ANALOG DEVICES

AHEAD OF WHAT'S POSSIBLE™

5G mmW Mixed-Signal and RF Front-End Solution

24 GHz to 48.2 GHz

SEPTEMBER 2022

VISIT ANALOG.COM/5GMMW

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/5GmmW for more information.

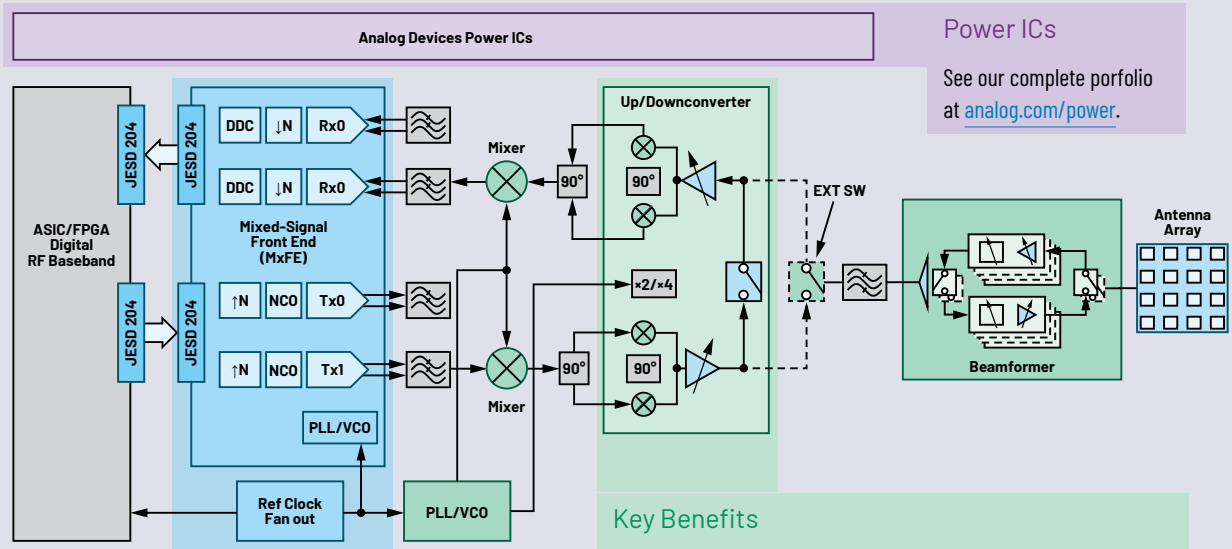
×2 Up/Downconverters + ×3 Beamformers to Cover the Entire 24 GHz to 48.2 GHz Spectrum

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



Power ICs

See our complete porfolio at analog.com/power.

Mixed-Signal Front End

Visit analog.com/RFMW to explore our MxFE® and clocking portfolio for high performance digitization of analog signals.

Key Benefits

- Next-generation CMOS IC technology delivering highest efficiency and output power.
- 1.2 V and 1.8 V V_{DD} power rails on CMOS ICs.
- Complete signal chain covering all 5G mmW bands (24 GHz to 48.2 GHz).
- External TDD switch portfolio with integrated negative supply generator.

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/km² 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/km²

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

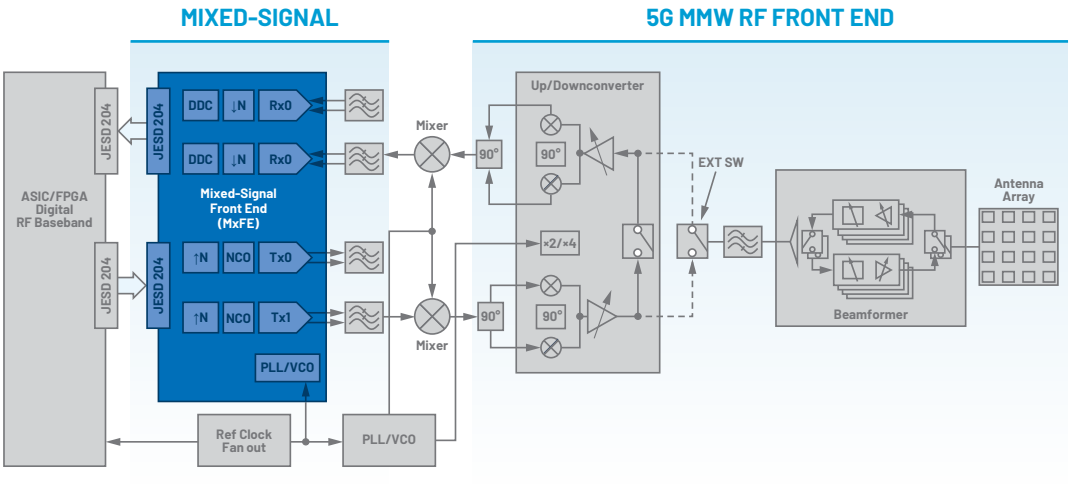
Supply chains complicated by narrow-band front-end IC designs each covering a small portion of the 24 GHz to 48.2 GHz frequency range.

