

## FEATURES

- Pin-for-pin, plug-in compatible to the ON Semiconductor MC100EP196
- Maximum frequency > 2.5GHz
- Programmable range: 2.2ns to 12.2ns
- 10ps increments
- 30ps fine tuning range
- PECL mode operating range:  $V_{CC} = 3.0V$  to  $5.5V$  with  $V_{EE} = 0V$
- NECL mode operating range:  $V_{CC} = 0V$  with  $V_{EE} = -3.0V$  to  $-5.5V$
- Open input default state
- Safety clamp on inputs
- A logic high on the /EN pin will force Q to logic low
- D[0:10] can accept either ECL, CMOS, or TTL inputs
- $V_{BB}$  output reference voltage
- Available in a 32-pin TQFP package



ECL Pro®

## DESCRIPTION

The SY100EP196V is a programmable delay line, varying the time a logic signal takes to traverse from IN to Q. This delay can vary from about 2.2ns to about 12.2ns. The input can be PECL, LVPECL, NECL, or LVNECL.

The delay varies in discrete steps based on a control word presented to SY100EP196V. The 10-bit width of this latched control register allows for delay increments of approximately 10ps. In addition, delay may be varied continuously in about a 30ps range by setting the voltage at the FTUNE pin.

An eleventh control bit allows the cascading of multiple SY100EP196V devices, for a wider delay range. Each additional SY100EP196V effectively doubles the delay range available.

For maximum flexibility, the control register interface accepts CMOS or TTL level signals, as well as the input level at the IN± pins.

All support documentation can be found on Micrel's web site at: [www.micrel.com](http://www.micrel.com).

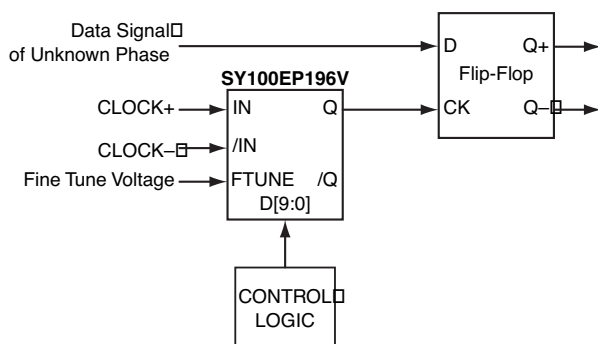
## APPLICATIONS

- Clock de-skewing
- Timing adjustment
- Aperture centering

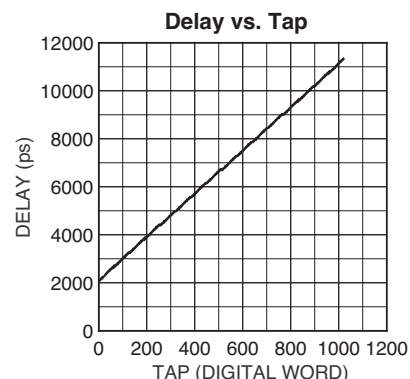
## CROSS REFERENCE TABLE

Micrel Semiconductor	ON Semiconductor
SY100EP196VTI	MC100EP196FA
SY100EP196VTITR	MC100EP196FAR2

