

FEATURES

- Improved Direct Replacement for AD7543 and DAC-8143
- Low Cost
- DNL and INL over Temperature: ± 0.5 LSB
- Easy, Fast and Flexible Serial Interface
- Daisy-Chain 3-Wire Interface for Multiple DAC Systems (LTC8143)
- 1LSB Maximum Gain Error over Temperature Eliminates Adjustment
- Asynchronous Clear Input for Initialization
- 4-Quadrant Multiplication
- Low Power Consumption
- 16-Pin PDIP and SO Packages

APPLICATIONS

- Process Control and Industrial Automation
- Remote Microprocessor-Controlled Systems
- Digitally Controlled Filters and Power Supplies
- Programmable Gain Amplifiers
- Automatic Test Equipment

DESCRIPTION

The LTC[®]7543/LTC8143 are serial-input 12-bit multiplying digital-to-analog converters (DACs). They are superior pin compatible replacements for the AD7543 and DAC-8143. Improvements include better accuracy, better stability over temperature and supply variations, lower sensitivity to output amplifier offset, tighter timing specifications and lower output capacitance.

An easy-to-use serial interface includes an asynchronous CLEAR input for systems requiring initialization to a known state. The LTC8143 has a serial data output to allow daisy-chaining multiple DACs on a 3-wire interface bus.

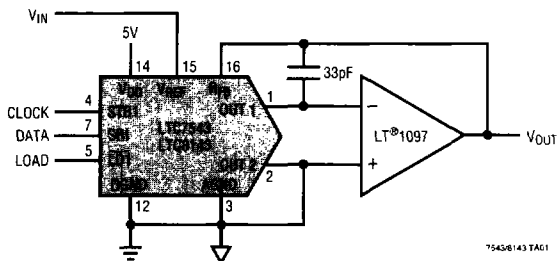
These DACs are extremely versatile. They can be used for 2-quadrant and 4-quadrant multiplying, programmable gain and single supply applications, such as noninverting voltage output and biased or offset ground mode.

Parts are available in 16-pin PDIP and SO packages and are specified over the extended industrial temperature range, -40°C to 85°C .

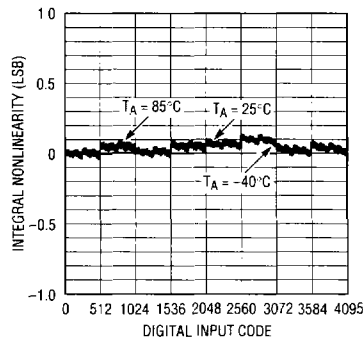
LT, LTC and LT are registered trademarks of Linear Technology Corporation.

TYPICAL APPLICATION

Multiplying DAC Has Easy 3-Wire Serial Interface



Integral Nonlinearity over Temperature



ABSOLUTE MAXIMUM RATINGS

V _{DD} to AGND	-0.5V to 7V
V _{DD} to DGND	-0.5V to 7V
AGND to DGND	V _{DD} + 0.5V
DGND to AGND	V _{DD} + 0.5V
Digital Inputs to DGND	-0.5V to (V _{DD} + 0.5V)
V _{OUT1} , V _{OUT2} to AGND	-0.5V to (V _{DD} + 0.5V)
V _{REF} to AGND, DGND	±25V
V _{RFB} to AGND, DGND	±25V
Maximum Junction Temperature	150°C
Operating Temperature Range	-40°C to 85°C
Storage Temperature Range	-65°C to 150°C
Lead Temperature (Soldering, 10 sec)	300°C

PACKAGE/ORDER INFORMATION

		ORDER PART NUMBER LTC7543GKN LTC7543KN LTC7543GKSW LTC7543KSW LTC8143EN LTC8143FN LTC8143ESW LTC8143FSW
N PACKAGE 16-LEAD PDIP SW PACKAGE 16-LEAD PLASTIC SO WIDE T _{JMAX} = 150°C, θ _{JA} = 100°C/W (N) T _{JMAX} = 150°C, θ _{JA} = 130°C/W (SW)		

Consult factory for Military grade parts.

