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Bombardier relies on the E²Brain Computer-on-Module

► Kontron's E²Brain Module Monitors Train Management Systems

The AGC (Autorail Grande Capacité) from Bombardier is a part of the latest generation of regional trains for local and long-distance travel. Up to 220 passengers glide along in the AGC at a top speed of 160 km/h (100 mph). Ensuring that the train offered excellent safety, comfort and value was the priority for the Bombardier engineers who developed it. The Train Management System, whose hardware and kernel functions were developed by Kontron, is the foundation that Bombardier built on to achieve this aim.

The Graphical User Interface (GUI) employed for the operation and monitoring of the Train Management System is based on an E²Brain module from Kontron Modular Computers, based in Kaufbeuren, Germany. The E²Brain is the RISC processor heart of the Bombardier GUI, which the conductor and maintenance personnel use to access the Train Management System.

The Train Management System acts as the central nervous system of the train, monitoring the train's core functions and managing the

passenger-oriented comfort systems.

The GUI is the central point of contact to the Train Management System, which is connected to the train's Ethernet. The visible element is a touch screen at each conductor station – at both ends of every power car – which provides an ergonomic user interface for the conductor and the maintenance personnel. The GUI is designed



to be intuitive to use; it processes information in real time, which allows for rapid decision-making, and also processes input from the touch screen as quickly as possible.

The EN50155 standard for electronic railroad applications places heavy demands on the Bombardier GUI, beyond simply operational

characteristics. The standard assumes that electronic systems on trains will need to operate 24 hours a day for 30 years, or approximately 250,000 hours, without failure. This means that train control systems must be designed to withstand the toughest environmental conditions: extended temperature ranges (-40°C to +85°C), humidity, vibrations and power fluctuations. Even heat build-up and therefore energy absorption have to stay within narrow ranges: failure-prone fans are prohibited in train electronics and only passive cooling technologies are permitted.



COTS modules on highly customizable boards

A housing was custom-designed to integrate the Bombardier GUI into the train cockpit. For the IT platform, Bombardier needed a solution that would last for the thirty-year lifespan of a train but be flexible enough to allow for the integration of higher-performance technologies in future. The solution they decided on is based on Computer-on-Modules (COM), with the processor and appropriate chipsets already integrated on a COM, which is merged with a custom-designed baseboard that has only the

interfaces Bombardier's system requires. The application-specific features are located on the baseboard, which is screwed vibration-free to the COM.

If a higher-performance CPU becomes necessary for the application later on, the COM can be replaced without any need to redevelop the baseboard. The reverse is also true, of course: the baseboard can be modified without having to replace the COM.

As a result, the COM concept allows for a lifecycle that stretches over the train's entire period of use, thereby offering greater investment security. Development work for the customer-specific solution is concentrated on the baseboard's design, which reduces the time to market and development costs.

RISC Computer-on-Module

The GUI solution for Bombardier is based on Kontron's E²Brain modules. These are always equipped with RISC processors such as XScale or PowerPC, and measure 75 mm x 115 mm. For a variety of reasons, a RISC CPU was the only real possibility for the visualization and operation of the Train Management System. The Bombardier GUI is a 'hard' real-time application that requires an extremely fast processor with minimal power consumption and heat emissions to meet railroad construction standards, an x86 PC processor was out of the question. A very high frequency x86 processor would have been required in order to achieve the necessary computation speed, which would have consumed too much energy and generated too much heat. Besides, a PC processor is quite a bit more expensive than a RISC CPU with the same performance. Finally, the Bombardier GUI is

designed as a thin client, which neither requires nor uses the abundance of features on an x86 chip.



The requirement for long-term availability also favored a RISC processor: with PC processors, one cannot develop applications that are designed to function for 30 years, because the processors' product life and availability are less than a decade. RISC processors, on the other hand, 'live' significantly longer – and if their production is canceled early then the COM concept, which permits a 'soft' CPU migration, helps to smooth the way.

The Bombardier GUI uses the E²Brain EB8245 with a 330 MHz Freescale PowerPC that offers a performance of 465 MIPS Dhrystone (2.1): maximum computing power without a fan and with minimal power consumption. For data handling, the board offers up to 512 MB SDRAM, up to 32 MB soldered Flash (133 MHz, 64 Bit), 1 MB buffered SRAM and E²Prom for application and configuration data. This level of performance allows the Train Management System can to handle all of the train's comfort, core system and maintenance functions without any critical system situations arising. As a result, there

is no need to implement software controlled prioritization routines to execute time-critical commands.

