ROHDE&SCHWARZ INSTRUMENT HEALTH GUIDE

For EMI test receivers – tips for avoiding instrument damage.

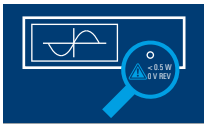
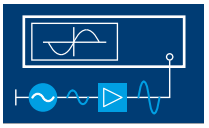
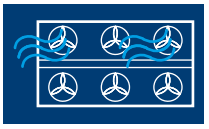
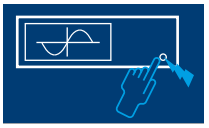
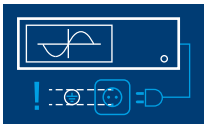
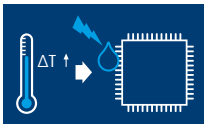
For further information on the topics below please consult

- ► the safety instructions
- ► the Windows malware protection white paper on the Rohde&Schwarz website
- ► the user manual for your instrument

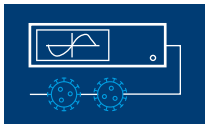
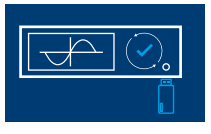
Flyer
Version 01.00

ROHDE&SCHWARZ
Make ideas real

PREVENTING ELECTRICAL DAMAGE

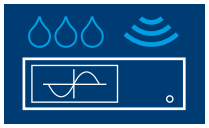
DO:	DO NOT:
 ► Consult the operating manual or data sheet for further information before using any port.	► Do not operate the instrument outside its specifications. ► Do not ignore warning labels placed at sensitive connectors.
 ► For unknown signals, always set high attenuation, AC coupling and use additional filters to avoid overloading. See more details in the chapter on preventing receiver overloading.	► Do not overload the instrument ports by exceeding the applicable input power or voltage limits specified in the data sheet.
 ► Ensure proper airflow by providing a minimum distance of 10 cm from other objects and by cleaning the fan inlets and outlets externally at regular intervals.	► Do not stack too many instruments. Instruments placed on top take in the hot air of lower ones, resulting in higher ambient temperature and potential overheating.
 ► Avoid electrostatic discharge by grounding yourself and disconnecting the receivers input when not in use. See more details in the chapter on preventing receiver overloading.	► Do not bypass the instrument's earth grounding protection by using a power or extension cable without a protective ground conductor.
 ► Consult the data sheet on the permissible characteristics of the instrument's power supply. Always use an AC power socket with a protective earth contact. Use a 3-wire power cable.	► Do not use any AC power cable other than that delivered with the instrument. Other cables may be of poorer quality and could result in damage to the instrument.
 ► Ensure that the ambient temperature is within the range specified in the data sheet.	► Do not operate the instrument if it shows signs of condensation. Condensation is the result of rapid temperature changes – following transport, for instance.

PREVENTING FIRMWARE ISSUES

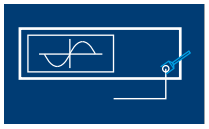
DO:	DO NOT:
 ► Read the Windows malware protection white paper available on the Rohde&Schwarz website and take the recommended precautions.	► Do not connect your instrument to computers or networks unless you are sure they are virus-free.
 ► Keep your instrument updated by sending it to R&S Service regularly or installing the latest firmware (FW) available on the R&S website. This also provides functional improvements and new features.	► Do not neglect critical FW updates. They protect your instrument from the latest malware and ensure it has necessary updates.

PREVENTING MECHANICAL DAMAGE

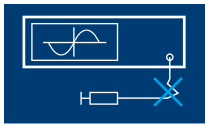
DO:



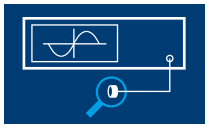
- Take preventive measures in humid environments or where excessive shock or vibration are present. High humidity can cause condensation. Excessive shock and vibration can cause components to become loose or even disconnected.



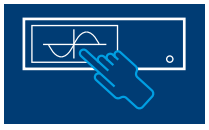
- Clean and inspect each connector prior to use. Make sure to align the connectors on the cable and the instrument along a common axis before tightening. Turn the outer connector nut, not the cable itself. Use a calibrated torque wrench to tighten the connector with the specified torque.
- Always use the supplied RF adapters to protect the instrument connectors.



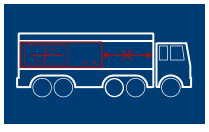
- Use cables of the proper length to avoid bending cables. Repeatedly bending cables increases wear.



- Look for dirt and damage to the outside and inside of the conductor before using any cable. If the conductor is dirty, use compressed air to dislodge larger debris. Use foam cleaning swabs moistened with isopropanol alcohol or use wooden cocktail sticks to remove the remaining dirt. Dry the connector using compressed air.



- Use your fingers or a stylus pen when touching the screen. Use a soft, dry, lint-free dust cloth for cleaning.