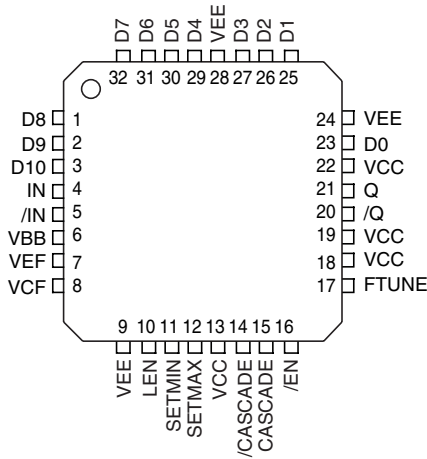
## TYPICAL APPLICATIONS CIRCUIT



## TYPICAL PERFORMANCE



**PACKAGE/ORDERING INFORMATION**



**32-Pin TQFP (T32-1)**

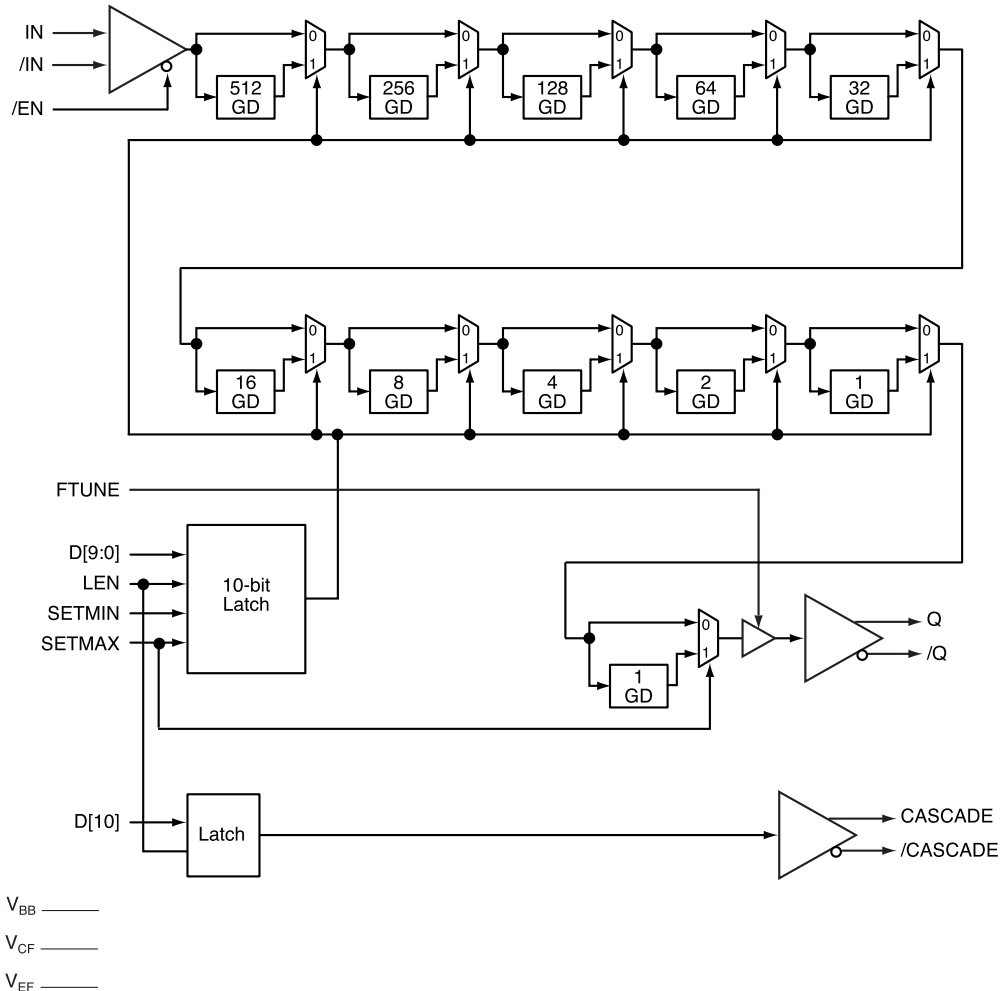
**Ordering Information<sup>(1)</sup>**

Part Number	Package Type	Operating Range	Package Marking	Lead Finish
SY100EP196VTI	T32-1	Industrial	SY100EP196V	Sn-Pb
SY100EP196VTITR <sup>(2)</sup>	T32-1	Industrial	SY100EP196V	Sn-Pb
SY100EP196VTG <sup>(3)</sup>	T32-1	Industrial	SY100EP196V with Pb-Free bar-line indicator	Pb-Free NiPdAu
SY100EP196VTGTR <sup>(2, 3)</sup>	T32-1	Industrial	SY100EP196V with Pb-Free bar-line indicator	Pb-Free NiPdAu

**Notes:**

1. Contact factory for die availability. Dice are guaranteed at T<sub>A</sub> = 25°C, DC Electricals only.
2. Tape and Reel.
3. Pb-Free package is recommended for new designs.

**FUNCTIONAL BLOCK DIAGRAM**



## PIN DESCRIPTION

Pin Number	Pin Name	Pin Function
23, 25, 26, 27, 29, 30, 31, 32, 1, 2	D[0:9]	CMOS, ECL, or TTL Select Inputs: These digital control signals adjust the amount of delay from IN to Q. Please refer to the “AC Electrical Table” (page 3) and Table 7 (page 17) for delay values. Figure 9 shows how to interface these inputs to various logic family standards. These inputs default to logic low when left unconnected. Bit 0 is the least significant bit, and bit 9 is the most significant bit.
3	D[10]	CMOS, ECL, or TTL Select Input: This input latches just like D[0:9] does. It drives the CASCADE, /CASCADE differential pair. Use only when cascading two or more SY100EP196V to extend the range of delays required.
4, 5	IN, /IN	ECL Input: This is the signal to be delayed. If this input pair is left unconnected, this is equivalent to a logic low input.
6	VBB	Voltage Output Reference: When using a single-ended logic source for IN and /IN, connect the unused input of the differential pair to this pin. This pin can also re-bias AC-coupled inputs to IN and /IN. When used, de-couple this pin to $V_{CC}$ through an $0.01\mu\text{F}$ capacitor. Limit current sinking or sourcing to 0.5mA or less.
7	VEF	Voltage Output: Connect this pin to VCF when the D inputs are ECL. Refer to the “Digital Control Logic Standard” section of the “Functional Description” to interface the D inputs to CMOS or TTL.
8	VCF	Voltage Input: The voltage at this pin sets the logic transition threshold for the D inputs.
9, 24, 28	VEE	Most Negative Supply. Supply ground for PECL systems.
10	LEN	ECL Control Input: When logic low, the D inputs flow through. Any changes to the D inputs reflect in the delay between IN, /IN and Q, /Q. When logic high, the logic values at D are latched, and these latched bits determine the delay.
11	SETMIN	ECL Control Input: When logic high, the contents of the D register are reset. This sets the delay to the minimum possible, equivalent to D[0:9] being set to 0000000000. When logic low, the value of the D register, or the logic value of SETMAX determines the delay from IN, /IN to Q, /Q. This input defaults to logic low when left unconnected.
12	SETMAX	ECL Control Input: When logic high and SETMIN is logic low, the contents of the D register are set high, and the delay is set to one step greater than the maximum possible with D[0:9] set to 1111111111. When logic low, the value of the D register, or the logic value of SETMIN determines the delay from IN, /IN to Q, /Q. This input defaults to logic low when left unconnected.
13, 18, 19, 22	VCC	Most Positive Supply: Supply ground for NECL systems. Bypass to $V_{EE}$ with $0.1\mu\text{F}$ and $0.01\mu\text{F}$ low ESR capacitors.
14, 15	CASCADE,	100k ECL Outputs: These outputs are used when cascading two or more SY100EP196V to /CASCADE extend the delay range required. Refer to Table 7 (page 17) for delay values.
16	/EN	ECL Control Input: When set active low, Q, /Q are a delayed version of IN, /IN. When set inactive high, IN, /IN are gated such that Q, /Q become a differential logic low. This input defaults to logic low when left unconnected.
17	FTUNE	Voltage Control Input: By varying the voltage at this pin from $V_{CC}$ through $V_{EE}$ , the delay may be fine tuned by approximately $\pm 15\text{ps}$ . Leave pin floating if not used.
20, 21	Q, /Q	100k ECL Outputs: This signal pair is the delayed version of IN, /IN.

### Absolute Maximum Ratings<sup>(1)</sup>

Supply Voltage ( $V_{CC}$ )	
PECL Mode ( $V_{EE}=0V$ )	-0.5V to +6.0V
Supply Voltage ( $V_{EE}$ )	
NECL Mode ( $V_{CC}=0V$ )	+0.5V to -6.0V
Any Input Voltage ( $V_{IN}$ )	
PECL Mode	-0.5V to $V_{CC}+0.5V$
NECL Mode	+0.5V to $V_{EE}-0.5V$
ECL Output Current ( $I_{OUT}$ )	
Continuous	50mA
Surge	100mA
$I_{BB}$ Sink/Source Current	±0.5mA
Lead Temperature (soldering, 20 sec.)	+260°C
Storage Temperature ( $T_S$ )	-65°C to +150°C
ESD Rating <sup>(3)</sup>	>1.5kV

### Operating Ratings<sup>(2)</sup>

Supply Voltage ( $V_{CC}$ )	
PECL Mode ( $V_{EE}=0V$ )	+3.0V to +5.5V
Supply Voltage ( $V_{EE}$ )	
NECL Mode ( $V_{CC}=0V$ )	-3.0V to -5.5V
Ambient Temperature ( $T_A$ )	-40°C to +85°C
Package Thermal Resistance	
TQFP-32 ( $\theta_{JA}$ )	
Still-air	50°C/W
500lfpm	42°C/W
TQFP-32 ( $\theta_{JC}$ )	20°C/W

