

# 5G mmW RF Front-End ICs

24 GHz to 48.2 GHz

# Why Choose Analog Devices For Your Next 5G mmW Design?

Analog Devices delivers the industry's highest performance 5G mmW front-end signal chain solution for next-generation 5G mmW infrastructure. A platform solution is created from complementary building blocks (24 GHz to 48.2 GHz) offering a future-proof design that lowers platform R&D costs and enables faster development times. Explore some of the key benefits of our full 5G mmW front-end signal chain solutions and visit [analog.com/5G](https://analog.com/5G) for more information.

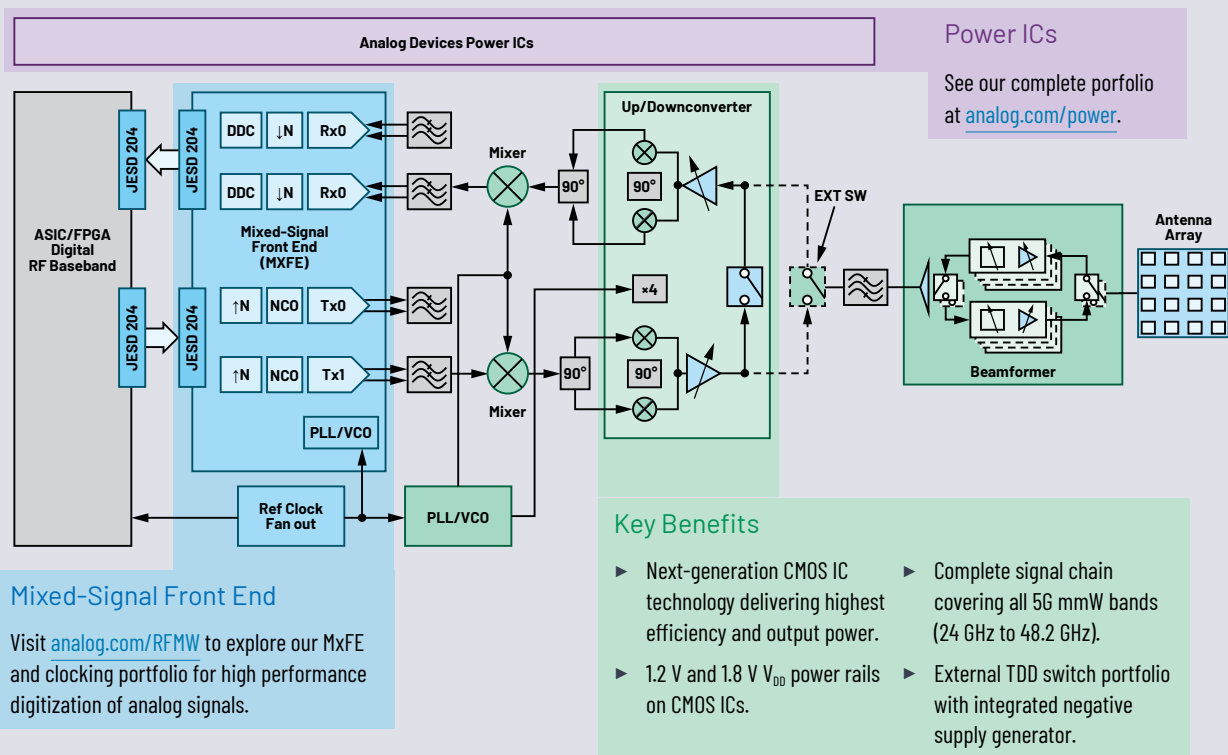
×2 Up/Downconverters + ×3 Beamformers to Cover the Entire 24 GHz to 48.2 GHz Spectrum

## Up/Downconverters

- ▶ Fully integrated LO chains and multipliers and LO synchronization
- ▶ Optional, bypassable TDD integrated switch
- ▶ Multimode operation: IF and direct conversion operation

## Beamformers

- ▶ Industry's highest channel count beamformers (16 channels in one IC)
- ▶ Dual polarized 8×2 configuration
- ▶ Onboard memory for storing beam positions and phase/gain calibration



## Enhanced Performance

- ▶ On-chip NVM plus online array calibration IP to optimize beamforming array performance.
- ▶ Wideband beamformers covering multiple 5G bands in one footprint.
- ▶ Portfolio of PLL/VCOs that deliver optimized phase noise performance for lowest EVM requirements.
- ▶ Industry-leading beamformer linearity and efficiency.

