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Understanding Embedded - DSP (Digital Signal Processors)

Embedded - DSP (Digital Signal Processors) are specialized microprocessors designed to perform complex mathematical computations on digital signals in real-time. Unlike general-purpose processors, DSPs are optimized for high-speed numeric processing tasks, making them ideal for applications that require efficient and precise manipulation of digital data. These processors are fundamental in converting and processing signals in various forms, including audio, video, and communication signals, ensuring that data is accurately interpreted and utilized in embedded systems.

Applications of Embedded - DSP (Digital Signal Processors)

Details	
Product Status	Obsolete
Type	Fixed Point
Interface	Synchronous Serial Port (SSP)
Clock Rate	52MHz
Non-Volatile Memory	External
On-Chip RAM	80kB
Voltage - I/O	3.30V
Voltage - Core	3.30V
Operating Temperature	0°C ~ 70°C (TA)
Mounting Type	Surface Mount
Package / Case	128-LQFP
Supplier Device Package	128-TQFP (14x20)
Purchase URL	https://www.e-xfl.com/product-detail/analog-devices/adsp-2183kstz-210

ADSP-2183* PRODUCT PAGE QUICK LINKS

Last Content Update: 02/23/2017

COMPARABLE PARTS

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EVALUATION KITS

- EZ-ICE® Serial Emulator for ADSP-218x Processor Family
- EZ-KIT Lite Evaluation Kit for ADSP-218x Processor

DOCUMENTATION

Application Notes

- AN-1: ADSP-21xx Legacy Application Notes
- AN-227: Digital Control System Design with the ADSP-2100 Family
- AN-227: Digital Control System Design with the ADSP-2100 Family
- AN-334: Digital Signal Processing Techniques
- AN-524: ADV601/ADV611 Bin Width Calculation in ADSP-21xx DSP
- EE-06: ADSP-21xx Serial Port Startup Issues
- EE-100: ADSP-218x External Overlay Memory
- EE-102: Mode D and ADSP-218x Pin Compatibility - the FAQs
- EE-103: Performing Level Conversion Between 5v and 3.3v IC's
- EE-104: Setting Up Streams with the VisualDSP Debugger
- EE-11: ADSP-2181 Priority Chain & IDMA Holdoffs
- EE-110: A Quick Primer on ELF and DWARF File Formats
- EE-115: ADSP-2189 IDMA Interface to Motorola MC68300 Family of Microprocessors
- EE-12: Interrupts and Programmable Flags on the ADSP-2185/2186
- EE-121: Porting Code from ADSP-21xx to ADSP-219x
- EE-122: Coding for Performance on the ADSP-219x
- EE-123: An Overview of the ADSP-219x Pipeline
- EE-124: Booting up the ADSP-2192
- EE-125: ADSP-218x Embedded System Software Management and In-System-Programming (ISP)
- EE-128: DSP in C++: Calling Assembly Class Member Functions From C++
- EE-129: ADSP-2192 Interprocessor Communication
- EE-130: Making Fast Transition from ADSP-21xx to ADSP-219x
- EE-131: Booting the ADSP-2191/95/96 DSPs
- EE-133: Converting From Legacy Architecture Files To Linker Description Files for the ADSP-218x
- EE-139: Interfacing the ADSP-2191 to an AD7476 via the SPI Port
- EE-142: Autobuffering, C and FFTs on the ADSP-218x
- EE-144: Creating a Master-Slave SPI Interface Between Two ADSP-2191 DSPs

DESIGN RESOURCES

- ADSP-2183 Material Declaration
- PCN-PDN Information
- Quality And Reliability
- Symbols and Footprints

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This takes place while the processor continues to:
- Receive and transmit data through the two serial ports
- Receive and/or transmit data through the internal DMA port
- Receive and/or transmit data through the byte DMA port
- Decrement timer

Development System

The ADSP-2100 Family Development Software, a complete set of tools for software and hardware system development, supports the ADSP-2183. The assembler has an algebraic syntax that is easy to program and debug. The linker combines object files into an executable file. The simulator provides an interactive instruction-level simulation with a reconfigurable user interface to display different portions of the hardware environment.

The EZ-KIT Lite is a hardware/software kit offering a complete development environment for the ADSP-21xx family: an ADSP-2189M evaluation board with PC monitor software plus Assembler, Linker, Simulator and PROM Splitter software. The ADSP-2189M evaluation board is a low-cost, easy to use hardware platform on which you can quickly get started with your DSP software design. The EZ-KIT Lite include the following features:

- 35.7 MHz ADSP-2189M
- Full 16-bit Stereo Audio I/O with AD73322 CODEC
- RS-232 Interface
- EZ-ICE Connector for Emulator Control
- DSP Demo Programs
- Evaluation Suite of VisualDSP

The ADSP-218x EZ-ICE® Emulator aids in the hardware debugging of ADSP-218x systems. The ADSP-218x integrates on-chip emulation support with a 14-pin ICE-Port interface. This interface provides a simpler target board connection requiring fewer mechanical clearance considerations than other ADSP-2100 Family EZ-ICEs. The ADSP-218x device need not be removed from the target system when using the EZ-ICE, nor are any adapters needed. Due to the small footprint of the EZ-ICE connector, emulation can be supported in final board designs.

The EZ-ICE performs a full range of functions, including:

- In-target operation
- Up to 20 breakpoints
- Single-step or full-speed operation
- Registers and memory values can be examined and altered
- PC upload and download functions
- Instruction-level emulation of program booting and execution
- Complete assembly and disassembly of instructions
- C source-level debugging

(See Designing An EZ-ICE-Compatible Target System section of this data sheet for exact specifications of the EZ-ICE target board connector.)

Additional Information

This data sheet provides a general overview of ADSP-2183 functionality. For additional information on the architecture and instruction set of the processor, refer to the *ADSP-2100 Family User's Manual,* Third Edition. For more information about the development tools, refer to the *ADSP-2100 Family Development Tools Data Sheet*.

ARCHITECTURE OVERVIEW

The ADSP-2183 instruction set provides flexible data moves and multifunction (one or two data moves with a computation) instructions. Every instruction can be executed in a single processor cycle. The ADSP-2183 assembly language uses an algebraic syntax for ease of coding and readability. A comprehensive set of development tools supports program development.

Figure 1 is an overall block diagram of the ADSP-2183. The processor contains three independent computational units: the ALU, the multiplier/accumulator (MAC) and the shifter. The computational units process 16-bit data directly and have provisions to support multiprecision computations. The ALU performs a standard set of arithmetic and logic operations; division primitives are also supported. The MAC performs single-cycle multiply, multiply/add and multiply/subtract operations with 40 bits of accumulation. The shifter performs logical and arithmetic shifts, normalization, denormalization and derive exponent operations. The shifter can be used to efficiently implement numeric format control including multiword and block floating-point representations.

The internal result (R) bus connects the computational units so that the output of any unit may be the input of any unit on the next cycle.

The ADSP-21xx family DSPs contain a shadow register that is useful for single cycle context switching of the processor.

A powerful program sequencer and two dedicated data address generators ensure efficient delivery of operands to these computational units. The sequencer supports conditional jumps, subroutine calls and returns in a single cycle. With internal loop counters and loop stacks, the ADSP-2183 executes looped code with zero overhead; no explicit jump instructions are required to maintain loops.

Two data address generators (DAGs) provide addresses for simultaneous dual operand fetches (from data memory and program memory). Each DAG maintains and updates four address pointers. Whenever the pointer is used to access data (indirect addressing), it is post-modified by the value of one of four possible modify registers. A length value may be associated with each pointer to implement automatic modulo addressing for circular buffers.

Efficient data transfer is achieved with the use of five internal buses:

- Program Memory Address (PMA) Bus
- Program Memory Data (PMD) Bus
- Data Memory Address (DMA) Bus
- Data Memory Data (DMD) Bus
- Result (R) Bus

The two address buses (PMA and DMA) share a single external address bus, allowing memory to be expanded off-chip, and the two data buses (PMD and DMD) share a single external data bus. Byte memory space and I/O memory space also share the external buses.

Program memory can store both instructions and data, permitting the ADSP-2183 to fetch two operands in a single cycle, one from program memory and one from data memory. The ADSP-2183 can fetch an operand from program memory and the next instruction in the same cycle.

