Serial 12-Bit Multiplying DAC in SO-8

FEATURES

- Improved Direct Replacement for DAC-8043 and MAX543
- **SO-8 Package with Standard Pinout**
- **DNL and INL Over Temperature: ±0.5LSB**
- Easy, Fast and Flexible Serial Interface
- **±1LSB Maximum Gain Error**
- 4-Quadrant Multiplication
- Low Power Consumption
- Low Cost

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®8043 is a serial-input 12-bit multiplying digital-to-analog converter (DAC). It is a superior pin compatible replacement for the DAC-8043. Improvements include better accuracy, better stability over temperature and supply variations, lower sensitivity to output amplifier offset, tighter timing specifications and lower output capacitance.

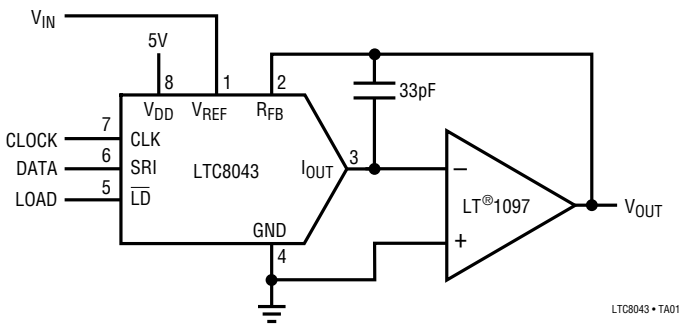
An easy-to-use 3-wire serial interface is well-suited to remote or isolated applications

The LTC8043 is extremely versatile. It can be used for 2-quadrant and 4-quadrant multiplying, programmable gain and single supply applications, such as noninverting voltage output mode.

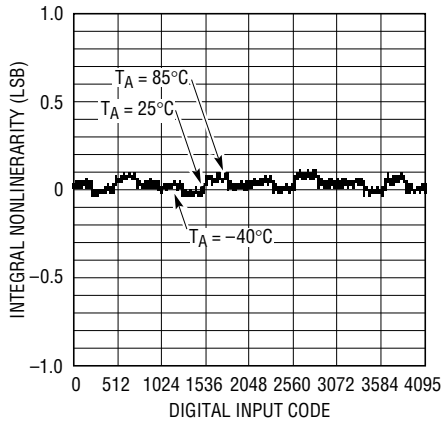
Parts are available in 8-pin SO and PDIP packages and are specified over the extended industrial temperature range, –40°C to 85°C.

TYPICAL APPLICATION

SO-8 Multiplying DAC Has Easy 3-Wire Serial Interface



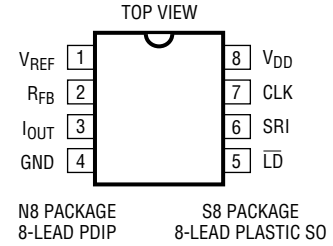
Integral Nonlinearity Over Temperature



ABSOLUTE MAXIMUM RATINGS

V_{DD} to GND ..... −0.5V to 7V
Digital Inputs to GND ..... −0.5V to (V_{DD} + 0.5V)
V_{IOUT} to GND ..... −0.5V to (V_{DD} + 0.5V)
V_{REF} to GND ..... ±25V
V_{RFB} to GND ..... ±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



N8 PACKAGE
8-LEAD PDIP

S8 PACKAGE
8-LEAD PLASTIC SO

T_{JMAX} = 150°C, θ_{JA} = 130°C/W (N8)
T_{JMAX} = 150°C, θ_{JA} = 190°C/W (S8)

ORDER PART NUMBER
LTC8043EN8
LTC8043FN8
LTC8043ES8
LTC8043FS8

Consult factory for Military grade parts.

