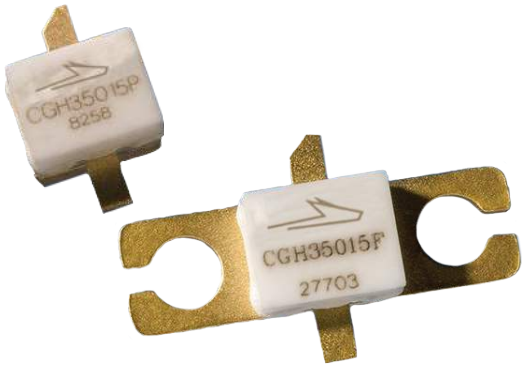
# CGH35015

## 15 W, 3.3-3.9 GHz, 28V, GaN HEMT for WiMAX




Package Types: 440166 and 440196
PNs: CGH35015F and CGH35015P

### Description

Wolfspeed's CGH35015 is a gallium nitride (GaN) high electron mobility transistor (HEMT) designed specifically for 802.16-2004 WiMAX Fixed Access applications. GaN HEMTs offer high efficiency, high gain and wide bandwidth capabilities, which makes the CGH35015 ideal for 3.3-3.9 GHz WiMAX and BWA amplifier applications. The transistor is available in both screw-down, flange and solder-down, pill packages.

### Typical Performance Over 3.3-3.8 GHz ($T_C$ = 25°C) of Demonstration Amplifier

| Parameter | 3.3 GHz | 3.4 GHz | 3.5 GHz | 3.6 GHz | 3.7 GHz | 3.8 GHz | Units |
|---|---|---|---|---|---|---|---|
| Small Signal Gain | 13.6 | 12.8 | 12.3 | 12.2 | 12.3 | 12.8 | dB |
| EVM at $P_{AVE}$ = 24 dBm | 2.71 | 2.31 | 2.1 | 2.12 | 2.54 | 3.04 | % |
| EVM at $P_{AVE}$ = 33 dBm | 2.63 | 2.29 | 1.93 | 1.70 | 1.70 | 2.14 | % |
| Drain Efficiency at $P_{AVE}$ = 33 dBm | 24.0 | 25.5 | 26.1 | 25.6 | 23.8 | 2.38 | % |

Note:
Measured in the CGH35015F-AMP amplifier circuit, under 802.16 OFDM, 3.5 MHz Channel BW, 1/4 Cyclic Prefix, 64 QAM Modulated Burst, 5ms Burst, Symbol Length of 59, Coding Type RS-CC, Coding Rate Type 2/3, PAR = 9.8 dB @ 0.01% Probability on CCDF.

### Features

- 3.3 - 3.9 GHz Operation
- 15 W Peak Power Capability
- 12 dB Small Signal Gain
- 2.0 W $P_{AVE}$ at < 2.0% EVM
- 26% Efficiency at 2 W Average Power
- WiMAX Fixed Access 802.16-2004 OFDM
- WiMAX Mobile Access 802.16e OFDMA

**Large Signal Models Available for ADS and MWO**

RoHS compliant


4600 Silicon Drive | Durham, NC 27703 | Tel: +1.919.313.5300

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

| Parameter | Symbol | Rating | Units | Conditions |
|---|---|---|---|---|
| Drain-Source Voltage | $V_{DSS}$ | 120 | V | 25°C |
| Gate-to-Source Voltage | $V_{GS}$ | -10, +2 | | |
| Power Dissipation | $P_{DISS}$ | 7 | W | |
| Storage Temperature | $T_{STG}$ | -65, +150 | °C | |
| Operating Junction Temperature | $T_J$ | 225 | | |
| Maximum Forward Gate Current | $I_{GMAX}$ | 4.0 | mA | 25°C |
| Maximum Drain Current[1] | $I_{DMAX}$ | 1.5 | A | |
| Soldering Temperature[2] | $T_S$ | 245 | °C | |
| Screw Torque | τ | 40 | in-oz | |
| Thermal Resistance, Junction to Case[3] | $R_{\theta JC}$ | 8.0 | °C/W | 85°C |
| Case Operating Temperature[3] | $T_C$ | -40, +150 | °C | |

Notes:
[1] Current limit for long term, reliable operation
[2] Refer to the Application Note on soldering at wolfspeed.com/rf/document-library
[3] Measured for the CGH35015 at $P_{DISS}$ = 7 W.

