FBG20N04A Datasheet

Features

- Low $R_{DS(on)}$
- Ultra-low Q_G For High Efficiency
- Logic Level
- Light Weight – 0.068 grams
- New Compact Hermetic Package
- Source Sense Pin
- Total Dose
  - Rated to 300 krad
- Single Event
  - SEE immunity for LET of 83.7 MeV/mg/cm^2 with V_{DS} up to 100% of rated Breakdown
- Low Dose Rate at 100 mRad/sec
  - Maintains Pre-Rad specification
- Neutron
  - Maintains Pre-Rad specification for up to 1 x 10^{13} Neutrons/cm^2

Application

- Commercial Satellite EPS & Avionics
- Deep Space Probes
- High Speed Rad Hard DC-DC Conversion
- Rad Hard Motor Controllers

FBG20N04A

Rad Hard e-GaN® 200 V, 4 A,
102 mΩ Surface Mount (FSMD-A)

Description

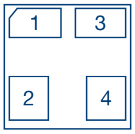
EPC Space FSMD-A series of eGaN® power switching HEMTs have been specifically designed for critical applications in the high reliability or commercial satellite space environments. These devices have exceptionally high electron mobility and a low temperature coefficient resulting in very low $R_{DS(on)}$ 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)	90	°C/W
$R_{\theta JC}$	Thermal Resistance Junction to Case	5.12	

I/O Pin Assignment *(Bottom View)*

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



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

Symbol	Parameter-Conditions	Value	Units
V_{DS}	Drain to Source Voltage (Note 1)	200	V
I_D	Continuous Drain Current ID @ V_{GS} = 5 V, T_C = 25°C, $R_{\theta JA}$ < 26 °C/W	4	A
I_{DM}	Single-Pulse Drain Current $t_{pulse} \leq 270$ µs	16	
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	Δ1A	

Electrical Characteristics *(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_G = 0 V		-	-	200	V
Drain to Source Leakage	I_{DSS}	V_{DS} = 200 V V_{GS} = 0 V	T_C = 25°C	-	26	50	µA
			T_C = 125°C	-		100	
Gate to Source Forward Leakage	I_{GSS}	V_{GS} = 5 V	T_C = 25°C	-	0.5	1.0	mA
Gate to Source Reverse Leakage	I_{GSS}	V_{GS} = -4 V	T_C = 25°C		-5	-50	µA
Gate to Source Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}$, I_D = 1 mA	T_C = 25°C	0.8	1.2	2.8	V
Gate to Source Threshold Voltage Temperature Coefficient	$\Delta V_{GS(th)}/\Delta T$	$V_{DS} = V_{GS}$, I_D = 1 mA	-55°C < T_A < 150°C	-	|2.4|	-	mV/°C
Drain to Source Resistance (Note 4)	$R_{DS(on)}$	I_D = 4 A, V_{GS} = 5 V	T_C = 25°C	-	68	102	mΩ
Source to Drain Forward Voltage (Note 5)	V_{SD}	I_S = 0.5 A, V_G = 0 V	T_C = 25°C		1.75		V

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}	f = 1 MHz, V_{DS} = 100 V, V_{GS} =0 V (Note 6)		106	150	pF
Output Capacitance	C_{OSS}			72	90	
Reverse transfer Capacitance	C_{RSS}			2	6	
Gate Resistance	R_G	f = 1 MHz, $V_{DS} = V_{GS}$ = 0 V		0.6		Ω
Total Gate Charge (Note 7)	Q_G	I_D = 4 A, V_{GS} = 5 V, V_{DS} = 100 V		1.6	3	nC
Gate to Drain Charge (Note 7)	Q_{GD}			0.2	1	
Gate to Source Charge (Note 7)	Q_{GS}			0.5	1.8	
Output Charge (Note 8)	Q_{OSS}	V_{GS} = 0 V, V_{DS} = 100 V		13		
Source to Drain Recovery Charge	Q_{RR}	I_D = 4 A, V_{DS} = 100 V		<1		

