



Am29000[®] and Am29005[™]

Streamlined Instruction Microprocessors

DISTINCTIVE CHARACTERISTICS

- Full 32-bit, three-bus architecture
- Efficient execution of high-level language programs
- CMOS technology/TTL compatible
- Concurrent instruction and data accesses
- Burst-mode access support
- 192 general-purpose registers
- Demultiplexed, pipelined address, instruction, and data buses
- Three-address instruction architecture
- On-chip byte-alignment support allows optional byte/half-word accesses
- 1.5 clock cycles per instruction average
- Double-precision, floating-point arithmetic unit (Am29027[™] arithmetic accelerator)
- Fully pipelined
- On-chip timer facility
- On-chip clock generation
- On-chip debugging support
- Master/slave chip output checking
- 23 million instructions per second (MIPS) sustained at 33-MHz operating frequency (Am29000 microprocessor only)
- 9 MIPS sustained at 16-MHz operating frequency (Am29005 microprocessor only)
- 33-, 25-, 20-, and 16-MHz operating frequencies (Am29000 microprocessor only)
- 4-Gb virtual address space with demand paging (Am29000 microprocessor only)
- 512-byte Branch Target Cache on-chip (Am29000 microprocessor only)
- 64-entry Memory Management Unit on-chip (Am29000 microprocessor only)

GENERAL DESCRIPTION

The Am29000[®] and the low-cost Am29005[™] Streamlined Instruction microprocessors are high-performance, general-purpose, 32-bit microprocessors implemented in CMOS technology. They support a variety of applications by virtue of a flexible architecture and rapid execution of simple instructions that are common to a wide range of tasks.

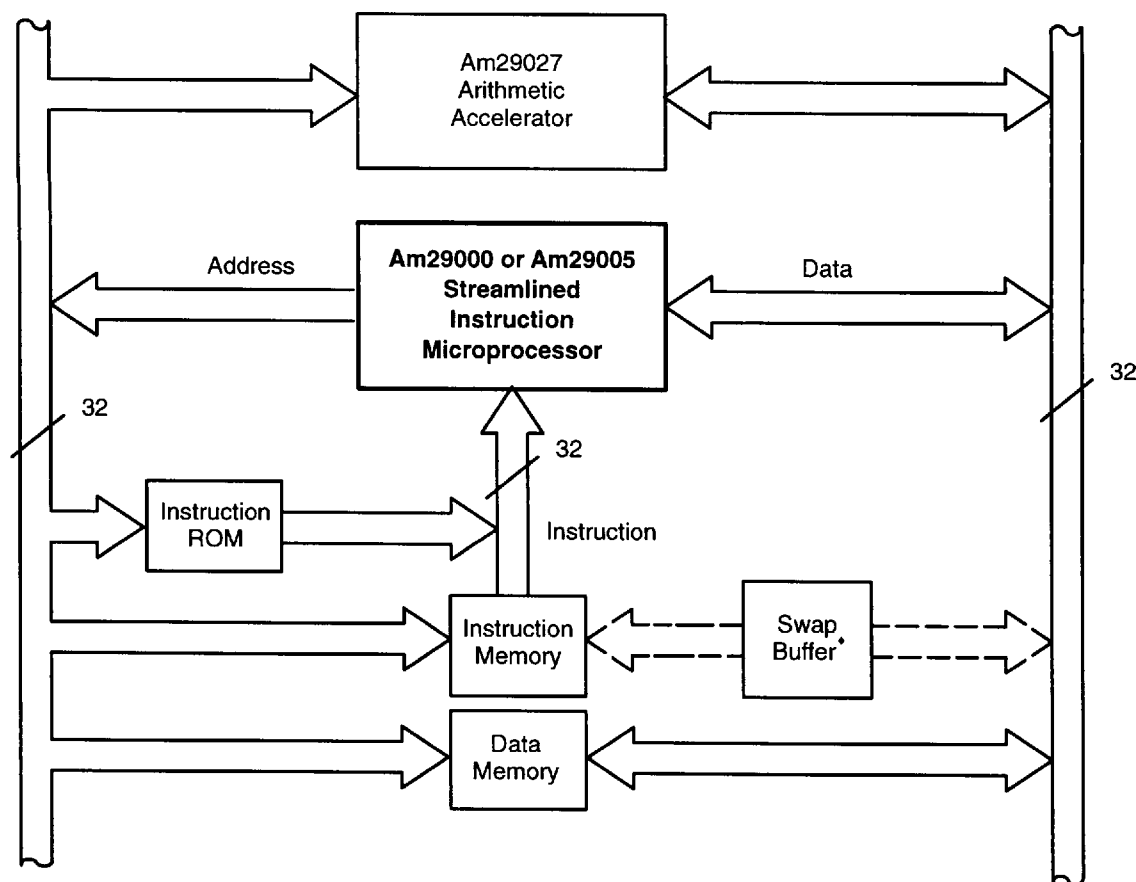
Both processors efficiently perform operations common to all systems, while deferring most decisions on system policies to the system architect. They are well-suited for application in high-performance workstations, general-purpose super-minicomputers, high-performance real-time controllers, laser printer controllers, network protocol converters, and many other applications where high performance, flexibility, and the ability to program using standard software tools is important.

The Am29000 and Am29005 microprocessor instruction sets have been influenced by the results of high-level language, optimizing compiler research. They are appropriate for a variety of languages because they efficiently execute operations that are common to all languages. Consequently, the Am29000 and Am29005 microprocessors are an ideal target for high-level languages such as C, FORTRAN, Pascal, Ada, and COBOL.

The Am29000 and Am29005 microprocessors are available in a 168-lead Plastic Quad Flat Pack (PQFP) package. The package has 141 signal pins and 27 power and ground pins. The Am29000 microprocessor is also available in a 169-lead Pin Grid Array (PGA) package. The PGA has 141 signal pins, 27 power and ground pins, and 1 alignment pin.

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SIMPLIFIED BLOCK DIAGRAM**Note:**

- ♦ As a system option, a Swap Buffer may be used to join the instruction and data buses. This enables the system to read instructions as data.

29K™ FAMILY DEVELOPMENT SUPPORT PRODUCTS

Contact your local AMD® representative for information on the complete set of development support tools. Software development products on several hosts:

- Optimizing compilers for common high-level languages
- Assembler and utility packages
- Source- and assembly-level software debuggers
- Target-resident development monitors
- Simulators

Hardware development products include:

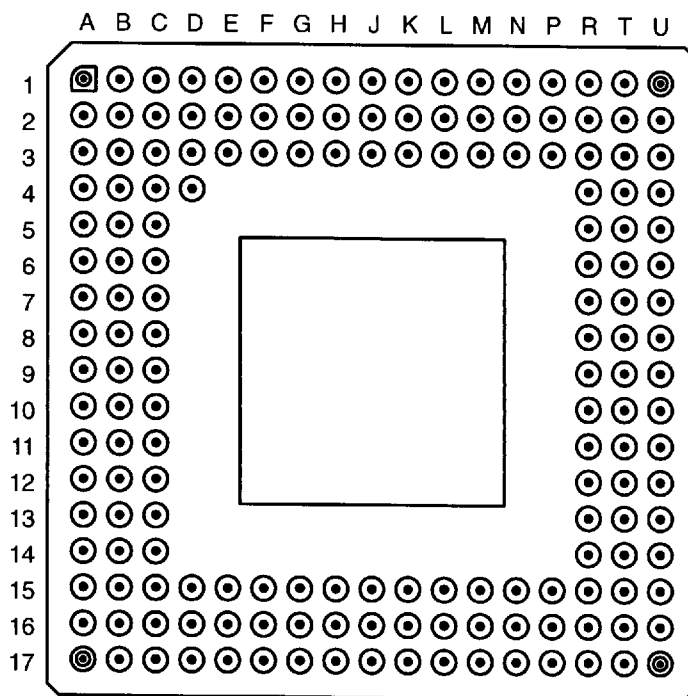
- In-circuit emulator and execution boards

RELATED AMD PRODUCTS

29K Family Devices

Part No.	Description
Am29027	Arithmetic Accelerator
Am29030™	RISC Microprocessor with 8-Kbyte Instruction Cache
Am29035™	RISC Microprocessor with 4-Kbyte Instruction Cache
Am29050™	Streamlined Instruction Microprocessor with On-Chip Floating Point
Am29200™	Single-Chip, 32-bit RISC Microcontroller
Am29205™	16-bit External Interface RISC Microcontroller

CONNECTION DIAGRAMS
169-Lead PGA—Am29000 Microprocessor Only
Bottom View



09075-001A

Note:

Pinout observed from pin side of package.

PGA PIN DESIGNATIONS (Sorted by Pin Number)—Am29000 Microprocessor Only

Pin No.	Pin Name	Pin No.	Pin Name	Pin No.	Pin Name	Pin No.	Pin Name
A1	GND	C10	GND	J16	A16	R12	STAT2
A2	I1	C11	GND	J17	A14	R13	GND
A3	I0	C12	D22	K1	I26	R14	OPT0
A4	D2	C13	D26	K2	I25	R15	A2
A5	D4	C14	V _{CC}	K3	GND	R16	A6
A6	D6	C15	D30	K15	V _{CC}	R17	A7
A7	D9	C16	D31	K16	A12	T1	INCLK
A8	D11	C17	A29	K17	A13	T2	BREQ
A9	D12	D1	I11	L1	I27	T3	DERR
A10	D14	D2	I10	L2	I28	T4	IRDY
A11	D16	D3	I7	L3	V _{CC}	T5	WARN
A12	D18	D4*	PIN169	L15	V _{CC}	T6	INTR2
A13	D20	D15	A31	L16	A10	T7	INTR0
A14	D21	D16	A28	L17	A11	T8	BINV
A15	D25	D17	A26	M1	I29	T9	BGRT
A16	D27	E1	I13	M2	I30	T10	DREQ
A17	GND	E2	I12	M3	GND	T11	LOCK
B1	I6	E3	V _{CC}	M15	GND	T12	MSERR
B2	I5	E15	GND	M16	A0	T13	STAT0
B3	I3	E16	A27	M17	A1	T14	SUP/US
B4	D0	E17	A23	N1	I31	T15	OPT1
B5	D1	F1	I16	N2	TEST	T16	A3
B6	D5	F2	I15	N3	SYSCLK	T17	A4
B7	D8	F3	I14	N15	GND	U1	GND
B8	D10	F15	A25	N16	MPGM1	U2	PEN
B9	D13	F16	A24	N17	MPGM0	U3	IERR
B10	D15	F17	A21	P1	CNTL1	U4	IBACK
B11	D17	G1	I19	P2	CNTL0	U5	INTR3
B12	D19	G2	I18	P3	PWRCLK	U6	INTR1
B13	D23	G3	I17	P15	A5	U7	TRAP0
B14	D24	G15	A22	P16	A8	U8	IBREQ
B15	D28	G16	A20	P17	A9	U9	IREQ
B16	D29	G17	A19	R1	RESET	U10	PIA
B17	A30	H1	I20	R2	CDA	U11	R/W
C1	I9	H2	I22	R3	DRDY	U12	DREQT1
C2	I8	H3	I21	R4	DBACK	U13	DREQT0
C3	I4	H15	GND	R5	GND	U14	STAT1
C4	I2	H16	A18	R6	V _{CC}	U15	IREQT
C5	GND	H17	A17	R7	TRAP1	U16	OPT2
C6	D3	J1	I23	R8	GND	U17	GND
C7	D7	J2	I24	R9	DBREQ		
C8	V _{CC}	J3	GND	R10	PDA		
C9	V _{CC}	J15	A15	R11	V _{CC}		

♦ **Note:**

- ♦ Pin Number D4 is the alignment pin and is electrically connected to the package lid.

