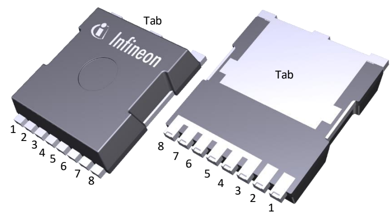
MOSFET

600V CoolMOS™ SJ S7 Power Device

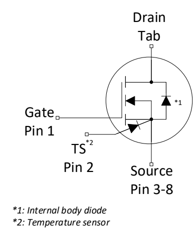
IPT60T022S7 enables the best price performance for low-frequency switching applications. CoolMOS™ S7 boasts the lowest Rdson values for an HV SJ MOSFET, with a distinctive increase in energy efficiency. The embedded Temperature sensor increases junction temperature sensing accuracy and robustness while 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.

PG-HSOF-8



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

RoHS

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
$R_{DS(on),max}$	40	mΩ
$Q_{g,typ}$	83	nC
V_{SD}	0.82	V
Pulsed I_{SD}, I_{DS}	203	A
ESD class (HBM)	2	JEDEC JS-001

Type / Ordering Code	Package	Marking	Related Links
IPT60T040S7	PG-HSOF-8	60I040S7	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	-	-	13	A	T_C=140°C Current is limited by $T_{j\,max}$ = 150°C; Lower case temp does increase current capability
Pulsed drain current[2]	$I_{D,pulse}$	-	-	203	A	T_C=25°C
Avalanche energy, single pulse	E_{AS}	-	-	156	mJ	I_D=2.7A; V_{DD}=50V; see table 11
Avalanche current, single pulse	I_{AS}	-	-	2.7	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}	-	-	245	W	T_C=25°C
Storage temperature	T_{stg}	-55	-	150	°C	-
Operating junction temperature[1]	T_j	-55	-	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	-	-	13	A	T_C=25°C Current is limited by $T_{j\,max}$ = 150°C
Diode pulse current[1]	$I_{S,pulse}$	-	-	203	A	T_C=25°C
Reverse diode dv/dt[4]	dv/dt	-	-	5	V/ns	V_{DS}=0 to 300V, I_{SD}<=13A, T_j=25°C see table 9
Maximum diode commutation speed	di_f/dt	-	-	800	A/µs	V_{DS}=0 to 300V, I_{SD}<=13A, T_j=25°C see table 9
Insulation withstand voltage	V_{ISO}	-	-	n.a.	V	-

[1] Please consider the App Note: AN_2308_PL52_2309_111546 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}	-	-	0.51	°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

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	4.5	V	V_{DS}=V_{GS}, I_D=0.78mA
Zero gate voltage drain current[1]	I_{DSS}	- -	- 20	2 -	µA	V_{DS}=600V, V_{GS}=0V, T_j=25°C 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	$R_{DS(on)}$	- -	0.036 0.084	0.040 -	Ω	V_{GS}=12V, I_D=13.0A, T_j=25°C V_{GS}=12V, I_D=13.0A, T_j=150°C
Gate resistance	R_G	-	0.8	-	Ω	f=1MHz, open drain

Table 5 Dynamic characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	C_{iss}	-	3128	-	pF	V_{GS}=0V, V_{DS}=300V, f=250kHz
Output capacitance	C_{oss}	-	50	-	pF	V_{GS}=0V, V_{DS}=300V, f=250kHz
Effective output capacitance, energy related[2]	$C_{o(er)}$	-	168	-	pF	V_{GS}=0V, V_{DS}=0 to 300V
Effective output capacitance, time related[3]	$C_{o(tr)}$	-	1476	-	pF	I_D=constant, V_{GS}=0V, V_{DS}=0 to 300V
Output charge	Q_{oss}	-	443	-	nC	V_{GS}=0V, V_{DS}=0 to 300V
Turn-on delay time	$t_{d(on)}$	-	18	-	ns	V_{DD}=300V, V_{GS}=13V, I_D=13.0A, R_G=8.0Ω; see table 9
Rise time	t_r	-	12	-	ns	V_{DD}=300V, V_{GS}=13V, I_D=13.0A, R_G=8.0Ω; see table 9
Turn-off delay time	$t_{d(off)}$	-	120	-	ns	V_{DD}=300V, V_{GS}=13V, I_D=13.0A, R_G=8.0Ω; see table 9
Fall time	t_f	-	9	-	ns	V_{DD}=300V, V_{GS}=13V, I_D=13.0A, R_G=8.0Ω; see table 9

[1] Open
[2] $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 300V
[3] $C_{o(tr)}$ 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}	-	17	-	nC	V_{DD}=300V, I_D=13.0A, V_{GS}=0 to 12V
Gate to drain charge	Q_{gd}	-	27	-	nC	V_{DD}=300V, I_D=13.0A, V_{GS}=0 to 12V
Gate charge total	Q_g	-	83	-	nC	V_{DD}=300V, I_D=13.0A, V_{GS}=0 to 12V
Gate plateau voltage	$V_{plateau}$	-	5.4	-	V	V_{DD}=300V, I_D=13.0A, 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=13.0A, T_j=25°C
Reverse recovery time	t_{rr}	-	360	-	ns	V_R=400V, I_F=13.0A, di_F/dt=100A/µs; see table 8
Reverse recovery charge	Q_{rr}	-	5.50	-	µC	V_R=400V, I_F=13.0A, di_F/dt=100A/µs; see table 8
Peak reverse recovery current	I_{rrm}	-	32.0	-	A	V_R=400V, I_F=13.0A, di_F/dt=100A/µs; see table 8

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}	- - -	- - -	1.5 0.2 0.1	A	T_C = 25°C, t_{pulse} = 1 µs T_C = 25°C, t_{pulse} = 1 ms T_C = 25°C, t_{pulse} = 1 s
Junction Temperature	T_j	-	-	185	°C	t < 50h, Sensor only

