Programmable Delay Chip

MC10E196
MC100E196

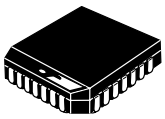
PROGRAMMABLE DELAY CHIP

The MC10E/100E196 is a programmable delay chip (PDC) designed primarily for very accurate differential ECL input edge placement applications.

The delay section consists of a chain of gates and a linear ramp delay adjust organized as shown in the logic symbol. The first two delay elements feature gates that have been modified to have delays 1.25 and 1.5 times the basic gate delay of approximately 80 ps. These two elements provide the E196 with a digitally-selectable resolution of approximately 20 ps. The required device delay is selected by the seven address inputs D[0:6], which are latched on chip by a high signal on the latch enable (LEN) control.

The FTUNE input takes an analog voltage and applies it to an internal linear ramp for reducing the 20 ps resolution still further. The FTUNE input is what differentiates the E196 from the E195.

An eighth latched input, D7, is provided for cascading multiple PDC's for increased programmable range. The cascade logic allows full control of multiple PDC's, at the expense of only a single added line to the data bus for each additional PDC, without the need for any external gating.



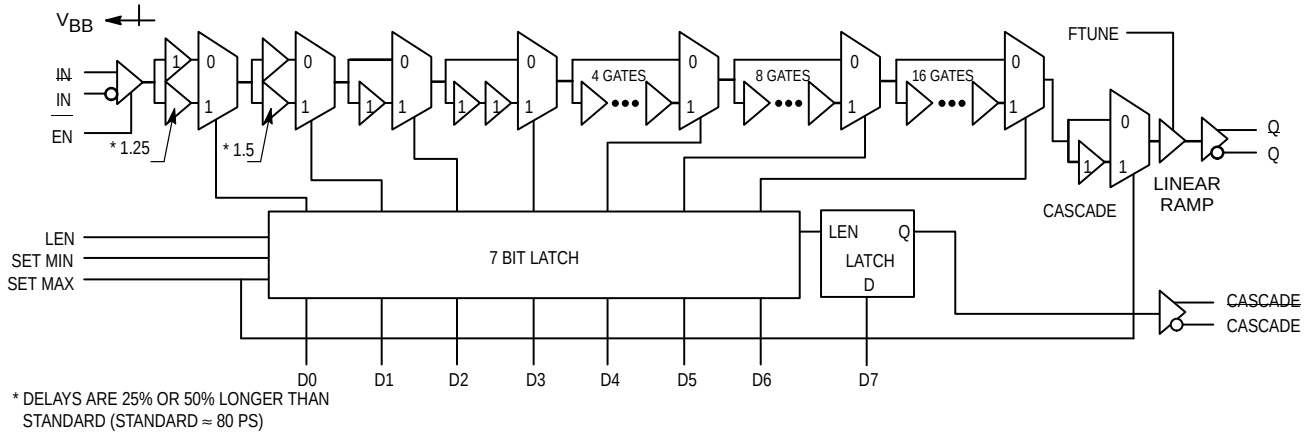
FN SUFFIX
PLASTIC PACKAGE
CASE 776-02

- 2.0ns Worst Case Delay Range
- ≈20ps/Delay Step Resolution
- Linear Input for Tighter Resolution
- >1.0GHz Bandwidth
- On Chip Cascade Circuitry
- Extended 100E V_{EE} Range of –4.2 to –5.46V
- 75KΩ Input Pulldown Resistors

