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eInstrument PC User's Manual

eInstrument PC User's Manual

The eInstrument PC User's Manual was prepared by the technical staff of Innovative Integration on November 10, 2009.

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Rev 1.1	Corrected table showing mezzanine connections to XMC modules.	11/21/08
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Introduction

Real Time Solutions!

Thank you for choosing Innovative Integration, we appreciate your business! Since 1988, Innovative Integration has grown to become one of the world's leading suppliers of DSP and data acquisition solutions. Innovative offers a product portfolio unrivaled in its depth and its range of performance and I/O capabilities .

Whether you are seeking a simple DSP development platform or a complex, multiprocessor, multichannel data acquisition system, Innovative Integration has the solution. To enhance your productivity, our hardware products are supported by comprehensive software libraries and device drivers providing optimal performance and maximum portability.

Innovative Integration's products employ the latest digital signal processor technology thereby providing you the competitive edge so critical in today's global markets. Using our powerful data acquisition and DSP products allows you to incorporate leading-edge technology into your system without the risk normally associated with advanced product development. Your efforts are channeled into the area you know best ... your application.

Vocabulary

What is Malibu?
Malibu is the Innovative Integration-authored component suite, which combines with the Borland BCB or Microsoft MSVC Integrated Development Environments (IDEs) to support programming of Innovative hardware products. Malibu supports both high-speed data streaming plus asynchronous mailbox communications between the DSP and the Host PC, plus a wealth of Host functions to visualize and post-process data received from or to be sent to the target DSP.

What is C++ Builder?
C++ Builder is a general-purpose code-authoring environment suitable for development of Windows applications of any type. Armada extends the Builder IDE through the addition of functional blocks (VCL components) specifically tailored to perform real-time data streaming functions.

What is Microsoft MSVC?
MSVC is a general-purpose code-authoring environment suitable for development of Windows applications of any type. Armada extends the MSVC IDE through the addition of dynamically created MSVC-compatible C++ classes specifically tailored to perform real-time data streaming functions.

What kinds of applications are possible with Innovative Integration hardware?
Data acquisition, data logging, stimulus-response and signal processing jobs are easily solved with Innovative Integration baseboards using the Malibu software. There are a wide selection of peripheral devices available in the Matador DSP product family, for all types of signals from DC to RF frequency applications, video or audio processing. Additionally, multiple Innovative Integration baseboards can be used for a large channel or mixed requirement systems and data acquisition cards from Innovative can be integrated with Innovative's other DSP or data acquisition baseboards for high-performance signal processing.

Why do I need to use Malibu with my Baseboard?
One of the biggest issues in using the personal computer for data collection, control, and communications applications is the relatively poor real-time performance associated with the system. Despite the high computational power of the PC, it cannot reliably respond to real-time events at rates much faster than a few hundred hertz. The PC is really best at processing data, not collecting it. In fact, most modern operating systems like Windows are simply not focused on real-time performance, but rather on ease of use and convenience. Word processing and spreadsheets are simply not high-performance real-time tasks.

The solution to this problem is to provide specialized hardware assistance responsible solely for real- time tasks. Much the same as a dedicated video subsystem is required for adequate display performance, dedicated hardware for real-time data collection and signal processing is needed. This is precisely the focus of our baseboards – a high performance, state-of-the-art, dedicated digital signal processor coupled with real-time data I/O capable of flowing data via a 64-bit PCI bus interface.

The hardware is really only half the story. The other half is the Malibu software tool set which uses state of the art software techniques to bring our baseboards to life in the Windows environment. These software tools allow you to create applications for your baseboard that encompass the whole job - from high speed data acquisition, to the user interface.

Finding detailed information on Malibu
Information on Malibu is available in a variety of forms:

- Data Sheet (http://www.innovative-dsp.com/products/malibu.htm)
- On-line Help
- Innovative Integration Technical Support
- Innovative Integration Web Site (www.innovative-dsp.com)

Online Help

The online help system for Malibu is fully integrated into the excellent OpenHelp system provided with Builder. Help for Malibu is provided in a single file, Malibu.hlp which is installed beneath the main Builder C++ directory tree during the default installation. It provides detailed information about the components contained in Malibu - their Properties, Methods, Events, and usage examples. An equivalent version of this help file in HTML help format is also provided: Malibu.chm, for use within the MSVC context.

Innovative Integration Technical Support

Innovative includes a variety of technical support facilities as part of the Malibu toolset. Telephone hotline supported is available via

Hotline (805) 578-4260 8:00AM-5:00 PM PST.

Alternately, you may e-mail your technical questions at any time to:

techsprt@innovative-dsp.com.

Innovative Integration Web Site

Additional information on Innovative Integration hardware and the Malibu Toolset is available via the Innovative Integration website at www.innovative-dsp.com

Typographic Conventions

This manual uses the typefaces described below to indicate special text.

Typeface	Meaning
`Source Listing`	Text in this style represents text as it appears onscreen or in code. It also represents anything you must type.
Boldface	Text in this style is used to strongly emphasize certain words.
Emphasis	Text in this style is used to emphasize certain words, such as new terms.
Cpp Variable	Text in this style represents C++ variables
Cpp Symbol	Text in this style represents C++ identifiers, such as class, function, or type names.
KEYCAPS	Text in this style indicates a key on your keyboard. For example, "Press **ESC** to exit a menu".
Menu Command	Text in this style represents menu commands. For example "Click View | Tools | Customize"

Using the eInstrument PC

Getting Started

As delivered, the eInstrument PC has its operating system installed and all options such as FLASH drive and GPS are installed. Included with the unit are the following:

eInstrument PC	Enclosure with SBC-ComEx motherboard, 125W power PC power supply, COM Express CPU module, active heat sink for COM Express Module, 4 GB RAM, 4 GB FLASH drive
Laptop Power Supply	Output is 12VDC, 8.5A (110 W). Input is 100-240VAC, 50-60 Hz.
Power Cord	Modular power cord with US, UK or EU type wall plug. IEC-320 C6 plug for laptop supply.
Software and Documentation	DVD (also available for download on web) Microsoft Windows Registration Certificate (Windows only)
Options installed in eInstrument PC	(90197) GPS Receiver includes external GPS antenna (80212-0) One Hard Disk Drive, 2.5 in, 200 GB, 7400 RPM (80212-1) Two Hard Disk Drives, 2.5 in, 200 GB, 7400 RPM
COM Express Modules (1 of these will be installed)	(90200-0) Radisys CE945GM2A-423-0 Single core Celeron CPU, 1.06 GHz (90200-1) Radisys CE945GM2A-T25-0 Dual core Core2Duo CPU, 2 GHz

Table 1. eInstrument PC Kit Contents

There are no keyboard, mouse, monitor or other cables included in the unit. The mouse and keyboard are USB type. Monitor is VGA type.

Setting Up the eInstrument PC

It is a good idea to boot up the eInstrument PC, register the software, then install any software and XMC modules in the system.

1. Attach keyboard, mouse and monitor to the rear of the unit.
2. Attach Ethernet with web access if possible.

3. Attach power supply to the rear of the unit and then plug into the wall power.



4. The unit will begin booting. You will see a Radisys splash screen and then operating system will begin to boot.

5. Windows users should register their software using the Microsoft Windows registration card included with the system.

6. Once the system is booted, you may want to configure network and other system settings to match your requirements.

7. Install software for IO cards and system devices. For Innovative software, follow the instructions in the Windows or Linux tools installation chapters provided in this manual. For these installations, you must have either network access to a DVD drive, a local DVD drive attached to a USB port, or internet access. The software installations will prompt you for shutdown to complete the installation.

8. Reboot the system and hit F2 to enter the BIOS setup screen.

9. Navigate the BIOS menus to the advanced configurations. Turn on the “ENABLE BUSMASTERING” option and the “EHNACED PCI EXPRESS COMPATIBILITY OPTIONS”. Set the boot drive ordering to either USB for the FLASH drive, or SATA drive 0 for the HDD. Disable the optional LVDS display.

10. Save the BIOS to FLASH and then exit the BIOS setup.

You are now ready to install any XMC modules into the eInstrument PC.

For Innovative X5 family of modules:

1. Shut down the eInstrument PC and DISCONNECT POWER COMPLETELY.

2. At a static controlled workstation, remove the top cover of the unit. There are 3 screws on each side of the unit to remove.



3. Remove the PCB retainer bars on each side of the PCB.



4. Install the XMC on the top of the motherboard in site 0 or site 1 by inserting its end bracket through the front panel and pressing the XMC down on the card. Be sure to carefully align the XMC module to the connectors. The card should seat firmly into the connectors.



5. Remove the two end bracket screws. Now the motherboard can pivot up for access to the bottom side.



6. Install the screws into the heat sink through the bottom side of the motherboard. These are metric M2x5 screws.
7. Put the motherboard back down into the chassis, and reattach the PCB retention bars on each side. Do not fully tighten screws yet.
8. Align the rear panel and install the rear panel screws.
9. Tighten all screws on the PCB retention bars.
10. Replace the cover and install the screws on each side.

For Innovative X3 family of modules:

1. Shut down the eInstrument PC and DISCONNECT POWER COMPLETELY.
2. At a static controlled workstation, remove the top cover of the unit. There are 3 screws on each side of the unit to remove.



3. Remove the PCB retainer bars on each side of the PCB.

4. Remove the two end bracket screws. Now the motherboard can pivot up for access to the bottom side.



5. Install the X3 hear conduction bar on the top the the motherboard, approximately across the center of the module. There are 5 screws (M2x5) to insert from the bottom side that screw into the bar.

6. Install the XMC on the top of the motherboard in site 0 or site 1 by inserting its end bracket through the front panel and pressing the XMC down on the card. Be sure to carefully align the XMC module to the connectors. The card should seat firmly into the connectors.



7. Add the heat bar screws through the top of the module. These are metric M2x5 screws.

8. Put the motherboard back down into the chassis, and reattach the PCB retention bars on each side. Do not fully tighten screws yet.

9. Align the rear panel and install the rear panel screws.

10. Tighten all screws on the PCB retention bars.

11. Replace the cover and install the screws on each side.

Installing a disk drive:

1. Shut down the eInstrument PC and DISCONNECT POWER COMPLETELY.

2. At a static controlled workstation, remove the top cover of the unit. There are 3 screws on each side of the unit to remove.



3. Remove the PCB retainer bars on each side of the PCB.
4. Remove the two end bracket screws. The card can now pivot up for access to the drive tray.



5. Remove the disk drive tray from the bottom of the chassis.
6.

7. Install HDD on the disk tray and reinstall the tray into the chassis.



8. Plug in power cable and SATA cable to HDD. SATA cable should go to the motherboard SATA connector.
9. Bundle the SATA and power cables and attach to chassis to prevent cables from getting into the fans.
10. Put the motherboard back down into the chassis, and reattach the PCB retention bars on each side. Do not fully tighten screws yet.
11. Align the rear panel and install the rear panel screws.
12. Tighten all screws on the PCB retention bars.
13. Replace the cover and install the screws on each side.

TroubleShooting

The eInstrument PC will not boot up.

Check cables and power. During shipping, the COM Express module may have come loose. Inspect the module seating but do not remove the module unless some problem is visible. The screws holding it have Loctite applied to the threads and may be difficult to remove.

Some XMC modules have an ID ROM on the IPMI bus. If this is blank or not recognized, the Radisys modules will not allow the system to boot.

The eInstrument starts to boot then the screen goes blank when Windows is booting.

In the BIOS, be sure to disable the optional LVDS screen. Also check the video settings so that VGA is enabled. If the display still fails to receive a signal, perform the following keystroke combination
Control+Alt+F1

If pressing Control+Alt+F1 fails to revive your display, take the following steps . . .

Make sure a VGA display is connected to your eInstrument-PC
Reboot your eInstrument-PC
Tap F8 repeatedly until the Windows "Boot Options" screen is displayed
Using the arrow keys on your keyboard, select "Enable VGA Mode"
Press Enter
Once Windows boots up, download and run video driver installer (winxp_14324.exe)
Follow the Wizard to complete the installation and reboot
Once Windows is fully booted after this install, your display should be functioning properly.
If the display fails to receive a signal, perform the following keystroke combination
Control+Alt+F1

The XMC is not recognized.

The XMC is not working, installed improperly or has a compatibility issue. On Innovative X3 and X5 modules, the link up LED indicates whether the PCI Express lane connected. If this LED is off, there is a serious problem. If it is on, then check the control panel and see if the XMC driver installed properly.

The Linux HDD is not recognized.

Linux has a configuration for each HDD that must be modified. If you change the HDD type, this system file must be modified. Contact technical support for assistance.

Insufficient room of Flash boot drive for development tools.

The flash boot drive is intended for delivery and execution of a final, debugged executable. It is not large enough to support all possible development environments. So, my recommendation is to install all development tools onto other hard disk drives in the system. If the particular tools involved do not support that, then you may be forced to disable the flash drive using the BIOS setup, or reassign the flash drive as a non-boot drive during the development cycle. You could then install any OS on a hard disk and use that in conjunction with the eInstrument throughout the development process. Finally, with all debugging complete, you could reverse the process, install the final executable on the flash and boot/run from flash.

Windows Installation

This chapter describes the software and hardware installation procedure for the Windows platform (WindowsXP and Vista).

> **Do *NOT*** install the hardware card into your system at this time. This will follow the software installation.

Host Hardware Requirements

The software development tools require an IBM or 100% compatible Pentium IV - class or higher machine for proper operation. An Intel-brand processor CPU is *strongly recommended*, since AMD and other "clone" processors are not guaranteed to be compatible with the Intel MMX and SIMD instruction-set extensions which the Armada and Malibu Host libraries utilize extensively to improve processing performance within a number of its components. The host system must have at least 128 Mbytes of memory (256MB recommended), 100 Mbytes available hard disk space, and a DVD-ROM drive. Windows2000 or WindowsXP (referred to herein simply as *Windows*) is required to run the developer's package software, and are the target operating systems for which host software development is supported.

Software Installation

The development package installation program will guide you through the installation process.

> **Note:** Before installing the host development libraries (VCL components or MFC classes), you must have Microsoft MSVC Studio (version 9 or later) and/or Codegear RAD Studio C++ (version 11) installed on your system, depending on which of these IDEs you plan to use for Host development. If you are planning on using these environments, it is imperative that they are tested and known-operational before proceeding with the library installation. If these items are not installed prior to running the Innovative Integration install, the installation program will not permit installation of the associated development libraries. However, drivers and DLLs may be installed to facilitate field deployment.

You must have **Administrator Privileges** to install and run the software/hardware onto your system, refer to the Windows documentation for details on how to get these privileges.

Starting the Installation

To begin the installation, start Windows. Shut down all running programs and disable anti-virus software. Insert the installation **DVD**. If Autostart is enabled on your system, the install program will launch. If the DVD does not Autostart, click on Start | Run... Enter the path to the **Setup.bat** program located at the root of your DVD-ROM drive (i.e. **E:\Setup.bat**) and click "OK" to launch the setup program.

> **SETUP.BAT** detects if the OS is 64-bit or 32-bit and runs the appropriate installation for each environment. It is important that this script be run to launch an install.

When installing on a Vista OS, the dialog below may pop up. In each case, select "Install this driver software anyway" to continue.



Figure 1. Vista Verification Dialog

The Installer Program

After launching Setup, you will be presented with the following screen.



Figure 2. Innovative Install Program

Using this interface, specify which product to install, and where on your system to install it.

1) Select the appropriate product from the Product Menu.

2) Specify the path where the development package files are to be installed. You may type a path or click "**Change**" to browse for, or create, a directory. If left unchanged, the install will use the default location of "C:\Innovative".

3) Typically, most users will perform a "Full Install" by leaving all items in the "**Components to Install**" box checked. If you do not wish to install a particular item, simply uncheck it. The Installer will alert you and automatically uncheck any item that requires a development environment that is not detected on your system.

4) Click the Install button to begin the installation.

> **Note:** The default "Product Filter" setting for the installer interface is "Current Only" as indicated by the combo box located at the top right of the screen. If the install that you require does not appear in the "Product Selection Box" (1), Change the "Product Filter" to "Current plus Legacy".

Each item of the checklist in the screen shown above, has a sub-install associated with it and will open a sub-install screen if checked. For example, the first sub-install for “Quadia - Applets, Examples, Docs, and Pismo libraries” is shown below.

The installation will display a progress window, similar to the one shown below, for each item checked.

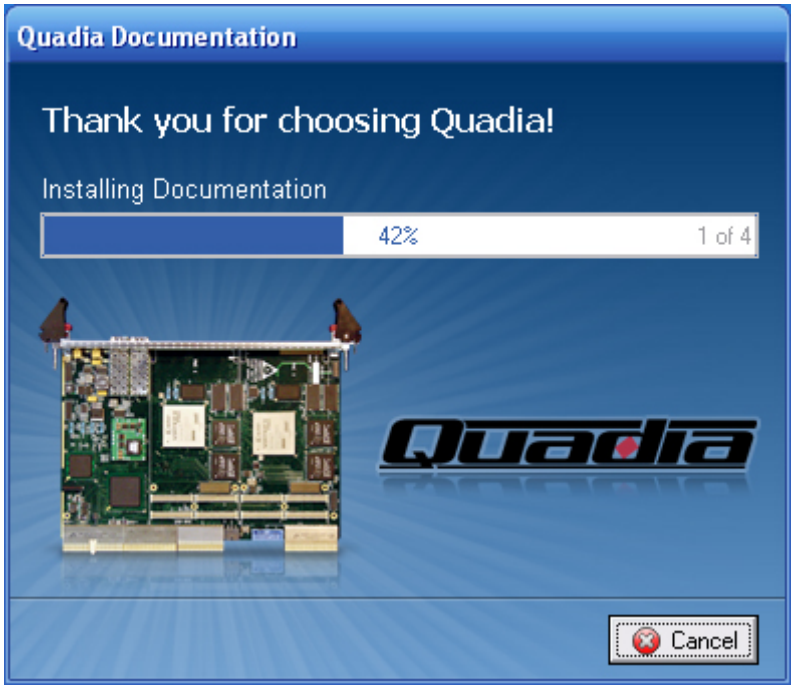
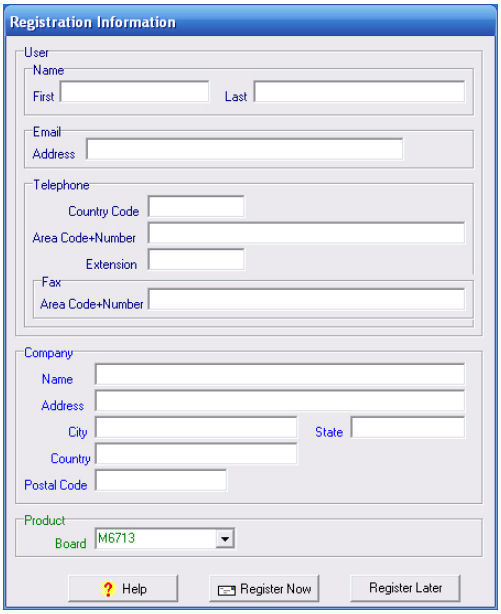


Figure 3. Progress is shown for each section.

Tools Registration



At the end of the installation process you will be prompted to register. If you decide that you would like to register at a later time, click "Register Later".

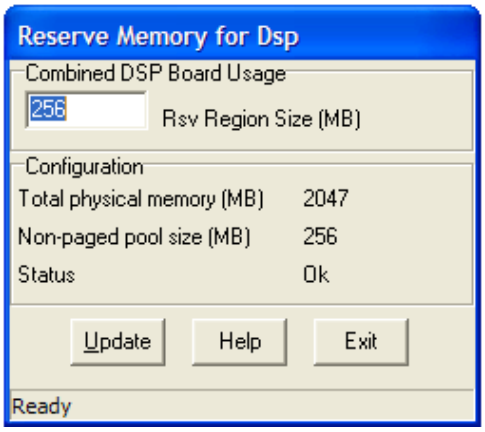
When you are ready to register, click Start | All Programs | Innovative | <Board Name> | Applets. Open the New User folder and launch **NewUser.exe** to start the registration application. The registration form to the left will be displayed.

Before beginning DSP and Host software development, you must register your installation with Innovative Integration. Technical support will not be provided until registration is successfully completed. Additionally, some development applets will not operate until unlocked with a passcode provided during the registration process.

It is recommend that you completely fill out this form and return it to Innovative Integration, via email or fax. Upon receipt, Innovative Integration will provide access codes to enable technical support and unrestricted access to applets.

Figure 4. ToolSet registration form

Bus Master Memory Reservation Applet.



At the conclusion of the installation process, **ReserveMem.exe** will run (except for SBC products). This will allow you to set the memory size needed for the busmastering to occur properly. This applet may be run from the start menu later if you need to change the parameters.

For optimum performance each Matador Family Baseboard requires 2 MB of memory to be reserved for its use. To reserve this memory, the registry must be updated using the ReserveMem applet. Simply select the **Number of Baseboards** you have on your system, click **Update** and the applet will update the registry for you. If at any time you change the number of boards in your system, then you must invoke this applet found in Start | All Programs | Innovative | <target board> | Applets | Reserve Memory.

After updating the system exit the applet by clicking the **exit** button to resume the installation process.

Figure 5. BusMaster configuration

At the end of the install process, the following screen will appear.

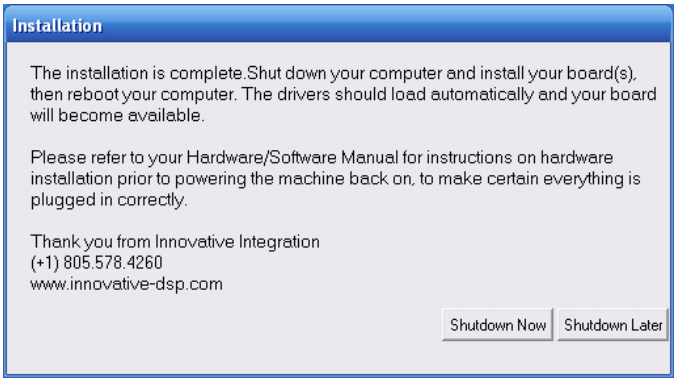


Figure 6. Installation complete

Click the "Shutdown Now" button to shut down your computer. Once the shutdown process is complete unplug the system power cord from the power outlet and proceed to the next section, "Hardware Installation."

Hardware Installation

Now that the software components of the Development Package have been installed the next step is to configure and install your hardware. Detailed instructions on board installation are given in the Hardware Installation chapter, following this chapter.

> **IMPORTANT:** Many of our high speed cards, especially the PMC and XMC Families, require forced air from a fan on the board for cooling. Operating the board without proper airflow may lead to improper functioning, poor results, and even permanent physical damage to the board. These boards also have temperature monitoring features to check the operating temperature. The board may also be designed to intentionally fail on over-temperature to avoid permanent damage. See the specific hardware information for airflow requirements.

After Power-up

After completing the installation, boot your system into Windows.

Innovative Integration boards are plug and play compliant, allowing Windows to detect them and auto-configure at start-up. Under rare circumstances, Windows will fail to auto-install the device-drivers for the JTAG and baseboards. If this happens, please refer to the “TroubleShooting” section.

Installation on Linux

This chapter contains instruction on the installation of the baseboard software for Linux operating systems.

Software installation on Linux is performed by loading a number of **packages**. A Package is a special kind of archive file that contains not only the files that are to be installed, but also installation scripts and dependency information to allow a smooth fit into the system. This information allows the package to be removed, or patched. Innovative uses RPM packages in its installs.

Package File Names
A package file name such as Malibu-LinuxPeriphLib-1.1-3.i586.rpm encodes a lot of information.

Package Name		**Package ID**		**Information Fields**	
Distribution	**Subpackage**	**Version**	**Revision**	**Hardware Type**	**Extension**
Malibu-Linux	PeriphLib	1.1	3	i586	.rpm

Prerequisites for Installation

In order to properly use the baseboard example programs and to develop software using the baseboard, some packages need to be installed before the actual baseboard package.

The Redistribution Package Group - MalibuRed

This set of packages contain the libraries and drivers needed to run a program using Malibu. This group is called "MalibuRed" because it contains the packages needed to allow running Malibu based programs on a target, non-development machine. (Red is short for 'redistributable').

MalibuRed Packages	**Description**
WinDriver-9.2-1.i586.rpm	Installs WinDriver 9.2 release.
MalibuLinux-Red-**[ver]**-**[rel]**.i586.rpm	Installs Baseboard Driver Kernel Plugin.
intel-ipp_rti-5.3p.x32.rpm	Installs Intel IPP library redistributable files.

The installation CD, or the web site contains a file called **LinuxNotes.pdf** giving instructions on how to load these packages and how to install the drivers onto your Linux machine. This file is also loaded onto the target machine by the the Malibu-LinuxRed RPM. These procedures need to be completed for every target machine.

Malibu

To develop software for a baseboard the Malibu packages also must be installed.

Malibu Packages	Description
Malibu-LinuxPeriphLib-**[ver]-[rel]**.i586.rpm	Installs Malibu Source, Libraries and Examples.

Other Software

Our examples use the DialogBlocks designer software and wxWidgets GUI library package for user interface code. If you wish to rebuild the example programs you will have to install this software as well.

Package	Company	URL
wxWidgets	wxWidgets	http://www.wxwidgets.org
DialogBlocks	Anthemion	http://www.anthemion.co.uk.org/dialogblocks

Baseboard Package Installation Procedure

Each baseboard installation for Linux consists of one or more package files containing self-extracting packages of compressed files, as listed in the table below. Note that package version codes may vary from those listed in the table.

Each of these packages automatically extract files into the `/usr/Innovative` folder, herein referred to as the *Innovative root folder* in the text that follows. For example, the X5-400 RPM extracts into `/usr/Innovative/X5-400-[ver]`. A symbolic link named `X5-400` is then created pointing to the version directory to allow a single name to apply to any version that is in use.

Board Packages

Baseboard	Packages	Description
X5-400M	Malibu-LinuxPeriphLib-[**ver]-[rel**].i586.rpm	Board files and examples.
X5-210M	X5-210M-LinuxPeriphLib-**[ver]-[rel**].i586.rpm	Board files and examples.
X3-10M	X3-10M-LinuxPeriphLib-**[ver]-[rel**].i586.rpm	Board files and examples.
X3-25M	X3-25M-LinuxPeriphLib-**[ver]-[rel**].i586.rpm	Board files and examples.
X3-A4D4	X3-A4D4-LinuxPeriphLib-**[ver]-[rel**].i586.rpm	Board files and examples.
X3-SD	X3-SD-LinuxPeriphLib-**[ver]-[rel**].i586.rpm	Board files and examples.
X3-SDF	X3-SDF-LinuxPeriphLib-**[ver]-[rel**].i586.rpm	Board files and examples.
X3-Servo	X3-Servo-LinuxPeriphLib-**[ver]-[rel**].i586.rpm	Board files and examples.
SBC-ComEx	Sbc-ComEx-LinuxPeriphLib-**[ver]-[rel**].i586.rpm	Board files and examples.

