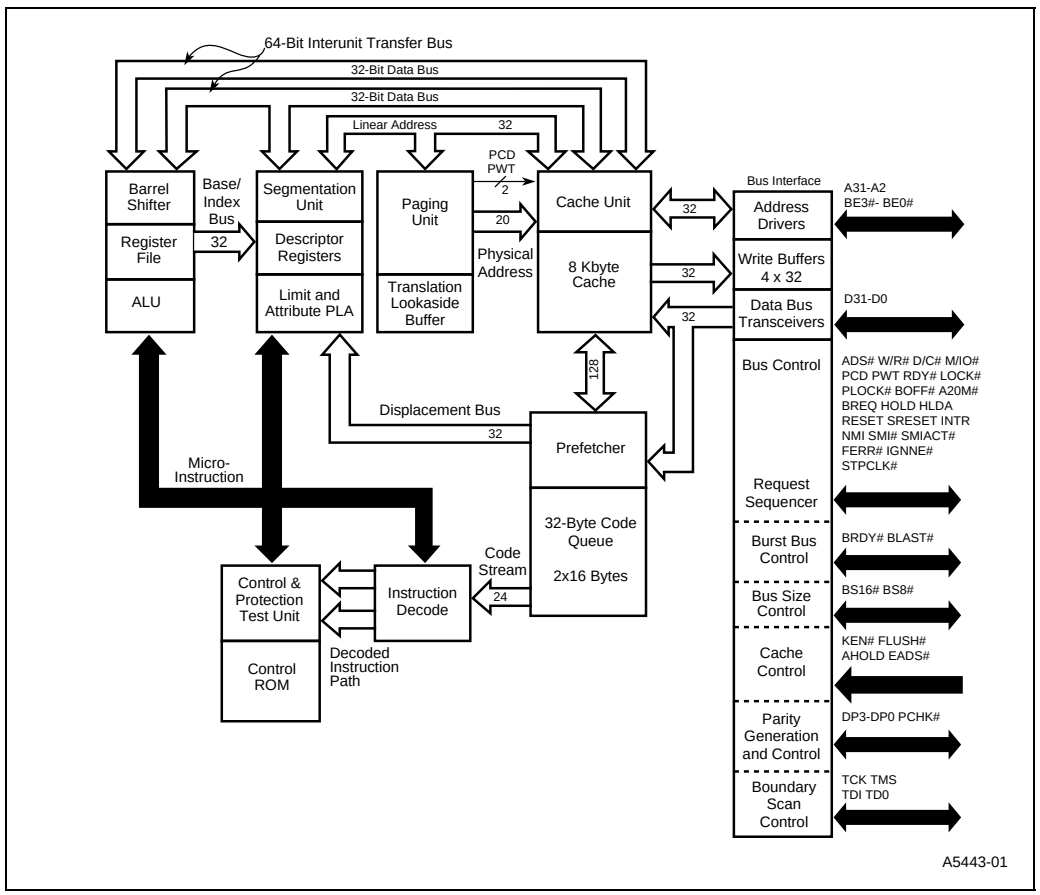
Embedded Intel486™ SX Processor

Datasheet

Product Features

- 32-Bit RISC Technology Core
- 8-Kbyte Write-Through Cache
- Four Internal Write Buffers
- Burst Bus Cycles
- Dynamic Bus Sizing for 8- and 16-bit Data Bus Devices
- SL Technology
- Data Bus Parity Generation and Checking
- Boundary Scan (JTAG)
- 5-Volt Processor
  - —196-Lead Plastic Quad Flat Pack (PQFP)
  - —168-Pin Pin Grid Array (PGA)
- Binary Compatible with Large Software Base



Order Number: 272769-004
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Contents

Figures

Tables

Revision History

Date	Revision	Description
August 2004	004	To address the fact that many of the package prefix variables have changed, all package prefix variables in this document are now indicated with an "x".
September 2001	003	Removed 3.3 V device. Added 5 V PGA information.
December 1997	002	Updated related documents list.
October 1995	001	First release of this datasheet for embedded.

1.0 Introduction

The embedded Intel486™ SX processor provides high performance to 32-bit, embedded applications. Designed for applications that do not need a floating-point unit, the processor is ideal for embedded designs running DOS*, Microsoft* Windows*, OS/2*, or UNIX* applications written for the Intel architecture. Projects can be completed quickly by utilizing the wide range of software tools, utilities, assemblers and compilers that are available for desktop computer systems. Also, developers can find advantages in using existing chip sets and peripheral components in their embedded designs.

The embedded Intel486 SX processor is binary compatible with the Intel386™ and earlier Intel processors. Compared with the Intel386 processor, it provides faster execution of many commonly-used instructions. It also provides the benefits of an integrated, 8-Kbyte, write-through cache for code and data. Its data bus can operate in burst mode which provides up to 106-Mbyte-per-second transfers for cache-line fills and instruction prefetches.

Intel's SL technology is incorporated in the embedded Intel486 SX processor. Utilizing Intel's System Management Mode (SMM), it enables designers to develop energy-efficient systems.

Two component packages are available for 5-Volt designs. Both products operate at 33 MHz.

- 196-lead Plastic Quad Flat Pack (PQFP)
- 168-pin Pin Grid Array (PGA).

1.1 Features

The embedded Intel486 SX processor offers these features:

- **32-bit RISC-Technology Core** — The embedded Intel486 SX processor performs a complete set of arithmetic and logical operations on 8-, 16-, and 32-bit data types using a full-width ALU and eight general purpose registers.
- **Single Cycle Execution** — Many instructions execute in a single clock cycle.
- **Instruction Pipelining** — Overlapped instruction fetching, decoding, address translation and execution.
- **On-Chip Cache with Cache Consistency Support** — An 8-Kbyte, write-through, internal cache is used for both data and instructions. Cache hits provide zero wait-state access times for data within the cache. Bus activity is tracked to detect alterations in the memory represented by the internal cache. The internal cache can be invalidated or flushed so that an external cache controller can maintain cache consistency.
- **External Cache Control** — Write-back and flush controls for an external cache are provided so the processor can maintain cache consistency.
- **On-Chip Memory Management Unit** — Address management and memory space protection mechanisms maintain the integrity of memory in a multitudinous and virtual memory environment. Both memory segmentation and paging are supported.
- **Burst Cycles** — Burst transfers allow a new double-word to be read from memory on each bus clock cycle. This capability is especially useful for instruction prefetch and for filling the internal cache.

- **Write Buffers** — The processor contains four write buffers to enhance the performance of consecutive writes to memory. The processor can continue internal operations after a write to these buffers, without waiting for the write to be completed on the external bus.
- **Bus Backoff** — When another bus master needs control of the bus during a processor initiated bus cycle, the embedded Intel486 SX processor floats its bus signals, then restarts the cycle when the bus becomes available again.
- **Instruction Restart** — Programs can continue execution following an exception generated by an unsuccessful attempt to access memory. This feature is important for supporting demand-paged virtual memory applications.
- **Dynamic Bus Sizing** — External controllers can dynamically alter the effective width of the data bus. Bus widths of 8, 16, or 32 bits can be used.
- **Boundary Scan (JTAG)** — Boundary Scan provides in-circuit testing of components on printed circuit boards. The Intel Boundary Scan implementation conforms with the IEEE Standard Test Access Port and Boundary Scan Architecture.

Intel's SL technology provides these features:

- **Intel System Management Mode (SMM)** — A unique Intel architecture operating mode provides a dedicated special purpose interrupt and address space that can be used to implement intelligent power management and other enhanced functions in a manner that is completely transparent to the operating system and applications software.
- **I/O Restart** — An I/O instruction interrupted by a System Management Interrupt (SMI#) can automatically be restarted following the execution of the RSM instruction.
- **Stop Clock** — The embedded Intel486 SX processor has a stop clock control mechanism that provides two low-power states: a Stop Grant state (20–40 mA typical, depending on input clock frequency) and a Stop Clock state (~100-200 µA typical, with input clock frequency of 0 MHz).
- **Auto HALT Power Down —** After the execution of a HALT instruction, the embedded Intel486 SX processor issues a normal Halt bus cycle and the clock input to the processor core is automatically stopped, causing the processor to enter the Auto HALT Power Down state (20–40 mA typical, depending on input clock frequency).

1.2 Family Members

Table 1 shows the embedded Intel486 SX processors and briefly describes their characteristics.

Table 1. The Embedded Intel486™ SX Processor Family

Product	Supply Voltage V_{CC}	Maximum Processor Frequency	Package
x80486SXSA33	5.0 V	33 MHz	168-Pin PGA
x80486SXSA33	5.0 V	33 MHz	196-Lead PQFP

NOTE: To address the fact that many of the package prefix variables have changed, all package prefix variables in this document are now indicated with an "x".

2.0 How To Use This Document

For a complete set of documentation related to the embedded Intel486 SX processor, use this document in conjunction with the following reference documents:

- *Embedded Intel486™ Processor Family Developer's Manual* — Order No. 273021
- *Embedded Intel486™ Processor Hardware Reference Manual* — Order No. 273025
- *Intel486™ Microprocessor Family Programmer's Reference Manual* — Order No. 240486
- Intel Application Note AP-485 — *Intel Processor Identification with the CPUID Instruction* — Order No. 241618

The information in the reference documents for the Intel486 SX processor, 1X Clock (CLK), applies to the embedded Intel486 SX processor. Some of the Intel486 SX processor information is duplicated in this document to minimize the dependence on the reference documents.

3.0 Pin Descriptions

3.1 Pin Assignments

The following figures and tables show the pin assignments of each package type for the embedded Intel486 SX processor. Tables are provided showing the pin differences between the embedded Intel486 SX processor and other embedded Intel486 processor products.

168-Pin PGA - Pin Grid Array

- Figure 1, Package Diagram for 168-Pin PGA Embedded Intel486™ SX Processor (pg. 8)
- Table 2, Pinout Differences for 168-Pin PGA Package (pg. 9)
- Table 3, Pin Assignment for 168-Pin PGA Package (pg. 9)
- Table 4, Pin Cross Reference for 168-Pin PGA Package (pg. 11)

196-Lead PQFP - Plastic Quad Flat Pack

- Figure 2, Package Diagram for 196-Lead PQFP Embedded Intel486™ SX Processor (pg. 12)
- Table 5, Pin Assignment for 196-Lead PQFP Package (pg. 13)
- Table 6, Pin Cross Reference for 196-Lead PQFP Package (pg. 14)

