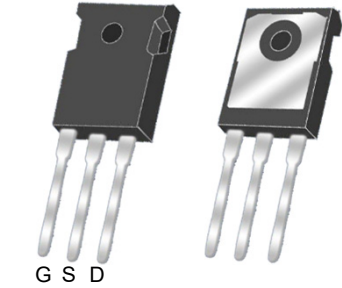


**650V Enhancement-mode GaN Transistor**
**Description**

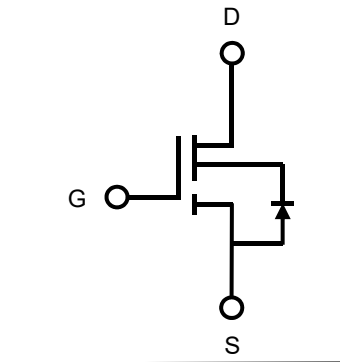
650V Normally-OFF GaN			
$V_{DS}(V)$	$R_{DS(on)}(m\Omega)$	$I_{DS}(A)$	$Q_G(nC)$
650	50	38	17


**TO-247-3L**
**Feature**

- Easy to use, compatible with standard gate drivers
- Excellent  $Q_G \times R_{DS(on)}$  figure of merit (FOM)
- Low  $Q_{RR}$ , no free-wheeling diode required
- Low switching loss
- RoHS compliant and Halogen-free
- Package: TO-247-3L

**Applications**

- High efficiency power supplies
- Telecom and datacom
- Automotive
- Servo motors


**Circuit Diagram**
**Absolute maximum rating@25°C**

Rating	Symbol	Value	Units
Drain-Source Voltage	$V_{DSS}$	650	V
Drain-Source Voltage-transient <sup>1)</sup>	$V_{TDSS}$	800	V
Gate-Source Voltage	$V_{GSS}$	$\pm 20$	V
Drain Current-Continuous	$T_C = 25^\circ C$	38	A
	$T_C = 100^\circ C$	25	
Pulse Drain Current (pulse width: 100 $\mu$ s)	$T_C = 25^\circ C$	156	A
	$T_C = 150^\circ C$	101	
Maximum Power Dissipation	$P_D$	139	W
Operating and Storage Temperature Range	$T_C, T_J, T_{STG}$	-55~+150	$^\circ C$
Soldering Peak temperature	$T_{CSOLD}$	260	$^\circ C$

**Thermal characteristics**

Parameter	Symbol	Typ.	Units
Thermal Resistance, Junction - Case	$R_{\theta JC}$	0.91	$^\circ C/W$
Thermal Resistance, Junction - Ambient <sup>2)</sup>	$R_{\theta JA}$	50	$^\circ C/W$

## Electrical characteristics per line@25°C (unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Drain-Source Voltage-Max	$V_{DSS-Max}$	$V_{GS}=0V$	650	-	-	V
Drain-Source Breakdown Voltage	$BV_{DSS}$	$V_{GS}=0V, I_{DS}=250\mu A$	-	1000	-	V
Total Drain Leakage Current	$I_{DSS}$	$V_{DS}=700V, V_{GS}=0V$	-	10	30	$\mu A$
		$V_{DS}=700V, V_{GS}=0V, T_J=150^\circ C$	-	50	-	
Gate Threshold Voltage	$V_{GS(th)}$	$V_{GS}=V_{DS}, I_D=500\mu A$	3.0	4.0	5.0	V
Gate Threshold Voltage Temperature Coefficient	$\Delta V_{GS(th)}/T_J$		-	-11.3	-	mV/°C
Gate-Source Leakage Current	$I_{GSS}$	$V_{GS}=\pm 20V$	-	-	$\pm 150$	nA
Static Drain-Source On-Resistance <sup>3)</sup>	$R_{DS(on)}$	$V_{GS}=12V, I_D=4A$	-	50	65	mΩ
		$V_{GS}=12V, I_D=4A, T_J=150^\circ C$	-	100	-	
Input Capacitance	$C_{iss}$	$V_{DS}=400V, V_{GS}=0V,$ $f=1MHz$	-	519	-	pF
Output Capacitance	$C_{oss}$		-	117	-	
Reverse Transfer Capacitance	$C_{rss}$		-	2.7	-	
Effective Output Capacitance, Energy Related	$C_{o(er)}$	$V_{GS}=0V, V_{DS}=0V$ to 400V	-	175	-	pF
Effective Output Capacitance, Time Related	$C_{o(tr)}$		-	317	-	
Output Charge	$Q_{oss}$		-	127	-	
Total Gate Charge	$Q_g$	$V_{GS}=0V$ to 12V, $V_{DS}=400V,$ $I_D=6A$	-	17	-	nC
Gate-Source Charge	$Q_{gs}$		-	4.6	-	
Gate-Drain Charge	$Q_{gd}$		-	5.6	-	
Turn-on Delay Time	$t_{d(on)}$	$V_{DS}=400V, V_{GS}=0V$ to 12V, $I_D=10A, R_G=40\Omega,$	-	44	-	ns
Turn-on Rise Time	$t_r$		-	16	-	
Turn-Off Delay Time	$t_{d(off)}$		-	40	-	
Turn-Off Fall Time	$t_f$		-	12	-	
Reverse Device Characteristics						
Diode Forward Voltage	$V_{SD}$	$V_{GS}=0V, I_S=12.5A$	-	1.3	-	V
		$V_{GS}=0V, I_S=25A$	-	1.9	-	
		$V_{GS}=0V, I_S=25A, T_J=150^\circ C$	-	3.0	-	
Reverse Recovery Time	$t_{rr}$	$I_S=25A, V_{DD}=400V,$ $d_f/d_r=1000A/\mu s, V_{GS}=0V$	-	43	-	ns
Reverse Recovery Charge	$Q_{rr}$		-	127	-	nC

