## Features

PRELIMINARY

- Ultra-low $Q_G$ For High Efficiency
- Logic Level
- Light Weight – 0.160 grams
- Low $R_{DS(on)}$
- New Compact Hermetic Package
- Source Sense Pin
- Total Ionizing Dose LDR and HDR Immune
- Single Event Effect (SEE) Hardened
  - SEE immunity up to LET of 85 MeV/mg/cm$^2$ with $V_{DS}$ up to 100% of rated Breakdown
- Neutron
  - Maintains Pre-Rad specification for up to 3 x 10$^{15}$ Neutrons/cm$^2$

## Applications

- Satellite and Avionics
- Deep Space Probes
- High Speed Rad Hard DC-DC Conversion
- Rad-Hard Motor Controllers
- Nuclear Facilities

# EPC7019D

**Rad-Hard eGaN® 40 V, 80 A, 5.0 mΩ Surface Mount**

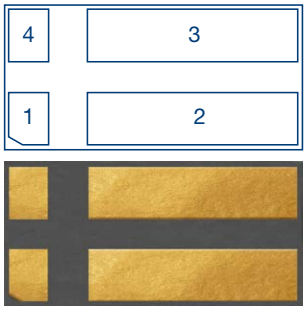
## Description

EPC Space FSMD-D series of eGaN® power switching HEMTs have been specifically designed for critical applications in the high reliability or commercial satellite space environments. These devices have exceptionally high electron mobility and a low temperature coefficient resulting in very low $R_{DS(on)}$ values. The lateral structure of the die provides for very low gate charge ($Q_G$) and extremely fast switching times. These features enable faster power supply switching frequencies resulting in higher power densities, higher efficiencies and more compact packaging.

### Thermal Characteristics

| Symbol | Parameter-Conditions | Value | Units |
|---|---|---|---|
| $R_{\theta JA}$ | Thermal Resistance Junction to Ambient (Note 3) | 48 | °C/W |
| $R_{\theta JC}$ | Thermal Resistance Junction to Case | 1.89 | |

| Pin | Symbol | Description |
|---|---|---|
| 1 | G | Gate |
| 2 | D | Drain |
| 3 | S | Source |
| 4 | SS | Source Sense |




### Absolute Maximum Rating *($T_C$ = 25°C unless otherwise noted)*

| Symbol | Parameter-Conditions | Value | Units |
|---|---|---|---|
| $V_{DS}$ | Drain to Source Voltage (Note 1) | 40 | V |
| | Drain-to-Source Voltage (up to 10,000 5 ms pulses at 150°C) | 48 | |
| $I_D$ | Continuous Drain Current ID @ $V_{GS}$ = 5 V | 80 | A |
| $I_{DM}$ | Single-Pulse Drain Current $t_{pulse}$ = 300 µs | 530 | |
| $V_{GS}$ | Gate to Source Voltage (Note 2) | +6 / -4 | V |
| $T_J$ , $T_{STG}$ | Operating and Storage Junction Temperature Range | -55 to +150 | °C |
| $T_{SOL}$ | Package Mounting Surface Temperature | 260 | |
| ESD | ESD Class | 1A | |

## Static Characteristics *(Typical (TYP) values are for reference only.)*

| Parameter | Symbol | Test Conditions | | MIN | TYP | MAX | Units |
|---|---|---|---|---|---|---|---|
| Drain to Source Voltage | $B_{VDSS}$ | $V_{GS}$ = 0 V, $I_D$ = 1 mA | | 40 | | | V |
| Drain to Source Leakage | $I_{DSS}$ | $V_{DS}$ = 40 V | $T_C$ = 25°C | | 0.001 | 0.4 | mA |
| | | $V_{GS}$ = 0 V | $T_C$ = 125°C | | 0.01 | | |
| Gate to Source Forward Leakage | $I_{GSS}$ | $V_{GS}$ = 5 V | $T_C$ = 25°C | | 0.05 | 1.0 | |
| Gate to Source Forward Leakage# | | $V_{GS}$ = 5 V | $T_C$ = 125°C | | 0.2 | 4.0 | |
| Gate to Source Reverse Leakage | | $V_{GS}$ = -4 V | $T_C$ = 25°C | | 0.05 | 1.0 | |
| Gate to Source Threshold Voltage | $V_{GS(th)}$ | $V_{DS}$ = $V_{GS}$ , $I_D$ = 18 mA | $T_C$ = 25°C | 0.8 | 1.4 | 2.5 | V |
| Gate to Source Threshold Voltage Temperature Coefficient | $\Delta V_{GS(th)}$ | | -55°C < $T_A$ < 150°C | | -2.0 | | mV/°C |
| Drain to Source Resistance (Note 4) | $R_{DS(on)}$ | $V_{GS}$ = 5 V, $I_D$ = 50 A | $T_C$ = 25°C | | 3.7 | 5.0 | mΩ |
| Source to Drain Forward Voltage (Note 5) | $V_{SD}$ | $I_S$ = 0.5 A, $V_G$ = 0 V | $T_C$ = 25°C | | 2.0 | | V |

