AS-Interface Analyser

User Manual

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1 The Symbols Used

Warning

This symbol warns the user of possible danger. Not following this warning can lead to personal injury or death and/or destruction of the equipment.

Attention

This symbol warns the user of a possible failure. Not following this warning can lead to total failure of the device or any other connected equipment.

Note

This symbol draws the user's attention to important information.

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2 Safety

2.1 Intended Use

Warning

The protection of operating personnel and the system against possible danger is not guaranteed if the control interface unit is not operated in accordance with its intended use.
The device may only be operated by appropriately qualified personnel in accordance with this operating manual.

2.2 General Safety Information

Warning

Safety and correct functioning of the device cannot be guaranteed if any operation other than that described in this operation manual is performed.
Connecting the equipment and any maintenance work to be carried out with voltage applied to the equipment must exclusively be performed by appropriately qualified electrotechnical personnel.
In case a failure cannot be repaired, the device must be taken out of operation and kept from inadvertently being put back into operation. Repair work is to be carried out by the manufacturer only. Additions or modifications to the equipment are not allowed and will void the warranty.

Note

The operator is responsible for the observance of local safety standards.

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3 The AS-Interface Analyser

3.1 General

In the following you will find a detailed description of the AS-Interface Analyser. The AS-Interface Analyser can give detailed information about the functionality of new or existing AS-Interface networks.

It completes a master's possibilities, and it is the more valuable the less information beyond the standard AS-Interface data is provided by the master and the more hidden an error is.

The analyser registers the entire data traffic without intervening and only evaluates it. So network errors or errors from individual slaves can be easily identified and corrected by the user. Configuration and quality of the network can now be logged and weak points can be prophylactically uncovered.

Like all AS-Interface devices the analyser is interoperable, that means it can be used in network with products from different manufacturers.

3.2 Version 2.0

The version 2.0 of the analyser brings a whole set of new possibilities apart from many improvements in the detail: definition and disposition of "consecutive errors" for a more rational evaluation of telegram repetitions, default-settings and offline-execution of the protocols, analog data output, function as safety monitor in the trace mode and finally an optimized operator guidance which allows also users with smaller experiences with AS-Interface to penetrate into the range of the "expert-mode".

3.2.1 Manual

The manual is structured into four major chapters, which addresses different users.

Chapter 4 Quick Start

For well experienced users who are familiar with AS-Interface or users who need a fast result without loss of time.

In this chapter we describe the fast installation and directly usable functions. Special cases and detailed descriptions will follow in the next chapters.

Chapter 5 Features and Functions

For users, who want to understand all functions of the analyser, or users who want detailed information about specific functions. This description presupposes only basic knowledge of AS-Interface.

For each function first the principle and then the possible result is described. After this a detailed description from the procedure will follow. Possible causes for an unexpected behavior of the network or the analyser will be discussed.

Chapter 6 Evaluation of Telegram Repetitions

AS-Interface is extremely fault tolerant. The analyser shows all telegram repetitions in the network, however, they must not be necessarily interpreted and eliminated as "errors".

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We will give you indications to a meaningful and economic handling of the results.

Chapter 7 To Use the Analyser

The analyser can be used for very different applications. This could be logging of net conditions, over detailed error tracing up to the optimization of the components. We will describe these different application types.

Chapter 8 Technical Data

Chapter 9 Index

Readers which use chapters 5, 6 and 7, can skip over chapter 4. Chapters 5 to 7 are written in a way that also readers without detailed AS-Interface knowledge can use the analyser.

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4 Quick Start

4.1 Installation and First Steps

The analyser is a "listener" in the AS-Interface network. It controls the message traffic and evaluates it, without intervening. So he can "hear" more than any superior control.

The results are stored in the analyser, then transmitted to a PC or notebook where it can be analysed and displayed.

Installation instructions:

- If the analyser is used for the first time: Please install the analyser software (setup_en.exe) on your PC or notebook which will be connected with the analyser. The analyser itself is ready for operation without any special preparation.
- Connect the analyser over the characterized inputs like a slave at any place in the AS-Interface net.
- Contrary to a normal slave the analyser does not have an own address. The AS-Interface does not have to be disconnected.
- Connect the analyser over the provided cable to the computer which contains the analyser software; you can connect to the computer's RS232-socket or – over a suitable adapter – to a USB port.

Note

If you use a USB adapter avoid to change the analyser or the USB adapter during the system is running. This can partly lead to crashes of the system.

- The analyser does not need an additional power supply. The PC and the AS-Interface net remain galvanically separated.
- Start the analyser software on your PC.

4.2 Index Card: Overview

With the start you receive immediately a current function overview of the network in a typical "traffic lights" representation (Fig. 3). It shows for the actual configuration, which slaves

- are without any problem (green),
- are noticeable because of Telegram repetitions ("warning", yellow),
- exhibit too many repetitions or (possibly temporary) completely fail ("error", red).

If the master of the net is in the "protected mode" the representation shows in addition which slave addresses are

- occupied, but not or wrongly configured (grey).

In this overview the critical messages "yellow", "red" and "grey" remain displayed as long as either the net gets a restart or the Analyser is put back by pushing the "Clear all" button.

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4.3 Index Card: Overview with Hold Time

In the "Overview with Hold Time" view the display is put back after the indicated "Hold Time".

So the success and failure of changes in the net can be verified quickly.

The "Hold Time" can be changed in the menu under "Options / Statistics".

4.4 Advanced Statistics

In this view you can find for each slave the number of the master's data calls and the number of the missing slave answers. Additionally you can see the voltage at the place of the analyser, the cycle time, the measured time since the last deleting process and the number of the slave telegrams without master calls (Fig. 4).

4.5 Consecutive Errors

All repetitions for each slave are analyzed here:

If only the narrow white field appears, no repetition has occurred during run time. Up to 6 following broader fields indicate that for the respective slave errors arose. This is depicted in such a way that you can see the number of consecutive repetitions from 1 until 6 which occurred (Increasing from olive green until red). The largest "consecutive error" is represented. If a slave is not represented by a field, this slave is not in an actual data exchange.

Pointing with the mouse to this error representation it is indicated how often that error has occurred (Fig. 5).

4.6 Configuration

The tab "Configuration" shows the configuration data of the connected slaves at that moment if the analyser has observed the net otherwise only the ID code is indicated.

4.7 Logging

For documentation of the facility condition the results from the overview, advanced statistics, consecutive error, and configuration window can be transferred to a protocol. It can be supplemented manually by detailed data regarding the facility.

4.8 I/O Data

The call of the "I/O Data" represents the momentary data results of all Slaves in the net. The representation is refreshed every second. The display shows the transferred values for the analog slaves and the values "free" or "released" for the 2 channel Safety Slaves.

4.9 Trace Mode

In the trace mode the analyser notes each particular telegram or telegrams selected according to Filter and Triggers on the AS-Interface line which then can be loaded into an attached notebook and analyzed there. With the call of the "Safety

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Monitor" an evaluation of the data telegrams of the safety related slaves is started. For details see chapter 5.7.9.

5 Functions of the Analyser

5.1 Overview

The Analyser is a "listener" in the AS-Interface network. It controls the message traffic and evaluates it without intervening. The results are stored in the analyser, then transmitted to a PC or notebook where it can be analysed and displayed.

The analyser listens and evaluates all signals (including incorrect signals) on the AS-Interface line. So he can "hear" more than the most masters and especially then any superior control.

This is used for logging the net status, for error analysis, and for the optimization of the network and application.

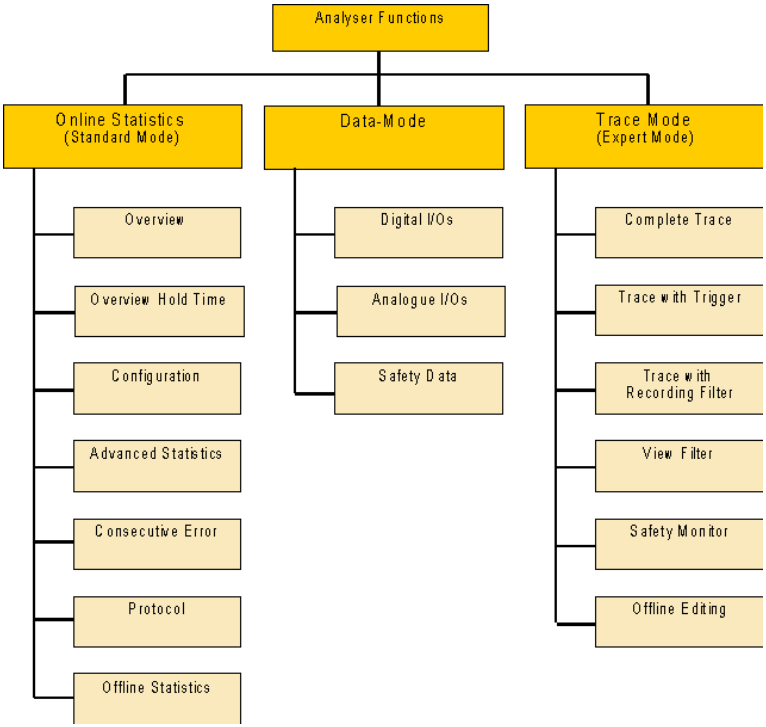

Fig. 1: The functions of the three operating modes.

Attention

Contrary to master and slave the analyser does not send telegrams. it does not have permanent memory for the determined data and is exclusively dependent on that what happens in the net.
It has got neither an address nor it keeps the configuration after switching off. It is completely independent of data which are stored in the master or an application program. The user has to consider this evaluating the results.

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The analyser can work in **three different operating modes**: in the online-statistics, in the data mode and in the trace mode (fig. 1). You can see the 3 paths in the block diagram of the hardware (fig. 2). For details see the following chapters.

