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# MAXIM

## 12-Bit, 100Mps TTL DAC

MAX5013

### General Description

The MAX5013 is a 12-bit, 100Mps digital-to-analog converter (DAC) designed for digital modulation, direct digital synthesis, high-resolution imaging, and arbitrary-waveform-generation applications. This device is pin-for-pin compatible with the AD9713 with significantly improved settling time and glitch-energy performance.

The MAX5013 is a TTL-compatible device. It features a fast 13ns settling time and low 15pV-s glitch impulse energy, which results in excellent spurious-free dynamic-range characteristics.

The MAX5013 is available in a 28-pin plastic DIP or PLCC package, in the -40°C to +85°C extended-industrial temperature range.

### Applications

Fast-Frequency-Hopping Spread-Spectrum Radios  
Direct-Sequence Spread Spectrum Radios  
Digital RF/IF Modulation  
Microwave and Satellite Modems  
Test and Measurement Instrumentation

### Features

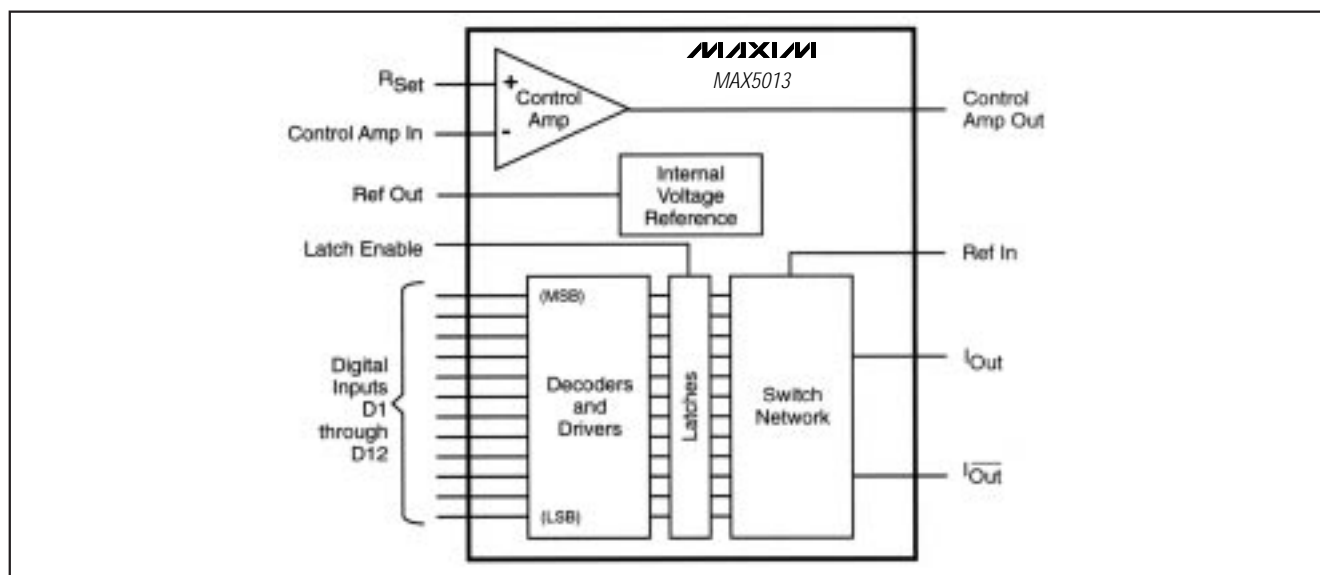
- ◆ 12-Bit, 100Mps DAC
- ◆ TTL-Compatible Inputs
- ◆ Low Power: 640mW
- ◆ 1/2LSB DNL
- ◆ 40MHz Multiplying Bandwidth
- ◆ Extended-Industrial Temperature Range
- ◆ Superior Performance over AD9713:
  - Improved Settling Time: 13ns
  - Improved Glitch Energy: 15pV-s
  - Master/Slave Latches

### Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX5013AEPI	-40°C to +85°C	28 Plastic DIP
MAX5013BEPI	-40°C to +85°C	28 Plastic DIP
MAX5013AEQI	-40°C to +85°C	28 PLCC
MAX5013BEQI	-40°C to +85°C	28 PLCC

Pin Configurations appear at end of data sheet.

