Gallium Nitride E-Mode HEMT
GS700EWF460G1: 460mΩ, 700V

Description

This is a 700V GaN-on-Si enhancement-mode power transistor. The properties of GaN allow for high current, high breakdown voltage and high switching frequency.

Features

- Ultra-low FOM
- Ultra-high switching frequency
- Reverse current capability
- Zero reverse recovery loss
- Monolithic integrated ESD protection
- RoHS, Pb-free, REACH-compliant

Applications

- AC/DC converters
- DC/DC converters
- Bridgeless totem pole PFC
- Fast chargers
- Power adapters
- LED lighting drivers
- Wireless power transfer
- Laser drivers
- TV display

Table 1 Key Performance Parameters at T_j = 25 °C

Parameters	Values	Units
$V_{DS,\ max}$	700	V
$R_{DS(on),\ max}$	600	mΩ
Q_G	0.7	nC
$I_{D,\ Pulse}$	6	A
Q_{OSS} @ 400 V	6.8	nC

Table 2 Ordering Information

Ordering Code	MOQ
GS700EWF460G1	12pcs Wafers

Table of contents

1 Maximum ratings

at T_j = 25 °C unless otherwise specified. Continuous application of maximum ratings can deteriorate transistor lifetime.

Table 3 Maximum rating

Parameters	Symbols	Values	Units	Notes/Test Conditions
Drain-source voltage	$V_{DS, max}$	700	V	V_{GS} = 0 V Tj = -55℃ to 150℃
Drain-source voltage transient [1]	$V_{DS, transient}$	800	V	V_{GS} = 0 V
Continuous current, drain-source	I_D	3.3	A	T_c = 25 °C
Pulsed current, drain-source [2]	$I_{D, pulse}$	6	A	T_c = 25 °C; V_G = 6 V
Pulsed current, drain-source [2]	$I_{D, pulse}$	3.3	A	T_c = 125 °C; V_G = 6 V
Gate-source voltage, continuous	V_{GS}	-1.4 to +7	V	T_j = -55 °C to 150 °C
Gate-source voltage, pulsed	$V_{GS, pulse}$	-20 to +10	V	T_j = -55 °C to 150 °C; t_{Pulse} = 50 ns, f = 100 kHz; open drain
Power dissipation	P_{tot}	32	W	T_c = 25 °C
Operating temperature	T_j	-55 to +150	°C	
Storage temperature	T_{stg}	-55 to +150	°C	

1. $V_{DS, transient}$ is intended for surge rating during non-repetitive events, t_{Pulse} < 1 µs.
2. Pulse width = 10 µs.

2 Thermal characteristics

Table 4 Thermal characteristics

Parameters	Symbols	Values			Units	Notes/Test Conditions
		Min.	Typ.	Max.		
Thermal resistance, junction-ambient	R_{thJA}		80		°C/W	
Thermal resistance, junction-case	R_{thJC}	-	3.5	-	°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	1.6	2.5	V	I_D = 3.5 mA; V_{DS} = V_{GS}; T_j = 25 °C
		-	2.0	-		I_D = 3.5 mA; V_{DS} = V_{GS}; T_j = 150 °C
Drain-source leakage current	I_{DSS}	-	0.01	0.5	μA	V_{DS} = 700 V; V_{GS} = 0 V; T_j = 25 °C
		-	0.6	-		V_{DS} = 700 V; V_{GS} = 0 V; T_j = 150 °C
Gate-source leakage current	I_{GSS}	-	0.5		μA	V_{GS} = 6 V; V_{DS} = 0 V
Drain-source on-state resistance	$R_{DS(on)}$	-	460	600	mΩ	V_{GS} = 6 V; I_D = 1.4 A; T_j = 25 °C
		-	1100	-	mΩ	V_{GS} = 6 V; I_D = 1.4 A; T_j = 150 °C
Gate resistance	R_G	-	15	-	Ω	f = 5 MHz; open drain

