ADSP-2100 Family Development Tools

ADDS-21xx-TOOLS

FEATURES

DEVELOPMENT SOFTWARE TOOLS

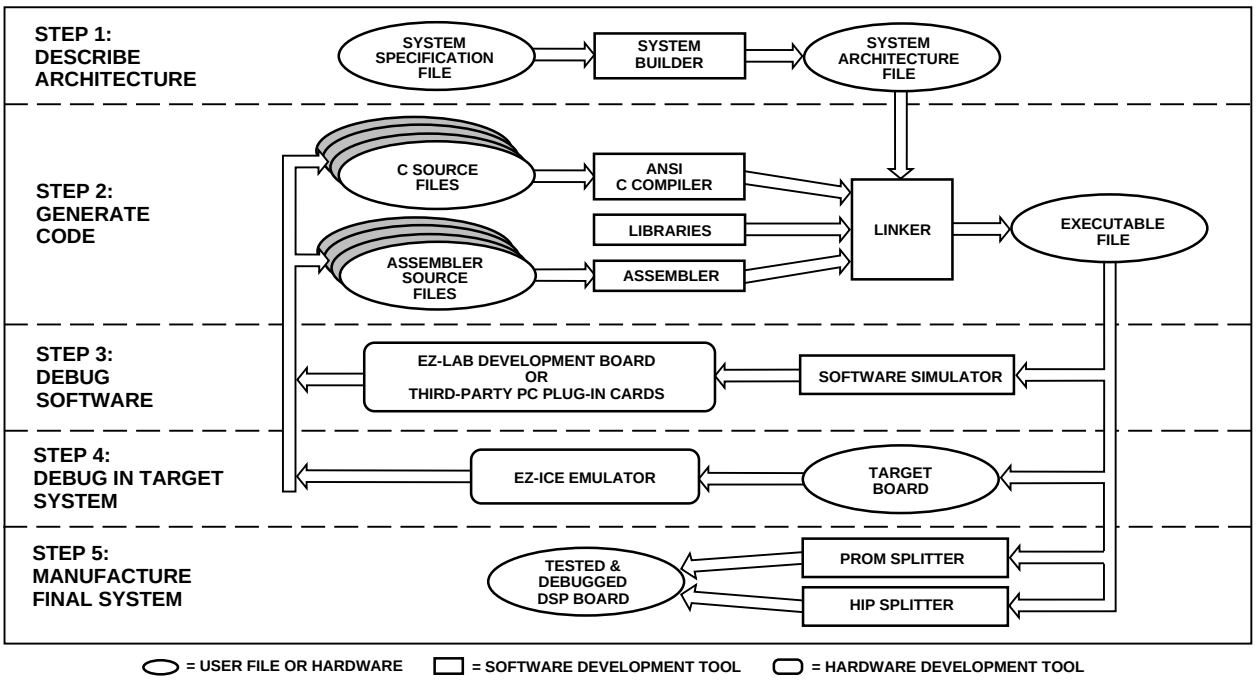
SYSTEM BUILDER
- Defines Architecture of ADSP-21xx System
- Specifies Amount of RAM/ROM Memory

ASSEMBLER
- Easy-to-Program, Algebraic Instruction Syntax
- Supports C Language Constructs
- Provides Flexible Macro Processing
- Encourages Modular Code Development

LINKER
- Maps Assembler Output to Target System Memory
- Supports User-Defined Library Routines
- Creates Memory Map Listing

PROM SPLITTER & HOST PROCESSOR PORT (HIP) SPLITTER
- Generates PROM Programmer Compatible Files in a Variety of Industry-Standard Formats
- Formats Executable File for Programming PROMs or for Host Processor Booting

SYSTEM DEVELOPMENT PROCESS OVERVIEW



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ADDS-21xx-TOOLS

SIMULATOR
- Features Reconfigurable GUI (Graphical User Interface)
- Supports Full Symbolic Disassembly and On-Line Assembly
- Provides Breakpoint and Single-Step Execution
- Includes CBUG™ C Source-Level Debugger as Integrated Tool
- Supports Multiple Break Conditions
- Provides Full View of All Processor Registers and Memory for Direct Modification of Contents
- Profiles Code Execution History
- Uses Data Files to Simulate Parallel I/O Ports, Serial Ports, HIPs, and Analog I/O Interface
- Plots Data Memory Graphically

G21 OPTIMIZING C COMPILER & C RUNTIME LIBRARY
- Compliant with ANSI C Standards
- Includes C-Callable Library of ANSI-Standard and DSP Functions
- Supports In-Line Assembly Code Using asm () Construct
- Incorporates Optimizing Algorithms
- Generates Reliable and ROM-able Code
- Simplifies Interrupt Handling via Library Functions
- Provides Support for Heap Memory Management
- Supports Switches Used by the ADSP-21000 Family G21K Floating Point C Compiler
- Supports Float Type IEEE-Single Precision Math Routines

CBUG C SOURCE-LEVEL DEBUGGER
- Supports Single Step Execution
- Supports Breakpoints
- Integrated with Simulators and EZ-ICE Emulators

DEVELOPMENT HARDWARE TOOLS

EZ-LAB® EVALUATION BOARD
- Complete Hardware Platform with Memory and I/O
- Preprogrammed with DSP Demo Programs
- Contains Audio/Voice I/O Port with Microphone Input and Powered Output for Speaker
- Memory Expansion and I/O from Bus Expansion Connector
- Serial Port Interface via SPORT Connector

EZ-KIT STARTER PACKAGES
- Complete Hardware and Software Development Kit
- Includes an EZ-LAB Evaluation Board and ADSP-2100 Family Assembler/Linker and Simulator Software for IBM PC

EZ-KIT LITE
- Low Cost Development System
- Including Hardware and Software
  - MS Windows 3.1 Based Monitor
  - Includes a Variety of Demonstration Programs with Source Code
  - Development Platform for all ADSP-21xx Processors
  - Audio Input/Output and Expansion Connectors

EZ-ICE® EMULATOR
- Performs Full-Speed, In-Circuit Emulation of ADSP-21xx Target Systems
- Software Uses Same GUI (Graphical User Interface) as Simulator for Easier Debugging Control
- Single-Step Capability
- Stand Alone Operation for Software Debugging
- Upload/Download Memory with IBM PC

3-VOLT EMULATION CONVERTER BOARD
- Used with the ADSP-2101 EZ-ICE to Enable Emulation with an ADSP-2103 (3 V) Target System

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Introduction to Development Tools

GENERAL DESCRIPTION

The ADSP-2100 Family Development Software, a complete set of software design tools, lets you program applications for this family of DSP microprocessors that includes the ADSP-2101, ADSP-2105, ADSP-2111, ADSP-2115, and the newest members, the ADSP-2171 and ADSP-2181. With these tools, an EZ-ICE In-Circuit Emulator, and an EZ-LAB Evaluation Board, you can quickly and efficiently design your DSP applications. The figure on page 1 ("System Development Process Overview") shows how the tools are typically used in the development process.

