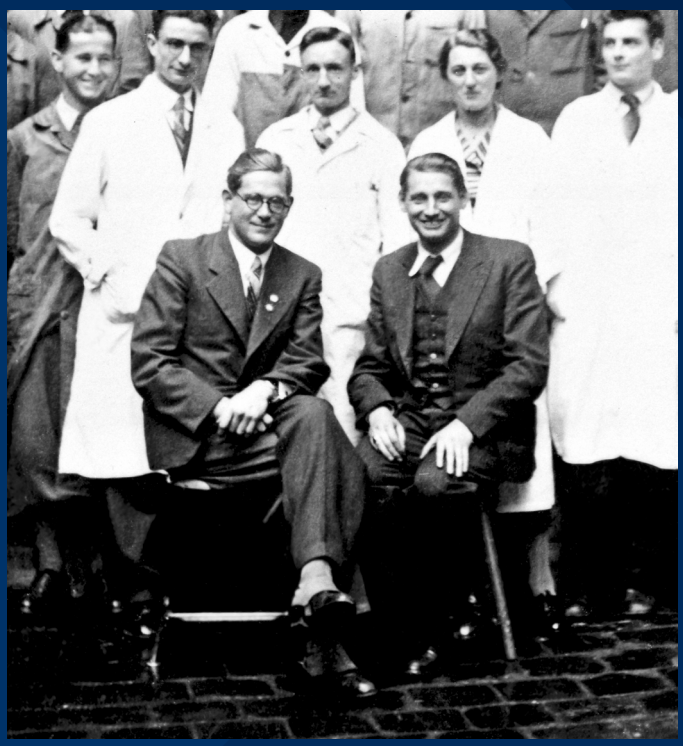
ROHDE&SCHWARZ
Make ideas real

# TEST AND MEASUREMENT SOLUTIONS FOR MEDICAL AND HEALTH APPLICATIONS

Brochure | Version 01.00


# YOUR MEDICAL AND HEALTH TESTING PARTNER



The healthcare sector has adopted many existing and emerging technologies for a wide range of applications. Performance degradation or failure of medical devices and test systems can have severe consequences. As a leader in test and measurement, Rohde&Schwarz partners closely with our customers at every stage of development and deployment. We can help define your testing needs and bring your products to market as quickly as possible – with the required quality and performance. We offer solutions that cover all your medical and health application requirements. Our comprehensive product portfolio has the right test and measurement solutions for your application and budget.

## About Rohde&Schwarz

The Rohde&Schwarz technology group is among the trailblazers when it comes to paving the way for a safer and connected world with its leading solutions in test and measurement, technology systems, and networks and cybersecurity. Founded more than 85 years ago, the group is a reliable partner for industry and government customers around the globe. The independent company is headquartered in Munich, Germany and has an extensive sales and service network with locations in more than 70 countries. Incorporated in the United States since 1978, Rohde&Schwarz USA, Inc. has a large team of sales and application engineers throughout North America with regional offices in Maryland, Texas, California and Oregon. We have a world-class service facility in Columbia, Maryland and our customers can expect extensive aftersales support, including training, free technical support and close personal contact with our engineers out in the field – with the desired quality and performance.

## MEDICAL PRODUCT DEVELOPMENT

The demand for wireless medical applications such as remote patient monitoring, real-time diagnostic analysis, smart surgical systems and implantable sensors has grown significantly over the last few years.

While wireless products offer a variety of end user benefits, they are challenging for designers. Implanted devices must be reliable and have long battery lives. Smaller packaging and higher operating frequencies increase the need for thoroughly evaluated designs. Understanding signal and power integrity issues helps optimize overall device performance. Debugging EMI issues early in the development process speeds up overall product deployment.

- Powering the device under test
- Battery life/power consumption
- Measuring small sensor signals
- Signal integrity
- Power integrity
- Precompliance EMI debugging
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## WIRELESS COMMUNICATIONS TESTING

Many medical devices use wireless machine-to-machine communications technologies to interact with one other and with IoT applications in the cloud. Testing overall medical device communications behavior is important in all product life cycle phases to ensure proper functioning as well as lifetime quality and performance.

During development, the RF design must be tested under specified RF conditions. Coexistence tests help to understand the behavior of the medical device's RF receiver in different electromagnetic environments. Before wireless devices can go live, they must be tested against the applicable regulatory and industry standards.

- Signal generation
- Signal and spectrum analysis
- Over-the-air testing
- Wireless coexistence testing
- Compliance EMC testing
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## HOSPITAL RADIO FREQUENCY (RF) SPECTRUM MONITORING

Despite careful frequency spectrum planning and management, interference is still an everyday problem for many radiocommunications services. Interference needs to be resolved with high priority and maximum efficiency, especially for critical health-relevant wireless communications services. Careful spectrum monitoring ensures that only the expected signals for the area are being emitted. Fixed and mobile monitoring sites allow operators to verify, identify and locate any radio interference they might encounter. Healthcare organizations are increasingly aware of the importance of adequate cybersecurity for their medical facilities. They need to secure applications, access technical, medical or patient applications and protect medical data.

- Wireless network security and RF interference hunting
- Protect your patient's personal data at all times
- Cybersecurity for healthcare providers
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# MEDICAL PRODUCT DEVELOPMENT

## POWERING THE DEVICE UNDER TEST

Before you start testing, it is important to spend some time thinking about how to power your device. Possible solutions range from simple voltage sources through advanced power supplies. When designing medical electronics, you should not compromise on low noise and ripple, accurate and stable output voltage to keep disturbances to a minimum, and precise power delivery to the device under test (DUT). When operating automated test systems, key features include remote control functions, rack adapters and rear-panel connectors – along with high test speed and a compact design.

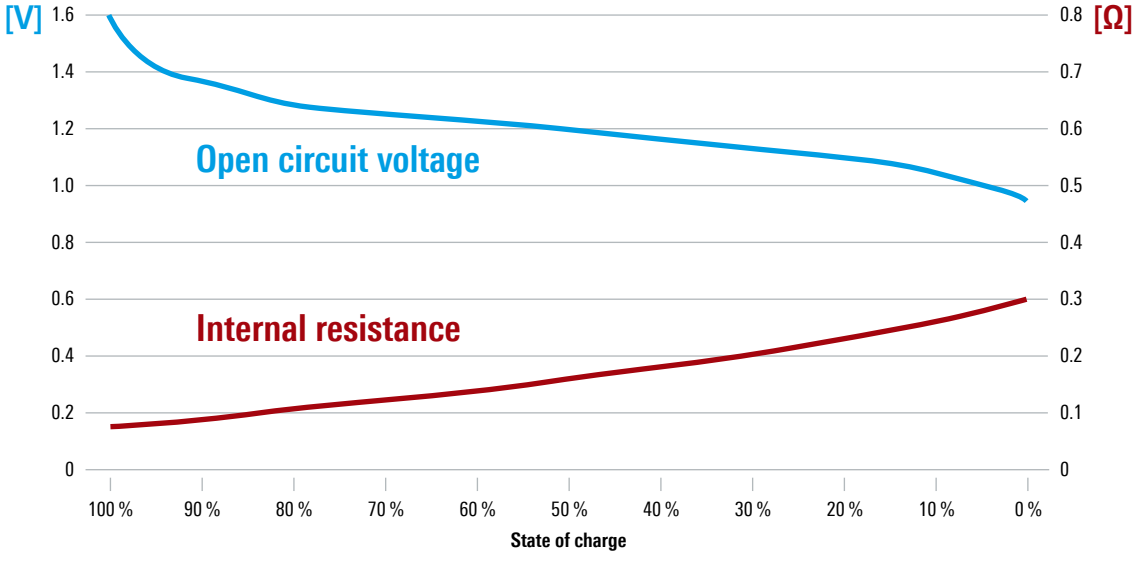
### Battery simulation

When designing battery-powered devices, it is necessary to understand how your device performs with respect to the discharge status, behavior and age of the battery. Key battery parameters include the internal resistance, capacity and open-circuit voltage. Specialty power supplies help when creating a model of the battery that can be used in simulations in order to test real-world scenarios with your device. A battery simulator emulates the real output behavior of a battery. Fast regulation of the battery simulator's voltage avoids a voltage drop when the device becomes active and draws significantly more current.

