PEEL™ 18CV8 -5/-7/-10/-15/-25
CMOS Programmable Electrically Erasable Logic Device

Features

- **Multiple Speed Power, Temperature Options**
  - Vcc = 5 Volts ±10%
  - Speeds ranging from 5ns to 25 ns
  - Power as low as 37mA at 25MHz
  - Commercial and industrial versions available
- **CMOS Electrically Erasable Technology**
  - Superior factory testing
  - Reprogrammable in plastic package
  - Reduces retrofit and development costs
- **Development / Programmer Support**
  - Third party software and programmers
  - ICT PLACE Development Software and PDS-3 programmer
  - PLD-to-PEEL JEDEC file translator

Architectural Flexibility
- Enhanced architecture fits in more logic
- 74 product terms x 36 input AND array
- 10 inputs and 8 I/O pins
- 12 possible macrocell configurations
- Asynchronous clear
- Independent output enables
-- 20 Pin DIP/SOIC/TSSOP and PLCC

- **Application Versatility**
  - Replaces random logic
  - Super sets PLDs (PAL, GAL, EPLD)
  - Enhanced Architecture fits more logic than ordinary PLDs

General Description

The PEEL18CV8 is a Programmable Electrically Erasable Logic (PEEL) device providing an attractive alternative to ordinary PLDs. The PEEL18CV8 offers the performance, flexibility, ease of design and production practicality needed by logic designers today.

The PEEL18CV8 is available in 20-pin DIP, PLCC, SOIC and TSSOP packages with speeds ranging from 5ns to 25ns with power consumption as low as 37mA. EE-Reprogrammability provides the convenience of instant reprogramming for development and reusable production inventory minimizing the impact of programming changes or errors. EE-Reprogrammability also improves factory testability, thus assuring the highest quality possible.

The PEEL18CV8 architecture allows it to replace over 20 standard 20-pin PLDs (PAL, GAL, EPLD etc.). It also provides additional architecture features so more logic can be put into every design. ICT's JEDEC file translator instantly converts to the PEEL18CV8 existing 20-pin PLDs without the need to rework the existing design. Development and programming support for the PEEL18CV8 is provided by popular third-party programmers and development software. ICT also offers free PLACE development software and a low-cost development system (PDS-3).

Figure 1 Pin Configuration

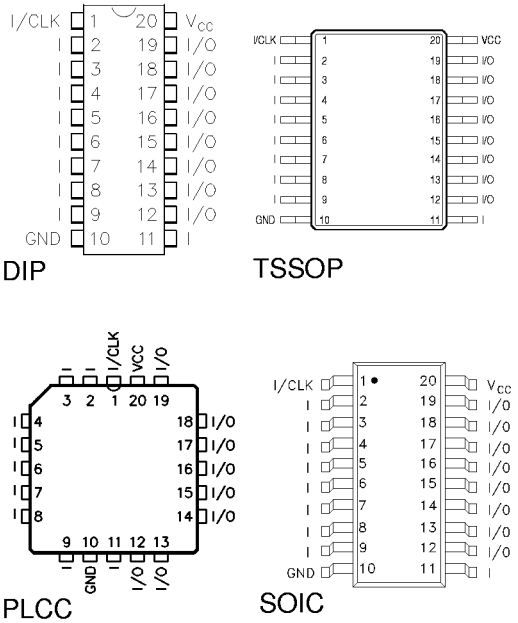
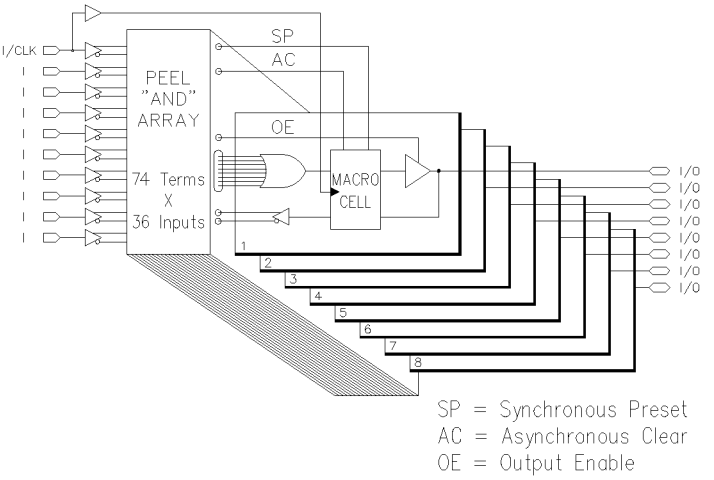