DSP Software Development Tools

The software development tools include the following programs:

- System Builder
- Assembler
- Linker
- Simulator
- G21 C Compile
- C Runtime Library
- CBUG C Source-Level Debugger
- PROM Splitter

The System Builder reads your system specification file and then generates an architecture description file that passes information about your target hardware to the linker, simulator, and emulator. Code generation begins with the creation of C language and/or assembly language source code modules. These modules are compiled/assembled separately and then linked together to form an executable program (memory image file).

The highly readable algebraic syntax of the ADSP-2100 Family instruction set eases programming in assembly language. Multiply-accumulate instructions are written in the same manner as the actual equation. For example, the algebraic statement

```
r = r + x*y
```

is coded in assembly language as

```
MR = MR + MX0*MY0.
```

The simulator configures program and data memory according to the architecture description file and simulates the memory-mapped I/O ports to let you debug your system and analyze its performance. After simulating your system and software, use the emulator with your prototype hardware to test circuitry, timing, and real-time software execution. The PROM Splitter then translates the linker-output executable file into an industry-standard file format for a PROM programmer. Once you burn the code into a PROM device and plug in an ADSP-21xx processor to the target board, your prototype is ready to run.

Development software is available for the IBM (or IBM-compatible) PC/AT and Sun4 workstation platforms.

DSP Hardware Development Tools

- EZ-ICE Emulators
- EZ-KIT Development Tools Packages
- EZ-LAB Evaluation Boards

The ADSP-2100 Family hardware development tools provide a controlled environment for observing, debugging, and testing activities in a full-speed target system. Our ADSP-2100 Family EZ-ICE Emulators provide this control by replacing the target processor or, in the case of the ADSP-2181, by assuming control of the DSP through its ICE-Port. The EZ-ICE, controlled by an IBM PC host computer, using a GUI interface similar to the ADSP-2100 Family Simulators, lets you examine and modify processor information such as registers and memory.

The ADSP-2100 Family EZ-LAB Evaluation Boards let you test coded applications in real time without a host or PC. At reset, the processor on the ADSP-2100 Family EZ-LAB boots code and program memory into its internal program memory from the EPROM, and then executes the code.

EZ-KIT offers a complete development environment including the ADSP-2100 Family Assembler/Linker and Simulator, an ADSP-2100 Family EZ-LAB Evaluation Board. The EZ-KITs for the ADSP-2101 and ADSP-2111 include an applications handbook (*Digital Signal Processing Applications Using the ADSP-2100 Family Applications*), plus a laboratory textbook (*Digital Signal Processing Laboratory Using the ADSP-2101 Microcomputer Laboratory Workbook with Introductory DSP Experiments*) and source code diskettes. The EZ-KIT Lite for the ADSP-2181 is a lower cost starter kit that includes a subset of the regular EZ-KIT software and documentation.

SOFTWARE TOOLS

SYSTEM BUILDER

The System Builder lets you define system hardware based on ADSP-21xx processors with memory that can be specified as RAM or ROM. It also lets you design ADSP-21xx Family systems with paged external data memory, extending the processor's address space for additional data storage.

G21 C COMPILER

The G21 C Compiler is an optimizing ANSI compiler based on the GNU gcc compiler. Applications written in C are compiled, assembled, and linked to create executable ADSP-21xx programs that can be debugged with an ADSP-21xx Simulator or Emulator. It also supports in-line assembly code using the asm( ) construct, which lets you use C expressions.

The G21 C Compiler contains optimization features to increase execution speed of the resultant assembly code. These features include algorithms to perform the following:

- Constant Folding
- Common Subexpression Elimination
- Loop Optimization and Strength Reduction
- Global and Local Register Allocation
- Parallelization
- Instruction Scheduling

C RUNTIME LIBRARY

The C Compiler comes with ANSI-standard functions and a set of C-callable library routines commonly used in digital signal processing to speed up development.

The ADSP-2100 Family C Runtime Library includes the ANSI-standard and DSP-specific functions listed in Table I.

Table I. C Runtime Library Functions

Function	Description
abs	absolute value
acos	arc cosine
asin	arc sine
atan	arc tangent
atan2	arc tangent of quotient
ceil	ceiling
cos	cosine
cosh	hyperbolic cosine
exp	exponential
fabs	absolute value
fir	finite impulse response (FIR) filter
floor	floor
fmod	floating-point modulus
frexp	separate fraction and exponent
ifftN	N-point inverse fast Fourier transform (IFFT)
iir	infinite impulse response (IIR) filter
interrupt	define interrupt handling
isalpha	detect alphabetic character
isdigit	detect decimal digit
labs	absolute value
ldexp	multiply by power of 2
log	natural logarithm
log10	base 10 logarithm
memcmp	compare objects
memcpy	copy characters from one object to another
memset	set range of memory to a character
modf	separate integral and fractional parts
pow	raise to a power
raise	force a signal
signal	define signal handling
sin	sine
sinh	hyperbolic sine
sqrt	square root
strcat	concatenate strings
strcmp	compare strings
strcpy	copy from one string to another
strlen	string length
strncat	concatenate characters from one string to another
strncmp	compare characters in strings
strncpy	copy characters from one string to another
tan	tangent
tanh	hyperbolic tangent
timer_off	disable ADSP-21xx timer
timer_on	enable ADSP-21xx timer
timer_set	initialize ADSP-21xx timer
va_arg	get next argument in variable list
va_end	reset variable list pointer
va_start	set variable list pointer

Interrupt Handling in C

The C environment supports hardware interrupts—a key feature that facilitates programming. The signal handling functions of the C library, `signal`, `raise`, and `interrupt`, process ADSP-21xx interrupts such as serial port transmit and receive interrupts, timer interrupts, and external interrupt request signals.

The `signal` and `raise` functions direct execution to a specific C interrupt service routine based on the type of interrupt that occurs. This routing service allows the entire application to be written in C without assembly language code. The signal handling routines save and restore registers, and the overhead is usually minimal compared to overall program execution time. If you choose to write custom interrupt service routines in assembly language, you can use the `signal` and `raise` functions to set up service routines in the C environment.

