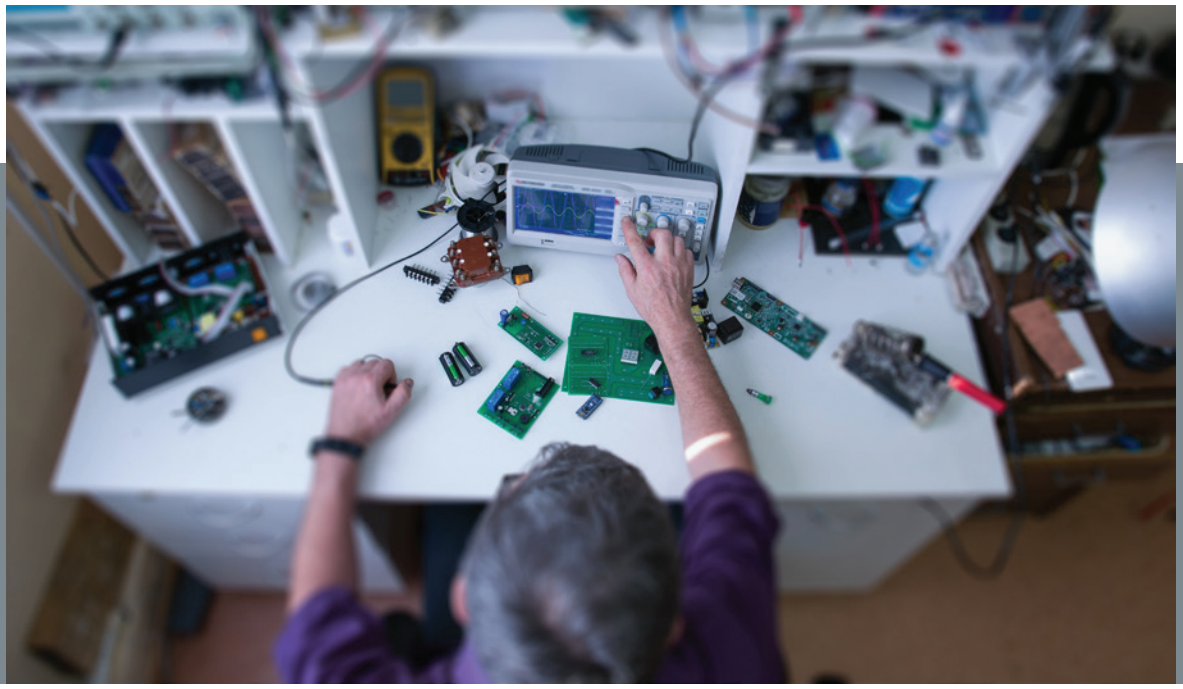
TECHNICAL BRIEF

10 Signal Generator Features You're Probably Paying Too Much For



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Introduction

A robust test bench is an essential element to any team conducting daily RF device and assembly prototyping, characterization, and calibration. And among the most common instruments you'll find on benches everywhere, from component and subsystem manufacturers to antenna system integrators and cellular network providers, is a signal generator. But when budgets are tight, engineers and test techs are often urged to "buy only what they really need." The dilemma presented is then a decision over the number of pieces of new equipment they need vs. the feature set of their finished test stand. The complexities of this decision are further compounded in companies developing radar and wireless network systems, which involve multiple and complex signal paths that require distinct signal sources. These test stands require a greater number of signal generators, and also necessitate a modular capability that can readily adapt to evolving standards and changing frequency bands to meet the latest applications.

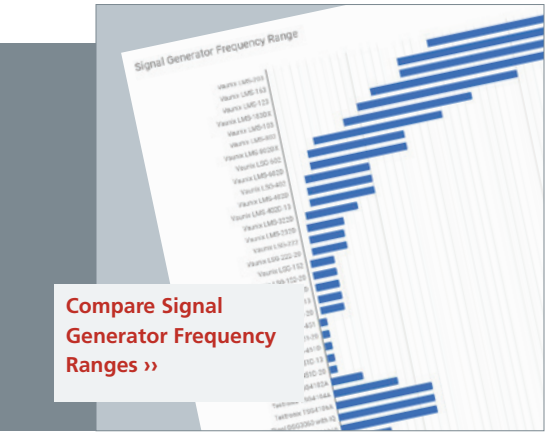
An evolving method of cost control for all companies encountering these challenges is buying wireless test devices that are more application-specific, portable, and self-programmable vs. feature-rich, preprogrammed, and costly benchtop equipment. This Tech Brief will help you gain an understanding of the features and flexibility to look for in a self-programmable signal generator so you can align your desired outcomes with the total budget you have for your bench.

