DATA SHEET

ControlSafe™ Platform

SIL4 Certified COTS Fail-Safe and Fault-Tolerant System for Train Control and Rail Signaling Applications

- Highly integrated COTS safety platform certified to SIL4 by TÜV SÜD
- Designed to deliver platform hardware availability of six nines (99.9999%)
- A modular and scalable solution suitable for both new deployments and upgrade projects
- Innovative data lock-step architecture allows seamless technology upgrades
- Hardware-based voting mechanism maximizes application software transparency
- Rugged design compliant with IEC 61373 and EN 50155
- 15 years product life and 25 years of service available
- Backed up by a global service organization
- Common platform to enable various wayside and carborne applications

Leveraging over 30 years of expertise in developing highly reliable and available embedded computer systems, SMART Embedded Computing is a premier supplier of commercial off-the-shelf (COTS) fail-safe computer systems to rail system integrators and rail application providers.

Fully certified to EN 50126 for reliability, availability, maintainability and safety (RAMS) processes; EN 50128 for safety-related software; and EN50129 for safety-related electronic systems, SMART EC's ControlSafe Platform provides a cost-effective and application-ready safety platform for implementation in a SIL4 application environment. As opposed to designing and building one from scratch, adopting the ControlSafe Platform as the core safety processing engine enables rail system integrators and application developers to effectively reduce cost and risk by leveraging a SIL4 COTS platform and substantially accelerate time-to-market by focusing on their value-added offering and final certification for the end solutions.

SMART EC is committed to building long-term partnerships with customers, based on proven and reliable systems with consistent performance. The ControlSafe Platform further strengthens this commitment by providing rail industry customers with an unmatched, highly reliable platform with 15 years of planned product life and 25 years of extended support and service available.

Adhering to SMART EC's future-proof development philosophy, the ControlSafe Platform is modular, scalable and designed to seamlessly accommodate additional I/O interfaces as well as new processor architectures throughout the product life cycle. SMART EC is focused on continued development to build a comprehensive product line to enable customers to seamlessly integrate the ControlSafe products in a variety of rail signaling applications. SMART EC's ultimate goal is to enhance customers' competitive positions by allowing them to focus their development efforts on differentiating end applications.

