RF ICs

Contents

Visit our new website for data sheets, samples, and additional resources.

Low Power, Small Packaging, High Dynamic Range: Our Newest Gain Block Amplifier Devices

The addition of RF/IF amplifier products to our RF IC portfolio means that designers can now source their complete RF signal chain from the most trusted IC supplier in the industry, Analog Devices. And the latest additions to that portfolio give options for high dynamic range without the normal accompanying power consumption or larger packaging.

For RF/IF amplification, the ADL5601 and ADL5602 are ideal gain block amplifiers; for IF amplification, the ADL5535 and ADL5536 provide the highest dynamic range available from internally matched SOT-89 gain blocks. This functionality is accomplished by providing extremely low noise figures and very high OIP3 specifications simultaneously across their entire frequency ranges.

The low noise and high linearity specifications of the ADL5534 dual IFA make it an excellent fixed gain ADC driver, as shown in the Circuits from the Lab™ circuit note CN-0049, which can be found at *www.analog.com/CN0049*.

Visit *www.analog.com/rfamps* for info on the entire amplifier family.

IF Gain Blocks

Part Number	Frequency Range (MHz)	Gain (dB)	Output IP3 (dBm)	Noise Figure (dB)	Supply Current (mA)	Price ($U.S.)
ADL5530*	DC to 1000	16.8	37.0	3.0	110	1.58
ADL5531	20 to 500	20.9	41.0	2.5	100	1.67
ADL5534 (Dual)	20 to 500	21.0	40.4	2.5	98	3.00
ADL5535	20 to 1000	16.1	45.5	3.2	97	1.75
ADL5536	20 to 1000	19.4	49.0	2.7	107	1.75

*3 V bias is also supported.

RF/IF Gain Blocks

Part Number	Frequency Range (MHz)	Gain (dB)	Output IP3 (dBm)	Noise Figure (dB)	Supply Current (mA)	Price ($U.S.)
AD8353*	1 to 2700	19.8	23.6	5.3	41	0.49
AD8354*	1 to 2700	19.5	19.0	4.2	23	0.49
ADL5541	50 to 6000	15.0	44.0	3.5	90	1.67
ADL5542	50 to 6000	19.5	46.0	2.8	93	1.67
ADL5601	50 to 4000	15.3	43.8	3.7	85	1.75
ADL5602	50 to 4000	19.5	42.0	3.3	89	1.75

*3 V bias is also supported.

Fractional-N PLL Generates Highly Linear Ramp for FMCW Radar

Widespread deployment of FMCW radar systems has been retarded by both the technical difficulty of generating a highly linear ramp and problems in finding high performance, easy to use, cost-effective solutions to build the technology. Analog Devices has addressed these challenges with the introduction of the new ADF4158, a 6.1 GHz, 25-bit modulus programmable fractional-N PLL. Since a 25-bit modulus can allow sub-Hz output frequency resolution, a FMCW ramp can be achieved by reprogramming the fractional-N divide ratio on the ADF4158—thereby producing a low cost, highly linear FMCW ramp function that is independent of VCO linearity. Adopting this approach shortens design cycle times and time to market while simplifying BOM structures and production logistics.

