



# Differential 5:1 or 4:1 ECL/PECL Multiplexers with Single/Dual Output Buffers

## General Description

The MAX9386/MAX9387/MAX9388 are fully differential, high-speed, low-jitter ECL/PECL multiplexers (muxes) with output buffer(s). The devices are designed for clock-and-data distribution applications, and feature extremely low propagation delays (318ps, typ) and output-to-output skews (3.9ps, typ). The MAX9386 is a 5:1 mux with a single output buffer. The MAX9387 is a 5:1 mux with dual output buffers, and is intended for use in redundant systems. The MAX9388 is a 4:1 mux with a single output buffer, and is pin compatible with the MC100EP57.

Three single-ended select inputs, SEL0, SEL1, and SEL2, control the mux function on the MAX9386/MAX9387. The MAX9388 has two select inputs, SEL0 and SEL1. The mux select inputs are compatible with ECL/PECL logic, and are internally referenced to the on-chip output V<sub>BB</sub>, nominally V<sub>CC</sub> - 1.425V. The select inputs accept signals between V<sub>CC</sub> and V<sub>EE</sub>. Internal pulldowns to V<sub>EE</sub> ensure a low-default condition if the select inputs are left open.

The differential inputs D<sub>+</sub>, D<sub>-</sub> can be configured to accept a single-ended signal when the unused complementary input is connected to the on-chip reference output V<sub>BB</sub>. All the differential inputs have internal bias and clamping circuits that ensure low-default output states when the inputs are left open.

The MAX9386/MAX9387/MAX9388 operate with a wide supply range |V<sub>CC</sub> - V<sub>EE</sub>| of 2.375V to 5.5V. The MAX9386/MAX9388 are offered in 20-pin TSSOP and QSOP packages. The MAX9387 is offered in 24-pin TSSOP and QSOP packages.

## Applications

High-Speed Telecom and Datacom Applications  
Central Office Backplane Clock Distribution  
DSLAM/DLC

## Features

- ◆ 318ps (typ) Propagation Delay
- ◆ >2.7GHz Toggle Frequency
- ◆ 0.3ps(RMS) Random Jitter
- ◆ <14ps (max) at +25°C Output-to-Output Skew (MAX9387)
- ◆ -2.375V to -5.5V Supplies for Differential LVECL/ECL
- ◆ +2.375V to +5.5V Supplies for Differential LVPECL/PECL
- ◆ Outputs Low for Open Inputs
- ◆ Dual Output Buffers (MAX9387)
- ◆ Pin Compatible with MC100EP57 (MAX9388EUP)
- ◆ >2kV ESD Protection (Human Body Model)

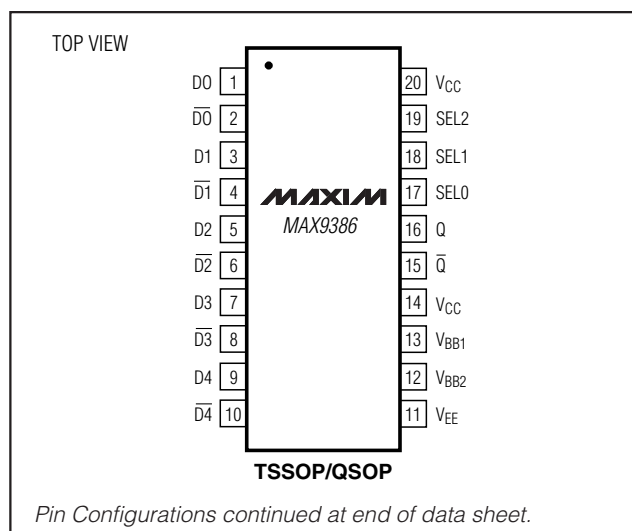
## Ordering Information

PART	TEMP RANGE	PIN-PACKAGE	SELECTION
MAX9386EUP	-40°C to +85°C	20 TSSOP	5:1 mux with 1 output buffer
MAX9386EEP*	-40°C to +85°C	20 QSOP	5:1 mux with 1 output buffer

Ordering Information continued at end of data sheet.

\*Future product—contact factory for availability.

## Pin Configurations



MAX9386/MAX9387/MAX9388



# Differential 5:1 or 4:1 ECL/PECL Multiplexers with Single/Dual Output Buffers

## ABSOLUTE MAXIMUM RATINGS

$V_{CC} - V_{EE}$  ..... -0.3V to +6.0V  
 Inputs ( $\overline{D}_-$ ,  $\overline{D}_+$ ,  $SEL_-$ ) to  $V_{EE}$  ..... -0.3V to ( $V_{CC} + 0.3$ )V  
 $D_-$  to  $\overline{D}_+$  .....  $\pm 3.0$ V  
 Continuous Output Current ..... 50mA  
 Surge Output Current ..... 100mA  
 $V_{BB}$  Sink/Source Current .....  $\pm 600\mu A$   
 Continuous Power Dissipation ( $T_A = +70^\circ C$ )  
   20-Lead TSSOP (derate 11.0mW/ $^\circ C$  above  $+70^\circ C$ ) ..... 880mW  
      $\theta_{JA}$  in Still Air .....  $+91^\circ C/W$   
      $\theta_{JC}$  .....  $+20^\circ C/W$   
   24-Lead TSSOP (derate 12.2mW/ $^\circ C$  above  $+70^\circ C$ ) ..... 976mW  
      $\theta_{JA}$  in Still Air .....  $+82^\circ C/W$   
      $\theta_{JC}$  .....  $+15^\circ C/W$

20-Lead QSOP (derate 9.1mW/ $^\circ C$  above  $+70^\circ C$ ) ..... 727mW  
    $\theta_{JA}$  in Still Air .....  $+110^\circ C/W$   
    $\theta_{JC}$  .....  $+34^\circ C/W$   
 24-Lead QSOP (derate 9.5mW/ $^\circ C$  above  $+70^\circ C$ ) ..... 762mW  
    $\theta_{JA}$  in Still Air .....  $+105^\circ C/W$   
    $\theta_{JC}$  .....  $+34^\circ C/W$   
 Operating Temperature Range .....  $-40^\circ C$  to  $+85^\circ C$   
 Junction Temperature .....  $+150^\circ C$   
 Storage Temperature Range .....  $-65^\circ C$  to  $+150^\circ C$   
 ESD Protection  
 Human Body Model ( $\overline{D}_-$ ,  $D_-$ ,  $Q_-$ ,  $\overline{Q}_-$ ,  $SEL_-$ ,  $V_{BB_-}$ ) .....  $\geq 2$ kV  
 Lead Temperature (soldering, 10s) .....  $+300^\circ C$

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.

