RadICS Digital I&C Platform Topical Report

Overview of Radiy and RadICS PlatformTopical Report

Phase 1 Review Kickoff Meeting (Open Session)

August 30, 2017, Rockville, Maryland

Agenda

- Meeting Purpose
- About “Radiy”
- Nuclear Organization
- Products for Nuclear Power Plants
- Manufacturing and Qualification Test Facility
- Product/Project Experience
- Third Party Certification
- Expected Outcomes

Meeting Purpose

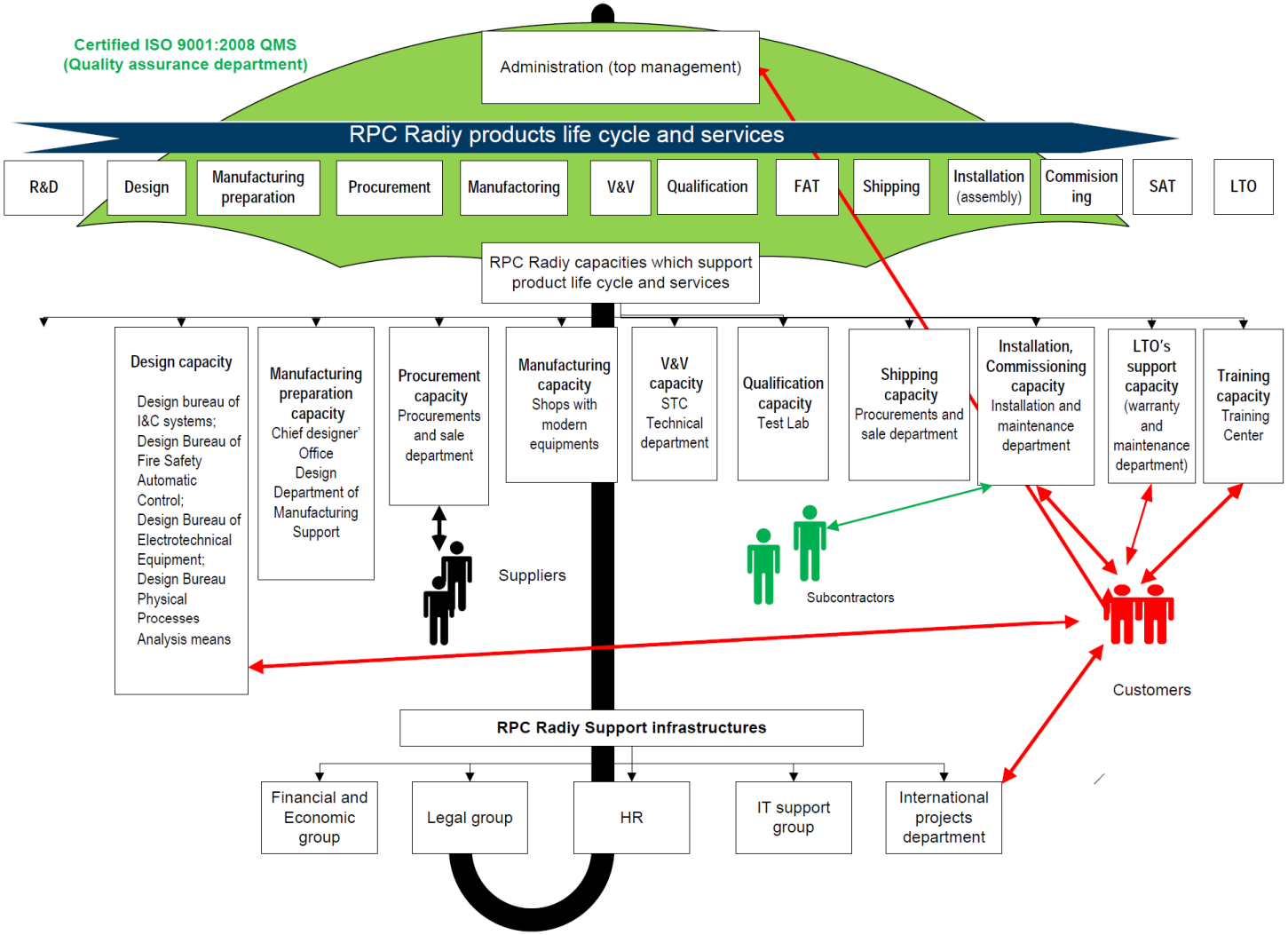
Radiy plans to support NRC review of RadICS Platform Topical Report

