



Integrated Device Technology, Inc.

RISC CPU PROCESSOR

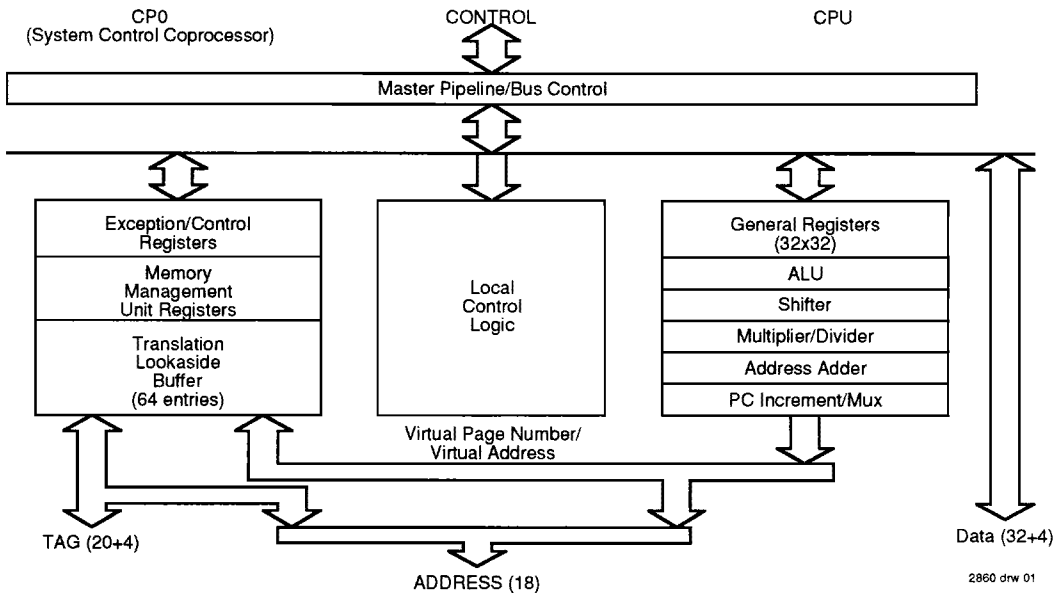
IDT79R3000A
IDT79R3000AE

FEATURES:

- Enhanced instruction set compatible version of the IDT79R2000, IDT79R3000 RISC CPUs.
- Upwardly pin-compatible with IDT79R3000 RISC CPU.
- IDT79R3000A "E" version relaxes system memory timing requirements in a high-speed systems.
- Full 32-bit Operation—Thirty-two 32-bit registers and all instructions and addresses are 32-bit.
- Efficient Pipelining—The CPU's 5-stage pipeline design assists in obtaining an execution rate approaching one instruction per cycle. Pipeline stalls and exceptions are handled precisely and efficiently.
- On-Chip Cache Control—The IDT79R3000A provides a high-bandwidth memory interface that handles separate external Instruction and Data Caches ranging in size from 4 to 256kB each. Both caches are accessed during a single CPU cycle. All cache control is on-chip.
- On-Chip Memory Management Unit—A fully-associative, 64-entry Translation Look-aside Buffer (TLB) provides fast address translation for virtual-to-physical memory mapping of the 4gB virtual address space.
- Dynamically able to switch between Big- and Little-Endian byte ordering conventions.
- Coprocessor Interface—The IDT79R3000A generates all addresses and handles memory interface control for up to three additional tightly coupled external processors.
- Optimizing Compilers are available for C, Fortran, Pascal, COBOL, Ada, PL/1, and C++.
- UNIX™ System V.4 and BSD 4.3 operating systems supported.
- High-speed CMOS technology.
- 16.7 through 40MHz clock rates yield up to 32VUPS sustained throughput.
- Supports independent multi-word block refill of both the instruction and data caches with variable block sizes.
- Supports concurrent refill and execution of instructions.
- Partial word stores executed as read-modify-write operations.
- 6 external interrupt inputs, 2 software interrupts, with single cycle latency to exception handler routine.
- Flexible multiprocessing support on chip with no impact on uniprocessor designs.

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IDT79R3000A PROCESSOR BLOCK DIAGRAM



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COMMERCIAL TEMPERATURE RANGE

JUNE 1992

DESCRIPTION

The IDT79R3000A RISC Microprocessor consists of two tightly-coupled processors integrated on a single chip. The first processor is a full 32-bit CPU based on RISC (Reduced Instruction Set Computer) principles to achieve a new standard of microprocessor performance. The second processor is a system control coprocessor, called CP0, containing a fully-associative 64-entry TLB (Translation Look-aside Buffer), MMU (Memory Management Unit) and control registers, supporting a 4GB virtual memory subsystem, and a Harvard Architecture Cache Controller achieving a bandwidth of 320mB/second using industry standard static RAMs.

This data sheet provides an overview of the features and architecture of the IDT79R3000A CPU, Revision 3.0. A more detailed description of the operation of the device is incorporated in the *IDT79R3000A Family Hardware User Manual*, and a more detailed architectural overview is provided in the *MIPS RISC Architecture* book, both available from IDT. Documentation providing details of the software and development environments supporting this processor are also available from IDT.

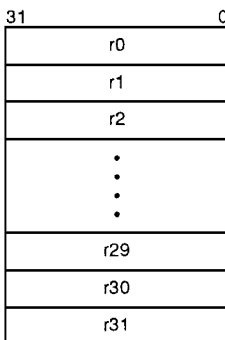
IDT79R3000A CPU Registers

The IDT79R3000A CPU provides 32 general-purpose 32-bit registers, a 32-bit Program Counter, and two 32-bit registers that hold the results of integer multiply and divide operations. Only two of the 32 general registers have a special purpose: register r0 is hard-wired to the value "0", which is a useful constant, and register r31 is used as the link register in jump-and-link instructions (return address for subroutine calls).

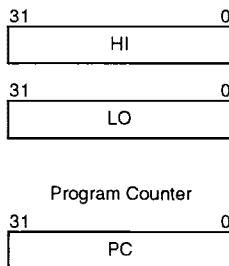
The CPU registers are shown in Figure 2. Note that there is no Program Status Word (PSW) register shown in this figure: the functions traditionally provided by a PSW register are instead provided in the Status and Cause registers incorporated within the System Control Coprocessor (CP0).

Instruction Set Overview

General Purpose Registers



Multiply/Divide Registers



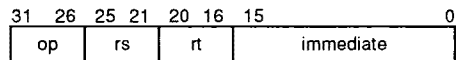
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Figure 2. IDT79R3000A CPU Registers

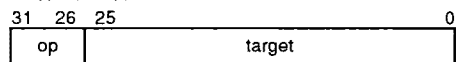
All IDT79R3000A instructions are 32 bits long, and there are only three instruction formats. This approach simplifies instruction decoding, thus minimizing instruction execution time. The IDT79R3000A processor initiates a new instruction on every run cycle, and is able to complete an instruction on almost every clock cycle. The only exceptions are the Load instructions and Branch instructions, which each have a single cycle of latency associated with their execution. Note, however, that in the majority of cases the compilers are able to fill these latency cycles with useful instructions which do not require the result of the previous instruction. This effectively eliminates these latency effects.

The actual instruction set of the CPU was determined after extensive simulations to determine which instructions should be implemented in hardware, and which operations are best synthesized in software from other basic instructions. This methodology resulted in the IDT79R3000A having the highest performance of any available microprocessor.

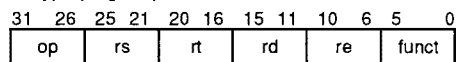
The IDT79R3000A instruction set can be divided into the I-Type (Immediate)



J-Type (Jump)



R-Type (Register)



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Figure 3. IDT79R3000A Instruction Formats

following groups:

- **Load/Store** instructions move data between memory and general registers. They are all I-type instructions, since the only addressing mode supported is base register plus 16-bit, signed immediate offset. The Load instruction has a single cycle of latency, which means that the data being loaded is not available to the instruction immediately after the load instruction. The compiler will fill this delay slot with either an instruction which is not dependent on the loaded data, or with a NOP instruction. There is no latency associated with the store instruction. Loads and Stores can be performed on byte, half-word, word, or unaligned word data (32-bit data not aligned on a modulo-4 address). The CPU cache is constructed as a write-through cache.
- **Computational** instructions perform arithmetic, logical and shift operations on values in registers. They occur in both R-type (both operands and the result are registers) and I-type (one operand is a 16-bit immediate) formats.

Note that computational instructions are three operand instructions; that is, the result of the operation can be stored into a different register than either of the two operands. This means that operands need not be overwritten by arithmetic operations. This results in a more efficient use of the large register set.

- **Jump and Branch** instructions change the control flow of a program. Jumps are always to a paged absolute address formed by combining a 26-bit target with four bits of the Program counter (J-type format, for subroutine calls), or 32-bit register byte addresses (R-type, for returns and dispatches). Branches have 16-bit offsets relative to the program counter (I-type). Jump and Link instructions save a return address in Register 31. The IDT79R3000A instruction set features a number of branch conditions. Included is the ability to compare a register to zero and branch, and also the ability to branch based on a comparison between two registers. Thus, net performance is

increased since software does not have to perform arithmetic instructions prior to the branch to set up the branch conditions.

- **Coprocessor** instructions perform operations in the coprocessors. Coprocessor Loads and Stores are I-type. Coprocessor computational instructions have coprocessor-dependent formats (see coprocessor manuals).
- **Coprocessor 0** instructions perform operations on the System Control Coprocessor (CP0) registers to manipulate the memory management and exception handling facilities of the processor.
- **Special** instructions perform a variety of tasks, including movement of data between special and general registers, system calls, and breakpoint. They are always R-type.

Table 1 lists the instruction set of the IDT79R3000A processor.

IDT79R3000A INSTRUCTION SUMMARY

| OP | Description | OP | Description |
|-------|---|---------|--|
| | Load/Store Instructions | | Multiply/Divide instructions |
| LB | Load Byte | MULT | Multiply |
| LBU | Load Byte Unsigned | MULTU | Multiply Unsigned |
| LH | Load Halfword | DIV | Divide |
| LHU | Load Halfword Unsigned | DIVU | Divide Unsigned |
| LW | Load Word | MFHI | Move From HI |
| LWL | Load Word Left | MTHI | Move To HI |
| LWR | Load Word Right | MFLO | Move From LO |
| SB | Store Byte | MTLO | Move To LO |
| SH | Store Halfword | | |
| SW | Store Word | | Jump and Branch Instructions |
| SWL | Store Word Left | J | Jump |
| SWR | Store Word Right | JAL | Jump and Link |
| | | JR | Jump to Register |
| | Arithmetic Instructions (ALU Immediate) | JALR | Jump and Link Register |
| ADDI | Add Immediate | BEQ | Branch on Equal |
| ADDIU | Add Immediate Unsigned | BNE | Branch on Not Equal |
| SLTI | Set on Less Than Immediate | BLEZ | Branch on Less than or Equal to Zero |
| SLTIU | Set on Less Than Immediate Unsigned | BGTZ | Branch on Greater Than Zero |
| ANDI | AND Immediate | BLTZ | Branch on Less Than Zero |
| ORI | OR Immediate | BGEZ | Branch on Greater than or Equal to Zero |
| XORI | Exclusive OR Immediate | BLTZAL | Branch on Less Than Zero and Link |
| LUI | Load Upper Immediate | BGEZAL | Branch on Greater than or Equal to Zero and Link |
| | Arithmetic Instructions (3-operand, register-type) | | Special Instructions |
| ADD | Add | SYSCALL | System Call |
| ADDU | Add Unsigned | BREAK | Break |
| SUB | Subtract | | Coprocessor Instructions |
| SUBU | Subtract Unsigned | LWCz | Load Word from Coprocessor |
| SLT | Set on Less Than | SWCz | Store Word to Coprocessor |
| | | MTCz | Move To Coprocessor |
| SLTU | Set on Less Than Unsigned | MFCz | Move From Coprocessor |
| AND | AND | CTCz | Move Control to Coprocessor |
| OR | OR | CFCz | Move Control From Coprocessor |
| XOR | Exclusive OR | COPz | Coprocessor Operation |
| NOR | NOR | BCzT | Branch on Coprocessor z True |
| | | BCzF | Branch on Coprocessor z False |
| | Shift Instructions | | System Control Coprocessor (CPO) Instructions |
| SLL | Shift Left Logical | MTC0 | Move To CP0 |
| SRL | Shift Right Logical | MFC0 | Move From CP0 |
| SRA | Shift Right Arithmetic | TLBR | Read indexed TLB entry |
| SLLV | Shift Left Logical Variable | TLBWI | Write Indexed TLB entry |
| SRLV | Shift Right Logical Variable | TLBWR | Write Random TLB entry |
| SRAV | Shift Right Arithmetic Variable | TLBP | Probe TLB for matching entry |
| | | RFE | Restore From Exception |

IDT79R3000A System Control Coprocessor (CP0)

The IDT79R3000A can operate with up to four tightly-coupled coprocessors (designated CP0 through CP3). The System Control Coprocessor (or CP0), is incorporated on the IDT79R3000 chip and supports the virtual memory system and exception handling functions of the IDT79R3000A. The virtual memory system is implemented using a Translation Look-aside Buffer and a group of programmable registers as shown in Figure 4.

