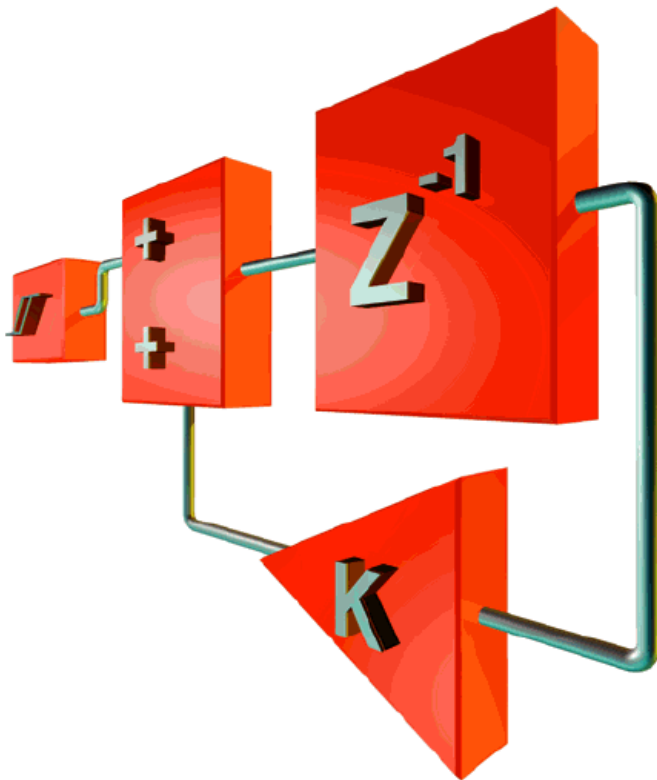# xPC Target

For Use with Real-Time Workshop ®

Modeling

Simulation

Implementation

Selecting Hardware Guide

Version 1.1

The MathWorks

How to Contact The MathWorks:

	www.mathworks.com	Web
	comp.soft-sys.matlab	Newsgroup
@	support@mathworks.com	Technical support
	suggest@mathworks.com	Product enhancement suggestions
	bugs@mathworks.com	Bug reports
	doc@mathworks.com	Documentation error reports
	service@mathworks.com	Order status, license renewals, passcodes
	info@mathworks.com	Sales, pricing, and general information
☎	508-647-7000	Phone
	508-647-7001	Fax
✉	The MathWorks, Inc.	Mail
	3 Apple Hill Drive	
	Natick, MA 01760-2098	

For contact information about worldwide offices, see the MathWorks Web site.

xPC Target Selecting Hardware Guide

Contents

Introduction

With xPC Target, there are literally <mark>thousands of possible combinations of form factors</mark>, I/O boards, and CPUs. Your unique application-specific constraints and performance requirements will determine your choice of hardware. This chapter includes the following sections:

What Is xPC Target? (p. 1-2)	Read about xPC Target and this guide.
Selecting a Target System (p. 1-4)	Select an xPC Target system for your real-time application.

What Is xPC Target?

xPC Target is a solution for prototyping, testing, and deploying real-time systems using standard PC hardware. It is an environment that uses a target PC, separate from a host PC, for running real-time applications.

This section includes the following topics:

- xPC Target
- xPC Target Embedded Option
- "Using This Guide"

xPC Target

xPC Target is a high performance host-target prototyping environment that enables you to connect your Simulink® and Stateflow® models to physical systems and execute them in real time on PC-compatible hardware. xPC Target is ideal for rapid controller prototyping and hardware-in-the-loop simulation of control and data processing systems. It enables you to add I/O blocks to your models, automatically generate code with Real-Time Workshop®, and download the code to a second PC running the xPC Target real-time kernel.

xPC Target lets you use PC-compatible hardware with Intel, AMD, and other x86-compatible CPUs as your real-time target PC. The target PC can be a desktop computer, a rack-mount or an industrial computer, a PC/104 or PC/104+, CompactPCI, or an all-in-one embedded PC computer. This lets you choose the right platform for your rapid prototyping applications without changing your development environment.

xPC Target lets you use your Simulink and Stateflow models further into your design process by:

- Providing real-time target and I/O capabilities on any PC-compatible system
- Eliminating the need to customize or write any code

Using xPC Target, you can solve many specific rapid controller prototyping applications or hardware-in-the-loop simulations by using a high performance mainstream environment.

xPC Target Embedded Option

The xPC Target Embedded Option extends xPC Target to enable you to deploy small numbers of systems on PC-compatible hardware. It is particularly useful when you have to test your prototype system in the field. The xPC Target Embedded Option allows the target PC system to work independently of a host PC. This independence is achieved by automatically loading and running the real-time kernel and application on power up.

Using This Guide

This guide is designed to help you select the hardware that meets your application needs. It does so by describing the types of hardware that are currently available, listing the advantages and disadvantages of each type, and providing a current list of manufacturers.

Selecting a Target System

Selecting a target system for your real-time application consists of three major steps: selecting the form factor, selecting the I/O boards, and selecting the CPU. You should, if possible, follow these steps in order.

This section includes the following topics:

- Selecting the Form Factor
- Selecting I/O Boards
- Suggested Method for Selecting I/O Boards
- Useful Tips for Selecting I/O Boards
- Selecting the CPU

Selecting the Form Factor

The key to determining the best form factor for your application is understanding the environment in which the target hardware is placed. Typical environmental constraints include:

- Lack of space for the target system
- Wide temperature range
- Mechanical vibration and shock
- Water and dust
- Electromagnetic interference (EMI)

The range of environmental conditions your hardware must endure can be very broad. At one end of the spectrum is a clean environment. For example, a clean environment could be an office that is climate controlled and has no mechanical or electrical interference. At the other end of the spectrum is a harsh, cramped environment with vibration, water, dust, EMI, and extreme temperatures. For example, a harsh environment would be on-board a heavy equipment vehicle operating in the field.

Computer hardware manufacturers provide thorough guidelines for installation and use of their equipment. You should consider these guidelines when selecting hardware. In addition, the following table provides a summary of the different form factors and their environmental requirements to help you with your selection of a target PC.

Table 1-1: Possible Form Factors for the Target PC

Hardware	Environment
Desktop PC	Should reside in a clean, climate- controlled environment without vibration or mechanical shocks and with minimal EMI. Typically resides in an office or clean laboratory.
Rack-mount or Industrial PC	Rugged and less sensitive to temperature and vibration than a desktop PC. Can be used in a manufacturing lab or on a factory floor.
CompactPCI	Rugged and tolerates a wide range of temperatures as well as considerable vibration. If necessary, it can be used in a mobile unit.
PC/104 and PC/104+	Highly portable and tolerates vibration, shock, and a harsh environment.
All-in-one embedded PC	Highly portable and tolerates vibration, shock, and a harsh environment. Black box enclosure highly recommended.
xPC TargetBox™	Highly portable and tolerates vibration, shock, and a harsh environment.

Note For detailed information about base system form factors, see Chapter 2, "Form Factors."

Selecting I/O Boards

After selecting the form factor for a system, you need to choose the I/O boards that will connect the target PC to the hardware being tested.

You already know the type of signal connections you require for an application. For example, you might need 6 A/D channels, 2 D/A channels, 1 PWM, and 1 counter. Also, you need to know which I/O board or boards will give these connections and whether they are compatible with the base form factor, and supported by xPC Target.

Table 1-2, Compatibility of Base System and I/O Form Factors shows the compatibility of base system form factors with I/O board form factors. This table helps you to quickly determine what I/O types are available for your chosen system. For example, if you have a PCI system, I/O boards using the PCI, PC/104+, PMC, and IP-Module form factors would all be compatible.

