

OptiMOS™ 3 Power-Transistor
Features

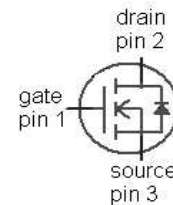
- Fast switching MOSFET for SMPS
- Optimized technology for DC/DC converters
- Qualified according to JEDEC¹⁾ for target applications
- N-channel, normal level
- Excellent gate charge x $R_{DS(on)}$ product (FOM)
- Very low on-resistance $R_{DS(on)}$
- 100% Avalanche tested
- Pb-free plating; RoHS compliant
- Halogen-free according to IEC61249-2-21

Product Summary

| | | |
|------------------|-----|----|
| V_{DS} | 40 | V |
| $R_{DS(on),max}$ | 4.1 | mΩ |
| I_D | 80 | A |



| Type | IPB041N04N G | IPP041N04N G |
|----------------|--------------|--------------|
| | | |
| Package | PG-TO263-3 | PG-TO220-3 |
| Marking | 041N04N | 041N04N |


Maximum ratings, at $T_j=25\text{ °C}$, unless otherwise specified

| Parameter | Symbol | Conditions | Value | Unit |
|---|---------------|---|-------|------|
| Continuous drain current | I_D | $V_{GS}=10\text{ V}, T_C=25\text{ °C}$ | 80 | A |
| | | $V_{GS}=10\text{ V}, T_C=100\text{ °C}$ | 80 | |
| Pulsed drain current ²⁾ | $I_{D,pulse}$ | $T_C=25\text{ °C}$ | 400 | |
| Avalanche current, single pulse ³⁾ | I_{AS} | $T_C=25\text{ °C}$ | 80 | |
| Avalanche energy, single pulse | E_{AS} | $I_D=80\text{ A}, R_{GS}=25\text{ Ω}$ | 60 | mJ |
| Gate source voltage | V_{GS} | | ±20 | V |

¹⁾ J-STD20 and JESD22

Maximum ratings, at $T_j=25\text{ °C}$, unless otherwise specified

| Parameter | Symbol | Conditions | Value | Unit |
|-------------------------------------|-----------------------|--------------------|-------------|------|
| Power dissipation | P_{tot} | $T_C=25\text{ °C}$ | 94 | W |
| Operating and storage temperature | T_j, T_{stg} | | -55 ... 175 | °C |
| IEC climatic category; DIN IEC 68-1 | | | 55/175/56 | |

| Parameter | Symbol | Conditions | Values | | | Unit |
|-----------|--------|------------|--------|------|------|------|
| | | | min. | typ. | max. | |

Thermal characteristics

| | | | | | | |
|-------------------------------------|-------------------|--|---|---|-----|-----|
| Thermal resistance, junction - case | R_{thJC} | | - | - | 1.6 | K/W |
| SMD version, device on PCB | R_{thJA} | minimal footprint | - | - | 62 | |
| | | 6 cm ² cooling area ⁴⁾ | - | - | 40 | |

Electrical characteristics, at $T_j=25\text{ °C}$, unless otherwise specified

Static characteristics

| | | | | | | |
|--|-----------------------------|---|----|-----|-----|---------------|
| Drain-source breakdown voltage | $V_{(\text{BR})\text{DSS}}$ | $V_{\text{GS}}=0\text{ V}, I_{\text{D}}=1\text{ mA}$ | 40 | - | - | V |
| Gate threshold voltage | $V_{\text{GS(th)}}$ | $V_{\text{DS}}=V_{\text{GS}}, I_{\text{D}}=45\text{ }\mu\text{A}$ | 2 | - | 4 | |
| Zero gate voltage drain current | I_{DSS} | $V_{\text{DS}}=40\text{ V}, V_{\text{GS}}=0\text{ V}, T_j=25\text{ °C}$ | - | 0.1 | 1 | μA |
| | | $V_{\text{DS}}=40\text{ V}, V_{\text{GS}}=0\text{ V}, T_j=125\text{ °C}$ | - | 10 | 100 | |
| Gate-source leakage current | I_{GSS} | $V_{\text{GS}}=20\text{ V}, V_{\text{DS}}=0\text{ V}$ | - | 10 | 100 | nA |
| Drain-source on-state resistance ⁵⁾ | $R_{\text{DS(on)}}$ | $V_{\text{GS}}=10\text{ V}, I_{\text{D}}=80\text{ A}$ | - | 3.3 | 4.1 | m Ω |
| Gate resistance | R_{G} | | - | 1.6 | - | Ω |
| Transconductance | g_{fs} | $ V_{\text{DS}} >2 I_{\text{D}} R_{\text{DS(on)max}}, I_{\text{D}}=80\text{ A}$ | 50 | 100 | - | S |

²⁾ See figure 3 for more detailed information

³⁾ See figure 13 for more detailed information

⁴⁾ Device on 40 mm x 40 mm x 1.5 mm epoxy PCB FR4 with 6 cm² (one layer, 70 μm thick) copper area for drain connection. PCB is vertical in still air.

