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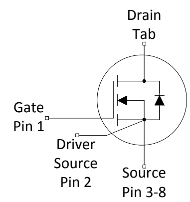
# MOSFET

## 600V CoolMOS™ G7 Power Transistor

The C7 GOLD series (G7) for the first time brings together the benefits of the C7 GOLD CoolMOS™ technology, 4 pin Kelvin Source capability and the improved thermal properties of the TOLL package to enable a possible SMD solution for high current topologies such as PFC up to 3kW

HSOF


### Features

• C7 Gold gives best in class FOM $R_{DS(on)}$*$E_{oss}$ and $R_{DS(on)}$*$Q_g$.
• Suitable for hard and soft switching (PFC and high performance LLC)
• C7 Gold technology enables best in class $R_{DS(on)}$ in smallest footprint.
• TOLL package has inbuilt $4^{th}$ pin Kelvin Source configuration and low parasitic source inductance (~1nH).
• TOLL package is MSL1 compliant, total Pb-free, has easy visual inspection grooved leads and is qualified for industrial applications according to JEDEC(J-STD20 and JESD22).
• TOLL SMD package combined with lead free die attach process enables improved thermal performance $R_{th}$.

### Benefits

• C7 Gold FOM $R_{DS(on)}$*$Q_g$ is 15% better than previous C7 600V enabling faster switching leading to higher efficiency.
• Increased economies of scale by use in PFC and PWM topologies in the application
• C7 Gold can reach 28mΩ in in TOLL 115mm$^2$ footprint, whereas previous BIC C7 600V was 40mΩ in 150mm$^2$ D$^2$PAK footprint.
• Reducing parasitic source inductance by Kelvin Source improves efficiency by faster switching and ease of use due to less ringing.
• TOLL package is easy to use and has the highest quality standards.
• Improved thermals enable SMD TOLL package to be used in higher current designs than has been previously possible.

### Applications

PFC stages and PWM stages (TTF, LLC) for high power/performance SMPS e.g. Computing, Server, Telecom, UPS and Solar.

*Please note: For MOSFET paralleling the use of ferrite beads on the gate or separate totem poles is generally recommended.*

### Table 1 Key Performance Parameters

| Parameter | Value | Unit |
|---|---|---|
| $V_{DS}$ @ $T_{j,max}$ | 650 | V |
| $R_{DS(on),max}$ | 28 | mΩ |
| $Q_{g.typ}$ | 123 | nC |
| $I_{D,pulse}$ | 245 | A |
| $I_{D,continuous}$ @ $T_j$<150°C | 87 | A |
| $E_{oss}$@400V | 14.7 | µJ |
| Body diode di/dt | 1000 | A/µs |

| Type / Ordering Code | Package | Marking | Related Links |
|---|---|---|---|
| IPT60R028G7 | PG-HSOF-8 | 60R028G7 | see Appendix A |

## Table of Contents

Description . . . 1
Maximum ratings . . . 3
Thermal characteristics . . . 4
Electrical characteristics . . . 5
Electrical characteristics diagrams . . . 7
Test Circuits . . . 11
Package Outlines . . . 12
Appendix A . . . 13
Revision History . . . 14
Trademarks . . . 14
Disclaimer . . . 14

# 1 Maximum ratings

at $T_j$ = 25°C, unless otherwise specified

## Table 2 Maximum ratings

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Continuous drain current[1)] | $I_D$ | -<br>- | -<br>- | 75<br>47 | A | $T_C$=25°C<br>$T_C$=100°C |
| Pulsed drain current[2)] | $I_{D,pulse}$ | - | - | 245 | A | $T_C$=25°C |
| Avalanche energy, single pulse | $E_{AS}$ | - | - | 288 | mJ | $I_D$=7.7A; $V_{DD}$=50V; see table 10 |
| Avalanche energy, repetitive | $E_{AR}$ | - | - | 1.44 | mJ | $I_D$=7.7A; $V_{DD}$=50V; see table 10 |
| Avalanche current, single pulse | $I_{AS}$ | - | - | 7.7 | A | - |
| MOSFET dv/dt ruggedness | dv/dt | - | - | 120 | V/ns | $V_{DS}$=0...400V |
| Gate source voltage (static) | $V_{GS}$ | -20 | - | 20 | V | static; |
| Gate source voltage (dynamic) | $V_{GS}$ | -30 | - | 30 | V | AC (f>1 Hz) |
| Power dissipation | $P_{tot}$ | - | - | 391 | W | $T_C$=25°C |
| Storage temperature | $T_{stg}$ | -55 | - | 150 | °C | - |
| Operating junction temperature | $T_j$ | -55 | - | 150 | °C | - |
| Mounting torque | - | - | - | n.a. | Ncm | - |
| Continuous diode forward current | $I_S$ | - | - | 75 | A | $T_C$=25°C |
| Diode pulse current[2)] | $I_{S,pulse}$ | - | - | 245 | A | $T_C$=25°C |
| Reverse diode dv/dt[3)] | dv/dt | - | - | 25 | V/ns | $V_{DS}$=0...400V, $I_{SD}$<=11.8A, $T_j$=25°C see table 8 |
| Maximum diode commutation speed | $di_f/dt$ | - | - | 1000 | A/µs | $V_{DS}$=0...400V, $I_{SD}$<=11.8A, $T_j$=25°C see table 8 |
| Insulation withstand voltage | $V_{ISO}$ | - | - | n.a. | V | $V_{rms}$, $T_C$=25°C, $t$=1min |

1) Limited by $T_{j\,max}$.
2) Pulse width $t_p$ limited by $T_{j,max}$
3) Identical low side and high side switch