### Emulate real-world scenarios

Modern circuits require different voltage and/or current levels in different operating states. For instance, simulating an embedded system startup sequence involves specialized voltage and current profiles synchronized across several channels. An advanced power supply solves this challenge with a built-in arbitrary waveform generator, enabling easy generation and customization of voltage and current levels over time. Simulation of long-term battery discharging or simulation of voltage drops with different durations and voltage levels can be performed easily.

**Internal resistance**

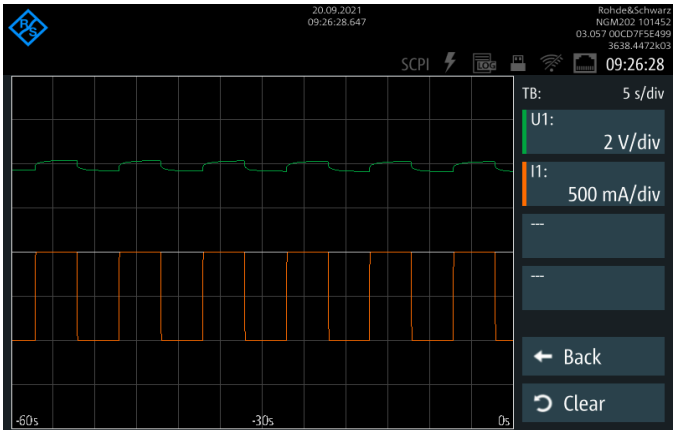


# POWERING THE DEVICE UNDER TEST

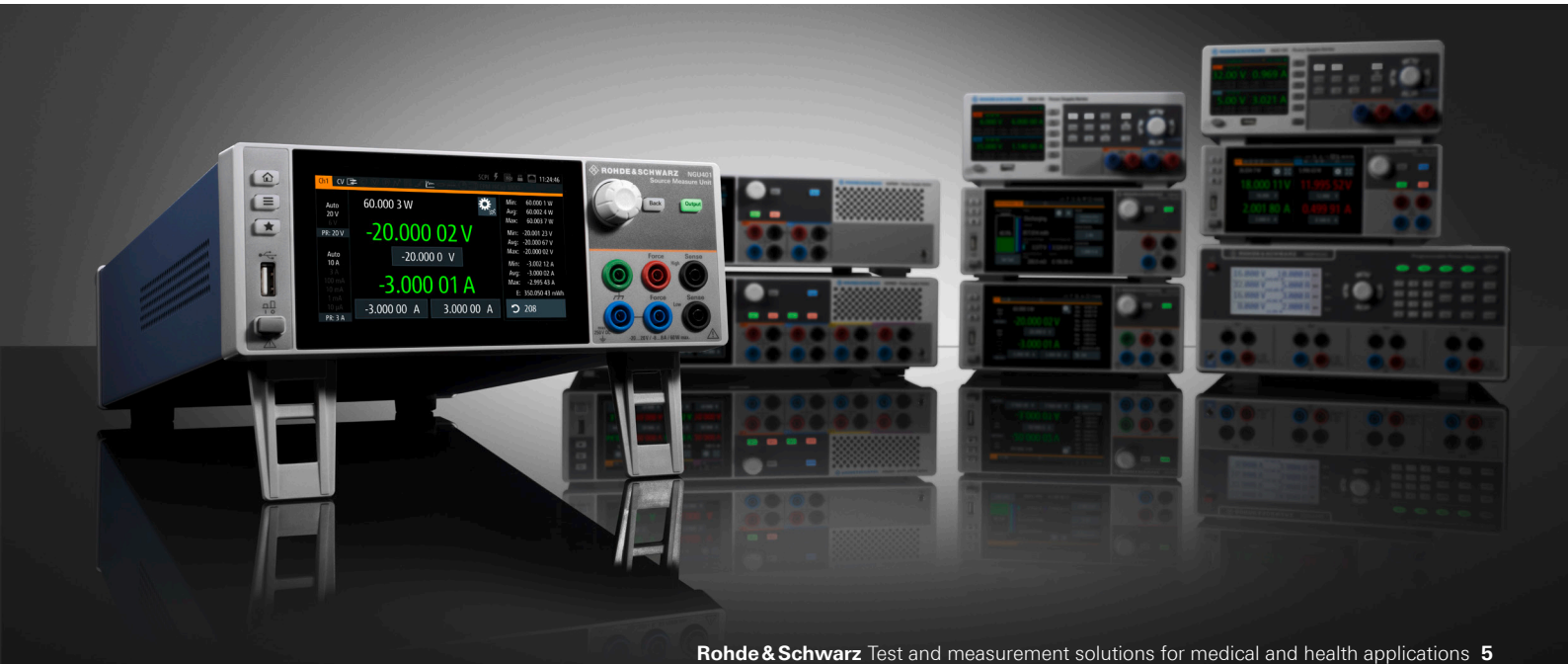
## Rohde&Schwarz power supplies

Rohde&Schwarz offers a broad range of basic, performance and advanced power supplies addressing and solving the challenges mentioned above.

- Multiple outputs, all electrically equivalent and isolated, allowing ultimate flexibility for powering designs
- Integrated arbitrary waveform generators to automatically adjust the output as required by your design
- Data logging to track power consumption over hours, days or even weeks
- Integrated measurement functions and DVM input limit the number of connections required to accurately measure voltage and current
- Battery simulation to emulate real-life battery performance




Example of the QuickArb editor interface in the R&S®NGM200 power supply series. It is set up for five repetitions of a ramp function forming a sawtooth waveform. At the end it is set to hold the last value by selecting the corresponding end behavior.



# BATTERY LIFE/POWER CONSUMPTION

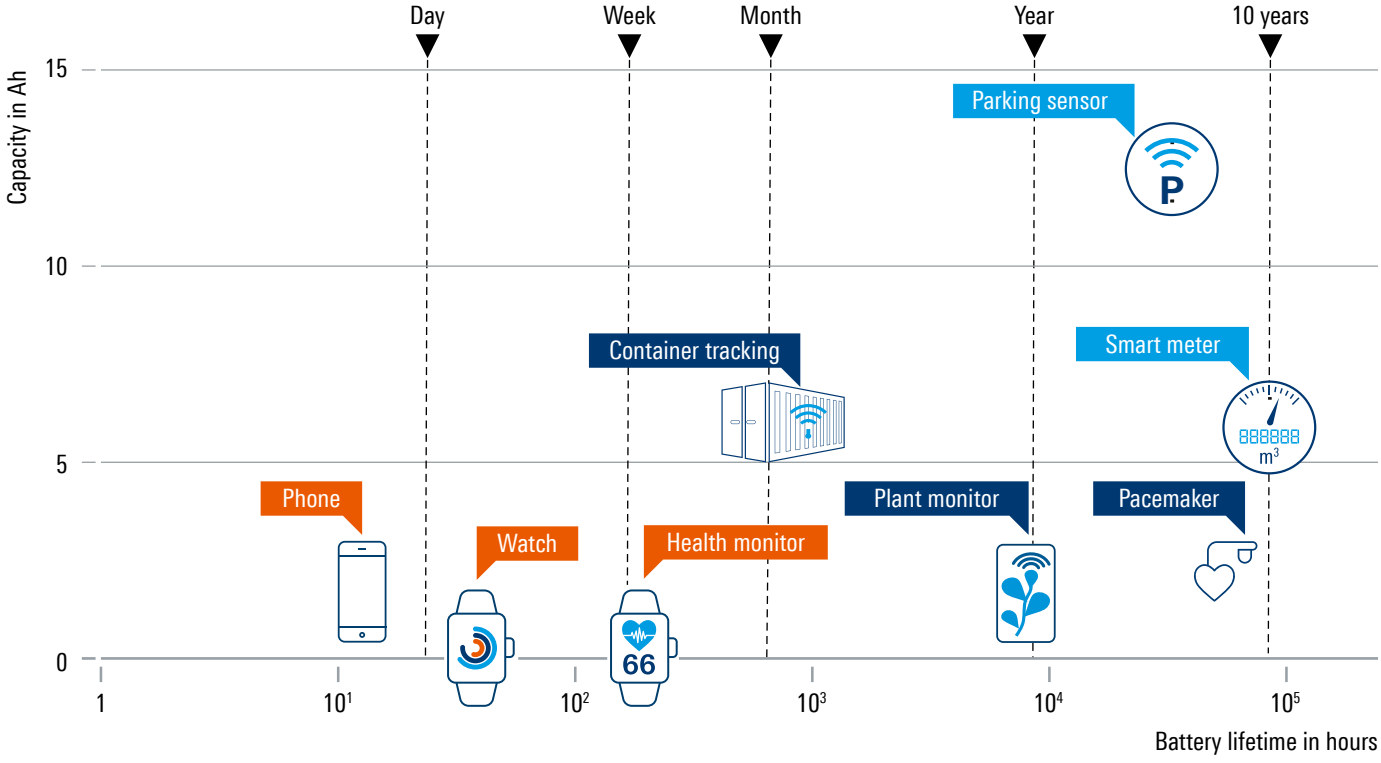
When designing a device, the focus is on achieving and verifying the desired performance and functions. Of course, it is also important to make sure the device has enough power to perform as expected. Devices powered directly from the grid are typically optimized for efficient power conversion. However, the power is already there and remains available when the device is plugged into the grid.