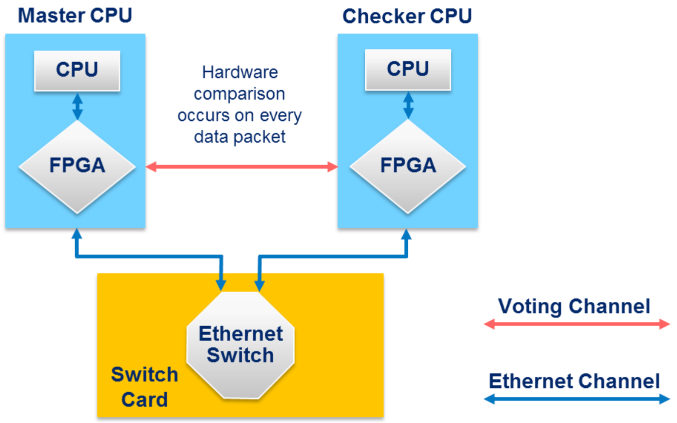
CONTROL SAFE™

TÜV SÜD Safety tested Production monitored Functional Safety

SMART™ Embedded Computing

CONTROLSAFE COMPUTER ARCHITECTURE

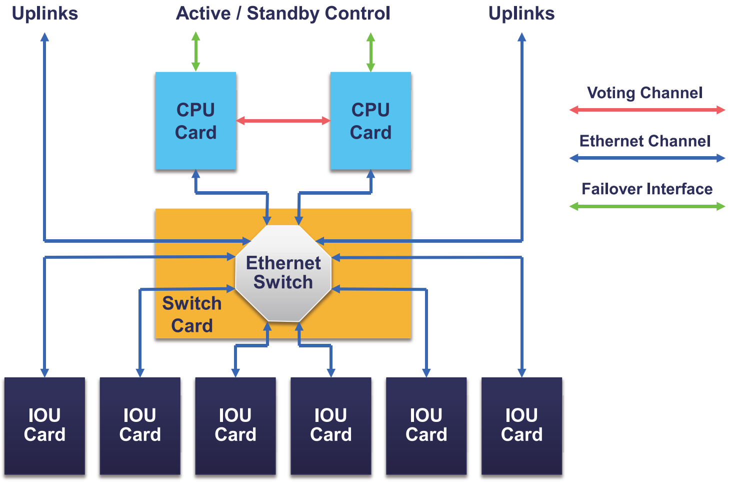
At the core of each ControlSafe Computer (CSC) are two identical CPU boards that run in data lockstep mode and implement a two-out-of-two (2oo2) voting mechanism. In the data lockstep mode, a deterministic boundary is created at the data fabric interface of the two CPUs. All transactions that are about to cross this deterministic boundary are compared to confirm correct operation of the two CPUs. As opposed to a hard lockstep mode, where the processor clocks are synchronized and the deterministic boundary is created at the address and data buses of the processors, the data lockstep mode can be implemented using modern high-performance processors which are not viable options for a hard lockstep safety architecture.



Comparison of the data fabric bound transactions is done using a 2oo2 voting mechanism, where any discrepancy between these two CPUs is considered a failure and causes the CSC to enter a fail-safe mode. In the fail-safe mode, by default all output ports are driven to their safe/silent state, eliminating any possibility of setting external equipment to a wrong state.

The CSC's data lock-step architecture makes it possible to upgrade the processor architecture over time while retaining the same I/O. Having implemented the 2oo2 voting facilities in hardware allows application developers to migrate existing application software with minimal modifications.

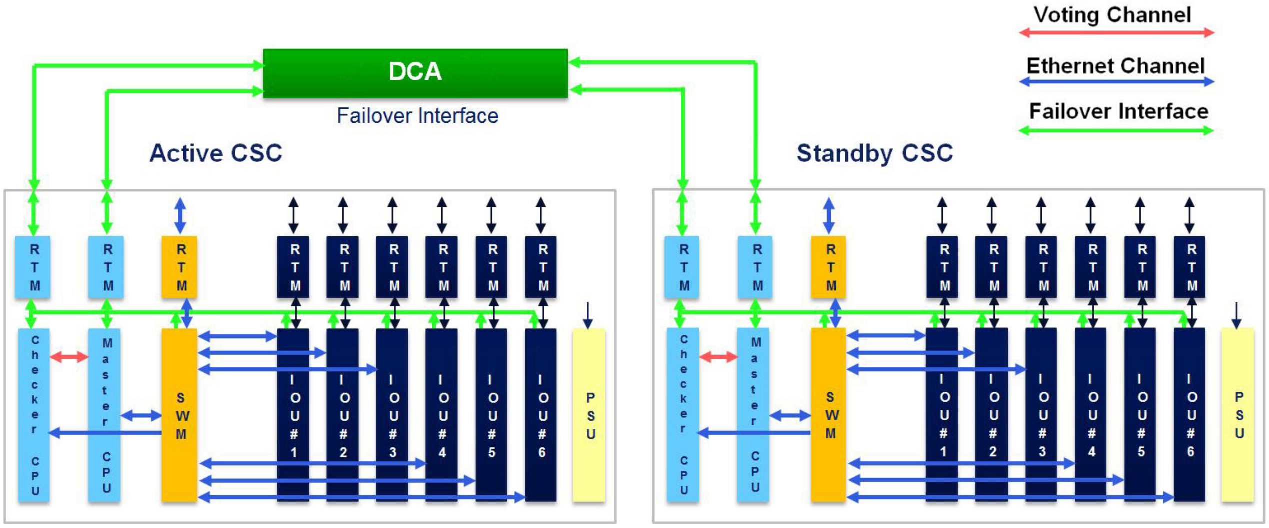
Deployable in both wayside and carborne applications, the SMART EC ControlSafe Platform is designed to support a broad range of I/O modules such as CAN, Ethernet, Ethernet Ring, UART, MVB, digital, analog and GPS/Wireless to enable solution integrators to handle both new deployments and upgrade projects easily. All communication I/O modules have a common architecture based on the same NXP® CPU and the same Wind River VxWorks 653 operating system, thus simplifying the software development environment. All I/O modules are accessed over Ethernet allowing a seamless distributed programming model. All modules support remote on-line software and firmware upgrade without risk of rendering a system inoperable.



