NXP Radio Power Solutions
Integrated Power Solutions

International Microwave Symposium
Boston, MA
June, 2019
RPS Product Lines

Radio Power Solutions
Business Line

High Power Solutions
Product Line
- Cellular Infrastructure Transistors
- RF Power Multi-Market
  (ISM, land mobile, A&D, RF Energy)

Integrated Power Solutions
Product Line
- Cellular Infrastructure ICs
- 5G mMIMO Infrastructures Modules

Smart Antenna Solutions
Product Line
- Mobile LNAs and Front-End ICs
  (LTE, GPS, WLAN)
- Infrastructure LNAs and 5G mmW Front-End ICs

#1 in RF Power

#1 in Mobile and Infrastructure LNAs
Integrated Power Solutions

mMIMO Overview

- IPS 5G History
- Past vs. 5G Future
- NXP Advantages
- Ease of Use

Highlighted Demos

- AFLP5G25641
- AFLP5G35645
- AFSC5G23D37
- AFSC5G35D35
- AFSC5G37D37
- AFLP5G25641
- ARFX5G372
- AFSC5G26D37
- AFSC5G35D37
- AFSC5G37D37
- AFDEV5G-26D37
- AFDEV5G-35D37

Select any item to learn more about our 5G Integrated Solutions.
NXP history for Airfast 5G Multi-Chip Modules

- **2016**: Demonstrated first 28V LDMOS multi-chip module compact reference design.

- **2017**: Introduced first integrated PA line-up solution in industry’s smallest footprint.

- **2018**: Full portfolio of multi-chip module solutions, in full production volumes, enabling Global 5G mMIMO Deployments.

- **2019**: Full line of reference circuits available reducing customer time to market and total cost of ownership.

- **2020**: Continued improvements in RF Performance (LDMOS & GaN) along with higher levels of Integration.
Conventional BTS vs. 5G Solutions

THE PAST
Conventional BTS

- Passive Antennas
- Masthead Amplifiers
- Small Cells
- Coaxial Cable
- Base Transceiver Station (Channel Cards, Radios, Amplifiers and Filters)

700 MHz  2.7 GHz

5G SOLUTIONS

Remote Radio Head
- Passive Antennas
- Fixed Wireless
- Remote Radio Head (Channel Cards)

5G
- Passive Antennas
- Active Antennas
- Small Cells
- Fiber Cable
- Base Station Server (Channel Cards)

600 MHz  6 GHz  26-29 GHz  37-40 GHz

NXP
AIRFAST 5G MCM Solutions – NXP Advantage

NXP is developing a family of fully integrated power amplifiers

Applications
- Massive MIMO Systems
- Outdoor Small Cells
- Communications
- Radar

Semiconductor Technologies
- LDMOS, GaN
- GaAs, SiGe

Power levels
- 1 to 5 Watt devices

Roadmap frequency bands
- 1.8 GHz to 5 GHz

Value Proposition
- Easy implementation - 50 Ω input & output
- Highly integrated form factor – smallest size in the industry - 6x10mm
- High efficiency Doherty PA
- Lowest circuit and DPD complexity in the industry
- Lowest OEM system & development cost
- Compatible with multilayer FR4 board
- Pin-compatibility between all frequency bands and power levels enables full design re-use and fast time to market
Airfast 5G MCM – *Experience the Ease of Use*

NXP is developing a family of fully integrated High Efficiency Power Amplifiers:

- Power levels up to 38 W Peak
- Roadmap covering bands 2.3 GHz to 5 GHz
- Easy implementation - 50 Ω input & output
- Pin-compatibility between all frequencies & power levels
- LDMOS – low cost solution

**Pre-Driver Amplifier**
3x4 mm² package

**PA Module**
6x10 mm² package

**Low Cost Small Size**
21x35 mm² solution

**Rx Front-End Module**
4x4 mm² package
AFLP5G25641

- 2300-2700 MHz
- P1dB: 25 dBm @ 3600 MHz, VCC2 = 3.3 Vdc
- P1dB: 29 dBm @ 3600 MHz, VCC2 = 5 Vdc
- Power consumption:
  - 105 mW @ VCC2 = 3.3 Vdc
  - 106 mW @ VCC2 = 5 Vdc
- 3.3 or 5 V

Comments:
- Integrated multi-chip module
- 4x3 mm² plastic package
- Three stages of amplification and support circuitry to work at 3.3 V or 5 V with very low power consumption.
- Internally matched to 50 ohm operation with no external matching, includes a 1.8 V logic control pin for bias enable/disable TDD operation.