ASSEMBLER

The Assembler reads source files containing ADSP-2100 Family assembly language and generates a relocatable object file. The Assembler includes a preprocessor that lets you use C preprocessor directives such as `#define`, `#include`, `#if`, `#ifdef`, and `#else` in assembly code.

Assembler directives define code modules, data buffers, data variables, and memory-mapped I/O ports. Either assembler directives or C preprocessor directives define and invoke macros.

LINKER

The Linker processes separately assembled object files to create a single executable program. It assigns memory locations to code and data in accordance with the architecture file defined by the System Builder.

The Linker also generates symbols (variable names and program labels) in the processed files, which the simulator, emulator, and the CBUG C Source-level debugger use to perform symbolic debugging.

PROM SPLITTER AND HIP SPLITTER

The PROM Splitter translates an ADSP-21xx executable program into a file used to program PROM memory devices. The PROM Splitter's output file can be generated in Motorola S Record or Intel Hex Record format. Motorola S2 format is supported for byte stream output.

The HIP Splitter utility generates ADSP-2111 and ADSP-2171 programs to be downloaded from a host processor through the DSP's Host Interface Port (HIP). The HIP Splitter's output file can be generated in Motorola S Record or Intel Hex Record format.

Both the PROM Splitter and the HIP Splitter have a boot loader option that enables loading of external memory.

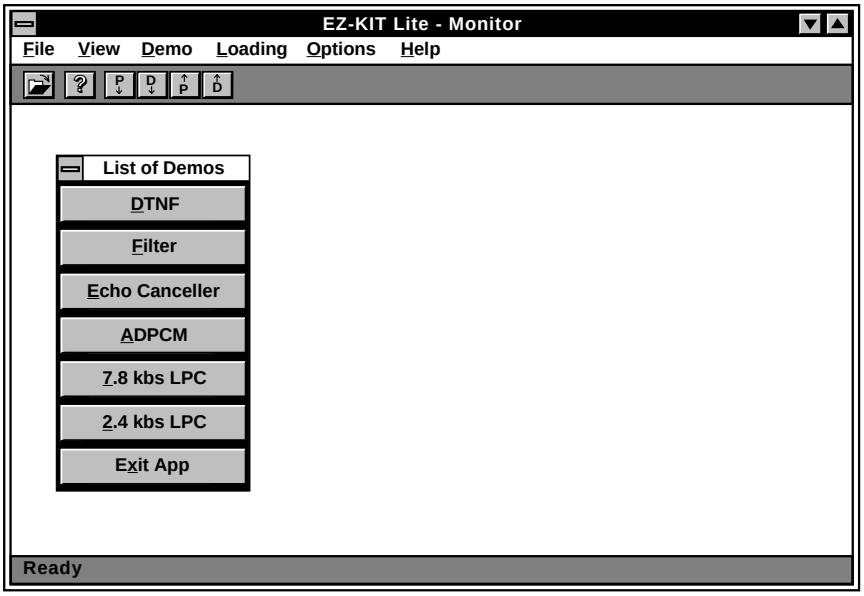

Figure 1. EZ-KIT Lite Monitor Software

SIMULATORS

There is a simulator for each ADSP-2100 Family processor that provides instruction-level simulation of program execution. The Simulator models system memory and I/O according to the contents of the system architecture file, and provides windows to display different portions of the target system hardware. The Graphical User Interface (GUI) lets system designers interactively observe and alter register and memory contents, providing a powerful debug environment. Simulator commands can be entered from the mouse or keyboard.

Features offered by the ADSP-2100 Family Simulators include the following:

- Program and Data Memory Simulation
- Memory-Mapped I/O Port Simulation
- Interrupt Simulation
- Program Booting (from PROM or host processor) Simulation
- Code Execution Pattern Profiling for Program Optimization
- On-Line Help
- Reconfigurable Windows
- Same User Interface as EZ-ICE Emulators

CBUG C SOURCE-LEVEL DEBUGGER

The Simulators are seamlessly integrated with the CBUG C source-level debugger. CBUG supports the following operations:

- Run, Step, Next, and Finish Program Execution Commands
- C Source Code Breakpoints
- Local and Global Variable Display with Auto Refresh Examines Value of Variables at Previously Executed Instructions
- Symbol Look-Up

HARDWARE TOOLS

EZ-KIT Lite

The ADSP-21xx EZ-KIT Lite is a low-cost, easy to use development platform on which you can quickly get started with your ADSP-2100 Family based DSP software design. The EZ-KIT Lite is a complete development system package that includes:

- ADDS-2181 EZ-LAB Board
- MS-Windows 3.1 Based Monitor Software
- Development Software Kit (upgradable to complete ADSP-2100 Family Development Software package for full-featured development of final systems)
- Demo Programs
  - Digital Filtering
  - Speech Compression
  - FFT
  - Echo Cancellation
  - DTMF Tone Generation
  - MPEG Audio Playback

The EZ-Kit Lite uses the ADDS-2181 EZ-LAB as a development platform on which you can develop software applications for any of the ADSP-2100 Family DSPs. This is possible because the ADSP-2181 represents a superset of the features of the ADSP-2101/2105/2111/2115/2171 processors. With the ADSP-2181's 32K words of on-chip RAM, there is no need for additional RAM devices on the EZ-LAB board. The board simply requires connection to power, an analog input source, and amplified speakers to be able to run audio applications and demos.

The EZ-LAB board can run in a stand-alone mode, or it can be connected to the RS-232 port of your PC. A Windows-based monitor program lets you interactively download programs and interrogate the ADSP-2181 (see Figure 1). The board comes with a socketed EPROM so that you can run the monitor program or demonstrations provided—or you can plug in an EPROM containing your own code.

An AD1847 SoundPort® codec is connected to the DSP through serial port 0. The AD1847's sampling rate can be programmed for analog-to-digital and digital-to-analog conversion from 5.5 kHz to 48 kHz. The high-speed synchronous serial port carries all of the data, control, and status information between the DSP and the codec. The codec may be disconnected from the serial port if the port is needed for other purposes. Input to the codec can be a microphone, signal generator, or any other high impedance source, while the resulting output signal can drive an amplified speaker or the line-level input of other audio equipment.

