F75P – 3U CompactPCI® PlusIO Safe Railway Computer

- **2x Intel® Atom™ E6xx, 512 MB DDR2 RAM (each) for onboard dual redundancy**
- **1x Intel® Atom™ E6xx, 1 GB DDR2 for I/O**
- **Independent supervisors for each block**
- **Fail-safe and fail-silent board architecture**
- **Clustering of two F75P to raise availability**
- **Event logging**
- **Certifiable up to SIL 4 (with report from TÜV SÜD)**
- **Developed according to EN 50129, EN 50128 and IEC 61508**
- **Full EN 50155 compliance**
- **-40 to +85°C qualified**
- **Conformal coating**

The F75P is a COTS computer with onboard functional safety that unites three CPUs on one 3U CompactPCI® PlusIO card. It makes Intel® Atom™ E6xx ("E600") performance with dual redundancy extremely compact, mainly targeting railway applications. Two independent Control Processors (CP) with independent DDR2 RAM and Flash and a supervision structure provide safety: with redundant software running on F75P, and with the software instances on the two CPs comparing their output, the board becomes a fail-silent subsystem, i.e. it can shut down in case of a fatal fault.
Its I/O Processor (IOP) is built up like a classic CompactPCI® CPU board, including DDR2 RAM, front and rear I/O. The front connectors include VGA, two USB 2.0, and two 100-Mbit (Fast) Ethernet channels. At the rear, the board provides another four USB 2.0, two Fast Ethernet ports, one 3-Gbit SATA and one PCI Express® x1 link. These interfaces comply with the standardized pinout of CompactPCI® PlusIO (PICMG 2.30). An onboard mSATA slot makes for scalable, robust mass storage. The intelligent board management controller of the IOP logs events such as reset, overvoltage or undervoltage in a non-volatile FRAM.
The Control (CP) and I/O Processors (IOP) communicate via internal Ethernet links provided by an FPGA. While the IOP also supports Windows®, the CPs are designed to run a deterministic real-time operating system such as VxWorks® or PikeOS. It is also possible to implement diversitary software on both kernels. All three CPUs support Linux and VxWorks®.
The F75P can replace multiprocessing systems with CPU redundancy and I/O by a small-footprint, low-power solution that is flexible for different types of application scenarios. It uses a single +5V supply voltage to allow operation with external power supplies that do not generate +3.3 V.
A clustering option is considered as well, to increase system availability: two F75P boards can operate next to each other, and can provide hot or cold stand-by.
F75P-based systems are generally certifiable up to SIL 4. Since the card has no voter of its own, the software that implements and controls functional safety behavior has to be added by the customer. The safety features such as the CP supervisors are designed to SIL 4 according to EN 50129. The board comes with the "safety case" document and a certificate from TÜV SÜD.
Its rugged set-up also make the F75P truly rail-ready: with assets like conformal coating and an operating temperature of -40 to +85°C with qualified components, it is fully EN 50155 compliant. A 4-HP version is available with RJ45 Ethernet connectors and a reduced temperature range for system design, while another standard card with 8 HP width provides the necessary space for M12 front connectors and a larger heat sink for -40 to +85°C.