ACCURACY CHARACTERISTICS (LTC7543)

V_{DD} = 5V, V_{REF} = 10V, V_{OUT1} = V_{OUT2} = AGND = DGND = 0V, T_A = T_{MIN} to T_{MAX}, unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	LTC7543GK			LTC7543K			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
	Resolution		●	12		12			Bits
INL	Integral Nonlinearity (Relative Accuracy)	(Note 1)	●		±0.5		±0.5		LSB
DNL	Differential Nonlinearity	Guaranteed Monotonic, T _{MIN} to T _{MAX}	●		±0.5		±0.5		LSB
GE	Gain Error	(Note 2) T _A = 25°C T _{MIN} to T _{MAX}	●		±1		±2		LSB
			●		±1		±2		LSB
	Gain Temperature Coefficient (ΔGain/ΔTemp)	(Note 3)	●	1	5		1	5	ppm/°C
I _{LKG}	Output Leakage Current	(Note 4) T _A = 25°C T _{MIN} to T _{MAX}	●		±1		±1		nA
			●		±10		±10		nA
	Zero-Scale Error	T _A = 25°C T _{MIN} to T _{MAX}	●		±0.006		±0.006		LSB
			●		±0.06		±0.06		LSB
PSRR	Power Supply Rejection Ratio	V _{DD} = 5V ±5%	●	±0.0001	±0.002		±0.0001	±0.002	%/%

6

ACCURACY CHARACTERISTICS (LTC8143)

$V_{DD} = 5V$, $V_{REF} = 10V$, $V_{OUT1} = V_{OUT2} = AGND = DGND = 0V$, $T_A = T_{MIN}$ to T_{MAX} , unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS		LTC8143E			LTC8143F			UNITS
				MIN	TYP	MAX	MIN	TYP	MAX	
	Resolution		●	12			12			Bits
INL	Integral Nonlinearity (Relative Accuracy)	(Note 1)	●			±0.5			±1	LSB
DNL	Differential Nonlinearity	Guaranteed Monotonic, T_{MIN} to T_{MAX}	●			±0.5			±1	LSB
GE	Gain Error	(Note 2) $T_A = 25^\circ C$ T_{MIN} to T_{MAX}	●			±1			±2	LSB
	Gain Temperature Coefficient ($\Delta Gain/\Delta Temp$)	(Note 3)	●		1	5		1	5	ppm/ $^\circ C$
I_{LKG}	Output Leakage Current	(Note 4) $T_A = 25^\circ C$ T_{MIN} to T_{MAX}	●			±5			±5	nA
	Zero-Scale Error	$T_A = 25^\circ C$ T_{MIN} to T_{MAX}	●			±0.03			±0.03	LSB
			●			±0.15			±0.15	LSB
PSRR	Power Supply Rejection Ratio	$V_{DD} = 5V \pm 5\%$	●		±0.0001	±0.002			±0.0001 ±0.002	%/ $^\circ$

ELECTRICAL CHARACTERISTICS

$V_{DD} = 5V$, $V_{REF} = 10V$, $V_{OUT1} = V_{OUT2} = AGND = DGND = 0V$, $T_A = T_{MIN}$ to T_{MAX} , unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS		LTC7543/LTC8143 ALL GRADES			UNITS
				MIN	TYP	MAX	
Reference Input							
R_{REF}	V_{REF} Input Resistance	(Note 5)	●	8	11	15	k Ω
AC Performance (Note 3)							
	Output Current Settling Time	(Notes 6, 7)	●		0.25	1	μs
	Multiplying Feedthrough Error	$V_{REF} = \pm 10V$, 10kHz Sinewave	●		0.8	2	mV $_{p-p}$
	Digital-to-Analog Glitch Energy	(Notes 6, 8)	●		2	20	nV-sec
THD	Total Harmonic Distortion	(Note 9)	●		-108	-92	dB
	Output Noise Voltage Density	(Note 10)	●			13	nV/ \sqrt{Hz}
Analog Outputs (Note 3)							
C_{OUT}	Output Capacitance	DAC Register Loaded to All 1s	C_{OUT1}	●	60	90	pF
			C_{OUT2}	●	20	60	pF
		DAC Register Loaded to All 0s	C_{OUT1}	●	30	60	pF
			C_{OUT2}	●	50	90	pF
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	$V_{IN} = 0V$ to V_{DD}	●		0.001	±1	μA
C_{IN}	Digital Input Capacitance	(Note 3), $V_{IN} = 0V$	●			8	pF
Digital Outputs: SRO (LTC8143 Only)							
V_{OH}	Digital Output High	$I_{OH} = -200\mu A$	●	4			V
V_{OL}	Digital Output Low	$I_{OL} = 1.6mA$	●			0.4	V