As with all EZ-LAB evaluation boards, the ADDS-2181 EZ-LAB provides a manual power-on reset button, an interrupt button, and an LED controlled by the FL1 Flagout pin. Although the IDMA port on the ADSP-2181 is not used on the EZ-LAB board, all of the IDMA signals are available through an expansion connector.

Device Specific EZ-KITs
Two other EZ-KITs are available for specific members of the ADSP-21xx Family.

ADSP-2101 EZ-KIT
The ADSP-2101 EZ-KIT is a starter package for system development that combines the ADSP-2101 EZ-LAB with an Assembler software package and a Simulator. This EZ-KIT may also be used for developing applications targeting the ADSP-2105 and ADSP-2115 processors.

ADSP-2111 EZ-KIT
The ADSP-2111 EZ-KIT is a starter package for ADSP-2111-based system development that combines the ADSP-2111 EZ-LAB with an Assembler software package and a Simulator.

ADSP-2100 FAMILY EZ-LAB EVALUATION BOARDS
The ADSP-2100 Family EZ-LAB Evaluation Boards are a complete DSP system on a single board that lets you test coded applications in real time. Some EZ-LABs provide for booting from EPROM and others allow upload/download capabilities from a host PC. Table II lists the features of the different versions of the EZ-LAB available for the ADSP-2100 family.

ADSP-2181 EZ-LAB
See the discussion of the ADSP-21xx EZ-KIT Lite for information on the ADSP-2181 EZ-LAB.

ADSP-2101 & ADSP-2111 EZ-LABs
The ADSP-2101 and ADSP-2111 EZ-LABs are similar in design and use. A complete DSP system on a single board, the EZ-LAB lets you test coded applications in real time without an external host. At reset, the processor on the EZ-LAB boots code and programs memory data into its internal program memory from a 64K × 8-bit EPROM and then executes the code.

The ADSP-2101 and ADSP-2111 EZ-LAB provide manual control of several functions. For example, push-buttons activate the IRQ2 interrupt and FLAG IN pins, and an on-board hardware RESET switch resets the EZ-LAB.

In addition to the standard features of the ADSP-2101, the ADSP-2111 includes a Host Interface Port (HIP) that is also included on the ADSP-2111 EZ-LAB board as a separate connector. The ADSP-2111 EZ-LAB board replaces the ADDS-2101's User Interface Connector with an Expansion Connector that allows access to the external address and data bus and control lines of the DSP.

The demonstration boards operates alone when you attach them to a +5 V dc @ 1 amp and ±12 V dc power supply with a common power return.

Demo Programs
Use the prepared demonstrations on the ADSP-2101 and ADSP-2111 EZ-LABs, which include speech and graphics applications, to familiarize yourself with and to evaluate the ADSP-2100 Family processors. The EPROM is mapped into the boot memory space. Upon reset, the processor loads boot page 0 into its internal program memory and begins execution. During program execution, any one of the eight boot pages can be loaded into the processor under software control.

The demonstrations use the microphone and speaker connections for audio input and output. The ADSP-2101 and ADSP-2111 EZ-LABs have four DAC outputs to connect to an oscilloscope for display. In addition to these outputs, these EZ-LABs have an expansion connector and a serial port connector for synchronous serial data I/O. The connectors let you access the serial ports, external address bus, external data bus, control signals, interrupt lines, and the host interface port.

Analog I/O
A codec attaches to the processor's serial port 0 on the ADSP-2101 and ADSP-2111 EZ-LABs. Configure the other serial port for interrupts and flags by changing on-board jumpers. The input signal to the codec can be a microphone, signal generator or any other high impedance source, and the resulting output signal can drive a small speaker.

The ADSP-2101 EZ-LAB and ADSP-2111 EZ-LABs contain socket-mounted 16.384 MHz crystals. The socket lets you replace the crystal to achieve different clock speeds.

ADSP-2105 and ADSP-2115 System Development
The ADSP-2101 EZ Development Tools support the ADSP-2105 and the ADSP-2115 because their architectures are subsets of the ADSP-2101. The ADSP-2105 has one serial port (instead of two), and both the ADSP-2105 and the ADSP-2115 have half the internal memory of the ADSP-2101. Use the ADSP-2101 EZ-LAB to evaluate, and the ADSP-2101 EZ-ICE for emulation and debugging of both the ADSP-2115 and ADSP-2105 target systems.

The ADSP-2171 EZ-LAB
The ADSP-2171 EZ-LAB is an easy to use hardware development platform on which you can quickly get started with your ADSP-2171-based application. Applications can be run in real-time with or without a PC host. This EZ-LAB has four modes of operation:

- EZ-LAB can be controlled from your PC host when the board is plugged into the PC backplane; programs can be downloaded and uploaded, the processor can be reset, and program execution can be initiated.
- EZ-LAB can be interfaced to an EZ-ICE Emulator; through the EZ-ICE, programs can be loaded into EZ-LAB, program execution can be initiated and halted, register and memory locations can be examined and altered, and other debugging operations can be performed.

SoundPort is a registered trademark of Analog Devices, Inc

Table II. ADSP-2100 Family EZ-LAB Evaluation Boards

Features	ADSP-2101 EZ-LAB	ADSP-2111 EZ-LAB	ADSP-2171 EZ-LAB	ADSP-2181 EZ-KIT Lite
For Use with These DSPs	**ADSP-2101 ADSP-2105 ADSP-2115 ADSP-216x**	**ADSP-2111**	**ADSP-2171**	**ADSP-2181**
DSP Clock Frequency	12.5 MHz	13 MHz	33 MHz	33 MHz
EZ-LAB Firmware	✓	✓	✓	✓
Windowed Software with GUI Interface	✓	✓	✓	✓
Context Sensitive Help	✓	✓	✓	✓
Bundled Software Development Tools				✓
Stand-Alone Operation	✓	✓	✓	✓
IBM-PC/AT Plug-In Board Operation			✓	
On-Board DSP Performance	16 MIPS	16 MIPS	33 MIPS	33 MIPS
Boot EPROM	64K × 8	64K × 8	64K × 8	64K × 8
DSP Internal RAM (Program)	2K × 24	2K × 24	2K × 24	16K × 24
DSP Internal RAM (Data)	1K × 16	1K × 16	2K × 16	16K × 16
On-Board RAM			32K × 24*	
Audio Input/Output Circuitry	✓	✓	✓	✓
Configuration Jumpers	✓	✓	✓	✓
LED Status Indicators	✓	✓	✓	✓
Expandable to Full Program and Data Memory Capability	✓	✓	✓	✓
Serial Port (SPORT) Connector	✓	✓	Note 1	Note 2
Manual Interrupt/Flag/Reset Switches	✓	✓	✓	✓
Host Interface Port (HIP) Connector		✓	✓	
MAFE Interface			✓	
EZ-ICE Connector			✓	✓
Expansion Connector	✓	✓	✓	✓

NOTES
* Optional
[1]Available as part of MAFE connector; connector not installed.
[2]Available through expansion connector.