# 2 Thermal characteristics

**Table 3 Thermal characteristics**

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Thermal resistance, junction - case | $R_{thJC}$ | - | - | 0.32 | °C/W | - |
| Thermal resistance, junction - ambient | $R_{thJA}$ | - | - | 62 | °C/W | device on PCB, minimal footprint |
| Thermal resistance, junction - ambient for SMD version | $R_{thJA}$ | - | 35 | 45 | °C/W | Device on 40mm*40mm*1.5mm epoxy PCB FR4 with 6cm² (one layer, 70µm thickness) copper area for drain connection and cooling. PCB is vertical without air stream cooling. |
| Soldering temperature, wave- & reflow soldering allowed | $T_{sold}$ | - | - | 260 | °C | reflow MSL1 |

# 3 Electrical characteristics

at $T_j$=25°C, unless otherwise specified

## Table 4 Static characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | 600 | - | - | V | $V_{GS}$=0V, $I_D$=1mA |
| Gate threshold voltage | $V_{(GS)th}$ | 3 | 3.5 | 4 | V | $V_{DS}$=$V_{GS}$, $I_D$=1.44mA |
| Zero gate voltage drain current | $I_{DSS}$ | -<br>- | -<br>10 | 1<br>- | µA | $V_{DS}$=600, $V_{GS}$=0V, $T_j$=25°C<br>$V_{DS}$=600, $V_{GS}$=0V, $T_j$=150°C |
| Gate-source leakage current | $I_{GSS}$ | - | - | 100 | nA | $V_{GS}$=20V, $V_{DS}$=0V |
| Drain-source on-state resistance | $R_{DS(on)}$ | -<br>- | 0.024<br>0.060 | 0.028<br>- | Ω | $V_{GS}$=10V, $I_D$=28.8A, $T_j$=25°C<br>$V_{GS}$=10V, $I_D$=28.8A, $T_j$=150°C |
| Gate resistance | $R_G$ | - | 0.85 | - | Ω | $f$=1MHz, open drain |

## Table 5 Dynamic characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Input capacitance | $C_{iss}$ | - | 4820 | - | pF | $V_{GS}$=0V, $V_{DS}$=400V, $f$=250kHz |
| Output capacitance | $C_{oss}$ | - | 99 | - | pF | $V_{GS}$=0V, $V_{DS}$=400V, $f$=250kHz |
| Effective output capacitance, energy related[1] | $C_{o(er)}$ | - | 184 | - | pF | $V_{GS}$=0V, $V_{DS}$=0...400V |
| Effective output capacitance, time related[2] | $C_{o(tr)}$ | - | 1900 | - | pF | $I_D$=constant, $V_{GS}$=0V, $V_{DS}$=0...400V |
| Turn-on delay time | $t_{d(on)}$ | - | 28 | - | ns | $V_{DD}$=400V, $V_{GS}$=13V, $I_D$=28.8A, $R_G$=1.8Ω; see table 9 |
| Rise time | $t_r$ | - | 9 | - | ns | $V_{DD}$=400V, $V_{GS}$=13V, $I_D$=28.8A, $R_G$=1.8Ω; see table 9 |
| Turn-off delay time | $t_{d(off)}$ | - | 100 | - | ns | $V_{DD}$=400V, $V_{GS}$=13V, $I_D$=28.8A, $R_G$=1.8Ω; see table 9 |
| Fall time | $t_f$ | - | 2.8 | - | ns | $V_{DD}$=400V, $V_{GS}$=13V, $I_D$=28.8A, $R_G$=1.8Ω; see table 9 |

## Table 6 Gate charge characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Gate to source charge | $Q_{gs}$ | - | 24 | - | nC | $V_{DD}$=400V, $I_D$=28.8A, $V_{GS}$=0 to 10V |
| Gate to drain charge | $Q_{gd}$ | - | 44 | - | nC | $V_{DD}$=400V, $I_D$=28.8A, $V_{GS}$=0 to 10V |
| Gate charge total | $Q_g$ | - | 123 | - | nC | $V_{DD}$=400V, $I_D$=28.8A, $V_{GS}$=0 to 10V |
| Gate plateau voltage | $V_{plateau}$ | - | 5.0 | - | V | $V_{DD}$=400V, $I_D$=28.8A, $V_{GS}$=0 to 10V |

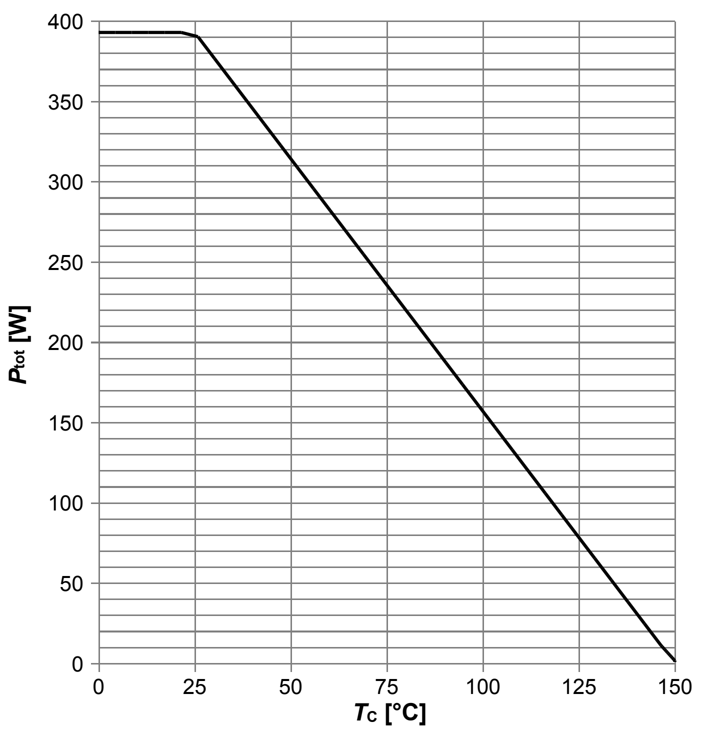
[1] $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as $C_{oss}$ while $V_{DS}$ is rising from 0 to 400V
[2] $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as $C_{oss}$ while $V_{DS}$ is rising from 0 to 400V

