GaNFast™ Power FET

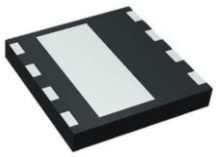
1. Features

GaNFast™ Power FET

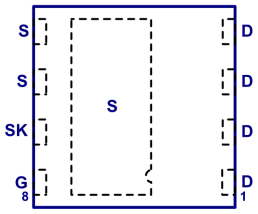
- eMode GaN power FET
- Low 120 mΩ resistance
- 10 MHz switching frequency capability
- Ultra-low gate charge
- Zero reverse recovery charge
- Low output charge
- 800 V Transient Voltage Rating
- 650 V Continuous Voltage Rating
- Source Kelvin (SK) pin for gate noise immunity
- Small, low-profile SMT DFN
- 8x8 mm PCB footprint
- Minimized package inductance
- Low thermal resistance
- Bottom-side cooled

Environmental

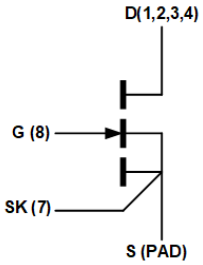
- RoHS, Pb-free, REACH-compliant



PDFN 8x8 mm



Package Outline (Top View)



Simplified Schematic

2. Topologies / Applications

- AC-DC, DC-DC, DC-AC
- QR flyback, ACF, buck, boost, half bridge, full-bridge, LLC resonant, Class D, PFC
- Wireless power
- LED lighting
- Solar Micro-inverters
- TV SMPS
- Server, Telecom

3. Description

This GaNFast™ power FET is a high performance eMode GaN FET that achieves excellent high-frequency and high efficiency operation. Features include a simple gate input and a Source Kelvin pin for noise immunity.

This GaN power FET combines the highest dV/dt immunity and industry-standard low-profile, low-inductance, bottom-side cooled SMT QFN packaging to enable designers to achieve simple, quick and reliable solutions.

Navitas' GaN technology extends the capabilities of traditional topologies such as flyback, half-bridge, buck/boost, LLC and other resonant converters to reach MHz+ frequencies with very high efficiencies and low EMI to achieve unprecedented power densities at a very attractive cost structure.

4. Table of Contents

5. Specifications

5.1. Absolute Maximum Ratings(1)

(with respect to Source (pad) unless noted)

SYMBOL	PARAMETER	MAX	UNITS
$V_{DS(TRAN)}$	Transient Drain-to-Source Voltage(2)	800	V
$V_{DS(CONT)}$	Continuous Drain-to-Source Voltage	-7 to +650	V
V_{GS}	Continuous Gate-to-Source Voltage	-10 to +7	V
V_{TGS}	Transient Gate-to-Source Voltage(3)	-20 to +10	V
I_D	Continuous Drain Current (@ T_C = 25ºC)	14	A
I_D	Continuous Drain Current (@ T_C = 100ºC)	9	A
I_D PULSE	Pulsed Drain Current (10 µs @ T_J = 25°C)	24	A
P_D	Power Dissipation (@ T_C = 25ºC)	73	W
dV/dt	Slew Rate on Drain-to-Source	200	V/ns
T_J	Operating Junction Temperature	-55 to 150	ºC
T_{STOR}	Storage Temperature	-55 to 150	ºC

(1) Absolute maximum ratings are stress ratings; devices subjected to stresses beyond these ratings may cause permanent damage.

(2) $V_{DS\ (TRAN)}$ rating allows for surge ratings during non-repetitive events that are < 100us (for example start-up, line interruption). $V_{DS\ (TRAN)}$ rating allows for repetitive events that are < 100ns, with 80% derating required (for example repetitive leakage inductance spikes). Refer to Section 7 for detailed recommended design guidelines.