## DC ELECTRICAL CHARACTERISTICS

$T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$

Symbol	Parameter	Condition	Min	Typ	Max	Units
$V_{CC}$	Power Supply Voltage (PECL)		3.0	3.3	3.6	V
			4.5	5.0	5.5	V
$V_{EE}$	Power Supply Voltage (NECL)		-3.6	-3.3	-3.0	V
			-5.5	-5.0	-4.5	V
$I_{EE}$	Power Supply Current <sup>(4)</sup>	No Load, Over Supply Voltage		150	175	mA

**Notes:**

1. Permanent device damage may occur if "Absolute Maximum Ratings" are exceeded. This is a stress rating only and functional operation is not implied at conditions other than those detailed in the operational sections of this data sheet. Exposure to "Absolute Maximum Rating" conditions for extended periods may affect device reliability.
2. The data sheet limits are not guaranteed if the device is operated beyond the operating ratings.
3. Devices are ESD sensitive. Handling precautions recommended.
4. Required 500lfpm air flow when using +5V or -5V power supply.

**(100kEP) LVPECL DC ELECTRICAL CHARACTERISTICS** $V_{CC} = 3.3V$ ,  $V_{EE} = 0V$ ;  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ <sup>(5, 6)</sup>

Symbol	Parameter	Condition	Min	Typ	Max	Units
$V_{OH}$	Output HIGH Voltage	Figures 2, 3, 6	2155	2280	2405	mV
$V_{OL}$	Output LOW Voltage	Figures 2, 3, 6	1355	1480	1605	mV
$V_{IH}$	Input HIGH Voltage PECL CMOS TTL	Figures 1, 4	2075 1815 2000		2420	mV mV mV
$V_{IL}$	Input LOW Voltage PECL CMOS TTL	Figures 1, 4	1355		1675 1485 800	mV mV mV
$V_{BB}$	Output Voltage Reference		1775	1875	1975	mV
$V_{CF}$	Input Select Voltage		1610	1720	1825	mV
$V_{EF}$	Mode Connection		1900	2000	2100	mV
$V_{IHCMR}$	Input HIGH Voltage Common Mode Range <sup>(7)</sup>	Figure 5	2.0		3.3	V
$I_{IH}$	Input HIGH Current				150	$\mu A$
$I_{IL}$	Input LOW Current IN /IN		0.5 -150			$\mu A$ $\mu A$

**Notes:**

- Device is guaranteed to meet the DC specifications, shown in the table above, after thermal equilibrium has been established. The device is tested in a socket such that transverse airflow of  $\geq 500$ lpm is maintained.
- Input and output parameters vary 1:1 with  $V_{CC}$ .  $V_{EE}$  can vary +0.3V to -2.2V.
- $V_{IHCMR}$  maximum varies 1:1 with  $V_{CC}$ . The  $V_{IHCMR}$  range is referenced to the most positive side of the differential input signal.

**(100kEP) PECL DC ELECTRICAL CHARACTERISTICS** $V_{CC} = 5.0V$ ,  $V_{EE} = 0V$ ;  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ (8, 9)

Symbol	Parameter	Condition	Min	Typ	Max	Units
$V_{OH}$	Output HIGH Voltage	Figures 2, 3, 6	3855	3980	4105	mV
$V_{OL}$	Output LOW Voltage	Figures 2, 3, 6	3055	3180	3305	mV
$V_{IH}$	Input HIGH Voltage PECL CMOS TTL	Figures 1, 4	3775 2750 2000		4120	mV mV mV
$V_{IL}$	Input LOW Voltage PECL CMOS TTL	Figures 1, 4	3055		3375 2250 800	mV mV mV
$V_{BB}$	Output Voltage Reference		3475	3575	3675	mV
$V_{IHCMR}$	Input HIGH Voltage Common Mode Range <sup>(10)</sup>	Figure 5	2.0		5.0	V
$I_{IH}$	Input HIGH Current				150	$\mu A$
$I_{IL}$	Input LOW Current IN /IN		0.5 -150			$\mu A$ $\mu A$

**(100kEP) NECL DC ELECTRICAL CHARACTERISTICS** $V_{CC} = 0V$ ,  $V_{EE} = -5.5V$  to  $-3.0V$ ;  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ (8)

Symbol	Parameter	Condition	Min	Typ	Max	Units
$V_{OH}$	Output HIGH Voltage	Figures 2, 3	-1145	-1020	-895	mV
$V_{OL}$	Output LOW Voltage	Figures 2, 3	-1945	-1820	-1695	mV
$V_{IH}$	Input HIGH Voltage NECL	Figures 1, 4	-1225		-880	mV
$V_{IL}$	Input LOW Voltage NECL	Figures 1, 4	-1945		-1625	mV
$V_{BB}$	Output Voltage Reference		-1525	-1425	-1325	mV
$V_{IHCMR}$	Input HIGH Voltage Common Mode Range <sup>(11)</sup>	Figure 5	$V_{EE}+2.0$		0.0	V
$I_{IH}$	Input HIGH Current				150	$\mu A$
$I_{IL}$	Input LOW Current IN /IN		0.5 -150			$\mu A$ $\mu A$

**Notes:**

- Device is guaranteed to meet the DC specifications, shown in the table above, after thermal equilibrium has been established. The device is tested in a socket such that transverse airflow of  $\geq 500$ lfpm is maintained.
- Input and output parameters vary 1:1 with  $V_{CC}$ .  $V_{EE}$  can vary +2.0V to -0.5V.
- $V_{IHCMR}$  maximum varies 1:1 with  $V_{CC}$ . The  $V_{IHCMR}$  range is referenced to the most positive side of the differential input signal.
- $V_{IHCMR}$  minimum varies 1:1 with  $V_{EE}$ . The  $V_{IHCMR}$  range is referenced to the most positive side of the differential input signal.

