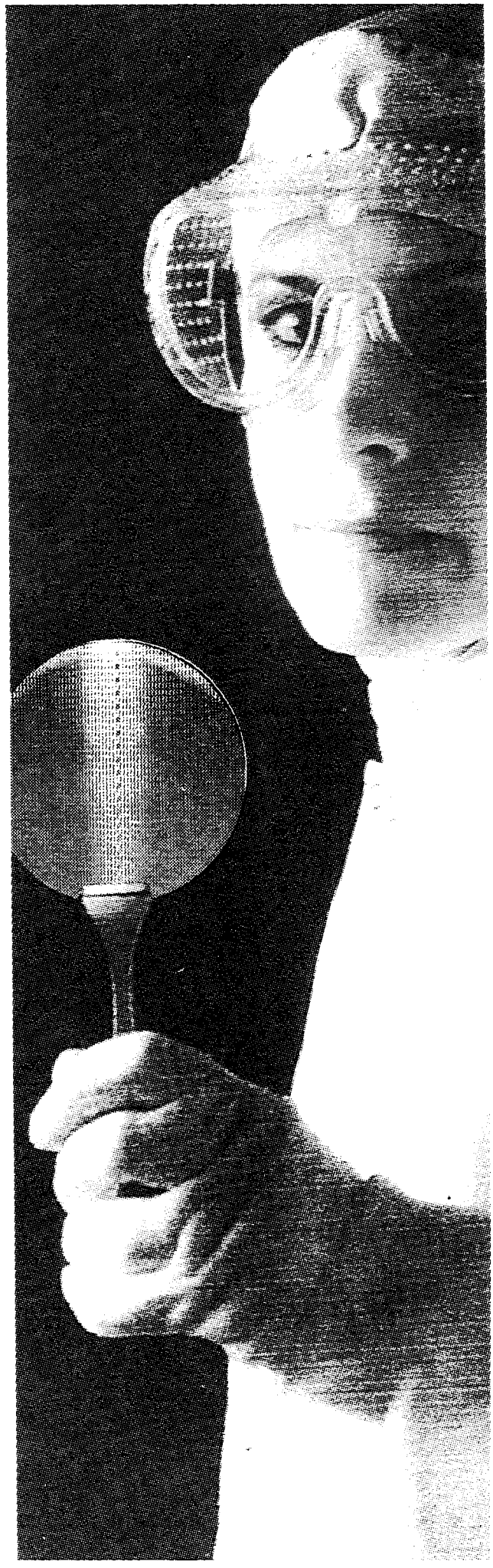
# CF003 Series GaAs Pseudomorphic HEMT and MESFET Chips

- ❑ **Low Noise Figure: 1.0 dB at 12 GHz**
- ❑ **High Gain: 10 dB at 12 GHz**
- ❑ **$P_{1dB}$ Power: +22 dBm at 12 GHz**
- ❑ **Wide Dynamic Range**
- ❑ **Active Layers Include: Pseudomorphic HEMT, Epitaxial and Ion Implanted**
- ❑ **Wafer Qualification Procedure**
- ❑ **Customer Wafer Selection Available**



## Celeritek CF003 Series Chips

Celeritek CF003 Series chips are GaAs-based transistors which include the CF003-01, CF003-02 and CF003-03 models. They are 600 µm gate width transistors with sub half-micron gate length and Celeritek's proprietary Silicon Nitride passivation.

Celeritek's Wafer Qualification Procedure for CF003 Series FETs consists of DC, RF and reliability testing of both individual die and generic 6 to 18 GHz amplifier modules.

The CF003-01, with it's unique straight gate design, provides high gain and medium output power. It is suitable in narrow- and wide-band amplifier applications up to 26 GHz.

The CF003-03 provides low-noise and wide dynamic range up to 26 GHz. It is suitable for narrow- and wide-band amplifiers. Superior $g_m$ also makes this model useful for high gain feed back amplifiers. Its rugged construction allows it to withstand the same input power as conventional MESFETs.