I. Frequency Range

A signal generator's frequency range of operation is the key factor in a buy decision—and it is also the reason why most companies overpay for their test equipment. To get the range of frequency they need, let's say 6 to 16 GHz, test teams have had to purchase

one ultra-wideband instrument. As a result, they end up with a signal generator that might fully operate from kHz to 20, 30, or even 50 GHz or more. In essence, a company pays for unneeded operating frequency and signal refinement capability that was costly to develop, and thus costly to acquire.

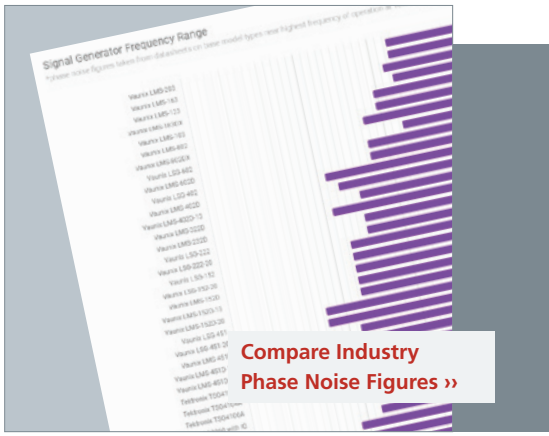
The alternative to this is to take a modular, self-programmable approach and buy only the bands (and features within those bands) you need. As you'll see in this comparison, Vaunix has assembled a suite of modular solutions that allows you to pick and choose the exact frequency band you need and analyze the features needed at each band.



II. Phase Noise

Phase noise is a critical specification for signal generators for the latest radar and wireless systems, as the complex modulations and digital techniques used by these systems are sensitive to phase error. Though it is considered straightforward, measuring and describing the phase noise performance of a signal generator is anything but simple. The phase noise performance for a given signal generator depends on many factors, such as power level, carrier frequency, measurement technique, and reference frequency from the carrier. Therefore, a phase noise performance figure given at specific levels may be inappropriate in describing the phase noise performance at the levels for a given application. This problem is compounded as many signal generator manufacturers advertise the "best-case" phase noise performance for their signal generators, which is often at the lower frequency regimes, and may only be for a specific model option.

The phase noise performance of a signal generator depends on the oscillator technology and frequency synthesis circuitry. Typically, the cost of better performing frequency synthesis technology becomes exponentially more with improved performance. Moreover, the phase noise of a signal generator is only a limiting factor for some applications, and opting for the few extra dBc/Hz of phase noise beyond what is needed may substantially increase the cost of the equipment. Lab Brick's Signal Generators offer solid phase noise performance comparable to much more expensive benchtop signal generators.



III. Frequency Resolution

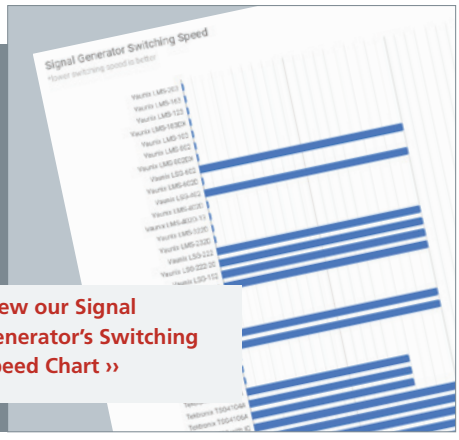
Frequency resolution determines the frequencies at which a signal generator can be programmed. Some applications may require signals at very precise frequencies, and the difference between a few hertz, or even millihertz, may be critical. But for most applications, frequency resolution of a few hundred hertz, or even kilohertz, is more than adequate. Most wireless standards are designated at starting and ending frequencies in the megahertz, and only occasionally in the hundreds of kilohertz.

Having greater frequency resolution for a signal generator requires more substantial and expensive tuning and control circuitry. If frequency resolution below 100 Hz isn't essential for an application, a Lab Brick Signal Generator is one of the lowest-cost and highest-performance solutions available.

IV. Frequency Switching Speed

The frequency switching speed of a signal generator dictates how swiftly that device can jump from one frequency to another. Certain frequency-agile radar, frequency-hopping wireless standards, and other multiband wireless devices require the ability to rapidly adjust frequencies and a signal generator will need to perform similarly to aid in prototyping and testing of such systems.

The frequency switching speed of a signal generator depends on the signal generator control and tuning technology, and is often different for manual control, programming, and external control configurations. For external control and programming frequency switching speed, Lab Brick's Signal Generators exhibit among the fastest speeds available, and generally cost much less than competitive models with switching speeds several times slower.



