

High Power RF Applications for Cellular Band with LDMOS Technology

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CONNECTS

Agenda

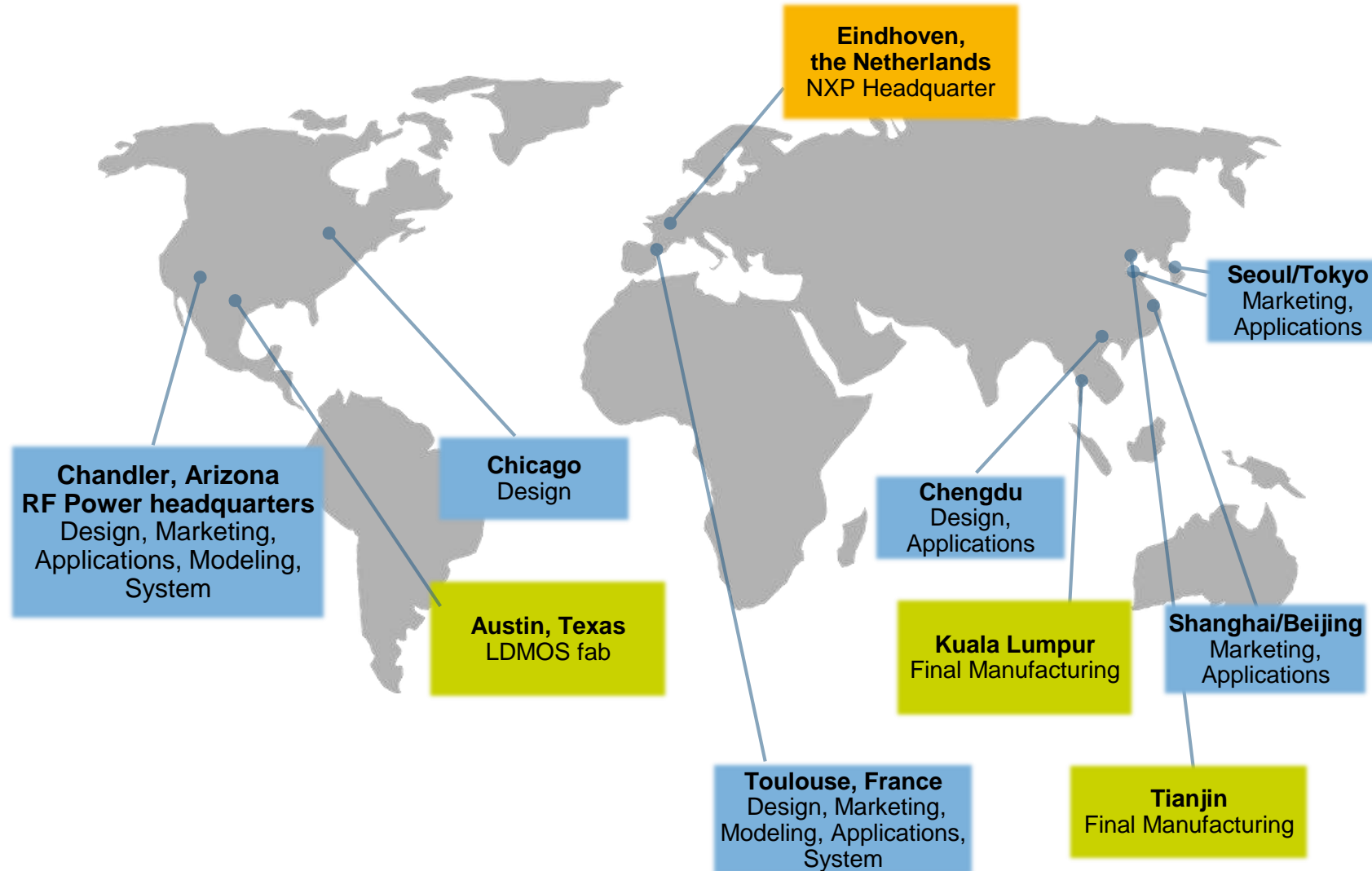
- NXP RF Power Introduction
- LDMOS Product Update
- Drivers and Small Cell
- LDMOS Full Roadmap



NXP 4 Business Units



NXP RF Power Global Presence



RF Power Applications

Cellular Power Amplifiers

- Base stations
- Repeaters
- From GSM to LTE

ISM (Industrial, Scientific, Medical)

- Laser/Plasma generator
- Medical
- Particle accelerators
- Industrial heating

Land Mobile Radio

- Handheld
- Vehicle
- Base stations

Cooking Appliances

- Ovens and ranges
- Counter top appliances
- Commercial
- Consumer

RF Low Power

- Picocells
- Pre-drivers
- Novel PA components

Broadcast

- FM
- VHF TV
- UHF TV

Commercial Avionics

- Distance measuring
- Transponders
- L- and S-band radars

Aerospace & Defense

- Radar
- Communications
- Electronic warfare

Technology Leadership



True Leader
RMS > 1.5

#1 in RF Power for Cellular Infrastructure

#1 in Total RF Power

Source: ABI Research

RF Cellular Investment Focus Areas

mMIMO

- PA modules starting to ramp into mass production
- Continue to drive integration and performance to enable lowest TCO

