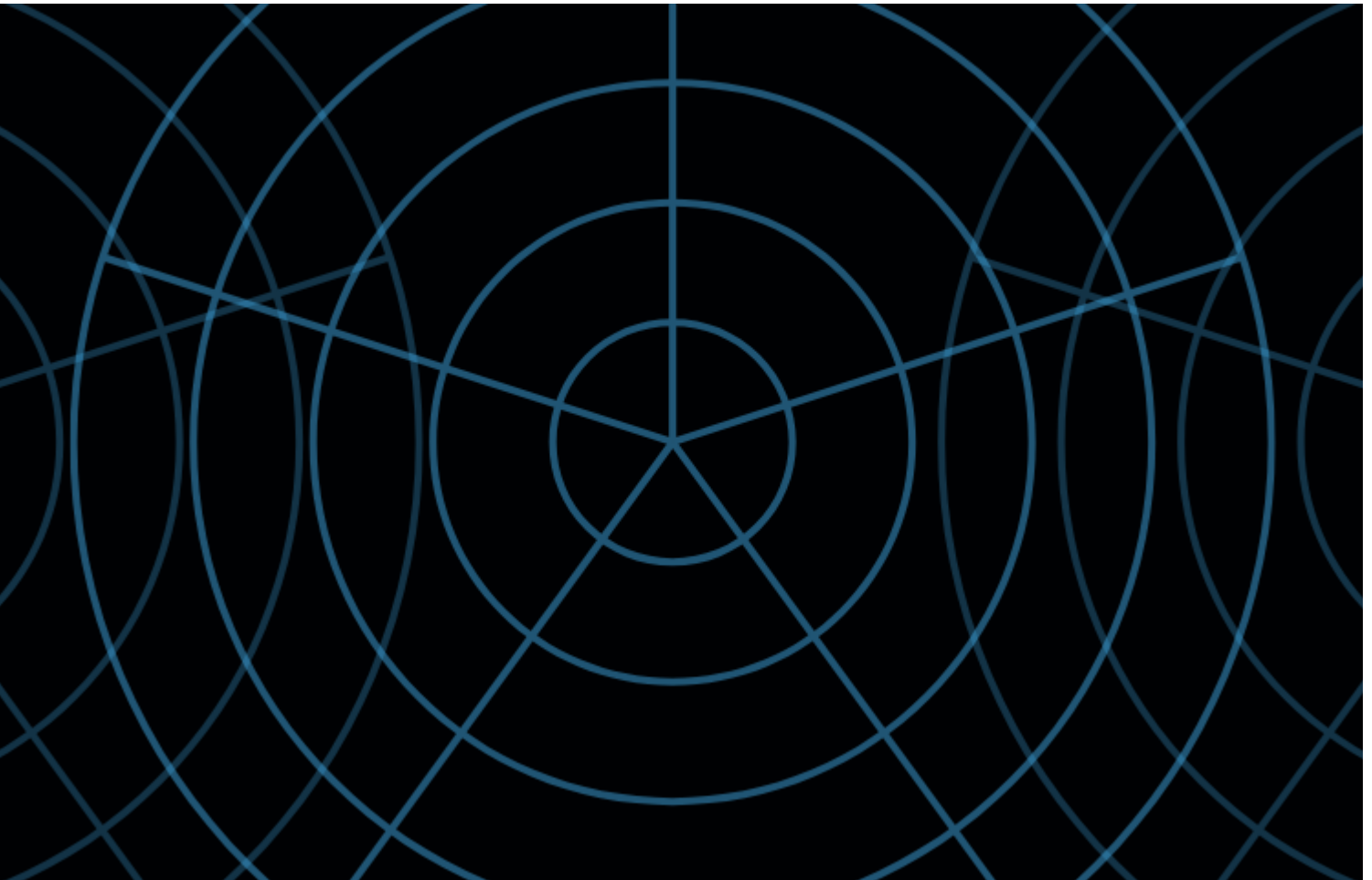


EXAMINING THE DEFINITION OF “WIDEBAND” THROUGH THE LENS OF ELECTRONIC WARFARE SYSTEMS



In complex radio frequency (RF) applications, “wideband” has varying definitions depending on both the application of interest and the portion of the RF circuit you’re focused on. Wideband can be used to describe the entire spectrum shown in Figure 1 or large portions of it.



Figure 1: IEEE radar bands with common uses.

Electronic warfare (EW) systems provide a valuable framework for understanding wideband, as they conceivably need to encompass a broad range of frequencies and bandwidths, including those used in search, track, targeting and communication links, as shown in Figure 1.

Within this context, we can take a closer look at how the definition of wideband depends on which part of the circuit you're looking at.

