ePC-K7

V2.0 5/23/16

INTERCONNECT SYSTEMS a molex company

Windows/Linux Embedded Computer with Kintex-7 FPGA, Dual FMC IO Sites, Integrated Timing Support

FEATURES

- Combines an industry-standard COM Express CPU Type 6 module with dual FMC IO modules in a compact, stand-alone design
- Programmable Kintex-7 325T/410T and Spartan-6 FPGAs
- Small form factor: 5” H x 8” W x 11” D
- Conduction cooled design: Fins or cold-plate
- Stand-alone operation: Able to operate headless, booting from SSD
- Windows, Linux OS support
- Dual VITA 57 FMC IO module sites. Add anything from RF receivers to industrial control modules
- IO sites deliver >3000MB/s to CPU memory**
- Integrated timing and triggering support for IO includes GPS, IEEE-1588 or IRIG -disciplined clock
- Supports Innovative and third-party FMC modules for private data channels, triggering and timing features
- USB 3.0 x2, 1Gb Ethernet x2, eSATA x2, DisplayPort, Touch Screen
- Up to 4x SSD or HDD (2.5 in)
- Flexible 8 to 36V DC operation

APPLICATIONS

- Embedded instrumentation
- Remote, autonomous IO
- Mobile instrumentation
- Distributed data acquisition

SOFTWARE

- Windows and Linux compatible
- Runs standard desktop applications
- MSVC / GNU C++ Developers Kit supporting IO integration and customization
- Device drivers, example software and support applets supplied for all peripherals

** Data rate dependent on the COM Express module capabilities

Figure 1. Front view of industrial, conduction-cooled ePC chassis

Figure 2. Rear view of industrial, conduction-cooled ePC chassis

Rugged, Compact PC with FPGA & FMC IO Sites

DESCRIPTION

The ePC-K7 is a user-customizable, turnkey embedded instrument that includes a full Windows/Linux PC and supports a wide assortment of ultimate-performance FMC modules. With its modular IO, scalable performance, and easy to use PC architecture, the ePC-K7 reduces time-to-market while providing the performance you need.

Distributed Data Acquisition – Put the ePC-K7 at the data source and reduce system errors and complexity. Optional GPS-synchronized timing, triggering and sample control is available for remote IO. Limitless expansion via multiple nodes. Up to 4 SSD or HDD for data logging.

Uniquely customizable - Dual FMC sites for IO, user-programmable FPGA for IO interfaces, triggering and timing control. Works with double width FMC modules. Expandable chassis tray for additional instrumentation.

Remote or Local Operation - Continuous data streaming up to 1000MB/s to SSD or 2000 Gb/s to Ethernet. Optional, stand-alone, autonomous operation with GPS-synchronized sampling.

Rugged – SSD boot drive support in a compact, rugged 8x11” footprint that is ready for embedded operation.

8-36V DC-Only Operation - Perfect for portable or automotive data loggers or waveform generators.

06/30/20

ePC-K7

ORDERING INFORMATION

Product	Part Number	Description
ePC-K7	90502-<CFG>-<ER>	ePC-K7 – (i7 CPU) User-customizable, turnkey embedded instrument consisting of SBC-K7 single-board computer with 2.1 GHz i7 Quad Core CPU, 16 GB DDR3 RAM, 1333 MHz FSB, 4x SATA ports (2x eSATA), 2x USB 3.0 plus USB 2.0 port for in-system use, 8-36V DC power supply, rugged enclosure with integrated heat spreaders, AC to DC Power adapter included (specify locale). 150W. No boot drive or OS, order separately. <CFG> is one of the available COM Express Module, FPGA type and speed configurations. <ER> is environmental rating L0..L4, per this table. For a complete list of operating system, SSD storage, GPS timing and all other options, visit the ePC-K7 online quotation page here.

