

NEC

GENERAL PURPOSE L TO X-BAND GaAs MESFET

NE721S01

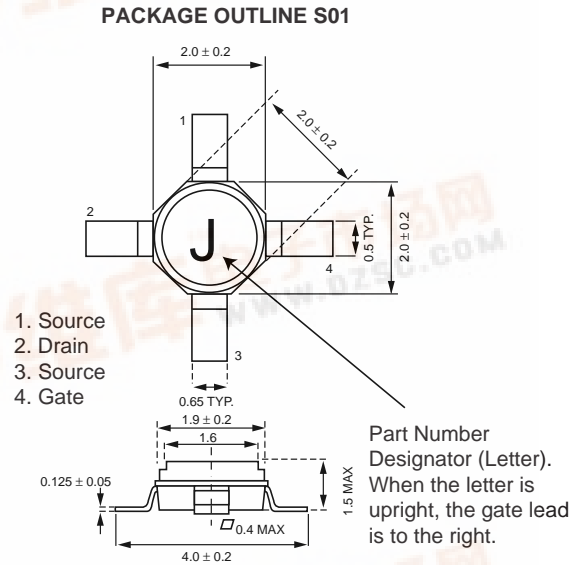
FEATURES

- **HIGH POWER GAIN:**
7 dB TYP at 12 GHz
- **HIGH OUTPUT POWER:**
15 dBm TYP at 12 GHz
- **L_G = 0.8 μm, W_G = 330 μm**
- **LOW PHASE NOISE:**
-110 dBc/Hz TYP at 100 KHz offset at f = 12 GHz
- **LOW COST PLASTIC PACKAGE**

DESCRIPTION

The NE721S01 is a low cost 0.8 μm recessed gate GaAs MESFET, suitable for both amplifier and oscillator applications. Larger gate geometry make this device ideal for second and third stages of low noise amplifiers operating in the 1-12 GHz frequency range. The NE721S01 is fabricated with an epitaxial process resulting in excellent phase noise in oscillator applications up to 14 GHz. NEC's latest high performance/low cost plastic packaging technology make the NE721S01 suitable for GPS, TVRO, DBS, PRD and other commercial applications.

OUTLINE DIMENSIONS (Units in mm)

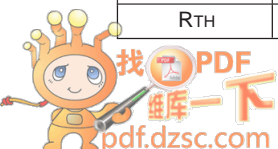


ORDERING INFORMATION

| PART NUMBER | QTY | PACKAGE | LEAD LENGTH |
|--------------|---------------|---------|-------------|
| NE721S01-T1 | 1K/Reel | S01 | 1.0 mm |
| NE721S01 | Bulk up to 4K | S01 | 1.0 mm |
| NE721S01-T1B | 4K/Reel | S01 | 1.0 mm |

ELECTRICAL CHARACTERISTICS (T_A = 25°C)

| PART NUMBER PACKAGE OUTLINE | | | NE721S01 S01 | | |
|--------------------------------|---|--------|-----------------|------|------|
| SYMBOL | PARAMETERS AND CONDITIONS | UNITS | MIN | TYP | MAX |
| PN | Phase Noise at V _{DS} = 3 V, I _D = 30 mA, f = 12 GHz, 100 KHz offset | dBc/Hz | | -110 | |
| G _s | Power Gain at V _{DS} = 3 V, I _D = 30 mA, f = 12 GHz | dB | | 7.0 | |
| P _{1dB} | Output Power at 1 dB Gain Compression Point, f = 12 GHz V _{DS} = 3 V, I _{DS} = 30 mA | dBm | | 15.0 | |
| I _{DSS} | Saturated Drain Current at V _{DS} = 3 V, V _{GS} = 0 | mA | 30 | 60 | 100 |
| V _P | Pinch Off Voltage at V _{DS} = 3 V, I _D = 100 μA | V | -4.0 | -2.0 | -0.5 |
| g _m | Transconductance at V _{DS} = 3 V, I _D = 10 mA | mS | 20 | 40 | |
| I _{GSO} | Gate to Source Leak Current at V _{GS} = -5 V | μA | | 1.0 | 10 |
| R _{TH} | Thermal Resistance | °C/W | | | 300 |



NE721S01

ABSOLUTE MAXIMUM RATINGS¹ (T_A = 25°C)