## Electrical Characteristics ($T_C$ = 25°C)

| Characteristics | Symbol | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| **DC Characteristics[1]** | | | | | | |
| Gate Threshold Voltage | $V_{GS(th)}$ | -3.8 | -3.0 | -2.3 | $V_{DC}$ | $V_{DS}$ = 10 V, $I_D$ = 3.6 mA |
| Gate Quiescent Voltage | $V_{GS(Q)}$ | – | -2.7 | – | | $V_{DS}$ = 28 V, $I_D$ = 60 mA |
| Saturated Drain Current | $I_{DS}$ | 2.9 | 3.5 | – | A | $V_{DS}$ = 6.0 V, $V_{GS}$ = 2.0 V |
| Drain-Source Breakdown Voltage | $V_{(BR)DSS}$ | 84 | – | – | $V_{DC}$ | $V_{GS}$ = -8 V, $I_D$ = 3.6 mA |
| **RF Characteristics[2, 3] ($T_C$ = 25°C, $F_0$ = 3.5 GHz unless otherwise noted)** | | | | | | |
| Small Signal Gain | $G_{SS}$ | 10.5 | 12 | – | dB | $V_{DD}$ = 28 V, $I_{DQ}$ = 100 mA |
| Drain Efficiency[4] | η | 22 | 26 | – | % | $V_{DD}$ = 28 V, $I_{DQ}$ = 100 mA, $P_{AVE}$ = 2.0 W |
| Back-Off Error Vector Magnitude | EVM | – | 2.5 | – | | $V_{DD}$ = 28 V, $I_{DQ}$ = 100 mA, $P_{AVE}$ = 18 dBm |
| Error Vector Magnitude | | – | | – | | $V_{DD}$ = 28 V, $I_{DQ}$ = 100 mA, $P_{AVE}$ = 2.0 W |
| Output Mismatch Stress | VSWR | – | – | 10:1 | Ψ | No damage at all phase angles, $V_{DD}$ = 28 V, $I_{DQ}$ = 100 mA, $P_{AVE}$ = 2.0 W |
| **Dynamic Characteristics** | | | | | | |
| Input Capacitance | $C_{GS}$ | – | 4.5 | – | pF | $V_{DS}$ = 28 V, $V_{GS}$ = -8 V, f = 1 MHz |
| Output Capacitance | $C_{DS}$ | – | 1.3 | – | | |
| Feedback Capacitance | $C_{GD}$ | – | 0.2 | – | | |

Notes:
[1] Measured on wafer prior to packaging
[2] Measured in the CGH35015F-AMP test fixture
[3] Under 802.16 OFDM, 3.5 MHz Channel BW, 1/4 Cyclic Prefix, 64 QAM Modulated Burst, 5ms Burst, Symbol Length of 59, Coding Type RS-CC, Coding Rate Type 2/3, PAR = 9.8 dB @ 0.01% Probability on CCDF
[4] Drain Efficiency = $P_{OUT}$ / $P_{DC}$

## Typical WiMAX Performance

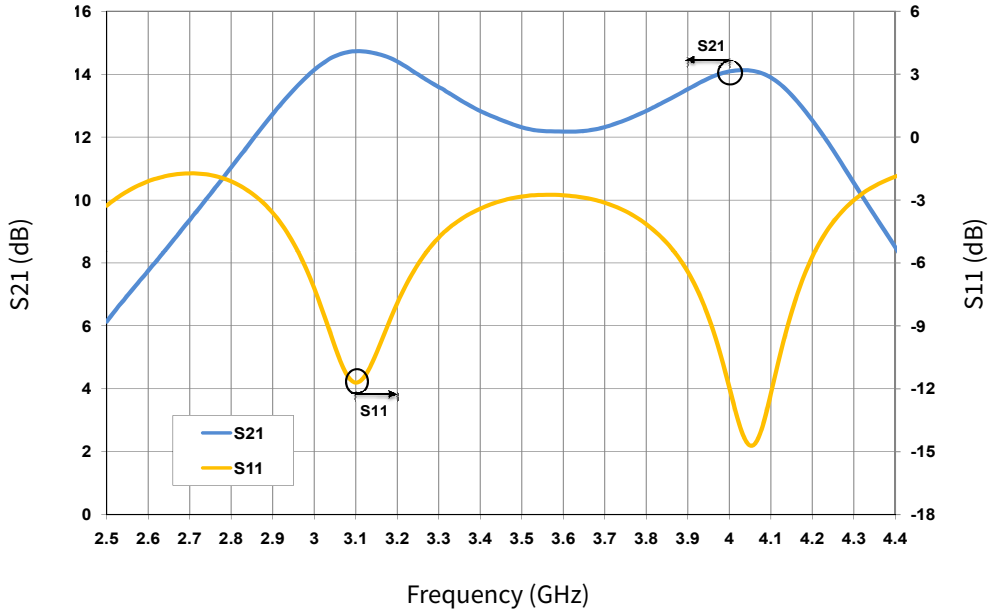



**Figure 1.** Small Signal S-Parameters vs Frequency measured in the CGH35015F-AMP
$V_{DD}$ = 28 V, $I_{DQ}$ = 100 mA

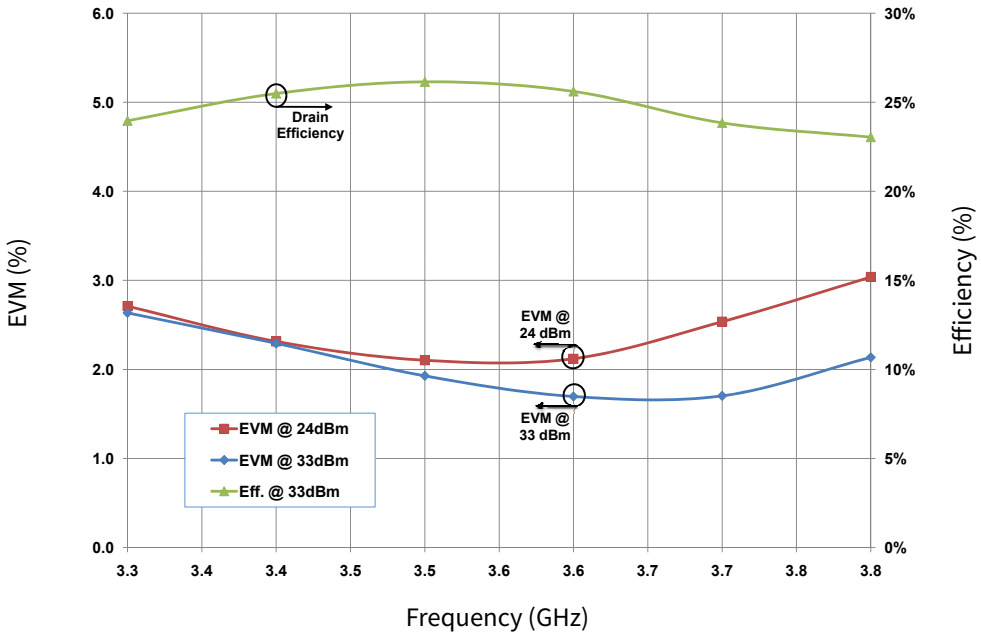



**Figure 2.** Typical EVM and Efficiency versus Frequency measured in the CGH35015F-AMP
$V_{DD}$ = 28 V, $I_{DQ}$ = 100 mA, 802.16-2004 OFDM, PAR = 9.8 dB

