3.3 V ECL Programmable Delay Chip With FTUNE

MC100EP196B

Descriptions

The MC100EP196B 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 has similar architecture to the EP195 with the added feature of further tunability 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 3. The delay increment of the EP196B has a digitally selectable resolution of about 10 ps and a net range of up to 10.4 ns. The required delay is selected by the 10 data select inputs D[9:0] values and controlled by the LEN (Pin 10). A LOW level on LEN allows a transparent LOAD mode of real time delay values by D[9:0]. A LOW to HIGH transition on LEN will LOCK and HOLD current values present against any subsequent changes in D[10:0]. The approximate delay values for varying tap numbers correlating to D0 (LSB) through D9 (MSB) are shown in Table 6 and Figure 4.

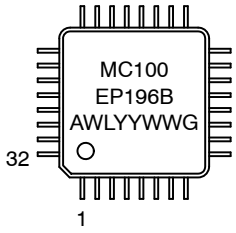
The IN/$\overline{\text{IN}}$ inputs can accept LVPECL (SE or Diff), or LVDS level signals. Because the MC100EP196B is designed using a chain of multiplexers it has a fixed minimum delay of 2.2 ns. An additional pin D10 is provided for controlling Pins 14 and 15, CASCADE and $\overline{\text{CASCADE}}$, also latched by LEN, in cascading multiple PDCs for increased programmable range. The cascade logic allows full control of multiple PDCs. Switching devices from all “1” states on D[0:9] with SETMAX LOW to all “0” states on D[0:9] with SETMAX HIGH will increase the delay equivalent to “D0”, the minimum increment.

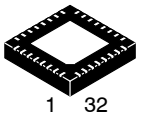
Select input pins D[10:0] may be threshold controlled by combinations of interconnects between V_{EF} (pin 7) and V_{CF} (pin 8) for receiving LVCMOS, ECL, or LVTTL level signals. For LVCMOS input levels, leave V_{CF} and V_{EF} open. For ECL operation, short V_{CF} and V_{EF} (Pins 7 and 8). For LVTTL level operation, connect a 1.5 V supply reference to V_{CF} and leave open V_{EF} pin. The 1.5 V reference voltage at the V_{CF} pin can be accomplished by placing a 2.2 kΩ resistor between V_{CF} and V_{EE} for a 3.3 V power supply.

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 μF capacitor and limit current sourcing or sinking to 0.5 mA. When not used, V_{BB} should be left open.

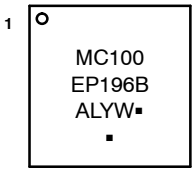
The 100 Series contains temperature compensation.

LQFP−32, 7 × 7
FA SUFFIX
CASE 561AB−01





QFN32
MN SUFFIX
CASE 488AM



MARKING DIAGRAMS*

A	= Assembly Location
WL, L	= Wafer Lot
Y, YY	= Year
W, WW	= Work Week
G or ▪	= Pb−Free Package

(Note: Microdot may be in either location)

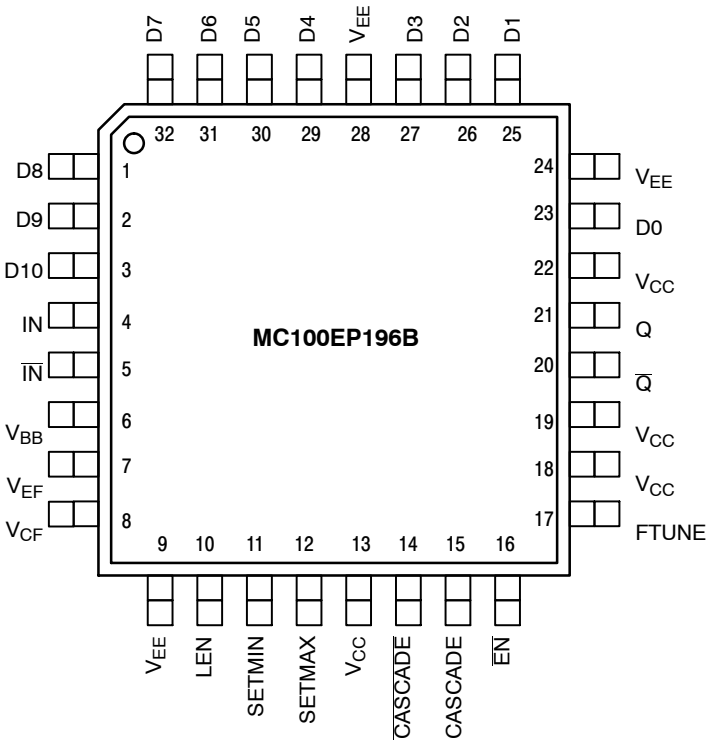
*For additional marking information, refer to Application Note AND8002/D.

Features

- Maximum Input Clock Frequency >1.2 GHz Typical
- Programmable Range: 0 ns to 10 ns
- Delay Range: 2.2 ns to 12.4 ns
- 10 ps Increments
- Linearity ±40 ps max
- PECL Mode Operating Range: V_{CC} = 3.0 V to 3.6 V with V_{EE} = 0 V
- NECL Mode Operating Range: V_{CC} = 0 V with V_{EE} = −3.0 V to −3.6 V
- IN/$\overline{\text{IN}}$ Inputs Accept LVPECL, LVNECL, LVDS Levels
- A Logic High on the $\overline{\text{EN}}$ Pin Will Force Q to Logic Low
- D[10:0] Can Select Either LVPECL, LVCMOS, or LVTTL Input Levels
- V_{BB} Output Reference Voltage
- These are Pb−Free Devices

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 16 of this data sheet.



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

Figure 1. 32−Lead LQFP (Top View)

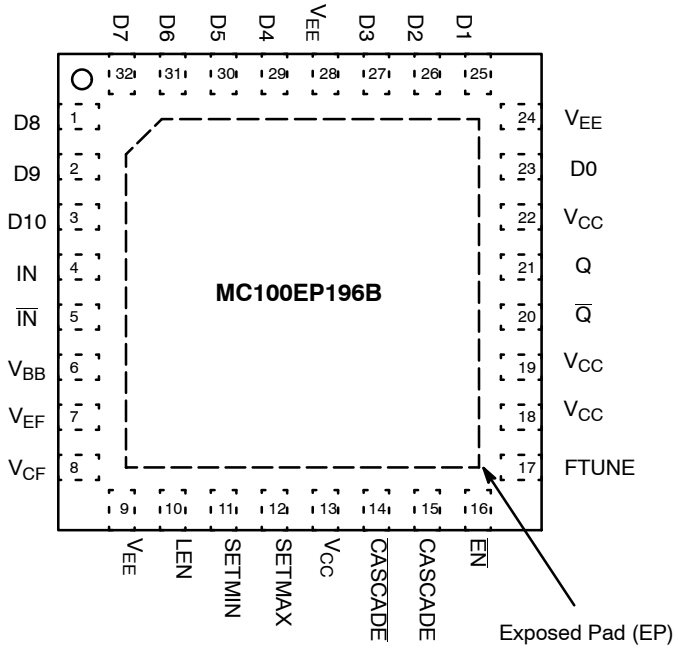


Figure 2. 32−Lead QFN (Top View)

