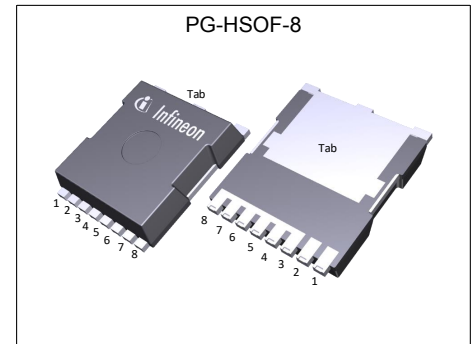


## MOSFET

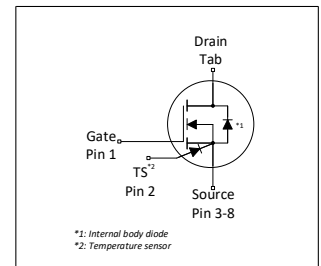
### 600V CoolMOS™ SJ S7 Power Device

IPT60T022S7 enables the best price performance for low-frequency switching applications. CoolMOS™ S7 boasts the lowest  $R_{DS(on)}$  values for an HV SJ MOSFET, with a distinctive increase in energy efficiency. The embedded Temperature sensor increases junction temperature sensing accuracy and robustness while keeping an easy and seamless implementation. CoolMOS™ S7 is optimized for “static switching” and high current applications. It is an ideal fit for solid-state relay, circuit breaker designs, and line rectification in SMPS and inverter topologies. The new temperature sensor enhances S7 features, allowing the best possible utilization of the power transistor.



### Features

- CoolMOS™ S7 technology enables lowest  $R_{DS(on)}$  in the smallest footprint
- Optimized price performance in low-frequency switching applications
- High pulse current capability
- Seamless diagnostics at the lowest system
- Temperature sense feature for protection and optimized thermal device utilization cost



### Benefits

- Minimized conduction losses (eliminate/reduce heat sink)
- Increased system performance
- More compact and more straightforward design
- 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 e.g. Computing, Telecom, UPS and Solar

### Product validation

Fully qualified according to JEDEC for Industrial Applications

**Table 1 Key Performance Parameters**

Parameter	Value	Unit
$R_{DS(on),max}$	22	mΩ
$Q_{g,typ}$	150	nC
$V_{SD}$	0.82	V
Pulsed $I_{SD}, I_{DS}$	371	A
ESD class (HBM)	2	JEDEC JS-001

Type / Ordering Code	Package	Marking	Related Links
IPT60T022S7	PG-HSOF-8	60I022S7	see Appendix A

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## 1 Maximum ratings

at  $T_j = 25^\circ\text{C}$ , unless otherwise specified

**Table 2 Maximum MOSFET ratings**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Drain current rating <sup>1)</sup>	$I_D$	-	-	23	A	$T_C=25^\circ\text{C}$ Current is limited by $T_{j\text{max}} = 150^\circ\text{C}$
Pulsed drain current <sup>2)</sup>	$I_{D,\text{pulse}}$	-	-	371	A	$T_C=25^\circ\text{C}$
Avalanche energy, single pulse	$E_{AS}$	-	-	286	mJ	$I_D=3.7\text{A}$ ; $V_{DD}=50\text{V}$ ; see table 11
Avalanche current, single pulse	$I_{AS}$	-	-	3.7	A	-
MOSFET dv/dt ruggedness <sup>3)</sup>	dv/dt	-	-	20	V/ns	$V_{DS}= 0\text{V to } 300\text{V}$
Gate source voltage (static)	$V_{GS}$	-20	-	20	V	static
Gate source voltage (dynamic)	$V_{GS}$	-30	-	30	V	AC ( $f>1\text{ Hz}$ )
Power dissipation	$P_{\text{tot}}$	-	-	390	W	$T_C=25^\circ\text{C}$
Storage temperature	$T_{\text{stg}}$	-55	-	150	$^\circ\text{C}$	-
Operating junction temperature <sup>1)</sup>	$T_j$	-55	-	150	$^\circ\text{C}$	-
Extended operating junction temperature	$T_j$	150	-	175	$^\circ\text{C}$	$\leq 50\text{ h}$ in the application lifetime
Mounting torque	-	-	-	n.a.	Ncm	-
Diode forward current rating	$I_S$	-	-	23	A	$T_C=25^\circ\text{C}$ Current is limited by $T_{j\text{max}} = 150^\circ\text{C}$
Diode pulse current <sup>1)</sup>	$I_{S,\text{pulse}}$	-	-	371	A	$T_C=25^\circ\text{C}$
Reverse diode dv/dt <sup>4)</sup>	dv/dt	-	-	5	V/ns	$V_{DS}=0\text{ to } 300\text{V}$ , $I_{SD}\leq 23\text{A}$ , $T_j=25^\circ\text{C}$ see table 9
Maximum diode commutation speed	di <sub>i</sub> /dt	-	-	800	A/ $\mu\text{s}$	$V_{DS}=0\text{ to } 300\text{V}$ , $I_{SD}\leq 23\text{A}$ , $T_j=25^\circ\text{C}$ see table 9
Insulation withstand voltage	$V_{\text{ISO}}$	-	-	n.a.	V	-

<sup>1)</sup> Please consider the App Note: AN\_2308\_PL52\_2309\_111546 for high delta  $T_j$  usage

<sup>2)</sup> Pulse width  $t_p$  limited by  $T_{j\text{max}}$

<sup>3)</sup> The dv/dt has to be limited by appropriate gate resistor

<sup>4)</sup> 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 6cm <sup>2</sup> (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  $T_j=25^\circ\text{C}$ , unless otherwise specified

**Table 4 Static characteristics**

For applications with applied blocking voltage >420V, 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	$V_{DS}=V_{GS}, I_D=1.43mA$
Zero gate voltage drain current <sup>1)</sup>	$I_{DSS}$	-	-	5	$\mu A$	$V_{DS}=600V, V_{GS}=0V, T_j=25^\circ C$ $V_{DS}=600V, V_{GS}=0V, T_j=150^\circ C$
Gate-source leakage current	$I_{GSS}$	-	-	100	nA	$V_{GS}=20V, V_{DS}=0V$
Drain-source on-state resistance	$R_{DS(on)}$	-	0.02	0.022	$\Omega$	$V_{GS}=12V, I_D=23.0A, T_j=25^\circ C$ $V_{GS}=12V, I_D=23.0A, T_j=150^\circ C$
Gate resistance	$R_G$	-	0.8	-	$\Omega$	$f=1MHz, \text{open drain}$