Note:
[1] 802.16 OFDM, 3.5 MHz Channel BW, 1/4 Cyclic Prefix, 64 QAM Modulated Burst,Symbol Length of 59, Coding Type RS-CC, Coding Rate Type 2/3

## Typical WiMAX Performance

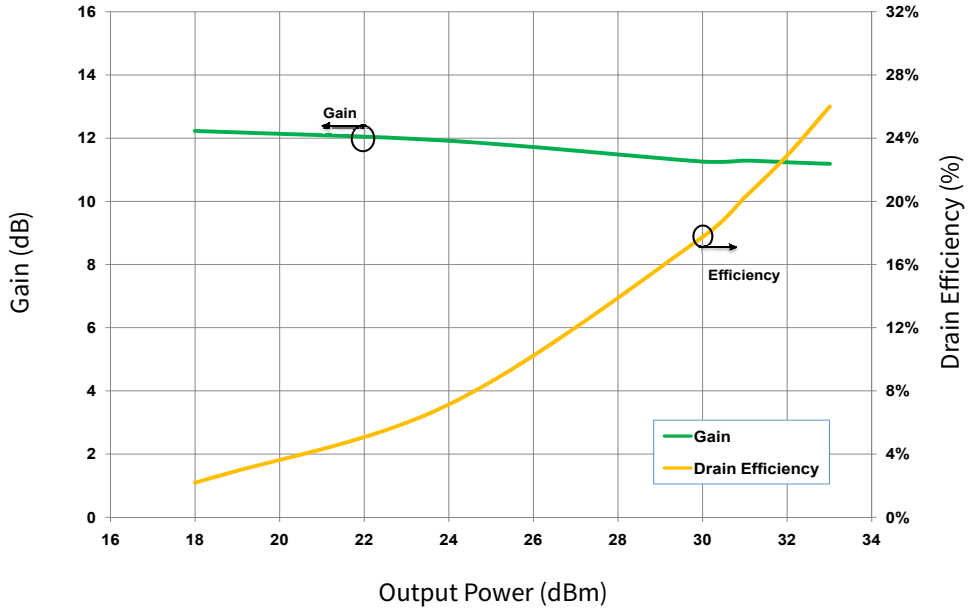



**Figure 3.** Drain Efficiency and Gain vs Output Power measured in the CGH35015F-AMP
$V_{DD}$ = 28 V, $I_{DQ}$ = 100 mA, 802.16-2004 OFDM, PAR = 9.8 dB

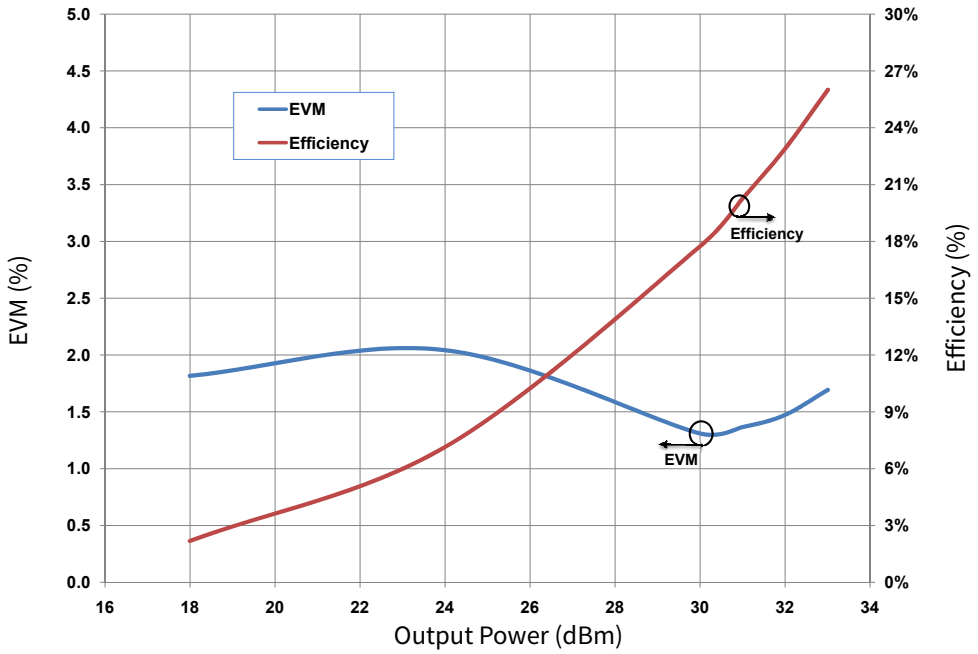



**Figure 4.** Typical EVM and Efficiency vs Output Power measured in the CGH35015F-AMP
$V_{DD}$ = 28 V, $I_{DQ}$ = 100 mA, 802.16-2004 OFDM, PAR = 9.8 dB