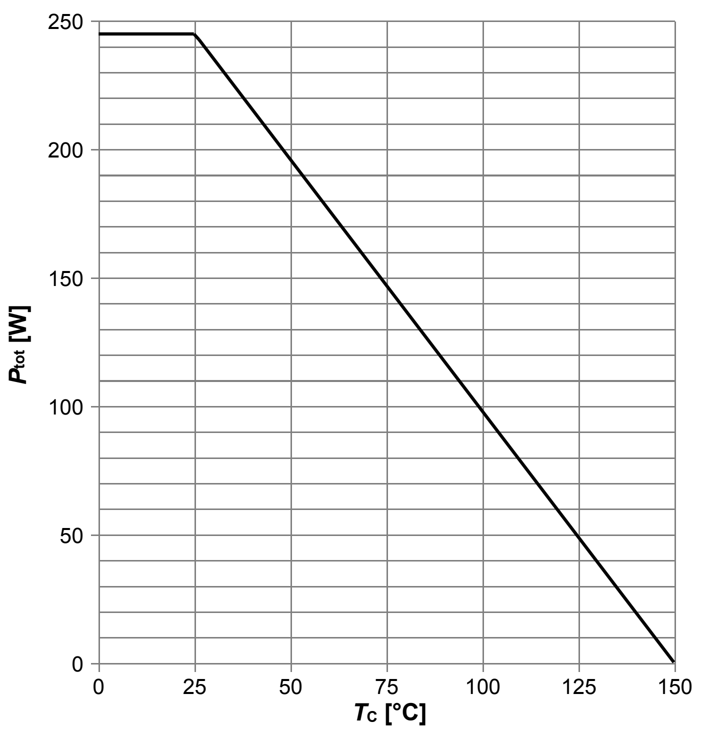
Table 9 Electrical characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Sensor forward voltage[1]	V_{F_25}	1.5601 - - 2.0665	1.6019 1.8103 1.9806 2.0966	1.6436 - - 2.1266	V	T_j = 25°C, I_F = 10 µA T_j = 25°C, I_F = 50 µA T_j = 25°C, I_F = 200 µA T_j = 25°C, I_F = 500 µA
Sensor forward voltage temperature coefficient	TC	- - - -	5.9644 5.5880 5.2287 5.0135	- - - -	mV/K	25°C ≤ T_j ≤ 175°C, I_F = 10 µA 25°C ≤ T_j ≤ 175°C, I_F = 50 µA 25°C ≤ T_j ≤ 175°C, I_F = 200 µA 25°C ≤ T_j ≤ 175°C, I_F = 500 µA
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°C, I_F = 10 µA T_j = 175°C, I_F = 50 µA T_j = 175°C, I_F = 200 µA T_j = 175°C, I_F = 500 µA
Reverse leakage current	I_R	- -	- -	1 20	µA	V_R = 10V, T_j = 25°C 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

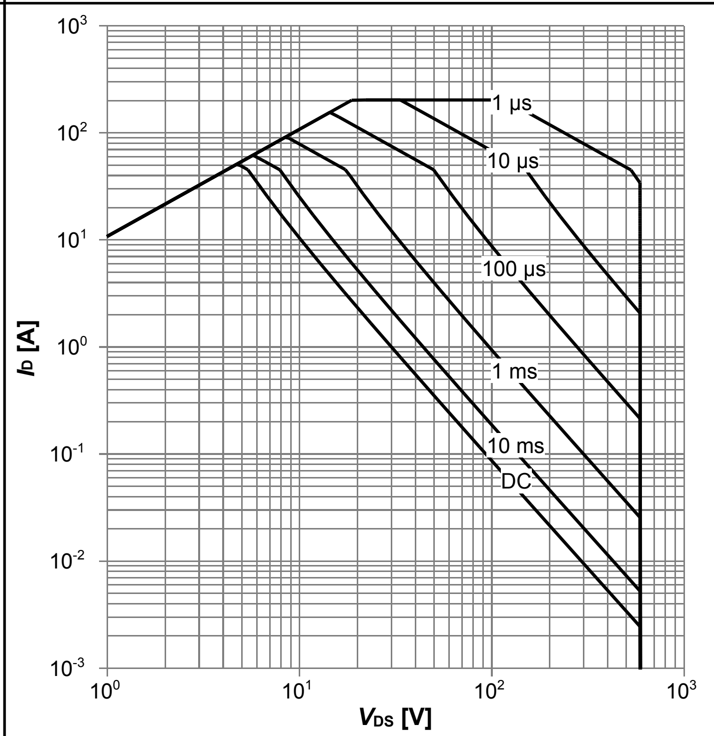
5 Electrical characteristics diagrams

Diagram 1: Power dissipation



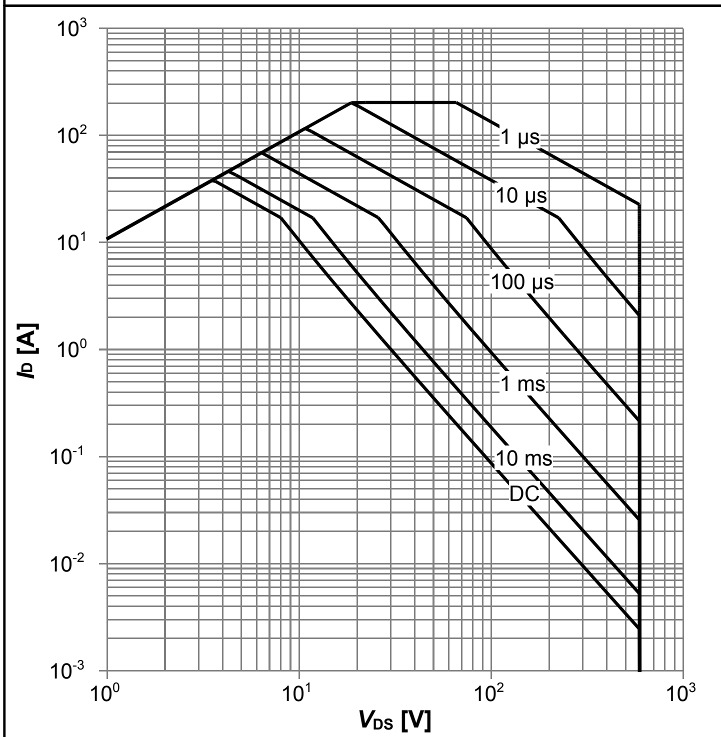
P_{tot}=f(T_C)