### Functional Diagram



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Maxim Integrated Products 1

For the latest literature: <http://www.maxim-ic.com>, or phone 1-800-998-8800.  
For small orders, phone 408-737-7600 ext. 3468.

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## ABSOLUTE MAXIMUM RATINGS

Supply Voltages	
Positive Supply Voltage (V <sub>CC</sub> )	+7V
Negative Supply Voltage (V <sub>EE</sub> )	-7V
A/D Ground Voltage Differential	0.5V
Input Voltages	
Digital Input Voltage (D1–D12, Latch Enable)	0V to V <sub>CC</sub>
Control Amp Input Voltage Range	0V to -4V
Reference Input Voltage Range (V <sub>REF</sub> )	-3.7V to V <sub>EE</sub>
Output Currents	
Internal-Reference Output Current	500 $\mu$ A
Control-Amplifier Output Current	$\pm$ 2.5mA

Continuous Power Dissipation	
Plastic DIP (derate 14.29mW/°C above +70°C)	1.14W
PLCC (derate 10.53mW/°C above +70°C)	.842mW
Operating Temperature Range	-40°C to +85°C
Junction Temperature	+150°C
Lead Temperature (soldering, 10sec)	+300°C
Storage Temperature Range	-65°C to +150°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## ELECTRICAL CHARACTERISTICS

(V<sub>CC</sub> = +5.0V, V<sub>EE</sub> = -5.2V, R<sub>SET</sub> = 7.5k $\Omega$ , Control Amp In = Ref Out, V<sub>OUT</sub> = 0V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted.)

PARAMETER	CONDITIONS	TEST LEVEL	MAX5013A			MAX5013B			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
<b>DC PERFORMANCE</b>									
Resolution			12			12			Bits
Differential Nonlinearity		I	$\pm$ 0.5	$\pm$ 0.75		$\pm$ 1.0	$\pm$ 1.25		LSB
	Max at full temperature	VI		$\pm$ 1.5			$\pm$ 20		
Integral Nonlinearity	Best fit	I	$\pm$ 0.75	$\pm$ 1.0		$\pm$ 1.0	$\pm$ 1.5		LSB
	Max at full temperature	VI		$\pm$ 1.75			$\pm$ 2.0		
Output Capacitance	T <sub>A</sub> = +25°C	V	10			10			pF
Gain Error (Note 1)	T <sub>A</sub> = +25°C	I	1.0	5.0		1.0	5.0		% F.S.
	Full temperature	VI		8.0			8.0		
Gain-Error Tempco	Full temperature	V	150			150			ppm/°C
Zero-Scale Offset Error	T <sub>A</sub> = +25°C	I	0.5	2.5		0.5	2.5		$\mu$ A
	Full temperature	VI		5.0			5.0		
Offset-Drift Coefficient	Full temperature	V	0.01			0.01			$\mu$ A/°C
Output Compliance Voltage	T <sub>A</sub> = +25°C	IV	-1.2	2.0		-1.2	2.0		V
Equivalent Output Resistance	T <sub>A</sub> = +25°C	IV	0.8	1.0	1.2	0.8	1.0	1.2	k $\Omega$
<b>DYNAMIC PERFORMANCE</b>									
Conversion Rate	T <sub>A</sub> = +25°C	IV	100			100			MspS
Settling Time (t <sub>ST</sub> ) (Note 2)	T <sub>A</sub> = +25°C	V	13			13			ns
Output Propagation Delay (t <sub>D</sub> ) (Note 3)	T <sub>A</sub> = +25°C	V	2			2			ns
Glitch Energy (Note 4)	T <sub>A</sub> = +25°C	V	15			15			pV-s
Full-Scale Output Current (Note 5)	T <sub>A</sub> = +25°C	V	20.48			20.48			mA
Spurious-Free Dynamic Range	T <sub>A</sub> = +25°C								
1.23MHz; 10Msps	2MHz span	V	70			70			dBc
5.055MHz; 20Msps			68			68			
10.1MHz; 50Msps			68			68			
16MHz; 40Msps			68			68			
Rise/Fall Time	R <sub>L</sub> = 50 $\Omega$	V	2			2			ns

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## ELECTRICAL CHARACTERISTICS (continued)

(V<sub>CC</sub> = +5.0V, V<sub>EE</sub> = -5.2V, R<sub>SET</sub> = 7.5kΩ, Control Amp In = Ref Out, V<sub>OUT</sub> = 0V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted.)