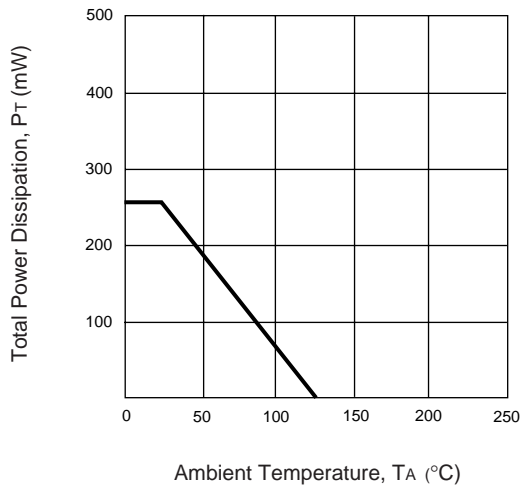
| SYMBOLS | PARAMETERS | UNITS | RATINGS |
|------------------|-------------------------|-------|------------------|
| V _{DS} | Drain to Source Voltage | V | 5 |
| V _{GDO} | Gate to Drain Voltage | V | -6 |
| V _{GSO} | Gate to Source Voltage | V | -6 |
| I _{DS} | Drain Current | mA | I _{DSS} |
| T _{CH} | Channel Temperature | °C | 125 |
| T _{STG} | Storage Temperature | °C | -65 to +125 |
| P _T | Total Power Dissipation | mW | 250 |

Note:

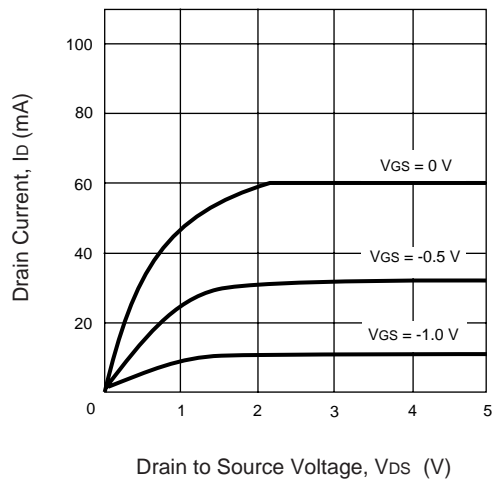
1. Operation in excess of any one of these parameters may result in permanent damage.

TYPICAL PERFORMANCE CURVES (T_A = 25°C)

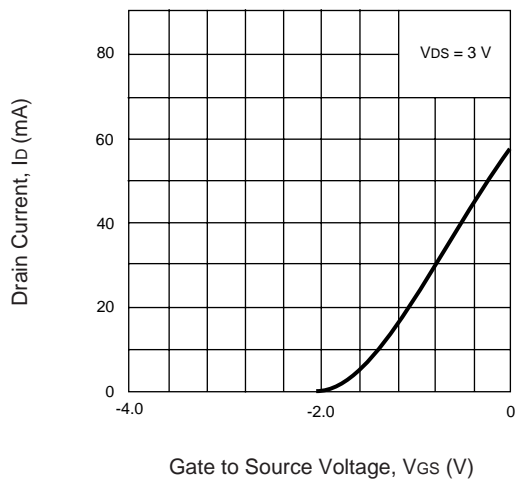
TOTAL POWER DISSIPATION vs. AMBIENT TEMPERATURE



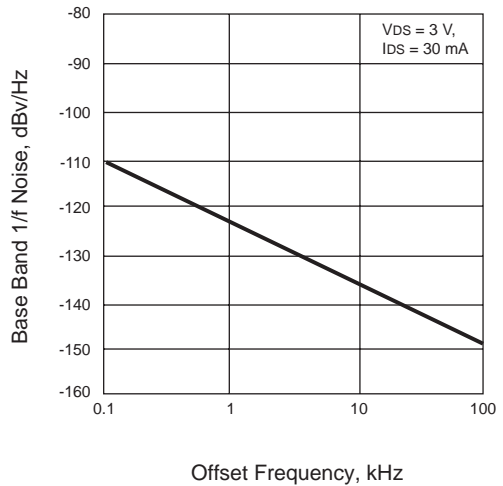
DRAIN CURRENT vs. DRAIN TO SOURCE VOLTAGE



