

FEATURES

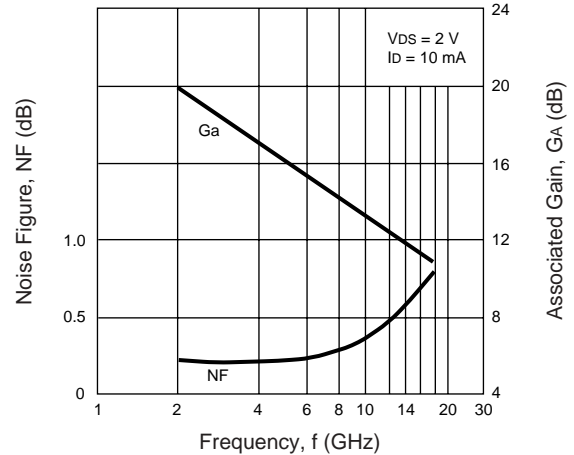
- **SUPER LOW NOISE FIGURE:**
0.45 dB TYP at 12 GHz
- **HIGH ASSOCIATED GAIN:**
12.5 dB TYP at 12 GHz
- **GATE LENGTH:** $\leq 0.20 \mu\text{m}$
- **GATE WIDTH:** $200 \mu\text{m}$
- **LOW COST PLASTIC PACKAGE**

DESCRIPTION

The NE325S01 is a Hetero-Junction FET that uses the junction between Si-doped AlGaAs and undoped InGaAs to create very high mobility electrons. Its excellent low noise figure and high associated gain make it suitable for commercial systems and industrial applications.

NEC's stringent quality assurance and test procedures assure the highest reliability and performance.

NOISE FIGURE & ASSOCIATED GAIN vs. FREQUENCY



RECOMMENDED OPERATING CONDITIONS (TA = 25°C)

| SYMBOLS | CHARACTERISTICS | UNITS | MIN | TYP | MAX |
|-----------------|-------------------------|-------|-----|-----|-----|
| V _{DS} | Drain to Source Voltage | V | | 2 | 3 |
| I _D | Drain Current | mA | | 10 | 20 |
| P _{in} | Input Power | dBm | | | 0 |

ELECTRICAL CHARACTERISTICS (TA = 25°C)

| PART NUMBER PACKAGE OUTLINE | | | NE325S01 S01 | | |
|--------------------------------|--|---------------|-----------------|------|------|
| SYMBOLS | PARAMETERS AND CONDITIONS | UNITS | MIN | TYP | MAX |
| NF ¹ | Noise Figure, V _{DS} = 2 V, I _D = 10 mA, f = 12 GHz | dB | | 0.45 | 0.55 |
| GA ¹ | Associated Gain, V _{DS} = 2 V, I _D = 10 mA, f = 12 GHz | dB | 11.0 | 12.5 | |
| I _{DSS} | Saturated Drain Current, V _{DS} = 2 V, V _{GS} = 0 V | mA | 20 | 60 | 90 |
| g _m | Transconductance, V _{DS} = 2 V, I _D = 10 mA | mS | 45 | 60 | |
| V _{GS(off)} | Gate to Source Cutoff Voltage, V _{DS} = 2 V, I _D = 100 μA | V | -0.2 | -0.7 | -2.0 |
| I _{GSO} | Gate to Source Leak Current, V _{GS} = -3 V | μA | | 0.5 | 10 |

Note:

1. Typical values of noise figures and associated gain are those obtained when 50% of the devices from a large number of lots were individually measured in a circuit with the input individually tuned to obtain the minimum value. Maximum values are criteria established on the production line as a "go-no-go" screening tuned for the "generic" type but not each specimen.