Table 6 Dynamic characteristics

Parameters	Symbols	Values			Units	Notes/Test Conditions
		Min.	Typ.	Max.		
Input capacitance	C_{iss}	-	27	-	pF	V_{GS} = 0 V; V_{DS} = 400 V; f = 100KHz
Output capacitance	C_{oss}	-	9	-	pF	V_{GS} = 0 V; V_{DS} = 400 V; f = 100KHz
Reverse transfer capacitance	C_{rss}	-	0.1	-	pF	V_{GS} = 0 V; V_{DS} = 400 V; f = 100KHz
Effective output capacitance, energy related [1]	$C_{o(er)}$	-	12.7	-	pF	V_{GS} = 0 V; V_{DS} = 0 to 400 V
Effective output capacitance, time related [2]	$C_{o(tr)}$	-	18.3	-	pF	V_{GS} = 0 V; V_{DS} = 0 to 400 V
Output charge	Q_{OSS}	-	6.8	-	nC	V_{GS} = 0 V; V_{DS} = 0 to 400 V
Turn-on delay time	$t_{d(on)}$	-	1	-	ns	V_{DS} = 400 V; I_D = 2.8 A; L = 318 μH; V_{GS} = 6 V; R_{on} = 10 Ω; R_{off} = 2 Ω
Turn-off delay time	$t_{d(off)}$	-	10	-	ns	
Rise time	t_r	-	4	-	ns	
Fall time	t_f	-	10	-	ns	

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	-	0.7	-	nC	V_{GS} = 0 to 6 V; V_{DS} = 400 V; I_D = 1.4 A
Gate-source charge	Q_{GS}	-	0.2	-	nC	
Gate-drain charge	Q_{GD}	-	0.3	-	nC	
Gate plateau voltage	V_{plat}	-	2.5	-	V	V_{DS} = 400 V; I_D = 1.4 A

Table 8 Reverse conduction characteristics

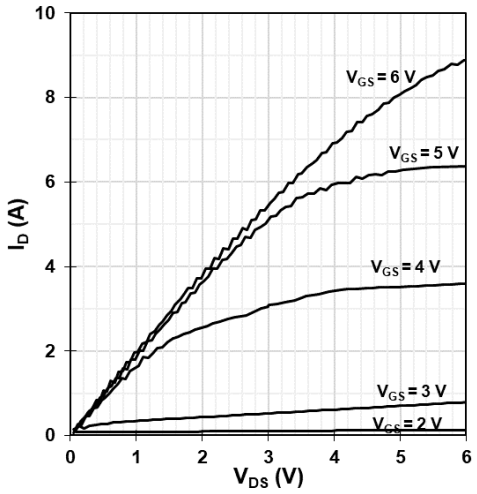
Parameters	Symbols	Values			Units	Notes/Test Conditions
		Min.	Typ.	Max.		
Source-drain reverse voltage	V_{SD}	-	4,4	-	V	V_{GS} = 0 V; I_{SD} = 1.4 A
Pulsed current, reverse	$I_{S,\ pulse}$	-	-	6	A	V_{GS} = 6 V
Reverse recovery charge [1]	Q_{rr}	-	0	-	nC	I_{SD} = 1.4 A; V_{DS} = 400 V
Reverse recovery time	t_{rr}	-	0	-	ns	
Peak reverse recovery current	I_{rrm}	-	0	-	A	

1. Excluding Q_{OSS}

4 Electrical Characteristics Diagram

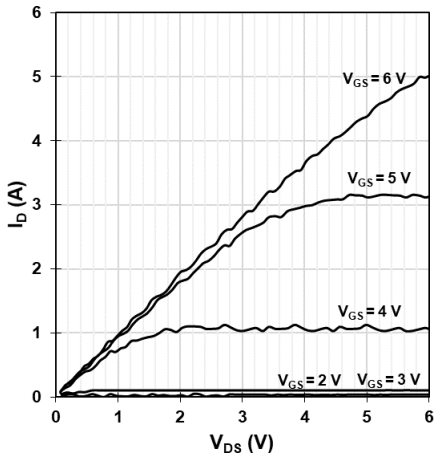
at T_j = 25 °C, unless specified otherwise.

