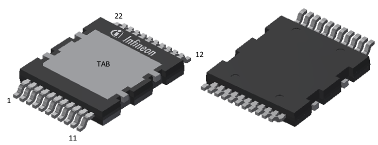
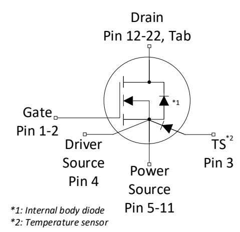
# MOSFET

## 600V CoolMOS™ SJ S7A Power Device

CoolMOS™ S7A reduce $R_{DS(on)}$ values for an HV SJ MOSFET, with a distinctive increase in energy efficiency. CoolMOS™ S7A is optimized for "static switching" and high current applications. The embedded temperature sensor increases junction temperature sensing accuracy and robustness while keeping an easy and seamless implementation.

PG-HDSOP-22






### Features

- CoolMOS™ S7A technology enables lowest $R_{DS(on)}$ and high pulse current capability in the smallest footprint
- Optimized price performance in low-frequency switching applications
- Seamless diagnostics at lowest system cost
- Temperature sense feature for protection and optimized thermal device utilization

### Benefits

- Minimized conduction losses (reduced heat sink size)
- Increased system performance
- Lower BOM or/and TCO over a prolonged lifetime
- Reduction of external sensing elements

**Compared to electromechanical devices:**
- Faster switching times; More reliability and longer system lifetime
- Shock & Vibration resistance; No contact arcing or bouncing

### Potential applications

- Solid state relays and circuit breakers
- Line rectification in high power/performance applications

### Product validation

Qualified according to AEC Q101

*Please note: The source and sense source pins are not exchangeable. Their exchange might lead to malfunction. For paralleling 4pin MOSFET devices the placement of the gate resistor is generally recommended to be on the Driver Source instead of the Gate. For production part approval process (PPAP) release we propose to share application related information during an early design phase to avoid delays in PPAP release. Please contact Infineon sales office.*

**Table 1 Key Performance Parameters**

| Parameter | Value | Unit |
|---|---|---|
| $R_{DS(on),max}$ | 10 | mΩ |
| $Q_{g,typ}$ | 318 | nC |
| $V_{SD}$ | 0.82 | V |
| Pulsed $I_{SD}$, $I_{DS}$ | 796 | A |
| ESD class (HBM) | 2 | JEDEC AEC Q101 |

| Type / Ordering Code | Package | Marking | Related Links |
|---|---|---|---|
| IPDQ60T010S7A | PG-HDSOP-22 | 60T010S7 | see Appendix A |

## Table of Contents

# 1 Maximum ratings

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

## Table 2 Maximum MOSFET ratings

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Drain current rating[1] | $I_D$ | -<br>- | -<br>- | 174<br>50 | A | $T_C$=25°C<br>$T_C$=140°C |
| Pulsed drain current[2] | $I_{D,pulse}$ | - | - | 796 | A | $T_C$=25°C |
| Avalanche energy, single pulse | $E_{AS}$ | - | - | 612 | mJ | $I_D$=6.3A; $V_{DD}$=50V; see table 12 |
| Avalanche current, single pulse | $I_{AS}$ | - | - | 6.3 | A | - |
| MOSFET dv/dt ruggedness[3] | dv/dt | - | - | 20 | V/ns | $V_{DS}$= 0V to 300V |
| 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 | $P_{tot}$ | - | - | 694 | W | $T_C$=25°C |
| Storage temperature | $T_{stg}$ | -55 | - | 150 | °C | - |
| Operating junction temperature[1] | $T_j$ | -40 | - | 150 | °C | - |
| Extended operating junction temperature | $T_j$ | 150 | - | 175 | °C | ≤50 h in the application lifetime |
| Mounting torque | - | - | - | n.a. | Ncm | - |
| Diode forward current rating | $I_S$ | - | - | 50 | A | $T_C$=140°C<br>Current is limited by $T_{j\,max}$ = 150°C; Lower case temp does increase current capability |
| Diode pulse current[2] | $I_{S,pulse}$ | - | - | 796 | A | $T_C$=25°C |
| Reverse diode dv/dt[4] | dv/dt | - | - | 5 | V/ns | $V_{DS}$=0 to 300V, $I_{SD}$<=50A, $T_j$=25°C see table 10 |
| Maximum diode commutation speed | $di_f/dt$ | - | - | 800 | A/µs | $V_{DS}$=0 to 300V, $I_{SD}$<=50A, $T_j$=25°C see table 10 |
| Insulation withstand voltage | $V_{ISO}$ | - | - | n.a. | V | - |

[1] Please consider the App Note: 600 V CoolMOS™ S7 with Temperature Sense for high delta $T_J$ usage
[2] Pulse width $t_p$ limited by $T_{j,max}$
[3] The dv/dt has to be limited by appropriate gate resistor
[4] 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 | $R_{thJC}$ | - | - | 0.18 | °C/W | - |
| Thermal resistance, junction - ambient | $R_{thJA}$ | - | - | 62 | °C/W | device on PCB, minimal footprint |
| Thermal resistance, junction - ambient for SMD version | $R_{thJA}$ | - | 45 | 55 | °C/W | Device on 40mm*40mm*1.5mm epoxy PCB FR4 with 6cm² (one layer, 70µm thickness) copper area. Tap exposed to air. PCB is vertical without air stream cooling. |
| Soldering temperature, reflow soldering allowed | $T_{sold}$ | - | - | 260 | °C | reflow MSL1 |

# 3 Electrical characteristics

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

## Table 4 Static characteristics

The CoolMOS[TM] mentioned in this datasheet shall not be operated in linear mode.
For any questions in this regard, please contact Infineon sales office.
For applications with applied blocking voltage >400V, it is required that the customer evaluates the impact of cosmic radiation effect in early design phase and contacts the Infineon sales office for the necessary technical support by Infineon

| 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 | $V_{(GS)th}$ | 3.5 | 4.0 | 4.5 | V | $V_{DS}$=$V_{GS}$, $I_D$=3.06mA |
| Zero gate voltage drain current | $I_{DSS}$ | -<br>- | -<br>80 | 8<br>- | µA | $V_{DS}$=600V, $V_{GS}$=0V, $T_j$=25°C<br>$V_{DS}$=600V, $V_{GS}$=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>- | 0.009<br>0.022 | 0.010<br>- | Ω | $V_{GS}$=12V, $I_D$=50A, $T_j$=25°C<br>$V_{GS}$=12V, $I_D$=50A, $T_j$=150°C |
| Gate resistance | $R_G$ | - | 0.45 | - | Ω | $f$=1MHz, open drain |

## Table 5 Dynamic characteristics

External parasitic elements (PCB layout) influence switching behavior significantly.
Stray inductances and coupling capacitances must be minimized.
For layout recommendations please use provided application notes or contact Infineon sales office.

