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High Speed ADC Products

High Performance Analog ICs

LINEAR TECHNOLOGY

High Speed ADC Products

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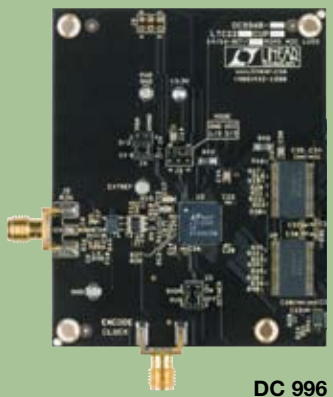
Lowest Power High Speed ADCs

Introduction

Our high speed ADCs offer the lowest power consumption and highest AC performance in the industry. They incorporate many unique features to ease system design and space constraints, including integrated bypass capacitance and integrated series resistance for 50ohm digital outputs. Each ADC family offers the ability to operate the digital output supply as low as 0.5V, helping to reduce digital feedback and allowing direct connection to low voltage digital interfaces.

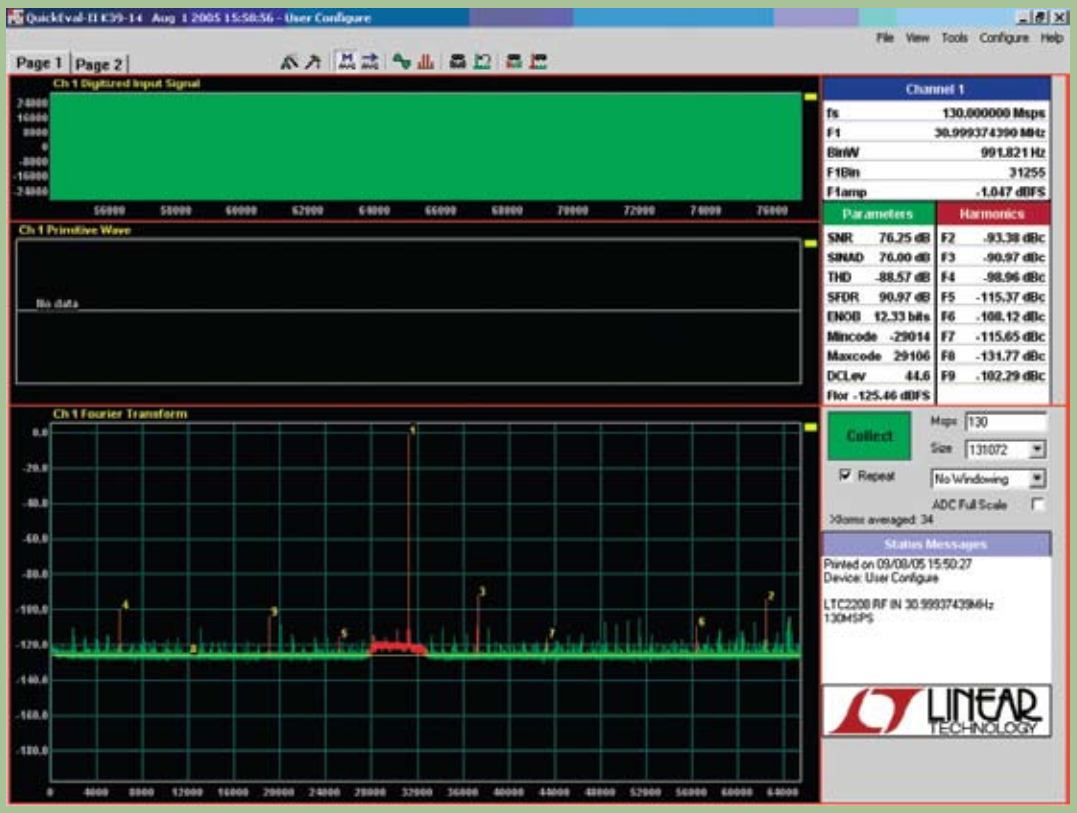
The entire ADC portfolio is supported with evaluation boards and a free Quick Eval-II PScope software tool that can be downloaded from our website at www.linear.com/company/software.jsp. The following tables provide a demo board selection guide for ADC evaluation.

