

CGH40120F

120 W, RF Power GaN HEMT

Cree's CGH40120F is an unmatched, gallium nitride (GaN) high electron mobility transistor (HEMT). The CGH40120F, operating from a 28 volt rail, offers a general purpose, broadband solution to a variety of RF and microwave applications. GaN HEMTs offer high efficiency, high gain and wide bandwidth capabilities making the CGH40120F ideal for linear and compressed amplifier circuits.

The transistor is available in a flange package.



Package Types: 440193
PN: CGH40120F

FEATURES

- Up to 2.5 GHz Operation
- 20 dB Small Signal Gain at 1.0 GHz
- 15 dB Small Signal Gain at 2.0 GHz
- 120 W Typical P_{SAT}
- 70 % Efficiency at P_{SAT}
- 28 V Operation

APPLICATIONS

- 2-Way Private Radio
- Broadband Amplifiers
- Cellular Infrastructure
- Test Instrumentation
- Class A, AB, Linear amplifiers suitable for OFDM, W-CDMA, EDGE, CDMA waveforms



Large Signal Models Available for SiC & GaN



Absolute Maximum Ratings (not simultaneous) at 25 °C Case Temperature

| Parameter | Symbol | Rating | Units | Conditions |
|---|-----------------|-----------|-------|------------|
| Drain-Source Voltage | V_{DSS} | 84 | Volts | 25 °C |
| Gate-to-Source Voltage | V_{GS} | -10, +2 | Volts | 25 °C |
| Storage Temperature | T_{STG} | -65, +150 | °C | |
| Operating Junction Temperature | T_J | 225 | °C | |
| Maximum Forward Gate Current | I_{GMAX} | 30 | mA | 25 °C |
| Maximum Drain Current ¹ | I_{DMAX} | 12 | A | 25 °C |
| Soldering Temperature ² | T_S | 245 | °C | |
| Screw Torque | τ | 80 | in-oz | |
| Thermal Resistance, Junction to Case ³ | $R_{\theta JC}$ | 1.5 | °C/W | 85 °C |
| Case Operating Temperature ^{3,4} | T_C | -40, +150 | °C | 30 seconds |

Note:

¹ Current limit for long term, reliable operation

² Refer to the Application Note on soldering at www.cree.com/products/wireless_appnotes.asp

³ Measured for the CGH40120F at $P_{DISS} = 112$ W.

⁴ See also, the Power Dissipation De-rating Curve on Page 7.

Electrical Characteristics ($T_C = 25$ °C)

| Characteristics | Symbol | Min. | Typ. | Max. | Units | Conditions |
|---|--------------|------|------|--------|----------|--|
| DC Characteristics¹ | | | | | | |
| Gate Threshold Voltage | $V_{GS(th)}$ | -3.8 | -3.0 | -2.3 | V_{DC} | $V_{DS} = 10$ V, $I_D = 28.8$ mA |
| Gate Quiescent Voltage | $V_{GS(Q)}$ | - | -2.7 | - | V_{DC} | $V_{DS} = 28$ V, $I_D = 1.0$ A |
| Saturated Drain Current ² | I_{DS} | 23.2 | 28.0 | - | A | $V_{DS} = 6.0$ V, $V_{GS} = 2.0$ V |
| Drain-Source Breakdown Voltage | V_{BR} | 120 | - | - | V_{DC} | $V_{GS} = -8$ V, $I_D = 28.8$ mA |
| RF Characteristics³ ($T_C = 25$ °C, $F_0 = 1.3$ GHz unless otherwise noted) | | | | | | |
| Small Signal Gain | G_{SS} | 17.5 | 19 | - | dB | $V_{DD} = 28$ V, $I_{DQ} = 1.0$ A |
| Power Output ⁴ | P_{SAT} | 100 | 120 | - | W | $V_{DD} = 28$ V, $I_{DQ} = 1.0$ A |
| Drain Efficiency ⁵ | η | 55 | 70 | - | % | $V_{DD} = 28$ V, $I_{DQ} = 1.0$ A, $P_{OUT} = P_{SAT}$ |
| Output Mismatch Stress | VSWR | - | - | 10 : 1 | Ψ | No damage at all phase angles, $V_{DD} = 28$ V, $I_{DQ} = 1.0$ A, $P_{OUT} = 100$ W CW |
| Dynamic Characteristics | | | | | | |
| Input Capacitance | C_{GS} | - | 35.3 | - | pF | $V_{DS} = 28$ V, $V_{GS} = -8$ V, $f = 1$ MHz |
| Output Capacitance | C_{DS} | - | 9.1 | - | pF | $V_{DS} = 28$ V, $V_{GS} = -8$ V, $f = 1$ MHz |
| Feedback Capacitance | C_{GD} | - | 1.6 | - | pF | $V_{DS} = 28$ V, $V_{GS} = -8$ V, $f = 1$ MHz |

Notes:

¹ Measured on wafer prior to packaging.

² Scaled from PCM data.

³ Measured in CGH40120F-TB.

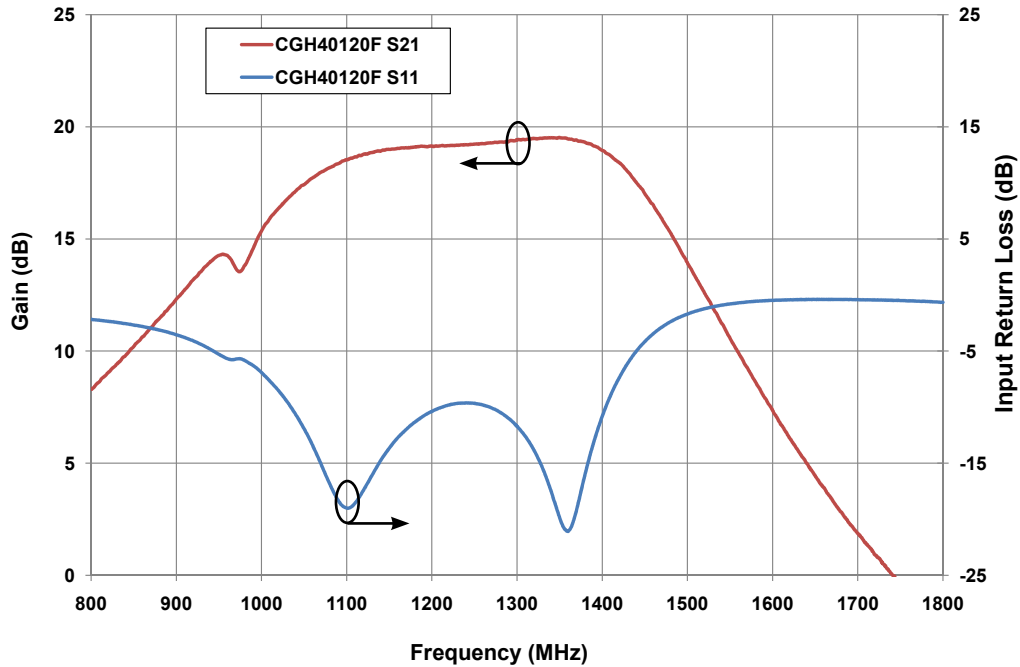
⁴ P_{SAT} is defined as $I_G = 2.8$ mA.