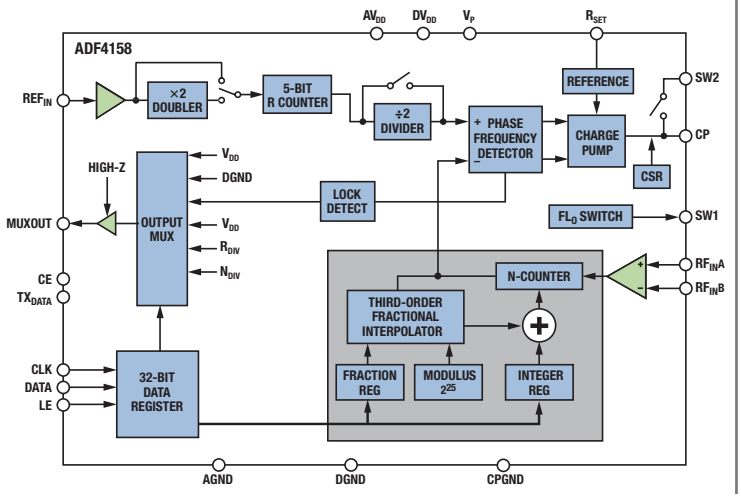
Solution

The ADF4158 is a 6.1 GHz fractional-N frequency synthesizer with modulation and waveform generation capability. It consists of a low noise digital phase frequency detector (PFD), precision charge pump, and programmable reference divider. There is a Σ-Δ based fractional interpolator to allow programmable fractional-N division. The INT and FRAC registers define an overall N divider: $N = INT + (FRAC/2^{25})$. The ADF4158 can be used to implement frequency shift keying (FSK) and phase shift keying (PSK) modulation. There are also a number of frequency sweep modes available, which generate various waveforms in the frequency domain, for example, sawtooth and triangular waveforms. The ADF4158 features cycle slip reduction circuitry, which leads to faster lock times without the need for modifications to the loop filter. With exceptional RF performance, feature rich functionality, and unsurpassed flexibility, all in a single, fully integrated 24-lead, 4 mm × 4 mm LFCSP, the ADF4158 is indeed a highly attractive solution for FMCW radar generation.

ADF4158 Features

- RF bandwidth to 6.1 GHz
- 25-bit fixed modulus allows sub-Hz frequency resolution
- Frequency and phase modulation capability
- Sawtooth and triangular waveforms in the frequency domain
- Parabolic ramp
- Ramp superimposed with FSK
- Ramp with two different sweep rates
- Ramp delay
- Ramp frequency readback
- Ramp interruption
- 2.7 V to 3.3 V power supply
- Separate V_P allows extended tuning voltage
- Programmable charge pump currents
- $4.88 (1k quantity)
- $4.14 (10k quantity)

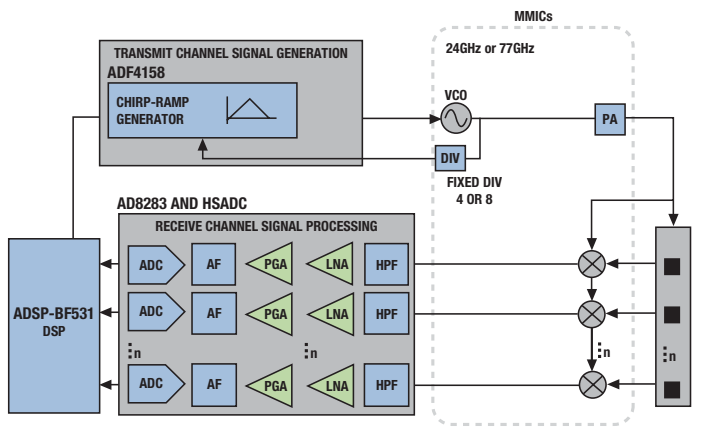
Block Diagram of ADF4158



Applications

- FMCW radar
- Communications test equipment

Block Diagram of a Typical 24 GHz/77 GHz FMCW Radar System



Web-Based Tools

The ADF4158 is fully characterized within ADIsimPLL,™ Analog Devices' industry-leading PLL design and simulation software. Download a free copy at *www.analog.com/adisimpll*.

Low Power, 18 GHz RF Prescaler Family Enables Cost-Effective Phase-Locked Signal Generation

The traditional approach to generate programmable phase-locked signals uses a VCO and PLL IC in the classical phase-locked loop configuration. In applications where the input range of the PLL IC is below the maximum input frequency of the PLL, it is relatively easy to generate the output phase-locked signal. However, in applications where the VCO frequency is significantly higher than the PLL IC input range, a RF prescaler is necessary to divide the VCO signal down in frequency to the input range of the PLL IC. In essence, the RF divider extends the effective input range of the PLL IC, allowing it to phase lock a VCO at much higher frequencies. Many microwave applications require low cost solutions extending up to 18 GHz for VSAT and point-to-point applications. An RF prescaler's function is, therefore, essential in these types of systems.

