



**enCLUSTRA**  
FPGA SOLUTIONS

**DEMO**

# SPECTRUM MONITORING WITH ENCLUSTRA'S POWERFUL ANDROMEDA RFSOC MODULE

**INTERVIEW AND VIDEO DEMO BY DR. HARRY COMMINS,  
LEAD FPGA/SOC FIRMWARE ENGINEER AT ENCLUSTRA**

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**enCLUSTRA**  
**Andromeda XRU50**



# FPGA Technology in Spectrum Monitoring

Over the past years, FPGA technology has reset expectations in terms of size, performance, and cost of electronics applications. By building out leading FPGA-powered system-on-chip modules into complete embedded processing systems, Enclustra has driven efforts to increase accessibility to the technology. Delivering all the electronics customers need to derive the full value from their hardware, their portfolio of FPGA solutions enables innovative solutions across verticals while drawing new markets into the fold.

Recently, Enclustra showcased the Andromeda XRU50 RF system on module (SoM), one of our latest products. The spectrum monitoring demo features two Andromeda XRU50 SoMs, demonstrating the module's impressive high-frequency RF signal processing capabilities that push performance limits in RF signal generation and transmission, as well as in RF signal reception and acquisition.

Dr. Harry Commin, Lead FPGA/SoC Firmware Engineer at Enclustra is one of the engineers behind the demo. In an interview, he shed light into what makes the spectrum monitoring system such a powerful illustration of the Andromeda XRU50's capabilities. Peering beyond spectrum monitoring, he also points at the myriad other use cases that the module stands to transform.

**Enabling increased  
accessibility to FPGA  
technology**

**Pushing  
performance  
limits in RF  
signal  
processing**

**Q: You've developed a spectrum monitoring demo for the newly released Andromeda XRU50 RFSoc. What audiences are you trying to reach?**

**Harry Commin:** It's always challenging to design a demo that showcases all the capabilities of a hardware component, especially when it's as multifaceted as the Andromeda XRU50. Our spectrum monitoring system highlights the module's impressive capabilities in high-frequency RF signal generation and acquisition. As a result, this setup will likely resonate most with the test and measurement and software defined radio communities. But the hardware's capabilities extend far beyond a single use case, with the potential to support applications as varied as radar beamforming, telecommunications geofencing, and controlling quantum computers.

**Q: Walk us through the demo that you've set up.**

**More than 3 GHz instantaneous RF bandwidth in real time**

**FFT resolution of about 18 kHz**

**Harry Commin:** Our demo consists of two complete systems. The spectrum monitoring part, implemented using an Andromeda XRU50 module, is contained in the receiver system. To push that system to its limit, we needed a very capable wideband RF transmitter. Because the RFSoc has both fast ADCs and DACs, we used exactly the same hardware platform to build a wideband transmitter system. The transmitter module transmits via two RF-DACs running at 9.5 Gsps. The receiver module receives via two RF-ADCs running at 4.5 Gsps. In total, it monitors more than 3 GHz of instantaneous RF bandwidth in real time, with an FFT resolution of about 18 kHz.

**Q: What happens when we switch it on?**

**Harry Commin:** The transmitter transmits eight signals simultaneously across two RF channels, and the receiver plots a very large (256k-point) power spectrum of the received signals. Using a video game controller, users can control the eight transmitted signals, setting the center frequencies across a total baseband frequency span of 4.75 GHz, adjusting their bandwidths across a wide range (from about 9 kHz to 600 MHz), and scaling the signals up and down. Each change in the transmitter configuration GUI is immediately reflected in the receiver's spectrum GUI.

**Q: What makes the Andromeda XRU50 such a good fit for spectrum monitoring applications?**

**Harry Commin:** A major challenge of spectrum monitoring is the wideband aspect. As we use more, and wider, frequency bands for our wireless signals, we need to monitor wider and wider RF bandwidths, requiring very high sample rates. Precisely this makes the Andromeda XRU50 such a good choice for this application, with its very fast ADCs and enough FPGA fabric to handle massive parallel computations.

**An impressive transmitter signal bandwidth of 4.75 GHz**

Another key aspect is the direct connectivity between the Andromeda XRU50's programmable logic and high-speed data converters, within the same package. By directly generating the microwave signals with highspeed data converters, the transmitter is able to achieve an impressive signal bandwidth of 4.75 GHz.

**Q: What were the main technical challenges on the transmitter side?**

**Harry Commin:** In each RF channel, we transmit multiple signals with configurable bandwidths between around 9 kHz and 600 MHz. Transmitting a 9 ksps complex signal at 9.5 Gsps requires interpolation by a factor of more than one million. Achieving this required careful fixed-point filter design and RTL implementation, especially considering that the transmission processing is clocked at 593.75 MHz.

**Q: How about on the receiver side?**

**Harry Commin:** We compute a 131'072-point spectrum with half overlap in each RF channel. Across the two RF channels, we're running four 131'072-point FFTs at the full 2.25 Gsps (complex) sample rate. This meant parallelizing the FFT algorithm by a factor of 4 and clocking it at 562.5 MHz. Such large FFTs also present a significant challenge in terms of dynamic range. This was overcome by using a small amount of floating-point arithmetic in the spectrum update calculation.

**Q: What do you want users to take away from the demo?**

**Harry Commin:** We would like users to appreciate the Andromeda XRU50's ability to directly generate and acquire microwave signals in the GHz range. On the hardware side, we expect the small size of the module to make a lasting impression. It's one thing to read the dimensions on a data sheet. It's another thing to experience it firsthand.

Developing the firmware to run the demo was also no simple accomplishment. This demo will further underscore our capabilities to support customers in developing sophisticated end applications.

# Experience the future of FPGA/SoC technology at Enclustra

The demo rounds up the state-of-the-art skillset of the Enclustra engineering team, encompassing FPGA/SoC hardware, software, and firmware. With expert support, they assist customers in implementing cutting-edge technological solutions while reducing project risks and shortening time-to-market.

**Watch the full demo video by Dr. Harry Commin to see the Andromeda XRU50 RFSoc in action and discover how it can revolutionize your RF applications.**

**WATCH DEMO**





## Dr. Harry Commin

### Lead FPGA/SoC Firmware Engineer | Enclustra

11+ years of experience in signal processing implementation in FPGAs and ASICs, digital radio system design, implementation and verification. Imperial College London graduate with PhD in Electrical and Electronic Engineering.

## About Enclustra

Enclustra is an innovative, dynamic, and growing company for FPGA design with headquarters in Zurich, Switzerland, with subsidiaries in Germany, France, USA, and China.

As a leader in FPGA design and development, Enclustra offers a product portfolio of FPGA-based electronic modules and FPGA-optimized IP solutions for industrial customers and R&D organizations. In parallel, Enclustra provides leading engineering services in FPGA system design, covering the entire spectrum of FPGA-based system development: from high-speed hardware or HDL firmware to embedded software, from system design, specification, and implementation to prototyping.

Leveraging our expertise in cutting-edge FPGA technology and diverse application knowledge, Enclustra delivers high-performance solutions across various industries, minimizing development effort and accelerating your time-to-market.

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