The RF Sub–Micron MOSFET Line
RF Power Field Effect Transistors
N–Channel Enhancement–Mode Lateral MOSFETs

MRF21125
MRF21125S

Designed for W–CDMA base station applications at frequencies from 2110 to 2170 MHz. Suitable for TDMA, CDMA and multicarrier amplifier applications. To be used in class AB for PCN–PCS/cellular radio and WLL applications.

**125 W, 2170 MHz, 28 V
LATERAL N–CHANNEL
BROADBAND
RF POWER MOSFETs**

- Typical 2–carrier W–CDMA Performance for V_{DD} = 28 Volts, I_{DQ} = 1600 mA, f1 = 2.1125 GHz, f2 = 2.1225 GHz, Channel bandwidth = 3.84 MHz, adjacent channels at ± 5 MHz , ACPR and IM3 measured in 3.84 MHz bandwidth. Peak/Avg = 8.5 dB @ 0.01% probability on CCDF.
  - Output Power: 20 Watts
  - Efficiency: 18%
  - Gain: 13 dB
  - IM3: –43 dBc
  - ACPR: –45 dBc
- 100% Tested under 2–carrier W–CDMA
- Internally Matched for Ease of Use
- High Gain, High Efficiency and High Linearity
- Integrated ESD Protection: Class 2 Human Body Model, Class M3 Machine Model
- Ease of Design for Gain and Insertion Phase Flatness
- Capable of Handling 5:1 VSWR, @ 28 Vdc, 2170 MHz, 125 Watts (CW) Output Power
- Excellent Thermal Stability

**CASE 465B–02, STYLE 1
(MRF21125)**
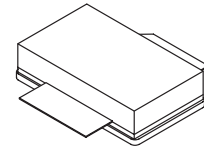
**CASE 465C–01, STYLE 1
(MRF21125S)**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain–Source Voltage	V_{DSS}	65	Vdc
Gate–Source Voltage	V_{GS}	+15, –0.5	Vdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	330 1.89	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.53	°C/W

NOTE – **CAUTION** – MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

MOTOROLA

ELECTRICAL CHARACTERISTICS $(T_C = 25°C$ unless otherwise noted)

| Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain–Source Breakdown Voltage ($V_{GS} = 0$, $I_D = 100$ µAdc)	$V_{(BR)DSS}$	65	—	—	Vdc
Gate–Source Leakage Current ($V_{GS} = 5$ Vdc, $V_{DS} = 0$ Vdc)	I_{GSS}	—	—	1	µAdc
Zero Gate Voltage Drain Leakage Current ($V_{DS} = 28$ Vdc, $V_{GS} = 0$)	I_{DSS}	—	—	10	µAdc
ON CHARACTERISTICS					
Forward Transconductance ($V_{DS} = 10$ Vdc, $I_D = 3$ Adc)	g_{fs}	—	10.8	—	S
Gate Threshold Voltage ($V_{DS} = 10$ V, $I_D = 300$ µA)	$V_{GS(th)}$	2	—	4	Vdc
Gate Quiescent Voltage ($V_{DS} = 28$ V, $I_D = 1300$ mA)	$V_{GS(Q)}$	2.5	3.9	4.5	Vdc
Drain–Source On–Voltage ($V_{GS} = 10$ V, $I_D = 1$ A)	$V_{DS(on)}$	—	0.12	—	Vdc
DYNAMIC CHARACTERISTICS					
Reverse Transfer Capacitance (1) ($V_{DS} = 28$ Vdc, $V_{GS} = 0$, f = 1 MHz)	C_{rss}	—	5.4	—	pF
FUNCTIONAL TESTS (In Motorola Test Fixture) 2–carrier W–CDMA, 10 MHz spacing, 3.84 MHz Channel Bandwidth, ± IM3 measured in 3.84 MHz Bandwidth. Peak/Avg = 8.5 dB @ 0.01% probability on CCDF.					
Common–Source Amplifier Power Gain ($V_{DD} = 28$ Vdc, $P_{out} = 20$ W Avg, 2–carrier W–CDMA, $I_{DQ} = 1600$ mA, f1 = 2.1125 GHz, f2 = 2.1225 GHz, and f1 = 2.1575 GHz, f2 = 2.1675 GHz)	G_{ps}	12	13	—	dB
Drain Efficiency ($V_{DD} = 28$ Vdc, $P_{out} = 20$ W Avg, 2–carrier W–CDMA, $I_{DQ} = 1600$ mA, f1 = 2.1125 GHz, f2 = 2.1225 GHz, and f1 = 2.1575 GHz, f2 = 2.1675 GHz)	η	17	18	—	%
Third Order Intermodulation Distortion ($V_{DD} = 28$ Vdc, $P_{out} = 20$ W Avg, 2–carrier W–CDMA, $I_{DQ} = 1600$ mA, f1 = 2.1125 GHz, f2 = 2.1225 GHz, and f1 = 2.1575 GHz, f2 = 2.1675 GHz. IM3 is measured in a 3.84 MHz bandwdith and referenced to the carrier power.)	± IM3	—	–43	–40	dBc
Adjacent Channel Power Ratio ($V_{DD} = 28$ Vdc, $P_{out} = 20$ W Avg, 2–carrier W–CDMA, $I_{DQ} = 1600$ mA, f1 = 2.1125 GHz, f2 = 2.1225 GHz, and f1 = 2.1575 GHz, f2 = 2.1675 GHz. ACPR is measured in a 3.84 MHz bandwdith and referenced to the carrier power.)	ACPR	—	–45	–40	dBc
Input Return Loss ($V_{DD} = 28$ Vdc, $P_{out} = 20$ W Avg, 2–carrier W–CDMA, $I_{DQ} = 1600$ mA, f1 = 2.1125 GHz, f2 = 2.1225 GHz, and f1 = 2.1575 GHz, f2 = 2.1675 GHz)	IRL	—	–12	–9.0	dB
Output Mismatch Stress ($V_{DD} = 28$ Vdc, $P_{out} = 125$ W CW, $I_{DQ} = 1600$ mA, f = 2170 MHz, VSWR = 5:1, All Phase Angles at Frequency of Test)	Ψ	No Degradation In Output Power Before and After Test			