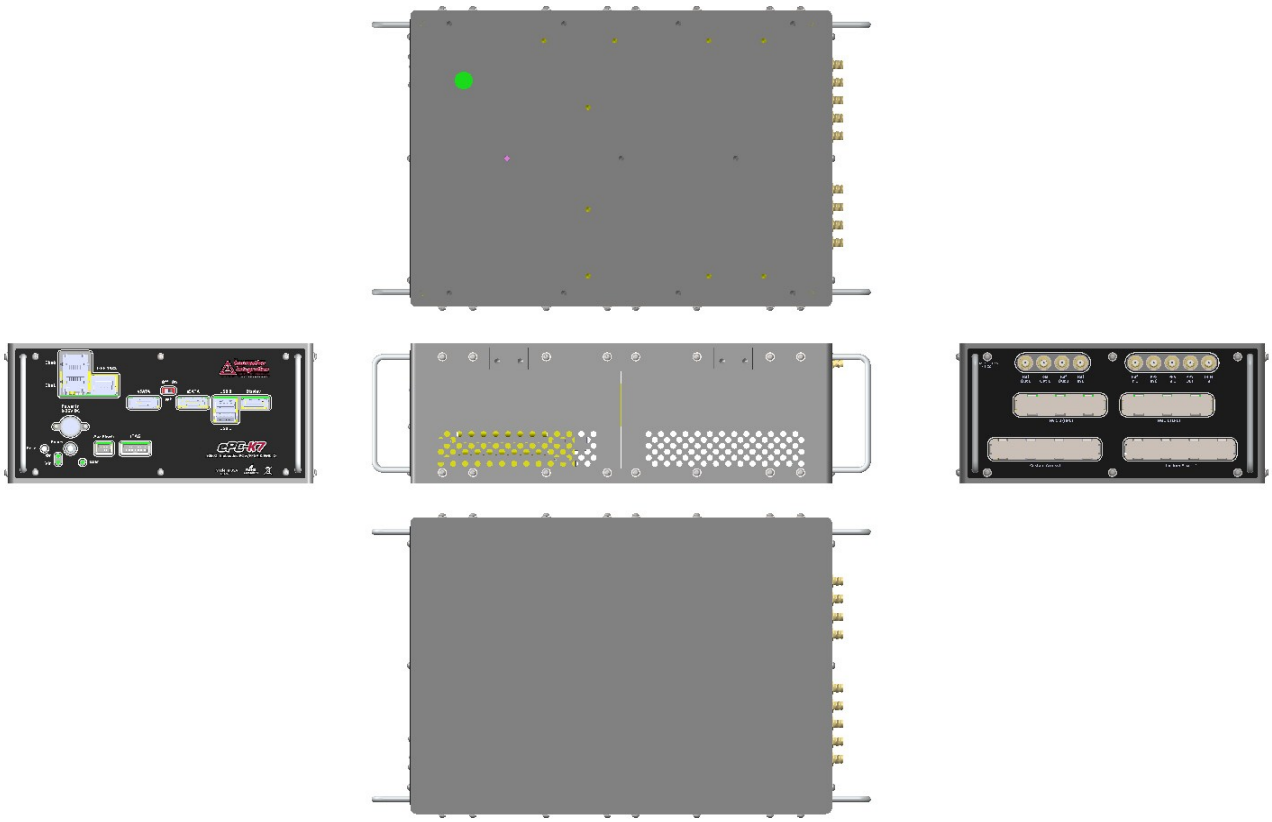


Illustration 1: Commercial ePC-K7 Chassis Isometric

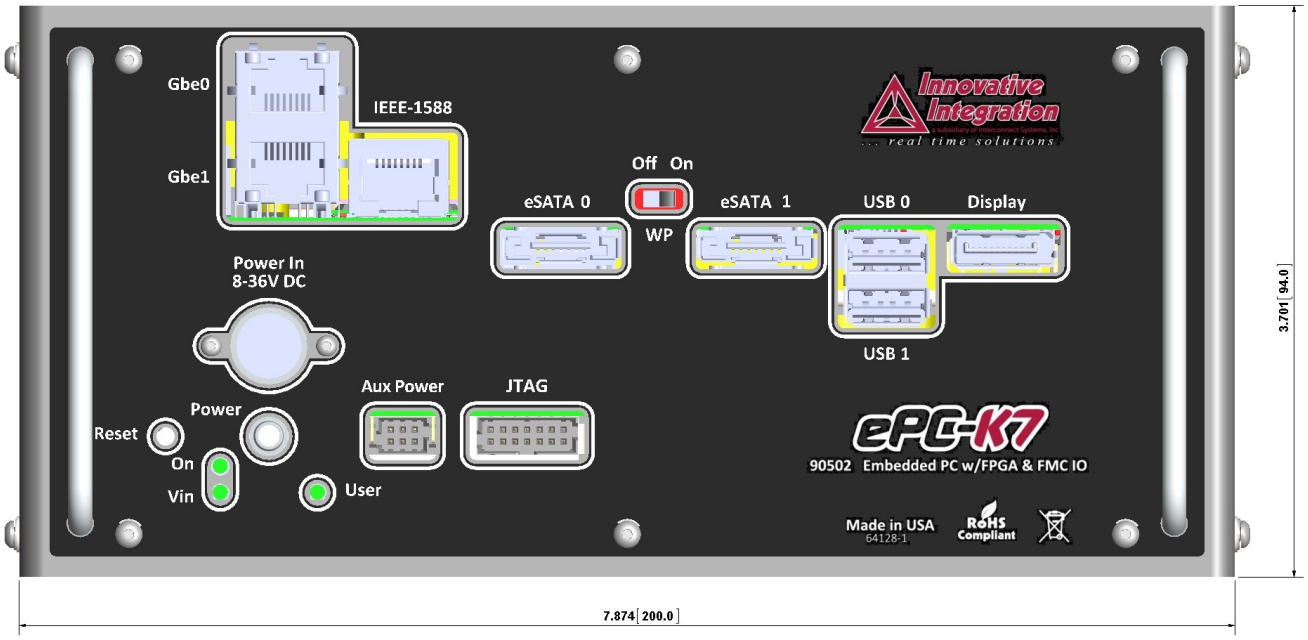


Illustration 2: Commercial ePC-K7 Chassis Front Panel

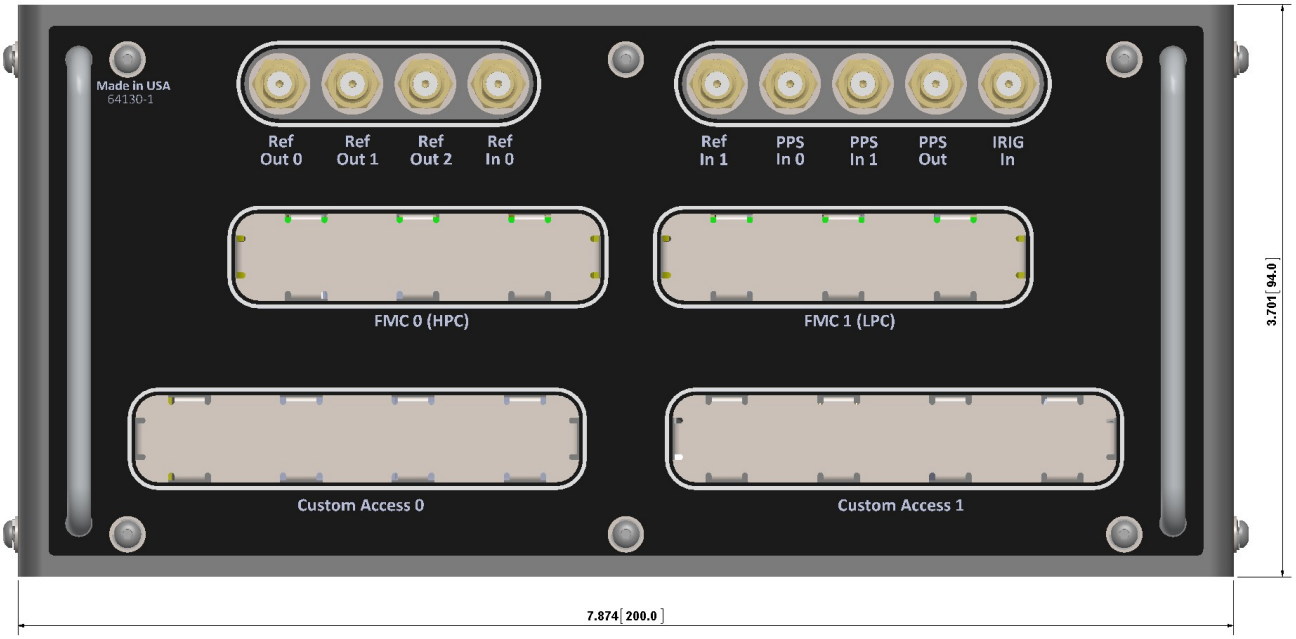


Illustration 3: Commercial ePC-K7 Chassis Rear Panel