DC 851



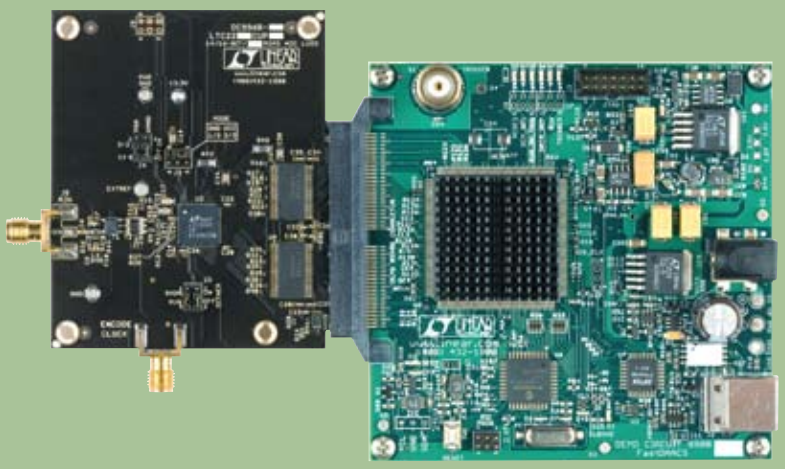
DC 996

DC 890



LTC2209 High Performance ADC Family

- Internal Transparent Dither
- Data Output Randomizer
- Single 3.3V Supply
- PGA Front End ($1.5V_{P-P}$ or $2.25V_{P-P}$)
- LVDS or CMOS Outputs
- Data Ready Output Clock
- Optional Clock Duty Cycle Stabilizer
- 64-pin 9mm × 9mm QFN Package



left: DC 996, right: DC 890

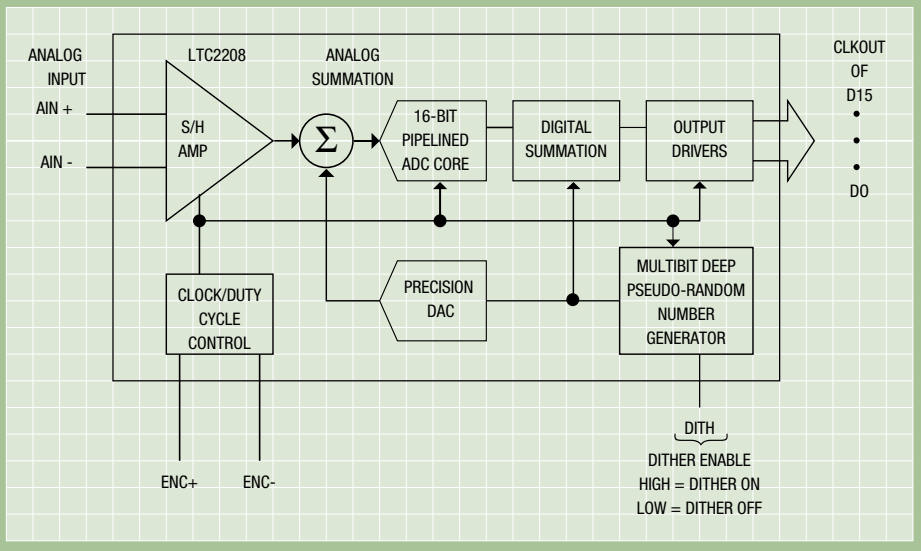
The LTC2209 is our highest performance ADC family, targeting the most demanding wideband, low noise, signal acquisition applications, while still offering the lowest power in the industry.

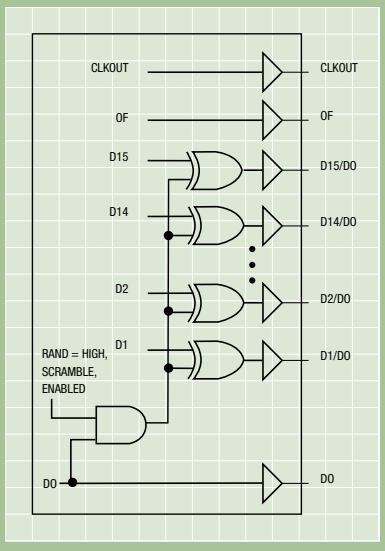
The LTC2209 and LTC2207 families incorporate two unique features that simplify digital receiver design and improve system performance. The first is an internal transparent dither circuit that improves the ADC's spurious free dynamic range (SFDR) response well beyond 100dBc for low level input signals. The second feature is a digital output randomizer that dramatically reduces unwanted tones caused by digital feedback.

The DC854D demo board family offers CMOS output evaluation, while DC996B is configured for LVDS outputs.

Applications: Software Defined Radio, Spectrum Analyzer, Oscilloscope, MRI, GPS, Avionics Instrumentation, Radar and Satellite Communications, Servowriter, CCD Tester, RFID, Disk Drive Tester, Radiography, RF Power Meter

Part Number	Resolution	Speed	SNR	SFDR	Full Power Bandwidth	Power Dissipation
LTC2209	16-Bit	160Msps	77.1dB	100dB	700MHz	1450mW
LTC2208	16-Bit	130Msps	77.7dB	100dB	700MHz	1250mW
LTC2209-14	14-Bit	160Msps	76.8dB	98dB	700MHz	1450mW
LTC2208-14	14-Bit	130Msps	77.1dB	98dB	700MHz	1320mW