Note:
[1] Under 802.16 OFDM, 3.5 MHz Channel BW, 1/4 Cyclic Prefix, 64 QAM Modulated Burst, Symbol Length of 59, Coding Type RS-CC, Coding Rate Type 2/3

## Typical Performance

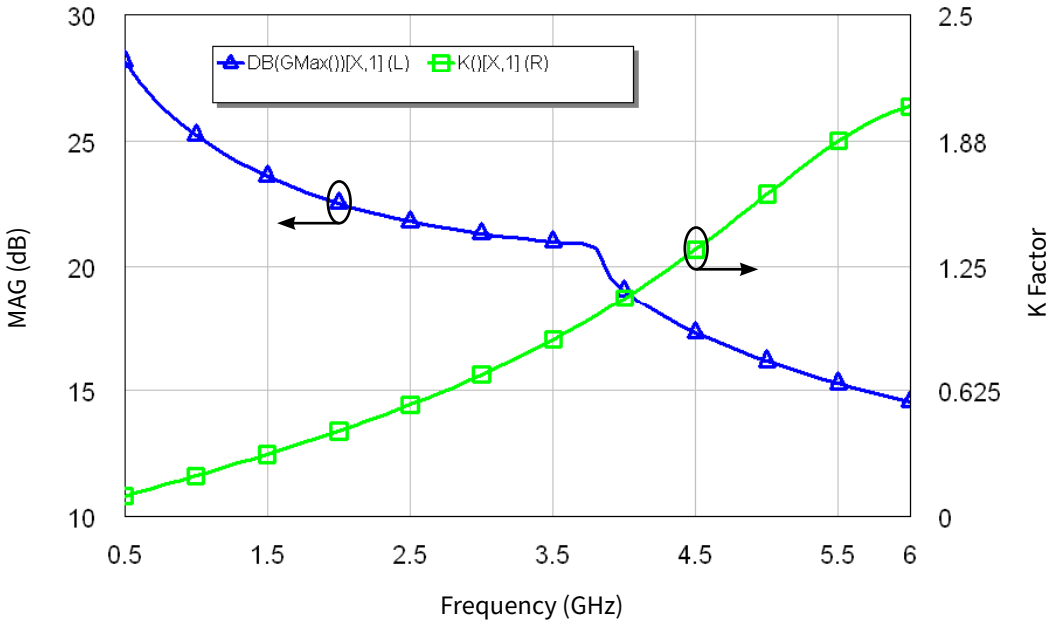



**Figure 5.** Simulated Maximum Available Gain and K Factor of the CGH35015
$V_{DD}$ = 28 V, $I_{DQ}$ = 100 mA

## Typical Noise Performance

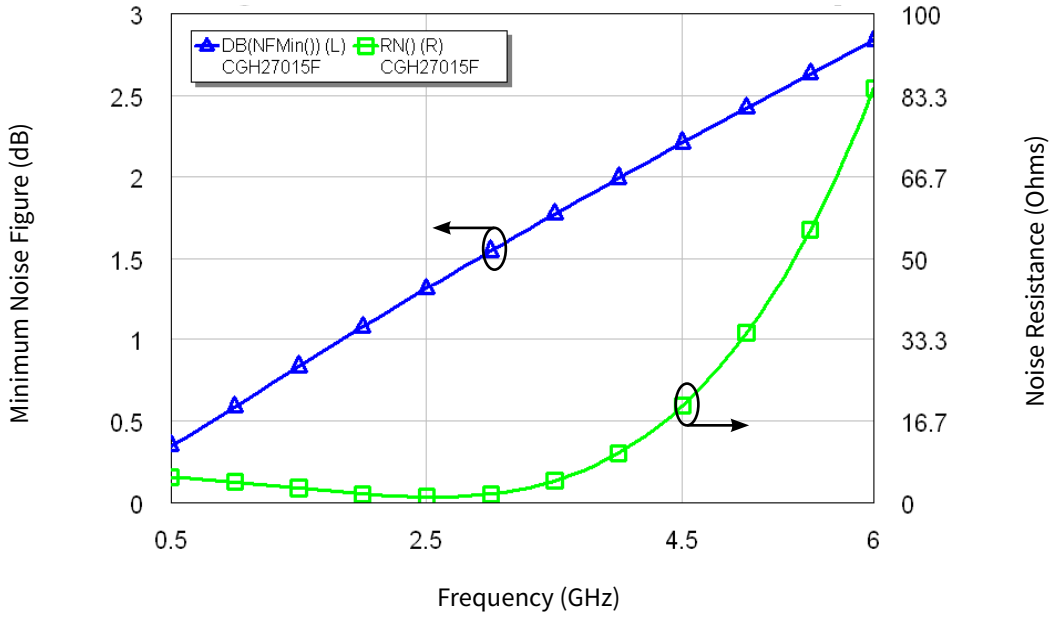
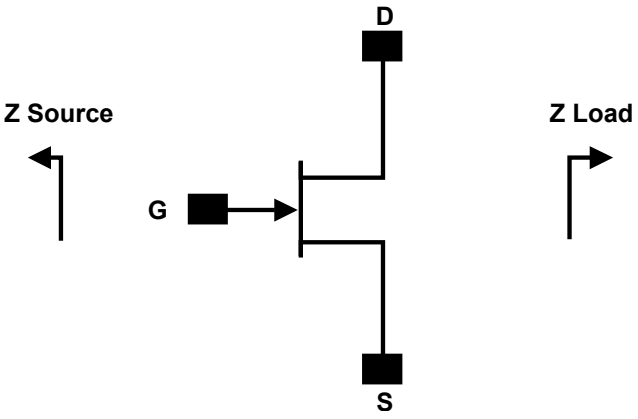