⁵⁾ Measured from drain tab to source pin

| Parameter | Symbol | Conditions | Values | | | Unit |
|-----------|--------|------------|--------|------|------|------|
| | | | min. | typ. | max. | |

Dynamic characteristics

| | | | | | | |
|------------------------------|--------------|---|---|------|------|----|
| Input capacitance | C_{iss} | $V_{GS}=0\text{ V}, V_{DS}=20\text{ V},$ $f=1\text{ MHz}$ | - | 3400 | 4500 | pF |
| Output capacitance | C_{oss} | | - | 980 | 1300 | |
| Reverse transfer capacitance | C_{rss} | | - | 36 | - | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD}=20\text{ V}, V_{GS}=10\text{ V},$ $I_D=30\text{ A}, R_G=1.6\ \Omega$ | - | 16 | - | ns |
| Rise time | t_r | | - | 3.8 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 23 | - | |
| Fall time | t_f | | - | 4.8 | - | |

Gate Charge Characteristics⁶⁾

| | | | | | | |
|------------------------------|---------------|--|---|------|----|----|
| Gate to source charge | Q_{gs} | $V_{DD}=20\text{ V}, I_D=30\text{ A},$ $V_{GS}=0\text{ to }10\text{ V}$ | - | 18 | - | nC |
| Gate charge at threshold | $Q_{g(th)}$ | | - | 10.3 | - | |
| Gate to drain charge | Q_{gd} | | - | 5.3 | - | |
| Switching charge | Q_{sw} | | - | 12.5 | - | |
| Gate charge total | Q_g | | - | 42 | 56 | |
| Gate plateau voltage | $V_{plateau}$ | | - | 5.1 | - | |
| Gate charge total, sync. FET | $Q_{g(sync)}$ | $V_{DS}=0.1\text{ V},$ $V_{GS}=0\text{ to }10\text{ V}$ | - | 40 | - | nC |
| Output charge | Q_{oss} | $V_{DD}=20\text{ V}, V_{GS}=0\text{ V}$ | - | 41 | - | |

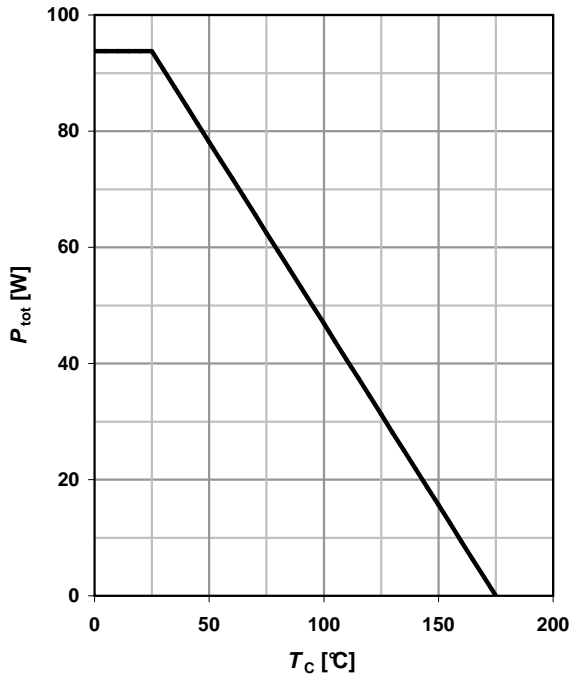
Reverse Diode

| | | | | | | |
|----------------------------------|---------------|---|---|------|-----|----|
| Diode continuous forward current | I_S | $T_C=25\text{ }^\circ\text{C}$ | - | - | 78 | A |
| Diode pulse current | $I_{S,pulse}$ | | - | - | 400 | |
| Diode forward voltage | V_{SD} | $V_{GS}=0\text{ V}, I_F=80\text{ A},$ $T_j=25\text{ }^\circ\text{C}$ | - | 0.96 | 1.2 | V |
| Reverse recovery charge | Q_{rr} | $V_R=20\text{ V}, I_F=I_S,$ $di_F/dt=400\text{ A}/\mu\text{s}$ | - | 46 | - | nC |