Diagram 2: Safe operating area



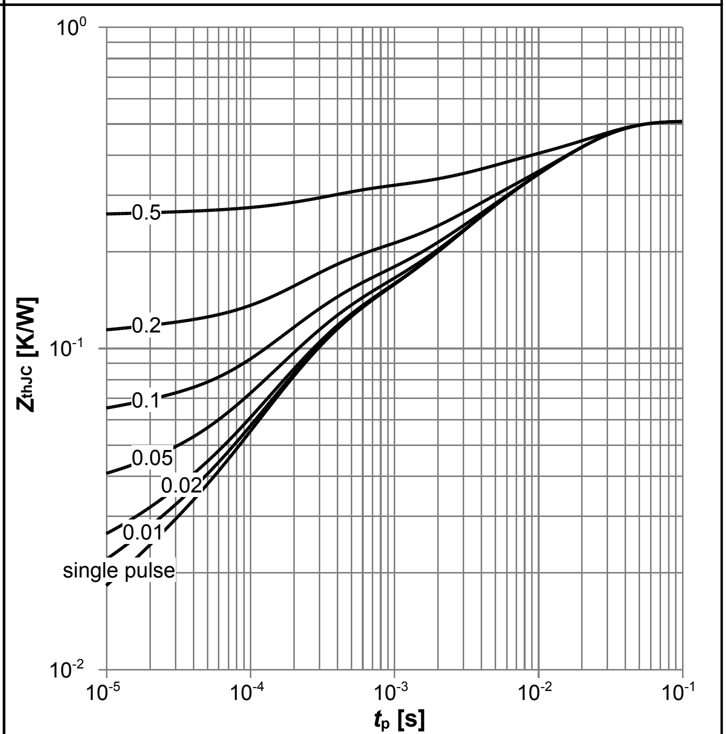
I_D=f(V_{DS}); T_C=25 °C; D=0; parameter: t_p

Diagram 3: Safe operating area



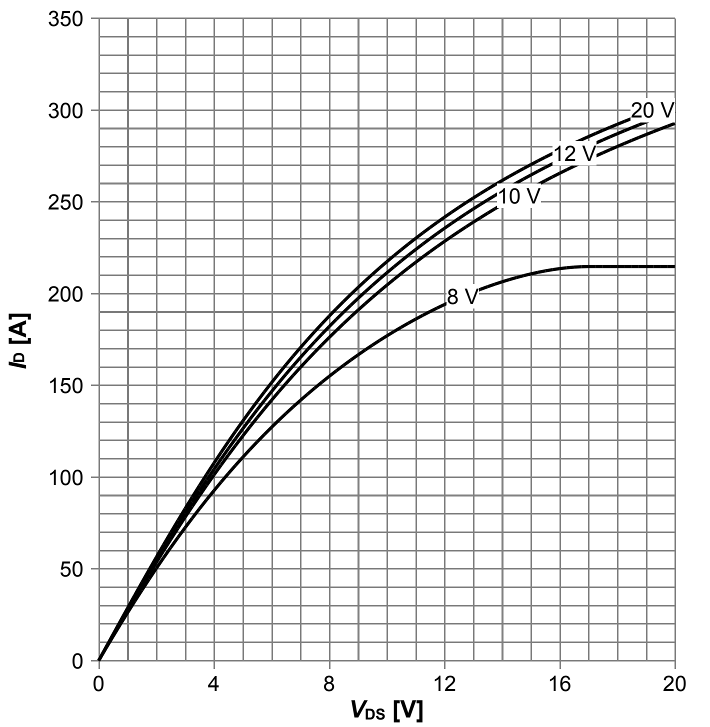
I_D=f(V_{DS}); T_C=80 °C; D=0; parameter: t_p