- SPORTs support serial data word lengths from 3 to 16 bits and provide optional A-law and μ-law companding according to CCITT recommendation G.711.
- SPORT receive and transmit sections can generate unique interrupts on completing a data word transfer.
- SPORTs can receive and transmit an entire circular buffer of data with only one overhead cycle per data word. An interrupt is generated after a data buffer transfer.
- SPORT0 has a multichannel interface to selectively receive and transmit a 24 or 32 word, time-division multiplexed, serial bitstream.
- SPORT1 can be configured to have two external interrupts ($\overline{IRQ0}$ and $\overline{IRQ1}$) and the Flag In and Flag Out signals. The internally generated serial clock may still be used in this configuration.

Pin Descriptions

The ADSP-2183 is available in a 128-lead LQFP package, and Mini-BGA.

PIN FUNCTION DESCRIPTIONS

Pin Name(s)	# of Pins	Input/ Output	Function
Address	14	O	Address Output Pins for Program, Data, Byte, & I/O Spaces
Data	24	I/O	Data I/O Pins for Program and Data Memory Spaces (8 MSBs Are Also Used as Byte Space Addresses)
$\overline{RESET}$	1	I	Processor Reset Input
$\overline{IRQ2}$	1	I	Edge- or Level-Sensitive Interrupt Request
$\overline{IRQL0}$, $\overline{IRQL1}$	2	I	Level-Sensitive Interrupt Requests
$\overline{IRQE}$	1	I	Edge-Sensitive Interrupt Request
$\overline{BR}$	1	I	Bus Request Input
$\overline{BG}$	1	O	Bus Grant Output
$\overline{BGH}$	1	O	Bus Grant Hung Output
$\overline{PMS}$	1	O	Program Memory Select Output
$\overline{DMS}$	1	O	Data Memory Select Output
$\overline{BMS}$	1	O	Byte Memory Select Output
$\overline{IOMS}$	1	O	I/O Space Memory Select Output
$\overline{CMS}$	1	O	Combined Memory Select Output
$\overline{RD}$	1	O	Memory Read Enable Output
$\overline{WR}$	1	O	Memory Write Enable Output
MMAP	1	I	Memory Map Select Input
BMODE	1	I	Boot Option Control Input
CLKIN, XTAL	2	I	Clock or Quartz Crystal Input
CLKOUT	1	O	Processor Clock Output.
SPORT0	5	I/O	Serial Port I/O Pins
SPORT1	5	I/O	Serial Port 1 *or* Two External $\overline{IRQ}$s, Flag In and Flag Out
$\overline{IRD}$, $\overline{IWR}$	2	I	IDMA Port Read/Write Inputs
$\overline{IS}$	1	I	IDMA Port Select
IAL	1	I	IDMA Port Address Latch Enable
IAD	16	I/O	IDMA Port Address/Data Bus
$\overline{IACK}$	1	O	IDMA Port Access Ready Acknowledge
$\overline{PWD}$	1	I	Power-Down Control
PWDACK	1	O	Power-Down Control
FL0, FL1, FL2	3	O	Output Flags
PF7:0	8	I/O	Programmable I/O Pins
EE	1	*	(Emulator Only*)
$\overline{EBR}$	1	*	(Emulator Only*)
$\overline{EBG}$	1	*	(Emulator Only*)
$\overline{ERESET}$	1	*	(Emulator Only*)
$\overline{EMS}$	1	*	(Emulator Only*)
$\overline{EINT}$	1	*	(Emulator Only*)
ECLK	1	*	(Emulator Only*)
ELIN	1	*	(Emulator Only*)
ELOUT	1	*	(Emulator Only*)
GND	11		Ground Pins (LQFP)
VDD	6		Power Supply Pins (LQFP)
GND	22		Ground Pins (Mini-BGA)
VDD	11		Power Supply Pins (Mini-BGA)

*These ADSP-2183 pins must be connected *only* to the EZ-ICE connector in the target system. These pins have no function except during emulation, and do not require pull-up or pull-down resistors.

Interrupts

The interrupt controller allows the processor to respond to the eleven possible interrupts and reset with minimum overhead. The ADSP-2183 provides four dedicated external interrupt input pins, $\overline{IRQ2}$, $\overline{IRQL0}$, $\overline{IRQL1}$ and $\overline{IRQE}$. In addition, SPORT1 may be reconfigured for $\overline{IRQ0}$, $\overline{IRQ1}$, FLAG_IN and FLAG_OUT, for a total of six external interrupts. The ADSP-2183 also supports internal interrupts from the timer, the byte DMA port, the two serial ports, software and the power-down control circuit. The interrupt levels are internally prioritized and individually maskable (except power-down and reset). The $\overline{IRQ2}$, $\overline{IRQ0}$ and $\overline{IRQ1}$ input pins can be programmed to be either level- or edge-sensitive. $\overline{IRQL0}$ and $\overline{IRQL1}$ are level-sensitive and $\overline{IRQE}$ is edge sensitive. The priorities and vector addresses of all interrupts are shown in Table I.

Table I. Interrupt Priority and Interrupt Vector Addresses

Source of Interrupt	Interrupt Vector Address (Hex)
Reset (or Power-Up with PUCR = 1)	0000 (*Highest Priority*)
Power-Down (Nonmaskable)	002C
$\overline{\text{IRQ2}}$	0004
$\overline{\text{IRQL1}}$	0008
$\overline{\text{IRQL0}}$	000C
SPORT0 Transmit	0010
SPORT0 Receive	0014
$\overline{\text{IRQE}}$	0018
BDMA Interrupt	001C
SPORT1 Transmit or $\overline{\text{IRQ1}}$	0020
SPORT1 Receive or $\overline{\text{IRQ0}}$	0024
Timer	0028 (*Lowest Priority*)

Interrupt routines can either be nested, with higher priority interrupts taking precedence, or processed sequentially. Interrupts can be masked or unmasked with the IMASK register. Individual interrupt requests are logically ANDed with the bits in IMASK; the highest priority unmasked interrupt is then selected. The power-down interrupt is nonmaskable.

The ADSP-2183 masks all interrupts for one instruction cycle following the execution of an instruction that modifies the IMASK register. This does not affect serial port autobuffering or DMA transfers.

The interrupt control register, ICNTL, controls interrupt nesting and defines the $\overline{\text{IRQ0}}$, $\overline{\text{IRQ1}}$ and $\overline{\text{IRQ2}}$ external interrupts to be either edge- or level-sensitive. The $\overline{\text{IRQE}}$ pin is an external edge-sensitive interrupt and can be forced and cleared. The $\overline{\text{IRQL0}}$ and $\overline{\text{IRQL1}}$ pins are external level-sensitive interrupts.

The IFC register is a write-only register used to force and clear interrupts.

On-chip stacks preserve the processor status and are automatically maintained during interrupt handling. The stacks are twelve levels deep to allow interrupt, loop and subroutine nesting.

The following instructions allow global enable or disable servicing of the interrupts (including power down), regardless of the state of IMASK. Disabling the interrupts does not affect serial port autobuffering or DMA.

ENA INTS;
DIS INTS;

When the processor is reset, interrupt servicing is enabled.

LOW POWER OPERATION

The ADSP-2183 has three low power modes that significantly reduce the power dissipation when the device operates under standby conditions. These modes are:

- Power-Down
- Idle
- Slow Idle

The CLKOUT pin may also be disabled to reduce external power dissipation.

Power-Down

The ADSP-2183 processor has a low power feature that lets the processor enter a very low power dormant state through hardware or software control. Here is a brief list of power-down features. Refer to the *ADSP-2100 Family User's Manual*, Third Edition, "System Interface" chapter for detailed information about the power-down feature.

- Quick recovery from power-down. The processor begins executing instructions in as few as 300 CLKIN cycles.
- Support for an externally generated TTL or CMOS processor clock. The external clock can continue running during power-down without affecting the lowest power rating and 300 CLKIN cycle recovery.
- Support for crystal operation includes disabling the oscillator to save power (the processor automatically waits 4096 CLKIN cycles for the crystal oscillator to start and stabilize), and letting the oscillator run to allow 300 CLKIN cycle start-up.
- Power-down is initiated by either the power-down pin ($\overline{\text{PWD}}$) or the software power-down force bit.
- Interrupt support allows an unlimited number of instructions to be executed before optionally powering down. The power-down interrupt also can be used as a nonmaskable, edge-sensitive interrupt.
- Context clear/save control allows the processor to continue where it left off or start with a clean context when leaving the power-down state.
- The $\overline{\text{RESET}}$ pin also can be used to terminate power-down.
- Power-down acknowledge pin indicates when the processor has entered power-down.

Idle

When the ADSP-2183 is in the Idle Mode, the processor waits indefinitely in a low power state until an interrupt occurs. When an unmasked interrupt occurs, it is serviced; execution then continues with the instruction following the *IDLE* instruction.

