SPECTRUM SIGNAL PROCESSING

Application Note

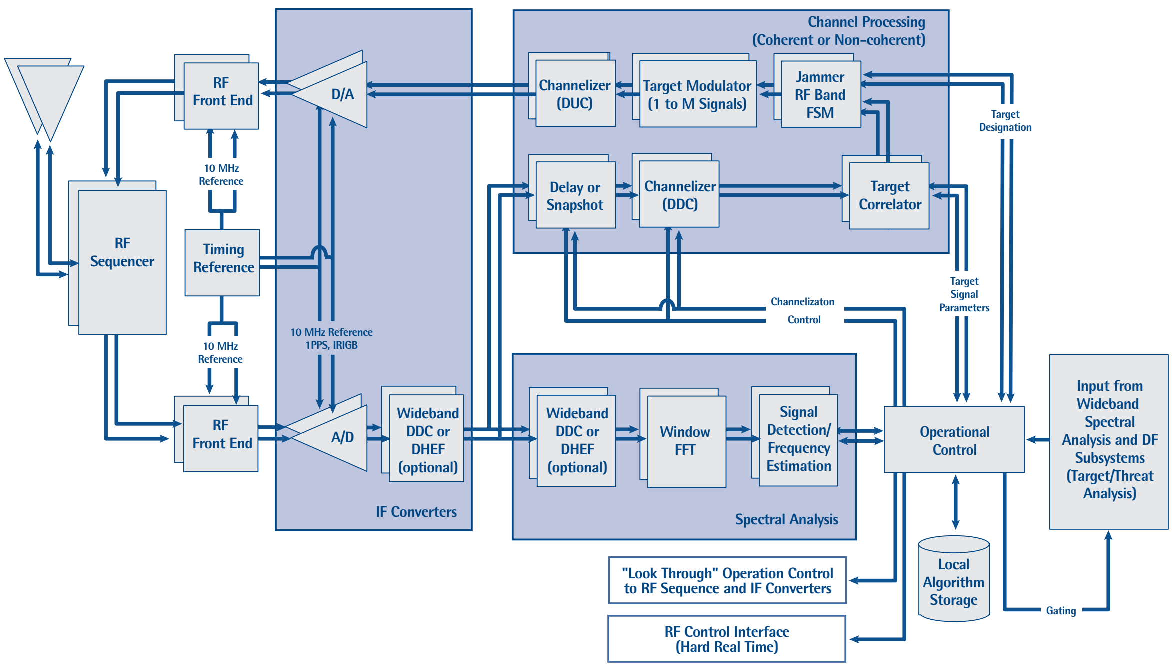
Electronic Counter Measures

Authored by Lee Pucker
Chief Technology Officer

flexComm

[Introduction]

The generic functional reference design for an Electronic Counter Measures (ECM) system is shown in the figure below. This system is used to lock onto and jam threat signals emitted by an enemy. These include both sensor signals, such as are used in RADAR, and communications signals. This system typically works in conjunction with an electronic support measure system performing wideband spectral analysis and direction finding to identify threat signals. In addition, the ECM system may target a single frequency band, jamming all threat signals within that band, or it may employ a search strategy where the RF front end will step through a larger frequency band in a pre-defined manner.



[Electronic Counter Measures Application]

Processing in an ECM system is generally broken into three sections: IF Conversion, Spectral Analysis, and Channel Processing. The primary purpose of the IF conversion section is to provide wideband analog to digital conversion of the IF signal from each RF front end to be used in target acquisition, and wideband digital to analog conversion for the jamming signal. Transmit and receive elements within the IF Conversion section are gated to support "look through", allowing shut down of receiver functions during jammer transmission. This gating function is also distributed across multiple channels when jamming is employed over multiple bands. In addition, the converted data from the receive channel is time-stamped to allow synchronization of threat signals with the time of day.

The IF Conversion block interfaces directly to the spectral analysis and channel processing sections. The spectral analysis section is used to allow a ”fast follower” approach, allowing the system to detect active signals in the target band. This is typically done using a large FFT and windowing function with follow-on processing to identify the exact center frequency and bandwidth of the target signal. Channel processing is then used to isolate the active signals from each digitized IF channel, and then correlate these signals against the current threat database received from the wideband analysis system or user input to identify active threat signals. If a threat signal is identified, a jamming signal is then created and sent out to the IF conversion section. The latency between the time a signal is detected and the time that the jammer signal is transmitted must typically be very small, often times less than a few microseconds, to provide effective jamming of short duration of frequency agile signals. As a result, the delay buffer utilized in this system to allow for the latency associated with the spectral analysis process is typically very small.

Coordination of these three processing sections is facilitated through an operational control element consisting of a finite state machine and a number of control ports. This control element typically maintains the threat database, and is used to dynamically load and unload jamming modulation schemes. In addition, when used in conjunction with electronic support measures, the operational control element must provide a gating mechanism to these other systems to coordinate ”look through”.

[Implementation on Spectrum's *flex*Comm Platform]

Support for this application at 160 MHz IF is provided two modules: the XMC-3311 Dual Channel Analog IO Module operating at 213.33 MSPS and the ePMC-8120 VirtexII Processing Engine. These modules are hosted on PRO-1900/1901 carriers as illustrated in the figure below. The XMC-3311 provides the IF Conversion and Channel Processing functions of the ECM application, maintaining tight integration between transmit and receive processes. Threat and jamming signal parameters are stored in the local SRAM associated with each FPGA processor, minimizing the latency associated with each ”look up” of this data. Time-stamping of each IF channel is supported through the 1PPS interface, and coordination of multi-channel ”look through” between multiple XMC-3311 modules is supported through a front panel gating connector. The ePMC-8120 modules provides for the spectral analysis section, with support provided for up to a 32K point FFT per IF channel while maintaining real-time performance. Operation control of this system is distributed, with local control shared between the XMC-3311 FPGA processors and the embedded MPC8240 processor on the PRO-1900.