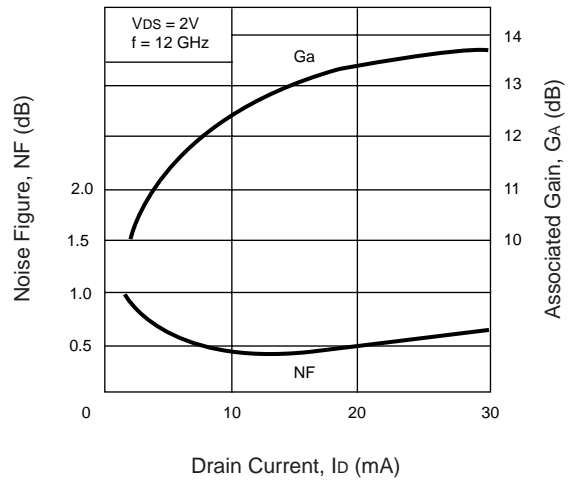
ABSOLUTE MAXIMUM RATINGS¹ (T_A = 25°C)

| SYMBOLS | PARAMETERS | UNITS | RATINGS |
|------------------|-------------------------|-------|------------------|
| V _{DS} | Drain to Source Voltage | V | 4.0 |
| V _{GS} | Gate to Source Voltage | V | -3.0 |
| I _D | Drain Current | mA | I _{DSS} |
| I _G | Gate Current | μA | 100 |
| P _T | Total Power Dissipation | mW | 165 |
| T _{CH} | Channel Temperature | °C | 125 |
| T _{stg} | Storage Temperature | °C | -65 to +125 |

Note:

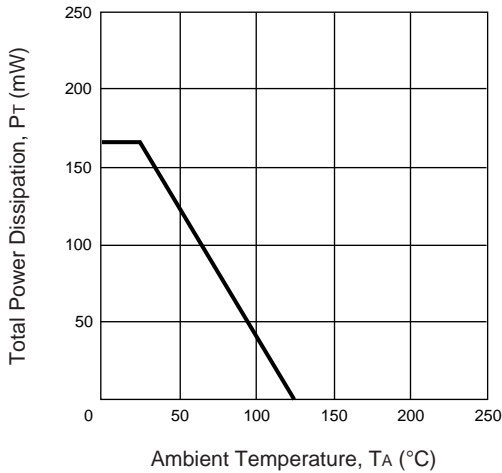
1. Operation in excess of any one of these parameters may result in permanent damage.

NOISE FIGURE, ASSOCIATED GAIN vs. DRAIN CURRENT

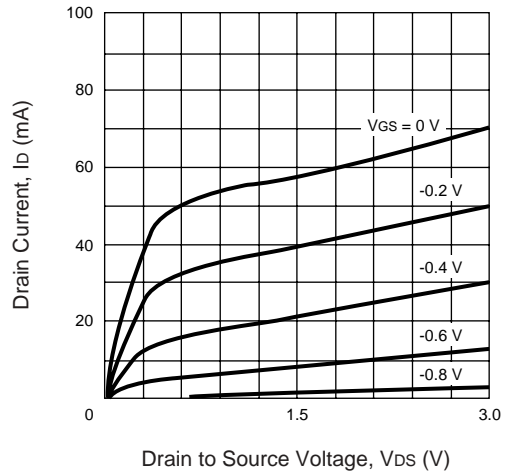


TYPICAL PERFORMANCE CURVES (T_A = 25°C)

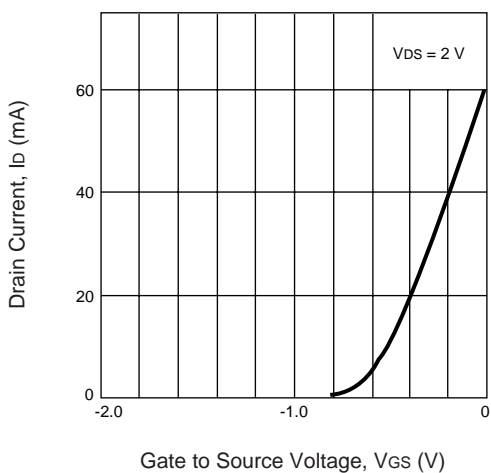
TOTAL POWER DISSIPATION vs. AMBIENT TEMPERATURE