(3) < 1 µs

5.2. Thermal Resistance

SYMBOL	PARAMETER	TYP	UNITS
$R_{\theta JC}$ (4)	Junction-to-Case	1.7	ºC/W
$R_{\theta JA}$ (4)	Junction-to-Ambient	54	ºC/W

(4) R_θ measured on DUT mounted on 1 square inch 2 oz Cu (FR4 PCB)

5.3. Electrical Characteristics

Typical conditions: V_{DS} = 400 V, F_{SW} = 1 MHz, T_{AMB} = 25 ºC, I_D = 6 A (or specified)

SYMBOL	PARAMETER	MIN	TYP	MAX	UNITS	CONDITIONS
GaN FET Characteristics						
I_{DSS}	Drain-Source Leakage Current		0.3	25	µA	V_{DS} = 650 V, V_{GS} = 0 V
I_{DSS}	Drain-Source Leakage Current		25		µA	V_{DS} = 650 V, V_{GS} = 0 V, T_C = 150 ºC
I_{GSS}	Gate-Source Leakage Current		75		µA	
$R_{DS(ON)}$	Drain-Source Resistance		120	170	mΩ	V_{GS} = 7 V, I_D = 6. A
$V_{GS(th)}$	Gate Threshold Voltage	1	1.7	2.8	V	I_D = 12 mA, V_{DS} = 0.1 V
V_{SD}	Source-Drain Reverse Voltage		3.2	5	V	V_{GS} = 0 V, I_{SD} = 6 A
T_{ON}	Turn-On Delay Time		4		ns	V_{DS} = 400 V, V_{GS} = 5.2 V, I_D = 6 A, R_G = 10 Ω
T_{OFF}	Turn-Off Delay Time		6		ns	V_{DS} = 400 V, V_{GS} = 5.2 V, I_D = 6 A, R_G = 10 Ω
T_R	Turn-Off Rise Time		10		ns	V_{DS} = 400 V, V_{GS} = 5.2 V, I_D = 6 A, R_G = 10 Ω
T_F	Turn-On Fall Time		5		ns	V_{DS} = 400 V, V_{GS} = 5.2 V, I_D = 6 A, R_G = 10 Ω
Q_{RR}	Reverse Recovery Charge		0		nC	
R_G	Internal Gate Resistance		1.8		Ω	
C_{ISS}	Input Capacitance		75		pF	V_{DS} = 400 V, V_{GS} = 0 V
C_{OSS}	Output Capacitance		28		pF	V_{DS} = 400 V, V_{GS} = 0 V
C_{RSS}	Reverse Transfer Capacitance		0.33		pF	V_{DS} = 400 V, V_{GS}= 0 V
Q_G	Total Gate Charge		3.3		nC	V_{GS} = 0-6 V, I_D = 11.3 A, V_{DS} = 400 V
Q_{GD}	Gate-to-Drain Charge		0.72		nC	V_{GS} = 0-6 V, I_D = 11.3 A, V_{DS} = 400 V
Q_{GS}	Gate-to-Source Charge		0.64		nC	V_{GS} = 0-6 V, I_D = 11.3 A, V_{DS} = 400 V
Q_{OSS}	Output Charge		26		nC	V_{GS} = 0 V, V_{DS} = 400 V
$C_{O(er)}$ (5)	Effective Output Capacitance, Energy Related		43		pF	V_{DS} = 400 V, V_{GS}= 0 V
$C_{O(tr)}$ (6)	Effective Output Capacitance, Time Related		64		pF	V_{DS} = 400 V, V_{GS}= 0 V

(5) $C_{O(er)}$ is a fixed capacitance that gives the same stored energy as C_{OSS} while V_{DS} is rising from 0 to 400 V

(6) $C_{O(tr)}$ is a fixed capacitance that gives the same charging time as C_{OSS} while V_{DS} is rising from 0 to 400 V

5.4. Characteristic Graphs

(GaN FET, T_C = 25 ºC unless otherwise specified)

