Sorting through multiple supplier lists to discover critical signal chain components can be a complex and time consuming experience. The huge number of available components and device configurations notwithstanding, choosing a signal chain component also depends upon more than just the few notable performance features. It is rarely convenient to gather or build models for every component being evaluated for use. Developing and optimized signal chain can be simplified with streamlined design tools and leveraging suppliers that can provide all major RF, analog, and digital functional building blocks. For example, Analog Devices’ ADIsimRF can be used to gauge the signal chain impact of various components, from mixed-signal domain analog-to-digital converters (ADC) and digital-to-analog converters (DAC) to RF and Microwave components.

The latest RF/microwave devices combine an increasingly complex array of multi-domain electronics, and require efficient and compact bill-of-materials (BOM) to bring cost-competitive products to market. Finding and coordinating with diverse suppliers for the RF, analog, and digital signal chain components, commonly employed in the latest RF devices, can require a substantial investment of engineering resources. Many engineers are only familiar with a specific domain. Unfortunately, the dedicated time of a systems engineer familiar with the requirements for each domain and complex simulation tools is often necessary to ensure the design meets the deadlines. However, intelligent sourcing with a supplier that provides a diverse range of solutions, a vast knowledge base of reference signal chains and circuit examples, and streamlined simulation tools, could enable ease-of-design and rapid prototyping with shortened design cycles.

Streamlined Design Tools Enable Rapid Insights And Shorten Design Cycles

There are many simulation and design tools available, though many of these tools are built for a specific domain or have a high-learning curve and complex setup requirements. When decisions between components are based upon the components impact on power, noise level, linearity, or other signal chain parameters, systems engineers will often use spreadsheets they compose with manually entered datasheet information. This process is generally very time consuming and error prone. Analog Devices Inc. has recently upgraded their free ADIsimRF design simulation and synthesis software, that combines a large library of embedded device models and the ability to rapidly generated data and plots on critical signal chain features.
Caption: ADIsimRF can be used to gain rapid insights into the cascaded power, linearity, and noise features of a signal chain.

**Easily Configured Signal Chain Parameter Plots Aid Decision Making**

Cascaded parameter analysis is a useful feature in determining if a signal chain meets the necessary specification criteria. Nevertheless, stage by stage influence over each parameter is often needed to make decisions between components. ADIsimRF features level plan, power sweep, gain sweep, and frequency sweep plots that can be used to identify each stage’s influence on all of the critical cascaded signal chain parameters.

Caption: A Level Plan Plot can be used to understand how each stage in the signal chain impacts cascaded performance.
For instance, the Level Plan plot labels the influence on a signal chain parameter at each stage, with the accompanying component label, which is especially useful for identifying a component whose performance is weak relative to the other components in the signal chain. The sweep-based plots can be used to gauge the change in performance vs. the RF input.

**Caption:** RF Power Sweeps provide an excellent overview of the trade-offs between noise and distortion as input signal levels vary.
Caption: Frequency sweeps overlay the gain, noise, and distortion of all of the signal chain components, providing an overview of performance across a complete band.

While ADIsimRF is prepopulated with a large library of components—well over 400 models—, custom components can be easily added into a stage. This feature can be used to estimate signal chain budgets when selecting parts or in the early stage of a new design. Also, hypothetical components and pre-spec components can be used to evaluate their impact on a customer's signal chain, with ease.
The large library of embedded component models makes selecting the ideal component fast and easy, as the cascaded signal chain parameters are immediately updated with the new components impact.

ADIsimRF also contains many valuable internal reference features and calculators, which can be used to rapidly look up and predict design relevant figures. Analog Devices Inc. is also dedicated to enhancing ADIsimRF with the inclusion of pre-built reference signal chains, which can be used as a time-saving and valuable design aid and learning tool. Transmitters and receiver signal chains can both be easily simulated, as the input or output referred setting can be toggled.
Instead of having to reference a myriad of charts, ADIsimRF provides an easily called reference and a variety of useful calculators.

Signal Chain Reference Signal Chains Provide Time Saving Circuit Reuse

There are many cases where reference circuits are valuable in shrinking design cycles and learning good circuit design techniques. Analog Devices Inc. provides a wide range of reference signal chains that service applications from radar to instrumentation, including a compact RF digital-to-analog converter (DAC)-based transmitter operating to 3.5 GHz. Not only is the basic circuit typology provided for these references, but also provided are component recommendations for each element in the signal chain. These reference signal chains can also be used to understand the capability and performance of individual components and segments of a signal chain.
A RF DAC Transmitter Reference signal chain can be adapted or added into new designs, bring valuable signal analysis functions without the need to design such a device from scratch. Reference signal chain from Analog Devices Inc. can also be used as learning tools to develop greater understanding of the interplay between components and frequency stages of an RF design.

Leveraging the JESD204B SERDES digital data interface of the AD9162 RF DAC, a high speed digital signal to 6 GSPS can be directly synthesised into RF at the output of the DAC-based transmitter reference signal chain. The differential output of the RF DAC is converted to a single ended 50 Ohm impedance with the BAL-009SMG balun and then amplified by the ADL5601 gain block amplifier. An attenuator at the input of the HMC1114 gallium-nitride (GaN) power amplifier (PA) ensures the signal power doesn’t exceed input power limits of the GaN PA. The bandwidth of the HMC1114 GaN PA enables a frequency range of the RF DAC design from 2.7 GHz to 3.8 GHz, which is 1.1 GHz of total bandwidth at over 50% power-added-efficiency (PAE). This reference signal chain can be used as a highly configurable transmitter for broadband communication systems, such as DOCSIS 3.1, wireless communication infrastructure, instrumentation, and radar/jammer applications.

