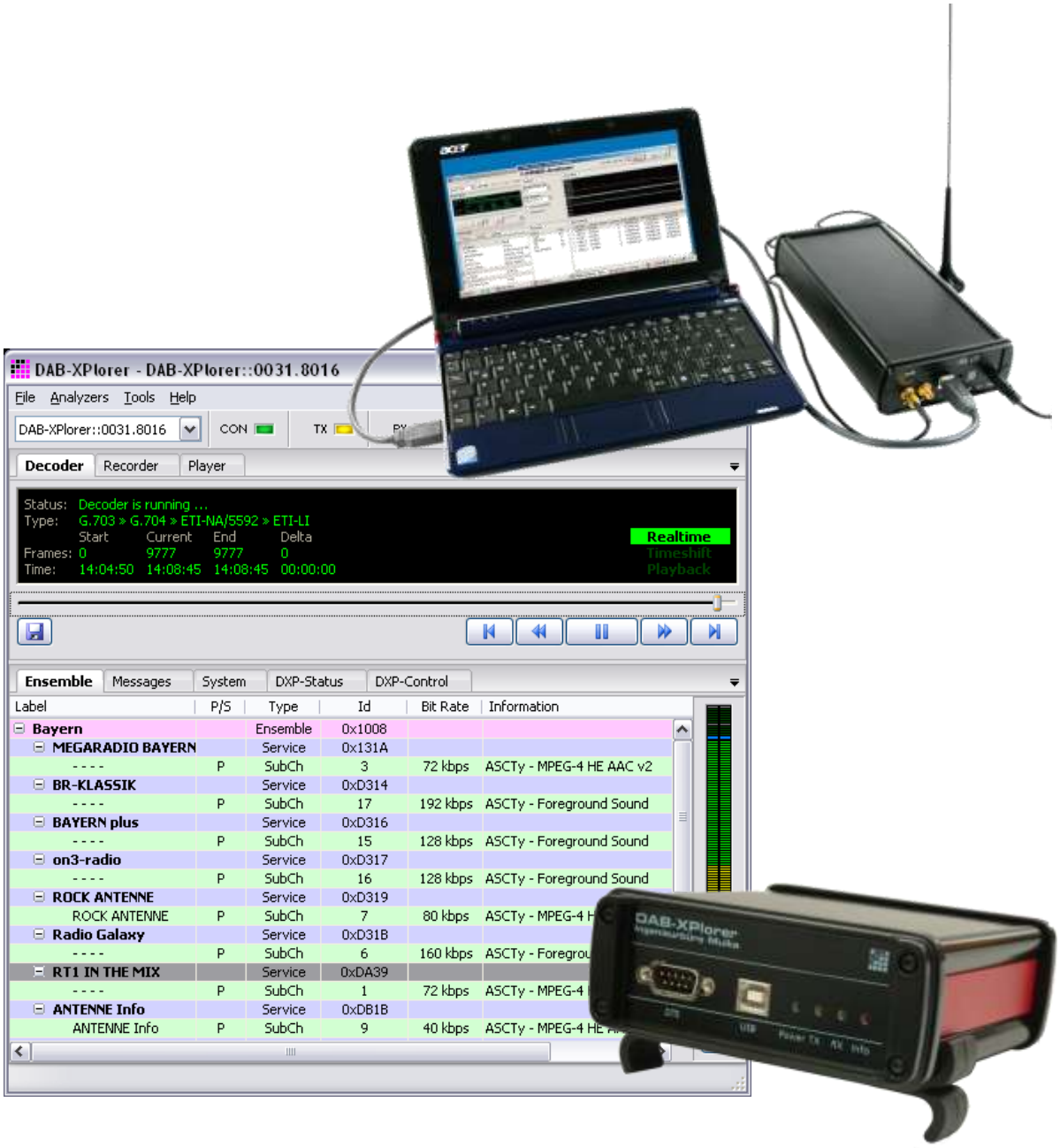
DAB-XPlorer Application—User Manual

Getting Started



Revision History

Version	Date	Modifications
2012.02	28.02.2012	Update to GUI version 2012.02 with EDI support
1.5.0.3	16.02.2010	Update to GUI version 1.5
1.1.0.2	26.03.2009	Release candidate of English version
1.1.0.1	20.05.2008	Page format A5, preparation for print-on-demand
1.1.0.0	02.05.2008	First version for CD-ROM version 1.1

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Table of Contents

1 Safety Instructions

1.1 Electrical Safety

Unless expressly permitted, never remove the cover or any part of the housing while the product is in operation. Doing so will expose circuits and components and can lead to injuries, fire or damage to the product.

Basically, the measurement on the live circuit parts with voltages higher than 30V with the DAB-XPlorer or UEB400-DXP is not allowed.

The earth of all connectors has a direct connection to the housing and the earth of the USB connector. All shields of connected lines must be connected to protective earth.

1.2 EMC Protection

In order to avoid possible electromagnetic disturbances, it is necessary to use shielded lines for the connection of the interfaces. The shield must be connected to protective earth. Additionally, please make sure that metalized connector housings are used, which must be connected to the shield of the line.

Besides, the device may only be operated if it is closed. In the case of calibration processes at the opened device, the respective protection measures must be taken.

1.3 Read the documentation!

Before connecting the DAB-XPlorer, the UEB400-DXP or the CM-Stick with your PC and before installing the software, please read section 5. This section contains a step-by-step installation procedure.

Please visit us at *http://www.ib-mulka.de* for information about current extensions and new developments.

We hope that you will be satisfied with your DAB-XPlorer or UEB400-DXP. If you have any questions, please feel free to contact us; we will be pleased to receive your comments or requests at any time.

2 What is the DAB-XPlorer?

For historical reasons the term *DAB-XPlorer* stands for two things a) the DAB-XPlorer software suite providing a collection of software tools to analyse DAB data streams and b) for the DAB-XPlorer hardware providing an ETI/RDI-to-USB interface. Originally, both the software and the hardware have been one product, the DAB-XPlorer, developed and manufactured by Ingenieurbüro Mulka. In the course of the evolution of this product, the software was modified and extended to support additional hardware products from other vendors. At this time the DAB-XPlorer software suite supports and can be delivered with

- the ETI/RDI-to-USB converter DAB-XPlorer from Ingenieurbüro Mulka,
- all Ethernet interfaces that can be used to receive EDI data streams,
- the DAB test receiver UEB400-DXP provided under the trademark VAD, and
- the products of VDL's DABSTOR family.

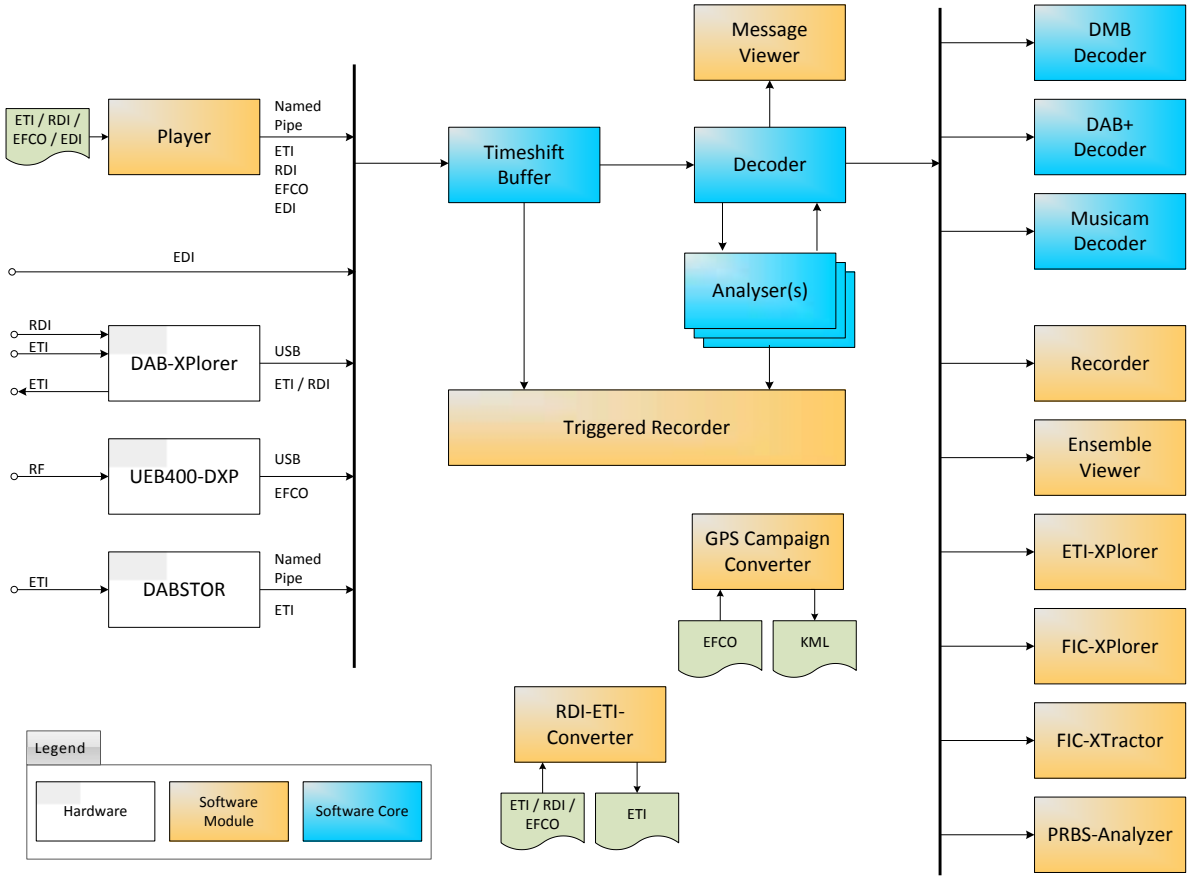

Figure 1 — Summary of components of the DAB-XPlorer application

The DAB-XPlorer software application is modular. The following tools are available

- Ensemble Viewer
- ETI-XPlorer
- FIC-XPlorer
- FIC-XTractor
- Message Viewer
- Recorder / Player / Timeshift Buffer
- RDI-ETI-Converter
- GPS-Campaign-Converter

- PRBS-Analyzer
- Triggered Recorder

Figure 1 gives a summary about all components of the system.

Together with the various hardware options, the software modules can be combined to support a great variety of use cases. Section 4.3 describes some examples.

3 How to Read the Manuals

3.1 Organisation of the manuals

3.1.1 First reading

This manual describes the DAB-XPlorer software suite in general. It will give you an overview of all software modules, of the accompanying hardware and of the installation procedure. Further manuals describe the main DAB-XPlorer application and the optional modules. All these manuals refer to this “Getting Started” manual.

3.1.2 Further manuals

Main Application: Manual describing the main DAB-XPlorer software application with its panels for hardware control and configuration.

Analyser: Description of the Analyser option with ETI-XPlorer and FIC-XPlorer.

FIC-XTractor: Description of option FIC-XTractor for detailed analysis of the Fast Information Channel.

PRBS-Analyser: Description of option PRBS-Analyser that serves for detailed examination of bit errors within the data stream.

RDI-ETI-Converter: Description of a software option to convert and manipulate various file types containing DAB data streams.

GPS Campaign Converter: Description of an option that allows using the system for coverage measuring and for the presentation of the results of measuring journeys.

Triggered Recorder: Manual describing the Triggered Recorder application that allows using a data stream recording by triggers gained by the analysis of the incoming data stream.

3.2 References

It is not possible to understand the DAB-XPlorer and the related manuals without profound knowledge of the DAB technology. Please refer to the related technical standards whenever you find terms, abbreviations or parameters that are not explained in the manuals. The standards of EUREKA 174 DAB family as mentioned in the following list are published by ETSI. Please download them from *www.etsi.org*.