Wideband in EW Evolves with RF Analog-to-Digital Converters (ADCs)

To understand how bandwidth varies depending on the analog-to-digital (ADC) technology in place, focus on a major component of an EW receiver, the tuner. EW tuners are tasked with selecting sections of spectrum that can be processed by the ADC.

As RFADC sampling rates increase, possible receiver architectures and bandwidths are widening, and EW receiver tuners are expected to select larger portions of the spectrum. What started at 200 MHz of available spectrum increased to 2GHz. Now, it can be upwards of 10GHz, shown in Figure 2. While this is a major advancement, there are tradeoffs to consider. For example, in highly sensitive receivers, such as those used in radio telescopes, you will still see traditional superheterodynes used for their sensitivity, despite a relatively narrow bandwidth.

Even still, this shift indicates that the roles of a filter are changing with technology choice and availability. Metaphorically speaking, filters function to clean up messes made by other parts of the system. To extend the metaphor, now, as we shift from IF conversion to RF conversion, there are fewer messes to clean up. The result? Filters can focus on other, arguably more essential, functions: band select and anti-alias.

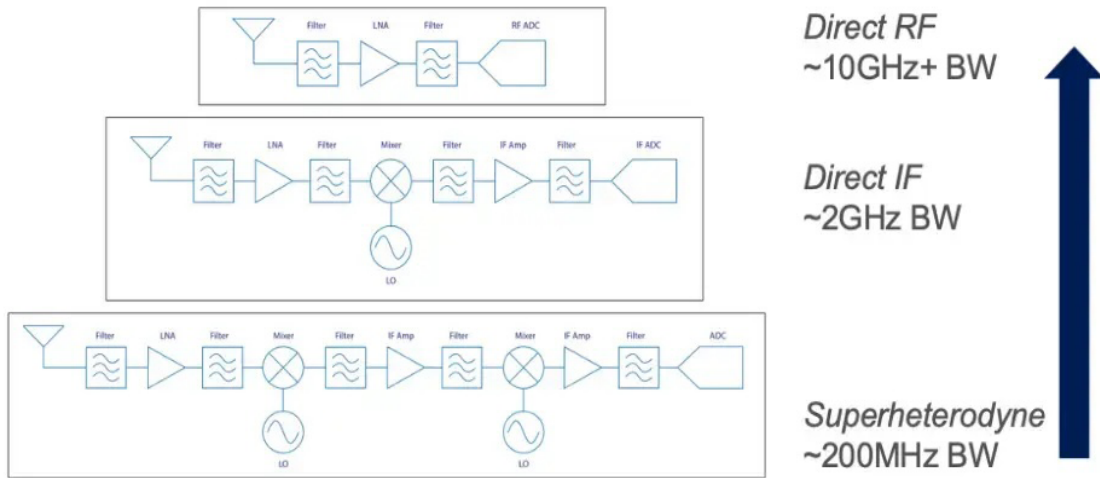


Figure 2: Example of channel bandwidth growth in RFADCs.

In a traditional wideband tuner, shown in Figure 3, a band select function (e.g., a switched filter bank) selects the relevant region of spectrum. A swept LO is set to the frequency needed to up-convert to a fixed, known band that's based on the bandwidth of the receiver. A fixed bandpass filter cleans up the converted signal and a fixed LO converts down to an IF that the ADC can handle. This approach (i.e., up, filter, down) supports frequency planning. In this case, the mid-stage bandpass and anti-alias bandpass are set by the sampling capability of the digital converter.