**Table 5 Dynamic characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	$C_{iss}$	-	5640	-	pF	$V_{GS}=0V, V_{DS}=300V, f=250kHz$
Output capacitance	$C_{oss}$	-	89	-	pF	$V_{GS}=0V, V_{DS}=300V, f=250kHz$
Effective output capacitance, energy related <sup>2)</sup>	$C_{o(er)}$	-	303	-	pF	$V_{GS}=0V, V_{DS}=0 \text{ to } 300V$
Effective output capacitance, time related <sup>3)</sup>	$C_{o(tr)}$	-	2678	-	pF	$I_D=\text{constant}, V_{GS}=0V, V_{DS}=0 \text{ to } 300V$
Output charge	$Q_{oss}$	-	803	-	nC	$V_{GS}=0V, V_{DS}=0 \text{ to } 300V$
Turn-on delay time	$t_{d(on)}$	-	23	-	ns	$V_{DD}=300V, V_{GS}=13V, I_D=23.0A, R_G=5.3\Omega; \text{ see table 9}$
Rise time	$t_r$	-	15	-	ns	$V_{DD}=300V, V_{GS}=13V, I_D=23.0A, R_G=5.3\Omega; \text{ see table 9}$
Turn-off delay time	$t_{d(off)}$	-	150	-	ns	$V_{DD}=300V, V_{GS}=13V, I_D=23.0A, R_G=5.3\Omega; \text{ see table 9}$
Fall time	$t_f$	-	9	-	ns	$V_{DD}=300V, V_{GS}=13V, I_D=23.0A, R_G=5.3\Omega; \text{ see table 9}$

<sup>1)</sup> Open

<sup>2)</sup>  $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 300V

<sup>3)</sup>  $C_{o(tr)}$  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	$Q_{gs}$	-	31	-	nC	$V_{DD}=300V, I_D=23.0A, V_{GS}=0$ to 12V
Gate to drain charge	$Q_{gd}$	-	50	-	nC	$V_{DD}=300V, I_D=23.0A, V_{GS}=0$ to 12V
Gate charge total	$Q_g$	-	150	-	nC	$V_{DD}=300V, I_D=23.0A, V_{GS}=0$ to 12V
Gate plateau voltage	$V_{plateau}$	-	5.4	-	V	$V_{DD}=300V, I_D=23.0A, V_{GS}=0$ 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	$V_{GS}=0V, I_F=23.0A, T_j=25^\circ C$
Reverse recovery time	$t_{rr}$	-	460	-	ns	$V_R=400V, I_F=23.0A, di_F/dt=100A/\mu s$ ; see table 8
Reverse recovery charge	$Q_{rr}$	-	9.00	-	$\mu C$	$V_R=400V, I_F=23.0A, di_F/dt=100A/\mu s$ ; see table 8
Peak reverse recovery current	$I_{rrm}$	-	40.0	-	A	$V_R=400V, I_F=23.0A, di_F/dt=100A/\mu s$ ; see table 8

## 4 Temperature Sensor parameters

at  $T_j=25^\circ\text{C}$ , 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	$I_R = 100 \mu\text{A}$
Sensor forward current	$I_F$	-	-	5	mA	-
Repetitive peak forward current	$I_{F\_pulse}$	-	-	25	mA	$t_{pulse} = 1 \text{ ms}$ , $T_{period} = 10 \text{ ms}$
Non-repetitive peak forward current	$I_{FSM}$	-	-	1.5 0.2 0.1	A	$T_C = 25^\circ\text{C}$ , $t_{pulse} = 1 \mu\text{s}$ $T_C = 25^\circ\text{C}$ , $t_{pulse} = 1 \text{ ms}$ $T_C = 25^\circ\text{C}$ , $t_{pulse} = 1 \text{ s}$
Junction Temperature	$T_j$	-	-	185	$^\circ\text{C}$	$t < 50\text{h}$ , Sensor only