Slow Idle

The *IDLE* instruction is enhanced on the ADSP-2183 to let the processor's internal clock signal be slowed, further reducing power consumption. The reduced clock frequency, a programmable fraction of the normal clock rate, is specified by a selectable divisor given in the *IDLE* instruction. The format of the instruction is

IDLE (n);

where n = 16, 32, 64 or 128. This instruction keeps the processor fully functional, but operating at the slower clock rate. While it is in this state, the processor's other internal clock signals, such as SCLK, CLKOUT and timer clock, are reduced by the same ratio. The default form of the instruction, when no clock divisor is given, is the standard *IDLE* instruction.

Memory Architecture
The ADSP-2183 provides a variety of memory and peripheral interface options. The key functional groups are Program Memory, Data Memory, Byte Memory and I/O.

Program Memory is a 24-bit-wide space for storing both instruction opcodes and data. The ADSP-2183 has 16K words of Program Memory RAM on chip and the capability of accessing up to two 8K external memory overlay spaces using the external data bus. Both an instruction opcode and a data value can be read from on-chip program memory in a single cycle.

Data Memory is a 16-bit-wide space used for the storage of data variables and for memory-mapped control registers. The ADSP-2183 has 16K words on Data Memory RAM on chip, consisting of 16,352 user-accessible locations and 32 memory-mapped registers. Support also exists for up to two 8K external memory overlay spaces through the external data bus.

Byte Memory provides access to an 8-bit-wide memory space through the Byte DMA (BDMA) port. The Byte Memory interface provides access to 4 MBytes of memory by utilizing eight data lines as additional address lines. This gives the BDMA Port an effective 22-bit address range. On power-up, the DSP can automatically load bootstrap code from byte memory.

I/O Space allows access to 2048 locations of 16-bit-wide data. It is intended to be used to communicate with parallel peripheral devices such as data converters and external registers or latches.

Program Memory
The ADSP-2183 contains a 16K × 24 on-chip program RAM. The on-chip program memory is designed to allow up to two accesses each cycle so that all operations can complete in a single cycle. In addition, the ADSP-2183 allows the use of 8K external memory overlays.

The program memory space organization is controlled by the MMAP pin and the PMOVLAY register. Normally, the ADSP-2183 is configured with MMAP = 0 and program memory organized as shown in Figure 4.

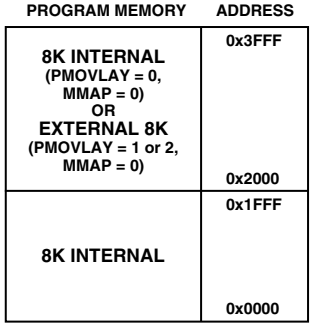


Figure 4. Program Memory (MMAP = 0)

There are 16K words of memory accessible internally when the PMOVLAY register is set to 0. When PMOVLAY is set to something other than 0, external accesses occur at addresses 0x2000 through 0x3FFF. The external address is generated as shown in Table II.

Table II.

PMOVLAY	Memory	A13	A12:0
0	Internal	Not Applicable	Not Applicable
1	External Overlay 1	0	13 LSBs of Address Between 0x2000 and 0x3FFF
2	External Overlay 2	1	13 LSBs of Address Between 0x2000 and 0x3FFF

This organization provides for two external 8K overlay segments using only the normal 14 address bits. This allows for simple program overlays using one of the two external segments in place of the on-chip memory. Care must be taken in using this overlay space because the processor core (i.e., the sequencer) does not take the PMOVLAY register value into account. For example, if a loop operation were occurring on one of the external overlays, and the program changes to another external overlay or internal memory, an incorrect loop operation could occur. In addition, care must be taken in interrupt service routines as the overlay registers are not automatically saved and restored on the processor mode stack.

For ADSP-2100 Family compatibility, MMAP = 1 is allowed. In this mode, booting is disabled and overlay memory is disabled (*PMOVLAY* must be 0). Figure 5 shows the memory map in this configuration.

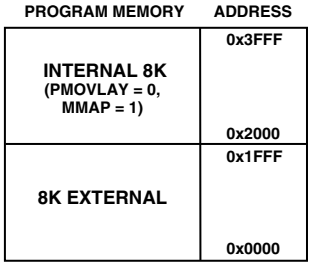


Figure 5. Program Memory (MMAP = 1)

Data Memory
The ADSP-2183 has 16,352 16-bit words of internal data memory. In addition, the ADSP-2183 allows the use of 8K external memory overlays. Figure 6 shows the organization of the data memory.

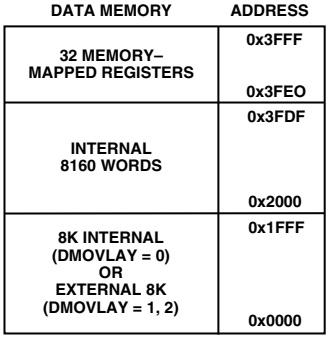


Figure 6. Data Memory

Target Board Connector for EZ-ICE Probe
The EZ-ICE connector (a standard pin strip header) is shown in Figure 7. You must add this connector to your target board design if you intend to use the EZ-ICE. Be sure to allow enough room in your system to fit the EZ-ICE probe onto the 14-pin connector.

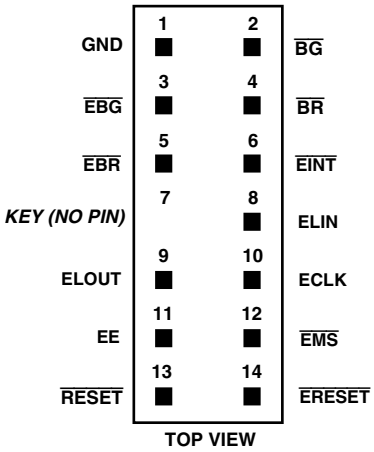


Figure 7. Target Board Connector for EZ-ICE

The 14-pin, 2-row pin strip header is keyed at the Pin 7 location—you must remove Pin 7 from the header. The pins must be 0.025 inch square and at least 0.20 inch in length. Pin spacing should be 0.1 × 0.1 inches. The pin strip header must have at least 0.15 inch clearance on all sides to accept the EZ-ICE probe plug. Pin strip headers are available from vendors such as 3M, McKenzie, and Samtec.

Target Memory Interface
For your target system to be compatible with the EZ-ICE emulator, it must comply with the memory interface guidelines listed below.

PM, DM, BM, IOM and CM
Design your Program Memory (PM), Data Memory (DM), Byte Memory (BM), I/O Memory (IOM), and Composite Memory (CM) external interfaces to comply with worst case device timing requirements and switching characteristics as specified in the DSP's data sheet. The performance of the EZ-ICE may approach published worst case specification for some memory access timing requirements and switching characteristics.

Note: If your target does not meet the worst case chip specification for memory access parameters, you may not be able to emulate your circuitry at the desired CLKIN frequency. Depending on the severity of the specification violation, you may have trouble manufacturing your system as DSP components statistically vary in switching characteristic and timing requirements within published limits.

Restriction: All memory strobe signals on the ADSP-2183 ($\overline{RD}$, $\overline{WR}$, $\overline{PMS}$, $\overline{DMS}$, $\overline{BMS}$, $\overline{CMS}$ and $\overline{IOMS}$) used in your target system must have 10 kΩ pull-up resistors connected when the EZ-ICE is being used. The pull-up resistors are necessary because there are no internal pull-ups to guarantee their state during prolonged three-state conditions resulting from typical EZ-ICE debugging sessions. These resistors may be removed at your option when the EZ-ICE is not being used.

Target System Interface Signals
When the EZ-ICE board is installed, the performance on some system signals changes. Design your system to be compatible with the following system interface signal changes introduced by the EZ-ICE board:

- EZ-ICE emulation introduces an 8 ns propagation delay between your target circuitry and the DSP on the $\overline{RESET}$ signal.
- EZ-ICE emulation introduces an 8 ns propagation delay between your target circuitry and the DSP on the $\overline{BR}$ signal.
- EZ-ICE emulation ignores $\overline{RESET}$ and $\overline{BR}$ when single-stepping.
- EZ-ICE emulation ignores $\overline{RESET}$ and $\overline{BR}$ when in Emulator Space (DSP halted).
- EZ-ICE emulation ignores the state of target $\overline{BR}$ in certain modes. As a result, the target system may take control of the DSP's external memory bus *only* if bus grant ($\overline{BG}$) is asserted by the EZ-ICE board's DSP.

Target Architecture File
The EZ-ICE software lets you load your program in its linked (executable) form. The EZ-ICE PC program can not load sections of your executable located in boot pages (by the linker). With the exception of boot page 0 (loaded into PM RAM), all sections of your executable mapped into boot pages are not loaded.