Figure 1. Package Diagram for 168-Pin PGA Embedded Intel486™ SX Processor

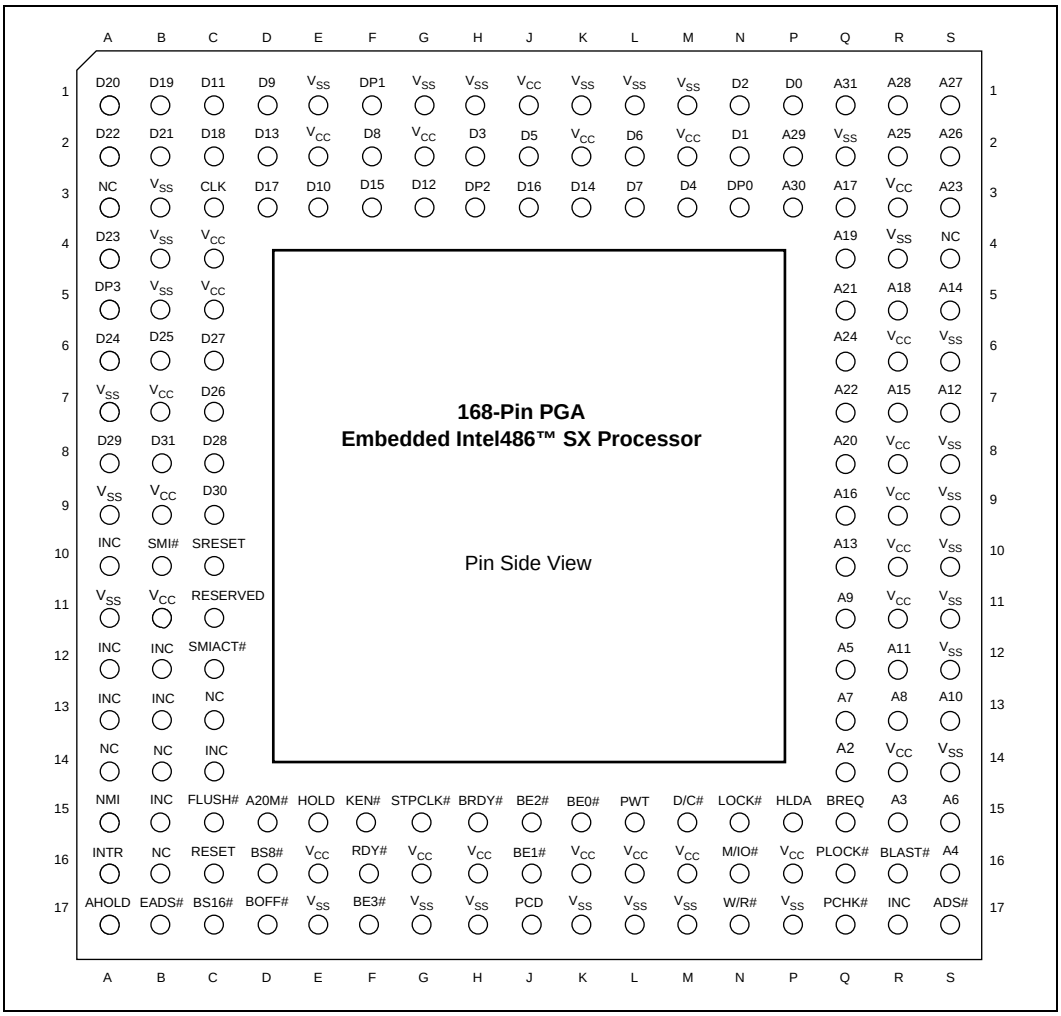


Table 2. Pinout Differences for 168-Pin PGA Package

Pin #	Embedded Intel486™ SX Processor	Embedded IntelDX2™ Processor	Embedded Write-Back Enhanced IntelDX4™ Processor
A3	NC	TCK	TCK
A10	INC†	INC†	INV
A12	INC†	INC†	HITM#
A14	NC	TDI	TDI
A15	NMI	IGNNE#	IGNNE#
B12	INC†	INC†	CACHE#
B13	INC†	INC†	WB/WT#
B14	NC	TMS	TMS
B15	INC†	NMI	NMI
B16	NC	TDO	TDO
C14	INC†	FERR#	FERR#
J1	VCC	VCC	VCC5
R17	INC†	INC†	CLKMUL
S4	NC	NC	VOLDET

† INC. Internal No Connect. These pins are not connected to any internal pad in the embedded Intel486 SX processor. However, new signals are defined for the location of the INC pins in the embedded IntelDX2 and IntelDX4 processors. One system design can accommodate any one of these processors provided the purpose of each INC pin is understood before it is used.

Table 3. Pin Assignment for 168-Pin PGA Package (Sheet 1 of 2)

Pin #	Description	Pin #	Description	Pin #	Description
A1	D20	D17	BOFF#	P2	A29
A2	D22	E1	V_{SS}	P3	A30
A3	NC	E2	V_{CC}	P15	HLDA
A4	D23	E3	D10	P16	V_{CC}
A5	DP3	E15	HOLD	P17	V_{SS}
A6	D24	E16	V_{CC}	Q1	A31
A7	V_{SS}	E17	V_{SS}	Q2	V_{SS}
A8	D29	F1	DP1	Q3	A17
A9	V_{SS}	F2	D8	Q4	A19
A10	INC[1]	F3	D15	Q5	A21
A11	V_{SS}	F15	KEN#	Q6	A24
A12	INC[1]	F16	RDY#	Q7	A22
A13	INC[1]	F17	BE3#	Q8	A20
A14	NC	G1	V_{SS}	Q9	A16
A15	NMI	G2	V_{CC}	Q10	A13
A16	INTR	G3	D12	Q11	A9
A17	AHOLD	G15	STPCLK#	Q12	A5
B1	D19	G16	V_{CC}	Q13	A7

Table 3. Pin Assignment for 168-Pin PGA Package (Sheet 2 of 2)

Pin #	Description	Pin #	Description	Pin #	Description
B2	D21	G17	V_{SS}	Q14	A2
B3	V_{SS}	H1	V_{SS}	Q15	BREQ
B4	V_{SS}	H2	D3	Q16	PLOCK#
B5	V_{SS}	H3	DP2	Q17	PCHK#
B6	D25	H15	BRDY#	R1	A28
B7	V_{CC}	H16	V_{CC}	R2	A25
B8	D31	H17	V_{SS}	R3	V_{CC}
B9	V_{CC}	J1	V_{CC}	R4	V_{SS}
B10	SMI#	J2	D5	R5	A18
B11	V_{CC}	J3	D16	R6	V_{CC}
B12	INC[1]	J15	BE2#	R7	A15
B13	INC[1]	J16	BE1#	R8	V_{CC}
B14	NC	J17	PCD	R9	V_{CC}
B15	INC[1]	K1	V_{SS}	R10	V_{CC}
B16	NC	K2	V_{CC}	R11	V_{CC}
B17	EADS#	K3	D14	R12	A11
C1	D11	K15	BE0#	R13	A8
C2	D18	K16	V_{CC}	R14	V_{CC}
C3	CLK	K17	V_{SS}	R15	A3
C4	V_{CC}	L1	V_{SS}	R16	BLAST#
C5	V_{CC}	L2	D6	R17	INC[1]
C6	D27	L3	D7	S1	A27
C7	D26	L15	PWT	S2	A26
C8	D28	L16	V_{CC}	S3	A23
C9	D30	L17	V_{SS}	S4	NC[2]
C10	SRESET	M1	V_{SS}	S5	A14
C11	RESERVED#	M2	V_{CC}	S6	V_{SS}
C12	SMIACT#	M3	D4	S7	A12
C13	NC	M15	D/C#	S8	V_{SS}
C14	INC[1]	M16	V_{CC}	S9	V_{SS}
C15	FLUSH#	M17	V_{SS}	S10	V_{SS}
C16	RESET	N1	D2	S11	V_{SS}
C17	BS16#	N2	D1	S12	V_{SS}
D1	D9	N3	DP0	S13	A10
D2	D13	N15	LOCK#	S14	V_{SS}
D3	D17	N16	M/IO#	S15	A6
D15	A20M#	N17	W/R#	S16	A4
D16	BS8#	P1	D0	S17	ADS#

NOTES:

1. INC. Internal No Connect. These pins are not connected to any internal pad in the embedded IntelDX2 processors. However, signals are defined for the location of the INC pins in the IntelDX4 processor. One system design can accommodate any one of these processors provided the purpose of each INC pin is understood before it is used.
2. NC. Do Not Connect. These pins should always remain unconnected. Connection of NC pins to V_{CC}, or V_{SS} or to any other signal can result in component malfunction or incompatibility with future steppings of the Intel486 processors.

Table 4. Pin Cross Reference for 168-Pin PGA Package

Address	Pin #	Data	Pin #	Control	Pin #	NC	INC	Vcc	Vss
A2	Q14	D0	P1	A20M#	D15	A3	A10	B7	A7
A3	R15	D1	N2	ADS#	S17	A14	A12	B9	A9
A4	S16	D2	N1	AHOLD	A17	B16	A13	B11	A11
A5	Q12	D3	H2	BE0#	K15	B14	B12	C4	B3
A6	S15	D4	M3	BE1#	J16	C13	B13	C5	B4
A7	Q13	D5	J2	BE2#	J15	S4	B15	E2	B5
A8	R13	D6	L2	BE3#	F17		C14	E16	E1
A9	Q11	D7	L3	BLAST#	R16		R17	G2	E17
A10	S13	D8	F2	BOFF#	D17			G16	G1
A11	R12	D9	D1	BRDY#	H15			H16	G17
A12	S7	D10	E3	BREQ	Q15			J1	H1
A13	Q10	D11	C1	BS16#	C17			K2	H17
A14	S5	D12	G3	BS8#	D16			K16	K1
A15	R7	D13	D2	CLK	C3			L16	K17
A16	Q9	D14	K3	D/C#	M15			M2	L1
A17	Q3	D15	F3	DP0	N3			M16	L17
A18	R5	D16	J3	DP1	F1			P16	M1
A19	Q4	D17	D3	DP2	H3			R3	M17
A20	Q8	D18	C2	DP3	A5			R6	P17
A21	Q5	D19	B1	EADS#	B17			R8	Q2
A22	Q7	D20	A1	FLUSH#	C15			R9	R4
A23	S3	D21	B2	HLDA	P15			R10	S6
A24	Q6	D22	A2	HOLD	E15			R11	S8
A25	R2	D23	A4	INTR	A16			R14	S9
A26	S2	D24	A6	KEN#	F15				S10
A27	S1	D25	B6	LOCK#	N15				S11
A28	R1	D26	C7	M/IO#	N16				S12
A29	P2	D27	C6	PCD	J17				S14
A30	P3	D28	C8	PCHK#	Q17				
A31	Q1	D29	A8	PLOCK#	Q16				
		D30	C9	PWT	L15				
		D31	B8	RDY#	F16				
				RESERVED#	C11				
				RESET	C16				
				SMI#	B10				
				SMIACT#	C12				
				SRESET	C10				
				STPCLK#	G15				
				W/R#	N17				

Figure 2. Package Diagram for 196-Lead PQFP Embedded Intel486™ SX Processor

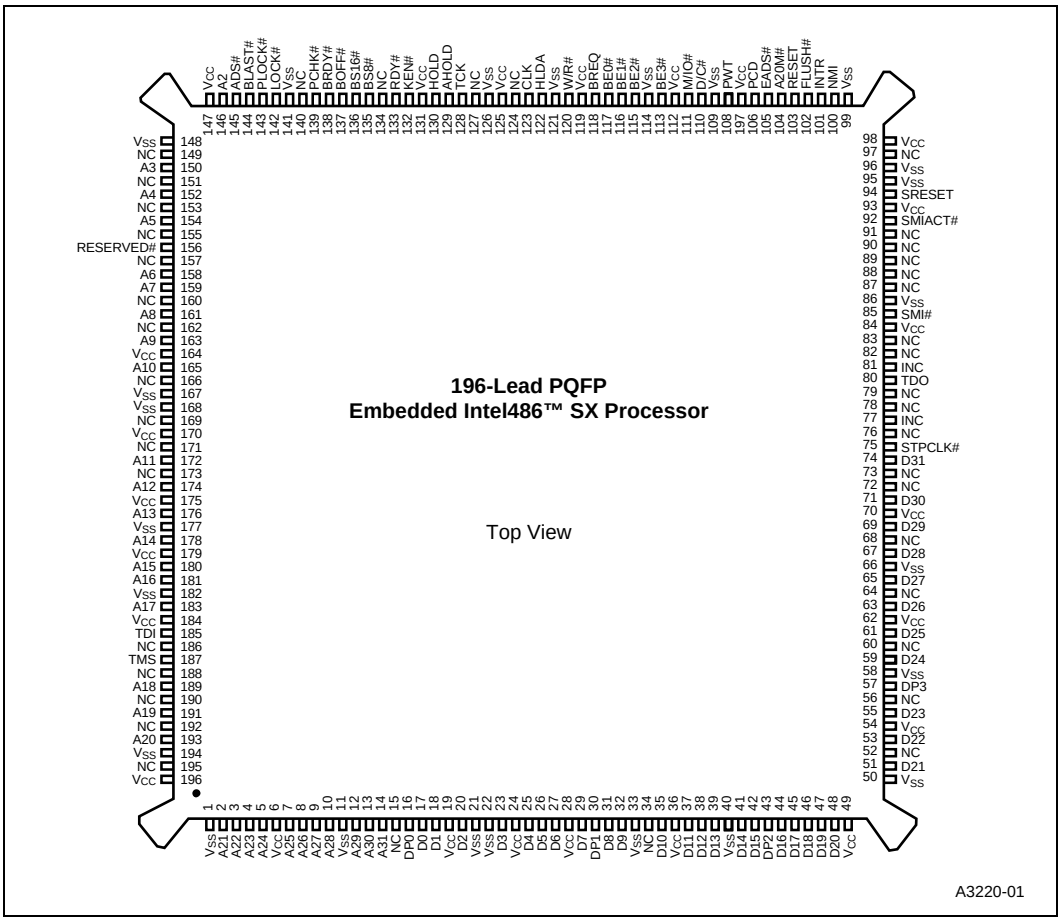


Table 5. Pin Assignment for 196-Lead PQFP Package (Sheet 1 of 2)