## Notes:

- Off-state spike duty cycle < 0.01, spike duration < 2us
- Device on one layer epoxy PCB for drain connection (vertical and without air stream cooling, with 6cm<sup>2</sup> copper area and 70μm thickness)
- Dynamic on-resistance; see Figure 17 and 18 for test circuit and configurations

Typical Characteristics

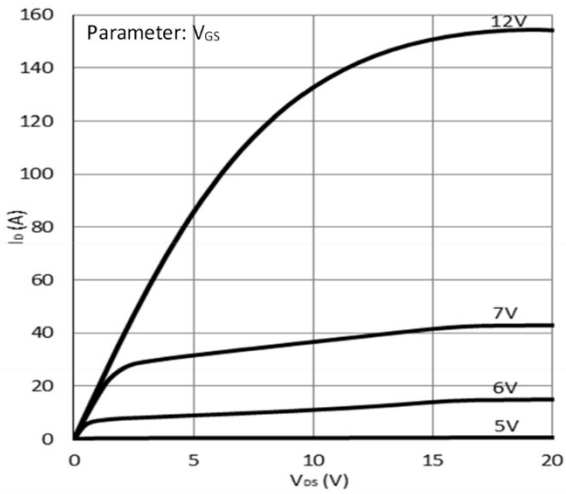


Figure 1. Typical Output Characteristics  $T_j=25^\circ\text{C}$

