Automatyczny system testujący do transpondera lotniczego
Automated Test System for SSR Transponder

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Agenda

1. Company Profile
2. Introduction to SSR and ADS-B
3. XPDR Under Test
4. XPDR Test System
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6. Conclusions
Company Profile
Becker Avionics Group

• Established in 1956 as Becker Flugfunk GmbH
• Certificates: EASA Part 21, EN 9100: 2009
• Main Product Families:
  o Communication, Navigation, Surveillance (CNS)
  o Intercommunication Systems
  o Search & Rescue (SAR) and Personal Locator Beacons (PLB)
  o Air Traffic Management (ATM) and ADS-B Systems
• Customers:
Company Profile
Becker Avionics Polska

• R&D Department of Becker Avionics Group
• Established: 1996
• Location: Wrocław Poland
• ISO9001:2008 certified
• Facility: development, RF lab, stock, low volume production
• Designs comply to EUROCAE/RTCA standards (ED-14/DO-160, ED-12/DO-178, ED-80/DO-254)
• Development: Mode S Transponders, ADS-B Receivers and Transmitters, VHF/AM Transceivers, Automatic Test Equipment
Introduction to SSR and ADS-B

System Concept
Introduction to SSR and ADS-B

Secondary Surveillance Radar

- Radar system used in ATC
- Detect, identify and collect data of aircrafts
- Interrogation/Reply communication
- Relies on targets equipped with transponders
- Mode A (identification), Mode C (altitude), Mode S (eg. flight ID, position)
Introduction to SSR and ADS-B

Automatic dependent surveillance – broadcast

- Automatic – requires no pilot intervention or external input, always on
- Dependent – depends on data from aircraft’s navigation system
- Surveillance – received by other aircraft to provide situational awareness and allow self separation
- Broadcast – continuously transmits aircraft data to any aircraft or ground receivers (Mode S Extended Squitter)
XPDR Under Test

BXT-6513 Mode S Transponder, Class 1, Level 2 andens

- ETSO certified (TSO-C112d, TSO-C166b)
- ADS-B Out (B1S/B1) and ADS-B In (A1S/A1)
- Class 1: Transmit Power \( \geq 250W \)
- Level 2: Mode A/C and Mode S
- ACAS/TCAS Capability (a)
- Antenna Diversity (d)
- Extended Squitter Capability (e)
- Enhanced Surveillance (n)
- Surveillance Identifier Code(s)
XPDR Under Test

BXT-6513 Interface Overview

- Supply Input (28VDC, <30W)
- External Memory Interface
- 2x RF Ports (TOP ANT, BOT ANT)
- LAN Interface (ADS-B Rx Msg)
- 20x Discrete IO (control and monitor)
- CAN Interface (A826/A825)
- 16x ARINC429 Inputs (A718A, A735B, A743A)
- 8x ARINC429 Outputs (A735B, A743A)
- USB interface (Service/Maintenance), TIA-422 (TM), TIA-232 (Altitude)
XPDR Test System

Technical Challenges

• Simulate and monitor real airborne environment
• RF generation and analysis—short duration, non-periodic pulses
• Dynamic range considerations
• Real-time signal analysis
• RF multichannel timing and synchronization
• High bandwidth and low-latency data streaming
XPDR Test System

Hardware Overview

- NI PXI System
- Power Supply
- Interface Box
- RF Box
- XPDR Under Test
XPDR Test System

PXI System Overview

- 2x PXIe-1075 chassis
- PXIe-8133 controller
- PXIe-6341 DAQ module
- PXI-8513/2 CAN module
- PXI429-3U-32 ARINC429 module
- 2x PXIe-7966R FlexRIO
- 2x NI6581 FAM
- 2x PXIe-5673E RF VSG
- 2x PXIe-5663E RF VSA
XPDR Test System

Software Overview

Test Framework
- Test Executive Application
- STTE Interface
- Console Interface
- Manual Testing UI
- Test Reports Engine
- Test Database Connectivity

STTE
- Test Equipment Declaration
- Configuration File
- Protocol Implementation
- Measurement Function
- Test Procedure and Test Sequence Definition

Component Libraries
- XPDR IO Library
- XPDR Interfaces Libraries (Serial, CAN, ARINCxxx)
- XPDR Communication Library

Device Drivers
- NI DAQmx
- NI VISA
- NI XNET
- AIT A429
- NI RIO
- NI RFSG
- NI RFSA
XPDR Test System
Test Executive Application

- Microsoft .NET based application
- Tools qualified according to:
  - DO-178C/ED-12C
  - DO-330/ED-215
- Automatic testing interface
- Test report output in Microsoft Word format, log text format and database records
- Download software structural coverage records
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STTE Interface

- List of available interfaces and measurement equipment
- Connection status and control
- Basic activity logging
- Control of settings of interfaces
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Console Interface

- Built-in Microsoft Power Shell Console
- Direct access to same API as for implemented automatic test procedures
- Standard script language
- Immediate diagnostic of problems, also during execution of automatic test
- Rapid measurement automation
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Manual Testing UI

- Flexible dynamic UI engine enabling user to adjust UI content to recent task
- All settings synchronized with console and automatic tests
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XPDR Communication Library

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Software defined processing on FPGA means:

- Deterministic point-by-point processing with minimum latency (ns)
- Hardware implemented DSP algorithms
- Dedicated logic in silicon for highest reliability
- Parallel processing (task parallelism, data parallelism, pipelining)

Real-time analysis means:

- Gap free acquisition
- Consistent speed
- High speed control and measurements
Issues

System Bandwidth

- PCIe Data Transfer
- NI P2P Streaming Technology
  - RIO to VSG:
    - 2x100MS/s is 800MB/s
  - VSA to RIO:
    - 2x50MS/s is 400MB/s
- PXI Backplane DMA channels
  - PC to/from RIO: ~10MB/s

Total System Bandwidth exceeds 1.2 GB/s!
Issues
System Timing and Synchronization

PXI Backplane of PXIe Chassis:
- 10MHz Reference Clock
- Trigger Bus (8 TTL)

Benefits:
- Long-term and stable
- Timing alignment
- Strictly defined triggers schema
Conclusions

- Modular, scalable and integrated PXIe platform
- High-throughput and low-latency technology (P2P, DMA)
- RF Instruments with open and easy reconfigurable FPGA
- NI solutions allowed performing even the most complex test procedures described in DO-181E and DO-260B documents.
- Performance and reliability confirmed by long-term development testing
- Flexibility allows quickly adapt from multiple stages of R&D to manufacturing process