EN 300 401	Radio Broadcasting Systems; Digital Audio Broadcasting (DAB) to mobile, portable and fixed receivers
EN 300 797	Digital Audio Broadcasting (DAB); Distribution interfaces; Service Transport Interface (STI)
EN 50248:2002	Characteristics of DAB receivers
EN 50255	DAB receiver interface for the output of the decoded DAB ensemble or individual sub-channels (RDI)

ETS 300 799	Digital Audio Broadcasting (DAB); Distribution interfaces; Ensemble Transport Interface (ETI)
TR 101 496-1	Digital Audio Broadcasting (DAB); Guidelines and rules for implementation and operation; Part 1: System outline
TR 101 496-2	Digital Audio Broadcasting (DAB); Guidelines and rules for implementation and operation; Part 2: System features
TR 101 496-3	Digital Audio Broadcasting (DAB); Guidelines and rules for implementation and operation; Part 3: Broadcast network
TS 101 757	Digital Audio Broadcasting (DAB); Conformance Testing for DAB Audio
TS 102 427	Digital Audio Broadcasting (DAB); Data Broadcasting — MPEG-2 TS streaming
TS 102 428	Digital Audio Broadcasting (DAB); DMB video service; User application specification
TS 102 563	Digital Audio Broadcasting (DAB); Transport of Advanced Audio Coding (AAC) audio
TS 102 693	Digital Audio Broadcasting (DAB); Encapsulation of DAB Interfaces (EDI)
TS 102 821	Digital Radio Mondiale (DRM); Distribution and Communications Protocol (DCP)

3.3 Abbreviations used in the manuals

DAB Digital Audio Broadcasting, ETSI EN 300 401, international standard for audio and video broadcasting to mobile, portable, and stationary receivers

EDI Encapsulation for DAB Distribution Interfaces as defined in TS 102 693

EFCO Enhanced Full Capacity Output; a proprietary data stream and file format of the DAB receiver UEB400-DXP containing the content of the complete DAB multiplex after channel decoding, additional quality information from the DAB receiver and geographic data from the GPS receiver.

ETI Ensemble Transport Interface, ETS 300 799, transmission protocol between DAB ensemble multiplexer and DAB transmitter

FIB Fast Information Block, part of the FIC, comprises a maximum of 30 bytes payload (FIGs) and 2 bytes check sum (CRC)

FIC Fast Information Channel, control channel of the DAB ensemble, includes the multiplex configuration and service information

FIG Fast Information Group, smallest information unit within the FIC

PRBS Pseudo-random binary sequence, artificially created random binary sequence

RDI Radio Data Interface, EN 50255, DAB receiver interface for the output of the decoded DAB ensemble or individual sub-channels

STI Service Transport Interface, EN 300 797, transmission protocol between DAB service multiplexer and DAB ensemble multiplexer

3.4 Symbols used in the manuals

Attention

Indicates instructions which might lead to material damages due to improper usage of the device or the software in the case of noncompliance. For reasons of security, these instructions must be followed by all means.

Important Note

Indicates instructions which make sense or are very useful for the usage of the device or the software.

4 Products

The following sections contain a short description of all software modules of the DAB-XPlorer application and of the hardware components that can be used with the DAB-XPlorer suite. Please refer to Appendix B for a concise summary of all available products with their appropriate ordering information.

4.1 Hardware

4.1.1 DAB-XPlorer box

Figure 2 – DAB-XPlorer

The DAB-XPlorer hardware converts an incoming data stream from G.703 or SPDIF to USB for recording and further processing on an attached PC. In the opposite direction ETI streams can be put out via a G.703 interface. It serves for the analysis of data streams in DAB networks, supporting the Ensemble Transport Interface (ETI) according to ETS 300 799 and the Receiver Data Interface (RDI) according to EN 50255.

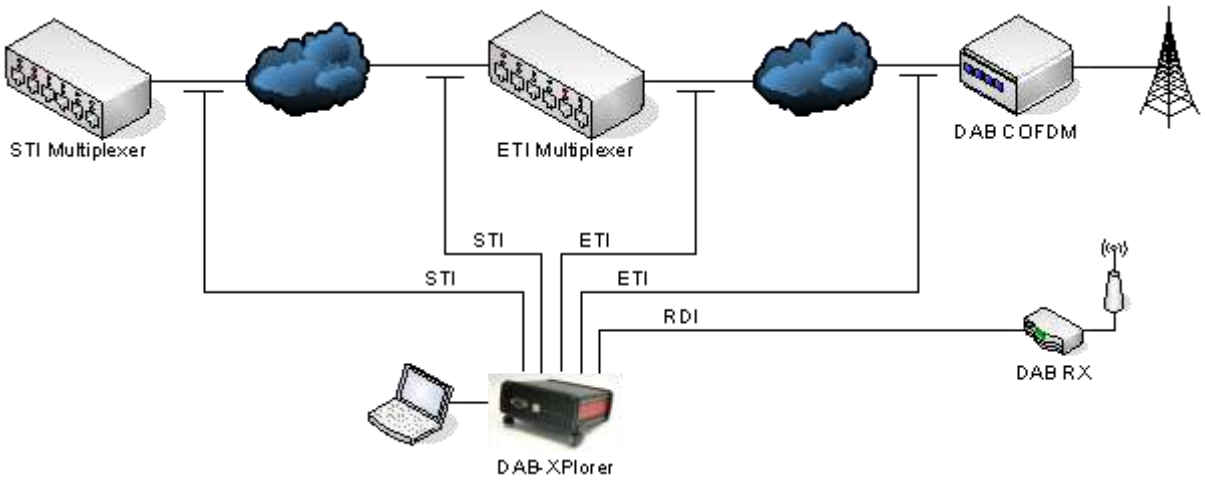

Figure 3 – Application area of the DAB-XPlorer

The device allows the continuous supervision of Transport Streams in real time and indicates every transmission or protocol failure. In parallel to the analyses a recording or replaying of the complete data stream is possible.

The place of application of the DAB-XPlorer is typically at the interface between Ensemble Multiplexer and COFDM Modulator or at the Receiver Data Interface (RDI) of a suitable DAB receiver.

Due to its small size and low weight the DAB-XPlorer is especially well suited for the portable use. The robust device was made to withstand the rugged application conditions of service technicians workaday.

Front View

Figure 4 – Front view of the DAB-XPlorer

Component	Description
USB	USB-client interface USB-B port Connects the DAB-XPlorer to the PC.
DTE	RS232C without hardware handshake SUB-D plug-in connector, 9-pole debug interface
Power	LED green Indicates availability of power supply through the PC.
TX	LED yellow Indicates data transmission (PC → DAB-XPlorer).
RX	LED yellow Indicates reception of data (DAB-XPlorer → PC).
Info	LED red Indicates errors or alarms at the DAB-XPlorer.

Back View

Figure 5 – Back view of the DAB-XPlorer

Component	Description
G.703-TX	G.703 output, HDB3 encoded BNC plug-in connector, 75 Ω
G.703-RX	G.703 input, HDB3 encoded BNC plug-in connector, 75 Ω
1PPS-IN	Input for time reference (currently without function) BNC plug-in connector, 75 Ω, TTL level
RDI-IN	S/PDIF input, corresponding to RDI standard optical, TOSLINK

4.1.2 UEB400-DXP

Figure 6 – UEB400-DXP receiver box

The UEB400-DXP allows the user to receive DAB signals according to ETSI EN300 401 and to perform a detailed analysis of the data streams contained therein.

Data streams recovered from the DAB signal can be captured in so-called EFCO files and converted to ETI data streams (with the software option RDI to ETI Converter). Such test patterns can be employed for the verification of DAB receivers and the final inspection of transmitters.

Using the measured data of the integrated GPS receiver, it is possible to calculate the time jitter of a DAB signal. In doing so, the synchronism of a single frequency network (SFN) can be validated.

Front View

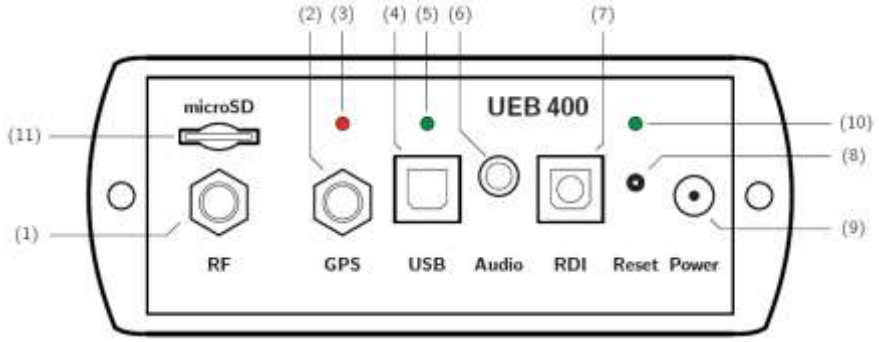

Figure 7 – Front view of the UEB400-DXP

Component	Description
RF (1)	SMA connector, 50 Ω Serves as RF input for signals in VHF band III as well as for signals in the L-band. It can be biased for the supply of active antennas with a regulated DC voltage of 8.5 V on costumer's demand.
GPS (2)	SMA connector, 50 Ω Serves as RF input of the integrated GPS receiver.
LED GPS (3)	LED red / green A red colour indicates the proper GPS reception. A green colour indicates the 1PPS pulse.
USB (4)	USB-B port USB-client interface, high speed Connects the UEB400-DXP to the PC.
LED STATE (5)	LED red / green / yellow Indicates the state of the USB interface.
Audio (6)	Audio Output Analogue stereo audio jack to feed active speakers
RDI (7)	S/PDIF output, corresponding to RDI standard optical, TOSLINK
Reset (8)	Reset button
Power (9)	Power connector Requires a DC voltage in the range 4.5 V to 14.5 V.
LED Power (10)	LED green Indicates the presence of the supply voltage.
micro SD (11)	micro SD card slot (reserved for future use)

4.1.3 CM stick

If the DAB-XPlorer software is used with the DAB-XPlorer hardware or with the UEB400-DXP receiver, the hardware acts as dongle for the software. The licence file coming with your software is bound to the serial number of the device that shall act as dongle and contains a list of all activated software options.

In order to allow using the DAB-XPlorer software applications as well without the converter or receiver hardware, a CodeMeter USB key is available for management of the software licensing.

The CM-Stick works as installation medium and includes the installation software and the licence file.

4.2 Software

4.2.1 UEB400DXP-REC — main application

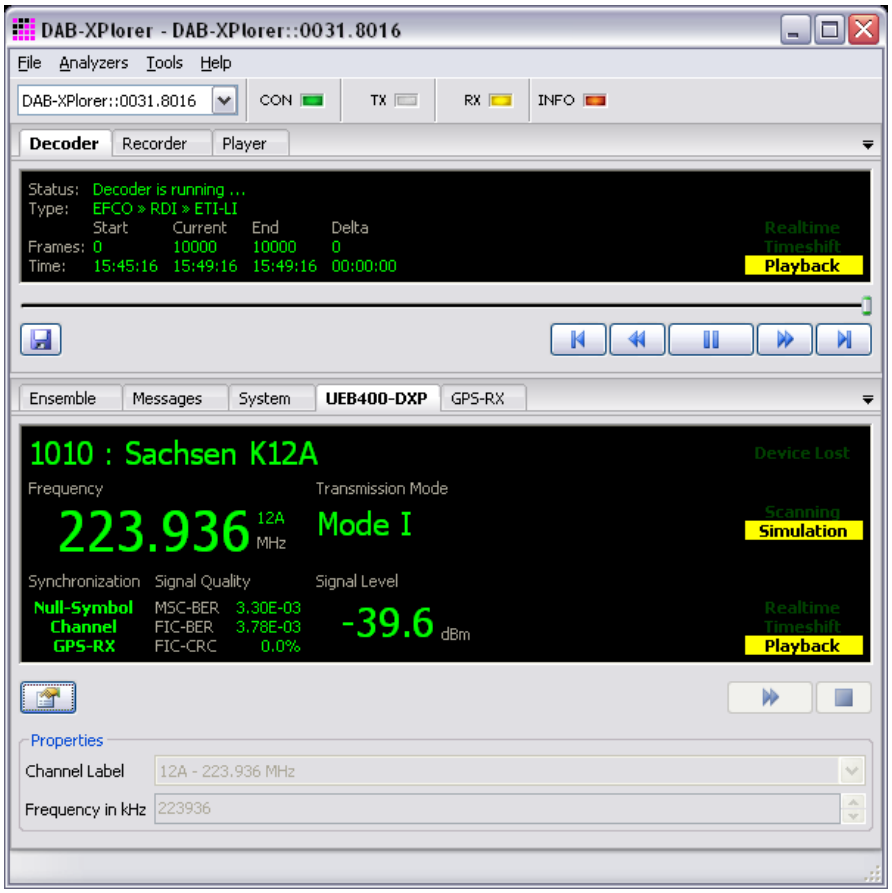

Figure 8 — Main window with Decoder *and* UEB400-DXP *panel*

This is the basic software as provided in a bundle with the test receiver UEB400-DXP. It comprises

- device configuration, frequency setup, frequency scan
- display of receiver status, RSSI level, FIC-BER, and MSC-BER

- display of MCI as tree containing all Services, Service Components and Sub-Channels
- output of decoded audio (MUSICAM) sub-channels of a selected service via the audio device of the PC
- recording and playback of EFCO

*The range of functions of **DABXP-BASIC** is the same like that of **UEB400DXP-REC** plus **UEB400DXP-OAN**.*

The *Decoder* panel gives a summary of the decoded data stream and of the position within the time-shift buffer (similar to the control of a TV hard-disc recorder). The *UEB400-DXP* panel shows the status of the DAB receiver and allows controlling the receiver by choosing frequency or DAB block respectively.