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 Mixed-Signal Platform Solution?



MxFE

- AD9986 (4T2R)
- AD9988 (4T4R)

AD9986

4T2R Direct RF Transmitter and Observation Receiver

AD9988

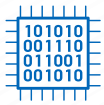
4T4R Direct RF Receiver and Transmitter

1.6 GHz

Highly integrated mixed-signal analog front end with 1.6 GHz bandwidth per transmit and receive channel.

7.2 GHz

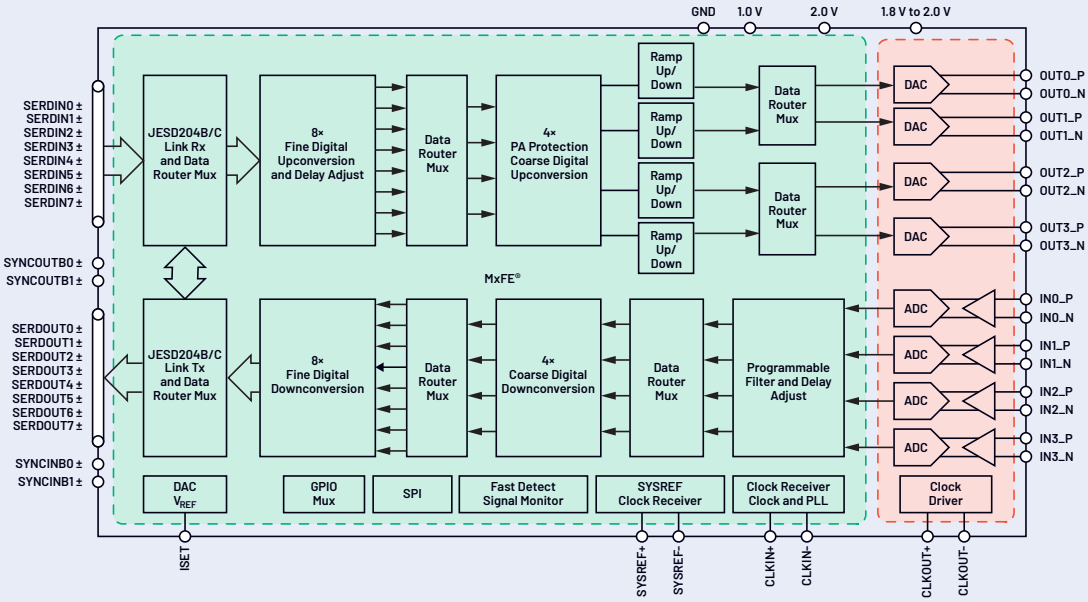
Enables direct RF conversion of intermediate frequencies up to 7.2 GHz.



Hardened on-chip digital signal processing provides system scalability and lower system power.

