

R&S®RSC

Step Attenuator

User Manual



1313891002

Version 05

ROHDE & SCHWARZ

Make ideas real



This manual describes the R&S®RSC and its instrument variants:

- R&S®RSC base unit without attenuator 1313.8004.02
- R&S®RSC attenuator up to 6 GHz from 0 dB to 139 dB in 1 dB steps
1313.8004.03/13
- R&S®RSC attenuator up to 6 GHz from 0 dB to 139 dB in 0.1 dB steps
1313.8004.04/14
- R&S®RSC attenuator up to 18 GHz from 0 dB to 115 dB in 5 dB steps
1313.8004.05/15
- External attenuator up to 40 GHz and an attenuation range from 0 dB to 75 dB
in 5 dB steps (R&S RSCZ405 1313.9952.02).
- External attenuator up to 67 GHz and an attenuation range from 0 dB to 75 dB
in 5 dB steps (R&S RSCZ675 1314.0065.02).

The software contained in this product uses several valuable open source software packages. For information, see the "Open Source Acknowledgment" on the user documentation CD-ROM (included in delivery).

Rohde & Schwarz would like to thank the open source community for their valuable contribution to embedded computing.

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1313.8910.02 | Version 05 | R&S®RSC

The following abbreviation is used in this manual: R&S®RSC is abbreviated as R&S RSC

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1 Documentation overview

This section provides an overview of the R&S RSC user documentation. Unless specified otherwise, you find the documents at:

<https://www.rohde-schwarz.com/manual/RSC>

User manual

The user manual is supplied with the delivery in printed form. It contains descriptions for all instrument functions and for remote control of the instrument. In addition, it contains notes on preventative maintenance for the R&S RSC and on troubleshooting based on the warnings and error messages that the instrument emits.

The user manual is also included on the documentation CD-ROM that is supplied with the delivery.

HTML help

The context-sensitive help is installed on the R&S RSC in its standard configuration. It supports you in operating the R&S RSC and its options, both manually and remote via control.

A modern HTML5 variant is available on the internet and supplied on the documentation CD-ROM.

Service manual

Describes the performance test for checking the rated specifications, module replacement and repair, firmware update, troubleshooting and fault elimination, and contains mechanical drawings and spare part lists.

The service manual is available for registered users on the global Rohde & Schwarz information system (GLORIS):

See <https://gloris.rohde-schwarz.com>.

Instrument security procedures

Deals with security issues when working with the R&S RSC in secure areas.

It is available for download on the internet and also included on the documentation CD-ROM.

Data sheets and brochures

The data sheet contains the technical specifications of the R&S RSC. It also lists the firmware applications and their order numbers, and optional accessories.

The brochure provides an overview of the instrument and deals with the specific characteristics.

See <https://www.rohde-schwarz.com/brochure-datasheet/RSC>.

Open source acknowledgment (OSA)

The R&S RSC firmware makes use of several valuable open source software packages. An open-source acknowledgment document provides verbatim license texts of the used open source software.

It is included on the documentation CD-ROM supplied with the delivery.

2 Introduction

The R&S RSC attenuator is a fast and accurate instrument for setting precisely defined attenuation values. Depending on the specific model, attenuation can be set at a value between 0 dB and 139.9 dB in the frequency range up to 18 GHz. In addition, external attenuators are available, which can be remotely controlled with the base unit.

The following models are available:


- Base unit: Instrument without internal attenuator.
- Attenuator up to 6 GHz and an attenuation range from 0 dB to 139 dB in 1 dB steps.
- Attenuator up to 6 GHz and an attenuation range from 0 dB to 139.9 dB in 0.1 dB steps.
- Attenuator up to 18 GHz and an attenuation range from 0 dB to 115 dB in 5 dB steps.
- External attenuator up to 40 GHz and an attenuation range from 0 dB to 75 dB in 5 dB steps.
- External attenuator up to 67 GHz and an attenuation range from 0 dB to 75 dB in 5 dB steps.

With all models, it is possible to connect and control up to 4 external attenuators.

3 Putting the instrument into operation

The R&S RSC attenuator is available in different models. You can equip the base unit with an internal attenuator and/or use it with up to four external attenuators, see [Chapter 2, "Introduction"](#), on page 7. The following description applies to all models; differences are pointed out explicitly where relevant.

The section below describes how to put the instrument into operation, connect external instruments and integrate the R&S RSC into a network. General notes are provided to ensure safety while operating the instrument.

 Please note that the general safety notes at the beginning of this manual also contain information about operating requirements to prevent damage to the instrument. In addition, the instrument's data sheet can contain further operating conditions.

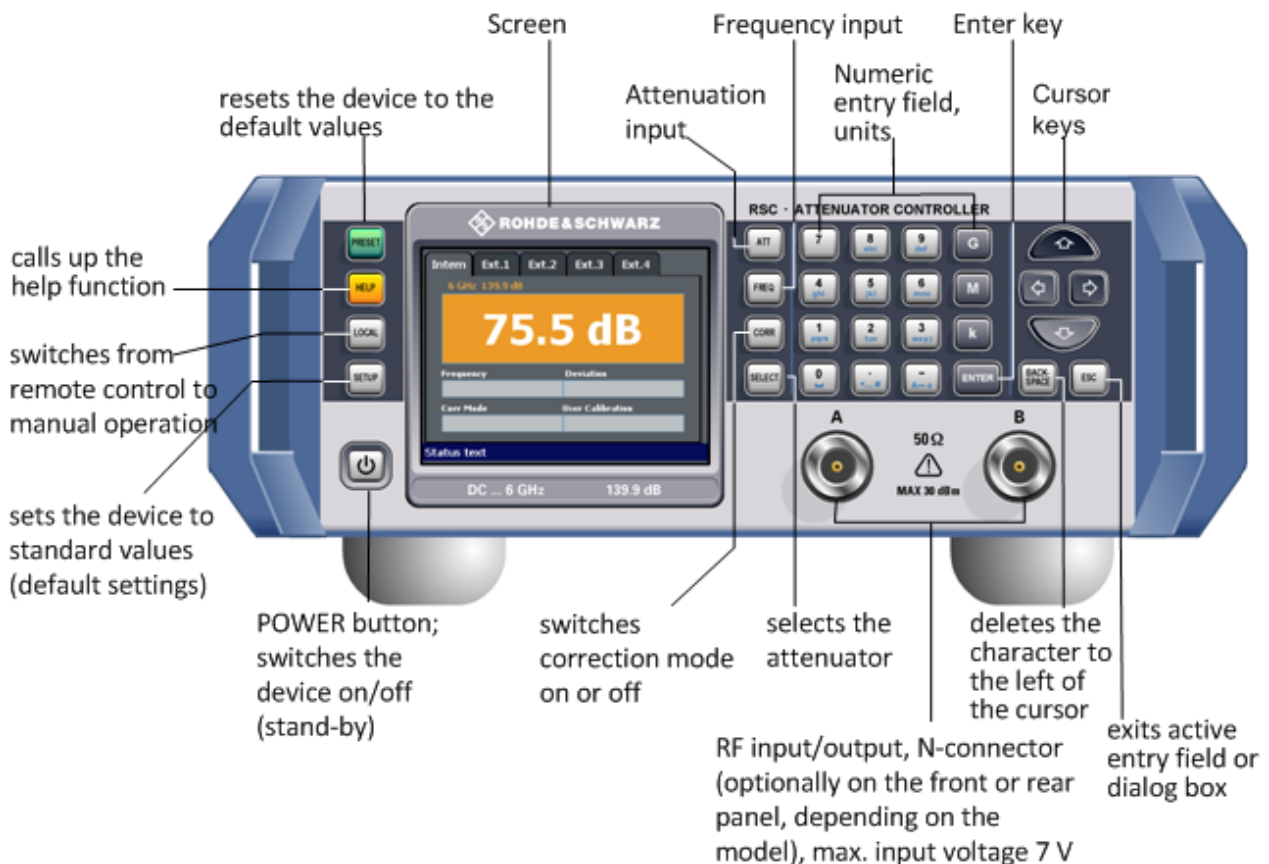
3.1 Explanation of the front and rear views

This chapter shows all function keys, control elements and connections on the front and rear of the R&S RSC.

3.1.1 Front view

The figure below shows the controls and connections on the front of the instrument.

Explanation of the front and rear views

**RF port**

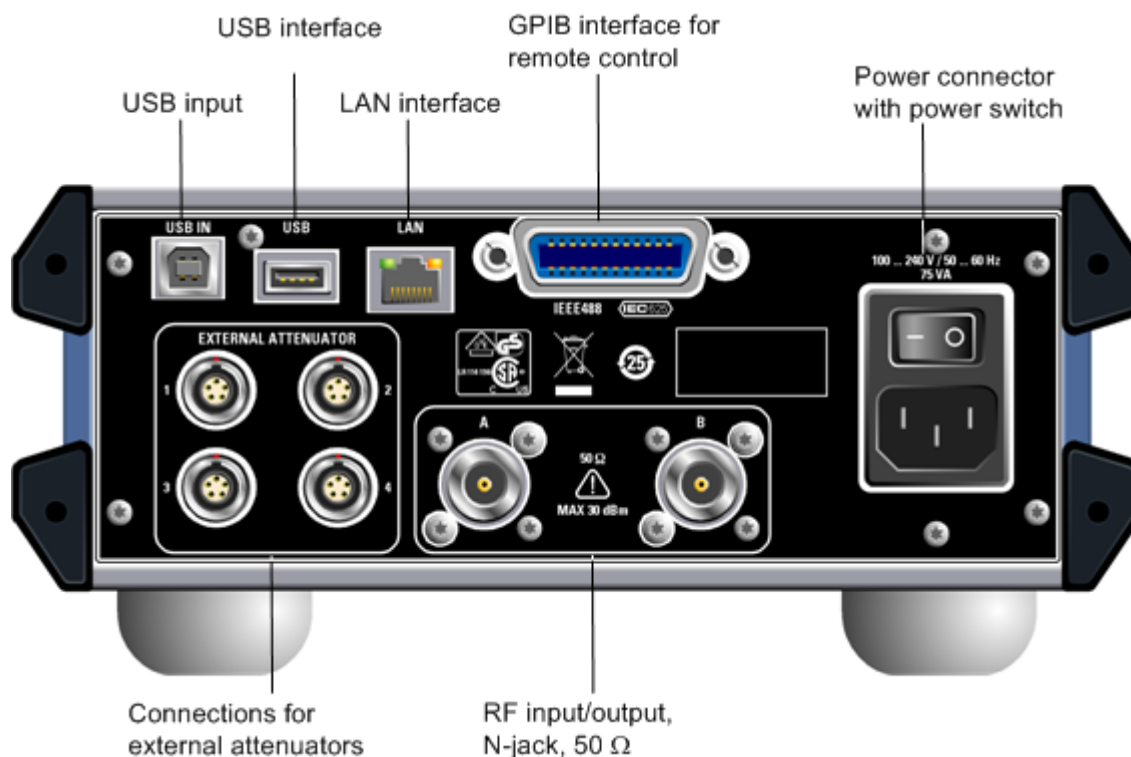
The two RF ports, "A" and "B", can be used as either an input or output port. Depending on the specific model, these interfaces are located on either the front or rear panel.

NOTICE**Possible damage due to overloading**

Ensure that the input level does not exceed 30 dBm (corresponds to 7 V or 1 W).

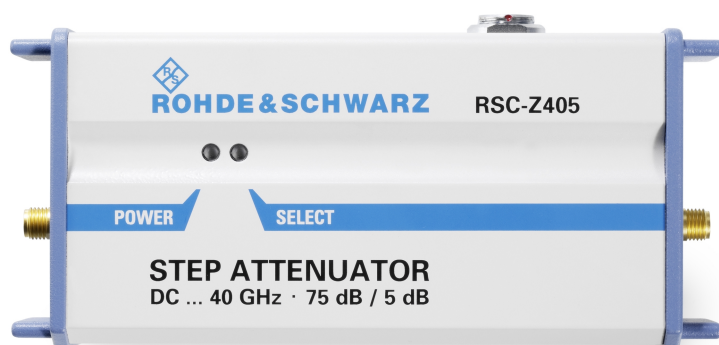
3.1.2 Rear view

This section shows all interfaces on the back of the R&S RSC.



3.1.3 View of the R&S RSC-Zxx

This view shows the external R&S RSC-Zxx attenuator.



3.2 Preparing the instrument

This section covers the basic steps required for setting up the R&S RSC and putting it into operation.

CAUTION

Safety precautions

Be sure to follow the instructions in the sections below to prevent injury to people or damage to the instrument. Following the instructions is particularly important the first time that you use the instrument. In addition, be sure to observe the general safety notes at the beginning of this manual.

3.2.1 Unpacking the instrument

The instrument is delivered together with the accessories in a cardboard box. Proceed as follows to unpack its contents:

1. Remove the instrument from its packaging.
2. Check the shipment for completeness by comparing it with the shipping document and the accessory lists for the various items.
3. Remove the protective cover made of corrugated cardboard from the rear of the instrument.
4. A corrugated cardboard cover protects the front of the instrument; carefully unthread this cover from its location in the instrument handles and remove it.
5. Check the instrument for any damage. If there is any damage, immediately contact the shipping company that delivered the instrument. In this case, be certain that you keep the cardboard box and packing materials.



Packing materials

We recommend that you retain the packaging. Keep the original packing material to prevent control elements and connectors from being damaged if the instrument has to be transported or shipped later.

3.2.2 Setting up the instrument

This instrument is designed for indoor use.

Always place the product on a stable, flat and level surface with the bottom of the product facing down. If the product is designed for different positions, secure the product so that it cannot fall over.

If the product has foldable feet, always fold the feet completely in or out to ensure stability. The feet can collapse if they are not folded out completely or if the product is moved without lifting it. The foldable feet are designed to carry the weight of the product, but not an extra load.

If stacking is possible, keep in mind that a stack of products can fall over and cause injury.