ELECTRICAL CHARACTERISTICS

V_{DD} = 5V, V_{REF} = 10V, V_{IOUT} = GND = 0V, T_A = T_{MIN} to T_{MAX}, unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS		LTC8043E MIN	LTC8043E TYP	LTC8043E MAX	LTC8043F MIN	LTC8043F TYP	LTC8043F MAX	UNITS
	Resolution		●	12			12			Bits
INL	Integral Nonlinearity	(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°C				±1			±2	LSB
		T_{MIN} to T_{MAX}	●			±2			±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				±5			±5	nA
		T_{MIN} to T_{MAX}	●			±25			±25	nA
	Zero-Scale Error	T_A = 25°C				±0.03			±0.03	LSB
		T_{MIN} to T_{MAX}	●			±0.15			±0.15	LSB
PSRR	Power Supply Rejection Ratio	V_{DD} = 5V ±5%	●		±0.0001	±0.002		±0.0001	±0.002	%/%
Reference Input										
R_{REF}	V_{REF} Input Resistance	(Note 5)	●	7	11	15	7	11	15	kΩ
AC Performance (Note 3)										
	Output Current Settling Time	(Notes 6, 7)	●		0.25	1		0.25	1	µs
	Multiplying Feedthrough Error	V_{REF} = ±10V, 10kHz Sine Wave	●		0.7	1		0.7	1	mV_{P-P}
	Digital-to-Analog Glitch Energy	(Notes 6, 8)	●		2	20		2	20	nV-sec
THD	Total Harmonic Distortion	(Note 9)	●		−108	−92		−108	−92	dB
	Output Noise Voltage Density	(Note 10)	●			17			17	nV/√Hz
Analog Outputs (Note 3)										
C_{OUT}	Output Capacitance	DAC Register Loaded to All 1s	●		60	90		60	90	pF
		DAC Register Loaded to All 0s	●		30	60		30	60	pF

ELECTRICAL CHARACTERISTICS

V_{DD} = 5V, V_{REF} = 10V, V_{IOUT} = GND = 0V, T_A = T_{MIN} to T_{MAX}, unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS		ALL GRADES MIN	TYP	MAX	UNITS
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	V_{IN} = 0V,(Note 3)	●			8	pF
Timing Characteristics (Note 3)							
t_{DS}	Serial Input to Clock Setup Time		●	30	–5		ns
t_{DH}	Serial Input to Clock Hold Time		●	60	25		ns
t_{SRI}	Serial Input Data Pulse Width		●	80			ns
t_{CH}	Clock Pulse Width High		●	80			ns
t_{CL}	Clock Pulse Width Low		●	80			ns
t_{LD}	Load Pulse Width		●	140			ns
t_{ASB}	LSB Clocked into Input Register to Load DAC Register Time		●	0			ns
Power Supply							
V_{DD}	Supply Voltage		●	4.75	5	5.25	V
I_{DD}	Supply Current	Digital Inputs = 0V or V_{DD} Digital Inputs = V_{IH} or V_{IN}	● ●			100 500	µA µA

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_{OUT} with DAC register loaded with all 0s.

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

Note 6: I_{OUT} load = 100Ω in parallel with 13pF.

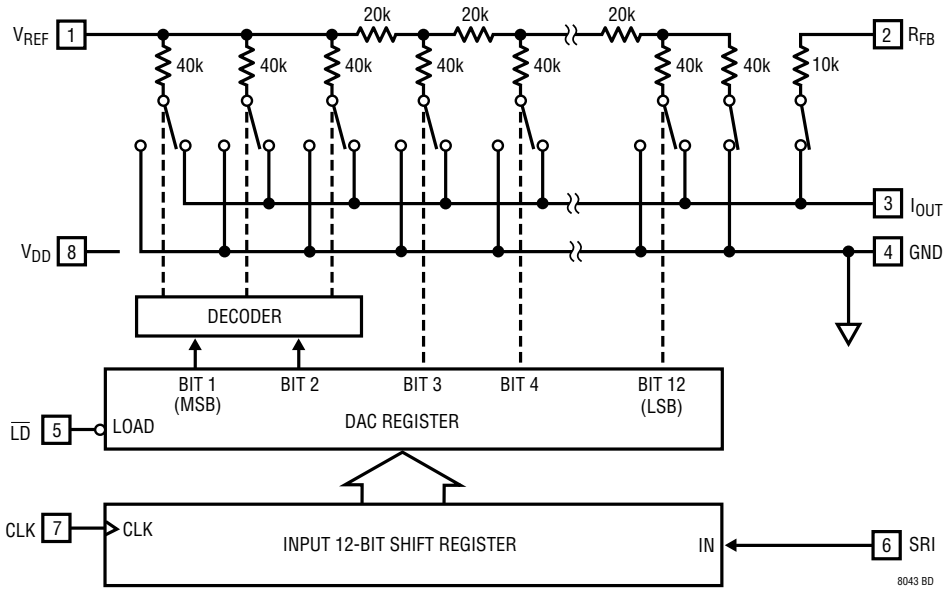
Note 7: To 0.01% for a full-scale change, measured from falling edge of $\overline{LD}$.