MXFE: SIMPLE, SCALABLE, EFFICIENT

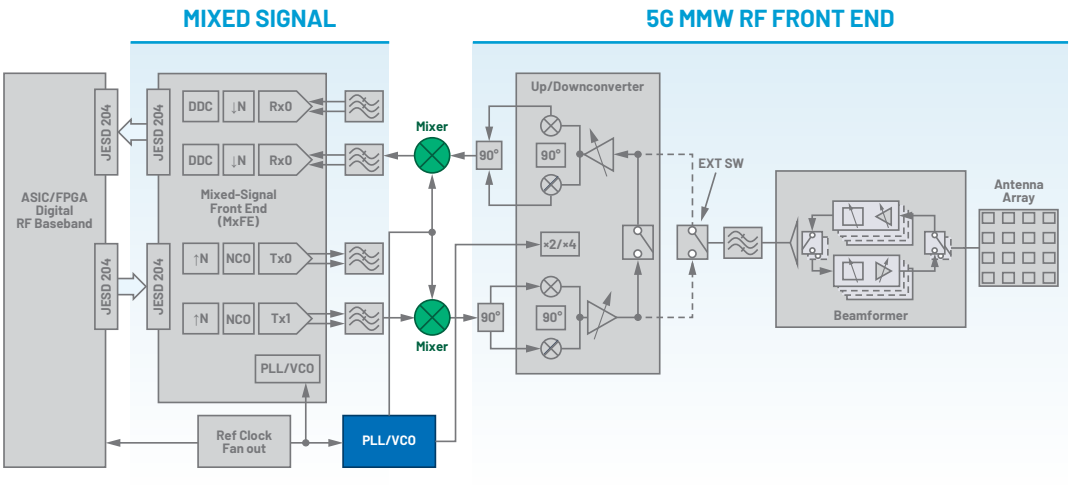
The MxFE platform of products tackles challenges with direct RF sampling and very wide channel bandwidth, all software defined, for a simple, scalable, efficient, and future-proof solution.



The green block highlights the on-chip DSP including a programmable FIR filter and coarse/fine decimation filters on the receive path and coarse/fine interpolation filters on the transmit path.

The orange block shows the AD9988 offering four ADC channels at 4 GSPS and four DAC channels at 12 GSPS.

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



PLL/VCO
- ADF4372
- ADF4371
- ADF4368 ***NEW***

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_{OUT} (GHz)	Figure of Merit (dBc/Hz)	PFDMAX Mode (MHz)	V_S (V)	I_S (mA)	Package (mm)	ECCN Code	Ordering Part Number
ADF4368 ***NEW***	PLL/VCO with multichip phase align	0.8 to 12.8	–106	–129	12	–239 (int.) –237 (frac.)	625 (int.) 250 (frac.)	3.3/5	—	7 × 7 LGA	EAR99	ADF4368BCCZ
ADF4377 ***NEW***	Int. only, PLL/VCO with multichip phase align	0.8 to 12.8	–106	–129	12	–239 (int.)	625 (int.)	3.3/5	—	7 × 7 LGA	EAR99	ADF4377BCCZ
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	LTC5549IUDB#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

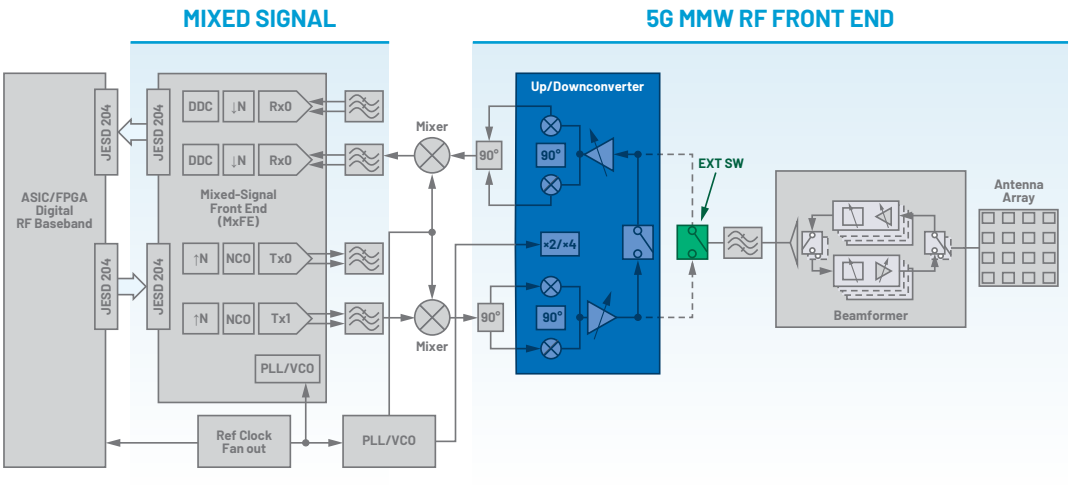
I/Q Modulator

	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_S (V)	I_S (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_S (V)	I_S (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 ***NEW***
- ADRF5024