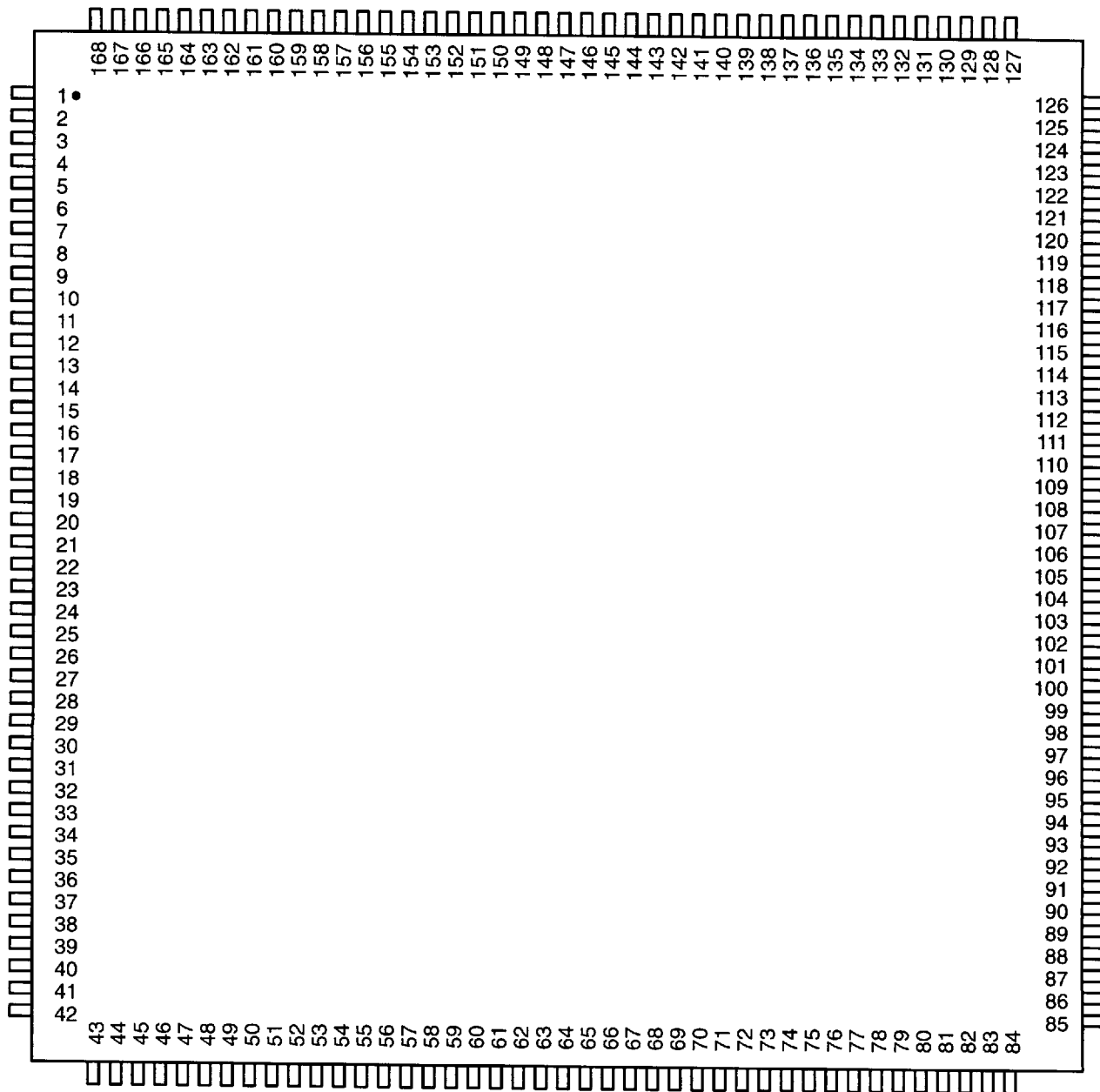
PGA PIN DESIGNATIONS (Sorted by Pin Name)—Am29000 Microprocessor Only

Pin Name	Pin No.	Pin Name	Pin No.	Pin Name	Pin No.	Pin Name	Pin No.
A0	M16	D5	B6	GND	K3	INCLK	T1
A1	M17	D6	A6	GND	N15	INTR0	T7
A2	R15	D7	C7	GND	R5	INTR1	U6
A3	T16	D8	B7	GND	U1	INTR2	T6
A4	T17	D9	A7	GND	R13	INTR3	U5
A5	P15	D10	B8	GND	R8	IRDY	T4
A6	R16	D11	A8	GND	M3	IREQ	U9
A7	R17	D12	A9	GND	U17	IREQT	U15
A8	P16	D13	B9	I0	A3	LOCK	T11
A9	P17	D14	A10	I1	A2	MPGM0	N17
A10	L16	D15	B10	I2	C4	MPGM1	N16
A11	L17	D16	A11	I3	B3	MSERR	T12
A12	K16	D17	B11	I4	C3	OPT0	R14
A13	K17	D18	A12	I5	B2	OPT1	T15
A14	J17	D19	B12	I6	B1	OPT2	U16
A15	J15	D20	A13	I7	D3	PDA	R10
A16	J16	D21	A14	I8	C2	PEN	U2
A17	H17	D22	C12	I9	C1	PIA	U10
A18	H16	D23	B13	I10	D2	PIN169	D4*
A19	G17	D24	B14	I11	D1	PWRCLK	P3
A20	G16	D25	A15	I12	E2	R/W	U11
A21	F17	D26	C13	I13	E1	RESET	R1
A22	G15	D27	A16	I14	F3	STAT0	T13
A23	E17	D28	B15	I15	F2	STAT1	U14
A24	F16	D29	B16	I16	F1	STAT2	R12
A25	F15	D30	C15	I17	G3	SUP/US	T14
A26	D17	D31	C16	I18	G2	SYSCLK	N3
A27	E16	DBACK	R4	I19	G1	TEST	N2
A28	D16	DBREQ	R9	I20	H1	TRAP0	U7
A29	C17	DERR	T3	I21	H3	TRAP1	R7
A30	B17	DRDY	R3	I22	H2	V _{CC}	C14
A31	D15	DREQ	T10	I23	J1	V _{CC}	L15
BGRT	T9	DREQT0	U13	I24	J2	V _{CC}	C8
BINV	T8	DREQT1	U12	I25	K2	V _{CC}	C9
BREQ	T2	GND	E15	I26	K1	V _{CC}	E3
CDA	R2	GND	H15	I27	L1	V _{CC}	K15
CNTL0	P2	GND	M15	I28	L2	V _{CC}	L3
CNTL1	P1	GND	C10	I29	M1	V _{CC}	R6
D0	B4	GND	A1	I30	M2	V _{CC}	R11
D1	B5	GND	A17	I31	N1	WARN	T5
D2	A4	GND	C5	IBACK	U4		
D3	C6	GND	C11	IBREQ	U8		
D4	A5	GND	J3	IERR	U3		

Note:

- * Pin Number D4 is the alignment pin and is electrically connected to the package lid.

CONNECTION DIAGRAMS (continued)
168-Pin PQFP—Am29000 and Am29005 Microprocessors
Top View



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PQFP PIN DESIGNATIONS (Sorted by Pin Number)—Am29000 and Am29005 Microprocessors

Pin No.	Pin Name	Pin No.	Pin Name	Pin No.	Pin Name	Pin No.	Pin Name
1	DRDY	43	V _{CC}	85	GND	127	GND
2	CDA	44	I3	86	A31	128	OPT0
3	INCLK	45	I2	87	A30	129	OPT1
4	PWRCLK	46	I1	88	A29	130	OPT2
5	SYSCLK	47	GND	89	A28	131	SUP/US
6	GND	48	I0	90	A27	132	IREQT
7	V _{CC}	49	D0	91	A26	133	STAT0
8	GND	50	D1	92	A25	134	STAT1
9	RESET	51	D2	93	A24	135	STAT2
10	CNTL0	52	D3	94	A23	136	MSERR
11	CNTL1	53	D4	95	A22	137	DREQT0
12	TEST	54	D5	96	A21	138	DREQT1
13	I31	55	D6	97	A20	139	LOCK
14	I30	56	D7	98	A19	140	R/W
15	I29	57	D8	99	A18	141	DREQ
16	I28	58	D9	100	A17	142	PDA
17	I27	59	D10	101	A16	143	PIA
18	I26	60	D11	102	A15	144	IREQ
19	I25	61	D12	103	GND	145	BGRT
20	I24	62	D13	104	V _{CC}	146	DBREQ
21	GND	63	D14	105	V _{CC}	147	IBREQ
22	V _{CC}	64	V _{CC}	106	A14	148	BINV
23	I23	65	GND	107	A13	149	V _{CC}
24	I22	66	D15	108	A12	150	V _{CC}
25	I21	67	D16	109	A11	151	GND
26	I20	68	D17	110	A10	152	V _{CC}
27	I19	69	D18	111	A1	153	GND
28	I18	70	D19	112	A0	154	TRAP0
29	I17	71	D20	113	MPGM0*	155	TRAP1
30	I16	72	D21	114	MPGM1*	156	INTR0
31	I15	73	D22	115	V _{CC}	157	INTR1
32	I14	74	D23	116	V _{CC}	158	INTR2
33	I13	75	D24	117	A9	159	INTR3
34	I12	76	D25	118	A8	160	WARN
35	I11	77	D26	119	A7	161	IBACK
36	I10	78	D27	120	A6	1652	IRDY
37	I9	79	D28	121	A5	163	IERR
38	I8	80	D29	122	A4	164	DERR
39	I7	81	D30	123	A3	165	DBACK
40	I6	82	D31	124	A2	166	PEN
41	I5	83	GND	125	GND	167	BREQ
42	I4	84	V _{CC}	126	GND	168	GND

Note:

* MPGM0 and MPGM1 apply only to the Am29000 microprocessor.