Table 1. PIN DESCRIPTION

Pin	Name	I/O	Default State	Description
23, 25, 26, 27, 29, 30, 31, 32, 1, 2	D[0:9]	LVCMOS, LVTTL, ECL Input	Low	Single−Ended Parallel Data Inputs [0:9]. Internal 75 kΩ to V_{EE}. (Note 1)
3	D[10]	LVCMOS, LVTTL, ECL Input	Low	Single−Ended CASCADE/$\overline{\text{CASCADE}}$ Control Input. Internal 75 kΩ to V_{EE}. (Note 1)
4	IN	LVPECL, LVDS	Low	Noninverted Differential Input. Internal 75 kΩ to V_{EE}.
5	$\overline{\text{IN}}$	LVPECL, LVDS	High	Inverted Differential Input. Internal 75 kΩ to V_{EE}.
6	V_{BB}	−	−	ECL Reference Voltage Output
7	V_{EF}	−	−	Reference Voltage for ECL Mode Connection
8	V_{CF}	−	−	LVCMOS, ECL, OR LVTTL Input Mode Select
9, 24, 28	V_{EE}	−	−	Negative Supply Voltage. All V_{EE} Pins must be Externally Connected to Power Supply to Guarantee Proper Operation. (Note 2)
13, 18, 19, 22	V_{CC}	−	−	Positive Supply Voltage. All V_{CC} Pins must be externally Connected to Power Supply to Guarantee Proper Operation. (Note 2)
10	LEN	ECL Input	Low	Single−ended D pins LOAD / HOLD input. Internal 75 kΩ to V_{EE}.
11	SETMIN	ECL Input	Low	Single−ended Minimum Delay Set Logic Input. Internal 75 kΩ to V_{EE}. (Note 1)
12	SETMAX	ECL Input	Low	Single−ended Maximum Delay Set Logic Input. Internal 75 kΩ to V_{EE}. (Note 1)
14	$\overline{\text{CASCADE}}$	ECL Output	−	Inverted Differential Cascade Output for D[10]. Typically Terminated with 50 Ω to $V_{TT} = V_{CC} - 2$ V.
15	CASCADE	ECL Output	−	Noninverted Differential Cascade Output. for D[10] Typically Terminated with 50 Ω to $V_{TT} = V_{CC} - 2$ V.
16	$\overline{\text{EN}}$	ECL Input	Low	Single−ended Output Enable Pin. Internal 75 kΩ to V_{EE}.
17	FTUNE	Analog Input	−	Fine Tune Input
21	Q	ECL Output	−	Noninverted Differential Output. Typically Terminated with 50 Ω to $V_{TT} = V_{CC} - 2$ V.
20	$\overline{\text{Q}}$	ECL Output	−	Inverted Differential Output. Typically Terminated with 50 Ω to $V_{TT} = V_{CC} - 2$ V.

1. SETMIN will override SETMAX if both are high. SETMAX and SETMIN will override all D[0:10] inputs.
2. All V_{CC} and V_{EE} pins must be externally connected to Power Supply to guarantee proper operation.

Table 2. CONTROL PIN

Pin	State	Function
EN	LOW (Note 3)	Input Signal is Propagated to the Output
	HIGH	Output Holds Logic Low State
LEN	LOW (Note 3)	Transparent or LOAD mode for real time delay values present on D[0:10].
	HIGH	LOCK and HOLD mode for delay values on D[0:10]; further changes on D[0:10] are not recognized and do not affect delay.
SETMIN	LOW (Note 3)	Output Delay set by D[0:10]
	HIGH	Set Minimum Output Delay
SETMAX	LOW (Note 3)	Output Delay set by D[0:10]
	HIGH	Set Maximum Output Delay
D10	LOW (Note 3)	CASCADE Output LOW, $\overline{\text{CASCADE}}$ Output HIGH
	HIGH	$\overline{\text{CASCADE}}$ Output LOW, CASCADE Output HIGH

3. Internal pulldown resistor will provide a logic LOW if pin is left unconnected.

Table 3. CONTROL D[0:10] INTERFACE

V_{CF}	V_{EF} Pin (Note 4)	ECL Mode
V_{CF}	No Connect	LVCMOS Mode
V_{CF}	1.5 V ± 100 mV	LVTTL Mode (Note 5)

4. Short V_{CF} (pin 8) and V_{EF} (pin 7).
5. When Operating in LVTTL Mode, the reference voltage can be provided by connecting an external resistor, R_{CF} (suggested resistor value is 2.2 kΩ ±5%), between V_{CF} and V_{EE} pins.

Table 4. DATA INPUT ALLOWED OPERATING VOLTAGE MODE TABLE

POWER SUPPLY	CONTROL DATA SELECT INPUTS PINS (D [0:10])			
	LVCMOS	LVTTL	LVPECL	LVNECL
PECL Mode Operating Range	YES	YES	YES	N/A
NECL Mode Operating Range	N/A	N/A	N/A	YES

Table 5. ATTRIBUTES

Characteristics		Value
Internal Input Pulldown Resistor	(R1)	75 kΩ
ESD Protection	Human Body Model Machine Model Charged Device Model	> 2 kV > 100 V > 2 kV
Moisture Sensitivity, Indefinite Time Out of Drypack (Note 6)		Pb−Free Pkg
	QFN−32 LQFP−32	Level 1 Level 2
Flammability Rating Oxygen Index: 28 to 34		UL 94 V−0 @ 0.125 in
Transistor Count		1237 Devices
Meets or exceeds JEDEC Spec EIA/JESD78 IC Latchup Test		