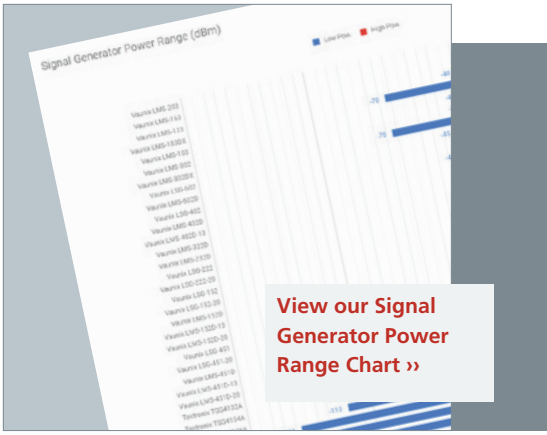
View our Signal Generator's Switching Speed Chart ››

V. Output Power Range

Output power range is another signal generator parameter that is often over-purchased. In many applications, power levels beyond a few dB or below -20 dB will require precision amplifiers or attenuators to adjust the signal strength to the desired level. Some signal generators include these amplifiers and attenuators inline, which must be designed to cover the entire operation frequency of the device. For wideband signal generators this may require several different attenuator or amplifier paths, as attenuators or amplifiers that cover extremely wide frequency ranges exhibit performance trade-offs. These additional signal paths and related hardware lead to added noise, phase noise, complexity, size, and cost.

For a given application, it is more cost-effective, and also a higher performance solution, for an engineer to purchase discreet precision attenuators and amplifiers that better fit their frequency and performance requirements, as opposed to a wideband power control solution that may necessitate design and performance trade-offs, some of which may negatively affect overall system performance.

Vaunix's Lab Brick Signal Generators offer output power range performance that fits most applications, and come at a price point that leaves plenty of room in the budget for precision accessories better optimized for a specific application.



View our Signal Generator Power Range Chart ››

VI. Harmonics

Harmonics are a natural result of signal generation, and are inevitable for all signal generator typologies. The power level of the second, third, and greater harmonics depends on the signal generator typology and how much filtering is applied to attenuate the harmonics. Reducing harmonic signal power comes with trade-offs for other performance aspects, which may or may not be desirable. Most benchtop "one-size-fits-all" signal generators include additional circuitry to reduce harmonics to as lowest levels possible across the entire operation frequency.

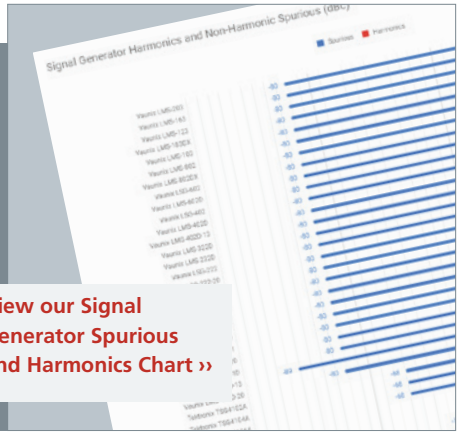
Though this approach allows a "good-looking" harmonic specification on a data sheet, it comes at significant cost. Harmonics can be readily filtered if a user has known frequency bands they will be using; harmonics affecting these bands can be accounted for as they occur at known frequencies related to the carrier frequency. Depending on the application, the harmonics may be outside of the bandwidth of concern or component/

device operation, making an extremely low harmonic level across a wide frequency spectrum a moot point.

Reducing harmonic levels inherently leads to an increase in non-harmonic spurious signal content which can occur at unpredictable and inconvenient frequencies. LabBrick's Signal Generators are designed to exhibit both excellent harmonic performance and non-harmonic spurious performance at application-specific bands.

VII. Non-harmonic Spurious Content

Spurs are unavoidable signal purity contaminates that are an unpredictable function of a signal generator component. Spurs are often difficult to filter out, especially for signal generators that operate over a wide frequency range. To obtain superior non-harmonic spurious performance from a benchtop signal generator, one typically has to purchase an additional option to meet those figures. This is not the case with Vaunix's versatile line of Signal Generators.



View our Signal Generator Spurious and Harmonics Chart ››

VIII. Modulation

Even the latest radar systems use modulation to enhance performance. During RF and microwave system testing and prototyping, modulating signals is often the only way to determine real-world receiver and system component performance. Hence, most RF signal generators include analog modulation, vector modulation, sweep, or pulse modes. Generally, the analog modulation modes include AM, FM, PM, and sometimes analog IQ program or input modes. For vector modulation, an engineer typically needs to either buy an upgrade module or a distinct vector signal generator.

The modulation upgrades are often much more expensive than the base signal generator, and may not include the modulation capability an application requires. However, the modulator circuits do not actually need to be part of the signal generator, and can be purchased at reasonable prices separately. Combined with a low-cost Vaunix Lab Brick Signal Generator with pulse and sweep trigger options, a modular test/prototype system could be a much more cost-effective approach than purchasing and customizing an all-in-one benchtop unit.