All I/O ports are user programmable as safety-relevant or non-safety relevant. In addition, the Switch Module provides eight (8) 10/100/1000Base-T ports via its rear transition module (RTM), for direct Ethernet/IP access to other processing nodes in the application's network, or to the peer CSC.

Chassis-Level Fault Management

The SMART EC ControlSafe Platform provides chassis-level Fault Management capabilities, utilizing both run time and in line diagnostics. Each Module runs a strenuous diagnostic check on start up (POST) to ensure readiness. A hardware-based Health and Safety monitoring subsystem connects to all modules in a chassis, including I/O modules. Hardware-based in line diagnostics provide continuous checking for latent faults in Safety Functions through the entire Safety path of the chassis, and Software Run Time Diagnostics provide checking of the correct operation of diagnostic functions. Hardware-detected, safety-related faults cause an immediate transition of all Safety Functions to the Failsafe state.



CONTROLSAFE PLATFORM ARCHITECTURE

SMART EC's ControlSafe Platform consists of two redundant CSCs, each of which delivers fail-safe operations and together provide a highly available platform. They are linked by a Direct Connect Algorithm (DCA) that monitors the health of the two CSCs and designates one of them as 'active' and the other as 'standby'. The user application running on the active CSC has full control of all I/O ports, while the same user application running on the standby CSC can monitor safety-relevant input ports and all interference free ports, but by default has no ability to drive any safety-relevant output. When the active CSC fails, its safety-relevant outputs are quiesced, and it signals its state through the DCA, which in turn causes the standby CSC to become active and begin driving its safety-relevant output. The unhealthy CSC is taken out of operation and, once it has been repaired by service personnel, can be brought back into service. Monitoring the health state of the two CSCs and controlling fail-over operation between them provides a highly available fail-safe computing system.

ACTIVE/STANDBY CONTROL

SMART EC's ControlSafe Carborne Platform supports Active/Standby control with the Direct Connect cabling method.

Direct Connect

The direct connect option uses a patented algorithm and special cables to link the two CSCs. Health status is exchanged and tracked in state machines running on all the CPU modules to control the active and standby roles. When power is applied, the first CSC that has healthy signals from both CPUs goes active. The Direct Connect Algorithm (DCA) is designed so that only one CSC can be active at a time, and that only a healthy CSC can be active.

I/O MODULE DEVELOPMENT

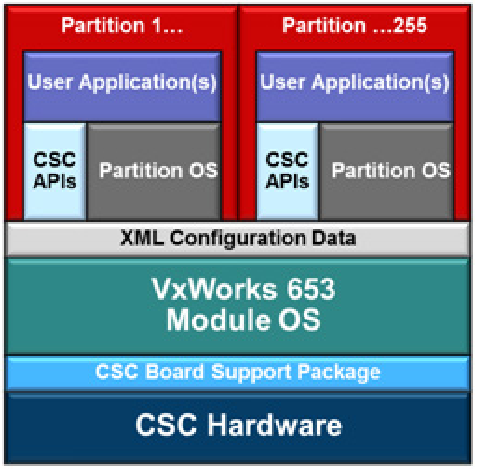
The ControlSafe Platform is designed as a common base platform to enable various applications, through the continuous addition of SMART EC I/O modules. In addition, SMART EC offers customers the flexibility to develop I/O modules to meet their specific needs by providing all necessary technical specifications, product support and service. The business model is intended to enhance the collaboration between SMART EC and customers and enable them to utilize available resources effectively and efficiently to handle both new development and upgrade projects.

