

# DornerWorks DO-254



DornerWorks, Ltd.

## 1.0 DornerWorks Information

DornerWorks was founded in 2000 by David Dorner with one aerospace client. Today, DornerWorks boasts an impressive portfolio of clients and is one of the most sought-after embedded software and electronic hardware engineering firms in the nation. With over 50 full time staff members at their Grand Rapids Michigan headquarters, DornerWorks has attracted some of the best talent in the industry including patent holders, multi-degreed engineers, PhD's, and a Six Sigma Black Belt. DornerWorks was recently honored as one of Michigan's 2010 50 Companies to Watch and an ICIC 2010 Inner City 100 Award Recipient. DornerWorks is an AS9100 and ISO 9001 certified company.



### 1.1 Why Choose DornerWorks

- ✓ Over seven DO-254 completed projects
- ✓ Knowledgeable engineers with over 100 years combined experience in the aerospace industry
- ✓ Over 50 full time Engineers on staff
- ✓ DornerWorks is developing ARLX\* – a flight-certifiable ARINC 653 partitioning environment based on the Xen Hypervisor with real-time Linux running in each domain
- ✓ Engineers on staff highly skilled in: Xilinx, VHDL, Altera, Xilinx, Actel, FPGA, and Custom Logic Design
- ✓ ASQ-Certified Six-Sigma Black Belt on staff
- ✓ Visionary and dedicated Principals who are intimately involved in the day-to-day activities of each project

\*ARLX – Currently in development at our headquarters R&D department in Grand Rapids, Michigan. To learn more about ARLX, please visit our website at [www.dornerworks.com](http://www.dornerworks.com) and select the **Portfolio** tab.

## 2.0 Aerospace Program Experience

DornerWorks has successfully completed many aerospace projects with some of the largest commercial and government programs in the world. These projects include:

- ➔ Boeing 787 Dreamliner
- ➔ Boeing 767 Tanker
- ➔ Boeing X-45 UAV
- ➔ Boeing C130 AMP

- F-18 IBU FPGA
- F-22 EXT PCB's
- Airbus A400 ViDP V&V
- AVIC ARJ21 SW V&V
- Embraer VLJ Software Development
- Embraer MSJ Software Architecture

## 2.1 Project Experience

DornerWorks has worked on numerous Aerospace custom logic and DO-254 related projects. This section highlights some of these successful projects from our portfolio.

### 2.2 TAMMAC ASIC

Our staff participated in the requirements, design, verification (including test bench development), and documentation of an ASIC for handling I/O functions on a data cartridge system for loading tactical digital map data. The project was executed to DO-254 standards. All hardware development and simulation was done using VHDL. The ASIC was designed with a number of system and I/O components including serial channels, DMA engines, Watch Dog Timer, Real Time Clock, and Memory Controllers. A fully automated and regression capable test bench with accompanying test drivers were designed for verification of the device. Hardware development plan, hardware requirements, hardware design, hardware test plan and hardware test case documents were generated. Traceability coverage from requirements through test cases was generated.

### 2.3 Airbus FMPIO ASIC

Our staff participated in the requirements, design, verification (including test bench development), and documentation of the Flight Management Peripheral I/O (FMPIO) ASIC on an Airbus I/O circuit card assembly (CCA). The project was executed to DO-254 standards. The previously designed TAMMAC ASIC was used as a baseline. All hardware development and simulation was done using VHDL. The ASIC was designed with a number of system and I/O components including serial channels, DMA engines, Watch Dog Timer, Real Time Clock, multi-channel ARINC429 8x305 16bit microcontroller core, and Error-Detection & Correction (EDC) Memory Controllers. A fully automated and regression capable test bench



with accompanying test drivers were designed for verification of the device. DornerWorks led the test team responsible for fully testing the ARINC429 8x305 16bit microcontroller core. Hardware development plan, hardware requirements, hardware design, hardware test plan and hardware test case documents were generated. Traceability coverage from requirements through test cases was generated.

## 2.4 Airbus A400 ViDP FPGA

Our staff participated in the development of a DO-254 compliant custom logic design for a Video Display and Processing (ViDP) unit aboard the Airbus A400. This consisted of a Xilinx Virtex FPGA design using VHDL, simulation using ModelSim, and lab integration. DornerWorks primary area of involvement on this project was the generation and execution of the extensive test cases required to fully verify the design according to DO-254 traceability and code coverage analysis using requirements based testing within an automated Test Bench simulation environment.