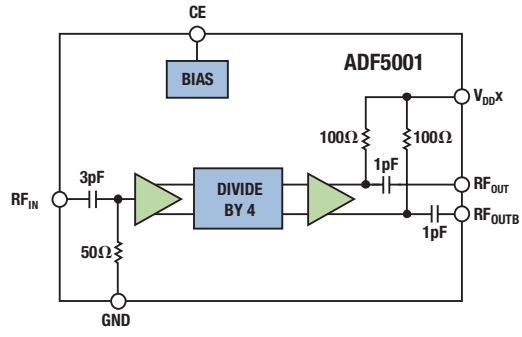
Solution

ADI's new ADF500x family of low power, fixed divide ratio prescalers operates up to 18 GHz. The family consists of the ADF5000, ADF5001, and ADF5002, which offer divide by 2, 4, and 8 functionality, respectively. All three parts operate off a 3.3 V supply and have differential 100 Ω RF outputs to allow direct interface to the differential RF inputs of PLLs, such as the ADF4156 and ADF4106. With current draw typically 32 mA, ADF500x RF prescalers consume half the power of alternatives, and single sideband phase noise of –150 dBc/Hz is achieved. The ADF5000, ADF5001, and ADF5002 prescalers are capable of operation up to 105°C and are available in small 3 mm × 3 mm LFCSP.

Features

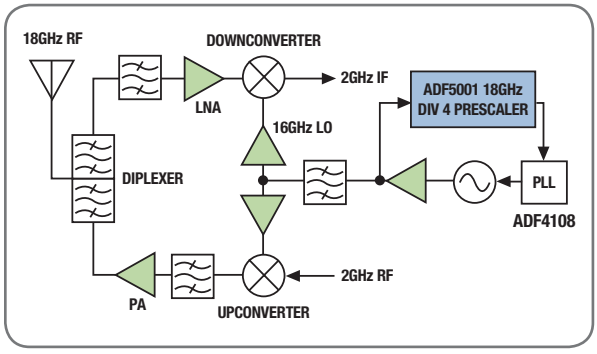
- High frequency operation: 4 GHz to 18 GHz
- Integrated RF decoupling capacitors
- Low power consumption active mode: 32 mA; power-down mode: 7 mA
- Single dc supply: 3.3 V compatible with ADF4xxx PLLs
- Temperature range: –40°C to +105°C
- ADF5001: $6.97 (10k quantity)

Functional Block Diagram



Applications

- Point-to-point radios
- VSAT radios
- Communications test equipment



ADF5001 used in conjunction with ADF4108 integer-N PLL where LO generation is required at 16 GHz.

Web-Based Tools

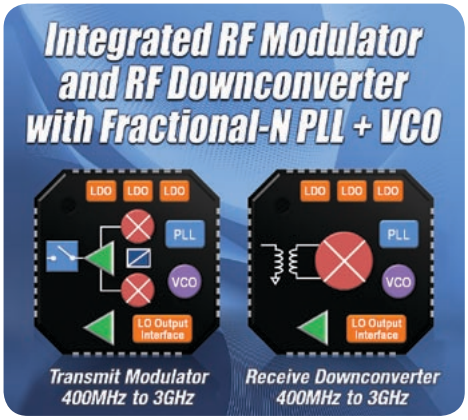
The ADF5000, ADF5001, and ADF5002 are fully characterized within ADIsimPLL, Analog Devices' industry-leading PLL design and simulation software. Download a free copy at *www.analog.com/adisimpll*.

Integrated RF ICs for Wireless Network Infrastructure

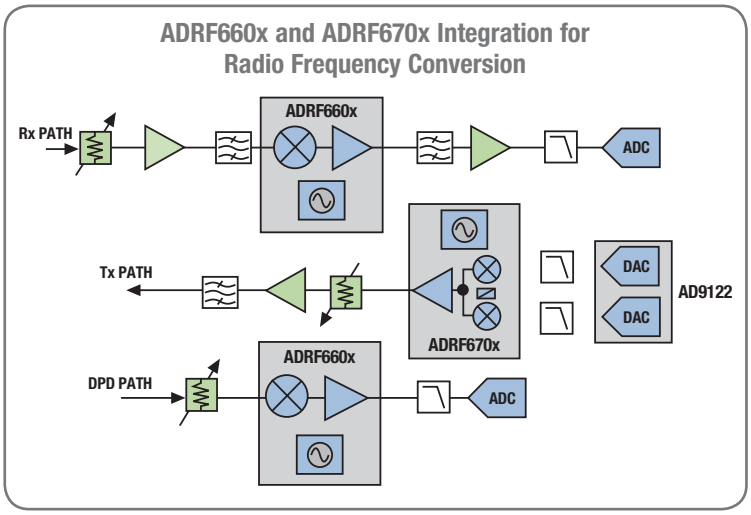
Integration of wireless communications infrastructure radio transceiver cards provides many challenges as, until now, standalone discrete devices were required for optimum performance across many different process technologies. For example, the radio receiver downconversion stage is often implemented and designed with discrete SiGe mixers, GaAs IF and LO amplifiers, CMOS PLL, and discrete or GaAs VCOs—thus, matching process technology for optimum performance.