# Delivering on the Promise of 5G mmW

Analog Devices tackles the world's most complex communications problems. Our latest 5G mmW RF ICs deliver uncompromising performance and target next-generation infrastructure solutions.

The portfolio of ICs breaks the current narrow-band vendor paradigm by simultaneously optimizing power consumption, bandwidth, and performance while delivering the highest level of integration.

**1000×**  
higher data volume than 4G

**10 to 100×**  
higher data rates than 4G

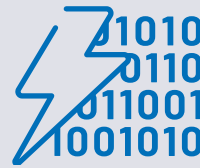
## 5G Requirements—What Do Operators Care About?

5G promises to deliver on the following key requirements at the network level. While 5G deployments require a customized, market-specific approach pulling on a mix of the pillars below, the need for a comprehensive understanding of the system challenges involved for effective execution is common. Analog Devices is democratizing commercial phased arrays by coupling market-leading mmWave IC design heritage, in-house packaging, and system design expertise with world-class quality and supply stability.



**10 TBps/km<sup>2</sup> Mobile Data Volume**

**Up to 10 Gbps Data Rate**



**10 Year Battery Life for IoT**

**10% of Current Energy Consumption**



**Availability 99.999%**

**E2E Latency 5 ms**



**Connected Devices 1M/km<sup>2</sup>**

**Mobility 500 km/h**

# What Are the 5G mmW Wireless Front-End Design Challenges?

## 24 GHz to 48.2 GHz

Full 5G mmW FR2 frequency coverage required.

## EIRP in Excess of 60 dBm

Outdoor coverage requires significantly high EIRP in small form factors at lowest bit error rates.

## Highest Signal Chain Integration

The mechanical radio enclosure must be small and aesthetically pleasing for widespread use.

## 1.6 GHz Channel Bandwidth

Maintain stable performance across the widest channel bandwidths with no EVM degradation to deliver the highest data rates to users.

## Path Loss at FR2

Path loss is higher and PA power is lower at mmWave, resulting in a more challenging link budget relative to sub-6 GHz.

## Multiple Streams Needed

Active phased array antennas with many radiating elements in each array supporting multiple simultaneous data streams for higher capacity.

## Multiple Radio Bands Across Wide RF Range

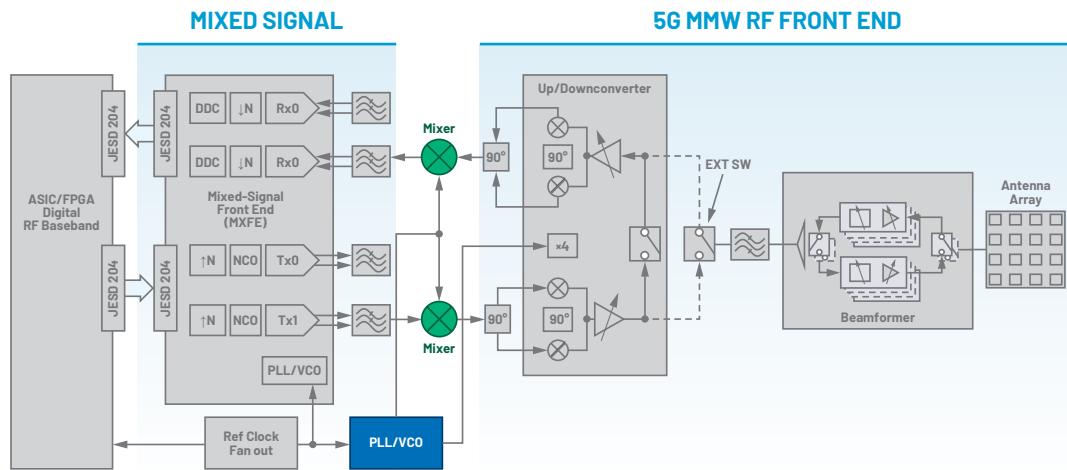
Supply chains complicated by narrow-band front-end IC designs each covering a small portion of the 24 GHz to 48.2 GHz frequency range.