**Table 9 Electrical characteristics**

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

<sup>1)</sup> Specified by Design and not tested

## 5 Electrical characteristics diagrams

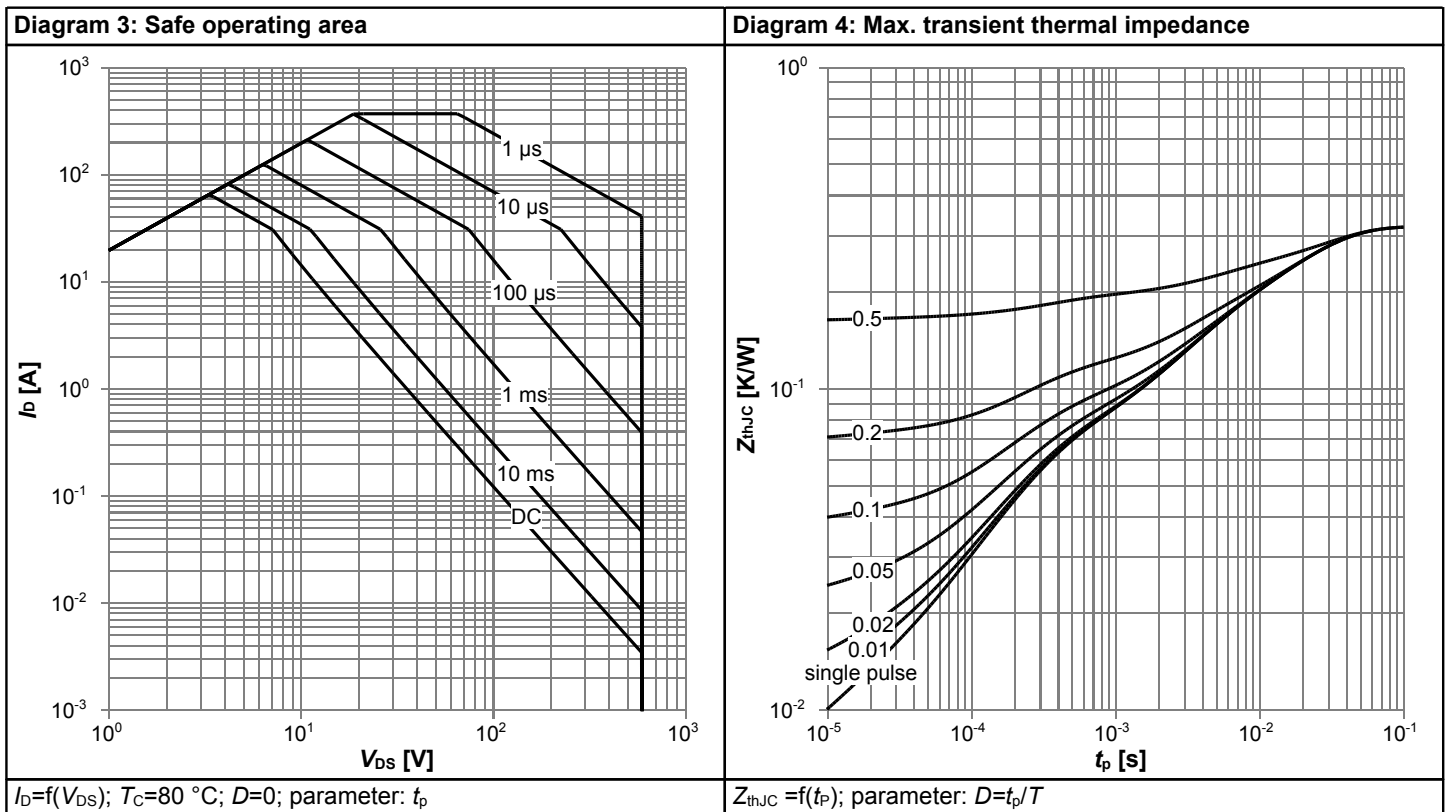
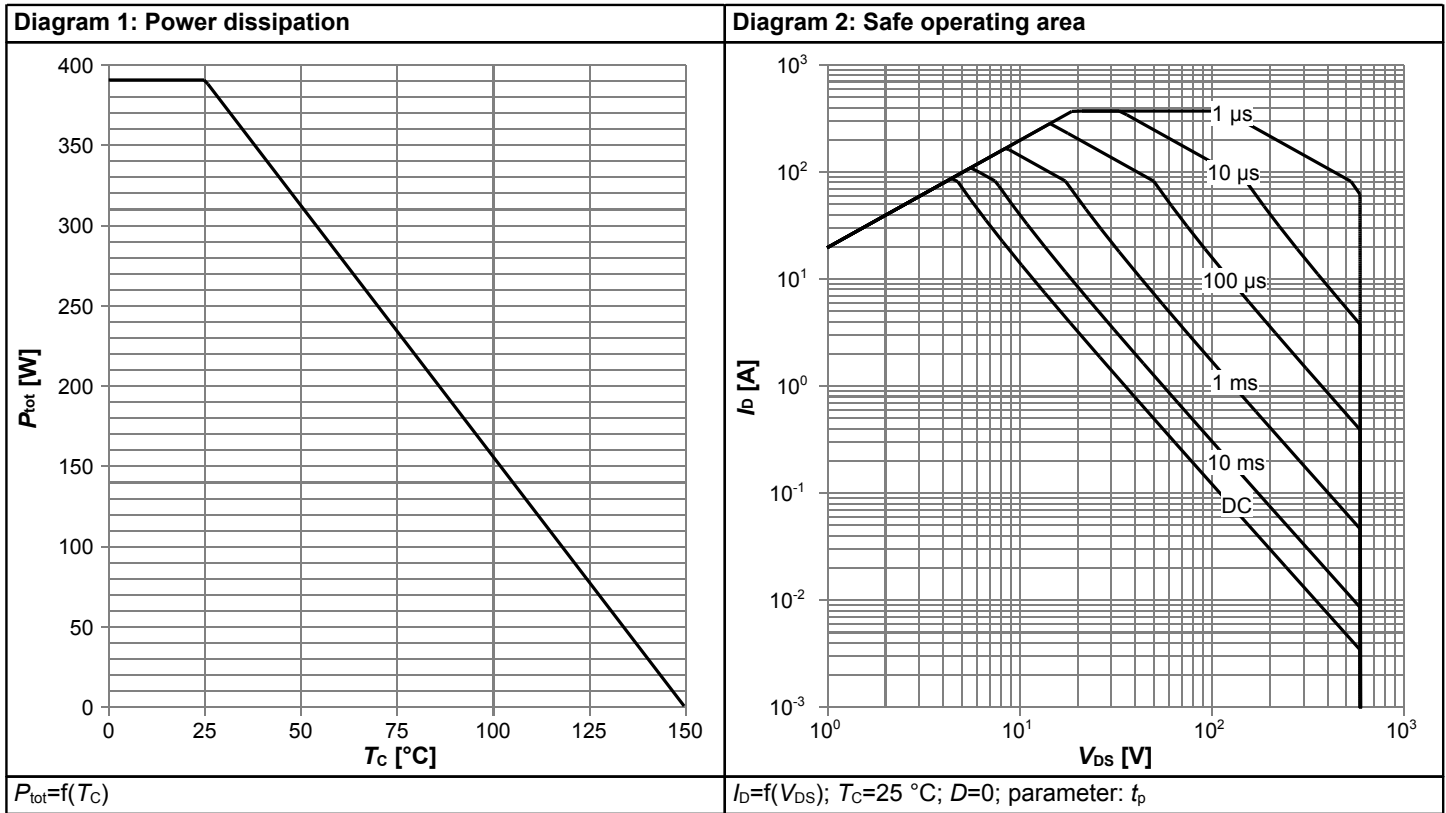
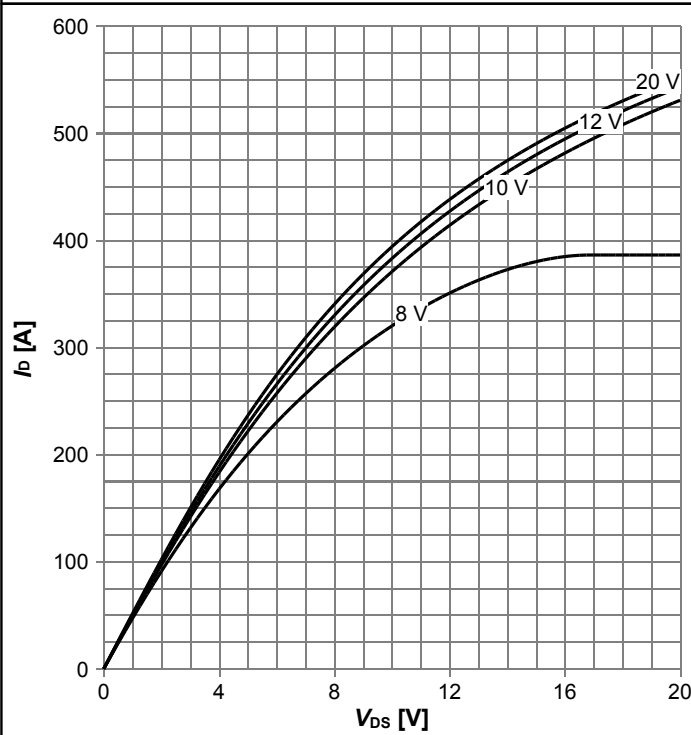


