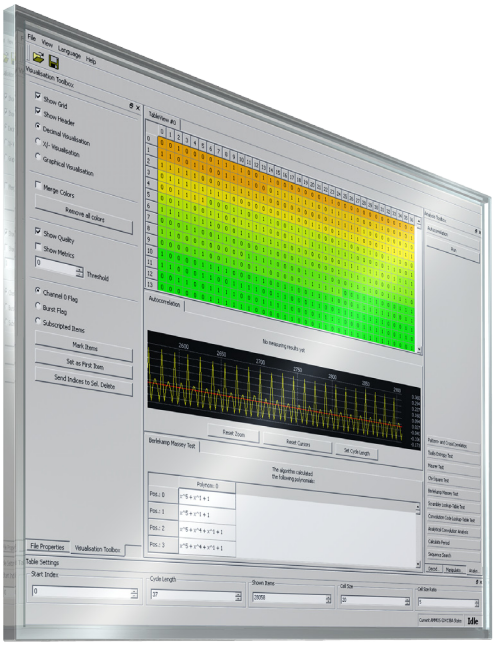
R&S®CA250
Bit Stream Analysis
Analysis and manipulation of signals at the bit stream/ symbol stream level



Radiomonitoring

Data Sheet | 01.00

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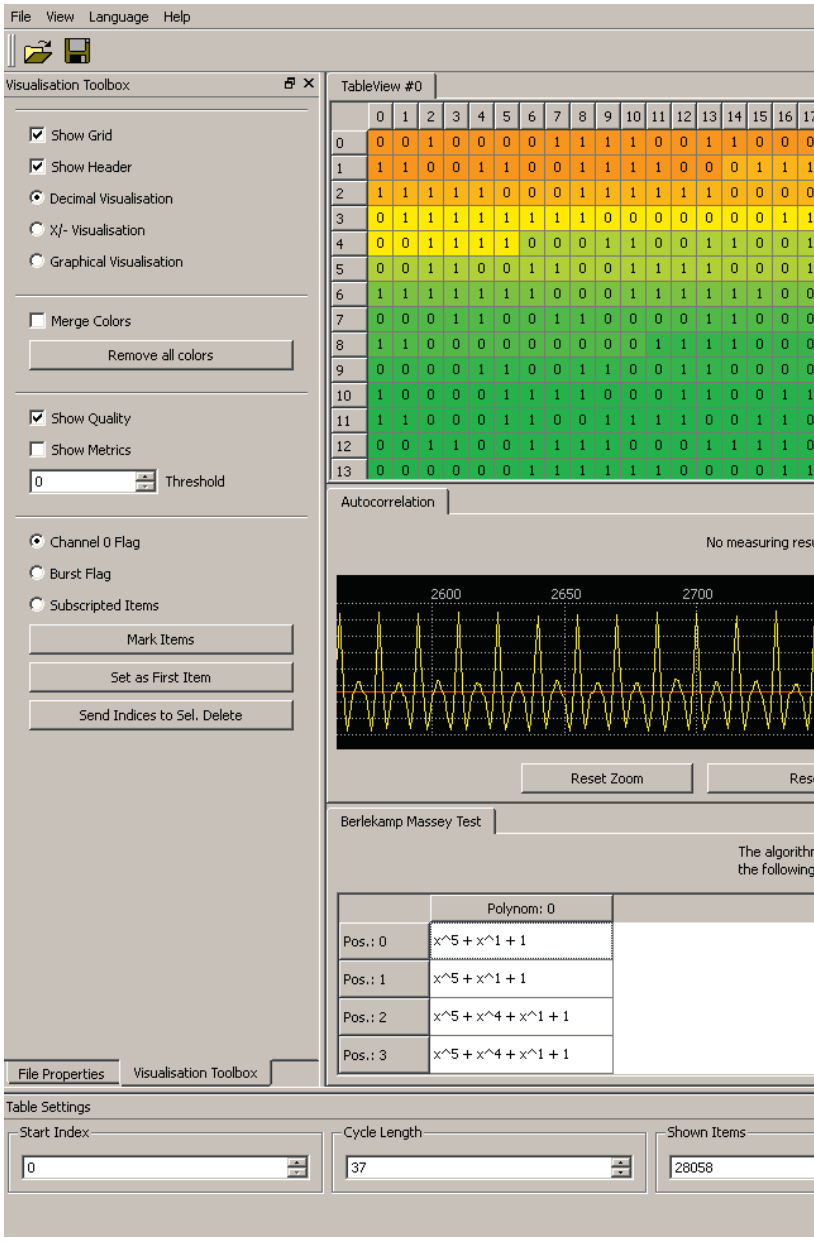
R&S®CA250 Bit Stream Analysis

At a glance

In the fields of technical analysis of modern communication signals, the capability to analyze the characteristics of demodulated signals with unknown codings is of major importance. In addition to various symbol stream/bit stream representations R&S®CA250 provides a large number of powerful analysis algorithms and bit stream manipulation functions.

