White paper
What makes mainboards fit for industrial Application?

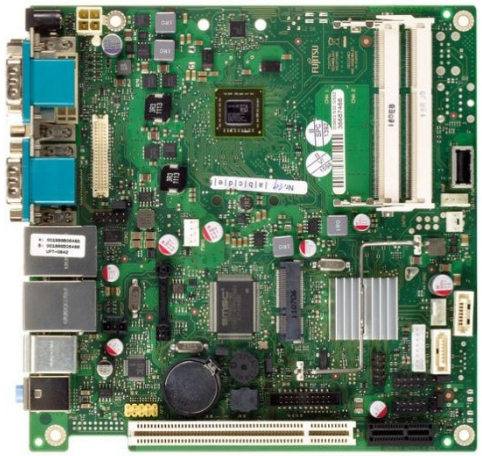
Content

Industrial PCs perform in a multitude of environments. The requirements these PCs have to meet are as varied as their areas of application. They control robots and CNC machines, are used in the automotive industry, work banking or gaming machines, or control digital signage. One thing they all have in common: any type of commercial usage requires highest availability and reliability. They operate around the clock, 7 days a week, in temperatures between 0°C – 50°C, resist, shock and vibration, endure interfering fields or function in combination with devices susceptible to interference.

Content

The mainboard plays an essential role in making a PC ready for the industry. As the leading European manufacturer of mainboards, with an annual output of roughly 2.5 million boards, Fujitsu Technology Solutions (FTS) is well aware of that fact. In an effort to provide the best possible product, all relevant factors are meticulously considered in the complete product definition, development, and production process.

Development & Design



Picture 1
Mini ITX Industrial Mainboard D3003-S

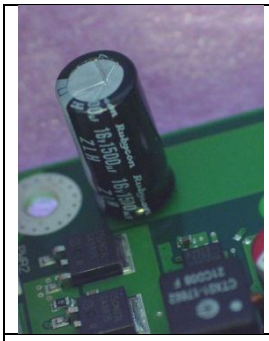
On first glance, there might not be too much of a difference between mainboards produced in Europe and Asian products. Form factor and interfaces are widely standardized. However, taking a closer look, the differences become obvious. There are up to 20 percent less single components and a level of automation in production that is 6 to 10 percent higher in mainboards "Made in Germany". Fewer components and consequently less soldering joints as a result of better component integration, combined with a higher grade of automation, makes for considerably better production quality and therefore industrial applicability.

Component selection focuses on reliability. For industrial PCs to work reliably and continuously in environments of up to 50°C, mainboards must be designed to endure at least 60°C. Capacitors are particularly sensible to high temperatures. Component selection requires an evaluation of expected operating conditions and application testing. New technologies such as solid, polymer and electrolyte caps have proven successful. Polymer capacitors feature low impedance, thus allowing for higher AC load. Less component self-heating means a longer service life. Towards the end of its service life, caps technical values (mainly capacity and stray current) diverge from a specified value range. Complete failure, however, occurs in rare cases only. Ample dimensioning in mainboard design accommodates such edge conditions.

	$$Lx = Lo * 10^{\left(\frac{to-tx}{20}\right)}$$
Polymer Electrolyth Capacitors	Service Life Lx , tx = Component operating temperature; Lo = 2.000h; to = 105°C

Picture 2
Evaluation of service life of Polymer Electrolyth Capacitors depending on product-specific data and board operating temperature

When electrolyth capacitors are required for technical reasons, 105°C-Longlife-types with ≥ 5.000h up to 10.000h service life are generally used. Technical aspects are e.g. the lack of availability of polymer-electrolyth-capacitors with higher capacity and voltage value (currently max. 470µF at 16V or 2700µF at 2.5V).



$$Lx = Lo * 2^{\left(\frac{to-tx}{10}\right)}$$

Aluminum Longlife Capacitor	Service Life Lx , tx = Component operating temperature; Lo = 5.000h/6.000h/8.000h/10.000h; to = 105°C

Picture 3
Evaluation of service life of Aluminum Electrolyth Capacitors depending on product-specific data and board operating temperature

Controller components are equally sensible to increased temperatures. An increase of temperature of 10K leads to a 50% reduction of Meantime-to-Failure (MTTF). Adequate cooling by adequate cooling units is a must.

