RoHS

# RF Power GaN Transistor

This 80 W asymmetrical Doherty RF power GaN transistor is designed for cellular base station applications requiring very wide instantaneous bandwidth capability covering the frequency range of 2300 to 2400 MHz.

This part is characterized and performance is guaranteed for applications operating in the 2300 to 2400 MHz band. There is no guarantee of performance when this part is used in applications designed outside of these frequencies.

**2300 MHz**

- Typical Doherty Single-Carrier W-CDMA Performance: $V_{DD}$ = 48 Vdc, $I_{DQA}$ = 300 mA, $V_{GSB}$ = –5.0 Vdc, $P_{out}$ = 80 W Avg., Input Signal PAR = 9.9 dB @ 0.01% Probability on CCDF.

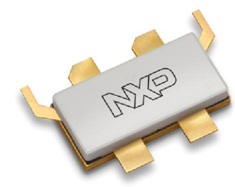
| Frequency | $G_{ps}$ (dB) | $\eta_D$ (%) | Output PAR (dB) | ACPR (dBc) |
|---|---|---|---|---|
| 2300 MHz | 14.5 | 53.7 | 8.4 | –30.5 |
| 2350 MHz | 14.6 | 52.8 | 8.3 | –30.6 |
| 2400 MHz | 14.2 | 53.2 | 8.1 | –31.9 |

**Features**

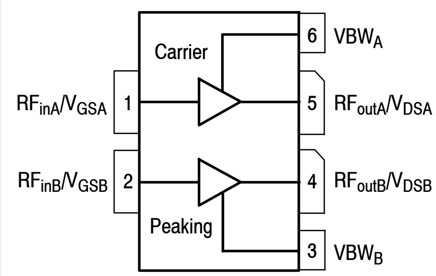
- High terminal impedances for optimal broadband performance
- Advanced high performance in-package Doherty
- Improved linearized error vector magnitude with next generation signal
- Able to withstand extremely high output VSWR and broadband operating conditions

**A3G23H500W17S**

**2300–2400 MHz, 80 W Avg., 48 V AIRFAST RF POWER GaN TRANSISTOR**




**NI-780S-4S2S**




(Top View)

**Figure 1. Pin Connections**

### Table 1. Maximum Ratings

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Drain-Source Voltage | $V_{DSS}$ | 125 | Vdc |
| Gate-Source Voltage | $V_{GS}$ | –8, 0 | Vdc |
| Operating Voltage | $V_{DD}$ | 55 | Vdc |
| Maximum Forward Gate Current, $I_{G\ (A+B)}$, @ $T_C$ = 25°C | $I_{GMAX}$ | 66 | mA |
| Storage Temperature Range | $T_{stg}$ | –65 to +150 | °C |
| Case Operating Temperature Range | $T_C$ | –55 to +150 | °C |
| Maximum Channel Temperature | $T_{CH}$ | 225 | °C |

### Table 2. Recommended Operating Conditions

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Operating Voltage | $V_{DD}$ | 48 | Vdc |

### Table 3. Thermal Characteristics

| Characteristic | Symbol | Value | Unit |
|---|---|---|---|
| Thermal Resistance by Infrared Measurement, Active Die Surface-to-Case<br>Case Temperature 90°C, $P_D$ = 84 W | $R_{\theta JC}$ (IR) | 0.53 (1) | °C/W |
| Thermal Resistance by Finite Element Analysis, Channel-to-Case<br>Case Temperature 90°C, $P_D$ = 84 W | $R_{\theta CHC}$ (FEA) | 0.96 (2) | °C/W |

### Table 4. ESD Protection Characteristics

| Test Methodology | Class |
|---|---|
| Human Body Model (per JS-001-2017) | 1C |
| Charge Device Model (per JS-002-2014) | C3 |

