

## RF FAMILY OF PRODUCTS

Core innovations for differentiated RF systems





# RF INNOVATIONS FOR TACKLING COMMON DESIGN CHALLENGES

Renesas is a leader in developing circuit-level RF innovations and is a trusted supplier to the leading communications systems providers. We use the Smart Silicon™ approach to leverage the best technologies to create a portfolio of differentiated RF products.

- Circuit-level innovations – Improved system-level performance and repeatability with lower power consumption and increased reliability
- Innovation through Smart Silicon™ – Unique product solutions using optimal process technology to achieve the best performance from SOI, GaAS, GaN, or SiGe
- Trusted partner – Technology supplier to world's leading communication system providers and deployed in global networks
- Established product portfolio – Broad portfolio with a proven history of reliability ranging from simple, single-function components to complex RF sub-systems



Glitch-Free™

## Glitch-Free™ Technology

Renesas' digital step attenuators (DSA) virtually eliminate transient overshoot that occurs during MSB attenuation state transitions of standard DSAs. With Glitch-Free technology, amplifier damage and loss of information at the ADC are avoided.



FlatNoise™

## FlatNoise™ Technology

Renesas' variable gain amplifier (VGA) noise figure is kept virtually flat in the critical region, while gain is reduced. This greatly eases design constraints for radio engineers by enhancing signal-to-noise ratio (SNR).



Zero-Distortion™

## Zero-Distortion™ Technology

Renesas' RF amplifiers and RF mixers improve SNR by reducing the noise floor and third order intermodulation distortion. This is important for crowded spectrum environments, as it enhances quality-of-service (QoS) and frees up under-utilized spectrum.



## K<sub>LIN</sub> Constant Linearity Technology

Renesas' variable gain amplifiers maintain constant high linearity as gain is adjusted. As the gain is reduced, the linearity (OIP3) remains constant in the critical region. This prevents intermodulation distortion from degrading as the gain is reduced.



## K<sub>|Z|</sub> Constant Impedance Technology

Renesas' RF switches maintain nearly constant impedance when switching between RF ports. By controlling the impedance during the switching process voltage standing wave ratio (VSWR), transients are minimized. This improves switch reliability, reduces voltage stresses on downstream components, and improves overall system performance.



## K<sub>GAIN</sub> Constant Gain Compensation Technology

Renesas amplifiers are able to maintain near constant gain with KGAIN technology that automatically reduces S21 variation over temperature. Allowing temperature dependence to be controlled by design provides better tolerance and relative immunity to process variation which is particularly ideal for large signal chains.

## RF Amplifiers

Amplifiers are key components for radio cards of various architectures. A versatile high-performance amplifier with low-power consumption will be critical to enabling the design of massive MIMO solutions for 5G wireless systems and other RF applications such as WiFi connectivity, radar and test and measurement.

Renesas offers RF amplifiers with a variety of gain, noise figure and linearity features, in either differential or single-ended input impedances. Our differentiated interface amplifiers feature built-in broadband baluns to support wide band applications with differential inputs and outputs. Some products feature innovative Zero-Distortion™ technology, enabling high output IP3 with very low current consumption – setting them apart from simple gain block amplifiers.

### Driver Amplifiers

Part Number	Frequency (GHz)	Gain (dB)	NF (dB)	OP1dB (dBm)	OIP3 (dBm)	Voltage (V)	Current (mA)	Package (mm)
F0424	0.6 – 5.0	17	2.3	21	40	3.3 / 5	70	2 x 2, 8-Pin
F1420	0.7 – 1.1	17.4	4.5	23.2	42	5	105	4 x 4, 24-Pin
F1421	1.7 – 2.2	20.3	5.5	23	40	5	138	4 x 4, 24-Pin
F1471	0.4 – 4.2	17	4.3	28.5	39	5	130	3 x 3, 16-Pin
F1475	2.3 – 4.2	21	5	30	–	5	120	3 x 3, 16-Pin
F1490	1.8 – 5	39.5 / 35.5 <sup>1</sup>	2.5	24	38	5	75	3 x 3, 16-Pin
F1495	3.3 – 4.2	39	5	30	–	5	120	3 x 3, 16-Pin