## DC ELECTRICAL CHARACTERISTICS

( $V_{CC} - V_{EE} = 2.375$ V to 5.5V, outputs loaded with 50 $\Omega$   $\pm 1\%$  to  $V_{CC} - 2$ V. Typical values are at  $V_{CC} - V_{EE} = 3.3$ V,  $V_{IHD} = V_{CC} - 1$ V,  $V_{ILD} = V_{CC} - 1.5$ V, unless otherwise noted.) (Notes 1–4)

PARAMETER	SYMBOL	CONDITIONS		-40°C			+25°C			+85°C			UNITS
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
INPUT (D <sub>-</sub> , $\overline{D}_-$ , SEL <sub>-</sub> )													
Single-Ended Input High Voltage	V <sub>IH</sub>	V <sub>BB</sub> connected to the unused input (Figure 1)		V <sub>CC</sub> - 1.225	V <sub>CC</sub> - 0.880	V <sub>CC</sub> - 1.225	V <sub>CC</sub> - 0.880	V <sub>CC</sub> - 1.225	V <sub>CC</sub> - 0.880	V <sub>CC</sub> - 1.225	V <sub>CC</sub> - 0.880	V	
Single-Ended Input Low Voltage	V <sub>IL</sub>	V <sub>BB</sub> connected to the unused input (Figure 1)		V <sub>CC</sub> - 1.945	V <sub>CC</sub> - 1.625	V <sub>CC</sub> - 1.945	V <sub>CC</sub> - 1.625	V <sub>CC</sub> - 1.945	V <sub>CC</sub> - 1.625	V <sub>CC</sub> - 1.945	V <sub>CC</sub> - 1.625	V	
Differential Input High Voltage	V <sub>IHD</sub>	Figure 1		V <sub>EE</sub> + 1.2	V <sub>CC</sub>	V <sub>EE</sub> + 1.2	V <sub>CC</sub>	V <sub>EE</sub> + 1.2	V <sub>CC</sub>	V <sub>EE</sub> + 1.2	V <sub>CC</sub>	V	
Differential Input Low Voltage	V <sub>ILD</sub>	Figure 1		V <sub>EE</sub>	V <sub>CC</sub> - 0.095	V <sub>EE</sub>	V <sub>CC</sub> - 0.095	V <sub>EE</sub>	V <sub>CC</sub> - 0.095	V <sub>EE</sub>	V <sub>CC</sub> - 0.095	V	
Differential Input Voltage	V <sub>IHD</sub> - V <sub>ILD</sub>	Figure 1	V <sub>CC</sub> - V <sub>EE</sub> < 3.0V	0.095	V <sub>CC</sub> - V <sub>EE</sub>	0.095	V <sub>CC</sub> - V <sub>EE</sub>	0.095	V <sub>CC</sub> - V <sub>EE</sub>	0.095	V <sub>CC</sub> - V <sub>EE</sub>	V	
			V <sub>CC</sub> - V <sub>EE</sub> ≥ 3.0V	0.095	3.000	0.095	3.000	0.095	3.000	0.095	3.000		
Input Current	I <sub>IN</sub>	V <sub>IH</sub> , V <sub>IL</sub> , V <sub>IHD</sub> , V <sub>ILD</sub>		-100	+100	-100	+100	-100	+100	-100	+100	μA	

# Differential 5:1 or 4:1 ECL/PECL Multiplexers with Single/Dual Output Buffers

MAX9386/MAX9387/MAX9388

## DC ELECTRICAL CHARACTERISTICS (continued)

( $V_{CC} - V_{EE} = 2.375V$  to  $5.5V$ , outputs loaded with  $50\Omega \pm 1\%$  to  $V_{CC} - 2V$ . Typical values are at  $V_{CC} - V_{EE} = 3.3V$ ,  $V_{IHD} = V_{CC} - 1V$ ,  $V_{ILD} = V_{CC} - 1.5V$ , unless otherwise noted.) (Notes 1–4)

PARAMETER	SYMBOL	CONDITIONS	-40°C			+25°C			+85°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
OUTPUT (Q <sub>-</sub> , Q̅ <sub>-</sub> )												
Single-Ended Output High Voltage	V <sub>OH</sub>	Figure 2	V <sub>CC</sub> - 1.145		V <sub>CC</sub> - 0.895	V <sub>CC</sub> - 1.145		V <sub>CC</sub> - 0.895	V <sub>CC</sub> - 1.145		V <sub>CC</sub> - 0.895	V
Single-Ended Output Low Voltage	V <sub>OL</sub>	Figure 2	V <sub>CC</sub> - 1.945		V <sub>CC</sub> - 1.695	V <sub>CC</sub> - 1.945		V <sub>CC</sub> - 1.695	V <sub>CC</sub> - 1.945		V <sub>CC</sub> - 1.695	V
Differential Output Voltage	V <sub>OH</sub> - V <sub>OL</sub>	Figure 2	650	830		650	840		650	840		mV
REFERENCE OUTPUT (V <sub>BB-</sub> )												
Reference Voltage Output	V <sub>BB1</sub> , V <sub>BB2</sub>	I <sub>BB1</sub> + I <sub>BB2</sub> = ±0.5mA (Note 5)	V <sub>CC</sub> - 1.525	V <sub>CC</sub> - 1.425	V <sub>CC</sub> - 1.325	V <sub>CC</sub> - 1.525	V <sub>CC</sub> - 1.425	V <sub>CC</sub> - 1.325	V <sub>CC</sub> - 1.525	V <sub>CC</sub> - 1.425	V <sub>CC</sub> - 1.325	V
POWER SUPPLY												
Supply Current (Note 6)	I <sub>EE</sub>	MAX9386	34		50	36		50	38		50	mA
		MAX9387	40		60	42		60	45		60	
		MAX9388	31		47	33		47	35		47	

## AC ELECTRICAL CHARACTERISTICS

( $V_{CC} - V_{EE} = 2.375V$  to  $5.5V$ , outputs loaded with  $50\Omega \pm 1\%$  to  $V_{CC} - 2V$ ,  $V_{IHD} - V_{ILD} = 0.15V$  to  $1V$ ,  $f_{IN} \leq 2.5GHz$  input duty cycle = 50%, input transition time = 125ps (20% to 80%). Typical values are at  $V_{CC} - V_{EE} = 3.3V$ ,  $V_{IHD} = V_{CC} - 1V$ ,  $V_{ILD} = V_{CC} - 1.5V$ ,  $f_{IN} = 622MHz$ , input duty cycle = 50%, input transition time = 125ps (20% to 80%), unless otherwise noted.) (Note 7)

PARAMETER	SYMBOL	CONDITIONS	-40°C			+25°C			+85°C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Differential Input-to-Output Delay	$t_{PLHD}$ , $t_{PHLD}$	Figure 2	222	309	377	238	318	395	254	333	431	ps
SEL_-to-Output Delay	$t_{PLH2}$ , $t_{PHL2}$	Figure 4, input transition time = 500ps (20% to 80%) (Note 8)			1.64			1.4			1.6	ns
Output-to-Output Skew	$t_{SKOO}$	MAX9387 only, Figure 5 (Note 9)		3.9	26		3.9	14		8.0	26	ps
Input-to-Output Skew	$t_{SKIO}$	Figure 6 (Note 10)		7.3	53		7.7	50		8.3	50	ps
Part-to-Part Skew	$t_{SKPP}$	(Note 11)			111			130			133	ps