⁵ Drain Efficiency = P_{OUT} / P_{DC}

Typical Performance

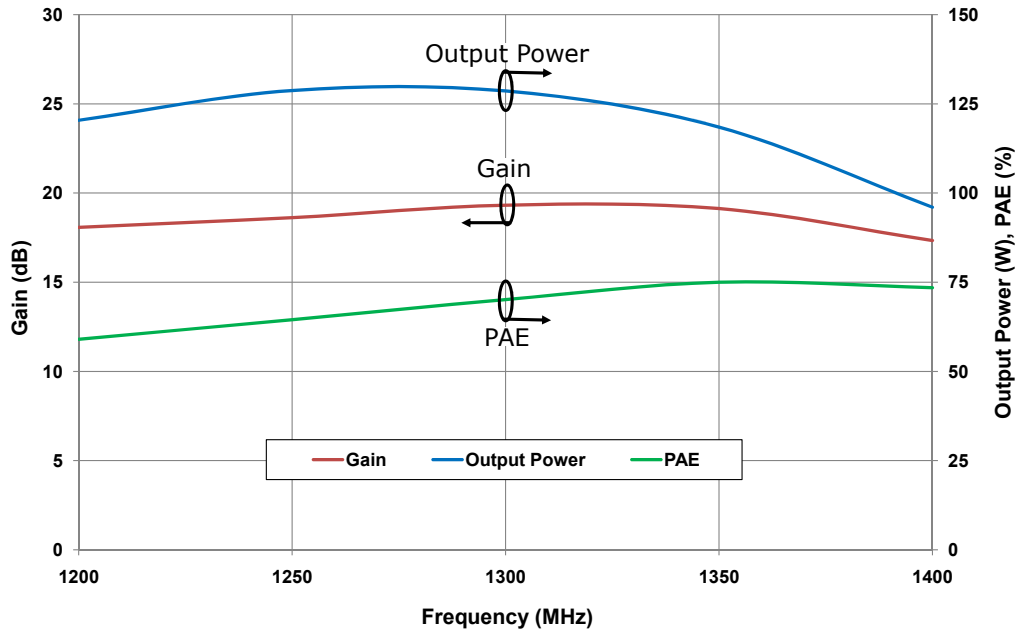
Gain and Input Return Loss vs Frequency of the CGH40120F measured in Broadband Amplifier Circuit CGH40120F-TB

$V_{DD} = 28\text{ V}, I_{DQ} = 1.0\text{ A}$



Gain, Output Power and PAE vs Frequency of the CGH40120F measured in Broadband Amplifier Circuit CGH40120F-TB

$V_{DD} = 28\text{ V}, I_{DQ} = 1.0\text{ A}$

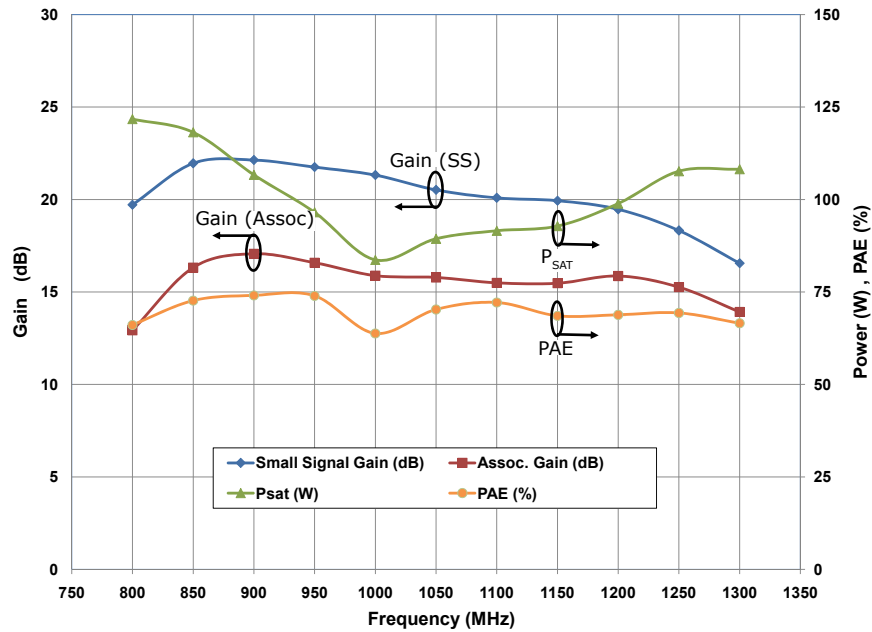




Typical 800 MHz - 1300 MHz Performance

Gain, Output Power, and Power Added Efficiency vs Frequency of the CGH40120F measured in 0.8-1.3 GHz Amplifier Circuit 03-000255.

