Electro Rent

EVOLVING TECHNOLOGY IN AEROSPACE & DEFENSE

How to Increase Test Equipment Utilization and Reduce Costs

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Introduction

Driven by a recovery in U.S. defense budgets, increased spending by major regional powers and higher demand for commercial aircraft, revenue in the aerospace and defense (A&D) sector for 2018 is projected to rise 4.1 percent, up from 2.1 percent the prior year, according to Deloitte's 2019 global aerospace and defense industry outlook. For 2019, solid growth is expected to continue.

- In defense, U.S. military budgets are rising, with increased spending by NATO countries, as well as China, India and Japan, to counter potential regional threats.
- In cybersecurity and the militarization of space, investments are increasing to protect satellites used for surveillance, communications and missile targeting.
- In commercial aircraft, production backlogs remain at all-time highs, driven by rising oil prices and demand for next-generation, fuel efficient designs.

While optimal utilization of test equipment is in the range of 85%, due to calibration and repair needs, the typical utilization of test assets at many companies is in the 30% range. — Frost & Sullivan

In 2017, the U.S. A&D industry generated $865 billion in sales and represented $143 billion in exports and about 2.4 million U.S. jobs, according to the Aerospace Industries Association. Going forward, Frost and Sullivan expects the A&D sector to be influenced and transformed by a variety of trends, including:

- Modular, customizable test solutions that enable cost-effective equipment upgrades.
- The increasing adoption of Industry 4.0 in manufacturing and operations.
- 5G communications, NewSpace, mmWave and new radars.
- Technological evolution that requires advanced test equipment.
- The need to upgrade legacy systems and avoid technological obsolescence.

There are many challenges to overcome, including rapidly-evolving technologies, testing support for legacy systems, and competition from agile startups that can operate faster at lower cost. Moreover, there is competition with the commercial sector to attract and retain engineers with expertise in robotics, artificial intelligence (AI) and autonomous systems. (Artificial Intelligence and the Future of Warfare, Duke University).

Due to strict timelines and increased scrutiny of budgets, pressure on testing and verification in A&D is also increasing. Engineers need reliable and easy-to-use test equipment that delivers data integrity on a consistent basis. They also need test asset suppliers that:

Challenges include competition from agile startups, evolving technologies, legacy system support and competition for engineers with expertise in robotics, AI and autonomous systems.

- Understand the defense industry and its particular challenges.
- Offer specialized instruments for military applications.
- Provide services to manage and improve operational efficiency.
- Stock leading equipment to ensure that testing is quick and thorough.
- Have a variety of flexible rental, leasing, new and used equipment options.
- Help companies reduce overspending and eliminate unnecessary purchasing.

Challenges

Global economic uncertainty, competition from nations like China and Russia, and smaller, more nimble competitors in the private sector are pressuring A&D companies to move faster and use budgets more efficiently. NewSpace is just one example. Composed of private sector companies and entrepreneurs seeking profit, this emerging area aims to provide innovative space products and services in shorter timelines at lower cost.

Another trend is the shift away from pure government funding for all military and defense R&D activities to include technology companies in the private sector. The National Security Strategy of the United States indicates that "The U.S. government will use private sector technical expertise and R&D capabilities more effectively", adding that "DoD and other agencies will establish strategic partnerships with U.S. companies to help align private-sector R&D resources to priority national security applications."

The National Security Innovation Base[iv], which is comprised of both traditional defense companies and commercial entities, is expected to look at leading technologies (i.e., hypersonic vehicles, artificial intelligence and 5G networks) to understand their national security importance and assess the U.S. position with regard to global competitors. (Inside Defense, New Task Force to examine 21st century national security innovation base, March 6, 2019).

Another trend is the shift away from pure government funding for all military and defense R&D activities to include technology companies in the private sector.