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 300 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	-	-	200	V
Gate to Source Threshold Voltage	$V_{GS(th)}$	V_{DS} = V_{GS} , I_D = 1 mA	0.8	1.0	2.8	V
Drain to Source Leakage	I_{DSS}	V_{DS} = 200 V, V_{GS} = 0 V	-	26	290	µA
Gate to Source Forward Leakage	I_{GSS}	V_{GS} = 5 V	-	0.5	1.0	mA
Gate to Source Reverse Leakage	I_{GSS}	V_{GS} = -4 V	-	-5	-50	µA
Drain to Source Resistance (Note 4)	$R_{DS(on)}$	I_D = 4 A, V_{GS} = 5 V	-	68	102	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/cm^2	Range µm	Energy MeV	V_{GS} = 0 V	V_{GS} = -4V
See SOA	Xe	50	131	1653	200	200
	Au	83.7	130	2482	175	175

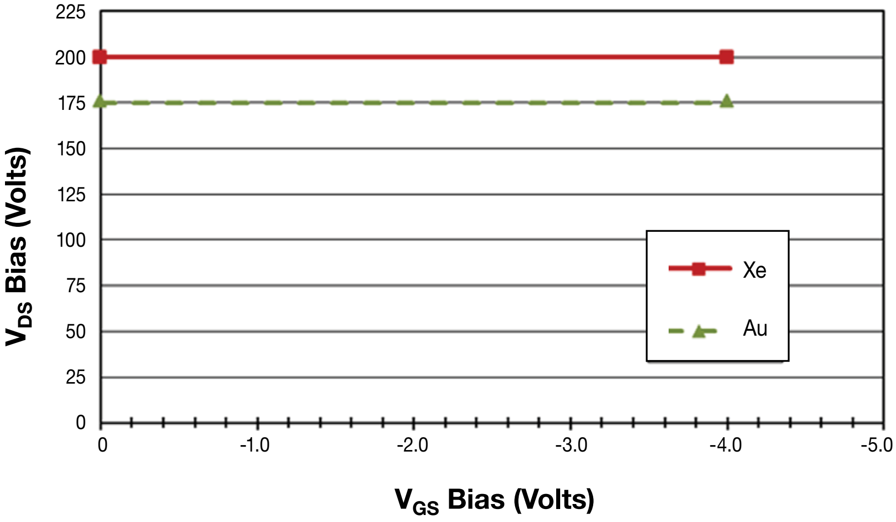


Figure 1. Typical Single Event Effect Safe Operating Area

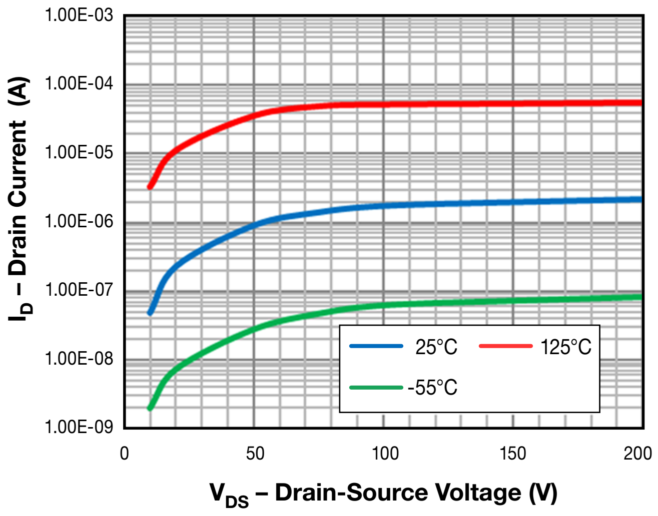


Figure 2. Typical Drain-Source Leakage Current vs. Ambient Temperature

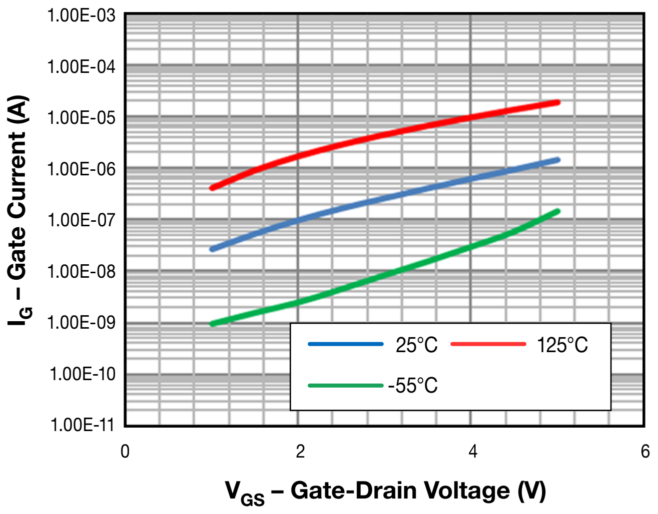


Figure 3. Gate-Source Leakage Current vs. Ambient Temperature

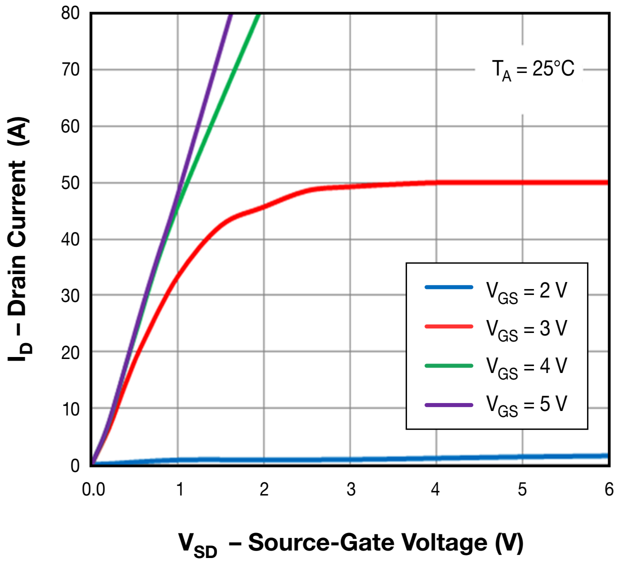


Figure 4. Typical Gate-Drain Transfer Characteristic

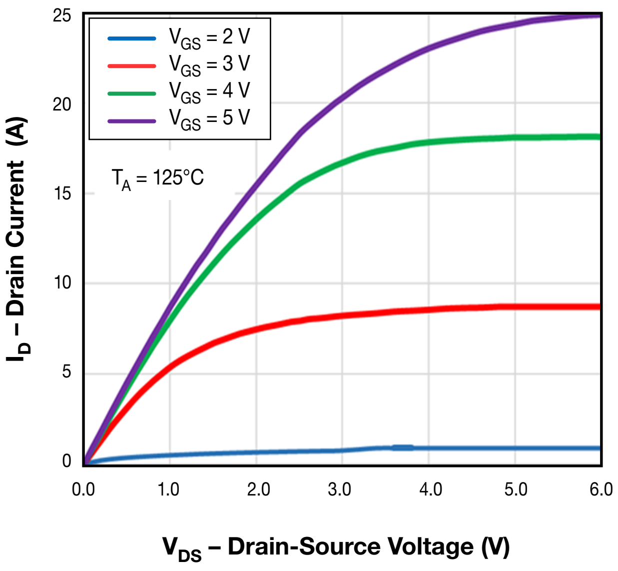


Figure 5. Typical Output Characteristics

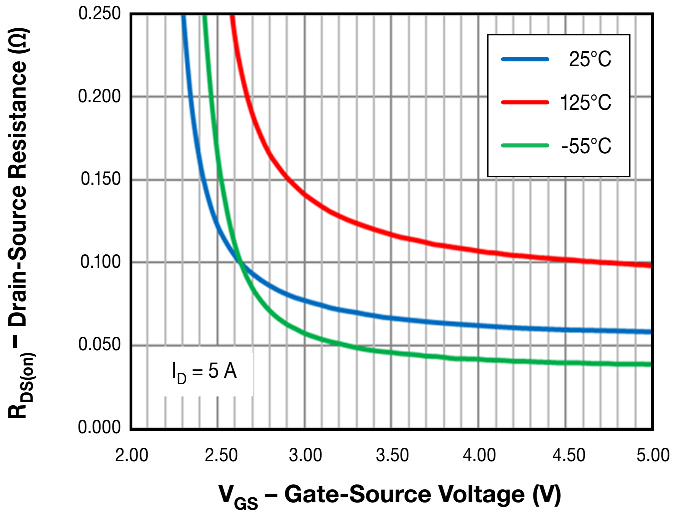


Figure 6. Typical Drain-Source ON Resistance vs. Gate-Source Voltage vs. Ambient Temperature

