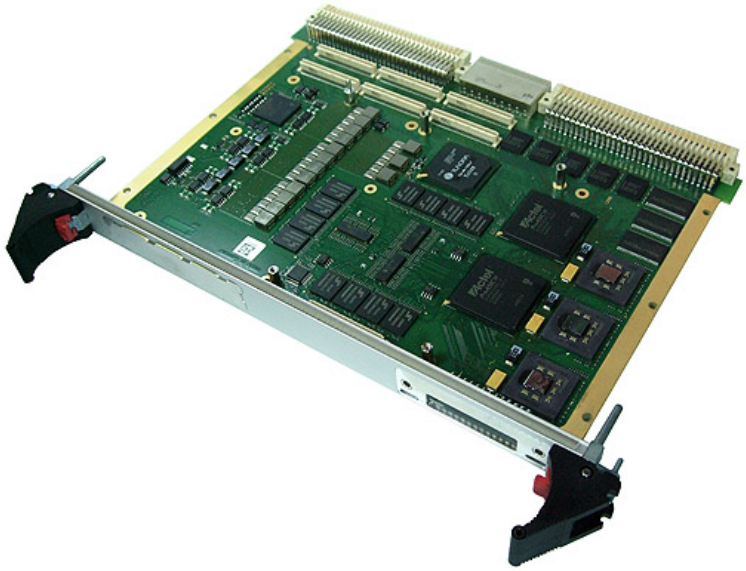
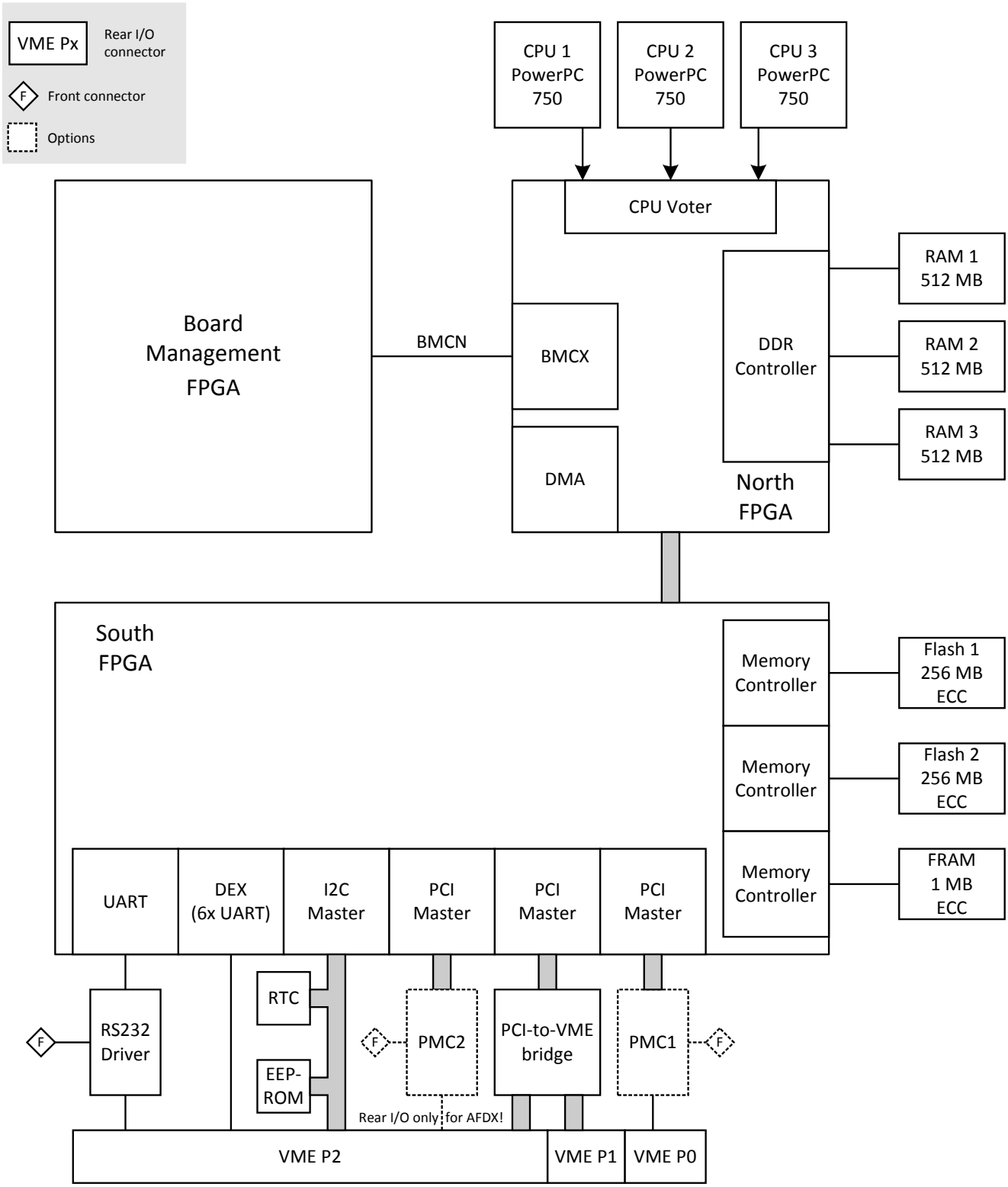
# A602 – 6U VME64 PowerPC® Safe Computer