If you mount products in a rack, ensure that the rack has sufficient load capacity and stability. Observe the specifications of the rack manufacturer. Always install the products from the bottom shelf to the top shelf so that the rack stands securely. Secure the product so that it cannot fall off the rack.

NOTICE**Possible damage to the instrument from overheating**

Restricted air current or excessively high ambient temperatures can cause the instrument to overheat.

To ensure sufficient air supply, all fan openings must be clear, and the air-flow at the vents on the sides of the instrument must not be impeded. The instrument must be positioned at least 10 cm away from the wall.

The ambient temperature must lie within the range specified in the data sheet.

NOTICE**Potential damage caused by electrostatic discharge**

Electrical discharges can damage components of the instrument or a connected instrument under test.

For this reason, the instrument must only be operated at a workplace that is protected against electrostatic discharge.

The following methods can be used separately or in combination to protect against electrostatic discharges:

- Protective wrist strap with a ground conductor
- Conductive floor covering combined with use of a heel grounder

NOTICE**EMI Suppression**

To suppress electromagnetic interference (EMI), the instrument can only be operated when it is closed and all covers are in place. The instrument's EMC rating is specified on the data sheet.

To prevent influences that cause disturbances, the following conditions must be adhered to:

- Use suitable double-shielded cables.
- Do not use any USB cables that are longer than 1 m.
- Only use USB devices that maintain the permitted EMC values.
- For the LAN connection, use CAT6 or CAT7 RJ-45 cables (LAN, Ethernet)

3.2.3 Connecting the R&S RSC to the AC power supply

NOTICE**Possible damage to the instrument**

Before you connect the instrument and turn it on, you must ensure observance of the following points to prevent damage to the instrument:

- The housing covers must be in place, and their screws must be fastened.
- The ventilation openings must be clear; it must be ensured that air can freely exit at the back of the instrument and at the holes on the sides. The minimum distance to the wall can, therefore, be at least 10 cm.
- The instrument must be dry.
- The instrument should only be operated in the horizontal position on an even surface.
- The ambient temperature must be within the range specified in the data sheet.
- It must be ensured that none of the voltage levels at the inputs exceed permissible limits.
- Explanation:
Measuring circuits as defined in section 6.7.4 of EN61010-1
Measuring category I is intended for measurements on circuits that are not connected to the high-voltage current system.
- It must be ensured that the instrument outputs are not overloaded or incorrectly connected.

When the instrument is connected to the AC supply, it automatically adjusts to the AC supply voltage (see the labeling for the voltage range). Do not manually adjust the instrument to a specific voltage or to change the fuse.

3.2.4 Turning the instrument on and starting



1. Use the supplied power cable to connect the R&S RSC to the AC power supply.

⚠ CAUTION**Danger of electric shock**

The attenuator complies with the specifications for the EN61010-1 protective class, which means that it can only be connected to a power outlet that has a protective contact.

2. Switch the power switch to [I].

The power switch has two positions:

- [0]: The instrument is disconnected from the AC supply.
- [I]: The instrument is receiving power from the AC supply.



3. Press the [POWER] (stand-by) button on the front of the instrument.

Depending on actuation of the POWER (stand-by) button, the instrument is either in stand-by mode or it is turned on.

After the instrument is turned on, the BIOS version that is installed and the computer characteristics are displayed on the screen for several seconds.

The Linux operating system boots and then starts the instrument's firmware. While its firmware is loading, the instrument performs a self test.

The R&S RSC loads the instrument's most recent state, if the previous measurement was ended properly. The booting process is complete when the R&S RSC's

standard image appears on the screen. The instrument is now ready for operation, and it can be operated manually or via remote control.

3.2.5 Switching the instrument off

NOTICE**Possible data loss due to premature switch-off**

If, during operation, you switch off the power switch on the back of the instrument loses its current settings. This is also the case, if you pull out the power plug before the operating system has powered down properly. In addition, it is possible that data will be lost and that problems will arise the next time the instrument is turned on.

Always press the [POWER] (stand-by) button on the front of the instrument beforehand to shut down the application properly.

To switch the R&S RSC off, proceed as follows:

1. Press the [POWER] (stand-by) button on the front of the instrument.
The instrument switches to stand-by mode, which means that the current configuration is stored. The R&S RSC application is closed, and the Linux operating system is shut down.
2. To separate the instrument completely from the AC supply, switch the power switch on the rear of the instrument to "0".
3. Disconnect the power cable at the AC power supply.

3.3 Function check

The R&S RSC automatically monitors the most important instrument functions when it is turned on.

3.4 Default settings

To set the instrument to a defined state, press the [PRESET] button on the front of the instrument.

This function resets all the instrument's settings to the default values, even if a mode is not currently turned on. The following table shows the most important parameters and their default settings:

Display	Switch to main screen
Main screen	Display of the internal attenuator. If no internal attenuator is installed, the first externally connected attenuator is displayed.
Attenuation	Max. (including external attenuators)
Frequency	Min.
Correction	Off
User Cal	Off
Abs/Rel	Rel
Offset	0 dB

3.5 Linux operating system

NOTICE

Possible impairment of instrument functions

The instrument runs the Linux operating system.

At the factory, the operating system configuration was tuned for ideal support of the attenuator functions. Change system settings only when the configuration of a connected network deviates from the standard settings.

After the R&S RSC is turned on, the operating system is loaded and the instrument's firmware starts automatically. Access to the operating system is locked. All required system settings can be defined in the setup menu. The instrument is equipped with internal flash memory. The flash memory contains the operating system, the firmware and the stored user data. Data can be transferred via the

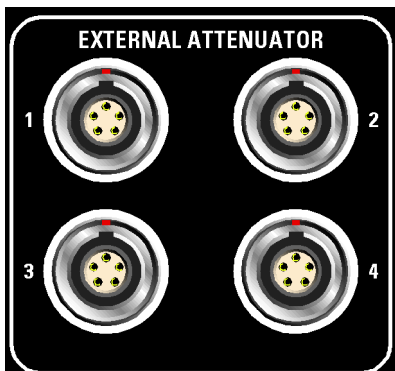
USB port using a USB flash drive. You can use the file manager to access the USB flash drive.

3.6 Connecting external devices

The R&S RSC is equipped with different interfaces, for example for connecting external attenuators or USB devices or for connecting to a network. Furthermore, the instrument is equipped with interfaces for integration into a network, see [Chapter 3.6.3, "Integrating the R&S RSC into a network"](#), on page 20.

3.6.1 Connecting external attenuators

The R&S RSC is equipped with 4 connections on the rear panel for external attenuators as standard. The sockets are labeled with [EXTERNAL ATTENUATOR 1...4].



The external attenuator is connected to the R&S RSC's rear panel sockets using an RSC-Z41 cable. An RSC-Z42 cable with a standard USB plug on one end is used to connect to a computer.

If an external attenuator is detected, it is initialized automatically. Autodetection can take a few seconds when connecting for the first time. A USB symbol is displayed in the status bar at the bottom edge of the screen during this time.



Initialization finishes more quickly if an attenuator has been connected to the RSC before.

The POWER LED on the external attenuator lights up in green after being connected. The SELECT LED lights up in orange after initialization or if the corresponding attenuator was selected using the [SELECT] button.

3.6.2 Connecting USB devices

You can connect different peripheral devices to the [USB] port (type A) at the back of the R&S RSC, such as:

- A USB flash drive for simple transmission of data, such as firmware updates, to or from a computer.
- A keyboard for easier operation and data entry, for example for data, comments, file names

All USB devices can be connected to or removed from the instrument during operation.

3.6.3 Integrating the R&S RSC into a network

NOTICE**Possible disturbance of network operation**

We recommend that you coordinate the connection of the instrument to a network with the network administrator. Connection errors can affect the entire network.

To ensure reliable detection of the network connection and to avoid faults during operation of the instrument, insert or remove the network cable only when the instrument is turned off.

The R&S RSC is equipped with a network interface, and can be connected to an Ethernet LAN (Local Area Network).

You can use this interface to transmit data between a control unit and the R&S RSC, if the network administrator has granted the required access rights, and has configured the Linux firewall accordingly. An example is for executing a remote control program. See chapter [Chapter 7, "Remote control"](#), on page 47.



The connection to the LAN is made using a commercially available RJ-45 cable via the LAN interface on the back of the instrument.

3.6.3.1 Configuring the R&S RSC for network operation

The network interface works with a 100 MHz IEEE 802.3u Ethernet. The TCP/IP network protocol and the associated network services are preconfigured. To exchange data in a local area network (LAN), it must be possible to address each connected computer or instrument via a unique IP address or a unique computer name. Access privileges among the different subscribers are controlled using access rights.

In this case, a unique computer name is used for identification within the network. Every R&S RSC is provided with a unique computer name right from the factory.

3.6.3.2 Networks with DHCP

The R&S RSC is preconfigured for use with networks that use the dynamic host configuration protocol (DHCP). In such networks, the R&S RSC is automatically assigned a free IP address.

Every R&S RSC is provided with a unique computer name right from the factory. You can call up and change this name in the setup menu under "Setup>IO" "Setup> LAN Setup". The corresponding mode is "DHCP+Auto".

3.6.3.3 Networks with assignment of static IP addresses

In networks that use static IP addresses, the addresses are usually assigned by the network administrator. A static IP address must be entered in the setup menu under Setup>IO Setup> LAN Setup. The corresponding mode is "Static IP".

3.6.3.4 Point-to-Point connections

Establishing a simple network – a LAN connection between an R&S RSC and a computer without integration into a larger network – requires assignment of an IP address for the R&S RSC and the computer. The 192.168.xxx.yyy IP addresses are available for this. The values for xxx and yyy range from 1 to 254; the value for the subnet mask is always 255.255.255.0. The IP address for the gateway must also be specified, but it is not of significance in this case.

Example:

On the PC:

1. Open the TCP/IP Settings window (Control Panel > Network Connections)
2. Set to static IP address (= deactivate DHCP)
3. Enter the IP address 192.168.0.1
4. Enter subnet mask 255.255.255.0

On the attenuator:

1. Press the [SETUP] key.
2. Using the cursor key, navigate to "IO Setup", and press the [ENTER] key.
3. Using the cursor key, navigate to "LAN Setup", and press the [ENTER] key.
4. Click "Static IP".
5. Using the cursor key, navigate to "IP Address" and enter the IP address 192.168.0.1.
6. Using the cursor key, navigate to "Subnetmask" and enter the subnet mask 255.255.255.0.

3.6.3.5 Network settings in the R&S RSC

1. Press the [SETUP] key.
2. Using the cursor key, navigate to "IO Setup", and press the [ENTER] key.
3. Using the cursor key, navigate to "LAN Setup", and press the [ENTER] key.
4. Enter the network data into the corresponding menu fields. The data is made available by the network administrator. You can change the computer name that is displayed in the "Computer name" field.

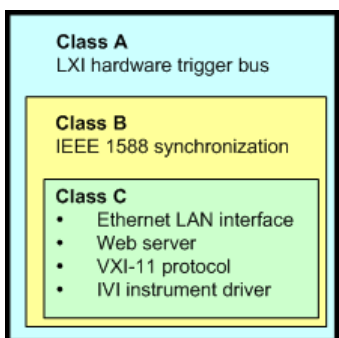
3.7 Configuration using LXI

LXI (LAN eXtensions for Instrumentation) is a platform for measuring instruments and test systems that is based on standard Ethernet technology. LXI is intended

to be the LAN-based successor to GPIB, combining the advantages of Ethernet with the GPIB's simplicity and familiar features. This standard provides a new way to configure virtual front panel instruments by using a network and a Web interface. The main tool for this configuration method is a browser such as Google Chrome, Microsoft Edge or Firefox.

3.7.1 LXI classes and LXI functions

LXI-compliant instruments are divided into three classes, A, B and C. The functionality of these classes expands hierarchically from one level to the next:



- Class C instruments are characterized by a common LAN implementation, including an ICMP ping responder for diagnostics. The instruments can be configured via a web browser; a LAN configuration initializes (LCI) mechanism resets the LAN configuration. Class C LXI instruments should also support automatic detection in a LAN via the VXI-11 discovery protocol, and programming with the aid of IVI drivers.
- Class B adds the IEEE 1588 precision time protocol (PTP) and peer-to-peer communications to the basic class, Class C. IEEE 1588 allows all instruments on the same network to automatically synchronize to the most accurate clock available. IEEE provides time stamps or time-based synchronization signals to all instruments with exceptional accuracy.
- Class A instruments also include the eight-channel hardware trigger bus (LVDS interface) in accordance with the LXI specification.

The Attenuator R&S RSC fulfills the general requirements for LXI Class C.

3.7.2 LXI LAN indicator

In the status bar at the bottom of the screen, the R&S RSC shows the instrument's LXI LAN status. The display has three states.

- Red LXI symbol

The instrument does not have valid IP address. This can be due to one of the following reasons:

- The instrument is configured with DHCP, but it is not connected to a DHCP router.
- The instrument is configured manually, and there is an IP address conflict.
- The instrument has lost its DHCP-configured IP address and has switched over to auto IP.

This state is referred to as "error state," and can normally be resolved with the LCI mechanism (LAN reset). This mechanism is required by the LXI standard, and can be started under [SETUP]→"IO Setup"→"LXI Setup" by selecting and actuating the "LAN RESET" field. After that, the instrument performs a restart.

- Green LXI symbol

The instrument has a valid IP address and can be reached via TCP/IP.

- LXI Symbol **flashes green**

The instrument is in the "Device Indicator" state that can be initiated in the WEB interface. This state is also required by the LXI standard, and it makes it easier to find a specific instrument in a rack of measurement instruments.