**Diverse Signal Chain Component Options Reduce Design Dilemmas**

Suppliers, such as Analog Devices Inc., provide a diverse range of signal chain components, which can simplify the sourcing and bill-of-materials (BOM) aspects of critical RF signal chain designs. For example, Analog Devices Inc. provides leading components for digital-to-analog conversion capable of direct RF synthesis to 7.5 GHz, high dynamic range gain block amplifiers, and highly efficient GaN PAs with excellent gain flatness. The highly integrated features of these components reduce the number of signal chain components necessary to reach the design’s power requirements, while maintaining high linearity and low cascaded noise figure.

**16-Bit 12 GSPS RF DAC Enables Direct Digital Synthesis to 7.5 GHz**

The heart of the RF DAC reference signal chain is the AD9162 16-Bit RF DAC with up to eight configurable JESD204B serializer/deserializer (SERDES) data interfaces and an SPI configuration interface. The JESD204B interface and the quad-switch architectures coupled with a 2x interpolator filter is able of performing direct RF synthesis at 6 GSPS and an effective DAC update rate of 12 GSPS in certain modes. Demonstrating great linearity across a wide bandwidth, the AD9162 is able to reconstruct RF carriers in the second and third Nyquist zones in Mix-Mode™ operation to 7.5 GHz.
The eight JESD204B SERDES digital data interfaces at the input of the AD9162 RF DAC enable a DAC update rate as high as 12 GSPS.

Source: Analog Devices, Inc. AD9161-9162 Datasheet

The AD9162’s bandwidth and dynamic range capability meet, and exceed, DOCSIS 3.1 compliance with additional performance margin from the minimum two carriers to the full maximum spectrum of 1.794 GHz. Additionally, the RF DAC can be configured for lower data rates and converter clocking, which reduces the system power consumption and eases the burden on filtering requirements. Also, the AD9162’s output current can be adjusted from 8 mA to 38.76 mA from the complementary differential current outputs.

Capable of converting complex digital modulation schemes, the AD9162 RF DAC can be used in wireless communication infrastructure applications servicing W-CDMA, LTE, LTE-A, and for microwave point-to-point (P2P) devices. Equally, the pulsed waveform conversion capability can also produce radar and jammer waveforms with high dynamic range. These features enable the AD9162 to provide agile RF synthesis with a single conversion component, which enables a much reduced BOM and system complexity than comparable performance RF synthesiser circuits and devices.

15dB Fixed Gain Block Amplifier Features An Integrated Input Bias Circuit And High Dynamic Range

Fabricated with an indium gallium phosphide (IGaP) heterojunction bipolar process (HBT) process, the ADL5601 offers 15 dB of highly linear amplification from 50 MHz to 4 GHz. With both low noise figure of 3.7 dB and high OIP3 specification of 43.0 dBm at 900 MHz, the internally matched gain block amplifier offers extremely high dynamic range capability. Additionally, the 15 dB of gain is highly stable over frequency, supply voltage, temperature, and through process variations from device to device.

Source: Analog Devices, Inc. ADL5601 Datasheet

The ADL5601 has both 50 Ohm internally matched input and output and an integrated bias control circuitry. These features enable the ADL5601 to only require external input/output ac coupling capacitors, power supply decoupling capacitors, and an external inductor for complete operation. With only a single 5 V supply and 83 mA max current consumption, the gain block amplifier is highly resilient and can operate within specification from −40°C to +85°C. Lastly, the ADL5601 demonstrates class 1C ESD rating of +/−1.5 kV in a thermally efficient SOT-89 package.

Highly Efficient And Compact GaN PA Delivers 1.1 GHz Bandwidth With +/-0.5 dB Gain Flatness
Delivering up to 10 watts of power with greater than 54% PAE, the HMC1114 GaN PA has a bandwidth of 2.7 GHz to 3.8 GHz with +/- 0.5 dB of gain flatness. The saturated output power of the HMC1114 is 41.5 dB, with high small signal gain of 35 dB and large signal gain of 25.5 dB. The high efficiency and low supply current of 150 mA at 28 V enables extending battery operation for mobile radio applications.

Caption: With the addition of gate bias bypass capacitors and power supply decoupling capacitors, the HMC1114 GaN PA can provide up to 10 watts of RF output power in a compact 5x5 mm LFSCP package.
Source: Analog Devices, Inc. HMC1114 Datasheet

Considering the ac coupled and 50 Ohm matched RF input/output, the HMC1114 only requires power supply and decoupling capacitors and external bypass capacitors at the gate bias control input as additional components for operation. The HMC1114 is fully specified from −40°C to +85°C in a compact 32-Lead and 5x5 mm LFSCP package.

Signal Chain Component Options, Tools, And Reference Circuits Breed Ease-Of-Design

Analog Devices Inc. provides an ecosystem that increases efficiency and helps engineers deliver higher quality designs faster to market with streamlined and easy-to-use signal chain analysis tools, available value-added reference signal chain architectures, and an input-to-output signal chain solutions. A feature rich RF DAC with direct digital synthesis and transmission to 3.5 GHz modeled in ADISimRF, provides an example of the BOM simplifications and valuable design resources available when sourcing from well-established suppliers with robust solution selections.