Drain Current



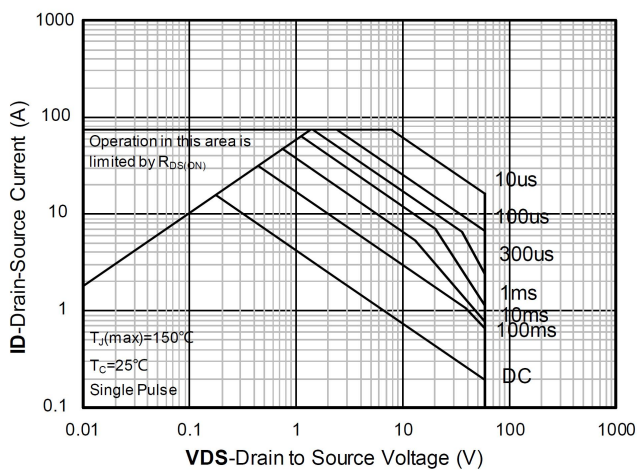
Forward characteristics of reverse diode



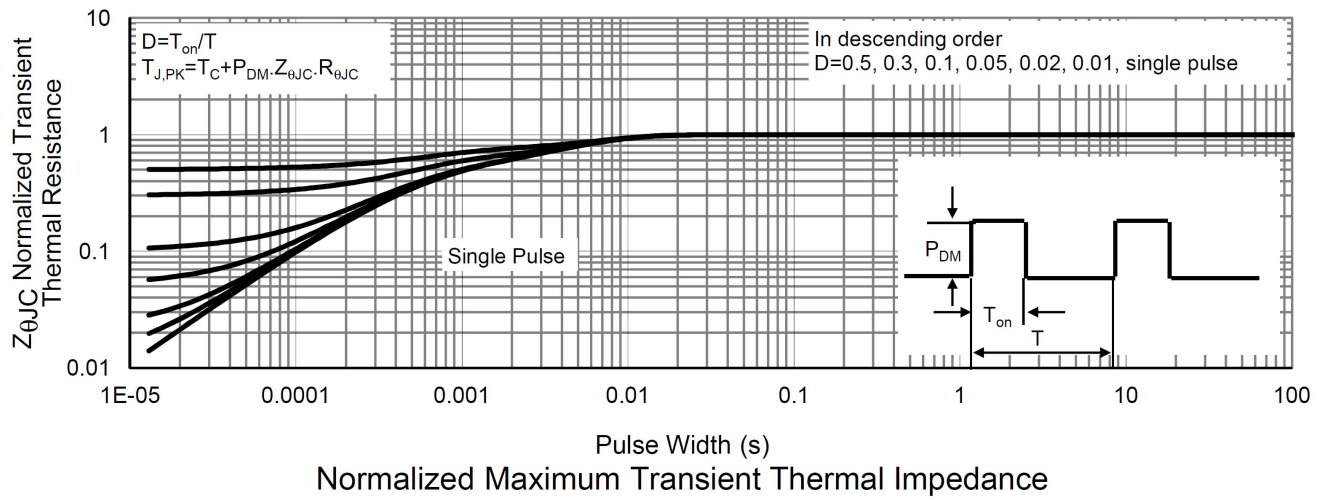
Normalized breakdown voltage



Normalized Threshold voltage

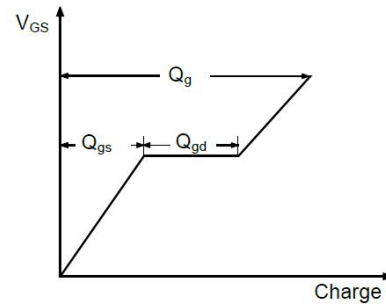
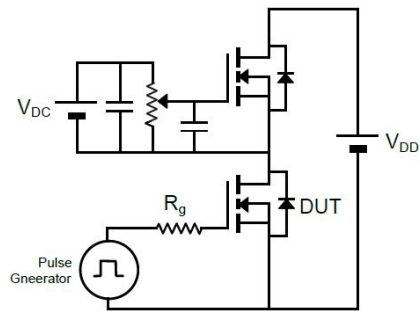


