

## *Innovation That's Agile: A Multi-Channel, Coherent Receiver System*

With continued advances in digital signal processing comes the need for flexible, high-performing RF hardware. Applications such as direction finding, signal intelligence and managing a congested RF spectrum require multi-channel, coherent transmit and receive systems. Additionally, in order to minimize cost and time-to-market, the hardware must be flexible and modular. To address this emerging need, Mercury Systems has developed a multi-channel, coherent system architecture.

### **Mercury's Multi-Channel, Coherent Architecture for Direct Conversion**

This system leverages Mercury's existing 3U OpenVPX™ products combined with COTS technology to reduce lead time and maximize design flexibility. Mercury's 18-output CLK3002 clock generation and distribution module provides the coherent clock signal. This clock signal drives Mercury's direct digitization assemblies—such as the DCM3110, a 3U digital transceiver that includes low-latency ADC/DAC blocks and FPGA processing. Using multiple clock modules the number of coherent outputs is easily scaled. For extended frequencies, Mercury's 3U RFM3101 ultra-wideband transceiver enables 6-18GHz operation.

In order to meet the coherency demands of complex digital signal processing algorithms, a coherent clock input to each direct-digitization transceiver is by itself insufficient. Proprietary algorithms installed in the FPGA modules further optimize the skew alignment,



**Figure 1: Mercury's 48-channel, L-band direct digitization system**

achieving a coherent output without the need for external signaling. These high levels of skew alignment across multiple channels are critical for applications such as accurate direction finding.

Mercury's family of 3U OpenVPX products are ideal for this application since their standard backplane technology enables rapid integration and customization. The number of channels and operational frequencies can easily be modified by simply using different product variants. The following case study highlights how quickly this technology can be applied to a specific customer need.

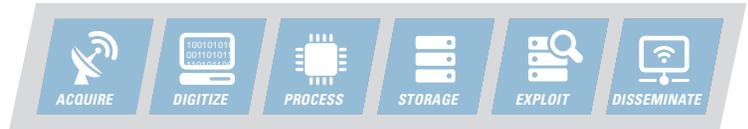
## Case Study: 48-channel, Direct-digitization Receiver at L-band

As congestion in the RF spectrum becomes more common, performing complex signal intelligence monitoring while mitigating the effects of interference is increasingly difficult. In order to assist a customer with these challenges, Mercury Systems was approached to develop a 48-channel, direct-digitization receiver operating at L-band. Using four CLK3002 clock generation/distribution modules, 12 DCM3110 direct conversion modules and some additional COTS hardware, Mercury developed a scalable and coherent receiver architecture.

This system coherently digitizes 48 channels with input frequencies in the L-band. By procuring the entire digitization system from Mercury, the customer was able to focus on the mission-specific DSP algorithms. Additionally, through the use of Mercury's existing OpenVPX products, the cost and lead time were dramatically less than a comparable custom solution.

### A Flexible and Scalable Full Sensor Chain Solution

A key benefit of this architecture is the ability to rapidly scale and customize the technology. For example, if the customer in the above case study needed extra channels, the system could easily scale through the addition of more clock and digitization modules. If the customer



required operation at frequencies above L-band, the lower data-rate digitization modules could be replaced with a higher data-rate version to enable direct conversion up to X-band. For wide-band applications, a microwave transceiver is available to convert a 6 – 18GHz signal down to an IF signal that can easily be digitized.

While the above case study describes a coherent receiver, the same hardware supports transmit functionality as well. Mercury's standard digital processing modules and wideband RF transceivers include the capability for both up and down conversion. This flexibility is critical to rapidly support a wide range of applications.

Using this framework, the system represents a full sensor chain solution. The internally developed microwave transceiver is customizable and provides front-end support for wideband operation. The IF output of the transceiver is processed with Mercury's digitization and FPGA technology. To simplify the installation of the customer's mission-specific algorithms, Mercury has developed advanced firmware. Additional elements such as the clock module and memory also support high-performance, coherent operation.

