Single/Dual, Ultra-Fast, Low-Power Precision TTL Comparators

ABSOLUTE MAXIMUM RATINGS

Positive Supply Voltage ....+7V
Negative Supply Voltage ....-7V
V+ to V- ....+13V
Differential Input Voltage ....+15V
Input Voltage (Referred to V-) ....-0.3V to +14V
Latch Pin Voltage ....Equal to Supplies
Continuous Output Current...±20mA
Continuous Power Dissipation (T$_A$ = +70°C)
   8-Pin Plastic DIP (derate 9.09mW/°C above +70°C) ...727mW

8-Pin SO (derate 5.88mW/°C above +70°C)................471mW
8-Pin μMAX (derate 4.5mW/°C above +70°C) 362mW
16-Pin Plastic DIP (derate 10.53mW/°C above +70°C)842mW
16-Pin Narrow SO (derate 8.70mW/°C above +70°C) .696mW
Operating Temperature Ranges:
MAX91_C_ _ ....0°C to +70°C
MAX91_E_ _ ....-40°C to +85°C
Storage Temperature Range ....-65°C to +150°C
Lead Temperature (soldering, 10s) ....+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+ = +5V, V- = -5V, V$_Q$ = 1.4V, V$_{LE}$ = 0V, T$_A$ = T$_{MIN}$ to T$_{MAX}$, unless otherwise noted. Typical values are at T$_A$ = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Input Offset Voltage (Note 2)	V$_{OS}$	R$_S$ ≤ 100Ω	T$_A$ = +25°C		0.1	2	mV
			T$_A$ = T$_{MIN}$ TO T$_{MAX}$			3	
Offset Drift	TCV$_{OS}$				2		μV/°C
Input Offset Current (Note 2)	I$_{OS}$	T$_A$ = +25°C			0.3	0.5	μA
		T$_A$ = T$_{MIN}$ TO T$_{MAX}$				1	
Input Bias Current	I$_B$	T$_A$ = +25°C			2	5	μA
		C, E temperature ranges				8	
Input Voltage Range	V$_{CM}$	C, E temperature ranges		-5.2		+3.5	V
		Single +5V	C, E temperature ranges	-0.2		+3.5	
Common-Mode Rejection Ratio	CMRR	-5.0V ≤ V$_{CM}$ ≤ +3.5V		80	110		dB
Power-Supply Rejection Ratio	PSRR	Positive supply; 4.5V ≤ V+ ≤ 5.5V		60	85		dB
		Negative supply; -2V ≥ V- ≥ -7V		80	100		
Small-Signal Voltage Gain	A$_V$	1V ≤ V$_Q$ ≤ 2V, T$_A$ = +25°C		1500	3500		V/V
Output Voltage	V$_{OH}$	V+ ≥ 4.5V	I$_{OUT}$ = 1mA	2.7	3.4		V
			I$_{OUT}$ = 10mA	2.4	3.0		
	V$_{OL}$	I$_{SINK}$ = 4mA			0.3	0.5	
		T$_A$ = +25°C, I$_{SINK}$ = 10mA			0.4		
Positive Supply Current Per Comparator (Note 3)	I+	C, E temperature ranges			6	10	mA
Negative Supply Current Per Comparator (Note 3)	I-				1	2	mA
Latch-Pin High Input Voltage	V$_{IH}$			2.0			V
Latch-Pin Low Input Voltage	V$_{IL}$					0.8	V
Latch-Pin Current	I$_{IL}$	V$_{LE}$ = 0V			-1	-20	μA

MAXIM

Single/Dual, Ultra-Fast, Low-Power
Precision TTL Comparators

ELECTRICAL CHARACTERISTICS (continued)

