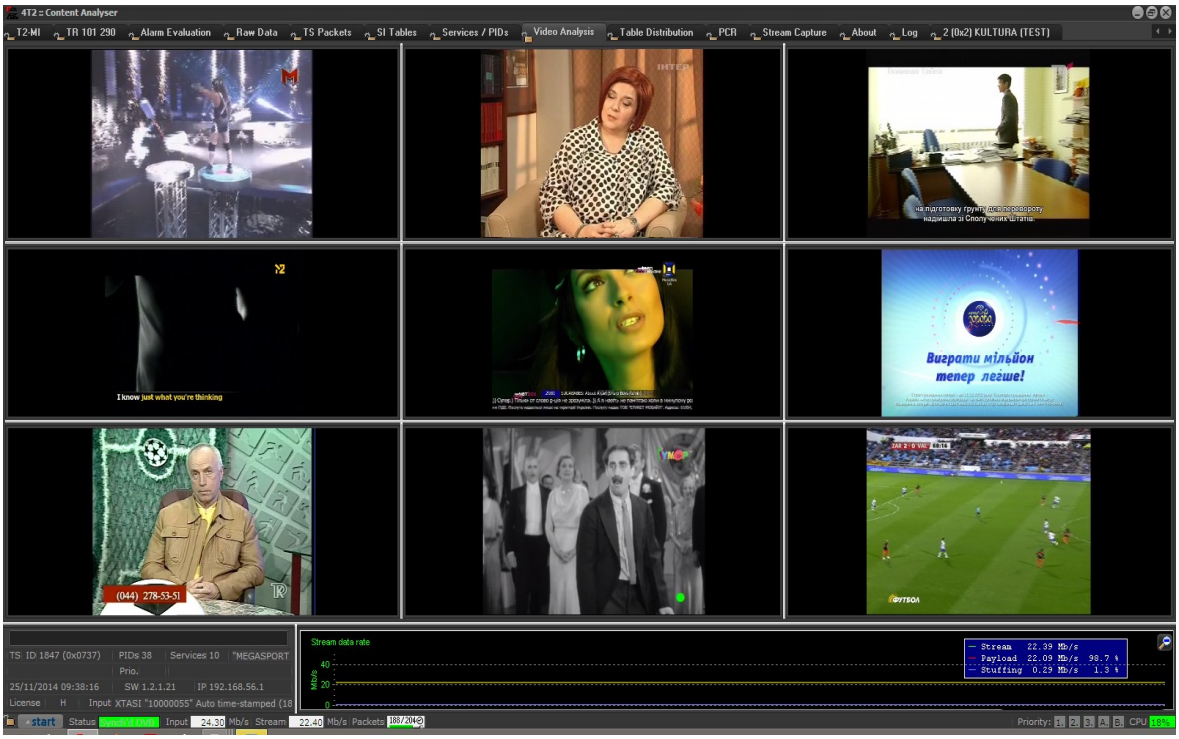
SW-Manual 4T2 Content-Analyser



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1 Introduction

Thank you for choosing the Advanced Broadcast Components **4T2™ Content-Analyser** to solve your MPEG Transport Stream measurement problems.

You may have received your analyser application as part of an ABC System, such as the **4T2™-Portable, 4T2™-Portable *light*,** or **4T2™-Rack** instruments.

This manual contains an introduction to most of the features of the analyser application. However, the software is undergoing a constant improvement process. Therefore we would like to encourage you to contact our support team if you do not find your specific question answered here.

There might also be already a new release of the application available, so a visit to the project website www.4T2.eu will always prove worthwhile.

The manual is updated frequently to reflect on new functions implemented. It is available for download from the same source as the application itself.

There is also a readme.txt file located in the applications directory with latest tips and tricks.

The MPEG-Analyser offers the following key features and controls:

- RF, and Content analysis on terrestrial DVB channels DVB-T, DVB T2
- RF, and Content analysis on satellite DVB channels DVB-S, DVB-S2
- Analysis of DVB-T2 MI Modulator Interface

- Visualisation of SDT Service Description Tables
- Visualisation of NIT Network Information Tables
- Visualisation of MIP Megaframe Initialisation Packets
- Visualisation of PID Packet Identifiers and associated bit-rates, and bit-stuffing
- Raw data analysis with smart packet-trigger, and bit dependencies checking
- Visualisation of time repetition intervals of tables defined in TR.101.290
- Analysis and visualisation of first, second, and third priority errors according to TR.101.290
- Registration of the Transport Stream to HDD in case of an error
- Measurement of PCR Program Clock Reference jitter
- Measurement of independent Transport Stream sources (several instances of the program running at the same time).
- Multi-Viewer function with Audio-bargraphs of all services in the Transport Stream
- Detection of black and freeze conditions on a single service in the transport stream
- Detection of audio mute condition on a single service in the transport stream
- remote capability with full SNMP support following the DVB MIB, including Traps

The Content-Analyser menu structure is based around tab-sheets.
The following pages show the tab-sheet details and the measurement results than can be read on them.
Please note that individual tab-sheets might not be visible, as they can be deactivated in the settings dialogue.

2 Multi-Dock interface

(This functionality applies to the **4T2 Content-Analyser** Release 1.x only)

With **Multi-Dock**, the **4T2 Content-Analyser** is open for customisation tailored to specific measurement tasks.
The most visible advantage of **Multi-Dock** is the ability to arrange any of the supported measurement tab-sheets together on a single display. All custom configuration can be stored and retrieved, allowing for an instrument-collection to be recalled instantly whenever required.

Together with the built-in ability to configure multiple instances of the program with different settings, the versatile **4T2 Content-Analyser** architecture is ready to replace a number of proprietary solutions.

The starting point for using the Multi-Dock interface of the **4T2 Content-Analyser** is clicking the ***ABC (Start)*** button.
In the opening ***Start menu***, one can not only find the key status information on the currently selected input, but all non-displayed measurement tab-sheets as well. The contents of any of those sheets are made visible by pointing on the tab with the mouse and then dragging the window anywhere on the screen. If a tab-sheet window is closed from the desktop, it falls back to the dock. This is a technique to arrange measurement results in a UNIX-like multi-window fashion.
The **4T2 Content-Analyser** supports also the Windows-native approach to integrate all measurement tab-sheets within the main program window.

Using drag and drop, any tab-sheet can be moved from display-cell to display-cell. Display-cells can be added, or deleted by right-click on their border-line and then by selecting the required function in the pop-up menu. The cell layout can be stored independently from the program settings, allowing for a multitude of display-layouts without interfering with the applications' functional parameters.

3 Tab-sheet menu structure

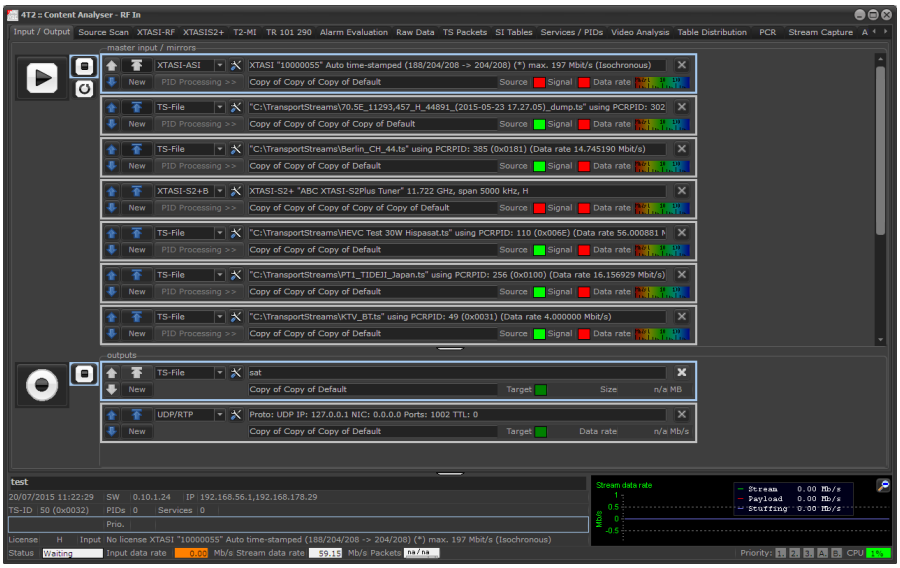


Illustration 1: Input/output tab-sheet

Following tab-sheets are available in the 4T2™ Content-Analyser application:

Input/Output	Input, and output selection
Source Scan	Input interface scanner with XML file output
XTASI-RF	DVB-T/T2 RF-Parameter measurement with XTASI-RF input module
XTASI-S2	DVB-S/S2 RF-Parameter measurement with XTASI-S2 input module
T2-MI	DVB-T2 Modulator Interface
TR 101 290	First, second, and third priority error evaluation
Alarm Evaluation	Expression Editor / Debugger for Alarm Relay activation
Raw Data	Bit transparent data analysis before the packetiser
TS Packets	Analysis based on transport stream packets
SI Tables	Service Information table analysis
Services / PIDs	Listing of services with correspondiong data-rates, same on PID level
Video Analysis	Decoding of content, and black/freeze detection, with multi-viewer
Table Distribution	Timing analysis on SI-table repetition
PCR	PCR Overview and analysis on program clock reference, and Jitter
Stream Capture	Recording of transport stream on errors, or manual
About	About box information, and application settings
Log	Internal application logfile display and sorter

Visible tab-sheets can be de-activated to customise the application to specific measurement requirements. The settings dialogue is accessible through the application system menu (ALT+Space)/Settings.

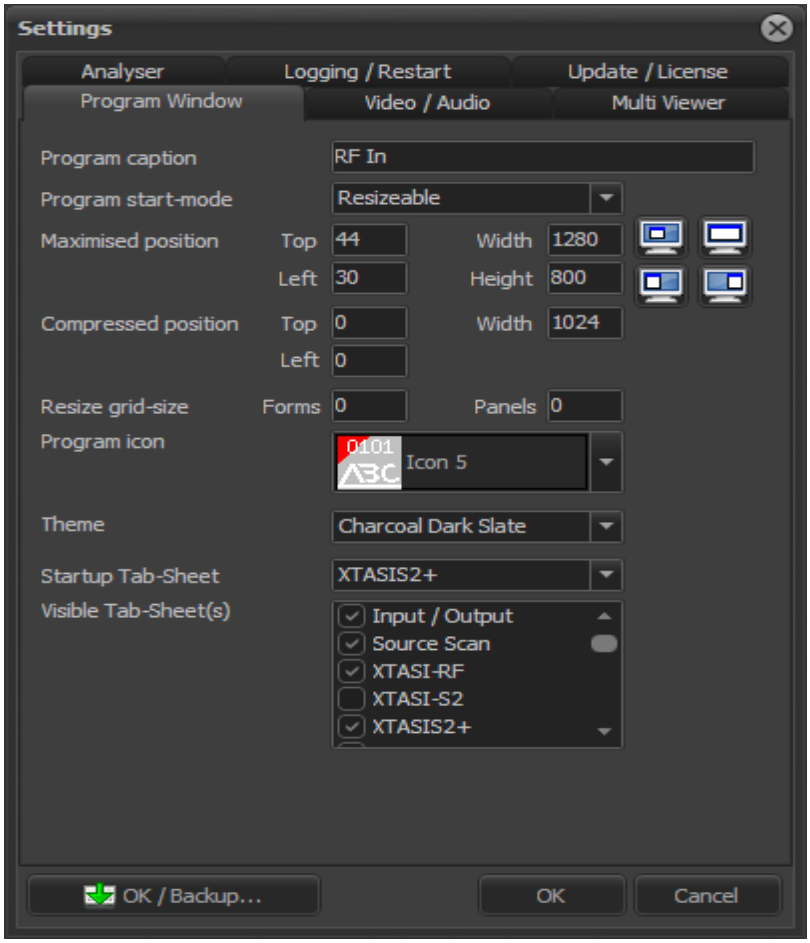


Illustration 2: Settings dialogue

As an example, in a standard MPEG, environment the tabs for ***T2-MI*** (modulator interface), ***XTASI-RF*** (measurements in the RF domain using ABC hardware), and ***RAW Data*** (byte aligned analysis of the Transport Stream) could be unchecked for de-activation. The tab-sheets can be re-activated at any time through the ***Settings*** dialogue

4 Input / Output

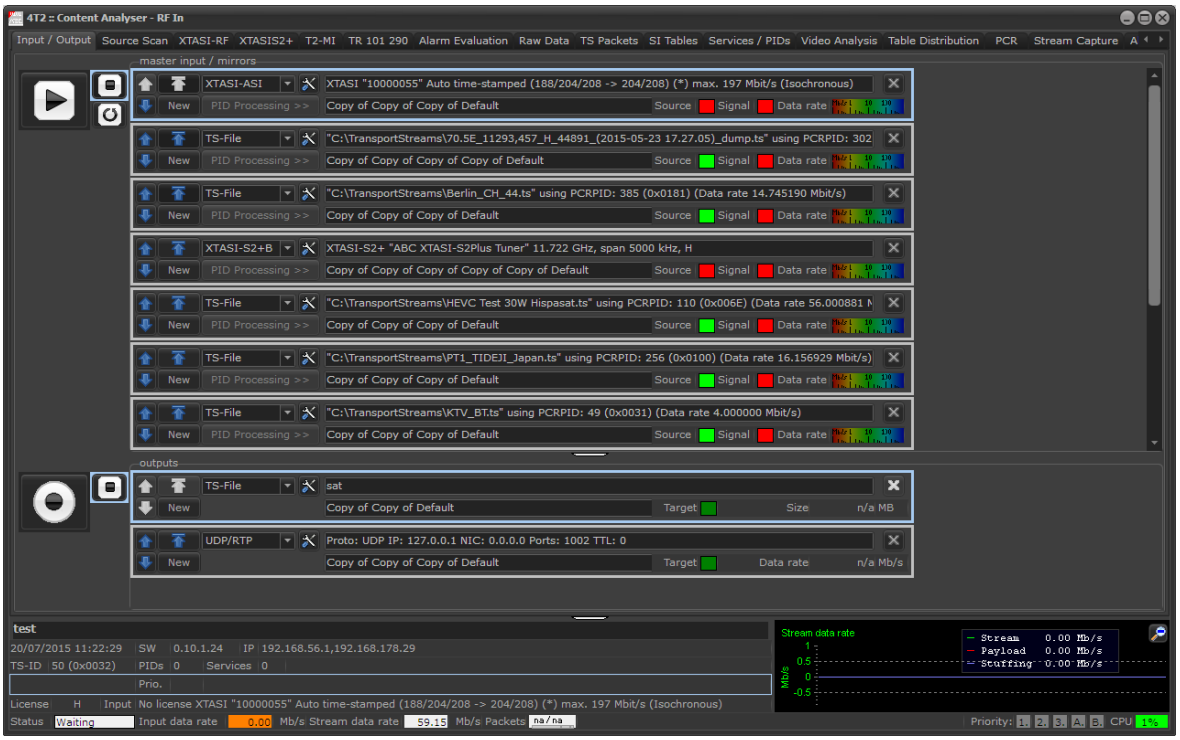


Illustration 3: Input/output tab-sheet

This sheet enables the selection of input, and output sources of the 4T2 Content-Analyser.

The uppermost input is the one that is actually feeding the analyser. You can prepare various inputs in a play-list (like shown above) for easier retrieval.

The uppermost output is the one that is forwarding the data from analyser.

Following interfaces are supported:

- Transport Stream files input and output
- IPTV udp, rtp input and output
- ABC XTASI-RF DVB-T/T2 input
- ABC XTASI-S2 DVB-S/S2 input
- ABC XTASI-ASI ASI input and output

Individual properties of the selected inputs or outputs are available by clicking on the corresponding tool buttons (screwdriver & wrench)

A “Source”- indicator verifies that the source is available

A “Data rate”-indicator verifies that there is data coming from the interface

The actual data rate is displayed in the bar to the right in a logarithmic scale. The measured “Input data rate” can be found in the status line.