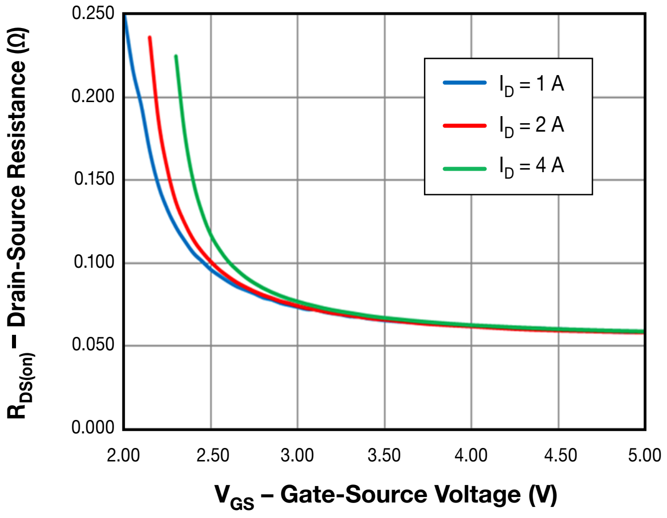


Figure 7. Typical Drain-Source ON Resistance vs. Gate-Source Voltage vs. Drain Current

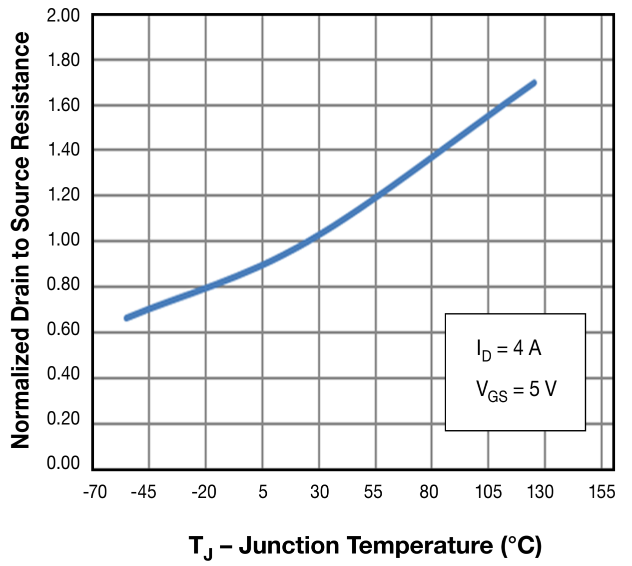


Figure 8. Typical Source-Drain Voltage vs. Temperature

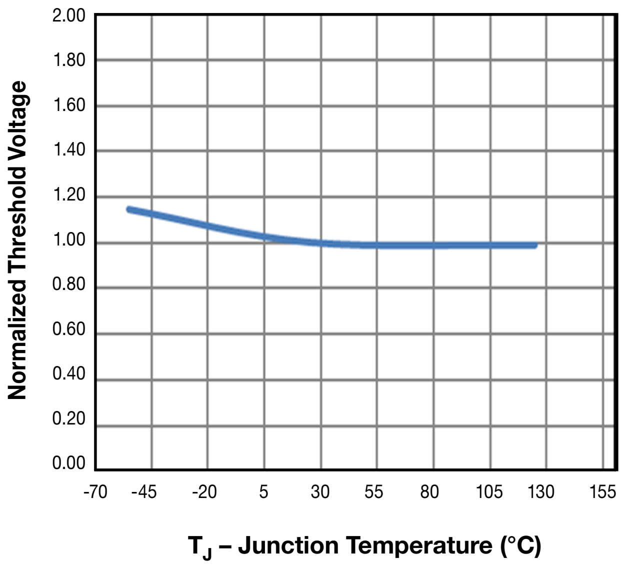


Figure 9. Normalized Drain-Source ON Resistance vs. Ambient Temperature