According to the Summary of the 2018 National Defense Strategy[v], there will be greater focus on gaining added value from taxpayer funds spent on defense through greater efficiency in procurement, use of non-traditional suppliers, prototyping, rapid iteration and experimentation. This means that speed of delivery, continuous adaptation and a drive for efficiency will take priority. For example, routine replacement of platform electronics and software will be increasingly favored over static configurations that remain in place for a decade or more.

Going forward, there will be greater focus on gaining added value from taxpayer funds spent on defense through greater efficiency in procurement, use of non-traditional suppliers, prototyping, rapid iteration and experimentation.

As a result, many A&D companies are conducting in-depth examinations of their operational efficiency, including manufacturing processes, sourcing and procurement, and the financial and technological approach to new product development. Some are

adopting an all-digital approach, incorporating digital twinning and virtual reality, while others are working to optimize supply chains, increase efficiency and productivity and reduce costs for the production of small satellites and reusable components.

As the pace of innovation accelerates, A&D companies are also moving toward a modular strategy, where design integration and verification is taking priority over pure R&D and in-house innovation. Today, it is not uncommon to add value to an off-the-shelf solution at the software level with proprietary IP, rather than developing IP at the hardware level. These scenarios are leading many manufacturers to reduce their capital expenditure (CapEx) and more closely manage operational expenditures (OpEx).

Some A&D companies are adopting an all-digital approach, incorporating digital twinning and virtual reality, while others are working to optimize supply chains, increase operational efficiency and reduce costs.

The Impact of Rapidly-Changing Technologies

According to Frost & Sullivan, the A&D test equipment market will change significantly in the next five to eight years[vi], with new technologies supporting higher frequencies, greater bandwidth and add-on functionality to existing systems. Military system complexity, technological advancement and evolving standards and regulations create additional challenges.

A&D companies that can adapt to these changes by procuring flexible, upgradeable and scalable testing platforms will enjoy enhanced asset longevity and reduced cost of test.

According to Frost & Sullivan, the A&D test equipment market will change significantly in the next five to eight years. Companies that can adapt to market changes by procuring flexible, upgradeable and scalable testing platforms will enjoy enhanced asset longevity and reduced cost of test.

Highly sophisticated, yet easy-to-use instruments are already available to meet the needs of most military production and field-testing operations. However, many military systems are based on legacy equipment supporting long-term products, where the ability to emulate the capability of legacy instruments—including air force avionics upgrades for older aircraft—is also needed.

As time goes by, it becomes challenging to maintain this legacy equipment. With legacy system testing, it becomes increasingly difficult and expensive to maintain older assets. In time, the cost of maintenance and repair can exceed the initial purchase price. When older equipment fails, the only options are replacement with the same piece (if still available) or a modern equivalent, which can be expensive.

Industry 4.0

Next-generation manufacturing will use technology, automation, demand-driven supply chains and big data analysis to speed the flow of information across a factory, increasing efficiency, productivity and output. Connected via IIoT, machines will share massive streams of data, images and video in real time, enabling systems to self-monitor, learn and optimize, largely autonomously.

According to McKinsey, more than 60% of manufacturing operations today can be automated using current technology[vii] . Once the Industrial Internet of Things (IIoT) gains widespread adoption, however, this will change significantly, with far-reaching impacts across business and society. The World Economic Forum predicts that Industry 4.0 will create up to $3.7 trillion in value by 2025[viii] . (The Next Economic Growth Engine, January 2018.)

Digital transformation can greatly benefit A&D companies. While many have adopted Industry 4.0 in factory manufacturing and supply chain activities, they have been slower to adopt digital transformation initiatives spanning the entire enterprise.

According to a Deloitte global survey, although 84% of A&D executives consider new digital technologies critical to market differentiation, only 25% are actually using these technologies to "access manage, analyze and leverage data from their digital assets to inform decision-making in real time". Limiting digital strategy to a few business functions may increase the risk of A&D companies being left behind in today's digital era (Deloitte, Aerospace and Defense 4.0).