⁶⁾ See figure 16 for gate charge parameter definition

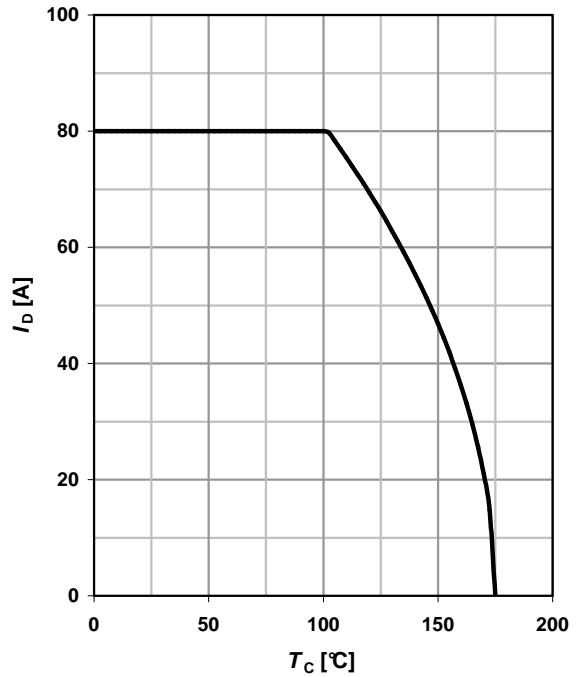
1 Power dissipation

$$P_{tot}=f(T_C)$$



2 Drain current

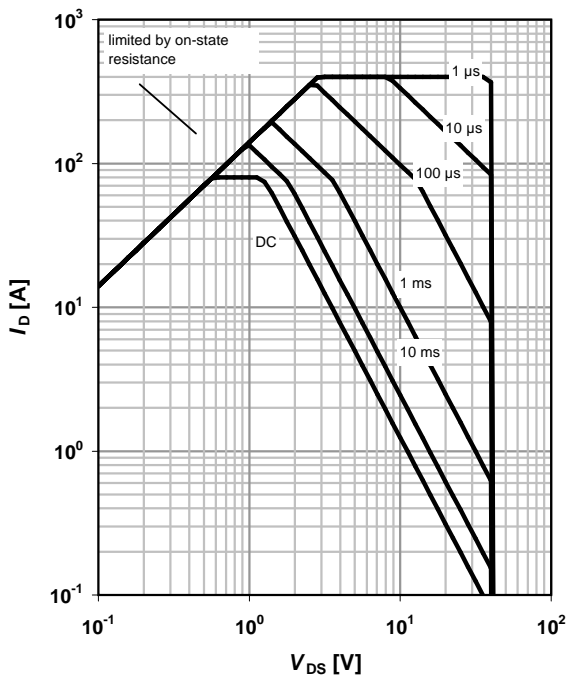
$$I_D=f(T_C); V_{GS} \geq 10 \text{ V}$$



