

# FMH35N60S1FD

FUJI POWER MOSFET

## Super J MOS<sup>®</sup> S1 series

N-Channel enhancement mode power MOSFET

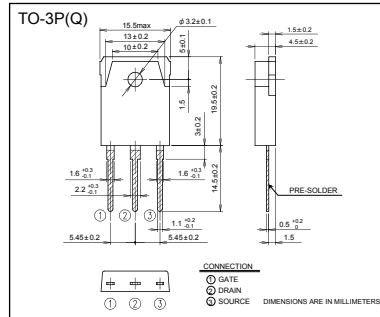
### ■ Features

- Low on-state resistance
- Low switching loss
- easy to use (more controllable switching dV/dt by R<sub>g</sub>)

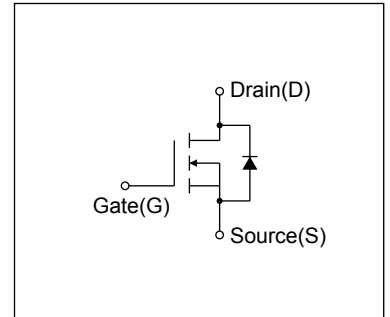
### ■ Applications

- UPS
- Server
- Telecom
- Power conditioner system
- Power supply

### ■ Outline Drawings [mm]



### ■ Equivalent circuit schematic



### ■ Absolute Maximum Ratings at T<sub>c</sub>=25°C (unless otherwise specified)

| Description                                             | Symbol               | Characteristics | Unit  | Remarks                      |
|---------------------------------------------------------|----------------------|-----------------|-------|------------------------------|
| Drain-Source Voltage                                    | V <sub>DS</sub>      | 600             | V     |                              |
|                                                         | V <sub>DSX</sub>     | 600             | V     | V <sub>GS</sub> =-30V        |
| Continuous Drain Current                                | I <sub>D</sub>       | ±35             | A     | T <sub>c</sub> =25°C Note*1  |
|                                                         | I <sub>D</sub>       | ±22             | A     | T <sub>c</sub> =100°C Note*1 |
| Pulsed Drain Current                                    | I <sub>DP</sub>      | ±105            | A     | Note*1                       |
| Gate-Source Voltage                                     | V <sub>GS</sub>      | ±30             | V     |                              |
| Repetitive and Non-Repetitive Maximum Avalanche Current | I <sub>AR</sub>      | 6.6             | A     | Note *2                      |
| Non-Repetitive Maximum Avalanche Energy                 | E <sub>AS</sub>      | 1239.6          | mJ    | Note *3                      |
| Maximum Drain-Source dV/dt                              | dV <sub>DS</sub> /dt | 50              | kV/μs | V <sub>DS</sub> ≤ 600V       |
| Peak Diode Recovery dV/dt                               | dV/dt                | 30              | kV/μs | Note *4                      |
| Peak Diode Recovery -di/dt                              | -di/dt               | 100             | A/μs  | Note *5                      |
| Maximum Power Dissipation                               | P <sub>D</sub>       | 2.5             | W     | T <sub>s</sub> =25°C         |
|                                                         |                      | 270             |       | T <sub>c</sub> =25°C         |
| Operating and Storage Temperature range                 | T <sub>ch</sub>      | 150             | °C    |                              |
|                                                         | T <sub>stg</sub>     | -55 to +150     | °C    |                              |

Note \*1 : Limited by maximum channel temperature.  
 Note \*2 : T<sub>ch</sub>≤150°C, See Fig.1 and Fig.2  
 Note \*3 : Starting T<sub>ch</sub>=25°C, I<sub>AS</sub>=4A, L=142mH, V<sub>DD</sub>=60V, R<sub>G</sub>=50Ω, See Fig.1 and Fig.2  
 E<sub>AS</sub> limited by maximum channel temperature and avalanche current.  
 Note \*4 : I<sub>F</sub>≤-I<sub>D</sub>, -di/dt=100A/μs, V<sub>DS peak</sub>≤600V, T<sub>ch</sub>≤150°C.  
 Note \*5 : I<sub>F</sub>≤-I<sub>D</sub>, dV/dt=30kV/μs, V<sub>DS peak</sub>≤600V, T<sub>ch</sub>≤150°C.

### ■ Electrical Characteristics at T<sub>c</sub>=25°C (unless otherwise specified)

• Static Ratings

| Description                      | Symbol              | Conditions                                                | min.                   | typ.  | max.  | Unit |    |
|----------------------------------|---------------------|-----------------------------------------------------------|------------------------|-------|-------|------|----|
| Drain-Source Breakdown Voltage   | BV <sub>DSS</sub>   | I <sub>D</sub> =250μA<br>V <sub>GS</sub> =0V              | 600                    | -     | -     | V    |    |
| Gate Threshold Voltage           | V <sub>GS(th)</sub> | I <sub>D</sub> =1.3mA<br>V <sub>DS</sub> =V <sub>GS</sub> | 3.0                    | 4.0   | 5.0   | V    |    |
| Zero Gate Voltage Drain Current  | I <sub>DSS</sub>    | V <sub>DS</sub> =600V<br>V <sub>GS</sub> =0V              | T <sub>ch</sub> =25°C  | -     | -     | 25   | μA |
|                                  |                     | V <sub>DS</sub> =480V<br>V <sub>GS</sub> =0V              | T <sub>ch</sub> =125°C | -     | 190   | -    |    |
| Gate-Source Leakage Current      | I <sub>GSS</sub>    | V <sub>GS</sub> = ± 30V<br>V <sub>DS</sub> =0V            | -                      | 10    | 100   | nA   |    |
| Drain-Source On-State Resistance | R <sub>DS(on)</sub> | I <sub>D</sub> =17.5A<br>V <sub>GS</sub> =10V             | -                      | 0.089 | 0.105 | Ω    |    |
| Gate resistance                  | R <sub>g</sub>      | f=1MHz, open drain                                        | -                      | 1.1   | -     | Ω    |    |