Table 1-2: Compatibility of Base System and I/O Form Factors

Base System Form Factor	PCI	ISA	cPCI	PC/104	PC/104+	PMC	IP-Module
PCI desktop and rack-mount	X				X[b]	X[c]	X[f]
ISA desktop and rack-mount		X		X[a]			X
PCI/ISA desktop and rack-mount	X	X		X[a]	X[b]	X[c]	X[f/g]
CompactPCI			X			X[d]	X[h]
PC/104 and all-in-one				X			X[i]
PC/104+ and all-in-one				X	X	X[e]	X[i]

Some base systems can accept different I/O form factors by using adapter boards or cards:

a — passive PC/104 to ISA adapter, `www.douglas.com`, `www.parvus.com`

b — Passive PC/104+ to PCI adapter, `www.douglas.com`

c — Passive PMC to PCI adapter, `www.technobox.com`

d — Passive PMC to cPCi adapter, `www.technobox.com`

e — Passive PMC to PC/104+ adapter, `www.douglas.com`

f — Active PCI carrier for IP-Modules, `www.sbs.com`

g — Active ISA carrier for IP-Modules, `www.sbs.com`

h — Active cPCI carrier for IP-Modules, `www.sbs.com`

i — Active PC/104 carrier for IP-Modules, `www.sbs.com`

Table 1-3, Supported I/O Boards gives you additional information to help you select the most appropriate I/O board form factor. This table lists the advantages and disadvantages of each I/O board form factor, enabling you to determine which type will be most appropriate for your needs.

Table 1-3: Supported I/O Boards

Form factors	Advantages	Disadvantages
PCI	Very large selection of I/O types available Fastest available bus for PC-compatible systems Plug-and-play operations	Can only be used in desktop and rack-mount PCs Not rugged
Compact PCI	Uses the fast PCI bus Plug-and-play operations	Can only be used in Compact PCI systems

Table 1-3: Supported I/O Boards (Continued)

Form factors	Advantages	Disadvantages
ISA	Large selection of generic I/O types	Bus is slow, uses 8MHz bus speed
		Manual jumper and DIP-switch settings on the board
		Modern desktop and rack-mount PCs do not have ISA slots
		Modern I/O technology not available on ISA boards
PC/104	Very small physical dimensions	Uses the slow ISA bus
	Large selection of available I/O types	Manual jumper and DIP-switch settings on the board
PC/104+	Very small physical dimensions	Limited number of I/O boards currently available
	Uses the fast PCI bus	
	Plug-and-play operations	

Table 1-3: Supported I/O Boards (Continued)

Form factors	Advantages	Disadvantages
PMC	Growing selection of I/O types available Uses the fast PCI bus Plug-and-play operations Can be used in desktop PCs, rack-mount PCs, PC/104+, and cPCI systems	Can only be used in systems with a PCI-compatible bus Requires a passive carrier board
IP Module	Large selection of I/O types available Same IP module can be used in any base system form factor through active carrier boards.	Older standard with performance similar to ISA Most IP modules use the slow 8MHz bus, but some support the 32MHz bus clock. Requires carrier boards, which can be expensive

If you need to use a number of form factors throughout a project, we recommend that you use PMC I/O boards because you can use them in CompactPCI, desktop PC, rack-mount PC, or PC/104 systems. You achieve this flexibility by plugging the PMC I/O boards into a passive carrier board for the corresponding form factor. This justifies your investment in I/O boards when you have to consider another form factor at a later stage. For example, you may start with one form factor in the laboratory and then choose another form factor for field tests.

"Selecting a Target System Using the xPC Target Interactive Hardware Selection Guide" on page 1-10 describes how to use the xPC Target Interactive Hardware Selection Guide to help you select an I/O board supported by xPC Target.

Suggested Method for Selecting I/O Boards

You can determine which specific boards with the desired I/O form factor are supported by xPC Target. Because the list of supported I/O boards is continually growing, it is not part of this guide. Please go to the xPC Target product page at
`http://www.mathworks.com/support/product/XP/productnews/productnews.shtml`. Here you will find an up-to-date list of supported I/O boards for each form factor. The list is updated regularly.

We recommend you use the following method to choose the right I/O boards for your application:

1 Use the xPC Target Interactive Hardware Selection Guide. For a description of this interactive selection guide, see "Selecting a Target System Using the xPC Target Interactive Hardware Selection Guide" on page 1-10.

2 Select the relevant form factor bus type and look up each I/O type you require for your application. See Table 1-2, Compatibility of Base System and I/O Form Factors, on page 1-6.

3 Choose the board that provides the right number of channels or lines for your needs.

4 Visit the board vendor's Web site and carefully read through the detailed technical specifications for the board. Make sure the board you select fulfills the requirements of your application and environment.

Selecting a Target System Using the xPC Target Interactive Hardware Selection Guide

To help you select an I/O board from the collection that xPC Target supports, use the xPC Target Interactive Hardware Selection Guide. This interactive selection guide is available from
`http://www.mathworks.com/support/product/XP/productnews/interactive_guide/xPC_Target_Interactive_Guide.html`.

The first page of the interactive selection guide appears.

The interactive selection guide is a Web-based guide that allows you to give selection criteria for the kind of I/O board you are seeking. Your selections enable the interactive selection guide to present you with a potentially suitable list of supported xPC Target boards. You choose these criteria from the dropdown list parameters in the interactive selection guide.

Dropdown Lists	Description
Manufacturer	Select an xPC Target I/O board manufacturer.
Bus Type	Select a particular I/O board bus type to fit your form factor.
Analog Input	Select the number of channels for analog input, A/D.
Analog Output	Select the number of channels for analog output, D/A.

Dropdown Lists	Description
Digital I/O	Select the number of lines for digital I/O, DIO.
Miscellaneous	For other types of I/O devices, select the functional type from the list of miscellaneous functional areas.

You can select entries for as many or as few of these parameters as you want. The fewer parameters you select, the larger the list of boards the interactive selection guide presents. When you are done, press the **Find** button.

Note Many manufacturers provide cross-functional boards. For example, some manufacturers provide one board that supports Analog Input, Analog Output, and Digital I/O. By default, the interactive selection guide sets all parameters to View All. To ensure that you see all the possible boards that satisfy your requirements, set only the parameters that matter to you and leave the other parameters at View All. If you set a parameter to None, you will not see the boards for that functional area, even if those boards do satisfy other parameters you have set.

The following are some sample lists the interactive selection guide can return.

Example 1

1 To obtain a list of the I/O boards with at least 4 A/D channels and at least 2 D/A channels, select:

- **Analog Input**: 4
- **Analog Output**: 2

2 Leave the other parameters at View All.

3 Press the **Find** button.

The interactive selection guide returns output like the following:

