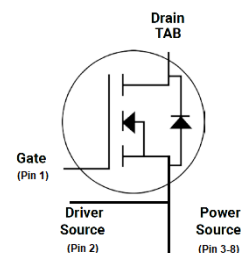
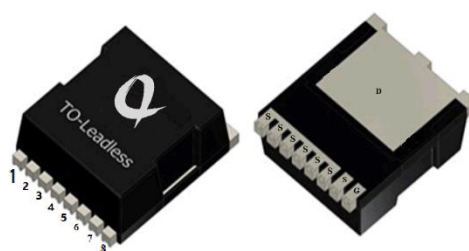


## Product Summary

$V_{DS} = 650\text{ V}$   
 $I_D@25^\circ\text{C} = 47\text{ A}$   
 $R_{DS(ON)} = 59\text{ m}\Omega$



TOLL

## Features

- High Blocking Voltage
- High Frequency Operation
- Dedicated Driver Source Pin
- Low on-resistance
- Fast intrinsic diode with low reverse recovery

## Benefits

- Higher System Efficiency
- Parallel Device Convenience without thermal runaway
- High Temperature Application
- Hard Switching & Higher Reliability
- Easy to drive

## Applications

- Motor Drives
- Solar Inverters
- Onboard EV Charger
- Energy Storage
- Server
- Telecom
- SMPS
- Uninterruptable power supplies

## Maximum Ratings ( $T_C=25^\circ\text{C}$ unless otherwise specified)

Parameter	Symbol	Test conditions	Value	Unit
Drain - Source Voltage	$V_{DSmax}$	$V_{GS}=0\text{V}$ , $I_D=100\mu\text{A}$	650	V
Gate - Source Voltage (dynamic)	$V_{GSmax}$	AC ( $f>1\text{ Hz}$ )	-8 / +23	V
Gate - Source Voltage (static)	$V_{GSop}$	static	-4 / +18	V
Continuous Drain Current	$I_D$	$V_{GS} = 18\text{V}$ , $T_C=25^\circ\text{C}$ $V_{GS} = 18\text{V}$ , $T_C=100^\circ\text{C}$	47 33	A
Pulsed Drain Current	$I_{D(pulse)}$	$T_C=25^\circ\text{C}$	94	A
Short Circuit Capability	$t_{SC}$	$V_{DD}=400\text{V}$ , $V_{GS}=18\text{V}$	9	$\mu\text{S}$
Short Circuit Capability	$I_{DS}$	$V_{DD}=400\text{V}$ , $V_{GS}=18\text{V}$	300	A
Total power dissipation	$P_D$	$T_C=25^\circ\text{C}$	166	W
Operating Junction Temperature	$T_J$		-55 to 175	$^\circ\text{C}$
Storage Temperature	$T_{STG}$		-55 to 175	$^\circ\text{C}$