LTC2207 High Performance ADC Family

- Internal Transparent Dither
- Data Output Randomizer
- Single 3.3V Supply
- PGA Front End
- CMOS Outputs
- Data Ready Output Clock
- Clock Duty Cycle Stabilizer
- 48-pin 7mm × 7mm QFN Package

left: DC 919, right: DC 718

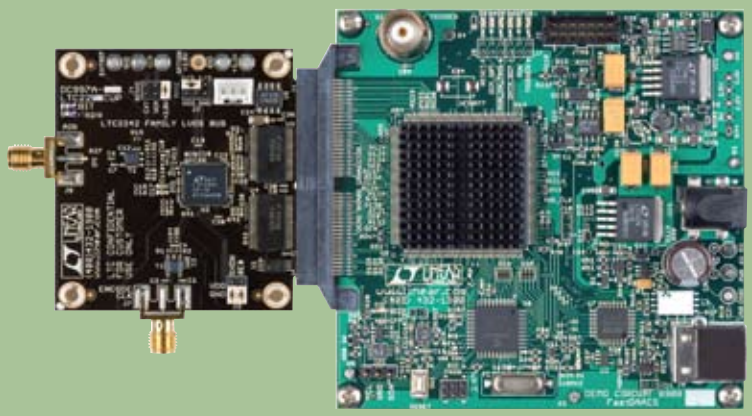
The LTC2202 through LTC2207 family of high speed ADCs use the DC718B USB board to interface between the demo board and a PC. Currently, two demo boards are available. The DC918C, with its AC-coupled analog inputs and differential clock input, targets the LTC2204 through the LTC2207. The DC919A offers the choice of DC- or AC-coupled analog inputs and has a single-ended clock input for the LTC2202/LTC2203. The LTC2205-LTC2207 ADCs can be evaluated using the DC-coupled DC919A, but the single-ended clock will slightly degrade performance.

Applications: Oscilloscope, MRI, IR and CCD Cameras, Bomb Detection, Spectroscopy, Disk Drive Tester

Part Number	Resolution	Speed	SNR	SFDR	Full Power Bandwidth	Power Dissipation
LTC2207	16-Bit	105Msps	77.9dB	100dB	700MHz	900mW
LTC2206	16-Bit	80Msps	77.9dB	100dB	700MHz	725mW
LTC2205	16-Bit	65Msps	79.0dB	100dB	700MHz	610mW
LTC2204	16-Bit	40Msps	79.1dB	100dB	700MHz	480mW
LTC2203	16-Bit	25Msps	81.6dB	100dB	380MHz	220mW
LTC2202	16-Bit	10Msps	81.6dB	100dB	380MHz	140mW
LTC2207-14	14-Bit	105Msps	77.3dB	98dB	700MHz	947mW
LTC2206-14	14-Bit	80Msps	77.3dB	98dB	700MHz	762mW
LTC2205-14	14-Bit	65Msps	78.3dB	98dB	700MHz	600mW

LTC2220-1 and LTC2242-12 High IF Sampling ADC Families

- Single 3.3V or 2.5V Supply
- LVDS or CMOS Outputs
- Data Ready Output Clock
- Selectable $1V_{P-P}$ or $2V_{P-P}$ Input Range
- Clock Duty Cycle Stabilizer
- 64-pin 9mm × 9mm QFN Package



left: DC 997, right: DC 890

The 3.3V LTC2220-1 family is pin-compatible with the 2.5V LTC2242-12 family of ADCs, sampling up to 250Msps at 12 bits. The LTC2242-12 offers higher sampling rates at lower power dissipation for multichannel applications. With a 1.2GHz full power bandwidth, undersampling at IFs as high as 1GHz are achievable. The CMOS outputs can be demultiplexed by a factor of two to reduce the data rate for data collection and processing in FPGAs.

Applications: Cable Headend Systems, CATV Return Path Digitizer, Power Amplifier Linearization, Data Acquisition, Disk Drive Tester, Multichannel Receivers, Radar and Jammers, GPS, High Definition Video, Laser Range Finders, Telemetry, Frequency Synthesizer, BTS Microwave Link, Wafer Defect Detection

Part Number	Resolution	Speed	SNR	SFDR	Full Power Bandwidth	Power Dissipation
LTC2220-1	12-Bit	185Msps	67.7dB	80dB	775MHz	910mW
LTC2220	12-Bit	170Msps	67.7dB	84dB	775MHz	890mW
LTC2221	12-Bit	135Msps	67.8dB	84dB	775MHz	660mW
LTC2230	10-Bit	170Msps	61.2dB	78dB	775MHz	890mW
LTC2231	10-Bit	135Msps	61.2dB	78dB	775MHz	660mW

Part Number	Resolution	Speed	SNR	SFDR	Full Power Bandwidth	Power Dissipation
LTC2242-12	12-Bit	250Msps	65.4dB	78dB	1.2GHz	740mW
LTC2241-12	12-Bit	210Msps	65.5dB	78dB	1.2GHz	585mW
LTC2240-12	12-Bit	170Msps	65.6dB	80dB	1.2GHz	445mW
LTC2242-10	10-Bit	250Msps	60.6dB	78dB	1.2GHz	740mW
LTC2241-10	10-Bit	210Msps	60.6dB	78dB	1.2GHz	585mW
LTC2240-10	10-Bit	170Msps	60.6dB	80dB	1.2GHz	445mW

LTC2224 High IF Sampling ADC Family

- Single 3.3V Supply
- CMOS Outputs
- Data Ready Output Clock
- Selectable $1V_{P-P}$ or $2V_{P-P}$ Input Range
- Clock Duty Cycle Stabilizer
- 48-pin 7mm × 7mm QFN Package

left: DC 751, right: DC 718

This high speed family is optimized for multicarrier wireless basestation transceiver applications for all major air interfaces including GSM, CDMA, WCDMA (UMTS), TD-SCDMA and WiMAX.