**Figure 6.** Simulated Minimum Noise Figure and Noise Resistance vs Frequency of the CGH35015
$V_{DD}$ = 28 V, $I_{DQ}$ = 100 mA

## Source and Load Impedances




| Frequency (MHz) | Z Source | Z Load |
|---|---|---|
| 3300 | 13.0 - j5.6 | 13.2 - j2.8 |
| 3400 | 17.2 - j6.0 | 13.2 - j2.8 |
| 3500 | 20.8 - j9.9 | 13.1 - j2.9 |
| 3600 | 20.1 - j15.8 | 13.1 - j3.3 |
| 3700 | 15.7 - j19.0 | 12.3 - j3.8 |

Notes:
[1] $V_{DD}$ = 28V, $I_{DQ}$ = 115 mA in the 440166 package
[2] Impedances are extracted from the CGH35015F-AMP demonstration amplifier and are not source and load pull data derived from the transistor

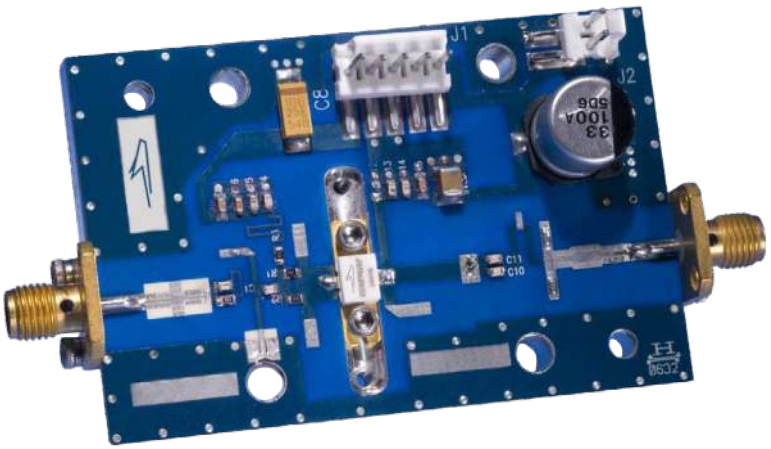
## Electrostatic Discharge (ESD) Classifications

| Parameter | Symbol | Class | Classification Level | Test Methodology |
|---|---|---|---|---|
| Human Body Model | HBM | TBD | ANSI/ESDA/JEDEC JS-001 Table 3 | JEDEC JESD22 A114-D |
| Charge Device Model | CDM | TBD | ANSI/ESDA/JEDEC JS-002 Table 3 | JEDEC JESD22 C101-C |

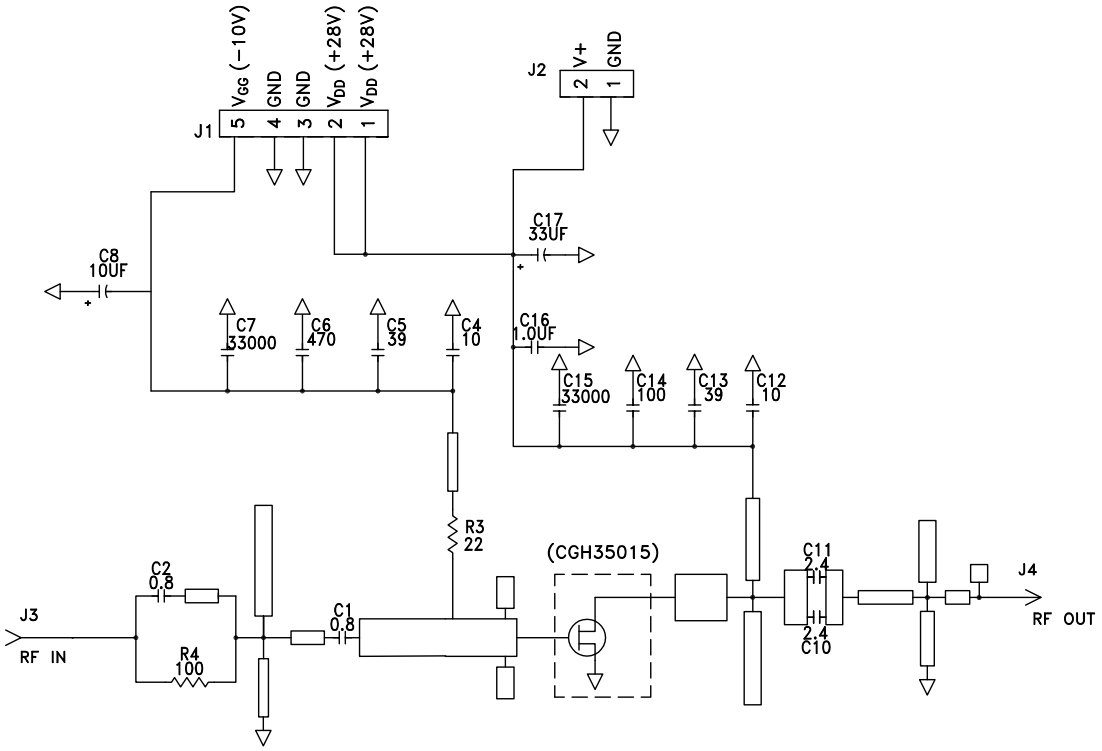
## CGH35015F-AMP Demonstration Amplifier Circuit Bill of Materials