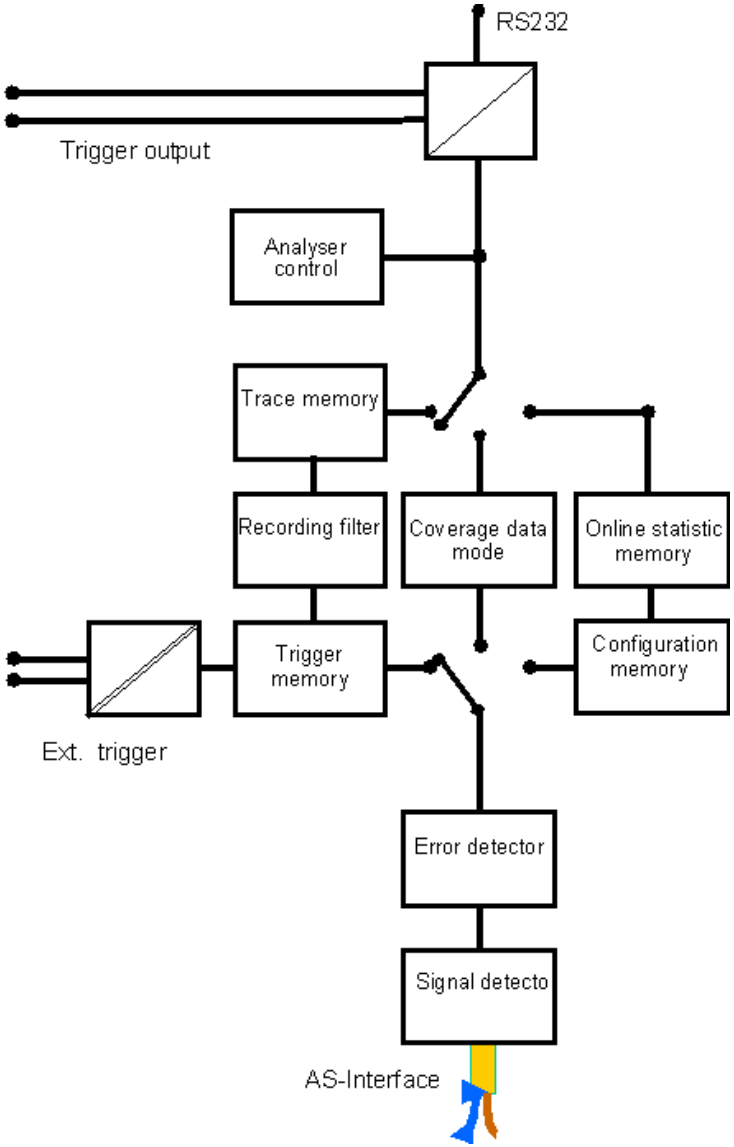

Fig. 2: Simplified block diagram of the hardware. It shows the 3 pathways of the analyser control.

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5.2 Installation

The package consists of the analyser as a data collector and of a PC software for the evaluation of the data.

The **hardware** can be connected at any place in the net via the marked inputs **AS-i +** und **AS-i -**. Connect the analyser over the characterized inputs like a slave at any place in the AS-Interface net without interrupting the network. The analyser is supplied from there and is ready for analyzing. It immediately begins with the storage of data from the online statistics. If separated from the voltage supply the data stored are lost.

The additional **trigger in- and -outputs** are needed for the trace mode only. The trigger input reacts to voltage changes between of 18 ... 30 V. The trigger output changes between 0 V und +5 V and can be used for the control of external devices.

Warning

Within the analyser a galvanic separation between net and PC, as well as to the trigger input exists. The trigger output is fed over the RS232 interface to the PC and may be loaded with maximally 2 mA. The trigger input must be fed from a PELV power supply.

The provided **software** (setup_en.exe) must be installed on a PC or a notebook.

The provided RS232 cable, possibly combined with a suitable RS232/USB adapter serves as a cable connection between PC and analyser. With the first call of the software the COM interface must be specified in the menu "Options / AS-Interface Analyser Hardware".

Afterwards the representation of the online statistics stored in the analyser starts automatically wit the start of the software (for exception see chapter 5.7.8).


Attention

The function of the analyser is signaled by 3 LEDs. However, the meaning depends on the operation situation.

- *In the normal operation mode with an attached notebook the first LED "green" signals that the analyser is supplied from the AS-Interface net; the second LED marked with "Ser.act." shines yellow during the communication with the PC. The third LED shows after a start of a trace the trigger condition: "green" means "trigger released", "red" means "trigger not released".*
- *In operation without PC the LED gives an overall status of the net traffic (compare chapter 5.3.6).*

5.3 Online Statistics (Standard Mode)

The standard mode with the "Online Statistics" is the mode most commonly used. The telegrams in the analyser are here statistically evaluated and handed over in a second rhythm to the PC for displaying and for further mathematical functions. The results are very simple to use and to interpret. They are immediately available and give an overview of the functions in several stages and of the possible errors in the net (fig. 3).

This mode is applicable for the logging of the actual condition as well as for long term analysis. The analyser begins to store data directly after being attached to the

AS-Interface net. The notebook needs to be attached only for a later data analysis (see chapter 5.3.6).

5.3.1 Overview

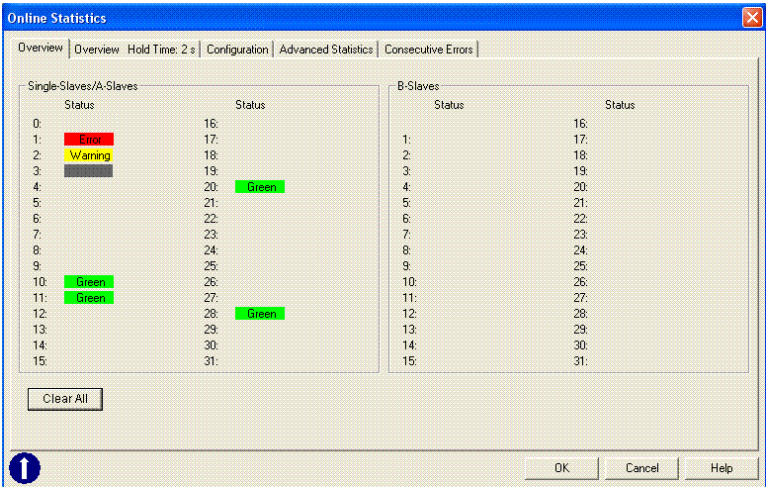

Fig. 3a: The traffic light representation of the online statistics shows how good or bad the slaves communicates

Then, if the analyser is attached in the net for the first time and the PC software is called, you receive a functional overview of the slaves in the "traffic light representation" (fig. 3). It is callable at any time over the main menu "**Measure / Online Statistics**" or over the colored marked button.

The traffic light representation shows,

- which slaves *work trouble-free (green)*,
- which slaves *stand out ("Warning" yellow)*,
- which slaves *exhibits too many telegram repetitions or (possibly at times) completely fails ("Error" red).*

If the master is in the protected mode, the representation shows in addition,

- *which slave addresses are occupied but not or wrongly configured (grey).*

In this overview the critical messages "yellow", "red" and "grey" remain displayed as long as either the net gets a restart or the analyser is put back by pushing the "Clear All" button.

Green	< 1% errors within one second
Warning	<1% - 5% errors within one second
Error	> 5% errors within one second or config error
	Slave found but not configured

Fig. 3 b: Legend to traffic light representation. Telegram repetitions up to 1 % can be seen in many applications as non critical. Thereby there are shown by the Analyser green. See chapter 3.

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Note

The analyser shows exactly those slaves that are available in the net and are taken up to communication. It cannot recognize slaves that are contained in the configuration of the master, but already failed before the connection of the analyser. These slaves appear in the protected mode as "Configuration Error" in the master or in the control.

Note

If the master is shifted during the measurement in the offline mode all slaves are represented in "red" even if the data exchange could function. In this manner the analyser displays the intervention in the function of the network.

5.3.2 Overview with Hold Time

In the representation "Overview with Hold Time" the holding time is put back automatically to that time indicated in the title. A slave only remains "yellow" or "red", if it exhibited the error rate in the elapsed period. So the success and failure of changes in the net ca be verified quickly.

The Hold Time can be changed in the menu under "**Options / Statistics**" between 1 s and "infinite" in many stages. This setting is stored and taken over for the next start of the analyser.

5.3.3 Advanced Statistics

By switching to the tab "Advanced Statistics" the user gets the number of repeated/missing messages for each slave as well as the number of master calls to each slave. It gives detailed information from the overview without the overall evaluation by the traffic light representation.

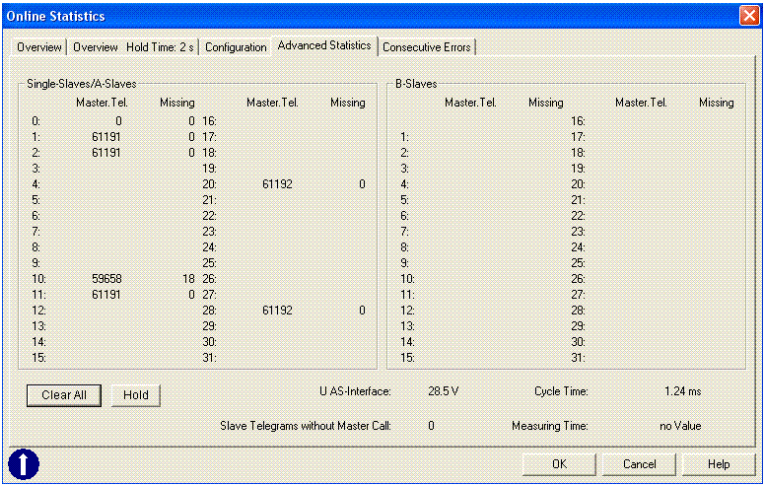

Fig. 4: The "Advanced Statistics" shows quantitatively, how frequently repetitions of the data calls were necessary.

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The advanced statistics implements at the same time the function of the bus and the analyser.

- The results of the analysers are transferred 1 time per second to the PC and displayed there in this rhythm.
- In a net which runs without repetitions, the number of master calls must be the same for each standard slave (stop the representation briefly: Button "Hold", continue with "Go" afterwards).
- If the statistics have been stopped, this is represented by a "Stop" indication in the window.
- The number of the calls to occupied A- and B-slaves must be half as big as the number of the calls from the standard slaves.
- If a slave is abruptly removed from the system, the master will try to contact him exactly sixtimes. If the slave does not respond after the 6th time the master would remove him from the list of active slaves. The number of calls will rise only if the slave regains communication with the master.

The advanced statistics displays additionally:

- The voltage at the place of the analyser,
- the cycle time,
- the measured time since the last deleting process,
- and the number of slave telegrams without master calls. These errors are very rare: They can occur, if the analyser is in a position in the net at which it recognizes slave telegrams but no master telegrams.
- **The button** "Hold" stops the counts in the display. However, it continues to run in the background as long as no other operating mode is activated. Pressing the button ("Go") again updates the display.

Note

If the statistics have been stopped, this is represented by a "Stop" indication in the window.

5.3.4 Consecutive Errors

The tab "Consecutive Errors" brings with the analysis of the multiple errors a further, detailed representation of the error situation. It is differentiated between errors that appear a single time and those for which more master calls are needed before getting a valid response telegram ("failure class").

If only the narrow white field is indicated for a slave this means that no telegram repetitions have occurred at run time. Up to 6 following broader fields indicate that errors arose for the respective slave. This is depicted in such a way that you can see the number of consecutive repetitions from 1 until 6 (increasing from olive green until red). The largest consecutive error is represented. If an existing slave is not represented by a white field, this slave is not in an actual data exchange.