3.7.3 LXI default state for network settings

After an LCI (LAN reset), the instrument restarts, and the following network settings apply:

Parameter	Setting
Hostname	RSRSCvvv-xxxxxx
Description	Step attenuator
TCP/IP Mode	DHCP + Auto IP address
Dynamic DNS	Enabled
ICMP Ping	Enabled
Negotiation	Auto detect
VXI-11 Discovery	Enabled
Password for LAN Configuration	LxiWebIfc



You can find more information about the LXI standard on the LXI website at <http://www.lxistandard.org> or in the article on LXI in "News from Rohde & Schwarz, 2006/II - 190".

3.7.4 LXI browser interface

The only information necessary for performing configuration via the LXI/Web interface is the name of the instrument (the Windows name) in networks. The networks operate with DHCP enabled, or its IP address in networks. The networks operate with manual network configuration. In rare cases, when neither one of these names is known, it is also possible to derive the IP address from the MAC address. The MAC address can be found on a label on the rear panel of the instrument.

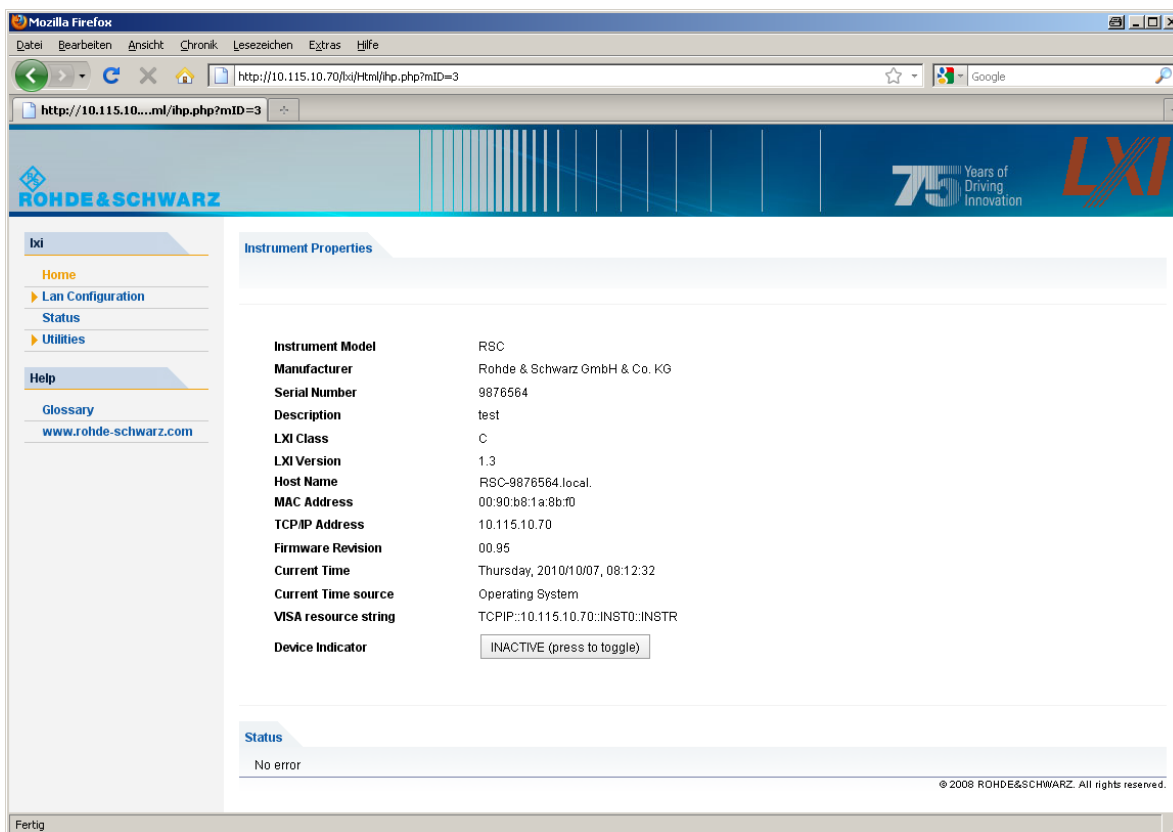
The instrument's LXI browser interface works correctly with all W3C-compliant browsers.

To start the instrument home page (welcome page), open the browser on the PC and enter the R&S RSC's instrument name or IP address in the address field.

Example:

`http://rsRSC-100002` or `http://10.113.10.203`.

With the R&S RSC, the instrument name is always RSC-xxxxxx, where xxxxxx stands for the instrument's six-digit serial number. The instrument name can be changed under [SETUP]→"IO Setup"→"LAN Setup" in the computer name entry field.



On the left side, a navigation bar is visible; there, you find the important "LAN Configuration" menu. This page for LXI WEB configuration now allows extensive configuration of all important LAN parameters.

3.7.5 IP configuration

The screenshot shows the 'LAN Parameters' configuration page in the RSC LXI web interface. The page is accessed via a Mozilla Firefox browser at the URL `http://10.115.10.70/lxi/html/ip_configuration.php?mID=6`. The interface includes a sidebar with navigation links: Home, Lan Configuration (selected), IP Configuration (selected), Advanced Config, Ping Client, Status, Utilities, Help, Glossary, and www.rohde-schwarz.com. The main content area displays the following configuration fields:

Parameter	Value
Hostname	RSC-xxxxxx
Domain	(none)
Description	test
TCP/IP Mode	DHCP + Auto IP Address
IP Address	10.115.10.70
Subnet Mask	255.255.0.0
Default Gateway	10.115.0.1
DNS Server(s)	10.0.2.166

A 'Submit' button is located below the DNS Server(s) field. A password field with the label '(Password required!)' is also present. The status bar at the bottom indicates 'No error'. The footer of the page contains the copyright notice: '© 2008 ROHDE&SCHWARZ. All rights reserved.'

- **TCP/IP mode**
Decides whether DHCP is switched on or not. The IP Address, Subnet Mask, Default Gateway and DNS servers configuration fields are only enabled if DHCP is disabled. Please consult your network administrator if it is necessary to modify these settings or any other settings.

i Switching from DHCP enabled mode to manual configuration mode can trigger the instrument to restart when the new setting is confirmed (depending on the configuration). If incorrect network configuration settings have been entered, using LAN RESET on the rear panel of the instrument is the only way to restore access to the Web interface.

- **IP address**
Makes it possible to change the instrument's IP address if DHCP is disabled.
- **Subnet mask, default gateway**

At times, these settings could have to be changed to differ from the displayed presets if DHCP is switched off. If so, ask your network administrator for the corresponding values.

- **DNS server**
This is the IP address of the domain name server for the network segment. Please consult your network administrator if it is necessary to modify this setting when operating with DHCP disabled.
- **Dynamic DNS**
This setting makes it possible to address different DNS servers in sequence. Please consult your network administrator if it is necessary to modify this setting when operating with DHCP disabled.

3.7.6 Advanced LAN configuration

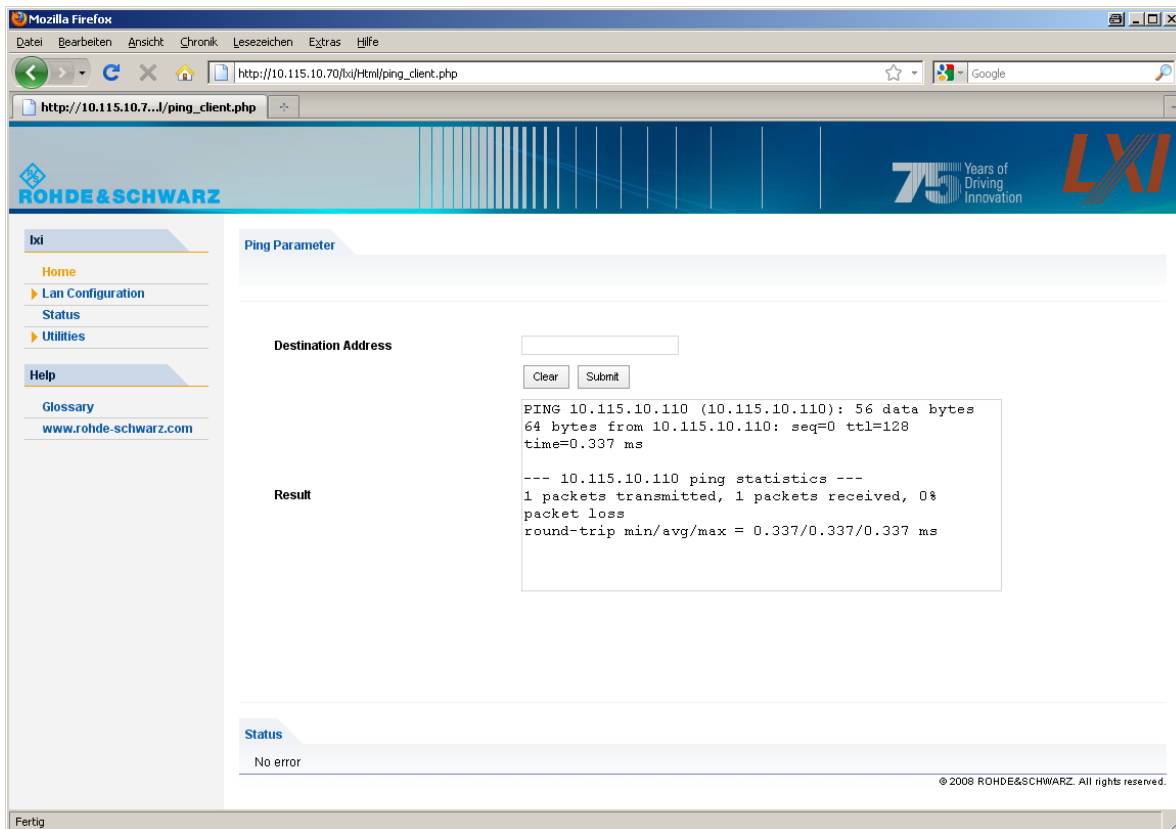
In the "Advanced LAN Configuration" dialog box, you can make LAN settings that are not required by the LXI standard. Only experienced users should modify these advanced parameters.

- **Negotiation**
The negotiation field makes it possible to set different Ethernet transmission parameters. In general, the Auto Detect mode is sufficient.
- **ICMP Ping**
ICMP Ping must be enabled to use the ping utility.
- **VXI-11 Discovery**
Enables or prevents instrument discovery via the VXI-11 Discovery Protocol, which is a protocol jointly developed by National Instruments and VISA for searching for instruments on a LAN.
VXI-11 is the protocol that is used to discover the instrument within the LAN. In accordance with the LXI standard, LXI devices must use the VXI-11 Protocol for a discovery mechanism; additional search modes are allowed.

3.7.7 Ping client

The ping utility can be used to check the connection between the LXI compatible device and other devices. The ping command uses ICMP `echo request` and `echo reply` to determine whether the LAN connection is functional. Ping is useful for diagnosing IP network or router failures.

Configuration of the GPIB bus (IEC 625 / IEEE 488)



The ping utility is not password-protected.

Here is how to start a ping between the LXI device and another connected device:

1. "Activate ICMP Ping" on the "Advanced LAN Configuration" page (activated after LCI).
2. Enter the IP address of the second device without the ping command and without any further parameters into the Destination Address field (e.g. 10.113.10.203).
3. Click "Submit".

3.8 Configuration of the GPIB bus (IEC 625 / IEEE 488)

The R&S RSC can be controlled remotely via the GPIB bus. You can call up the configuration dialog box for this via [SETUP]→"IO Setup"→"GPIB Setup".

Configuration of the GPIB bus (IEC 625 / IEEE 488)

The following settings are possible:

- Under "GPIB Address", you can enter the IEC bus address between 0 and 30. The factory setting is 20.
- In the "ID String" field, you can switch between the ID set at the factory and a user-defined ID. You can set the user ID under [SETUP]→"IO Setup"→"General Setup".
- Under "Compatibility", you can select different command sets for remote control.
This makes it possible to continue to use the control software for older R&S attenuator models.
- Selecting "EOI" changes the instrument's line terminator.
For ASCII data, the specification stipulates the use of <LF> and/or <EOI> as the line terminator. For transmission of binary data (such as trace data) to the instrument, the binary code (0AH) used for <LF> can be contained in the binary data block. However, it must not be interpreted as a terminator in such a case. This can be accomplished by changing the receive terminator to EOI only.

SCPI commands:

`SYSTem:COMMunicate:GPIB:ADDRes` on page 71

`SYSTem:COMMunicate:GPIB:RTERminator` on page 72

`SYSTem:LANGuage` on page 73

4 Manual operation

The R&S RSC's RF attenuator is set using the keypad on the front panel, via variation with the cursor keys or via remote control interfaces. As an alternative, an externally connected keyboard or mouse permits direct (and thus easy) access for making entries and settings.

The display shows the values that are currently set for the R&S RSC. Numerous help functions support the user during configuration.

4.1 Entering parameters

In manual mode, the values are set via the control panel.



The values are entered in the following order: Parameter – Data – Enter key

Example:

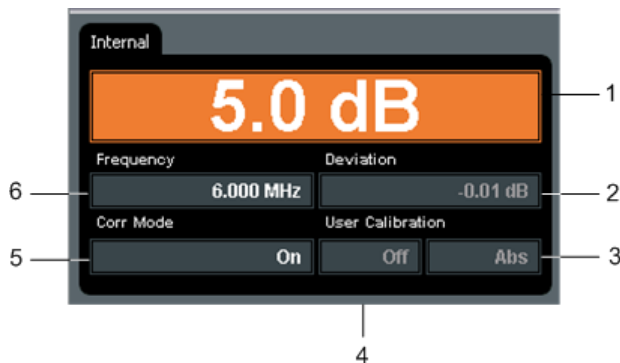
6 dB attenuation

- Press the [ATT] key.
- Press the [6] key.
- Press the [ENTER] key.

The attenuation value can also be changed in configurable incremental steps using the [\uparrow and \downarrow] cursor keys.

Using the [BACK SPACE] key, you can delete values. All values are accepted by pressing the [ENTER] key.

