

# MAXIM

## 660ns $\mu$ P-Compatible, 8-Bit ADC with Track/Hold

**MX7821**

### General Description

The MX7821 high-speed, microprocessor-compatible ( $\mu$ P), 8-bit analog-to-digital converter (ADC) is a plug-in upgrade for the industry-standard 7820. The MX7821 uses a half-flash technique, resulting in a 660ns conversion time vs. 1.36 $\mu$ s for the 7820. A V<sub>SS</sub> pin, not supplied by the 7820, supports dual power supplies and bipolar analog inputs.

The MX7821 has track-and-hold function capable of digitizing a 100kHz signal, and is tested for both its static and dynamic capability. The converter- $\mu$ P interface appears as a memory location or input/output port that requires no external interface logic. The data outputs use latched, three-state buffered circuitry for direct connection to a  $\mu$ P data bus or system input port. The MX7821 has an overflow output for cascading devices to attain higher resolution. The ADC's input/reference arrangement enables ratiometric operation. For a detailed description of MX7821 operation, refer to the MX7820 data sheet.

### Applications

- Digital-Signal Processing
- High-Speed Data Acquisition
- Telecommunications
- High-Speed Servo Loops
- Audio Systems

### Features

- ◆ 660ns Conversion Time
- ◆ 20-Pin Narrow DIP Package
- ◆ No External Clock
- ◆ Pin-Compatible Upgrade for Industry-Standard 7820
- ◆ 100kHz Input Signal Bandwidth
- ◆ Bipolar/Unipolar Inputs
- ◆ Single +5V or Dual  $\pm$ 5V Supplies
- ◆ Ratiometric Reference Inputs
- ◆ Static and Dynamic Tested
- ◆ Internal Track/Hold

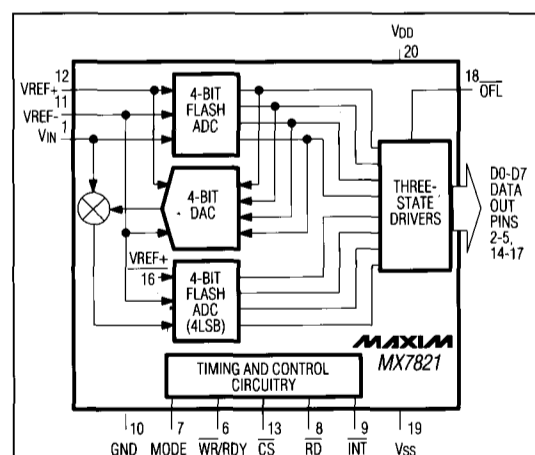
### Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MX7821KN	0°C to +70°C	20 Plastic DIP
MX7821KR	0°C to +70°C	20 Wide SO
MX7821KP	0°C to +70°C	20 PLCC
MX7821K/D	0°C to +70°C	Dice*
MX7821BQ	-40°C to +85°C	20 CERDIP
MX7821KEWP	-40°C to +85°C	20 Wide SO
MX7821TE	-55°C to +125°C	20 LCC**
MX7821TQ	-55°C to +125°C	20 CERDIP**

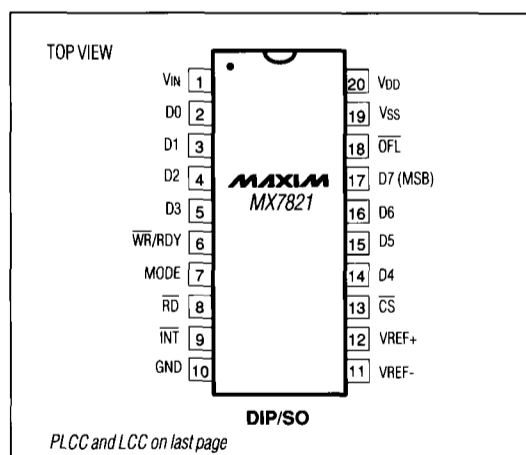
\* Contact factory for dice specifications.