PIN NAMES

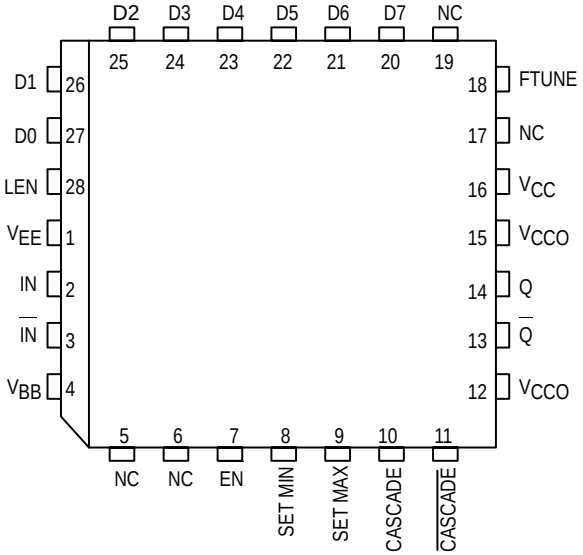
Pin	Function
$\overline{IN}$/IN	Signal Input
EN	Input Enable
D[0:7]	Mux Select Inputs
Q/$\overline{Q}$	Signal Output
LEN	Latch Enable
SET MIN	Min Delay Set
SET MAX	Max Delay Set
CASCADE	Cascade Signal
FTUNE	Linear Voltage Input

LOGIC DIAGRAM – SIMPLIFIED



* DELAYS ARE 25% OR 50% LONGER THAN STANDARD (STANDARD ≈ 80 PS)

Pinout: 28-Lead PLCC (Top View)



DC CHARACTERISTICS (V_{EE} = V_{EE}(min) to V_{EE}(max); V_{CC} = V_{CCO} = GND)

		0°C			25°C			85°C				
Symbol	**Characteristic**	**Min**	**Typ**	**Max**	**Min**	**Typ**	**Max**	**Min**	**Typ**	**Max**	**Unit**	**Condition**
I_{IH}	Input HIGH Current			150			150			150	µA	
I_{EE}	Power Supply Current										mA	
	10E		130	156		130	156		130	156		
	100E		130	156		130	156		150	179		

AC CHARACTERISTICS (V_{EE} = V_{EE}(min) to V_{EE}(max); V_{CC} = V_{CCO} = GND)

		0°C			25°C			85°C				
Symbol	**Characteristic**	**Min**	**Typ**	**Max**	**Min**	**Typ**	**Max**	**Min**	**Typ**	**Max**	**Unit**	**Notes**
t_{PLH} t_{PHL}	Propagation Delay										ps	
	IN to Q; Tap = 0	1210	1360	1510	1240	1390	1540	1440	1590	1765		
	$\overline{IN}$ to Q; Tap = 127	3320	3570	3820	3380	3630	3880	3920	4270	4720		
	EN to Q; Tap = 0	1250	1450	1650	1275	1475	1675	1350	1650	1950		
	D7 to CASCADE	300	450	700	300	450	700	300	450	700		
t_{RANGE}	Programmable Range										ps	
	t_{PD} (max) – t_{PD} (min)	2000	2175		2050	2240		2375	2580			
Δt	Step Delay										ps	6
	D0 High		17			17.5			21			
	D1 High		34			35			42			
	D2 High	55	68	105	55	70	105	65	84	120		
	D3 High	115	136	180	115	140	180	140	168	205		
	D4 High	250	272	325	250	280	325	305	336	380		
	D5 High	505	544	620	515	560	620	620	672	740		
	D6 High	1000	1088	1190	1030	1120	1220	1240	1344	1450		
Lin	Linearity	D1	D0		D1	D0		D1	D0			7
t_{SKEW}	Duty Cycle Skew										ps	
	t_{PHL}–t_{PLH}		±30			±30			±30			1