All measurements were done with substrate shorted to source.
# Defined by design. Not subject to production test.

## Dynamic Characteristics *($T_C$ = 25°C unless otherwise noted. Typical (TYP) values are for reference only.)*

| Parameter | Symbol | Test Conditions | MIN | TYP | MAX | Units |
|---|---|---|---|---|---|---|
| Input Capacitance | $C_{ISS}$ | $V_{DS}$ = 20 V, $V_{GS}$ = 0 V | | 2830 | | pF |
| Reverse transfer Capacitance | $C_{RSS}$ | | | 35 | | |
| Output Capacitance | $C_{OSS}$ | | | 1660 | | |
| Effective Output Capacitance, Energy Related | $C_{OSS(ER)}$ | $V_{DS}$ = 0 to 20 V, $V_{GS}$ = 0 V | | 2130 | | |
| Effective Output Capacitance, Time Related | $C_{OSS(TR)}$ | | | 2540 | | |
| Total Gate Charge | $Q_G$ | $V_{DS}$ = 0 to 20 V, $V_{GS}$ = 0 V, $I_D$ = 50 A | | 22 | | nC |
| Gate to Source Charge | $Q_{GS}$ | $V_{DS}$ = 20 V, $I_D$ = 50 A | | 9.1 | | |
| Gate to Drain Charge | $Q_{GD}$ | | | 3.4 | | |
| Output Charge (Note 6) | $Q_{OSS}$ | $V_{DS}$ = 20 V, $V_{GS}$ = 0 V | | 51 | | |
| Source to Drain Recovery Charge | $Q_{RR}$ | | | 0 | | |

All measurements were done with substrate shorted to source.

## Radiation Characteristics

EPC Space eGaN® HEMTs are tested according to MIL-STD-750 Method 1019 for total ionizing dose validation. Every manufacturing lot is tested for total ionizing dose of Gamma radiation with an in-situ bias for (i) $V_{GS}$ = 5 V, (ii) $V_{DS}$ = $V_{GS}$ = 0 V and (iii) $V_{DS}$ = 80% $B_{VDSS}$.

**Electrical Characteristics up to 1000 krads** *($T_C$ = 25°C unless otherwise noted. Typical (TYP) values are for reference only.)*

| Parameter | Symbol | Test Conditions | MIN | TYP | MAX | Units |
|---|---|---|---|---|---|---|
| Maximum Drain to Source Voltage | $V_{DSMAX}$ | $V_{GS}$ = 0 V, $I_D$ = 1 mA | 40 | | | V |
| Gate to Source Threshold Voltage | $V_{GS(th)}$ | $V_{DS}$ = $V_{GS}$ , $I_D$ = 18 mA | 0.8 | 1.4 | 2.5 | |
| Drain to Source Leakage | $I_{DSS}$ | $V_{DS}$ = 40 V, $V_{GS}$ = 0 V | | 0.001 | 0.4 | mA |
| Gate to Source Forward Leakage | $I_{GSS}$ | $V_{GS}$ = 5 V | | 0.05 | 1.0 | |
| Gate to Source Reverse Leakage | | $V_{GS}$ = -4 V | | 0.05 | 1.0 | |
| Drain to Source Resistance (Note 4) | $R_{DS(on)}$ | $I_D$ = 50 A, $V_{GS}$ = 5 V | | 3.7 | 5.0 | mΩ |

