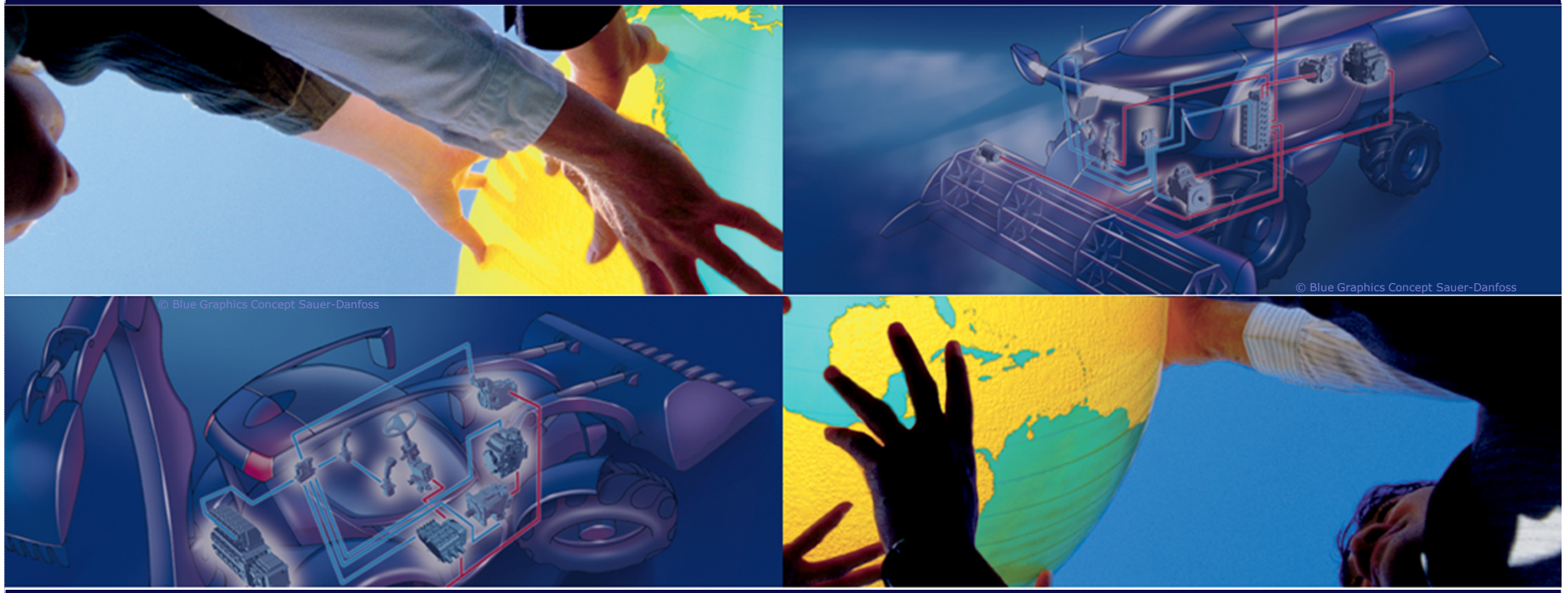
Sauer-Danfoss - JCB Technology Day



Electronic Components Business Area

04.09.2012

SAUER DANFOSS

Electronic Components Business Area

MENU

Product Line Structure

COMPLIANT — COMPLIANT — COMPLIANT

Controllers

Standard/Safety Controller



Custom Controller





Human Machine Interface

Joysticks



Displays



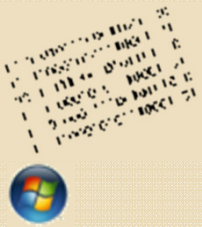


Position Controls & Sensors



Software

Embedded Operating Systems





System Dev Tools





Application Software





PLUS+1™ GUIDE

C source

Simulink®

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Electronic Components Business Area

MENU

Components to Systems

Components → **Software** → **Whole Machine Systems**













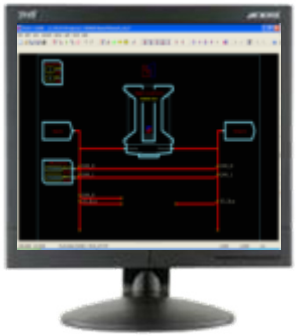

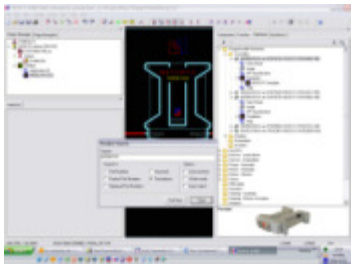





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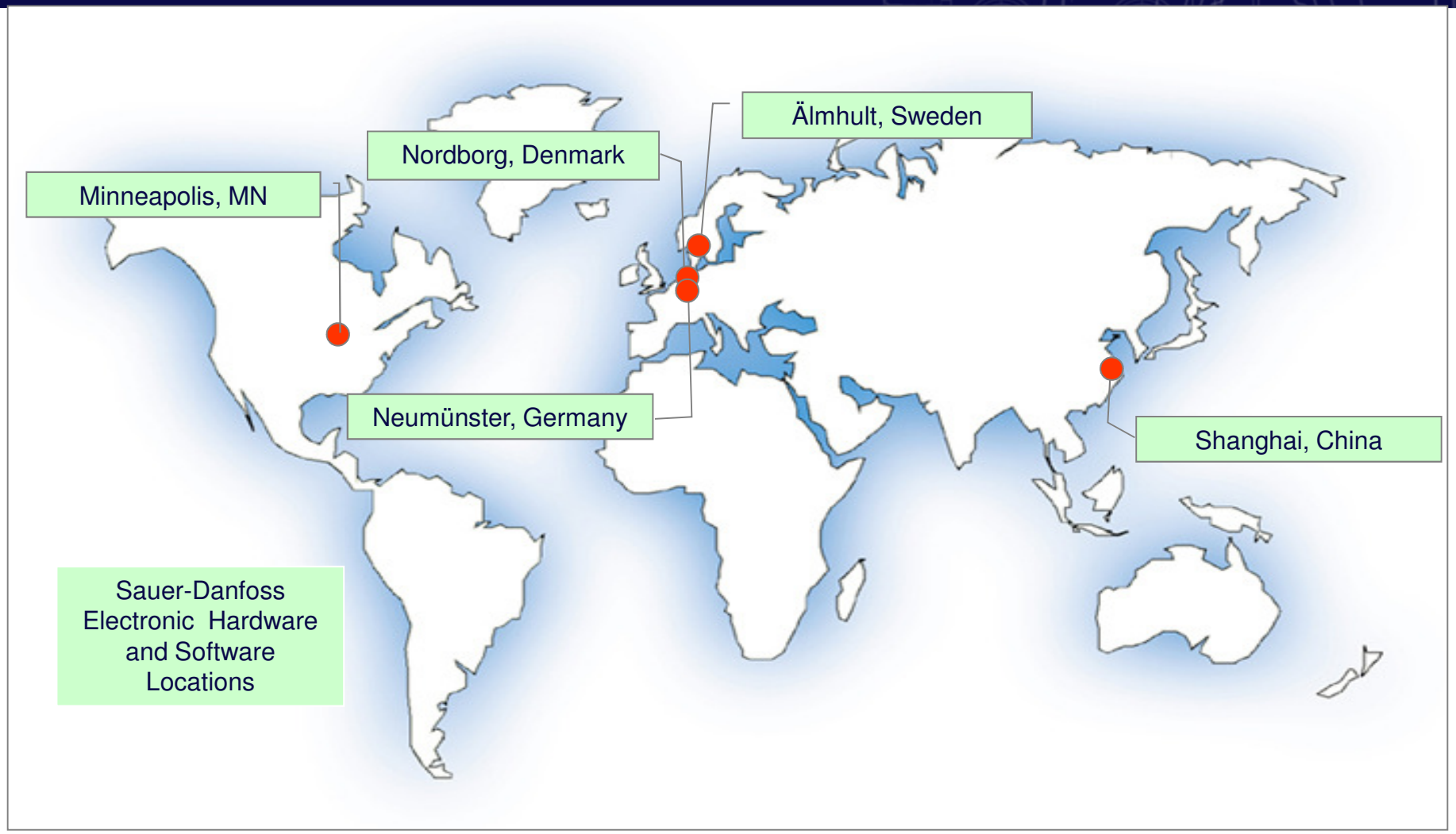
Electronic Components Business Area

MENU

Operating Locations



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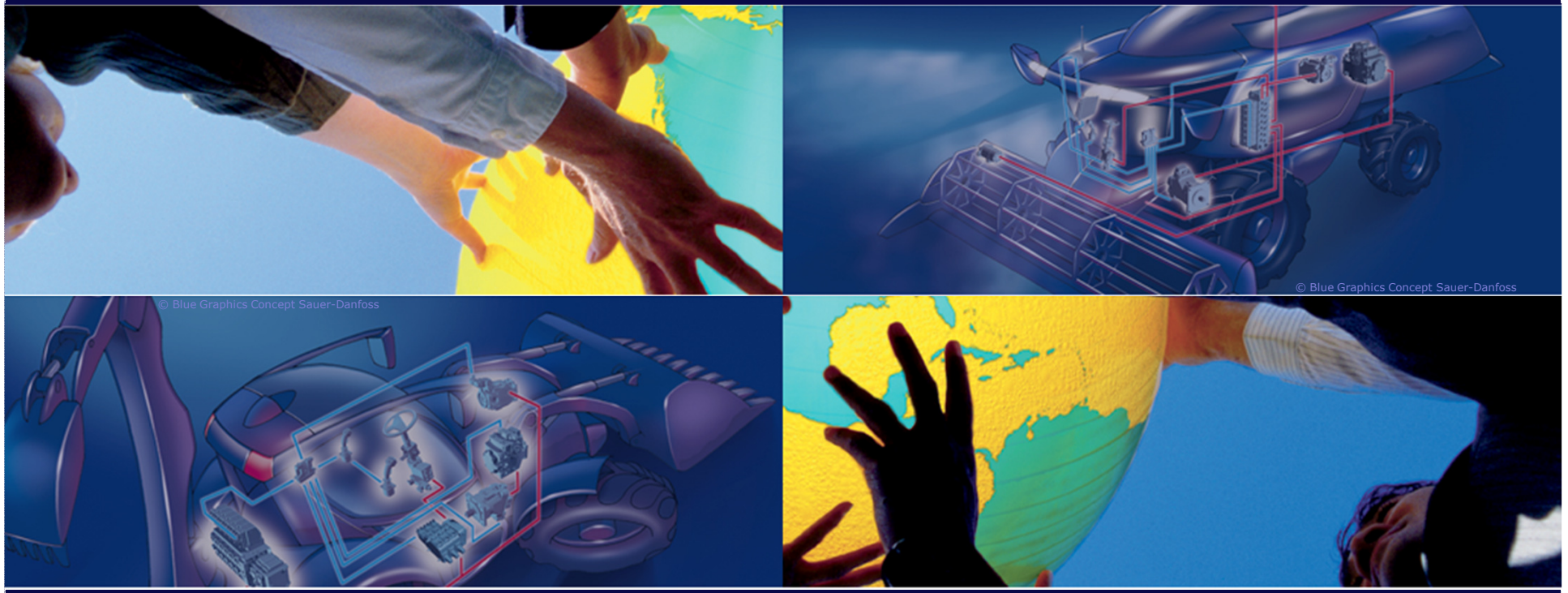
PLUS+1™ Controls Platform



Product overview and Tool Chain

PLUS+1™ by SAUER-DANFOSS

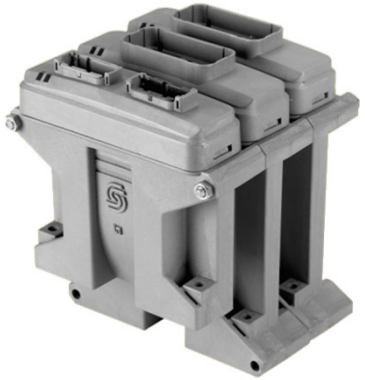
SAUER DANFOSS

PLUS+1™ Controls Platform

MENU

Overview

- Sauer-Danfoss 'next generation' high power family of Mobile Electronics control solutions!