Pointing with the **mouse** to this error representation you learn additionally how often that error has occurred (slave 19 in fig. 5). So the analyser makes a new im-

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portant valuation criterion available: Single repetitions (broad green field) are relatively harmless and can be usually tolerated. Consecutive errors of the class 5 and 6 (red fields) threaten the availability of a facility and should be examined more exactly (see chapter 3).

Please note that the numerical data shown in fig. 5 are absolute numbers (in contrast to the "Overview"). They must be seen in relation to the number of the master calls from the advanced statistics.

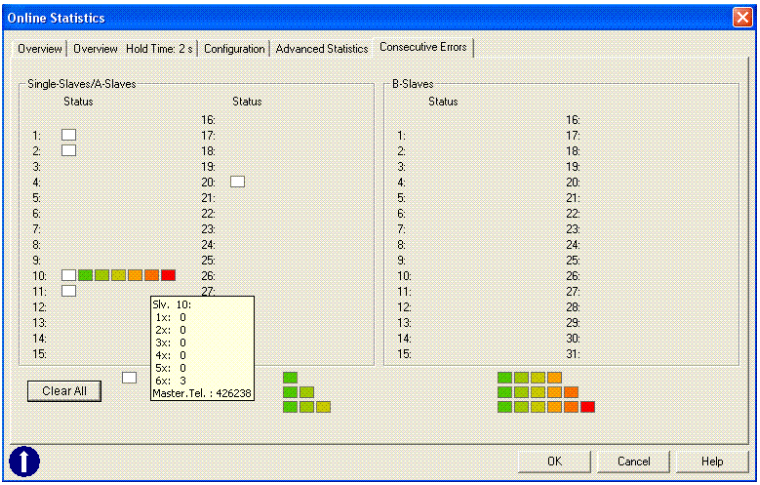

Fig. 5: The consecutive error evaluates the arisen repetitions graphically and numerically. With the mouse pointer the distribution on 6 classes can be made visible: Slave 10 is failed once completly.

5.3.5 Configuration

The tab "Configuration" shows for each slave the current configuration data stored in the slave: I/O configuration, ID code, ID1 and ID2 code.

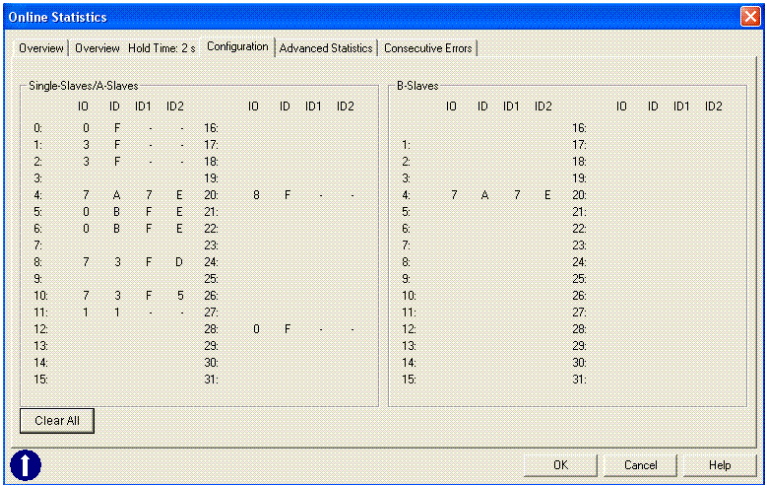

Fig. 6: Configuration of the used net: The slaves 4A, 4B, 5, 6, 8 and 10 are slaves according to specification 2.1, slaves 5 and 6 are safety slaves, 8 and 10 are analog slaves.

These data serve for the identification of the different types of slave. It can be concluded from the absence of the values for ID1 and ID2 that a slave according to specification 2.0 is concerned. This means this is no slave according to specification 2.1. If ID1 and ID2 are missing for all slaves, this can mean that the net is operated from a master according to specification 2.0. Older masters do not call ID1 and ID2.

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Note

The function of the analysers as a "listener" in the AS-Interface network which takes all information out of the telegrams within the network has an important consequence for the representation of the configuration: It can be only indicated if it was queried at the analyser's run time by the master as well. That happens with AS-Interface whenever a new slave is taken up to the net. There are four consequences for the user due to that:

- *The configuration of the slaves is only indicated if the analyser observed a recording phase. Examples: A system start (switch off the master or the power supply of the network) after a temporary stop of the communication ("offline phase" with connected voltage), or with the resumption of failed slaves (for this slave). If the analyzer is attached to a network which is already running it can recognize the ID code only which is queried at regular intervals.*
- *If a slave drop out its configuration is not queried any longer. The previous configuration remains indicated up to the next deletion. Therefore, the drop out of the slave is only recognisable in the overview or in the advanced statistics. Only with the reuptake of the slave the configuration is completely called.*
- *By deleting (button"Clear All") in the overview tab, however, a failed slave is removed from the tab "Configuration" also, to adapt the representation to the current network situation.*
- *If a slave with a wrong configuration is attached after a drop its wrong configuration is represented. If the master is here in the protected operating mode it does not take up this slave to data exchange. Therefore, no further increase of the data calls can be recognised in the advanced statistics. The slave appears grey in the overview. The master reports a configuration error.*

5.3.6 Online Statistics without Notebook

The online statistics is available without notebook also and therefore, it is suitable for long-term control of the network.

If the analyser is started without communication with the notebook the 3 LEDs at the analyser have a changed meaning: They indicate the accumulated errors in the net in terms of the overview. As long as all slaves work perfectly the power-LED lights "green"; if it should be warned for one or more slaves the second LED shines "yellow". If the net is affected by more massive disturbances the test LED lights "red". Operating without a notebook the **LED-traffic light representation at the analyser** shows the status of the net.

***Four** restrictions are to be considered with the work without a notebook:*

- *Measured values remain stored only as long as the analyser is supplied out of AS-Interface net. The notebook must be attached to the analyser for further analysis.*
- *If the notebook is attached to the analyser first (for example to set-up the analyser), but then removed, the data stored up to this point is deleted (the filter adjustments remain however!).*
- *The indication "Measuring Time" is generated by the PC and not by the analyser. Therefore, the "Measuring Time" can be indicated only if the online statistics have been deleted at least one time via the PC and have been started again in this way. Therefore, it continues to run also if the communication is temporarily interrupted by the master or the user program but the voltage in the AS-Interface net persists.*
- *The memory in the analyser is limited. In the continuous mode without attached notebook data can be stored max. 14 days in the statistic mode. The counter stops if it reached its maximum value. With attached notebook this period is extended to approximately 1 year.*

5.4 Logging of the Online Statistics

The results of the online statistics (overview, configuration, advanced statistics and consecutive errors, as well as minimum and maximum value of the voltage) can be printed out or stored as standardized protocol. The protocol can be supplemented manually in the form by a description of facility including the indication of the type of the used components manually. This describes the facility completely. The data from the analyser are protected (fig. 7).

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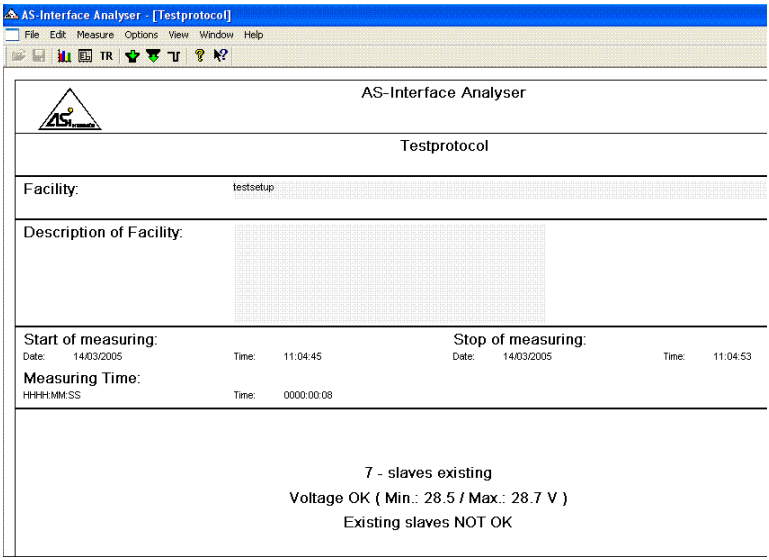

Fig. 7: With the protocol description a complete documentation of the actual condition of the facility is possible. The picture shows the summary of the protocol's first page.

You can reach the protocol in two ways:

- Either after the test run over the main menu "**File / Protocol edit**". The protocol contains the won data already.
- Or before a test run over the main menu "**Measure / Test assistant**". Here a new statistics is started. The intended measuring time can be entered directly. At its expiration the protocol sheet appears.

If several protocols are provided without a restart the data once entered manually are adopted. In particular the **description of facility** does not need to be entered a second time. That works also if a protocol which has been already stored (see below) is loaded.

This will ease your work substantially, but it can lead to an incorrect documentation if used imprudently. Example: the stored protocol of a facility is used as basis for the protocol of another facility. The software cannot examine manual entries!

*Frequently recurring entries (such as examiners name etc.) can be put down in a **standard protocol** which is called by the program categorically. It must be stored under the file name "default.ptx" in the directory in which the evaluation software is located.*

5.5 Offline Statistics

The data of the online statistics including the test protocols can be stored and are available offline for later evaluations, controls and comparisons or for documentation then.

Saving: The moment of storing is determined by leaving the online statistics. Storing can take place either directly or after complementing the protocol.

- With save test protocol (extension *.ptx): The complete online statistics is stored. When opened the statistics and the protocol are indicated.
- With save test protocol (extension *.txt): Only the protocols in the txt-format are exported. It can be read without the analyser software; but the formatting is lost.

Loading: When **loading** the appropriate file in offline mode you can see a stored statistics. Manual data of the description of facility can be supplemented and stored offline then.

Note

The momentary result of an online statistics is frozen by leaving the statistics mask but it keeps running in the background (that means inside the analyser). The current statistics is stopped and deleted only if a file is loaded. Therefore, a warning appears while loading ("The data on statistics are not saved yet. Dou you want to save?"). It refers to the momentarily running.

5.6 Data Mode

The I/O data mode does not focus on possible telegram errors but the momentary valid data of the slaves. The analyser takes over the current values approx. one time per second. If the data/signal is applied for a period shorter than 1 second it is sometimes not indicated.

Three register tabs are available:

5.6.1 Digital Data

Here all I/O data are binary indicated, which have been exchanged with each individual slave. As suggested in the heading (from right to the left): the input data I0, I1, I2, I3 and the output data O0, O1, O2, O3.