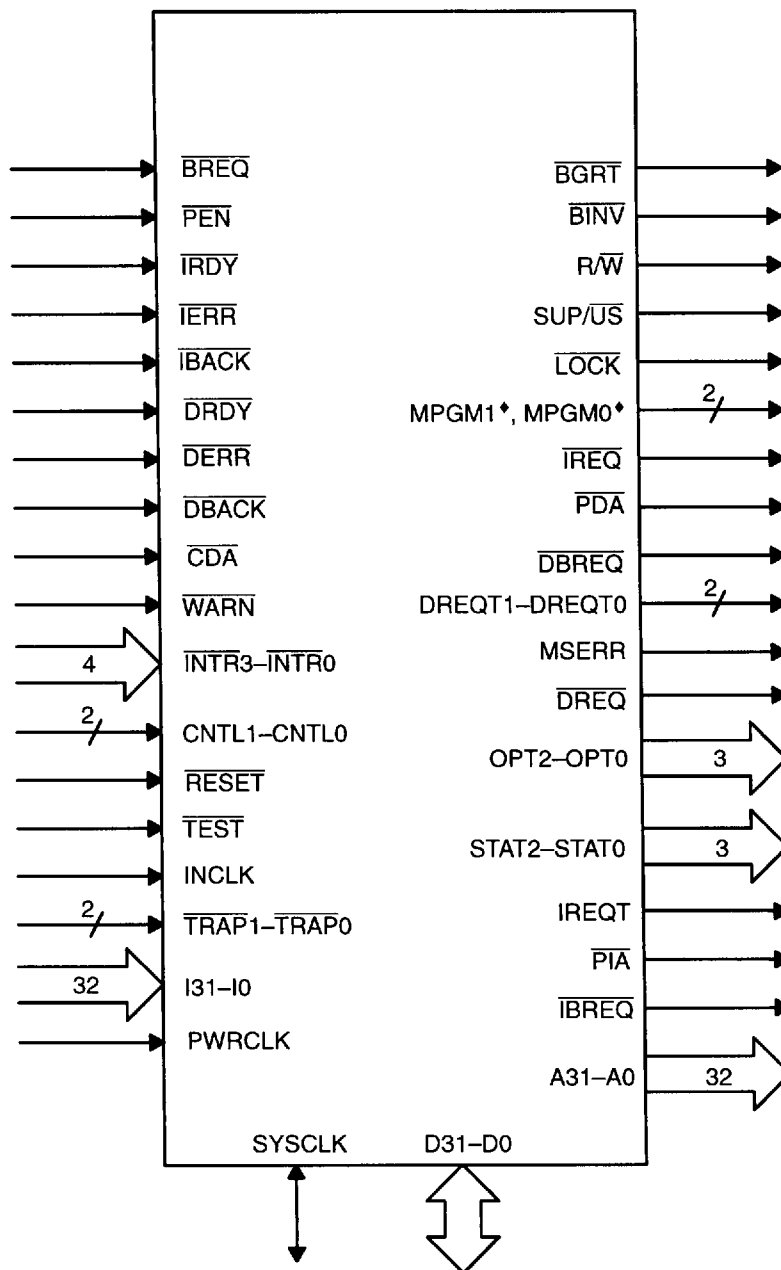
PQFP PIN DESIGNATIONS (Sorted by Pin Name)—Am29000 and Am29005 Microprocessors

Pin Name	Pin No.	Pin Name	Pin No.	Pin Name	Pin No.	Pin Name	Pin No.
A0	112	D4	53	GND	103	INCLK	3
A1	111	D5	54	GND	125	INTR0	156
A2	124	D6	55	GND	126	INTR1	157
A3	123	D7	56	GND	127	INTR2	158
A4	122	D8	57	GND	151	INTR3	159
A5	121	D9	58	GND	153	IRDY	162
A6	120	D10	59	GND	168	IREQ	144
A7	119	D11	60	I0	48	IREQT	132
A8	118	D12	61	I1	46	LOCK	139
A9	117	D13	62	I2	45	MPGM0*	113
A10	110	D14	63	I3	44	MPGM1*	114
A11	109	D15	66	I4	42	MSERR	136
A12	108	D16	67	I5	41	OPT0	128
A13	107	D17	68	I6	40	OPT1	129
A14	106	D18	69	I7	39	OPT2	130
A15	102	D19	70	I8	38	PDA	142
A16	101	D20	71	I9	37	PEN	166
A17	100	D21	72	I10	36	PIA	143
A18	99	D22	73	I11	35	PWRCLK	4
A19	98	D23	74	I12	34	R/W	140
A20	97	D24	75	I13	33	RESET	9
A21	96	D25	76	I14	32	STAT0	133
A22	95	D26	77	I15	31	STAT1	134
A23	94	D27	78	I16	30	STAT2	135
A24	93	D28	79	I17	29	SUP/US	131
A25	92	D29	80	I18	28	SYSCLK	5
A26	91	D30	81	I19	27	TEST	12
A27	90	D31	82	I20	26	TRAP0	154
A28	89	DBACK	165	I21	25	TRAP1	155
A29	88	DBREQ	146	I22	24	V _{CC}	7
A30	87	DERR	164	I23	23	V _{CC}	22
A31	86	DRDY	1	I24	20	V _{CC}	43
BGRT	145	DREQ	141	I25	19	V _{CC}	64
BINV	148	DREQT0	137	I26	18	V _{CC}	84
BREQ	167	DREQT1	138	I27	17	V _{CC}	104
CDA	2	GND	6	I28	16	V _{CC}	105
CNTL0	10	GND	8	I29	15	V _{CC}	115
CNTL1	11	GND	21	I30	14	V _{CC}	116
D0	49	GND	47	I31	13	V _{CC}	149
D1	50	GND	65	IBACK	161	V _{CC}	150
D2	51	GND	83	IBREQ	147	V _{CC}	152
D3	52	GND	85	IERR	163	WARN	160

Note:

* MPGM0 and MPGM1 apply only to the Am29000 microprocessor.

LOGIC SYMBOL



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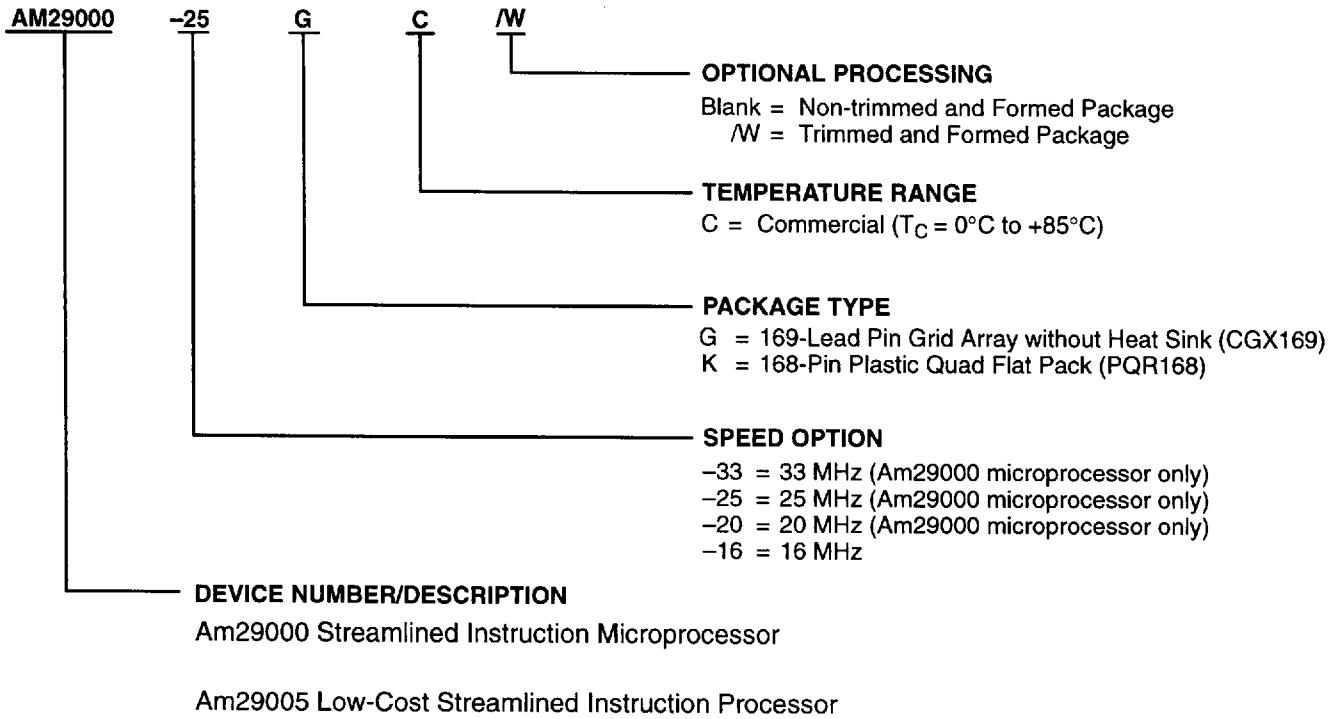
Note:

♦ *MPGM1 and MPGM0 apply only to the Am29000 microprocessor.*

ORDERING INFORMATION

Standard Products

AMD standard products are available in several packages and operating ranges. The ordering number (Valid Combination) is formed by a combination of the following elements.



Valid Combinations	
AM29000-16	KC/W, GC, KC
AM29000-20	
AM29000-25	GC
AM29000-33	GC
AM29005-16	KC, KC/W

Valid Combinations

Valid Combinations list configurations planned to be supported in volume for this device. Consult the local AMD sales office to confirm availability of specific valid combinations or to check on newly released combinations, and to obtain additional data on AMD's standard military grade products.

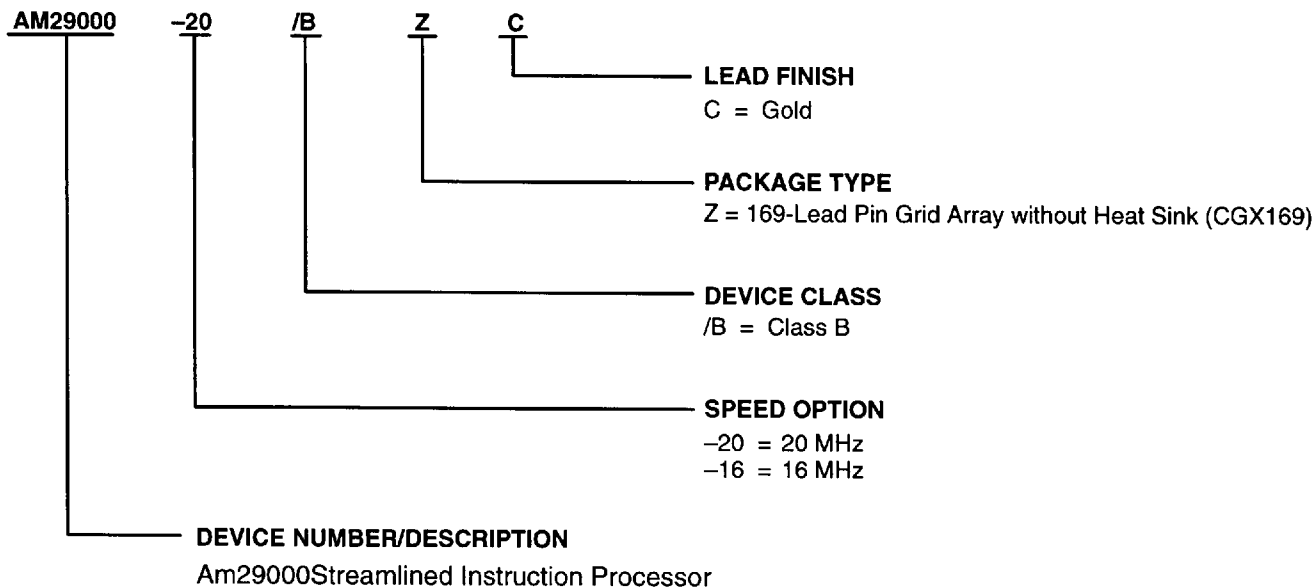
Note: /W denotes a trimmed and formed package.