- Purpose of meeting is to present:
  - Technical information about the RadICS Platform
  - Information about RadICS Platform Topical Report submittal
- Meeting will be presented in two parts:
  - Open Session – General overview of Radiy and RadICS LLC
  - Closed Session – Proprietary information about the RadICS Platform and Topical Report submittal

About “Radiy”

- 920 employees, 200 engineers, headquartered in Kirovograd, Ukraine
  - 22 years servicing Ukrainian NPP industry
  - 18 years providing FPGA-based systems to Ukrainian NPP industry
  - 8 years providing FPGA-based systems to Bulgarian NPP industry
- Annual revenue: 100 million Euros
- Main profile: FPGA-based I&C systems for NPPs
- All internal processes: design, procurement, manufacturing, testing, installation

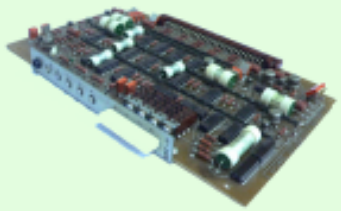
Nuclear Organization



Radiy Product Evolution

1995

Started development and supply of the equipment for NPP I&C systems



Replacement of obsolete NPP I&C modules

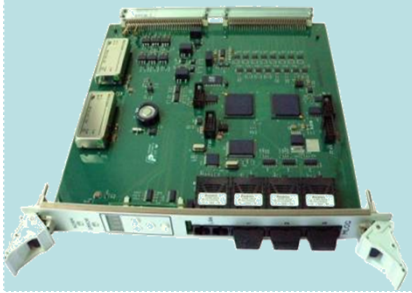
1998

First generation of equipment for NPP I&C systems

FPGA-based I&C systems for NPP

2002

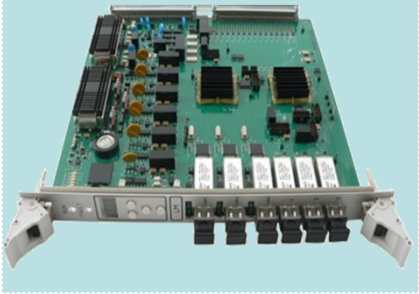
Second generation of equipment for NPP I&C systems



FPGA-based I&C platform for NPP

2014

Third generation of equipment for NPP I&C systems



SIL3 certified FPGA-based I&C platform for NPP

FPGA-based Universal I&C Platform

RadICS™ | Comprising Modules

Logic Module (LM)

- Dedicated FPGA chip for user configurable control logic
- Logical and physical separation of control logic and system function
- Integrity checks on each communication line (CRC)
- 14 LVDS full duplex lines for communication with OCM and I/O modules
- 2 LVDS simplex/duplex lines for diagnostic purposes
- 3 galvanic-isolated discrete inputs
- 3 fiber optical lines for internal system communications
- 1 input for Tuning PC programming access key signal
- 3 Fast Ethernet (100 BASE-FX) optical communication lines
- Hot swappable

Discrete Input Module (DIM)

- 32 independent input discrete channels ("dry" contact type)
- Enhanced inputs diagnostics
- Integrity checks on each communication line (CRC)
- 2 LVDS lines (diagnostic and information)
- Hot swappable

Analog Input Module (AIM)

- Enhanced I/O diagnostics
- 32 independent analog input channels
- 16-bit A/D conversion in each analog input channel
- 2 LVDS full duplex lines (diagnostic and information)
- Integrity checks on each communication line (CRC)
- Built-in calibration channel
- Hot swappable