\*\* Contact factory for availability and processing to MIL-STD-883.

### Functional Diagram



### Pin Configurations


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### ABSOLUTE MAXIMUM RATINGS

V <sub>DD</sub> to GND	-0.3V to +7V
V <sub>SS</sub> to GND	+0.3V to -7V
Digital Output Voltage to GND (Pins 2-5, 9, 14-16, 18)	-0.3V to V <sub>DD</sub> +0.3V
VREF+ to AGND	V <sub>SS</sub> -0.3V to V <sub>DD</sub> +0.3V
VREF- to AGND	V <sub>SS</sub> -0.3V to V <sub>DD</sub> +0.3V
V <sub>IN</sub> to GND	V <sub>SS</sub> -0.3V to V <sub>DD</sub> +0.3V
Continuous Power Dissipation (any package) to +75°C	1000mW
derate above +75°C by	10mW/°C

### Operating Temperature Ranges:

MX7821K	0°C to +70°C
MX7821B	-40°C to +85°C
MX7821T	-55°C to +125°C
Storage Temperature Range	-65°C to +150°C
Lead Temperature (soldering, 10 sec)	+300°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>DD</sub> = +5V  $\pm$ 5%; GND = 0V; Unipolar Input Range: V<sub>SS</sub> = 0V, VREF+ = 5V, VREF- = 0V; Bipolar Input Range: V<sub>SS</sub> = -5V  $\pm$ 5%, VREF+ = 2.5V, VREF- = -2.5V; specifications apply for RD mode, Pin 7 = 0V; T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>UNIPOLAR INPUT RANGE</b>						
Resolution	N		8			Bits
Total Unadjusted Error (Note 2)	TUE				$\pm 1$	LSB
No Missing Codes Resolution			8			Bits
<b>BIPOLAR INPUT RANGE</b>						
Resolution	N		8			Bits
Zero-Code Error					$\pm 1$	LSB
Full-Scale Error					$\pm 1$	LSB
Signal-to-Noise Ratio	SNR	V <sub>IN</sub> = 99.85kHz full-scale sine wave with f <sub>SAMPLING</sub> = 500kHz	45			dB
Total Harmonic Distortion	THD	V <sub>IN</sub> = 99.85kHz full-scale sine wave with f <sub>SAMPLING</sub> = 500kHz			-50	dB
Peak Harmonic or Spurious Noise		V <sub>IN</sub> = 99.85kHz full-scale sine wave with f <sub>SAMPLING</sub> = 500kHz			-50	dB
Intermodulation Distortion	IMD	f <sub>a</sub> (84.72kHz) and f <sub>b</sub> (94.97kHz) full-scale sine waves with f <sub>SAMPLING</sub> = 500kHz	2nd-order terms		-50	dB
			3rd-order terms		-50	
Slew Rate, Tracking				2.36	1.6	V/ $\mu$ s
<b>REFERENCE INPUT</b>						
Input Resistance		Resistance between VREF+ and VREF-	1		4	k $\Omega$
VREF+ Input Range			VREF-		V <sub>DD</sub>	V
VREF- Input Range			V <sub>SS</sub>		VREF+	V
<b>ANALOG INPUT</b>						
Input Voltage Range			VREF-		VREF+	V
Input Leakage Current		-5V $\leq$ V <sub>IN</sub> $\leq$ 5V			$\pm 3$	$\mu$ A
Input Capacitance	C <sub>IN</sub>			32		pF

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### ELECTRICAL CHARACTERISTICS (continued)