Manufacturer	Boardname	Bus Type	A/D Channels	A/D Latency	D/A Channels	D/A Latency	Digital I/O	Digital I/O Latency
Advantech	PCL-1800	ISA	16 12-bit	55	2 12-bit	10	32	1 to 2
Advantech	PCL-812	ISA	16 12-bit	55	2 12-bit	10	32	1 to 2
Advantech	PCL-812PG	ISA	16 12-bit	55	2 12-bit	10	32	1 to 2
Advantech	PCL-818LS	ISA	16 12-bit	55	2 12-bit	10	32	1 to 2
Data Translation	DT2823	ISA	4 16-bit	55	2 16-bit	10	8	2+0.3N
Data Translation	DT2821	ISA	16 12-bit	55	2 12-bit	10	8	2+0.3N
Data Translation	DT2827	ISA	4 16-bit	55	2 12-bit	10	16	2+0.3N
Data Translation	DT2821-G-8DI	ISA	8 12-bit	55	2 12-bit	10	8	2+0.3N
Data Translation	DT2821-G-16SE	ISA	16 12-bit	55	2 12-bit	10	8	2+0.3N
Data Translation	DT2821-F-8DI	ISA	8 12-bit	55	2 12-bit	10	8	2+0.3N
Data Translation	DT2821-F-16SE	ISA	16 12-bit	55	2 12-bit	10	8	2+0.3N
Data Translation	DT2825	ISA	16 12-bit	55	2 12-bit	10	8	2+0.3N
Data Translation	DT2828	ISA	4 12-bit	55	2 12-bit	10	16	2+0.3N
Diamond	Prometheus	PC/104	16 16-bit	7+15N	4 12-bit	17.55+11.54N	24	15+2.6N
Diamond	MM-32	PC/104	32 16-bit	6+10N	4 12-bit	15	24	2+0.3N
Diamond	Diamond MM	PC/104	16 12-bit	6+10N	2 12-bit	7	8	2+0.3N
General Standards	PMC-ADADIO	PCI	8 16-bit	5	4 16-bit	3	8	1 + .3N
Gespac	GESADA-1	ISA	16 10-bit	null	4 10-bit	3	0	N/A
Humusoft	AD 512	ISA	8 12-bit	5+10N	2 12-bit	7	8	2+0.3N
Keithley MetraByte	KPCI-1802HC	PCI	64 12-bit	5+5N	2 12-bit	7	8	1+0.3N
Keithley MetraByte	KPCI-1801HC	PCI	64 12-bit	5+5N	2 12-bit	7	8	1+0.3N
Measurement Computing	PCI-DAS1602 12	PCI	16 12-bit	3 + 8N	2 12-bit	5.3+1N	24	1+0.12N
Measurement Computing	PCI-DAS1200	PCI	16 12-bit	3 + 6N	2 12-bit	6.5	24	1+0.12N
Measurement Computing	PCI-DAS1602 16	PCI	16 16-bit	3 + 8N	2 16-bit	5.3+1N	24	1+0.12N
Measurement Computing	CIO-DAS1601 12	ISA	16 12-bit	4 + 7N	2 12-bit	5+1N	24	2 + 0.3N
Measurement Computing	CIO-DAS1602 16	ISA	16 16-bit	4 + 10N	2 16-bit	5+1N	24	2 + 0.3N
Measurement Computing	PCIM-DAS1602 16	PCIM	16 16-bit	3 + 8N	2 16-bit	5.3+1N	24	1+0.12N
Measurement Computing	CIO-DAS1602 12	ISA	16 12-bit	4 + 10N	2 12-bit	5+1N	24	2 + 0.3N
National Instruments	PCI-MIO-16E-1	PCI	16 12-bit	5+2N	2 12-bit	6.5	8	1+0.12N
National Instruments	PCI-MIO-16XE-10	PCI	16 16-bit	5+2N	2 16-bit	6.5	8	1+0.12N
National Instruments	PXI-6040E	Compact PCI	16 12-bit	5+2N	2 12-bit	6.5	8	1+0.12N
National Instruments	PXI-6070E	Compact PCI	16 12-bit	5+2N	2 12-bit	6.5	8	1+0.12N
National Instruments	PCI-6024E	PCI	16 12-bit	5+2N	2 12-bit	6.5	8	1+0.12N
National Instruments	PCI-MIO-16E-4	PCI	16 12-bit	5+2N	2 12-bit	6.5	8	1+0.12N
National Instruments	PCI-6071E	PCI	64 12-bit	5+2N	2 12-bit	6.5	8	1+0.12N
National Instruments	PCI-6052E	PCI	16 16-bit	5+2N	2 16-bit	6.5	8	1+0.12N
National Instruments	PCI-6031E	PCI	64 16-bit	5+2N	2 16-bit	6.5	8	1+0.12N
National Instruments	PCI-6025E	PCI	16 12-bit	5+2N	2 12-bit	6.5	8	1+0.12N
Real Time Devices	DM6420	PC/104	16 12-bit	2 + 4N	2 12-bit	6.5+2.4N	16	2 + 0.3N
UEI	PD2-MFS-8-2M/14DG	PCI	8 14-bit	6.5+0.65N	2 12-bit	6.5	16	4.5
UEI	PDXI-MF-16-500/16H	Compact PCI	16 14-bit	6.5+0.65N	2 12-bit	6.5	16	4.5

Each line has the following columns:

Manufacturer — Board manufacturer. This entry typically contains a link to the manufacturer Web site.

Boardname — Board name. This entry typically contains a link to a Web page describing the board.

Bus Type — Bus type of the board.

A/D Channels — Number of A/D channels on the board.

A/D Latency — Latency is the time, in microseconds, between initiating a request for data and the beginning of the actual data transfer. It is calculated as the base time plus a channel time multiplied by the number of A/D channels (N) being used by the xPC Target application.

D/A Channels — Number of D/A channels on the board.

D/A Latency — Latency is the time, in microseconds, between initiating a request for data and the beginning of the actual data transfer. It is calculated

as the base time plus a channel time multiplied by the number of D/A channels (`N`) being used by the xPC Target application.
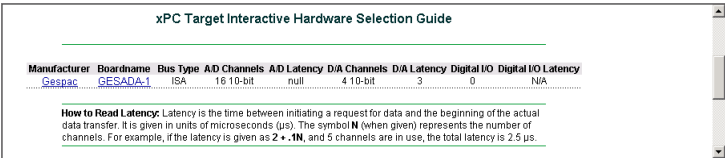
Digital I/O — Number of digital I/O lines on the board.

Digital I/O Latency — Latency is the time, in microseconds, between initiating a request for data and the beginning of the actual data transfer. It is calculated as the base time plus a channel time multiplied by the number of digital I/O lines (`N`) being used by the xPC Target application.

Example 2

1 To obtain a list of the I/O boards with at least 4 A/D channels, at least 2 D/A channels, and no digital I/O lines, select:

- **Analog Input**: 4
- **Analog Output**: 2
- **Digital I/O**: None

2 Leave the other parameters at `View All`.

3 Press the **Find** button.

The interactive selection guide returns output like the following:

Example 3

1 To obtain a list of the PCI D/A boards with at least 4 channels and no digital I/O lines, select:

- **Bus Type**: `PCI`
- **Analog Input**: `None`
- **Analog Output**: 4
- **Digital I/O**: `None`

2 Press the **Find** button.

The interactive selection guide returns output like the following:

Example 4

1 To obtain a list of all audio boards, select:

Miscellaneous: `Audio`

2 Press the **Find** button.

The interactive selection guide returns output like the following:

Useful Tips for Selecting I/O Boards

This information will help you determine which board meets your
requirements:

- If there are several boards with similar characteristics, choose a board in a
  form factor based on the PCI bus rather than on the ISA bus. This ensures
  higher throughput and lower latency, and also increases maintainability due
  to its plug-and-play operation.

- Check for adequate signal conditioning (buffering, isolation, filtering,
  grounding, etc.). If an I/O board does not offer the proper signal conditioning
  on board, consider using external signal conditioning modules.

- Many I/O boards combine multiple I/O types. For example, a standard data
  acquisition board may combine A/D, D/A, and digital I/O. The xPC Target

Interactive Hardware Selection Guide lists show relevant I/O types that are supported. Be sure to use this as a way to minimize the total number of boards required for your application.

- If a board provides the required characteristics but does not offer enough channels, consider using multiple boards.

- Once you have found appropriate boards for all the I/O types required for your application, make sure that the selected base system's form factor offers enough room and bus slots. If this is not the case, you may need to consider bus expanders (for desktop or rack-mount PCs), different form factors, or similar I/O boards with more channels.