**AC ELECTRICAL CHARACTERISTICS**

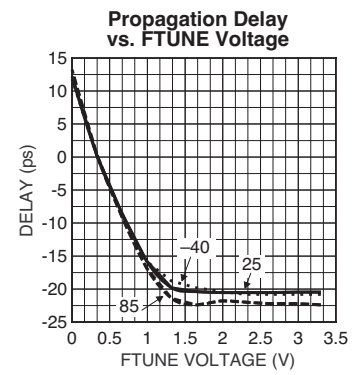
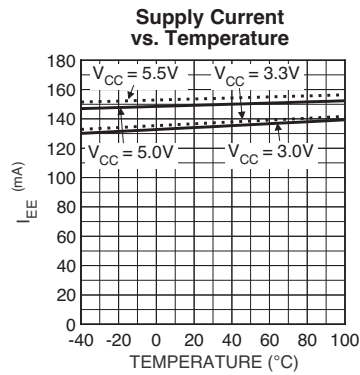
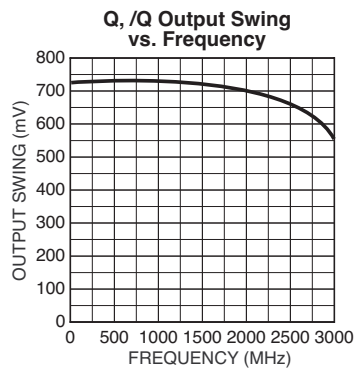
V<sub>CC</sub> = 3.0 to 5.5V, V<sub>EE</sub> = 0V or V<sub>CC</sub> = 0V, V<sub>EE</sub> = -3.0 to -5.5V; T<sub>A</sub> = -40°C to +85°C<sup>(12, 13)</sup>

Symbol	Parameter	T <sub>A</sub> = -40°C			T <sub>A</sub> = +25°C			T <sub>A</sub> = +85°C			Unit	
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max		
f <sub>MAX</sub>	Maximum Frequency <sup>(14)</sup>		2.5			2.5			2.5		GHz	
t <sub>PD</sub>	Propagation Delay											
	IN to Q; D[0-10]=0	1650	2000	2450	1800	2050	2600	1950	2250	2750	ps	
	IN to Q; D[0-10]=1023	9500	11500	13500	9800	12200	14000	10600	13300	15800	ps	
	/EN to Q; D[0-10]=0	1600	2150	2600	1800	2300	2800	2000	2500	3000	ps	
	D10 to CASCADE	300	420	500	325	450	550	325	525	625	ps	
t <sub>RANGE</sub>	Programmable Range t <sub>PD(max)</sub> -t <sub>PD(min)</sub>	7850	9450		8200	10000		8850	10950		ps	
Δt	Step Delay <sup>(15)</sup>	D0 High		9		10		10			ps	
		D1 High		25		26		27			ps	
		D2 High		42		42		43			ps	
		D3 High		75		80		81			ps	
		D4 High		142		143		150			ps	
		D5 High		296		300		310			ps	
		D6 High		532		540		565			ps	
		D7 High		1080		1095		1140			ps	
		D8 High		2100		2150		2250			ps	
	D9 High		4250		4300		4500			ps		
Lin	Linearity <sup>(16)</sup>		±10		±10		±10			%LSB		
t <sub>SKEW</sub>	Duty Cycle Skew <sup>(17)</sup> t <sub>PHL</sub> -t <sub>PLH</sub>					25					ps	
t <sub>S</sub>	Setup Time	D to LEN	200	0	200	0	200	0	200	0	ps	
		D to IN <sup>(18)</sup>	300	140	300	160	300	180	300	180	ps	
		/EN to IN <sup>(19)</sup>	300	150	300	170	300	180	300	180	ps	
t <sub>H</sub>	Hold Time	LEN to D	200	60	200	100	200	80	200	80	ps	
		IN to /EN <sup>(20)</sup>	400	250	400	280	400	300	400	300	ps	
t <sub>R</sub>	Release Time	/EN to IN <sup>(21)</sup>				500					ps	
		SETMAX to LEN	400	200	400	250	400	300	400	300	ps	
		SETMIN to LEN	350	275	350	200	350	335	350	335	ps	
t <sub>JIT</sub>	Cycle-to-Cycle Jitter <sup>(22)</sup>		0.2	< 1		0.2	< 1		0.2	< 1	ps <sub>RMS</sub>	
V <sub>PP</sub>	Input Voltage Swing (Differential)	150	800	1200	150	800	1200	150	800	1200	mV	
t <sub>r</sub> t <sub>f</sub>	Output Rise/Fall Time	20% to 80% (Q)		180	250		210	300		230	325	ps
		20% to 80% (CASCADE)		180	250		210	300		230	325	ps

**Notes:**

12. AC characteristics are guaranteed by design and characterization.
13. Measured using 750mV source, 50% duty cycle clock source.
14. Refer to "Typical Operating Characteristics" for output swing performance.
15. The delays of the individual bits are cumulative.
16. Linearity is the deviation from the ideal delay.
17. Duty cycle skew guaranteed only for differential operation measured from the crosspoint of the input edge to the crosspoint of the corresponding output edge.
18. Setup time defines the amount of time prior to an edge on IN, /IN that the D[0:9] bits must be set to guarantee the new delay will occur for that edge.
19. Setup time is the minimum that /EN must be asserted prior to the next transition of IN, /IN to prevent an output response greater than ±75mV to that IN, /IN transition.
20. Hold time is the minimum time that /EN must remain asserted after a negative going IN or a positive going /IN to prevent an output response greater than ±75mV to that IN, /IN transition.
21. Release time is the minimum time that /EN must be deasserted prior to the next IN, /IN transition to ensure an output response that meets the specified IN to Q propagation delay and transition times.
22. This is the amount of generated jitter added to an otherwise jitter free clock signal, going from IN, /IN to Q, /Q, where the clock may be any frequency between 0.0 and 2.5GHz.