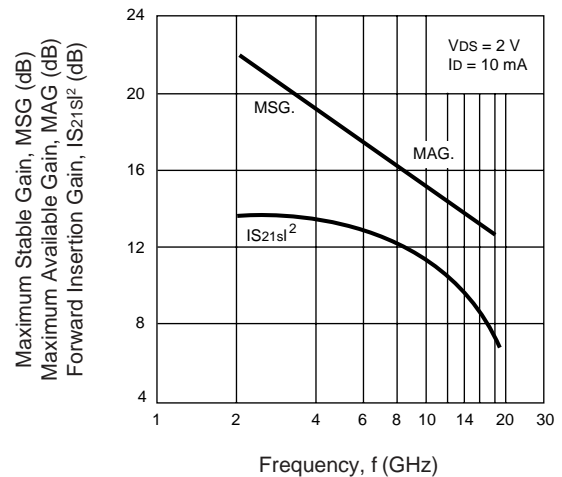
DRAIN CURRENT vs. DRAIN TO SOURCE VOLTAGE



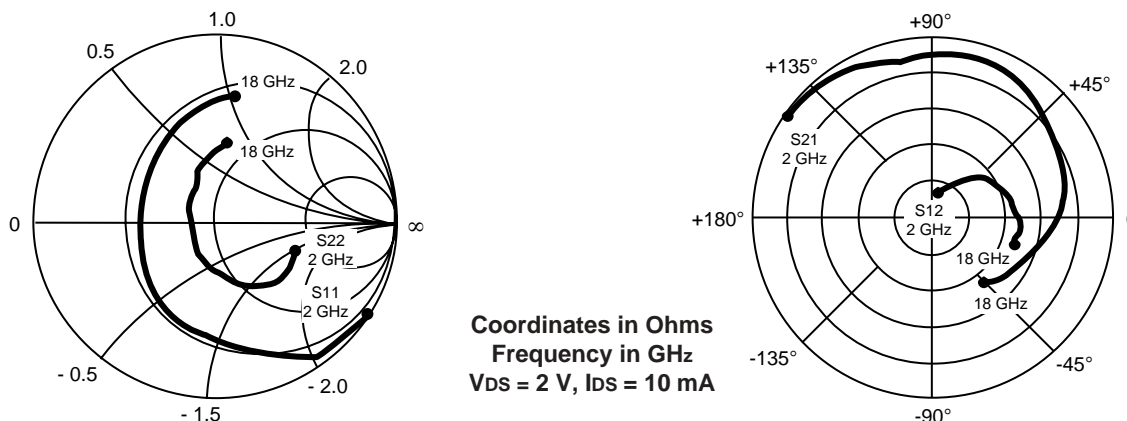
DRAIN CURRENT vs. GATE TO SOURCE VOLTAGE



MAXIMUM AVAILABLE GAIN, FORWARD INSERTION GAIN vs. FREQUENCY



TYPICAL COMMON SOURCE SCATTERING PARAMETERS (T_A = 25°C)