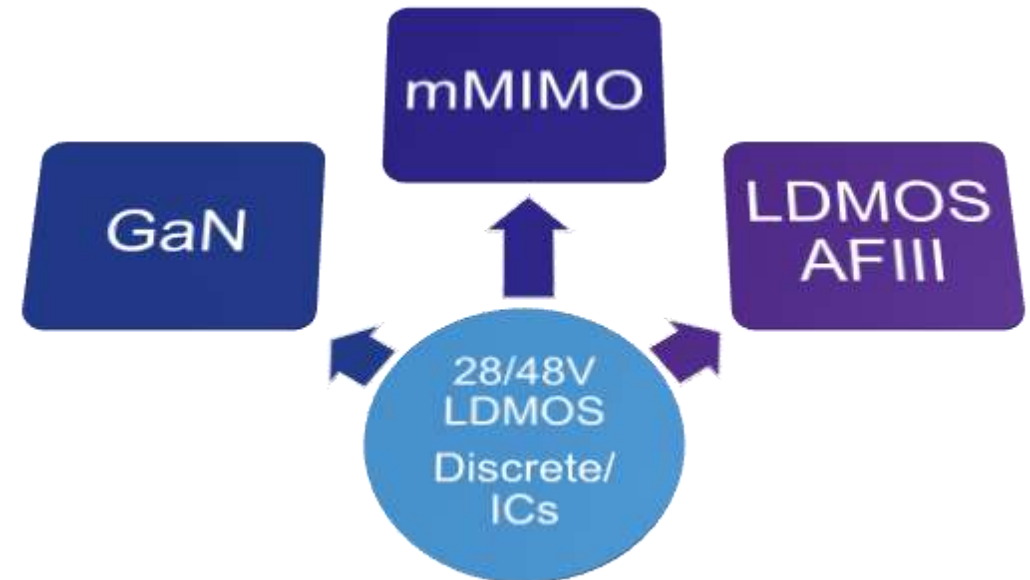
GaN

- Aggressive GaN device technology roadmap
- Internal matching Technology
- Packaging

LDMOS

- New 2-stage 48V drivers and Doherty finals enable single and multi-band solutions below 1GHz
- Full portfolio of industry leading 28V solutions launched and ramping
- Continued development on next generation Doherty drivers and enhanced SBW finals