Diagram 4: Max. transient thermal impedance



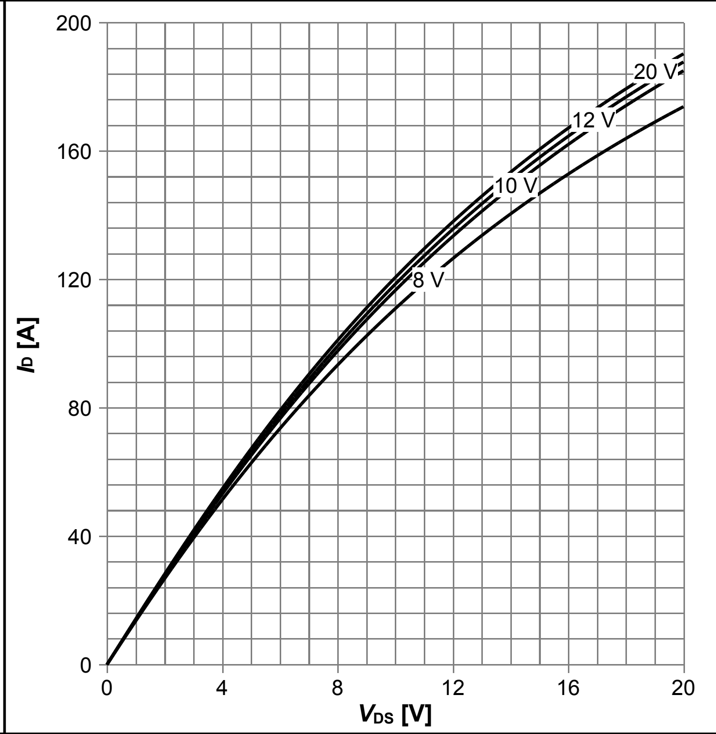
Z_{thJC} =f(t_P); parameter: D=t_p/T

Diagram 5: Typ. output characteristics



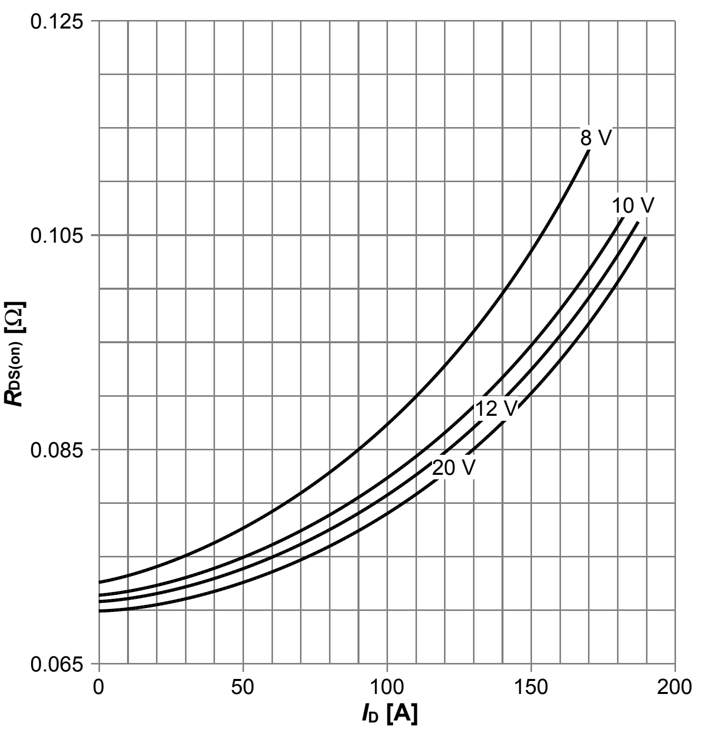
I_D=f(V_{DS}); T_j=25 °C; parameter: V_{GS}

Diagram 6: Typ. output characteristics



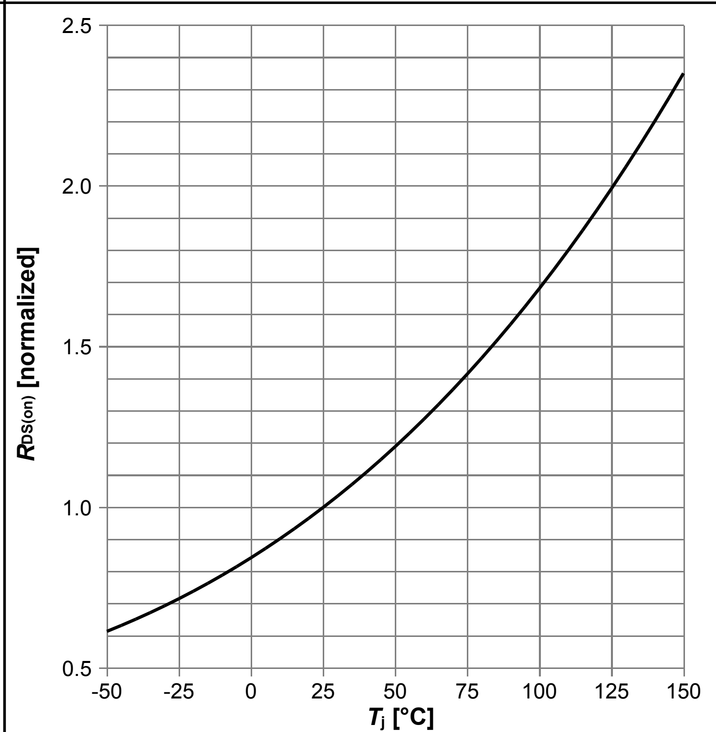
I_D=f(V_{DS}); T_j=125 °C; parameter: V_{GS}

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



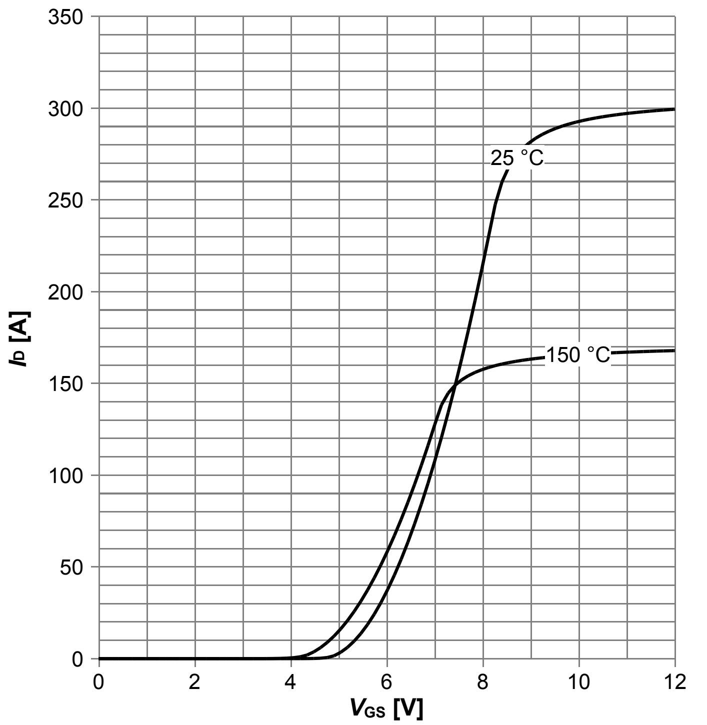
$R_{DS(on)}$=f(I_D); T_j=125 °C; parameter: V_{GS}