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

## Electrical Characteristics (T<sub>C</sub>=25°C unless otherwise specified)

Parameter	Symbol	Test conditions	Min	Typ	Max	Unit
Drain-Source Breakdown Voltage	V <sub>(BR)DSS</sub>	V <sub>GS</sub> = 0V, I <sub>D</sub> = 100μA	650			V
Gate Threshold Voltage	V <sub>GS(th)</sub>	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 5mA	1.9	2.7	3.9	V
		V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 5mA, T <sub>J</sub> = 150°C		2.0		V
		V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 5mA, T <sub>J</sub> = 175°C		1.9		V
Zero Gate Voltage Drain Current	I <sub>DSS</sub>	V <sub>DS</sub> = 650V, V <sub>GS</sub> = 0V	0	1	100	μA
Gate-Source Leakage Current	I <sub>GSS</sub>	V <sub>GS</sub> = 18V, V <sub>DS</sub> = 0V	0	10	200	nA
Gate-Source Leakage Current	I <sub>GSS</sub>	V <sub>GS</sub> = -4V, V <sub>DS</sub> = 0V	-200	-10	0	nA
Drain-Source On-State Resistance	R <sub>DS(on)</sub>	V <sub>GS</sub> = 16V, I <sub>D</sub> = 15 A		68		mΩ
		V <sub>GS</sub> = 16V, I <sub>D</sub> = 15 A, T <sub>J</sub> = 150°C		68		
		V <sub>GS</sub> = 16V, I <sub>D</sub> = 15 A, T <sub>J</sub> = 175°C		72		
		V <sub>GS</sub> = 18V, I <sub>D</sub> = 20 A		59	75	
		V <sub>GS</sub> = 18V, I <sub>D</sub> = 20 A, T <sub>J</sub> = 150°C		64		
		V <sub>GS</sub> = 18V, I <sub>D</sub> = 20 A, T <sub>J</sub> = 175°C		68		
Transconductance	g <sub>fs</sub>	V <sub>DS</sub> = 20V, I <sub>D</sub> = 20 A,		11		S
		V <sub>DS</sub> = 20V, I <sub>D</sub> = 20 A, T <sub>J</sub> = 150°C		10.7		
		V <sub>DS</sub> = 20V, I <sub>D</sub> = 20 A, T <sub>J</sub> = 175°C		10.5		
Input capacitance	C <sub>iss</sub>	V <sub>DS</sub> = 400V, V <sub>GS</sub> = 0V f = 1MHz		1600		pF
Output capacitance	C <sub>oss</sub>			145		
Reverse transfer capacitance	C <sub>rss</sub>			11		
C <sub>oss</sub> Stored Energy	E <sub>oss</sub>			14		
Total gate charge	Q <sub>g</sub>	V <sub>DS</sub> = 400V, V <sub>GS</sub> = -4V / 18V I <sub>D</sub> = 20 A,		78		nC
Gate-source charge	Q <sub>gs</sub>			21		
Gate-drain charge	Q <sub>gd</sub>			34		
Internal gate input resistance	R <sub>g(int)</sub>	f = 1MHz, I <sub>D</sub> = 0A		2.1		Ω
Turn-On Switching Energy	E <sub>ON</sub>	V <sub>DS</sub> = 400 V, V <sub>GS</sub> = -4V/18V, I <sub>D</sub> = 20A, R <sub>G(ext)</sub> = 2Ω, L = 200μH		13		μJ
Turn-Off Switching Energy	E <sub>OFF</sub>			14		
Turn-On Delay Time	t <sub>d(on)</sub>			9		ns
Rise Time	t <sub>r</sub>			7		
Turn-Off Delay Time	t <sub>d(off)</sub>			18		
Fall Time	t <sub>f</sub>			5		
Avalanche Capability	E <sub>AS</sub>	V <sub>DD</sub> = 100V, V <sub>GS</sub> = 18V, L = 1mH		200		mJ
Avalanche Capability	I <sub>AV</sub>			20		A

## Reverse Diode Characteristics (T<sub>C</sub>=25°C unless otherwise specified)

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Diode Forward Voltage	V <sub>SD</sub>	V <sub>GS</sub> = -4V, I <sub>SD</sub> = 10A,		3.9		V
		V <sub>GS</sub> = -4V, I <sub>SD</sub> = 10A, T <sub>J</sub> = 150°C		3.5		
		V <sub>GS</sub> = -4V, I <sub>SD</sub> = 10A, T <sub>J</sub> = 175°C		3.4		
Continuous Diode Forward Current	I <sub>S</sub>	V <sub>GS</sub> = -4V		30		A
Reverse Recovery time	t <sub>rr</sub>	V <sub>GS</sub> = -4V, I <sub>SD</sub> = 20A, V <sub>R</sub> = 400V, dif/dt = 2000 A/μs		20		ns
Reverse Recovery Charge	Q <sub>rr</sub>			160		nC
Peak Reverse Recovery Current	I <sub>rrm</sub>			14		A

## Thermal Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Thermal Resistance (per device)	R <sub>th(j-c)</sub>	junction-case		0.74	0.9	°C/W