V_{ds} = 2 V, I_D = 10 mA

| FREQUENCY (GHz) | S ₁₁ | | S ₂₁ | | S ₁₂ | | S ₂₂ | | K | MAG ¹ (dB) |
|--------------------|-----------------|---------|-----------------|--------|-----------------|--------|-----------------|---------|-------|--------------------------|
| | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG | | |
| 2.0 | 0.969 | -24.84 | 4.798 | 152.65 | 0.026 | 73.02 | 0.574 | -18.45 | 0.237 | 22.661 |
| 2.5 | 0.957 | -30.87 | 4.756 | 146.03 | 0.032 | 68.77 | 0.566 | -22.99 | 0.277 | 21.721 |
| 3.0 | 0.944 | -36.91 | 4.730 | 139.49 | 0.038 | 64.98 | 0.556 | -27.48 | 0.310 | 20.951 |
| 3.5 | 0.926 | -43.10 | 4.699 | 132.75 | 0.044 | 60.81 | 0.544 | -32.03 | 0.358 | 20.286 |
| 4.0 | 0.906 | -49.43 | 4.663 | 126.04 | 0.050 | 56.76 | 0.531 | -36.56 | 0.403 | 19.697 |
| 4.5 | 0.884 | -55.58 | 4.600 | 119.31 | 0.055 | 52.64 | 0.515 | -41.22 | 0.454 | 19.224 |
| 5.0 | 0.852 | -62.02 | 4.523 | 112.42 | 0.060 | 48.77 | 0.496 | -45.75 | 0.524 | 18.773 |
| 5.5 | 0.819 | -68.28 | 4.449 | 105.80 | 0.064 | 44.73 | 0.475 | -50.42 | 0.595 | 18.421 |
| 6.0 | 0.785 | -74.48 | 4.370 | 99.62 | 0.068 | 41.16 | 0.454 | -55.09 | 0.659 | 18.080 |
| 6.5 | 0.753 | -80.82 | 4.276 | 93.42 | 0.072 | 37.54 | 0.434 | -59.78 | 0.716 | 17.737 |
| 7.0 | 0.723 | -87.00 | 4.200 | 87.18 | 0.075 | 34.03 | 0.414 | -64.50 | 0.771 | 17.482 |
| 7.5 | 0.696 | -93.23 | 4.136 | 81.15 | 0.078 | 30.60 | 0.396 | -69.09 | 0.816 | 17.245 |
| 8.0 | 0.670 | -99.64 | 4.066 | 75.30 | 0.081 | 27.44 | 0.379 | -73.80 | 0.854 | 17.007 |
| 8.5 | 0.643 | -105.78 | 4.011 | 69.03 | 0.084 | 24.34 | 0.363 | -78.31 | 0.894 | 16.790 |
| 9.0 | 0.622 | -112.38 | 3.968 | 63.04 | 0.087 | 21.18 | 0.347 | -82.72 | 0.919 | 16.591 |
| 9.5 | 0.597 | -119.18 | 3.920 | 56.93 | 0.090 | 18.07 | 0.330 | -87.24 | 0.950 | 16.390 |
| 10.0 | 0.571 | -126.73 | 3.857 | 50.48 | 0.092 | 14.85 | 0.308 | -91.89 | 0.995 | 16.225 |
| 10.5 | 0.538 | -134.31 | 3.799 | 44.20 | 0.094 | 11.58 | 0.287 | -96.77 | 1.047 | 14.743 |
| 11.0 | 0.503 | -142.42 | 3.740 | 38.29 | 0.096 | 8.35 | 0.262 | -102.63 | 1.100 | 13.983 |
| 11.5 | 0.475 | -150.84 | 3.621 | 32.04 | 0.098 | 5.11 | 0.237 | -109.34 | 1.156 | 13.284 |
| 12.0 | 0.453 | -160.32 | 3.545 | 25.99 | 0.099 | 1.78 | 0.214 | -116.89 | 1.200 | 12.834 |
| 12.5 | 0.435 | -170.10 | 3.482 | 20.11 | 0.101 | -1.21 | 0.191 | -126.44 | 1.227 | 12.500 |
| 13.0 | 0.422 | 179.93 | 3.423 | 14.37 | 0.102 | -4.53 | 0.173 | -137.47 | 1.255 | 12.220 |
| 13.5 | 0.413 | 169.88 | 3.362 | 8.03 | 0.103 | -7.66 | 0.160 | -149.76 | 1.278 | 11.970 |
| 14.0 | 0.408 | 159.68 | 3.309 | 1.70 | 0.104 | -11.00 | 0.151 | -161.84 | 1.294 | 11.771 |
| 14.5 | 0.405 | 149.30 | 3.250 | -4.80 | 0.106 | -14.39 | 0.145 | -174.45 | 1.302 | 11.572 |
| 15.0 | 0.406 | 138.94 | 3.182 | -11.37 | 0.107 | -17.92 | 0.144 | -171.72 | 1.316 | 11.364 |
| 15.5 | 0.410 | 128.31 | 3.108 | -18.01 | 0.108 | -21.80 | 0.148 | -157.82 | 1.330 | 11.155 |
| 16.0 | 0.418 | 117.54 | 3.031 | -24.47 | 0.109 | -25.41 | 0.154 | -142.64 | 1.343 | 10.940 |
| 16.5 | 0.434 | 106.98 | 2.943 | -30.70 | 0.110 | -29.36 | 0.168 | -127.26 | 1.350 | 10.739 |
| 17.0 | 0.455 | 96.84 | 2.869 | -37.11 | 0.111 | -33.17 | 0.188 | -114.01 | 1.344 | 10.619 |
| 17.5 | 0.484 | 87.21 | 2.799 | -43.55 | 0.111 | -37.06 | 0.214 | -102.68 | 1.330 | 10.577 |
| 18.0 | 0.521 | 77.71 | 2.720 | -50.10 | 0.111 | -41.23 | 0.246 | -92.62 | 1.303 | 10.591 |