Cellular Investment Focus



Next Gen Radios: Semiconductor Technology Tool Box

LDMOS 28V

Higher efficiency, integration, and frequency operation

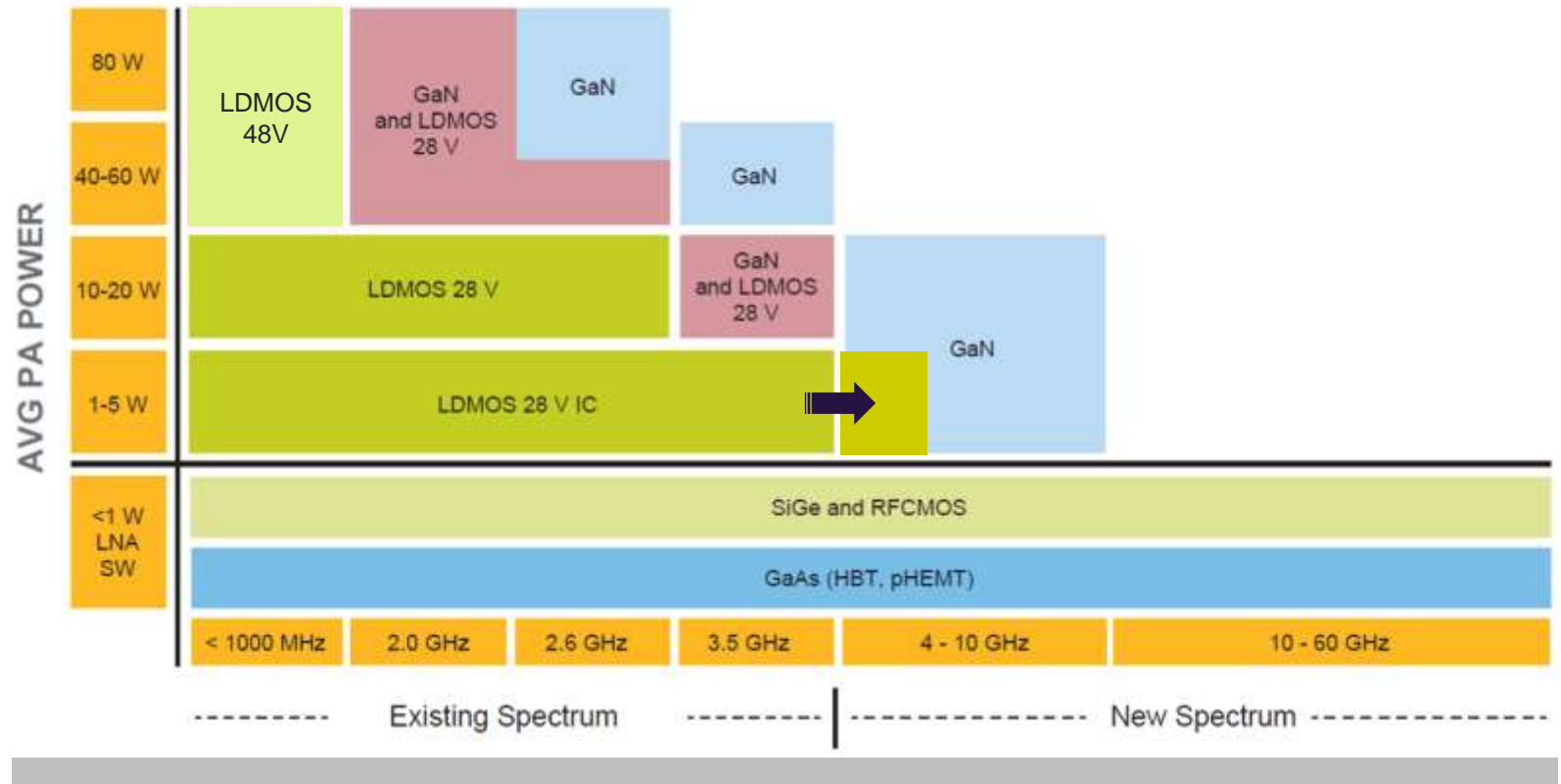
LDMOS 48V

Efficiency and power density of GaN with cost of LDMOS for sub 1GHz high power macro

GaN 48V

Highest efficiency. High band and multiband PA applications

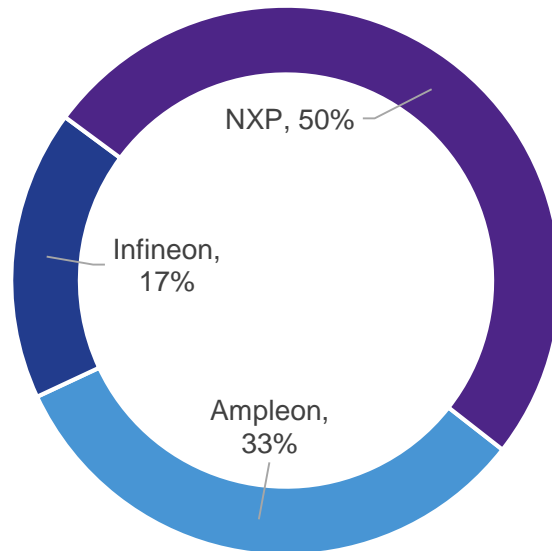
NXP's RF Technology Breadth: From sub-1GHz to mm-wave, and from mW to 10's of W