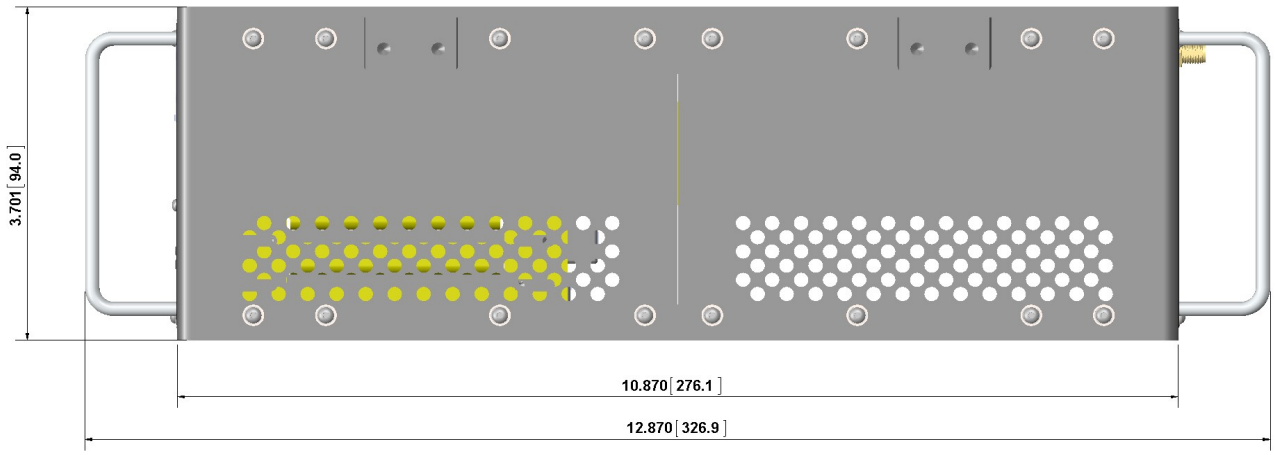


Illustration 4: Commercial ePC-K7 Chassis Side

Illustration 5: Commercial Chassis Front View

Illustration 6: Commercial Chassis Rear View

Illustration 7: Optional ruggedized packaging (contact factory for availability)