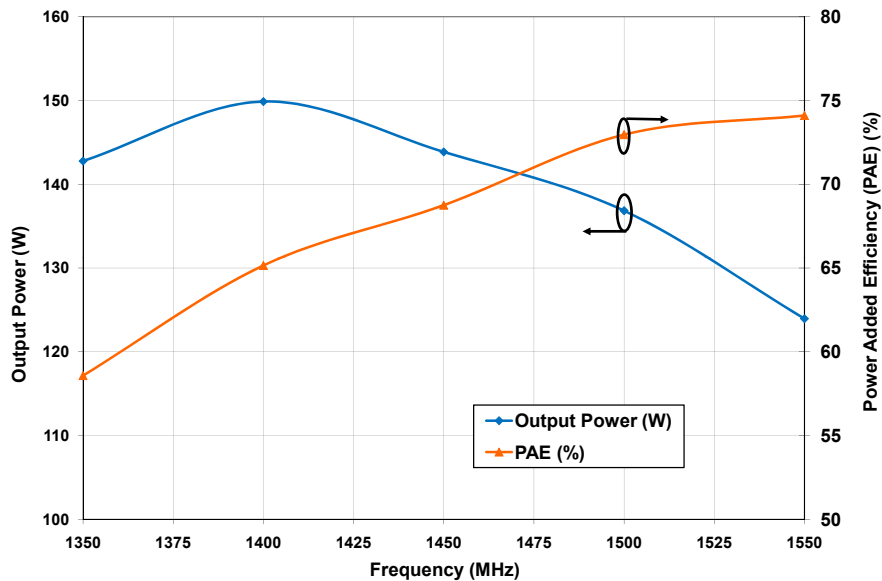
$$V_{DD} = 28 \text{ V}, I_{DQ} = 1.0 \text{ A}$$



Typical Digital Video Broadcast (DVB) Performance

Output Power and Power Added Efficiency vs Frequency of the CGH40120F measured in DVB Amplifier Circuit 03-000256.

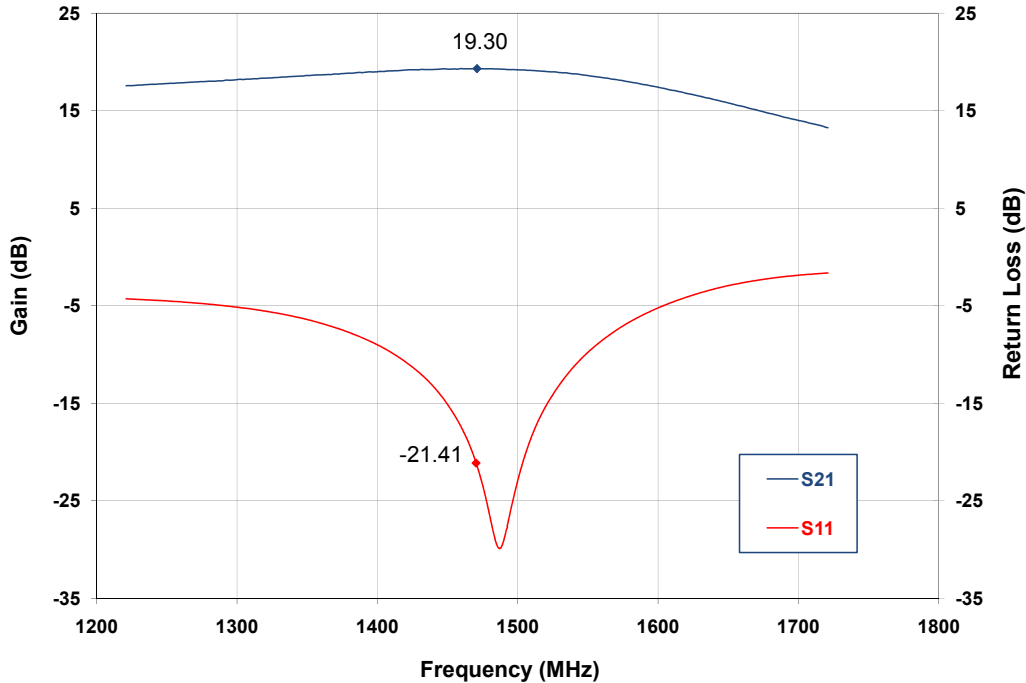
$$V_{DD} = 32 \text{ V}, I_{DQ} = 1.0 \text{ A}$$



Typical Digital Video Broadcast (DVB) Performance

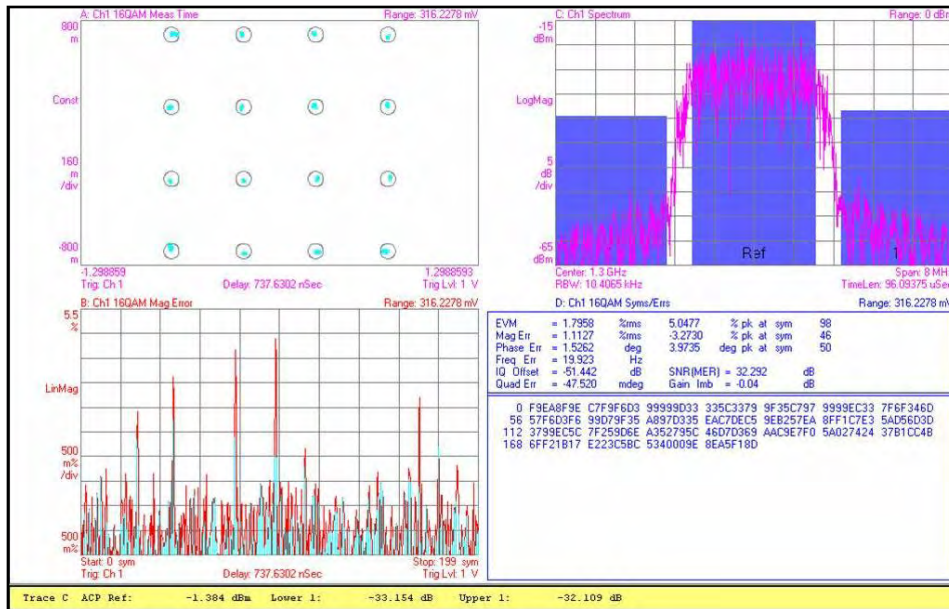
Small Signal Gain and Return Loss vs Frequency of the CGH40120F measured in DVB Amplifier Circuit 03-000256.