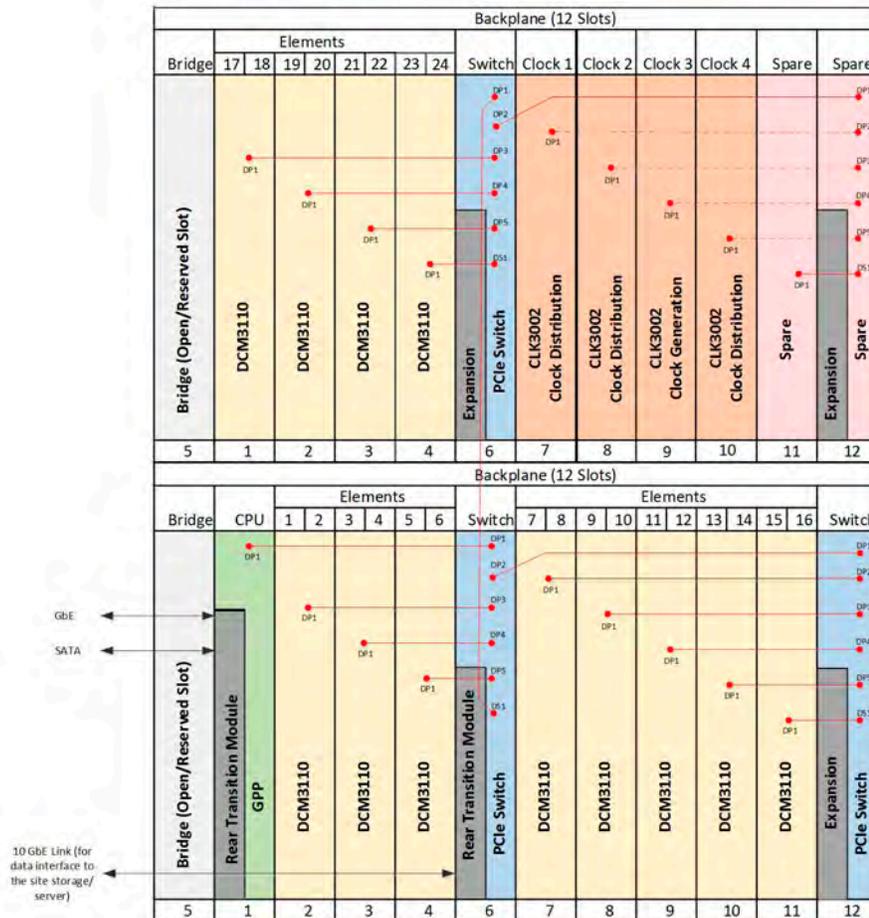


Figure 2: Block diagram of Mercury's 48-channel, L-band direct digitization system

## Conclusion

In our current environment of an increasingly congested and contested electromagnetic spectrum, the ability to rapidly deploy high-performance systems is critically important. No longer can we afford to spend years designing custom hardware for a specific program. To address these challenges, Mercury has committed to developing state-of-the-art products that comply with open architecture standards. This commitment enabled the rapid development and production of the 48 channel coherent receiver. As our library of building blocks continues to grow, we look forward to finding new, innovative ways to apply our scalable and standardized technology to the toughest problems.

## Mercury's 3U, Mixed-Signal Product Portfolio

### RFM3101

The SpectrumSeries™ RFM3101 is an ultra-wideband microwave transceiver with versatile local oscillator (LO), excellent spurious performance and packaged in a compact, 3U module. This flexible transceiver is open system architecture compliant in both the digital and RF domains through OpenVPX (VITA 65) and OpenRFM. The modular design approach confines the up and down converters to separate sub-assemblies to maximize the ability to customize the product for a specific customer requirement.



### DCM3110

The EnsembleSeries™ DCM3110 is a compact 3U digital transceiver that incorporates low-latency ADC and DAC channels with powerful FPGA processing. Designed to deliver excellent spectral purity, coherent multi-channel functionality and real-time processing, the DCM3110 is a scalable module rugged enough for the harshest environments.



### CLK3002

Mercury's EnsembleSeries™ CLK3002 is a customizable, 3U OpenVPX clock generation and distribution solution ideally suited for demanding high-fidelity, coherent signal-processing applications. The three independent clock banks can be customized to specific output rates to support complex system requirements, such as integrated ADCs, DACs, and LO references. To enable high-performance digitization, the CLK3002 has been designed for optimal slew rate with minimal jitter.



## Mixed-Signal Products

### Microwave Transceiver/Tuner Products

	Description	RF (GHz)	IF (GHz)	Gain (dB)	Noise Figure (dB)	IP3 (dBm)	Tuning Speed (μs)	Format/size
RFM3101	Wideband transceiver with one Rx and one Tx channel	6 – 18	1.375 – 2.375	20	14 dB (typical)	30 (up convert OIP3)	25	3U OpenVPX OpenRFM
RFM6101	Wideband transceiver with 4 Rx channels and 1 Tx channel	6 – 18	1.375 – 2.375	20	14 dB (typical)	30 (up convert OIP3)	25	6U OpenVPX OpenRFM
RFM1802 with ADV1800 Synthesizer	Wideband tuner featuring low phase noise and fast tuning speed	0.5 – 18	0.75 – 1.25	22	13 dB (typical)	0 (IIP3)	3	6U VME

### Digital Processing Modules

	Processor	Memory	ADC Channels	DAC Channels	Format/size
DCM3110	Kintex Ultrascale KU115 FPGA	4GB DDR4	2 12-bit, 3.0 GSPS	2 12-bit, 3.0 GSPS	3U OpenVPX (VITA 65)
DCM6212	3 Kintex Ultrascale KU115 FPGAs	16GB DDR4	2 12-bit, 6.4 GSPS	2 12-bit, 6.4 GSPS	6U OpenVPX (VITA 65)
DCM6112	3 Kintex Ultrascale KU115 FPGAs	16GB DDR4	4 12-bit, 3.2 GSPS	4 12-bit, 3.2 GSPS	6U OpenVPX (VITA 65)
DCM6111	3 Kintex Ultrascale KU115 FPGAs	18GB DDR4	2 12-bit, 2.5 GSPS	2 12-bit, 3.0 GSPS	6U OpenVPX (VITA 65)

To request additional information or ask about custom designs, please contact Mercury Systems at [Digital.RF@mrcy.com](mailto:Digital.RF@mrcy.com) or visit [www.mrcy.com/mixed-signal-processing](http://www.mrcy.com/mixed-signal-processing) for a detailed listing of products and capabilities.

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