Improved Industry Standard CMOS 12-Bit Multiplying DAC

FEATURES

- Improved Direct Replacement for AD7541A and AD7541
- 4-Quadrant Multiplication
- **12-Bit End-Point Linearity: ±0.5LSB DNL and INL Over Temperature**
- All Grades Guaranteed Monotonic
- **Maximum Gain Error: ±1LSB**
- Single 5V to 15V Supply
- TTL and CMOS Logic Compatible
- Reduced Sensitivity to Op Amp Offset
- Low Power Consumption
- Virtually Latch-Up Proof
- Low Cost

APPLICATIONS

- Motion Control Systems
- Microprocessor-Controlled Calibration
- Automatic Test Equipment
- Programmable Gain Amplifiers
- Digitally Controlled Filters

DESCRIPTION

The LTC®7541A is a 12-bit resolution multiplying digital-to-analog converter (DAC).

Laser-trimmed thin-film resistors provide excellent absolute accuracy. Precision matched resistors and CMOS circuitry result in remarkable stability with temperature and supply variations.

The LTC7541A is a superior pin compatible replacement for the industry standard AD7541A/AD7541. Improvements include better typical accuracy and stability and reduced sensitivity to output amplifier offset. The LTC7541A is also very resistant to latch-up.

In addition to 2-quadrant and 4-quadrant multiplying configurations, the LTC7541A performs well in digitally programmable gain and noninverting voltage output applications. Low cost, improved performance and versatility make the LTC7541A the best choice for many new designs and for upgrading existing systems. Parts are available in 18-pin PDIP and 18-pin SO Wide packages.

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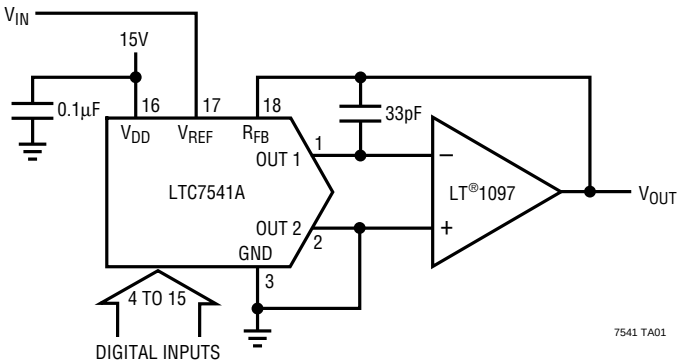
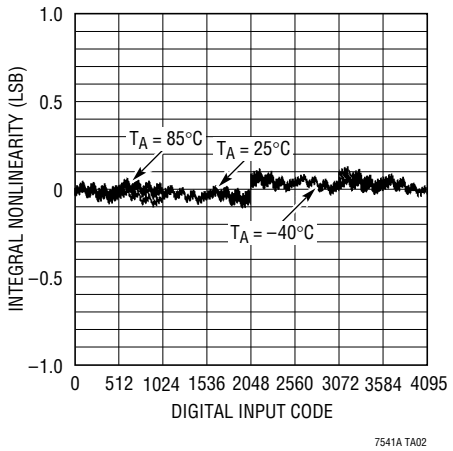
TYPICAL APPLICATION

2-Quadrant Multiplying DAC Has Less Than 0.5LSB (Typ) Total Unadjusted Error



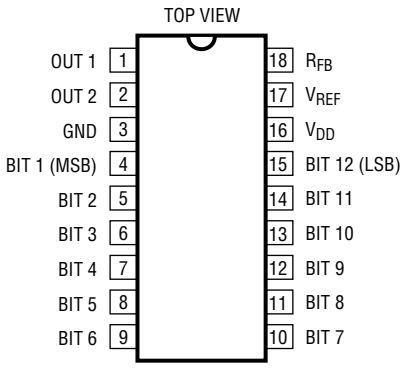
Integral Nonlinearity Over Temperature



ABSOLUTE MAXIMUM RATINGS

V_{DD} to GND ..... –0.5V to 17V
V_{REF} to GND ..... ±25V
R_{FB} to GND ..... ±25V
Digital Inputs to GND ..... –0.5V to (V_{DD} + 0.5V)
OUT 1, OUT 2 to GND ..... –0.5V to (V_{DD} + 0.5V)
Power Dissipation 450mW
(Derate 6mW/°C Above 75°C)
Maximum Junction Temperature ..... –65°C to 125°C
Operating Temperature Range
Commercial (J, K Versions) ..... 0°C to 70°C
Industrial (B Version) ..... –40°C to 85°C
Storage Temperature Range ..... –65°C to 150°C
Lead Temperature (Soldering, 10 sec) ..... 300°C

PACKAGE/ORDER INFORMATION



N PACKAGE
18-LEAD PDIP

SW PACKAGE
18-LEAD PLASTIC SO WIDE

T_{JMAX} = 150°C, θ_{JA} = 100°C/W (N)
T_{JMAX} = 150°C, θ_{JA} = 130°C/W (SW)

ORDER PART NUMBER

LTC7541ABN
LTC7541ABSW
LTC7541AJN
LTC7541AKN
LTC7541AJSW
LTC7541AKSW

Consult factory for Military grade parts.