When designing a battery-powered device, there is a different challenge which involves reducing the charge frequency to a minimum. Some devices need to function for as long as ten years or more because the battery is hard to access. This is the case for medical devices implanted in the human body. While a device might work well as long as the battery delivers enough power, it is critical to extend that time as much as possible.

First, the power consumption needs to be analyzed for various activities of the device. Medical devices often use an embedded design for cost reasons. The various functional cores are integrated into a chip or module. Integrating wireless radios increases the embedded design complexity. A typical device may have multiple components, such as a wireless chip, an A/D converter, memory, power management, a processor and sensors. Each component draws current from the battery. Several approaches can help to increase the battery lifetime:

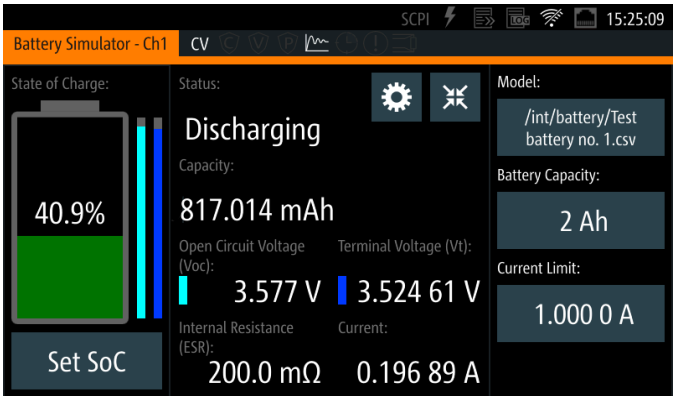
- Optimize the device's firmware
- Improve the battery performance
- Make the device's performance resistant to battery aging
- Reduce the sleep or standby current

**Battery requirements of various device types**



# BATTERY LIFE/POWER CONSUMPTION

If the power consumption of the various functional cores is already well understood and the overall power consumption of the medical device is the main interest, the R&S®NGU201 is a very attractive and simple solution for this purpose. It provides excellent readback resolution and accuracy for precise voltage and current measurements.

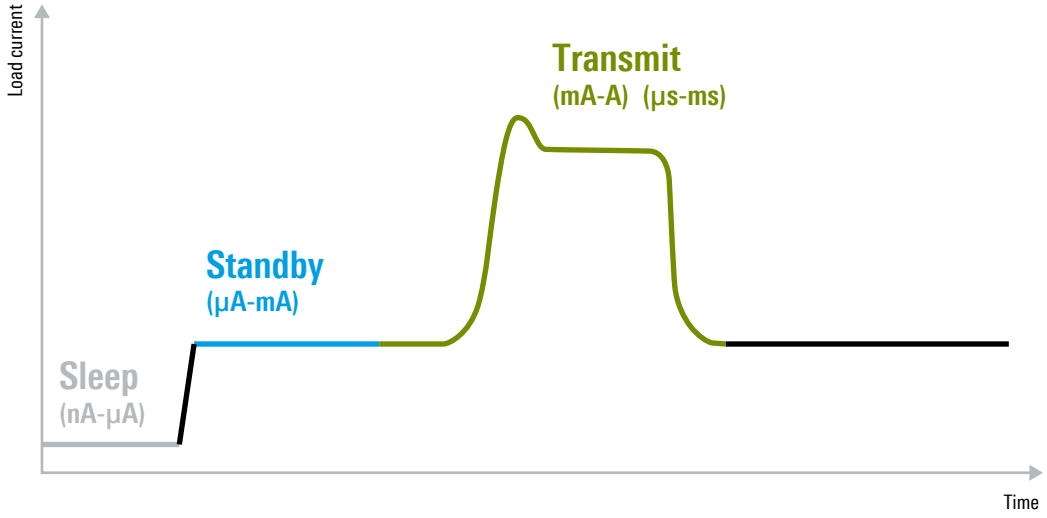



While you may need to rely on standard batteries in most cases, the situation can be improved by optimizing the firmware and adapting to the battery aging.

Battery-powered devices are typically busy less than 1 % of the time. More than 99 % of the time, your device remains in standby, sleep or even deep-sleep mode. You want to minimize such power use. It makes a significant difference in power consumption whether your sleep current is 100 µA or 10 µA.

When optimizing the sleep/standby current of your device, you may wonder how you can verify the improvement. Measuring very low currents requires test solutions with dedicated low current measurement performance.

**Typical current profile of a battery powered device**



# MEASURING SMALL SENSOR SIGNALS

A specialty power supply such as a sensitive battery simulator helps when creating a battery model, simulating a battery (as discussed in the previous section) and measuring the power consumption of low-power devices. It provides you with:

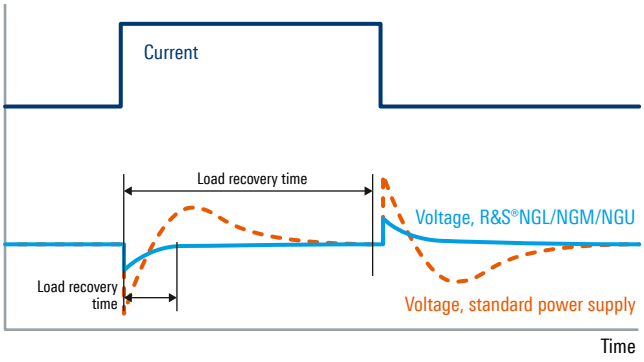
- I-V curves with charge and discharge behavior
- Optimized recovery time after fast load changes
- Adjustable internal resistance to simulate battery aging
- Dynamic current measurements from several amps down to nano amps

Rohde&Schwarz specialty power supplies address and solve these challenges.

The R&S®ZVC probes are good alternatives when measuring power consumption in the device's busy and standby modes and focusing on dynamic behavior or dedicated applications.

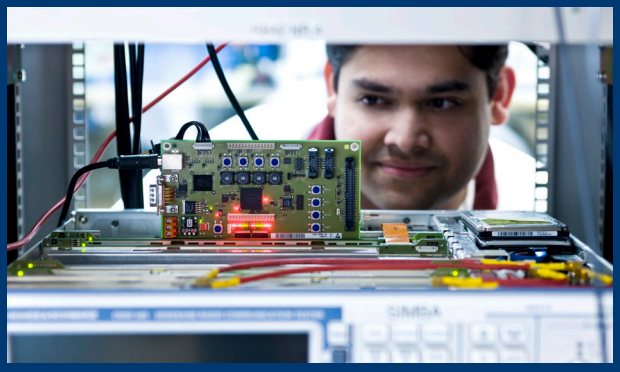
However, there is no good way around specialty power supplies when it comes to simulating batteries and measuring very low current consumption in sleep modes.

### Optimized load recovery time




### Multi-channel power consumption measurements with a Rohde&Schwarz oscilloscope and the R&S®ZVC multi-channel probe

When you are analyzing and verifying your device's performance, multi-domain measurements with an oscilloscope can be a comprehensive test approach that also covers power consumption measurements while evaluating dynamic current profiles.