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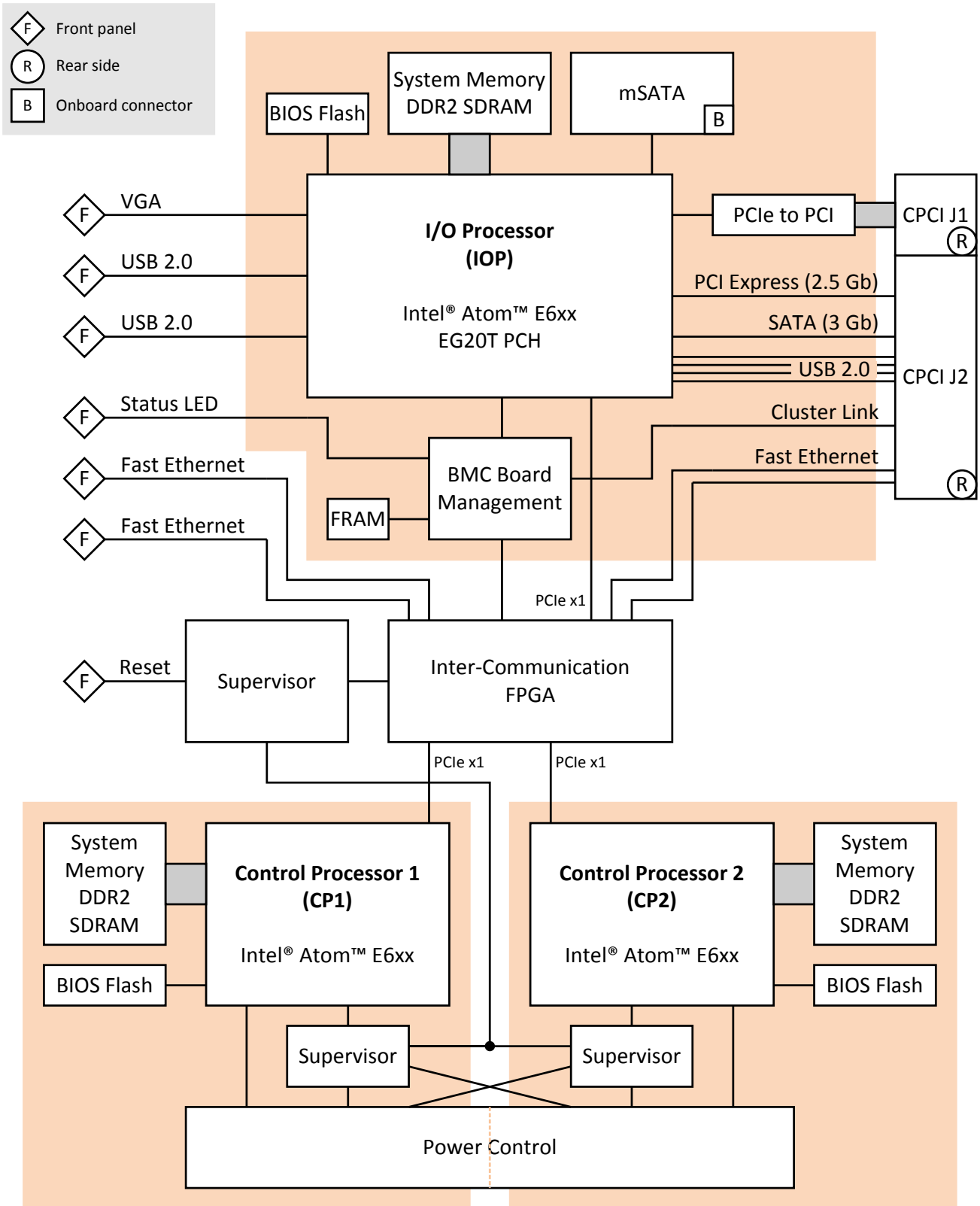
Diagram


F Front panel
R Rear side
B Onboard connector
BIOS Flash
System Memory DDR2 SDRAM
mSATA
B
VGA
USB 2.0
USB 2.0
I/O Processor (IOP)
Intel® Atom™ E6xx EG20T PCH
PCIe to PCI
CPCI J1
R
PCI Express (2.5 Gb)
SATA (3 Gb)
USB 2.0
CPCI J2
Status LED
Cluster Link
Fast Ethernet
Fast Ethernet
Fast Ethernet
BMC Board Management
FRAM
R
PCIe x1
Reset
Supervisor
Inter-Communication FPGA
PCIe x1
PCIe x1
System Memory DDR2 SDRAM
Control Processor 1 (CP1)
Intel® Atom™ E6xx
Control Processor 2 (CP2)
Intel® Atom™ E6xx
System Memory DDR2 SDRAM
BIOS Flash
BIOS Flash
Supervisor
Supervisor
Power Control

Technical Data

CPUs	■ Three onboard processors □ Two Control Processors (CP) □ One I/O Processor (IOP) ■ Intel® Atom™ E6xx Series □ 0.6 GHz to 1.6 GHz processor core frequency □ Three identical processors □ Please see Standard Configurations and Options below for options and available standard versions. ■ Chipset □ Intel® EG20T Platform Controller Hub (PCH) □ Implemented only once for I/O Processor
Memory	■ 512 KB L2 cache integrated in E6xx for each processor ■ Up to 1 GB SDRAM system memory to each of the Control Processors (CP) □ Soldered □ DDR2 □ 800 MHz memory bus frequency (800 MT/s data rate) ■ Up to 2 GB SDRAM system memory to I/O Processor (IOP) □ Soldered □ DDR2 □ 800 MHz memory bus frequency (800 MT/s data rate) ■ 2 MB BIOS Flash ■ 8 KB non-volatile FRAM connected to IOP for event logging ■ mSATA disk slot □ Connected via one SATA channel ■ Please see Standard Configurations and Options below for options and available standard versions.
Mass Storage	■ Serial ATA (SATA) □ One port for mSATA onboard devices □ One port for rear I/O □ SATA Revision 2.x support □ Transfer rates up to 300 MB/s (3 Gbit/s)
Graphics	■ Integrated in E6xx processor □ 320 or 400 MHz graphics base frequency, depending on processor type □ Maximum resolution: 1280 x 1024 pixels ■ VGA connector at front panel
I/O	■ USB □ Six USB 2.0 host ports □ Two Series A connectors at front panel □ Four ports via rear I/O on CompactPCI® J2 □ OHCI and EHCI implementation □ Data rates up to 480 Mbit/s ■ Ethernet □ Four 10/100Base-T Ethernet channels □ Two channels via RJ45 or M12 connectors at front panel, with status LEDs □ Two channels via rear I/O on CompactPCI® J2 ■ PCI Express® □ One PCI Express® x1 link via rear I/O on CompactPCI® J2 □ PCIe® 1.0a support □ Data rate up to 250 MB/s in each direction (2.5 Gbit/s per lane)
Front Connections (Standard)	■ VGA ■ Two USB 2.0 (Series A) ■ Two 10/100Base-T Ethernet (RJ45 or M12)