# Differential 5:1 or 4:1 ECL/PECL Multiplexers with Single/Dual Output Buffers

## AC ELECTRICAL CHARACTERISTICS (continued)

$V_{CC} - V_{EE} = 2.375V$  to  $5.5V$ , outputs loaded with  $50\Omega \pm 1\%$  to  $V_{CC} - 2V$ ,  $V_{IHD} - V_{ILD} = 0.15V$  to  $1V$ ,  $f_{IN} \leq 2.5GHz$  input duty cycle = 50%, input transition time = 125ps (20% to 80%). Typical values are at  $V_{CC} - V_{EE} = 3.3V$ ,  $V_{IHD} = V_{CC} - 1V$ ,  $V_{ILD} = V_{CC} - 1.5V$ ,  $f_{IN} = 622MHz$ , input duty cycle = 50%, input transition time = 125ps (20% to 80%), unless otherwise noted.) (Note 7)

PARAMETER	SYMBOL	CONDITIONS		-40°C			+25°C			+85°C			UNITS
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Added Random Jitter (Note 12)	tRJ	Clock pattern	fIN = 156MHz	0.3	1.15	0.3	1.15	0.3	1.15	ps(RMS)			
			fIN = 622MHz	0.3	1.15	0.3	1.15	0.3	1.15				
			fIN = 2.5GHz	0.3	1.15	0.3	1.15	0.3	1.15				
Added Deterministic Jitter (Note 12)	TDJ	PRBS 2 <sup>23</sup> - 1	fIN = 156Mbps	33	95	33	95	33	95	psP-P			
			fIN = 622Mbps	21	61	21	61	21	61				
Switching Frequency	fMAX	VOH - VOL ≥ 300mV, Figure 2		2.7			2.7			2.7			GHz
Select Toggle Frequency	fSEL			100			100			100			MHz
Output Rise and Fall Time (20% to 80%)	tR, tF	Figure 2		67	105	138	74	117	155	81	128	165	ps

**Note 1:** Measurements are made with the device in thermal equilibrium.

**Note 2:** Current into an I/O pin is defined as positive. Current out of an I/O pin is defined as negative.

**Note 3:** DC parameters production tested at  $T_A = +25^\circ C$  and guaranteed by design over the full operating temperature range.

**Note 4:** Single-ended data input operation using  $V_{BB-}$  is limited to  $(V_{CC} - V_{EE}) \geq 3.0V$ .

**Note 5:** Use  $V_{BB-}$  only for inputs that are on the same device as the  $V_{BB-}$  reference.

**Note 6:** All pins open except  $V_{CC}$  and  $V_{EE}$ .

**Note 7:** Guaranteed by design and characterization. Limits are set at  $\pm 6$  sigma.

**Note 8:** Measured from the 50% point of the input signal with the 50% point equal to  $V_{BB-}$ , to the 50% point of the output signal.

**Note 9:** Measured between outputs of the same part at the signal crossing points for a same-edge transition.

**Note 10:** Measured between input-to-output paths of the same part at the signal crossing points for a same-edge transition of the differential input signal.

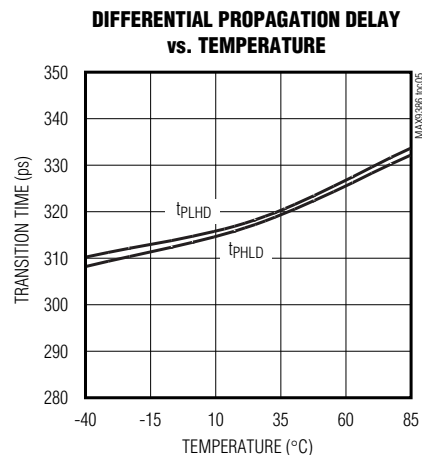
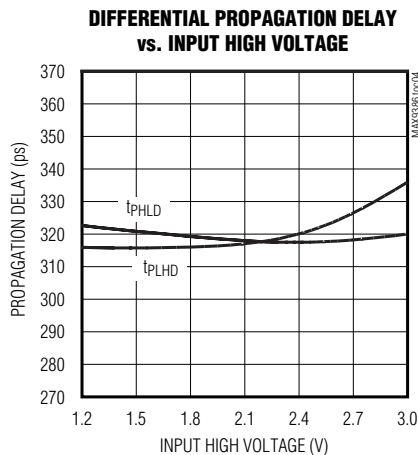
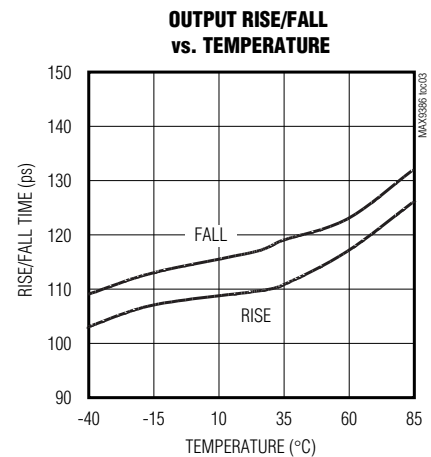
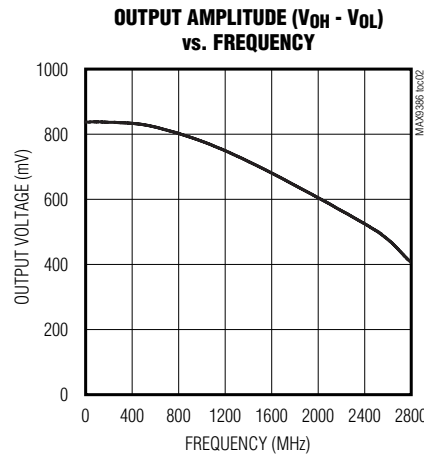
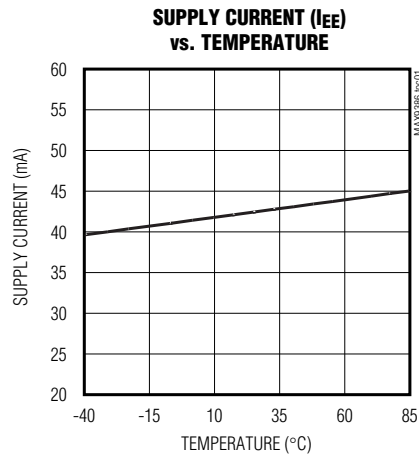
**Note 11:** Measured between outputs of different parts at the signal crossing points under identical conditions for a same-edge transition.

**Note 12:** Device jitter added to the differential input signal.

# Differential 5:1 or 4:1 ECL/PECL Multiplexers with Single/Dual Output Buffers

## Typical Operating Characteristics

( $V_{CC} - V_{EE} = 3.3V$ ,  $V_{IHD} = V_{CC} - 1V$ ,  $V_{ILD} = V_{CC} - 1.5V$ , outputs loaded with  $50\Omega \pm 1\%$  to  $V_{CC} - 2V$ ,  $f_{IN} = 1.5GHz$ , input duty cycle = 50%, input transition time = 125ps (20% to 80%), unless otherwise noted.)