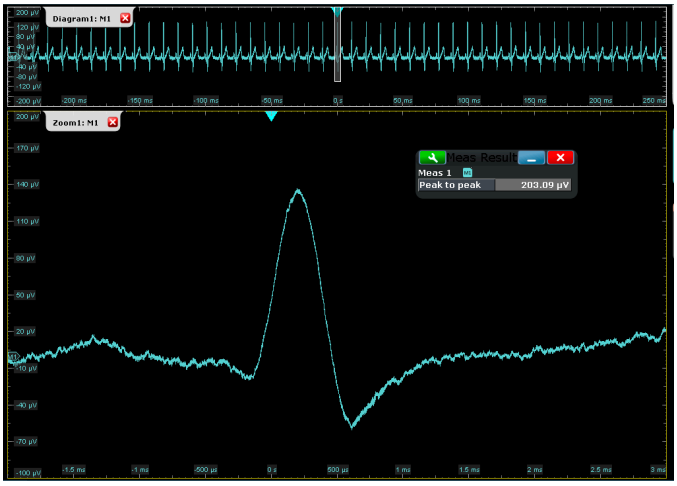


### Power consumption in a live network environment

Power consumption can also be evaluated in a live network environment using the R&S®CMW500 wideband radio communication tester. This solution addresses these key challenges:

- Measure very low and transient current, voltage and power simultaneously
- Independently and simultaneously evaluate power consumption of each key interface for proper management
- Simulate real-life use cases with wireless networks
- Synchronize signaling activities with power measurements

# MEASURING SMALL SENSOR SIGNALS




Measuring small currents has become even more crucial for battery-powered portable and wearable consumer devices, IoT and medical applications. Designers must measure currents from the sub-milliampere range up to the ampere range.

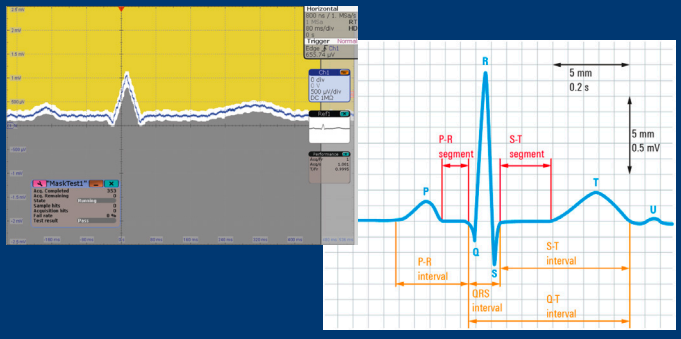
### Very low-noise frontend

The wide dynamic range and low-noise design of the R&S®RT-ZVC probe enables clear measurement of small sensor signals. Using current inputs in external shunt mode enables maximum sensitivity, resulting in 18-bit resolution at 45 mV full-scale differential input voltage. A cardiac voltage pulse with a signal level of only 200 µV (peak-to-peak) can easily be captured and analyzed.

# CAPTURING SMALL ECG SIGNALS IN MEDICAL APPLICATIONS

An electrocardiogram (ECG) is widely used to monitor small electrical changes on a patient's body skin due to cardiovascular activity. This simple and noninvasive measurement can detect a variety of heart diseases. The medical industry builds dedicated equipment that aids in diagnosis. Such equipment requires precise oscilloscopes for design and verification. An ECG typically has 12 leads connected to the chest, arms and legs. Voltage is measured between different connection points. This example shows signal lead I, which is the voltage between the left and right arms.

The R&S®RTE is well suited for medical applications such as high fidelity analysis of small ECG signals. The frontend provides excellent low-noise values and, at 500 µV, the lowest vertical scale in its class. Analysis requires no additional circuitry, and the HD mode increases vertical resolution, improves trigger sensitivity and reduces inband noise power. Users can then capture signal details important for analysis.

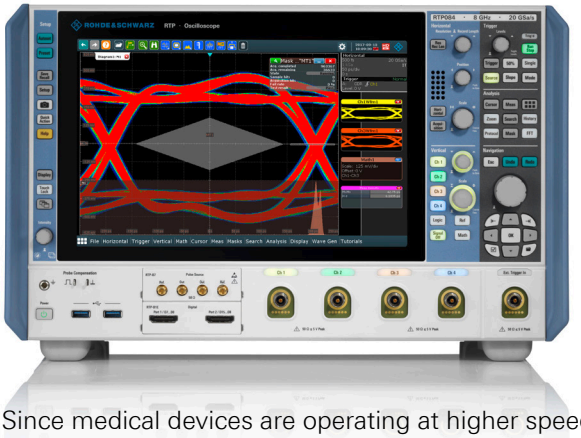



### Mask testing for easy detection of medical indications

The stable signal can be used for further tests. For example, a mask test easily detects several medical indications appearing in a distorted signal. Different masks can be applied to test for indications. The screenshot shows the ECG signal with the associated mask test, derived from a healthy human. The white area around the signal trace is the permissible area; the colored areas (top and bottom) are the upper and lower masks.

Note the performance is 1 frame/s and 1 acquisition/s, which equals a heartbeat rate of 60 bpm. In this setup, the R&S®RTE triggers, acquires and processes every pulse, although the acquisition time occupies 80 % of the period of 1 s, leaving just 200 ms for processing. This example illustrates the outstanding R&S®RTE performance.

# SIGNAL INTEGRITY



Since medical devices are operating at higher speeds and have more complex designs, signal integrity (SI) has become even more important. Engineers nowadays face a wide variety of influencing factors, such as impedance mismatch and reflections, insertion loss, propagation delay, intra/inter-pair skew, etc. Managing signal integrity is vital to developing reliable medical devices with wireless technologies.

## Fast eye diagrams

High-speed serial buses such as USB 3.2 and PCIe 3.0 operate at 5 Gbit/s, 8 Gbit/s or 10 Gbit/s per lane. Clock recovered or "real-time" eye diagrams display overall system quality. Equipped with the R&S®RTP-K141 high-speed serial pattern trigger and clock recovery option, the R&S®RTP can lock onto serial data signals at 16 Gbit/s. Once locked, the R&S®RTP can generate eye diagrams at a rate of up to 750 000 unit intervals per second.

## Interface testing

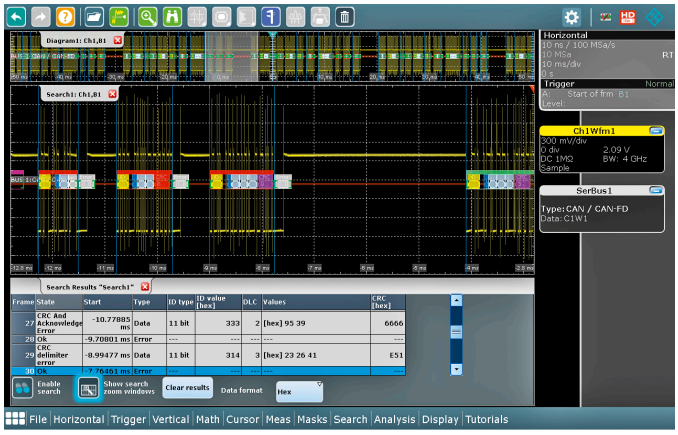
Modern oscilloscopes provide the most generic approach for SI measurements. They are easy to use and common among electronic designers. Rohde&Schwarz oscilloscopes offer a unique set of benefits:

- Real-time deembedding for verification and debug as well as compliance testing
- Trigger and decode solutions for various standards
- First TDR/TDT solution in a real-time oscilloscope
- Powerful jitter analysis including simple setup via a jitter wizard
- Signal model based jitter and noise decomposition, also providing the channel step response
- Precise trigger functions and fastest acquisition rate of up to 1 million waveforms/s
- Superior spectrum analysis (FTT) for in-depth debugging
- Test automation for interface compliance

## High-speed serial decode

High-speed digital interfaces use data encoding and symbols to transmit data. Signal decoding tools make troubleshooting, debugging and characterizing system performance much easier.

The R&S®RTO and R&S®RTP oscilloscopes provide triggering and decoding capabilities for many low-speed and high-speed serial buses. The individual protocol areas within the logical signals are color-coded to make the decoded data easy to read. Hex, bin and ASCII data formats are available. The protocol data can also be displayed in a decode table.