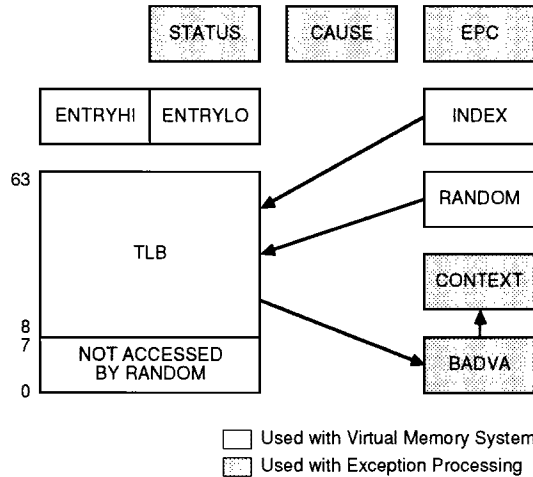
SYSTEM CONTROL COPROCESSOR (CP0) REGISTERS

The CP0 registers shown in Figure 4 are used to control the memory management and exception handling capabilities of the IDT79R3000A. Table 2 provides a brief description of each register.

SYSTEM CONTROL COPROCESSOR (CP0) REGISTERS

| Register | Description |
|----------|--|
| EntryHi | HIGH half of a TLB entry |
| EntryLo | LOW half of a TLB entry |
| Index | Programmable pointer into TLB array |
| Random | Pseudo-random pointer into TLB array |
| Status | Mode, interrupt enables, and diagnostic status info |
| Cause | Indicates nature of last exception |
| EPC | Exception Program Counter |
| Context | Pointer into kernel's virtual Page Table Entry array |
| BadVA | Most recent bad virtual address |
| PRId | Processor revision identification (Read only) |

2860 tbl 02



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Figure 4. The System Coprocessor Registers

Memory Management System

The IDT79R3000A has an addressing range of 4gB. However, since most IDT79R3000A systems implement a physical memory smaller than 4gB, the IDT79R3000A provides for the logical expansion of memory space by translating addresses composed in a large virtual address space into available physical memory address. The 4gB address space is divided into 2gB which can be accessed by both the users and the kernel, and 2gB for the kernel only.

The TLB (Translation Lookaside Buffer)

Virtual memory mapping is assisted by the Translation Lookaside Buffer (TLB). The on-chip TLB provides very fast virtual memory access and is well-matched to the requirements of multi-tasking operating systems. The fully-associative

TLB contains 64 entries, each of which maps a 4kB page, with controls for read/write access, cacheability, and process identification. The TLB allows each user to access up to 2gB of virtual address space.

Figure 5 illustrates the format of each TLB entry. The Translation operation involves matching the current Process ID (PID) and upper 20 bits of the address against PID and VPN (Virtual Page Number) fields in the TLB. When both match (or the TLB entry is Global), the VPN is replaced with the PFN (Physical Frame Number) to form the physical address.

TLB misses are handled in software, with the entry to be replaced determined by as simple RANDOM function. The routine to process a TLB miss in the UNIX environment requires only 10-12 cycles, which compares favorably with many CPUs which perform the operation in hardware.

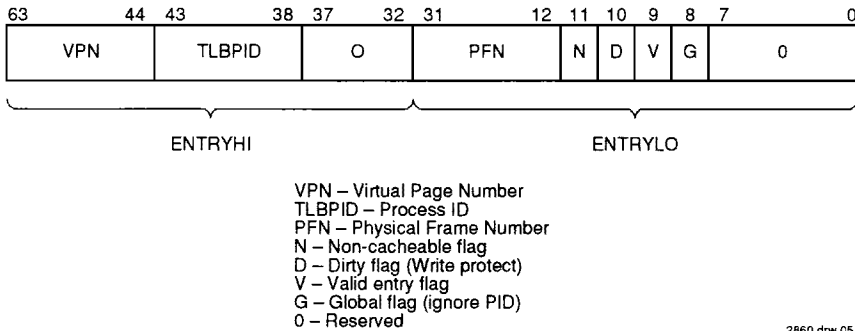
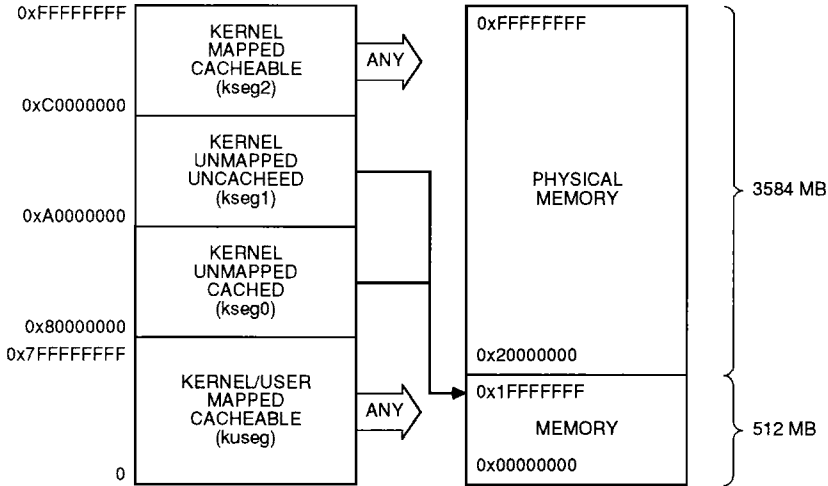


Figure 5. TLB Entry Format

IDT79R3000 Operating Modes

The IDT79R3000A has two operating modes: User mode and Kernel/mode. The IDT79R3000A normally operates in the User mode until an exception is detected forcing it into the Kernel mode. It remains in the Kernel mode until a Restore

From Exception (RFE) instruction is executed. The manner in which memory addresses are translated or mapped depends on the operating mode of the IDT79R3000A (Figure 6) shows the MMU translation performed for each of the operating modes.



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Figure 6. IDT79R3000A Virtual Address Mapping

User Mode—in this mode, a single, uniform virtual address space (kuseg) of 2gB is available. Each virtual address is extended with a 6-bit process identifier field to form unique virtual addresses. All references to this segment are mapped through the TLB. Use of the cache for up to 64 processes is determined by bit settings for each page within the TLB entries.

Kernel Mode—four separate segments are defined in this mode:

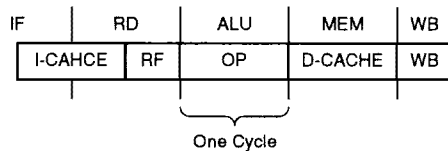
- *kuseg*—when in the kernel mode, references to this segment are treated just like user mode references, thus streamlining kernel access to user data.
- *kseg0*—references to this 512mB segment use cache memory but are not mapped through the TLB. Instead, they always map to the first 0.5gB of physical address space.
- *kseg1*—references to this 512mB segment are not mapped through the TLB and do not use the cache. Instead, they are hard-mapped into the same 0.5gB segment of physical address space as *kseg0*.
- *kseg2*—references to this 1gB segment are always mapped through the TLB and use of the cache is determined by bit settings within the TLB entries.

IDT79R3000 Pipeline Architecture

The execution of a single IDT79R3000A instruction consists of five primary steps:

- 1) **IF** — Fetch the instruction (I-Cache).
- 2) **RD** — Read any required operands from CPU registers while decoding the instruction.
- 3) **ALU** — Perform the required operation on instruction operands.
- 4) **MEM** — Access memory (D-Cache).
- 5) **WB** — Write back results to register file.

Each of these steps requires approximately one CPU cycle, as shown in Figure 7 (parts of some operations overlap into another cycle while other operations require only 1/2 cycle).



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Figure 7. IDT79R3000A Instruction Pipeline

memory. Some microprocessors provide a limited amount of cache memory on the CPU chip itself. The external caches supported by the IDT79R3000A can be much larger; while a small cache can improve performance of some programs, significant improvements for a wide range of programs require large caches.

- **Separate Caches for data and instructions**—Even with high-speed caches, memory speed can still be a limiting factor because of the fast cycle time of a high-performance microprocessor. The IDT79R3000A supports separate caches for instructions and data and alternates accesses of the two caches during each CPU cycle. Thus, the processor can obtain data and instructions at the cycle rate of the CPU using caches constructed with commercially available IDT static RAM devices.

In order to maximize bandwidth in the cache while minimizing the requirement for SRAM access speed, the IDT79R3000A divides a single-processor clock cycle into two phases. During one phase, the address for the data cache access is presented while data previously addressed in the instruction cache is read; during the next phase, the data operation is completed while the instruction cache is being addressed. Thus, both caches are read in a single processor cycle using only one set of address and data pins.

- **Write Buffer**—in order to ensure data consistency, all data that is written to the data cache must also be written out to main memory. The cache write model used by the IDT79R3000A is that of a write-through cache; that is, all data written by the CPU is immediately written into the main memory. To relieve the CPU of this responsibility (and the inherent performance burden) the IDT79R3000A supports an interface to a write buffer. The IDT79R3020 Write Buffer captures data (and associated addresses) output by the CPU and ensures that the data is passed on to main memory.

IDT79R3000A Processor Subsystem Interfaces

Figure 11 illustrates the three subsystem interfaces provided by the IDT79R3000A processor:

- **Cache control** interface (on-chip) for separate data and instruction caches permits implementation of off-chip caches using standard IDT SRAM devices. The IDT79R3000A directly controls the cache memory with a minimum of external components. Both the instruction and data cache can vary from 0 to 256kB (64K entries). The IDT79R3000A also includes the TAG control logic which determines whether or not the entry read from the cache is the desired data. The IDT79R3000A cache controller implements a direct mapped cache for high net performance (bandwidth). It has the ability to refill multiple words when a cache miss occurs, thus reducing the effective miss rate to less than 2% for large caches. When a cache miss occurs, the

IDT79R3000A can support refilling the cache in 1, 4, 8, 16, or 32-word blocks to minimize the effective penalty of having to access main memory. The IDT79R3000A also incorporates the ability to perform instruction streaming; while the cache is refilling, the processor can resume execution once the missed word is obtained from main memory. In this way, the processor can continue to execute concurrently with the cache block refill.