MAX9386/MAX9387/MAX9388

# Differential 5:1 or 4:1 ECL/PECL Multiplexers with Single/Dual Output Buffers

## MAX9386/MAX9388 Pin Description

PIN		NAME	FUNCTION
MAX9386	MAX9388		
1	2	D0	Noninverting Differential Input 0. Internal 250k $\Omega$ to V <sub>CC</sub> and 150k $\Omega$ to V <sub>EE</sub> .
2	3	$\overline{D0}$	Inverting Differential Input 0. Internal 150k $\Omega$ to V <sub>CC</sub> and 150k $\Omega$ to V <sub>EE</sub> .
3	4	D1	Noninverting Differential Input 1. Internal 250k $\Omega$ to V <sub>CC</sub> and 150k $\Omega$ to V <sub>EE</sub> .
4	5	$\overline{D1}$	Inverting Differential Input 1. Internal 150k $\Omega$ to V <sub>CC</sub> and 150k $\Omega$ to V <sub>EE</sub> .
5	6	D2	Noninverting Differential Input 2. Internal 250k $\Omega$ to V <sub>CC</sub> and 150k $\Omega$ to V <sub>EE</sub> .
6	7	$\overline{D2}$	Inverting Differential Input 2. Internal 150k $\Omega$ to V <sub>CC</sub> and 150k $\Omega$ to V <sub>EE</sub> .
7	8	D3	Noninverting Differential Input 3. Internal 250k $\Omega$ to V <sub>CC</sub> and 150k $\Omega$ to V <sub>EE</sub> .
8	9	$\overline{D3}$	Inverting Differential Input 3. Internal 150k $\Omega$ to V <sub>CC</sub> and 150k $\Omega$ to V <sub>EE</sub> .
9	—	D4	Noninverting Differential Input 4. Internal 250k $\Omega$ to V <sub>CC</sub> and 150k $\Omega$ to V <sub>EE</sub> .
10	—	$\overline{D4}$	Inverting Differential Input 4. Internal 150k $\Omega$ to V <sub>CC</sub> and 150k $\Omega$ to V <sub>EE</sub> .
11	10, 11	V <sub>EE</sub>	Negative Supply
12	12	V <sub>BB2</sub>	Reference Output Voltage 2. Connect to the inverting or noninverting data input to provide a reference for single-ended operation. When used, bypass V <sub>BB2</sub> to V <sub>CC</sub> with a 0.01 $\mu$ F ceramic capacitor. Otherwise leave open.
13	13	V <sub>BB1</sub>	Reference Output Voltage 1. Connect to the inverting or noninverting data input to provide a reference for single-ended operation. When used, bypass V <sub>BB1</sub> to V <sub>CC</sub> with a 0.01 $\mu$ F ceramic capacitor. Otherwise leave open.
14, 20	1, 14 17, 20	V <sub>CC</sub>	Positive Supply. Bypass each V <sub>CC</sub> to V <sub>EE</sub> with 0.1 $\mu$ F and 0.01 $\mu$ F ceramic capacitors. Place the capacitors as close to the device as possible with the smaller value capacitor closest to the device.
15	15	$\overline{Q}$	Inverting Output. Typically terminate with 50 $\Omega$ resistor to V <sub>CC</sub> - 2V.
16	16	Q	Noninverting Output. Typically terminate with 50 $\Omega$ resistor to V <sub>CC</sub> - 2V.
17	18	SEL0	Select Logic Input 0. Internal 120k $\Omega$ pulldown to V <sub>EE</sub> .
18	19	SEL1	Select Logic Input 1. Internal 120k $\Omega$ pulldown to V <sub>EE</sub> .
19	—	SEL2	Select Logic Input 2. Internal 120k $\Omega$ pulldown to V <sub>EE</sub> .

# Differential 5:1 or 4:1 ECL/PECL Multiplexers with Single/Dual Output Buffers

## MAX9387 Pin Description

PIN	NAME	FUNCTION
MAX9387		
1, 18, 24	V <sub>CC</sub>	Positive Supply. Bypass each V <sub>CC</sub> to V <sub>EE</sub> with 0.1μF and 0.01μF ceramic capacitors. Place the capacitors as close to the device as possible with the smaller value capacitor closest to the device.
2	D0	Noninverting Differential Input 0. Internal 250kΩ to V <sub>CC</sub> and 150kΩ to V <sub>EE</sub> .
3	$\overline{D0}$	Inverting Differential Input 0. Internal 150kΩ to V <sub>CC</sub> and 150kΩ to V <sub>EE</sub> .
4	D1	Noninverting Differential Input 1. Internal 250kΩ to V <sub>CC</sub> and 150kΩ to V <sub>EE</sub> .
5	$\overline{D1}$	Inverting Differential Input 1. Internal 150kΩ to V <sub>CC</sub> and 150kΩ to V <sub>EE</sub> .
6	D2	Noninverting Differential Input 2. Internal 250kΩ to V <sub>CC</sub> and 150kΩ to V <sub>EE</sub> .
7	$\overline{D2}$	Inverting Differential Input 2. Internal 150kΩ to V <sub>CC</sub> and 150kΩ to V <sub>EE</sub> .
8	D3	Noninverting Differential Input 3. Internal 250kΩ to V <sub>CC</sub> and 150kΩ to V <sub>EE</sub> .
9	$\overline{D3}$	Inverting Differential Input 3. Internal 150kΩ to V <sub>CC</sub> and 150kΩ to V <sub>EE</sub> .
10	D4	Noninverting Differential Input 4. Internal 250kΩ to V <sub>CC</sub> and 150kΩ to V <sub>EE</sub> .
11	$\overline{D4}$	Inverting Differential Input 4. Internal 150kΩ to V <sub>CC</sub> and 150kΩ to V <sub>EE</sub> .
12, 13	V <sub>EE</sub>	Negative Supply
14	V <sub>BB2</sub>	Reference Output Voltage 2. Connect to the inverting or noninverting data input to provide a reference for single-ended operation. When used, bypass V <sub>BB2</sub> to V <sub>CC</sub> with a 0.01μF ceramic capacitor. Otherwise leave open.
15	V <sub>BB1</sub>	Reference Output Voltage 1. Connect to the inverting or noninverting data input to provide a reference for single-ended operation. When used, bypass V <sub>BB1</sub> to V <sub>CC</sub> with a 0.01μF ceramic capacitor. Otherwise leave open.
16	$\overline{Q1}$	Inverting Output 1. Typically terminate with 50Ω resistor to V <sub>CC</sub> - 2V.
17	Q1	Noninverting Output 1. Typically terminate with 50Ω resistor to V <sub>CC</sub> - 2V.
19	$\overline{Q0}$	Inverting Output 0. Typically terminate with 50Ω resistor to V <sub>CC</sub> - 2V.
20	Q0	Noninverting Output 0. Typically terminate with 50Ω resistor to V <sub>CC</sub> - 2V.
21	SEL0	Select Logic Input 0. Internal 120kΩ pulldown to V <sub>EE</sub> .
22	SEL1	Select Logic Input 1. Internal 120kΩ pulldown to V <sub>EE</sub> .
23	SEL2	Select Logic Input 2. Internal 120kΩ pulldown to V <sub>EE</sub> .