V+ = +5V, V- = -5V, V_Q = 1.4V, V_{LE} = 0V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS			MIN	TYP	MAX	UNITS
Propagation Delay (Note 4)	t_{PD+}, t_{PD-}	ΔV_{IN} = 100mV, V_{OD} = 5mV	T_A = +25°C			10	14	ns
			T_A = T_{MIN} TO T_{MAX}				16	
		ΔV_{IN} = 100mV, V_{OD} = 20mV	T_A = +25°C			9	12	
			T_A = T_{MIN} TO T_{MAX}				15	
Differential Propagation Delay (Note 4)	Δt_{PD}	ΔV_{IN} = 100mV, V_{OD} = 5mV	T_A = +25°C	MAX913		2	4	ns
				MAX912		3	5	
Channel-to-Channel Propagation Delay (Note 4)		ΔV_{IN} = 100mV, V_{OD} = 5mV (MAX912 only)	T_A = +25°C			500		ps
Latch Setup Time (Note 5)	t_{SU}				2	0		ns
Latch Hold Time (Note 5)	t_H				5	2		ns
Latch Propagation Delay (Note 6)	t_{LPD}					7		ns

Note 1: All specifications are 100% tested at T_A = +25°C, unless otherwise noted. Specification limits over temperature (T_A = T_{MIN} to T_{MAX}) are guaranteed by design.

Note 2: Input Offset Voltage (V_{OS}) is defined as the average of the two input offset voltages, measured by forcing first one output, then the other to 1.4V. Input Offset Current (I_{OS}) is defined the same way.

Note 3: Supply currents are measured with V_Q driven to both V_{OH} and V_{OL} (not 1.4V).

Note 4: Propagation Delay (t_{PD}) and Differential Propagation Delay (Δt_{PD}) cannot be measured in automatic handling equipment with low input overdrive values. Characterization and correlation tests have shown that t_{PD} and Δt_{PD} limits can be guaranteed by design. Electrical Characteristic DC tests are performed to guarantee that all internal bias conditions are correct. For low overdrive conditions, V_{OS} is added to overdrive. Differential Propagation Delay is defined as Δt_{PD} = t_{PD+} - t_{PD-}.
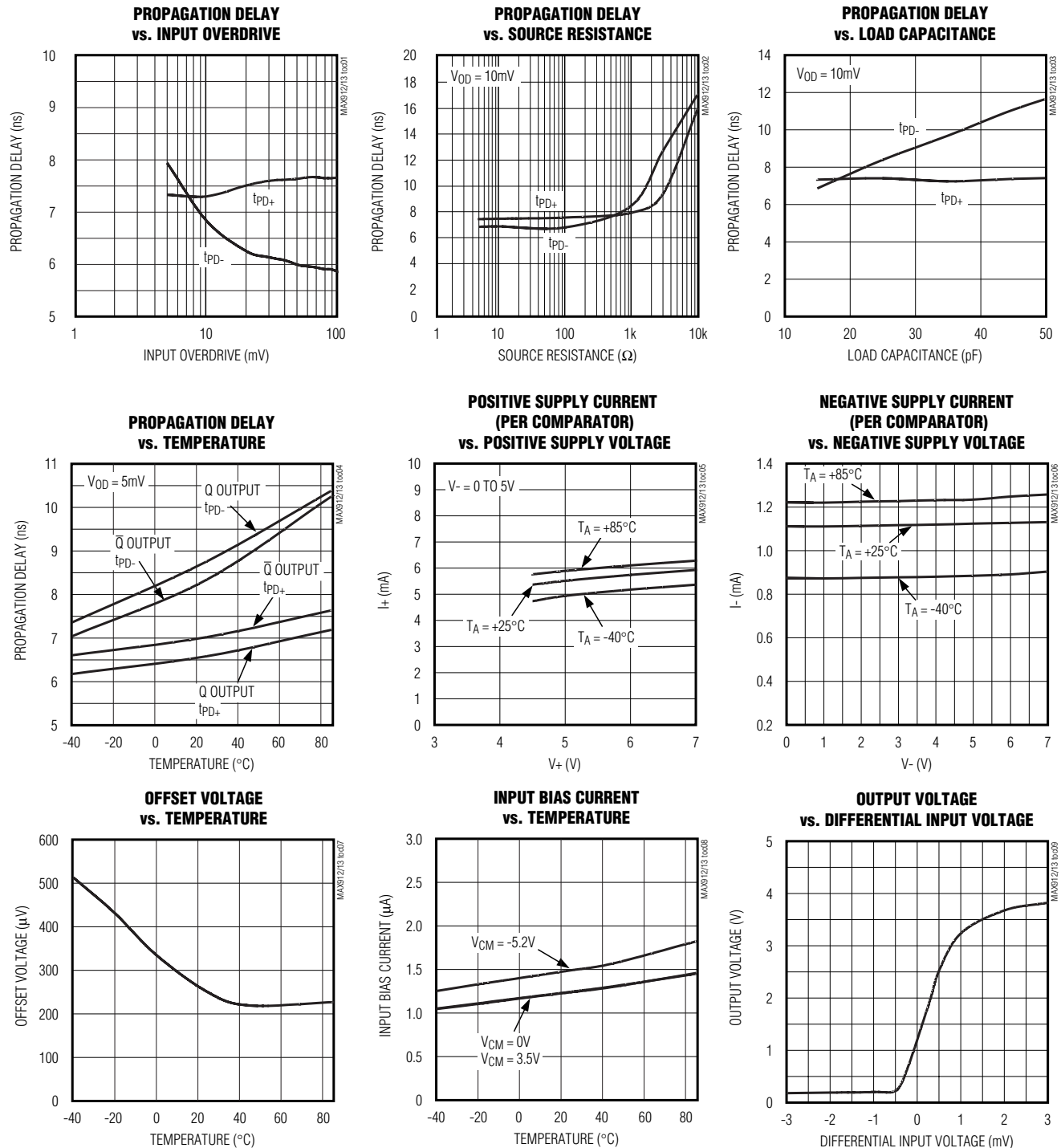
Note 5: Input latch setup time (t_{SU}) is the interval in which the input signal must be stable prior to asserting the latch signal. The hold time (t_H) is the interval after the latch is asserted in which the input signal must be stable. These parameters are guaranteed by design.