**TYPICAL OPERATING CHARACTERISTICS**





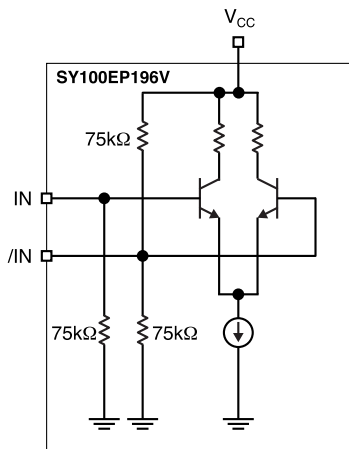


Figure 1a. Differential Input Structure

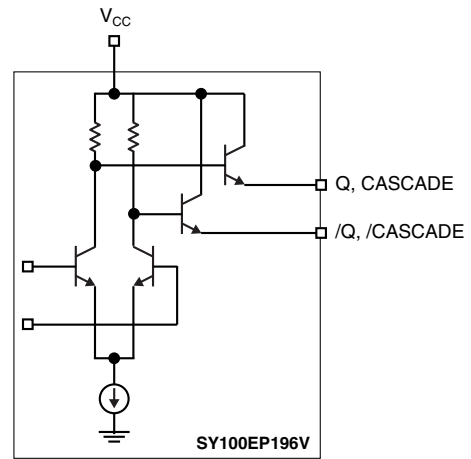


Figure 2. Emitter Output Structure

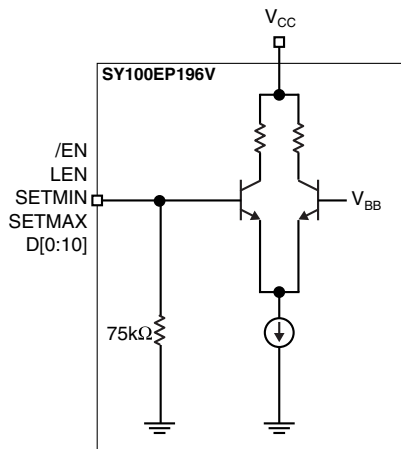


Figure 1b. Single-Ended Input Structure

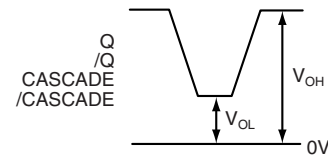


Figure 3a. Output Levels, PECL, LVPECL

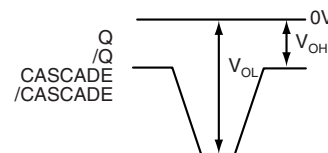


Figure 3b. Output Levels, NECL

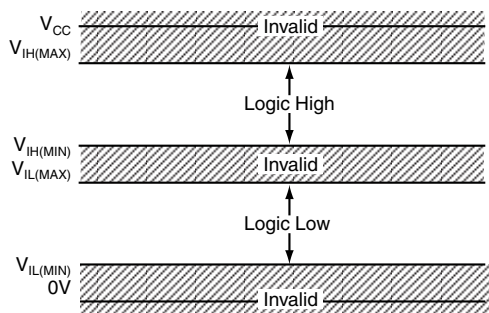


Figure 4a. Input Levels, PECL

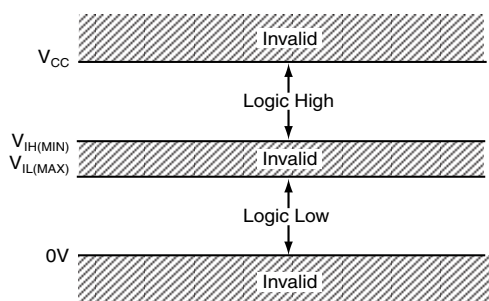


Figure 4b. Input Levels, CMOS, TTL

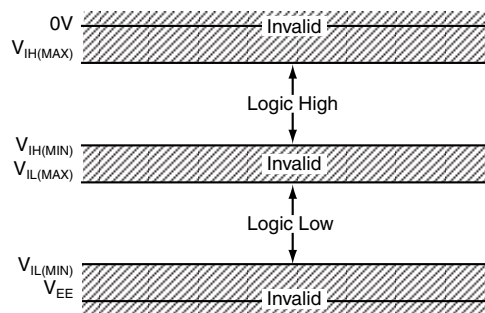


Figure 4c. Input Levels, NECL

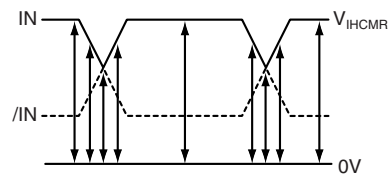


Figure 5a. Input Common Mode, PECL, LVPECL

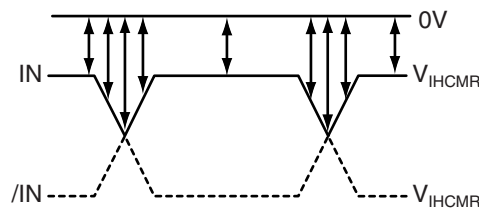
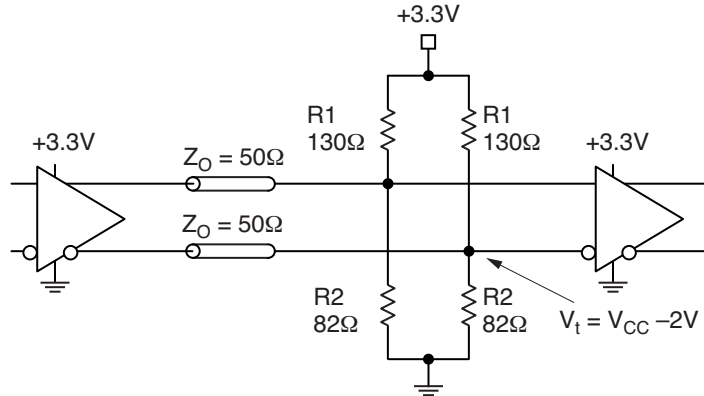


Figure 5b. Input Common Mode, NECL

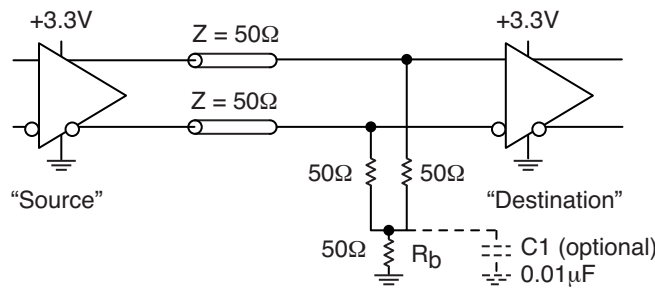
**TERMINATING PECL**



**Figure 6a. Parallel Termination—Thevenin Equivalent**

**Note:**

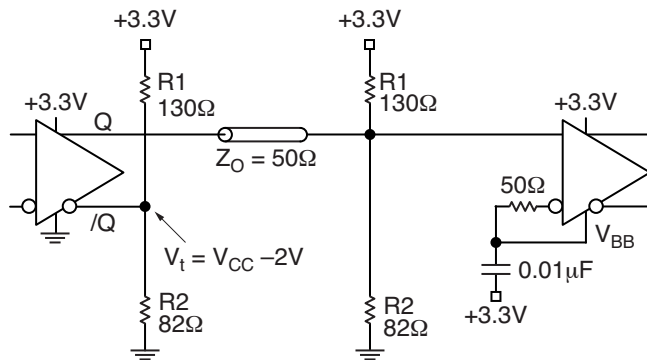
1. For +5.0V systems: R1 = 82Ω, R2 = 130Ω.



**Figure 6b. Three-Resistor “Y-Termination”**

**Notes:**

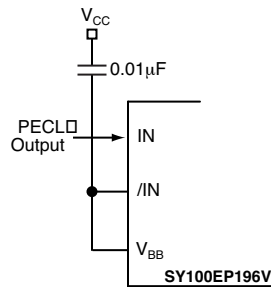
1. Power-saving alternative to Thevenin termination.
2. Place termination resistors as close to destination inputs as possible.
3. R<sub>b</sub> resistor sets the DC bias voltage, equal to V<sub>t</sub>. For +3.3V systems R<sub>b</sub> = 46Ω to 50Ω. For +5V systems, R<sub>b</sub> = 110Ω.