IX. Connectivity and Control

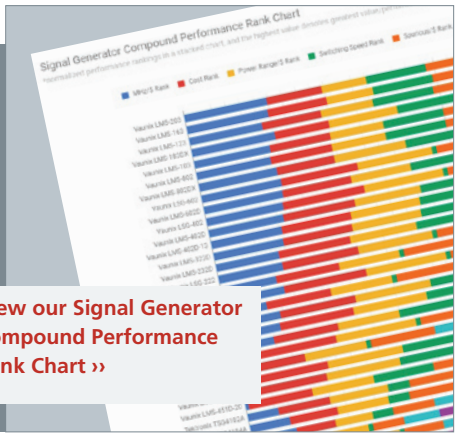
The most common signal generators are benchtop (or rack) units that have some sort of manual control based on knobs, buttons, and a display. Though familiar and time-tested, the size and form factors of these legacy signal generators require additional components, increase the device size and cost, and introduce potential failure modes. Manual-control signal generators are often not customizable, and sometimes difficult, or impossible, to program or operate externally, as external control and programming wasn't the targeted focus of the design.

Vaunix's Lab Brick Signal Generators circumvent these problems by operating from universal USB cable for both power and control. They come with free and easy-to-use GUI software, unlike most other Signal Generator that require the purchase of proprietary software for external programming/control. Moreover, Lab Brick's are also programmable via LabView® software drivers from National Instruments®, and Lab Brick support software includes free 32-bit and 64-bit DLLs that provide comprehensive and easy-to-use API. This signal generator software enables the control of several Lab Brick Signal Generators from the same PC, which can allow a user to easily set up a multi-signal test or prototyping system.

X. Cost/Performance Ratio

The table below offers a ranking and comparison of over 70 signal generators available on the open market. Each of these signal generators is compared through several key performance categories. Traditionally with RF/microwave technology, low cost has often been synonymous with "poor quality," but the data in the linked table below demonstrates that not only are Vaunix's Lab Brick Signal Generators some of the lowest-cost available, they are also some of the most efficient options for quality signal generator performance.

From the analysis, it is evident that Vaunix's Lab Brick Signal Generators offer excellent frequency switching speed, frequency range, and non-harmonic spurious performance at a fraction of the cost of other signal generators. Moreover, Lab Brick's offer comparable phase noise and power range performance without the need to purchase optional upgrades.



View our Signal Generator Compound Performance Rank Chart ››

Conclusion

Even in the most well-managed, cost-sensitive organizations today, you'll still find test benches with expensive test boxes that are largely underutilized. But as the release of cost-efficient, self-programmable, and portable test instruments continues from many leading suppliers, a test engineer has the ability to now consider his/her bench in a new way. For many, it's a dream come true. For others who've become comfortable with legacy systems, it's a new learning experience. But for all, there are key features to look for from each instrument and supplier that will help you realize your cost and performance objectives. Chief among them when it comes to programmable signal generators are those mentioned here. By zeroing in on who offers you the most intuitive connectivity and control, and figuring out what features are most critical within your desired frequency ranges, you'll be ready to build a new test bench that suits your needs and budget perfectly.

Vaunix offers a wide variety of Lab Brick Signal Generators that covers select frequency bands. This enables engineers to purchase a signal generators that are designed, and specified to better fit the frequencies they need.

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Next Steps:
Shop Vaunix's entire line of Signal Generators.