- 12, 24, 38, 50, 88 and 90-pin controllers and I/O modules

- GUIDE graphical programming environment
  - ✓ Customizable 'off the shelf' software solut ns



- Full array of product support options
  - ✓ Your strongest partner for machine controls

- Fully ready to meet industry trends/regulations, i.e. ti Safety, Tier IV etc

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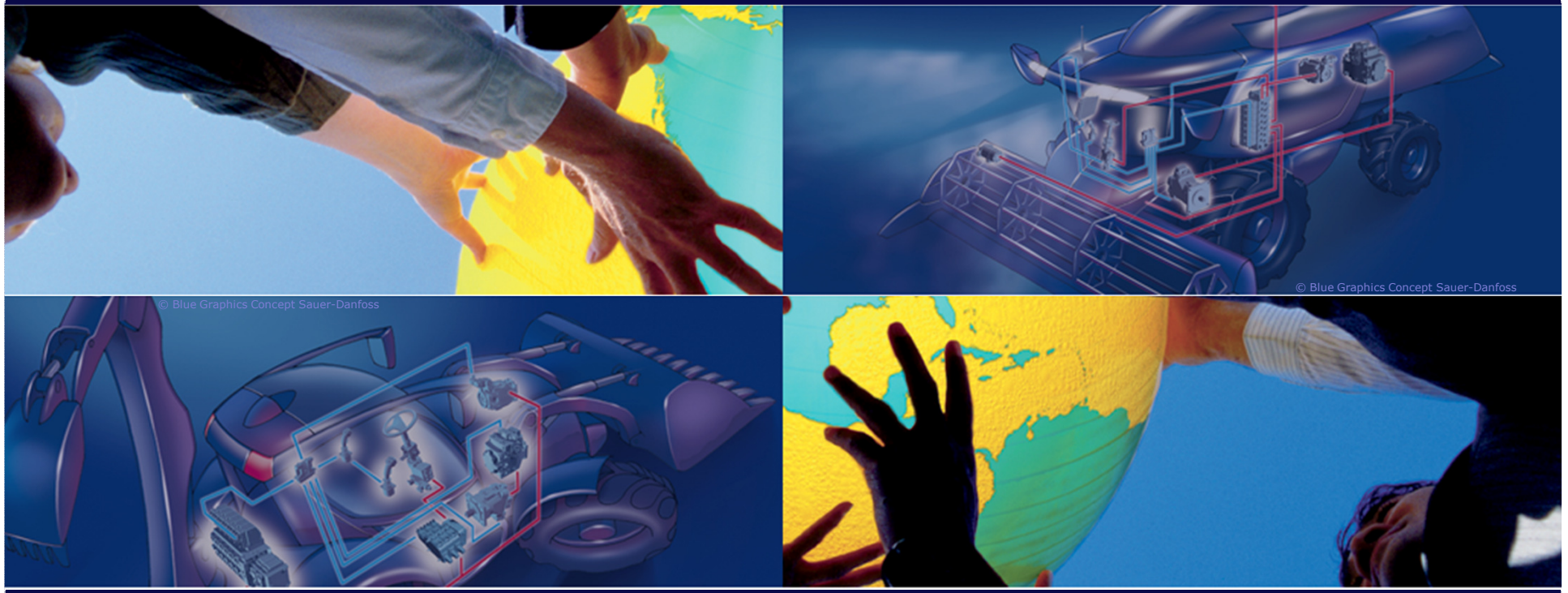
Sauer-Danfoss - Electronic Components



Controllers

SAUER DANFOSS

Rugged Design for Mobile Off Highway Use

- Temperature range: -40C to +70C
- Ingress protection: IP67
- Shock: 100g, 6ms, 3 shocks in each of 6 directions
- Vibration: 5g RMS, 3 directions (x,y.z)
- EMC protection: to 150V/m
- Deutsch electrical connectors
- CE marked
- IEC61508, SIL 2, PL d
- Deutsch® electrical connectors
- Multiple mounting configurations



PLUS+1™ Controllers

Hardware Family

Flexible, High Performance Electronics



- 150Mhz Texas Instruments DSP processor core
  - High performance for even complex applications
- Multifunction Inputs
  - Digital (pull up, pull down, or to 2.5VDC for 3 positions)
  - Analog: 0 to battery voltage (programmable range)
  - Frequency input
  - Temperature sensor input
  - Rheostat input
  - 12-bit A/D analog inputs for high precision sensing
  - 4-20ma input on some models
- Diagnostic LED’s

PLUS+1™ Controllers

Hardware Family



Flexible, High Performance Electronics

- Software configurable outputs
  - 0.1 mA to 3.0 Amp PWM drivers (open or closed loop)
  - PVG ratiometric valve drivers
  - Digital Outputs
  - Some versions capable of up to 10amps
- CAN based communications on all devices
- Flexible I/O reduces need for hardware variants -> reduces inventory needs
- FLASH memory for data logging
- Extended temperature range options

PLUS+1™ Controllers

Hardware Family

- PLUS+1 Input/Output Modules
  - Expand the input and output capabilities of a PLUS+1 controller
  - Preconfigured CAN messaging makes it easy
  - Variants with
    - Inputs only
    - Outputs only
    - Combination of inputs and outputs



PLUS+1™ Controllers

Key Product Features and Benefits

Features	Benefits
Digital Signal Processor (DSP) driven	Large processing power Tackle complex applications and full CAN systems
Ruggedized design	Reliable even in harsh conditions Mounting flexibility
Software configurable I/O	One controller for multiple applications Reduce inventory needs

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PLUS+1™ Controllers

Key Product Features and Benefits

Features	Benefits
GUIDE programmable	Customizable software solutions
Sauer-Danfoss application library	High performance, proven solutions Faster time to market
Service tool interface	Flexible field solutions Powerful development aide

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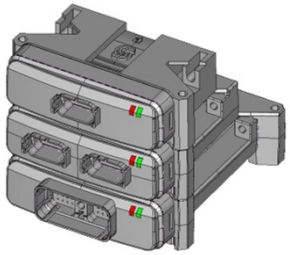
PLUS+1™ Controllers

MENU

Low to High Volume Solutions







Standard Products

Semi Custom

Full Custom

Prototype –Low Volume

2 Week Delivery

Fully Tested & Proven

Versatile – Adaptable

1000 to 5000 / Year

Based on standard product

From Depopulation,
To Mix of Standard Circuits

Compatible with Existing
Production Systems

Good Savings with
Lower Engineering Cost

> 5K/ Year

Customer Defined
Housing Connector,
Electrical Specifications

Our Market Specific
Engineering Knowledge
Applied to Your Needs

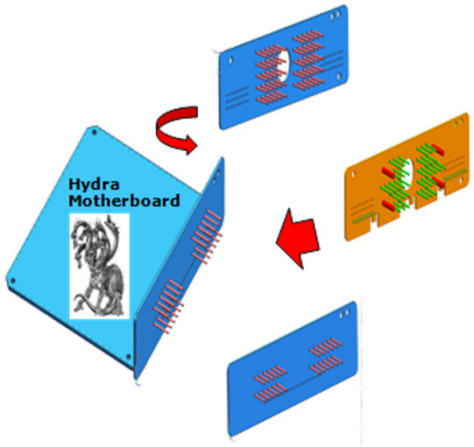
Optimized for
Low Unit Price Cost

SAUER DANFOSS

New Products

PLUS+1™ Safety Controller -

- Complimentary to MC
  - SC = pin compatible with MC
- Features
  - Enhanced functionality
  - Configurable
  - Dual processors
  - Larger memory capacity
  - Higher environmental performance
- Customer Benefits
  - Ease of machine certification
    - EU Machine Directive 2006/42/EC – Functional Safety & Related Standards
    - Designed to achieve SIL 2 (to IEC 61508) and PL d (to ISO 13849-1)
  - System design flexibility
  - PLUS+1 platform





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PLUS+1™ SC Hardware

Design Architecture

MENU

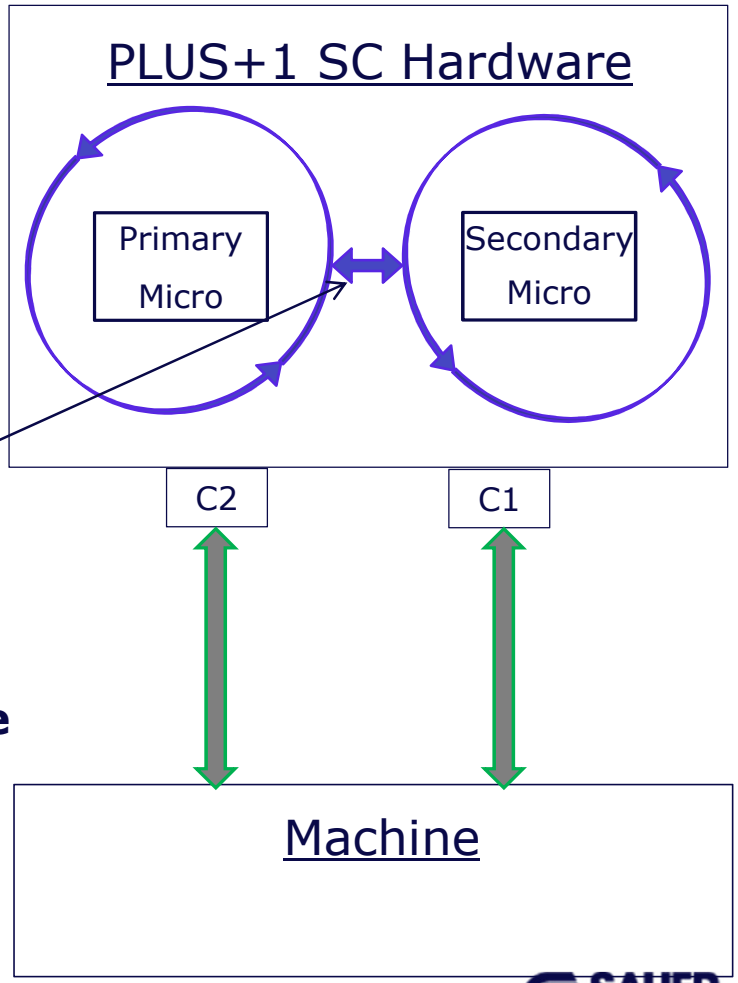
- Achieving Safety Function Hazard & Risk Assessment PL-d
  - PLUS+1 SC Hardware utilizes (2) independent operating systems within a single piece of hardware.

