

# RF Power GaN Transistor

This 56 W symmetrical Doherty RF power GaN transistor is designed for cellular base station applications requiring very wide instantaneous bandwidth capability covering the frequency range of 1805 to 2200 MHz.

This part is characterized and performance is guaranteed for applications operating in the 1805 to 2200 MHz band. There is no guarantee of performance when this part is used in applications designed outside of these frequencies.

## 2000 MHz

- Typical Doherty Single-Carrier W-CDMA Performance:  $V_{DD} = 48$  Vdc,  $I_{DQA} = 250$  mA,  $V_{GSB} = -5.0$  Vdc,  $P_{out} = 56$  W Avg., Input Signal PAR = 9.9 dB @ 0.01% Probability on CCDF.

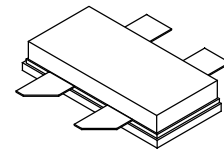
Frequency	$G_{ps}$ (dB)	$\eta_D$ (%)	Output PAR (dB)	ACPR (dBc)
1805 MHz	16.0	54.3	8.0	-26.4
1995 MHz	16.8	52.2	7.8	-31.9
2170 MHz	15.4	53.9	7.6	-33.8

## 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

## A3G18D510-04S

1805–2200 MHz, 56 W Avg., 48 V  
AIRFAST RF POWER GaN  
TRANSISTOR



NI-780S-4L

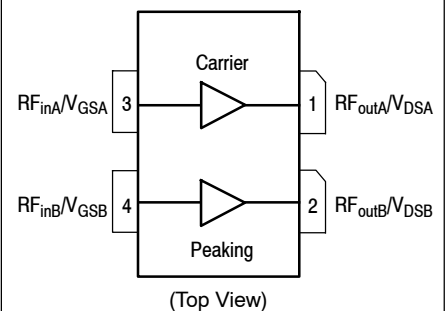


Figure 1. Pin Connections

**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	$V_{DD}$	0 to +55	Vdc
Maximum Forward Gate Current, $I_G$ (A+B), @ $T_C = 25^\circ\text{C}$	$I_{GMAX}$	25	mA
Storage Temperature Range	$T_{stg}$	-65 to +150	$^\circ\text{C}$
Case Operating Temperature Range	$T_C$	-55 to +150	$^\circ\text{C}$
Operating Active Die Surface Temperature Range	$T_J$	-55 to +225	$^\circ\text{C}$
Maximum Channel Temperature (1)	$T_{CH}$	275	$^\circ\text{C}$

**Table 2. Thermal Characteristics**

Characteristic	Symbol	Value	Unit
Thermal Resistance by Infrared Measurement, Active Die Surface-to-Case Case Temperature $72^\circ\text{C}$ , $P_D = 68\text{ W}$	$R_{\theta JC}$ (IR)	0.83 (2)	$^\circ\text{C/W}$
Thermal Resistance by Finite Element Analysis, Channel-to-Case Case Temperature $72^\circ\text{C}$ , $P_D = 68\text{ W}$	$R_{\theta CHC}$ (FEA)	1.1 (3)	$^\circ\text{C/W}$

**Table 3. ESD Protection Characteristics**

Test Methodology	Class
Human Body Model (per JS-001-2017)	1B
Charge Device Model (per JS-002-2014)	IV

**Table 4. Electrical Characteristics** ( $T_A = 25^\circ\text{C}$  unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
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**Off Characteristics (4)**

Off-State Drain Leakage ( $V_{DS} = 150\text{ Vdc}$ , $V_{GS} = -8\text{ Vdc}$ )	Carrier Peaking	$I_{D(BR)}$	—	—	24.3	mAdc
( $V_{DS} = 150\text{ Vdc}$ , $V_{GS} = -8\text{ Vdc}$ )		—	—	—	24.3	mAdc

**On Characteristics — Side A, Carrier**

Gate Threshold Voltage ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 24.3\text{ mAdc}$ )	$V_{GS(th)}$	-3.8	-3.0	-2.3	Vdc
Gate Quiescent Voltage ( $V_{DD} = 48\text{ Vdc}$ , $I_D = 250\text{ mAdc}$ , Measured in Functional Test)	$V_{GSA(Q)}$	-3.7	-3.2	-2.7	Vdc
Gate-Source Leakage Current ( $V_{DS} = 150\text{ Vdc}$ , $V_{GS} = -8\text{ Vdc}$ )	$I_{GSS}$	-12.2	—	—	mAdc

**On Characteristics — Side B, Peaking**

Gate Threshold Voltage ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 24.3\text{ mAdc}$ )	$V_{GS(th)}$	-3.8	-3.3	-2.3	Vdc
Gate-Source Leakage Current ( $V_{DS} = 150\text{ Vdc}$ , $V_{GS} = -8\text{ Vdc}$ )	$I_{GSS}$	-12.2	—	—	mAdc

- Reliability tests were conducted at  $225^\circ\text{C}$ . Operations with  $T_{CH}$  at  $275^\circ\text{C}$  will reduce median time to failure.
- Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers*. Go to <http://www.nxp.com/RF> and search for AN1955.
- $R_{\theta CHC}$  (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,  $A = -10.3$  and  $B = 8263$ .
- Each side of device measured separately.