PARAMETERS	CONDITIONS	TEST LEVEL	MAX5013A			MAX5013B			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
<b>POWER-SUPPLY REQUIREMENTS</b>									
Positive Supply Voltage		IV	4.75	5.0	5.25	4.75	5.0	5.25	V
Negative Supply Voltage		IV	-5.46	-5.2	-4.94	-5.46	-5.2	-4.94	
Positive Supply Current (+5.0V)	T <sub>A</sub> = +25°C	I		8	14		8	14	mA
	Full temperature	VI			16			16	
Negative Supply Current (-5.2V)	T <sub>A</sub> = +25°C	I		115	140		115	140	mA
	Full temperature	VI			148			148	
Nominal Power Dissipation		V		640			640	mW	
Power-Supply Rejection Ratio	±5% of V <sub>EE</sub> and V <sub>CC</sub> , external reference, T <sub>A</sub> = +25°C	I		30	100		30	100	μA/V
<b>VOLTAGE INPUT AND CONTROL</b>									
Reference Input Impedance	T <sub>A</sub> = +25°C	V		3			3		kΩ
Reference Multiplying Bandwidth	T <sub>A</sub> = +25°C	V		40			40		MHz
Internal Reference Voltage		VI	-1.15	-1.20	-1.25	-1.15	-1.20	-1.25	V
Internal Reference Voltage Drift	Full temperature	V		50			50		ppm/°C
Amplifier Input Impedance	T <sub>A</sub> = +25°C	V		3			3		MΩ
Amplifier Input Bandwidth	T <sub>A</sub> = +25°C	V		1			1		MHz
<b>DIGITAL INPUTS</b>									
Logic 1 Voltage	Full temperature	VI	2.0			2.0			V
Logic 0 Voltage	Full temperature	VI			0.8			0.8	V
Logic 1 Current	Full temperature	VI			20			20	μA
Logic 0 Current	Full temperature	VI			600			600	μA
Input Capacitance	T <sub>A</sub> = +25°C	V		3			3		pF
Input Setup Time (t <sub>s</sub> )	T <sub>A</sub> = +25°C	IV	3	2		3	2		ns
	Full temperature	IV	3.5			3.5			
Input Hold Time (t <sub>H</sub> )	T <sub>A</sub> = +25°C	IV	0.5	0		0.5	0		ns
	Full temperature	IV	0.5			0.5			
Latch Pulse Width (t <sub>PWL</sub> , t <sub>PWH</sub> )	T <sub>A</sub> = +25°C	IV	5.0	4.0		5.0	4.0		ns

**Note 1:** Gain is measured as a ratio of the full-scale current to I<sub>SET</sub>. The ratio is nominally 128.

**Note 2:** Measured as voltage at mid-scale transition to ±0.024%; R<sub>L</sub> = 50Ω.

**Note 3:** Measured from the rising edge of Latch Enable to where the output signal has left a 1LSB error band.

**Note 4:** Glitch is measured as the largest single transient.

**Note 5:** Calculated using  $I_{FS} = 128 \times \left( \frac{\text{Control Amp In}}{R_{SET}} \right)$

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## TEST LEVEL CODES

All electrical characteristics are subject to the following conditions:

All parameters having min/max specifications are guaranteed. The Test Level column indicates the specific device testing actually performed during production and Quality Assurance inspection. Any black section in the data column indicates that the specification is not tested at the specified condition.

## TEST LEVEL TEST PROCEDURE

I	100% production tested at the specified temperature.
II	100% production tested at $T_A = +25^\circ\text{C}$ , and sample tested at the specified temperatures.
III	QA sample tested only at the specified temperatures.
IV	Parameter is guaranteed (but not tested) by design and characterization data.
V	Parameter is a typical value for information purposes only.
VI	100% production tested at $T_A = +25^\circ\text{C}$ . Parameter is guaranteed over specified temperature range.