Watchdog Timer

Safety Layer

Safety Layer is NEW to PLUS+1 SC Hardware

The Safety Layer performs an internal monitoring that each PLUS+1 SC operating systems is properly functioning.



PLUS+1™ SC Hardware

MENU

Enhanced Capability

- PLUS+1 MC to PLUS+1 SC Product Enhancements

Feature	MC	SC
Power Supply	9-36 Vdc	7-36 Vdc
Temperature Operating Range	-40°C - 70°C	-40°C - 85°C
EMI / RFI	100 V/M	150 V/M
Sensor Power	Fixed (5 Vdc)	Selectable (3-12 Vdc)
PWM Frequency Outputs	Grouped	Individual (20,000 Hz)
LED's	2 Single Mode Green X Red	2 Dual Mode Green/Yellow X Red/Yellow

High-performance ARM Cortex-M3 MCU with 512 Kbytes Flash, 120 MHz CPU, ART Accelerator

PLUS+1™ SC Hardware

MENU

Key Feature & Benefits

Features	Benefits
Enhanced Input Compatibility AIN – Analog on All 4-20 ma	More Accessory Devices Supported Hardware Flexibility = Saves $
Adjustable Regulated Sensor Power Supply 3 – 12 Vdc	More Accessory Devices Supported Hardware Flexibility = Saves $
Individual PWM Output Control	Optimize Performance Hardware Flexibility = Saves $

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PLUS+1™ SC Hardware

MENU

Key Feature & Benefits

Features	Benefits
Extended Power Supply Operating Range	Operational through Engine Crank and / or “Low Battery. Controller “Up-Time” & Diagnostic”
Increased Environment Compliance EMI / RFI / Temperatures to 85º C	Satisfy Wider Range of Customer Requirements Mounting environment flexibility
Larger Software Memory	Tackle even more complex machines / applications.

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PLUS+1™ SC Hardware

MENU

Key Feature & Benefits

Features	Benefits
Dual Mode LED	Low Level Diagnostic = Less Troubleshooting = Less Downtime
MC ↔ SC Form, Fit, Function - Backwards Compatible “Pin for Pin”	New features / functionality at minimal effort
Dual Processors Architecture Safety Layer Independent Operating Systems	Compliant to ISO 13849 PL-d Support for non-safety changes without certification impact.

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PLUS+1™ SC Hardware

MENU

Key Feature & Benefits

Features	Benefits
Empower Tool Chain GUIDE	Application Software equals “Pole Position”
Software Configurable Hardware I/O	Reduce inventory One controller for multiple machine needs
Software Libraries	Performance, proven solutions Faster time to market

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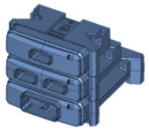
Controllers

MENU

Roadmap



Low Spec Controller



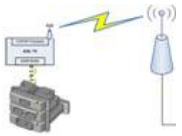
Safety Controller



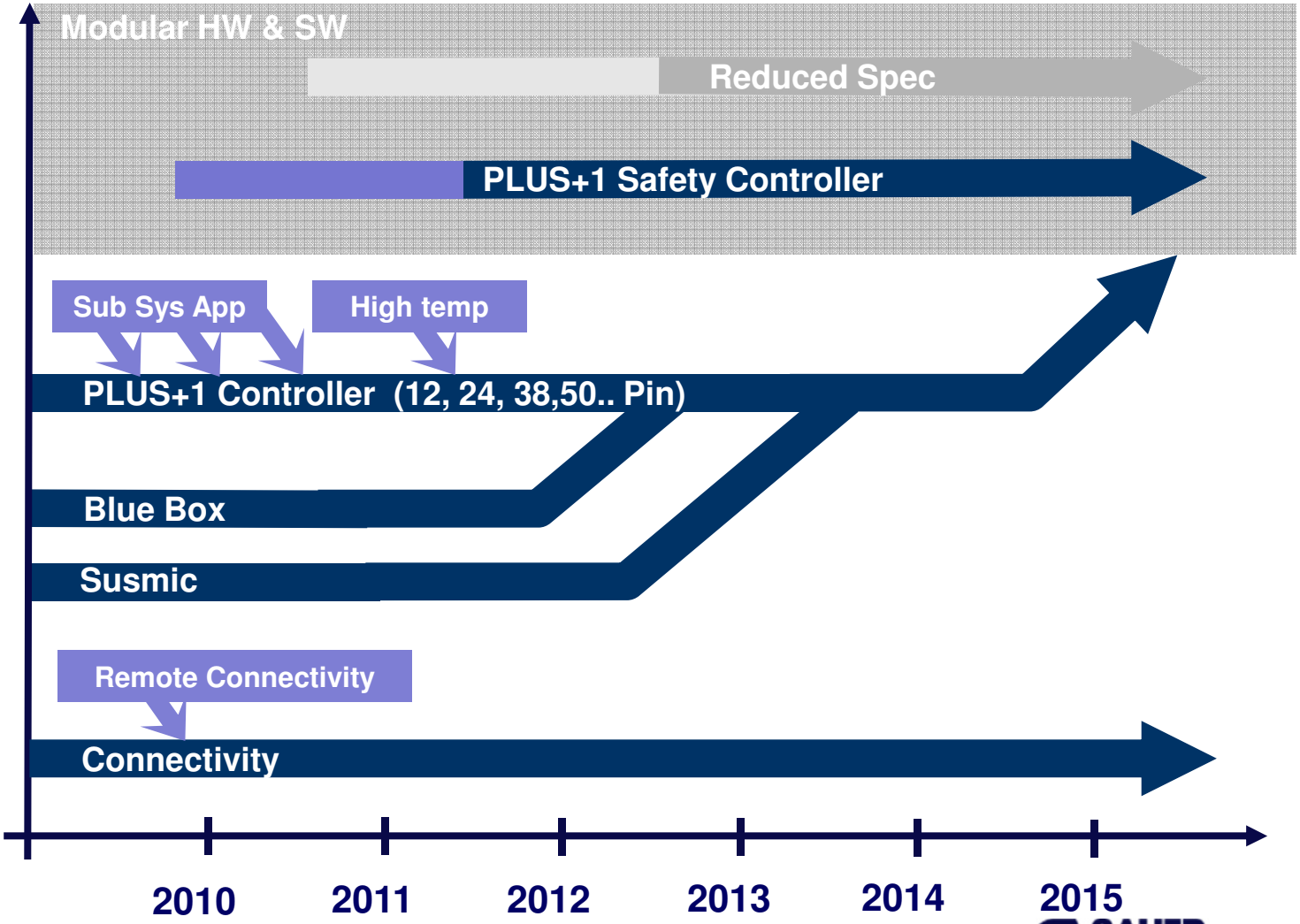
Standard Controller



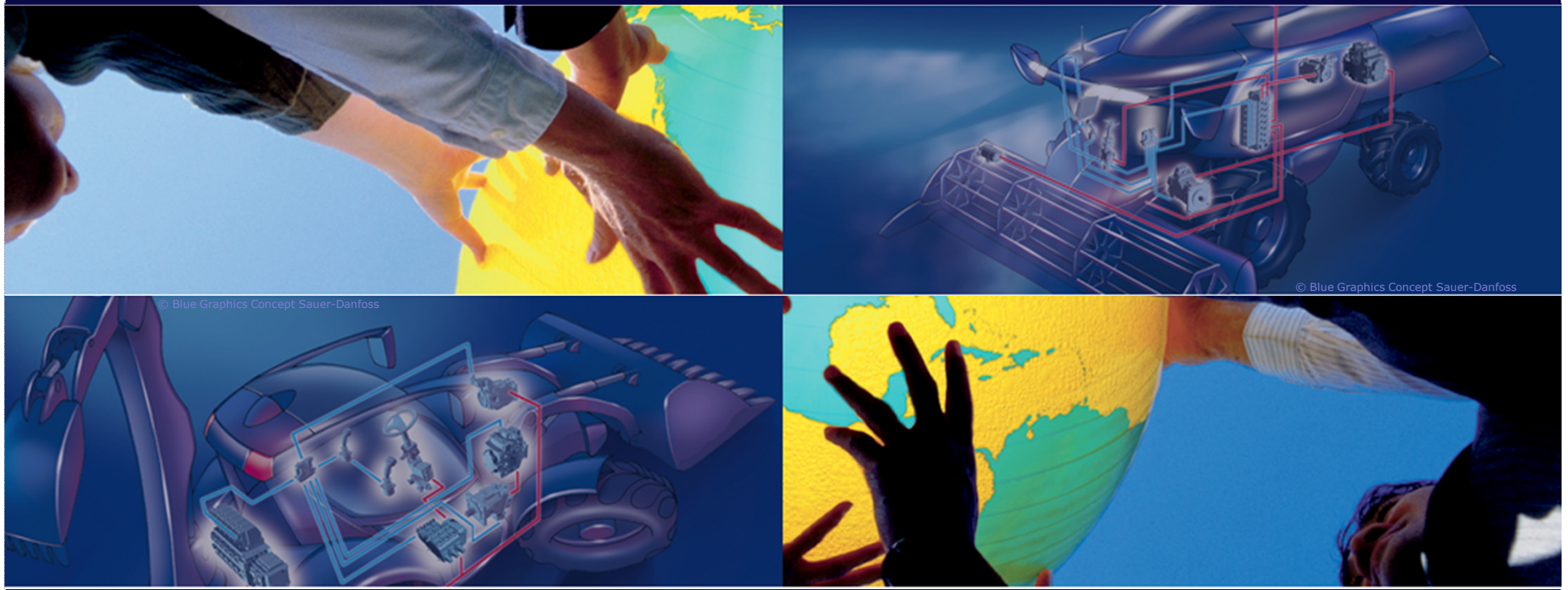
Legacy products



Connectivity



Sauer-Danfoss - Electronic Components



Software

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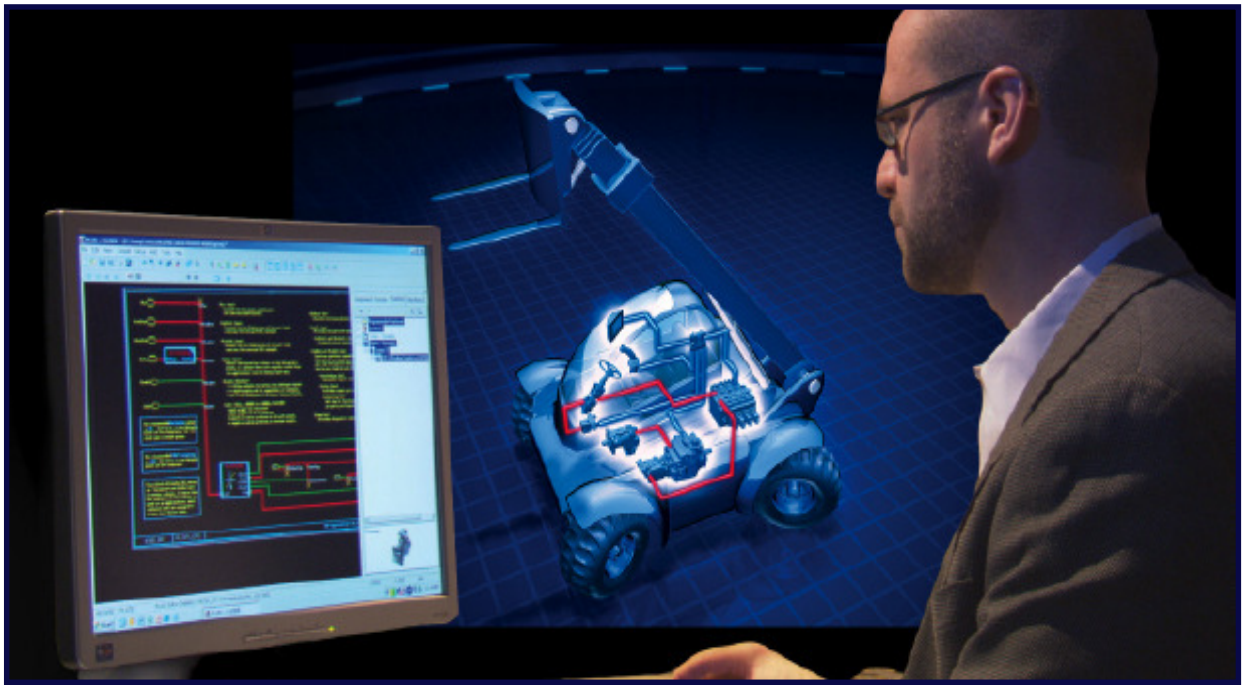
PLUS+1™ Controls Platform