## Typical Performance

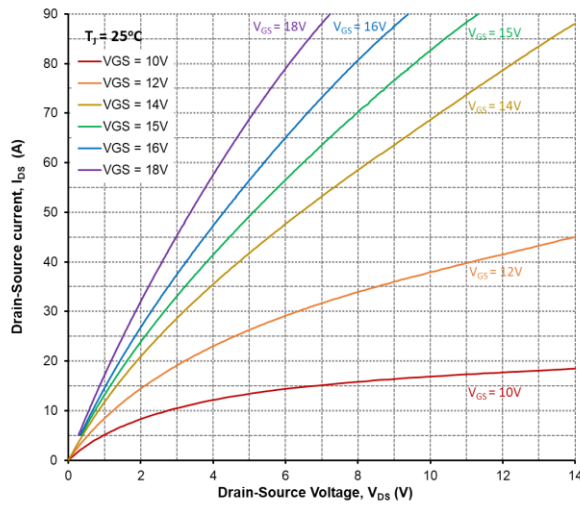


Figure 1. Output Characteristics,  $T_J = 25^\circ\text{C}$

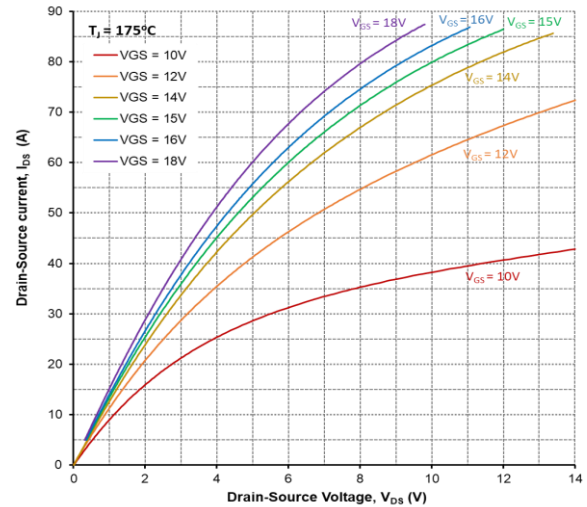


Figure 2. Output Characteristics,  $T_J = 175^\circ\text{C}$

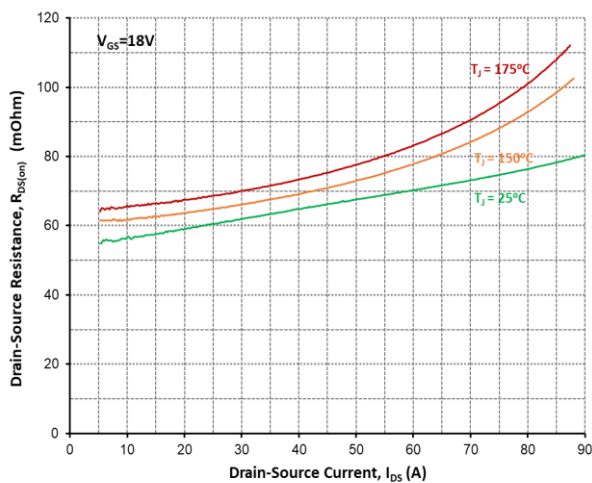


Figure 3. On-Resistance vs. Drain Current For Various Temperatures

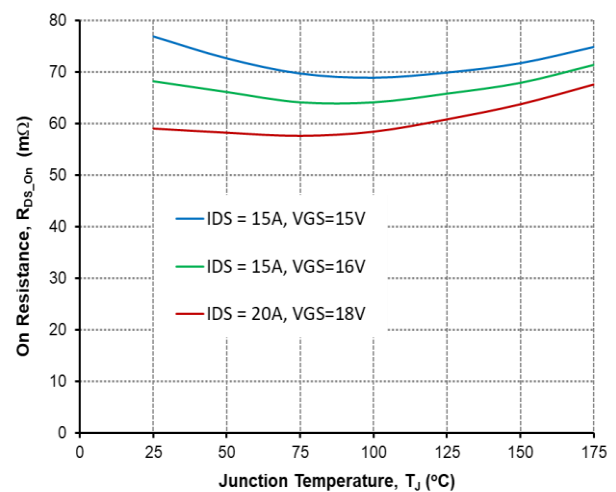


Figure 4. On-Resistance vs. Temperature