## Typical Single Event Effect Safe Operating Area

*Note : All Single Event Effect testing is performed on the K-500 Cyclotron at Texas A&M University*

| Test | Environment | | | | $V_{DS}$ Voltage ( V) | |
|---|---|---|---|---|---|---|
| | Ion | LET MeV/mg/cm² | Range µm | Energy MeV | $V_{GS}$ = 0 V | $V_{GS}$ = -4V |
| See SOA | Xe | 50 | 131 | 1653 | 40 | 40 |
| | Au | 83.7 | 130 | 2482 | 40 | 40 |

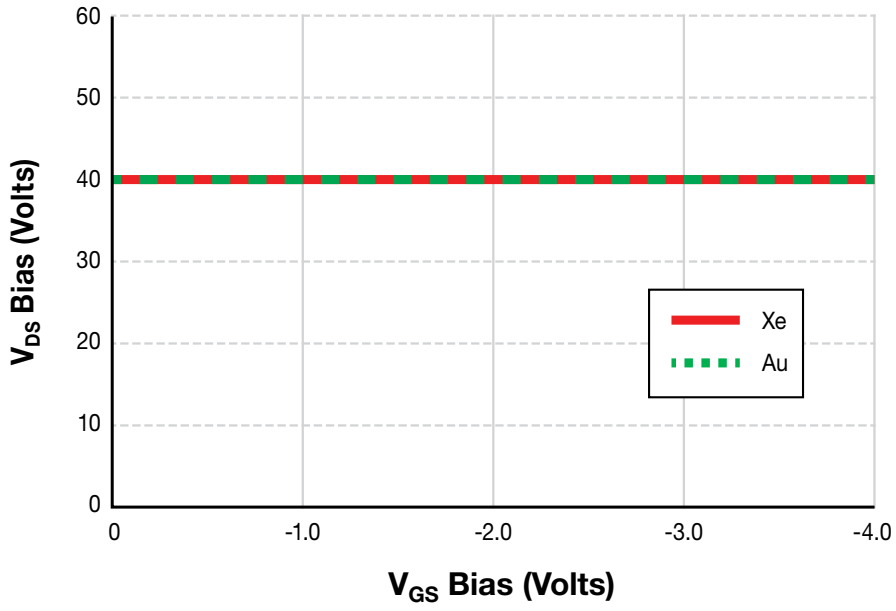



*Figure 1: Typical Single Event Effect Safe Operating Area*