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

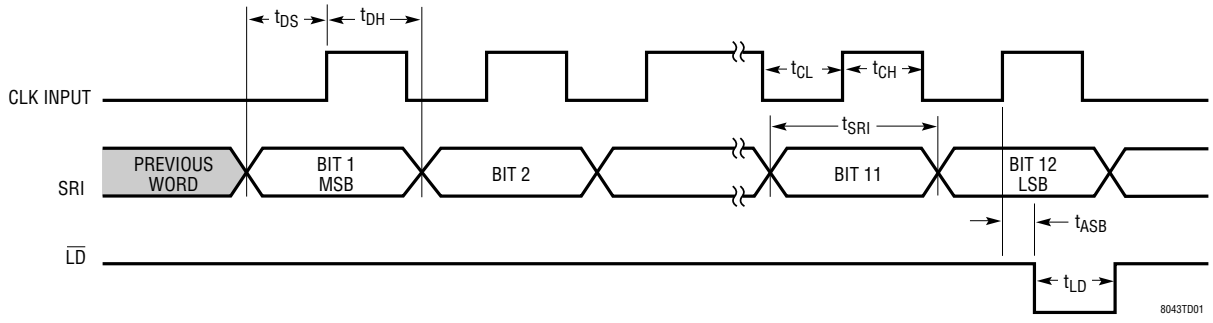
Note 9: V_{REF} = $6V_{RMS}$ at 1kHz. DAC register loaded with all 1s.

Note 10: 10Hz to 100kHz between R_{FB} and I_{OUT}. Calculation from $e_n = \sqrt{4KTRB}$ where: K = Boltzmann constant (J/K°); R = resistance (Ω); T = resistor temperature (°K); B = bandwidth (Hz).

BLOCK DIAGRAM



TIMING DIAGRAM



TYPICAL APPLICATIONS

Unipolar Operation (2-Quadrant Multiplication)

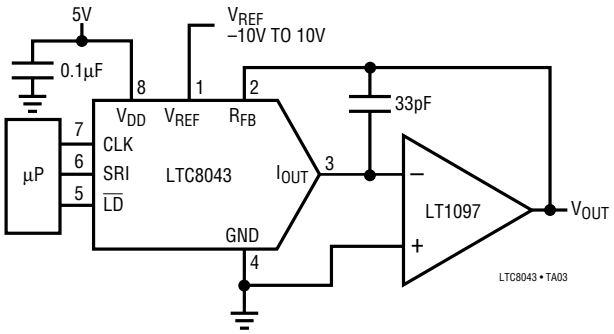


Table 1. Unipolar Binary Code Table

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

Bipolar Operation (4-Quadrant Multiplication)