### Interface Amplifiers

Part Number	Frequency (GHz)	Input	Output	Gain (dB)	NF (dB)	OP1dB (dBm)	OIP3 (dBm)	Voltage (V)	Current (mA)	Package (mm)
F1129LB	1.4 – 3.2	50Ω SE	100Ω DIFF	20	1.6	20.5	36	3.3 / 5	61	2 x 2, 12-Pin
F1129MB	3 – 4.2	50Ω SE	100Ω DIFF	19	1.8	18	32	3.3 / 5	60	2 x 2, 12-Pin
F1423	0.6 – 3.0	50Ω DIFF	50Ω SE	13.1	5.1	21.5	41.8	5	120	4 x 4, 24-Pin
F1429LB	1.4 – 3.2	100Ω DIFF	50Ω SE	21.5	1.9	22	40	3.3 / 5	64	2 x 2, 12-Pin
F1429MB	3.0 – 4.2	100Ω DIFF	50Ω SE	21	1.8	21	40	3.3 / 5	73	2 x 2, 12-Pin

### Low Noise Amplifiers

Part Number	Frequency (GHz)	Gain (dB)	NF (dB)	OP1dB (dBm)	OIP3 (dBm)	Voltage (V)	Current (mA)	Package (mm)
F0109 <sup>2</sup>	0.65 – 1	18	0.55 <sup>3</sup>	24.5	41	5	120	4 x 4, 16-Pin
F0110 <sup>2</sup>	1.5 – 2.3	18.5	0.55 <sup>3</sup>	22	39	5	110	4 x 4, 16-Pin
F0111	2.3 to 2.7	18	0.7 <sup>3</sup>	23	38	5	90	4 x 4, 16-Pin

### Low Noise Amplifiers for Satcom / Radar

Part Number	Description	Frequency (GHz)	Gain (dB)	OP1dB (dBm)	Voltage (V)	Current (mA)	Package (mm)
F6921	Dual-ch LNA, Ku-Band SATCOM	10.7 – 12.75	19	–5	0.95 – 1.05	15	2.7 x 2.7, 23-BGA
F6922	Dual-ch LNA, Ka-Band SATCOM	17.7 – 21.2	19	–3	0.95 – 1.05	20	2.7 x 2.7, 23-BGA
F6923	Dual-ch LNA, Ku / CDL-Band	14.4 – 17.3	19	–2	0.95 – 1.05	20	2.7 x 2.7, 23-BGA

<sup>1</sup> Dual gain modes (high gain and low gain settings)

<sup>2</sup> Dual path amplifiers specified in a balanced configuration

<sup>3</sup> De-embedded to input pin of input hybrid coupler

## Variable Gain Amplifiers

Renesas offers digitally controlled intermediate frequency (IF) and radio frequency (RF) variable gain amplifiers (VGA) with FlatNoise™ technology, an innovative technology where noise does not degrade as gain is reduced. These low-noise devices improve quality-of-service (QoS) and ease the signal-to-noise ratio (SNR) requirements of the downstream data converter to reduce system cost.

Some of Renesas' digital VGAs feature patented Glitch-Free™ technology, eliminating attenuation setting overshoot from the transmit and / or receive paths by reducing transient "glitches" by up to 95 percent during most significant bit (MSB) transitions. The Renesas RF VGAs are ideal for receiver and transmitter systems located in cellular base stations and other wireless infrastructure equipment.