Functional Block Diagram:

Typical line-up:

Driver: AFLP5G25641
Final stage: AFSC5G26D37
AFLP5G35645

- 3400-3800 MHz
- P1dB: 25 dBm @ 3600 MHz, VCC2 = 3.3 Vdc
- P1dB: 29 dBm @ 3600 MHz, VCC2 = 5 Vdc
- Power consumption:
  - 105 mW @ VCC2 = 3.3 Vdc
  - 106 mW @ VCC2 = 5 Vdc
- 3.3 or 5 V

Comments:
- Integrated multi-chip module
- 4x3 mm² plastic package
- Three stages of amplification and support circuitry to work at 3.3 V or 5 V with very low power consumption.
- Internally matched to 50 ohm operation with no external matching, includes a 1.8 V logic control pin for bias enable/disable TDD operation.

Typical line-up:

Driver: AFLP5G35645
Final stage: AFSC5G35D37

Functional Block Diagram:
AFRX5G272

- 5 V Switch LNA Module
- Noise Figure: 1.2 dB (typical @ 25°C)
- Gain: 33 dB
- 2300-2700 MHz
- 50 ohm without external matching

Functional Block Diagram:

Comments:

- Integrated multi-chip module for TD-LTE and 5G applications
- 6.2x6.2 mm² plastic package
- Support circuitry to work from a 5 V supply and a 1.8 logic-level T/R control
- Support Tx and Rx modes, which are controlled by T/R logic signaling
AFRX5G372

- 5 V Switch LNA Module
- Noise Figure: 1.3 dB (typical @ 25°C)
- Gain: 33 dB
- 3300-5000 MHz
- 50 ohm without external matching

**Functional Block Diagram:**

**Typical line-up:**

- **Driver:** AFLP5G25641
- **Final stage:** AFSC5G26D37
- **RX Module:** AFRX5G272

**Comments:**

- Integrated multi-chip module for TD-LTE and 5G applications
- 6.2x6.2 mm² plastic package
- Support circuitry to work from a 5 V supply and a 1.8 logic-level T/R control
- Support Tx and Rx modes, which are controlled by T/R logic signaling
AFSC5G23D37

- 2300-2400 MHz
- 34.7 W Peak, 45.4 dBm (5 W AVG)
- 38% efficiency @ 8 dB OBO
- 27 dB gain
- 28 V LDMOS

Planned Reference Circuit:

Typical LTE Performance: P = 5 W Avg., V = 26 Vdc, 1 × 20 MHz LTE, Input Signal PAR = 8 dB @ 0.01% Probability on CCDF.

<table>
<thead>
<tr>
<th>Carrier Center Frequency</th>
<th>Gain (dB)</th>
<th>ACPR (dBc)</th>
<th>PAE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2300 MHz</td>
<td>26.7</td>
<td>–29.4</td>
<td>38.4</td>
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<tr>
<td>2355 MHz</td>
<td>27.0</td>
<td>–30.9</td>
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<tr>
<td>2400 MHz</td>
<td>27.1</td>
<td>–31.2</td>
<td>37.0</td>
</tr>
</tbody>
</table>

Comments:
- Fully integrated Doherty power amplifier module
- 10x6 mm² plastic package
- Ideal for applications in massive MIMO systems, outdoor small cells, and low power remote radio heads
- Simple digital predistortion (DPD) algorithms and crest factor reduction (CFR) techniques in both TDD and FDD-LTE systems.

Typical line-up:

Driver: AFLP5G25641
Final stage: AFSC5G23D37

1. All data measured with device soldered in NXP reference circuit.
AFSC5G26D37

- 2545-2655 MHz
- 37.2 W Peak, 45.7 dBm (5 W AVG)
- 38% efficiency @ 8 dB OBO
- 27 dB gain
- 28 V LDMOS

**Planned Reference Circuit:**

Typical LTE Performance: P = 5 W Avg., V = 28 Vdc, 1 × 20 MHz LTE, Input Signal PAR = 8 dB @ 0.01% Probability on CCDF. (1)

<table>
<thead>
<tr>
<th>Carrier Center Frequency</th>
<th>Gain (dB)</th>
<th>ACPR (dBc)</th>
<th>PAE (%)</th>
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</thead>
<tbody>
<tr>
<td>2575 MHz</td>
<td>27.4</td>
<td>-27.8</td>
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<tr>
<td>2600 MHz</td>
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<td>39.9</td>
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<tr>
<td>2625 MHz</td>
<td>27.1</td>
<td>-27.7</td>
<td>40.0</td>
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1. All data measured with device soldered in NXP reference circuit.

**Comments:**

- Fully integrated Doherty power amplifier module
- 10x6 mm² plastic package
- Ideal for applications in massive MIMO systems, outdoor small cells, and low power remote radio heads
- Simple digital predistortion (DPD) algorithms and crest factor reduction (CFR) techniques in both TDD and FDD-LTE systems.