Unpacking the Package

As root, type:

```
rpm -i -h X5-400-LinuxPeriphLib-1.1-4.i586.rpm
```

This extracts the X5-400 board files into the Innovative root directory. Use the package for the particular board you are installing.

Creating Symbolic Links

The example programs assume that the user has created symbolic links for the installed board packages. A script file is provided to simplify this operation by the Malibu Red package. In the MalibuRed/KerPlug directory, there is a script called quicklink.

```
quicklink X5-400 1.1
```

These commands will create a symbolic link `X5-400` pointing to `X5-400-1.1`.

This script can be moved to the user's `bin` directory to allow it to be run from any directory.

Completing the Board Install

The normal board install is complete with the installation of the files. The board driver install is already complete with the loading of the Malibu Red package. If there are any board-specific steps they will be listed at the end of this chapter.

Linux Directory Structure

When a board package is installed, its files are placed under the `/usr/Innovative` folder. The base directory is named after the board with a version number attached -- for example, the version 2.0 X5-400 RPM extracts into `/usr/Innovative/X5-400-2.0.`

This allows multiple version of installs to coexist by using a symbolic link to point to a particular version. Changing the symbolic link changes with version will be used.

Under the main directory there are a number of subdirectories.

Applets
The applets subdirectory contains small application programs that aid in the use of the board. For example, there is a Finder program that allows the user to flash an LED on the board to determine which board is associated with a target number. See the Applets chapter for a fuller description of the applets for a board.

Documentation
This directory contains any documentation files for the project. Open the index.html file in the directory with a web browser to see the available files and a description of the contents.

Examples
This directory and its subdirectories contain the projects, source and example programs for the board.

Hardware
This directory contains files associated with programming the board Logic and any logic images provided.

Writing Custom Applications

The SBC-ComEx carrier card is high performance carrier module which accepts an industry-standard COMEX processor module and up to two XMC I/O modules. All of the I/O features of the COMEX processor module and installed XMC modules are made available via standard connectors for SATA, USB, Ethernet, etc. These are standard peripherals, documented extensively elsewhere, and therefore will not be discussed further in this chapter.

However, there are a number of unique I/O devices on the SBC-ComEx carrier which are not controlled automatically via the operating system or BIOS. Among these peripherals are the onboard PLL, digital I/O ports and optional Tyco A1029 GPS. These devices are mapped as custom resources onto the PCI bus of the COMEX module and may be controlled using features of the Innovative::Sbc-ComEx object within the Malibu libraries as detailed in the following paragraphs.

SBC-ComEx Example Software

The SBC-ComEx `TestbedApp` example in the software distribution, demonstrates functionality of the non-standard carrier hardware features. It consists of a host program executable and source code, which works with the default firmware provided in the board's flash ROM. It is based on the Innovative Malibu software libraries to accomplish low-level device control.

Tools Required

In general, writing applications for the SBC-ComEx requires the development of host program. This requires a development environment, a debugger, and a set of support libraries from Innovative.

Table 2. Development Tools for the SBC-ComEx Example

Processor	Development Environment	Innovative Toolset	Project Directory
Host PC	Borland Developers Studio C++	Malibu	Examples\Snap\Bcb11
	Microsoft Visual Studio .NET		Examples\Snap\VC9
	Anthemion Dialogblocks		Examples\Snap\DialogBlocks
	Common Host Code		Examples\Snap\Common

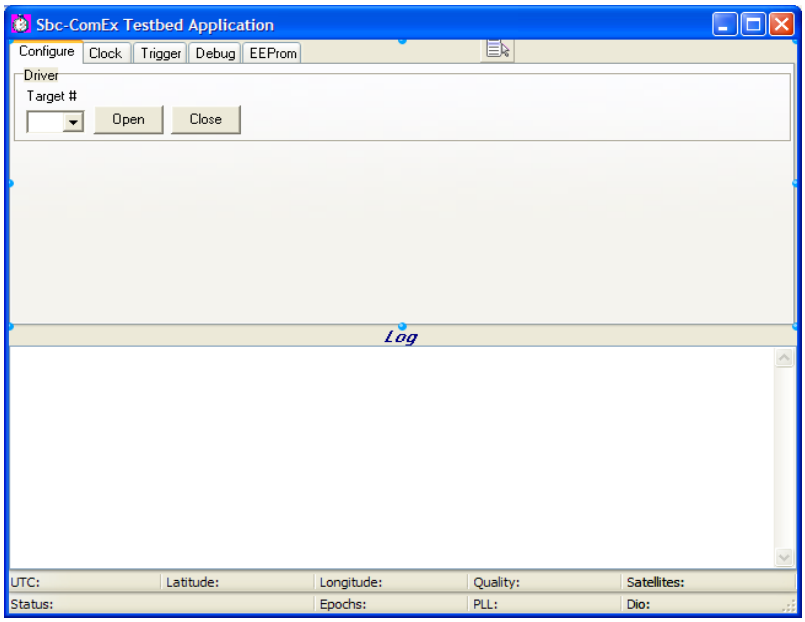
On the host side, the Malibu library is provided in source form, plus pre-compiled Microsoft, Borland or GCC libraries. The application code that implements the entirety of the board-specific functionality of example is factored into the `ApplicationIo.cpp/h` unit. All User Interface aspects of the program are completely independent from the code in `ApplicationIo`, which contains code portable to either compilation environment (i.e., it is common code). While each compiler implements the GUI differently, each version of the example project uses the same file to interact with the hardware and acquire data.

Program Design

The example is designed to illustrate access to the onboard, low-jitter sample clock and digital I/O ports. Additionally, for carriers equipped with the GPS option, a means of accessing fields parsed from serial records send from the Tyco GPS unit to the Host is shown.

The Host Application

The picture to the right shows the main window of SBC-ComEx example. This form is from the designer of the BCB11 version of the example, but the MSVC version is similar. It shows the layout of the controls of the User Interface.



User Interface

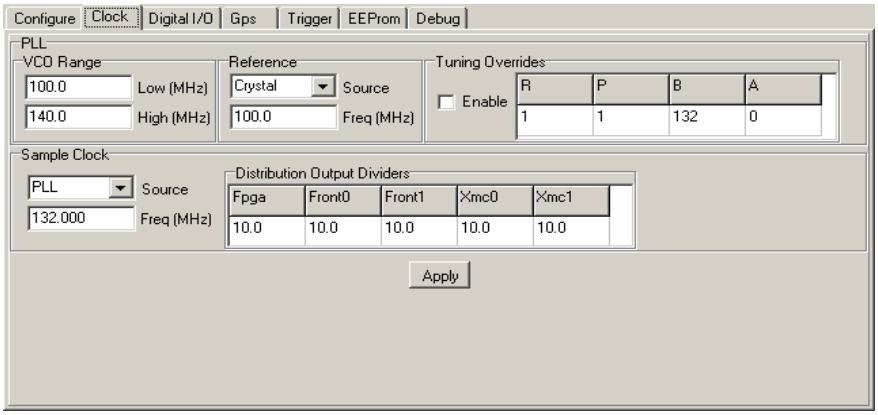
This application has five tabs. Each tab has its own significance and usage, though few are inter-related. All these tabs share a common Log area, which displays messages and feedback throughout the operation of the program.

Configure Tab

As soon as the application is launched, the Configure tab is displayed. In this tab, a combo box is available to allow the selection of the device from those present in the system. All SBC-ComEx devices share a sequence of target number identifiers. The first board found is Target 0, the second Target 1, and so on. This combo box is dynamically filled with available targets detected following a PCI bus scan.

Select an available target, then click the `Open` button to open the driver. To change targets, click the `Close` button to close the driver, select the number of the desired target using the `Target #` combo box, then click `Open` to open communications with the specified target module. The order of the targets is determined by the location of the Sbc-ComEx peripherals on the PCI bus. Since these peripherals are fixed on the SBC-ComEx design, target zero will be used universally under the current software.

Clock Tab



This tab has a set of controls that configure the onboard AD9511 PLL which can act as a sample clock for XMC modules installed in sites 0 or 1. Additionally, a second group of controls allows configuration of the digital I/O port pins available on the baseboard.

The controls within the `Clock` group box support configuration and routing of the clock.

The `Pll | VCO Range` edit controls specify the frequency range of the on-board VCO which is controlled by the PLL. In the default SBC-ComEx configuration, the VCO which is populated on the card operates from 100 to 140 MHz. However, custom ranges for the VCO may be custom-ordered to allow the PLL to generated a sample clock in a range other than the sub-140MHz band. When using such aVCO, the values in these controls should be modified to match the operational band of the VCO in-use.

The `PLL | Reference | Source` combo box specifies the source of the reference clock supplied to the onboard AD9511 PLL. The reference clock is sourced via external SMA connector J30 when this control is set to `External`. When this control is set to `Crystal`, the output from on-board, 100 MHz oscillator Y1 is used as the source for the PLL. When the control is set to `Gps`, the 1 MHz clock synthesized by the on-board FPGA from the 1 pps epoch output is used as the PLL reference source. If set to `None`, the PLL reference input is disabled, to conserve power.

When the PLL reference input is enabled, the `PLL | Reference | Freq (MHz)` edit box should be changed to match the actual frequency supplied to the PLL reference input. The on-board crystal Y1 operates at 100 MHz, whereas the synthesized GPS reference clock operates at 1 MHz. If supplying a clock from external equipment, edit this control with the actual frequency applied, in MHz.

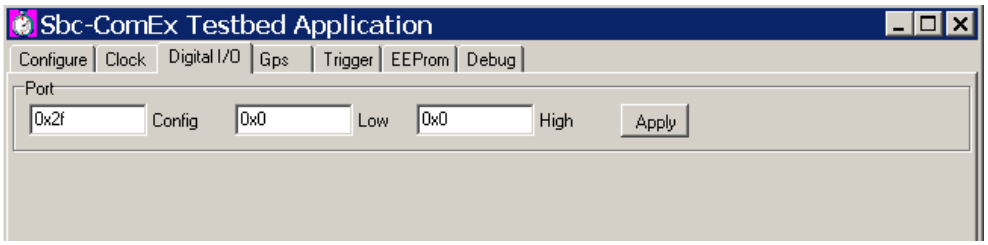
The `Sample Clock | Source` combo box determines the origin of the sample clock. The SBC-ComEx distributes five separate buffered copies of this sample clock: One copy is routed to the on-board Spartan 2 FPGA, two are routed to front panel SMA connectors J28 and J29, and two are routed as differential pairs to XMC connector P16 pins A9(+) and B9 (-) . These buffered sample clock signals may optionally be divided by an integer factor between 1 and 32, controlled by the Distribution Output Dividers grid settings. The divider feature works regardless of the `Sample Clock | Source` setting. However, when the `Sample Clock | Source` is set to PLL, the Malibu libraries will automatically calculate an output divider greater than unity if the `Sample Clock | Frequency` is set to a value below `PLL | VCO Range | Low (MHz)`. If this occurs, you must insure that the product of the automatically-generated output divider and the value entered in the `Distribution Output Dividers` grid is in the range of 1..32. For example, if the `Sample Clock | Source` is `PLL` and the `Sample Clock | Frequency` is set to 50 MHz, Malibu will calculate an output divider of 2, since the VCO output must be divided by 2 to achieve a 50 MHz output rate. So, a value of 4 in `Distribution Output Divider | Front0` will result in a 12.5 instead of 25 MHz output at the Front0 SMA connector.

The PLL tuning parameters R, P, B and A described in the AD9511 data sheet are automatically derived by Malibu when you call the `Sbc_ComEx::Clock().Frequency` method. The algorithm is designed to provide maximum frequency accuracy.

However, if you wish to use custom settings for these tuning parameters, enable the `Tuning Overrides | Enable` check box and enter the desired parameters within the `Tuning Overrides` grid control.

Use the `Clock | Apply` button to apply the control settings to the hardware. The `PLL:` field of the status bar at the bottom of the application will display the PLL lock status. Valid tuning parameters will allow the PLL to lock, whereas invalid or out-of-range parameters will disallow locking.

Digital I/O Tab



The controls in the `Digital I/O | Port` group support configuration of the direction of the digital I/O pins on the carrier.

The value of the `Port | Config` edit control is treated as a bit-mask. Each bit within the mask controls the direction of a bank of eight DIO bits using the convention that a zero value for that bit configures that bank for input., while a one configures for output. Bit zero in the mask corresponds to the direction of DIO bits 0..7, bit one controls DIO bits 8..15, etc. The mask value is applied to the hardware via the `Sbc_ComEx` module object through the `Dio()` sub-object, via

```
Board.Dio().DioPortConfig(Settings.DioConfig);
```

Following configuration, the state of the DIO port can be read or written at any time. When reading, bits configured as inputs will return the current state of each pin in the bank, whereas pins configured as outputs will return the value last written to the bank. When writing, bits configured as outputs will assume the written state immediately following the write operation, whereas bits configured for input will remain unchanged.

To access to the low-order 32-bits of the DIO port, use the methods shown below.

Reading:

```
int state = Board.Dio().DioPortData().Value();
```

Writing

```
Board.Dio().DioPortData().Value(state);
```

To access to the upper-order 16-bits of the DIO port, use the methods shown below.

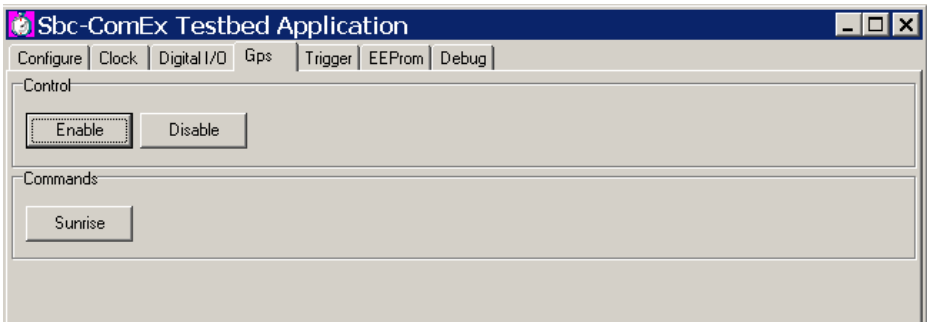
Reading:

```
short state = Board.Dio().DioPortDataHigh().Value();
```

Writing

```
Board.Dio().DioPortDataHigh().Value(state);
```

Gps Tab

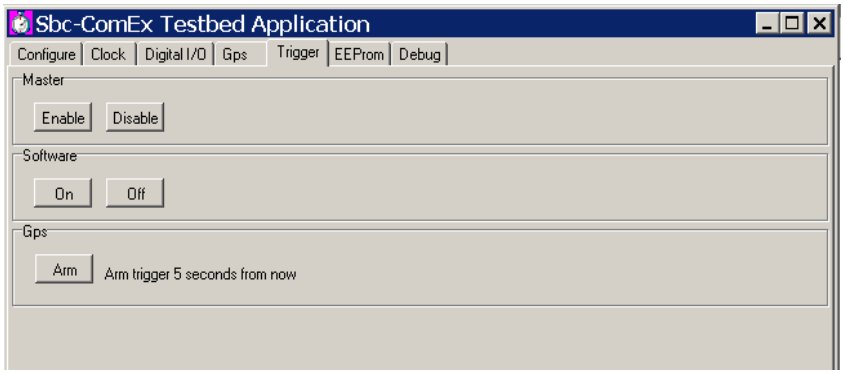


Features on the Gps tab illustrate access to the optional Tyco A1029 GPS circuitry.

Click `Control | Enable` to enable the GPS. When enabled, the GPS will generate NEMA-compliant GPS time and position messages plus an epoch output signal at 1 Hz which is handled as an interrupt by the Sbc_ComEx object. The interrupt handler automatically parses the NEMA messages and updates static structures within the Sbc_ComEx which are accessible via the `Gps()` member function. Refer to the `TycoGps_Mb.cpp/h` source unit for usage details.

Click the Commands | Sunrise button to toggle the transmission of Tyco sunrise messages. This illustrates use of a Tyco GPS command which is not parsed by the Sbc_ComEx object by default.

Trigger Tab



Features on the trigger tab illustrate access to the triggering features of the board.

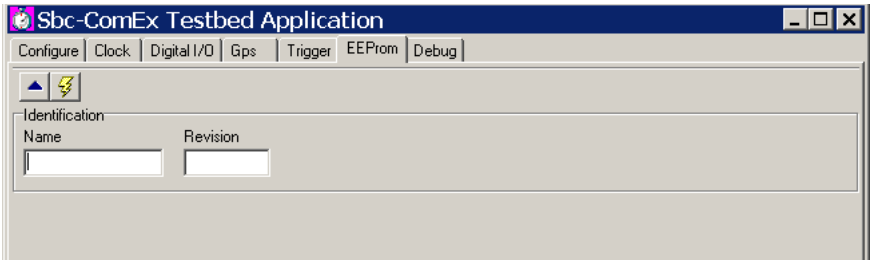
The trigger signal generated by the carrier FPGA is routed to each of the two XMC sites. The source of the trigger may be either a software command or a user-specified date and time accurate to within one microsecond synchronous with the epoch output from the Tyco GPS module.

Triggers must be enabled globally prior to use. Click the `Master | Enable` button to enable trigger generation or `Master | Disable` to disable trigger generation globally.

To use the software trigger, click `Software | On` or `Software | Off` buttons to enable and disable, respectively.

If the Tyco Gps unit is installed and has been enabled via the `Gps | Control | Enable` button, a the trigger signal can be actuated at a specified time and date. Clicking the `Gps | Arm` button programs the trigger to actuate five seconds from the current time via `Sbc_ComEx::Board.GpsTriggerTime()` method. See the online Malibu reference for details.

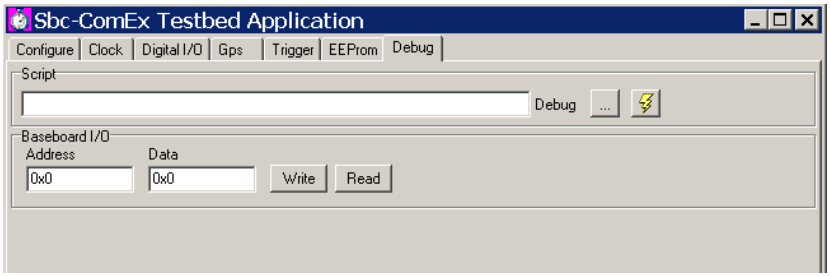
EEProm Tab



The SBC-ComEx features an onboard I2C EEPROM which can be user-programmed to contain custom coefficients, or other data in a non-volatile manner.

Clicking the LoadFromRom toolbar button loads the factory-programmed board name and revision code into the Identification edit boxes. Conversely, the StoreToRom toolbar button writes the current contents of these edit controls to the Flash ROM.

Debug Tab



The controls on the Debug tab are used to provide low-level access to the SBC-ComEx registers during custom FPGA development.

Specify the full path spec to a text file in the `Script | File` edit control. The `Script | Browse` button can be used to select an existing script file via a file selection dialog. Then, click the `Script | Execute` button to parse and execute the script commands. See the `Innovative::Scripter` object in the online help for command syntax.

Alternately, an individual slave access to a memory-mapped register at a known integer offset into the peripheral region assigned to the SBC-ComEx FPGA in PC memory space by the Malibu driver can be effected via the `Baseboard I/O | Write` or `Read` buttons.

Host Side Program Organization

The Host example program is designed to be rebuild-able in each of three different host environments: CodeGear RAD Studio and Microsoft Visual Studio using the .NET UI under Windows and DialogBlocks using GCC under Linux. Because Malibu provides a common library within each of these environments, the code that interacts with Malibu is separated out into a class, *ApplicationIo* in the files ApplicationIo.cpp and .h. This class acts identically in all the platforms.

The Main form of the application instantiates an *ApplicationIo* object to perform the work of the example. The UI can call the methods of the *ApplicationIo* to perform the work when, for example, a button is pressed or a control is changed.

Sometimes, however, the *ApplicationIo* object needs to 'call back into' the UI. But since portability is essential, it can't use a pointer to the main window or form, as this would make *ApplicationIo* dependent on the details of Borland, MSVC or DialogBlocks.

The solution used to decouple the *ApplicationIo* from the form is to use an interface class to hide the communications implementation. An interface class is an abstract class that defines a set of methods that can be called by a client (here, *ApplicationIo*). Within the GUI unit, a concrete version of the interface is constructed by inheriting from the interface. Within the concrete implementation, user interface actions are forwarded UI form class to perform the action. *ApplicationIo* remains completely decoupled from the GUI implementation since it manipulates only a pointer to the abstract class, which is initialized to point to the concrete implementation.

The predefined *IUserInterface* interface class is defined in ApplicationIo.h. The constructor of *ApplicationIo* requires a pointer to the interface, which is saved and used to perform the actual updates to the UI inside of *ApplicationIo's* methods.

ApplicationIo

Initialization

The main form creates an ApplicationIo object in its constructor. The object creates a number of Malibu objects at once as can be seen from this detail from the header ApplicationIo.h.

```
// Fields
bool                          FOpened;

// Data
Innovative::Sbc_ComEx         Board;
IUserInterface *              UI;
Innovative::SoftwareTimer     Timer;
unsigned int                  Lost;
unsigned int                  EpochTally;
Innovative::Scripter          Script;
  ...
```

In Malibu, objects are defined to represent units of hardware as well as software units. The `Sbc-ComEx` object represents the COM carrier board. A `Scripter` object can be used to add a simple scripting language to the application, for the purposes of performing hardware initialization during FPGA firmware development. The `SoftwareTimer` object is used to perform operations periodically, within a background thread.

When the GUI is started, an `ApplicationIo` object is instantiated via code substantially similar to the following Borland code snippet:

```
__fastcall TMainForm::TMainForm(TComponent* Owner)
        : TForm(Owner), UI(new UserInterface(this)), Io(new ApplicationIo(UI))
{
        SetSettings();

//      OutputClockComboBoxChange(this);
}
```

This constructor creates a concrete instance of the `UserInterface` class, which is passed to a newly-created instance of `ApplicationIo` by pointer, so that the `ApplicationIo` can notify the UI at strategic times during execution of board-specific functions.

The `ApplicationIo` object latches the address of the UI concrete class within a private variable called `UI`, for use in any of its methods or event handlers, as shown below.

```
ApplicationIo::ApplicationIo(IUserInterface * ui)
```

```
        : FOpened(false), UI(ui), EpochTally(0)
{
    Board.OnEpoch.SetEvent(this, &ApplicationIo::HandleOnEpoch);
    OnLog.SetEvent(this, &ApplicationIo::HandleOnLog);
    OnStatus.SetEvent(this, &ApplicationIo::HandleOnStatus);
    Timer.OnElapsed.SetEvent(this, &ApplicationIo::HandleTimer);

    Status(sStatus, "Status: Idle");

    Status(sStatus, "Status: Running");
    Timer.Enabled(true);
}
```

Within the constructor, Malibu software events are linked to callback functions, which are simply methods of the `ApplicationIo` object, via the `SetEvent` method intrinsic to all `OpenWire::Event` objects.

```
    // Hook script event handlers.
    Board.OnEpoch.SetEvent(this, &ApplicationIo::HandleOnEpoch);
    OnLog.SetEvent(this, &ApplicationIo::HandleOnLog);
    OnStatus.SetEvent(this, &ApplicationIo::HandleOnStatus);
    Timer.OnElapsed.SetEvent(this, &ApplicationIo::HandleTimer);
```

This code attaches event handlers to their corresponding events. Malibu *events* allow functions to be 'plugged into' library classes to be called at certain times or in response to certain events detected. Events allow a tight integration between an application and the library. For example, the `Board.OnEpoch` event fires when a GPS epoch event occurs, once per second. The `ApplicationIo::HandleOnEpoch` method contains code which is executed once per second, when the epoch event fires.

Similarly, `HandleTimer`, handles events issued when the software timer elapses. These handlers could be designed to perform multiple tasks as events occur including displaying messages for user.

```
    Timer.OnElapsed.SetEvent(this, &ApplicationIo::HandleTimer);
    Timer.OnElapsed.Thunk();
```

In this example, a Malibu SoftwareTimer object has been added to the ApplicationIo class to provide periodic status updates to the user interface. The handler above serves this purpose.

Every event may be are configured to execute in the callers thread context (unsynchronized), or within the main GUI thread context (thunked or synchronized). The latter should be used whenever the handler is designed to perform any sort of user-interface operation, since UI actions are not reentrant and must be executed within the GUI main thread context.

An event may not necessarily be called in the same thread as the main UI thread. If it is not, and if you want to call a UI function in the handler you have to have the event synchronized with the UI thread. A call to `Synchronize()` directs the event to call the event handler in the main UI thread context. This results in a slight performance penalty, but allows us to call UI methods in the event handler freely. The Timer uses a similar synchronization method, `Thunk()`. Here the event is called in the main thread context, but the issuing thread does not wait for the event to be handled before proceeding. This method is useful for notification events.