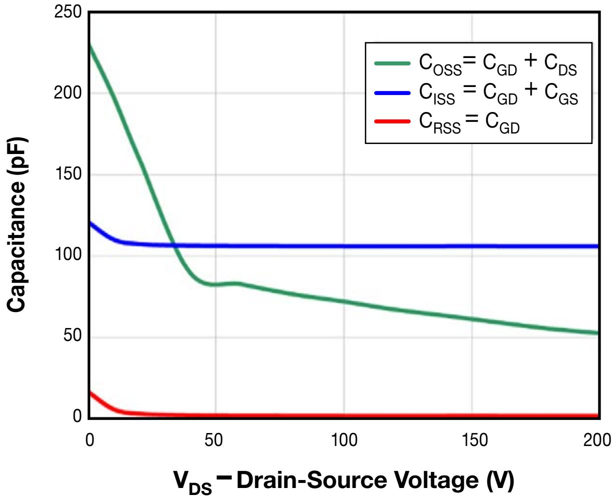


Figure 10. Typical Inter-Electrode Capacitance vs. Drain-Source Voltage

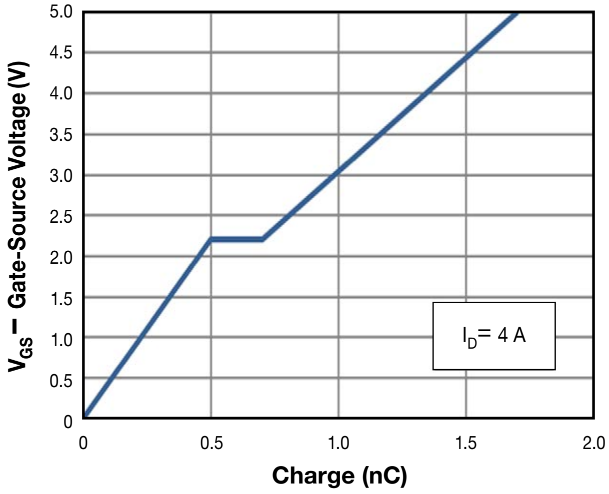


Figure 11. Typical Gate Charge vs. Drain Current

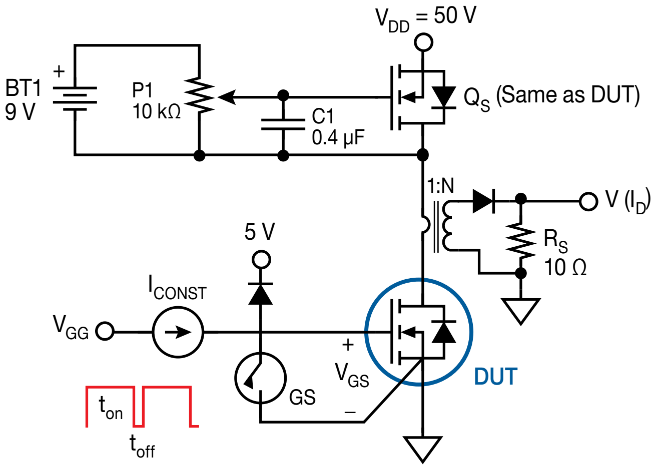


Figure 12. Charge Test Circuit

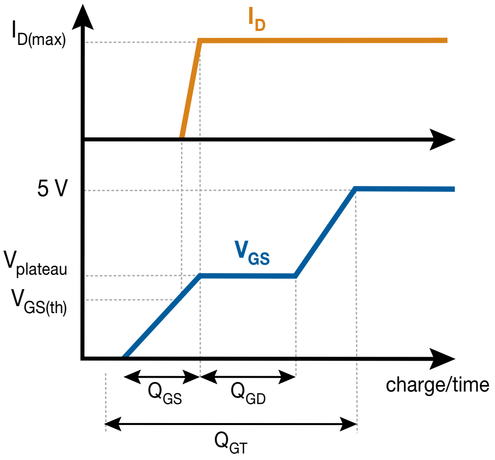
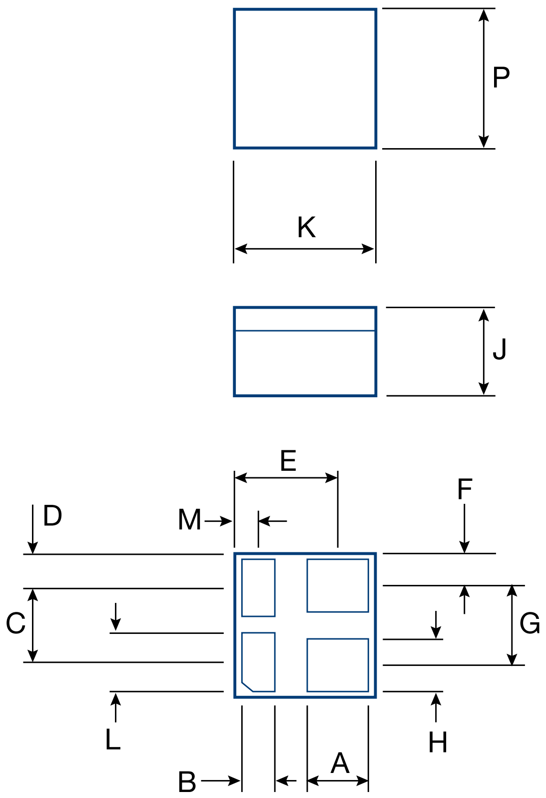