## High Performance Phased Array Design

A holistic system-level design approach beyond ICs is required to enable first pass success in challenging mmWave designs.

Networks are no longer just about coverage.  
It's now about **CAPACITY.**

# What Is ADI's 5G mmW Front-End Platform Solution?



## PLL/VCO

- ▶ ADF5610
- ▶ ADF4372
- ▶ ADF4371
- ▶ ADF4377 *UPCOMING*

## Mixer (Optional)

- ▶ LTC5510

## I/Q Mods/Demods (Optional)

- ▶ LTC5589
- ▶ LTC5594

## Frac-N PLL with Integrated VCO

|                                   | Description                        | Frequency (GHz) | Open-Loop VCO Phase Noise @ 100 kHz (dBc/Hz) | Open-Loop VCO Phase Noise @ 1 MHz (dBc/Hz) | @ F <sub>OUT</sub> (GHz) | Figure of Merit (dBc/Hz) | PFDMAX Frac-N Mode (MHz) | V <sub>s</sub> (V) | I <sub>s</sub> (mA) | Package (mm) | ECCN Code | Ordering Part Number |
|-----------------------------------|------------------------------------|-----------------|--|--|--------------------------|--------------------------|--------------------------|--------------------|---------------------|--------------|-----------|----------------------|
| <b>ADF4377</b><br><i>UPCOMING</i> | PLL/VCO with multichip phase align | 0.8 to 12.8 GHz | —  | —  | —                        | -239                     | 500                      | 3.3/5              | —                   | 7 × 7 LGA    | EAR99     | ADF4377BCCZ          |
| ADF5610                           | PLL/VCO                            | 0.057 to 14.6   | -114   | -135                                       | 10                       | -229                     | 100                      | 3.3/5              | 126.7/110           | 7 × 7 LGA    | EAR99     | ADF5610BCCZ          |
| ADF4372                           | PLL/VCO                            | 0.062 to 16.0   | -111   | -134                                       | 8                        | -234                     | 155                      | 3.3/5              | 70/110              | 7 × 7 LGA    | EAR99     | ADF4372BCCZ          |
| ADF4371                           | PLL/VCO                            | 0.062 to 32.0   | -100   | -123                                       | 24                       | -234                     | 160                      | 3.3/5              | 190/135             | 7 × 7 LGA    | EAR99     | ADF4371BCCZ          |

## Mixers

|         | Description | RF (GHz)   | LO (GHz)     | IF (GHz)   | Conversion Gain (dB) | Input IP3 (dBm) | NF (dB) | Input P1dB (dBm) | LO Drive (dBm) | Package (mm) | ECCN Code | Ordering Part Number |
|---------|-------------|------------|--------------|------------|----------------------|-----------------|---------|------------------|----------------|--------------|-----------|----------------------|
| LTC5510 | Active      | 0.001 to 6 | 0.001 to 6.5 | 0.001 to 6 | 1.1                  | 25              | 11.6    | 11.5             | 0              | 4 × 4 QFN    | EAR99     | LTC5510IUF#TRPBF     |
| LTC5549 | Passive     | 2 to 14    | 1 to 12      | 0.5 to 6   | -10.8                | 24              | 10.4    | 14.3             | 0              | 3 × 3 QFN    | EAR99     | LTC5549IUB#TRPBF     |
| LTC5576 | Active      | 3 to 8     | 1 to 8       | 0.03 to 6  | -0.6                 | 26              | 14.1    | 10.4             | 0              | 4 × 4 QFN    | EAR99     | LTC5576IUF#TRPBF     |