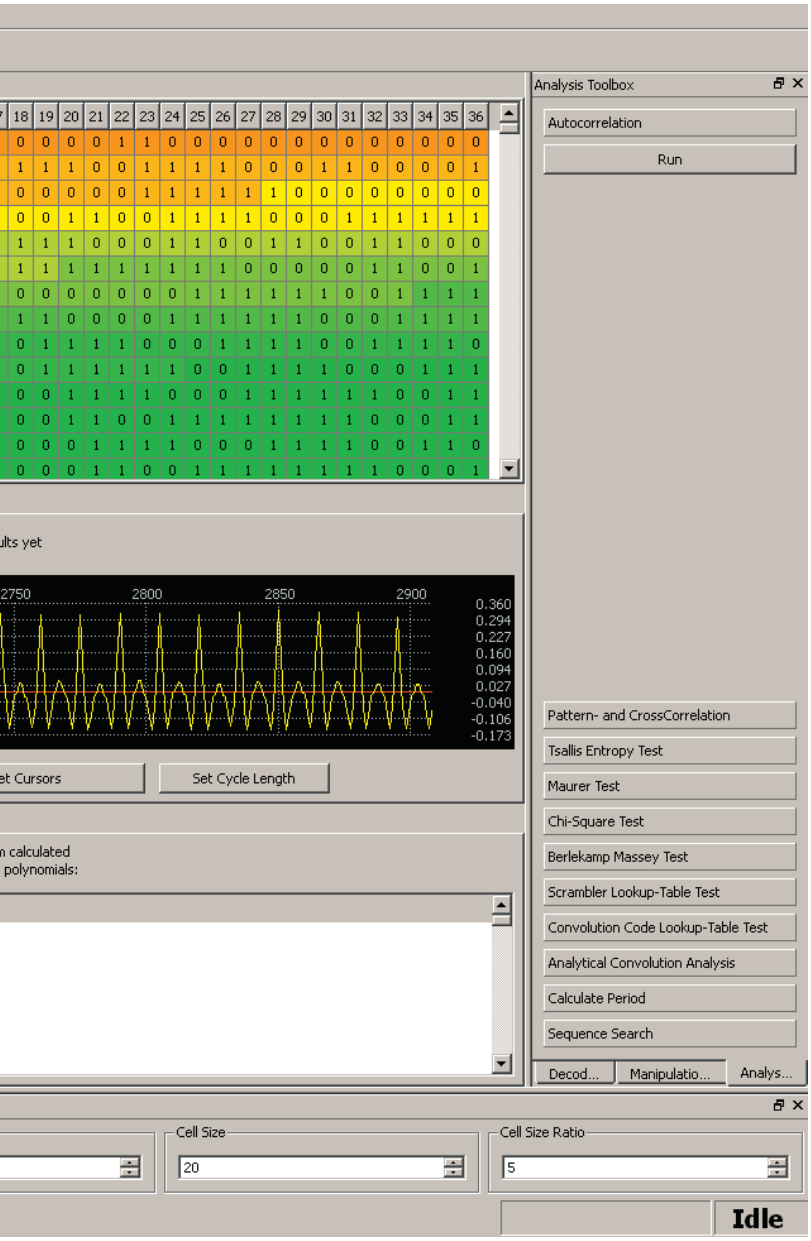
By selectively using these tools, you can obtain technical data from the unknown bit stream. This data provides information about the type and content of the analyzed signal. Ideally, it is possible to resolve all aspects of the unknown code, thus allowing you to program your own decoder for the unknown signal (e.g. by using the R&S®GX400ID decoder development environment).

R&S®CA250 operating window



R&S®CA250 Bit Stream Analysis

Benefits and key features



Versatile data import and symbol stream/bit stream representation

- Import of various symbol stream/bit stream formats
- Symbol-to-bit mapping and bit stream representation as 0/1 and -/X representation as well as graphical visualization

Versatile bit stream analysis functions

- Structure analysis, entropy analysis (block codes), scrambler analysis, convolutional code analysis

Wide variety of bit manipulation functions

- Deletion, inversion, multiplexing, demultiplexing, descrambling, deinterleaving, decoding of convolutional codes, decoding of standard alphabets and decoding of voice codecs

Code analysis and automation

- Integration of user-specific algorithms into the R&S®CA250 operation sequences
- Programmable script control for performing automatic analysis sequences

Versatile data import and symbol stream/bit stream representation

Data import and symbol stream/bit stream representation

R&S®CA250 supports the import of files in different symbol stream and bit stream formats. In symbol stream representation, the symbols generated by the demodulator are displayed according to their valency (line-by-line representation from left to right).

The symbol stream is transferred to a bit stream by means of predefined and user-definable symbol-to-bit mapping specifications.

Symbol stream with four valued symbols (symbol values: 0, 1, 2, 3)