(V<sub>DD</sub> = +5V  $\pm$ 5%; GND = 0V; Unipolar Input Range: V<sub>SS</sub> = 0V, VREF+ = 5V, VREF- = 0V; Bipolar Input Range: V<sub>SS</sub> = -5V  $\pm$ 5%, VREF+ = 2.5V, VREF- = -2.5V; specifications apply for RD mode, Pin 7 = 0V; T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>LOGIC INPUTS</b>						
Input High Voltage	V <sub>INH</sub>	CS, WR, RD	2.4			V
		MODE	3.5			
Input Low Voltage	V <sub>INL</sub>	CS, WR, RD			0.8	V
		MODE			1.5	
Input High Current	I <sub>INH</sub>	CS, RD			1	$\mu$ A
		WR			3	
		MODE	50		200	
Input Low Current	I <sub>INL</sub>				-1	$\mu$ A
Input Capacitance (Note 3)	C <sub>IN</sub>			5	8	pF
<b>LOGIC OUTPUTS</b>						
Output Low Voltage	V <sub>OL</sub>	D7-D0, INT, OFL; I <sub>SINK</sub> = 1.6mA			0.4	V
		RDY; I <sub>SINK</sub> = 2.6mA			0.4	
Output High Voltage	V <sub>OH</sub>	D7-D0, INT, OFL; I <sub>SOURCE</sub> = -360 $\mu$ A	4.0			V
Floating State Leakage Current	I <sub>LKG</sub>	D7-D0, RDY			$\pm$ 3	$\mu$ A
Floating State Output Capacitance (Note 3)	C <sub>OUT</sub>	D7-D0, RDY		5	8	pF
<b>POWER REQUIREMENTS</b>						
Supply Current	I <sub>DD</sub>	CS = RD = 0V	MX7821K		15	mA
			MAX7821B/T		20	
	I <sub>SS</sub>				100	$\mu$ A
Power Dissipation	P <sub>D</sub>			50		mW
Power-Supply Sensitivity	PSR	V <sub>DD</sub> = 4.75V to 5.25V, VREF+ = 4.75V MAX for unipolar mode		$\pm$ 1/16	$\pm$ 1/4	LSB

**Note 1:** Performance over power-supply tolerance guaranteed by power-supply rejection test.

**Note 2:** Total Unadjusted Error includes relative accuracy, zero-code error, and full-scale error.

**Note 3:** Guaranteed by design.

### TIMING CHARACTERISTICS

(V<sub>DD</sub> = +5V, V<sub>SS</sub> = 0V or -5V, Unipolar or Bipolar Input Range, T<sub>A</sub> = +25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
CS to RD/WR Setup Time	t <sub>CSS</sub>		0			ns
CS to RD/WR Hold Time	t <sub>CSH</sub>		0			ns
CS to RDY Delay (Note 4)	t <sub>RDY</sub>	T <sub>A</sub> = +25°C			70	ns
		T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	MX7821B/K		85	
			MX7821T		100	
Conversion Time (RD Mode)	t <sub>CRD</sub>	T <sub>A</sub> = +25°C			700	ns
		T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	MX7821B/K		875	
			MX7821T		975	

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### TIMING CHARACTERISTICS (continued)