- **Memory controller** interface for system (main) memory. This interface also includes the logic and signals to allow operation with a write buffer to further improve memory bandwidth. In addition to the standard full word access, the memory controller supports the ability to write bytes and half-words by using partial word operations. The memory controller also supports the ability to retry memory accesses if, for example, the data returned from memory is invalid and a bus error needs to be signalled.
- **Coprocessor Interface**—The IDT79R3000A features a tightly coupled co-processor interface in which all coprocessors maintain synchronization with the main processor; reside on the same data bus as the main processor; and participate in bus transactions in an identical manner to the main processor. The IDT79R3000A generates all required cache and memory control signals, including cache and memory addresses for attached coprocessors. As a result, only the data bus and a few control signals need to be connected to a coprocessor. The interface supports three types of coprocessor instructions: loads/stores, coprocessor operations, and processor-coprocessor transfers. Note that coprocessor loads and stores occur directly between the coprocessor and memory, without requiring the data to go through the CPU. Synchronization between the CPU and external coprocessors is achieved using a Phased-Lock Loop interface to the coprocessor. The coprocessor physical interface also includes coprocessor condition signals (CpCond(n)), which are used in coprocessor branch instructions, and a coprocessor busy signal (CpBusy) which is used to stall the CPU if the coprocessor needs to hold off subsequent operations.

Finally, a precise exception interface is defined between the CPU and coprocessors using the external interrupt inputs of the CPU. This allows a coprocessor exception, even if it was the result of a multi-cycle operation, to be traced to the precise coprocessor operation which caused it. This is an important feature for languages which can define specific error handlers for each task.

The interface supports up to four separate coprocessors. Coprocessor 0 is defined to be the system control coprocessor, and resides on the same chip as the CPU unit. Coprocessor 1 is the Floating Point Accelerator, IDT79R3010A. Coprocessors 2 and 3 are available to support an interface to application specific functions.

MULTIPROCESSING SUPPORT

The IDT79R3000A supports multiprocessing applications in a simple but effective way. Multiprocessing applications require cache coherency across the multiple processors. The IDT79R3000A offers two signals to support cache coherency: the first, MPStall, stalls the processor within two cycles of being received and keeps it from accessing the cache. This allows an external agent to snoop into the processor data cache. The second signal, MPInvalidate, causes the processor to write data on the data cache bus which indicates the externally addressed cache entry is invalid. Thus, a subsequent access to that location would result in a cache miss, and the data would be obtained from main memory.

The two MP signals would be generated by an external logic which utilizes a secondary cache to perform bus snooping functions. The IDT79R3000A does not impose an architecture for this secondary cache, but rather is flexible enough to support a variety of application specific architecture stand still maintain cache coherency. Further, there is no impact on designs which do not require this feature. The IDT79R3000A has further improved on the microprocessor support found in the IDT79R3000, by allowing the use of cache RAMs with internal address latches in multiprocessor systems.

ADVANCED FEATURES

The IDT79R3000A offers a number of additional features such as the ability to swap the instruction and data caches, facilitating diagnostics and cache flushing. Another feature isolates the caches, which forces cache hits to occur regardless of the contents of the tag fields. The IDT79R3000A allows the processor to execute user tasks of the opposite byte ordering (endianness) of the operating system, and further allows parity checking to be disabled. More details on these features can be found in the IDT79R3000A Family Hardware User's Manual.

Further features of the IDT79R3000A are configured during the last four cycles prior to the negation of the RESET input. These functions include the ability to select cache sizes and cache refill block sizes; the ability to utilize the multiprocessor interface; whether or not instruction streaming is enabled; whether byte ordering follows "Big-Endian" or "Little-Endian" protocols, etc. Table 3 shows the configuration options selected at Reset. These are further discussed in the *Hardware User's Manual*.

BACKWARD COMPATIBILITY WITH IDT79R2000

The IDT79R3000A can be used in sockets designed for the IDT79R3000. The pin-out of the IDT79R3000A has been selected to ensure this compatibility, with new functions mapped onto previously unused pins. The instruction set is compatible with that of the IDT79R2000 at the binary level. As a result, code written for the older processor can be executed. New features can be selectively disabled.

In most IDT79R3000 applications, the IDT79R3000A can be placed in the socket with no modification to initialization settings. Further application assistance on this topic is available from IDT.

PACKAGE THERMAL SPECIFICATIONS

The IDT79R3000A utilizes special packaging techniques to improve both the thermal and electrical characteristics of the microprocessor.

In order to improve the electrical characteristics of the device, the package is constructed using multiple signal planes, including individual power planes and ground planes to reduce noise associated with high-frequency TTL parts. In addition, the 175-pin PGA package utilizes extra power and ground pins to reduce the inductance from the internal power planes to the power planes of the PC Board.

In order to improve the electrical characteristics of the microprocessor, the device is housed using cavity down packaging. In addition, these packages incorporate a copper-tungsten thermal slug designed to efficiently transfer heat from the die to the case of the package, and thus effectively lower the thermal resistance of the package. The use of an additional external heat sink affixed to the package thermal slug further decreases the effective thermal resistance of the package.

The case temperature may be measured in any environment to determine whether the device is within the specified operating range. The case temperature should be measured at the center of the top surface opposite the package cavity (the package cavity is the side where the package lid is mounted).

The equivalent allowable ambient temperature, T_A , can be calculated using the thermal resistance from case to ambient (θ_{ca}) for the given package. The following equation relates ambient and case temperature:

$$T_A = T_c - P \cdot \theta_{ca}$$

where P is the maximum power consumption, calculated by using the maximum Icc from the DC Electrical Characteristics section.

Typical values for θ_{ca} at various airflows are shown in table 4 for various CPU packages.

R3000A PACKAGE CHARACTERISTICS

| | Airflow - (ft/min) | | | | | |
|-----------------------------------|--------------------|-----|-----|-----|------|-----|
| | 200 | 400 | 600 | 800 | 1000 | |
| θ_{ca} (175-PGA, 144-PGA) | 21 | 7 | 3 | 2 | 1 | 0.5 |
| θ_{ca} (172 Quad Flatpack) | 23 | 9 | 4 | 3 | 2.5 | 1.5 |

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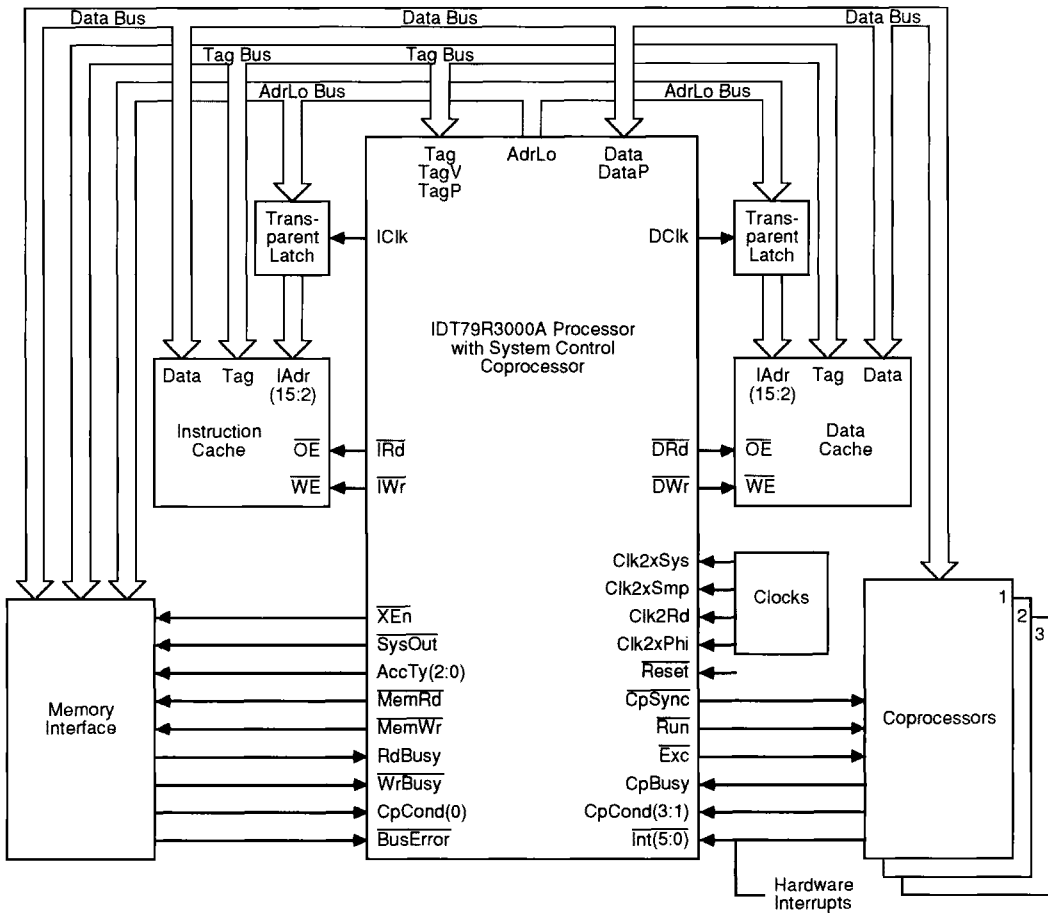
R3000A MODE SELECTABLE FEATURES

| Input | W Cycle | X Cycle | Y Cycle | Z Cycle |
|-------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| Int0 | DBlkSize0 | DBlkSize1 | Extend Cache | Big Endian |
| Int1 | IBlkSize0 | IBlkSize1 | MPAdrDisable | TriState |
| Int2 | DispPar/RevEnd | IStream | IgnoreParity | NoCache |
| Int3 | Reserved ⁽¹⁾ | StorePartial | MultiProcessor | BusDriveOn |
| Int4 | PhaseDelayOn ⁽²⁾ | PhaseDelayOn ⁽²⁾ | PhaseDelayOn ⁽²⁾ | PhaseDelayOn ⁽²⁾ |
| Int5 | R3000 Mode ⁽²⁾ | R3000 Mode ⁽²⁾ | R3000 Mode ⁽²⁾ | R3000 Mode ⁽²⁾ |

NOTES:
 1. Reserved entries must be driven high.
 2. These values must be driven stable throughout the entire RESET period.

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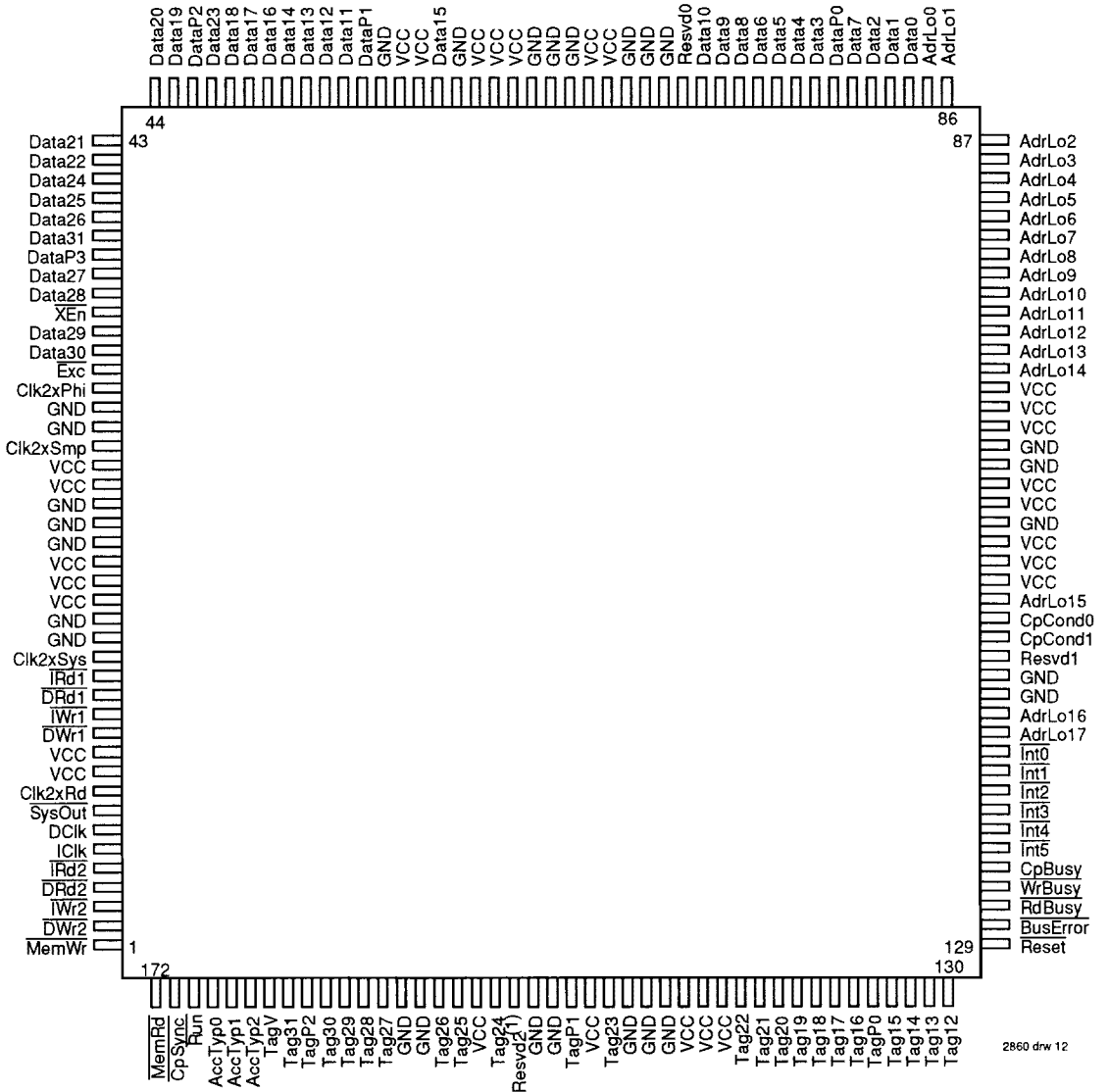
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Figure 11. IDT79R3000A Subsystem Interfaces Example; 64 KB Caches