Note 6: Latch Propagation Delay (t_{LPD}) is the delay time for the output to respond when the latch-enable pin is deasserted (see *Timing Diagram*).

MAXIM _____ 3

Single/Dual, Ultra-Fast, Low-Power
Precision TTL Comparators

_____Typical Operating Characteristics

(V+ = +5V, V- = -5V, V_{LE} = 0V, C_L = 15pF, T_A = +25°C, unless otherwise noted.)

PROPAGATION DELAY
vs. INPUT OVERDRIVE

PROPAGATION DELAY
vs. SOURCE RESISTANCE

PROPAGATION DELAY
vs. LOAD CAPACITANCE

PROPAGATION DELAY
vs. TEMPERATURE

POSITIVE SUPPLY CURRENT
(PER COMPARATOR)
vs. POSITIVE SUPPLY VOLTAGE

NEGATIVE SUPPLY CURRENT
(PER COMPARATOR)
vs. NEGATIVE SUPPLY VOLTAGE

OFFSET VOLTAGE
vs. TEMPERATURE

INPUT BIAS CURRENT
vs. TEMPERATURE

OUTPUT VOLTAGE
vs. DIFFERENTIAL INPUT VOLTAGE

4 _____

MAXIM

Single/Dual, Ultra-Fast, Low-Power
Precision TTL Comparators

_____Typical Operating Characteristics (continued)

(V+ = +5V, V- = -5V, V$_{LE}$ = 0V, C$_L$ = 15pF, T$_A$ = +25°C, unless otherwise noted.)
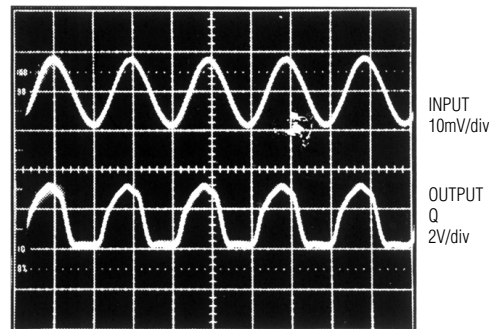
POSITIVE-TO-NEGATIVE PROPAGATION DELAY