ELECTRICAL CHARACTERISTICS

$V_{DD} = 5V$, $V_{REF} = 10V$, $V_{OUT1} = V_{OUT2} = AGND = DGND = 0V$, $T_A = T_{MIN}$ to T_{MAX} , unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	LTC7543/LTC8143 ALL GRADES			UNITS	
			MIN	TYP	MAX		
Timing Characteristics (Note 3)							
t_{DS1}	Serial Input to Strobe Setup Time ($t_{STB} = 80ns$)	STB1 Used as the Strobe	●	50	5	ns	
t_{DS2}		STB2 Used as the Strobe	●	20	-5	ns	
t_{DS3}		STB3 Used as the Strobe	●	0	-30	ns	
t_{DS4}		STB4 Used as the Strobe	●	0	-30	ns	
t_{DH1}	Serial Input to Strobe Hold Time ($t_{STB} = 80ns$)	STB1 Used as the Strobe	●	30	10	ns	
t_{DH2}		STB2 Used as the Strobe	●	50	25	ns	
t_{DH3}		STB3 Used as the Strobe	●	80	55	ns	
t_{DH4}		STB4 Used as the Strobe	●	80	55	ns	
t_{SRI}	Serial Input Data Pulse Width		●	80		ns	
t_{STB1} , t_{STB2} , t_{STB3} , t_{STB4}	Strobe Pulse Width	(Note 11)	●	80		ns	
t_{STB1} , t_{STB2} , t_{STB3} , t_{STB4}	Strobe Pulse Width	(Note 12)	●	80		ns	
t_{LD1} , t_{LD2}	Load Pulse Width		●	140		ns	
t_{ASB}	LSB Strobed into Input Register to Load DAC Register Time		●	0		ns	
t_{CLR}	Clear Pulse Width		●	80		ns	
SRO Timing Characteristics (LTC8143 Only)							
t_{PD}	STB2, STB3, STB4 Strobe to SRO Propagation Delay	$C_L = 50pF$	●	120	220	ns	
t_{PD1}	STB1 to SRO Propagation Delay	$C_L = 50pF$	●	80	150	ns	
Power Supply							
V_{DD}	Supply Voltage		●	4.75	5	5.25	V
I_{OD}	Supply Current	Digital Inputs = 0V or V_{DD} Digital Inputs = V_{IH} or V_{IL}	● ●			0.1 2	mA mA

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

Note 1: $\pm 0.5LSB = \pm 0.012\%$ of full scale.

Note 2: Using internal feedback resistor.

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

Note 4: I_{OUT1} with DAC register loaded with all 0s or I_{OUT2} with DAC register loaded with all 1s.

Note 5: Typical temperature coefficient is 100ppm/°C.

Note 6: OUT 1 load = 100 Ω in parallel with 13pF.

Note 7: To 0.01% for a full-scale change, measured from falling edge of LD1 or LD2.

Note 8: $V_{REF} = 0V$. DAC register contents changed from all 0s to all 1s or from all 1s to all 0s.