Figure 1 Typ. output characteristics



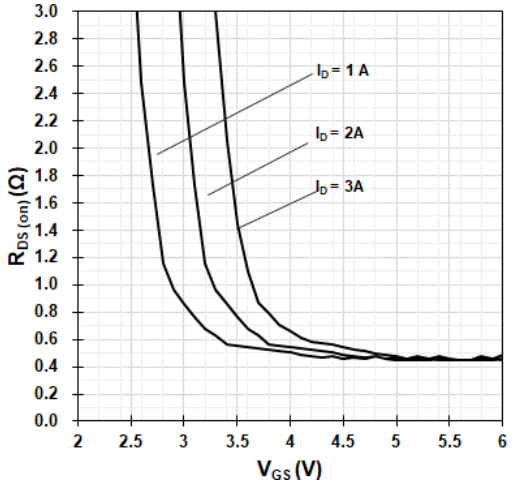
$I_D = f(V_{DS}, V_{GS})$; T_j = 25 °C

Figure 2 Typ. output characteristics



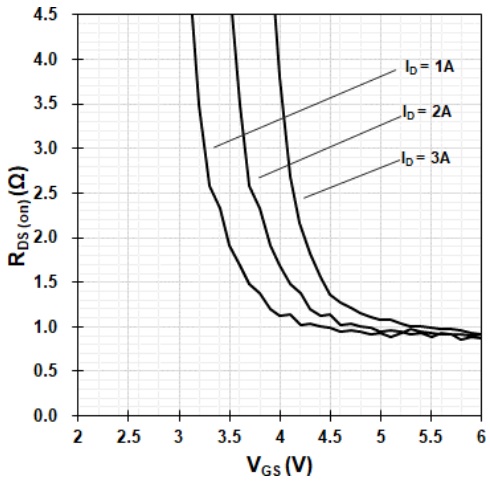
$I_D = f(V_{DS}, V_{GS})$; T_j = 125 °C

Figure 3 Typ. drain-source on-state resistance



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

Figure 4 Typ. drain-source on-state resistance



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

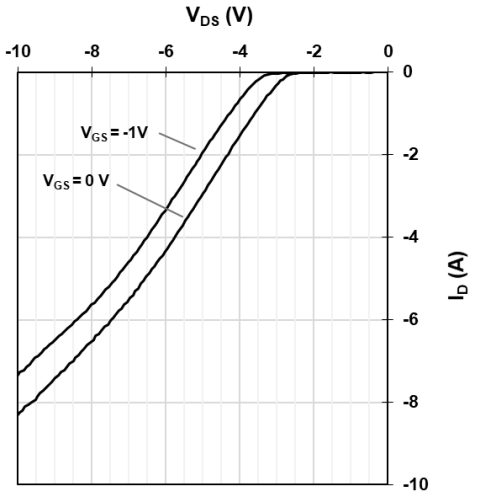
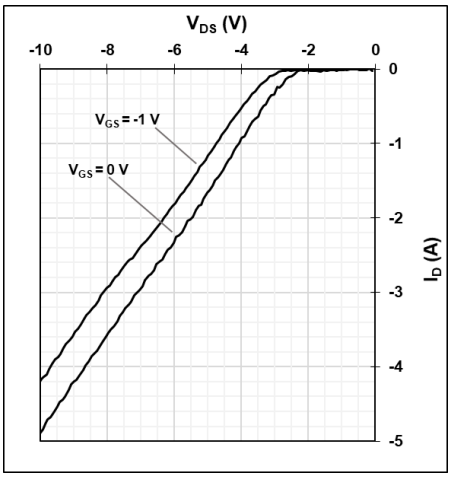
Figure 5 Typ. channel reverse characteristics	Figure 6 Typ. channel reverse characteristics
	
$I_D = f(V_{DS}, V_{GS})$; T_j = 25 ºC	$I_D = f(V_{DS}, V_{GS})$; T_j = 125 ºC

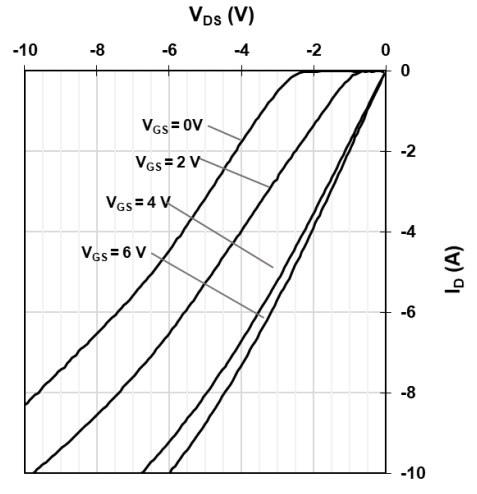
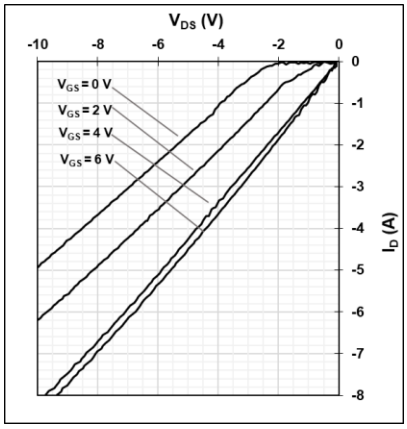
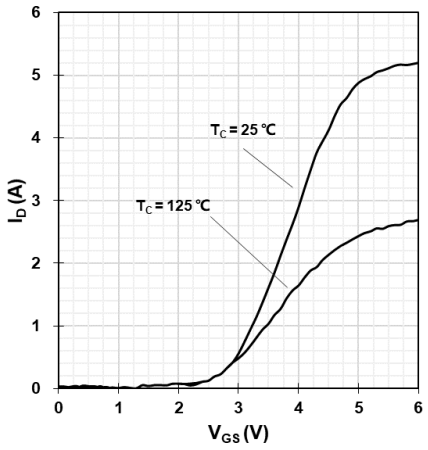
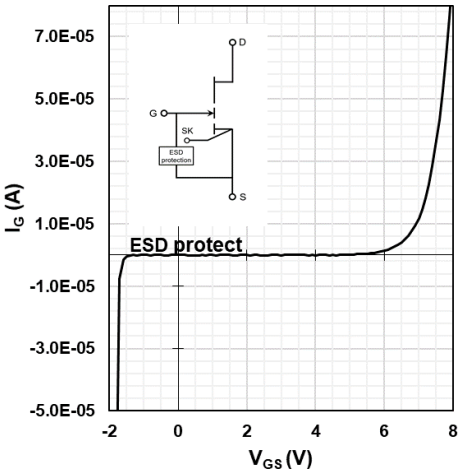
Figure 7 Typ. channel reverse characteristics	Figure 8 Typ. channel reverse characteristics
	