Applications: PA Linearization, WiMAX Radio, Satellite Communications, CATV Return Path, Wireless Modem, Flow and Jitter Meters, Missile Guidance System, Plasma Generator, DVD Equipment, Battery Monitor, Fiber Optic Gyro, Blood Analyzer, Digital Oscilloscope

Part Number	Resolution	Speed	SNR	SFDR	Full Power Bandwidth	Power Dissipation
LTC2224	12-Bit	135Msps	67.6dB	84dB	775MHz	630mW
LTC2222	12-Bit	105Msps	68.4dB	84dB	775MHz	475mW
LTC2223	12-Bit	80Msps	68.5dB	84dB	775MHz	366mW
LTC2222-11	11-Bit	105Msps	65.7dB	84dB	775MHz	475mW
LTC2234	10-Bit	135Msps	61.2dB	78dB	775MHz	630mW
LTC2232	10-Bit	105Msps	61.3dB	78dB	775MHz	475mW
LTC2233	10-Bit	80Msps	61.3dB	78dB	775MHz	366mW

LTC2255 Lowest Power ADC Family

- Single 3V Supply
- CMOS Outputs
- Single-Ended Clock Input
- Selectable $1V_{P-P}$ or $2V_{P-P}$ Input Range
- Clock Duty Cycle Stabilizer
- 32-pin 5mm × 5mm QFN Package

left: DC 782, right: DC 718

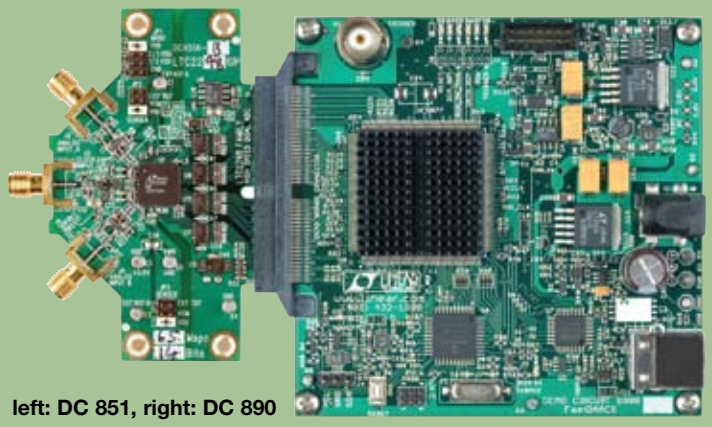
The combination of high performance and low power makes this family ideal for battery-powered, test and measurement equipment.

Applications: WiMAX, Software Defined Radio, CCD and Thermal Imaging, MRI Equipment, Industrial Camera, Ultrasound, Radar, Spectroscopy, Handheld Instrumentation, RFID

Part Number	Resolution	Speed	SNR	SFDR	Full Power Bandwidth	Power Dissipation
LTC2255	14-Bit	125Msps	72.5dB	88dB	640MHz	395mW
LTC2254	14-Bit	105Msps	72.4dB	88dB	640MHz	320mW
LTC2249	14-Bit	80Msps	73.0dB	90dB	575MHz	222mW
LTC2248	14-Bit	65Msps	74.3dB	90dB	575MHz	204mW
LTC2247	14-Bit	40Msps	74.4dB	90dB	575MHz	120mW
LTC2246	14-Bit	25Msps	74.5dB	90dB	575MHz	75mW
LTC2245	14-Bit	10Msps	74.4dB	90dB	575MHz	60mW
LTC2253	12-Bit	125Msps	70.2dB	88dB	640MHz	395mW
LTC2252	12-Bit	105Msps	70.2dB	88dB	640MHz	320mW
LTC2229	12-Bit	80Msps	70.6dB	90dB	575MHz	211mW
LTC2228	12-Bit	65Msps	71.3dB	90dB	575MHz	204mW
LTC2227	12-Bit	40Msps	71.4dB	90dB	575MHz	120mW
LTC2226	12-Bit	25Msps	71.4dB	90dB	575MHz	75mW
LTC2225	12-Bit	10Msps	71.3dB	90dB	575MHz	60mW
LTC2251	10-Bit	125Msps	61.6dB	85dB	640MHz	395mW
LTC2250	10-Bit	105Msps	61.6dB	85dB	640MHz	320mW
LTC2239	10-Bit	80Msps	61.6dB	85dB	575MHz	211mW
LTC2238	10-Bit	65Msps	61.8dB	85dB	575MHz	204mW
LTC2237	10-Bit	40Msps	61.8dB	85dB	575MHz	120mW
LTC2236	10-Bit	25Msps	61.8dB	85dB	575MHz	75mW