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0	3	2	0	0	0	1	1	2	0	3	2	2	1	1	1	3	2	2	0	2	2	0	0	0	0	3	2	1	1	1	3	2
1	3	3	1	1	3	1	3	2	1	1	1	3	2	2	0	3	1	3	2	0	2	2	1	3	3	2	2	2	0	2	3	3
2	3	2	1	3	2	0	2	2	1	3	3	3	0	3	2	2	1	0	3	3	3	0	2	0	3	2	2	0	2	2	0	0
3	0	0	3	2	1	0	3	2	0	2	2	1	3	3	3	0	3	2	2	1	1	1	3	2	2	0	3	1	3	2	0	2
4	2	1	3	3	2	2	2	1	1	0	0	1	0	0	0	3	2	0	3	1	3	3	3	0	2	0	3	2	3	3	1	1
5	2	2	1	3	2	1	0	3	3	3	1	1	3	1	3	2	1	1	1	2	1	1	2	2	1	3	3	2	2	3	3	1
6	1	2	2	0	1	3	2	3	3	1	1	3	1	3	3	3	0	3	2	3	2	2	2	0	2	3	2	0	1	3	2	3
7	3	0	2	0	3	2	2	0	3	0	0	0	0	3	2	0	3	1	3	2	1	1	0	1	3	1	3	3	3	0	2	0
8	3	2	2	1	0	3	3	3	1	0	1	1	3	2	3	2	2	3	3	1	0	1	1	2	0	3	2	2	1	1	1	3
9	2	2	0	2	2	0	0	0	0	3	2	1	1	1	3	2	3	3	1	1	3	1	3	2	1	1	1	3	2	2	0	3
10	1	3	2	0	2	2	1	3	3	2	2	2	0	2	3	2	1	3	2	0	3	0	1	3	2	3	3	0	2	0	2	0
11	2	0	3	2	2	0	3	0	0	1	3	0	1	3	2	3	2	2	3	3	0	2	1	0	1	1	3	2	2	0	3	1
12	3	2	0	3	0	0	0	0	3	2	0	2	3	3	2	1	3	3	3	1	0	0	3	2	0	2	2	1	3	3	3	1

Bit stream obtained from a symbol stream after using the natural symbol-to-bit mapping

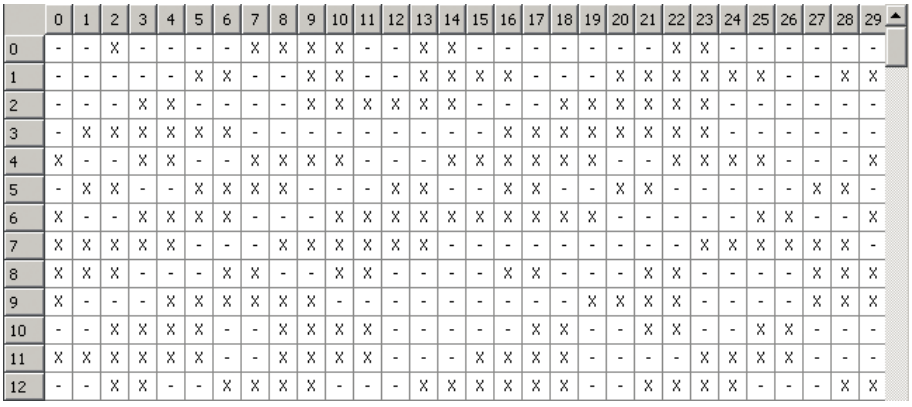
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0	1	1	1	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	1	1	0	1	0	0	1	0	1	0	1	1	1
1	1	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	1	0	1	1	1	1	0
2	1	1	1	1	0	1	0	1	1	1	0	1	1	1	1	0	0	1	0	1	0	1	1	1	1	0	1	0	0	0	1	1
3	0	1	1	1	1	0	0	0	1	0	1	0	0	1	1	1	1	1	1	0	1	0	1	0	0	0	1	0	1	1	1	1
4	1	1	1	0	0	1	1	1	1	0	0	0	1	0	1	0	0	1	1	1	1	1	1	1	0	0	1	1	1	0	1	0
5	0	1	0	0	1	1	1	1	1	1	0	0	1	0	0	0	1	1	1	0	1	0	0	0	1	0	1	0	0	0	0	0
6	0	0	0	0	1	1	1	0	0	1	0	0	1	1	1	0	0	0	1	0	1	0	0	1	1	1	1	1	1	1	0	0
7	1	1	1	0	1	0	0	1	0	1	0	1	1	1	1	0	1	0	0	0	1	1	0	1	1	1	1	0	0	0	1	0
8	1	0	0	1	1	1	1	1	0	1	0	1	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1
9	1	0	0	0	1	1	0	1	1	1	1	1	1	1	0	0	1	0	0	0	1	1	1	0	1	1	1	1	0	1	0	1
10	1	0	1	0	0	1	1	1	1	0	0	1	0	0	1	1	1	1	1	1	0	1	0	1	1	1	0	1	1	1	1	0
11	0	1	0	1	0	1	1	0	0	1	0	1	1	0	1	0	0	1	1	1	1	1	1	0	1	0	1	1	1	1	0	1
12	0	1	1	0	1	0	0	0	0	1	1	1	1	0	1	1	1	1	0	1	0	1	1	1	0	1	1	1	1	1	1	1