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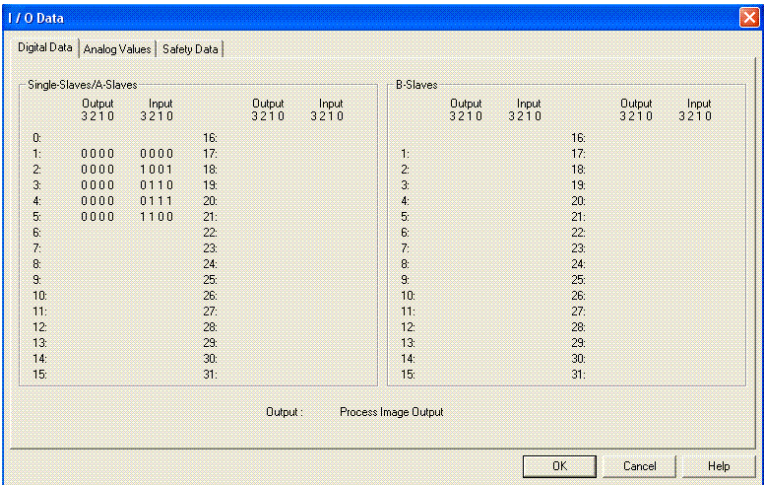

Fig. 8: In the data mode the momentary data of the slaves are indicated. The tab "Digital Data" shows the transferred bits from master call and slave response of all slaves taken up to communication.

For a correct interpretation here four **details** to AS-Interface:

- According to the SPS-standard EN 61131 binary **output data** are transmitted as "1" for a HIGH-level, as "0" for a LOW-level. That applies to communication between control and master in the data image of the outputs. According to the AS-Interface standards IEC 62026-2 and EN 50295 within the AS-Interface net exactly the opposite applies to the "AS-Interface Level".
  Both representations are possible: In the menu it can be given under "**Options / Statistics**" whether the exits are indicated as "AS-Interface level outputs" or as "Process Image Output". The display of the output data is inverted thereby so that the comparison with the data of the control or within the net becomes simpler depending upon the situation.
- With each data call 4 bits between master and slave are exchanged in both directions. That applies, even if they are partly insignificant. Therefore, the analyser shows 4 output bits for example also with a pure input slave. They have, however, no meaning for the application.
- With **analog slaves** and **safety-related slaves** the in- and/or output values transferred in the net constantly change. That is to be detected in the 1 second-rhythm and corresponds to the function of AS-Interface. But this does not mean that an error has been observed.
- With A/B-slaves according to specification C.S.2.1 the **output bit A3** of the data call is not available as a usable output value. It serves for the distinction between A- and B-slaves. So the output bit O3 of the data call for A/B-slaves exhibits always fixed values. In fig.8 the values for the slaves for 4A and 4B are 1 and/or 0.

5.6.2 Analog I/O Data

The data of the existing analog slaves in the net which are working according to the slave profiles S-7.3.x are indicated here. For digital slaves the display remains empty (Fig. 9).

Attention

The analyser *must convert the captured data telegrams according to the* ***profile*** *of the slaves; therefore it is a requirement for this indication that the analyser knows the profile of each individual attached device. He must have observed at least one time the start of the slave communication. Only in this way the four configuration data can be captured and displayed in the representation.*

The details of communication and the kind and number of the channels but not the physical meaning of the values are fixed in the profile. It is specified by the manufacturer in such a way that different slaves are realizable. The user of the analyser must convert, however, the received values according to the calibration curve of the equipment. If a slave indicates an overflow through its "overflow bit" this is represented by an additional point in the appropriate channel.

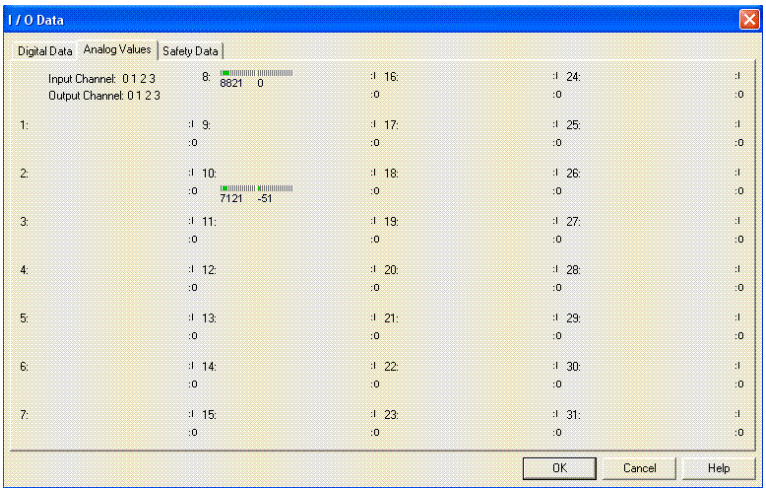

Fig 9: In the example the slaves with address 8 und 10 are analog slaves are a 2-channel input slave (address 8) and a 2-channel output slave (address 10).

Example: In fig. 9 an analog input module (slave 8) and an analog output module (slave 10) with two channels each are attached. In both cases the value "0" corresponds to 0 V, the value 10.000 to a voltage of 10 V. The modules have a resolution of 1 mV. The displayed values results:

Input module Sl. 8:	Channel 0	8,821 V
	Channel 1	0 V
Output module Sl. 10:	Channel 0	7,121 V
	Channel 1	-0,051 V

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5.6.3 Safety Data

For all 2 channel safety-related slaves according to "Safety at Work" the tab "Safety Data" indicates, whether the slave has "released" or it is "free".

Two details:

- The representation of the safety data is only valid for a moment – as for all I/O data – , i.e. it is updated approx. in a 1 second rhythm. Safety slaves, which have to be reset externally after they have been released, keep on sending the released signal. The information "Released" persists.
- In this representation only 2-channel slaves in which both channels switch on or off, are interpreted. If only 1-channel of a 2-channel slave has been switched off that cannot be represented here correctly. However, the situation can be evaluated in the safety monitor of the trace mode (see chapter 5.7.9).

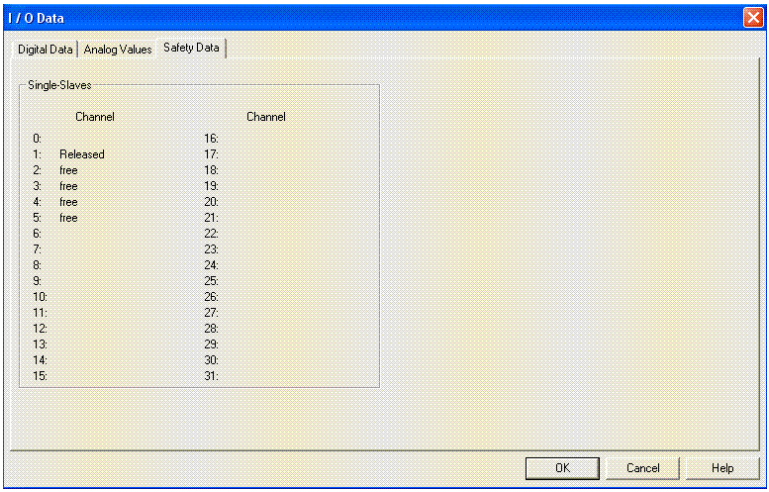


Fig 10: The status is indicated for 1-channel, safety related slaves.

5.7 Trace Mode (Expert Mode)

In the "Trace Mode" the analyser notes each particular telegram or those which are selected after triggers and filters. They are loaded into an attached notebook and analyzed there. The analysis requires some detail knowledge of the function of AS-Interface, but it is a very powerful tool for the analysis of a facility. Therefore, the mode is called "Expert Mode".

The trace mode is unjustifiably regarded as something complicated. This software supports the user and prevents faulty operation largely. If you have sufficient knowledge of AS-Interface, to interpret a trace you can create it in a few steps by yourself:

In order to **trace** you specify,

- when you want to begin and let end a trace (starting mask),
- whether you want to use different trigger options (trigger mask),

- whether you want to record all or only one part of the telegrams (recording mask),
- whether you want to see only one part of the registered telegrams on the screen (view mask).

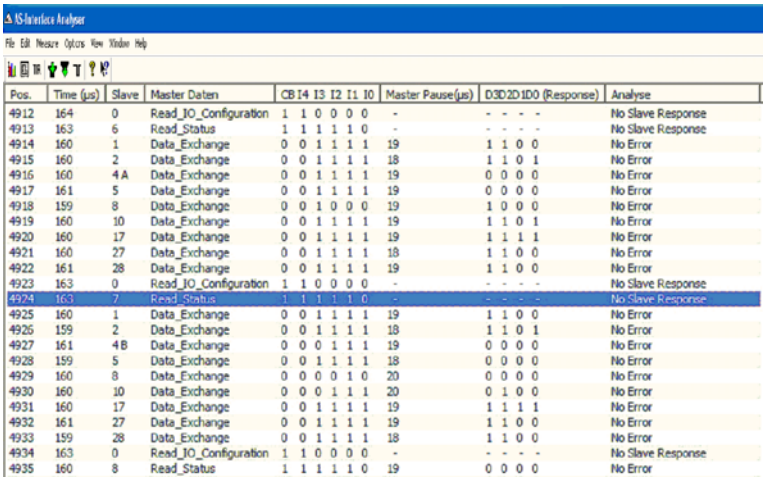
Trigger, recording, and view mask are nearly identical and have the same structure, in order to ease the operation training. They are described in detail in the following chapters.

A trace acquires the selected data traffic on the bus, evaluates and logs it. With this information which goes far beyond the amount of data available from a master or a control, errors caused by the net or by individual slaves or by the application can be identified and corrected substantially more easily than with other means. Weak points can be uncovered preventively.

If the options "Trigger" and "Recording Filter" are used you are able to collect telegrams in the analyser eventually over a long time. The PC needs to be attached for the definition of the trace conditions for the start and for the subsequent evaluation only.

Note

During a trace phase the online statistics is not active. It is continued after the trace phase and the loading. Telegram errors which have occurred before the start of a trace remains registered. On the other hand possible errors during a trace are listed only in the trace but not in the online statistics.