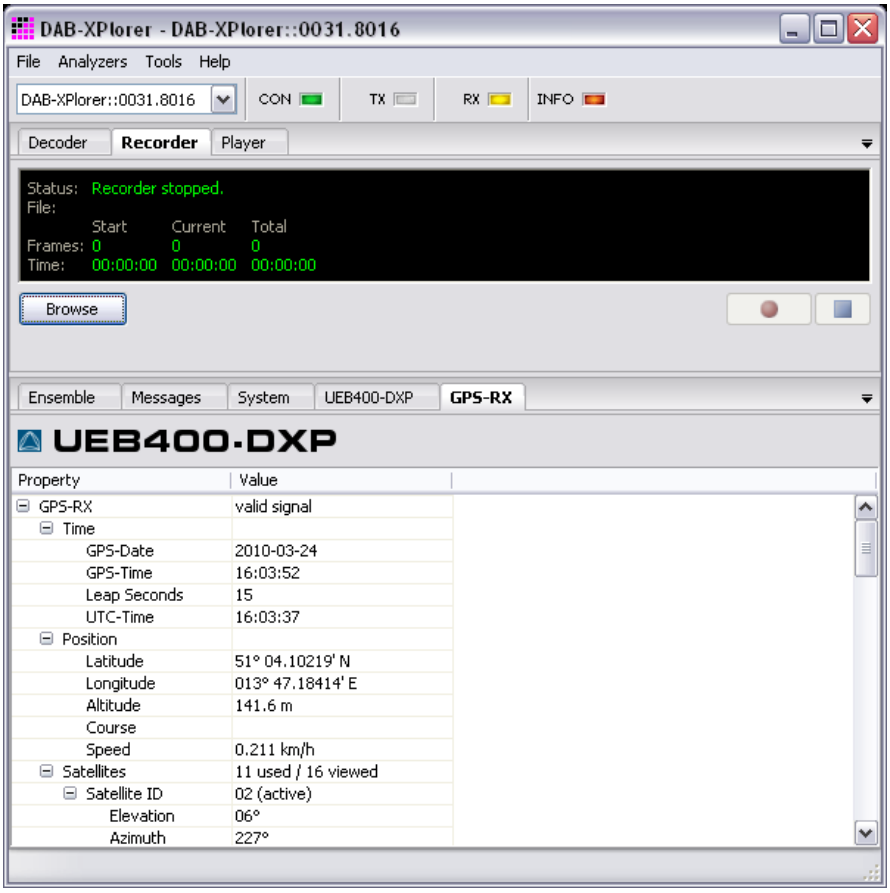

Figure 9 — Main window with Recorder *and* GPS-RX *panel*

On the *Recorder* panel, you can control the recording of the received multiplex. The *GPS-RS* panel gives an overview of the quality of GPS reception.

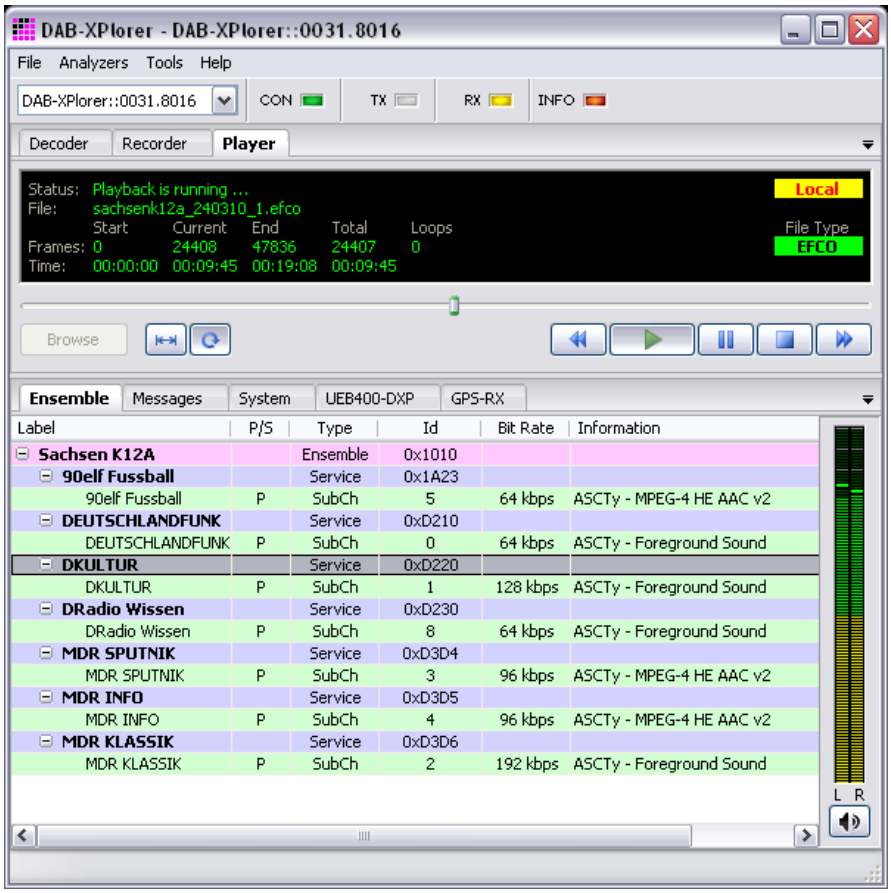

Figure 10 — Main window with Player *and* Ensemble *panels*

With the panel *Player* you can play back recorded EFCO, RDI, or ETI files for off-line analysis. During the play back of EFCO files the frequency, GPS information, RSSI level and bit error rates will be displayed according to the information saved within the EFCO file.

The *Ensemble* panel gives a summary of the decoded ensemble with its services and sub-channels. The gauge on the right displays the audio level of a selected audio service.

4.2.2 UEB400DXP-OAN — multiplex analyser

Option *UEB400DXP-OAN* extends the main application by the following components for analysis and logging of errors.

- EFCO / RDI / ETI Analyser (Core Library)
- Messages Viewer
- ETI-XPlorer
- FIC-XPlorer
- Measuring of the temporal position of the received RF signal (synchronism of SFN)

Messages Viewer

The *Messages* panel shows all errors, warnings and events that have been detected during the analysis of received or played back EFCO, RDI or ETI data streams. The

messages will be stored in a log file. The *Messages* panel provides filtering functions to find particular events.

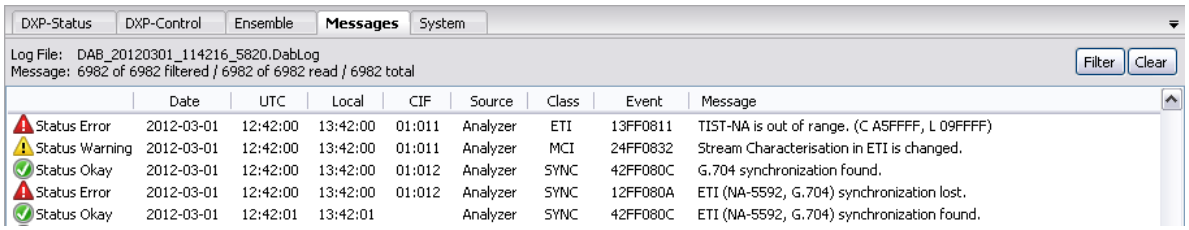

Figure 11 — Messages *panel that will be activated in the main application window after the installation of option* UEB400DXP-OAN

ETI-XPlorer window

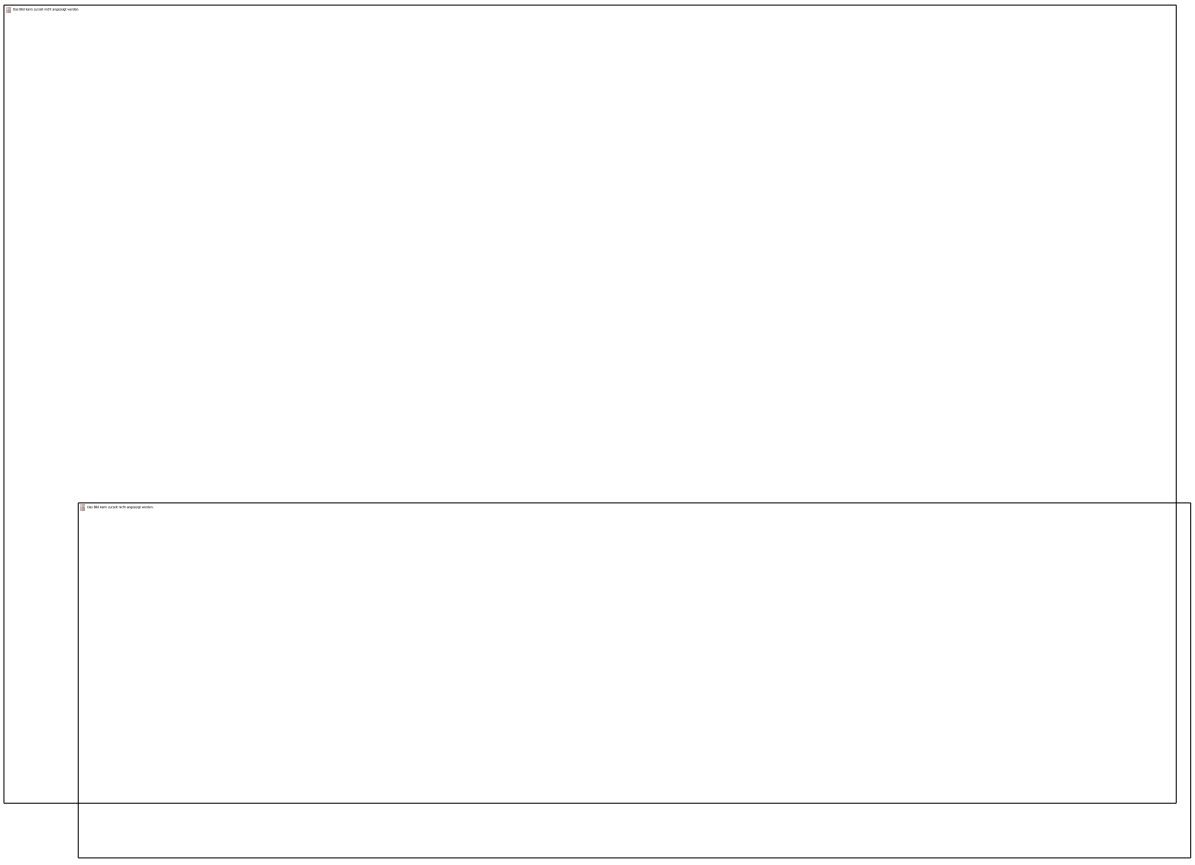

Figure 12 — ETI-XPlorer window

The *ETI-XPlorer*[1] does a real-time decoding of ETI, RDI or EFCO data streams and checks them for compliance with the DAB standards. Irregularities will be logged as events within a log file, counted and displayed in various tables of the graphical user interface. The following parameters will be tested and displayed.

- ETI-NI/NA, RDI and EFCO decoding

[1] The naming of this window comes from the history of the DAB-XPlorer application (refer to section 2). Actually, it could be named Multiplex-XPlorer as well.