• Dynamic Ratings

| Description                                            | Symbol       | Conditions                                                                    | min. | typ. | max. | Unit |
|--------------------------------------------------------|--------------|-------------------------------------------------------------------------------|------|------|------|------|
| Forward Transconductance                               | $g_{fs}$     | $I_D=17.5A$<br>$V_{DS}=25V$                                                   | 13.5 | 27   | -    | S    |
| Input Capacitance                                      | $C_{iss}$    | $V_{DS}=400V$                                                                 | -    | 2530 | -    | pF   |
| Output Capacitance                                     | $C_{oss}$    | $V_{GS}=0V$<br>$f=250kHz$                                                     | -    | 75   | -    |      |
| Reverse Transfer Capacitance                           | $C_{rss}$    |                                                                               | -    | 5.5  | -    |      |
| Effective output capacitance, energy related (Note *6) | $C_{o(er)}$  | $V_{GS}=0V$<br>$V_{DS}=0...400V$                                              | -    | 195  | -    |      |
| Effective output capacitance, time related (Note *7)   | $C_{o(tr)}$  | $V_{GS}=0V$<br>$V_{DS}=0...400V$<br>$I_D=constant$                            | -    | 670  | -    |      |
| Turn-On Time                                           | $t_{d(on)}$  | $V_{DD}=400V, V_{GS}=10V$<br>$I_D=17.5A, R_G=18\Omega$<br>See Fig.3 and Fig.4 | -    | 116  | -    | ns   |
|                                                        | $t_r$        |                                                                               | -    | 28   | -    |      |
| Turn-Off Time                                          | $t_{d(off)}$ |                                                                               | -    | 163  | -    | ns   |
|                                                        | $t_f$        |                                                                               | -    | 18   | -    |      |
| Total Gate Charge                                      | $Q_G$        | $V_{DD}=400V, I_D=35A$<br>$V_{GS}=10V$<br>See Fig.5                           | -    | 92   | -    | nC   |
| Gate-Source Charge                                     | $Q_{GS}$     |                                                                               | -    | 24.5 | -    |      |
| Gate-Drain Charge                                      | $Q_{GD}$     |                                                                               | -    | 38   | -    |      |
| Drain-Source crossover Charge                          | $Q_{SW}$     |                                                                               | -    | 13   | -    |      |

Note \*6 :  $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 400V.