- EZ-LAB can be controlled from a host plugged into the Host Interface Port (HIP) connector when the EZ-LAB is running in a stand-alone configuration.
- EZ-LAB can be controlled from software contained in a boot EPROM when the board is used in a stand-alone configuration.

The ADSP-2171 interfaces directly to its program and data memories. The expansion connector may be used to interface to external devices. The DSP is also connected to indicator lights for data output and to pushbuttons for manual data input. Modular Analog Front End (MAFE) daughter cards can be connected to the ADDS-2171's MAFE Interface Connector, allowing the DSP to communicate with a variety of I/O peripherals through memory mapped registers.

Modular Analog Front End (MAFE)
The MAFE specification provides a standard configuration for connecting analog I/O devices to MAFE compatible EZ-LAB products. This specification is used by Analog Devices and third-party vendors to design and manufacture add-on adapters which contain, for example, A/D and D/A converters. These A/D and D/A converters can communicate data either serially or on a parallel bus. These devices can also contain a number of internal control registers as well as some external control lines.

If the MAFE device uses parallel data transfer, the memory location designated as the MAFE data is written to or read from in order to transfer data to/from the MAFE device. Data for a control register and data which represents the analog sample are both transferred in this manner. If the MAFE device uses a serial data transfer, the appropriate serial port of the DSP is used. Transfer of control data may also need to be done in a parallel fashion.

ADSP-2100 Family EZ-ICE Emulators
The ADSP-2100 Family EZ-ICE in-circuit emulators are used for testing and debugging an ADSP-21xx-based system. The EZ-ICEs make it easy to view and manipulate the data needed to debug your DSP applications. Table III lists the features of each version of EZ-ICE currently available for the ADSP-2100 family.

Control and debug features include single-step capabilities, with or without register displays, and multiple breakpoint selections.

At power-up, the host PC automatically resets and performs a diagnostic check to ensure that both host memory and the EZ-ICE are functional; it automatically displays any failures found.

ADSP-2181 EZ-ICE TOOLS
Features
The ADSP-2181 EZ-ICE In-Circuit is a development tool for debugging programs running in real time on a target system based on the ADSP-2181. It includes all of the standard functionality of the other EZ-ICEs, with the added advantages of full speed emulation, a smaller connector interface, and ease of use.

The ADSP-2181 EZ-ICE provides a simpler target board connection that requires fewer mechanical clearance considerations than other EZ-ICE Emulators by utilizing the ICE-Port™ emulation interface built into the ADSP-2181 (see Figure 3). The ICE-Port interface requires little more than a 14-pin header connector to implement it. All of the standard functionality of the other EZ-ICEs are provided, with the added advantages of full speed emulation, a very small connector interface, and ease of use.

EZ-ICE Software
Like the rest of the ADSP-2100 Family EZ-ICE Emulators, the ADSP-2181 uses the same EZ-ICE software and GUI interface design as the other EZ-ICEs and the ADSP-2100 Family Simulators. This makes the development process easier as the tools share so much commonality in use.

ADSP-2101 AND ADSP-2111 EZ-ICE TOOLS
Features
These versions of the EZ-ICE are designed with a PGA connector protruding from the bottom of the probe board that fits into the processor socket on the target system. Connector adaptors for PQFP and TQFP are available. The ADSP-2101 EZ-ICE is also used in developing systems based on the ADSP-2105, ADSP-2115, and ADSP-216x DSPs. Systems based on the ADSP-2111 use the ADSP-2111 EZ-ICE.

EZ-ICE Software
The ADSP-2101 and ADSP-2111 EZ-ICE Emulators use the same EZ-ICE software and GUI interface design as all of the ADSP-2100 Family EZ-ICEs and the ADSP-2100 Family Simulators. Development productivity is increased by making your data easier to view and manipulate when debugging. In addition, you can view relevant information without switching between screens and can obtain on-line help for the currently selected window. The user interface is similar to the one used with the ADSP-2100 Family Simulators, making both tools easier to use.

ADSP-2171 EZ-ICE TOOL
Features
The ADSP-2171 EZ-ICE In-Circuit Emulator is a development tool for debugging programs running in real time on a target system based on the ADSP-2171 processor. This is made possible through the use of the ADDS-21xx EZ-ICE Board which differs from other EZ-ICE models in its use of a pair of dedicated header connectors that allow it to plug directly onto the target board and interface with the target DSP (see Figure 2) or to use an adaptor to clip onto the target DSP itself, depending on the device package used.

EZ-ICE Software
Like the rest of the ADSP-2100 Family EZ-ICE Emulators, the ADSP-2171 uses the same EZ-ICE software and GUI interface design as the other EZ-ICEs and the ADSP-2100 Family Simulators. This makes the development process easier as the tools share so much commonality in use.

ICE-Port is a trademark of Analog Devices, Inc.

Table III. ADSP-2100 Family EZ-ICE Emulators

Features	ADSP-2101 EZ-ICE	ADSP-2111 EZ-ICE	ADSP-2171 EZ-ICE	ADSP-2181 EZ-ICE
For Use with These DSPs	**ADSP-2101 ADSP-2105 ADSP-2115 ADSP-216x**	**ADSP-2111**	**ADSP-2171**	**ADSP-2181**
Windowed GUI Interface Software	✓	✓	✓	✓
User Breakpoints	30	30	30	30
Memory Plot	✓	✓	✓	✓
Program Code Modification Directly in Memory Window	✓	✓	✓	✓
Symbolic Debugging (CBUG)	✓	✓	✓	✓
Context Sensitive On-Line Help	✓	✓	✓	✓
Registers, Stacks, and Memory values may be examined and altered	✓	✓	✓	✓
View Relevant Data Without Switching Screens	✓	✓	✓	✓
Overlay Memory	✓	✓	✓	✓
Memory Plot	✓	✓	✓	✓
Execute Instruction	✓	✓	✓	✓
Macro Capability	✓	✓	✓	✓
Command Aliasing	✓	✓	✓	✓
Single Step/Full Speed Operation in Target	✓	✓	✓	✓
Flag 0 Output (FL0) LED Indicator				✓
PC Upload/Download Functions	✓	✓	✓	✓
Stand-Alone Operation	✓	✓	✓	✓
In-Target Operation	✓	✓	✓	✓
Non-Intrusive Target Connection			✓	✓
ICE-Port™ Interface				✓
Connector Clip Snaps Over Target DSP Chip (PQFP)			✓	
Target Board Connection Through DSP Processor Socket	✓	✓		
Plugs Onto Dedicated Target Connectors			✓	✓
Separate Target Board Connector				✓
Adaptors Available	✓	✓		

EZ-ICE EMULATORS: SPECIAL CONSIDERATIONS

Connector Requirements

The PGA probe's footprint that protrudes from the bottom of the ADSP-2101 and ADSP-2111 EZ-ICE boards fits into the DSP chip socket on your target system. Note that the socket must allow sufficient clearance for the ADSP-21xx's footprint.