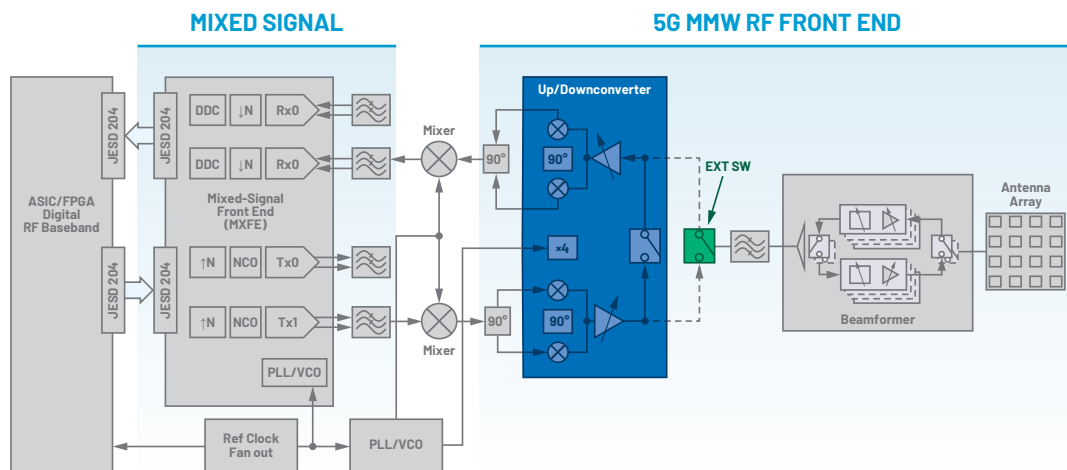
## I/Q Modulator

|         | Description | RF Frequency (GHz) | LO Leakage (dBm) | Sideband Suppression (dBc) | Noise (dBm/Hz) | Output P1dB (dBm) | Output IP3 (dBm) | BB-BW @ 3 dB (MHz) | V <sub>s</sub> (V) | I <sub>s</sub> (mA) | Package (mm) | ECCN Code | Ordering Part Number |
|---------|-------------|--------------------|------------------|----------------------------|----------------|-------------------|------------------|--------------------|--------------------|---------------------|--------------|-----------|----------------------|
| LTC5589 | Low power   | 0.7 to 6           | -40.2            | -41.5                      | -158.1         | 3.9               | 17.5             | 167                | 3.3                | 29.5                | 4 × 4 QFN    | EAR99     | LTC5589IUF#TRPBF     |

## I/Q Demodulator

|         | Description                             | RF Frequency (GHz) | Gain Error (dB) | Phase Error (°) | Noise Figure (dB) | Input P1dB (dBm) | Input IP3 (dBm) | BB-BW @ 3 dB (MHz) | V <sub>s</sub> (V) | I <sub>s</sub> (mA) | Package (mm) | ECCN Code | Ordering Part Number |
|---------|---|--------------------|-----------------|-----------------|-------------------|------------------|-----------------|--------------------|--------------------|---------------------|--------------|-----------|----------------------|
| LTC5594 | Ultrawideband, with VGA, digital IR cal | 0.3 to 9           | 0.06            | 1.6             | 21.2              | 4                | 27.8            | 1000               | 5                  | 470                 | 5 × 5 QFN    | EAR99     | LTC5594IUH#TRPBF     |

# What Is ADI's 5G mmW Front-End Platform Solution?



## Without TDD High Power Switch

- ▶ ADMV1013/ADMV1014 (SiGe)
- ▶ ADMV1017/ADMV1018 (SiGe)

## With TDD High Power Switch and Bypass Mode

- ▶ ADMV1128/ADMV1139 (CMOS SOI)