## PCB and interconnect testing

At frequencies above 1 Gbps, PCB traces act as transmission lines, requiring sophisticated measurements and verification methods. Vector network analyzers are standard measuring instruments for signal path evaluation. The R&S®ZNB delivers market-leading performance and features advanced SI capabilities such as:

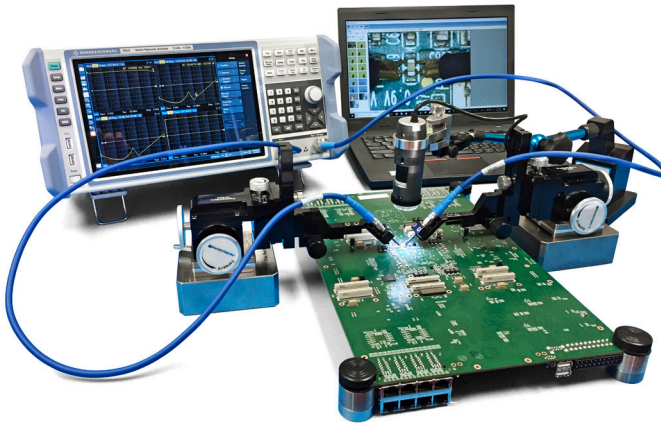
- Time domain analysis of signal line impedances and discontinuities
- Extended time domain analysis including eye diagrams
- Test fixture characterization and deembedding
- Fast and easy calibration

# POWER INTEGRITY

The ongoing trends toward lower voltage levels, higher data rates and smaller, more compact product dimensions make it a challenge to ensure extremely stable and clean supply voltages in medical devices. Designing for best power integrity requires extremely sensitive and accurate measurements.

Clean and stable power rail voltages are the basis for any properly functioning electronic design. The continuing demand for higher performance, greater integration and lower power consumption is pushing supply voltages down while making voltage tolerances tighter and power rail qualification more challenging.

Ripple, noise and load step response measurements on integrated circuits such as ASICs, DDR memories and FPGAs require very low noise and broadband probe solutions that can measure in the single-digit millivolt range. Qualifying a power supply for sensitive circuits means measuring very small disturbances at relatively high DC offset levels.



## Power integrity measurements

Advanced oscilloscopes and probes are needed to verify and analyze the remaining ripple and noise of your power rails. The R&S®RTO and R&S®RTE oscilloscopes in combination with the R&S®RT-ZPR20 and R&S®RT-ZPR40 power rail probe offer:

- Up to 4 GHz bandwidth to capture even fast disturbances and transients
- Superior low-noise measurements
- Powerful spectrum analysis of noise components
- High waveform update rate for fast worst-case analysis
- Highest offset up to ±60 V
- Built-in 16-bit DC voltmeter with 0.05 % accuracy

## PDN impedance measurement

Vector network analyzers can investigate the power delivery network (PDN) to identify and remove critical frequency ranges exceeding maximum target impedance. Worst case scenarios need to be taken into consideration for deeper analysis and further supply voltage network optimization. An impedance plot of the entire PDN helps to determine critical constellations. State-of-the-art Rohde&Schwarz VNAs are powerful tools to quickly and easily create impedance plots of PDNs and optimize designs to meet the given target impedance.

# PRECOMPLIANCE EMI DEBUGGING

The compliance testing and approvals required for medical devices dwarf other wireless applications. This means addressing EMC compliance issues is critical.

When a new design has to pass its final EMI compliance test, the sooner testing is done and possible design issues are addressed the better. The cost for rectifying a design problem rises exponentially the closer the project is to completion. Designing with EMI in mind can help. With 50% to 80% of all devices failing initial EMI compliance tests, discovering and addressing potential issues early in the design cycle pays off.

Choose the best spectrum analyzer, oscilloscope and accessories for the device frequency range, harmonic figures (some EMI standards require a 10th harmonic check) and the desired dynamic range. Tests should also be carried out as close to the final EMI-compliant receiver as possible to ensure maximum dynamic range and performance. A better receiver or spectrum analyzer helps prevent false failures.

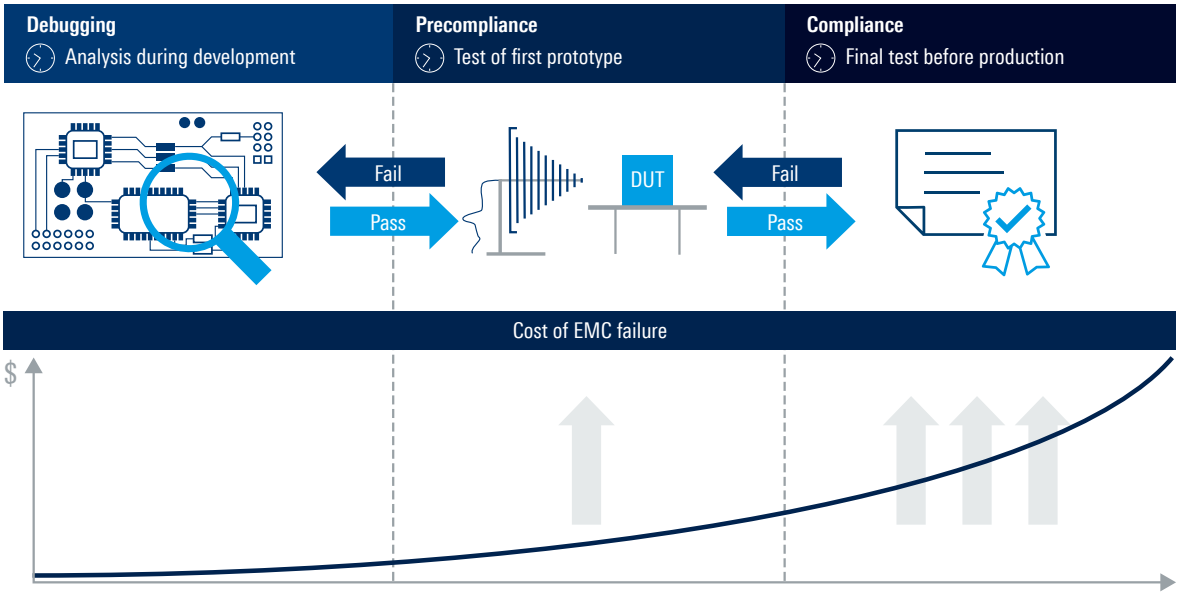
## Analyzing EMI with an oscilloscope

- High capture bandwidth and easy navigation in the frequency domain
- Overlap FFT implementation with color-coded display of spectral components
- Gated FFT for correlated time-frequency analysis
- Capturing sporadic events with the zone trigger measurement tasks

## Analyzing EMI with a spectrum analyzer

- Standard-compliant EMI detectors: peak, quasi-peak, CISPR-average, RMS-average
- EMI bandwidths for commercial and military standards
- Limit lines and transducers for typical measurement tasks
- AM/FM audio demodulation for easier identification of interferers
- Remote control of V-networks (LISN) via built-in AUX port

## Value of solving EMI problems early in the cycle



# WIRELESS COMMUNICATIONS TESTING

## SIGNAL GENERATION

Medical applications today use many of the wireless communications standards. During the development process, generating signals that meet these standards is often useful. Rohde&Schwarz offers a broad range of products to meet your design and testing needs.

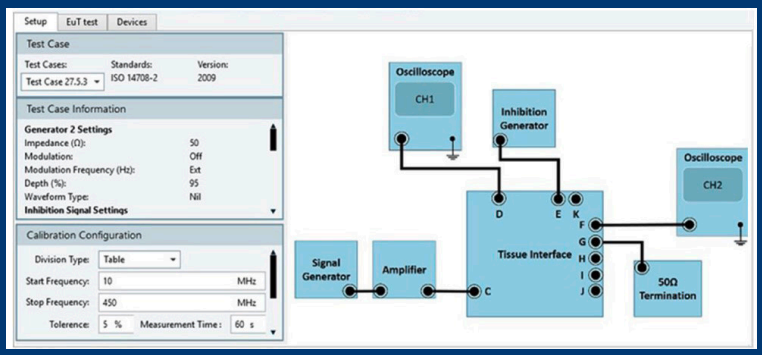
Baseband, RF and microwave signal generators from Rohde&Schwarz have excellent signal quality, flexibility and usability. Rohde&Schwarz signal generators cover wide frequency ranges up to 67 GHz (up to 170 GHz with frequency multipliers), have modulation bandwidths up to 2 GHz and support all major mobile communications and wireless digital standards.

The portfolio ranges from ultra compact and top-of-the-line fast analog and digital signal sources, optimized for production and automated solutions, to premium class vector signal generators with multichannel and fading simulation capabilities for the most demanding applications.