4.1 Transport Stream Files

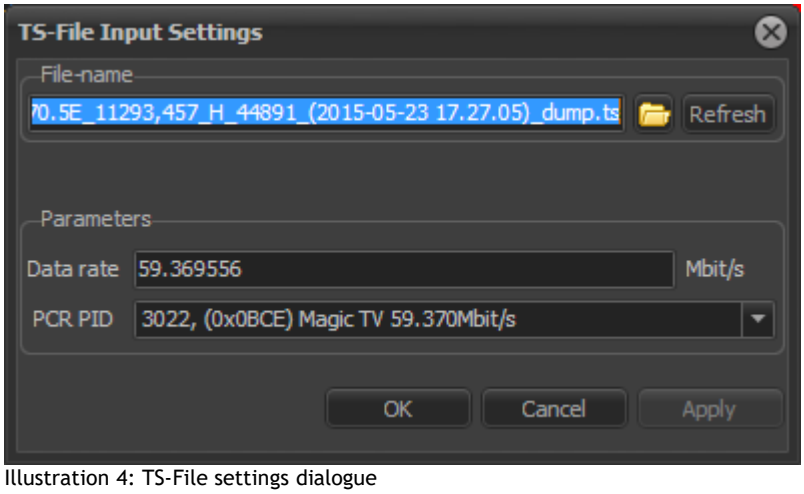


Illustration 4: TS-File settings dialogue

The 4T2 Content-Analyser allows to read and decode content which is stored in files on your computer or in your network. To read a file, you can either enter a valid file-name manually or select a file using the Browse button.

The analyser currently supports transport stream files in the following formats:

- n*188 bytes (plain transport stream packets)
- n*204 bytes (transport stream packets followed by 16 byte error correction code)

The Transport Stream file format will be detected automatically.

The analyser is working on standard MPEG files, or ones with ATSC, DVB SI tables, or ISDB format. It is also working on stored DVB-T2 MI files.

The playback data-rate can be entered manually, or is automatically determined by a PCR-PID in the transport stream. The PCR-PID can be selected using the drop-down list.

4.2 IPTV

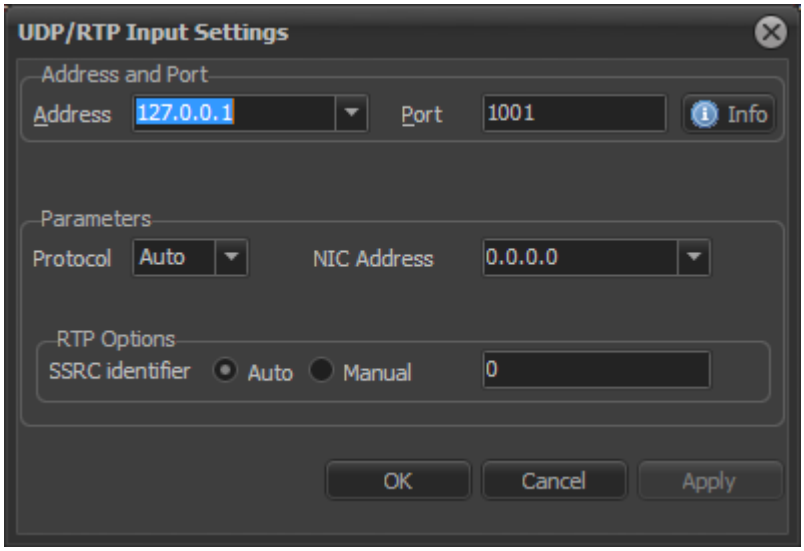


Illustration 5: Network settings dialogue

The 4T2 Content Analyser can receive and decode IPTV streams.

For unicasts, a local IP address can be used. To connect to a multicast on your network, you can enter an arbitrary multicast address. Streams received using this feed type, can be encoded using plain UDP or RTP.

The info button displays the network interfaces available on the current computer. The purpose is to determine the NIC address of the network interface should more than one network interface be available on the computer. With the NIC address drop-down list, the user can specify which interface should perform as the transport stream receiver.

The encapsulation type will be detected automatically.

The Transport Stream file format will be detected automatically.

The analyser is working on standard MPEG files, or ones with ATSC, DVB SI tables, or ISDB format. It is also working on stored DVB-T2 MI files.

4.3 XTASI-ASI input

ABC receiver module for Asynchronous Serial Interface transport stream input via USB interface.

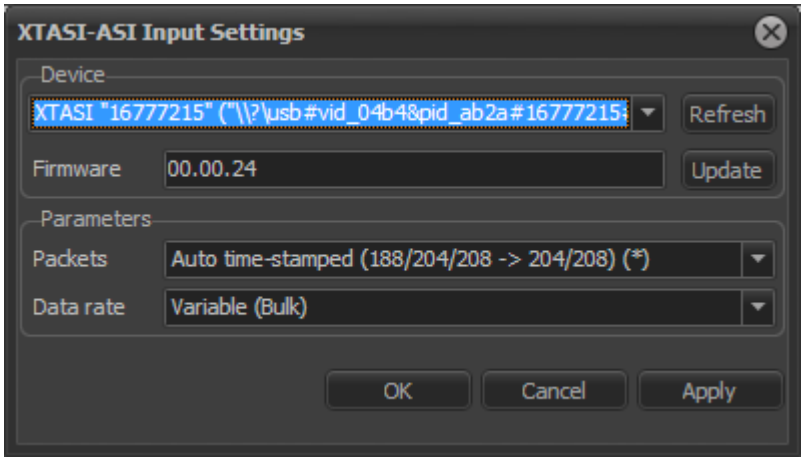


Illustration 6: XTASI-ASI input settings dialogue

The Transport Stream file format will be detected automatically.

The analyser is working on standard MPEG files, or ones with ATSC, DVB SI tables, or ISDB format. It is also working on stored DVB-T2 MI files.

Multiple devices can be attached to a single computer. The selection is performed through the drop- down list.

XTASI-ASI input firmware can be upgraded through the settings dialogue. The appropriate firmware is copied to your computers' hard-drive during the installation of the 4T2 Content Analyser.

XTASI-ASI works successfully with both burst-mode and packet-mode formatted data at signal amplitudes of up to 1000 mV @ 75 Ohm. The connector is BNC female.

Various MPEG transport stream packet lengths are supported.

Available options are:

- Auto (188/204/208 byte packets),
  the 4T2 Content Analyser automatically detects the packet length
- Auto time-stamped (188/204/208 → 204/208) (*), this is the default choice,
  188 byte packets are stuffed using a time-stamp to improve performance in timing measurements
- 188 byte packets only'
- 204 byte packets only
- 188 time stamped (188 → 204)
- 204 time stamped (204 → 204)
- 208 byte packets only
- 208 time stamped (208 → 208)

USB-bulk, or isochronous mode is supported. The latter is giving high timing accuracy in timing related measurements

Available options are:

- Variable (Bulk), lower precision timing, supporting up to 128 modules on one USB root hub

- max. 65 Mbit/s (Isochronous) (*), this is the default choice, higher precision timing,
  handles up to 65 Mbit/s ASI data-rate,
  occupies 2 USB microframes, supporting up to 3 isochronous modules on one USB root hub

- max. 131 Mbit/s (Isochronous) (*), higher precision timing,
  handles up to 131 Mbit/s ASI data-rate,
  occupies 4 USB microframes, supporting up to 2 isochronous modules on one USB root hub

- max. 197 Mbit/s (Isochronous) (*), higher precision timing,
  handles up to 197 Mbit/s ASI data-rate,
  occupies 6 USB microframes, supporting 1 isochronous module on one USB root hub

4.4 XTASI-RF

ABC receiver module for direct terrestrial RF-input via USB interface. XTASI-RF supports DVB-T, and DVB-T2 modulated COFDM signals.

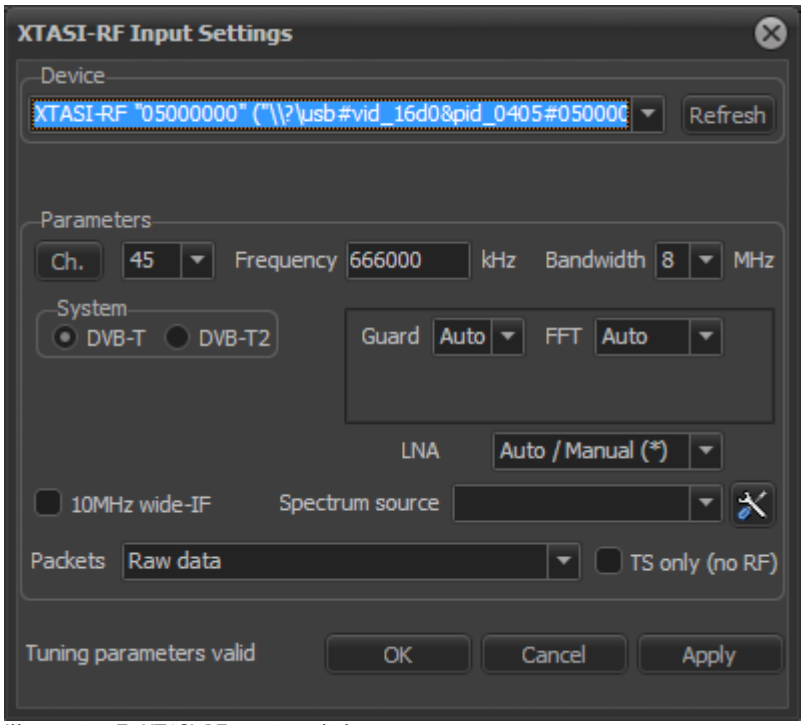


Illustration 7: XTASI-RF settings dialogue

Multiple devices can be attached to a computer. The selection is performed through the ***Device drop- down*** list.

The ***Parameters-group*** establishes the tuning of the receiver. Clicking the ***Ch.-button*** gives access to channel table files stored as comma seperated values on the computer.

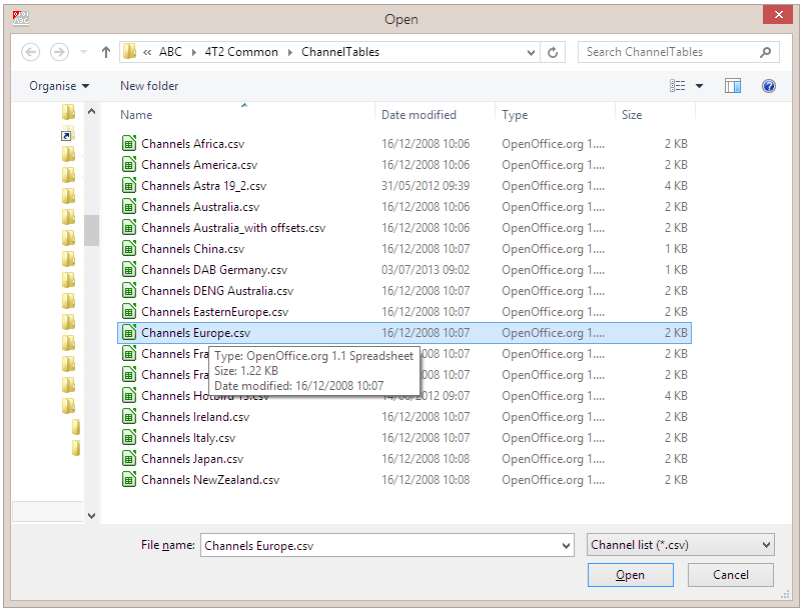


Illustration 8: Channel tables selection

Having selected a file, the channel drop-down list selects ***Frequency*** and ***Bandwith*** automatically, following the entry of the channel file.

System selects for DVB-T, or DVB-T2 reception.

Guard and ***FFT*** selector helps the receiver finding a lock in more demanding receiving conditions.

LNA mode selects the behaviour of the integrated low noise pre-amplifier.
For high level transmitter monitoring applications, it is recommended to select ***Fixed-off*** for higher level measurement accuracy. In all other applications, it is recommended to use the ***Auto/ Manual (*)*** setting.

The 10MHz IF filter is recommended in transmitter monitoring applications, when no adjacent channel is present.

TS only (no RF) disables the tuning, as well as the RF measurements in the XTASI-RF tab-sheet. This is the mandatory setting when using the modules with the **4T2 RF-Analyser** in multi-channel coverage applications. This setting avoids conflicts on accessing the modules, while still allowing for content decoding.

4.5 XTASI-S2

ABC receiver module for direct satellite RF-input via USB interface. XTASI-S2 supports DVB-S, and DVB-S2 modulated signals.

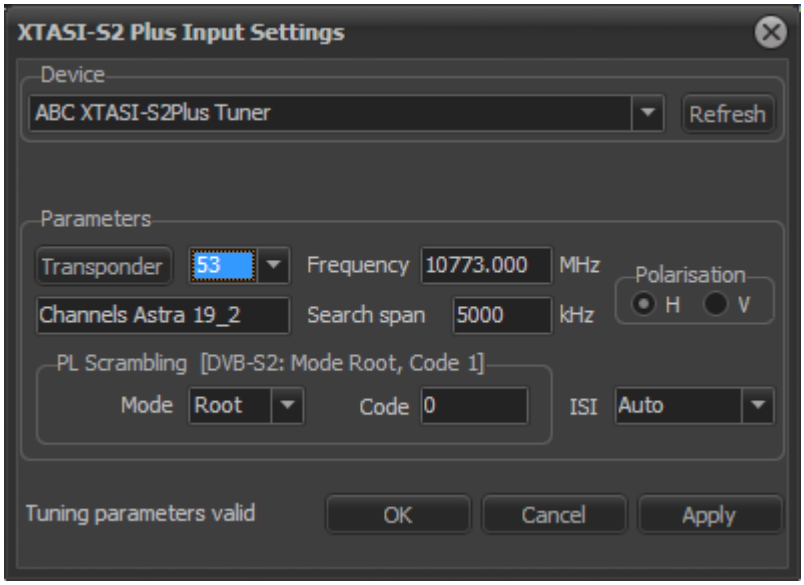


Illustration 9: XTASI-S2 settings dialogue

The ***Parameters-group*** establishes the tuning of the receiver. Clicking the ***Transponder-button*** gives access to channel table files stored as comma seperated values on the computer.

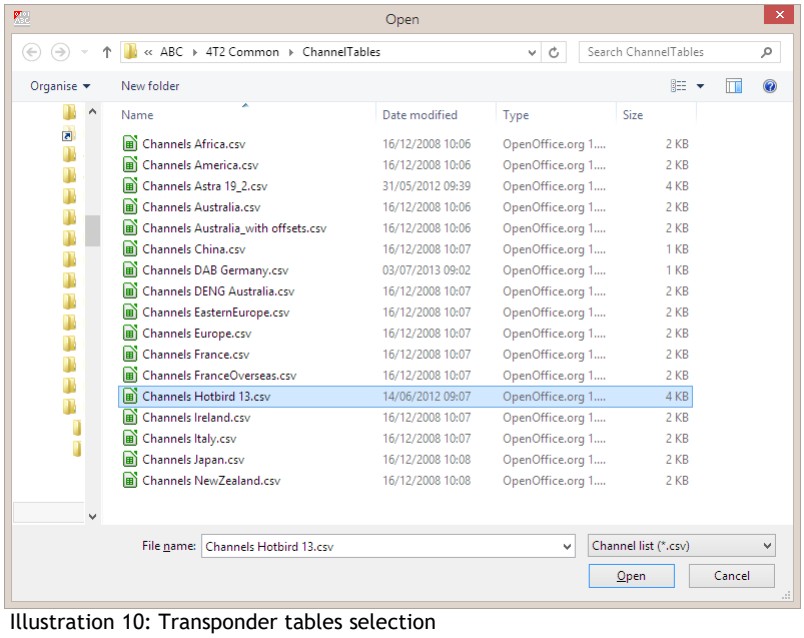


Illustration 10: Transponder tables selection

Having selected a file, the transponder drop-down list selects ***Frequency*** and ***Polarisation*** automatically, following the entry of the channel file.

Search Span selects the lock range of the blind-scan algorithm on tuning to a transponder.

PL Scrambling settings for DVB-S2 reception can be entered in the appropriate menues.

Physical Layer Scrambling is used in DVB-S2 as a way to improve data integrity. A number called the "scrambling sequence index" is used by the modulator as a master key to generate the uplink signal. This same number must be known by the receiver so that demodulation is possible.
Most satellite transponders use Mode Root, Code 1 as a default value but there are some transponders that use other values.

5 XTASI-RF

This sheet displays measurement parameters of the XTASI-RF module.

The upper left section selects the measurement graph, and the number of carriers displayed.