(1) Part is internally matched both on input and output.

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
TYPICAL TWO–TONE PERFORMANCE					
Common–Source Amplifier Power Gain (V_{DD} = 28 Vdc, P_{out} = 125 W PEP, I_{DQ} = 1600 mA, f1 = 2110.0 MHz, f2 = 2120.0 MHz, and f1 = 2160.0 MHz, f2 = 2170.0 MHz)	G_{ps}	—	12	—	dB
Intermodulation Distortion (V_{DD} = 28 Vdc, P_{out} = 125 W PEP, I_{DQ} = 1600 mA, f1 = 2110.0 MHz, f2 = 2120.0 MHz, and f1 = 2160.0 MHz, f2 = 2170.0 MHz)	IMD	—	–30	—	dBc
Drain Efficiency (V_{DD} = 28 Vdc, P_{out} = 125 W PEP, I_{DQ} = 1600 mA, f1 = 2110.0 MHz, f2 = 2120.0 MHz, and f1 = 2160.0 MHz, f2 = 2170.0 MHz)	η	—	34	—	%
TYPICAL CW PERFORMANCE					
Common–Source Amplifier Power Gain (V_{DD} = 28 Vdc, P_{out} = 125 W CW, I_{DQ} = 1600 mA, f1 = 2170.0 MHz)	G_{ps}	—	11.5	—	dB
Drain Efficiency (V_{DD} = 28 Vdc, P_{out} = 125 W CW, I_{DQ} = 1600 mA, f = 2170.0 MHz)	η	—	46	—	%