- check of Reed-Solomon coding for ETI-NA
- check of ETI header and main stream CRC
- check of CRC of FIBs
- check of the Frame Counter ($FCT_n = (FCT_{n-1} + 1)$ MOD 250)
- check of the Frame Phase ($FP_n = (FP_{n-1} + 1)$ MOD 8)
- check of Frame Counter or Phase resp. compared with the CIF Counter in FIG 0/0
- check of the Frame Length
- check of sub-channels for overlapping by analysis of start addresses and sizes given in CUs; graphical display of MSC payload
- check of TIST LI/NA ($TIST_n = (TIST_{n-1} + 24$ ms) MOD 1000 ms)
- display of TIST LI/NA for FCT = 0
- display of ETI type, DAB Mode, ERR Field, utilised capacity
- display of sub-channel list with start address (SAD), size in CUs, bit rate, Protection Level, and labels of linked Service Components or Services
- display of the content types of sub-channels (MPEG Audio Layer II, DAB+ audio according to MPEG 4 HE AAC v2, DMB video, Packet Mode, Enhanced Packet Mode, Stream Data)
- counting and display of errors per sub-channel per Sub-Channel
- display of the temporal position of the received Null symbol compared with the 1 PPS clock provided by the GPS receiver of the UEB400-DXP hardware
- audio decoder MPEG-1/2 Layer II, 48 / 24 kHz sampling
    - check of the audio bit rate against the bit rate of the sub-channel
    - check of the Audio Header CRC and of the Scale Factor CRC
- audio decoder MPEG-4 HE AAC v2 (only with option DABXP-OPL)
    - check of the Fire code
    - check of the DAB+ Reed-Solomon error protection
    - check of the AU CRC
- display of audio levels in the range of -96 dB_{FS} to +6 dB_{FS}
- DMB RS code (only with option DABXP-OPL)
- EPM RS code and CRC check (only with option DABXP-OPL)

Checking for synchronism of the SFN

Figure 13 — Panel in ETI-XPlorer *window showing the temporal position of the received RF signal*

The temporal position measuring of the received RF signal allows checking for the synchronism of the transmitter under test with the residual SFN. This measuring has to be done at the transmitter site. It requires the UEB400-DXP receiver hardware and good GPS reception.

The receiver measures the temporal position of the received RF signal gained by a comparison of the Null symbol with the 1 PPS signal from the GPS receiver. The measured value has to be unique for all transmitters within the same SFN and it has to be stable over the time. The synchronism of the SFN can be checked by a comparison of the measured values on all transmitter sites.

FIC-XPlorer window

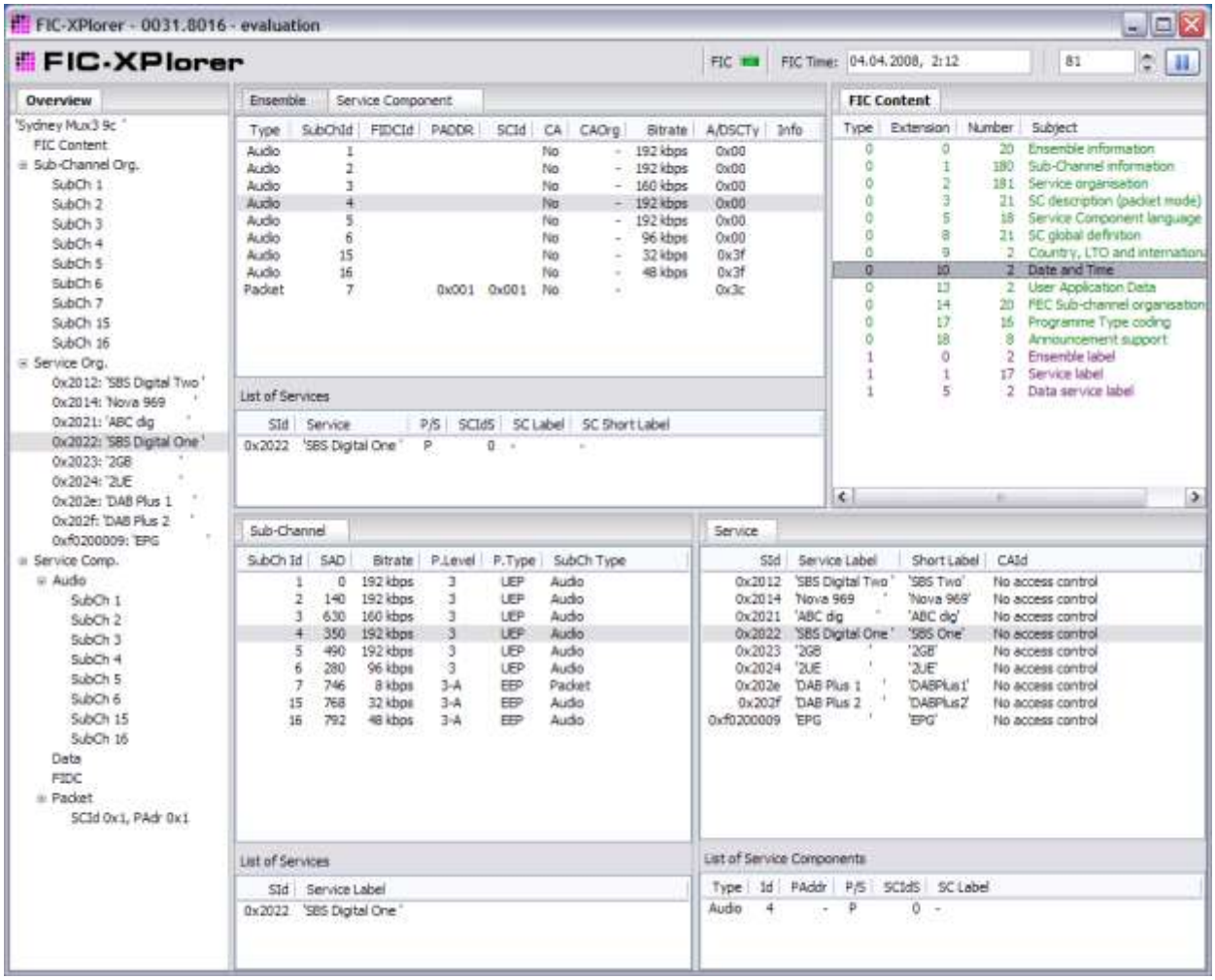

Figure 14 — FIC-XPlorer

The FIC-XPlorer decodes the Fast Information Channel (FIC) and collects received FIGs over a configurable number of frames in a database. Various lists and a tree view show the Multiplex Configuration Information (MCI) and important parts of the Service Information to give you a fast overview over the ensemble.

4.2.3 DABXP-OXT — FIC-XTractor

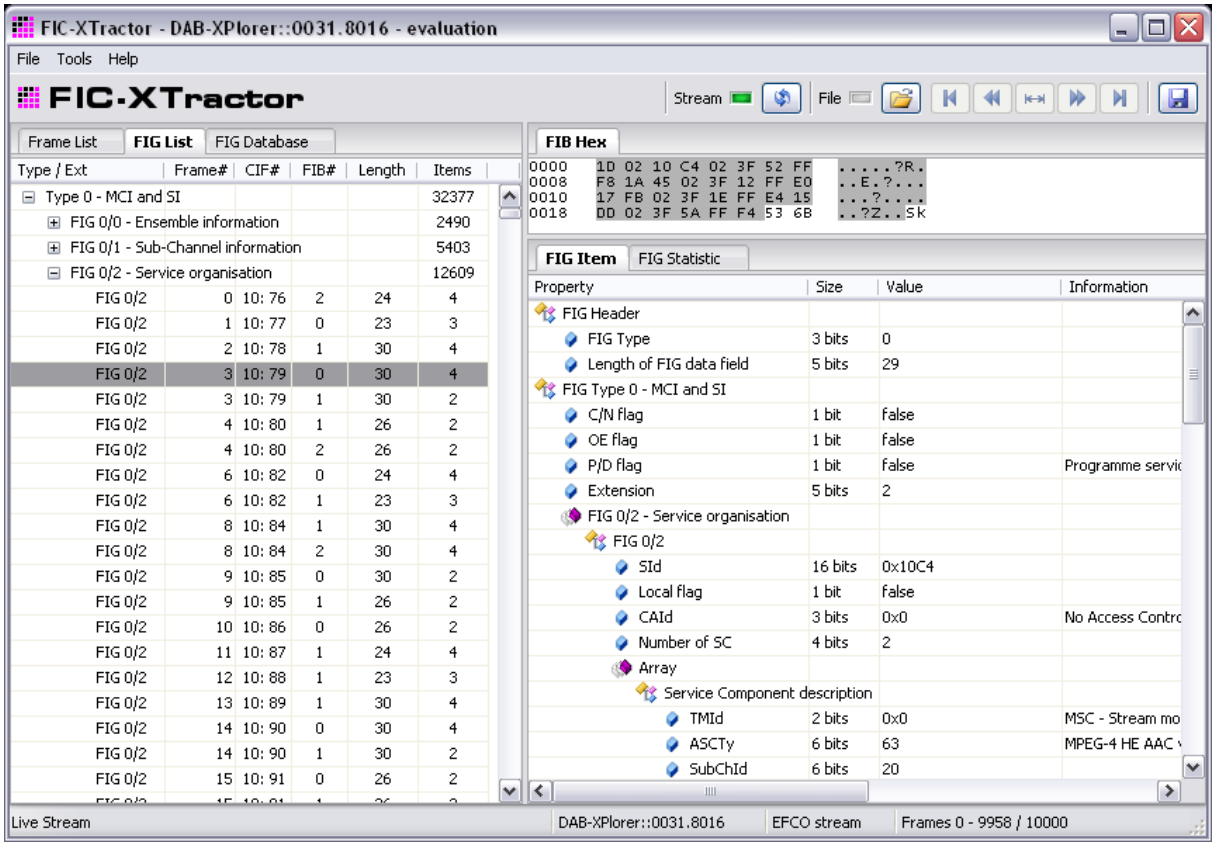

Figure 15 — The FIC-XTractor window with its three views to the FIC content

The FIC-XTractor is a powerful, yet easy to use tool for everybody who wants to dig into the content of the Fast Information Channel (FIC). Similar to a protocol analyser, the tool parses the FIC on bit stream level. The FIC-XTractor reads the FIC from a file or from the contents of the time-shift buffer. Then it decodes the FIC and displays the results according either to their chronological order frame by frame or to their FIG type and extension.

A chosen FIG will be presented in a tree-like view where the FIG, according to the DAB standard, will be resolved into its elements. Moreover, the binary patterns of these elements will be translated into a form readable by men; this may be a text string, a date as in FIG 0/10, a frequency as in FIG 0/21, or geographic coordinates as in FIG 0/22.

The *FIB Hex* panel displays the FIB in hexadecimal form. The analysed FIG will be marked within the FIB with a grey background. Small icons within the frame list or FIG list flag erroneous FIGs, FIBs with CRC errors, and multiplex reconfigurations.