Write your target architecture file to indicate that only PM RAM is available for *program storage*, when using the EZ-ICE software's loading feature. Data can be loaded to PM RAM or DM RAM.

ABSOLUTE MAXIMUM RATINGS*

Supply Voltage . . . . . –0.3 V to +4.6 V
Input Voltage . . . . . –0.5 V to V_{DD} + 0.5 V
Output Voltage Swing . . . . . –0.5 V to V_{DD} + 0.5 V
Operating Temperature Range (Ambient) . . . . –40°C to +85°C
Storage Temperature Range . . . . . –65°C to +150°C
Lead Temperature (5 sec) LQFP . . . . . +280°C

*Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only; 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 device reliability.

ESD SENSITIVITY

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although the ADSP-2183 features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high-energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.

TIMING PARAMETERS

GENERAL NOTES

Use the exact timing information given. Do not attempt to derive parameters from the addition or subtraction of others. While addition or subtraction would yield meaningful results for an individual device, the values given in this data sheet reflect statistical variations and worst cases. Consequently, you cannot meaningfully add up parameters to derive longer times.

TIMING NOTES

Switching Characteristics specify how the processor changes its signals. You have no control over this timing—circuitry external to the processor must be designed for compatibility with these signal characteristics. Switching characteristics tell you what the processor will do in a given circumstance. You can also use switching characteristics to ensure that any timing requirement of a device connected to the processor (such as memory) is satisfied.

Timing Requirements apply to signals that are controlled by circuitry external to the processor, such as the data input for a read operation. Timing requirements guarantee that the processor operates correctly with other devices.

MEMORY TIMING SPECIFICATIONS

The table below shows common memory device specifications and the corresponding ADSP-2183 timing parameters, for your convenience.

Memory Device Specification	ADSP-2183 Timing Parameter	Timing Parameter Definition
Address Setup to Write Start	t_{ASW}	A0–A13, $\overline{xMS}$ Setup before $\overline{WR}$ Low
Address Setup to Write End	t_{AW}	A0–A13, $\overline{xMS}$ Setup before $\overline{WR}$ Deasserted
Address Hold Time	t_{WRA}	A0–A13, $\overline{xMS}$ Hold after $\overline{WR}$ Deasserted
Data Setup Time	t_{DW}	Data Setup before $\overline{WR}$ High
Data Hold Time	t_{DH}	Data Hold after $\overline{WR}$ High
$\overline{OE}$ to Data Valid	t_{RDD}	$\overline{RD}$ Low to Data Valid
Address Access Time	t_{AA}	A0–A13, $\overline{xMS}$ to Data Valid

$\overline{xMS}$ = $\overline{PMS}$, $\overline{DMS}$, $\overline{BMS}$, $\overline{CMS}$, $\overline{IOMS}$.

FREQUENCY DEPENDENCY FOR TIMING SPECIFICATIONS

t_{CK} is defined as $0.5t_{CKI}$. The ADSP-2183 uses an input clock with a frequency equal to half the instruction rate: a 16.67 MHz input clock (which is equivalent to 60 ns) yields a 30 ns processor cycle (equivalent to 33 MHz). t_{CK} values within the range of $0.5t_{CKI}$ period should be substituted for all relevant timing parameters to obtain the specification value.

Example: $t_{CKH} = 0.5t_{CK} – 7$ ns = 0.5 (34.7 ns) – 7 ns = 10.35 ns

Parameter		Min	Max	Unit
Bus Request–Bus Grant				
Timing Requirements:				
t_{BH}	$\overline{BR}$ Hold after CLKOUT High[1]	$0.25t_{CK} + 2$		ns
t_{BS}	$\overline{BR}$ Setup before CLKOUT Low[1]	$0.25t_{CK} + 17$		ns
Switching Characteristics:				
t_{SD}	CLKOUT High to $\overline{xMS}$, $\overline{RD}$, $\overline{WR}$ Disable		$0.25t_{CK} + 10$	ns
t_{SDB}	$\overline{xMS}$, $\overline{RD}$, $\overline{WR}$ Disable to $\overline{BG}$ Low	0		ns
t_{SE}	$\overline{BG}$ High to $\overline{xMS}$, $\overline{RD}$, $\overline{WR}$ Enable	0		ns
t_{SEC}	$\overline{xMS}$, $\overline{RD}$, $\overline{WR}$ Enable to CLKOUT High	$0.25t_{CK} - 4$		ns
t_{SDBH}	$\overline{xMS}$, $\overline{RD}$, $\overline{WR}$ Disable to $\overline{BGH}$ Low[2]	0		ns
t_{SEH}	$\overline{BGH}$ High to $\overline{xMS}$, $\overline{RD}$, $\overline{WR}$ Enable[2]	0		ns

NOTES
$\overline{xMS}$ = $\overline{PMS}$, $\overline{DMS}$, $\overline{CMS}$, $\overline{IOMS}$, $\overline{BMS}$.
[1]$\overline{BR}$ is an asynchronous signal. If $\overline{BR}$ meets the setup/hold requirements, it will be recognized during the current clock cycle; otherwise the signal will be recognized on the following cycle. Refer to the *ADSP-2100 Family User's Manual,* Third Edition, for $\overline{BR}$/$\overline{BG}$ cycle relationships.
[2]$\overline{BGH}$ is asserted when the bus is granted and the processor requires control of the bus to continue.

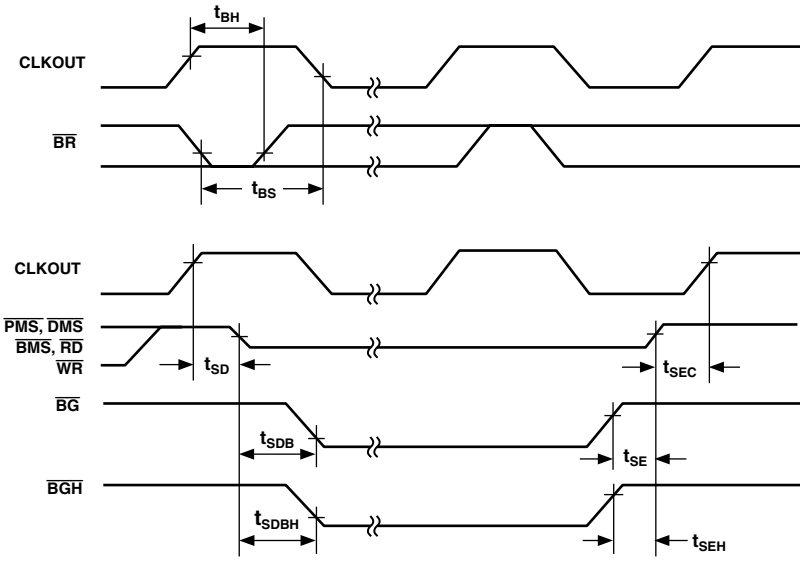


Figure 10. Bus Request–Bus Grant

Parameter		Min	Max	Unit
Memory Read				
Timing Requirements:				
t_{RDD}	$\overline{RD}$ Low to Data Valid		$0.5t_{CK} - 8 + w$	ns
t_{AA}	A0–A13, $\overline{xMS}$ to Data Valid		$0.75t_{CK} - 10.5 + w$	ns
t_{RDH}	Data Hold from $\overline{RD}$ High	0		ns
Switching Characteristics:				
t_{RP}	$\overline{RD}$ Pulsewidth	$0.5t_{CK} - 5 + w$		ns
t_{CRD}	CLKOUT High to $\overline{RD}$ Low	$0.25t_{CK} - 2$	$0.25t_{CK} + 7$	ns
t_{ASR}	A0–A13, $\overline{xMS}$ Setup before $\overline{RD}$ Low	$0.25t_{CK} - 4$		ns
t_{RDA}	A0–A13, $\overline{xMS}$ Hold after $\overline{RD}$ Deasserted	$0.25t_{CK} - 3$		ns
t_{RWR}	$\overline{RD}$ High to $\overline{RD}$ or $\overline{WR}$ Low	$0.5t_{CK} - 5$		ns

w = wait states × t_{CK}.
$\overline{xMS}$ = $\overline{PMS}$, $\overline{DMS}$, $\overline{CMS}$, $\overline{IOMS}$, $\overline{BMS}$.