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

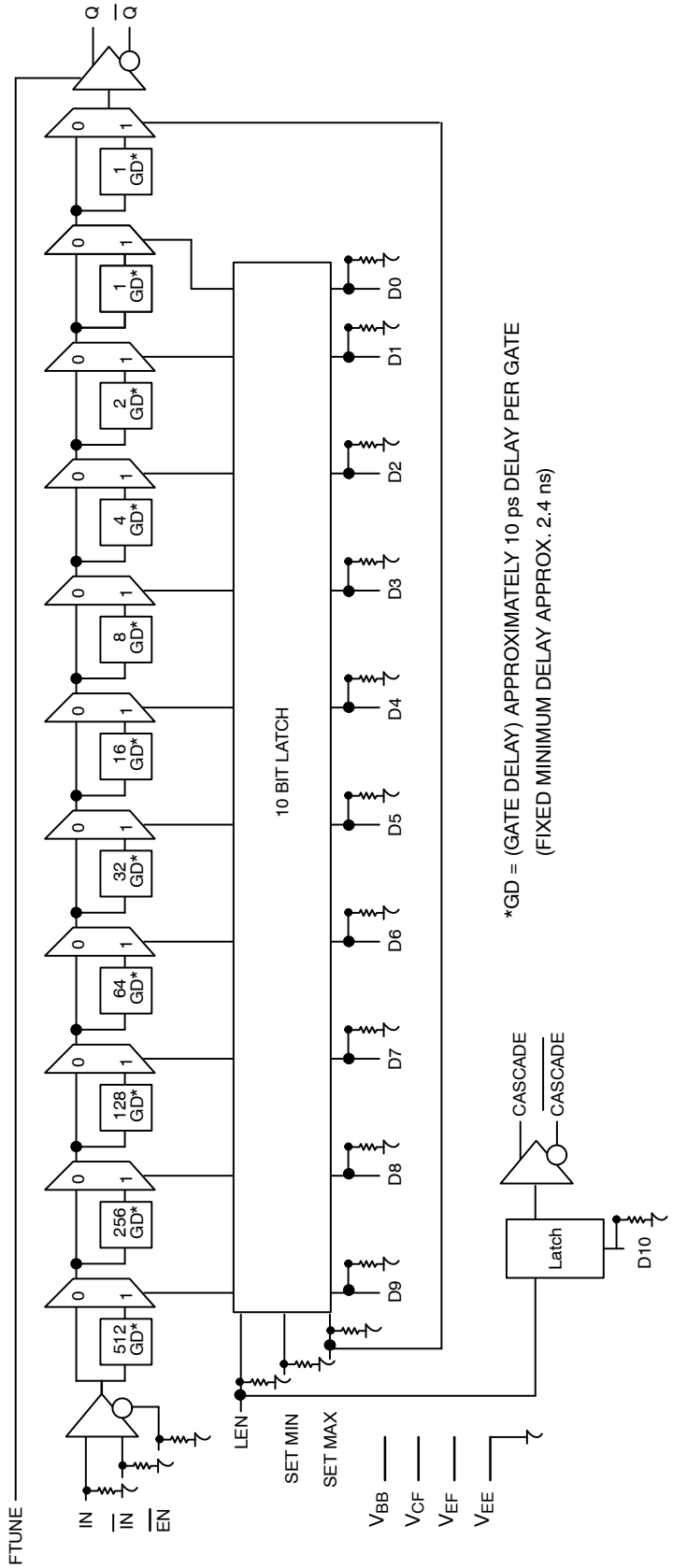


Figure 3. Logic Diagram

Table 6. THEORETICAL DELAY VALUES

D(9:0) Value	SETMIN	SETMAX	Programmable Delay*
XXXXXXXXXX	H	L	0 ps
0000000000	L	L	0 ps
0000000001	L	L	10 ps
0000000010	L	L	20 ps
0000000011	L	L	30 ps
0000000100	L	L	40 ps
0000000101	L	L	50 ps
0000000110	L	L	60 ps
0000000111	L	L	70 ps
0000001000	L	L	80 ps
0000010000	L	L	160 ps
0000100000	L	L	320 ps
0001000000	L	L	640 ps
0010000000	L	L	1280 ps
0100000000	L	L	2560 ps
1000000000	L	L	5120 ps
1111111111	L	L	10230 ps
XXXXXXXXXX	L	H	10240 ps

*Fixed minimum delay not included.