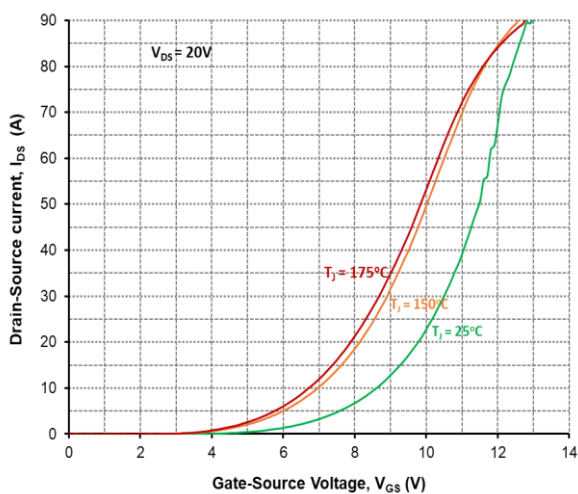


Figure 5. Transfer Characteristic For Various Junction Temperatures

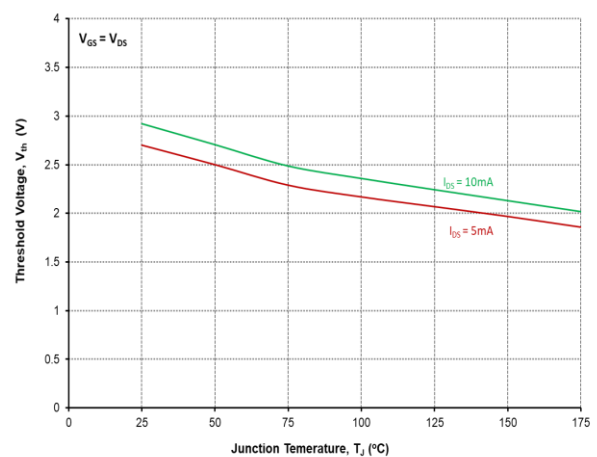


Figure 6. Threshold Voltage vs. Temperature

## Typical Performance

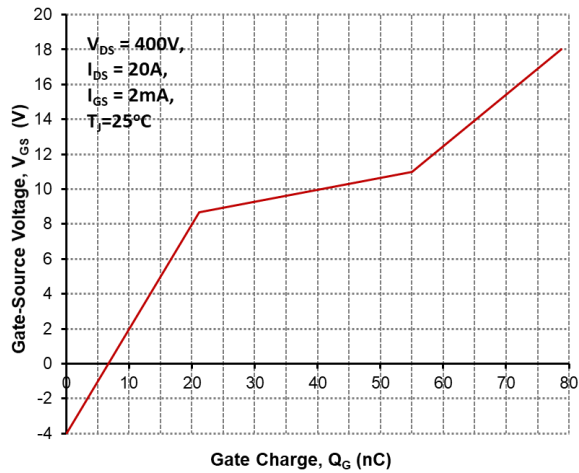


Figure 7. Gate Charge Characteristics

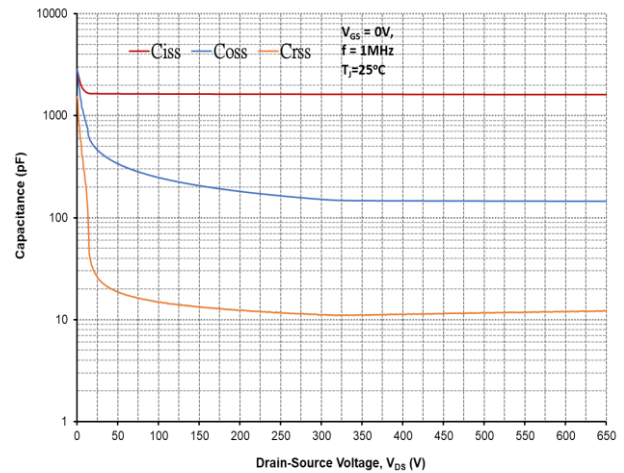


Figure 8. Capacitances vs. Drain-Source Voltage (0-650V)