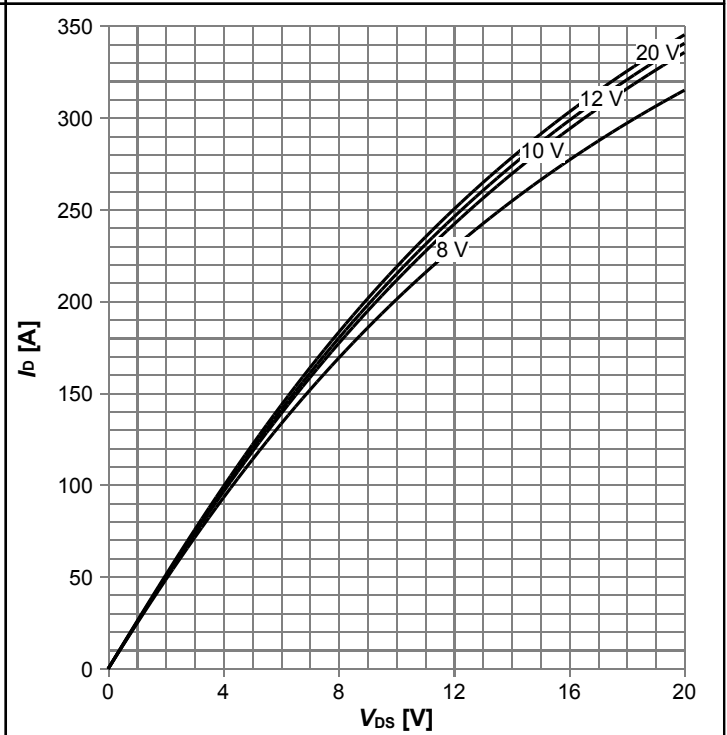


Diagram 5: Typ. output characteristics



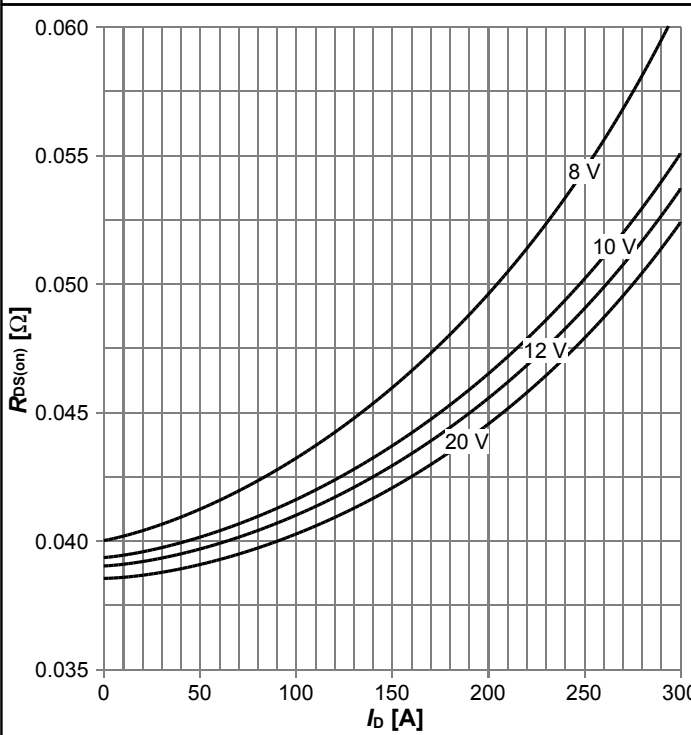
$I_D=f(V_{DS})$ ;  $T_j=25\text{ °C}$ ; parameter:  $V_{GS}$

Diagram 6: Typ. output characteristics



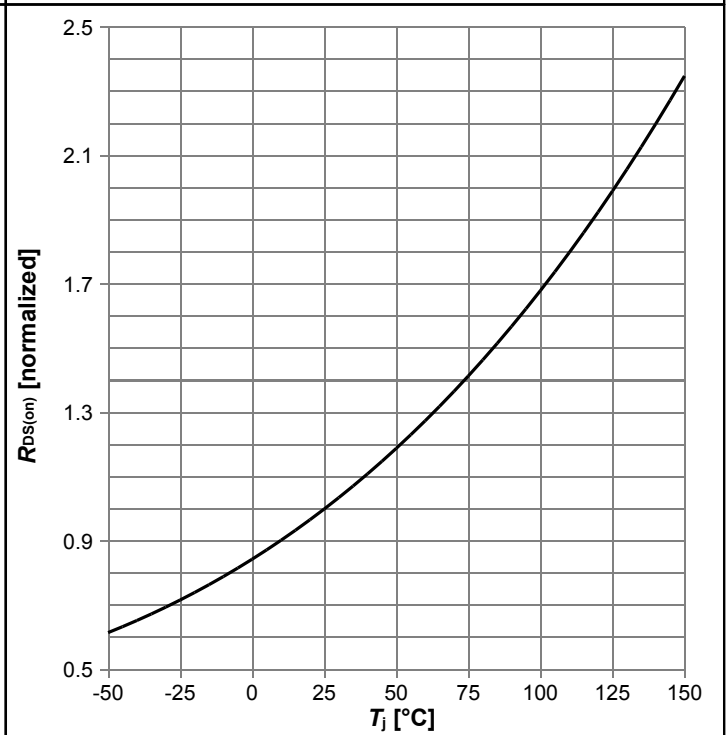
$I_D=f(V_{DS})$ ;  $T_j=125\text{ °C}$ ; parameter:  $V_{GS}$

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



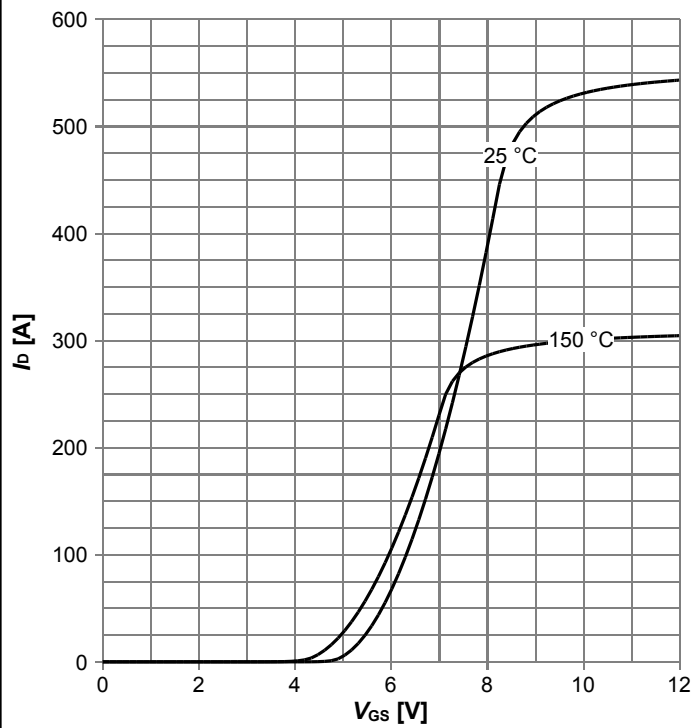
$R_{DS(on)}=f(I_D)$ ;  $T_j=125\text{ °C}$ ; parameter:  $V_{GS}$