$V_{DD} = 32 \text{ V}$, $I_{DQ} = 1.0 \text{ A}$



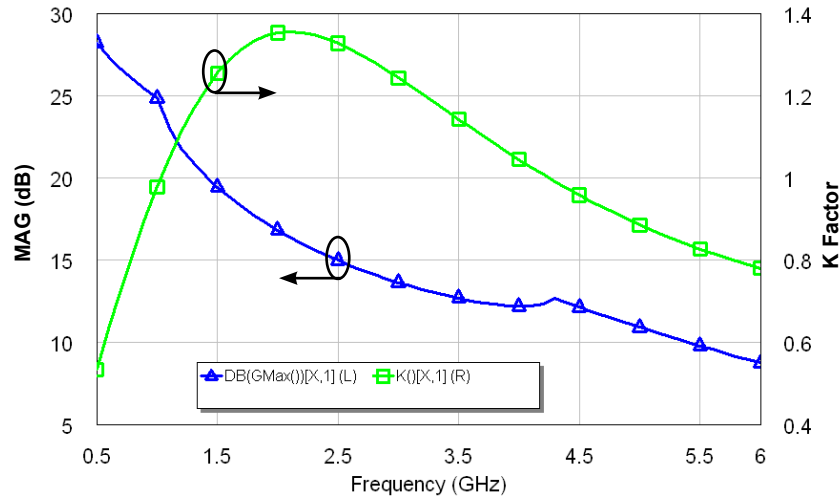
Typical Constellation Chart and Spectral Mask using 16QAM OFDM for a CGH40120F in DVB Amplifier Circuit 03-000256 at 1450 MHz.

$V_{DD} = 32 \text{ V}$, $I_{DQ} = 1.0 \text{ A}$, $P_{AVE} = 40 \text{ W}$, Drain Efficiency = 40 %, Signal PAR = 5.3 dB



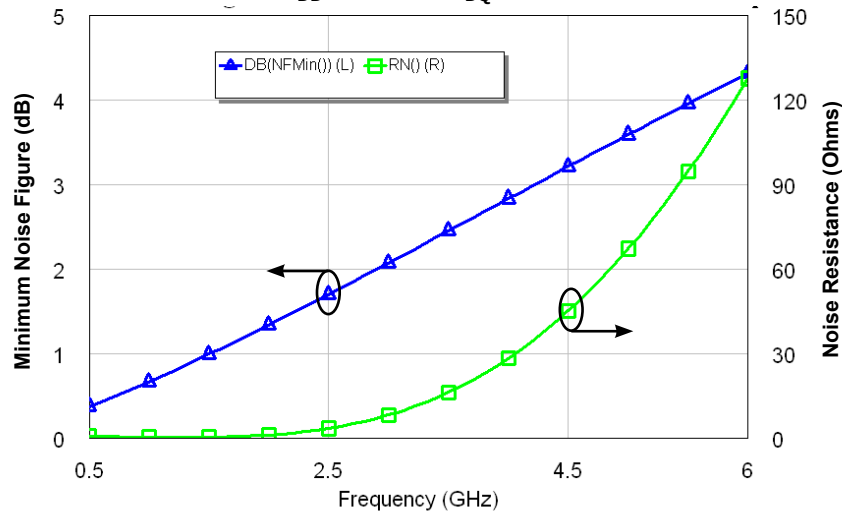
Typical Performance

Simulated Maximum Available Gain and K Factor of the CGH40120F
 $V_{DD} = 28\text{ V}, I_{DQ} = 1.0\text{ A}$



Typical Noise Performance

Simulated Minimum Noise Figure and Noise Resistance vs Frequency of the CGH40120F
 $V_{DD} = 28\text{ V}, I_{DQ} = 1\text{ A}$

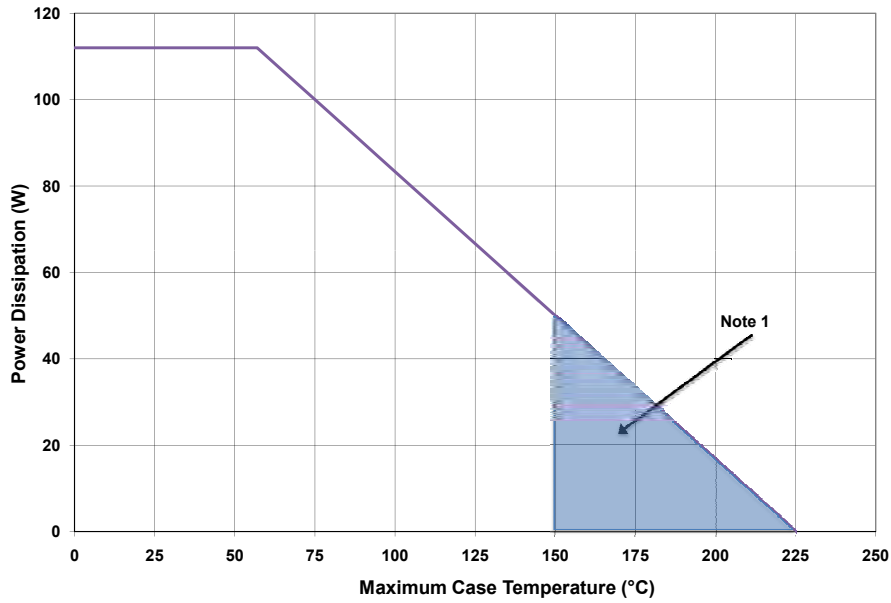


Electrostatic Discharge (ESD) Classifications

| Parameter | Symbol | Class | Test Methodology |
|---------------------|--------|------------|---------------------|
| Human Body Model | HBM | 1A > 250 V | JEDEC JESD22 A114-D |
| Charge Device Model | CDM | 1 < 200 V | JEDEC JESD22 C101-C |