Bit stream in 0/1 representation

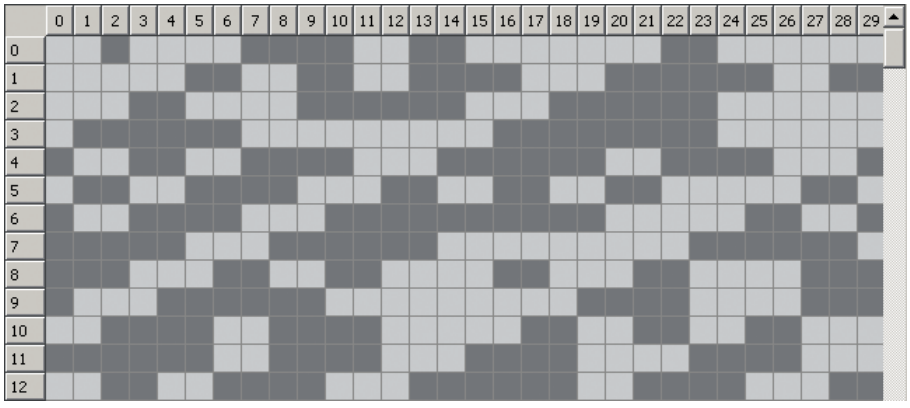
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
0	0	0	1	0	0	0	0	1	1	1	1	0	0	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
1	0	0	0	0	0	1	1	0	0	1	1	0	0	1	1	1	1	0	0	0	1	1	1	1	1	1	0	0	1	1
2	0	0	0	1	1	0	0	0	0	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
3	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0
4	1	0	0	1	1	0	0	1	1	1	1	0	0	0	1	1	1	1	1	1	0	0	1	1	1	1	0	0	0	1
5	0	1	1	0	0	1	1	1	1	0	0	0	1	1	0	0	1	1	0	0	1	1	0	0	0	0	0	1	1	0
6	1	0	0	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1	0	0	1	
7	1	1	1	1	1	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0
8	1	1	1	0	0	0	1	1	0	0	1	1	0	0	0	0	1	1	0	0	0	1	1	0	0	0	0	1	1	1
9	1	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1
10	0	0	1	1	1	1	0	0	1	1	1	1	0	0	0	0	0	1	1	0	0	1	1	0	0	1	1	0	0	0
11	1	1	1	1	1	1	0	0	1	1	1	1	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0
12	0	0	1	1	0	0	1	1	1	1	0	0	0	1	1	1	1	1	1	0	0	1	1	1	1	0	0	0	1	1

The bit stream representation can be switched between 0/1 and -/X representation and graphical visualization. In addition it is scalable with respect to size and form (number of lines x number of columns).

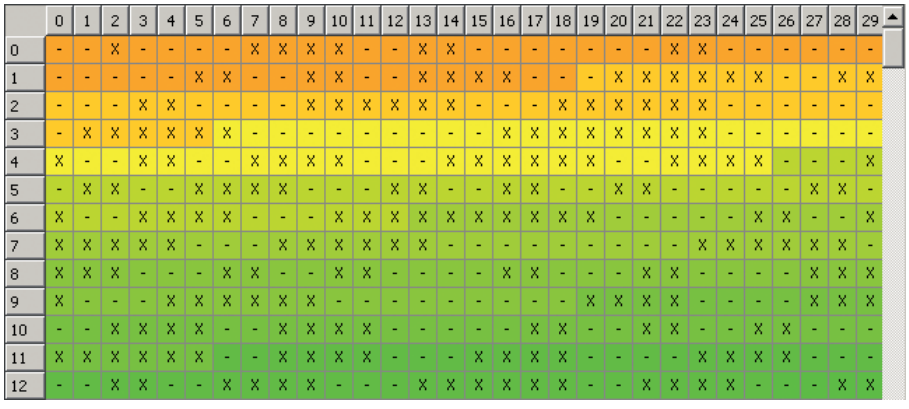
If the original symbol streams were obtained by using R&S®GX400, R&S® GX410 or R&S®GX430, each symbol contains quality information that is added during demodulation. This information is transferred to the bit stream generated from the symbol stream and can be visualized in color. You can thus easily distinguish between segments with good quality and those with bad quality, where analysis might be less promising.



Bit stream in -/X representation



Bit stream in graphical visualization



-/X representation of a bit stream with highlighted quality information on every bit (red = low quality, green = high quality)

Versatile bit stream analysis functions

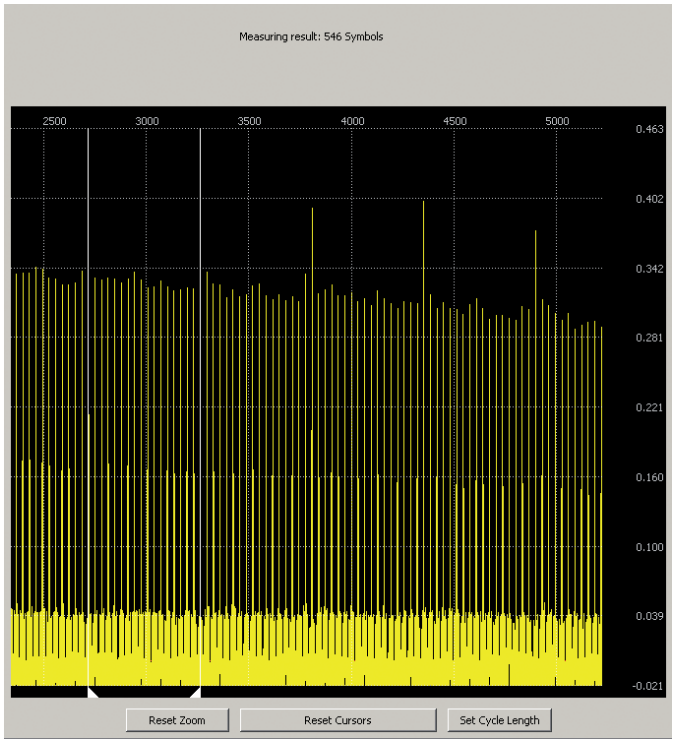
Bit structure analysis

For the analysis of bit structures, R&S®CA250 features versatile functions such as autocorrelation and cross correlation, configurable pattern search, entropy test (Tsallis, Maurer, Chi-square), calculations of column sum/parity and line sum/parity.