Creating a hardware object does not attach it to the hardware. The object has to be explicitly opened. The `Open()` method activates the board for use. It opens the device driver and allocates internal resources for use.

```
//---------------------------------------------------------------------------
//  ApplicationIo::Open() --  Open board driver
//---------------------------------------------------------------------------

void ApplicationIo::Open()
```

```
{
    if (FOpened)
        return;

        UI->GetSettings();

        //
        //  Open Devices
    Board.Target(Settings.Target);
        Board.Target(0);    // always use target 0
        Board.Open();
        FOpened = true;
    Log("Carrier driver opened...");

    DisplayLogicVersion();

    EpochTally = 0;
}
```

After the driver is opened, we capture and display some information to the screen. This includes the logic version, PCB type and family code. .

```
void  ApplicationIo::DisplayLogicVersion()
{
    {
    std::stringstream msg;
    msg << std::hex << "Logic Revision: " << Board.PciLogicVersion().PciLogicRevision()
        << ", Family: " << Board.PciLogicVersion().PciLogicFamily()
        << ", Pcb: " << Board.PciLogicVersion().PciLogicPcb()
        << ", Type: " << Board.PciLogicVersion().PciLogicType();
    Log(msg.str());
    }
}
```

Similarly, the `Close()` method closes the hardware. Inside this method, first we disable the GPS interrupt handler to avoid spurious ISR handling during the close operation. Then, the module is detached from the hardware and its resources are released.

```
void ApplicationIo::Close()
{
    if (!FOpened)
        return;

    Board.GpsEnabled(false);
    Board.Close();
    FOpened = false;

    Log("Carrier driver closed...");
}
```

Using the Programmable Timebase

The carrier includes a low-jitter, programmable PLL which may be used as a timebase (sample clock) for either or both of the installed XMC modules. The `SetClock` method applies the timebase-related settings cached within the Settings object to the PLL hardware, as shown below:

```
//---------------------------------------------------------------------------
//  ApplicationIo::StartClock() --   Enable the clock output using current settings
```

```
//---------------------------------------------------------------------------

void ApplicationIo::SetClock()
{
```

The call to the UI `GetSettings` method is used to refresh the Settings cache from the controls on the UI form.

```
        UI->GetSettings();
```

The SBC-ComEx clock circuitry may either generate a sample clock via the onboard PLL, or it can simply steer a clock connected to the EXT CLOCK connector to the XMC sites, controlled via the `Board.ClockSource` method. If the PLL is generating the clock, its frequency is specified via the `Board.Clock.Frequency` method and the source for the PLL reference clock is programmed via the `Board.ReferenceSource` method.

```
Sbc_ComEx::IIClockOutput output[] = { Sbc_ComEx::coFpga, Sbc_ComEx::coFront0, Sbc_ComEx::coFront1,
Sbc_ComEx::coXmc0, Sbc_ComEx::coXmc1 };

    for (unsigned int i = 0; i < Settings.PllDivider.size(); ++i)
        {
        if (Settings.PllDivider[i])
            Board.ClockDivider(output[i], Settings.PllDivider[i]);
        else
            Board.ClockDivider(output[i], 1);
        }

        // Disable outputs during frequency changes
        Board.ReferenceSource(static_cast<Sbc_ComEx::IIRefSource>(Settings.PllReferenceSource));
        Board.ClockSource(static_cast<Sbc_ComEx::IIClockSource>(Settings.OutputClock));

    switch (Settings.PllReferenceSource)
        {
        case 0:
               Board.Clock().Reference(Settings.PllReferenceFrequency*1.e6);
            break;
        case 1:
               Board.Clock().Reference(100.0*1.e6);
            break;
        case 2:
               Board.Clock().Reference(1.0*1.e6);
            break;
        default:
        case 3:
               Board.Clock().Reference(100.0*1.e6);
            break;
        }

    // Accomodate VCO range
        Board.Clock().VcoRange(Settings.PllVcoLowFrequency*1.e6,
Settings.PllVcoHighFrequency*1.e6);

    // Set output sample rate.  Note, if PLL dividers active
    // actual rates on outputs will be integer sub-multiples of this rate
        Board.Clock().Frequency(Settings.OutputFrequency*1.e6);
```

The onboard PLL allows generation of a high-performance sample clock over a wide range of frequencies. However, due to limitation of the onboard VCO, the actual output frequency may not precisely match the requested frequency. The `Board.Clock().FrequencyActual()` method can be used to retrieve the actual clock frequency, as shown above.

```
        {
        std::stringstream msg;
        msg << "PLL actual frequency: " << std::scientific << std::setprecision(9) <<
            Board.Clock().FrequencyActual();
```

```
        Log(msg.str());
        }
```

Using Programmable Bit I/O

The carrier features thirty-two bits of programmable bit I/O. The direction of bit I/O may be programmed in groups of eight bits, via the `Board.Dio().DioPortConfig` method. The parameter of this method is a bit mask, in which each mask bit corresponds to eight I/O bits - Bit zero controls port bits 0..7, bit 1 controls port bits 8..15, etc. Bit groups configured for output will change state when written and will return their current programmed state when read. Bit groups configured for input will not change when written and will return the current input state when read.

Bits 0..31 of the available I/O bits written or read via the `Board.Dio().DioPortData()` property methods. Bits 32..47 of the available I/O bits written or read via the `Board.Dio().DioPortDataHigh()` property methods, as shown below.

```
//-----------------------------------------------------------------------------
//  ApplicationIo::SetDio() --
//-----------------------------------------------------------------------------

void ApplicationIo::SetDio()
{
        UI->GetSettings();

    Board.Dio().DioPortConfig(Settings.DioConfig);
    Board.Dio().DioPortData().Value(Settings.DioDataLow);
    Board.Dio().DioPortDataHigh().Value(Settings.DioDataHigh);
}
```

Polling Thread

The ApplicationIo object for the Sbc-ComEx employs a background thread to implement polling operations which is used to update the user interface periodically with the PLL lock status and the current readback state of the digital I/O bits. The polling operation is implemented through use of an `Innovative::SoftwareTimer` object whose sole event handler, `OnElapsed`, is configured to call the `ApplicationIo::HandleTimer` method, illustrated below.

```
//-----------------------------------------------------------------------------
//  ApplicationIo::HandleTimer() --  Periodic status check
//-----------------------------------------------------------------------------

void ApplicationIo::HandleTimer(OpenWire::NotifyEvent & event)
{
    if (!FOpened)
        return;

        stringstream msg;
        msg << "PLL: " << (Board.Clock().Locked() ? "Locked" : "Unlocked");
        Status(sPll, msg.str());

        msg.str("");
        msg << "Dio: " << hex << Board.Dio().DioPortDataHigh().Field(0, 16)
         << " " << Board.Dio().DioPortData().Value();
        Status(sDio, msg.str());
}
```

Calls to the `ApplicationIo::Status` method forward the specified text string through the `IUserInterface` object pointer, `UI`, into the main form, as shown below.

```
//---------------------------------------------------------------------------
//  ApplicationIo::Status() --  Log message thunked to main thread
//---------------------------------------------------------------------------

void  ApplicationIo::Status(IIStatusType type, const std::string & msg)
{
    StatusMessageEvent e(type, msg);
    OnStatus.Execute(e);
}

//---------------------------------------------------------------------------
//  ApplicationIo::HandleOnStatus() --
//---------------------------------------------------------------------------

void ApplicationIo::HandleOnStatus(StatusMessageEvent & Event)
{
    UI->Status(Event.Type, Event.Message);
}
```

Inspection of the prototype for `Innovative::SoftwareTimer` within SoftwareTimer_Mb.h shows that the `OnElapsed` event is of type `OpenWire::ThunkedEventHandler`, which means that the call `ApplicationIo::HandleOnStatus` will automatically be thunked into the foreground thread context at runtime, making it safe to perform UI updates within the called UI method.

GPS Support

The Sbc-ComEx carrier supports an optional Tyco GPS plug-in module for precision timebase synchronization and position tracking. If installed, the module may be enabled via the `GpsEnabled` method, after which the `IsGpsAntenna` and `IsGpsLocked` methods may be used to check whether a GPS antenna is properly installed and satellite locking has occurred, respectively.

Features of the Tyco A1029 GPS module may be accessed via the `Gps()` sub-object of the `Innovative::Sbc_ComEx`. Code within the `Innovative::Sbc_ComEx` object performs processing of GPS messages using a internal interrupt service routine (ISR) which executes at epoch (one-second) intervals.

By default, the GPS module is programmed to emit the standard GPS sentences listed below. These messages are automatically parsed within the built-in ISR and the results of the parsing operation is stored in the structures listed below:

Structure	GPS Sentence	Description
`Time()`	Zda	UTC Time / Date and Local Time Zone Offset
`Course()`	Vtg	Course Over Ground and Ground Speed
`FixData()`	Gga	Global Positioning System Fix Data

`RmsData()`	Rms	Recommended Minimum Specific GPS Data
`Satellites()`	Gsa	GPS DOP and Active Satellites
`View()`	Gsv	GPS Satellites in View

See the *Tyco GPS Firmware A1029 / A1035-C User's Manual* for details on these standard GPS sentences.

The A1029 supports a large number of additional messages which may be enabled by sending commands to the the device via the TycoGps::Command method. If additional sentences are enabled in this fashion, they will ignored during ISR processing but can be analyzed within your application code by installing an Sbc_ComEx::OnEpoch event handler, as illustrated below.

```
//-----------------------------------------------------------------------------
//  ApplicationIo::HandleOnEpoch() --  Periodic status check
//-----------------------------------------------------------------------------

void ApplicationIo::HandleOnEpoch(Innovative::EpochEvent & Event)
{
    StringList & list(Event.List);
    for (StringList::iterator i = list.begin(); i != list.end(); ++i)
        Log(*i);

      std::stringstream msg;
      msg << "Epochs: " << ++EpochTally;

    Status(sEpoch, msg.str());

    {
    std::stringstream msg;
    msg << "UTC: " << Board.Gps().Time().Utc;
    Status(sUtc, msg.str());
    }
    {
    std::stringstream msg;
    msg << "Latitude: " << Board.Gps().FixData().Latitude.Value
        << " " << Board.Gps().FixData().Latitude.Units;
    Status(sLatitude, msg.str());
    }
    {
    std::stringstream msg;
    msg << "Longitude: " << Board.Gps().FixData().Longitude.Value
        << " " << Board.Gps().FixData().Longitude.Units;
    Status(sLongitude, msg.str());
    }
    {
    std::stringstream msg;
    msg << "Quality: " << Board.Gps().FixData().FixQuality;
    Status(sQuality, msg.str());
    }
    {
```

```
        std::stringstream msg;
        msg << "Satellites: " << Board.Gps().FixData().SatellitesInUse;
        Status(sSatellites, msg.str());
        }
    }
```

This event handler inspects the state of the parsed `Gps` sentence structures and provides a mechanism for accessing unparsed messages. The parameter to this event handler is an object of type `Innovative::EpochEvent`, which is merely a wrapper on a `Innovative::StringList` containing all unparsed sentences emitted by the A1029 , stored as a collection of `std::string`s.

```
//============================================================================
// CLASS EpochEvent  --
//============================================================================

class EpochEvent : public OpenWire::Event
{
public:
    StringList List;

    EpochEvent(StringList & list)
        :  List(list)
        {
        }
}
```

The `Sbc_ComEx::GpsTriggerTime` method is used to specify a future date and time when the trigger hardware on the Sbc-ComEx is to be armed. Within the ISR, the current time reported by the GPS is compared to the time specified by this method. When they match , the trigger is armed. The hardware will automatically activate the trigger at the inception of the next epoch event, accurate to within 1 uS, allowing multiple Sbc-ComEx modules located throughout the world to initiate I/O simultaneously within 1 uS of one-another.

Developing Host Applications

Developing an application will more than likely involve using an integrated development environment (IDE) , also known as an integrated design environment or an integrated debugging environment. This is a type of computer software that assists computer programmers in developing software.

The following sections will aid in the initial set-up of these applications in describing what needs to be set in Project Options or Project Properties.

Borland Turbo C++

BCB10 (Borland Turbo C++) Project Settings

When creating a new application with File, New, VCL Forms Application - C++ Builder

Change the Project Options for the Compiler:

Project Options
++ Compiler (bcc32)
C++ Compatibility
Check 'zero-length empty base class (-Ve)'
Check 'zero-length empty class member functions (-Vx)'

In our example Host Applications, if not checked an access violation will occur when attempting to enter any event function.

i.e.
Access Violation OnLoadMsg.Execute – Load Message Event
Because of statement
Board->OnLoadMsg.SetEvent(this, &ApplicationIo::DoLoadMsg);

Change the Project Options for the Linker:

Project Options
Linker (ilink32)
Linking – **uncheck 'Use Dynamic RTL'**

In our example Host Applications, if not unchecked, this will cause the execution to fail before the Form is constructed.

Error: First chance exception at $xxxxxxxx. Exception class EAccessViolation with message "Access Violation!"
Process ???.exe (nnnn)

Other considerations:

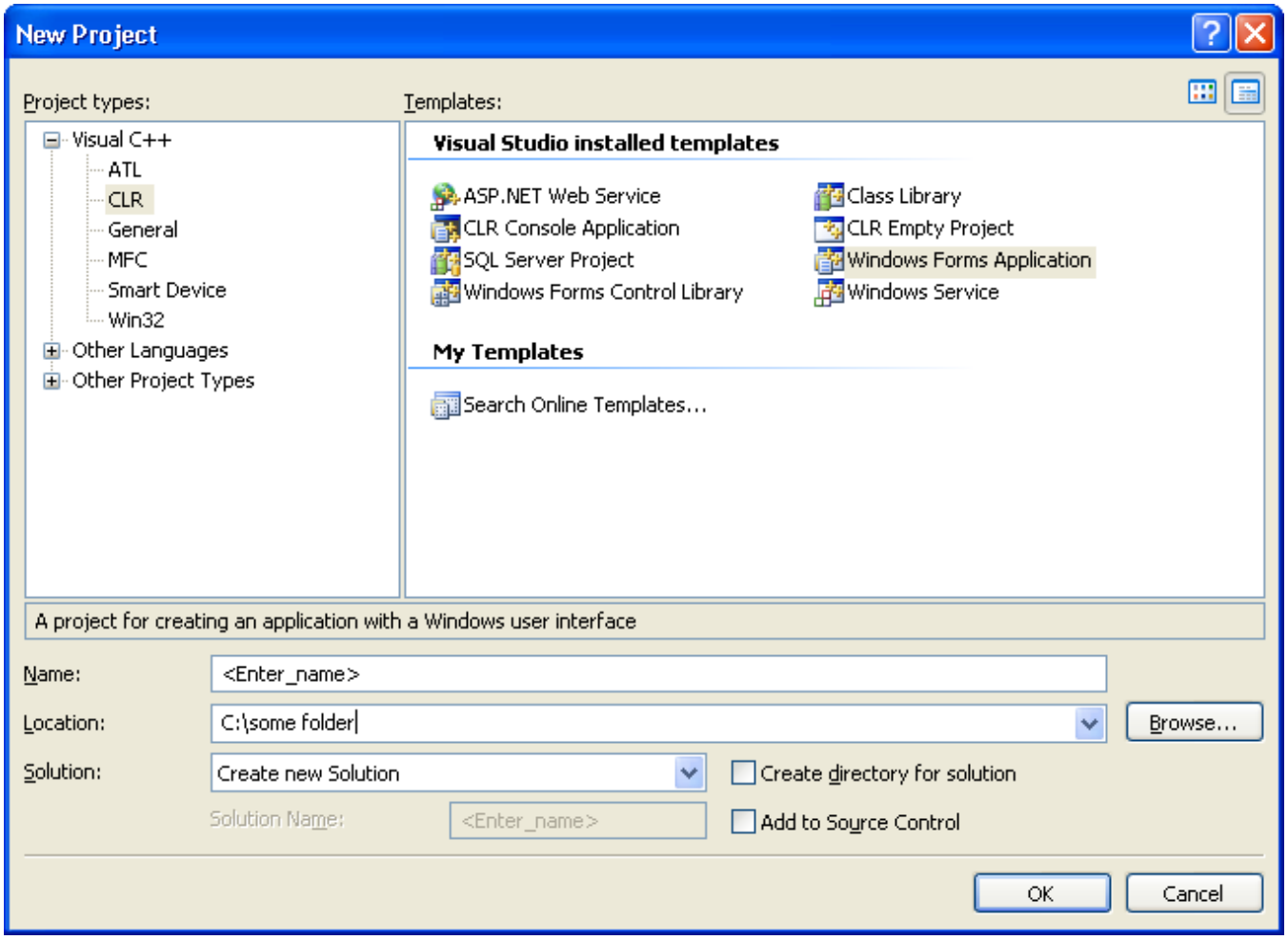
Project Options
++ Compiler (bcc32)
Output Settings
check – Specify output directory for object files(-n)
(release build) Release
(debug build) Debug
Paths and Defines
add Malibu
Pre-compiled headers
uncheck everything
Linker (ilink32)
Output Settings
check – Final output directory
(release build) Release
(debug build) Debug
Paths and Defines
(ensure that Build Configuration is set to All Configurations)
add Lib/Bcb10
(change Build Configuration to Release Build)
add lib\bcb10\release
(change Build Configuration to Debug Build)
add lib\bcb10\debug
(change Build Configuration back to All Configurations)

Packages
uncheck - Build with runtime packages

Microsoft Visual Studio 2005

Microsoft Visual C++ 2005 (version 8) Project Properties

When creating a new application with File, New, Project with Widows Forms Application:



Project Properties (Alt+F7)
Configuration Properties

Project Defaults	
Configuration Type	Application (.exe)
Use of MFC	Use Standard Windows Libraries
Use of ATL	Not Using ATL
Minimize CRT Use in ATL	No
Character Set	Use Unicode Character Set
Common Language Runtime support	Common Language Runtime Support (/clr)
Whole Program Optimization	No Whole Program Optimization

C++
General
Additional Include Directories

Malibu
PlotLab/Include – for graph/scope display

Code Generation
Run Time Library

Multi-threaded Debug DLL (/Mdd)

Precompiled Headers
Create/Use Precompile Headers

Not Using Precompiled Headers

Linker
Additional Library Directories

Innovative\Lib\Vc8

If anything appears to be missing, view any of the example sample code Vc8 projects.

Summary

Developing Host and target applications utilizing Innovative DSP products is straightforward when armed with the appropriate development tools and information.

Applets

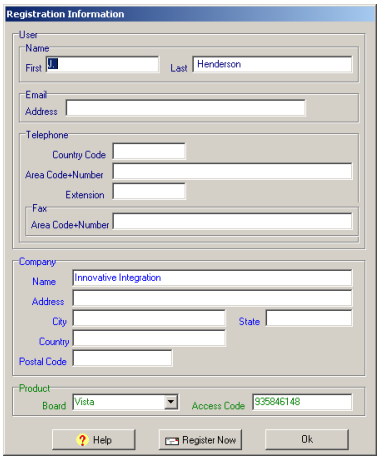
The software release for a baseboard contains programs in addition to the example projects. These are collectively called "applets". They provide a variety of services ranging from post analysis of acquired data to loading programs and logic to a full replacement host user interface. The applets provided with this release are described in this chapter.

Shortcuts to these utilities are installed in Windows by the installation. To invoke any of these utilities, go to the Start Menu | Programs | <<Baseboard Name>> and double-click the shortcut for the program you are interested in running.

Common Applets

Registration Utility (NewUser.exe)

Some of the Host applets provided in the Developers Package are keyed to allow Innovative to obtain end-user contact information. These utilities allow unrestricted use during a 20 day trial period, after which you are required to register your package with Innovative. After, the trial period operation will be disallowed until the unlock code provided as part of the registration is entered into the applet. After using the NewUser.exe applet to provide Innovative Integration with your registration information, you will receive:



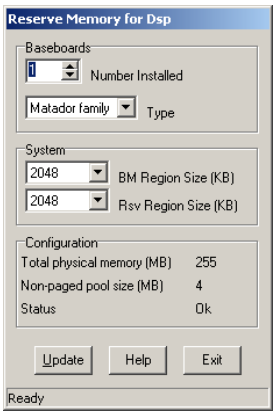
The unlock code necessary for unrestricted use of the Host applets

A WSC (tech-support service code) enabling free software maintenance downloads of development kit software and telephone technical hot line support for a one year period.

Reserve Memory Applet (ReserveMemDsp.exe)

Each Innovative PCI-based DSP baseboard requires 2 to 8 MB of memory to be reserved for its use, depending on the rates of bus-master transfer traffic which each baseboard will generate. Applications operating at transfer rates in excess of 20 MB/sec should reserve additional, contiguous busmaster memory to ensure gap-free data acquisition.

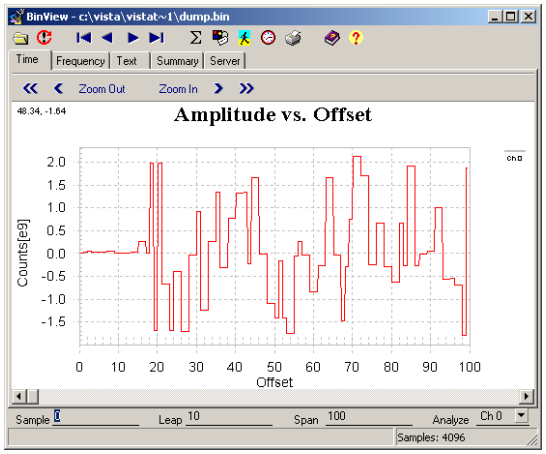
To reserve this memory, the registry must be updated using the ReserveMemDsp applet. If at any time you change the number of or rearrange the baseboards in your system, then you must invoke this applet to reserve the proper space for the busmaster region. See the Help file ReserveMemDsp.hlp, for operational details.



Data Analysis Applets

Binary File Viewer Utility (BinView.exe)

BinView is a data display tool specifically designed to allow simplified viewing of binary data stored in data files or a resident in shared DSP memory. Please see the on-line BinView help file in your Binview installation directory.



eInstrument PC Hardware

Introduction

The eInstrument PC integrates an embedded PC with high performance PCI Express XMC module IO and supporting peripherals. The hardware is a PC-compatible computer that runs either Windows or Linux.

The major subsystems of the eInstrument PC are

- COM Express CPU Module
- Dual PCI Express XMC module sites
- Sample clock and triggering controls
- GPS
- SATA ports and dual internal Hard Disk Drives
- USB 2.0 ports
- 10/100/1000 Ethernet Port
- Cabled PCI Express expansion port
- VGA
- IO Expansion FPGA and Mezzanine Card
- Temperature sensor
- EEPROM
- Power Controls

The eInstrument PC is packaged in a compact enclosure, measuring about 250 x 195 x 77 mm. The unit is powered by a single 8-23V DC power supply and consumes from 20 to 100W depending on the configuration.



Figure 7. eInstrument PC

Custom application logic development for the eInstrument PC is supported by the FrameWork Logic system from Innovative using VHDL and/or MATLAB Simulink. Signal processing, data analysis, and application-specific algorithms may be developed for use in the eInstrument PC logic and integrated with the hardware using the FrameWork Logic.

Software support for the eInstrument PC includes Windows and Linux drivers for on-card peripherals, system integration and test, data logging and support applets. The Malibu Toolkit provides C++ development tools and examples for peripheral configuration and use, module interfacing examples and data logging.

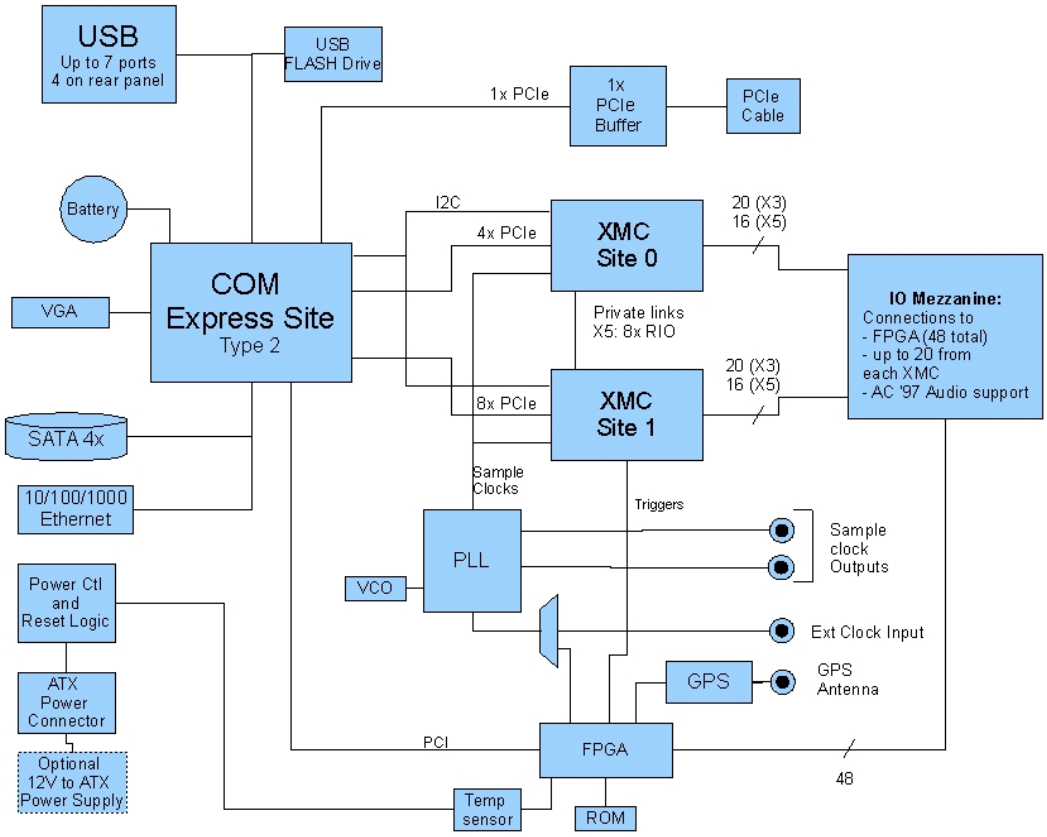


Figure 8. eInstrument PC Block Diagram

COM Express CPU Site

The eInstrument PC has a COM Express CPU site, type 2, conforming to PCIMG COM.0 specification. The table here shows the maximum and minimum number of ports supported by type 2 modules.

Feature	Min/ Max	Description	How it is used in the eInstrument PC
System IO			

Feature	Min/ Max	Description	How it is used in the eInstrument PC
PCI Express Graphics (PEG)	0/1	PCI Express Graphics port	Connected to XMC site 1 as x8 lanes.
PCI Express Lanes 0-5	2/6	PCI Express lanes	Lanes 0-3 connected to XMC site 0. Lane 4 connected to Cabled PCI Express Expansion port.
SDVO Channels	0/2	Serial digital video support	Not used.
LVDS Channels	0/2	Flat panel support	Not used.
VGA Port	0/1	VGA video port	VGA port is accessible on the rear panel.
TV-Out	0/1	Television output	Not used.
PATA Port	1/1	Parallel ATA disk drive interface	Not used.
SATA/SAS Ports	2/4	SATA ports for HDD	Connectors for four ports are on the motherboard. The most common use is SATA 0 : Boot HDD SATA 1 : Secondary internal drive SATA 2 : eSATA port on rear panel SATA 3 : eSATA port on rear panel
AC'97 Audio Port	0/1	Sound port, AC'97 compatible.	Mapped to mezzanine card. Optional mezzanine card has audio CODEC and amplifiers.
USB 2.0 Ports	4/8	USB 2.0 peripheral ports	Port 0: Rear panel Port 1: Rear panel Port 2: Internal JP10 header Port 3: USB FLASH Drive port Port 4: Rear panel Port 5: Rear panel Port 6: Internal JP12 header Port 7: Internal JP15 header
LAN Port	1/1	Ethernet Port	10/100/1000 port on rear panel.
PCI Bus	1/1	32-bit PCI bus	Connected to IO Expansion FPGA supporting the GPS interface, EEPROM and timing controls logic.
Express Card Support	1/2	Express card support features for power control and configuration.	Not used.
LPC Bus	1/1	System expansion and debug bus.	Not used.
System Management			
General Purpose Inputs	4/4	General purpose inputs to CPU	Not used

Feature	Min/ Max	Description	How it is used in the eInstrument PC
General Purpose Outputs	4/4	General purpose outputs from CPU	GPO0: mapped to Mezzanine connector JN1. GPO1-3: Not used.
SMBus	1/1	System Management bus.	Not used
I2C bus	1/1	I2C peripheral bus.	Not used.
Watchdog Timer	1/1	Watchdog timer for CPU.	May be enabled with jumper JP4 to reset CPU.
Speaker Out	1/1	Speaker	Not used.
External BIOS Support	1/1	Allows an external BIOS to be used.	Not used.
Reset Functions	1/1	External reset control.	Rear panel pushbutton switch and 2-pin header connection JP2.
Power Management			
Thermal Protection	0/1	Thermal shutdown protection for CPU	Shuts down CPU when thermal overload is sensed.
Battery Low Alarm	0/1	Battery low detection for CMOS.	CMOS backup battery is monitored.
Suspend	0/1	Power saving modes.	Sleep mode is supported for power saving.
Wake	0/2	IO can wake sleeping CPU	XMC modules can wake up CPU.
Power Button Support	1/1	Power on/off.	Front panel power button.
Power Good	1/1	Power monitor for CPU.	Support circuitry monitors power and resets the CPU when a failure occurs.