| Designator | Description | Qty |
|---|---|---|
| C1, C2 | CAP, 0.8pF, +/-0.1pF, 0603, ATC 600S | 2 |
| C10, C11 | CAP, 2.4pF,+/-0.1pF, 0603, ATC 600S | 2 |
| C4, C12 | CAP, 10.0pF, +/-5%, 0603, ATC 600S | 1 |
| C5, C13 | CAP, 39pF ±5%, 0603, ATC 600S | 2 |
| C14 | CAP, 100pF ±5%, 0603, ATC 600S | 1 |
| C6 | CAP, 470pF ±10%, 100V, 0603 | 1 |
| C7, C15 | CAP, 33000pF, 100V, 0805, X7R | 2 |
| C8 | CAP, 10µF, 16V, SMT, TANTALUM (240096) | 1 |
| C16 | CAP, 1.0µF ±10%, 100V, 1210, X7R | 1 |
| C17 | CAP, 33µF, 100V, ELECT, FK, SMD | 1 |
| R3 | RES, 1/16W, 0603, 22 Ohms ≤5% | 1 |
| R4 | RES, 1/16W, 0603, 100 Ohms ≤5% | 1 |
| J1 | 5-PIN, MOLEX, MALE, CONNECTOR | 1 |
| J2 | 2-PIN, MOLEX, MALE, CONNECTOR | 1 |
| J3, J4 | SMA, FEMALE, CONNECTOR | 2 |
| - | PCB, RO4350B, Er = 3.48, h = 20 mil | 1 |
| - | CGH35015F or CGH35015P | 1 |

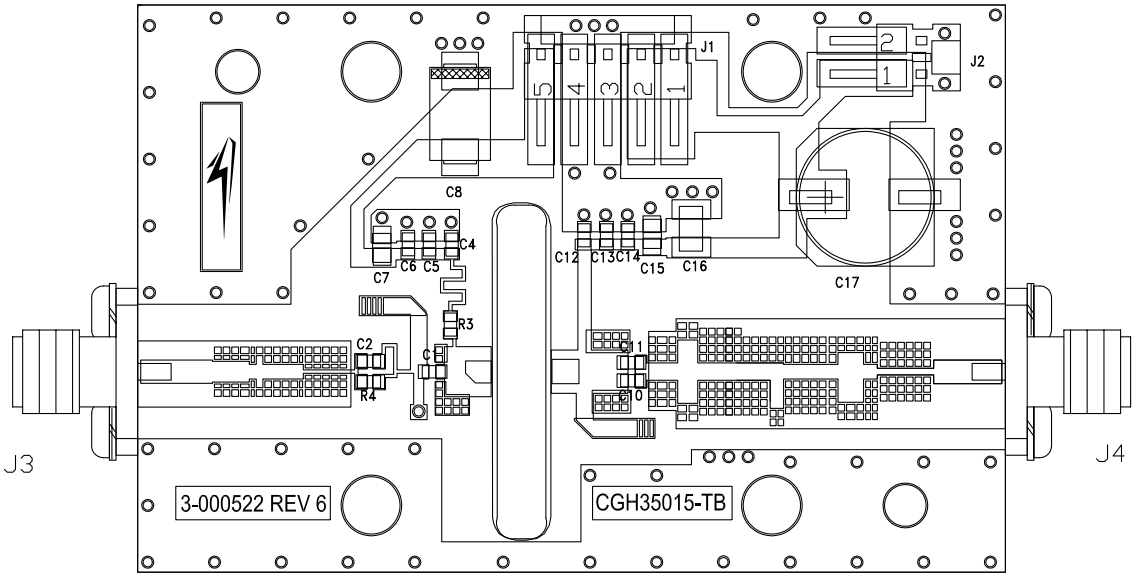
## CGH35015F-AMP Demonstration Amplifier Circuit