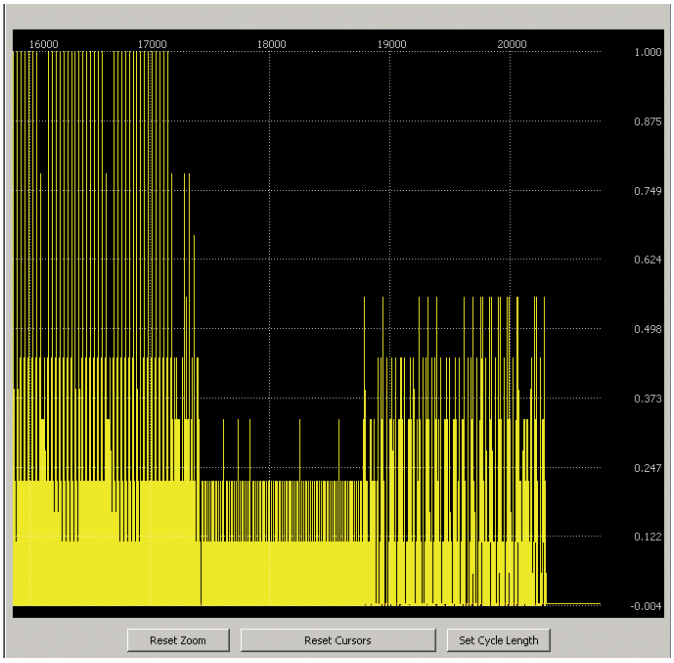
By using the pattern search, you can detect and display all possible variations of a bit pattern in the bit stream. The parameterization of tolerance ranges with respect to bit errors for the search allows the algorithm to run successfully even in bit streams containing bit errors.

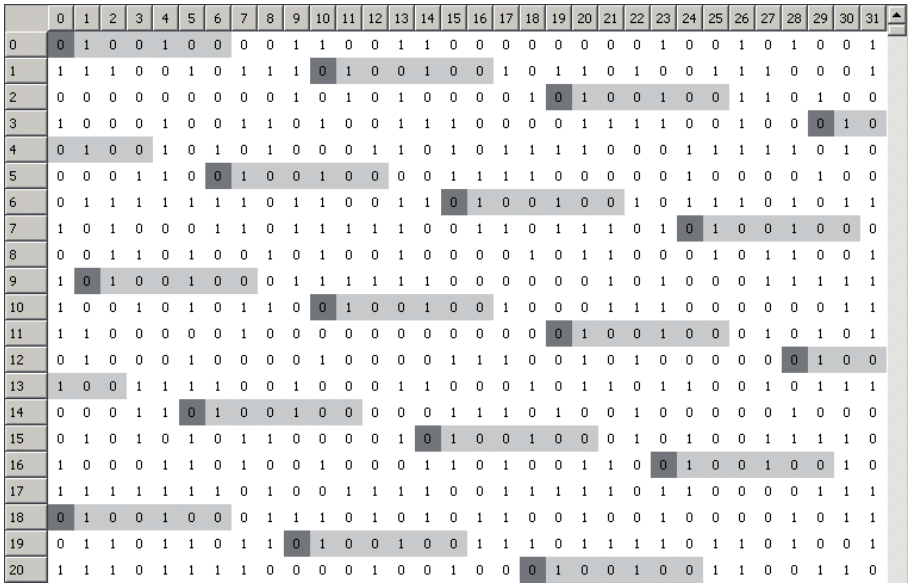
An entropy test is available for analyzing block codes. It involves testing the bit stream with respect to its randomness. Decreases in entropy provide information on the use of a block code with a specific code length. R&S®CA250 offers various statistical analysis methods.

Maxima in autocorrelation representation indicate regular, repeating structures (e.g. frame structures) in the bit stream.