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Input capacitance | $C_{iss}$ | - | 11986 | - | pF | $V_{GS}$=0V, $V_{DS}$=300V, $f$=250kHz |
| Output capacitance | $C_{oss}$ | - | 188 | - | pF | $V_{GS}$=0V, $V_{DS}$=300V, $f$=250kHz |
| Effective output capacitance, energy related[1)] | $C_{o(er)}$ | - | 643 | - | pF | $V_{GS}$=0V, $V_{DS}$=0 to 300V |
| Effective output capacitance, time related[2)] | $C_{o(tr)}$ | - | 5714 | - | pF | $I_D$=constant, $V_{GS}$=0V, $V_{DS}$=0 to 300V |
| Output charge | $Q_{oss}$ | - | 1714 | - | nC | $V_{GS}$=0V, $V_{DS}$=0 to 300V |
| Turn-on delay time | $t_{d(on)}$ | - | 32 | - | ns | $V_{DD}$=300V, $V_{GS}$=13V, $I_D$=50A, $R_G$=3Ω; see table 11 |
| Rise time | $t_r$ | - | 12 | - | ns | $V_{DD}$=300V, $V_{GS}$=13V, $I_D$=50A, $R_G$=3Ω; see table 11 |
| Turn-off delay time | $t_{d(off)}$ | - | 170 | - | ns | $V_{DD}$=300V, $V_{GS}$=13V, $I_D$=50A, $R_G$=3Ω; see table 11 |
| Fall time | $t_f$ | - | 9 | - | ns | $V_{DD}$=300V, $V_{GS}$=13V, $I_D$=50A, $R_G$=3Ω; see table 11 |

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 300V
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 300V

## Table 6 Gate charge characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Gate to source charge | $Q_{gs}$ | - | 69 | - | nC | $V_{DD}$=300V, $I_D$=50A, $V_{GS}$=0 to 12V |
| Gate to drain charge | $Q_{gd}$ | - | 105 | - | nC | $V_{DD}$=300V, $I_D$=50A, $V_{GS}$=0 to 12V |
| Gate charge total | $Q_g$ | - | 318 | - | nC | $V_{DD}$=300V, $I_D$=50A, $V_{GS}$=0 to 12V |
| Gate plateau voltage | $V_{plateau}$ | - | 5.7 | - | V | $V_{DD}$=300V, $I_D$=50A, $V_{GS}$=0 to 12V |

## Table 7 Reverse diode characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Diode forward voltage | $V_{SD}$ | - | 0.82 | - | V | $V_{GS}$=0V, $I_F$=50A, $T_j$=25°C |
| Reverse recovery time | $t_{rr}$ | - | 600 | - | ns | $V_R$=300V, $I_F$=50A, d$i_F$/d$t$=100A/µs; see table 10 |
| Reverse recovery charge | $Q_{rr}$ | - | 17 | - | µC | $V_R$=300V, $I_F$=50A, d$i_F$/d$t$=100A/µs; see table 10 |
| Peak reverse recovery current | $I_{rrm}$ | - | 55 | - | A | $V_R$=300V, $I_F$=50A, d$i_F$/d$t$=100A/µs; see table 10 |

# 4 Temperature Sensor parameters

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

## Table 8 Maximum ratings

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Repetitive Peak Reverse Voltage | $V_{RRM}$ | - | - | 15 | V | $I_R$ = 100 µA |
| Sensor forward current | $I_F$ | - | - | 5 | mA | - |
| Repetitive peak forward current | $I_{F\_pulse}$ | - | - | 25 | mA | $t_{pulse}$ = 1 ms, $T_{period}$ = 10 ms |
| Non-repetitive peak forward current | $I_{FSM}$ | -<br>-<br>- | -<br>-<br>- | 1.5<br>0.2<br>0.1 | A | $T_C$ = 25°C, $t_{pulse}$ = 1 µs<br>$T_C$ = 25°C, $t_{pulse}$ = 1 ms<br>$T_C$ = 25°C, $t_{pulse}$ = 1 s |
| Junction Temperature | $T_j$ | - | - | 185 | °C | t < 50h, Sensor only |

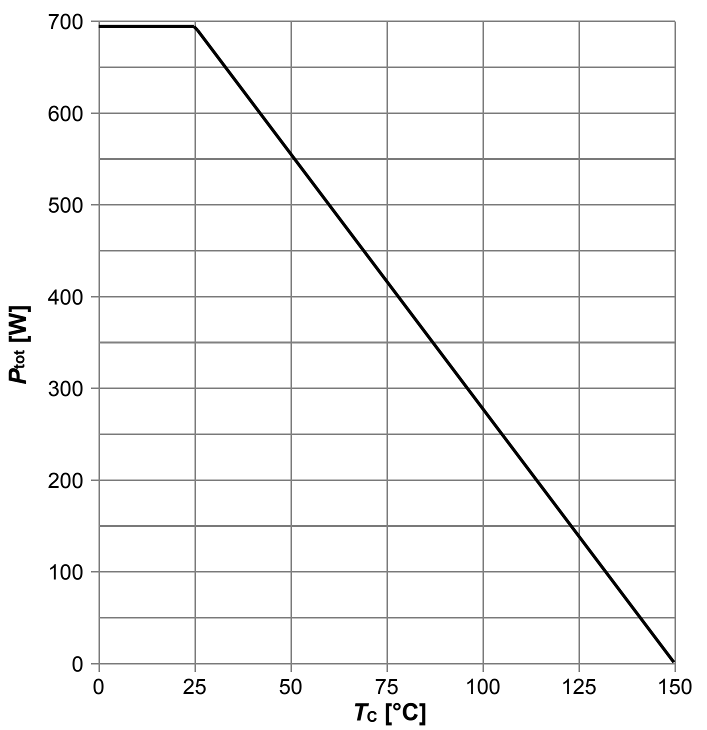
## Table 9 Electrical characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Sensor forward voltage[1] | $V_{F\_25}$ | 1.5601<br>-<br>-<br>2.0665 | 1.6019<br>1.8103<br>1.9806<br>2.0966 | 1.6436<br>-<br>-<br>2.1266 | V | $T_j$ = 25°C, $I_F$ = 10 µA<br>$T_j$ = 25°C, $I_F$ = 50 µA<br>$T_j$ = 25°C, $I_F$ = 200 µA<br>$T_j$ = 25°C, $I_F$ = 500 µA |
| Sensor forward voltage temperature coefficient | $TC$ | -<br>-<br>-<br>- | 5.9644<br>5.5880<br>5.2287<br>5.0135 | -<br>-<br>-<br>- | mV/K | 25°C ≤ $T_j$ ≤ 175°C, $I_F$ = 10 µA<br>25°C ≤ $T_j$ ≤ 175°C, $I_F$ = 50 µA<br>25°C ≤ $T_j$ ≤ 175°C, $I_F$ = 200 µA<br>25°C ≤ $T_j$ ≤ 175°C, $I_F$ = 500 µA |
| Sensor forward voltage | $V_{F\_175}$ | 0.6655<br>-<br>-<br>1.3144 | 0.7072<br>0.9721<br>1.1963<br>1.3445 | 0.7490<br>-<br>-<br>1.3746 | V | $T_j$ = 175°C, $I_F$ = 10 µA<br>$T_j$ = 175°C, $I_F$ = 50 µA<br>$T_j$ = 175°C, $I_F$ = 200 µA<br>$T_j$ = 175°C, $I_F$ = 500 µA |
| Reverse leakage current | $I_R$ | -<br>- | -<br>- | 1<br>20 | µA | $V_R$ = 10V, $T_j$ = 25°C<br>$V_R$ = 10V, $T_j$ = 175°C |
| Sensor G Capacitance | $C_{GTS}$ | - | 4.2 | - | pF | f = 1 MHz, $I_F$ = 50 µA |
| Sensor Capacitance | $C_{STS}$ | - | 4.8 | - | pF | f = 1 MHz, $I_F$ = 50 µA |
| Anode-Drain Capacitance | $C_{DTS}$ | - | 0.5 | - | pF | f = 1 MHz, $V_{DS}$ = 0 V |