- **3x PowerPC® 750 (lockstep mode), 3x 512 MB DDR RAM**
- **Fail-operational, fault-tolerant behavior**
- **Fail-safe and fail-silent board architecture**
- **Clustering of two A602 to raise availability**
- **Board management, BITE**
- **SEU (radiation) tolerant**
- **Certifiable up to SIL 4 (with report from TÜV Süd) and DAL-A**
- **Developed according to RTCA DO-254, EN 50129 and IEC 61508**
- **EN 50155 compliance**
- **Up to -40 to +70°C with qualified components**
- **Convection or conduction cooling**



The A602 is a 6U 64-bit VME COTS computer with onboard functional safety that realizes triple redundancy on a single board to achieve fail-operational, fault-tolerant behavior. The board can also act as a fail-silent subsystem, i.e. it can shut down in case of a fatal fault. Its complex FPGA-based design helps dramatically lower software development costs as it automatically manages the system's triple-redundant processors and memory. The result: The system's redundant architecture is fully taken advantage of by software designed for a standard single-CPU board.
The A602 is designed for deterministic operation and offers extensive BITE features (e.g., ECC error counters for all types of memory, monitoring of all internal voltages), internal buses with error correction and fault-tolerant (fail-operational) implementation. Its three processors run in lockstep mode with 2-out-of-3 (2oo3) voting implemented in FPGA and software-assisted resynchronization, while its triple redundant dynamic memory automatically corrects upsets caused by cosmic radiation (SEU) and hardware faults. The system is powered by redundant local power supplies with separate power supplies for the three CPUs and the three main memory ranks.
The A602 has been developed according to DO-254, compliant to DO-160 and certifiable up to DAL-A in avionics applications. Additionally, the product meets the requirements of EN50128/EN50129 and can be deployed in signalling and rolling stock applications up to SIL 4. All I/O is realized in SEU-resistant FPGAs and available on the system's rear connectors. Additionally, the A602 offers two PMC slots with rear I/O for PMC1. As an option, the second PMC slot can be customized for an AFDX® PMC (rear I/O only). A second A602 can be connected to build a high reliability/availability cluster. The two A602s exchange data via a sextuple UART connection and a BMCX link.

# Diagram


VME Px
Rear I/O connector
F
Front connector
Options
CPU 1 PowerPC 750
CPU 2 PowerPC 750
CPU 3 PowerPC 750
CPU Voter
Board Management FPGA
BMCN
BMCX
DMA
DDR Controller
North FPGA
RAM 1 512 MB
RAM 2 512 MB
RAM 3 512 MB
South FPGA
Memory Controller
Memory Controller
Memory Controller
Flash 1 256 MB ECC
Flash 2 256 MB ECC
FRAM 1 MB ECC
UART
DEX (6x UART)
I2C Master
PCI Master
PCI Master
PCI Master
RS232 Driver
RTC
EEP-ROM
PMC2
PCI-to-VME bridge
PMC1
Rear I/O only for AFDX!
VME P2
VME P1
VME P0