The ADSP-2171 EZ-ICE attaches to the target DSP chip by simply clipping over the PQFP package version of the DSP. An alternate approach is needed for use with the TQFP package version of the DSP. Because the TQFP packaged chip and its leads are too small for a probe, the target board should include a pair of header connectors to allow the EZ-ICE board to plug directly onto it in order to interface with the DSP chip. Both methods are illustrated in Figure 2.

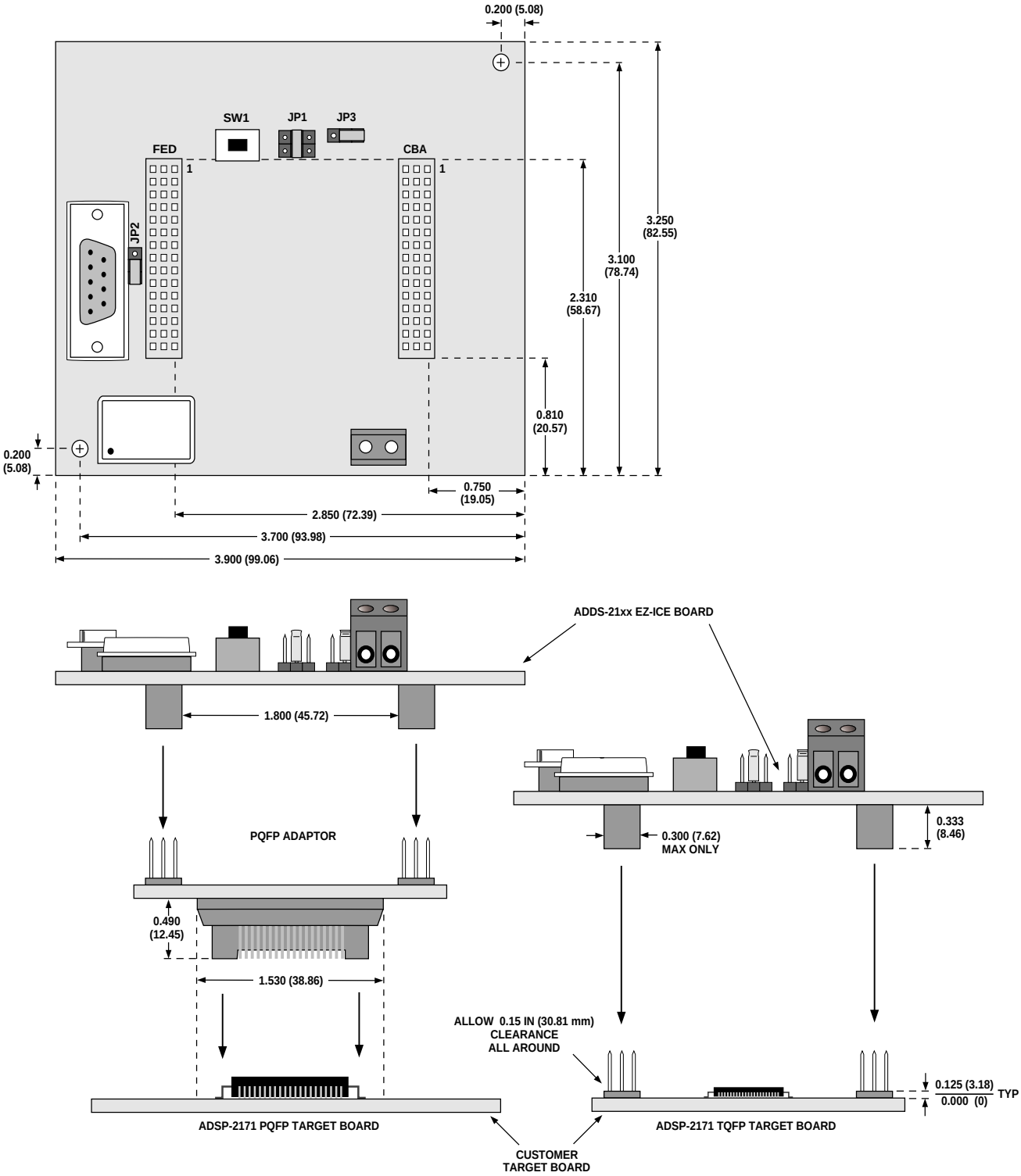

Figure 2. ADDS-2171 EZ-ICE Installation

GUI Interface
EZ-ICE software uses a Graphical User Interface (GUI) to increase development productivity by making your data easier to view and manipulate—without switching between screens—when debugging. In addition, you can obtain on-line help for the currently selected window. The GUI user interface design is the same one used with the ADSP-2100 Family Simulator software, making both tools easier to use.

Clock Speed
EZ-ICE runs at full speed. There is no degradation of processor performance other than $\overline{R}$, $\overline{G}$, and $\overline{RESET}$, which are slightly delayed. A jumper is used to select either the target system clock or the EZ-ICE clock. The oscillator socket lets you use other oscillator devices to achieve different clock speeds.

Memory
The ADSP-2101, ADSP-2111, and ADSP-2171 EZ-ICE each have 8K × 24-bit overlay program memory and 16K × 16-bit overlay data memory. You can either run programs from target system memory, emulator overlay memory, or from a combination of both. The overlay memory option is jumper-selectable.

Additional Equipment Required
EZ-ICE requires a +5 V dc power supply capable of supplying 1 A of current.

3-Volt Emulation
The 3-Volt Emulation Converter Board may be used with the ADSP-2101 EZ-ICE to enable emulation of ADSP-2103 (3 V) systems.