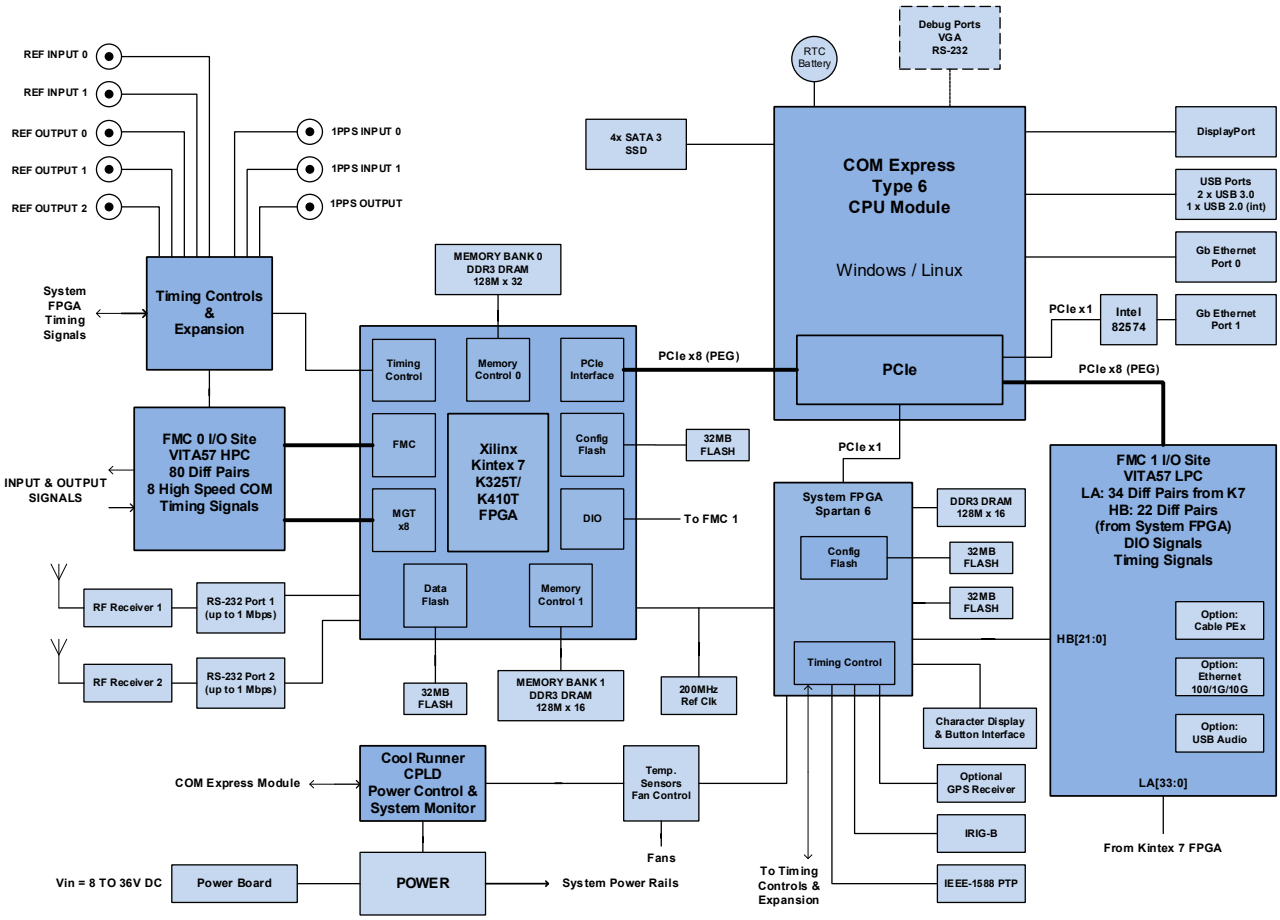


Illustration 8: ePC-K7 Block Diagram (typical application)

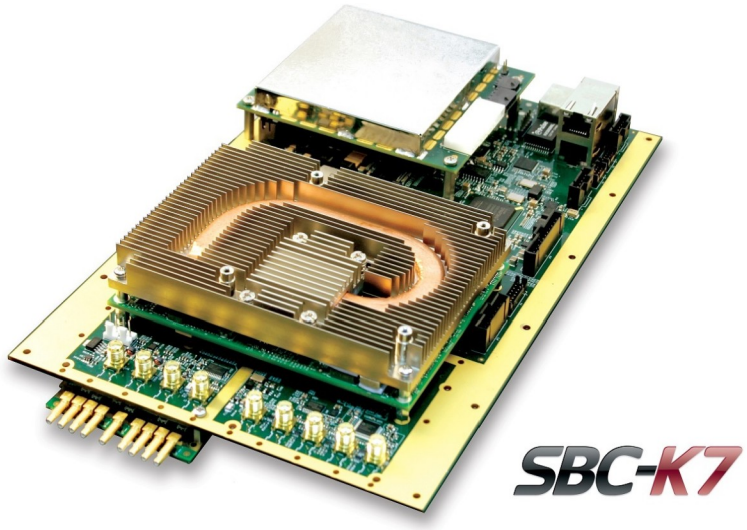


Illustration 9: SBC-K7 Carrier Board with COM Express TYPE 6 CPU Module and a single FMC Module, the heart of the ePC-K7 System

ePC-K7

Standard Features

FMC Sites	
Specification	VITA 57 FMC, HPC (FMC site 0) and LPC (FMC site 1). Double width FMC card supported
High Speed Pairs	8 lanes (Tx/Rx pair) 6.5 Gbps max rate
Signal Pairs	**FMC 0 (HPC)** - 80 diff pairs total LA: 34 diff pairs (K7 FPGA) HA: 24 diff pairs (K7 FPGA) HB: 22 diff pairs (K7 FPGA) **FMC 1 (LPC)** - 56 diff pairs total LA: 34 pairs (K7 FPGA) HB: 22 diff pairs (Spartan-6)
IO Standards	**FMC 0** LA, HA : LVCMOS25, LVDS25, LVDCI2, SSTL25, HSTL25 HB: all Kintex-7 IO standards supported **FMC 1** LA: LVCMOS25, LVDS25, LVDCI2, SSTL25, HSTL25 HB: All Spartan-6 IO standards supported