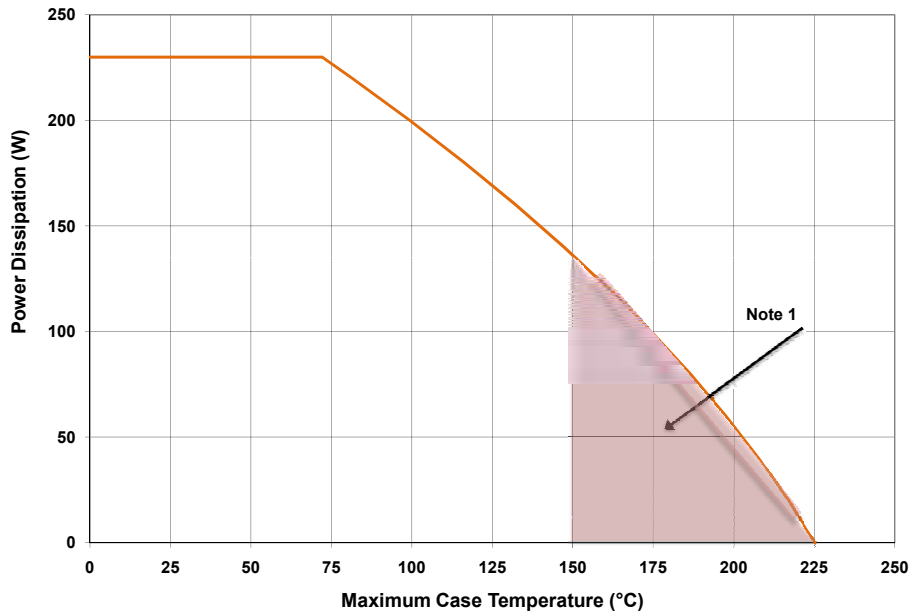


CGH40120F CW Power Dissipation De-rating Curve



Note 1. Area exceeds Maximum Case Operating Temperature (See Page 2).

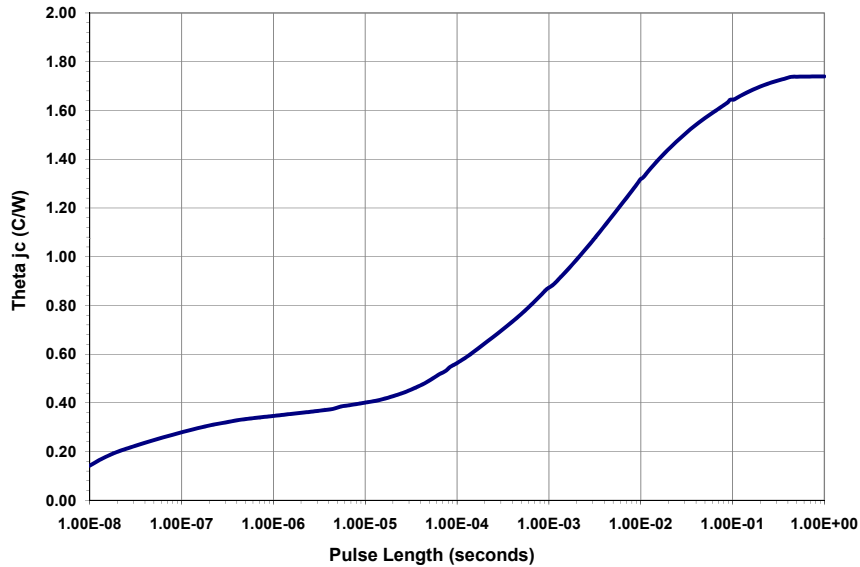
CGH40120F Transient Power Dissipation De-rating Curve



Note 1. Area exceeds Maximum Case Operating Temperature (See Page 2).

Note 2. This transient de-rating curve assumes a 100usec pulse with a 10% duty cycle with no power dissipated during the "off-cycle."

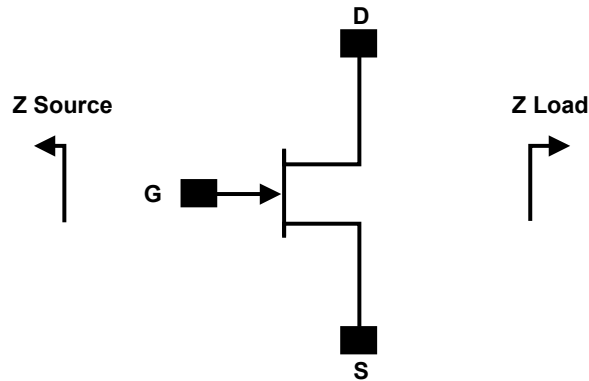
Thermal Resistance as a Function of Pulse Width



Note 1: This heating curve assumes zero power dissipation during the “off” portion of the duty cycle.

Note 2: This data is for transient power dissipation at 230 W, Duty Cycle = 10 %.

Source and Load Impedances



| Frequency (MHz) | Z Source | Z Load |
|-----------------|--------------|--------------|
| 500 | 2 + j3.3 | 5.14 + j0.04 |
| 1000 | 0.81 + j0.18 | 4.68 - j0.26 |
| 1500 | 0.75 - j1.56 | 3.44 - j0.77 |
| 2000 | 0.84 - j3 | 2.34 - j0.95 |
| 2500 | 1.2 - j4.43 | 2.7 - j2.56 |
| 3000 | 1.09 - j5.9 | 3.06 - j3.82 |

Note 1. $V_{DD} = 28V$, $I_{DQ} = 1.0 A$ in the 440193 package.

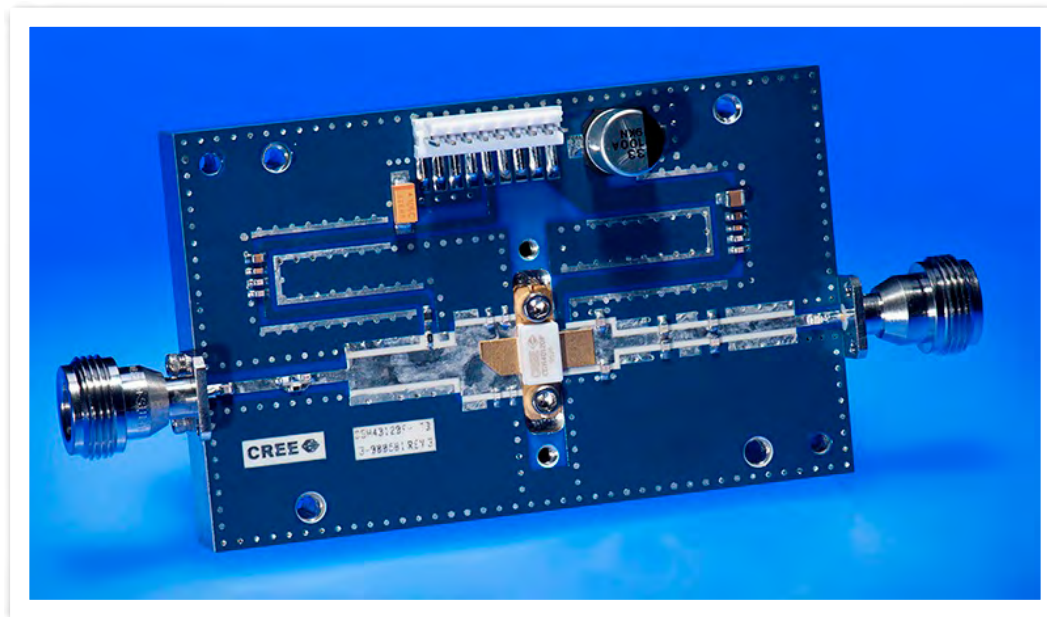
Note 2. Optimized for power gain, P_{SAT} and PAE.