### Digital Variable Gain Amplifiers (DVGA)

Part Number	Frequency (GHz)	# Ch	Att. Range (dB)	Att. Step (dB)	Gain (dB)	NF (dB)	OP1dB (dBm)	OIP3 (dBm)	Voltage (V)	Current (mA)	Package (mm)
F0440	0.6 – 2.7	2	6, 23, 18	6, 1, 6	11.6	4.7	20.2	40	5	245	6 x 6, 36-Pin
F0443	0.6 – 2.7	2	6, 6, 23, 18	6, 6, 1, 6	29.5	3.2	19.7	39	5	372	7 x 7, 48-Pin
F0448	3.4 – 3.8	2	6, 23, 18	6, 1, 6	13	5.9	18	37	5	220	6 x 6, 36-Pin
F0480	0.4 – 2.7	1	23	1	13	4	22.2	41	4.75 – 5.25	100	5 x 5, 32-Pin
F1106	1.4 – 3	2	31.5	0.5	32	7.3	20	39	3.3 / 5.0	390	6 x 6, 36-Pin
F1107	3 – 4	2	31.5	0.5	30.5	8.7	21	38	3.3 / 5.0	410	6 x 6, 36-Pin
F1200	0.05 – 0.16	1	23	0.25	21.7	2.6	19.4	48	5	110	5 x 5, 28-Pin
F1240	0.01 – 0.5	2	31.5	0.5	20	4	19.7	47	5	160	5 x 5, 32-Pin
F1431B	0.35 – 3	1	23	0.5	14.3	4.2	23.3	41.1	5	150	4 x 4, 24-Pin
F1451	0.45 – 1.1	1	29.5	0.5	32	3.6	23	41	5	185	6 x 6, 28-Pin
F1455	1.4 – 2.3	1	29.5	0.5	32.8	3.9	23	38.5	5	220	6 x 6, 28-Pin
F1456	2.1 – 2.95	1	31.5	0.5	32.1	3.9	21.5	38	5	215	6 x 6, 28-Pin
F4481	0.4 – 1.1	4	31.5	0.5	28	5.7	17	35	3.3	524	8 x 8, 56-Pin
F4482	1.3 – 2.8	4	31.5	0.5	27.5	5.7	16.7	36.8	3.3	485	8 x 8, 56-Pin

### Variable Gain Amplifiers (VGA)

Part Number	Frequency (GHz)	Max Att. (dB)	Gain (dB)	NF (dB)	OP1dB (dBm)	OIP3 (dBm)	Voltage (V)	Current (mA)	Package (mm)
F2480	0.4 – 3	35.5	14.1	4.5	19.7	41	36	106	5 x 5, 32-Pin

### Switch + Low Noise Amplifier Modules

Part Number	Frequency (GHz)	TX Mode Power Handling (dBm)	High / Low Gain Mode (dB)	NF (dB)	OP1dB (dBm)	OIP3 (dBm)	Voltage (V)	Current (mA)	Package (mm)
F0452C	2.3 – 2.7	30 + 7.5dB PAR	34 / 28	1.6	15	23	3.3	130	6 x 6, 32-Pin
F0453C	3.3 – 4.0	30 + 7.5dB PAR	35 / 29	1.35	15	23	3.3	130	6 x 6, 32-Pin
F0472B	2.3 – 2.7	34 + 9dB PAR	35 / 29	1.2	15	23	3.3	130	5 x 5, 32-Pin
F0473B	3.3 – 4.2	34 + 9dB PAR	35 / 29	1.2	15	23	3.3	130	5 x 5, 32-Pin

## RF Attenuators

Renesas offers a wide range of monolithic silicon RF Attenuators that utilize either digital or analog control. All of Renesas' RF attenuators offer broad bandwidth, low insertion loss, low error, and high linearity with high attenuation accuracy. Patented Glitch-Free™ technology eliminates attenuation setting overshoot from the transmit and / or receive paths by reducing transient glitches during most significant bit (MSB) transitions by up to 95 percent. This enables customers to simplify their software interface, improve reliability, and limit over-ranging of data converter inputs while preventing damage to expensive sub-assemblies such as power amplifiers, and limit over-ranging of data converter inputs.