Soon, 5G NR networks, devices and services will be widely available to widen the impact of IoT and Industry 4.0. The 5G vision is to offer massive bandwidth improvements (100 times more devices per unit area versus 4G LTE), significantly faster speeds, uptime of 99.999%, and ultra-low latency for mission-critical applications such as connected and autonomous cars, industrial robotics, machine communications and remote robotic surgery.

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The increased bandwidth, greater speed and lower latency of 5G will give rise to innovations previously considered impossible. Theoretical maximum 5G speeds of 10 Gbps or more, combined with an expected 10-year battery life for low-power IoT sensors and machine-type devices, mean that a wealth of data can be analyzed and acted upon.

The result may be a complete rethink of the way we create, innovate, and manufacture products, conduct business and scientific research and transfer knowledge between humans and machines. In the IoT and 5G era, a flood of new innovations and applications will be developed, increasing the burden on R&D teams and their test equipment. Engineers and lab managers need high-quality test and measurement tools to get the job done efficiently and cost effectively, reducing risk to military program timelines and schedules.

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Trends and Evolving Technologies

Among the many notable trends in the A&D sector is the threat to information and data flow. Otherwise known as cybersecurity, it is now recognized as the fifth domain of warfare in addition to land, sea, air and space. A related threat is electronic warfare, one area where technology budgets are expected to grow significantly and where RF and microwave play a critical role.

Ultimately, electronic warfare can take many guises, including everything from signal jamming and radar strikes to discrete signal detection. Among the requirements here is the need move acquired or stored RF signal data from one test instrument or sub-element to another at a minimum rate of 10 GB/s (equivalent to 2 GHz RF bandwidth). Several data transfer technologies could be considered, including:

- 10 Gb LAN
- PCIe (PXI) Gen 3 with many lanes
- Optical, which is a good choice for integrated boxes
- A dedicated peer-to-peer local bus or backplane (AXIe)

Other trends are driven by radar, electronic warfare and signals intelligence technologies, which increasingly require multiple coherent RF channels to extend performance and capability, greater wideband capabilities for better signal generation and analysis and enhanced ease of use.

Another emerging area is high-speed (to real time) data reduction and analysis within the actual instrument. Processes and methodologies may include digital down and up conversion as well as real-time metadata or pulse descriptor word generation from acquired raw data or generated algorithmically for playback. Simultaneous high-resolution time and frequency display might also be considered.

In radar and electronic warfare, the use of active electronically scanned array (AESA) antennas have become nearly ubiquitous. AESA antennas allow systems to function in multiple modes and engage multiple threats or targets simultaneously with powerful signal processing capabilities. As the beam can be steered electronically, no gimballing is required, permitting agile repositioning at extremely high rates.

For satellite applications, phased-array antennas deliver many benefits compared to reflector antennas. The principal advantages of antenna arrays include greater flexibility, lower manufacturing and maintenance costs, modularity and more efficient deployment of the spectrum.

A single antenna can communicate with multiple, spatially-distributed ground stations by repositioning the antenna beam from user to user. In addition, the distributed amplifiers constituting the active array provide a fault-tolerant architecture. Furthermore, multi-mission stations can be developed to track various satellites concurrently by dividing the array into sub-arrays with simultaneous beamforming.

There are many challenges associated with antenna testing. Some of these include a distinct increase in the element count within phased arrays to permit more simultaneous functions and a narrow focus of the main lobe in beamforming. Also of note, digital (broadband) signals are moving closer to the antenna.

There is some discussion that eventually the sole connection to the transmit/receive (T/R) module for each element will be a digital bus (no analog). Another challenge is that signals are no longer being simply pulsed, but also being broadband modulated, which creates an increasing requirement to generate and analyze wider bandwidth signals.

Satellites

In the satellite industry, the pace of change is accelerating. In addition to the competitive dynamics of NewSpace, there is also the use of higher frequencies in communications links. Traditionally, satellite communication has been performed in the C, L and Ku bands, but the spectrum in these bands is limited. Therefore, many satellite operators are using, or have plans to use, the Ka band, which is typically considered to be 27 to 40 GHz.