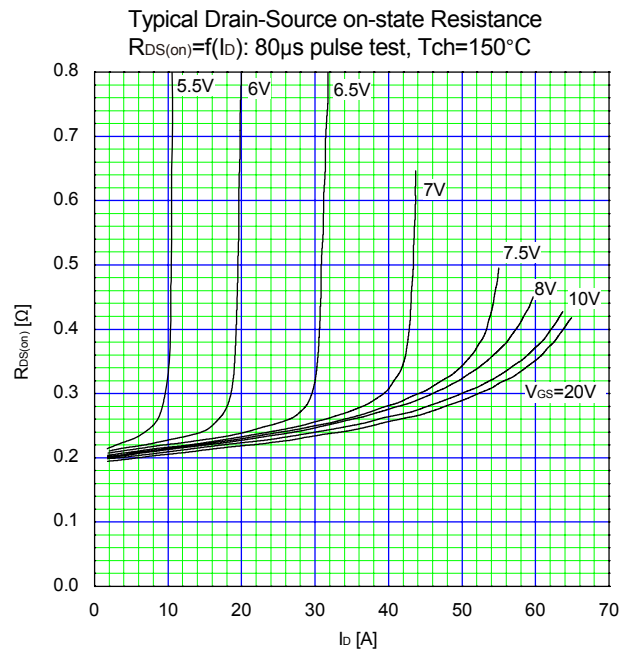
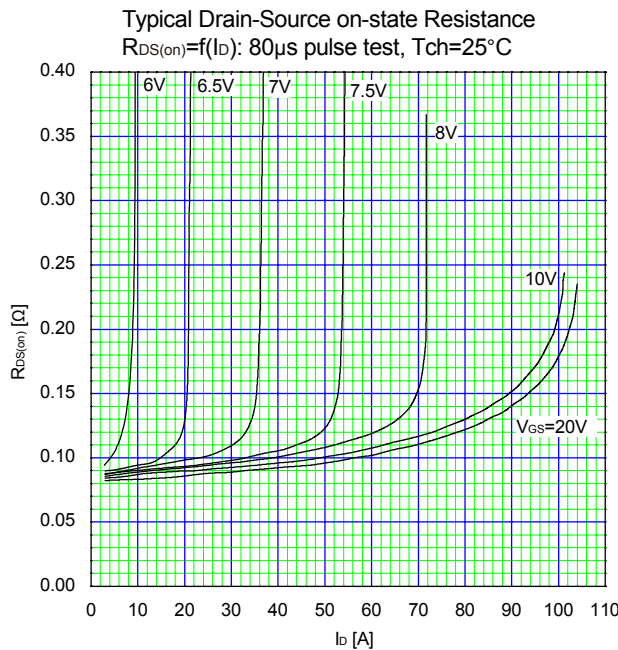
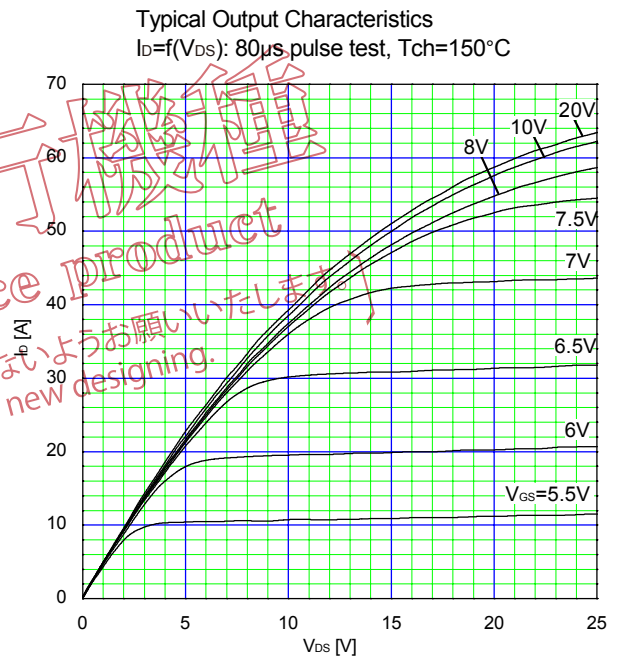
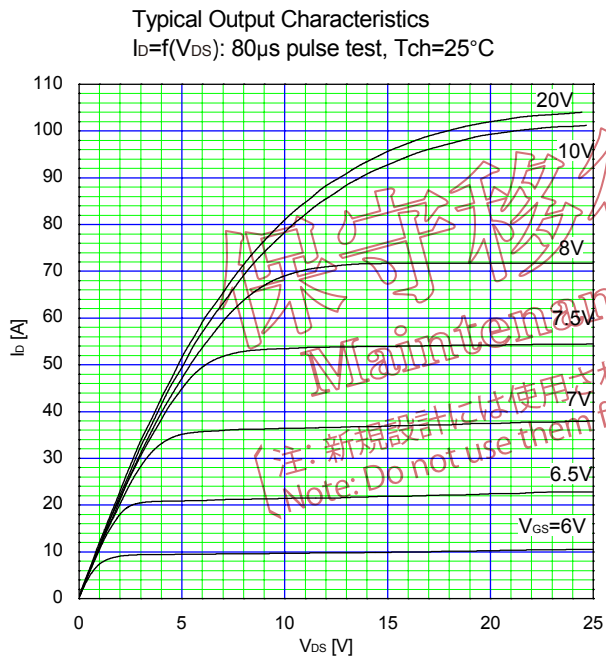
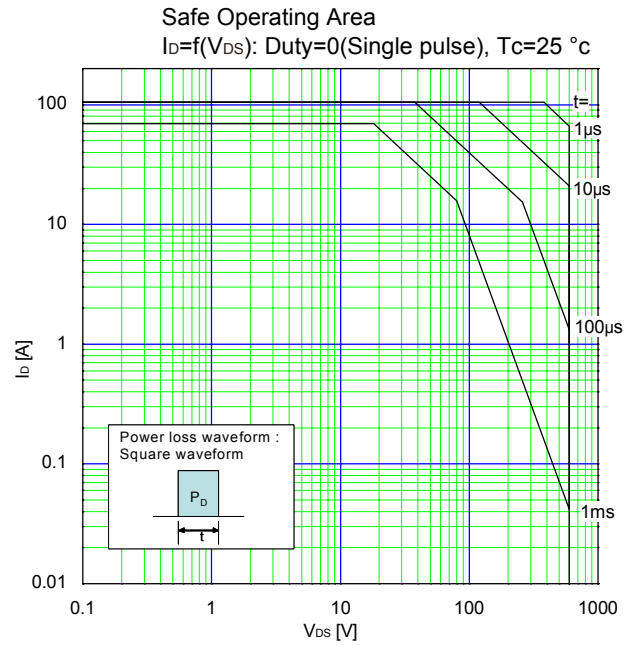
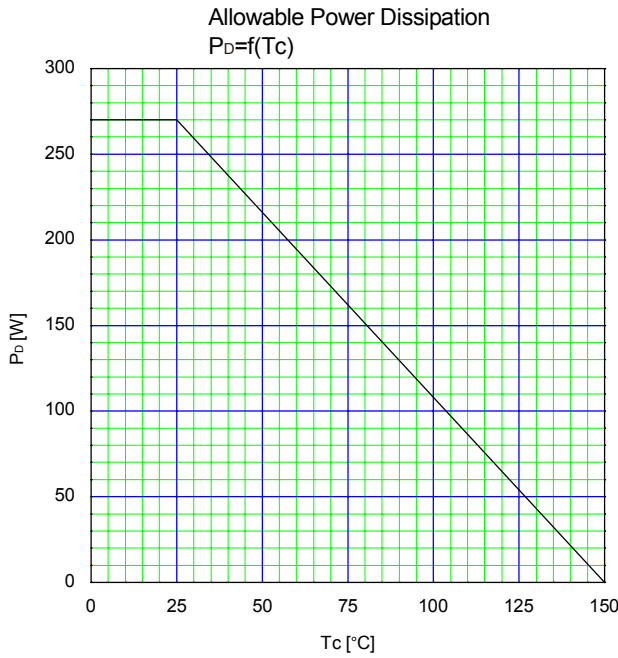
Note \*7 :  $C_{o(tr)}$  is a fixed capacitance that gives the same charging times as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 400V.