Software

PLUS+1™ GUIDE is a graphical development environment for control system application software



G raphical

U ser

I ntegrated

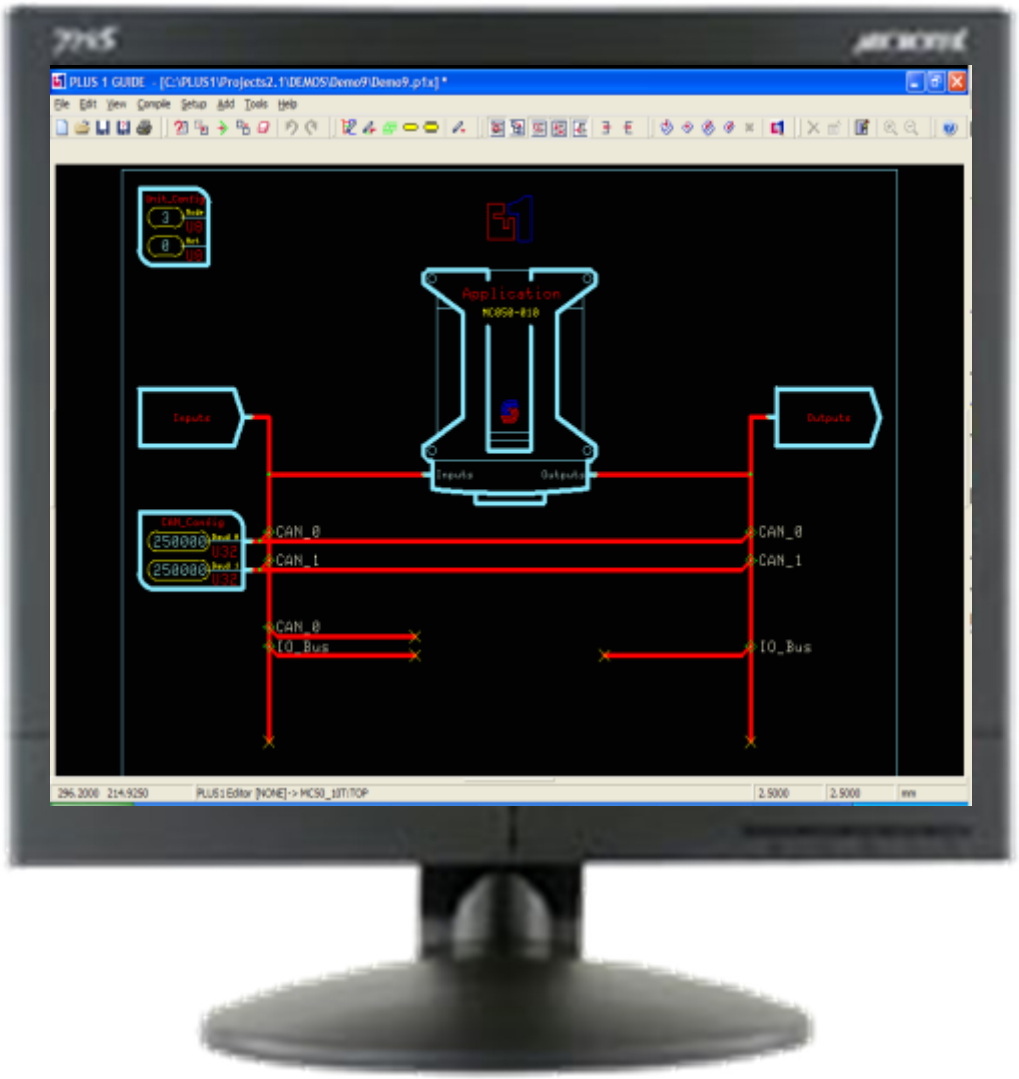
D evelopment

E nvironment

PLUS+1™ Controls Platform

MENU

GUIDE Development Environment



- Program logic and signal flow is easily visualized in GUIDE
- Drag, drop, and connect graphical modules on the programming workspace
- Save, and then download your new application to a PLUS+1 controller or display

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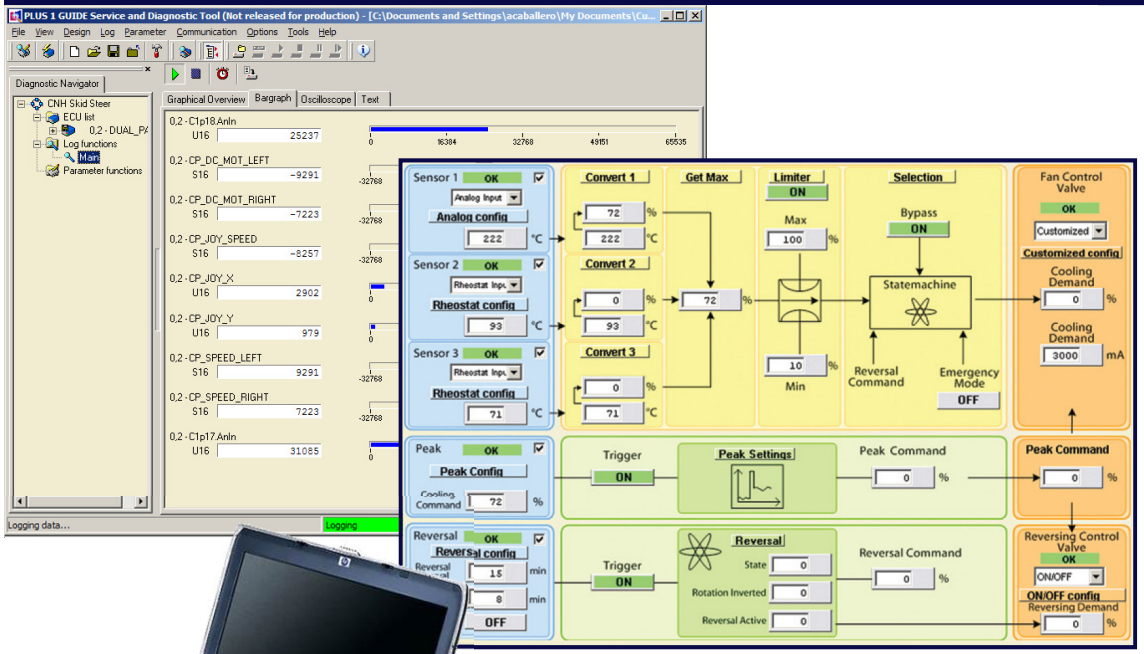
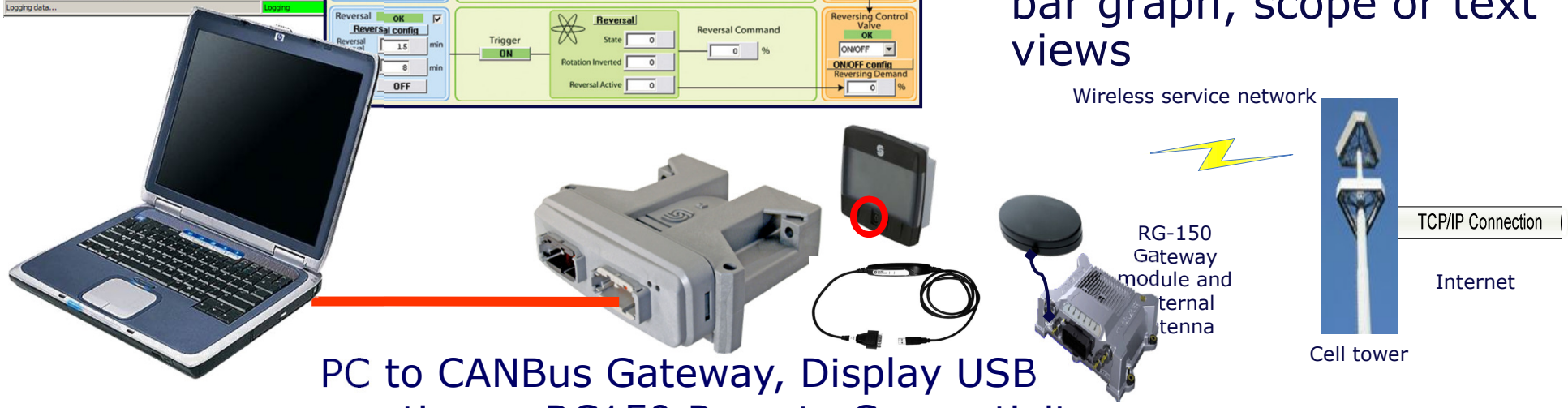
PLUS+1™ Controls Platform

MENU

Service Tools



- Downloads code that's programmed in GUIDE, from PC to micro via CAN link
- Assigns and retrieves parameter values
- Sets up screens with bar graph, scope or text views



PC to CANBus Gateway, Display USB connection or RC150 Remote Connectivity GPRS Gateway

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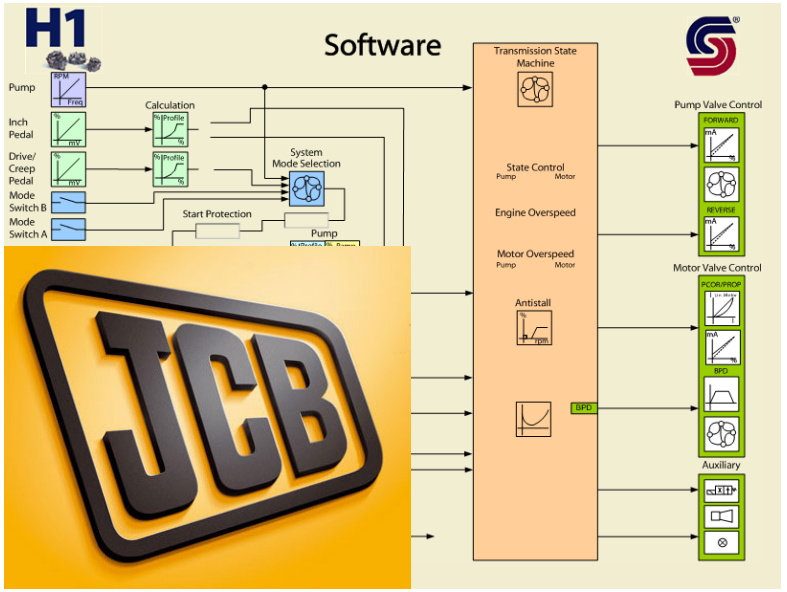
PLUS+1™ Controls Platform