OPTIONAL INTEGRATED FAN COOLING SUBSYSTEM

In order to enable customers to address various operating environments, SMART EC also offers an optional integrated fan cooling subsystem to ensure that a fully populated and fully operational ControlSafe Platform chassis operates from -40 °C to +70 °C inlet ambient temperature. The active air cooling subsystem consists of an installation bay fixed on the top of the chassis and a 1U hot pluggable, modular and autonomous fan tray that only activates if the inlet ambient temperature exceeds a minimum threshold temperature. When the cooling system is in operation, air flow is bottom-to-top. Featuring a controller, the fan tray operation status is indicated by front panel LEDs and can be polled by the ControlSafe Platform over an I^{2}C interface.

OPERATING SYSTEM

All modules in the ControlSafe Platform support Wind River's VxWorks 653 operating system. It provides both resource management and a partitioning environment that permits multiple independent applications of different criticality levels to run on a single target platform under protected conditions. At the heart of VxWorks 653 is the Core OS. The Core OS component uses the features of the target architecture to enforce isolation between applications residing in separate partitions. The partitions can contain application software that is supported by one of three interface layers: VxWorks-based APIs, APEX Interface (ARINC 653 Interface), or POSIX APIs. These interface layers provide various levels of scheduling and thread management to the application. In addition to controlling partition memory and CPU time usage, the Core OS also provides services to manage system resources, such as I/O.



The Core OS implements a partition scheduler using a statically defined configuration table that allocates CPU cycles to each partition and specifies the order of partition execution. The Core OS manages all shared resources on behalf of the application partitions including system time and memory. The Core OS ensures that resources required by an application partition are available to it after a partition switch, and prevents applications from corrupting each other. Communications between partitions, and between partitions and the Core OS, are only performed if appropriate communication channels are used, and if they are permitted by the system configuration table.

The VxWorks 653 Health Monitor (HM) provides a framework to raise and handle events such as alarms or messages in an Integrated Modular Avionics (IMA) system. The framework supports the ARINC API, and includes a standalone API. The HM functions at three levels: module, partition and process. Fault responses and recovery actions are table-driven at the partition and module level, while application actions are driven at the process level. Partition or module level handlers can communicate information to other partitions by notifying them of given events. For instance, one partition handler can tell another about an event that caused it to restart the partition.

APPLICATION PROGRAMMING INTERFACES

A library of Application Programming Interfaces (APIs) is provided to ease the process of building a safety application. These provide functions that can query the state of the safety logic, aid with the communications between the layers and monitor health of vital components like the system memory. In addition there are a range of control and status APIs giving the safety application full control down to the level of watchdog timer, I/O port control and physical health monitoring. The following is the list of APIs:

- CAN-Ethernet
- Control/Status
- DRAM Scrubber
- Firmware Upgrade
- Flash Integrity
- Link Health Check
- Logging
- Maintenance Mode Watchdog
- Network Routing
- Persistent DRAM
- Platform Management
- Runtime Diagnostics
- Switch Management
- Safety Layer
- Vital Product Data (VPD)
- Voting Logic

CERTIFICATION EVIDENCE

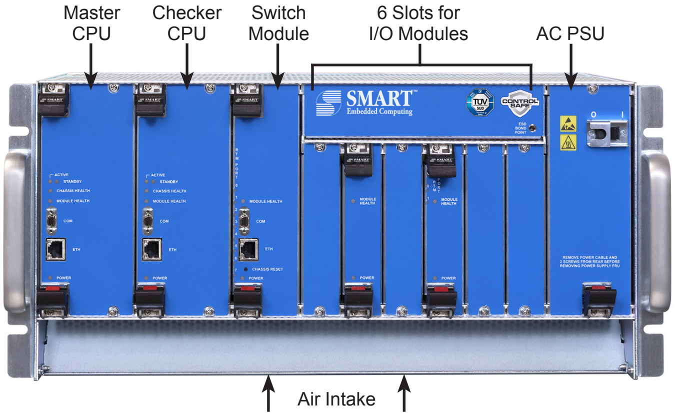
SMART EC's ControlSafe Platform strictly adheres to all industry specifications and standards required to deliver a highly reliable and available platform for modern safety applications. SMART EC provides customers with a complete Certification Evidence Package to facilitate the certification process for their integrated systems.