Pin #	Description	Pin #	Description	Pin #	Description	Pin #	Description
1	V_{SS}	50	V_{SS}	99	V_{SS}	148	V_{SS}
2	A21	51	D21	100	NMI	149	NC[1]
3	A22	52	NC[1]	101	INTR	150	A3
4	A23	53	D22	102	FLUSH#	151	NC[1]
5	A24	54	V_{CC}	103	RESET	152	A4
6	V_{CC}	55	D23	104	A20M#	153	NC[1]
7	A25	56	NC[1]	105	EADS#	154	A5
8	A26	57	DP3	106	PCD	155	NC[1]
9	A27	58	V_{SS}	107	V_{CC}	156	RESERVED#
10	A28	59	D24	108	PWT	157	NC[1]
11	V_{SS}	60	NC[1]	109	V_{SS}	158	A6
12	A29	61	D25	110	D/C#	159	A7
13	A30	62	V_{CC}	111	M/IO#	160	NC[1]
14	A31	63	D26	112	V_{CC}	161	A8
15	NC[1]	64	NC[1]	113	BE3#	162	NC[1]
16	DP0	65	D27	114	V_{SS}	163	A9
17	D0	66	V_{SS}	115	BE2#	164	V_{CC}
18	D1	67	D28	116	BE1#	165	A10
19	V_{CC}	68	NC[1]	117	BE0#	166	NC[1]
20	D2	69	D29	118	BREQ	167	V_{SS}
21	V_{SS}	70	V_{CC}	119	V_{CC}	168	V_{SS}
22	V_{SS}	71	D30	120	W/R#	169	NC[1]
23	D3	72	NC[1]	121	V_{SS}	170	V_{CC}
24	V_{CC}	73	NC[1]	122	HLDA	171	NC[1]
25	D4	74	D31	123	CLK	172	A11
26	D5	75	STPCLK#	124	NC[1]	173	NC[1]
27	D6	76	NC[1]	125	V_{CC}	174	A12
28	V_{CC}	77	INC[2]	126	V_{SS}	175	V_{CC}
29	D7	78	NC[1]	127	NC[1]	176	A13
30	DP1	79	NC[1]	128	TCK	177	V_{SS}
31	D8	80	TDO	129	AHOLD	178	A14
32	D9	81	INC[2]	130	HOLD	179	V_{CC}
33	V_{SS}	82	NC[1]	131	V_{CC}	180	A15

NOTES:
1. NC. Do Not Connect. These pins should always remain unconnected. Connection of NC pins to V_{CC}, or V_{SS} or to any other signal can result in component malfunction or incompatibility with future steppings of the Intel486 processors.
2. INC. Internal No Connect. These pins are not connected to any internal pad in the embedded Intel486 SX processors.

Table 5. Pin Assignment for 196-Lead PQFP Package (Sheet 2 of 2)

Pin #	Description	Pin #	Description	Pin #	Description	Pin #	Description
34	NC[1]	83	NC[1]	132	KEN#	181	A16
35	D10	84	V_{CC}	133	RDY#	182	V_{SS}
36	V_{CC}	85	SMI#	134	NC[1]	183	A17
37	D11	86	V_{SS}	135	BS8#	184	V_{CC}
38	D12	87	NC[1]	136	BS16#	185	TDI
39	D13	88	NC[1]	137	BOFF#	186	NC[1]
40	V_{SS}	89	NC[1]	138	BRDY#	187	TMS
41	D14	90	NC[1]	139	PCHK#	188	NC[1]
42	D15	91	NC[1]	140	NC[1]	189	A18
43	DP2	92	SMIACT#	141	V_{SS}	190	NC[1]
44	D16	93	V_{CC}	142	LOCK#	191	A19
45	D17	94	SRESET	143	PLOCK#	192	NC[1]
46	D18	95	V_{SS}	144	BLAST#	193	A20
47	D19	96	V_{SS}	145	ADS#	194	V_{SS}
48	D20	97	NC[1]	146	A2	195	NC[1]
49	V_{CC}	98	V_{CC}	147	V_{CC}	196	V_{CC}

NOTES:
1. NC. Do Not Connect. These pins should always remain unconnected. Connection of NC pins to V_{CC}, or V_{SS} or to any other signal can result in component malfunction or incompatibility with future steppings of the Intel486 processors.
2. INC. Internal No Connect. These pins are not connected to any internal pad in the embedded Intel486 SX processors.

Table 6. Pin Cross Reference for 196-Lead PQFP Package (Sheet 1 of 2)

Address	Pin #	Data	Pin #	Control	Pin #	NC	NC	V_{CC}	V_{SS}
A2	146	D0	17	A20M#	104	15	77	6	1
A3	150	D1	18	ADS#	145	34	81	19	11
A4	152	D2	20	AHOLD	129	52		24	21
A5	154	D3	23	BE0#	117	56		28	22
A6	158	D4	25	BE1#	116	60		36	33
A7	159	D5	26	BE2#	115	64		49	40
A8	161	D6	27	BE3#	113	68		54	50
A9	163	D7	29	BLAST#	144	72		62	58
A10	165	D8	31	BOFF#	137	73		70	66
A11	172	D9	32	BRDY#	138	76		84	86
A12	174	D10	35	BREQ	118	78		93	95
A13	176	D11	37	BS16#	136	79		98	96
A14	178	D12	38	BS8#	135	82		107	99
A15	180	D13	39	CLK	123	83		112	109

Table 6. Pin Cross Reference for 196-Lead PQFP Package (Sheet 2 of 2)

Address	Pin #	Data	Pin #	Control	Pin #	NC	NC	V_{CC}	V_{SS}
A16	181	D14	41	D/C#	110	87		119	114
A17	183	D15	42	DP0	16	88		125	121
A18	189	D16	44	DP1	30	89		131	126
A19	191	D17	45	DP2	43	90		147	141
A20	193	D18	46	DP3	57	91		164	148
A21	2	D19	47	EADS#	105	97		170	167
A22	3	D20	48	FLUSH#	102	124		175	168
A23	4	D21	51	HLDA	122	127		179	177
A24	5	D22	53	HOLD	130	134		184	182
A25	7	D23	55	INTR	101	140		196	194
A26	8	D24	59	KEN#	132	149			
A27	9	D25	61	LOCK#	142	151			
A28	10	D26	63	M/IO#	111	153			
A29	12	D27	65	NMI	100	155			
A30	13	D28	67	PCD	106	157			
A31	14	D29	69	PCHK#	139	160			
		D30	71	PLOCK#	143	162			
		D31	74	PWT	108	166			
				RDY#	133	169			
				RESERVED#	156	171			
				RESET	103	173			
				SMI#	85	186			
				SMIACT#	92	188			
				SRESET	94	190			
				STPCLK#	75	192			
				TCK	128	195			
				TDI	185				
				TDO	80				
				TMS	187				
				W/R#	120				

3.2 Pin Quick Reference

The following is a brief pin description. For detailed signal descriptions refer to Appendix A, "Signal Descriptions," in the *Embedded Intel486™ Processor Family Developer's Manual*, order No. 273021.

Table 7. Embedded Intel486™ SX Processor Pin Descriptions (Sheet 1 of 5)

Symbol	Type	Name and Function
CLK	I	**Clock** provides the fundamental timing and internal operating frequency for the embedded Intel486 SX processor. All external timing parameters are specified with respect to the rising edge of CLK.
ADDRESS BUS		
A31-A4 **A3–A2**	I/O O	**Address Lines** A31–A2, together with the byte enable signals, BE3#–BE0#, define the physical area of memory or input/output space accessed. Address lines A31–A4 are used to drive addresses into the embedded Intel486 SX processor to perform cache line invalidation. Input signals must meet setup and hold times t_{22} and t_{23}. A31–A2 are not driven during bus or address hold.
BE3# **BE2#** **BE1#** **BE0#**	O O O O	**Byte Enable** signals indicate active bytes during read and write cycles. During the first cycle of a cache fill, the external system should assume that all byte enables are active. BE3#–BE0# are active LOW and are not driven during bus hold. BE3# applies to D31–D24 BE2# applies to D23–D16 BE1# applies to D15–D8 BE0# applies to D7–D0
DATA BUS		
D31–D0	I/O	**Data Lines.** D7–D0 define the least significant byte of the data bus; D31–D24 define the most significant byte of the data bus. These signals must meet setup and hold times t_{22} and t_{23} for proper operation on reads. These pins are driven during the second and subsequent clocks of write cycles.
DATA PARITY		
DP3–DP0	I/O	There is one **Data Parity** pin for each byte of the data bus. Data parity is generated on all write data cycles with the same timing as the data driven by the embedded Intel486 SX processor. Even parity information must be driven back into the processor on the data parity pins with the same timing as read information to ensure that the correct parity check status is indicated by the embedded Intel486 SX processor. The signals read on these pins do not affect program execution. Input signals must meet setup and hold times t_{22} and t_{23}. DP3–DP0 must be connected to V_{CC} through a pull-up resistor in systems that do not use parity. DP3–DP0 are active HIGH and are driven during the second and subsequent clocks of write cycles.
PCHK#	O	**Parity Status** is driven on the PCHK# pin the clock after ready for read operations. The parity status is for data sampled at the end of the previous clock. A parity error is indicated by PCHK# being LOW. Parity status is only checked for enabled bytes as indicated by the byte enable and bus size signals. PCHK# is valid only in the clock immediately after read data is returned to the processor. At all other times PCHK# is inactive (HIGH). PCHK# is never floated.

Table 7. Embedded Intel486™ SX Processor Pin Descriptions (Sheet 2 of 5)

Symbol	Type	Name and Function
BUS CYCLE DEFINITION		
M/IO# **D/C#** **W/R#**	O O O	**Memory/Input-Output**, **Data/Control** and **Write/Read** lines are the primary bus definition signals. These signals are driven valid as the ADS# signal is asserted. **M/IO# D/C# W/R# Bus Cycle Initiated** 0 0 0 Interrupt Acknowledge 0 0 1 HALT/Special Cycle (see details below) 0 1 0 I/O Read 0 1 1 I/O Write 1 0 0 Code Read 1 0 1 Reserved 1 1 0 Memory Read 1 1 1 Memory Write **HALT/Special Cycle** **Cycle Name BE3# - BE0# A4-A2** Shutdown 1110 000 HALT 1011 000 Stop Grant bus cycle 1011 100
LOCK#	O	**Bus Lock** indicates that the current bus cycle is locked. The embedded Intel486 SX processor does not allow a bus hold when LOCK# is asserted (address holds are allowed). LOCK# goes active in the first clock of the first locked bus cycle and goes inactive after the last clock of the last locked bus cycle. The last locked cycle ends when Ready is returned. LOCK# is active LOW and not driven during bus hold. Locked read cycles are not transformed into cache fill cycles when KEN# is returned active.
PLOCK#	O	**Pseudo-Lock** indicates that the current bus transaction requires more than one bus cycle to complete. For the embedded Intel486 SX processor, examples of such operations are segment table descriptor reads (64 bits) and cache line fills (128 bits). The embedded Intel486 SX processor drives PLOCK# active until the addresses for the last bus cycle of the transaction are driven, regardless of whether RDY# or BRDY# have been returned. PLOCK# is a function of the BS8#, BS16# and KEN# inputs. PLOCK# should be sampled only in the clock in which Ready is returned. PLOCK# is active LOW and is not driven during bus hold.
BUS CONTROL		
ADS#	O	**Address Status** output indicates that a valid bus cycle definition and address are available on the cycle definition lines and address bus. ADS# is driven active in the same clock in which the addresses are driven. ADS# is active LOW and not driven during bus hold.
RDY#	I	**Non-burst Ready** input indicates that the current bus cycle is complete. RDY# indicates that the external system has presented valid data on the data pins in response to a read or that the external system has accepted data from the embedded Intel486 SX processor in response to a write. RDY# is ignored when the bus is idle and at the end of the first clock of the bus cycle. RDY# is active during address hold. Data can be returned to the embedded Intel486 SX processor while AHOLD is active. RDY# is active LOW and is not provided with an internal pull-up resistor. RDY# must satisfy setup and hold times t_{16} and t_{17} for proper chip operation.