## 2.5 Boeing 787 SX ASIC

Two of our senior staff developed the system architecture for the SX (System Interconnect) ASIC, developed to DO-254 Level A. This ASIC was a complex flight redundant and fault tolerant ASIC for the Boeing Dreamliner 787 commercial aircraft. This ASIC cross checked 60X PPC bus cycles in real-time across 3 redundant PPC processors for fault tolerance against single event upsets caused by atmospheric radiation. In addition, this ASIC served as an I/O super hub on-board the General Purpose Computer, tying together serial channels, Ethernet, AFDX (deterministic flight-worthy Ethernet), DMA, FLASH and RAM data paths with EDC, and other I/O. Other involvement on this project included high and low level requirements, detailed design documentation, implementation of *VHDL coding*, design and implementation of sophisticated, automated, and regression based test benches, authoring and execution of test cases, DO-254 requirements based testing, code coverage, and traceability. The ASIC vendor was AMI and used a standard gate array process. RTL functional simulations as well as pre-layout and post-layout gate level simulations with full timing across all corner cases were performed. The Mentor Graphics ModelSim tool was used for simulation and verification.



## 2.6 Additional DO-254 Projects

Other projects that DornerWorks has participated in the design and execution of DO-254 requirements based testing but not owned the entire product development lifecycle include:

- P8-A SCU, SMC
- C130-J CNI-JP
- J-UKAS EIU-FPGA

### 3.0 DornierWorks Engineers

Our engineers have significant DO-254 documentation experience. The following highlights six of our most qualified staffs' expertise:

This engineer has 20 years of experience in the aerospace industry in engineering and technical management. He has presented at the Digital Avionics Systems Conference and is published in their conference proceedings. He has participated in *DO-254* and *DO-178B* processes on multiple projects and was responsible for development and/or



review of artifacts at all stages of the certification and development life cycle. He has extensive experience with *VHDL* and is familiar with tool chains for all major *FPGA* and *CPLD* providers (such as *Altera*, *Xilinx*, and *Actel*). Degree: Ph.D. in Computer Engineering.

This engineer has over 15 years of experience in the aerospace industry in digital custom logic design, embedded software, and program management. He has led the system architecture definition of a complex flight redundant and fault tolerant *DO-254* ASIC for the Boeing Dreamliner 787 program. This ASIC cross checked 60X PPC bus cycles in real-time across 3 redundant PPC processors for fault tolerance against single event upsets caused by atmospheric radiation. In addition, this ASIC served as an I/O super hub on-board the General Purpose Computer, tying together serial channels, Ethernet, AFDX (deterministic flight-worthy Ethernet), DMA, FLASH and RAM data paths, and other I/O. He has led a Test Team for a flight worthy ARINC 429 microcontroller embedded within an ASIC, implemented with a custom 8x305 16bit microprocessor core. He has experience with system architecting designs, high and low level requirements, detailed design documentation, implementation of *VHDL coding*, design and implementation of sophisticated, automated, and regression based test benches, authoring and execution of test cases, *DO-254* requirements based testing, code coverage, and traceability. He has participated in the full development life cycle for both *DO-178B* software and *DO-254 custom logic designs*. He has experience with *VHDL*, AMI standard gate array ASICs, *Xilinx* and *Altera* *FGPAs*, and Mentor Graphics ModelSim for simulation and verification.

Degree: M.S. in Electrical Engineering with Digital Design Concentration and B.S. in Electrical Engineering, Physics, and Mathematics.

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This engineer has 5 years of experience in the aerospace industry in hardware and software engineering. He has participated in *DO-254* and *DO-178B* processes on multiple projects. While responsible for development and/or review of artifacts at all stages of the certification and development life cycle, this Engineer focused primarily on the verification and validation areas. He has extensive experience with *VHDL* and is familiar with tool chains for *Xilinx*, *Actel*, and *Altera* logic devices. He has extensive experience with the HDL simulation tool ModelSim, and experience with Cadence's HDL simulator, and has used both simulators in the verification of a project done to a *DO-254 process*. Degree: B.S. in Electrical Engineering, M.S. in Computer Science.

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This engineer has 6 years of experience as a hardware and custom logic design engineer. He has worked with multiple *FPGA* and *CPLD* devices from major providers (including *Altera*, *Xilinx*, *Actel*, and *Lattice*) and is experienced with their corresponding tool chains. He has extensive experience developing scalable self checking test benches for custom logic designs. He has worked under the *DO-254* and *DO-178B* processes to produce traceability artifacts for design requirements, design implementation, test requirements, and test procedures. Degree: B.S. in Electrical Engineering.

