WS1A3940

GaN on SiC Power Amplifier Module for 5G

Description

The WS1A3940 is an Asymmetric Doherty Power Amplifier Module (PAM) integrating the GaN on SiC HEMT transistors with RF matching and biasing networks on a multilayer laminate substrate with advanced heat sinking technology. The WS1A3940 has been designed to operate from 3700 MHz to 3980 MHz, from supply voltages up to 50 V, at average output power levels of 8 to 10 W with crest-factor reduced and digitally pre-distorted LTE and 5G NR signals with instantaneous bandwidths of 200 MHz or more. The device is housed in a 6 mm X 6 mm land grid array (LGA) package.

Features

- GaN on SiC technology
- Frequency: 3700-3980 MHz
- Average Output Power: 39.5 dBm
- P_{SAT} = 48 dBm
- RF inputs matched to 50 Ω and DC matched
- Gate bias supply for main and peak sides available from either side of device
- Integrated harmonic terminations
- Pb-free and RoHS compliant

WS1A3940
Package PG-LGA-6x6-3-1

Typical Broadband Performance

Single-carrier LTE Performance (tested in the applications circuit for 3700 – 4100 MHz)
V_{DD} = 48 V, $I_{DQ(main)}$ = 45 mA, $V_{GS(peak)}$ = –5.1 V, channel bandwidth = 20 MHz, input PAR = 10 dB @ 0.01% CCDF

	P_{OUT} (dBM)	Gain (dB)	Efficiency (%)	ACPR – (dBc)	ACPR + (dBc)	PAR (dB)
3700 MHz	39.5	14.5	53.0	–26	–26	8.3
3850 MHz	39.5	13.7	52.0	–30	–30	8.5
3980 MHz	39.5	12.9	51.0	–32	–32	8.5
4100 MHz	39.5	11.7	48.5	–29	–29	8.0

All published data at T_{CASE} = 25°C unless otherwise indicated

RoHS compliant

Rev. 03, 2023-02-04

Maximum Ratings at T_{CASE} = 25 °C

Parameter		Symbol	Value	Unit
Drain-source Voltage		V_{DSS}	125	V
Gate-source Voltage		V_{GS}	–10 to +2	V
Operating Voltage		V_{DD}	55	V
RF Input Power (main)	Pulse CW, 10% duty cycle, 20 µs pulse width	P_{IN}	35.2	dBm
(peak)		P_{IN}	38	dBm
Case Temperature		T_C	135	°C
Storage Temperature Range		T_{STG}	–65 to +150	°C

Operation above the maximum values listed here may cause permanent damage. Maximum ratings are absolute ratings; exceeding only one of these values may cause irreversible damage to the component. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. For reliable continuous operation, the device should be operated within the operating voltage range (V_{DD}) specified above.

DC Characteristics

Characteristics	Conditions	Symbol	Min	Typ	Max	Unit
Drain-Source Breakdown Voltage (main)	V_{GS} = –8 V, I_D = 3.36 mA	$V_{(BR)DSS}$	150	—	—	V
(peak)	V_{GS} = –8 V, I_D = 5.6 mA	$V_{(BR)DSS}$	150	—	—	V
Gate Leakage Current	V_{GS} = –8 V, V_{DS} = 50 V	I_{GSS}	—	—	–1.5	mA
Gate Threshold Voltage (main)	V_{DS} = 10 V, I_D = 3.36 mA	$V_{GS(th)}$	–3.8	–3.0	–2.3	V
(peak)	V_{DS} = 10 V, I_D = 5.6 mA	$V_{GS(th)}$	–3.6	–2.7	–2	V

Recommended Operating Conditions

Parameter	Conditions	Symbol	Min	Typ	Max	Unit
Operating Voltage		V_{DD}	0	—	50	V
Gate Quiescent Voltage (main)	V_{DS} = 48 V, I_D = 30 mA	$V_{GS(Q)}$	–3.6	–3.1	–2.6	V
(peak)	V_{DS} = 48 V, I_D = 40 mA	$V_{GS(Q)}$	–3.6	–3.1	–2.6	V

Moisture Sensitivity Level

Level	Test Standard	Package Temperature	Unit
3	IPC/JEDEC J-STD-020	260	°C

ESD Characteristics

Parameter	Class	Standard
Human Body Model (HBM)	Class 1B	ANSI/ESDA/JEDEC JS-001
Charge Device Model (CDM)	Class C3	ANSI/ESDA/JEDEC JS-002

RF Characteristics (tested in the production test fixture)