Service Tools

- Fully customizable service solutions
  - Add ‘check points’ at any place in the application
  - Design PC screens to meet the need of the user (developer, service technician, etc.)
  - Password access capabilities
  - CAN bus interface provides access to all controllers in a system
  - **OEM service tool integration**
  - **Support S1X & legacy Products via PLUS+1 Tool Chain**

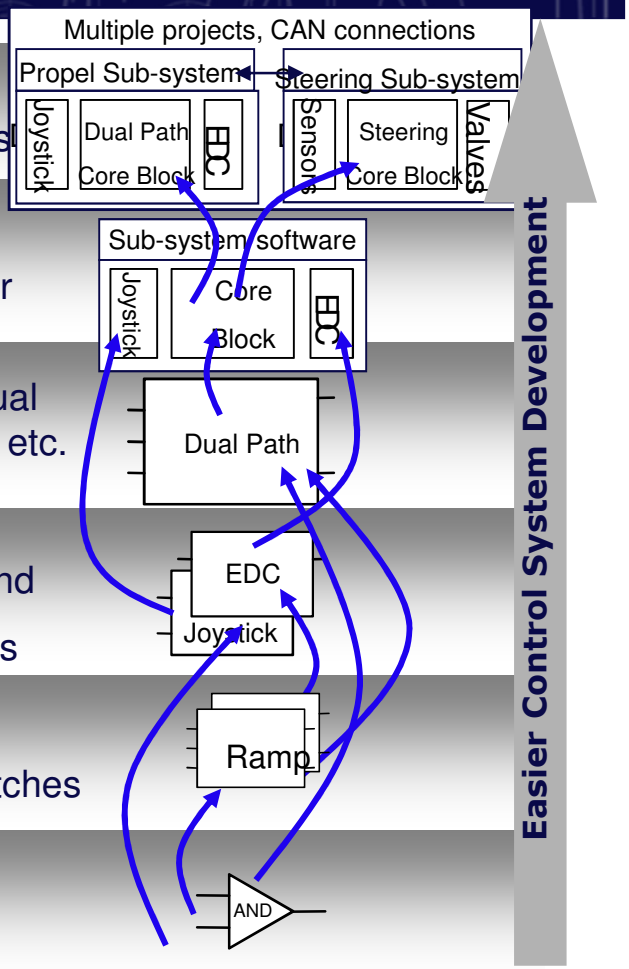


PLUS+1™ Controls Platform

MENU

Application Software Solutions

6	**Vehicle Solutions**	Integrated, CAN-connected Sub-systems
5	**Subsystem Applications**	Dual Path, Automotive, Fan Drive, Transit mixer
4	**Application Blocks**	Core and Plug-ins for Dual Path, Automotive, Hitch, etc.
3	**Compliance Blocks (GUIDE)**	PVE, Joystick, Motors and Pump actuators, Sensors
2	**Function Blocks (GUIDE)**	PID, Ramp, Filter, PWM Drivers, FNR Switches
1	**Components (GUIDE)**	Math, Logical, Limit, Compare, CAN, E^2



Included in GUIDE | **Keyed Applications** | **Custom Product**

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MENU

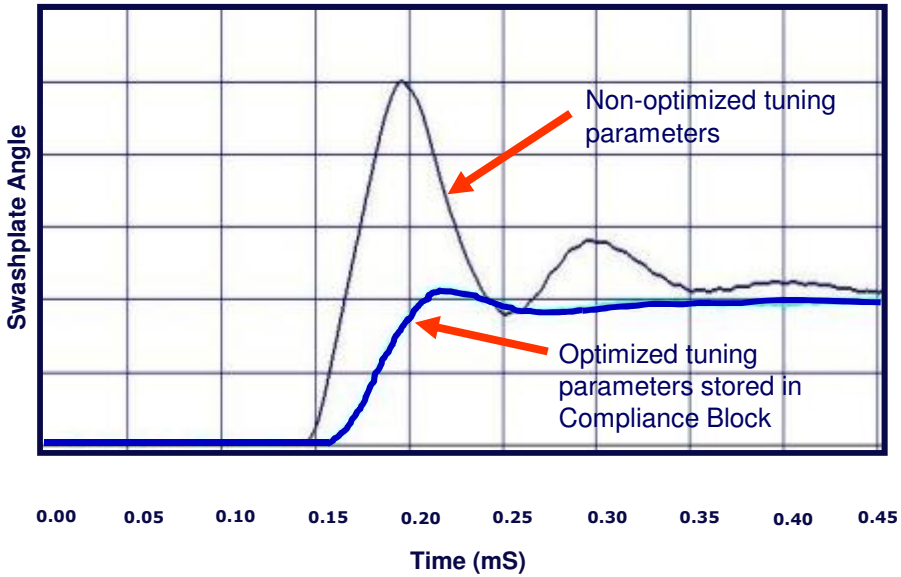
PLUS+1™ Compliance

Over 60 PLUS+1™ Compliance Blocks:

Pumps, motors, valves, sensors, displays and HMI products are represented in software, tested and optimized by Sauer-Danfoss



Example: Optimized Pump Tuning



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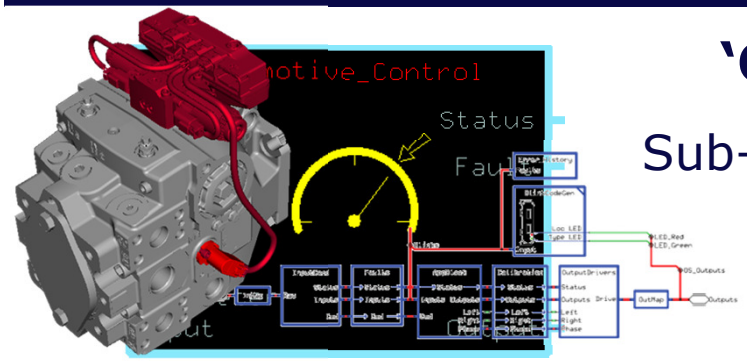
PLUS+1™ Controls Platform

MENU

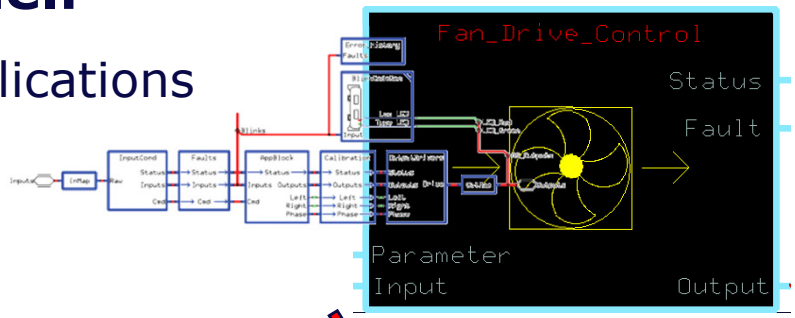
Sub-system Applications

'Off-the-Shelf'

Sub-System Applications



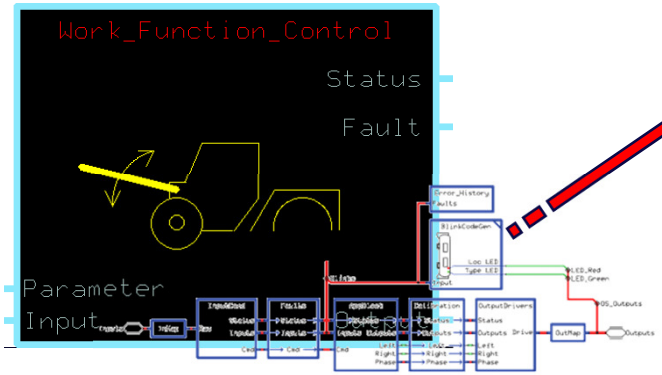
Automotive Control (NFPE)



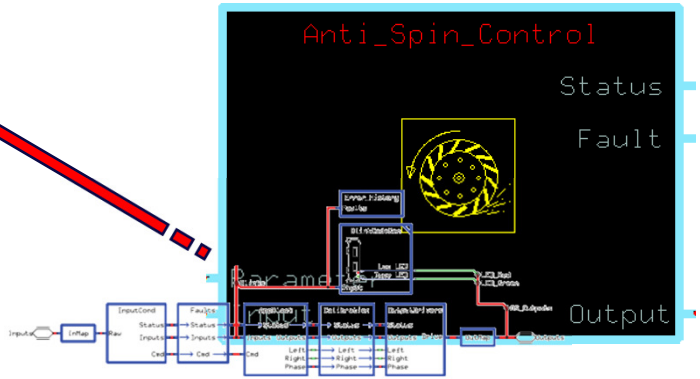
Fan Drive Control



Work Function Control (Boom)



Anti-Spin Control

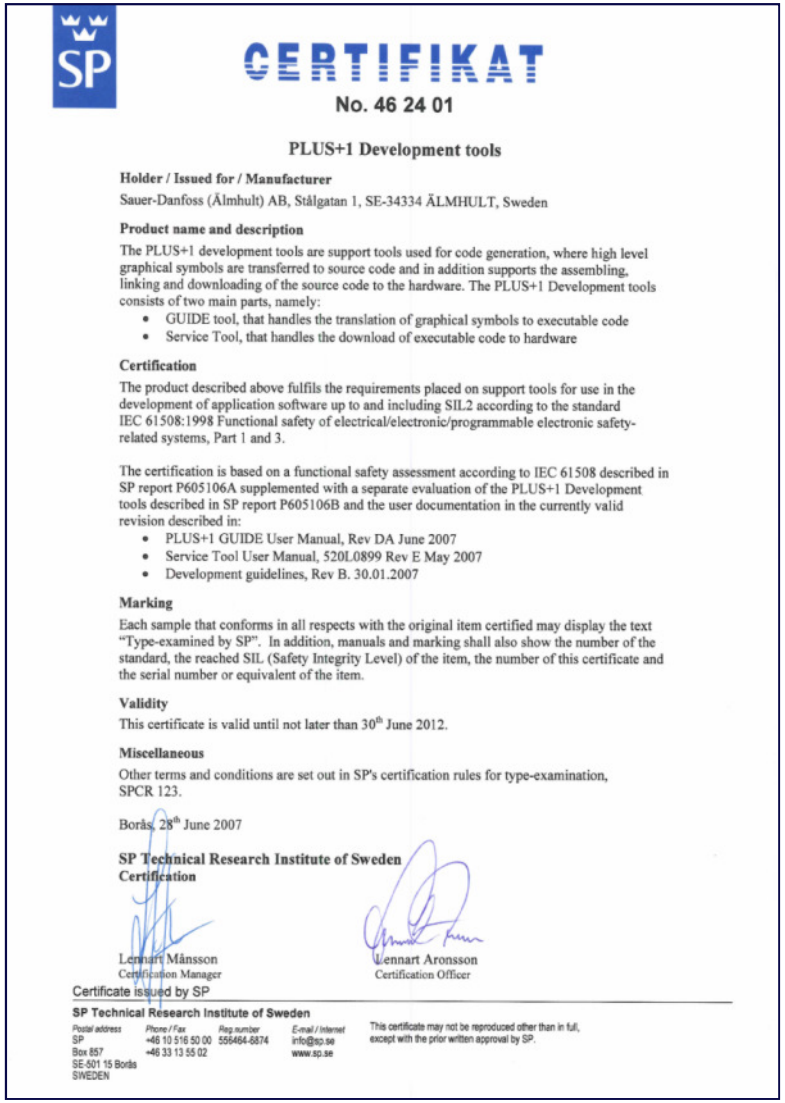


PLUS+1™ by SAUER-DANFOSS

SAUER DANFOSS

Functional Safety (FS)

How we can help you with solutions



SP

CERTIFIKAT

No. 46 24 01

PLUS+1 Development tools

Holder / Issued for / Manufacturer

Sauer-Danfoss (Älmhult) AB, Stålgatan 1, SE-34334 ÄLMHULT, Sweden

Product name and description

The PLUS+1 development tools are support tools used for code generation, where high level graphical symbols are transferred to source code and in addition supports the assembling, linking and downloading of the source code to the hardware. The PLUS+1 Development tools consists of two main parts, namely:

- GUIDE tool, that handles the translation of graphical symbols to executable code
- Service Tool, that handles the download of executable code to hardware

Certification

The product described above fulfils the requirements placed on support tools for use in the development of application software up to and including SIL2 according to the standard IEC 61508:1998 Functional safety of electrical/electronic/programmable electronic safety-related systems, Part 1 and 3.