# Technical Data

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|---|---|
| **CPU** | ■ 3x PowerPC® 750 CL<br>□ Scalable performance<br>□ 1 GHz processor core frequency<br>□ Superscalar<br>□ Classic PowerPC® FPU, MMU<br>□ CPU bus to FPGA: 100-MHz/64-bit<br>■ Lock-step operation<br>□ All CPUs do the same thing at the same time<br>□ 2-out-of-3 voting in FPGA with CPU bus clock speed (100MHz)<br>□ Software-assisted resynchronization<br>□ No functional interruption in case of an SEU inside the CPU<br>■ Chipset<br>□ North- and Southbridge realized in FPGA |
| **Memory** | ■ 2x 32 kB L1 cache, 1MB L2 cache integrated in each CPU<br>■ 3 independent ranks of 512MB DDR SDRAM system memory, FPGA-controlled<br>□ 100MHz memory bus frequency (32 bit)<br>□ Up to 800 MB/s<br>□ 2-out-of-3 voting in FPGA<br>□ Scrubbing to prevent accumulation of SEU<br>□ No functional interruption in case of an SEU inside the memory<br>■ 2 independent ranks of 256MB Flash, FPGA-controlled<br>□ Primary and backup Flash ranks contain the same data, auto-selection by boot loader<br>□ ECC protection<br>■ 1MB FRAM<br>□ ECC protection<br>■ 4KB serial EEPROM for production data (serial number etc.) |
| **I/O** | ■ All I/O realized in FPGA and available at rear I/O<br>■ Sextuple UART<br>□ E.g., for communication with other A602<br>□ Data rates up to 460,800 Baud for each channel<br>□ Handshake lines: none<br>■ RS232 UART<br>□ Also available at front panel<br>□ Data rates up to 460,800 Baud<br>□ 2x 256 Byte transmit/receive buffer<br>□ Handshake lines: none<br>■ I²C bus |
| **Mezzanine Slots** | ■ Two PMC slots<br>□ 32 bit/33 MHz, 3.3V V(I/O)<br>□ PMC slot 1 with rear I/O |
| **Miscellaneous** | ■ Voltage monitoring<br>■ Temperature monitoring<br>■ Watchdog<br>■ Reset signal control<br>■ Control of redundant power supplies<br>■ Sleep mode<br>□ Lowers power consumption in case of primary power supply interruption<br>□ Power failure indicated through signals from backplane<br>□ Supports power interruptions specified in Airbus directive ABD0100.1.9<br>□ CPUs and memory can be put into sleep mode<br>■ Redundant clock generation<br>■ Connection with second A602 possible (with special backplane)<br>□ Control of shared outputs<br>□ Exchange of state information<br>□ BMC and 6x UART link |

# Technical Data

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| **Local PCI Bus** | ■ 32-bit/33-MHz, 3.3V V(I/O)<br>■ Compliant with PCI Specification 2.2 |
| **VMEbus** | ■ TSI148 controller<br>■ Compliant with VME64, VME64 and 2eSST specification<br>■ Slot-1 function with auto-detection<br>■ Master<br>□ D08(EO):D16:D32:D64:A16:A24:A32:ADO:BLT:RMW<br>■ 1MB shared fast SRAM<br>■ Mailbox functionality<br>■ Single level 3 fair requester<br>■ Single level 3 arbiter<br>■ Bus timer<br>■ Location Monitor<br>■ Performance<br>□ Coupled read/write D32 non-block transfer rate 6.5 MB/s |
| **Electrical Specifications** | ■ Dual power input from VMEbus, uninterrupted (EN50155, Class S1)<br>□ +5V (-3%/+5%)<br>□ +3.3V (-5%/+5%) optional<br>□ Standard backplane supplies both input rails with power<br>□ Continued operation if one power input fails (or is not present)<br>□ Separate power supplies for the three CPUs and the three main memory ranks<br>■ Supply voltage/power consumption:<br>□ 33W (39W when 3.3V are not supplied)<br>□ 6 W (optional +3.3V supply) |
| **Mechanical Specifications** | ■ Dimensions: standard double Eurocard, 233.3mm x 160mm<br>■ Weight (without mezzanines and accessories): 548g |
| **Environmental Specifications** | ■ Temperature range (operation):<br>□ 1-slot models: -40..+55°C (qualified components), temperature classes T1, T2, and TX inside buildings, or in containers with temperature control for signalling equipment, according to EN 50125-3, table 2<br>□ 2-slot models: -40..+70°C (qualified components), temperature classes T1, T2, and T3 for equipment onboard rolling stock, according to EN 50125-1, table 2<br>□ Airflow: min. 2 m/s<br>■ Temperature range (storage): -40..+85°C<br>■ Relative humidity (operation): max. 95% non-condensing<br>■ Relative humidity (storage): max. 95% non-condensing<br>■ Altitude: -300m to +2,000m (EN50124, Class AX)<br>■ Compliant to EN50125-1, meeting requirements of EN61373, Cat. 1, Class B and Classes GTX, GL3 for rolling stock<br>□ Shock: 50 m/s², 30 ms (EN 61373)<br>□ Vibration (function): 1 m/s², 5 Hz - 150 Hz (EN 61373)<br>□ Vibration (lifetime): 7.9 m/s², 5 Hz - 150 Hz (EN 61373)<br>■ For signalling equipment, a distance of 3m from the track bed is required<br>■ Protection class IP00 (EN50124, Category PD1)<br>■ Conformal coating on request<br>■ All components soldered |
| **MTBF** | ■ 270 311 h @ 40°C according to IEC/TR 62380 (RDF 2000)<br>■ 424 061 h for continuous operation @ 25°C according to IEC/TR 62380 (RDF 2000) |
| **Safety** | ■ Erroneous behavior of CPU/memory subsystem < 1E-8 / h<br>□ Considering hardware failures and worst-case SEU environment<br>■ PCB manufactured with a flammability rating of 94V-0 by UL recognized manufacturers |