Analog Input for Neutron Flux Measurement Module (AIFM)

- 3 high-sensitive independent galvanic-isolated analog input channels with counting, cambelling or current mode
- Enhanced I/O diagnostics
- 3 analog output channels with linear or logarithmic D/A conversion
- 2 LVDS lines (diagnostic and information)
- Integrity checks on each communication line (CRC)

Discrete Output Module (DOM)

- 32 independent digital form-A optic-relay isolated output channels (switching up to 48 V DC / 0.5 A)
- 2 LVDS lines (diagnostic and information)
- Integrity checks on each communication line (CRC)
- Enhanced active output diagnostics
- Fuse and Overvoltage protected outputs
- Hot swappable

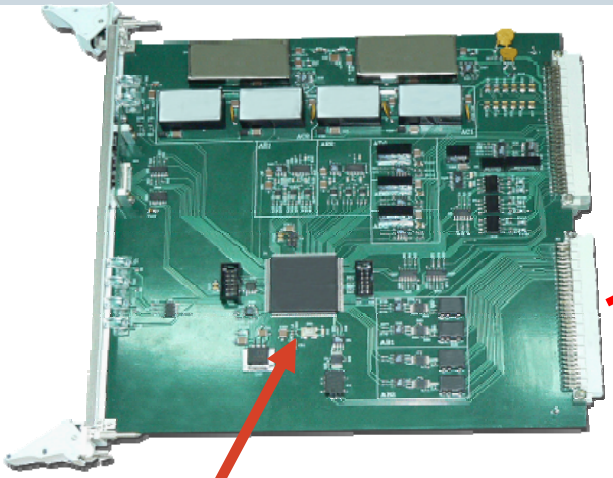
Analog Output Module (AOM)

- 32 independent output channels
- 16 bit D/A conversion in each channel
- Enhanced diagnostics of output current channels
- 2 LVDS lines (diagnostic and information)
- Integrity checks on each communication line (CRC)
- Hot swappable

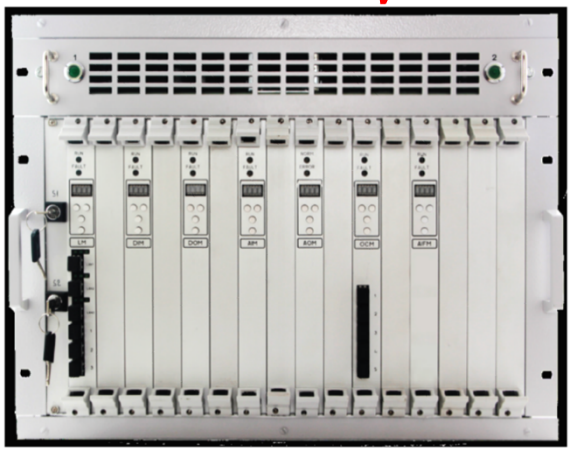
Optical Communication Module (OCM)

- 5 fiber optical lines
- 2 LVDS lines (diagnostic and information)
- Integrity checks on each communication line (CRC)
- Hot swappable
- 5 RS-232 or RS-485 serial communication interfaces