LTC2285 Lowest Power Dual ADC Family

- Single 3V Supply
- -110dB Channel-to-Channel Crosstalk
- CMOS Outputs
- Single-Ended Clock Input
- Selectable $1V_{P-P}$ or $2V_{P-P}$ Input Range
- Clock Duty Cycle Stabilizer
- 64-pin 9mm × 9mm QFN Package



left: DC 851, right: DC 890

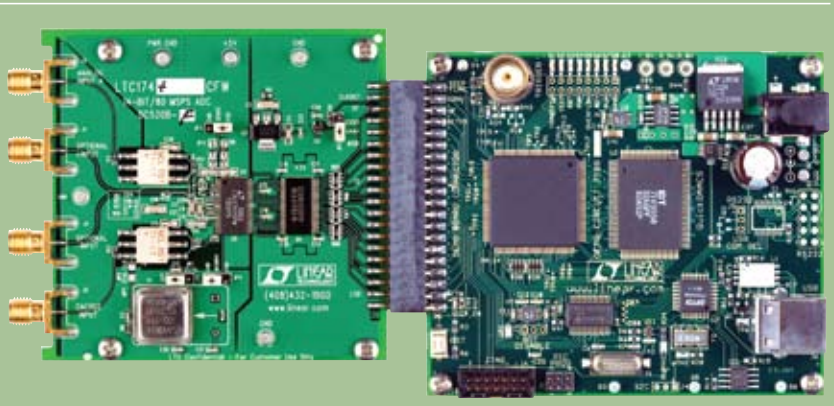
The LTC2285 dual ADC family offers exceptionally low crosstalk between channels of -110dB, the best performance in the industry. Each ADC has a separate single-ended input clock, which is combined on the evaluation boards for ease of evaluation. The duals can be evaluated in their multiplexed output bus configuration using the DC816 family, but the MUX feature is limited to 65Msps per channel. The DC851 family demultiplexed (parallel) output demo board allows for evaluation of the entire family of dual ADCs.

Applications: Antenna Diversity, RFID, WiMAX Basestation, Phased Array Multichannel Radio, Non-Destructive Testing, Software Defined Radio, Collision Avoidance Systems, Wireless Microphone, Night Vision Goggles, NTSC Video Digitizer

Part Number	Resolution	Speed	SNR	SFDR	Full Power Bandwidth	Power Dissipation
LTC2285	14-Bit	125Msps	72.4dB	88dB	640MHz	790mW
LTC2284	14-Bit	105Msps	72.4dB	88dB	575MHz	540mW
LTC2299	14-Bit	80Msps	73.0dB	90dB	575MHz	444mW
LTC2298	14-Bit	65Msps	74.3dB	90dB	575MHz	400mW
LTC2297	14-Bit	40Msps	74.4dB	90dB	575MHz	235mW
LTC2296	14-Bit	25Msps	74.5dB	90dB	575MHz	150mW
LTC2295	14-Bit	10Msps	74.4dB	90dB	575MHz	120mW
LTC2283	12-Bit	125Msps	70.2dB	88dB	640MHz	790mW
LTC2282	12-Bit	105Msps	70.1dB	88dB	575MHz	540mW
LTC2294	12-Bit	80Msps	70.6dB	90dB	575MHz	422mW
LTC2293	12-Bit	65Msps	71.3dB	90dB	575MHz	400mW
LTC2292	12-Bit	40Msps	71.4dB	90dB	575MHz	235mW
LTC2291	12-Bit	25Msps	71.4dB	90dB	575MHz	150mW
LTC2290	12-Bit	10Msps	71.3dB	90dB	575MHz	120mW
LTC2281	10-Bit	125Msps	61.6dB	85dB	640MHz	790mW
LTC2280	10-Bit	105Msps	61.6dB	85dB	575MHz	540mW
LTC2289	10-Bit	80Msps	61.6dB	85dB	575MHz	422mW
LTC2288	10-Bit	65Msps	61.8dB	85dB	575MHz	400mW
LTC2287	10-Bit	40Msps	61.8dB	85dB	575MHz	235mW
LTC2286	10-Bit	25Msps	61.8dB	85dB	575MHz	150mW

