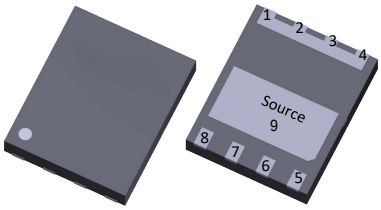
CoolGaN™ Transistor 650 V N-Channel Enhancement Mode

General description

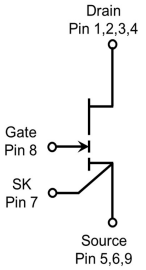
650V GaN-on-Silicon Enhancement-mode Power Transistor in Dual Flat No-lead Package (DFN) with 5 mm × 6 mm Size

Features

- Enhancement-mode transistor - normally-OFF power switch
- Ultra-high switching frequency
- No reverse-recovery charge
- Low gate charge, low output charge
- ESD safeguard
- RoHS, Pb-free, REACH-compliant



Gate	8
Drain	1, 2, 3, 4
Kelvin Source	7
Source	5, 6, 9



ORDERING INFORMATION

HT65N23EVDRZ

T_A = -55° to 150° C for all packages

Applications

- AC-DC converters
- DC-DC converters
- Totem pole PFC
- Fast battery charging
- High-density power conversion
- High-efficiency power conversion

Table 1 Key Performance Parameters at T_j = 25 °C

Parameters	Values	Units
$V_{DS, max}$	650	V
$R_{DS(on), max}$	140	mΩ
$Q_{G, typ}$	3.3	nC
$I_{D, Pulse}$	32	A
Q_{OSS} @ 400 V	33	nC
Q_{rr}	0	nC

1 Maximum ratings

at T_j = 25 °C unless otherwise specified. Continuous application of maximum ratings can deteriorate transistor lifetime. For further information, contact CloudSemi sales office.

Table 3 Maximum rating

Parameters	Symbols	Values			Units	Notes/Test Conditions
		Min.	Typ.	Max.		
Drain-source voltage	$V_{DS, max}$	-	-	650	V	V_{GS} = 0 V, I_D = 10 μA
Drain-source voltage transient [1]	$V_{DS, transient}$	-	-	750	V	V_{GS} = 0 V, V_{DS} = 750 V
Continuous current, drain-source	I_D	-	-	17	A	T_c = 25 °C
Pulsed current, drain-source [2]	$I_{D, pulse}$	-	-	32	A	T_c = 25 °C; V_G = 6 V
Pulsed current, drain-source [2]	$I_{D, pulse}$	-	-	18	A	T_c = 125 °C; V_G = 6 V
Gate-source voltage, continuous [3]	V_{GS}	-1.4	-	+7	V	T_j = -55 °C to 150 °C
Gate-source voltage, pulsed	$V_{GS, pulse}$	-	-	+10	V	T_j = -55 °C to 150 °C; t_{Pulse} = 50 ns, f = 100 kHz; open drain
Power dissipation	P_{tot}	-	-	113	W	T_c = 25 °C
Operating temperature	T_j	-55	-	+150	°C	
Storage temperature	T_{stg}	-55	-	+150	°C	

1. $V_{DS, transient}$ is intended for surge rating during non-repetitive events, t_{Pulse} < 1 μs.
2. Pulse width = 10 μs.
3. The minimum V_{GS} is clamped by ESD protection circuit, as shown in Figure 8.

2 Thermal characteristics

Table 4 Thermal characteristics

Parameters	Symbols	Values			Units	Notes/Test Conditions
		Min.	Typ.	Max.		
Thermal resistance, junction-case	R_{thJC}	-	-	1.1	°C/W	
Reflow soldering temperature	T_{sold}	-	-	260	°C	MSL3

3 Electrical characteristics

at T_j = 25 °C, unless specified otherwise.

