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How Varex drove performance improvements in industrial X-ray source technology

How Fidus and Enclustra reduced development risks in combined FPGA & SoM design partnership

In the world of industrial X-ray sources, value is defined by performance, accuracy, and quality, while competitiveness is measured by the speed of introducing advanced capabilities to market within strict regulatory frameworks. To meet release targets, customer expectations, and manage the demanding supply chains, Varex Imaging Corporation, a global supplier of X-ray tubes and image processing solutions, trusted the partnership between Enclustra and Fidus Systems to improve the performance of their FPGA-based X-ray sources. These components are used in a variety of applications ranging from non-destructive testing (NDT) and thickness gauging to X-ray inspection and border security.

THE COMPANIES

Varex Imaging is a leading innovator, designer, and manufacturer of X-ray imaging components for medical, industrial, and security applications. With over $800M in annual revenue and 2,100 employees across North America, Europe, and Asia, Varex helps customers become world-class system suppliers by strengthening their technical competitiveness and enabling faster time to market.

Fidus Systems specializes in leading-edge electronic product and IP development to transform cross-industry innovative ideas into market-leading value. Certified in the latest technologies and standards, Fidus services include FPGA & ASIC Design, UVM Verification, Hardware, PCB Layout and Packaging, Embedded Software, Mechanical and Thermal Design, as well as Signal & Power Integrity. Bringing over 20 years of experience, Fidus has the expertise,

> " "The growth of this market is attributed to the stringent government regulations regarding the safety of assets, increasing consumer awareness regarding quality standards, and rising security concerns in strategic infrastructure installations."
>
> **RESEARCH AND MARKETS[1]**

capacity, and commitment to getting designs and prototypes to market faster.

Enclustra provides services covering the whole range of FPGA and SoC-based system development, including highly integrated FPGA system on modules (SoM) and FPGA-optimized IP cores. Enclustra specializes in the adaptation of FPGAs and SoC-based SoMs to a variety of industries and applications, including test and measurement, wireless, medical and life sciences, aerospace and defense, semiconductors, and industrial.

THE BUSINESS CHALLENGES

Success in X-ray imaging products comes from understanding the current technology landscape and knowing how to leverage unique combinations of technologies to deliver high performance and robust systems in faster timeframes. Exacerbating these challenges are the strict customer requirements of today's X-ray products, driven by higher resolutions, safety, increased feature complexity, advanced power capabilities, and end-users demanding the utmost experience and reliability from every system.

To capture and grow share within the border security applications market, Varex wanted to deliver the next generation of X-ray sources that take advantage of modern

processing capabilities, modularity, and performance techniques. The new device had to incorporate previously unachievable functionality while being smaller and more cost-effective than the previous state-of-the-art products. It also had to support multiple system control interface types, including CAN bus, Ethernet, and Serial Peripheral Interface (SPI), and be reconfigurable and adaptable for future applications.

The design project had five goals:

1. Deliver new high-speed pulse modulation techniques.
2. Meet strict power, data, latency, and signal integrity requirements
3. Decrease technical risks (quality, rework)
4. Increase modularity, consolidate Bill of Materials, and support future reconfiguration
5. Meet strict development and release milestones

The latter goals precluded some options that Varex considered, as the complexity of the system and performance requirements were at the cutting edge of the current technology state of the art. "The Varex team wanted a compact, production-grade, and cost-efficient hardware module coupled with a customizable development board that reduced their time to market for a new product,"

said Tristan Martin, US Technical Representative at Enclustra. "Enclustra's AMD Zynq-based Mercury ZX5 SoC module was their natural choice. Combined with Fidus' embedded software and FPGA design services, Varex was confident that we could deliver a fully functional system on time with absolutely no risk to performance and quality."

THE SOLUTION

The engineering leadership team at Varex knew they needed a high-performance solution that didn't incur costly mistakes that could impact release schedule or product quality. After looking at multiple options, they decided that Enclustra's AMD Zynq-based Mercury ZX5 SoC module and expertise combined with custom Fidus FPGA design and Embedded Linux programming was the best choice.

"With our dense and easy-to-use modules, customizable baseboards, and collateral design resources, Varex knew they could release their product in less than twelve months, retain intellectual property, and have the ability to reconfigure the design in the future," said Martin.

Varex also had to account for the supply shortages in labor and silicon that affected the entire industry, as Martin explained. "It doesn't make financial or technical sense to order components in advance and have them sit on a shelf waiting for development. That's why Varex counted on our guaranteed availability of modules and stocking to give them a head start on the competition when it was time to kick off the project."