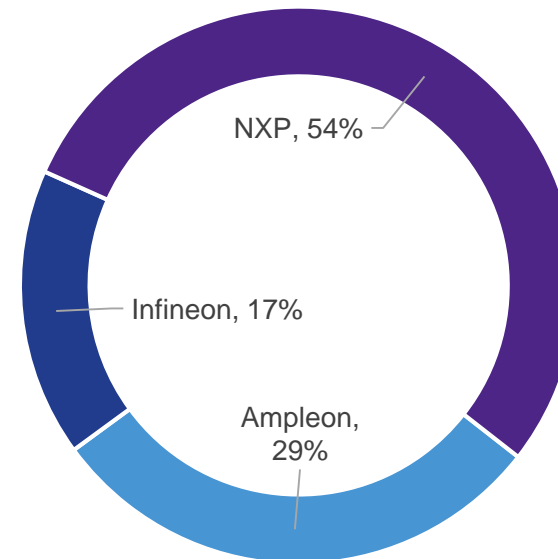
Overall LDMOS Cellular Market Share

2015 RF High Power Cellular:
Vendor Shares (Si only)

ABI Estimates



2016 RF High Power Cellular:
Vendor Shares (Si Only)

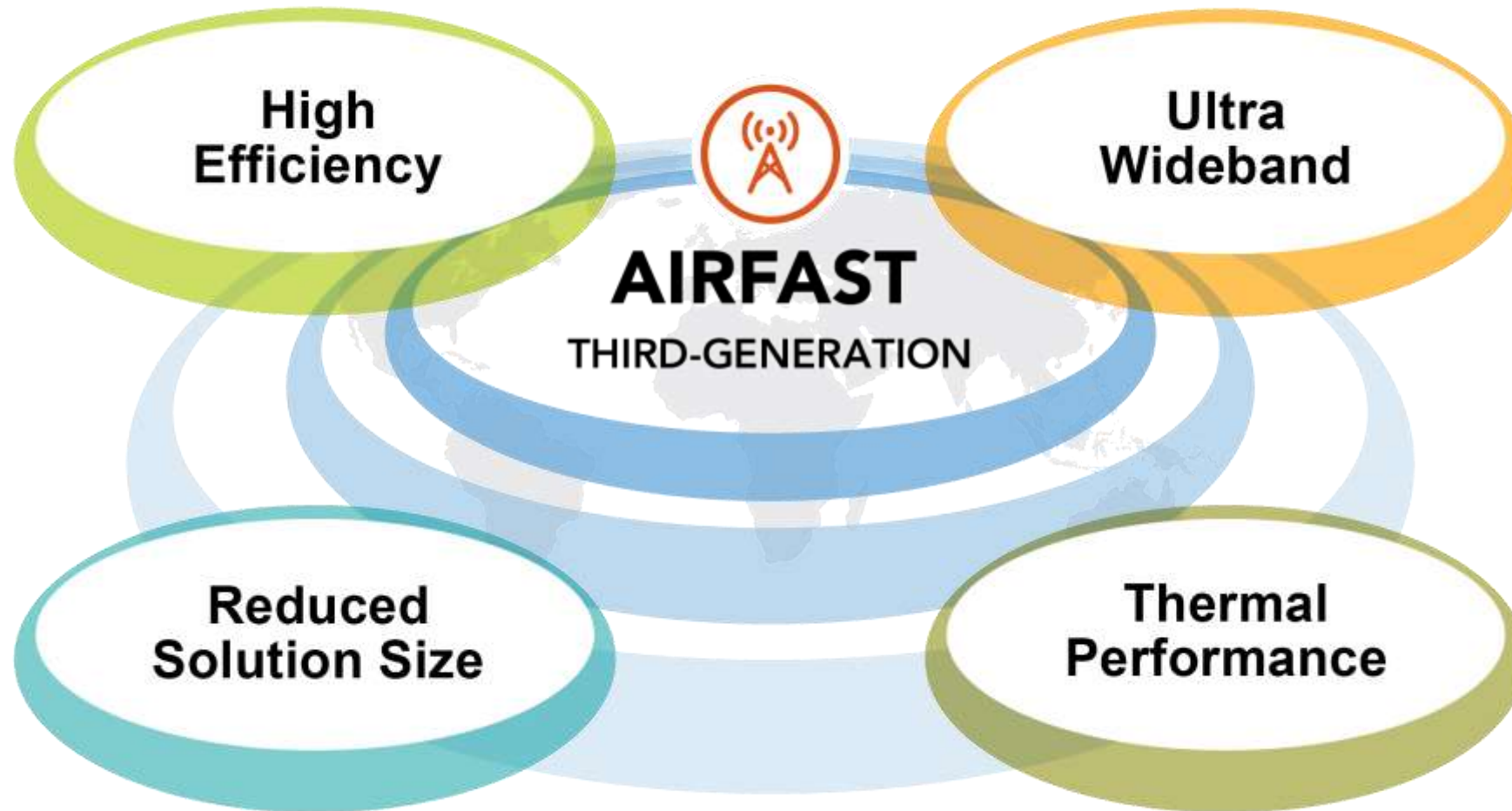


Source: Allied Business Intelligence

LDMOS Product Update



NXP Airfast RF Products



LDMOS Airfast Gen 3

- 50% line-up efficiency for 40W and 60W BTS
- Full band operation up to 90MHz
- Best in class thermal performance with Cu flange