### Digital Step Attenuators (DSA)

Part Number	Description	Frequency (GHz)	Max Att. (dB)	Resolution (dB)	IL (dB)	IP0.1dB (dBm)	IIP3 (dBm)	Voltage (V)	Current (mA)	Package (mm)
F1912	6-bit	0.001 – 4	31.5	0.5	1.4	31	60	3.3	0.55	4 x 4, 20-Pin
F1950	7-bit	0.15 – 4	31.75	0.25	1.3	27.5	63	3.3	0.25	4 x 4, 24-Pin
F1951	6-bit	0.1 – 5	31.5	0.5	1.2	29	64	3.3	1.1	4 x 4, 24-Pin
F1953	6-bit	0.4 – 4	31.5	0.5	1.4	28.5	66	3	0.2	4 x 4, 20-Pin
F1956	7-bit	0.001 – 6	31.75	0.25	1.6	34.5	64	3.3	0.35	5 x 5, 32-Pin
F1958	7-bit	0.001 – 6	31.75	0.25	1.6	35	64	3.3	0.25	4 x 4, 24-Pin
F1975	6-bit, 75Ω	0.005 – 3	31.5	0.5	1.2	30.5	64	3.3	0.55	4 x 4, 20-Pin
F1977	7-bit, 75Ω	0.005 – 3	31.75	0.25	1.4	32	64	3.3	0.322	5 x 5, 32-Pin
F1978	6-bit, 75Ω	0.005 – 3	31.5	0.5	1.2	30.5	64	3.3	0.55	4 x 4, 20-Pin

### Variable Voltage Attenuators (VVA)

Part Number	Description	Frequency (GHz)	Max Att. (dB)	IL (dB)	IP1dB (dBm)	IIP3 (dBm)	Voltage (V)	Current (mA)	Package (mm)
F2250	Positive or Negative Slope Control	0.05 – 6	35	1.4	34.4	65	3.3	1.17	3 x 3, 16-Pin
F2251	Positive Slope Control	0.05 – 6	35	1.4	34.4	67	3.3	0.8	3 x 3, 16-Pin
F2255	Positive or Negative Slope Control	0.001 – 3	34.6	1.1	36	60	3.3	1.15	3 x 3, 16-Pin
F2258	Negative Slope Control	0.05 – 6	35	1.4	34.4	65	3.3	1.17	3 x 3, 16-Pin
F2270	Positive or Negative Slope Control	0.005 – 3	35	1.1	36	60	3.3	1.4	3 x 3, 16-Pin

## Integrated TRx ICS

Renesas' integrated TRx ICs leverage several key technology innovations, such as Zero-Distortion™ mixers in combination with interstage filtering and proprietary DVGAs. The synergy of these technologies greatly benefit 2G/3G/4G MIMO and multi-carrier basestation receivers. The F159V completes the new lineup as this dual path RF Transmitter IC includes a quadrature modulator, voltage variable attenuator, digital step attenuator and fixed gain amplifier on each signal path.

Part Number	Description	Frequency (GHz)	Gain (dB)	OP1dB(dBm)	OIP3 (dBm)	Voltage (V)	Current (mA)	Package (mm)
F0502	Dual Path Rx IC	0.6 – 1.0	28.2	20.2	44	4.75 – 5.25	480	10 x 10, 68-QFN
F0552	Dual Path Rx IC	1.7 – 2.0	28	19.5	46	4.75 – 5.25	455	10 x 10, 68-QFN
F0562	Dual Path Rx IC	2.3 – 2.7	29	19.8	44	4.75 – 5.25	390	10 x 10, 68-QFN
F159V	Dual Path Tx IC	0.45 – 2.8	18.3	14	31	3.3	685	10 x 10, 68-QFN

## RF Switches

The ever-increasing demand for more data at higher throughput continues to drive the evolution of systems standards and require RF components with much higher performance that will improve a system's SNR to increase data rates and throughput. Renesas continues to expand its RF switches portfolio with industry leading performance to address these evolving needs. Many switches feature very low insertion loss, high input IP3 performance, and Kz constant impedance technology. High-isolation switches feature wide frequency bandwidth and an extended operating temperature range designed for high-reliability applications.