[1] Specified by Design and not tested

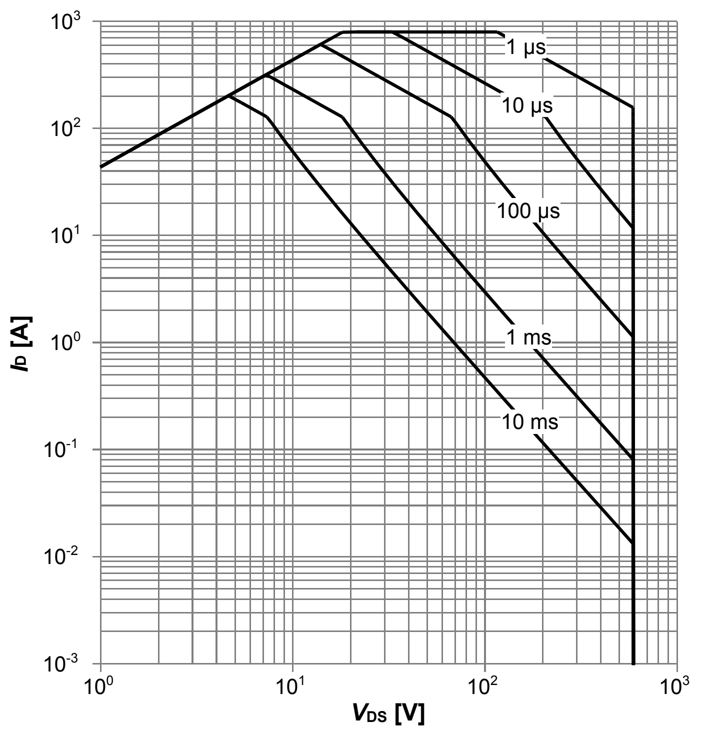
# 5 Electrical characteristics diagrams

**Diagram 1: Power dissipation**



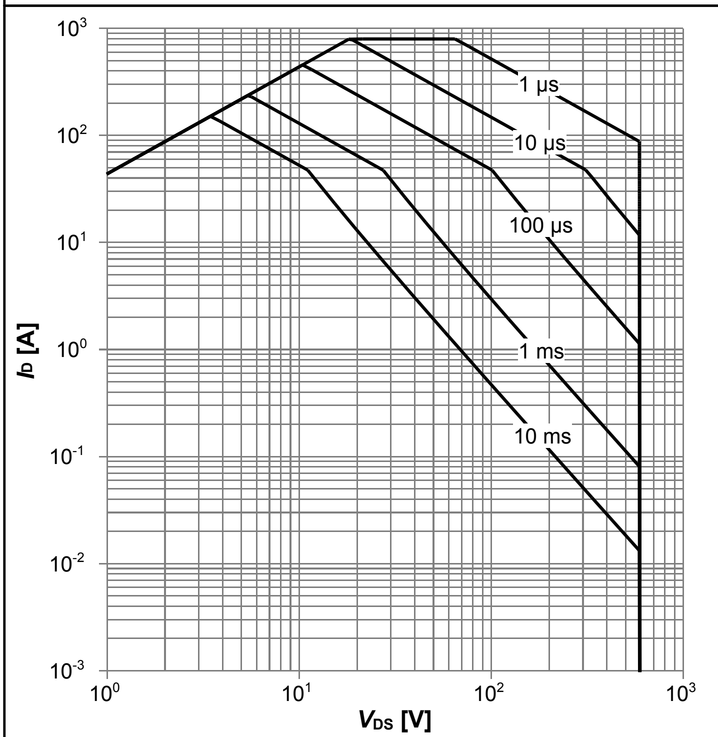

$P_{tot}$=f($T_C$)