A3T18H360W23S



28 V LDMOS Solution

Doherty Performance @ 8 dB OBO

Frequency (MHz)	Gain (dB)	Efficiency	Peak Power (dBm)
1805-1880	17.5	53%	55.5

A3T21H450W23S



28 V LDMOS Solution

Doherty Performance @ 8 dB OBO

Frequency (MHz)	Gain (dB)	Efficiency	Peak Power (dBm)
2110-2200	15.5	49.5%	57.4

LDMOS Airfast Gen 3

A3T18H400W23S

28 V LDMOS Solution



Doherty Performance @ 8 dB OBO

Frequency (MHz)	Gain (dB)	Efficiency	Peak Power (dBm)
1805-1880	17.2	53%	56.0

A3T21H400W23S

28 V LDMOS Solution



Doherty Performance @ 8 dB OBO

Frequency (MHz)	Gain (dB)	Efficiency	Peak Power (dBm)
2110-2200	15.5	51%	56.0

A3T18H455W23S

28 V LDMOS Solution



Doherty Performance @ 8 dB OBO

Frequency (MHz)	Gain (dB)	Efficiency	Peak Power (dBm)
1805-1880	17.2	52.5%	57.4

A2T23H200W23S

28 V LDMOS Solution



Doherty Performance @ 8 dB OBO

Frequency (MHz)	Gain (dB)	Efficiency	Peak Power (dBm)
2110-2200	15.5	50%	54.5

VHV LDMOS Technology

- Full portfolio of drivers and finals 575 MHz to 960 MHz
- First VHV 2-stage IC driver on the market
- Leading gain and efficiency performance
- Enabling resurgence of sub-1GHz cellular bands with VHV 48V LDMOS

A2V08H525-04N



48 V LDMOS Solution

Doherty Performance @ 8 dB OBO

Frequency (MHz)	Gain (dB)	Efficiency	Peak Power (dBm)
575-960	18.7	53%	58.5

A2I09VD030N



48 V LDMOS Solution

Class AB Performance @ 10 dB OBO

Frequency (MHz)	Gain (dB)	Efficiency	Peak Power (dBm)
575-960	34.4	20%	46

VHV LDMOS Technology

A2V09H300-04N

48 V LDMOS Solution



Doherty Performance @ 8 dB OBO

Frequency (MHz)	Gain (dB)	Efficiency	Peak Power (dBm)
720-960	19.5	55%	56.0

A2V09H400-04N

48 V LDMOS Solution



Class AB Performance @ 10 dB OBO

Frequency (MHz)	Gain (dB)	Efficiency	Peak Power (dBm)
720-960	17.5	55%	57.4

A2V07H525-04N

48 V LDMOS Solution



Doherty Performance @ 8 dB OBO

Frequency (MHz)	Gain (dB)	Efficiency	Peak Power (dBm)
575-850	18.5	52%	58.4

A2V09H525-04N

48 V LDMOS Solution



Class AB Performance @ 10 dB OBO

Frequency (MHz)	Gain (dB)	Efficiency	Peak Power (dBm)
720-960	18.5	52%	58.4

Drivers and Small Cell



Driver and Small Cell Solutions

Solution Type	Package	Summary
Driver & Small Cell Final	TO270-WB	2-stage, 2-path IC solutions with highest power capability and multi-band wideband solutions
Driver	PLD1.5, TO270	1-stage discrete ultra-wideband drivers for macro base stations

Driver and Small Cell Solutions

- 2-stage LDMOS ICs with leading RF performance
- Full line of solutions from 700 MHz to 3800 MHz
- Up to 1GHz RF bandwidth and 400MHz SBW
- Optimized for Class AB and Doherty operation

A2I20D040N



A3I35D025N



5W IC Final Small Cell Solution

Doherty Performance @ 8 dB OBO

Frequency (MHz)	Gain (dB)	Efficiency	Peak Power (dBm)
1400-2300	29.2	46.5%	47.6

5W IC Final Small Cell Solution

Doherty Performance @ 8 dB OBO

Frequency (MHz)	Gain (dB)	Efficiency	Peak Power (dBm)
3400-3600	25	35%	42.8

Driver and Small Cell Solutions

A2I09D015N



5W IC Final Small Cell Solution

Class AB Performance @ 10 dB OBO

Frequency (MHz)	Gain (dB)	Efficiency	Peak Power (dBm)
575-1000	31-33	20%	47.6

A2I25D025N



5W IC Final Small Cell Solution

Doherty Performance @ 8 dB OBO

Frequency (MHz)	Gain (dB)	Efficiency	Peak Power (dBm)
2100-2900	28	40%	44.5

A2I08H040N



5W IC Final Small Cell Solution

Doherty Performance @ 8 dB OBO

Frequency (MHz)	Gain (dB)	Efficiency	Peak Power (dBm)
728-960	30.7	46%	47.0

A2I35H060N



5W IC Final Small Cell Solution

Doherty Performance @ 8 dB OBO

Frequency (MHz)	Gain (dB)	Efficiency	Peak Power (dBm)
3400-3600	24	33%	48.0

Full Roadmap



48V LDMOS



575MHz-960MHz Solutions

Macro Base Stations 48V LDMOS

Type	40W	60W	80W
Final Asym	<p>A2V09H300-04N OM-780-4L <i>Production</i></p>	<p>A2V09H400-04N OM-780-4L <i>Production</i></p> <p>A2V07H400-04N OM-780-4L <i>Production</i></p>	<p>A2V09H300-04N x2 OM-780-4L <i>Production</i></p> <p>A2V07H525-04N OM-1230-4L <i>Production</i></p> <p>A2V09H525-04N OM-1230-4L <i>Production</i></p>
Final Sym	<p>A2T09VD300N TO-270WB-6A <i>Production</i></p> <p>A2T09VD250N TO-270WB-6A <i>Production</i></p>	<p>AFV09P350-04N OM-780-4 <i>Production</i></p>	<p>A2T09VD300N x2 TO-270WB-6A <i>Production</i></p>
Discrete & IC Driver	<p>A2T08VD020N PQFN8x8 <i>Production</i></p>	<p>A2I09VD030N TO270WB-15 <i>Production</i></p> <p>A2T08VD020N PQFN8x8 <i>Production</i></p>	<p>A2T08VD020N x2 PQFN8x8 <i>Production</i></p>