### GENERATION OF SIGNALS FOR TESTING CARDIAC PACEMAKERS

Given the increase in electronic devices such as smart wearables, smartphones and IoT smart products for home, city and mobility applications, there is a growing concern that electromagnetic emitters will interact with active implants. Ensuring active implant electromagnetic resilience is very important. The International Organization for Standardization (ISO) includes representatives from various national standards organizations. The ISO 14708-2, 14708-3, 14708-6 and 14117 standards ensure the proper operation of active implantable medical devices such as cardiac pacemakers, cardioverter defibrillators, neurostimulators and cardiac resynchronization devices in real-world usage.

Our solutions can perform automated testing in line with ISO 14708-2, 14708-3 and 14117 and ensure reliability of active implants by providing EMS and EMI testing throughout a range of frequencies and power levels. This automated solution handles a complex variety of unique test methods for each test case.




# SIGNAL AND SPECTRUM ANALYSIS

Medical applications also need to analyze signals for compliance with wireless communications standards. Rohde&Schwarz offers a broad range of products to meet your design and testing needs.

## Signal and spectrum analyzers

Rohde&Schwarz signal and spectrum analyzers offer the right model with the optimum combination of price and performance, whether for testing wireless medical devices in accordance with the latest communications standards or for measurements on components and subassemblies with low phase noise, high sensitivity and high analysis bandwidth.

They include measurement applications for noise figure and phase noise, EMI diagnostics, analog and vector signal modulation as well as wireless and wideband communications standards. They help users shorten development and save test time in production.

## Power meters and sensors

Power meters and power sensors from Rohde&Schwarz stand for the highest possible measurement accuracy and reliability – and have done so for decades.

Rohde&Schwarz power sensors are intelligent standalone instruments with a flexible connection design. The comprehensive USB-capable sensor portfolio can be operated with the power meter base unit or a PC/laptop. The latest power sensor family can also be controlled via LAN.

## Network emulation

Evaluating performance in an actual network setting is useful. The R&S®CMW network base station emulator helps create test signal environments such as 4G, 5G, Bluetooth®, Wi-Fi, etc. The emulator can simulate network scenarios with different power levels, different channels – all in a controlled environment. It is repeatable and can be used to verify performance in challenging situations.

# OVER-THE-AIR TESTING

Over-the-air (OTA) testing involves wireless evaluation of the radiated performance of a medical device – in the same manner that it will be used. In the past, discrete components or subsystems could be tested with RF cables connected directly to the device, but the highly integrated nature of wireless solutions makes OTA testing necessary. Many products now have antennas integrated directly into their design or even etched onto the RF chipset, making it impossible to connect an RF cable.

Test methodologies and performance metrics are being defined for OTA testing standards to characterize wireless devices and their performance. The new standards include requirements for radiated measurements.

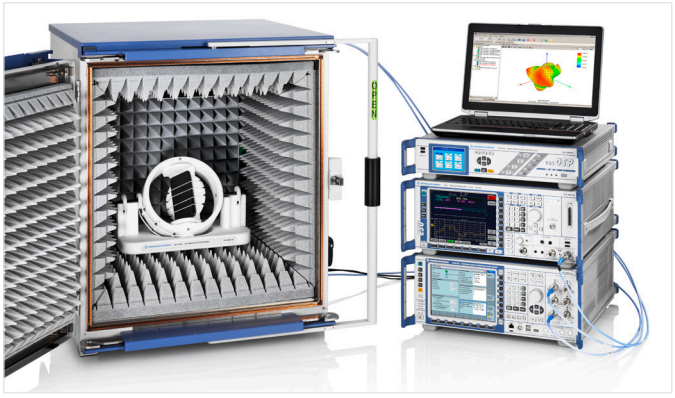
Many medical designs use off-the-shelf modules along with an enclosure and an antenna. However, you will need to characterize the wireless performance of your device as a final product since testing the module alone is not sufficient.

OTA testing may require characterization of a DUT for a range of angles of arrival (AoA). These radiated characteristics are captured in a full 3D assessment and include elevation, azimuth and polarization variations.

A metal shielded anechoic chamber or box houses the DUT during OTA testing. This setup shields the DUT from ambient RF signals and creates a low-noise environment for measuring receiver sensitivity. The DUT is mounted on a multi-axis gimbal that enables the TRP and TIS measurements.

## R&S®DST200 RF diagnostic chamber

The R&S®DST200 RF diagnostic chamber – ideal for RF analysis during development – supports a wide range of radiated wireless test applications. It is compact enough for the workbench in any R&D lab and can be put to good use during product design and optimization.



## R&S®ATS1800C CATR based test chamber

Rohde&Schwarz offers very compact far-field OTA test systems based on compact antenna test range (CATR) technology. The R&S®ATS1800C CATR based test chamber is fully shielded from the outside world, providing an ideal environment for uninterrupted measurements. Antennas, modules and devices can be characterized and analyzed throughout the entire development lifecycle, from R&D to conformance tests for both active and passive measurements (3D antenna gain patterns, ACLR, EVM, EiRP, TRP, EiS, etc.).

# WIRELESS COEXISTENCE TESTING

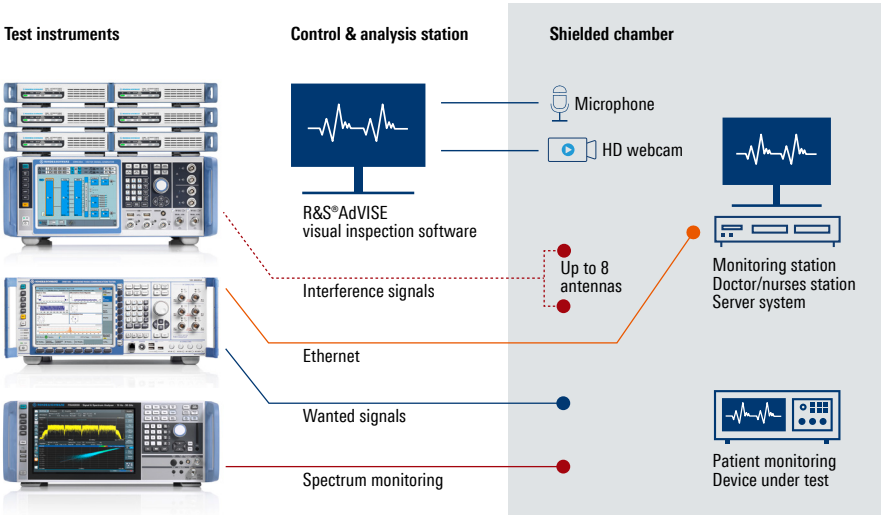
Given the proliferation of wireless medical devices, the FDA has identified wireless communications system risks and encourages wireless coexistence testing in line with existing standards. ANSI C63.27 specifies methods for assessing the radio frequency wireless coexistence of equipment that incorporates RF communications. The standard defines key performance indicators (KPI) for equipment under test (EUT) requiring monitoring of parameters such as latency, throughput and packet error rate.

## Complete test solutions

Rohde&Schwarz is a one-stop shop for all wireless RF coexistence test and measurement needs. Our solution for performing coexistence testing on medical devices involves placing the DUT in a fully-anechoic chamber for radiated testing applications. The R&S®CMW500 radio communication tester establishes active end-to-end connections with the DUT by emulating a non-cellular network (such as Bluetooth® and WLAN) as well as cellular networks (such as 3G, 4G and 5G).

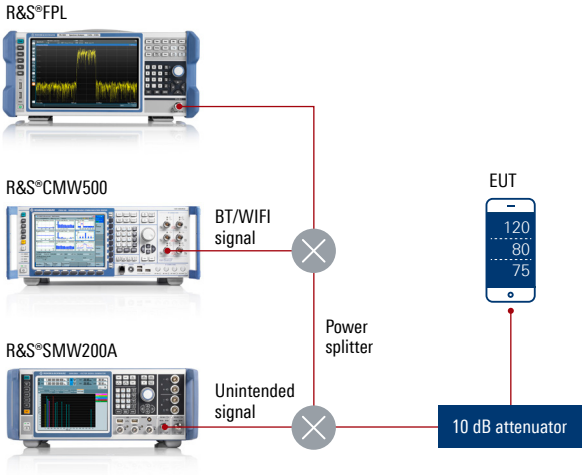
The R&S®SMW200A vector signal generator generates realistic wideband modulated EM interference signals. The interference station delivers up to eight fully calibrated EMI signals with the combination of six R&S®SGT units. The R&S®BBA150 high-power amplifier can boost the signal level in radiated testing for both the emulated network and the interference signal. The RF spectrum should be monitored during coexistence testing and is mandatory in most standards. The R&S®FSVA3000 spectrum analyzer monitors the RF spectrum in this test system.