## Pin Description

PIN	NAME	FUNCTION
1-10	D2-D11	Digital Input Bits 2-11
11	D12 (LSB)	Digital Input Bit 12 (LSB)
12, 21	Digital $V_{EE}$	Digital Negative Supply (-5.2V)
13	Analog Return	Analog Return Ground
14	$I_{OUT}$	Analog Current Output
15, 25	Analog $V_{EE}$	Analog Negative Supply (-5.2V)
16	$\overline{I_{OUT}}$	Complementary Analog Current Output
17	Ref In	Voltage Reference Input
18	Control Amp Out	Output of Internal Control Amplifier. Control Amp Out is normally connected to Ref In.
19	Control Amp In	Normally connected to Ref Out if not connected to external reference.
20	Ref Out	Internal Voltage Reference Output. Ref Out is normally connected to Control Amp In.
22	Ref GND	Ground return for internal voltage reference and amplifier.
23	Digital $V_{CC}$	Digital Positive Supply (+5.0V)
24	$R_{SET}^*$	Connection for external resistance reference when using internal amplifier (nominally 7.5k $\Omega$ ).
26	Latch Enable	Latch-Control Line
27	DGND	Digital Ground Return
28	D1 (MSB)	Digital Input Bit 1 (MSB)

\*Full-Scale Current Out = 128 (Control Amp In /  $R_{SET}$ ).

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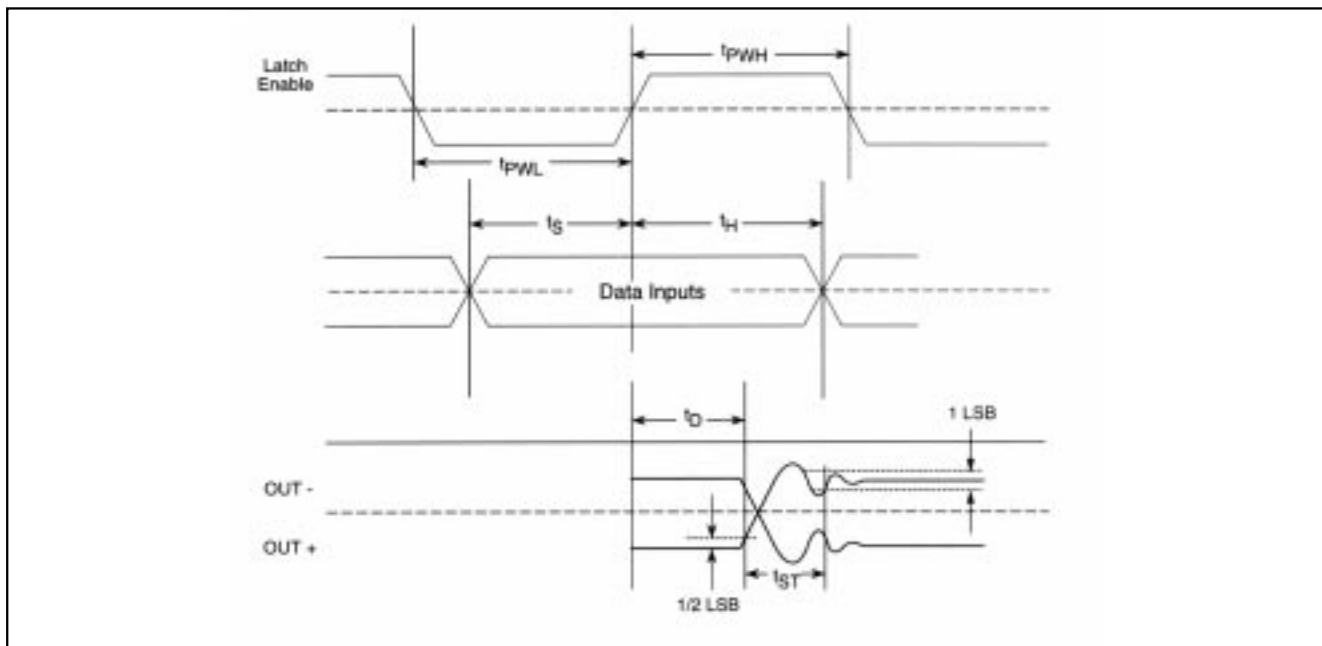