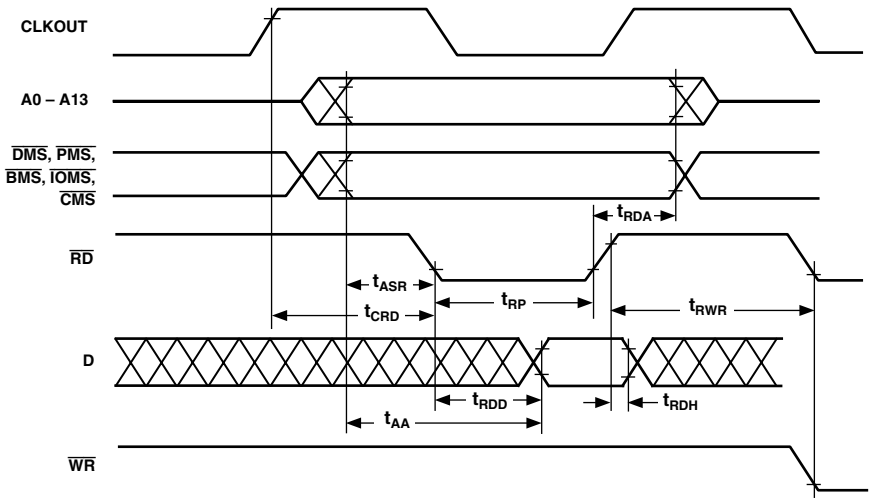


Figure 11. Memory Read

Parameter		Min	Max	Unit
IDMA Write, Short Write Cycle				
Timing Requirements:				
t_{IKW}	$\overline{IACK}$ Low before Start of Write[1]	0		ns
t_{IWP}	Duration of Write[1, 2]	15		ns
t_{IDSU}	IAD15–0 Data Setup before End of Write[2, 3, 4]	5		ns
t_{IDH}	IAD15–0 Data Hold after End of Write[2, 3, 4]	2		ns
Switching Characteristic:				
t_{IKHW}	Start of Write to $\overline{IACK}$ High		15	ns

NOTES
[1]Start of Write = $\overline{IS}$ Low and $\overline{IWR}$ Low.
[2]End of Write = $\overline{IS}$ High or $\overline{IWR}$ High.
[3]If Write Pulse ends before $\overline{IACK}$ Low, use specifications t_{IDSU}, t_{IDH}.
[4]If Write Pulse ends after $\overline{IACK}$ Low, use specifications t_{IKSU}, t_{IKH}.

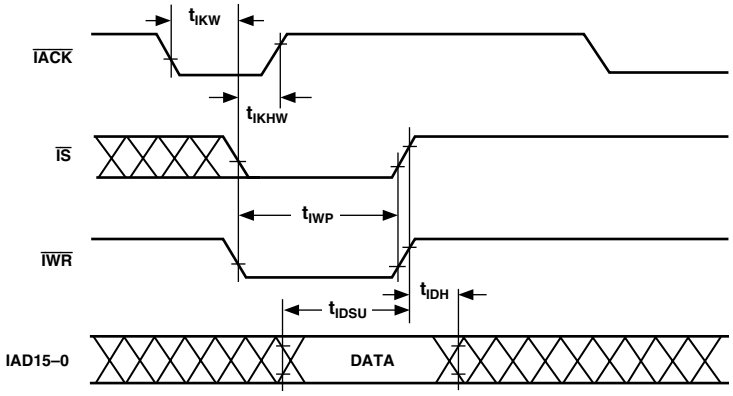


Figure 15. IDMA Write, Short Write Cycle

Parameter		Min	Max	Unit
IDMA Write, Long Write Cycle				
Timing Requirements:				
t_{IKW}	$\overline{IACK}$ Low before Start of Write[1]	0		ns
t_{IKSU}	IAD15–0 Data Setup before $\overline{IACK}$ Low[2, 3]	$0.5t_{CK}$ + 10		ns
t_{IKH}	IAD15–0 Data Hold after $\overline{IACK}$ Low[2, 3]	2		ns
Switching Characteristics:				
t_{IKLW}	Start of Write to $\overline{IACK}$ Low[4]	$1.5t_{CK}$		ns
t_{IKHW}	Start of Write to $\overline{IACK}$ High		15	ns

NOTES
[1]Start of Write = $\overline{IS}$ Low and $\overline{IWR}$ Low.
[2]If Write Pulse ends before $\overline{IACK}$ Low, use specifications t_{IDSU}, t_{IDH}.
[3]If Write Pulse ends after $\overline{IACK}$ Low, use specifications t_{IKSU}, t_{IKH}.
[4]This is the earliest time for $\overline{IACK}$ Low from Start of Write. For IDMA Write Cycle relationships, please refer to the *ADSP-21xx Family User's Manual*, Third Edition.

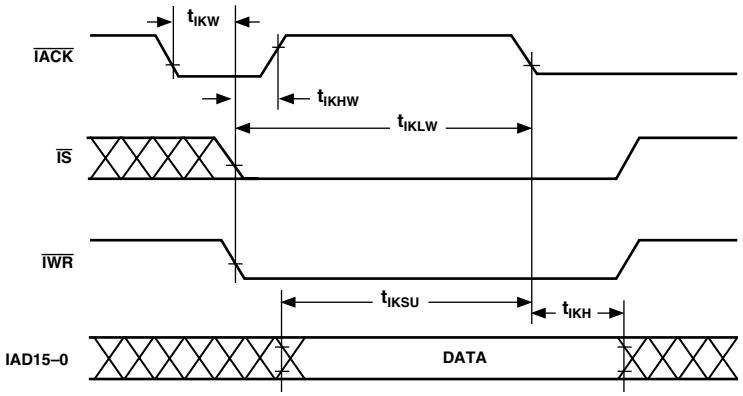


Figure 16. IDMA Write, Long Write Cycle

Parameter		Min	Max	Unit
IDMA Read, Short Read Cycle				
Timing Requirements:				
t_{IKR}	$\overline{IACK}$ Low before Start of Read[1]	0		ns
t_{IRP}	Duration of Read	15		ns
Switching Characteristics:				
t_{IKHR}	$\overline{IACK}$ High after Start of Read[1]		15	ns
t_{IKDH}	IAD15–0 Data Hold after End of Read[2]	0		ns
t_{IKDD}	IAD15–0 Data Disabled after End of Read[2]		10	ns
t_{IRDE}	IAD15–0 Previous Data Enabled after Start of Read	0		ns
t_{IRDV}	IAD15–0 Previous Data Valid after Start of Read		15	ns

NOTES
[1]Start of Read = $\overline{IS}$ Low and $\overline{IRD}$ Low.
[2]End of Read = $\overline{IS}$ High or $\overline{IRD}$ High.

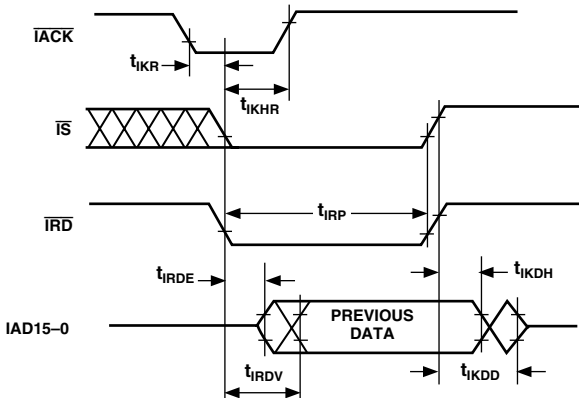


Figure 18. IDMA Read, Short Read Cycle

OUTPUT DRIVE CURRENTS

Figure 19 shows typical I-V characteristics for the output drivers of the ADSP-2183. The curves represent the current drive capability of the output drivers as a function of output voltage.

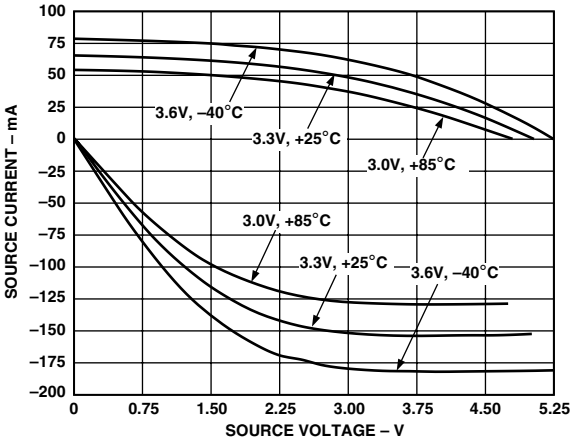
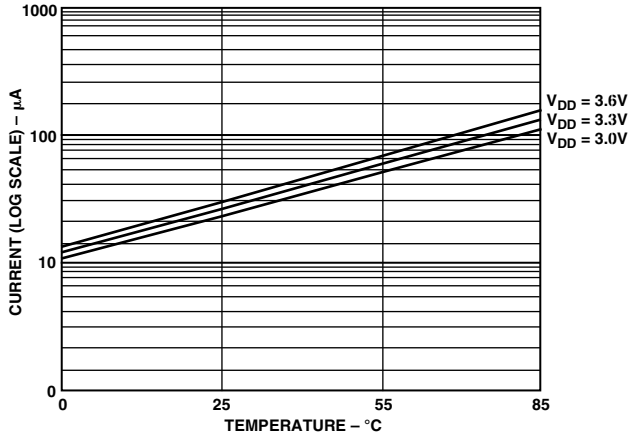


Figure 19. Typical Drive Currents



NOTES:
1. REFLECTS ADSP-2183 OPERATION IN LOWEST POWER MODE. (SEE "SYSTEM INTERFACE" CHAPTER OF THE *ADSP-2100 FAMILY USER'S MANUAL* FOR DETAILS.)
2. CURRENT REFLECTS DEVICE OPERATING WITH NO INPUT LOADS.