Table 5 Static characteristics

Parameters	Symbols	Values			Units	Notes/Test Conditions
		Min.	Typ.	Max.		
Gate threshold voltage	$V_{GS(TH)}$	1.2	1.7	2.5	V	I_D = 17.2 mA; V_{DS} = V_{GS}; T_j = 25 °C
		-	1.6	-		I_D = 17.2 mA; V_{DS} = V_{GS}; T_j = 125 °C
Drain-source leakage current	I_{DSS}	-	0.6	20	μA	V_{DS} = 650 V; V_{GS} = 0 V; T_j = 25 °C
		-	1	-		V_{DS} = 650 V; V_{GS} = 0 V; T_j = 125 °C
Gate-source leakage current	I_{GSS}	-	40	200	μA	V_{GS} = 6 V; V_{DS} = 0 V
Drain-source on-state resistance	$R_{DS(on)}$	-	100	140	mΩ	V_{GS} = 6 V; I_D = 5 A; T_j = 25 °C
		-	200	-	mΩ	V_{GS} = 6 V; I_D = 5 A; T_j = 125 °C
Gate resistance	R_G	-	3.5	-	Ω	f = 5 MHz; open drain

Table 6 Dynamic characteristics

Parameters	Symbols	Values			Units	Notes/Test Conditions
		Min.	Typ.	Max.		
Input capacitance	C_{iss}	-	125	-	pF	V_{GS} = 0 V; V_{DS} = 400 V; f = 100 kHz
Output capacitance	C_{oss}	-	40	-	pF	V_{GS} = 0 V; V_{DS} = 400 V; f = 100 kHz
Reverse transfer capacitance	C_{rss}	-	0.5	-	pF	V_{GS} = 0 V; V_{DS} = 400 V; f = 100 kHz
Effective output capacitance, energy related [1]	$C_{o(er)}$	-	53	-	pF	V_{GS} = 0 V; V_{DS} = 0 to 400 V
Effective output capacitance, time related [2]	$C_{o(tr)}$	-	81	-	pF	V_{GS} = 0 V; V_{DS} = 0 to 400 V
Output charge	Q_{OSS}	-	33	-	nC	V_{GS} = 0 V; V_{DS} = 0 to 400 V

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

Table 7 Gate charge characteristics

Parameters	Symbols	Values			Units	Notes/Test Conditions
		Min.	Typ.	Max.		
Gate charge	Q_G	-	3.3	-	nC	V_{GS} = 0 to 6 V; V_{DS} = 400 V; I_D = 5 A
Gate-source charge	Q_{GS}	-	0.3	-	nC	
Gate-drain charge	Q_{GD}	-	1.25	-	nC	
Gate plateau voltage	V_{plat}	-	2.4	-	V	V_{DS} = 400 V; I_D = 5 A

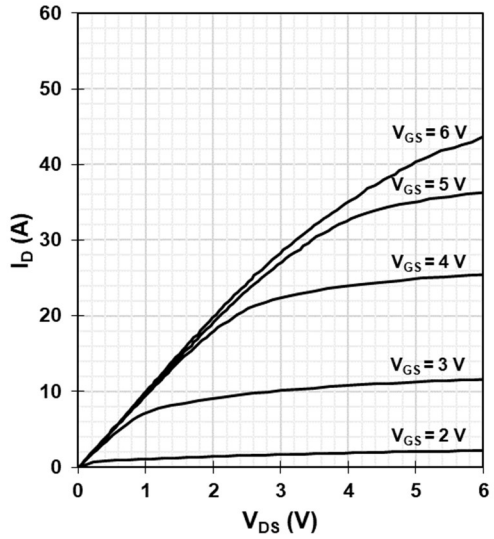
Table 8 Reverse conduction characteristics

Parameters	Symbols	Values			Units	Notes/Test Conditions
		Min.	Typ.	Max.		
Source-drain reverse voltage	V_{SD}	-	2.5	-	V	V_{GS} = 0 V; I_{SD} = 5 A
Pulsed current, reverse	$I_{S,\ pulse}$	-	28	-	A	V_{GS} = 6 V
Reverse recovery charge	Q_{rr}	-	0	-	nC	I_{SD} = 5 A; V_{DS} = 400 V
Reverse recovery time	t_{rr}	-	0	-	ns	
Peak reverse recovery current	I_{rrm}	-	0	-	A	

