

# MC10EP196, MC100EP196

## Product Preview

### 3.3V/5V ECL Programmable Delay Chip with FTUNE

The MC10/100EP196 is a programmable delay chip (PDC) designed primarily for clock deskewing and timing adjustment. It provides variable delay of a differential NECL/PECL input transition. It is identical to the EP195 with the exception of the added feature of further tuneability in delay using the FTUNE pin. The FTUNE input takes an analog voltage from  $V_{CC}$  to  $V_{EE}$  to fine tune the output delay from 0 to 60 ps.

The delay section consists of a programmable matrix of gates and multiplexers as shown in the logic diagram, Figure 2. The delay increment of the EP196 has a digitally selectable resolution of about 10 ps and a range of up to 10.2 ns. The required delay is selected by 10 data select inputs D[0:9] which are latched on chip by a high signal on the latch enable (LEN) control. The approximate delay values for varying tap numbers correlating to D0 (LSB) through D9 (MSB) are shown in Table 1, Table 2, and Figure 3.

Because the EP196 is designed using a chain of multiplexers, it has a fixed minimum delay of 2.2 ns. An additional pin, D10, is provided for cascading multiple PDCs for increased programmable range. The cascade logic allows full control of multiple PDCs.

Select input pins, D0–D10, may be threshold controlled by combinations of interconnects between  $V_{EF}$  (pin 7) and  $V_{CF}$  (pin 8) for CMOS, ECL, or TTL level signals. For CMOS input levels, leave  $V_{CF}$  and  $V_{EF}$  open. For ECL operation, short  $V_{CF}$  and  $V_{EF}$  (pins 7 and 8). For TTL level operation, connect a 1.5 V supply reference to  $V_{CF}$  and leave open  $V_{EF}$  pin. The 1.5 V reference voltage to  $V_{CF}$  pin can be accomplished by placing a 1.5 k $\Omega$  or 500  $\Omega$  resistor between  $V_{CF}$  and  $V_{EE}$  for 3.3 V or 5.0 V power supplies, respectively.

The  $V_{BB}$  pin, an internally generated voltage supply, is available to this device only. For single-ended input conditions, the unused differential input is connected to  $V_{BB}$  as a switching reference voltage.  $V_{BB}$  may also rebias AC coupled inputs. When used, decouple  $V_{BB}$  and  $V_{CC}$  via a 0.01  $\mu$ F capacitor and limit current sourcing or sinking to 0.5 mA. When not used,  $V_{BB}$  should be left open.

The 100 Series contains temperature compensation.

- Maximum Frequency > 1.8 GHz Typical
- PECL Mode Operating Range:  $V_{CC} = 3.0$  V to 5.5 V with  $V_{EE} = 0$  V
- NECL Mode Operating Range:  $V_{CC} = 0$  V with  $V_{EE} = -3.0$  V to -5.5 V
- Open Input Default State
- Safety Clamp on Inputs
- A Logic High on the  $\overline{EN}$  Pin Will Force Q to Logic Low
- D[0:10] Can Accept Either ECL, CMOS, or TTL Inputs
- $V_{BB}$  Output Reference Voltage

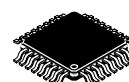
This document contains information on a product under development. ON Semiconductor reserves the right to change or discontinue this product without notice.



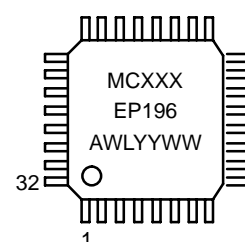
ON Semiconductor®

<http://onsemi.com>

#### MARKING DIAGRAM\*



LQFP-32  
FA SUFFIX  
CASE 873A



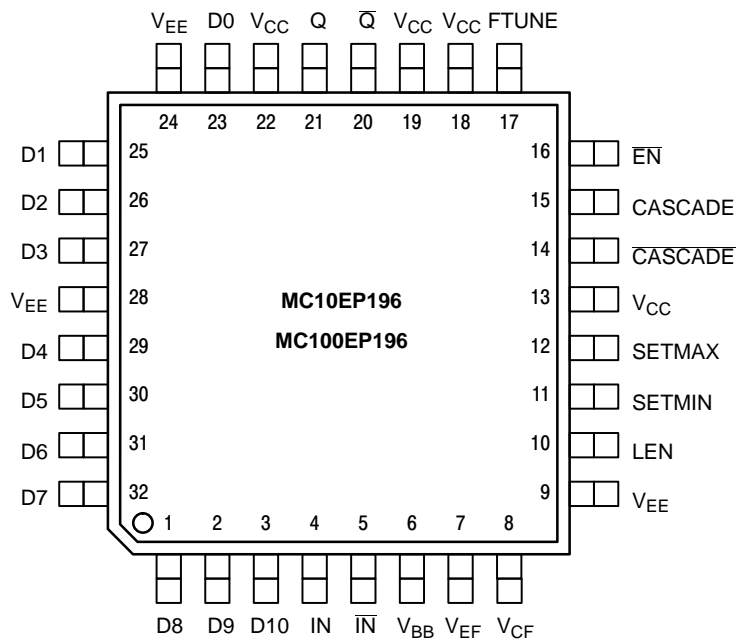
XXX = 10 OR 100  
A = Assembly Location  
WL = Wafer Lot  
YY = Year  
WW = Work Week

\*For additional information, refer to Application Note AND8002/D

#### ORDERING INFORMATION

Device	Package	Shipping
MC10EP196FA	LQFP-32	250 Units/Tray
MC10EP196FAR2	LQFP-32	2000 Tape & Reel
MC100EP196FA	LQFP-32	250 Units/Tray
MC100EP196FAR2	LQFP-32	2000 Tape & Reel

# MC10EP196, MC100EP196



Warning: All  $V_{CC}$  and  $V_{EE}$  pins must be externally connected to Power Supply to guarantee proper operation.

Figure 1. 32-Lead LQFP Pinout (Top View)

## PIN DESCRIPTION

PIN	FUNCTION
$IN^*$ , $\overline{IN}^*$	ECL Signal Input
$\overline{EN}^*$	ECL Input Enable
$D[0:10]^*$	CMOS, ECL, or TTL Select Inputs
$Q$ , $\overline{Q}$	ECL Signal Output
$LEN^*$	ECL Latch Enable
$SETMIN^*\dagger$	ECL Minimum Delay Set
$SETMAX^*$	ECL Maximum Delay Set
$CASCADE$ , $\overline{CASCAD}$	ECL Cascade Signal
$V_{BB}$	Output Reference Voltage
$V_{CC}$	Positive Supply
$V_{EE}$	Negative Supply
$V_{CF}$	CMOS, ECL, or TTL Input Select
$V_{EF}$	ECL Reference Mode Connection
$FTUNE$	Fine Tuning Input

\* Pins will default LOW when left open.

$\dagger$ SETMIN will override SETMAX if both pins are high.

## TRUTH TABLE

$\overline{EN}$	L*	$Q = IN$
$\overline{EN}$	H	Q Logic Low
$LEN$	L*	Pass Through $D[0:10]$
$LEN$	H	Latch $D[0:10]$
$SETMIN$	L*	Normal Mode
$SETMIN$	H	Min Delay Path
$SETMAX$	L*	Normal Mode
$SETMAX$	H	Max Delay Path
$V_{CF}$	$V_{EF}$ Pin***	ECL Mode
$V_{CF}$	No Connect	CMOS Mode
$V_{CF}$	1.5 V	TTL Mode**

\* Internal pulldown will provide logic low if pin left unconnected.