Pos.	Time (µs)	Slave	Master Daten	CB I4 I3 I2 I1 I0	Master Pause(µs)	D3D2D1D0 (Response)	Analyse
4912	164	0	Read_IO_Configuration	1 1 0 0 0 0	-	- - - -	No Slave Response
4913	163	6	Read_Status	1 1 1 1 1 0	-	- - - -	No Slave Response
4914	160	1	Data_Exchange	0 0 1 1 1 1	19	1 1 0 0	No Error
4915	160	2	Data_Exchange	0 0 1 1 1 1	18	1 1 0 1	No Error
4916	160	4 A	Data_Exchange	0 0 1 1 1 1	19	0 0 0 0	No Error
4917	161	5	Data_Exchange	0 0 1 1 1 1	19	0 0 0 0	No Error
4918	159	8	Data_Exchange	0 0 1 0 0 0	19	1 0 0 0	No Error
4919	160	10	Data_Exchange	0 0 1 1 1 1	19	1 1 0 1	No Error
4920	160	17	Data_Exchange	0 0 1 1 1 1	19	1 1 1 1	No Error
4921	160	27	Data_Exchange	0 0 1 1 1 1	18	1 1 0 0	No Error
4922	161	28	Data_Exchange	0 0 1 1 1 1	19	1 1 0 0	No Error
4923	163	0	Read_IO_Configuration	1 1 0 0 0 0	-	- - - -	No Slave Response
4924	163	7	Read_Status	1 1 1 1 1 0	-	- - - -	No Slave Response
4925	160	1	Data_Exchange	0 0 1 1 1 1	19	1 1 0 0	No Error
4926	159	2	Data_Exchange	0 0 1 1 1 1	18	1 1 0 1	No Error
4927	161	4 B	Data_Exchange	0 0 0 1 1 1	19	0 0 0 0	No Error
4928	159	5	Data_Exchange	0 0 1 1 1 1	18	0 0 0 0	No Error
4929	160	8	Data_Exchange	0 0 0 0 1 0	20	0 0 0 0	No Error
4930	160	10	Data_Exchange	0 0 0 1 1 1	20	0 1 0 0	No Error
4931	160	17	Data_Exchange	0 0 1 1 1 1	19	1 1 1 1	No Error
4932	161	27	Data_Exchange	0 0 1 1 1 1	19	1 1 0 0	No Error
4933	159	28	Data_Exchange	0 0 1 1 1 1	18	1 1 0 0	No Error
4934	163	0	Read_IO_Configuration	1 1 0 0 0 0	-	- - - -	No Slave Response
4935	160	8	Read_Status	1 1 1 1 1 0	19	0 0 0 0	No Error

Fig 11: Cut-out from a complete trace. The telegrams 4912 to 4935 are shown, here the expiration of 2 error free AS-Interface cycles is recognisable (line 4914 - 4924 and 4925 - 4935). Each AS-Interface call needs 156 µs. In the management phase the slaves 7 and 8 are searched with a read_status command. With slave 7 the search is futile. It is missing in the existing network.

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5.7.1 Contents of a Trace

Fig. 11 shows a small cut-out from a trace with approx. 256.000 lines. Each line of the trace consists of the "data pakket" of a pair of telegrams.

In the first detail the continuous number of the data packet within the trace is indicated, then the time, which elapsed up to the next represented pair of telegrams. It follows the slave address, the master call as text and as bit pattern (without address), the length of the pause between master-call and slave response, the answer telegram of the slaves and the diagnosis as plain text.

In the status line (to be activated in the menu under "View") the sum of all times between the red underlined line and cursor marked line is indicated. Without using the trigger function the first line of the Trace is marked red. Using the trigger the trigger time is marked red.

The **output bits** which are contained in a master data call *always* appear in the trace on the AS-Interface level (see chapter 5.3.1). For the meaning of each individual bit see the AS-Interface specification.

Note

If adopting a recording filter (see below) some lines of the trace are needed internally, to record the periods between individual lines. In the practical experience, therefore, often somewhat less than 256.000 lines are available for a trace.

5.7.2 Complete Tracing

With the complete trace each individual telegram on the AS-Interface line is captured and stored. The memory stores approx. 256.000 master and slave telegrams from the moment of starting the trace. It corresponds to a cycle time of approx. 40 s (extension see below).

After reaching this value or after a stop of the recording the telegrams are loaded automatically into the notebook, as shown in fig. 11.

For the representation of a complete trace a complete setting of the recording filter and the view filter is necessary (see there).

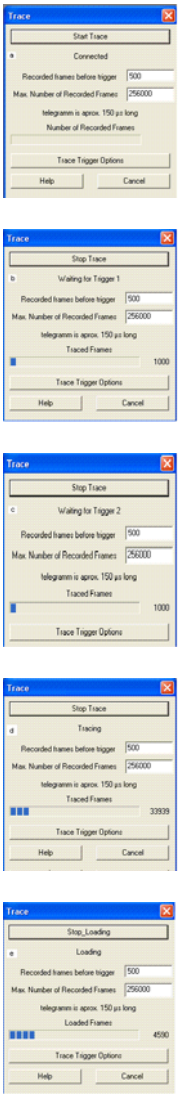

Fig 12: The starting mask of the Trace Mode shows the momentary operation and progress.

5.7.3 Manual Start: Trace without a Trigger

Basically each trace process is started from a query window (fig. 12) which opens with the call of a trace (under **Measure "Trace"** or with the button "**TR**"). In

this window also the progress is indicated. The trace procedure and/or the following downloading of the trace into the PC can be aborted in this window at any time.

The manual start without triggering is the direct way to create a trace and to test all telegrams. It is started with "Start Trace" (fig. 12 a). For this purpose the trigger conditions described in the next sections must be switched off. This occurs with the start of the software automatically. But it must be done manually if a trigger condition was entered before. So set the "Number of Trigger Conditions" in all three trigger levels to "0" additionally (details see below).

In fig. 12 in this case the field's b and c are skipped.

5.7.4 Trace with Trigger

The analyser offers additionally a sophisticated system of trigger **possibilities** for the final start of traces which can be also combined:

5.7.4.1 Internal Trigger

During internal triggering from the observed telegrams in the analyser a signal is derived which specifies the beginning of storage. The internal trigger runs over up to three levels which are processed in sequence. A trace is taken up only if the conditions of the trigger level1, then those of the trigger level 2 and finally those of trigger level 3 are fulfilled.

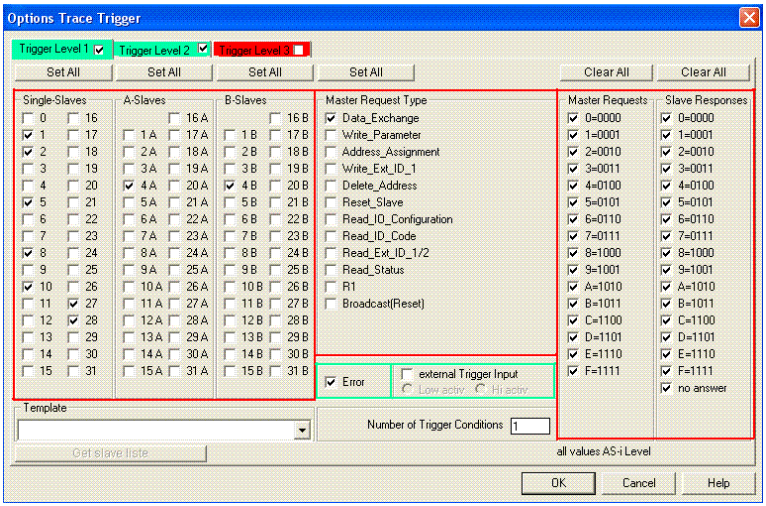

Fig 13: The trace trigger processes three levels in sequence. the trigger mask represented here is the same for each of the three levels. Between the red marked fields an AND-conjunction exists, the green marked fields are OR-linked. For details see text.

For adjustment of the possible options the **mask "Trace Trigger"** must be called in the menu over options "**Trace Trigger**" or over the starting mask (fig 13). It contains 3 levels which correspond to 3 trigger conditions which can be processed one after another. The trigger event of the last level releases the race.

The following rules apply to the definition of the **trigger condition** to each level:

1. *Within* each red marked range from fig. 13 at least in each case one presetting must be fulfilled in order to activate the trigger (that corresponds to a logical OR-conjunction within these ranges).
2. Additionally *each* of the red marked ranges must be activated as described in number 1 (that corresponds to a logical AND-conjunction within the red ranges).
3. The "**Number of Trigger Conditions**" indicates, how often the adjusted trigger condition must be fulfilled before it is changed over to the next trigger level. If this number is specified as "0" the trigger level is not active. This is indicated by a red flag on the tab.
4. "**Error**" means a identification of an incorrect AS-Interface telegram. The analyser examines (just as the receivers inside master and slave) each single telegram according to a set to criteria for formal correctness. These are the well-known error protection mechanisms of AS-Interface. If the analyser finds a incorrect telegram, this leads to triggering the trace, provided that "Error" is marked. This function is independent of the red marked fields (so it corresponds to a logical OR-conjunction with the red marked fields).

- **Input assistance**: Generating of the trigger conditions is simplified by the following:
- With the call of the trigger mask (after restart of the software or with the transition to the online statistics) the automatic assumption of the recognized slaves into the masks is offered if the net and the analyser are active.
- Three frequently used basic adjustments are offered in the field "Template": "All Single Slaves", "All A/B-Slaves" and "Errors". In the first two settings all meaningful defaults for all slaves are entered. In the third case all possible errors in data exchange, i.e. incorrect telegrams or missing slave responses. These basic adjustments can be manually adapted to the respective situation.
- In the upper range of the sheet several buttons are contained, with which whole fields can be reset or set. They change between "Clear All" and "Set All" and are coupled in a way that unreasonable combinations are avoided.
- The field "Master Data" describes the trigger conditions for the data bits D0 to D3. These can have different meanings for each type of telegram. With some telegram types they have fixed values and so they are redundant to the field "Master Requests" located next to the filed "Master Data". As long as special situations do not have to be examined the button "Set All" works very well. The selection of the trigger takes place via the AND-conjunction with the type of telegram. If here special defaults are to be made, the meaning of the bit D3 for A/B-slaves is to be considered.
- The button "OK" is created in such a way that it can be only operated if theoretical meaningful settings are to be confirmed.
- If the software is loaded for the first time the manual trigger is switched off as default setting.
- You can get the current list of the slaves over the button "Get Slave List" if you have already made a statistics measurement.

You can trigger xx1x on the slave answer with read status calls to detect a periphery error.
There is a template for this as well.

Note

In order to trigger on the releasing of the safety monitor, attach the trigger input to the reporting exit of the monitor and trigger then on low active on the external trigger input.

Note

Start traces and recorded frames before trigger:

Similarly as with a memory oscilloscope, you can set a various number of telegrams to be saved before the trigger event. This causes that the stored trace does not only begin at the trigger time but that it also shows a given number of data pakkets directly before accomplishing the last trigger condition. Thus the trace looks backwards to the direct past from the trigger time still another piece into. So a prehistory analysis is possible.

You can specify in the menu "**Options / Trigger Point**" the **size of the telegrams of this prehistory view**. It can various between 0 and 256.000.

Also when triggering internally (or externally) the trace procedure must be started manually (fig. 12a). This start causes that the analyser takes up data packets immediately as "frames before trigger event". However, these are overwritten again and again until the last trigger condition is true. In fig 12b and c a "preview" from 500 data packets is adjusted.

The further "tracing" begins when the trigger events of the levels 1 - 3 arise (fig. 12b and c). After the stop of the trace the data packets are loaded automatically into the PC (fig. 12d and e). This can be interrupted if necessary.

The last trigger condition is marked red in the trace.