4 Electrical characteristics diagrams

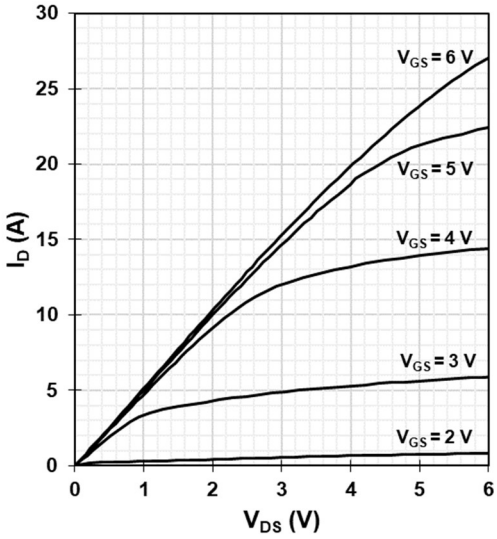
at T_j = 25 ºC, unless specified otherwise.

Figure 1 Typ. output characteristics



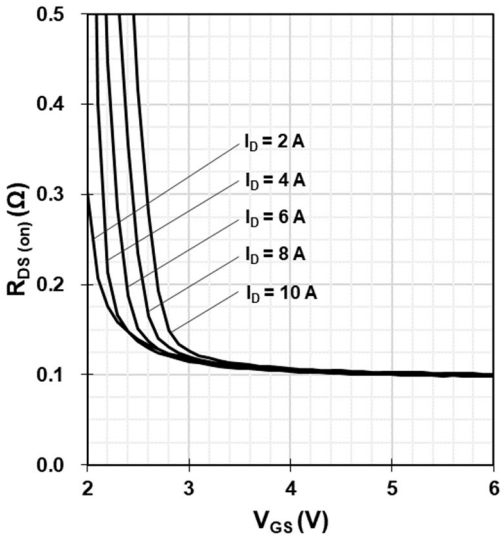
$I_D = f(V_{DS}, V_{GS})$; T_j = 25 ºC

Figure 2 Typ. output characteristics



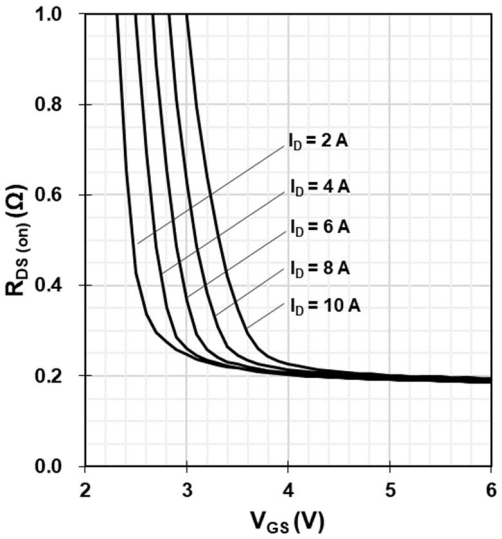
$I_D = f(V_{DS}, V_{GS})$; T_j = 125 ºC

Figure 3 Typ. drain-source on-state resistance



$R_{DS(on)} = f(I_D, V_{GS})$; T_j = 25 ºC

Figure 4 Typ. drain-source on-state resistance