Note:

1. Gain Calculation:

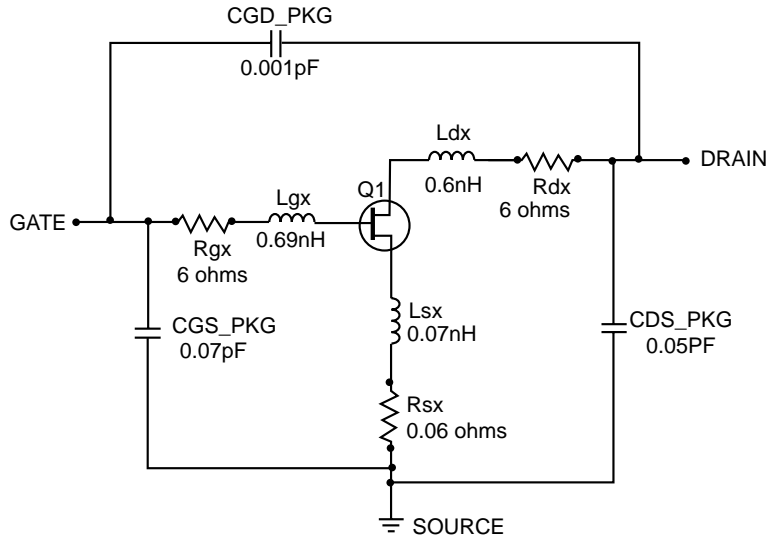
$$\text{MAG} = \frac{|S_{21}|}{|S_{12}|} (K \pm \sqrt{K^2 - 1}). \text{ When } K \leq 1, \text{ MAG is undefined and MSG values are used. } \text{MSG} = \frac{|S_{21}|}{|S_{12}|}, K = \frac{1 + |\Delta|^2 - |S_{11}|^2 - |S_{22}|^2}{2 |S_{12} S_{21}|}, \Delta = S_{11} S_{22} - S_{21} S_{12}$$

MAG = Maximum Available Gain

MSG = Maximum Stable Gain

NONLINEAR MODEL

SCHEMATIC



FET NONLINEAR MODEL PARAMETERS ⁽¹⁾

| Parameters | Q1 | Parameters | Q1 |
|------------|----------|------------|------|
| VTO | -0.8 | RG | 3 |
| VTOSC | 0 | RD | 2 |
| ALPHA | 8 | RS | 2 |
| BETA | 0.103 | RGMET | 0 |
| GAMMA | 0.092 | KF | 0 |
| GAMMADC | 0.08 | AF | 1 |
| Q | 2 | TNOM | 27 |
| DELTA | 1 | XTI | 3 |
| VBI | 0.715 | EG | 1.43 |
| IS | 3e-13 | VTOTC | 0 |
| N | 1.22 | BETATCE | 0 |
| RIS | 0 | FFE | 1 |
| RID | 0 | | |
| TAU | 4e-12 | | |
| CDS | 0.13e-12 | | |
| RDB | 5000 | | |
| CBS | 1e-9 | | |
| CGSO | 0.3e-12 | | |
| CGDO | 0.02e-12 | | |
| DELTA1 | 0.3 | | |
| DELTA2 | 0.1 | | |
| FC | 0.5 | | |
| VBR | Infinity | | |