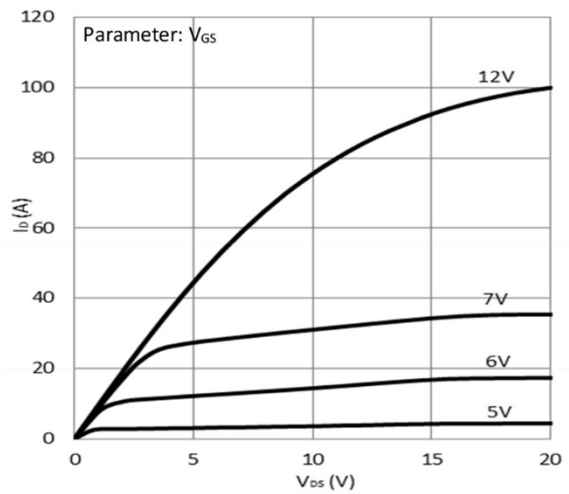


Figure 2. Typical Output Characteristics  $T_j=150^\circ\text{C}$

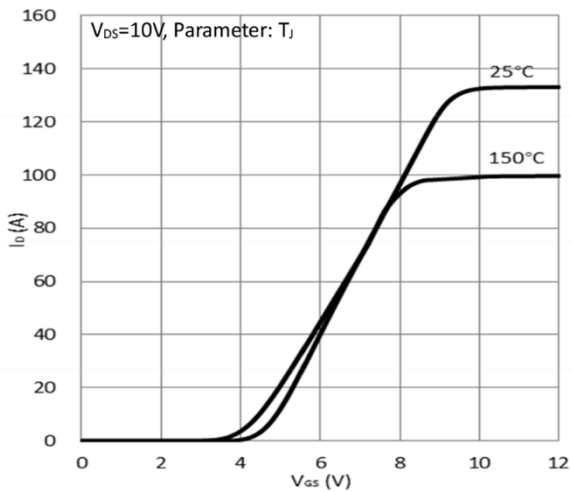


Figure 3. Typical Transfer Characteristics

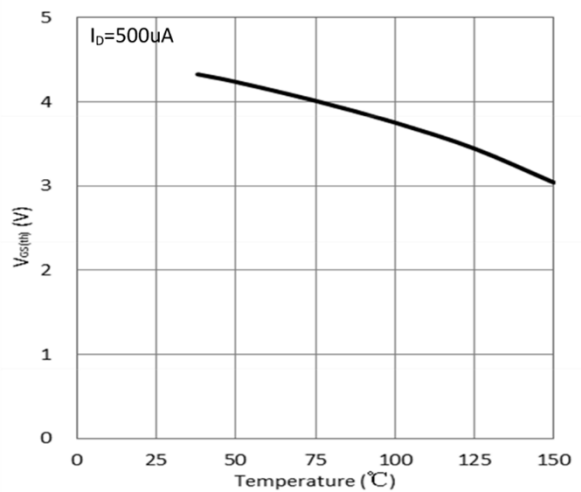


Figure 4.  $V_{GS(th)}$  Vs Temperature Characteristics

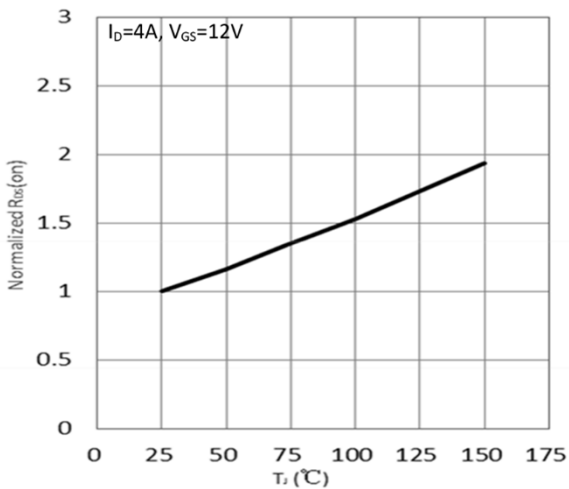


Figure 5. Normalized On-resistance

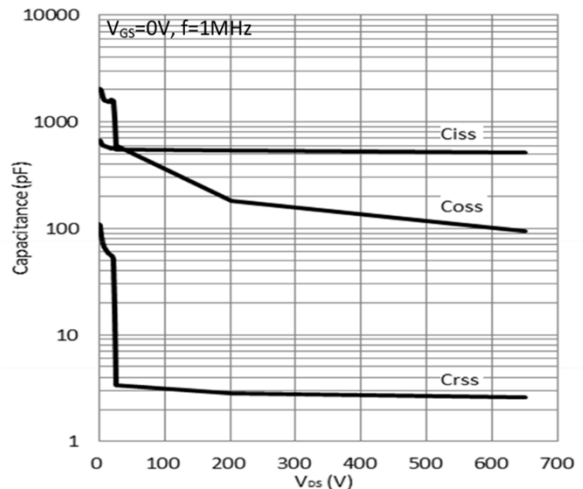


Figure 6. Typical Capacitance