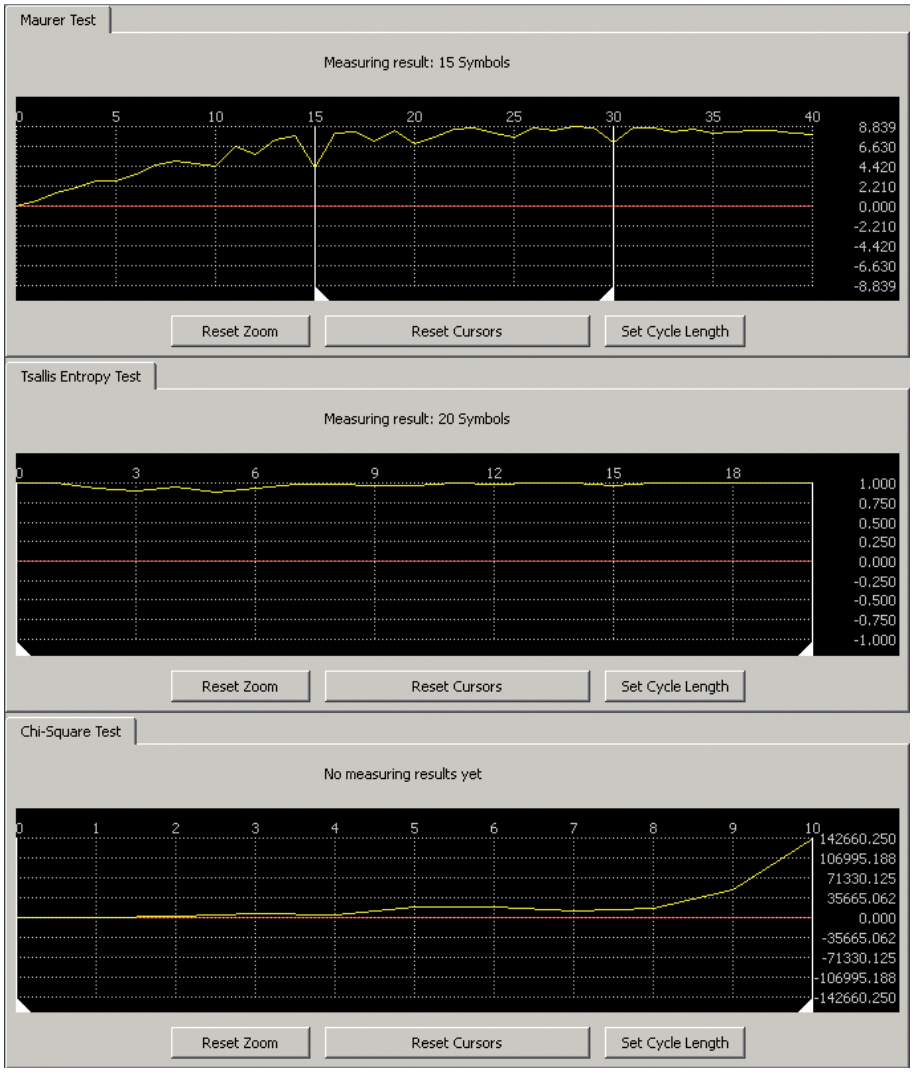


The cross correlation indicates how often a user-defined bit pattern (e.g. a preamble) occurs in a bit stream.





Search result of the preamble bit pattern 0100100.

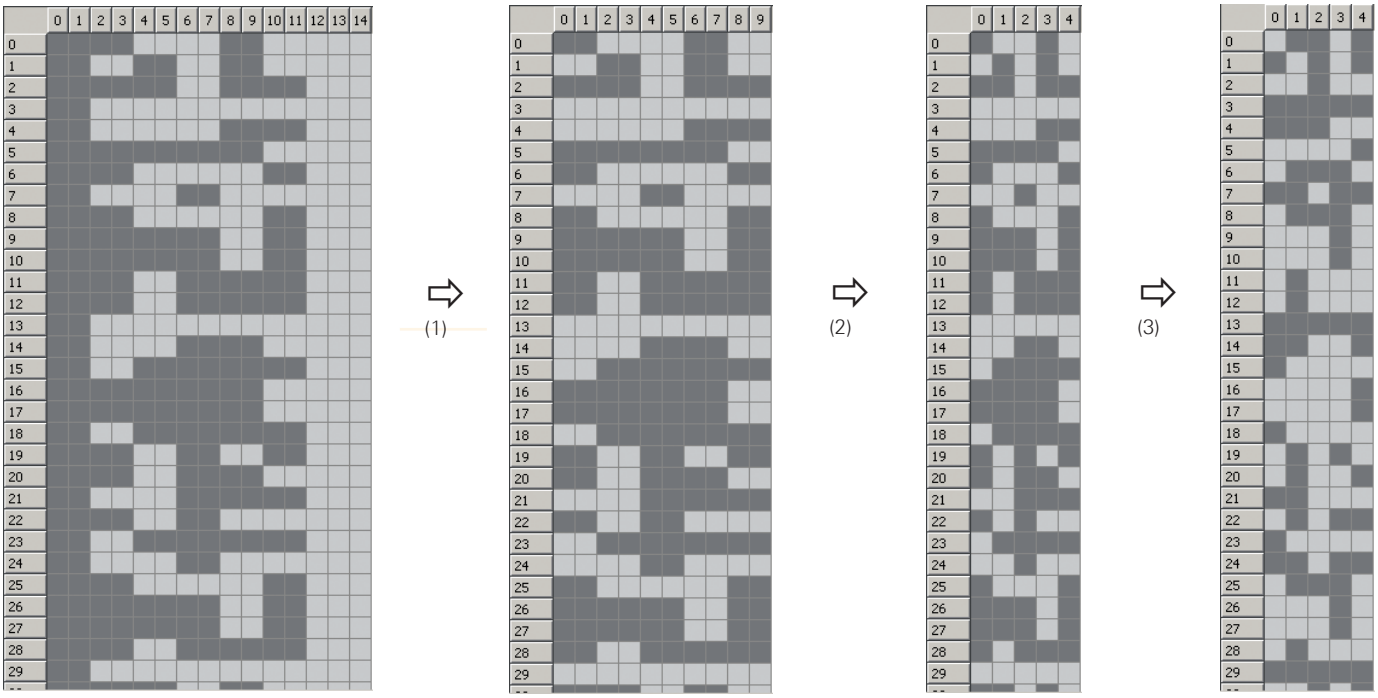


The decreases in entropy in Maurer test (see top representation; search for statistical defects of a random sequence) at the values 15 and 30 substantiate the following: When the bit stream is divided into 15-bit code words, any regular occurrence is revealed (specific code words occur more often than others).