**Figure 2: Typical Output Characteristics at 25°C**

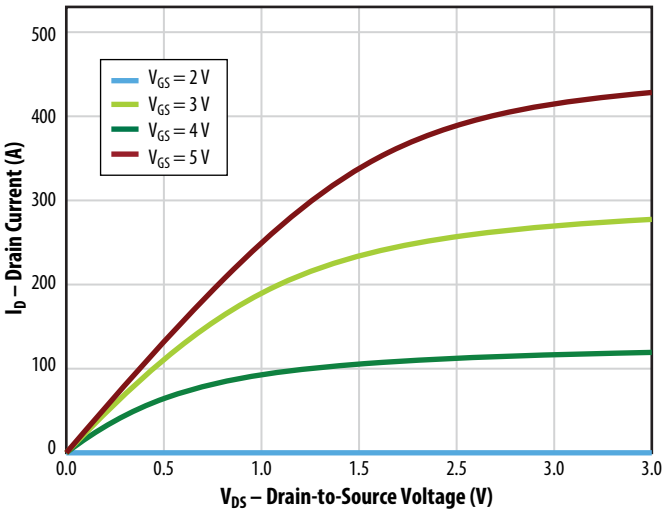



**Figure 3: Typical Output Characteristics at 125°C**

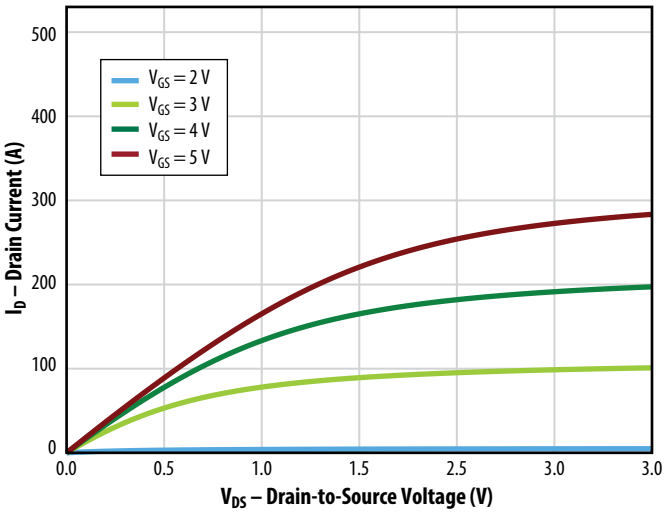



**Figure 4: Typical Transfer Characteristics**

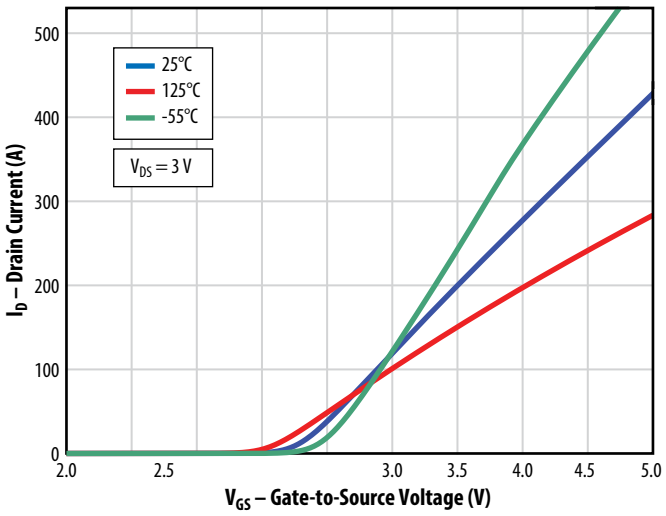



**Figure 5: Typical $R_{DS(on)}$ vs. $V_{GS}$ for Various Temperatures**

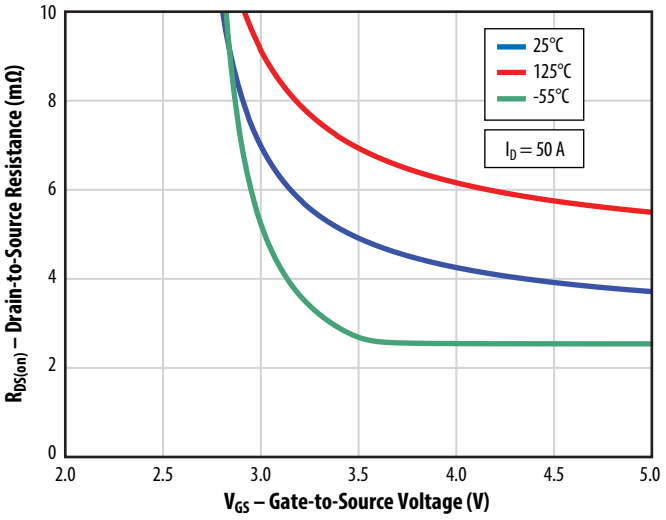



**Figure 6: Typical $R_{DS(on)}$ vs. $V_{GS}$ for Various Drain Currents**

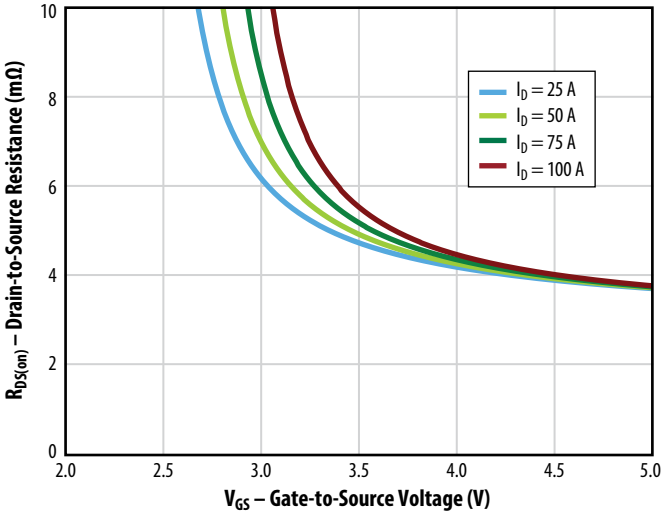