3 Safe operating area

$$I_D=f(V_{DS}); T_C=25 \text{ °C}; D=0$$

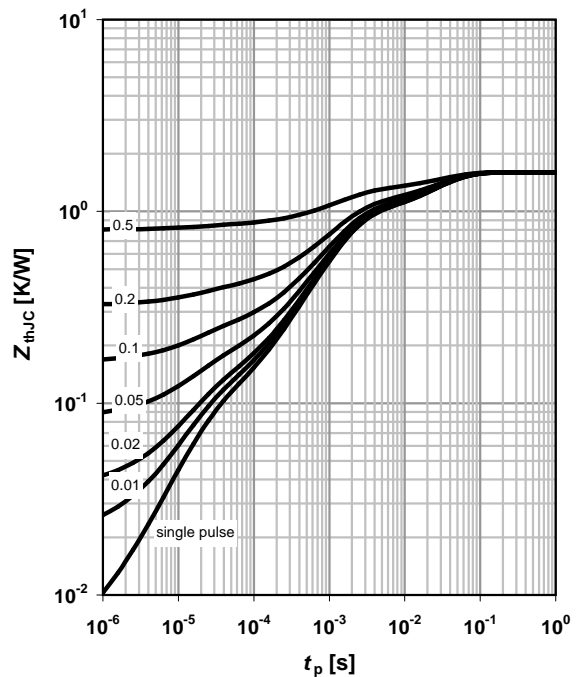
parameter: t_p



4 Max. transient thermal impedance

$$Z_{thJC}=f(t_p)$$

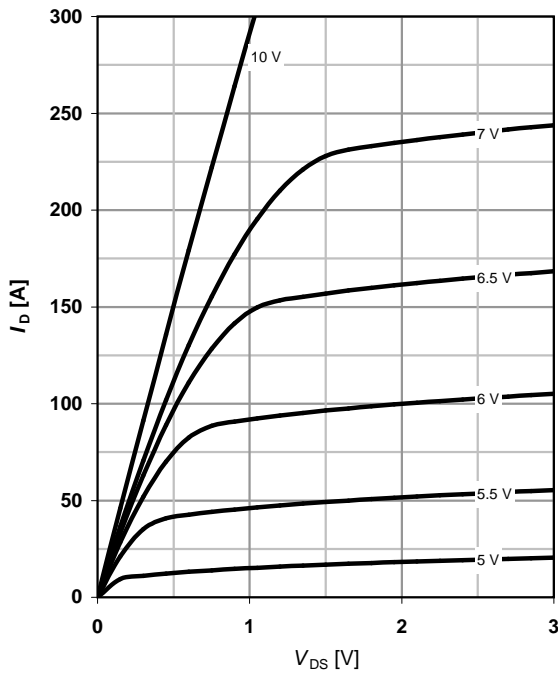
parameter: $D=t_p/T$



5 Typ. output characteristics

$I_D = f(V_{DS}); T_j = 25\text{ °C}$

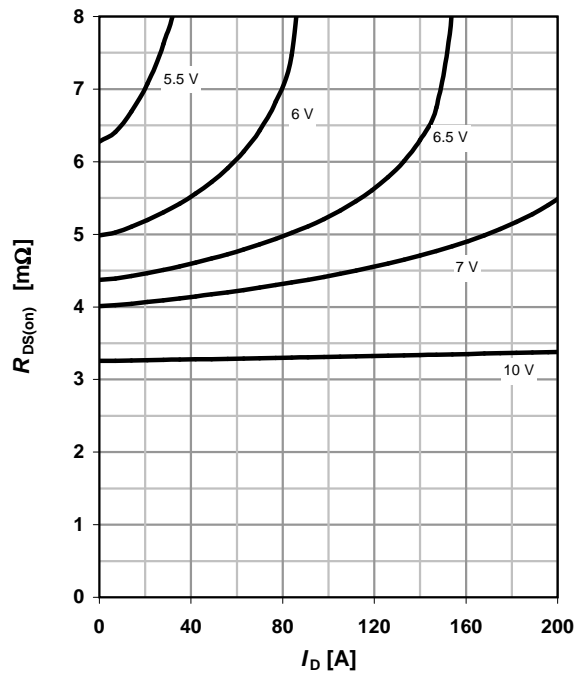
parameter: V_{GS}



6 Typ. drain-source on resistance

$R_{DS(on)} = f(I_D); T_j = 25\text{ °C}$

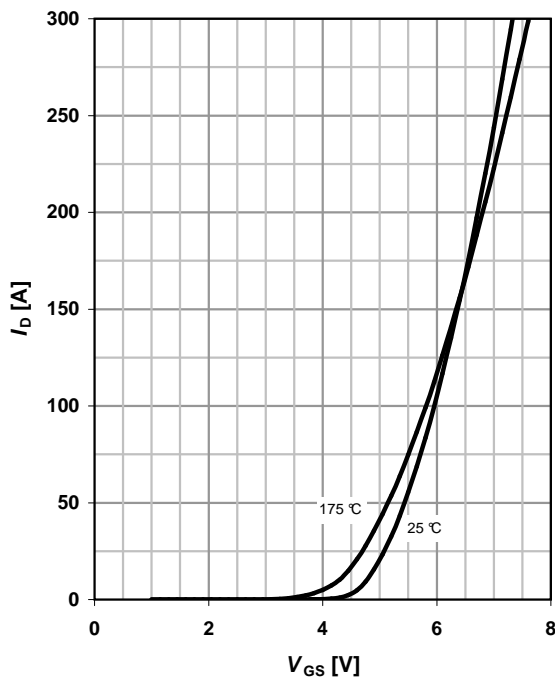
parameter: V_{GS}



7 Typ. transfer characteristics

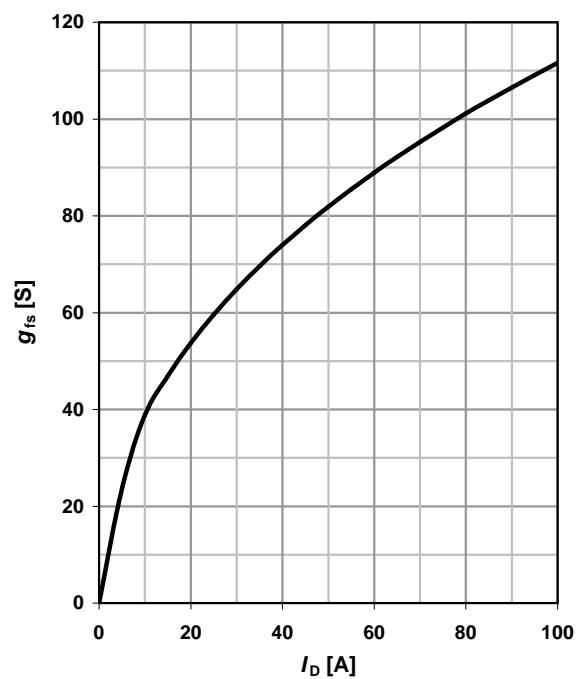
$I_D = f(V_{GS}); |V_{DS}| > 2|I_D|R_{DS(on)max}$