Upconverter

	Description	RF (GHz)	LO (GHz)	IF (GHz)	Conversion Gain (dB)	Output IP3 (dBm)	Sideband Rejection (dBc)	LO Drive Nominal	V_S (V)	I_S (mA)	Package (mm)	ECCN Code	Ordering Part Number
ADMV1013	Wideband I/Q 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_S (V)	I_S (mA)	Package (mm)	ECCN Code	Ordering Part Number
ADMV1014	Wideband I/Q 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_S (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) 3 to 10.5 (IF)	−8	3.3/ 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) 2 to 9.5 (IF)	−8	3.3/ 1.8/1.5	1.75	9 × 8 LGA	EAR99	ADMV1018BCCZ

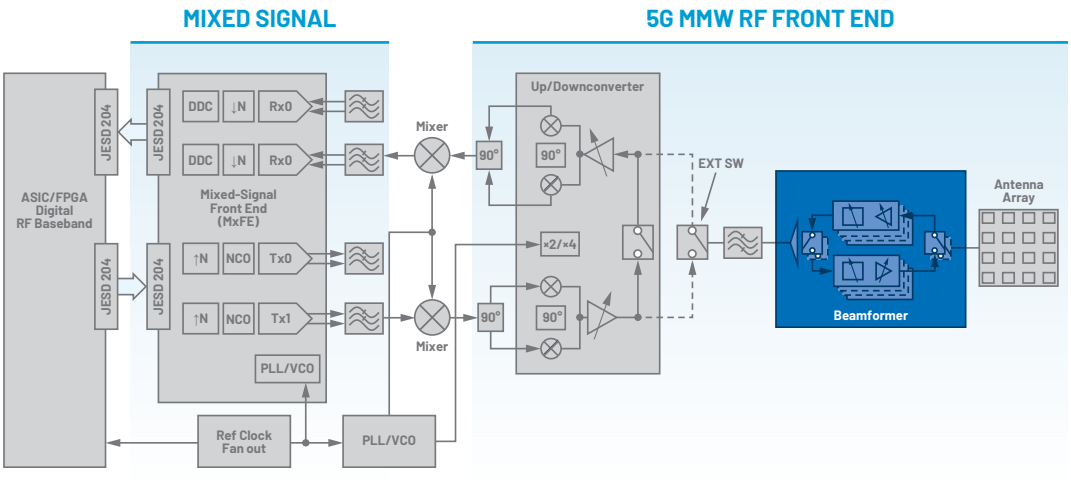
Upconverters and Downconverters with Internal Transmit/Receive Switch (Can Bypass)

	Description	RF (GHz)	LO (GHz)	IF (GHz)	LO Drive (dBm)	V_S (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	With internal hybrid: 3.2 to 7 (IF) Without internal hybrid: 2 to 8 (IF) I/Q: DC to 1.5 (BB)	−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	With internal hybrid: 3.2 to 7 (IF) Without internal hybrid: 2 to 8 (IF) I/Q: DC to 1.5 (BB)	−10	1.8	1	6 × 6.5 BGA	5A991.b	ADMV1139BBCZ

SPDT Switches

	Description	Frequency (GHz)	Insertion Loss (dB)	Isolation (dB)	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 ***NEW***	SPDT with no neg. supply	37 to 46	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?



SiGe

- ADMV4801
- ADMV4821

SOI

- ADMV4828 ***NEW***
- ADMV4928 ***NEW***
- ADMV4728 ***NEW***

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) 17 (Rx)	0.5	10 × 10	5A991.b	ADMV4801BCCZ
ADMV4821	16T16R dual polarization beamformer	24 to 29.5	360	5.625	32.4 (Tx) 17.1 (Rx)	0.5	10 × 10 LGA	5A991.b	ADMV4821BCCZ
ADMV4828 ***NEW***	16-channel, dual polarization beamformer	24 to 29.5	360	5.625	34.5 (Tx) 28 (Rx)	0.5	10 × 8.5 BGA	5A991.b	ADMV4828BBCZ
ADMV4928 ***NEW***	16-channel, dual polarization beamformer	37 to 43.5	360	5.625	34 (Tx) 28 (Rx)	0.5	10 × 7 BGA	5A991.b	ADMV4928BBCZ
ADMV4728 ***NEW***	16-channel, dual polarization beamformer	47.2 to 48.2	360	5.625	34.5 (Tx) 28 (Rx)	0.5	9 × 6 BGA	5A991.b	ADMV4728BBCZ

