

**Measuring device and measuring method for detecting errors
in signals**

5

The invention relates to a measuring device and a measuring method for detecting errors, especially protocol errors, in signals of one or more devices under test.

10 In recent years, communication networks have become more and more complex. Especially multi-layered protocol stacks are meanwhile in use. In order to analyze errors within a sequence of messages, regular measuring devices display the messages in list-form. The German patent application
15 DE 102 04 657 A1 shows hierarchically grouping the messages. These known measuring devices though are disadvantageous, since it requires a detailed knowledge of the employed protocols for a user of the measuring device to detect errors.

20

Accordingly, the object of the invention is to provide a measuring device and a measuring method which are capable of accurately detecting errors within signals of devices under test without requiring intensive knowledge of the
25 employed communication standard from the user of the measuring device or measuring method.

The object is solved by the features of the independent claim 1 for the measuring device and by the features of
30 the independent claim 9 for the measuring method. The dependent claims contain further developments.

An inventive measuring device for detecting errors in a signal of at least a first device under test comprises

reception means for receiving a first signal from the first device under test, error detection means for detecting errors in the first signal, display means and display control means for displaying simultaneously at
5 least the first signal or information within the first signal and errors detected in the first signal using the display means. Extensive knowledge of the received signal is therefore not necessary for detecting errors.

10 Advantageously, the display control means are set up for displaying messages of at least the first signal in a time-domain diagram, showing messages as blocks each of a length corresponding to a duration of the message and a height corresponding to a signal power during the duration
15 of the message, and for displaying detected errors in the time-domain diagram. It is therefore easily possible to determine the location of errors within the signal.

The reception means are furthermore advantageously set up
20 for receiving a second signal of a second device under test. The error detection means are then set up for detecting errors in the second signal. The display control means are then set up for displaying simultaneously at least the second signal or information within the second
25 signal and errors detected in the second signal using the display means. In this configuration, it is possible to detect where errors occur within a message flow between the two devices under test.

30 Advantageously, the display control means are set up for displaying messages of the first signal und messages of the second signal in a message sequence diagram, and for displaying errors detected within the message sequence

diagram. This makes it even easier for the user to detect the origins of errors in the message sequence.

Advantageously, the errors detected by the error detection means are protocol errors and/or timing errors and/or frequency offset errors and/or message order errors and/or modulation scheme errors and/or coding scheme errors and/or bit errors. This enables the analysis of a great deal of different error types.

10

Advantageously, the errors are displayed symbolically and/or color coded and/or pattern coded and/or shading coded and/or brightness coded and/or size coded and/or as plaintext dependent upon an error type and/or as an error severity and/or as an error origin and/or as an error consequence. It is therefore very easy for a user to differentiate between different errors.

The measuring device advantageously comprises analog error detection means for detecting timing errors and/or frequency offset errors. The measuring device advantageously comprises digital error detection means for detecting protocol errors and/or timing errors and/or message order errors and/or modulation scheme errors and/or coding scheme errors and/or bit errors. These dedicated error detection means allow a very accurate error detection.

Advantageously, the display control means are set up for additionally displaying further information regarding all signals displayed. The further information includes a bit error rate and/or a signal power and/or a time duration of individual messages within the respective signal and/or a time duration of bursts within the respective signal

and/or time intervals between messages and/or whether
messages within the respective signal are acknowledged.
The additional information is displayed symbolically
and/or color coded and/or pattern coded and/or shading
5 coded and/or brightness coded and/or size coded and/or as
plaintext. This gives a user more valuable information
regarding the signals in view.

An inventive measuring method serves the purpose of
10 detecting errors in a signal of at least a first device
under test. The measuring method comprises receiving a
first signal from the first device under test, detecting
errors in the first signal and displaying simultaneously
at least the first signal or information within the first
15 signal and errors detected in the first signal. Extensive
knowledge of the received signal is therefore not
necessary for detecting errors.

An exemplary embodiment of the invention is now further
20 explained with respect to the drawings, in which

Fig. 1 shows an embodiment of the inventive measuring
device;

25 Fig. 2 shows a first detail of the embodiment of the
inventive measuring device;

Fig. 3 shows a second detail of the embodiment of the
inventive measuring device;

30 Fig. 4 shows a first exemplary diagram to be displayed
by the embodiment of the inventive measuring
device;

Fig. 5 shows a second exemplary diagram to be displayed by the embodiment of the inventive measuring device, and

5 Fig. 6 shows an embodiment of the inventive measuring method.

First we demonstrate the general construction and function of an embodiment of the inventive measuring device with regard to Fig. 1. Along Fig. 2 - Fig. 3, we go into detail regarding the construction and function. Afterwards, the function of the measuring device and measuring method are further explained along Fig. 4 and Fig. 5. Finally, the function of an embodiment of the inventive measuring method is shown with reference to Fig. 6. Reference numbers of similar entities in different figures have been partially omitted.