ELECTRICAL CHARACTERISTICS

V_{DD} = 15V, V_{REF} = 10V, OUT 1 = OUT 2 = GND = 0V, T_A = T_{MIN} to T_{MAX}, unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS		LTC7541AJ MIN	LTC7541AJ TYP	LTC7541AJ MAX	LTC7541AK/LTC7541AB MIN	LTC7541AK/LTC7541AB TYP	LTC7541AK/LTC7541AB MAX	UNITS
Accuracy										
	Resolution		●	12			12			Bits
INL	Integral Nonlinearity (Relative Accuracy)	(Note 1)	●			±1			±0.5	LSB
DNL	Differential Nonlinearity	Guaranteed Monotonic, T_{MIN} to T_{MAX}	●			±1			±0.5	LSB
GE	Gain Error	(Note 2) T_A = 25°C				±6			±1	LSB
		T_{MIN} to T_{MAX}	●			±8			±2	LSB
	Gain Temperature Coefficient	(Note 3)	●		1	5		1	5	ppm/°C
I_{LKG}	Output Leakage Current	(Note 4) T_A = 25°C				±5			±5	nA
		T_{MIN} to T_{MAX}	●			±10			±10	nA
PSRR	Power Supply Rejection	V_{DD} = 15V ±5%	●			±0.002			±0.002	%/%
Reference Input										
R_{REF}	V_{REF} Input Resistance		●	7	11	15	7	11	15	kΩ
	V_{REF} Input Resistance Temperature Coefficient				–100			–100		ppm/°C

ELECTRICAL CHARACTERISTICS

V_{DD} = 15V, V_{REF} = 10V, OUT 1 = OUT 2 = GND = 0V, T_A = T_{MIN} to T_{MAX}, unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS		ALL GRADES MIN	TYP	MAX	UNIT
Power Supply							
V_{DD}	Operating Supply Range		●	5	15	16	V
I_{DD}	Suppy Current	Digital Inputs = V_{IH} or V_{IL}	●			2	mA
		Digital Inputs = 0V or V_{DD}	●			100	µA
Digital Inputs							
V_{IH}	Digital Input High Voltage		●	2.4			V
V_{IL}	Digital Input Low Voltage		●			0.8	V
I_{IN}	Digital Input Current		●		0.001	±1	µA
C_{IN}	Digital Input Capacitance	(Note 3), V_{IN} = 0V	●			8	pF
AC Performance							
	Propagation Delay	(Notes 5, 6)			100		ns
	Digital-to-Analog Glitch Impulse	(Notes 5, 7)			1000		nV-sec
	Multiplying Feedthrough Error	V_{REF} = ±10V, 10kHz Sinewave			1.0		mV_{P-P}
	Output Current Settling Time	(Note 5), To 0.01% for Full-Scale Change			0.6		µs
C_{OUT}	Output Capacitance (Note 3)	Digital Inputs = V_{IH} C_{OUT1}	●			200	pF
		C_{OUT2}	●			70	pF
		Digital Inputs = V_{IL} C_{OUT1}	●			70	pF
		C_{OUT2}	●			200	pF

The ● denotes specifications which apply over the full operating temperature range.

Note 1: ±0.5LSB = ±0.012% of full scale.

Note 2: Using internal feedback resistor.

Note 3: Guaranteed by design, not subject to test.

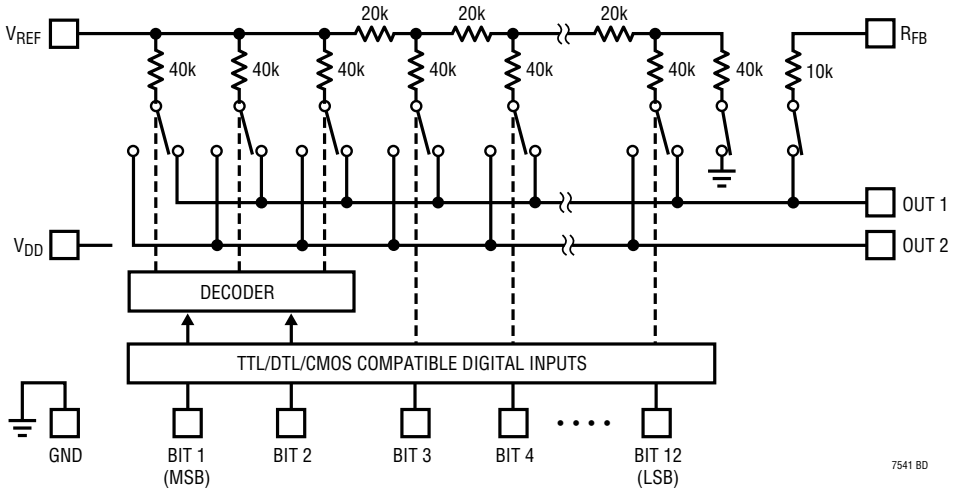
Note 4: I_{OUT1} with all digital inputs = 0V or I_{OUT2} with all digital inputs = V_{DD}.