Analog Devices' new SiGe BiCMOS RF ICs are highly integrated frequency translation devices that deliver optimum performance on a single chip. The new ADRF660x and ADRF670x series of RF downconverters and I/Q upconverters integrate the entire frequency conversion stage in one compact RF IC and offer performance that, until now, could only be attainable through discrete circuit implementations.

The ADRF660x active mixers and ADRF670x modulators offer the highest linearity IP3 specifications and signal power levels required by demanding multicarrier, multistandard radio transceivers. The ADRF6655 is a flexible broadband up/downconversion solution, and the ADRF6750 further integrates a wide dynamic range digital step attenuator. ADI's new family of integrated RF ICs further minimizes external components through integrated on-chip LDO regulators, helping to deliver a low phase noise LO from the on-chip VCOs. The generated LO is also made available to drive additional stages that can be useful for multichannel platforms and applications.



Fully integrated RF upconversion (ADRF670x) and downconversion (ADRF660x) RF ICs for next generation wireless base station radio cards.



Integrated RF ICs

Part Number	Function	Frequency Range (MHz)	Price ($U.S.)
ADRF6601	Downconverter with PLL + VCO	450 to 1600	8.98*
ADRF6602	Downconverter with PLL + VCO	1350 to 2750	8.98*
ADRF6603	Downconverter with PLL + VCO	1450 to 2850	8.98*
ADRF6604	Downconverter with PLL + VCO	1600 to 3250	8.98*
ADRF6655	Up/downconverter with PLL + VCO	IF to 2500	8.98
ADRF6701	I/Q modulator with PLL + VCO	550 to 1000	9.98*
ADRF6702	I/Q modulator with PLL + VCO	1550 to 2200	9.98*
ADRF6703	I/Q modulator with PLL + VCO	1900 to 2450	9.98*
ADRF6704	I/Q modulator with PLL + VCO	2400 to 2800	9.98*
ADRF6750	I/Q modulator with PLL + VCO and attenuator	950 to 1575	9.98

*Price shown in 10k quantity.

High Linearity Mixers Enable RF Design with High Dynamic Range and Low Noise Requirements

Designing a mixer application that requires high linearity and low noise has always been a challenge. Existing mixer solutions often require external components such as baluns and amplifiers, which add complexity to the design. The recently announced ADL5353 and ADL5354 integrated passive mixers will lessen design complexity, offer best-in-class performance, and extend the frequency coverage of mixer products from Analog Devices.

The ADL5353 and ADL5354 are narrow-band mixers designed to operate with an RF input frequency from 2300 MHz to 2900 MHz. The single channel ADL5353 and dual channel ADL5354 offer the highest level of integration including an RF balun, LO switch for dual LO frequency applications, LO driver, and integrated IF amplifier. The balun integration enables the RF signal to be driven single-ended, and the integrated IF amplifier provides gain and eliminates the need for an external component. Both the ADL5353 and ADL5354 provide best-in-class input IP3 and noise figure performance resulting in excellent spurious-free dynamic range. These mixers also offer the best-in-class noise figure under blocker signal performance. High spurious-free dynamic range and low noise figure under blocker performance will enable the mixer to be used in applications where the receiver will be operating in the presence of large interfering signals.

The passive single and dual channel mixers are designed to operate over a 3.3 V to 5 V supply voltage range, are manufactured on an advanced SiGe bipolar process, and provide 1500 V HBM ESD protection, thereby simplifying handling procedures as compared to sensitive GaAs mixers.