### Table 5. Electrical Characteristics ($T_A$ = 25°C unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **Off Characteristics (3)** | | | | | |
| Drain-Source Breakdown Voltage<br>($V_{GS}$ = –8 Vdc, $I_D$ = 24 mAdc) Carrier<br>($V_{GS}$ = –8 Vdc, $I_D$ = 42 mAdc) Peaking | $V_{(BR)DSS}$ | <br>150<br>150 | — | — | Vdc |
| **On Characteristics — Side A, Carrier** | | | | | |
| Gate Threshold Voltage<br>($V_{DS}$ = 10 Vdc, $I_D$ = 20 mAdc) | $V_{GS(th)}$ | –3.5 | –2.8 | –2.3 | Vdc |
| Gate Quiescent Voltage<br>($V_{DD}$ = 48 Vdc, $I_{DA}$ = 300 mAdc, Measured in Functional Test) | $V_{GSA(Q)}$ | –3.2 | –2.7 | –2.2 | Vdc |
| Gate-Source Leakage Current<br>($V_{DS}$ = 150 Vdc, $V_{GS}$ = –8 Vdc) | $I_{GSS}$ | –9.9 | — | — | mAdc |
| **On Characteristics — Side B, Peaking** | | | | | |
| Gate Threshold Voltage<br>($V_{DS}$ = 10 Vdc, $I_D$ = 20 mAdc) | $V_{GS(th)}$ | –3.8 | –3.1 | –2.3 | Vdc |
| Gate-Source Leakage Current<br>($V_{DS}$ = 150 Vdc, $V_{GS}$ = –8 Vdc) | $I_{GSS}$ | –9.9 | — | — | mAdc |

1. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers.* Go to http://www.nxp.com/RF and search for AN1955.
2. $R_{\theta CHC}$ (FEA) must be used for purposes related to reliability and limitations on maximum channel temperature. MTTF may be estimated by the expression MTTF (hours) = $10^{[A + B/(T + 273)]}$, where *T* is the channel temperature in degrees Celsius, *A* = –11.1 and *B* = 8366.
3. Each side of device measured separately.

(continued)

**Table 5. Electrical Characteristics** ($T_A$ = 25°C unless otherwise noted) **(continued)**

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **Functional Tests** (1) (In NXP Doherty Production Test Fixture, 50 ohm system) $V_{DD}$ = 48 Vdc, $I_{DQA}$ = 300 mA, $V_{GSB}$ = –5.0 Vdc, $P_{out}$ = 80 W Avg., f = 2300 MHz, Single-Carrier W-CDMA, IQ Magnitude Clipping, Input Signal PAR = 9.9 dB @ 0.01% Probability on CCDF. ACPR measured in 3.84 MHz Channel Bandwidth @ ±5 MHz Offset. **[See note on correct biasing sequence.]** | | | | | |
| Power Gain | $G_{ps}$ | 13.3 | 14.3 | 16.5 | dB |
| Drain Efficiency | $\eta_D$ | 48.0 | 52.7 | — | % |
| $P_{sat}$, Pulsed CW | $P_{sat}$ | 55.7 | 56.4 | — | dBm |
| Adjacent Channel Power Ratio | ACPR | — | –34.2 | –31.3 | dBc |
| **Wideband Ruggedness** (In NXP Doherty Production Test Fixture, 50 ohm system) $I_{DQA}$ = 300 mA, $V_{GSB}$ = –5.0 Vdc, f = 2350 MHz, Additive White Gaussian Noise (AWGN) with 10 dB PAR | | | | | |
| ISBW of 400 MHz at 55 Vdc, 151 W Avg. Modulated Output Power (3 dB Input Overdrive from 80 W Avg. Modulated Output Power) | No Device Degradation | | | | |
| **Typical Performance** (In NXP Doherty Production Test Fixture, 50 ohm system) $V_{DD}$ = 48 Vdc, $I_{DQA}$ = 300 mA, $V_{GSB}$ = –5.0 Vdc, 2300–2400 MHz Bandwidth | | | | | |
| $P_{out}$ @ 3 dB Compression Point (2) | P3dB | — | 603 | — | W |
| AM/PM (Maximum value measured at the P3dB compression point across the 2300–2400 MHz bandwidth) | $\Phi$ | — | –8 | — | ° |
| VBW Resonance Point (IMD Third Order Intermodulation Inflection Point) | $VBW_{res}$ | — | 300 | — | MHz |
| Gain Flatness in 100 MHz Bandwidth @ $P_{out}$ = 80 W Avg. | $G_F$ | — | 0.25 | — | dB |
| Gain Variation over Temperature (–40°C to +85°C) | $\Delta G$ | — | 0.008 | — | dB/°C |
| Output Power Variation over Temperature (–40°C to +85°C) | $\Delta P3dB$ | — | 0.003 | — | dB/°C |

**Table 6. Ordering Information**

| Device | Tape and Reel Information | Package |
|---|---|---|
| A3G23H500W17SR3 | R3 Suffix = 250 Units, 44 mm Tape Width, 13-inch Reel | NI-780S-4S2S |

1. Part internally input matched.
2. P3dB = $P_{avg}$ + 7.0 dB where $P_{avg}$ is the average output power measured using an unclipped W-CDMA single-carrier input signal where output PAR is compressed to 7.0 dB @ 0.01% probability on CCDF.