## Ext. Switch

- ▶ ADRF5300
- ▶ ADRF5301 **UPCOMING**
- ▶ ADRF5024

## Upconverter

|          | Description                         | RF (GHz) | LO (GHz)     | IF (GHz) | Conversion Gain (dB) | Output IP3 (dBm) | Sideband Rejection (dBc) | LO Drive Nominal | V <sub>s</sub> (V) | I <sub>s</sub> (mA) | Package (mm) | ECCN Code | Ordering Part Number |
|----------|-------------------------------------|----------|--------------|----------|----------------------|------------------|--------------------------|------------------|--------------------|---------------------|--------------|-----------|----------------------|
| ADMV1013 | Wideband I/O upconverter with 4× LO | 24 to 44 | 5.4 to 10.25 | 0 to 6   | 18                   | 23               | 26                       | 0                | 3.3                | 550                 | 6 × 6 LGA    | EAR99     | ADMV1013ACCZ         |

## Downconverter

|          | Description                           | RF (GHz) | LO (GHz)     | IF (GHz) | Conversion Gain (dB) | Input IP3 (dBm) | Image Rejection (dBc) | NF (dB) | LO Drive Nominal (dBm) | V <sub>s</sub> (V) | I <sub>s</sub> (mA) | Package (mm) | ECCN Code | Ordering Part Number |
|----------|---------------------------------------|----------|--------------|----------|----------------------|-----------------|-----------------------|---------|------------------------|--------------------|---------------------|--------------|-----------|----------------------|
| ADMV1014 | Wideband I/O downconverter with 4× LO | 24 to 44 | 5.4 to 10.25 | 0 to 6   | 17                   | 0               | 30                    | 5.5     | 0                      | 3.3                | 437                 | 5 × 5 LGA    | EAR99     | ADMV1014ACCZ         |

## Upconverters and Downconverters

|          | Description                                | RF (GHz)   | LO (GHz) | IF (GHz)                         | LO Drive (dBm) | V <sub>s</sub> (V) | DC Power (W) | Package (mm) | ECCN Code | Ordering Part Number |
|----------|--|------------|----------|----------------------------------|----------------|--------------------|--------------|--------------|-----------|----------------------|
| ADMV1017 | Integrated mmW 5G up/downconverter         | 24 to 29.5 | 5 to 15  | DC to 1.5 (BB)<br>3 to 10.5 (IF) | -8             | 3.3/<br>1.8/1.5    | 1.75         | 9 × 8 LGA    | EAR99     | ADMV1017BCCZ         |
| ADMV1018 | Thermally enhanced mmW 5G up/downconverter | 24 to 29.5 | 5 to 15  | DC to 1.5 (BB)<br>2 to 9.5 (IF)  | -8             | 3.3/<br>1.8/1.5    | 1.75         | 9 × 8 LGA    | EAR99     | ADMV1018BCCZ         |

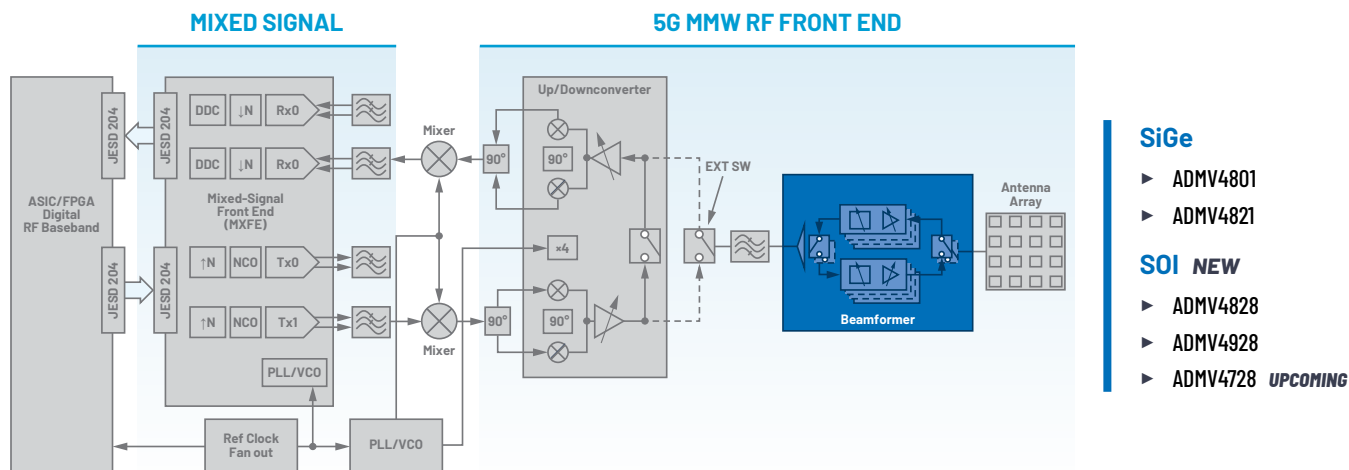
## Upconverters and Downconverters with Internal Transmit/Receive Switch (Can Bypass)