Figure 1. Timing Diagram

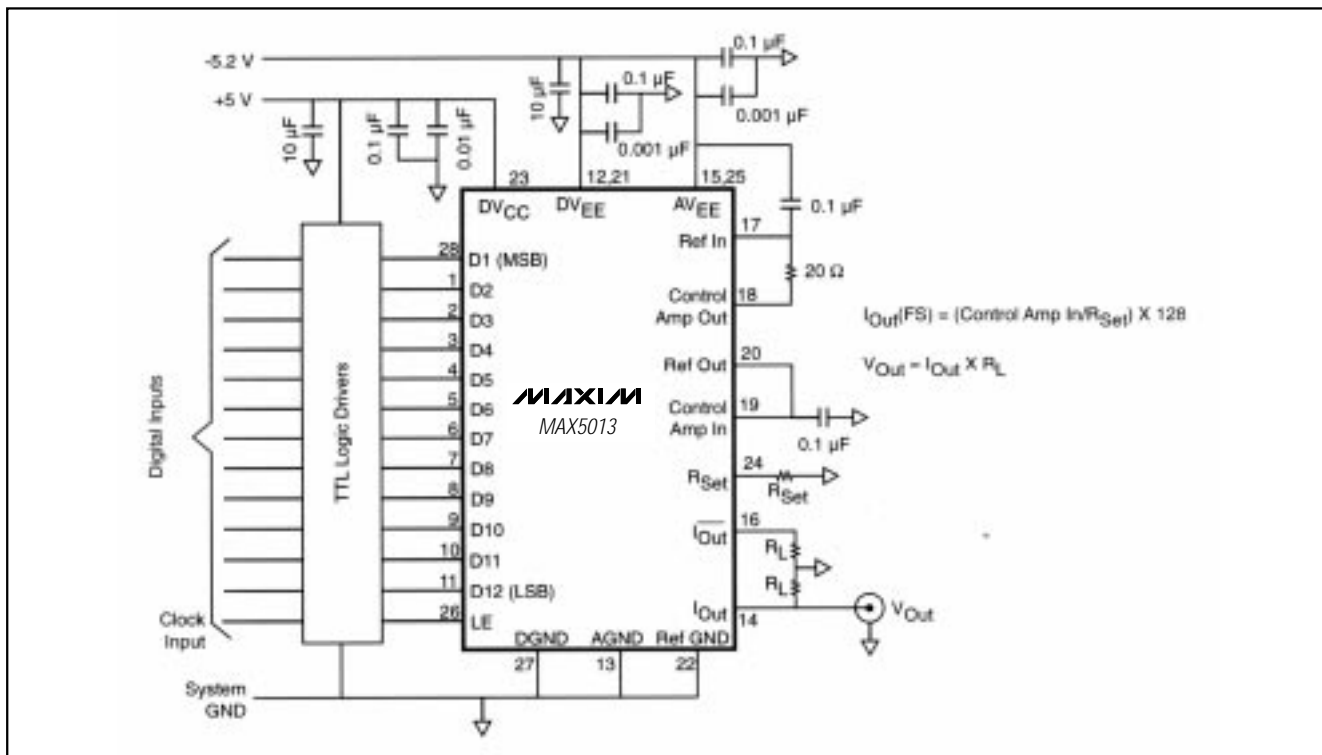
