



RFEL FPGA and Signal Processing Capability For EW, Radar, COMINT and SIGINT Applications

White Paper
January 2016

RFEL Ltd.

Signal and Video Processing Specialists

RFEL is a UK technology company based in Newport on the Isle of Wight. The company is part of the Rheinmetall Group, located in the Defence division and reports through the Defence Electronics unit within Electronics Solutions. The company was acquired by Rheinmetall in 2009. The company has 28 employees, of which 21 are engineers, many with PhDs.



The company has two key areas of expertise; Signal Processing and Video Processing. The Signal Processing group provides world-leading IP products that customers use to provide cutting edge COMINT, SIGINT, Radar, Satellite Intercept and EW equipment. RFEL's key value-add is in the delivery of high-performance Digital Signal Processing (DSP) algorithms, implemented with ultra-efficient resource utilisation in modern Field-Programmable Gate Array (FPGA) devices.

Systems Engineering Capability

The Signal Processing group is led by a team of very capable, dedicated system engineers. Many of these engineers have been involved in developing EW equipment solutions currently in use worldwide and therefore, the team is very

familiar with the EW environment, current equipment capabilities and their limitations.

Development Using The Flex-IQ™ IP Library

Signal Processing is a core capability for RFEL, where typically, the company undertakes around 12-20 DSP programmes per year, for a wide range of applications and markets. These programmes all benefit from RFEL's Flex-IQ™ library of DSP primitives, cores and modules, which allow rapid realisation of complex DSP solutions, reducing both cost and risk for our customers.

The Flex-IQ™ library includes high-speed Fourier Transforms, both real and inverse, as well as Wideband Down-converters and Channelisers. Filters such as the Distributed Half-Band Filter provide a simple means to translate between the real and complex signal domains and the Fractional Rate Resampler core, allows users to match arbitrary sample rates to sub-Hertz precision. All of these cores are essential building blocks when developing high-performance, high-bandwidth systems, such as Radar, ESM and ECM systems. Other cores such as matched filters, perfect reconstruction filter banks and up/down-converters mean that RFEL is well positioned to support most Radar and EW requirements.

Using this underpinning IP, allows RFEL to react rapidly to customer requirements, building complex systems from proven, extensible IP cores. All the modules in the Flex-IQ™ IP library are fully modelled to bit-true level, ensuring low risk development. These models are then used to validate the synthesised IP, ensuring the delivered product performs in-line with customer expectation and predicted performance.

Real-world Implementation

One of the key areas of focus for RFEL's systems team is in the development of these complex models cognisant of the need for real-world



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implementation. The company supports a range of modelling environments, but typically uses C++ and Matlab™ with Simulink™ for the majority of modelling tasks.

From these models a specialised team of VHDL engineers code the algorithms and ensure that the translation from behavioural model to coded implementation is as rapid, accurate and effective as possible.

Design-IQ™ For Custom Design

The majority of RFEL's customers require some level of bespoke design and this is achieved using our in-house [Design-IQ™](#) Design Services. The in-house design team include software, hardware and firmware engineering. RFEL can also design PCBs and provide design validation and verification.

Using this capability, RFEL regularly develops full turnkey solutions for our customers, providing the full design cycle from establishing requirements and conducting requirement decomposition, architectural analysis, development, through to test, validation and verification including environmental testing.

RFEL's Hardware Platforms

A recent development programme saw RFEL develop a PCIe compliant host, fitted with large Xilinx Kintex FPGA and a large Xilinx Zynq System-on-a-Module (SoM) device. The Zynq integrates dual ARM processors in addition to traditional FPGA fabric. Data can be received or generated by the board using a High Pin Count (HPC) FPGA Mezzanine Card (FMC), which give access to hundreds of OEM data converters. Coupled with 3 GB of DDR3 memory, the platform is unrivalled for processing power in this form-factor.



A recent RFEL HW design

Future Product Development

RFEL plans to utilise this platform, to provide a [Flexible Scenario Generator™](#) tool including multi-channel RF synthesis, which is due for release in late 2016. This will provide a powerful tool which will support the generation of synthetic Radar and EW environments to allow comprehensive and dynamic testing of equipment.

[ChannelCore Flex™](#), RFEL's flagship product is on a continuous improvement roadmap. VITA 49 compatible timestamping has been introduced and the development plan for 2016 includes the introduction of wideband inputs, multiple inputs, improved resource utilisation and input flow control, in addition to a range of advanced features such as beam-forming.

Case Studies

A number of customer case studies are included below. Where necessary, these have been abstracted for security reasons.



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Case Study 1 Surface Naval EW

RFEL provides the core of the latest generation Naval ESM systems currently entering service with the UK Royal Navy.

RFEL have worked with a major UK prime for many years developing FPGA implementation of Fast Fourier Transforms (FFTs) for their latest generation Digital ESM equipment. The FFTs are implemented using RFEL's **HyperSpeed™** FFT cores and feature data processing rates of 56 Gbps. The solution is fitted cross fleet, including the Type 45 Destroyer. RFEL continue to support this prime with on-going evolutions of the core on new FPGA devices.



Case Study 3 Submarine Naval EW

RFEL provides the IP cores providing advanced features for the systems in the UK Royal Navy submarine fleet.

Delivering new ESMs to the UK Royal Navy, RFEL provided IP cores to a UK prime providing advanced signal detection for the UK submarine fleet. The solution was implemented using a variant of RFEL's **HyperSpeed™** FFT cores and utilised the switched length options that these cores offer.

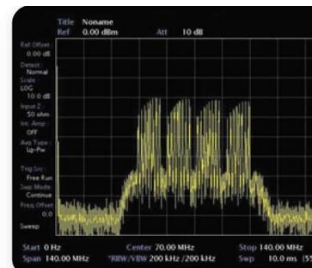
All the systems are now deployed and in-service providing situation awareness to the Trafalgar, Vanguard and Astute platforms.



Case Study 2 Satellite Monitoring

RFEL provides a highly capable Satellite Monitoring System for a wide range of satellite constellations and protocols.

RFEL provide a Satellite Monitoring system for a European customer. This system is designed to monitor a wide range of satellite constellations and protocols and at its heart utilises **ChannelCore Flex™** to provide hundreds of analysis channels, allowing the system to monitor all the possible frequency hop locations simultaneously, giving excellent interception capability.



Case Study 4 COMINT and EW Test

RFEL's Broadband Signal Generator (BSG32) supports testing of complex COMINT and EW systems.

RFEL's **Broadband Signal Generator™** (BSG) is used by a European customer to perform characterisation, test and validation of a wideband intercept equipment.

Driven from a Matlab design environment, BSG is used to generate ultra-long test sequences, which provide comprehensive soak testing of the intercept equipment, simulating a wide range of real-world environments in an automated test environment.

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