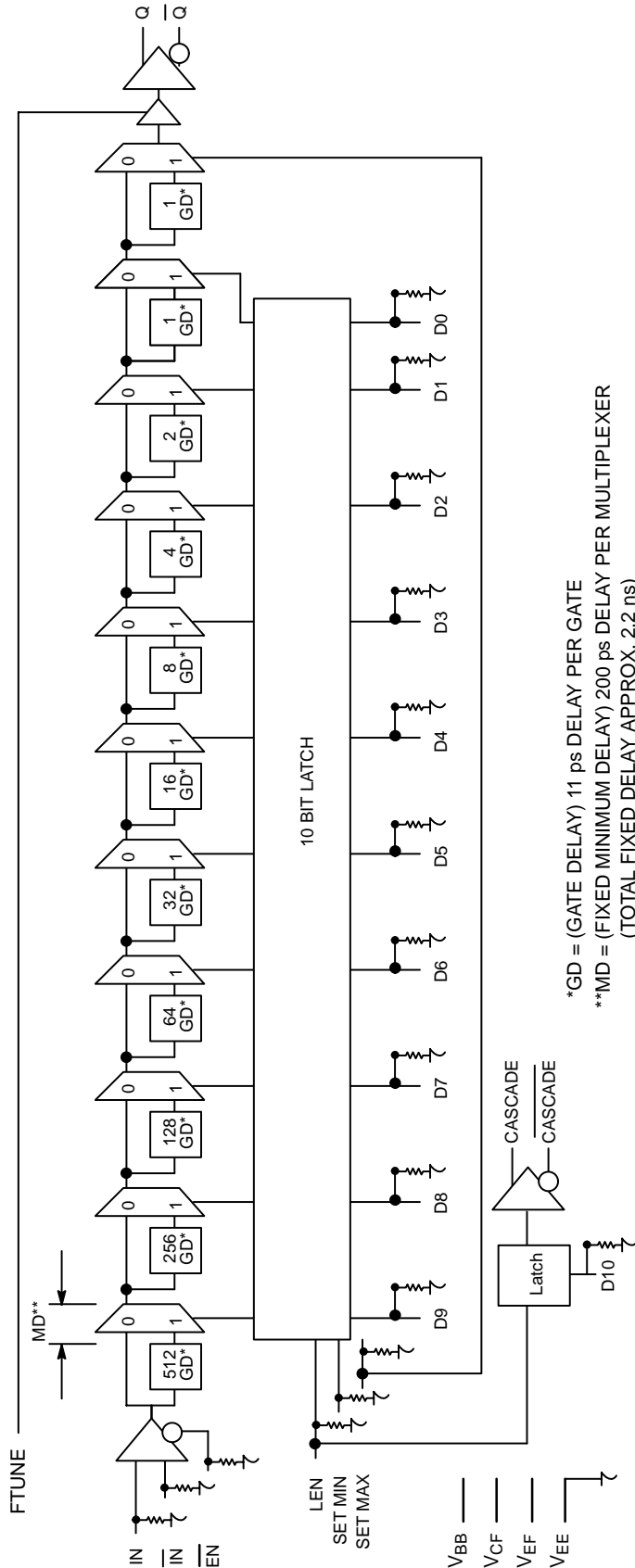
\*\* For TTL Mode, connect appropriate resistor between  $V_{CF}$  and  $V_{EE}$  pin.

\*\*\* Short  $V_{CF}$  (pin 8) and  $V_{EF}$  (pin 7).

Resistor Value	Power Supply
1.5 k $\Omega$	3.3 V
500 $\Omega$	5.0 V

## DATA INPUT OPERATING VOLTAGE TABLE

POWER SUPPLY ( $V_{CC}$ , $V_{EE}$ )	DATA SELECT INPUTS (D [0:10])			
	CMOS	TTL	PECL	NECL
PECL	✓	✓	✓	N/A
NECL	N/A	N/A	N/A	✓



### Figure 2. Logic Diagram

### TABLE 1. THEORETICAL DELAY VALUES

D10	D(9:0) Value	Delay Value	Comment
	0000000000	0 ps	(SET MIN)
	0000000001	10 ps	
	0000000010	20 ps	
	0000000011	30 ps	
	0000000100	40 ps	
	0000000101	50 ps	
	0000000110	60 ps	
	0000000111	70 ps	
	0000001000	80 ps	
	0000010000	160 ps	
	0000100000	320 ps	
	0001000000	640 ps	
	0010000000	1280 ps	
	0100000000	2560 ps	
	1000000000	5120 ps	
	1111111111	10230 ps	
1	XXXXXXXXXX	10240 ps	(SET MAX)

**TABLE 2. FTUNE DELAY PIN**

Input Range	Output Range
$V_{CC}-V_{EE}$ (V)	0 – 60 (ps)

## MC10EP196, MC100EP196

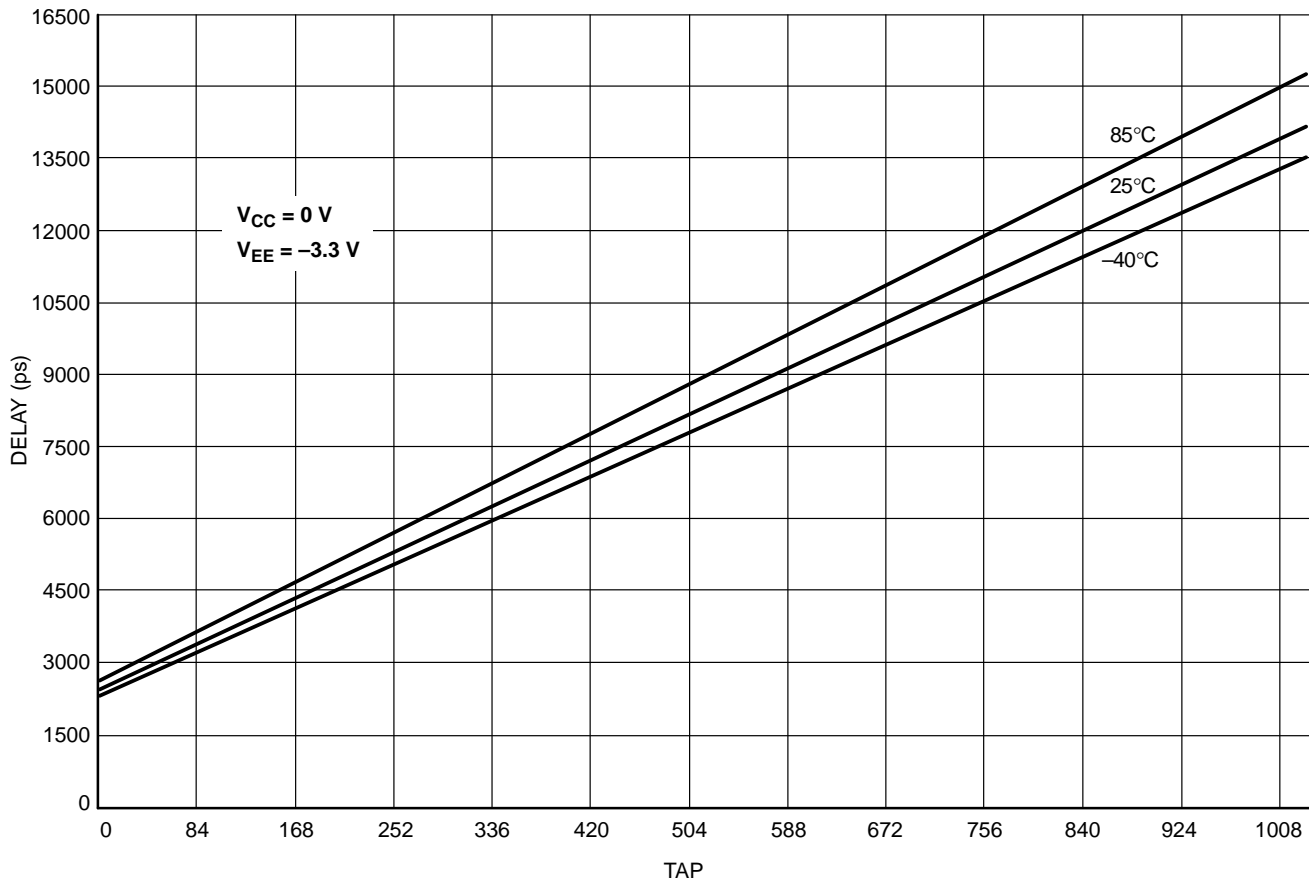


Figure 3. Estimated Delay versus Tap

### ATTRIBUTES

Characteristics		Value
Internal Input Pulldown Resistor		75 kΩ
Internal Input Pullup Resistor		N/A
ESD Protection	Human Body Model	> 2 kV
	Machine Model	> 100 V
	Charged Device Model	> 2 kV
Moisture Sensitivity (Note 1)		Level 2
Flammability Rating Oxygen Index		UL-94 code V-0 A 1/8" 28 to 34
Transistor Count		1279 Devices
Meets or exceeds JEDEC Spec EIA/JESD78 IC Latchup Test		