SURFACE MOUNT ADAPTORS

ADSP-2101/ADSP-2105/ADSP-2115
Several surface mount adaptors are available for emulation of the ADSP-2101. For example: for the 68-pin PLCC package of the ADSP-2101 and ADSP-2105, a PGA-to-PLCC adaptor is available from the vendors listed at the end of this data sheet. For the 80-pin PQFP package of the ADSP-2101, a 68-pin PGA to 80-pin PQFP adaptor is also available.

The ADDS-2101-PGA/PQFP, a surface-mountable PGA-to-PQFP adaptor, provides a footprint that exactly matches the 80-pin package. This solution does not require extra space around the adaptor or an extra through hole to the PQFP package to let you use the same PCB in production. The PGA-to-PQFP adaptor is surface mounted in the usual manner, and the PGA connector of the ADSP-2101 EZ-ICE or ICE can be directly plugged in.

ADSP-2111
The ADDS-2100-PGA/PQFP, a surface-mountable 101-pin PGA to 100-pin PQFP adaptor, matches the ADSP-2111 package footprints. This solution does not require extra space around the adaptor, and you can use the same PCB in production. The PGA-to-PQFP adaptor is surface mounted in the usual manner, and the PGA connector of the ADSP-2111 EZ-ICE can be directly plugged in.

ADSP-2171
The ADSP-2171 EZ-ICE Emulator is designed for compatibility with the surface mountable 128-pin PQFP package using an adaptor card which plugs onto the ADDS-21xx EZ-ICE board and then snaps onto the PQFP chip. This is illustrated in Figure 3. Extra space should be allowed around the PQFP chip to allow clearance for the adaptor.

An alternate approach is required for the TQFP chip package. Because of the extremely low profile of the surface mount TQFP package, it is not practical to use a snap-on adaptor or probe. Thus, in order to use the EZ-ICE, it is necessary to provide a pair of header connectors on the target board that the ADDS-21xx EZ-ICE board can plug directly onto. Extra space around the adaptor and extra through-holes to the PQFP package are not required to let you use the same PCB in production. Dimensional requirements for placing the headers is also shown in Figure 2.

ADSP-2181
There is no need for a surface mount adaptor for the ADSP-2181 EZ-ICE. Instead, the ICE-Port Emulator Interface allows for a simple 14-pin connector interface between the target board and the EZ-ICE.

DESIGNING AN EZ-ICE COMPATIBLE TARGET SYSTEM FOR THE ADSP-2181 AND THE ADSP-2171

ADSP-2181 Target System Requirements
The ADSP-2181 has on-chip emulation support and a special set of pins that interface to the EZ-ICE called the ICE-Port. The ICE-Port allows in-circuit emulation without replacing the target system's processor or overriding it with a probe, requiring only a simple 14-pin header connector to interface to the EZ-ICE (see Figure 3).

Table IV lists the pins and functions used in the ADSP-2181's ICE-Port emulation interface.

Table IV. ADSP-2181 ICE-Port Emulation Interface

Pin	Description
$\overline{R}$	Bus Request
$\overline{G}$	Bus Grant
$\overline{RESET}$	Reset
GND	Ground
$\overline{ER}$	Emulator Bus Request (emulator-only*)
$\overline{EG}$	Emulator Bus Grant (emulator-only*)
$\overline{ERESET}$	Emulator Reset (emulator-only*)
$\overline{EMS}$	Emulator Memory Space (emulator-only*)
$\overline{EINT}$	Emulator Interrupt Request (emulator-only*)
ECLK	Emulator Clock (emulator-only*)
ELIN	Emulator Data In (emulator-only*)
ELOUT	Emulator Data Out (emulator-only*)
EE	Emulator Enable (emulator-only*)

NOTE
*These ADSP-2181 pins must be connected only to the ICE-Port connector in the target system. These pins have no function except during emulation. Keep all traces as short as possible; no longer than 3 inches.

Table V lists the pinout for the female connectors on the EZ-ICE's EB board. See the ADSP-2171 Data Sheet for TQFP pin locations, footprint, and mechanical information.

Table V. ADDS-21xx EZ-ICE EB Connector Pinout

Pin/ Row	F	E	D	C	B	A
1	VDD	VDD	NU	NU	VDD	VDD
2	PWDAK	GND	$\overline{RESET}$	$\overline{WR}$	$\overline{RD}$ *	NU
3	XCYC*	IADR*	A0	PMS	GND	$\overline{DMS}$
4	A1	GND	A2	D22	D23	$\overline{IOMS}$
5	A3	A4	A5	D20	GND	D21
6	A6	GND	A7	D17	D18	D19
7	NU	NU	CLKOUT	D15	GND	D16
8	A8	VDD	A9	D12	D13	D14
9	A10	A11	A12	D10		D11
10	A13	GND	NU	D7	D8	D9
11	EMMAP*	MMAP	PWD	D5	GND	D6
12	EBMODE*	BMODE	NU	D2	D3	D4
13	$\overline{RESET}$	GND	$\overline{RESET}$ *	D0	GND	D1
14	DF0*	VDD	DF1*	$\overline{BR}$ *	VDD	$\overline{BG}$ *
15	NU	GND	EE*	$\overline{IRQ2}$	$\overline{IRQ1}$ *	BG

Table VI lists the ADSP-2171's emulator-only pins that correspond to the EZ-ICE connector pins. These emulator-only pins are listed on the ADSP-2171 data sheet as no-connects (NC). Also, note that the emulator-only pins must be connected only from the DSP to the emulator connector. These pins have no function except during emulation. Keep all connections as short as possible. The scheme of mounting the connectors on opposite sides of the DSP is best.

Do not connect a separate power supply to your EZ-ICE board when it is inserted in your prototype through the emulator connectors. The power connectors on the EZ-ICE EB board are for stand-alone operation only.

(Note: For use in a stand-alone mode, a DSP target card is supplied with the EZ-ICE and plugs onto the EZ-ICE through the same pair of connectors described above.)