If the supported I/O boards do not include an I/O type needed for your application or you do not find an I/O board with the required characteristics, contact your MathWorks sales representative to discuss alternatives.

Proceed to the final step, which consists of selecting the CPU class according to your performance needs. See "Selecting the CPU" on page 1-16.

Selecting the CPU

The last major step in the hardware selection process is to choose the appropriate CPU class for your application. This section presents guidelines to help you estimate if the overall system performance is sufficient for your application.

Your real-time application runs at a certain base sample time derived from the dynamic characteristics of your application. The overall performance for the target system must be sufficient to execute within the base sample time without overloading the CPU. However, the overall performance is not simply determined by the complexity of the Simulink and Stateflow models, but also the I/O complexity, since each channel of I/O introduces latencies to the target application. This section discusses these two components to help you quantify their effect on the system performance.

xPC Target is a high performance, real-time prototyping environment that allows smaller applications to execute with a base sample time of 10 μs on high-performance CPUs, such as the Athlon or Pentium III. We recommend the Pentium III over the Pentium 4 as the CPU for a target PC running the xPC Target kernel. According to our benchmarks, the Pentium 4 architecture seems to be less effective for floating-point intensive applications. As the application and I/O grow in size and complexity, the achievable minimal base sample time

also increases. It is therefore important to choose a CPU from a class that is powerful enough to provide sufficient performance headroom.

The general rule is to select the fastest CPU available for the chosen form factor without violating the given system constraints. Choosing the fastest CPU leads to the best performing system without adding significant cost. However, because your system needs to work within the constraints that have led you to already choose the form factor and I/O type, you can sometimes be limited to the level, and therefore the power, of the available CPU. For example, if you require the system to work within an extended temperature range then you need a low power CPU. For example, this requirement limits your available choices, and in this case you cannot use an Athlon CPU.

To better understand the complexity of your application and if the selected target PC system will execute your application, use the following steps as a guideline. Considerations include whether the selected target system with a certain CPU class will execute the application at the given base sample time:

1 Calculate the total I/O driver latency.

Each I/O channel that is accessed by your application adds latency, thereby increasing the achievable minimal base sample time. Because the I/O boards are accessed through the peripheral bus, latency time depending on the amount of I/O can quickly become larger than the time needed to execute the algorithm (model) itself.

The supported I/O board list (see "Selecting a Target System Using the xPC Target Interactive Hardware Selection Guide" on page 1-10) provides latency information for the driver of each board. By knowing the number of channels you use on each board, you can calculate the total I/O driver latency. This total is a conservative estimate, but if the estimated latency is already larger than the given base sample time, the real-time execution will fail independent of CPU performance. In this case, contact your MathWorks sales representative to discuss alternatives.

2 Subtract the total I/O driver latency estimate from the base sample time.

3 To provide headroom for background task switching and cache misses, subtract an additional 25 µs. The resulting time is roughly the time available to execute the Simulink-based algorithm (model).

4 Visit the benchmark page of the xPC Target Product area at
`www.mathworks.com/support/author/xpc/benchmarks.shtml`. Compare
the complexity of the benchmark models to the complexity of your
application model. This enables you to estimate the CPU class that you need
to execute your target application at the given base sample time.

Based on MathWorks experience, applications can be separated into the
following four distinctive classes concerning the base sample time you need to
achieve.

Base Sample Time Above 1ms

This sample time is usually not a problem. It leaves enough time to execute
even the most complex models with large amounts of I/O on almost any typical
CPU class. For complex hardware-in-the-loop applications with very complex
I/O, you should calculate and check the total I/O latency.

Base Sample Time Between 250 μs and 1ms

This sample time is usually not a problem. Consider the I/O driver latency only
if the application depends on high I/O complexity. Calculate and check that the
total I/O latency is within the relevant sample time. We recommend a
Pentium-class CPU running no slower than 200MHz.

Base Sample Time Between 50 μs and 250 μs

Total I/O latency and model complexity estimation are important. In most
cases, you will need a powerful CPU in the Pentium II/III or AMD Athlon class.
And if the I/O complexity is average to large, you might need to use advanced
I/O boards with low-latency drivers.

Base Sample Time Between 10 μs and 50 μs

Applications that need these very small base sample times are usually
controller applications with moderate I/O complexity. Nevertheless, I/O driver
latency has to be kept to a minimum by using advanced parallel converting
boards and parallel I/O access at the software level. Additionally, the algorithm
(Simulink model) has to be optimal, and the CPU performance should be the
highest available. Depending on the application, you may have to use the
polling execution scheme of the xPC Target kernel to achieve these small
sample times. In this case, contact your MathWorks sales representative to
discuss your application.

Form Factors

Each of the PC-compatible form factors presented in the following sections has advantages and disadvantages. You should carefully read through all the descriptions before making your selection. Information about the performance and I/O expendability is also given in these sections. This chapter includes the following sections:

Desktop PC

The desktop PC is the ideal choice for a clean, climate-controlled environment with no space limitations, no vibration or mechanical shocks, and an electrical environment with minimal EMI such as an office or laboratory.

This section includes the following topics:

- Overview of Desktop PC Computers
- Performance
- I/O Expandability
- Advantages
- Disadvantages
- Vendors

Overview of Desktop PC Computers

Desktop PCs offer the highest performance-to-cost ratio of all available form factors. New CPU families and the highest performance CPUs are available in desktop PCs before any other form factor. Using the PCI bus, desktop PCs offer the best I/O performance available in PC-compatible systems. For these reasons, if the working environment is suitable, select a desktop computer as the target PC.

Typical Desktop PC Computer

Performance

As the impact of the CPU cost on the entire configuration is small, we recommend you use the highest performance CPU architecture with the highest clock rate available. Select a desktop PC with either an Intel Pentium III or an AMD Athlon CPU. We recommend the Pentium III over the Pentium 4 as the CPU for a target PC running the xPC Target kernel. According to our benchmarks, the Pentium 4 architecture seems to be less effective for floating-point intensive applications.

All modern desktop PCs use the PCI bus for expansion purposes. This bus has the fastest I/O throughput and lowest latency available in a PC-compatible system.

I/O Expandability

Modern desktop PCs have a mainboard (motherboard) that normally has three to five PCI bus slots available for expansion with PCI I/O boards. Very few offer the older-style ISA bus slots. Those that have ISA bus slots use a PCI-to-ISA bridge. If more slots are required for I/O boards, then you can use a bus expander. A bus expander consists of a PCI (or ISA) board that is plugged into the desktop PC. This board has a copper or fiber-optical connection to an external chassis (usually a rack-mount system) with a passive backplane and up to 14 PCI or ISA slots. You need at least one ISA or PCI slot available in the desktop PC to have ISA or PCI bus expansion.

An alternative to using bus expanders would be to switch to the rack-mount or industrial PC form factor.

If possible, you should use PCI I/O boards because of their higher throughput, lower latency, and ease of operation.