• Reverse Diode

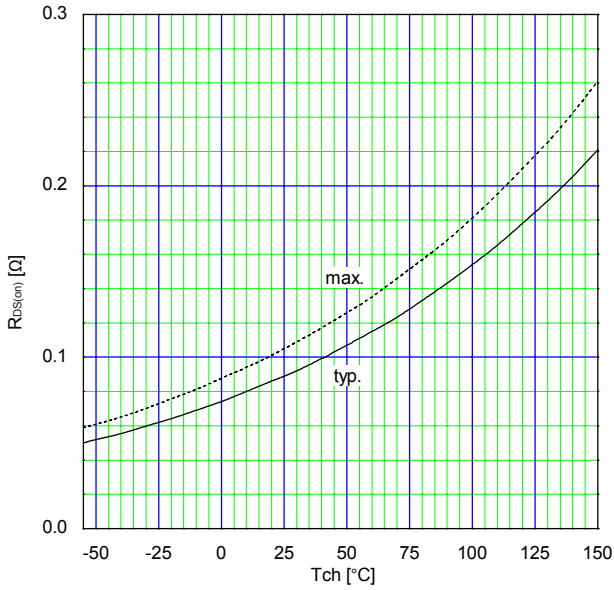
| Description                   | Symbol    | Conditions                                                                                                 | min. | typ. | max. | Unit    |
|-------------------------------|-----------|------------------------------------------------------------------------------------------------------------|------|------|------|---------|
| Avalanche Capability          | $I_{AV}$  | $L=31.6mH, T_{ch}=25^\circ C$<br>See Fig.1 and Fig.2                                                       | 6.6  | -    | -    | A       |
| Diode Forward On-Voltage      | $V_{SD}$  | $I_S=35A, V_{GS}=0V$<br>$T_{ch}=25^\circ C$                                                                | -    | 1    | 1.35 | V       |
| Reverse Recovery Time         | $t_{rr}$  | $I_S=35A, V_{DD}=400V$<br>$-di/dt=100A/\mu s$<br>$R_G=150\Omega, T_{ch}=25^\circ C$<br>See Fig.6 and Fig.7 | -    | 185  | -    | ns      |
| Reverse Recovery Charge       | $Q_{rr}$  |                                                                                                            | -    | 1.3  | -    | $\mu C$ |
| Peak Reverse Recovery Current | $I_{rrp}$ |                                                                                                            | -    | 14   | -    | A       |

■ Thermal Resistance

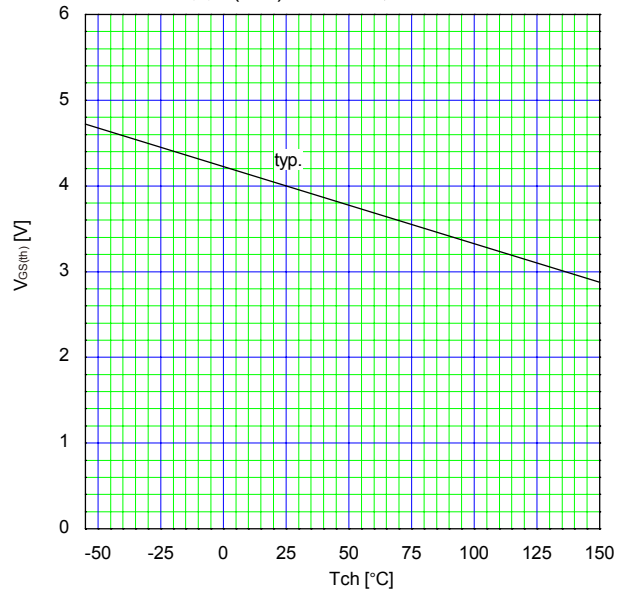
| Parameter          | Symbol         | min. | typ. | max. | Unit         |
|--------------------|----------------|------|------|------|--------------|
| Channel to Case    | $R_{th(ch-c)}$ | -    | -    | 0.46 | $^\circ C/W$ |
| Channel to Ambient | $R_{th(ch-a)}$ | -    | -    | 50   | $^\circ C/W$ |



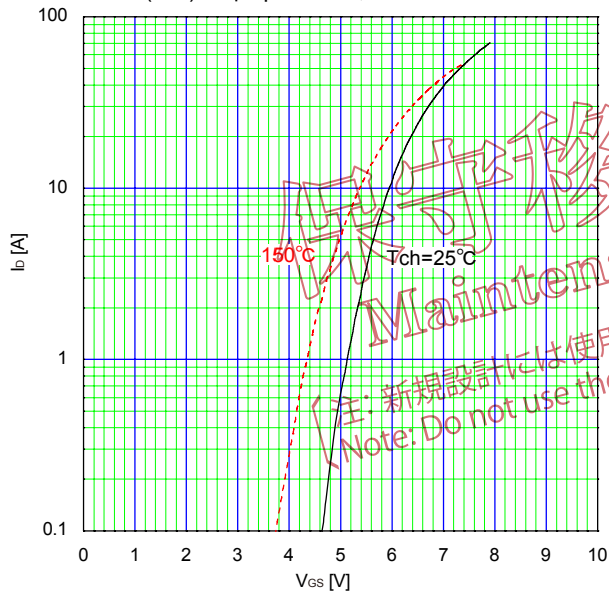
Drain-Source On-state Resistance  
 $R_{DS(on)}=f(T_{ch}): I_D=17.5A, V_{GS}=10V$