1. For additional information, see Application Note AND8003/D.

# MC10EP196, MC100EP196

## MAXIMUM RATINGS (Note 2)

Symbol	Parameter	Condition 1	Condition 2	Rating	Units
V <sub>CC</sub>	PECL Mode Power Supply	V <sub>EE</sub> = 0 V		6	V
V <sub>EE</sub>	NECL Mode Power Supply	V <sub>CC</sub> = 0 V		–6	V
V <sub>I</sub>	PECL Mode Input Voltage NECL Mode Input Voltage	V <sub>EE</sub> = 0 V V <sub>CC</sub> = 0 V	V <sub>I</sub> ≤ V <sub>CC</sub> V <sub>I</sub> ≥ V <sub>EE</sub>	6 –6	V V
I <sub>out</sub>	Output Current	Continuous Surge		50 100	mA mA
I <sub>BB</sub>	V <sub>BB</sub> Sink/Source			± 0.5	mA
T <sub>A</sub>	Operating Temperature Range			–40 to +85	°C
T <sub>stg</sub>	Storage Temperature Range			–65 to +150	°C
θ <sub>JA</sub>	Thermal Resistance (Junction–to–Ambient)	0 LFPM 500 LFPM	32 LQFP 32 LQFP	80 55	°C/W °C/W
θ <sub>JC</sub>	Thermal Resistance (Junction–to–Case)	std bd	32 LQFP	12 to 17	°C/W
T <sub>sol</sub>	Wave Solder	< 2 to 3 sec @ 248°C		265	°C

2. Maximum Ratings are those values beyond which device damage may occur.

## 10EP DC CHARACTERISTICS, PECL V<sub>CC</sub> = 3.3 V, V<sub>EE</sub> = 0 V (Note 3)

Symbol	Characteristic	–40°C			25°C			85°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
I <sub>EE</sub>	Power Supply Current					TBD					mA
V <sub>OH</sub>	Output HIGH Voltage (Note 4)	2165	2290	2415	2230	2355	2480	2290	2415	2540	mV
V <sub>OL</sub>	Output LOW Voltage (Note 4)	1365	1490	1615	1430	1555	1680	1490	1615	1740	mV
V <sub>IH</sub>	Input HIGH Voltage (Single–Ended) PECL CMOS TTL	2090		2415	2155 1815 2000		2480	2215		2540	mV
V <sub>IL</sub>	Input LOW Voltage (Single–Ended) PECL CMOS TTL	1365		1690	1430		1755 1485 400	1490		1815	mV
V <sub>BB</sub>	Output Voltage Reference	1790	1890	1990	1855	1955	2055	1915	2015	2115	mV
V <sub>CF</sub>	Input Select	1610	1710	1810	1620	1718	1820	1625	1725	1825	mV
V <sub>EF</sub>	Mode Connection	1920	2020	2120	1980	2080	2180	2030	2130	2230	mV
V <sub>IHCMR</sub>	Input HIGH Voltage Common Mode Range (Differential) (Note 5)	2.0		3.3	2.0		3.3	2.0		3.3	V
I <sub>IH</sub>	Input HIGH Current			150			150			150	μA
I <sub>IL</sub>	Input LOW Current IN IN	0.5 –150			0.5 –150			0.5 –150			μA

NOTE: EP circuits are designed to meet the DC specifications shown in the above table after thermal equilibrium has been established. The circuit is in a test socket or mounted on a printed circuit board and transverse airflow greater than 500 lfpm is maintained.

3. Input and output parameters vary 1:1 with V<sub>CC</sub>. V<sub>EE</sub> can vary +0.3 V to –2.2 V.

4. All loading with 50 Ω to V<sub>CC</sub>–2.0 volts.

5. V<sub>IHCMR</sub> min varies 1:1 with V<sub>EE</sub>, V<sub>IHCMR</sub> max varies 1:1 with V<sub>CC</sub>. The V<sub>IHCMR</sub> range is referenced to the most positive side of the differential input signal.

# MC10EP196, MC100EP196

## 10EP DC CHARACTERISTICS, PECL $V_{CC} = 5.0\text{ V}$ , $V_{EE} = 0\text{ V}$ (Note 6)

Symbol	Characteristic	-40°C			25°C			85°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
$I_{EE}$	Power Supply Current (Note 7)					TBD					mA
$V_{OH}$	Output HIGH Voltage (Note 8)	3865	3990	4115	3930	4055	4180	3990	4115	4240	mV
$V_{OL}$	Output LOW Voltage (Note 8)	3065	3190	3315	3130	3255	3380	3190	3315	3440	mV
$V_{IH}$	Input HIGH Voltage (Single-Ended) PECL CMOS TTL	3790		4115	3855 2750 2000		4180	3915		4240	mV
$V_{IL}$	Input LOW Voltage (Single-Ended) PECL CMOS TTL	3065		3390	3130		3455 2250 400	3190		3515	mV
$V_{BB}$	Output Voltage Reference	3490	3590	3690	3555	3655	3755	3615	3715	3815	mV
$V_{CF}$	Input Select					TBD					mV
$V_{EF}$	Mode Connection					TBD					mV
$V_{IHCMR}$	Input HIGH Voltage Common Mode Range (Differential) (Note 9)	2.0		5.0	2.0		5.0	2.0		5.0	V
$I_{IH}$	Input HIGH Current			150			150			150	$\mu\text{A}$
$I_{IL}$	Input LOW Current IN IN	0.5 -150			0.5 -150			0.5 -150			$\mu\text{A}$

NOTE: EP circuits are designed to meet the DC specifications shown in the above table after thermal equilibrium has been established. The circuit is in a test socket or mounted on a printed circuit board and transverse airflow greater than 500 lfm is maintained.

6. Input and output parameters vary 1:1 with  $V_{CC}$ .  $V_{EE}$  can vary +2.0 V to -0.5 V.

7. Required 500 lfm air flow when using +5 V power supply. For  $(V_{CC} - V_{EE}) > 3.3\text{ V}$ , 5  $\Omega$  to 10  $\Omega$  in line with  $V_{EE}$  required for maximum thermal protection at elevated temperatures. Recommend  $V_{CC} - V_{EE}$  operation at  $\leq 3.8\text{ V}$ .

8. All loading with 50  $\Omega$  to  $V_{CC} - 2.0$  volts.

9.  $V_{IHCMR}$  min varies 1:1 with  $V_{EE}$ ,  $V_{IHCMR}$  max varies 1:1 with  $V_{CC}$ . The  $V_{IHCMR}$  range is referenced to the most positive side of the differential input signal.