## Table 7 Reverse diode characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Diode forward voltage | $V_{SD}$ | - | 0.8 | - | V | $V_{GS}$=0V, $I_F$=28.8A, $T_j$=25°C |
| Reverse recovery time | $t_{rr}$ | - | 440 | - | ns | $V_R$=400V, $I_F$=28.8A, d$i_F$/d$t$=100A/µs; see table 8 |
| Reverse recovery charge | $Q_{rr}$ | - | 8.7 | - | µC | $V_R$=400V, $I_F$=28.8A, d$i_F$/d$t$=100A/µs; see table 8 |
| Peak reverse recovery current | $I_{rrm}$ | - | 39 | - | A | $V_R$=400V, $I_F$=28.8A, d$i_F$/d$t$=100A/µs; see table 8 |

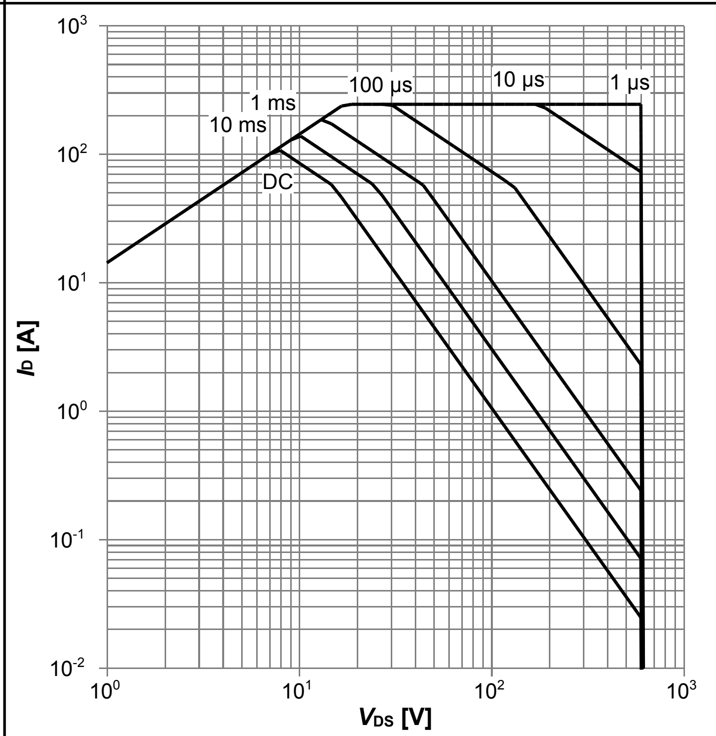
# 4 Electrical characteristics diagrams

**Diagram 1: Power dissipation**



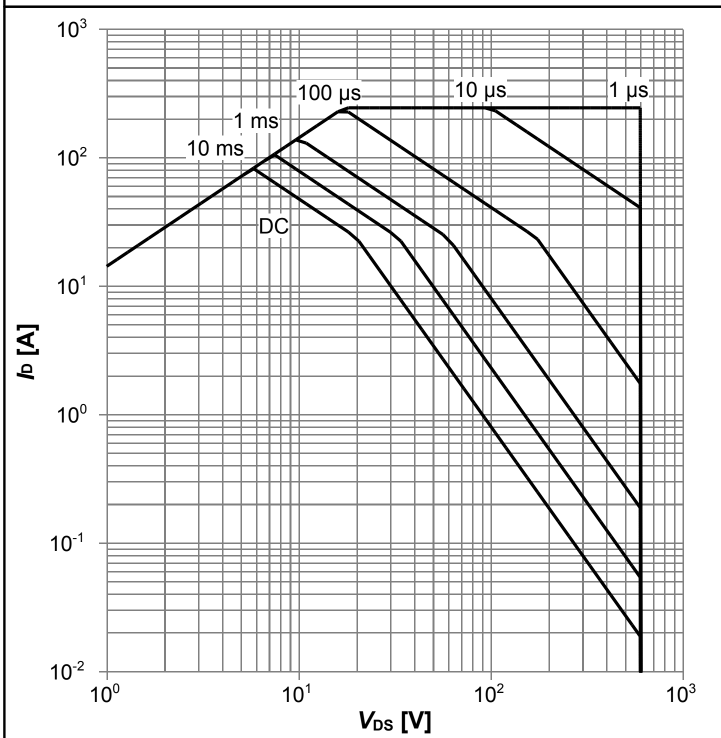

$P_{tot}$=f($T_C$)