INPUT
100mV/div

OUTPUT
$\overline{Q}$

1V/div

Q
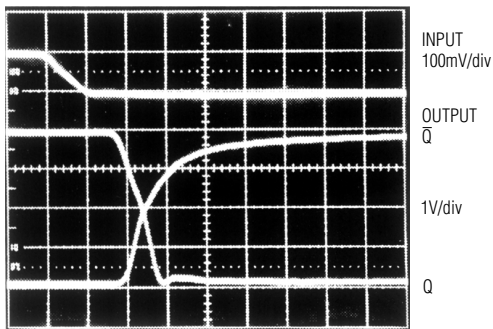
5ns/div

NEGATIVE-TO-POSITIVE PROPAGATION DELAY

INPUT
100mV/div

OUTPUT
Q

1V/div

$\overline{Q}$
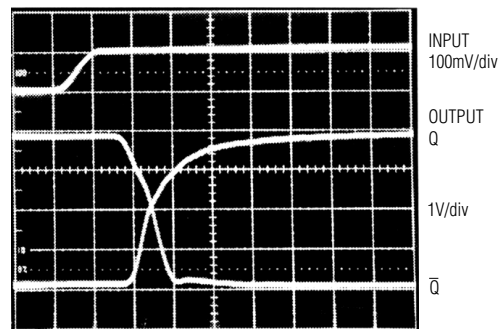
5ns/div

MAX912/MAX913 RESPONSE TO
50MHZ (±10mV$_{P-P}$) SINE WAVE

INPUT
10mV/div

OUTPUT
Q
2V/div

10ns/div

MAX912/MAX913 RESPONSE TO SLOW-MOVING TRIANGLE WAVE

MAX912/MAX913 RESPONSE

INPUT
20mV/div

OUTPUT
Q
1V/div

$\overline{Q}$
1V/div
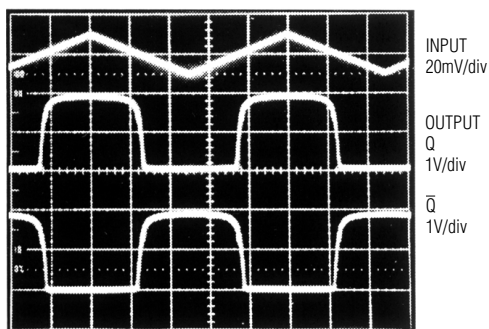
20µs/div

INDUSTRY-STANDARD
686 RESPONSE
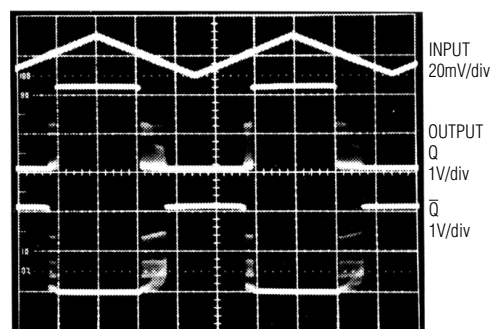
INPUT
20mV/div

OUTPUT
Q
1V/div

$\overline{Q}$
1V/div

20µs/div

MAX912/MAX913

PIN	NAME	FUNCTION
1	QA	Comparator A TTL Output
2	$\overline{\text{QA}}$	Comparator A Complementary TTL Output
3, 14	GND	Logic Ground. Connect **both** GND pins to ground.
4	LEA	Comparator A Latch Enable. QA and $\overline{\text{QA}}$ are latched when LEA is TTL high or floating. Comparator A latch is transparent when LEA is low.
5, 12	N.C.	No Connection. Not internally connected.
6	V-	Negative Power Supply. -5V for dual supplies (bypass to GND with a 0.1µF capacitor) or GND for a single supply.
7	INA-	Comparator A Inverting Input
8	INA+	Comparator A Noninverting Input
9	INB+	Comparator B Noninverting Input
10	INB-	Comparator B Inverting Input
11	V+	Positive Power Supply, +5V. Bypass to GND with a 0.1µF capacitor.
13	LEB	Comparator B Latch Enable. QB and $\overline{\text{QB}}$ are latched when LEB is TTL high or floating. Comparator B latch is transparent when LEB is low.
15	$\overline{\text{QB}}$	Comparator B Complementary TTL Output
16	QB	Comparator B TTL Output

