Whitepaper

Downconverter Applications for Aerospace and Defense

A Practical Approach to Expanding Traditional RF Monitoring Solutions

thinkRF™

Introduction

RF spectrum monitoring is becoming more challenging and complex. With applications that are pushing into higher frequency bands such as millimeter wave 5G, radar and increasing diversity and bandwidths of the wireless signals being transmitted, RF professionals need solutions to keep pace with the rapidly evolving wireless landscape.

Yesterday's RF test and measurement solutions cannot accommodate this new RF signal environment. As new signals continue to emerge, military agencies must be able to adapt their systems to meet new operational requirements in an agile manner, while managing ever-tighter resources and budgets. For many RF professionals upgrading their existing equipment - or even replacing it wholesale - is not a practical option. There is a pressing need for more innovative and cost-effective ways to meet the challenges of this new RF world.

Aerospace and Defense (A&D) organizations in particular are moving away from customized, single-purpose RF monitoring solutions for their intelligence gathering and maintenance applications and insisting more and more on commercial off-the-shelf (COTS) solutions from their partners and vendors. Since commercially available technologies tend to evolve more quickly, they are proving to be more suitable for creating systems that can adapt to an ever-evolving wireless landscape.

Rather than buying increasingly complex and costly spectrum monitoring equipment, RF professionals have other options.

This white paper explores the use of downconverters as an integral part of an RF measurement solution for higher frequency applications. Deployed in conjunction with other RF measurement components, downconverters can extend the frequency range of existing test and measurement equipment, enabling high performance at a much lower cost than other all-in-one-box solutions.

Downconverters: A Practical Approach to Expanding Traditional RF Monitoring Solutions

As RF signals push into higher and higher frequencies, RF engineers need test and measurement solutions that can capture those signals. If, for example, their existing test setup is designed to monitor Wi-Fi and 4G networks, the equipment may not be capable of capturing signals above 6 GHz. Instead of replacing their existing equipment with new components that support those higher frequencies, RF operators can use a downconverter with their current test and measurement components to capture higher frequency signals - and preserve the capital expenditure (CapEx) investment they have made in their current RF instrumentation.

Downconverters represent a fairly simple concept - translating an incoming higher frequency RF signal to an intermediate frequency that's within the bandwidth of the instrument being used to analyze it - but they're a powerful component for building high-performing (and cost-effective) RF signal monitoring solutions. The block diagram below shows a downconverter that consists of RF components such as Bandpass filters, Low Noise Amplifiers and Mixers.

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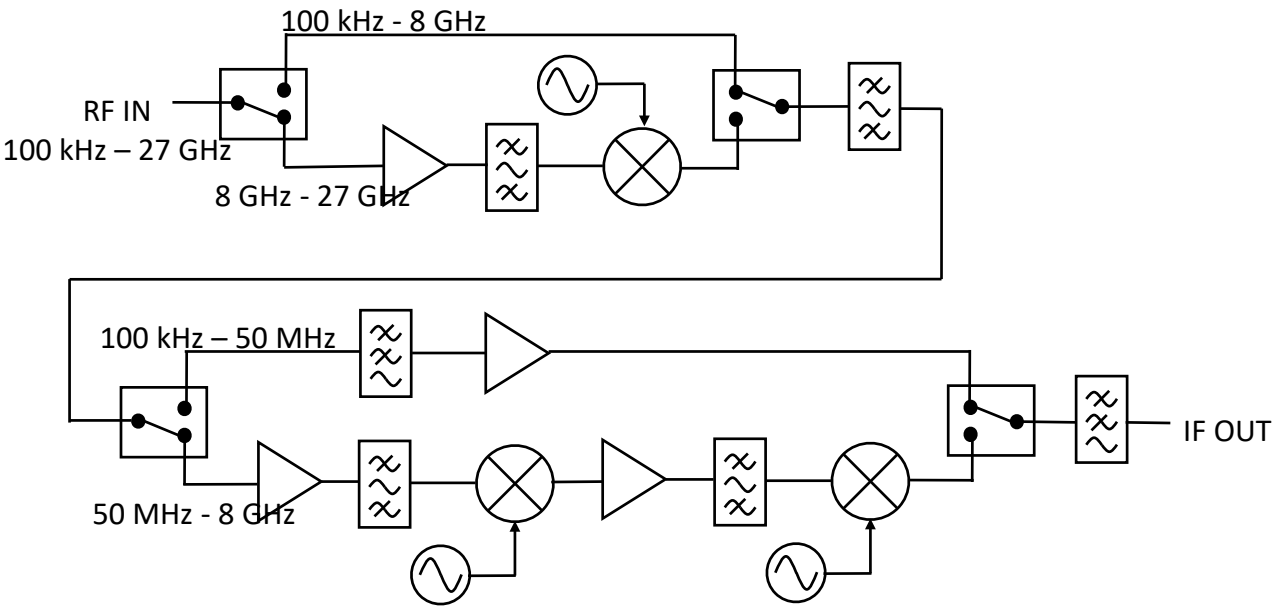