Also, while this scheme may be used for either the PQFP or TQFP DSP packages, one alternative does exist for the PQFP target system. This alternative involves a snap on PQFP adaptor, also shown in Figure 1, that plugs onto the EZ-ICE EB board and snaps onto the DSP chip

Table VI. ADSP-2171 Emulator-Only Pins

Signal Name	TQFP Pin	PQFP Pin	Pin Description
EMMMAP	34	32	Emulator controlled MMAP
EBMODE	40	37	Emulator controlled BMODE
DF0	42	39	Emulator status pin
DF1	43	40	Emulator status pin
$\overline{RESET}$	47	44	Emulator controlled $\overline{RESET}$
EE	65	62	Emulator enable
$\overline{IRQ2}$	68	64	Emulator interrupt
$\overline{BR}$	69	65	Emulator controlled $\overline{BR}$
$\overline{BG}$	71	67	Emulator controlled $\overline{BG}$
XCYC	103	100	Emulator status pin
IADR	104	101	Emulator status pin
$\overline{DMS}$	105	102	Emulator memory select

Do not connect a separate power supply to your EZ-ICE board when it is inserted in your prototype through the emulator connectors. The power connectors on the EZ-ICE EB board are for stand-alone operation only.

(Note: For use in a stand-alone mode, a DSP target card is supplied with the EZ-ICE and plugs onto the EZ-ICE through the same pair of connectors described above.)

Also, while this scheme may be used for either the PQFP or TQFP DSP packages, one alternative does exist for the PQFP target system. This alternative involves a snap on PQFP adaptor, also shown in Figure 1, that plugs onto the EZ-ICE EB board and snaps onto the DSP chip.

Using EZ-LAB and EZ-ICE Together

Combining an EZ-LAB with an EZ-ICE forms a high speed DSP evaluation and development environment with an interactive, window-based debugging interface. For the ADSP-2101 and ADSP-2111 EZ-LAB/EZ-ICE combinations, remove the processor device from its socket on the EZ-LAB board and plug the EZ-ICE into the DSP's empty socket. For the ADSP-2171 EZ-LAB/EZ-ICE combination, simply snap the EZ-ICE with its PQFP adaptor onto the EZ-LAB's processor. And for the ADSP-2181 EZ-LAB/EZ-ICE combination, simply plug the EZ-ICE's ribbon cable connector onto the EZ-LAB's ICE-Port connector. These combinations let you prototype and evaluate your application without initial time investment in hardware design.

ADSP-2100 Family Ordering Guide

Ordering Information

Model Number	Description
STARTER PACKAGES	
ADDS-2101-EZ-KIT	Starter Package: Assembler Package and Simulators,* ADSP-2101 EZ-LAB
ADDS-2111-EZ-KIT	Starter Package: Assembler Package and Simulators,* ADSP-2111 EZ-LAB
ADDS-21XX-EZLITE	Starter Package: ADSP-21xx EZ-KIT Lite (includes ADSP-2181 EZ-LAB, monitor software)
SOFTWARE AND HARDWARE	
ADDS-21XX-SW-PC	Assembler Package and Simulators, and C Tools (for IBM PC)
ADDS-21XX-SW-SUN	Assembler Package, Simulators,* and C Tools** (for the Sun4)
ADDS-2101-EZ-ICE	ADSP-2101 EZ-ICE Emulator
ADDS-2101-EZ-LAB	ADSP-2101 EZ-LAB Evaluation Board
ADDS-2101-3V	ADSP-2101 3-Volt Emulation Converter Board
ADDS-2111-EZ-ICE	ADSP-2111 EZ-ICE Emulator
ADDS-2111-EZ-LAB	ADSP-2111 Evaluation Board
ADDS-2171-EZ-ICE	ADSP-2171 EZ-ICE Emulator (for TQFP)
ADDS-2171-EZ-ICE-P	ADSP-2171 EZ-ICE Emulator (with PQFP Clip-On Adaptor)
ADDS-2171-EZ-LAB	ADSP-2171 EZ-LAB Evaluation Board
ADDS-2181-EZ-ICE	ADSP-2181 EZ-ICE Emulator
AVAILABLE FROM OTHER VENDORS	A comprehensive listing of additional hardware and software tools is available in the Analog Devices' 1996 *DSP Third Party Developer Directory*.

NOTES
*Assembler, Assembly Library/Librarian, Linker, PROM Splitter, HIP Splitter, and ADSP-21xx Simulators.
**G21 C Compiler, C Runtime Library, and CBUG C Source-Level Debugger.

Accessories Available from Other Vendors:

Model Number	Description / Vendor
68-PIN PGA-PLCC ADAPTOR (for ADSP-2101 and ADSP-2105)	
AP4-68-PGA	Emulation Technology 2344 Walsh Avenue, Bldg. F Santa Clara, CA 95051 (408) 982-0660
68-PGA/PLCC	EDI Corporation P.O. Box 366 Patterson, CA 95363 (209) 892-3270
68-PGA/PLCC	McKenzie Technology 910 Page Avenue Fremont, CA 94538-7340 (510) 651-2700
ADSP-2101 68-PIN PGA to 80-PIN PQFP ADAPTOR (for ADSP-2101 EZ-ICE)	
AS-V143S	Emulation Technology 2344 Walsh Avenue, Bldg. F Santa Clara, CA 95051 (408) 982-0660
RAM EXPANSION CARD FOR THE EZ-LAB (for ADSP-2101 and ADSP-2111)	The RAM Expansion card expands the amount of program and data RAM available to the maximum amount each DSP can address. The card also provides a user prototype area which includes four (4) fully coded block select lines for addressing the expansion area, and all DSP signals are brought out to an expansion header for easy connection. You may also load a boot program into RAM and then restart the DSP without reprogramming the EPROM. Available from: Momentum Data Systems 1520 Nutmeg Place #108 Costa Mesa, CA 92626 (714) 557-6884 fax (714) 557-6969
PC INTERFACE CARD FOR THE EZ-LAB	The PC Interface card lets you use an IBM compatible computer as a host for the DSP and RAM expansion cards. Using the Bus Request and Bus Grant signals, the PC gains access to the RAM and prototype expansion areas. The PC can interrupt the DSP, and the DSP can interrupt the PC via a communication register. This register enables signaling from the DSP to the PC without slowing down the DSP for bus accesses to check status. The card also provides access to the boot section of the expansion card for downloading programs and restarting the DSP so the developer can design and test programs without needing to burn EPROMs. Available from: Momentum Data Systems 1520 Nutmeg Place #108 Costa Mesa, CA 92626 (714) 557-6884 fax (714) 557-6969
LAB+ FOR ADSP-2101 EZ-LAB EVALUATION	The LAB+ Enhancement Board, designed specifically for the ADSP-2101 EZ-LAB, provides a full complement of external program and data RAM. As a low cost alternative to an in-circuit emulator, LAB+ contains a dual UART with RS-232 drivers that enable a Host PC communication link with the

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