## 10EP DC CHARACTERISTICS, NECL $V_{CC} = 0\text{ V}$ , $V_{EE} = -5.5\text{ V}$ to $-3.0\text{ V}$ (Note 10)

Symbol	Characteristic	-40°C			25°C			85°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
$I_{EE}$	Power Supply Current (Note 11)					TBD					mA
$V_{OH}$	Output HIGH Voltage (Note 12)	-1135	-1010	-885	-1070	-945	-820	-1010	-885	-760	mV
$V_{OL}$	Output LOW Voltage (Note 12)	-1935	-1810	-1685	-1870	-1745	-1620	-1810	-1685	-1560	mV
$V_{IH}$	Input HIGH Voltage (Single-Ended) NECL	-1210		-885	-1145		-820	-1085		-760	mV
$V_{IL}$	Input LOW Voltage (Single-Ended) NECL	-1935		-1610	-1870		-1545	-1810		-1485	mV
$V_{BB}$	Output Voltage Reference	-1510	-1410	-1310	-1445	-1345	-1245	-1385	-1285	-1185	mV
$V_{CF}$	Input Select					TBD					mV
$V_{EF}$	Mode Connection					TBD					mV
$V_{IHCMR}$	Input HIGH Voltage Common Mode Range (Differential) (Note 13)	$V_{EE} + 2.0$		0.0	$V_{EE} + 2.0$		0.0	$V_{EE} + 2.0$		0.0	V
$I_{IH}$	Input HIGH Current			150			150			150	$\mu\text{A}$
$I_{IL}$	Input LOW Current IN IN	0.5 -150			0.5 -150			0.5 -150			$\mu\text{A}$

NOTE: EP circuits are designed to meet the DC specifications shown in the above table after thermal equilibrium has been established. The circuit is in a test socket or mounted on a printed circuit board and transverse airflow greater than 500 lfm is maintained.

10. Input and output parameters vary 1:1 with  $V_{CC}$ .

11. Required 500 lfm air flow when using +5 V power supply. For  $(V_{CC} - V_{EE}) > 3.3\text{ V}$ , 5  $\Omega$  to 10  $\Omega$  in line with  $V_{EE}$  required for maximum thermal protection at elevated temperatures. Recommend  $V_{CC} - V_{EE}$  operation at  $\leq 3.8\text{ V}$ .

12. All loading with 50  $\Omega$  to  $V_{CC} - 2.0$  volts.

13.  $V_{IHCMR}$  min varies 1:1 with  $V_{EE}$ ,  $V_{IHCMR}$  max varies 1:1 with  $V_{CC}$ . The  $V_{IHCMR}$  range is referenced to the most positive side of the differential input signal.

# MC10EP196, MC100EP196

## 100EP DC CHARACTERISTICS, PECL $V_{CC} = 3.3\text{ V}$ , $V_{EE} = 0\text{ V}$ (Note 14)

Symbol	Characteristic	-40°C			25°C			85°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
$I_{EE}$	Power Supply Current					TBD					mA
$V_{OH}$	Output HIGH Voltage (Note 15)	2155	2280	2405	2155	2280	2405	2155	2280	2405	mV
$V_{OL}$	Output LOW Voltage (Note 15)	1355	1480	1605	1355	1480	1605	1355	1480	1605	mV
$V_{IH}$	Input HIGH Voltage (Single-Ended) PECL CMOS TTL	2075		2420	2075 1815 2000		2420	2075		2420	mV
$V_{IL}$	Input LOW Voltage (Single-Ended) PECL CMOS TTL	1355		1675	1490		1675 1485 400	1490		1675	mV
$V_{BB}$	Output Voltage Reference	1775	1875	1975	1775	1875	1975	1775	1875	1975	mV
$V_{CF}$	Input Select	1610	1720	1825	1610	1720	1825	1610	1720	1825	mV
$V_{EF}$	Mode Connection	1900	2000	2100	1900	2000	2100	1900	2000	2100	mV
$V_{IHCMR}$	Input HIGH Voltage Common Mode Range (Differential) (Note 16)	2.0		3.3	2.0		3.3	2.0		3.3	V
$I_{IH}$	Input HIGH Current			150			150			150	$\mu\text{A}$
$I_{IL}$	Input LOW Current $I_{IN}$ $I_{\overline{IN}}$	0.5 -150			0.5 -150			0.5 -150			$\mu\text{A}$

NOTE: EP circuits are designed to meet the DC specifications shown in the above table after thermal equilibrium has been established. The circuit is in a test socket or mounted on a printed circuit board and transverse airflow greater than 500 lfm is maintained.

14. Input and output parameters vary 1:1 with  $V_{CC}$ .  $V_{EE}$  can vary +0.3 V to -2.2 V.

15. All loading with 50  $\Omega$  to  $V_{CC}$ -2.0 volts.

16.  $V_{IHCMR}$  min varies 1:1 with  $V_{EE}$ ;  $V_{IHCMR}$  max varies 1:1 with  $V_{CC}$ . The  $V_{IHCMR}$  range is referenced to the most positive side of the differential input signal.

## 100EP DC CHARACTERISTICS, PECL $V_{CC} = 5.0\text{ V}$ , $V_{EE} = 0\text{ V}$ (Note 17)

Symbol	Characteristic	-40°C			25°C			85°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
$I_{EE}$	Power Supply Current (Note 18)					TBD					mA
$V_{OH}$	Output HIGH Voltage (Note 19)	3855	3980	4105	3855	3980	4105	3855	3980	4105	mV
$V_{OL}$	Output LOW Voltage (Note 19)	3055	3180	3305	3055	3180	3305	3055	3180	3305	mV
$V_{IH}$	Input HIGH Voltage (Single-Ended) PECL CMOS TTL	3775		4120	3775 2750 2000		4120	3775		4120	mV
$V_{IL}$	Input LOW Voltage (Single-Ended) PECL CMOS TTL	3790		3375	3190		3375 2250 400	3190		3375	mV
$V_{BB}$	Output Voltage Reference	3475	3575	3675	3475	3575	3675	3475	3575	3675	mV
$V_{CF}$	Input Select					TBD					mV
$V_{EF}$	Mode Connection					TBD					mV
$V_{IHCMR}$	Input HIGH Voltage Common Mode Range (Differential) (Note 20)	2.0		5.0	2.0		5.0	2.0		5.0	V
$I_{IH}$	Input HIGH Current			150			150			150	$\mu\text{A}$
$I_{IL}$	Input LOW Current $I_{IN}$ $I_{\overline{IN}}$	0.5 -150			0.5 -150			0.5 -150			$\mu\text{A}$

NOTE: EP circuits are designed to meet the DC specifications shown in the above table after thermal equilibrium has been established. The circuit is in a test socket or mounted on a printed circuit board and transverse airflow greater than 500 lfm is maintained.

17. Input and output parameters vary 1:1 with  $V_{CC}$ .  $V_{EE}$  can vary +2.0 V to -0.5 V.

18. Required 500 lfm air flow when using +5 V power supply. For  $(V_{CC} - V_{EE}) > 3.3\text{ V}$ , 5  $\Omega$  to 10  $\Omega$  in line with  $V_{EE}$  required for maximum thermal protection at elevated temperatures. Recommend  $V_{CC} - V_{EE}$  operation at  $\leq 3.8\text{ V}$ .

19. All loading with 50  $\Omega$  to  $V_{CC}$ -2.0 volts.

20.  $V_{IHCMR}$  min varies 1:1 with  $V_{EE}$ ;  $V_{IHCMR}$  max varies 1:1 with  $V_{CC}$ . The  $V_{IHCMR}$  range is referenced to the most positive side of the differential input signal.

# MC10EP196, MC100EP196

## 100EP DC CHARACTERISTICS, NECL $V_{CC} = 0\text{ V}$ , $V_{EE} = -5.5\text{ V}$ to $-3.0\text{ V}$ (Note 21)

Symbol	Characteristic	-40°C			25°C			85°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
$I_{EE}$	Power Supply Current (Note 22)					TBD					mA
$V_{OH}$	Output HIGH Voltage (Note 23)	-1145	-1020	-895	-1145	-1020	-895	-1145	-1020	-895	mV
$V_{OL}$	Output LOW Voltage (Note 23)	-1945	-1820	-1695	-1945	-1820	-1695	-1945	-1820	-1695	mV
$V_{IH}$	Input HIGH Voltage (Single-Ended) NECL	-1225		-880	-1225		-880	-1225		-880	mV
$V_{IL}$	Input LOW Voltage (Single-Ended) NECL	-1945		-1625	-1945		-1625	-1945		-1625	mV
$V_{BB}$	Output Voltage Reference	-1525	-1425	-1325	-1525	-1425	-1325	-1525	-1425	-1325	mV
$V_{CF}$	Input Select					TBD					mV
$V_{EF}$	Mode Connection					TBD					mV
$V_{IHCMR}$	Input HIGH Voltage Common Mode Range (Differential) (Note 24)	$V_{EE}+2.0$		0.0	$V_{EE}+2.0$		0.0	$V_{EE}+2.0$		0.0	V
$I_{IH}$	Input HIGH Current			150			150			150	$\mu\text{A}$
$I_{IL}$	Input LOW Current	$I_N$ $\overline{I_N}$	0.5 -150		0.5 -150			0.5 -150			$\mu\text{A}$

NOTE: EP circuits are designed to meet the DC specifications shown in the above table after thermal equilibrium has been established. The circuit is in a test socket or mounted on a printed circuit board and transverse airflow greater than 500 lfm is maintained.