**Diagram 2: Safe operating area**



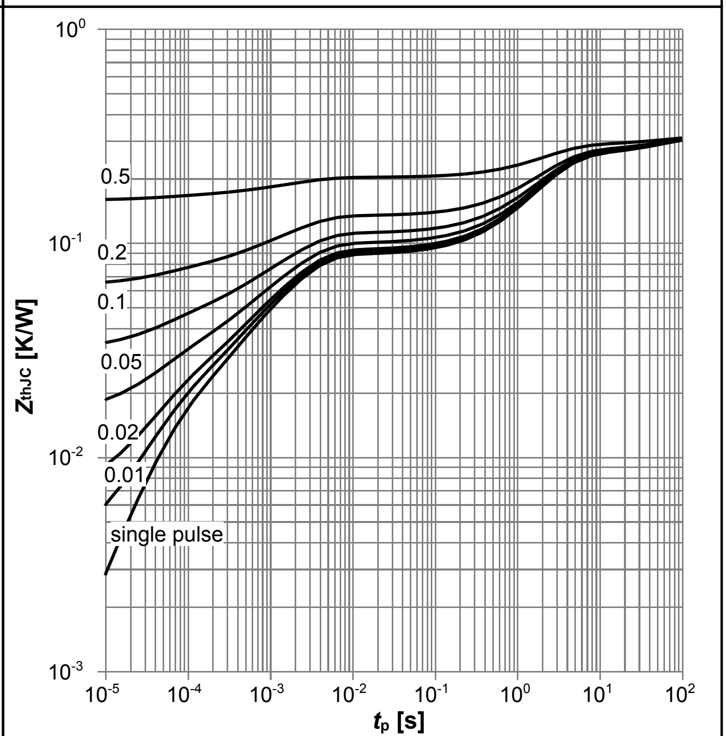

$I_D$=f($V_{DS}$); $T_C$=25 °C; $D$=0; parameter: $t_p$

**Diagram 3: Safe operating area**



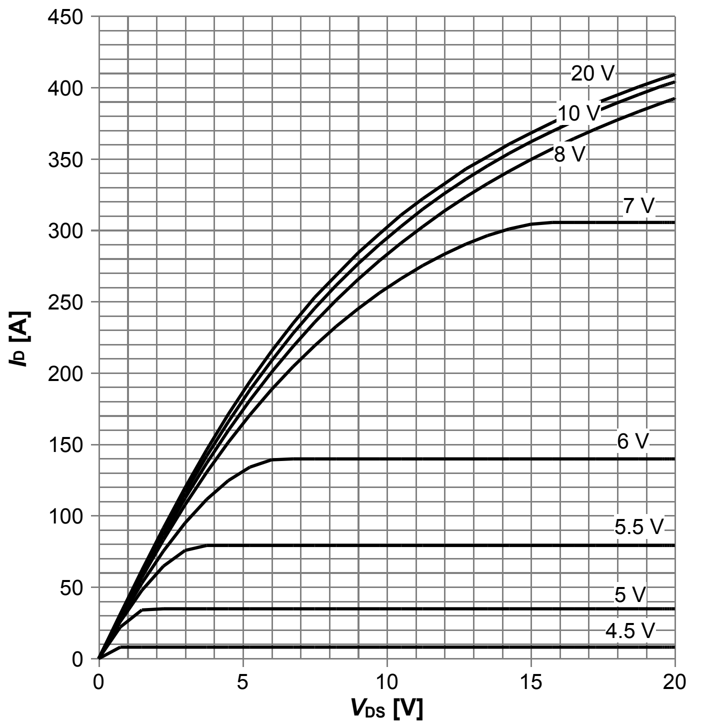

$I_D$=f($V_{DS}$); $T_C$=80 °C; $D$=0; parameter: $t_p$

**Diagram 4: Max. transient thermal impedance**



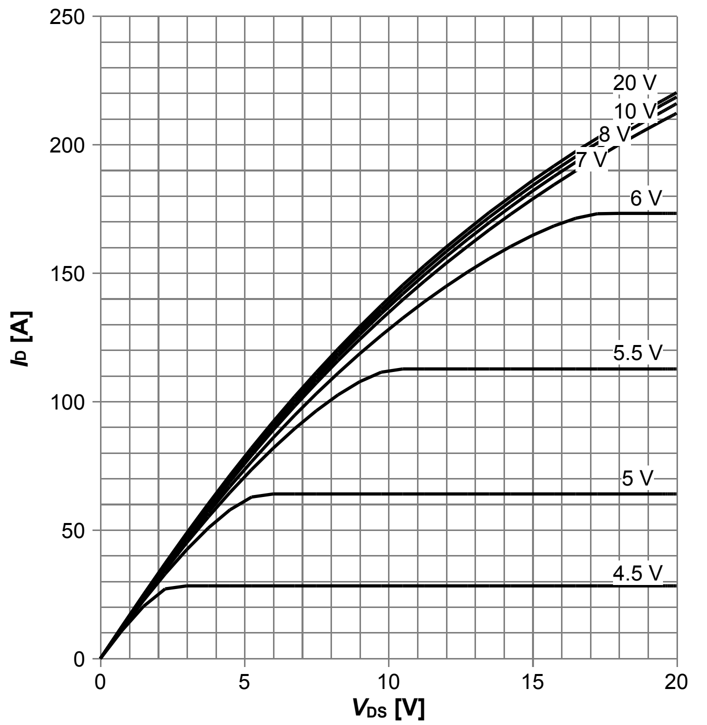

$Z_{thJC}$ =f($t_P$); parameter: $D$=$t_p$/$T$

**Diagram 5: Typ. output characteristics**



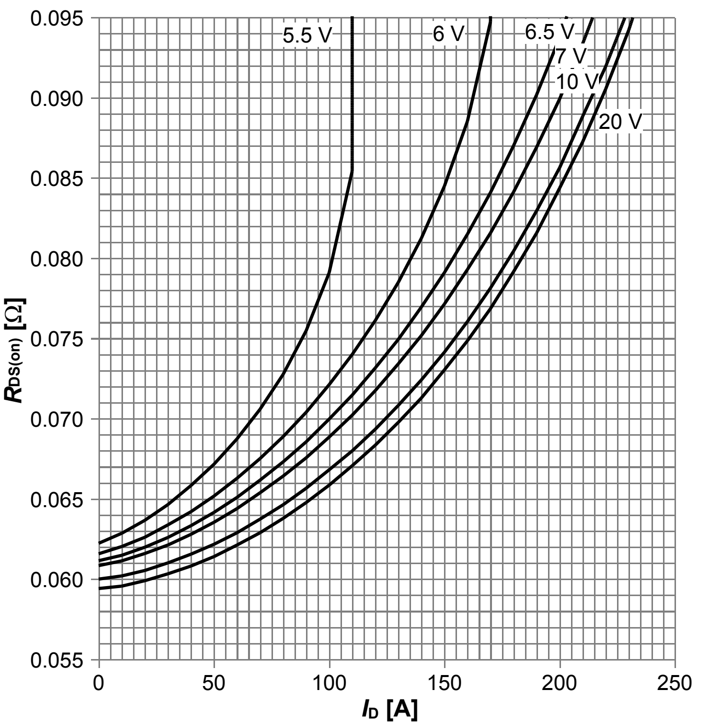

