

# Remote Emulation with the R&S®SMF100A Microwave Signal Generator Application Note

## Products:

| R&S®SMF100A

The R&S®SMF100A Microwave Signal Generator offers a remote emulation feature that makes it possible to control the instrument by commands other than the built-in native SCPI commands. This feature allows the user to replace signal generators, e.g. from other manufacturers, with the R&S®SMF100A without having to change the remote control code.

This application note describes how to use the remote emulation feature in general. Furthermore, it describes in detail the remote emulation for each supported instrument, limitations of the individual emulations and the remaining differences between the emulated and the original commands.

---

## Table of Contents

<b>1</b>	<b>Abbreviations .....</b>	<b>3</b>
<b>2</b>	<b>Overview .....</b>	<b>4</b>
<b>3</b>	<b>Basics .....</b>	<b>5</b>
<b>3.1</b>	<b>Remote Control Languages .....</b>	<b>5</b>
<b>3.1.1</b>	<b>SCPI-Compatible Languages .....</b>	<b>6</b>
<b>3.1.2</b>	<b>Non-SCPI-Compatible Languages .....</b>	<b>6</b>
<b>3.2</b>	<b>Remote Emulation Compatibility .....</b>	<b>6</b>
<b>3.2.1</b>	<b>Command Compatibility .....</b>	<b>6</b>
<b>3.2.2</b>	<b>IDN / OPT Strings .....</b>	<b>7</b>
<b>3.2.3</b>	<b>Timing .....</b>	<b>7</b>
<b>3.2.4</b>	<b>Sweep Operation .....</b>	<b>7</b>
<b>3.2.5</b>	<b>Trigger Control .....</b>	<b>8</b>
<b>3.2.6</b>	<b>Status and Error Reporting .....</b>	<b>11</b>
<b>3.3</b>	<b>Preset / Reset .....</b>	<b>12</b>
<b>3.4</b>	<b>Power Down / Power Up .....</b>	<b>12</b>
<b>4</b>	<b>Activating a Remote Emulation .....</b>	<b>13</b>
<b>4.1</b>	<b>Manual Operation .....</b>	<b>13</b>
<b>4.2</b>	<b>Remote Operation .....</b>	<b>18</b>
<b>5</b>	<b>Emulating the Hewlett-Packard 83620, 83630, 83640, 83650 .....</b>	<b>19</b>
<b>6</b>	<b>References .....</b>	<b>25</b>
<b>7</b>	<b>Ordering Information .....</b>	<b>25</b>

# 1 Abbreviations

The following abbreviations are used in this application note:

- HP83620 83620 signal generator from Hewlett-Packard / Agilent Technologies
- HP83630 83630 signal generator from Hewlett-Packard / Agilent Technologies
- HP83640 83640 signal generator from Hewlett-Packard / Agilent Technologies
- HP83650 83650 signal generator from Hewlett-Packard / Agilent Technologies
- SMF R&S®SMF100A signal generator from Rohde & Schwarz

## 2 Overview

Measuring instruments used in commercial test systems for applications such as testing of mobile radio base stations typically have a much longer lifespan than the test system itself. Some five to seven years of usage is normal prior to replacement. On the other hand, test systems for use in aerospace & defense applications can have a typical lifespan of 25 years or even more. If standard measuring instruments with a lifespan that is significantly less than this time frame are used in such test systems, an obvious question is how to handle maintenance, repair, calibration and even replacement of the instruments that are no longer supported by their manufacturer. Moreover, the test program sets used in such test systems are generally certified, which makes it very time-consuming and costly to modify and reaccept them.

A feasible strategy to solve this problem is the migration with new measuring instruments that emulate the discontinued instruments.

This migration approach is saves time and is cost-effective. It involves replacing obsolete measuring instruments with new ones that emulate their functionality and programming.

The requirements for the new instruments revolve around the electrical and functional features of the instruments to be emulated as well as the test programs, which ideally should not require any modifications.

To fulfill the last requirement, the SMF offers the remote emulation feature.

Remote emulation means that the SMF will understand the programming commands of the emulated instrument and also emulate the behavior as fully as possible.

Most instruments from other manufacturers in the category of the SMF are emulated by the SMF. An overview of actually implemented remote emulations is given in the following table:

Remote emulations in the SMF			
Manufacturer	Instrument	Language	Section
Agilent Technologies Hewlett-Packard	HP83620	SCPI	5
	HP83630		
	HP83640		
	HP83650		

## 3 Basics

### 3.1 Remote Control Languages

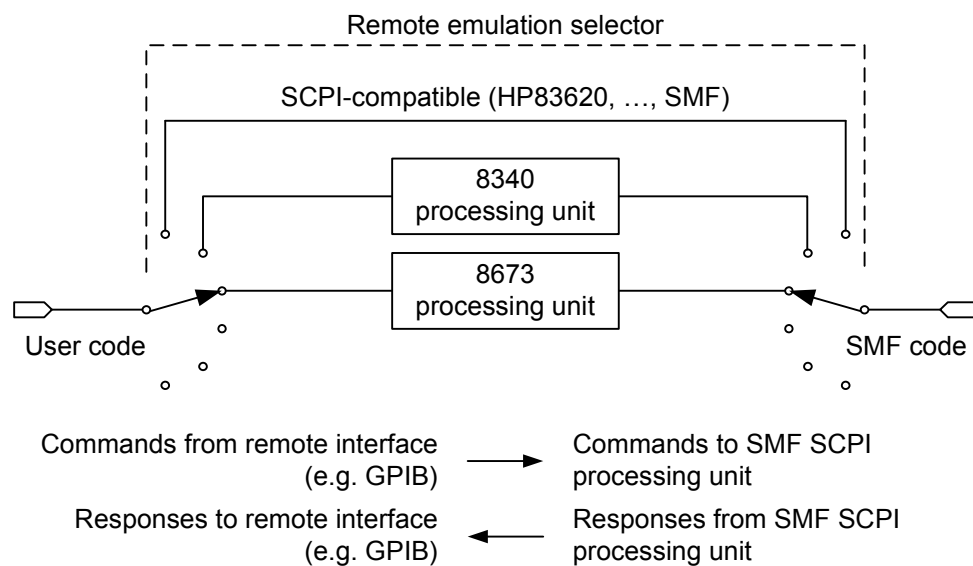
Instruments implement different kind of remote control languages. These languages are grouped into two basic categories:

- SCPI-compatible
- Non-SCPI-compatible

Command examples				
Function	HP8642 Non-SCPI	HP8657 Non-SCPI	AF2023 SCPI	SMF SCPI
Resetting the instrument	PR	PR	*RST	*RST
Clearing the system status		CS	*CLS	*CLS
Setting the RF frequency	CW10MZ	FR10MZ	:CFRQ:VALUE 10MHZ	:FREQ 10MHZ
Setting the RF power	AP-10DB	PL-10DM	:RFLV:VALUE -10DBM	:POW -10DBM
Activating the RF output	ON	R3	:RFLV:ON	:OUTP 1

Older instruments often implement a simple, unstructured and non-SCPI-compatible language, whereas modern instruments implement usually a complex, well structured and SCPI-compatible language.