Figure 1. MRF21125 Test Circuit Schematic
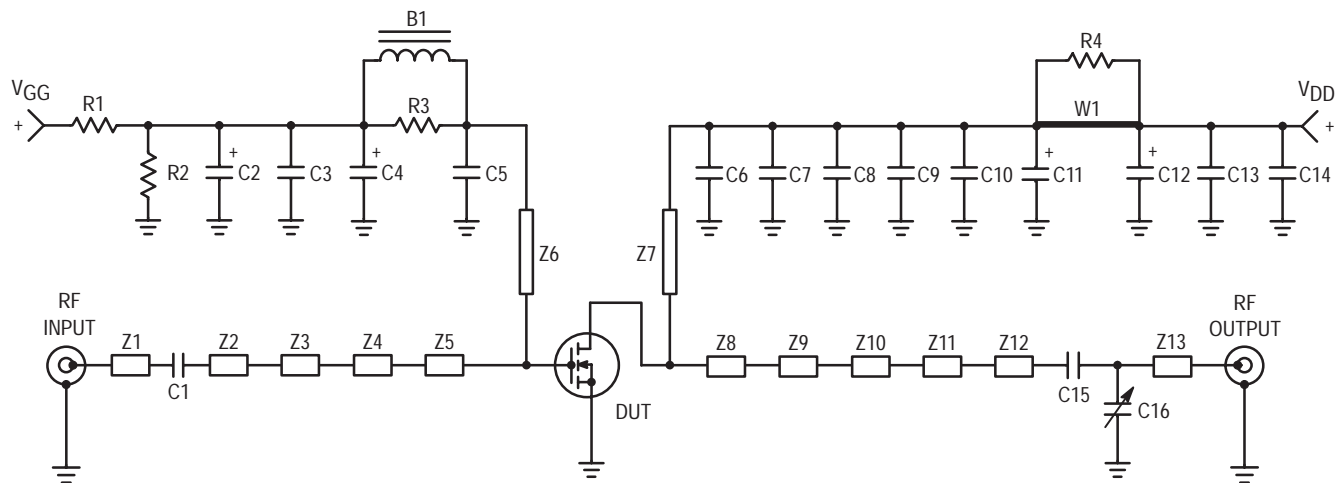
Z1   1.212″ x 0.082″ Microstrip
Z2   0.236″ x 0.082″ Microstrip
Z3   0.086″ x 0.254″ Microstrip
Z4   0.357″ x 0.082″ Microstrip
Z5   0.274″ x 1.030″ Microstrip
Z6   0.466″ x 0.050″ Microstrip
Z7   0.501″ x 0.050″ Microstrip
Z8   0.600″ x 1.056″ Microstrip

Z9   0.179″ x 0.219″ Microstrip
Z10   0.100″ x 0.336″ Microstrip
Z11   0.534″ x 0.142″ Microstrip
Z12   0.089″ x 0.080″ Microstrip
Z13   0.620″ x 0.080″ Microstrip
Raw Board   0.030″ Glass Teflon®, 2 oz Copper,
  Material   3″ x 5″ Dimensions,
             Arlon GX0300–55–22, ε_r = 2.55

Table 1. MRF21125 Component Designations and Values

Designators	Description
C1	9.1 pF, ATC RF Chip Capacitor, Case "B", #100B9R1CCA500X
C2, C4, C11, C12	22 µF, 35 V, Tantalum Surface Mount Chip Capacitors, Kemet, #T491X226K035AS4394