Table 7. Embedded Intel486™ SX Processor Pin Descriptions (Sheet 3 of 5)

Symbol	Type	Name and Function
BURST CONTROL		
BRDY#	I	**Burst Ready** input performs the same function during a burst cycle that RDY# performs during a non-burst cycle. BRDY# indicates that the external system has presented valid data in response to a read or that the external system has accepted data in response to a write. BRDY# is ignored when the bus is idle and at the end of the first clock in a bus cycle. BRDY# is sampled in the second and subsequent clocks of a burst cycle. Data presented on the data bus is strobed into the embedded Intel486 SX processor when BRDY# is sampled active. If RDY# is returned simultaneously with BRDY#, BRDY# is ignored and the burst cycle is prematurely aborted. BRDY# is active LOW and is provided with a small pull-up resistor. BRDY# must satisfy the setup and hold times t_{16} and t_{17}.
BLAST#	O	**Burst Last** signal indicates that the next time BRDY# is returned, the burst bus cycle is complete. BLAST# is active for both burst and non-burst bus cycles. BLAST# is active LOW and is not driven during bus hold.
INTERRUPTS		
RESET	I	**Reset** input forces the embedded Intel486 SX processor to begin execution at a known state. The processor cannot begin executing instructions until at least 1 ms after V_{CC}, and CLK have reached their proper DC and AC specifications. The RESET pin must remain active during this time to ensure proper processor operation. However, for warm resets, RESET should remain active for at least 15 CLK periods. RESET is active HIGH. RESET is asynchronous but must meet setup and hold times t_{20} and t_{21} for recognition in any specific clock.
INTR	I	**Maskable Interrupt** indicates that an external interrupt has been generated. When the internal interrupt flag is set in EFLAGS, active interrupt processing is initiated. The embedded Intel486 SX processor generates two locked interrupt acknowledge bus cycles in response to the INTR pin going active. INTR must remain active until the interrupt acknowledges have been performed to ensure processor recognition of the interrupt. INTR is active HIGH and is not provided with an internal pull-down resistor. INTR is asynchronous, but must meet setup and hold times t_{20} and t_{21} for recognition in any specific clock.
NMI	I	**Non-Maskable Interrupt** request signal indicates that an external non-maskable interrupt has been generated. NMI is rising-edge sensitive and must be held LOW for at least four CLK periods before this rising edge. NMI is not provided with an internal pull-down resistor. NMI is asynchronous, but must meet setup and hold times t_{20} and t_{21} for recognition in any specific clock.
SRESET	I	**Soft Reset** pin duplicates all functionality of the RESET pin except that the SMBASE register retains its previous value. For soft resets, SRESET must remain active for at least 15 CLK periods. SRESET is active HIGH. SRESET is asynchronous but must meet setup and hold times t_{20} and t_{21} for recognition in any specific clock.
SMI#	I	**System Management Interrupt** input invokes System Management Mode (SMM). SMI# is a falling-edge triggered signal which forces the embedded Intel486 SX processor into SMM at the completion of the current instruction. SMI# is recognized on an instruction boundary and at each iteration for repeat string instructions. SMI# does not break LOCKed bus cycles and cannot interrupt a currently executing SMM. The embedded Intel486 SX processor latches the falling edge of one pending SMI# signal while it is executing an existing SMI#. The nested SMI# is not recognized until after the execution of a Resume (RSM) instruction.
SMIACT#	O	**System Management Interrupt Active**, an active LOW output, indicates that the embedded Intel486 SX processor is operating in SMM. It is asserted when the processor begins to execute the SMI# state save sequence and remains active LOW until the processor executes the last state restore cycle out of SMRAM.

Table 7. Embedded Intel486™ SX Processor Pin Descriptions (Sheet 4 of 5)

Symbol	Type	Name and Function
STPCLK#	I	**Stop Clock Request** input signal indicates a request was made to turn off or change the CLK input frequency. When the embedded Intel486 SX processor recognizes a STPCLK#, it stops execution on the next instruction boundary (unless superseded by a higher priority interrupt), empties all internal pipelines and write buffers, and generates a Stop Grant bus cycle. STPCLK# is active LOW. Though STPCLK# has an internal pull-up resistor, an external 10-KΩ pull-up resistor is needed if the STPCLK# pin is not used. **STPCLK# is an asynchronous signal, but must remain active until the** embedded Intel486 SX processor **issues the Stop Grant bus cycle. STPCLK# may be de-asserted at any time after the processor has issued the Stop Grant bus cycle.**
BUS ARBITRATION		
BREQ	O	**Bus Request** signal indicates that the embedded Intel486 SX processor has internally generated a bus request. BREQ is generated whether or not the processor is driving the bus. BREQ is active HIGH and is never floated.
HOLD	I	**Bus Hold Request** allows another bus master complete control of the embedded Intel486 SX processor bus. In response to HOLD going active, the processor floats most of its output and input/output pins. HLDA is asserted after completing the current bus cycle, burst cycle or sequence of locked cycles. The embedded Intel486 SX processor remains in this state until HOLD is de-asserted. HOLD is active HIGH and is not provided with an internal pull-down resistor. HOLD must satisfy setup and hold times t_{18} and t_{19} for proper operation.
HLDA	O	**Hold Acknowledge** goes active in response to a hold request presented on the HOLD pin. HLDA indicates that the embedded Intel486 SX processor has given the bus to another local bus master. HLDA is driven active in the same clock that the processor floats its bus. HLDA is driven inactive when leaving bus hold. HLDA is active HIGH and remains driven during bus hold.
BOFF#	I	**Backoff** input forces the embedded Intel486 SX processor to float its bus in the next clock. The processor floats all pins normally floated during bus hold but HLDA is not asserted in response to BOFF#. BOFF# has higher priority than RDY# or BRDY#; if both are returned in the same clock, BOFF# takes effect. The embedded Intel486 SX processor remains in bus hold until BOFF# is negated. If a bus cycle is in progress when BOFF# is asserted the cycle is restarted. BOFF# is active LOW and must meet setup and hold times t_{18} and t_{19} for proper operation.
CACHE INVALIDATION		
AHOLD	I	**Address Hold** request allows another bus master access to the embedded Intel486 SX processor's address bus for a cache invalidation cycle. The processor stops driving its address bus in the clock following AHOLD going active. Only the address bus is floated during address hold, the remainder of the bus remains active. AHOLD is active HIGH and is provided with a small internal pull-down resistor. For proper operation, AHOLD must meet setup and hold times t_{18} and t_{19}.
EADS#	I	**External Address** - This signal indicates that a *valid* external address has been driven onto the embedded Intel486 SX processor address pins. This address is used to perform an internal cache invalidation cycle. EADS# is active LOW and is provided with an internal pull-up resistor. EADS# must satisfy setup and hold times t_{12} and t_{13} for proper operation.
CACHE CONTROL		
KEN#	I	**Cache Enable** pin is used to determine whether the current cycle is cacheable. When the embedded Intel486 SX processor generates a cycle that can be cached and KEN# is active one clock before RDY# or BRDY# during the first transfer of the cycle, the cycle becomes a cache line fill cycle. Returning KEN# active one clock before RDY# during the last read in the cache line fill causes the line to be placed in the on-chip cache. KEN# is active LOW and is provided with a small internal pull-up resistor. KEN# must satisfy setup and hold times t_{14} and t_{15} for proper operation.

Table 7. Embedded Intel486™ SX Processor Pin Descriptions (Sheet 5 of 5)

Symbol	Type	Name and Function
FLUSH#	I	**Cache Flush** input forces the embedded Intel486 SX processor to flush its entire internal cache. FLUSH# is active LOW and need only be asserted for one clock. FLUSH# is asynchronous but setup and hold times t_{20} and t_{21} must be met for recognition in any specific clock.
PAGE CACHEABILITY		
PWT **PCD**	O O	**Page Write-Through** and **Page Cache Disable** pins reflect the state of the page attribute bits, PWT and PCD, in the page table entry, page directory entry or control register 3 (CR3) when paging is enabled. When paging is disabled, the embedded Intel486 SX processor ignores the PCD and PWT bits and assumes they are zero for the purpose of caching and driving PCD and PWT pins. PWT and PCD have the same timing as the cycle definition pins (M/IO#, D/C#, and W/R#). PWT and PCD are active HIGH and are not driven during bus hold. PCD is masked by the cache disable bit (CD) in Control Register 0.
BUS SIZE CONTROL		
BS16# **BS8#**	I I	**Bus Size 16** and **Bus Size 8** pins (bus sizing pins) cause the embedded Intel486 SX processor to run multiple bus cycles to complete a request from devices that cannot provide or accept 32 bits of data in a single cycle. The bus sizing pins are sampled every clock. The processor uses the state of these pins in the clock before Ready to determine bus size. These signals are active LOW and are provided with internal pull-up resistors. These inputs must satisfy setup and hold times t_{14} and t_{15} for proper operation.
ADDRESS MASK		
A20M#	I	**Address Bit 20 Mask** pin, when asserted, causes the embedded Intel486 SX processor to mask physical address bit 20 (A20) before performing a lookup to the internal cache or driving a memory cycle on the bus. A20M# emulates the address wraparound at 1 Mbyte, which occurs on the 8086 processor. A20M# is active LOW and should be asserted only when the embedded Intel486 SX processor is in real mode. This pin is asynchronous but should meet setup and hold times t_{20} and t_{21} for recognition in any specific clock. For proper operation, A20M# should be sampled HIGH at the falling edge of RESET.
TEST ACCESS PORT		
TCK	I	**Test Clock**, an input to the embedded Intel486 SX processor, provides the clocking function required by the JTAG Boundary scan feature. TCK is used to clock state information (via TMS) and data (via TDI) into the component on the rising edge of TCK. Data is clocked out of the component (via TDO) on the falling edge of TCK. TCK is provided with an internal pull-up resistor.
TDI	I	**Test Data Input** is the serial input used to shift JTAG instructions and data into the processor. TDI is sampled on the rising edge of TCK, during the SHIFT-IR and SHIFT-DR Test Access Port (TAP) controller states. During all other TAP controller states, TDI is a “don’t care.” TDI is provided with an internal pull-up resistor.
TDO	O	**Test Data Output** is the serial output used to shift JTAG instructions and data out of the component. TDO is driven on the falling edge of TCK during the SHIFT-IR and SHIFT-DR TAP controller states. At all other times TDO is driven to the high impedance state.
TMS	I	**Test Mode Select** is decoded by the JTAG TAP to select test logic operation. TMS is sampled on the rising edge of TCK. To guarantee deterministic behavior of the TAP controller, TMS is provided with an internal pull-up resistor.
RESERVED PINS		
RESERVED#	I	**Reserved** is reserved for future use. This pin MUST be connected to an external pull-up resistor circuit. The recommended resistor value is 10 kΩ. The pull-up resistor must be connected only to the RESERVED# pin. **Do not share this resistor with other pins requiring pull-ups.**

Table 8. Output Pins

Name	Active Level	Output Signal		
		Floated During Address Hold	Floated During Bus Hold	During Stop Grant and Stop Clock States
BREQ	HIGH			Previous State
HLDA	HIGH			As per HOLD
BE3#-BE0#	LOW		•	Previous State
PWT, PCD	HIGH		•	Previous State
W/R#, M/IO#, D/C#	HIGH/LOW		•	Previous State
LOCK#	LOW		•	HIGH (inactive)
PLOCK#	LOW		•	HIGH (inactive)
ADS#	LOW		•	HIGH (inactive)
BLAST#	LOW		•	Previous State
PCHK#	LOW			Previous State
A3-A2	HIGH	•	•	Previous State
SMIACT#	LOW			Previous State

NOTE: The term “Previous State” means that the processor maintains the logic level applied to the signal pin just before the processor entered the Stop Grant state. This conserves power by preventing the signal pin from floating.

Table 9. Input/Output Pins

Name	Active Level	Output Signal		
		Floated During Address Hold	Floated During Bus Hold	During Stop Grant and Stop Clock States
D31-D0	HIGH		•	Floated
DP3–DP0	HIGH		•	Floated
A31-A4	HIGH	•	•	Previous State

NOTE: The term “Previous State” means that the processor maintains the logic level applied to the signal pin just before the processor entered the Stop Grant state. This conserves power by preventing the signal pin from floating.