Power (available to each module)	3.3V @ 3A 12V @ 1A 3.3V AUX @ 0.5A Vadj = 2.5V @ 4A

FPGA	
Device	Xilinx Kintex-7
Speed Grades	-1, -2
Logic Cells	K325T: 326K K410T: 406K
Flip-Flops /Slices	K325T: 407K /50K K410T: 508K /63K
DSP48E1 elements/ BlockRAMs	K325T: 840 K410T: 1540
GTX 12.5 Gb/s Transceivers	16 available
Configuration	JTAG or on-board Flash NVRAM In-System reprogrammable

FPGA Memories 2 Banks Total	
DDR3 SDRAM	128M x 16 128 MHz x 32 clock rate 800 MHz

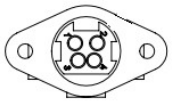
FPGA IO Interfaces	
PCI Express	Supports PCI Express Base 2.1 specification at Gen1 and Gen2 data rates

ePC-K7

COM Express CPU and Site	
Standards	PCIMG COM.0 COM Express Rev 2.0
Type	6
Size	Supports Basic (125 x 95 mm) or Compact (95 x 95 mm) module sizes
Verified Modules	Adlink: Type 6, Skylake i7-6820EQ 3.5GHz, 32 GB DDR4 @ 2133 MHz, ETT, CC
CPU Types	Skylake i7-6820EQ 3.5GHz
COM Express Memory	32 GB DDR4 @ 2133 MHz, ETT
BIOS	