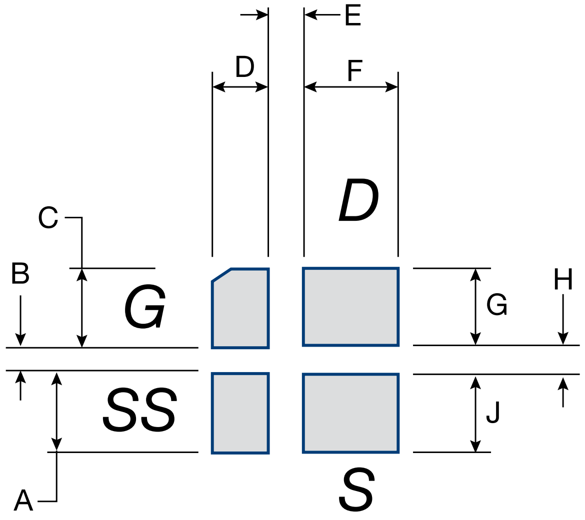
Figure 13. Typical Gate Charge Test Waveform

Package Outline and Dimensions



Symbol	Inches		Millimeters		Note
	MIN	MAX	MIN	MAX	
A	0.052	0.062	1.320	1.574	
B	0.027	0.037	0.685	0.939	
C	0.063	0.073	1.600	1.854	
D	0.026	0.036	0.660	0.914	
E	0.092	0.102	2.336	2.590	
F	0.024	0.034	0.609	0.863	
G	0.068	0.078	1.727	1.981	
H	0.042	0.052	1.066	1.320	
J	0.080	0.090	2.032	2.286	Ref. only
K	0.125	0.135	3.175	3.429	
L	0.048	0.058	1.219	1.473	
M	0.016	0.026	0.406	0.664	
P	0.125	0.135	3.175	3.429	

FSMD-A Footprint for Printed Circuit Board Design



Symbol	Inches		Millimeters		Note
	MIN	MAX	MIN	MAX	
A	0.051	0.061	1.295	1.549	
B	0.010	0.020	0.254	0.508	
C	0.051	0.061	1.295	1.549	
D	0.033	0.043	0.838	1.092	
E	0.020	0.030	0.508	0.762	
F	0.058	0.068	1.473	1.727	
G	0.048	0.058	1.219	1.473	
H	0.015	0.025	0.381	0.635	
J	0.048	0.058	1.219	1.473	

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 use at no greater than +5 V as the HEMT is fully conducting at this point.

Note 3. $R_{\theta JA}$ measured with FSMD-A 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.

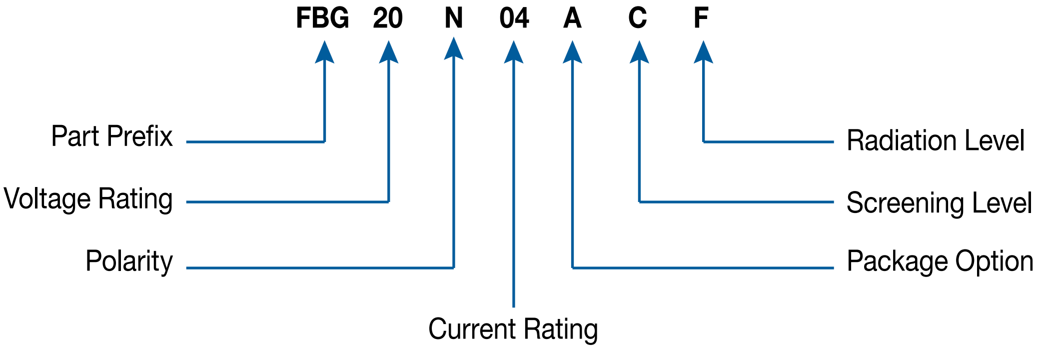
Note 5. Operation of the device in the third quadrant region is not recommended.