$R_{DS(on)} = f(I_D, V_{GS})$; T_j = 125 ºC

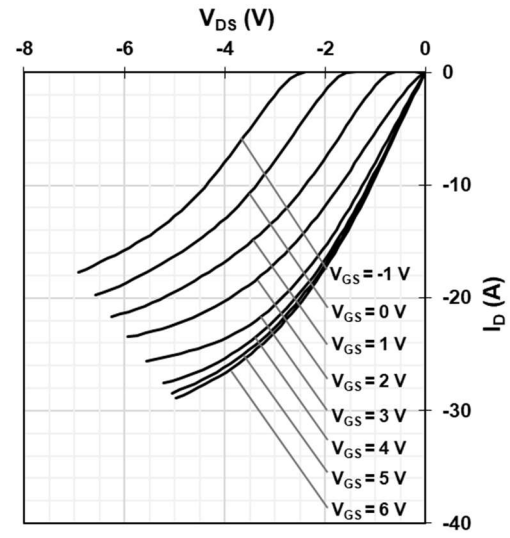
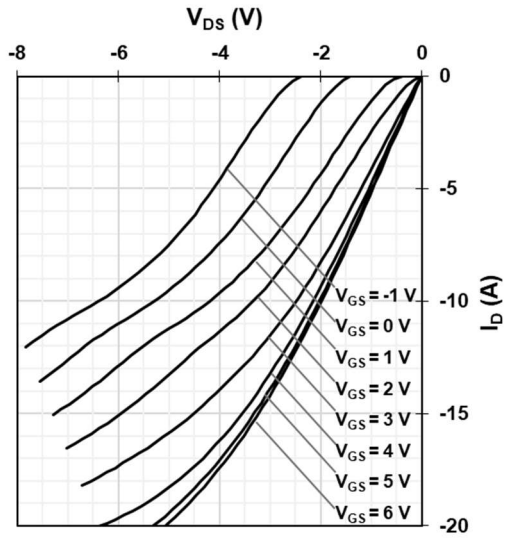
Figure 5 Typ. channel reverse characteristics	Figure 6 Typ. channel reverse characteristics
	
$I_D = f(V_{DS}, V_{GS})$; T_j = 25 °C	$I_D = f(V_{DS}, V_{GS})$; T_j = 125 °C

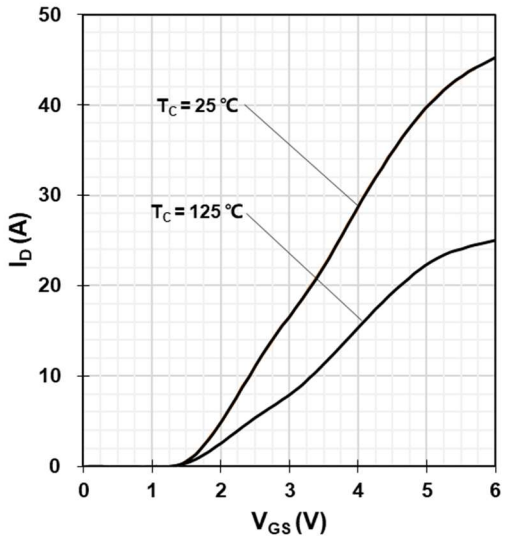
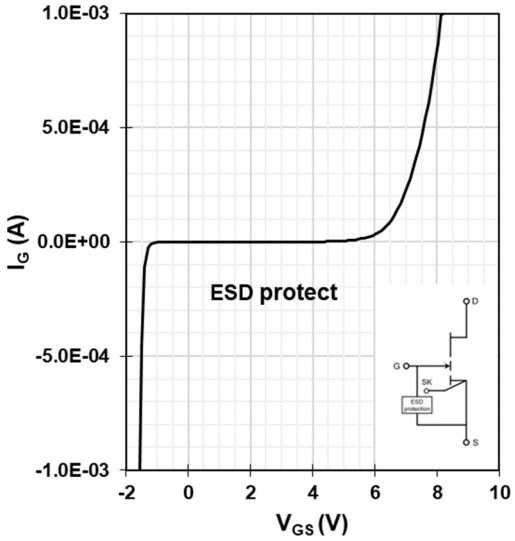
Figure 7 Typ. transfer characteristics	Figure 8 Typ. gate-to-source leakage
	
$I_D = f(V_{GS})$; V_{DS} = 5 V	$I_G = f(V_{GS})$; I_G reverse turn on by ESD unit; V_D = open