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MILITARY ORDERING INFORMATION

APL Products

AMD products for Aerospace and Defense applications are available in several packages and operating ranges. APL (Approved Products List) products are fully compliant with MIL-STD-883 requirements. The ordering number (Valid Combination) is formed by a combination of the following elements.



Valid Combinations	
AM29000-20	/BZC
AM29000-16	

Valid Combinations

Valid Combinations list configurations planned to be supported in volume for this device. Consult the local AMD sales office to confirm availability of specific valid combinations or to check on newly released combinations.

PIN DESCRIPTIONS

Although certain outputs are described as being three-state or bidirectional outputs, all outputs (except MSERR) may be placed in a high-impedance state by the Test mode. The three-state and bidirectional terminology in this section is for those outputs (except SYCLK) that are disabled when the processor grants the channel to another master.

A31–A0

Address Bus (Three-state Output; Synchronous)

The Address Bus transfers the byte address for all accesses except Burst-mode accesses. For Burst-mode accesses, it transfers the address for the first access in the sequence.

$\overline{\text{BGRT}}$

Bus Grant (Output; Synchronous)

This output signals to an external master that the processor is relinquishing control of the channel in response to $\overline{\text{BREQ}}$.

$\overline{\text{BINV}}$

Bus Invalid (Output; Synchronous)

This output indicates that the address bus and related controls are invalid. It defines an idle cycle for the channel.

$\overline{\text{BREQ}}$

Bus Request (Input; Synchronous)

This input allows other masters to arbitrate for control of the processor channel.

$\overline{\text{CDA}}$

Coprocessor Data Accept (Input; Synchronous)

This signal allows the coprocessor to indicate the acceptance of operands or operation codes. For transfers to the coprocessor, the processor does not expect a $\overline{\text{DRDY}}$ response; an active level on $\overline{\text{CDA}}$ performs the function normally performed by $\overline{\text{DRDY}}$. $\overline{\text{CDA}}$ may be active whenever the coprocessor is able to accept transfers.

CNTL1–CNTL0

CPU Control (Input; Asynchronous)

These inputs control the processor mode:

CNTL1	CNTL0	Mode
0	0	Load Test Instruction
0	1	Step
1	0	Halt
1	1	Normal

D31–D0

Data Bus (Bidirectional; Synchronous)

The Data Bus transfers data to and from the processor for load and store operations.

$\overline{\text{DBACK}}$

Data Burst Acknowledge (Input; Synchronous)

This input is active whenever a Burst-mode data access has been established. It may be active even though no data is currently being accessed.

$\overline{\text{DBREQ}}$

Data Burst Request (Three-state Output; Synchronous)

This signal is used to establish a Burst-mode data access and to request data transfers during a Burst-mode data access. $\overline{\text{DBREQ}}$ may be active even though the address bus is being used for an instruction access. This signal becomes valid late in the cycle, with respect to $\overline{\text{DREQ}}$.

$\overline{\text{DERR}}$

Data Error (Input; Synchronous)

This input indicates that an error occurred during the current data access. For a load, the processor ignores the content of the data bus. For a store, the access is terminated. In either case, a Data Access Exception trap occurs. The processor ignores this signal if there is no pending data access.

$\overline{\text{DRDY}}$

Data Ready (Input; Synchronous)

For loads, this input indicates that valid data is on the data bus. For stores, it indicates that the access is complete and that data no longer needs to be driven on the data bus. The processor ignores this signal if there is no pending data access.

$\overline{\text{DREQ}}$

Data Request (Three-state Output; Synchronous)

This signal requests a data access. When it is active, the address for the access appears on the address bus.

DREQT1–DREQT0

Data Request Type

(Three-state Output; Synchronous)

These signals specify the address space of a data access as follows (the value “x” is a “don’t care”):

DREQT1	DREQT0	Mode
0	0	Instruction/data memory access
0	1	Input/output access
1	x	Coprocessor transfer

An interrupt/trap vector request is indicated as a data-memory read. If required, the system can identify the vector fetch by the STAT2–STAT0 outputs. DREQT1–DREQT0 are valid only when \overline{DREQ} is active.

I31–I0

Instruction Bus (Input; Synchronous)

The Instruction Bus transfers instructions to the processor.

\overline{IBACK}

Instruction Burst Acknowledge (Input; Synchronous)

This input is active whenever a Burst-mode instruction access has been established. \overline{IBACK} may be active even though no instructions are currently being accessed.

\overline{IBREQ}

Instruction Burst Request (Three-state Output; Synchronous)

This signal is used to establish a Burst-mode instruction access and to request instruction transfers during a Burst-mode instruction access. \overline{IBREQ} may be active even though the address bus is being used for a data access. This signal becomes valid late in the cycle with respect to \overline{IREQ} .

\overline{IERR}

Instruction Error (Input; Synchronous)

This input indicates that an error occurred during the current instruction access. The processor ignores the content of the instruction bus, and an Instruction Access Exception trap occurs if the processor attempts to execute the invalid instruction. The processor ignores this signal if there is no pending instruction access.

INCLK

Input Clock (Input)

When the processor generates the clock for the system, this is an oscillator input to the processor at twice the processor's operating frequency. In systems where the clock is not generated by the processor, this signal must be tied High or Low, except in certain master/slave configurations.

$\overline{INTR3}$ – $\overline{INTR0}$

Interrupt Request (Input; Asynchronous)

These inputs generate prioritized interrupt requests. The interrupt caused by $\overline{INTR0}$ has the highest priority, and the interrupt caused by $\overline{INTR3}$ has the lowest priority. The interrupt requests are masked in prioritized order by the Interrupt Mask field in the Current Processor Status Register.

\overline{IRDY}

Instruction Ready (Input; Synchronous)

This input indicates that a valid instruction is on the instruction bus. The processor ignores this signal if there is no pending instruction access.

\overline{IREQ}

Instruction Request (Three-state Output; Synchronous)

This signal requests an instruction access. When it is active, the address for the access appears on the address bus.

IREQT

Instruction Request Type (Three-state Output; Synchronous)

This signal specifies the address space of an instruction request when \overline{IREQ} is active:

IREQT	Mode
0	Instruction/data memory access
1	Instruction read-only memory access

LOCK

Lock (Three-state Output; Synchronous)

This output allows the implementation of various channel and device interlocks. It may be active only for the duration of an access, or active for an extended period of time under control of the Lock bit in the Current Processor Status.

MPGM1–MPGM0

MMU Programmable (Three-state Output; Synchronous)

In the Am29000 microprocessor, these outputs reflect the value of two PGM bits in the Translation Look-Aside Buffer entry associated with the access. If no address translation is performed, these signals are both Low.

These outputs have no function in the Am29005 microprocessor and are always driven Low on an access. They are defined to ensure pin compatibility with the Am29000 microprocessor.

MSERR

Master/Slave Error (Output; Synchronous)

This output shows the result of the comparison of processor outputs with the signals provided internally to the off-chip drivers. If there is a difference for any enabled driver, this line is asserted.

OPT2–OPT0

Option Control

(Three-state Output; Synchronous)

These outputs reflect the value of bits 18–16 of the load or store instruction that begins an access. Bit 18 of the instruction is reflected on OPT2, bit 17 on OPT1, and bit 16 on OPT0.

The standard definitions of these signals (based on DREQT) are as follows (the value “x” is a “don’t care”):

DREQT1	DREQT0	OPT2	OPT1	OPT0	Meaning
0	x	0	0	0	Word-length access
0	x	0	0	1	Byte access
0	x	0	1	0	Half-word access
0	0	1	0	0	Instruction ROM access (as data)
0	0	1	0	1	Cache control
0	0	1	1	0	In-circuit emulator accesses
—All Others—					Reserved

During an interrupt/trap vector fetch, the OPT2–OPT0 signals indicate a word-length access (000). Also, the system should return an entire aligned word for a read, regardless of the indicated data length.

The Am29000/005 microprocessor does not explicitly prevent a store to the instruction ROM. OPT2–OPT0 are valid only when \overline{DREQ} is active.

PDA

Pipelined Data Access

(Three-state Output; Synchronous)

If \overline{DREQ} is not active, this output indicates that a data access is pipelined with another in-progress data access. The indicated access cannot be completed until the first access is complete. The completion of the first access is signaled by the assertion of \overline{DREQ} .

PEN

Pipeline Enable (Input; Synchronous)

This signal allows devices that can support pipelined accesses (i.e., that have input latches for the address and required controls) to signal that a second access may begin while the first is being completed.

PIA

Pipelined Instruction Access

(Three-state Output; Synchronous)

If \overline{IREQ} is not active, this output indicates that an instruction access is pipelined with another in-progress instruction access. The indicated access cannot be completed until the first access is complete. The completion of the first access is signaled by the assertion of \overline{IREQ} .

R/W

Read/Write (Three-state Output; Synchronous)

This signal indicates whether data is being transferred from the processor to the system, or from the system to the processor. R/W is valid only when the address bus is valid. R/W will be High when \overline{IREQ} is active.

RESET

Reset (Input; Asynchronous)

This input places the processor in the Reset mode.

STAT2–STAT0

CPU Status (Output; Synchronous)

These outputs indicate the state of the processor’s execution stage on the previous cycle. They are encoded as follows:

STAT2	STAT1	STAT0	Condition
0	0	0	Halt or Step Modes
0	0	1	Pipeline Hold Mode
0	1	0	Load Test Instruction Mode, Halt/Freeze
0	1	1	Wait Mode
1	0	0	Interrupt Return
1	0	1	Taking Interrupt or Trap
1	1	0	Non-sequential Instruction
1	1	1	Fetch Executing Mode

SUP/US

Supervisor/User Mode

(Three-state Output; Synchronous)

This output indicates the program mode for an access. The processor does not relinquish the channel (in response to \overline{BREQ}) when \overline{LOCK} is active.

SYSCLK

System Clock (Bidirectional)

This is either a clock output with a frequency that is half that of INCLK, or an input from an external clock generator at the processor’s operating frequency.

TEST

Test Mode (Input; Asynchronous)

When this input is active, the processor is in Test mode. All outputs and bidirectional lines, except MSERR, are forced to the state.

TRAP1–TRAP0

Trap Request (Input; Asynchronous)

These inputs generate prioritized trap requests. The trap caused by TRAP0 has the highest priority. These trap requests are disabled by the DA bit of the Current Processor Status Register.

WARN

Warn (Input; Asynchronous; Edge-sensitive)

A High-to-Low transition on this input causes a non-maskable $\overline{\text{WARN}}$ trap to occur. This trap bypasses the normal trap vector fetch sequence, and is useful in situations where the vector fetch may not work (e.g., when data memory is faulty).

The following pins are not signal pins, but are named in Am29000 and Am29005 microprocessor documentation because of their special role in the processor and system.

PWRCLK

Power Supply for SYSCLK Driver

This pin is a power supply for the SYSCLK output driver. It isolates the SYSCLK driver and is used to determine whether or not the Am29000 or Am29005 microprocessor generates the clock for the system. If power (+5 V) is applied to this pin, the Am29000 or Am29005 microprocessor generates a clock on the SYSCLK output. If this pin is grounded, the Am29000 or Am29005 microprocessor accepts a clock generated by the system on the SYSCLK input.

PIN169 (PGA Package Only)

Alignment pin

In the PGA package, this pin is used to indicate proper pin-alignment of the Am29000 microprocessor and is used by the in-circuit emulator(s) to communicate its presence to the system. This pin does not exist on the Am29000 or Am29005 microprocessor in the PQFP package.