Level is displayed in dBm to the right of the measurement graph. Below the result is a field where a target value can be entered, with a delta button to display the delta value between target value and actual result to the right when activated.

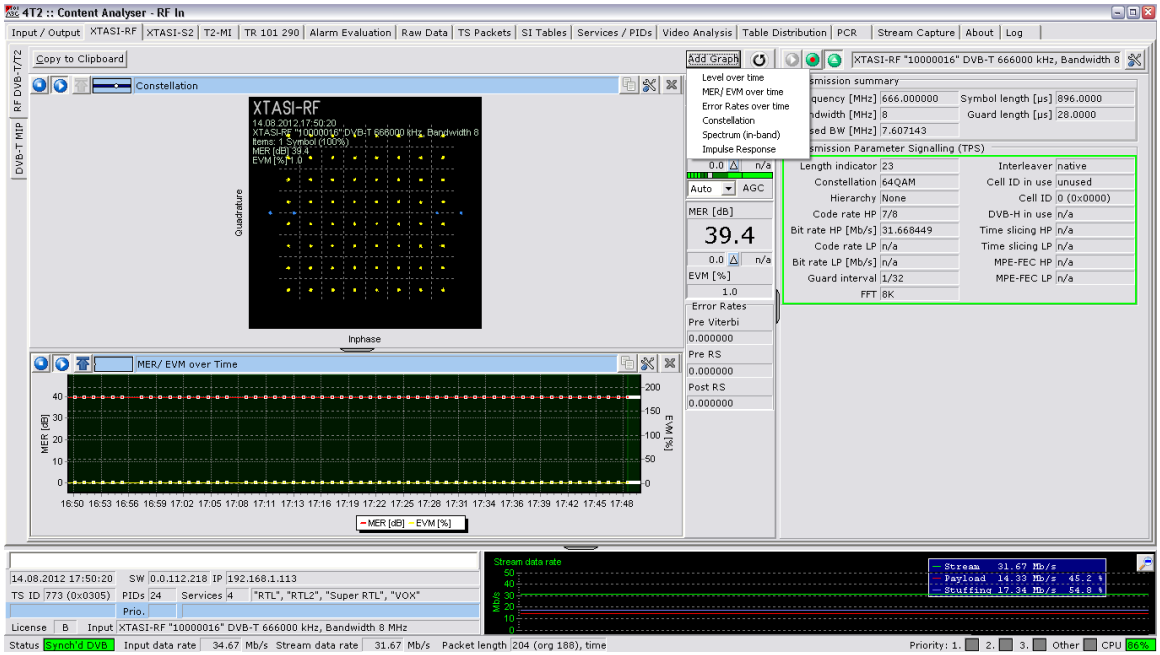


Illustration 11: XTASI-RF with DVB-T input signal applied

The MER result works like the Level result.

Error rates are displayed below Level and MER. This display alters when DVB-T2 is present.

The bottom section gives an overview on the application sync-status and data-rates of input-traffic and payload (all displays).

The data-rates are divided into Stream-, Payload-, and Stuffing-Rates.

Priority one, two, and three errors are summarised by indicating lights. Green is used to display no errors, red indicates an error, and yellow to show a previous error that is no longer present.

Although user-interactive operation is available in all areas of the application, remote SNMP-controlled operation is limiting the local operator to an observer without the option to change any of the settings in the content analyser software.

5.1 Input Level Conversion dialogue

The XTASI-RF tab includes a comprehensive input level conversion formula editor to perform automatic level unit, or level to field-strength conversions.
The conversion can include gain factors, antenna factors, and any other expressible formula.

The user may select between the units Watt, Volt, Ampere respectively dBm, dBµV, dBµA or dBµV/m if using of calibrated antennas. A conversion check-box for 75 Ohm inputs is included.

Any gain factors may be included to include amplification (positive values), or cable losses (negative values).

The applied formulas are displayed in the expression field. Please note that application internally works with the unit dBm.
Fields with a light red background contain the results of actually measured values. Fields with light blue background can be used for checking an entered formula

The application automatically stores a history of previously entered expressions.

The input level, displayed is always a result of the level measurement at the input connector and an expression (formula) for input level conversion.

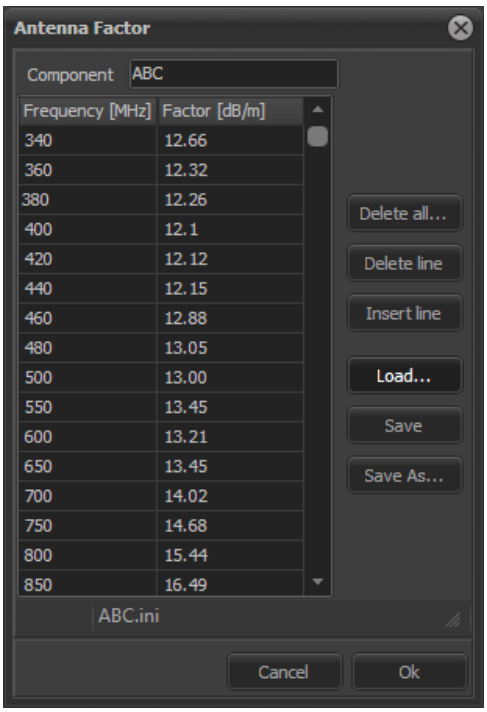


Illustration 12: Antenna factor dialogue

Using calibrated measurement antennas requires a possibility to adopt the 4T2 to the antenna calibration data. This task can be easily done within the Input Level conversion section.

In the Antenna Factor dialogue (Button: Ant. factor), the corresponding frequency and antenna factors may either be entered manually, or loaded from an external file. Antenna correction files are of ASCII type with .ini extension.

By default, the factor files are located in the AntennaCorrectionFactors folder within the \ program files\ABC\ system directory.

During measurements, the software performs a linear interpolation between the entered frequency references.

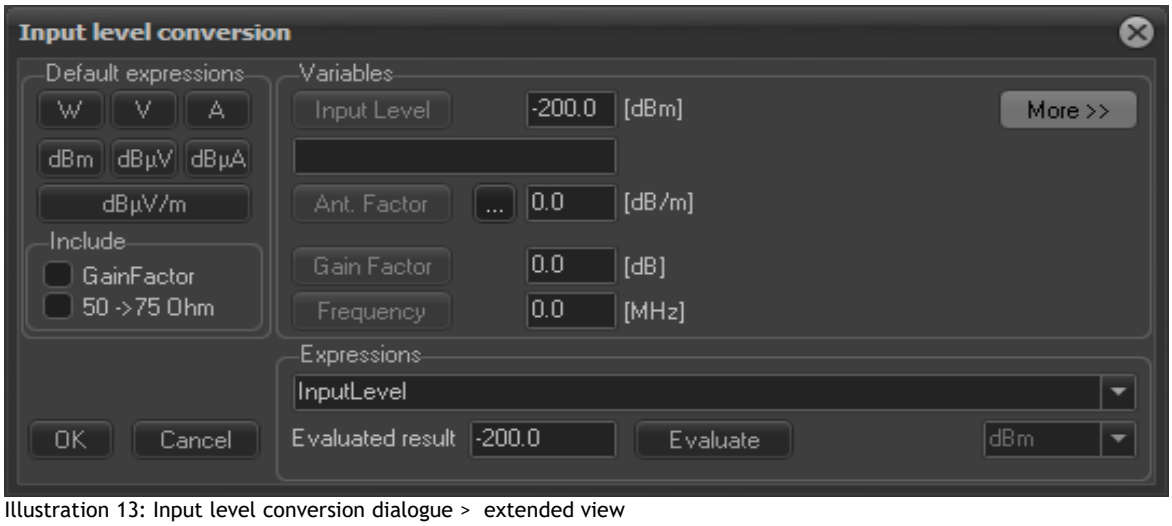


Illustration 13: Input level conversion dialogue > extended view

For user defined level conversions, a comprehensive calculator is provided, giving a variety of mathematical-functions. The evaluated result will be used for all further measurements.

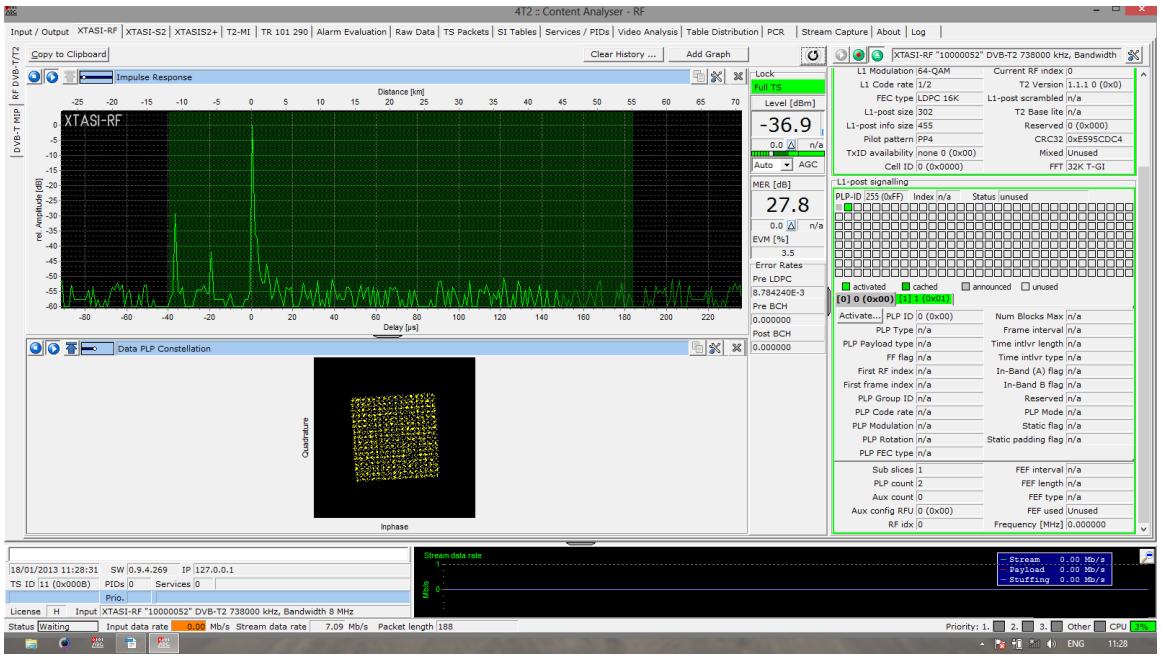


Illustration 14: XTASI-RF tab-sheet with DVB-T2 input signal applied

On switching between DVB-T2 and DVB-T signals, the XTASI-RF receiver hardware has to be retuned with the correct system selected. There is no automatic detection to distinguish between DVB-T and DVB-T2.
The settings of the DVB-T Constellation or the DVB-T2 Data PLP Constellation regarding the amount of carriers (points), are used to calculate the MER/EVM even if the display itself is off.

A manual mode of the tuner Gain/Attenuation is possible to find the best working position, reflecting the best MER and lowest bit error ratio. Changing those settings may influence the transport stream quality.

The automatic mode will override those settings only in "edge"-situations and will not attempt to tweak to finding a better MER.
The behaviour is displayed by two green bars. The right bar shows the inverted IF-Gain, the left bar the inverted RF-Gain.
As a result, more green indicates a higher level at the antenna input.

To get the best MER readings, try to move the green bar in the middle of the RF-Gain.

The MER calculated and displayed is a result of an internal correction of the constellation points, calibrated with an SNR-reference signal. The correction is performed once on every displayed constellation point. The displayed MER is calculated to give a 1:1 relation of the displayed constellation points to the MER.

An RF-Recording and RF-Replay function has been build in. Having no XTASI-RF attached, you are able to replay some previously recorded samples. After pressing the "play" button you may select a file from the folder C:\Program Files\ABC\4T2 Content Analyser\XTASI-RF-Recordings

One DVB-T live reception and one DVB-T2 generator signal are captured for you. Please activate all wanted displays like constellation or impulse response.

Having an XTASI-RF attached, you can record the RF-Parameters (RF-Level, TPS / L1 information, and Constellation etc.). Only activated displays are saved, e.g. if your Impulse response is deactivated the data will not be saved into the recorded file.

MultiPLP for DVB-T2 is supported. The receiver can demodulate one of the transmitted PLPs at a time. The number of the PLP has to passed while tuning. Since the announced PLPs are only found while tuned, you should use the "Auto" setting for the PLP selection. This will select the first announced PLP and update the list of PLPs.
The display below the DVB-T2 L1 pre and post parameters displays the announced PLPs. You can switch to a different PLP simply by double-clicking on one of the green boxes.
All fetched PLP information are hold in memory until restart.
The PLP selection is stored in the last-mode file. If you tune to a different channel, the selected PLP may not be present. It seems that the receiver uses the first announced PLP if the selected PLP is not in the list.
The latest XTASI-RF are equipped with an analogue-spectrum with a span of (almost) 10MHz and a resolution of 10kHz. This is independent of the kind of the attached signal (no decoder "lock" is required).
To see the shoulders of a DVB-T/T2 signals it is required to increase the IF-Filter bandwidth of the Tuner to 10 MHz. Select the "10MHz IF-Filter" check-box in the XTASI-RF tuning dialogue, prior to tuning.
If you experience influences of adjacent channels (lower MER, higher BER and RF-level deviations) "10MHz IF-Filter" check-box should be unchecked again to increase the suppression of out of band signals. In this case the displayed spectrum looks different for each selected channel bandwidth and the upper shoulder (in RF-domain) is located very close to the end of the spectrum graph.
The "Spectrum" graph could be inserted by clicking "Add Graph" and "Spectrum" in the pop-up menu. Spectrum data are only collected while the "run" button in the spectrum graph is checked. Stopping the spectrum collection will give more time to collect the other values, thus increasing the display speed of the constellation etc.

6 XTASI-S2

This tab-sheet displays measurement parameters of the XTASI-S2+ module.

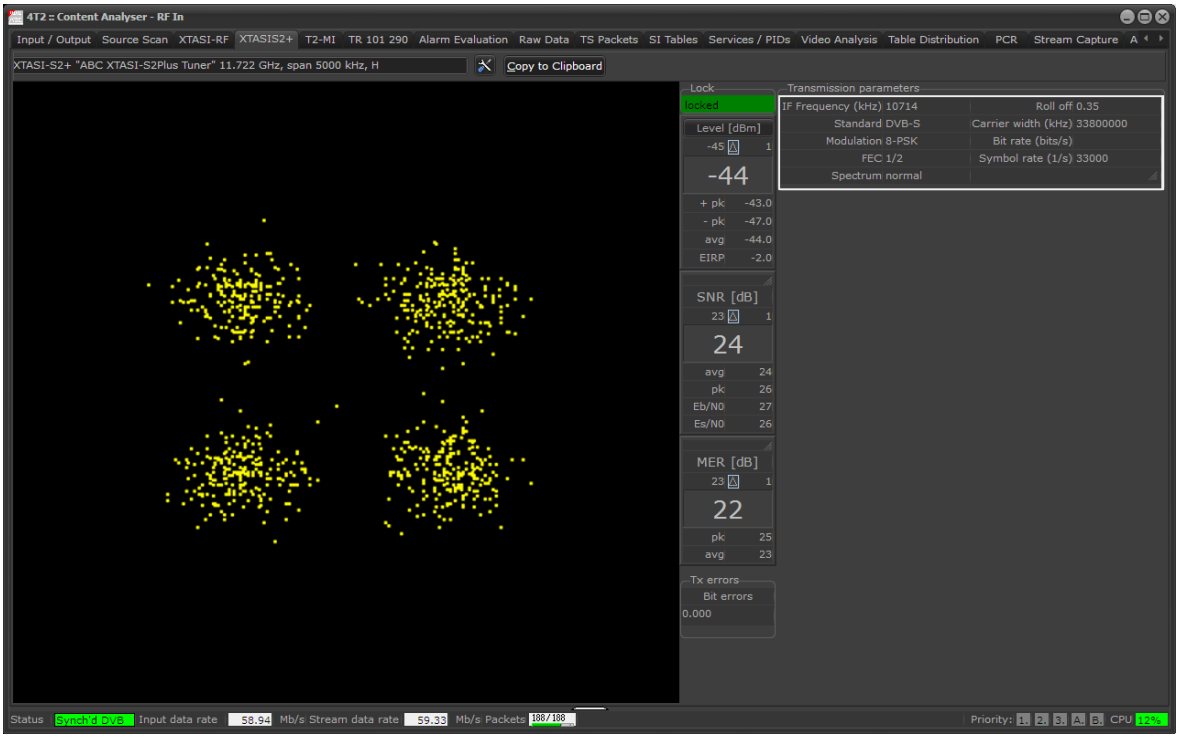


Illustration 15: XTASI-S2+ tab-sheet

Level is displayed in dBm to the right of the constellation graph. Below the result is a field where a target value can be entered, with a delta button to display the delta value between target value and actual result to the right when activated.