## NOTE: Correct Biasing Sequence for GaN Depletion Mode Transistors in a Doherty Configuration

### Bias ON the device

1. Set gate voltage $V_{GSA}$ and $V_{GSB}$ to –5 V.
2. Set drain voltage $V_{DSA}$ and $V_{DSB}$ to nominal supply voltage (+48 V).
3. Increase $V_{GSA}$ (carrier side) until $I_{DQA}$ current is attained.
4. Increase $V_{GSB}$ (peaking side) to target bias voltage.
5. Apply RF input power to desired level.

### Bias OFF the device

1. Disable RF input power.
2. Adjust gate voltage $V_{GSA}$ and $V_{GSB}$ to –5 V.
3. Adjust drain voltage $V_{DSA}$ and $V_{DSB}$ to 0 V. Allow adequate time for drain voltage to reduce to 0 V from external drain capacitors.
4. Disable $V_{GSA}$ and $V_{GSB}$.

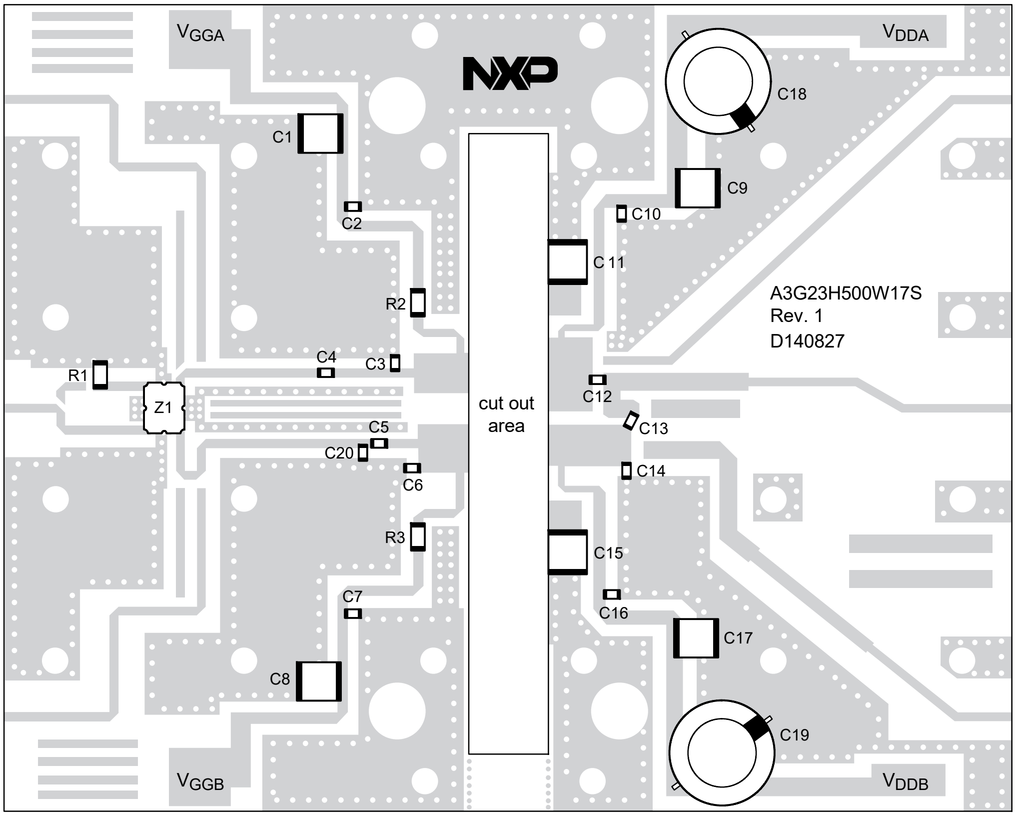
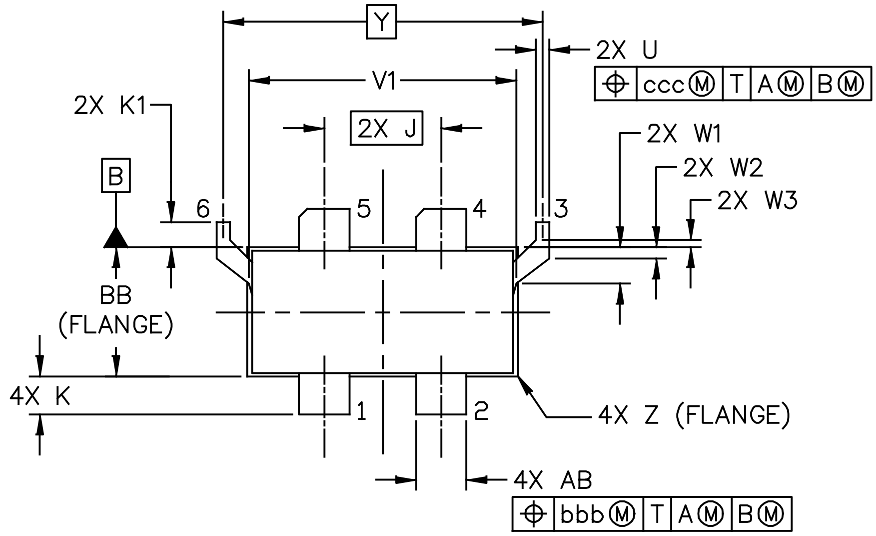