MAX9386/MAX9387/MAX9388

## Differential 5:1 or 4:1 ECL/PECL Multiplexers with Single/Dual Output Buffers

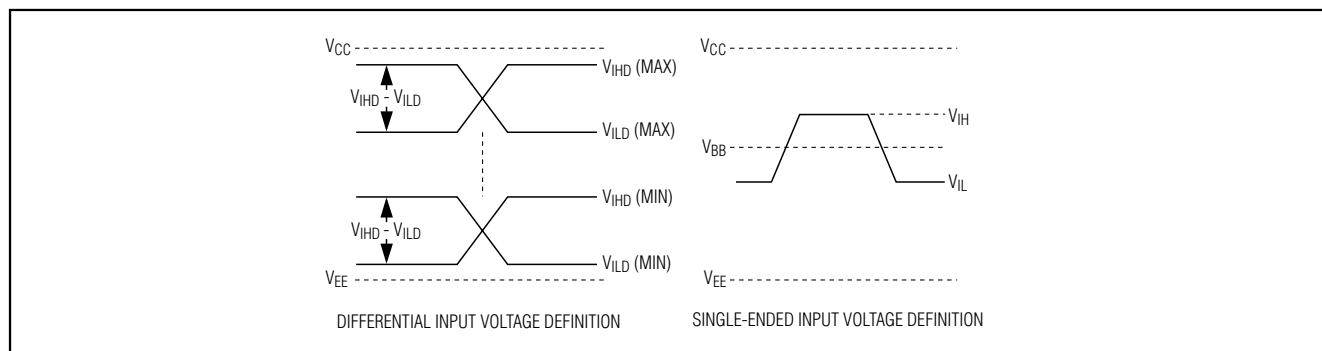


Figure 1. Input Definitions

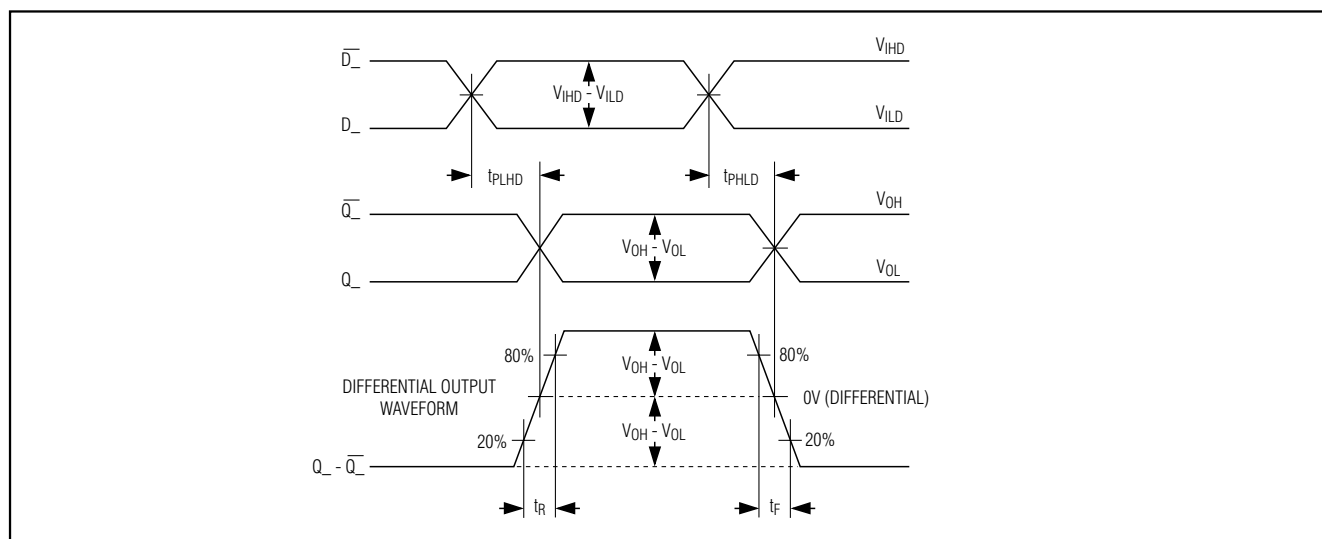


Figure 2. Differential Input-to-Output Propagation Delay Timing Diagram

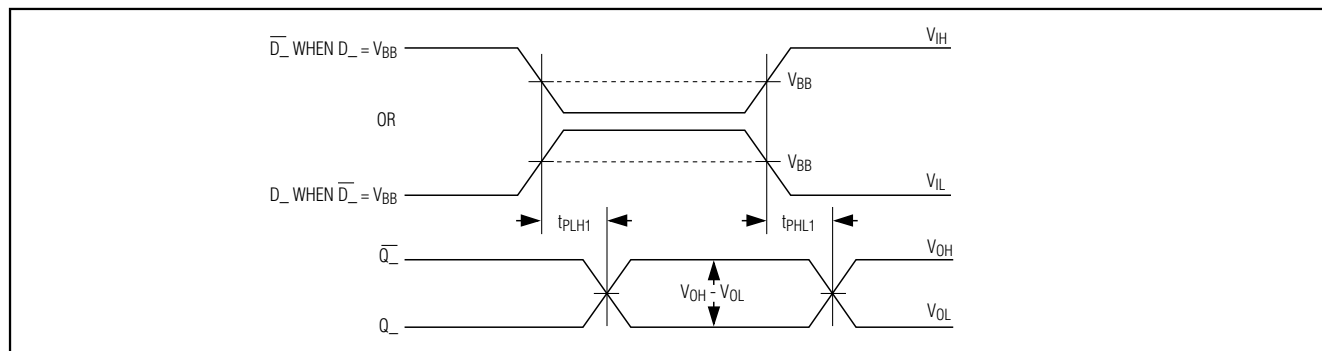


Figure 3. Single-Ended Input-to-Output Propagation Delay Timing Diagram



# Differential 5:1 or 4:1 ECL/PECL Multiplexers with Single/Dual Output Buffers

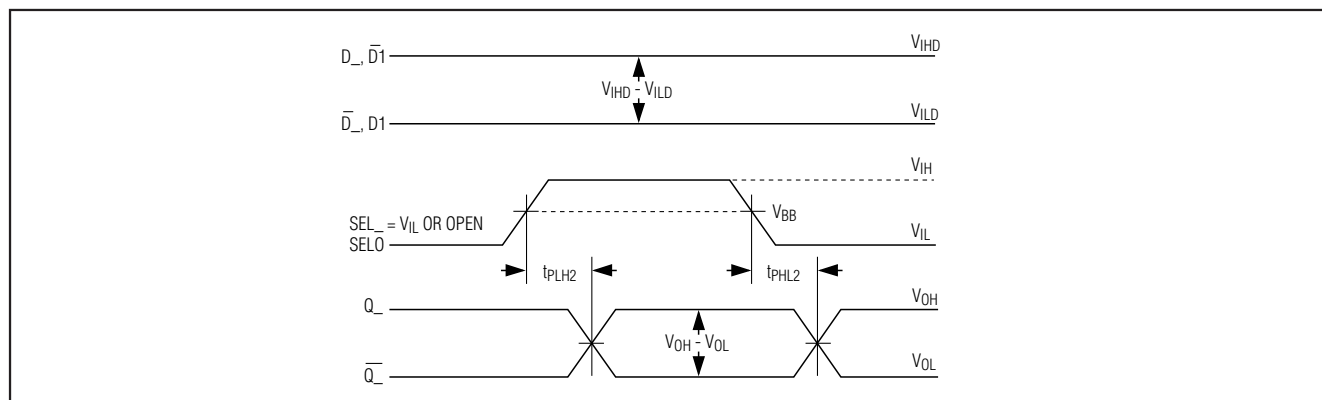


Figure 4. Select Input (SEL0)-to-Output (Q<sub>-</sub>, Q<sub>-</sub>) Delay Timing Diagram