Safe Operation Area

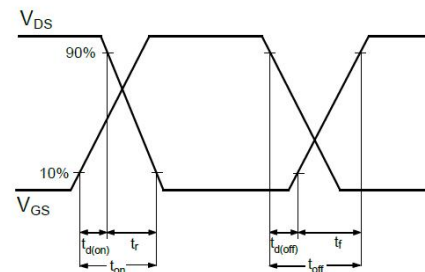
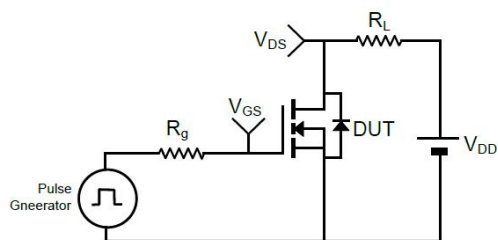


## Test Circuit

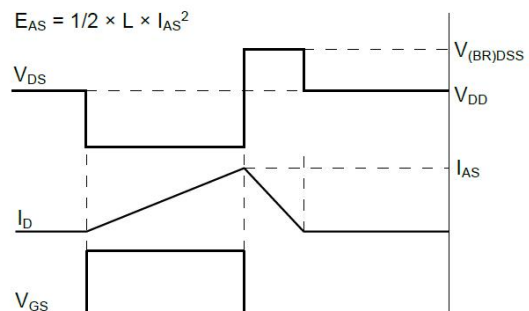
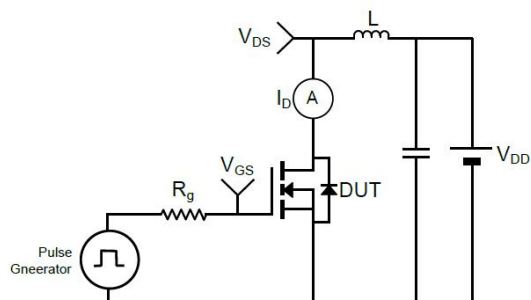
### Gate Charge



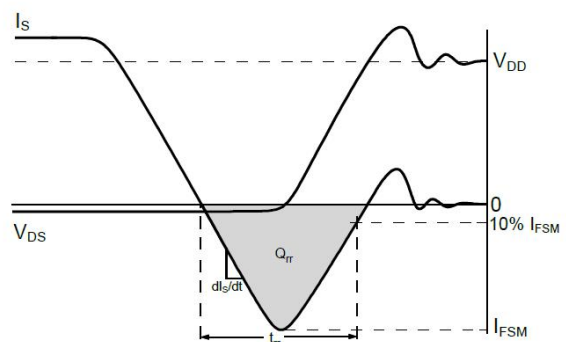
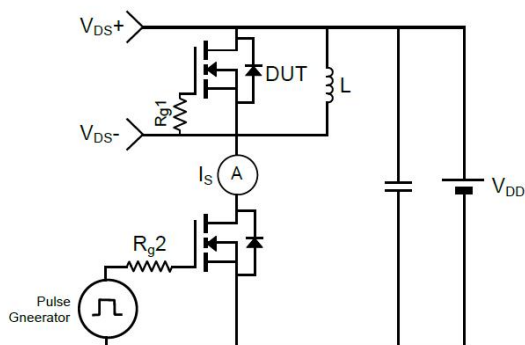
### Resistive Load Switching Time