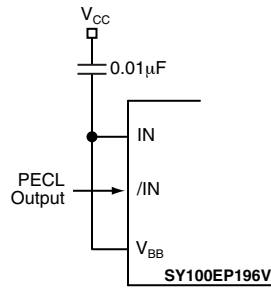
**Figure 6c. Terminating Unused I/O**

**Notes:**

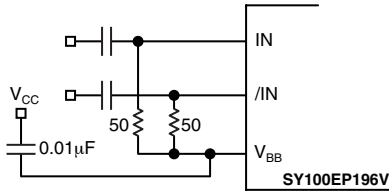
1. Unused output (/Q) must be terminated to balance the output.
2. Micrel's differential I/O logic devices include a V<sub>BB</sub> reference pin.
3. Connect unused input through 50Ω to V<sub>BB</sub>. Bypass with a 0.01μF capacitor to V<sub>CC</sub>, not GND, as PECL is referenced to V<sub>CC</sub>.



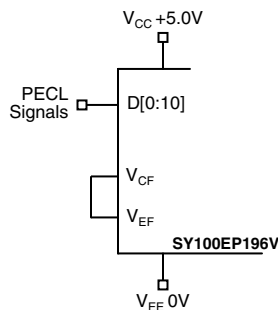
**Figure 7a. Interfacing to a Single-Ended PECL Signal**



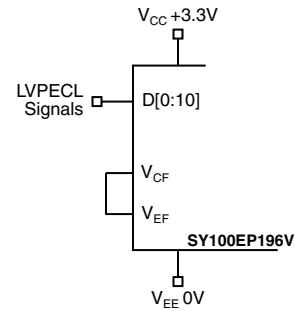
**Figure 7b. Interfacing to and Inverting a Single-Ended PECL Signal**



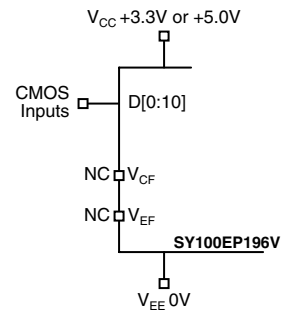
**Figure 8. Re-Biasing an AC-Coupled Signal**



**Figure 9a. Connecting PECL Signals to the D Inputs**

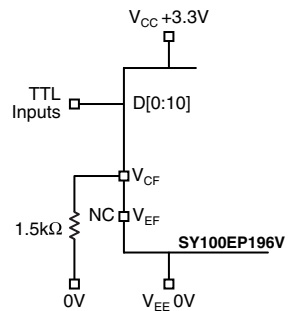


**Figure 9b. Connecting LVPECL Signals to the D Inputs**

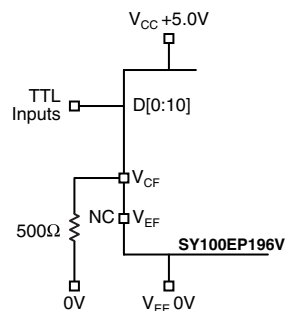


**Figure 9c. Connecting CMOS Signals to the D Inputs**

*Note:  $V_{CF}$  and  $V_{EF}$  are not connected*



**Figure 9d. Connecting TTL Signals to the D Inputs with  $V_{CC} = 3.3V$**



**Figure 9e. Connecting TTL Signals to the D Inputs with  $V_{CC} = 5.0V$**

## FUNCTIONAL DESCRIPTION

SY100EP196V is a programmable delay line, varying the delay of a PECL or NECL input signal by any amount between about 2.2ns and 12.2ns. A 10-bit digital control register affords delay steps of approximately 10ps.

SY100EP196V implements the delay using a multiplexer chain and a set of fixed delay elements. Under digital control, various subsets of the delay elements are included in the signal chain. To simplify interfacing, the 10-bit digital delay control word interfaces to PECL, CMOS, or TTL interface standards.

Since multiplexers must appear in the delay path, SY100EP196V has a minimum delay of about 2.2ns. Delays below this value are not possible. In addition, when cascading multiple SY100EP196V to extend the delay range, the minimum delay is about 2.2ns times the number of SY100EP196V in cascade. An eleventh control bit, D[10], along with the CASCADE and /CASCADE outputs and the SETMIN and SETMAX inputs, simplifies the task of cascading.

### Signal Path Logic Standard

The signal path, from IN, /IN to Q, /Q, interfaces to PECL, LVPECL, or NECL signals, as shown in Table 6. The choice of signal path logic standard may limit possible choices for the delay control inputs, D.

### Input Enable

The /EN input gates the signal at IN, /IN. When disabled, the input is effectively gated out, just as if a logic low was being provided to SY100EP196V.

/EN	Value at Q, /Q
L	IN, /IN Delayed
H	Logic Low Delayed

Table 1. /EN Truth Table

### Digital Control Latch

SY100EP196V can capture the digital delay control word into its internal 11-bit latch, 10 bits for D[0:9], and an extra bit for the D[10] cascade control. The LEN input controls the action of this latch, as per Table 2.

Note that the LEN input is always PECL, LVPECL, or NECL, the same as the IN, /IN signal pair. The 11-bit delay control word, however, may also be CMOS or TTL.

LEN	Latch Action
L	Pass Through D[0:10]
H	Latch D[0:10]

Table 2. LEN Truth Table

The nominal delay value is based on the binary value in D[0:9], where D[0] is the least significant bit, and D[9] is the most significant bit. This delay from IN, /IN to Q, /Q is about:

$$\Delta t = 2200 + 10 \times \text{value}(D[9:0]) + \text{delay}(\text{FTUNE}), \text{ps}$$

### Digital Control Logic Standard

When used in systems where  $V_{EE}$  connects to ground, SY100EP196V may interface either to PECL, CMOS, or TTL on its D[0:10] inputs. To this end, the VCF pin sets the threshold at which the D inputs switch between logic low and logic high.

As shown in Table 3, connecting  $V_{CF}$  to  $V_{EF}$  sets the threshold to PECL (if  $V_{CC}$  is 5V) or LVPECL (if  $V_{CC}$  is 3.3V). Leaving  $V_{CF}$  and  $V_{EF}$  open yields a threshold suitable for detecting CMOS output logic levels. Leaving  $V_{EF}$  open and connecting  $V_{CF}$  to a 1.5V source allows the D inputs to accept TTL signals.