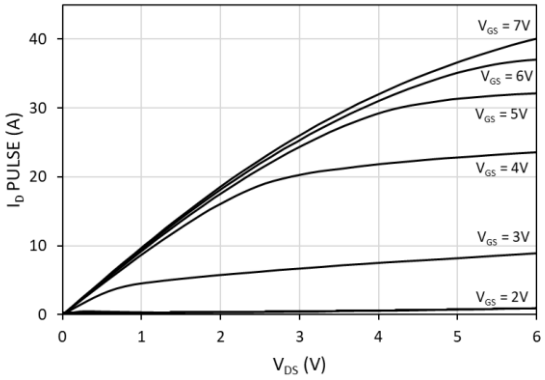


Fig. 1 Pulsed drain current (I_D PULSE) vs. drain-to-source voltage (V_{DS}) at T = 25 °C

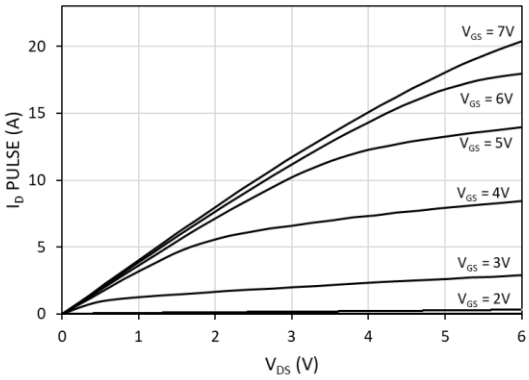


Fig. 2 Pulsed drain current (I_D PULSE) vs. drain-to-source voltage (V_{DS}) at T = 150 °C

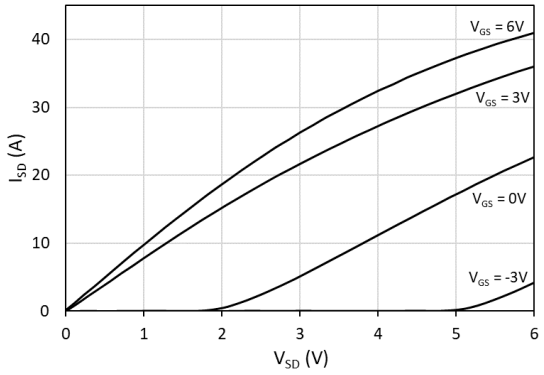


Fig. 3 Source-to-drain reverse conduction voltage at T = 25 °C

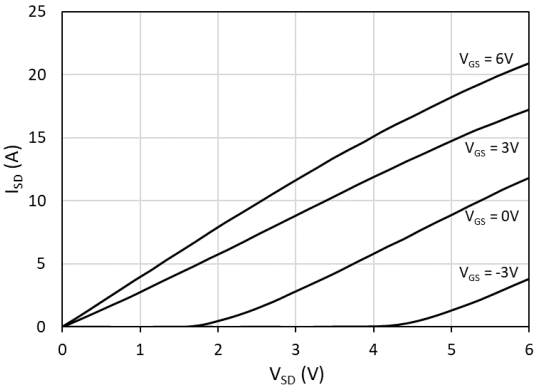


Fig. 4 Source-to-drain reverse conduction voltage at T = 150 °C

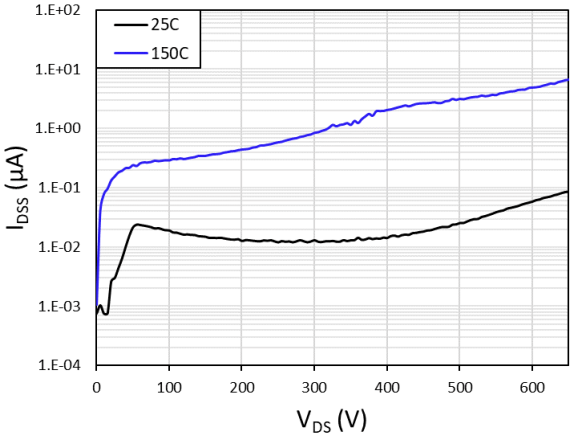


Fig. 5 Drain-to-source leakage current (I_{DSS}) vs drain-to-source voltage (V_{DS})