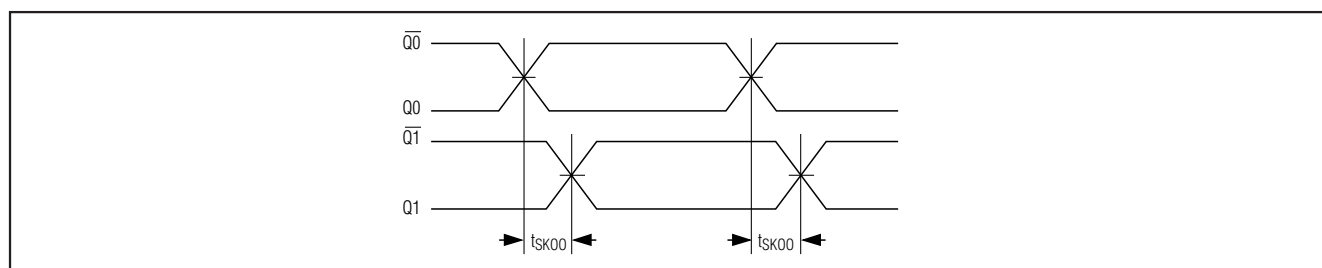


Figure 5. Output-to-Output Skew (t<sub>SK00</sub>) Definition (MAX9387 Only)

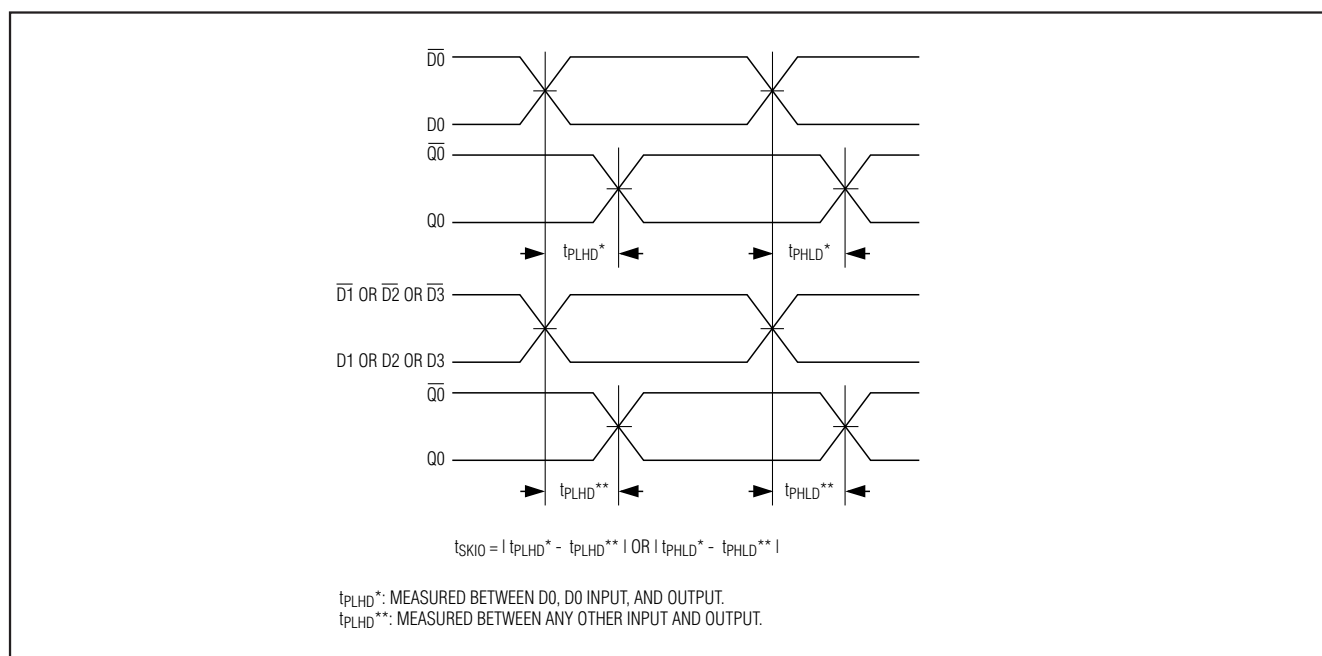


Figure 6. Input-to-Output Skew (t<sub>SKIO</sub>) Definition

# Differential 5:1 or 4:1 ECL/PECL Multiplexers with Single/Dual Output Buffers

## Detailed Description

The MAX9386/MAX9387/MAX9388 are fully differential, high-speed, and low-jitter ECL/PECL muxes with output buffer(s). The devices are designed for clock-and-data distribution applications, and feature extremely low propagation delays (318ps, typ) and output-to-output skews (3.9ps, typ). The MAX9386 is a 5:1 mux with a single output buffer. The MAX9387 is a 5:1 mux with dual output buffers, and is intended for use in redundant systems. The MAX9388 is a 4:1 mux with a single output buffer, and is pin compatible with the MC100EP57.

Three single-ended select inputs, SEL0, SEL1, and SEL2, control the mux function on the MAX9386/MAX9387. The MAX9388 has two select inputs, SEL0 and SEL1 (see Tables 1 and 2). The mux select inputs are compatible with ECL/PECL logic, and are internally referenced to the on-chip output  $V_{BB}$ , nominally  $V_{CC} - 1.425V$ . The select inputs accept signals between  $V_{CC}$  and  $V_{EE}$ . Internal 120k $\Omega$  pulldowns to  $V_{EE}$  ensure a low default condition if the select inputs are left open, selecting the D0,  $\overline{D0}$  input.

The differential inputs D,  $\overline{D}$  can be configured to accept a single-ended signal when the unused complementary input is connected to the on-chip reference voltage

$V_{BB}$ . The reference output voltages,  $V_{BB1}$  and  $V_{BB2}$ , provide the reference voltage for single-ended operation for each mux. A single-ended input of at least  $V_{BB} \pm 100mV$  or a differential input of at least 100mV switches the outputs to the  $V_{OH}$  and  $V_{OL}$  levels specified in the *DC Electrical Characteristics*. The maximum magnitude of the differential input from D to  $\overline{D}$  is  $\pm 3.0V$ . This limit also applies to the difference between a single-ended input and any reference voltage input.

Specifications for the high and low voltages of a differential input ( $V_{IHD}$  and  $V_{ILD}$ ) and the differential input voltage ( $V_{IHD} - V_{ILD}$ ) apply simultaneously.

## Single-Ended Operation

The recommended supply voltage for single-ended operation is 3.0V to 5.5V. The differential inputs (D,  $\overline{D}$ ) can be configured to accept single-ended inputs when operating at supply voltages greater than 2.725V. In single-ended mode operation, the unused complementary input needs to be connected to the on-chip reference voltage,  $V_{BB}$ , as a reference. For example, the differential D,  $\overline{D}$  input is converted to a noninverting, single-ended input by connecting  $V_{BB}$  to  $\overline{D}$  and connecting the single-ended input to D. Similarly, an inverting input is obtained by connecting  $V_{BB}$  to D and connecting the single-ended input to  $\overline{D}$ . With a differential input configured as single ended (using  $V_{BB}$ ), the single-ended input can be driven to  $V_{CC}$  or  $V_{EE}$  or with a single-ended LVPECL/LVECL signal.