Technical Data

Rear I/O (PICMG 2.30)	■ One SATA (3 Gb) ■ Four USB 2.0 ■ Two 10/100Base-T Ethernet ■ One PCI Express® x1 link ■ Compatible with PICMG 2.30 CompactPCI® PlusIO □ 1PCI33/1PCIE2.5/1SATA3/4USB2/2ETH100 □ Some pins are used for signals differing from the PICMG 2.30 specification, e.g., for clustering. However, these signals do not destroy or cause any malfunction of a connected I/O board based on this standard.
Event Logging	■ Event history logged in non-volatile FRAM, e.g., reset, overvoltage, undervoltage, excess temperature ■ 256 entries possible ■ Events are generated by board hardware or user application
Cluster Link	■ Two F75P boards can be connected to form a cluster ■ Cluster link interface based on RS422 □ Accessible on CompactPCI® J2 rear I/O connector □ Bidirectional, full-duplex, differential interface
Miscellaneous	■ Real-time clock with supercapacitor backup connected to I/O Processor ■ Three independent supervisors for Control Processors and Inter-Communication FPGA □ Check for overvoltage, undervoltage, excess temperature, internal errors of FPGA and CPUs, CPU und FPGA clock □ Perform a range of self tests □ Watchdog ■ Board Management Controller for I/O Processor ■ Status LED at front panel ■ Reset button at front panel
CompactPCI® Bus	■ Compliance with CompactPCI® Core Specification PICMG 2.0 R3.0 ■ System slot ■ 32-bit/33-MHz PCI-to-PCI bridge ■ V(I/O): +3.3 V (+5 V tolerant) ■ Hot insertion and removal without damage
Busless Operation	■ Board can be supplied with +5 V only, all other voltages are generated on the board ■ Backplane connectors used only for power supply
Electrical Specifications	■ Supply voltage/power consumption: □ +5 V (-5%/+5%), tbd. A
Mechanical Specifications	■ Dimensions: conforming to CompactPCI® specification for 3U boards ■ Front panel: 4 HP or 8 HP with ejector ■ Weight: tbd. g (incl. heat sink)
Environmental Specifications	■ Temperature range (operation): □ -40..+50°C in 4 HP version (qualified components) □ -40..+85°C in 8 HP version (qualified components), compliant with EN 50155, class Tx □ Conditions: airflow 1.5 m/s, typical power dissipation: tbd. ■ Temperature range (storage): -40..+85°C ■ Relative humidity (operation): max. 95% non-condensing ■ Relative humidity (storage): max. 95% non-condensing ■ Altitude: -300 m to +3000 m ■ Vibration (function): 1 m/s², 5 Hz - 150 Hz (EN 50155 (12.2.11) / EN 61373) ■ Vibration (lifetime): 7.9 m/s², 5 Hz - 150 Hz (EN 50155 (12.2.11) / EN 61373) ■ Shock: 50 m/s², 30 ms (EN 50155 (12.2.11) / EN 61373) ■ Conformal coating (standard)
MTBF	■ tbd. h @ 40°C according to IEC/TR 62380 (RDF 2000)