Table 10. Test Pins

Name	Input or Output	Sampled/ Driven On
TCK	Input	N/A
TDI	Input	Rising Edge of TCK
TDO	Output	Failing Edge of TCK
TMS	Input	Rising Edge of TCK

Table 11. Input Pins

Name	Active Level	Synchronous/ Asynchronous	Internal Pull-Up/ Pull-Down
CLK			
RESET	HIGH	Asynchronous	
SRESET	HIGH	Asynchronous	Pull-Down
HOLD	HIGH	Synchronous	
AHOLD	HIGH	Synchronous	Pull-Down
EADS#	LOW	Synchronous	Pull-Up
BOFF#	LOW	Synchronous	Pull-Up
FLUSH#	LOW	Asynchronous	Pull-Up
A20M#	LOW	Asynchronous	Pull-Up
BS16#, BS8#	LOW	Synchronous	Pull-Up
KEN#	LOW	Synchronous	Pull-Up
RDY#	LOW	Synchronous	
BRDY#	LOW	Synchronous	Pull-Up
INTR	HIGH	Asynchronous	
NMI	HIGH	Asynchronous	
RESERVED#	LOW	Asynchronous	Pull-Up
SMI#	LOW	Asynchronous	Pull-Up
STPCLK#	LOW	Asynchronous	Pull-Up[1]
TCK	HIGH		Pull-Up
TDI	HIGH		Pull-Up
TMS	HIGH		Pull-Up

NOTES:
1. Though STPCLK# has an internal pull-up resistor, an external 10-KΩ pull-up resistor is needed if the STPCLK# pin is not used.

4.0 Architectural and Functional Overview

The embedded Intel486 SX processor architecture is essentially the same as the Intel486 SX processor with a 1X clock (CLK) input. Refer to the *Embedded Intel486™ Processor Family Developer's Manual* (order number 273021) for a description of the Intel486 SX processor.

Note that the embedded Intel486 SX processor has one pin reserved for possible future use. This pin, an input signal, is called RESERVED# and must be connected to a 10-KΩ pull-up resistor. The pull-up resistor must be connected only to the RESERVED# pin. **Do not share this resistor with other pins requiring pull-ups.**

4.1 CPUID Instruction

The embedded Intel486 SX processor supports the CPUID instruction (see Table 12). Because not all Intel processors support the CPUID instruction, a simple test can determine if the instruction is supported. The test involves the processor's ID Flag, which is bit 21 of the EFLAGS register. If software can change the value of this flag, the CPUID instruction is available. The actual state of the ID Flag bit is irrelevant and provides no significance to the hardware. This bit is cleared (reset to zero) upon device reset (RESET or SRESET) for compatibility with Intel486 processor designs that do not support the CPUID instruction.

CPUID-instruction details are provided here for the embedded Intel486 SX processor. Refer to Intel Application Note AP-485 *Intel Processor Identification with the CPUID Instruction* (Order No. 241618) for a description that covers all aspects of the CPUID instruction and how it pertains to other Intel processors.

4.1.1 Operation of the CPUID Instruction

The CPUID instruction requires the software developer to pass an input parameter to the processor in the EAX register. The processor response is returned in registers EAX, EBX, EDX, and ECX.

Table 12. CPUID Instruction Description

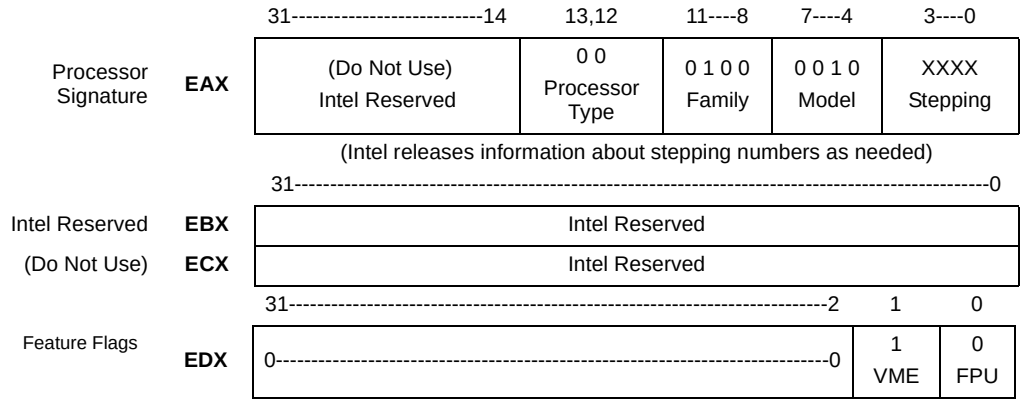
OP CODE	Instruction	Processor Core Clocks	Parameter passed in EAX (Input Value)	Description
0F A2	CPUID	9	0	Vendor (Intel) ID String
		14	1	Processor Identification
		9	> 1	Undefined (Do Not Use)

Vendor ID String - When the parameter passed in EAX is 0 (zero), the register values returned upon instruction execution are shown in the following table.

		31----------24	23----------16	15----------8	7----------0
High Value (= 1)	**EAX**	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 1
Vendor ID String	**EBX**	u (75)	n (6E)	e (65)	G (47)
(ASCII	**EDX**	I (49)	e (65)	n (6E)	i (69)
Characters)	**ECX**	l (6C)	e (65)	t (74)	n (6E)

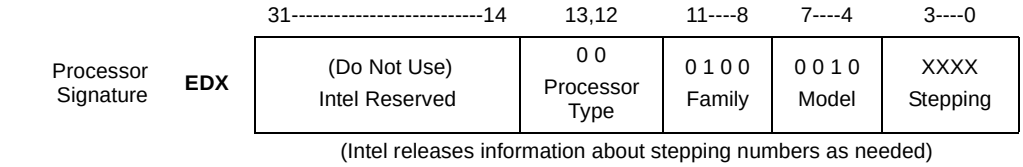
The values in EBX, EDX and ECX indicate an Intel processor. When taken in the proper order, they decode to the string "GenuineIntel."

Processor Identification - When the parameter passed to EAX is 1 (one), the register values returned upon instruction execution are:



4.2 Identification After Reset

Processor Identification - Upon reset, the EDX register contains the processor signature:



4.3 Boundary Scan (JTAG)

4.3.1 Device Identification

Table 13 shows the 32-bit code for the embedded Intel486 SX processor. This code is loaded into the Device Identification Register.

Table 13. Boundary Scan Component Identification Code (5 Volt Processor)

Version	**Part Number**				**Mfg ID** 009H = Intel	**1**
	V_{CC} 0=5 V 1=3.3 V	**Intel Architecture Type**	**Family** 0100 = Intel486 CPU Family	**Model** 00010 = embedded Intel486 SX processor		
31----28	27	26----------21	20----17	16--------12	11----------1	0
XXXX	0	000001	0100	00010	00000001001	1

(Intel releases information about version numbers as needed)
Boundary Scan Component Identification Code = x028 2013 (Hex)

4.3.2 Boundary Scan Register Bits and Bit Order

The boundary scan register contains a cell for each pin as well as cells for control of bidirectional and three-state pins. There are “Reserved” bits which correspond to no-connect (N/C) signals of the embedded Intel486 SX processor. Control registers WRCTL, ABUSCTL, BUSCTL, and MISCCTL are used to select the direction of bidirectional or three-state output signal pins. A “1” in these cells designates that the associated bus or bits are floated if the pins are three-state, or selected as input if they are bidirectional.

- WRCTL controls D31-D0 and DP3–DP0
- ABUSCTL controls A31-A2
- BUSCTL controls ADS#, BLAST#, PLOCK#, LOCK#, W/R#, BE0#, BE1#, BE2#, BE3#, M/IO#, D/C#, PWT, and PCD
- MISCCTL controls PCHK#, HLDA, and BREQ

The following is the bit order of the embedded Intel486 SX processor boundary scan register:

TDO ← A2, A3, A4, A5, RESERVED#, A6, A7, A8, A9, A10, A11, A12, A13, A14, A15, A16, A17, A18, A19, A20, A21, A22, A23, A24, A25, A26, A27, A28, A29, A30, A31, DP0, D0, D1, D2, D3, D4, D5, D6, D7, DP1, D8, D9, D10, D11, D12, D13, D14, D15, DP2, D16, D17, D18, D19, D20, D21, D22, D23, DP3, D24, D25, D26, D27, D28, D29, D30, D31, STPCLK#, Reserved, Reserved, SMI#, SMIACT#, SRESET, NMI, INTR, FLUSH#, RESET, A20M#, EADS#, PCD, PWT, D/C#, M/IO#, BE3#, BE2#, BE1#, BE0#, BREQ, W/R#, HLDA, CLK, Reserved, AHOLD, HOLD, KEN#, RDY#, BS8#, BS16#, BOFF#, BRDY#, PCHK#, LOCK#, PLOCK#, BLAST#, ADS#, MISCCTL, BUSCTL, ABUSCTL, WRCTL ← **TDI**

5.0 Electrical Specifications

5.1 Maximum Ratings

Table 14 is a stress rating only. Extended exposure to the Maximum Ratings may affect device reliability.

Furthermore, although the embedded Intel486 SX processor contains protective circuitry to resist damage from electrostatic discharge, always take precautions to avoid high static voltages or electric fields.

Functional operating conditions are given in **Section 5.2, DC Specifications** and **Section 5.3, AC Specifications**.

Table 14. Absolute Maximum Ratings

Case Temperature under Bias	-65 °C to +110 °C
Storage Temperature	-65 °C to +150 °C
DC Voltage on Any Pin with Respect to Ground	-0.5 V to V_{CC} + 0.5 V
Supply Voltage VCC with Respect to VSS	-0.5 V to +6.5 V

5.2 DC Specifications

The following tables show the operating supply voltages, DC I/O specifications, and component power consumption for the embedded Intel486 SX processor.

Table 15. Operating Supply Voltages

Product	V_{CC}
x80486SXSA33	5.0 V ± 0.25 V
x80486SXSA33	5.0 V ± 0.25 V

NOTE: To address the fact that many of the package prefix variables have changed, all package prefix variables in this document are now indicated with an "x".

Table 16. 5 V DC Specifications

Functional operating range: V_{CC} = 5 V ± 0.25 V; T_{CASE} = 0° C to +85° C

Symbol	Parameter	Min	Max	Unit	Notes
V_{IL}	Input LOW Voltage	-0.3	+0.8	V	
V_{IH}	Input HIGH Voltage	2.0	V_{CC}+0.3	V	
V_{OL}	Output LOW Voltage		0.45	V	Note 1
V_{OH}	Output HIGH Voltage	2.4		V	Note 2
I_{LI}	Input Leakage Current		15	µA	Note 3
I_{IH}	Input Leakage Current SRESET		200 300	µA µA	Note 4 Note 4
I_{IL}	Input Leakage Current		400	µA	Note 5
I_{LO}	Output Leakage Current		15	µA	
C_{IN}	Input Capacitance		20	pF	Note 6
C_{OUT}	Output or I/O Capacitance		20	pF	Note 6
C_{CLK}	CLK Capacitance		20	pF	Note 6

NOTES:
1. This parameter is measured at:
   Address, Data, BE*n*# 4.0 mA
   Definition, Control 5.0 mA
2. This parameter is measured at:
   Address, Data, BE*n*# -1.0 mA
   Definition, Control -0.9 mA
3. This parameter is for inputs without pull-ups or pull-downs and $0 V \le V_{IN} \le V_{CC}$.
4. This parameter is for inputs with pull-downs and V_{IH} = 2.4 V.
5. This parameter is for inputs with pull-ups and V_{IL} = 0.45 V.
6. F_C=1 MHz; Not 100% tested.

Table 17. 5 V I_{cc} Values

Functional Operating Range: V_{CC} = 5 V ±0.25 V; T_{CASE} = 0° C to +85° C

Parameter	Operating Frequency	Typ	Maximum	Notes
I_{CC} Active (Power Supply)	33 MHz		685 mA	Note 1
I_{CC} Active (Thermal Design)	33 MHz	497 mA	654 mA	Notes 2, 3, 4
I_{CC} Stop Grant	33 MHz	40 mA	80 mA	Note 5
I_{CC} Stop Clock	0 MHz	200 µA	2 mA	Note 6

NOTES:

1. This parameter is for proper power supply selection. It is measured using the worst case instruction mix at V_{CC} = 5.25 V.
2. The maximum current column is for thermal design power dissipation. It is measured using the worst case instruction mix at V_{CC} = 5 V.
3. The typical current column is the typical operating current in a system. This value is measured in a system using a typical device at V_{CC} = 5 V, running Microsoft Windows 3.1 at an idle condition. This typical value is dependent upon the specific system configuration.
4. Typical values are not 100% tested.
5. The I_{CC} Stop Grant specification refers to the I_{CC} value once the embedded Intel486 SX processor enters the Stop Grant or Auto HALT Power Down state.
6. The I_{CC} Stop Clock specification refers to the I_{CC} value once the processor enters the Stop Clock state. The V_{IH} and V_{IL} levels must be equal to V_{CC} and 0 V, respectively, in order to meet the I_{CC} Stop Clock specifications.