PIN	NAME	FUNCTION
1	V+	Positive Power Supply. Bypass to GND with a 0.1µF capacitor.
2	IN+	Noninverting Input
3	IN-	Inverting Input
4	V-	Negative Power Supply. -5V for dual supplies (bypass to GND with a 0.1µF capacitor) or GND for a single supply.
5	LE	Latch Enable. Q and $\overline{\text{Q}}$ are latched when LE is TTL high or floating. The comparator latch is transparent when LE is low.
6	GND	Logic Ground
7	Q	TTL Output
8	$\overline{\text{Q}}$	Complementary TTL Output

MAXIM

Detailed Description

The MAX912 (dual) and MAX913 (single) high-speed comparators have a unique design that prevents oscillation when the comparator is in its linear region. No minimum input slew rate is required.

Many high-speed comparators oscillate in the linear region, as shown in the *Typical Operating Characteristics'* industry-standard 686 response graph. One way to overcome this oscillation is to sample the output after it has passed through the unstable region. Another practical solution is to add hysteresis. Either solution results in a loss of resolution and bandwidth.

Because the MAX912/MAX913 do not need hysteresis, they offer high resolution to all signals—including low-frequency signals.

The MAX912/MAX913 provide a TTL-compatible latch function that holds the comparator output state (Figure 1). As long as Latch Enable (LE) is high or floating, the input signal has no effect on the output state. With LE low, the outputs are controlled by the input differential voltage and the latch is transparent.

Input Amplifier

A comparator can be thought of as having two sections; an input amplifier and a logic interface. The MAX912/MAX913's input amplifier is fully differential with input offset voltage trimmed to below 2.0mV at +25°C. Input common-mode range extends from 200mV **below** the negative supply rail to 1.5V below the positive power supply. The total common-mode range is 8.7V when operating from ±5VDC supplies.

The MAX912/MAX913's amplifier has no built-in hysteresis. For highest accuracy, do not add hysteresis. Figure 2 shows how hysteresis degrades resolution.

Resolution

A comparator's ability to resolve small signal differences—its resolution—is affected by various factors. As with most amplifiers, the most significant factors are the input offset voltage (V_{OS}) and the common-mode and power-supply rejection ratios (CMRR, PSRR). If source impedance is high, input offset current can be significant. If source impedance is unbalanced, the input bias current can introduce another error.

For high-speed comparators, an additional factor in resolution is the comparator's stability in its linear region. Many high-speed comparators are useless in their linear region because they oscillate. This makes the differential input voltage region around 0V unusable, as does a high V_{OS}. Hysteresis does not cure the problem, but acts to keep the input away from its linear range (Figure 2).

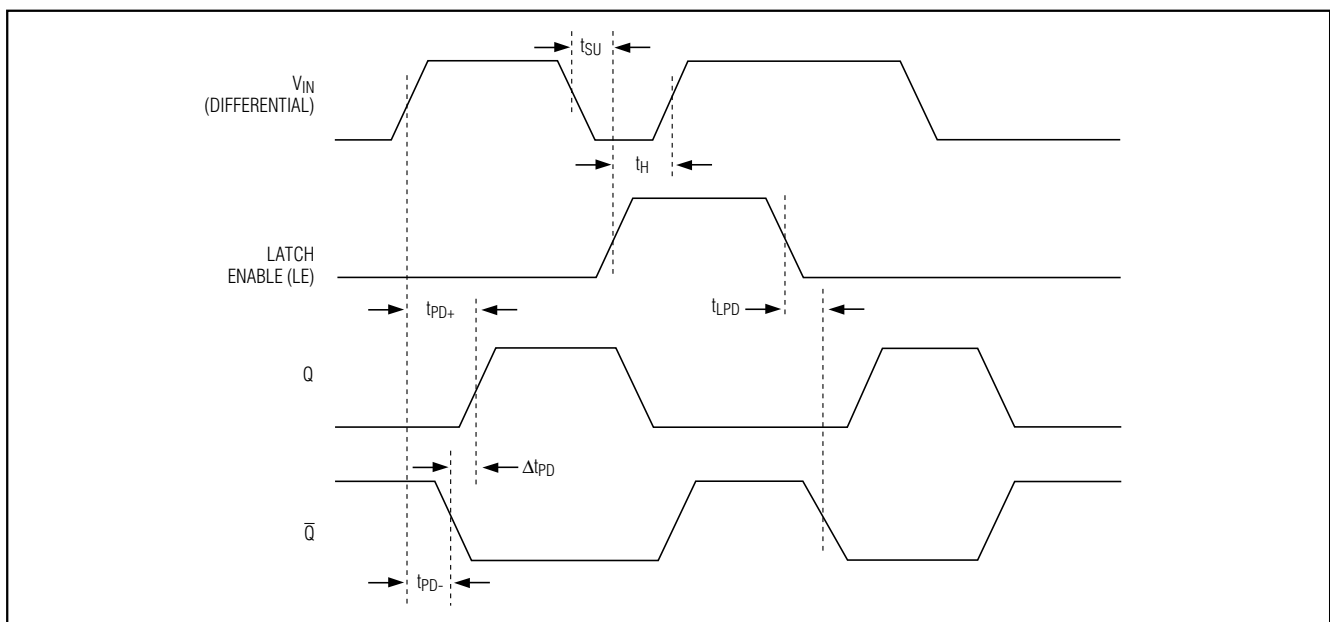The MAX912/MAX913 do not oscillate in the linear region, which greatly enhances the comparator's resolution.

