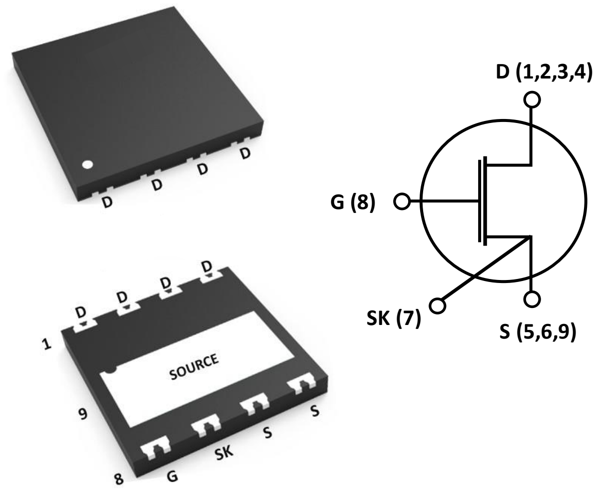
6506ED1

650 V E-mode GaN Transistor

Features

- 650 V enhancement mode GaN power transistor
- Advanced GaN-on-QST technology
- DFN 8x8 package
- Typical $R_{DS(on)}$ = 60 mΩ
- $I_{DS\ max,DC}$ = 20 A
- Simple gate drive 0 V to 6 V and large $V_{GS(th)}$
- High switching frequency (> 1 MHz)
- Reverse conduction capability
- Zero reverse recovery loss
- Kelvin Source for optimized gate drive



Applications

- DC-DC converters
- AC-DC converters
- Fast Battery Charging
- Industrial Motor Drives
- Power Factor Correctors
- Industrial Power Supplies

Description

The 6506ED1 is an enhancement mode GaN transistor designed for large power density and high switching frequency. Its large threshold voltage and the presence of a kelvin source connection enable fast and safe gate driving. These features enable high efficiency and reliable power switching.

Pin Description

Pin No.	Pin Name	Description
1,2,3,4	D	Drain
5,6,9	S	Source
7	SK	Kelvin Source
8	G	Gate

Absolute Maximum Ratings

T_J = 25 °C except as noted. Exceeding the maximum ratings may damage the device.

Parameter	Symbol	Value	Unit
Drain-to-Source Voltage	V_{DS}	650	V
Drain-to-Source Voltage – transient (Note 1)	V_{DS} (transient)	750	V
Gate-to-Source Voltage	V_{GS}	-10 to +7	V
Gate-to-Source Voltage – transient (Note 1)	V_{GS} (transient)	-20 to 10	V
Continuous Drain Current (T_{case} = 25 °C)	I_{DS}	20	A
Pulsed Drain Current (T_{case} = 25 °C) (Pulse width 10us, V_{GS} = 6 V) (Note 2)	$I_{DS, Pulse}$	45	A
Pulsed Drain Current (T_{case} = 150 °C) (Pulse width 10us, V_{GS} = 6 V) (Note 2)	$I_{DS, Pulse}$	20	A
Max Power Dissipation at T_{case} = 25 °C	P_{tot}	204	W
Operating Junction Temperature	T_J	-55 to +150	°C
Storage Temperature Range	T_S	-55 to +150	°C

Note 1: for pulses ≤ 100us

Note 2: Defined by product design and characterization. Value is not tested to full current in production.

Thermal Characteristics

Parameter	Symbol	Value	Unit
Thermal Resistance Junction-to-Case – (bottom side)	$R_{TH,J-C}$	0.61	°C/W
Thermal Resistance Junction-to-Ambient (Note 3)	$R_{TH,J-A}$	32.9	°C/W

Note 3: Based on a 4-layer, 1.6 mm-thick PCB. The copper thickness of the external layer is 2 oz. while the buried layers are 1 oz. thick. PCB in a horizontal position without air stream cooling.