The SMF offers a solution for both kinds of languages using specialized processing units in non-SCPI-compatible languages:



### 3.1.1 SCPI-Compatible Languages

Commands are routed directly from the remote interface to the SMF SCPI command processing unit; responses are routed in the reverse direction.

### 3.1.2 Non-SCPI-Compatible Languages

Commands are routed from the remote interface to the SMF SCPI command processing unit through a remote emulation specific processing unit; responses are routed in the reverse direction.

This specific processing unit parses the non-SCPI-compatible commands with reference to the corresponding syntax and translates them into SCPI-compatible ones. The unit also reformats the responses with respect to the requirements of the emulated instrument.

## 3.2 Remote Emulation Compatibility

An emulated instrument having fewer features than, or the same features as, the SMF can be replaced without special care.

However, replacing an emulated instrument having more features than the SMF or features that differ from those of the SMF requires additional care. The user must


- ensure that the SMF complies with the functional requirements
- verify that application code does not use features in the emulated instrument which are not available in the SMF

### 3.2.1 Command Compatibility

Most of the remote emulations in the SMF implement all commands of the original instrument. However, e.g. due to functional differences in hardware, in certain remote emulations the SMF

- does not support all commands
- does not support all parameters of a command
- implements a different behavior for a command

In the command tables of the different remote emulations, the status column gives compatibility information to a command:

Command compatibility status	
Status	Comment
✓	Command implementation is fully compatible.
	Command implementation is not fully compatible. The implementation in the SMF <ul style="list-style-type: none"> <li>• does not support the same parameter(s) as the emulated instrument does</li> <li>• has different functionality than the emulated instrument</li> <li>• reports an invalid parameter or execution error if possible</li> </ul>
○	Command is implemented without any functionality. The implementation in the SMF <ul style="list-style-type: none"> <li>• ignores setting commands</li> <li>• returns default value in query commands</li> <li>• does not report errors</li> <li>• does not change any operating mode of the instrument</li> <li>• does not change any system state of the instrument</li> </ul>
✘	Command is not implemented. The implementation in the SMF reports an unknown command error if possible.
+	Command has been added to enhance the functionality of the emulated instrument.

If the application software uses commands that are fully compatible, no special care has to be taken. The application software can be used as is.

If the application software uses commands that are not fully compatible, the application software must be verified and normally also modified. If the required modifications to the application software are infeasible, the SMF cannot be used as replacement for another instrument.

### 3.2.2 IDN / OPT Strings

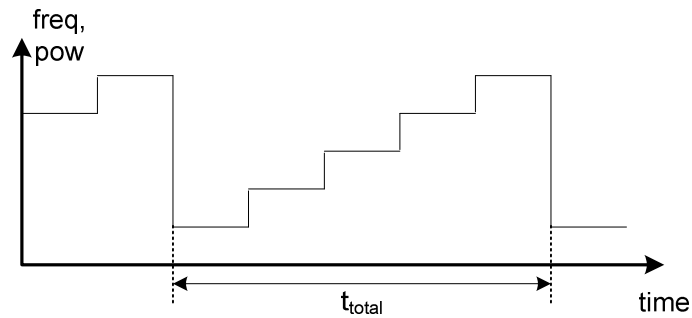
The remote emulation provides user-defined responses to \*IDN? and \*OPT? queries. This feature is of informational character only and has no impact on the functionality of the SMF.

### 3.2.3 Timing

The remote emulation cannot provide exact timing compatibility with the emulated instrument, since timing is a hardware-related property.

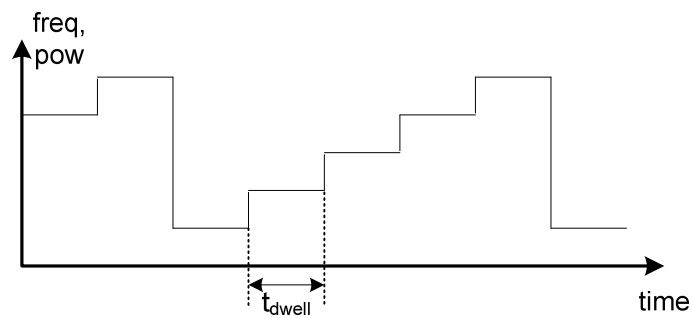
### 3.2.4 Sweep Operation

Some of the emulated instruments implement sweep operations with a constant total sweep time:



Changing the start, stop or steps parameter of the sweep operation does not have an impact on the total sweep time.

In the SMF, all sweep operations are based on the dwell time:



Changing the start, stop or steps parameter directly affects the total sweep time.