**Diagram 2: Safe operating area**



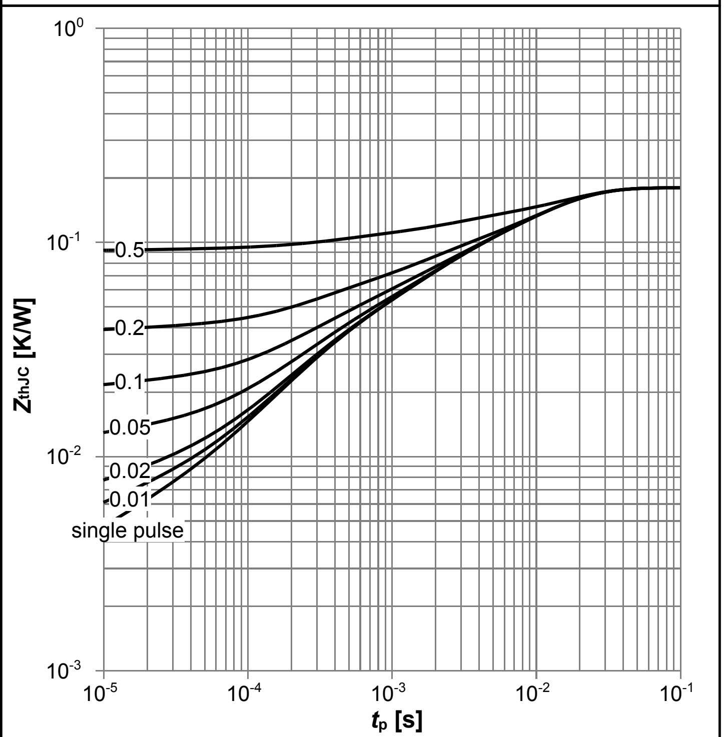

$I_D$=f($V_{DS}$); $T_C$=25 °C; $D$=0; parameter: $t_p$

**Diagram 3: Safe operating area**



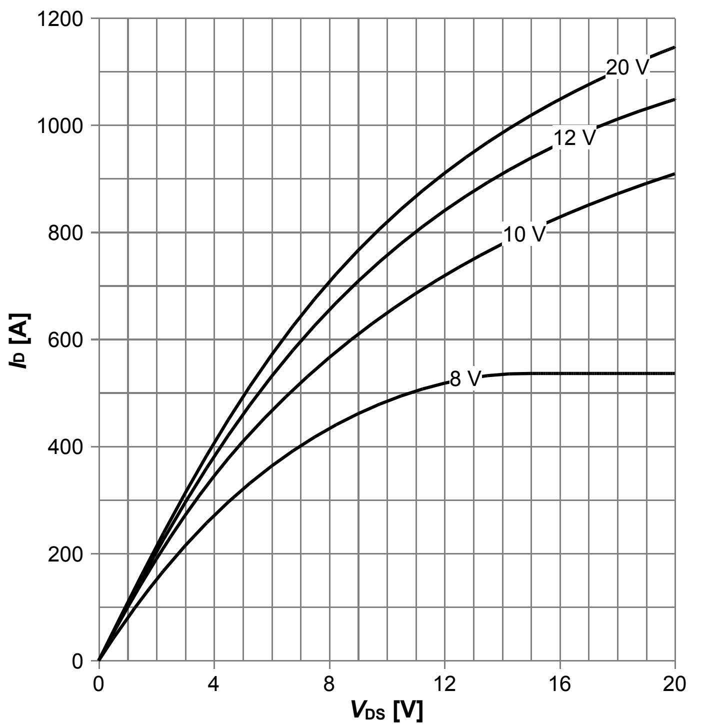

$I_D$=f($V_{DS}$); $T_C$=80 °C; $D$=0; parameter: $t_p$

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



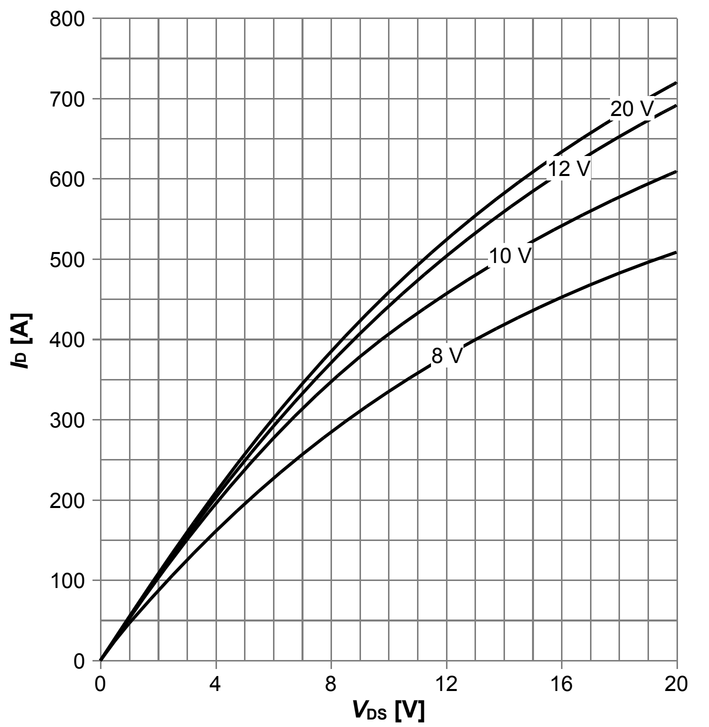

$Z_{thJC}$ =f($t_P$); parameter: $D$=$t_p$/$T$

**Diagram 5: Typ. output characteristics**



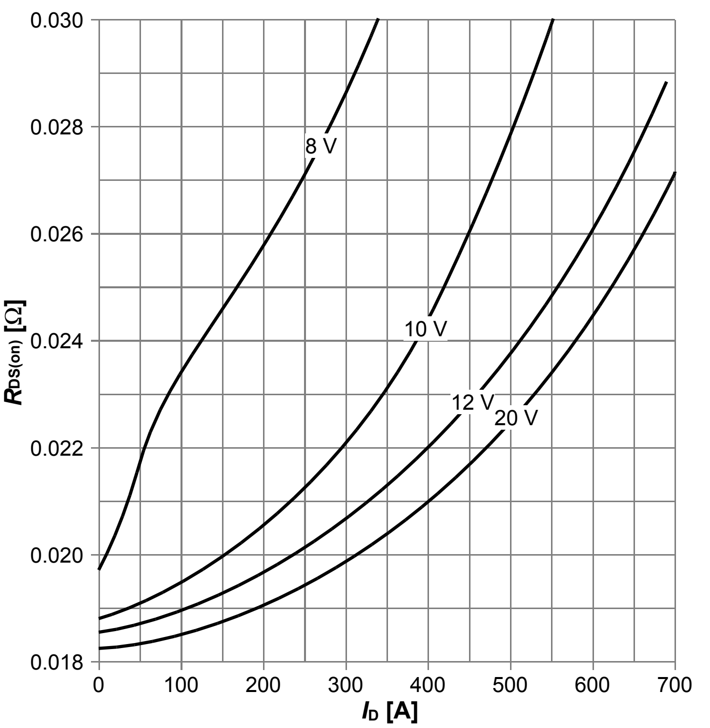

$I_D$=f($V_{DS}$); $T_j$=25 °C; parameter: $V_{GS}$