Electrical Characteristics

Static Characteristics

Parameters	Symbol	Min	Typ	Max	Unit	Condition
Drain-to-Source On Resistance	$R_{DS(on)}$	-	60	90	mΩ	I_{DS} = 8 A, V_{GS} = 6 V, T_J = 25 °C
		-	134	-	mΩ	I_{DS} = 8 A, V_{GS} = 6 V, T_J = 150 °C
Gate-to-Source Threshold Voltage	$V_{GS(th)}$	1.1	1.7	2.6	V	I_{DS} = 2.4 mA, T_J = 25 °C
		-	1.53	-	V	I_{DS} = 2.4 mA, T_J = 150 °C
Gate-to-Source Current	I_{GS}	-	300	-	µA	V_{GS} = 6 V, T_J = 25 °C
Drain-to-Source Leakage Current	I_{DSS}	-	65	-	µA	V_{DS} = 650 V, T_J = 25 °C
		-	90	-	µA	V_{DS} = 650 V, T_J = 150 °C
Internal Gate Resistance	R_G	-	1.32	-	Ω	f = 5 MHz, open drain

Dynamic Characteristics

Input Capacitance	C_{ISS}	-	295	-	pF	V_{DS} = 400 V, V_{GS} = 0 V, f = 100 kHz
Output Capacitance	C_{OSS}	-	70	-	pF	
Reverse Transfer Capacitance	C_{RSS}	-	0.4	-	pF	
Effective Output Capacitance, Energy-Related (Note 4)	$C_{O(ER)}$	-	100	-	pF	V_{DS} = 0 V to 400 V, V_{GS} = 0 V
Effective Output Capacitance, Time-Related (Note 5)	$C_{O(TR)}$	-	137	-	pF	
Output Charge	Q_{OSS}	-	55.8	-	nC	V_{DS} = 0 V to 400 V
Turn-On Delay	$t_{D(on)}$	-	4	-	ns	V_{DD} = 400 V, V_{GS} = 0 to 6 V, I_{DS} = 16 A, $R_{G(on)}$ = 10 Ω, $R_{G(off)}$ = 2.2 Ω, L = 100 µH (see Figure 14,15)
Rise Time	t_R	-	7	-	ns	
Turn-Off Delay	$t_{D(off)}$	-	4	-	ns	
Fall Time	t_F	-	7	-	ns	
Switching Energy During Turn-on	E_{on}	-	33	-	µJ	

Switching Energy During Turn-off	E_{off}	-	12	-	µJ	
Output Capacitance Stored Energy	E_{OSS}	-	8	-	µJ	V_{DS} = 0 V to 400 V

Note 4: $C_{O(ER)}$ is a fixed capacitance that would give the same stored energy as C_{OSS} while V_{DS} is rising from 0 V to the stated V_{DS}.

Note 5: $C_{O(TR)}$ is a fixed capacitance that would give the same charging time as C_{OSS} while V_{DS} is rising from 0 V to the stated V_{DS}.

Gate Charge Characteristics

Total Gate Charge	Q_G	-	9.8	-	nC	V_{GS} = 0 to 6 V, V_{DS} = 0 to 400 V, I_{DS} = 8 A
Gate-to-Source Charge	Q_{GS}	-	1.1	-	nC	
Gate-to-Drain Charge	Q_{GD}	-	6.7	-	nC	
Gate Plateau Voltage	V_{Plat}	-	1.93	-	V	V_{DS} = 400 V, I_{DS} = 10 A

Reverse Conduction Characteristics

Source-Drain Reverse Voltage	V_{SD}	-	2.5	-	V	V_{GS} = 0 V, I_{SD} = 4 A
Reverse Recovery Charge	Q_{rr}	-	0	-	nC	
Reverse Recovery Time	t_{rr}	-	0	-	ns	