(continued)

**Table 4. Electrical Characteristics** ( $T_A = 25^\circ\text{C}$  unless otherwise noted) (continued)

Characteristic	Symbol	Min	Typ	Max	Unit
<b>Functional Tests</b> <sup>(1,2)</sup> (In NXP Doherty Production Test Fixture, 50 ohm system) $V_{DD} = 48\text{ Vdc}$ , $I_{DQA} = 250\text{ mA}$ , $V_{GSB} = -5.0\text{ Vdc}$ , $P_{out} = 56\text{ W Avg.}$ , $f = 1805\text{ MHz}$ , 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 @ $\pm 5\text{ MHz}$ Offset. <b>[See note on correct biasing sequence.]</b>					
Power Gain	$G_{ps}$	15.0	16.0	18.0	dB
Drain Efficiency	$\eta_D$	44.3	54.3	—	%
$P_{out}$ @ 3 dB Compression Point, CW	P3dB	53.6	55.1	—	dBm
Adjacent Channel Power Ratio	ACPR	—	-26.4	-21.9	dBc

**Wideband Ruggedness** (In NXP Doherty Production Test Fixture, 50 ohm system)  $I_{DQA} = 250\text{ mA}$ ,  $V_{GSB} = -5.0\text{ Vdc}$ ,  $f = 1995\text{ MHz}$ , Additive White Gaussian Noise (AWGN) with 10 dB PAR

ISBW of 400 MHz at 55 Vdc, 228 W Avg. Modulated Output Power (8.5 dB Input Overdrive from 228 W Avg. Modulated Output Power)	No Device Degradation
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**Typical Performance** (In NXP Doherty Production Test Fixture, 50 ohm system)  $V_{DD} = 48\text{ Vdc}$ ,  $I_{DQA} = 250\text{ mA}$ ,  $V_{GSB} = -5.0\text{ Vdc}$ , 1805–2170 MHz Bandwidth

$P_{out}$ @ 3 dB Compression Point <sup>(2)</sup>	P3dB	—	355	—	W
AM/PM (Maximum value measured at the P3dB compression point across the 1805–2170 MHz bandwidth)	$\Phi$	—	-25	—	$^\circ$
VBW Resonance Point (IMD Third Order Intermodulation Inflection Point)	VBW <sub>res</sub>	—	260	—	MHz
Gain Flatness in 365 MHz Bandwidth @ $P_{out} = 56\text{ W Avg.}$	$G_F$	—	1.7	—	dB
Gain Variation over Temperature (-40°C to +85°C)	$\Delta G$	—	0.013	—	dB/°C
Output Power Variation over Temperature (-40°C to +85°C)	$\Delta P_{1dB}$	—	0.013	—	dB/°C

**Table 5. Ordering Information**

Device	Tape and Reel Information	Package
A3G18D510-04SR3	R3 Suffix = 250 Units, 32 mm Tape Width, 13-inch Reel	NI-780S-4L

1. Part internally input matched.
2. P3dB =  $P_{avg} + 7.0\text{ dB}$  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  $V_{GSB}$ .