All CF003 Series devices are available in chip form and are suitable for airborne, shipboard and ground-based equipment. Screening includes MIL-STD-750 Class B, Class S and commercial screening. These devices are also available in packaged form. Please consult the CFB003 Series and CFC003 Series data sheets or contact the factory for further information.

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# CF003 Series GaAs Chips

| Specifications ($T_A$ = 25°C) | | | | CF003-01 | | | CF003-02 | | | CF003-03 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Active Layer** | | | | Ion Implanted | | | Epitaxial | | | Pseudomorphic HEMT | | |
| **Symbol** | **Parameters and Conditions** | **Frequency (GHz)** | **Units** | **Min** | **Typ** | **Max** | **Min** | **Typ** | **Max** | **Min** | **Typ** | **Max** |
| $NF_{opt}$ | Optimum Noise Figure $V_{DS}$ = 3.0 V, $I_{DS}$ = 30 mA | 12.0 | dB | | 1.8 | 2.6 | | 1.4 | 2.0 | | 1.0 | 1.4 |
| Ga | Gain at $NF_{opt}$ $V_{DS}$ = 3.0 V, $I_{DS}$ = 30 mA | 12.0 | dB | 7.0 | 8.0 | | 8.0 | 9.0 | | 9.0 | 10.0 | |
| $\|S_{21}\|^2$ | 50 Ohm Insertion Gain $V_{DS}$ = 6.0 V, $I_{DS}$ = 80 mA | 2.0<br>10.0<br>18.0 | dB<br>dB<br>dB | | 16.0<br>7.0<br>3.0 | | | 17.0<br>8.0<br>4.0 | | | 18.0<br>9.0<br>5.0 | |
| $P_{1dB}$ | Power Output @ 1 dB GC $V_{DS}$ = 6.0 V, $I_{DS}$ = 80 mA | 12.0 | dBm | | 22.0 | | | 20.0 | | | 20.0 | |
| $g_m$ | Transconductance $V_{DS}$ = 3.0 V, $V_{GS}$ = 0 V | | mS | | 120 | | | 150 | | | 180 | |
| $I_{DSS}$ | Drain Current $V_{DS}$ = 3.0 V, $V_{GS}$ = 0 V | | mA | 120 | 180 | 240 | 120 | 180 | 240 | 120 | 180 | 240 |
| $V_P$ | Pinchoff Voltage $V_{DS}$ = 3.0 V, $I_{DS}$ = 1 mA | | Volts | -0.7 | -1.3 | -2.5 | -0.7 | -1.3 | -2.5 | -0.7 | -1.3 | -2.5 |
| $BV_{GD}$ | Breakdown Voltage, Gate-Drain $I_{GD}$ = 100 µA | | Volts | -5.5 | -8.0 | | -5.5 | -8.0 | | -5.5 | -8.0 | |
| $R_{th}$ | Thermal Resistance | | °C/W | | 80 | | | 80 | | | 80 | |

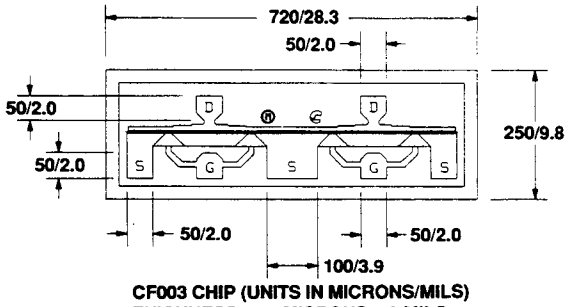
### Absolute Maximum Ratings

| Parameter | Symbol | Ratings |
|---|---|---|
| Drain-Source Voltage | $V_{DS}$ | 8V |
| Gate-Source Voltage | $V_{GS}$ | -5V |
| Drain Current | $I_{DS}$ | $I_{DSS}$ |
| Continuous Dissipation | $P_T$ | 1600 mW |
| Channel Temperature | $T_{CH}$ | 175°C |
| Storage Temperature | $T_{STG}$ | -65°C to +175°C |