V_{DD} = 48 V, Pulse CW 10% duty cycle, 20 µs pulse width

Parameter	Symbol	Conditions	Main		Peak		Unit
			Min	Max	Min	Max	
3700 MHz							
Gain	G	P_{OUT} = 38 dBm (main) P_{OUT} = 37.5 dBm (peak)	13	16.3	12.5	16.5	dB
Saturated Power	P_{SAT}	I_{DQ} = 30 mA (main) I_{DQ} = 40 mA (peak)	42.8	–	43	–	dBm
Efficiency	Eff	I_{DQ} = 30 mA (main), P_{SAT} I_{DQ} = 40 mA (peak), P_{SAT}	45	–	34	–	%
3980 MHz							
Gain	G	P_{OUT} = 38 dBm (main) P_{OUT} = 37.5 dBm (peak)	12	16	10	14	dB
Saturated Power	P_{SAT}	I_{DQ} = 30 mA (main) I_{DQ} = 40 mA (peak)	41	–	41	–	dBm
Efficiency	Eff	I_{DQ} = 30 mA (main), P_{SAT} I_{DQ} = 40 mA (peak), P_{SAT}	46	–	31	–	%

Ordering Information

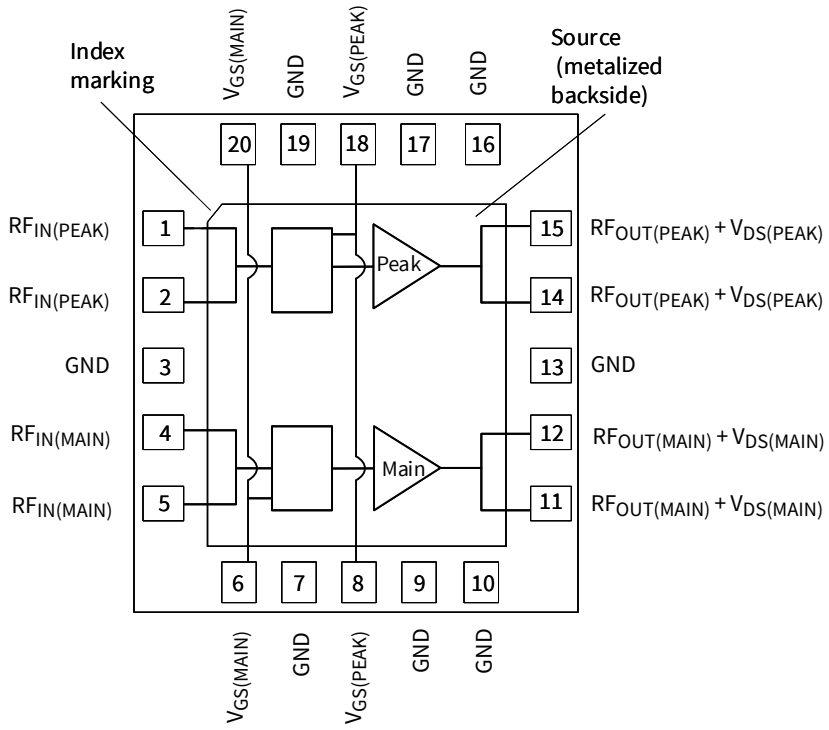
Order Code	Description
WS1A3940-V2-R00A	Sample Quantities
WS1A3940-V2-R1	330 mm (13") Reel 100 pcs
WS1A3940-V2-R3K	330 mm (13") Reel 3,000 pcs
FXA/ WSGPA01V1-18	3.7-3.98 GHz Driver Evaluation Board
FXA/WS1A3940V2-04	3.7-3.98 GHz Evaluation Board

Evaluation Boards - Typical RF Performance

Part Number	Frequency	P_{OUT} (dBm)	Eff (%)	Gain (dB)	PAR (dB)	ACPR+ (dBc)	ACPR– (dBc)
Output Stage : WS1A3940 Single-carrier WCDMA Performance, V_{DD} = 48 V, $I_{DQ(main)}$ = 45 mA, channel bandwidth = 3.84 MHz, input PAR = 10 dB @ 0.01% CCDF							
FXA/WS1A3940V2-04	3.7-3.98 GHz	39.5	44.5	29.8	8	–27.5	–27.5

WSGPA01 Driver Single-carrier WCDMA Performance, V_{DD} = 48 V, I_{DQ} = 25 mA, channel bandwidth = 3.84 MHz, input PAR = 10 dB @ 0.01% CCDF							
FXA/WSGPA01V1-18	3.7-3.98 GHz	26.5	17.5	16.8	9.1	–46.3	–45.2