Table 3. eInstrument PC COM Express Site Features

COM Express Site Compatibility

The COM Express module site in the eInstrument PC supports TYPE 2 modules ONLY. The motherboard checks the type ID of the module and will ONLY power on if TYPE 2 is detected.

COM Express Site	
Module Type	2
Specification Compliance	PICMG COM.0
Size	125 x 95 mm
Power Capability	Up to 80 W
Mounting Height	8 mm
PCI Express Lanes	5 total, 4+1 grouping

Table 4. COM Express Site Specifications

Compatible COM Express modules are available from several vendors, although features vary from module to module as allowed by the COM.0 specification. The following table shows the modules that have been qualified by Innovative.

Innovative P/N	Mfr	Model Number	CPU	CPU Speed FSB Speed Cache Size	Chipset	Memory	USB Ports	Ethernet	SATA
80201-1	Radisys	CE945GM2A-423-0	Single core Celeron	1.06 GHz 533 MHz 1 MB	Intel GME 945	Up to 4 GB (3GB usable), dual channel	8	1 port, 10/100/1000 BaseT	2, 150 Ports Raid 0 and 1
80201-1	Radisys	CE945GM2A-T25-0	Core2 Duo, dual core	2 GHz 667 MHz 2 MB	Intel GME 945	Up to 4 GB (3GB usable), dual channel	8	1 port, 10/100/1000 BaseT	2, 150 Ports Raid 0 and 1
-	Kontron	38006-0000-22-2	Core2 Duo, dual core	2.2 GHz 800 MHz 4 MB	Intel GME 945	Up to 4 GB (3GB usable), dual channel	8	1 port, 10/100/1000 BaseT	2, 300 Ports Raid 0 and 1

Table 5. Qualified COM Express Modules

Considerations when Selecting Other COM Express Modules

In general, any COM Express Type 2 module will work in the eInstrument PC. The modules have differences in peripherals and chipset configurations that usually require the software be re-installed. Changing the COM Express module is similar to changing a motherboard in a PC, which requires a reinstall of the operating system with different drivers, so plan on re-installing the OS when the COM Express module is changed.

Memory changes do not usually require any OS update.

COM Express modules can have different of SATA, USB and PCI Express capabilities. Check the module specifications what ports are available and how many PCI Express lanes are provided. COM Express modules with less than 5 PCI Express ports available will render the Cabled PCI Express port inoperable and may restrict XMC site 0 capabilities.

XMC IO Module Sites

The eInstrument PC has two IO module sites that are industry-standard XMC format using PCI Express. A variety of modules are available for signal processing, analog and digital IO, and communications from Innovative and other vendors.

The module sites provide high performance IO expansion for the eInstrument PC using PCI Express bus connections to the COM Express CPU. The eInstrument PC module sites also have features for private interconnections, coordinated triggering and clocking that are useful in system integration.

XMC Module Sites	
Sites	2
Specification Compliance	VITA 42.3 - XMC Modules for PCI Express VITA 20 – Conduction Cooled PMC PCISIG PCI Express 1.0a
Size	75 x 150 mm
Power Capability	Up to 40 W per module
Mounting Height	10 mm
Cooling	Fan (~8 CFM) Conduction per VITA 20
Interface	PCI Express 2.5 Gbps Site 0: 4 lanes max Site 1: 8 lanes max
Secondary Interface**	x8 high speed serial lanes 27 digital IO lines 2 triggers 2 clock inputs
Voltages	3.3V, 12V, -12V
Indicators	Front panel led, green

Table 6. XMC Site Specifications

** Note: Features listed are supported by the eInstrument PC motherboard. System features are module dependent.

XMC Module Site Connectivity

The XMC Module sites connect to the COM Express CPU using PCI Express on the primary connector (J15/J25). The primary connectors (J15/J25) used for the PCI Express interface conform to VITA 42.3 for connector type and signal assignments.

Inter-module connections from the secondary connector (J16/J26) use differential or single-ended signals. Depending on the XMC module, these connections can be used for high speed serial lanes such as Rocket IO ports and are used for standards like Serial Rapid IO (SRIO), Aurora and others. Transfer rates of up to 4 GB/s can be achieved using these serial lanes. Lower speed digital signals can be used for buses or coordination signals between the modules.

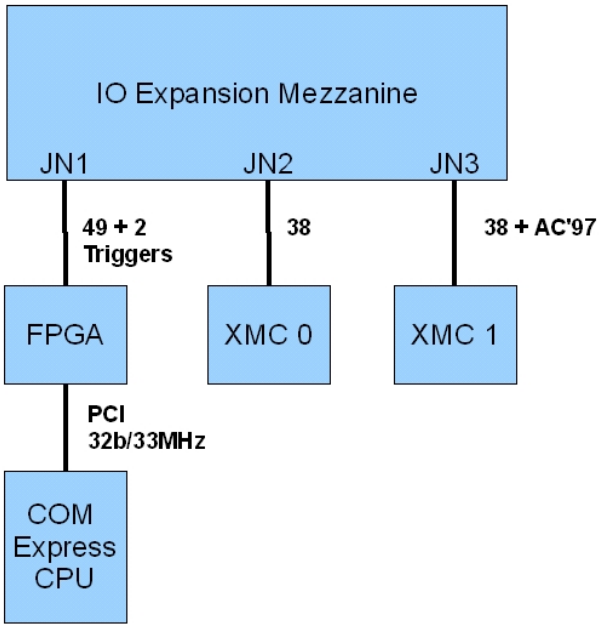


Figure 1. XMC Data Connectivity

XMC Interface	Type	XMC Connector	Number of Connections	Data Rate	Innovative X3/X5 Modules	Notes
Host CPU	PCI Express 1.0 VITA 42.3	J15/J25	XMC 0 : 4 lanes XMC 1 : 8 lanes	~800 MB/s full duplex ~1600 MB/s full duplex	X3: ~200 MB/s X5: ~800 MB/s site 0 ~1200 MB/s site 1	XMC 1 site is connected to PEG interface on COM Express
XMC-to-XMC	High speed serial pairs suitable for Rocket IO	J16/J25	8 lanes in each direction	~2 GB/s full duplex	X3: not supported X5: x8 lanes	The XMC modules must support RIO ports on J16.
XMC to IO Expansion Mezzanine	Single-ended digital IO	J16/J26	27 per module	~ 200 MB/s	X3: 27 total X5: 16 total	XMC modules must support digital IO on J16.

Table 1. XMC Data Connectivity Details

Intermodule Connectivity

The two XMC modules are connected using 16 signal pairs suitable for Rocket IO or high speed serial data. Innovative X5 modules can use these signal pairs to connect the 8 Rocket IO lanes available on P16. The motherboard does not have any connection to these signals, they are only connected between XMC site 0 (P16) and XMC site 1 (P26).

Lane	XMC Site 0 P16 Pins (+/-)	XMC Site 0 P26 Pins (+/-)	Innovative X5 module use
Tx0	A1/B1	A11/B11	XMC0 transmit to XMC1 lane 0
Tx1	D1/E1	D11/E11	XMC0 transmit to XMC1 lane 1
Tx2	A3/B3	A13/B13	XMC0 transmit to XMC1 lane 2
Tx3	D3/E3	D13/E13	XMC0 transmit to XMC1 lane 3
Tx4	A5/B5	A15/B15	XMC0 transmit to XMC1 lane 4
Tx5	D5/E5	D15/E15	XMC0 transmit to XMC1 lane 5
Tx6	A7/B7	A17/B17	XMC0 transmit to XMC1 lane 6
Tx7	D7/E7	D17/E17	XMC0 transmit to XMC1 lane 7
Rx0	A11/B11	A1/B1	XMC1 transmit to XMC0 lane 0
Rx1	D11/E11	D1/E1	XMC1 transmit to XMC0 lane 1
Rx2	A13/B13	A3/B3	XMC1 transmit to XMC0 lane 2
Rx3	D13/E13	D3/E3	XMC1 transmit to XMC0 lane 3
Rx4	A15/B15	A5/B5	XMC1 transmit to XMC0 lane 4
Rx5	D15/E15	D5/E5	XMC1 transmit to XMC0 lane 5
Rx6	A17/B17	A7/B7	XMC1 transmit to XMC0 lane 6
Rx7	D17/E17	D7/E7	XMC1 transmit to XMC0 lane 7

Table 2. XMC-to-XMC Communications Lanes

Front Panel LED from XMC

Each XMC site can control a front panel LED via a signal on J15 or J25, pin F19. This pin is undefined in the VITA 42 specification for XMC. The LED is on when this signal is grounded.

XMC Site	Front Panel LED	XMC Connector/Pin Number	When lit, what it means for X5/X3 modules with standard logic
0	XMC 0	J15, pin F19	PCI Express is able to communicate
1	XMC 1	J25, pin F19	PCI Express is able to communicate

Table 3. XMC LEDs

Custom logic can use these LEDs for other purposes. This requires that the XMC module logic be modified to control the LED for the application.

XMC Site Identification

Each module site has a geographic address as defined in the XMC VITA 42 specification. This can be used by software to identify the module location in an eInstrument PC.

XMC Site	Geographic ID
0	0
1	1

Table 4. XMC Geographic Addresses

Ethernet Port

The Ethernet port on the eInstrument PC supports 10/100/1000 BaseT communications. The port will auto-select the fastest mode possible based upon the network connection.

Specific features on the Ethernet port are defined by the COM Express module. See the datasheet on the COM Express module for more details.

LED indicators on the Ethernet port show current status and configuration.

LED	Function
Yellow	Ethernet activity
Green	Link is present
Orange	Link is 1000BaseT

Table 5. Ethernet LED Functions

USB Ports

The eInstrument PC supports up to eight 8 USB 2.0 ports. These ports are direct connections to the COM Express module. Type 2 COM Express modules have a minimum of 4 ports and a maximum of 8 ports. All currently approved COM Express modules have eight ports.

Each USB port, except port 3, has current limiting. The USB port power supply is +5V @ 500 mA. Exceeding the current limit results in temporary shutdown of the port until it disconnected. ESD protection is provided on each port.

USB Port Number	Connector	Use	Notes
0	P3	Rear panel	Type A
1	P3	Rear panel	Type A
2	JP10	Internal USB	
3	JP11	FLASH Drive	
4	P3	Rear panel type A	Not present on all Type 2 COM Express modules – check module specifications
5**	P3	Rear panel type A	Not present on all Type 2 COM Express modules – check module specifications
6**	JP12	Internal USB	Not present on all Type 2 COM Express modules – check module specifications
7**	JP15	Internal USB	Not present on all Type 2 COM Express modules – check module specifications

Table 6. USB Port Connectors and Assignments

SATA and Hard Disk Options

The eInstrument PC has up to 4 SATA ports for storage connections. Type 2 COM Express modules support 2 to 4 ports, so not all CPU modules have enough SATA ports to support all the features in the eInstrument PC. SATA ports are also either 1.5 Gbps or 3.0 Gbps data rates ("SATA 150" or SATA 300"). Check COM Express module documentation for details.

In the eInstrument PC, the SATA ports have internal connectors. There is space for two internal hard disk drives (HDD) mounted in the lower front of the enclosure. Internal cables connect the ports as described in this table. Port assignments can be easily rearranged by changing the cable connections to the motherboard.

SATA Port	Connector	Use	Notes
0	U34	Internal HDD 0	
1	U38	Internal HDD 1	
2	U35	eSATA to drive array	Optional on Type 2 COM Express
3	U39	eSATA to drive array	Optional on Type 2 COM Express

Table 7. SATA Port Assignments

The eSATA connectors on the rear panel are used to support external drives such as JBOD arrays. This provides not only increased storage capacity but also higher storage rates if the drive array has RAID control.

The HDD subsystem in the eInstrument PC provides mounting for two standard 2.5 inch HDD, commonly referred to as notebook drives. These drives must be SATA types. Many COM Express CPU modules support RAID 0 and 1 configurations for the SATA ports, supporting higher storage rates or redundant drives. Power to the drive is provided using a multiple-ended power adapter from the system power supply.

There are many drives on the market to choose from. Innovative has selected the drives for the highest write-to-platter performance to support data acquisition applications. This is a measure of the *sustained* write rate, not the burst rate to disk cache memory. If the drive is used only for system booting, lower performance drives are usually acceptable.

Drive Capacity	Spin Rate	SATA	Manufacturer	Part Number	Write to Platter Rate
200 GB	7200 RPM	150	Hitachi	HTS722020K9A00	~67 MB/s
60 GB	5400 RPM	150	Hitachi	HTS542580K9SA00	~40 MB/s

Table 8. Approved Hard Disk Drives

FLASH Drive

The eInstrument PC can be optionally configured to boot from a FLASH disk drive. The FLASH drives is a solid-state, non-rotating media that uses USB port 3. The drive is an Intel Z-130, 4 GB and includes a controller with wear-leveling.

FLASH drives have a usable life dependent upon the number of write cycles. This means that disk caching should be turned off in Windows to limit drive writes. Without disk caching and with wear-leveling, the Z-130 drive should have a usable life of over 5 years with Windows or Linux.

Watchdog Timer

The eInstrument PC supports a watchdog timer to prevent runaway operation. If the COM Express CPU gives a watchdog timeout, the eInstrument PC is reset if a jumper is on JP4. If no jumper is installed, the watchdog timer feature is disabled.

The eInstrument PC is shipped with the watchdog timer disabled.

Battery and Monitor

A 3V lithium battery is used for the COM Express CPU real-time clock and BIOS. A low battery warning will be issued to the CPU if the battery voltage goes below 1.84V .

Battery Type	Size	Rated Capacity
CR2032	20 mm diameter, 3.2 mm thick	225 mA-hr

Table 9. Lithium Battery Type

The battery is sized to last a minimum of 3 years at 40 C.

Reset

The eInstrument PC can be reset through a small access hole in the rear panel. If a remote reset is needed, jumper JP2 can be used with a momentary button. Shorting JP2 will reset the CPU.

Resets are also tripped if the motherboard detects low voltage, the wrong module type or over-temperature conditions.

Sample Clocks and Triggering Controls

The sample clock and trigger features in the eInstrument PC support precise data acquisition for the XMC modules and distributed data acquisition applications using many eInstrument PCs. Simultaneous sampling on multiple systems is supported using shared clocks and triggers. An optional GPS receiver allows precise timing between remote, distributed data acquisition systems by locking to a GPS time reference.

The eInstrument PC has a PLL and clock divider circuit that generates low phase noise sample clocks. On the motherboard, these clocks are distributed to the XMC modules and also to front panel connectors. Innovative X3 module family can use the eInstrument PC clocks for sample clocks without additional connections. Other modules or system devices connect using the front panel SMA connectors.

The clock generation circuitry is programmable by the CPU. Drivers are provided that configure the clock circuitry and program the PLL in the Malibu software for the eInstrument PC.

Updates to Rev D

The eInstrument PC Rev D hardware has additional clock features to accommodate an integrated high precision GPS clock reference. A 10 MHz reference from the GPS on J32 can be used as the PLL reference. For lower cost GPS, the FPGA can still supply a 1 MHz reference using a digital PLL in the FPGA as on Rev A through C.

The clock circuitry has been improved to provide lower phase noise when the 100 MHz clock is used as the PLL reference. The system FPGA now receives a copy of the 100 MHz refernce from the clock multiplexer.

A programmable VCXO option has been added to extend the PLL operating range from 10 MHz to 820 MHz. The programmable VCXO has an I2C port connection to the system FPGA, allowing the eInstrument PC CPU to program the center frequency of the device. The VCXO has <0.001 Hz resolution over the tuning range.

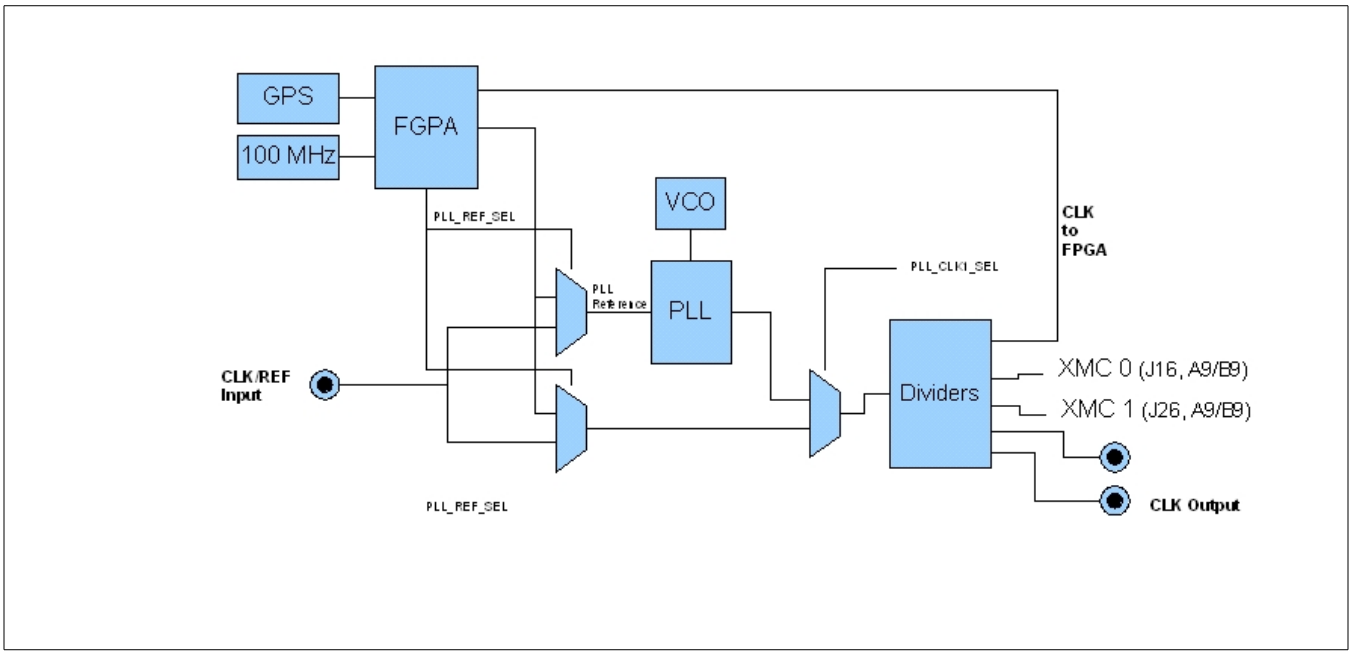


Figure 2. eInstrument PC Sample Clock Diagram (Rev A-C)

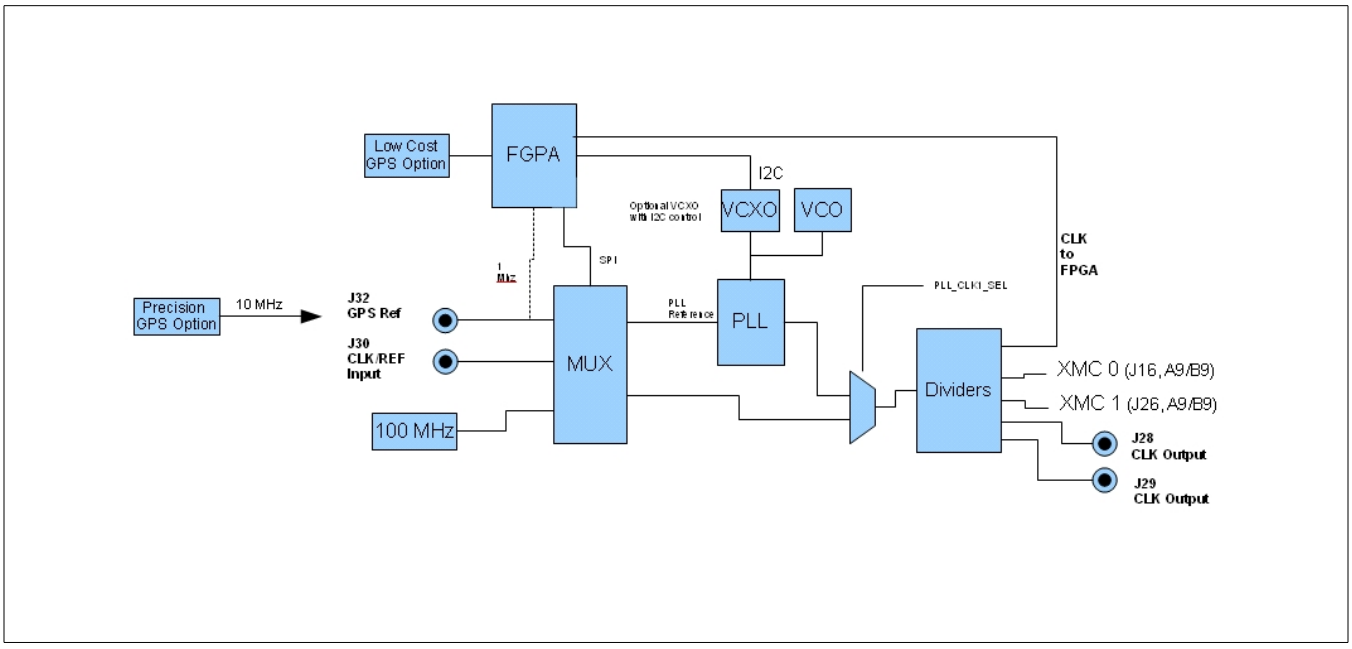


Figure 3. eInstrument PC Sample Clock Diagram (Rev D)

Sample Clocking Modes

The eInstrument PC can either internally generate sample clocks or use an external clock input. The external clock input can be used as the sample clock or as a reference to the clock. These modes allow the eInstrument PC to synchronize the data sampling to system clocks so that many units can sample simultaneously and coordinate data sampling.

The FPGA receives a copy of the sample clock, or a divided sample clock from the output divider/distribution. This is used for triggering functions in the logic.

Clock Mode	Use for	Restrictions	Benefits
PLL with internal reference	Software programmable clock	Clock rate has tuning resolution of about 0.05 Hz	Low jitter clock provides best dynamic performance
PLL with external reference	Software programmable clock referenced to external clock input	External reference must be 1 to 100 MHz, 50-50 duty cycle, see electrical requirements below	Lock to an external clock and generate an A/D clock locked to it; Clean up external clock jitter using the PLL
External Clock	Synchronize sampling to system devices	External clock must be 200 kHz to 500 MHz, 50-50 duty cycle, low jitter	Sample according to an external clock

Table 1. Sample Clock Modes

External Clock and Reference Input

The single input to the clock circuitry may be used as either a PLL reference or as a sample clock. This input is on the front panel labeled as “REF CLK”.

	Specification
Coupling	AC Coupled
DC Input Bias	-8V to +8V
AC Input Voltage	-20 dBm min to 6 dBm
Input Impedance	500 ohms, Fin > 1 MHz
Input Frequency	2 kHz/500MHz
Connector	J30, SMA, female, front panel accessible

Table 2. External Clock/Reference Specifications

The external clock input is AC coupled. Clocks lower than 2 KHz, 0.5 Vp-p require a modification to the input – contact technical support to discuss these requirements.

Sample Clock Outputs

Sample clocks are provided to the front panel SMA connectors, XMC modules and the motherboard FPGA. The clocks are output from the divider circuit. The clocks are synchronous.

Innovative X3 module family can use the clocks provided on XMC connector J16 and J26 as sample clocks for the analog. The X3 module must be programmed to take in the LVDS clock as its sample clock, see details on the module programming.

Sample Clock	Divider Output	IO Standard	Connection
To FPGA	0	LVPECL- 3.3	U1
Front Panel 0	1	Single-ended, 50 ohm	Front panel SMA, J28
Front Panel 1	2	Single-ended, 50 ohm	Front panel SMA, J29
XMC 0	3	LVDS	P16, pins A9/B9
XMC 1	4	LVDS	P26, , pins A9/B9

Table 3. Sample Clock Outputs

	Specification
Coupling	AC Coupled
DC Input Bias	-50/+50 mV
AC Output Voltage	800 mVp-p (-8.8 dBm)
Output Impedance	50 ohms
Output Frequency	200 KHz to 500 MHz
Connector	SMA, female, front panel accessible

Table 4. Front Panel Sample Clock Output Specifications

Internal Sample Generation Using PLL

The PLL can generate many sample rates that suit most applications. The advantage of using the PLL is that the sample clock is very clean and provides the best AC performance. The output frequency of the PLL is programmable and is determined by the reference clock rate and the VCO tuning range.

PLL Output Range and Resolution Limitations

The sample rates that can be generated are limited by the VCO tuning range, the PLL reference frequency, and the PLL tuning parameter limits. For the standard VCO and PLL circuitry, the sample clocks are limited to 100 kHz resolution. There are also “holes” in the sample rate outputs where the PLL cannot make any frequency because of the VCO tuning range and output divisors.

For the standard VCO tuning range of 100 to 140 MHz, and integer output divisors D = 1 to 32, the allowable output ranges are shown.

Output Divisor, D	Lower Limit (MHz)	Upper Limit (MHz)
1	100	140
2	50	70
3	33.33	46.67
4	25	35
5	20	28
32	3.125	4.375

Table 5. Allowable Sample Clock Output Ranges using 100-140 MHz VCO

Notice that lower limit for the standard VCO is 3.125 MHz that there are holes from 70 to 100 MHz and 46.67 to 50 MHz where it is impossible for the PLL to make an output sample clock for the standard configuration. If you need a sample clock not in the allowable ranges, then you must either use an external clock or change the VCO. Contact sales for customizing the VCO to your application requirements.

The optional programmable VCXO can tune to any frequency from 10 to 820 MHz with very fine resolution.

Output Divisor, D	Lower Limit (MHz) VCXO = 10 MHz	Upper Limit (MHz) VCXO= 820 MHz
1	10	820
32	0.31	25.625

Table 6. Allowable Sample Clock Output Ranges using Programmable VCXO with 10-820 MHz Range

Software functions for PLL configuration, monitoring and clock distribution are provided in Innovative's Malibu software toolkit that configure the operating mode and sample rate required for the desired sample rate. This takes into consideration the PLL frequency limits to keep within its specified operating range

Programming the PLL

For most applications, the Malibu support software configures the PLL according to the desired sample rate. The software configures all PLL registers so that the output frequency is as close as possible to the required sample rate given the constraints of resolution as determined by the tuning parameters and the VCO tuning range.

Note: It is best to use the Malibu drivers for almost all applications and the following discussion is only for users who need to modify the PLL tuning for very unique applications.