In Fig. 1, an embodiment of the inventive measuring device 1 is shown. The measuring device 1 comprises reception means 20, which comprise for example an antenna and a preamplifier. Moreover, the measuring device 1 comprises analog processing means 21 connected to the reception means 20. The analog processing means 21 are connection to an analog-digital-converter 22, which in turn is connected to digital processing means 23. The digital processing means 23 are connected to display means 24. The analog processing means 21, the digital processing means 23 and the display means 24 are each connected to control means 25. Moreover, the analog processing means 21 are connected to the digital processing means 23.

The control means 25 control the function of the analog processing means 21, the digital processing means 23 and

the display means 24. Alternatively, the control means can additionally be connected to the reception means 20 and then control for example the function of the preamplifier.

5 The inventive measuring device 1 receives signals of a first device under test 2 and a second device under test 3. These signals though are not intended for the measuring device 1, but for the respective other device under test 2, 3. Therefore, the measuring device 1 listens in on the
10 communication between the first device under test 2 and the second device under test 3. Also a communication between more than two devices under test can be monitored. Alternatively, also a communication of only a single device under test can be monitored.

15

The signals of the devices under test 2, 3 are received by the reception means 20. The reception means 20 pre-processes the received signals and hands them on to the analog processing means 21. The analog processing means 21
20 perform for example a frequency conversion into the baseband and/or a frequency offset compensation, etc.. Relevant for the present invention is that the analog processing means 21 furthermore detect errors of the signals and pass the detected errors on to the digital
25 processing means 23. The errors detectable by the analog processing means 21 are for example frequency offset errors and/or timing errors. The errors detected by the analog processing means 21 are, however, not limited to this list. Regarding the function of the analog processing
30 means 21, reference is made to Fig. 2.

The signal is passed on to the analog-digital-converter 22 from the analog processing means 21. It is digitized by the analog-digital-converter 22 and passed on to the

digital processing means 23. The digital processing means 23 furthermore perform digital processing on the digital signal. For example, a demodulation and a decoding is performed. Relevant for the present invention though is
5 that the digital processing means 23 furthermore detect additional errors within the signal. Regarding the function of the digital processing means 23, it is referred to Fig. 3.

10 After passing the digital processing means 23, the signal is passed on to the display means 24 and displayed. Furthermore, the digital processing means 23 pass on the information regarding the errors detected to the display means 24, which displays the errors alongside with the
15 signals received from the devices under test 2, 3. Regarding the displaying of information, it is referred to Fig. 4 and Fig. 5.

In Fig. 2, a detail of the embodiment of the inventive
20 measuring device of Fig. 1 is shown. Fig. 2 merely shows the inner workings of the analog processing means 21. Only aspects of the analog processing means 21 relevant to the present invention are displayed. Therefore, the regular signal path of the received signal through the analog
25 processing means is not shown in detail here.

The analog processing means 21 comprise processing means 29, which the signal is provided to by the reception means 20 of Fig. 1. The processing means 29 perform the analog
30 processing. The inner workings of these processing means 29 are of no concern though for the present invention. The signal of the reception means 20 of Fig. 1 is provided to the analog error detection means 30 along with signals

from several points along the signal flow through the processing means 29.

5 The analog processing means 21 moreover comprise analog error detection means 30 and an analog signal database 31. The signal received by the reception means 20 and signal at different points through the analog processing of the signal within the processing means 29 is passed on to the analog error detection means 30. The analog error
10 detection means 30 are furthermore connected to the control means 25 of Fig. 1. The function of the analog error detection means are controlled by the control means 25 of Fig. 1.

15 The analog error detection means 30 detect errors within the signals passed on to the analog error detection means 30. In order to detect these errors, the analog error detection means 30 uses data regarding the communication scheme employed from the analog signal database 31.

20 The signal resulting from the processing means 29 is passed on to the analog-digital-converter of Fig. 1. The errors detected by the analog error detection means 30 are passed on to the digital processing means 23.

25 In Fig. 3, a second detail of the embodiment of the inventive measuring device 1 of Fig. 1 is shown. In Fig. 3, the inner processing of the digital processing means 23 are shown.