4.2.4 DABXP-OPL — DAB$^+$-Decoder

This option comprises the following components and functions:

- audio decoding of DAB$^+$ sub-channels and output via the sound card
- analysis of errors in DAB$^+$ streams; display of errors in Fire code, RS code, and AU CRCs

- analysis of errors in DMB streams; display of errors in RS-Code
- analysis of errors in Enhanced Packet Mode streams; display of errors in RS code and Packet CRCs
- streaming of all sub-channels via UDP/TCP or named pipes to external decoders
- decoding of EDI streams coming in via UDP or as file

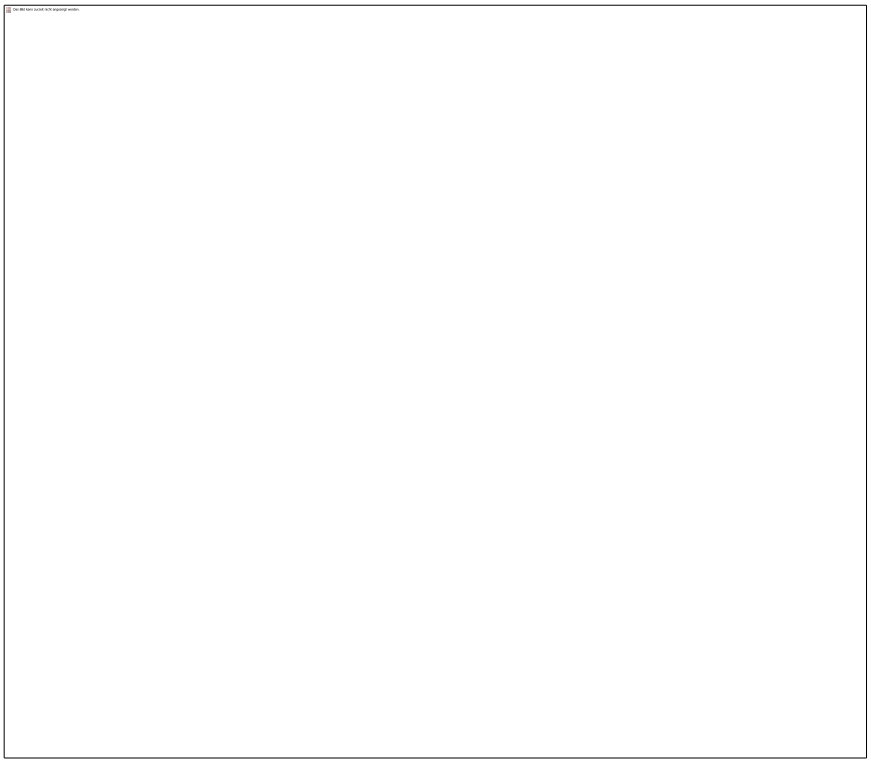

Figure 16 — New functions for EDI analysis coming with DABXP-OPL in the main window

4.2.5 DABXP-OCO — RDI-ETI-Converter

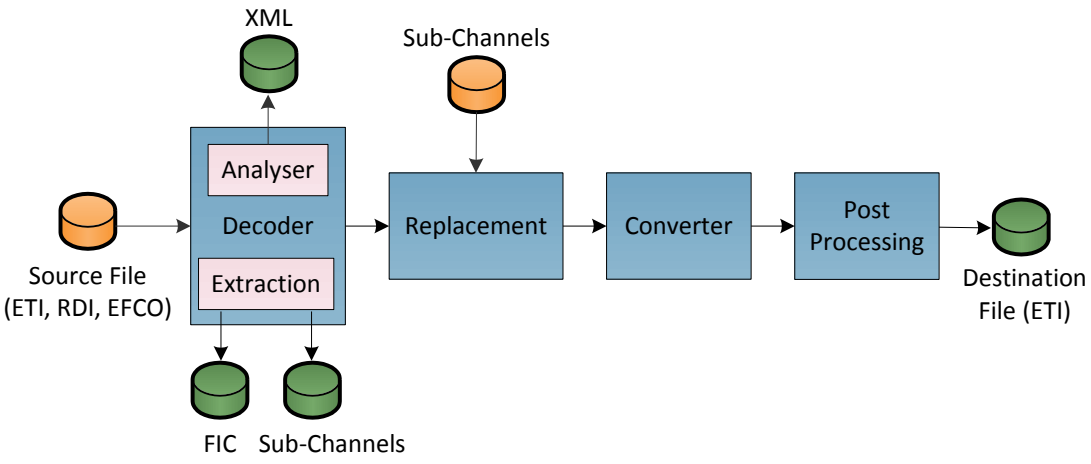

Figure 17 — Overview over the conversion process

For the development of DAB receivers—especially for compliance tests—data streams are required that should mirror real live scenarios as good as possible. The

DAB test receiver UEB400-DXP allows recording of a DAB ensemble from an on-air signal. The RDI-ETI-Converter can convert the recorded EFCO file into an ETI file that can be used to feed a COFDM modulator in a testbed in the lab.

Figure 17 illustrates the tool chain used in the conversion process. The real converter is only one block in this chain. In fact, in addition to the raw conversion of RDI or EFCO files into ETI-NI or ETI-NA files, the software tool provides the following additional functions for extraction, logging, replacement and post processing:

- input formats: RDI, ETI-LI, ETI-NI, ETI-NA;
- output formats: ETI-NI, ETI-NA, FIC, sub-channel content;
- change of DAB mode;
- extraction of the FIC or of single sub-channels;
- trimming of output file with start and stop conditions;
- replacing labels;
- replacing content of sub-channels with pre-recorded binary sequences;
- replacing sub-channels by pseudo-random bit streams (PRBS);
- replacing TIST;
- insertion of FIC markers that enable to observe the FIC on an oscilloscope;
- keying of random bit errors with pre-defined frequency;
- keying of CRC or frame errors.

During the conversion, the RDI-ETI-Converter performs a complete analyse of the input data stream. This analysis is similar to that accomplished by the real-time analyser used in DABXP-BASIC or UEB400DXP-OAN respectively. The analytical result will be provided in a text frame on the GUI and as XML file. The latter can be very helpful to document the data stream.

4.2.6 DABXP-OPR — PRBS-Analyser

Measuring of the true bit error rates plays an important role in compliance tests of DAB transmitters (ETSI EN 302 077) and of DAB receivers (EN 50248). The PRBS-Analyser in conjunction with DAB-XPlorer hardware respectively UEB400-DXP was made for such measuring and makes costly measuring devices obsolete.

The PRBS-Analyser detects sub-channels that contain one of several pre-defined pseudo-random binary sequences (PRBS). Then the tool measures the true bit error rate within these sub-channels and displays the measuring result with a delay of less than one second. Additionally, the software displays the position of the bit errors within the frame and the (pseudo) bit error rate provided by the DAB receiver.

You can save the results of the measuring into an XML file. This file contains the positions of detected bit errors as bit mask and a summary of the resulting bit rates and error rates at the end of the file. Developers can gain valuable hints about the signal processing and regulation behaviour of their transmitter or receiver units from this XML file.

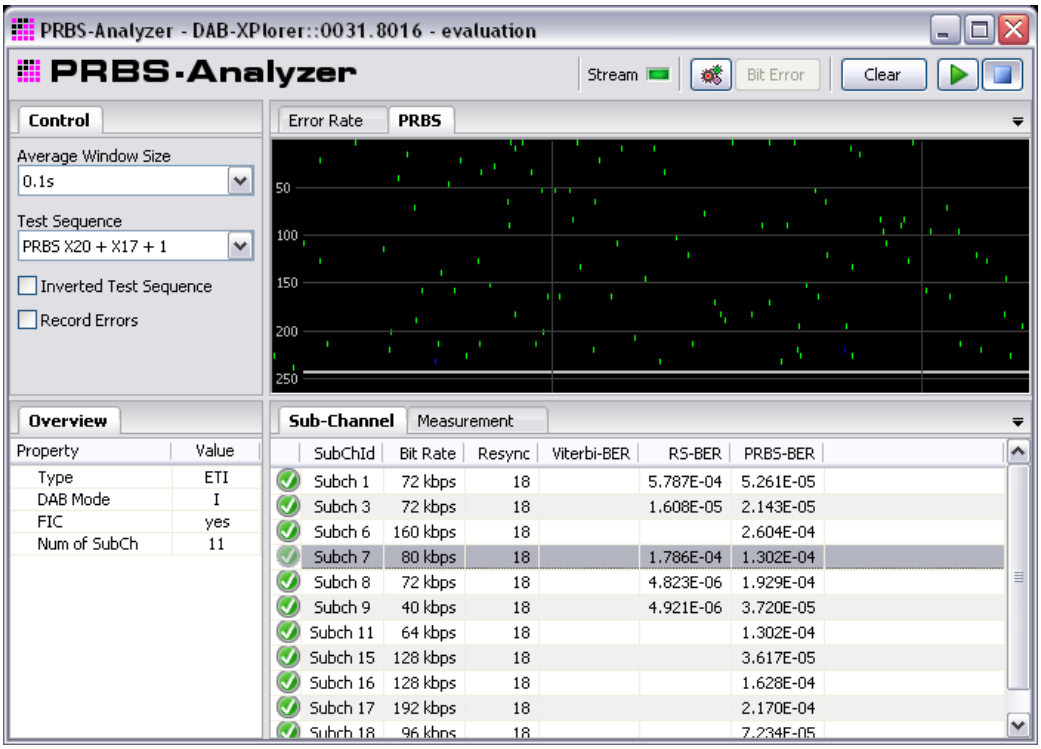

Figure 18 — PRBS-Analyser window

4.2.7 DABXP-OCC — GPS-Campaign-Converter

The GPS-Campaign-Converter makes a coverage measuring system from your UEB400-DXP. Using this tool, you can visualise the data from recorded EFCO files in Google Earth. The EFCO file contains measuring data gained from the DAB receiver (BERs of MSC and FIC; RSSI level; synchronisation states) as well as data from the integrated GPS receiver (time, position) and the complete content of the multiplex. The GPS-Campaign-Converter decodes all audio sub-channels from the input file to gain audio quality information (RS BER, header CRCs, scale factor CRCs). Then it puts everything together into a KML file that you can open in Google Earth for presentation. Since the KML file is an XML file, it will be easy to use it as basis for advanced statistical evaluation that may be required for the test of mobile DAB receivers.