|          | Description                            | RF (GHz)   | LO (GHz)      | IF (GHz)                      | LO Drive (dBm) | V <sub>s</sub> (V) | DC Power (W) | Package (mm) | ECCN Code | Ordering Part Number |
|----------|--|------------|---------------|-------------------------------|----------------|--------------------|--------------|--------------|-----------|----------------------|
| ADMV1128 | 1T1R 5G mmW microwave up/downconverter | 24 to 29.5 | 5 to 15       | DC to 1.5 (BB)<br>3 to 7 (IF) | -10            | 1.8                | 1            | 6 × 6.5 BGA  | 5A991.b   | ADMV1128BBCZ         |
| ADMV1139 | 1T1R 5G mmW microwave up/downconverter | 37 to 48.2 | 7.25 to 12.05 | DC to 1.5 (BB)<br>2 to 8 (IF) | -10            | 1.8                | 1            | 6 × 6.5 BGA  | 5A991.b   | ADMV1139BBCZ         |

## SPDT Switches

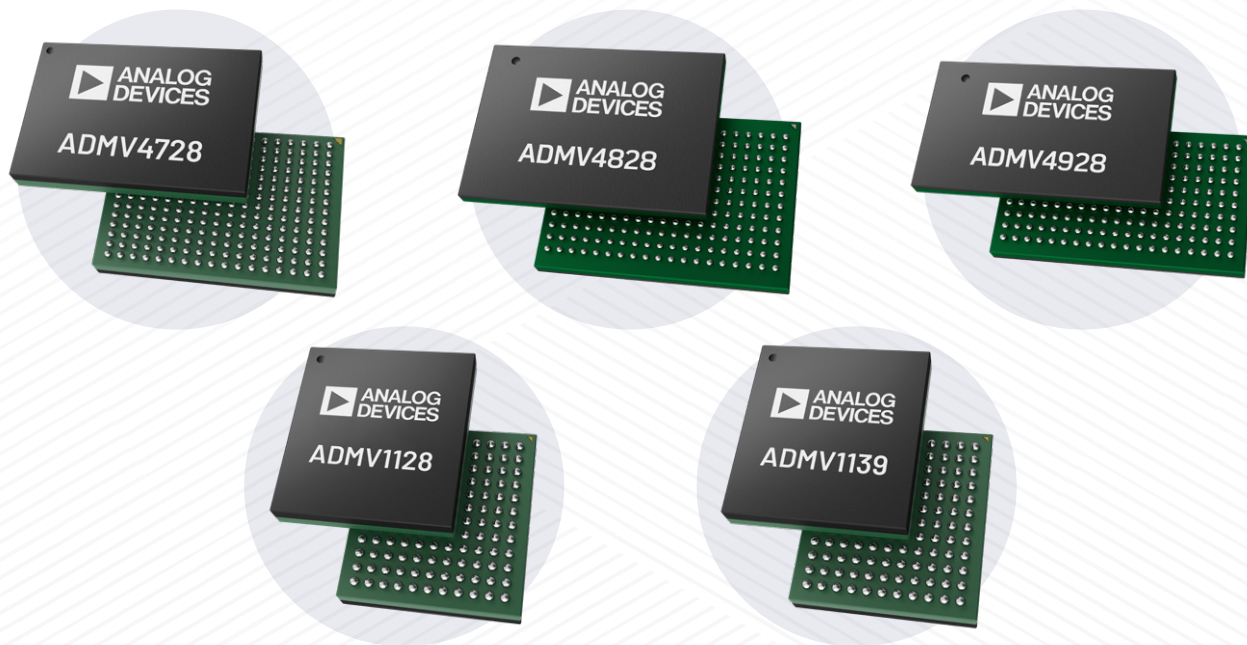
|                          | Description              | Frequency (GHz) | Insertion Loss (dB) | Isolation (dB) | Input P1dB (dBm) | Input P0.1dB (dBm) | Input IP3 (dBm) | On/Off Time (ns) | Control Input (VDC)   | Package (mm)    | ECCN Code | Ordering Part Number |
|--------------------------|--------------------------|-----------------|---------------------|----------------|------------------|--------------------|-----------------|------------------|-----------------------|-----------------|-----------|----------------------|
| ADRF5300                 | SPDT with no neg. supply | 24 to 32        | 1.1                 | 38             | —                | 37                 | 65              | 60/60            | CMOS/LVTTL compatible | 3 × 3 LGA       | EAR99     | ADRF5300BCCZN        |
| ADRF5301 <b>UPCOMING</b> | SPDT with no neg. supply | 35 to 44        | 1.2                 | 35             | —                | 37                 | 52              | 35               | CMOS/LVTTL compatible | 3 × 3 LGA       | TBD       | ADRF5301BCCZN        |
| ADRF5024                 | SPDT, reflective         | 0.1 to 44       | 1.4                 | 38             | —                | 27                 | 50              | 10/10            | 0/3.3                 | 2.25 × 2.25 LGA | EAR99     | ADRF5024BCCZN        |