30 The digital processing means 23 of Fig. 1 comprise processing means 39 for performing the regular digital processing. For example, the processing means 39 perform a demodulation and a decoding of the signal provided by the

analog-digital-converter 22 of Fig. 1. Resulting signals are passed on to the display means 24 of Fig. 1. Moreover, signals of several points within the data flow through the processing means 39 are passed on to digital error
5 detection means 40. The digital error detection means 40 are furthermore supplied with the signal from the analog-digital-converter 22 of Fig. 1. The digital error detection means 40 then detect errors within the signal. For example, protocol errors and/or timing errors and/or
10 message order errors and/or modulation scheme errors and/or coding scheme errors and/or bit errors are detected by the digital error detection means 40. In order to perform its function, the digital error detection means uses information regarding the employed communication
15 scheme stored within a digital signal database 41 also present within the digital processing means 23.

Furthermore, the digital processing means 23 comprise display control means 42 for controlling the display of
20 the signals and of the errors within the signals. The display control means 42 receive the errors detected by the analog error detection means 30 of Fig. 2. Moreover, the errors detected by the digital error detection means 40 are passed on to the display control means 42. The
25 display control means 42 is furthermore connected to the control means 25 of Fig. 1 and controlled therefrom.

The display control means 42 control the display of the errors and the according signals in such a manner, that
30 the errors are displayed symbolically and/or color coded and/or pattern coded and/or shading coded and/or brightness coded and/or size coded and/or as plain text. By these different ways of displaying the errors, different error types or error severities or error origins

or error consequences can be depicted. Regarding the resulting displayed image, it is referred to Fig. 4 and Fig. 5.

- 5 Since the errors are clearly visible for a user without extensive knowledge of the employed communication standard it is possible to determine the message or messages within the signal, which errors originate from.
- 10 In Fig. 4 a first exemplary display diagram depicted by the embodiment of the inventive measuring device of Fig. 1 is shown. The diagram shown here is a message sequence diagram showing messages 50-56 between a first device under test and a second device under test. A first message
- 15 50 is transmitted from the second device under test to the first device under test. This message is not highlighted in any way. This signifies that this message does not comprise any error. A second message 51 is transmitted from the first device under test to the second device
- 20 under test. Also the second message is not highlighted and therefore comprises no error. A third message 52 is afterwards transmitted from the second device under test to the first device under test. This message is depicted slightly shaded, indicating that the message is erroneous.
- 25 In this example, the message comprises a syntax error. The ensuing three messages 53-55 again are displayed without any detected errors. Between messages 55 and 56, a symbol 57 indicating a timing error though is displayed. The symbol 57 shows that the acknowledge message 56 has
- 30 arrived later than specified by the protocol employed as a response to the message 55.

It is therefore very easy for a user of the inventive measuring device to see and understand where errors occur.

Moreover, through the different ways of indicating the errors, it is very easy for the user to distinguish between different error types and error sources.

5 In Fig. 5, a second exemplary display content of the embodiment of the inventive measuring device of Fig. 1 is shown. Here, a time-domain diagram 69 is shown. The messages are depicted in their order of occurrence. The messages 60-66 are displayed from left to right in their
10 succession through time. The height of the blocks corresponding to the messages 60-66 in this example indicates the reception power of the individual message. This reception power for example is detected by the analog error detection means 30 within the analog processing
15 means 21 of Fig. 1. For example here, the message 61 has a very low height indicating a too low reception power of the message. Moreover, the message 62 is depicted in a shaded manner indicating in this example that a signal-to-noise-ratio of the message 62 is too low.

20 As discussed above, different colors, shadings, shapes, heights, widths and additional error symbols can be used in order to indicate errors. Moreover, different error types, different error severities, different error origins
25 and/or different error consequences can be shown similarly. For example, errors which would not lead to any further consequences could be displayed in yellow, while errors, which lead to a corrupt transmission, could be displayed in red.

30 In Fig. 6, an embodiment of the inventive measuring method is shown. In a first step 100, a measurement is performed. Resulting signals are recorded. In a second step 101 errors of the different signals are detected. Regarding

the error detection, it is referred to Fig. 2 and Fig. 3. In a third step 102, the detected errors and the according signals are displayed simultaneously. Regarding the display of errors, it is referred to Fig. 4 and Fig. 5.

5

The invention is limited to the examples shown.

Especially, the invention can be applied to signals of any communication standard. Moreover, any number of devices under test can be used. The characteristics of the

10 exemplary embodiments can be used in any advantageous combination.