ABSOLUTE MAXIMUM RATINGS

Storage Temperature -65°C to $+150^{\circ}\text{C}$
 Voltage on any Pin
 with Respect to GND -0.5 V to $V_{\text{CC}} + 0.5\text{ V}$

Stresses above those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent device failure. Functionality at or above these limits is not implied. Exposure to absolute maximum ratings for extended periods may affect device reliability.

OPERATING RANGES

Commercial (C) Devices

Case Temperature (T_{C}) 0°C to $+85^{\circ}\text{C}$
 Supply Voltage (V_{CC}) $+4.75\text{ V}$ to $+5.25\text{ V}$

Military (MIL) Devices

Case Temperature (T_{C}) -55°C to $+125^{\circ}\text{C}$
 Supply Voltage (V_{CC}) $+4.5\text{ V}$ to $+5.5\text{ V}$

Operating ranges define those limits between which the functionality of the device is guaranteed.

DC CHARACTERISTICS over COMMERCIAL and MILITARY operating ranges

Symbol	Parameter Description	Test Conditions	Min	Max	Unit
V_{IL}	Input Low Voltage		-0.5	0.8	V
V_{IH}	Input High Voltage		2.0	$V_{\text{CC}} + 0.5$	V
V_{ILINCLK}	INCLK Input Low Voltage		-0.5	0.8	V
V_{IHINCLK}	INCLK Input High Voltage		2.0	$V_{\text{CC}} + 0.5$	V
V_{ILSYSCLK}	SYSCLOCK Input Low Voltage		-0.5	0.8	V
V_{IHSYSCLK}	SYSCLOCK Input High Voltage		$V_{\text{CC}} - 0.8$	$V_{\text{CC}} + 0.5$	V
V_{OL}	Output Low Voltage for All Outputs except SYSCLOCK	$I_{\text{OL}} = 3.2\text{ mA}$		0.45	V
V_{OH}	Output High Voltage for all Outputs except SYSCLOCK	$I_{\text{OH}} = -400\text{ }\mu\text{A}$	2.4		V
I_{LI}	Input Leakage Current	$0.45\text{ V} \leq V_{\text{IN}} \leq V_{\text{CC}} - 0.45\text{ V}$		± 10	μA
I_{LO}	Output Leakage Current	$0.45\text{ V} \leq V_{\text{OUT}} \leq V_{\text{CC}} - 0.45\text{ V}$		± 10	μA
I_{CCOP}	Operating Power Supply Current	$V_{\text{CC}} = 5.25\text{ V}$, Outputs Floating; Holding RESET active with externally supplied SYSCLOCK		22 (C) 25 (MIL)	mA/MHz
V_{OLC}	SYSCLOCK Output Low Voltage	$I_{\text{OLC}} = 20\text{ mA}$		0.6	V
V_{OHC}	SYSCLOCK Output High Voltage	$I_{\text{OHC}} = 20\text{ mA}$	$V_{\text{CC}} - 0.6$		V
I_{OSGND}	SYSCLOCK GND Short Circuit Current	$V_{\text{CC}} = 5.0\text{ V}$	100		mA
I_{OSVCC}	SYSCLOCK V_{CC} Short Circuit Current	$V_{\text{CC}} = 5.0\text{ V}$	100		mA

CAPACITANCE

Symbol	Parameter Description	Test Conditions	Min	Max	Unit
C_{IN}	Input Capacitance			15	pF
C_{INCLK}	INCLK Input Capacitance			20	pF
C_{SYSCLK}	SYSCLOCK Capacitance	$f_{\text{C}} = 1\text{ MHz}$ (Note 1)		90	pF
C_{OUT}	Output Capacitance			20	pF
$C_{\text{I/O}}$	I/O Pin Capacitance			20	pF

Note:

1. Not 100% tested.

SWITCHING CHARACTERISTICS over COMMERCIAL operating ranges

Am29000 Microprocessor Only

No.	Parameter Description	Notes	33 MHz		25 MHz		Unit
			Min	Max	Min	Max	
1	System Clock (SYSCLK); Period (T)	1	30	125	40	125	ns
1A	SYSCLK at 1.5 V to $\overline{\text{SYSCLK}}$ at 1.5 V when used as an output	13	$0.5T - 1$	$0.5T + 1$	$0.5T - 1$	$0.5T + 1$	ns
2	SYSCLK High Time when used as input	13	14		19		ns
3	SYSCLK Low Time when used as input	13	13		17		ns
4	SYSCLK Rise Time	2		4		5	ns
5	SYSCLK Fall Time	2		4		5	ns
6	Synchronous SYSCLK Output Valid Delay	3, 12	2	12	2	14	ns
6A	Synchronous SYSCLK Output Valid Delay for D31–D0	12	2	14	2	18	ns
7	Three-State Synchronous SYSCLK Output Invalid Delay	4, 14, 15	2	20	2	30	ns
8	Synchronous SYSCLK Output Valid Delay	5, 12	2	10	2	14	ns
8A	Three-State SYSCLK Synchronous Output Invalid Delay	5, 14, 15	2	20	2	30	ns
9	Synchronous Input Setup Time	7	10		12		ns
9A	Synchronous Input Setup Time for D31–D0, I31–I0		4		6		ns
9B	Synchronous Input Setup Time for $\overline{\text{DRDY}}$		11		13		ns
10	Synchronous Input Hold Time	6	2		2		ns
11	Asynchronous Input Minimum Pulse Width	8	$T + 10$		$T + 10$		ns
12	INCLK Period		15	62.5	20	62.5	ns
12A	INCLK to SYSCLK Delay		2	8	2	10	ns
12B	INCLK to $\overline{\text{SYSCLK}}$ Delay		2	8	2	10	ns
13	INCLK Low Time		3.5		8		ns
14	INCLK High Time		3.5		8		ns
15	INCLK Rise Time			3		5	ns
16	INCLK Fall Time			3		5	ns
17	INCLK to Deassertion of $\overline{\text{RESET}}$ (for phase synchronization of SYSCLK)	9	0	4	0	5	ns
18	$\overline{\text{WARN}}$ Asynchronous Deassertion Hold Minimum Pulse Width	10	$4T$		$4T$		ns
19	$\overline{\text{BINV}}$ Synchronous Output Valid Delay from SYSCLK	12	0	6	0	7	ns
20	Three-State Synchronous SYSCLK Output Invalid Delay for D31–D0	11, 14, 15	2	15	2	20	ns

SWITCHING CHARACTERISTICS over COMMERCIAL operating ranges

Am29000 and Am29005 Microprocessors

No.	Parameter Description	Notes	20 MHz*		16 MHz**		Unit
			Min	Max	Min	Max	
1	System Clock (SYSCLK); Period (T)	1	50	125	60	125	ns
1A	SYSCLK at 1.5 V to $\overline{\text{SYSCLK}}$ at 1.5 V when used as an output	13	$0.5T - 1$	$0.5T + 1$	$0.5T - 2$	$0.5T + 2$	ns
2	SYSCLK High Time when used as input	13	22		27		ns
3	SYSCLK Low Time when used as input	13	19		22		ns
4	SYSCLK Rise Time	2		5		5	ns
5	SYSCLK Fall Time	2		5		5	ns
6	Synchronous SYSCLK Output Valid Delay	3, 12	2	16	2	16	ns
6A	Synchronous SYSCLK Output Valid Delay for D31–D0	12	2	20	2	20	ns
7	Three-State Synchronous SYSCLK Output Invalid Delay	4, 14, 15	2	30	2	30	ns
8	Synchronous $\overline{\text{SYSCLK}}$ Output Valid Delay	5, 12	2	16	2	16	ns
8A	Three-State $\overline{\text{SYSCLK}}$ Synchronous Output Invalid Delay	5, 14, 15	2	30	2	30	ns
9	Synchronous Input Setup Time	7	15		15		ns
9A	Synchronous Input Setup Time for D31–D0, I31–I0		8		8		ns
9B	Synchronous Input Setup Time for $\overline{\text{DRDY}}$		16		16		ns
10	Synchronous Input Hold Time	6	2		2		ns
11	Asynchronous Input Minimum Pulse Width	8	$T + 10$		$T + 10$		ns
12	INCLK Period		25	62.5	30	62.5	ns
12A	INCLK to SYSCLK Delay		2	12	2	15	ns
12B	INCLK to $\overline{\text{SYSCLK}}$ Delay		2	12	2	15	ns
13	INCLK Low Time		10		12		ns
14	INCLK High Time		10		12		ns
15	INCLK Rise Time			5		5	ns
16	INCLK Fall Time			5		5	ns
17	INCLK to Deassertion of $\overline{\text{RESET}}$ (for phase synchronization of SYSCLK)	9	0	5	0	5	ns
18	$\overline{\text{WARN}}$ Asynchronous Deassertion Hold Minimum Pulse Width	10	$4T$		$4T$		ns
19	$\overline{\text{BINV}}$ Synchronous Output Valid Delay from $\overline{\text{SYSCLK}}$	12	0	8	0	9	ns
20	Three-State Synchronous SYSCLK output invalid delay for D31–D0	11, 14, 15	2	25	2	25	ns

Notes:

* 20 MHz applies to the Am29000 microprocessor only.

** 16 MHz applies to both the Am29000 and Am29005 microprocessors.

SWITCHING CHARACTERISTICS over MILITARY operating ranges

Am29000 Microprocessor Only

No.	Parameter Description	Notes	20 MHz		16 MHz		Unit
			Min	Max	Min	Max	
1	System Clock (SYSCLK); Period (T)	1	50	125	60	125	ns
1A	SYSCLK at 1.5 V to $\overline{\text{SYSCLK}}$ at 1.5 V when used as an output	13	$0.5T - 1$	$0.5T + 1$	$0.5T - 2$	$0.5T + 2$	ns
2	SYSCLK High Time when used as input	13	22		27		ns
3	SYSCLK Low Time when used as input	13	19		22		ns
4	SYSCLK Rise Time	2		5		5	ns
5	SYSCLK Fall Time	2		5		5	ns
6	Synchronous SYSCLK Output Valid Delay	3, 12	0	16	0	16	ns
6A	Synchronous SYSCLK Output Valid Delay for D31–D0	12	0	20	0	20	ns
7	Three-State Synchronous SYSCLK Output Invalid Delay	4, 14, 15	0	30	0	30	ns
8	Synchronous $\overline{\text{SYSCLK}}$ Output Valid Delay	5, 12	0	16	0	16	ns
8A	Three-State $\overline{\text{SYSCLK}}$ Synchronous Output Invalid Delay	5, 14, 15	0	30	0	30	ns
9	Synchronous Input Setup Time	7	15		15		ns
9A	Synchronous Input Setup Time for D31–D0, I31–I0		8		8		ns
9B	Synchronous Input Setup Time for $\overline{\text{DRDY}}$		16		16		ns
10	Synchronous Input Hold Time	6	2		2		ns
11	Asynchronous Input Minimum Pulse Width	8	$T + 10$		$T + 10$		ns
12	INCLK Period		25	62.5	30	62.5	ns
12A	INCLK to SYSCLK Delay		2	12	2	15	ns
12B	INCLK to $\overline{\text{SYSCLK}}$ Delay		2	12	2	15	ns
13	INCLK Low Time		10		12		ns
14	INCLK High Time		10		12		ns
15	INCLK Rise Time			5		5	ns
16	INCLK Fall Time			5		5	ns
17	INCLK to Deassertion of $\overline{\text{RESET}}$ (for phase synchronization of SYSCLK)	9	0	5	0	5	ns
18	$\overline{\text{WARN}}$ Asynchronous Deassertion Hold Minimum Pulse Width	10	$4T$		$4T$		ns
19	$\overline{\text{BINV}}$ Synchronous Output Valid Delay from SYSCLK	12	0	8	0	9	ns
20	Three-State Synchronous SYSCLK output invalid delay for D31–D0	11, 14, 15	0	25	0	25	ns