Logic Standard	$V_{CF}$ Connects To
ECL, PECL	VEF
CMOS	No Connect
TTL	1.5V Source

Table 3. Digital Control Standard Truth Table

If a 1.5V source is not available, connecting  $V_{CF}$  to  $V_{EE}$  through an appropriate resistor will bias  $V_{CF}$  at about 1.5V. The value of this resistor depends on the  $V_{CC}$  supply, as indicated in Table 4.

$V_{CC}$	Resistor Value
3.3V	1.5k $\Omega$
5.0V	500 $\Omega$

Table 4. Resistor Values for TTL Input

### Cascade Logic

SY100EP196V is designed to ease cascading multiple devices in order to achieve a greater delay range. The SETMIN and SETMAX pins accomplish this, as set out in the applications section below. SETMIN and SETMAX override the delay by changing the value in the D latch register. Table 5 lists the action of these pins.

SETMIN	SETMAX	Nominal Delay (ps)
L	L	As per D Latch
L	H	2200 + 10 × 1024
H	L	2200
H	H	Not Allowed

Table 5. SETMIN and SETMAX Action

**Fine Tune Control**

In addition to the digital delay control, the FTUNE input permits a continuous variation in delay. Though it may be set to any voltage between  $V_{CC}$  and  $V_{EE}$ , most of the delay variation occurs between  $V_{EE}$  and  $V_{EE} + 1.5V$ . Refer to

*“Typical Operating Characteristics.”* For convenience, a  $V_{CC}$  of 3.3V is assumed. Typically, the FTUNE input will be fed by a DAC whose purpose is to provide extremely fine delay under digital control.

Signal Path Logic Standard	$V_{CC}$	$V_{EE}$	Delay Control Input Choices
PECL	+4.5V to +5.5V	0V	PECL, CMOS, TTL
LVPECL	+3.0V to +3.6V	0V	LVPECL, CMOS, TTL
NECL	0V	-3.0 to -5.5V	NECL

**Table 6. Signal Path Logic Standard**

**APPLICATIONS INFORMATION**

For best performance, use good high frequency layout techniques, filter  $V_{CC}$  supplies, and keep ground connections short. Use multiple vias where possible. Also, use controlled impedance transmission lines to interface with the SY100EP196V data inputs and outputs.

**$V_{BB}$  Supply**

The VBB pin is an internally generated supply, and is available for use only by the SY100EP196V. When unused, this pin should be left unconnected. The two common uses for  $V_{BB}$  are to handle a single-ended PECL input, and to re-bias inputs for AC-coupling applications.

If IN, /IN is driven by a single-ended output,  $V_{BB}$  is used to bias the unused input. Please refer to Figures 9. The PECL signal driving SY100EP196V may optionally be inverted in this case.

When the signal is AC-coupled,  $V_{BB}$  is used, as shown in Figure 10, to re-bias IN, /IN. This ensures that SY100EP196V inputs are within its acceptable common mode range.

In all cases,  $V_{BB}$  current sinking or sourcing must be limited to 0.5mA or less.

**Setting D Input Logic Thresholds**

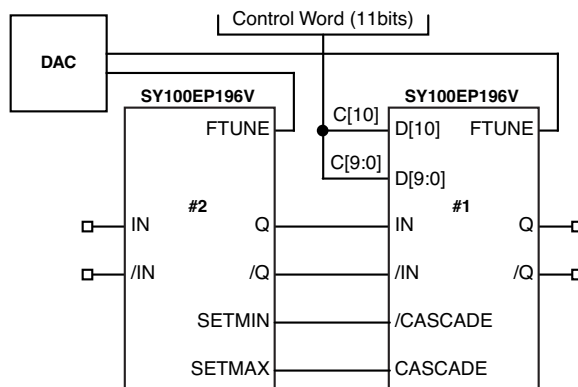
As explained earlier, in all designs where the SY100EP196V  $V_{EE}$  supply is at zero volts, the D inputs may accommodate CMOS and TTL level signals, as well as PECL or LVPECL. Figures 9 show how to connect  $V_{CF}$  and  $V_{EF}$  for all possible cases.

**Cascading**

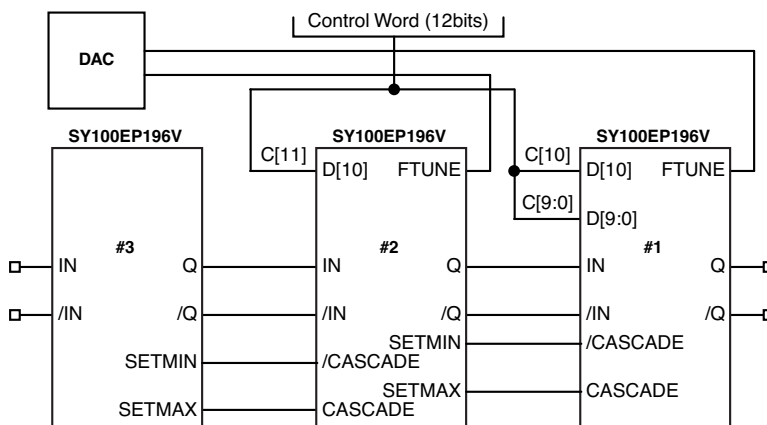
Two or more SY100EP196V may be cascaded, in order to extend the range of delays permitted. Each additional SY100EP196V adds about 2200ps to the minimum delay, and adds another 10240ps to the delay range.

Internal cascade circuitry has been included in the SY100EP196V. Using this internal circuitry, SY100EP196V may be cascaded without any external gating.

Examples of cascading 2, 3, or 4 SY100EP196V appear in Figures 10. Table 7 lists the nominal delay for all the cases that appear in Figures 10.