parameter: T_j



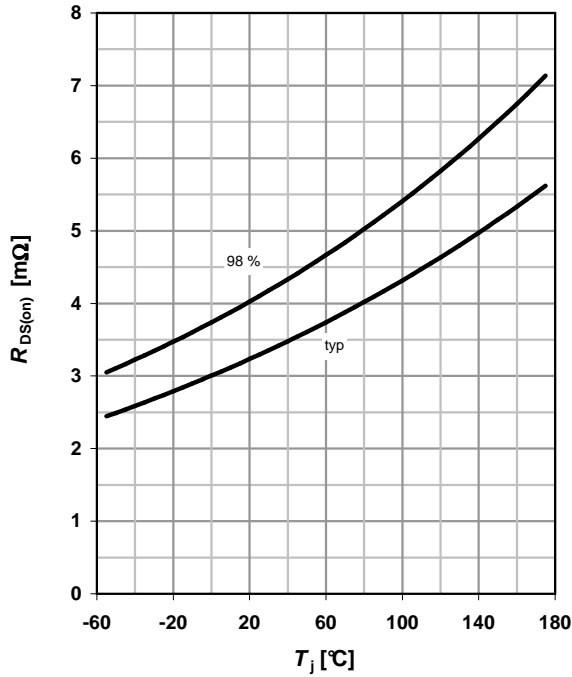
8 Typ. forward transconductance

$g_{fs} = f(I_D); T_j = 25\text{ °C}$



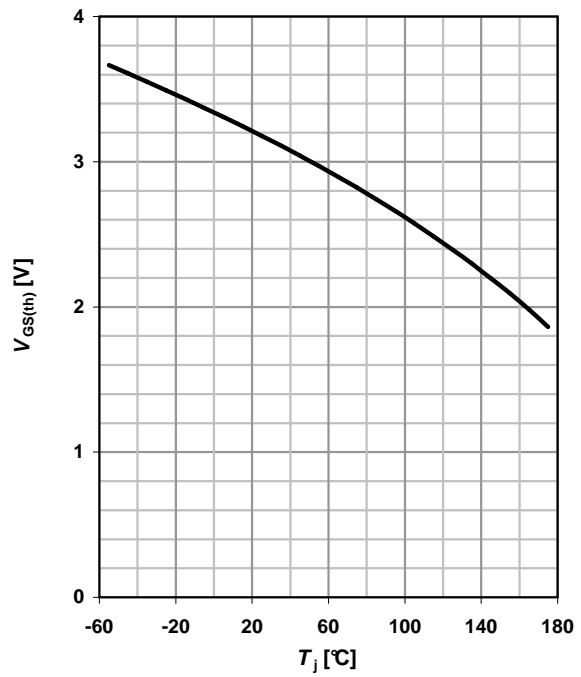
9 Drain-source on-state resistance

$R_{DS(on)}=f(T_j); I_D=80\text{ A}; V_{GS}=10\text{ V}$



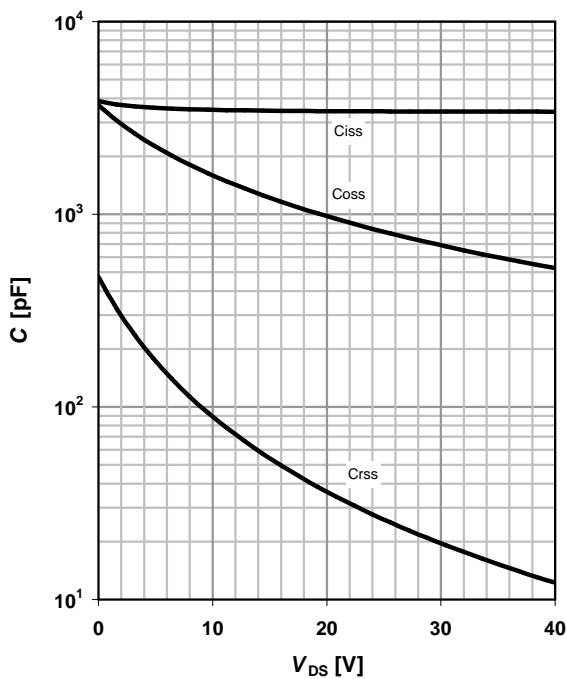
10 Typ. gate threshold voltage

$V_{GS(th)}=f(T_j); V_{GS}=V_{DS}; I_D=250\ \mu\text{A}$



11 Typ. capacitances

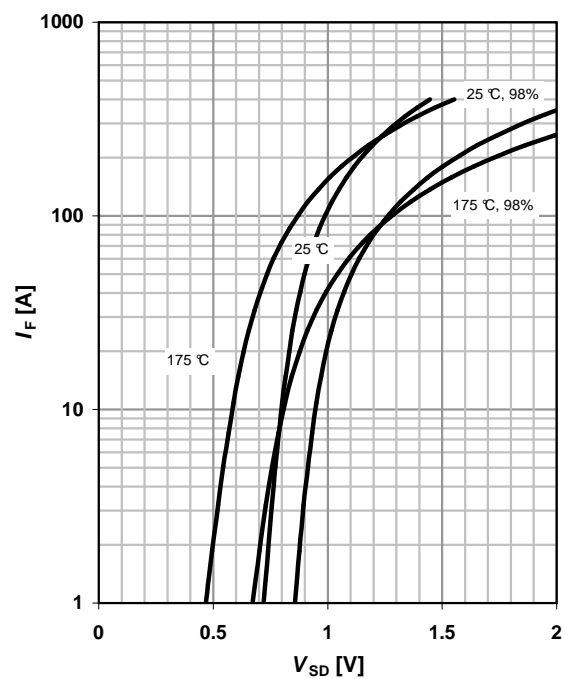
$C=f(V_{DS}); V_{GS}=0\text{ V}; f=1\text{ MHz}$