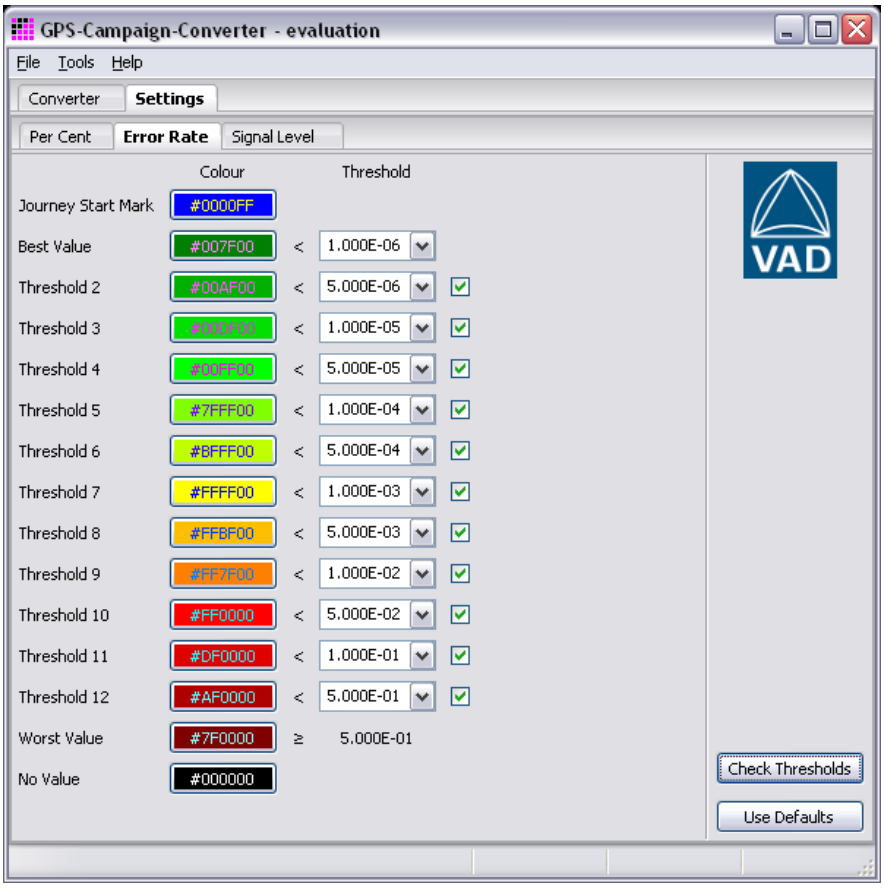

Figure 19 — Legend definition in GPS-Campaign-Converter window

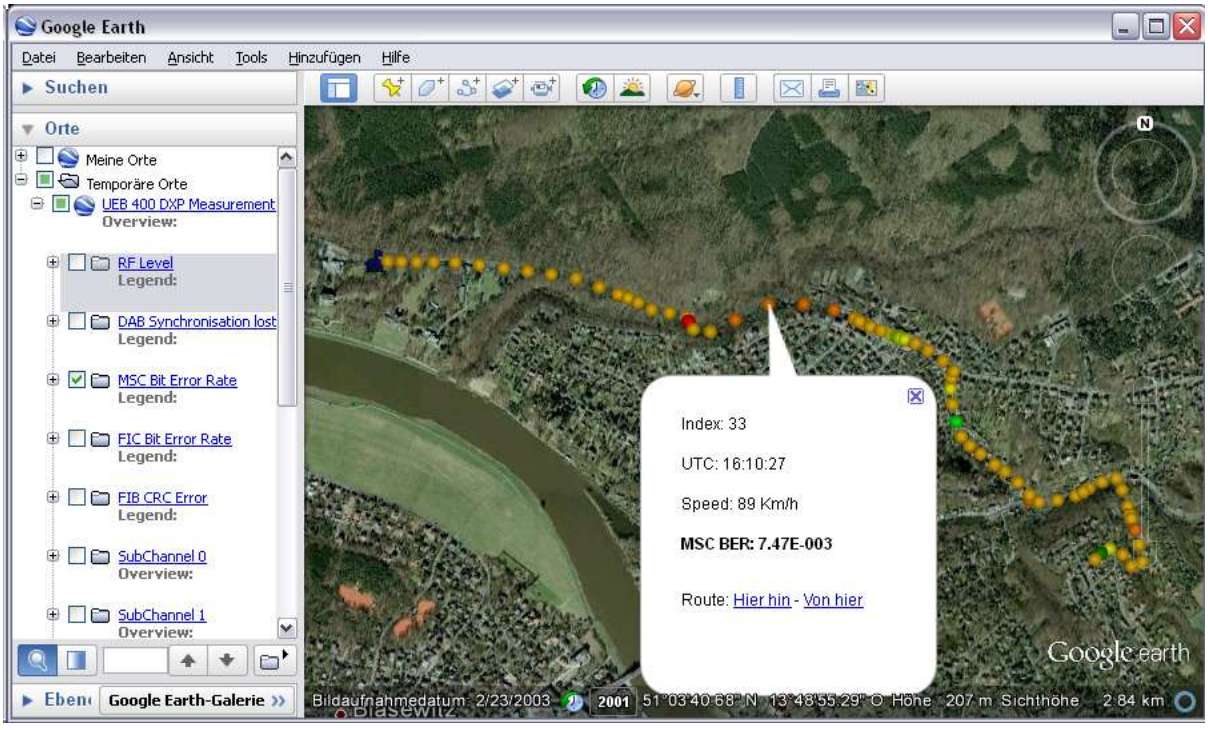

Figure 20 — Visualisation of the resulting KML file in Google Earth

4.2.8 DABXP-OTR — Triggered Recorder

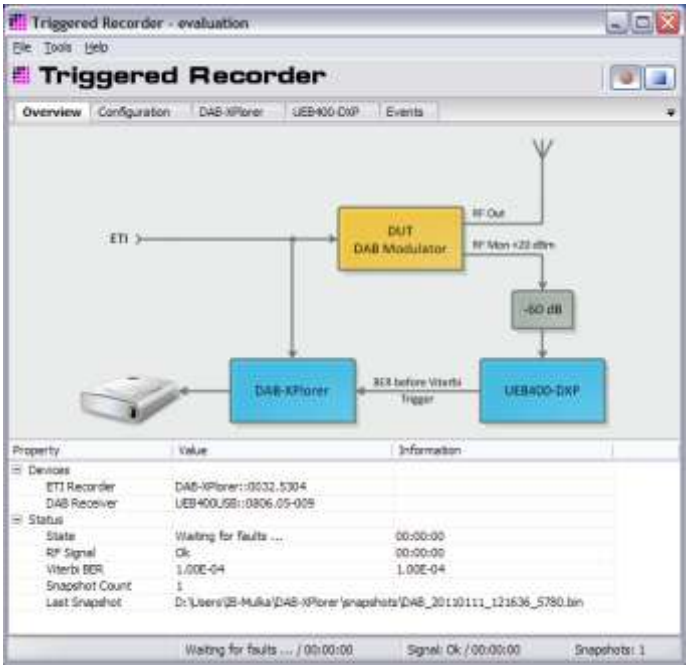

Figure 21 — Triggered Recorder

The Triggered Recorder was developed especially for developers of DAB COFDM modulators. During practical operation in can happen that the ETI data stream becomes corrupted during its transmission to the transmitter site. By chance this can bring the transmitter into an instable state. It is very difficult to reproduce such failures in the laboratory. Therefor it is desirable to have the possibility to record the ETI stream that provokes such erroneous transmitter behaviour.

The Triggered Recorder serves for the event-triggered recording of ETI data streams. Figure 21 shows the principle. The setup requires both, the DAB-XPlorer hardware for ETI recording and an UEB400-DXP receiver for quality measuring. The UEB400-DXP receives the RF signal from the DAB transmitter and measures the bit error rate. Overstepping of a pre-defined reference value starts the recording of the ETI data stream by the DAB-XPlorer hardware. The time-shift buffer provides the forerun required to catch the ETI section that caused the RF failure.

4.3 Examples of use cases and configurations

This section gives some example to illustrate the variety of use cases of the DAB-XPlorer software with various hardware configurations.

4.3.1 ETI analysis for broadcasters

Setup

- DABXP-HWU
- DABXP-BASIC
- DABXP-OXT

Uses

As broadcaster, you can use the DAB-XPlorer device to analyse the content of the pre-multiplex coming from the studio and to check the ETI at the output of the transport multiplexer or at the transmitter input (see Figure 3 on page 11).

Use the recorder function, the log files and the copy function for documentation and error reporting.

Use the FIC-XTractor to clear up complex problems in the interaction of your multiplexer configuration and consumer receivers.

4.3.2 Transmitter setup

Setup

- DABXP-HWU
- UEB400DXP-HWU
- DABXP-BASIC
- UEB400DXP-REC
- UEB400DXP-OAN

Uses

Use the DAB-XPlorer for a general check of the ETI input of the transmitter:

- Is it the right ensemble?
- Check the time stamps (TIST).

Use the UEB400-DXP to check the RF output:

- Check the transmitter for correct time position in the SFN.
- Check the error rates of the received RF signal.

4.3.3 Coverage measuring

Setup

- UEB400DXP-HWU
- UEB400DXP-REC
- UEB400DXP-OCC

Uses

Use the UEB400-DXP with UEB400DXP-REC to record EFCO files in test drives. After the measuring journey, use the GPS-Campaign-Converter (UEB400DXP-OCC) to make KML files from your recorded EFCO files. Open the KML files in Google Earth to get a presentation of the results. Consider using a scripting language (like Python) to extract data from the KML file for further statistical evaluation.

With the same test equipment and statistical evaluation, suppliers of car antennas can compare different antenna setups doing several subsequent measuring journeys on the same route.

4.3.4 SFN test

Setup

- UEB400DXP-HWU
- UEB400DXP-REC
- UEB400DXP-OAN

Use

Choose one transmitter of your network as reference for the timing of the whole SFN. Measure the parameter *Time Position* and press the *Resume* button to copy the value into the field *Reference* in the *SFN* panel of the *ETI-XPlorer* window. Visit every transmitter within your network and check if *Deviation* is zero or equal to the wanted additional delay of the transmitter under test.

4.3.5 Test of transmitter components

Setup

- DABXP-HWU
- DABXP-BASIC
- DABXP-OCO
- UEB400DXP-HWU
- UEB400DXP-REC
- DABXP-OPR
- (DABXP-OTR)

Uses

With the above setup we first use the UEB400-DXP with the Recorder application to catch a DAB multiplex from an on-air signal. Afterwards, use the RDI-ETI-Converter to convert the recorded EFCO file into an ETI (NI or NA) file. Use the DAB-XPlorer to replay the so prepared ETI file into the input of your transmitter under test.

(1) Replace the sub-channel content by pseudo-random binary sequences. Together with the PRBS-Analyser, you can use the so prepared ETI files to assess the coding quality of your transmitter. The PRBS-Analyser measures not only the bit error rate but shows as well error positions within the frame and over the time thus allowing you to locate bugs in, for instance, the modulator firmware.
(2) Use the post-processing functions of the RDI-ETI-Converter software to insert an FIC marker and replace the TIST. Together with a sampling oscilloscope, this will allow you measuring the operational delay of the COFDM modulator.
(3) Again, use the post-processing functions to insert random bit, frame or CRC errors into your ETI stream. Put the UEB400-DXP on the transmitter output, and check the behaviour of your transmitter with the corrupted ETI input.
(4) Use the Triggered Recorder to catch real world scenarios of corrupted ETI input.

4.3.6 Receiver test

Setup

- DABXP-HWU
- DABXP-BASIC
- DABXP-OCO
- UEB400DXP-HWU
- UEB400DXP-REC
- DABXP-OPR
- COFDM modulator from third-party supplier

Uses

Software test with real-life scenarios

Use the UEB400-DXP to record EFCO files from on-air signals with content that is interesting for your receiver tests. Convert the files into ETI files with the RDI-ETI-Converter. Replay the ETI files with the DAB-XPlorer into the input of a COFDM modulator to produce the RF signal to test your receiver.

The analyser functions coming with ETI-XPlorer, FIC-XPlorer, and FIC-XTractor will be helpful to check the integrity of the caught ensemble configurations and to research strange compatibility issues.

Accompanying tests in tuner development

Tests regarding the tuner hardware and firmware components like the Viterbi decoder of your receiver will be possible with the PRBS-Analyser. For these tests, your receiver under test must have an RDI output. Moreover, a second DAB-XPlorer or alternatively, a test signal generator that can replay ETI files will be required.

Use the RDI-ETI-Converter to replace the sub-channels of a recorded ETI file with pseudo-random binary sequences. Feed the resulting ETI file into a test transmitter formed by DAB-XPlorer plus COFDM modulator. Use the second DAB-XPlorer with the PRBS-Analyser to do a true bit error analysis at the RDI output of your receiver.

5 Installation

5.1 System Requirements

The following table provides the recommended minimum requirements for successful installation and operation of the software.

Component	Requirement (recommended minimum)
Hardware	
Processor	Intel Pentium IV 3.0 GHz, Intel Core 2 Duo, 1.5 GHz
Main memory	1024 MBytes RAM
Hard disk	approximately 300 MBytes free memory for software and temporary data on the system drive, approximately 1 GByte for operating protocol (log files) and data recordings in the user directory
Graphics card	graphics card with DirectX 9.0 support
Display resolution	1024 x 768 pixels
Mouse	standard mouse, two-key wheel mouse recommended
USB host	one free USB host interface (USB-A port), version 2.0, high speed data rate
Sound	stereo sound card and external or integrated speakers
Software	
Operating system	Microsoft Windows XP Service Pack 3 or above 32 bit version
Libraries	Internet Explorer 7 or above

The program requires approximately 300 MBytes RAM per connected input stream.

5.2 Installation Process

Before connecting the DAB-XPlorer or UEB400-DXP to your PC via USB and installing the software, you should carry out a backup first, saving all your important files as well as the system. For more information, please refer to the operating system documentation.

The following steps are necessary in order to install the drivers and the user software on a PC:

1. Switch on your PC and start the operating system.
2. Log in with administrator rights.
3. Insert the installation CD into the CD drive.
4. Start the installer program ***DAB-XPlorer-x.x.x.x-setup.exe***.

5. Follow the instructions of the install wizard.

The installation program will first check whether the required version of the operating system is available. After a successful check of the version, you can select a language for the installation process.

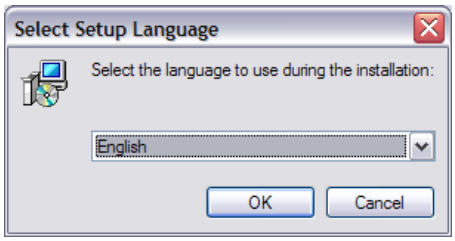

Figure 22 – Language selection for setup

Figure 23 – Display of the software to be installed and its version

As with most other software, the DAB-XPlorer application is protected by copyright. This protection is guaranteed by the Software License Agreement to be subsequently concluded between you and Ingenieurbüro Mulka. Please read it thoroughly. You will find it in Appendix C as well as on the installation medium. If necessary, please print the Agreement for your records.

Figure 24 – Software license agreement

If you do not agree, you will not be able to use the software.

Figure 25 – Information and important advice

Subsequently, you can select the installation folder, although it is recommended to use the default folder.