In addition to the display of current level, positive and negative peak values as well as averaged values are displayed. The entry of a coupling factor allows the calculation of EIRP values in uplink scenarios.

The **SNR** (Signal to Noise Ratio) display has a delta function similar to the level display. Average and peak levels for SNR are displayed for quality assessment purposes. Based on the modulation scheme, data rate and used bandwidth, Eb/N0 and Es/N0 values are calculated and displayed.

Eb/N0 (the energy per bit to noise power spectral density ratio) describes a normalised signal-to-noise ratio (SNR) measurement, also known as the "SNR per bit". It is used to compare the bit error ratio (BER) performance of different digital modulation schemes without taking bandwidth into account.

Eb is the signal energy associated with each user data bit. It is equal to the signal power divided by the user bit rate (StreamDataRate in the 4T2 Content Analyser). If signal power is in watts and bit rate is in bits per second, Eb is in units of joules (watt-seconds). N0 is the noise spectral density, the noise power in a 1 Hz bandwidth, measured in watts per hertz or joules. These are the same units as Eb so the ratio Eb/N0 is dimensionless; it is frequently expressed in decibels. Eb/N0 directly indicates the power efficiency of the system without regard to modulation type, error correction coding or signal bandwidth.

Signal bandwidth is defined in broadcast transmission systems, hence Eb/N0 is also equal to the signal-to-noise ratio (SNR) in that bandwidth divided by the "gross" link spectral efficiency in (bit/s)/Hz, where the bits in this context again refer to user data bits (StreamData), irrespective of error correction information and modulation type.

Eb/N0 must be used with care on interference-limited channels since additive white noise (with constant noise density N0) is assumed, and interference is not always noise-like.

Eb/N0 can be seen as a normalised measure of the energy per symbol to noise power spectral density (Es/N0).

Es/N0 can further be expressed as Es/N0 = C/N * B/fs, where
C/N is the carrier-to-noise ratio or signal-to-noise ratio.
B is the channel bandwidth in hertz.
fs is the symbol rate in baud or symbols per second.

The **MER** (Modulation Error Ratio) display works like the SNR display, including average and peak values.

Error rates are displayed below the MER.

The receiver works with a blind scan function that does not require the entry of modulation parameters, like like selecting DVB-S or DVB-S2.

The bottom section gives an overview on the application sync-status and data-rates of input-traffic and payload (all displays).

7 T2-MI

This tab-sheet displays the parameters of the DVB-T2 MI (modulator interface) module.

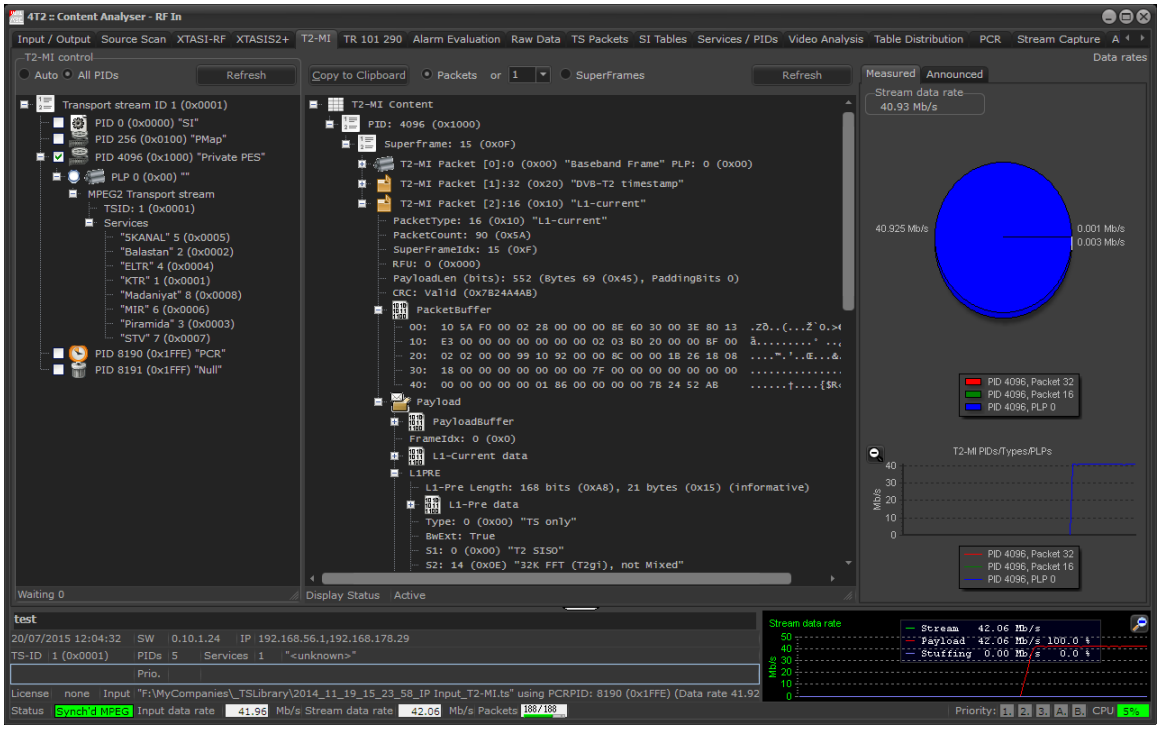


Illustration 16: T2-MI tab-sheet

The 4T2 Content-Analyser application is able to perform an analysis of T2-MI Transport Streams according to ETSI TS.102.773.

T2-MI Transport Streams can be fed into the 4T2 Content Analyser using the ASI, UDP, File, or DVB-S2 input interfaces

The implementation decodes BasebandFrames, L1-Current, and DVB-T2 time-stamp packets.

Additionally, one physical layer pipe PLP in one packet identifier PID may be selected to de-capsulate the content and forward this MPEG2 Transport Stream into the Content-Analyser engine.

This enables further analysis of the encapsulated MPEG2 Transport Stream.

It is not possible to automatically detect T2MI, since the content could be encapsulated into any PID and without any additional PSI information.
Although this would present the lowest data overhead, the standard recommends that it may be helpful to add a minimum PSI with a private stream identifier 0x06 to be announced in the PMT.

Since private streams with identifier 0x06 are used by several streams including AC3 Audio, only an active "probing" (currently not implemented) could solve the problem.

The T2-MI implementation in the 4T2 Content Analyser is as follows:
a) If "Auto" is selected in the T2-MI control box on the T2-MI tab-sheet, all PIDs of the MPEG-TS announced in the PMT and containing a private stream 0x06, without any additional information (e.g. descriptors) that identify those streams as AC3, DSMCC, etc., are listed in the T2-MI Control tree.

b) If "All PIDs" is selected, all available PIDs are shown.
The PIDs listed can be activated by checking their boxes. After checking one or more PIDs the corresponding payloads are treated as T2-MI packets.

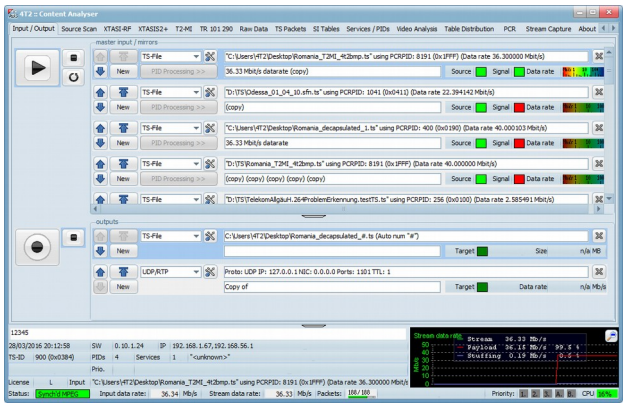
Selecting non T2-MI PIDs will almost certainly show undetermined results, visible through invalid CRC32 check-sums.

If PLPs are available they are listed in the control tree below their corresponding PIDs.
(n.b. The current release fails to extract MPEG2 streams from the PLP if the data-stream is not byte aligned (e.g. Offset and length are not modulo 8)).

Exemplary steps to analyse a DVB T2-MI Transport Stream with the 4T2 Content Analyser

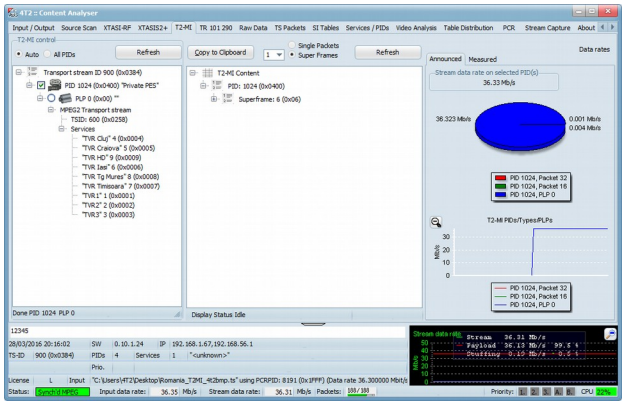
1) Feed a T2-MI compatible Transport Stream to the 4T2 Content Analyser through one of the supported input interfaces (here: file-interface).

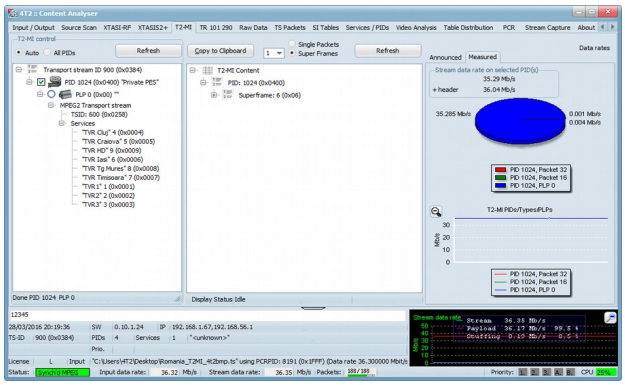
Notes:
A T2-MI compatible Transport Stream shows 'Synch'd MPEG' in the status line, as it is compatible to ISO/IEC standard 13818-1 or ITU-T Rec. H.222.0.
On selecting file as input, you might have to manually enter the data-rate, as some of real-world T2-MI Transport Streams do not carry a Program Clock Reference signal (PCR) (the correct value for playback can be derived from the 'announced data rate' display described below).



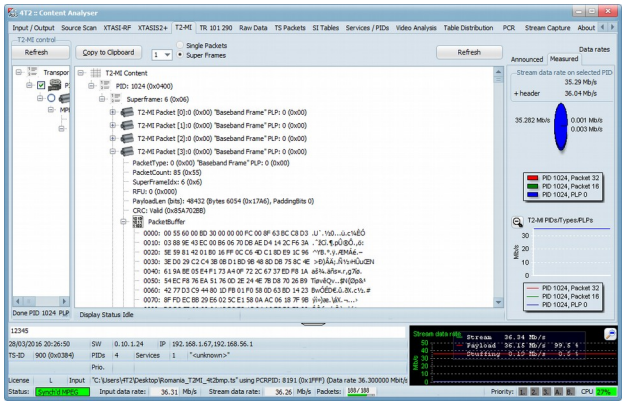
2) Open the T2-MI tab-sheet of the 4T2 Content Analyser. The display is divided into three parts – the left hand side is used for controlling the analyser.
'Auto' is selected in T2-MI Control, showing only one PID 1024 carrying private data with identifier 0x06.
Checking the PID, starts a PLP scanning subroutine. One PLP is found, displaying a number of services in the encapsulated DVB-T2 compatible Transport Stream.
The right hand side display shows two tab sheets, with announced and measured data rate of the selected PIDs.

Notes:
'Announced data rate' is the data rate of the stream including all pids and synch bytes.
'Measured data rate' is normally lower, as the header information is typically omitted during transmission. The '+header' display adds 4 bytes per MPEG Packet to simulate this.





3) The center display allows for a detailed analysis of T2-MI Content.
The user has the choice to select single packets, or to collect packets of a selectable number of Super Frames for the analysis.

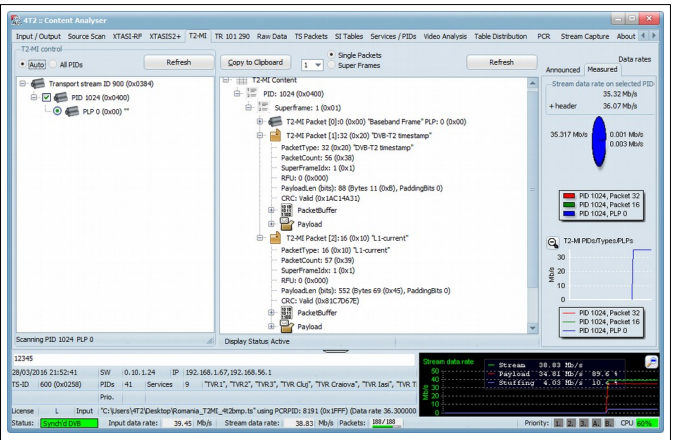


4) In addition to T2-MI analysis, the 4T2 Content Analyser allows for the de-capsulation of single PLPs for further processing.

There is the option to store of forward selected PIDs, or to analyse above PID within the 4T2 Content Analyser itself.

The de-capsulation is initiated through selecting the radio-button to the left hand side of the corresponding PLP (here PLP 0). Once the PLP is activated, the contents are de-capsulated and corresponding headers are added (like 0x47 sync-bytes, CC counters, or stuffing bytes). Therefore the resulting data rate of the DVB-T2 compatible Transport Stream is certainly significantly higher than the data rate of the T2-MI Transport Stream.

After the PLP has been selected, the 4T2 Content Analyser is feeding the DVB-T2 Transport Stream back to the input (the status changes from 'Synch'd MPEG' to 'Synch'd DVB' in the process).

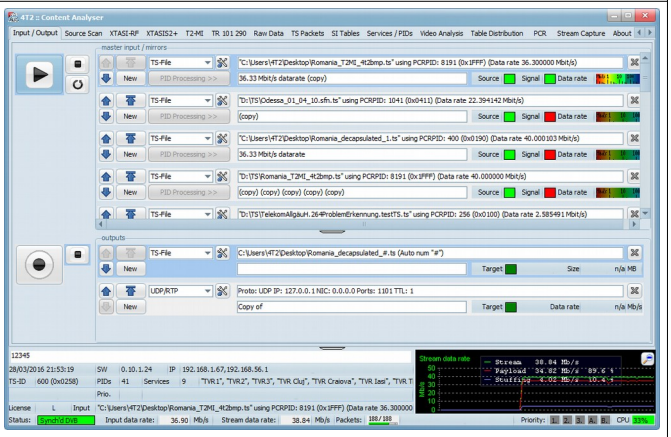


Notes:

Further to analysis of the T2-MI Transport Stream, the de-capsulated contents can be forwarded to either file (for documentation purposes) or to the network via UDP, RTP.

De-capsulation of a T2-MI Transport Stream is a memory and processing power intensive task, that requires a high single-thread performance of the CPU utilised. Therefore, it might be required (mostly in portable platforms) to split the task of analysis and content decoding (which is another memory and processing power intensive task on its own). To achieve this, it is recommended to write the de-capsulated PLP first to file and then perform the file analysis later.

This procedure avoids data rate mis-readings, once the 4T2 Content Analyser can not cope with the amount of real-time data due to temporary CPU overloads.



8 TR.101.290

This tab-sheet displays first, second, and third priority error tests described in TR.101.290. Each individual error event checking can be activated, or deactivated.

Comments on the right hand side together with date and time of occurrence are logged to file and announced through the SNMP interface.

Overall number of errors and time of last error is displayed.
The errors are grouped into categories which in turn can be activated or deactivated in full.