The tuning equation for the AD9510 is :

$$F_{vco} = (F_{ref}/R) \times (PB + A)$$

where Fref = 100 MHz (or external reference frequency)

R = 1 to 16383, integers

B= 3 to 8191, integers; 1 = bypass

A= 0 to 63, integers, used only in dual modulus mode

P= 1,2,3,4,8,16, or 32

and 100 MHz < Fvco < 140 MHz for standard VCO, 10 MHz < Fvco < 840 Mhz for optional VCXO

All PLL tuning parameters R, B, A and P are software programmable through the PLL interface.

Step		
1	Pick a phase detector frequency close to 100 kHz. This matches the PLL configuration on the card.	Fphase_detector ≈ 100kHz
2	Calculate a reference divisor so that the phase detector frequency is close to 100kHz.	Fphase_detector = Fref / R ≈ 100kHz R = 1 to 16383 100 kHz ≤ Fref ≤ 250 MHz R= 1000 for on-board reference
3	For an output sample clock Fout, find the output divisor D that keeps the VCO within its tuning range.	Fvco = Fout/D D= 1,2,4,6,8,10,12,14,16,18,20,22,24,26,28,30 or 32 100 MHz ≤ Fvco ≤ 140 MHz For the programmable VCXO, set the center frequency to the desired value.
4	Find PLL feedback divisor	M = int (Fvco / Fphase_detector) 1 ≤ M < 262144
5	Find operating mode, fixed modulus or dual modulus and value of A.	A= Fvco mod Fphase_detector If A = 0, then mode should be fixed divide; if A> 0 then dual modulus mode is used
6	Select value of prescaler P based on operating mode and divisor ratio M.	Pick P and B such that M= P*B using smallest values possible. For fixed divide, P = 1, 2, or 3. For dual modulus, P= 2, 4, 8, 16 or 32. B = 3 to 8191, integers; 1 = bypass
7	Check calculations.	Fout = Fvco/D Fvco = (PB+A) * Fref / R , 100 MHz ≤ Fvco ≤ 140 MHz

Table 7. Selecting values for PLL Divisors

$F_{vco} = (F_{ref}/R) \times (PB + A)$

Fs (MHz)	D	FVCO	Fref (MHz)	R	M	A	P	B
100	1	100	100	1000	1000	0	1	1000
70.000	2	140	100	1000	700	0	1	700
69.900	2	139.8	100	1000	699	0	1	699
69.700	2	139.4	100	1000	697	0	1	697
51.300	2	102.6	100	1000	513	0	1	513
31.100	4	124.4	100	1000	311	0	1	311
11.000	10	110	100	1000	110	0	1	110
5.100	20	102	100	1000	51	0	1	51
3.300	32	105.6	100	1000	33	0	1	33
3.200	32	102.4	100	1000	32	0	1	32

Table 8. PLL Example Settings

PLL Lock and Status

The PLL has a status pin that can be programmed to show when the PLL is locked or other status information. The Malibu software configures this pin to be digital lock detect. It indicates when the PLL is locked and ready for use. If the PLL lock is false, the PLL is not working properly and may give poor results or inaccurate frequencies. Even when the PLL is unable to lock, it will produce an output so the mere presence of data does not indicate that the PLL is operating at the correct frequency or is stable.

Triggering

The eInstrument PC has a trigger control component in the FPGA to provide controls the data acquisition process. The sample clock specifies the instant in time when data is sampled, whereas triggering specifies when data is kept. This allows the application to collect data at the desired rate, and keep only the data that is required. This triggering logic can be modified using the FrameWork Logic package for the eInstrument PC to meet other requirements.

The eInstrument PC has external, software and GPS-sourced triggering inputs. These are used to create triggers to the XMC modules and IO Mezzanine. All of these trigger outputs are identical timing in the standard logic.

The GPS can also be used to trigger data acquisition at a specified time for synchronizing remote units to one another. Remote units can monitor GPS time and begin sampling at the same time.

Trigger Input and Outputs

There are six trigger outputs available in the system: two per XMC module, and two for the IO Expansion mezzanine card. These triggers are from the motherboard FPGA trigger control logic.

An external trigger input on the front panel SMA (J31) is an input to the FPGA.

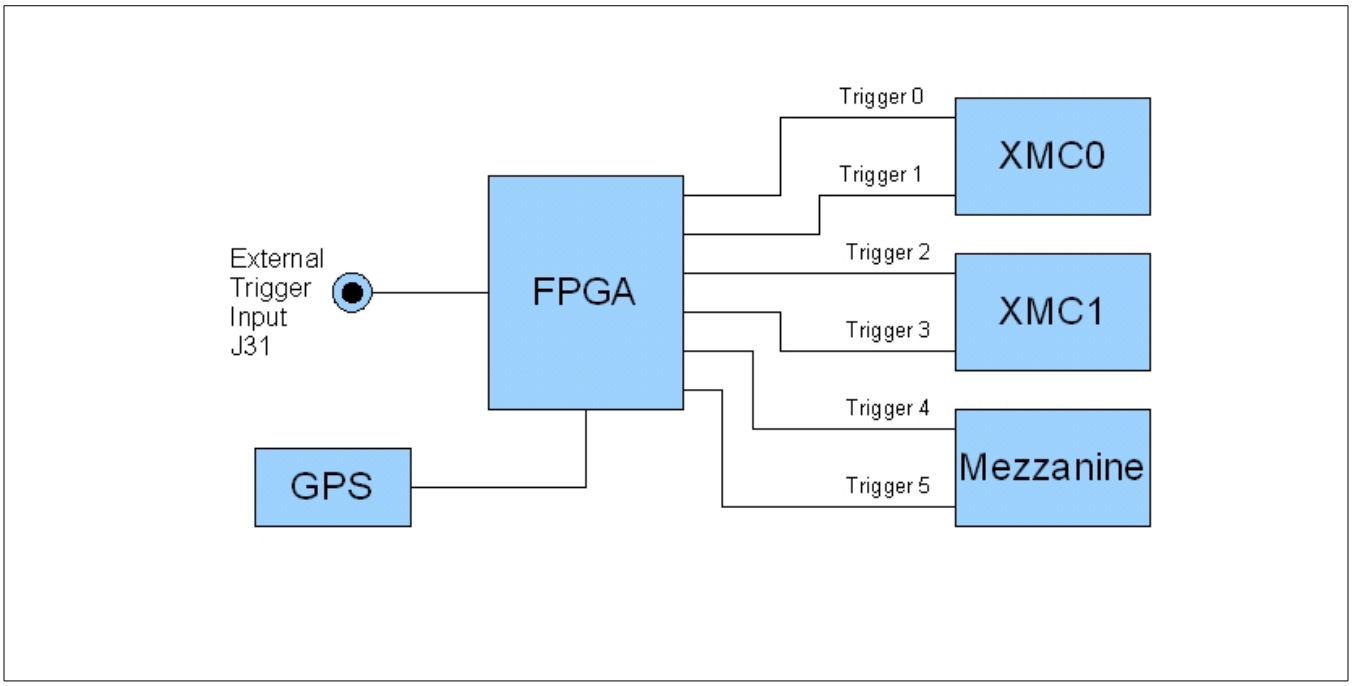


Figure 1. Trigger Connections

Trigger	Connector
External Trigger Input	J31 (Front Panel)
Trigger 0	P16, pin A19
Trigger 1	P16, pin B19
Trigger 2	P26, pin A19
Trigger 3	P26, pin B19
Trigger 4	JN1, pin 58
Trigger 5	JN1, pin 60

Table 1. Trigger Connectors

Parameter	Specification
Coupling	DC Coupled
Input Min/Max Voltage	-0.5V/5.5V
Logic High ('1')	>2V

Logic Low ('0')	<0.7V
Input Impedance	>1M ohm, 15 pF
Input Frequency	Up to 100 MHz
Connector	SMA, female, front panel accessible

Table 2. Input Trigger Specifications (Front Panel, J31)

Parameter	Specification
Coupling	DC Coupled
Input Min/Max Voltage	-0.5V/3.6V
Logic High ('1')	>2V
Logic Low ('0')	<0.7V
Drive Current	8 mA
Output Frequency	Up to 100 MHz

Table 3. Output Trigger Specifications

Trigger Modes

In the eInstrument PC,. The eInstrument PC trigger modes allow data to be acquired continuously or during a specified time, as triggered by either a software or external trigger. The XMC modules may sample synchronously using the trigger and clock features. The trigger can also be used to decimate the samples to reduce data rates.

Trigger Mode	Data Collected/Played Back	Start Trigger	Stop Trigger
Continuous	Each rising edge during trigger valid period	Software or rising edge of external trigger	Software or falling edge of external trigger
Framed	Trigger period is N sample points	Software or rising edge of external trigger	Stops when N samples are collected back
Decimation	M points are discarded for every point kept. May be used with either trigger mode.	-	-

Table 1: Trigger Modes

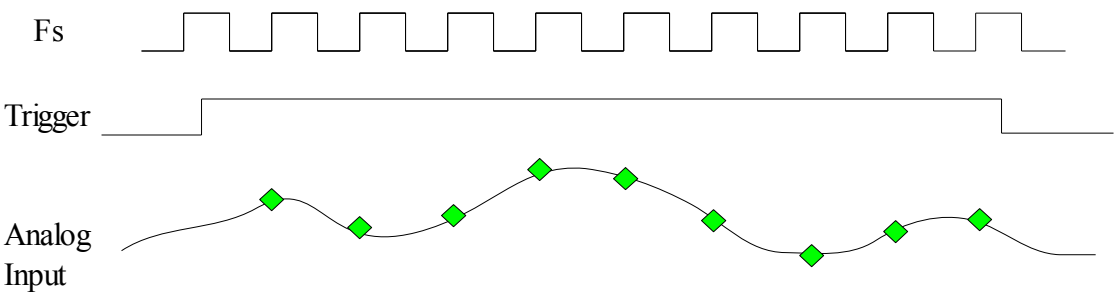


Figure 1. Sample Trigger Timing

As shown in the diagram, samples are captured when the sample clock and the trigger are true. The trigger is true in continuous mode after a rising edge on the trigger input, software or external, until a falling edge is found. The trigger is timed against the sample clock and may have a 0 to +1 sample clock uncertainty for an asynchronous trigger input.

The trigger component assumes a one-to-one ratio of the sample clock to the captured points, meaning that the trigger logic expects a sample is taken for each rising edge of the sample clock. If this is not the case, the frame size and decimation ratio should be adjusted accordingly.

The trigger mode controls are mapped to CPU memory as shown here.

Bit	Bit Field Name	Function
23..0	Frame Count	How many sample clocks to count in frame mode
27..24	-	
28	Trigger_run	Enable triggering module; 0=disabled (default)
29	-	-
30	Trigger Mode	0= unframed; 1 = framed
31	External Trigger Enable	0 = disabled (default)

Table 1. Triggering Control (PCI BAR + 0x6A000)

Trigger Source

A software trigger or external trigger can be used by the trigger controls. Software trigger can always be used, but external triggering must be selected. The trigger source is level-sensitive for the continuous mode or edge-triggered for the framed mode triggering.

The external trigger is front panel accessible on connector J31. See the input specifications above.

The Malibu software tools provide support for use of the software trigger. The software trigger is mapped to CPU memory as shown here. Writing a '1' to this register creates a software trigger. To retrigger, the software must write a '0' followed by a '1'.

Bit	Function
0	Software trigger
31..1	-

Table 2. Software Triggering Control (PCI BAR + 0x5D000)

Framed Trigger Mode

Framed trigger mode is useful for collecting data sets of a fixed size each time the input trigger is fired. In framed mode, the trigger goes false once the programmed number of points, N, have been collected. Start triggers that occur during a frame trigger are ignored.

The maximum number of points per frame is 16,777,216 (2^24) points, while the minimum number of points is 2.

To use the framed triggering mode, the software first initializes the number of points in the frame and the decimation ratio. The trigger source, either external or software trigger is enabled. For Innovative X3 and X5 modules, the data frame size is usually set to the frame size so that once the data is captured the Malibu software will deliver a data buffer of the captured data to the application software.

Decimation

The data may be decimated by a programmed ratio to reduce the data rate. The decimation simply discards M points for every point kept – no averaging or filtering is used. When decimation is true, the number of points captured in the framed mode is the number of decimated points, in other words the discarded points do not count. Maximum decimation rate is 1/4095.

When decimation is used in the framed trigger mode, the number of points captured is after decimation.

Bit	Bit Field Name	Function
11..0	**Decimation**	**Decimate 1/N clocks for each trigger**
31..12	**-**	**Not used**

Table 3. Decimation Control (PCI BAR + 0x6F000)

GPS Triggering (Optional Feature)

The GPS provides a Pulse-Per-Second (PPS) output that can be used to create a trigger. In this mode, the software arms this trigger so that when the next PPS rising edge occurs, a trigger is created. If the CPU monitors the GPS time, then the GPS trigger mode can be armed at a specific time, thus ensuring all units are triggered simultaneously in this mode. This trigger is synchronous to the sample clock.

This register enables triggering on next GPS PPS rising edge. Any writes to this register trigger on next rising edge of PPS.

Bit	Bit Field Name	Function
31.. 0	GPS Trigger Enable	x

Table 4. GPS Triggering Control (0x70000)

Software features in Malibu provide support for GPS trigger control and setup.

Temperature Monitoring and Thermal Design

The eInstrument PC module has temperature monitoring and power controls to aid in system integration. Also, the module has been designed to include conduction cooling to improve heat dissipation from the module. These features can make the module more reliable in operation and also reduce power consumption.

System Thermal Design

The eInstrument PC can dissipate 10W to 100W depending on the COM Express module, XMC modules install, disk drives, and other features. Forced air cooling is usually required because of the eInstrument PC power dissipation for most ambient operating temperatures. This requirement is highly application dependent and must be evaluated for each installation.

If forced air cooling is not used, conduction cooling is another method of dissipating heat from the eInstrument PC. All heat is conducted to the chassis, which may be bolted down to provide a conductive cooling path. The four rubber feet are removed and these screw attachments are used attachments.

Temperature Sensor and Over Temperature Protection

Temperature monitoring for the module consists of a Texas Instruments TMP175 temperature sensor mounted near the center of the module and a logic component that monitors the temperature continuously.

Current temperature can always be read from the temperature sensor register. The temperature is updated at approximately a 100 Hz rate with a nominal resolution of 0.06 degrees C. The temperature sensor should be accurate to about 2 degrees C. Keep in mind that the actual temperature around the motherboard is 5C higher at the hottest spots.

The temperature sensor logic component provides programmable temperature warning and failure levels. A temperature failure shuts down the system power supply.

Alarm Setting	Temperature (Celsius)	Set Register to	Default
Warning	60	X”3C0”	60
Fail	65	X”410”	65

Table 5. Motherboard Temperature Failure and Warning Levels

The temperature sensor must be present and responding for the eInstrument PC to operate. If the temperature sensor fails, this is treated as a temperature failure.

Reading the Motherboard Temperature

The motherboard temperature is read from a memory-mapped register and gives the current temperature when read. Scaling from the temperature sensor is a 2's complement number that is sign extended to 16-bits from the 12-bit value given in this table. Note that 0 degrees is 0 output and scale factor is 0.0625 C/bit.

*Temperature(C) = reading * 0.0625*

TEMPERATURE (°C)	DIGITAL OUTPUT (BINARY)	HEX
128	0111 1111 1111	7FF
127.9375	0111 1111 1111	7FF
100	0110 0100 0000	640
80	0101 0000 0000	500
75	0100 1011 0000	4B0
50	0011 0010 0000	320
25	0001 1001 0000	190
0.25	0000 0000 0100	004
0	0000 0000 0000	000
−0.25	1111 1111 1100	FFC
−25	1110 0111 0000	E70
−55	1100 1001 0000	C90

Table 5. Temperature Data Format

Bits	Function
15..0	Temperature (read only)
(Others)	Not used

Table 6. Motherboard Temperature Register (PCI BAR + 0x52000 R)

Temperature Monitoring

The motherboard logic monitors the temperature to prevent damage to the eInstrument PC. Temperature warning and failure levels are programmable memory-mapped registers that are used for this monitoring function.

Alarm Setting	Temperature (Celsius)	Set Register to	Default
Warning	60	X”3C0”	60
Fail	65	X”410”	65

Table 7. Motherboard Temperature Failure and Warning Levels

Writing to the temperature warning of failure level register sets the monitor level and clears a temperature warning when read.

Bits	Function
15..0	Temperature
29..16	-
30	Temperature Warning
31	Temperature Failure

Table 8. Motherboard Temperature Warning (PCI BAR + 0x53000) and Failure Registers (PCI BAR + 0x54000)

XMC Cooling

The XMC modules are cooled using both conduction and convection cooling. In general, if the power dissipation from any module is >10W, then convection cooling must be used. Conduction cooling is effective in many installations if the XMC provides good heat conduction to the heat bars.

Convection Cooling

For convection cooling, each module has a fan that provides ~8 CFM of air. This fan is only on when the module is installed and power is on. Adequate ventilation must be provided for the eInstrument PC so that the front and side panel air inlets and the top panel air exhaust are not obstructed.

When an XMC module is installed, the fan for that XMC site can be either always on or controlled by the XMC module. When the module controls that fan, the XMC must drive the fan control signal low to turn the fan on.

XMC Site	Fan Control Jumper	Fan Control Signal	Jumper
0	JP18	J15, pin C19	Installed = Fan controlled by XMC 0 No jumper = on when XMC 0 site is used
1	JP19	J25, pin C19	Installed = Fan controlled by XMC 1 No jumper = on when XMC 1 site is used

Table 9. Fan Control Jumper

Conduction Cooling

The conduction cooling for each module uses heat conduction bars from the module to the motherboard. The motherboard conducts heat to the card edges that are attached to the metal enclosure. It is normal for the enclosure to feel slightly warm to the touch during operation.

The heat conduction pattern on the motherboard is a subset of VITA 20 (Conduction Cooled PMC) specification. The module bracket may also be used for thermal conduction to the motherboard.

Innovative X3 modules use a single heat bar per module, along the midsection of them module. Innovative X5 modules use either two heat bars along each module edge or an integrated heat sink/thermal assembly.

Generic XMC modules with VITA 20 cooling can use heat bars 61121 and 61122 for heat sinking to the eInstrument PC motherboard.

Module Type	Thermal Bar P/N	Qty	Description
X3	61121	1	Thermal bar for Innovative X3 and other XMC modules.
X5	61120	1	Integrated heat sink and thermal bar assembly
X5	61122	2	Thermal bars for Innovative X5 and other XMC modules.

Table 10. Heat Sinks for XMC Modules

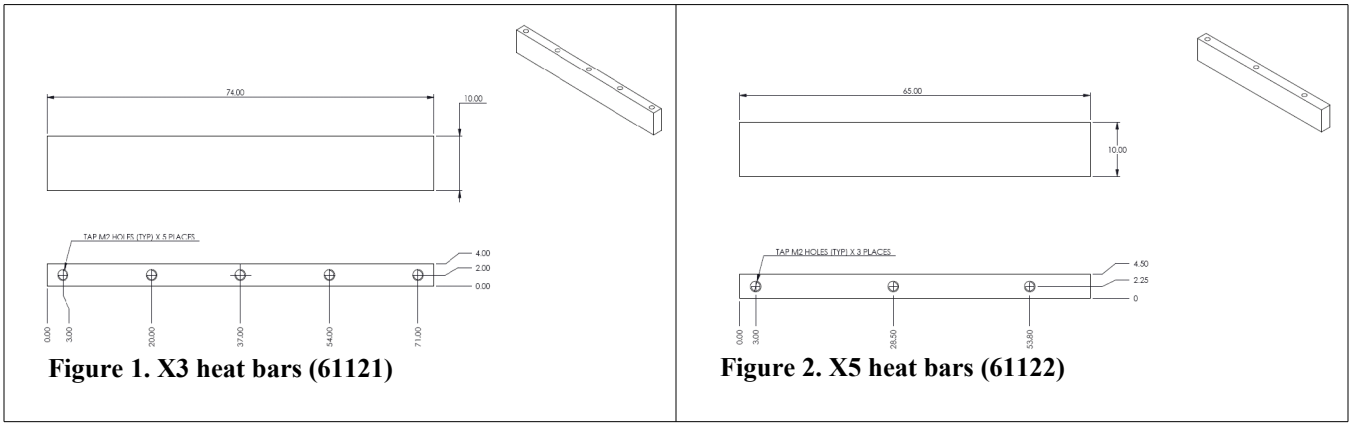


Figure 1. X3 heat bars (61121)

Figure 2. X5 heat bars (61122)

GPS Receiver Option

A GPS receiver option is available for the eInstrument PC for position information and timing control. The sample clocks on the eInstrument PC can be locked to the GPS clock so that remote units can sample simultaneously and to remove long term clock errors on the eInstrument PC. The GPS time is also used to synchronize data acquisition as a trigger to the XMC sites.

GPS Module

The GPS receiver module is a Tyco A1029-D.

Channels		12, parallel tracking
Frequency		L1 (= 1575 MHz)
Position Accuracy	Stand alone	3m CEP (SA off)
	Differential	< 2m CEP
Time To First Fix – TTFF (theoretical minimum values; values in real world may differ)	Obscuration recovery (1)	1s
	Hot start (2)	< 3s
	Warm (3)	< 32s
	Autonomous / cold (4) (6)	< 60s
	Power-off start (5) (6)	Varying

Table 1. GPS Performance

GPS Antenna



It is recommended to use an active GPS antenna with supply voltage of 3 to 5VDC and a current draw of 50mA maximum. The quality of the GPS antenna chosen is of paramount importance for the overall sensitivity of the GPS system. An active antenna should have a gain ≥ 20dB and a noise figure ≤ 1.5dB, which applies to more than 95% of the active antennas available in the market.

The antenna available from Innovative (P/N 68013G) provides +25 dBm amplification and uses a 3.3V supply. This antenna has a 3m cable and has screw or magnetic attachment.

The antenna must have an unobstructed view of the sky for the GPS to lock. Indoor operation is not possible in most cases.

GPS Interface

The GPS unit has a serial interface for control and status. The protocol for the port is given in the Tyco A1029 GPS manual. The FPGA interface provides serial port interface to the module, status and control. The host configures the GPS to a baud rate of 4800 for default use. The UART has a 16 byte FIFO on transmit (TX) and 2K FIFO on receive (RX). The GPS_TX_RDY bit shows when the TX FIFO has room for at least 4 more bytes. The GPS_RX_NOT_EMPTY shows when the RX FIFO is not empty.

An interrupt can be used to signal the host when GPS data is available, once every second. The interrupt is triggered by the PPS signal from the GPS unit. The CPU should acknowledge the interrupt by reading the interrupt status register, then read the GPS FIFO for all data.

Bit	Direction	Function
7..0	R/W	Serial data; R = RX FIFO read

		W = TX FIFO write
31..8		-

Table 2. GPS Serial Port (PCI BAR + 0x68000)

This register sets provides UART status and control.

Bit	Bit Field Name	Direction	Function
2..0	BAUD Rate	R/W	UART BAUD rate (default = 4800) “000” =115200 “001” =57600 “010” =38400 “011” =19200 “100” =9600 “101” =4800
3	GPS TX RDY	R	TX FIFO ready; '1' = can accept 4 more points '0' = FIFO is almost full
4	GPS RX NOT EMPTY	R	RX FIFO not empty; '1' = FIFO is not empty
15..5	GPS_RX_FIFO_RD_COUNT	R	RX FIFO read count -1 (NOT EMPTY is true when only 1 point is available)
31..16	-		Not Used.

Table 3. GPS UART Configuration /Status (PCI BAR + 0x6E000)

Bit	Direction	Function
0	R/W	GPS enable. '0' = disabled (default) This powers down the unit. GPS will be forced to acquire a new fix.
1	R	GPS Lock '1' = locked
2	R	GPS antenna status '1' = good
3	R/W	GPS FIFO Reset, 1 = reset (default) Resets both RX and TX FIFOs.

Table 4. GPS UART Status and Control (PCI BAR + 0x69000)

This register reports the PCI interrupt status. The status is cleared on read.

Bit	Function
0	GPS packet ready
31..1	-

Table 5. PCI Interrupt Register (PCI BAR + 0x64000, read)

This register provides an interrupt mask.

Bit	Interrupt Source
0	GPS packet interrupt 0= disabled (default)

31..1	*Not used*

Table 6. PCI Interrupt Mask Register (0x51000, write)

Cabled PCI Express Expansion Port

The cable PCI Express Expansion port provides a way to add more IO capability to the eInstrument PC. This port is ~10x faster than USB 2.0 and supports hot plug operation, and is completely software transparent. No additional software or drivers are required to run any PCI express peripheral over the cable.

Innovative's eInstrument DAQ Node can be used to add another XMC-based IO to the system using the cabled PCI Express port. It supports one XMC site as a PCI Express endpoint. Integrated power supplies allow the eInstrument DAQ Node to run off a single +12V nominal input.



The cabled PCI Express interface is a single (x1) lane operating at 2.5 Gbps from the eInstrument PC. The COM Express module PCI Express lane 4 is buffered with a cable driver. The interface is full duplex (sends and receives simultaneously). The interface supports burst rates of 250 MB/s and continuous data rates of about 200 MB/s between the module and the host.

Limits on data transfer rates are determined primarily by the XMC and COM Express capabilities. The only impact on performance is that the cable introduces some additional latency in the link. This latency can affect overall rate because of low level PCI Express credit management, as well as the whatever mechanism the XMC uses for data transfer, are slowed by this latency introduced by the cable length. This is not usually an even measurable effect.

The PCI Express interface is completely compatible with any PCI Express system and complies with PCI Express Gen 1 1.1 specifications. The cable is defined in the PCI Express Cable Interface 1.0 specification. The approved cable is is provided here.

PCI Express Cables

The PCI Express cable is available in several lengths. The eInstrument PC settings at the factory are for the 1m cable.

Innovative Part Number	Description	Manufacturer	Manufacturer Part Number
67057	PCI Express Cable, x1 lane, 5 meter	Molex	7457600005
67058	PCI Express Cable, x1 lane, 3 meter	Molex	7457600003
67059	PCI Express Cable, x1 lane, 1 meter	Molex	7457600001

Table 7. Approved PCI Express cable list for eInstrument PC

Electrical Isolation and Hot Plug

Any cabled PCI Express peripheral must electrically isolated from the eInstrument PC. The isolation barrier in the eInstrument PC provides an isolated 100 MHz reference clock and transmit pair to the peripheral. The receive pair should be isolated in the peripheral. Sideband signals for reset, presence and power control should be isolated in the peripheral. The remote peripheral is NOT supplied any power from the eInstrument PC.

As defined in the PCI Express Cable Specification, the PCI Express cable supports hot-plug operation. Provided that the cable peripheral is electrically isolated, it is safe to hot plug the unit. It is also safe to turn the unit on or off while the eInstrument PC is connected.

Tuning for PCI Express Cable Lengths and Signal Quality

The eInstrument PC has tuning controls for the PCI Express cable interface that adjust the signal amplitude, de-emphasis, and equalization characteristics to improve reliability for longer cables. These controls are set at the factory for the 1 meter cable.