Figure 1. Timing Diagram

MAX912/MAX913

Applications Information

Power Supplies and Bypassing

The MAX912/MAX913 are tested with ±5V power sup-plies that provide an input common-mode range (V_{CM}) of 8.7V (-5.2V to +3.5V). Operation from a single +5V supply provides a common-mode input range of 3.7V (-0.2V to +3.5). Connect V- to GND for single-supply operation. The MAX912/MAX913 will operate from a minimum single-supply voltage of +4.5V.

The V+ supply provides power to both the analog input stage and digital output circuits, whereas the V- supply only powers the analog section. Bypass V+ and V- to ground with 0.1µF to 1.0µF ceramic capacitors in parallel with 10µF or greater tantalum capacitors. Connect the ceramic capacitors very close to the MAX912/MAX913's supply pins, keeping leads short to minimize lead induc-tance. For particularly noisy applications, use ferrite beads on the power-supply lines.

Board Layout

As with all high-speed components, careful attention to layout is essential for best performance.

1) Use a printed circuit board with an unbroken ground plane.

2) Pay close attention to the bandwidth of bypass com-ponents and keep leads short.

3) Avoid sockets; solder the comparator and other components directly to the board to minimize unwanted parasitic inductance and capacitance.

Input Slew Rate

The MAX912/MAX913 design eliminates the input slew-rate requirement imposed on many standard compara-tors. As long as LE is high after the maximum propaga-tion delay and the input is greater than the comparator's total DC error, the output will be valid without oscillations.