## CGH35015-AMP Demonstration Amplifier Circuit Schematic




## CGH35015-AMP Demonstration Amplifier Circuit Outline

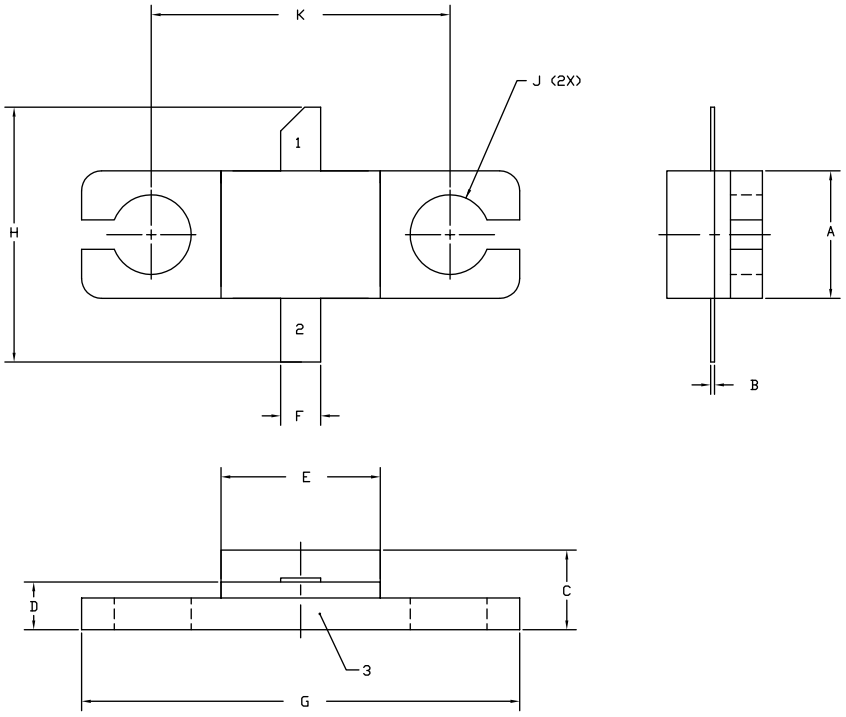


## Typical Package S-Parameters for CGH35015
## (Small Signal, $V_{DS}$ = 28 V, $I_{DQ}$ = 100 mA, angle in degrees)

| Frequency | Mag S11 | Ang S11 | Mag S21 | Ang S21 | Mag S12 | Ang S12 | Mag S22 | Ang S22 |
|---|---|---|---|---|---|---|---|---|
| 500 MHz | 0.909 | -124.41 | 17.41 | 107.81 | 0.026 | 21.06 | 0.335 | -93.73 |
| 600 MHz | 0.902 | -134.04 | 15.04 | 101.48 | 0.027 | 15.39 | 0.322 | -101.61 |
| 700 MHz | 0.898 | -141.62 | 13.18 | 96.16 | 0.028 | 10.74 | 0.315 | -107.78 |
| 800 MHz | 0.894 | -147.78 | 11.71 | 91.54 | 0.028 | 6.79 | 0.312 | -112.73 |
| 900 MHz | 0.892 | -152.91 | 10.51 | 87.43 | 0.028 | 3.35 | 0.312 | -116.77 |
| 1.0 GHz | 0.890 | -157.30 | 9.53 | 83.68 | 0.028 | 0.28 | 0.314 | -120.15 |
| 1.1 GHz | 0.889 | -161.12 | 8.71 | 80.20 | 0.028 | -2.51 | 0.318 | -123.04 |
| 1.2 GHz | 0.889 | -164.51 | 8.01 | 76.95 | 0.028 | -5.07 | 0.322 | -125.57 |
| 1.3 GHz | 0.888 | -167.56 | 7.41 | 73.86 | 0.028 | -7.45 | 0.328 | -127.82 |
| 1.4 GHz | 0.888 | -170.34 | 6.89 | 70.91 | 0.028 | -9.69 | 0.335 | -129.87 |
| 1.5 GHz | 0.888 | -172.91 | 6.44 | 68.07 | 0.028 | -11.81 | 0.342 | -131.77 |
| 1.6 GHz | 0.888 | -175.30 | 6.04 | 65.32 | 0.028 | -13.82 | 0.349 | -133.56 |
| 1.7 GHz | 0.888 | -177.55 | 5.69 | 62.65 | 0.027 | -15.74 | 0.357 | -135.25 |
| 1.8 GHz | 0.888 | -179.68 | 5.37 | 60.05 | 0.027 | -17.58 | 0.364 | -136.89 |
| 1.9 GHz | 0.888 | 178.29 | 5.09 | 57.50 | 0.027 | -19.34 | 0.373 | -138.48 |
| 2.0 GHz | 0.888 | 176.34 | 4.83 | 55.01 | 0.027 | -21.04 | 0.381 | -140.03 |
| 2.1 GHz | 0.889 | 174.45 | 4.60 | 52.56 | 0.026 | -22.69 | 0.389 | -141.55 |
| 2.2 GHz | 0.889 | 172.63 | 4.39 | 50.14 | 0.026 | -24.27 | 0.397 | -143.06 |
| 2.3 GHz | 0.889 | 170.84 | 4.20 | 47.76 | 0.026 | -25.80 | 0.405 | -144.56 |
| 2.4 GHz | 0.889 | 169.10 | 4.02 | 45.41 | 0.025 | -27.28 | 0.413 | -146.04 |
| 2.5 GHz | 0.890 | 167.39 | 3.86 | 43.09 | 0.025 | -28.70 | 0.421 | -147.52 |
| 2.6 GHz | 0.890 | 165.71 | 3.71 | 40.79 | 0.025 | -30.08 | 0.429 | -149.00 |
| 2.7 GHz | 0.891 | 164.04 | 3.57 | 38.51 | 0.024 | -31.41 | 0.437 | -150.48 |
| 2.8 GHz | 0.891 | 162.39 | 3.44 | 36.26 | 0.024 | -32.69 | 0.445 | -151.95 |
| 2.9 GHz | 0.891 | 160.76 | 3.32 | 34.01 | 0.024 | -33.92 | 0.452 | -153.43 |
| 3.0 GHz | 0.892 | 159.13 | 3.21 | 31.79 | 0.023 | -35.10 | 0.459 | -154.92 |
| 3.2 GHz | 0.892 | 155.89 | 3.00 | 27.38 | 0.023 | -37.31 | 0.473 | -157.90 |
| 3.4 GHz | 0.893 | 152.65 | 2.83 | 23.00 | 0.022 | -39.32 | 0.486 | -160.90 |
| 3.6 GHz | 0.893 | 149.39 | 2.67 | 18.66 | 0.021 | -41.09 | 0.499 | -163.93 |
| 3.8 GHz | 0.894 | 146.09 | 2.54 | 14.34 | 0.020 | -42.63 | 0.510 | -166.99 |
| 4.0 GHz | 0.894 | 142.74 | 2.41 | 10.02 | 0.020 | -43.90 | 0.521 | -170.10 |
| 4.2 GHz | 0.895 | 139.33 | 2.31 | 5.70 | 0.019 | -44.88 | 0.530 | -173.24 |
| 4.4 GHz | 0.895 | 135.84 | 2.21 | 1.37 | 0.018 | -45.53 | 0.539 | -176.45 |
| 4.6 GHz | 0.895 | 132.26 | 2.12 | -2.98 | 0.018 | -45.84 | 0.547 | -179.71 |
| 4.8 GHz | 0.895 | 128.59 | 2.04 | -7.36 | 0.017 | -45.78 | 0.554 | 176.97 |
| 5.0 GHz | 0.895 | 124.80 | 1.97 | -11.79 | 0.016 | -45.32 | 0.561 | 173.56 |
| 5.2 GHz | 0.895 | 120.90 | 1.91 | -16.27 | 0.016 | -44.47 | 0.566 | 170.07 |
| 5.4 GHz | 0.895 | 116.87 | 1.85 | -20.81 | 0.016 | -43.25 | 0.571 | 166.48 |
| 5.6 GHz | 0.895 | 112.70 | 1.80 | -25.41 | 0.015 | -41.72 | 0.575 | 162.78 |
| 5.8 GHz | 0.895 | 108.38 | 1.75 | -30.10 | 0.015 | -39.97 | 0.579 | 158.96 |
| 6.0 GHz | 0.895 | 103.92 | 1.70 | -34.88 | 0.016 | -38.13 | 0.581 | 155.00 |