DRAIN CURRENT vs. GATE TO SOURCE VOLTAGE



BASE BAND 1/f NOISE vs. OFFSET FREQUENCY



TYPICAL SCATTERING PARAMETERS ($T_A = 25^\circ\text{C}$)**V_{DS} = 3 V, I_D = 10 mA**

| FREQUENCY (GHz) | S ₁₁ | | S ₂₁ | | S ₁₂ | | S ₂₂ | |
|--------------------|-----------------|--------|-----------------|--------|-----------------|-------|-----------------|--------|
| | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .936 | -48.8 | 2.501 | 135.8 | .070 | 57.1 | .700 | -26.5 |
| 3.0 | .877 | -71.9 | 2.387 | 115.2 | .096 | 41.9 | .662 | -40.8 |
| 4.0 | .813 | -95.7 | 2.271 | 95.2 | .115 | 26.4 | .619 | -53.4 |
| 5.0 | .743 | -119.4 | 2.153 | 75.6 | .127 | 12.5 | .568 | -66.2 |
| 6.0 | .691 | -144.7 | 2.063 | 56.5 | .135 | -1.1 | .518 | -77.4 |
| 7.0 | .649 | -174.6 | 1.931 | 36.8 | .136 | -14.2 | .448 | -86.4 |
| 8.0 | .639 | 158.2 | 1.765 | 18.4 | .129 | -24.8 | .370 | -95.5 |
| 9.0 | .659 | 136.5 | 1.609 | 1.2 | .122 | -33.4 | .305 | -111.4 |
| 10.0 | .683 | 115.8 | 1.480 | -15.7 | .117 | -39.8 | .257 | -132.8 |
| 11.0 | .710 | 95.8 | 1.351 | -32.9 | .113 | -46.8 | .234 | -159.5 |
| 12.0 | .748 | 78.1 | 1.215 | -49.8 | .107 | -52.8 | .226 | -173.4 |
| 13.0 | .776 | 64.2 | 1.073 | -65.3 | .102 | -54.7 | .235 | 143.9 |
| 14.0 | .805 | 53.9 | .954 | -79.8 | .101 | -59.5 | .288 | 113.0 |
| 15.0 | .839 | 45.8 | .837 | -93.9 | .103 | -61.9 | .388 | 89.1 |
| 16.0 | .859 | 36.4 | .722 | -106.6 | .104 | -67.1 | .485 | 75.7 |
| 17.0 | .858 | 25.5 | .614 | -118.9 | .100 | -70.8 | .576 | 66.0 |
| 18.0 | .877 | 18.5 | .522 | -130.0 | .100 | -77.8 | .628 | 55.5 |
| 19.0 | .874 | 13.8 | .449 | -140.1 | .101 | -82.2 | .675 | 45.9 |
| 20.0 | .875 | 10.1 | .392 | -148.3 | .098 | -85.0 | .724 | 36.4 |

V_{DS} = 3 V, I_{DS} = 20 mA

| FREQUENCY (GHz) | S ₁₁ | | S ₂₁ | | S ₁₂ | | S ₂₂ | |
|--------------------|-----------------|--------|-----------------|--------|-----------------|-------|-----------------|--------|
| | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .925 | -51.4 | 2.988 | 134.5 | .064 | 56.9 | .676 | -26.8 |
| 3.0 | .858 | -75.6 | 2.819 | 113.5 | .087 | 41.3 | .636 | -40.9 |
| 4.0 | .786 | -100.2 | 2.641 | 93.4 | .102 | 26.7 | .591 | -53.1 |
| 5.0 | .715 | -124.5 | 2.472 | 73.9 | .112 | 13.6 | .540 | -65.4 |
| 6.0 | .662 | -150.4 | 2.335 | 55.0 | .118 | 1.7 | .493 | -75.9 |
| 7.0 | .625 | 179.8 | 2.155 | 35.8 | .117 | -10.9 | .425 | -84.3 |
| 8.0 | .622 | 153.4 | 1.950 | 17.9 | .111 | -19.1 | .352 | -92.9 |
| 9.0 | .647 | 132.5 | 1.773 | 1.4 | .109 | -26.1 | .286 | -107.5 |
| 10.0 | .675 | 112.7 | 1.625 | -15.1 | .106 | -30.7 | .236 | -128.9 |
| 11.0 | .703 | 93.2 | 1.480 | -31.8 | .107 | -36.3 | .212 | -156.0 |
| 12.0 | .742 | 76.3 | 1.332 | -48.4 | .105 | -41.6 | .204 | 175.1 |
| 13.0 | .776 | 62.7 | 1.178 | -63.7 | .105 | -45.5 | .212 | 143.6 |
| 14.0 | .806 | 52.7 | 1.051 | -77.6 | .108 | -50.7 | .266 | 111.8 |
| 15.0 | .833 | 44.8 | .925 | -91.5 | .108 | -54.8 | .360 | 88.4 |
| 16.0 | .859 | 35.4 | .804 | -104.2 | .112 | -59.3 | .458 | 75.1 |
| 17.0 | .855 | 24.7 | .686 | -116.6 | .109 | -65.3 | .553 | 65.9 |
| 18.0 | .876 | 17.9 | .586 | -127.6 | .108 | -74.0 | .610 | 55.5 |
| 19.0 | .871 | 12.7 | .509 | -138.1 | .108 | -77.0 | .655 | 46.0 |
| 20.0 | .866 | 9.2 | .446 | -147.2 | .102 | -81.9 | .703 | 36.8 |