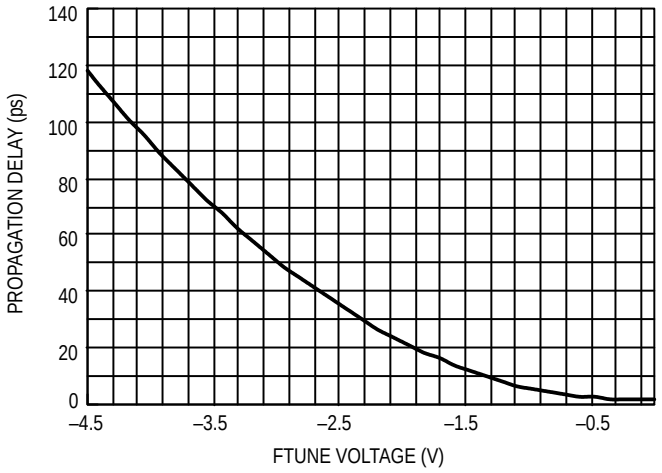
AC CHARACTERISTICS (continued) (V_{EE} = V_{EE}(min) to V_{EE}(max); V_{CC} = V_{CCO} = GND)

		0°C			25°C			85°C				
Symbol	**Characteristic**	**Min**	**Typ**	**Max**	**Min**	**Typ**	**Max**	**Min**	**Typ**	**Max**	**Unit**	**Notes**
t_S	Setup Time										ps	
	D to LEN	200	0		200	0		200	0			
	D to IN	800			800			800				2
	EN to IN	200			200			200				3
t_h	Hold Time										ps	
	LEN to D	500	250		500	250		500	250			
	IN to EN	0			0			0				4
t_R	Release Time										ps	
	EN to IN	300			300			300				5
	SET MAX to LEN	800			800			800				
	SET MIN to LEN	800			800			800				
t_{jit}	Jitter		<5.0			<5.0			<5.0		ps	8
t_r	Output Rise/Fall Time										ps	
t_f	20–80% (Q)	125	225	325	125	225	325	125	225	325		
	20–80% (CASCADE)	300	450	650	300	450	650	300	450	650		

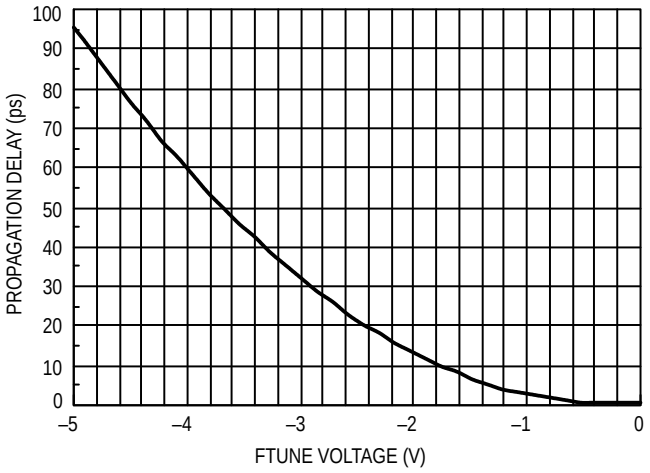
1. Duty cycle skew guaranteed only for differential operation measured from the cross point of the input to the cross point of the output.
2. This setup time defines the amount of time prior to the input signal the delay tap of the device must be set.
3. This setup time is the minimum time that EN must 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.
4. This hold time is the minimum time that 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/$\overline{IN}$ transition.
5. This release time is the minimum time that 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.
6. 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.
7. The linearity specification guarantees to which delay control input the programmable steps will be monotonic (i.e. increasing delay steps for increasing binary counts on the control inputs Dn). Typically the device will be monotonic to the D0 input, however under worst case conditions and process variation, delays could decrease slightly with increasing binary counts when the D0 input is the LSB. With the D1 input as the LSB the device is guaranteed to be monotonic over all specified environmental conditions and process variation.
8. The jitter of the device is less than what can be measured without resorting to very tedious and specialized measurement techniques.

ANALOG INPUT CHARACTERISTICS

Ftune = V_{CC} to V_{EE}



Propagation Delay versus Ftune Voltage (100E196)



Propagation Delay versus Ftune Voltage (10E196)

USING THE FTUNE ANALOG INPUT

The analog FTUNE pin on the E196 device is intended to enhance the 20 ps resolution capabilities of the fully digital E195. The level of resolution obtained is dependent on the number of increments applied to the appropriate range on the FTUNE pin.