The certification is based on a functional safety assessment according to IEC 61508 described in SP report P605106A supplemented with a separate evaluation of the PLUS+1 Development tools described in SP report P605106B and the user documentation in the currently valid revision described in:

- PLUS+1 GUIDE User Manual, Rev DA June 2007
- Service Tool User Manual, 520L0899 Rev E May 2007
- Development guidelines, Rev B. 30.01.2007

Marking

Each sample that conforms in all respects with the original item certified may display the text "Type-examined by SP". In addition, manuals and marking shall also show the number of the standard, the reached SIL (Safety Integrity Level) of the item, the number of this certificate and the serial number or equivalent of the item.

Validity

This certificate is valid until not later than 30th June 2012.

Miscellaneous

Other terms and conditions are set out in SP's certification rules for type-examination, SPCR 123.

Borås, 28th June 2007

SP Technical Research Institute of Sweden
Certification

Lennart Månsson
Certification Manager

Lennart Aronsson
Certification Officer

Certificate issued by SP

SP Technical Research Institute of Sweden

Postal address: SP, Box 857, SE-501 15 Borås, SWEDEN
Phone / Fax: +46 10 516 50 00, +46 33 13 55 02
Reg.number: 556464-6874
E-mail / Internet: info@sp.se, www.sp.se

This certificate may not be reproduced other than in full, except with the prior written approval by SP.

- **GUIDE software and GUIDE Service Tool are SIL 2 certified**
  - Reduced OEM documentation requirements
- **Example of pre-certified application software using GUIDE:**
  - H1 Automotive Control (SIL 2)

SAUER DANFOSS

Sauer-Danfoss Electronic Components

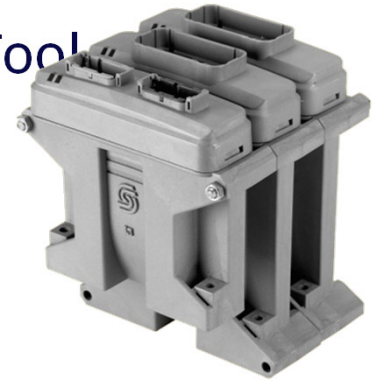
PLUS+1™ Acceleration Program

- PLUS+1™ Tools has a history of innovation
- The PLUS+1™ Investment will make PLUS+1™ the application development tool of choice in the Mobile Market
- Designed for:
  - Modelling
  - Functional Safety
  - Customisable, versatile, automated, multi-lingual PLUS+1™ Service Tool
  - Display Screen development
  - Fast, cost effective, production quality software development for mobile machinery

PLUS+1 Controls Platform

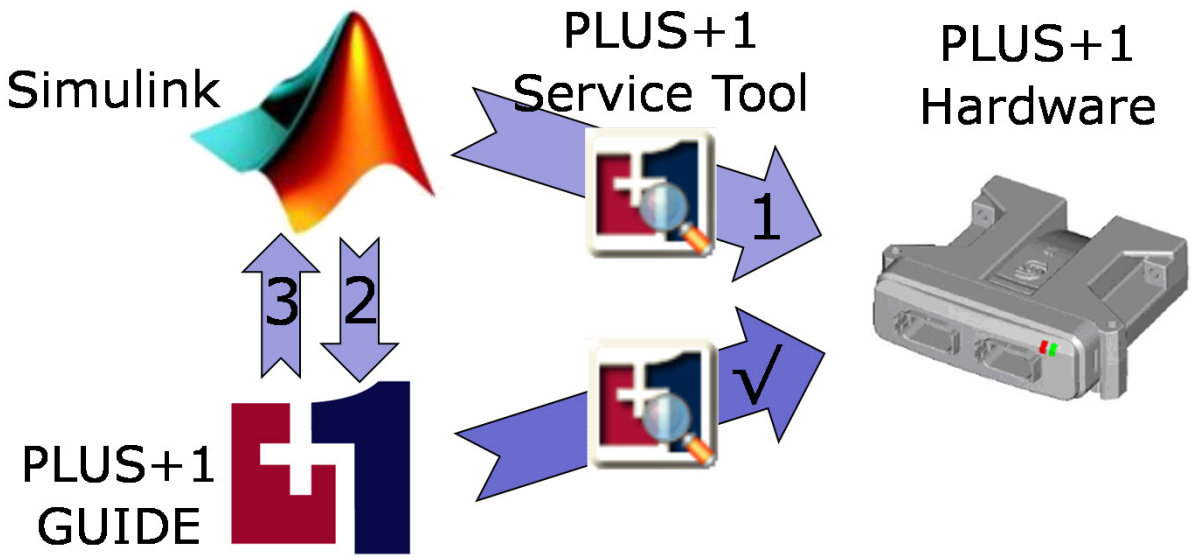
C-Code Integration

- Two methods
  - CCP (Compiled Code Package)
    - Re-use existing Assembler, C, C++ source code on PLUS+1 controller
    - Call function/object from GUIDE application
  - PLUS+C
    - Work outside of GUIDE with HWD C file
    - Download to PLUS+1 micro with Service Tool



PLUS+1™ Controls Platform

Simulink integration



1. Development in Simulink only
2. Use Simulink code within a PLUS+1 GUIDE application
3. Use PLUS+1 GUIDE code in a Simulink Model

Use the best tool for each part of the software development and combine the results

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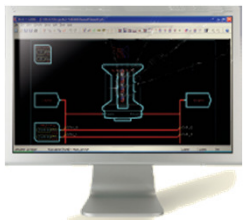
Sauer-Danfoss Electronic Components

Roadmap - Software

C-Code

PLUS+1 GUIDE

Legacy Support



PLUS+C (TI development environment)

PLUS+1 C-code target

Simulink generated C-code

C-code Application library

Enhanced GUIDE (C-code in GUIDE)

PLUS+1 GUIDE

Automated functional safety test tools

Enhanced Service Tool

Service Tool

Common Sauer-Danfoss Service Tool

WebGPI (legacy service tool)

2009 **2010** **2011** **2012** **2013** **2014** **2015**

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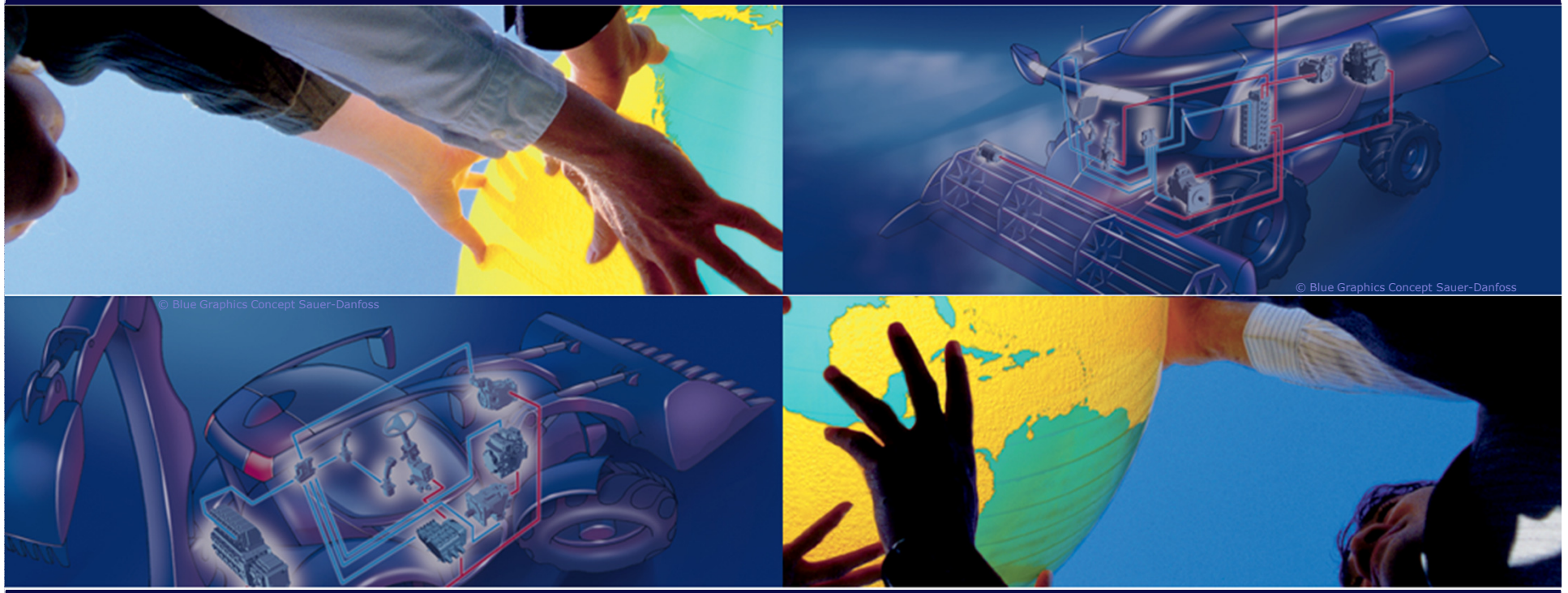
Sauer-Danfoss Electronic Components



Human-Machine Interface - Joysticks

SAUER DANFOSS

HMI - Joysticks

Overview

- Vast array of joystick options
  - Mini
    - JS120, JS2000 mini joystick
    - Includes proportional rockers and rollers
    - Small, low force
    - Sensor level outputs
  - Standard
    - Standard Duty ”hall-ball” base
    - Sensor level outputs
    - Discrete valve and CAN outputs
  - Special Functions
    - Heavy Duty base
    - Friction Held, Detents, Twist function
    - Redundant sensors
    - Sensor, discrete valve and CAN outputs