C3, C7	20000 pF, ATC RF Chip Capacitors, Case "B", #100B203JCA50X
C5, C14	5.1 pF, ATC RF Chip Capacitors, Case "B", #100B5R1CCA500X
C6	100000 pF, ATC RF Chip Capacitor, Case "B", #100B104JCA50X
C8	10000 pF, ATC RF Chip Capacitor, Case "B", #100B103JCA50X
C9	7.5 pF, ATC RF Chip Capacitor, Case "B", #100B7R5CCA500X
C10	1.2 pF, ATC RF Chip Capacitor, Case "B", #100B1R2CCA500X
C13	0.1 µF, Chip Capacitor, Kemet, #CDR33BX104AKWS
C15	16 pF, ATC RF Chip Capacitor, Case "B", #100B160KP500X
C16	0.6 – 4.5 pF, Variable Capacitor, Johanson Gigatrim, #27271SL
R1	1.0 kΩ, 1/8 W Chip Resistor
R2	560 kΩ, 1/8 W Chip Resistor
R3	4.7 Ω, 1/8 W Chip Resistor
R4	12 Ω, 1/8 W Chip Resistor
B1	Ferrite Bead (Square), Fair Rite, #2743019447
W1	Solid Copper Buss Wire, 16 AWG
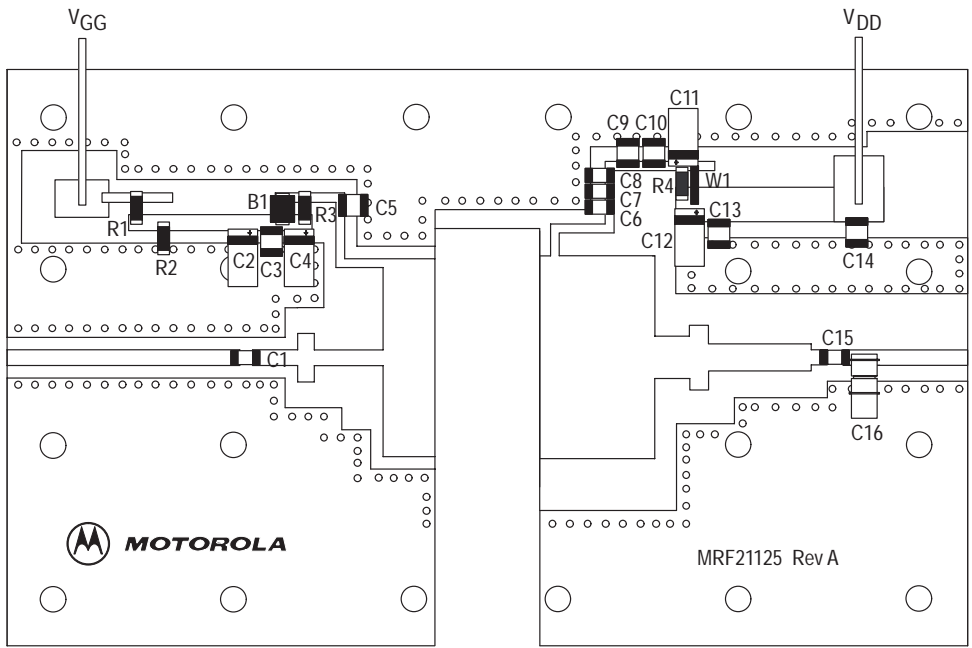
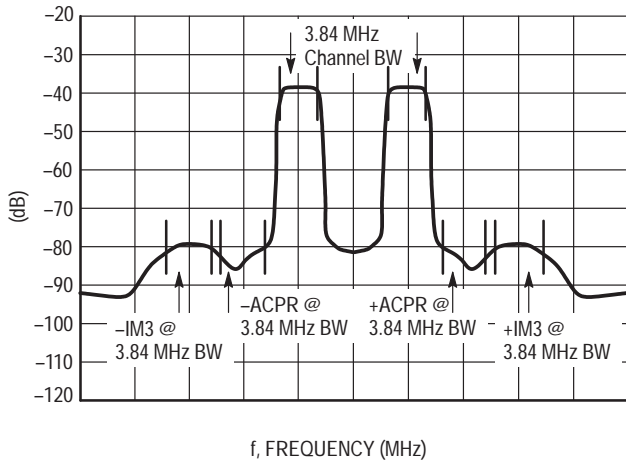**Figure 2. MRF21125 Test Circuit Component Layout**