5.3 AC Specifications

The AC specifications for the embedded Intel486 SX processor are given in this section.

Table 18. AC Characteristics

T_{CASE} = 0° C to +85° C; C_L = 50 pF, unless otherwise specified. (Sheet 1 of 2)

	CLK Frequency	8	33	8	33	MHz		Note 1
t_1	CLK Period	30	125	30	125	ns	3	
t_{1a}	CLK Period Stability		±250		±250	ps	3	Adjacent clocks
t_2	CLK High Time	11		11		ns	3	at 2V
t_3	CLK Low Time	11		11		ns	3	at 0.8V
t_4	CLK Fall Time		3		3	ns	3	2V to 0.8V
t_5	CLK Rise Time		3		3	ns	3	0.8V to 2V
t_6	A31–A2, PWT, PCD, BE3–BE0#, M/IO#, D/C#, W/R#, ADS#, LOCK#, BREQ, HLDA, SMIACT# Valid Delay	3	16	3	16	ns	7	
t_7	A31–A2, PWT, PCD, BE3–BE0#, M/IO#, D/C#, W/R#, ADS#, LOCK#, BREQ, HLDA Float Delay		20		20	ns	8	Note 2
t_8	PCHK# Valid Delay	3	22	3	22	ns	6	
t_{8a}	BLAST#, PLOCK# Valid Delay	3	20	3	20	ns	7	
t_9	BLAST#, PLOCK# Float Delay		20		20	ns	8	Note 2

Table 18. AC Characteristics

T_{CASE} = 0° C to +85° C; C_L = 50 pF, unless otherwise specified. (Sheet 2 of 2)

t_{10}	D31–D0, DP3–DP0 Write Data Valid Delay	3	19	3	18	ns	7	
t_{11}	D31–D0, DP3–DP0 Write Data Float Delay		20		20	ns	8	Note 2
t_{12}	EADS# Setup Time	6		5		ns	4	
t_{13}	EADS# Hold Time	3		3		ns	4	
t_{14}	KEN#, BS16#, BS8# Setup Time	6		5		ns	4	
t_{15}	KEN#, BS16#, BS8# Hold Time	3		3		ns	4	
t_{16}	RDY#, BRDY# Setup Time	6		5		ns	5	
t_{17}	RDY#, BRDY# Hold Time	3		3		ns	5	
t_{18}	HOLD, AHOLD Setup Time	6		6		ns	4	
t_{18a}	BOFF# Setup Time	9		8		ns	4	
t_{19}	HOLD, AHOLD, BOFF# Hold Time	3		3		ns	4	
t_{20}	FLUSH#, A20M#, NMI, INTR, SMI#, STPCLK#, SRESET, RESET Setup Time	6		5		ns	4	Note 3
t_{21}	FLUSH#, A20M#, NMI, INTR, SMI#, STPCLK#, SRESET, RESET Hold Time	3		3		ns	4	Note 3
t_{22}	D31–D0, DP3–DP0, A31–A4 Read Setup Time	6		5		ns	5 5	
t_{23}	D31–D0, DP3–DP0, A31–A4 Read Hold Time	3		3		ns	5 5	

NOTES:

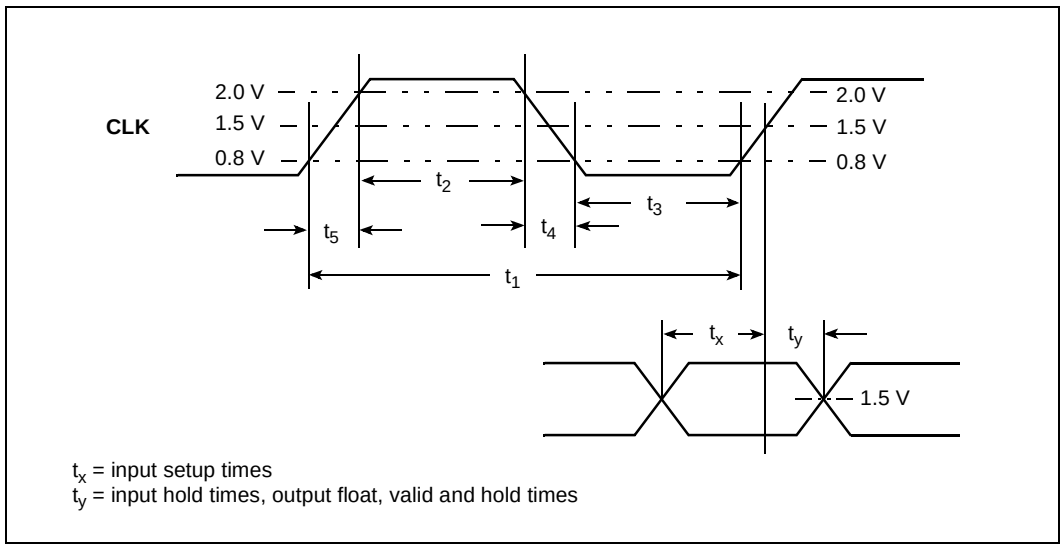
1. 0-MHz operation is guaranteed when the STPCLK# and Stop Grant bus cycle protocol is used.
2. Not 100% tested, guaranteed by design characterization.
3. A reset pulse width of 15 CLK cycles is required for warm resets (RESET or SRESET). Power-up resets (cold resets) require RESET to be asserted for at least 1 ms after V_{CC} and CLK are stable.

Table 19. AC Specifications for the Test Access Port
(5V PQFP Processors) T_{CASE} = 0° C to +85° C; C_L = 50 pF

Symbol	Parameter	Min	Max	Unit	Figure	Notes
t_{24}	TCK Frequency		8	MHz		Note 1
t_{25}	TCK Period	125		ns	9	
t_{26}	TCK High Time	40		ns	9	@ 2.0V
t_{27}	TCK Low Time	40		ns	9	@ 0.8V
t_{28}	TCK Rise Time		8	ns	9	Note 2
t_{29}	TCK Fall Time		8	ns	9	Note 2
t_{30}	TDI, TMS Setup Time	8		ns	10	Note 3
t_{31}	TDI, TMS Hold Time	10		ns	10	Note 3
t_{32}	TDO Valid Delay	3	30	ns	10	Note 3
t_{33}	TDO Float Delay		36	ns	10	Note 3
t_{34}	All Outputs (except TDO) Valid Delay	3	30	ns	10	Note 3
t_{35}	All Outputs (except TDO) Float Delay		36	ns	10	Note 3
t_{36}	All Inputs (except TDI, TMS, TCK) Setup Time	8		ns	10	Note 3
t_{37}	All Inputs (except TDI, TMS, TCK) Hold Time	10		ns	10	Note 3

NOTES:
1. TCK period ≤ CLK period.
2. Rise/Fall times are measured between 0.8 V and 2.0 V. Rise/Fall times can be relaxed by 1 ns per 10-ns increase in TCK period.
3. Parameters t_{30} – t_{37} are measured from TCK.

Figure 3. CLK Waveform



t_x = input setup times
t_y = input hold times, output float, valid and hold times