PIN CONFIGURATION



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NOTES:

1. Reserved pins must not be connected.
2. AdrLo 16 and 17 are multifunction pins which are controlled by mode select programming on interrupt pins at reset time
 AdrLo 16: MP Invalidate, CpCond (2).
 AdrLo 17: MP Stall, CpCond (3).

172-Pin Flatpack (Top View)

PIN CONFIGURATION

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|----------|--------------------------|-------------------------|----------|----------|--------------------------|-------------------------|-------------------------------|----------------------------|----------------------------|----------------------------|-------------------------------|----------------------------|-----------------------------|----------|
| A | (No Pin) | AdrLo 6 | AdrLo 10 | AdrLo 11 | VCC | AdrLo 14 | AdrLo 15 | CpCond 0 | AdrLo 16 | AdrLo 17 | $\overline{\text{Int}}(2)$ | $\overline{\text{Int}}(5)$ | Wr Busy | $\overline{\text{Reset}}$ | VCC |
| B | AdrLo 3 | $\overline{\text{DRd}}2$ | AdrLo 7 | AdrLo 9 | AdrLo 12 | $\overline{\text{IRd}}2$ | AdrLo 13 | CpCond 1 | $\overline{\text{Int}}(1)$ | $\overline{\text{Int}}(3)$ | Cp Busy | $\overline{\text{Bus Error}}$ | DWr2 | Tag12 | Tag15 |
| C | AdrLo 0 | AdrLo 4 | VCC | AdrLo 5 | AdrLo 8 | GND | GND | VCC | $\overline{\text{Int}}(0)$ | $\overline{\text{Int}}(4)$ | Rd Busy | GND | Tag13 | TagP0 | Tag18 |
| D | Data 1 | AdrLo 2 | GND | GND | VCC | GND | VCC | GND | VCC | GND | VCC | GND | Tag14 | Tag17 | Tag19 |
| E | DataP 0 | Data 0 | AdrLo 1 | VCC | | | | | | | | VCC | Tag16 | Tag20 | VCC |
| F | VCC | Data 7 | Data 2 | GND | | | | | | | | GND | GND | Tag21 | Tag23 |
| G | Data 4 | Data 3 | GND | VCC | | | | | | | | VCC | GND | Tag22 | TagP1 |
| H | Data 6 | Data 5 | Data 8 | GND | | | | | | | | GND | VCC | Tag25 | Tag24 |
| J | Data 10 | DataP 1 | Data 9 | VCC | | | | | | | | VCC | Tag28 | Tag29 | Tag26 |
| K | Data 15 | Data 11 | GND | GND | | | | | | | | GND | GND | TagP2 | Tag27 |
| L | VCC | Data 12 | Data 17 | VCC | | | | | | | | VCC | Acc Typ2 | Tag31 | Tag30 |
| M | Data 13 | Data 16 | DataP 2 | GND | VCC | GND | VCC | GND | VCC | GND | VCC | GND | GND | Acc Typ1 | VCC |
| N | Data 14 | Data 18 | Data 19 | GND | Data 24 | DataP 3 | VCC | VCC | GND | GND | $\overline{\text{DRd}}1$ | $\overline{\text{Mem Wr}}$ | $\overline{\text{Mem Rd}}$ | $\overline{\text{Run}}$ | TagV |
| P | Data 23 | Data 20 | $\overline{\text{WR}}2$ | Data 22 | Data 26 | Data 27 | $\overline{\text{XEn}}$ | Data 30 | Clk2x Sys | Clk2x Rd | DClk | $\overline{\text{IRd}}1$ | $\overline{\text{WR}}1$ | $\overline{\text{Cp Sync}}$ | Acc Typ0 |
| Q | VCC | Data 21 | Data 25 | Data 31 | Data 28 | GND | Data 29 | $\overline{\text{Exception}}$ | Clk2x Phi | Clk2x Smp | $\overline{\text{SysOut}}$ | VCC | IClk | $\overline{\text{DWr}}1$ | VCC |

NOTE:

1. AdrLo 16 and 17 are multifunction pins which are controlled by mode select programming on interrupt pins at reset time
 AdrLo 16: MP Invalidate, CpCond (2).
 AdrLo 17: MP Stall, CpCond (3).

175-Pin PGA (Top View)

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PIN CONFIGURATION

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|--------------------|--------------------------|-------------------------|---------------------|---------------------|--------------------------|-------------------------|-------------------------------|----------------------------|----------------------------|----------------------------|-------------------------------|----------------------------|-----------------------------|----------|
| A | VCC | AdrLo ₆ | AdrLo ₁₀ | AdrLo ₁₁ | VCC | AdrLo ₁₄ | AdrLo ₁₅ | CpCond ₀ | AdrLo ₁₆ | AdrLo ₁₇ | $\overline{\text{Int}}(2)$ | $\overline{\text{Int}}(5)$ | Wr Busy | $\overline{\text{Reset}}$ | VCC |
| B | AdrLo ₃ | $\overline{\text{DRd}}2$ | AdrLo ₇ | AdrLo ₉ | AdrLo ₁₂ | $\overline{\text{IRd}}2$ | AdrLo ₁₃ | CpCond ₁ | $\overline{\text{Int}}(1)$ | $\overline{\text{Int}}(3)$ | Cp Busy | $\overline{\text{Bus Error}}$ | $\overline{\text{DWr}}2$ | Tag12 | Tag15 |
| C | AdrLo ₀ | AdrLo ₄ | VCC | AdrLo ₅ | AdrLo ₈ | GND | GND | VCC | $\overline{\text{Int}}(0)$ | $\overline{\text{Int}}(4)$ | Rd Busy | GND | Tag13 | TagP0 | Tag18 |
| D | Data ₁ | AdrLo ₂ | GND | GND | | | | | | | | | Tag14 | Tag17 | Tag19 |
| E | DataP ₀ | Data ₀ | AdrLo ₁ | | | | | | | | | Tag16 | Tag20 | VCC | |
| F | VCC | Data ₇ | Data ₂ | | | | | | | | | GND | Tag21 | Tag23 | |
| G | Data ₄ | Data ₃ | GND | | | | | | | | | GND | Tag22 | TagP1 | |
| H | Data ₆ | Data ₅ | Data ₈ | | | | | | | | | VCC | Tag25 | Tag24 | |
| J | Data ₁₀ | DataP ₁ | Data ₉ | | | | | | | | | Tag28 | Tag29 | Tag26 | |
| K | Data ₁₅ | Data ₁₁ | GND | | | | | | | | | GND | TagP2 | Tag27 | |
| L | VCC | Data ₁₂ | Data ₁₇ | | | | | | | | | Acc Typ2 | Tag31 | Tag30 | |
| M | Data ₁₃ | Data ₁₆ | DataP ₂ | | | | | | | | | GND | Acc Typ1 | VCC | |
| N | Data ₁₄ | Data ₁₈ | Data ₁₉ | GND | Data ₂₄ | DataP ₃ | VCC | VCC | GND | GND | $\overline{\text{DRd}}1$ | $\overline{\text{Mem Wr}}$ | $\overline{\text{Mem Rd}}$ | $\overline{\text{Run}}$ | TagV |
| P | Data ₂₃ | Data ₂₀ | $\overline{\text{IW}}2$ | Data ₂₂ | Data ₂₆ | Data ₂₇ | $\overline{\text{XEn}}$ | Data ₃₀ | Clk2x Sys | Clk2x Rd | DClk | $\overline{\text{IRd}}1$ | $\overline{\text{IW}}1$ | $\overline{\text{Cp Sync}}$ | Acc Typ0 |
| Q | VCC | Data ₂₁ | Data ₂₅ | Data ₃₁ | Data ₂₈ | GND | Data ₂₉ | $\overline{\text{Exception}}$ | Clk2x Phi | Clk2x Smp | $\overline{\text{SysOut}}$ | VCC | IClk | $\overline{\text{DWr}}1$ | VCC |

NOTE:

1. AdrLo 16 and 17 are multifunction pins which are controlled by mode select programming on interrupt pins at reset time
 AdrLo 16: MP Invalidate, CpCond (2).
 AdrLo 17: MP Stall, CpCond (3).

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144-Pin PGA (Top View)

PIN DESCRIPTIONS

| Pin Name | I/O | Description |
|-------------------------------|-----|--|
| Data (0-31) | I/O | A 32-bit bus used for all instruction and data transmission among the processor, caches, memory interface, and coprocessors. |
| DataP (0-3) | I/O | A 4-bit bus containing even parity over the data bus. |
| Tag (12-31) | I/O | A 20-bit bus used for transferring cache tags and high addresses between the processor, caches, and memory interface. |
| TagV | I/O | The tag validity indicator. |
| Tag P (0-2) | I/O | A 3-bit bus containing even parity over the concatenation of TagV and Tag. |
| AdrLo (0-17) | O | An 18-bit bus containing byte addresses used for transferring low addresses from the processor to the caches and memory interface. (AdrLo 16: CpCond (2), AdrLo 17: CpCond (3) set by reset initialization). |
| $\overline{\text{IRd1}}$ | O | Read enable for the instruction cache. |
| $\overline{\text{IWrt1}}$ | O | Write enable for the instruction cache. |
| $\overline{\text{IRd2}}$ | O | An identical copy of $\overline{\text{IRd1}}$ used to split the load. |
| $\overline{\text{IWrt2}}$ | O | An identical copy of $\overline{\text{IWrt1}}$ used to split the load. |
| IClk | O | The instruction cache address latch clock. This clock runs continuously. |
| $\overline{\text{DRd1}}$ | O | The read enable for the data cache. |
| $\overline{\text{DWr1}}$ | O | The write enable for the data cache. |
| $\overline{\text{DRd2}}$ | O | An identical copy of $\overline{\text{DRd1}}$ used to split the load. |
| $\overline{\text{DWr2}}$ | O | An identical copy of $\overline{\text{DWr1}}$ used to split the load. |
| DClk | O | The data cache address latch clock. This clock runs continuously. |
| $\overline{\text{XEn}}$ | O | The read enable for the Read Buffer. |
| AccTyp(0-2) | O | A 3-bit bus used to indicate the size of data being transferred on the data bus, whether or not a data transfer is occurring, and the purpose of the transfer. |
| MemWr | O | Signals the occurrence of a main memory write. |
| MemRd | O | Signals the occurrence of a main memory read. |
| BusError | I | Signals the occurrence of a bus error during a main memory read or write. |
| Run | O | Indicates whether the processor is in the run or stall state. |
| Exception | O | Indicates that the instruction about to commit state should be aborted and other exception related information. |
| SysOut | O | A reflection of the internal processor clock used to generate the system clock. |
| CpSync | O | A clock which is identical to SysOut and used by coprocessors for timing synchronization with the CPU. |
| RdBusy | I | The main memory read stall termination signal. In most system designs RdBusy is normally asserted and is deasserted only to indicate the successful completion of a memory read. RdBusy is sampled by the processor only during memory read stalls. |
| WrBusy | I | The main memory write stall initiation/termination signal. |
| CpBusy | I | The coprocessor busy stall initiation/termination signal. |
| CpCond (0-1) | I | A 2-bit bus used to transfer conditional branch status from the coprocessors to the main processor. |
| CpCond (2-3) | I | Conditional branch status from coprocessors to the processor. Function is provided on AdrLo 16/17 pins and is selected at reset time. |
| MPStall | I | Multiprocessing Stall. Signals to the processor that it should stall accesses to the caches in a multiprocessing environment. This is physically the same pin as CpCond3; its use is determined at RESET initialization. |
| MPInvalidate | I | Multiprocessing Invalidate. Signals to the processor that it should issue invalidate data on the cache data bus. The address to be invalidated is externally provided. This is the same pin as CpCond2; its use is determined at RESET initialization. |
| $\overline{\text{Int}}$ (0-5) | I | A 6-bit bus used by the memory interface and coprocessors to signal maskable interrupts to the processor. At reset time, mode select values are read in. |