Figure 2 Block Diagram



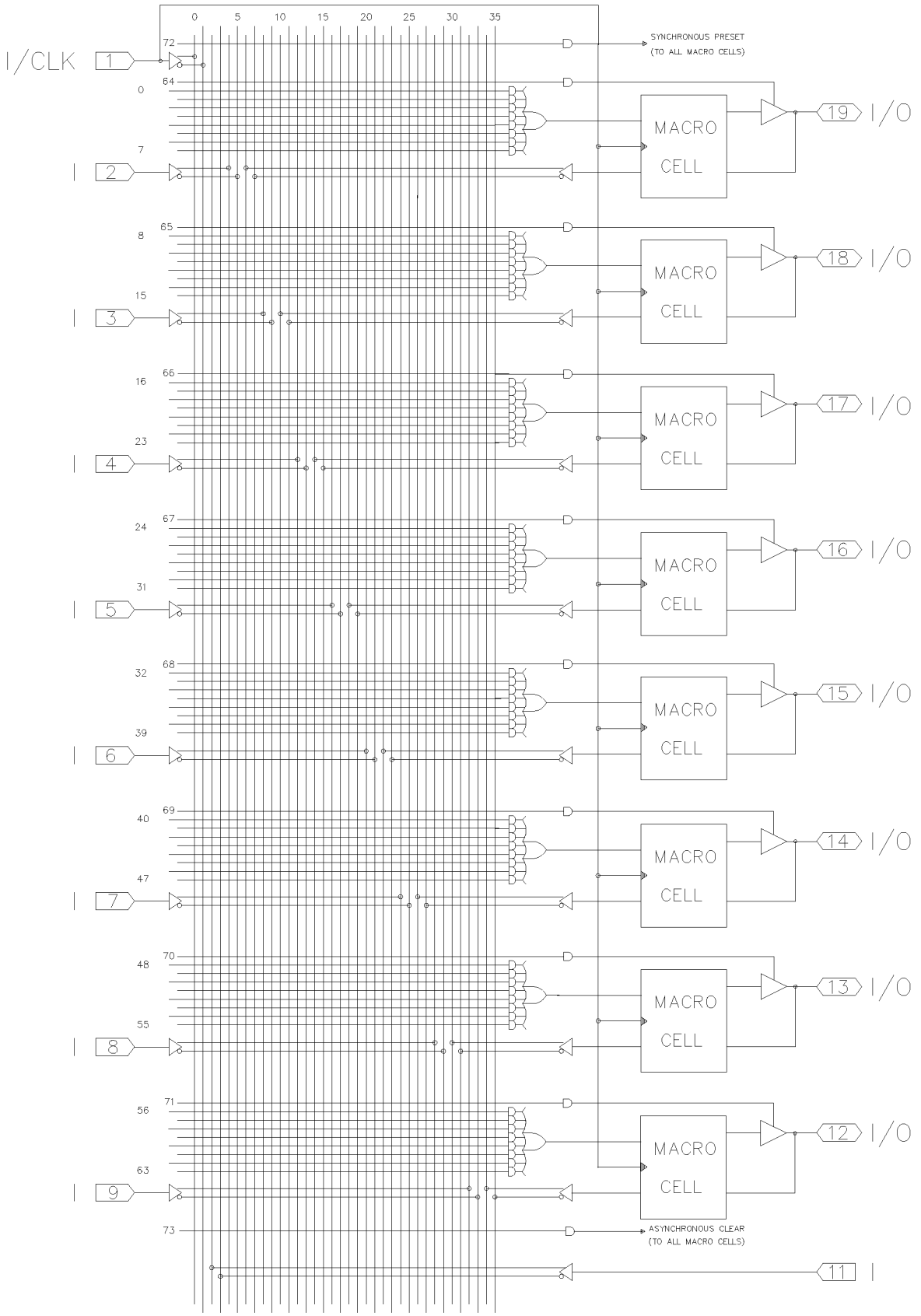


Figure 3 PEEL18CV8 Logic Array Diagram

Function Description

The PEEL18CV8 implements logic functions as sum-of-products expressions in a programmable-AND/fixed-OR logic array. User-defined functions are created by programming the connections of input signals into the array. User-configurable output structures in the form of I/O macrocells further increase logic flexibility.

Architecture Overview

The PEEL18CV8 architecture is illustrated in the block diagram of Figure 2. Ten dedicated inputs and 8 I/Os provide up to 18 inputs and 8 outputs for creation of logic functions. At the core of the device is a programmable electrically-erasable AND array which drives a fixed OR array. With this structure, the PEEL18CV8 can implement up to 8 sum-of-products logic expressions.

Associated with each of the 8 OR functions is an I/O macrocell which can be independently programmed to one of 12 different configurations. The programmable macrocells allow each I/O to create sequential or combinatorial logic functions of active-high or active-low polarity, while providing three different feedback paths into the AND array.

AND/OR LOGIC ARRAY

The programmable AND array of the PEEL18CV8 (shown in Figure 3) is formed by input lines intersecting product terms. The input lines and product terms are used as follows:

- **36 Input Lines:**
  - 20 input lines carry the true and complement of the signals applied to the 10 input pins
  - 16 additional lines carry the true and complement values of feedback or input signals from the 8 I/Os
- **74 product terms:**
  - 64 product terms (arranged in groups of 8) are used to form sum of product functions
  - 8 output enable terms (one for each I/O)
  - 1 global synchronous preset term
  - 1 global asynchronous clear term

At each input-line/product-term intersection, there is an EEPROM memory cell that determines whether or not there is a logical connection at that intersection. Each product term is essentially a 36-input AND gate. A product term that is connected to both the true and complement of an input signal will always be FALSE and thus will not affect the OR function that it drives. When all the connections on a product term are opened, a “don’t care” state exists and that term will always be TRUE.

When programming the PEEL18CV8, the device programmer first performs a bulk erase to remove the previous pattern. The erase cycle opens every logical connection in the array. The device is configured to perform the user-defined function by programming selected connections in the AND array. (Note that PEEL device programmers automatically program all of the connections on unused product terms so that they will have no effect on the output function).

Programmable I/O Macrocell

The unique twelve-configuration output macrocell provides complete control over the architecture of each output. The ability to configure each output independently permits users to tailor the configuration of the PEEL18CV8 to the precise requirements of their designs.

Macrocell Architecture

Each I/O macrocell, as shown in Figure 4, consists of a D-type flip-flop and two signal-select multiplexers. The configuration of each macrocell is determined by the four EEPROM bits controlling these multiplexers. These bits determine output polarity, output type (registered or non-registered) and input-feedback path (bidirectional I/O, combinatorial feedback). Refer to Table 1 for details.

Equivalent circuits for the twelve macrocell configurations are illustrated in Figure 5. In addition to emulating the four PAL-type output structures (configurations 3,4,9, and 10), the macrocell provides eight additional configurations. When creating a PEEL device design, the desired macrocell configuration generally is specified explicitly in the design file. When the design is assembled or compiled, the macrocell configuration bits are defined in the last lines of the JEDEC programming file.

Output Type

The signal from the OR array can be fed directly to the output pin (combinatorial function) or latched in the D-type flip-flop (registered function). The D-type flip-flop latches data on the rising edge of the clock and is controlled by the global preset and clear terms. When the synchronous preset term is satisfied, the Q output of the register will be set HIGH at the next rising edge of the clock input. Satisfying the asynchronous clear will set Q LOW, regardless of the clock state. If both terms are satisfied simultaneously, the clear will override the preset.