### Typical Noise Parameters - CF003-03 $V_{DS}$= 3.0V, $I_{DS}$= 30mA

| Frequency (GHz) | NF opt (dB) | Ga (dB) | Gamma opt (Mag) | Gamma opt (Ang) | Rn/50 |
|---|---|---|---|---|---|
| 2.0 | 0.38 | 18.8 | 0.84 | 14 | 0.29 |
| 4.0 | 0.50 | 15.8 | 0.70 | 37 | 0.19 |
| 6.0 | 0.62 | 13.6 | 0.59 | 61 | 0.16 |
| 8.0 | 0.74 | 12.1 | 0.52 | 88 | 0.13 |
| 10.0 | 0.86 | 11.1 | 0.48 | 114 | 0.09 |
| 12.0 | 0.98 | 10.4 | 0.47 | 141 | 0.06 |
| 14.0 | 1.10 | 9.9 | 0.48 | 166 | 0.04 |
| 16.0 | 1.22 | 9.3 | 0.49 | -171 | 0.04 |
| 18.0 | 1.34 | 8.6 | 0.51 | -151 | 0.07 |
| 20.0 | 1.46 | 7.4 | 0.53 | -135 | 0.14 |

### Chip Outline Drawing




CF003 CHIP (UNITS IN MICRONS/MILS)
THICKNESS: 110 MICRONS/4.3 MILS

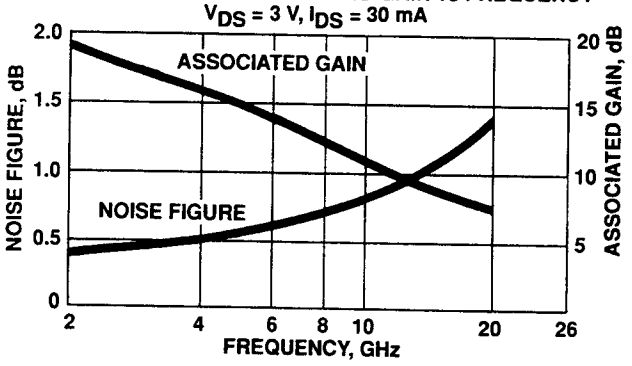
### Die Attach and Bonding Procedures

**Die Attach:** Conductive epoxy or eutectic die attach is recommended. For eutectic die attach: Preform: AuSn (80% Au, 20% Sn); Stage Temperature: 290°C, ±5°C; Handling Tool: Tweezers; Time: 1 min or less.

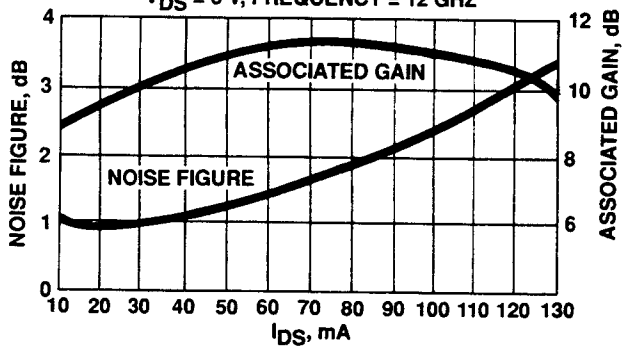
**Wire Bonding:** Wire Size: 0.7 to 1.0 mil in diameter (pre-stressed); Thermocompression bonding is preferred over thermosonic bonding. For thermocompression bonding: Stage Temperature: 250°C; Bond Tip Temperature: 150°C; Bonding Tip Pressure: 18 to 40 gms depending on size of wire.

## Typical Performance ($T_A$ = 25°C)

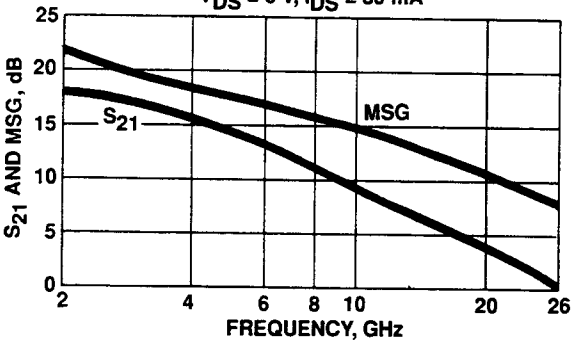
CF003-03
NOISE FIGURE AND ASSOCIATED GAIN vs FREQUENCY
$V_{DS}$ = 3 V, $I_{DS}$ = 30 mA