Delayed tracing: By adjusting a negative "advance trigger" the start of the trace can be further retarded. It starts an adjustable number of packets only after the trigger event.

5.7.4.2 External Trigger

Alternatively is it possible to start a trace by an external trigger. That is done by an external voltage of 24 V (+6 V) at the external trigger input. The trigger is released with 0 V or with 24 V depending upon the setting.

The settings takes place with the help of the **trigger mask** (fig 13) in which the external trigger is activated. The external trigger can be selected either as "Low active" or as "High active". In the first case the trigger condition is fulfilled if no voltage is set to the input. In the second case a voltage of 24 V releases the trigger event. The field "Number of Trigger Conditions" serves switching the in- and output of the trigger level ("1" and/or. "0").

The field "external Trigger Input" of the trigger mask is independent of the red marked fields of the internal trigger (according to a logical OR-conjunction with these fields). If an internal and an external trigger condition are adjusted, then the trigger

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can be released thus by each of these conditions. A temporal sequence can be created by activating several trigger levels.

5.7.4.3 Trigger Output

The analyser can be used in order to trigger external devices. So for example a memory oscilloscope can be triggered by an error in the net. In this case exactly the analog signal which caused an error on the AS-Interface line can be represented. Another application is controlling a camera.

For the **definition of the trigger conditions** a mask just as build as the mask for the internal trigger is available under "**Options / Trigger Output**". It also offers three trigger levels.

The trigger output switches for approx. 150 µs from +5 V to 0 V when the trigger condition is reached. It responds approx. 450 µs after the trigger event. Its maximum current load is 2 mA. The potential of the trigger output corresponds to the potential of the RS232 interface. The trigger output uses the trace mode and therefore, only works when a trace runs.

As long as the trigger and the trace are active, a trigger output impulse is set with each occurrence of the trigger condition. If the trigger event reappears the trigger is set again. So for example cyclical measurements become possible.

5.7.5 Trace with Recording Filter

With a recording filter the number of captured telegrams is limited. Furthermore the evaluation is more clearly arranged and the possible recording time is drastically extended eventually. For the definition of the filter conditions a mask just as build as the mask for the Internal trigger is available under "**Options / Trace Recording Filter**". The same rules and adjusting help apply as in the mask for the internal trigger.

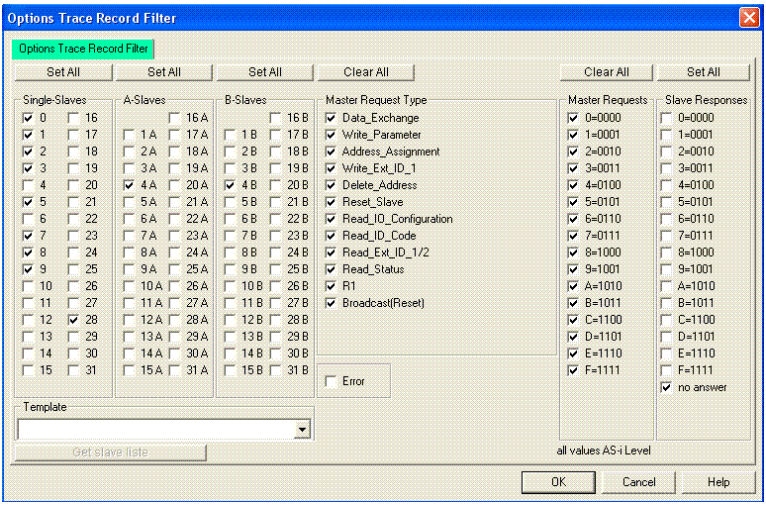

Fig 14: It is specified in the recording filter which data packets are stored. in the example only calls with incorrect telegrams and missing telegrams are stored.

The setting for a **complete trace** is particular simple: By pressing the button "Set All" (or automatic assumption of the slave list from the online statistics) you get the correct configuration of the filter.

5.7.6 Trace View Filter

With a trace view filter not the number of captured telegrams but the representation in the PC is limited. The representation is reduced to certain data packets, in order to filter only data which are really interesting. This presentation can be changed at any time.

A mask under "**Options / Trace View Filter**" stands for disposal for the definition of the filter conditions. also it is similarly build as the mask for the internal trigger and the recording filter. Apply as in the mask for the internal trigger and the recording filter.

The setting for a **complete view** is particularly simple: By pressing the button "set all" (or automatic assumption of the slave list from the online statistics) you get the correct configuration of the filter.

Note

The AS-i master sends search calls cyclically to all addresses, including B-addresses (inclusion-phase). If a single slave is selected, the calls to the corresponding B-addresses cannot be indicated.
The field "Show Management Calls of B-Slaves at Single Address" exists to prevent this. It shows exactly these calls.

Note

The displayed result of a trace depends on the combination of the recording filter and the view filter. Arbitrary combinations are possible in order to achieve the greatest flexibility for the analyser use. This can lead to situations hardly interpretable. In a normal application you should take care that only slaves are searched which are actually in the net or should have to be found there. So unsatisfactory representations can be avoided.

5.7.7 Trace without Notebook

The analyser can take up a trace even when a notebook is not attached constantly. The notebook (or a PC) is only required for the determination of the settings and for the (manual) start, as well as for al subsequent read out of the traces. This configuration is interesting if a trace starts only due to a rarely arising trigger condition or if a very long recording time is necessary effected by a recording filter.

This kind of storage and of the following analysis is supported in a user friendly way: If the notebook is attached after storage to the analyser again, the analyser software recognizes this situation. The software does not only read out the stored trace automatically, but also the trigger conditions and filters, stored in the analyser. So the user gets a consistent view afterwards.

5.7.8 Safety Data in the Trace

the analyser software can analyze the telegrams of safety-related slaves for code violations. The software works in this analysis similarly to a safety monitor. Being a passive participant the analyser cannot intervene.

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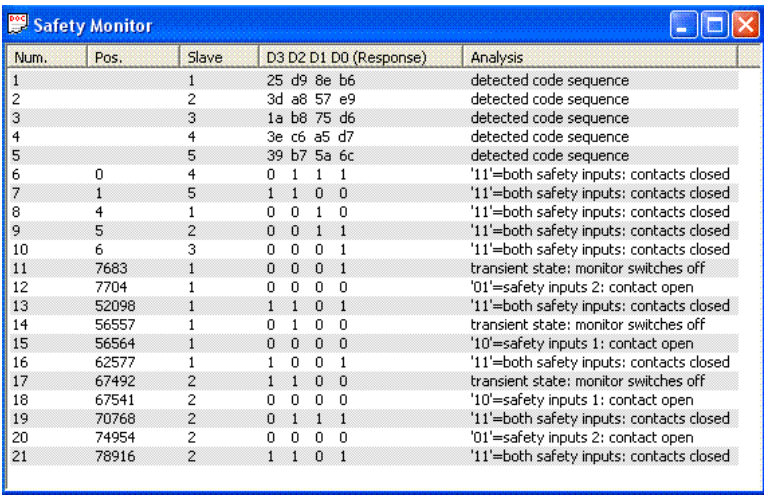
If a trace is loaded into the PC this function can be called in the menu under "**Measure / Safety Monitor**" (fig. 15). The mask shows at first the code sequence of the slaves in a hexadecimal form, and all status changes of safety-related slaves afterwards (profile S 0.B.x and S 7.B.x). The column "Pos." shows a relation to the complete trace.



Num.	Pos.	Slave	D3 D2 D1 D0 (Response)	Analysis
1		1	25 d9 8e b6	detected code sequence
2		2	3d a8 57 e9	detected code sequence
3		3	1a b8 75 d6	detected code sequence
4		4	3e c6 a5 d7	detected code sequence
5		5	39 b7 5a 6c	detected code sequence
6	0	4	0 1 1 1	'11'=both safety inputs: contacts closed
7	1	5	1 1 0 0	'11'=both safety inputs: contacts closed
8	4	1	0 0 1 0	'11'=both safety inputs: contacts closed
9	5	2	0 0 1 1	'11'=both safety inputs: contacts closed
10	6	3	0 0 0 1	'11'=both safety inputs: contacts closed
11	7683	1	0 0 0 1	transient state: monitor switches off
12	7704	1	0 0 0 0	'01'=safety inputs 2: contact open
13	52098	1	1 1 0 1	'11'=both safety inputs: contacts closed
14	56557	1	0 1 0 0	transient state: monitor switches off
15	56564	1	0 0 0 0	'10'=safety inputs 1: contact open
16	62577	1	1 0 0 1	'11'=both safety inputs: contacts closed
17	67492	2	1 1 0 0	transient state: monitor switches off
18	67541	2	0 0 0 0	'10'=safety inputs 1: contact open
19	70768	2	0 1 1 1	'11'=both safety inputs: contacts closed
20	74954	2	0 0 0 0	'01'=safety inputs 2: contact open
21	78916	2	1 1 0 1	'11'=both safety inputs: contacts closed

Fig 15: Evaluation of a trace like in a safety monitor. it shows first the code sequence (in hexadecimal) of the two safety slaves with the addresses 1 and 2 and then the changes between "free" and "released" for both slaves within the trace.

In this mask you can see:

- the individual code sequence of the safety slaves,
- the time of disconnections which can then be analyzed more exactly in the trace then,
- telegram errors which did not lead to disconnection because of well timed repetitions,
- code errors which can be valid telegrams and therefore, cannot not be recognized elsewhere.

Note

While switching depending on the type of slave transient conditions arise which are represented in the evaluation. Generally transient conditions are no errors.

Note

The evaluation of the PC takes place in the PC. It recognizes the safety slaves by their ID code and the code sequence from the correct data calls. The recording filter must not fade out (before switch off) both neither the ID codes nor the data calls to the decisive safety slaves.

5.7.9 Storage and Offline Working on Traces

Traces can be stored and are available off-line for subsequent evaluations, controls, and comparisons or documentation.

Storing can occur in two ways:

- with "Save Trace" (extension *.trc): The trace is stored in a analyser format. It can be opened and processed with the analyser software afterwards.
- with "Trace Export (extension *.tsv): The trace is stored in a "tabulator separated value" format. So it can be exported into an Excel sheet.

Opening: You can "open" a stored trace off-line by a click on the appropriate file. If due to a track view filter only a part of the data packets have been displayed, this reduced view is displayed when opening a stored file first. In the background however, the entire trace is present and can be represented by a change of the trace view filter. Furthermore the last used settings for trigger and recording filter are stored and can be used for the data analysis as well.

With the export of a *.tsv-file in Excel data formats are queried. The following settings are recommendable: "separated" for the data type, "Tab stop" for separators, " as text recognition characters and "text" as data format for *all* columns. If due to a trace view filter only a part of the data packets have been displayed at the moment of storing this reduced view appears in Excel. The rest of the file cannot be represented. However that solves another problem: Excel can represent only a limited number of lines. Due to a view filter the trace can be reduced in such a way that it is representable in Excel (In the last column the content of all lines is repeated in a hexadecimal form for a second time).