Part Number	Description	Frequency (GHz)	Type	IL (dB)	IP0.1dB (dBm)	IP1dB (dBm)	IIP3 (dBm)	Voltage (V)	Current (mA)	Package (mm)
F2910	SPST	0.03 – 8	Absorptive	0.55	34	35	67	3.3	0.19	2 x 2, 8-Pin
F2911	SPST 75Ω	0.001 – 3.5	Absorptive	0.33	33	34	64	3.3	0.19	2 x 2, 8-Pin
F2912	SPDT	0.000009 – 9	Absorptive	0.4	–	30	66	3.3	0.02	4 x 4, 20-Pin
F2913	SPDT	0.05 – 6	Absorptive	0.79	–	36	65	3.3	0.09	4 x 4, 20-Pin
F2914	SP4T	0.05 – 8	Absorptive	1.1	35	–	60	3.3	0.29	4 x 4, 24-Pin
F2915	SP5T	0.05 – 8	Absorptive	1.1	35	36.5	60.5	3.3	0.29	4 x 4, 24-Pin
F2923	SPDT	0.0003 – 8	Absorptive	0.48	–	32	66	3.3	0.127	4 x 4, 20-Pin
F2932	SPDT	0.05 – 8	Absorptive	0.79	32.3	36.5	64	5	0.26	4 x 4, 16-Pin
F2933	SPDT	0.05 – 8	Absorptive	0.79	32.3	36.5	64	5	0.26	4 x 4, 16-Pin
F2934	SPDT	0.05 – 8	Absorptive	0.79	32.3	36.5	64	5	0.26	3 x 3, 16-Pin
F2955	SPDT	0.05 – 8	Absorptive	1.1	35	36.5	60.5	3.3	0.29	4 x 4, 24-Pin
F2970	SPDT 75Ω	0.005 – 3	Absorptive	0.32	–	32	63	3	0.02	4 x 4, 20-Pin
F2971	SPDT 75Ω	0.005 – 3	Absorptive	0.31	–	32	67	3	0.02	4 x 4, 20-Pin
F2972	SPDT	0.005 – 10	Reflective	0.4	40	–	77	3.3	0.08	2 x 2, 12-Pin
F2976	SPDT	0.005 – 10	Reflective	0.4	40	–	77	3.3	0.08	2 x 2, 12-Pin
F2977	SPDT	0.03 – 6	Reflective	0.38	40	–	77	3.3	0.08	2 x 2, 12-Pin

## RF Mixers

Renesas' RF mixers feature patented Zero-Distortion™ technology which dramatically improves the maximum signal levels (IM3 tones) that a receiver can withstand at a desired SNR. These devices are scalable, so one can run the devices in modes that significantly reduce power consumption while still maintaining high linearity. The active mixers have excellent out-of-band spur performance which eases pre-filtering requirements. RF and LO baluns are internal allowing for simple 50Ω interfaces. The IF ports are configured as differential 200Ω to drive pre-ADC filters with low even-order distortion.

Part Number	Description	RF Freq. (GHz)	LO Freq. (GHz)	IF Freq. (GHz)	Gain (dB)	IP1dB (dBm)	OIP3 (dBm)	Voltage (V)	Current (mA)	Package (mm)
F1100	RF to IF Dual	0.698 – 0.915	0.848 – 1.365	0.15 – 0.45	9	13.1	41	5	350	6 x 6, 36-Pin
F1102	RF to IF Dual	0.4 – 1	0.5 – 1.15	0.05 – 0.3	9.2	12.5	43	5	330	6 x 6, 36-Pin
F1130	RF to IF Dual	0.4 – 1.1	0.5 – 1.13	0.03 – 0.40	9.0	9.0	43	5	360	7 x 7, 48-Pin
F1150	RF to IF Dual	1.7 – 2.2	1.8 – 2.65	0.05 – 0.45	8.5	13	40	5	335	6 x 6, 36-Pin
F1152	RF to IF Dual	1.4 – 2.2	1.35 – 2.1	0.05 – 0.35	8.5	13.2	43	5	327	6 x 6, 36-Pin
F1162	RF to IF Dual	2.3 – 2.7	1.8 – 2.9	0.05 – 0.5	8.9	13	43	5	330	6 x 6, 36-Pin
F1178	RF to IF Dual	3.4 – 3.8	2.9 – 3.62	0.05 – 0.5	9	11	37.5	5	297	6 x 6, 36-Pin
F1180	RF to IF Dual	1.4 – 2.7	1.35 – 2.90	0.03 – 0.55	8.2	9	38	5	365	7 x 7, 48-Pin
F1192B	Dual Wideband Gain-Settable	0.4 – 3.8	0.4 – 3.6	0.05 – 0.6	11.1	7	35	3.3	240	4 x 4, 24-Pin
F1701	RF to IF Single	0.6 – 1.06	0.63 – 1.26	0.07 – 0.3	11.8	10.2	43	5	184	5 x 5, 20-Pin
F1751	RF to IF Single	1.4 – 2.5	1.4 – 2.5	0.05 – 0.5	11.8	9.7	43	5	190	5 x 5, 20-Pin
F1763	RF to IF Single	2 – 2.9	1.8 – 3	0.05 – 0.5	11.7	10.2	42	5	200	5 x 5, 20-Pin
F1792	Single Wideband Gain-Settable	0.4 – 3.8	0.4 – 3.6	0.05 – 0.6	11.1	7	35	3.3	134	4 x 4, 24-Pin