You can use the following standard I/O board form factors with a desktop PC:

- PCI
- ISA — If mainboard is equipped with a PCI-to-ISA bridge
- PC/104 — Through a passive ISA carrier board
- PC/104+ — Through a passive PCI carrier board
- PMC — Through a passive PCI carrier board
- IP-modules — Through an active ISA or PCI carrier board

Advantages

The advantages of selecting a desktop PC computer for your target PC are

- Highest performance-to-cost ratio
- Widely available, many vendors
- Familiar PC architecture

Disadvantages

The disadvantages of a desktop PC computer for your target PC are

- Large physical dimensions
- Dependent on a clean operating environment
- Limited PCI I/O board expandability
- Unavailable or very limited ISA I/O board expandability
- Short life cycle of specific models

Vendors

There are hundreds of vendors for desktop PCs, including

- Gateway, `www.gateway.com`
- Dell Computer Corporation, `www.dell.com`
- Hewlett-Packard Company, `www.hp.com`
- IBM Corporation, `www.ibm.com`
- Compaq Computer Corporation, `www.compaq.com`
- Sony Electronics, `www.sonystyle.com/vaio`
- Toshiba Corporation, `www.toshiba.com`

Vendors of bus expanders include:

- Measurement Computing Corporation, `www.measurementcomputing.com`
- SBS Technologies, Inc., `www.sbs.com`
- MAGMA, `www.magma.com`
- Contec Microelectronics, `www.contec.com`
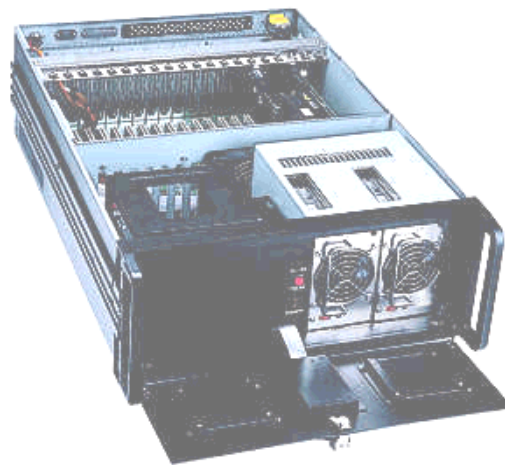
Rack-Mount or Industrial PC

The industrial PC system consists of a standardized industrial chassis (19", 4U, 6U) and a passive or active backplane with up to twenty ISA and PCI bus slots. The industrial PC system mainboard is a CPU board that is plugged into one of the available slots similar to an I/O board.

This section includes the following topics:

- Overview for Industrial PC Computers
- Performance
- I/O Expandability
- Advantages
- Disadvantages
- Vendors

Overview for Industrial PC Computers

Industrial CPU cards are sometimes called Single Board Computers (SBCs) because they combine the entire PC functionality on a single board. You can use the remaining PCI or ISA slots of the rack-mount PC for I/O expansion.

Rack-Mount or Industrial PC Chassis

The backplane is normally manufactured using thicker PCI boards than found in desktop PCs. These thicker boards result in better mechanical characteristics. This allows for frequent plugging and unplugging of the CPU or I/O cards.
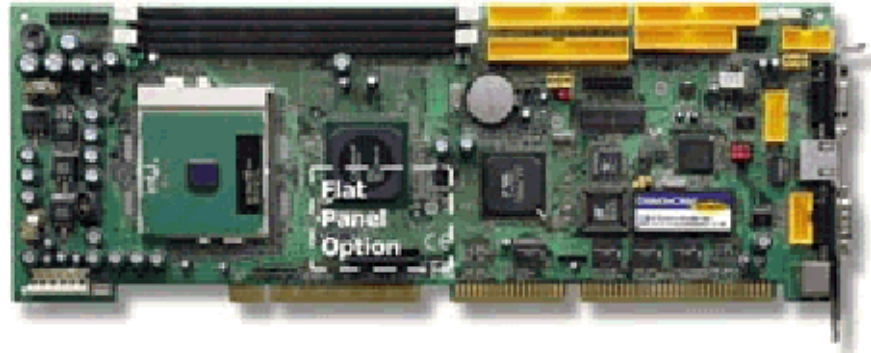
Rack-Mount or Industrial PC Motherboard

Additionally, maintainability is improved over desktop PCs because all I/O boards, including the CPU board, are easily accessible from the top of the chassis.

We do not recommend equipping a rack-mount chassis with a standard mainboard found in desktop PCs because you can lose mechanical ruggedness and good maintainability.

The rack-mount PC has the following special capabilities:

- It can be mounted in a rack that contains other units such as special signal conditioning, remote I/O, and redundant power supplies.
- It is more powerful for hardware-in-the-loop or other applications that consist of hundreds of I/O channels or use many I/O boards.
- It can be placed in a harsher environment.
- It is more easily maintained.

Performance

The CPU boards (SBCs) are usually available with high-performance CPUs (Intel Pentium III, AMD Athlon) that are similar to those in desktop PCs. Because the industrial PC has a smaller market and has a special design, the introduction of boards with the most recent CPU technology is behind that of the desktop PC market by 6 to 12 months. Modern CPU boards use the PCI bus for I/O expansion, resulting in the same I/O throughput and latency as the best desktop PCs.

I/O Expandability

All modern CPU boards (SBCs) extend the ISA and PCI bus to the backplane through a special slot called PICMG. The PICMG slot combines the ISA and PCI bus in the same slot (row). The PICMG slot is on the backplane in the middle of the PCB with the ISA slots on one side and the PCI slots on the other. Backplanes are available in passive and active versions. The passive versions offer as many as 20 ISA bus slots and/or up to four free PCI bus slots. Use active backplanes to overcome the limitation of four PCI bus slots. These backplanes are equipped with one to several PCI-to-PCI bridges. These bridges include up to 14 PCI slots and usually have one to three ISA bus slots.

As with desktop PCs, you can use bus expanders to expand the I/O capacity of the system.

You should use PCI I/O boards for expansion due to their higher throughput, lower latency, and plug-and-play operation.

The following standard I/O board form factors can be found in rack-mount or industrial PC computers:

- PCI
- ISA — If the CPU card is of the PICMG type and has a PCI-to-ISA bridge
- PC/104 — Through a passive ISA carrier board
- PC/104+ — Through a passive PCI carrier board
- PMC — Through a passive PCI carrier board
- IP-modules — Through an active ISA or PCI carrier board

Advantages

The advantages of selecting a rack-mount or industrial PC computer for your target PC are

- High performance
- Highest I/O expandability
- Standard rugged industrial chassis, which is ideal for the laboratory
- Clean design using backplane technology
- Good maintainability
- Similar architecture to the desktop PC
- Reusable I/O boards from a desktop PC configuration

Disadvantages

The disadvantages of selecting a rack-mount or industrial PC computer for your target PC are

- Large physical dimensions
- Higher acquisition costs than desktop PCs
- CPU performance lags behind desktop PCs by 6 to 12 months.

Vendors

There are many suppliers of rack-mount and industrial PCs. You can get general information from `www.picmg.com`. Vendors include

- Diversified Technology, Inc., `www.dtims.com`
- Base Technology, `www.ibase-i.com.tw`
- ICS Advent, `www.icsadvent.com`
- Trenton Technology Inc., `www.trentonprocessors.com`
- Lanner Electronics Inc., `www.lannerinc.com`
- Teknor Applicom Inc. (Kontron Embedded Computers), `www.teknor.com`
- I-Bus/Phoenix, `www.ibus.com`
- Technoland, Inc., `www.technoland.com`
- Arbor Technology Co., `www.arbor.com.tw`
- Advantech Co., Ltd, `www.advantech.com`

CompactPCI

CompactPCI is an adaptation of the PCI specification for industrial computer applications requiring a smaller, more robust mechanical form factor than the one defined for the desktop PC.