12 Forward characteristics of reverse diode

$I_F=f(V_{SD})$

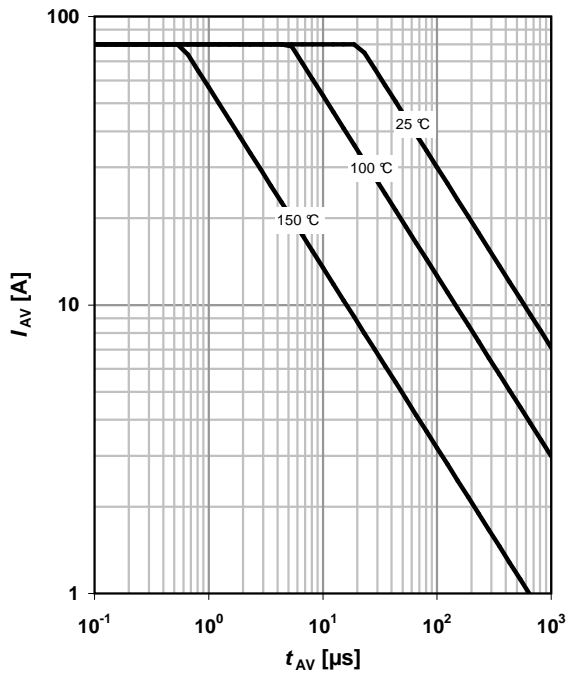
parameter: T_j



13 Avalanche characteristics

$I_{AS}=f(t_{AV}); R_{GS}=25 \Omega$

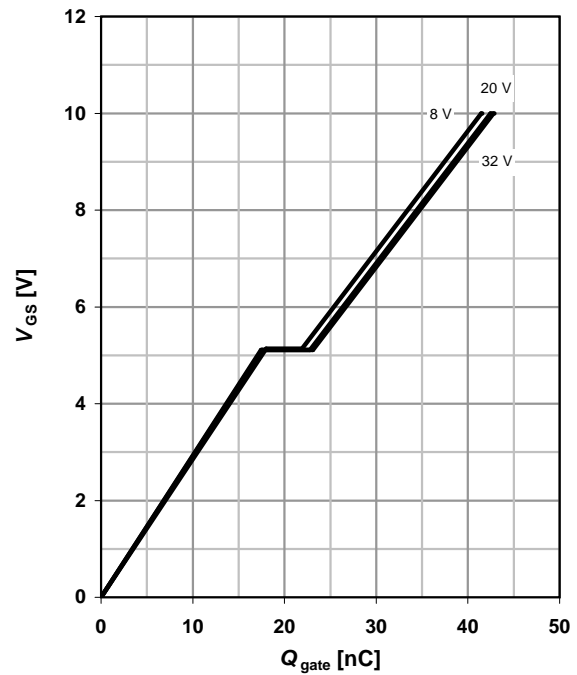
parameter: $T_{j(start)}$



14 Typ. gate charge

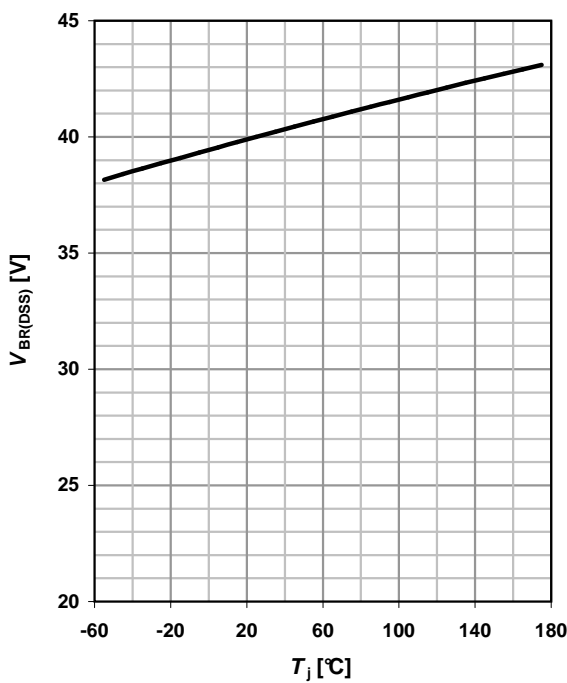
$V_{GS}=f(Q_{gate}); I_D=30 \text{ A pulsed}$