Output Polarity

Each macrocell can be configured to implement active-high or active-low logic. Programmable polarity eliminates the need for external inverters.

Output Enable

The output of each I/O macrocell can be enabled or disabled under the control of its associated programmable output enable product term. When the logical conditions programmed on the output enable term are satisfied, the output signal is propagated to the I/O pin. Otherwise, the output buffer is switched into the high-impedance state.

Under the control of the output enable term, the I/O pin can

function as a dedicated input, a dedicated output, or a bi-directional I/O. Opening every connection on the output enable term will permanently enable the output buffer and yield a dedicated output. Conversely, if every connection is intact, the enable term will always be logically false and the I/O will function as a dedicated input.

Input/Feedback Select

The PEEL18CV8 macrocell also provides control over the feedback path. The input/feedback signal associated with each I/O macrocell may be obtained from three different locations; from the I/O input pin, from the Q output of the flip-flop (registered feedback), or directly from the OR gate (combinatorial feedback).

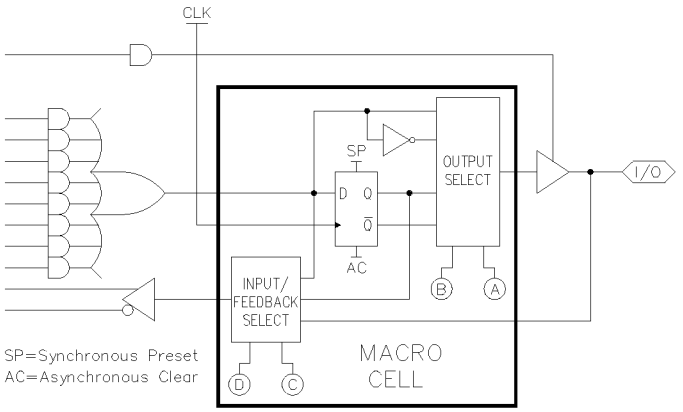
Bi-directional I/O

The input/feedback signal is taken from the I/O pin when using the pin as a dedicated input or as a bi-directional I/O. (Note that it is possible to create a registered output function with a bi-directional I/O.)

Combinatorial Feedback

The signal-select multiplexer gives the macrocell the ability to feedback the output of the OR gate, bypassing the output buffer, regardless of whether the output function is registered or combinatorial. This feature allows the creation of asynchronous latches, even when the output must be disabled. (Refer to configurations 5,6,7 and 8 in Figure 5.)

Figure 4 Block Diagram of the PEEL18CV8 I/O Macrocell



Registered Feedback

Feedback also can be taken from the register, regardless of whether the output function is to be combinatorial or registered. When implementing a combinatorial output function, registered feedback allows for the internal latching of states without giving up the use of the external output.

Design Security

The PEEL18CV8 provides a special EEPROM security bit that prevents unauthorized reading or copying of designs programmed into the device. The security bit is set by the PLD programmer, either at the conclusion of the programming cycle or as a separate step, after the device has been programmed. Once the security bit is set it is impossible to verify (read) or program the PEEL until the entire device has first been erased with the bulk-erase function.

Programming Support

ICT's JEDEC file translator allows easy conversion of existing 20 pin PLD designs to the PEEL18CV8, without the need for redesign. ICT supports a broad range of popular third party design entry systems, including Data I/O Synario and Abel, Logical Devices CUPL and others. ICT also offers (for free) its proprietary PLACE software, an easy-to-use entry level PC-based software development system.

Programming support includes all the popular third party programmers; Data I/O, Logical Devices, and numerous others. ICT also provides a low cost development programmer system, the PDS-3.

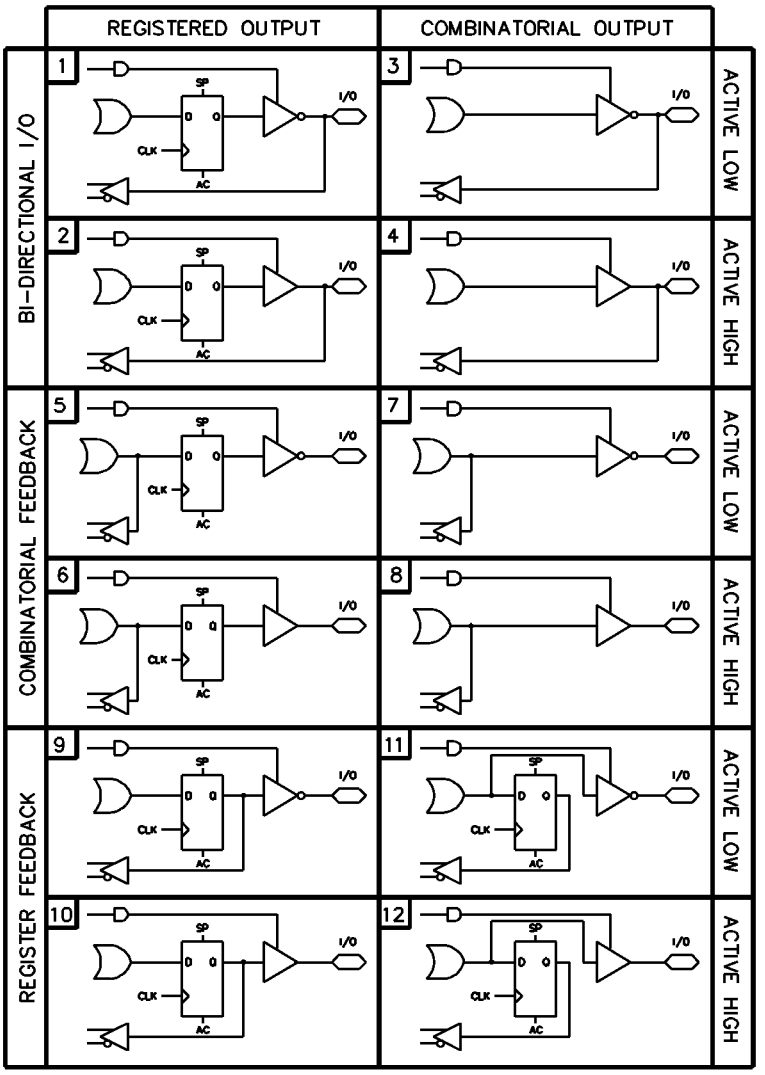


Figure 5 Equivalent Circuits for the Twelve Configurations of the PEEL18CV8 I/O Macrocell