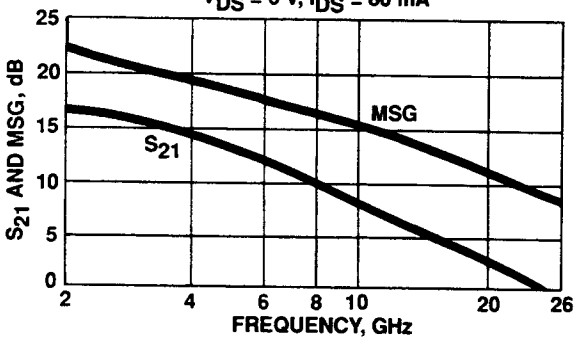

CF003-03
NOISE FIGURE AND ASSOCIATED GAIN vs $I_{DS}$
$V_{DS}$ = 3 V, FREQUENCY = 12 GHZ



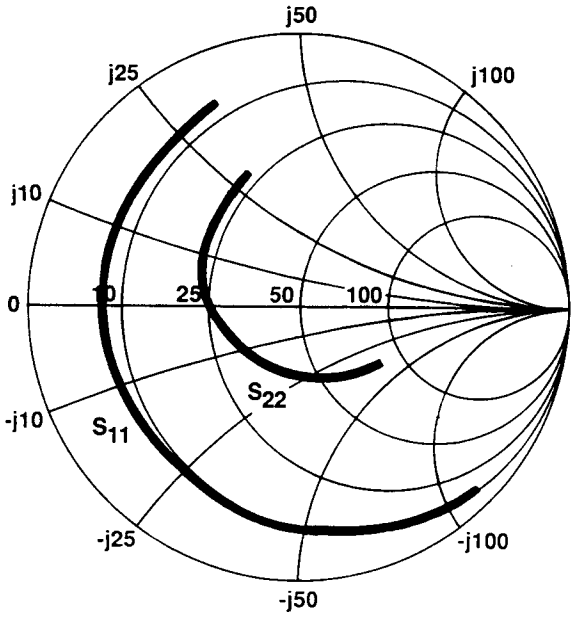

CF003-03
$S_{21}$ AND MSG vs FREQUENCY at LOW NOISE BIAS
$V_{DS}$ = 3 V, $I_{DS}$ = 30 mA




CF003-01
$S_{21}$ AND MSG vs FREQUENCY at POWER BIAS
$V_{DS}$ = 6 V, $I_{DS}$ = 80 mA

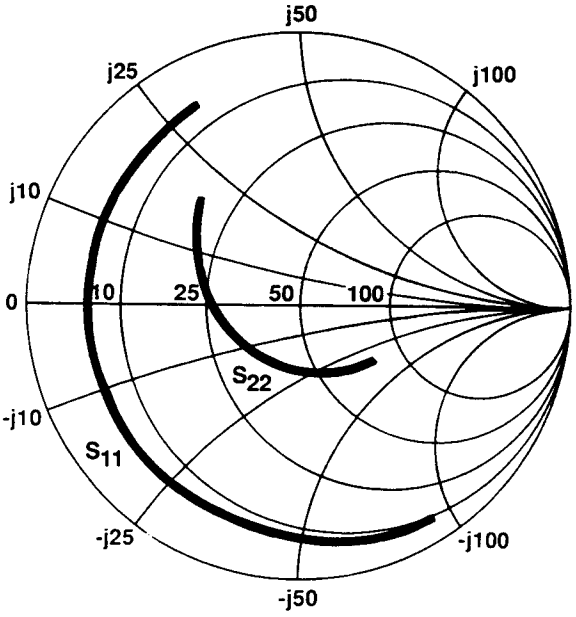



CF003-03
$S_{11}$ AND $S_{22}$ vs FREQUENCY at LOW NOISE BIAS
$V_{DS}$ = 3 V, $I_{DS}$ = 30 mA




FREQUENCY 2.0 to 26.0 GHz

CF003-01
$S_{11}$ AND $S_{22}$ vs FREQUENCY at POWER BIAS
$V_{DS}$ = 6 V, $I_{DS}$ = 80 mA




FREQUENCY 2.0 to 26.0 GHz

# CF003 Series GaAs Chips

**Typical Scattering Parameters, Common Source** (S-Parameters Include Bonding Wire Parasitics)

**CF003-01 at Power Bias** $V_{DS}$ = 6 V, $I_{DS}$ = 80 mA

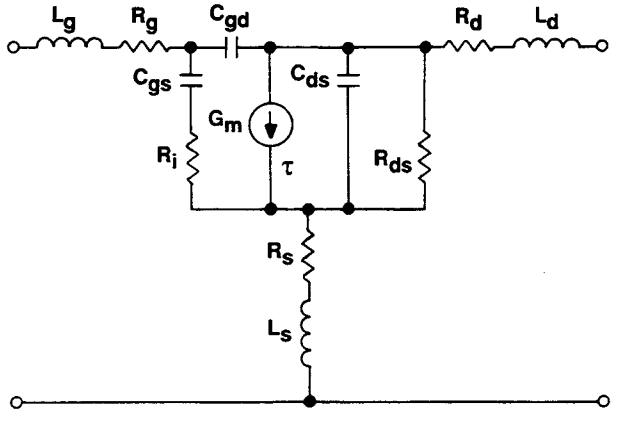
| Frequency | $S_{11}$ | | | $S_{21}$ | | | $S_{12}$ | | | $S_{22}$ | | K | MSG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (GHz) | (Mag) | (Ang) | (dB) | (Mag) | (Ang) | (dB) | (Mag) | (Ang) | (Mag) | (Ang) | | (dB) |