Maximum Clock (LE) and Signal Rate

The maximum clock and signal rate is 70MHz, based on the comparator's rise and fall time with a 5mV over-drive at +25°C (Figure 1). With a 20mV overdrive, the maximum propagation delay is 12ns and the clock sig-nal rate is 85MHz.
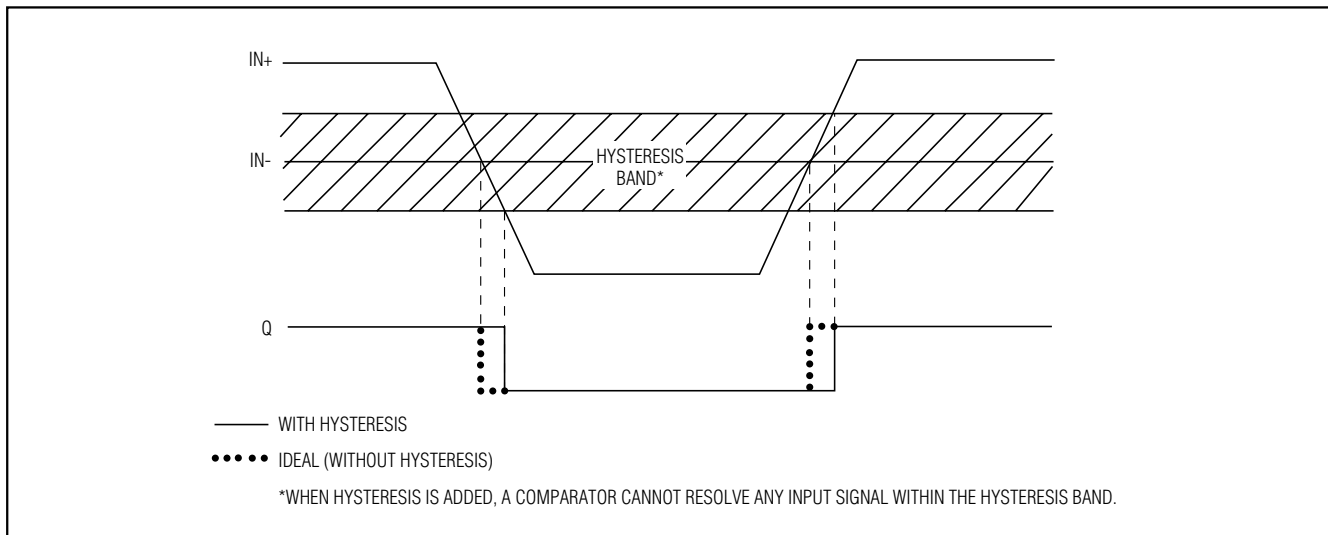

Figure 2. Effect of Hysteresis on Input Resolution

Chip Information

MAX912 TRANSISTOR COUNT: 285
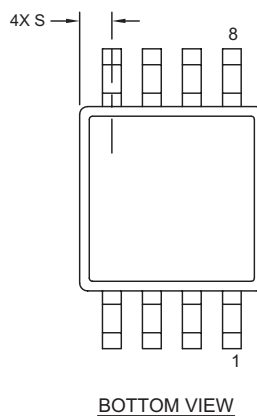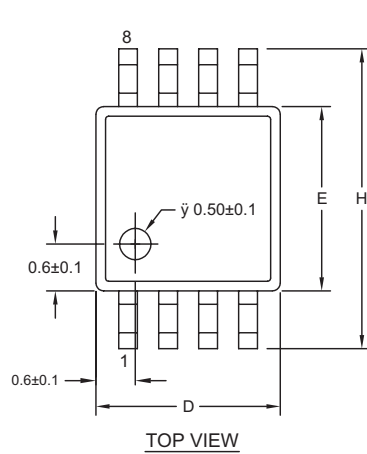
MAX913 TRANSISTOR COUNT: 154

PROCESS: Bipolar

MAXIM

MAX912/MAX913

Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to **www.maxim-ic.com/packages**.)

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	-	0.043	-	1.10
A1	0.002	0.006	0.05	0.15
A2	0.030	0.037	0.75	0.95
b	0.010	0.014	0.25	0.36
c	0.005	0.007	0.13	0.18
D	0.116	0.120	2.95	3.05
e	0.0256 BSC		0.65 BSC	
E	0.116	0.120	2.95	3.05
H	0.188	0.198	4.78	5.03
L	0.016	0.026	0.41	0.66
α	0∞	6∞	0∞	6∞
S	0.0207 BSC		0.5250 BSC	

TOP VIEW

BOTTOM VIEW

FRONT VIEW

SIDE VIEW

NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15MM (.006").
3. CONTROLLING DIMENSION: MILLIMETERS.
4. MEETS JEDEC MO−187C−AA.