# What Is ADI's 5G mmW Front-End Platform Solution?



## Beamformers

|                             | Description                              | Frequency (GHz) | Phase Adj Range (°) | Phase Adj Step (°) | Ampl Adj Range (dB)    | Ampl Adj Step (dB) | Package (mm) | ECCN Code | Ordering Part Number |
|-----------------------------|--|-----------------|---------------------|--------------------|------------------------|--------------------|--------------|-----------|----------------------|
| ADMV4801                    | 16T16R beamformer                        | 24 to 29.5      | 360                 | 5.625              | 33.4 (Tx)<br>17 (Rx)   | 0.5                | 10 × 10      | 5A991.b   | ADMV4801BCCZ         |
| ADMV4821                    | 16T16R dual polarization beamformer      | 24 to 29.5      | 360                 | 5.625              | 32.4 (Tx)<br>17.1 (Rx) | 0.5                | 10 × 10 LGA  | 5A991.b   | ADMV4821BCCZ         |
| ADMV4828                    | 16-channel, dual polarization beamformer | 24 to 29.5      | 360                 | 5.625              | 34.5 (Tx)<br>28 (Rx)   | 0.5                | 10 × 8.5 BGA | 5A991.b   | ADMV4828BBCZ         |
| ADMV4928                    | 16-channel, dual polarization beamformer | 37 to 43.5      | 360                 | 5.625              | 34 (Tx)<br>28 (Rx)     | 0.5                | 10 × 7 BGA   | 5A991.b   | ADMV4928BBCZ         |
| ADMV4728<br><b>UPCOMING</b> | 16-channel, dual polarization beamformer | 47.2 to 48.2    | 360                 | 5.625              | –                      | –                  | –            | 5A991.b   | ADMV4728BBCZ         |



# 5G mmW RF Front End ICs

## 24 GHz to 48.2 GHz



Complete  
24 GHz to 48.2 GHz  
Frequency Coverage



Industry's  
Highest Channel  
Count Beamforming IC



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Consumption and  
Highest Output Power

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