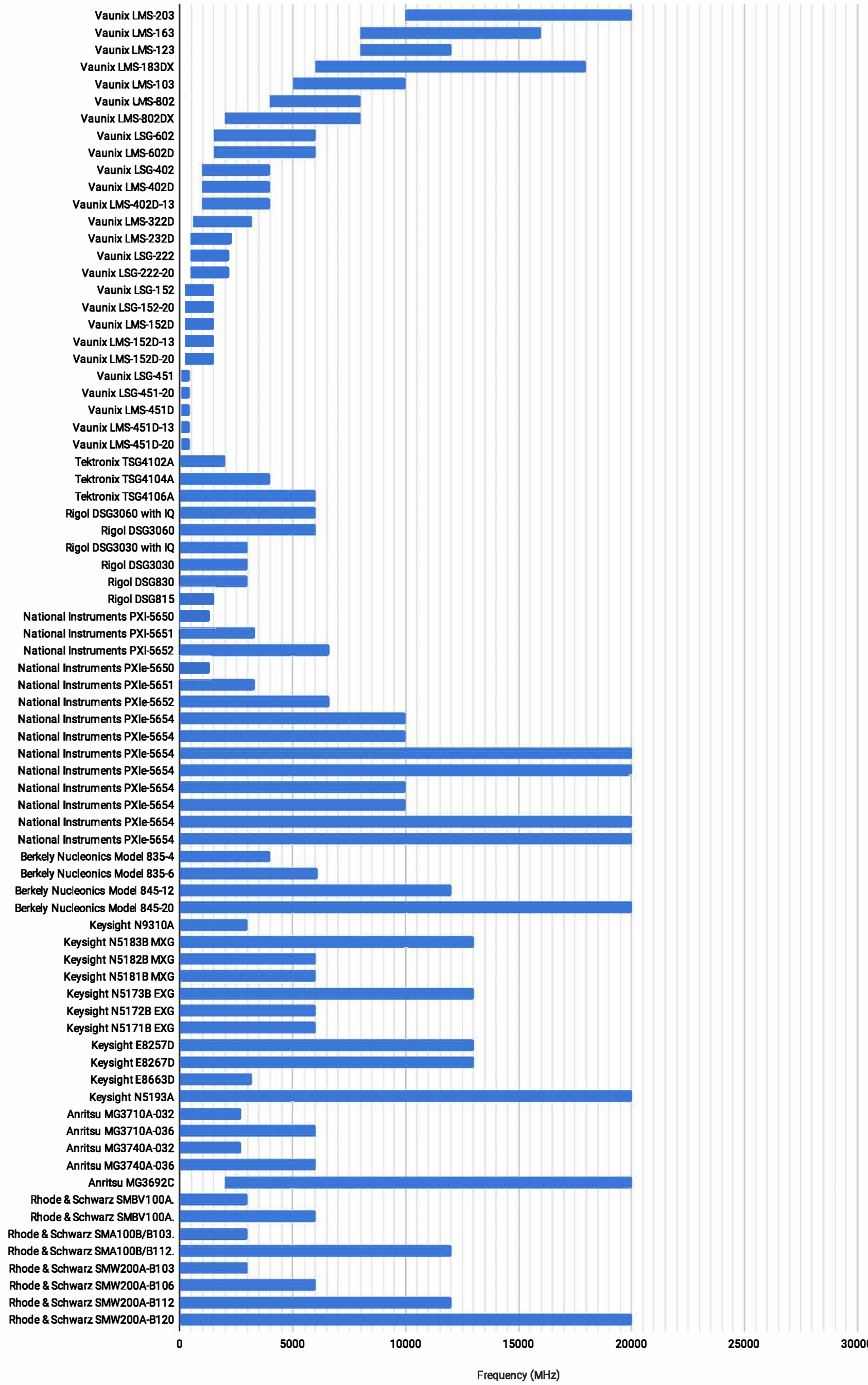
Download our Tech Brief: Creating Advanced Handover Testing Platforms Using Low-Cost Programmable Devices.

Visit our Support Page for our additional technical resources and to request application assistance.

References

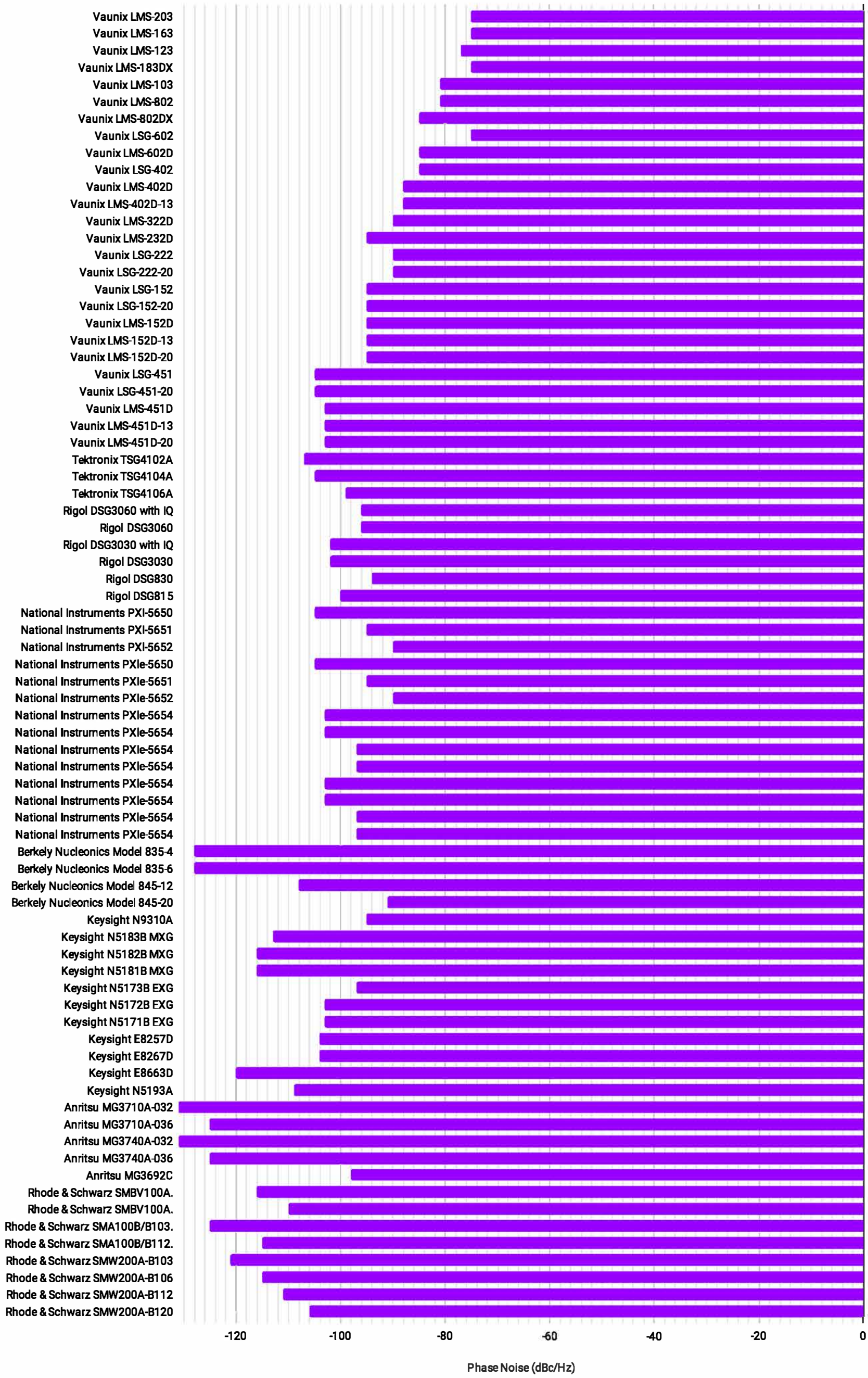
Phase Noise Measurement and Techniques PDF Presentation