RFCMOS—Enabling Power-Efficient Solutions

ADMV4828 24.0 GHz to 29.5 GHz Transmit/ Receive Dual Polarization Beamformer

ADMV4928 37.0 GHz to 43.5 GHz Transmit/ Receive Dual Polarization Beamformer

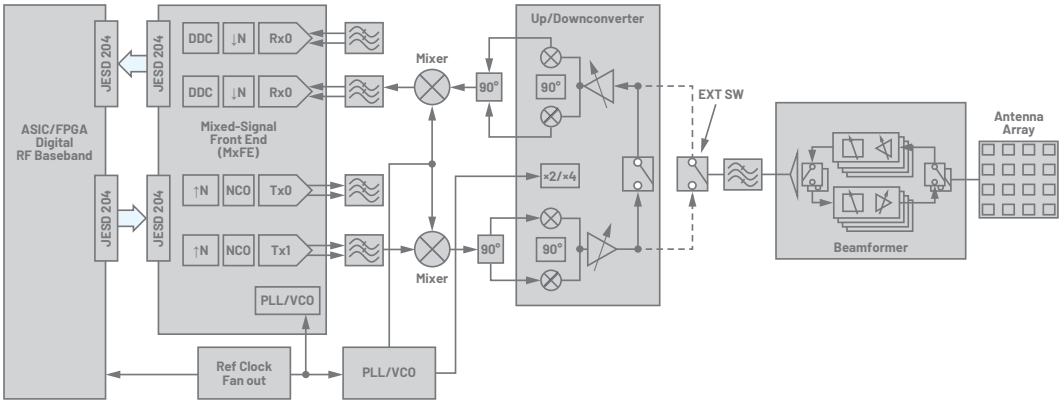
ADMV4728 47.2 GHz to 48.2 GHz, Dual Polarization Beamformer

ADMV1128 24 GHz to 29.5 GHz, 5G, Microwave Upconverter and Downconverter

ADMV1139 37 GHz to 48.2 GHz, 5G, Microwave Upconverter and Downconverter

What Is ADI's 5G mmW Ultralow Noise Power Solution?

Silent Switcher Step-Down Regulators | **LDO Linear Regulators**



Silent Switcher Devices

- LT8625S
- LT8625SP
- LT8625SP-1
- LT8627SP

LDO Linear Regulators

- LT3045
- LT3045-1
- ADM7150/ADM7151
- ADP1765

Ultralow Noise Silent Switcher Step-Down Converters with High PSRR

	I_{OUT} (A)	V_{IN} Range (V)	V_{OUT} Range (V)	RMS Noise	Noise Density, 10 kHz (nV/√Hz)	Max Temp	Features	Package (mm)
LT8625S	8	2.7 to 18	0 to 6	4	2	125°C	Internal $INTV_{CC}$ capacitor, fast transient, polyphase	4 × 3 LQFN
LT8625SP	8	2.7 to 18	0 to 6			150°C	Fast transient, double-side cooling, polyphase	4 × 3 LQFN
LT8625SP-1	8	2.7 to 18	0 to 6			150°C	Ultralow noise, fast transient, double-side cooling, polyphase; pin-compatible with LT8627SP	4 × 4 LQFN
LT8627SP	16	2.8 to 18	0 to 6			150°C	Ultralow noise, fast transient, double-side cooling, polyphase	4 × 4 LQFN

High Power Supply Rejection PSRR >40 dB at 1 MHz LDO Linear Regulators

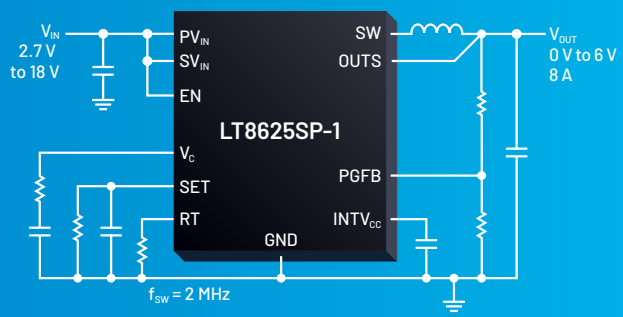
	I_{OUT} (A)	V_{IN} Range (V)	V_{OUT} Range (V)	RMS Noise 10 Hz to 100 kHz (µV RMS)	Noise Density, 10 kHz (nV/√Hz)	Typ PSRR @ 100 kHz, (dB)	Typ PSRR @ 1 MHz (dB)	Dropout Voltage (mV)	Quiescent Current (mA)	Package (mm)
LT3045	0.5	1.8 to 20	0 to 15	0.8	2	78	76	260	2.2	3 × 3, 10-lead DFN, 12-lead MSOP-E
LT3045-1	0.5	1.8 to 20	0 to 15	0.8	2	78	76	260	2.2	3 × 3, 10-lead DFN, 12-lead MSOP-E
ADM7150/ ADM7151	0.8	4.5 to 16	1.8 to 5 fixed/ 1.5 to 5.1 adj.	1.6	1.7	94	62	600	4.3	3 × 3, 8-lead LFCSP, 8-lead SOIC