Configuration					Input/Feedback Select	Output Select	
#	A	B	C	D			
1	1	1	1	1	Bi-directional I/O	Register	Active Low
2	0	1	1	1			Active High
3	1	0	1	1		Combinatorial	Active Low
4	0	0	1	1			Active High
5	1	1	1	0	Combinatorial Feedback	Register	Active Low
6	0	1	1	0			Active High
7	1	0	1	0		Combinatorial	Active Low
8	0	0	1	0			Active High
9	1	1	0	0	Register Feedback	Register	Active Low
10	0	1	0	0			Active High
11	1	0	0	0		Combinatorial	Active Low
12	0	0	0	0			Active High

This device has been designed and tested for the specified operating ranges. Proper operation outside of these levels is not guaranteed. Exposure to absolute maximum ratings may cause permanent damage.

Absolute Maximum Ratings

Symbol	Parameter	Conditions	Rating	Unit
V_{CC}	Supply Voltage	Relative to Ground	-0.5 to + 6.0	V
V_I, V_O	Voltage Applied to Any Pin[2]	Relative to Ground[1]	-0.5 to V_{CC} + 0.6	V
I_O	Output Current	Per Pin (I_{OL}, I_{OH})	±25	mA
T_{ST}	Storage Temperature		-65 to +150	°C
T_{LT}	Lead Temperature	Soldering 10 Seconds	+300	°C

Operating Range

Symbol	Parameter	Conditions	Min	Max	Unit
Vcc	Supply Voltage	Commercial	4.75	5.25	V
		Industrial	4.5	5.5	V
T_A	Ambient Temperature	Commercial	0	+70	°C
		Industrial	-40	+85	°C
TR	Clock Rise Time	See Note 3.		20	ns
TF	Clock Fall TIme	See Note 3.		20	ns
T_{RVCC}	V_{CC} Rise Time	See Note 3.		250	ms

D.C. Electrical Characteristics Over the operating range (Unless otherwise specified)

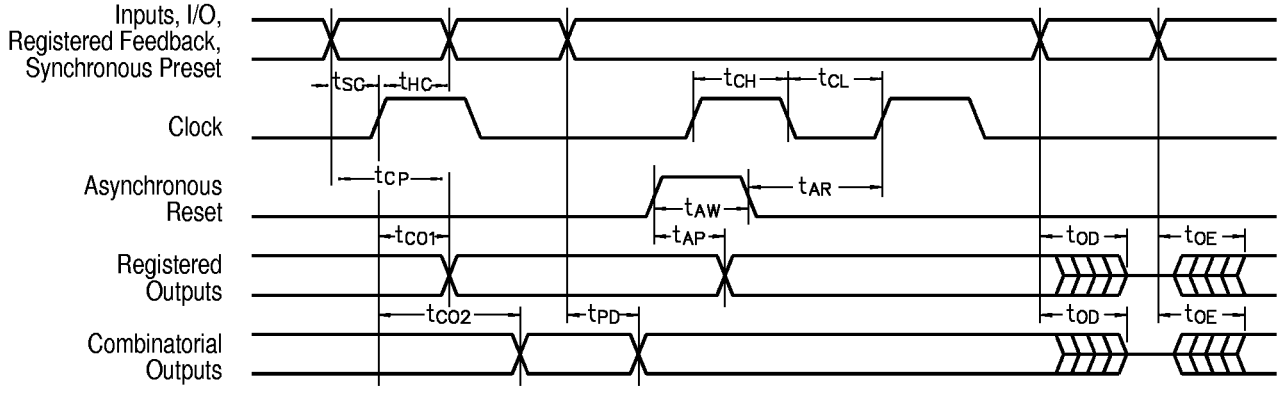
Symbol	Parameter	Conditions		Min	Max	Unit
V_{OH}	Output HIGH Voltage - TTL	V_{CC} = Min, I_{OH} = -4.0 mA		2.4		V
V_{OHC}	Output HIGH Voltage - CMOS[12]	V_{CC} = Min, I_{OH} = -10 µA		VCC - 0.3		V
V_{OL}	Output LOW Voltage - TTL	V_{CC} = Min, I_{OL} = 16mA/24mA[13]			0.5	V
V_{OLC}	Output LOW Voltage - CMOS[12]	V_{CC} = Min, I_{OL} = 10 µA			0.15	V
V_{IH}	Input HIGH level			2.0	V_{CC} + 0.3	V
V_{IL}	Input LOW Voltage			-0.3	0.8	V
I_{IL}	Input, I/O Leakage Current LOW Input and I/O pull-ups disabled	VCC = Max, VIN = GND, I/O = High Z			-10	µA
I_{IP}	Input, I/O Leakage Current LOW Input and I/O pull-ups enabled	VCC = Max, VIN = GND, I/O = High Z			-100	µA
I_{IH}	Input, I/O Leakage Current HIGH	VCC = Max, VIN = V_{CC}, I/O = High Z		0 (Typical)	40	µA
I_{SC}[9]	Output Short Circuit Current	V_{CC} = 5V, V_O = 0.5V, TA = 25°C		-30	-135	mA
I_{CC}[10]	V_{CC} Current, f=1MHz	VIN = 0V or V_{CC}, f = 25 MHz All Outputs disabled[4]	-5		90	mA
			-7		90	
			-10		110/115	
			-15		45/55	
			-25		37/50	
C_{IN}[7]	Input Capacitance	TA = 25°C, VCC = 5.0V @ f = 1 MHz			6	pF
C_{OUT}[7]	Output Capacitance				12	pF