Reliability Test (HTOL)				MTTF (Field)	
Vdd	Tj	Duration	Result	Tj	1.5V
1.8V	125C	1000 hours	No fail (0/45)	50C	18,615,911
				60C	8,749,720
				70C	4,297,570
				80C	2,197,586
				90C	1,166,050
				100C	640,097
				110C	362,557
Unit: Hours					

Picture 4
Meantime to Failure (MTTF) chart of a controller module using the example of a chipset controller

For reliable, long-life operations in temperatures of up to 60°C, additional adequate components have to be selected, e.g.

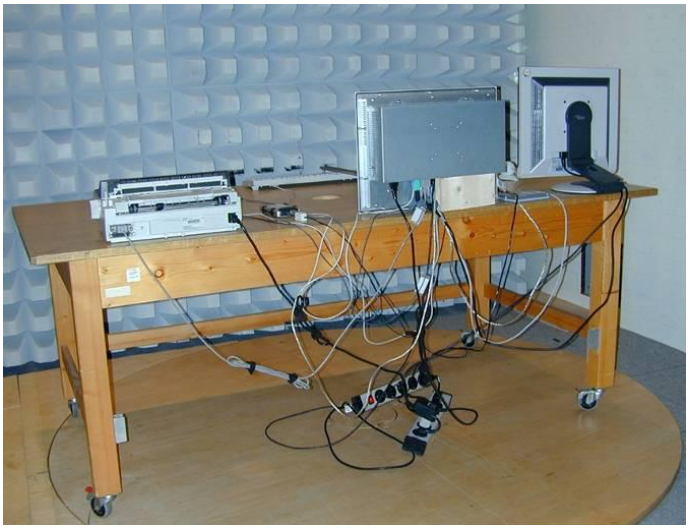
- RS232 - Buffer with increased industrial temperature range
- switch regulator instead of linear regulator for reduced dissipation loss
- quartzes with extended temperature ranges

Before the actual development phase, high-speed signal quality is optimized by analog simulations. The result is an optimized mainboard layout that also ensures signal quality over the required temperature range.

Fujitsu Technology Solutions' in-house accredited test lab is involved in module development from the beginning. That way, even prototypes meet nearly all industrial requirements, and the dimensioning of components is appropriate. Comprehensive final testing verifies all quality features in the end product.

Test and Compliance

EMC (Electromagnetically Compliance)



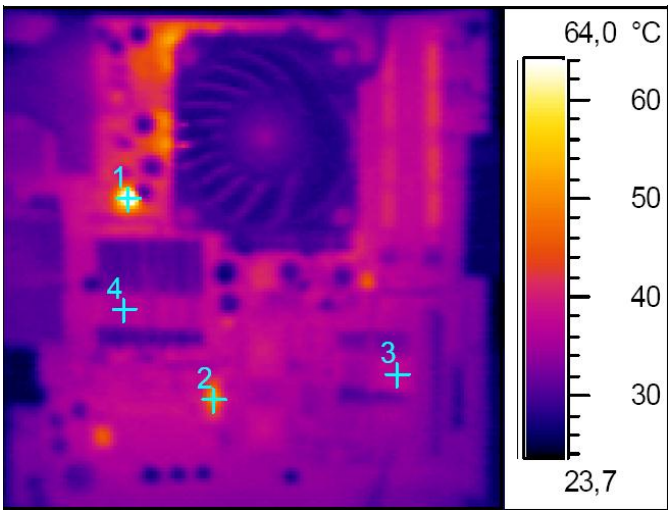
EMC requirements are verified by EN-61000-6-2-Test (industrial interference resistance). Adherence to emission categories also depends on overall system integration. In addition to a well-contacting housing and the use of EMC-compatible power supply units and extension cards, the mainboard plays a deciding role whether a system gets EMC-qualified. Many years of experience help Fujitsu Technology Solutions engineers in designing mainboards with EMC-suitable layout. Respective guidelines and procedures are improved and extended with each new product. The electric field rating of the running system (intended operations) is, nevertheless, always valuable confirmation.