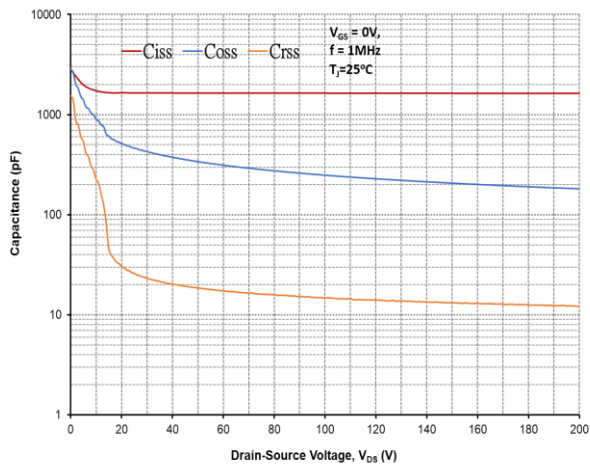


Figure 9. Capacitances vs. Drain-Source Voltage (0-200V)

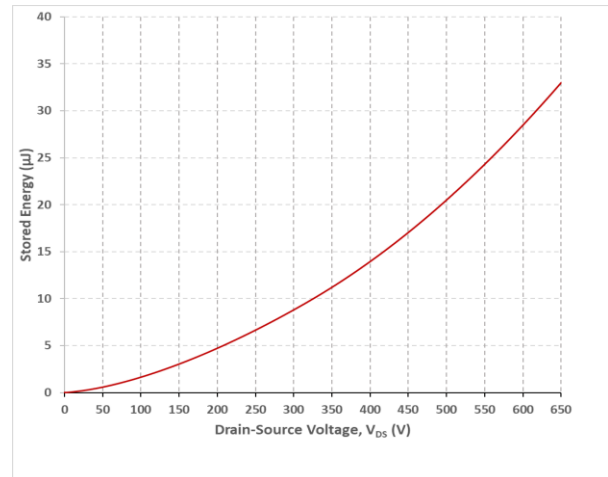


Figure 10. Output Capacitor Stored Energy

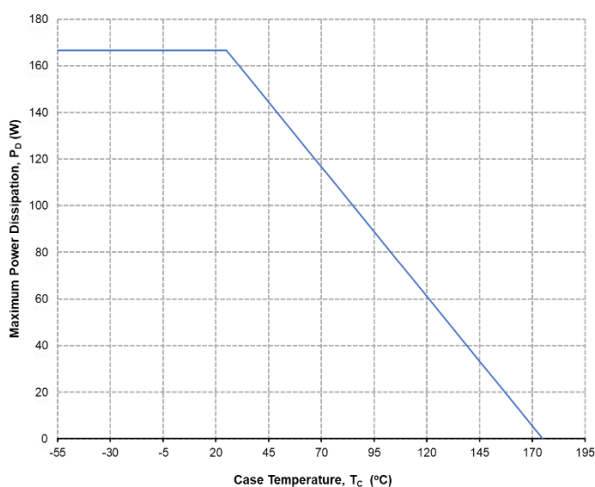


Figure 11. Maximum Power Dissipation Derating vs. Case Temperature