Downconverters effectively multiply the existing RF range capabilities of the signal analyzers they connect to. They allow for measurements to be taken at much higher frequencies, be downconverted to an intermediate frequency (IF), and sent to the analyzer for post processing and analysis.

But not all downconverters are created equal: the myriad of downconverter options available on the market range in form factor (from integrated chips to 1-slot modules, to standalone components), capability (from upper limit frequencies of 6 GHz to 72 GHz), and price - and many are vendor-dependent, requiring complementary modules or chassis from the same manufacturer for operation.

A standard block downconverter takes a range of Input Signals frequencies and translates them down to a lower range of frequencies. In other words, the output frequency is not fixed but varies depending on the input frequency, which complicates the job of the receiver that it interfaces to. In addition, the block downconverter may not include a built-in local oscillator and sometimes requires the user to provide one externally - adding to cost, overall size, and complexity.

The suitability of one downconverter model over another ultimately comes down to cost, capability, and performance, and the RF application it is being used for.

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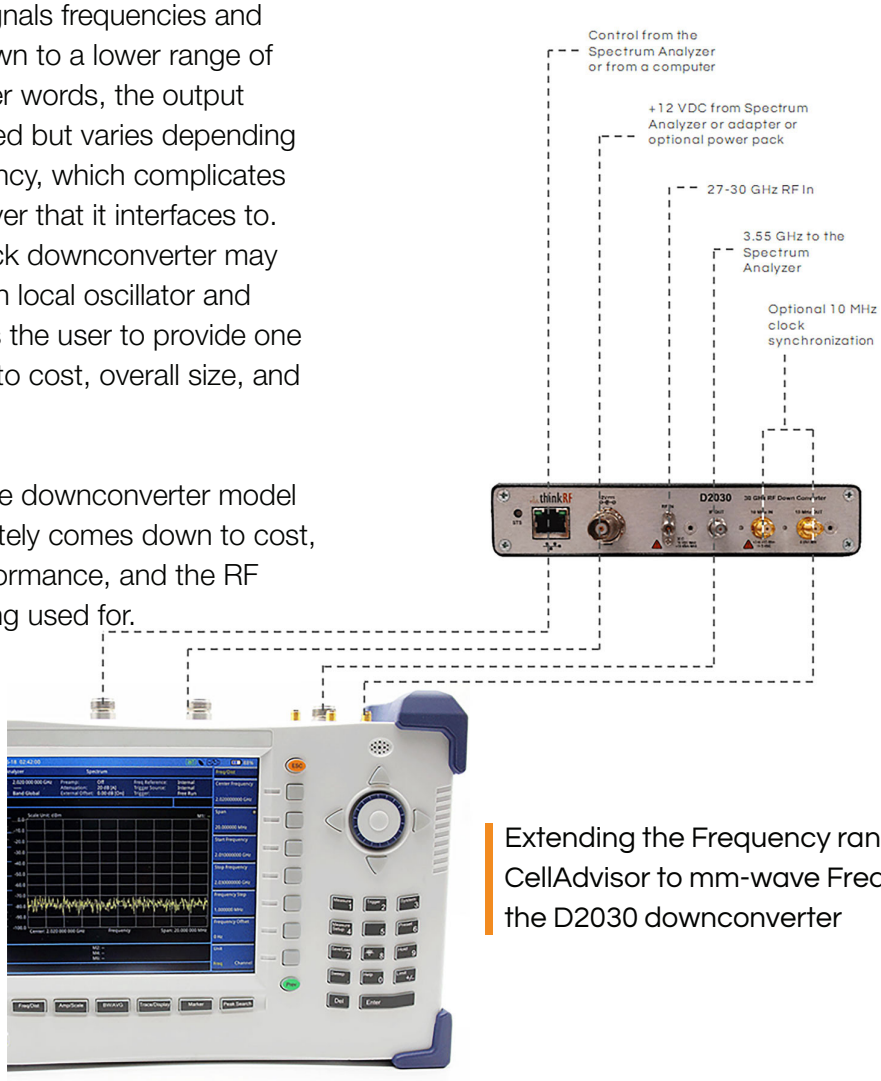