LTC1750 High Performance 5V ADC Family

- Single 5V Supply
- CMOS Outputs
- Data Ready Output Clock
- Selectable Input Ranges (Varied)
- 48-pin TSSOP Package



left: DC 520, right: DC 718

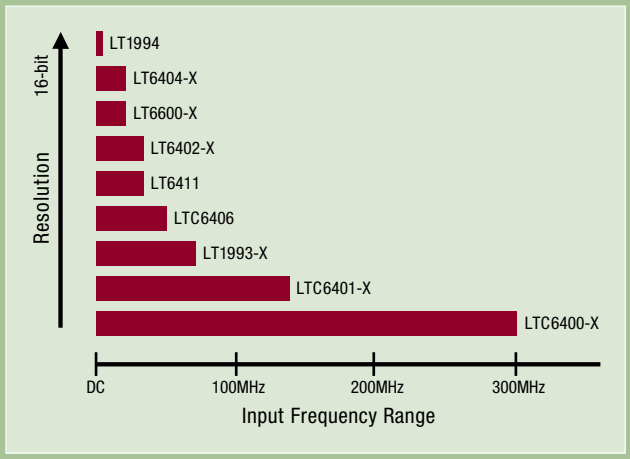
The LTC1750 and LTC1749 are high IF sampling ADCs up to 500MHz IF, while the rest of the family is best suited for IFs below 250MHz. This pin-compatible family provides excellent SNR performance from a 5V supply.

Applications: PA Linearization, ATE, Instrumentation, Video Equipment, Particle Monitoring Equipment, Cardiac Ultrasound, CMOS Imaging, Digital Communications Simulator, Cell Sorter, Broadcast Camera, Data Acquisition

Part Number	Resolution	Speed	SNR	SFDR	Full Power Bandwidth	Power Dissipation
LTC1750	14-Bit	80Msps	75.5dB	90dB	500MHz	1450mW
LTC1748	14-Bit	80Msps	76.3dB	90dB	240MHz	1400mW
LTC1742	14-Bit	65Msps	76.5dB	90dB	240MHz	1275mW
LTC1746	14-Bit	25Msps	77.5dB	91dB	240MHz	390mW
LTC1749	12-Bit	80Msps	71.8dB	87dB	500MHz	1450mW
LTC1747	12-Bit	80Msps	72.0dB	85dB	240MHz	1400mW
LTC1741	12-Bit	65Msps	72.0dB	85dB	240MHz	1275mW
LTC1743	12-Bit	50Msps	72.5dB	85dB	150MHz	1000mW
LTC1745	12-Bit	25Msps	72.5dB	96dB	240MHz	380mW

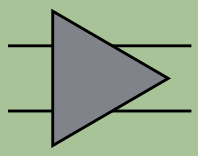
Fully Differential ADC Drivers

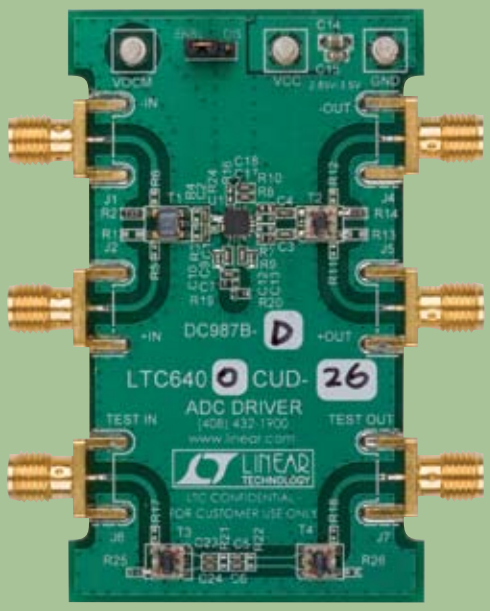
Linear Technology offers a wide range of fully differential amplifiers optimized for driving high-speed ADCs. They provide a wide variety of features, including built-in gain-setting resistors and integrated single pole filters, 4th order integrated filters, and the wide common mode input range. These amplifiers can also easily convert single-ended inputs to differential outputs.