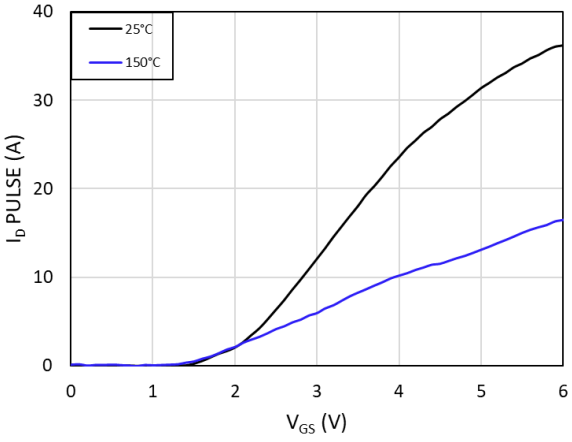


Fig. 6 Pulsed drain current (I_D PULSE) vs. gate-to-source voltage (V_{GS})

Characteristic Graphs (Cont.)

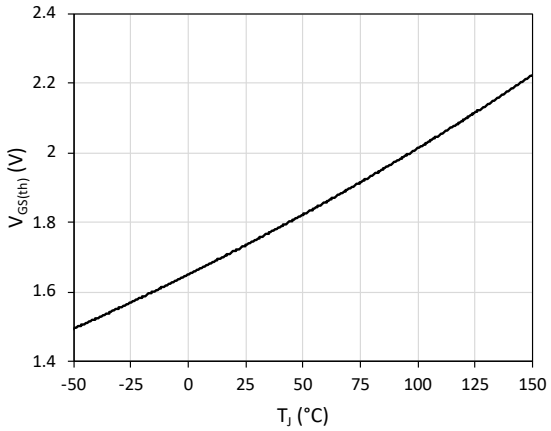


Fig. 7 Gate threshold voltage ($V_{GS(th)}$) vs. junction temperature (T_J)

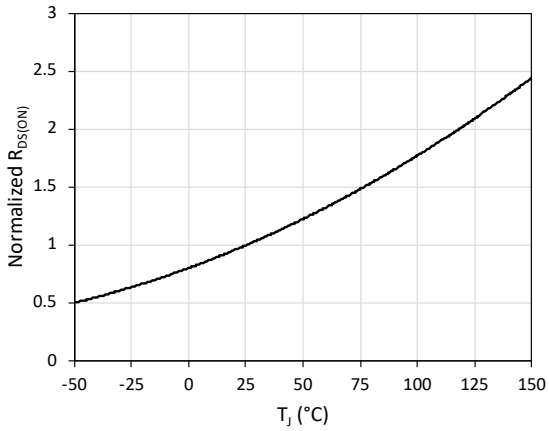


Fig. 8 Normalized on-resistance ($R_{DS(ON)}$) vs. junction temperature (T_J)

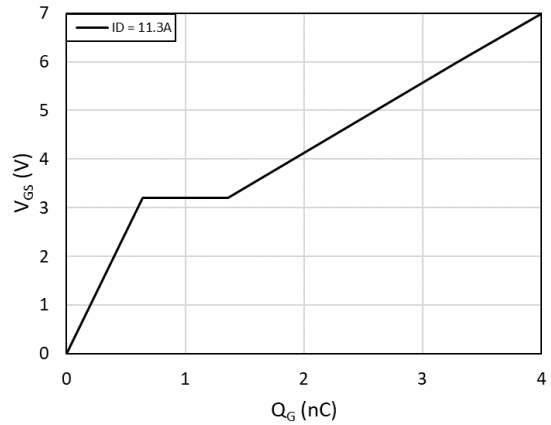


Fig. 9 Gate-to-source voltage (V_{GS}) vs. total gate charge (Q_G)