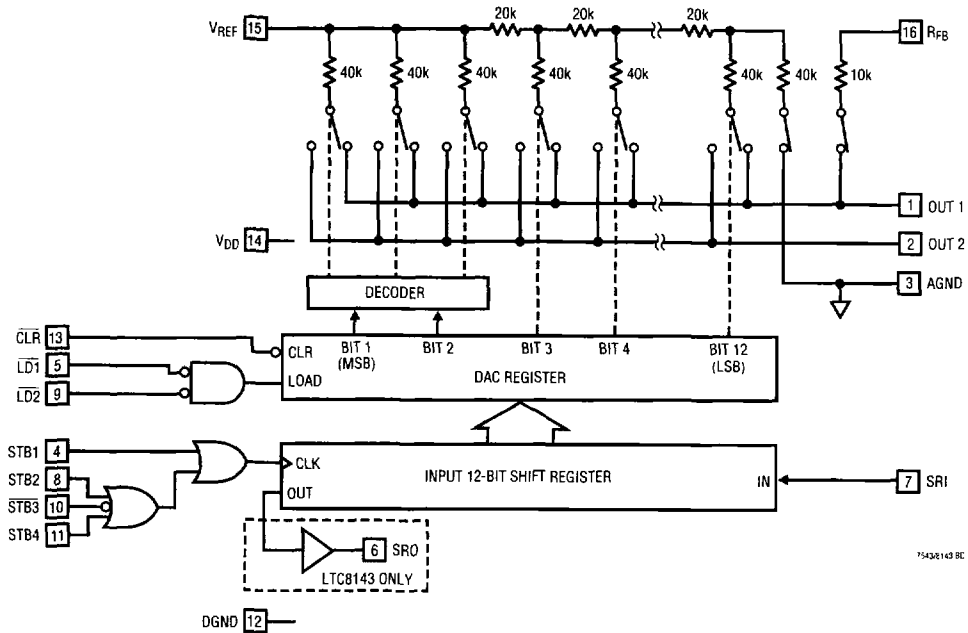
Note 9: $V_{REF} = 6V_{RMS}$ at 1kHz. DAC register loaded with all 1s.

Note 10: Calculation from $e_n = \sqrt{4KTRB}$ where: K = Boltzmann constant (J/K°); R = resistance (Ω); T = resistor temperature (°K); B = bandwidth (Hz).

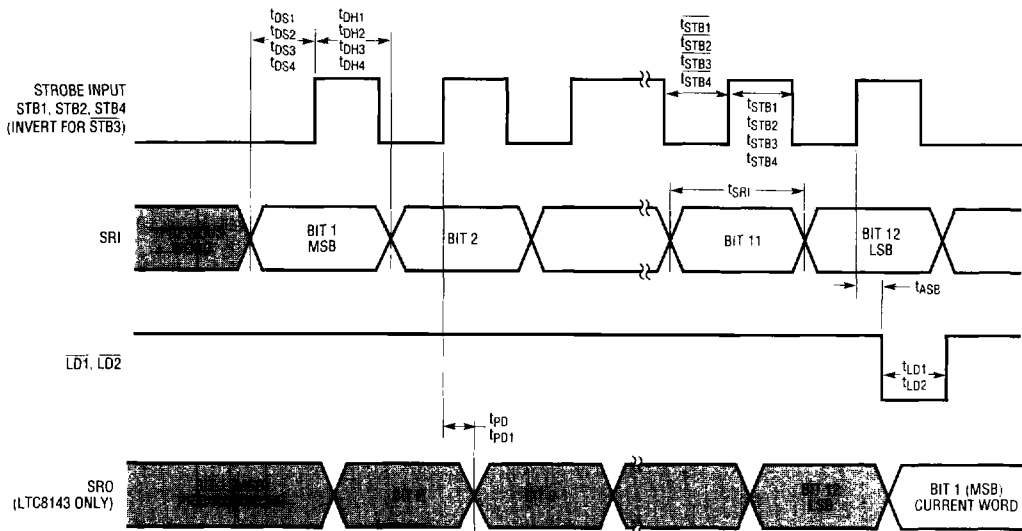
Note 11: Minimum high time for STB1, STB2, STB4. Minimum low time for STB3.