Product	Input Frequency Range	Gain Range	Distortion HD2/HD3	Noise	Is	Vs	Price (1,000 pcs)	Features
LT1994	DC to 2MHz	Resistor-set	-96dBc @ 1MHz	3 nV/√Hz	13.3mA	2.4V to 12.6V	$1.65	RR Output
LT6600-2.5	DC to 2.5MHz	Resistor-set	-88dBc @ 1MHz	23 nV/√Hz	26mA	3V to 11V	$2.95	Integrated 4th order filter fc = 2.5MHz
LT6600-5	DC to 5MHz	Resistor-set	-93dBc @ 1MHz	16 nV/√Hz	28mA	3V to 11V	$2.95	Integrated 4th order filter fc = 5MHz
LTC6403-1	DC to 5MHz	Resistor-set	-95dBc @ 3MHz	2.8 nV/√Hz	11mA	2.7V to 5.25V	TBD	RR Output
LTC6404-1	DC to 10MHz	Resistor-set	-92dBc @ 10MHz	1.5 nV/√Hz	27mA	2.7V to 5.5V	$3.44	RR Output
LTC6404-2	DC to 15MHz	Resistor-set	-98dBc @ 10MHz	1.5 nV/√Hz	30mA	2.7V to 5.25V	$3.44	Min Gain = 2V/V
LT6600-10	DC to 10MHz	Resistor-set	-88dBc @ 1MHz	14 nV/√Hz	35mA	3V to 11V	$2.95	Integrated 4th order filter fc = 10MHz
LT6600-15	DC to 15MHz	Resistor-set	-86dBc @ 1MHz	19 nV/√Hz	35mA	3V to 11V	$2.95	Integrated 4th order filter fc = 15MHz
LT6600-20	DC to 20MHz	Resistor-set	-83dBc @ 2.5MHz	15 nV/√Hz	42mA	3V to 11V	$2.95	Integrated 4th order filter fc = 20MHz
LT6402-6	DC to 30MHz	6dB	-84dBc @ 25MHz	3.9 nV/√Hz	30mA	4V to 5.5V	$2.39	1st order filter
LT6402-12	DC to 30MHz	12dB	-82dBc @ 25MHz	2.6 nV/√Hz	30mA	4V to 5.5V	$2.39	1st order filter
LT6402-20	DC to 30MHz	20dB	-80dBc @ 25MHz	1.9 nV/√Hz	30mA	4V to 5.5V	$2.39	1st order filter
LT6411	DC to 50MHz	0dB, 6dB	-76dBc @ 10MHz	7.7 nV/√Hz	8mA	4.5V to 12.5V	$2.39	Fixed Gain
LTC6406	DC to 50MHz	Resistor-set	-72dBc @ 50MHz	1.6 nV/√Hz	18mA	2.7V to 3.5V	$3.44	RR Input
LT1993-2	DC to 70MHz	6dB	-70dBc @ 70MHz	3.8 nV/√Hz	100mA	4V to 5.5V	$2.95	1st order filter
LT1993-4	DC to 70MHz	12dB	-73dBc @ 70MHz	2.4 nV/√Hz	100mA	4V to 5.5V	$2.95	1st order filter
LT1993-10	DC to 70MHz	20dB	-70dBc @ 70MHz	1.9 nV/√Hz	100mA	4V to 5.5V	$2.95	1st order filter
LTC6401-8	DC to 140MHz	8dB	-87dBc @ 70MHz	3.2 nV/√Hz	45mA	2.85V to 3.5V	$2.95	1st order filter
LTC6401-20	DC to 140MHz	20dB	-88dBc @ 70MHz	2.1 nV/√Hz	50mA	2.85V to 3.5V	$2.95	1st order filter
LTC6401-26	DC to 140MHz	26dB	-81dBc @ 70MHz	1.5 nV/√Hz	45mA	2.85V to 3.5V	$2.95	1st order filter
LTC6400-20	DC to 300MHz	20dB	-76dBc @ 140MHz	2.1 nV/√Hz	90mA	2.85V to 3.5V	$3.20	1st order filter
LTC6400-26	DC to 300MHz	26dB	-81dBc @ 140MHz	1.5 nV/√Hz	85mA	2.85V to 3.5V	$3.20	1st order filter

LTC6400 High Speed Fully Differential ADC Driver Family





LTC6400

Integrated Gain-Setting Resistors:

- LTC6400-8 8dB
- LTC6400-14 14dB
- LTC6400-20 20dB
- LTC6400-26 26dB

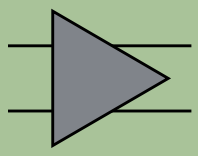
High Performance (LTC6400-20):

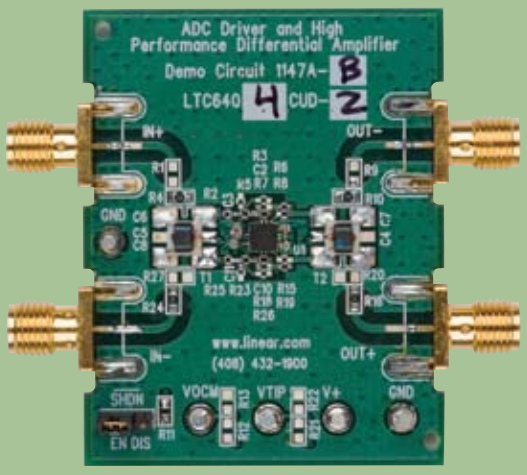
- 1.8GHz GBW
- 4500V/us Slew Rate
- 41 dBm OIP3 @ 240MHz
- -74dBc IMD3 @ 240MHz
- 1.9nV/√Hz Op Amp Noise

- Integrated First-Order Filter
- Independent Output Common Mode Control
- 3mm × 3mm QFN Package
- Lower Power, Lower Speed LTC6401 Available

The LTC6400 high-speed fully differential amplifier family achieves high performance while simplifying system design. Capable of driving up to 300MHz signals with low noise and distortion, the LTC6400 has integrated gain-setting resistors, adjustable output filtering, and flexible I/O coupling. This integration maximizes performance and simplifies board design. Fully specified at 3V supply, the LTC6400 can often share the same supply rail with the ADC.

