

R&S[®] SMCVB-K548

Crest Factor Reduction

User Manual



This document describes the following software options:

- R&S®SMCVB-K548
1434.5640.02

This manual describes firmware version FW 4.70.176.xx and later of the R&S®SMCV100B.

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1179.1293.02 | Version 02 | R&S®SMCVB-K548

Throughout this manual, products from Rohde & Schwarz are indicated without the ® symbol, e.g. R&S®SMCV100B is indicated as R&S SMBVB. Linux® is abbreviated as Linux.

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1 Preface

1.1 About this Manual

This user manual provides all the information **specific to the options R&S SMCVB-K548**. All general instrument functions and settings common to all applications and operating modes are described in the main R&S SMCV100B user manual.

The main focus in this manual is on the provided settings and the tasks required to generate a signal. The following topics are included:

- **Welcome to the Crest Facor Reduction option R&S SMCVB-K548**
Introduction to and getting familiar with the option
- **About the Crest Facor Reduction**
Background information on basic terms and principles in the context of the signal generation
- **Configuration and Settings**
A concise description of all functions and settings available to configure signal generation with their corresponding remote control command
- **Remote Control Commands**
Remote commands required to configure and perform signal generation in a remote environment, sorted by tasks
(Commands required to set up the instrument or to perform common tasks on the instrument are provided in the R&S SMCV100B user manual)
Programming examples demonstrate the use of many commands and can usually be executed directly for test purposes
- **List of remote commands**
Alphabetical list of all remote commands described in the manual
- **Index**

1.2 Documentation Overview

This section provides an overview of the R&S SMCV100B user documentation. Unless specified otherwise, you find the documents on the R&S SMCV100B product page at:

www.rohde-schwarz.com/manual/smcv100b

1.2.1 Getting Started Manual

Introduces the R&S SMCV100B and describes how to set up and start working with the product. Includes basic operations, typical measurement examples, and general information, e.g. safety instructions, etc. A printed version is delivered with the instrument.

1.2.2 User Manuals and Help

Separate manuals for the base unit and the software options are provided for download:

- **Base unit manual**
Contains the description of all instrument modes and functions. It also provides an introduction to remote control, a complete description of the remote control commands with programming examples, and information on maintenance, instrument interfaces and error messages. Includes the contents of the getting started manual.
- **Software option manual**
Contains the description of the specific functions of an option. Basic information on operating the R&S SMCV100B is not included.

The contents of the user manuals are available as help in the R&S SMCV100B. The help offers quick, context-sensitive access to the complete information for the base unit and the software options.

All user manuals are also available for download or for immediate display on the Internet.

1.2.3 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):

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

1.2.4 Instrument Security Procedures

Deals with security issues when working with the R&S SMCV100B in secure areas. It is available for download on the Internet.

1.2.5 Printed Safety Instructions

Provides safety information in many languages. The printed document is delivered with the product.

1.2.6 Data Sheets and Brochures

The data sheet contains the technical specifications of the R&S SMCV100B. It also lists the options and their order numbers and optional accessories.

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

See www.rohde-schwarz.com/brochure-datasheet/smcv100b

1.2.7 Release Notes and Open Source Acknowledgment (OSA)

The release notes list new features, improvements and known issues of the current firmware version, and describe the firmware installation.

The open-source acknowledgment document provides verbatim license texts of the used open source software.

See www.rohde-schwarz.com/firmware/smcv100b

1.2.8 Application Notes, Application Cards, White Papers, etc.

These documents deal with special applications or background information on particular topics.

See www.rohde-schwarz.com/application/smcv100b

2 Welcome to the R&S SMCVB-K548 Option

The R&S SMCVB-K548 is a software option that allows you to generate signals with reduced crest factor.

R&S SMCVB-K548 key features

- Reduces the crest factor of a baseband signal through clipping the high signal peaks and filtering the waveform afterwards.
- Can be applied to any waveform file loaded in the arbitrary waveform generator.
- It uses an iterative process to reach the desired crest factor delta.
- It is possible to adjust the filter characteristics. In simple mode, you can specify the channel spacing and signal bandwidth. Alternatively in the advanced filter mode you can specify the lowpass filter through passband and stopband frequencies.

This user manual contains a description of the functionality that the application provides, including remote control operation.

All functions not discussed in this manual are the same as in the base unit and are described in the R&S SMCV100B user manual. The latest version is available at:

www.rohde-schwarz.com/manual/SMCV100B

Installation

You can find detailed installation instructions in the delivery of the option or in the R&S SMCV100B service manual.