Diagram 8: Drain-source on-state resistance



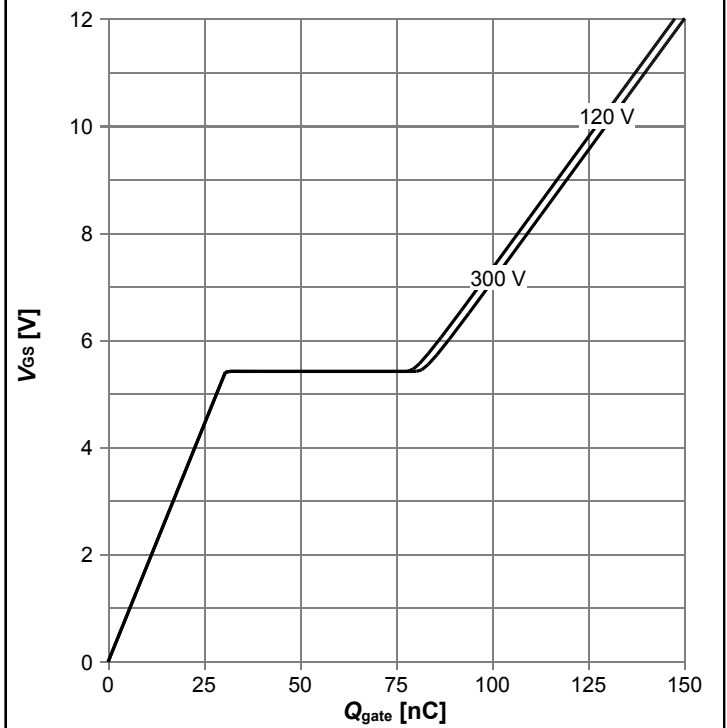
$R_{DS(on)}=f(T_j)$ ;  $I_D=23.0\text{ A}$ ;  $V_{GS}=12\text{ V}$

Diagram 9: Typ. transfer characteristics



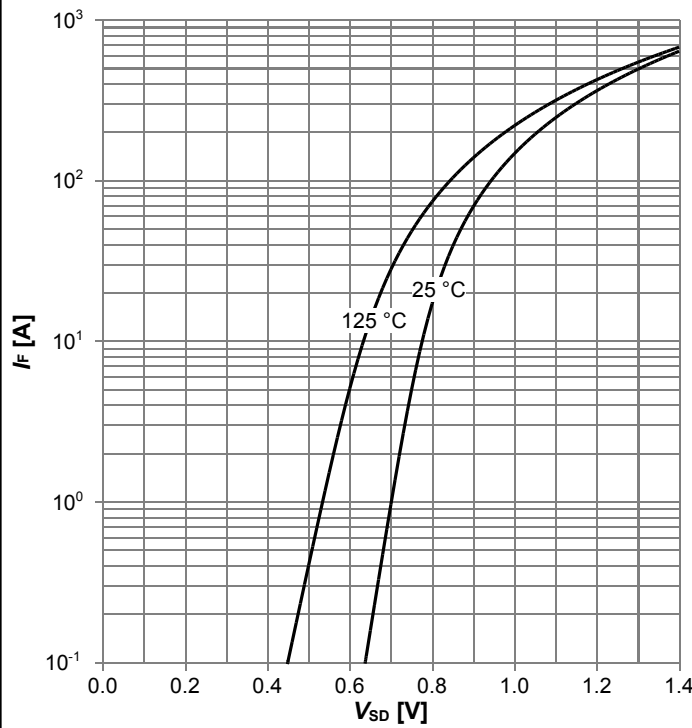
$I_D = f(V_{GS})$ ;  $V_{DS} = 20V$ ; parameter:  $T_j$

Diagram 10: Typ. gate charge



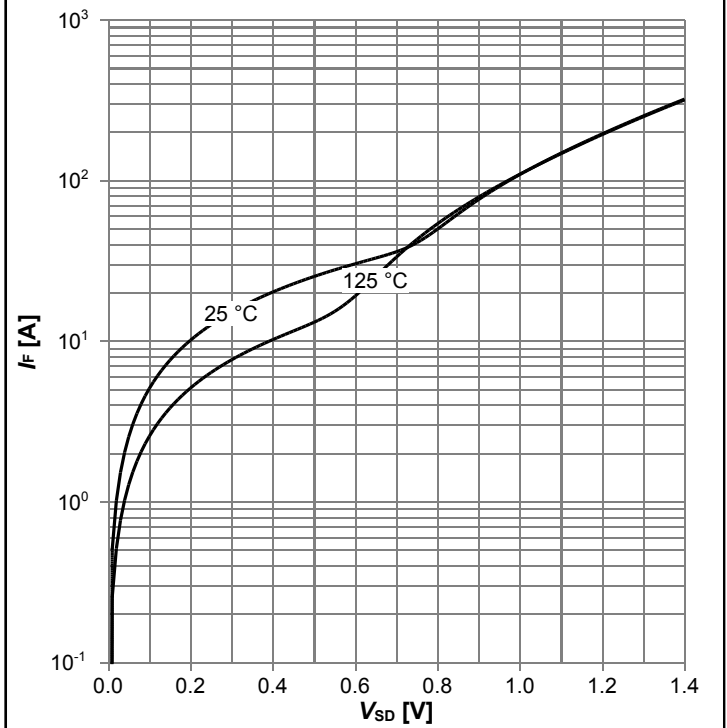
$V_{GS} = f(Q_{gate})$ ;  $I_D = 23.0 A$  pulsed; parameter:  $V_{DD}$

Diagram 11: Forward characteristics of reverse diode



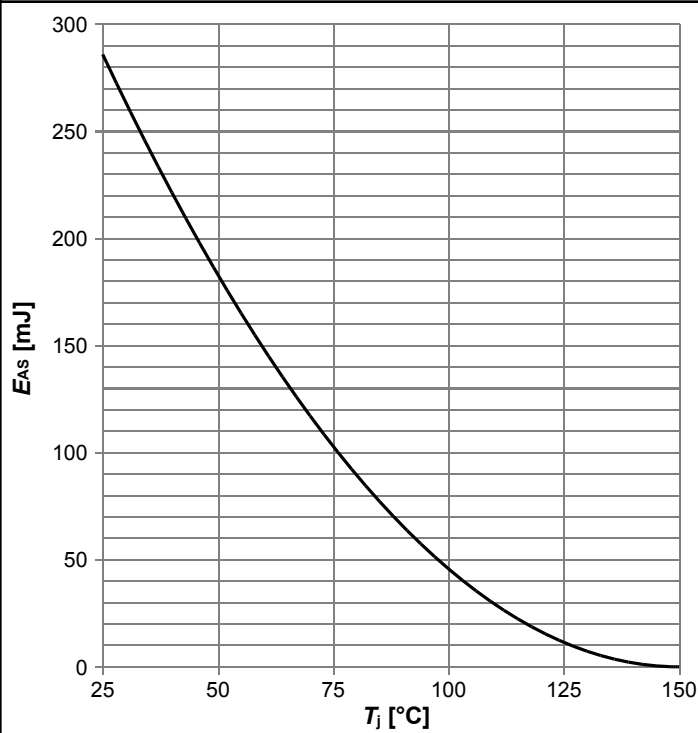
$I_F = f(V_{SD})$ ;  $V_{GS} = 0 V$ ; parameter:  $T_j$