Transmitting in this range permits the deployment of smaller antennas. One challenge associated with this trend is the need for test equipment that can manage higher frequencies. Moving up in frequency means more atmospheric attenuation. Uplinks are at the higher frequency, because power is available on the ground. Downlinks have power constraints.

Outside the atmosphere, there are no issues with absorption, which means many mmWave frequencies are being used for crosslinks between satellites, particularly those in the high absorption bands like 60 to 65 GHz. Communication using optical lasers is gaining interest, not only for crosslink communications, but also for links through the atmosphere.

Another market driver is the need for higher data rates, which are achieved through the use of wider bandwidth signals and higher order modulation formats, which together can present test challenges.

Until recently, many signal analyzers were restricted to around 100 MHz of analysis bandwidth. The combination of wide bandwidth and higher frequency signals make it difficult to use traditional wideband test equipment such as oscilloscopes, which are capable of accommodating the wider bandwidth, but not the higher frequencies.

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Test equipment needs good dynamic range in order to handle the low signal-to-noise ratio (SNR) issues typically seen in satellite testing. Higher order modulation formats mean that factors such as compression and slight amplitude errors in the channel now have increased potential to appear as a bit error. Test equipment must maintain the dynamic range and leave enough test margin to identify these issues.

In the satellite arena, there is also a shift toward smaller, more complicated payloads, which is driving the development of more complex test devices that are capable of measuring multiple communications strategies. When validating higher-level integrated assemblies and sub-systems, test equipment manufacturers offer integrated test systems that feature both hardware and software.

Some examples for satellite testing include payload test stations, power and solar array simulator sub-systems, telemetry tracking and command sub-systems, and command and data handling subsystems.

Also noteworthy is software-defined instrumentation, which provides flexibility in creating a full solution for nearly any test challenge without resorting to an expensive and limited-use custom system. There are many applications for software-defined instrumentation, including spectrum/signal monitoring, signals intelligence, surveillance, spectrum security, radar target simulation, satellite channel emulation and threat emitter simulation and more.

Some of the important attributes here include:

- Channel density and scalability
- RF data throughput and streaming
- Flexibility in platform form factor
- Synchronization infrastructure
- User-friendly access

Elements of the full solution include stages for processing the RF signal in, to RF out; or from RF to storage or another processing engine. Software-defined instrument structures may not require all these blocks if their target function is a receiver for the gapless capture of signals or to provide arbitrary waveform generation in real time.

In the A&D sector, there is growing demand for broadband SATCOM testing. As these bands become more popular and transmit more data, tests must become more rigorous. Many leading manufacturers offer arbitrary waveform generators that can produce complex simulated signals based on optimized sample rates, signal fidelity and waveform memory. Spectrum analyzers can also be used to monitor signals in broadband SATCOM testing applications.

The Importance of Reliable, Proven Suppliers

Given the increasing complexity of A&D systems, validation and verification of modern devices can be challenging. For advanced radar systems, "wider bandwidths, higher resolution, lower phase noise and pre-dynamic range, and higher signal fidelity are of primary importance." In aerospace electronics and avionics, advanced testing solutions are driven by "compute-intensive, high-speed and high bandwidth avionics and electronics." (Frost Perspectives, August 2018)

Industry leaders need trusted test equipment partners to provide objective guidance on product selection and financing options as well as recommendations to optimize test equipment fleets, increase operational efficiency and improve productivity.

Industry leaders need trusted test equipment partners to provide objective guidance on product selection and financing options. They also need independent recommendations to streamline and optimize their test equipment fleets, increase operational efficiency and improve employee productivity. Today's challenges include the need to:

- Drive for higher productivity and a faster pace in R&D labs and for testing/verification.
- Reduce development times and increase time-to-market.
- Regularly refresh test equipment to measure new technologies and avoid obsolescence.
- Optimize the test fleet and divest of underutilized or unused test assets.
- Increase visibility into the global fleet, share equipment and increase utilization.