In single-ended mode operation, a user must ensure that the supply voltage ( $V_{CC} - V_{EE}$ ) is greater than 2.725V. This is because the input high minimum level must be at ( $V_{EE} + 1.2V$ ) or higher for proper operation. The reference voltage,  $V_{BB}$ , must be at least ( $V_{EE} + 1.2V$ ) for the same reason because it becomes the high-level input when a single-ended input swings below it. The minimum  $V_{BB}$  output for the MAX9386/MAX9387/MAX9388 is ( $V_{CC} - 1.38V$ ). Substituting the minimum  $V_{BB}$  output for ( $V_{BB} = V_{EE} + 1.2V$ ) results in a minimum supply ( $V_{CC} - V_{EE}$ ) of 2.725V. Rounding up to standard supplies gives the recommended single-ended operating supply ranges ( $V_{CC} - V_{EE}$ ) of 3.0V to 5.5V.

When using the  $V_{BB}$  reference output, bypass it with a 0.01 $\mu F$  ceramic capacitor to  $V_{CC}$ . If not used, leave it open. The  $V_{BB}$  reference can source or sink a total of 0.5mA (shared between  $V_{BB1}$  and  $V_{BB2}$ ), which is sufficient to drive five inputs.

**Table 1. Mux Select Input Truth Table for MAX9386/MAX9387**

SEL2	SEL1	SEL0	DATA OUTPUT
L or open	L or open	L or open	D0*
L or open	L or open	H	D1
L or open	H	L or open	D2
L or open	H	H	D3
H	X	X	D4

\*Default output when SEL0, SEL1, and SEL2 are left open.

**Table 2. Mux Select Input Truth Table for MAX9388**

SEL1	SEL0	DATA OUTPUT
L or open	L or open	D0*
L or open	H	D1
H	L or open	D2
H	H	D3

\*Default output when SEL0 and SEL1 are left open.

# Differential 5:1 or 4:1 ECL/PECL Multiplexers with Single/Dual Output Buffers

## Applications Information

### Output Termination

Terminate the outputs through  $50\Omega$  to  $V_{CC} - 2V$  or use equivalent Thevenin terminations. Terminate each Q and  $\bar{Q}$  output with identical termination on each for minimal distortion. When a single-ended signal is taken from the differential output, terminate both Q and  $\bar{Q}$ .

Ensure that output currents do not exceed the current limits as specified in the *Absolute Maximum Ratings* table. Under all operating conditions, the device's total thermal limits should be observed.

### Supply Bypassing

Bypass  $V_{CC}$  to  $V_{EE}$  with high-frequency surface-mount ceramic  $0.1\mu F$  and  $0.01\mu F$  capacitors. For PECL, bypass each  $V_{CC}$  to  $V_{EE}$ . For ECL, bypass each  $V_{EE}$  to  $V_{CC}$ . Place the capacitors as close to the device pins as possible with the  $0.01\mu F$  capacitor closest to the device pins.

Use multiple vias when connecting the bypass capacitors to ground. When using the  $V_{BB1}$  or  $V_{BB2}$  reference outputs, bypass each one with a  $0.01\mu F$  ceramic capacitor to  $V_{CC}$ . If the  $V_{BB1}$  or  $V_{BB2}$  reference outputs are not used, they can be left open.

### Traces

Circuit board trace layout is very important to maintain the signal integrity of high-speed differential signals. Maintaining integrity is accomplished in part by reducing signal reflections and skew, and increasing common-mode noise immunity.

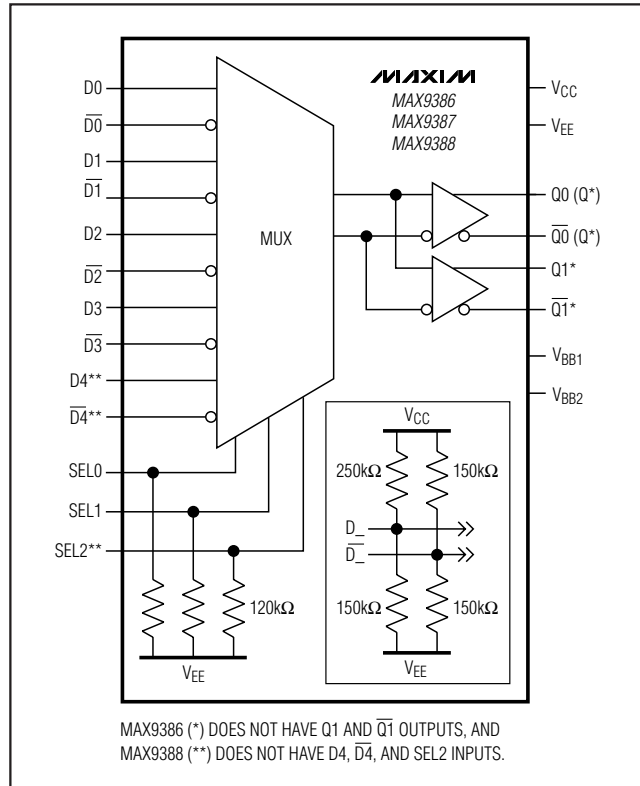
Signal reflections are caused by discontinuities in the  $50\Omega$  characteristic impedance of the traces. Avoid discontinuities by maintaining the distance between differential traces, not using sharp corners or using vias. Maintaining distance between the traces also increases common-mode noise immunity. Reducing signal skew is accomplished by matching the electrical length of the differential traces.

## Chip Information

TRANSISTOR COUNT: 583

PROCESS: Bipolar

## Functional Block Diagram



## Ordering Information (continued)

PART	TEMP RANGE	PIN-PACKAGE	SELECTION
MAX9387EUG	-40°C to +85°C	24 TSSOP	5:1 mux with 2 output buffers
MAX9387EEG*	-40°C to +85°C	24 QSOP	5:1 mux with 2 output buffers
MAX9388EUP	-40°C to +85°C	20 TSSOP	4:1 mux with 1 output buffer
MAX9388EEP*	-40°C to +85°C	20 QSOP	4:1 mux with 1 output buffer

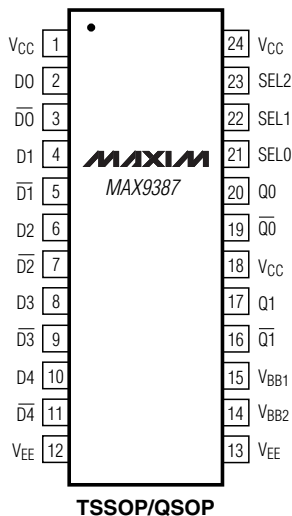
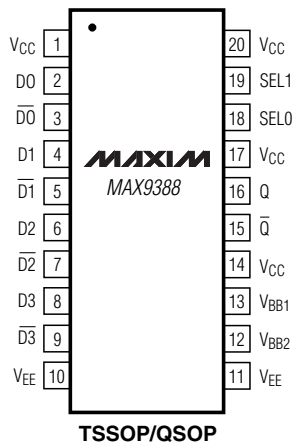
\*Future product—contact factory for availability.