LDMOS 1GHz



720-960MHz Solutions

Micro Base Stations 28V

Type	5W	10W	20W
Final Discrete	MRF8P9040N TO-270WB-4 <i>Production</i>	MRFE6S9060N TO270-2 <i>Production</i>	A2T07D160W04S NI780-4 <i>Production</i> MRFE6S9060N TO270-2 <i>Production</i>
Final Two Stage IC	MD8IC970N TO-270WB-14 <i>Production</i> A2I08H040N TO-270WB-15 <i>Production</i>	MDE6IC9120N TO-270WB-16 <i>Production</i>	MDE6IC9120N TO-270WB-16 <i>Production</i>
Discrete Driver	MMG3006N QFN4x4 <i>Production</i>	A2T27S007N DFN 4X6 <i>Production</i> AFT27S006 PLD – 1.5W <i>Production</i>	A2T27S007N DFN 4X6 <i>Production</i> AFT27S006 PLD – 1.5W <i>Production</i>

720-960MHz Solutions

Macro Base Stations 28V

Type	40W	60W	80W
Final Discrete	AFT09S200W02N x2 OM-780-2 <i>Production</i>	AFT09S200W02N/AFT09S282N OM-780-2/OM-780-2 <i>Production/ Production</i>	AFT09S200W02N x3 OM-780-2 <i>Production</i> AFT09S220-02N/AFT09S282N OM-780-2/OM-780-2 <i>Production/ Production</i>
Final HiP	A2T07H310-24S NI-1230S-4L2L <i>Production</i> A2T09D400-23N OM-1230S-4L2S <i>Production</i>	AFT09H310-03S NI-1230S-4S <i>Production</i> A2T09H360W23S NI-1230S-4L2S <i>Now</i>	A2T07H310-24S x2 NI-1230S-4L2L <i>Production</i> AFT09H310-03S x2 NI-1230S-4S <i>Production</i>
Two Stage IC Driver	MW7IC915N PQFN8x8 <i>Production</i> MW8IC925N x2 TO-270WB-14 <i>Production</i>	MW7IC930N TO-270WB-14 <i>Production</i> MD8IC925N TO-270WB-14 <i>Production</i>	A2I08H040N TO-270WB-17 <i>Production</i>
Discrete Driver	A2T27S020N TO-270-2 <i>Production</i> AFT27S010N x2 PLD1.5W <i>Production</i>	A2T27S020N TO-270-2 <i>Production</i> MRF8P9040N TO-270WB-4 <i>Production</i>	MRF8P9040N TO-270WB-4 <i>Production</i>

LDMOS 1.4-2.0GHz



1400-2000 MHz Solutions

Micro Base Stations 28V

Type	5W		10W		15W-20W	
Final Dual path/ HiP			A2T18H100-25S NI780-4L4S <i>Production</i>		A2T20H160W04N OM-780-4L <i>Production</i>	AFT20P140-4WN OM-780-4 <i>Production</i>
Final 2 stage IC	A2I20D040N TO-270WB-17 <i>Production</i>	A2I20H060N TO-270WB-15 <i>Production</i>	A2I20H080N TO-270WB-15 <i>Production</i>			
Discrete Driver	MMG3006N QFN4x4 <i>Production</i>	AFT27S006N PLD-1.5W <i>Production</i>	MMG3006N QFN4x4 <i>Production</i>	AFT27S006N PLD-1.5W <i>Production</i>	MMG3006N QFN4x4 <i>Production</i>	AFT27S006N PLD-1.5W <i>Production</i>
	A2T27S007N DFN 4X6 <i>Production</i>		A2T27S007N DFN 4X6 <i>Production</i>		A2T27S007N DFN 4X6 <i>Production</i>	
2 Stage IC Driver	MMZ25332B QFN3x3 <i>Production</i>		MMZ25332B x2 QFN3x3 <i>Production</i>		MD7IC2012N TO-270WB-14 <i>Production</i>	MD7IC1812N TO-270WB-14 <i>Production</i>