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This engineer has 32 years of experience as a multifaceted engineer with skills and expertise in hardware design, custom logic design using *VHDL*, and testing and verification. He has particular experience and expertise in military and aerospace products and systems and is experienced with *VHDL* and the development tools from the major silicon vendors for custom logic. His extensive experience in testing, verification and validation will be very valuable for this project. Degree: B.S. in Electrical Engineering.

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This engineer has 19 years of experience as a digital hardware and custom logic design engineer. He has skill with *FPGA* and *CPLD* design using multiple vendors and tools, including *Actel*, *Xilinx*, and *Altera*, *VHDL*, ModelSim, Aldec, Synplicity, and HyperLynx. He has experience developing *DO-254* compliant documentation using Telelogic DOORS and other configuration management tools, and in testing *CPLD* designs to 100% code coverage in *VHDL*. Degree: B.S. in Electrical Engineering, M.S. in Electrical Engineering.

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### 3.1 Quality Staff

Our projects are overseen and directed by several professionals within our organization. These designees were selected for their expertise, attention to detail, and leadership qualities.



**Director of Quality Assurance:** The Director of Quality Assurance provides direction and coordination for all Quality initiatives, oversees the quality management system, and reports on its effectiveness to top management.

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and has been certified as a Black Belt by the American Society for Quality (ASQ).

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**ASQ-Certified Six Sigma Black Belt:** This key member of our Quality department is experienced in process improvement activities using the Six Sigma method,

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**Quality Assurance Auditors:** Our fully-trained staff of auditors assists the Director of Quality Assurance in organizing and conducting internal audits of our quality management system and of engineering projects in progress.

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**Certification Liaisons:** Our experienced experts, having received FAA DER training, provide key expertise to assist clients in developing their products to meet DO-178B and DO-254 standards.

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**Process Assurance Engineer:** Audits and reviews development work products to ensure compliance with the standards and documented processes of the project. May also contribute to plans and process documentation at start of project.

## 4.0 Case Studies

### 4.1.1 Boeing 787 BSP

- The Control System Board is a dual CPU, dual FPGA, and dual ASIC board running full ARINC653 partitioning used as the main computing resource for the entire aircraft. During development, emulating the AFDX communications using VirtuTech Simics, our engineers identified problems arising during emulation.

- Engineers became experts in Simics software rewriting key pieces of the project including a major overhaul of the ARINC-665 data-loader.

### Key Accomplishments

- Context specific hardware exception handling to support/ allow different behaviors
- ISR rewritten to allow AltiVec handling for some partitions and not for others. Included proper routing of exceptions into AE653 partitions and ensuring the guaranteed separation of the partitions.
- Wrote tests to ensure DO-178B level A compliance and DER acceptance of the changes.
- Designed into AE653 a mechanism to ensure that the module Operating System and health monitoring application are running by implementing a two level software watchdog timer system.
- Identified and solved complex interactions between partition scheduling context switches and the queuing ports that resulted in modifications to the OS preventing partition over-runs.
- Developed a partition monitoring system that tracked OS operation and context switches that interacted with the system health monitoring system. Required analysis of OS and unpublished data structures to identify key parameters and areas then work with Wind River to ensure stability of these structures.

### 4.2 Crash Recorder\*

\* This project is automotive in nature, but highlights DornerWorks capabilities in Altera FPGA design.

- A durable data recorder for automotive crash testing environment
- Full product development life cycle responsibility on a Firm Fixed Price basis
- Design disciplines: electronic hardware and embedded software, FPGA, mechanical durability
- Manufacturing oversight with supplier management
- Project management: aggressive schedule

### Key accomplishments

- Advance procurement of long-lead-time components
- Flexible hardware and FPGA design allows add-on data acquisition capability
- 7.5 A, 12 V automotive power input
- Reverse polarity protection
- Solid state over voltage and over current protection
- 8-18V input, 80V survivable

- Ddual high efficiency dc-dc converters charge and discharge energy storage capacitors
- 9000 joule energy storage capacity
- 4 downstream switching supplies provide 6 logic voltages
- 16 channels 8 MHz EIA-485 receivers
- 4 channels 10-bit analog input
- Altera Cyclone III 240-pin FPGA
- 2 SRAM's with 20bit address and 8-bit data bus
- 5 independent SPI flashes
- TI Stellaris MCU (ARM Cortex M3 running @ 50 MHz)
- USB 2.0
- 24 channels 10-bit DAC outputs
- 3 CCA's: power board, main processor board, & UI board
- Flexible interconnects
- Circular connectors
- Lightweight, impact resistant enclosure
- 30-g mechanical shock in 3 orthogonal axis