## Example: Radiated testing solution




R&S®AdVISE inspection software uses commercial off-the-shelf HD webcams and microphones to monitor the application level KPIs such as audio and video quality in real time.

## Example: Conducted testing solution




Rohde&Schwarz test instruments such as the spectrum analyzer, signal generator and radio communications tester can also be used as standalone equipment for manual conducted measurements in line with ANSI C63.27 or easily automated with simple SCPI commands.

# COMPLIANCE EMC TESTING

Successful EMC certification is a major milestone when designing electronic products – and a source of high risks and costs in the go-to-market strategy. Minimizing these risks and costs is crucial, making early and consistent EMC testing vital to success.

Rohde&Schwarz is the global market leader for EMC compliance testing, with over 80 years of business experience in developing and producing cutting-edge test and measurement instruments and solutions. Our instrument designs meet and even exceed the latest EMC standards and customer requirements. Whether for electromagnetic interference (EMI) or electromagnetic susceptibility (EMS), Rohde&Schwarz has the test equipment and accessories for all necessary measurements.

## Medical test standards

| Standard | Description |
|---|---|
| ANSI C63.18 | On-site medical radiated RF immunity |
| ANSI C63.19 | EMC for hearing aids |
| CISPR 11 | Conducted and radiated emissions |
| IEC 61000-4-2 | ESD |
| IEC 61000-4-3 | Radiated immunity |
| IEC 61000-4-4 | Electrical fast transients/bursts |
| IEC 61000-4-5 | Power surge immunity |
| IEC 61000-4-6 | Conducted RF immunity |
| IEC 61000-4-8 | Magnetic fields |
| IEC 61000-4-11 | Voltage dips/interruptions |
| IEC 61000-3-2 | Current harmonics |
| IEC 61000-3-3 | Flicker and fluctuations |

### Electromagnetic interference (EMI)

Rohde&Schwarz EMI test receivers offer outstanding RF characteristics, including wide dynamic range and high measurement accuracy. They meet the most stringent requirements for certification measurements in line with CISPR, EN, MIL-STD-461, DO-160 and FCC. With their FFT-based time domain scan, they can capture and display disturbance spectra in virtually no time. The instrument's real-time spectrum analysis with spectrogram function permits detailed analysis of disturbance signals and their history. MultiView mode delivers a straightforward display of results, even for multiple operating modes.

### Electromagnetic susceptibility (EMS)

A product can be exposed to many different electromagnetic phenomena, including continuous RF signals such as emissions from a nearby transmitter, transitory disturbances such as noise introduced into the power grid due to device switching, or pulse-shaped disturbances resulting from electrostatic discharge. Tests of radiated and conducted EMS, ESD and direct power injection are the most common. Our reliable and powerful solutions allow customers to generate the signals needed to demonstrate the immunity of their electronic designs under defined circumstances.

### EMC test systems

Rohde&Schwarz EMC test systems are used to test electrical devices and equipment for compliance with applicable EMC standards. Rohde&Schwarz has the right solution for your requirements, ranging from small precompliance test systems through large, standard-compliant, fully automated systems. Our experts know the current EMC standards and are pleased to offer advice and define critical components such as amplifiers, antennas, test receivers and low-loss RF cables.

# HOSPITAL RADIO FREQUENCY (RF) SPECTRUM MONITORING

## WIRELESS NETWORK SECURITY AND RF INTERFERENCE HUNTING

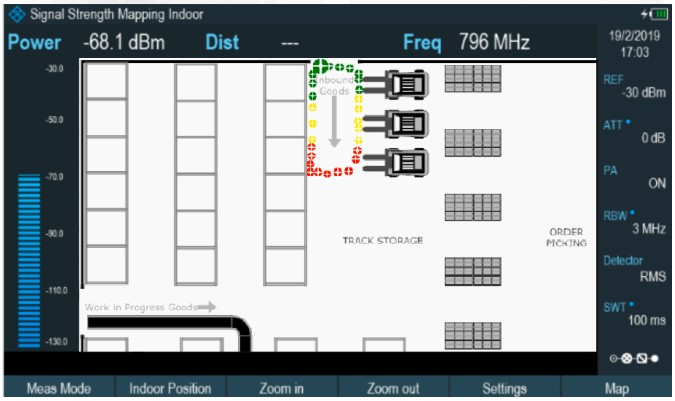
Despite careful frequency planning and management, interference is still a common problem for many radiocommunications services. Since healthcare facilities rely heavily on wireless communications technology to monitor patients and roll out new test procedures, the effects of radio interference can be as diverse as its causes.

For health-critical wireless communications services, interference needs to be resolved quickly and efficiently. This involves signal verification, identification and location, as RF interferers are invisible to the naked eye. Interference signals can have intentional or unintentional sources, be modulated or unmodulated, appear at any time and be located anywhere. Determining interference locations can be challenging and time-consuming.

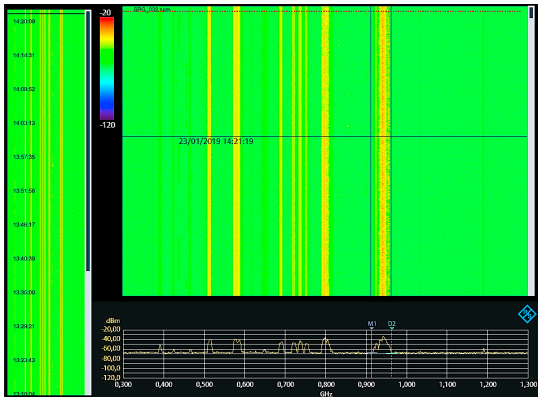
Experts can use ITU-compliant measurement tools to verify whether analog signal transmission satisfies the technical standards stipulated for licensed operation. There are a broad range of tools and functions to handle tasks such as interference hunting, geolocation of transmitters of interest, resolving on-site frequency conflicts and more.

### Portable monitoring receivers

- Detect, analyze and locate RF signals
- Wide range of tools for frequency and time domain analysis
- High RF performance optimized for use in dense spectrum environments
- Optimized for demanding field operation with minimal size, weight and power consumption
- Convenient, simple and intuitive to operate with application-oriented user interface




Monitor and postprocess interference behavior and combine signal strength measurements on your floorplan to locate interference sources.



# PROTECT YOUR PATIENT'S PERSONAL DATA AT ALL TIMES

The digitalization of the health sector is generating a flood of health data. Collection and processing of such data are subject to strict regulations. Since medical data is private and sought after, but also confidential, it must be protected. The data is also more exposed since a large number of stakeholders have access (hospitals, city doctors, laboratories, etc.). Connected devices with inadequate security are another source of exposure. This increases vulnerability to cyberattacks, making it more complex to protect such data from theft or leaks.

Many healthcare facilities are vulnerable due to aging equipment acting as a gateway for more IT system failures, leaving the data less protected than in other industries. Health sector application development is both increasing and accelerating exponentially in order to ensure the continuity and coordination of medical care. New applications can be subject to malfunction and become targets of malicious cyberattacks. All of the different stakeholders are now worried about the confidentiality and integrity of medical data.