PC Peripherals	
USB	2x USB 3.0/2.0 ports 2x USB 2.0 for internal in-system use
Ethernet	2x 10/100/1000 ports IEEE-1588 Precision Timing Protocol on dedicated port
SATA	4x SATA 6 Gb/s
Video/Audio	DisplayPort video port
Serial/CAN	RS232 and/or AX/RX port depending on the COM Express module used
GPS Port	UART (RS232) to GPS
Storage	SSD boot drive; removable SSD drive (4 total SATA ports are supported)
Touchscreen (optional)	LVDS panel support with I2C/USB touch controller Resolution up to 1280x768 @ 60Hz 18 or 24-bit pixel color depths
Watchdog Timer	Optionally resets CPU
Temperature Monitor	CPU monitor and independent system monitoring Over-temperature shutdown

Sample Clocks and Triggering	
Clock Sources	2x SMA for FMC external reference clocks; On-board high-precision crystal based reference clock
Time stamping/ Trigger Sources	2x SMA for 1 PPS external sources. Can be also used for FMC triggering
GPS (option)	10MHz reference disciplined to GPS signal 1 PPS timing reference input Position and UTC time reporting Support for Jackson Labs CSAC/ Symmetricom GPS-500 and similar units
IEEE-1588 PTP (option)	10MHz disciplined to PTP reference 1 PPS timing reference input Software stack runs on CPU Timing resolution to <100 ns

Power	
Consumption	30W typical baseline power (K325T @ 200 MHz clock rate, Atom CPU based COM Express module, FMC power not included)
Temperature Monitor	Software with programmable alarms Over-temperature protection
Power Control	Deep sleep mode FMC power controls
Cooling	Conduction cooled
Power Connector 	Kycon KPJX-PM-4S Pinout: Pin 1: +POWER Pin 2: +POWER Pin 3: GND Pin 4: GND

SATA/RAID 0 Data Rates		
	Adlink i7-6820EQ	Adlink i7-4700EQ
Single SSD	450 MB/s	450 MB/s
2 SSD RAID 0	850 MB/s	850 MB/s
4 SSD RAID 0	1300 MB/s	1050 MB/s
(NOTE: rates are limited by the capability of the RAID controller built in to the COM module)		

Physicals	
Form Factor	275 x 200 x 124 mm (11 x 8 x 5 in.)
Hazardous Materials	Lead-free and RoHS compliant

ABSOLUTE MAXIMUM RATINGS

Exposure to conditions exceeding these ratings may cause damage!

Parameter	Min	Max	Units	Conditions
Input Voltage Range (DC)	8	36	V	
Operating Temperature	5	60	C	Non-condensing, convective air flow or cold plate required
Storage Temperature	-40	+100	C	
ESD Rating	-	1k	V	Human Body Model
Vibration	-	5	g	9-200 Hz, Class 3.3 per ETSI EN 300 019-1-3 V2.1.2 (2003-04)
Shock	-	30g, 11mS	g peak	Class 3.3 per ETSI EN 300 019-1-3 V2.1.2 (2003-04)

ePC-K7

Architecture and Features

The ePC-K7 combines an embedded PC with integrated Xilinx Kintex-7 FPGA and two FMC IO module sites plus supporting peripherals. The architecture tightly couples the FPGA to the FMC and enables the card to perform real-time signal processing with low latency and extremely high rates, while providing all the ease-of-use and convenience of a PC. Along with available extension tray it allows to create a customizable instrument for a wide variety of applications.

Embedded PC

The ePC-K7 architecture is Windows/Linux compatible – it runs the same applications as a desktop computer. The COM Express CPU Type 6 module is a PC on a module and provides the computing engine, available with the advanced high-end multi-core Intel i7 processors as well as a low-power Atom CPU.

COM Express Advantages

- Intel compatible PC runs Windows, Linux
- Scalable performance
- Latest technologies: PCI Express 2.0, Gb Ethernet, USB 3.0, SATA 3.
- Upgradeable as requirements change and evolve
- Compact 95 x 125 mm form-factor
- Industry-standard, multi-vendor

The modularity of the COM Express module allows the ePC-K7 to be configured for the performance and power that is right for the application. When newer processors are available or the system requirements change, the COM Express module can be changed without changing the system architecture or software. Leveraging this industry standard also means that there are many vendors and varieties to choose from.