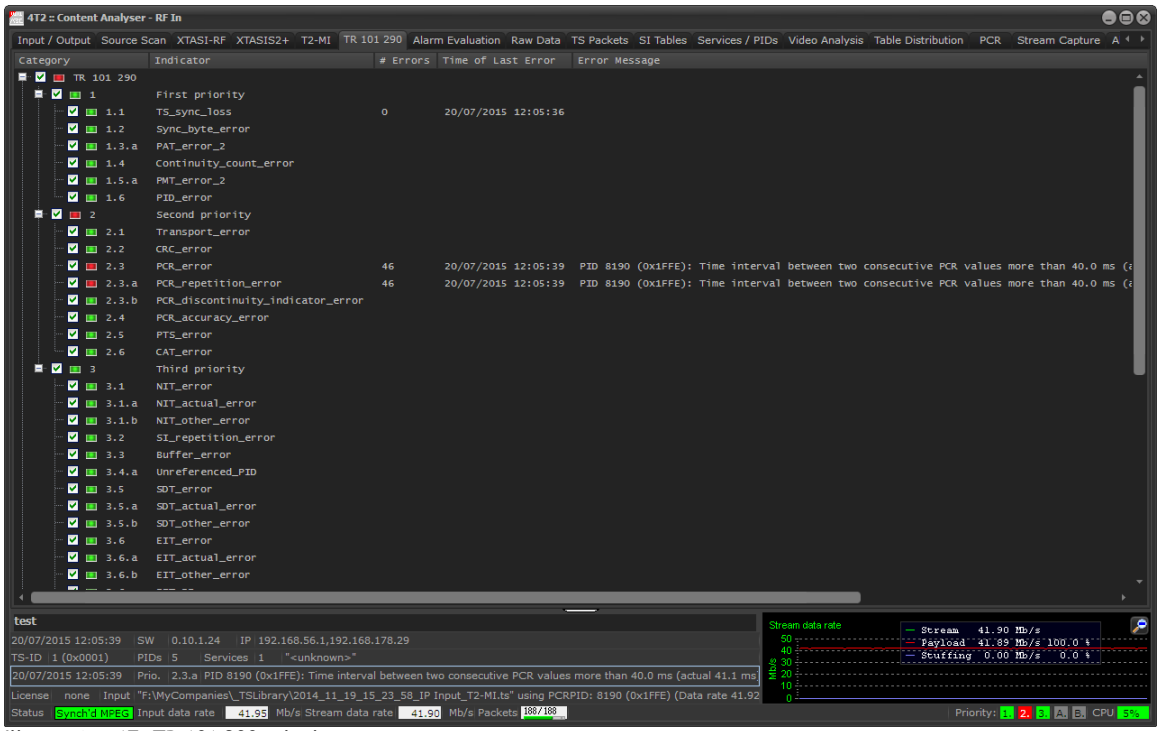


Illustration 17: TR 101 290 tab-sheet

The bottom section gives an overview on the application sync-status and data-rates of input-traffic and payload (all displays).

The data-rates are divided into Stream-, Payload-, and Stuffing-Rates.

Priority one, two, and three errors are summarised by indicating lights. Green is used to display no errors, red indicates an error, and yellow to show a previous error that is no longer present.

A combined A. and B. summary error display is employed in addition to the ones defined in TR.101.290, to allow for further error checking.

Although user-interactive operation is available in all areas of the application, remote SNMP-controlled operation is limiting the local operator to an observer without the option to change any of the settings in the content analyser software.

9 Raw Data

This tab sheet allows for analysis of the Transport Stream content before the signal is packetised.

The sheet allows to check the transport stream on a bit and byte level. No synchronisation is required. The function can be compared to the works of an oscilloscope.

Lines defines the number of bytes displayed, with Length the number of bytes per line, and Count the number of lines.
The Trigger control selects between Single-, or Multiple trigger.
Smart trigger allows the selection of bit-wise Value, and Mask definitions to uncover bit-related problems in processing equipment, such as shorts, or open circuits.

The analyser can pick up missing sync-bytes, or bits that are stuck at a low, or high logic level.

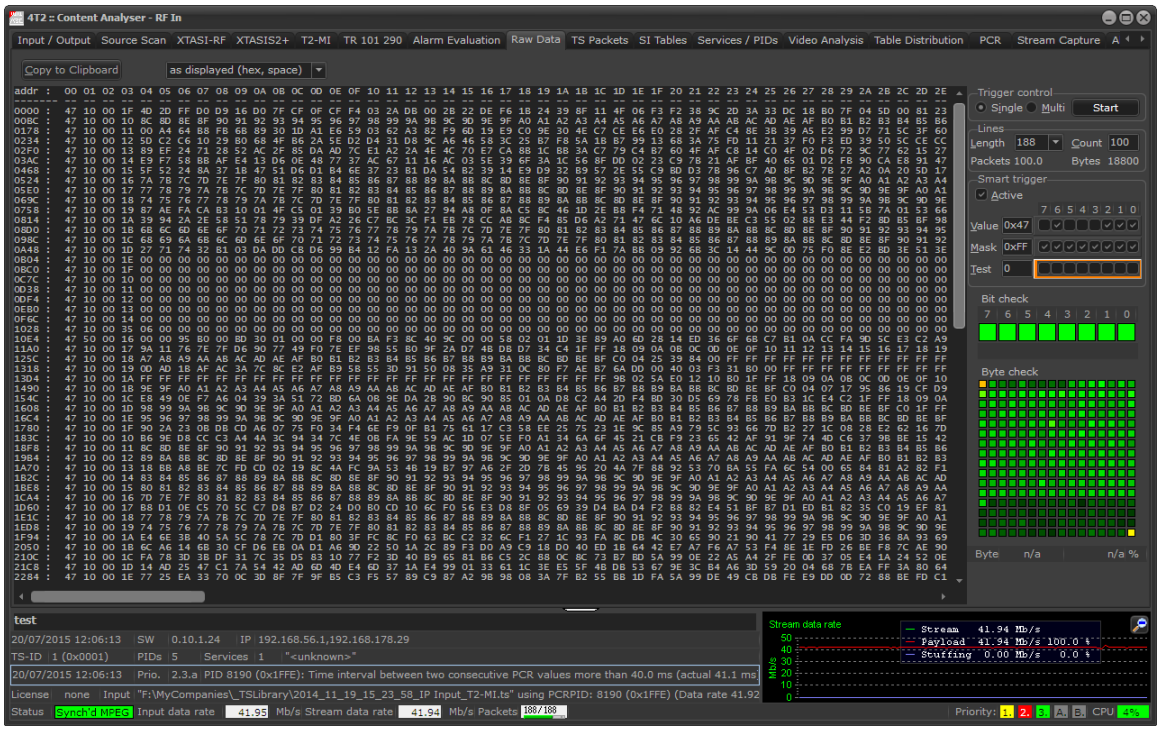


Illustration 18: Raw-data tab-sheet

The Bit check function also allows the detection of bits that are shorted with other bits, or stuck at VCC or GND. This feature is invaluable in R&D scenarios.

The Byte check display shows if certain bytes are not present, or overly present in the transport stream.

10 TS-Packets

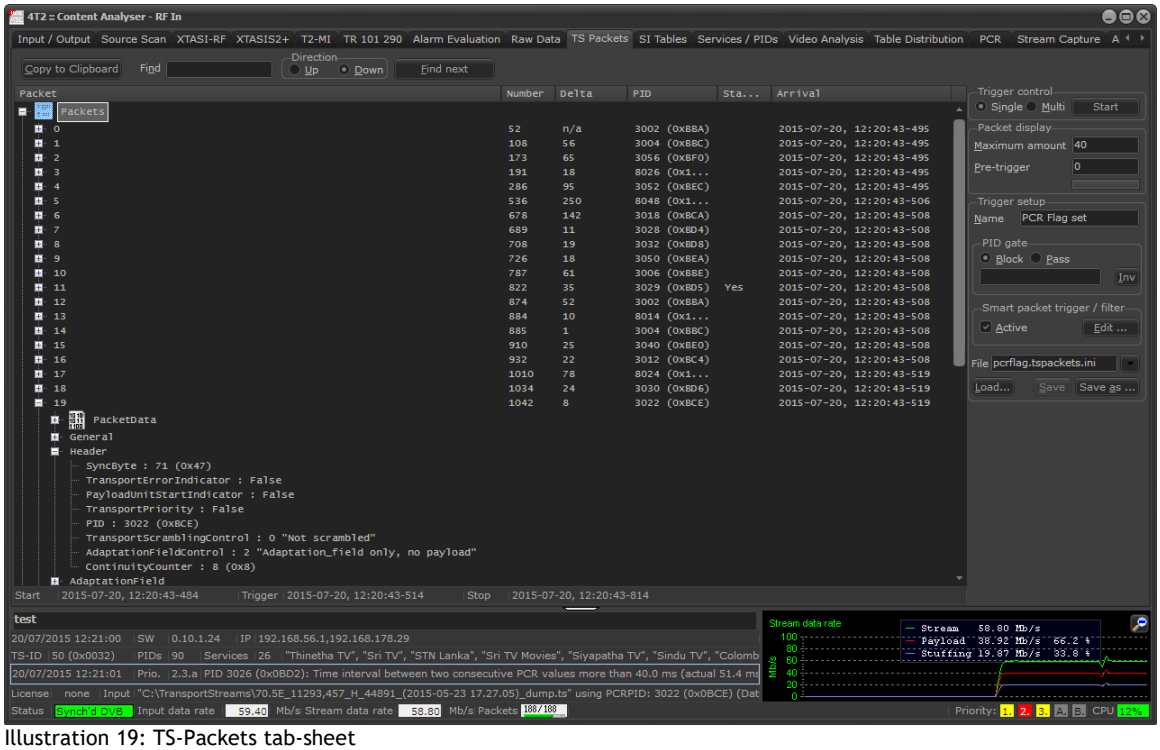


Illustration 19: TS-Packets tab-sheet

The **TS-Packets** section of the **4T2 Content-Analyser** allows for the detailed inspection of the transport stream on packet-level.

The key to the transport stream packet display is the definition of the trigger-condition.
Once a trigger-event has occurred, the packets will be displayed following the defined rules until the **Maximum amount** of lines is reached

You can perform the **Trigger setup** in a **simple**, or in a **smart** (sophisticated) manner.

The **simple** approach can detect the occurrence of a specific PID, or PIDs within a range. By using **PID gate** with the **block**, **pass**, and **invert** features, you can tweak the display to only show packets you are interested in.

The **smart** approach can detect all most every case of packet configurations, including the evaluation of packet flags and counters. It is possible to detect resent packets, or to capture one block of packets between payload unit start indicators.

Trigger control

- Selecting **Single** configures for a single-shot capture process of packets.
- Selecting **Multi** configures for continuous capture processes (interrupted by small pauses).
- **Start** starts the capture engine (the button inverts into **Stop**, which allows the abortion of the current capture process). The button blinks on slow trigger situation to indicate this condition.

Packet Display

- **Maximum amount** sets the number of packets to display

- **Pre-trigger** determines the number of packets displayed before the trigger event

You define how many packets to display, and how many packets to display before the trigger event.
The progress bar below the field indicates how many packets are in the **Pre-trigger** queue, or already in the display.

Remark: There may be less packets displayed than defined in **Maximum amount,** if a **Smart packet trigger / filter** expression has prematurely stopped the capture processing

Remark: **Pre-trigger** might not always work as expected. If the trigger condition is true before the amount of packets specified in **Pre-trigger** is received, the capture starts regardless.

Trigger setup
- **Name** allows to select a user defined name for the trigger setting

PID gate
- **Block** packets from the display
- **Pass** packets to the display
- **Inv**ert inverts the entered gate condition

Data entry follows the <PIDLIST> syntax shown below. Overlapping of ranges or multiple PIDs are allowed.

Single PID	defines exactly one PID number
<PID> ::=	"0.."8191" | "0x0000" .. "0x1FFF" | "$0000.."$1FFF"
V	valid examples: 0, $0B00, 0x1000
I	invalid examples 10000 (larger than 8191), B00 (missing "$" or "0x" as Hexadecimal identifier), -2 (negative numbers not allowed)
Range of PIDs	defines a range of continuous PIDs
<PIDRange> ::=	<PID>-<PID>
V	valid example: 10-$10 (contains the PIDs 10, 11, 12, 13, 14, 15, 16)
I	invalid example: 20-18 (second PID smaller than first PID)
List of PIDs	defines a list of several PIDs
<PIDList> ::=	<PID>|<PIDRange> [, <PIDList>]
V	0 (contains the single PID 0) 10-$10 (contains all PIDs from 10 to 16) 0, 10-$10, 0x400 (contains PIDs 0, 10, 11, 12, 13, 14, 15, 16, 1024)

The **Inv** button inverts the gate condition.

Example:
You want to pass PID 161 only:
Enter 161 in the field and click **Inv**. The content of the field changes to 0-160,162-8191, reflecting that all pids from 0 to 160, as well as from 162 to 8191 should be ingnored.

Smart packet trigger / filter
The setup must be activated prior to use.
Please note that the **PID gate** is located before the **Smart packet trigger / filter.**
A packet **block**ed at the **PID gate** will not arrive at the **Smart packet trigger / filter**.

The **Smart trigger / filter** setup uses three independent lists of expressions. The expressions are evaluated during the capture processing.
If the result value of the last expression in the list is greater than 0.1, or smaller than -0.1, the whole expression evaluates “true”

The three lists of expression are
- Packet filter expression
- Trigger expression
- Stop expression

If an expression list is left empty, it evaluates “true” for filter-, and trigger-expressions, but “false” for the stop expression.

The **Packet filter expression** evaluates every packet passing through the **PID gate**.
If the expression evaluates “true”, then the packet is entered into a packet-queue, otherwise it is discarded.

If the **Trigger expression** evaluates “true”, the capture process is triggered. From that point onwards, all packets from the packet-queue (including **Pre-trigger,** if any) are displayed.

Once triggered, the **Stop expression** is used on any further packet that passes the **Packet filter** (The packet that actually caused the trigger is blocked). If the **Stop expression** evaluates “true”, the capture process is stopped.

All expressions share the same parser and the same database of variables to interact between the expressions.

The syntax of the expressions consist of:
comments, all lines starting with “//” are ignored by the parser
constants, numbers like 1.23 or 42
variables, place holders for numbers
operators, to merge two intermediate results like “+”, “-”, “and”, “=”
brackets, “(“ and “)” to order the precedence of evaluation
a delimiter, “;” to separate expressions and parameters
functions, which return a modified value based on the parameters, like “round”, “max”, or “if”
additionally the assign operator “:=” exists to store a result to a variable.
Variables can be formed as an array. The indices may be any expression (but are rounded before usage).

The “if” function returns the value of the second parameter, once the first parameter evaluates “true”, else the third parameter.

Examples:
IsMax := max(2;3);
assigns the result of the maximum function, returning the greater of two values passed to the function, to the variable named “IsMax”

If(1;2;3);
returns 2, since 1 evaluates “true”

For testing purposes, you can enter this example into the **Command** field in the **Smart trigger / filter** dialogue and evaluate by clicking on **Execute**.