1400-2000 MHz Solutions

Type	40W	60W	80W
Final HiP	<p>A2T20H330W24N OM-1230-4L2L <i>Production</i></p> <p>A3T18H400W23S ACP-1230S-4L2S <i>Production</i></p>	<p>A3T18H455W23S ACP-1230S-4L2S <i>Production</i></p> <p>A2T14H450-23N OM-1230-4L2S <i>Production</i></p> <p>A2T18H455W23N OM-1230-4L2S <i>Production</i></p>	<p>A3T18H360W23S x2 ACP-1230S-4L2S <i>Production</i></p> <p>A3T18H400W23S x2 ACP-1230S-4L2S <i>Production</i></p>
Final Asym		<p>A2T18S160W31S/ AFT18S260W02S NI-780S-2L2LA/NI-780S-2L2LA <i>Production /Production</i></p>	<p>A2T18S260-12S x3 NI-780-2L2L <i>Production</i></p> <p>A2T18S262W12N x3 OM-880X-2L2L <i>Production</i></p>
Final Sym	<p>A2T18S165-12S x2 NI-780S-2L2L <i>Production</i></p> <p>AFT18P350-4S2L NI-1230-4L2L <i>Production</i></p>	<p>AFT18S230S x2 NI-780S-2L4S <i>Production</i></p>	<p>AFT18S290-13S x2 NI-880S-2L4S <i>Production</i></p> <p>AFT18P350-4S2L x2 NI1230-4L2L <i>Production</i></p>
IC Driver	<p>A2I20D020N TO-270WB-17 <i>Production</i></p>	<p>A2I20D040N TO-270WB-17 <i>Production</i></p>	<p>A2I20H080N TO-270WB-15 <i>Production</i></p> <p>A2I22D050N TO-270WB-15 <i>Production</i></p>
Discrete Driver	<p>A2T27S020N TO-270-2 <i>Production</i></p> <p>AFT20S015N x2 TO-270-2 <i>Production</i></p>	<p>AFT27S010N x2 PLD1.5W <i>Production</i></p>	<p>A2T27S020N TO-270-2 <i>Production</i></p> <p>AFT27S010N x2 PLD1.5W <i>Production</i></p> <p>AFT20P060-4N OM-780-4 <i>Production</i></p> <p>A2T27S020N x2 TO-270-2 <i>Production</i></p>

LDMOS 2.1GHz



2100 MHz Solutions

Line Up Micro Base Stations 28Volts

Type	5W	10W	20W
Final Discrete	AFT20P060-4N OM-780-4 <i>Production</i>	A2T21H100-25S NI780-4L4S <i>Production</i>	A2T20H160W04N OM-780-4L <i>Production</i>
Final 2 Stage IC	A2I20D040N TO-270WB-17 <i>Production</i> A2I20H060N TO270WB-15 <i>Production</i>	A2I20H080N TO-270WB-15 <i>Production</i>	
Discrete Driver	A2T27S007N DFN 4X6 <i>Production</i> AFT27S006N PLD1.5W <i>Production</i> MMG15241H SOT-89 <i>Production</i>	A2T27S007N DFN 4X6 <i>Production</i> AFT27S006N PLD1.5W <i>Production</i> AFT27S010N PLD1.5W <i>Production</i>	A2T27S007N DFN 4X6 <i>Production</i> AFT27S006N PLD1.5W <i>Production</i> AFT27S010N PLD1.5W <i>Production</i>
2 Stage IC Driver	MMZ25332B QFN3x3 <i>Production</i>	MMZ25332B x2 QFN3x3 <i>Production</i>	A2I25D012N TO-270WB-15 <i>Production</i> MD7IC2012N TO-270WB-14 <i>Production</i>

2100 MHz Solutions Line Up Macro Base Stations 28Volts

Type	40W	60W	80W
Final HiP	A3T21H360W23S ACP-1230S-4L2S <i>Production</i> A2T21H360-24N OM-1230-4L2S <i>Production</i>	A3T21H450W23S ACP-1230S-4L2S <i>Production</i>	A3T21H360W23S x2 ACP-1230S-4L2S <i>Production</i>
Final Asym	A2T21S140W02S/A2T21S220W02 NI780-2L/NI-780-2L <i>Production/Production</i>	A2T21S160-12S/A2T21S260-12S NI-780S-2L2L/NI-780S-2L2L <i>Production / Production</i>	A2T21S260W12N x3 OM-880X-2L2L <i>Production</i>
Final Sym		AFT21S240-12S x2 NI-880XS-2L2L <i>Production</i>	AFT21S240-12S x2 NI-880XS-2L2L <i>Production</i>
IC Driver	A2I25D025N TO-270WB-17 <i>Production</i> A2I20D020N TO-270WB-17 <i>Production</i>	A2I20D040N TO-270WB-17 <i>Production</i>	A2I22D050N TO-270WB-15 <i>Production</i> A2I20H080N TO-270WB-15 <i>Production</i>
Discrete Driver	A2T27S020N TO-270-2 <i>Production</i> AFT20S015N x2 TO-270-2 <i>Production</i> AFT27S010N x2 PLD1.5W <i>Production</i>	A2T27S020N TO-270-2 <i>Production</i> AFT20S015N x2 TO-270-2 <i>Production</i> AFT27S010N x2 PLD1.5W <i>Production</i>	AFT20P060-4N OM-780-4 <i>Production</i> A2T27S020N x2 TO-270-2 <i>Production</i>