6 Valuation of Errors

With the analyser a very effective instrument for the examination of the data traffic on the AS-Interface line is made available. It indicates each telegram repetition as an "Error". However, it is the user of the analyser who has to interpret the practical meaning of such an "error".

AS-Interface was developed as an industrial communication system with an unshielded cable and therefore, it is used extremely successfully. Single telegram repetitions are taken into account thereby. They appear if the safety routines detect an incorrect code in a telegram. That forces immediately a first repetition of the telegram which leads to a delay of approx. 150 µs. If also this repetition remains unsuccessful also the master attempts two communicate another two times with this slave during the two following cycles. The analyser registers this as a "consecutive error. Only if a slave exhibits a consecutive error of the class 6 (a total of 6 repetitions in 3 cycles in a row), the master takes the slave out of communication automatically and report a "Configuration Error" (the slave is automatically taken up to communication again at the moment it works correct again - compare AS-Interface specification).

The user of the analysers must know that these repetitions, called "errors", only interfere with the network level. So the superior control or an actuator obtains no wrong values. Exactly the safety routines mentioned prevent this.

Using AS-Interface single telegram repetitions are (nearly) a normal subject. The "green" area is defined according to this knowledge (fig. 3b). Therefore, the detailed results of an analysers in the "advanced statistics" or in the trace mode must not lead to the unreasonable demand that each AS-Interface net must run absolutely free of telegram repetitions. In fact the results give indications concerning the quality and insensitivity to interference of the respective net. They should be interpreted according to the application and to the particular situation.

The new function "Consecutive Error" supplies an important assistance for this interpretation additionally. It shows how frequently successive repetitions took place in order to receive a valid slave response. Thus, it shows how close a slave was to log-off from communication. This is to be regarded as a critical case.

6.1 Uncritical Networks

If a net is considered to be "uncritical" in the sense that a short disturbance (e.g. even a temporary malfunction of a slave) does not threaten the application because the application does not stop, this state can be tolerated in many cases. One of these uncritical situations is e.g.: single yellow slaves or even red slaves appear (beside many green slaves) for hours in a net which is, nevertheless, not "noticeable" in a different way.

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6.2 More Critical Networks

A net of similar quality which is used in an application which stops even if a slave fails for a short time only, should be examined more precisely. Every "yellow" or "red" slave basically indicates the risk of a reduced availability.

Something similar applies to applications used by operators who cannot handle AS-Interface. The examination with the analyser as well as the detailed clarification of the repetitions` occurrence decreases the danger of taking expensive repair services.

It should be inspected also if the effort for avoiding repetitions` can be justified economically. The **evaluation of the consecutive error** helps to decide rationally: If repetitions` only occur in the lower classes – even though this net has been observed for a longer period – a good forecast for a further trouble-free run is likely to be made.

In some cases eventual risks can be evaded by determining in the software or on the master's level whether the failure of a particular slave should effect an immediate stop of the facility or whether it is sufficient to stop the facility after the end of a **facility cycle**. The second option can be handled more easily.

6.3 Facility and Safety Engineering

Facility and safety engineering represents potentially two exceptions:

- In the field of facility engineering there are applications, whose breakdown must be absolutely avoided for cost reasons. Here it can be suggested to arrive close to the theoretical ideal of "no telegram repetitions". Eventually you even try to avoid repetitions of "only green" slaves.
- A second special case is safety related facilities according to "**Safety at Work**". Here repetitions are acceptable also because they will be intercepted by the system and do not limit the security. In order to ensure a turn off after max. 40 ms, it is fixed here that the safety monitor already responds after the fourth telegram repetition. Therefore, with safety slaves a consecutive error of the class 4 leads to a turn off and so to a reduced availability of the facility. Therefore repetitions are judged here more critically.

6.4 Example

Fig. 16 exemplarily shows how the representation of the consecutive error can affect the validation. The slave 1 communicates badly in a net with excess length. The overview with hold time indicates that the slave is red. According to the „advanced statistics“ about 17 % repetitions arise with this slave. However, the control of the consecutive errors shows that all repetitions refer to the class 1. After a runtime of more than 2 minutes the slave exhibits many errors which belong to class 1 only.

Validation: The net should be stabilized indeed because is it not working “clean”. Depending upon the cause of the disturbance this stabilisation can be achieved by using an AS-i bus termination or an AS-i tuner. If EMC disturbances cause the problems they must be eliminated. But due to the fact that only one repetition of each call is necessary the error is tolerable first. That applies also to the relevant times

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because of the mechanisms of AS-Interface: The cycle time extends in this case only by 150 µs. Only fundamental considerations e.g. the change of a slave or the potential instability of the net recommend the correction in this case.

In practice quite a few nets in a comparable condition might work trouble-free without ever being noticed by the user. It would be more critical if a slave would exhibit a *single failure* of the class 6.

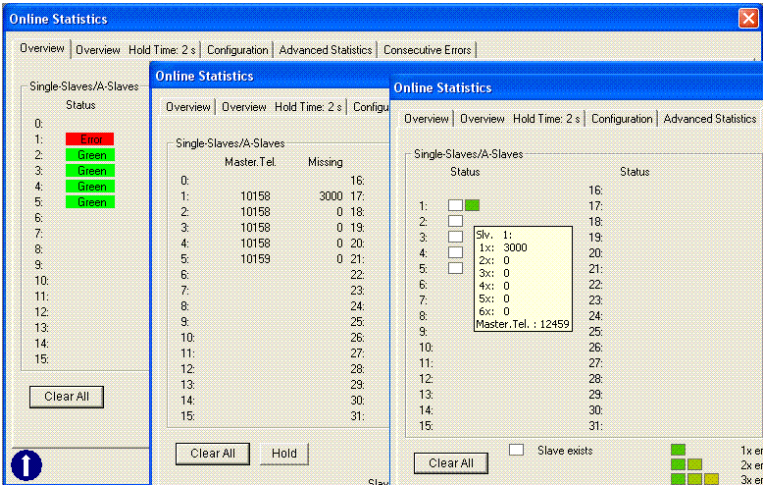

Fig 16: Example of a net strongly disturbed. The effect of this disturbance becomes visible only by an error analysis: The representation as a consecutive error shows that the disturbance can be tolerated temporarily (see text).

7 Using the Analyser

The analyser can be used for many different tasks. The most important functions are described in the following sections.

7.1 Checking the actual state

The online statistics permit the complete examination and logging of the momentary condition of an attached net. It can be improved step by step:

- The "Overview" of the online statistics gives a direct visual impression of the of the net's quality by the classical traffic light representation "green" – "yellow" – "red" (example in fig. 3). It verifies the period between power-on of the analyser (or a deleting process) and the read-out. During this period the worst condition of a slave (red or yellow) is indicated. This mode is a basic mode of the analyser. It is appropriate for long-term verifications. The notebook needs to be attached for analysis only (up to measurement periods of 14 days).
- The "Advanced Statistics" give detailed results. They show the number of master calls to each slave during the observation time. It shows the number of repetitions also which were necessary due to incorrect or missing telegrams and in addition cycle time and voltage in the net (example in fig. 4).
- The "Consecutive Error" split up the errors into simple and multiple errors and so it permits a qualified evaluation of the observed repetitions. Compare chapter 3 and fig. 5.
- The configuration which the analyser provides is based on net data therefore, it corresponds to the slaves actually found in the net. At the same time it is recognized which slave types are present to which the master does not respond in the protected mode, or whether an individual slave does not correspond to the configuration stored in the master.

With these analysis steps the attached net is described almost completely. The user receives:

- An overview of all attached slaves (addresses, profiles),
- an overview of the ability to communicate of each individual slave,
- a basis for evaluation deviations from the ideal situation,
- a means to control the effect of an AS-i bus termination or an AS-i tuner or for other measures which concern the net or individual slaves,
- an analysis of the long-term stability of a net.

So these deviations from the nominal condition can be eliminated.

7.2 Logging the Actual State

The protocol of the online statistics can be stored and printed out. It covers the points mentioned in the chapter before and it can be manually supplemented by a description of facility. This description contains for example the type numbers, the manufacturers or detailed data of the used components. So the actual state of the net is precisely documented.

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Therefore the protocol can be used

- as an overview of the actual state,
- as a test certificate of a new net,
- as a control and planning instrument for preventing maintenance work,
- for documentation of conscious or unconscious changes.

Such a protocol of the starting situation of the facility is very useful if subsequent changes must be examined.

7.3 Error Diagnostics in the Network

The analyser can identify or at least isolate errors in the AS-Interface net. In most cases the online statistics either with a current measurement or by a long-term test is sufficient for this purpose. With PC attached the number of sent telegrams exceeds the largest representable number (11 digits) after a year principally. Then the counter stops. A even finer analysis is possible with the trace mode by clever use of trigger conditions and/or recording filter.

The analyser does no show only communication errors continuously but it examines the AS-Interface voltage at the position of the analyser although. These errors can be seen In the "Overview", in the "Advanced Statistics" and in the "Consecutive Error" immediately. In the trace they can be proven most easily over the setting "Error" with trigger and filter.

However, communication errors can have a completely different cause and must be interpreted:

7.3.1 Failure of a Slave

If a slave failed completely (before beginning of the measurement), so that no communication is possible anymore, this slave is missing in all other representations of the analysers also. The analyser "does not see" this slave. The slave is missing in the configuration representation also. The master reports in the protected mode, however, a configuration error. The read-out of the target configuration or the comparison with earlier protocols clarify the situation.

The opposite applies if e.g. the external connections of a module are defective. In this case the communication via AS-Interface is perfect, and the slave is represented green. In the data mode, however, the reaction of the application to the transferred in- or output data can be identified and the error can be identified.

7.3.2 Error by External Disturbances

Usually errors by external disturbances result from electromagnetic stray effects e.g. by switching an engine or by electric discharge in the environment. In such cases using the help of the "Overview with Hold Time" (adjusted with short holding time) you can frequently show which timing correlation arises wit an event. This proves that the change in the traffic light representation is synchronous to certain facility conditions of the application or the environment.

An external source of disturbance is proven by the synchronous occurrence with certain events. Such disturbances, however, are very rare with AS-Interface if the net is correctly built. Their most frequent physical cause is an earth fault in the net if they arise. Due to the functional principle of the analyser it cannot identify the

cause directly but rather their effect. The user should examine, therefore, first of all the possibility of an earth fault. Themed: "Not the disturbances are the problem but a possible earth fault". For that purpose an earth fault detector in the master, in the power supply or as an individual component is available.

Even if slaves can have different disturbance sensitivities, it is typical for this kind of disturbance that usually several Slaves in the net are affected.