2.1 Accessing the Required Settings

1. In the block diagram of the R&S SMCV100B, select the "Baseband" > "ARB".
A dialog box opens that displays the provided general settings.
2. Select "Load Waveform".
Navigate to waveform file and load it.
3. Select "ARB > State > On".
4. Select "Crest Factor Reduction".

The signal generation is started. To apply the crest factor reduction with the default settings, select "State > On".

2.2 Scope



Tasks (in manual or remote operation) that are also performed in the base unit in the same way are not described here.

In particular, it includes:

- Managing settings and data lists, like storing and loading settings, creating and accessing data lists, or accessing files in a particular directory.
- Information on regular trigger, marker and clock signals and filter settings, if appropriate.
- General instrument configuration, such as checking the system configuration, configuring networks and remote operation
- Using the common status registers

For a description of such tasks, see the R&S SMCV100B user manual.

2.3 Notes on Screenshots

When describing the functions of the product, we use sample screenshots. These screenshots are meant to illustrate as many as possible of the provided functions and possible interdependencies between parameters. The shown values may not represent realistic usage scenarios.

The screenshots usually show a fully equipped product, that is: with all options installed. Thus, some functions shown in the screenshots may not be available in your particular product configuration.

3 About this Manual

This user manual provides all the information **specific to the options R&S SMCVB-K548**. All general instrument functions and settings common to all applications and operating modes are described in the main R&S SMCV100B user manual.

The main focus in this manual is on the provided settings and the tasks required to generate a signal. The following topics are included:

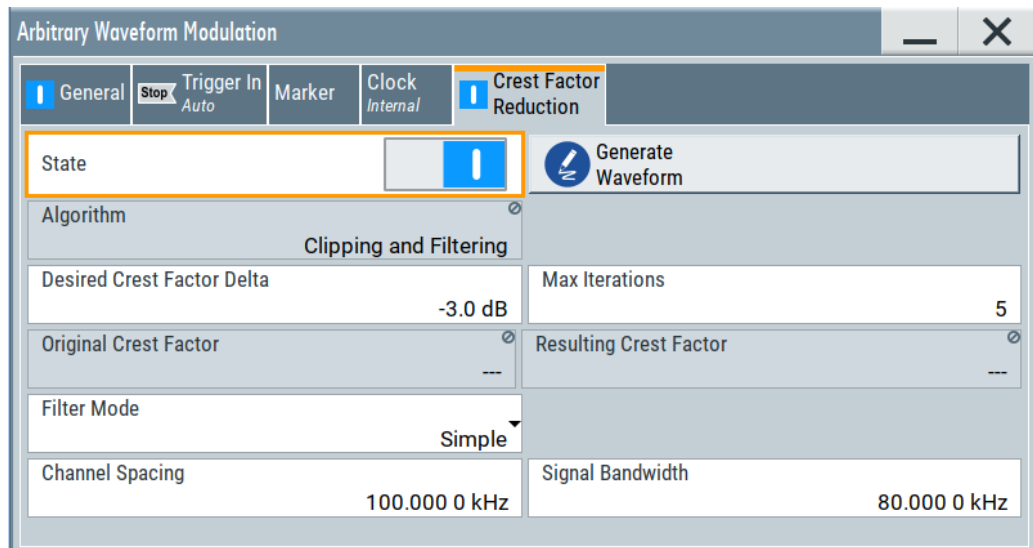
- **Welcome to the Crest Facor Reduction option R&S SMCVB-K548**
Introduction to and getting familiar with the option
- **About the Crest Facor Reduction**
Background information on basic terms and principles in the context of the signal generation
- **Configuration and Settings**
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4 Crest Factor Reduction Settings

Prerequisite: An ARB file is loaded and enabled.

Access:

- ▶ Select the "Baseband > ARB > Crest Factor Reduction".



The remote commands required to define these settings are described in [Chapter 5, "Remote-Control Commands"](#), on page 15.

Settings:

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State

Enables the crest factor reduction calculation.

Note: You cannot activate the crest factor reduction and the notch filter simultaneously. Enabling the notched filter automatically disables the crest factor reduction.

Remote command:

`[:SOURce<hw>] :BB:ARbitrary:CFR[:STATe]` on page 16

Generate Waveform

With enabled signal generation, triggers the instrument to store the current settings in a waveform file. Waveform files can be further processed.

The filename and the directory it is stored in are user-definable; the predefined file extension for waveform files is *.wv.