Enter: IsMax := max(2;3)
The result: “3.0000” will be displayed

Enter: IsMax+3;
The result: “6.0000” will be displayed

All non existing variables (**User vars**) will be created on the fly and initialised to “0”

There are pre-defined variables (**Packet vars**) to allow the evaluation of trigger, and filter conditions:

csb	CurrentSyncByte: range [0..255 (0xFF)]. Current sync byte, value 71 (0x47), a single occurrence of a different value is allowed
ctei	CurrentTransportErrorIndicator: range [0,1]. Set by the demodulator to indicate that at least one byte in the packet could not be corrected
cpusi	CurrentPayloadUnitStartIndicator: range [0,1]. Indicates that the payload contains a starting point
ctp	CurrentTransportPriority: range [0,1]. Indicates that the payload has a higher priority
cpid	CurrentPID: range [0..8191 (0x1FFF)]. Identifier of the current packet
ctsc	CurrentTransportScramblingControl: range [0..3]. 0 not scrambled, 1..3 scrambled by different methods
cafc	CurrentAdaptationFieldControl: range [0..3]. 0 reserved, 1 payload-only, 2 adaptation-field-only, 3 adaptation-field plus payload
cafl	CurrentAdaptationFieldLength: range [0..255 (0xFF)]. Length of the adaptation field. Since the field must fit into a single packet values are limited to 182 or 183
ccc	CurrentContinuityCounter: range [0..15 (0xF)]. All packets with the same PID contain a counter that loops through the range. One packet may be resend once, keeping the previous value
cdi	CurrentDiscontinuityIndicator: range [0,1]. If 1, the continuity-counter was not updated and should be ignored
crai	CurrentRandomAccessIndicator: range [0,1]. current packet contains some information to aid random access at this point
cespi	CurrentElementaryStreamPriorityIndicator: range [0,1]. If 1, the payload has a higher priority than the payloads of other packets
cpcrf	CurrentPCRFlag: range [0,1]. 1 indicates that PCR value exists
copcrf	CurrentOPCRFlag: range [0,1]. 1 indicates that original PCR value exists
cspf	CurrentSplicingPointFlag: range [0,1]. 1 indicates that splice countdown value exists
ctpdf	CurrentTransportPrivateDataFlag: range [0,1]. 1 indicates that the packet contains private data
cafef	CurrentAdaptationFieldFxtensionFlag: range [0,1]. 1 indicates that the packet contains an adaptation field extension
cprcb	CurrentProgramClockReferenceBase: range [0..8589934591 (0x1FFFFFFFF)]. Current sample of the PCR-clock. The clock runs with 90kHz ~ 1/11.11µs
cpcre	CurrentProgramClockReferenceExtension: range [0..511 (0x1FF)]. Extension of the PCR clock. This extension runs with 27MHz ~ 1/37.037ns
copcrb	CurrentOriginalProgramClockReferenceBase: range [0..8589934591 (0x1FFFFFFFF)]. Current sample of the original PCR clock. The clock runs with 90kHz ~ 1/11.11µs
coprce	CurrentOriginalProgramClockReferenceExtension: range [0..511 (0x1FF)]. Extension of the original PCR clock. This extension runs with 27MHz ~ 1/37.037ns
cspc	CurrentSpliceCountDown: range [0..255 (0xFF)]. number of packets until a splicing point is reached
ctpdl	CurrentTransportPrivateDataLength: range [0..255 (0xFF)]. number of bytes containing private data. Since the data must fit into a single packet values are limited to lower values
cafel	CurrentAdaptationFieldExtensionLength: range [0..255 (0xFF)]. length in bytes of the adaptations field extension. Since the data must fit into a single packet values are limited to lower values
cltwf	CurrentLtwFlag: range [0,1]. legal time window_flag 1 indicates the presence of the ltw_offset field
cprf	CurrentPiecewiseRateFlag: range [0,1]. 1 indicates the presence of the piecewise_rate field
cssf	CurrentSeamlessSpliceFlag: range [0,1]. 1 indicates that the splice_type and DTS_next_AU fields are present
cltwvf	CurrentLtwValidFlag: range [0,1]. Legal time window_valid_flag. 1 indicates that the value of the

	ltw_offset shall be valid
cltwo	CurrentLtwOffset: range [0..32767 (0x7FFF)]. Legal time window offset see ISO 13181-1 for further information
cpr	CurrentPiecewiseRate: range [0..4194303 (0x3FFFFF)]. See ISO 13181-1 for further information
cst	CurrentSpliceType: range [0..15 (0xF)]. See ISO 13181-1 for further information
cdtsnau	CurrentDTSNextAU: range [0..8589934591 (0x1FFFFFFFF)]. See ISO 13181-1 for further information

Example 1
Wait for the first packet whith ContinuityCounter value “0”

	Variable used	Evaluates true on
Packet filter expression		
./.	./.	./.
Trigger expression		
ccc=0	CurrentContinuityCounter	0
Stop expression		
	./.	./.

If ccc equals 0 the expression returns “True”, starting the capture process.

Example 2
Capture a continous block between two PayloadUnitStartIndicators to display one elementary stream unit.
Use **PID gate** to pass a single PID, since this is more efficent than evaluating the filter expression.

	Variable used	Evaluates true on
Packet filter expression		
./.	./.	./.
Trigger expression		
cpusi	CurrentUnitStartIndicator	
Stop expression		
cpusi		

The first packet coming through the **PID gate** with the CurrentUnitStartIndicator set triggers the capture.
PIDs containing SI Tables, or Video and Audio streams inform the decoder by setting this flag that within the payload of this packet, a new “thing” (unit) starts (this happens not neccessarily synchronised with packet boundaries). Depending on the amount of information, the block(unit) of data could span more than one transport stream packet, while the information of tables like PAT, TDT, or TOT may fit into a single transport stream packet.
Since the packet that actually caused the trigger is blocked, the same expression text can be used to stop the capture process.
The display shows the (first) packet with the CurrentUnitStartIndicator set, all subsequent packets containing the same block (unit) of payload, and at last the next packet with the CurrentUnitStartIndicator set.
The last packet displayed may contain the tail of the block (unit), since the payload information is not neccessarily synchronised with packet boundaries.

Example 3

As above, capture a continous block between two PayloadUnitStartIndicators to display one elementary stream unit, but using the first PID that has the PayloadUnitStartIndicator set as a filter.

Set **PID gate** to pass all PIDs.

Packet filter expression

if(TriggerPid;cpid+1=TriggerPid;1)

Trigger expression

TriggerPid := if(cpusi;cpid+1;0)

Stop expression

cpusi

Filter expression

The **Filter expression** is evaluated prior to the Trigger and Stop expressions.

This example has two states of filtering.

Prior trigger, the filter shall pass all packets (passive state), after trigger only packets with TriggerPid should pass (active state).

The filter states are toggled by the “if” function.

Prior trigger, the variable TriggerPid is 0 (default after creating a new **user var**iable).

The **Filter expression** must evaluate “true” to let all packets pass.

Since “0” evaluates to “false”, the third parameter of the “if” function is set to “1” returning “true” for the whole expression, hence letting pass all packets to the queue.

After trigger, the variable TriggerPid contains a value between 1 and 8192 (The PID of the packet with the CurrentUnitStartIndicator set). This is different from 0, causing the “if” function to return the second parameter “cpid+1=TriggerPid”.

“cpid” contains the current PID, and TriggerPid the trigger condition (cpid+1).

Therefore “cpid+1” equals TriggerPid only if the packet arriving has the same PID as the packet that has triggered the capture.

Only for these packets the **Filter expression** evaluates “true” and passes the packets to the queue and the **Stop expression**.

Trigger Expression

The “if”-function assigns “cpid+1” to TriggerPid once the first packet with the CurrentUnitStartIndicator set is coming through the **PID gate** (trigger condition).

The usage of “cpid+1” makes sure that also a PAT (with a cpid of 0) can evaluate as “true”.

The result is assigned to the **user var**iable “TriggerPid”.

Stop Expression

The next packet having the CurrentUnitStartIndicator set evaluates “true”.

Since following the trigger only one PID is passed to the **Stop expression,** only a CurrentUnitStartIndicator on this PID can stop the capture.

Example 4
Catch all packets that have been re-sent.
Packets may be send twice. In this case the continuity counters are not increased and the payload is not changed. Only PCR values may be altered.
This example uses a **Packet filter expression** only.

Packet filter expression

```
CCSameFilter := LastCC[cpid] = (ccc+1);
LastCC[cpid] := (ccc+1);
CCSameFilter
```

Filter expression
The **Filter expression** uses the array capabilities of the parser (can cause high CPU load)

User variable “LastCC” holds the ContinuityCounter for every PID present in the transport stream.
Since ContinuityCounters start from 0, we add 1.
User variable “CCSameFilter” is used to block all packets, except the ones where the current ContinutyCounter value is the same as the previous ContinuityCounter value.

CCSameFilter := LastCC[cpid] = (ccc+1);
stores the evaluation of LastCC[cpid] = (ccc+1) in the user variable “CCSameFilter”.
(ccc+1) instead of (ccc) is used here, because once the first packet of a new PID is evaluated, a new **User var**iable LastCC[cpid] is created and initialised to 0. Should the ContinuityCounter (ccc) of this packet be 0, the filter condition “CCSameFilter” would wrongly evaluate true.
To prevent this special-case, the term (ccc+1) is used instead.

LastCC[cpid] := (ccc+1);
the current ContinuityCounter is assigned to be used for the next packet.

CCSameFilter
The last line returns the evaluation result of the first line.
PID gate may be left empty for testing purposes, to verify that usually the Null packets (PID 8191, 0x1FFF) have static Continuity Counters.
In normal operation, the Null packets should be blocked by the PID gate.

File
Trigger setups can be stored, and retrieved.
The last 10 files are available in a drop down list for quick-access.

11 SI Tables

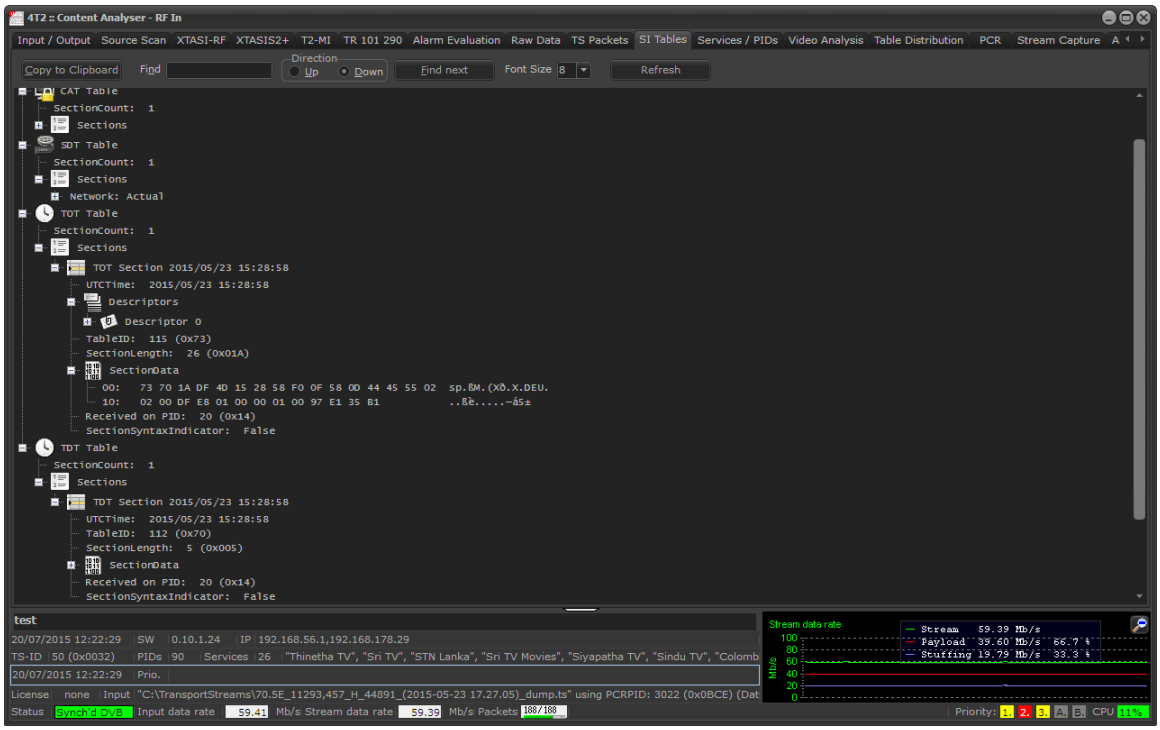


Illustration 20: SI-Tables tab-sheet

The SI tab-sheet decodes the service information embedded in the transport stream.

The SI is displayed in a tree-like fashion.
The information is displayed as interpreted test, and on byte-level.

A find function supports to find the required information inside the SI-tree.

The full tree can be copied to the windows clipboard to be opened in an external editor for documentation purposes.

Sub-branches of the tree can be copied to the clipboard by pointing with the mouse and clicking the right mouse button.

12 Services / PIDs

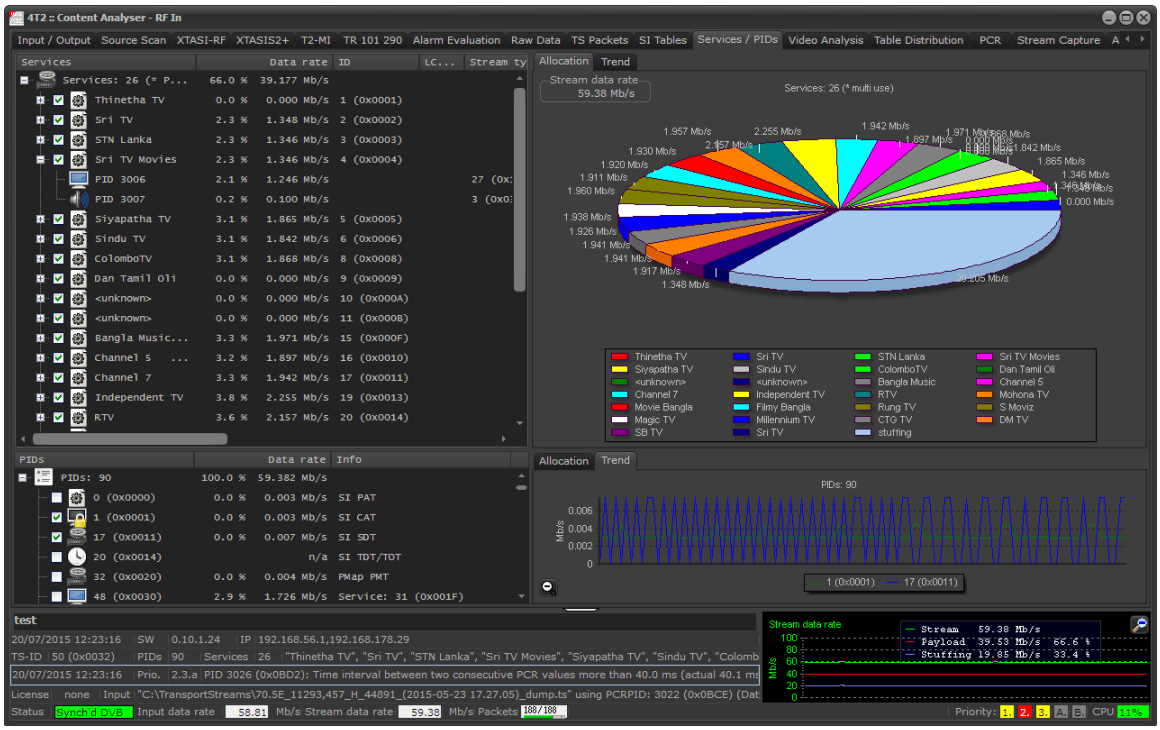


Illustration 21: Services/PIDs tab-sheet

This sheet arranges the Transport Stream content into services and packet identifiers displays. Each individual service (program) is shown with its name and identifier, both in decimal and hexadecimal notation.

The data-rates of the services are displayed in Mega-bits per second, and as a percentage of the overall payload.
The display is arranged in an Explorer-like fashion. All PIDs belonging to a service are displayed with data-rates and content.

An allocation pie-chart is employed for quick evaluation of the services allocation. A second display there allows to follow the trend of the services distribution.
Individual services can be activated or deactivated and hence removed from the displays.

A similar trend-display is found in the lower-right section of the screen to provide this function on individual PIDs in the transport stream.

The vertical dividers between tree-, and pie-display can be moved with the mouse. Likewise can be performed horizontally. By holding down the Ctrl-key, both sections can be moved independantly of each other.

13 Table Distribution

This sheet allows for comprehensive analysis of the distribution of service information tables in the Transport Stream.