A.C. Electrical Characteristics

Over the operating range [8]

Symbol	Parameter	-5		-7		-10/I-10		-15/I-15		-25/I-25		Units
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
t_{PD}	Input[5] to non-registered output		5		7.5		10		15		25	ns
t_{OE}	Input[5] to output enable[6]		5		7.5		10		15		25	ns
t_{OD}	Input[5] to output disable[6]		5		7.5		10		15		25	ns
t_{CO1}	Clock to Output		4		7		7		12		15	ns
t_{CO2}	Clock to comb. output delay via internal registered feedback		7.5		10		12		25		35	ns
t_{CF}	Clock to Feedback		2.5		3.5		4		8		15	ns
t_{SC}	Input[5] or feedback setup to clock	3.5		5		5		12		20		ns
t_{HC}	Input[5] hold after clock	0		0		0		0		0		ns
t_{CL}, t_{CH}	Clock low time, clock high time[8]	3		3.5		5		10		15		ns
t_{CP}	Min clock period Ext (t_{SC} + t_{CO1})	7		12		12		24		35		ns
f_{MAX1}	Internal feedback ($1/t_{SC}+t_{CF}$)[11]	166.7		117.6		111		50		28.5		MHz
f_{MAX2}	External Feedback ($1/t_{CP}$)[11]	133		83.3		83.3		41.6		28.5		MHz
f_{MAX3}	No Feedback ($1/t_{CL}+t_{CH}$)[11]	166.7		142.8		100		50		33.3		MHz
t_{AW}	Asynchronous Reset Pulse Width	5		7.5		10		15		25		ns
t_{AP}	Input[5] to Asynchronous Reset		5		7.5		10		15		25	ns
t_{AR}	Asynchronous Reset recovery time		5		7.5		10		15		25	ns
t_{RESET}	Power-on reset time for registers in clear state		5		5		5		5		5	µs

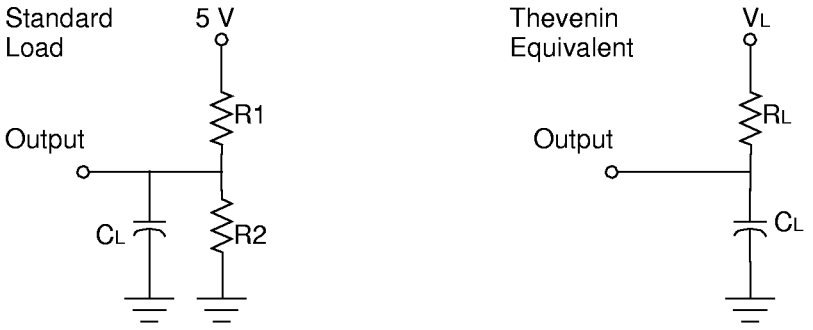
Switching Waveforms



Notes:

1. Minimum DC input is -0.5V, however, inputs may undershoot to -2.0V for periods less than 20 ns.
2. V_I and V_O are not specified for program/verify operation.
3. Test Points for Clock and VCC in t_R and t_F are referenced at the 10% and 90% levels.
4. I/O pins are 0V and V_{CC}.
5. "Input" refers to an input pin signal.
6. t_{OE} is measured from input transition to V_{REF}±0.1V, t_{OD} is measured from input transition to V_{OH}-0.1V or V_{OL}+0.1V; V_{REF}=V_L.
7. Capacitances are tested on a sample basis.
8. Test conditions assume: signal transition times of 3ns or less from the 10% and 90% points, timing reference levels of 1.5V (Unless otherwise specified).
9. Test one output at a time for a duration of less than 1 second.
10. I_{CC} for a typical application: This parameter is tested with the device programmed as an 8-bit Counter.
11. Parameters are not 100% tested. Specifications are based on initial characterization and are tested after any design process modification that might affect operational frequency.
12. Available only for 18CV8 -15/I-15/-25/I-25 grades
13. 24mA available for 18CV8-5/-7. All other speeds are 16mA.

PEEL Device and Array Test Loads

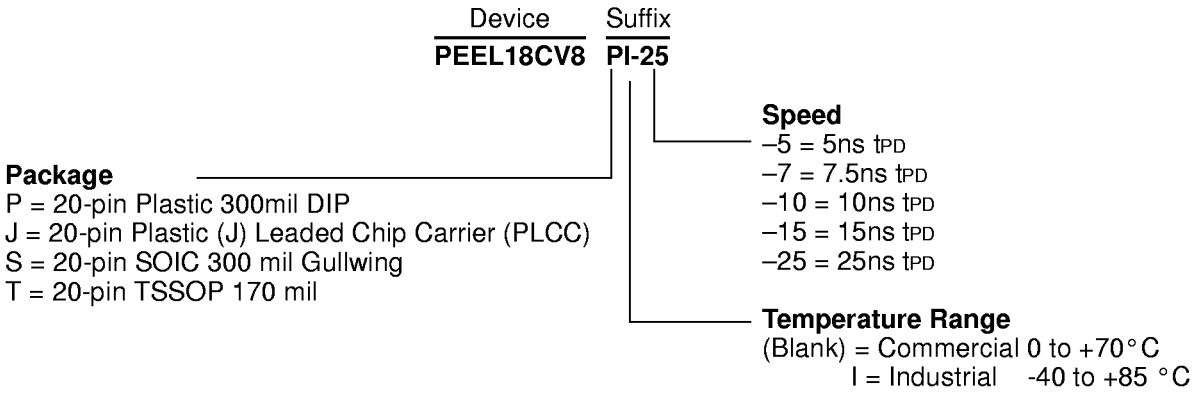


Technology	R1	R2	R_L	V_L	C_L
CMOS[12]	480kΩ	480kΩ	228kΩ	2.375V	33 pF
TTL -10/-15/-25	235Ω	159Ω	95Ω	2.02V	33 pF
TTL -5/-7	159Ω	118Ω	68Ω	2.129V	33 pF