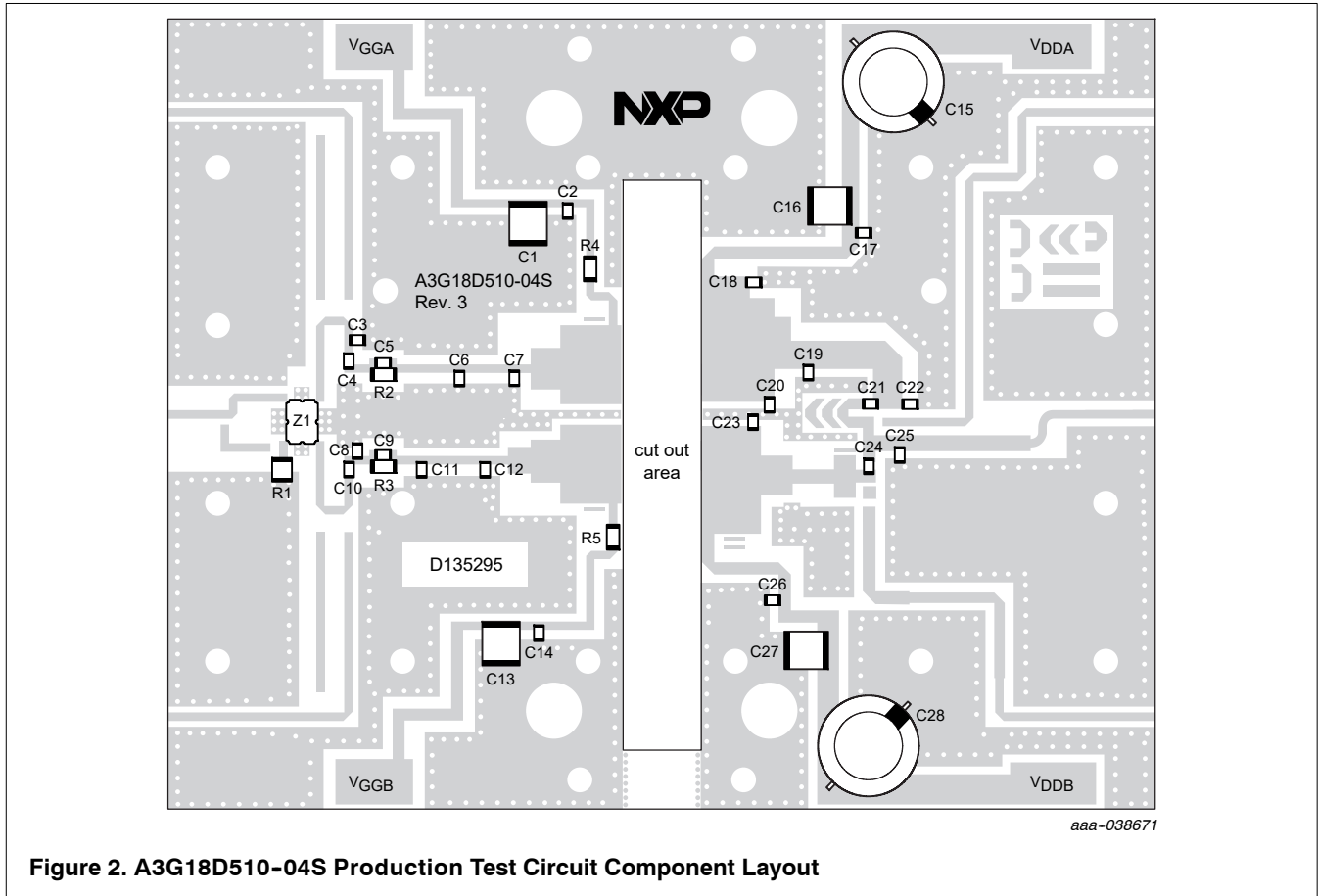
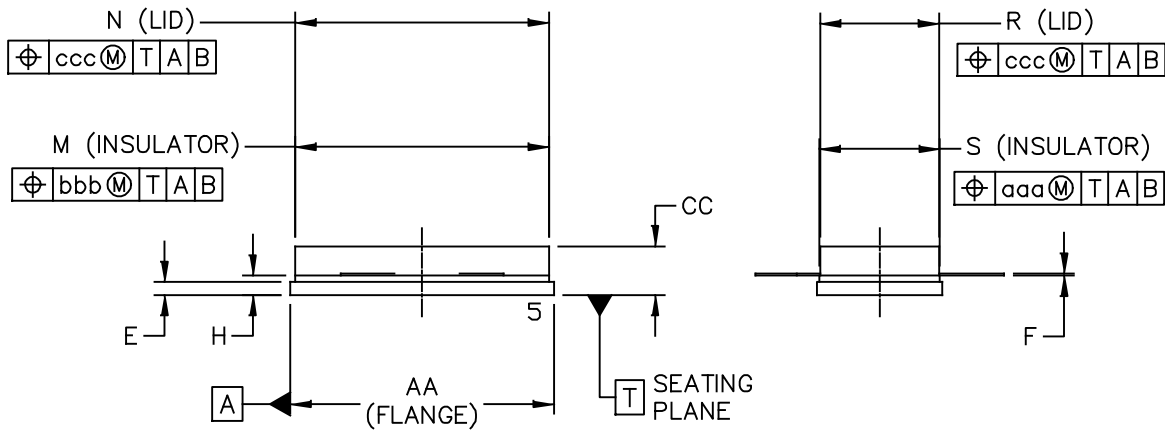
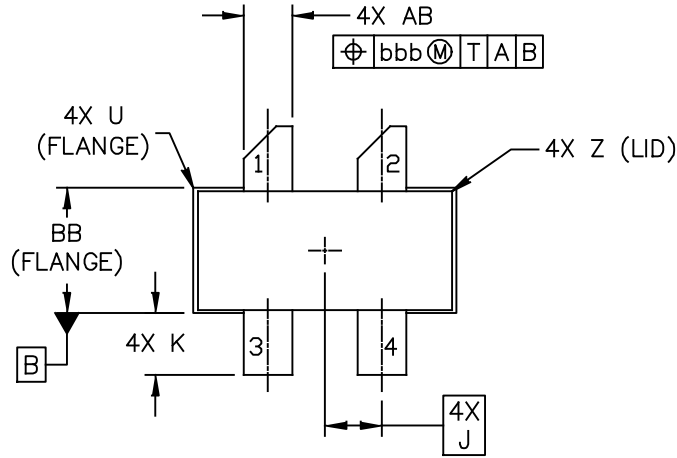