Picture 5
EMC: Test setup for CE conformity verification

Extended Temperature Range

Industrial mainboards are specified for a temperature range (mainboard air circulation) of 0° C to 60° C . Extended temperature resistance is essential for industrial usage. FTS industrial mainboards proved stable in specified temperature ranges in accordance with DIN EN 60068-2-Series. All relevant components are selected to guarantee long-term and stable mainboard operations in high temperatures and under high system load. The basic assumption is, that all components stay within defined surface temperature limits und continuous full load operations.

Using thermo graphic analysis, possible hot spots on a module are identified.

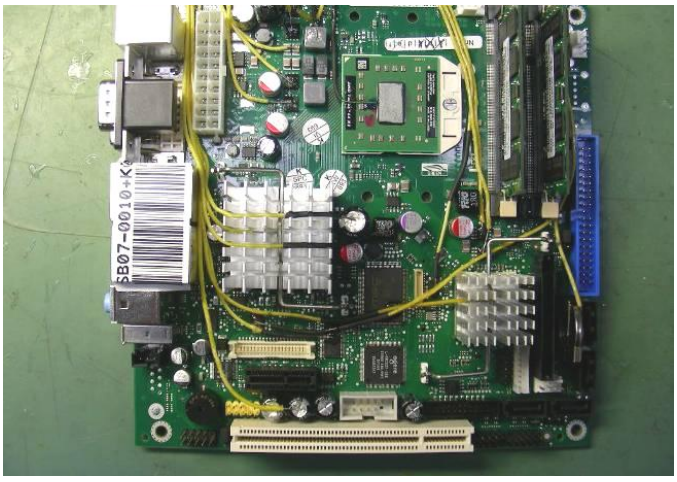


Picture 6
Thermal imaging: mini-ITX Industrial Mainboard D2703-S in operation

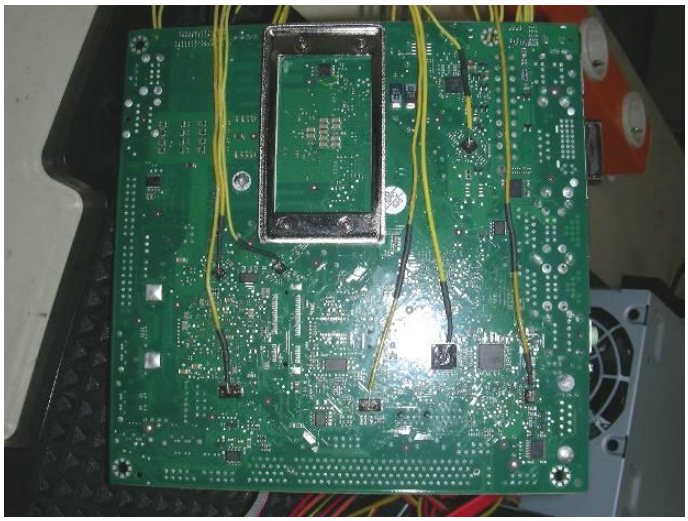
Picture 7
Thermal imaging: Heat image to detect hotspots on mini ITX Industrial Mainboard D2703-S

During the following climate testing (60°C climate chamber; system under high load, minimal air flow) all relevant mainboard components are monitored via temperature sensor to ensure that components under extreme operations (maximum environment temperature!) remain below the defined surface temperature for this type of component at all times.

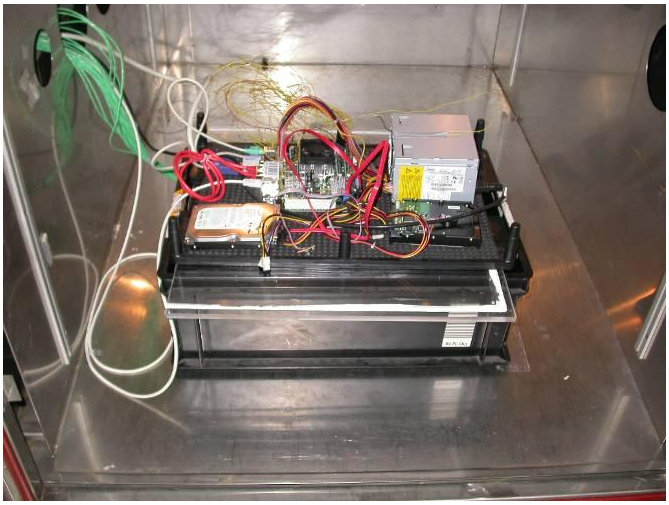
At the same time, system stability under maximum environment temperatures is verified using special software tools. To exclude possible side effects, the system undergoes additional stability endurance testing with changing temperatures (temperature cycles within the defined minimum and maximum environment temperatures).