MAX9386/MAX9387/MAX9388

# Differential 5:1 or 4:1 ECL/PECL Multiplexers with Single/Dual Output Buffers

## Pin Configurations (continued)

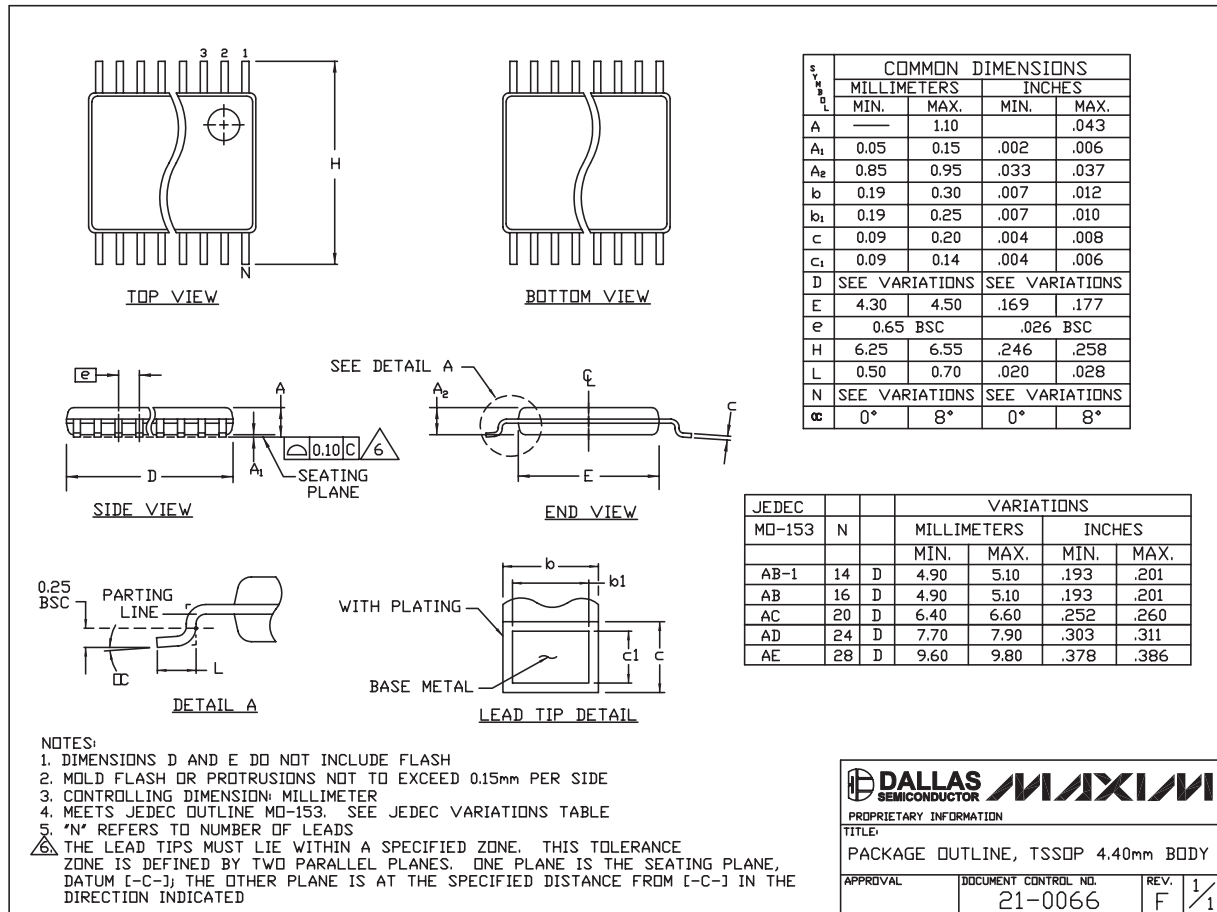
TOP VIEW



# Differential 5:1 or 4:1 ECL/PECL Multiplexers with Single/Dual Output Buffers

## 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](http://www.maxim-ic.com/packages).)



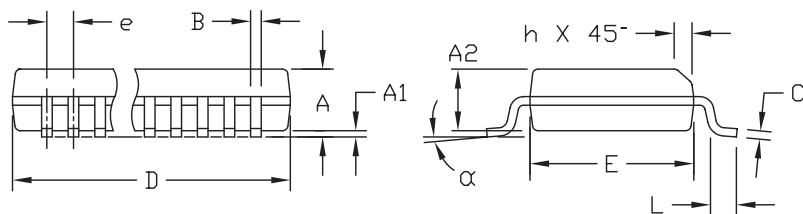
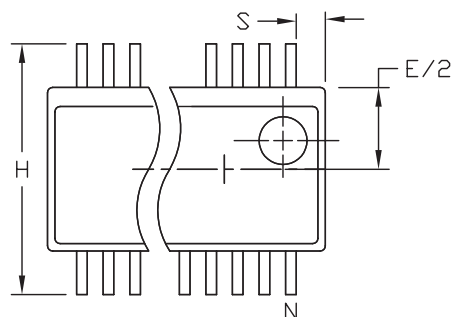
TSSOP4.40mm EPS

MAX9386/MAX9387/MAX9388

# Differential 5:1 or 4:1 ECL/PECL Multiplexers with Single/Dual Output Buffers

## 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](http://www.maxim-ic.com/packages).)



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.061	.068	1.55	1.73
A1	.004	.0098	0.102	0.249
A2	.055	.061	1.40	1.55
B	.008	.012	0.20	0.31
C	.0075	.0098	0.191	0.249
D	SEE VARIATIONS			
E	.150	.157	3.81	3.99
e	.025 BSC		0.635 BSC	
H	.230	.244	5.84	6.20
h	.010	.016	0.25	0.41
L	.016	.035	0.41	0.89
N	SEE VARIATIONS			
α	0°	8°	0°	8°

### VARIATIONS:

	INCHES		MILLIMETERS		N
	MIN.	MAX.	MIN.	MAX.	
D	.189	.196	4.80	4.98	16 AA
S	.0020	.0070	0.05	0.18	
D	.337	.344	8.56	8.74	20 AB
S	.0500	.0550	1.270	1.397	
D	.337	.344	8.56	8.74	24 AC
S	.0250	.0300	0.635	0.762	
D	.386	.393	9.80	9.98	28 AD
S	.0250	.0300	0.635	0.762	

### NOTES:

- 1). D & E DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
- 2). MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .006" PER SIDE.
- 3). CONTROLLING DIMENSIONS: INCHES.
- 4). MEETS JEDEC MO137.

<b>MAXIM</b>			
PROPRIETARY INFORMATION			
TITLE:			
PACKAGE OUTLINE, QSOPE, .150", .025" LEAD PITCH			
APPROVAL	DOCUMENT CONTROL NO.	REV	1/1
	21-0055	D	

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.

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

# Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

[Maxim Integrated:](#)

[MAX9384EWP](#)