JS7000 Joystick

Introduction

- Clean sheet design approach
- Best-in-class performance
  - Ruggedness
  - Durability
  - Flexibility
  - Controllability
- Industrial design
  - Ergonomics / comfort
  - Aesthetics
- Design for functional safety performance



Design Process – Research

Methodology



- Video recorded working tasks



- Open discussion



- Discuss examples

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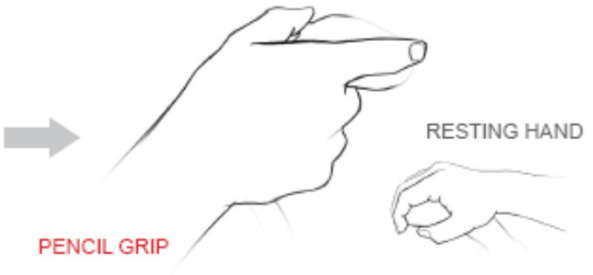
JS7000 Joystick

Design Process – Grip Research



STATIC OPERATOR





TRAVELLING OPERATOR





RUGGED OPERATOR



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JS7000 Joystick

Grip Example: Design for Comfort



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JS7000 Joystick

Future Option: Horizontal Grips Concepts



JS7000 Joystick

MENU

Summary of Features and Benefits

Features	Benefits
>15 million cycle life •Bronze bearings •High strength materials •Advanced boot design •High strength shaft •Field serviceable	Low lifetime vehicle ownership cost Higher vehicle "uptime" (increased productivity)
Highly engineered cone and nest interface & materials	Smooth, precise control Consistent performance over lifetime of vehicle

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S7000 Joystick

MENU

Summary of Features and Benefits

Features	Benefits
Patent-pending grip design •Ergonomics •Aesthetics	Reduced operator fatigue Greater vehicle productivity Best-in-class vehicle cabin environment
Dual gimbal movement Independent X, Y axis configurability	Best-in-class, tailored “feel”, functionality Improved operator, vehicle productivity

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JS7000 Joystick

Summary of Features and Benefits

Features	Benefits
Design for functional safety •Redundant Hall sensor signals (each axis) •CAN + Analog redundant output	Faster OEM time-to-market for vehicle safety functions to SIL 2 / PLd
Modular design Large option portfolio	•Tailored, differentiated “feel”, •Faster OEM time-to-market •Reduced development cost

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MENU

Roadmap - Joysticks



Large
Dual axis

Prof1
JS7000
JS6000
Configurable Options
Build Center Ready
JS7000
On-going Feature Releases



Large
Single axis

JS1500
Configurable Options
Build Center Ready
MCH



Mid size
Single / Dual
axis

On-going Feature Releases
JS1000
JS1000
PVRES / PVREL



Small
Single axis

JS1200
JS120

2009 2010 2011 2012 2013 2014 2015

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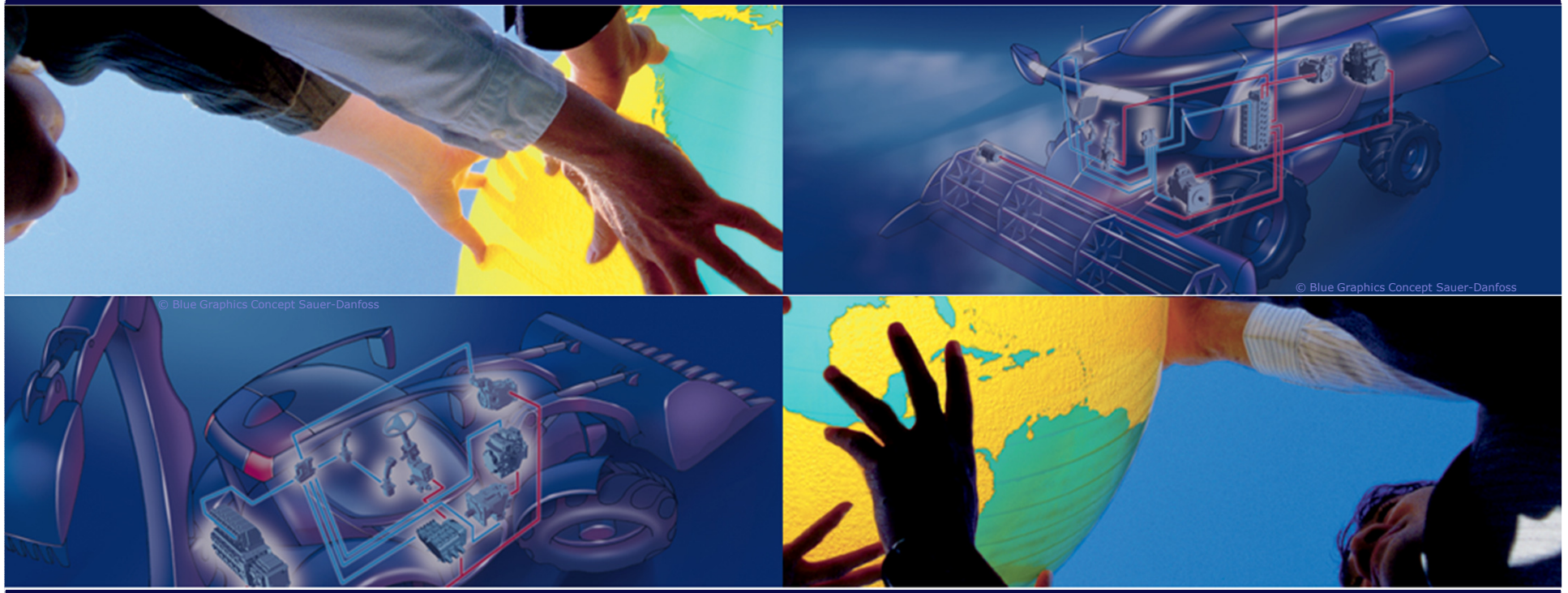

Human Machine Interface - Displays

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HMI - Displays



DP6xx

J1939 COMPLIANT

DP600 Series Graphical Terminals



DP7xx



DP20x



DP25x

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MENU

DP250 Overview

- Part of DP2xx rugged display family
- **High resolution color screen!! – Improved operator experience**
  - 320x240 pixels
  - 15 Bit color resolution
- Arm-7 powerful processor
- Transmissive TFT LCD – Viewable in direct sunlight
- LED backlight
- Integrated Heater
- Ambient light sensor (under SW control)
- 4 Tactile soft keys
- 6 indicators (LED)
- USB
- Multiple I/O
- EIC J1939 Engine Interface software off-the-shelf



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MENU

HMI – Displays







Current DP6xx

- Successful product in a limited range of applications
- Aging technology
- Custom-made embedded operating system

DP6xx LX (Upgrade)

- Launch: March 2012
- State of the art iMX processor designed for automotive graphical applications
- Improved connectivity options
- Embedded Linux operating system

DP700

- Built on JS7000 design language
- Best in class connectivity
- Modular options for in-cab and cab-less applications

DP6xx LX Colour Graphical Display

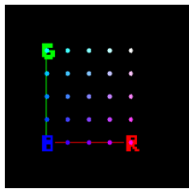
MENU

Summary: Better Today, Ready for tomorrow



Arm-11 processor

Optically bonded LCD / Lens assy.







Multi-function inputs

16MB app log memory

NTSC

PAL

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DP6xx LX Color Graphical Display

MENU

Key Product Features and Benefits

Features	Benefits
New ARM-11 processor	Greater responsiveness Faster screen data updates
New Linux operating system	Industry standard Greater application SW support

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DP6xx LX Color Graphical Display

MENU

Key Product Features and Benefits

Features	Benefits
Optically Bonded LCD/Lens Technology	Improved sunlight viewability Eliminate fogging
NTSC and PAL video support	Global compatibility with regional video formats, cameras
USB Host Support	Allows download of machine application log data to USB memory stick

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DP6xx LX Color Graphical Display

MENU

Key Product Features and Benefits

Features	Benefits
More Application and logging Memory	Increased capacity to store machine operating data
15-Bit Color Resolution	Improved, sharper color

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HMI - Displays

MENU

DP700



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MENU

DP700 Overview

- 7” Display module 800x480 Resolution
- Optically Bonded LCD Assembly
  - Enhanced optics and prevents fogging or dust contamination
- 3 different LCD Options
  - Out of cab
  - In cab
  - Value
- Optional Projective Capacitive Touchscreen
  - Best in class optics, works through mud water and with gloves
- State of the art iMX Arm 11 processor (500 MHz)
- Expandable memory and data-logging options
- USB and Ethernet Options
- Linux Operating system
  - Supports sophisticated application development using third party tools

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MENU

Best in-class Screen Editor

- Two solutions will be launched with the DP700
- GUIDE Users
  - Productivity Enhancements to existing GUIDE Tools
  - Reduce development time
  - Enables porting of applications between projects
  - Automates repetitive steps
- Linux Users
  - Fixed API Interface to Linux OS
  - Will allow the use of independent tool chains such as QT Creator
  - Create complex and sophisticated display applications
  - Leverage full benefit of Linux OS