4.2 Display



- 1 = Attenuation display with a decimal point, resolution of 0.1 dB
- 2 = Display of the attenuation deviation with a decimal point.
- 3 = Abs (absolute) or Rel (relative, regarding 0 dB position) value display
- 4 = Display of the "User Calibration"; the possible modes are: Off, A, A(f), Full
- 5 = Display that indicates if correction mode is on or off.
- 6 = Frequency display with a decimal point

While the values are being entered, the digits for the newly entered value are shown progressively on the display of the corresponding parameter.

4.3 Help system – [HELP] key

The R&S RSC is equipped with a context-sensitive help function. This help offers a help page for every parameter, and it can be called up anytime during operation of the instrument. You can open the context-sensitive page by pressing the [HELP] key, and it is part of an extensive help system. It is possible to move from this context-sensitive page to any page within the help system.

The help system features an index with tabs that contain the contents, view and index displays.

Table 4-1: Using the context-sensitive help

Function	Front panel	PC keyboard
Opening the help system The help page for the respective parameter is displayed.	Press the [HELP] key.	Press the [F2] key.
Activating the link The help system branches to the linked page.	Use the arrow keys to select the link and then click the [ENTER] key to activate it.	Use the arrow keys to select the link and then click the [ENTER] key to activate it.
Closing the help system	Press the [ESC] key.	Press the [ESC] key.
Selecting the index tab	Press the [SELECT] key. Use the arrow keys to select the index tab.	Press [Ctrl] and [Tab] keys.
Scrolling	Use the arrow keys to move the displayed help window area.	Use the arrow keys to move the displayed help window area.
Switching to the next selection	Press the [G] key.	Press the [Tab] key.

4.4 File functions

The following file functions are available under [SETUP] → "File".

Save

A dialog box opens to enable you to enter a file name. The instrument settings are stored under this name.

Load

A file selection dialog box opens to enable selection of a file containing instrument settings.

Support

A dialog box opens to enable you to enter a file name. Data on the current instrument setup is stored under this name. If corrective maintenance becomes necessary, this function can help with troubleshooting.

File manager

You can use the file manager to copy and delete files and to set up and delete directories.

Example:

To copy a file from the USB stick:

- Start the file manager with [SETUP] → "File" → "File Manager".
- Select the USB directory with ↑ and ↓ and confirm your selection with the [ENTER] key.
- Select a file with ↑ and ↓ and confirm with [ENTER].
- Select the "Copy" item with ↑ and ↓ and confirm with [ENTER].
- Select the "..." item and confirm with [ENTER].
- Select the target directory and the file name as described above.
- Select the "Copy" item and confirm with [ENTER].

5 Instrument functions

This chapter explains the functions and setting parameters for the R&S RSC. The accompanying SCPI commands are specified for every parameter; they refer to the description of the corresponding command.

5.1 Setting the attenuation

Depending on the model, pressing the [ATT] key sets the attenuation to 0 dB or changes it in 0.1 dB steps within the range from 1 dB to 139.9 dB.

If you are in the main display, it is not necessary to press the [ATT] key; all you have to do is press the number keys. This automatically activates the entry field for the attenuation.

SCPI command:

[ATTenuator<n>:ATTenuation](#) on page 63

5.2 Varying the attenuation

If you are in the main menu, you can change the attenuation in predefined steps using the [\uparrow] and [\downarrow] cursor keys.



You define the step size under [SETUP] → "ATTENUATOR" → "SETTINGS" in the "Step Size" entry field.

5.3 Setting the frequency

The following frequency settings are possible:

- Range (depending on the model)
- Smallest unit: 1 Hz
- Units: Hz, kHz, MHz, GHz

Turning the correction mode On/Off

Setting the frequency is necessary when the set and displayed attenuation value should be corrected with the aid of the fault table stored in the instrument.

1. Press the [FREQ] key.
2. Enter the desired frequency value.
3. Press one of the unit keys (G, M, k) and then press ENTER.
4. You can exit the entry field by pressing the [ESC] key.

SCPI command:

[ATTenuator<n>:FREQuency](#) on page 66

5.4 Turning the correction mode On/Off

Pressing the [CORR] button toggles the instrument between the corrected and uncorrected attenuation settings.

The current status is shown in the "Corr Mode" display field. When turning correction mode on or off, the field briefly lights up in orange until the instrument's internal tables have been calculated.

When correction mode is off (the display shows: "Corr Mode Off"), the R&S RSC always displays the attenuator setting that the user has selected. The resulting attenuation deviation for the given frequency is indicated under "Deviation".

After correction mode is turned on (with the display showing "Corr Mode On"), the R&S RSC compares the selected attenuation with the table of correction values and turns on the attenuation position that has the lowest deviation from the desired value for the given frequency. Under "Deviation", the display continues to show the resulting attenuation deviation for the given frequency.

SCPI command:

[ATTenuator<n>:CORRection](#) on page 65

5.5 Display of the attenuation deviation

The R&S RSC's attenuator was tested before delivery, and the correction data was stored for all attenuation settings throughout the entire frequency range. This makes it possible to display the deviation between the displayed and actual attenuation for a given frequency. In addition, this deviation can be minimized by the correction mode.

In addition to the values determined at the factory, different user calibration methods can be employed.

The following section describes use of the correction modes. If the RSC controls multiple attenuators, you can make these settings individually for each attenuator by using the [SELECT] button to pick the desired attenuator.

SCPI command:

`ATTenuator<n>:DEViation?` on page 65

5.5.1 Abs Rel

When calculating the attenuation deviation, we always distinguish between two different modes:

- In **Rel Mode**, the attenuation deviations are always calculated relative to the residual attenuation. The residual attenuation is defined as the attenuation that the attenuator produces when the attenuator pads are switched off, due to ohmic losses in the wires. This mode is well suited for use when the residual attenuation was already accounted for in the calibration of the test setup, and precise attenuations are to be switched on.
- **Abs Mode** factors the residual attenuation into the calculation. Here, the system's overall attenuation is always calculated at the reference plane (RF jacks). This mode is recommended when precise attenuation is required on the reference plane without a system calibration.

You can switch between "Abs" and "Rel" under [SETUP] → "Attenuator" → "Correction Mode".

SCPI command:

`ATTenuator<n>:CMODE` on page 64

5.5.2 User calibration

In the [SETUP] → "Attenuator" → "Correction Mode" menu, you can select different user calibration types. To do this, use the [↑] or [↓] cursor keys to navigate to the "User Cal" selection area. Here, you can select the four modes "Off", "Offset", "A(f)" and "Full" by using the [←] and [→] keys. In the "Offset" entry field, you can enter a value for the User Cal Mode "Offset". One click on the "Load File" button opens a file selection dialog box in which frequency response for the "A(f)" and "Full" modes can be loaded. The last file that was loaded is then indicated in the "Calibration File". User calibration has the following effect on the correction data:

Cal Mode	Data basis for correction data	Example of use
Off	Factory calibration	
Offset	A fixed attenuation value is added to the residual attenuation across the entire frequency range. The attenuation value is entered into the offset field.	An attenuator pad is connected at the RSC's input port (for example as protection against excessive power levels).
A(f)	The correction data for the residual attenuation are overwritten by the data in the "calibration file." The factory calibration for the relative attenuation error for the individual attenuation values remains in place.	A frequency-independent test setup (for example, connection cable, amplifier) is to be calculated into the correction data. The attenuator, including the test setup, is measured at the 0 dB setting. In this way, it is possible to set defined attenuations on the reference plane.
Full	The complete set of correction data is overwritten by the "Calibration File."	The exact attenuation error is to be displayed for a frequency for which no factory calibration has been performed. For example, for a frequency that is higher than the specified frequency range or is between two measurement points. Users must determine the measurement values for all the attenuator settings that are of interest to them.

Positive attenuations must be entered for both the offset value and the calibration files.

SCPI commands:

[ATTenuator<n>:UCALibration](#) on page 67

[ATTenuator<n>:UCALibration:LOAD](#) on page 67

[ATTenuator<n>:UCALibration:OFFSet](#) on page 68

5.5.3 File format for user calibration

A CSV file is used as the file format. The decimal separator is a dot (.) and a semicolon (;) is used to separate columns from each other. The frequency points where a calibration measurement was taken are in the first column. The attenuation deviations for the various attenuator settings are stored in the other columns. Attenuations are always specified as positive values in the process. The RSC interpolates the area between the frequency data points. If user calibration only covers a portion of the RSC's frequency range, the value from the last measuring point is displayed in the remaining frequency range.

Examples of a Cal File:

For this file, the value of the 0 dB position was read off and the attenuation values in dB were entered in the file in dB. The values from the S21 measurement have to be negated for this.

```
FREQ[Hz];0
0;0.02
5.00E+07;1.03E-01
1.00E+08; 1.39E-01
1.50E+08; 1.74E-01
2.00E+08; 2.24E-01
2.50E+08; 2.48E-01
3.00E+08; 2.71E-01
3.50E+08; 2.85E-01
.
.
.
```

In addition, a column for the 10 dB position is added for this file. The attenuation from the 0 dB position and the target attenuation value have to be subtracted from the measured attenuation.

```
FREQ[Hz];0;10
0;0.02;0.05
5.00E+07;1.03E-01;-1.40E-2
1.00E+08; 1.39E-01;-1.20E-2
```

Cascading external attenuators

```

1.50E+08; 1.74E-01;-8.53E-3
2.00E+08; 2.24E-01;-4.67E-3
2.50E+08; 2.48E-01;4.32E-3
3.00E+08; 2.71E-01;7.67E-3
3.50E+08; 2.85E-01;1.02E-2
.
.
.

```

SCPI command:

[ATTenuator<n>:UCALibration:LOAD](#) on page 67

5.6 Switching to external attenuators

All R&S RSC models can remotely control up to 4 attenuators that are connected externally. When these external attenuators are connected with the instrument, their data is read in as the first step. The attenuator is then displayed as a tab element on the main screen.

Using the [SELECT] key, you can switch between several attenuators.

SCPI commands:

[ATTenuator:ENUM?](#) on page 66

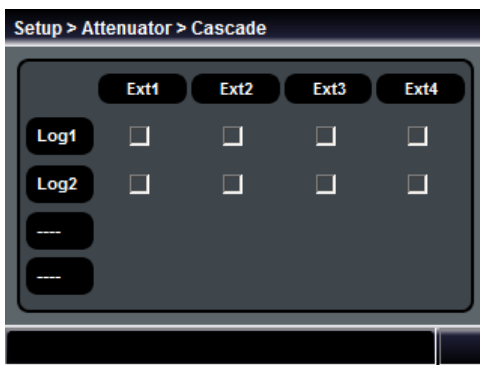
5.7 Cascading external attenuators

The external attenuators can be cascaded to achieve higher attenuation values. Thus connecting two R&S RSC-Z405 in series, for instance, can achieve a total attenuation of 150 dB in 5 dB steps.

Cascading for external attenuators is configured in the [SETUP] → "Attenuator" → "Cascade" menu. Four external attenuators can be assigned to two logical attenuators in the dialog.

In the figure, attenuators Ext1 and Ext2 have been connected together one logical attenuator, Log1.

Cascading external attenuators



This logical attenuator then behaves exactly like a single attenuator. Activation is configured automatically and the correction data is calculated.

SCPI commands:

[ATTenuator:ENUM?](#) on page 66

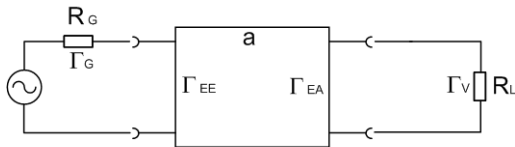
[ATTenuator<n>:CASCade?](#) on page 63

6 Application

6.1 Effect of reflection on the attenuation deviation

The error to be expected for the set attenuation depends on the attenuator's own attenuation error, but also on the reflection coefficient present in the test setup. Besides the input and output reflection factors for the attenuator itself, the reflection coefficient for the signal source and for the connected load also play a crucial role here. When the reflection coefficients are known, it is possible to calculate the maximum expected additional attenuation for a specific attenuation setting, if all reflection errors add up in phase:

$$a_{\text{zus}} = 20 \lg \frac{\left| 1 - \Gamma_G \Gamma_{EA} - \Gamma \sqrt{\Gamma_{EA}} + \Gamma_G \Gamma_L \left(\Gamma_{EE} \Gamma_{EA} - 10^{\frac{a}{10}} \right) \right|}{\left| 1 - \Gamma_G \Gamma_V \right|}$$



- Γ_G = Reflection coefficient for the generator
- Γ_{EE} = Reflection coefficient for the attenuator input
- Γ_{EA} = Reflection coefficient for the attenuator output
- Γ_V = Reflection coefficient for the load

If the generator or the load has a reflection coefficient >15 %, the attenuator should only be set to an attenuation >10 dB. This keeps the attenuation error from rising. The attenuation that is present then acts as a decoupling between the generator and load.

6.2 Disturbance voltages

The accuracy of the set attenuation value depends on the accuracy of the individual resistors in the attenuator pads, which are therefore subject to strict tolerances. With high attenuations, low output voltages, achieving precise separation

Disturbance voltages

requires ensuring that no energy flows from the attenuator input to the output by going around the attenuator. The attenuator ensures fulfillment of this prerequisite through careful shielding.

Nevertheless, it is possible that – when attenuations are high – the voltage at the attenuator output can be higher than can be calculated from the attenuation that is switched on. It could also be the case that it cannot be possible to realize an extremely small voltage, although a corresponding attenuation has been switched on. This situation is due to a disturbance voltage that influences the test receiver's input resistance. The reason that this arises is not due to the attenuator, but rather to its external connections to other devices. For this reason, it is important to pay particularly close attention to those connections. With direct current and low frequencies (< 100 kHz), it must be ensured that no conductive parallel connection can arise between the output and input under any circumstances. Otherwise, the result is a coupling of the current that is flowing back to the generator with the output. This requirement essentially means that, when high attenuations are employed, either the generator or the receiver must be supplied with power from batteries. Otherwise a method of isolating the potential must be implemented.