## Modulators / Demodulators

Renesas' Zero-Distortion™ and Glitch-Free™ pin-compatible IQ demodulators offer excellent IM3 performance and ultra-low-power consumption while at the same time resulting in less than 0.5dB overshoot ringing during MSB gain transitions. Similarly, Renesas' Zero-Distortion IQ modulators provide very high IP3 and IP2 performance resulting in superb ACLR performance compared to other devices.

### Demodulators

Part Number	Description	RF Freq. (GHz)	LO Freq. (GHz)	IF Freq. (GHz)	Gain (dB)	Max Att. (dB)	OIP3 (dBm)	Voltage (V)	Current (mA)	Package (mm)
F1320	DPD for PA Linearization	0.55 – 1.15	0.5 – 1.3	0.02 – 0.035	12.5	25.5	43	5	262	6 x 6, 36-Pin
F1350	DPD for PA Linearization	1.30 – 2.90	1.40 – 2.90	0.02 – 0.500	12.5	25.5	41	5	275	6 x 6, 36-Pin
F1358	DPD for PA Linearization	3.2 – 4	3.1 – 3.8	0.02 – 0.5	10.2	25.5	41	5	216	6 x 6, 36-Pin
F1385	DPD for PA Linearization	3.2 – 4.4	2.85 – 4.05	0.02 – 0.5	18	25.5	39	5	210	6 x 6, 36-Pin
F1375	DPD for PA Linearization	1.3 – 2.9	1.3 – 2.9	0.02 – 0.5	9	25.5	40	5	270	6 x 6, 36-Pin

### Modulators

Part Number	Description	RF Freq. (GHz)	LO Freq. (GHz)	BB Freq. (GHz)	Gain (dB)	OP1dB (dBm)	OIP3 (dBm)	Voltage (V)	Current (mA)	Package (mm)
F1653	ZIF / CIF	0.6 – 2.9	0.6 – 2.9	0 – 0.6	3	15	36	3.3	178	4 x 4, 24-Pin

## RF and Microwave PLL / Synthesizers

Renesas RF and microwave PLLs integrate voltage-controlled oscillators (VCOs) offering leading performance and an octave of frequency tuning range for multi-band local oscillator (LO) frequency synthesis up to 18 GHz. The wideband capability of these devices makes them ideal for applications where multiple frequencies are used or for reuse in different high-performance applications. Renesas RF PLLs offer low phase noise variation in temperature and operate up to 105°C case temperature, reducing the thermal constraints for the application.

Part Number	Description	Grade	Input Frequency Range (GHz)	VCO Frequency Range (GHz)	Output Frequency Range (GHz)	FOM (dBc / Hz)	Max Output Power (dBm)	Package (mm)
8V97003	Wideband 18 GHz RF and microwave synthesizer	5G	0.01 – 1.6	5.5 – 11	0.172 – 18	-236 (Integer) -231 (Fractional)	+14	7x7, 48-Pin
8V97051L	Low-power wideband fractional RF synthesizer	GSM900	0.005 – .31	2.2 – 4.4	0.034 – 4.4	-231	+7	5x5, 32-Pin
8V97053L	High-performance wideband fractional RF synthesizer / PLL	GSM1800	0.005 – .31	2.2 – 4.4	0.034 – 4.4	-231	+7	5x5, 32-Pin

## Beamforming ICs and LNAs

Renesas' phased array beamforming ICs enable cost-effective, next generation system solutions for mmWave 5G, Satcom, and radar applications. Each beamforming IC contains multiple independently controlled active channels for element-level beam pattern shaping in electronically scanned array antennas (ESAs). The compact ICs are available in chip-scale BGA packages to enable very low profile and small form factor phased array antennas with  $\lambda / 2$  element spacing. The ICs are available as transmit-only (Tx), receive-only (Rx), or transmit / receive (TRx) variants covering 5G mmWave, Satcom and radar frequency bands. Renesas' beamformer product line is rapidly expanding to keep up with the growing commercial demand for affordable phased array antennas.