$I_D = f(V_{DS}, V_{GS})$; T_j = 25 ºC	$I_D = f(V_{DS}, V_{GS})$; T_j = 125 ºC

Figure 9 Typ. transfer characteristics



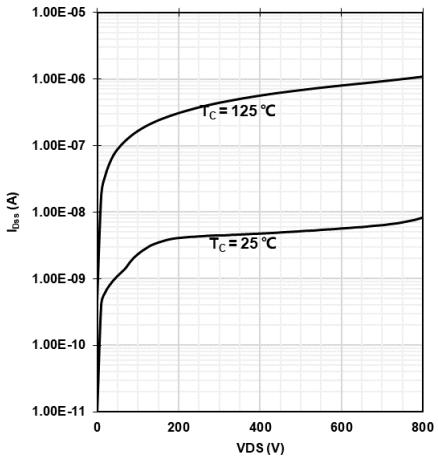
$I_D = f(V_{GS})$; V_{DS} = 3 V

Figure 10 Typ. gate-to-source leakage



$I_G = f(V_{GS})$; V_D = open

Figure 11 Drain-source leakage characteristics



Idss = f(Vds); Vgs = 0V

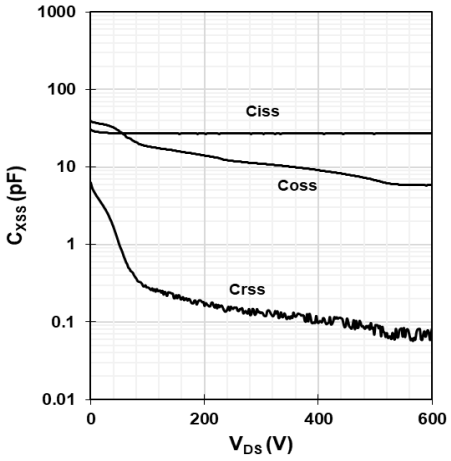
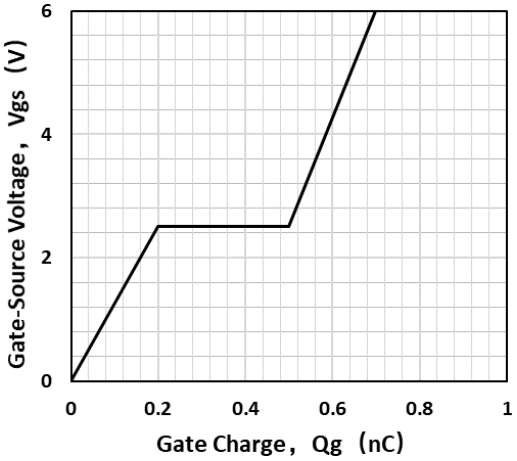
Figure 12 Typ. capacitances	Figure 13 Typ. gate charge
	