Note 6. $C_{ISS} = C_{GS} + C_{GD}$ with C_{DS} shorted. $C_{OSS} = C_{DS} + C_{GD}$. $C_{RSS} = C_{GD}$.

Note 7. The gate charge parameters are measured using the circuit shown in Figure 11. Qs and associated components BT1, P1 and C1 form a high speed current source that serves as the test load for the DUT. A constant gate current (I_{const}) of 1.5-3 mA is provided to the Gate of the DUT during the time that the ground switch (G_S) is OFF (t_{off}). The DUT is switched ON and OFF using ground-sensed switch GS. The gate current is adjusted to yield the desired charge per unit time (I_{const} · time per division) on the measuring oscilloscope. The GS pulse drive ON time (t_{on})is adjusted for the desired observability of the gate-source voltage (V_{GS}) waveform. The maximum duty cycle of the ground switch (t_{off}/t_{on}) should be set to 1% maximum. Please note that all gate-related signals are referenced to the "Source Sense" pin on the package. At all times during the measurement, the maximum gate-source voltage is clamped to 5 V_{DC}.

Note 8. Guaranteed by design/device construction. Not tested.

EPC Space Part Number Information



Ordering Information Availability

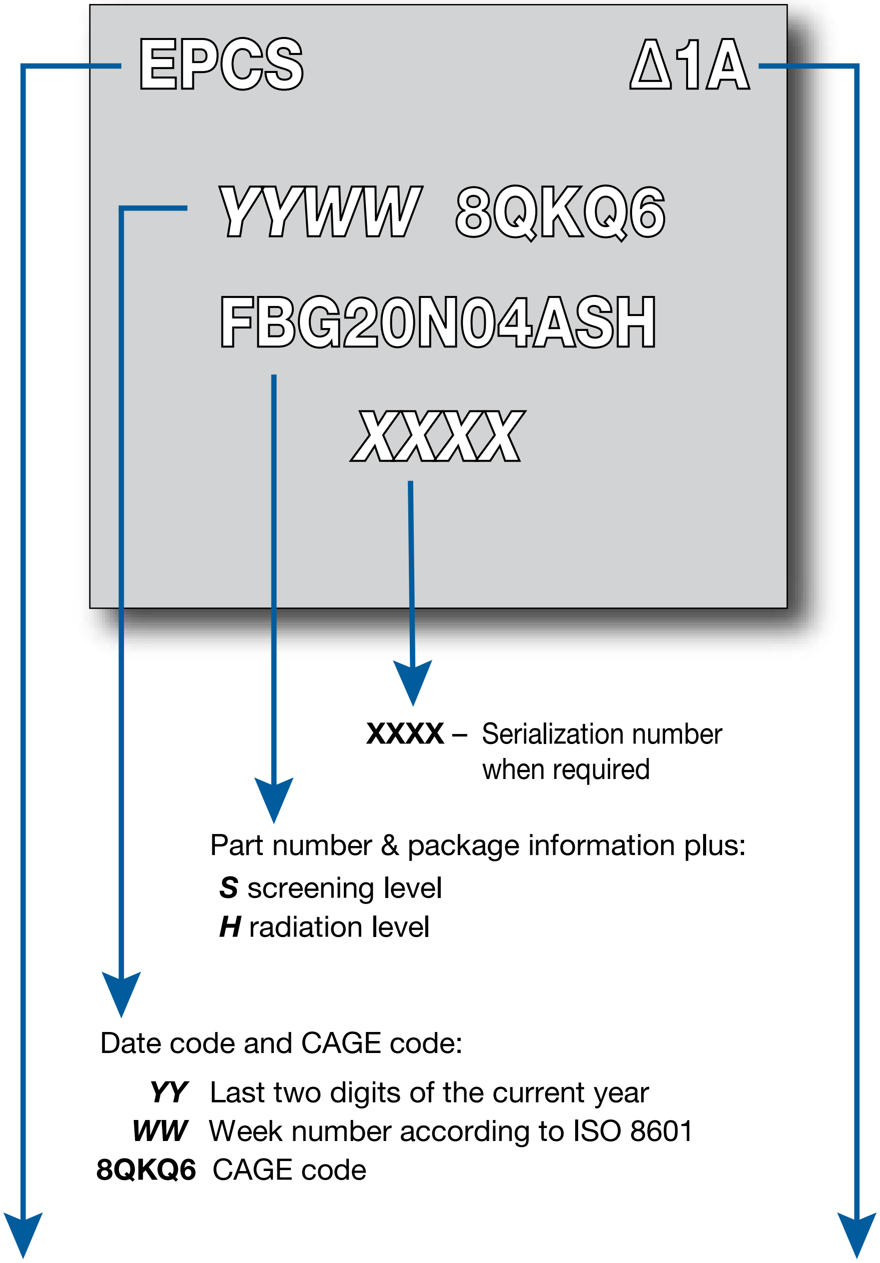
Screening Options	Rad Assurance Options
1 character	1 character
C = Developmental Unit V = Lite Screened S = Space Level[1]	R = 100 krad, LET = 64 F = 300 krad, LET = 64 G = 500 krad, LET = 64 H = 1000 krad, LET = 64 Z = 1000 krad, LET = 84