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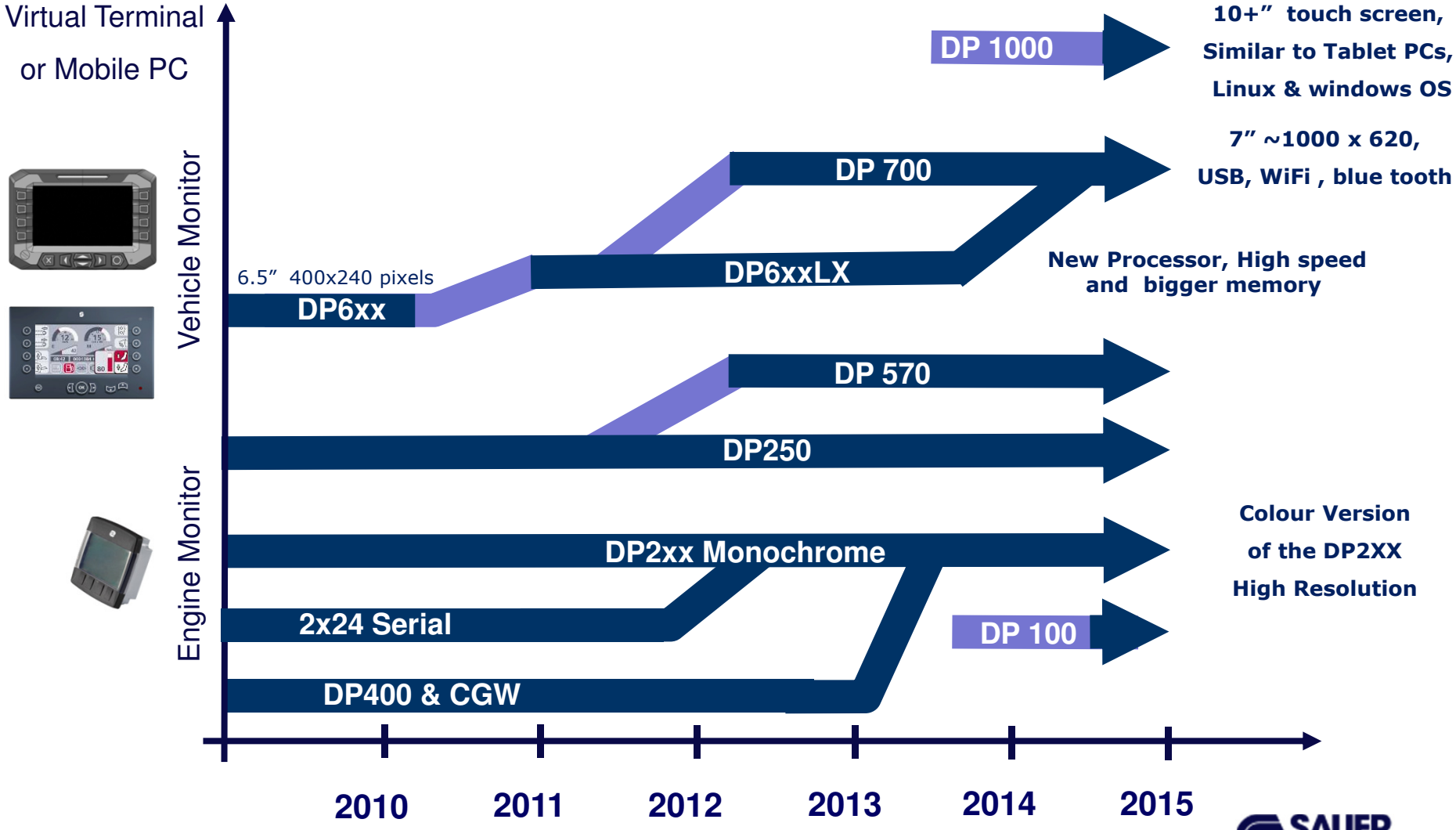
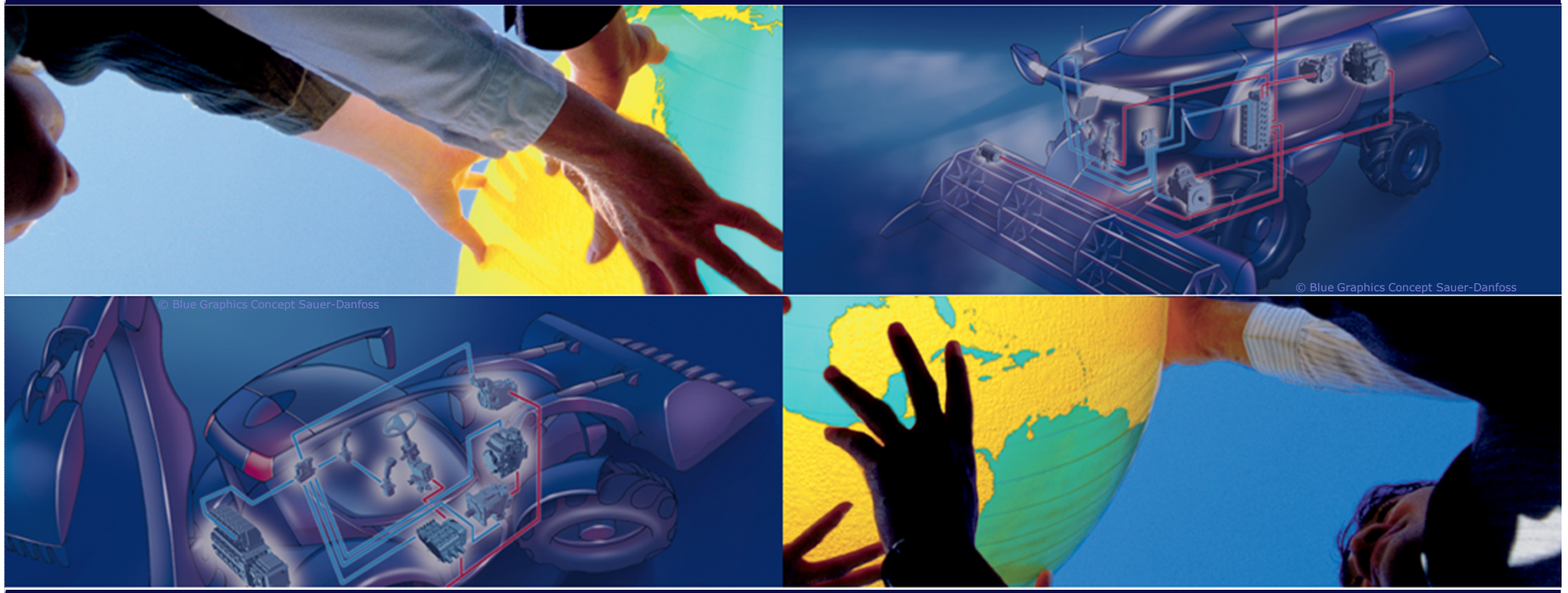
HMI - Displays

Roadmap



Sauer-Danfoss Electronic Components



Position Control & Sensors

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Position Controls & Sensors

MENU

Overview

Footpedals



COMPLIANT



COMPLIANT

Temp, Pressure, Speed

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Position Controls & Sensors

MENU

KEP3 Footpedal

- Market Drivers:
  - Growing need for additional human machine interface (HMI)
  - Improved machine performance
  - Foot operated controls with redundancy to help meet Functional Safety

- The KEP3 is a rocker type electronic Foot Pedal.

- Activation is (forward/neutral/reverse) spring center.

- Designed to meet the Truck and Bus Rugged operating conditions



- Designed for high duty cycle life.

- PLUS+1 Compliant

Position Controls & Sensors

KEP3 Footpedal

Features	Benefits
• **Rugged Design**	○ Hi degree of mechanical strength. ○ Minimum 3 million duty cycles.
• **Redundant Dual Hall Sensor**	○ Reliability with non-contacting sensors ○ Help to achieving External Safety Certification for SIL2
• **PLUS+1 Compliant**	○ Availability of Function Blocks for ease of adding the KEP3 into a PLUS+1 control scheme.

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Position Controls & Sensors

MENU

Roadmap – Slope Sensors

SD slope



MCX



TOPCON slope



CAN based, MEMS

Gyro stabilized

Faster response

Higher accuracy

Less susceptible to machine motion

2010 **2011** **2012** **2013** **2014** **2015** **2016**

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Position Controls & Sensors

Roadmap – Distance / Position Sensors

New Generation



Ultra Sonic distance Sensors







Position and Yoyo-Sensors

CAN

Ultra Sonic

High resolution

Ongoing development i.e. CAN BUS Schnittstelle

Easy to use and robust

2010 **2011** **2012** **2013** **2014** **2015** **2016**

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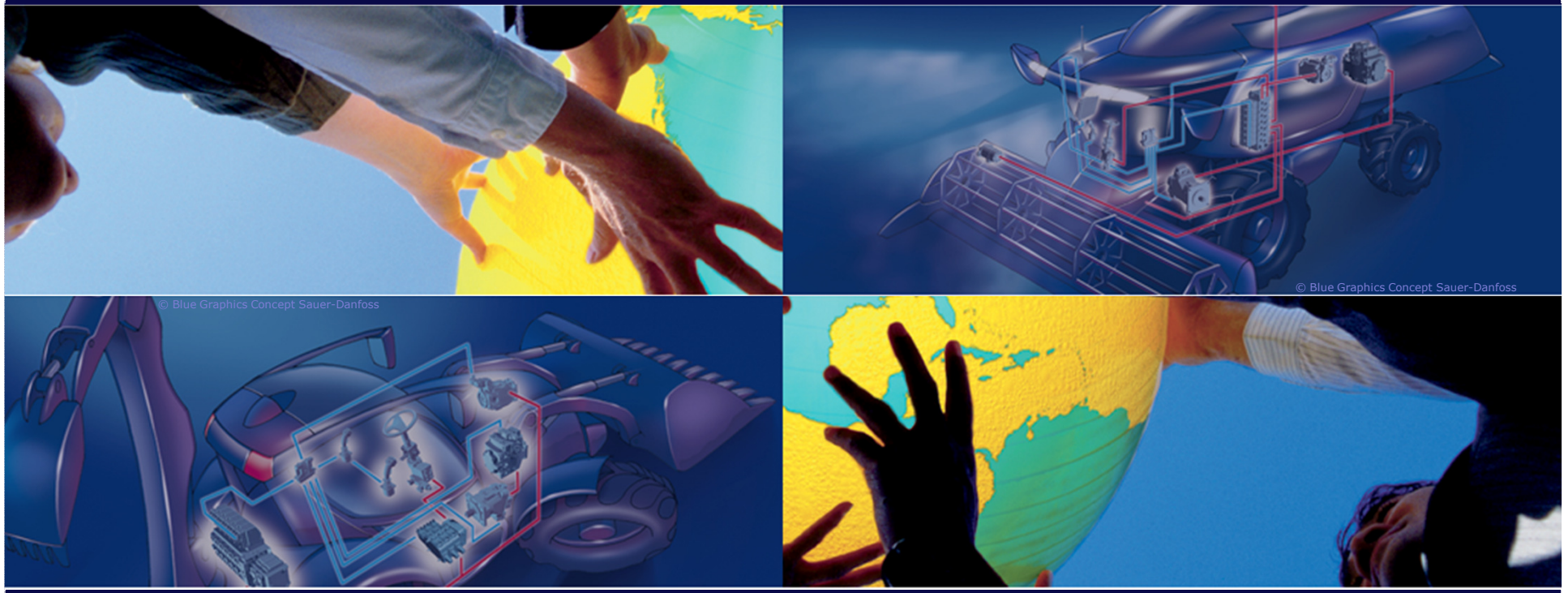


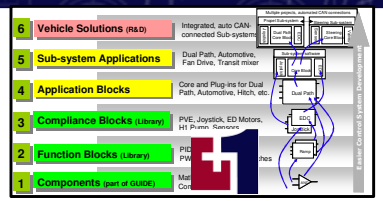
Summary

PLUS+1™ Controls Platform

MENU

Product Support

- Application software Library
- PLUS+1 Compliance
- Documentation
- eLearning
- Classroom training
- Email support & web site FAQ
- Helpdesk telephone support

















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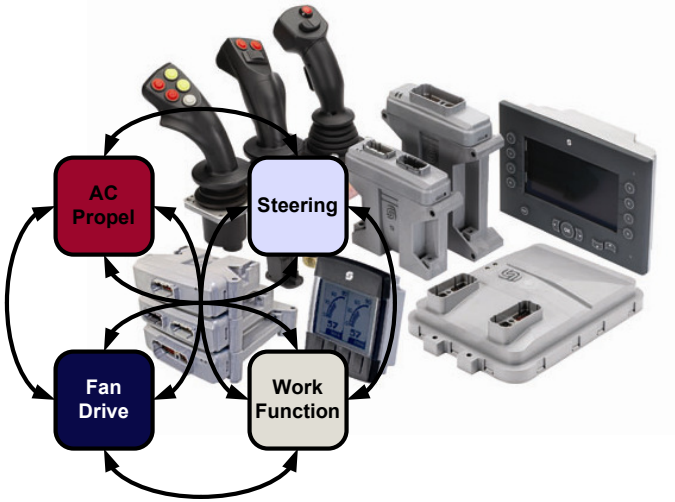
Summary

The key to success will be an intelligent Vehicle System Control

Sauer-Danfoss Electronics provide the opportunity to cope with the increasing demand for Electronic System Controls.

We are well positioned to supply an Integrated Machine Control Strategy.





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Thank you for your kind attention!

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What really matters is inside®