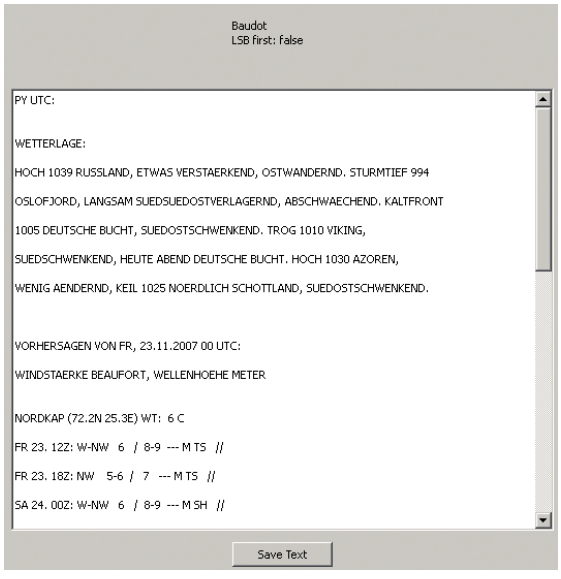
Wide variety of bit manipulation functions

Bit manipulation

R&S®CA250 offers various alternatives for manipulating the bit stream. If an analysis result is available, a function is provided for applying the analysis result to the bit stream and for beginning the next analysis step. In addition to easier manipulation functions such as selective deletion or bit inversion, the following complex functions are available: conversion from differential coding to absolute coding, decoding of line codes (NRZ-L, NRZ-M, NRZ-S), Boolean operations, multiplexing, demultiplexing, descrambling and deinterleaving.



Several bit manipulation steps are applied sequentially to extract the content of the signal. (1) The demultiplexer removes the detected frame structure (start/stop bits). (2) The demultiplexer removes double (redundant) bits. (3) Bit inversion.



The application of the Baudot alphabet to the bit stream from the section “Bit Manipulation” generates readable text and thus confirms that all analysis steps and bit manipulation steps (demultiplexing, inversion) have been performed successfully.