To provide another level of resolution the FTUNE pin must be capable of adjusting the delay by greater than the 20 ps digital resolution. From the provided graphs one sees that this requirement is easily achieved as over the entire FTUNE voltage range a 100 ps delay can be achieved. This extra analog range ensures that the FTUNE pin will be capable even under worst case conditions of covering the 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, the graphs provided should be used. As an example if a range of 40 ps is selected to cover worst case conditions and ensure coverage of the digital range, from the 100E196 graph a voltage range of –3.25 V to –4.0 V would be necessary on the FTUNE pin. Obviously 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.

Cascading Multiple E196's

To increase the programmable range of the E195 internal cascade circuitry has been included. This circuitry allows for the cascading of multiple E195's without the need for any external gating. Furthermore this capability requires only one more address line per added E195. Obviously cascading multiple PDC's will result in a larger programmable range, however, this increase is at the expense of a longer minimum delay.

Figure 1 illustrates the interconnect scheme for cascading two E195's. As can be seen, this scheme can easily be expanded for larger E195 chains. The D7 input of the E195 is the cascade control pin. With the interconnect scheme of Figure 1 when D7 is asserted it signals the need for a larger programmable range than is achievable with a single device.

An expansion of the latch section of the block diagram is pictured below. Use of this diagram will simplify the explanation of how the cascade circuitry works. When D7 of chip #1 above is low the cascade output will also be low while the cascade bar output will be a logical high. In this condition the SET MIN 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. Since the RESET and SET inputs of the latches are overriding any changes on the A0–A6 address bus will not affect the operation of chip #2.

Chip #1 on the other hand will have both SET MIN and SET MAX de-asserted so that its delay will be controlled entirely by the address bus A0–A6. If the delay needed is greater than can be achieved with 31.75 gate delays (1111111 on the A0–A6 address bus) D7 will be asserted to signal the need to cascade the delay to the next E195 device. When D7 is asserted the SET MIN pin of chip #2 will be de-asserted and the delay will be controlled by the A0–A6 address bus. Chip #1 on the other hand will have its SET MAX pin asserted resulting in the device delay to be independent of the A0–A6 address bus.

When the SET MAX pin of chip #1 is asserted the D0 and D1 latches will be reset while the rest of the latches will be set. In addition, to maintain monotonicity an additional gate delay is selected in the cascade circuitry. As a result when D7 of chip #1 is asserted the delay increases from 31.75 gates to 32 gates. A 32 gate delay is the maximum delay setting for the E195.

When cascading multiple PDC's it will prove more cost effective to use a single E196 for the MSB of the chain while using E195 for the lower order bits. This is due to the fact that only one fine tune input is needed to further reduce the delay step resolution.