**Diagram 6: Typ. output characteristics**



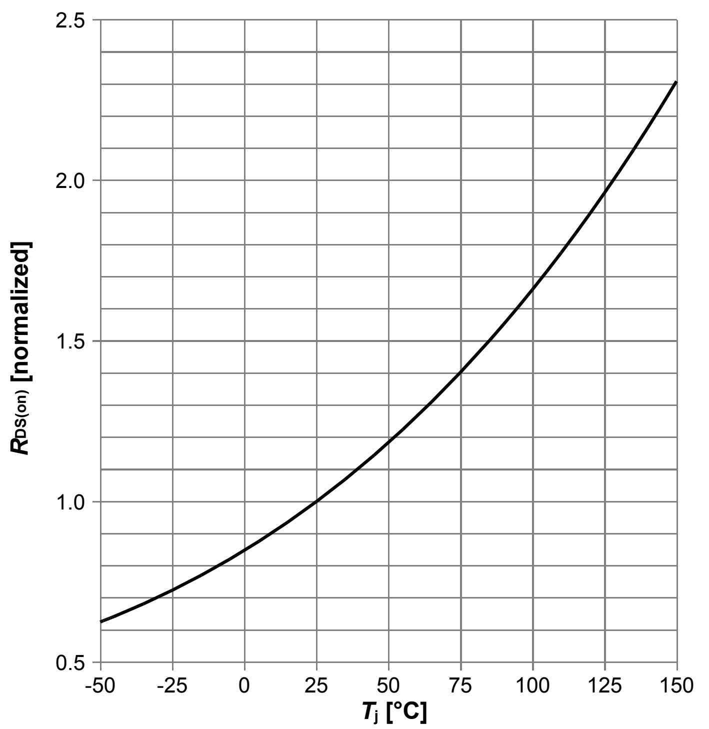

$I_D$=f($V_{DS}$); $T_j$=125 °C; parameter: $V_{GS}$

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



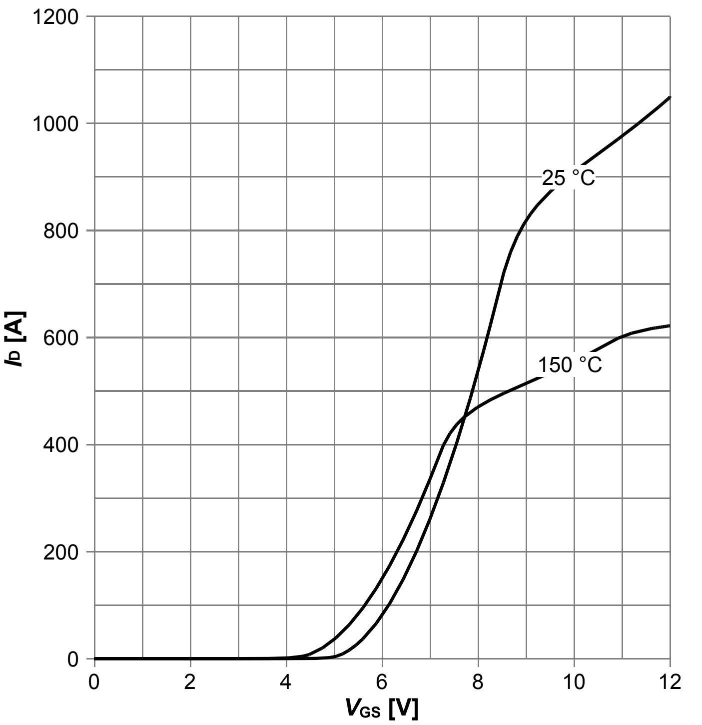

$R_{DS(on)}$=f($I_D$); $T_j$=125 °C; parameter: $V_{GS}$

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



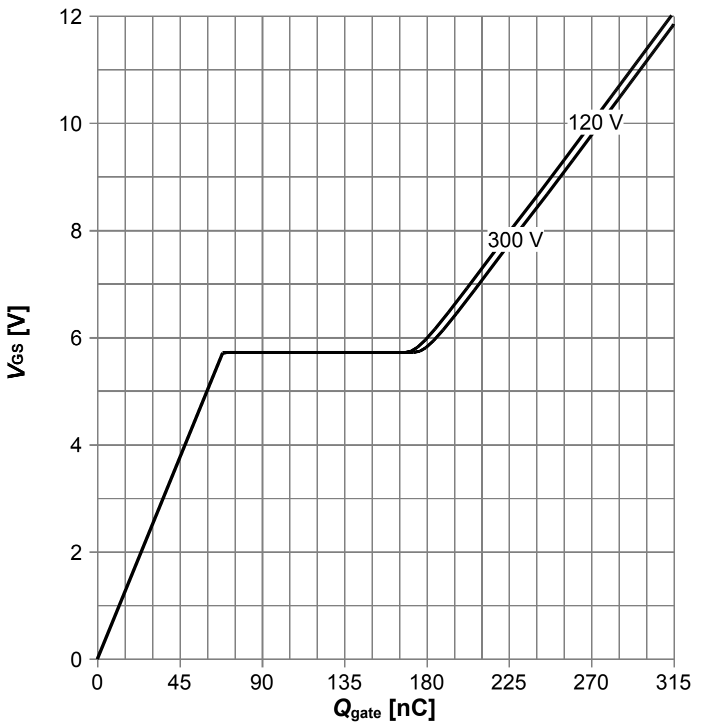

$R_{DS(on)}$=f($T_j$); $I_D$=50 A; $V_{GS}$=12 V

**Diagram 9: Typ. transfer characteristics**



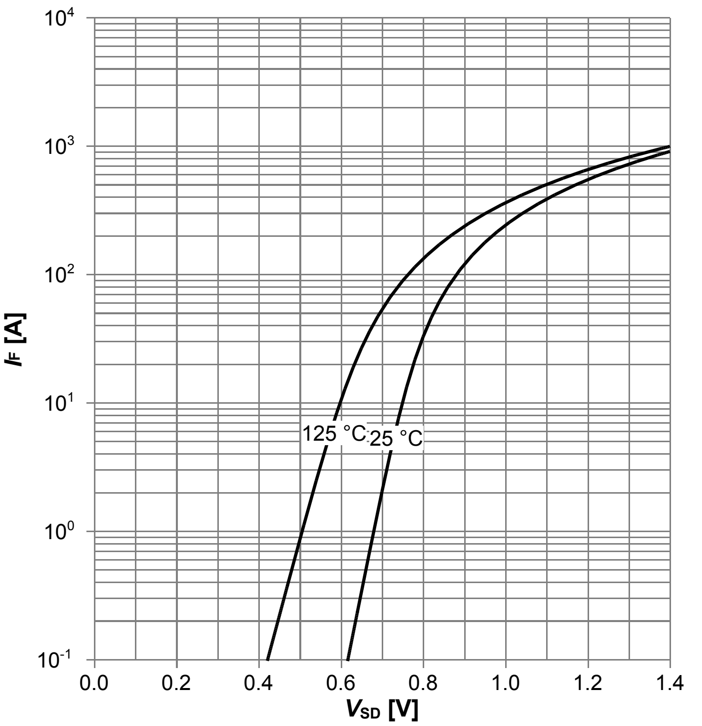

$I_D$=f($V_{GS}$); $V_{DS}$=20V; parameter: $T_j$