# Technical Data

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| **EMC Conformity** | ■ EN55011 (radiated emission disturbances - rolling stock)<br>■ EN 61000-6-4 (radiated emission disturbances - signalling equipment)<br>■ EN 61000-4-3 (electromagnetic field immunity)<br>■ EN61000-4-2 (electrostatic discharge immunity)<br>■ EN61000-4-8 (power - frequency magnetic field)<br>■ EN61000-4-9 (pulsed magnetic field) |
| **BIOS** | ■ MENMON |
| **Software Support** | ■ VxWorks®, VxWorks®/Cert<br>■ PikeOS |

# Configuration & Options

### Standard Configurations

| Article No. | CPU Type | Clock | System RAM | Flash | FRAM | PMC Slots | Cooling | Operating Temperature |
|---|---|---|---|---|---|---|---|---|
| 01A602-02 | 3x PPC 750 CL | 1 GHz | 3x 512 MB | 2x 256 MB | 1 MB | 2 | Convection | -40..+50°C |

### Options

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| **Mezzanine Slots** | ■ PMC slot 2 customized for AFDX® PMC (rear I/O only) |
| **Real-time Clock** | ■ Buffered by GoldCap |
| **Environmental Specifications** | ■ Temperature range (operation):<br>□ -40..+70°C (8HP front panel with convection cooling or 4HP front panel with conduction cooling) |

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

# Ordering Information

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|---|---|---|
| **Standard A602 Models** | **01A602-02** | 3x PowerPC® 750CL 1 GHz, 3x 512 MB DRAM, 2x 256 MB Flash, 1 MB FRAM, 2 standard PMC slots, convection cooling (airflow 2 m/s), -40 to +50°C with qualified components |
| **Related Hardware** | **08CT15-00** | Rear I/O adapter for A602 without front panel; with RS232, PMC rear I/O, 6x DEX UART, BMCX, AFDX®, debug signals, -40..+85°C with qualified components |
| **Certification Packages** | **23X602-00** | SIL 4 railway certification package according to EN 5012x for A602/D602, including:<br><br>Safety User Manual including the safety-relevant application requirements, a detailed description of the hardware and instructions for appropriate operation.<br>Safety Case describing the concepts for reaching functional safety as well as all safety and quality-relevant processes and measures to meet the SIL 4 requirements.<br>Assessment report and SIL 4 certificate from TÜV SÜD (German Technical Inspection Agency).<br><br>Please contact us to get more information about the certification package and to request a copy of the documents. |
| | For more information on the A602/D602 certification package, see this introductory overview presentation (PDF). | |
| **Miscellaneous Accessories** | **05P000-01** | 25 mounting screw sets to fix PMC/XMC modules on carrier boards |
| | **08AE33-00** | A602/D602 debug adapter to connect debug terminal, JTAG equipment and Freescale™ CodeTest Probe, -40..+85°C with qualified components |
| | **08CT15-00** | Rear I/O adapter for A602 without front panel; with RS232, PMC rear I/O, 6x DEX UART, BMCX, AFDX®, debug signals, -40..+85°C with qualified components |
| **Software: VxWorks®** | This product is designed to work under VxWorks®. For details regarding supported/unsupported board functions please refer to the corresponding software data sheets. | |
| | **10D602-60** | VxWorks® BSP (MEN) for A602 and D602 |
| **Software: PikeOS** | This product is designed to work under PikeOS by SYSGO. PikeOS is a real-time operating system for use in safety and mission-critical systems which can be certified according to DO-178B DAL-B and EN 50128 SIL 4. For more information and product support please contact www.sysgo.com. | |
| **Software: Firmware/BIOS** | MENMON is MEN's firmware/BIOS for PowerPC® platforms. | |
| | **14A602-00** | MENMON (Firmware) for A602 (object code) |

**For operating systems not mentioned here contact MEN sales.**

# Ordering Information

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|---|---|
| **Documentation** | Compare Chart 6U VMEbus CPU and I/O cards » Download<br><br>Compare Chart safe computers from MEN » Download |
| **23X602-00** | SIL 4 railway certification package according to EN 5012x for A602/D602, including:<br><br>Safety User Manual including the safety-relevant application requirements, a detailed description of the hardware and instructions for appropriate operation.<br>Safety Case describing the concepts for reaching functional safety as well as all safety and quality-relevant processes and measures to meet the SIL 4 requirements.<br>Assessment report and SIL 4 certificate from TÜV SÜD (German Technical Inspection Agency).<br><br>Please contact us to get more information about the certification package and to request a copy of the documents. |
| | For more information on the A602/D602 certification package, see this introductory overview presentation (PDF). |

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