$I_D$=f($V_{DS}$); $T_j$=25 °C; parameter: $V_{GS}$

**Diagram 6: Typ. output characteristics**



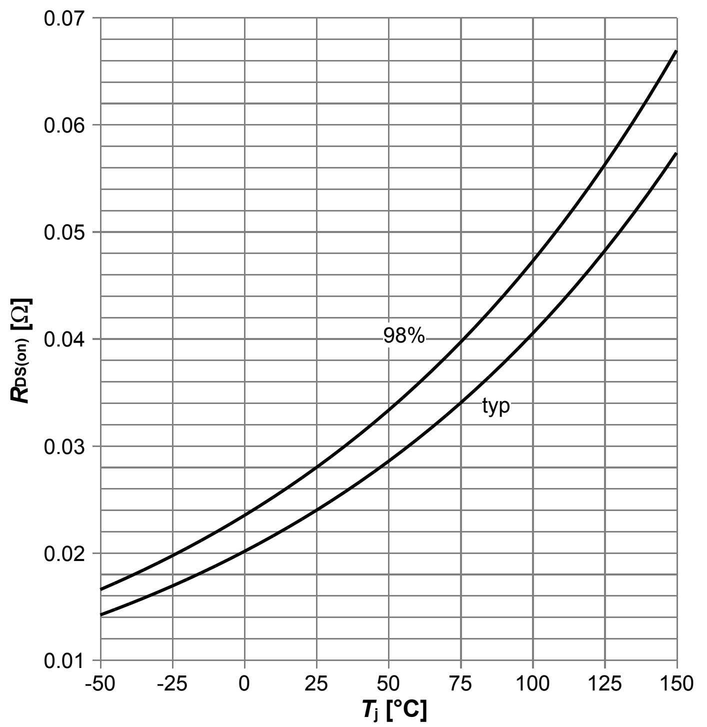

$I_D$=f($V_{DS}$); $T_j$=125 °C; parameter: $V_{GS}$

**Diagram 7: Typ. drain-source on-state resistance**



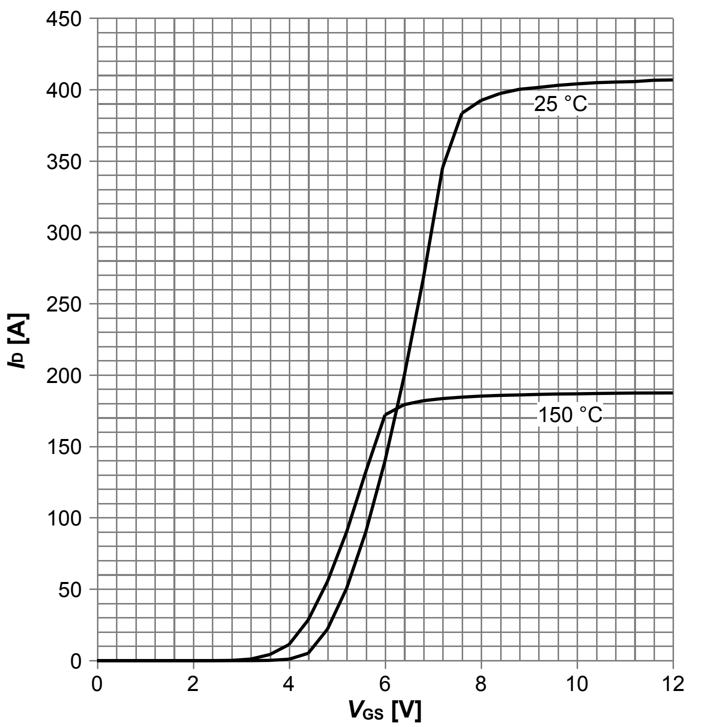

$R_{DS(on)}$=f($I_D$); $T_j$=125 °C; parameter: $V_{GS}$

**Diagram 8: Drain-source on-state resistance**



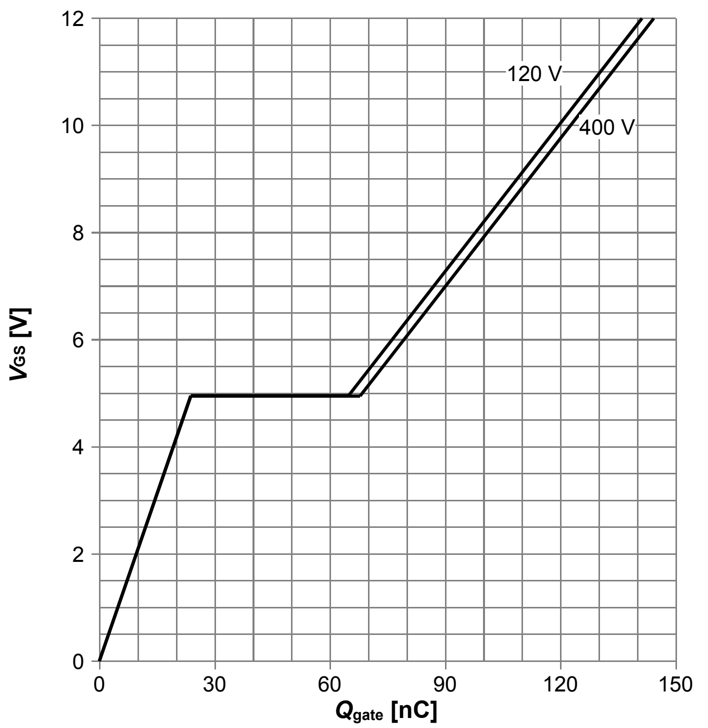