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PIN DESCRIPTIONS (Continued)

| Pin Name | I/O | Description |
|---------------------------|-----|--|
| Clk2xSys | I | The master double frequency input clock used for generating $\overline{\text{SysOut}}$. |
| Clk2xSmp | I | A double frequency clock input used to determine the sample point for data coming into the processor and coprocessors. |
| Clk2xRd | I | A double frequency clock input used to determine the enable time of the cache RAMs. |
| Clk2xPhi | I | A double frequency clock input used to determine the position of the internal phases, phase1 and phase2. |
| $\overline{\text{Reset}}$ | I | Synchronous initialization input used to force execution starting from the reset memory address. $\overline{\text{Reset}}$ must be deasserted synchronously but asserted asynchronously. The deassertion of $\overline{\text{Reset}}$ must be synchronized by the leading edge of $\overline{\text{SysOut}}$. |

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ABSOLUTE MAXIMUM RATINGS^(1, 3)

| Symbol | Rating | Commercial | Unit |
|--------------------|--------------------------------------|---|------|
| V _{TERM} | Terminal Voltage with Respect to GND | -0.5 to +7.0 | V |
| T _{A, TC} | Operating Temperature | 0 to +70 ⁽⁴⁾ (Ambient) 0 to +90 ⁽⁵⁾ (Case) | °C |
| T _{BIAS} | Case Temperature Under Bias | -55 to +125 ⁽⁴⁾ 0 to +90 ⁽⁵⁾ | °C |
| T _{STG} | Storage Temperature | -55 to +125 | °C |
| V _{IN} | Input Voltage | -0.5 to +7.0 | V |

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NOTE:

- Stresses greater than those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.
- V_{IN} minimum = -3.0V for pulse width less than 15ns.
V_{IN} should not exceed V_{CC} +0.5 Volts.
- Not more than one output should be shorted at a time. Duration of the short should not exceed 30 seconds.
- 16-33 MHz only.
- 37-40 MHz only.

AC TEST CONDITIONS

| Symbol | Parameter | Min. | Max. | Unit |
|------------------|--------------------|------|------|------|
| V _{IH} | Input HIGH Voltage | 3.0 | — | V |
| V _{IL} | Input LOW Voltage | — | 0.4 | V |
| V _{IHS} | Input HIGH Voltage | 3.5 | — | V |
| V _{ILS} | Input LOW Voltage | — | 0.4 | V |

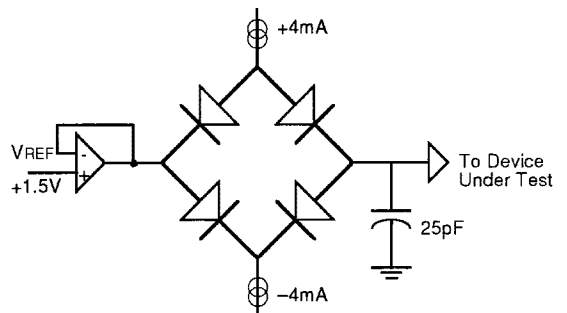
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RECOMMENDED OPERATING TEMPERATURE AND SUPPLY VOLTAGE

| Grade | Temperature | GND | V _{CC} |
|-------------------------|---------------------------|-----|-----------------|
| Commercial 16-33 MHz | 0°C to +70°C (Ambient) | 0V | 5.0 ±5% |
| Commercial 40 MHz | 0°C to +90°C (Case) | 0V | 5.0 ±5% |

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OUTPUT LOADING FOR AC TESTING



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DC ELECTRICAL CHARACTERISTICS

COMMERCIAL TEMPERATURE RANGE ($T_A = 0^\circ\text{C}$ to $+70^\circ\text{C}$, $V_{CC} = +5.0\text{V} \pm 5\%$)

| Symbol | Parameter | Test Conditions | 79R3000A | | | | 79R3000AE | | | | Unit |
|-----------|--------------------------------------|--|----------|------|---------|------|-----------|------|----------|------|---------------|
| | | | 16.67MHz | | 20.0MHz | | 25.0MHz | | 33.33MHz | | |
| | | | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | |
| V_{OH} | Output HIGH Voltage | $V_{CC} = \text{Min.}, I_{OH} = -4\text{mA}$ | 3.5 | — | 3.5 | — | 3.5 | — | 3.5 | — | V |
| V_{OL} | Output LOW Voltage | $V_{CC} = \text{Min.}, I_{OL} = 4\text{mA}$ | — | 0.4 | — | 0.4 | — | 0.4 | — | 0.4 | V |
| V_{OHc} | Output HIGH Voltage ⁽⁷⁾ | $V_{CC} = \text{Min.}, I_{OH} = -4\text{mA}$ | 4.0 | — | 4.0 | — | 4.0 | — | 4.0 | — | V |
| V_{OHT} | Output HIGH Voltage ^(4,6) | $V_{CC} = \text{Min.}, I_{OH} = -8\text{mA}$ | 2.4 | — | 2.4 | — | 2.4 | — | 2.4 | — | V |
| V_{OLT} | Output LOW Voltage ^(4,6) | $V_{CC} = \text{Min.}, I_{OL} = 8\text{mA}$ | — | 0.8 | — | 0.8 | — | 0.8 | — | 0.8 | V |
| V_{IH} | Input HIGH Voltage ⁽⁵⁾ | | 2.0 | — | 2.0 | — | 2.0 | — | 2.0 | — | V |
| V_{IL} | Input LOW Voltage ⁽¹⁾ | | — | 0.8 | — | 0.8 | — | 0.8 | — | 0.8 | V |
| V_{IHS} | Input HIGH Voltage ^(2,5) | | 3.0 | — | 3.0 | — | 3.0 | — | 3.0 | — | V |
| V_{ILS} | Input LOW Voltage ^(1,2) | | — | 0.4 | — | 0.4 | — | 0.4 | — | 0.4 | V |
| C_{IN} | Input Capacitance ⁽⁶⁾ | | — | 10 | — | 10 | — | 10 | — | 10 | pF |
| C_{OUT} | Output Capacitance ⁽⁶⁾ | | — | 10 | — | 10 | — | 10 | — | 10 | pF |
| I_{CC} | Operating Current | $V_{CC} = 5\text{V}, T_A = 70^\circ\text{C}$ | — | 450 | — | 550 | — | 650 | — | 750 | mA |
| I_{IH} | Input HIGH Leakage ⁽³⁾ | $V_{IH} = V_{CC}$ | — | 100 | — | 100 | — | 100 | — | 100 | μA |
| I_{IL} | Input LOW Leakage ⁽³⁾ | $V_{IL} = \text{GND}$ | -100 | — | -100 | — | -100 | — | -100 | — | μA |
| I_{OZ} | Output Tri-state Leakage | $V_{OH} = V_{CC}, V_{OL} = \text{GND}$ | -100 | 100 | -100 | 100 | -100 | 100 | -100 | 100 | μA |

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NOTES:

- V_{IL} Min. = -3.0V for pulse width less than 15ns. V_{IL} should not fall below -0.5 Volts for larger periods.
- V_{IHS} and V_{ILS} apply to Clk2xSys , Clk2xSmp , Clk2xRd , Clk2xPhi , CpBusy , and $\overline{\text{Reset}}$.
- These parameters do not apply to the clock inputs.
- V_{OHT} and V_{OLT} apply to the bidirectional data and tag busses only. Note that V_{IH} and V_{IL} also apply to these signals. V_{OHT} and V_{OLT} are provided to give the designer further information about these specific signals.
- V_{IH} should not be held above $V_{CC} + 0.5$ volts.
- Guaranteed by design.
- V_{OHc} applies to RUN and Exception .

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DC ELECTRICAL CHARACTERISTICS

COMMERCIAL TEMPERATURE RANGE (T_C = 0°C to +90°C, V_{CC} = +5.0V ±5%)

| Symbol | Parameter | Test Conditions | 79R3000AE | | Unit |
|------------------|--------------------------------------|---|-----------|------|------|
| | | | 40.0MHz | | |
| | | | Min. | Max. | |
| V _{OH} | Output HIGH Voltage | V _{CC} = Min., I _{OH} = -4mA | 3.5 | — | V |
| V _{OL} | Output LOW Voltage | V _{CC} = Min., I _{OL} = 4mA | — | 0.4 | V |
| V _{OHc} | Output HIGH Voltage ⁽⁷⁾ | V _{CC} = Min., I _{OH} = -4mA | 4.0 | — | V |
| V _{OHt} | Output HIGH Voltage ^(4,6) | V _{CC} = Min., I _{OH} = -8mA | 2.4 | — | V |
| V _{OLt} | Output LOW Voltage ^(4,6) | V _{CC} = Min., I _{OL} = 8mA | — | 0.8 | V |
| V _{IH} | Input HIGH Voltage ⁽⁵⁾ | | 2.0 | — | V |
| V _{IL} | Input LOW Voltage ⁽¹⁾ | | — | 0.8 | V |
| V _{IHS} | Input HIGH Voltage ^(2,5) | | 3.0 | — | V |
| V _{ILS} | Input LOW Voltage ^(1,2) | | — | 0.4 | V |
| C _{IN} | Input Capacitance ⁽⁶⁾ | | — | 10 | pF |
| C _{OUT} | Output Capacitance ⁽⁶⁾ | | — | 10 | pF |
| I _{CC} | Operating Current | V _{CC} = 5V, T _A = 70°C | — | 850 | mA |
| I _{IH} | Input HIGH Leakage ⁽³⁾ | V _{IH} = V _{CC} | — | 100 | μA |
| I _{IL} | Input LOW Leakage ⁽³⁾ | V _{IL} = GND | -100 | — | μA |
| I _{OZ} | Output Tri-state Leakage | V _{OH} = V _{CC} , V _{OL} = GND | -100 | 100 | μA |

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NOTES:

- V_{IL} Min. = -3.0V for pulse width less than 15ns. V_{IL} should not fall below -0.5 Volts for larger periods.
- V_{IHS} and V_{ILS} apply to Clk2xSys, Clk2xSmp, Clk2xRd, Clk2xPhi, CpBusy, and Reset.
- These parameters do not apply to the clock inputs.
- V_{OHt} and V_{OLt} apply to the bidirectional data and tag busses only. Note that V_{IH} and V_{IL} also apply to these signals. V_{OHt} and V_{OLt} are provided to give the designer further information about these specific signals.
- V_{IH} should not be held above V_{CC} + 0.5 volts.
- Guaranteed by design.
- V_{OHc} applies to RUN and Exception.