parameter: V_{DD}

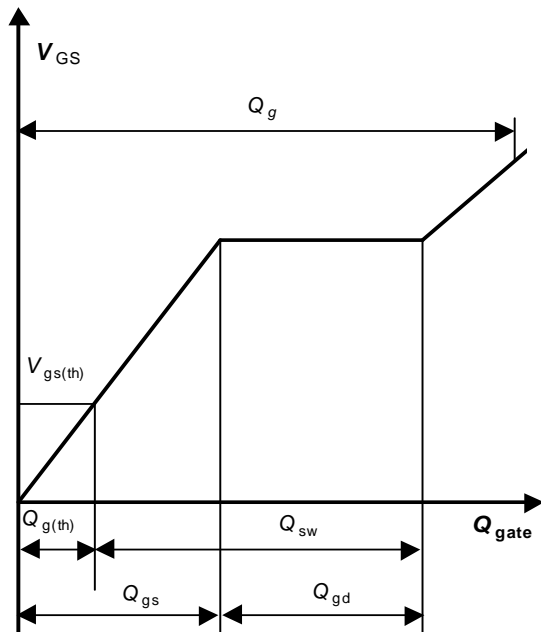


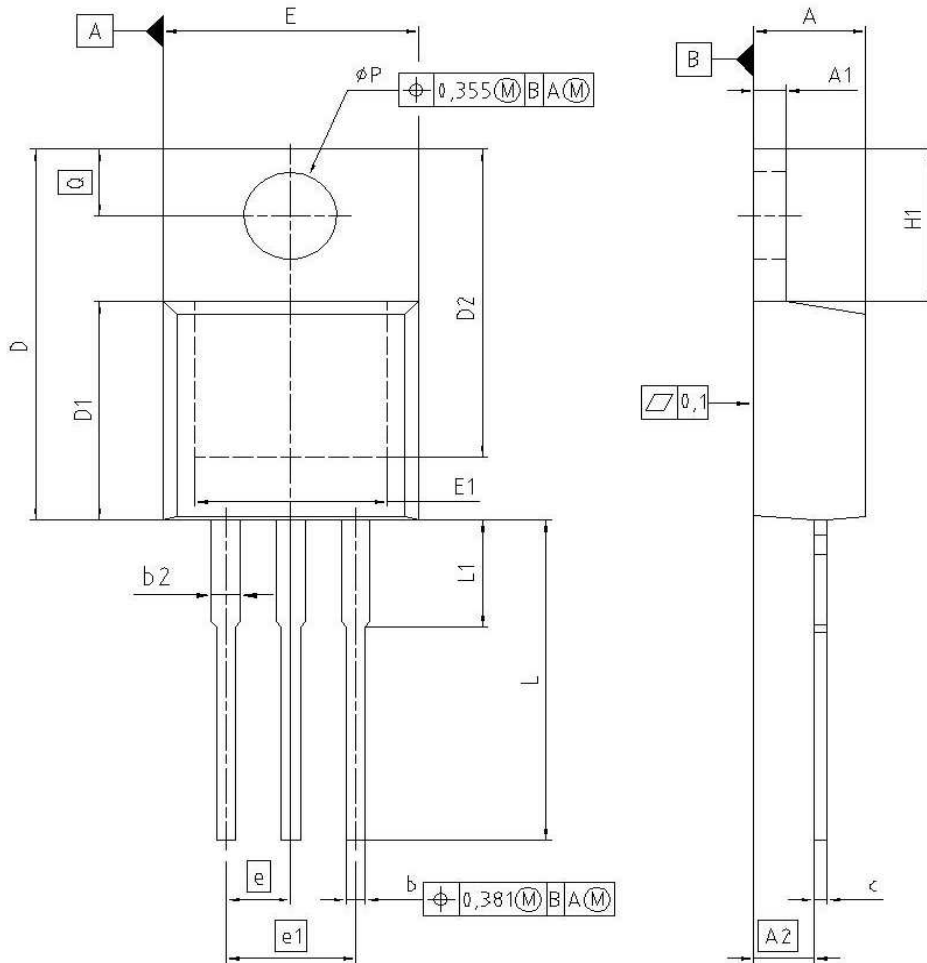
15 Drain-source breakdown voltage

$V_{BR(DSS)}=f(T_j); I_D=1 \text{ mA}$



16 Gate charge waveforms



Package Outline
PG-TO220-3-1


| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|--------|--------|-------|
| | MIN | MAX | MIN | MAX |
| A | 4.300 | 4.572 | 0.169 | 0.180 |
| A1 | 1.170 | 1.400 | 0.046 | 0.055 |
| A2 | 2.215 | 2.718 | 0.087 | 0.107 |
| b | 0.650 | 0.864 | 0.026 | 0.034 |
| b2 | 0.635 | 1.778 | 0.025 | 0.070 |
| c | 0.330 | 0.600 | 0.013 | 0.024 |
| D | 14.808 | 15.950 | 0.583 | 0.628 |
| D1 | 8.509 | 9.450 | 0.335 | 0.372 |
| D2 | 12.850 | 13.100 | 0.506 | 0.516 |
| E | 9.700 | 10.363 | 0.382 | 0.408 |
| E1 | 6.500 | 8.600 | 0.256 | 0.339 |
| e | 2.540 | | 0.100 | |
| e1 | 5.080 | | 0.200 | |
| N | 3 | | 3 | |
| H1 | 5.900 | 6.900 | 0.232 | 0.272 |
| L | 13.000 | 14.000 | 0.512 | 0.551 |
| L1 | - | 4.800 | - | 0.189 |
| pP | 3.700 | 3.886 | 0.146 | 0.153 |
| Q | 2.600 | 3.000 | 0.102 | 0.118 |