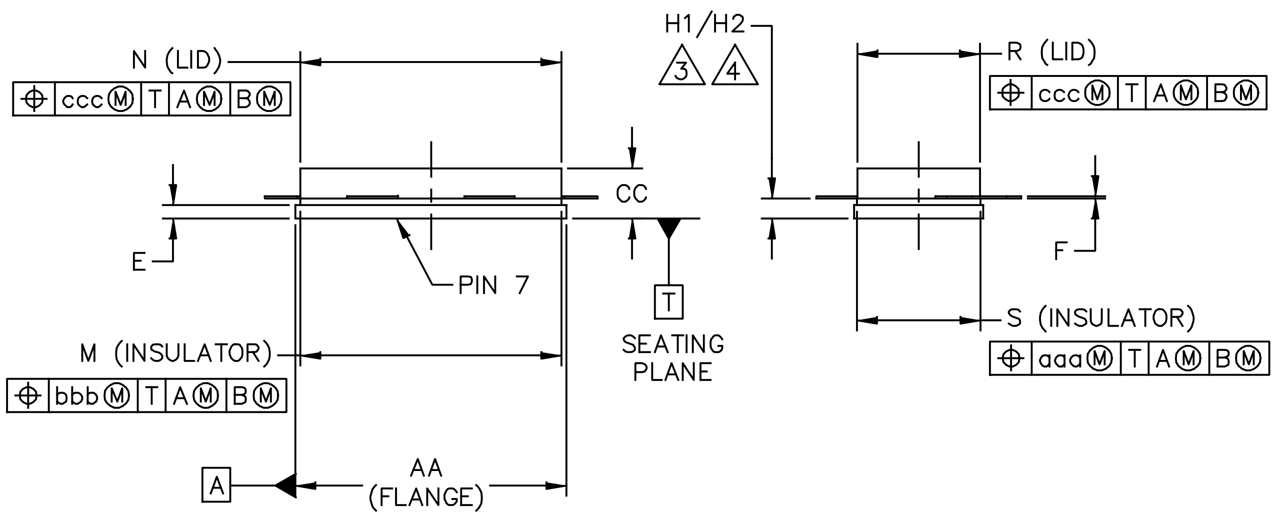

**Figure 2. A3G23H500W17S Production Test Circuit Component Layout**

**Table 7. A3G23H500W17S Production Test Circuit Component Designations and Values**

| Part | Description | Part Number | Manufacturer |
|---|---|---|---|
| C1, C8, C9, C11, C15, C17 | 10 uF Chip Capacitor | C5750X7S2A106M | TDK |
| C2, C4, C5, C7, C10, C16 | 11 pF Chip Capacitor | 600F110JT250XT | ATC |
| C3 | 1.2 pF Chip Capacitor | 600F1R2BT250XT | ATC |
| C6 | 0.8 pF Chip Capacitor | 600F0R8BT250XT | ATC |
| C12 | 3.9 pF Chip Capacitor | 600F3R9BT250XT | ATC |
| C13 | 6.8 pF Chip Capacitor | 600F6R8BT250XT | ATC |
| C14 | 0.6 pF Chip Capacitor | 600F0R6BT250XT | ATC |
| C18, C19 | 220 μF, 100 V Electrolytic Capacitor | MCGPR100V227M16X26-RH | Multicomp |
| C20 | 0.3 pF Chip Capacitor | 600F0R3BT250XT | ATC |
| R1 | 50 Ω, 10 W Termination Chip Resistor | C10A50Z4 | Anaren |
| R2, R3 | 3.6 Ω, 1/4 W Chip Resistor | CRCW12063R60FKEA | Vishay |
| Z1 | 2300–2700 MHz, 90°, 4 dB Hybrid Coupler | X3C25P1-04S | Anaren |
| PCB | Rogers RO4350B, 0.020″, $\varepsilon_r$ = 3.66 | D140827 | MTL |

## PACKAGE INFORMATION

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NOTES:

1. CONTROLLING DIMENSION: INCH.

2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M−1994.

3. (△) DIMENSIONS H1 AND H2 ARE MEASURED .030 INCH (0.762 MM) AWAY FROM FLANGE PARALLEL TO DATUM B TO CLEAR EPOXY FLOW OUT. H1 APPLIES TO PINS 1, 2, 4 & 5. H2 APPLIES TO PINS 3 & 6.

| DIM | INCH MIN | INCH MAX | MILLIMETER MIN | MILLIMETER MAX | DIM | INCH MIN | INCH MAX | MILLIMETER MIN | MILLIMETER MAX |