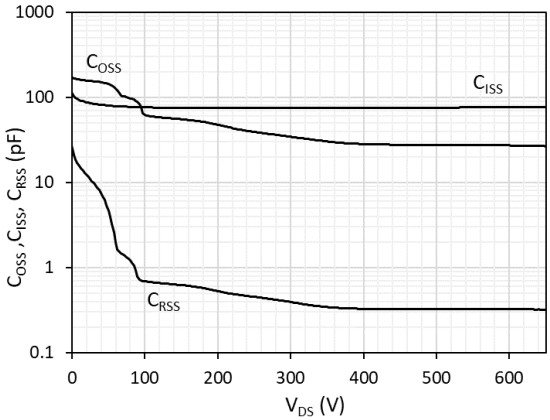


Fig. 10 Input capacitance (C_{ISS}), Output capacitance (C_{OSS}), Reverse Transfer capacitance (C_{RSS}), vs drain-to-source voltage (V_{DS})

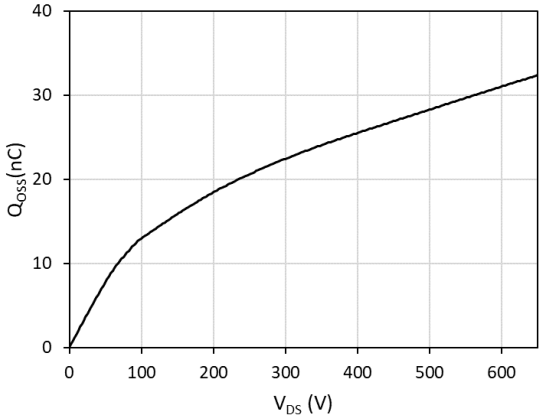


Fig. 11 Charge stored in output capacitance (Q_{OSS}) vs drain-to-source voltage (V_{DS})

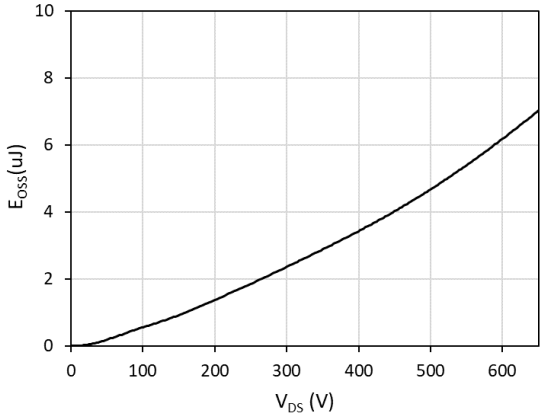


Fig. 12 Energy stored in output capacitance (E_{OSS}) vs. drain-to-source voltage (V_{DS})

Characteristic Graphs (Cont.)