The Certification Evidence Package includes:

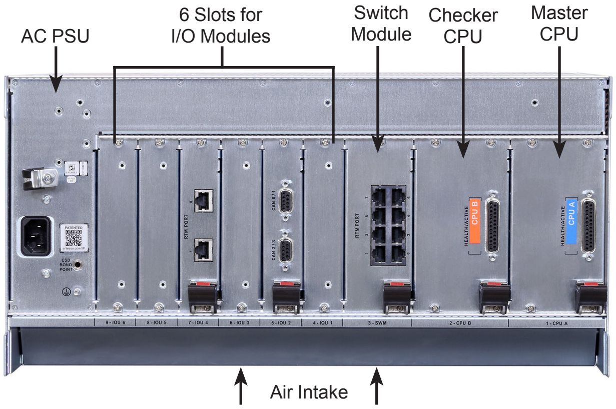
- Safety Case
  - Definition of system
  - Quality management report
  - Safety management report
  - Technical safety report
- Safety Assessment Report
- Safety Manual
  - Specifies user's actions required to enable the integration of the ControlSafe Platform into a safety-relevant system
- Safety Certificate *No. Z10 16 08 87324 008* issued by TÜV SÜD, one of the most trusted certification bodies worldwide

SYSTEM CHASSIS

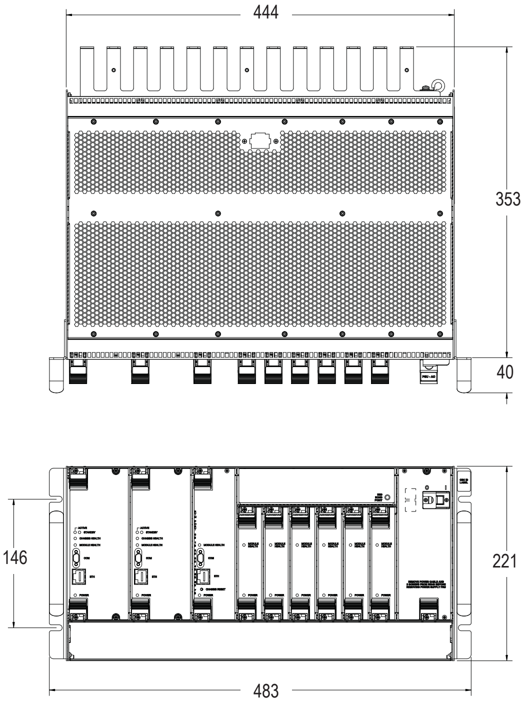
Front View



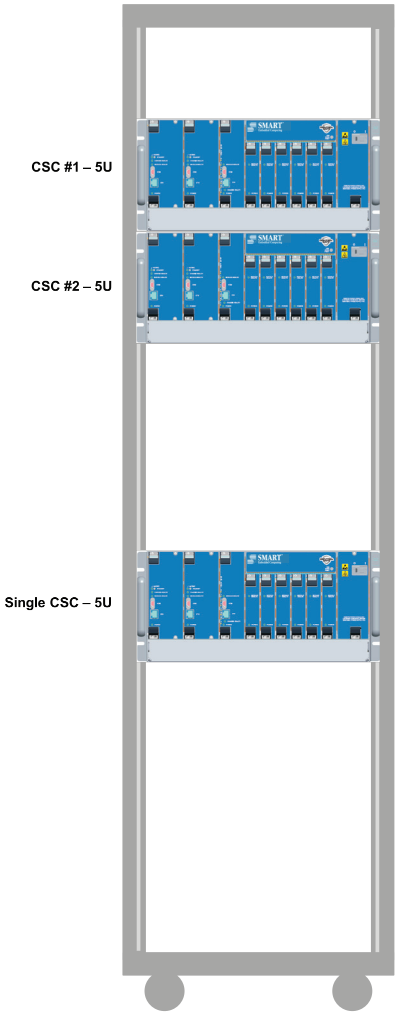
Rear View



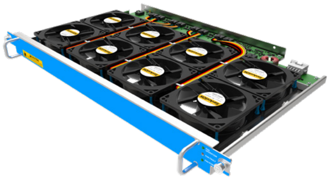
CSC DIMENSIONS (UNIT: MM)