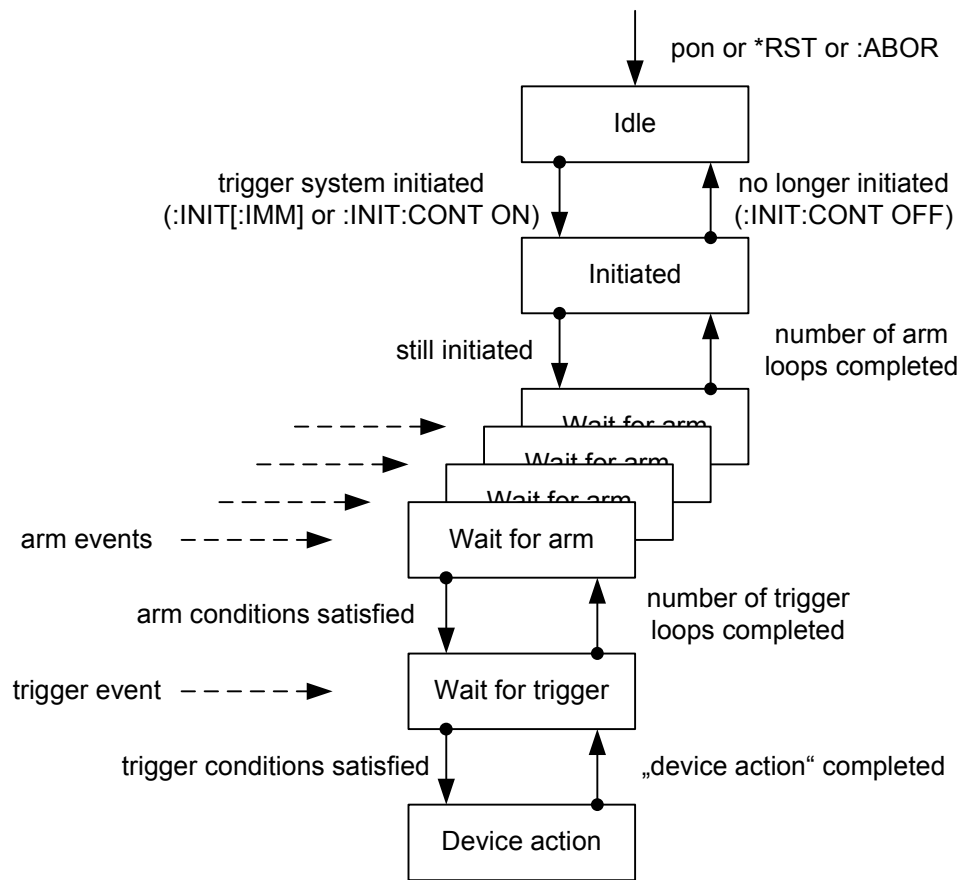
$$n_{steps} = \left\lceil \frac{f_{stop} - f_{start}}{f_{step}} \right\rceil + 1$$

$$t_{total} = n_{steps} \cdot t_{dwell}$$

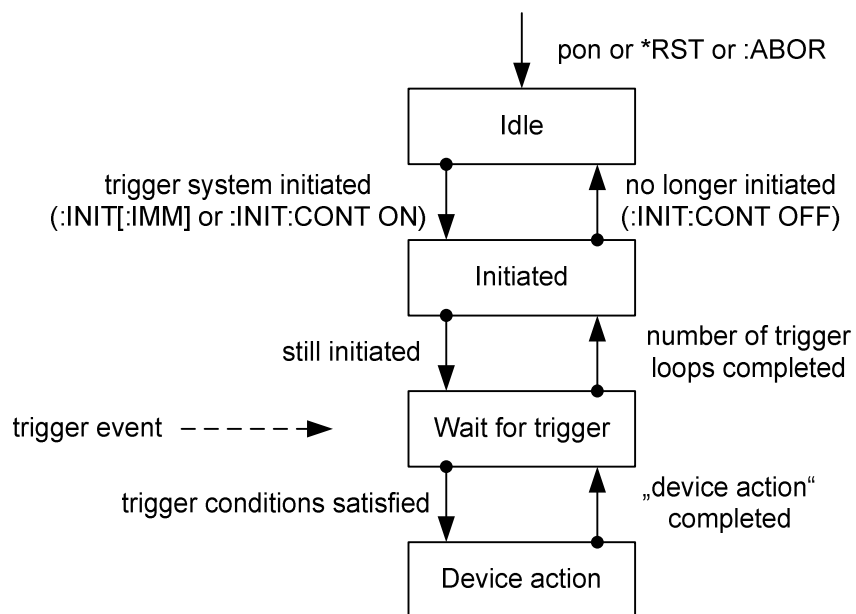
### 3.2.5 Trigger Control

In signal generators with sweeping features, all sweep operating modes use the trigger control system. The figure below shows the SCPI trigger control system proposal:

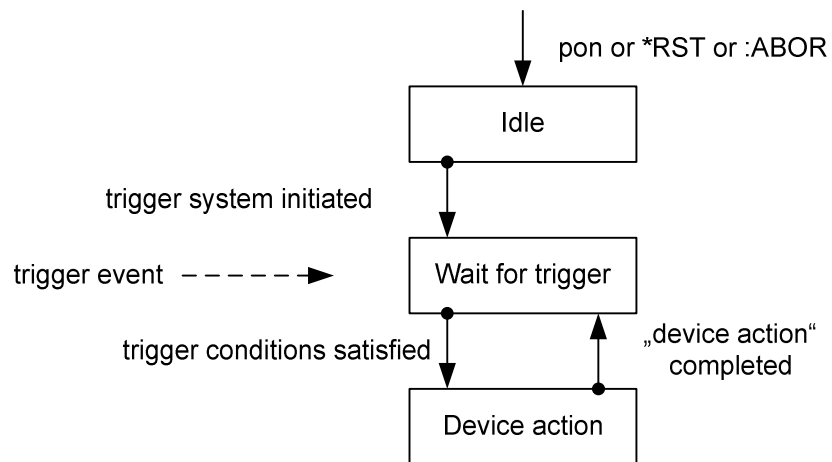




Some of the emulated instruments implement a simplified trigger control system:



Other emulated instruments and also the SMF implement the trigger control system shown in the following figure:

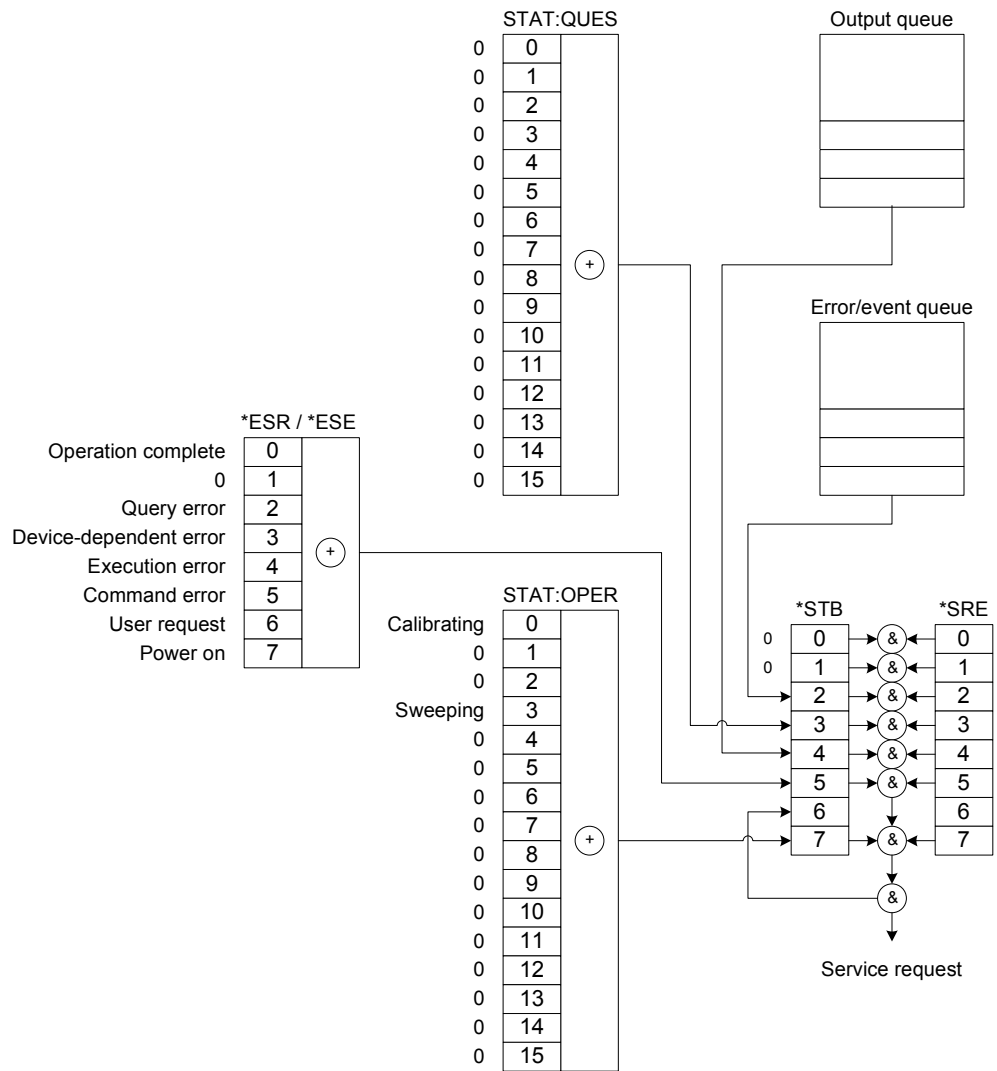


The main difference between the emulated instrument's and the SMF's trigger control system is that there is no "Initiated" state in the SMF. The SMF implementation assumes that the trigger system is initiated automatically in the "Idle" state. As a result, any sweep operation in the SMF, once activated, can only be controlled by internal or external trigger events.

This has an important impact on the user application. Application code that requires an "Initiated" state in the trigger control system must be adapted.

### 3.2.6 Status and Error Reporting

The SMF implements the minimal status and error reporting system required by the SCPI proposal. The following figure shows the status and error reporting model:



Some of the emulated instruments implement a more detailed status and error reporting system. Since the additional information stored in that system is not available in the SMF, application code that uses the additional information must be changed.

### 3.3 Preset / Reset

Changing the remote emulation does not automatically trigger a reset operation to the instrument. Therefore it is strongly recommended to manually execute a reset to the SMF after changing the remote emulation.

To apply the default of a particular remote emulation, the user must send the corresponding command via the remote control interface, e.g. the \*RST command in SCPI-compatible languages.

### 3.4 Power Down / Power Up

The selected remote emulation and the user-defined responses to \*IDN? and \*OPT? queries are saved when the instrument is switched off.

When the instrument is switched on again, it starts up with the same settings that were active before it was switched off.

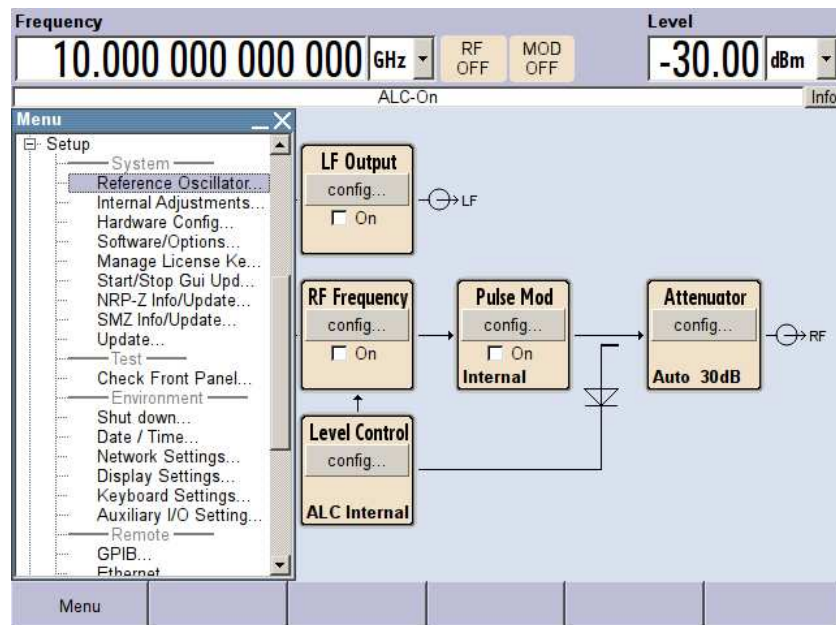
## 4 Activating a Remote Emulation

In order to use a specific remote emulation, it must first be activated by the user. Activation is done either

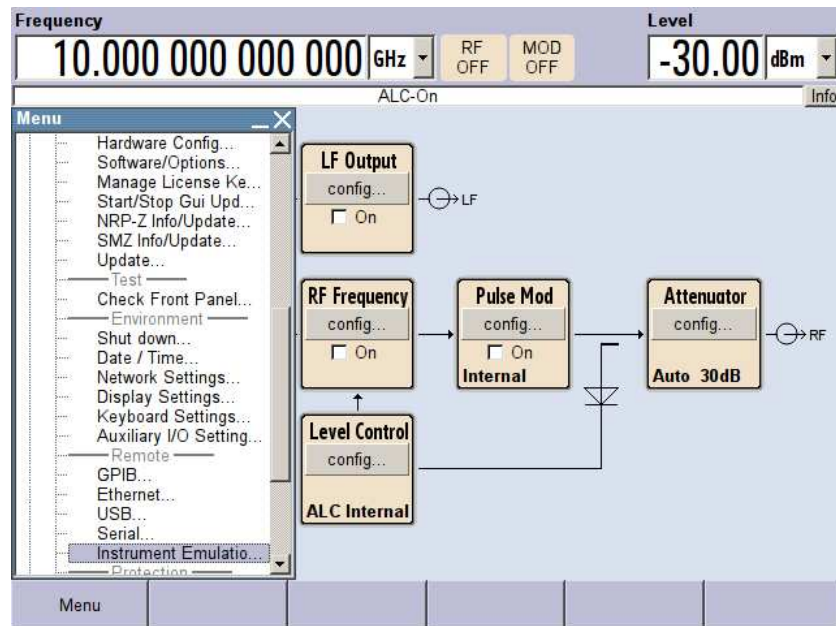
- manually using the SMF front panel
- remotely using SCPI commands

