

CGH40006S

6 W, RF Power GaN HEMT, Plastic

Cree's CGH40006S is an unmatched, gallium nitride (GaN) high electron mobility transistor (HEMT). The CGH40006S, 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 CGH40006S ideal for linear and compressed amplifier circuits. The transistor is available in a 3mm x 3mm, surface mount, quad-flat-no-lead (QFN) package.



Package Types: 440203
PN's: CGH40006S

FEATURES

- Up to 6 GHz Operation
- 13 dB Small Signal Gain at 2.0 GHz
- 11 dB Small Signal Gain at 6.0 GHz
- 8 W typical at $P_{IN} = 32$ dBm
- 65 % Efficiency at $P_{IN} = 32$ dBm
- 28 V Operation
- 3mm x 3mm Package

APPLICATIONS

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



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

| Parameter | Symbol | Rating | Units |
|---|-----------------|-----------|-------|
| Drain-Source Voltage | V_{DSS} | 84 | Volts |
| Gate-to-Source Voltage | V_{GS} | -10, +2 | Volts |
| Storage Temperature | T_{STG} | -65, +150 | °C |
| Operating Junction Temperature | T_J | 175 | °C |
| Maximum Forward Gate Current | I_{GMAX} | 2.1 | mA |
| Soldering Temperature ¹ | T_S | 260 | °C |
| Thermal Resistance, Junction to Case ^{2,3} | $R_{\theta JC}$ | 10.1 | °C/W |
| Case Operating Temperature ^{2,3} | T_C | -40, +150 | °C |

Note:

¹ Refer to the Application Note on soldering at www.cree.com/products/wireless_appnotes.asp

² Measured for the CGH40006S at $P_{DISS} = 8$ W.

³ T_C = Case temperature for the device. It refers to the temperature at the ground tab underneath the package. The PCB will add additional thermal resistance. The RTH for Cree's demonstration amplifier, CGH40006S-TB, with 13 (Ø20 mil) via holes designed on a 20 mil thick Rogers 5880 PCB, is 5.1°C. The total Rth from the heat sink to the junction is 10.1°C + 5.1°C = 15.2 °C/W.

Electrical Characteristics ($T_C = 25^\circ\text{C}$)

| Characteristics | Symbol | Min. | Typ. | Max. | Units | Conditions |
|--|--------------|------|------|--------|----------|--|
| DC Characteristics¹ | | | | | | |
| Gate Threshold Voltage | $V_{GS(th)}$ | -3.8 | -3.3 | -2.3 | V_{DC} | $V_{DS} = 10$ V, $I_D = 2.1$ mA |
| Gate Quiescent Voltage | $V_{GS(Q)}$ | - | -3.0 | - | V_{DC} | $V_{DS} = 28$ V, $I_D = 100$ mA |
| Saturated Drain Current | I_{DS} | 1.7 | 2.1 | - | A | $V_{DS} = 6.0$ V, $V_{GS} = 2.0$ V |
| Drain-Source Breakdown Voltage | V_{BR} | 120 | - | - | V_{DC} | $V_{GS} = -8$ V, $I_D = 2.1$ mA |
| RF Characteristics² ($T_C = 25^\circ\text{C}$, $F_0 = 5.8$ GHz unless otherwise noted) | | | | | | |
| Small Signal Gain | G_{SS} | 10 | 11.8 | - | dB | $V_{DD} = 28$ V, $I_{DQ} = 100$ mA |
| Power Output at $P_{IN} = 30$ dBm | P_{OUT} | 5 | 6.9 | - | W | $V_{DD} = 28$ V, $I_{DQ} = 100$ mA |
| Drain Efficiency ³ | η | 40 | 53 | - | % | $V_{DD} = 28$ V, $I_{DQ} = 100$ mA, $P_{IN} = 30$ dBm |
| Output Mismatch Stress | VSWR | - | - | 10 : 1 | Ψ | No damage at all phase angles, $V_{DD} = 28$ V, $I_{DQ} = 100$ mA, $P_{IN} = 32$ dBm |
| Dynamic Characteristics | | | | | | |
| Input Capacitance | C_{GS} | - | 2.7 | - | pF | $V_{DS} = 28$ V, $V_{GS} = -8$ V, $f = 1$ MHz |
| Output Capacitance | C_{DS} | - | 0.8 | - | pF | $V_{DS} = 28$ V, $V_{GS} = -8$ V, $f = 1$ MHz |
| Feedback Capacitance | C_{GD} | - | 0.1 | - | pF | $V_{DS} = 28$ V, $V_{GS} = -8$ V, $f = 1$ MHz |

Notes:

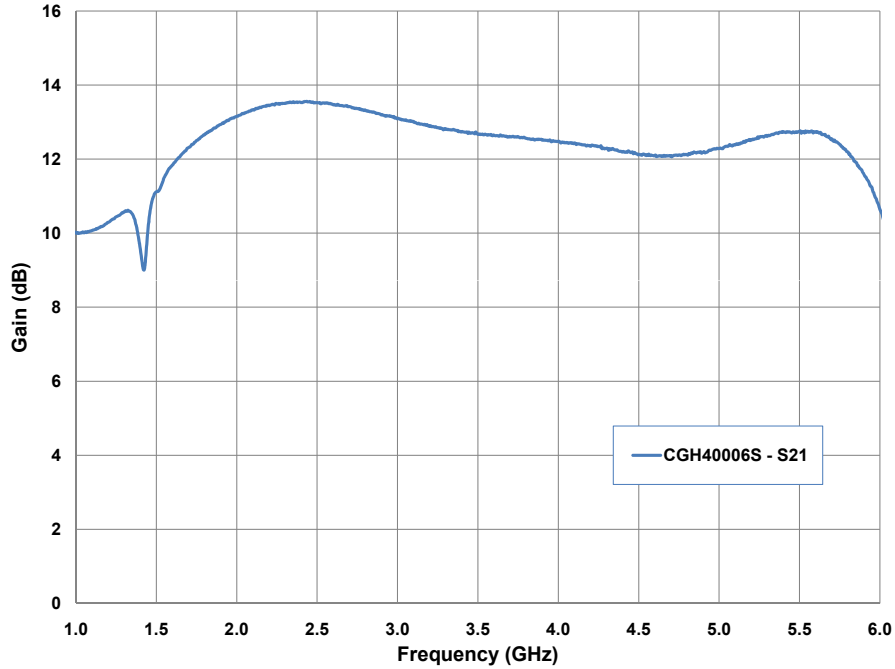
¹ Measured on wafer prior to packaging.

² Measured in Cree's narrow band production test fixture AD-000291. This fixture is designed for high volume test at 5.8 GHz and may not show the full capability of the device due to source inductance and thermal performance. The demonstration amplifier, CGH40006S-TB, is a better indicator of the true RF performance of the device.