Pinout Diagram (top view)



Bias Sequencing

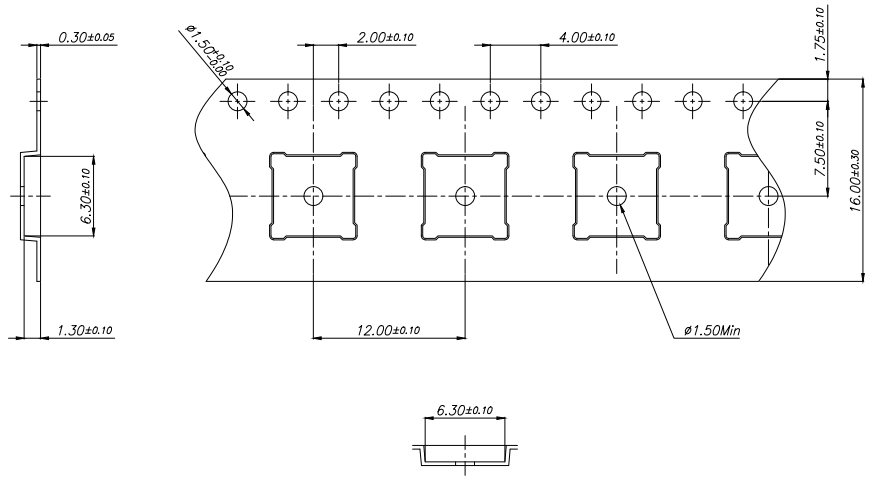
Bias ON

1. Ensure RF is turned off
2. Apply pinch-off voltage of –5 V to the gate
3. Apply nominal drain voltage
4. Bias gate to desired quiescent drain current
5. Apply RF