### 4.1 Manual Operation

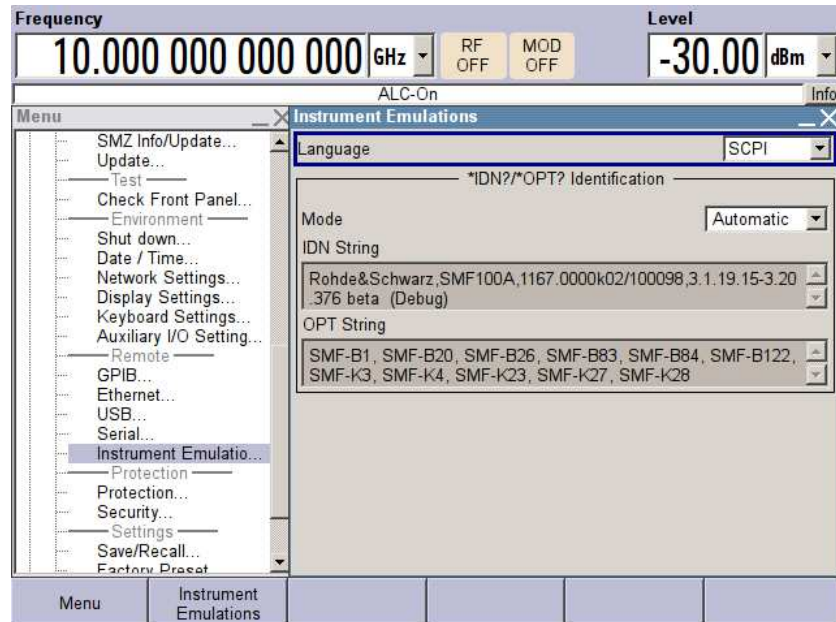
On the SMF front panel, press the SETUP key to open the Menu tree:



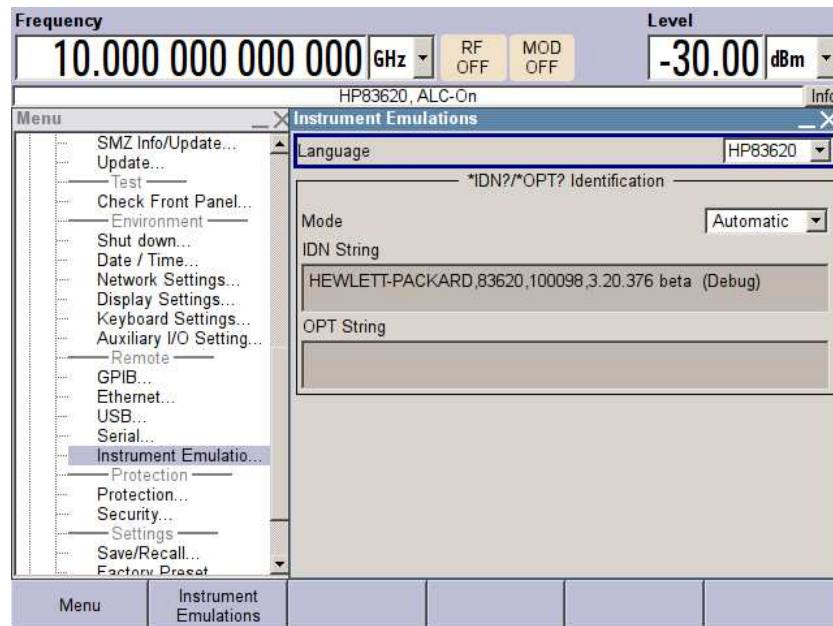
In the Menu tree, select Instrument Emulations... and open the Instrument Emulations dialog:



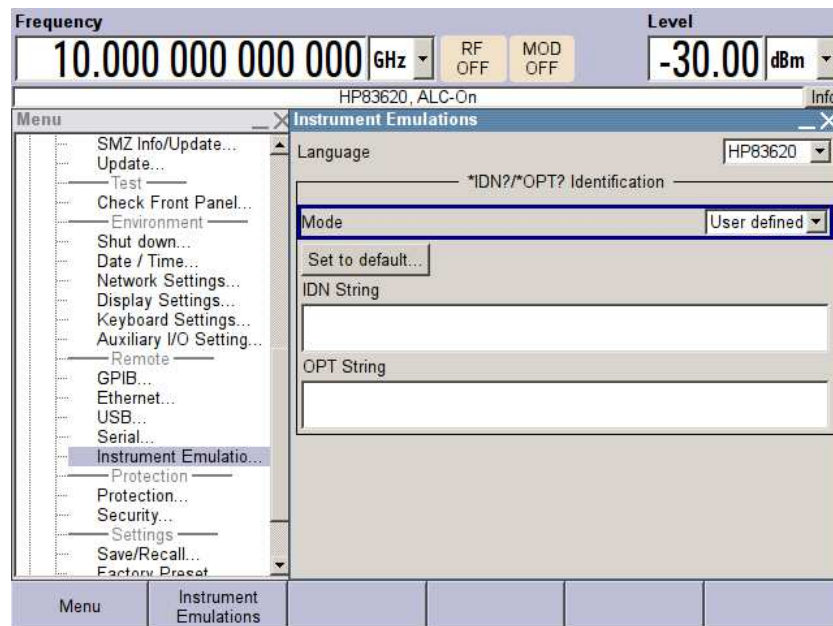
In the Instrument Emulations dialog, set up the remote emulation specific parameters:



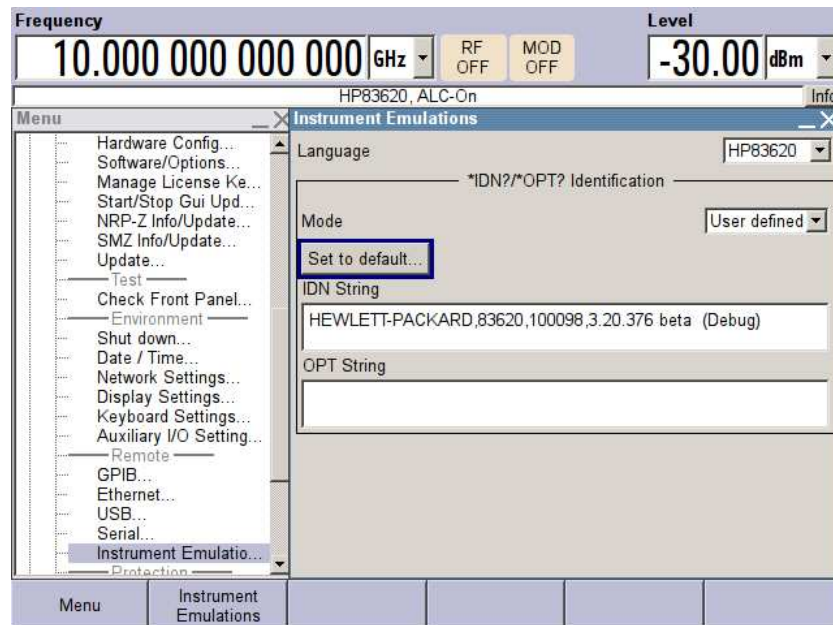
Select the Language and open the drop-down list. Pick an item from the list and confirm the selection:



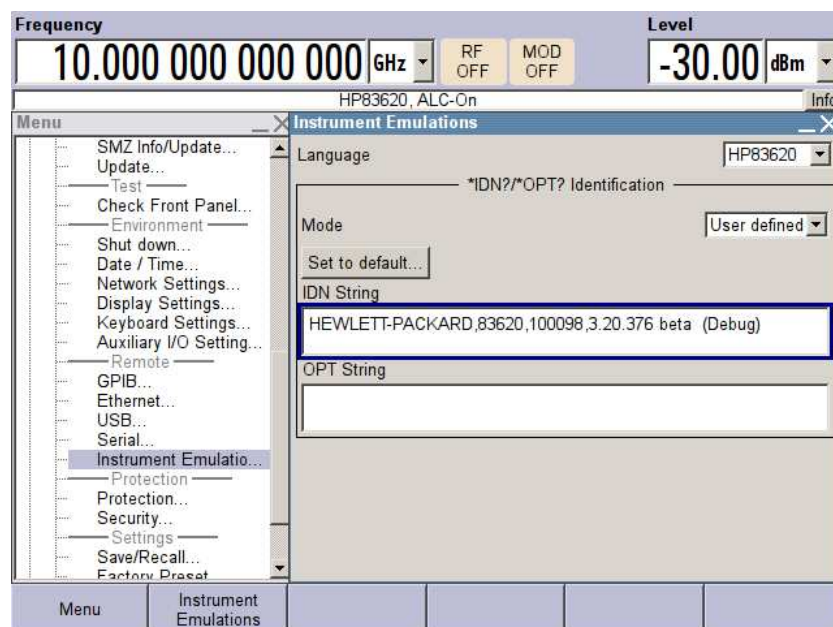
Select the Mode and open the drop-down list. Pick either “Automatic” or “User defined” from the list and confirm the selection. In “Automatic” mode, the response text to \*IDN? and \*OPT? queries is generated by the signal generator itself. In “User defined” mode, the response text to \*IDN? and \*OPT? queries must be entered in the corresponding IDN string and/or OPT string text boxes:



In “User defined” mode, press the “Set to default...” button to preset the corresponding IDN string and/or OPT string text boxes with the default settings from the selected remote emulation:

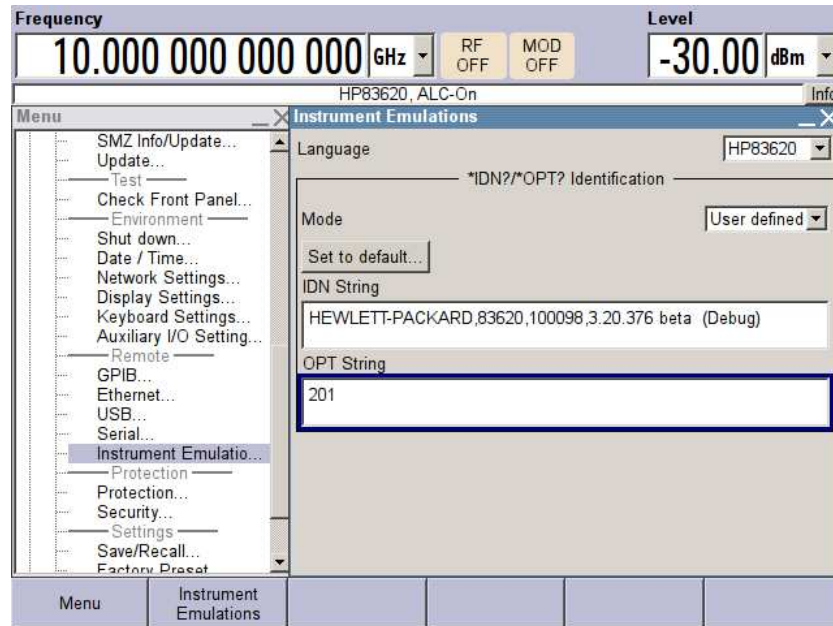


Then select the IDN String text box and edit the response text to \*IDN? queries. When finished, confirm the text:

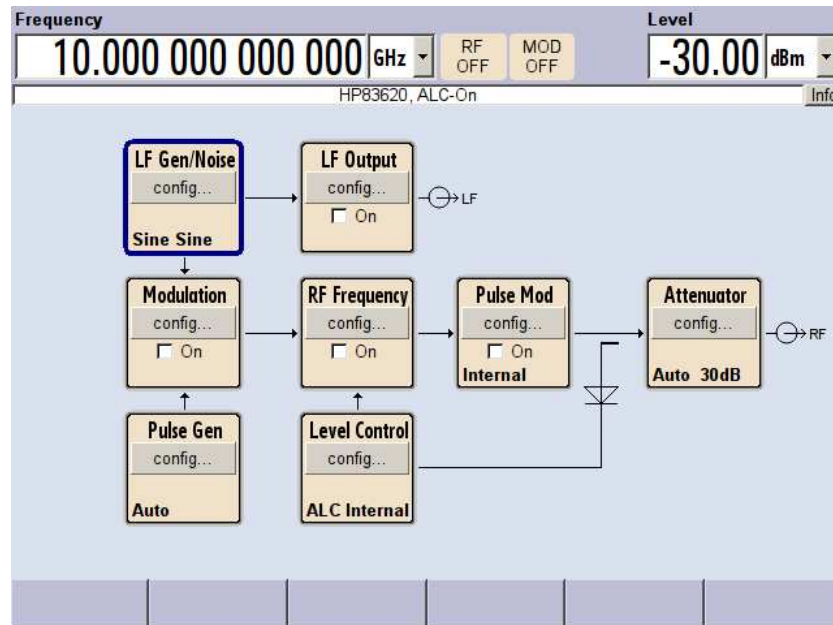




Finally select the OPT String text box and edit the response text to \*OPT? queries. When finished, confirm the text:



Exit the Remote Channel Settings dialog by pressing the ESC key and verify the selected remote emulation on the SMF front panel:



## 4.2 Remote Operation

When the SMF uses a non-SCPI-compatible language, the remote emulation cannot be changed remotely. The emulation needs to be changed manually.





When the SMF uses an SCPI-compatible language, use the following commands to modify the remote emulation parameters:


Commands to modify remote emulation relevant settings	
Command	Comment
:SYSTem:IDENt <value>	<p>Sets the state of the identification mode.</p> <p>If the identification mode is set to USER, the value provided with the command :SYSTem:IDN &lt;value&gt; is returned on an *IDN? query and the value provided with the command :SYSTem:OPT &lt;value&gt; is returned on *OPT? query.</p> <p>If the identification mode is set to AUTO, the factory default setting is returned on a *IDN? query or an *OPT? query.</p> <p>The value range of character-type parameter &lt;value&gt; is</p> <ul style="list-style-type: none"> <li>• AUTO</li> <li>• USER</li> </ul>
:SYSTem:IDENt?	Gets the state of the identification mode.
:SYSTem:IDN <value>	<p>Sets the user-defined response to an *IDN? query.</p> <p>The string-type parameter &lt;value&gt; allows up to 128 characters. The parameter has to be enclosed in single or double quotes.</p>
:SYSTem:IDN?	Gets the user-defined response to an *IDN? query.
:SYSTem:OPT <value>	<p>Sets the user-defined response to a *OPT? query.</p> <p>The string-type parameter &lt;value&gt; allows up to 128 characters. The parameter has to be enclosed in single or double quotes.</p>
:SYSTem:OPT?	Gets the user-defined response to a *OPT? query.
:SYSTem:LANGuage <value>	<p>Activates the remote emulation to be used for further communications.</p> <p>The value range of the string-type parameter &lt;value&gt; is:</p> <ul style="list-style-type: none"> <li>• "HP83620", "HP83630", "HP83640", "HP83650"</li> <li>• "EXIT"</li> </ul> <p><b>Attention:</b></p> <p>The remote emulation is changed immediately after parsing this command. Succeeding commands such as *WAI, *OPC or *OPC? are not allowed, since these commands may not be a part of the newly selected command set.</p> <p><b>Therefore, this command must be the one and only command in a program message unit.</b></p> <p>After sending this command, a delay of two seconds must be applied to the application software before the next command is sent.</p> <p>The parameter value "EXIT" must be used to return to the native SCPI command set of the instrument.</p>
:SYSTem:LANGuage?	Gets the current active remote emulation.


## 5 Emulating the Hewlett-Packard 83620, 83630, 83640, 83650



The following tables show the current implementation status of each command. Commands not shown in these tables are not supported.



IEEE488.2 functions	
Command syntax	Status
*CLS	✓
*ESE value *ESE? <b>Remark:</b> Layout of ESE register corresponds to Rohde & Schwarz signal generator.	✋
*ESR? <b>Remark:</b> Layout of ESE register corresponds to Rohde & Schwarz signal generator.	✋
*IDN? <b>Remark:</b> If the response does not match the requirements, a user-specific response to *IDN? and *OPT? can be applied on the instrument's front panel.	✋
*OPC *OPC?	✓
*OPT? <b>Remark:</b> If the response does not match the requirements, a user-specific response to *IDN? and *OPT? can be applied on the instrument's front panel.	✋
*RCL value	✓
*RST	✓
*SAV value	✓
*SRE value *SRE? <b>Remark:</b> Layout of ESE register corresponds to Rohde & Schwarz signal generator.	✋
*STB? <b>Remark:</b> Layout of ESE register corresponds to Rohde & Schwarz signal generator.	✋
*TRG	✓
*TST?	✓
*WAI	✓

Device-specific functions	
Command syntax	Status
ABORt	✓
AM[:DEPth] value AM[:DEPth]?	✓
AM:INTernal:FREQuency value AM:INTernal:FREQuency?	✓
AM:INTernal:FREQuency:STEP[:INCRement] value AM:INTernal:FREQuency:STEP[:INCRement]?	✓
AM:INTernal:FUNCTion value AM:INTernal:FUNCTion? <b>Remark:</b> RAMP is not supported.	
AM:MODE value AM:MODE? <b>Remark:</b> DEEP is not supported.	
AM:SOURce value AM:SOURce?	✓
AM:STATe value AM:STATe?	✓
AM:TYPE value AM:TYPE? <b>Remark:</b> EXPonential is not supported.	
DISPlay[:STATe] value DISPlay[:STATe]?	✓
FM:COUPling value FM:COUPling?	✓
FM[:DEViation] value FM[:DEViation]?	✓
FM:INTernal:FREQuency value FM:INTernal:FREQuency?	✓
FM:INTernal:FUNCTion value FM:INTernal:FUNCTion? <b>Remark:</b> RAMP is not supported.	
FM:SOURce value FM:SOURce?	✓