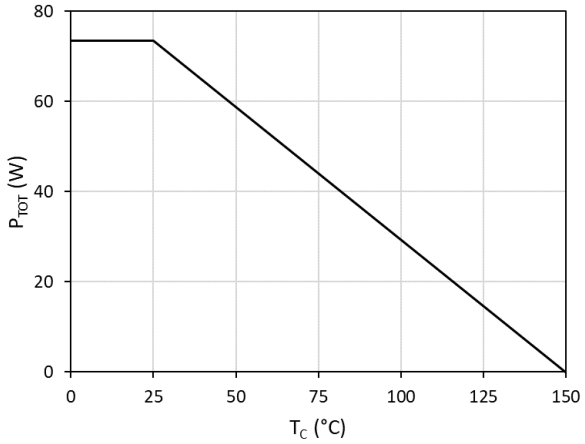


Fig. 13 Power Dissipation (PTOT) vs case temperature

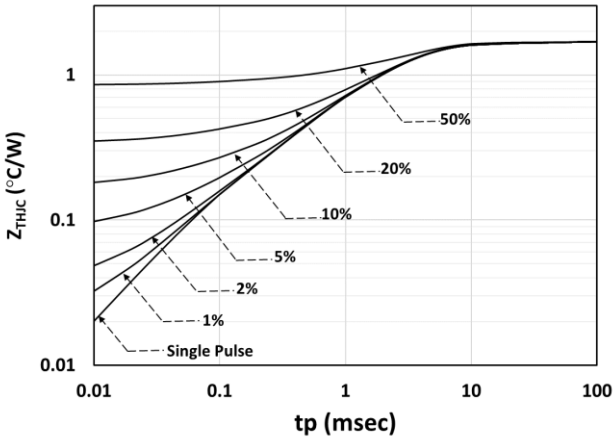


Fig. 14 Max. Thermal Transient Impedance (Z_{thJC}) vs. Pulse Width (t_P)

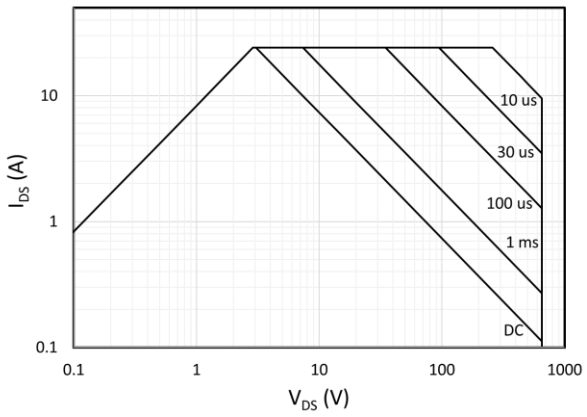
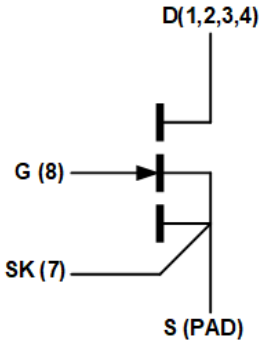
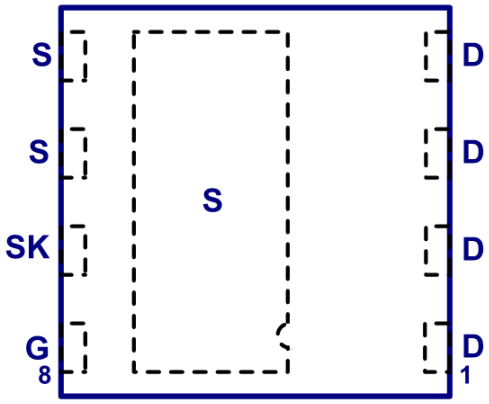


Fig. 15 Safe Operation Area (SOA) @ T_{CASE} = 25°C

6. Pin Configurations and Functions





Package Top View

Pin Number	Pin Name	Description
5, 6	S	Source of power FET
7	SK	Kelvin sense of FET source. Use for driver connection
8	G	Gate of power FET
1, 2, 3, 4	D	Drain of power FET
PAD	S	Source of power FET. Metal pad on bottom of package.

7. Drain-to-Source Voltage Considerations

GaN Power ICs have been designed and tested to provide significant design margin to handle transient and continuous voltage conditions that are commonly seen in single-ended topologies, such as quasi-resonant (QR) flyback applications. The different voltage levels and recommended margins in a typical QR flyback can be analyzed using Fig. 16. When the device is switched off, the energy stored in the transformer leakage inductance will cause V_{DS} to overshoot to the level of V_{SPIKE}. The clamp circuit should be designed to control the magnitude of V_{SPIKE}. After dissipation of the leakage energy, the device V_{DS} will settle to the level of the bus voltage plus the reflected output voltage which is defined in Fig. 16 as V_{DS-OFF}.