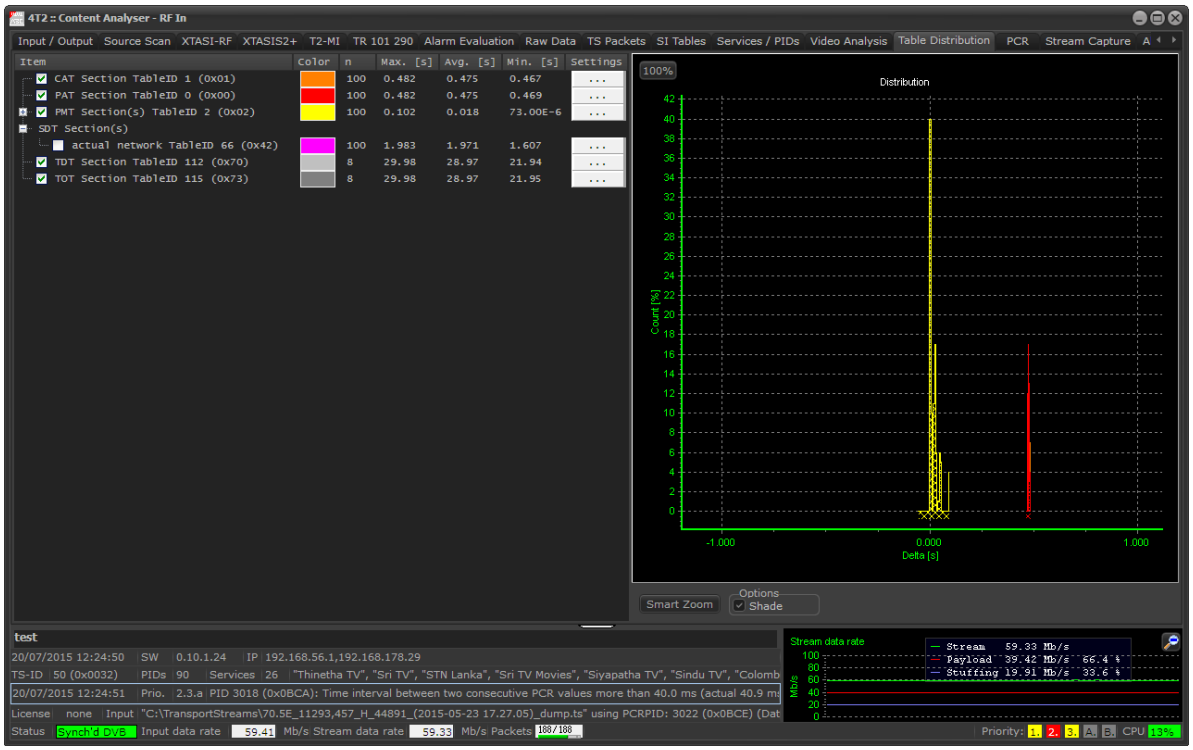


Illustration 22: Table distribution tab-sheet

Each individual table can be selected and the repetition rate is displayed in form of a histogram.

100% zooms the y-axis to 100% of the packet count.

SmartZoom allows to center the distribution display in the x-axis.

Shade enables hatching of the distribution display for better visibility.

The colour of the graph drawing can be set by clicking on the corresponding colour in the tree-view.

14 PCR

This sheet displays the PCR related analysis on the services in the Transport Stream. There are 3 tab-sheets to help with the analysis.

14.1 PCR Summary

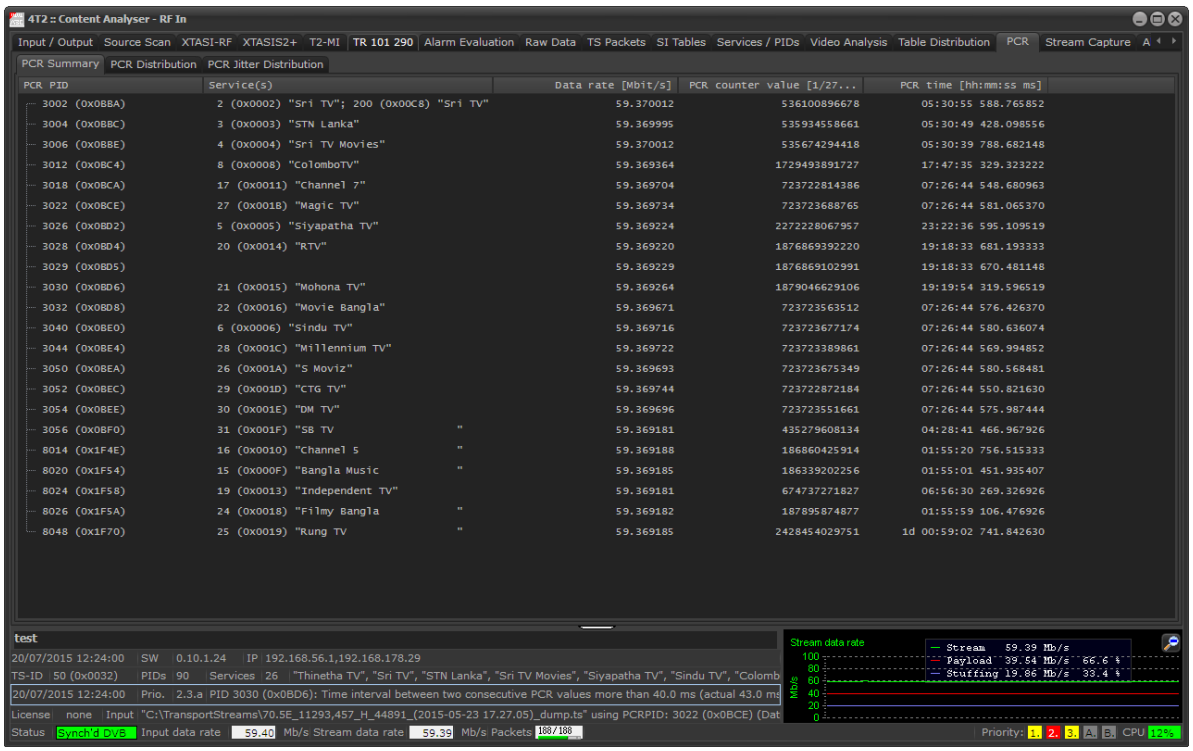


Illustration 23: PCR Summary tab-sheet

This display lists all PIDs carrying PCR with the name of the corresponding service. The data-rate is displayed as well as is the PCR counter value and the PCR time-stamp.

This allows for evaluating re-multiplexed content from unrelated sources, i.e. in a headend.

14.2 PCR distribution

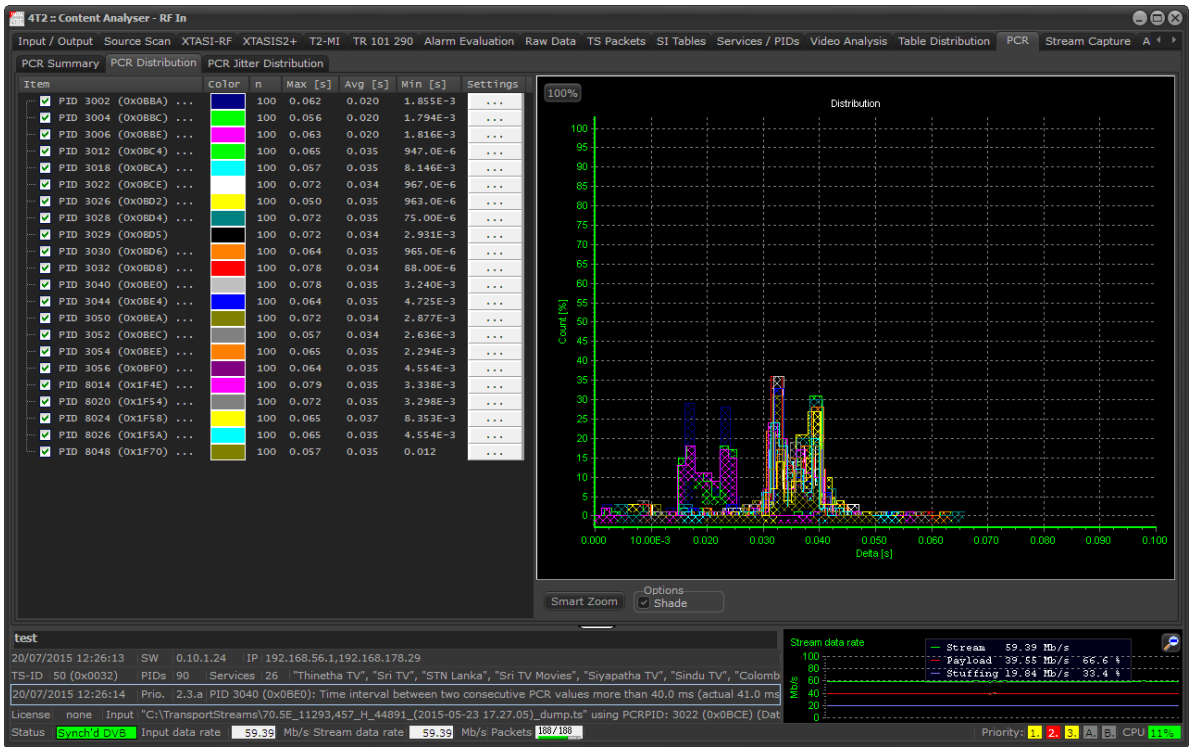


Illustration 24: PCR Distribution tab-sheet

This sheet displays the PCR PID distribution of the services in the Transport Stream.

100% zooms the y-axis to 100% of the packet count.

SmartZoom allows to center the distribution display in the x-axis.

Shade enables hatching of the distribution display for better visibility.

14.3 PCR Jitter distribution

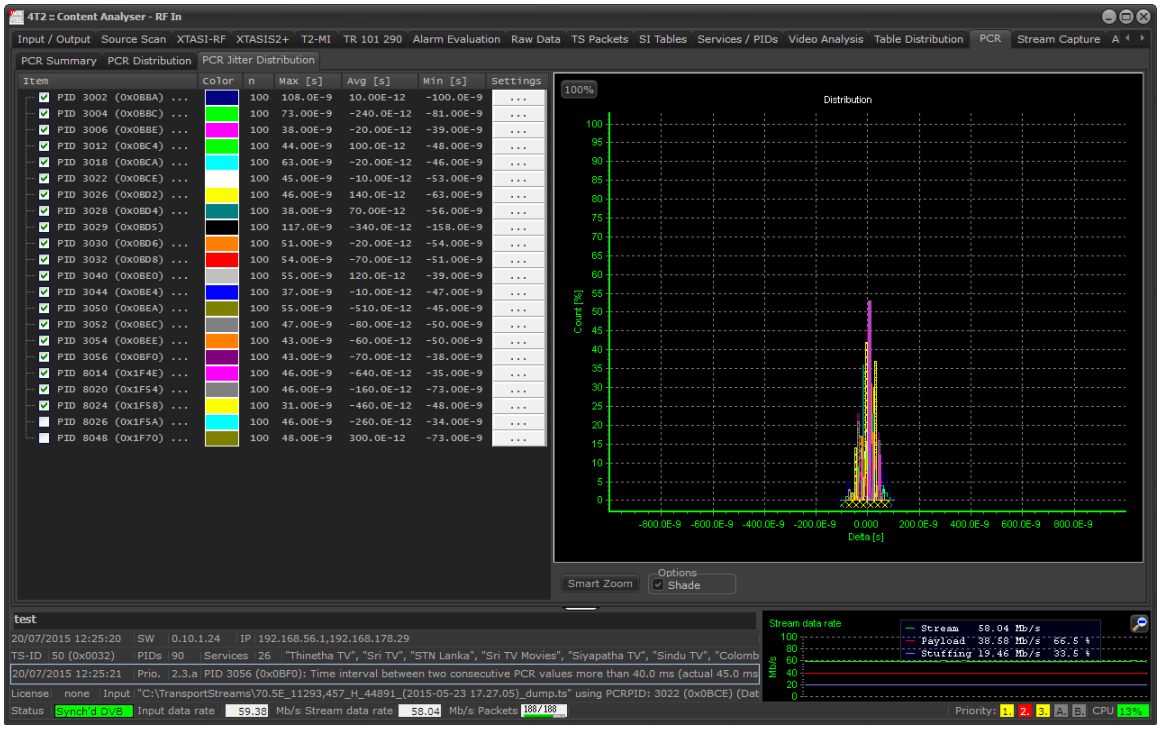


Illustration 25: PCR Jitter Distribution tab-sheet

This sheet displays the PCR PID Jitter distribution of the services in the Transport Stream.

100% zooms the y-axis to 100% of the packet count.

SmartZoom allows to center the distribution display in the x-axis.

Shade enables hatching of the distribution display for better visibility.

15 Video Analysis

This tab-sheet allows for comprehensive Video and Audio Analysis of the Transport Stream.

Each individual program is shown with its name and identifier, both in decimal and hexadecimal notation.

Thumbnails, or moving video content are created.

The individual tab-sheets provide information on the elementary-stream decoders. This includes frame-rates, spatial, and coding resolutions.
In the audio-domain, bar graphs show the loudness of left/right, front/rear, and center channels.

Thresholds for the black- and freeze-frame detectors can be set in the settings dialogue.

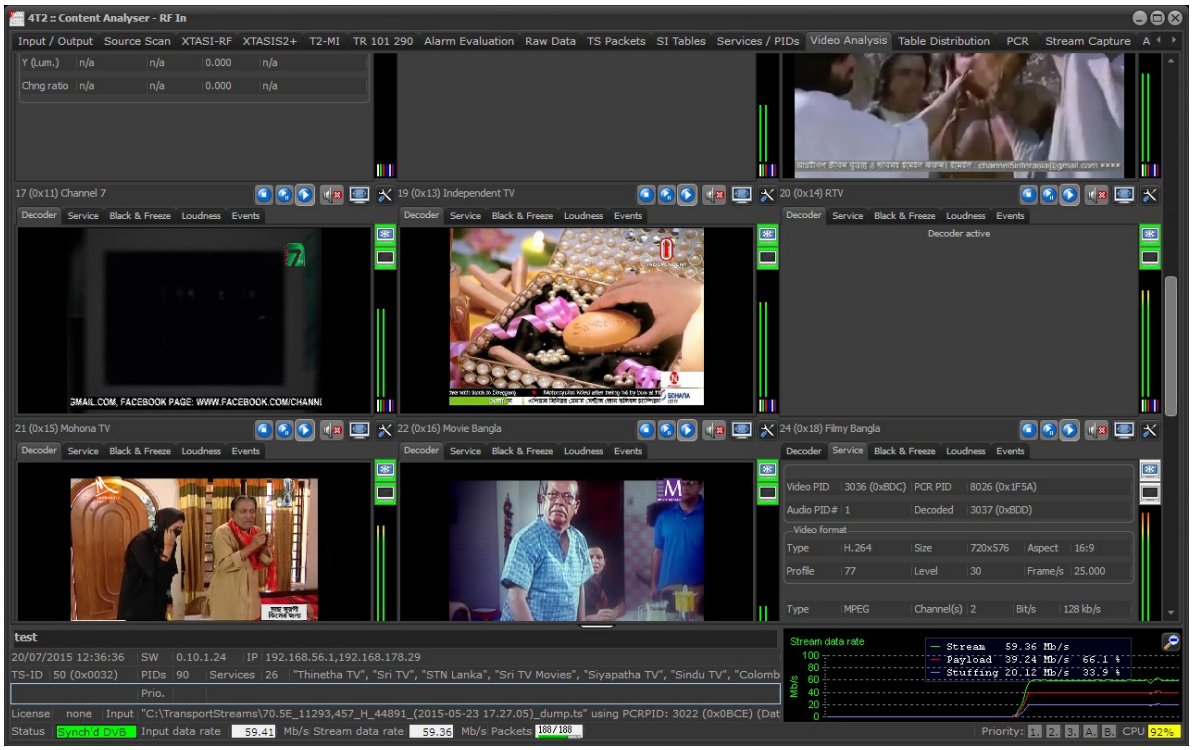


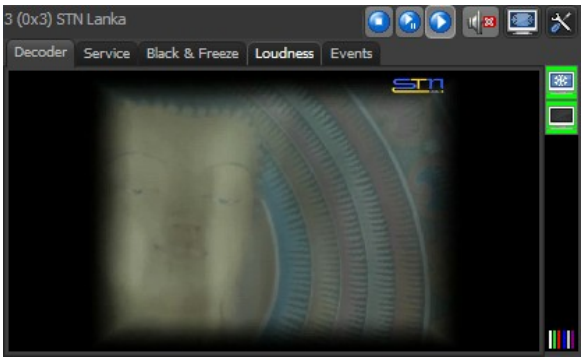
Illustration 26: Video Analysis tab-sheet

By clicking on one of the content-thumbnails, the corresponding program is zoomed, and its audio is output to the speakers.

The actual volume of the audio output can be set through the windows mixer and audio console.