**Diagram 10: Typ. gate charge**



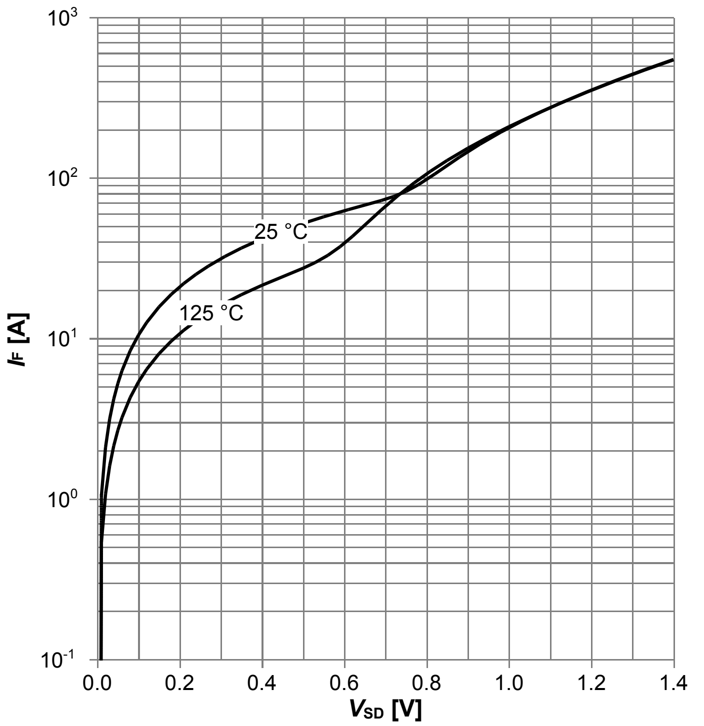

$V_{GS}$=f($Q_{gate}$); $I_D$=50 A pulsed; parameter: $V_{DD}$

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



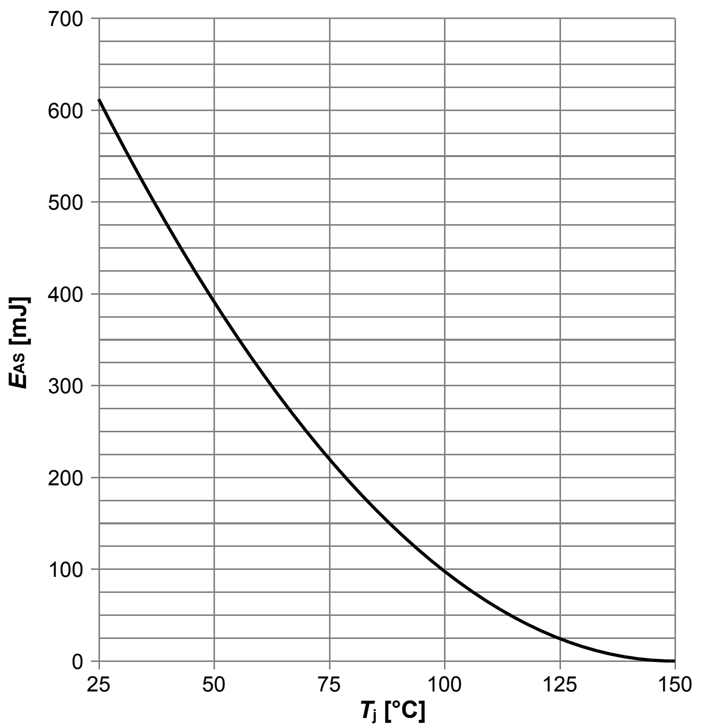

$I_F$=f($V_{SD}$); $V_{GS}$=0 V; parameter: $T_j$

**Diagram 12: Forward characteristics of reverse diode**



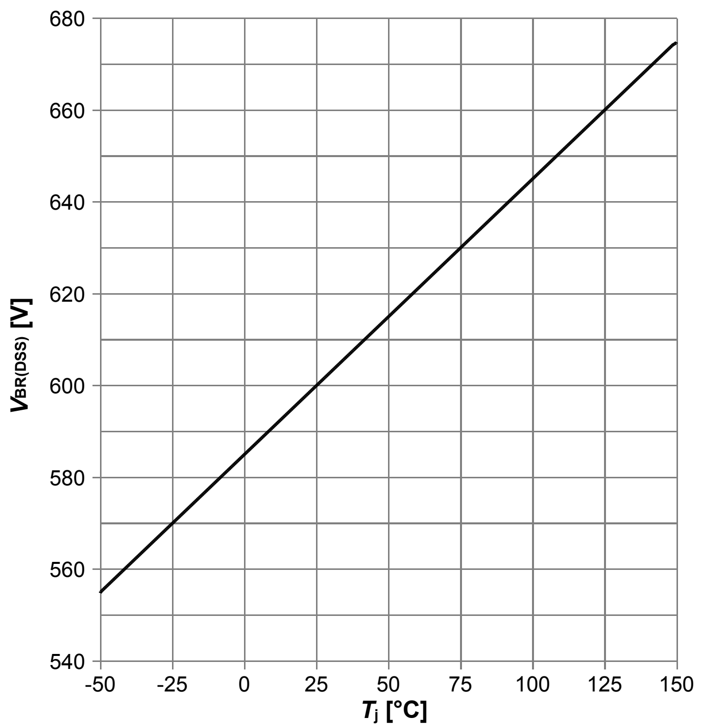

$I_F$=f($V_{SD}$); $V_{GS}$=12 V; parameter: $T_j$

**Diagram 13: Avalanche energy**



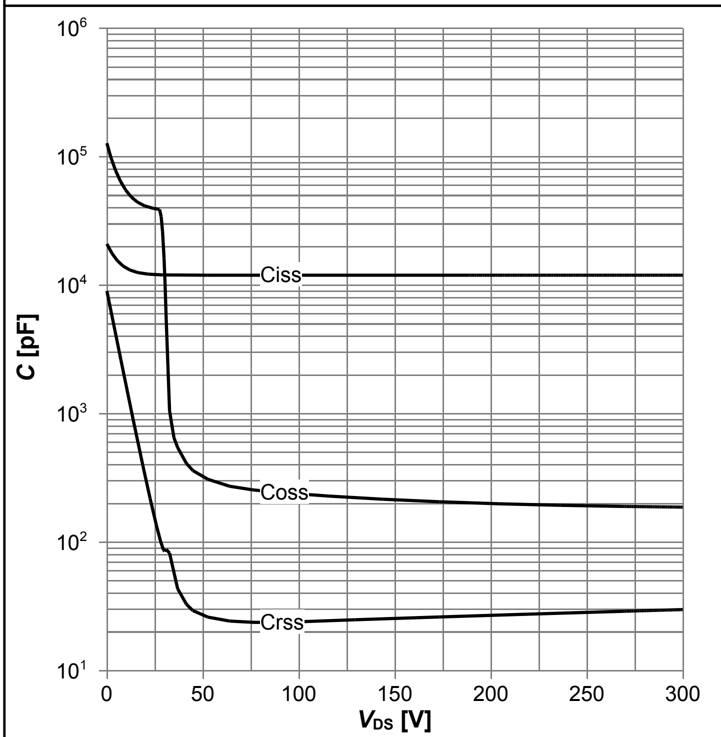

$E_{AS}$=f($T_j$); $I_D$=6.3 A; $V_{DD}$=50 V