#### 4.2.1 787 SX ASIC

- System Architecture for 787 SX ASIC design
  - Delivered System Definition and VHDL code
- Redundant fault-tolerant design
- Targeted at ARINC 653 operating environment

#### Key accomplishments

- DO-254 process and artifacts support
- DMA engine
- Triple-CPU bus interface

#### 4.3 A400 VIDP

- Custom logic design for a video display and distribution unit for crew on Airbus A400 platform
- DO-254 compliant implementation
- Xilinx Virtex FPGA design using VHDL
- Simulation using ModelSim

## Key accomplishments

- ➔ Support of DO-254 process and artifacts, including PHAC, HRD, HDD, and HLCD

### 4.4 Video Overlay System\*

\*This project is commercial in nature, but highlights DornerWorks diverse experience in Xilinx FPGA.

- Closed-circuit TV device that applies an overlay for scrolling messages and announcements
- Responsible for complete engineering effort
  - Electronics hardware and software, FPGA, transfer to production
- Xilinx FPGA using VHDL for NTSC video processing and color space conversions
- Freescale ColdFire processor provides operator interface via Internet web server

## Key accomplishments

- Video technologies for blending, overlay, fade in/out, and digital on-screen graphics
- Iterative design process responsive to customer input

## 5.0 Partners

Partnerships matter - whether working with clients, manufacturers, or design services, DornerWorks understands what it takes to keep us ahead of the competition. We have formed professional alliances and partnerships with the following organizations to ensure your project is done right!



With a leadership position in the safety critical markets of Aerospace, Medical, Automotive, and Industrial, Actel has chosen DornerWorks to be a member of the Solution Partner Program. Actel is the leader in low-power FPGAs and mixed-signal FPGAs, offering the most comprehensive portfolio of system and power management solutions. DornerWorks is the first company in Michigan to meet the Solution Partners Program requirements by demonstrating a high level of expertise with Actel FPGA's.



DornerWorks is a registered Altera Consultants Alliance Program (ACAP) partner. ACAP partners are a part of a global network of design service providers which offer experience and expertise in wireless communications, wireline communications, consumer, medical, test and measurement, industrial, automotive, computing, and storage applications.



DornerWorks is a Certified Consultant for Cypress Semiconductor's USB and PSoC Mixed Signal Arrays products. The CYPros® certified consultants program maintains a list of independent consultants that have been certified and have demonstrated competence in

Cypress products.



DornerWorks has brought our embedded expertise to the Freescale Alliance Program. The Freescale Alliance Program is a community of companies from around the world. This community is built around

reducing design cycle time and getting products to market faster through the access of the newest design tools, support, and training.



DornerWorks is a registered Microchip Design Partner. The Design Partners Program is designed to help Microchip clients find a third-

party design firm that meets their criteria to help them bring products to market.



QNX is a commercial Unix-like real-time operating system, aimed primarily at the embedded systems market. QNX has chosen

DornerWorks to join their Partner Network Program which consists of several hundred leading hardware and software as well as service vendors worldwide. Their offerings include solutions and services compatible with QNX products.



DornerWorks is a member of the Texas Instruments DSP Third Party Network. The TI DSP Third Party Network is a worldwide community of respected, well-established companies offering products and services that support TI DSPs.

Products and services include a broad range of end-equipment solutions, embedded software, engineering services and development tools that help customers accelerate development efforts and cut time-to-market.



DornerWorks is also a member of the Texas Instruments MSP430 Developer Network. The TI MSP 430 Third Party Network is a worldwide community of respected, well-established companies offering products and services that support TI MCU's. Products and services include a broad range of end-equipment solutions, embedded software, engineering services and

development tools that help customers accelerate development efforts and cut time-to-market.

## 6.0 Conclusion

DornerWorks has a decade long history supporting the Aerospace industry. Our clients return to us when they are seeking an experienced, responsive, and professional engineering team. We partner with you from the beginning of the project through completion:

- We listen to you to understand your project needs
- We assemble a top-notch team to work with yours
- We provide a dedicated Project Manager to oversee every project for every client
- We offer frequent communication and reporting on your terms
- We follow a Quality System that meets and often exceeds your own

DornerWorks is well prepared and ready to partner with you on your next project!

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