21. Input and output parameters vary 1:1 with  $V_{CC}$ .

22. Required 500 lfm air flow when using +5 V power supply. For  $(V_{CC} - V_{EE}) > 3.3\text{ V}$ , 5  $\Omega$  to 10  $\Omega$  in line with  $V_{EE}$  required for maximum thermal protection at elevated temperatures. Recommend  $V_{CC}-V_{EE}$  operation at  $\leq 3.8\text{ V}$ .

23. All loading with 50  $\Omega$  to  $V_{CC}-2.0$  volts.

24.  $V_{IHCMR}$  min varies 1:1 with  $V_{EE}$ ,  $V_{IHCMR}$  max varies 1:1 with  $V_{CC}$ . The  $V_{IHCMR}$  range is referenced to the most positive side of the differential input signal.



# MC10EP196, MC100EP196

**AC CHARACTERISTICS**  $V_{CC} = 0\text{ V}$ ;  $V_{EE} = -3.0\text{ V}$  to  $-5.5\text{ V}$  or  $V_{CC} = 3.0\text{ V}$  to  $5.5\text{ V}$ ;  $V_{EE} = 0\text{ V}$  (Note 25)

Symbol	Characteristic	-40°C			25°C			85°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
$f_{\max}$	Maximum Frequency (See Figure 4. $F_{\max}/\text{JITTER}$ )		> 1.8			> 1.8			> 1.8		GHz
$t_{\text{PLH}}$ $t_{\text{PHL}}$	Propagation Delay IN to Q; D(0-10) = 0 IN to Q; D(0-10) = 1023 $\overline{\text{EN}}$ to Q; D(0-10) = 0 D0 to CASCADE					2200 12200 2300 450					ps
$t_{\text{RANGE}}$	Programmable Range $t_{\text{PD}}(\text{max}) - t_{\text{PD}}(\text{min})$					10000					ps
$\Delta t$	Step Delay (Note 26) D0 High D1 High D2 High D3 High D4 High D5 High D6 High D7 High D8 High D9 High					TBD					ps
Lin	Linearity					TBD					
$t_{\text{SKEW}}$	Duty Cycle Skew (Note 27) $t_{\text{PHL}} - t_{\text{PLH}}$					TBD					ps
$t_{\text{s}}$	Setup Time D to LEN D to IN (Note 28) $\overline{\text{EN}}$ to IN (Note 29)					0 160 170					ps
$t_{\text{h}}$	Hold Time LEN to D IN to $\overline{\text{EN}}$ (Note 30)					100 280					ps
$t_{\text{R}}$	Release Time $\overline{\text{EN}}$ to IN (Note 31) SET MAX to LEN SET MIN to LEN					TBD 250 200					ps
$t_{\text{jit}}$	Cycle-to-Cycle Jitter (See Figure 4.)		0.2	< 1		0.2	< 1		0.2	< 1	ps
$V_{\text{PP}}$	Input Voltage Swing (Differential)	150	800	1200	150	800	1200	150	800	1200	mV
$t_{\text{r}}$ $t_{\text{f}}$	Output Rise/Fall Time 20-80% (Q) 20-80% (CASCADE)					210 210					ps

25. Measured using a 750 mV source, 50% duty cycle clock source. All loading with  $50\ \Omega$  to  $V_{CC} - 2.0\text{ V}$ .

26. Specification limits represent the amount of delay added with the assertion of each individual delay control pin. The various combinations of asserted delay control inputs will typically realize D0 resolution steps across the specified programmable range.

27. Duty cycle skew guaranteed only for differential operation measured from the cross point of the input to the cross point of the output.

28. This setup time defines the amount of time prior to the input signal the delay tap of the device must be set.

29. This setup time is the minimum time that  $\overline{\text{EN}}$  must be asserted prior to the next transition of IN/ $\overline{\text{IN}}$  to prevent an output response greater than  $\pm 75\text{ mV}$  to that IN/ $\overline{\text{IN}}$  transition.

30. This hold time is the minimum time that  $\overline{\text{EN}}$  must remain asserted after a negative going IN or positive going  $\overline{\text{IN}}$  to prevent an output response greater than  $\pm 75\text{ mV}$  to that IN/ $\overline{\text{IN}}$  transition.

31. This release time is the minimum time that  $\overline{\text{EN}}$  must be deasserted prior to the next IN/ $\overline{\text{IN}}$  transition to ensure an output response that meets the specified IN to Q propagation delay and transition times.

## MC10EP196, MC100EP196

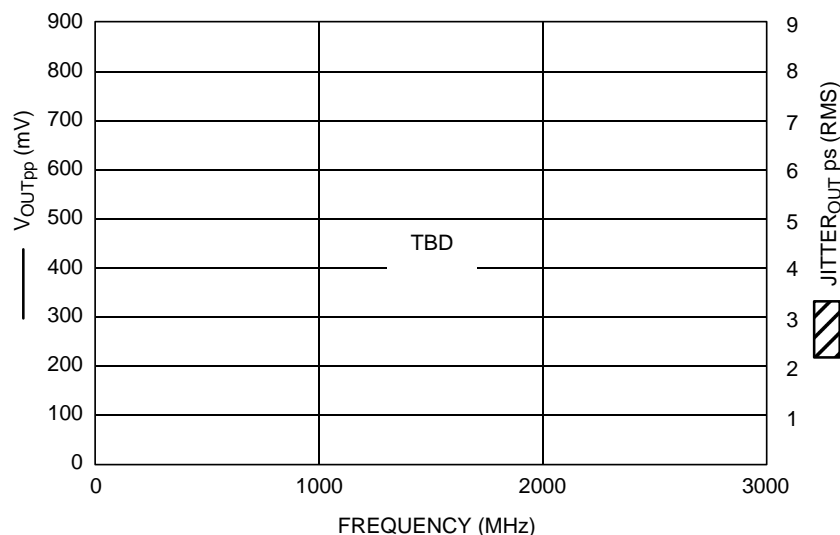


Figure 4.  $F_{max}/Jitter$

### Using the FTUNE Analog Input

The analog FTUNE pin on the EP196 device is intended to add more delay in a tunable gate to enhance the 10 ps resolution capabilities of the fully digital EP196. The level of resolution obtained is dependent on the voltage applied to the FTUNE pin.

To provide this further level of resolution, the FTUNE pin must be capable of adjusting the additional delay finer than the 10 ps digital resolution (See Logic Diagram). This requirement is easily achieved because a 60 ps additional delay can be obtained over the entire FTUNE voltage range (See Figure 5). This extra analog range ensures that the FTUNE pin will be

capable even under worst case conditions of covering a digital resolution. Typically, the analog input will be driven by an external DAC to provide a digital control with very fine analog output steps. The final resolution of the device will be dependent on the width of the DAC chosen.

To determine the voltage range necessary for the FTUNE input, Figure 5 should be used. There are numerous voltage ranges which can be used to cover a given delay range; users are given the flexibility to determine which one best fits their designs.