Signal Generator Frequency Range Comparison Chart



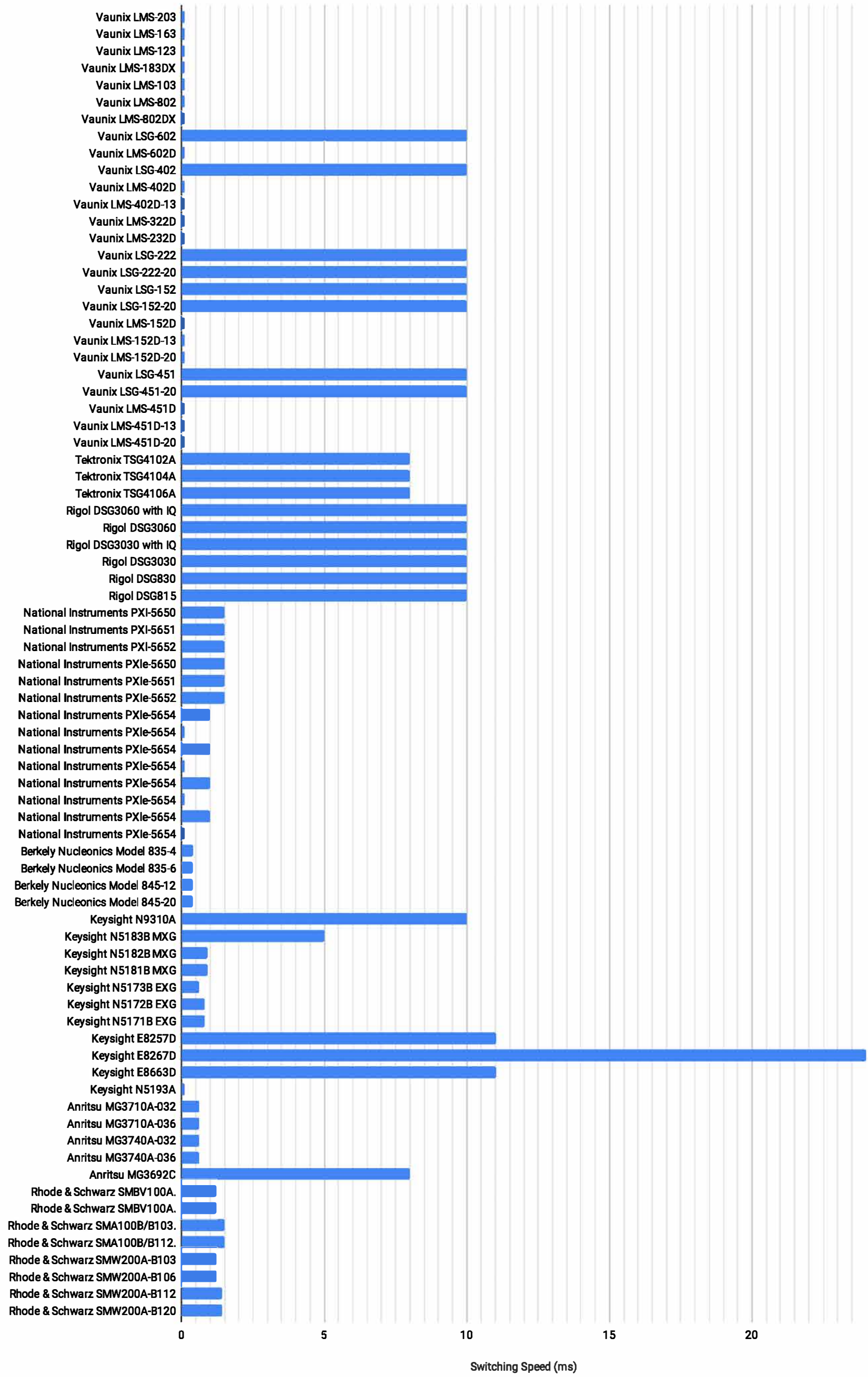
Signal Generator Phase Noise Comparison Chart