Figure 4. Input Setup and Hold Timing

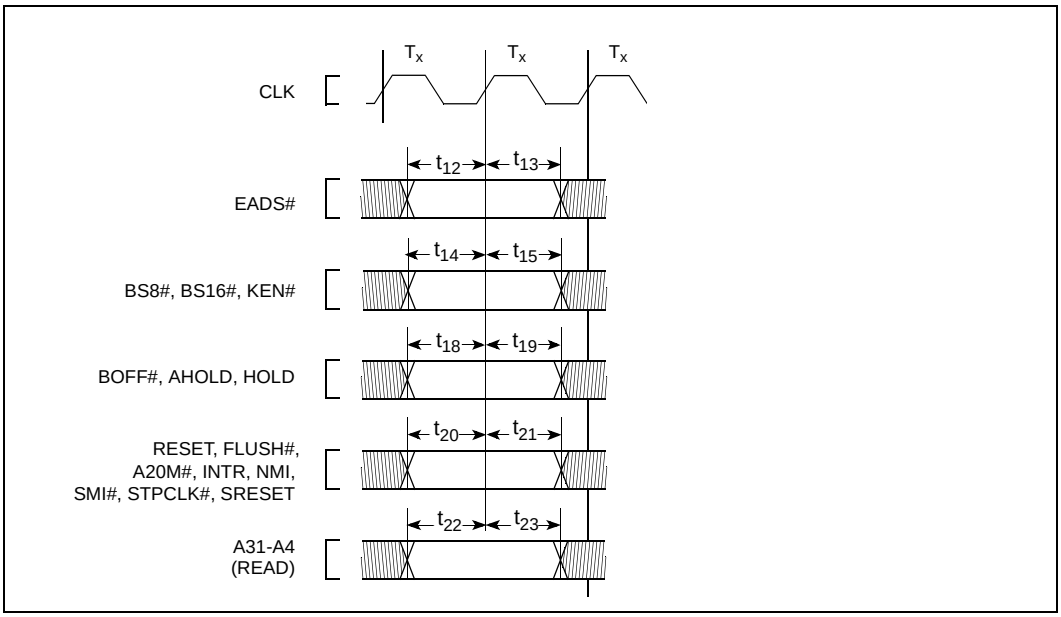


Figure 5. Input Setup and Hold Timing

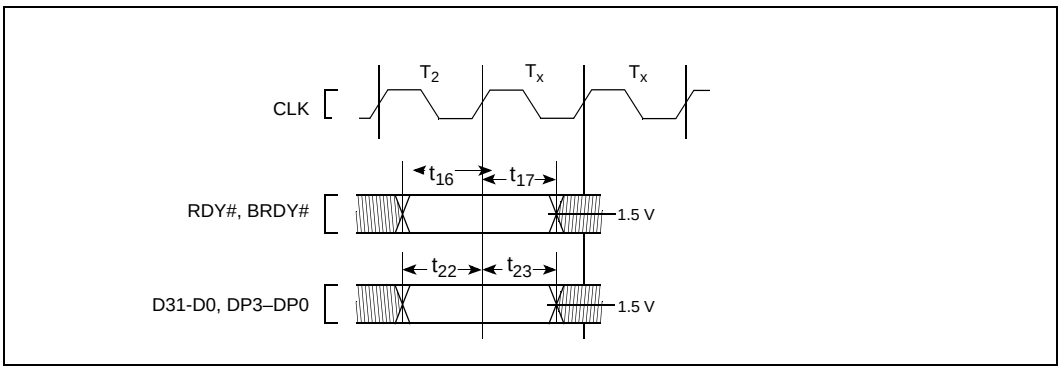


Figure 6. PCHK# Valid Delay Timing

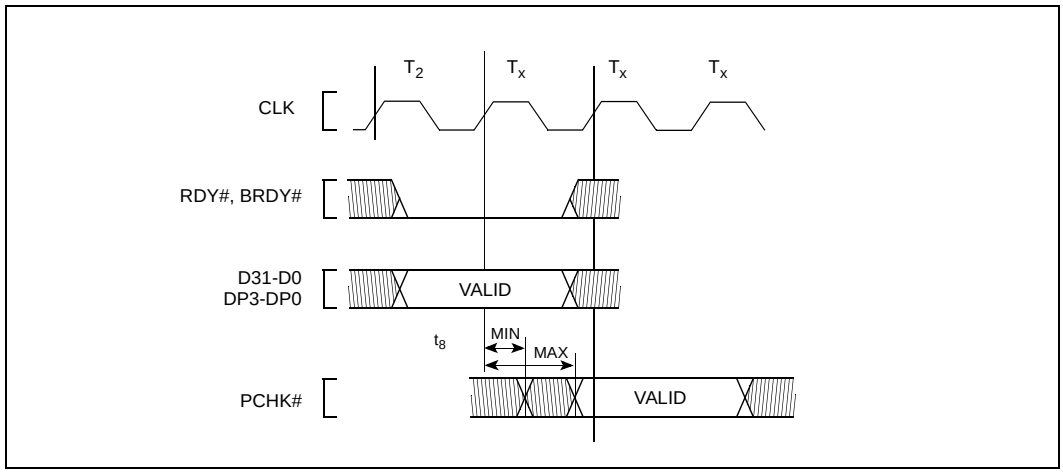


Figure 7. Output Valid Delay Timing

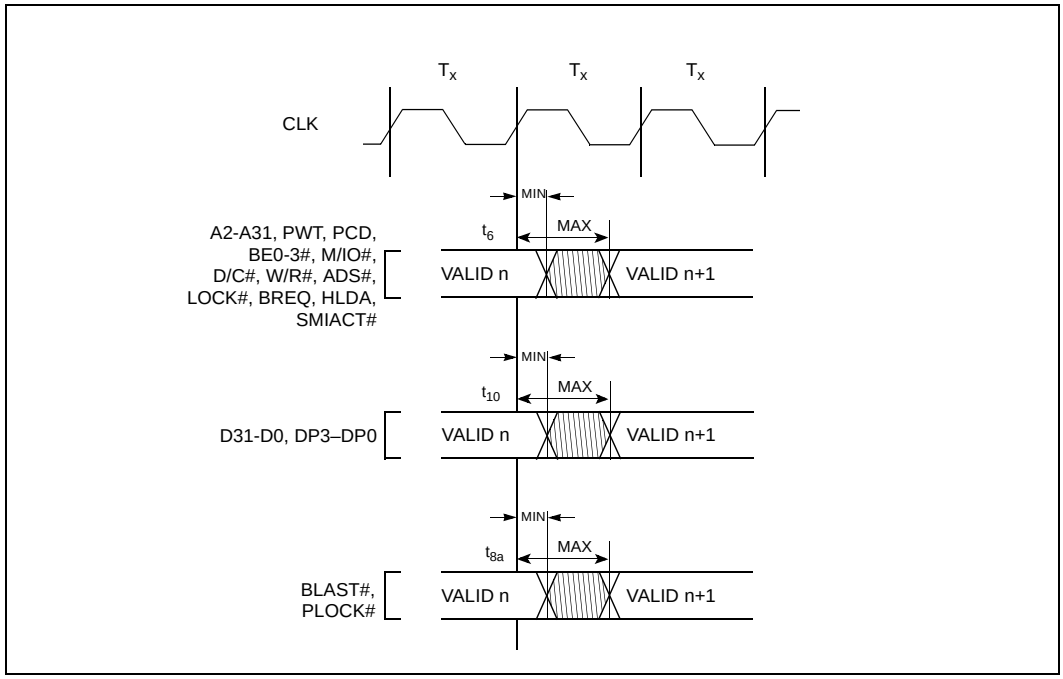


Figure 8. Maximum Float Delay Timing

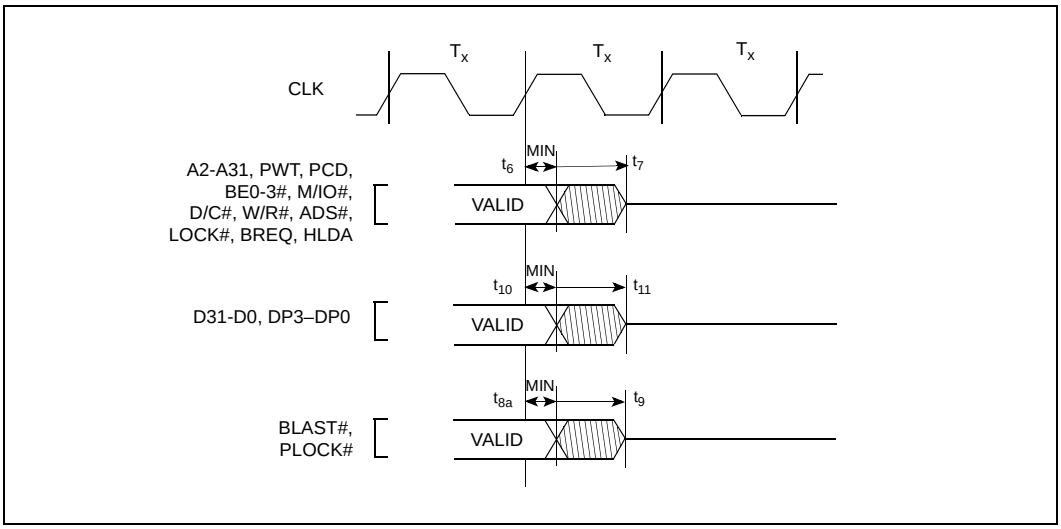


Figure 9. TCK Waveform

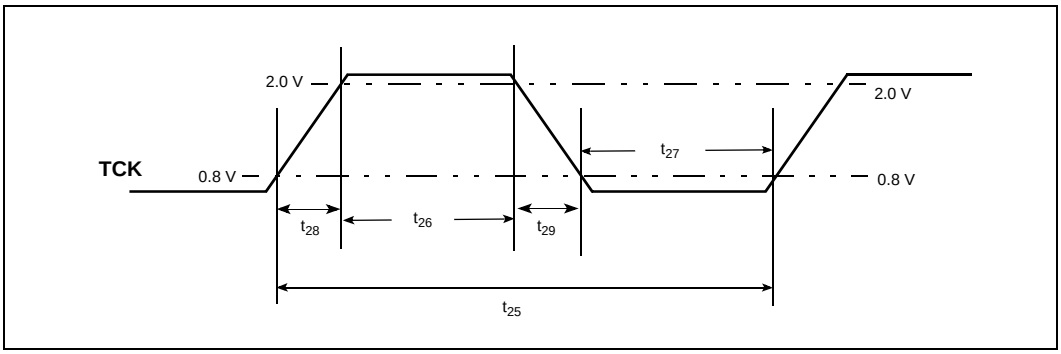
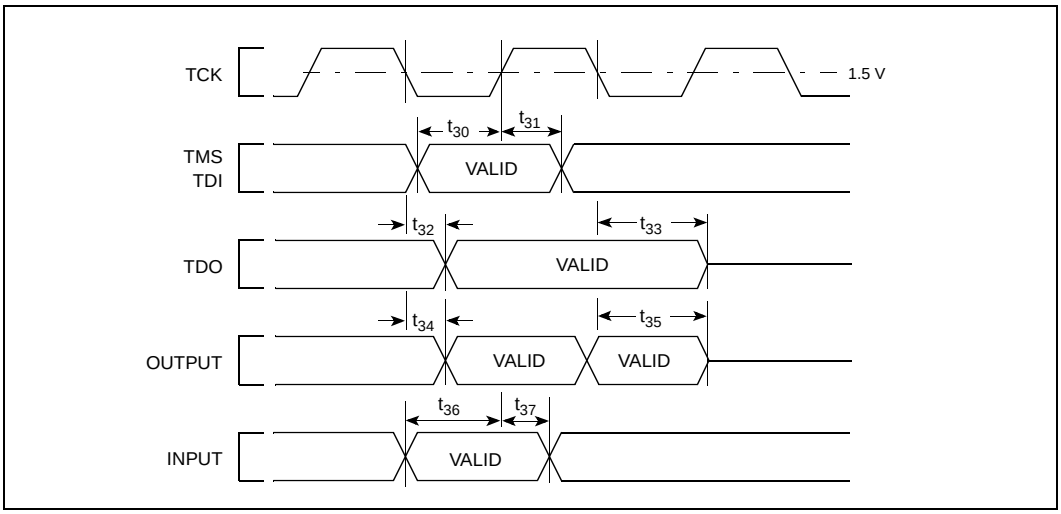


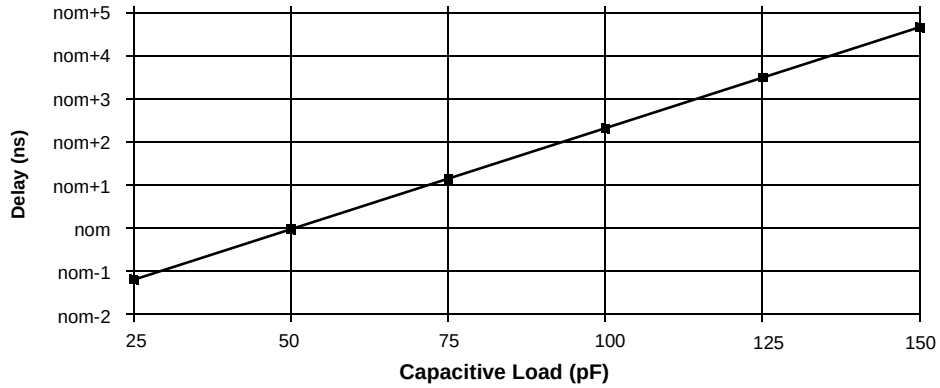
Figure 10. Test Signal Timing Diagram



5.4 Capacitive Derating Curves

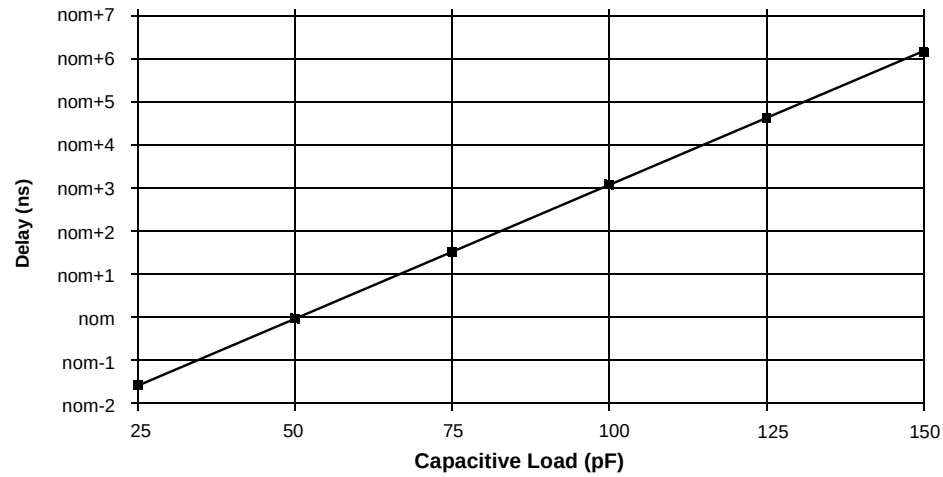
The following graphs are the capacitive derating curves for the embedded Intel486 SX processor.

Figure 11. Typical Loading Delay versus Load Capacitance under Worst-Case Conditions for a Low-to-High Transition, 5 V Processor



NOTE: This graph will not be linear outside of the capacitive range shown.
nom = nominal value from the AC Characteristics table.

Figure 12. Typical Loading Delay versus Load Capacitance under Worst-Case Conditions for a High-to-Low Transition, 5 V Processor



NOTE: This graph will not be linear outside of the capacitive range shown.
nom = nominal value from the AC Characteristics table.

6.0 Mechanical Data

This section describes the packaging dimensions and thermal specifications for the embedded Intel486 SX processor.