## Regulatory compliance

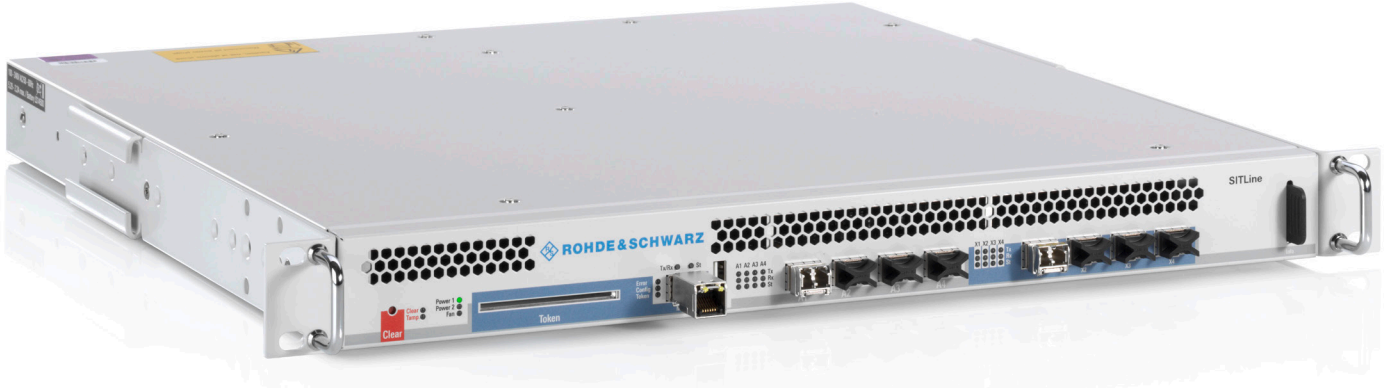
Healthcare organizations face ever more complex regulations. US healthcare establishments are subject to Health Insurance Portability and Accountability Act (HIPAA) regulations, as well as the amendments in the Health Information Technology for Economic and Clinical Health Act (HITECH). Outside the US, the European GDPR and the NIS Directive pose additional challenges for the international circulation of medical data. These regulations protect the confidentiality, integrity and availability of all medical information and help anticipate cyberattacks with adequate security measures.

## R&S®Trusted Gate – protecting medical data

Numerous healthcare establishments are moving forward with Microsoft 365 to take advantage of the cloud. R&S®Trusted Gate provides data security and protection for public clouds and collaboration tools. The solution is protecting medical data with dynamic encryption and virtualization technologies. Without compromising performance and flexibility, this solution can be implemented in hospital centers or any other healthcare establishment in line with current data protection regulations.

## R&S®SITLine ETH – protecting sensitive communications

The R&S®SITLine ETH product line protects sensitive data from spying and illicit manipulation in hospitals. The layer 2 encryption with cutting-edge methods and standards secures communications and the flow of data via Ethernet over landlines, radio relays and satellite connections. This solution significantly reduces operational costs, while maintaining high levels of security.



# CYBERSECURITY FOR HEALTHCARE PROVIDERS

Healthcare organizations realize the importance of adequate cybersecurity in their medical facilities, but their security updates are lagging because of budget shortages and lack of qualified staff. Rohde&Schwarz Cybersecurity solutions meet national security standards and can be used to secure applications, access technical, medical or patient applications and protect medical data. These solutions will ensure that healthcare institutions comply with standards by strengthening the information system's security policy and responding to different departmental requirements as well as ever increasing patient expectations. The solutions include features that facilitate integration and maintain staff productivity, while keeping costs low. The expert solutions from Rohde&Schwarz Cybersecurity ensure compliance with national and European laws and regulations, and are not subject to the Patriot Act or the CLOUD Act.

## Data availability

Healthcare operators require continuous and constant data availability. An outage of electronic prescription services or patient file access, or in an emergency room situation, can have severe consequences.

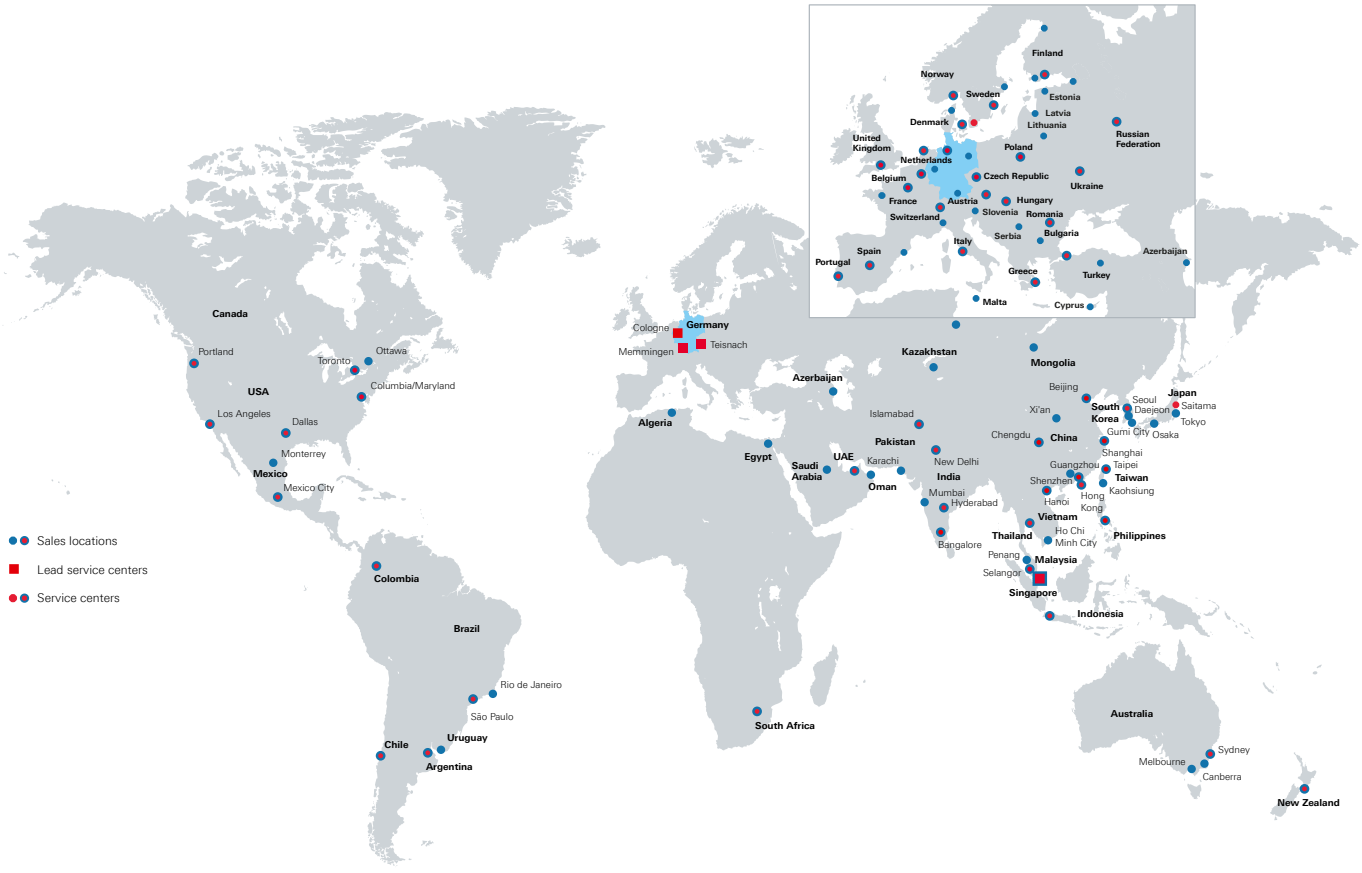
Even as budgets remain tight, IT systems remain essential – the availability of IT services, even in case of network failure, is actually a regulatory requirement. IT systems must ensure continuity of service even in case of malfunction or attempted cyberattacks.

# FROM PRESALES TO SERVICE. AT YOUR DOORSTEP.

## The Rohde&Schwarz network in over 70 countries ensures optimum on-site support by highly qualified experts.

User risks are reduced to a minimum at all project stages:

- Solution finding/purchase
- Technical startup/application development/integration
- Training
- Operation/calibration/repair



**Rohde&Schwarz**
The Rohde&Schwarz technology group is among the trailblazers when it comes to paving the way for a safer and connected world with its leading solutions in test&measurement, technology systems and networks&cybersecurity. Founded more than 85 years ago, the group is a reliable partner for industry and government customers around the globe. The independent company is headquartered in Munich, Germany and has an extensive sales and service network with locations in more than 70 countries.

www.rohde-schwarz.com

**Service that adds value**
- Worldwide
- Local and personalized
- Customized and flexible
- Uncompromising quality
- Long-term dependability

**Sustainable product design**
- Environmental compatibility and eco-footprint
- Energy efficiency and low emissions
- Longevity and optimized total cost of ownership

Certified Quality Management
ISO 9001

Certified Environmental Management
ISO 14001

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Test and measurement solutions for medical and health applications
Data without tolerance limits is not binding | Subject to change


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