With experienced suppliers that understand A&D technology applications and can provide expert recommendations about specialized applications, A&D companies can make informed decisions on radar, electronic warfare, satellite, navigation, guidance, communications and radio monitoring programs. To meet strict project timelines and budgets, A&D leaders also need a variety of financial procurement and sourcing options to support the entire project lifecycle, from concept and prototyping to development and full-scale production.

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Asset Optimization

With near real-time data, better decisions and more efficient management of the entire test asset portfolio become possible. Asset optimization services can help to reduce costs and increase the efficiency and productivity of A&D testing operations.

With access to dashboards and reports on asset status, location, and calibration and repair activities, A&D leaders can make informed, data-driven decisions to support accelerated project timelines and more effective use of budgets and capital expenditures.

With access to dashboards and reports on asset status, location, and calibration and repair activities, management can make informed, data-driven decisions to support accelerated timelines and more effective use of budgets and capital expenditures.

A variety of functions across the organization can benefit from asset optimization. With simultaneous access to data on the global asset portfolio, groups such as R&D, engineering, finance and procurement can track reserve and schedule assets, allocate and evaluate costs, and improve utilization.

Use of these systems often leads to increased asset sharing, higher utilization and faster time to market. Companies also use asset optimization to evaluate rent vs. buy decisions, avoid technological obsolescence and sell unneeded equipment to free capital for newer, higher-demand test assets.

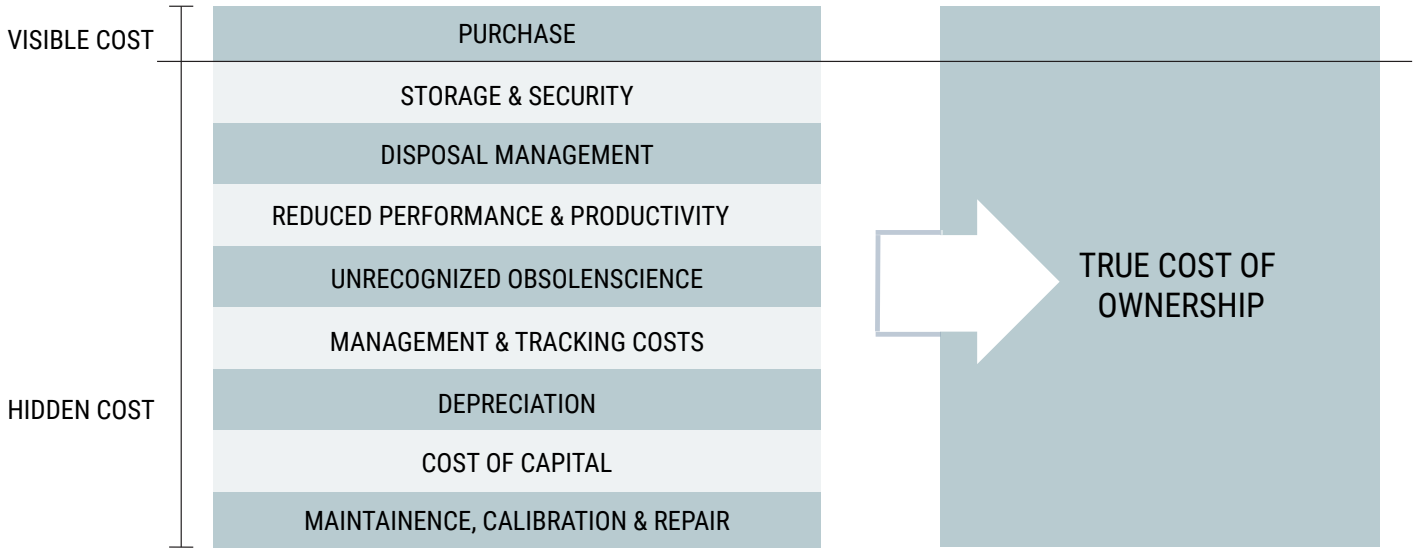
Cost of Ownership

Many studies, including those from Frost & Sullivan, show that a great deal of equipment is purchased each year to satisfy current needs without considering future requirements. As a result, companies find themselves with a surplus of unneeded or outdated equipment that is costly to track and maintain.