To download the s-parameters in s2p format, go to the CGH35015 Product Page and click on the documentation tab.

## Product Dimensions CGH35015F (Package Type — 440166)



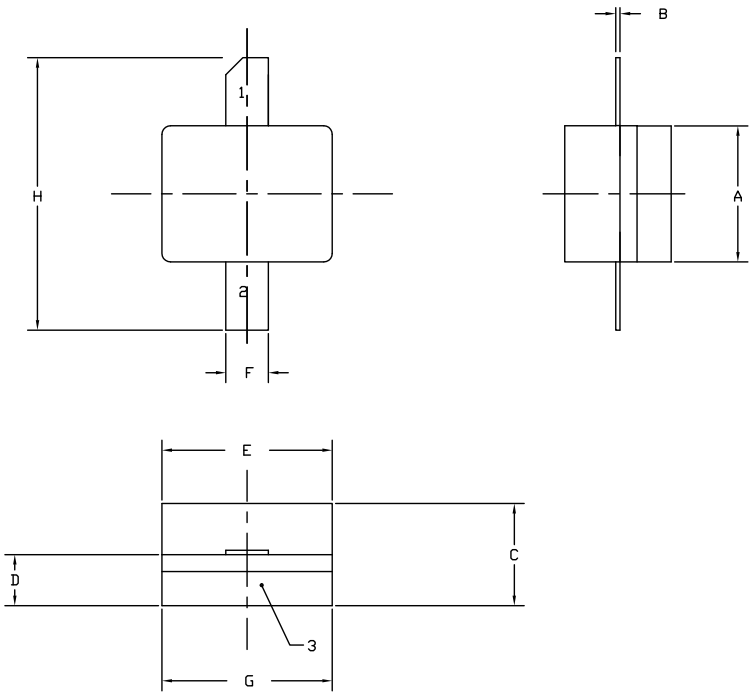

NOTES:

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 | 0.155 | 0.165 | 3.94 | 4.19 |
| B | 0.004 | 0.006 | 0.10 | 0.15 |
| C | 0.115 | 0.135 | 2.92 | 3.43 |
| D | 0.057 | 0.067 | 1.45 | 1.70 |
| E | 0.195 | 0.205 | 4.95 | 5.21 |
| F | 0.045 | 0.055 | 1.14 | 1.40 |
| G | 0.545 | 0.555 | 13.84 | 14.09 |
| H | 0.280 | 0.360 | 7.11 | 9.14 |
| J | ø .100 | | 2.54 | |
| K | 0.375 | | 9.53 | |

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

## Product Dimensions CGH35015P (Package Type — 440196)

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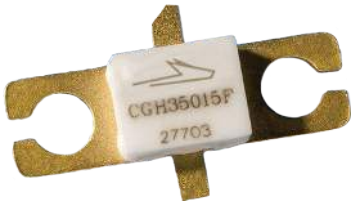
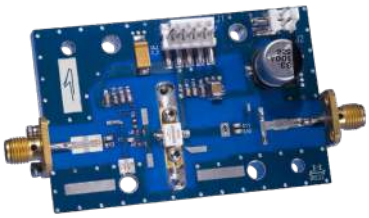
5. ALL PLATED SURFACES ARE NI/AU

| DIM | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 0.155 | 0.165 | 3.94 | 4.19 |
| B | 0.003 | 0.006 | 0.10 | 0.15 |
| C | 0.115 | 0.135 | 2.92 | 3.17 |
| D | 0.057 | 0.067 | 1.45 | 1.70 |
| E | 0.195 | 0.205 | 4.95 | 5.21 |
| F | 0.045 | 0.055 | 1.14 | 1.40 |
| G | 0.195 | 0.205 | 4.95 | 5.21 |
| H | 0.280 | 0.360 | 7.11 | 9.14 |

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

## Product Ordering Information

| Order Number | Description | Unit of Measure | Image |
|---|---|---|---|
| CGH35015F | GaN HEMT | Each |   |
| CGH35015P | GaN HEMT | Each |   |
| CGH35015-AMP | Test board with GaN HEMT installed | Each |  |

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