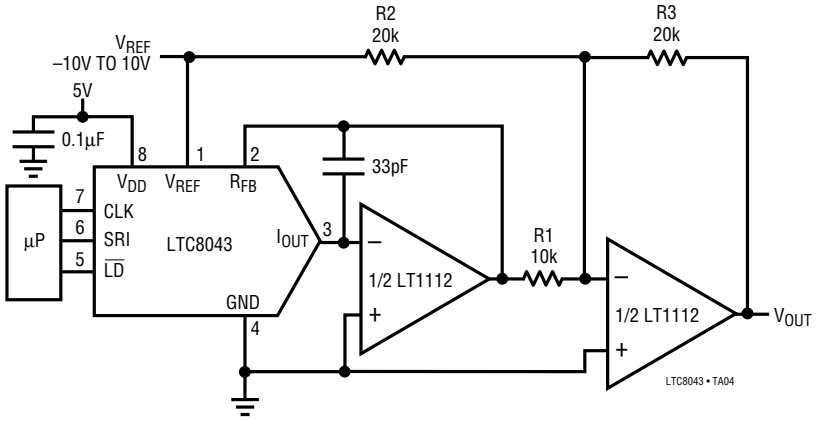
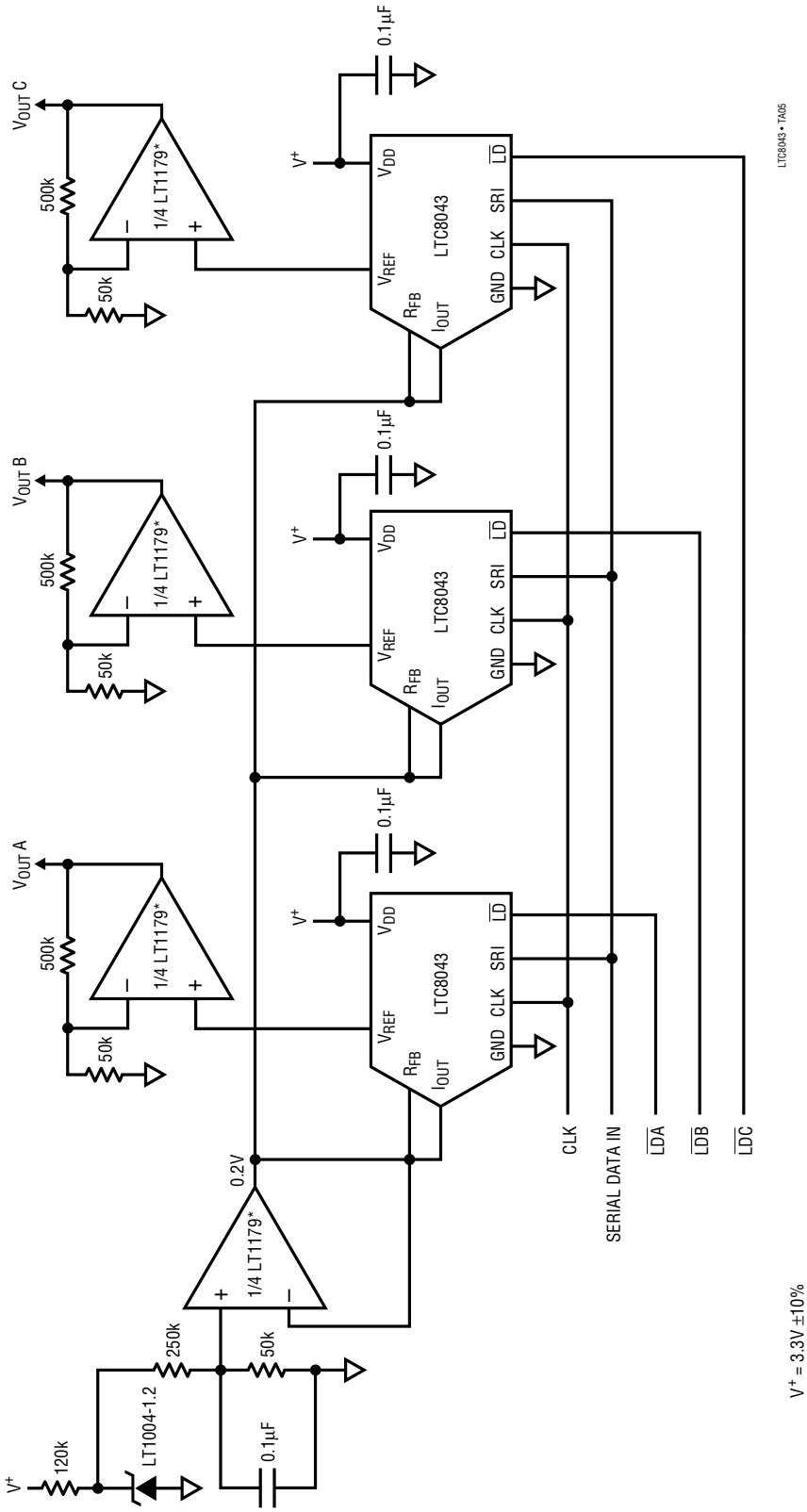