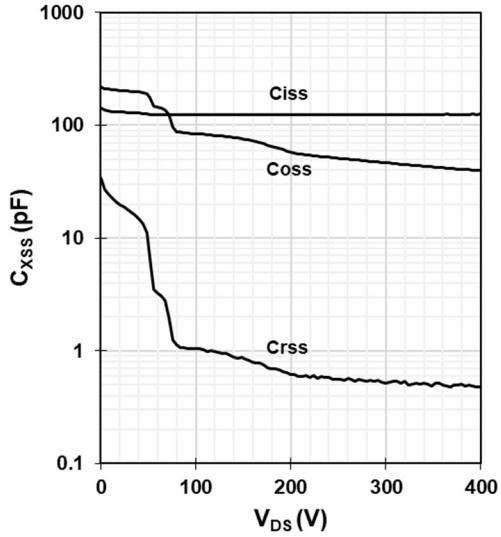
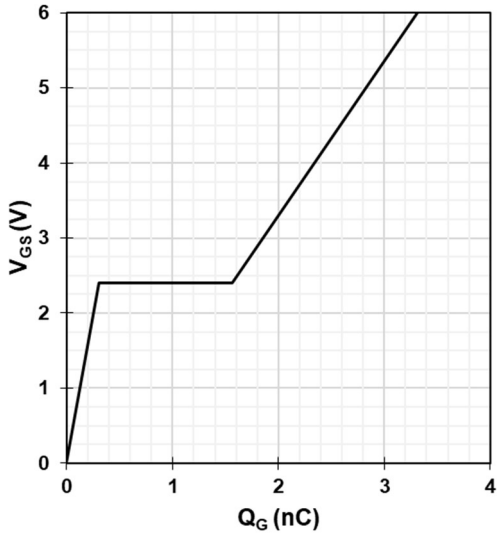
Figure 9 Typ. capacitances	Figure 10 Typ. gate charge
	
C_{XSS} = f(V_{DS}); Freq. = 100 kHz	V_{GS} = f(Q_G); V_{DS} = 400 V; I_D = 5 A

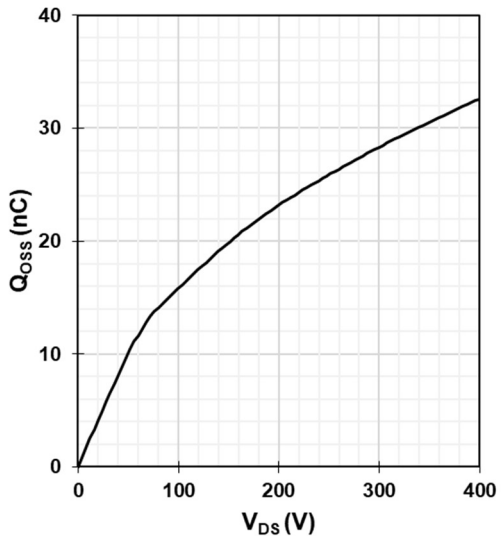
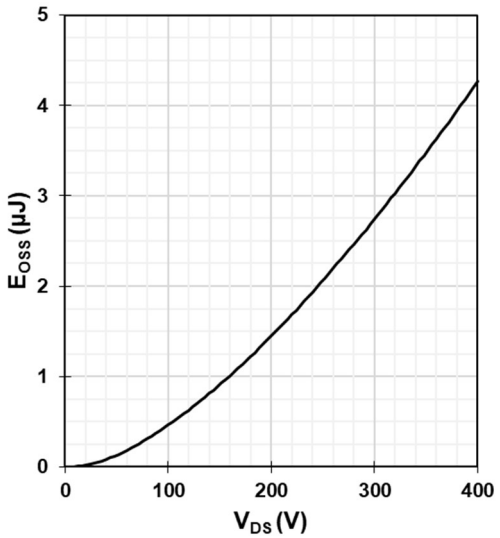
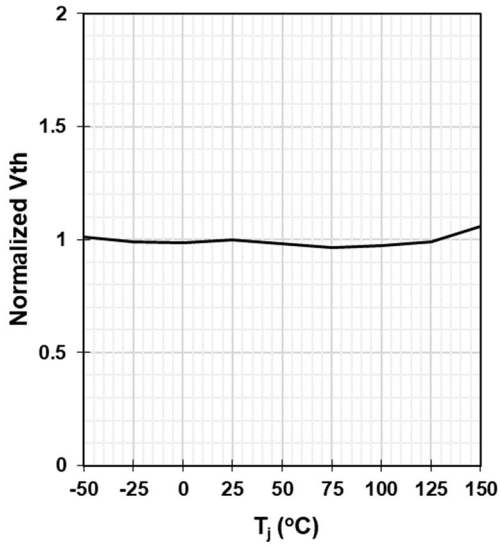
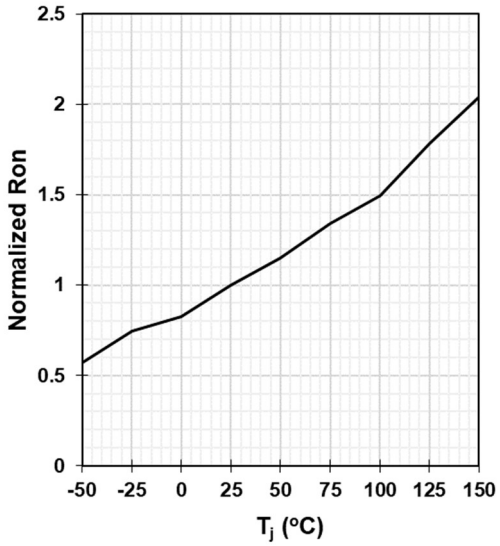
Figure 11 Typ. output charge	Figure 12 Typ. C_{oss} stored energy
	