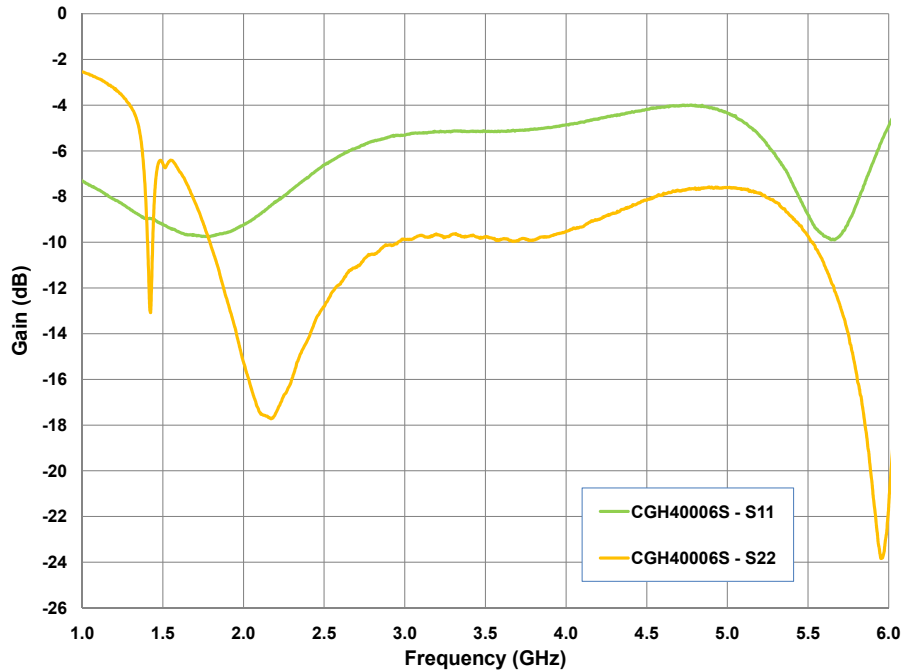
³ Drain Efficiency = P_{OUT} / P_{DC}

Typical Performance

**Small Signal Gain vs Frequency at 28 V
of the CGH40006S in the CGH40006S-TB**

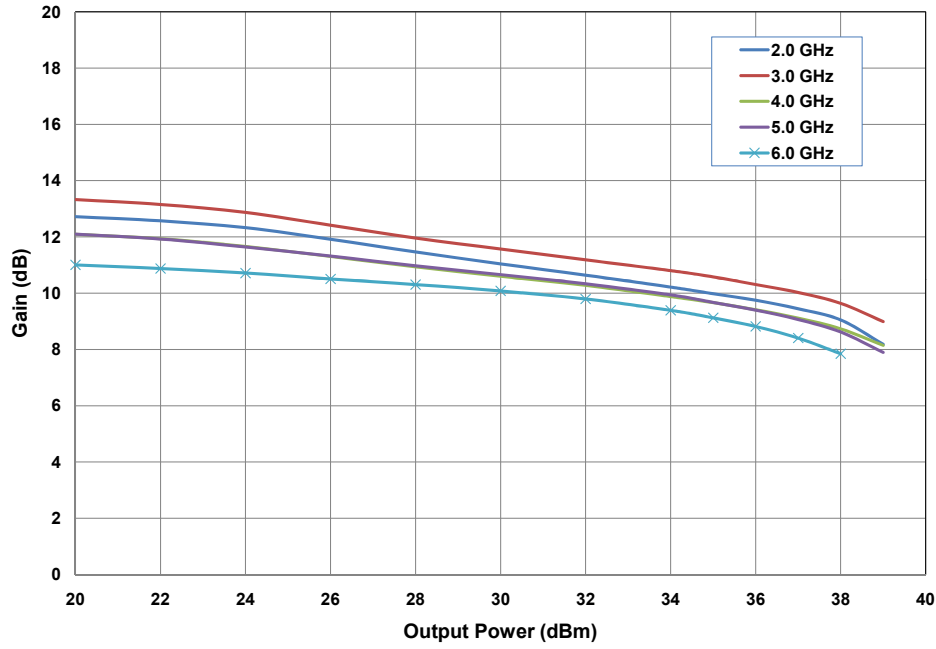


**Input & Output Return Losses vs Frequency at 28 V
of the CGH40006S in the CGH40006S-TB**

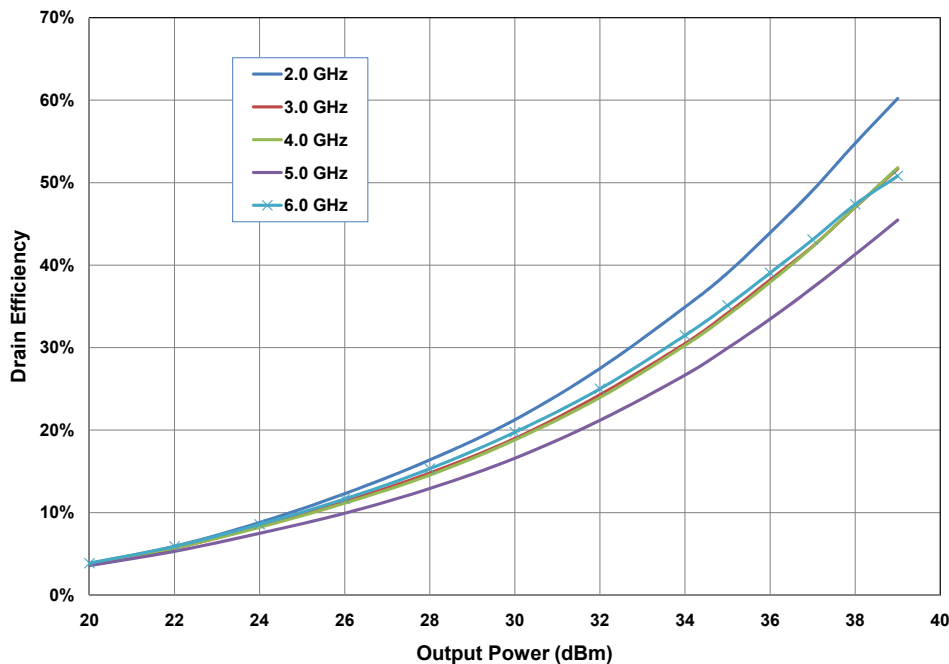


Typical Performance

**Power Gain vs Output Power as a Function of Frequency
of the CGH40006S in the CGH40006S-TB**
 $V_{DD} = 28\text{ V}, I_{DQ} = 100\text{ mA}$