**Figure 10a. Cascading Two SY100EP196V**



**Figure 10b. Cascading Three SY100EP196V**

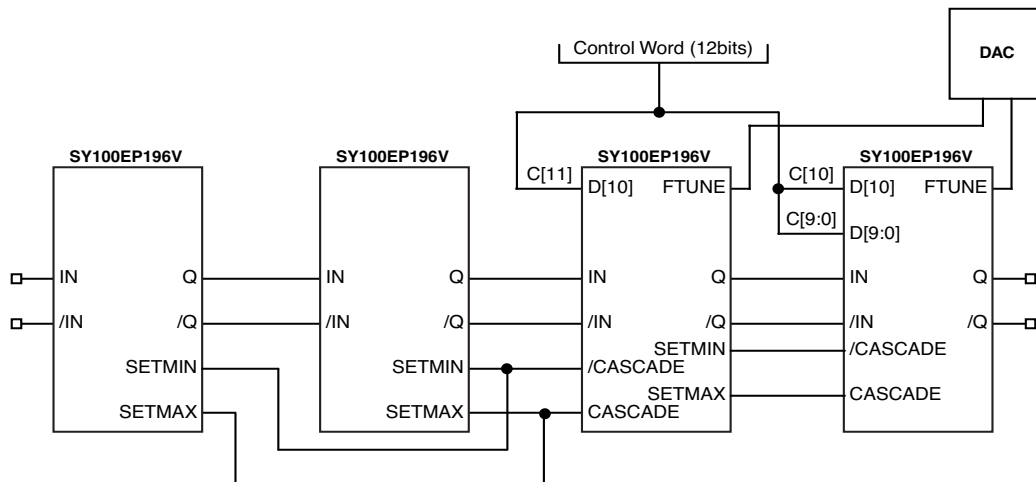


Figure 10c. Cascading Four SY100EP196V

**RELATED PRODUCT AND SUPPORT DOCUMENTATION**

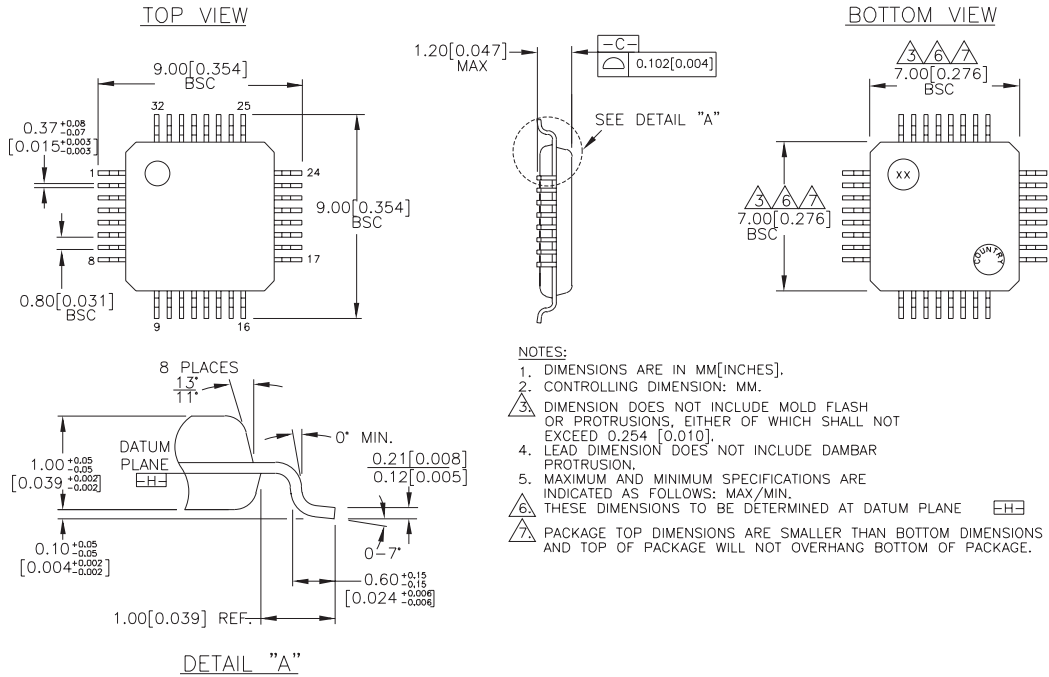
Part Number	Function	Data Sheet Link
SY100EP195VTI	3.3V/5V 2.5GHz Programmable Delay Chip	<a href="http://www.micrel.com/product-info/products/sy100ep195v.shtml">http://www.micrel.com/product-info/products/sy100ep195v.shtml</a>
SY55856UHI	2.5V/3.3V 2.5GHz Differential 2-Channel Precision CML Delay Line	<a href="http://www.micrel.com/product-info/products/sy55856u.shtml">http://www.micrel.com/product-info/products/sy55856u.shtml</a>



Control Inputs			Nominal Delay (ps)			
D[11]	D[10]	D[9:0]	One Chip	Two Chips	Three Chips	Four Chips
0	0	000000000	2,200	4,400	6,600	8,800
0	0	000000001	2,210	4,410	6,610	8,810
0	0	000000010	2,220	4,420	6,620	8,820
0	0	000000100	2,240	4,440	6,640	8,840
0	0	000001000	2,280	4,480	6,680	8,880
0	0	000010000	2,360	4,560	6,760	8,960
0	0	000100000	2,520	4,720	6,920	9,120
0	0	001000000	2,840	5,040	7,240	9,440
0	0	001000000	3,480	5,680	7,880	10,080
0	0	010000000	4,760	6,960	9,160	11,360
0	0	100000000	7,320	9,520	11,720	13,920
0	0	111111111	12,430	14,630	16,830	19,030
0	1	000000000		14,640	16,840	19,040
0	1	000000001		14,650	16,850	19,050
0	1	000000010		14,660	16,860	19,060
0	1	000000100		14,680	16,880	19,080
0	1	000001000		14,720	16,920	19,120
0	1	000010000		14,800	17,000	19,200
0	1	000100000		14,960	17,160	19,360
0	1	001000000		15,280	17,480	19,680
0	1	001000000		15,920	18,120	20,320
0	1	010000000		17,200	19,400	21,600
0	1	100000000		19,760	21,960	24,160
0	1	111111111		24,870	27,070	29,270
1	0	000000000			27,080	29,280
1	0	000000001			27,090	29,290
1	0	000000010			27,100	29,300
1	0	000000100			27,120	29,320
1	0	000001000			27,160	29,360
1	0	000010000			27,240	29,440
1	0	000100000			27,400	29,600
1	0	001000000			27,720	29,920
1	0	001000000			28,360	30,560
1	0	010000000			29,640	31,840
1	0	100000000			32,200	34,400
1	0	111111111			37,310	39,510
1	1	000000000			27,080	39,520
1	1	000000001			27,090	39,530
1	1	000000010			27,100	39,540
1	1	000000100			27,120	39,560
1	1	000001000			27,160	39,600
1	1	000010000			27,240	39,680
1	1	000100000			27,400	39,840
1	1	001000000			27,720	40,160
1	1	001000000			28,360	40,800
1	1	010000000			29,640	42,080
1	1	100000000			32,200	44,640
1	1	111111111			37,310	49,750

**Table 7. List of Nominal Delay Values for Cascaded SY100EP196V**

**32-PIN TQFP (T32-1)**



Rev. 01

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