Electrical Performance Graphs

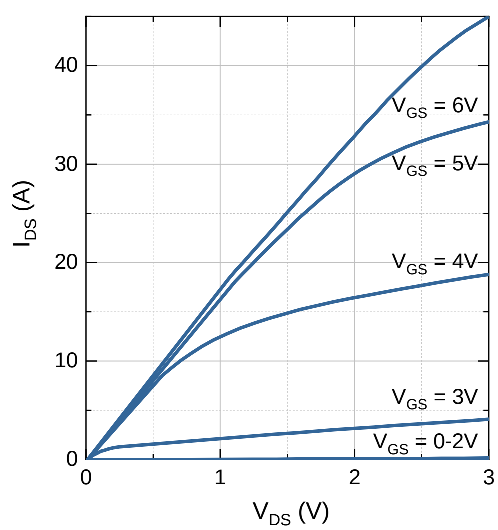


Figure 1: Typical pulsed I_{DS} vs. V_{DS} at T_J = 25 °C

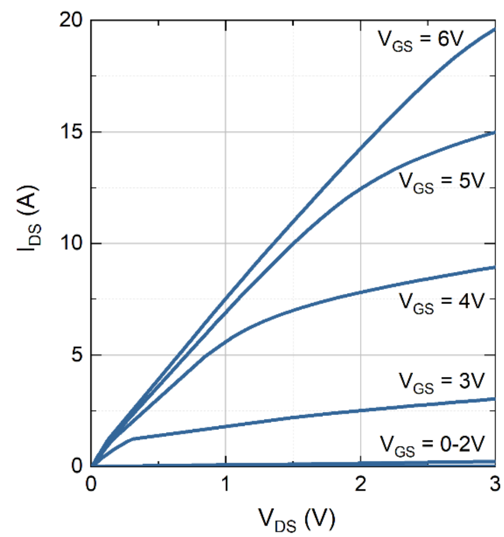


Figure 2: Typical pulsed I_{DS} vs. V_{DS} at T_J = 150 °C

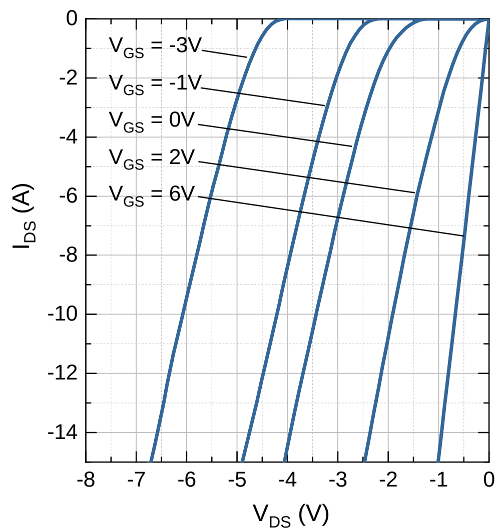


Figure 3: Typical Reverse Conduction Characteristics at T_J = 25 °C

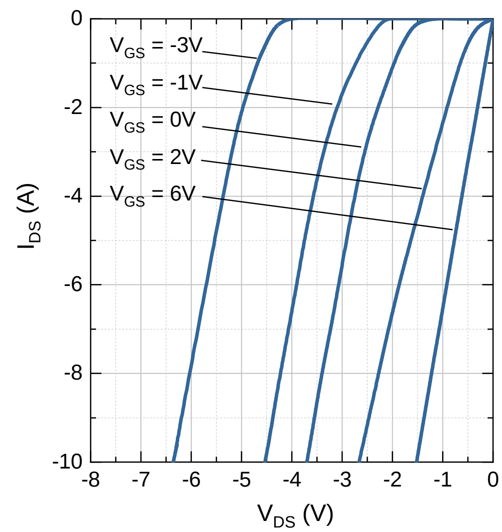


Figure 4: Typical Reverse Conduction Characteristics at T_J = 150 °C

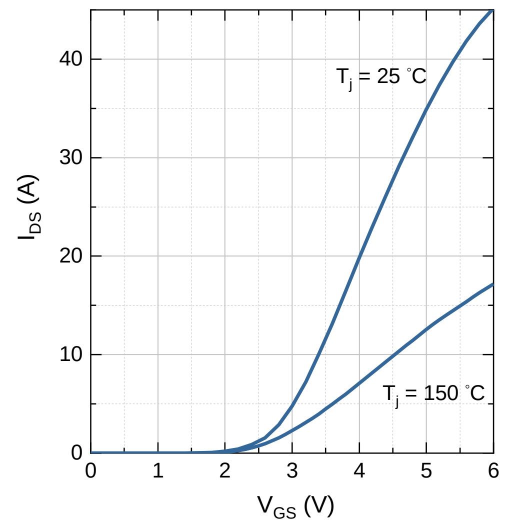


Figure 5: Typical I_{DS} vs. V_{GS} at T_J = 25 °C and T_J = 150 °C for V_{DS} = 3 V