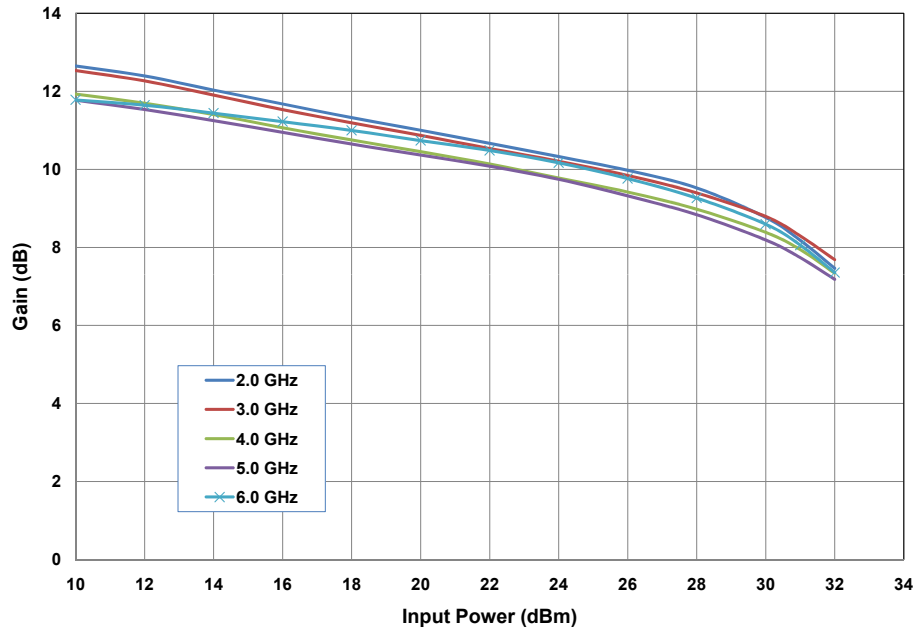


**Drain Efficiency vs Output Power as a Function of Frequency
of the CGH40006S in the CGH40006S-TB**
 $V_{DD} = 28\text{ V}, I_{DQ} = 100\text{ mA}$

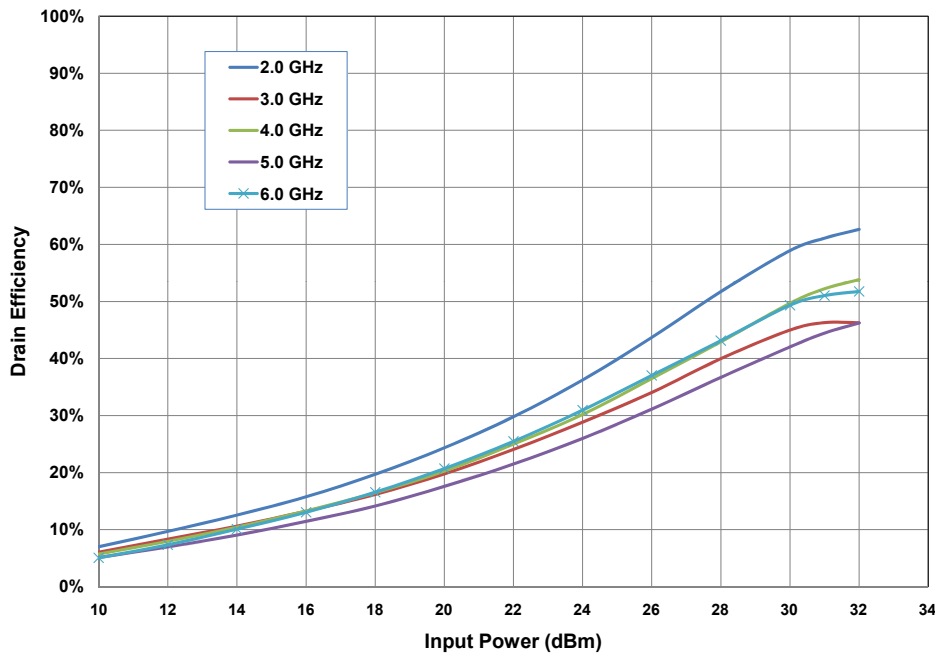


Typical Performance

**Power Gain vs Input Power as a Function of Frequency
of the CGH40006S in the CGH40006S-TB**
 $V_{DD} = 28\text{ V}, I_{DQ} = 100\text{ mA}$

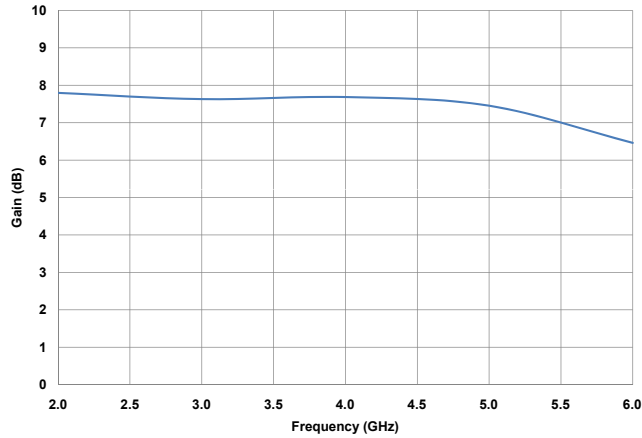


**Drain Efficiency vs Input Power as a Function of Frequency
of the CGH40006S in the CGH40006S-TB**
 $V_{DD} = 28\text{ V}, I_{DQ} = 100\text{ mA}$

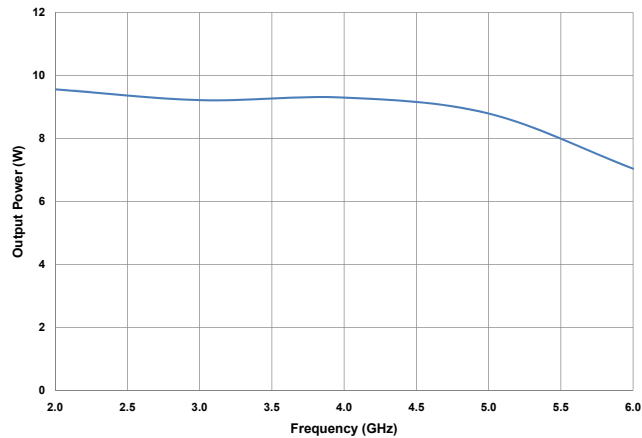


Typical Performance

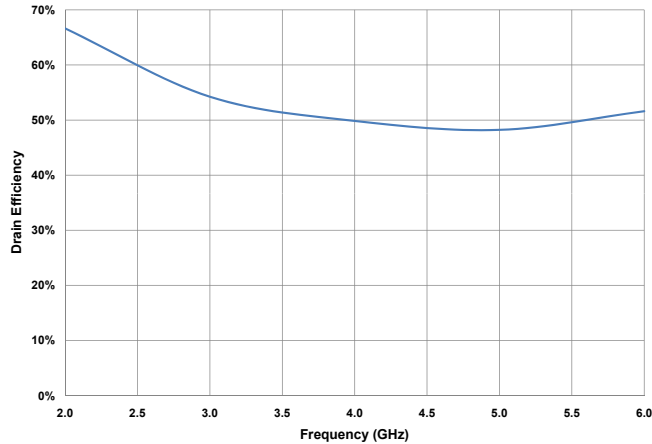
Power Gain vs Frequency of the CGH40006S
in the CGH40006S-TB at $P_{IN} = 32$ dBm, $V_{DD} = 28$ V



Output Power vs Frequency of the CGH40006S
in the CGH40006S-TB at $P_{IN} = 32$ dBm, $V_{DD} = 28$ V