NE721S01

TYPICAL SCATTERING PARAMETERS (T_A = 25°C)

V_{DS} = 3 V, I_{DS} = 30 mA

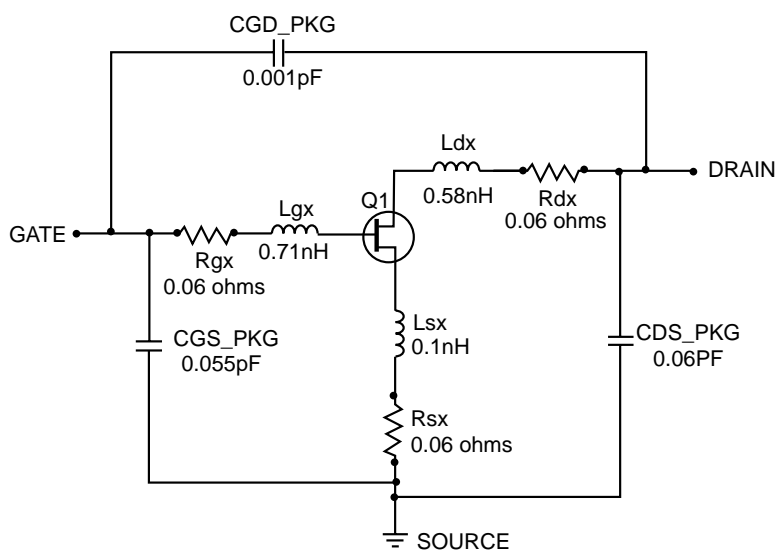
| FREQUENCY (GHz) | S ₁₁ | | S ₂₁ | | S ₁₂ | | S ₂₂ | |
|--------------------|-----------------|--------|-----------------|--------|-----------------|-------|-----------------|--------|
| | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .922 | -52.5 | 3.250 | 134.0 | .060 | 56.7 | .672 | -26.7 |
| 3.0 | .853 | -77.0 | 3.048 | 112.9 | .082 | 41.7 | .632 | -40.6 |
| 4.0 | .780 | -102.0 | 2.842 | 92.9 | .097 | 27.8 | .586 | -52.6 |
| 5.0 | .706 | -126.7 | 2.645 | 73.4 | .105 | 14.8 | .538 | -64.6 |
| 6.0 | .652 | -152.7 | 2.483 | 54.6 | .110 | 2.9 | .488 | -74.8 |
| 7.0 | .618 | 177.5 | 2.283 | 35.6 | .110 | -8.2 | .426 | -82.8 |
| 8.0 | .618 | 151.5 | 2.057 | 18.1 | .102 | -16.3 | .354 | -90.8 |
| 9.0 | .648 | 131.0 | 1.871 | 1.8 | .100 | -20.7 | .288 | -105.1 |
| 10.0 | .676 | 111.6 | 1.713 | -14.5 | .102 | -26.3 | .239 | -126.2 |
| 11.0 | .707 | 92.3 | 1.559 | -31.1 | .104 | -31.1 | .214 | -153.1 |
| 12.0 | .747 | 75.5 | 1.403 | -47.5 | .104 | -35.9 | .204 | 178.3 |
| 13.0 | .779 | 62.3 | 1.241 | -62.7 | .106 | -40.8 | .209 | 146.7 |
| 14.0 | .814 | 52.3 | 1.109 | -76.6 | .109 | -44.5 | .260 | 113.7 |
| 15.0 | .845 | 44.3 | .980 | -90.6 | .114 | -49.5 | .356 | 89.5 |
| 16.0 | .868 | 35.3 | .855 | -103.2 | .116 | -54.7 | .457 | 76.4 |
| 17.0 | .866 | 24.3 | .727 | -115.4 | .114 | -63.3 | .547 | 66.7 |
| 18.0 | .888 | 17.6 | .621 | -127.2 | .112 | -67.9 | .610 | 56.1 |
| 19.0 | .882 | 12.8 | .539 | -137.3 | .111 | -76.8 | .656 | 46.7 |
| 20.0 | .874 | 8.8 | .473 | -146.1 | .110 | -81.7 | .706 | 37.3 |