Single Channel Passive Mixers with Integrated IF Amplifier

Part Number	RF Frequency (MHz)	LO Frequency (MHz)	Conversion Gain (dB)	Input IP3 (dBm)	Noise Figure (dB)	P1dB (dBm)	Price ($U.S.)
ADL5353	2300 to 2900	2330 to 3350	8.5	25	9.9	10.6	6.98
ADL5355	1200 to 2500	1230 to 2470	8.4	27	9.2	10	6.98
ADL5357	500 to 1700	730 to 1670	8.6	26.6	9.1	10.2	6.98

Single Channel Passive Mixers

Part Number	RF Frequency (MHz)	LO Frequency (MHz)	Conversion Gain (dB)	Input IP3 (dBm)	Noise Figure (dB)	P1dB (dBm)	Price ($U.S.)
ADL5365	1200 to 2500	1300 to 2300	–7.3	36	7.3	25	5.99
ADL5367	500 to 1700	700 to 1700	–7.3	34	7.3	25	5.99

Dual Channel Passive Mixers with Integrated IF Amplifier

Part Number	RF Frequency (MHz)	LO Frequency (MHz)	Conversion Gain (dB)	Input IP3 (dBm)	Noise Figure (dB)	P1dB (dBm)	Price ($U.S.)
ADL5354	2300 to 2900	1850 to 2870	8.5	25	9.9	10.6	9.98
ADL5356	1200 to 2500	1230 to 2470	8.2	31	9.9	11	9.98
ADL5358	500 to 1700	730 to 1670	8.3	25.2	9.9	10.6	9.98

Evaluation boards are available to allow users to configure and test the device.

Design RF Systems in Less Time with Free Tool Downloads

The development of RF systems has never been easier with design tools from Analog Devices. Get assistance for the entire RF signal chain with ADIsimRF.™ Reduce design iterations with ADIsimPLL.™ Optimize short-range systems in no time with ADIsimSRD Design Studio.™ Visit *www.analog.com/rftools* for more information.

RMS Power Detector Offers Communications Customers Best-In-Class Power Management Accuracy for 3G and 4G Mobile Terminals

Applications requiring power transmission are dramatically affected by even the smallest margin of RF power transmission error. Without accurate RF power management, it is impossible to ensure that transmitted RF power meets regulatory compliance. In mobile wireless systems, reducing current consumption is pivotal to maximize battery life. Given a ±1 dB transmitted RF power uncertainty, the additional current expended by the power amplifier can exceed 27% and drain battery rapidly. RF power management becomes more difficult with the advent of more complex modulations, such as long-term evaluation (LTE), which add to the uncertainty of power measurement techniques.

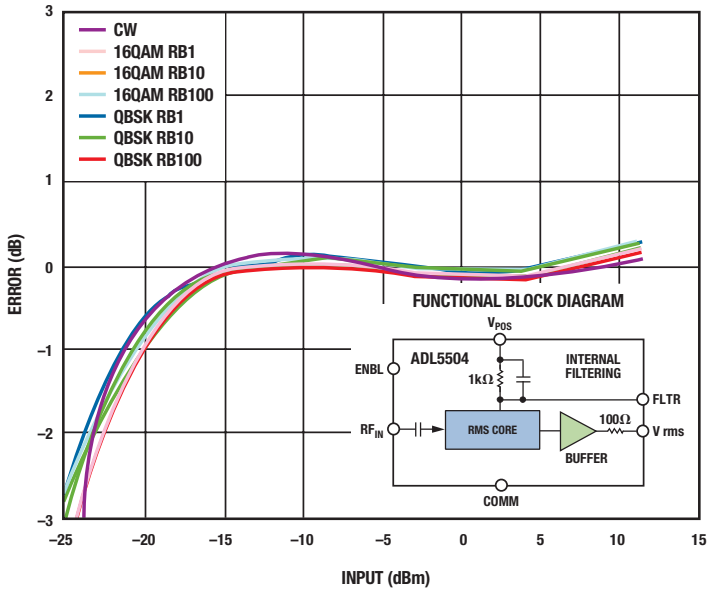
Solution

The ADL5504 is the newest member of the industry-leading TruPwr™ RF power detector product family. The ADL5504 is a highly accurate, easy to use means of determining the root mean square (rms) power of complex waveforms. It can be used for power measurements of both simple and complex waveforms and is particularly useful for measuring high crest factor (high peak-to-rms ratio) signals, such as W-CDMA, CDMA2000, WiMAX, WLAN, and LTE waveforms. The temperature stability and waveform independence of the device offer best-in-class accuracy, significantly increasing efficiency, battery life, and signal quality. It is the ideal device for 3G and 4G mobile terminals.