- For repetitive events, 80% derating should be applied from $V_{DS\ (TRAN)}$ rating (800V) to 640V max under the worst case operating conditions.
- It is recommended to design the system such that V_{DS-OFF} is derated 80% from the $V_{DS(CONT)}$ (650V) max rating to 520V.
- For half-bridge based topologies, such as LLC, V_{DS} voltage is clamped to the bus voltage. V_{DS} should be designed such that it meets the V_{DS-OFF} derating guideline (520V).
- Non-repetitive events are infrequent, one-time conditions such as line surge, ESD, and lightning. No derating from the $V_{DS(TRAN)}$ rating (800V) is needed for non-repetitive V_{SPIKE} durations < 100 µs. The $V_{DS(TRAN)}$ rating (800V) allows for repetitive events that are <100ns, with 80% derating required (for example repetitive leakage inductance spikes).

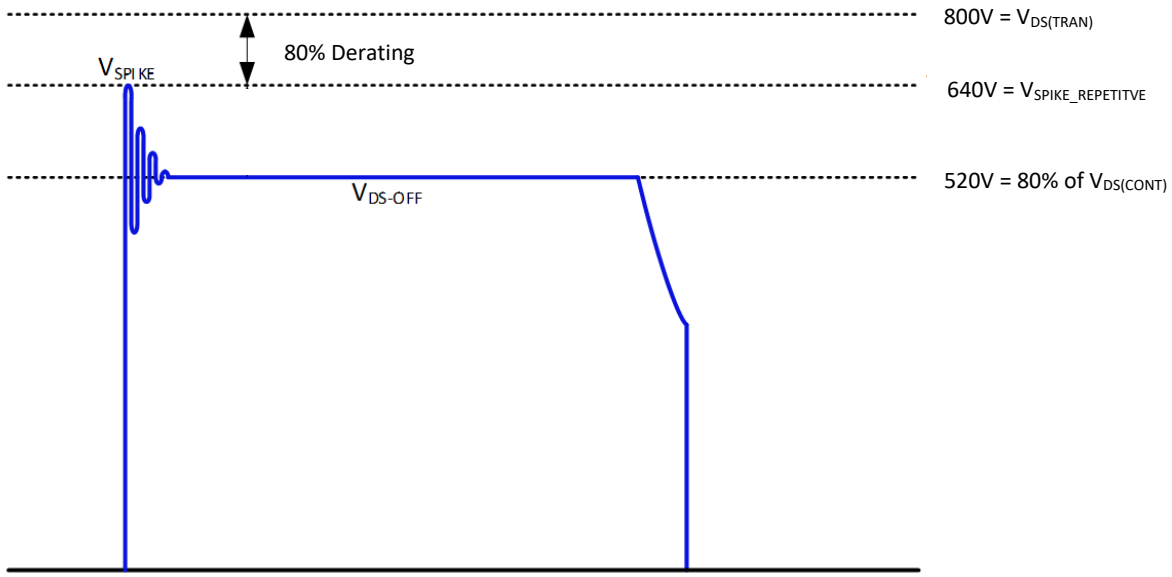
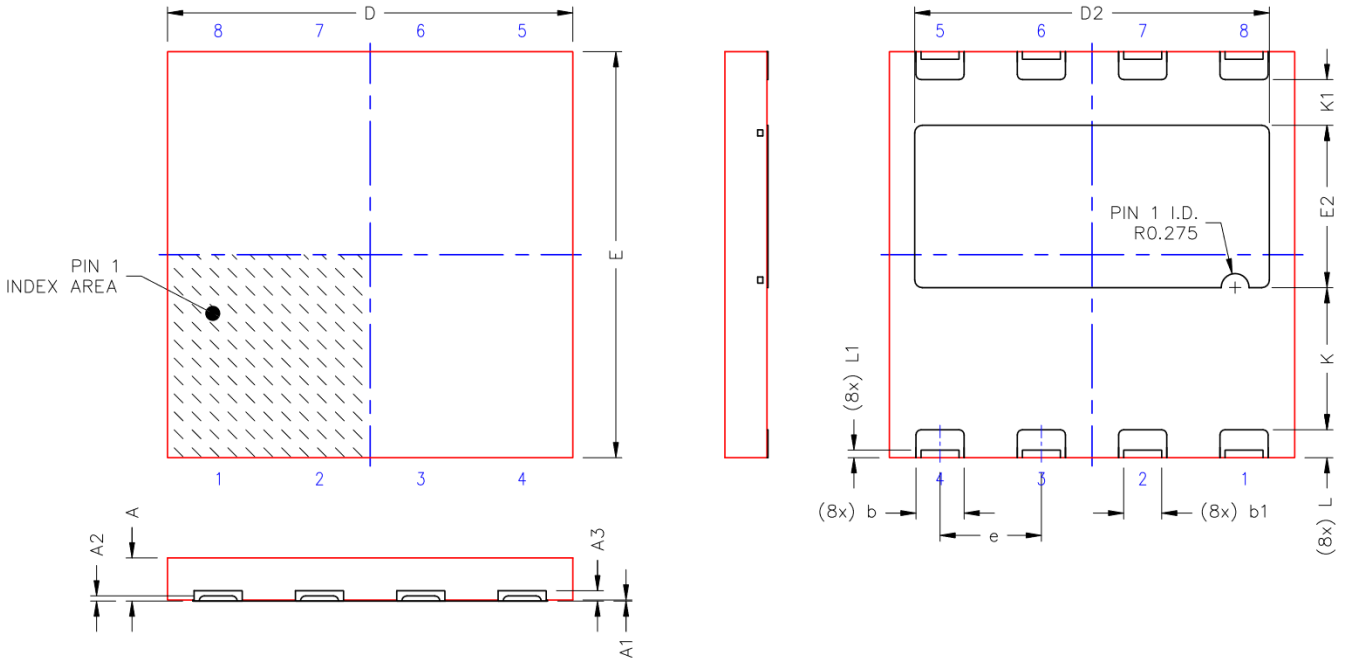