V_{DS} = 3 V, I_{DS} = 40 mA

| FREQUENCY (GHz) | S ₁₁ | | S ₂₁ | | S ₁₂ | | S ₂₂ | |
|--------------------|-----------------|--------|-----------------|--------|-----------------|-------|-----------------|--------|
| | MAG | ANG | MAG | ANG | MAG | ANG | MAG | ANG |
| 2.0 | .921 | -53.1 | 3.386 | 133.7 | .055 | 57.6 | .690 | -25.9 |
| 3.0 | .850 | -78.0 | 3.166 | 112.6 | .076 | 41.4 | .650 | -39.4 |
| 4.0 | .774 | -103.0 | 2.944 | 92.4 | .087 | 27.8 | .606 | -50.9 |
| 5.0 | .701 | -127.9 | 2.732 | 73.2 | .094 | 15.7 | .560 | -62.5 |
| 6.0 | .647 | -153.9 | 2.556 | 54.5 | .098 | 5.7 | .517 | -72.1 |
| 7.0 | .615 | 176.2 | 2.344 | 35.7 | .097 | -5.6 | .457 | -79.7 |
| 8.0 | .617 | 150.6 | 2.116 | 18.3 | .092 | -11.4 | .393 | -87.4 |
| 9.0 | .645 | 130.4 | 1.926 | 2.1 | .091 | -14.8 | .332 | -101.3 |
| 10.0 | .678 | 111.1 | 1.768 | -14.1 | .094 | -19.4 | .282 | -120.5 |
| 11.0 | .708 | 92.0 | 1.612 | -30.7 | .096 | -22.1 | .254 | -144.2 |
| 12.0 | .750 | 75.3 | 1.453 | -47.1 | .101 | -27.1 | .238 | -170.8 |
| 13.0 | .784 | 62.3 | 1.292 | -62.2 | .106 | -33.1 | .231 | 159.5 |
| 14.0 | .820 | 52.6 | 1.157 | -76.6 | .113 | -37.0 | .269 | 125.6 |
| 15.0 | .853 | 44.3 | 1.026 | -90.5 | .118 | -43.9 | .361 | 98.1 |
| 16.0 | .875 | 34.9 | .890 | -103.7 | .121 | -50.7 | .462 | 81.9 |
| 17.0 | .872 | 24.2 | .754 | -116.4 | .118 | -58.0 | .556 | 71.2 |
| 18.0 | .893 | 17.5 | .648 | -127.8 | .119 | -65.5 | .619 | 59.7 |
| 19.0 | .890 | 12.4 | .558 | -138.2 | .119 | -72.2 | .665 | 49.8 |
| 20.0 | .882 | 9.0 | .490 | -147.8 | .120 | -79.8 | .715 | 39.8 |

NE721S01 NONLINEAR MODEL

SCHEMATIC

FET NONLINEAR MODEL PARAMETERS ⁽¹⁾

| Parameters | Q1 | Parameters | Q1 |
|------------|-----------|------------|----------|
| VTO | -1.699 | RG | 7 |
| VTOSC | 0 | RD | 6 |
| ALPHA | 2.5 | RS | 4 |
| BETA | 0.0254 | RGMET | 0 |
| GAMMA | 0.09 | KF | 1.36e-10 |
| GAMMADC | 0.09 | AF | 1.74 |
| Q | 1.95 | TNOM | 27 |
| DELTA | 1.1 | XTI | 3 |
| VBI | 0.8 | EG | 1.43 |
| IS | 1e-14 | VTOTC | 0 |
| N | 1.2 | BETATCE | 0 |
| RIS | 0 | FFE | 1 |
| RID | 0 | | |
| TAU | 6e-12 | | |
| CDS | 0.18e-12 | | |
| RDB | 5000 | | |
| CBS | 1e-10 | | |
| CGSO | 0.7e-12 | | |
| CGDO | 0.055e-12 | | |
| DELTA1 | 1.2 | | |
| DELTA2 | 1 | | |
| FC | 0.5 | | |
| VBR | Infinity | | |

(1) Series IV Libra TOM Model

Note:

This nonlinear model utilized the latest data available. See our Design Parameter Library at www.cel.com for this data.

UNITS

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

MODEL RANGE

Frequency: 0.1 to 18 GHz

Bias: $V_{DS} = 2\text{ V to }4\text{ V}$, $I_D = 20\text{ mA to }40\text{ mA}$

Date: 7/97