6.1 Package Dimensions

Figure 13. 168-Pin PGA Package Dimensions

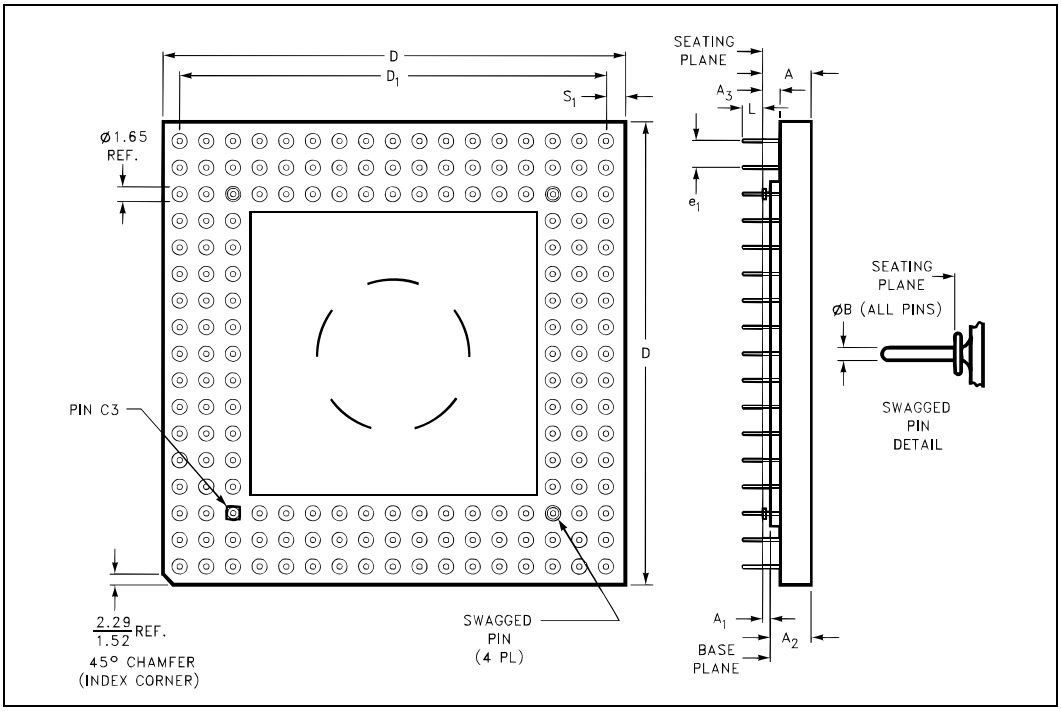


Table 20. 168-Pin Ceramic PGA Package Dimensions

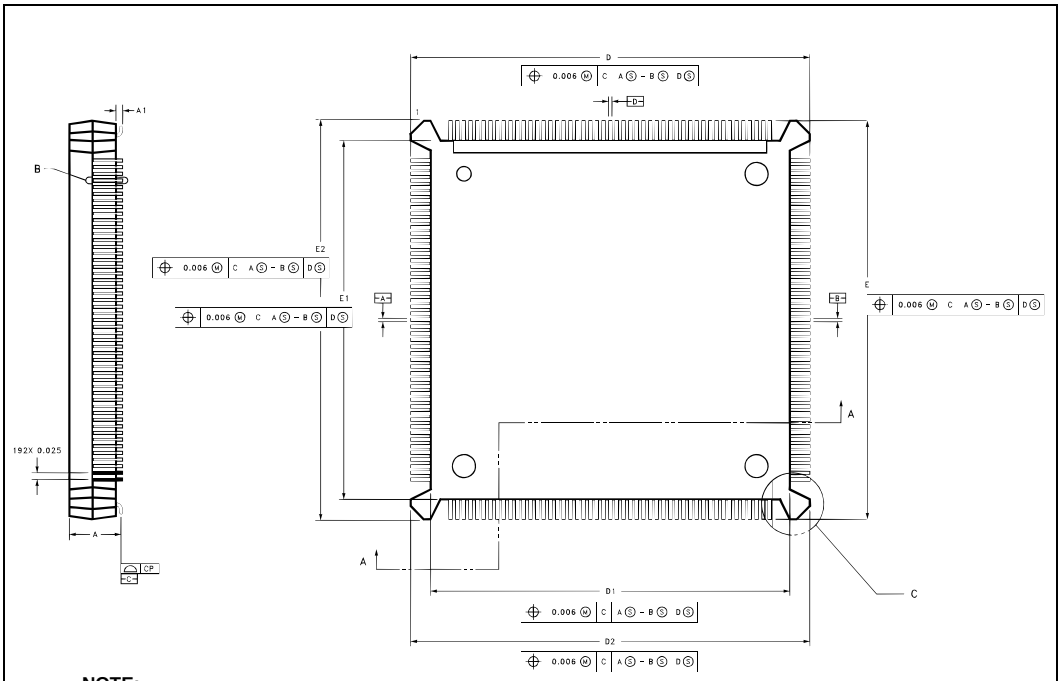
Symbol	Millimeters			Inches		
	Min	Max	Notes	Min	Max	Notes
A	3.56	4.57		0.140	0.180	
A_1	0.64	1.14	SOLID LID	0.025	0.045	SOLID LID
A_2	2.8	3.5	SOLID LID	0.110	0.140	SOLID LID
A_3	1.14	1.40		0.045	0.055	
B	0.43	0.51		0.017	0.020	
D	44.07	44.83		1.735	1.765	
D_1	40.51	40.77		1.595	1.605	
e_1	2.29	2.79		0.090	0.110	
L	2.54	3.30		0.100	0.130	
N	168			168		
S_1	1.52	2.54		0.060	0.100	

Table 21. Ceramic PGA Package Dimension Symbols

Letter or Symbol	Description of Dimensions
A	Distance from seating plane to highest point of body
A_1	Distance between seating plane and base plane (lid)
A_2	Distance from base plane to highest point of body
A_3	Distance from seating plane to bottom of body
B	Diameter of terminal lead pin
D	Largest overall package dimension of length
D_1	A body length dimension, outer lead center to outer lead center
e_1	Linear spacing between true lead position centerlines
L	Distance from seating plane to end of lead
S_1	Other body dimension, outer lead center to edge of body

NOTES:
1. Controlling dimension: millimeter.
2. Dimension “e_1” (“e”) is non-cumulative.
3. Seating plane (standoff) is defined by P.C. board hole size: 0.0415–0.0430 inch.
4. Dimensions “B”, “B_1” and “C” are nominal.
5. Details of Pin 1 identifier are optional.

Figure 14. Principal Dimensions and Data for 196-Lead Plastic Quad Flat Pack Package



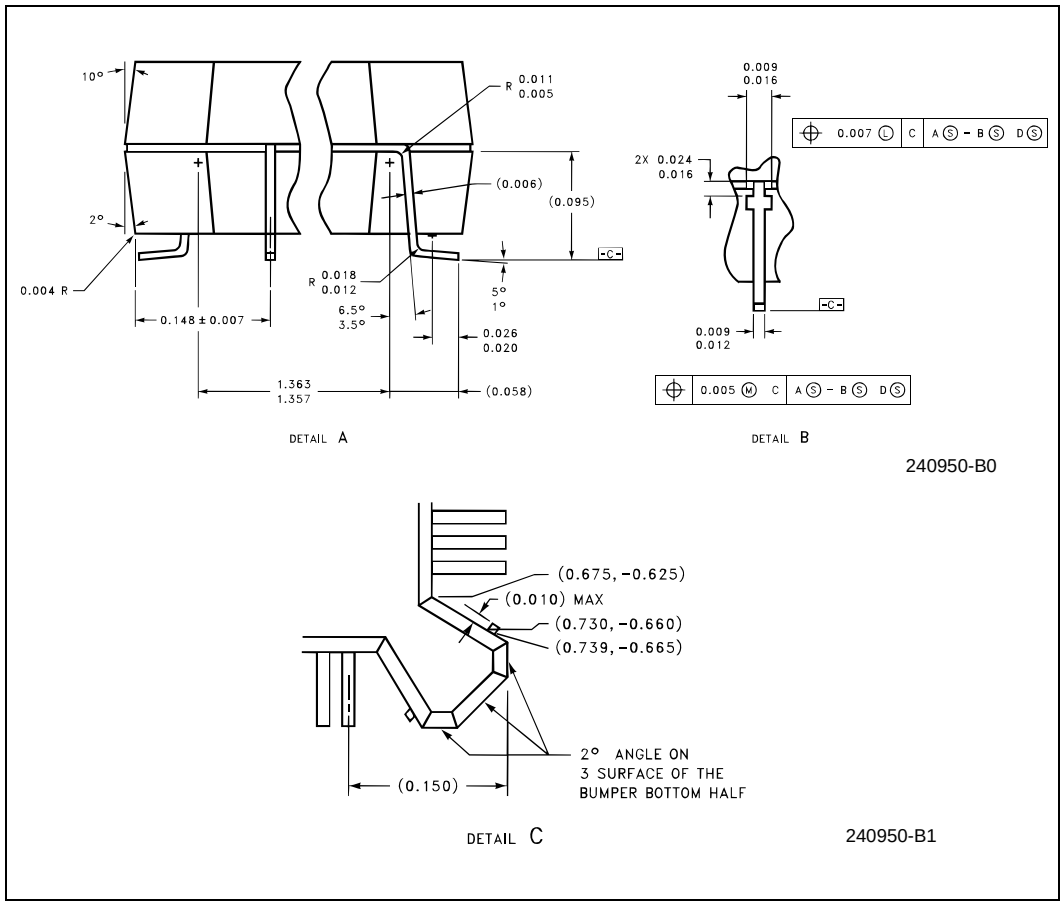
NOTE:
Interpret dimensions and tolerances in accordance with ANSI Y14.5M-1982.

Table 22. Symbol List and Dimensions for 196-Lead PQFP Package

Symbol	Description of Dimensions	Min	Max
A	**Package Height:** Distance from the seating plane to the highest point of body.	0.160	0.175
A1	**Standoff:** The distance from the seating plane to the base plane.	0.020	0.035
D, E	**Overall Package Dimension:** Lead tip to lead tip.	1.470	1.485
D1, E1	Plastic Body Dimension	1.347	1.353
D2, E2	Bumper Distance		
	Without FLASH	1.497	1.503
	With FLASH	1.497	1.510
CP	Seating Plane Coplanarity	0.000	0.004

NOTES:
1. All dimensions and tolerances conform to ANSI Y14.5M-1982.
2. Dimensions are in inches.

Figure 15. Typical Lead for 196-Lead PQFP Package



6.2 Package Thermal Specifications

The embedded Intel486 SX processor is specified for operation when the case temperature (T_C) is within the range of 0° C to 85° C. T_C may be measured in any environment to determine whether the processor is within the specified operating range.

The ambient temperature (T_A) can be calculated from θ_{JC} and θ_{JA} from the following equations:

$$T_J = T_C + P * \theta_{JC}$$

$$T_A = T_J - P * \theta_{JA}$$

$$T_C = T_A + P * [\theta_{JA} - \theta_{JC}]$$

$$T_A = T_C - P * [\theta_{JA} - \theta_{JC}]$$

Where T_J, T_A, T_C equals Junction, Ambient and Case Temperature respectively. θ_{JC}, θ_{JA} equals Junction-to-Case and Junction-to-Ambient thermal Resistance, respectively. P is defined as Maximum Power Consumption.

Values for θ_{JA} and θ_{JC} are given in the following tables for each product operating at 33 MHz. Maximum T_A is shown in Table 26 for each product operating at 33 MHz.

Table 23. Thermal Resistance, θ_{JA} (°C/W) for the 196-Lead PQFP Package

	θ_{JA} vs. Airflow — ft/min. (m/sec)			
	0 (0)	**200 (1.01)**	**400 (2.03)**	**600 (3.04)**
196-Lead PQFP (5V) - Without Heat Sink	20.5	16.5	14.0	12.5
196-Lead PQFP (5V) - With Heat Sink†	17.0	10.5	8.5	8.0

† 0.350" high omnidirectional heat sink.

Table 24. Thermal Resistance, θ_{JC} (°C/W) for the 196-Lead PQFP Package

	θ_{JC} vs. Airflow — ft/min. (m/sec)			
	0 (0)	**200 (1.01)**	**400 (2.03)**	**600 (3.04)**
196-Lead PQFP (5V)	3.5	-	-	-

Table 25. Thermal Resistance, θ_{JA} (°C/W) for the 168-Lead PQFP Package

	θ_{JC}	θ_{JA} vs. Airflow — ft/min. (m/sec)					
		0 (0)	**200 (1.01)**	**400 (2.03)**	**600 (3.04)**	**800 (4.06)**	**1000 (5.07)**
168-Pin PGA (5V) - Without Heat Sink	1.5	17.0	14.5	12.5	11.0	10.0	9.5
168-Pin PGA (5V) - With Heat Sink†	1.5	13.0	8.0	6.0	5.0	4.5	4.25

† 0.350" high omnidirectional heat sink.

Table 26. Maximum $T_{ambient}$ (T_A, °C)

	Airflow — ft/min. (m/sec)				
	Freq. (MHz)	**0 (0)**	**200 (1.01)**	**400 (2.03)**	**600 (3.04)**
196-Lead PQFP (5V) Without Heat Sink	33	29	42	51	56
196-Lead PQFP (5V) With Heat Sink	33	41	62	69	70
168-Pin PGA (5 V) Without Heat Sink	33	34	42	49	57
168-Pin PGA (5 V) With Heat Sink	33	47	64	70	74