Q_{OSS} = f(V_{DS}); Freq. = 100 kHz	E_{OSS} = f(V_{DS}); Freq. = 100 kHz

Figure 13 Gate threshold voltage



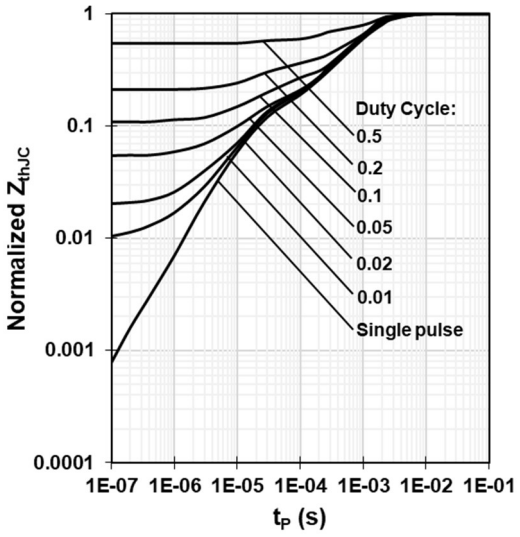
$V_{GS(TH)} = f(T_j)$; $V_{GS} = V_{DS}$; I_D = 17.2 mA

Figure 14 Drain-source on-state resistance



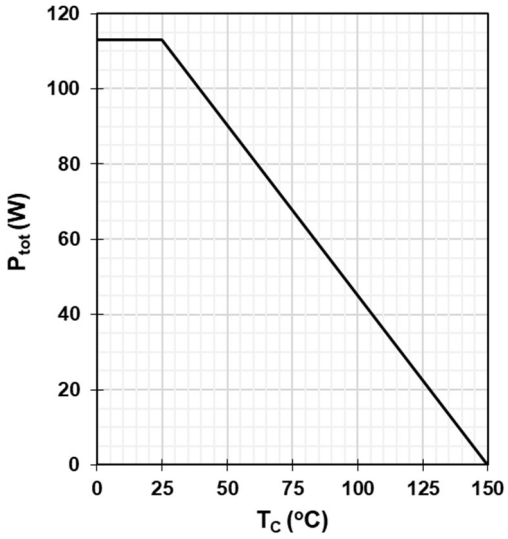
$R_{DS(on)} = f(T_j)$; I_D = 5 A; V_{GS} = 6 V