TYPICAL CHARACTERISTICS

Figure 3. 2 Carrier (10 MHz spacing) W–CDMA Spectrum
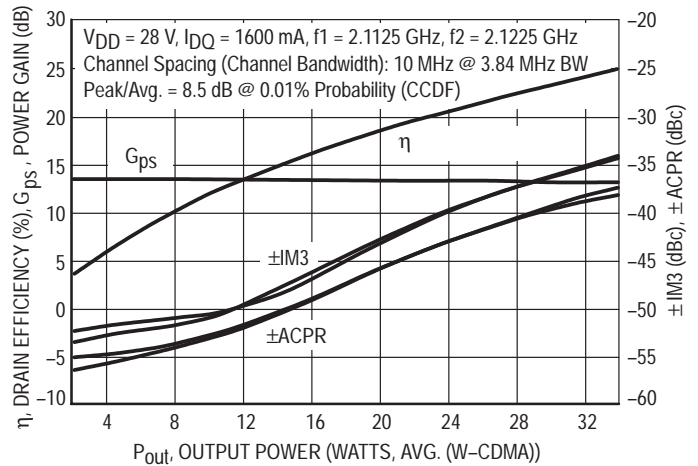

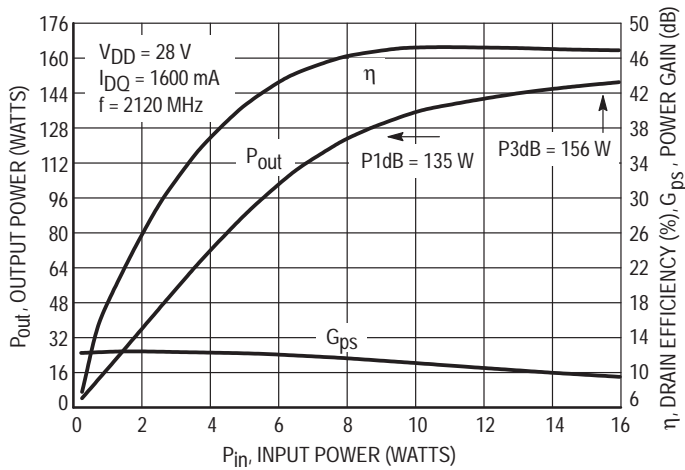**Figure 4. 2 Carrier W–CDMA ACPR, IM3, Power Gain and Drain Efficiency versus Output Power**
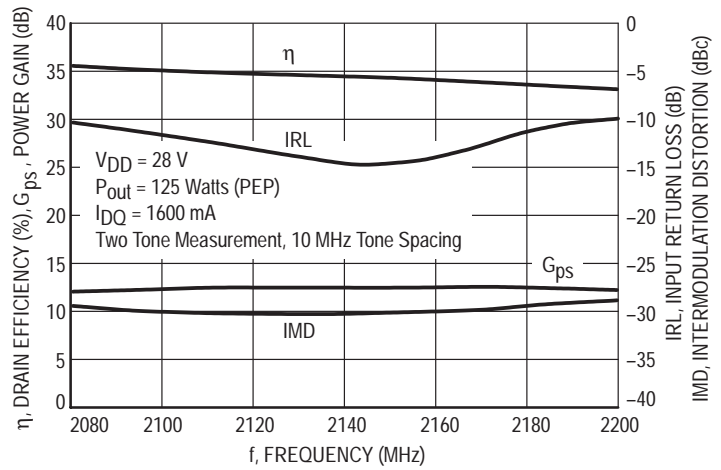

Figure 5. CW Performance
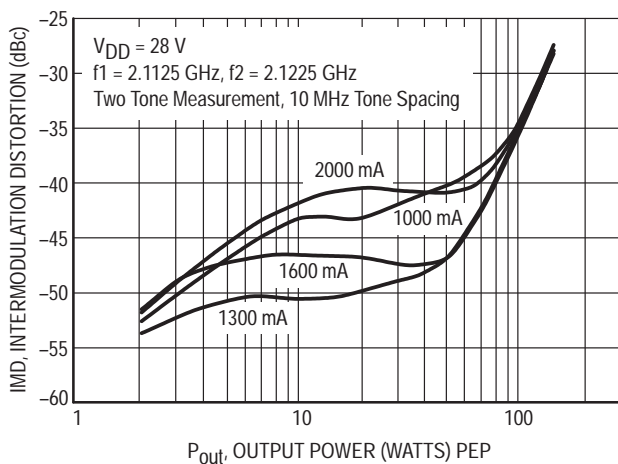

Figure 6. Broadband Linearity Performance

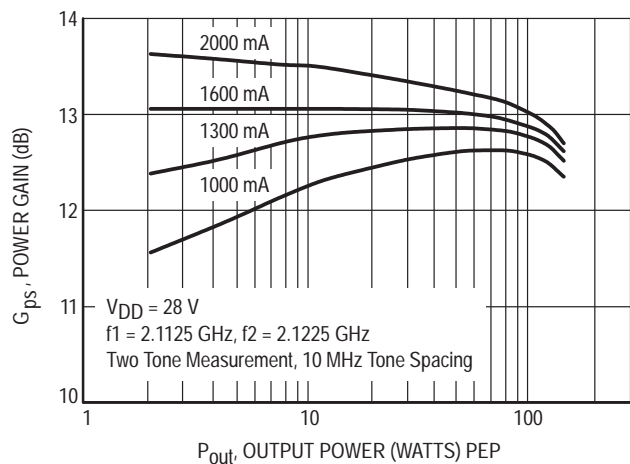
Figure 7. Intermodulation Distortion versus Output Power