Diagram 8: Drain-source on-state resistance



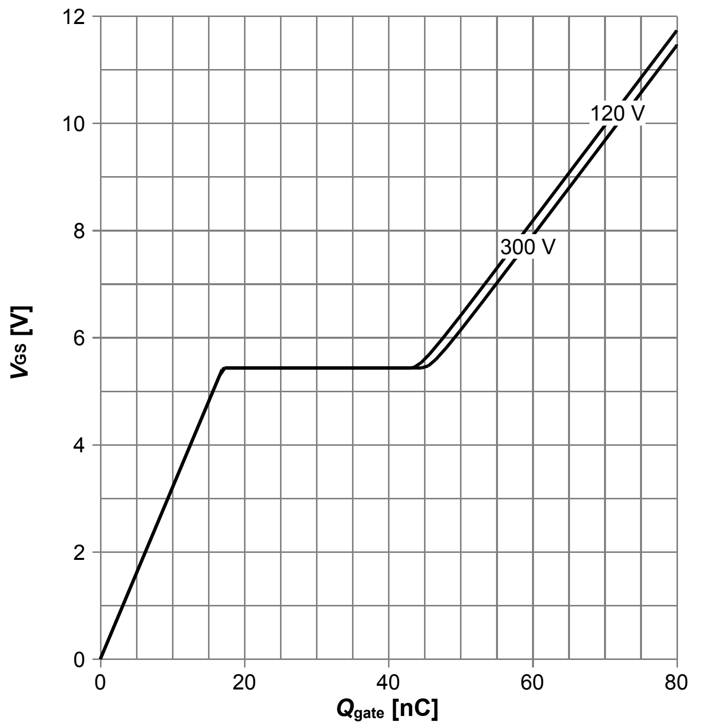
$R_{DS(on)}$=f(T_j); I_D=13.0 A; V_{GS}=12 V

Diagram 9: Typ. transfer characteristics



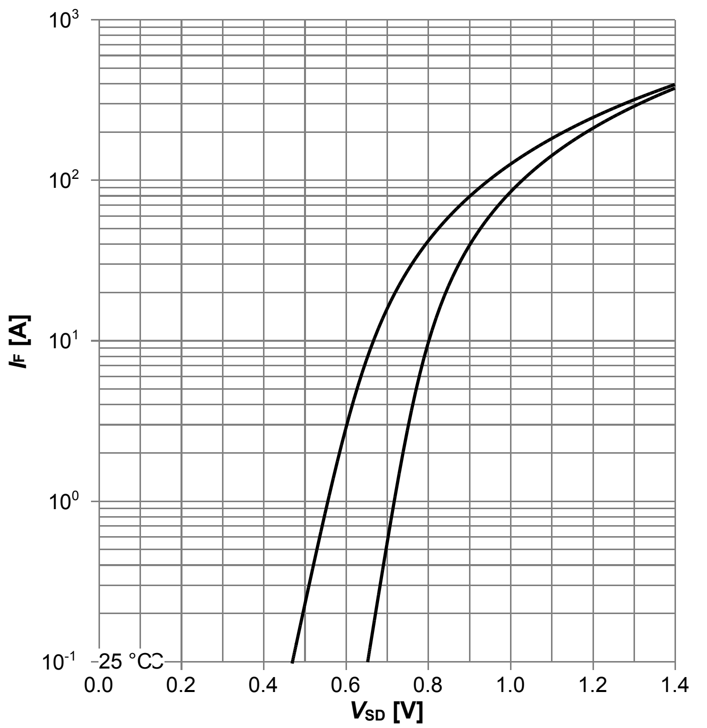
$I_D=f(V_{GS})$; $V_{DS}=20V$; parameter: T_j

Diagram 10: Typ. gate charge



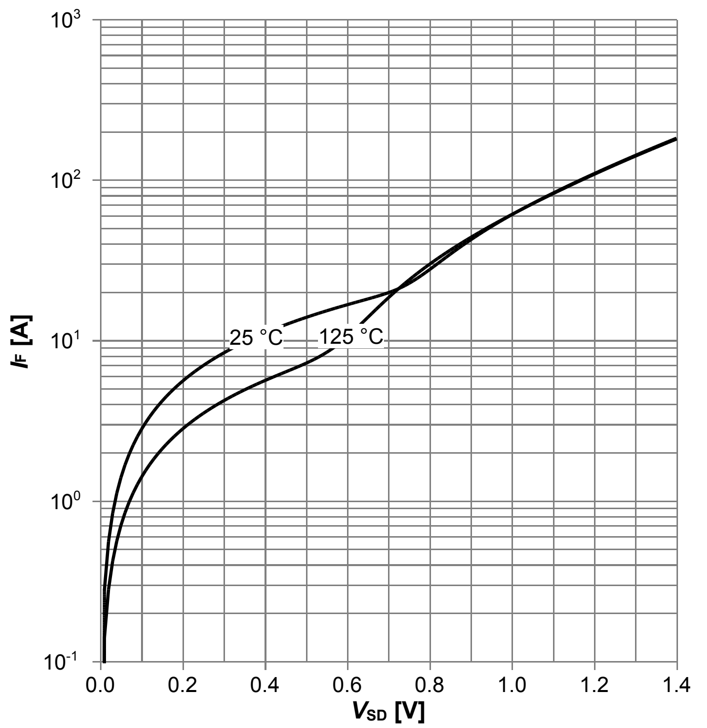
$V_{GS}=f(Q_{gate})$; $I_D=13.0$ A pulsed; parameter: V_{DD}