(V<sub>DD</sub> = +5V, V<sub>SS</sub> = 0V or -5V, Unipolar or Bipolar Input Range, T<sub>A</sub> = +25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Data-Access Time (RD Mode) (Note 5)	t <sub>ACC0</sub>	T <sub>A</sub> = +25°C, C <sub>L</sub> = 20pF			t <sub>CRD</sub> +25	ns
		T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> , C <sub>L</sub> = 20pF	MX7821B/K		t <sub>CRD</sub> +30	
			MX7821T		t <sub>CRD</sub> +35	
		T <sub>A</sub> = +25°C, C <sub>L</sub> = 100pF	MX7821B/K		t <sub>CRD</sub> +50	
MX7821T			t <sub>CRD</sub> +75			
RD to INT Delay (RD Mode)	t <sub>INTH</sub>	T <sub>A</sub> = +25°C, C <sub>L</sub> = 50pF		50	80	ns
		T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> , C <sub>L</sub> = 50pF	MX7821B/K		85	
			MX7821T		90	
Data-Hold Time (Note 6)	t <sub>DH</sub>	T <sub>A</sub> = +25°C			60	ns
		T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	MX7821B/K		70	
			MX7821T		80	
Delay Time Between Conversions	t <sub>p</sub>	T <sub>A</sub> = +25°C		350		ns
		T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	MX7821B/K		425	
			MX7821T		500	
Write Pulse Width	t <sub>WR</sub>	T <sub>A</sub> = +25°C		0.250	10	μs
		T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	MX7821B/K		0.325	
			MX7821T		0.400	10
Delay Time Between WR and RD Pulses	t <sub>RD</sub>	T <sub>A</sub> = +25°C		250		ns
		T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	MX7821B/K		350	
			MX7821T		450	
RD Pulse Width (WR-RD Mode) Determined by t <sub>ACC1</sub>	t <sub>READ1</sub>	T <sub>A</sub> = +25°C (Figure 3)		160		ns
		T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> (Figure 3)	MX7821B/K		205	
			MX7821T		240	
Data-Access Time (WR-RD Mode) (Note 5)	t <sub>ACC1</sub>	T <sub>A</sub> = +25°C, C <sub>L</sub> = 20pF (Figure 3) (Note 3)			160	ns
		T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> , C <sub>L</sub> = 20pF (Figure 3) (Note 3)	MX7821B/K		205	
			MX7821T		240	
		T <sub>A</sub> = +25°C, C <sub>L</sub> = 100pF (Figure 3)	MX7821B/K		185	
MX7821T			275			
RD to INT Delay	t <sub>RI</sub>	T <sub>A</sub> = +25°C			150	ns
		T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	MX7821B/K		185	
			MX7821T		220	
WR to INT Delay	t <sub>INTL</sub>	T <sub>A</sub> = +25°C, C <sub>L</sub> = 50pF		380	500	ns
		T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> , C <sub>L</sub> = 50pF	MX7821B/K		610	
			MX7821T		700	

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### TIMING CHARACTERISTICS (continued)

(V<sub>DD</sub> = +5V, V<sub>SS</sub> = 0V or -5V, Unipolar or Bipolar Input Range, T<sub>A</sub> = +25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
RD Pulse Width (WR-RD Mode) Determined by t <sub>ACC2</sub>	t <sub>READ2</sub>	T <sub>A</sub> = +25°C (Figure 4)			65	ns
		T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> (Figure 4)	MX7821B/K		75	
			MX7821T		85	
Data-Access Time (WR-RD Mode) (Note 5)	t <sub>ACC2</sub>	T <sub>A</sub> = +25°C, C <sub>L</sub> = 20pF (Figure 4) (Note 3)			65	ns
		T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> , C <sub>L</sub> = 20pF (Note 3)	MX7821B/K		75	
			MX7821T		85	
		T <sub>A</sub> = +25°C, C <sub>L</sub> = 100pF (Figure 4)			90	
		T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> , C <sub>L</sub> = 100pF (Figure 4)	MX7821B/K		110	
MX7821T			130			
WR to INT Delay (Stand-Alone Operation)	t <sub>IHWR</sub>	T <sub>A</sub> = +25°C, C <sub>L</sub> = 50pF			80	ns
		T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> , C <sub>L</sub> = 50pF	MX7821B/K		100	
			MX7821T		120	
Data-Access Time After INT (Stand-Alone Operation) (Note 5)	t <sub>ID</sub>	T <sub>A</sub> = +25°C, C <sub>L</sub> = 20pF (Note 3)			30	ns
		T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> , C <sub>L</sub> = 20pF (Note 3)	MX7821B/K		35	
			MX7821T		40	
		T <sub>A</sub> = +25°C, C <sub>L</sub> = 100pF			45	
		T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> , C <sub>L</sub> = 100pF	MX7821B/K		60	
MX7821T			70			

**Note 3:** Guaranteed by design.

**Note 4:** C<sub>L</sub> = 50pF and R<sub>L</sub> = 5k $\Omega$  pull-up resistor.

**Note 5:** See Figure 1 for load circuit. Parameter defined as the time required for the output to cross +0.8V or +2.4V.