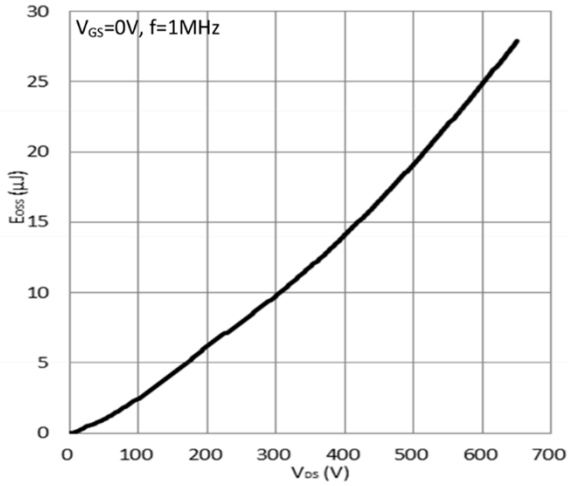


Figure 7. Typical Coss Stored Energy

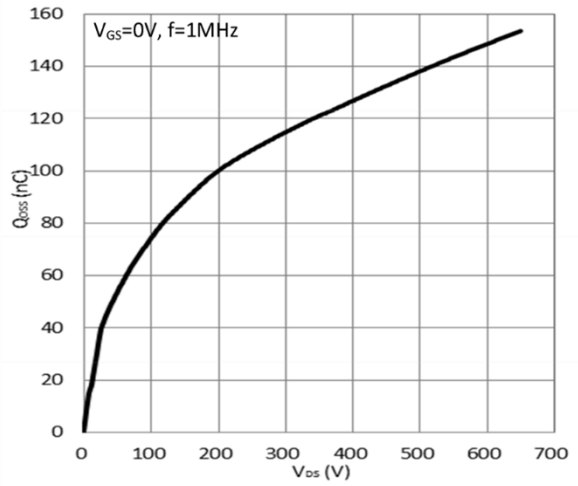


Figure 8. Typical Qoss

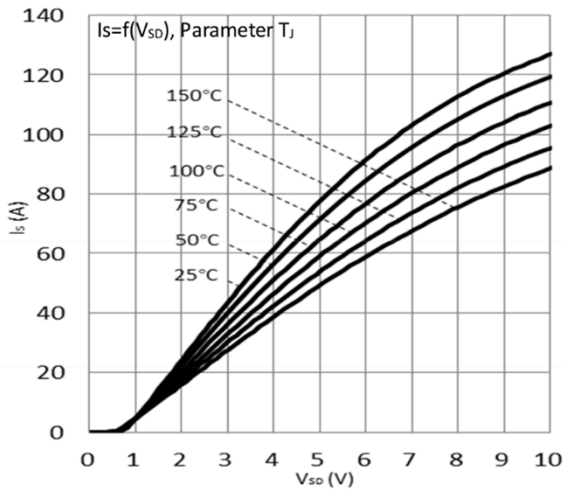


Figure 9. Forward Characteristic of Rev. Diode

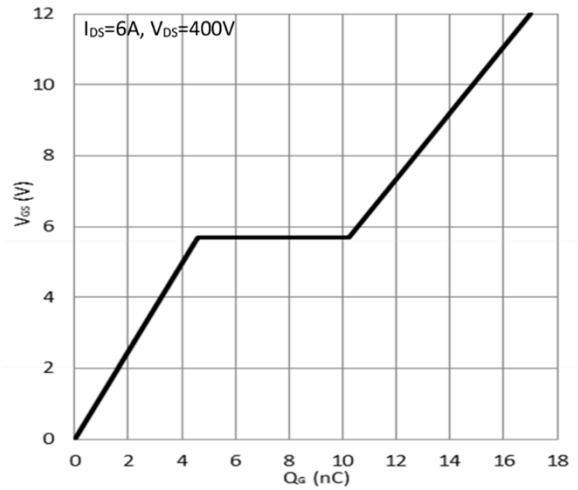


Figure 10. Typical Gate Charge

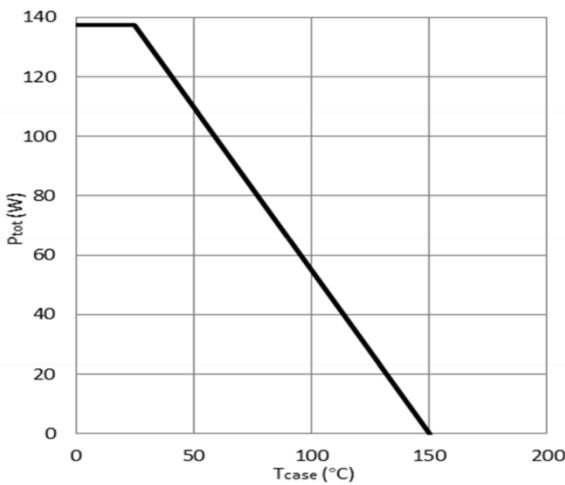


Figure 11. Power Dissipation

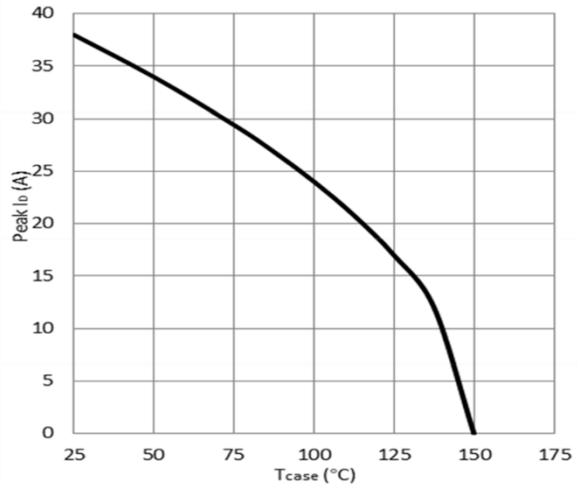


Figure 12. Current Derating