**Diagram 14: Drain-source breakdown voltage**



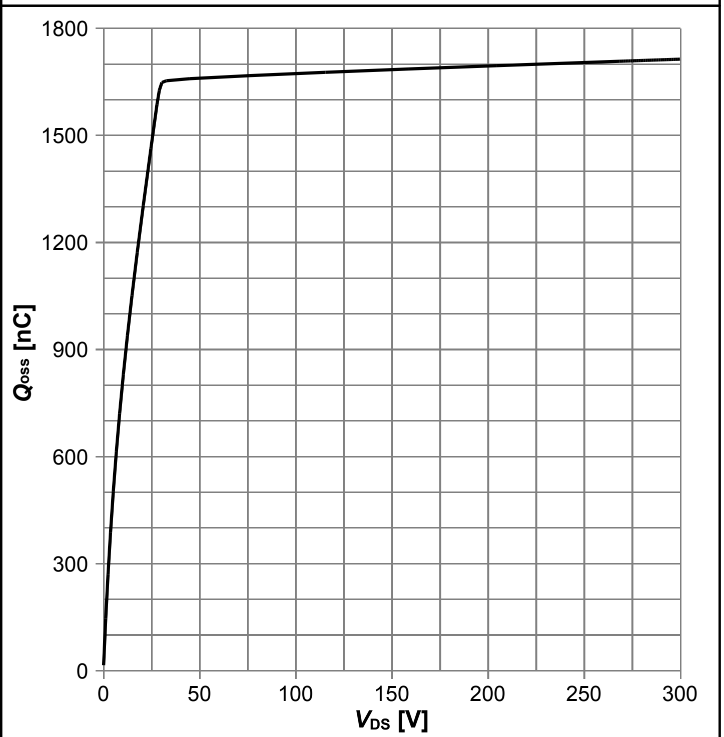

$V_{BR(DSS)}$=f($T_j$); $I_D$=1 mA

**Diagram 15: Typ. capacitances**



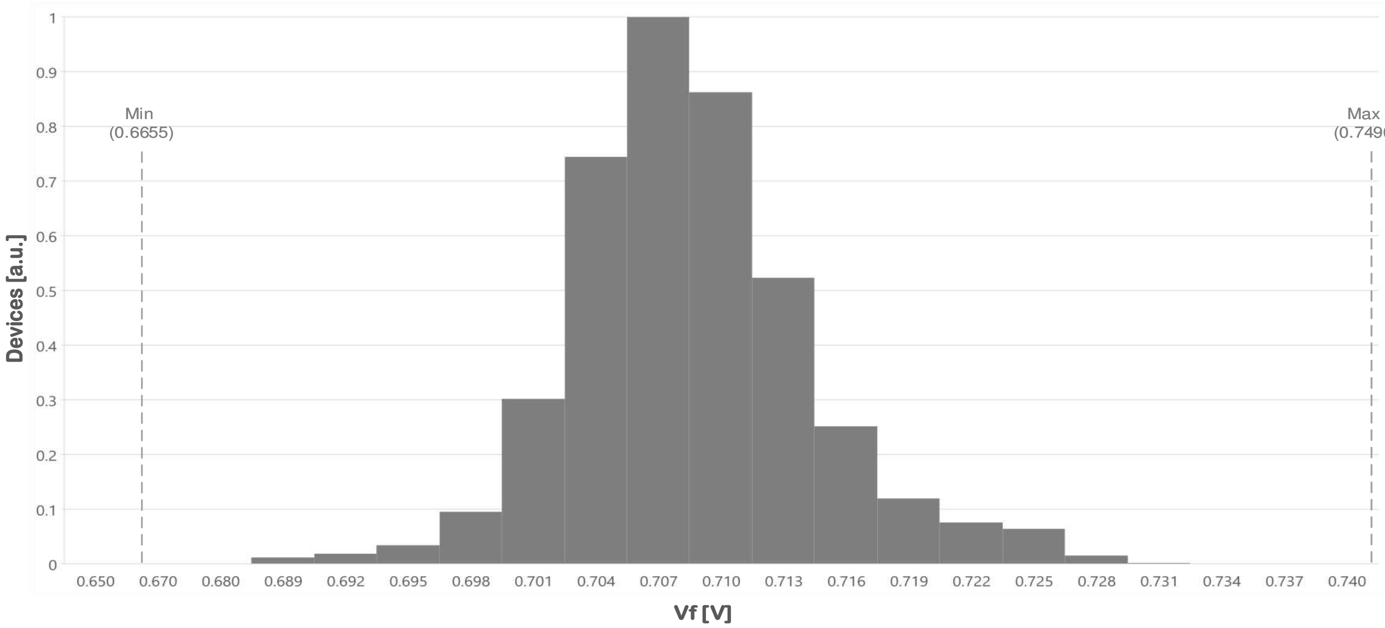

$C$=f($V_{DS}$); $V_{GS}$=0 V; $f$=250 kHz

**Diagram 17: Typ. Qoss output charge**




$Q_{oss}$=f($V_{DS}$); $V_{GS}$=0 V

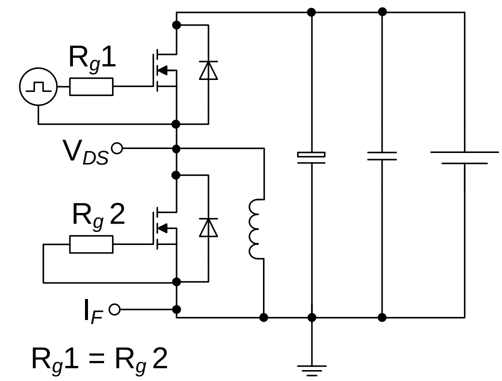
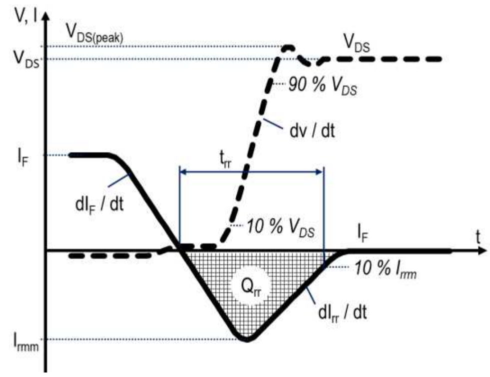
**Diagram: Distribution of typical temperature sensor signal**




$T_{j\_set}$=175 °C; $I_{F\_set}$ = 10 µA

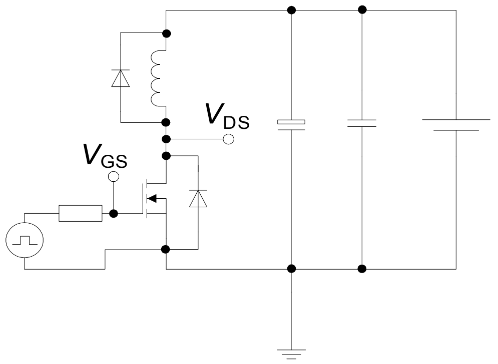
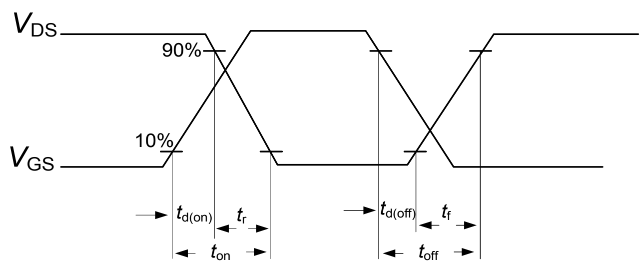
# 6 Test Circuits