AC ELECTRICAL CHARACTERISTICS(1,2,3)

COMMERCIAL TEMPERATURE RANGE (TA = 0°C to +70°C, VCC = +5.0V ±5%)

| Symbol | Parameter | Test Conditions | 79R3000A | | | | 79R3000AE | | | | Unit |
|---------------------------------|---|-----------------|----------|--------------------|---------|--------------------|-----------|--------------------|----------|--------------------|-----------------|
| | | | 16.67MHz | | 20.0MHz | | 25.0MHz | | 33.33MHz | | |
| | | | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | |
| Clock | | | | | | | | | | | |
| TckHigh | Input Clock HIGH ⁽²⁾ | Note 7 | 12.5 | — | 10 | — | 8.0 | — | 6.0 | — | ns |
| TckLow | Input Clock LOW ⁽²⁾ | Note 7 | 12.5 | — | 10 | — | 8.0 | — | 6.0 | — | ns |
| TckP | Input Clock Period ⁽²⁾ | | 30 | 500 | 25 | 500 | 20 | 500 | 15 | 500 | ns |
| | Clk2xSys to Clk2XSmp ⁽⁶⁾ | | 0 | t _{cy} /4 | 0 | t _{cy} /4 | 0 | t _{cy} /4 | 0 | t _{cy} /4 | ns |
| | Clk2XSmp to Clk2xRd ⁽⁶⁾ | | 0 | t _{cy} /4 | 0 | t _{cy} /4 | 0 | t _{cy} /4 | 0 | t _{cy} /4 | ns |
| | Clk2XSmp to Clk2xPhi ⁽⁶⁾ | | 9.0 | t _{cy} /4 | 7.0 | t _{cy} /4 | 5.0 | t _{cy} /4 | 3.5 | t _{cy} /4 | ns |
| Run Operation | | | | | | | | | | | |
| TDEn | Data Enable ⁽³⁾ | | — | -2.0 | — | -2.0 | — | -1.5 | — | -1.5 | ns |
| TDDis | Data Disable ⁽³⁾ | | — | -1.0 | — | -1.0 | — | -0.5 | — | -0.5 | ns |
| TdVal | Data Valid | Load= 25pF | — | 3.0 | — | 3.0 | — | 2.0 | — | 2.0 | ns |
| TWrDly | Write Delay | Load= 25pF | — | 5.0 | — | 4.0 | — | 3.0 | — | 2.0 | ns |
| TDS | Data Set-up | | 9.0 | — | 8.0 | — | 6.0 | — | 4.5 | — | ns |
| TDH | Data Hold ⁽³⁾ | | -2.5 | — | -2.5 | — | -2.5 | — | -2.5 | — | ns |
| TCBS | CpBusy Set-up | | 13 | — | 11 | — | 9.0 | — | 7.0 | — | ns |
| TCBH | CpBusy Hold | | -2.5 | — | -2.5 | — | -2.5 | — | -2.5 | — | ns |
| TAcTy | Access Type (1:0) | Load= 25pF | — | 7.0 | — | 6.0 | — | 5.0 | — | 3.5 | ns |
| TAT2 | Access Type 2 | Load= 25pF | — | 17 | — | 14 | — | 12 | — | 8.5 | ns |
| TMWr | Memory Write | Load= 25pF | — | 27 | — | 23 | — | 18 | — | 9.5 | ns |
| TExc | Exception | Load= 25pF | — | 7.0 | — | 7.0 | — | 5.0 | — | 3.5 | ns |
| TAval | Address Valid | Load= 25pF | — | 2.0 | — | 2.0 | — | 1.5 | — | 1.0 | ns |
| TIntS | Int(n) Set-up | | 9.0 | — | 8.0 | — | 6.0 | — | 4.5 | — | ns |
| TIntH | Int(n) Hold | | -2.5 | — | -2.5 | — | -2.5 | — | -2.5 | — | ns |
| Stall Operation | | | | | | | | | | | |
| TSVal | Address Valid | Load= 25pF | — | 30 | — | 23 | — | 20 | — | 15 | ns |
| TSActy | Access Type | Load= 25pF | — | 27 | — | 23 | — | 18 | — | 13.5 | ns |
| TMRdi | Memory Read Initiate | Load= 25pF | 1.0 | 27 | 1.0 | 23 | 1.0 | 18 | 1.0 | 13.5 | ns |
| TMRdt | Memory Read Terminate | Load= 25pF | — | 27 | — | 23 | — | 18 | — | 10 | ns |
| TStl | Run Terminate | Load= 25pF | 3.0 | 17 | 3.0 | 15 | 3.0 | 10 | 2.0 | 7.5 | ns |
| TRun | Run Initiate | Load= 25pF | — | 7.0 | — | 6.0 | — | 4.0 | — | 3.0 | ns |
| TSMWr | Memory Write | Load= 25pF | 3.0 | 27 | 3.0 | 23 | 3.0 | 18 | 2.0 | 9.5 | ns |
| TSExc | Exception Valid | Load= 25pF | — | 15 | — | 13 | — | 10 | — | 7.5 | ns |
| Reset Initialization | | | | | | | | | | | |
| TRST | Reset Pulse Width | | 6.0 | — | 6.0 | — | 6.0 | — | 6.0 | — | T _{cy} |
| T _{rst} PLL | Reset timing, Phase-lock on ^(4,5) | | 3000 | — | 3000 | — | 3000 | — | 3000 | — | T _{cy} |
| Trstcp | Reset timing, Phase-lock off ^(4,5) | | 128 | — | 128 | — | 128 | — | 128 | — | T _{cy} |
| Capacitive Load Deration | | | | | | | | | | | |
| CLD | Load Derate ⁽⁶⁾ | | 0.5 | 2.0 | 0.5 | 1.0 | 0.5 | 1.0 | 0 | 1.0 | ns/25pF |

NOTES:

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- All timings are referenced to 1.5V.
- The clock parameters apply to all four 2xClocks: Clk2xSys, Clk2xSmp, Clk2xRd, and Clk2xPhi.
- This parameter is guaranteed by design.
- These parameters apply when the IDT79R3010 Floating Point Coprocessor is connected to the CPU. With phase lock on, Reset must be asserted for the longer of 3000 clock cycles or 200 microseconds.
- T_{cy} is one CPU clock cycle (two cycles of a 2x clock).
- With the exception of the Run signal, no two signals on a given device will derate for a given load by a difference greater than 15%.
- Clock transition time < 2.5ns for 33.33MHz; clock transition time < 5ns for other speeds.

5

AC ELECTRICAL CHARACTERISTICS(1,2,3)

COMMERCIAL TEMPERATURE RANGE (T_c = 0°C to +90°C, V_{cc} = +5.0V ±5%)

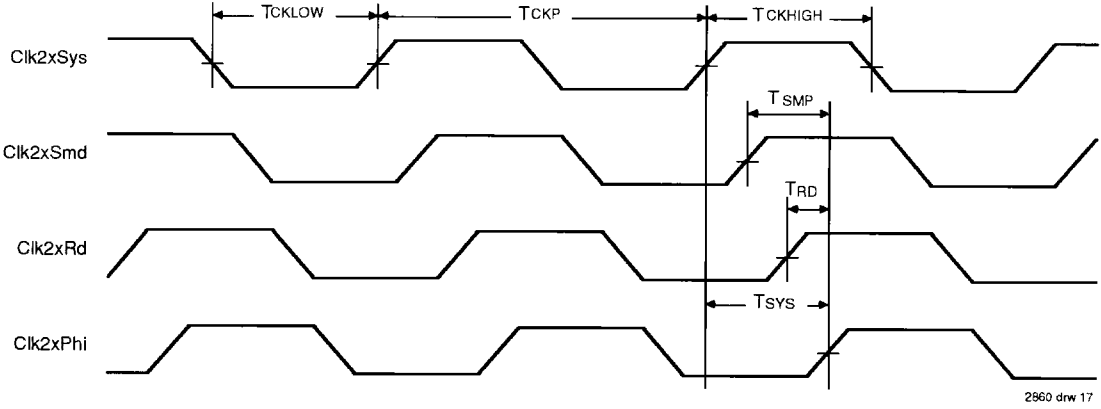
| Symbol | Parameter | Test Conditions | 79R3000AE | | Unit |
|---------------------------------|---|----------------------------|-----------|---------------------|------------------|
| | | | 40.0MHz | | |
| | | | Min. | Max. | |
| Clock | | | | | |
| T _{CKHigh} | Input Clock High ⁽²⁾ | Note 7 | 5.0 | — | ns |
| T _{CKLow} | Input Clock Low ⁽²⁾ | Note 7 | 5.0 | — | ns |
| T _{CKP} | Input Clock Period ⁽²⁾ | | 12.5 | 500 | ns |
| | Clk2xSys to Clk2XSmp ⁽⁶⁾ | | 0 | t _{cyc} /4 | ns |
| | Clk2xSmp to Clk2xRd ⁽⁶⁾ | | 0 | t _{cyc} /4 | ns |
| | Clk2xSmp to Clk2xPhi ⁽⁶⁾ | | 3.0 | t _{cyc} /4 | ns |
| Run Operation | | | | | |
| | TDE _n | Data Enable ⁽³⁾ | — | -1.5 | ns |
| TDDIs | Data Disable ⁽³⁾ | | — | -0.5 | ns |
| TDVal | Data Valid | Load= 25pF | — | 1.5 | ns |
| TWrdly | Write Delay | Load= 25pF | — | 2.0 | ns |
| TDS | Data Set-up | | 4.0 | — | ns |
| TDH | Data Hold ⁽³⁾ | | -2.5 | — | ns |
| TCBS | CpBusy Set-up | | 6.0 | — | ns |
| TCBH | CpBusy Hold | | -2.5 | — | ns |
| TAcTy | Access Type (1:0) | Load= 25pF | — | 3.0 | ns |
| TAT2 | Access Type 2 | Load= 25pF | — | 7.5 | ns |
| TMWr | Memory Write | Load= 25pF | — | 9.0 | ns |
| TExc | Exception | Load= 25pF | — | 3.0 | ns |
| TAval | Address Valid | Load= 25pF | — | 0.5 | ns |
| TIntS | Int(n) Set-up | | 4.0 | — | ns |
| TIntH | Int(n) Hold | | -2.5 | — | ns |
| Stall Operation | | | | | |
| TSaVal | Address Valid | Load= 25pF | — | 12.5 | ns |
| TSaCy | Access Type | Load= 25pF | — | 9.0 | ns |
| TMRdi | Memory Read Initiate | Load= 25pF | — | 9.0 | ns |
| TMRdt | Memory Read Terminate | Load= 25pF | — | 9.0 | ns |
| TStl | Run Terminate | Load= 25pF | 2.0 | 6.0 | ns |
| TRun | Run Initiate | Load= 25pF | — | 3.0 | ns |
| TSMWr | Memory Write | Load= 25pF | 2.0 | 9.0 | ns |
| TSExc | Exception Valid | Load= 25pF | — | 6.0 | ns |
| Reset Initialization | | | | | |
| TRST | Reset Pulse Width | | 6.0 | — | T _{cyc} |
| TrstPLL | Reset timing, Phase-lock on ^(4,5) | | 3000 | — | T _{cyc} |
| Trstcp | Reset timing, Phase-lock off ^(4,5) | | 128 | — | T _{cyc} |
| Capacitive Load Deration | | | | | |
| CLD | Load Derate ⁽⁶⁾ | | 0 | 1.0 | ns/25pF |

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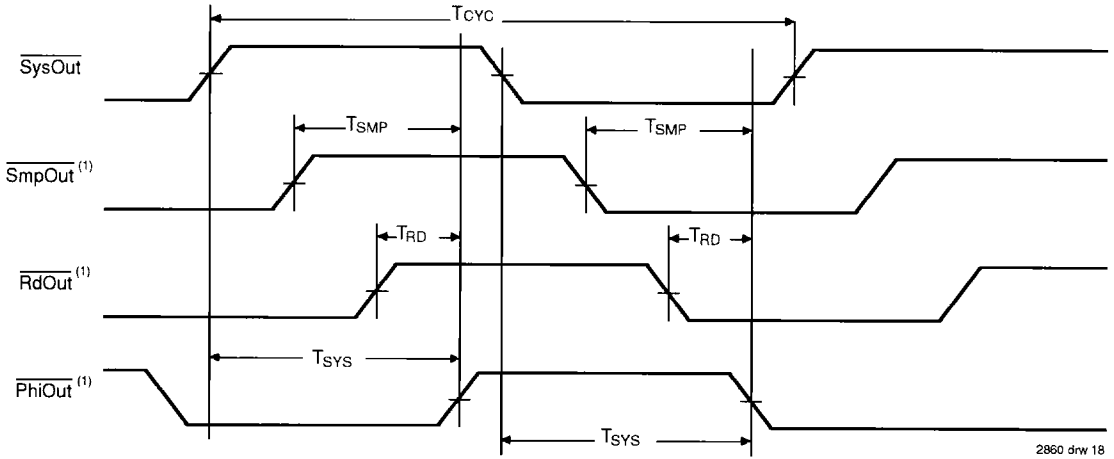
NOTES:

- All timings are referenced to 1.5V.
- The clock parameters apply to all four 2xClocks: Clk2xSys, Clk2XSmp, Clk2xRd, and Clk2xPhi.
- This parameter is guaranteed by design.
- These parameters apply when the IDT79R3010 Floating Point Coprocessor is connected to the CPU. With phase lock on, Reset must be asserted for the longer of 3000 clock cycles or 200 microseconds.
- T_{cyc} is one CPU clock cycle (two cycles of a 2x clock).
- With the exception of the RUN signal, no two signals on a given device will derate for a given load by a difference greater than 15%.
- Clock transition time < 2.5ns.