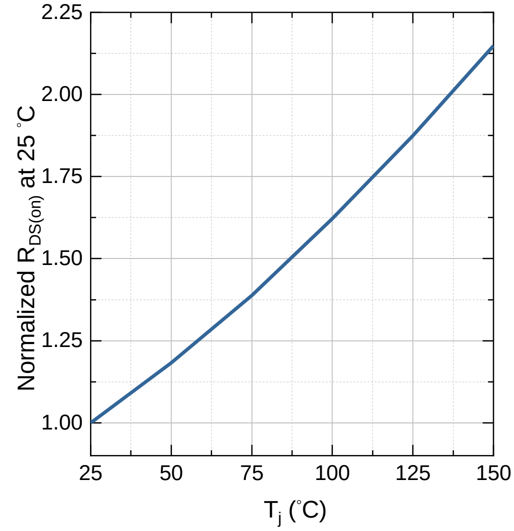


Figure 6: Normalized $R_{DS(on)}$ as a function of T_J

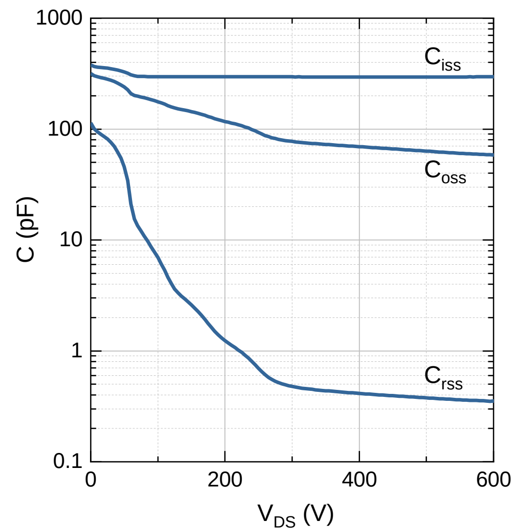


Figure 7: Typical C_{iss}, C_{oss}, C_{rss} vs. V_{DS}

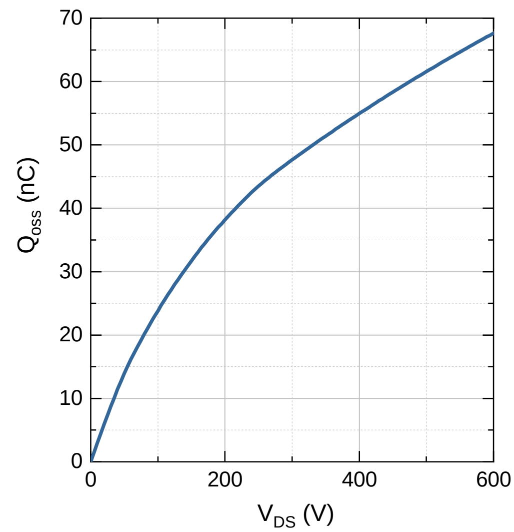


Figure 8: Typical charge stored in C_{oss}

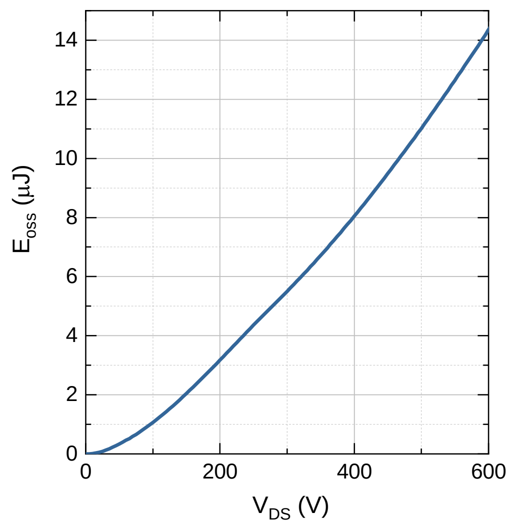


Figure 9: Typical energy stored in C_{oss}

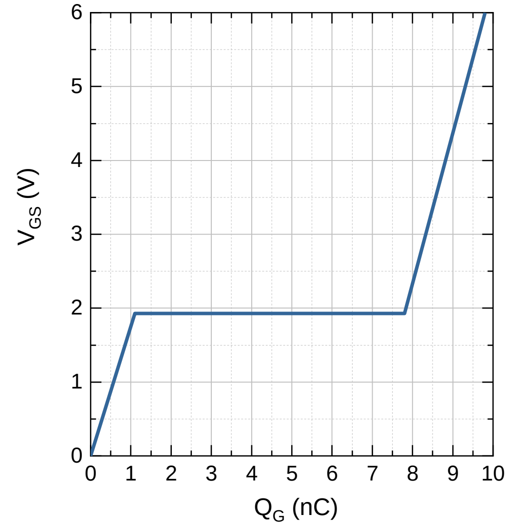


Figure 10: Typical V_{GS} vs. Q_G at V_{DS} = 400 V