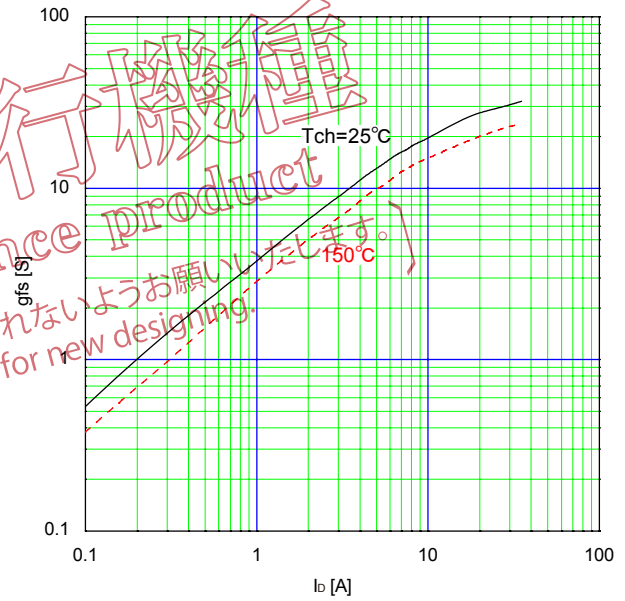
Gate Threshold Voltage vs. T<sub>ch</sub>  
 $V_{GS(th)}=f(T_{ch}): V_{DS}=V_{GS}, I_D=1.3mA$



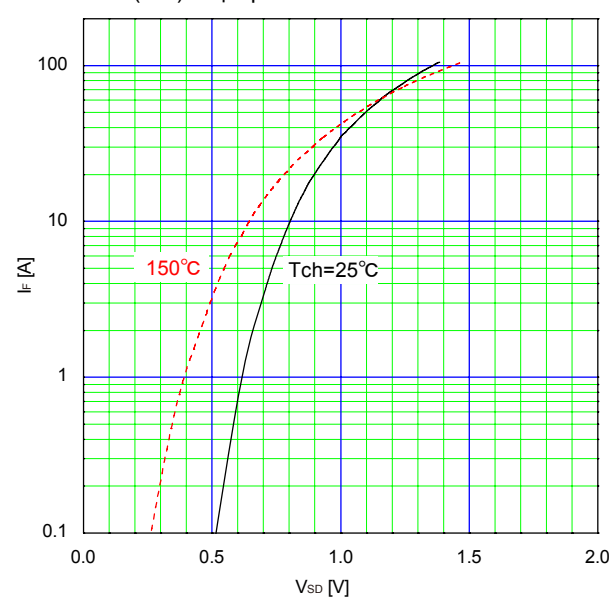
Typical Transfer Characteristic  
 $I_D=f(V_{GS}): 80\mu s \text{ pulse test}, V_{DS}=25V$



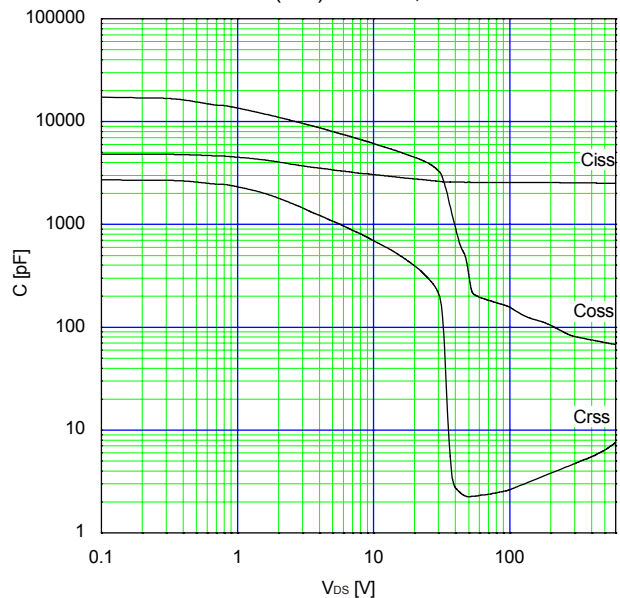
Typical Transconductance  
 $g_{fs}=f(I_D): 80\mu s \text{ pulse test}, V_{DS}=25V$



Typical Forward Characteristics of Reverse Diode  
 $I_F=f(V_{SD}): 80\mu s \text{ pulse test}$