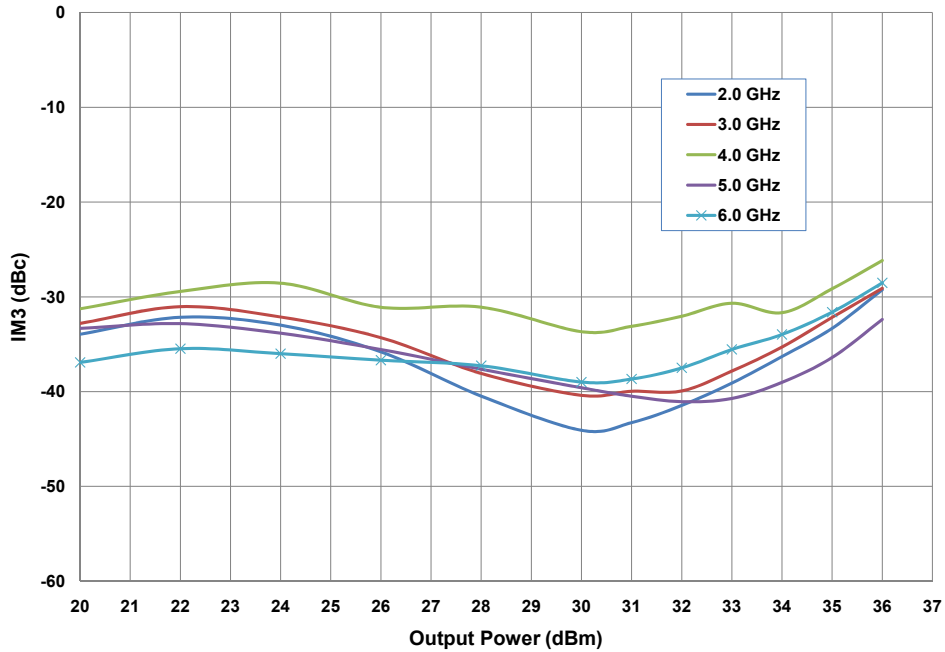


Drain Efficiency vs Frequency of the CGH40006S
in the CGH40006S-TB at $P_{IN} = 32$ dBm, $V_{DD} = 28$ V



Typical Performance

Third Order Intermodulation Distortion vs Average Output Power as a Function of Frequency of the CGH40006S in the CGH40006S-TB
 $V_{DD} = 28\text{ V}$, $I_{DQ} = 60\text{ mA}$



Electrostatic Discharge (ESD) Classifications

| Parameter | Symbol | Class | Test Methodology |
|---------------------|--------|--------------------|---------------------|
| Human Body Model | HBM | 1A (> 250 V) | JEDEC JESD22 A114-D |
| Charge Device Model | CDM | 2 (125 V to 250 V) | JEDEC JESD22 C101-C |

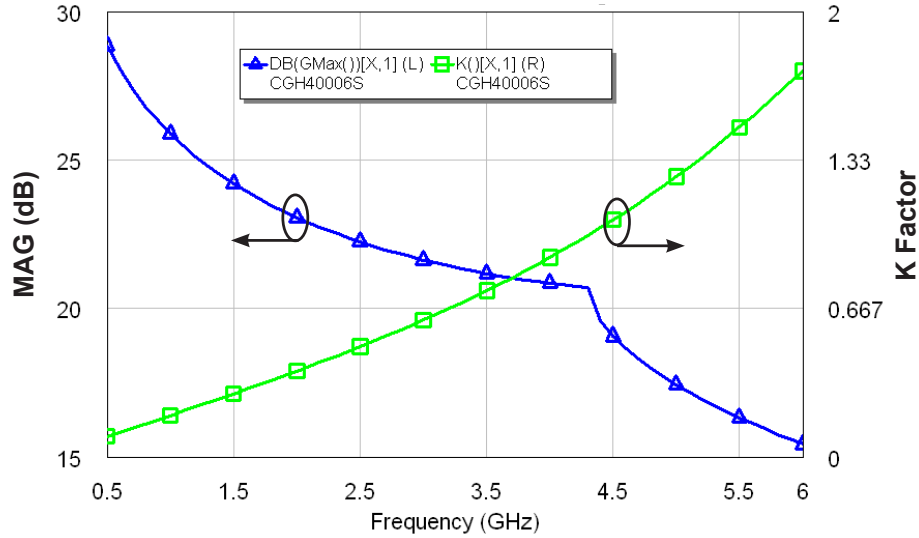
Moisture Sensitivity Level (MSL) Classification

| Parameter | Symbol | Level | Test Methodology |
|----------------------------|--------|---------------|--------------------|
| Moisture Sensitivity Level | MSL | 3 (168 hours) | IPC/JEDEC J-STD-20 |

Typical Performance

Simulated Maximum Available Gain and K Factor of the CGH40006S

$V_{DD} = 28\text{ V}$, $I_{DQ} = 100\text{ mA}$

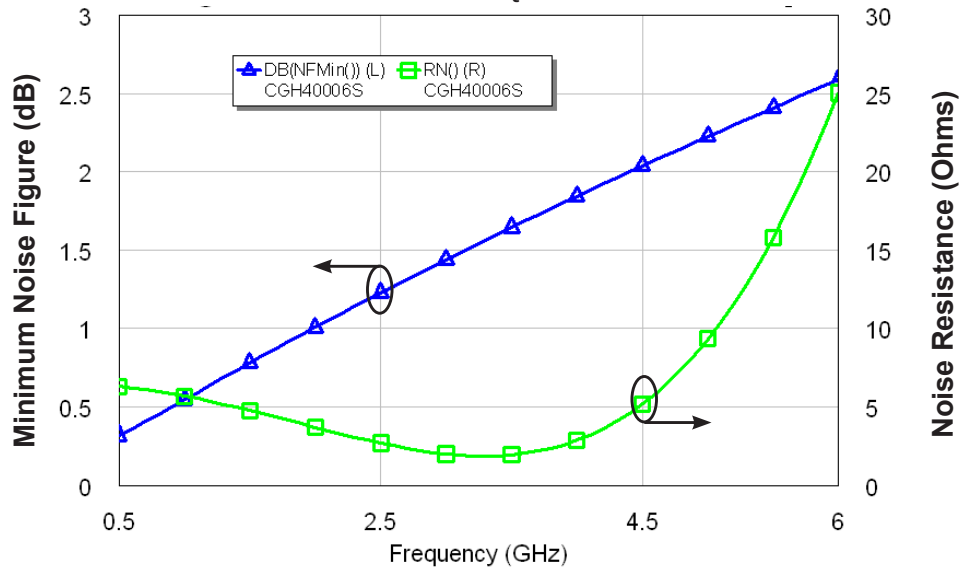


Note 1. On a 20 mil thick PCB.