Table 2. Bipolar Offset Binary Code Table

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) = $-V_{REF}$

TYPICAL APPLICATIONS

Very Low Power Triple DAC

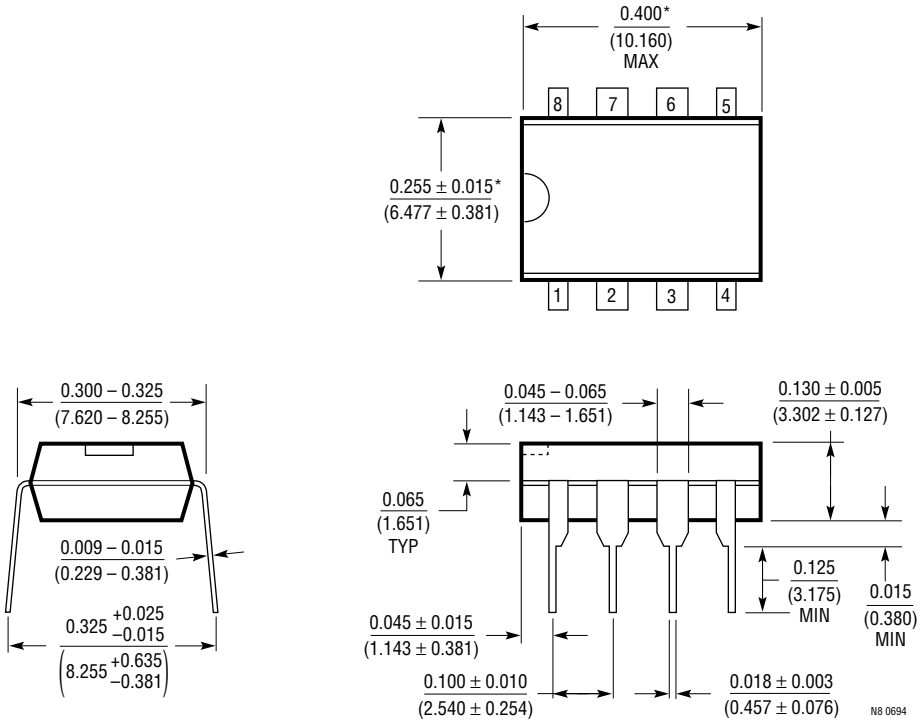


V+ = 3.3V ±10%
VOUT = 0V TO 2.2V
ISUPPLY, WORST-CASE CODE: MAX = 150µA, 50µA/DAC
ISUPPLY, WORST-CASE CODE: TYP = 120µA, 40µA/DAC
*LT1178, DUAL IN SO-8, MAY BE PREFERRED OVER LT1179, SW-16

PACKAGE DESCRIPTION

Dimensions in inches (millimeters) unless otherwise noted.

N8 Package
8-Lead PDIP (Narrow 0.300)
(LTC DWG # 05-08-1510)

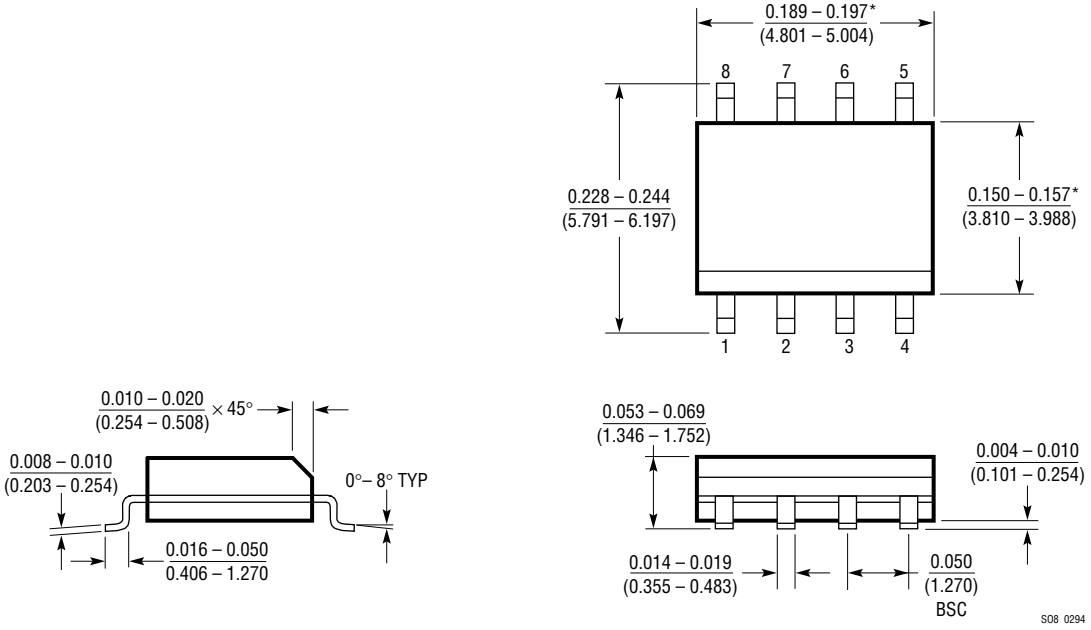


*THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
MOLD FLASH OR PROTURSIONS SHALL NOT EXCEED 0.010 INCH (0.254mm).

PACKAGE DESCRIPTION

Dimensions in inches (millimeters) unless otherwise noted.

S8 Package
8-Lead Plastic Small Outline (Narrow 0.150)
(LTC DWG # 05-08-1610)



*THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.006 INCH (0.15mm).

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	Rail-to-Rail V_{OUT}, 3V/5V Single Supply in 8-Pin SO and PDIP
LTC7541A	Parallel I/O Multiplying I_{OUT} 12-Bit DAC	12-Bit Wide Parallel Input
LTC7543/LTC8143	Serial I/O Multiplying I_{OUT} 12-Bit DACs	Clear Pin and Serial Data Output (LTC8143)

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