Technical Data

Safety	■ Functional Safety □ Certifiable up to SIL 4 according to EN 50129 ("safety case" document and certificate from TÜV SÜD available) □ Hazard rate for safety functions <= 1E-9 / h □ Configured for deterministic behavior, e.g., Hyper-Threading disabled, speed-step disabled, BIOS interrupts disabled □ Board maintains safe state after a failure (factory configuration) ■ Flammability □ PCB manufactured with a flammability rating of 94V-0 by UL recognized manufacturers
EMC Conformity	■ When integrated into an EMC protected rack ■ EN 50121-3-2 (tables 5 and 6) / EN 55011 (radio disturbance) ■ EN 50121-3-2 (table 9) / IEC 61000-4-6 (ESD) ■ EN 50121-3-2 (table 9) / IEC 61000-4-3 (electromagnetic field immunity) ■ EN 50121-3-2 (table 8) / IEC 61000-4-4 (burst) ■ EN 50121-3-2 (table 8) / IEC 61000-4-6 (conducted disturbances)
BIOS	■ InsydeH2O™ UEFI Framework
Software Support	■ I/O Processor □ Windows® 7 □ Windows® Embedded Standard 7 (in preparation) □ Linux (in preparation) □ VxWorks® (on request) ■ Control Processors □ Linux (in preparation) □ VxWorks® (in preparation) □ VxWorks®/Cert (on request) □ PikeOS (in preparation) ■ For more information on supported operating system versions and drivers see Downloads.

Configuration & Options

Standard Configurations

Article No.	CPU Type	System RAM	Ethernet connectors	Front Panel	Conformal Coating	Operating Temperature
02F075P00	3x E680T, 1.6 GHz	CPs: 512 MB each, IOP: 1 GB	RJ45	4 HP	Yes	-40..+50°C qualified
02F075P01	3x E680T, 1.6 GHz	CPs: 512 MB each, IOP: 1 GB	M12 (right)	8 HP	Yes	-40..+85°C qualified

Options

CPU	■ Intel® Atom™ E620T, 0.6 GHz, 320 MHz graphics frequency, 3.3 W TDP (estimated) ■ Intel® Atom™ E640T, 1.1 GHz, 320 MHz graphics frequency, 3.6 W TDP ■ Intel® Atom™ E660T, 1.3 GHz, 400 MHz graphics frequency, 3.6 W TDP ■ Intel® Atom™ E680T, 1.6 GHz, 400 MHz graphics frequency, 4.5 W TDP (estimated)
Memory	■ System RAM □ 512 MB or 1 GB for each Control Processor □ 1 GB or 2 GB for I/O Processor ■ mSATA disk □ 0 MB up to maximum available
I/O	■ Ethernet □ RJ45 or M12 connectors □ M12 connectors need a second front-panel slot (8 HP total width) and can be placed to the left or right side of the CPU PCB.
Operating Temperature	■ -40..+50°C (4 HP) ■ -40..+85°C (8 HP, with larger heat sink) ■ Depends on heat sink configuration
Coating	■ With or without conformal coating
Cooling Concept	■ Also available with conduction cooling in MEN CCA frame
Restart Option	■ Board can be configured to restart automatically after entering safe state (by factory configuration)
Software Support	■ VxWorks® for I/O Processor (on request) ■ VxWorks®/Cert for Control Processors (on request)

Please note that some of these options may only be available for large volumes. Please ask our sales staff for more information.

Ordering Information

Standard F75P Models	**02F075P00**	3x Intel® Atom™ E680T (1.6 GHz), 2x 512 MB, 1x 1 GB DDR2 DRAM, RJ45 ETH connectors, 4 HP, -40..+50°C with qualified components, conformal coating
	02F075P01	3x Intel® Atom™ E680T (1.6 GHz), 2x 512 MB, 1x 1 GB DDR2 DRAM, 8 HP, Ethernet on the right by 2x M12, -40..+85°C with qualified components, conformal coating
Related Hardware	**08CT12-00**	CompactPCI® PlusIO rear transition module 3U/80mm, 2 Ethernet, 4 USB, 4 SATA, 4 PCIe® x1, -40°C..+85°C qualified
Memory	**0751-0051**	SSD mSATA, 8 GB, -40..+85°C
	0754-0007	SSD SATA 256 GB, 2.5" MLC, 0..+70°C
Systems & Card Cages	**0701-0046**	CompactPCI® 19" 4U/24HP desktop system for 3U cards, 3-slot 3U CompactPCI® backplane, system slot right, 1U fan tray with 1 fan, 8 HP space for 1 pluggable PSU
	0701-0056	CompactPCI® 19" 4U/84HP rack-mount enclosure for 3U cards (vertical), 4+4-slot 3U CompactPCI® / CompactPCI® Serial hybrid backplane, prepared for rear I/O, 250W power supply wide range 90..264VAC on rear, 1U fan tray with 2 fans included, 0..+60°C
Documentation	Compare Chart 3U CompactPCI® Serial CPU and I/O cards » Download Compare Chart safe computers from MEN » Download Compare Chart 3U CompactPCI® / PlusIO CPU cards » Download Compare Chart 3U CompactPCI® / PlusIO peripheral cards » Download For more information on the architecture of safe computer systems based on 3U CompactPCI®, please read our white paper Railway Computer 3.0: An Innovative Board Design Could Revolutionize The Market, available in English and German. » Download	

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