UNITS

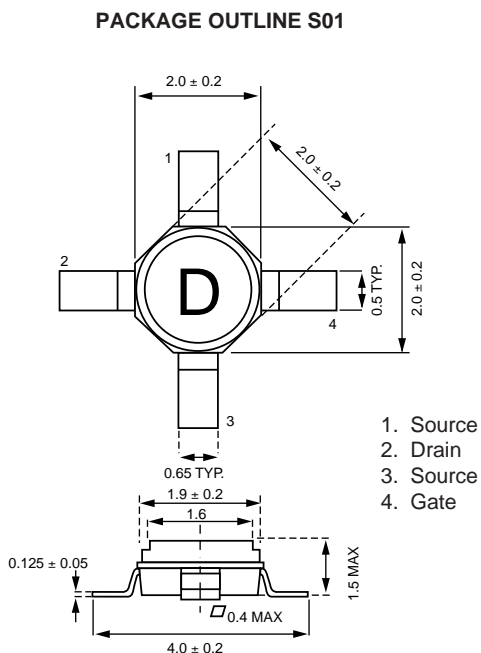
| Parameter | Units |
|-------------|---------|
| time | seconds |
| capacitance | farads |
| inductance | henries |
| resistance | ohms |
| voltage | volts |
| current | amps |

MODEL RANGE

Frequency: 0.1 to 18 GHz
 Bias: $V_{ds} = 1\text{ V to }3\text{ V}$, $I_D = 5\text{ mA to }30\text{ mA}$
 $I_{DSS} = 59.9\text{ ma @ }V_{GS} = 0, V_{DS} = 2\text{ V}$
 Date: 2/98

(1) Series IV Libra TOM Model

OUTLINE DIMENSIONS (Units in mm)

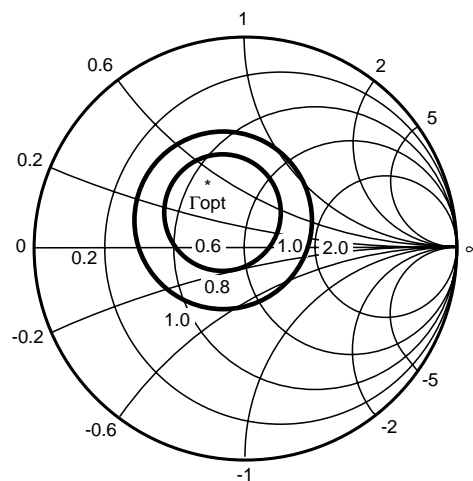


TYPICAL NOISE PARAMETERS ($T_A = 25^\circ\text{C}$)

$V_{DS} = 2\text{ V}$, $I_D = 10\text{ mA}$

| FREQ. (GHz) | NF _{MIN} (dB) | G _A (dB) | Γ _{OPT} | | R _{n/50} |
|----------------|---------------------------|------------------------|------------------|------|-------------------|
| | | | MAG | ANG | |
| 2 | 0.29 | 20.0 | 0.93 | 14 | 0.38 |
| 4 | 0.30 | 18.3 | 0.80 | 29 | 0.33 |
| 6 | 0.32 | 16.5 | 0.65 | 48 | 0.25 |
| 8 | 0.35 | 15.0 | 0.49 | 72 | 0.18 |
| 10 | 0.40 | 13.6 | 0.36 | 102 | 0.11 |
| 12 | 0.45 | 12.5 | 0.27 | 139 | 0.08 |
| 14 | 0.53 | 12.0 | 0.24 | -176 | 0.07 |
| 16 | 0.67 | 11.8 | 0.30 | -122 | 0.10 |
| 18 | 0.83 | 11.5 | 0.47 | -58 | 0.22 |

TYPICAL CONSTANT NOISE FIGURE CIRCLE ($V_{DS} = 2\text{ V}$, $I_D = 10\text{ mA}$, $f = 12\text{ GHz}$)



ORDERING INFORMATION

| PART NUMBER | SUPPLY FORM | PACKAGE OUTLINE |
|--------------|----------------------------|-----------------|
| NE325S01 | Bulk | S01 |
| NE325S01-T1 | Tape & Reel 1000 pcs./reel | S01 |
| NE325S01-T1B | Tape & Reel 4000 pcs./reel | S01 |

Life Support Applications

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