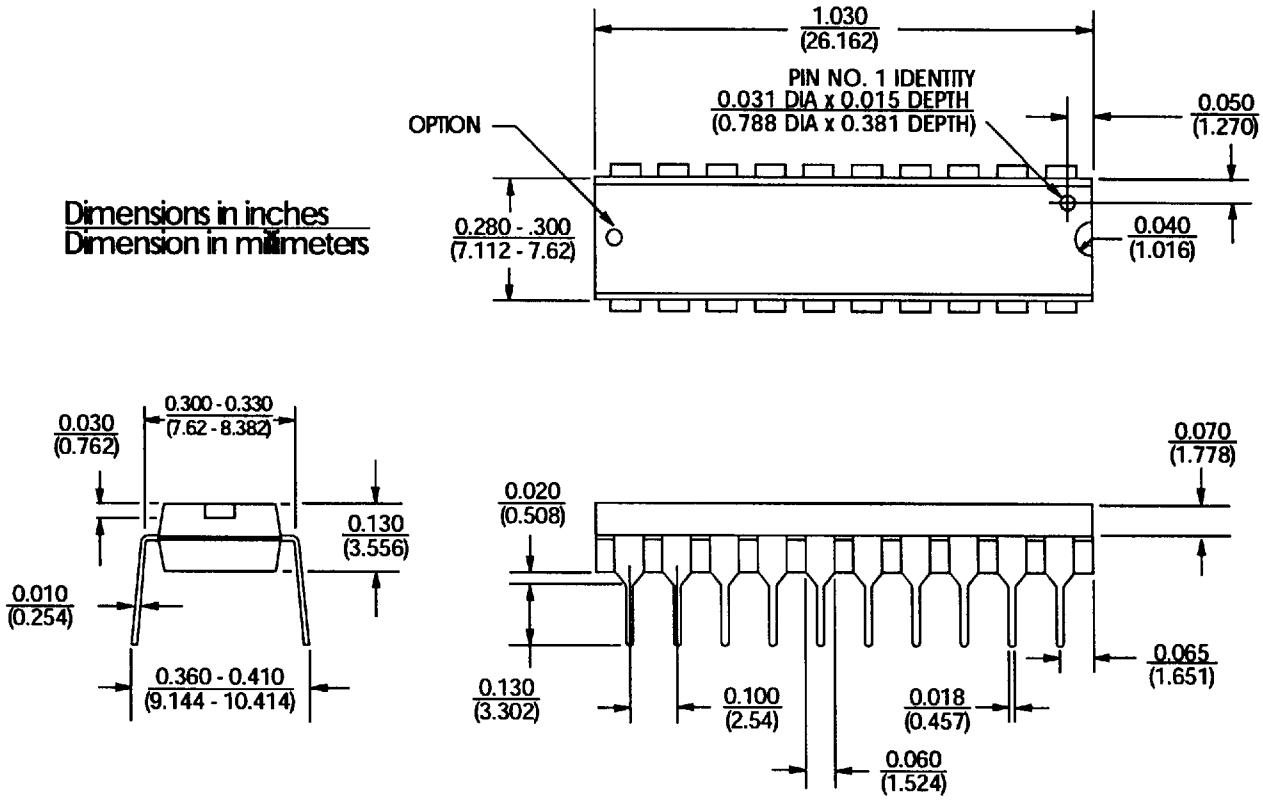
Ordering Information

Part Number	Speed	Temperature	Package
PEEL18CV8J-5	5 ns	Commercial	20-pin Plastic (J) Leaded Chip Carrier (PLCC)
PEEL18CV8P-7	7.5 ns	Commercial	20-pin Plastic 300 mil DIP
PEEL18CV8J-7	7.5 ns	Commercial	20-pin Plastic (J) Leaded Chip Carrier (PLCC)
PEEL18CV8S-7	7.5 ns	Commercial	20-pin SOIC
PEEL18CV8P-10	10 ns	Commercial	20-pin Plastic 300 mil DIP
PEEL18CV8PI-10		Industrial	
PEEL18CV8J-10	10 ns	Commercial	20-pin Plastic (J) Leaded Chip Carrier (PLCC)
PEEL18CV8JI-10		Industrial	
PEEL18CV8S-10	10 ns	Commercial	20-pin SOIC
PEEL18CV8SI-10		Industrial	
PEEL18CV8T-10	10 ns	Commercial	20-pin TSSOP 170 mil
PEEL18CV8TI-10		Industrial	
PEEL18CV8P-15	15 ns	Commercial	20-pin Plastic 300 mil DIP
PEEL18CV8PI-15		Industrial	
PEEL18CV8J-15	15 ns	Commercial	20-pin Plastic (J) Leaded Chip Carrier (PLCC)
PEEL18CV8JI-15		Industrial	
PEEL18CV8S-15	15 ns	Commercial	20-pin SOIC
PEEL18CV8SI-15		Industrial	
PEEL18CV8T-15	15 ns	Commercial	20-pin TSSOP 170 mil
PEEL18CV8TI-15		Industrial	
PEEL18CV8P-25	25 ns	Commercial	20-pin Plastic 300 mil DIP
PEEL18CV8PI-25		Industrial	
PEEL18CV8J-25	25 ns	Commercial	20-pin Plastic (J) Leaded Chip Carrier (PLCC)
PEEL18CV8JI-25		Industrial	
PEEL18CV8S-25	25 ns	Commercial	20-pin SOIC
PEEL18CV8SI-25		Industrial	
PEEL18CV8T-25	25 ns	Commercial	20-pin TSSOP 170 mil
PEEL18CV8TI-25		Industrial	