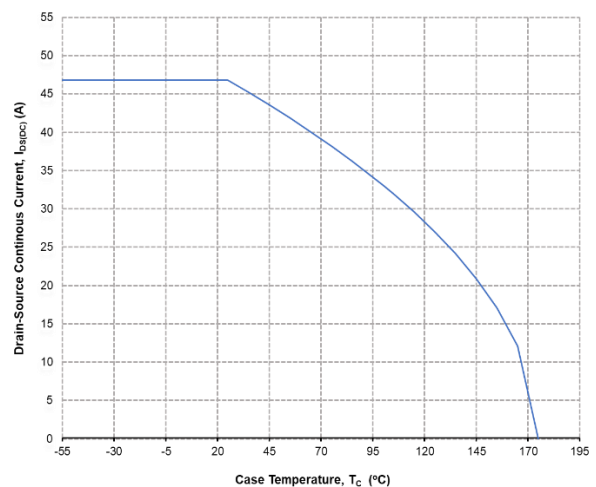


Figure 12. Continuous Drain Current Derating vs. Case Temperature

## Typical Performance

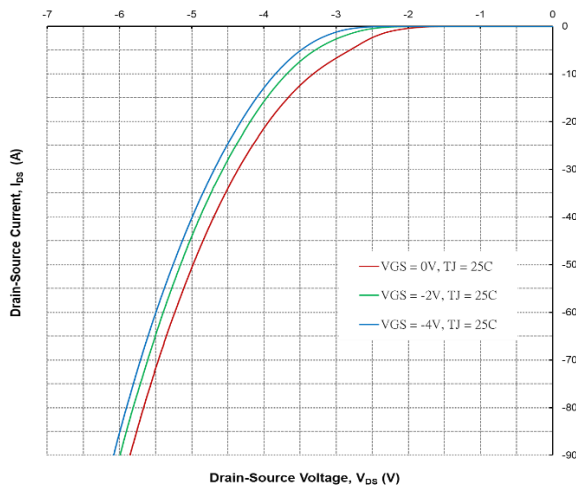


Figure 13. Body Diode Characteristics @ 25°C

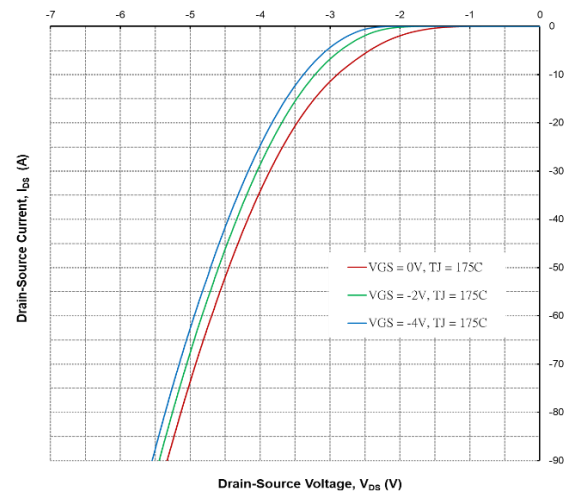