Diagram 11: Forward characteristics of reverse diode



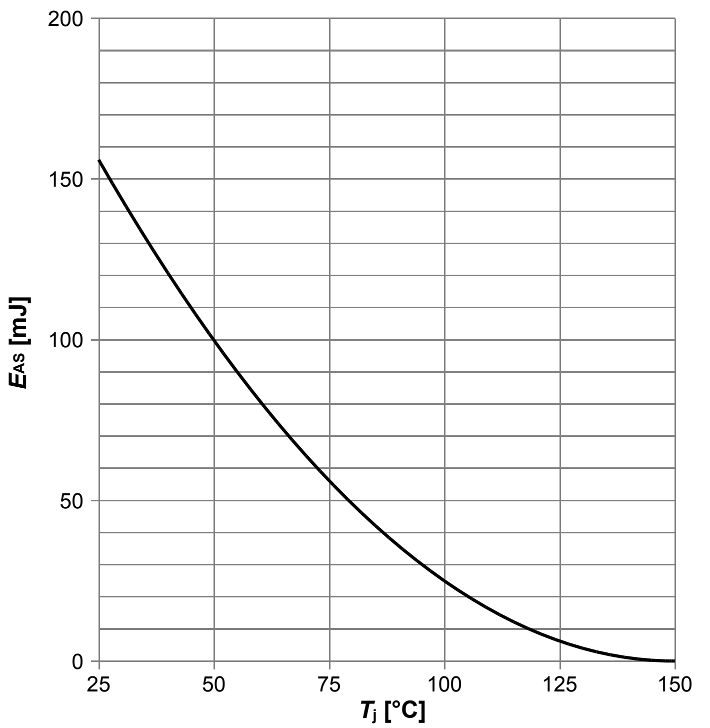
$I_F=f(V_{SD})$; $V_{GS}=0$ V; parameter: T_j

Diagram 12: Forward characteristics of reverse diode



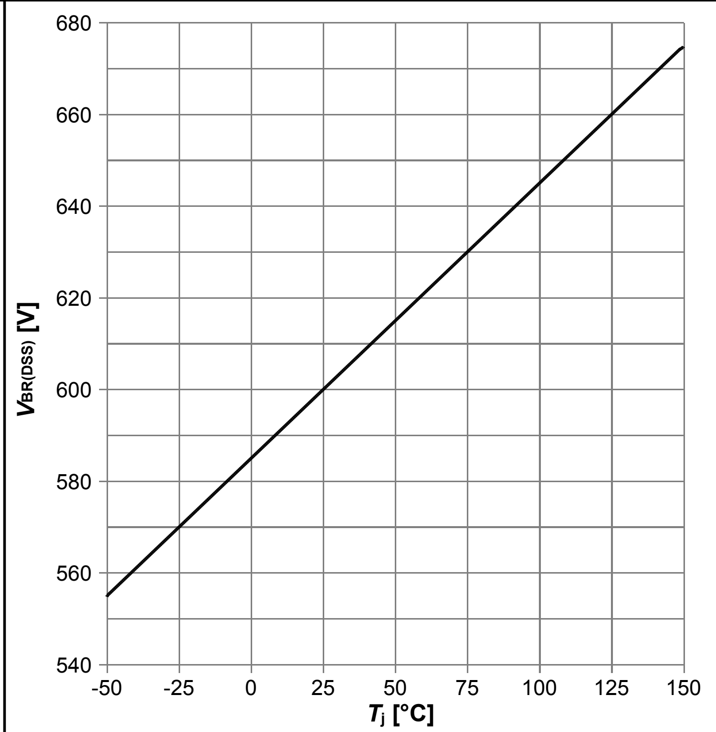
$I_F=f(V_{SD})$; $V_{GS}=12$ V; parameter: T_j