Figure 8. Power Gain versus Output Power
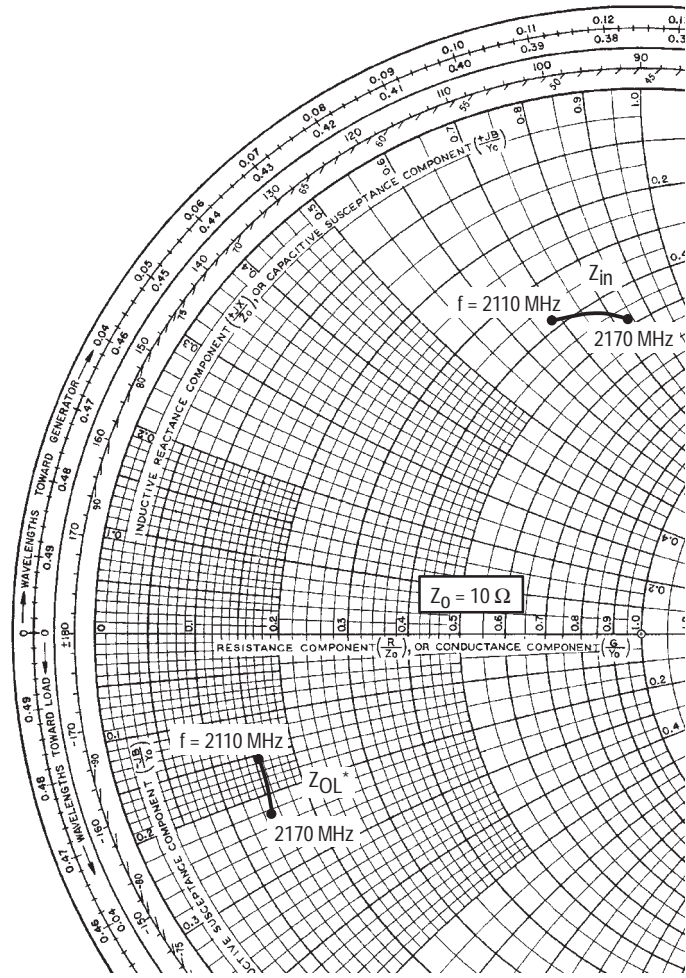
V_{DD} = 28 V, I_{DQ} = 1600 mA, P_{out} = 20 W_{avg}.,
2 – Carrier W–CDMA

f MHz	Z_{in} Ω	Z_{OL}^* Ω
2110	3.81 + j6.86	1.56 – j1.58
2140	4.33 + j7.90	1.53 – j1.90
2170	4.84 + j8.46	1.48 – j2.26

Z_{in} = Complex conjugate of source impedance.

Z_{OL}^* = Complex conjugate of the optimum load
           impedance at a given output power, voltage,
           IMD, bias current and frequency.

Note 1: Z_{OL}^* was chosen based on tradeoffs between gain, output
         power, drain efficiency and intermodulation distortion.
Note 2: Measurements were taken on the MRF21125 test circuit
         with SMA Launchers.

Figure 9. Series Equivalent Input and Output Impedance

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PACKAGE DIMENSIONS
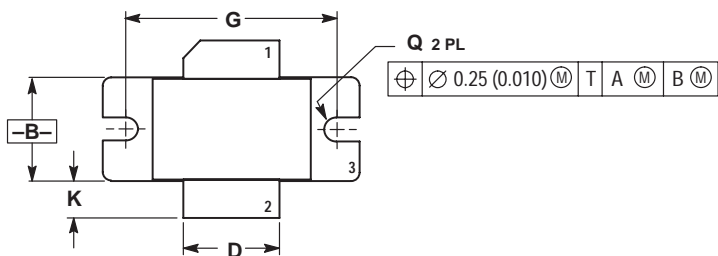
**CASE 465B–02
ISSUE A
(MRF21125)**
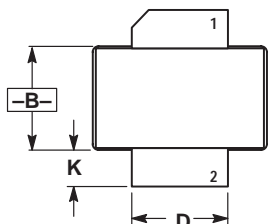
	INCHES		MILLIMETERS	
DIM	**MIN**	**MAX**	**MIN**	**MAX**
A	1.335	1.345	33.91	34.16
B	0.535	0.545	13.6	13.8
C	0.155	0.200	3.94	5.08
D	0.495	0.505	12.57	12.83
E	0.035	0.045	0.89	1.14
F	0.003	0.006	0.08	0.15
G	1.100 BSC		27.94 BSC	
H	0.057	0.067	1.45	1.70
K	0.170	0.210	4.32	5.33
N	0.871	0.889	19.30	22.60
Q	0.118	0.138	3.00	3.51
R	0.515	0.525	13.10	13.30

STYLE 1:
PIN 1. DRAIN
2. GATE
3. SOURCE

**CASE 465C–01
ISSUE O
(MRF21125S)**

	INCHES		MILLIMETERS	
DIM	**MIN**	**MAX**	**MIN**	**MAX**
A	0.905	0.915	22.99	23.24
B	0.535	0.545	13.6	13.8
C	0.155	0.200	3.94	5.08
D	0.495	0.505	12.57	12.83
E	0.035	0.045	0.89	1.14
F	0.003	0.006	0.08	0.15
H	0.057	0.067	1.45	1.70
K	0.170	0.210	4.32	5.33
N	0.871	0.889	19.30	22.60
R	0.515	0.525	13.10	13.30

STYLE 1:
PIN 1. DRAIN
2. GATE
3. SOURCE

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