Table 7. TYPICAL FTUNE DELAY PIN

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

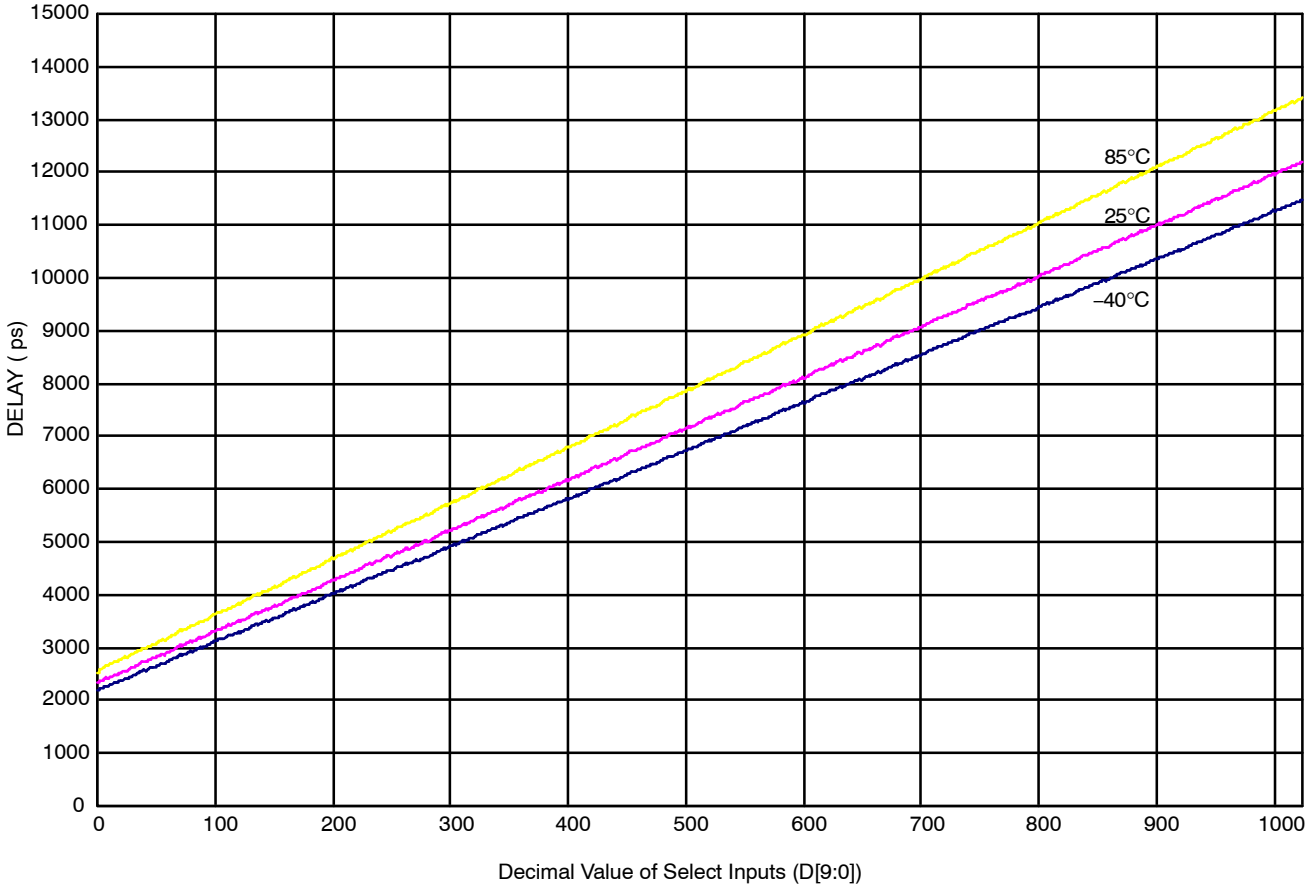


Figure 4. Measured Delay vs. Select Inputs

Table 8. MAXIMUM RATINGS

Symbol	Parameter	Condition 1	Condition 2	Rating	Unit
V_{CC}	Positive Mode Power Supply	V_{EE} = 0 V		6	V
V_{EE}	Negative Mode Power Supply	V_{CC} = 0 V		–6	V
V_I	Positive Mode Input Voltage Negative Mode Input Voltage	V_{EE} = 0 V V_{CC} = 0 V	$V_I \le V_{CC}$ $V_I \ge V_{EE}$	6 –6	V V
I_{out}	Output Current	Continuous Surge		50 100	mA mA
I_{BB}	V_{BB} Sink/Source			±0.5	mA
T_A	Operating Temperature Range			–40 to +85	°C
T_{stg}	Storage Temperature Range			–65 to +150	°C
θ_{JA}	Thermal Resistance (Junction–to–Ambient)	0 lfpm 500 lfpm	QFN–32 QFN–32	31 27	°C/W °C/W
		0 lfpm 500 lfpm	LQFP–32 LQFP–32	80 55	°C/W °C/W
θ_{JC}	Thermal Resistance (Junction–to–Case)	2S2P standard boards	QFN–32	12	°C/W
			LQFP–32	12 to 17	°C/W
T_{sol}	Wave Solder Pb–Free	<2 to 3 sec @ 260°C		265	°C

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

Table 9. 100EP DC CHARACTERISTICS, PECL V_{CC} = 3.3 V, V_{EE} = 0 V (Note 7)

Symbol	Characteristic	−40°C			25°C			85°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
I_{EE}	Negative Power Supply Current	90	115	170	100	140	170	100	145	175	mA
V_{OH}	Output HIGH Voltage (Note 8)	2155	2280	2405	2155	2280	2405	2155	2280	2405	mV
V_{OL}	Output LOW Voltage (Note 8)	1305	1480	1605	1305	1480	1605	1305	1480	1605	mV
V_{IH}	Input HIGH Voltage (Single−Ended) LVPECL CMOS TTL	 2075 2000 2000		 2420 3300 3300	 2075 2000 2000		 2420 3300 3300	 2075 2000 2000		 2420 3300 3300	mV
V_{IL}	Input LOW Voltage (Single−Ended) LVPECL CMOS TTL	 1305 0 0		 1675 800 800	 1305 0 0		 1675 800 800	 1305 0 0		 1675 800 800	mV
V_{BB}	ECL Output Voltage Reference	1775	1875	1975	1775	1875	1975	1775	1875	1975	mV
V_{CF}	LVTTL Mode Input Detect Voltage	1.4	1.5	1.6	1.4	1.5	1.6	1.4	1.5	1.6	V
V_{EF}	Reference Voltage for ECL Mode Connection	1900	2020	2150	1900	2020	2150	1900	2020	2150	mV
V_{IHCMR}	Input HIGH Voltage Common Mode Range (Differential Configuration) (Note 9)	1.2		3.3	1.2		3.3	1.2		3.3	V
I_{IH}	Input HIGH Current (@ V_{IH})	0		150	0		150	0		150	μA
I_{IL}	Input LOW Current (@ V_{IL}) IN, $\overline{IN}$	0		150	0		150	0		150	μA

NOTE: Device will meet the specifications after thermal equilibrium has been established when mounted in a test socket or printed circuit board with maintained transverse airflow greater than 500 lfpm.

7. Input and output parameters vary 1:1 with V_{CC}. V_{EE} can vary +0.3 V to −0.3 V.
8. All loading with 50 Ω to V_{CC} − 2.0 V.
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.

Table 10. 100EP DC CHARACTERISTICS, NECL V_{CC} = 0 V, V_{EE} = −3.3 V (Note 10)

Symbol	Characteristic	−40°C			25°C			85°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
I_{EE}	Negative Power Supply Current (Note 11)	90	115	170	100	140	170	100	145	175	mA
V_{OH}	Output HIGH Voltage (Note 12)	−1145	−1020	−895	−1145	−1020	−895	−1145	−1020	−895	mV
V_{OL}	Output LOW Voltage (Note 12)	−1995	−1820	−1695	−1995	−1820	−1695	−1995	−1820	−1695	mV
V_{IH}	Input HIGH Voltage (Single−Ended) LVNECL	−1225		−880	−1225		−880	−1225		−880	mV
V_{IL}	Input LOW Voltage (Single−Ended) LVNECL	−1995		−1625	−1995		−1625	−1995		−1625	mV
V_{BB}	ECL Output Voltage Reference	−1525	−1425	−1325	−1525	−1425	−1325	−1525	−1425	−1325	mV
V_{EF}	Reference Voltage for ECL Mode Connection	−1400	−1280	−1250	−1400	−1280	−1250	−1400	−1280	−1250	mV
V_{IHCMR}	Input HIGH Voltage Common Mode Range (Differential Configuration) (Note 13)	V_{EE}+ 1.2		0.0	V_{EE}+ 1.2		0.0	V_{EE}+ 1.2		0.0	V
I_{IH}	Input HIGH Current (@ V_{IH})	0		150	0		150	0		150	μA
I_{IL}	Input LOW Current (@ V_{IL}) IN, $\overline{IN}$	0		150	0		150	0		150	μA

NOTE: Device will meet the specifications after thermal equilibrium has been established when mounted in a test socket or printed circuit board with maintained transverse airflow greater than 500 lfpm.

10. Input and output parameters vary 1:1 with V_{CC}. V_{EE} can vary +0.3 V to −0.3 V.
11. Required 500 lfpm air flow when using +5 V power supply. For (V_{CC} − V_{EE}) > 3.3 V, 5 Ω to 10 Ω in line with V_{EE} required for maximum thermal protection at elevated temperatures. Recommend V_{CC} − V_{EE} operation at ≤ 3.8 V.
12. All loading with 50 Ω to V_{CC} − 2.0 V.
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.