Claims

1. Measuring device for detecting errors in a signal of at least a first device under test (2, 3),
5 wherein the measuring device (1) comprises:
- reception means (20) for receiving a first signal from the first device under test, and
- display means (24),
characterized in that
10 the measuring device (1) further comprises:
- error detection means (30, 40) for detecting errors in the first signal, and
- display control means (42) for displaying simultaneously at least the first signal or information within the first
15 signal and errors detected in the first signal using the display means (24).
2. Measuring device according to claim 1,
characterized in that
20 the display control means (42) are set up for
- displaying messages (60 - 66) of at least the first signal in a time-domain diagram (69), showing messages (60 - 66) as blocks each of a length corresponding to a duration of the message (60 - 66) and a correspondence to
25 a signal power during the duration of the message (60 - 66), and for
- displaying detected errors in the time-domain diagram (69).
- 30 3. Measuring device according to claim 1 or 2,
characterized in that
the reception means (20) are set up for receiving a second signal of a second device under test (2, 3),

the error detection means (30, 40) are set up for detecting errors in the second signal, and the display control means (42) are set up for displaying simultaneously at least the second signal and/or
5 information within the second signal and errors detected in the second signal using the display means (24).

4. Measuring device according to claim 3,
characterized in that

10 the display control means (42) are set up for
- displaying messages (51, 53, 54, 56) of the first signal und messages (50, 52, 55) of the second signal in a message sequence diagram (59), and for
- displaying errors detected within the message sequence
15 diagram (59).

5. Measuring device according to any of the claims 1 to 4,
characterized in that

the errors detected by the error detection means (30, 40)
20 are protocol errors and/or timing errors and/or frequency offset errors and/or message order errors and/or modulation scheme errors and/or coding scheme errors and/or bit errors.

25 6. Measuring device according to any of the claims 1 to 5,
characterized in that

the errors are displayed symbolically and/or color coded and/or pattern coded and/or shading coded and/or brightness coded and/or size coded and/or as plaintext
30 dependent upon an error type and/or as an error severity and/or as an error origin and/or as an error consequence.

7. Measuring device according to any of the claims 1 to 6,
characterized in that

the measuring device (1) comprises

- analog error detection means (30) for detecting timing errors and/or frequency offset errors, and
 - digital error detection means (40) for detecting
- 5 protocol errors and/or timing errors and/or message order errors and/or modulation scheme errors and/or coding scheme errors and/or bit errors.

8. Measuring device according to any of the claims 1 to 7,
10 **characterized in that**

the display control means (42) are set up for additionally displaying further information regarding all signals displayed,

that the further information includes a bit error rate

15 and/or a signal power and/or a time duration of individual messages within the respective signal and/or a time duration of bursts within the respective signal and/or time intervals between messages and/or whether messages within the respective signal are acknowledged, and

20 that the additional information is displayed symbolically and/or color coded and/or pattern coded and/or shading coded and/or brightness coded and/or size coded and/or as plaintext.

25 9. Measuring method for detecting errors in a signal of at least a first device under test (2, 3), wherein the measuring method comprises the steps:

- receiving a first signal from the first device under test,

30 - displaying at least the first signal;

characterized in that

the measuring method further comprises the steps:

- detecting errors in the first signal,

- displaying simultaneously at least the first signal or information within the first signal and errors detected in the first signal.

5 10. Measuring method according to claim 9,

characterized in that

the method comprises:

- displaying messages (60 - 66) of at least the first signal in a time-domain diagram (69), showing messages (60
- 10 - 66) as blocks each of a length corresponding to a duration of the message (60 - 66) and a height corresponding to a signal power during the duration of the message (60 - 66), and
- displaying detected errors in the time-domain diagram
- 15 (69).

11. Measuring method according to claim 9 or 10,

characterized in that

the method comprises:

- 20 - receiving a second signal of a second device under test (2, 3),
- detecting errors in the second signal,
- displaying simultaneously at least the second signal and/or information within the second signal and errors
- 25 detected in the second signal using the display means (24).

12. Measuring method according to claim 11,

characterized in that

30 the method comprises:

- displaying messages (51, 53, 54, 56) of the first signal und messages (50, 52, 55) of the second signal in a message sequence diagram (59), and

- displaying errors detected within the message sequence diagram (59).

13. Measuring method according to any of the claims 9 to 12,

characterized in that

the errors detected are protocol errors and/or timing errors and/or frequency offset errors and/or message order errors and/or modulation scheme errors and/or coding scheme errors and/or bit errors.

14. Measuring method according to one of the claims 9 to 13,

characterized in that

the errors are displayed symbolically and/or color coded and/or pattern coded and/or shading coded and/or brightness coded and/or size coded and/or as plaintext dependent upon an error type and/or as an error severity and/or as an error origin and/or as an error consequence.

15. Measuring method according to one of the claims 9 to 14,

characterized in that

the method comprises additionally displaying further information regarding all signals displayed, wherein the further information includes a bit error rate and/or a signal power and/or a time duration of individual messages within the respective signal and/or a time duration of bursts within the respective signal and/or time intervals between messages and/or whether messages within the respective signal are acknowledged, and that the additional information is displayed symbolically and/or color coded and/or pattern coded and/or shading

coded and/or brightness coded and/or size coded and/or as
plaintext.