INPUT CLOCK TIMING



PROCESSOR REFERENCE CLOCK TIMING

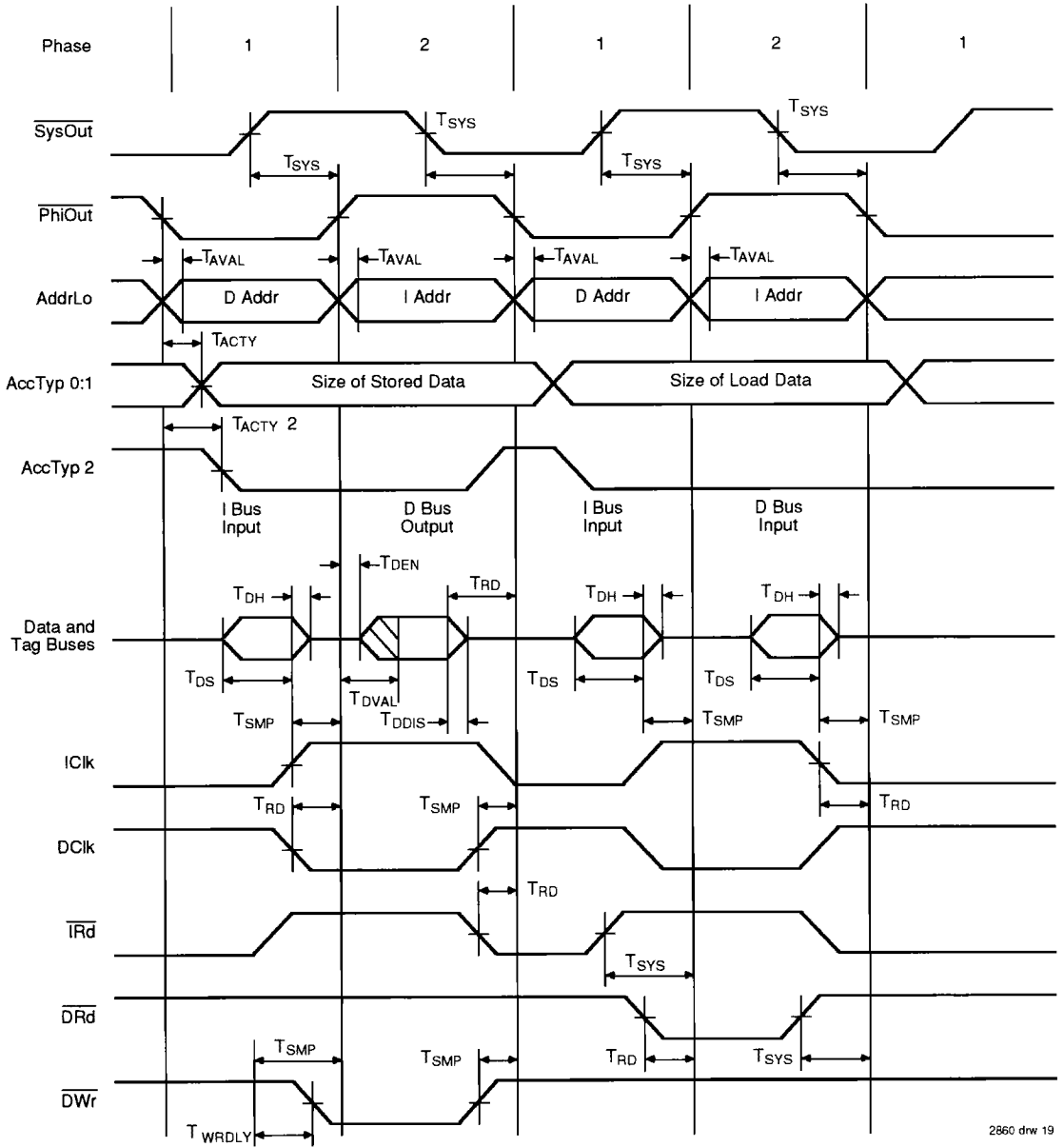


NOTE:

1. These signals are not actually output from the processor. They are drawn to provide a reference for other timing diagrams.

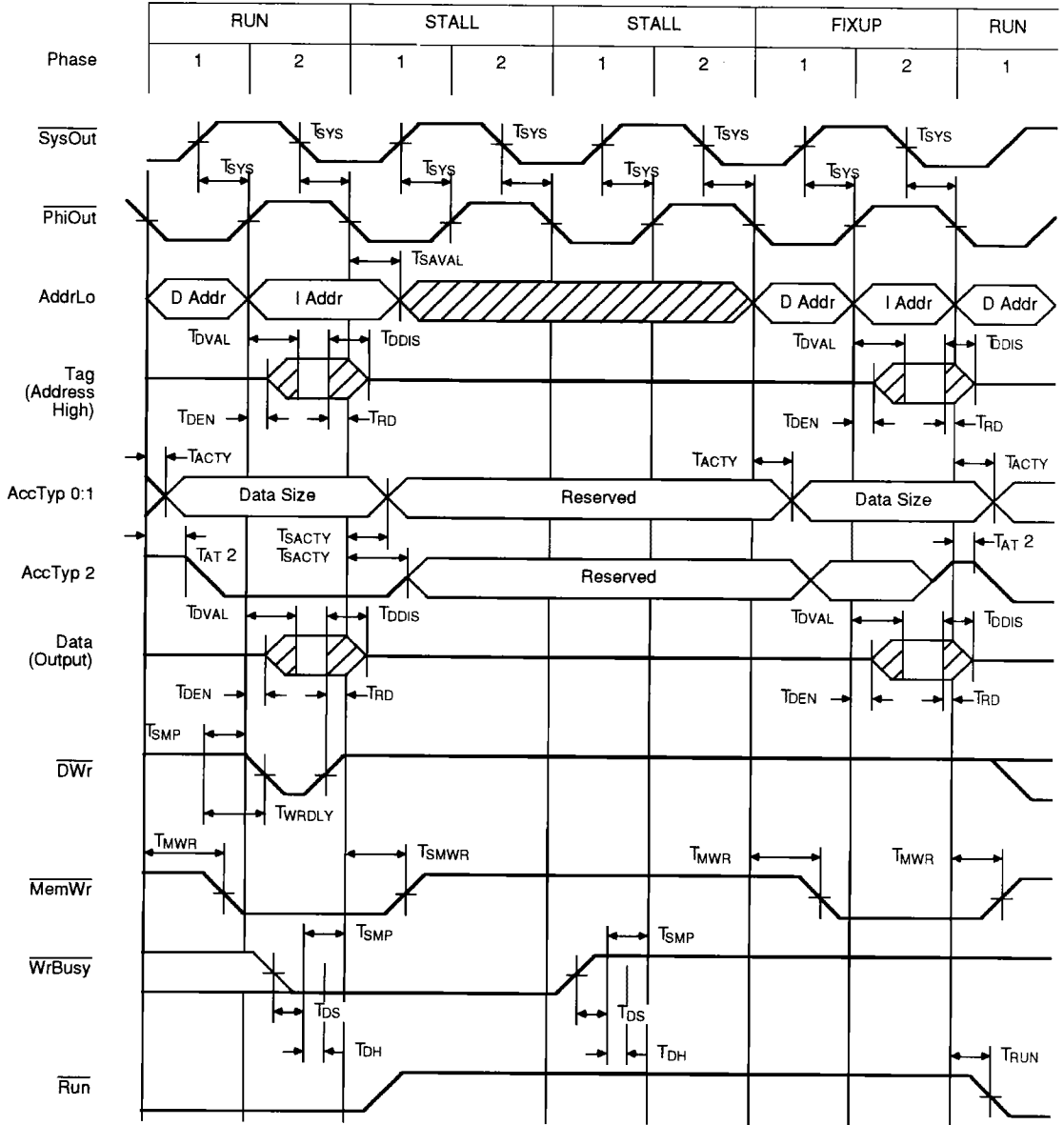
5

SYNCHRONOUS MEMORY (CACHE) TIMING



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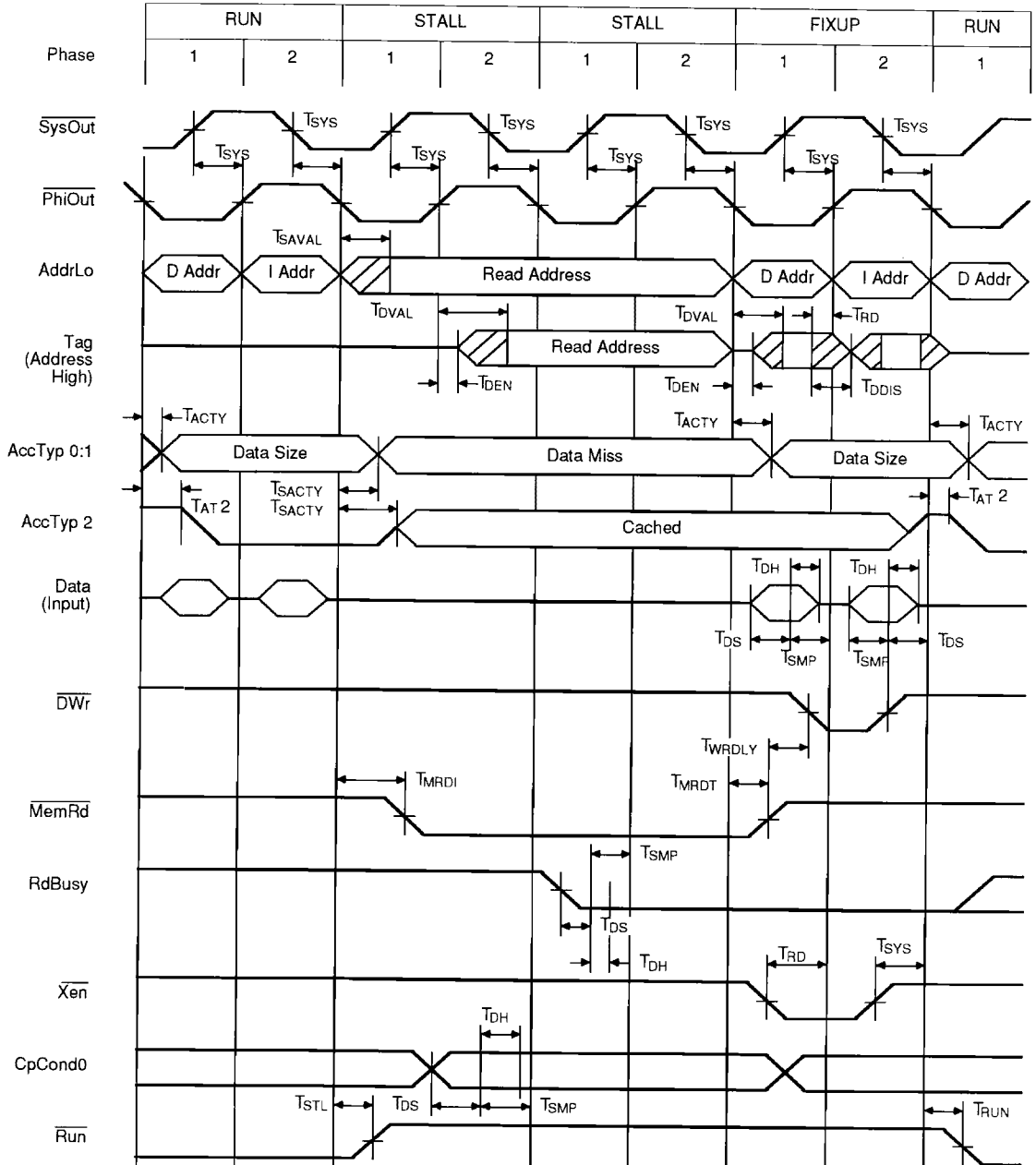
MEMORY WRITE TIMING