**Figure 7: Normalized Threshold Voltage vs. Temperature**

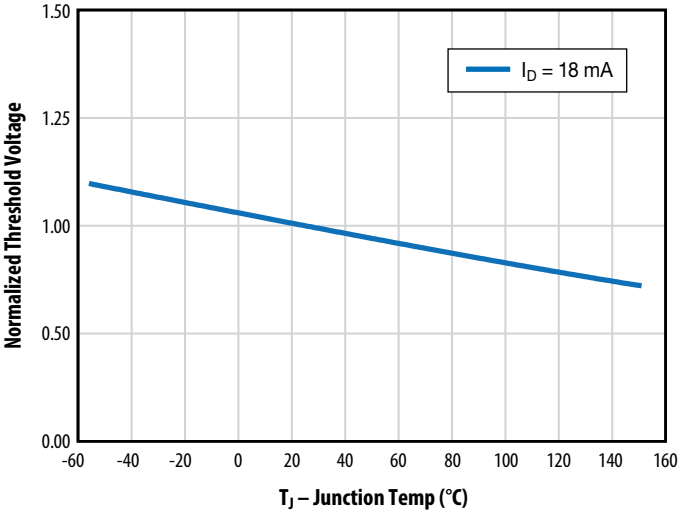



**Figure 8: Normalized On-State Resistance vs. Temperature**

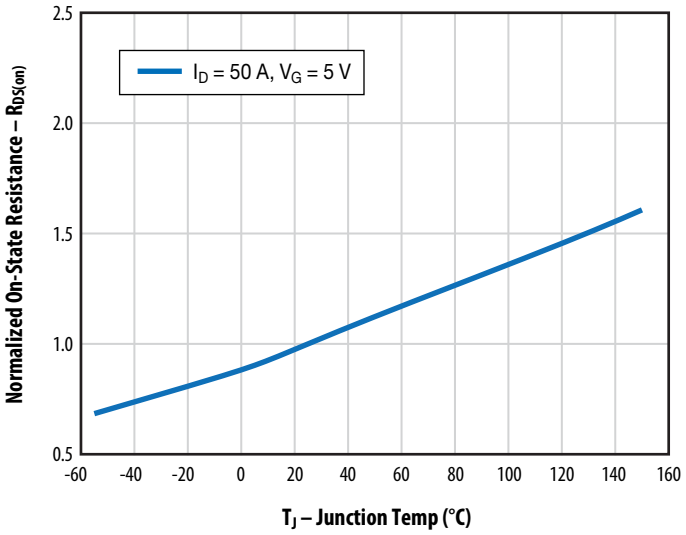



**Figure 9: Typical Capacitance (Linear Scale)**

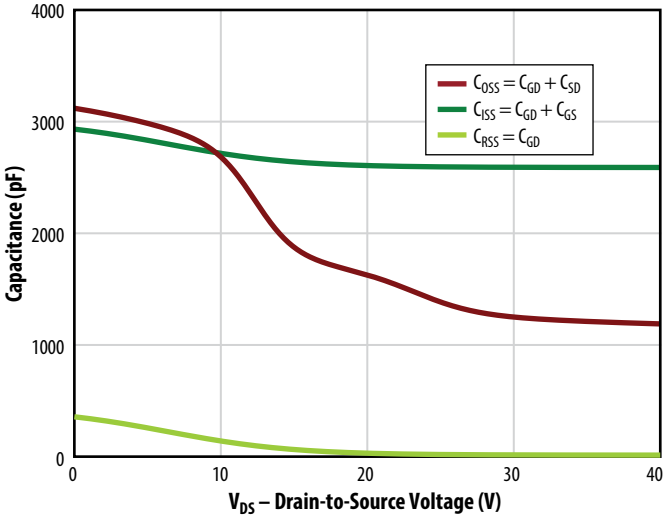



**Figure 10: Typical Gate Charge**

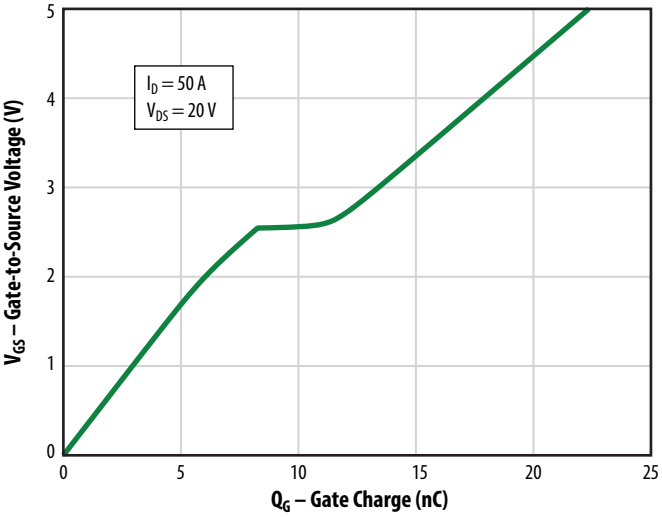
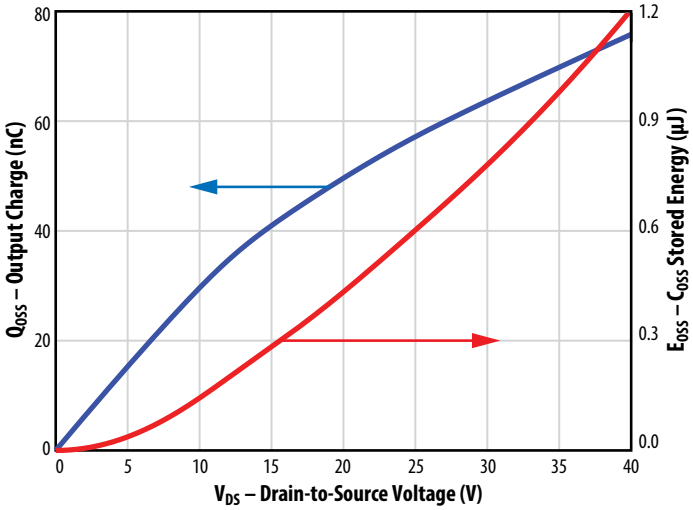
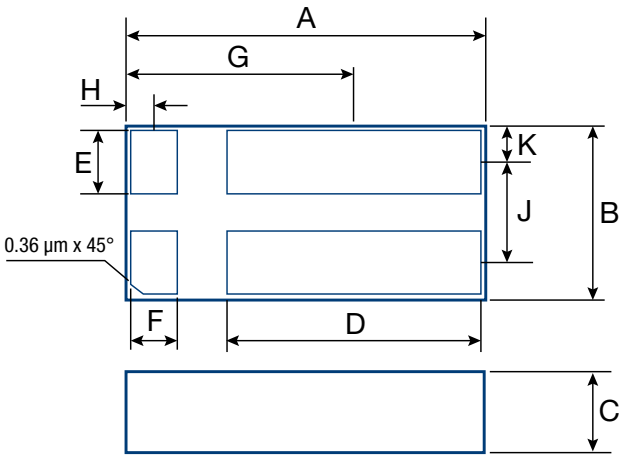



**Figure 11: Typical Output Charge and $C_{OSS}$ Stored Energy**



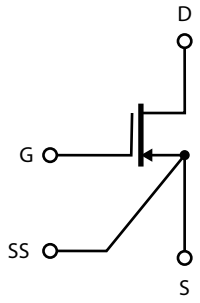
## Package Outline and Dimensions




| Symbol | Inches | | Millimeters | | Note |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| **A** | 0.311 | 0.321 | 7.90 | 8.15 | |
| **B** | 0.177 | 0.187 | 4.50 | 4.75 | |
| **C** | 0.078 | 0.088 | 1.98 | 2.24 | |
| **D** | 0.222 | 0.232 | 5.64 | 5.89 | |
| **E** | 0.065 | 0.075 | 1.65 | 1.91 | |
| **F** | 0.045 | 0.055 | 1.14 | 1.40 | |
| **G** | 0.195 | 0.205 | 4.95 | 5.21 | |
| **H** | 0.025 | 0.035 | 0.64 | 0.89 | |
| **K** | 0.035 | 0.045 | 0.89 | 1.14 | |
| **J** | 0.095 | 0.105 | 2.41 | 2.67 | |