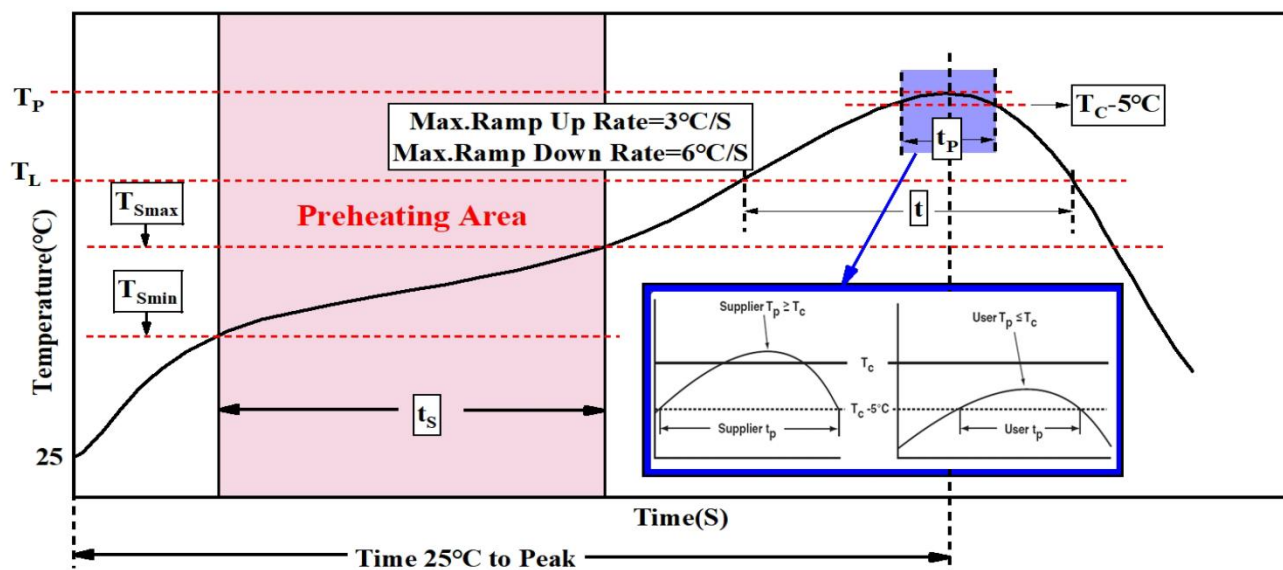
### Un-clamped Inductive Load Switching



### Drain-Source Body Diode Reverse Recovery



## Temperature Profile for IR Reflow Soldering



| Profile Feature                                                                                                                                                                                                            | Sn-Pb Eutectic Assembly            | Pb-Free Assembly                   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|------------------------------------|
| <b>Preheat &amp; Soak</b>                                                                                                                                                                                                  |                                    |                                    |
| Temperature min ( $T_{Smin}$ )                                                                                                                                                                                             | 100°C                              | 150°C                              |
| Temperature max ( $T_{Smax}$ )                                                                                                                                                                                             | 150°C                              | 200°C                              |
| Time ( $T_{Smin}$ to $T_{Smax}$ ) ( $t_s$ )                                                                                                                                                                                | 60-120 seconds                     | 60-120 seconds                     |
| Average ramp-up rate ( $T_{Smax}$ to $T_P$ )                                                                                                                                                                               | 3 °C/second max.                   | 3°C/second max.                    |
| Liquidous temperature ( $T_L$ )                                                                                                                                                                                            | 183 °C                             | 217°C                              |
| Time at liquidous ( $t_L$ )                                                                                                                                                                                                | 60-150 seconds                     | 60-150 seconds                     |
| Peak package body Temperature e ( $T_P$ )*                                                                                                                                                                                 | See Classification Temp in table 1 | See Classification Temp in table 2 |
| Time ( $t_P$ )** within 5°C of the specified classification temperature ( $T_C$ )                                                                                                                                          | 20** seconds                       | 30** seconds                       |
| Average ramp-down rate ( $T_P$ to $T_{Smax}$ )                                                                                                                                                                             | 6 °C/second max.                   | 6 °C/second max.                   |
| Time 25°C to peak temperature                                                                                                                                                                                              | 6 minutes max.                     | 8 minutes max.                     |
| * Tolerance for peak profile Temperature ( $T_P$ ) is defined as a supplier minimum and a user maximum.<br>** Tolerance for time at peak profile temperature ( $t_P$ ) is defined as a supplier minimum and a user maximum |                                    |                                    |