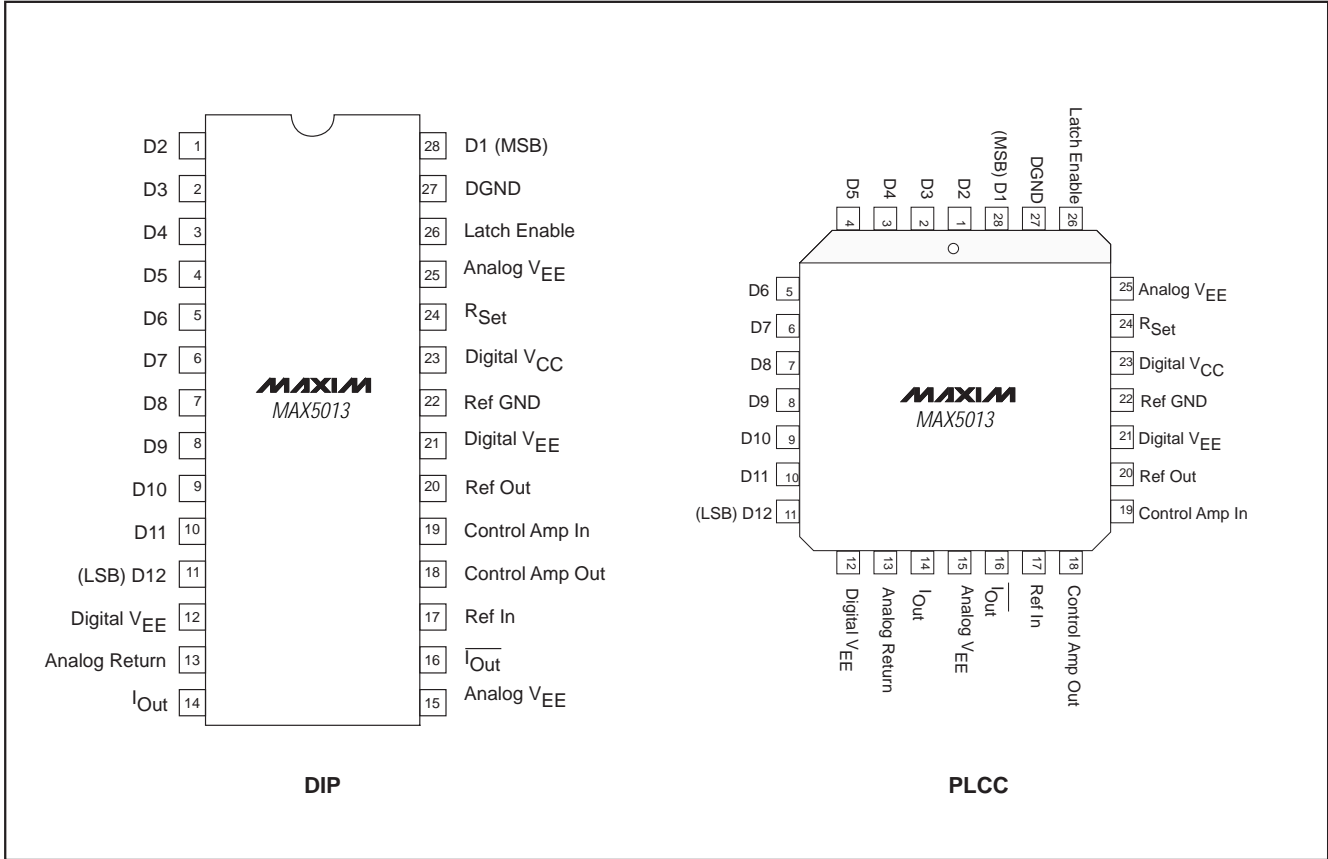