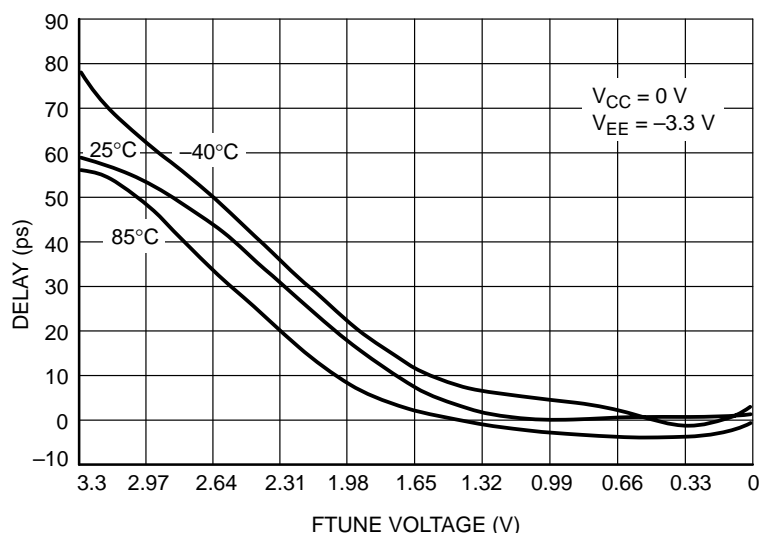
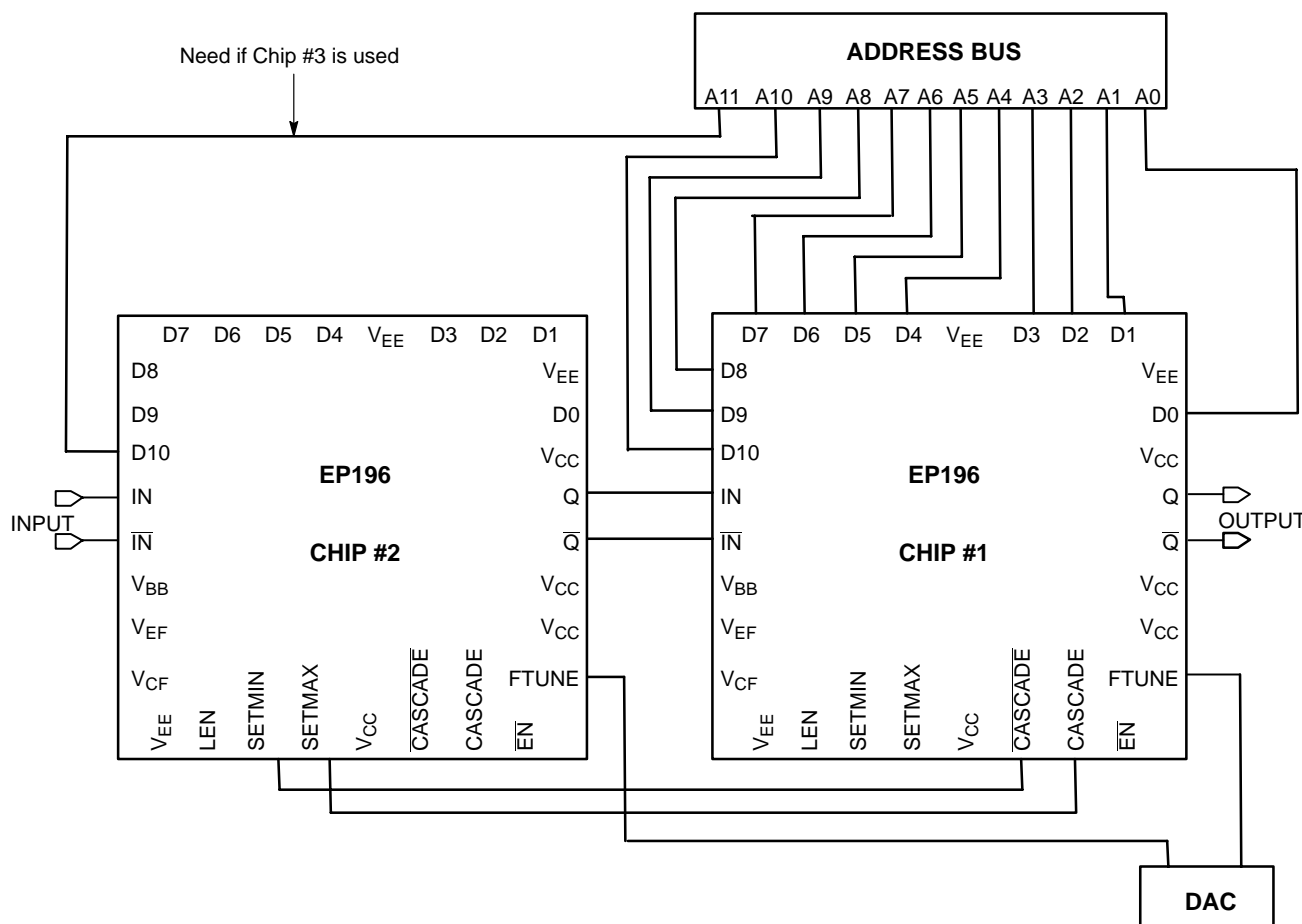


Figure 5. Propagation Delay versus FTUNE Voltage

## Cascading Multiple EP196s

To increase the programmable range of the EP196, internal cascade circuitry has been included. This circuitry allows for the cascading of multiple EP196s without the need for any external gating. Furthermore, this capability requires only one more address line per added E196. Obviously, cascading multiple programmable delay chips will result in a larger programmable range; however, this increase is at the expense of a longer minimum delay.

Figure 6 illustrates the interconnect scheme for cascading two EP196s. As can be seen, this scheme can easily be expanded for larger EP196 chains. The D10 input of the EP196 is the cascade control pin. With the interconnect scheme of Figure 6 when D10 is asserted, it signals the need for a larger programmable range than is achievable with a single device. The A11 address can be added to generate a cascade output for the next EP196. For a 2–device configuration, A11 is not required.



### Figure 6. Cascading Interconnect Architecture

An expansion of the latch section of the block diagram is pictured in Figure 7. Use of this diagram will simplify the explanation of how the cascade circuitry works. When D10 of chip #1 in Figure 6 is low, the cascade output will also be low while the cascade bar output will be a logical high. In this condition, the SETMIN pin of chip #2 will be asserted and thus all of the latches of chip #2 will be reset and the device will be set at its minimum delay.

Chip #1, on the other hand, will have both SETMIN and SETMAX deasserted so that its delay will be controlled entirely by the address bus A0–A9. If the delay needed is greater than can be achieved with 1023 gate delays (1111111111 on the A0–A9 address bus), D10 will be asserted to signal the need to cascade the delay to the next EP196 device. When D10 is asserted, the SETMIN pin of

chip #2 will be deasserted and the SETMAX pin asserted, resulting in the device delay to be the maximum delay. Figure 8 shows the delay time of two EP196 chips in cascade.

To expand this cascading scheme to more devices, one simply needs to connect the D10 pin from the next chip to the address bus and CASCADE outputs to the next chip in the same manner as pictured in Figure 6. The only addition to the logic is the increase of one line to the address bus for cascade control of the second programmable delay chip.

Furthermore, to fully utilize EP196, the FTUNE pin can be used for additional delay and for finer resolution than 10 ps. As shown in Figure 5, an analog voltage input from DAC can adjust the FTUNE pin with an extra 60 ps of delay for each chip.