Regarding the frequency, we can differentiate between two types of disturbance voltages. One type has the same frequency as the signal voltage, which means that it affects both broadband measurements and selective measurements. The other type comes from the power system and has a frequency of 50 Hz and it is harmonic. For this reason, this disturbance is always indicated by broadband voltmeters. Meanwhile it only effects on selective measurements when the receiver is tuned to the power system's frequency or it is harmonic.

Disturbance voltages of the first type – in other words, those with the same frequency as the signal voltage – can be kept at a sufficiently low level. This is possible by making the coupling impedance as low as possible and making the return voltage as high as possible. You can keep the coupling impedance low by using cables that are as short as possible and have impeccable phase conductors. Cables that use copper braiding are sufficient for use as phase conductors for relatively low frequencies (up to about 100 MHz). However, for higher frequencies, we recommend using cables that have a corrugated conduit. Ensuring flawless plug-and-socket connections is also required for ensuring a low coupling impedance. You can achieve a high return resistance by inserting appropriate chokes (Ch.) in the supply cable from the AC power supply, as shown in Fig. [Figure 6-1](#). Finally, it is important to note that the disturbance voltage also depends on how high the input voltage is. For this reason, it is important to keep the input voltage as low as possible.

NOTICE**Maximum input voltage of 7 V**

Higher voltage damages the attenuator.

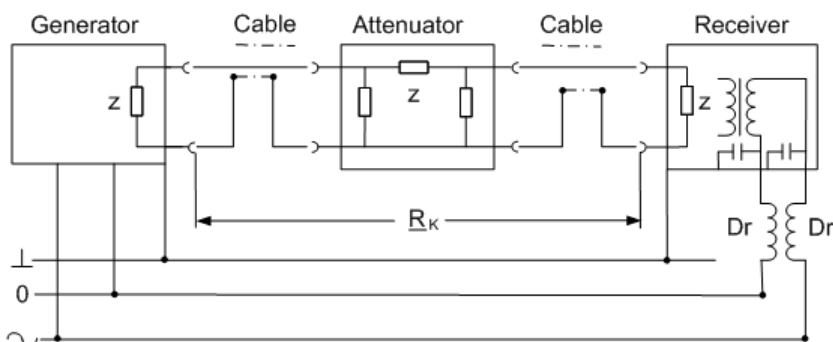


Figure 6-1: Reduction of a disturbance voltage from the signal voltages by using a coupling resistor (R_K) and a high return resistance by using chokes (Ch .)

You can keep disturbance voltages from the power system low by connecting the generator and the receiver to electrical outlets that are located as close as possible to the instrument. This essentially reduces the dropout voltage on the null line, which is one cause of disturbance voltage, to zero. In addition, the induction loop that is formed by the receiver's power cord must be kept as small as possible. The reason is that the hum voltages interspersed there also act as disturbance voltages. You can do this by keeping the power cord and the coaxial cable as close together as possible, this minimizing the area (shaded in [Figure 6-2](#)) between them.

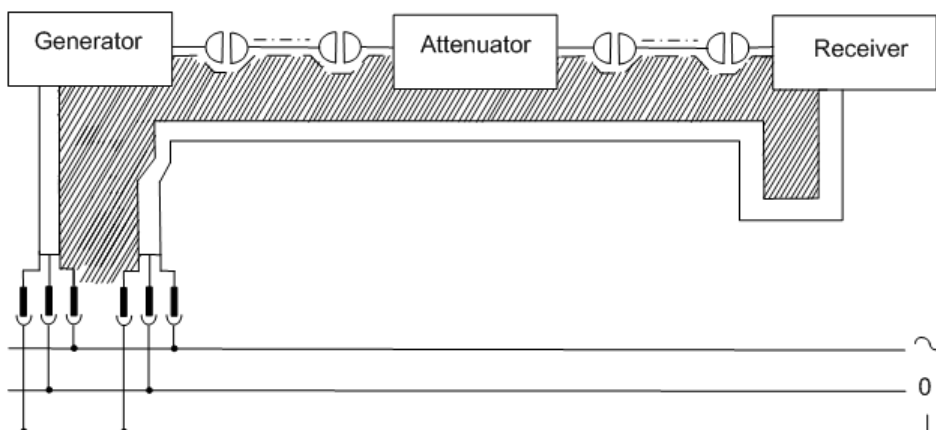


Figure 6-2: Reducing a disturbance voltage caused by induction

7 Remote control

The following sections describe the steps and commands required for remote control of the R&S RSC attenuator.

In [Chapter 7.1, "Basic information on remote control"](#), on page 47 you find information on setting up the attenuator for remote control and on the available interfaces and protocols. You also find a brief description of the status register. The remote control commands are explained in detail in [Chapter 7.2, "Remote control – commands"](#), on page 57.

A detailed description of the connections can be found in [Chapter A, "Instrument interfaces"](#), on page 79.



This description of the remote control functionality assumes that you understand programming and how to operate the controller. You find detailed information on the syntax and the interface commands in the corresponding description on SCPI.

7.1 Basic information on remote control

This chapter contains basic information on remote control of the R&S RSCAttenuator. It contains instructions for setting up the attenuator for remote control and a brief description of the status register.

7.1.1 Interfaces and protocols

The instrument has different interfaces for remote control. The following table provides an overview:

Basic information on remote control

Table 7-1: Remote control interfaces and protocols

Interface	Protocols, VISA*) Address	Comments
Local Area Network (LAN)	<ul style="list-style-type: none"> HiSLIP High-Speed LAN Instrument Protocol (IVI-6.1) TCPIP:: host address:: hislip0[:: INSTR] VXI-11 TCPIP:: host address:: inst0[::INSTR] Socket communication (raw Ethernet, simple Telnet) TCPIP:: host address[:: LAN device name]: :<port>::SOCKET 	<p>There is a LAN interface on the back of the instrument. This interface is based on TCP/IP, and it supports different protocols.</p> <p>You find the description in: Chapter 7.1.1.4, "LAN interface", on page 52</p>
USB	VISA*) Address: USB::<Manufacturer ID>::<Product ID>::<Serial No.>[::INSTR]	<p>On the back of the instrument, there is a type-B USB interface for communications with the host device.</p> <p>You find further information on the interface in Chapter 7.1.1.5, "USB interface", on page 54.</p>
GPIB (IEC/IEEE bus interface)	VISA*) Address: GPIB::primary address[::INSTR] (no secondary address)	<p>There is a GPIB bus interface in line with the IEC 625.1/IEEE 488.1 standard on the back of the instrument.</p> <p>In Chapter 7.1.1.3, "GPIB interface (IEC 625 / IEEE 488)", on page 51, you find further information on the IEC/IEEE bus interface.</p>

*) VISA is a standardized program interface library that makes the input and output functions available for instrument communications. For remote control of an instrument via the LAN interface, i.e. for the VXI-11 protocol, the VISA library must be installed on the controller (see also [Chapter 7.1.1.1, "VISA libraries"](#), on page 49).




The instrument is addressed via a defined interface address as described in [Chapter 7.1.1.4, "LAN interface"](#), on page 52, [Chapter 7.1.1.5, "USB interface"](#), on page 54 and [Chapter 7.1.1.3, "GPIB interface \(IEC 625 / IEEE 488\)"](#), on page 51.

The term GPIB is used here as a synonym for the IEC/IEEE bus interface.

Standard Commands for Programmable Instruments (SCPI)

For remote control of the instrument, commands – data messages – in line with the SCPI standard are used. The syntax of commands that are not included in that standard still follows the SCPI rules. The instrument supports SCPI version 1999 (Standard Commands for Programmable Instruments). The SCPI standard is built on the foundation of the IEEE 488.2 standard, and it aims to standardize instrument-specific commands, error handling and status register. For further information on SCPI concepts and definitions, please refer to the book "Automatic Measurement Control – A tutorial on SCPI and IEEE 488.2" by John M. Pieper, R&S order number 0002.3536.00.

 This description of the remote control functionality assumes that you understand programming and how to operate the controller. You find detailed information on syntax and on the interface commands in the SCPI descriptions mentioned above.

7.1.1.1 VISA libraries

VISA is a standardize program interface library that makes the input and output functions available for instrument communications.

The input/output channel (LAN, USB or GPIB, etc.) is selected during initialization by a channel-specific address. The address is referred to as the "VISA resource string," by a corresponding alias name (VISA alias).

7.1.1.2 Messages

The data messages that are transmitted via the data lines are divided into two categories:

- **Interface messages**

Interface messages are transmitted on the data lines to the R&S RSC, whereby the ATN (Attention) control line is active (LOW). These messages are used for communications between the controller and the instrument, and they can only be transmitted between devices that have the GPIB bus functionality.

There are two categories of interface commands:

- **Universal commands**, which address all instruments connected to the GPIB bus without prior addressing.

Basic information on remote control

- **Addressed commands**, which only address the instruments that are addressed as listeners.
- **Instrument-dependent messages**
Instrument-dependent messages are transmitted on the data lines in the same way for all interfaces. The ATN control line is not active (HIGH). The messages are transmitted in ASCII code.
Depending on the direction of the transmission, we differentiate between two categories:
 - **Commands**
 - **Responses**

Commands

Commands are messages that the controller sends to the instrument. They operate the instrument functions and request information. The commands are divided into types based on two criteria:

- Based on the effect that they have on the instrument
 - **Setting commands** control instrument settings, such as resetting the instrument, or entering setting values.
 - **Query commands** make output data for the remote control, for example for identifying the instrument or for querying a setting's value. Queries have a question mark ? at the end of the setting command.
- Based on how they are defined in the IEEE 488.2 and SCPI standards:
 - **Common commands** are precisely defined regarding their function and syntax in the IEEE 488.2 standard. These commands are identical for all instruments, and they refer to functions such as the management of the standardized status register, resetting and self-testing.
 - **Instrument-dependent commands** are for functions that depend on the characteristics of the specific instrument, such as frequency setting. Many of these commands have also been standardized by the SCPI Consortium. Such commands are labeled "SCPI compliant" in the command reference. Commands without the SCPI label are instrument-dependent, however, their syntax follows the SCPI rules, as allowed by the standard.

Responses

Responses are messages that the instrument transmits to the controller after a query command. Responses contain measurement results, instrument settings or status information on the instrument.

Basic information on remote control

You find detailed descriptions of the commands for controlling the R&S RSC in [Chapter 7.2, "Remote control – commands"](#), on page 57.

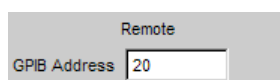
7.1.1.3 GPIB interface (IEC 625 / IEEE 488)

To be able to control the instrument via the GPIB bus interface, the instrument and controller must be connected together with a GPIB bus cable. The controller requires as GPIB bus card, the driver for the card, and the program libraries for the programming language that is used.

You find further information about the interface (for example, regarding functions, pin assignments, data bus lines, and interface messages in the Appendix under [Chapter A.1, "GPIB bus \(IEC 625 / IEEE 488\)"](#), on page 79.

GPIB instrument address

The controller must address the instrument using the GPIB bus address contained in the settings. The factory default setting for the instrument's GPIB bus address is 20. This can be altered in the Config Panel (in the Utilities menu). Addresses from 0 to 30 are permissible.



The GPIB address can be set manually or with the aid of the `SYST:COMM:GPIB:ADDR 18` remote control command. After setting of a new address, the R&S RSC's entire instrument status is stored with the new address. You find information on how to set the GPIB address in the R&S RSC in [Chapter 3.8, "Configuration of the GPIB bus \(IEC 625 / IEEE 488\)"](#), on page 29.

Remote control mode begins when the first command is transmitted.

Interface messages

There are two types of GPIB interface messages:

- **Universal commands**

The universal commands are in the code range from 0x10 to 0x1F. Without any prior addressing, they affect all instruments that are connected to the bus.

- **Addressed commands**

The addressed commands are in the code range from 0x00 to 0x0F. They only affect instruments that are addressed as listeners.

7.1.1.4 LAN interface

The instrument is equipped with a LAN interface to enable integration into a local areas network (LAN). This interface consists of a connector, a network card, and protocols (VXI-11).

For remote control via the network, the controller and the instrument must be connected via the LAN interface to a common network that uses the TCP/IP network protocol. They are connected using commercially available RJ-45 cables. The TCP/IP network protocol and the network services associated with it are preconfigured on the instrument. The software for controlling measurement instruments, and the VISA program library must be installed on the controller.

You find further information on the LAN interface in the Appendix in [Chapter A.2, "Ethernet interface \(LAN\)"](#), on page 83.

VISA library

Access to the instrument via the VXI-11 protocol is usually accomplished using high-level programming platforms with VISA as intermediate storage. VISA combines the Low-Level VXI" or "GPIB" function calls and thus makes the transport interface transparent for the user. The VISA library is available as a separate product.

IP address

To establish the connection, you need the instrument's IP address or computer name. The IP address/computer name is part of the "resource name" (VISA resource string) that the programs use to identify and control the instrument. The resource name has the following structure:

```
TCPIP::host address[::LAN device name][::INSTR]
```


Where:

- **TCPIP** designates the network protocol that is used
- **Host addr** is the IP address
- **LAN device name** is the controller's computer name (as an alternative to the IP address)
- **INSTR** indicates that the protocol is being used in accordance with the VXI-11 standard.

Example:

If the instrument's IP address is 192.1.2.3; its resource name is: `TCP::192.1.2.3::INSTR`

The controller named RSSM1 is addressed using the resource name `TCP::RSSM1::INSTR`.

 If multiple instruments are connected to the network, each instrument has its own IP address and the corresponding resource name. The controller uses the resource name to distinguish between the instruments.