Diagram 12: Forward characteristics of reverse diode



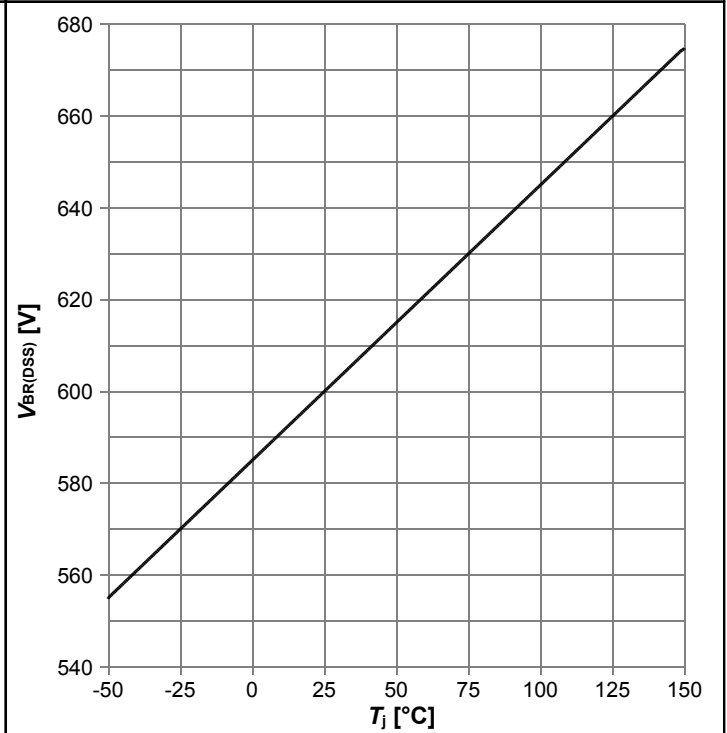
$I_F = f(V_{SD})$ ;  $V_{GS} = 12 V$ ; parameter:  $T_j$

Diagram 13: Avalanche energy



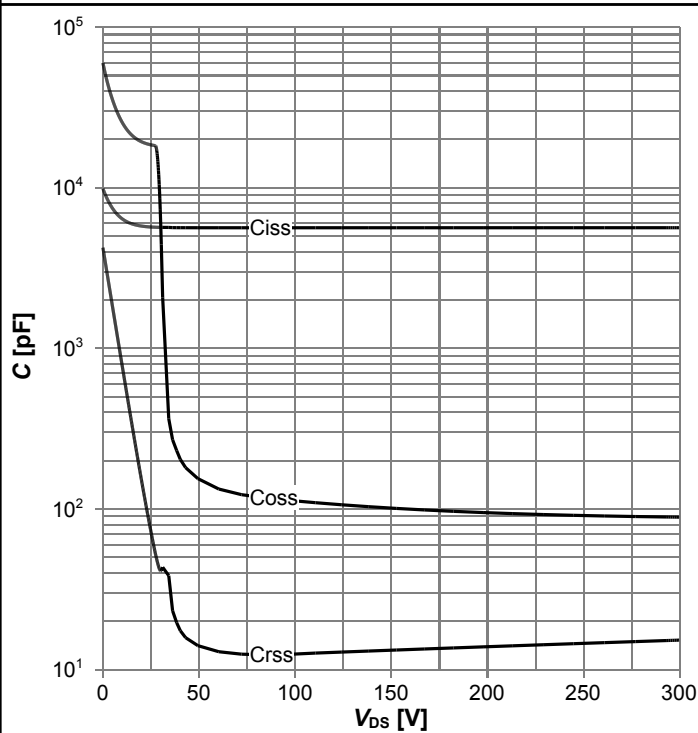
$E_{AS}=f(T_j)$ ;  $I_D=3.7$  A;  $V_{DD}=50$  V