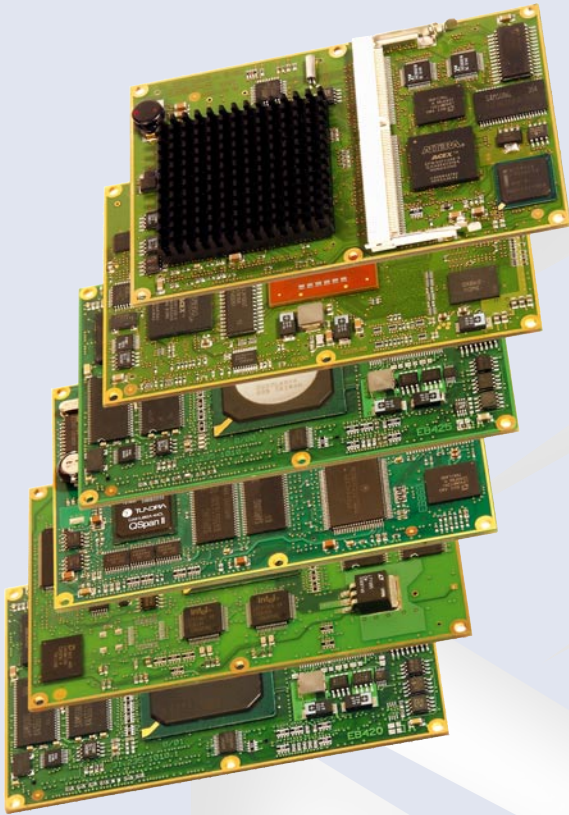
Beyond pure processor performance, the E²Brain EB8245 offers users the features and interfaces needed for real-time applications in industry as well as in trains.

The power supply is designed as 'single source' with 3.3 volts. The standard version E²Brain modules are specified for temperatures from 0°C to 70°C. The -40°C to +85°C extended temperature range that Bombardier requires is also offered. The thermally and mechanically robust design of the modules qualifies them for use in the toughest environmental conditions, such as those on trains (railway norm: S2 level). The user interface runs on Linux because Linux is standard in several other Bombardier trains.



Once a COM, always a COM

"Because strong competitive pressure rules the market, Bombardier is always challenged to provide better solutions at more attractive prices; it is crucial for the company to get the best and most cost-effective solution in every case. Both the module concept and the efficient implementation of the crucial GUI solution by



create customer-specific solutions, because the advantages that made them the best choice for the GUI project are also significant in other situations. The wide variety processors available on E²Brain modules makes it possible to use them even where demands go beyond operation and control to, for example, especially computation-intensive control tasks. They range from the EB860 with an 80 MHz Motorola MPC8xx processor, and the EB405 with a 266 MHz IBM 405 PowerPC processor, to the EB8245 with a 330 MHz MPC8245 processor and the EB425 with a 533 MHz Intel XScale IPX425 processor, all the way up to the Freescale MPC8540/8541 PowerPC processor; new processors are continually being added to the range.

The E²Brain Product Family of Kontron

Kontron prove that this is possible”, says Freddy Guillaume. “For Bombardier, working with a partner that takes the right approach to creating a solution is just as crucial as their competence in implementation, and we as Kontron meet both requirements with our products, our development knowledge, and our project management experience.”

E²Brain COMs offer countless opportunities to

Authors:

Winfried Wolf is Product Manager for RISC Computer-on-Module with Kontron Modular Computers, Kaufbeuren

Freddy Guillaume is Director Kontron Transportation of Kontron SA in Wemmel, Belgium

➤ **Corporate Offices**

Europe, Middle East & Africa

Oskar-von-Miller-Strasse 1
85386 Eching
Germany
Tel.: +49 (0)8165/ 77-777
Fax: +49 (0)8165/ 77-279
sales@kontron.com
www.kontron-emea.com

North America

14118 Stowe Dr
Poway, CA 92064-7147
USA
Tel.: +1 (888) 294-4558
Fax: +1 (858) 677-0898
sales@us.kontron.com
www.kontron.com

Asia Pacific

Far East Science Pa., 2nd Fl. No. 2,
Lane 50, Nan Kang Road Section 3
Nan Kang District Taipei Taiwan
Tel: +886 2 2782 0201
Fax: +886 2 2782 7486
sales@kontron.com.tw
www.kontron.com.tw

Kontron Modular Computers

Kontron Transportation
Koning Albert I laan, 46
1780 Wemmel - Belgium
Tel.: +32 2 456 06 40
Fax: +32 2 461 00 31
sales@kontron.com
www.kontron.com/transportation