VXI-11 protocol

The VXI-11 standard is based on the Open Network Computing Remote Procedure Call (ONC RPC) protocol, which builds upon the TCP/IP as a network protocol/transport layer. The TCP/IP network protocol and the associated network services are preconfigured. TCP/IP communications are connection-oriented, with the sequence of the exchanged messages being maintained and interrupted links identified. With this protocol, messages are not lost.


HiSLIP protocol

The High Speed LAN Instrument Protocol (HiSLIP) is the successor protocol for VXI-11 for TCP-based instruments specified by the IVI foundation. The protocol uses two TCP sockets for a single connection - one for fast data transfer, the other for non-sequential control commands (e.g. `Device Clear` or `SRQ`).

HiSLIP has the following characteristics:

- High performance as with raw socket network connections
- Compatible IEEE 488.2 support for Message Exchange Protocol, Device Clear, Serial Poll, Remote/Local, Trigger, and Service Request
- Uses a single IANA registered port (4880), which simplifies the configuration of firewalls
- Supports simultaneous access of multiple users by providing versatile locking mechanisms
- Usable for IPv6 or IPv4 networks

Basic information on remote control

 Using VXI-11, each operation is blocked until a VXI-11 instrument handshake returns. However, using HiSLIP, data is sent to the instrument using the "fire and forget" method with immediate return. Thus, a successful return of a VISA operation such as `viWrite()` guarantees only that the command is delivered to the instrument's TCP/IP buffers. There is no confirmation, that the instrument has started or finished the requested command.

For more information see also the application note:

[1MA208: Fast Remote Instrument Control with HiSLIP](#)

Socket communication

An alternative way for remote control of the product is to establish a simple network communication using sockets. The socket communication, also referred to as "Raw Ethernet communication", does not necessarily require a VISA installation on the remote controller side. It is available by default on all operating systems.

The simplest way to establish socket communication is to use the built-in telnet program. The telnet program is part of every operating system and supports a communication with the software on a command-by-command basis. For more convenience and to enable automation by programs, user-defined sockets can be programmed.

Socket connections are established on a specially defined port. The socket address is a combination of the IP address or the host name of the instrument and the number of the port configured for remote-control. Typically, the products of Rohde & Schwarz use port number 5025 for this purpose. The port is configured for communication on a command-to-command basis and for remote control from a program.

LAN interface messages

In a LAN connection, the interface messages are called "low-level control messages." These messages can be used to emulate the GPIB Bus's interface messages.

7.1.1.5 USB interface

For remote control via the USB bus, connect the controller with the R&S RSC's type-B USB interface.

Basic information on remote control

The software for controlling instruments, and the VISA program library with USB support (Version 3.4. or higher) must be installed on the controller. VISA automatically detects and configures the R&S instrument when the USB connection is established. You do not have to enter an address or install a driver.

USB address

To establish the connection, you need the vendor ID from Rohde & Schwarz, the R&S RSC's class ID, and its serial number. The resource name has the following structure:

```
USB::<vendor ID>::<product ID>::<serial nuber>[::INSTR]
```

Where:

- **<Vendor ID>** is the vendor ID for Rohde & Schwarz
- **<Product ID>** is the R&S instrument's product ID
- **<Serial number>** is the instrument's serial number (on the back of the instrument)
- **INSTR** indicates that the VXI-11 standard is being used.

Example:

```
USB::0x0AAD::0x004D::100534::INSTR
```

- USB indicates the interface being used
- 0x0AAD is the vendor ID for R&S
- 0x004D is the R&S RSC's product ID
- 100534 is the R&S instrument's product ID

7.1.2 Starting and stopping remote control mode




In manuals for the connected R&S instrument, for example an R&S signal generator, you find examples of how to put your R&S RSC's remote control into operation via the different interfaces.

When you turn on the R&S RSC, the instrument is always in the "LOCAL" manual operating mode, and can be operated via the front panel. You can switch the instrument to remote control mode, if the corresponding connection has been

Basic information on remote control

established. Switching between the operating modes does not change the instrument settings.

A remote control program must first establish the connection to the instrument via the VISA functionality before it can transmit commands or receive responses.

 When you begin the remote control program, we recommend that you set the instrument to a defined initial state by using the `*RST` command.


7.1.2.1 Activating remote control mode

To start remote control:

- Transmit a command from the controller.
- VXI-11 protocol (LAN or USB interface): Use the `>R` (go to remote) command.

In remote control mode, display and operation via the front panel are deactivated. The "REMOTE" operating mode is indicated on the display.

7.1.2.2 Returning to manual mode

 Make certain that the command processing is complete before you switch over to manual mode. Otherwise, the instrument switches back to remote control.

The instrument switches to manual mode when the remote connection is interrupted, or when you switch to manual mode either manually or via remote control.

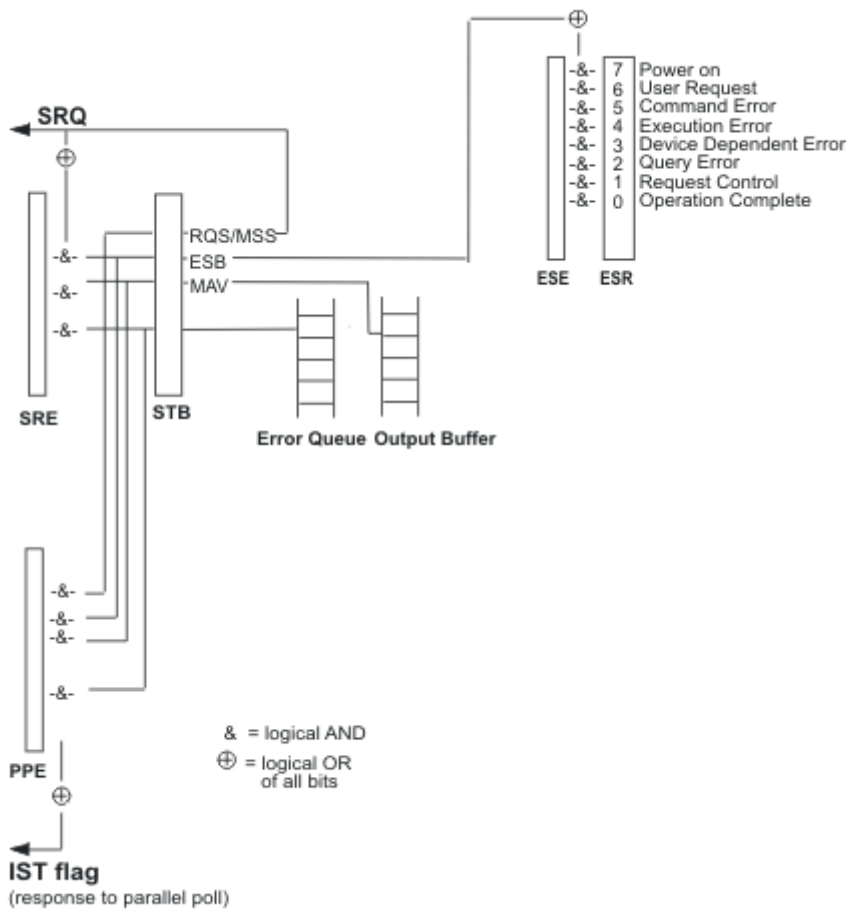
Switching to manual mode:

- Press the [LOCAL] key to the left of the screen.
- VXI-11 protocol (LAN or USB interface): Use the `>L` (**Go To Local**) command.

7.1.3 Status reporting system

The status reporting system stores all information on the instrument's current status and on the errors that have arisen. This information is stored in the status register and in an error output queue, and it is made available when queried.

The R&S RSC uses the basic status register as shown in the figure below.



For further information on how the status register can be configured and read with standard commands such as *ESE and *ESR?, see [Chapter 7.2.1, "Common commands"](#), on page 58.

7.2 Remote control – commands

This chapter describes all the commands that are relevant for remote control of the Attenuator R&S RSC. The commands are arranged according to the structure

of the instrument's dialog boxes. The "List of Commands" at the end of the manual contains all commands in alphabetic order.



Tips and tricks for operation ...

- **The use of upper and lower case letters** designates the long and short forms of a command: `ATTenuator<n>:... = ATT<n>:...`
- **The suffix <n>** differentiates between several variations of a function: `ATTenuator2:...`
- **The special character |** identifies alternative parameters: `ATT2:UCAL AF|FULL|OFF|OFS`
- **Text parameters** are separated from the header by a space. They follow the strict syntax rules for keywords.
- **Character strings**, including file names, are set off with single or double quotation marks: `ATT1:UCAL:LOAD 'myfile'`
- **[..]** can be left out

7.2.1 Common commands

The common commands are taken from the IEEE 488.2 (IEC 625.2) standard. Identical commands have an identical effect in different instruments. The header for these commands consists of an asterisk (*) followed by three letters. Many of the common commands are related to the status reporting system (see [Chapter 7.1.3, "Status reporting system"](#), on page 57).

*CAL?	59
*CLS	59
*ESE	59
*ESR?	59
*IDN?	59
*OPC	60
*OPC?	60
*OPT?	60
*PSC	60
*RST	61
*SRE	61
*STB?	61

Remote control – commands

*TRG.....	61
*TST?.....	62
*WAI.....	62

***CAL?**

CALIBRATION QUERY triggers calibration of the instrument and then queries the calibration status. Responses greater than 0 indicate errors.

Usage: Query only

***CLS**

CLEAR STATUS sets the status byte (STB), the event status register (ESR) and the EVENT part of the OPERATION, the QUESTIONable and the XQUESTIONable registers to zero. The command does not change the register's mask and transition parts. It clears the output buffer.

***ESE <Value>**

EVENT STATUS ENABLE sets the event status enable register to the specified value. The *ESE? query command returns the event status enable register's content in decimal form.

Parameters:

<Value> 0 to 255

***ESR? <Value>**

STANDARD EVENT STATUS QUERY returns the event status register's content in decimal form (0 to 255) and then sets the register to zero.

Parameters:

<Value> 0 to 255

Usage: Query only

***IDN?**

IDENTIFICATION QUERY queries the device ID. The instrument type, the stock/serial number and the firmware version number are returned.

Example: Return value
Rohde&Schwarz, R&S RSC = Instrument model
2.1.60.0 = COMPASS version
2.3.0 = R&S R&S RSC version

Usage: Query only

*OPC

OPERATION COMPLETE sets bit 0 in the event status register when all previous commands have been processed. This bit can be used to trigger a service request.

Usage: Setting only

*OPC?

OPERATION COMPLETE QUERY returns a 1 when all previous commands have been processed. Ensure that the timeout on the GPIB bus is set long enough.

Usage: Query only

*OPT?

OPTION IDENTIFICATION QUERY queries the options contained in the instrument and returns a list of the installed options. The options are separated from one another by commas.

Usage: Query only

*PSC <Function>

POWER ON STATUS CLEAR establishes whether the contents of the ENABLE registers is retained or is reset when the instrument is powered on.

The ***PSC? query command** returns the content of the Power On Status Clear flag. The answer can be either 0 or 1.

Parameters:

<Function> 0 | 1

Remote control – commands

0

The content of the status registers is retained on power-on. As a result, a service request can be triggered if the corresponding ESE and SRE status registers are configured accordingly.

1

The contents of the status registers are reset at power-on.

***RST**

[RESET] sets the instrument to a defined default state. This command corresponds to pressing of the [PRESET] button.

Usage: Event

***SRE <Value>**

SERVICE REQUEST ENABLE sets the service request enable register to the specified value. Bit 6 (MSS mask bit) remains 0. This command determines the conditions under which a service request is triggered. The *SRE? query command returns the service request enable register's content in decimal form. Bit 6 is always 0.

Parameters:

<Value> 0 to 255

***STB?**

READ STATUS BYTE QUERY returns the content of the status byte in decimal form.

Usage: Query only

***TRG**

TRIGGER triggers a measurement or a sweep.

Usage: Event

***TST? <Errorcode>**

SELF TEST QUERY triggers the instrument's self test and, if an error is found, outputs an error code.

Parameters:

<Errorcode> 0 = no error

Usage: Query only

***WAI**

WAIT-to-CONTINUE does not allow subsequent commands to be processed until all previous commands have been executed.

Usage: Event

7.2.2 ATTenuator subsystem

The following description contains the `ATTenuator` subsystem's commands for setting the attenuator parameters.

You can connect up to five attenuators to the signal generator. They are differentiated by the `ATTenuator<n>:ATTenuation:...` suffix with $n = 1$ to 5.

Example:

`ATT2:UCAL...`

<code>ATTenuator<n>:ATTenuation</code>	63
<code>ATTenuator<n>:CASCade?</code>	63
<code>ATTenuator:CATalog?</code>	64
<code>ATTenuator<n>:CMODE</code>	64
<code>ATTenuator<n>:CORRection</code>	65
<code>ATTenuator<n>:DEViation?</code>	65
<code>ATTenuator:ENUM?</code>	66
<code>ATTenuator<n>:FREQency</code>	66
<code>ATTenuator<n>:UCALibration</code>	67
<code>ATTenuator<n>:UCALibration:LOAD</code>	67
<code>ATTenuator<n>:UCALibration:OFFSet</code>	68

ATTenuator<n>:ATTenuation <Attenuation>

This command sets the attenuation for the specified attenuator.

Suffix:

<n>	1 to 7
	Selection of the attenuator to be controlled.
	1: Internal attenuator
	2: Ext 1
	3: Ext 2
	4: Ext 3
	5: Ext 4
	6: Log 1
	7: Log 2

Setting parameters:

<Attenuation>	Range: 0 to amax
	Increment: 0.1
	(The maximum attenuation depends on the attenuator model.)

Example:

ATT1:ATT 10
Sets the internal attenuator to 10 dB.

ATTenuator<n>:CASCade? <Status>[,2][,3][,4][,5]

This command sets the cascading of external attenuators.

Suffix:

<n>	6 to 7
	Selection of the logical attenuator.
	6: Log 1
	7: Log 2

Parameters:

Status	ON OFF
2	Ext1 is added to the logical attenuator.
3	Ext2 is added to the logical attenuator.
4	Ext3 is added to the logical attenuator.
5	Ext4 is added to the logical attenuator.