Figure 20. Power-Down Supply Current (Typical)

POWER DISSIPATION

To determine total power dissipation in a specific application, the following equation should be applied for each output:

$$C \times V_{DD}^2 \times f$$

C = load capacitance, f = output switching frequency.

Example:

In an application where external data memory is used and no other outputs are active, power dissipation is calculated as follows:

Assumptions:

- External data memory is accessed every cycle with 50% of the address pins switching.
- External data memory writes occur every other cycle with 50% of the data pins switching.
- Each address and data pin has a 10 pF total load at the pin.
- The application operates at V_{DD} = 3.3 V and t_{CK} = 30.0 ns.

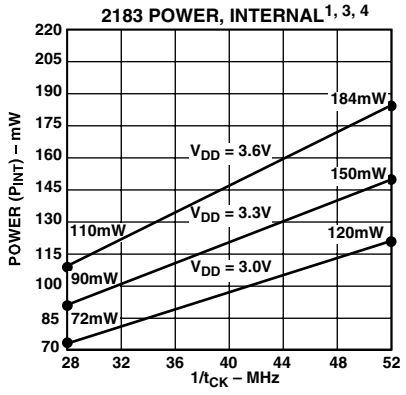
Total Power Dissipation = P_{INT} + $(C \times V_{DD}^2 \times f)$

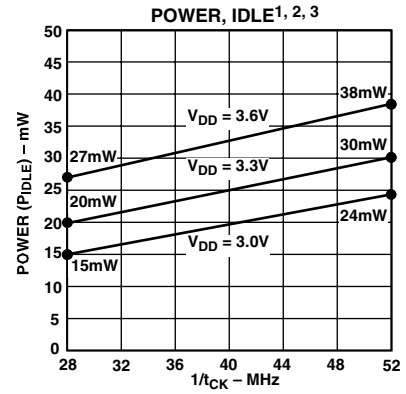
P_{INT} = internal power dissipation from Power vs. Frequency graph (Figure 20).

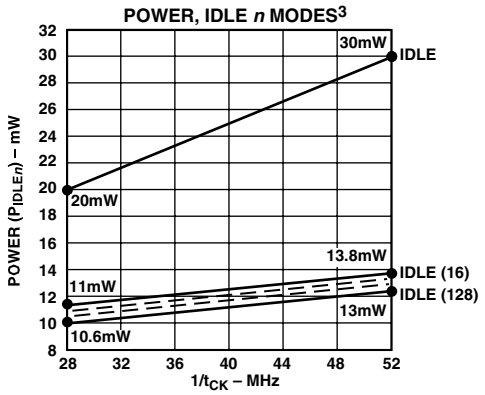
$(C \times V_{DD}^2 \times f)$ is calculated for each output:

	# of Pins	× C	× V_{DD}^2	× f		
Address, $\overline{DMS}$	8	× 10 pF	× 3.3² V	× 33.3 MHz	=	29.0 mW
Data Output, $\overline{WR}$	9	× 10 pF	× 3.3² V	× 16.67 MHz	=	16.3 mW
$\overline{RD}$	1	× 10 pF	× 3.3² V	× 16.67 MHz	=	1.8 mW
CLKOUT	1	× 10 pF	× 3.3² V	× 33.3 MHz	=	3.6 mW
						50.7 mW

Total power dissipation for this example is P_{INT} + 50.7 mW.







VALID FOR ALL TEMPERATURE GRADES.
[1]POWER REFLECTS DEVICE OPERATING WITH NO OUTPUT LOADS.
[2]IDLE REFERS TO ADSP-2183 STATE OF OPERATION DURING EXECUTION OF IDLE INSTRUCTION. DEASSERTED PINS ARE DRIVEN TO EITHER V_{DD} OR GND.
[3]TYPICAL POWER DISSIPATION AT 3.3V V_{DD} AND 25°C EXCEPT WHERE SPECIFIED.
[4]I_{DD} MEASUREMENT TAKEN WITH ALL INSTRUCTIONS EXECUTING FROM INTERNAL MEMORY. 50% OF THE INSTRUCTIONS ARE MULTIFUNCTION (TYPES 1,4,5,12,13,14), 30% ARE TYPE 2 AND TYPE 6, AND 20% ARE IDLE INSTRUCTIONS.

Figure 21. Power vs. Frequency

CAPACITIVE LOADING

Figures 22 and 23 show the capacitive loading characteristics of the ADSP-2183.

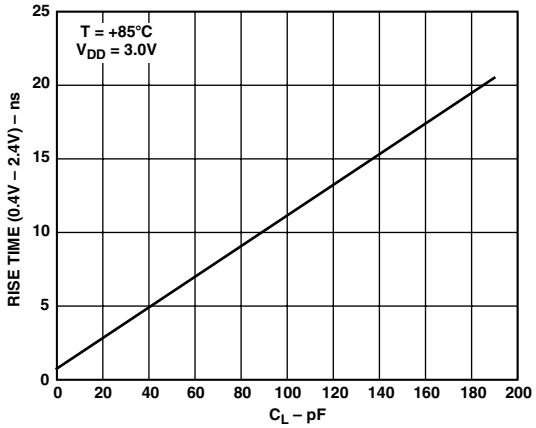


Figure 22. Typical Output Rise Time vs. Load Capacitance, C_L (at Maximum Ambient Operating Temperature)

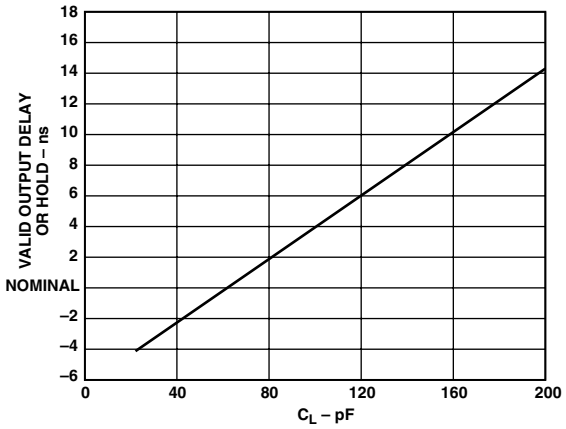


Figure 23. Typical Output Valid Delay or Hold vs. Load Capacitance, C_L (at Maximum Ambient Operating Temperature)

TEST CONDITIONS

Output Disable Time

Output pins are considered to be disabled when they have stopped driving and started a transition from the measured output high or low voltage to a high impedance state. The output disable time (t_{DIS}) is the difference of $t_{MEASURED}$ and t_{DECAY}, as shown in the Output Enable/Disable diagram. The time is the interval from when a reference signal reaches a high or low voltage level to when the output voltages have changed by 0.5 V from the measured output high or low voltage. The decay time, t_{DECAY}, is dependent on the capacitive load, C_L, and the current load, i_L, on the output pin. It can be approximated by the following equation:

$$t_{DECAY} = \frac{C_L \bullet 0.5\,V}{i_L}$$

from which

$$t_{DIS} = t_{MEASURED} - t_{DECAY}$$

is calculated. If multiple pins (such as the data bus) are disabled, the measurement value is that of the last pin to stop driving.

Figure 24. Voltage Reference Levels for AC Measurements (Except Output Enable/Disable)

Output Enable Time

Output pins are considered to be enabled when they have made a transition from a high-impedance state to when they start driving. The output enable time (t_{ENA}) is the interval from when a reference signal reaches a high or low voltage level to when the output has reached a specified high or low trip point, as shown in the Output Enable/Disable diagram. If multiple pins (such as the data bus) are enabled, the measurement value is that of the first pin to start driving.