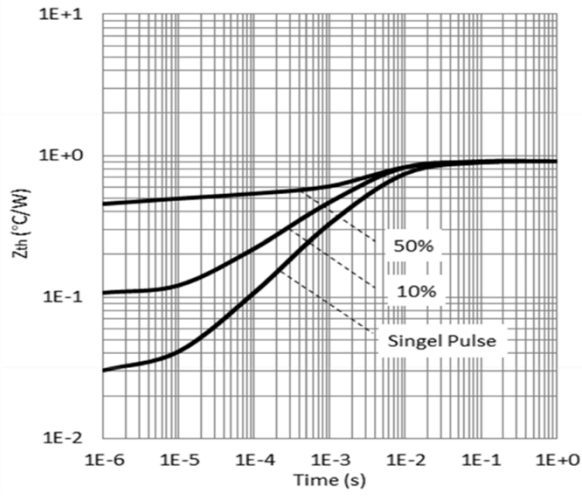


Figure 13. Transient Thermal Resistance

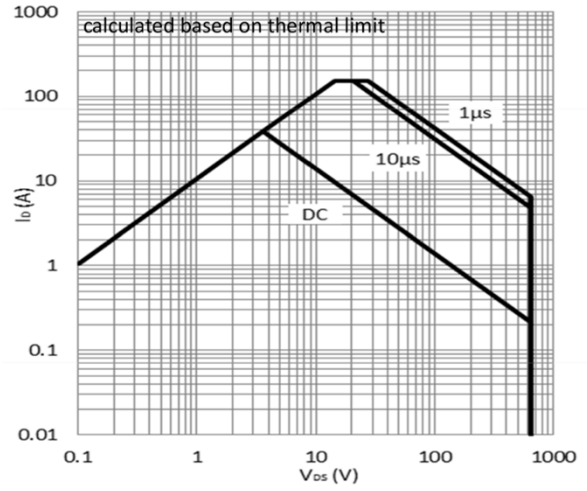


Figure 14. Safe Operating Area  $T_c=25^{\circ}\text{C}$

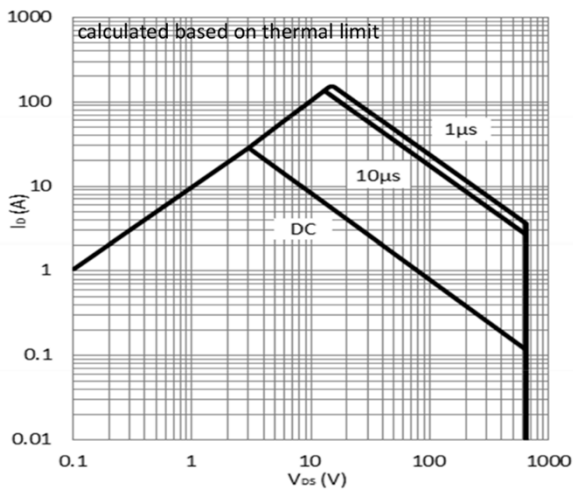


Figure 15. Safe Operating Area  $T_c=80^{\circ}\text{C}$

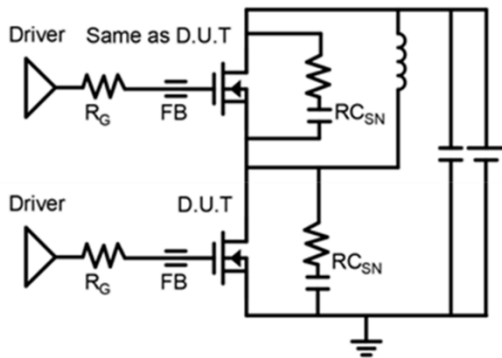


Figure 15. Switching Time Test Circuit

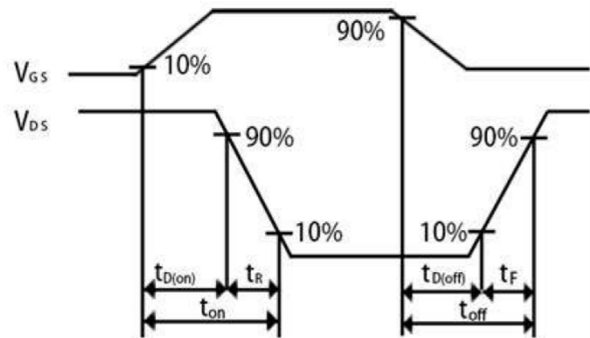


Figure 16. Switching Time Waveform