Figure 14. Body Diode Characteristics @ 175°C

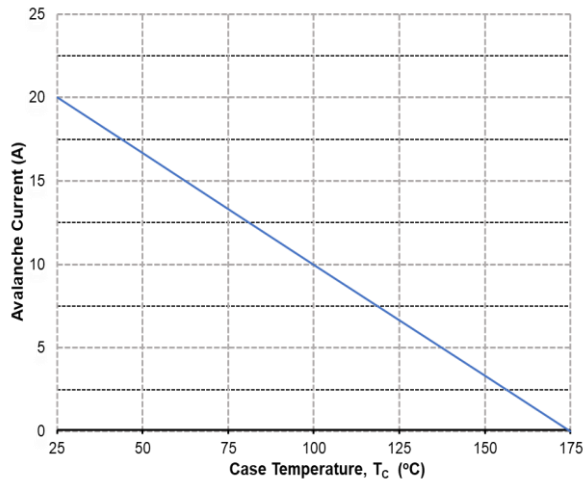


Figure 15. Single Avalanche vs. Temperature

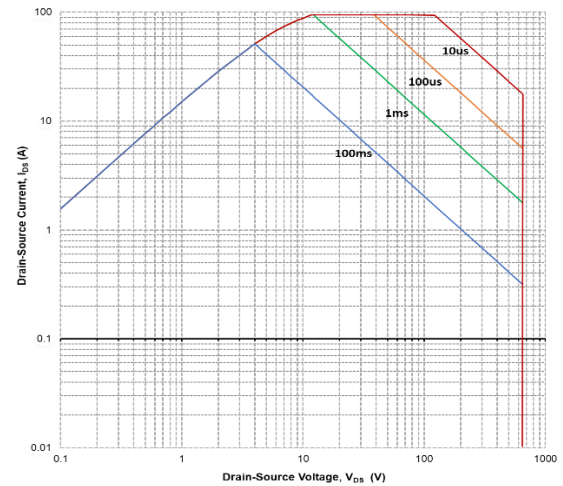
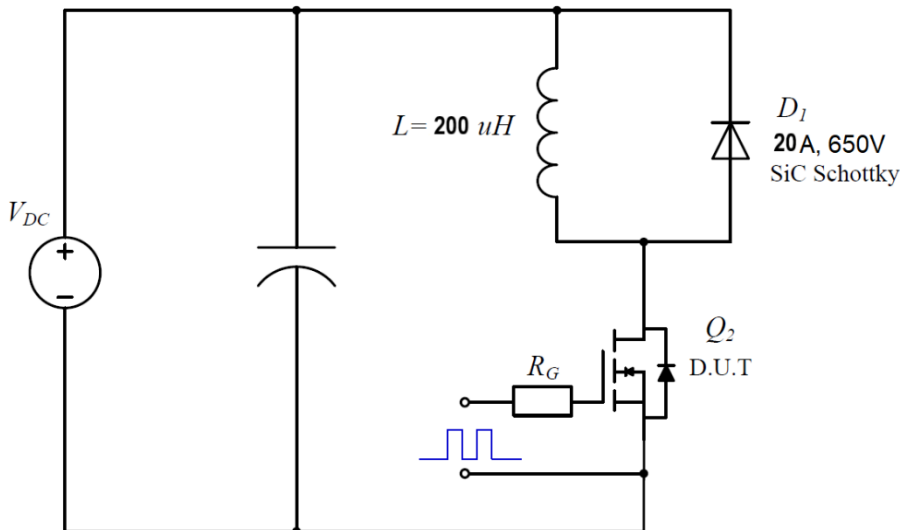
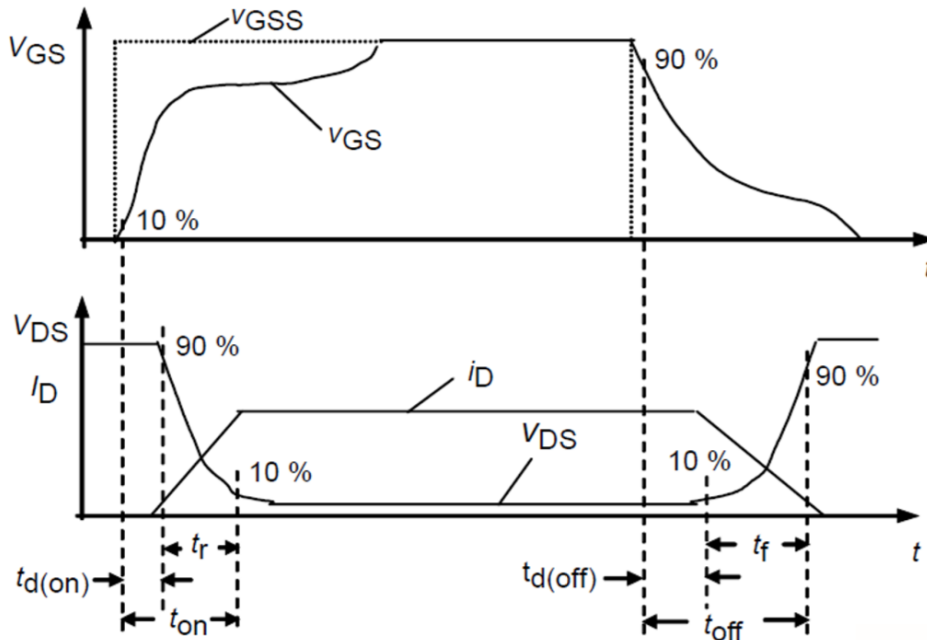