**Note 6:** See Figure 2 for load circuit. Parameter defined as the time required for data lines to change 0.5V.

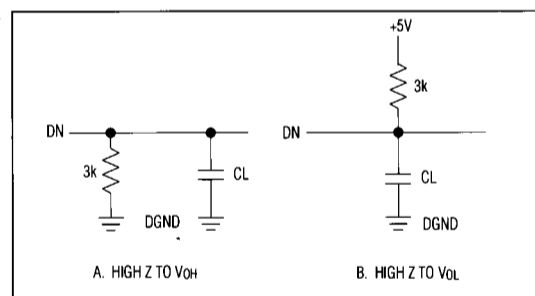


Figure 1. Load Circuits for Data-Access Time Test

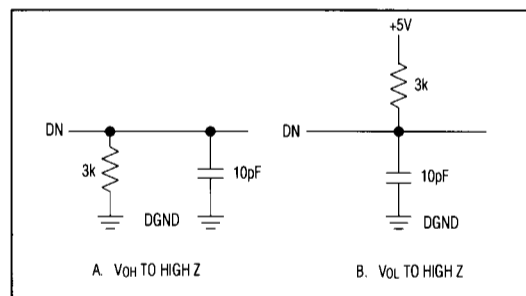


Figure 2. Load Circuits for Data-Hold Time Test

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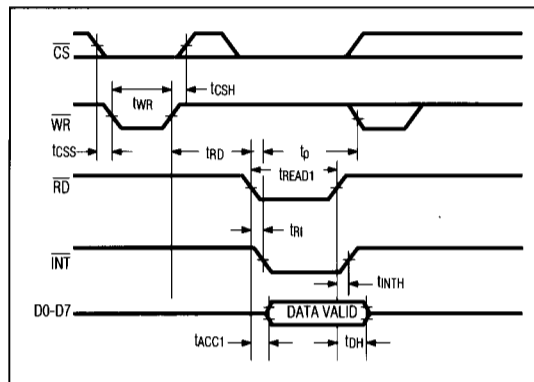


Figure 3. WR-RD Mode Timing ( $t_{RD} < t_{INTL}$ )

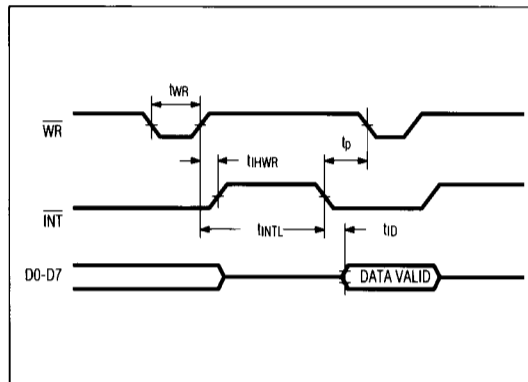


Figure 6. WR-RD Mode Stand-Alone Operation ( $CS = \overline{RD} = 0$ )

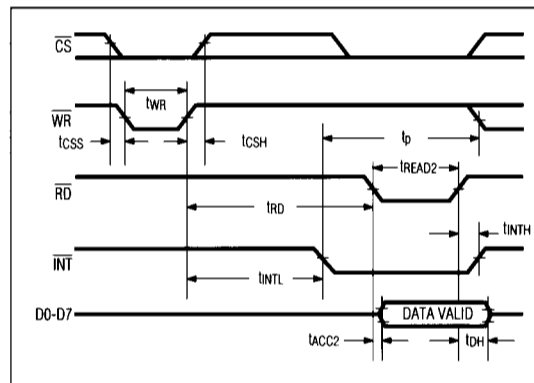


Figure 4. WR-RD Mode Timing ( $t_{RD} > t_{INTL}$ )