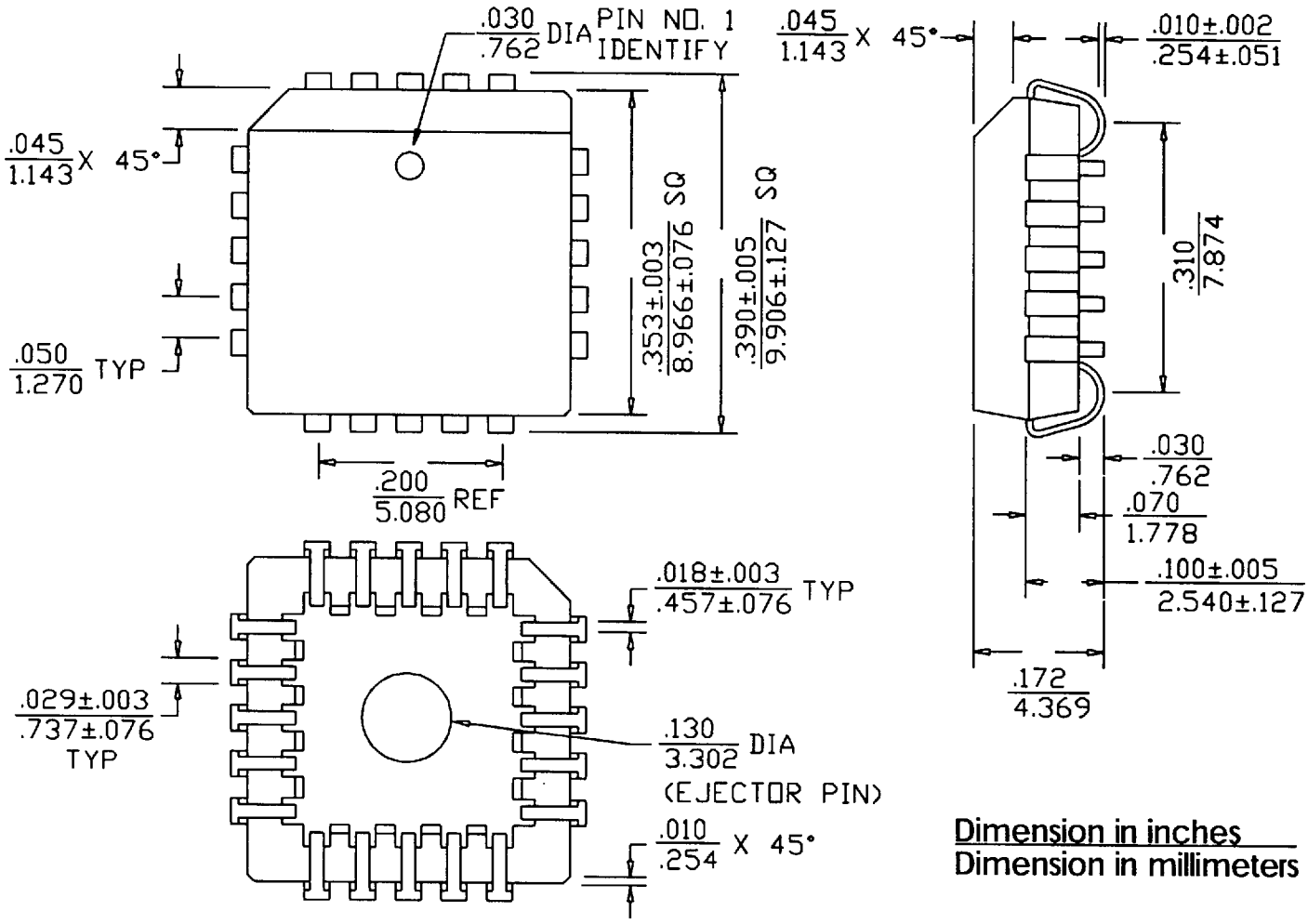
Part Number


Device
Suffix
PEEL18CV8
PI-25
Package
P = 20-pin Plastic 300mil DIP
J = 20-pin Plastic (J) Leaded Chip Carrier (PLCC)
S = 20-pin SOIC 300 mil Gullwing
T = 20-pin TSSOP 170 mil
Speed
–5 = 5ns tPD
–7 = 7.5ns tPD
–10 = 10ns tPD
–15 = 15ns tPD
–25 = 25ns tPD
Temperature Range
(Blank) = Commercial 0 to +70°C
I = Industrial -40 to +85 °C

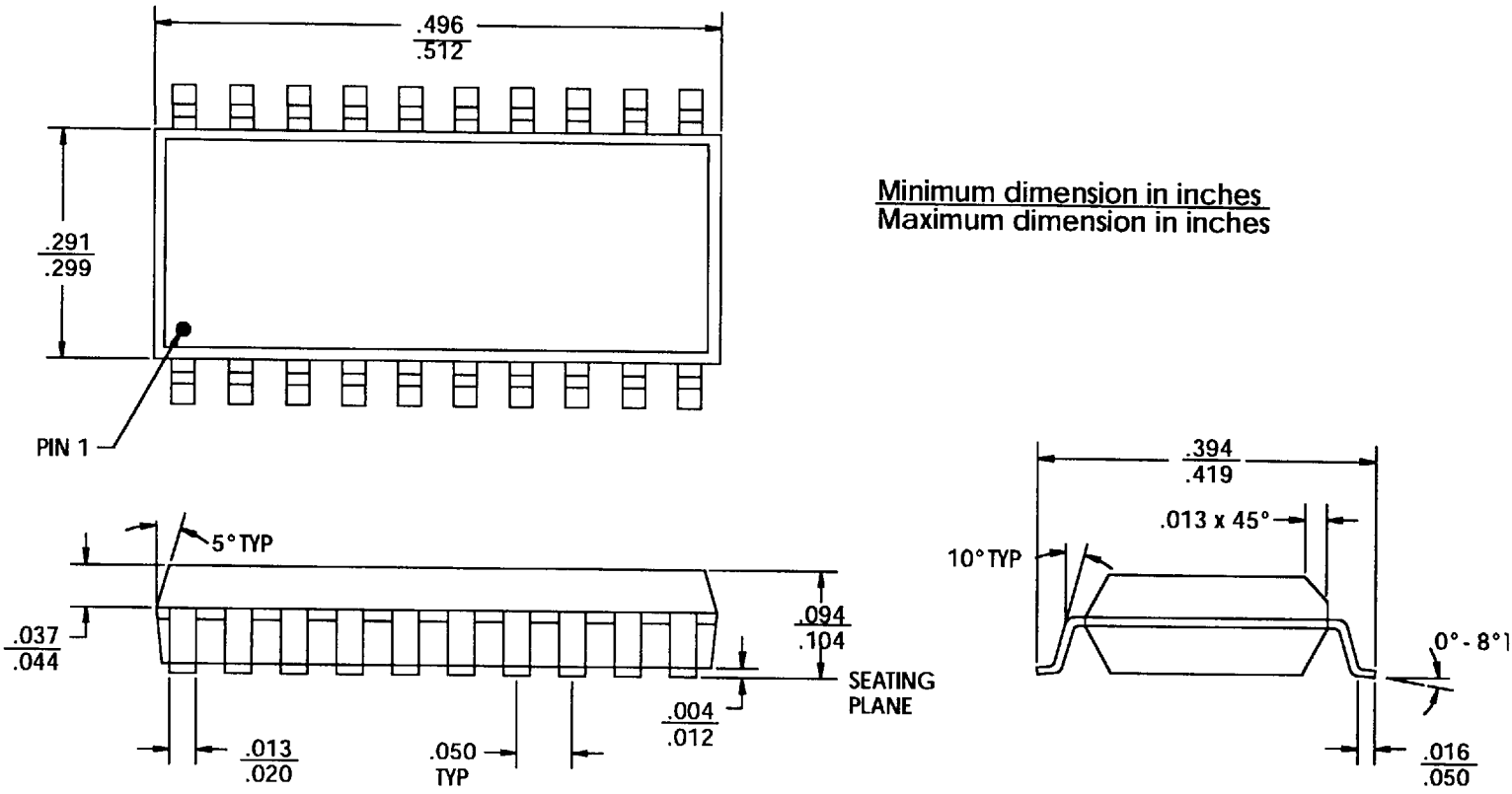
Dimensions in inches
Dimension in millimeters