Figure 16. Safe Operating Area

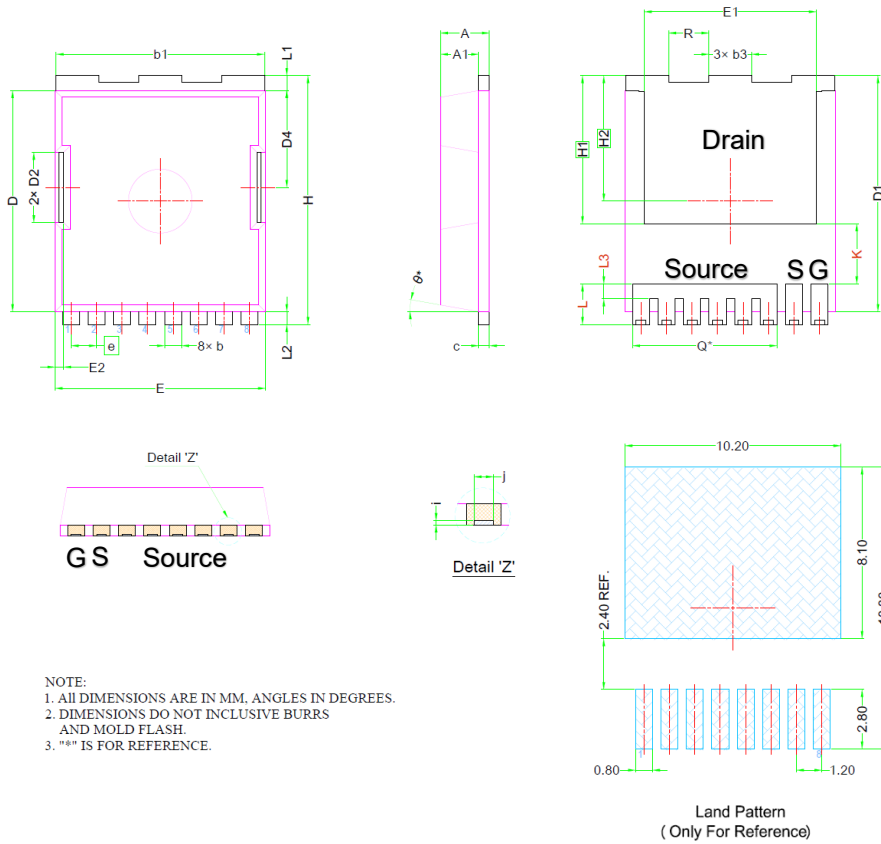


## Switching Times Definition and Test Circuit



## Package Dimensions

(TOLL Package)



NOTE:  
1. All DIMENSIONS ARE IN MM. ANGLES IN DEGREES.  
2. DIMENSIONS DO NOT INCLUSIVE BURRS AND MOLD FLASH.  
3. "6°" IS FOR REFERENCE.

SYMBOL	DIMENSIONS		
	MIN.	NOM.	MAX.
A	2.20	2.30	2.40
A1	1.70	1.80	1.90
b	0.70	0.80	0.90
b1	9.70	9.80	9.90
b3	1.90	2.00	2.10
c	0.40	0.50	0.60
D	10.28	10.38	10.48
D1	10.98	11.08	11.18
D2	3.20	3.30	3.40
D4	4.45	4.55	4.65
E	9.80	9.90	10.00
E1	8.00	8.10	8.20
E2	0.30	0.40	0.50
e	1.20 BSC		
H	11.58	11.68	11.78
H1	6.95 BSC		
H2	5.89 BSC		
i	0.10 REF.		
j	0.46 REF.		
K	2.80 REF.		
L	1.60	1.90	2.10
L1	0.60	0.70	0.80
L2	0.50	0.60	0.70
L3	0.60	0.70	0.80
N	8		
Q	6.80 REF.		
R	1.80	1.90	2.00
$\theta$	10° REF.		