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Next-Generation Military Communications Challenges

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Military communications (MILCOM) has been the backbone for deployed soldiers since the Vietnam War. While these units have proven their capability and security for decades, the next generation of MILCOM platforms will need to leverage more modern communication technologies that have been developed to enable commercial platforms such as cell phones and Wi-Fi. MILCOM systems are often handheld units—walkie talkies—with a push to talk (PTT) button that the users can press when they need to relay a voice message. When the PTT button is not depressed, an incoming voice message can be received from another walkie talkie. The voice message relayed between two radios is modulated, encrypted, amplified, and transmitted wirelessly between the two soldiers. There are many differences between these MILCOM walkie talkies and a commercial cell phone or communication system, just a few of which are shown in Table 1.

Table 1. Summary of Differences Between MILCOM and Commercial Communication Systems

Feature	Legacy MILCOM System	Commercial System
Bandwidth	<25 kHz	<20 MHz
Frequency Coverage	<500 MHz	<6 GHz
Frequency Hopping	Various agility	Static frequency
Transmit Power	<5 W	Typical 0.5 W
Data Payload	Voice only	Voice, SMS, data, location
Modulation	FM, AM, MSK	QAM, QPSK, DSS

Next generation MILCOM platforms face the challenge of maintaining several of these critical differences, while closing some of the gaps between military and commercial communications systems. These MILCOM platforms will need to change from voice only systems by adding data and text capability. This will enable the delivery of data such as mapping, images, and video to a soldier in the battlefield. The challenge is that wider bandwidths create challenges for the radio platforms, primarily around size, weight, and power (SWaP). The traditional radio frequency (RF) signal chains used by MILCOM platforms will not scale to wider bandwidths and digital modulation schemes without consuming much more power, and they will increase size and weight. This growth in SWaP is unacceptable to the soldier, who needs a smaller, more capable radio that can be powered for long mission durations on minimal battery power. Thus, next-generation MILCOM platforms will require new RF signal chain architectures.

One revolution in small form factor radio design has been integrated RF transceivers. Integrated transceivers reduce size and power by repartitioning the radio in several ways. First, RF and analog devices can be transferred to the digital domain—RF filters becoming digital filters, for instance. The digital implementations of these blocks are more efficient and more programmable than their RF counterparts. Second, discrete RF signal chains are often heterodyne architectures, which require several layers of frequency conversion, filtering, amplification, and digital sampling. Integrated transceivers can use a zero-intermediate frequency (ZIF) architecture that drastically reduces the required components in the signal chain, specifically the required filtering and amplification stages. Removing these stages reduces both size and power. Finally, the ZIF architecture is a more efficient use of the digital converters, which, in a wideband system, can drive overall power consumption. While commercial platforms have been able to take advantage of ZIF transceivers for the last decade, the first products with MILCOM applicable features have only come to market in the last few years. The latest transceiver that can be used in MILCOM systems is the ADRV9009, shown in Figure 1.

The ADRV9009 is a CMOS transceiver with several MILCOM appropriate features. First, the device is a native time duplex device (TDD), which is how a PTT architecture typically operates, and this saves power compared to having two local oscillators (LO) in the device. Second, the integrated LO supports frequency hopping natively in the transceiver, both from a frequency generation perspective, but also from a calibration perspective. Third, the usable bandwidth of the ADRV9009 can be programmed between 20 MHz and 200 MHz, allowing for a range of wide bandwidth operating modes. Fourth, the ADRV9009 is a waveform agnostic transceiver, meaning that it delivers RF to bits with no limits on what waveform is used. This allows for the ADRV9009 to implement waveforms that are available today, but also to implement waveforms that may be developed in the future. Finally, the ADRV9009 integrates several auxiliary features into the transceiver. Automatic gain control (AGC) is critical for optimizing the receiver dynamic range, and the ADRV9009 has an internal AGC loop with 30 dB of range. Temperature sensors, control converters, and general-purpose outputs (GPOs) are also integrated into the device, saving space in the radio system.