Table 11. AC CHARACTERISTICS V_{CC} = 0 V; V_{EE} = −3.0 V to −3.6 V or V_{CC} = 3.0 V to 3.6 V; V_{EE} = 0 V (Note 14)

Symbol	Characteristic	−40°C			25°C			85°C			Unit
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
f_{max}	Maximum Frequency		1.2			1.2			1.2		GHz
V_{outpp}	Output Voltage Amplitude	610	820		610	820		610	820		mV
t_{PLH} t_{PHL}	Propagation Delay IN to Q; D(0−10) = 0, SETMIN IN to Q; D(0−10) = 1023, SETMAX $\overline{EN}$ to Q; D(0−10) = 0 D0 to CASCADE	 2000 10900 1990 375	 2400 12400 2500 475	 2800 13900 2990 575	 2150 11500 2130 400	 2500 13000 2600 500	 2950 14500 3130 600	 2250 12250 2380 425	 2700 13750 2800 525	 3050 15250 3380 625	ps
t_{RANGE}	Programmable Range t_{PD} (max) − t_{PD} (min)	8950	9950	10950	9450	10450	11450	10110	11100	12110	ps
Δt	Step Delay (Note 15) D0 High D1 High D2 High D3 High D4 High D5 High D6 High D7 High D8 High D9 High		 10 16 32 65 155 310 620 1200 2500 4900			 11 18 33 72 166 325 650 1300 2600 5200			 15 26 46 92 195 370 720 1400 2800 5500		ps
NLIN	Non−Linearity (Notes 16 and 17) 0 to 511 decimal values for D[9:0] range 512 to 1023 dec. values for D[9:0] range 1 to 1023 decimal values for D[9:0] range		 ±7.0 ±7.0 ±11			 ±7.0 ±7.0 ±11			 ±7.0 ±7.0 ±11		ps
t_{SKEW}	Duty Cycle Skew (Note 18) $\lvert t_{PHL} - t_{PLH} \rvert$		25	90		25	90		25	90	ps
t_s	Setup Time D to LEN D to IN (Note 19) $\overline{EN}$ to IN (Note 20)	 200 500 300	 −40 −550 100		 200 500 300	 −40 −590 100		 200 500 300	 −40 −650 120		ps
t_h	Hold Time LEN to D IN to $\overline{EN}$ (Note 21)	 200 400	 50 −320		 200 400	 40 −350		 200 400	 30 −400		ps
t_R	Release Time $\overline{EN}$ to IN (Note 22) SET MAX to LEN SET MIN to LEN	 300 400 350	 −150 180 220		 300 400 350	 −170 200 250		 300 400 350	 −200 210 260		ps
t_{jitter}	RMS Random Clock Jitter @ 1.2 GHz IN to Q; D(0:10) = 0 or SETMIN IN to Q; D(0:10) = 1023 or SETMAX		 0.9 1.9	 2.0 5.0		 1.1 2.6	 2.0 5.0		 1.2 3.3	 2.0 5.0	ps
V_{PP}	Input Voltage Swing (Differential Configuration)	150	800	1200	150	800	1200	150	800	1200	mV
t_r t_f	Output Rise/Fall Time @ 50 MHz 20−80% (Q) 20−80% (CASCADE)	 85 110	 115 160	 140 210	 100 120	 120 175	 140 230	 100 120	 130 190	 165 250	ps

NOTE: Device will meet the specifications after thermal equilibrium has been established when mounted in a test socket or printed circuit board with maintained transverse airflow greater than 500 lfpm.

14. Measured using a 750 mV source, 50% duty cycle clock source. All loading with 50 Ω to V_{CC} − 2.0 V.
15. 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.
16. Deviation from a linear delay (actual Min to Max) in the 1024 programmable steps.
17. For NLIN, Max temperature is 70°C.
18. Duty cycle skew guaranteed only for differential operation measured from the cross point of the input to the cross point of the output.
19. This setup time defines the amount of time prior to the input signal the delay tap of the device must be set.
20. This setup time is the minimum time that $\overline{EN}$ must be asserted prior to the next transition of IN/$\overline{IN}$ to prevent an output response greater than ±75 mV to that IN/$\overline{IN}$ transition.
21. This hold time is the minimum time that $\overline{EN}$ must remain asserted after a negative going IN or positive going $\overline{IN}$ to prevent an output response greater than ±75 mV to that IN/IN transition.
22. This release time is the minimum time that $\overline{EN}$ must be deasserted prior to the next IN/$\overline{IN}$ transition to ensure an output response that meets the specified IN to Q propagation delay and transition times.

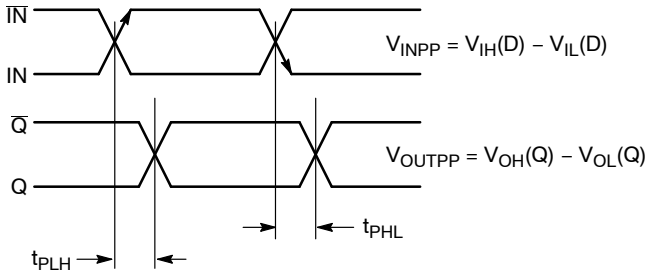


Figure 5. AC Reference Measurement

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 6). 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 6 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.

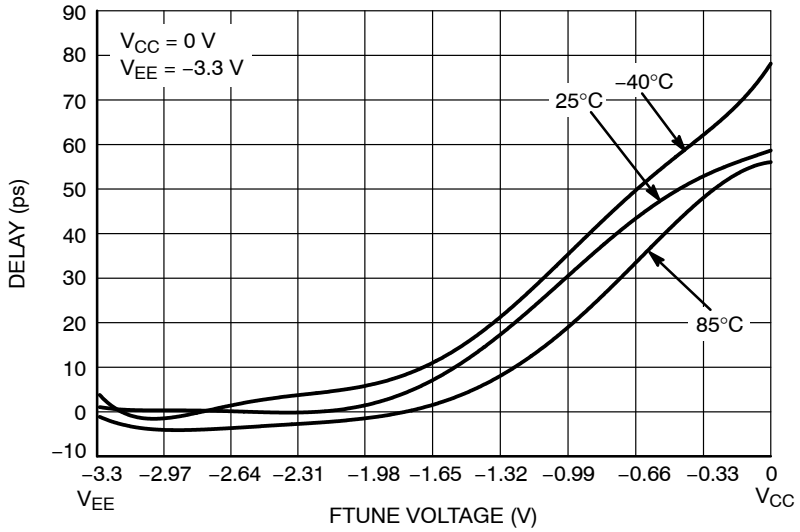


Figure 6. Typical EP196B Delay versus FTUNE Voltage

CASCADING MULTIPLE EP196BS

To increase the programmable range of the EP196B, internal cascade circuitry has been included. This circuitry allows for the cascading of multiple EP196Bs without the need for any external gating. Furthermore, this capability requires only one more address line per added EP196B. 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 7 illustrates the interconnect scheme for cascading two EP196Bs. As can be seen, this scheme can easily be expanded for larger EP196B chains. The D10 input of the EP196B is the CASCADE control pin. With the interconnect scheme of Figure 7 when D10 is asserted, it signals the need for a larger programmable range than is achievable with a single device and switches output pin CASCADE HIGH and pin $\overline{\text{CASCADE}}$ LOW. The A11 address can be added to generate a cascade output for the next EP196B. For a 2−device configuration, A11 is not required.