Figure 26 – Selection of installation folder

Figure 27 – Selection of components

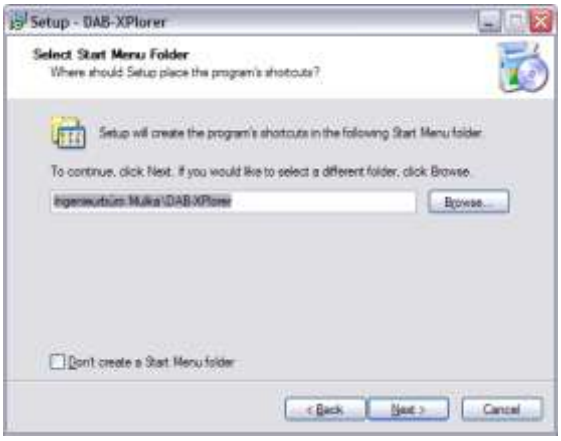

Figure 28 – Selection of the start menu folder

Figure 29 – Optional selection of shortcuts on the desktop

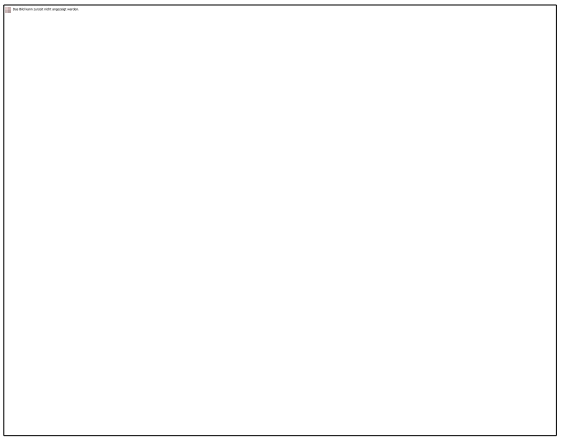

Figure 30 – Preparation of the installation has now been concluded

While the installation process additional wizards for the device drivers will be started. Follow the instructions of these wizards.

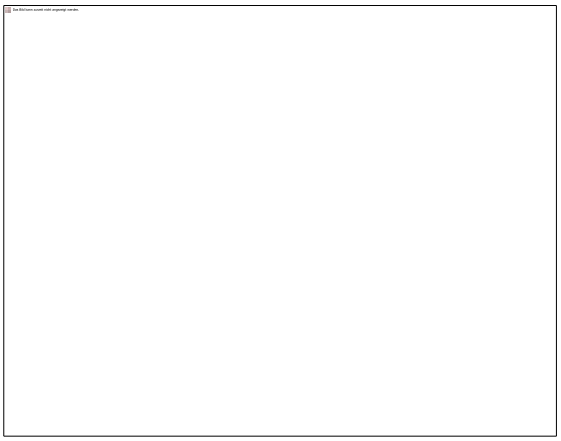

Figure 31 – Final overview of the current state of the software

Figure 32 – Installation successfully completed

If the installation of the user software and the pre-installation of the drivers have been successfully concluded, you can now connect your DAB-XPlorer or UEB400-DXP to the PC by the USB cable enclosed. The operating system will recognize the DAB-XPlorer or UEB400-DXP as a new device and will automatically start a wizard:

Figure 33 – Device wizard - select “No, not now” and “Next >”.

Figure 34 – Select “Install software automatically (recommended)” and “Next >”.

Figure 35 – Driver installation concluded successfully.

You can check the correct driver installation in the Device Manager of the system administration (Start menu → Control Panel → Administrative Tools → Computer Management → System Tools).

Figure 36 – Device manager showing the DAB-XPlorer as a new device

If the software installation has been successfully concluded, you can now start the DAB-XPlorer software and activate your license.

5.3 Licence Activation

If you ordered the RDI-ETI-Converter with CM-Stick, no license activation is needed. You can start the RDI-ETI-Converter so long the CM-Stick is connected to your PC.

The DAB-XPlorer software must be activated using the user-specific license. For other installations, the activation procedure is described below.

Start the DAB-XPlorer software (e.g. via the desktop shortcut).

Figure 37 – DAB-XPlorer main window before licence activation

Open the License Manager in the ***Tools*** menu.

Figure 38 – License Manger without activated license

Select and import the license file on your installation medium using the ***Import*** button.

Figure 39 – Valid license imported and activated

Once the licence has been activated license, the available applications and software components are displayed in the ***License Manager***. If you purchase further options later, these can also be activated by the “Import” procedure as described above.

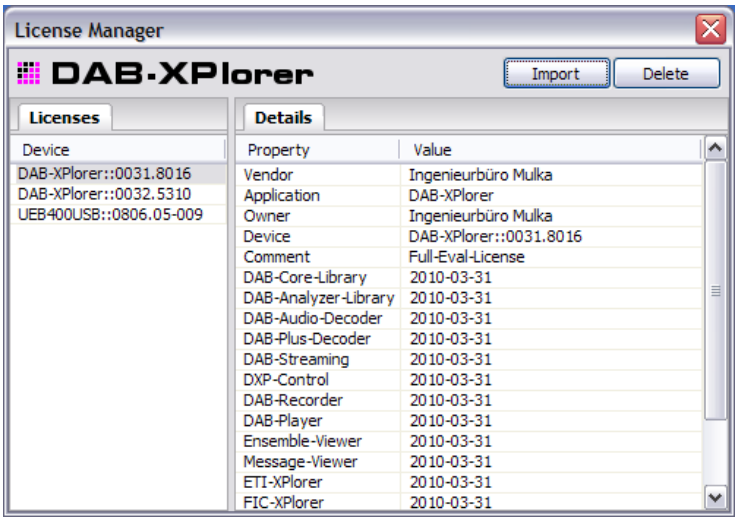

Figure 40 – License Manager displaying details

This last step concludes the installation; you can now begin with the analysis of DAB data streams.

The license that you have purchased is specific to your device, i.e. the options activated with the license are only able to run on the DAB-XPlorer or UEB400-DXP with the same serial number. According to the license agreement, you are, however, entitled to install the software on as many computers as you like and to activate the license simultaneously on all of these. Thus, you can use your DAB-XPlorer or UEB400-DXP at several consecutive locations.

5.4 Familiarisation

5.4.1 Overview

Operation and analysis are appropriately assigned to the following components:

Device panel:	provides selection of the connected device (DAB-XPlorer or UEB400-DXP).
Decoder panel:	shows the status of the data stream received and facilitates control of the time-shift buffer.
Recorder panel:	records the current data stream transparently as a file.
Player panel:	sends the content of an ETI file to the time-shift buffer. Additionally offers control functions for the current playback position within the file.
DXP-Status panel:	serves the display of the DAB-XPlorer specific status information.
DXP-Control panel:	serves for configuration of the DAB-XPlorer device.
UEB400-DXP panel:	serves for configuration of the UEB400-DXP device and the display of the UEB400-DXP specific status information.

GPS-RX panel:	serves the display of the GPS receiver specific status information.
Ensemble panel:	lists all services and service components.
Messages panel:	lists all the events detected in chronological order as short messages.
System panel:	serves for display of device-specific parameters and information.
ETI-XPlorer:	shows the current ensemble and the analysis results.
FIC-XPlorer:	shows the MCI and parts of the service information.
FIC-XTractor:	shows the FIC on bit-stream level.
PRBS-Analyzer:	shows errors within PRBS sequences.
RDI-ETI-Converter:	converts ETI, R2D, RDI and EFCO files to ETI.

5.4.2 Tips and tricks

Context-Related Help

If you need further information about a specific element, position the mouse cursor over the element and help text will appear automatically after a few seconds.

Don't miss the log files!

By default, the log files will be stored below the folder *DAB-XPlorer* in your *My Documents* folder. Consider installing a text editor providing syntax highlighting and other advanced functions to inspect and edit the DabLog, XML, KML, and DabCfg files.

Copying table content

Try using the right mouse button on any of the tables in the GUI or simply press CTRL+C to copy the table content into the clipboard. Paste the content into a plain text file and enjoy.

Familiarise yourself with the time-shift buffer

The time-shift buffer opens interesting additional opportunities in some applications.

Be clear about the file types

The DAB-XPlorer allows choosing file extensions freely. You are free to save e.g. an EFCO file as well with the extension *.efco* as with *.bin* or even with *.eti*. Make your own convention about how to name different file types.

5.5 Troubleshooting

5.5.1 Error during start-up

If you start the DAB-XPlorer application and no licensed device is connected, you get the following message within the Main Window. In this case make sure that a device is connected and, respectively, a valid license file is installed.

Figure 41 – DAB-XPlorer main window before licence activation

If you start an application, of which the license is bound to a CM-Stick, and no CM-Stick is connected to the PC, or the maximum of available licenses is reached, you get a dialog with a detailed error message.

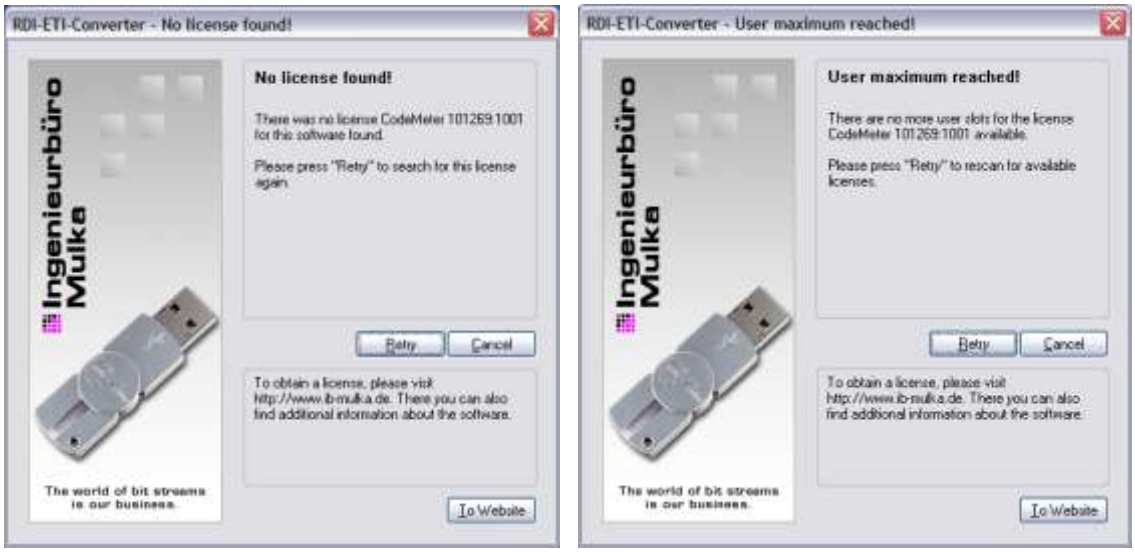

Figure 42 – Dialog boxes if no license key is connected or if the maximum number of licenses is reached

5.5.2 No audio output

Go to the main application window into the tab *Ensemble* and check the button  .

Chose an audio service from the service list.

Check if the audio output is muted by your operating system or if it is switched off by your computer hardware.

5.5.3 The decoder does not work in Playback mode

If the *Decoder* panel shows a red G.703 » NO SYNC whilst the player is running, check the Loopback settings.

5.5.4 I have found a bug!

Please send your bug report to *info@ib-mulka.de*. Your feedback is important for the further improvement of the software and very welcome!