When all costs of ownership are considered, the true cost becomes apparent.

- There is the cost of capital and financing, and as with any capital asset, depreciation starts immediately.
- Each year, there will be costs for calibration and maintenance, as well as the associated labor and management time for these expenses. At some point, repairs may also be needed.
- There are annual costs for asset management, including sourcing, procurement, tracking, inventory control, logistics, security and storage.
- If the equipment becomes obsolete or no longer meets project requirements, additional funds may be needed to upgrade or buy another unit.

When you take these factors into account, the real cost of ownership is often close to twice the original purchase price.



Sourcing Options

Today, leading A&D companies utilize a mix of asset acquisition strategies to accomplish various business and project objectives. Mixed sourcing strategies, which are tailored to individual project timelines and technology needs, are highly effective at balancing cost and flexibility. With a full understanding of the options available, companies can choose the best combination of equipment and sourcing method on a case-by-case basis—without the need for compromise.

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RENTING AS AN ALTERNATIVE

To remain agile and respond to ongoing technological advancements, many A&D companies choose renting to fulfill both short and long-term requirements, minimize downtime when assets are unavailable due to calibration or repair and to meet unexpected, urgent needs. Compared to other options, renting allows companies to manage rapid change at far lower cost and with higher utilization rates.

Renting reduces cost of test by maximizing the use of existing budgets and funding without large CapEx investments. With the flexibility to return, exchange or upgrade equipment, renting ensures access to the latest solutions.

- Pay only as long as you keep the asset— no more, no less.
- Try a new test asset or technology before making a long-term commitment.
- Meet urgent or short-term needs by acquiring or disposing of assets, as needed.
- Use renting for additional testing capacity when other assets are unavailable.
- Return, exchange or upgrade technology if needs or timelines change.
- Avoid long-term costs for calibration, repair, downtime, depreciation and taxes.

With the flexibility to return, exchange or upgrade equipment if technology or testing needs change, renting ensures access to the latest solutions.

ADDITIONAL OPTIONS

Other sourcing options include rent-to-own, leasing, new equipment, used equipment and certified pre-owned programs. Available at considerable savings, Certified Pre-Owned (CPO) instruments feature a 14-day, "no-questions-asked" return policy and a one-year warranty. Many of these high-quality, pre-owned instruments are former rental units that have been properly maintained while in service. For end-of-life or to sell underutilized or surplus test equipment, we can evaluate your unwanted equipment, make an offer and handle shipping and logistics.

The Electro Rent Value Proposition

With a proven record of reducing costs and optimizing test fleets for world-class organizations, Electro Rent has a deep understanding of the needs of companies and suppliers in the A&D sector. We bring our experience, benchmarks and best practices to military, defense, aerospace and related organizations to help them:

- Improve operational efficiency and reduce testing costs.
- Optimize the test fleet to minimize capital expenditures and maximize budgets.
- Improve the efficiency of calibration activities and minimize downtime.
- Manage short-term or peak demand with renting or leasing.
- Dispose of obsolete or unwanted equipment to derive value from unused assets.

Conclusion

With rapidly advancing technologies in the A&D sector, it is clear that test equipment must continuously evolve and improve to help engineers complete testing in a timely and cost-effective manner. To achieve this goal, companies must have continual access to leading equipment and testing technologies. Procurement strategies can be a pivotal element to success. Leading companies use a mix of sourcing methods to mitigate risk, save time and money, shorten procurement cycles, fill short-term or urgent needs, improve utilization and avoid unnecessary spending.