# MC10EP196, MC100EP196

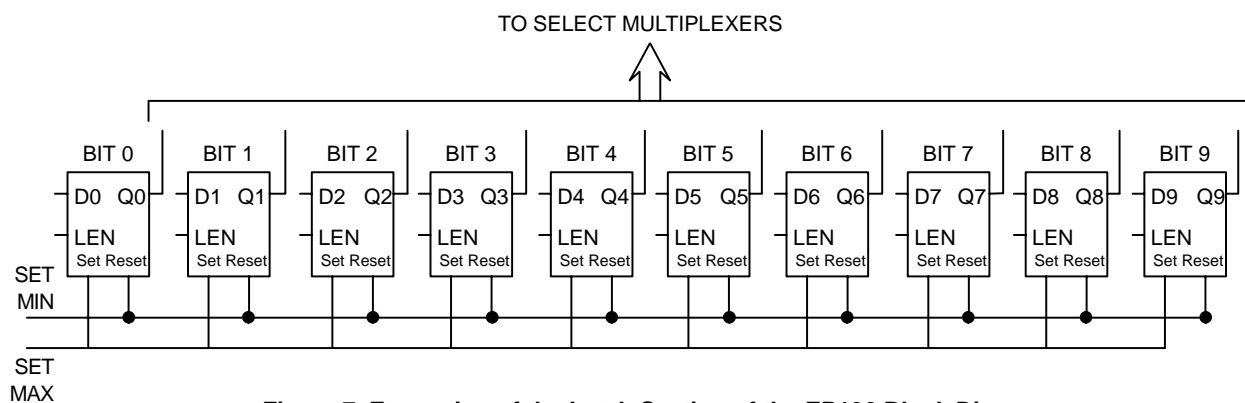


Figure 7. Expansion of the Latch Section of the EP196 Block Diagram

VARIABLE INPUT TO CHIP #1 AND <i>SETMIN</i> FOR CHIP #2												
INPUT FOR CHIP #1												Total
D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	Delay Value	Delay Value
0	0	0	0	0	0	0	0	0	0	0	0 ps	4400 ps
0	0	0	0	0	0	0	0	0	0	1	10 ps	4410 ps
0	0	0	0	0	0	0	0	0	1	0	20 ps	4420 ps
0	0	0	0	0	0	0	0	0	1	1	30 ps	4430 ps
0	0	0	0	0	0	0	0	1	0	0	40 ps	4440 ps
0	0	0	0	0	0	0	0	1	0	1	50 ps	4450 ps
0	0	0	0	0	0	0	0	1	1	0	60 ps	4460 ps
0	0	0	0	0	0	0	0	1	1	1	70 ps	4470 ps
0	0	0	0	0	0	0	1	0	0	0	80 ps	4480 ps
0	0	0	0	0	0	1	0	0	0	0	160 ps	4560 ps
0	0	0	0	0	1	0	0	0	0	0	320 ps	4720 ps
0	0	0	0	1	0	0	0	0	0	0	640 ps	5040 ps
0	0	0	1	0	0	0	0	0	0	0	1280 ps	5680 ps
0	0	1	0	0	0	0	0	0	0	0	2560 ps	6960 ps
0	1	0	0	0	0	0	0	0	0	0	5120 ps	9520 ps
0	1	1	1	1	1	1	1	1	1	1	10230 ps	14630 ps

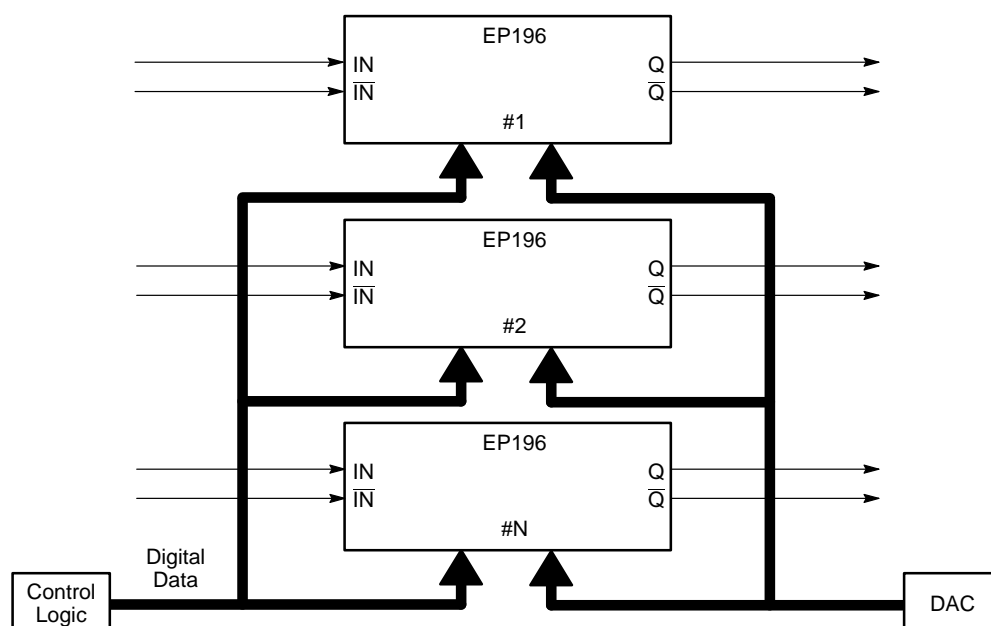
VARIABLE INPUT TO CHIP #1 AND SETMAX FOR CHIP #2												
INPUT FOR CHIP #1												Total
D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	Delay Value	Delay Value
1	0	0	0	0	0	0	0	0	0	0	10240 ps	14640 ps
1	0	0	0	0	0	0	0	0	0	1	10250 ps	14650 ps
1	0	0	0	0	0	0	0	0	1	0	10260 ps	14660 ps
1	0	0	0	0	0	0	0	0	1	1	10270 ps	14670 ps
1	0	0	0	0	0	0	0	1	0	0	10280 ps	14680 ps
1	0	0	0	0	0	0	0	1	0	1	10290 ps	14690 ps
1	0	0	0	0	0	0	0	1	1	0	10300 ps	14700 ps
1	0	0	0	0	0	0	0	1	1	1	10310 ps	14710 ps
1	0	0	0	0	0	0	1	0	0	0	10320 ps	14720 ps
1	0	0	0	0	0	1	0	0	0	0	10400 ps	14800 ps
1	0	0	0	0	1	0	0	0	0	0	10560 ps	14960 ps
1	0	0	0	1	0	0	0	0	0	0	10880 ps	15280 ps
1	0	0	1	0	0	0	0	0	0	0	11520 ps	15920 ps
1	0	1	0	0	0	0	0	0	0	0	12800 ps	17200 ps
1	1	0	0	0	0	0	0	0	0	0	15360 ps	19760 ps
1	1	1	1	1	1	1	1	1	1	1	20470 ps	24870 ps

Figure 8. Cascaded Delay Value of Two EP196s

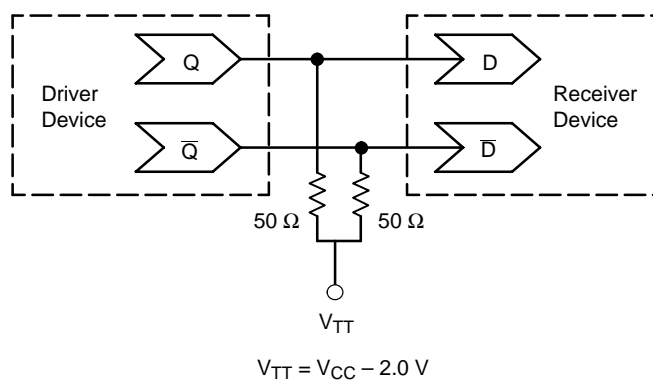
## Multi-Channel Deskewing

The most practical application for EP196 is in multiple channel delay matching. Slight differences in impedance and cable length can create large timing skews within a high-speed system. To deskew multiple signal channels, each channel can be sent through each EP196 as shown in

Figure 9. One signal channel can be used as reference and the other EP196s can be used to adjust the delay to eliminate the timing skews. Nearly any high-speed system can be fine tuned (as small as 10 ps) to reduce the skew to extremely tight tolerances using the available FTUNE pin.