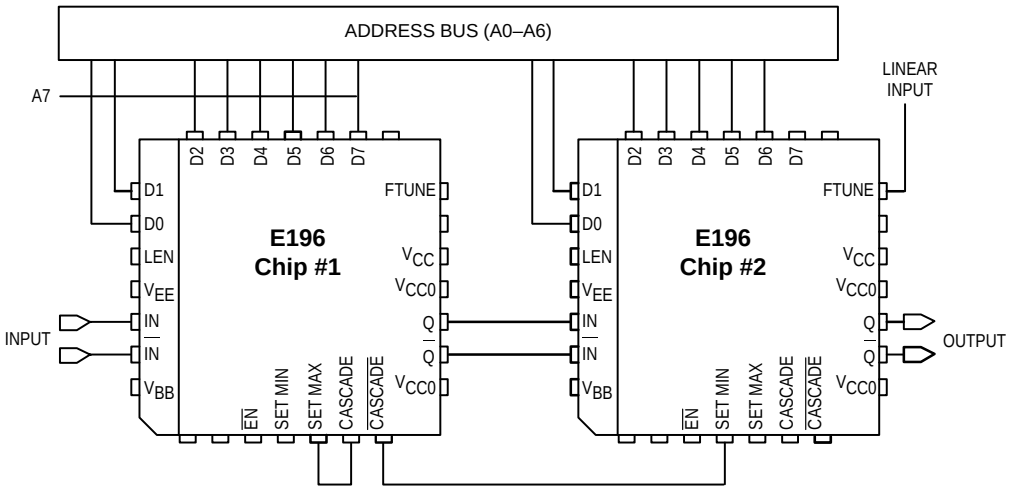


Figure 1. Cascading Interconnect Architecture

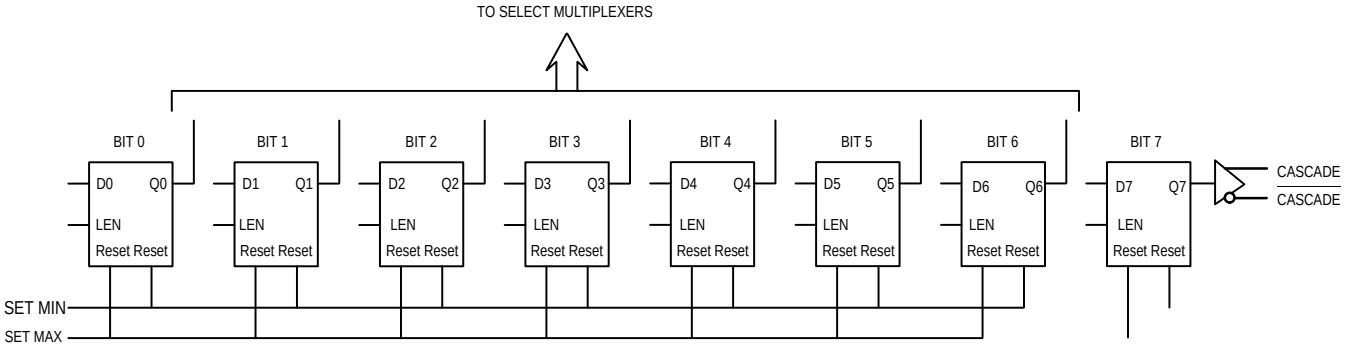
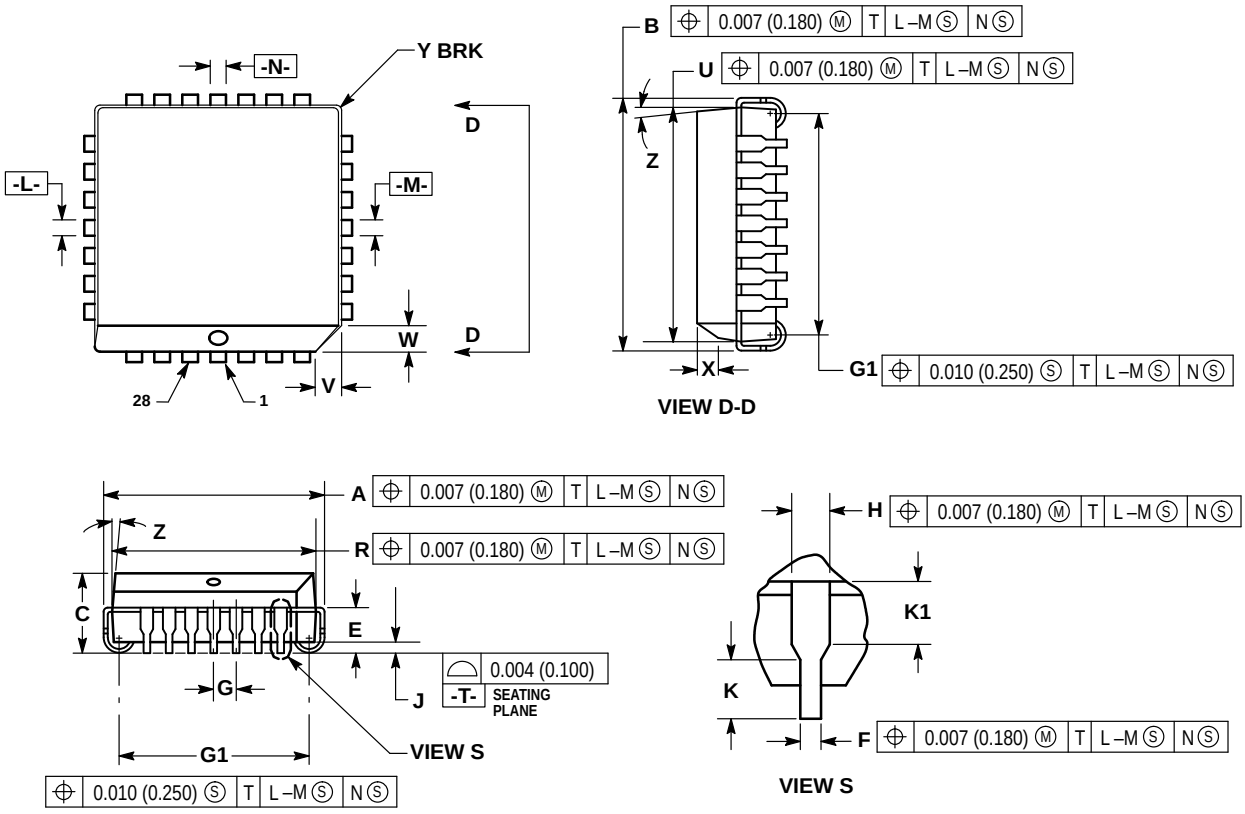