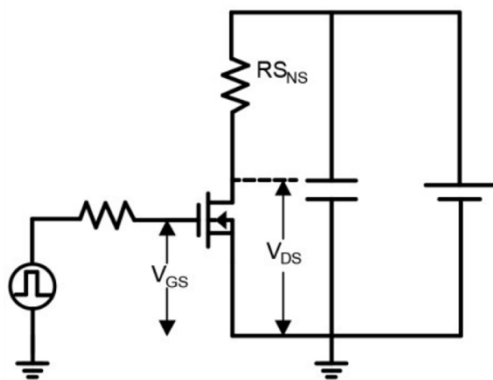


Figure 17. Dynamic  $R_{DS(on)}$  Test Circuit

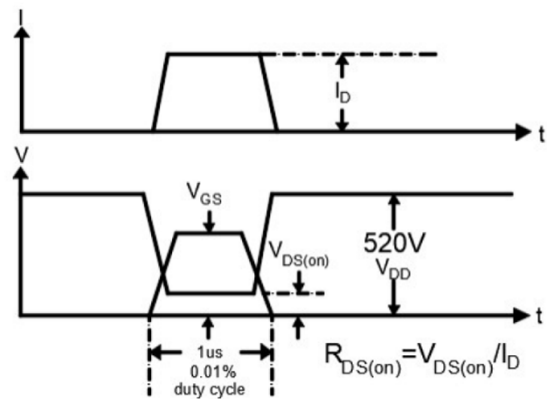


Figure 18. Dynamic  $R_{DS(on)}$  Waveform

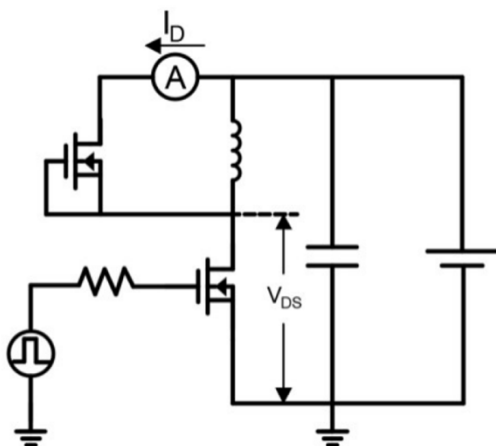


Figure 19. Diode Characteristic Test Circuits

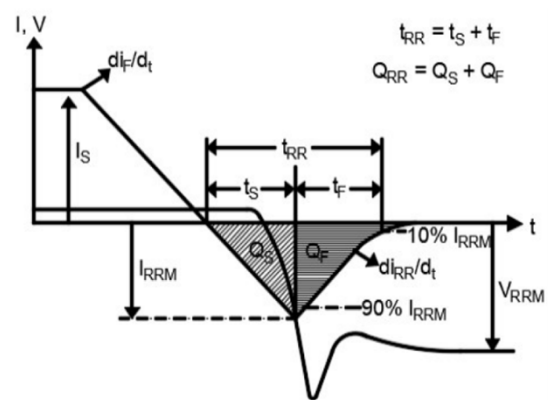
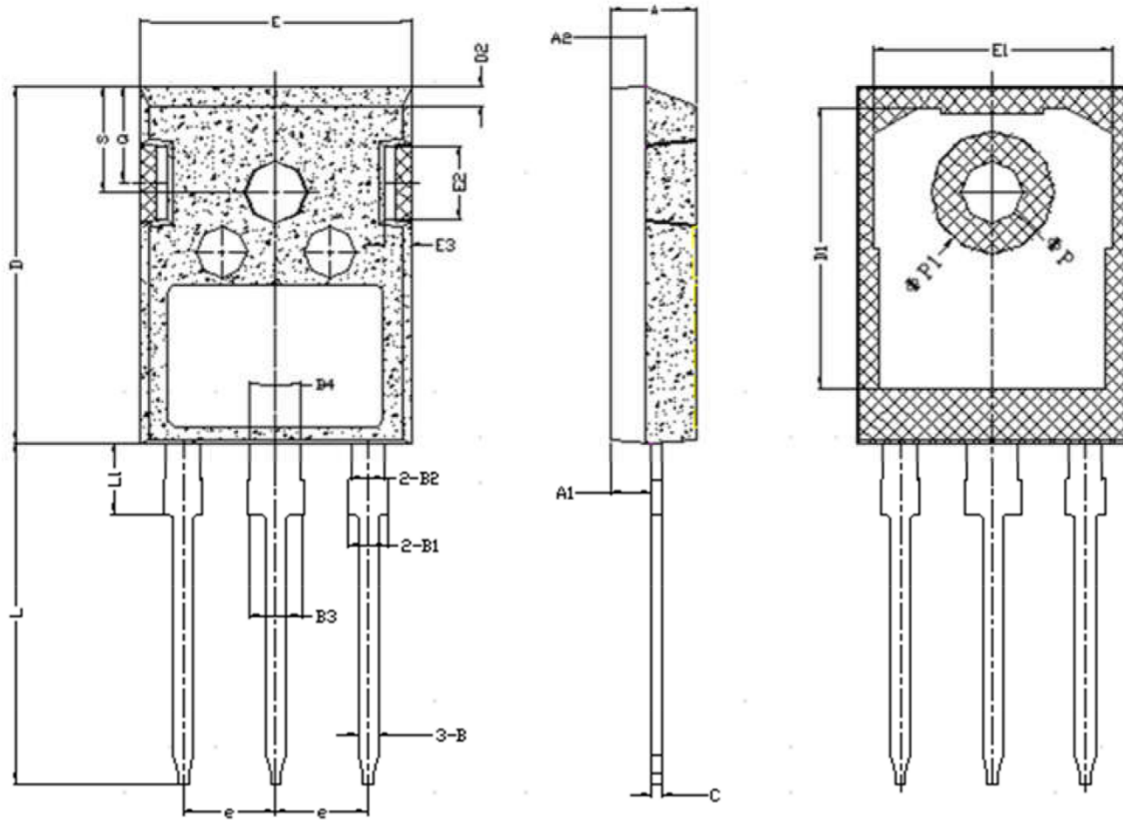



Figure 20. Diode Recovery Waveform

Product Dimension (TO-247-3L)



SYMBOL	Millimeter		
	Min	Nom	Max
A	4.60	4.90	5.20
A1	2.20	2.40	2.60
B	0.90	1.20	1.40
B1	1.75	2.05	2.35
B2	1.75	1.95	2.15
B3	2.80	3.00	3.35
B4	2.80	2.95	3.15
C	0.50	0.60	0.70
D	20.60	21.00	21.30
D1	16.00	17.00	18.00
E	15.50	15.80	16.10
E1	13.00	13.80	14.70
E2	3.80	4.50	5.30
E3	0.80	1.70	2.60
E	5.20	5.40	5.7
L	19.00	20.00	20.50
L1	3.90	4.30	4.60
ΦP	3.30	3.50	3.70
ΦP1	7.00	7.20	7.40
Q	5.20	5.60	6.00
S	5.80	6.20	6.60


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