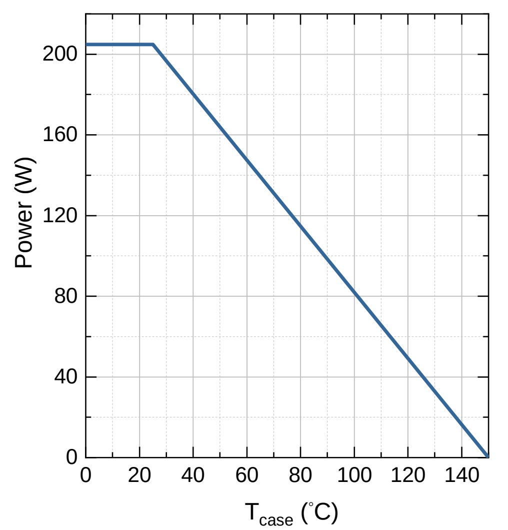


Figure 11: Power Derating vs. T_{case}

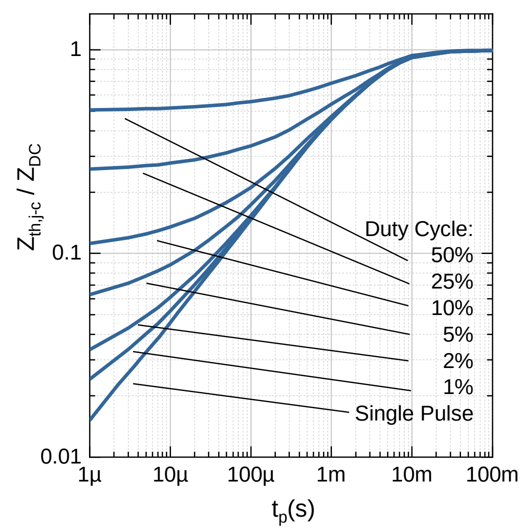


Figure 12: Normalized Transient Thermal Impedance

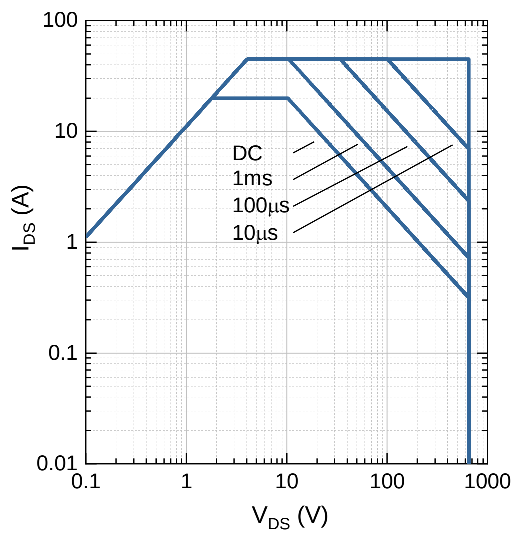


Figure 13: Safe Operating Area at T_{case} = 25 °C

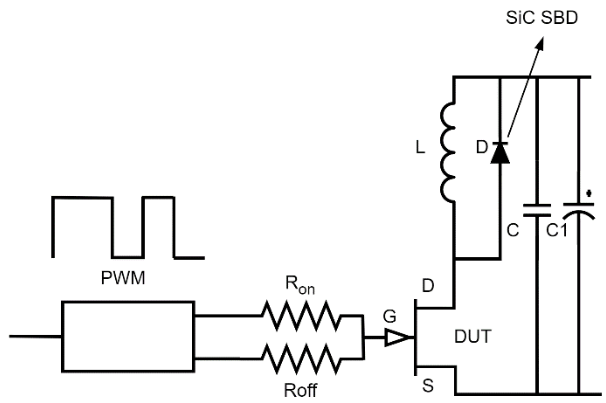


Figure 14: DPT circuit used for switching times measurement, V_{DS} = 400 V, I_{DS} = 16 A, L = 100 µH, V_{GS} = 6 V, R_{on} = 10 Ω, R_{off} = 2.2 Ω