- Use the original packaging for transportation. It is specifically designed to prevent mechanical damage and provide ESD protection. If the original packaging is lost, it can always be ordered separately.

DO NOT:

- Do not operate the instrument in a wet or polluted environment or expose it to high electromagnetic interference. These conditions can cause premature aging or damage to the instrument.
- Do not tighten cables too much or too little. Overtightening can damage cables and connectors, and insufficient tightening can lead to inaccurate measurement results.
- Do not mix incompatible connector systems.
- Do not put too much load on connectors. Connectors are sensitive and can easily be damaged. Avoid cascading multiple adapters. Instead, use the correct adapter for each connected system.
- Do not sharply bend cables. This can result in reflections and may cause permanent cable damage.
- Do not apply too much pressure when cleaning the inside of connectors with foam cleaning swabs or wooden cocktail sticks. On female connectors with air dielectrics, the slotted inner conductor contacts are easily bent. On male connectors, the center pin is easily bent.
- Do not use cleaning agents as they can dam age the screen, panel labeling or plastic parts. Never touch the screen with a ballpoint pen or other sharp object.
- Do not leave empty space in the transport box. Loosely packed cargo is easily damaged. Never use styrene pellets for packaging as they do not provide proper cushioning.

PREVENTING INSTRUMENT OVERLOADING

Receivers are designed to measure small signals with the lowest possible noise floor. At the same time, interference measurements set the highest requirements on dynamic range to resolve pulsed emissions at unknown power levels. To precisely measure interference in such a demanding environment, the receiver's hardware is more complex than for any other instrument. Even though the receiver's hardware offers dynamic range at the highest, the upper acceptable power is somewhere limited. The instruments have internal protection measures in place, but they cannot guarantee the prevention of any damages. If the upper limits are exceeded, permanent component damages can result from input overloading. Consequentially, it is important to reduce risks. Costly repairs and instrument outages can result from such overload damages. To avoid those, the following sections help to understand the instrument limitations and presents measures to avoid input overloading.

MAX. INPUT LEVEL DATASHEET PARAMETERS

The maximum acceptable input level limits are given in the datasheet by multiple parameters. Different signal situations can lead to an instrument overload, a narrow band signal is not the same as broadband or pulsed signal. Consequentially, the receiver's datasheet informs about a number of different parameters:

Parameter	Description	How to prevent overloading
DC voltage	When DC coupled for accurate measurements below 10 MHz, the instruments input stage doesn't withstand any DC voltage. AC coupling protects the instrument against smaller DC voltages with a capacitive input network.	Use AC coupling for every measurement above 10 MHz. For measurements below 10 MHz, make sure no DC voltage is introduced to the input port.
CW RF power	Defines the maximum input power in dBm depending on attenuator and preamplifier settings. The preamplifier as an active component is very sensitive to overloading.	Use at least 10 dB attenuation and turn off the preamplifier if larger signals are expected (e.g. conducted measurements).
Pulse spectral density	Defines the maximum level reading normalized to 1 MHz RBW. Pulsed signals can introduce high power on a wide bandwidth without high voltage levels. The limit is significantly reduced at lower RBW: ▶ -74 dB @ 200 Hz ▶ -41 dB @ 9 kHz ▶ -18 dB @ 120 kHz ▶ 0 dB (reference) @ 1 MHz The specification relates to Peak detector reading. Depending on signal characteristics, weighting detectors might show lower levels than introduced to the input.	Keep in mind the total power introduced to the instrument, even if large spectral power is out of the investigated span. Reduce the total power by limiting the signals bandwidth with filtering. In addition to the preselection filter of the receiver, notch filters or high pass filters help to reduce the spectral energy. The R&S®ESW features notch filters for 2.4 GHz and 5 GHz ISM bands as well as selectable high pass filters for the conducted band.
Max. pulse voltage	Defines the maximum pulse voltage for the shortest time. Receivers with a 2nd input have an additional (switchable) pulse limiter that accept an increased pulse voltage.	Use the 2nd receiver input with internal pulse protection, external pulse limiters or switch on the LISN's internal pulse limiter.
Max. pulse energy	While the max. pulse voltage is the limit for extreme short voltage peaks, the max. pulse energy describes the limit with relation to the pulse duration. The longest time the input resists a pulse with voltage U can be derived by: $t = \frac{E_{limit} \cdot 50\Omega}{U^2}$	Pulses are critical as they carry a high energy. Attenuation at the input and the use of input 2 with the pulse limiter protects the receiver especially for unknown high energetic signals.