Extending the Frequency range of the Viavi CellAdvisor to mm-wave Frequencies with the D2030 downconverter

Downconverter Applications in the 5G World

Downconverters enable RF signal capture and measurement at higher frequencies than the signal equipment is capable of. In practice, this capability enables operators in the RF space to both leverage existing RF equipment and capture more complex wideband waveforms, at a much lower cost than if using more traditional all-in-one RF test solutions.

Both these advantages are particularly important for A&D applications involving Technical Surveillance Countermeasures (TSCM) and Signals Intelligence (SIGINT).

Extending Existing RF Signal Detection Equipment

Regulatory agencies and A&D organizations have made considerable investments in spectrum analysis solutions to detect and locate interference in the current Cellular and Wi-Fi bands - but this equipment typically only has a frequency range up to 6 GHz. Most organizations don't have the budget for large-scale investments in more equipment merely to improve frequency performance.

As 5G mobile and wireless communications technologies continue to draw on higher frequencies (and the 28 GHz band in particular), RF engineers and technicians must have the capability to monitor those frequencies for interference or signals of interest.

By integrating a ThinkRF RF downconverter with any existing spectrum analyzer, they can monitor, detect, and analyze signals in the 50 MHz to 40 GHz range - without upgrading or replacing their existing equipment.

In addition, such an approach allows these organizations to realize savings in training costs. Because their RF professionals can still use their existing signal analysis equipment, there is no new learning curve for them when acquiring and analyzing signals at higher frequencies, because the downconverter translates those signals of interest to signals they already recognize.

Enabling Wideband Signal Measurement at Lower Cost

The high data rates associated with higher frequency signals demand wider bandwidth, making those signals more challenging to capture and analyze. Similarly, frequency-hopping signals are common in A&D communication countermeasures applications and require wideband monitoring capabilities for proper detection and analysis.

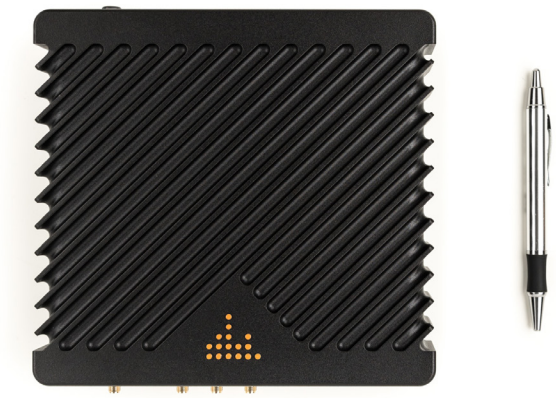
Instead of purchasing expensive wideband systems to capture and analyze these RF signals, RF engineers can use downconverters to accommodate the wider bandwidth requirements in a more cost-effective solution - without sacrificing performance.

For example, by running multiple synchronized ThinkRF downconverters in parallel with staggered tuning, wideband signals can be captured and analyzed at a much lower cost. When combined with other components such as high-speed digitizers and signal analysis software, RF engineers have a total measurement solution for microwave test and measurement applications up to 40 GHz, including wideband signal recording systems.

Downconverters for the Next Generation RF Environment

Downconverters are one of the most economical and cost-effective methods for increasing the frequency performance of RF signal analysis systems. In the new world of 5G networks, a downconverter can reduce time to market and costs for mobile operators and system integrators.