RadICS Platform Equipment

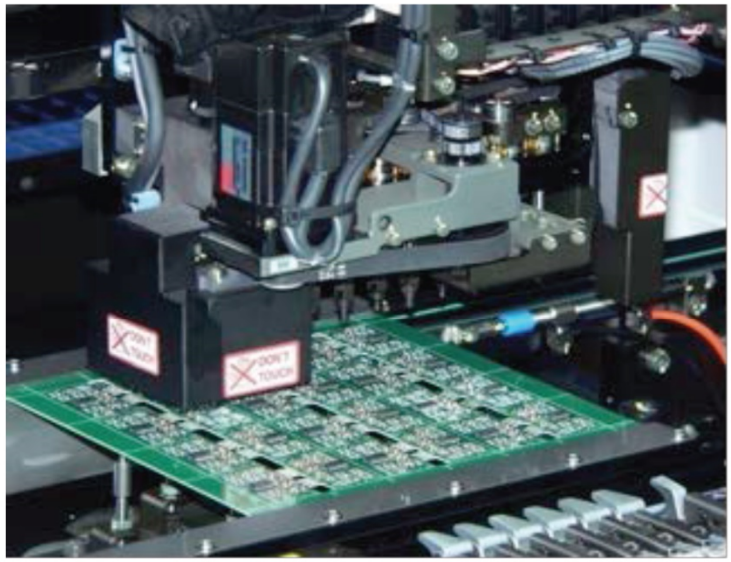


FPGA



Manufacturing Test Facility

- Manufacturing and inspection facilities comply with Company Quality Management System (QMS) based on ISO 9001:2008 and applicable IEC and IPC Standards



Automated production line for PCBs surface mounting

Automated sheet shearing machine AMADA

Qualification Test Laboratory

- Radiy Qualification Test Facility certified to ISO/IEC 17025:2005
  - Environmental and Seismic Capabilities

Electrodynamic Vibration Table V875-440 HBT Combo, LVD

Climatic thermal pressure chamber KTBV 8 1

- Kinectrics test laboratory will be used for RadICS Platform qualification testing

Modernization of Ukrainian NPPs

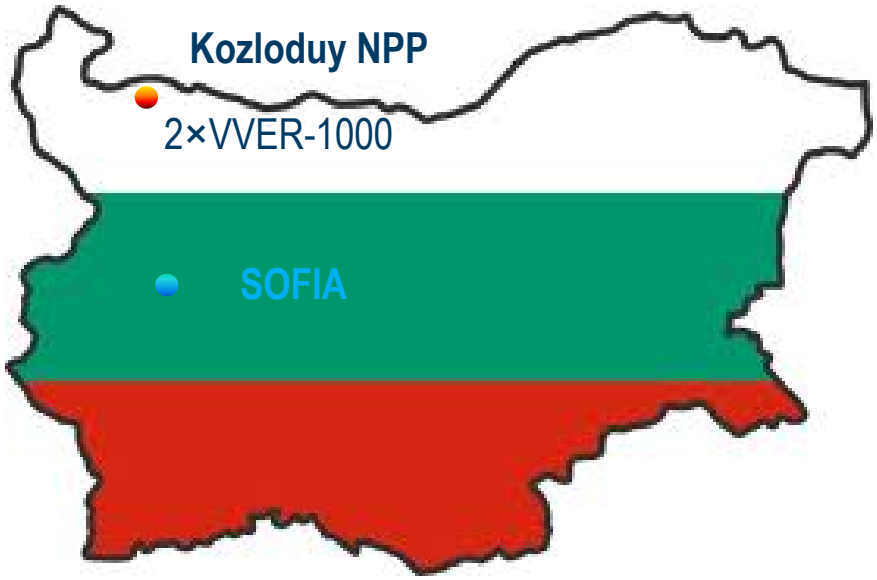
Total Gross Capacity: 13,835 MW
4 sites
15 units
2 units under construction

Top 5 of Europe
Top 10 of the World
About 50% of national power generation
One utility: National company NNEGC "Energoatom"
http://www.energoatom.kiev.ua/
Regulatory Authority: State Nuclear Regulatory Inspectorate of Ukraine
http://www.snrc.gov.ua/nuclear

Product/Project Experience

Systems Supplied	Nuclear Power Plant	Number of Installed Systems	Installation Years
Reactor Trip System	Zaporozhye NPP; South-Ukraine NPP; Rivne NPP; Khmelnitski NPP	30	2004-2015
Reactor Power Control and Limitation System	Zaporozhye NPP; South-Ukraine NPP; Rivne NPP; Khmelnitski NPP	11	2004-2015
Engineered Safety Feature Actuation System	South-Ukraine NPP, Rivne NPP, Kozloduy NPP, Bulgaria	18	2005-2010