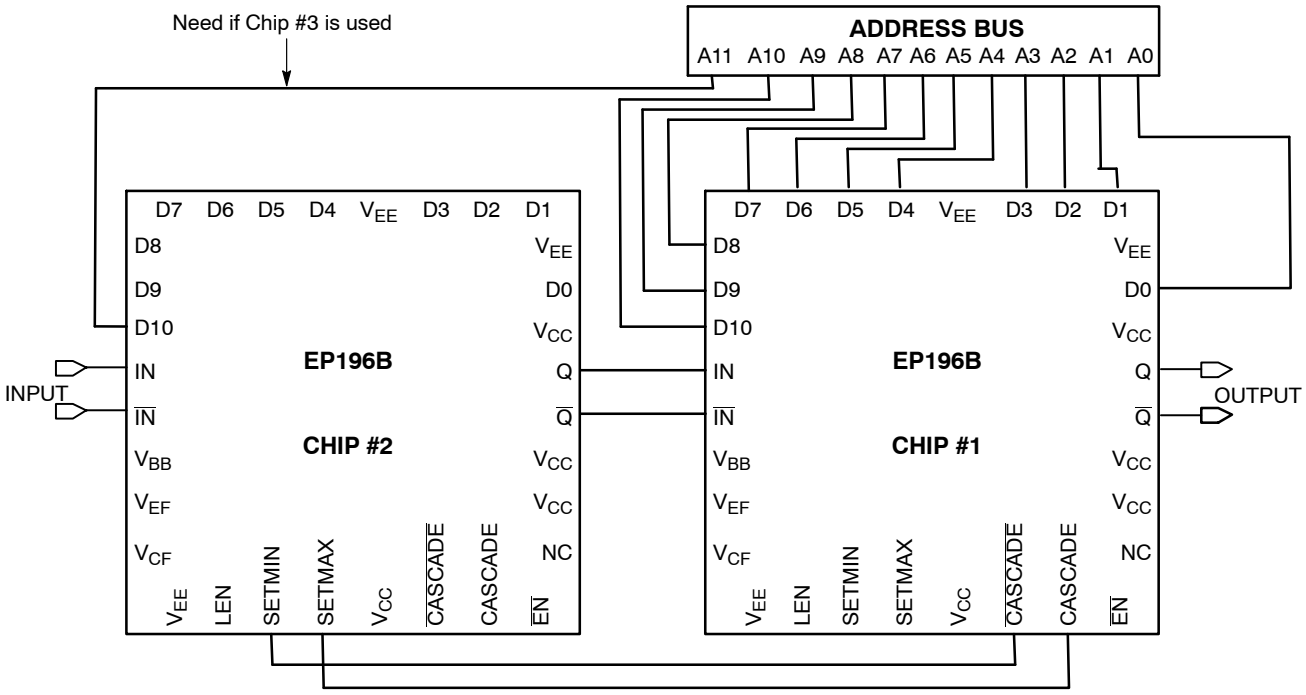


Figure 7. Cascading Interconnect Architecture

An expansion of the latch section of the block diagram is pictured in Figure 8. Use of this diagram will simplify the explanation of how the cascade circuitry works. When D10 of chip #1 in Figure 7 is LOW this device's CASCADE output will also be low while the $\overline{\text{CASCADE}}$ output will be high. In this condition the SET MIN pin of chip #2 will be asserted HIGH 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 SET MIN and SET MAX 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 EP196B device. When D10 is asserted, the SET MIN pin of chip #2 will be deasserted and SET MAX pin asserted resulting in the device delay to be the maximum delay. Table 12 shows the delay time of two EP196B 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 7. 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.

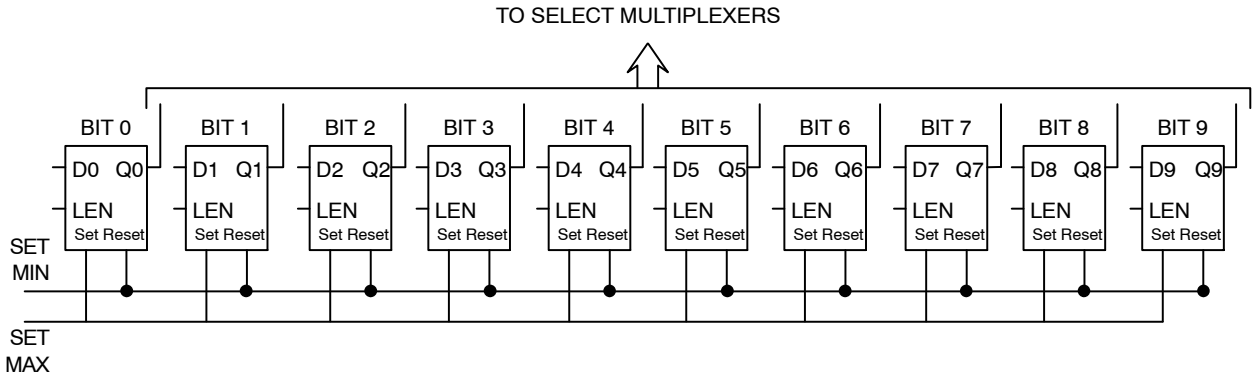


Figure 8. Expansion of the Latch Section of the EP196B Block Diagram

Table 12. Delay Value of Two EP196B Cascaded

VARIABLE INPUT TO CHIP #1 AND *SETMIN* 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	220 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

Multi−Channel Deskewing

The most practical application for EP196B 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 EP196B as shown in Figure 9. One signal channel can be used as reference and the other EP196Bs 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.

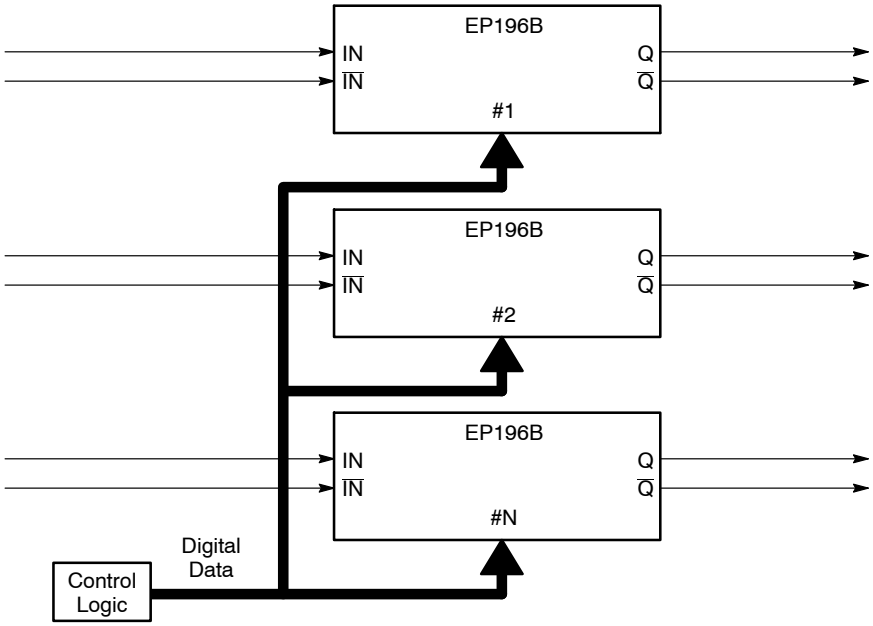


Figure 9. Multiple Channel Deskewing Diagram

Measure Unknown High Speed Device Delays

EP196Bs provide a possible solution to measure the unknown delay of a device with a high degree of precision. By combining two EP196Bs and EP31 as shown in Figure 10, the delay can be measured. The first EP196B can be set to SETMIN and its output is used to drive the unknown delay device, which in turn drives the input of a D flip−flop of EP31. The second EP196B is triggered along with the first EP196B and its output provides a clock signal for EP31. The programmed delay of the second EP196B is varied to detect the output edge from the unknown delay device.