Notes:

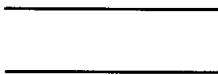




1. AC measurements made relative to 1.5 V, except where noted.
2. SYSCLK rise and fall times measured between 0.8 V and ($V_{CC} - 1.0$ V).
3. Synchronous Outputs relative to SYSCLK rising edge include: A_{31-A0} , \overline{BGRT} , R/\overline{W} , SUP/\overline{US} , \overline{LOCK} , $MPGM1-MPGM0$, \overline{IREQ} , \overline{IREQT} , \overline{PIA} , \overline{DREQ} , $\overline{DREQT1-DREQT0}$, \overline{PDA} , $\overline{OPT2-OPT0}$, $\overline{STAT2-STAT0}$, and \overline{MSERR} .
4. Three-state Synchronous Outputs relative to SYSCLK rising edge include: A_{31-A0} , R/\overline{W} , SUP/\overline{US} , \overline{LOCK} , $MPGM1-MPGM0$, \overline{IREQ} , \overline{IREQT} , \overline{PIA} , \overline{DREQ} , $\overline{DREQT1-DREQT0}$, \overline{PDA} , and $\overline{OPT2-OPT0}$.
5. Synchronous Outputs relative to SYSCLK falling edge (\overline{SYSCLK}): \overline{IBREQ} , \overline{DBREQ} .
6. Synchronous Inputs include: \overline{BREQ} , \overline{PEN} , \overline{IRDY} , \overline{IERR} , \overline{IBACK} , \overline{DERR} , \overline{DBACK} , \overline{CDA} , I_{31-I0} , \overline{DRDY} , and D_{31-D0} .
7. Synchronous Inputs include: \overline{BREQ} , \overline{PEN} , \overline{IRDY} , \overline{IERR} , \overline{IBACK} , \overline{DERR} , \overline{DBACK} , and \overline{CDA} .
8. Asynchronous Inputs include: \overline{WARN} , $\overline{INTR3-INTR0}$, $\overline{TRAP3-TRAP0}$, and $\overline{CNTL1-CNTL0}$.
9. \overline{RESET} is an asynchronous input on assertion/deassertion. As an option to the user, \overline{RESET} deassertion can be used to force the state of the internal divide-by-two flip-flop to synchronize the phase of SYSCLK (if internally generated) relative to $\overline{RESET}/INCLK$.
10. \overline{WARN} has a minimum pulse width requirement upon deassertion.
11. To guarantee Store/Load with one-cycle memories, D_{31-D0} must be asserted relative to SYSCLK falling edge from an external drive source.
12. Refer to Capacitive Output Delay table when capacitive loads exceed 80 pF.
13. When used as an input, SYSCLK presents a 90-pF maximum load to the external driver. When SYSCLK is used as an output, timing is specified with an external load capacitance of ≤ 200 pF.
14. Three-State Output Inactive Test Load. Three-State Synchronous Output Invalid Delay is measured as the time to a ± 500 mV change from prior output level.
15. When a three-state output makes a synchronous transition from a valid logic level to a high-impedance state, data is guaranteed to be held valid for an amount of time equal to the lesser of the minimum Three-state Synchronous Output Invalid Delay and the minimum Synchronous Output Valid Delay.

Conditions:

- a. All inputs/outputs are TTL compatible for V_{IH} , V_{IL} , V_{OH} , and V_{OL} unless otherwise noted.
- b. All output timing specifications are for 80 pF of loading.
- c. All setup, hold, and delay times are measured relative to SYSCLK or INCLK unless otherwise noted.
- d. All input Low levels must be driven to 0.45 V and all input High levels must be driven to 2.4 V except SYSCLK.

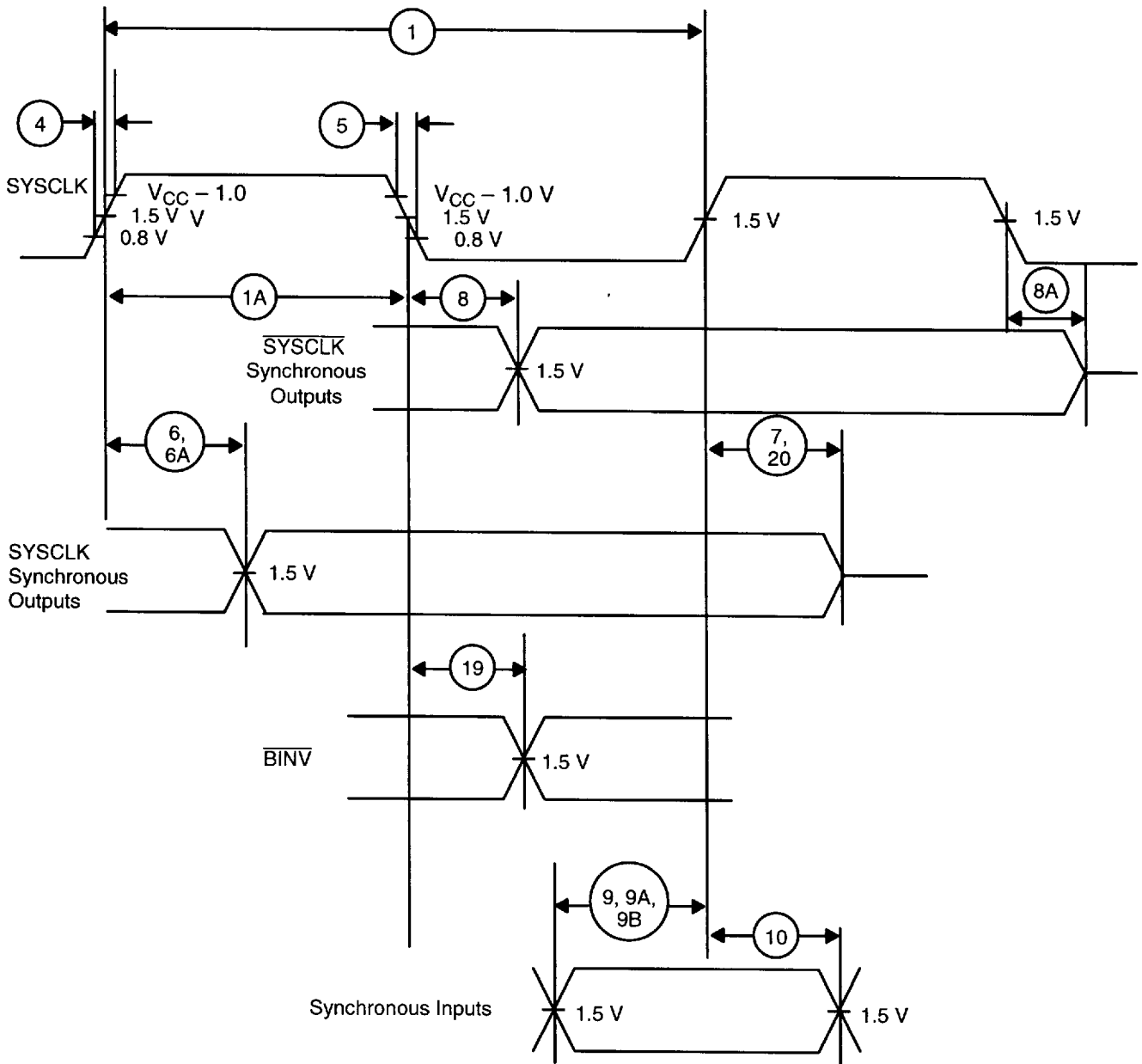
SWITCHING WAVEFORMS

Key To Switching Waveforms

WAVEFORM	INPUTS	OUTPUTS
	Must be Steady	Will be Steady
	May Change from H to L	Will be Changing from H to L
	May Change from L to H	Will be Changing from L to H
	Don't Care, Any Change Permitted	Changing, State Unknown
	Does Not Apply	Center Line is High-Impedance "Off" State

SWITCHING WAVEFORMS (continued)