SAFETY MEASURES TO PREVENT OVERLOADING

Avoid ESD

Do not touch the antenna! Antennas expose the inner core of the receiver's input. Touching them with the receiver connected can lead to damages from Electrostatic discharge (ESD). ESD is a sudden flow of electric current from a charged object to the ground reaching short pulsed voltages of up to 10.000 V. When discharging through an antenna, the receiver input will immediately get overloaded and destroyed. Use ESD protection as grounded shoes, wristbands, etc. to avoid charging, disconnect the antenna from the receiver when not in use and remember to never touch the antenna.

The R&S®ESW features and RF Input OFF button to internally disconnect the input without the need to physically disconnect the antenna.

EMC automation software as R&S®ELEKTRA can disable the antenna connection between measurements.

Touching the antenna can lead to damages from Electrostatic discharge (ESD)

Add attenuation

Choosing the right attenuation level is a trade-off between instrument overload at to low attenuation and lost dynamic range or sensitivity with choosing to high attenuation. By adding attenuation to the input path, the acceptable input signal range is expanded towards higher powered signals. Signals in the overrange will lead to an overload detected and displayed by the instrument. By adding attenuation, we reduce all levels and avoid the overload. In order to maximize the dynamic range, it is desired to reduce the attenuation to the lowest possible while ensuring the safe and correct operation without having levels in the overrange. Per default, all receivers have a minimum of 10 dB attenuation selected, disable only if signal level is known to be small.

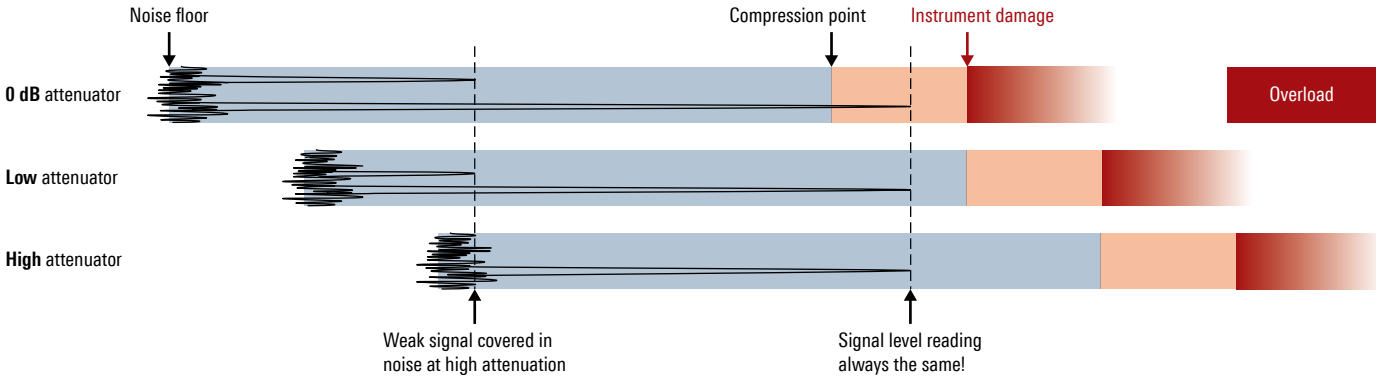


Figure 2 Two signals read with changed attenuation levels to maximize dynamic range while safely operating the instrument. With 0 dB attenuation the instrument is overloaded, leading to potential inconsistencies and/or damages. The high attenuation loses sensitivity with increased noise floor, the weak signal is hidden in the noise. The best compromise is the low attenuation, ensuring best dynamic range and safe instrument operation.

Preselection filters

One core component of a receiver is the preselection. This filter bank consists of a large number of analog band pass filters that ensure frequency selectivity. This does not only reduce the required attenuation (see Section on "Add attenuation") and therefore increases dynamic range, but also protects the receiver against large power from out of band signals. Be aware of large signals out of the investigated span, that might overload the receiver. Always enable the preselection filters. For R&S®ESW and R&S®ESR, preselection is always turned on in Receiver Mode, but optionally in Spectrum Mode.

Attenuation Auto Ranging

"Auto Ranging" is a useful function to automatically find the right attenuation for each input signal. The function explicitly does not act as an overload prevention but helps optimizing the attenuation level for best sensitivity (see Section on "Add Attenuation"). For unknown and potentially high-power signals, use a high manual attenuation level instead of "Auto Ranging" as the function might not range up fast enough to prevent instrument damage. When using "Auto Ranging" always keep the "10 dB minimum" active.

LISN with pulse limiter and additional filters

Conducted testing typically involves high signal levels, in some cases with strong carriers. Modern Line Impedance Stabilization Networks (LISN) used for decoupling of conducted emissions on power or data lines, are equipped with internal pulse limiters and filters. It is highly recommended to activate those to reduce the risk of damages from strong pulses or high signal power. Filters limit the signal bandwidth to reduce the overall spectral power transferred to the instruments input.ducted tests. There are also external pulse limiters available (R&S®ESH3-Z2). Receivers featuring an input 2 with internal pulse limitation offer the same protection functionality if used with LISN's that don't come with a pulse limiter. Make sure to add attenuation in the receiver setting when performing conducted tests. There are also external pulse limiters available (R&S®ESH3-Z2).