If the programmed delay through the second EP196B is too long, the flip−flop output will be at logic high. On the other hand, if the programmed delay through the second EP196B is too short, the flip−flop output will be at a logic low. If the programmed delay is correctly fine−tuned in the second EP196B, the flip−flop will bounce between logic high and logic low. The digital code in the second EP196B can be directly correlated into an accurate device delay.

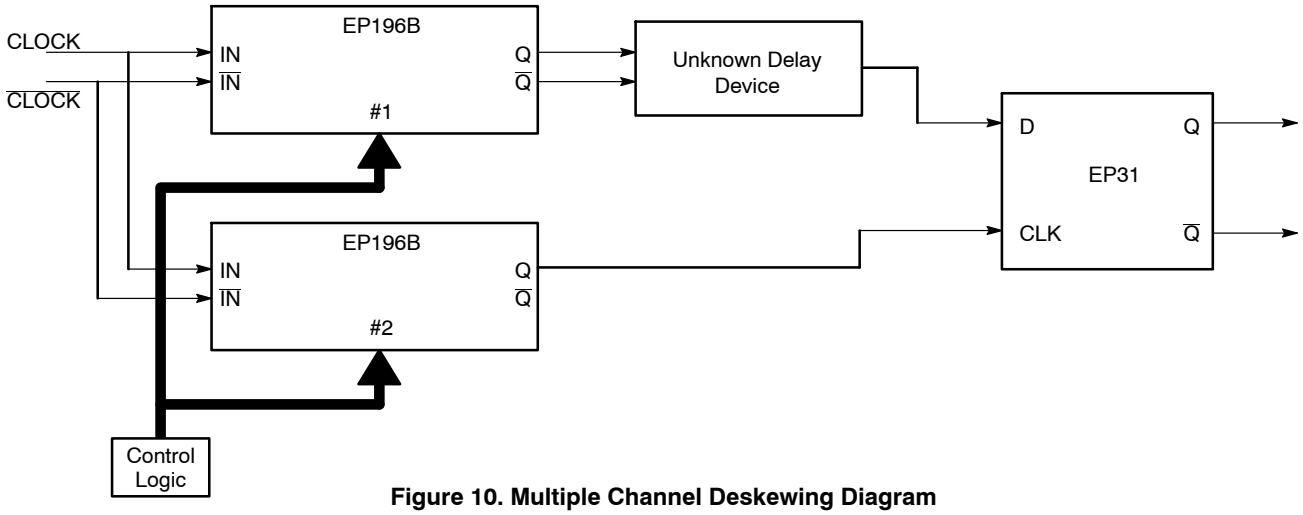


Figure 10. Multiple Channel Deskewing Diagram

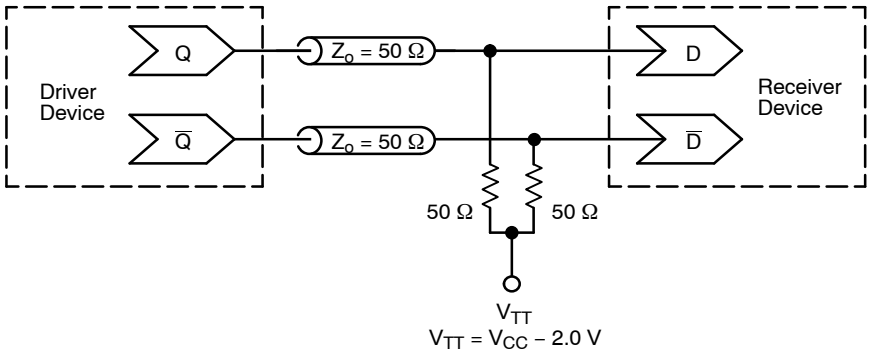


Figure 11. Typical Termination for Output Driver and Device Evaluation (See Application Note AND8020/D – Termination of ECL Logic Devices.)

ORDERING INFORMATION

Device	Package	Shipping
MC100EP196BFAG	LQFP−32 (Pb−Free)	250 Units / Tray
MC100EP196BMNG	QFN−32 (Pb−Free)	74 Units / Rail

Resource Reference of Application Notes

AN1405/D – ECL Clock Distribution Techniques

AN1406/D – Designing with PECL (ECL at +5.0 V)

AN1503/D – ECLinPS™ I/O SPiCE Modeling Kit

AN1504/D – Metastability and the ECLinPS Family

AN1568/D – Interfacing Between LVDS and ECL

AN1672/D – The ECL Translator Guide

AND8001/D – Odd Number Counters Design

AND8002/D – Marking and Date Codes

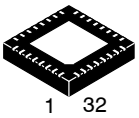
AND8020/D – Termination of ECL Logic Devices

AND8066/D – Interfacing with ECLinPS

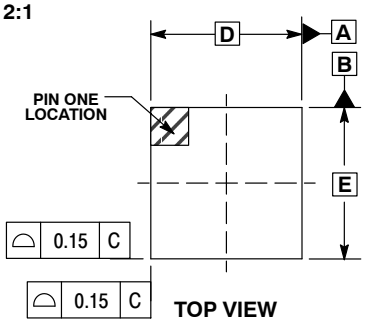
AND8090/D – AC Characteristics of ECL Devices

QFN32 5x5, 0.5P
CASE 488AM
ISSUE A

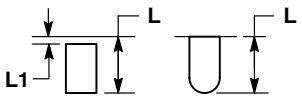
DATE 23 OCT 2013



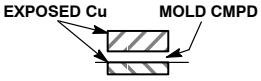
SCALE 2:1



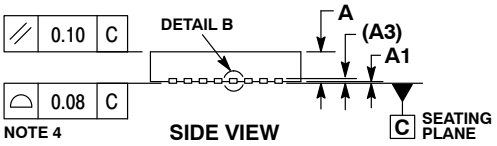
TOP VIEW



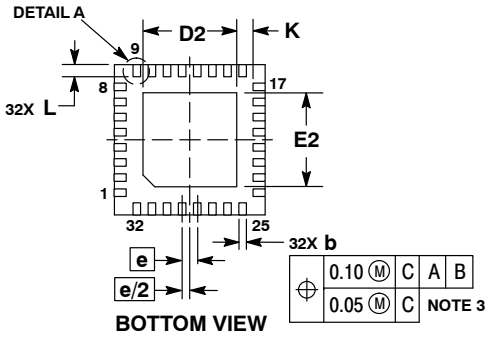
DETAIL A
ALTERNATE TERMINAL CONSTRUCTIONS



DETAIL B
ALTERNATE CONSTRUCTION



SIDE VIEW

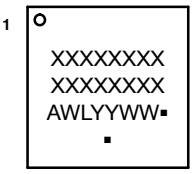


BOTTOM VIEW

NOTES:
1. DIMENSIONS AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30MM FROM THE TERMINAL TIP.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