Fig. 16. QR flyback drain-to-source voltage stress diagram

8. PDFN Package Outline



SYM	MIN	NOM	MAX
A	0.80	0.85	0.90
A1	0.00	–	0.05
A2	–	0.102 REF.	–
A3	–	0.203 REF.	–
b	0.90	0.95	1.00
b1	–	0.75 REF.	–
D	7.90	8.00	8.10
D2	6.95	7.00	7.05
E	7.90	8.00	8.10
E2	3.15	3.20	3.25
e		2.00 TYP.	
K	–	2.80 REF.	–
K1	–	0.90 REF.	–
L	0.50	0.55	0.60
L1	–	0.15 REF.	–

NOTES:

1. DIMENSIONING AND TOLERANCING CONFORM TO ASME Y14.5M – 1994.
2. ALL DIMENSIONS ARE IN MILLIMETERS.
3. MAXIMUM ALLOWABLE BURRS IS 0.050 MM IN ALL DIRECTIONS.

9. Ordering Information

Part Number	Operating Temperature Grade	Storage Temperature Range	Package	MSL Rating	Packing (Tape & Reel)
NV6027-RA	-55 °C to +150 °C T_{CASE}	-55 °C to +150 °C T_{CASE}	8 x 8 mm QFN	3	1,000 : 7” Reel
NV6027	-55 °C to +150 °C T_{CASE}	-55 °C to +150 °C T_{CASE}	8 x 8 mm QFN	3	5,000 : 13” Reel

10. Revision History

Date	Status	Notes
May 23, 2022	Final	First Publication
August 22, 2022	Final	Add HV Timing Parameters
March 7, 2024	Final	Add Carbon Neutral logo, PD Abs Max parameter
Apr. 17, 2024	Final	Update POD, update VDSmax footnote, update Section 7 Drain-to-Source Voltage Considerations

Additional Information

Contact info@navitassemi.com