|---|---|---|---|---|---|---|---|---|---|
| AA | .805 | .815 | 20.45 | 20.70 | R | .365 | .375 | 9.27 | 9.53 |
| BB | .380 | .390 | 9.65 | 9.91 | S | .365 | .375 | 9.27 | 9.53 |
| CC | .125 | .170 | 3.18 | 4.32 | U | .035 | .045 | 0.89 | 1.14 |
| E | .035 | .045 | 0.89 | 1.14 | V1 | .795 | .805 | 20.19 | 20.45 |
| F | .004 | .007 | 0.10 | 0.18 | W1 | .0975 | .1175 | 2.48 | 2.98 |
| H1 | .057 | .067 | 1.45 | 1.70 | W2 | .0225 | .0425 | 0.57 | 1.08 |
| H2 | .054 | .070 | 1.37 | 1.78 | W3 | .0125 | .0325 | 0.32 | 0.83 |
| J | .350 BSC | | 8.89 BSC | | Y | .956 BSC | | 24.28 BSC | |
| K | .0995 | .1295 | 2.53 | 3.29 | Z | R.000 | R.040 | R0.00 | R1.02 |
| K1 | .070 | .090 | 1.78 | 2.29 | AB | .145 | .155 | 3.68 | 3.94 |
| M | .774 | .786 | 19.66 | 19.96 | aaa | .005 | | 0.13 | |
| N | .772 | .788 | 19.61 | 20.02 | bbb | .010 | | 0.25 | |
| | | | | | ccc | .015 | | 0.38 | |

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## PRODUCT DOCUMENTATION, SOFTWARE AND TOOLS

Refer to the following resources to aid your design process.

**Application Notes**

- AN1908: Solder Reflow Attach Method for High Power RF Devices in Air Cavity Packages
- AN1955: Thermal Measurement Methodology of RF Power Amplifiers

**Software**

- .s2p File

**Development Tools**

- Printed Circuit Boards

## REVISION HISTORY

The following table summarizes revisions to this document.

| Revision | Date | Description |
|---|---|---|
| 0 | Apr. 2021 | • Initial release of data sheet |
| 1 | May 2021 | • Table 3, ESD Protection Characteristics: added Human Body Model, p. 2 |

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