$R_{DS(on)}$=f($T_j$); $I_D$=28.8 A; $V_{GS}$=10 V

**Diagram 9: Typ. transfer characteristics**



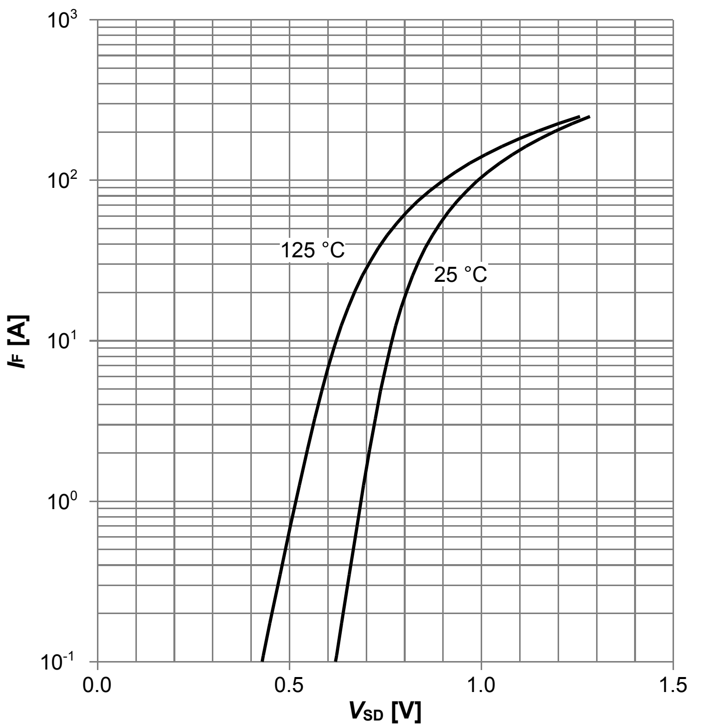

$I_D$=f($V_{GS}$); $V_{DS}$=20V; parameter: $T_j$

**Diagram 10: Typ. gate charge**



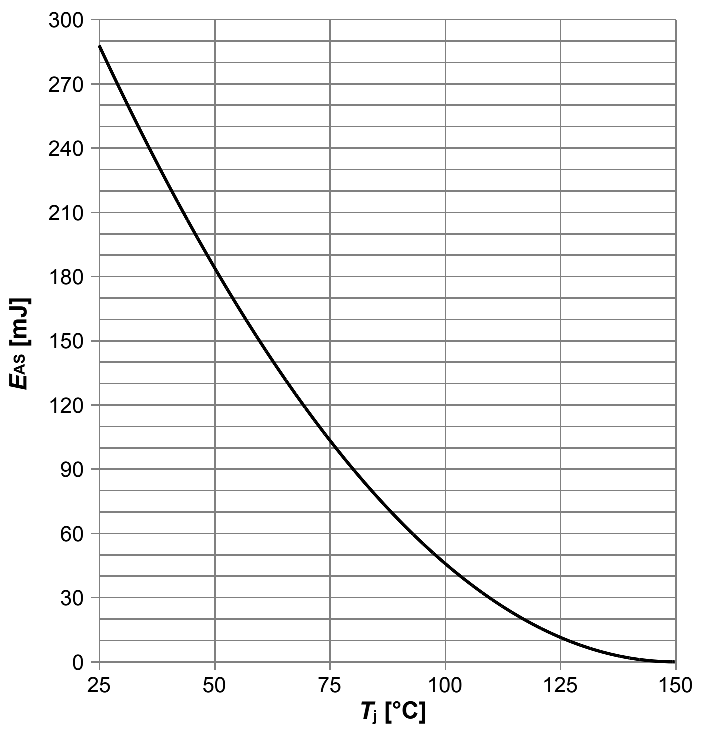

$V_{GS}$=f($Q_{gate}$); $I_D$=28.8 A pulsed; parameter: $V_{DD}$

**Diagram 11: Forward characteristics of reverse diode**



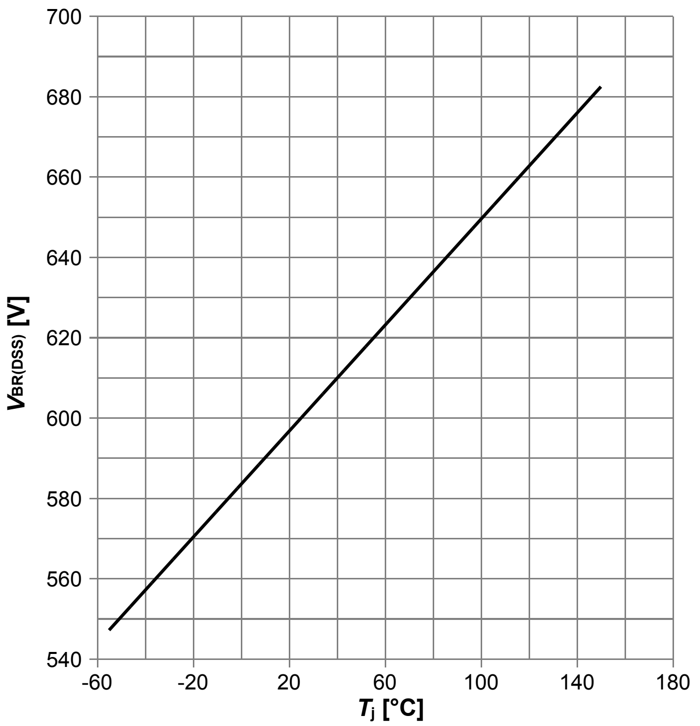