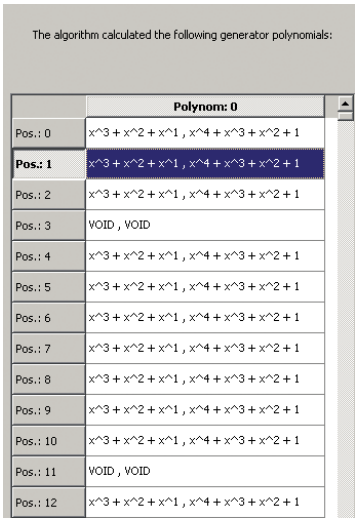
Code analysis and automation

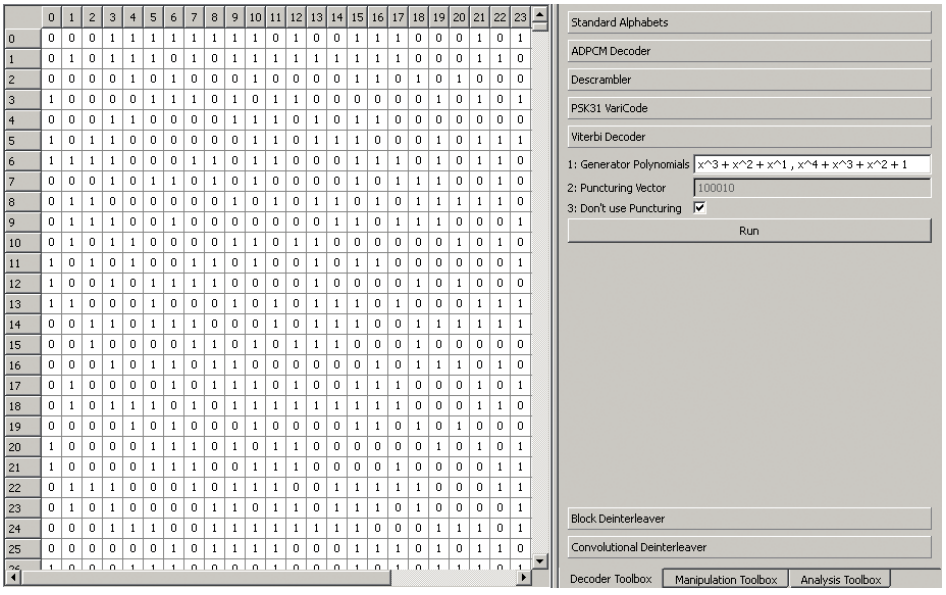
Convolutional code analysis and decoder

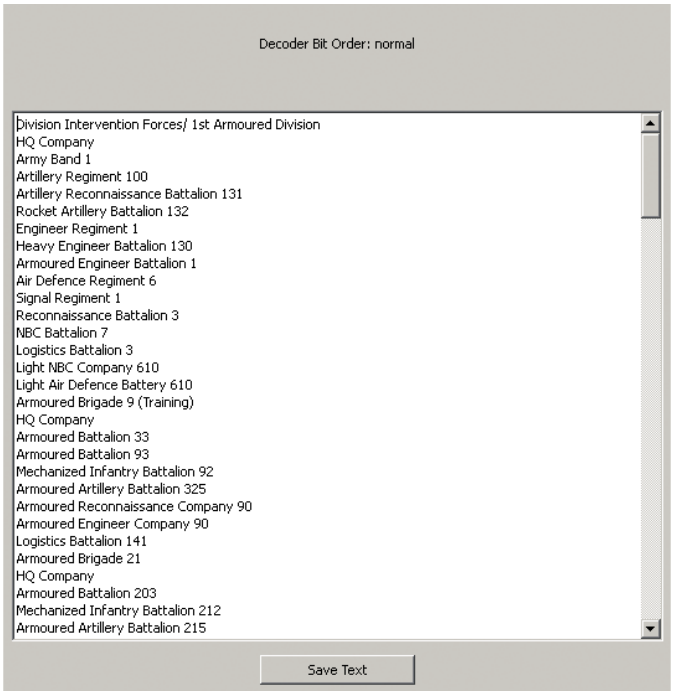
Complex convolutional codes are analyzed by using convolutional code analysis, where the generator polynomials, which form the basis of the convolutional code (or of its shift registers), are calculated. The polynomials obtained from this analysis can be transferred to a Viterbi decoder to decode the convolutional code.

Convolutional code analysis calculates the most likely generator polynomial set for each position in the bit stream.

By including and using the generator polynomials in the Viterbi decoder, the convolutional coding on the bit stream is reversed.







After removing the convolutional code, a further bit inversion and the use of an alphabet (Varicode) are sufficient for obtaining the readable text.

Extension and automation

R&S®CA250 allows you to integrate bit stream analysis or manipulation algorithms that you have developed yourself. By using the Python script language, you can program automatic operating sequences to simplify recurrent sequences or to run complicated calculation sequences automatically.

Specifications

R&S®CA250 bit stream analysis	
Analysis algorithms	❙ Autocorrelation
	❙ Cross correlation
	❙ Configurable pattern search
	❙ Tsallis entropy
	❙ Maurer test
	❙ Chi-square test
	❙ Histogram
	❙ Calculation of column sum/parity
	❙ Calculation of line sum/parity
Decoder and manipulation functions	❙ Symbol-to-bit conversion
	❙ Conversion of differential coding to absolute coding
	❙ Line codes
	– NRZ-L
	– NRZ-M
	– NRZ-S
	❙ Boolean operations
	❙ Multiplexing
	❙ Demultiplexing
	❙ ASCII alphabet
	❙ Baudot (ITA2) alphabet
	❙ ITA3 alphabet
	❙ ITA476-5 alphabet
	❙ ITA2-P alphabet
	❙ RUM-FEC alphabet
	❙ HNG-FEC alphabet
	❙ Varicode alphabet
	❙ Huffmann alphabet
Representation	❙ Symbol stream/bit stream in tabular form
	– decimal representation (0/1)
	– –/X representation
	– graphical visualization
	– display of demodulation quality as color-coded background
	– tags for start-of-burst
	– tags for the first channel (in multichannel methods)
	– zoom functions
	❙ Line charts
	❙ Window for displaying decoded text
System functions	❙ Generation of reports in XML format (compatible with R&S®ReportEdit)

Recommended computer equipment	
Operating system	Windows
CPU (minimum)	Intel Pentium IV, 3 GHz
Memory (minimum)	1 Gbyte
Graphics card	OpenGL 1.4 capable
Hard disk memory (minimum)	150 Mbyte (for installing R&S®CA250)
Minimum screen resolution	1024 x 768
Sound playback	Sound card

R&S®CA250-E extended bit stream analysis [1]	
Analysis algorithms	❙ Search for CRC codes
	❙ Search for BCH codes
	❙ Search for Reed-Solomon codes
	❙ Analysis of rate 1/N convolutional codes
	❙ Analysis of 1/N to rate K/N punctured convolutional codes
	❙ Analysis of rate K/N convolutional codes
	❙ Search for the most common polynomials
Decoder and manipulation functions	❙ Block interleaving
	❙ Block interleaver with skip bits
	❙ Cross interleaving
	❙ Convolutional interleaving
	❙ Helical interleaving
	❙ CRC decoder
	❙ BCH decoder
	❙ Reed-Solomon decoder
	❙ Viterbi decoder with/without puncturing

R&S®CA250-P professional bit stream analysis [2]	
Analysis algorithms	Analysis of additive scrambling
	Analysis of multiplicative scrambling
	Analysis of the spread spectrum code (DSSS)
Decoder and manipulation functions	Additive descrambling
	Multiplicative descrambling
	Despreader
	ADPCM voice codec (in line with ITU G.726)
	CVSD voice codec (in line with STANAG 4209)
Representation	Audio player for playing back decoded voice codecs
System functions	Application automation via script control (Python)
	Linking of customer-specific algorithms via MS Windows DLL interface

[1] Available from autumn 2008
[2] Available from spring 2009

Ordering information

Designation	Type
Bit stream representation, bit stream analysis and bit stream manipulation	R&S®CA250
Options	
Extended bit stream analysis and decoding; requires R&S®CA250	R&S®CA250-E
Professional bit stream analysis and decoding, including algorithm, expandability and automation (script language); requires R&S®CA250-E	R&S®CA250-P

Service you can rely on
- In 70 countries
- Person-to-person
- Customized and flexible
- Quality with a warranty
- No hidden terms

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 75 years ago, Rohde&Schwarz has a global presence and a dedicated service network in over 70 countries. Company headquarters are in Munich, Germany.

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(search term: CA250)

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*0.14 €/min within German wireline network; rates may vary in other networks (wireline and mobile) and countries.