C_{XSS} = f(V_{DS}); Freq. = 100kHz	V_{GS} = f(Q_G); V_{DS} = 400 V; I_D = 1.4 A

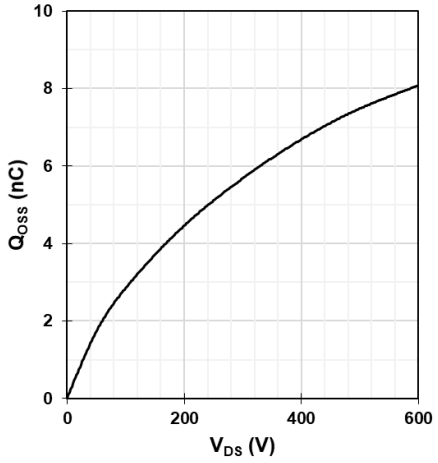
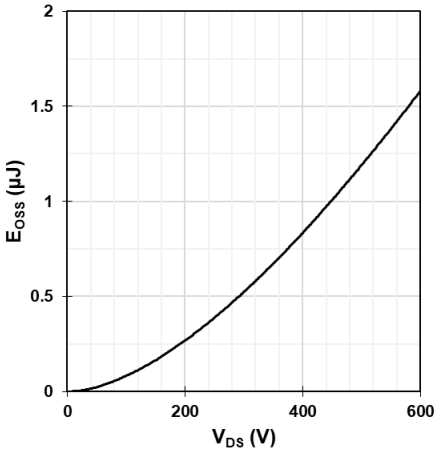
Figure 14 Typ. output charge	Figure 15 Typ. C_{oss} stored energy
	
Q_{OSS} = f(V_{DS}); Freq. = 100khz	E_{OSS} = f(V_{DS}); Freq. = 100khz

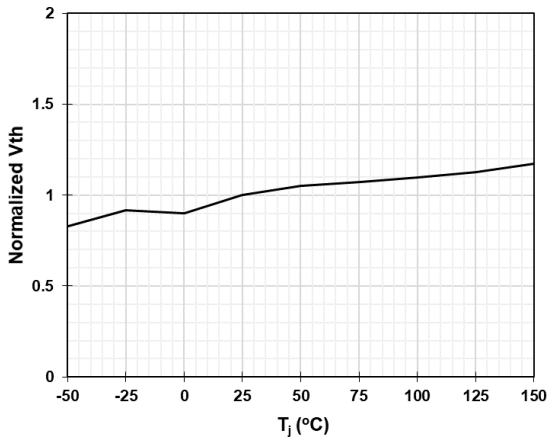
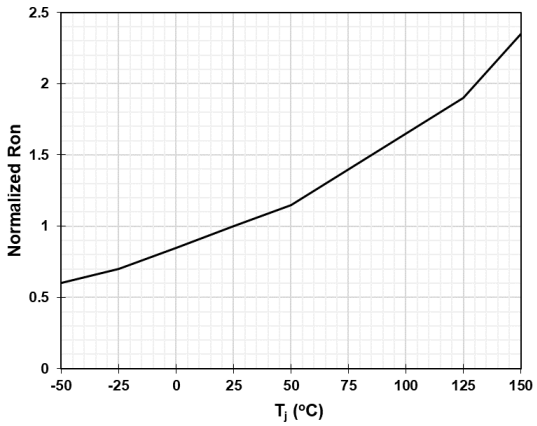
Figure 16 Gate threshold voltage	Figure 17 Drain-source on-state resistance
	
$V_{GS(TH)} = f(T_j)$; $V_{GS} = V_{DS}$; I_D = 16 mA	$R_{DS(on)} = f(T_j)$; I_D = 5 A; V_{GS} = 6 V

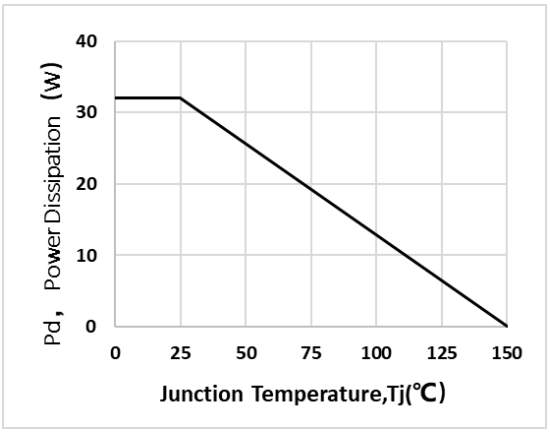
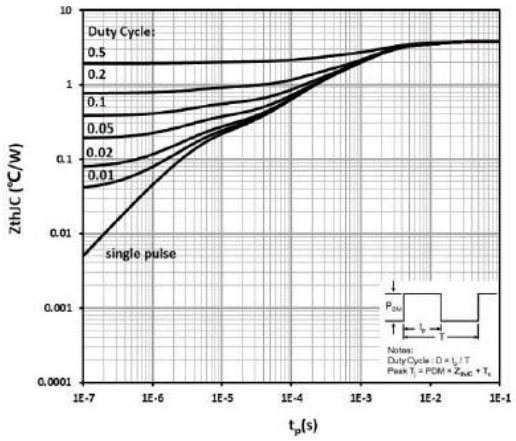
Figure 18 Power dissipation	Figure 19 Max.transient thermal impedance
	