## Table 10 Diode characteristics

| Test circuit for diode characteristics | Diode recovery waveform |
|---|---|
|  |  |

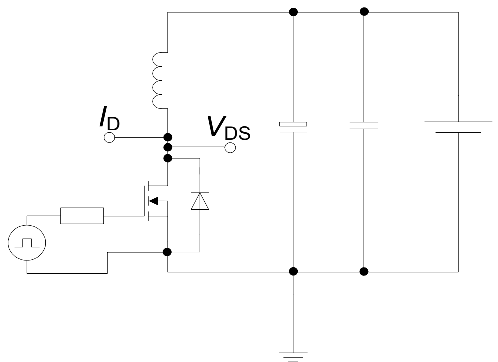
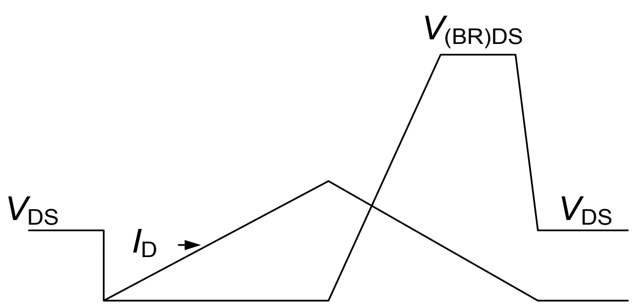



## Table 11 Switching times (ss)

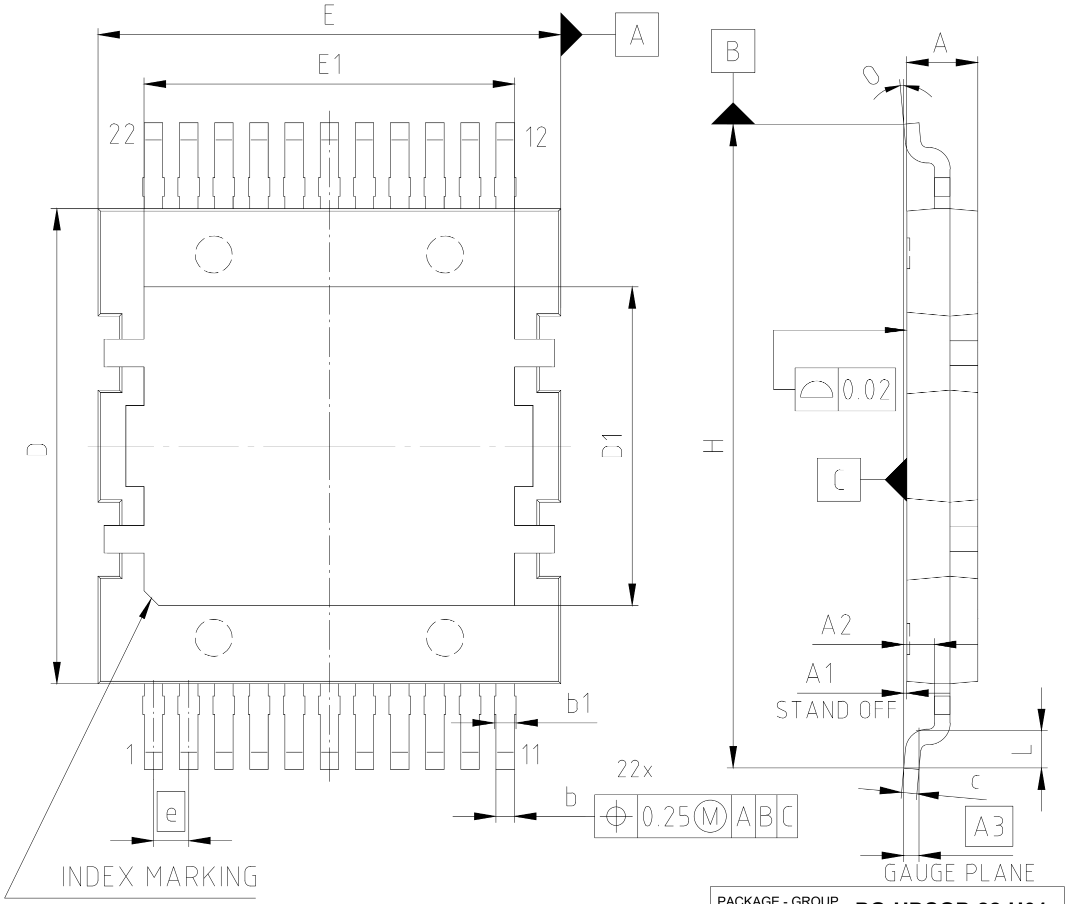
| Switching times test circuit for inductive load | Switching times waveform |
|---|---|
|  |  |

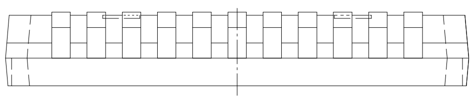



## Table 12 Unclamped inductive load (ss)

| Unclamped inductive load test circuit | Unclamped inductive waveform |
|---|---|
|  |  |

# 7 Package Outlines



NOTES:

1. ALL DIMENSIONS REFER TO JEDEC STANDARD TO-252 AND DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
2. ALL METAL SUFACES ARE TIN PLATED, EXCEPT AREA OF CUT.

| PACKAGE - GROUP NUMBER: | PG-HDSOP-22-U01 | |
|---|---|---|
| DIMENSIONS | MILLIMETERS | |
| | MIN. | MAX. |
| A | 2.25 | 2.35 |
| A1 | 0.00 | 0.15 |
| A2 | 0.89 | 1.10 |
| A3 | 0.5 | |
| b | 0.50 | 0.70 |
| b1 | 0.50 | 0.90 |
| c | 0.46 | 0.58 |
| D | 15.30 | 15.50 |
| D1 | 10.23 | 10.43 |
| E | 14.90 | 15.10 |
| E1 | 11.91 | 12.11 |
| e | 1.14 | |
| N | 22 | |
| H | 20.86 | 21.06 |
| L | 1.20 | 1.40 |
| O | 0° | 8° |

**Figure 1 Outline PG-HDSOP-22, dimensions in mm**

# 8 Appendix A

**Table 13 Related Links**

- **IFX CoolMOS™ S7TA Webpage:** www.infineon.com
- **IFX CoolMOS™ S7TA application note:** www.infineon.com
- **IFX CoolMOS™ S7TA simulation model:** www.infineon.com
- **IFX Design tools:** www.infineon.com

## Revision History

| | | |
|---|---|---|
| IPDQ60T010S7A | | |
| **Revision: 2024-03-18, Rev. 2.0** | | |
| Previous Revision | | |
| Revision | Date | Subjects (major changes since last revision) |
| 2.0 | 2024-03-18 | Release of final version |



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