**Typical line-up:**

Driver: AFLP5G25641
Final stage: AFSC5G26D37
AFSC5G35D35

- 3400-3600 MHz
- 20.9 W Peak, 43.2 dBm (3 W AVG)
- 36% efficiency @ 8 dB OBO
- 27 dB gain
- 28 V LDMOS

Comments:
- Fully integrated Doherty power amplifier module
- 10x6 mm² plastic package
- Ideal for applications in massive MIMO systems, outdoor small cells, and low power remote radio heads
- Simple digital predistortion (DPD) algorithms and crest factor reduction (CFR) techniques in both TDD and FDD-LTE systems.

Planned Reference Circuit:

Typical LTE Performance: P = 3 W Avg., V = 24 Vdc, 1 × 20 MHz LTE, Input Signal PAR = 10 dB @ 0.01% Probability on CCDF.

<table>
<thead>
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<th>Carrier Center Frequency</th>
<th>Gain (dB)</th>
<th>ACPR (dBc)</th>
<th>PAE (%)</th>
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<td>3400 MHz</td>
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<td>3500 MHz</td>
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<td>25.14</td>
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1. All data measured with device soldered in NXP reference circuit.
**AFSC5G35D37**

- 3400-3600 MHz
- 36.3 W Peak, 45.6 dBm (5 W AVG)
- 38% efficiency @ 8 dB OBO
- 29 dB gain
- 28 V LDMOS

**Planned Reference Circuit:**

Typical LTE Performance: $P = 5$ W Avg., $V = 28$ Vdc, $1 \times 20$ MHz LTE,
Input Signal PAR = 8 dB @ 0.01% Probability on CCDF.

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<tr>
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<th>PAE (%)</th>
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</thead>
<tbody>
<tr>
<td>3400 MHz</td>
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<td>3500 MHz</td>
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<td>29.36</td>
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<td>38.56</td>
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1. All data measured with device soldered in NXP reference circuit.

**Comments:**

- Fully integrated Doherty power amplifier module
- 10x6 mm² plastic package
- Ideal for applications in massive MIMO systems, outdoor small cells, and low power remote radio heads
- Simple digital predistortion (DPD) algorithms and crest factor reduction (CFR) techniques in both TDD and FDD-LTE systems.
Typical line-up:

- 3600-3800 MHz
- 36.3 W Peak, 45.6 dBm (5 W AVG)
- 38% efficiency @ 8 dB OBO
- 29 dB gain
- 28 V LDMOS

Comments:

- Fully integrated Doherty power amplifier module
- 10x6 mm² plastic package
- Ideal for applications in massive MIMO systems, outdoor small cells, and low power remote radio heads
- Simple digital predistortion (DPD) algorithms and crest factor reduction (CFR) techniques in both TDD and FDD-LTE systems.

Planned Reference Circuit:

Typical LTE Performance: P = 5 W Avg., V = 29 Vdc, 1 × 20 MHz LTE, Input Signal PAR = 8 dB @ 0.01% Probability on CCDF.

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<tr>
<th>Carrier Center Frequency</th>
<th>Gain (dB)</th>
<th>ACPR (dBc)</th>
<th>PAE (%)</th>
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<tr>
<td>3600 MHz</td>
<td>29.5</td>
<td>-32.4</td>
<td>39.3</td>
</tr>
<tr>
<td>3700 MHz</td>
<td>29.7</td>
<td>-33.6</td>
<td>38.8</td>
</tr>
<tr>
<td>3800 MHz</td>
<td>29.9</td>
<td>-34.4</td>
<td>37.6</td>
</tr>
</tbody>
</table>

1. All data measured with device soldered in NXP reference circuit.
AFDEV5G-26D37

- 30 V LDMOS
- 5 W AVG, 37 dBm
- 2496-2690 MHz
- Integrated RF design
- 50 ohm input/output

Functional Block Diagram:

Typical line-up:

Driver: AFLP5G25641
Final stage: AFSC5G26D37
RX Module: AFRX5G272

Design Size:
Total height including cover 9.7 mm
57.15 mm x 34.52 mm x 20.95 mm x 38.35 mm
AFDEV5G-35D37

- 30 V LDMOS
- 5 W AVG, 37 dBm
- 3400-3600 MHz
- Integrated RF design
- 50 ohm input/output

Functional Block Diagram:

Typical line-up:

Driver: AFLP5G35645
Final stage: AFSC5G35D37
RX Module: AFRX5G372

Design Size:
Total height including cover 9.7 mm

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