Ptot = f(Tc)	Zthjc = f(tp,D)

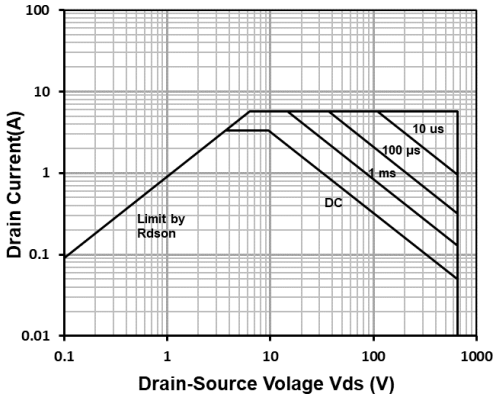
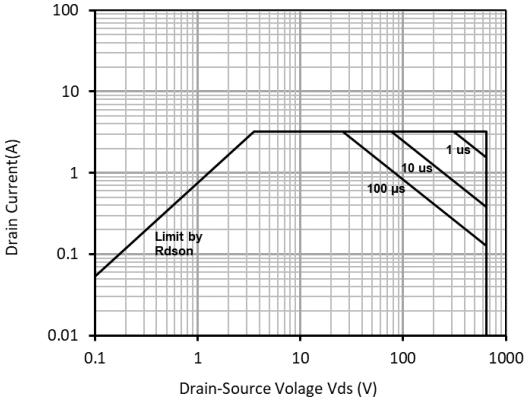
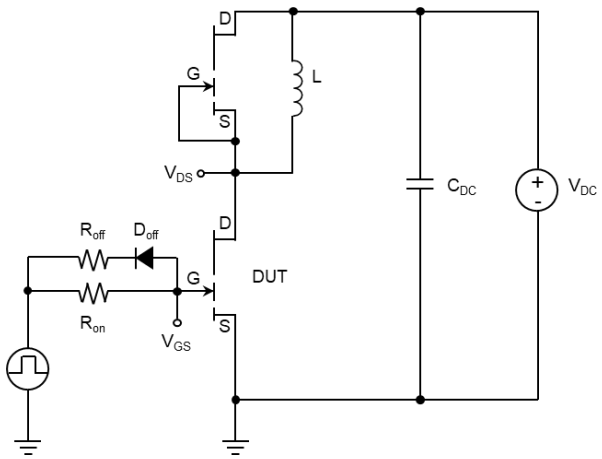
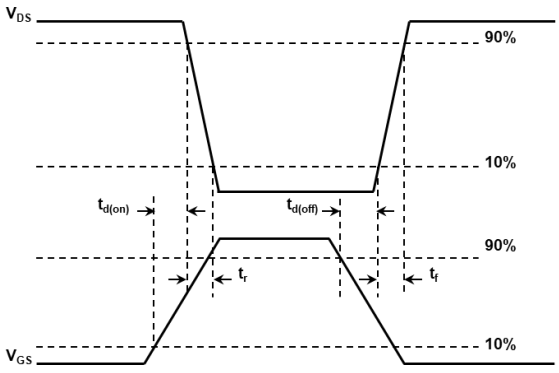
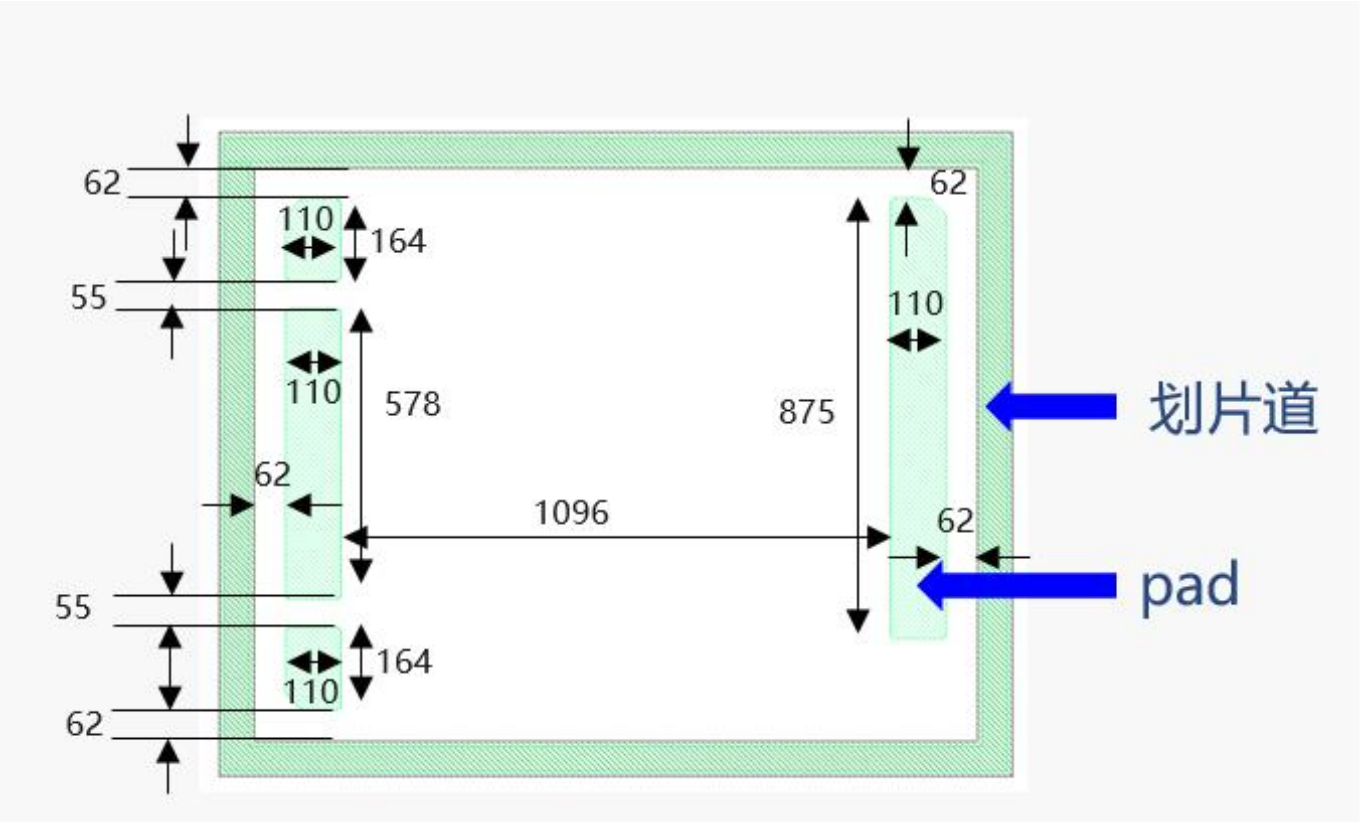
Figure 20 Safe Operation Area	Figure 21 Safe Operation Area
	