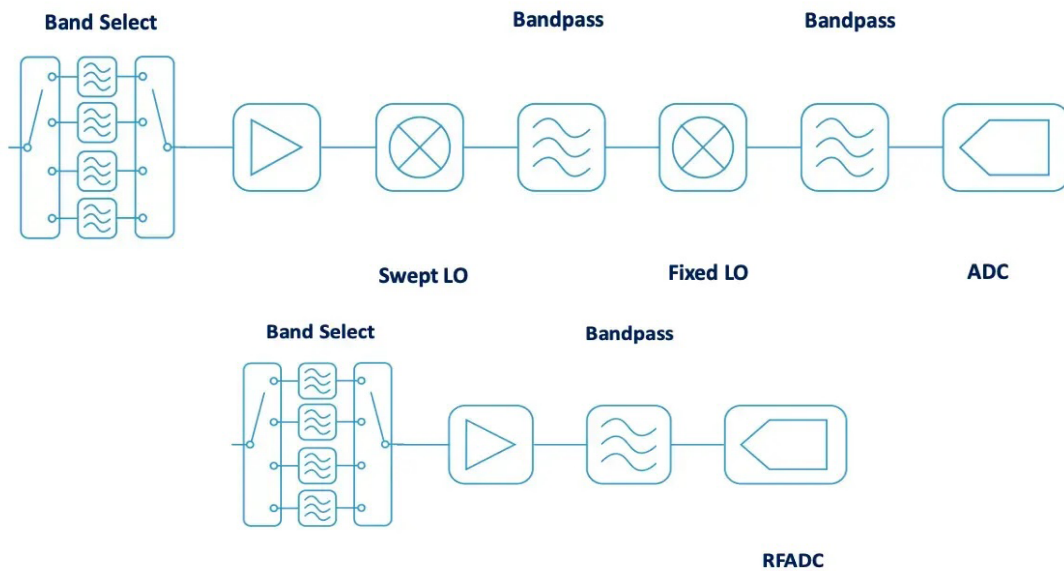


Figure 3: Traditional (top) vs. modern (bottom) wideband tuner design.

A modern tuner, shown in Figure 3, can take advantage of an RFADC to sample RF directly, simplifying the receiver. Similarly, a band select function (e.g., switched filter bank or tunable filter) selects the relevant region of spectrum followed by a single bandpass filter, which can ideally perform anti-aliasing for the ADC. Anti-aliasing, a critical filter function, enables the RFADC to select the correct Nyquist zone, effectively boosting the system's availability to sample high-frequency signals.

Frequency planning is simpler in a direct-to-digital receiver. The RFADC accommodates direct RF sampling, removing the need for frequency conversion stages. In turn, this frees up the receiver to make full use of the RFADC bandwidth, shifting the definition of “wideband” to encompass the bandwidth of the RFADC and the filters available to perform anti-aliasing at increasing bandwidths.

Wideband in EW Evolves with Transmitter Bandwidth

Engineers working on EW systems are looking for broader bandwidth across a wider range of frequencies, which has expanded the spectrum of interest over the last ten years. Building power amplifiers from MMIC amplifier stages often involves combining their outputs using hybrid couplers to reach the desired transmitter power (Figure 4).

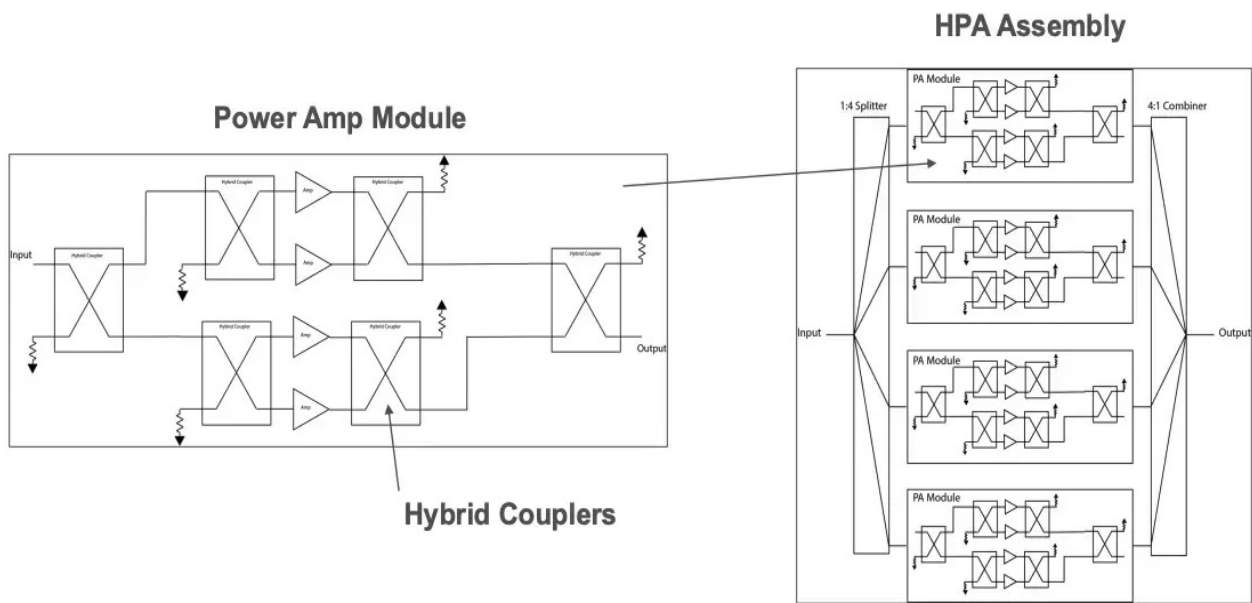


Figure 4: Broadband, high-power amplifiers.