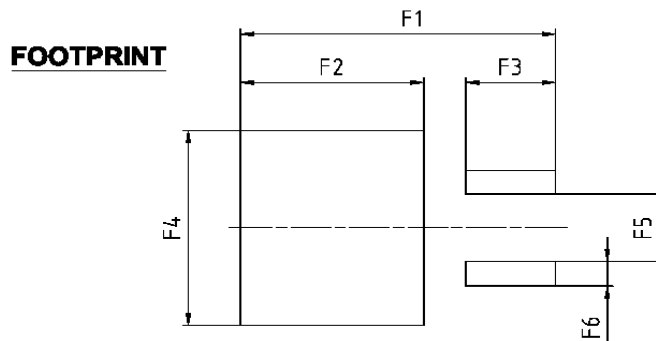
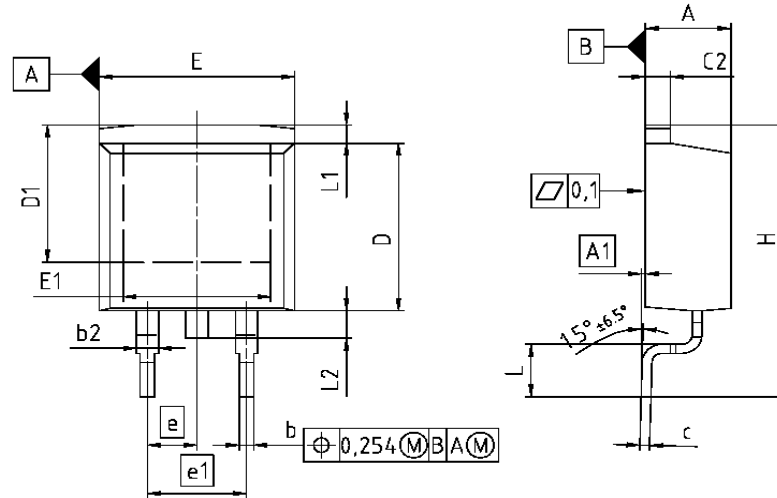
REFERENCE
JEDEC TO220

SCALE

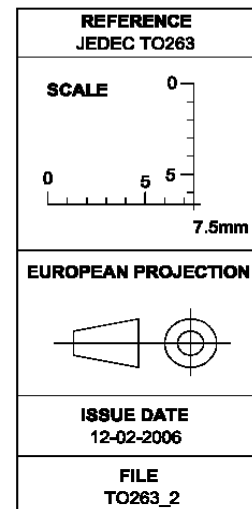
EUROPEAN PROJECTION

ISSUE DATE
01-06-2005

FILE
TO220_1



| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|--------|--------|-------|
| | MIN | MAX | MIN | MAX |
| A | 4.300 | 4.572 | 0.169 | 0.180 |
| A1 | 0.000 | 0.254 | 0.000 | 0.010 |
| b | 0.650 | 0.850 | 0.026 | 0.033 |
| b2 | 0.950 | 1.321 | 0.037 | 0.052 |
| c | 0.330 | 0.650 | 0.013 | 0.026 |
| c2 | 0.170 | 1.400 | 0.046 | 0.055 |
| D | 8.509 | 9.450 | 0.335 | 0.372 |
| D1 | 7.100 | - | 0.280 | - |
| E | 9.800 | 10.312 | 0.386 | 0.406 |
| E1 | 6.500 | - | 0.256 | - |
| e | 2.540 | | 0.100 | |
| e1 | 5.080 | | 0.200 | |
| N | 2 | | 2 | |
| H | 14.605 | 15.875 | 0.575 | 0.625 |
| L | 2.200 | 3.000 | 0.087 | 0.118 |
| L1 | - | 1.600 | - | 0.063 |
| L2 | 1.000 | 1.778 | 0.039 | 0.070 |
| F1 | 16.050 | 16.250 | 0.632 | 0.640 |
| F2 | 9.300 | 9.500 | 0.366 | 0.374 |
| F3 | 4.500 | 4.700 | 0.177 | 0.185 |
| F4 | 10.700 | 10.900 | 0.421 | 0.429 |
| F5 | 3.630 | 3.830 | 0.143 | 0.151 |
| F6 | 1.100 | 1.300 | 0.043 | 0.051 |



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