Remote control – commands

Example: `ATT6:CASC ON,3,4?`
 Defines the logical attenuator Log1 as a cascade of Ext2 and Ext3

Usage: Query only

ATTenuator:CATalog?

This command queries a string list from all attenuators.

Return values:

Return values `Index1,Name1,SerialNumber1,StockNumber1 |`
 `Index2,Name2,SerialNumber2,StockNumber2 | etc.`
 List of connected attenuators.

Example: `ATT:CAT?`
 Queries which attenuators are connected.
`1,Internal,,|2,RSC-Z405,999001000,`
`1313.9952.02|3,RSC-Z675,999002000,`
`1314.0065.02`
 The internal attenuator and external attenuators Ext2 and Ext3 are connected.

Usage: Query only

ATTenuator<n>:CMODE <Cmode>

This command sets the correction mode for the specified attenuator.

Suffix:

<n> 1 to 7
 Selection of the attenuator to be controlled.
 1: Internal attenuator
 2: Ext 1
 3: Ext 2
 4: Ext 3
 5: Ext 4
 6: Log 1
 7: Log 2

Setting parameters:

<Cmode> ABS | REL

Example: `ATT1:CMOD REL`
Sets the internal attenuator's correction mode to "Rel."

ATTenuator<n>:CORRection <Corr>

This command turns the correction mode for the specified attenuator on or off.

Suffix:

<n> 1 to 7
Selection of the attenuator to be controlled.
1: Internal attenuator
2: Ext 1
3: Ext 2
4: Ext 3
5: Ext 4
6: Log 1
7: Log 2

Setting parameters:

<Corr> ON | OFF

Example: `ATT1:CORR ON`
Switches the internal attenuator's correction mode on.

ATTenuator<n>:DEViation?

This command queries the attenuation deviation for the specified attenuator at the set frequency.

Suffix:

<n> 1 to 7
Selection of the attenuator to be controlled.
1: Internal attenuator
2: Ext 1
3: Ext 2
4: Ext 3
5: Ext 4
6: Log 1
7: Log 2

Parameters:

<Deviation> Range: -100E+24 to 100E+24
 Increment: 0

Example:

ATT1:DEV?
 Queries the attenuation deviation of the internal attenuator.
 0.347000

Usage:

Query only

ATTenuator:ENUM?

This command queries the attenuators that are available.

Return values:

Return values Index1,Name1,SerialNumber1,StockNumber1 |
 Index2,Name2,[SerialNumber2,StockNumber2][Index-
 Log1,IndexLog2,etc.] | etc.

List of the attenuators that can be controlled. The serial number and stock number are output for external attenuators. The indexes for the cascaded attenuators are output for logical attenuators.

Example:

ATT:ENUM?
 Queries which attenuators are available.
 "1,Internal,,|6,Log1,2,3"
 The internal attenuator and the logical attenuator consisting of attenuators 2 and 3 connected together is available.

Usage:

Query only

ATTenuator<n>:FREQuency <Frequency>

This command sets the frequency for which the attenuation deviation should be calculated.

Suffix:

<n> 1 to 7
 Selection of the attenuator to be controlled.
 1: Internal attenuator
 2: Ext 1
 3: Ext 2
 4: Ext 3
 5: Ext 4
 6: Log 1
 7: Log 2

Setting parameters:

<Frequency> Range: 0 to fmax (model-dependent)

Example:

ATT1:FREQ 2000000
 Sets the frequency of the internal attenuator to 2 MHz.

ATTenuator<n>:UCALibration <Ucal>

This command turns on different possible user calibrations for the specified attenuator.

Suffix:

<n> 1 to 7
 Selection of the attenuator to be controlled.
 1: Internal attenuator
 2: Ext 1
 3: Ext 2
 4: Ext 3
 5: Ext 4
 6: Log 1
 7: Log 2

Return values:

<UCAL> AF | FULL | OFF | OFS

Example:

ATT1:UCAL AF
 Switches the internal attenuator's user calibration to A(f).

ATTenuator<n>:UCALibration:LOAD <File>

This command loads a file with correction data for the specified attenuator.

Suffix:

<n> 1 to 7
Selection of the attenuator to be controlled.
1: Internal attenuator
2: Ext 1
3: Ext 2
4: Ext 3
5: Ext 4
6: Log 1
7: Log 2

Setting parameters:

<File> '<file>'
Path and file name for the file that is to be used for user correction.

Example:

```
ATT1:UCAL:LOAD 'a0user.dat'
```

Loads the a0user.dat file as the user calibration for the internal attenuator.

ATTenuator<n>:UCALibration:OFFSet <Offset>

This command sets the offset value for the user calibration for the specified attenuator.

Suffix:

<n> 1 to 7
Selection of the attenuator to be controlled.
1: Internal attenuator
2: Ext 1
3: Ext 2
4: Ext 3
5: Ext 4
6: Log 1
7: Log 2

Setting parameters:

<Offset> Offset value that should be used with the offset user correction mode.

Example: `ATT1:UCAL:LOFFS 5`
Sets the offset value for the user calibration for the internal attenuator to 5 dB.

7.2.3 DIAGnostic subsystem

This chapter describes the commands for the `DIAGnostic` subsystem.

<code>DIAGnostic:SERVice:HWINfo?</code>	69
<code>DIAGnostic:SERVice:PASSword</code>	70
<code>DIAGnostic:SERVice:SFUNction</code>	70
<code>DIAGnostic:SERVice:STEST</code>	70
<code>DIAGnostic:SERVice:STEST:RESult?</code>	70
<code>DIAGnostic:SERVice:SWINfo?</code>	71

`DIAGnostic:SERVice:HWINfo?`

This command queries the hardware information.

Return values:

Return values "<component 1>|<serial #>|<order #>|<model>| <hardware code>|<revision>|<subrevision>",
 "<component 2>|<serial #>|<order #>|<model>| <hardware code>|<revision>|<subrevision>",
 ...
 Output of the table rows is accomplished using string files with separation by commas. Individual table columns are separated from one another with |.

Example: `DIAG:SERV:HWIN?`
 Queries the hardware information.
 "RSC|101250|1313.8004.03|RSC|1|06|00"
 "MB|101288|1406.6800.07|BASISBOARD3|0|04|09"
 "ATT|101736|1313.9752.02|RSC139|00|02|00"
 "Ext1|999001|1313.9952.02|RSC-Z405|00|01|00"
 "Ext2|999002|1314.0065.02|RSC-Z675|00|01|00"

Usage: Query only

DIAGnostic:SErvice:PASSword <Password>

This command sets the service password and thus controls access to the service functions.

Parameters:

<Password> '<String>'

Example: DIAG:SERV:PASS XXXX

Usage: Setting only

DIAGnostic:SErvice:SFUNction <ServiceFunction>

This command activates a service function. The parameter string's content is identical to the code that is used for manual entry.

Entry is only executed when service password Level 1 or Level 2 was entered beforehand, [DIAGnostic:SErvice:PASSword](#) on page 70.

Parameters:

<ServiceFunction> '<String>'

Example: DIAG:SERV:SFUN '2.0.14.0'

Usage: Setting only

DIAGnostic:SErvice:STESt

This command starts the instrument's self test.

Example: DIAG:SERV:STES

Usage: Setting only

DIAGnostic:SErvice:STESt:RESult?

This command reads the self test results. Output of the result list's rows is accomplished in the form of a string, with the rows separated by commas:

Parameters:

<Result> "Total Selftest Status: PASSED", "Date (dd/mm/yyyy):
09/07/2004
TIME: 16:24:54", "Runtime: 00:06", "..."

Remote control – commands

Example: `DIAG:SERV:STES:RES?`

Usage: Query only

DIAGnostic:SERVice:SWINfo?

This command queries the software information.

Example: `DIAG:SERV:SWIN?`
 Queries the software information.
 "OS Version|0.99 [Build 75]|RSC
 Firmware|00.95|Compass|3.0.4.0"

Usage: Query only

7.2.4 SYSTem subsystem

This chapter describes the commands for the SYSTem subsystem.

<code>SYSTem:COMMunicate:GPIB:ADDRess</code>	71
<code>SYSTem:COMMunicate:GPIB:RTERminator</code>	72
<code>SYSTem:DATE</code>	72
<code>SYSTem:ERRor?</code>	72
<code>SYSTem:ERRor:CLEar:ALL</code>	73
<code>SYSTem:ERRor:LIST?</code>	73
<code>SYSTem:LANGuage</code>	73
<code>SYSTem:LXI:INFo?</code>	73
<code>SYSTem:LXI:LANReset</code>	74
<code>SYSTem:LXI:MDEscription</code>	74
<code>SYSTem:LXI:PASSword</code>	74
<code>SYSTem:TIME</code>	74

SYSTem:COMMunicate:GPIB:ADDRess

This command sets the IEC/IEEE bus address.

Parameters:

<Address> Integer
 Range: 0 to 30

Example: `SYST:COMM:GPIB:ADDR 14`
 Sets the IEC bus address to 14.

SYSTem:COMMunicate:GPIB:RTERminator <rterminator>

This command changes the instrument's receive terminator. For ASCII data, the specification stipulates the use of <LF> and/or <EOI> as the line terminator. For transmitting binary data (such as trace data) to the instrument, the binary code (0AH) used for <LF> can be contained in the binary data block. However, it must not be interpreted as a terminator in such a case. This can be accomplished by changing the receive terminator to EOI only.

Changing the terminator is not necessary for reading binary data out of the instrument.

Parameters:

<rterminator> LFEOI | EOI

Example:

SYST:COMM:GPIB:RTER EOI
Sets EOI as the receive terminator.

SYSTem:DATE <Numeric value>

This command sets the date for instrument's internal calendar. The date is entered in the format year, month, day

Parameters:

<Numeric value> 1980 to 2099, 1 to 12, 1 to 31

Example:

SYST:DATE 2010,6,1
Enters the data June 1, 2010

SYSTem:ERRor?

This command queries the oldest entry in the error queue, and thus deletes it.

Positive error numbers mark instrument-dependent errors, negative error numbers mark error messages specified by SCPI. When the error queue is empty, error number 0 ("No error") is returned. This command is only a query; therefore, it does not have an *RST value.

Example:

SYST:ERR?

Usage:

Query only

SYSTem:ERRor:CLEar:ALL

This command deletes all entries in the `SYSTEM MESSAGES` table.

This command is an event; therefore, it has not a query or an *RST value.

Example: `SYST:ERR:CLE:ALL`

Usage: Event

SYSTem:ERRor:LIST?

This command reads out all system messages, whereby a list of strings separated by commas is returned. Here, every string corresponds to an entry in the `SYSTEM MESSAGES` table.

If the error list is empty, an empty string "" is returned.

This command is only a query; therefore, it does not have an *RST value.

Example: `SYST:ERR:LIST?`

Usage: Query only

SYSTem:LANGuage <Language>

This command activates emulation of different attenuator instruments. The attenuator's preset command set is "SCPI."

Parameters:

<Language> "SCPI" | "RSP" | "RSG" | "DPSP"

Example: `SYST:LANG 'SCPI'`

SYSTem:LXI:INFo?

This query delivers the current parameters for LXI class C.

Parameters:

Return value <Current version> | <LXI class> | <Computer name> |
(example) <MAC address> | <IP address> | <Auto MDIX>

Example: `SYST:LXI:INF?`

Usage: Query only

SYSTem:LXI:LANReset

This command resets the LAN configuration as required by the LXI standard. In addition, the password and the LXI instrument description are reset.

Example: `SYST:LXI:LANR`

Usage: Event

SYSTem:LXI:MDEscription <String>

This command shows the LXI instrument description or makes it possible to change the description.

Parameters:

<String> <String>

Example: `SYST:LXI:MDES`

SYSTem:LXI:PASSword <Password>

This command sets the LXI password.

Parameters:

<Password> '<String>'

Example: `SYSTem:LXI:PASS XXXX`

Usage: Setting only

SYSTem:TIME <Time>

This command sets the internal clock in this format: hour, minute, second.

Parameters:

<Time> 0 to 23, 0 to 59, 0 to 59

Example: `SYST:TIME 12,30,30`

8 Maintenance

The R&S RSC attenuator does not require maintenance at regular intervals. Maintenance work is limited to cleaning the instrument. It is, however, advisable to check the nominal data from time to time.

CAUTION

Danger of electric shock

Before cleaning, make sure that the instrument is switched off and that it is disconnected from all power supplies.

Cleaning agents can damage the instrument

Cleaning agents contain substances that can damage the instrument. Solvents such as nitrocellulose thinners or acetone, for instance, can damage plastic components and the labeling on the front panel.

For this reason, only use a soft, lint-free cloth for cleaning.

Service work

Replacing modules and ordering spare parts is described in the service manual. There you also find all the ID numbers required for ordering spare parts. In addition, the service manual contains information on troubleshooting, repairs, replacing modules and calibration. See "[Service manual](#)" on page 5.

If you have any questions, contact our customer support as described in [Chapter 9, "Contacting customer support"](#), on page 77.

Packing and storage

The storage temperature for the R&S RSC is specified in the data sheet. When storing for longer periods, protect the instrument from dust.

Before transport or shipping, pack the instrument just as it was originally packed. The two protective covers guard the controls and connections against damage. The anti-static packaging film prevents undesired electrostatic charges.

If you no longer have the original packaging, employ a sturdy cardboard box of a suitable size. Ensure that there is enough padding to keep the instrument from

slipping around inside the package. Wrap the instrument in anti-static film to protect it against electrostatic charging.

9 Contacting customer support

Technical support – where and when you need it

For quick, expert help with any Rohde & Schwarz product, contact our customer support center. A team of highly qualified engineers provides support and works with you to find a solution to your query on any aspect of the operation, programming or applications of Rohde & Schwarz products.