The COM Express module provides the PCI Express bus that links the FMC modules to the CPU. The PCI Express bus tightly couples the CPU to the FMC modules and outperforms previous generation systems by 2 to 4 times. Data transfer rates to CPU memory are at 3200 MB/s for both FMC sites.

The ePC-K7 provides familiar PC interfaces for expansion and connectivity: Gigabit Ethernet, USB ports, and SATA. The boot image can be stored on a rugged low power Solid State Drive (SSD). The ePC-K7 may also be booted from USB or Ethernet. Dual eSATA ports provide expansion to additional SSD or HDD for data storage.

The ePC-K7 operates either “headless” for embedded applications or supports a monitor, keyboard and mouse over the USB and DisplayPort. Standard PC DisplayPort screens with up to 2048x1536 resolution are supported. Support for touchscreen LCD panel makes standalone instruments easier to use while leveraging the PC development environment. In the headless mode, the ePC-K7 can be remotely controlled and accessed over Ethernet.

The CPU core connects to the FPGA over a x8 PCI Express link. This link supports up to ~3200 MB/s sustained transfer rates and is used as the primary data path between the CPU and FPGA (write-host is 3200 bidirectional and FPGA-FMC card is 6400 MB/s unidirectional). Software and firmware support high speed DMA transfers to the CPU, enabling data logging and signal processing on the CPU.

FMC IO Sites

Dual FMC IO module sites enable the ePC-K7 to be configured with a wide variety of IO modules. The FMC sites are for PCI Express mezzanine cards conforming to VITA 57.1 standard. Each FMC site has a heat frame routed directly under the module to support efficient conduction cooling. FMC Site 0 supports HPC (High Pin Count) modules; FMC Site 1 supports LPC (Low Pin Count) modules. Double width FMC module is also supported.

The Innovative FMC module families offer a range of analog performance mated to the state-of-the-art performance of the Kintex-7 FPGA computing core. Innovative's Velocia architecture data packet system allows these modules to stream data continuously to system memory at rates up to 3.2 GB/s – making the ePC-K7 well suited for data logging and playback functions. When configured with a four SSD RAID0 array, sustained rates to 2000MB/s are achievable.

ePC-K7

Importantly, all Innovative FMC modules for the ePC-K7 support simultaneous sampling, triggering, controls and private inter-module communications. System triggers and matched reference clocks from the baseboard provide simultaneous sampling for the two modules. The FMC modules are interconnected via the Spartan-6, so they can communicate bidirectionally for real-time applications demanding low latency and deterministic performance.

Triggering and Sample Clocks

The ePC-K7 has unique clocking and triggering features for the FMC modules. Each module receives two triggers from Application FPGA and two clock inputs through its mezzanine connector. Innovative FMC modules can use these to support simultaneous sampling and unique trigger scenarios using the Kintex-7 application FPGA.

Sample clocks for the FMC modules can be generated using an on-card PLL or from an external reference clock input. The PLL can use either the internal FMC generated clock or the external clock input from the baseboard, which can be selected from a few available options - GPS/IRIG/IEEE-1588 disciplined clock - as a reference. The disciplined clock allows multiple, remote instruments to sample simultaneously and act cooperatively. Position and time data is also available from the GPS when installed.

Remote Operation

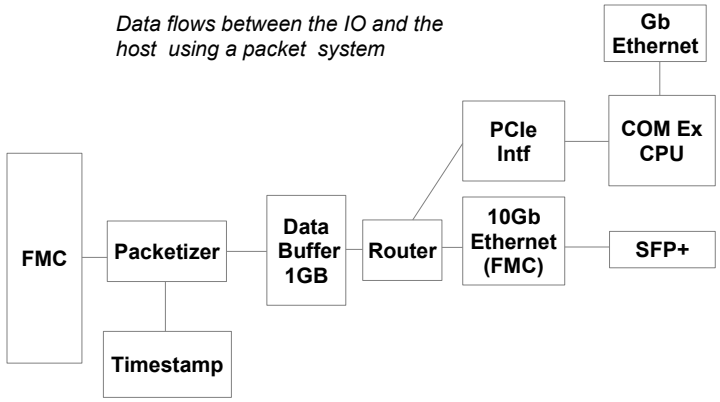
ePC-K7 can be operated using Ethernet as a remote computer or embedded instrument. For pure embedded operation, the ePC-K7 can operate "headless" without monitor, keyboard or mouse. The system boots from a SATA SSD or HDD.