**Figure 9. Multiple Channel Deskewing Diagram**



**Figure 10. Typical Termination for Output Driver and Device Evaluation  
(See Application Note AND8020 – Termination of ECL Logic Devices.)**

**Resource Reference of Application Notes**

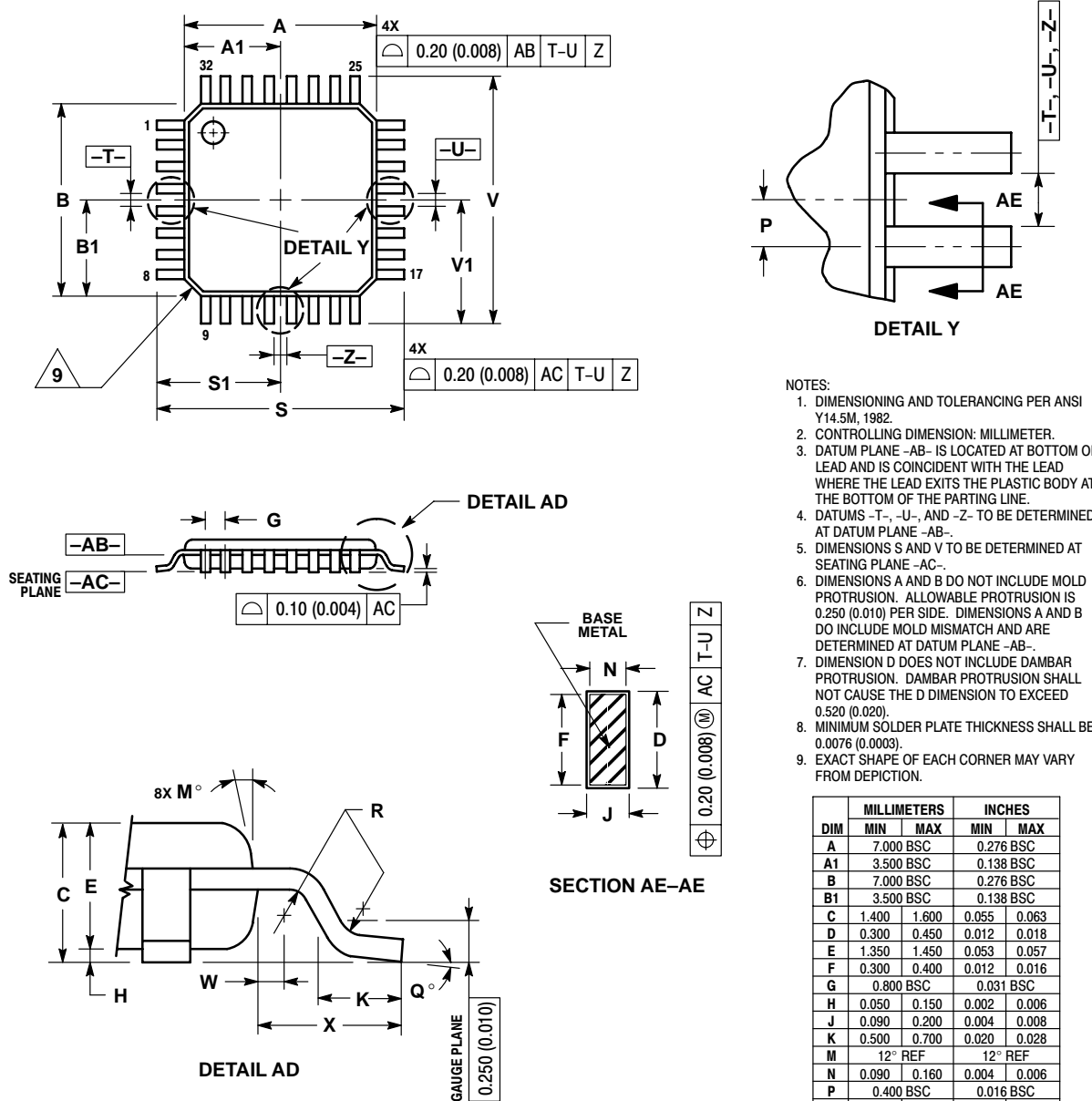
- AN1404** – ECLinPS Circuit Performance at Non-Standard  $V_{IH}$  Levels
- AN1405** – ECL Clock Distribution Techniques
- AN1406** – Designing with PECL (ECL at +5.0 V)
- AN1504** – Metastability and the ECLinPS Family
- AN1568** – Interfacing Between LVDS and ECL
- AN1650** – Using Wire-OR Ties in ECLinPS Designs
- AN1672** – The ECL Translator Guide
- AND8001** – Odd Number Counters Design
- AND8002** – Marking and Date Codes
- AND8009** – ECLinPS Plus Spice I/O Model Kit
- AND8020** – Termination of ECL Logic Devices

For an updated list of Application Notes, please see our website at <http://onsemi.com>.

# MC10EP196, MC100EP196


## PACKAGE DIMENSIONS

LQFP  
FA SUFFIX  
32-LEAD PLASTIC PACKAGE  
CASE 873A-02  
ISSUE A



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: MILLIMETER.
  3. DATUM PLANE -AB- IS LOCATED AT BOTTOM OF LEAD AND IS COINCIDENT WITH THE LEAD WHERE THE LEAD EXITS THE PLASTIC BODY AT THE BOTTOM OF THE PARTING LINE.
  4. DATUMS -T-, -U-, AND -Z- TO BE DETERMINED AT DATUM PLANE -AB-.
  5. DIMENSIONS S AND V TO BE DETERMINED AT SEATING PLANE -AC-.
  6. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS 0.250 (0.010) PER SIDE. DIMENSIONS A AND B DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE -AB-.
  7. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. DAMBAR PROTRUSION SHALL NOT CAUSE THE D DIMENSION TO EXCEED 0.520 (0.020).
  8. MINIMUM SOLDER PLATE THICKNESS SHALL BE 0.0076 (0.0003).
  9. EXACT SHAPE OF EACH CORNER MAY VARY FROM DEPICTION.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	7.000 BSC		0.276 BSC	
A1	3.500 BSC		0.138 BSC	
B	7.000 BSC		0.276 BSC	
B1	3.500 BSC		0.138 BSC	
C	1.400	1.600	0.055	0.063
D	0.300	0.450	0.012	0.018
E	1.350	1.450	0.053	0.057
F	0.300	0.400	0.012	0.016
G	0.800 BSC		0.031 BSC	
H	0.050	0.150	0.002	0.006
J	0.090	0.200	0.004	0.008
K	0.500	0.700	0.020	0.028
M	12° REF		12° REF	
N	0.090	0.160	0.004	0.006
P	0.400 BSC		0.016 BSC	
Q	1°	5°	1°	5°
R	0.150	0.250	0.006	0.010
S	9.000 BSC		0.354 BSC	
S1	4.500 BSC		0.177 BSC	
V	9.000 BSC		0.354 BSC	
V1	4.500 BSC		0.177 BSC	
W	0.200 REF		0.008 REF	
X	1.000 REF		0.039 REF	

**ON Semiconductor** and  are registered trademarks of Semiconductor Components Industries, LLC (SCILLC). SCILLC reserves the right to make changes without further notice to any products herein. SCILLC makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does SCILLC assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. "Typical" parameters which may be provided in SCILLC data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. SCILLC does not convey any license under its patent rights nor the rights of others. SCILLC products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the SCILLC product could create a situation where personal injury or death may occur. Should Buyer purchase or use SCILLC products for any such unintended or unauthorized application, Buyer shall indemnify and hold SCILLC and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that SCILLC was negligent regarding the design or manufacture of the part. SCILLC is an Equal Opportunity/Affirmative Action Employer.

## PUBLICATION ORDERING INFORMATION

### Literature Fulfillment:

Literature Distribution Center for ON Semiconductor  
P.O. Box 5163, Denver, Colorado 80217 USA  
**Phone:** 303-675-2175 or 800-344-3860 Toll Free USA/Canada  
**Fax:** 303-675-2176 or 800-344-3867 Toll Free USA/Canada  
**Email:** ONlit@hibbertco.com

**N. American Technical Support:** 800-282-9855 Toll Free USA/Canada

**JAPAN:** ON Semiconductor, Japan Customer Focus Center  
4-32-1 Nishi-Gotanda, Shinagawa-ku, Tokyo, Japan 141-0031  
**Phone:** 81-3-5740-2700  
**Email:** r14525@onsemi.com

**ON Semiconductor Website:** <http://onsemi.com>

For additional information, please contact your local  
Sales Representative.