Technical challenges can be overcome, but project delays and cost overruns caused by equipment unavailability—due to conflicting project schedules or downtime due to calibration, maintenance, or repair—can be detrimental to an organization, both financially and reputationally. This situation can be easily resolved by making informed decisions with help from the right partner for test and measurement equipment and fleet optimization.

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Microwave Network Analysis

Keysight
N5244B-224/29

10MHz-43.5GHz 2-port PNA-X Microwave Network Analyzer with configurable test set, source attenuators and receiver attenuators, extended power range and bias tees, internal combiner and mechanical switches.

The Keysight N5244B PNA-X Network Analyzer is an integrated and flexible microwave test engine for measuring active devices like amplifiers, mixers and frequency converters. The combination of two internal signal sources, a signal combiner, S-parameter and noise receivers, pulse modulators and generators, and a flexible set of switches and RF access points provide a powerful hardware core for a broad range of linear and nonlinear measurements, all with a single set of connections to your device-under-test.

In R&D, the Keysight N5244B provides a level of measurement integrity that helps you transform deeper understanding into better designs. On the production line, the N5244B delivers the throughput and repeatability you need to transform great designs into competitive products. The Keysight N5244B PNA-X applications bring speed, accuracy, and ease-of-use to common RF measurements, in coaxial, fixtured and on-wafer environments.

UXA Signal Analysis

Keysight
N9040B-550/H1G/P50

The Keysight N9040B UXA signal analyzer is part of the X-Series spectrum analyzers, representing an evolutionary approach to signal analysis that spans instrumentation, measurement and software. It provides the flexibility to satisfy business and technical requirements across multiple products and programs.

The UXA is the flagship of the X-Series line of signal analyzers and is built on proprietary technology. The N9040B combines high-quality analysis bandwidth to 510 MHz, full-band, real-time analysis and industry-leading phase noise performance. The UXA also uses a streamlined, touch-driven interface on a large 14.1” display that simplifies measurement setup through the X-Series menu structure. With its wider, deeper views of elusive and wideband signals, the UXA enables better designs in aerospace, defense, commercial communications and more.

Waveform Generation

Keysight
M8195A-004/16G/FSW/SEQ

The Keysight M8195A arbitrary waveform generator provides up to 65 GSa/s, 25 GHz bandwidth, 8 bits vertical resolution, and up to 4 channels in a 1-slot AXIe module - simultaneously.

As devices and interfaces become faster and more complex, the M8195A AWG provides versatility to create the signals needed for digital applications, advanced research, wideband radar, satcom and optical communications.

Key Facts

- Multi-level / Multi-channel digital signals - generate NRZ, PAM4, PAM8, DMT, etc. signals at up to 32 GBaud.
- Supports protocols such as HDMITM, C-PHYTM and D-PHYTM.
- Embed/De-embed channels, add Jitter, ISI, noise and other distortions.
- Electronics research – generate any mathematically defined arbitrary waveform, ultra-short yet precise pulses and extremely wideband chirps.
- Wideband RF/μW - generate extremely wideband RF signals with an instantaneous bandwidth of DC to 25 GHz.

Signal and Spectrum Analysis

Rohde & Schwarz
FSW50/B4/B24/B1200

The R&S FSW signal and spectrum analyzer provides low phase noise, wide analysis bandwidth and straightforward and intuitive operation.

Key Facts

- Frequency range from 2 Hz to 8/13.6/26.5/43.5/50/67/85 GHz (with external harmonic mixers from Rohde & Schwarz up to 110 GHz).
- Low phase noise of –137 dBc (1 Hz) at 10 kHz offset (1 GHz carrier).
- –88 dBc dynamic range (with noise cancellation) for WCDMA ACLR measurements.
- Up to 2 GHz analysis bandwidth.
- < 0.4 dB total measurement uncertainty up to 8 GHz.
- Real-time analysis up to 512 MHz bandwidth.
- High-resolution 12.1” (31 cm) touchscreen.
- Multiple measurement applications can be run and displayed in parallel.