Features

- True rms response detector
- Best-in-class waveform independence
- Excellent temperature stability
- ±0.25 dB rms detection accuracy vs. temperature
- Over 35 dB input power dynamic range, inclusive of crest factor
- RF bandwidths from 450 MHz to 6000 MHz
- Single-supply operation: 2.5 V to 3.3 V
- Low power: 1.8 mA at 3.0 V supply
- Tiny 0.8 mm × 1.2 mm WLCSP
- $3.00 (1k quantity)

Best-in-Class Waveform Independence and Temperature Stability for 3G and 4G Mobile Terminals



Applications

- Power measurement of W-CDMA, CDMA2000, QPSK-/QAM-based OFDM (LTE and WiMAX)
- Other complex modulation waveforms
- RF transmitter or receiver power measurement

Free Webcast Available on Demand

"Differential Circuit Design Techniques": One of the major challenges in communications system design is successfully capturing signals with adequate fidelity. Of course, strict standard specifications call for proper interface topology selection. In this webcast, we will explore the advantages of differential design techniques and how their performance benefits affect the stringent system requirements of today's high performance communications systems. In addition, we will review RF definitions, provide a basic overview of system budgeting, and contrast different implementations. View at *www.analog.com/diffcircuitwebinar*.

Wide Portfolio of RF Frequency Clock Buffers

Current and future generations of wireless communications infrastructures require a challenging combination of integration, flexibility, performance, small size, high frequencies, and lower cost, while also adding energy efficiency for recent green initiatives. These requirements challenge clock vendors when they want to offer all of them at the same time.

The ADCLK9xx series is a family of ultrafast clock/data buffers fabricated on Analog Devices' proprietary complementary bipolar (XFCB-3) silicon-germanium (SiGe) process, which answers the demanding requirements above by providing a wide choice of fanout capability for flexibility, between one and 12 copies of an input clock, and up to 7.5 GHz toggle rate. They provide ECL/LVPECL outputs with a wideband rms jitter down to 50 fs to 75 fs rms, from a large range of input types such as sine wave, LVPECL, LVDS, CML, or CMOS inputs. This family is available in tiny packages from a 3 mm × 3 mm, 16-lead LFCSP to a 6 mm × 6 mm, 40-lead LFCSP for the maximum fanout capability.

The ADCLK905/ADCLK907/ADCLK925 can provide 60 fs rms jitter and up to two copies of an input clock with an operation frequency up to 7.5 GHz, while being characterized on an extended temperature range of –40°C to +125°C. The ADCLK944 provides four ECL outputs with 50 fs rms jitter for frequencies up to 7 GHz; the ADCLK946/ADCLK948/ADCLK950/ADCLK954 provide between six and 12 copies of one or two inputs, while yielding a low jitter of 75 fs rms and low output skew of 9 ps typical. The ADCLK914 features high voltage differential signaling (HVDS) operating up to 7.5 GHz with 110 fs rms wideband rms jitter performance suitable for driving the latest Analog Devices high speed digital-to-analog converters (DACs).

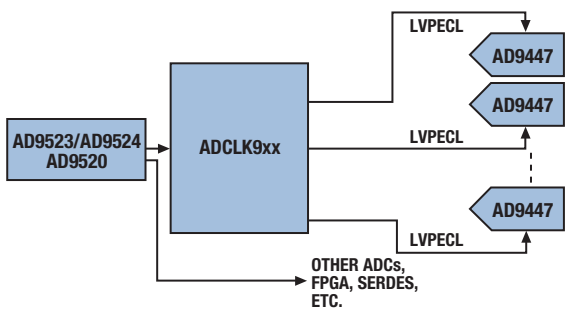
For clocking distribution requiring LVDS or CMOS, Analog Devices also offers the ADCLK8xx series of 1.2 GHz/250 MHz, LVDS/CMOS fanout buffers optimized for low jitter and low power operation, which provide between six and 12 LVDS outputs and up to 24 CMOS outputs. They yield low additive rms wideband jitter from 100 fs for CMOS outputs and from 150 fs for LVDS outputs. The ADCLK8xx series of clock fanout buffers offers power consumption less than 16 mW per channel (100 MHz operation).