| 2.0 | 0.91 | -62 | 16.7 | 6.86 | 138 | -28.6 | 0.04 | 59 | 0.23 | -37 | 0.38 | 22.7 |
| 4.0 | 0.83 | -108 | 14.1 | 5.10 | 107 | -25.1 | 0.06 | 41 | 0.18 | -74 | 0.53 | 19.6 |
| 6.0 | 0.80 | -132 | 11.8 | 3.88 | 88 | -24.0 | 0.06 | 33 | 0.17 | -90 | 0.71 | 17.9 |
| 8.0 | 0.79 | -155 | 9.6 | 3.01 | 71 | -23.7 | 0.07 | 26 | 0.19 | -120 | 0.88 | 16.6 |
| 10.0 | 0.78 | -172 | 7.6 | 2.39 | 57 | -24.1 | 0.06 | 24 | 0.23 | -134 | 1.15 | 15.8 |
| 12.0 | 0.80 | 177 | 6.2 | 2.03 | 45 | -23.3 | 0.07 | 21 | 0.27 | -147 | 1.10 | 14.7 |
| 14.0 | 0.80 | 166 | 5.0 | 1.78 | 33 | -23.2 | 0.07 | 17 | 0.31 | -156 | 1.20 | 14.1 |
| 16.0 | 0.79 | 150 | 4.1 | 1.61 | 20 | -22.1 | 0.08 | 14 | 0.33 | -163 | 1.20 | 13.1 |
| 18.0 | 0.80 | 135 | 3.5 | 1.49 | 5 | -21.3 | 0.09 | 9 | 0.32 | 179 | 1.18 | 12.4 |
| 20.0 | 0.81 | 126 | 2.3 | 1.31 | -10 | -20.4 | 0.10 | 2 | 0.36 | 153 | 1.19 | 11.3 |
| 22.0 | 0.87 | 117 | 1.1 | 1.14 | -22 | -19.6 | 0.11 | -4 | 0.46 | 138 | 0.79 | 10.3 |
| 24.0 | 0.83 | 112 | -0.7 | 0.93 | -28 | -18.9 | 0.11 | -4 | 0.48 | 136 | 1.11 | 9.1 |
| 26.0 | 0.87 | 115 | -1.4 | 0.85 | -33 | -18.1 | 0.13 | -9 | 0.51 | 134 | 0.73 | 8.3 |