Standard Terminal Pad finish is a solder alloy of 63%Pb 37%Sn

## Package Connections




**NOTE:** SS pin is connected directly to source of internal die.

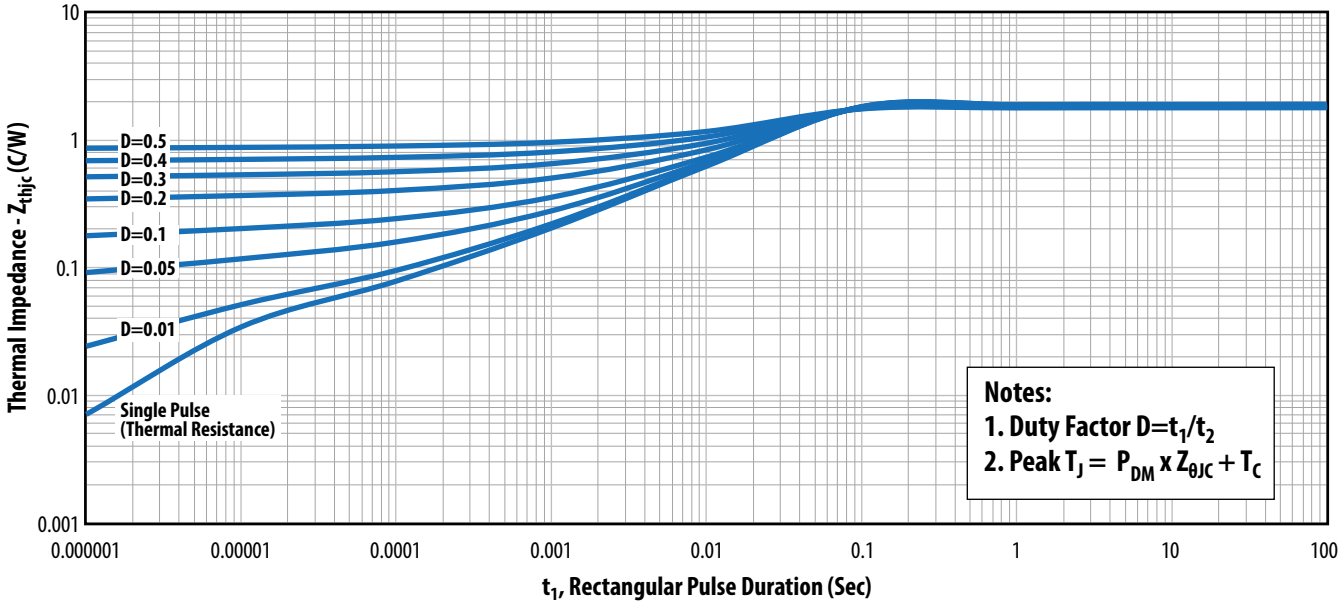



*Figure 12: Thermal Impedance diagram*

## Notes

Note 1. NEVER exceed the absolute maximum $V_{DS}$ of the device otherwise permanent damage/destruction may result.

Note 2. NEVER exceed the absolute maximum $V_{GS}$ of the device otherwise permanent damage/destruction may result. We recommend a $V_{GS}$ of 5 V for optimum operation across life and radiation.

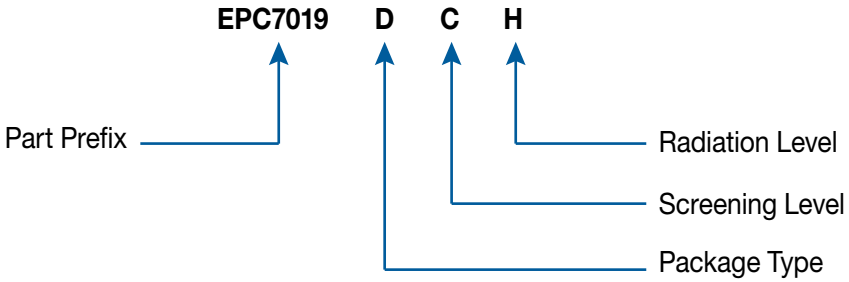
Note 3. $R_{\theta JA}$ measured with FSMD-D package mounted to double-sided PCB, 0.063" thickness with 1.0 square inches of copper area on the top (mounting side) and a flood etch (3 square inches) on the bottom side.

Note 4. Measured using four wire (Kelvin) sensing and pulse measurement techniques. Measurement pulse width is 80 µs and duty cycle is 1%, maximum.

Note 5. With pulse measurement width 100–380 µs.

Note 6. Guaranteed by design/device construction. Not tested.