Remote command:

[\[:SOURce<hw>\]:BB:ARbitrary:CFR:WAVeform:CREate](#) on page 20

Algorithm

Displays the algorithm used for the crest factor reduction. The "Clipping and filtering" algorithm performs a hard clipping. It is followed by a low pass filtering of the result in an iterative manner until the target crest factor is reached. You can define the settings of the filter that is used for the calculation.

Remote command:

[\[:SOURce<hw>\]:BB:ARbitrary:CFR:ALGorithm](#) on page 17

Desired Crest Factor Delta

Sets the value difference by which you want to change your crest factor.

Remote command:

[\[:SOURce<hw>\]:BB:ARbitrary:CFR:DCFDelta](#) on page 17

Max Iterations

Sets the number of iterations that are used for calculating the resulting crest factor. The iteration process is stopped when the desired crest factor delta is achieved by 0.1 dB.

Remote command:

[\[:SOURce<hw>\]:BB:ARbitrary:CFR:ITERations](#) on page 18

Original Crest Factor

Displays the original crest factor of the waveform after the calculation of the resulting crest factor is completed. The original crest factor is calculated as an average over the whole waveform, including any idle periods that might be present in TDD waveforms.

Remote command:

[\[:SOURce<hw>\]:BB:ARbitrary:CFR:OCFactor?](#) on page 18

Resulting Crest Factor

Displays the resulting crest factor of the waveform after the calculations are completed. The resulting crest factor is calculated as an average over the whole waveform, including any idle periods that might be present in TDD waveforms.

Remote command:

[\[:SOURce<hw>\]:BB:ARbitrary:CFR:RCFactor?](#) on page 19

Filter Mode

Selects which filter mode is used for the filtering.

"Simple"

You can specify the RF bandwidth and channel spacing of the signal. The lowpass filter is designed to pass through frequency components inside the signal bandwidth and suppress components in the adjacent channel.

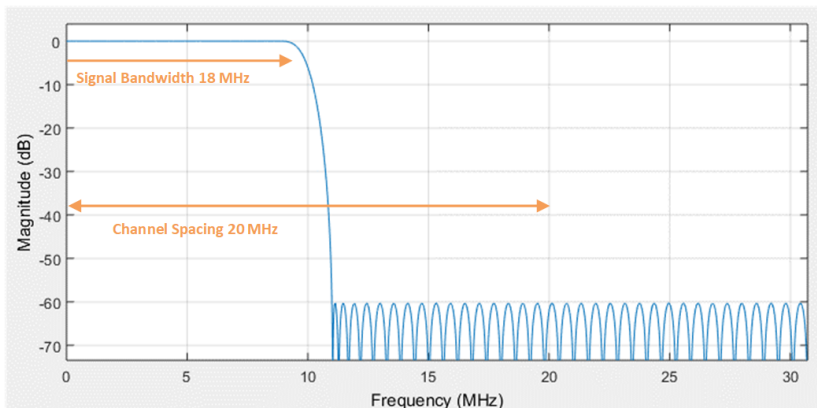


Figure 4-1: Simple filter mode

"Enhanced"

In the enhanced filter mode, you can specify the passband and stopband frequencies of the lowpass filter.

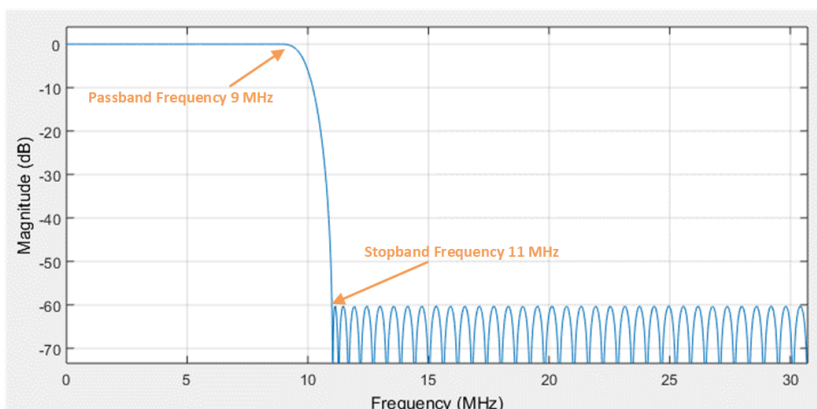


Figure 4-2: Enhanced filter mode

Remote command:

[\[:SOURce<hw>\]:BB:ARBitrary:CFR:FILTer](#) on page 17

Channel Spacing

Available for "Filter Mode > Simple".