DC blockers for active antennas with phantom powering

Active antennas with internal preamplifier are often supplied with power via a bias tee (e.g. R&S®IN600) over the antenna cable. A faulty connection of the bias tee can lead to a direct feed of the bias power to the receiver's input and will consequentially damage it. Make sure to correctly connect the bias tee.

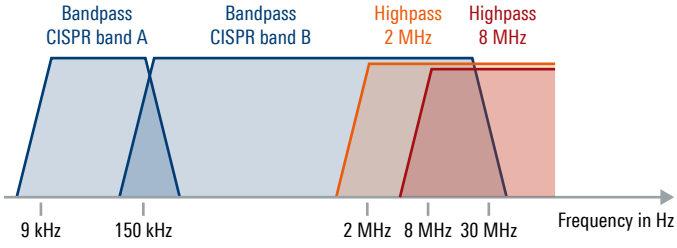
Other applications require the use of e.g. internal vehicle antennas that might feature phantom powering. AC coupling or external DC blockers (e.g. R&S®FSE-Z4) avoid instrument damage from unknown phantom power.

AC coupling

DC voltage on active components such as mixers, amplifiers or switches lead to component damages. As a consequence, it is not allowed to apply any DC voltage to the receiver input path. To ensure a safe operation, the AC coupling adds capacitors to the input to block up to 50 V of DC. This high pass filter will influence the level reading in the low frequency range, so that it is needed to switch to DC coupling for measurements below 10 MHz. Always make sure no DC voltage is applied to the instrument when switching to DC coupling and use AC coupling in any other testing scenario!

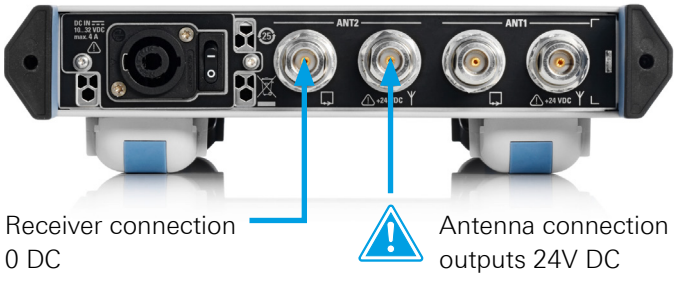
Notch and high pass filters

Power electronics often emit high interference levels from fast switching and corresponding short rise and fall times as well as high clock frequencies of e.g. switched power supplies, converters, etc. typically in the low MHz range. Additional to the preselection filters covering the CISPR bands A and B, high pass filters help to reduce spectral power. This allows more sensitive measurements at lower attenuation (see Section on "Add attenuation"). The same principle applies for notch filters, allowing the suppression of intended traffic in the ISM bands. Rejecting the ISM band with high spectral power, the sensitivity in neighboring frequency ranges is increased to enable safe measurements at low signal levels.



R&S®ESW: Selectable high pass filters (in addition to preselection) for increased sensitivity in presence of large signals below 2 MHz and/or below 8 MHz

R&S®IN600



THE ROHDE & SCHWARZ TECHNOLOGY ACADEMY.

PRACTICAL KNOWLEDGE.

All of our courses are designed and delivered with real-world applications in mind. You will be able to apply your newly acquired knowledge, combined with proper certification, to your workplace, increasing both your own and your employer's productivity.

INDUSTRY INSIGHT.

With decades of radio frequency expertise, combined with years of industry specialization, Rohde & Schwarz offers unique industry insights through the best technical training courses available on the market.

REAL EXPERTS.

The Rohde & Schwarz Technology Academy helps technical professionals develop valuable skills and gain deep knowledge through a range of high-quality and practical training courses delivered by real-world experts, certified at manufacturer's quality.

Find more information: https://training.rohde-schwarz.com

Service at Rohde&Schwarz
You're in great hands

- Worldwide
- Local and personalized
- Customized and flexible
- Uncompromising quality
- Long-term dependability

Rohde&Schwarz

The Rohde&Schwarz electronics group offers innovative solutions in the following business fields: test and measurement, broadcast and media, secure communications, cybersecurity, monitoring and network testing. Founded more than 80 years ago, the independent company which is headquartered in Munich, Germany, has an extensive sales and service network with locations in more than 70 countries.

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

Rohde&Schwarz training
www.training.rohde-schwarz.com

Rohde&Schwarz customer support
www.rohde-schwarz.com/support

PD 3685.0034.32 | Version 01.00 | November 2023 (nk)
Rohde&Schwarz instrument health guide for EMI test receicers
Data without tolerance limits is not binding | Subject to change

3685003432
3685.0034.32 01.00 PDP 1 en