Contact information

Contact our customer support center at www.rohde-schwarz.com/support, or follow this QR code:



Figure 9-1: QR code to the Rohde & Schwarz support page

Annex

A Instrument interfaces

The following section describes the R&S RSC's interfaces for remote control.

A.1 GPIB bus (IEC 625 / IEEE 488)

The instrument comes with a GPIB bus connection as one of the standard features. The IEEE 488-compliant connector jack is located on the back of the instrument. The interface can be used to connect a controller to allow remote control of the instrument. The connection is made using a shielded cable.

A.1.1 GPIB bus characteristics

The GPIB bus has the following characteristics:

- 8-bit parallel data transmission
- Bidirectional data transfer
- Three-wire handshake
- High data transmission rate
- Up to 15 instruments can be connected
- Maximum length of the connection cable is 15 m (2 m for an individual connection)
- Wired-Or operation with parallel connection of several instruments

A.1.2 GPIB bus lines

Pin assignment

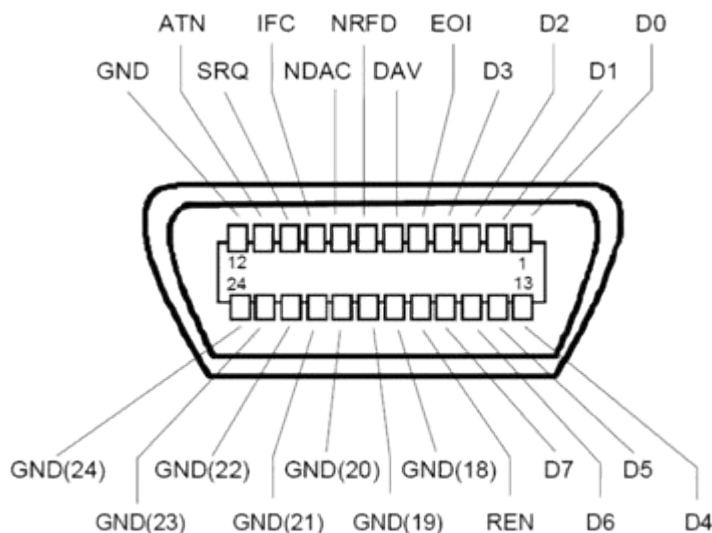


Figure A-1: Pin assignment for the GPIB Bus interface

Lines

- **Data bus with 8 lines, DIO 1 to DIO 8**
The transmission is accomplished in bit-parallel and byte-serial order in the ASCII/ISO code. DIO1 is the lowest value bit and is the DIO8 highest.
- **Control bus with 5 lines:**
 - **IFC** (interface clear):
Active LOW resets the interfaces of the connected instruments to their initial settings.
 - **ATN** (attention):
Active LOW signals transmission of interface messages.
Inactive HIGH indicates transmission of instrument messages.
 - **SRQ** (service request):
Active LOW allows the connected instrument to send a service request to the controller.
 - **REN** (remote enable):
Active LOW allows switchover to remote-control mode.
 - **EOI** (end or identify):

GPIB bus (IEC 625 / IEEE 488)

This has two functions in conjunction with ATN:

ATN=HIGH active LOW marks the end of a data transmission.

ATN=LOW active LOW triggers a parallel poll.

- **Third handshake bus with three lines:**

- **DAV** (data valid):
"Active LOW" signals a valid data byte on the data bus.
- **NRFD** (not ready for data):
"Active LOW" signals that one of the connected instruments is not ready to receive data.
- **NDAC** (not data accepted):
"Active LOW" while the connected instrument is receiving the data on the data bus.

A.1.3 GPIB bus interface functions

Remote controllable instruments can be equipped with different interface functions via the GPIB bus. The table below lists the interface functions that are applicable for the R&S RSC.

Table A-1: Interface functions

Control character	Interface functions
SH1	Full source handshake capability
AH1	Full acceptor handshake capability
L4	Full listener function capability, unaddressing by MTA
T6	Full talker function capability, capability of responding to serial query, unaddressing by MLA
SR1	Full-service request capability
PP1	Full parallel poll capability
RL1	Full remote/local switchover capability
DC1	Full reset (device clear) capability
DT1	Full trigger (device trigger) capability
C0	No controller function

A.1.4 GPIB bus interface messages

Interface messages are transferred to the instrument on the data lines, whereby the ATN "attention" control line is active (LOW). They are used for communications between the controller and the instrument and can only be transmitted by a controller that has the controller function on the GPIB bus.

Universal commands

The universal commands are in the code range from 0x10 to 0x1F. Without any prior addressing, they affect all instruments that are connected to the bus.

Table A-2: Universal commands

Command	VISUAL BASIC command	Effect on the instrument
DCL (device clear)	IBCMD (controller%, CHR \$(20))	Cancels processing of the commands that were received and sets the command processing software to a defined initial status. Does not change the instrument setting.
IFC (interface clear)	IBSIC (controller%)	Resets the interfaces to their default setting.
LLO (local lockout)	IBCMD (controller%, CHR \$(17))	Locks manual switchover to LOCAL.
SPE (serial poll enable)	IBCMD (controller%, CHR \$(24))	Ready for a serial poll
SPD (serial poll disable)	IBCMD (controller%, CHR \$(25))	End of a serial poll
PPU (parallel poll unconfigure)	IBCMD (controller%, CHR \$(21))	End of the parallel poll query status

Addressed commands

The addressed commands are in the code range from 0x00 to 0x0F. They only affect instruments that are addressed as listeners.

Command		Effect on the instrument
&GET	(Group execute trigger)	Triggers a measurement or a sweep.
>L	(Go to local)	Transition to the local state (manual operation).

Ethernet interface (LAN)

Command		Effect on the instrument
>R	(Go to remote)	Transition to the remote state (remote control).
&PPC	(Parallel poll configure)	Configures the instrument for parallel poll.
&SDC	(Selected device clear)	Cancels processing of the commands that were received and sets the command processing software to a defined initial status. Does not change the instrument setting.

A.2 Ethernet interface (LAN)

The instrument comes with an Ethernet interface as a standard feature. The connection jack is located on the back of the instrument. As a result, when the appropriate rights have been assigned by the network administrator, it is possible to transfer files across the network. It is also possible to use network resources, such as network directories or network printers. The instrument can also be remote-controlled and manually operated in the network. The connection is made with a commercially available RJ-45 cable.

The network card works with an IEEE 802.3u 100 MHz Ethernet. TCP/IP network protocol and the associated network services are preconfigured. TCP/IP permits connection-oriented communications that maintain the order of the exchanged messages and detects interrupted connections. In addition, no messages can be lost when using this protocol.

Remote control of the instrument via a network is based on these standardized protocols, which follow the OSI reference model (see figure below).

Application	Test Application
	VXI-11 Protocol
Presentation	XDR
Session	ONC/RPC
Transport	TCP/UDP
Network	IP
Data Link	802.3 (Ethernet)
Physical	802.3 (10BASE-T)

Figure A-2: Example of LAN remote control in accordance with OSI reference model (VXI-11)

Based on TCP/UDP, the messages are exchanged between the controller and the instrument by Open Network Computing (ONC) Remote Procedure Calls (RPC). The permitted RPC messages are, with XDR, known as the VXI-11 standard. Messages are exchanged between the controller and the instrument based on this standard. These messages are identical with the SCPI commands. They can be divided into four groups: program messages (control commands to the instrument), response messages (values returned by the instrument), service requests (spontaneous requests by the instrument) and low-level control messages (interface messages).

A VXI-11 connection between a controller and an instrument is based on three channels: the core, abort and interrupt channels. The essential control of the instrument is accomplished via the core channel (program, response, and low-level control messages). The abort channel is used for immediate cancellation of the core channels, and the interrupt channel transports the instrument's spontaneous service requests. The process for establishing the connection is complex. Further details can be found in the VXI-11 specification ("TCP/IP Instrument Protocol Specification VXI-11, Revision 1.0 VMEbus Extensions for Instrumentation, VXIbus" and "TCP/IP-IEEE 488.2 Instrument Interface Specification VXI-11.3, Draft 0.3 VMEbus Extensions for Instrumentation, VXIbus").

Ethernet interface (LAN)

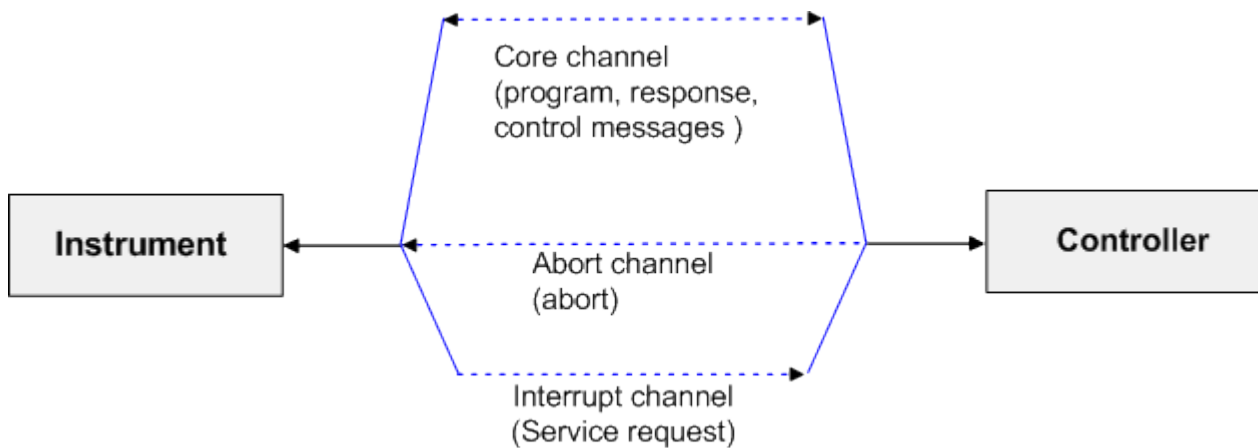


Figure A-3: Channels between the instrument and the controller with VXI-11

Within the network, the number of controllers that can access an instrument is practically unlimited. Inside the instrument, the individual controllers are clearly differentiated from one another. This differentiation continues all the way to a controller's application level, which means that the instrument views two applications running on one PC as two different controllers.

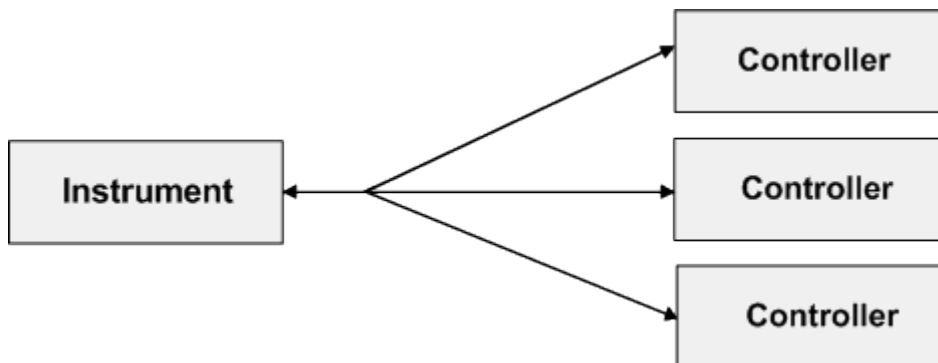
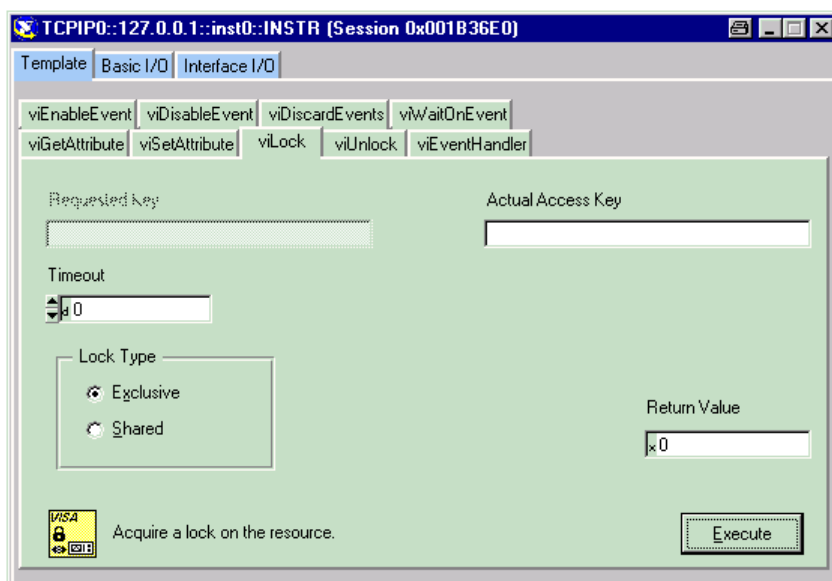


Figure A-4: Remote control via LAN with several controllers

The controllers can lock and unlock the instrument to permit exclusive access. In this way, it is possible to control access from multiple controllers.

In the "Measurement & Automation Control" program, this setting is made in the panel template.



A.2.1 VXI-11 interface messages

With an Ethernet connection, the interface messages are referred to as low-level control messages. They can be used to emulate the GPIB Bus's interface messages.

Table A-3: VXI-11 interface messages

Command		Effect on the instrument
&ABO	(Abort)	Ends processing of the commands that were received.
&DCL	(Device clear)	Cancels processing of the commands that were received and sets the command processing software to a defined initial status. Does not change the instrument setting.
&GET	(Group execute trigger)	Triggers a measurement or a sweep.
>L	(Go to local)	Switches the instrument to the local state (manual operation).
>R	(Go to remote)	Switches the instrument to the remote state (remote control).
&LLO	(Local lockout)	Locks manual switchover to LOCAL mode.
&NREN	(Not remote enable)	Unlocks manual switchover to LOCAL mode.
&POL	(Serial poll)	Performs a serial poll.

List of commands

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