Typical Noise Performance

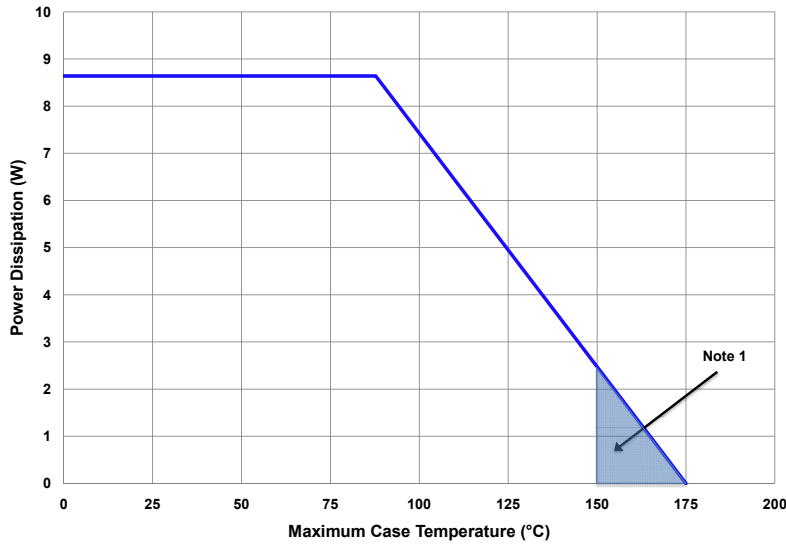
Simulated Minimum Noise Figure and Noise Resistance vs Frequency of the CGH40006S

$V_{DD} = 28\text{ V}$, $I_{DQ} = 100\text{ mA}$



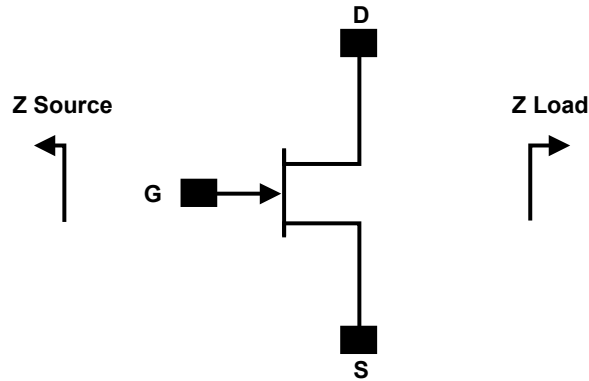
Note 1. On a 20 mil thick PCB.

CGH40006S CW Power Dissipation De-rating Curve



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

Source and Load Impedances



| Frequency (MHz) | Z Source | Z Load |
|-----------------|---------------|--------------|
| 1000 | 12.7 + j20.2 | 62.3 + j42 |
| 2000 | 5.98 + j6.81 | 32.7 + j32.9 |
| 3000 | 3.32 - j2.89 | 19.2 + j29.8 |
| 4000 | 2.38 - j9.45 | 15.2 + j15.7 |
| 5000 | 2.62 - j15.6 | 9.98 + j9.6 |
| 6000 | 1.94 - j21.35 | 8.51 + j2.07 |

Note 1. $V_{DD} = 28V$, $I_{DQ} = 100mA$ in the 440203 package.

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

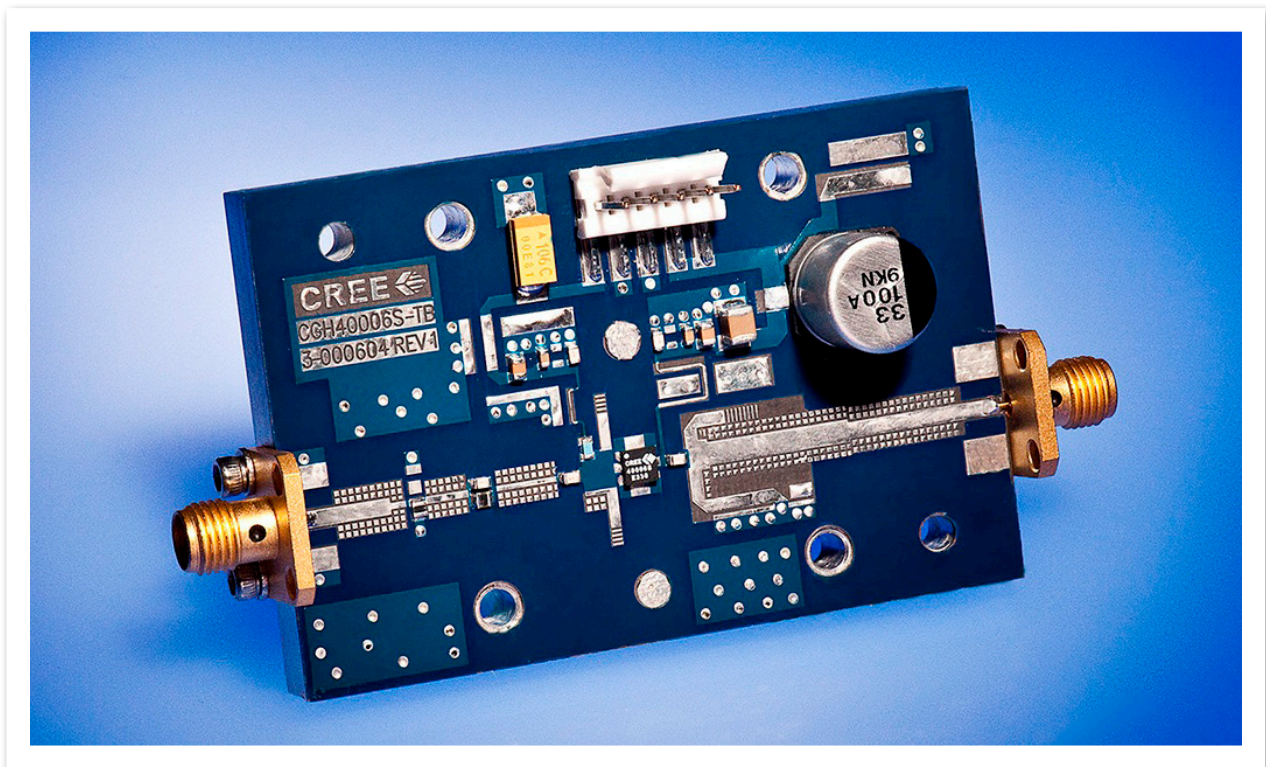
Note 3. When using this device at low frequency, series resistors should be used to maintain amplifier stability.

Note 4. 35 pH source inductance is assumed between the package and RF ground (20 mil thick PCB).