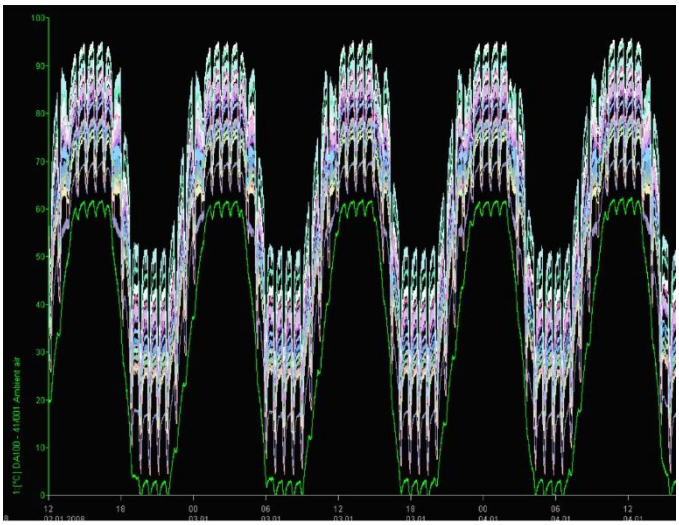
Picture 8
Climate testing: Temperature sensors on relevant components on the upper side of mini ITX Industrial Mainboard D2703-S



Picture 9
Climate testing: Temperature sensors on relevant components on the bottom side of mini ITX Industrial Mainboard D2703-S