Phase Noise Analysis

Rohde & Schwarz
FSWP26/B1/B4/B60

The R&S FSWP phase noise analyzer and VCO tester features very high sensitivity thanks to low-noise internal sources and cross-correlation. It can measure phase noise on highly stable sources such as those found in radar applications. Additional options such as pulsed signal measurements, additive phase noise (including pulsed) characterization, and integrated high end signal and spectrum analysis make the R&S FSWP unique.

Key Facts

- Frequency range from 1 MHz to 8/26.5/50 GHz.
- High sensitivity for phase noise measurements thanks to cross correlation and extremely low noise internal reference sources.
- Typ. –172 dBc (1 Hz) at 1 GHz carrier frequency and 10 kHz offset.
- Typ. –158 dBc (1 Hz) at 10 GHz carrier frequency and 10 kHz offset.
- Simultaneous measurement of amplitude noise and phase noise.
- Internal source for measuring additive phase noise, including on pulsed signals.
- Signal and spectrum analyzer and phase noise analyzer in a single box.
- Wide dynamic range thanks to low displayed average noise level (DANL) of –156 dBm (1 Hz) (without noise cancellation) and high TOI of typ. 25 dBm.
- 320 MHz signal analysis bandwidth.
- Total measurement uncertainty: < 0.2 dB up to 3.6 GHz, < 0.3 dB up to 8 GHz.
- Touchscreen operation.

Microwave Signal Generation

Rohde & Schwarz
SMA100B-20/HW4

The R&S SMA100B RF and microwave signal generator delivers maximum performance without compromise. It provides pure output signals while maintaining the highest output power level. It can handle the most demanding component, module and system measurement tasks in the RF semiconductor, wireless communications and aerospace and defense industries.

Key Facts

- Frequency range from 8 kHz to 3 GHz, 6 GHz, 12.75 GHz or 20 GHz.
- Excellent SSB phase noise of –152 dBc (typ.) at 1 GHz and –132 dBc (typ.) at 10 GHz, each at 20 kHz offset.
- Virtually no wideband noise –162 dBc (meas.) at 10 GHz and an offset of 30 MHz.
- Ultra-high output power.
- Up to 38 dBm with the 6 GHz instrument.
- Up to 32 dBm in the microwave frequency range with the 20 GHz instrument.
- Exceptionally low harmonics.
- State-of-the-art GUI with touchscreen.

Arbitrary Waveform Generation

Tektronix
AWG70001B-150/MEM/SEQ

The AWG70000B Series Arbitrary Waveform Generator represents the leading edge in sample rate, signal fidelity and waveform memory, making it ideal for design, testing and operations of complex components, systems and experiments. With up to sample rate of 50 GS/s and 10-bit vertical resolution, it delivers an ideal signal stimulus solution for easy generation of ideal, distorted and “real-life” signals.

- A single-box solution for wideband RF signal generation, fully operational without external PC.
- Direct generation of wideband signals with carriers up to 20 GHz, removing the need for external RF conversion.
- Simulate real-world analog effects on high speed digital data streams.
- Model signal impairments up to speeds of 12.5 GB/s.
- Generate high precision RF signals. Spurious Free Dynamic Range performance better than -80 dBc.
- Create high speed baseband signals for optical transmission with the vertical resolution to handle higher order complex modulation.
- 10 bits of vertical resolution at a sample rate of 50 GS/s.
- Create long waveforms scenarios without building complex sequences.
- Up to 32 GSamples of Waveform Memory plays 640 ms of data at 50 GS/s.
- Synchronize multiple units (manually or with the AWG Synchronization Hub) to achieve a multi-channel high speed AWG system.
- Built-in display and buttons make it possible to quickly select, edit and play waveforms directly from the front panel of the AWG.

ENDNOTES

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x Frost Perspectives, August 2018

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