SYSTEM RACK MOUNTING EXAMPLES



OPTIONAL INTEGRATED FAN COOLING SUBSYSTEM



Fan Tray

CSC Chassis with Fan Tray Installation Bay

Technical Specifications

	Processor Modules	Switch Module and IOU Modules
Processor	NXP P2020 (1 GHz)	NXP P1011 (800 MHz)
Operating System	VxWorks 653	VxWorks 653
Memory	1GB (optional 4GB) DDR3-800 SDRAM, ECC	512MB (optional 2GB) DDR3-667 SDRAM, ECC
Flash	2 X 128MB NOR	2 X 64MB NOR
MRAM	2 X 2MB MRAM	1 X 2MB MRAM
Maintenance Ports	10/100/1000 BASE-T and RS-232	10/100/1000 BASE-T and RS-232 (for Switch Module only)
Data Fabric	Nine (9) GbE links	
Board Management	Voltage and temperature sensors	

I/O Interfaces

Number of IOU Slots	Six (6)
10/100/1000 BASE-T Ethernet Ports	Standard: Eight (8) from Switch Module; Optional: Two (2) per Ethernet IOU
CANbus Ports	Optional: Four (4) per CAN IOU

Physical Specifications

Operating Temperature	-40 °C to 60 °C	in open rack environment
	-40 °C to 70 °C	in closed rack installation with 50LFM airflow measured at the intake to the bottom of chassis; or with an optional integrated fan tray solution
Cooling	Convection or Forced Air	
Power	AC: 90-264V, 47-63Hz	
Vibration	Compliant with EN 61373, Category 1, Class B (EN 50155 12.2.11)	
Shock	Compliant with EN 61373, Category 1, Class B (IEC 60068-2-27)	
Chassis Sealing	Standard: IP20; Optional: IP30	
Conformal Coating	ST1 rating for EN 50155 Section 12.2.10 (Salt Mist Test)	
Standards	Designed in accordance with EN50121, EN50124, EN50155, EN50126, EN50128, EN50129, EN55024, EN60529, EN60571, IEC61508. See documentation for specific compliances.	
Safety Certificates	EN50126, EN 50128, EN50129 (SIL4) and IEC61508 (SIL3) (Safety Certificate No. Z10 110176 0003 issued by TÜV SÜD)	

Ordering Information

Part Number	Description
CSP-CSC-CORE-AC-01	ControlSafe Platform core that comprises one chassis, one AC power supply unit, two CPU modules, and one switch module
CSP-CSC-CAN-01	4-port CAN I/O module
CSP-CSC-CAN-RTM-01	High speed rear transition module for CAN I/O module
CSP-CSC-ETH-01	2-port Ethernet I/O module
CSP-CSC-ETH-RTM-01	Rear transition module for Ethernet I/O module
CSP-CBL-PWR-B-01	Power cord for USA/Canada/Japan
CSP-CBL-PWR-EU-01	Power cord for Korea/Germany/Italy/France
CSP-CBL-PWR-I-01	Power cord for China
CSP-CBL-SRB-01	Two cables for Safety Relay Box (SRB) operation
CSP-CBL-DIRECT-01	Two cables for Direct Connect (DCA) operation
CSP-CSC-FILL-01	Front filler panel
CSP-CSC-FLL-RTM-01	Rear filler panel
SERIAL-MINI-D2	Serial cable - micro D-sub connector to standard DE9

Note: The components of the ControlSafe Platform core are not listed in this table but can be ordered separately as spare parts.
Please contact SMART EC regional sales teams for further details.

SOLUTION SERVICES

Smart Embedded Computing provides a portfolio of solution services optimized to meet your needs throughout the product lifecycle. Design services help speed time-to-market. Deployment services include worldwide technical support. Renewal services enable product longevity and technology refresh.

CONTACT DETAILS

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