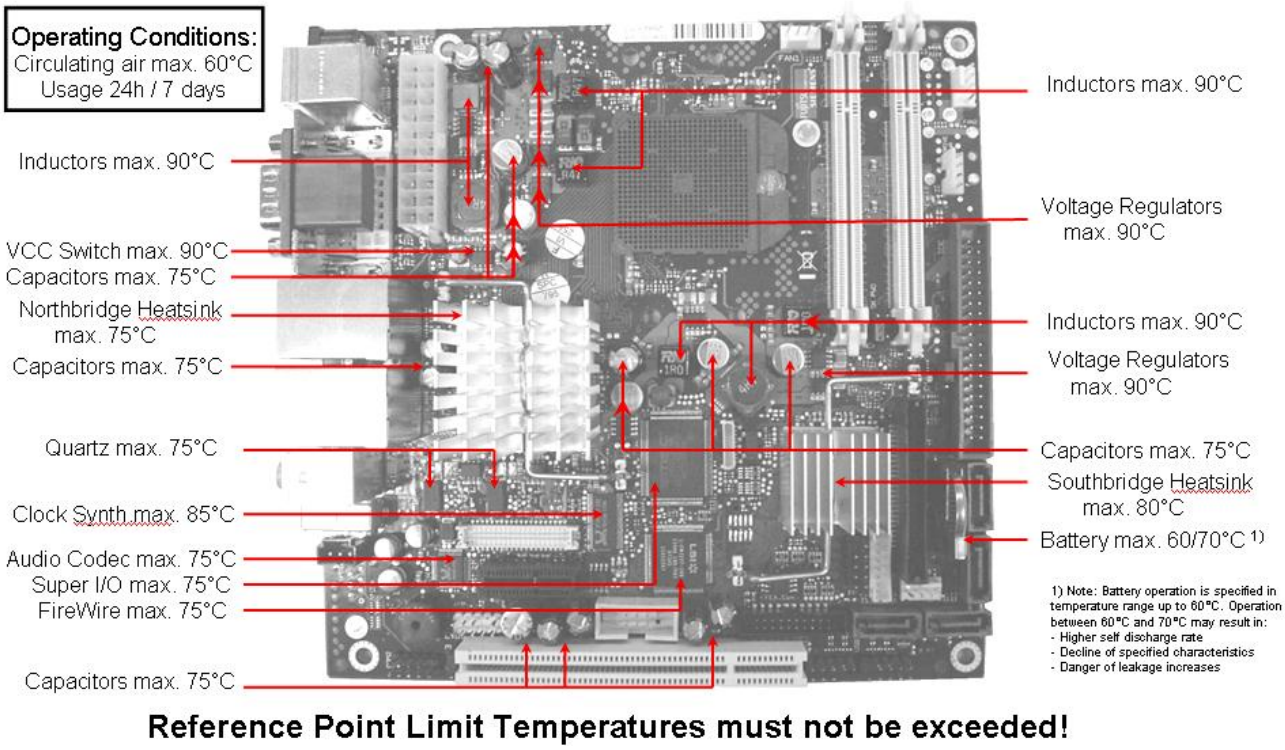


Picture 10
Climate testing: mini ITX Industrial Mainboard D2703-S during performance and long-term stability testing in the 60°C climate chamber without air flow



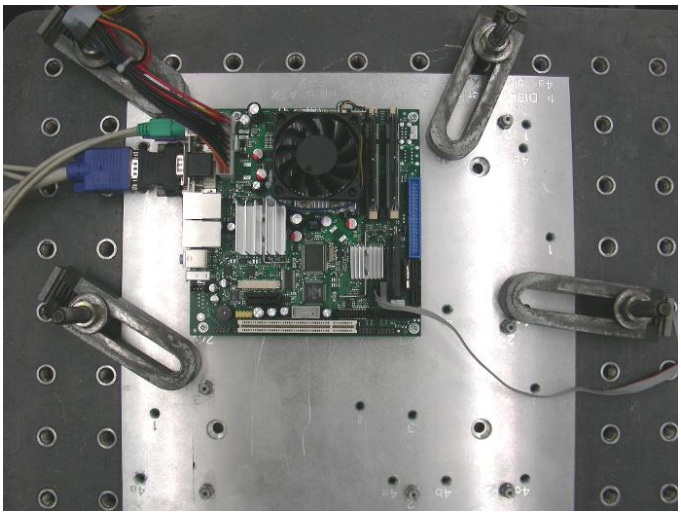
Picture 11
Selected component temperatures during Climate-Cycle-Testing (continuous system load with changing environment temperatures between 0°C und 60°C)

Component temperatures specified by development and verified by climate testing are made available to FTS industrial clients. Using that data, customers can review their specific system design and ensure the reliability of their individual solutions.



Picture 12
Overview of maximum acceptable component temperatures for reliable and long-life 24/7 operations of mini ITX Industrial Mainboard D2703-S at 60°C air temperature

Shock and Vibration



Picture 13
Mechanical testing: Mini ITX Industrial Mainboard D2703-S during shake and shock testing on the „Shaker" to simulate respective industrial environments

Rough operational conditions call for resistance to mechanical shock and vibration. Fujitsu Technology Solutions' new industrial board was tested for industrial applicability under increased requirements in accordance with DIN EN 60068-2-27 (shock) and DIN EN 60068-2-54 (vibration).

By passing those tests, FTS mainboards prove to be fit for industrial environments. They are stable and have an extraordinary long operational life. Their memory modules and contacts are permanently locked, and will not lead to system failures. Large cooling units are permanently fixed on the mainboard.

Picture 14
Mechanical Testing: Installation for vibration testing

Production

For quality reasons, Fujitsu Technology Solutions industrial mainboards are exclusively produced in Augsburg, Germany. The high degree of automation excludes human assembly errors such as polarity reversal or the use of wrong components. Water-based fluxing agents and NoClean soldering paste prevent corroding residue on the board and consequently possible failures. Soldering in nitrogen atmosphere supports the use of low-residue soldering and flux agents and results in much higher reliability of soldering joints.

Picture 15
Mainboard production in Augsburg

General Information

Following all described measures, industrial mainboards by Fujitsu Technology Solutions are ideal for reliable industrial PCs. But Fujitsu Technology Solutions provides more than just a great mainboard. Customers benefit from comprehensive integration tools, like a tool for individual fan control, and technical information like the graphical display of critical mainboard temperatures.

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