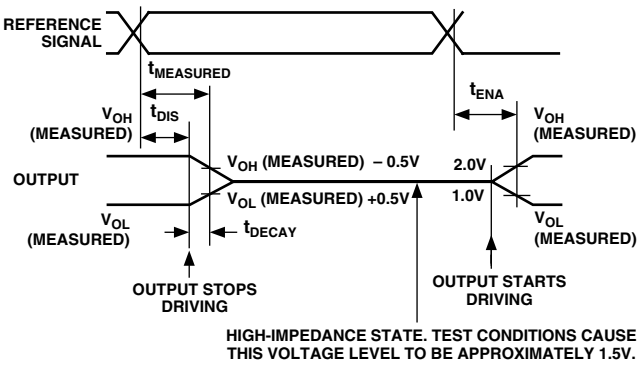


Figure 25. Output Enable/Disable

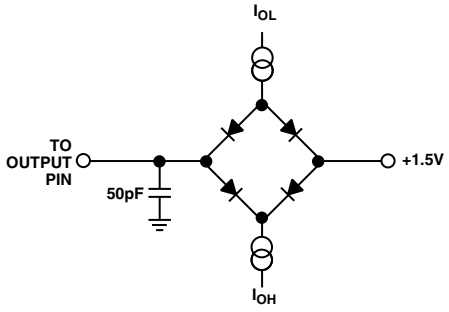


Figure 26. Equivalent Device Loading for AC Measurements (Including All Fixtures)

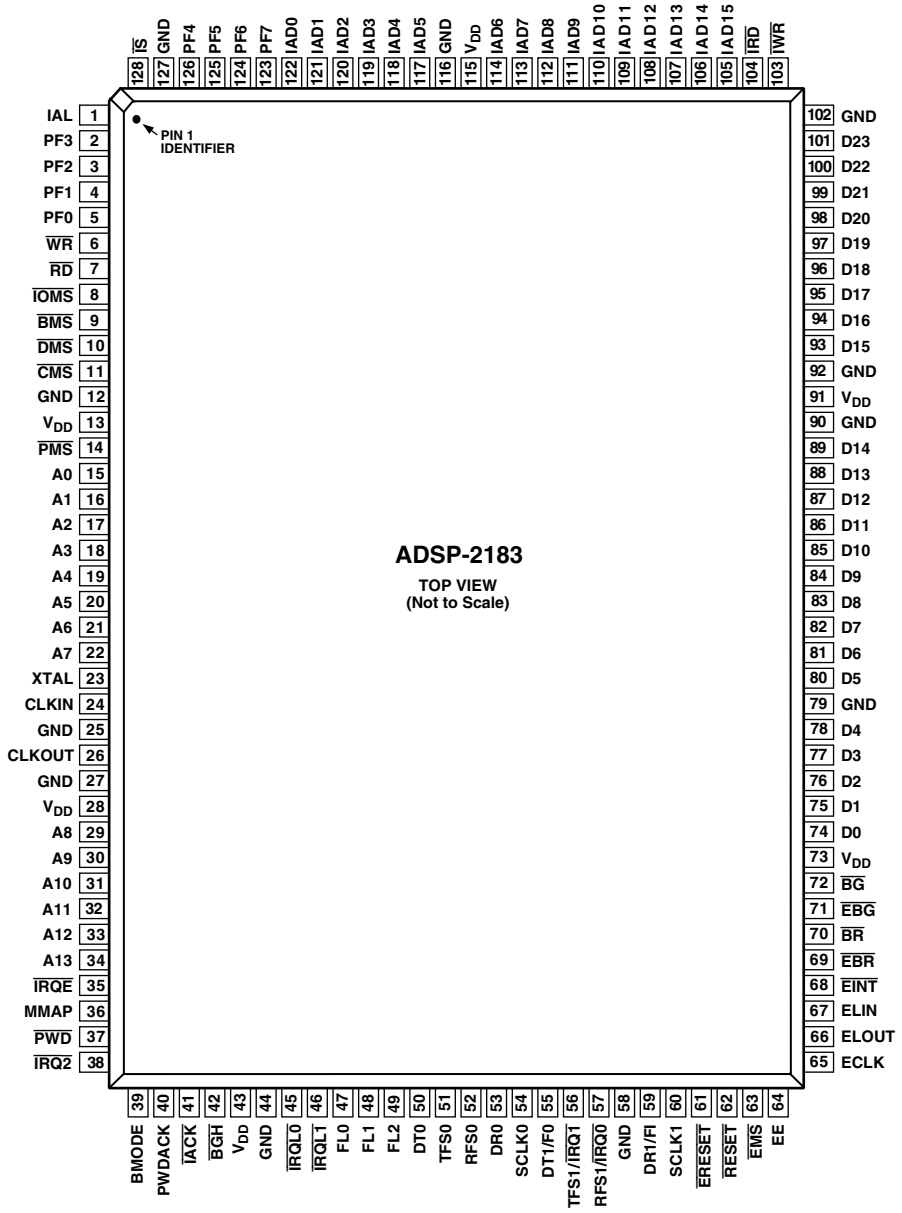
ENVIRONMENTAL CONDITIONS

Ambient Temperature Rating:

$T_{AMB} = T_{CASE} - (PD \times \theta_{CA})$
T_{CASE} = Case Temperature in °C
PD = Power Dissipation in W
θ_{CA} = Thermal Resistance (Case-to-Ambient)
θ_{JA} = Thermal Resistance (Junction-to-Ambient)
θ_{JC} = Thermal Resistance (Junction-to-Case)

Package	θ_{JA}	θ_{JC}	θ_{CA}
LQFP	50°C/W	2°C/W	48°C/W
Mini-BGA	70.7°C/W	7.4°C/W	63.3°C/W

128-Lead LQFP Package Pinout



LQFP Pin Configurations

LQFP Number	Pin Name	LQFP Number	Pin Name	LQFP Number	Pin Name	LQFP Number	Pin Name
1	IAL	33	A12	65	ECLK	97	D19
2	PF3	34	A13	66	ELOUT	98	D20
3	PF2	35	$\overline{\text{IRQE}}$	67	ELIN	99	D21
4	PF1	36	MMAP	68	$\overline{\text{EINT}}$	100	D22
5	PF0	37	$\overline{\text{PWD}}$	69	$\overline{\text{EBR}}$	101	D23
6	$\overline{\text{WR}}$	38	$\overline{\text{IRQ2}}$	70	$\overline{\text{BR}}$	102	GND
7	$\overline{\text{RD}}$	39	BMODE	71	$\overline{\text{EBG}}$	103	$\overline{\text{IWR}}$
8	$\overline{\text{IOMS}}$	40	PWDACK	72	$\overline{\text{BG}}$	104	$\overline{\text{IRD}}$
9	$\overline{\text{BMS}}$	41	$\overline{\text{IACK}}$	73	VDD	105	IAD15
10	$\overline{\text{DMS}}$	42	$\overline{\text{BGH}}$	74	D0	106	IAD14
11	$\overline{\text{CMS}}$	43	VDD	75	D1	107	IAD13
12	GND	44	GND	76	D2	108	IAD12
13	VDD	45	$\overline{\text{IRQL0}}$	77	D3	109	IAD11
14	$\overline{\text{PMS}}$	46	$\overline{\text{IRQL1}}$	78	D4	110	IAD10
15	A0	47	FL0	79	GND	111	IAD9
16	A1	48	FL1	80	D5	112	IAD8
17	A2	49	FL2	81	D6	113	IAD7
18	A3	50	DT0	82	D7	114	IAD6
19	A4	51	TFS0	83	D8	115	VDD
20	A5	52	RFS0	84	D9	116	GND
21	A6	53	DR0	85	D10	117	IAD5
22	A7	54	SCLK0	86	D11	118	IAD4
23	XTAL	55	DT1/F0	87	D12	119	IAD3
24	CLKIN	56	TFS1/$\overline{\text{IRQ1}}$	88	D13	120	IAD2
25	GND	57	RFS1/$\overline{\text{IRQ0}}$	89	D14	121	IAD1
26	CLKOUT	58	GND	90	GND	122	IAD0
27	GND	59	DR1/FI	91	VDD	123	PF7
28	VDD	60	SCLK1	92	GND	124	PF6
29	A8	61	$\overline{\text{ERESET}}$	93	D15	125	PF5
30	A9	62	$\overline{\text{RESET}}$	94	D16	126	PF4
31	A10	63	$\overline{\text{EMS}}$	95	D17	127	GND
32	A11	64	EE	96	D18	128	$\overline{\text{IS}}$