Note 5: OUT 1 load = 100Ω in parallel with 13pF.

Note 6: Measured from digital input change to 90% of final analog value. Digital inputs = 0V to V_{DD} or V_{DD} to 0V.

Note 7: V_{REF} = 0V. All digital inputs 0V to V_{DD} or V_{DD} to 0V. Measured using LT1363 as output amplifier.

BLOCK DIAGRAM



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TYPICAL APPLICATIONS

Unipolar Operation (2-Quadrant Multiplication)

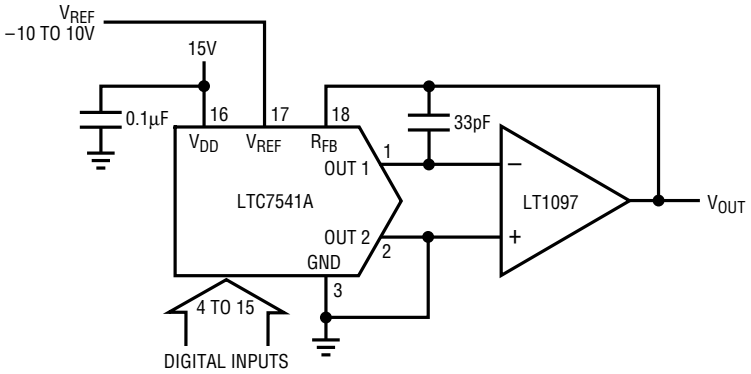

Table 1. Unipolar Binary Code Table

DIGITAL INPUT MSB LSB	ANALOG OUTPUT V_{OUT}
1111 1111 1111	$-V_{REF}$ (4095/4096)
1000 0000 0000	$-V_{REF}$ (2048/4096) = $-V_{REF}/2$
0000 0000 0001	$-V_{REF}$ (1/4096)
0000 0000 0000	0V

7541 TA03

Bipolar Operation (4-Quadrant Multiplication)

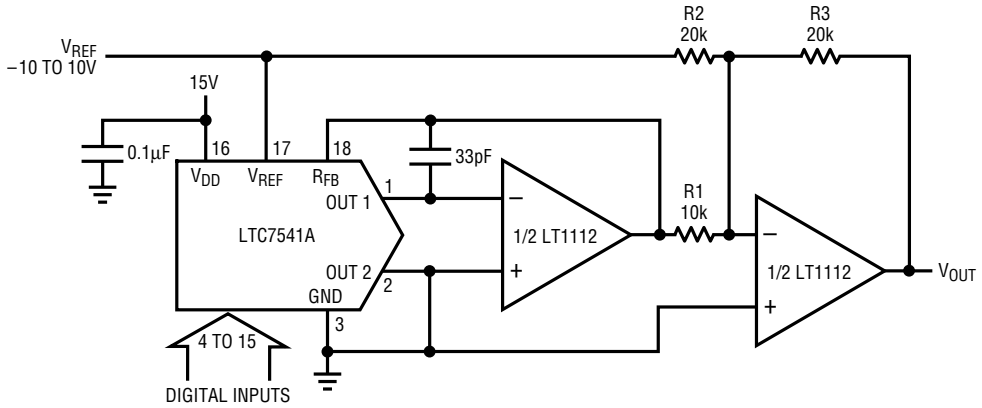

Table 2. Bipolar Offset Binary Code Table

DIGITAL INPUT MSB LSB	ANALOG OUTPUT V_{OUT}
1111 1111 1111	V_{REF} (2047/2048)
1000 0000 0001	V_{REF} (1/2048)
1000 0000 0000	0V
0111 1111 1111	$-V_{REF}$ (1/2048)
0000 0000 0000	$-V_{REF}$

7541 TA04

RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LTC1257	Complete Serial I/O V_{OUT} 12-Bit DAC	5V to 15V Single Supply in 8-Pin SO and PDIP
LTC1451/LTC1452/LTC1453	Complete Serial I/O V_{OUT} 12-Bit DACs	3V/5V Single Supply in 8-Pin SO and PDIP
LTC7543/LTC8143	Serial I/O Muliplying 12-Bit DACs	Clear Pin, Serial Data Output (LTC8143)
LTC8043	Serial Mulitplying 12-Bit DAC	8-Pin SO and PDIP

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