Sets the channel spacing.

Remote command:

[\[:SOURce<hw>\]:BB:ARBitrary:CFR:CSPacing](#) on page 17

Signal Bandwidth

Available for "Filter Mode > Simple".

Sets the signal bandwidth. The value of the "Signal Bandwidth" should not be higher than the "Channel Spacing".

Remote command:

[\[:SOURce<hw>\]:BB:ARbitrary:CFR:SBANdwidth](#) on page 19

Stopband Frequency

Available for "Filter Mode > Enhanced".

Sets the stopband frequency of the filter. Frequency components higher than the stopband frequency are filtered out by the lowpass filter.

Remote command:

[\[:SOURce<hw>\]:BB:ARbitrary:CFR:SFReq](#) on page 20

Passband Frequency

Available for "Filter Mode > Enhanced".

Sets the passband frequency. Frequency components lower than the passband frequency are passed through unfiltered.

Remote command:

[\[:SOURce<hw>\]:BB:ARbitrary:CFR:PFReq](#) on page 19

Maximum Filter Order

Available for "Filter Mode > Enhanced".

Sets the maximum filter order.

Remote command:

[\[:SOURce<hw>\]:BB:ARbitrary:CFR:FORDER](#) on page 18

5 Remote-Control Commands

The following commands are required to perform signal generation in a remote environment. We assume that the R&S SMCV100B has already been set up for remote operation in a network as described in the R&S SMCV100B user manual. Knowledge about the remote control operation and the SCPI command syntax is assumed.



Conventions used in SCPI command descriptions

For a description of the conventions used in the remote command descriptions, see section "Remote Control Commands" in the R&S SMCV100B user manual.

Common suffixes

The following common suffixes are used in remote commands:

Suffix	Value range	Description
SOURce<hw>	1	Available baseband signals

Programming examples

The corresponding sections of the same title provide simple programming examples for the R&S SMCV100B. The purpose of the examples is to present **all** commands for a given task. In real applications, one would rather reduce the examples to an appropriate subset of commands.

The programming examples have been tested with a software tool which provides an environment for the development and execution of remote tests. To keep the examples as simple as possible, only the "clean" SCPI syntax elements are reported. Non-executable command lines (e.g. comments) start with two // characters.

At the beginning of the most remote control program, an instrument (p) reset is recommended to set the R&S SMCV100B to a definite state. The commands `*RST` and `SYSTem:PRESet` are equivalent for this purpose. `*CLS` also resets the status registers and clears the output buffer.

In all the examples, we assume that a remote PC is connected to the instrument, the remote PC and the instrument are switched on, a connection between them is established. We also assume that the security setting "System Config > Setup > Security > SCPI over LAN" is enabled.

Example: Configuring the CFR

Prerequisite: An ARB file is loaded and enabled.

```
SOURcel:BB:ARBitrary:CFR:ALGorithm CLFiltering
SOURcel:BB:ARBitrary:CFR:DCFDelta -3
SOURcel:BB:ARBitrary:CFR:ITERations 5
SOURcel:BB:ARBitrary:CFR:FILTer SIMPLe
SOURcel:BB:ARBitrary:CFR:CSPacing 20E6
SOURcel:BB:ARBitrary:CFR:SBANdwidth 18E6
SOURcel:BB:ARBitrary:CFR:STATe ON
SOURcel:BB:ARBitrary:CFR:MEASure:STATe?
//ON
SOURcel:BB:ARBitrary:CFR:OCFactor?
//6
SOURcel:BB:ARBitrary:CFR:RCFactor?
//3
SOURcel:BB:ARBitrary:CFR:CREate "cfr"
```

Example: Setting up an Enhanced Filter

```
SOURcel:BB:ARBitrary:CFR:FILTer ENHanced
SOURcel:BB:ARBitrary:CFR:PFReq 9E6
SOURcel:BB:ARBitrary:CFR:SFReq 11E6
SOURcel:BB:ARBitrary:CFR:FORDER 100
```

The following commands specific to the R&S SMCVB-K548 option are described here:

[:SOURce<hw>]:BB:ARBitrary:CFR[:STATe]	16
[:SOURce<hw>]:BB:ARBitrary:CFR:ALGorithm	17
[:SOURce<hw>]:BB:ARBitrary:CFR:CSPacing	17
[:SOURce<hw>]:BB:ARBitrary:CFR:DCFDelta	17
[:SOURce<hw>]:BB:ARBitrary:CFR:FILTer	17
[:SOURce<hw>]:BB:ARBitrary:CFR:FORDER	18
[:SOURce<hw>]:BB:ARBitrary:CFR:ITERations	18
[:SOURce<hw>]:BB:ARBitrary:CFR:MEASure[:STATe]?	18
[:SOURce<hw>]:BB:ARBitrary:CFR:OCFactor?	18
[:SOURce<hw>]:BB:ARBitrary:CFR:PFReq	19
[:SOURce<hw>]:BB:ARBitrary:CFR:RCFactor?	19
[:SOURce<hw>]:BB:ARBitrary:CFR:SBANdwidth	19
[:SOURce<hw>]:BB:ARBitrary:CFR:SFReq	20
[:SOURce<hw>]:BB:ARBitrary:CFR:WAVEform:CREate	20

[\[:SOURce<hw>\]:BB:ARBitrary:CFR\[:STATe\] <ArbCfrState>](#)

Enables the crest factor reduction calculation.

Parameters:

<ArbCfrState> 0 | 1 | OFF | ON
 *RST: 0

Example: See [Example "Configuring the CFR"](#) on page 16.

Manual operation: See ["State"](#) on page 11

[:SOURce<hw>]:BB:ARBitrary:CFR:ALGorithm <ArbCfrAlgorithm>

Displays the algorithm used for the crest factor reduction. The "Clipping and filtering" algorithm performs a hard clipping. It is followed by a low pass filtering of the result in an iterative manner until the target crest factor is reached. You can define the settings of the filter that is used for the calculation.

Parameters:

<ArbCfrAlgorithm> CLFiltering
*RST: CLFiltering

Example: See [Example "Configuring the CFR"](#) on page 16.

Manual operation: See ["Algorithm"](#) on page 12

[:SOURce<hw>]:BB:ARBitrary:CFR:CSPacing <ArbCfrChanSpac>

Sets the channel spacing, if [\[:SOURce<hw>\]:BB:ARBitrary:CFR:FILTer](#) is set to SIMPLe.

Parameters:

<ArbCfrChanSpac> float
Range: 0 to depends on the sample rate of the loaded file
Increment: 0.1
*RST: 250E6

Example: See [Example "Configuring the CFR"](#) on page 16.

Manual operation: See ["Channel Spacing"](#) on page 13

[:SOURce<hw>]:BB:ARBitrary:CFR:DCFDelta <ArbCfrDCFDelta>

Sets the value difference by which you want to change your crest factor.

Parameters:

<ArbCfrDCFDelta> float
Range: -20 to 0
Increment: 0.1
*RST: -3

Example: See [Example "Configuring the CFR"](#) on page 16.

Manual operation: See ["Desired Crest Factor Delta"](#) on page 12

[:SOURce<hw>]:BB:ARBitrary:CFR:FILTer <ArbCfrFilterMod>

Selects which filter mode is used for the filtering.

Parameters:

<ArbCfrFilterMod> SIMPLe | ENHanced
*RST: SIMPLe

Example: See [Example "Configuring the CFR"](#) on page 16.

Manual operation: See ["Filter Mode"](#) on page 12

[:SOURce<hw>]:BB:ARbitrary:CFR:FORDER <ArbCfrMaxFilOrd>

Sets the maximum filter order, if [:SOURce<hw>]:BB:ARbitrary:CFR:FILTer is set to ENHanced.

Parameters:

<ArbCfrMaxFilOrd> integer
 Range: 0 to 300
 *RST: 100

Example: See [Example "Configuring the CFR"](#) on page 16.

Manual operation: See ["Maximum Filter Order"](#) on page 14

[:SOURce<hw>]:BB:ARbitrary:CFR:ITERations <ArbCfrMaxIter>

Sets the number of iterations that are used for calculating the resulting crest factor. The iteration process is stopped when the desired crest factor delta is achieved by 0.1 dB.

Parameters:

<ArbCfrMaxIter> integer
 Range: 1 to 10
 *RST: 5

Example: See [Example "Configuring the CFR"](#) on page 16.

Manual operation: See ["Max Iterations"](#) on page 12

[:SOURce<hw>]:BB:ARbitrary:CFR:MEASure[:STATe]?

Queries the state of the crest factor reduction calculation.

Return values:

<MeasureState> 0 | 1 | OFF | ON
 ON: the original and resulting crest factors are already calculated.
 *RST: 0

Example: See [Example "Configuring the CFR"](#) on page 16.