$I_F$=f($V_{SD}$); parameter: $T_j$

**Diagram 12: Avalanche energy**



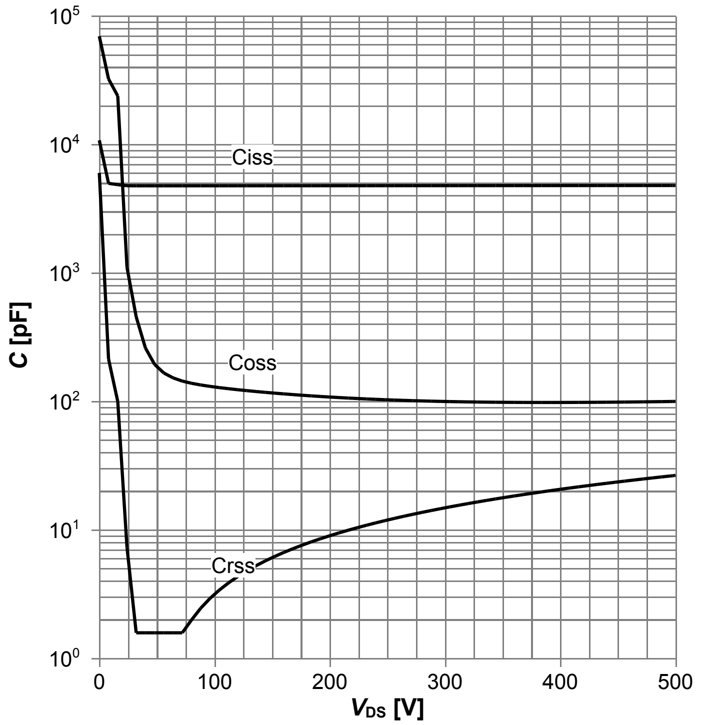

$E_{AS}$=f($T_j$); $I_D$=7.7 A; $V_{DD}$=50 V

**Diagram 13: Drain-source breakdown voltage**



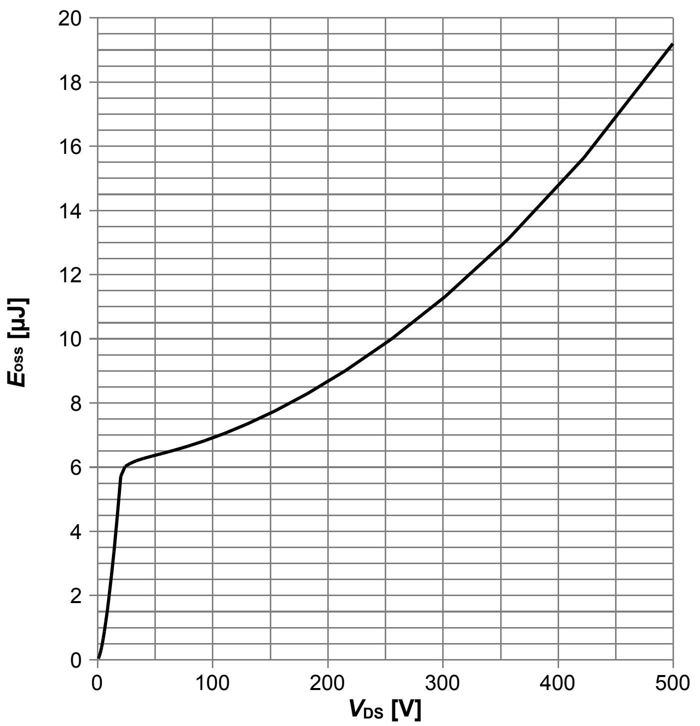

$V_{BR(DSS)}$=f($T_j$); $I_D$=1 mA

**Diagram 14: Typ. capacitances**




$C$=f($V_{DS}$); $V_{GS}$=0 V; $f$=250 kHz

**Diagram 15: Typ. Coss stored energy**

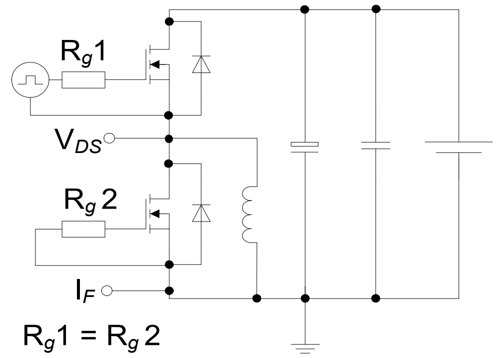



$E_{oss}$=f($V_{DS}$)