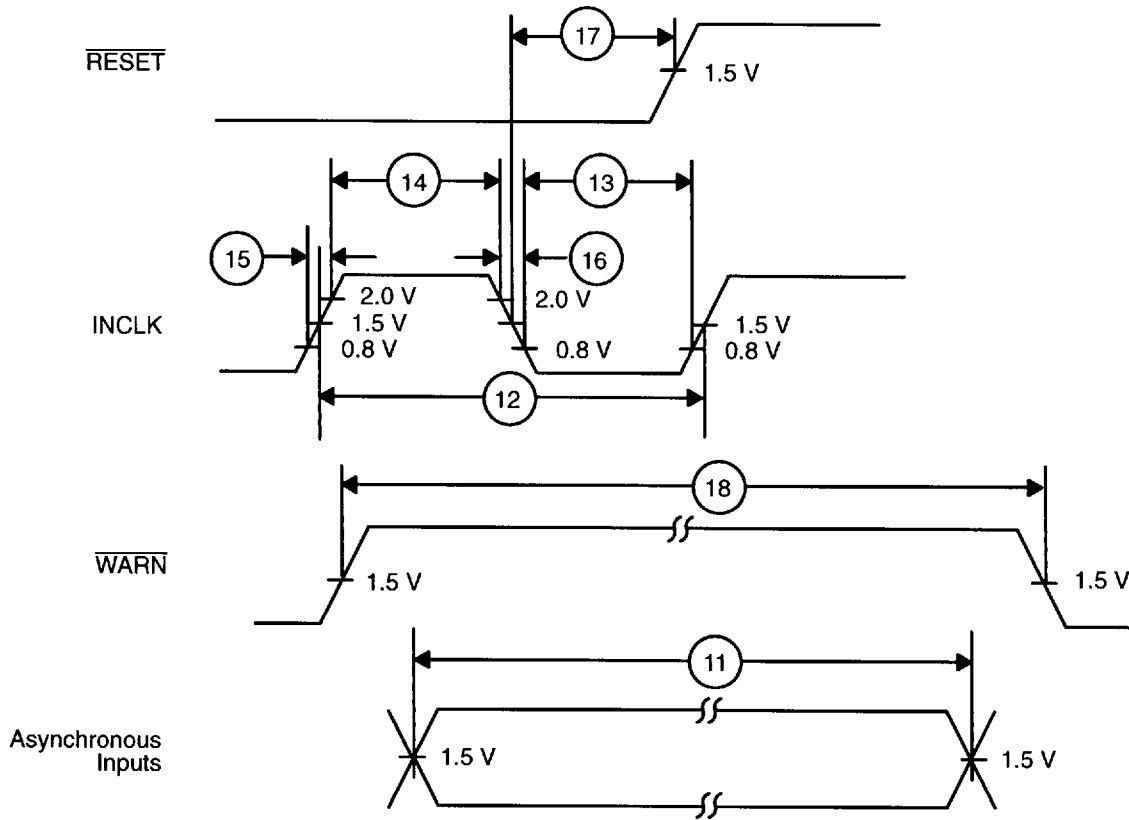
Relative to SYSCLK



09075-006A

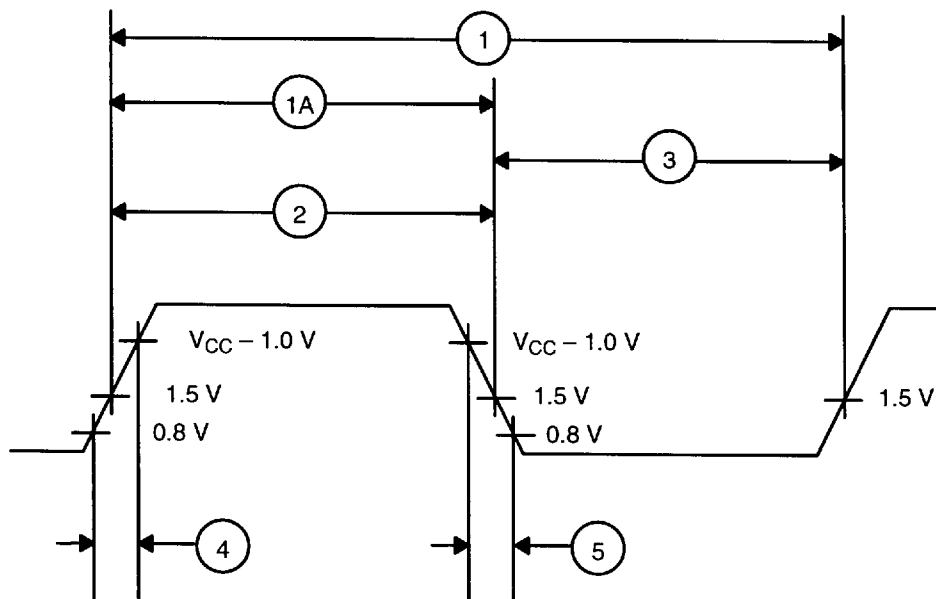
SWITCHING WAVEFORMS (continued)

INCLK and Asynchronous Inputs



09075-007A

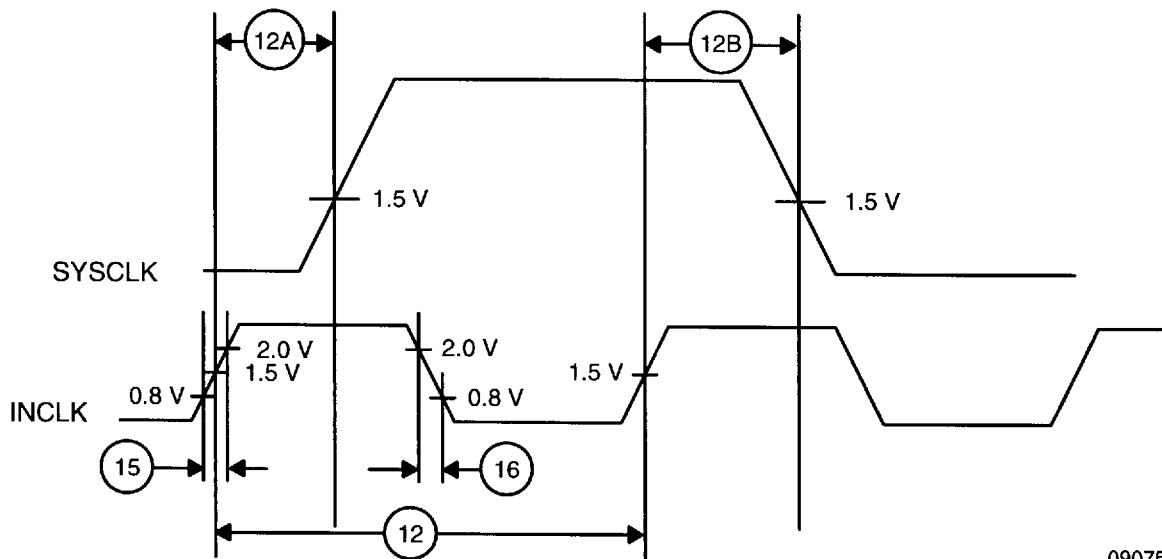
SYSCLK Definition



09075-008A

SWITCHING WAVEFORMS (continued)

INCLK to SYSCLK Delay



09075-009A

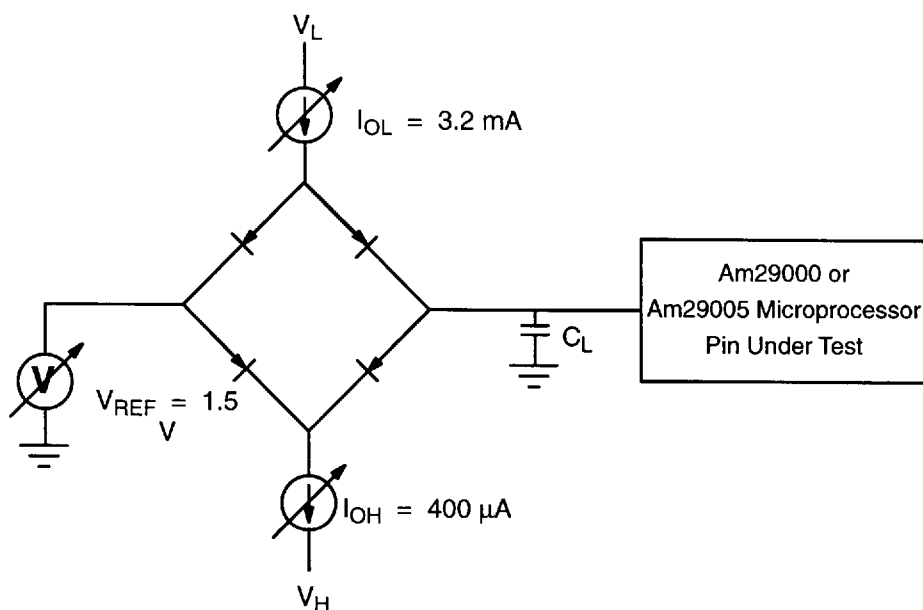
CAPACITIVE OUTPUT DELAYS

For loads greater than 80 pF

This table describes the additional output delays for capacitive loads greater than 80 pF. Values in the Maximum Additional Delay column should be added to the value listed in the Switching Characteristics table. For loads less than or equal to 80 pF, refer to the delays listed in the Switching Characteristics table.

No.	Parameter Description	Total External Capacitance	Maximum Additional Delay
6	Synchronous SYSCLK Output Valid Delay	100 pF	+1 ns
		150 pF	+2 ns
		200 pF	+4 ns
		250 pF	+6 ns
		300 pF	+8 ns
6A	Synchronous SYSCLK Output Valid Delay for D31-D0	100 pF	+1 ns
		150 pF	+6 ns
		200 pF	+10 ns
		250 pF	+15 ns
		300 pF	+19 ns
8	Synchronous $\overline{\text{SYSCLK}}$ Output Valid Delay	100 pF	+1 ns
		150 pF	+2 ns
		200 pF	+4 ns
		250 pF	+6 ns
		300 pF	+8 ns
19	$\overline{\text{BINV}}$ Synchronous Output Valid Delay from $\overline{\text{SYSCLK}}$	100 pF	+1 ns
		150 pF	+3 ns
		200 pF	+4 ns
		250 pF	+6 ns
		300 pF	+7 ns

SWITCHING TEST CIRCUIT

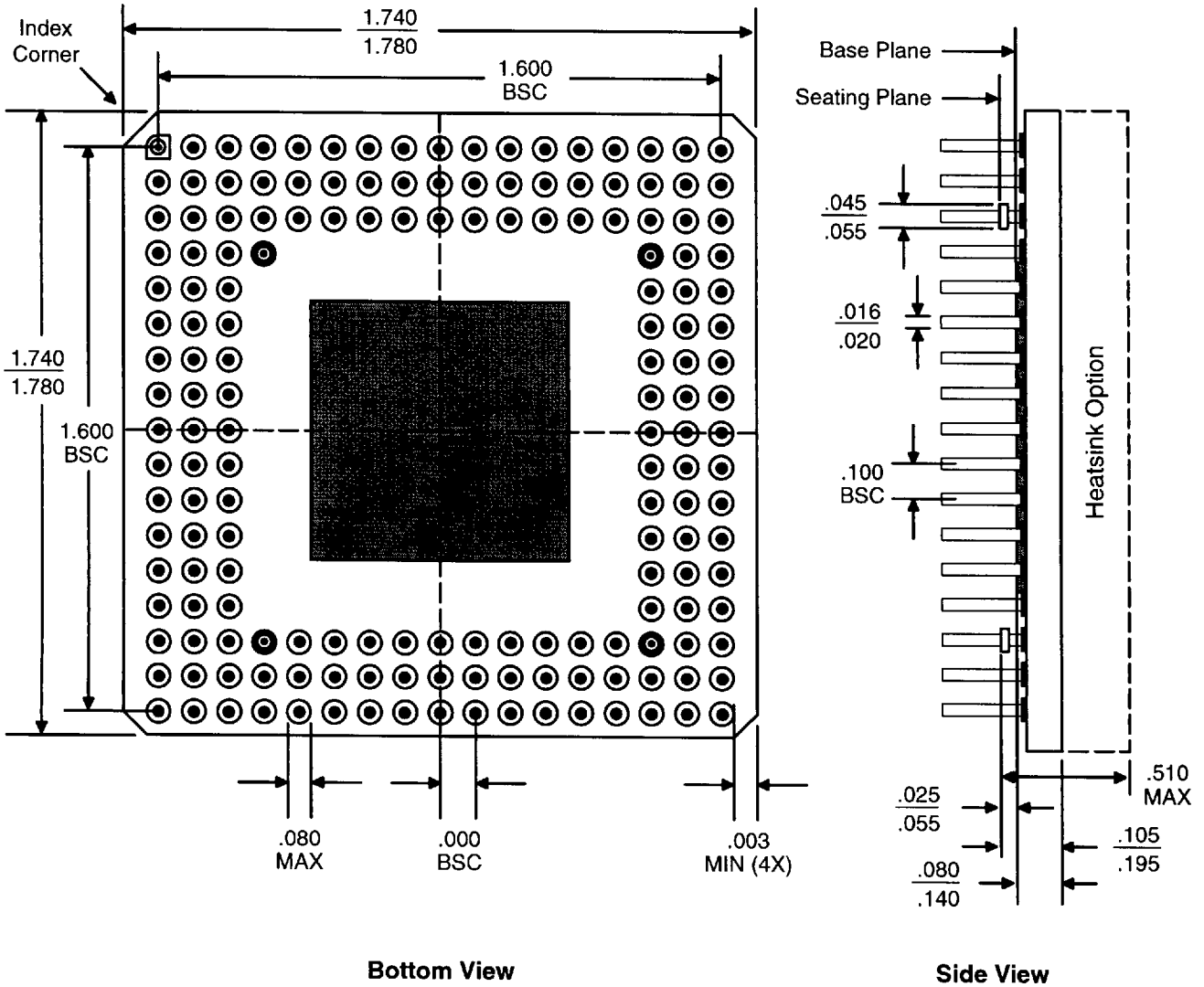


C_L is guaranteed to 80 pF. For capacitive loading greater than 80 pF, refer to the Capacitive Output Delay table.