LTC6404-1 High-Resolution Fully Differential ADC Driver Family





LTC6404

- Low Noise: 1.5nV/√Hz
- Very Low Distortion: < -90dBc @ 10MHz
- Closed Loop -3dB Bandwidth: 600MHz
- 450V/us Slew Rate
- Independent Output Common Mode Control
- 3mm × 3mm QFN Package
- Lower power, Lower Speed LTC6403 Available
- 2.7V to 5.25V Supply Voltage Range

The LTC6404-1 is capable of driving 10MHz input signals into today's state-of-the-art high-speed 14- to 18-bit ADCs while operating on the same supply voltage. It draws only 27mA and features a hardware shutdown mode which reduces current consumption to 0.25mA.

CMOS vs LVDS Outputs

Low-Voltage Differential Signaling (LVDS) is often preferred as a means to reduce ground currents and radiated noise when sampling at speeds greater than 100Msps. LVDS allows for good common-mode noise rejection at the digital receiver and faster switching rates. The lower signaling levels allow properly terminated transmission paths which are of paramount importance in maintaining good signal integrity.

CMOS obliges you to use source termination (provided internally on Linear Technology high-speed ADCs) but this is still not ideal as there is some lumped capacitance after the internal resistor. Single-ended CMOS outputs have longer rise and fall times that limit the maximum bit rate due to the larger voltage swing and are potentially more sensitive to crosstalk and above all, ground bounce.

However, LVDS is not completely immune to noise. The CMRR of receivers is not more than 20-30dB at higher frequencies, and the signaling levels are lower. Adjacent lines routed in close proximity will still result in crosstalk. The presence of a high level CMOS signal routed alongside an LVDS pair will potentially compromise signal integrity. In addition, high speed ADCs using LVDS can require up to a quarter Watt more power than CMOS.

An advantage of Linear Technology's high-speed ADCs is the ability to reduce the digital output supply (OV_{DD}) as low as 0.5V for running low-voltage CMOS outputs. Lowering the CMOS levels greatly reduces the resulting noise and also helps reduce digital feedback. For routing short distances, buffering can be eliminated at the ADC output for direct connection to an FPGA or DSP without discernable performance degradation compared to LVDS. However, if there is ground bounce in the FPGA as a result of activity at asynchronous or subharmonic frequencies, the elimination of buffers may allow noise to be injected back into the ADC.

Another technique that can be used to reduce digital noise is to configure the part in a Pseudo-LVDS output mode where the outputs are configured as CMOS but OV_{DD} is biased at 1.4V and OGND at 1V (see Figure 1). The outputs are then run into a standard LVDS receiver. This requires a bypassed 1.2V reference voltage near the ADC, and needs to represent similar source impedance to the driven line at the receiver. If these lines are routed over a belt of copper that is biased at the ADC, it may offer many of the advantages of LVDS without the power consumption in the ADC.

Figure 1 also shows the integrated series resistance included on every digital output so that each output appears as 50ohms.

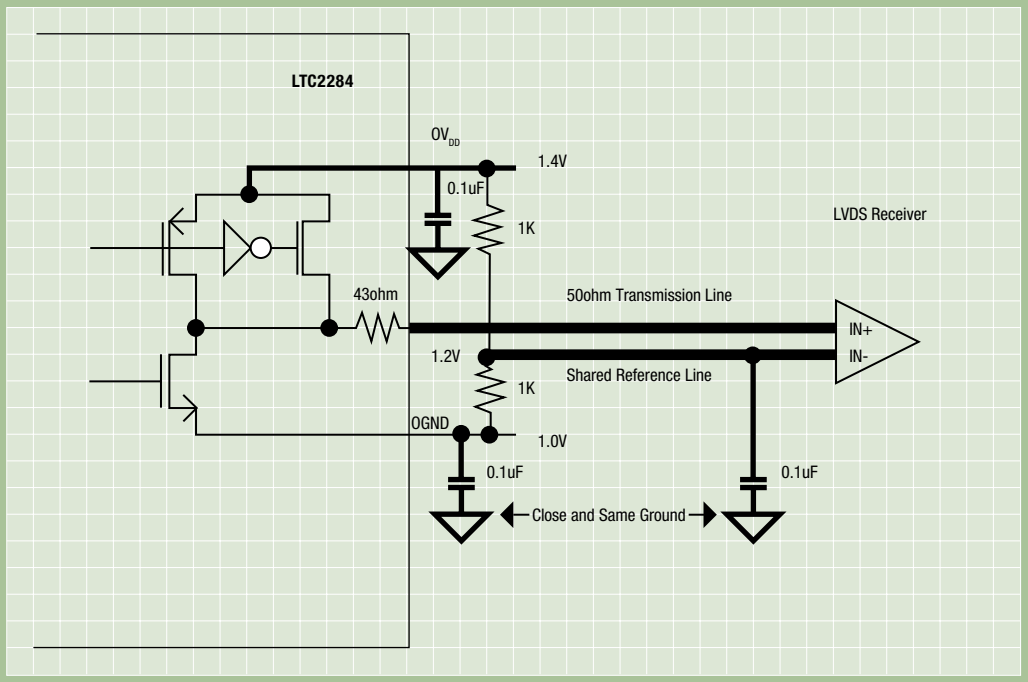


Figure 1. Pseudo-LVDS Interface

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