*phase noise figures taken from datasheets on base model types near highest frequency of operation at 10kHz or 20kHz reference from carrier frequency

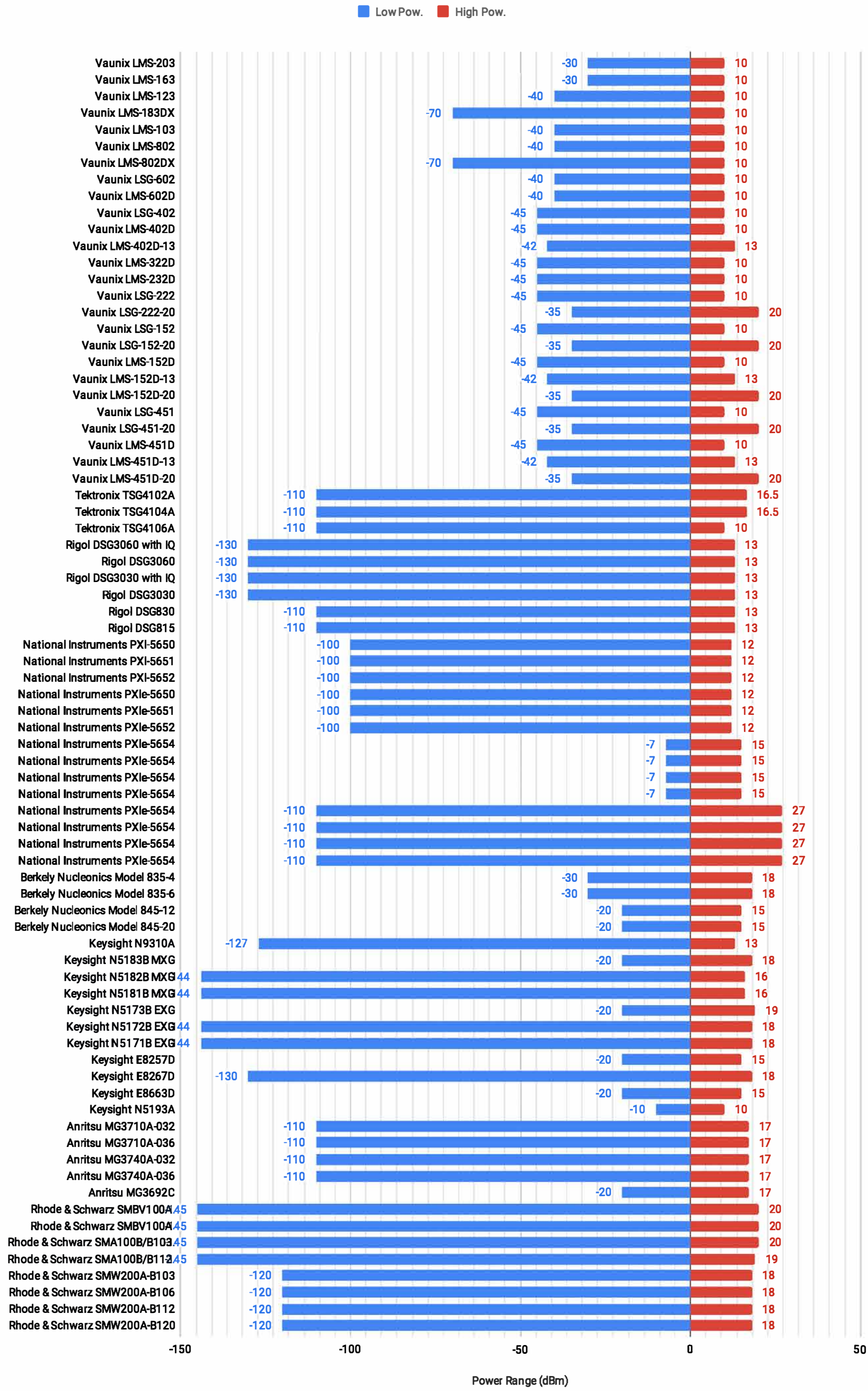


Signal Generator Switching Speed Comparison Chart

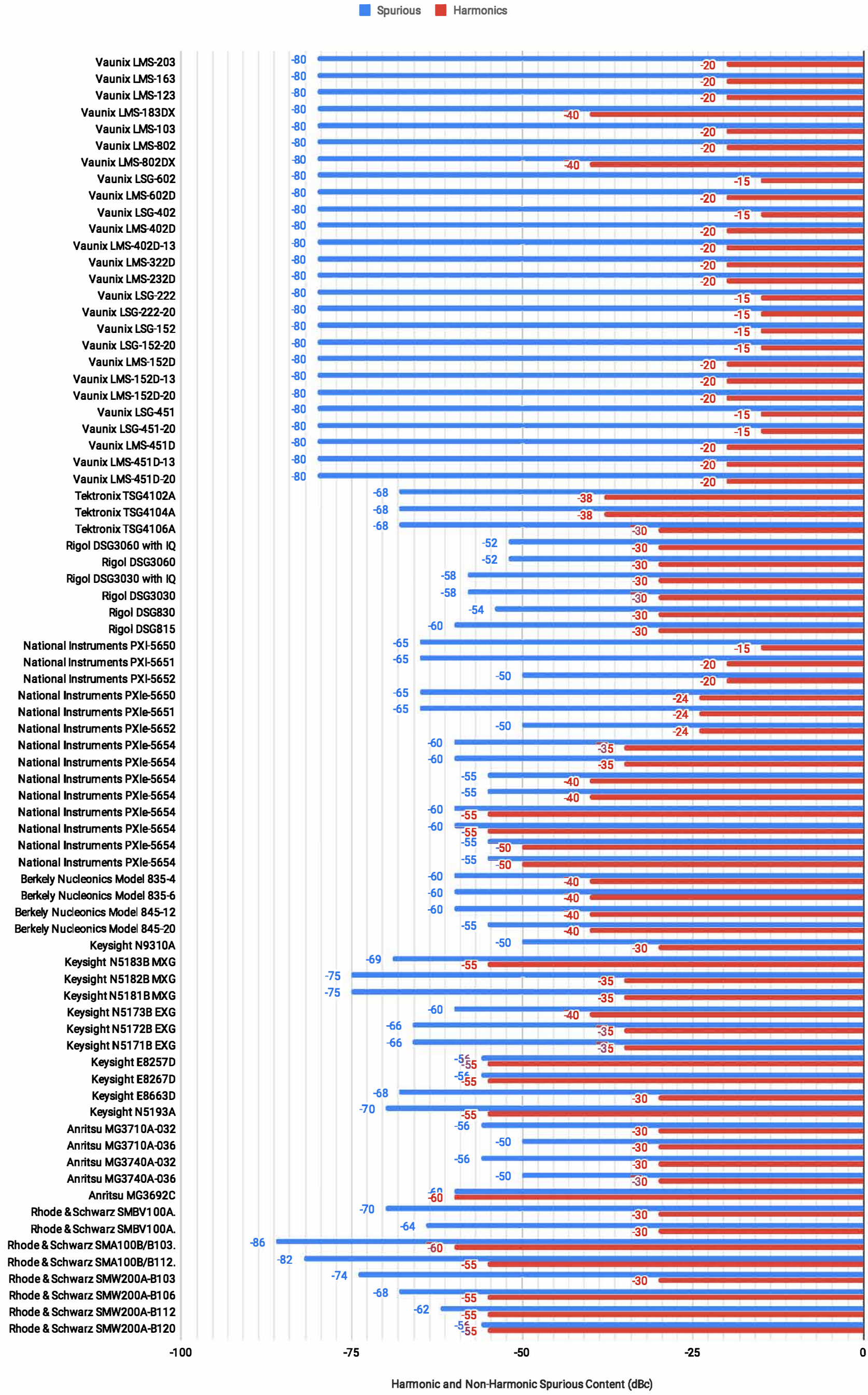
*lower switching speed is better



Signal Generator Power Range (dBm) Comparison Chart



Signal Generator Harmonics and Non-Harmonic Spurious (dBc) Comparison Chart



Signal Generator Compound Performance Comparison Chart

*normalized performance rankings in a stacked chart, and the highest value denotes greatest value/performance