Appendix A Product Characteristics

A.1. DAB-XPlorer

Connectors	
USB-B	USB-B plug-in connector, USB device interface, USB 2.0 full speed
G.703 input	HDB3 coded, BNC, female, 75 Ω
G.703 output	HDB3 coded, BNC, female, 75 Ω
S/PDIF input	optical TOSLINK input
1PPS input	BNC, female, 75 Ω, TTL, for synchronisation to GPS (for future use) or as electrical S/PDIF input
RS232 DTE	SUB-D plug-in connector 9-pole, RS232C without hardware handshake, for debugging purpose

General	
Case	Aluminium pressure die casting, black powder-coated
Dimensions	125 x 120 x 48 mm^3
Weight	650 g
Supply voltage	5 V, USB powered, max. 100 mA
Operating temperature	0 … +40°C

A.2. UEB400-DXP

Connectors	
USB-B	USB-B plug-in connector, USB device interface, USB 2.0 high speed
S/PDIF output	optical TOSLINK output, RDI or optional S/PDIF audio[2]
RF input	SMA, female, 50 Ω
GPS input	SMA, female, 50 Ω
Audio jack	3.5 mm, analogue stereo audio jack, to connect active speakers
Power supply	Power supply connector, with integrated reverse polarity protection

General	
Case	Aluminium, black powder-coated
Dimensions	108 x 200 x 42 mm[3]
Weight	400 g
Supply voltage	4.5 V … 14.5 V, lower than 2 W power consumption
Operating temperature	0°C … +40°C

RF Characterisation	
Input impedance	50 Ω, VSWR < 2.0
Input level range[3]	-95 dBm … -20 dBm
Input frequency range	175 MHz … 240 MHz, 1452 MHz ... 1492 MHz
Tuning step size	16 kHz
Adjacent channel selectivity[3]	> 40 dB
Overall selectivity[3]	> 60 dB

[2] The desired function is determined by an internal jumper; manufacturer's default is RDI

[3] for BER < 1 * 10^{-4} according to EN 50248: "Characteristics of DAB receivers"

Appendix B Ordering Information

B.1. Hardware components (require additional software options)

Item / Option	Description
DABXP-CM	USB dongle CodeMeter with 2 GByte flash
DABXP-HWU	DAB-XPlorer hardware • G.703 / SPDIF to USB converter box • USB 2.0 A/B cable
UEB400DXP-HWU	DAB(+)/DMB test receiver with USB and GPS • DAB receiver • antenna for VHF band III and L-band • active GPS antenna • wall power supply 230V AC to 12 V DC • USB 2.0 A/B cable

B.2. UEB400-DXP-specific software options

Item / Option	Description
UEB400DXP-REC	Recorder, player, and configuration for UEB400-DXP • configuration, tuning, scanning, receiver status, FIC-BER, MSC-BER, RSSI level • recording and playback of EFCO • service, sub-channel and SC list • decoding of the selected audio sub-channel (MUSICAM)
UEB400DXP-OAN	Option Analyser (ETI-XPlorer, FIC-XPlorer, and SFN) • EFCO/RDI/ETI Decoder/Analyser • ETI-XPlorer, FIC-XPlorer, Messages-Viewer • measurement of the SFN

B.3. Software options (require one of the hardware components)

Item / Option	Description
DABXP-BASIC	Option Recorder, Player, ETI-XPlorer, and FIC-XPlorer • configuration, hardware status • recording and playback of ETI, RDI, and EFCO • service, sub-channel and SC list • decoding of the selected audio sub-channel (MUSICAM) • EFCO/RDI/ETI Decoder/Analyser • ETI-XPlorer, FIC-XPlorer, and Messages-Viewer
DABXP-OCO	Option RDI/EFCO/ETI Converter Converter of RDI, EFCO, ETI-NI, ETI-NA, ETI-LI files with off-line analysis, replacement and post-processing • converting to ETI-NI or ETI-NA • offline analysis of the data stream, analysing results may be exported as XML file • optional extracting of the FIC or sub-channel content • changing of DAB transmission mode • replacement of labels and sub-channel content by file content • replacement of sub-channel content by PRBS • insertion of bit or frame errors
DABXP-OPL	Option DAB+/FEC/Streaming DAB+ audio decoder, analysis of FEC, sub-channel streaming, EDI decoder • DAB+ audio decoder incl. VIA licence • analysing errors within the DAB+ Fire-Code, RS-Code or AU-CRC (requires ETI-XPlorer) • analysing errors within the DMB RS-Code (requires ETI-XPlorer) • sub-channel streaming to external decoders via UDP • decoding of EDI streams via UDP • analysing errors within the Enhanced Packet Mode RS-Code or Packet-CRC (requires ETI-XPlorer)
DABXP-OPR	Option PRBS Analyser Real-time PRBS analyser • displays the signal level over the time • displays the Viterbi-BER and RS-BER over the time • displays the error position (error bitmap) within the sub-channel over the time

Item / Option	Description
DABXP-OXT	Option FIC-XTractor Analyser of the Fast Information Channel on bit-stream level like a protocol analyser • frame oriented list of received FIGs • FIG list sorted by type or extension • database oriented list of received FIGs, all doublets are removed from the view, gets statistic of the FIGs • tree view of the decoded FIG
DABXP-OCC	Option GPS Campaign Converter Converter of EFCO to KML • displays the measured data on the map of Google Earth
DABXP-OTR	Option Triggered Recorder • ETI recording triggered by an external event

Appendix C Software License Agreement

As of January 2010

§1 Purpose of License Agreement

Object of the agreement is the computer program saved on the data carrier or made available for download, as well as the help programs, program libraries, scripts, example files, the program description and user manual, and any other respective material in writing – in the following called the software.

The software is protected by copyright law and international treaties on copyright, as well as by additional laws and agreements on intellectual property. The use of an unregistered version represents a violation of this agreement.

The terms of this software license agreement are of unlimited validity with respect to space and time for all the software products offered and sold by Ingenieurbüro Mulka (in the following “IB-Mulka”), particularly for any software of the DAB-XPlorer product family, with the exception of software of which IB-Mulka is not the producer (third producer). In this case, the license terms of the third producer are valid. Software produced by IB-Mulka is marked visibly and invisibly as such.

§2 Conclusion of the License Agreement

The licensee accepts as binding the conditions of this software license agreement by downloading, installing, and/or using the software, without any restrictions with respect to space and time. This software license agreement is a legal contract between the licensee (as a natural or legal person) and IB-Mulka as producer of the software.

Should the licensee not agree with the terms of this agreement (objection in written form to be submitted to IB-Mulka within 14 days upon purchase of the software), he/she is not entitled to use the software or any parts of it; the purchased software must be deleted by the licensee or an agent of the licensee (for example a provider). If the software was bought from the IB-Mulka, then purchase price will be refunded by IB-Mulka after the proof of deletion of the software will have been submitted, deletion also referring to any copies in electronic and/or written form which have been lawfully made on the grounds of this contract. IB-Mulka is entitled to request an affidavit in written form if any reasonable doubt will occur as to the deletion.

§3 Scope of the License

In the framework of this agreement, IB-Mulka grants the plain, non-exclusive, and personal right to the licensee to install the software on an arbitrary number of computers and to apply the software exclusively in combination with a hardware product of IB-Mulka.

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Insofar as IB-Mulka provides software of which the company is only granted a derived right of use (foreign software), the terms of use agreed upon for the foreign software are additionally valid and preferential to the terms agreed upon within this contract.

If and insofar as open source software is made available, the terms of use to which the open source software is subject are additionally valid and preferential to the terms agreed upon within this contract. Upon request, IB-Mulka will make available the source code of relevant open source software, insofar as the terms of use of such open source software allow for a publication of the source code. IB-Mulka will indicate in the records of this agreement the presence and the terms of use of ceded foreign software or open source software and will make available upon request the respective terms of use.

§6 Rights Granted

By accepting the license, the licensee obtains ownership only of the corporeal data carrier carrying the software. Besides, the licensee is granted the right of use agreed upon within this license agreement. He/she does not acquire any copyrights as to the software itself. IB-Mulka reserves any software rights particularly with respect to publication, duplication, development, and commercialization.

§7 Demo Version

Should the enclosed data carrier, the program itself, or parts of the program be marked as a demo version, the user is only entitled to apply the software exclusively for evaluation reasons in the framework of this license agreement; a productive or commercial application of a demo version is strictly prohibited.

The demo version may be subject to functional restrictions. Any warranty or liability is excluded for the demo version. The demo version is applied at the user's own risk. Upon purchase of a valid full license, the program can be used to its full extent.

§8 Transfer of the Right of Use

The licensee, who has purchased the software not for reasons of resale (end customer), is only entitled to transfer the right of use to any third parties if it is transferred together with the product which he/she has acquired from IB-Mulka in combination with the software. In the case of a transfer of the right of use to any third parties, the licensee has to make sure that the third party will not be granted any further rights than those to which the licensee is entitled to according to the present terms; moreover, the third party must at least be bound to observe the obligations as to the software according to the present agreement. In this case, the licensee is obliged to transfer the entire software and any existing copies (including all the components, media, and the printed material), not holding back any parts of the software.

The licensee is not entitled to grant any sub-licenses. If the licensee transfers the software to a third party, he/she is responsible for the observation of any existing export requirements, dispensing IB-Mulka from any respective obligations.

§9 Duration of the Agreement

The duration of the agreement is unlimited. The right of use of the licensee with respect to the software automatically ceases without notice if he/she violates a term of this agreement. Upon termination of the right of use, the licensee is bound to destroy the original data carriers and any copies of the software including any modified versions, as well as the material in writing. Upon request of IB-Mulka, the complete destruction must be declared under oath before a notary.

§10 Damages in the Case of Violation

The licensee is liable for any damages due to the violation of copyrights, which will occur to IB-Mulka on the grounds of a violation of the terms of this agreement by the licensee.

§11 Modifications and Updates

IB-Mulka is entitled to develop updates of the software at the company's own discretion. The company is not obliged to provide any updates of the program to licensees whose software has not been registered or who have not paid the required update fee.

§12 Warranty

IB-Mulka indicates to the customers that according to the current state of the art, it is impossible to develop software in such a way that it is working error-free anytime in all applications and combinations, especially together with different hardware components. IB-Mulka guarantees for a period of 24 months upon date of delivery that the software delivered by IB-Mulka is essentially free from material and production defects and is essentially working according to the accompanying user manual. Warranty is limited to these terms.

In the case of a rightful notice of defects, IB-Mulka reserves the right to remedy the defects for three times or, in the case of a final failure of such remedy, to grant to the licensee the right to cancellation or price reduction at his/her choice.

A right to cancellation or reduction will only be granted to the licensee if a program defect will prove to be substantial and essential for the entire performance and if such defect cannot be neutralized through other possibilities of the software.

Any other warranty is expressly excluded, particularly as to the appropriateness of the software for the licensee's purposes, as to damages caused directly or indirectly (e. g., lost profit or interruptions in operation) or as to the loss of data, as well as to damages in connection with the reproduction of lost data, to the exception that intent or gross negligence can be proved to IB-Mulka or its employees.

IB-Mulka reserves the right to make modifications of the software also after delivery if these will improve the performance of the software and will not affect any other parts of the software. Information in manuals and/or documentations and/or promotion materials which refers to extension possibilities of a product or to available accessories, is non-binding, especially because the software is subject to continuous adaptations and such information may also refer to future developments.

§13 Limitation of Liability

Liability (also non-contractual) of IB-Mulka is excluded insofar as IB-Mulka is not liable due to binding legal provisions, for example on the grounds of intent or gross negligence, missing properties which have been ensured, or violation of obligations essential to the agreement.

If a third party puts forward any claims against the licensee on the grounds of protective rights or with respect to protective rights due to the delivery according to the object of the agreement, IB-Mulka is entitled and bound to

- either obtain a right of use from the person entitled to legally dispose of the protective right, or to
- exchange the parts violating the protective right by such parts free of protective rights, or to
- take back the respective products, refunding the purchase price,

at the company's choice and own expenses, to the exclusion of any further liability.

IB-Mulka is obliged to examine the data carriers or the master data carriers with the latest version of a commercially available virus scanning program before sending these to the copying company, and to delete any viruses which might have been found. Should any viruses be detected on the data carriers delivered by IB-Mulka in spite of these measures, liability of IB-Mulka is excluded.

Should IB-Mulka provide any fault-clearing services due to a malfunction indicated by the licensee, IB-Mulka is entitled to charge the licensee for the time required according to the respectively valid hourly rates if it will turn out that either there has been no malfunction or that exclusively the licensee has been responsible for the malfunction (for example, operating error, configuration error, defects of the hardware or line connections applied by the licensee).

§14 Applicable Law, Place of Execution and Jurisdiction

Exclusively applicable is the law of the Federal Republic of Germany, to the exception of the standard UN sales law. Place of execution and jurisdiction is Dresden, insofar as the licensee is a registered trader or legal person of public law, or represents special assets under public law. IB-Mulka is however entitled to claim rights on the grounds of this license agreement at the licensee’s place of residence.

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