Low Dropout Voltage LDO Linear Regulators

	I_{OUT}	V_{IN} Range	V_{OUT} Range (V)	RMS Noise (µV RMS)	Dropout Voltage (mV)	Quiescent Current (µA)	Package (mm)
ADP1765	5.0	1.1 to 1.98	Adj (0.5 to 1.5), fixed	3	59	5000	3 × 3 LFCSP

SILENT SWITCHER 3 STEP-DOWN REGULATORS

- Eliminate PCB layout sensitivity
- Ultralow quiescent current Burst Mode® minimizes output ripple voltage
- Up to 16 A output from each channel simultaneously (LT8627SP)

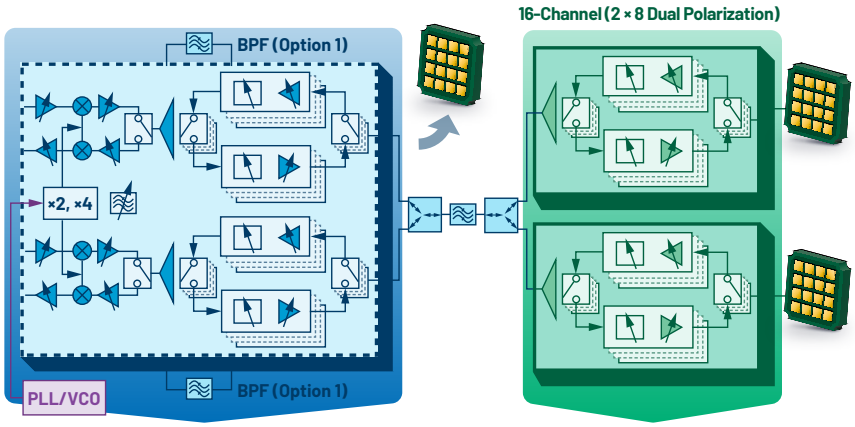


Maximize Data Throughput with **5G mmW Customer Premise Front-End ICs**

Create high speed 5G mmW modular arrays in a small form factor using ADI's latest CPE technology.

Option One: CPE IC to Antenna Elements

Option Two: CPE IC Driving BFICs for Greater Antenna Gain



SAMPLING NOW
2 UDCS + 16-CHANNEL BFIC

IN PRODUCTION
16-CHANNEL BFIC

RFCMOS—Enabling Power-Efficient Solutions

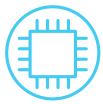
ADMV1228 24.0 GHz to 29.5 GHz, 2T2R Dual Polarization UDC + Beamformer

ADMV4828 24.0 GHz to 29.5 GHz Dual Polarization Beamformer

ADMV1239 37.0 GHz to 43.5 GHz 2T2R Dual Polarization UDC + Beamformer

ADMV4928 37.0 GHz to 43.5 GHz Dual Polarization Beamformer

ADF4368 12.8 GHz Wideband PLL/VCO



CPE ICs:

- Significant power consumption reduction compared to previous generations.
- Optional external filtering for spurious rejection.
- Contains complete 2T2R up/downconverter plus 16-channel (2 × 8) beamformer.
- Two ICs cover entire 24 GHz to 43.5 GHz spectrum.

Patented DPD and full system online calibration IP to enhance radio performance.

Characterized for 5G NR, Wi-Fi, and CPE UL.

Reference designs based on all-ADI portfolio, including LO generation, power, digital control, and antenna design.

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

Lowest Power
Consumption and
Highest Output Power

Learn more at analog.com/5GmmW

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ANALOG DEVICES

AHEAD OF WHAT'S POSSIBLE™

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