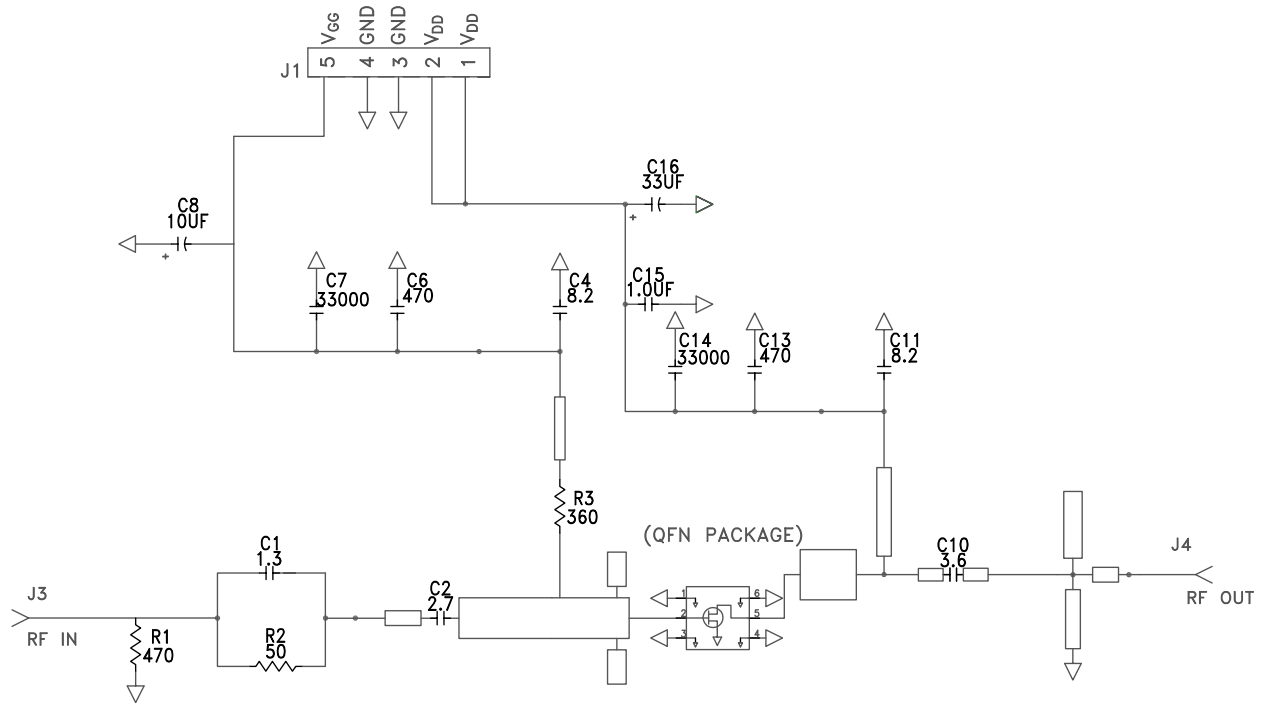
CGH40006S-TB Demonstration Amplifier Circuit Bill of Materials

| Designator | Description | Qty |
|------------|--|-----|
| R1 | RES, AIN, 0505, 470 Ohms ($\leq 5\%$ tolerance) | 1 |
| R2 | RES, AIN, 0505, 50 Ohms ($\leq 5\%$ tolerance) | 1 |
| R3 | RES, AIN, 0505, 360 Ohms ($\leq 5\%$ tolerance) | 1 |
| C1 | CAP, 1.3 pF +/-0.1 pF, 0603, ATC 600S | 1 |
| C2 | CAP, 2.7 pF +/-0.25 pF, 0603, ATC 600S | 1 |
| C10 | CAP, 3.6 pF +/-0.1 pF, 0603, ATC 600S | 1 |
| C4,C11 | CAP, 8.2 pF +/-0.25, 0603, ATC 600S | 2 |
| C6,C13 | CAP, 470 pF +/-5%, 0603, 100 V | 2 |
| C7,C14 | CAP, 33000 pF, CER, 100V, X7R, 0805 | 2 |
| C8 | CAP, 10 uf, 16V, SMT, TANTALUM | 1 |
| C15 | CAP, 1.0 uF +/-10%, CER, 100V, X7R, 1210 | 1 |
| C16 | CAP, 33 uF, 100V, ELECT, FK, SMD | 1 |
| J3,J4 | CONN, SMA, STR, PANEL, JACK, RECP | 2 |
| J1 | HEADER RT>PLZ .1CEN LK 5POS | 1 |
| - | PCB, RO5880, 0.020" THK | 1 |
| Q1 | CGH40006S | 1 |

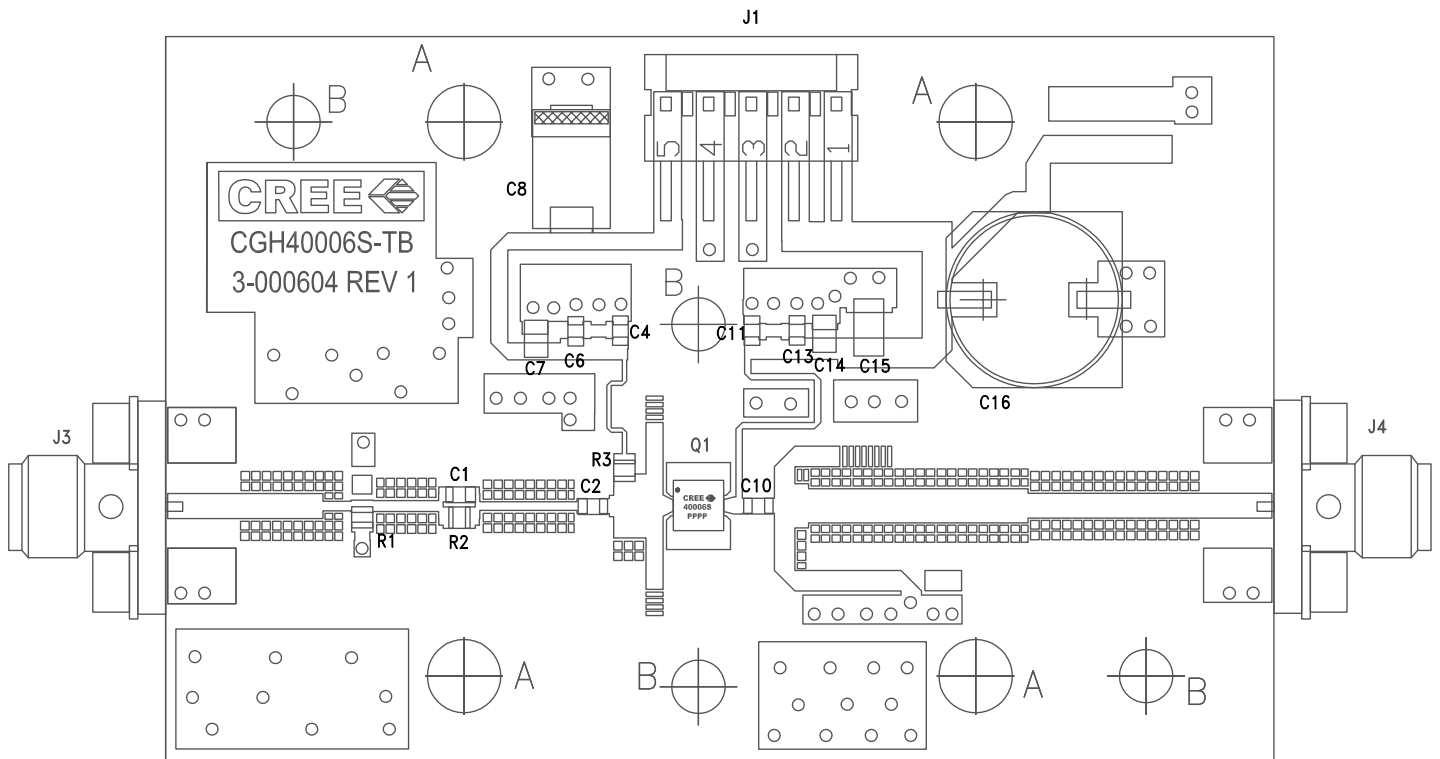
CGH40006S-TB Demonstration Amplifier Circuit