7.3.3 Error by Bad Contact

Disturbances caused by a bad contact can be proven in a similar way. Typically the error always concerns a certain slave. This can be proven most simply in the online statistics (if necessary during a longer period). If a bad connection leads more frequently to telegram repetitions, without the slave failing completely, this can be seen in the "Consecutive Errors". Fig. 17 shows this as cut-out from a trace.

AS-Interface Analyser - [Trace11]

File Edit Measure Options View Window Help

TR

Pos.	Time (µs)	Slave	Master Daten	CB	I4	I3	I2	I1	I0	Master Pause(µs)	D3	D2	D1	D0	(Response)	Analyse
6507	2063	28	Data_Exchange	0	0	1	1	1	1	18	1	1	0	0		No Error
6508	2058	28	Data_Exchange	0	0	1	1	1	1	18	1	1	0	0		No Error
6509	1984	28	Data_Exchange	0	0	1	1	1	1	-	-	-	-	-		No Slave Response
6511	189	28	Data_Exchange	0	0	1	1	1	1	-	-	-	-	-		No Slave Response
6512	2129	28	Data_Exchange	0	0	1	1	1	1	17	1	1	0	0		No Error
6513	2061	28	Data_Exchange	0	0	1	1	1	1	18	1	1	0	0		No Error
6514	2060	28	Data_Exchange	0	0	1	1	1	1	18	1	1	0	0		No Error
6515	1991	28	Data_Exchange	0	0	1	1	1	1	-	-	-	-	-		No Slave Response
6517	188	28	Data_Exchange	0	0	1	1	1	1	-	-	-	-	-		No Slave Response
6518	2054	28	Data_Exchange	0	0	1	1	1	1	-	-	-	-	-		No Slave Response
6521	180	28	Data_Exchange	0	0	1	1	1	1	-	-	-	-	-		No Slave Response
6522	2131	28	Data_Exchange	0	0	1	1	1	1	18	1	1	0	0		No Error
6523	1987	28	Data_Exchange	0	0	1	1	1	1	-	-	-	-	-		No Slave Response
6526	170	28	Data_Exchange	0	0	1	1	1	1	-	-	-	-	-		No Slave Response
6527	2129	28	Data_Exchange	0	0	1	1	1	1	18	1	1	0	0		No Error
6528	2065	28	Data_Exchange	0	0	1	1	1	1	18	1	1	0	0		No Error
6529	1988	28	Data_Exchange	0	0	1	1	1	1	-	-	-	-	-		No Slave Response
6531	169	28	Data_Exchange	0	0	1	1	1	1	-	-	-	-	-		No Slave Response
6532	2129	28	Data_Exchange	0	0	1	1	1	1	-	-	-	-	-		No Slave Response
6533	97	28	Data_Exchange	0	0	1	1	1	1	-	-	-	-	-		No Slave Response
6534	2132	28	Data_Exchange	0	0	1	1	1	1	-	-	-	-	-		No Slave Response
6535	163	28	Data_Exchange	0	0	1	1	1	1	-	-	-	-	-		No Slave Response
6536	30185	28	Read_Status	1	1	1	1	1	0	-	-	-	-	-		No Slave Response
6537	723	28	Read_Status	1	1	1	1	1	0	-	-	-	-	-		No Slave Response
6538	940	28	Read_Status	1	1	1	1	1	0	18	0	0	0	0		No Error
6539	1900	28	Read_ID_Code	1	1	0	0	0	1	18	1	1	1	1		No Error
6540	1902	28	Read_IO_Configuration	1	1	0	0	0	0	18	0	0	1	1		No Error
6541	1836	28	Read_Extended_ID_Code1	1	1	0	0	1	0	-	-	-	-	-		No Slave Response
6542	163	28	Read_Extended_ID_Code1	1	1	0	0	1	0	-	-	-	-	-		No Slave Response
6543	1904	28	Read_Extended_ID_Code2	1	1	0	0	1	1	-	-	-	-	-		No Slave Response
6544	163	28	Read_Extended_ID_Code2	1	1	0	0	1	1	-	-	-	-	-		No Slave Response
6545	1965	28	Write_Parameter	0	1	1	1	1	1	18	1	1	1	1		No Error
6546	1835	28	Data_Exchange	0	0	1	1	1	1	17	1	1	0	0		No Error
6547	1737	28	Data_Exchange	0	0	1	1	1	1	18	1	1	0	0		No Error

Fig 17: A slave with the address 28 with a bad contact is installed in a net. During storage this Slave is moved. By filtering on this slave 28 individual failures are indicated first (lines 6509f, 6515ff, 6523f), then a loss up to a configuration error (starting from line 6529) and finally the resumption into the net (line 6538 - 6546).

7.3.4 Error by Overloaded Slaves

If their in- or outputs are overloaded or another (external) malfunction is present some slaves break up the communication. A reset is released inside the slave. But after the removal the cause for this reset the slave is retaken to communication. In contrast to the error by bad contact bad contact one will find consecutive errors of the class 6 only. In the trace lines like 6509f, 6515ff and 6523f shown in fig. 17

would be missing then. Eventually such an error is combined with an output slave switching a large consumer.

7.3.5 Errors by Excess Length or by High-capacity Slaves

The analog signal on the AS-Interface line is deformed by capacitive loads, e.g. nets with excess length or faulty slaves, and cannot be clearly recognized, in the worst case, by the master and the slaves anymore with the consequence that communication errors occurs.

Then individual slaves fail in the online statistics. Slaves which are located close to the master are endangered empirically. But often the first repetition is already successful (error of the class 1 as shown in fig. 16). By taking the following measures the distinction of other communication errors becomes possible:

- A (occasionally) decrease of the capacitive load (by taking off "green" slaves or by shorten the net length) leads to the resumption of the critical slave, if an outsized large capacitive load is present.
- Often faulty capacity-rich slaves do not become a problem unless several copies of this faulty slave are used in the net simultaneously. If alternate removing of some of these slaves leads to the resumption of other failed slaves they presumably poses an outsized entrance capacity.
- An AS-i bus termination or an AS-i tuner can compensate incorrect impedance in some cases.
- In the trace the situation can be observed more exactly. Depending upon its position in the net, even the analyser cannot recognize individual telegrams any more then.

7.3.6 Error by Configuration Deviation

In the configuration mode of the master, which is used particularly to build up the AS-Interface net, each slave is taken up to communication. The tab "Configuration", however, constantly permits an examination of the current configuration (please note that all configuration data are indicated only if the analyser has been attached during a start up phase of the net).

In the "**Safety Operation Mode**" of the master (normal used with an installed facility) each incorrect configuration leads to a stop of communication with the affected slaves and to a message "Configuration Errors" displayed on the master. Additionally you find in the traffic light representation of the overview:

- Slaves temporary missing (or defective or blocked),
- Slaves with a correct address and a wrong configuration data
- Slaves with the wrong address (not configured slaves)
- Replaced slaves with address "0" which are not readdressed and taken up to communication again.

In the first case the relevant slave appears red. The message "Config_error" is indicated on the master additionally. The communication with this slave is interrupted.

In the second and the third case the relevant slave appears grey: Communication with this slave is not taken up by the master since the slave is not configured. A previous log or the examination of the master data can give information about this.

A **backup slave**, which is not taken up to communication, is indicated grey as slave "0". In the nominal condition the slave it is readdressed automatically by the master to the address of the old slave. 4 conditions must be fulfilled for this:

- The previous slave must be removed,
- The slave "0" must have the same profile like the previous slave,
- The master must work in the protected operating mode,
- The option "auto addressing" must be enabled in the master.

If all these conditions are fulfilled the readdressing takes place. That can be observed with the Analyser: First the missing slave appears red. Being attached the slave "0" appears grey in the overview with hold time first. Shortly after this it disappears again, while the slave which missed before is represented green again. If the representation remains grey one of the conditions specified above is not fulfilled.

7.3.7 Control of Corrective Measures

Especially the "Overview with Hold Time" and the "Advanced Statistics" are appropriate for a check of corrective measures in the net. Changes can be pursued directly on the screen if a short holding time has been entered.

7.4 Error Diagnostics and Optimization of the Application

The current digital and analog data, as well as the safety data "free" and "released" are available in the **data mode** provided that they do not vary to quickly. So the course of a process in the automatic or in the manual operation mode can be pursued and Errors can be found easily.

The **trace mode** is another very flexible instrument: The data of the application are captured and displayed in a 150 µs rhythm. The internal and the external trigger, as well as a recording filter permit the user to examine individual sections of an application. The large amount of data which a trace makes available can be used for example in order to examine or to optimize timings. Furthermore sending parameters to a slave and their effect can be examined.

External devices can be switched over the trigger output of the trace mode. For example: a camera which records movements of the application. In this way e.g. courses of motion or errors can be represented and optimized afterwards.

With Safety at Work-applications a trace with the function "Safety Monitor" can be evaluated which represents each condition of change of the safety related slave. (fig.15).

7.5 Development Accompanying Control of Slave and Master

New product developments of master, repeater, IC or slaves can be tested with the analyser intensively as soon as they can be placed as devices into a test net. The analyser becomes here a tester of any communication situation in a heavily loaded or unloaded net or device.

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8 Accessories

8.1 AS-i Repeater, AS-i Tuner, AS-i Bus Termination

Housing	Device	Art. No.	Characteristic
	AS-i Tuner	AC1146	Extension of the cable to a maximum of 200 m http://www.ifm-electronic.com/ifmgb/web/dsfs!AC1146.html
	AS-i Bus Termination	AC1147	Extension of the cable to a maximum of 200 m http://www.ifm-electronic.com/ifmgb/web/dsfs!AC1147.html
	AS-i Repeater	AC2215	Extension of the AS-i network by another 100 m http://www.ifm-electronic.com/ifmgb/web/dsfs!AC2215.html
	AS-i Repeater IP65	AC1015	Extension of the AS-i network by another 100 m http://www.ifm-electronic.com/ifmgb/web/dsfs!AC1015.html

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9 Technical Data

Technical Data	
Type	Passive AS-Interface member
Interface	- AS-Interface - RS 232 für connection to a PC - Trigger input (24 V) - Trigger ouput (TTL)
Displays	
LED display	
LED green (Power)	Power on
LED yellow (ser active)	RS 232 interface in operation
LED green/red (Test)	Test mode
Telegram memory	256.000 AS-Interface telegrams
Operating current	Approx. 70 mA out of AS-Interface
Voltage of insulation	≥ 500 V
EMC directions	EN 50081-2, EN 61000-6-2
Operating temperature	0°C … +55°C
Storage temperature	-25°C … +70°C
AS-Interface specification	2.1

Requirements:

IBM compatible PC 80486 or higher

Operating system: Windows 95/98, Windows Me, Windows 2000, Windows XP and Windows NT4

Specification:

Software: AS-Interface Analyser

Hardware: AS-Interface Analyser
D-sub-transmission cord

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