Modernizing defense communications systems is a challenge, one that will require innovation across a range of engineering disciplines. For the backbone of the radio circuitry, however, integrated transceivers are taking great strides toward providing single-chip solutions that will integrate the bulk of the receiver and transmitter signal chains, while maintaining features such as frequency hopping, AGC, and the capability to upgrade to future waveforms. Building on these transceivers as a core block of the radio will enable the next generation of MILCOM radio systems.

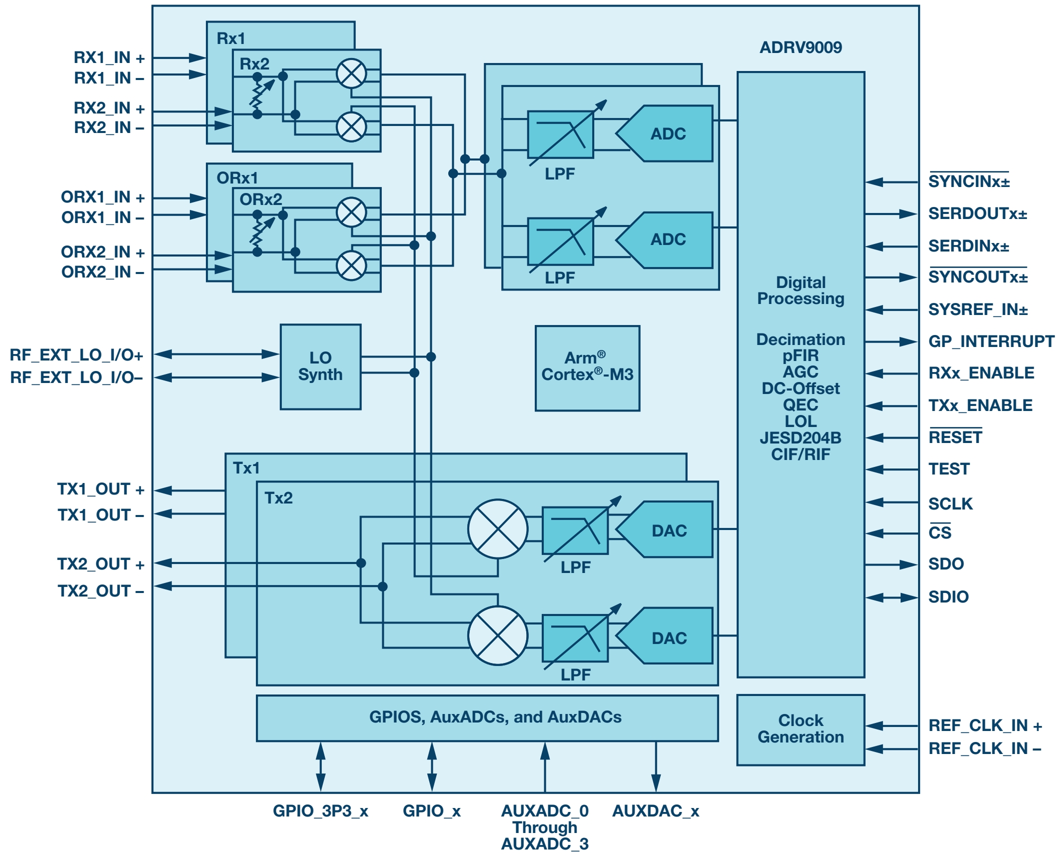

Figure 1. ADRV9009 functional block diagram.

About the Author

Wyatt Taylor is a senior RF systems engineer with Analog Devices, located in Greensboro, North Carolina. He is focused on aerospace and defense radio applications, with a particular emphasis on integrated RF transceivers, small form factor microwave design, and software-defined radio (SDR). Formerly, Wyatt was an RF design engineer at Thales Communications, Inc., and Digital Receiver Technology, Inc. in the Maryland area. Wyatt received his M.S.E.E. and B.S.E.E.from Virginia Tech in Blacksburg, Virginia, in 2006 and 2005, respectively. He can be reached at *wyatt.taylor@analog.com*.

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