Note 3. When using this device at low frequency, series resistors should be used to maintain amplifier stability.

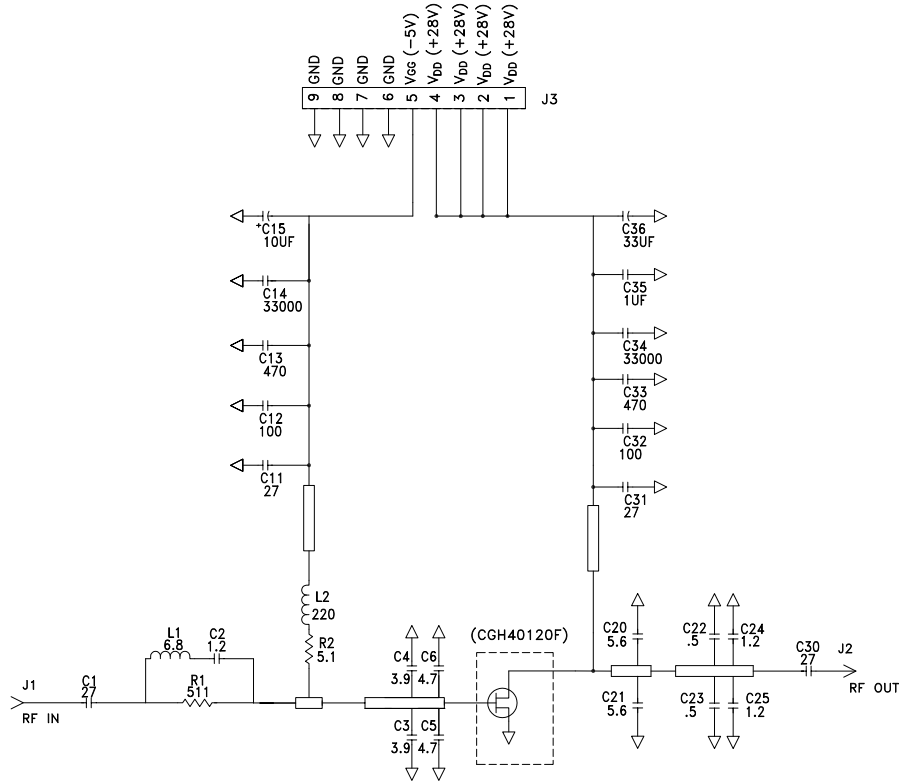
CGH40120F-TB Demonstration Amplifier Circuit Bill of Materials

| Designator | Description | Qty |
|------------|---|-----|
| C1, C30 | CAP, 27 PF +/- 5%, 250V, 0805, ATC 600F | 2 |
| C2 | CAP, 1.2 pF, +/- 0.1 pF, 0603, ATC 600S | 1 |
| C3, C4 | CAP, 3.9 pF, +/- 0.1 pF, 0603, ATC 600S | 2 |
| C5, C6 | CAP, 4.7 pF, +/- 0.1 pF, 0603, ATC 600S | 2 |
| C11, C31 | CAP, 27pF,+/-5%, 0603, ATC 600S | 2 |
| C12, C32 | CAP, 100 pF, +/- 5%, 0603, ATC 600S | 2 |
| C13, C33 | CAP, 470 pF +/- 5%,100 V, 0603, Murata | 2 |
| C14, C34 | CAP, CER, 33000 pF, 100V, X7R, 0805, Murata | 2 |
| C15 | CAP, 10 uF, 16V, SMT, TANTALUM | 1 |
| C35 | CAP, CER, 1.0 uF, 100V, +/- 10%, X7R, 1210 | 1 |
| C36 | CAP, 33 uF, 100V, ELECT, FK, SMD | 1 |
| C20, C21 | CAP, 5.6 PF +/- 0.1 pF, 0805, ATC 600F | 2 |
| C22, C23 | CAP, 0.5 PF +/- 0.05 pF, 0805, ATC 600F | 2 |
| C24, C25 | CAP, 1.2 PF +/- 0.1 pF, 0805, ATC 600F | 2 |
| R1 | RES, 1/16W, 0603, 511 Ohms (≤5% tolerance) | 1 |
| R2 | RES, 1/16W, 0603, 5.1 Ohms (≤5% tolerance) | 1 |
| L1 | IND, 6.8 nH, 0603, L-14C6N8ST | 1 |
| L2 | IND, FERRITE, 220 OHM, 0805, BLM21PG221SN1 | 1 |
| J1, J2 | CONN, N-Type, Female, 0.500 SMA Flange | 2 |
| J3 | CONN, Header, RT> PLZ, 0.1 CEN, LK, 9 POS | 1 |
| - | PCB, RO4003, Er = 3.38, h = 32 mil | 1 |
| Q1 | CGH40120F | 1 |