Switches SW1 and SW2 are used for the receive and transmit tuning. These are dip switches located on the card which must be set manually during the tuning procedure. The default settings are the recommended settings for most applications.

Switch	Tuning Control	Default (4:1)
SW1	Receive (cable to eInstrument PC)	0000 (off-off-off-off)
SW2	Transmit (eInstrument PC to cable)	0000 (off-off-off-off)

Switch	Function	Settings	Notes
2:1	Receive equalization	00 = no equalization 01 = 0 : 2.54 dB 10 = 2.5 : 4.5 dB 11 = 4.5 : 6.5 dB	SW1: Tunes the signal to the XMC from the cable SW2: Tunes the signals to the cable from the XMC Higher equalization is usually required for longer cables
3	Output swing	0 = 1x 1 = 1.2x	Higher output swing is usually required for longer cables
4	Output De-emphasis	0 = 0 dB 1 = -3.5 dB	Output De-emphasis may be required for short cables or for signals to the PCI Express host bus.

Table 8. Settings for PCI Express Transceiver Switches

Note: Switches in the ON position are 0 in this table.

The recommended tuning procedure is to connect the eInstrument PC to the remote device and perform a test for data

integrity. This could be a large data transfer or communications test to the remote device. The signal tuning should be changed until reliable data transfers are achieved.

Innovative provides test programs to validate connection quality for its data acquisition cards that are included with each XMC module.

EEPROM

A serial EEPROM on the motherboard is used to store configuration and calibration information. This is a non-volatile memory that is programmable by the CPU. The EEPROM is an Atmel AT24C16-10SI, a 16K bit device.

The interface to the serial EEPROM is an I2C bus that is mapped to the CPU memory through the FPGA. The I2C bus is slow this memory is only used for initialization and configuration data. This I2C bus is implemented using a simple hardware interface with the I2C protocol in software.

The EEPROM also has a write cycle limit of 100K cycles, so it should only be written to when calibration is performed or configuration information changes. Once the write cycle duration limit is exceeded, the device will not reliably store data any more.

Software drivers are provided in the Malibu tools for accessing the EEPROM. Since these drivers implement the I2C protocol in software, it is important to use these drivers for all communications with the EEPROM.

IO Expansion Mezzanine

The IO Expansion Mezzanine provides a simple way to add application-specific features to the eInstrument PC. By designing a small add-on card for the eInstrument PC, unique features can be readily added to the system. The IO Mezzanine has direct connections to the motherboard FPGA and XMC module sites, allowing either the CPU or XMC modules to control IO devices or have additional digital IO. The motherboard FPGA can be modified for the application-specific mezzanine card so that devices can be mapped to the PCI bus of the CPU. The AC '97 audio port controls are provided as well as power.

The mezzanine mounts in the rear of the enclosure providing rear-panel access to connectors on the mezzanine with appropriate cut-outs to the rear panel.

Mezzanine IO Connections

The IO mezzanine has three connectors to the motherboard, providing connections to each XMC and the motherboard FPGA.

Connector	Provides Access to..	Signal Groups
JN1	Baseboard FPGA	FPGA connections (48 total)
JN2	XMC 0 J16	XMC 0 DIO (38 total) AC'97 controls

JN3	XMC 1 J26	XMC 1 DIO (38 total)

Table 9. IO Mezzanine Connector Functions

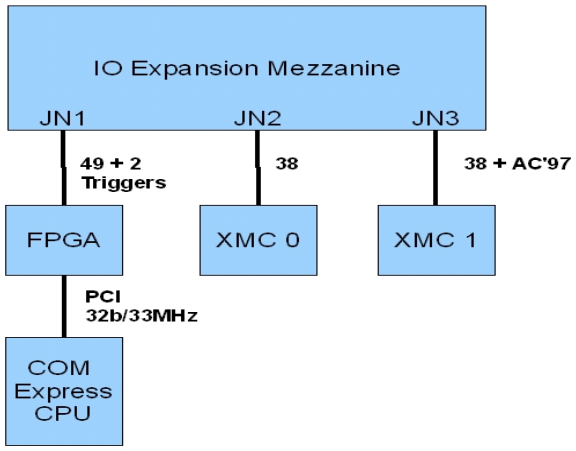


Figure 1. IO Expansion Mezzanine Connections

The digital IO from the XMC modules may have any single-ended IO signaling standard. Consult the specific XMC module information on the IO from that module.

The AC'97 sound port control signals are direct connection from the COM Express module. These control signals can be used to implement an AC '97 audio subsystem that is software compatible with Windows or Linux. See the AC'97 specification for more information on these signals and timing.

Mezzanine Interface to Baseboard FPGA

FPGA digital IO is LVTTL IO signaling standard. These signals are a direct connection to the motherboard FPGA. Signal rates up to 66 MHz are possible, providing that signal termination is implemented. Drive strength from the FPGA is programmable in the range of 2 to 16 mA.

A pinout diagram of JN1 is provided in the connectors section of this manual. This table shows the connectivity between the motherboard FPGA (U1) and JN1.

Signal	FPGA Pin	JN1 Pin
FDIO0	A7	5
FDIO1	E7	6
FDIO2	C8	7
FDIO3	A9	8
FDIO4	A10	9

FDIO5	D9	10
FDIO6	E9	11
FDIO7	F9	12
FDIO8	D10	13
FDIO9	E10	14
FDIO10	B11	15
FDIO11	C11	16
FDIO12	D11	17
FDIO13	E11	18
FDIO14	A12	19
FDIO15	A13	20
FDIO16	B13	21
FDIO17	A14	22
FDIO18	B14	23
FDIO19	C16	24
FDIO20	C15	25
FDIO21	D16	26
FDIO22	D15	27
FDIO23	D14	28
FDIO24	F15	29
FDIO25	F14	30
FDIO26	F13	31
FDIO27	F12	32
FDIO28	G16	33
FDIO29	G15	34
FDIO30	G14	35
FDIO31	G13	36
FDIO32	H14	37
FDIO33	H15	38
FDIO34	K16	39
FDIO35	J16	40

FDIO36	K15	41
FDIO37	K14	42
FDIO38	K13	43
FDIO39	K12	44
FDIO40	L14	45
FDIO41	L15	46
FDIO42	M14	47
FDIO43	M16	48
FDIO44	N16	49
FDIO45	P16	50
FDIO46	P15	51
FDIO47	R16	52
FDIO_CLKP	T9	57

Table 1. IO Mezzanine Connections to FPGA

The FPGA pins are implemented as simple digital IO in the standard FPGA logic. The FPGA can be modified with the FrameWork Logic tools so that these signals can be used for application-specific purposes.

There is no termination on the motherboard for any of these signals. High speed applications should add termination resistors, usually 51 ohms in series, to each signal on the mezzanine.

The FDIO control registers are for data[31:0], data[47:32], and output enables. The output enables are one per byte of FDIO. For output, write output data to the data registers and then write to the byte output enables. For input, read the FDIO registers for the current state of the bits. Reading a byte configured as an output simply returns the state of the pins. All bits are input at system reset.

Bit	Bit Field Name	Direction from PCI FPGA	Function
31..0	FDIO[31:0]	I/O	Digital IO to mezzanine

Table 2. DIO 31..0 Register (PCI BAR + 0x6B000)

Bit	Bit Field Name	Direction from PCI FPGA	Function
15..0	FDIO[47:32]	I/O	Digital IO to mezzanine
31..16	-	-	-

Table 3. DIO 47..32 Register (PCI BAR + 0x6C000)

Bit	Bit Field Name	Direction from PCI FPGA	Function
5..0	DIO_EN	-	Enable Digital IO to mezzanine 0= input (default) bit 0 for byte 0, bit 1 for byte 1

Table 4. DIO Enables Register (PCI BAR + 0x6D000)

Mezzanine Interface to Innovative X3 and X5 Module Families

The IO Mezzanine has connections to each XMC module secondary connector (P16, P26). These signals are connected to the application FPGA on Innovative X3 and X5 modules, providing a means for each XMC to have application-specific connectors and IO devices on the mezzanine card. On X3 modules, these are simple digital IO in the standard logic. On X5 modules, they are left undefined in the standard logic.

The signals that are available on this connector for Innovative X3 and X5 modules are shown here. P16 and P26 have identical pinouts for these signals, as do JN2 and JN3. P16 connects to XMC site 0, P26 connects to XMC site 1. Signal names are prefixed by the module site number.

Signal	JN2/JN3	P16/P26 pin	X3 FPGA Signal	X3 Modules FPGA pin (EXCEPT X3-SD and X3-SDF)	X3 Modules FPGA pin (X3-SD and X3-SDF ONLY)	X5 FPGA SIGNAL	X5 Modules FPGA pins	X5 IO Standard
XMCx_DIO0	5	C1	DIO0	P22	L22	DIO24	J32	LVCMOS2.5
XMCx_DIO1	7	C2	DIO1	N21	L21	DIO0	J22	LVCMOS3.3
XMCx_DIO2	9	C3	DIO2	L24	L20	DIO25	J34	LVCMOS2.5
XMCx_DIO3	11	C4	DIO3	M23	L19	DIO2	J21	LVCMOS3.3
XMCx_DIO4	15	C5	DIO4	N18	L18	DIO26	K34	LVCMOS2.5
XMCx_DIO5	17	C6	DIO5	N17	L17	DIO4	L21	LVCMOS3.3
XMCx_DIO6	19	C7	DIO6	J26	J22	DIO27	L34	LVCMOS2.5
XMCx_DIO7	21	C8	DIO7	J25	J21	DIO6	J20	LVCMOS3.3
XMCx_DIO8	25	C9	DIO8	N20	K20	DIO28	P34	LVCMOS2.5
XMCx_DIO9	27	C10	DIO9	M20	K19	DIO8	H19	LVCMOS3.3
XMCx_DIO10	29	C11	DIO10	P18	K18	DIO29	J14	LVCMOS3.3
XMCx_DIO11	31	C12	DIO11	N19	K17	DIO10	L16	LVCMOS3.3
XMCx_DIO12	35	C13	DIO12	J23	G22	DIO30	H15	LVCMOS3.3
XMCx_DIO13	37	C14	DIO13	J22	G21	DIO12	H18	LVCMOS3.3
XMCx_DIO14	39	C15	DIO14	M21	J19	DIO31	J16	LVCMOS3.3
XMCx_DIO15	41	C16	DIO15	M22	J18	DIO14	L18	LVCMOS3.3
XMCx_DIO16	45	C17	DIO16	L18	E22	DIO32	J17	LVCMOS3.3
XMCx_DIO17	47	C18	DIO17	L17	E21	-	-	
XMCx_DIO18	49	C19	DIO18	M19	J17	-	-	
XMCx_DIO19	6	F1	DIO19	M18	H18	DIO16	E34	LVCMOS2.5
XMCx_DIO20	8	F2	DIO20	K25	K22	DIO1	K22	LVCMOS3.3
XMCx_DIO21	10	F3	DIO21	K26	K21	DIO17	E33	LVCMOS2.5
XMCx_DIO22	12	F4	DIO22	L22	H19	DIO3	K21	LVCMOS3.3
XMCx_DIO23	16	F5	DIO23	K21	G20	DIO18	F34	LVCMOS2.5
XMCx_DIO24	18	F6	DIO24	G23	F21	DIO5	H20	LVCMOS3.3
XMCx_DIO25	20	F7	DIO25	G24	F20	DIO19	F33	LVCMOS2.5
XMCx_DIO26	22	F8	DIO26	L20	G19	DIO7	L20	LVCMOS3.3
XMCx_DIO27	26	F9	DIO27	K20	F19	DIO20	G33	LVCMOS2.5
XMCx_DIO28	28	F10	DIO28	F25	G18	DIO9	K16	LVCMOS3.3
XMCx_DIO29	30	F11	DIO29	F24	G17	DIO21	G32	LVCMOS2.5
XMCx_DIO30	32	F12	DIO30	K23	H22	DIO11	L15	LVCMOS3.3
XMCx_DIO31	36	F13	DIO31	K22	H21	DIO22	H34	LVCMOS2.5
XMCx_DIO32	38	F14	DIO32	E24	E20	DIO13	L14	LVCMOS3.3
XMCx_DIO33	40	F15	DIO33	F23	E19	DIO23	H33	LVCMOS2.5
XMCx_DIO34	42	F16	DIO34	K19	F18	DIO15	H17	LVCMOS3.3
XMCx_DIO35	46	F17	DIO35	K18	E18	-	2.5V	
XMCx_DIO36	48	F18	DIO36	F22	D22	-	-	
XMCx_DIO37	50	F19	DIO37	G22	D21	-	-	

Table 5. IO Mezzanine Connections to XMC Sites (Rev C and later)

Notes for use with X3 Modules: All IO are LVTTL, +3.3 logic. Series termination should be added to each signal of 51 ohms. +5V signals must have at least 100 ohm series resistors.

Notes for use with X5 Modules: For X5 modules, the IO are mixed LVCMOS 3.3V and LVCMOS 2.5V. Blocks in yellow are 2.5V signals. Signals in **both** yellow and green are available on the X5-400M Rev E ONLY. Do NOT use +5V signals to any pin or damage may occur. Series termination should be added to each signal of 51 ohms. The 2.5V on pin F17 in intended for IO reference only – do not consume more than 25 mA from this signal.

Mezzanine Mechanicals

The IO mezzanine can have rear panel access for connectors. The module mounts to the upper side of the motherboard at the rear of the chassis. The following diagram shows the dimensions to each of the pin one locations of the mezzanine connectors, as well as the location of two mount holes. The diagram includes three keepout areas where the components are taller than 0.1" from the card surface. In these areas, verify that your design will provide clearance to the tall components on the eInstrument PC board. All other areas have a maximum component height on the eInstrument PC of 0.1 inches.

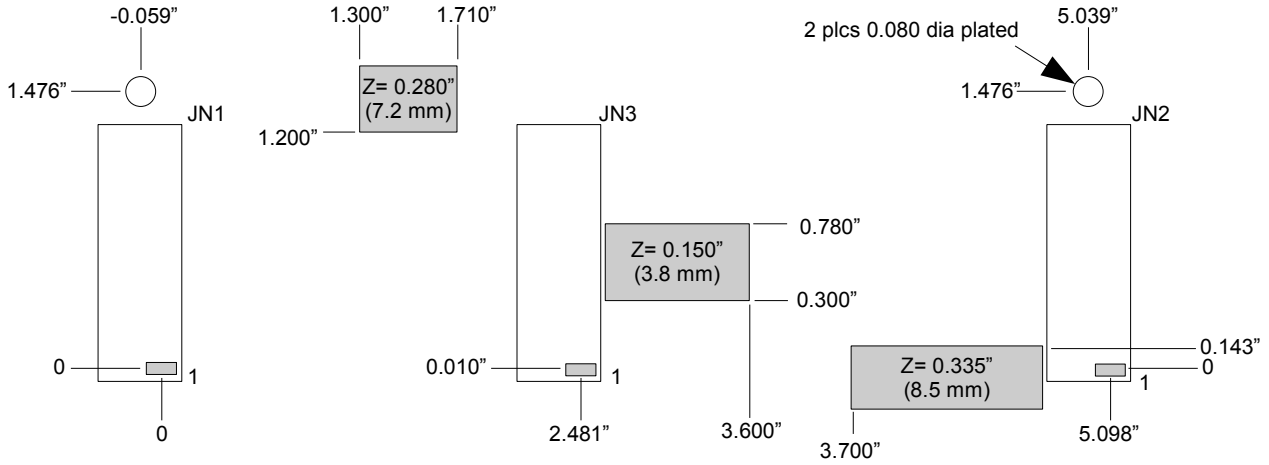


Figure 2. IO Mezzanine Mechanicals

Powering the eInstrument

PC Power Supply

The eInstrument PC has an ATX compatible DC power supply that plugs directly into the power connector P5. There are two supplies available, one providing 125W or 225W. Both supplies may be powered with a "laptop" power supply that delivers 12V nominal.

12V DC-DC Supply (80200-1)

Characteristic	
Input Voltage	12V+/-1V
Minimum input voltage	6V

Characteristic	
Maximum input voltage	24V (clamping will occur at 25-27V)
Deep-Discharge shutdown threshold	11.2V
Input current limit (fuse protected)	15A
Max Output Power	125 Watts (8-16V, see chart below)
Deep Sleep Current Consumption.	< 0.5mA
Storage and operating temperature	-55 to +125 degrees Celsius (storage), -40 – 65C (operating)
MTBF	150,000 hrs @ 50C, 96,000 hrs @65C
Efficiency (Input 9-16V)	>94%, all rails combined, 50% load
Input connector	Faston 0.25” terminal
Output Connector	ATX Power 20 pin (Molex P/N 39-01-2200)

Output Rail	Current (Max)	Current Peak (<30 seconds)	Regulation
5V	6A	8A	1.5%
3.3V	6A	8A	1.5%
5V Standby	1.5A	2A	1.5%
-12V	0.15A	0.2A	10%
+12V	4A (6-8V input) 5A (8-11 V input) 6A (11-16V input) 4A (16-24V input)	6A (6-8V input) 7A (8-11 V input) 8A (11-16V input) 7A (16-24V input)	2%

Note: When operating at <8V or >16V or extreme temperatures, de-rate by 25-50%, ventilation will be required.

Table 1. eInstrument PC Power Supply 80200-1 Characteristics

12V DC-DC Supply (80200-4)

Characteristic	
Input Voltage	12V+/-1V
Minimum input voltage	9V
Maximum input voltage	18V
Max Output Power	225 Watts (8-16V, see chart below)
Deep Sleep Current Consumption.	< 5mA
Storage and operating temperature	-55 to +125 degrees Celsius (storage), -40 – 65C (operating)
MTBF	150,000 hrs @ 50C, 96,000 hrs @65C
Efficiency (Input 9-18V)	>94%, all rails combined, 50% load
Input connector	Faston 0.25” terminal
Output Connector	ATX Power 24 pin (Molex P/N 15-24-7241)

Output Rail	Current (Max)	Current Peak (<30 seconds)	Regulation
5V	10A	12A	1.5%
3.3V	15A	20A	1.5%
5V Standby	1A	1.5A	1.5%
-12V	0.15A	0.2A	10%
+12V	10A	14A	2%

Note: When operating at <8V or >16V or extreme temperatures, de-rate by 25-50%, ventilation will be required.

Table 1. eInstrument PC Power Supply 80200-4 Characteristics

External Power Supply

Innovative uses a notebook style power supply as the AC power source.

Specifications	
Input Range	AC 100 to 240V, 50-60 Hz

Specifications	
Output Voltage	12V, 8.5A
Output Power	110W
Safety	IEC
Dimensions	171x35x60mm 6.74”x1.38”x2.37”
Weight	0.5 kg (1.1 lb)
Power Cord	IEC 320 C6

Table 2. External Power Supply Specifications

Power Controls

The eInstrument PC has power control circuitry that supports standby and normal power operation. The power mode is set by jumper JP20, located on the bottom of the card next to the COM Express module.

Jumper Setting	Mode
None	Disable power
1-2	Standby Mode Allowed
2-3	Always on

Table 3. Power Mode Control Jumper JP20

In the standby allowed mode, the COM Express module will enter standby mode if the CPU is inactive for a short time. The inactive period may be set in the control panel. The CPU will wake up on LAN or XMC activity. When the CPU is in standby, the front panel LED labeled “STANDBY”is lit. The front panel power button can also wake up the eInstrument PC.

The Always ON mode forces the CPU to be active at all times. This mode is useful if the CPU must be ready at all times for activity.

IMPORTANT! Power is NEVER completely off unless the 12V input is removed. Never install or remove an XMC module, GPS receiver, COM Express CPU or FLASH drive when power is on.

An auxiliary connector for remote power button is provided on JP3. Shorting JP3 will cause a power-on.

Power Consumption

The eInstrument PC power consumption varies with the COM Express module and the application software. XMC modules and mezzanine cards are additional.

Power consumption is quoted for a

Configuration	Voltage	Typical Current Required (A)	Typical Power (W)	Surge Current
90199-0 eInstrument PC with Radisys CE945GM Celeron 423 CPU @ 1.2 GHz, 4 GB, HDD, Windows No XMC modules installed	12V	1.8 (Mixed Activity) 2.1 (Calculating FFTs)	22 25	5A
90199-1 eInstrument PC with Radisys CE945GM Core2 Duo CPU @ 2 GHz, 4 GB, HDD, Windows No XMC modules installed	12V	3.4 (Mixed Activity) 4.5(Calculating FFTs)	41 54	10A
90199-2 eInstrument PC with Radisys CEG45GM Core2 Duo CPU @ 2.53 GHz, 4 GB, HDD, Windows No XMC modules installed	12V	2.6 (Mixed Activity) 3.9 (Calculating FFTs)	31 47	8A

Table 4. eInstrument PC Power Consumption

Environmental Limits

Table 5. eInstrument PC Environmental Limits

Condition	Limits
Operating Ambient Temperature	0 to 55 C
Humidity	5 to 95 %, non condensing
Storage Temperature	-30 to 85 C
Forced Air Cooling	Dependent on application
Vibration, operating	ETS 300 019- 1.3 [R3], class 3.3
Vibration, storage	ETS 300 019- 1.1 [R1], class 1.2
Vibration, transportation	ETS 300 019- 1.2 [R2], class 2.3 except for free-fall: class 2.2

J28, J29, J30, J31 - SMA Connectors

The SMA connectors are positioned on the front panel provide trigger and clock inputs to the eInstrument PC.

Connector Type	SMA 50 ohm
Number of Connections	1 per signal
Connector Part Number	Amphenol 901-143
Mating Connector	Amphenol 901-9511-3 or equivalent
Cable	Innovative part number 67048 SMA to BNC cable

Connector	Function
J28	Sample Clock 0
J29	Sample Clock 1
J30	Reference Clock Input
J31	Trigger Input

Figure 1. Connectors J28-J30 Functions

J15, J25 - XMC PCI Express Connectors

J15 is the XMC site PCI Express connector to the host, J25 is the XMC site 1 PCI Express connector

Connector Types	XMC pin header, 0.05 in pin spacing, vertical mount
Number of Connections	114, arranged as 6 rows of 19 pins each
Connector Part Number	Samtec ASP-105884-01
Mating Connector	Samtec ASP-105885-01

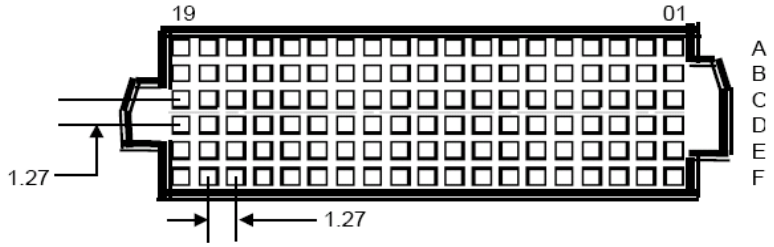


Figure 2. J15/J25 XMC Connector Pin Arrangement

	Column					
Row	A	B	C	D	E	F
1	PET0p0	PET0n0	3.3V	PET0p1	PET0n1	VPWR
2	GND	GND		GND	GND	MRSTI#
3	PET0p2	PET0n2	3.3V	PET0p3	PET0n3	VPWR
4	GND	GND		GND	GND	MRSTO#
5	PET0p4	PET0n4	3.3V	PET0p5	PET0n5	VPWR
6	GND	GND		GND	GND	+12V
7	PET0p6	PET0n6	3.3V	PET0p7	PET0n7	VPWR
8	GND	GND		GND	GND	-12V
9						GA0
10	GND	GND		GND	GND	VPWR
11	PER0p0	PER0n0	MBIST#	PER0p1	PER0n1	MPRESENT#
12	GND	GND	GA1	GND	GND	VPWR
13	PER0p2	PER0n2	3.3VAUX	PER0p3	PER0n3	MSDA
14	GND	GND	GA2	GND	GND	VPWR
15	PER0p4	PER0n4		PER0p5	PER0n5	MSCL
16	GND	GND	MVMRO	GND	GND	
17	PER0p6	PER0n6		PER0p7	PER0n7	
18	GND	GND		GND	GND	
19	PEX REFCLK+	PEX REFCLK-	FAN CONTROL	WAKE#	ROOT#	LED

Table 1. eInstrument PC XMC Connector P15 Pinout

Note: All unlabeled pins are not used by X5 modules but may defined in VITA42 and VITA42.3 specifications.

Note: Special function pins are shown in yellow. These are reserved pins on VITA 42.3 specification.

Table 2. J15/J25 Signal Descriptions

Signal	Direction (relative to eInstrument PC)	Description
PET0px/PET0nx	O	PCI Express Tx +/-
PER0px/PER0nx	I	PCI Express Rx +/-
PEX REFCLK+/-	O	PCI Express reference clock, 100 MHz +/-
MRSTI#	O	Master Reset Input, active low
MRSTO#	I	Master Reset Output, active low
GA0	O	Geographic Address 0
GA1	O	Geographic Address 1
GA2	O	Geographic Address 2
MBIST#	O	Built-in Self Test, active low
MPRESENT#	I	Present, active low
MSDA	I/O	PCI Express Serial ROM data
MSCL	O	PCI Express Serial ROM clock
MVMRO	O	PCI Express Serial ROM write enable
WAKE#	I	Wake indicator to upstream device, active low
ROOT#	I	Root device, active low
FAN CONTROL	I	Fan control from XMC. Fan is on when high.
LED#	I	Application LED control from XMC. LED is on when low.

J16, J26 – XMC Secondary Connectors

J16 is the XMC site 0 secondary connector to the host and is used for digital IO, data links and triggering functions. J26 is XMC Site 1 secondary connector.