This section includes the following topics:

- Overview of CompactPCI Computers
- Performance
- I/O Expandability
- Advantages
- Disadvantages
- Vendors

Overview of CompactPCI Computers

The PCI bus and CompactPCI bus are architecturally identical, except that CompactPCI computers have a higher maximum load that allows doubling the four slots of the PCI bus to eight slots without the need for an active PCI-to-PCI bridge
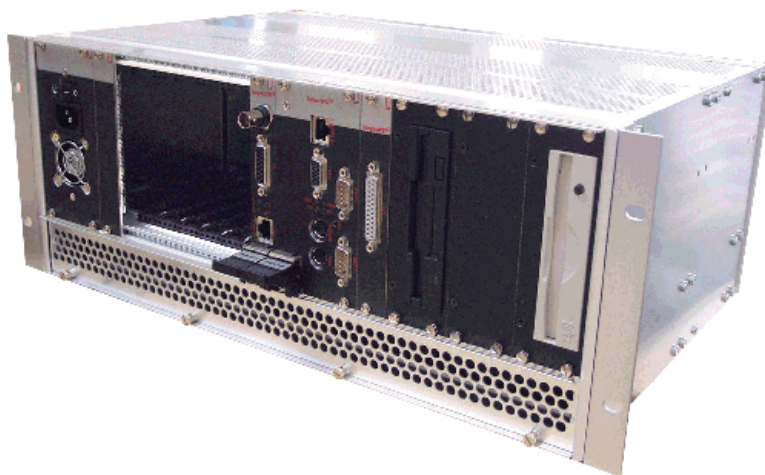
CompactPCI Chassis from GESPAC

A CompactPCI system consists of a standardized industrial chassis (19", 3U, 6U) and a passive or active backplane with up to 14 CompactPCI slots. The CompactPCI system mainboard is a CPU board that is plugged into one of the available slots. I/O boards are available in the CompactPCI form factor and are plugged into free CompactPCI slots.

CompactPCI Motherboard

The chassis usually contains either an AC or DC power supply, which generates voltage levels required by the system. The CPU and I/O boards are accessible at the front of the chassis and all I/O connectors are mounted on the front plate. This leads to a highly maintainable system. A CompactPCI configuration is more rugged than both desktop and rack-mount PCs, making it an ideal form factor for harsh environments and, in some circumstances, mobile applications.

A CompactPCI is a good alternative to the desktop PC or rack-mount PC when

- Space is limited — CompactPCI systems are usually smaller than desktop and rack-mount PCs.
- A high degree of maintainability is very important — I/O has to be accessible at the front of the chassis.
- The system has to be placed in a harsh environment — Examples include increased temperature ranges, increased vibration, and mobile applications.
- The system has a high number of I/O boards — The boards need to fit within a restricted space.

Because CompactPCI systems depend on I/O boards in the CompactPCI form factor, you cannot reuse I/O boards that have been used in desktop or rack-mount PCs in a CompactPCI configuration. The acquisition cost of a CompactPCI system is higher than a desktop PC or rack-mount PC system. This is because of its smaller market and rugged design.

Performance

The entire PC functionality is combined on a single-width or double-width CompactPCI board that limits the CPU performance. The fastest available boards are currently equipped with Pentium III CPUs with clock rates below 1GHz. Since CompactPCI systems could operate in harsh environments, they usually have no cooling fans, but could operate in extended temperature ranges. Low power or lower clocked CPUs are commonly used to meet this requirement, and so most CompactPCI CPU boards are equipped with Pentium I or Mobile Pentium CPUs. Therefore, a typical CompactPCI does not reach the typical performance level of a desktop PC or rack-mount PC. However, since CompactPCI computers are based on the PCI bus, I/O throughput and latency are equivalent to the best desktop PCs.

I/O Expandability

CompactPCI systems usually use passive backplanes that provide up to eight CompactPCI slots. This backplane allows six or seven PCI slots for I/O expansion. Recently, active backplanes with PCI-to-PCI bridges and wide chassis were introduced that offer up to 14 CompactPCI slots. You can use bus expanders to extend the PCI bus to another CompactPCI chassis, but the overall system may become too large for mobile or space-restricted applications.

Many vendors of PCI I/O boards offer a compatible board in the CompactPCI form factor. Nevertheless, the range of available CompactPCI I/O boards is still smaller than the range of available PCI boards for the desktop PC or rack-mount PC.

We recommend that you use PMC I/O boards. You can use these boards in CompactPCI, desktop PC, rack-mount PC, or PC/104 systems by plugging them into a passive carrier board for the corresponding form factor. This flexibility reduces your risk when investing in expensive I/O boards. CompactPCI systems cannot be equipped with ISA I/O boards at all, and this may be a problem if a special, usually legacy, I/O connectivity is required.

You can use the following standard I/O board form factors in CompactPCI systems:

- CompactPCI
- PMC — Through a passive CompactPCI carrier board
- PC/104+ — Through a passive CompactPCI carrier board
- IP-modules — Through an active CompactPCI carrier board

Advantages

The advantages of selecting a CompactPCI computer for your target PC are

- A well designed, clean specification that standardizes all components, including the chassis
- Smaller physical dimensions than desktop or rack-mount PCs
- Rugged design for use in harsh environments
- High I/O expandability
- Easily accessible I/O connectors
- Very high level of maintainability

Disadvantages

The disadvantages of selecting a CompactPCI computer for your target PC are

- High acquisition costs
- Limited CPU performance
- Relatively small selection of native CompactPCI I/O boards

Vendors

Vendors supplying CompactPCI systems are

- PEP Modular Computers, `www.pep.com`
- Inova Computers, Inc., `www.inova-computers.com`
- VMIC, `www.vmic.com`
- Gespac S.A, `www.gespac.com`
- Lanner Electronics, Inc., `www.lannerinc.com`
- Technoland, Inc., `www.technoland.com`
- Teknor Applicom (Kontron Embedded Computers), `www.teknor.com`
- Force Computers, Inc., `www.forcecomputers.com`

For general information on CompactPCI, including specifications, please visit the PCI Special Interest Group (PCI-SIG) at `www.pcisig.com/home`.

PC/104 and PC/104+

PC/104 and PC/104+ is a PC-compatible computer designed especially for embedded applications.

This section includes the following topics:

- Overview for PC/104 Computers
- Performance
- I/O Expandability
- Advantages
- Disadvantages
- Vendors

Overview for PC/104 Computers

The PC/104 standard defines both the size of the board, roughly 4"-by-4" (10cm-by-10cm), and the bus that is electrically compatible to the ISA bus but mechanically different.
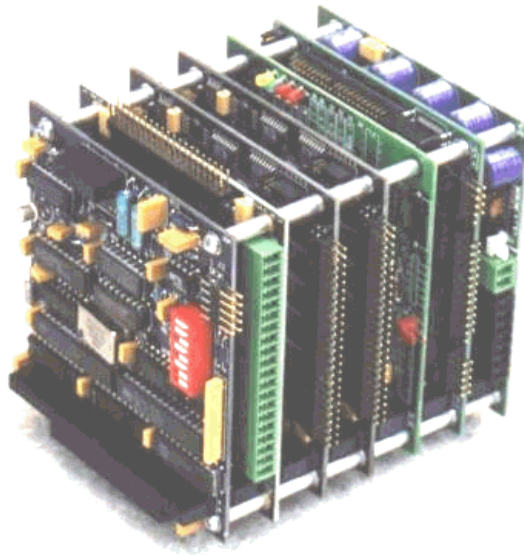
PC/104 Stack

The PC/104 bus connector pins are extended to the top and bottom of the board. This type of connector pin configuration allows you to connect PC/104 boards on top of each other, and eliminates the need for a separate backplane. Without a separate backplane, the system has a smaller physical dimension and a shape similar to a small tower. This is why a PC/104 system is often called a PC/104 stack. The PC/104 stack consists of a PC-compatible CPU board, a power supply board, and additional I/O boards in the same PC/104 form factor.

After the introduction of the PCI bus to the desktop PC, the PC/104 standard was extended by the PC/104+ standard. The PC/104+ standard adds a PCI-compatible bus to the form factor. The PCI bus connector is located on the opposite side of the board to the ISA bus and is extended in the same way.