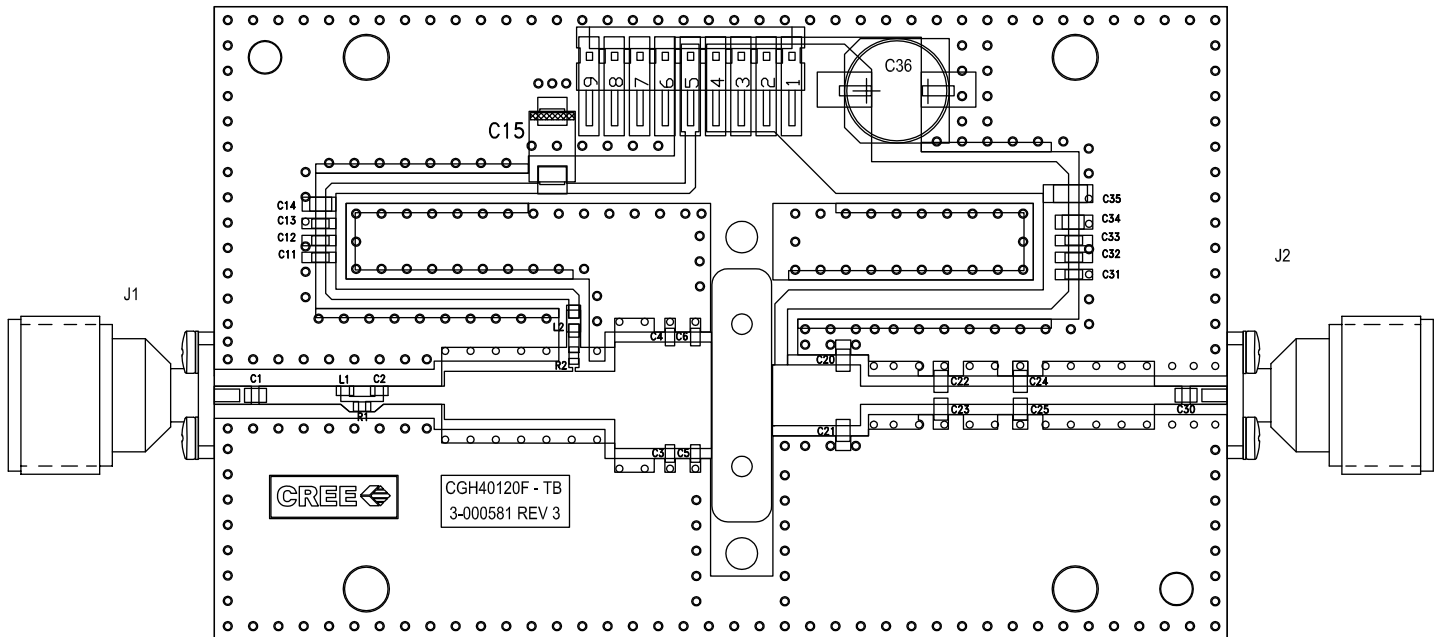
CGH40120F-TB Demonstration Amplifier Circuit



CGH40120F-TB Demonstration Amplifier Circuit Schematic



CGH40120F-TB Demonstration Amplifier Circuit Outline



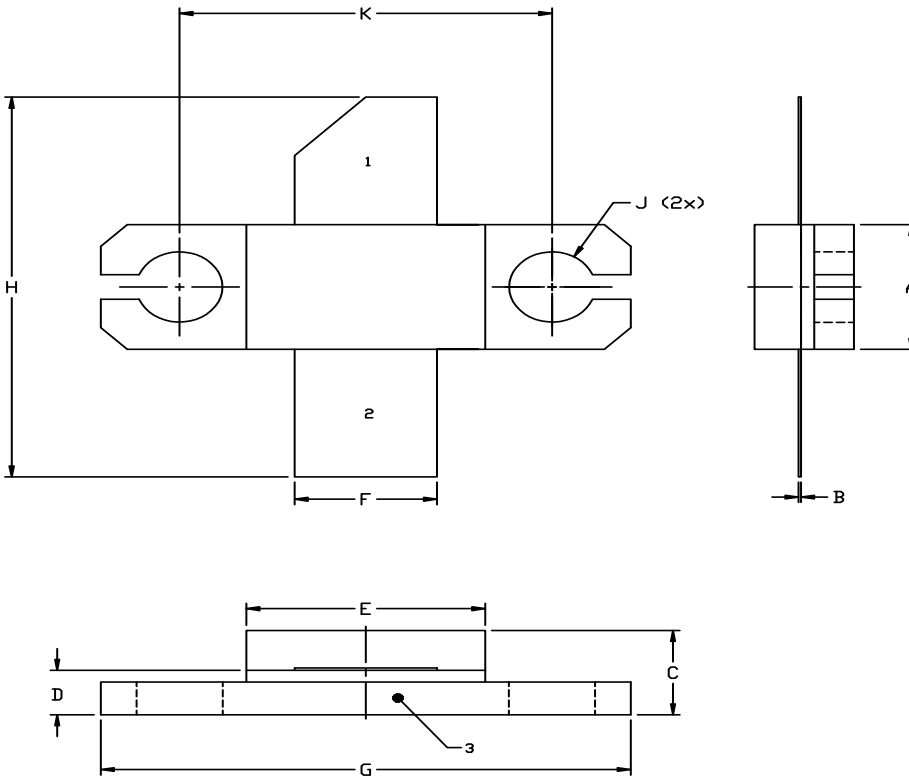


Typical Package S-Parameters for CGH40120F
(Small Signal, $V_{DS} = 28\text{ V}$, $I_{DQ} = 1.0\text{ A}$, angle in degrees)