**CF003-03 at Low Noise Bias** $V_{DS}$ = 3 V, $I_{DS}$ = 30 mA

| Frequency | $S_{11}$ | | | $S_{21}$ | | | $S_{12}$ | | | $S_{22}$ | | K | MSG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (GHz) | (Mag) | (Ang) | (dB) | (Mag) | (Ang) | (dB) | (Mag) | (Ang) | (Mag) | (Ang) | | (dB) |
| 2.0 | 0.92 | -58 | 18.0 | 7.93 | 139 | -25.7 | 0.05 | 60 | 0.32 | -48 | 0.21 | 21.9 |
| 4.0 | 0.81 | -103 | 15.5 | 5.95 | 109 | -22.2 | 0.08 | 40 | 0.24 | -94 | 0.40 | 18.8 |
| 6.0 | 0.75 | -127 | 13.2 | 4.55 | 91 | -21.0 | 0.09 | 31 | 0.20 | -118 | 0.56 | 17.1 |
| 8.0 | 0.73 | -151 | 11.0 | 3.54 | 74 | -20.7 | 0.09 | 24 | 0.23 | -147 | 0.70 | 15.8 |
| 10.0 | 0.71 | -169 | 9.0 | 2.80 | 61 | -21.0 | 0.09 | 19 | 0.27 | -159 | 0.91 | 15.0 |
| 12.0 | 0.73 | 180 | 7.5 | 2.38 | 49 | -20.5 | 0.10 | 16 | 0.30 | -169 | 0.93 | 14.0 |
| 14.0 | 0.73 | 168 | 6.4 | 2.08 | 38 | -20.2 | 0.10 | 11 | 0.33 | -177 | 1.01 | 13.3 |
| 16.0 | 0.73 | 154 | 5.5 | 1.89 | 26 | -19.5 | 0.11 | 7 | 0.33 | 174 | 1.04 | 12.5 |
| 18.0 | 0.74 | 141 | 4.8 | 1.74 | 12 | -18.9 | 0.11 | 1 | 0.33 | 150 | 1.06 | 11.8 |
| 20.0 | 0.76 | 132 | 3.7 | 1.53 | -2 | -18.2 | 0.12 | -3 | 0.40 | 126 | 1.07 | 10.9 |
| 22.0 | 0.82 | 124 | 2.4 | 1.32 | -13 | -17.7 | 0.13 | -9 | 0.50 | 114 | 0.87 | 10.1 |
| 24.0 | 0.79 | 118 | 0.7 | 1.08 | -20 | -17.1 | 0.14 | -9 | 0.51 | 114 | 1.05 | 8.9 |
| 26.0 | 0.84 | 120 | -0.2 | 0.98 | -24 | -16.7 | 0.15 | -11 | 0.53 | 114 | 0.84 | 8.2 |

## Device Model

| Parameters | CF003-01 VDS = 6V, IDS = 80mA | CF003-03 VDS = 3V, IDS = 30mA | Units |
|---|---|---|---|
| $L_g$ | 0.21 | 0.20 | nH |
| $R_g$ | 0.50 | 0.50 | Ω |
| $C_{gs}$ | 0.71 | 0.55 | pF |
| $R_i$ | 1.4 | 1.4 | Ω |
| $C_{gd}$ | 0.053 | 0.068 | pF |
| $G_m$ | 134 | 158 | mS |
| $\tau$ | 2.8 | 2.3 | ps |
| $C_{ds}$ | 0.16 | 0.15 | pF |
| $R_{ds}$ | 87 | 92 | Ω |
| $R_d$ | 0.67 | 0.67 | Ω |
| $L_d$ | 0.21 | 0.22 | nH |
| $R_s$ | 0.53 | 0.80 | Ω |
| $L_s$ | 0.4 | 0.05 | nH |




## Wafer Qualification Procedure

- 100% DC Test, 100% Visual Insp.
- Sample Chip Performance Test — NF, Power, S-Parameters, IP3, Power Blast
- Sample Circuit Performance Tests 6-18 GHz Module — NF, Power, Gain, VSWR
- Reliability Assesment — Power Blast & Burn-In

80% of tested samples must meet specifications for wafer acceptance.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Specifications subject to change.

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