Diagram 14: Drain-source breakdown voltage



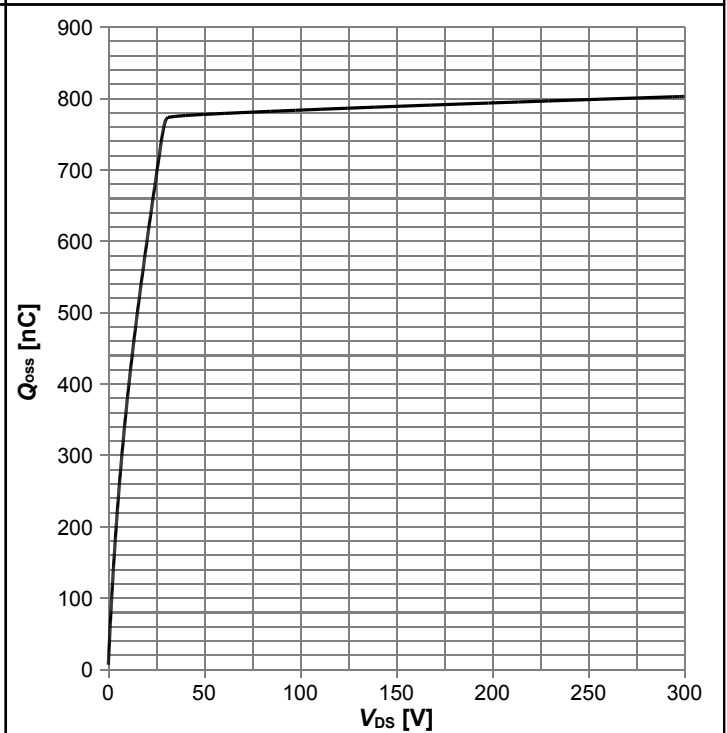
$V_{BR(DSS)}=f(T_j)$ ;  $I_D=1$  mA

Diagram 15: Typ. capacitances

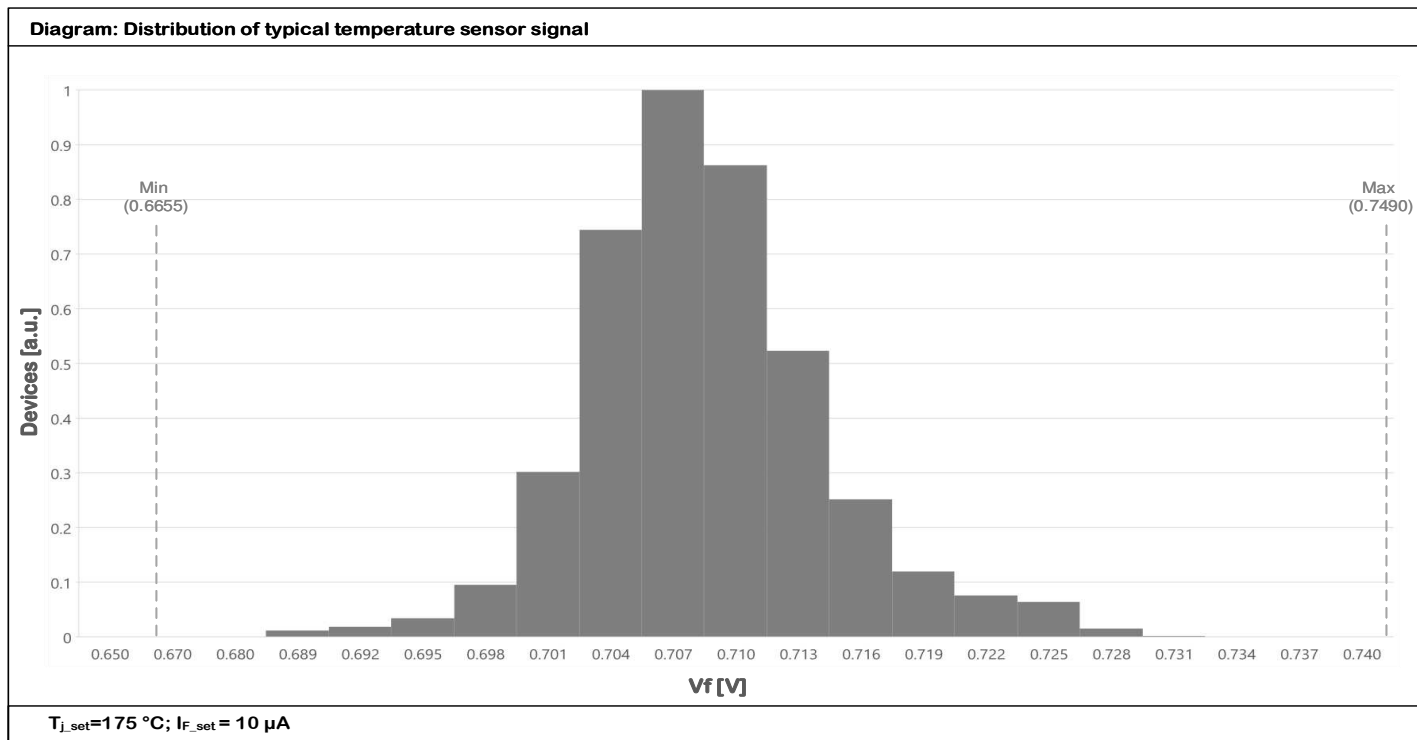


$C=f(V_{DS})$ ;  $V_{GS}=0$  V;  $f=250$  kHz

Diagram 17: Typ. Qoss output charge

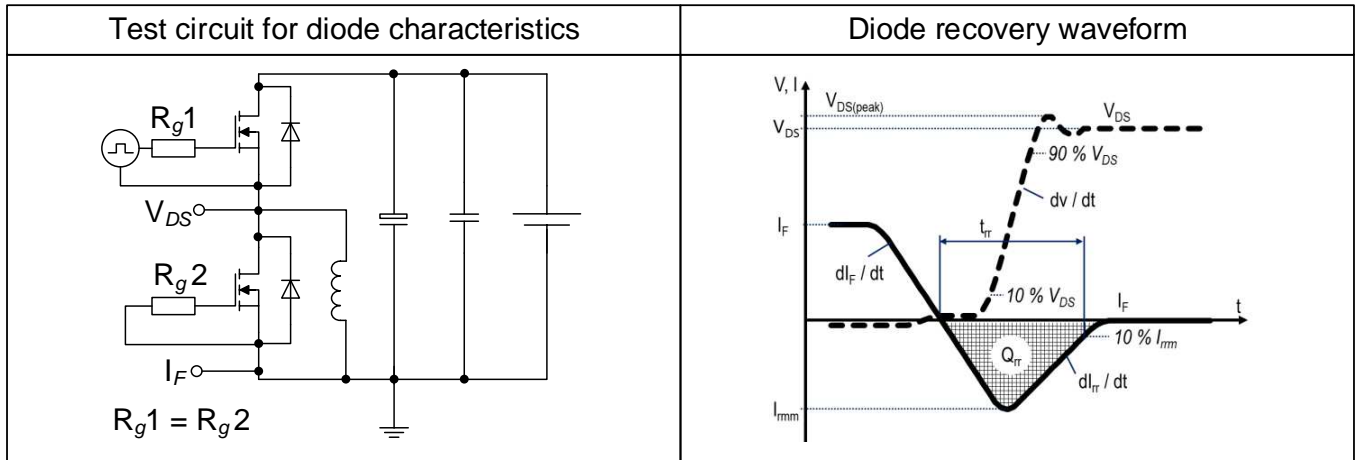


$Q_{oss}=f(V_{DS})$ ;  $V_{GS}=0$  V

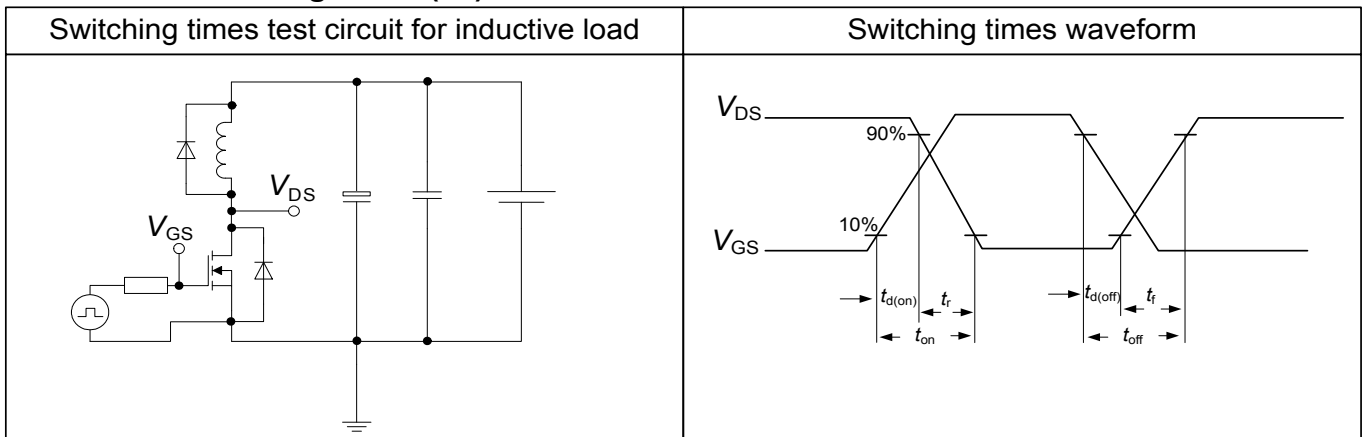


## 6 Test Circuits

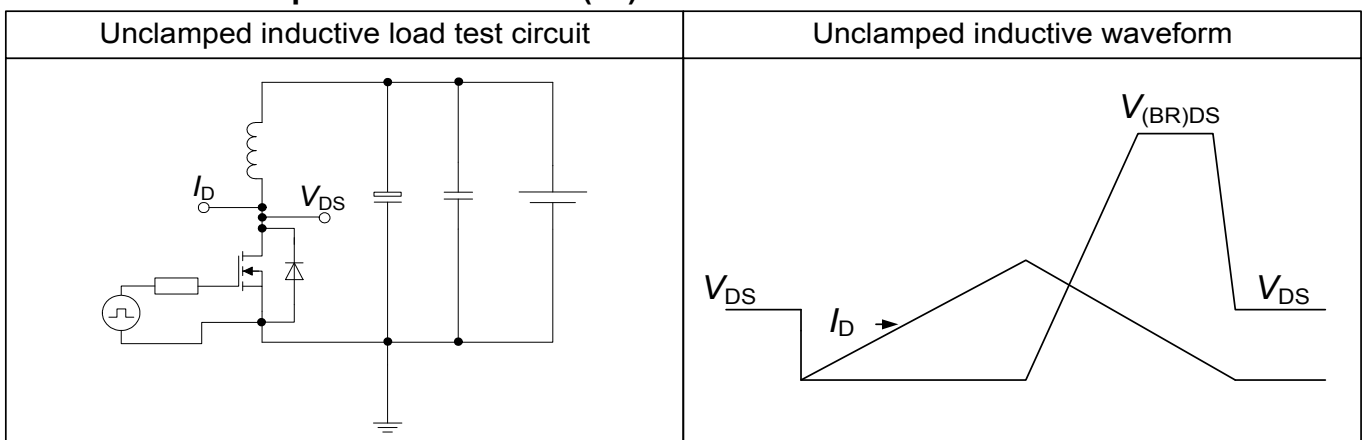
**Table 10 Diode characteristics**



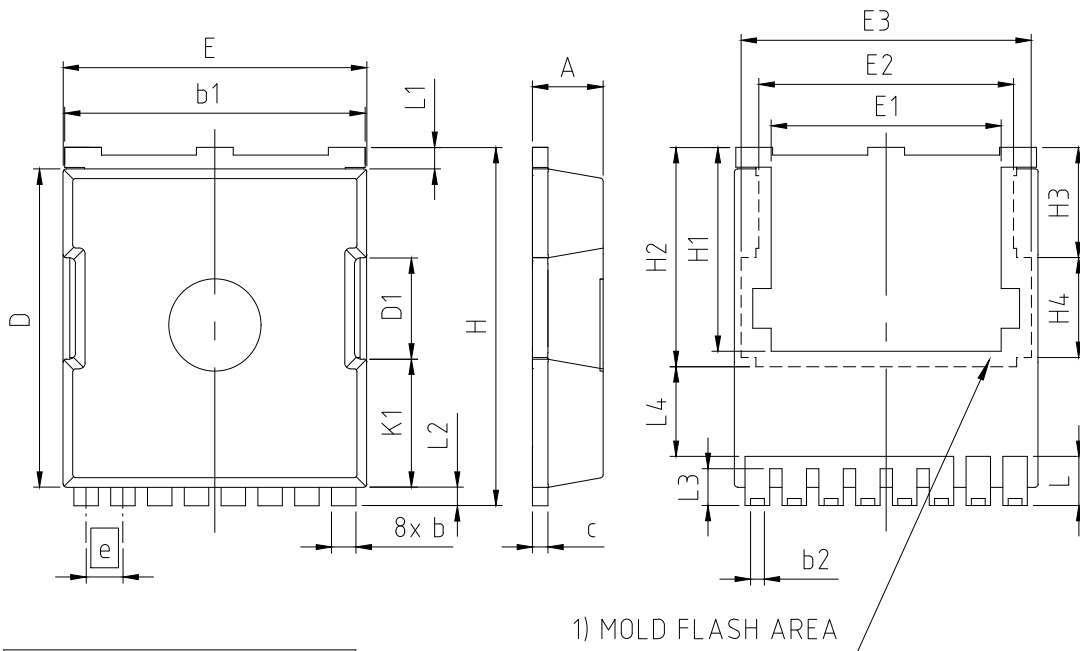
**Table 11 Switching times (ss)**



**Table 12 Unclamped inductive load (ss)**



## 7 Package Outlines



1) MOLD FLASH AREA

PACKAGE - GROUP NUMBER:		PG-HSOF-8-U02	
DIMENSIONS	MILLIMETERS		
	MIN.	MAX.	
A	2.20	2.40	
b	0.70	0.90	
b1	9.70	9.90	
b2	0.42	0.50	
c	0.40	0.60	
D	10.28	10.58	
D1	3.30		
E	9.70	10.10	
E1	7.50		
E2	8.50		
E3	9.46		
e	1.20 (BSC)		
H	11.48	11.88	
H1	6.55	6.95	
H2	7.15		
H3	3.59		
H4	3.26		
N	8		
K1	4.18		
L	1.40	1.80	
L1	0.50	0.90	
L2	0.50	0.70	
L3	1.00	1.30	
L4	2.62	2.81	

1) PARTIALLY COVERED WITH MOLD FLASH

Figure 1 Outline PG-HSOF-8, dimensions in mm

## 8 Appendix A

### Table 13 Related Links

- IFX CoolMOS S7T Webpage: [www.infineon.com](http://www.infineon.com)
- IFX CoolMOS S7T application note: [www.infineon.com](http://www.infineon.com)
- IFX CoolMOS S7T simulation model: [www.infineon.com](http://www.infineon.com)
- IFX Design tools: [www.infineon.com](http://www.infineon.com)

## Revision History

IPT60T022S7

**Revision: 2023-09-18, Rev. 2.0**

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.0	2023-09-18	Release of final version

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