20-Pin Plastic DIP (P20)

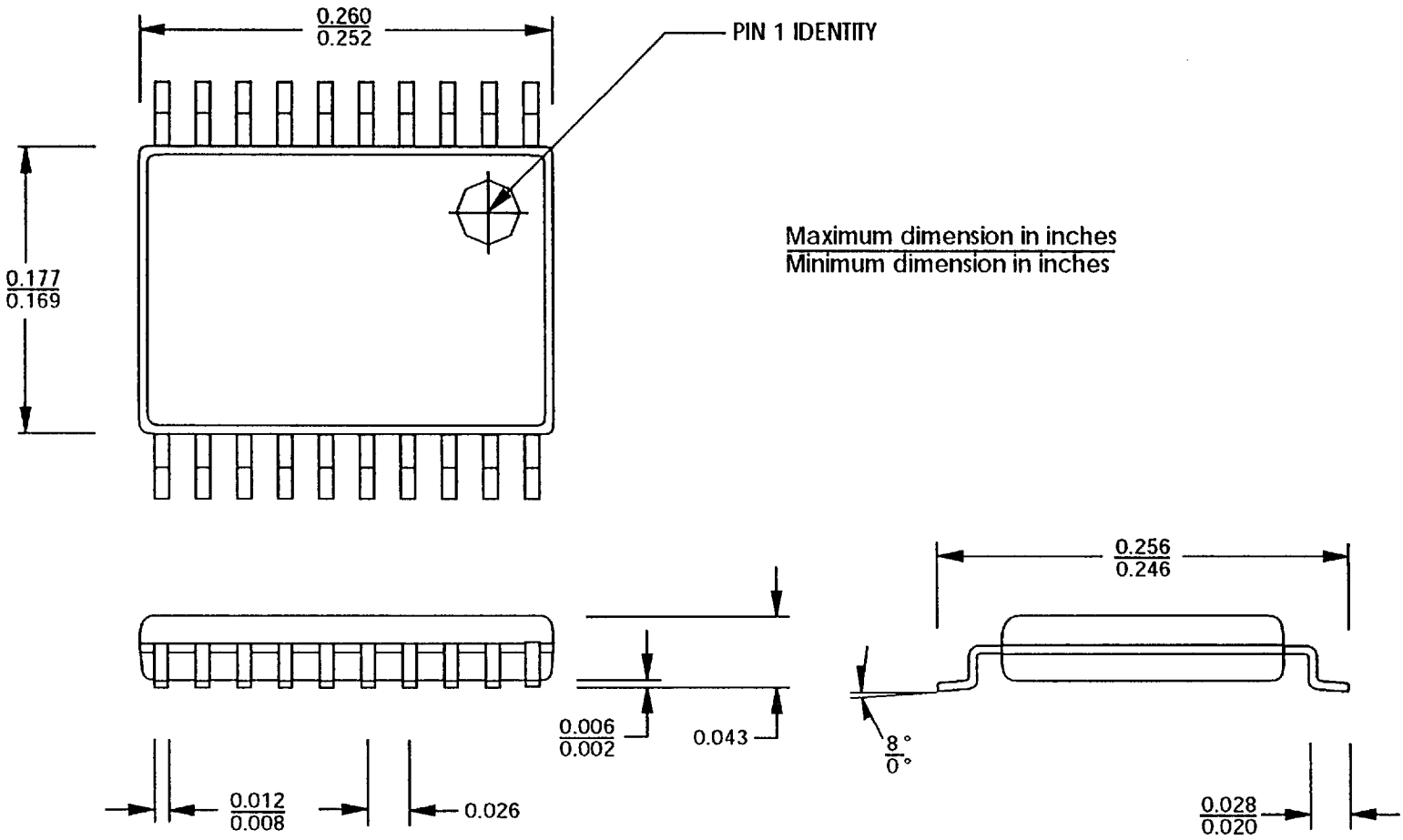


20-Pin PLCC (J20)



Minimum dimension in inches
Maximum dimension in inches

20-Pin SOIC (S20)



20-Pin TSSOP (T20)