Usage: Query only

[:SOURce<hw>]:BB:ARbitrary:CFR:OCFactor?

Queries the original crest factor of the waveform after the calculation of the resulting crest factor is completed. The original crest factor is calculated as an average over the whole waveform, including any idle periods that might be present in TDD waveforms.

Return values:

<ArbCfrOCrestFac> float
 Range: 1 to 100
 Increment: 0.01
 *RST: 6

Example: See [Example "Configuring the CFR"](#) on page 16.

Usage: Query only

Manual operation: See ["Original Crest Factor"](#) on page 12

[:SOURce<hw>]:BB:ARbitrary:CFR:PFReq <ArbCfrPassBFreq>

Sets the passband frequency, if [:SOURce<hw>]:BB:ARbitrary:CFR:FILTer is set to ENHanced. Frequency components lower than the passband frequency are passed through unfiltered.

Parameters:

<ArbCfrPassBFreq> float
 Range: 0 to depends on the sample rate of the loaded file
 Increment: 0.1
 *RST: 250E6

Example: See [Example "Setting up an Enhanced Filter"](#) on page 16.

Manual operation: See ["Passband Frequency"](#) on page 14

[:SOURce<hw>]:BB:ARbitrary:CFR:RCFactor?

Queries the resulting crest factor of the waveform after the calculations are completed. The resulting crest factor is calculated as an average over the whole waveform, including any idle periods that might be present in TDD waveforms.

Return values:

<ArbCfrResCreFac> float
 Range: 1 to 100
 Increment: 0.1
 *RST: 6

Example: See [Example "Configuring the CFR"](#) on page 16.

Usage: Query only

Manual operation: See ["Resulting Crest Factor"](#) on page 12

[:SOURce<hw>]:BB:ARbitrary:CFR:SBANdwidth <ArbCfrSignalBw>

Sets the signal bandwidth, if [:SOURce<hw>]:BB:ARbitrary:CFR:FILTer is set to SIMPLe.

The value of the signal bandwidth should not be higher than the channel spacing ([:SOURce<hw>]:BB:ARbitrary:CFR:CSPacing).

Parameters:

<ArbCfrSignalBw> float
 Range: 0 to depends on the sample rate of the loaded file
 Increment: 0.1
 *RST: 250E6

Example: See [Example "Configuring the CFR"](#) on page 16.

Manual operation: See ["Signal Bandwidth"](#) on page 13

[:SOURce<hw>]:BB:ARBitrary:CFR:SFReq <ArbCfrStopBFreq>

Sets the stopband frequency of the filter, if `[:SOURce<hw>]:BB:ARBitrary:CFR:FILTer` is set to `ENHanced`. Frequency components higher than the stopband frequency are filtered out by the lowpass filter.

Parameters:

<ArbCfrStopBFreq> float
 Range: 0 to depends on the sample rate of the loaded file
 Increment: 0.1
 *RST: 250E6

Example: See [Example "Setting up an Enhanced Filter"](#) on page 16.

Manual operation: See ["Stopband Frequency"](#) on page 14

[:SOURce<hw>]:BB:ARBitrary:CFR:WAVeform:CREate <CreateWvFile>

With enabled signal generation, triggers the instrument to store the current settings in a waveform file. Waveform files can be further processed.

The filename and the directory it is stored in are user-definable; the predefined file extension for waveform files is `*.wv`.

Setting parameters:

<CreateWvFile> string

Example: See [Example "Configuring the CFR"](#) on page 16.

Usage: Setting only

Manual operation: See ["Generate Waveform"](#) on page 12

List of Commands

[:SOURce<hw>]:BB:ARBitrary:CFR:ALGorithm.....	17
[:SOURce<hw>]:BB:ARBitrary:CFR:CSPacing.....	17
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[:SOURce<hw>]:BB:ARBitrary:CFR:MEASure[:STATe]?	18
[:SOURce<hw>]:BB:ARBitrary:CFR:OCFactor?	18
[:SOURce<hw>]:BB:ARBitrary:CFR:PFReq.....	19
[:SOURce<hw>]:BB:ARBitrary:CFR:RCFactor?	19
[:SOURce<hw>]:BB:ARBitrary:CFR:SBANdwidth.....	19
[:SOURce<hw>]:BB:ARBitrary:CFR:SFRReq.....	20
[:SOURce<hw>]:BB:ARBitrary:CFR:WAVeform:CREate.....	20
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