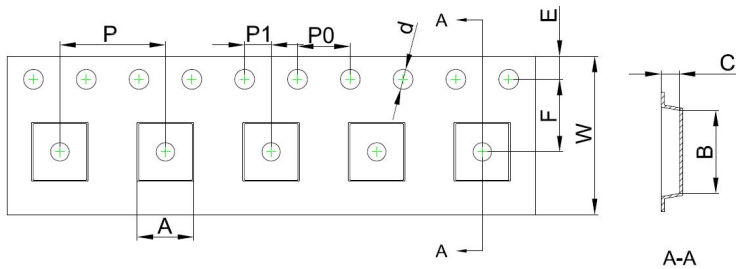
Table 1. SnPb Eutectic Process – Classification Temperatures ( $T_C$ )

| Package Thickness | Volume mm <sup>3</sup> <350 | Volume mm <sup>3</sup> ≥350 |
|-------------------|-----------------------------|-----------------------------|
| <2.5 mm           | 235 °C                      | 220 °C                      |
| ≥2.5 mm           | 220 °C                      | 220 °C                      |

Table 2. Pb-free Process – Classification Temperatures ( $T_C$ )

| Package Thickness | Volume mm <sup>3</sup> <350 | Volume mm <sup>3</sup> 350-2000 | Volume mm <sup>3</sup> >2000 |
|-------------------|-----------------------------|---------------------------------|------------------------------|
| <1.6 mm           | 260 °C                      | 260 °C                          | 260 °C                       |
| 1.6 mm – 2.5 mm   | 260 °C                      | 250 °C                          | 245 °C                       |
| ≥2.5 mm           | 250 °C                      | 245 °C                          | 245 °C                       |

## PDFN3X3-8L Reel Information

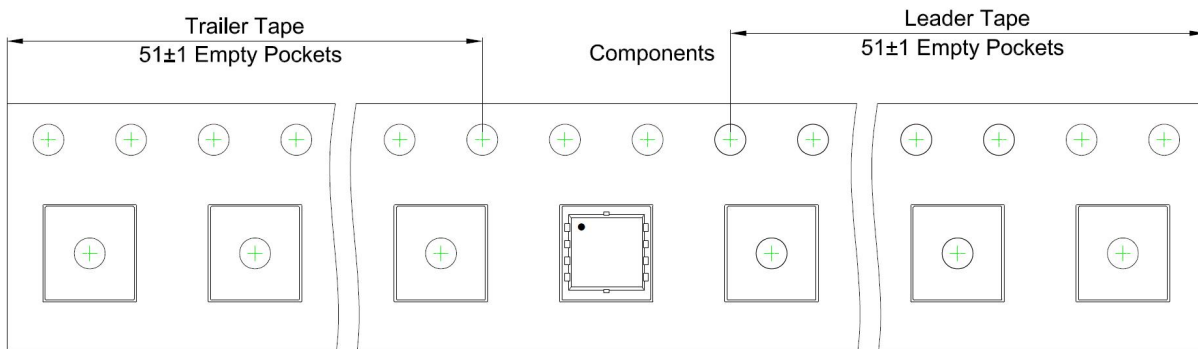


### Packaging Description:

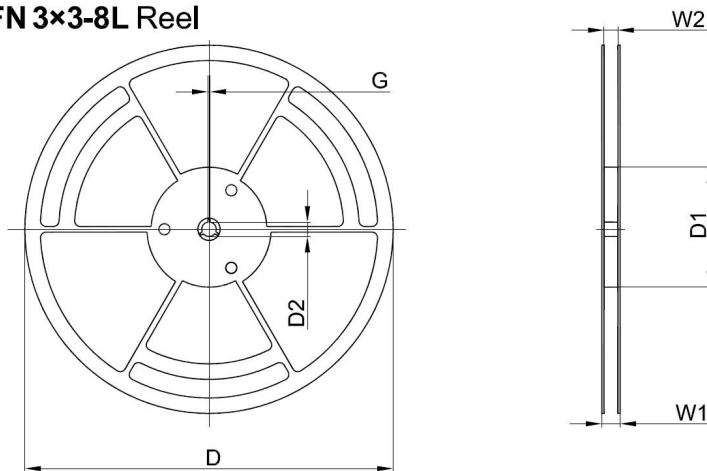
**PDFN 3x3-8L** parts are shipped in tape. The carrier tape is made from a dissipative (carbon filled) polycarbonate resin. The cover tape is a multilayer film (Heat Activated Adhesive in nature) primarily composed of polyester film, adhesive layer, sealant, and anti-static sprayed agent. These reeled parts in standard option are shipped with 5,000 units per 13" or 33.0 cm diameter reel. The reels are clear in color and is made of polystyrene plastic (anti-static coated).