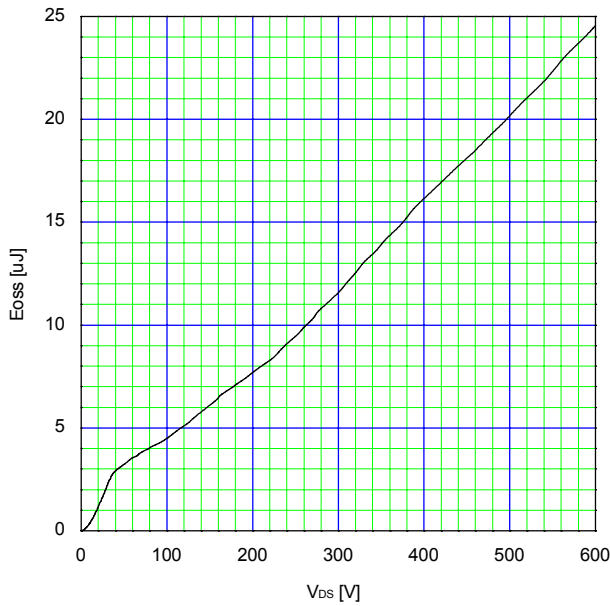


Typical Capacitance  
 $C=f(V_{DS}): V_{GS}=0V, f=250kHz$

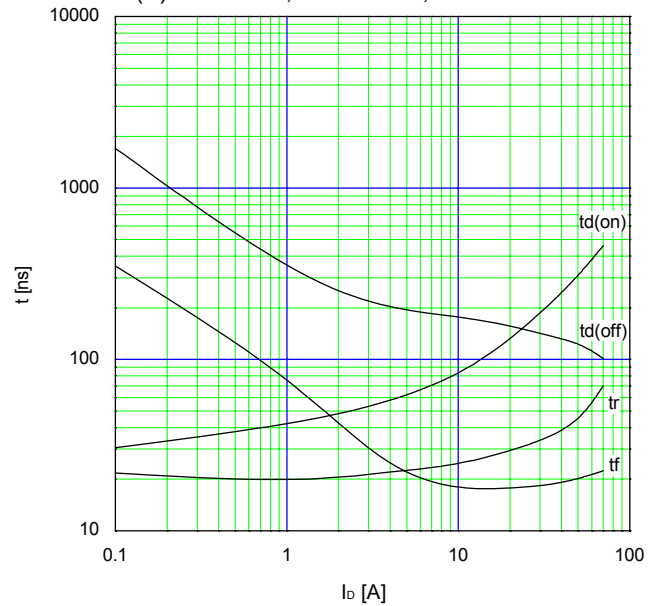


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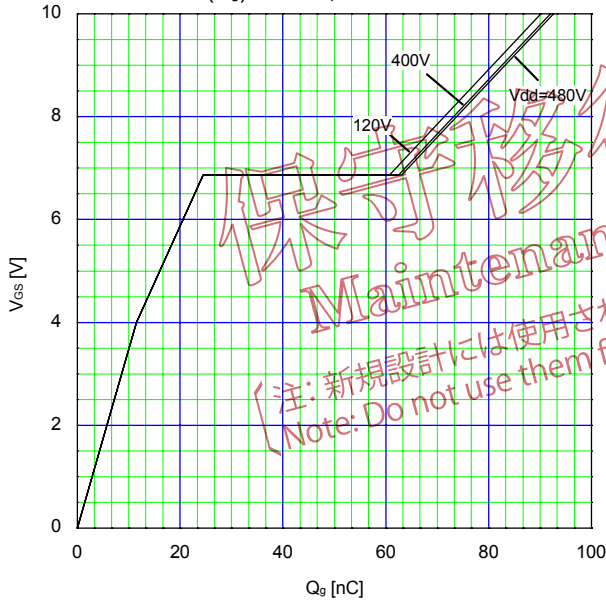
Typical Coss stored energy



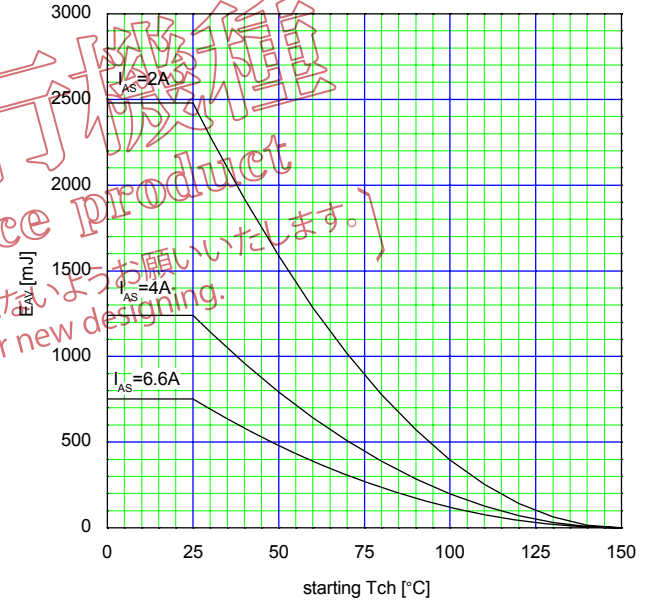
Typical Switching Characteristics vs. ID T<sub>ch</sub>=25 °C  
t=f(I<sub>D</sub>): V<sub>dd</sub>=400V, V<sub>GS</sub>=10V/0V, R<sub>G</sub>=18Ω



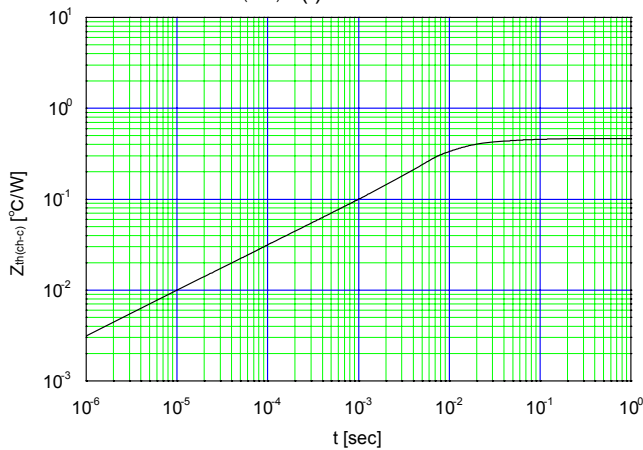
Typical Gate Charge Characteristics  
V<sub>GS</sub>=f(Q<sub>G</sub>): I<sub>D</sub>=35A, T<sub>ch</sub>=25°C