The ThinkRF series of RF downconverters / tuners are designed for maximum performance and interoperability. The D4000, R5550 and D2030 RF Downconverters / Tuners enable translation of RF signals in the frequency range of 50 MHz to 40 GHz with up to 500 MHz of real-time bandwidth (RTBW), to capture modern waveforms like 802.11ac and 5G.



D4000 RF Downconverter / Tuner

The following are some of the key features and benefits of ThinkRF series of RF downconverters / tuners:

- Frequency coverage from 50 MHz to 40 GHz: This covers all major frequency bands currently in use.
- Pre-select filtering: sophisticated RF filter technology that eliminates out-of-band signals and enables spurious mitigation. Without filtering these can result in interference within the analysis bands.
- Single IF output: makes it easier to integrate with Spectrum Analyzers or Receivers.
- Calibrated output: the output IF signal is accurate to within a small range of the input signal so there's no need to account for gain or losses in the signal chain and this makes integration simpler.
- Built-in local oscillator: eliminates the need for external synthesizers.
- Built-in digitizer: provides access to a built-in spectrum analyzer.
- Wideband and mode support: allows flexibility for both wideband and narrowband signal capture where the user can trade off bandwidth for better spurious response rejection.

Compact Form Factor

With a compact design, ThinkRF RF Downconverters are portable and easy to set up in any deployment scenario, whether in the lab or out in the field, without adding significant size, weight and power (SWaP) requirements. Power input of +12V DC at 6W supports charging through a standard electrical outlet with plug adaptor, or an external battery or vehicle power outlet for increased mobility.

D4000 RF Downconverter / Tuner

Standard Configuration Interface

ThinkRF RF downconverters support open APIs for C/C++ and Python, and standard configuration protocols via SCPI commands over a Telnet connection, or configuration via spectrum analyzer software over a LAN connection.

R5550 RF Downconverter / Tuner

Open Platform

ThinkRF RF Downconverters work with third party test equipment, RF signal detectors, and interfaces. The open platform works seamlessly with current spectrum analysis solutions through standard SCPI control over Ethernet, allowing control of the unit through the spectrum analyzer or any standard PC.

D2030 RF Downconverter / Tuner

Multi-Unit Synchronization Capability

ThinkRF RF Downconverters include 10 MHz input and output clock references to support clock synchronization with external modules. The allows the ability to run multiple units in parallel to coordinate a compound signal monitoring system, particularly for wideband signal monitoring and capture.

Conclusion

As the RF spectrum environment continues to evolve at a breakneck pace, organizations and agencies operating in the RF communication space - and the RF test and measurement equipment providers that support them - must keep up. With the growing complexity of signals, and the specificity of RF applications in the A&D sector in particular, the organizations responsible for monitoring these new frequency bands need solutions that enhance the lifetime of their existing test equipment and deliver performance at a reasonable cost.

The bulk and limited extensibility of traditional RF test equipment has moved the RF market toward a more open approach to assembling RF test and monitoring systems. Simple but powerful components, when combined in a single solution, can deliver enhanced performance in lower-cost platforms, and still preserve existing investments. The application of downconverters to measure higher frequency signals is a prime example of this flexible approach in action and allows RF organizations to take advantage of emerging RF technologies without replacing their existing equipment.

For A&D agencies, this approach will solve many of the challenges facing RF engineers as they design signal detection and monitoring applications for the 21st century.

D4000 RF Downconverter / Tuner

ABOUT THINKRF

ThinkRF is the leader in software-defined spectrum analysis platforms that monitor, detect and analyze complex waveforms in today's rapidly evolving wireless landscape. By providing more flexibility, greater coverage, increased functionality and better ROI, ThinkRF solutions are ideal for regulatory and intelligence monitoring, telecom deployment optimization and RF application development. With open APIs and proven integrations, ThinkRF offers the only compact and networkable spectrum analyzer that can be deployed without a PC and the best price to performance on the market. Founded in 2006, ThinkRF is headquartered in Ottawa, Canada with offices and partners globally.

For more information, visit www.thinkrf.com, contact info@thinkrf.com or on Twitter, LinkedIn and YouTube.

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