### TRx Active Beamforming ICs for 5G mmWave

Part Number	Description	Frequency (GHz)	Tx Gain (dB)	Tx OP1dB (dBm)	RX Gain (dB) <sup>1</sup>	RX NF (dB)	Rx IP1dB (dBm)	Voltage (V)	Package (mm)
F5268	4T4R DP 26 GHz	24.25 – 27.5	28	21	19	4.3	–28	2.3 – 2.7	5.1 x 5.1, 118-BGA
F5280	4T4R SP 28 GHz	26.5 – 29.5	27	13	22	5.5	–30	2.3 – 2.7	3.6 x 3.6, 49-BGA
F5288	4T4R DP 28 GHz	26.5 – 29.5	28	21	19	4.4	–28	2.3 – 2.7	5.1 x 5.1, 118-BGA

<sup>1</sup>Single-path gain (SPG): RX gain is measured from single antenna port to common output port (SPG). Electronic gain can be calculated by adding back the division loss to SPG.

### Up / Downconverters for 5G mmWave

Part Number	Description	RF Freq. (GHz)	IF Freq. (GHz)	RX Gain (dB)	RX NF (dB)	TX Gain (dB)	OP1dB (dBm)	Voltage (V)	Package (mm)
F5728	1T1R Up/Down Converter	24.25 – 29.5	2 – 7	23	7	29	16	2.3 – 2.7	4 x 4, 49-BGA

### Rx Dual-Beam Active Beamforming ICs for Satcom / Radar

Part Number	Description	Frequency (GHz)	Electronic Gain (dB)	Voltage (V)	Package (mm)
F6121	16-channel Ku–Band	10.7 – 12.75	11	2.1 – 2.5	3.8 x 4.6, 63-BGA
F6123	16-channel Ku / CDL–Band	14.4 – 17.3	11	2.1 – 2.5	3.8 x 4.6, 63-BGA
F6212	16-channel Ka–Band	17.7 – 21.2	27	2.1 – 2.5, 0.95 – 1.05	7.6 x 7.6, 165-BGA

### Tx Active Beamforming ICs for Satcom / Radar

Part Number	Description	Frequency (GHz)	Gain (dB)	OP1dB (dBm)	Voltage (V)	Package (mm)
F6521	8–ch Tx Ku–Band	13.75 – 14.5	25	10.5	2.1 – 2.5	3.8 x 4.6, 62-BGA
F6522	8–ch Ka–Band	27.5 – 31.0	28	11	2.1 – 2.5	3.8 x 4.6, 62-BGA
F6513	8–ch Ku / CDL–Band	14.4 – 17.3	23	12.5	2.1 – 2.5	3.8 x 4.6, 62-BGA

### Low Noise Amplifiers for Satcom / Radar

Part Number	Description	Frequency (GHz)	Gain (dB)	OP1dB (dBm)	Voltage (V)	Current (mA)	Package (mm)
F6921	Dual–ch LNA, Ku–Band Satcom	10.7 – 12.75	19	–5	0.95 – 1.05	15	2.7 x 2.7, 23-BGA
F6922	Dual–ch LNA, Ka–Band Satcom	17.7 – 21.2	19	–3	0.95 – 1.05	20	2.7 x 2.7, 23-BGA
F6923	Dual–Ch LNA, Ku / CDL–Band	14.4 – 17.3	19	–2	0.95 – 1.05	20	2.7 x 2.7, 23-BGA

Visit [idt.com/rf](http://idt.com/rf) for more details on the complete portfolio of RF products, including datasheets, eval boards and samples.



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