Figure 2. A3G18D510-04S Production Test Circuit Component Layout

Table 6. A3G18D510-04S Production Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
C1, C13, C16, C27	10 $\mu$ F Chip Capacitor	C5750X7S2A106M230KB	TDK
C2, C14, C17, C21, C24, C26	15 pF Chip Capacitor	600F150JT250XT	ATC
C3	0.4 pF Chip Capacitor	600F0R4BT250XT	ATC
C4, C5, C9, C10	11 pF Chip Capacitor	600F110JT250XT	ATC
C6	1.6 pF Chip Capacitor	600F1R6BT250XT	ATC
C7, C22	1 pF Chip Capacitor	600F1R0BT250XT	ATC
C8, C18	0.8 pF Chip Capacitor	600F0R8BT250XT	ATC
C11, C20	1.5 pF Chip Capacitor	600F1R5BT250XT	ATC
C12	2 pF Chip Capacitor	600F2R0BT250XT	ATC
C15, C28	220 $\mu$ F, 100 V Electrolytic Capacitor	MCGPR100V227M16X26	Multicomp
C19, C23	1.2 pF Chip Capacitor	600F1R2BT250XT	ATC
C25	0.2 pF Chip Capacitor	600F0R2BT250XT	ATC
R1	50 $\Omega$ , 10 W Termination Chip Resistor	C10A50Z4	Anaren
R2	9.1 $\Omega$ , 1/4 W Chip Resistor	CRCW12069R10FKEA	Vishay
R3	7.5 $\Omega$ , 1/4 W Chip Resistor	CRCW12067R50FKEA	Vishay
R4	3.9 $\Omega$ , 1/4 W Chip Resistor	CRCW12063R90FKEA	Vishay
R5	4.3 $\Omega$ , 1/4 W Chip Resistor	CRCW12064R30FKEA	Vishay
Z1	1700–2000 MHz, 90°, 3 dB Hybrid Coupler	X3C19P1-03S	Anaren
PCB	RO4350B, 0.020", $\epsilon_r = 3.66$	D135295	MTL

# Package Information



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NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
2. CONTROLLING DIMENSION: INCH.
3. DELETED
4. DIMENSION H IS MEASURED .030 (0.762) AWAY FROM FLANGE TO CLEAR EPOXY FLOW OUT PARALLEL TO DATUM B.

DIM	INCH		MILLIMETER		DIM	INCH		MILLIMETER	
	MIN	MAX	MIN	MAX		MIN	MAX	MIN	MAX
AA	.805	.815	20.45	20.70	U		.040		1.02
BB	.382	.388	9.70	9.86	Z		.030		0.76
CC	.125	.170	3.18	4.32	AB	.145	.155	3.68	- 3.94
E	.035	.045	0.89	1.14					
F	.003	.006	0.08	0.15	aaa		.005		0.127
H	.057	.067	1.45	1.70	bbb		.010		0.254
J	.175 BSC		4.44 BSC		ccc		.015		0.381
K	.170	.210	4.32	5.33					
M	.774	.786	19.61	20.02					
N	.772	.788	19.61	20.02					
R	.365	.375	9.27	9.53					
S	.365	.375	9.27	9.52					
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TITLE:					DOCUMENT NO: 98ASA10718D      REV: C				
NI-780S-4L					STANDARD: NON-JEDEC				
					SOT1826-1		01 AUG 2016		

**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.

<b>Revision</b>	<b>Date</b>	<b>Description</b>
0	Aug. 2020	<ul style="list-style-type: none"><li>• Initial release of data sheet</li></ul>

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