By delivering best-in-class jitter and flexible fanout capability at high frequencies, these products serve a large range of clocking requirements in a variety of wireless and RF infrastructure applications. For additional information, please click on *www.analog.com/clock-and-timing*. ADIsimCLK, the user friendly design and simulation tool, is readily available to clock and timing engineers in order to develop fast to market applications. Download for free at *www.analog.com/ADIsimCLK*.

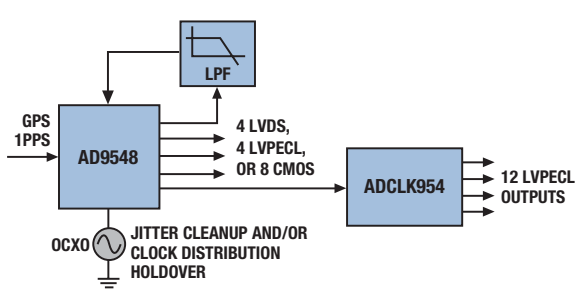
Part Number	Input/ Output	Logic		Toggle Rate	RMS Jitter (ps)	Typical Output to Output Skew (ps)	Division Capability
		Input	Output				
AD9512/AD9513/ AD9514/AD9515	1 or 2 to 2*/3*/5*	Differential	LVDS/ CMOS	800 MHz LVDS/ 250 MHz CMOS	0.3	N/A	Yes (32 bits)
ADCLK905/ADCLK907	1 to 1, dual 1 to 1	Differential or single-ended	LVPECL	7.5 GHz	0.06	N/A	No
ADCLK925	1 to 2	Differential or single-ended	LVPECL	7.5 GHz	0.06	9	No
ADCLK944	1 to 4	Differential	LVPECL	7 GHz	0.05	9	No
ADCLK946/ADCLK948/ ADCLK950/ADCLK954	1 or 2 to 6/8/10/12	LVPECL/CML/ CMOS/LVDS	LVPECL	4.8 GHz	0.075	9	No
ADCLK914	1 to 1	LVPECL/CML/ CMOS/LVTTL/LVDS	HVDS	7.5 GHz	0.11	N/A	No
ADCLK846/ADCLK854	1 or 2 to 6*/8*	LVPECL/LVDS/HSTL/ CML/CMOS	LVDS/ CMOS	1.2 GHz LVDS/ 250 MHz CMOS	0.1	65	No

*Some differential channels may be configured as single-ended CMOS outputs, increasing the total number of output channels.

Converter Clocking for Base Stations



1PPS GPS-Referenced Clock Application



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ISM Band Transmitters and Transceivers Deliver Robust RF Performance for Short-Range Devices

Analog Devices' ADF7xxx series of transmitters and transceivers provides for low cost, robust, short-range wireless connections. Covering both licensed and unlicensed sub-1 GHz and 2.4 GHz frequency bands, these products feature excellent RF performance, low power consumption, and best-in-class blocking resistance, as well as high performance in terms of receive sensitivity, data rates, link robustness, and transmit power. These features make the ADF7xxx transmitters and transceivers ideal solutions for applications such as automatic meter reading (AMR), industrial automation, alarm and security systems, home automation systems, remote controls, and other wireless network and telemetry systems.

Analog Devices has recently expanded its portfolio with three new devices. The ADF7022 transceiver is available to io-homecontrol® members and includes layers 1 and 2 support for the io-homecontrol protocol stack, while the ADF7023 is a general-purpose FSK/GFSK sub-GHz transceiver supporting up to 300 kbps with flexible packet structures. The latest transceiver, the ADF7242, operates in the global 2.4 GHz ISM band and has been designed with emphasis on flexibility, ease of use, and low current consumption.

For a complete table of ADI's broad portfolio of short-range transceivers and transmitters, please visit *www.analog.com/srd*.

Web-Based Tools

The ADF7xxx transmitters and transceivers are supported by a wide range of evaluation boards, protocol software, and reference designs to allow the user to set up a radio link "straight out of the box." Furthermore, the popular ADIsimSRD™ design tool allows real-time simulation and optimization of many parameters in a typical short-range wireless system. Download your free copy at *www.analog.com/adisimsrd*.

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All prices in this bulletin are in USD in quantities greater than 1000 (unless otherwise noted), recommended lowest grade resale, FOB U.S.A.

I²C refers to a communications protocol originally developed by Philips Semiconductors (now NXP Semiconductors).

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