Maximum Avalanche Energy vs. starting T<sub>ch</sub>  
E(AV)=f(starting T<sub>ch</sub>): V<sub>CC</sub>=60V, I(AV)≤6.6A



Transient Thermal Impedance  
Z<sub>th(ch-c)</sub>=f(t): D=0



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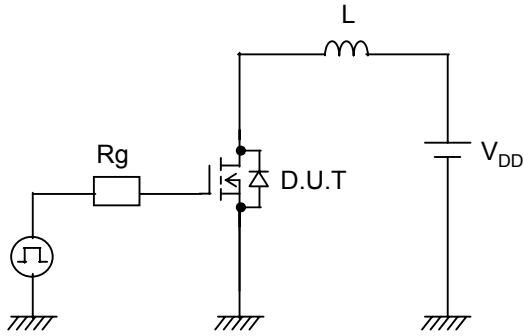


Fig.1 Avalanche Test circuit

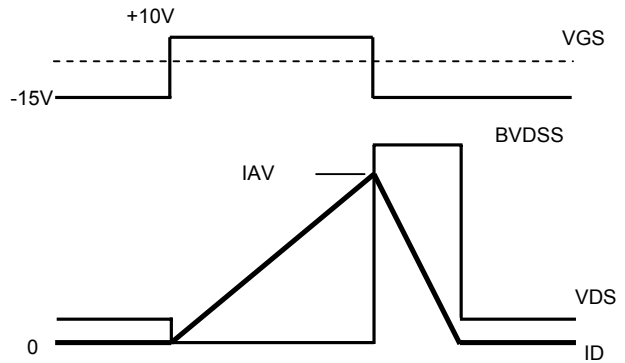


Fig.2 Operating waveforms of Avalanche Test

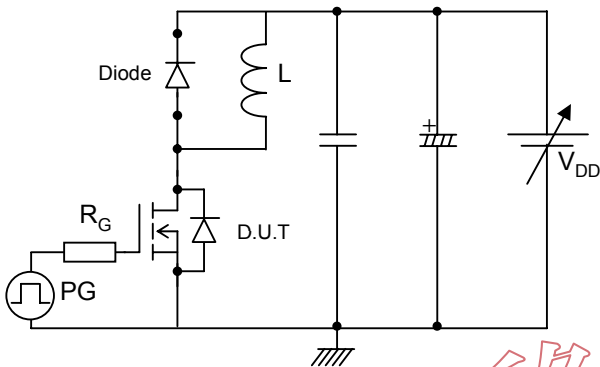


Fig.3 Switching Test circuit

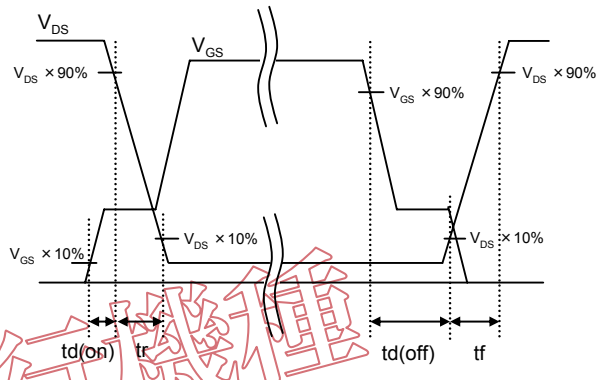


Fig.4 Operating waveform of Switching Test