	MILLIMETERS	
DIM	MIN	MAX
A	0.80	1.00
A1	---	0.05
A3	0.20 REF	
b	0.18	0.30
D	5.00 BSC	
D2	2.95	3.25
E	5.00 BSC	
E2	2.95	3.25
e	0.50 BSC	
K	0.20	---
L	0.30	0.50
L1	---	0.15

GENERIC MARKING DIAGRAM*

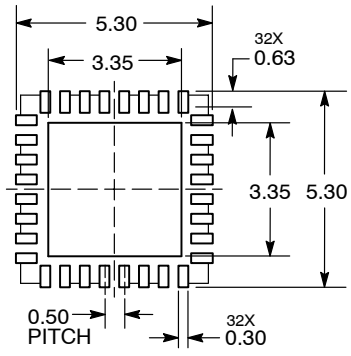


XXXXX = Specific Device Code
A = Assembly Location
WL = Wafer Lot
YY = Year
WW = Work Week
▪ = Pb−Free Package

(Note: Microdot may be in either location)

*This information is generic. Please refer to device data sheet for actual part marking.
Pb−Free indicator, “G” or microdot “ ▪”, may or may not be present.

RECOMMENDED SOLDERING FOOTPRINT*



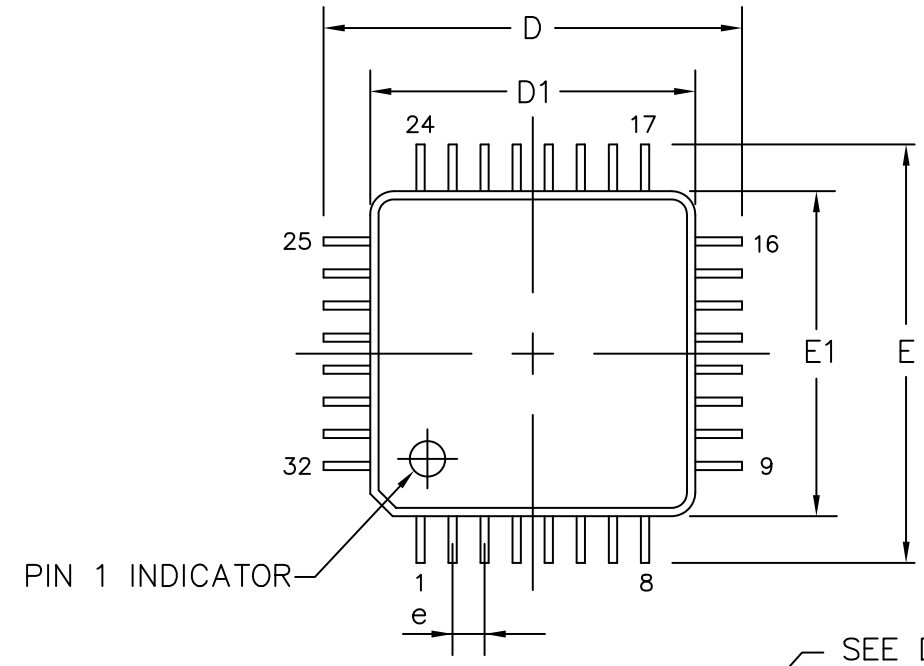
DIMENSION: MILLIMETERS

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

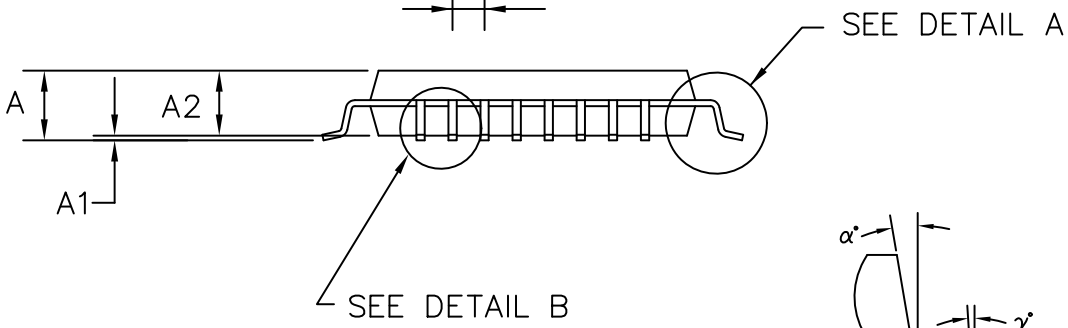
DOCUMENT NUMBER:	**98AON20032D**	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped “CONTROLLED COPY” in red.
DESCRIPTION:	**QFN32 5x5 0.5P**	**PAGE 1 OF 1**

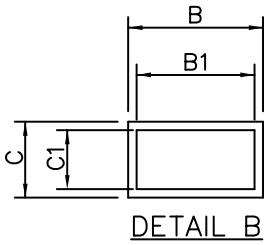
LQFP−32, 7x7
CASE 561AB
ISSUE O

DATE 19 JUN 2008

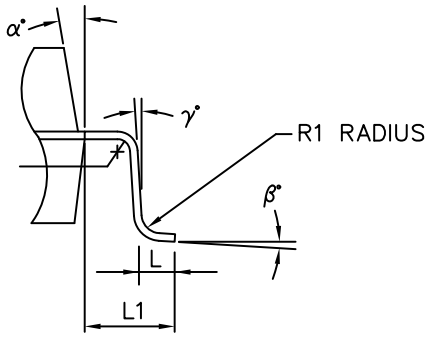


SYMBOL	MIN	NOM	MAX
A	–	–	1.60
A1	0.05	–	0.15
A2	1.35	1.40	1.45
B	0.30	0.37	0.45
B1	0.30	0.35	0.40
C	0.09	–	0.20
C1	0.09	–	0.16
D	9.00 BSC		
D1	7.00 BSC		
E	9.00 BSC		
E1	7.00 BSC		
e	0.80 BSC.		
L	0.45	0.60	0.75
L1	1.00		
R1	0.08	–	0.20
α°	11	–	13
β°	0	–	7
γ°	0	–	–





DETAIL B



DETAIL A

ALL DIMENSIONS IN MM

DOCUMENT NUMBER:	**98AON30893E**	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red.	
DESCRIPTION:	**32 LEAD LQFP, 7X7**		**PAGE 1 OF 1**

ADDITIONAL INFORMATION

TECHNICAL PUBLICATIONS:
Technical Library: www.onsemi.com/design/resources/technical−documentation
onsemi Website: www.onsemi.com

ONLINE SUPPORT: www.onsemi.com/support
For additional information, please contact your local Sales Representative at www.onsemi.com/support/sales