DALLAS SEMICONDUCTOR **MAXIM**

PROPRIETARY INFORMATION

TITLE:
PACKAGE OUTLINE, 8L uMAX/uSOP

APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0036	J	1⁄1

MAXIM _____ 9

Single/Dual, Ultra-Fast, Low-Power
Precision TTL Comparators
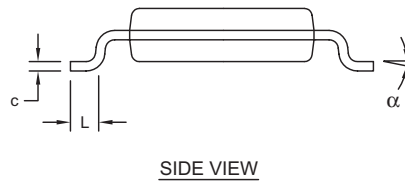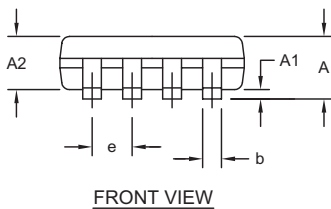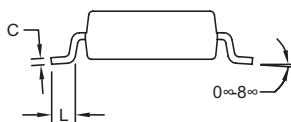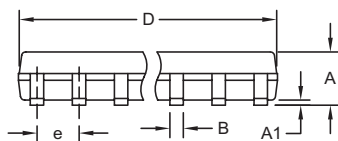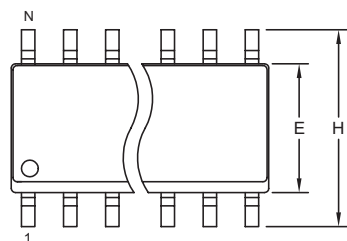
_____ Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to **www.maxim-ic.com/packages**.)

SOICN_.EPS

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.053	0.069	1.35	1.75
A1	0.004	0.010	0.10	0.25
B	0.014	0.019	0.35	0.49
C	0.007	0.010	0.19	0.25
e	0.050 BSC		1.27 BSC	
E	0.150	0.157	3.80	4.00
H	0.228	0.244	5.80	6.20
L	0.016	0.050	0.40	1.27

VARIATIONS:

	INCHES		MILLIMETERS			
DIM	MIN	MAX	MIN	MAX	N	MS012
D	0.189	0.197	4.80	5.00	8	AA
D	0.337	0.344	8.55	8.75	14	AB
D	0.386	0.394	9.80	10.00	16	AC

N

E H

1

TOP VIEW

D

A

e   B   A1

FRONT VIEW

C

0∝-8∝

L

SIDE VIEW

NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15mm (.006").
3. LEADS TO BE COPLANAR WITHIN 0.10mm (.004").
4. CONTROLLING DIMENSION: MILLIMETERS.
5. MEETS JEDEC MS012.
6. N = NUMBER OF PINS.

DALLAS SEMICONDUCTOR **MAXIM**

PROPRIETARY INFORMATION

TITLE:
PACKAGE OUTLINE, .150" SOIC

APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0041	B	1/1

MAXIM

MAX912/MAX913

Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to **www.maxim-ic.com/packages**.)

PDIPN.EPS

	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	---	0.180	---	4.572
A1	0.015	---	0.38	---
A2	0.125	0.175	3.18	4.45
A3	0.055	0.080	1.40	2.03
B	0.015	0.022	0.381	0.56
B1	0.045	0.065	1.14	1.65
C	0.008	0.014	0.2	0.355
D1	0.005	0.080	0.13	2.03
E	0.300	0.325	7.62	8.26
E1	0.240	0.310	6.10	7.87
e	0.100 BSC.		2.54 BSC.	
eA	0.300 BSC.		7.62 BSC.	
eB	0.400 BSC.		10.16 BSC.	
L	0.115	0.150	2.921	3.81

	INCHES		MILLIMETERS			
	MIN	MAX	MIN	MAX	N	MS001
D	0.348	0.390	8.84	9.91	8	AB
D	0.735	0.765	18.67	19.43	14	AC
D	0.745	0.765	18.92	19.43	16	AA
D	0.885	0.915	22.48	23.24	18	AD
D	1.015	1.045	25.78	26.54	20	AE
D	1.14	1.265	28.96	32.13	24	AF
D	1.360	1.380	34.54	35.05	28	✳5

NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15mm (.006")
3. CONTROLLING DIMENSION: MILLIMETER
4. MEETS JEDEC MS001-XX AS SHOWN IN ABOVE TABLE
5. SIMILIAR TO JEDEC MO-058AB
6. N = NUMBER OF PINS

MAXIM
120 SAN GABRIEL DR SUNNYVALE CA 94086 FAX (408) 737 7194
PROPRIETARY INFORMATION

PACKAGE FAMILY OUTLINE: PDIP .300"
TITLE

1/1

21-0043 D
DOCUMENT CONTROL NUMBER REV

Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.

Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086 408-737-7600 _____ **11**