LDMOS 2.3 GHz



2300 MHz Solutions

Line Up Macro Base Stations 28Volts

Type	5W	20W
Final Discrete		A2T23H160-24S NI-780S-4L2L <i>Production</i>
Final 2 stage IC	A2I25H060N TO-270WB-17 <i>Production</i>	
Discrete Driver	MMG15241H SOT-89 <i>Production</i>	A2T27S007N DFN 4X6 <i>Production</i> AFT27S006 PLD1.5W <i>Production</i> AFT27S010N PLD1.5W <i>Production</i>
2 Stage IC Driver	MMZ2332B DFN 3X3 <i>Production</i>	A2I25D012N TO-270WB-15 <i>Production</i>

2300 MHz Solutions

Line Up Macro Base Stations 28Volts

Type	40W	60W
Final HiP	A2T23H200W23S ACP-1230-4L2S <i>Production</i>	A2T23H300-24S NI-1230-4S2L <i>Production</i>
IC Driver	A2I25D025N TO-270WB-15 <i>Production</i>	A2I25H060N TO-270WB-17 <i>Production</i>
Discrete Driver	A2T27S020N TO-270-2 <i>Production</i> AFT20S015N x2 TO-270-2 <i>Production</i> AFT27S010N x2 PLD1.5W <i>Production</i>	A2T27S020N x2 TO-270-2 <i>Production</i> AFT20S015N x2 TO-270-2 <i>Production</i>

LDMOS 2.6/3.5 GHz



2600 MHz Solutions

Line Up Micro Base Stations 28Volts

Type	5W	10W	20W
Final HiP	AFT26HW050S NI-780-8S <i>Production</i>		A2T26H160-24S NI780-4L2L <i>Production</i> A2T26H165-24S NI780-4L2L <i>Production</i>
Final Sym		AFT26P100-4WS NI-780-4S <i>Production</i>	
Final 2 stage IC	MD7IC2755N TO-270WB-14 <i>Production</i> A2I25H060N TO270WB-17 <i>Production</i>	A2I25H060N x2 TO270WB-17 <i>Production</i>	
Discrete Driver	A2T27S007N DFN 4X6 <i>Production</i> AFT27S006N PLD1.5W <i>Production</i> MMG15241H SOT-89 <i>Production</i>	AFT20S015N TO-270-2 <i>Production</i> AFT27S010N PLD1.5W <i>Production</i>	A2T27S020N TO-270-2 <i>Production</i> AFT20S015N TO-270-2 <i>Production</i> AFT27S010N x2 PLD1.5W <i>Production</i>
2 Stage IC Driver	MMZ25332B QFN3x3 <i>Production</i>	A2I25D012N TO-270WB-15 <i>Production</i>	A2I25D025N TO-270WB-17 <i>Production</i>

2600 MHz Solutions

Line Up Macro Base Stations 28Volts

Type	30W	40-60 W
Final HiP	AFT26H250-24S NI1230-4L2L <i>Production</i>	A2T26H300-24S NI1230-4L2L <i>Production</i>
	AFT26H200W03S/-24S NI-1230-4S /NI-1230-4L2L <i>Production</i>	AFT26H250-24S NI1230-4L2L <i>Production</i>
IC Driver	A2I25D025N TO-270WB-17 <i>Production</i>	A2I25H060N TO270WB-17 <i>Production</i>
Discrete Driver	A2T27S020N TO-270-2 <i>Production</i>	A2T27S020N TO-270-2 <i>Production</i>
	AFT20S015N x2 TO-270-2 <i>Production</i>	AFT20S015N x2 TO-270-2 <i>Production</i>
	AFT27S010N x2 PLD1.5W <i>Production</i>	AFT27S010N x2 PLD1.5W <i>Production</i>

3500 MHz Solutions

Line Up Micro Base Stations 28Volts

Type	1-2W	5W	10W	15-20W
Finals	<p>A3I35D012N TO-270WB-17 <i>Now</i></p> <p>AFT27S006N PLD1.5W Production</p>	<p>A3I35D025N TO-270-WB-17 <i>Now</i></p> <p>A3I35H060N TO-270-WB-17 Production</p>	<p>A2I35H060N x2 TO-270-WB-17 Production</p>	
Drivers			<p>A2T27S007N DFN 4X6 Production</p> <p>AFT27S006N PLD1.5W Production</p>	<p>A3I35D012N TO-270WB-17 <i>Now</i></p> <p>AFT27S010N PLD1.5W Production</p>



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