Application FPGA

The Kintex-7 application FPGA allows the ePC-K7 to be customized for many IO functions, such as triggering and control features. The FPGA is a PCIe bus peripheral to the COM Express CPU. New functions can be added to the system as PCIe devices by adding them to the FPGA design. FPGA logic is provided in the FrameWork Logic tools, which includes the standard functionality that

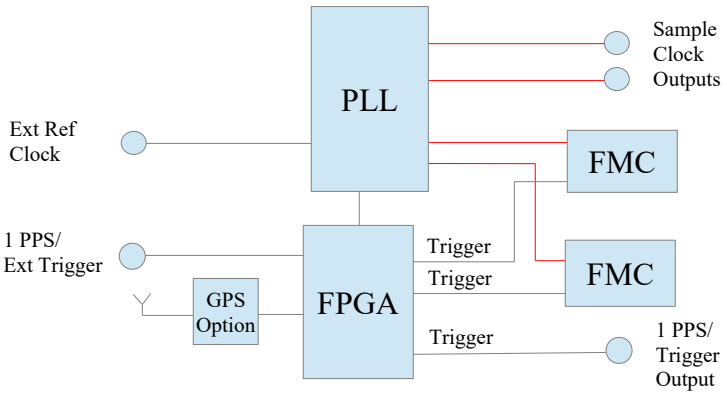
FMC Modules for IO

- Flexible, modular IO
- Industry-standard VITA 57.1
- PCI Express with up to 3.2 GB/s transfer rates
- Innovative modules for SDR, IF Rx and Tx and digital communications
- Third party modules with wide I/O complement
- Industry-standard, multi-vendor



Example ePC-K7 Architecture

Sample Controls and Clocking



can be modified or used as an example.

The Kintex-7 logic is loaded from an on-card NVRAM that is field reprogrammable. Development uses a Xilinx USB Platform II JTAG Cable and Xilinx ISE development tools (free download at www.xilinx.com).

Software Tools

Software development tools for the ePC-K7 provide comprehensive support including device drivers, data buffering, card controls, and utilities that allow developers to be productive from the start. At the most fundamental level, the software tools deliver data buffers to your application without the burden of low-level real-time control of the cards. Software classes provide C++ developers a powerful, high-level interface to the card that makes real-time, high speed data acquisition easier to integrate into applications.

Software for data logging and analysis are provided with every Innovative FMC module. Data can be logged to system memory at full rate or to disk drives at rates supported by the drive and controller. Triggering and sample rate controls are provided to support data acquisition applications without writing code. Innovative software applets include *Binview* which provides data viewing with FFT function, analysis and import to MATLAB for large data files.

Support for MS Visual C++ is provided. Supported OSes include Windows and Linux (including real-time variants). Download the software tools User Guide and on-line help for more information.

Logic Tools

Customized IO interfaces, triggering and other unique features may be added to the ePC-K7 by modifying the FPGA logic. The FrameWork Logic tools provide support for VHDL/Verilog developments. Application logic can be modified by building upon the Innovative components for hardware interfaces and system functions. Each design is provided as a Xilinx ISE project with VHDL source for top level logic with a ModelSim testbench illustrating logic functionality.

FMC Modules

Plug FMC modules into the ePC-K7 to build your custom, turnkey embedded instrument. Innovative Integration offers an array of ultra-performance, FMC modules to create your solution.

Innovative FMC modules feature analog and digital IO which is directly controlled by the Kintex 7 FPGA located on the SBC-K7 carrier board, which functions as a FPGA computing engine connected to the host via a high performance PCI Express bus. The FrameWork Logic development tools allow you to design in MATLAB and VHDL and rapidly implement high speed signal processing on the FMC.

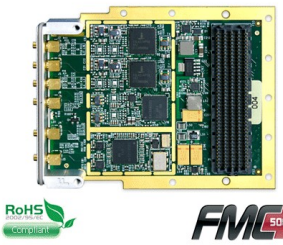
Some of the Innovative FMC modules are shown in the table below.

See the full selection of FMC IO modules here.

ePC-K7

FMC-250

FMC Module with 2x 250 MSPS 16-bit ADCs, 2x 625 MSPS (up to 1230 MSPS with Interpolation) 16-bit DACs with PLL and Timing Controls
P/N 80315



FMC-500M

FMC Module with 2x 500 MSPS 14-bit ADCs, 2x 625 MSPS (up to 1230 MSPS with Interpolation) 16-bit DACs with PLL and Timing Controls
P/N 80281

FMC-SFP+

FMC Module with Four SFP+ Ports
P/N 80285

ePC-K7

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