## EPC Space Part Number Information




## Ordering Information Availability

| Screening Options | Rad Assurance Options |
|---|---|
| 1 character | 1 character |
| C or Q = Developmental Units<br>S = Space Level[1] | H = 1000 krad |

| Part Number | Screening Level | Shipping |
|---|---|---|
| EPC7019DC | Developmental Units | Waffle trays |
| EPC7019DSH | Space Level | |

[1] Screening and qualification consistent to an equivalent MIL-PRF-19500 specification.

EPC7019DC devices are intended for engineering development purposes only and are NOT intended to be used as flight units.

EPC Space Rad Hard HEMT are not sensitive to Total Ionizing Dose as such the H level covers the R,F,G radiation levels.

## Screening Flow Equivalent to a MIL-PRF-19500 General Specification

| EPC SPACE Qual Flow Equivalent to a MIL-PRF-19500 Specification | | | | | |
|---|---|---|---|---|---|
| **Operation** | **Test** | **Test Methods Per Mil STD 750** | **Sample Size** | **Space Level** | **COT** |
| **Pre-Assembly** | Probe Testing | EPC SPACE Internal | 100% | ✓ | ✓ |
| | Visual inspection | EPC SPACE Internal | 100% | ✓ | ✓ |
| **Post-Assembly** | Die Shear | 2,017 | 5 | ✓ | ✓ |
| | X-Ray | 2076 | 5 | ✓ | ✓ |
| **Screening** | Serilialization | | 100% | ✓ | |
| | Electricals | 3411,3413,3421,3404 | 100% | ✓ | ✓ |
| | Temp Cycling | 1051 | 100% | ✓ | |
| | Constant Acceleration | 2006 | 100% | ✓ | |
| | PIND | 2052 | 100% | ✓ | |
| | Initial Electricals (Read and Record) | 3411,3413,3421,3404 | 100% | ✓ | |
| | HTGB | 1042 Condition B | 100% | ✓ | |
| | Interim Electricals (Read and Record) | 3411,3413,3421,3404 | 100% | ✓ | |
| | HTRB | 1042 Condition A 240 Hours | 100% | ✓ | |
| | Final Electricals (Read and Record) | 3411,3413,3421,3404 | 100% | ✓ | |
| | Final Electricals (High and Low Temperatures) | 3411,3413,3421,3404 | 100% | ✓ | |
| | Deltas | Per Procurement Specification | 100% | ✓ | |
| | Percent Defective Allowable | Per Procurement Specification | 100% | ✓ | |
| | Dynamic RDSON | EPC SPACE Internal | 100% | ✓ | |
| | OutLiers Removal | EPC SPACE Internal | 100% | ✓ | |
| | X-RAY | 2076 | 100% | ✓ | |
| | Tinning | | 100% | ✓ | |
| | Hermetic Seal, Fine & Gross Leak | 1071 | 100% | ✓ | |
| | Final Electricals | 3411,3413,3421,3404 | 100% | ✓ | |
| **Group A Inspection (Conformance)** | A-2 DC Static Tests at 25°C | 3411,3413,3421,3404 | 116 | ✓ | |
| | A-3 High & Low Temp DC Static Tests | 3411,3413,3421,3404 | 116 | ✓ | |
| | A-7 Gate Charges | 3471 Condition B | 45 | ✓ | |
| | A-7 Capacitance | 3473 | 45 | ✓ | |
| **Group B Inspection (Conformance)** | B-1, B-2, B-3, B-4, B-5 | Sample base equivalent to a MIL-PRF-19500 flow or as required by procurement specificcation | | | |
| **Group C Inspection (Conformance)** | C-1, C-2, C-3, C-4, C-6, C-7 | Sample base performed yearly per package style equivalent to a MIL-PRF-19500 flow or as required by procurement specification | | | |
| **Group D Inspection (Conformance)** | TID | 1019 | 15 | ✓ | |
| | SEE | 1080 | 5 | ✓ | |
| **Group E Inspection (Qualification Inspection)** | E-1, E-2, E-5, E-6 E-7 | Performed during product introduction or a major process change equivalent to a MIL-PRF-19500 flow or as required by procurement specification | | | |
| | E8 Switching | | | | |

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## Revisions

| Datasheet Revision | Product Status |
|---|---|
| REV Q1 | Characterization and Qualification |
| Preliminary | Production Released |

Information subject to change without notice.
Revised October, 2023