Part Number	Screening Level	Shipping
FBG20N04A*C	Engineering Samples	Waffle trays
FBG20N04A*S	Space Level	

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

C version FSMD-A units are intended for engineering development purposes only and NOT supplied with radiation performance guarantees nor supplemental data packages

EPC Space Product Marking Information



XXXX – Serialization number when required

Part number & package information plus:
S screening level
H radiation level

Date code and CAGE code:

YY	Last two digits of the current year
WW	Week number according to ISO 8601
8QKQ6	CAGE code

Company Identifier (**EPCS**)

ESD rating of the device located directly over the Gate pin

Data Package Order Detail
Consistent to MIL-PRF-19500 general specification

SPACE Screen

1. FBG20N04A*S – STANDARD DATA PACKAGE

A. Certificate of Compliance

B. Serialization Records

C. Preconditioning – Attributes Data Sheet

– HTRB - Hi Temp Gate Stress Post Reverse Bias Data and Delta Data

– HTRB - Hi Temp Drain Stress Post Reverse Bias Delta Data

D. Group A – Attributes Data Sheet

E. Group B – Attributes Data Sheet

F. Group D – Attributes Data Sheet

2. FBG20N04A*S – OPTIONAL DATA PACKAGE

A. Certificate of Compliance

B. Serialization Records

C. Assembly Flow Chart

D. SEM Photos and Report

E. Preconditioning – Attributes Data Sheet

– HTRB - Hi Temp Gate Stress Post Reverse Bias Data and Delta Data

– HTRB - Hi Temp Drain Stress Post Reverse Bias Delta Data

– X-Ray and X-Ray Report

F. Group A – Attributes Data Sheet

– Subgroups A1, A2, A3 and A7 Data

G. Group B – Attributes Data Sheet

– Subgroups B1, B2, B3, B4, B5 and B6 Data

H. Group C – Attributes Data Sheet

– Subgroups C1, C2, C3, C4, C6 and C7 Data

I. Group D – Attributes Data Sheet

– Pre and Post Radiation Data

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Patents

EPC Space holds numerous U.S patent. Any that apply to the product(s) listed in this document are identified by markings on the product(s) or on internal components of the product(s) in accordance with U.S Patent laws

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Revisions

Datasheet Revision	Product Status
REV P#	Proposal/development
REV Q#	Characterization and Qualification
M-700-005-E	Production Released

Information subject to change without notice.
Revised September, 2020

Contact EPC Space for further information and to order:

Email: sales@epc.space

Phone: +1 978 208 1334

Website: epc.space

Address: 17 Parkridge Road
Unit # E
Haverhill, MA 01835
USA