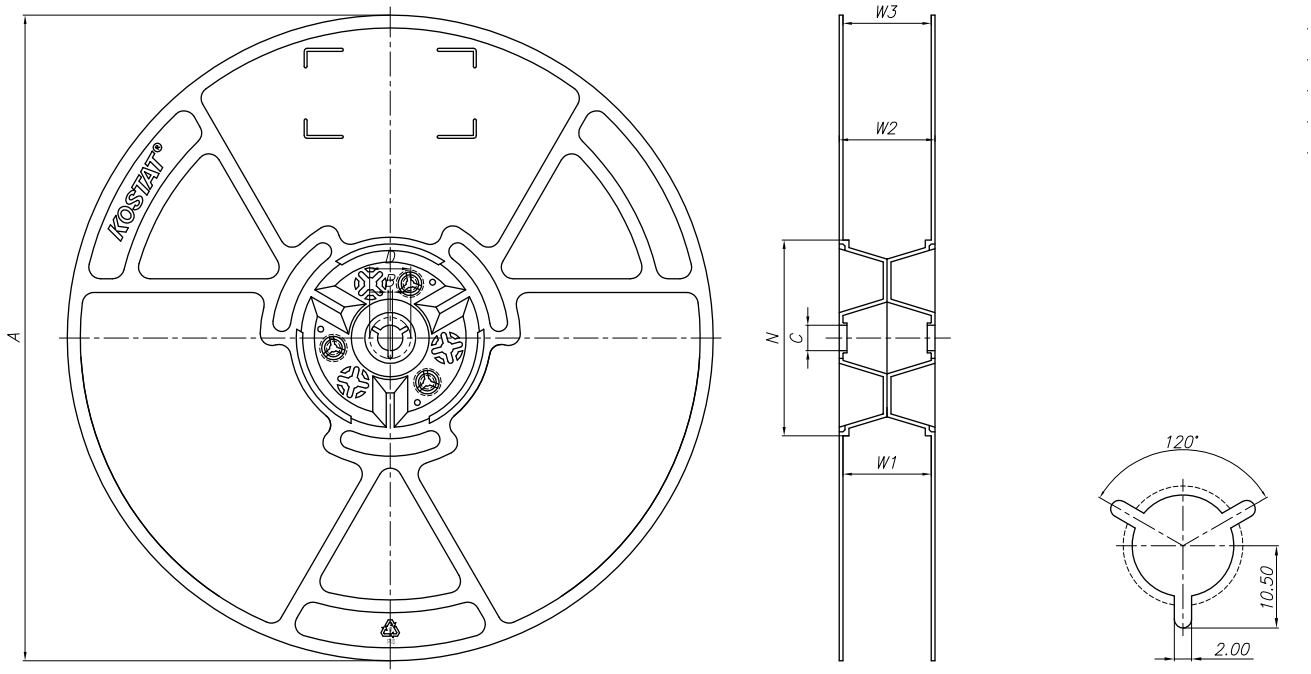
Bias OFF

1. Turn RF off
2. Apply pinch-off voltage to the gate
3. Turn-off drain voltage
4. Turn-off gate voltage

Tape and Reel Information

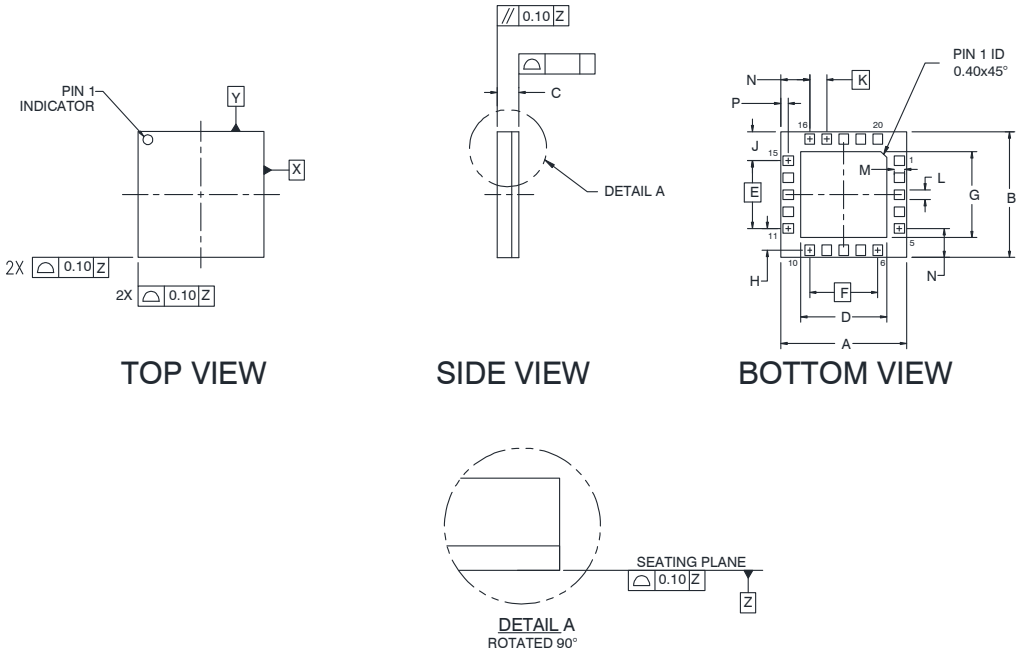


(I) 10 sprocket hole pitch cumulative tolerance ± 0.20
(II) Camber not to exceed 1 mm in 250 mm
(III) Material : Black conductive Polystyrene
(IV) Ao and Bo measured on a plane 0.3 mm above the bottom of the pocket.
(V) Ko measured from a plane on the inside bottom of the pocket to the top surface of the carrier
(VI) Pocket position relative to sprocket hole measured as true position of pocket, not pocket hole
ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE STATED.



Size	A	B	C	D	N	W1	W2	W3
16mm	330 +2.0 -2.0	1.5min	13.0 +0.5 -0.2	20.2 min	100 +3.0 -0.0	16.4 +2.0 -0.0	20.4 +2.0 -2.0	17.65 +1.75 -1.75

Package Outline Specifications - Package PG-LGA-6x6-3-1



DIM	INCHES			MILLIMETERS		
	MIN	TYP	MAX	MIN	TYP	MAX
A	.234	.236	.238	5.95	6.00	6.05
B	.234	.236	.238	5.95	6.00	6.05
C	.037	.041	.045	0.93	1.03	1.13
D	.157	.161	.165	4.00	4.10	4.20
E	–	.128	–	–	3.24	–
F	–	.128	–	–	3.24	–
G	–	.161	–	–	4.10	–
H	–	.041	–	–	1.03	–
J	.054	.054	.055	1.37	1.38	1.39
K	–	.032	–	–	0.81	–
L	–	.018	–	–	0.46	–
M	–	.020	–	–	0.50	–
N	.054	.054	.055	1.37	1.38	1.39
P	.013	.014	.014	0.34	0.35	0.36

Diagram Notes–unless otherwise specified:

1. Interpret dimensions and tolerances per ASME Y14.5M-1994.

Notes & Disclaimer

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