09075-010A

PHYSICAL DIMENSIONS

CGX 169 Pin Grid Array (measured in inches)



Bottom View

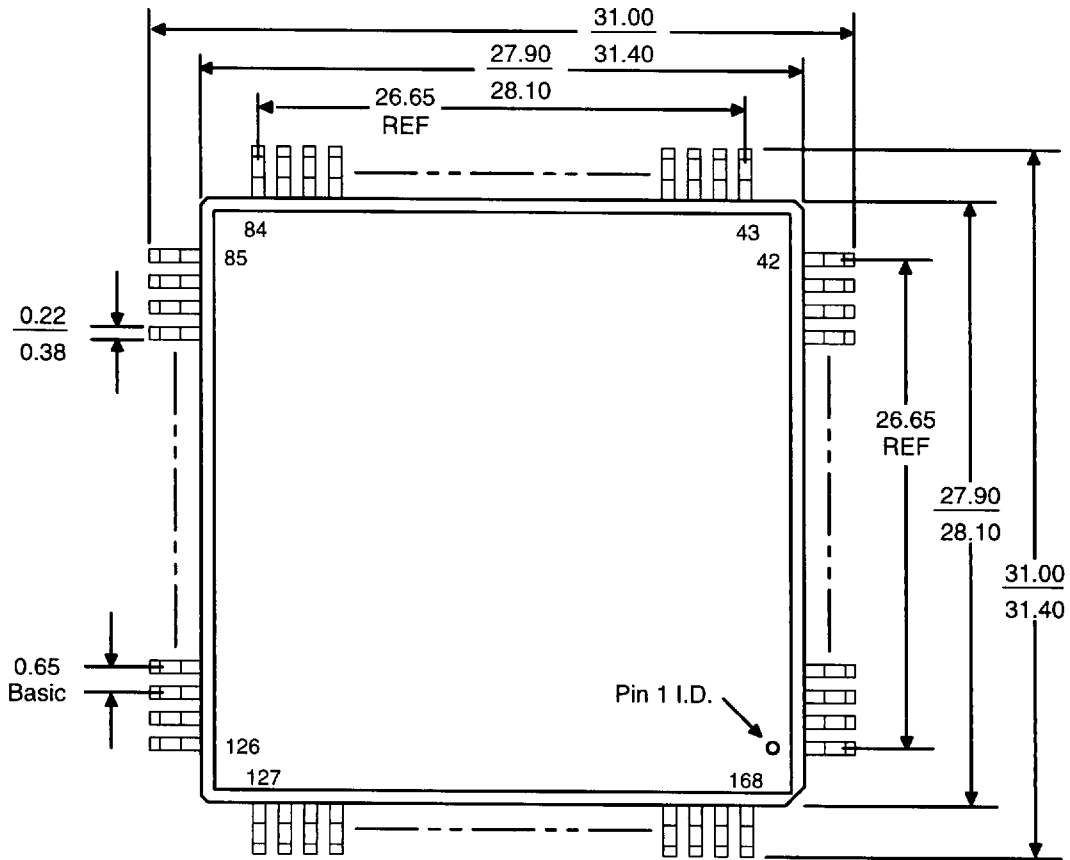
Side View

07322E
 BP 37 CGX169
 7/8/92 c dc
 09075-011A

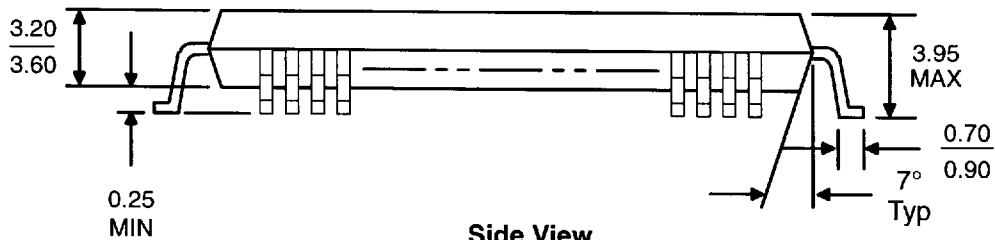
Note:

BSC is an ANSI standard for Basic Space Centering.

PQR 168 Plastic Quad Flat Pack; Trimmed and Formed (measured in millimeters)



Top View



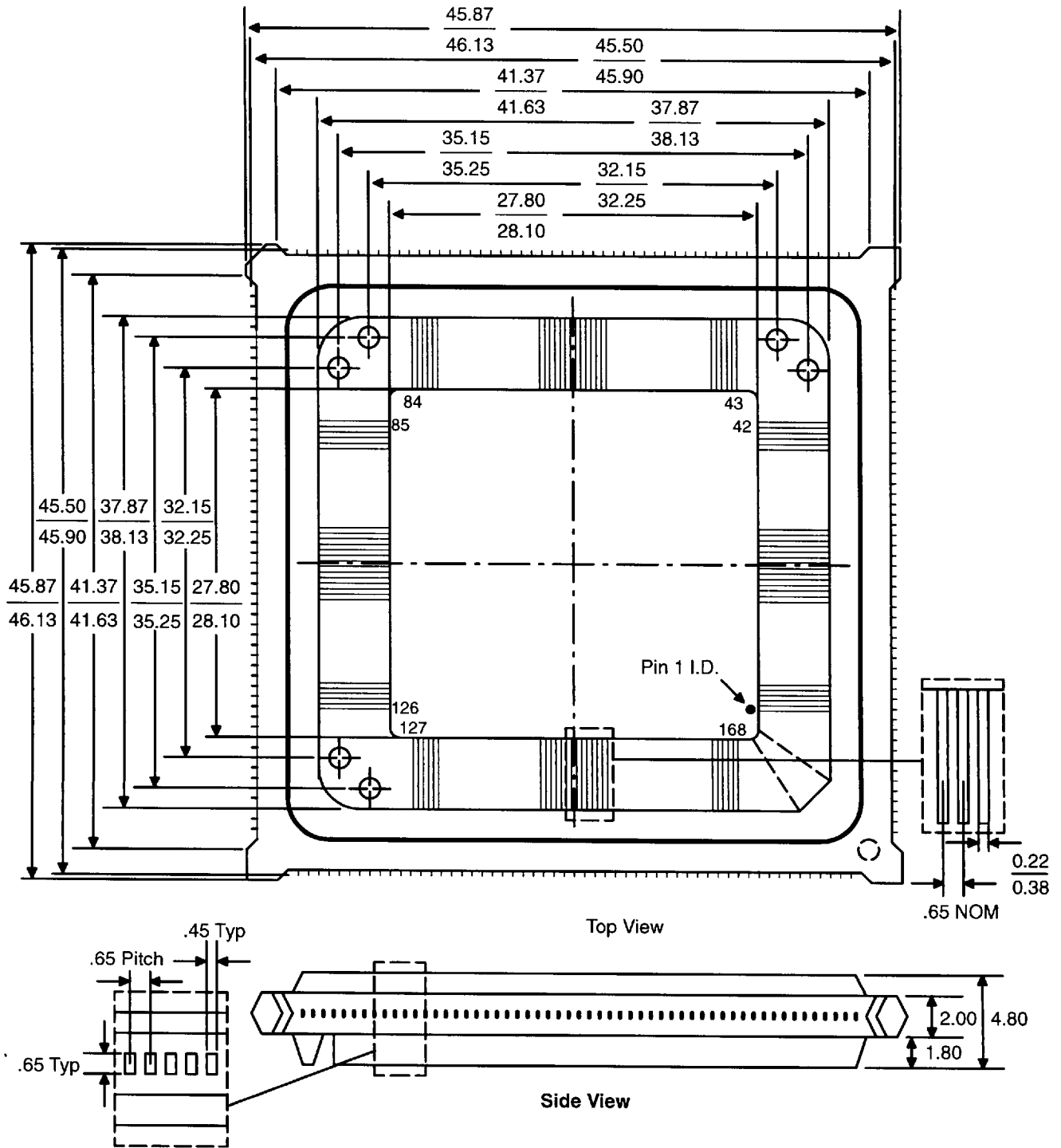
Side View

14995C
CG 47
5/4/92 SG
09075-012A

Note:

All dimensions are measured in millimeters unless otherwise noted. BSC is an ANSI standard for Basic Space Centering.

PQR 168 Plastic Quad Flat Pack with Molded Carrier Ring (measured in millimeters)



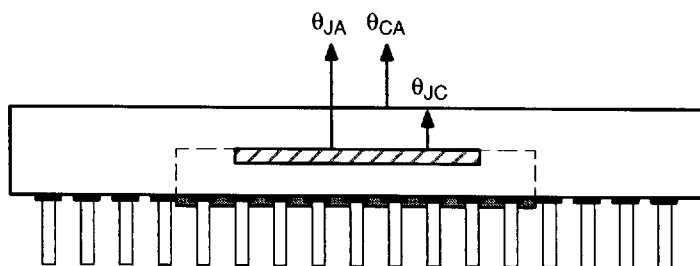
15000C
CG 50
5/4/92 SG
09075-013A

Note:

All dimensions are measured in millimeters unless otherwise noted. BSC is an ANSI standard for Basic Space Centering.

THERMAL CHARACTERISTICS

Pin Grid Array (PGA) Package



$$\theta_{JA} = \theta_{JC} + \theta_{CA}$$

Average Thermal Resistance — °C/Watt

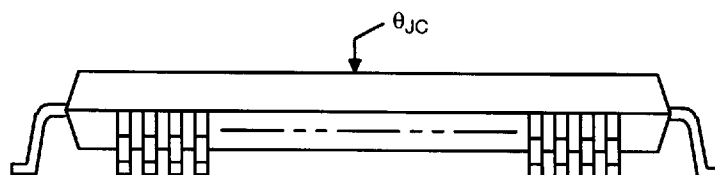
Parameter	Airflow—ft./min. (m/sec)				
	0 (0)	200 (1.01)	400 (2.03)	600 (3.04)	800 (4.05)
θ_{JC} Junction-to-Case	2	2	2	2	2
θ_{CA} Case-to-Ambient (no Heatsink)	20	16	15	14	12
θ_{CA} Case-to-Ambient (with omnidirectional 4-Fin Heatsink, Thermalloy 0417261)	9	7	4	3	2

Notes:

09075-014A

1. θ_{JC} measured in controlled fluorinert fluid bath as infinite heatsink medium.
2. $\theta_{JA} = \theta_{JC} + \theta_{CA}$.

Plastic Quad Flat Pack (PQFP) Package



PQFP Thermal Resistance — °C/Watt

Parameter	Airflow—ft./min. (m/sec)				
	0 (0)	200 (1.01)	400 (2.03)	600 (3.04)	800 (4.05)
θ_{JC} Junction-to-Case	10	10	10	10	10
θ_{CA} Case-to-Ambient (no Heatsink)	27	23	21	18	17

Notes:

09075-015A

1. θ_{JC} measured in controlled fluorinert fluid bath as infinite heatsink medium.
2. $\theta_{JA} = \theta_{JC} + \theta_{CA}$.

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