Note 12: Minimum low time for STB1, STB2, STB4. Minimum high time for STB3.

BLOCK DIAGRAM



TIMING DIAGRAM



TRUTH TABLES

Table 1. LTC7543/LTC8143 Input Register

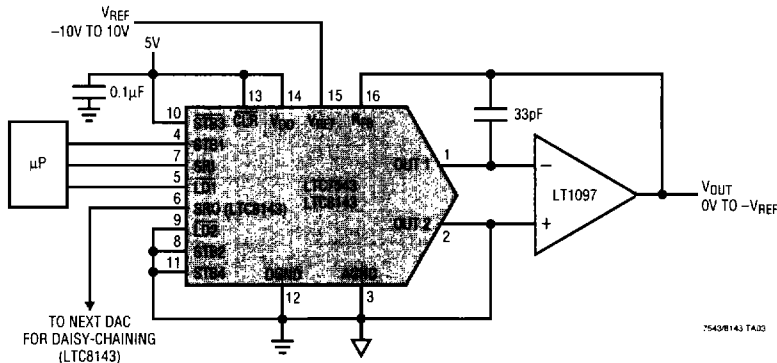
CONTROL INPUTS				Input Register Operation (LTC8143: SRO Operation)
STB1	STB2	STB3	STB4	
1	0	1	0	Serial Data Bit on SRI Loaded into Input Register, MSB First (LTC8143: Data Bit or SRI Appears on SRO Pin After 12 Clocked Bits)
0	1	1	0	
0	0	1	0	
0	0	1	1	
1	X	X	X	No Input Register Operation (LTC8143: No SRO Operation)
X	1	X	X	
X	X	0	X	
X	X	X	1	

Table 2. LTC7543/LTC8143 DAC Register

CONTROL INPUTS			DAC Register Operation
CLR	LD1	LD2	
0	X	X	Reset DAC Register to All 0s (Asynchronous Operation; No Effect on Input Register)
1	1	X	No DAC Register Operation
1	X	1	
1	0	0	Load DAC Register with the Contents of Input Register

TYPICAL APPLICATIONS

Unipolar Operation (2-Quadrant Multiplication)

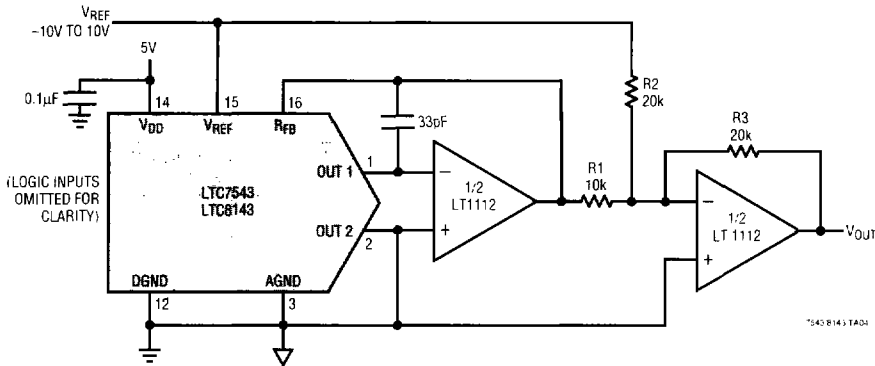


Unipolar Binary Code Table

DIGITAL INPUT BINARY NUMBER IN DAC REGISTER		ANALOG OUTPUT V_{OUT}
MSB	LSB	
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

TYPICAL APPLICATIONS

Bipolar Operation (4-Quadrant Multiplication)



Bipolar Offset Binary Code Table

DIGITAL INPUT BINARY NUMBER IN DAC REGISTER			ANALOG OUTPUT V_{OUT}
MSB		LSB	
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	$-V_{REF}$ (2048/2048) = $-V_{REF}$

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
LTC7541A	Parallel I/O Multiplying 12-Bit DAC	12-Bit Wide Input
LTC8043	Serial Multiplying 12-Bit DAC	8-Pin SO and PDIP