Device-specific functions	
Command syntax	Status
FM:STATe value FM:STATe?	✓
FREQuency:CENTer value FREQuency:CENTer?	✓
FREQuency[:CW] value FREQuency[:CW]?	✓
FREQuency[:CW]:AUTO value FREQuency[:CW]:AUTO?	✓
FREQuency:MANual value FREQuency:MANual?	✓
FREQuency:MODE value FREQuency:MODE? <b>Remark:</b> CW and SWEep are supported.	
FREQuency:MULTIplier value FREQuency:MULTIplier?	✓
FREQuency:OFFSet value FREQuency:OFFSet?	✓
FREQuency:SPAN value FREQuency:SPAN?	✓
FREQuency:STARt value FREQuency:STARt?	✓
FREQuency:STEP[:INCRement] value FREQuency:STEP[:INCRement]?	✓
FREQuency:STOP value FREQuency:STOP?	✓
INITiate:CONTInuous value INITiate:CONTInuous?	✓
INITiate[:IMMediate]	✓
MODulation:OUTPut:SOURce value MODulation:OUTPut:SOURce?	✓
MODulation:OUTPut:STATe value MODulation:OUTPut:STATe?	✓
MODulation:STATe value MODulation:STATe?	✓
OUTPut[:STATe] value OUTPut[:STATe]?	✓

Device-specific functions	
Command syntax	Status
POWer:CENTer value POWer:CENTer?	✓
POWer[:LEVel] value POWer[:LEVel]?	✓
POWer:MODE value POWer:MODE? <b>Remark:</b> CW and SWEep are supported.	
POWer:OFFSet value POWer:OFFSet?	✓
POWer:SPAN value POWer:SPAN?	✓
POWer:STARt value POWer:STARt?	✓
POWer:STEP[:INCRement] value POWer:STEP[:INCRement]?	✓
POWer:STOP value POWer:STOP?	✓
PULSe:FREQuency value PULSe:FREQuency?	✓
PULSe:PERiod value PULSe:PERiod?	✓
PULSe:WIDTh value PULSe:WIDTh?	✓
PULM:EXTernal:POLarity value PULM:EXTernal:POLarity?	✓
PULM:INTernal:FREQuency value PULM:INTernal:FREQuency?	✓
PULM:INTernal:PERiod value PULM:INTernal:PERiod?	✓
PULM:INTernal:TRIGger:SOURce value PULM:INTernal:TRIGger:SOURce?	✓
PULM:INTernal:WIDTh value PULM:INTernal:WIDTh?	✓

Device-specific functions	
Command syntax	Status
PULM:SOURce value PULM:SOURce? <b>Remark:</b> SCALar is not supported.	
PULM:STATe value PULM:STATe?	✓
STATus:OPERation:CONDition?	✓
STATus:OPERation:ENABLE value STATus:OPERation:ENABLE?	✓
STATus:OPERation[:EVENT]?	✓
STATus:OPERation:NTRansition value STATus:OPERation:NTRansition?	✓
STATus:OPERation:PTRansition value STATus:OPERation:PTRansition?	✓
STATus:PRESet	✓
STATus:QUEStionable:CONDition?	✓
STATus:QUEStionable:ENABLE value STATus:QUEStionable:ENABLE?	✓
STATus:QUEStionable[:EVENT]?	✓
STATus:QUEStionable:NTRansition value STATus:QUEStionable:NTRansition?	✓
STATus:QUEStionable:PTRansition value STATus:QUEStionable:PTRansition?	✓
SWEep:DWELI value SWEep:DWELI?	✓
SWEep:DWELI:AUTO value SWEep:DWELI:AUTO?	✓
SWEep:GENeration value SWEep:GENeration? <b>Remark:</b> ANALog is not supported.	
SWEep:MODE value SWEep:MODE?	✓
SWEep:POINts value SWEep:POINts?	✓
SWEep:TIME value SWEep:TIME?	✓

Device-specific functions	
Command syntax	Status
SWEep:TRIGger:SOURce value SWEep:TRIGger:SOURce?	✓
SYSTem:COMMunicate:GPIB:ADDRess value SYSTem:COMMunicate:GPIB:ADDRess?	✓
SYSTem:ERRor? <b>Remark:</b> Returns the original error code of the Rohde & Schwarz signal generator.	
SYSTem:LANGuage value SYSTem:LANGuage? <b>Remark:</b> "SCPI" and "EXIT" are supported.	
SYSTem:PRESet	✓
SYSTem:VERSion?	✓
TRIGger[:IMMediate]	✓
TRIGger:SOURce value TRIGger:SOURce?	✓
TRIGger[:IMMediate]	✓
TSWeep	✓
UNIT:POWer value UNIT:POWer?	✓



## 6 References

- [1] Rohde & Schwarz, R&S®SMF100A Microwave Signal Generator Operating Manual

## 7 Ordering Information

Please visit the R&S®SMF100A product website for comprehensive ordering information (“Options”) at [www.rohde-schwarz.com](http://www.rohde-schwarz.com).

### **About Rohde & Schwarz**

Rohde & Schwarz is an independent group of companies specializing in electronics. It is a leading supplier of solutions in the fields of test and measurement, broadcasting, radiomonitoring and radiolocation, as well as secure communications. Established more than 75 years ago, Rohde & Schwarz has a global presence and a dedicated service network in over 70 countries. Company headquarters are in Munich, Germany.

### **Environmental commitment**

- Energy-efficient products
- Continuous improvement in environmental sustainability
- ISO 14001-certified environmental management system



### **Regional contact**

Europe, Africa, Middle East

+49 89 4129 12345

[customersupport@rohde-schwarz.com](mailto:customersupport@rohde-schwarz.com)

North America

1-888-TEST-RSA (1-888-837-8772)

[customer.support@rsa.rohde-schwarz.com](mailto:customer.support@rsa.rohde-schwarz.com)

Latin America

+1-410-910-7988

[customersupport.la@rohde-schwarz.com](mailto:customersupport.la@rohde-schwarz.com)

Asia/Pacific

+65 65 13 04 88

[customersupport.asia@rohde-schwarz.com](mailto:customersupport.asia@rohde-schwarz.com)

China

+86-800-810-8228 /+86-400-650-5896

[customersupport.china@rohde-schwarz.com](mailto:customersupport.china@rohde-schwarz.com)

This application note and the supplied programs may only be used subject to the conditions of use set forth in the download area of the Rohde & Schwarz website.

R&S® is a registered trademark of Rohde & Schwarz GmbH & Co. KG; Trade names are trademarks of the owners.

**Rohde & Schwarz GmbH & Co. KG**

Mühlhofstraße 15 | D - 81671 München

Phone + 49 89 4129 - 0 | Fax + 49 89 4129 - 13777

[www.rohde-schwarz.com](http://www.rohde-schwarz.com)