144-Lead Mini-BGA Package Pinout
(Bottom View)

12	11	10	9	8	7	6	5	4	3	2	1	
GND	GND	$\overline{\text{IWR}}$	IAD14	IAD10	IAD6	GND	IAD2	PF6	GND	$\overline{\text{IS}}$	IAL	A
D21	D23	$\overline{\text{IRD}}$	IAD15	IAD11	VDD	GND	IAD1	PF5	GND	PF3	PF1	B
D17	D20	D22	IAD13	IAD8	VDD	IAD0	PF4	PF2	$\overline{\text{WR}}$	PF0	$\overline{\text{RD}}$	C
GND	D15	D18	D19	D16	IAD9	IAD5	PF7	$\overline{\text{IOMS}}$	GND	$\overline{\text{DMS}}$	GND	D
D14	GND	VDD	GND	GND	IAD7	$\overline{\text{CMS}}$	IAD3	$\overline{\text{BMS}}$	A0	VDD	VDD	E
D10	D11	D13	D12	IAD12	D8	IAD4	$\overline{\text{PMS}}$	A3	A4	A1	A2	F
D6	D5	D9	D4	D7	DT0	A7	A8	A6	GND	A5	XTAL	G
GND	D2	GND	D0	D3	DT1	$\overline{\text{IRQL0}}$	VDD	GND	GND	GND	CLKIN	H
VDD	VDD	D1	BG	RFS1	SCLK0	$\overline{\text{IRQL1}}$	VDD	VDD	A10	VDD	CLKOUT	J
$\overline{\text{EBG}}$	$\overline{\text{BR}}$	$\overline{\text{EBR}}$	$\overline{\text{ERESET}}$	SCLK1	TFS1	TFS0	FL2	PWDACK	A11	A12	A9	K
$\overline{\text{EINT}}$	ELOUT	ELIN	$\overline{\text{RESET}}$	GND	DR0	FL0	GND	$\overline{\text{IACK}}$	$\overline{\text{IRQE}}$	MMAP	A13	L
ECLK	EE	$\overline{\text{EMS}}$	DR1	GND	RFS0	FL1	GND	$\overline{\text{BGH}}$	BMODE	$\overline{\text{IRQ2}}$	$\overline{\text{PWD}}$	M

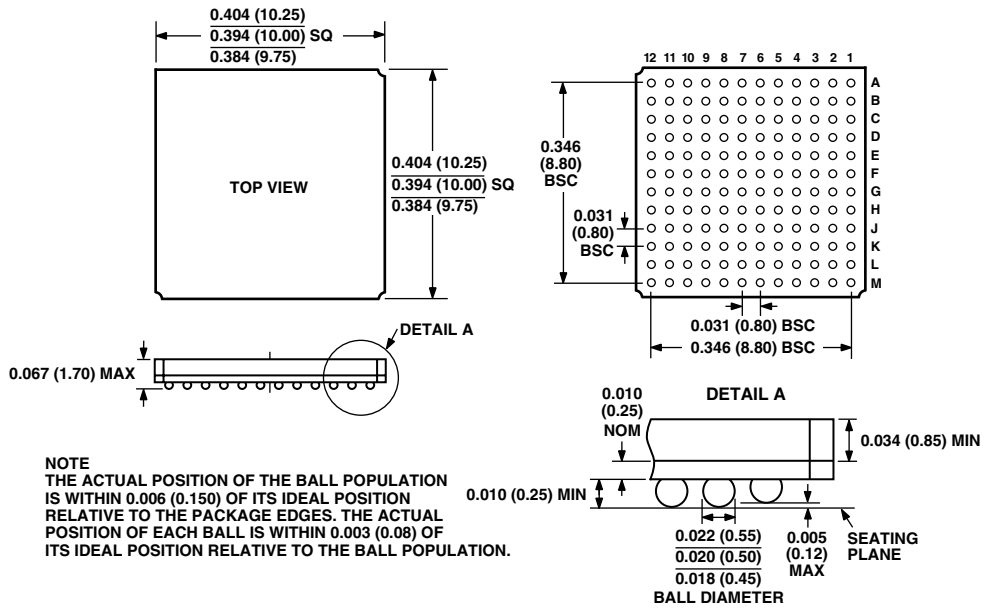
Mini-BGA Pin Configurations

Ball #	Name	Ball #	Name	Ball #	Name	Ball #	Name
A01	IAL	D01	GND	G01	XTAL	K01	A9
A02	$\overline{IS}$	D02	$\overline{DMS}$	G02	A5	K02	A12
A03	GND	D03	GND	G03	GND	K03	A11
A04	PF6	D04	$\overline{IOMS}$	G04	A6	K04	PWDACK
A05	IAD2	D05	PF7	G05	A8	K05	FL2
A06	GND	D06	IAD5	G06	A7	K06	TFS0
A07	IAD6	D07	IAD9	G07	DT0	K07	TFS1
A08	IAD10	D08	D16	G08	D7	K08	SCLK1
A09	IAD14	D09	D19	G09	D4	K09	$\overline{ERESET}$
A10	$\overline{IWR}$	D10	D18	G10	D9	K10	EBR
A11	GND	D11	D15	G11	D5	K11	BR
A12	GND	D12	GND	G12	D6	K12	EBG
B01	PF1	E01	VDD	H01	CLKIN	L01	A13
B02	PF3	E02	VDD	H02	GND	L02	MMAP
B03	GND	E03	A0	H03	GND	L03	$\overline{IRQE}$
B04	PF5	E04	$\overline{BMS}$	H04	GND	L04	$\overline{IACK}$
B05	IAD1	E05	IAD3	H05	VDD	L05	GND
B06	GND	E06	$\overline{CMS}$	H06	$\overline{IRQL0}$	L06	FL0
B07	VDD	E07	IAD7	H07	DT1	L07	DR0
B08	IAD11	E08	GND	H08	D3	L08	GND
B09	IAD15	E09	GND	H09	D0	L09	$\overline{RESET}$
B10	$\overline{IRD}$	E10	VDD	H10	GND	L10	ELIN
B11	D23	E11	GND	H11	D2	L11	ELOUT
B12	D21	E12	D14	H12	GND	L12	EINT
C01	$\overline{RD}$	F01	A2	J01	CLKOUT	M01	$\overline{PWD}$
C02	PF0	F02	A1	J02	VDD	M02	$\overline{IRQ2}$
C03	$\overline{WR}$	F03	A4	J03	A10	M03	BMODE
C04	PF2	F04	A3	J04	VDD	M04	$\overline{BGH}$
C05	PF4	F05	$\overline{PMS}$	J05	VDD	M05	GND
C06	IAD0	F06	IAD4	J06	$\overline{IRQL1}$	M06	FL1
C07	VDD	F07	D8	J07	SCLK0	M07	RFS0
C08	IAD8	F08	IAD12	J08	RFS1	M08	GND
C09	IAD13	F09	D12	J09	BG	M09	DR1
C10	D22	F10	D13	J10	D1	M10	$\overline{EMS}$
C11	D20	F11	D11	J11	VDD	M11	EE
C12	D17	F12	D10	J12	VDD	M12	ECLK

OUTLINE DIMENSIONS

Dimensions given in mm and (inches).

144-Lead Mini-BGA Package Pinout
(CA-144)



NOTE
THE ACTUAL POSITION OF THE BALL POPULATION IS WITHIN 0.006 (0.150) OF ITS IDEAL POSITION RELATIVE TO THE PACKAGE EDGES. THE ACTUAL POSITION OF EACH BALL IS WITHIN 0.003 (0.08) OF ITS IDEAL POSITION RELATIVE TO THE BALL POPULATION.

ORDERING GUIDE

Part Number	Ambient Temperature Range	Instruction Rate (MHz)	Package Description	Package Option
ADSP-2183KST-115	0°C to +70°C	28.8	128-Lead LQFP	ST-128
ADSP-2183BST-115	–40°C to +85°C	28.8	128-Lead LQFP	ST-128
ADSP-2183KST-133	0°C to +70°C	33.3	128-Lead LQFP	ST-128
ADSP-2183BST-133	–40°C to +85°C	33.3	128-Lead LQFP	ST-128
ADSP-2183KST-160	0°C to +70°C	40	128-Lead LQFP	ST-128
ADSP-2183BST-160	–40°C to +85°C	40	128-Lead LQFP	ST-128
ADSP-2183KST-210	0°C to +70°C	52	128-Lead LQFP	ST-128
ADSP-2183KCA-210	0°C to +70°C	52	144-Lead Mini-BGA	CA-144

C00184b–0–7/00 (rev. C)

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