Connector Types	XMC pin header, 0.05 in pin spacing, vertical mount
Number of Connections	114, arranged as 6 rows of 19 pins each
Connector Part Number	Samtec ASP-105884-01
Mating Connector	Samtec ASP-105885-01

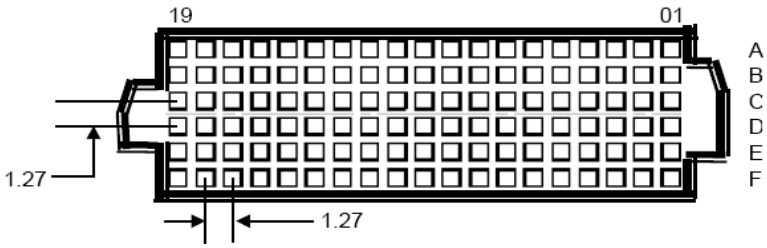


Figure 1. J16/J26 XMC Connector Pin Arrangement

Table 1. eInstrument PC XMC Secondary Connector P16/P26 Pinout (rev A only)

	Column					
Row	A	B	C	D	E	F
1	TXP0	TXN0		TXP1	TXN1	DIO19
2	DGND	DGND		DGND	DGND	DIO20
3	TXP2	TXN2		TXP3	TXN3	DIO21
4	DGND	DGND		DGND	DGND	DIO22
5	TXP4	TXN4		TXP5	TXN5	DIO23
6	DGND	DGND		DGND	DGND	DIO24
7	TCP6	TXN6		TXP7	TXN7	DIO25
8	DGND	DGND		DGND	DGND	DIO26
9						DIO27
10	DGND	DGND		DGND	DGND	DIO28
11	RXP0	RXN0		RXP1	RXN1	DIO29
12	DGND	DGND		DGND	DGND	DIO30
13	RXP2	RXN2		RXP3	RXN3	DIO31
14	DGND	DGND		DGND	DGND	DIO32
15	RXP4	RXN4		RXP5	RXN5	DIO33
16	DGND	DGND		DGND	DGND	DIO34
17	RXP6	RXN6		RXP7	RXN7	DIO35
18	DGND	DGND		DGND	DGND	DIO36
19						DIO37

Table 2. J16/J26 Signal Descriptions (rev A only)

Signal	Description
DIO19-37	Digital IO
TXP0-7/TXN0-7	Transmit pairs, P/N, from XMC modules
RXP0-7/RXN0-7	Receive pairs, P/N, from XMC modules

Table 3. eInstrument PC XMC Secondary Connector P16/P26 Pinout (rev B only)

	Column					
Row	A	B	C	D	E	F
1	TXP0	TXN0		TXP1	TXN1	DIO19
2	DGND	DGND	DIO1	DGND	DGND	DIO20
3	TXP2	TXN2		TXP3	TXN3	DIO21
4	DGND	DGND	DIO3	DGND	DGND	DIO22
5	TXP4	TXN4		TXP5	TXN5	DIO23
6	DGND	DGND	DIO5	DGND	DGND	DIO24
7	TCP6	TXN6		TXP7	TXN7	DIO25
8	DGND	DGND	DIO7	DGND	DGND	DIO26
9						DIO27
10	DGND	DGND	DIO9	DGND	DGND	DIO28
11	RXP0	RXN0		RXP1	RXN1	DIO29
12	DGND	DGND	DIO11	DGND	DGND	DIO30
13	RXP2	RXN2		RXP3	RXN3	DIO31
14	DGND	DGND	DIO13	DGND	DGND	DIO32
15	RXP4	RXN4		RXP5	RXN5	DIO33
16	DGND	DGND	DIO15	DGND	DGND	DIO34
17	RXP6	RXN6		RXP7	RXN7	DIO35
18	DGND	DGND		DGND	DGND	DIO36
19						DIO37

Table 4. J16/J26 Signal Descriptions (rev B only)

Signal	Description
DIO1,3,5,7,9,11,13,15,19-37	Digital IO
TXP0-7/TXN0-7	Transmit pairs, P/N, from XMC modules
RXP0-7/RXN0-7	Receive pairs, P/N, from XMC modules

Table 5. eInstrument PC XMC Secondary Connector P16/P26 Pinout (rev C+)

	Column					
Row	A	B	C	D	E	F
1	TXP0	TXN0	DIO0	TXP1	TXN1	DIO19
2	DGND	DGND	DIO1	DGND	DGND	DIO20
3	TXP2	TXN2	DIO2	TXP3	TXN3	DIO21
4	DGND	DGND	DIO3	DGND	DGND	DIO22
5	TXP4	TXN4	DIO4	TXP5	TXN5	DIO23
6	DGND	DGND	DIO5	DGND	DGND	DIO24
7	TCP6	TXN6	DIO6	TXP7	TXN7	DIO25
8	DGND	DGND	DIO7	DGND	DGND	DIO26
9			DIO8			DIO27
10	DGND	DGND	DIO9	DGND	DGND	DIO28
11	RXP0	RXN0	DIO10	RXP1	RXN1	DIO29
12	DGND	DGND	DIO11	DGND	DGND	DIO30
13	RXP2	RXN2	DIO12	RXP3	RXN3	DIO31
14	DGND	DGND	DIO13	DGND	DGND	DIO32
15	RXP4	RXN4	DIO14	RXP5	RXN5	DIO33
16	DGND	DGND	DIO15	DGND	DGND	DIO34
17	RXP6	RXN6	DIO16	RXP7	RXN7	DIO35
18	DGND	DGND	DIO17	DGND	DGND	DIO36
19			DIO18			DIO37

Table 6. J16/J26 Signal Descriptions (rev C+)

Signal	Description
DIO0-37	Digital IO
TXP0-7/TXN0-7	Transmit pairs, P/N, from XMC modules
RXP0-7/RXN0-7	Receive pairs, P/N, from XMC modules

JP1 - Xilinx JTAG Connector

JP1 is used for the Xilinx JTAG chain. It connects directly with Xilinx JTAG cables such as Parallel Cable IV or Platform USB.

Connector Types	14-pin dual row male header, 2mm pin spacing, vertical, center polarized
Number of Connections	14, arranged as 2 rows of 7 pins each
Connector Part Number	Molex 87831-1420
Mating Connector:	AMP 111623-3 or equivalent

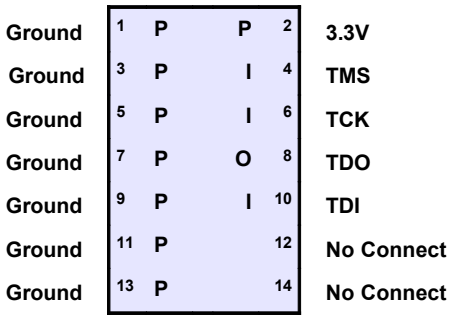


Figure 2. JP1 FPGA JTAG Connector Pinouts

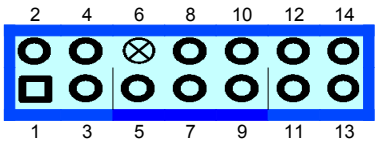


Figure 3. JP1 FPGA JTAG Connector Pin Orientation

JN1 - Rear Mezzanine Connector

JN1 is used for connection to mezzanine cards from the eInstrument PC FPGA

Connector Types	Vertical 1 mm dual row connector
Number of Connections	64, arranged as 2 rows of 32 pins each
Connector Part Number	Molex 71439-0164
Mating Connector:	Molex 71436

GND	1	P	P	2	3.3V S0
GND	3	P	P	4	3.3V S0
FDIO0	5	I/O	I/O	6	FDIO1
FDIO2	7	I/O	I/O	8	FDIO3
FDIO4	9	I/O	I/O	10	FDIO5
FDIO6	11	I/O	I/O	12	FDIO7
FDIO8	13	I/O	I/O	14	FDIO9
FDIO10	15	I/O	I/O	16	FDIO11
FDIO12	17	I/O	I/O	18	FDIO13
FDIO14	19	I/O	I/O	20	FDIO15
FDIO16	21	I/O	I/O	22	FDIO17
FDIO18	23	I/O	I/O	24	FDIO19
FDIO20	25	I/O	I/O	26	FDIO21
FDIO22	27	I/O	I/O	28	FDIO23
FDIO24	29	I/O	I/O	30	FDIO25
FDIO26	31	I/O	I/O	32	FDIO27
FDIO28	33	I/O	I/O	34	FDIO29
FDIO30	35	I/O	I/O	36	FDIO31
FDIO32	37	I/O	I/O	38	FDIO33
FDIO34	39	I/O	I/O	40	FDIO35
FDIO36	41	I/O	I/O	42	FDIO37
FDIO38	43	I/O	I/O	44	FDIO39
FDIO40	45	I/O	I/O	46	FDIO41
FDIO42	47	I/O	I/O	48	FDIO43
FDIO44	49	I/O	I/O	50	FDIO45
FDIO46	51	I/O	I/O	52	FDIO47
	53	-	-	54	
	55	-	-	56	
DIO38	57	I/O	I/O	58	TRIG4
	59	-	I/O	60	TRIG5
GND	61	P	P	62	+5V S0
GND	63	P	P	64	+12V S0

Figure 4. JN1 Mezzanine Connector Pinout

JN2 - Rear Mezzanine Connector (Revision A only)

JN2 is used for connection to mezzanine cards from the XMC modules and audio

Connector Types	Vertical 1 mm dual row connector
Number of Connections	64, arranged as 2 rows of 32 pins each
Connector Part Number	Molex 71439-0164
Mating Connector	Molex 71436

+5V S0	1	P	P	2	3.3V S0
+5V S0	3	P	P	4	3.3V S0
XMC0 DIO37	5	I/O	I/O	6	XMC1 DIO37
XMC0 DIO36	7	I/O	I/O	8	XMC1 DIO36
XMC0 DIO35	9	I/O	I/O	10	XMC1 DIO35
XMC0 DIO34	11	I/O	I/O	12	XMC1 DIO34
XMC0 DIO33	13	I/O	I/O	14	XMC1 DIO33
XMC0 DIO32	15	I/O	I/O	16	XMC1 DIO32
XMC0 DIO31	17	I/O	I/O	18	XMC1 DIO31
XMC0 DIO30	19	I/O	I/O	20	XMC1 DIO30
XMC0 DIO29	21	I/O	I/O	22	XMC1 DIO29
XMC0 DIO28	23	I/O	I/O	24	XMC1 DIO28
XMC0 DIO27	25	I/O	I/O	26	XMC1 DIO27
XMC0 DIO26	27	I/O	I/O	28	XMC1 DIO26
XMC0 DIO25	29	I/O	I/O	30	XMC1 DIO25
XMC0 DIO24	31	I/O	I/O	32	XMC1 DIO24
XMC0 DIO23	33	I/O	I/O	34	XMC1 DIO23
XMC0 DIO22	35	I/O	I/O	36	XMC1 DIO22
XMC0 DIO21	37	I/O	I/O	38	XMC1 DIO21
XMC0 DIO20	39	I/O	I/O	40	XMC1 DIO20
XMC0 DIO19	41	I/O	I/O	42	XMC1 DIO19
	43	I/O	I/O	44	
	45	I/O	I/O	46	
	47	I/O	I/O	48	
	49	I/O	I/O	50	
	51	I/O	I/O	52	
	53	I/O	I/O	54	
HEADPHONE OFF#	55	O	-	56	
AC BITCLK	57	I/O	O	58	AC SDOUT
AC SDIN0	59	I	O	60	AC SYNC
AC RST#	61	O	P	62	GND
+12V S0	63	P	P	64	GND

JN2 - Rear Mezzanine Connector (Revision B only)

JN2 is used for connection to mezzanine cards from the XMC modules and audio

Connector Types	Vertical 1 mm dual row connector
Number of Connections	64, arranged as 2 rows of 32 pins each
Connector Part Number	Molex 71439-0164
Mating Connector	Molex 71436

+5V S0	1	P	P	2	3.3V S0
+5V S0	3	P	P	4	3.3V S0
XMC0 DIO15	5	I/O	I/O	6	XMC1 DIO15
XMC0 DIO13	7	I/O	I/O	8	XMC1 DIO13
XMC0 DIO35	9	I/O	I/O	10	XMC1 DIO35
XMC0 DIO34	11	I/O	I/O	12	XMC1 DIO34
XMC0 DIO33	13	I/O	I/O	14	XMC1 DIO33
XMC0 DIO32	15	I/O	I/O	16	XMC1 DIO32
XMC0 DIO31	17	I/O	I/O	18	XMC1 DIO31
XMC0 DIO30	19	I/O	I/O	20	XMC1 DIO30
XMC0 DIO29	21	I/O	I/O	22	XMC1 DIO29
XMC0 DIO28	23	I/O	I/O	24	XMC1 DIO28
XMC0 DIO27	25	I/O	I/O	26	XMC1 DIO27
XMC0 DIO26	27	I/O	I/O	28	XMC1 DIO26
XMC0 DIO25	29	I/O	I/O	30	XMC1 DIO25
XMC0 DIO24	31	I/O	I/O	32	XMC1 DIO24
XMC0 DIO23	33	I/O	I/O	34	XMC1 DIO23
XMC0 DIO22	35	I/O	I/O	36	XMC1 DIO22
XMC0 DIO21	37	I/O	I/O	38	XMC1 DIO21
XMC0 DIO20	39	I/O	I/O	40	XMC1 DIO20
XMC0 DIO19	41	I/O	I/O	42	XMC1 DIO19
XMC0 DIO11	43	I/O	I/O	44	XMC1 DIO11
XMC0 DIO9	45	I/O	I/O	46	XMC1 DIO9
XMC0 DIO7	47	I/O	I/O	48	XMC1 DIO7
XMC0 DIO5	49	I/O	I/O	50	XMC1 DIO5
XMC0 DIO3	51	I/O	I/O	52	XMC1 DIO3
XMC0 DIO1	53	I/O	I/O	54	XMC1 DIO1
HEADPHONE OFF#	55	O	-	56	
AC BITCLK	57	I/O	O	58	AC SDOUT
AC SDIN0	59	I	O	60	AC SYNC
AC RST#	61	O	P	62	GND
+12V S0	63	P	P	64	GND

JN2 – IO Mezzanine Connector (Revision C+)

JN2 is used for connection to mezzanine cards from the XMC module 0

Connector Types	Vertical 1 mm dual row connector
Number of Connections	64, arranged as 2 rows of 32 pins each
Connector Part Number	Molex 71439-0164
Mating Connector	Molex 71436

+5V S0	1	P	P	2	3.3V S0
+5V S0	3	P	P	4	3.3V S0
XMC0 DIO0	5	I/O	I/O	6	XMC0 DIO19
XMC0 DIO1	7	I/O	I/O	8	XMC0 DIO20
XMC0 DIO2	9	I/O	I/O	10	XMC0 DIO21
XMC0 DIO3	11	I/O	I/O	12	XMC0 DIO22
GND	13	I/O	I/O	14	GND
XMC0 DIO4	15	I/O	I/O	16	XMC0 DIO23
XMC0 DIO5	17	I/O	I/O	18	XMC0 DIO24
XMC0 DIO6	19	I/O	I/O	20	XMC0 DIO25
XMC0 DIO7	21	I/O	I/O	22	XMC0 DIO26
GND	23	I/O	I/O	24	GND
XMC0 DIO8	25	I/O	I/O	26	XMC0 DIO27
XMC0 DIO9	27	I/O	I/O	28	XMC0 DIO28
XMC0 DIO10	29	I/O	I/O	30	XMC0 DIO29
XMC0 DIO11	31	I/O	I/O	32	XMC0 DIO30
GND	33	I/O	I/O	34	GND
XMC0 DIO12	35	I/O	I/O	36	XMC0 DIO31
XMC0 DIO13	37	I/O	I/O	38	XMC0 DIO32
XMC0 DIO14	39	I/O	I/O	40	XMC0 DIO33
XMC0 DIO15	41	I/O	I/O	42	XMC0 DIO34
GND	43	I/O	I/O	44	GND
XMC0 DIO16	45	I/O	I/O	46	XMC0 DIO35
XMC0 DIO17	47	I/O	I/O	48	XMC0 DIO36
XMC0 DIO18	49	I/O	I/O	50	XMC0 DIO37
	51	-	-	52	
	53	-	-	54	
	55	-	-	56	
	57	-	-	58	
	59	-	-	60	
	61	-	P	62	GND
+12V S0	63	P	P	64	GND

JN3– IO Mezzanine Connector (Revision C+)

JN3 is used for connection to mezzanine cards from the XMC module 1 and audio

Connector Types	Vertical 1 mm dual row connector
Number of Connections	64, arranged as 2 rows of 32 pins each
Connector Part Number	Molex 71439-0164
Mating Connector	Molex 71436

+5V S0	1	P	P	2	3.3V S0
+5V S0	3	P	P	4	3.3V S0
XMC1 DIO0	5	I/O	I/O	6	XMC1 DIO19
XMC1 DIO1	7	I/O	I/O	8	XMC1 DIO20
XMC1 DIO2	9	I/O	I/O	10	XMC1 DIO21
XMC1 DIO3	11	I/O	I/O	12	XMC1 DIO22
GND	13	I/O	I/O	14	GND
XMC1 DIO4	15	I/O	I/O	16	XMC1 DIO23
XMC1 DIO5	17	I/O	I/O	18	XMC1 DIO24
XMC1 DIO6	19	I/O	I/O	20	XMC1 DIO25
XMC1 DIO7	21	I/O	I/O	22	XMC1 DIO26
GND	23	I/O	I/O	24	GND
XMC1 DIO8	25	I/O	I/O	26	XMC1 DIO27
XMC1 DIO9	27	I/O	I/O	28	XMC1 DIO28
XMC1 DIO10	29	I/O	I/O	30	XMC1 DIO29
XMC1 DIO11	31	I/O	I/O	32	XMC1 DIO30
GND	33	I/O	I/O	34	GND
XMC1 DIO12	35	I/O	I/O	36	XMC1 DIO31
XMC1 DIO13	37	I/O	I/O	38	XMC1 DIO32
XMC1 DIO14	39	I/O	I/O	40	XMC1 DIO33
XMC1 DIO15	41	I/O	I/O	42	XMC1 DIO34
GND	43	I/O	I/O	44	GND
XMC1 DIO16	45	I/O	I/O	46	XMC1 DIO35
XMC1 DIO17	47	I/O	I/O	48	XMC1 DIO36
XMC1 DIO18	49	I/O	I/O	50	XMC1 DIO37
	51	-	-	52	
	53	-	-	54	
HEADPHONE OFF#	55	O	-	56	
AC BITCLK	57	I/O	O	58	AC SDOUT
AC SDIN0	59	I	O	60	AC SYNC
AC RST#	61	O	P	62	GND
+12V S0	63	P	P	64	GND

JP10, JP12, JP15 - USB Headers

These connectors are USB ports from the COM Express module. They may NOT be active on all modules – see module features list. The pinout of these USB ports is compatible with industry standards used on PC motherboards.

Connector Types	Single row male header, 0.1 in pin spacing, vertical
Number of Connections	5, arranged as 1 row
Connector Part Number	Berg 68001-236 (cut to length)
Mating Connector	Tyco 87499-9 Housing, 87667-1 contacts

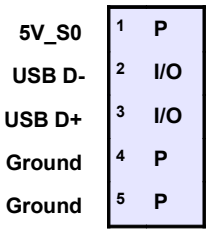


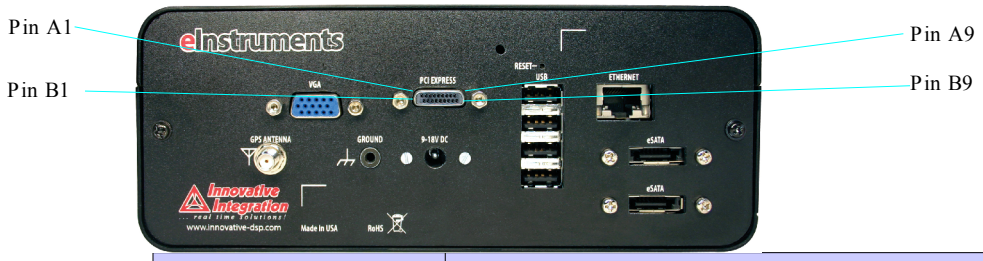
Figure 5. JP10, JP12, JP15 USB Header Pinouts

Note: Pin 1 is marked using a square solder pad and silkscreen notch.

P2 – Cabled PCI Express Connector

Connector P2 provides the cabled PCI Express port.

Connector Types	Miniature D-Sub, Male
Number of Connections	18 total, arranged as two rows of 9 each
Connector Part Number	Molex 74150-001
Mating Cable	See table of approved cables.



Pins	Signal
A1/A2	PEX_RXn/p
A5/A6	PEX REFCLKn/p
B8/B9	PEX Txn/p
A9, B1, B5	GROUND
A8	PEX RESETn
B3	WAKEn
B4	PRESENTn
B7	PWR ON
A4	SB_RTN
A3, A7, B2, B6	No Connects

Figure 6. P2 Cabled PCI Express Connector Pinout

COM Express CPU Site – P1

This connector is the COM Express CPU site connector. A “Type 2” pinout is used.

Connector Types	CONN, COM EXPRESS CARRIER TYPE 2, 440 PIN, 4 ROW, 8MM STACK HEIGHT
Number of Connections	440
Connector Part Number	Tyco 3-5353652-6
Type	2

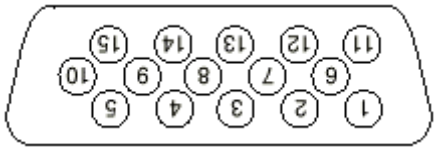
See the COM Express Specification for a detailed pinout of this connector.

VGA Connector – J27

This connector is the VGA port connector

Connector Types	HD DB15, FEMALE, RT ANGLE, PCB MT
Number of Connections	15
Connector Part Number	Tyco 1734344-1
Type	2

(As seen from rear panel.)



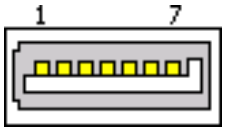


Pin	Type	Signal
1	O	RED
2	O	GREEN
3	O	BLUE
4	-	No connect
5	P	GND
6	I	RED RTN
7	I	GREEN RTN
8	I	BLUE RTN
9	P	+5V_S0
10	P	GND
11	-	NO CONNECT
12	I/O	I2C DATA
13	O	HORIZONTAL SYNC
14	O	VERTICAL SYNC
15	O	I2C CLOCK

U34, U35, U38, U39 – SATA Ports

These are the SATA ports from the COM Express module. These are not available on all COM Express modules. See module documentation for details.

Connector Types	CONNECTOR, SATA, 7PIN, VERTICAL, THROUGH HOLE
Number of Connections	7
Connector Part Number	Molex 67491-1032
Mating Cables	SATA 7 pin “L” type





Internal SATA Ports on motherboard

eSATA Ports on Rear Panel

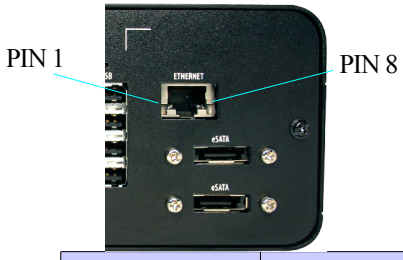
Pin	Type	Signal
1	P	Ground
2	O	Tx+
3	O	Tx-
4	P	Ground
5	I	Rx-
6	I	Rx+
7	P	Ground

Figure 7. U34, U35, U38, U39 SATA Connectors Pinout

U12 - Ethernet Connector

This connector provides the rear panel Ethernet port.

Connector Types	CONN, ETHERNET RJ45, INTEGRATED MAGNETICS FOR 1000BT
Number of Connections	8
Connector Part Number	Stewart L829-1J1T-43
Mating Cables	Modular RJ-45 CAT5/6 cables



Pin	Type	Signal
1	I/O	TP0+
2	I/O	P0-
3	I/O	TP1+
4	I/O	TP1-
5	I/O	TP2+
6	I/O	TP2-
7	I/O	TP3+
8	I/O	TP3-

Figure 8. U12 Ethernet Connector Pinout

JP11- FLASH Drive USB Header

This connector is the USB port used for the FLASH drive.

Connector Types	Dual row male header, 0.1 in pin spacing, vertical
Number of Connections	10, arranged as 2 rows of 5 pins
Connector Part Number	Sullins GBC05DABN-M30
Mating Connector	Connector on FLASH Drive (Intel Z-130)

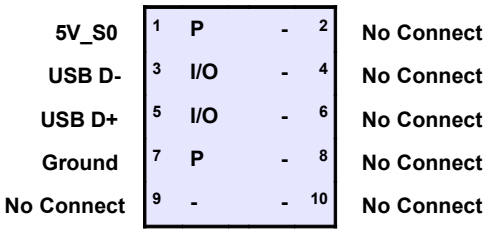


Figure 9. JP11 FLASH Drive USB Pinout

Note: Pin 1 is marked using a square solder pad and silkscreen notch.

P5 – ATX Power Connector

P5 is an ATX style power connector. Unique polarization pattern on this connector prevents incorrect mate orientation.

Connector Types	CONN ATX PWR, 12X2 4.2MM HEADER, VERTICAL, SHROUDED, POLARIZED, TIN
Number of Connections	24, arranged as 2 rows of 12 pins each
Connector Part Number	Molex 39-29-9242
Mating Connector	Molex 39-01-2245

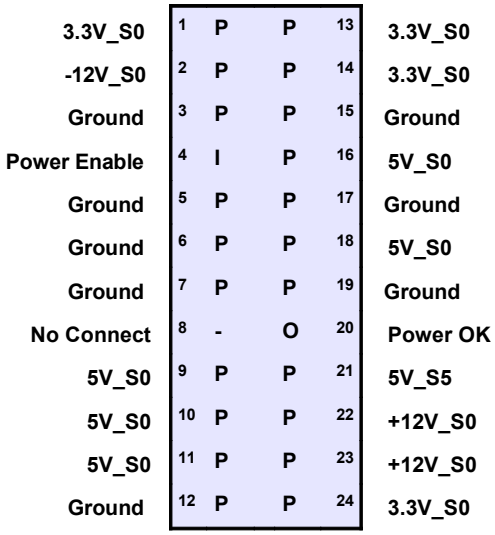


Figure 10. P5 ATX Power Connector

JP17 – GPS Module Connector

JP17 is the interface connector for the GPS module.

Connector Types	HEADER 13X2, MALE, VERTICAL, Through Hole, 50 MIL PIN GRID
Number of Connections	26, arranged as 2 rows of 13 pins each
Connector Part Number	Samtec FTS-113-01-L-D
Mating Connector	Samtec CLP-113-02-L-D

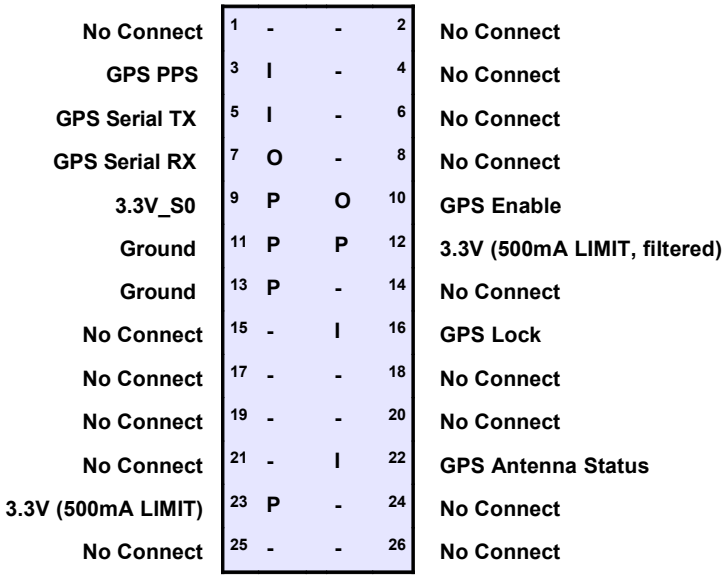
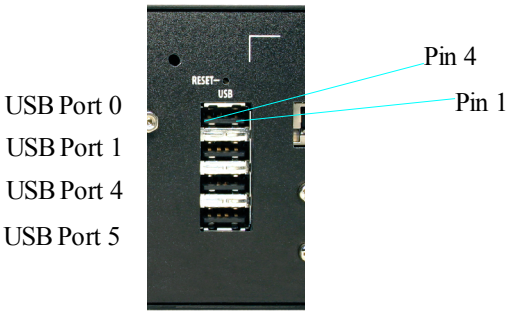


Figure 11. JP17 GPS Connector Pinouts

P3 -Rear Panel USB Ports

This connector is the 4 USB ports on the rear panel.