The physical dimensions of the PC/104 form factor have become a limitation for CPU boards that use today's more powerful CPU families and have highly integrated components (for example, Ethernet controller, FlashRAM, etc.) on board. This has led to the development of some PC/104 CPU boards that exceed the physical dimensions defined by the PC/104 standard. These larger boards are collectively referred to as Single Board Computers (SBCs). One of the larger boards was standardized by Ampro and Motorola several years ago with the introduction of the EBX form factor. Since these boards use the PC/104+ bus for I/O expansion, SBC systems function the same way as standard PC/104+ stacks.

The PC/104 standard includes recommendations for the type and location of only some I/O connectors. Vendors usually spread the remaining I/O connectors over the entire surface of the board because of its small size. This makes it very difficult to purchase an enclosure that has the right I/O connector breakouts for a specific PC/104 stack. Some vendors offer complete enclosure kits, but they are usually only compatible with their own boards. This incompatibility makes it difficult for you to create stacks with PC/104 boards from multiple vendors. Therefore, if you require an enclosure, it will normally need to be custom built.

Because of their design, PC/104 systems are rugged and especially suited for mobile applications in harsh environments. You can use low power, fanless PC/104 CPU boards in extended temperature range environments where increased system life cycle is important.

PC/104 stacks are the right choice in the following situations:

• Where there are extreme space limitations, such as in mobile applications

• When the system is placed in a harsh environment

The acquisition cost for a complete PC/104 stack is relatively low and is in the same range as an equivalent desktop PC.

Performance

Due to the small physical dimensions of the PC/104 standard, CPU boards cannot be equipped with the more powerful CPU families that are available. PC/104 CPU boards normally use processors that are one or two generations behind those available in the desktop PC. Currently, very few CPU boards use processors running faster than 400 MHz.
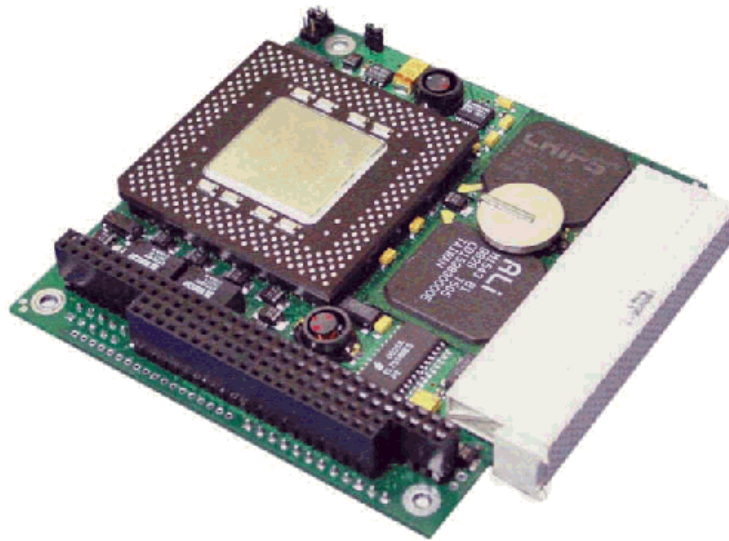
PC/104 CPU Board

If low-power consumption or fanless operation is necessary, then PC/104 boards make use of mobile Pentium CPUs or special embedded CPUs (Intel, AMD, and others) running at even slower rates (66MHz-300MHz). Therefore,

the maximum achievable CPU performance of a PC/104 stack is significantly lower than that of a desktop PC, rack-mount PC, or CompactPCI system.

Because only a few PC/104+ I/O boards are available, typical PC/104 systems need to use ISA bus-based I/O boards. This impacts the overall system performance since the ISA bus has a lower I/O throughput and higher latency than the PCI bus.

I/O Expandability

Modern CPU boards usually conform to the PC/104+ standard, providing both ISA and PCI buses for currently available. This limitation makes it very difficult for you to build a stack that is exclusively made up of boards using the faster PCI bus. Within a PC/104+ system, you can combine PC/104 (ISA) and PC/104+ (PCI) boards as long as the PC/104+ boards are stacked onto the CPU board before the PC/104 boards.

The choice of available PC/104 I/O boards is very broad and covers most I/O types. The PC/104+ standard defines the expansion of the stack with up to three PC/104+ (PCI) boards and up to eight PC/104 (ISA) boards. However, because PC/104 systems are usually used for mobile controller applications, which do not need a very high number of I/O channels, this limit is rarely reached.

You can use the following standard I/O board form factors in a PC/104 stack system:

- PC/104 (ISA)
- PC/104+ (PCI) — If the CPU module is a PC/104+ board
- PMC — Through a passive PC/104+ carrier board
- IP-modules — Through an active PC/104 carrier board

Advantages

The advantages of selecting a PC/104 computer for your target PC are

- Very small, ideal for mobile applications
- Rugged system, well suited for deployment in a harsh environment
- DC power operation
- Extended temperature range operation

2-17

- Low power consumption and fanless options readily available
- Good I/O expandability
- Moderate acquisition costs

Disadvantages

The disadvantages of selecting a PC/104 computer for your target PC are

- Overall performance is low compared to desktop and rack-mount PCs.
- PC/104 standard does not cover connector, chassis, or enclosure specifications.
- Most I/O boards are available only in the PC/104 (ISA) standard, reducing the I/O throughput and overall system performance.

Vendors

There are many vendors for PC/104 systems. General information on this form factor can be obtained from: www.pc104.org

Vendors that support PC/104 systems include

- Versalogic Corporation, www.versalogic.com
- Digital-Logic AG, www.digitallogic.com
- JUMPtec Group, www.jumptec.de
- Ampro Computers, Inc., www.ampro.com
- Real Time Devices USA, Inc., www.rtdusa.com
- Diamond Systems Corporation, www.diamondsys.com
- Advantech Co., Ltd, www.advantech.com
- Arcom Control Systems, www.arcomcontrols.com
- Arbor Technology Co, www.arbor.com.tw
- Advanced Micro Peripherals LTD, www.ampltd.com
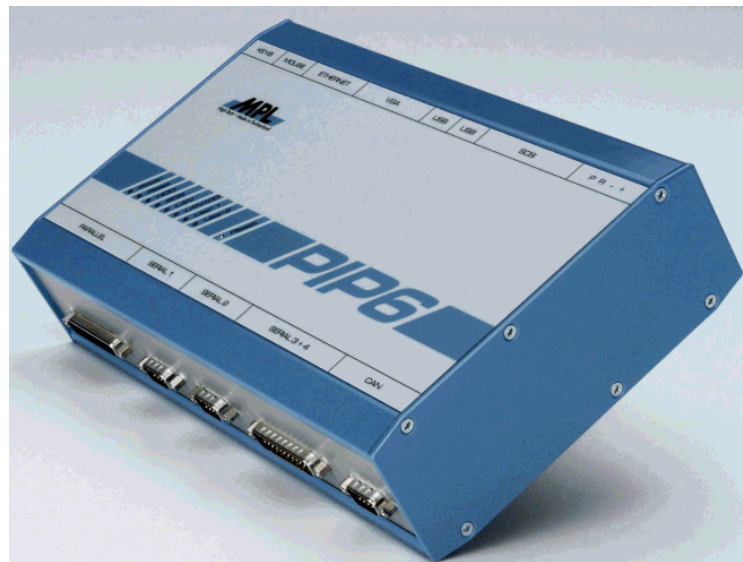
All-In-One Embedded PC

The all-in-one embedded PC computer form factor is very similar to PC/104, but overcomes a major disadvantage. This disadvantage is the lack of a standardized chassis and enclosure.