CGH40006S-TB Demonstration Amplifier Circuit Schematic



CGH40006S-TB Demonstration Amplifier Circuit Outline



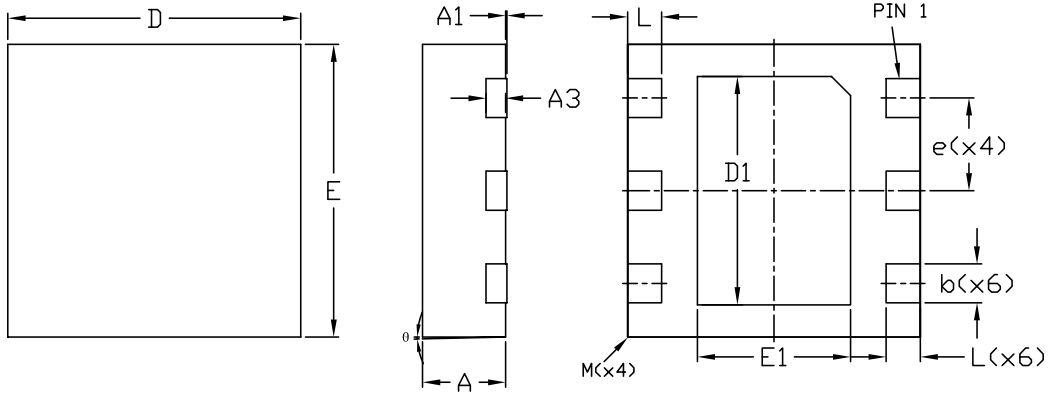


Typical Package S-Parameters for CGH40006S
(Small Signal, $V_{DS} = 28\text{ V}$, $I_{DQ} = 100\text{ mA}$, angle in degrees)

| Frequency | Mag S11 | Ang S11 | Mag S21 | Ang S21 | Mag S12 | Ang S12 | Mag S22 | Ang S22 |
|-----------|---------|---------|---------|---------|---------|---------|---------|---------|
| 500 MHz | 0.933 | -92.95 | 18.74 | 125.47 | 0.024 | 38.02 | 0.459 | -48.87 |
| 600 MHz | 0.922 | -104.26 | 16.89 | 118.64 | 0.026 | 31.70 | 0.428 | -54.78 |
| 700 MHz | 0.912 | -113.77 | 15.28 | 112.75 | 0.028 | 26.33 | 0.402 | -59.82 |
| 800 MHz | 0.905 | -121.83 | 13.90 | 107.61 | 0.029 | 21.71 | 0.381 | -64.21 |
| 900 MHz | 0.899 | -128.73 | 12.70 | 103.06 | 0.030 | 17.68 | 0.365 | -68.10 |
| 1.0 GHz | 0.894 | -134.72 | 11.67 | 98.96 | 0.030 | 14.11 | 0.352 | -71.62 |
| 1.1 GHz | 0.891 | -139.97 | 10.77 | 95.23 | 0.030 | 10.91 | 0.342 | -74.86 |
| 1.2 GHz | 0.888 | -144.62 | 9.99 | 91.80 | 0.031 | 8.00 | 0.334 | -77.87 |
| 1.3 GHz | 0.886 | -148.78 | 9.31 | 88.61 | 0.031 | 5.34 | 0.328 | -80.72 |
| 1.4 GHz | 0.884 | -152.55 | 8.71 | 85.61 | 0.031 | 2.88 | 0.325 | -83.43 |
| 1.5 GHz | 0.883 | -155.97 | 8.17 | 82.77 | 0.031 | 0.58 | 0.322 | -86.03 |
| 1.6 GHz | 0.881 | -159.12 | 7.69 | 80.07 | 0.031 | -1.57 | 0.321 | -88.54 |
| 1.7 GHz | 0.881 | -162.04 | 7.26 | 77.49 | 0.031 | -3.60 | 0.321 | -90.98 |
| 1.8 GHz | 0.880 | -164.75 | 6.88 | 75.00 | 0.031 | -5.53 | 0.321 | -93.35 |
| 1.9 GHz | 0.879 | -167.29 | 6.53 | 72.60 | 0.031 | -7.38 | 0.323 | -95.67 |
| 2.0 GHz | 0.879 | -169.68 | 6.21 | 70.26 | 0.031 | -9.14 | 0.325 | -97.94 |
| 2.1 GHz | 0.879 | -171.94 | 5.92 | 68.00 | 0.030 | -10.83 | 0.327 | -100.17 |
| 2.2 GHz | 0.879 | -174.09 | 5.65 | 65.79 | 0.030 | -12.46 | 0.330 | -102.36 |
| 2.3 GHz | 0.879 | -176.14 | 5.40 | 63.62 | 0.030 | -14.03 | 0.334 | -104.51 |
| 2.4 GHz | 0.879 | -178.10 | 5.18 | 61.51 | 0.030 | -15.55 | 0.338 | -106.63 |
| 2.5 GHz | 0.879 | -179.98 | 4.97 | 59.43 | 0.030 | -17.02 | 0.342 | -108.71 |
| 2.6 GHz | 0.879 | 178.20 | 4.77 | 57.38 | 0.029 | -18.44 | 0.346 | -110.77 |
| 2.7 GHz | 0.879 | 176.44 | 4.59 | 55.37 | 0.029 | -19.83 | 0.351 | -112.81 |
| 2.8 GHz | 0.879 | 174.74 | 4.42 | 53.39 | 0.029 | -21.18 | 0.355 | -114.82 |
| 2.9 GHz | 0.879 | 173.09 | 4.26 | 51.43 | 0.029 | -22.48 | 0.360 | -116.80 |
| 3.0 GHz | 0.880 | 171.49 | 4.11 | 49.50 | 0.028 | -23.76 | 0.366 | -118.76 |
| 3.2 GHz | 0.880 | 168.39 | 3.84 | 45.70 | 0.028 | -26.20 | 0.376 | -122.63 |
| 3.4 GHz | 0.881 | 165.43 | 3.60 | 41.97 | 0.027 | -28.51 | 0.387 | -126.41 |
| 3.6 GHz | 0.882 | 162.57 | 3.38 | 38.31 | 0.026 | -30.70 | 0.399 | -130.13 |
| 3.8 GHz | 0.883 | 159.81 | 3.19 | 34.71 | 0.025 | -32.75 | 0.410 | -133.78 |
| 4.0 GHz | 0.884 | 157.13 | 3.01 | 31.16 | 0.025 | -34.68 | 0.422 | -137.38 |
| 4.2 GHz | 0.885 | 154.52 | 2.85 | 27.65 | 0.024 | -36.47 | 0.433 | -140.91 |
| 4.4 GHz | 0.887 | 151.96 | 2.71 | 24.19 | 0.023 | -38.12 | 0.445 | -144.40 |
| 4.6 GHz | 0.888 | 149.45 | 2.57 | 20.77 | 0.022 | -39.63 | 0.457 | -147.84 |
| 4.8 GHz | 0.889 | 146.98 | 2.45 | 17.38 | 0.022 | -40.97 | 0.468 | -151.24 |
| 5.0 GHz | 0.890 | 144.55 | 2.33 | 14.03 | 0.021 | -42.15 | 0.480 | -154.60 |
| 5.2 GHz | 0.892 | 142.15 | 2.23 | 10.71 | 0.020 | -43.15 | 0.491 | -157.92 |
| 5.4 GHz | 0.893 | 139.78 | 2.13 | 7.41 | 0.019 | -43.95 | 0.503 | -161.20 |
| 5.6 GHz | 0.894 | 137.43 | 2.04 | 4.15 | 0.018 | -44.53 | 0.514 | -164.45 |
| 5.8 GHz | 0.896 | 135.11 | 1.95 | 0.91 | 0.018 | -44.89 | 0.525 | -167.66 |
| 6.0 GHz | 0.897 | 132.80 | 1.87 | -2.30 | 0.017 | -45.00 | 0.535 | -170.85 |