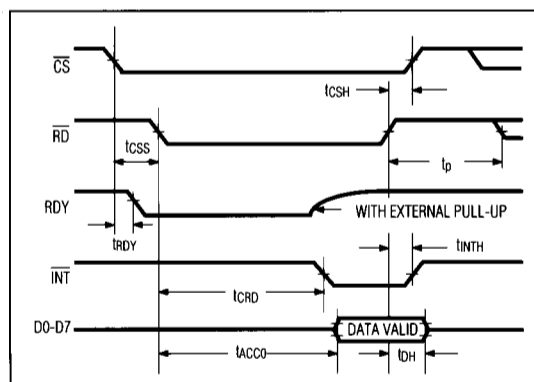
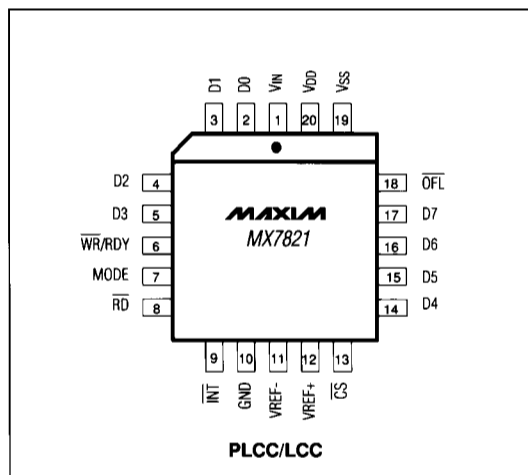


Figure 5. RD Mode

**Pin Configurations (continued)**

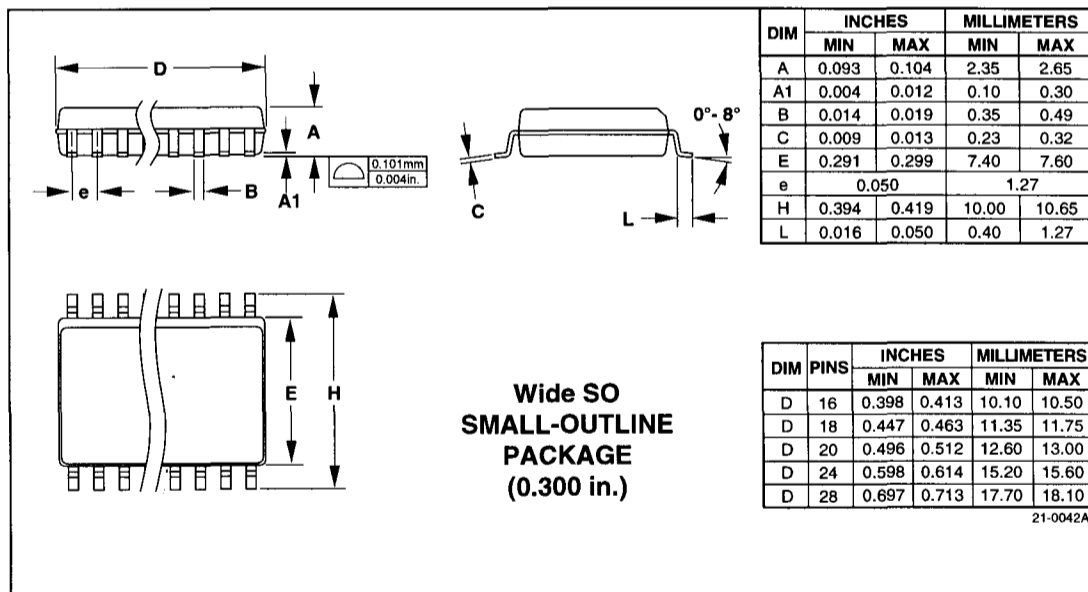
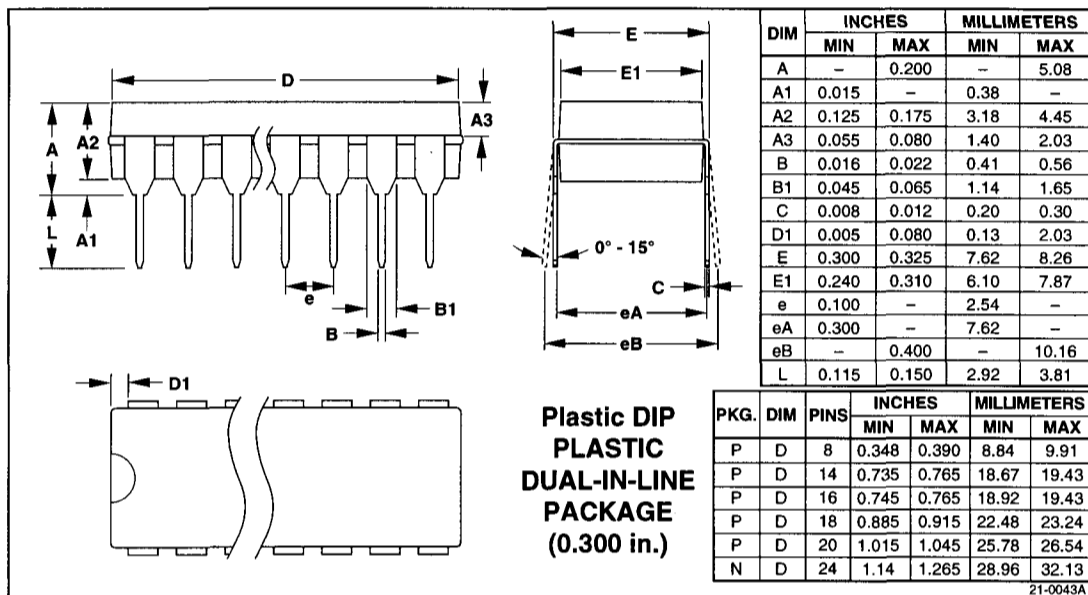