Diagram 13: Avalanche energy



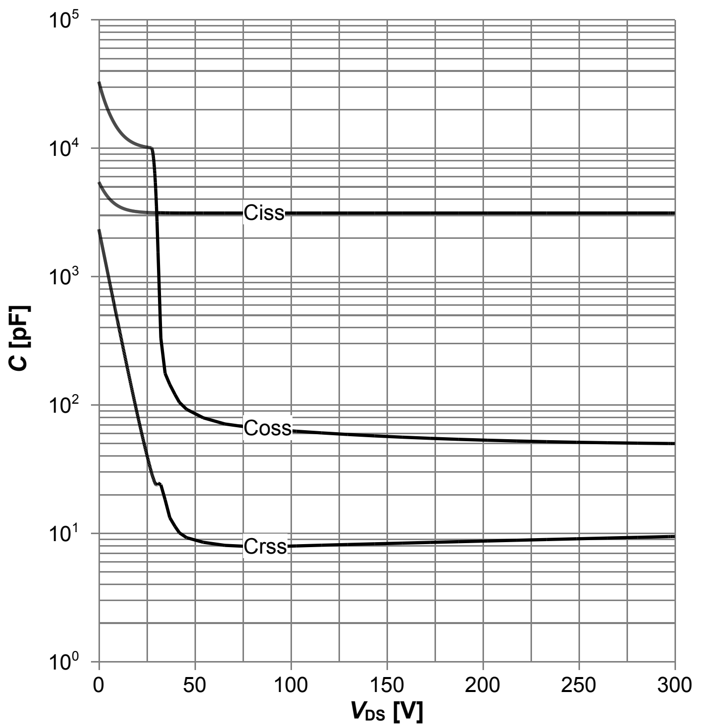
E_{AS}=f(T_j); I_D=2.7 A; V_{DD}=50 V

Diagram 14: Drain-source breakdown voltage



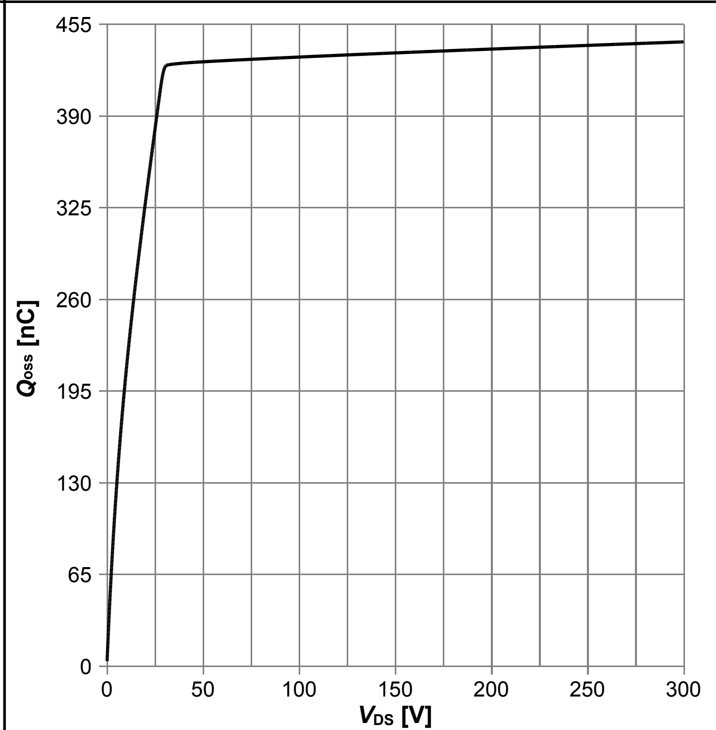
$V_{BR(DSS)}$=f(T_j); I_D=1 mA

Diagram 15: Typ. capacitances



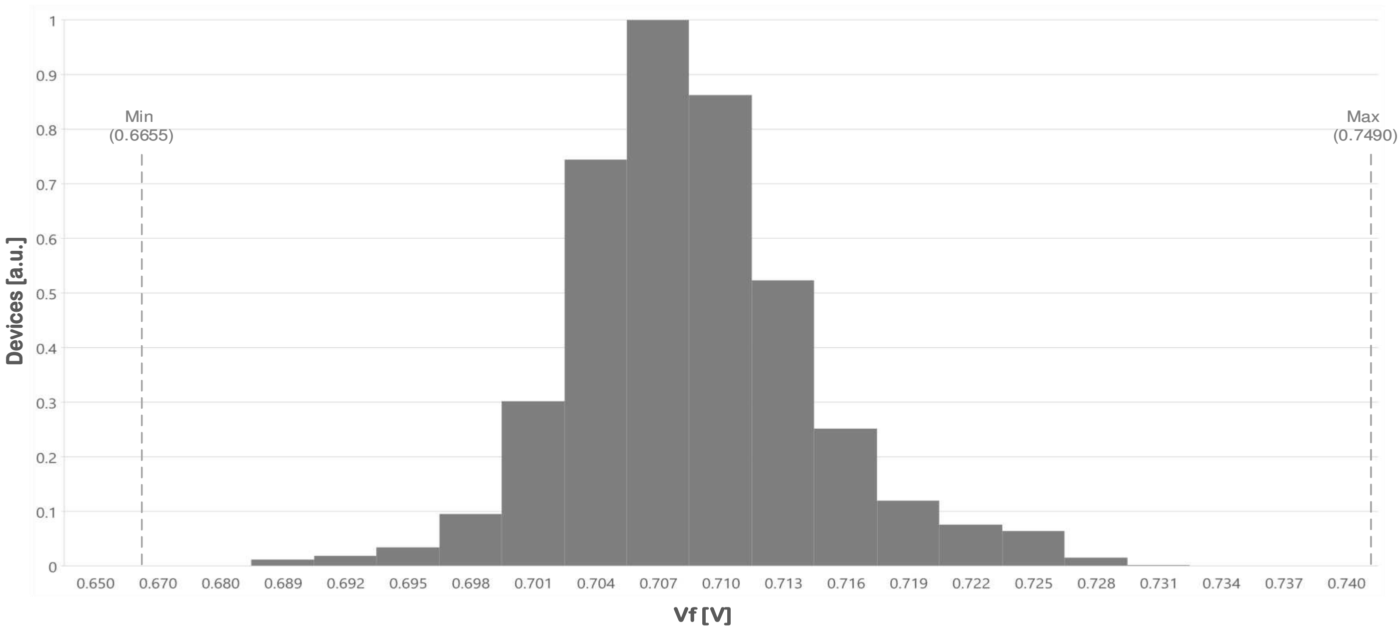
C=f(V_{DS}); V_{GS}=0 V; f=250 kHz

Diagram 17: Typ. Qoss output charge



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

Diagram: Distribution of typical temperature sensor signal



T_{j_set}=175 °C; I_{F_set} = 10 µA

6 Test Circuits

Table 10 Diode characteristics

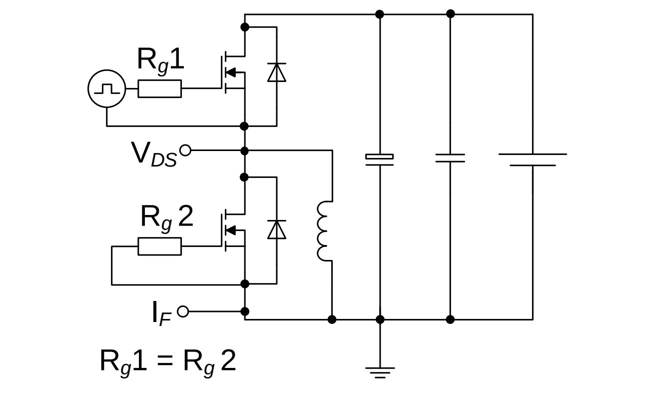
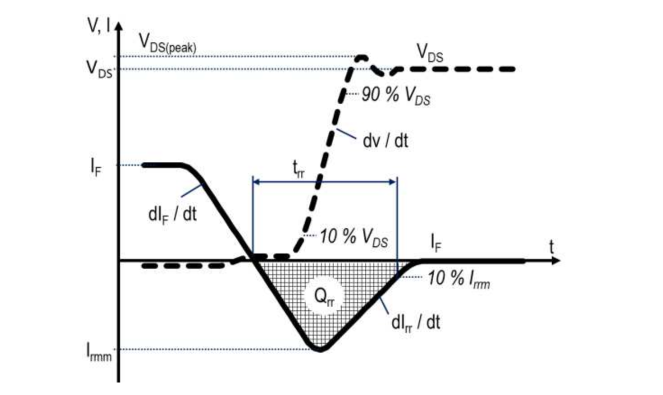
Test circuit for diode characteristics	Diode recovery waveform
	