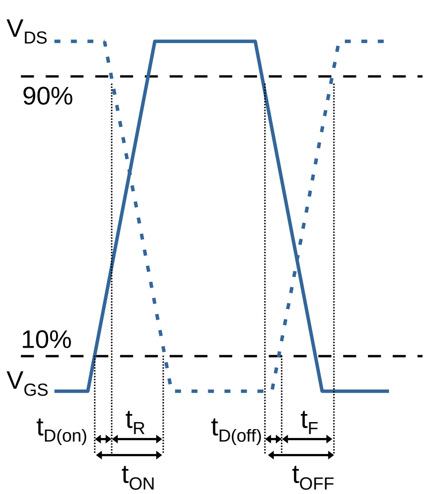
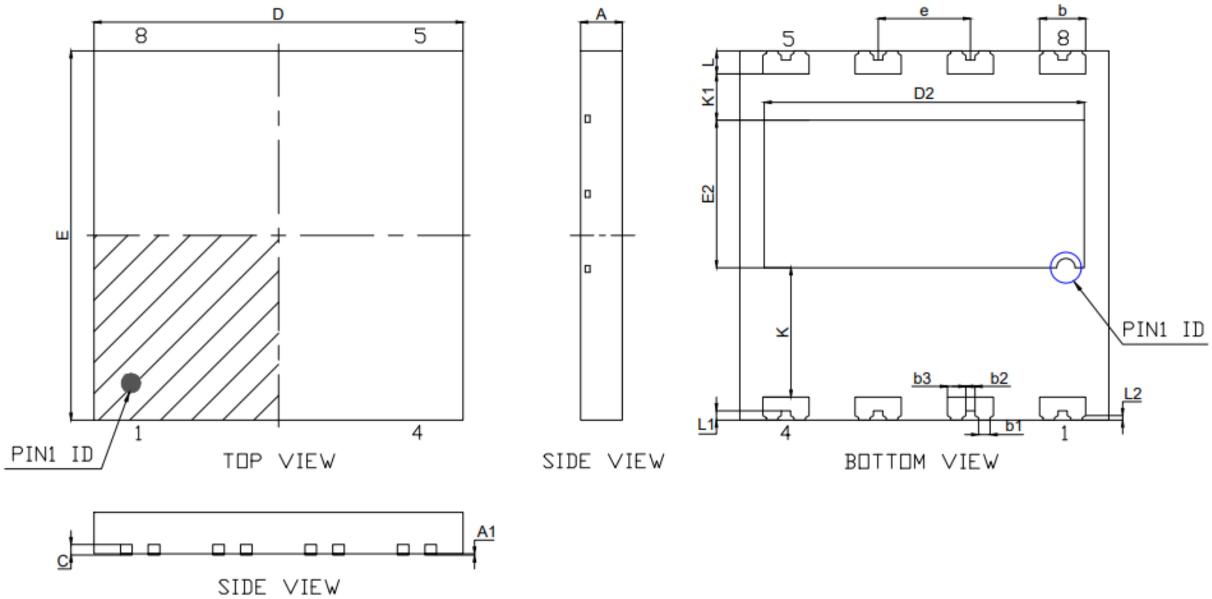


Figure 15: Switching waveform used to determine the switching times values

Package Information



SYMBLE	MILLIMETER			SYMBLE	MILLIMETER		
	MIN	NOM	MAX		MIN	NOM	MAX
A	0.80	0.90	1.00	e	2.00BSC		
A1	0	0.02	0.05	E	7.90	8.00	8.10
b	0.95	1.00	1.05	E2	3.10	3.20	3.30
b1	0.25REF			L	0.40	0.50	0.60
b2	0.20REF			L1	0.20REF		
b3	0.35	0.40	0.45	L2	0.10REF		
c	0.203REF			K	2.80REF		
D	7.90	8.00	8.10	K1	1.00REF		
D2	6.84	6.94	7.04				

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