Figure 15 Max. transient thermal impedance



$Z_{thJC} = f(t_P, D)$

Figure 16 Power dissipation



$P_{tot} = f(T_C)$

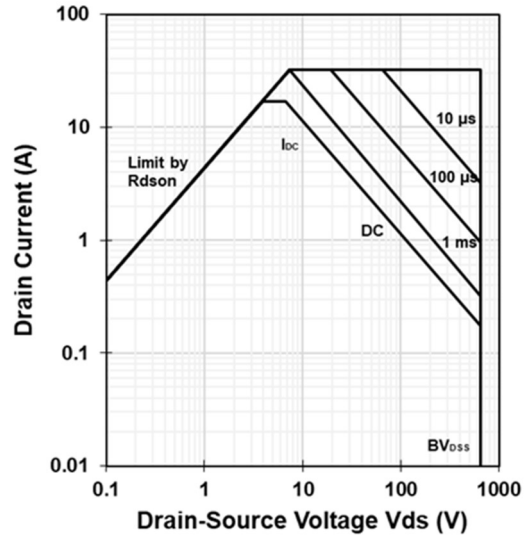
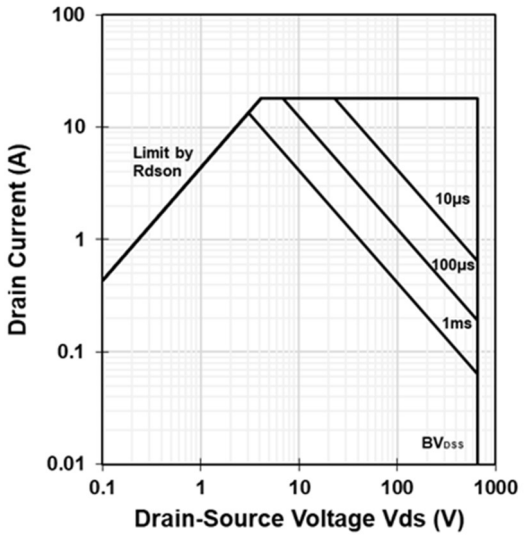
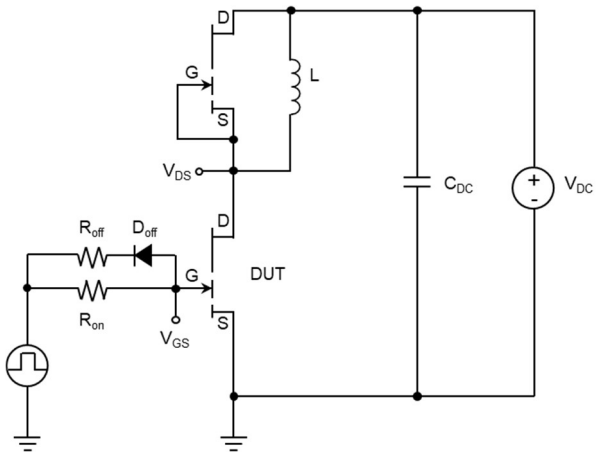
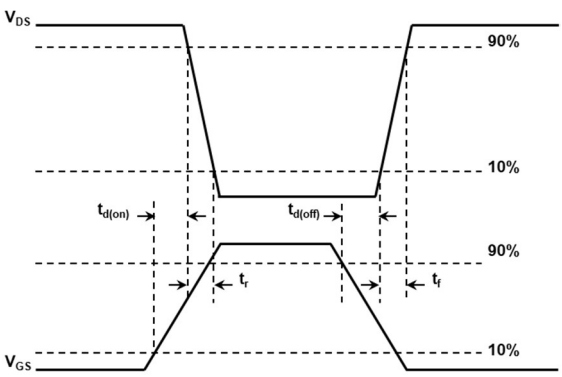
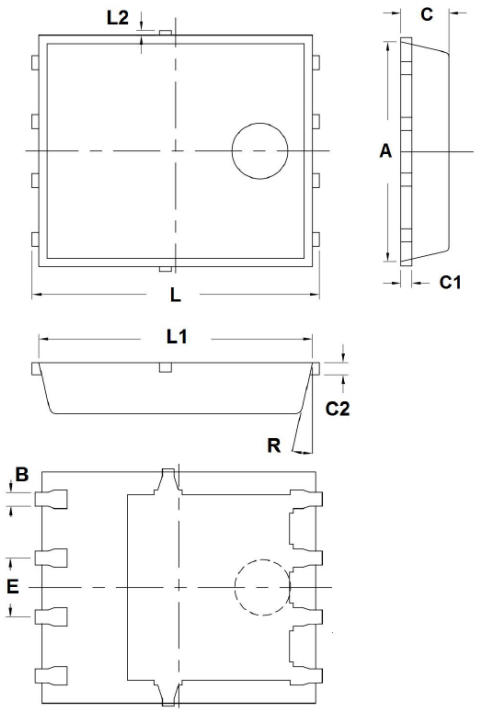
Figure 17 Safe operating area	Figure 18 Safe operating area
	