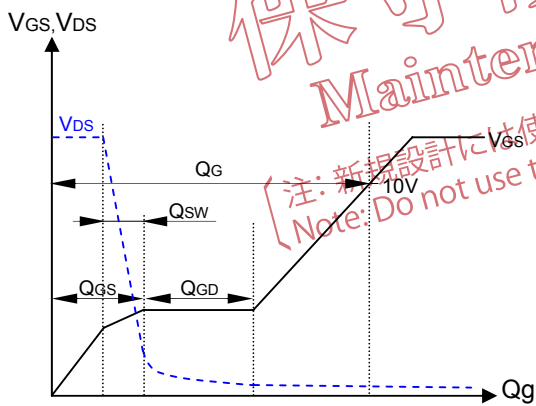


Fig.5 Operating waveform of Gate charge Test

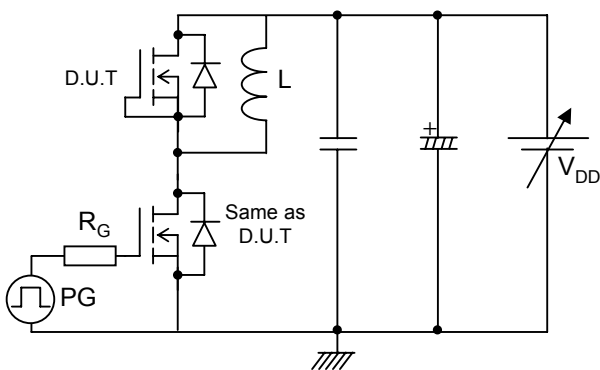


Fig.6 Reverse recovery Test circuit

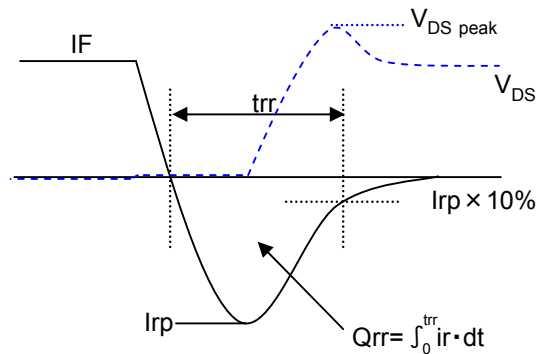
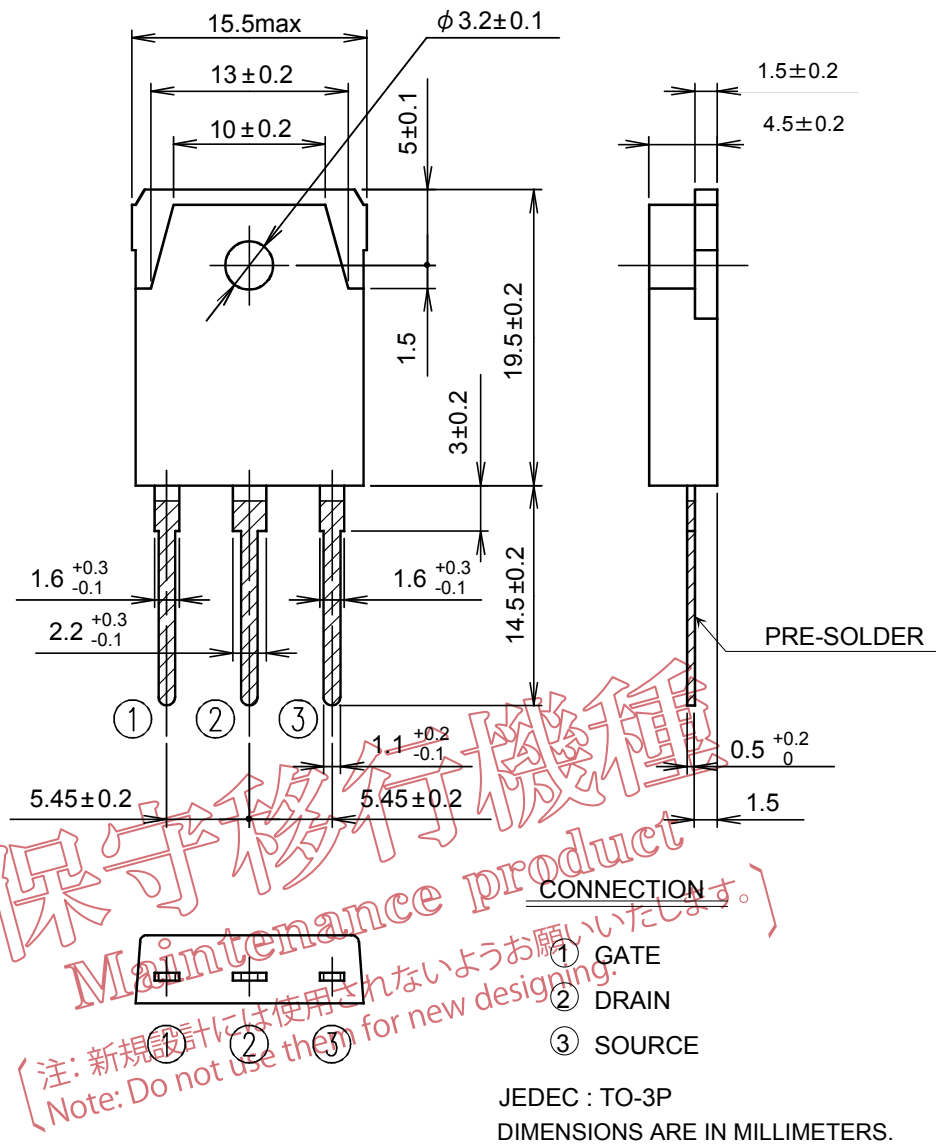


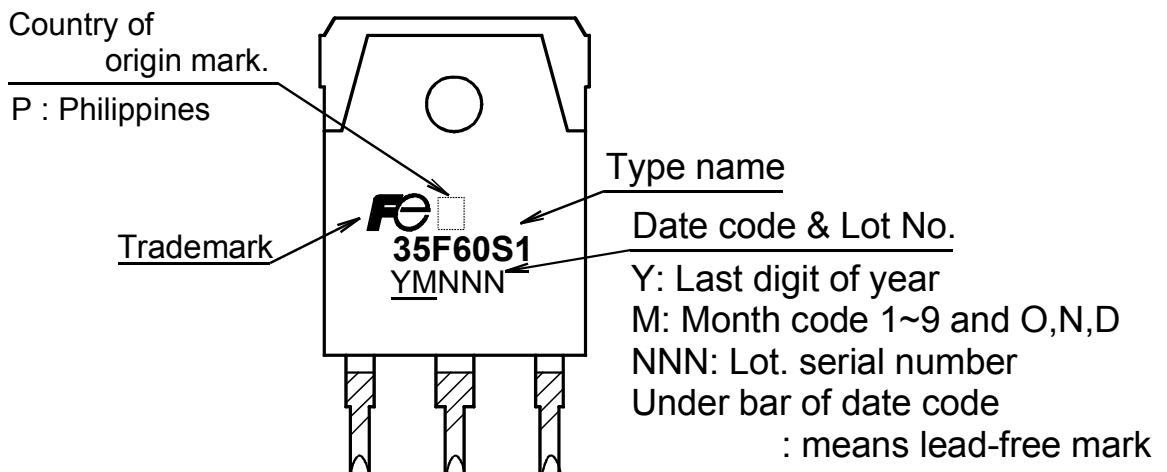
Fig.7 Operating waveform of Reverse recovery Test

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■ Outview: TO-3P(Q) Package



■ Marking



\* The font (font type,size) and the trademark-size might be actually different.



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