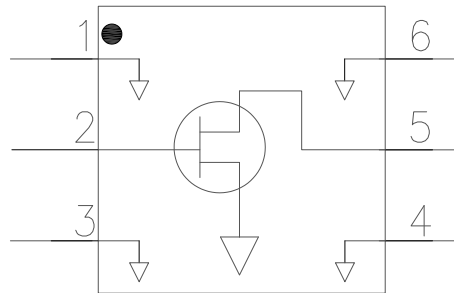
Note 1. Download this s-parameter file in ".s2p" format at http://www.cree.com/products/wireless_s-parameters.asp
 Note 2. On a 20 mil thick PCB.

Product Dimensions CGH40006S (Package Type — 440203)

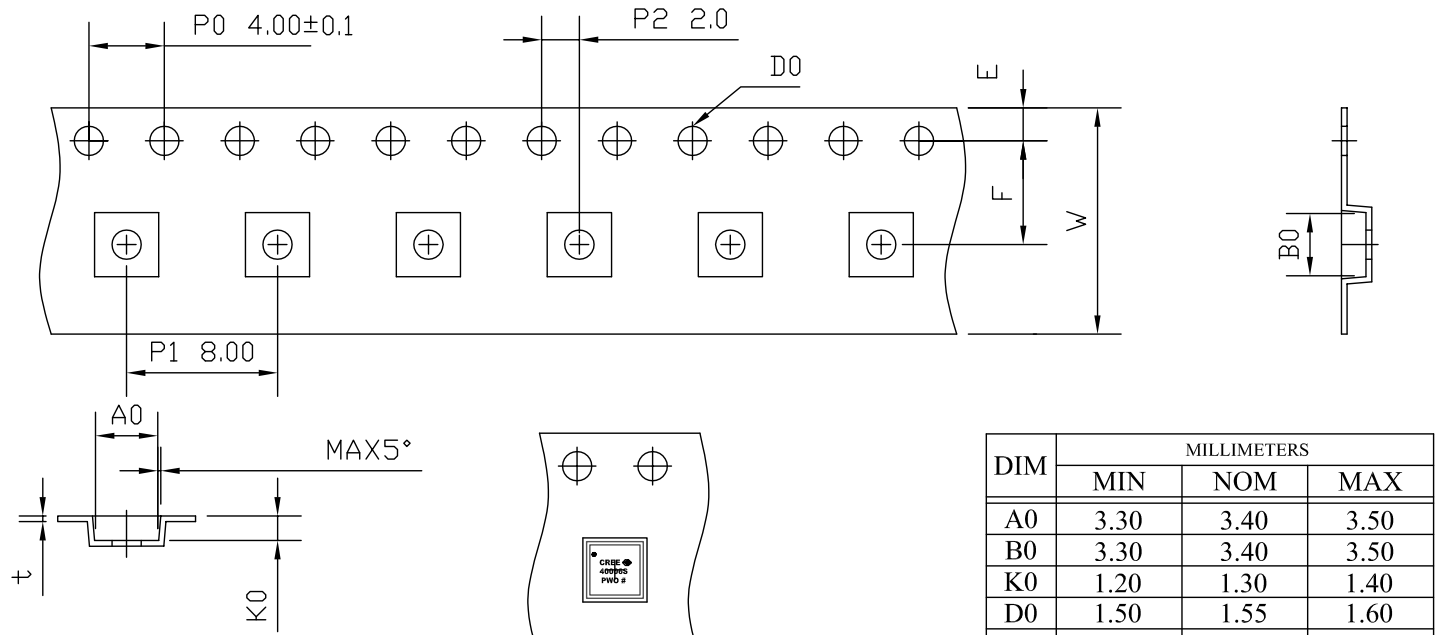


| DIM | MILLIMETERS | | | INCHES | | |
|-----|-------------|----------|------|--------|-----------|-------|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 0.80 | 0.90 | 1.00 | 0.032 | 0.035 | 0.039 |
| A1 | 0 | 0.02 | 0.05 | 0 | 0.0008 | 0.002 |
| A3 | — | 0.20REF. | — | — | 0.008REF. | — |
| b | 0.30 | 0.40 | 0.45 | 0.012 | 0.016 | 0.018 |
| D | 2.85 | 3.00 | 3.15 | 0.112 | 0.118 | 0.124 |
| D1 | — | 2.34BSC | — | — | 0.092BSC | — |
| E | 2.85 | 3.00 | 3.15 | 0.112 | 0.118 | 0.124 |
| E1 | — | 1.57BSC | — | — | 0.062BSC | — |
| e | — | 0.95BSC | — | — | 0.037BSC | — |
| L | 0.20 | 0.30 | 0.45 | 0.008 | 0.012 | 0.018 |
| ø | 0 | — | 12 | 0 | — | 12 |
| M | — | — | 0.05 | — | — | 0.002 |

| Pin | Input/Output |
|-----|--------------|
| 1 | GND |
| 2 | RF IN |
| 3 | GND |
| 4 | GND |
| 5 | RF OUT |
| 6 | GND |



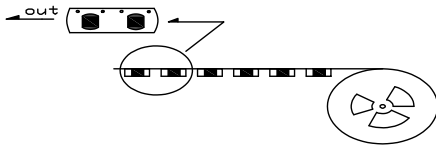
Tape & Reel Dimensions



TAPING STYLE

PACKAGE POSITION IN REEL

| DIM | MILLIMETERS | | |
|-----|-------------|-------|-------|
| | MIN | NOM | MAX |
| A0 | 3.30 | 3.40 | 3.50 |
| B0 | 3.30 | 3.40 | 3.50 |
| K0 | 1.20 | 1.30 | 1.40 |
| D0 | 1.50 | 1.55 | 1.60 |
| E | 1.65 | 1.75 | 1.85 |
| F | — | 5.50 | — |
| t | 0.25 | 0.30 | 0.35 |
| W | 11.70 | 12.00 | 12.30 |



LEADER OF 400 MM AND TRAILER OF 160 MM OF UNPOPULATED POCKET/REEL



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For more information, please contact:

Cree, Inc.
4600 Silicon Drive
Durham, NC 27703
www.cree.com/wireless

Ryan Baker
Marketing
Cree, Wireless Devices
919.407.7816

Tom Dekker
Sales Director
Cree, Wireless Devices
919.407.5639