Mazen Matar, Director, Technical Sales and Business Development at Fidus Systems, agrees. "This partnership reduced the overall development risks on a very complex and time-critical project. Enclustra's high-quality SoMs met Varex's performance and support needs while our FPGA and Embedded Linux design expertise eliminated the need to hire and train new skilled resources – improving Varex's ability to confidently execute its go-to-market plan. We take the same approach with all our partners to ensure product teams get the right technologies and skills for the job."

With complex requirements and a constrained schedule, Fidus and Enclustra worked closely together to design and integrate the new FPGA code with the Mercury ZX5 SoC module. The development work included Fidus porting Enclustra's PetaLinux board support package (BSP) and FPGA reference design to Varex's custom carrier board and implementing CAN bus interfaces in the FPGA along with software drivers that supported the new capabilities.

This included overcoming several technical challenges by getting the design right up front:

- **Form factor** – Designing a custom baseboard for the Enclustra SoM was made simpler thanks to the reference baseboard and schematics review services offered by Enclustra. The Varex team used their experiences with schematics, layout, and connection points to minimize iterations in design and validation.

- **Interface specifications** – With complex industry standards, tight tolerances, and licensing costs, Fidus ensured all FPGA connections with the SoM and external devices were designed to specifications and analyzed thoroughly before fabrication.

- **Latency** – As the primary goal was to introduce new high-performance capabilities to market, Fidus and Enclustra developed input/output strategies and low-latency FPGA IP and Linux drivers to maximize performance between the system and SoM components.

- **Signal Integrity and Power Integrity** – Very high data rates and a complex feature set meant Fidus had to employ rigorous modelling and simulation techniques to ensure all communication channels worked with minimal distortion before going to production.

"Navigating the technical complexities of modern FPGA design is challenging enough for most teams but you must also consider the impacts of industry-specific validation and licensing costs on the overall program budget and schedule," said Matar. "For example, a simple CAN bus interface requires licensing fees to use the technology, as well as knowledge to simulate and test it correctly. Fidus provides this insight and expertise to customers like Varex to minimize design churn and development rework, ensuring their first iteration accurately matches their requirements and delivers a competitive product in a shorter amount of time."

FOSTERING IMPROVED EXPERIENCES FOR USERS

With the successful delivery of the new FPGA and SoM, Varex continues to take advantage of the design IP, incorporating the technology to improve the performance of several products. Working together to solve complex technical, performance, and development challenges, Fidus and Enclustra are ready to deliver more innovative FPGA-based solutions across a variety of markets.

"Any company starting an FPGA or SoC design project in today's hardware supply and labor environment shouldn't have to worry about getting it done fast and correctly," said Martin. "Combining proven SoM and development board products with experienced design services is how the top vendors release to market in six months or less without compromising on price and retaining all intellectual property."

Fidus FPGA designers have the expertise and skills to transform your project requirements into robust and competitive products. With decades of experience, our team understands how to design and deliver successfully, eliminating the need for your team to research, experiment, rework FPGA designs, and, worse, incur costly PCB re-spins that delay product launches.

Interested in accelerating your next FPGA design project? Contact Fidus and Enclustra today.

DESIGN SOLUTIONS WITH FIDUS
Need prototype and product design help?

We'll work with you to understand what you're looking for, and we'll dedicate the necessary resources to make sure it's a success the first time. Come to us with just an idea or specific challenges that are keeping you up at night, and we'll help you solve them.

Fueled by 20+ years' experience, our expertise, and creativity, along with our collaborative and process driven approach, turns complex challenges into well-designed solutions, and we keep customers like you coming back, again and again:

1. We are committed to "first time right".
2. Experience has taught us how to solve problems on any scale.
3. Faster time to market means faster time to benefit.
4. You choose how we work together.
5. Unique projects are our obsession.
6. We believe transparency builds trust.
7. Customer focus is our calling card.

20+ years experience	**3,000+** successful projects	**400+** customers	**95%** return rate
Collaborating with smart teams is what fuels us every day.	Your unique challenges are our obsession.	Extending your team with our expertise brings designs to market faster.	Customers love to work with us, again and again.

ABOUT FIDUS

Fidus Systems, founded in 2001, specializes in leading-edge electronic product development with offices in Ottawa and Waterloo, Ontario, and San Jose, California. Our hardware, software, FPGA, verification, wireless, mechanical and signal integrity teams work to innovate, design and deliver next-generation products for customers in emerging technology markets. Fueled by 20+ years' experience and creativity, along with our collaborative and process driven approach, we turn complex challenges into well-designed solutions. And with over 400 customers and 3000+ completed projects, we have the expertise to be a seamless extension of your team, providing a clear focus and commitment to getting designs and prototypes to market faster. Once you start working with us, you'll trust us like one of your own. Our hallmark is transparency. Our guiding principle is first time right.

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