$I_D = f(V_{DS})$; T_C = 25 °C	$I_D = f(V_{DS})$; T_C = 125 °C

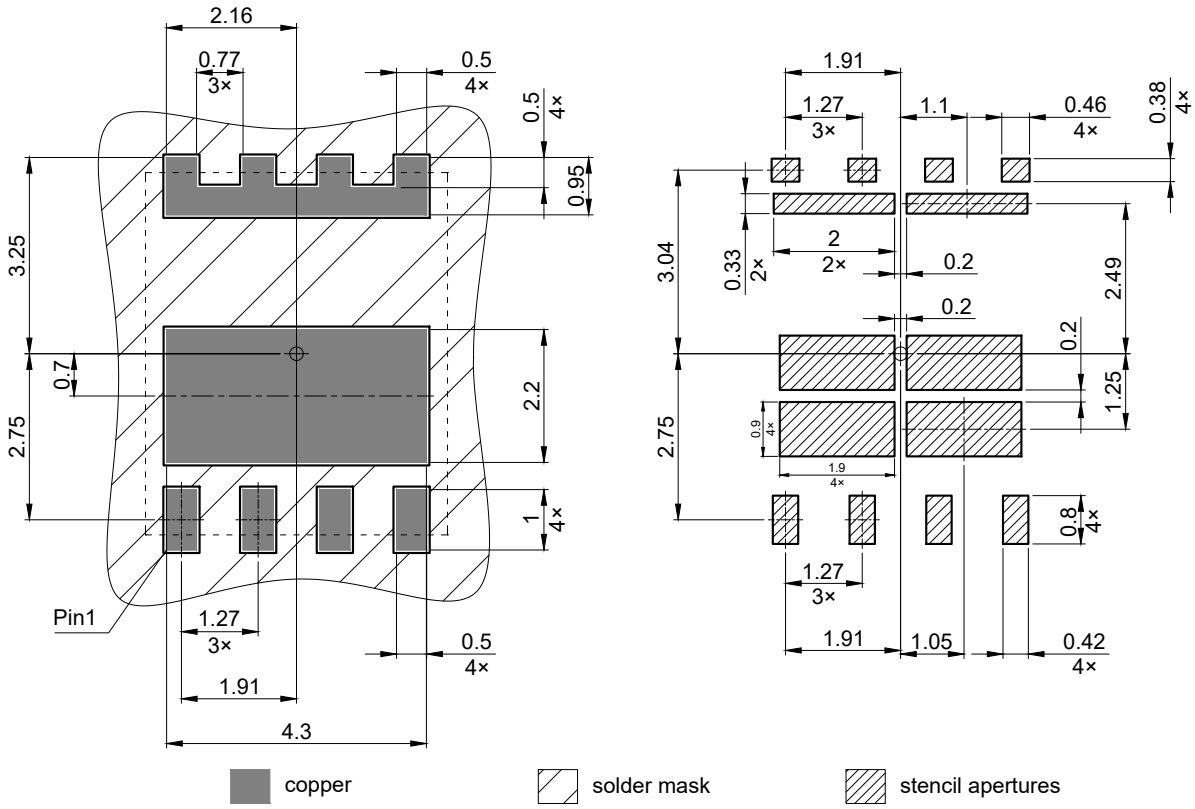
Figure 19 Switching times test circuit	Figure 20 Typ. switching times waveform
	
V_{DS} = 400 V, I_D = 10 A, L = 318 μH, V_{GS} = 6 V, R_{on} = 10 Ω, R_{off} = 2 Ω	

Package outlines



Dim.	Min.	Max.
A	4.8	5.2
B	0.25	0.35
C	1.0	1.2
C1	Typ 0.254	
C2	Typ 0.254	
E	Typ 1.27	
L	6.0	6.3
L1	5.7	6.0
L2	MAX 0.2	
R	Typ 13°	

All Dimensions in millimeter



All pads are non-solder mask defined
All dimensions are in units mm