2860 drw 20

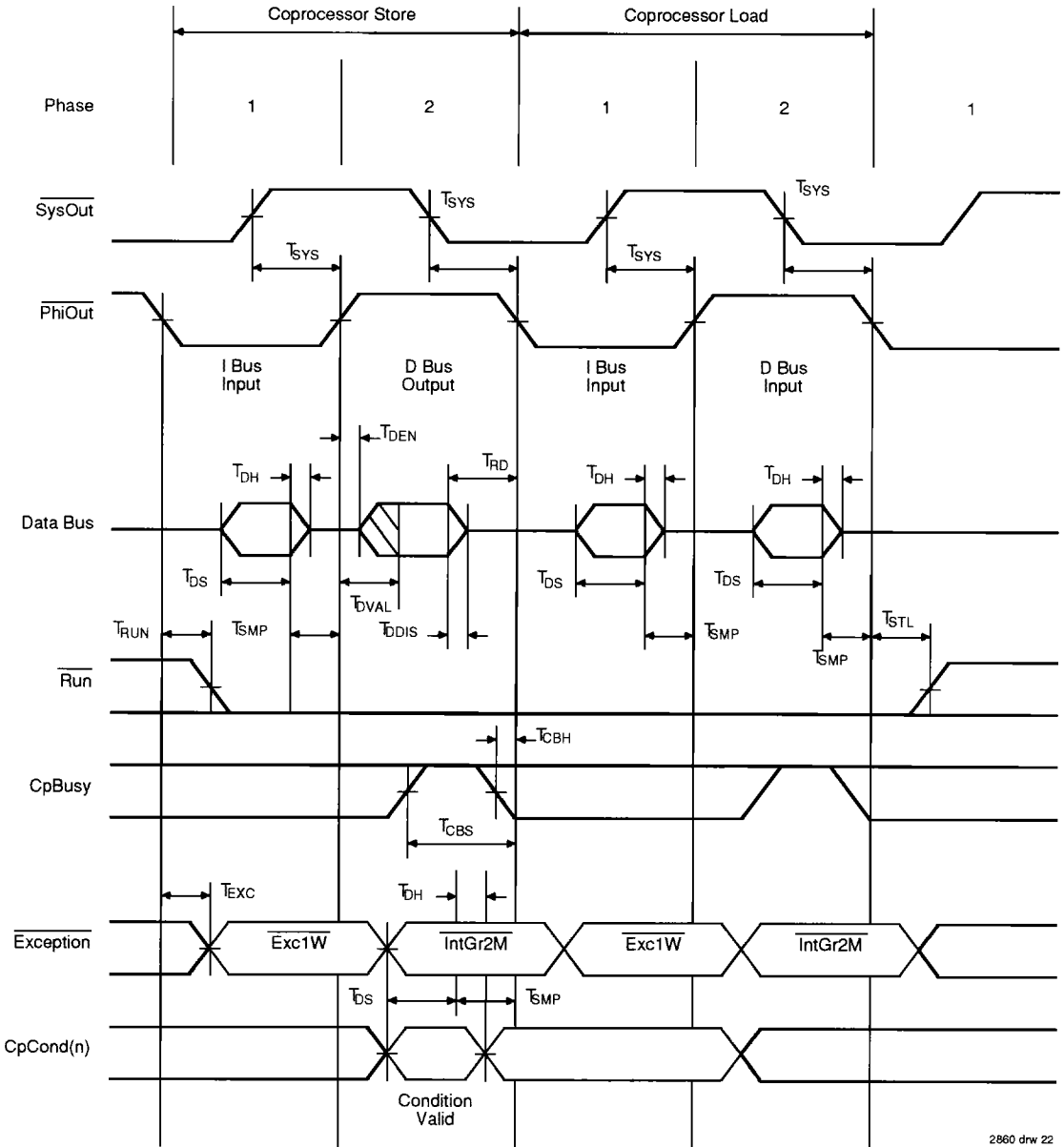
5

MEMORY READ TIMING



2860 drw 21

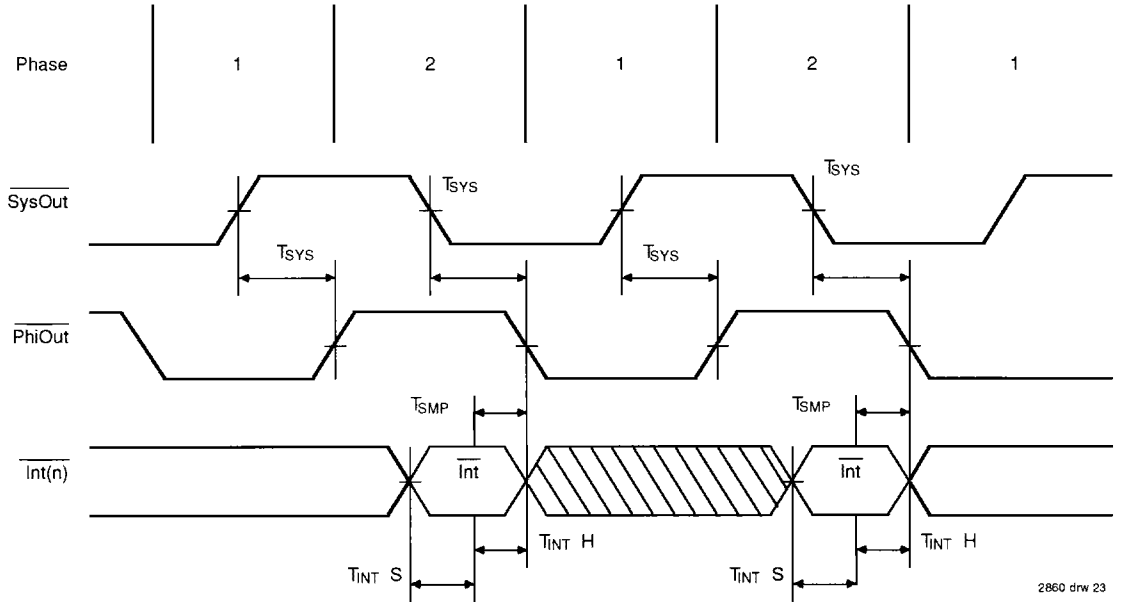
COPROCESSOR LOAD/STORE TIMING



5

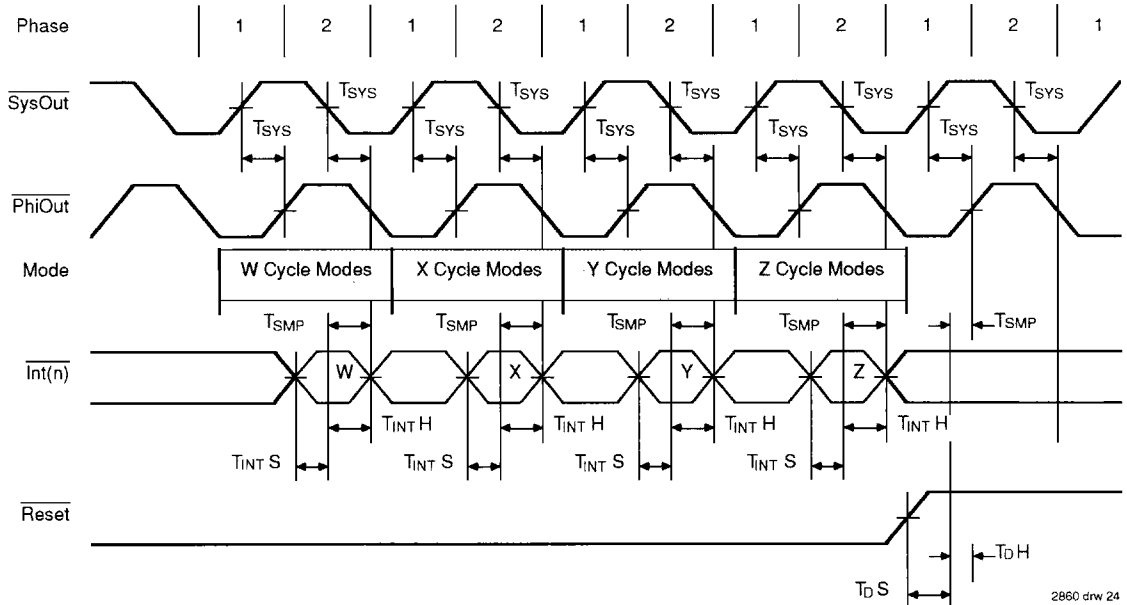
2860 drw 22

INTERRUPT TIMING



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MODE VECTOR INITIALIZATION

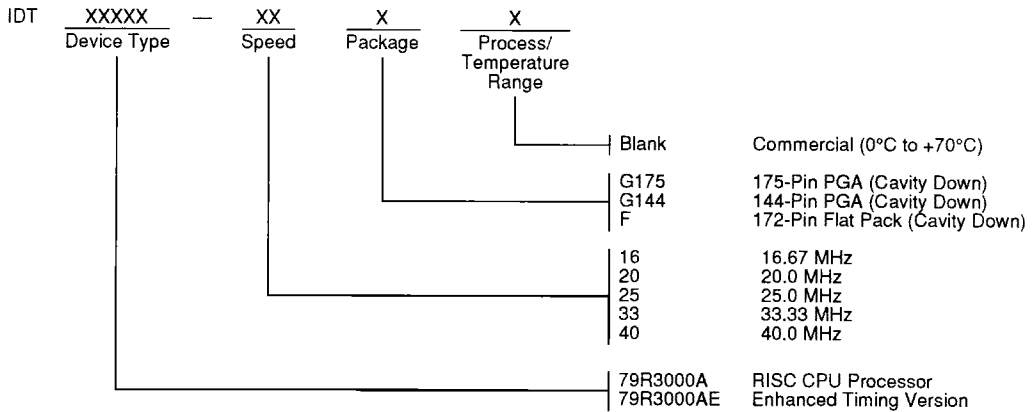


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NOTES:

1. Reset must be negated synchronously; however, it should be asserted asynchronously. Designs must not rely on the proper functioning of \overline{SysOut} prior to the assertion of \overline{Reset} .
2. If Phase-Lock On or R3000 Mode are asserted as mode select options, they should be asserted throughout the \overline{Reset} period, to insure that the slowest coprocessor in the system has sufficient time to lock to the CPU clocks.
3. Reset is actually sampled in both Phase 1 and Phase 2. To insure proper initialization, it must be negated relative to the end of Phase 1.

ORDERING INFORMATION



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VALID COMBINATIONS

IDT 79R3000A - 16, 20
79R3000AE - 25, 33, 40

All Packages
All Packages