Connector Types:	Quad stack USB Connector
Number of Connections:	4 ports of 5 pins each
Connector Part Number	Molex 67857-0011
Mating Connector	USB Type A



Pin	Type	Signal
1	P	5V
2	I/O	USB D-
3	I/O	USB D+
4	P	Ground

Figure 12. P3 Rear Panel USB Ports Pinout

Rear Panel Power Jack

This connector power connector on the rear panel. The power connector can connect to many AC -DC supplies or a cable may be made with the mating connector specified. The outer diameter is 5.5 mm, the inner barrel is 2.1mm.

Connector Types:	Panel mount, 2.5x5.5x10.0 mm power jack
Number of Connections:	2 (barrel and inner jack)
Connector Part Number	Switchcraft 712A or L712A
Mating Connector	CUI P/N PP3-002B

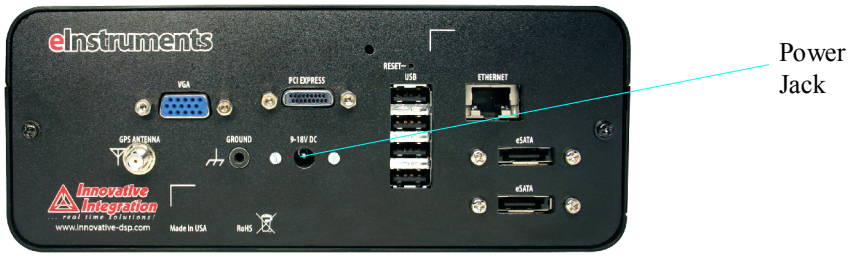


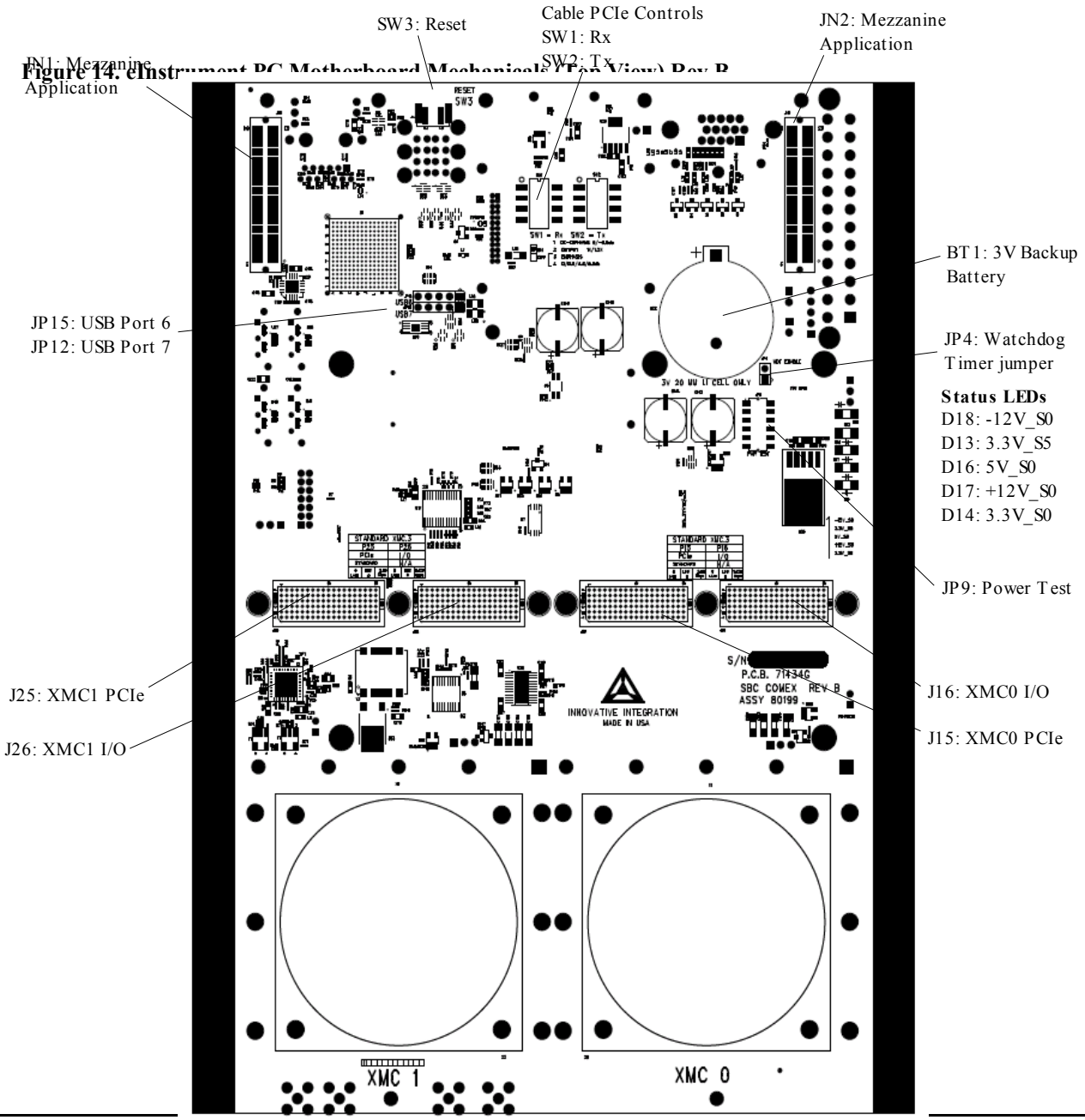
Figure 13. Rear Panel Power Jack

Mechanicals

The following diagrams show the eInstrument PC motherboard connectors and physical locations. Front and rear panels of the eInstrument PC are shown.

Detailed drawings for mechanical design work are available through technical support.

Figure 14. eInstrument PC Motherboard Mechanicals (Top View) Rev B



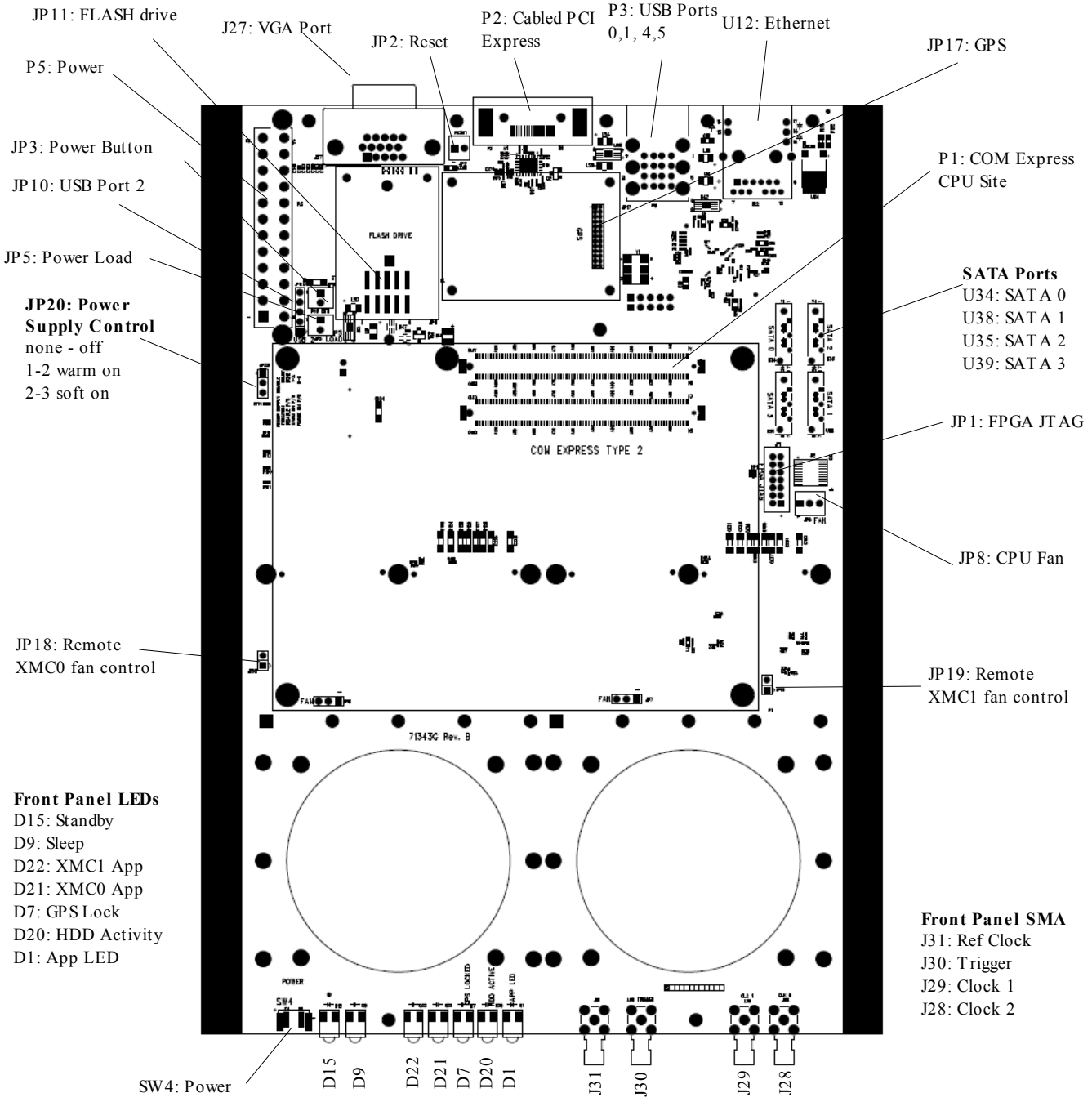


Figure 15. eInstrument PC Motherboard Mechanicals (Bottom View) Rev B

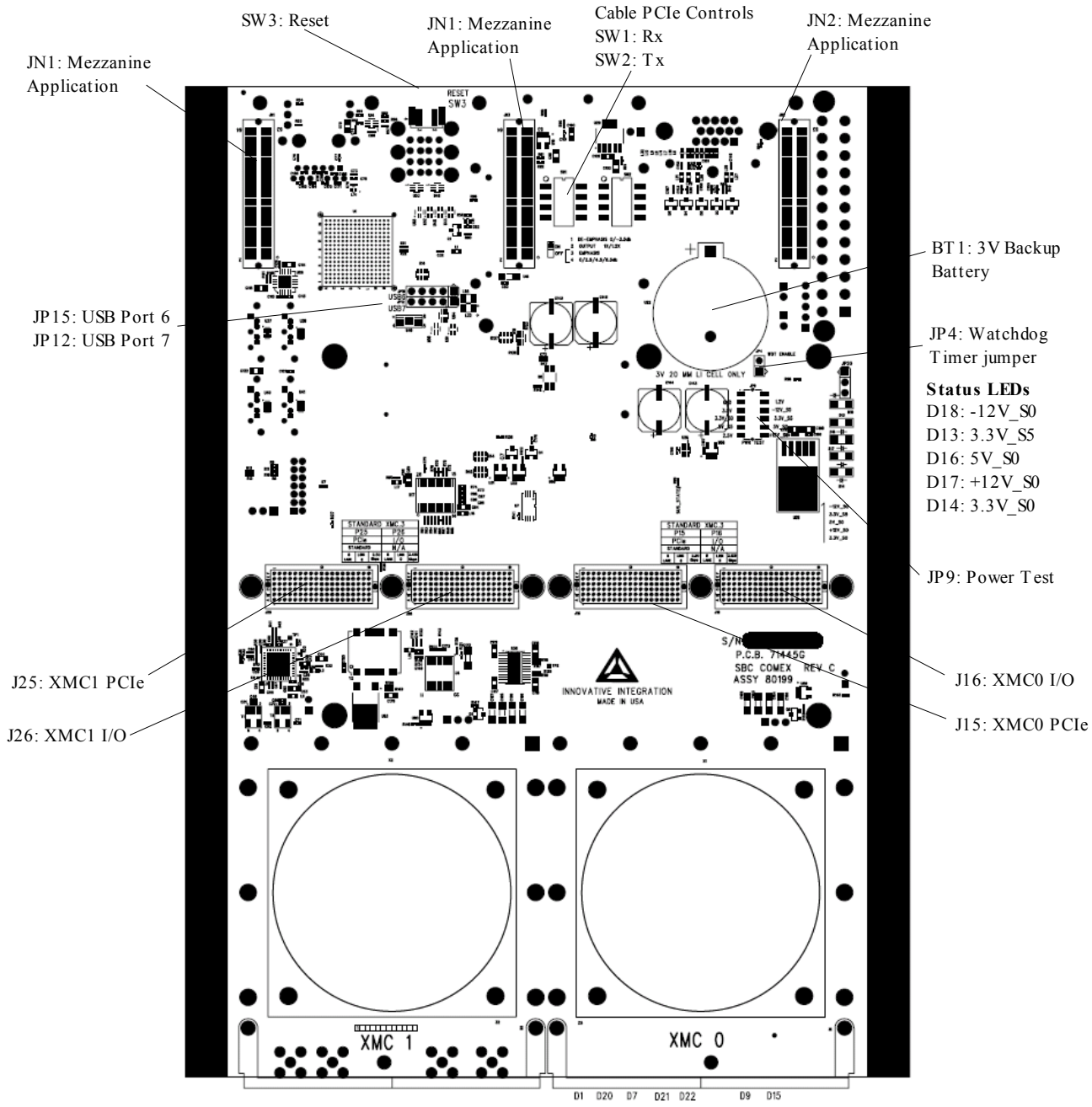


Figure 16. eInstrument PC Motherboard Mechanicals (Top View) Rev C

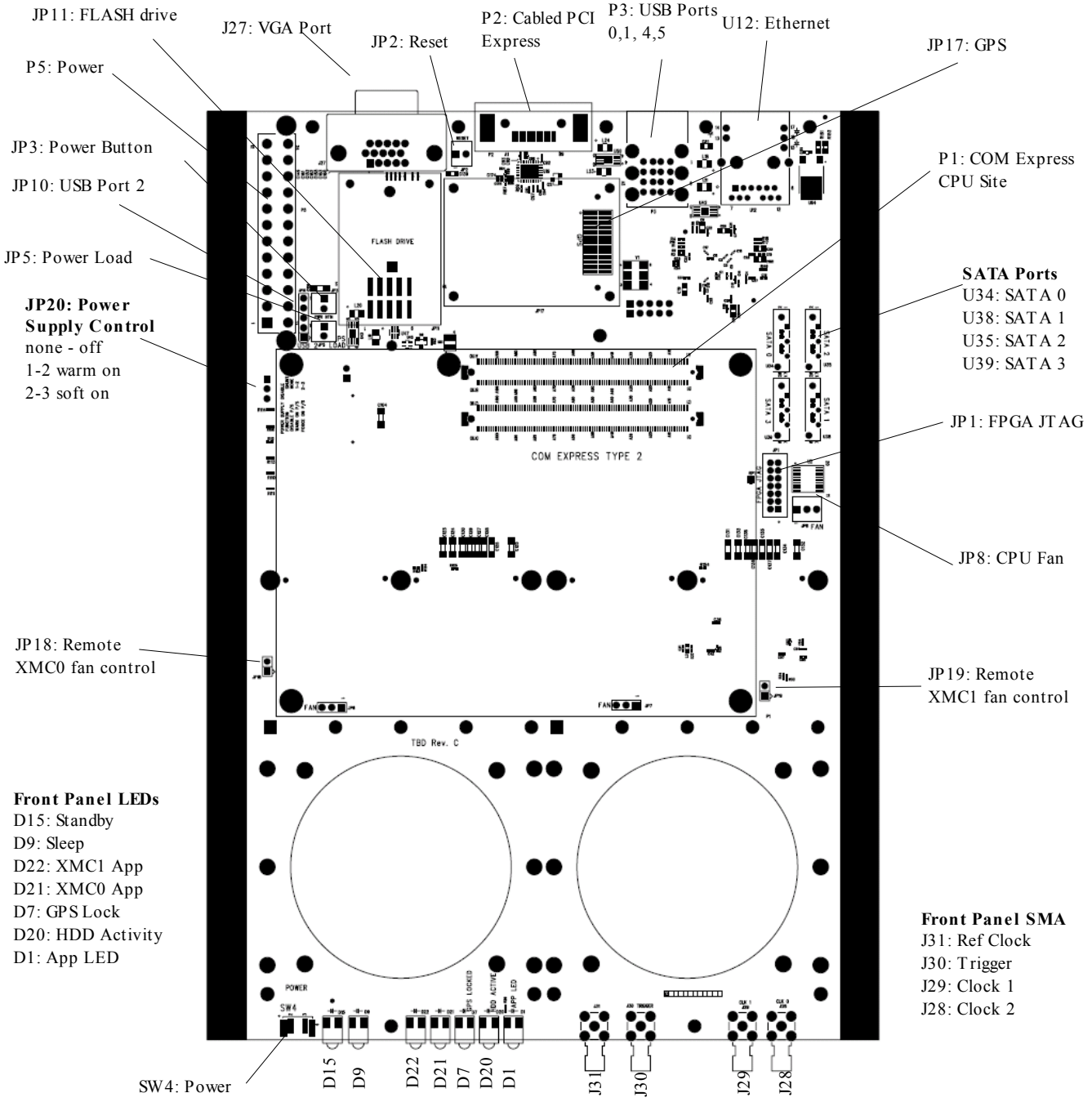


Figure 17. eInstrument PC Motherboard Mechanicals (Bottom View) Rev C



Figure 18. eInstrument PC Front Panel

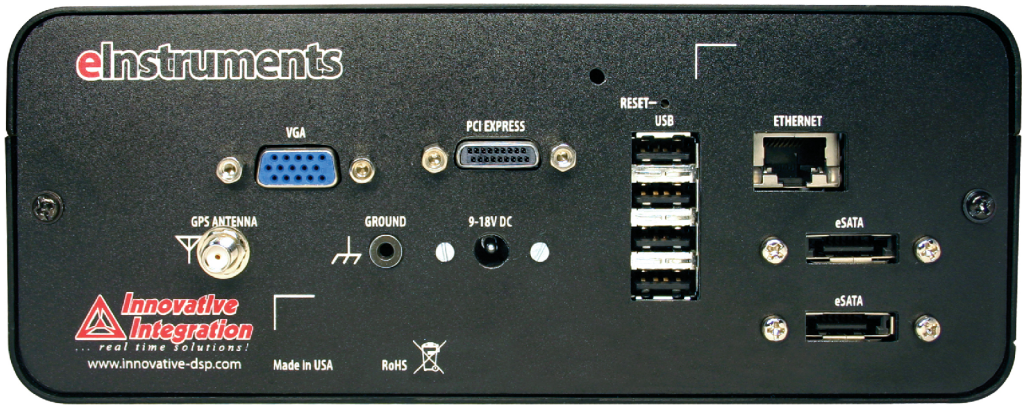
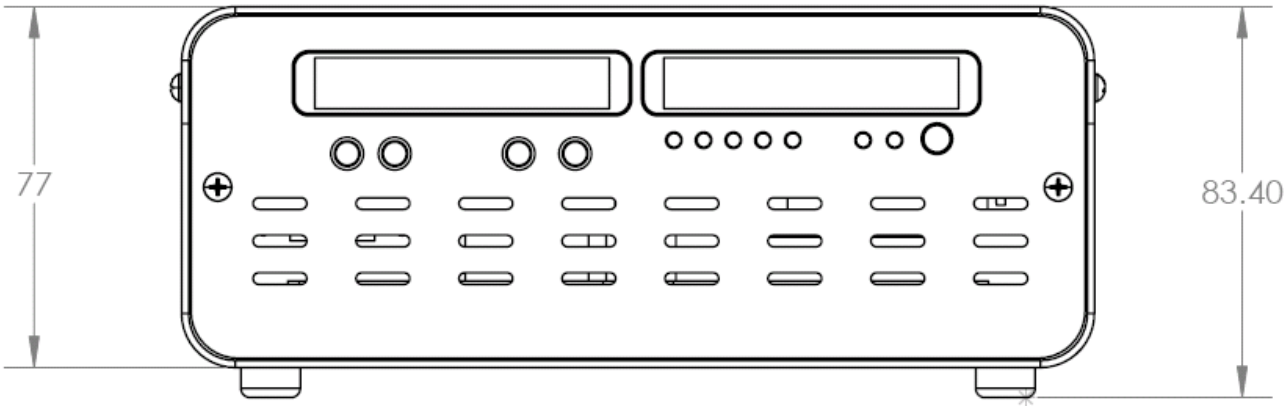
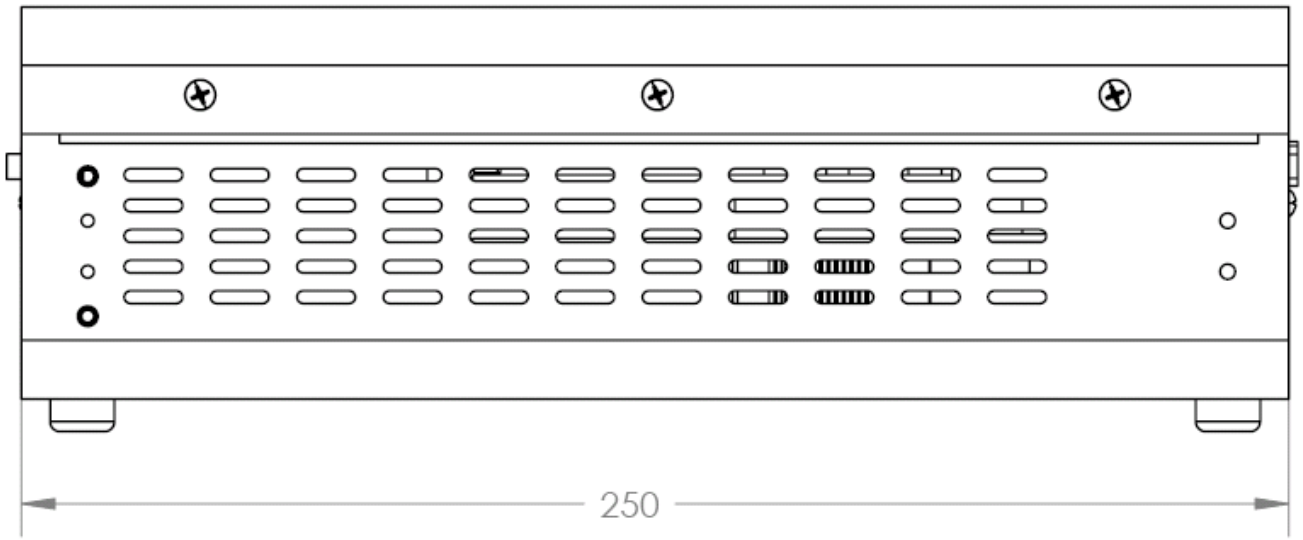


Figure 19. eInstrument PC Rear Panel



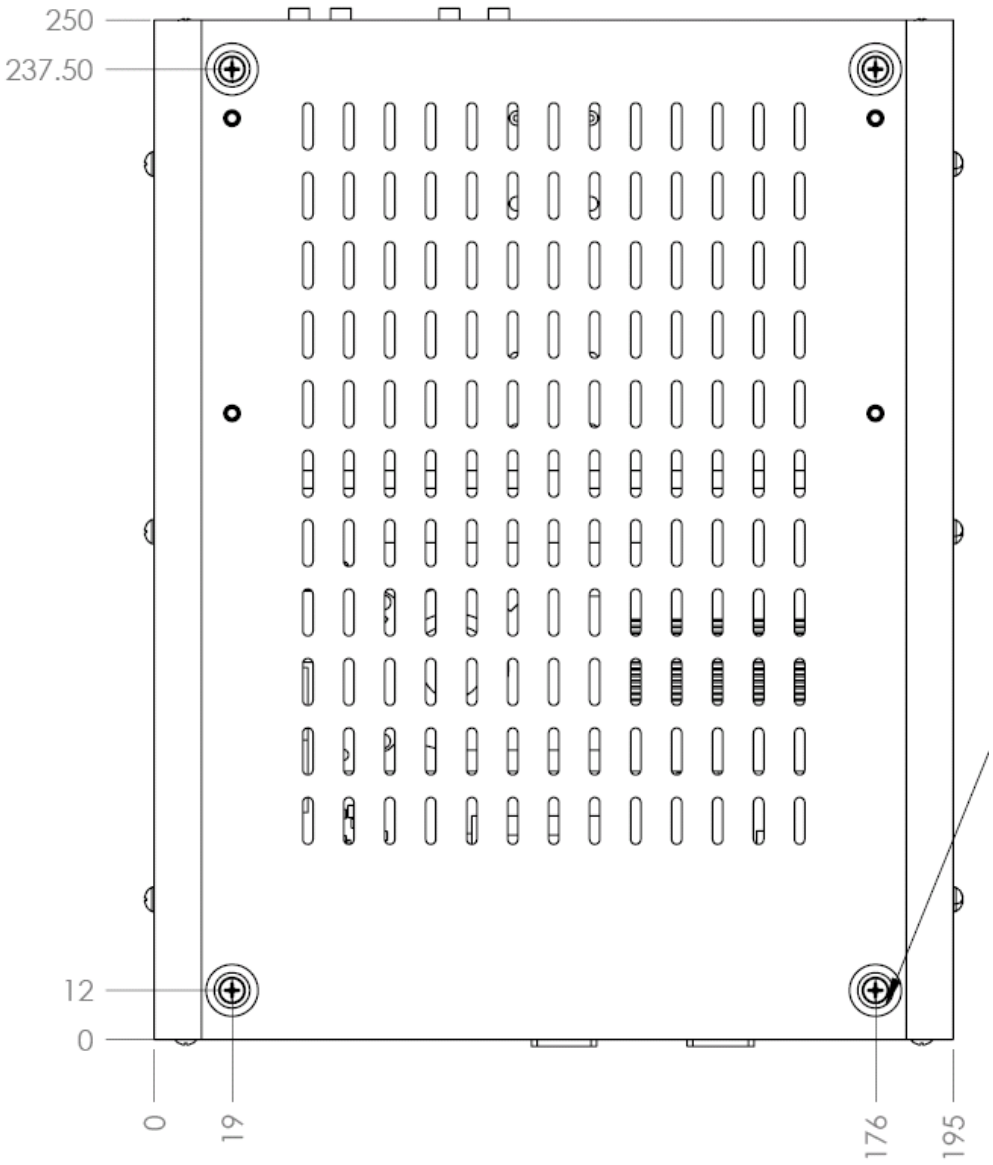
Note: Dimensions in mm

Figure 20. eInstrument PC Front View Overall Dimensions



Note: Dimensions in mm

Figure 21. eInstrument PC Side View Overall Dimensions



Note: Dimensions in mm

Figure 22. eInstrument PC Bottom View Overall Dimensions

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