Id = f(Vds); Tc = 25℃	Id = f(Vds); Tc = 125℃

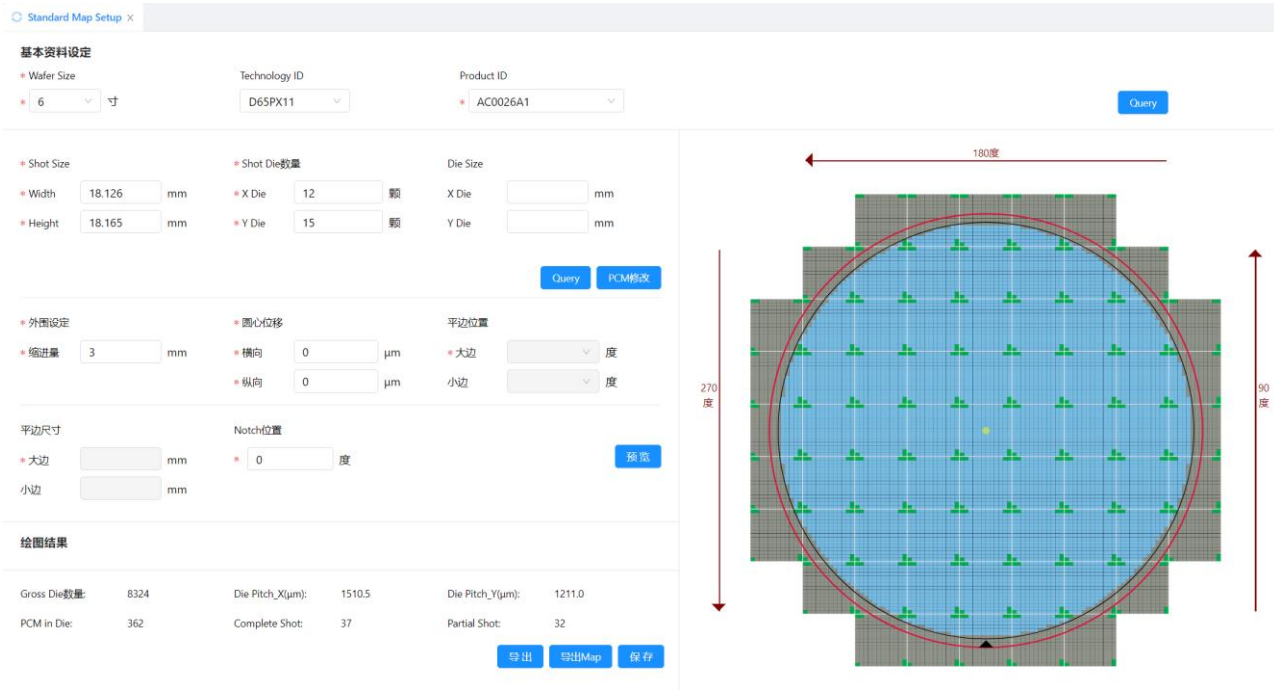
Figure 22 Switching time test circuit	Figure 23 Typ. switching time waveforms
	