This section includes the following topics:

- Overview for All-In-One Embedded PC Computers
- Performance
- I/O Expandability
- Advantages
- Disadvantages
- Vendors

Overview for All-In-One Embedded PC Computers

Vendors offering all-in-one embedded PC computers do not try to define a new standard, but offer a specific all-in-one system based on the PC/104 bus.

All-In-One Computer from MPL

This system includes chassis, enclosure, connector breakouts, and an internal power supply. All-in-one embedded systems are designed for the same types of applications (for example, mobile controller applications) as PC/104 and Single Board Computers (SBC).

All-in-one embedded PCs are the right choice in the following situations:

- Space is extremely limited, such as in mobile applications.
- The system is placed in a harsh environment (mainly mobile applications).
- The system should be of a black box type in which the system border is defined at the enclosure level.

The acquisition cost for an all-in-one embedded PC is slightly higher than a PC/104 or SBC system. However, you do not have the additional cost of designing and manufacturing an enclosure because the system includes the enclosure.

Performance

With an all-in-one embedded PC, the size of the system is not defined so that you can use larger and newer CPU classes. However, the CPU class is limited by heat dissipation and power restrictions. Typical all-in-one embedded systems use low power Pentium II or Pentium III CPUs running at 266 – 400 MHz. Since all-in-one embedded PCs usually use PC/104 for I/O expansion, the resulting overall performance is similar to a PC/104 system.

I/O Expandability

All-in-one embedded computers usually use the PC/104 and PC/104+ bus to expand the base system with I/O connectivity. Therefore, the same broad choice of I/O boards for PC/104 stacks is available. However, since all-in-one embedded PCs have a specific enclosure, there is a limit to the number of PC/104 I/O boards that you can use. Vendors may offer a number of enclosure options to accommodate additional I/O boards.

Advantages

The advantages of selecting an all-in-one embedded PC are

- Very small and ideal for mobile applications
- Rugged system that is well suited for deployment in a harsh environment
- Can be treated as a black box type of system (system boundary defined at enclosure level)
- DC power operation
- Extended temperature range operation
- Low power consumption and fanless options readily available
- Moderate acquisition costs

Disadvantages

The disadvantages for selecting an all-in-one embedded PC are

- Overall performance is low compared to desktop and rack-mount PCs.
- Most I/O boards are available only in the PC/104 (ISA) standard. This limitation reduces the I/O throughput and overall system performance.
- Limited I/O expansion

Vendors

Vendors for all-in-one computers include

- MPL AG, www.mpl.ch (for PIP5, PIP6, and PIP7)
- SBS Technologies, Inc., www.sbs.com (for PC7)
- Real Time Devices USA, Inc., www.rtdusa.com (for IDAN and HiDAN)
- Diamond Systems Corporation, www.diamondsys.com (for Pandora)

xPC TargetBox

xPC TargetBox is based on the all-in-one embedded PC computer form factor, but overcomes a major disadvantage. This disadvantage is the lack of easy hardware configurability. xPC TargetBox is a turnkey hardware system that also gives you optional configuration flexibility.

This section includes the following topics:

- Overview xPC TargetBox
- Performance
- I/O Expandability
- Advantages
- Disadvantages
- Vendor

Overview xPC TargetBox

xPC TargetBox is a high-performance, industrial PC that enables you to execute target applications generated by Real-Time Workshop and xPC Target in real time for rapid control prototyping.

xPC TargetBox

This system includes chassis, enclosure, external floppy drive, panel connectors, internal and external I/O cables, screw terminal boards, and an external power adapter. xPC TargetBox systems are designed for the same types of applications as all-in-one embedded systems.

xPC TargetBox systems are the right choice in the following situations:

- Space is extremely limited, such as in mobile applications.
- The system is placed in a harsh environment (mobile or field applications).
- A convenient turnkey system is desired.

The acquisition cost for an xPC TargetBox system is slightly higher than an all-in-one embedded PC. However, you do not have the additional cost of designing and manufacturing an enclosure because the system includes the enclosure. In addition, you can use the xPC TargetBox system with minimal special configuration. It is a true turnkey system.

Performance

xPC TargetBox systems can achieve sample rates approaching 50 KHz. This performance depends on the processor used in the xPC TargetBox. Such sample rates make the xPC TargetBox system well suited for rapid control prototyping. You can buy xPC TargetBox systems with Pentium II or Pentium III CPUs running at 266 MHz – 700 MHz.

For many control design applications and DSP applications in the audio/speech area, xPC TargetBox performance is excellent.

I/O Expandability

xPC TargetBox systems use the PC/104 bus to expand the base system with I/O capability. xPC TargetBox allows for up to three PC/104 expansion boards and provides seven I/O options.

I/O Option	I/O Type	Description
xPC TargetBox IO 301	A/D, D/A, DIO	32 single-ended or 16 differential 16-bit A/D channels 4 12-bit D/A channels 24 DIO lines grouped into three groups with 8 bits
xPC TargetBox IO 302	D/A 12, DIO	16 12-bit D/A channels 24 DIO lines grouped into three groups with 8 bits
xPC TargetBox IO 303	D/A 16, DIO	4 16-bit D/A channels 24 DIO lines grouped into three groups with 8 bits
xPC TargetBox IO 304	DIO	48 DIO lines grouped into six groups with 8 bits
xPC TargetBox IO 305	CTR	10 16-bit general-purpose counters, PWM output
xPC TargetBox IO 306	ENC	3 16-bit incremental encoder channels
xPC TargetBox IO 308	CAN	2 CAN channels (standard and extended identifiers)

Advantages

The advantages of selecting the xPC TargetBox system are

- Turnkey hardware system with a number of possible configurations
- Pentium III units include QuickBoot capability
- Very small and ideal for mobile and field applications
- Rugged system that is well suited for use in a harsh environment
- DC and AC power operation
- Extended temperature range operation (-40 to 75°C)
- Low power consumption
- No fans or other moving parts
- Includes all necessary internal and external I/O cables, shielded I/O panel connectors, and screw terminal boards for I/O.

Disadvantages

The disadvantages of selecting an xPC TargetBox system are

- Overall performance is less than that of desktop and rack-mount PCs.
- xPC TargetBox is not a good fit for high-end DSP and communications or hardware-in-the-loop applications. These applications typically have higher performance and I/O capability requirements, and do not require the space saving capability of xPC TargetBox.
- I/O boards are available only in the PC/104 (ISA) standard. This limitation reduces the I/O throughput and overall system performance.
- Limited to three I/O expansion slots, with four possible in special cases.

Vendor

The vendor for the xPC TargetBox is The MathWorks, www.mathworks.com.

Laptop PC

The MathWorks does not recommend using a laptop PC as the target platform. The reasons include:

- You can only expand the functionality of a laptop PC I/O with PCMCIA cards. A standard laptop PC can accommodate one Type III or two Type II PCMCIA cards, giving you very limited I/O expandability.

- Vendors offer only a small selection of I/O types as PCMCIA cards.

- Because of their small size, PCMCIA cards have fragile I/O connectors.

- Standard laptop PCs are not as rugged as they appear, and they cannot operate in extended temperature ranges. CompactPCI, PC/104, Single Board Computers (SBC), and all-in-one embedded PC computers are a better alternative.

- Standard laptop PCs with an open display are not as convenient as they may appear. CompactPCI, PC/104, Single Board Computers (SBC), and all-in-one embedded PCs have a more versatile height-width-length ratio.

The laptop PC, however, is a very attractive form factor for the host PC in an xPC Target configuration. For mobile or in-vehicle applications, the use of a laptop as the host PC is superior to other form factors.

Index