Modernization Project for Kozloduy



- Modernization of 2 sets of Power Supply equipment for Rod Control System for Units 5&6 (2007– 2008)
- Modernization of 6 Engineering Safety Actuation Systems (ESFAS) for Units 5&6 (2008-2010)
- Modernization of 10 switchgear sets (RTZO cabinets) of ESFASs and of Nuclear and Conventional Island Control Systems for Units 5&6 (2013 – 2015)

Modernization Project for Kozloduy

- Increase safety of the NPP
- Increase NPP availability
- Assure long-term operation ability
- Improve human-machine interface for control, diagnostic and maintenance
- Improvement of electrical and physical separation between safety divisions
- Assure lifetime service and maintenance
- Comply with regulatory requirements
- Assure minimization of on-site premises reconfiguration

exida CERTIFICATION

The manufacturer may use the mark:

CERTIFIED • exida • IEC 61508 • SIL 3 CAPABLE •

Valid until October 1, 2017
Revision 1.0 September 26, 2014

ANSI Accredited Program
PRODUCT CERTIFICATION
#1004

Certificate / Certificat
Zertifikat / 合格証

RAD 1406037 C001

exida hereby confirms that the:

FPGA-Based Safety Controller (FSC) RadICS
produced by **RPC Radiy**
29 Geroyiv Stalingrada Street
Kirovograd, Ukraine

Has been assessed per the relevant requirements of:

IEC 61508 : 2010 Parts 1-7

and meets requirements providing a level of integrity to:

Systematic Capability: SC 3 (SIL 3 Capable)

Random Capability: Type B Element

SIL 3 @ HFT = 0; Route 1_H

PFD_{AVG} and Architecture Constraints must be verified for each application

Safety Function:
The FSC will read input signals, perform user-defined application layer logic and write results to the output signals within the stated response time.

Application Restrictions:
The unit must be properly designed into a Safety Instrumented Function per the Safety Manual requirements.

exida Certification

Evaluating Assessor

Rudolf P. Chalupka
Certifying Assessor

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FPGA-Based Safety Controller (FSC) RadICS

exida CERTIFICATION

64 N Main St
Sellersville, PA 18960

T-002, V3R4-3

Certificate / Certificat / Zertifikat / 合格証

RAD 1406037 C001

Systematic Capability: SC 3 (SIL 3 Capable)

Random Capability: Type B Element

SIL 3 @ HFT=0; Route 1_H

PFD_{AVG} and Architecture Constraints must be verified for each application

Systematic Capability :

The product has met manufacturer design process requirements of Safety Integrity Level (SIL) 3. These are intended to achieve sufficient integrity against systematic errors of design by the manufacturer.
A Safety Instrumented Function (SIF) designed with this product must not be used at a SIL level higher than stated.

Random Capability:

The SIL limit imposed by the Architectural Constraints must be met for each element.

SIL Verification:

The Safety Integrity Level (SIL) of an entire Safety Instrumented Function (SIF) must be verified via a calculation of average Probability of Failure on Demand (PFD_{AVG}), or Probability of Failure per hour (PFH), considering redundant architectures, proof test interval, proof test effectiveness, any automatic diagnostics, average repair time and the specific failure rates of all products included in the SIF. Each subsystem must be checked to assure compliance with minimum hardware fault tolerance (HFT) requirements.

The following documents are a mandatory part of certification:

Assessment Report: RAD 14-06-037 R002 V1R0 61508 Assessment - FSC

Safety Manual: D11.1 - Radiy FSC Product Safety Manual V1R2

SIL3 in single channel configuration

Note: IEC SIL is different than IEEE Std 1012 SIL

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Expected Outcomes

- Closed session will cover the following topics:
  - RadICS Digital I&C Platform
  - RadICS Platform Development Processes
  - RadICS LLC Quality Management System
  - RadICS Platform Qualification Test Plan
  - Commercial Grade Dedication Plan
  - Details of RadICS Platform Topical Report Review Schedule
- Radiy would like NRC feedback on understanding of RadICS Platform features and proposed equipment qualification requirements
- Radiy would also like NRC feedback on the overall review plan and schedule

Thank you for your attention!

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