V_{DS} = 400 V, I_D = 6 A, L = 318 µH, V_{GS} = 6 V, R_{on} = 10 Ω, R_{off} = 2 Ω	

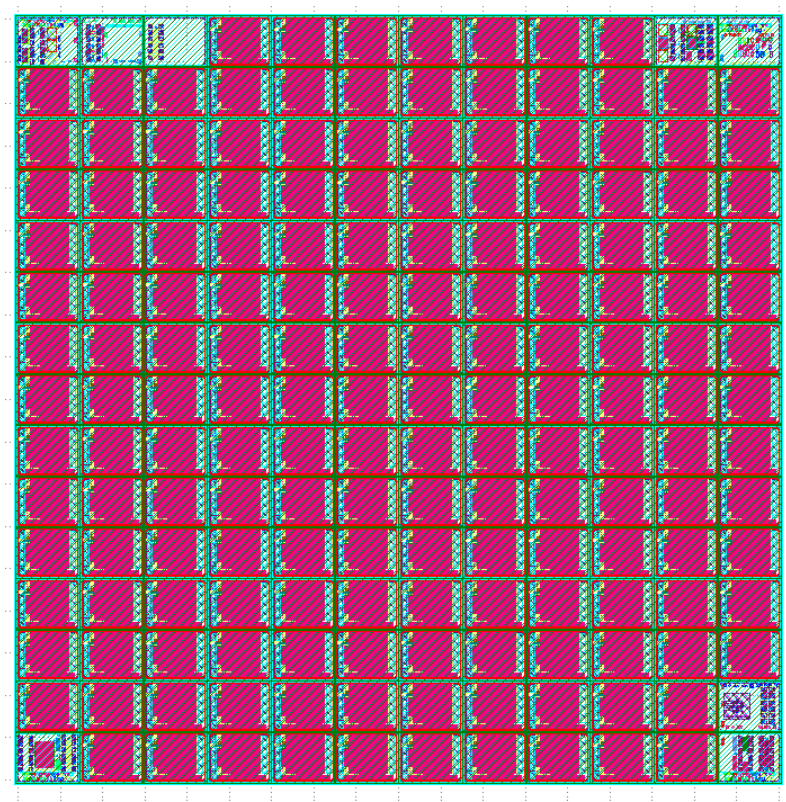
5 Die Information



Physical Characteristics		Unit
Wafer Size	6	Inches
Wafer Thickness	1150	μm
Die Size（with S/L）	1.510×1.211	mm^2
Scribe Street width	70	μm
Top Metal Materials	Al-Si	
Top Metal Thickness	4	μm
Passivation Materials	SiN, SiO2	
Passivation Thickness	2.1	μm
PI Materials	Polyimide	
PI Thickness	8	μm
Gate Pad Size	164×110	$μm^2$
Source Pad Size	578×110	$μm^2$
Drain Pad Size	875×110	$μm^2$
Backside	Si	

6 Wafer Information





7 Revision history

Major changes since the last revision

Revision	Date	Description of changes
1.0	2025-01-23	1.0 version release
2.0	2025-04-28	Implemented the Wafer Information
3.0	2025-05-23	Implemented the Electrical Characteristic Diagram