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THE RISE OF WIDEBAND WIRELESS

Radio system design is becoming ever more complex, with increasing demands on performance, cost, and power consumption. With many different frequency bands in use around the world, and commercial systems now extending up into the millimeter wave frequencies above 50 GHz, today's RF system designer is facing significant challenges.

Wideband amplifiers are addressing this challenge of multiple bands and complex radio front ends. Instead of a separate chain of components for each band, the new generation of wideband amplifiers provide a single front end that can handle a wide range of frequencies with high performance across the whole band. This can significantly reduce the complexity of an RF design.

Analog Devices, Inc. (ADI) and EBV Elektronik work closely together to support design engineers by providing the latest information at their desk for these designs. ADI is using the latest design techniques and process technologies for high performance wideband amplifiers, while the technical specialists at EBV assist developers with the selection of suitable components for their design and provide design in support during the development phase.

There are several areas where wideband designs are shaking up the market, from cellular infrastructure and point-to-point links, to test and measurement. Equipment manufacturers are increasingly looking at a platform approach where a single board or system can be used for customers in different regions around the world. Ideally, this same platform can also be used for different applications with minimal configuration, opening up more opportunities for cost savings from economies of scale.

In the cellular infrastructure market, wideband amplifiers are able to provide the RF front end for existing 2G, 3G, 4G, and 5G base stations with a single device instead of dozens or even hundreds of components. These wideband devices span frequencies from 800 MHz to 3.5 GHz and deliver a number of advantages for both the designer and the operator of the networks. Traditional RF front-end designs require separate amplifiers and support components for each band, so a single wideband device can replace many other components in the front-end RF board. This reduces the cost and complexity of the board and increases the reliability by having fewer components. This design approach also reduces the complexity of parts management and the operating expenses for the operator as a single board can be used for networks around the world rather than requiring an operator to manage multiple versions.

EBV's specialist engineers are also seeing the use of wideband amplifiers increasing in small cells. As the name suggests, these are smaller cells supporting 10 or 20 users and are smaller, cheaper, and lower power than large base stations. This allows operators to cost effectively expand network coverage and so wideband amplifier use is increasingly popular.

For small cells the wideband amplifiers have current consumption as low as possible, allowing for a smaller design compared to using a separate front-end signal chain for each frequency band that the phone network needs to support. EBV's field applications engineers (FAE) are increasingly showing customers the range of devices available that can help the developers balance the number of users supported by the small cell with the power consumption and bill of materials (BOM) cost.

EBV's FAEs can also provide support for modeling the amplifier performance and simulating its use in a design and guide developers through the different trade-offs. For example, while the wideband amplifier may have a higher noise figure than a dedicated narrow-band amplifier, there is no need for an additional RF switch to change frequency bands. As a result, the overall noise of the signal chain is reduced. This can then be used to reduce the cost of other components in the signal chain to achieve the desired performance, or provide longer range. EBV can also supply evaluation boards so that developers can test out the wideband amplifier along with the whole signal chain to demonstrate the lower overall noise figure.

This single amplifier approach also allows the designer to focus on the challenging issues of antenna design and the power efficiency of the whole link. The ADI wideband amplifiers operate up to 80 GHz to enable this flexible design, reducing the complexity of product management and, through the higher reliability, helping to reduce the operating costs.

Wideband amplifiers are also increasingly popular in test and measurement systems. The same challenges of addressing many different RF bands in cellular infrastructure equipment are multiplied for the instrumentation developer. The latest instruments have to handle wider bandwidths than ever before, from the low end up to 80 GHz and 90 GHz. Whether testing the latest point-to-point communication link design or a high performance phased array radar platform, the instrument designer has to be able to provide gain for a signal with the best possible linearity across the widest possible band. While cost is perhaps less of a factor, the performance is vital, as the instrument—whether a signal generator or spectrum analyzer—has to provide the highest possible signal quality.

There are a number of key parameters for designers using wideband amplifiers. Alongside the frequency, gain, and 1 dB power point, the IP3—the third-order intercept point—value is also used to indicate the maximum signal the amplifier can handle before intermodulation distortion occurs.

For low noise amplifiers such as the HMC1049 and HMC753, the noise figure (NF) is key, and the P1dB output power enables the amplifier to function as a local oscillator driver.

	HMC1126	HMC1127	HMC1049	HMC753
Frequency (GHz)	2 to 50	2 to 50	0.3 to 20	1 to 11
Gain (dB)	11	14.5	15	17
NF (dB)	—	—	1.8	1.5
Output Power @ 1 dB (dBm)	17.5	12.5	29	30
Output IP3 (dBm)	28	23	15	18

All this means there are several different ranges for the wideband amplifiers, and EBV's FAEs can help the designer determine the right parts for the RF range of the application. Cellular base station and small cell designs typically use frequencies from 100 MHz to 6 GHz or 8 GHz with modulation around the carrier frequencies of 2G, 3G, 4G, and 5G. The 100 MHz to 20 GHz band covers most of the military communications systems, where a wideband amplifier can support *cognitive* software-defined radios that analyze all the available bands and identify a particular network to connect to. The protocols for that network are then downloaded to a controller chip, allowing one handset to be used with many different radio systems. This band also coves military radar applications.

Instrumentation designs will be generally looking to use a wideband amplifier above 20 GHz, rising to 40 GHz or 50 GHz for mainstream designs and reaching 80 GHz and 90 GHz for testing very high performance applications. The point-to-point links will be operating at 60 GHz in the unlicensed band and up to 86 GHz in the most challenging designs and need test and measurement systems that can extend reliably up into this frequency range.

ADI has patents covering techniques that allow the wideband operation across the higher range of frequencies with noise figure and power consumption that is appropriate for the different applications. A key role for EBV's engineers is helping developers with the range of devices for those applications.

The process technology used to implement the amplifier is an essential part of the performance of the device. There is always a compromise in providing the highest performance at the best possible price, which is why the target bands are important. Sometimes a lower cost technology such as 0.25 µm gallium arsenide (GaAs) pHEMT (pseudomorphic high electron mobility transistor) can be used to deliver sufficient performance in the RF bands from 2 GHz to 20 GHz with good linearity and gain, making use of decades of experience at ADI in the development of new architectures. Other applications, especially at 50 GHz and above, require a shorter gate length of 0.1 µm to 0.15 µm in the pHEMT GaAs devices. These GaAs-based wideband pHEMT amplifiers provide the best linearity and lowest noise for ADI's designers to provide the wideband performance at the higher frequencies. This expertise delivers the noise and current performance that allows the wideband amplifiers to be used across the range of frequencies and applications.

Conclusion

A large number of applications are opening up for wideband amplifiers. As the demands of cellular infrastructure equipment increases, designers can make use of wideband amplifiers to reduce the complexity and power consumption of designs, hence reducing cost both in the installation and maintenance of systems around the world. The same technology can be used to reduce the cost and enhance the reliability of high performance point-to-point links to bring broadband connectivity to wider areas and new customers. The technology also provides the performance necessary for leading edge instrumentation, delivering the test and measurement capabilities that help develop these sophisticated RF systems.

Links to Products and Applications:

- Wideband distributed amplifiers: *www.analog.com/en/products/amplifiers/rf-amplifiers/wideband-distributed-amplifiers.html*
- Power amplifiers: *www.analog.com/en/products/rf-microwave/rf-amplifiers/power-amplifiers.html*
- Low noise amplifiers: *www.analog.com/en/products/rf-microwave/rf-amplifiers/low-noise-amplifiers.html*

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