Table 11 Switching times (ss)

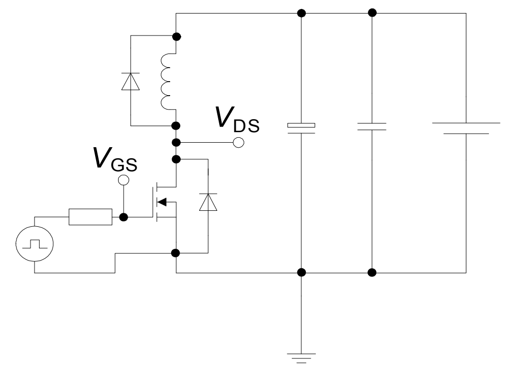
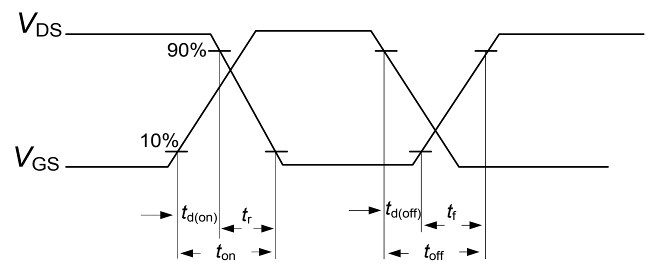
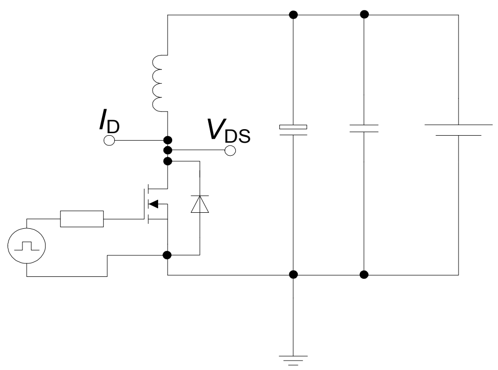
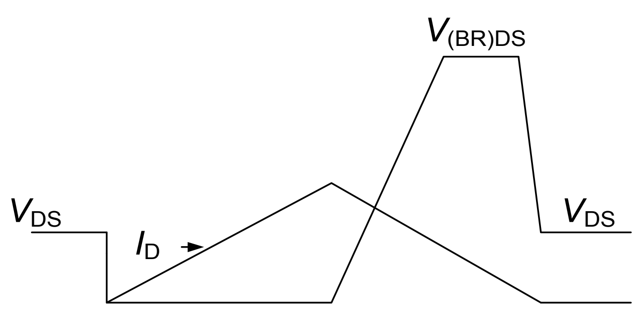
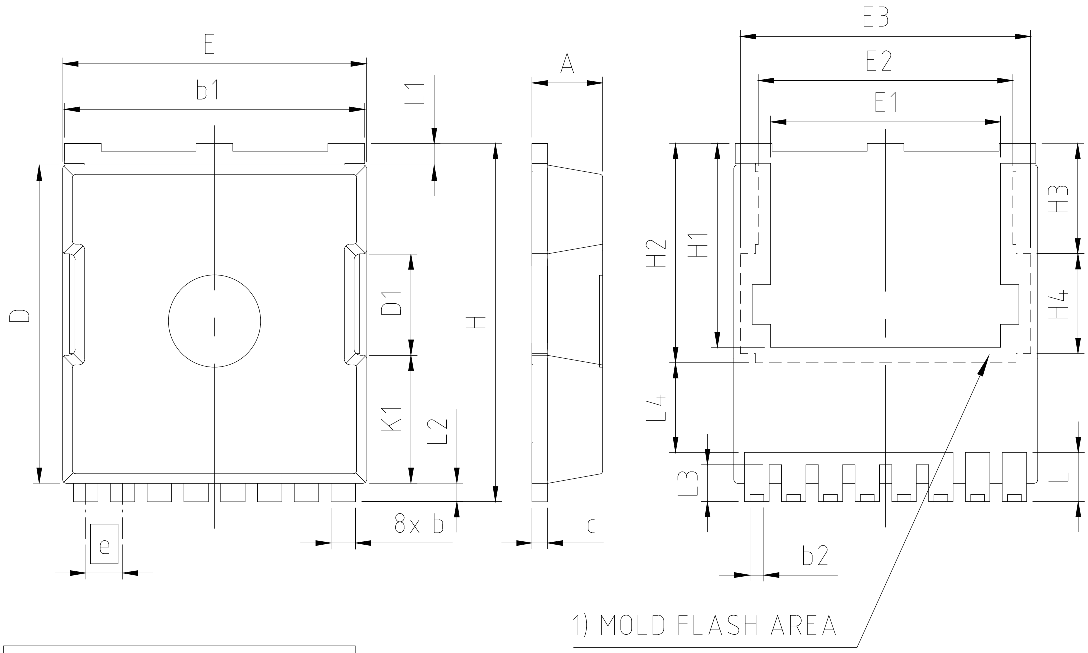
Switching times test circuit for inductive load	Switching times waveform
	

Table 12 Unclamped inductive load (ss)

Unclamped inductive load test circuit	Unclamped inductive waveform
	

7 Package Outlines



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
- **IFX CoolMOS S7T application note:** www.infineon.com
- **IFX CoolMOS S7T simulation model:** www.infineon.com
- **IFX Design tools:** www.infineon.com

Revision History

IPT60T040S7

Revision: 2023-09-25, Rev. 2.1

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.0	2023-09-18	Release of final version
2.1	2023-09-25	Drain current – change of test condition

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