Figure 2. Typical Interface Circuit

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## Pin Configurations

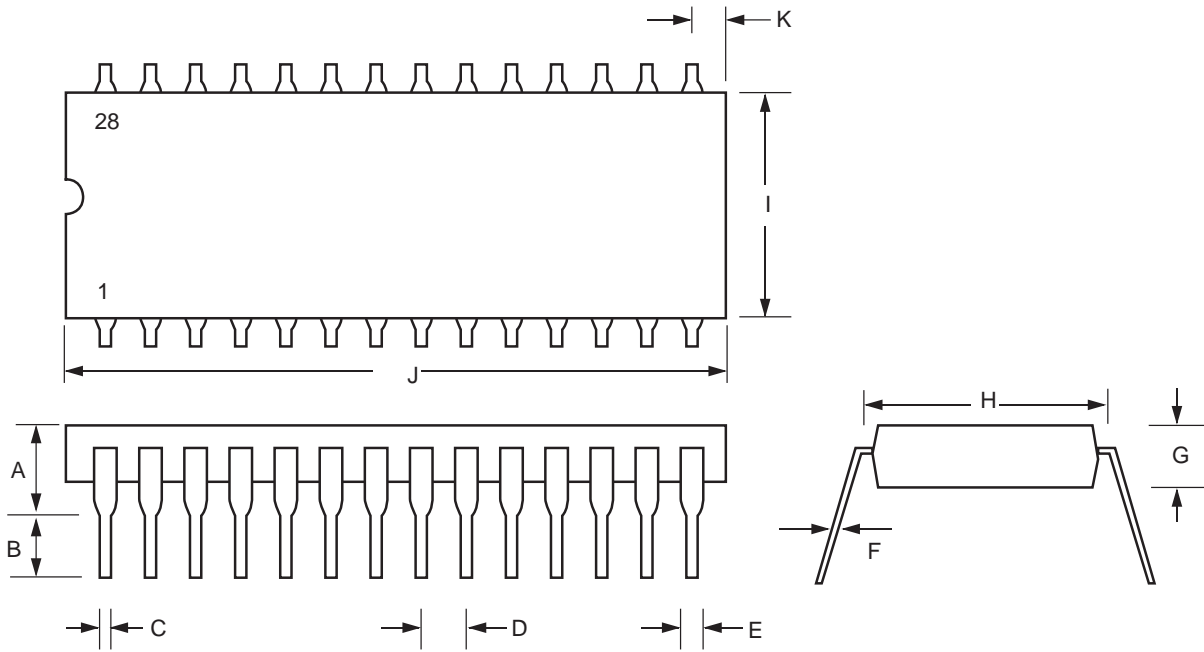


# 12-Bit, 100Mps TTL DAC

## Package Information

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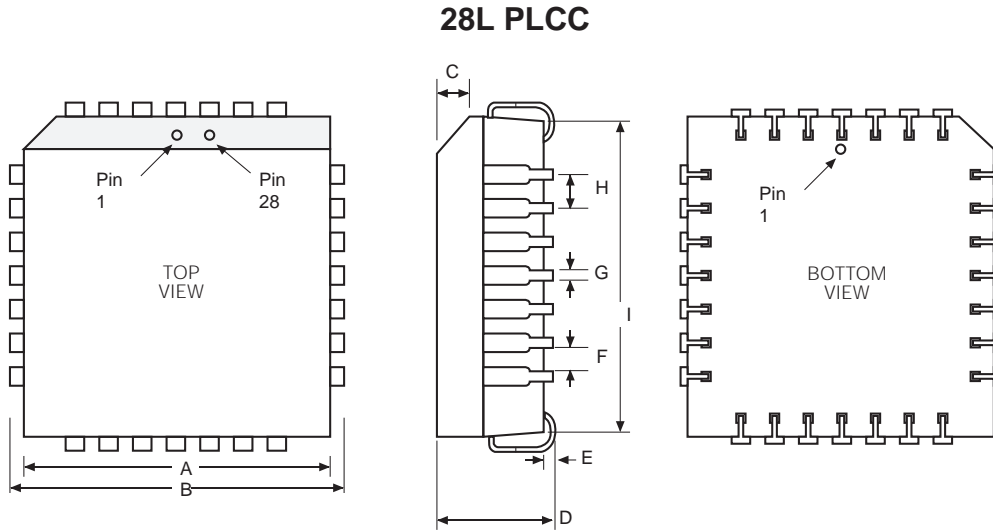
28L Plastic DIP



SYMBOL	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A		0.200		5.08
B	0.120	0.135	3.05	3.43
C		0.020		0.51
D		0.100		2.54
E		0.067		1.70
F		0.013		0.33
G	0.170	0.180	4.32	4.57
H		0.622		15.80
I		0.555		14.10
J		1.460		37.08
K		0.085		2.16

# 12-Bit, 100MSPS TTL DAC

Package Information (continued)



SYMBOL	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.450	0.456	11.43	11.58
B	0.485	0.495	12.32	12.57
C	45°		45°	
D	0.165	0.175	4.19	4.45
E		0.010		0.25
F	0.022 typ		.56 typ	
G	0.18 typ		4.57 typ	
H	0.05 typ		1.27 typ	
I	0.039	0.430	0.99	10.92