**For application information, refer to the MX7820 data sheet.**

## 660ns $\mu$ P-Compatible, 8-Bit ADC with Track/Hold

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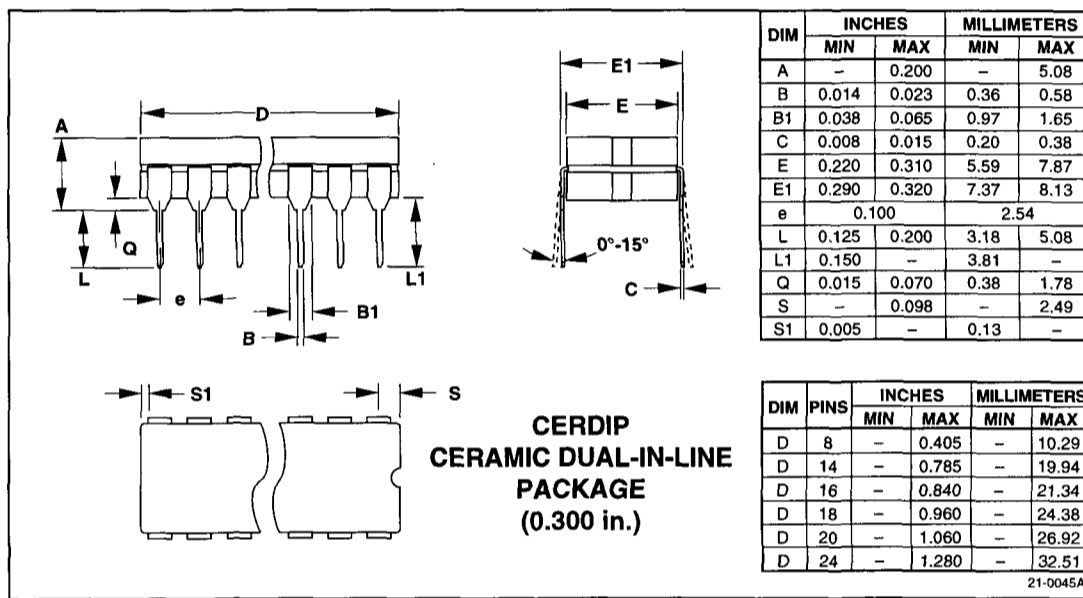
### Package Information



MX7821

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**Package Information (continued)**



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