| Frequency | Mag S11 | Ang S11 | Mag S21 | Ang S21 | Mag S12 | Ang S12 | Mag S22 | Ang S22 |
|-----------|---------|---------|---------|---------|---------|---------|---------|---------|
| 500 MHz | 0.961 | -177.60 | 4.19 | 80.16 | 0.006 | 13.42 | 0.807 | -179.57 |
| 600 MHz | 0.961 | -178.85 | 3.49 | 77.38 | 0.006 | 15.30 | 0.808 | -179.85 |
| 700 MHz | 0.961 | -179.89 | 2.99 | 74.72 | 0.006 | 17.30 | 0.810 | 179.89 |
| 800 MHz | 0.961 | 179.22 | 2.61 | 72.16 | 0.007 | 19.36 | 0.811 | 179.66 |
| 900 MHz | 0.961 | 178.41 | 2.32 | 69.66 | 0.007 | 21.47 | 0.813 | 179.42 |
| 1.0 GHz | 0.960 | 177.67 | 2.09 | 67.22 | 0.007 | 23.59 | 0.815 | 179.18 |
| 1.1 GHz | 0.960 | 176.96 | 1.89 | 64.83 | 0.007 | 25.71 | 0.817 | 178.94 |
| 1.2 GHz | 0.960 | 176.28 | 1.73 | 62.49 | 0.007 | 27.81 | 0.819 | 178.68 |
| 1.3 GHz | 0.960 | 175.63 | 1.60 | 60.18 | 0.007 | 29.86 | 0.822 | 178.41 |
| 1.4 GHz | 0.960 | 174.99 | 1.48 | 57.92 | 0.008 | 31.86 | 0.824 | 178.13 |
| 1.5 GHz | 0.960 | 174.36 | 1.38 | 55.69 | 0.008 | 33.80 | 0.826 | 177.83 |
| 1.6 GHz | 0.960 | 173.73 | 1.30 | 53.50 | 0.008 | 35.65 | 0.828 | 177.52 |
| 1.7 GHz | 0.960 | 173.11 | 1.22 | 51.35 | 0.008 | 37.40 | 0.830 | 177.19 |
| 1.8 GHz | 0.959 | 172.49 | 1.15 | 49.23 | 0.009 | 39.06 | 0.832 | 176.84 |
| 1.9 GHz | 0.959 | 171.86 | 1.10 | 47.15 | 0.009 | 40.61 | 0.835 | 176.47 |
| 2.0 GHz | 0.959 | 171.23 | 1.04 | 45.09 | 0.010 | 42.04 | 0.837 | 176.09 |
| 2.1 GHz | 0.958 | 170.59 | 0.99 | 43.07 | 0.010 | 43.36 | 0.839 | 175.69 |
| 2.2 GHz | 0.958 | 169.95 | 0.95 | 41.08 | 0.011 | 44.56 | 0.840 | 175.28 |
| 2.3 GHz | 0.957 | 169.29 | 0.91 | 39.12 | 0.011 | 45.64 | 0.842 | 174.85 |
| 2.4 GHz | 0.957 | 168.63 | 0.88 | 37.18 | 0.012 | 46.60 | 0.844 | 174.40 |
| 2.5 GHz | 0.956 | 167.95 | 0.85 | 35.28 | 0.012 | 47.45 | 0.845 | 173.93 |
| 2.6 GHz | 0.956 | 167.26 | 0.82 | 33.39 | 0.013 | 48.18 | 0.847 | 173.45 |
| 2.7 GHz | 0.955 | 166.56 | 0.79 | 31.53 | 0.014 | 48.80 | 0.848 | 172.94 |
| 2.8 GHz | 0.954 | 165.84 | 0.77 | 29.68 | 0.014 | 49.32 | 0.849 | 172.43 |
| 2.9 GHz | 0.953 | 165.10 | 0.75 | 27.86 | 0.015 | 49.74 | 0.850 | 171.89 |
| 3.0 GHz | 0.952 | 164.34 | 0.73 | 26.04 | 0.016 | 50.05 | 0.851 | 171.33 |
| 3.2 GHz | 0.950 | 162.75 | 0.70 | 22.46 | 0.018 | 50.40 | 0.852 | 170.17 |
| 3.4 GHz | 0.948 | 161.07 | 0.68 | 18.91 | 0.020 | 50.38 | 0.852 | 168.93 |
| 3.6 GHz | 0.944 | 159.27 | 0.66 | 15.37 | 0.023 | 50.02 | 0.852 | 167.61 |
| 3.8 GHz | 0.941 | 157.33 | 0.65 | 11.82 | 0.025 | 49.32 | 0.850 | 166.19 |
| 4.0 GHz | 0.936 | 155.23 | 0.64 | 8.23 | 0.029 | 48.30 | 0.848 | 164.68 |
| 4.2 GHz | 0.931 | 152.94 | 0.64 | 4.57 | 0.033 | 46.94 | 0.844 | 163.06 |
| 4.4 GHz | 0.925 | 150.43 | 0.64 | 0.80 | 0.037 | 45.24 | 0.840 | 161.32 |
| 4.6 GHz | 0.917 | 147.66 | 0.65 | -3.12 | 0.042 | 43.18 | 0.834 | 159.44 |
| 4.8 GHz | 0.908 | 144.59 | 0.66 | -7.23 | 0.048 | 40.72 | 0.826 | 157.41 |
| 5.0 GHz | 0.896 | 141.14 | 0.68 | -11.60 | 0.055 | 37.83 | 0.817 | 155.20 |
| 5.2 GHz | 0.883 | 137.25 | 0.71 | -16.29 | 0.064 | 34.45 | 0.805 | 152.81 |
| 5.4 GHz | 0.866 | 132.84 | 0.74 | -21.37 | 0.074 | 30.53 | 0.791 | 150.19 |
| 5.6 GHz | 0.845 | 127.78 | 0.78 | -26.94 | 0.086 | 25.97 | 0.774 | 147.33 |
| 5.8 GHz | 0.820 | 121.95 | 0.83 | -33.09 | 0.101 | 20.69 | 0.755 | 144.21 |
| 6.0 GHz | 0.789 | 115.17 | 0.88 | -39.95 | 0.118 | 14.58 | 0.731 | 140.79 |

Download this s-parameter file in ".s2p" format at http://www.cree.com/products/wireless_s-parameters.asp

Product Dimensions CGH40120F (Package Type – 440193)



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. ADHESIVE FROM LID MAY EXTEND A MAXIMUM OF 0.020" BEYOND EDGE OF LID.
4. LID MAY BE MISALIGNED TO THE BODY OF THE PACKAGE BY A MAXIMUM OF 0.008" IN ANY DIRECTION.
5. ALL PLATED SURFACES ARE NI/AU

| DIM | INCHES | | MILLIMETERS | |
|-----|--------|-------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 0.225 | 0.235 | 5.72 | 5.97 |
| B | 0.004 | 0.006 | 0.10 | 0.15 |
| C | 0.145 | 0.165 | 3.18 | 4.19 |
| D | 0.077 | 0.087 | 1.96 | 2.21 |
| E | 0.355 | 0.365 | 9.02 | 9.27 |
| F | 0.210 | 0.220 | 5.33 | 5.59 |
| G | 0.795 | 0.805 | 20.19 | 20.45 |
| H | 0.670 | 0.730 | 17.02 | 18.54 |
| J | Ø .130 | | 3.30 | |
| k | 0.562 | | 14.28 | |

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



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JONHON

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ВЧ соединители, коаксиальные кабели,
кабельные сборки и микроволновые компоненты:

(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).



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