| Dimensions are in millimeter |      |      |      |       |      |      |      |      |      |       |
|------------------------------|------|------|------|-------|------|------|------|------|------|-------|
| Pkg type                     | A    | B    | C    | d     | E    | F    | P0   | P    | P1   | W     |
| PDFN3x3-8L                   | 3.55 | 3.55 | 1.10 | Ø1.50 | 1.75 | 5.50 | 4.00 | 8.00 | 2.00 | 12.00 |

## PDFN 3x3-8L Tape Leader and Trailer



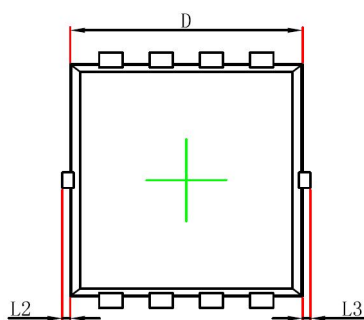
## PDFN 3x3-8L Reel



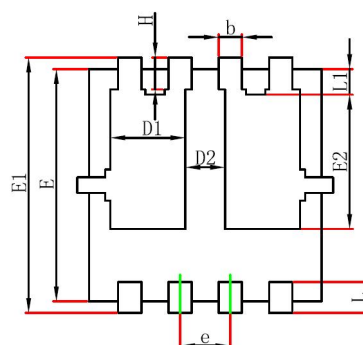
| Dimensions are in millimeter |         |        |       |      |       |       |
|------------------------------|---------|--------|-------|------|-------|-------|
| Reel Option                  | D       | D1     | D2    | G    | W1    | W2    |
| 13"Dia                       | Ø330.00 | 100.00 | 13.00 | 1.90 | 17.60 | 12.40 |

| REEL      | Reel Size | Box       | Box Size(mm) | Carton     | Carton Size(mm) |
|-----------|-----------|-----------|--------------|------------|-----------------|
| 5,000 pcs | 13 inch   | 5,000 pcs | 340×336×29   | 50,000 pcs | 353×346×365     |

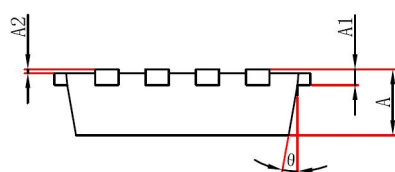
# PDFN3X3-8L Package Information



Top View  
[顶视图]



Bottom View  
[背视图]



Side View  
[侧视图]

| Symbol | Dimensions In Millimeters |       |
|--------|---------------------------|-------|
|        | Min.                      | Max.  |
| A      | 0.650                     | 0.850 |
| A1     | 0.152 REF.                |       |
| A2     | 0~0.05                    |       |
| D      | 2.900                     | 3.200 |
| D1     | 0.935                     | 1.135 |
| D2     | 0.280                     | 0.480 |
| E      | 2.900                     | 3.100 |
| E1     | 3.100                     | 3.450 |
| E2     | 1.535                     | 1.935 |
| b      | 0.200                     | 0.400 |
| e      | 0.550                     | 0.750 |
| L      | 0.300                     | 0.500 |
| L1     | 0.180                     | 0.480 |
| L2     | 0~0.100                   |       |
| L3     | 0~0.100                   |       |
| H      | 0.315                     | 0.515 |
| θ      | 9°                        | 13°   |