In the context of EW systems design, engineers seek to cover as much of the spectrum as possible to enable multi-purpose transmitters. The bandwidth of the MMIC amplifier factors into the overall power amplifier bandwidth. Since MMIC amplifiers are trending toward higher bandwidths, **broadband hybrid couplers** (e.g. 6 to 18 GHz) are required to take full advantage of their capability.

Wideband in EW Evolves with Filter Technologies

Lumped element, ceramic, cavity and planar (e.g., microstrips) are common filter technologies that can be compared in terms of their frequency and bandwidth (Figure 5).

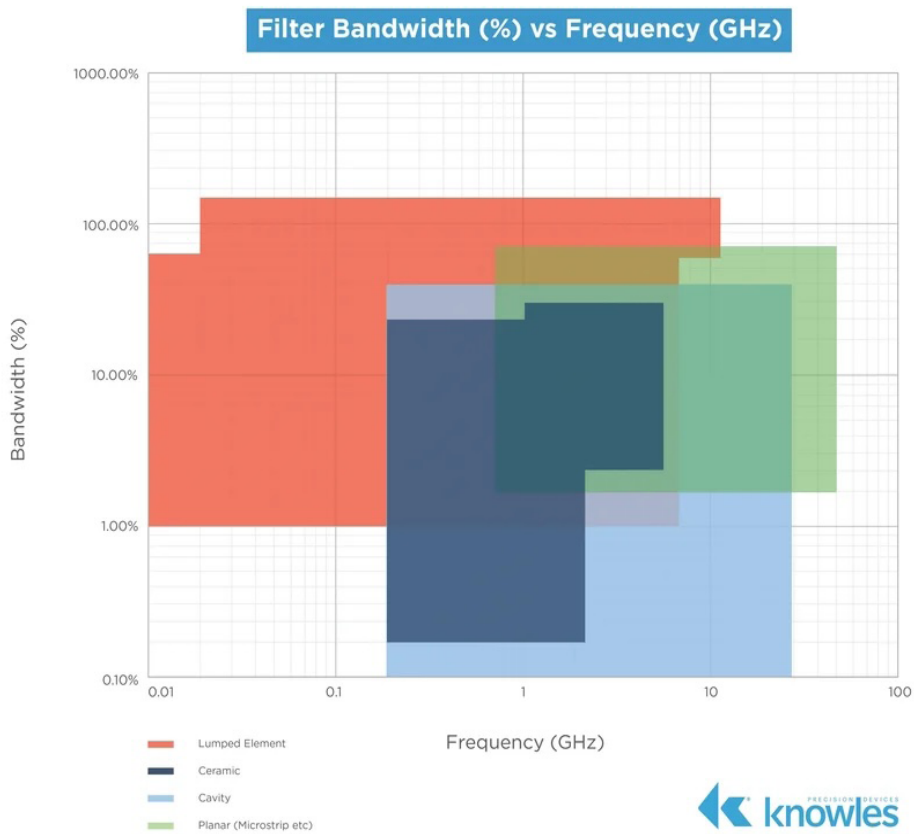


Figure 5: Bandwidth vs. frequency for common filter types.

With the help of lumped elements for lower frequencies and waveguides for higher frequencies, filters can be adapted to different bandwidth requirements, but what about the ultrawideband portions of the circuit? Multi-mission EW systems need to cover larger and larger portions of spectrum to counter traditional and emerging threats.

Knowles Precision Devices developed a [solution](#) where quasi-lumped elements are combined with other filter types (e.g., planar, ceramic, cavity) into a single device that's designed specifically for those really high bandwidth applications facing size, weight and power constraints. For example, the B100RH2W is a 2 – 18 GHz bandpass filter featuring a very small surface mount package.

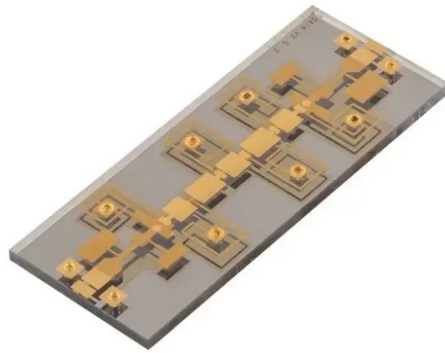


Figure 6: B100RH2W, a 2 – 18 GHz bandpass filter from Knowles Precision Devices.

Knowles Precision Devices is prepared to address a wide range of bandwidth needs, and we continue innovating to [expand your capabilities](#) and align with evolving definitions of wideband.

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If you need help selecting from our portfolio please [contact us](#) and we can guide you through the selection process.



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