Figure 2. Expansion of the Latch Section of the E195 Block Diagram

OUTLINE DIMENSIONS

FN SUFFIX
PLASTIC PLCC PACKAGE
CASE 776–02
ISSUE D



NOTES:
1. DATUMS -L-, -M-, AND -N- DETERMINED WHERE TOP OF LEAD SHOULDER EXITS PLASTIC BODY AT MOLD PARTING LINE.
2. DIM G1, TRUE POSITION TO BE MEASURED AT DATUM -T-, SEATING PLANE.
3. DIM R AND U DO NOT INCLUDE MOLD FLASH. ALLOWABLE MOLD FLASH IS 0.010 (0.250) PER SIDE.
4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
5. CONTROLLING DIMENSION: INCH.
6. THE PACKAGE TOP MAY BE SMALLER THAN THE PACKAGE BOTTOM BY UP TO 0.012 (0.300). DIMENSIONS R AND U ARE DETERMINED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY EXCLUSIVE OF MOLD FLASH, TIE BAR BURRS, GATE BURRS AND INTERLEAD FLASH, BUT INCLUDING ANY MISMATCH BETWEEN THE TOP AND BOTTOM OF THE PLASTIC BODY.
7. DIMENSION H DOES NOT INCLUDE DAMBAR PROTRUSION OR INTRUSION. THE DAMBAR PROTRUSION(S) SHALL NOT CAUSE THE H DIMENSION TO BE GREATER THAN 0.037 (0.940). THE DAMBAR INTRUSION(S) SHALL NOT CAUSE THE H DIMENSION TO BE SMALLER THAN 0.025 (0.635).

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.485	0.495	12.32	12.57
B	0.485	0.495	12.32	12.57
C	0.165	0.180	4.20	4.57
E	0.090	0.110	2.29	2.79
F	0.013	0.019	0.33	0.48
G	0.050 BSC		1.27 BSC	
H	0.026	0.032	0.66	0.81
J	0.020	—	0.51	—
K	0.025	—	0.64	—
R	0.450	0.456	11.43	11.58
U	0.450	0.456	11.43	11.58
V	0.042	0.048	1.07	1.21
W	0.042	0.048	1.07	1.21
X	0.042	0.056	1.07	1.42
Y	—	0.020	—	0.50
Z	2°	10°	2°	10°
G1	0.410	0.430	10.42	10.92
K1	0.040	—	1.02	—

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