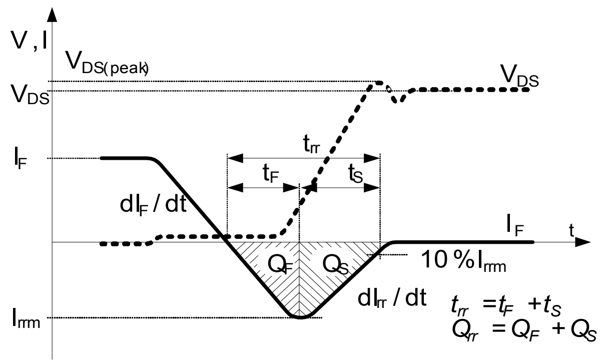
# 5 Test Circuits

## Table 8 Diode characteristics

Test circuit for diode characteristics

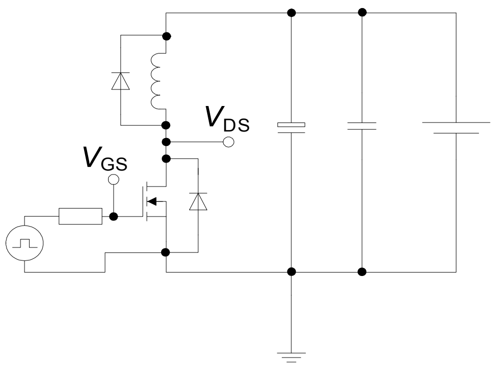



Diode recovery waveform

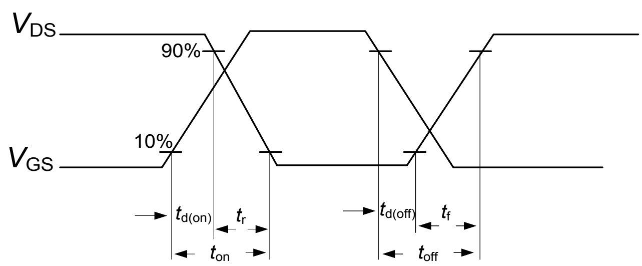



## Table 9 switching times (ss)

Switching times test circuit for inductive load

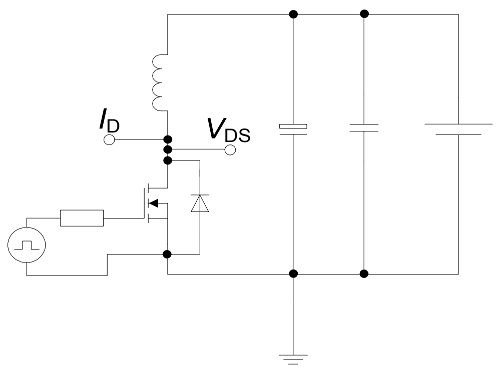



Switching times waveform

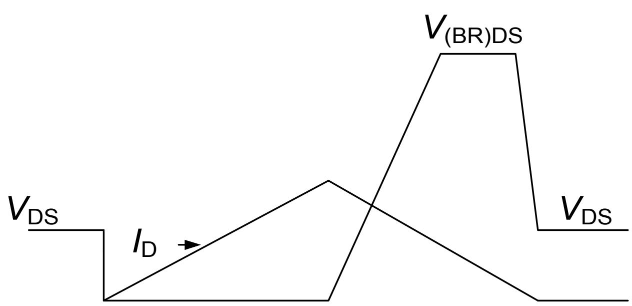



## Table 10 Unclamped inductive load (ss)

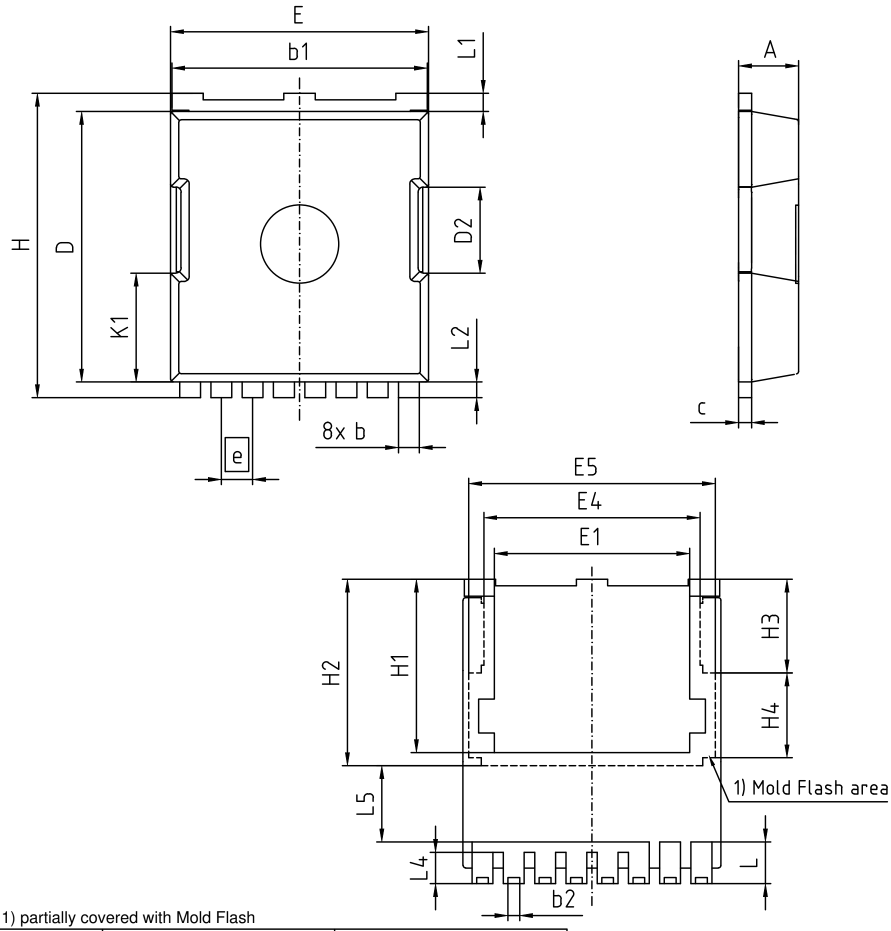
Unclamped inductive load test circuit




Unclamped inductive waveform



# 6 Package Outlines




1) partially covered with Mold Flash

| DIM | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 2.20 | 2.40 | 0.087 | 0.094 |
| b | 0.70 | 0.90 | 0.028 | 0.035 |
| b1 | 9.70 | 9.90 | 0.382 | 0.390 |
| b2 | 0.42 | 0.50 | 0.017 | 0.020 |
| c | 0.40 | 0.60 | 0.016 | 0.024 |
| D | 10.28 | 10.58 | 0.405 | 0.416 |
| D2 | 3.30 | | 0.130 | |
| E | 9.70 | 10.10 | 0.382 | 0.398 |
| E1 | 7.50 | | 0.295 | |
| E4 | 8.50 | | 0.335 | |
| E5 | 9.46 | | 0.372 | |
| e | 1.20 (BSC) | | 0.047 (BSC) | |
| H | 11.48 | 11.88 | 0.452 | 0.468 |
| H1 | 6.55 | 6.75 | 0.258 | 0.266 |
| H2 | 7.15 | | 0.281 | |
| H3 | 3.59 | | 0.141 | |
| H4 | 3.26 | | 0.128 | |
| N | 8 | | 8 | |
| K1 | 4.18 | | 0.165 | |
| L | 1.40 | 1.80 | 0.055 | 0.071 |
| L1 | 0.50 | 0.90 | 0.020 | 0.035 |
| L2 | 0.50 | 0.70 | 0.020 | 0.028 |
| L4 | 1.00 | 1.30 | 0.039 | 0.051 |
| L5 | 2.62 | 2.81 | 0.103 | 0.111 |

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Z8B00176939

SCALE 0 2 4mm

EUROPEAN PROJECTION

ISSUE DATE
28-04-2015

REVISION
01

**Figure 1 Outline PG-HSOF-8**

# 7 Appendix A

**Table 11 Related Links**

- **IFX CoolMOS™ G7 Webpage:** www.infineon.com
- **IFX CoolMOS™ G7 application note:** www.infineon.com
- **IFX CoolMOS™ G7 simulation model:** www.infineon.com
- **IFX Design tools:** www.infineon.com

## Revision History

IPT60R028G7

**Revision: 2016-12-15, Rev. 2.0**

Previous Revision

| Revision | Date | Subjects (major changes since last revision) |
|---|---|---|
| 2.0 | 2016-12-15 | Release of final version |



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