Clicking on the audio-tab will show the audio properties of the corresponding program. Double-click will show the audio properties of all programs.

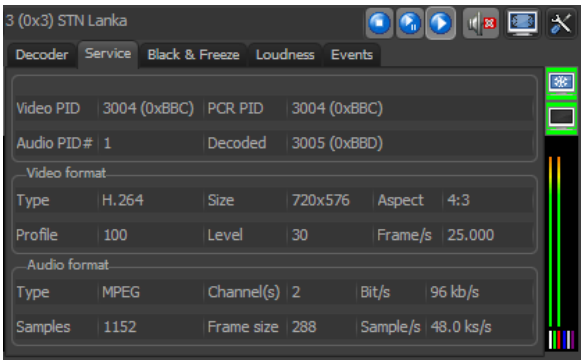
Clicking on the video-tab will show the video properties of the corresponding program. Double-click will show the video properties of all programs.



Decoder Sub-tab

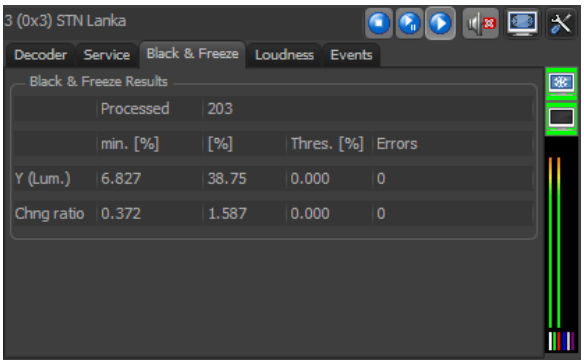
A single service is decoded in real-time by having the play button activated. Play/Pause is for slower CPUs, as it performs the decoding in a round-robin fashion with the other remaining services in the transport stream.

By clicking in the picture, a second decoder process is launched for single progran decoding with audio content.



Service Sub-tab

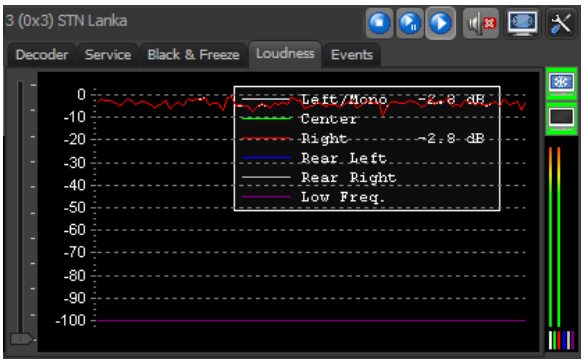
Key information on Video and Audio PIDs and their corresponding formats are displayed here



Black & Freeze Sub-tab

Black & Freeze current levels and thresholds are displayed on this tab.
The settings can be found in the main settings dialogue, or by clicking on Thres. [%].

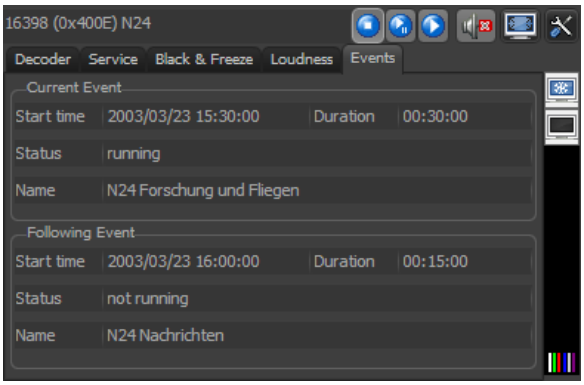
The results of the black and freeze evaluation is visible on the black and freeze icons to the right of the display.



Loudness Sub-tab

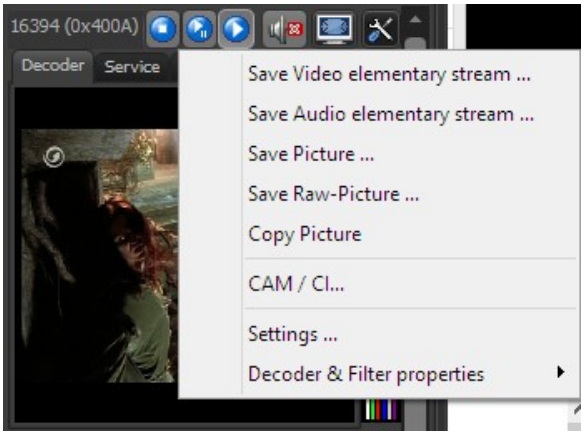
5+1 Audio levels are displayed over time in this chart.

The slider on the left-hand side adjusts the audio for this individual service in the multiviewer setup.



Events Sub-tab

The event information table current and next events are decoded and displayed here.



Functions available through the settings menu

Clicking on the settings button opens the service-related sub menu. From here, elementary streams can be saved.

Pictures, either in PC pixel, or RAW encoded format can be saved (or copied to clipboard).

CAM/CI settings are located here for allowing the usage of common interface based decryption.

16 Stream Capture

This sheet controls the transport stream capture feature of the content analyser.
The content analyser can either write the full transport stream manually, or triggered by any error event raised by the analyser engine.
The content analyser always holds a selectable time worth of transport stream in memory to provide a history that has led to the error event.

In order to keep the amount of data recorded within reasonable limits, you can decide to limit the recording time of a single event.

Quota management is enabled by means of individual file sizes and overall folder size.

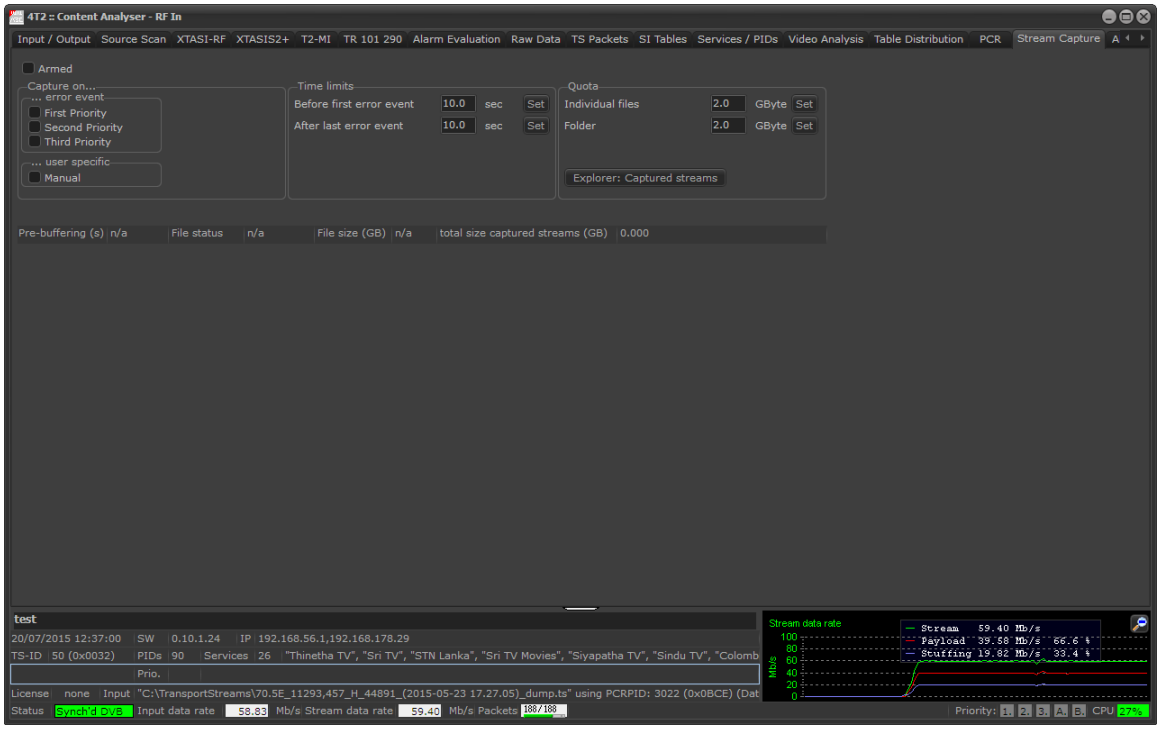


Illustration 27: Stream Capture tab-sheet

17 Log

This sheet gives access to the most comprehensive logging features of the 4T2 Content-Analyser.

All Messages stored in the log can be sorted by group, log-level, and date and time of occurrence.

A find-functions supports finding a specific error.

The sorting dialogue opens through the tools-button.
The log-file folder can be opened by a button-click.

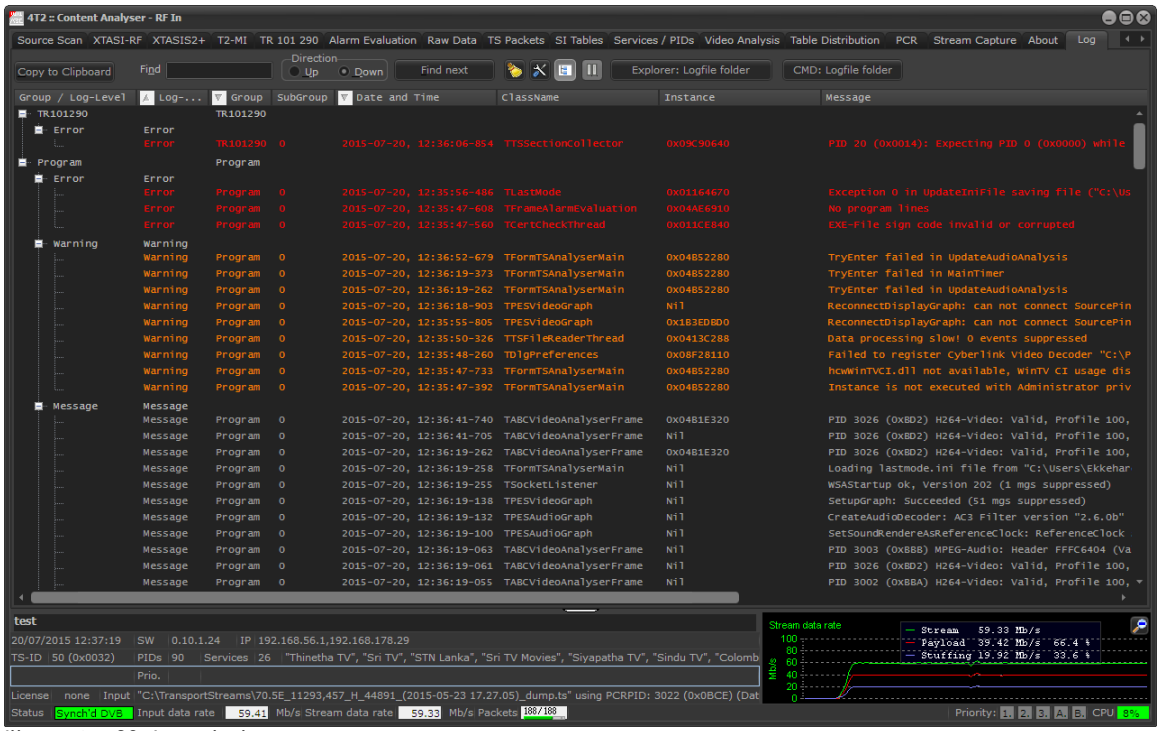


Illustration 28: Log tab-sheet

18 4T2 Content-Analyser: TR 101.290 first priority errors

No	Indicator	Description	Reference	4T2 Content-Analyser
1.1	TS_sync_loss	Loss of synchronization with consideration of hysteresis parameters	ISO 13818-2SO/IEC 13818-1 [1]: clause 2.4.3.3 and annex G.01	Implemented
1.2	Sync_byte_error	Sync_byte not equal 0x47	ISO/IEC 13818-1 [1]: clause 2.4.3.3	Implemented
1.3	PAT_error	PID 0x0000 does not occur at least every 0,5 s a PID 0x0000 does not contain a table_id 0x00 (i.e.a PAT) Scrambling_control_field is not 00 for PID 0x0000	ISO/IEC 13818-1 [1]: clauses 2.4.4.3, 2.4.4.4	Implemented
1.3.a (note 1)	PAT_error_2	Sections with table_id 0x00 do not occur at least every 0,5 s on PID 0x0000. Section with table_id other than 0x00 found on PID 0x0000. Scrambling_control_field is not 00 for PID 0x0000	TR 101 154 [4] 4.1.7 ISO/IEC 13818-1 [1]: clauses 2.4.4.3, 2.4.4.4	Implemented
1.4	Continuity_count_error	Incorrect packet order a packet occurs more than twice lost packet	ISO/IEC 13818-1 [1]: clauses 2.4.3.2, 2.4.3.3	Implemented
1.5	PMT_error	Sections with table_id 0x02, (i. e. a PMT), do not occur at least every 0,5 s on the PID which is referred to in the PAT Scrambling_control_field is not 00 for all PIDs containing sections with table_id 0x02 (i.e. a PMT)	ISO/IEC 13818-1 [1]: clauses 2.4.4.3, 2.4.4.4, 2.4.4.8	Implemented
1.5.a (note 2)	PMT_error_2	Lost or mis-ordered packet in the transport stream	TR 101 154 [4] 4.1.7 (note 3) ISO/IEC 13818-1 [1]: clauses 2.4.4.3, 2.4.4.4, 2.4.4.8	Implemented
1.6	PID_error	Referred PID does not occur for a user specified period.	ISO/IEC 13818-1 [1]: clause 2.4.4.8	Implemented
NOTE 1: In TR.101.290 Recommended for implementations as a replacement of 1.3. NOTE 2: In TR.101.290 Recommended for implementations as a replacement of 1.5; this excludes specificly network_PIDs. NOTE 3: In TR 101 154 [4], it is recommended that the interval between two sections should not exceed 100 ms.				

Table 1: First priority: De-codability (basic monitoring)

TS_sync_loss
The most important function for the evaluation of data from the MPEG-2 TS is the sync-acquisition.
The synchronisation of the TS depends on the number of correct sync bytes necessary for the device to synchronize and on the number of distorted sync bytes which the device can not cope with.
Five (5) consecutive correct sync bytes (ISO/IEC 13818-1 [1], clause G.01) should be sufficient for sync-acquisition, and two or more consecutive corrupted sync bytes should indicate a sync loss.
Sync_byte_error
The indicator ***Sync_byte_error*** is set as soon as the correct sync byte (0x47) does not appear after 188, or 204 bytes.
This is fundamental because this structure is used throughout the channel encoder and decoder chains for synchronisation. It is also important that every sync byte is checked for correctness since the encoders may not necessarily check the sync byte.
PAT_error
The Program Association Table (PAT), which only appears in PID 0x0000 packets, tells the decoder what programs are in the TS and points to the Program Map Tables (PMT) which in turn point to

the component video, audio and data streams that make up the program.
If the PAT is missing then the decoder can do nothing, no program is decodable. Nothing other than a PAT should be contained in a PID 0x0000.

PAT_error_2

The reworded description of the error in PAT_error_2 refers to the possibility that the Program Association Table may consist of several (consecutive) sections with the same table_id 0x00.

Continuity_count_error

For this indicator three checks are combined. The preconditions ***Incorrect packet order*** and ***Lost packet*** could cause problems for IRD which are not equipped with additional buffer storage and intelligence. It is not necessary for the test equipment to distinguish between these two preconditions as they are logically OR-ed, together with the third precondition, into one indicator. The latter is also covering the packet loss that may occur on ATM links, where one lost ATM packet would cause the loss of a complete MPEG-2 packet.
The precondition ***a packet occurs more than twice*** may be symptomatic of a deeper problem that the service provider would like to keep under observation.

PMT_error

The Program Association Table (PAT) tells the decoder how many programs there are in the stream and points to the PMTs which contain the information where the parts for any given event can be found. Parts in this context are the video stream (normally one) and the audio streams and the data stream (e.g. Teletext). Without a PMT the corresponding program is not decodable.

PID_error

It is checked whether there exists a data stream for each PID that occurs. This error might occur where TS are multiplexed, or demultiplexed and again remultiplexed.
The user specified period should not exceed five (5) seconds for video or audio PIDs. Data services and audio services with ISO 639 [17] language descriptor with type greater than '0' should be excluded from this 5 second limit.
NOTE: For PIDs carrying other information such as sub-titles, data services or audio services with ISO 639 [17] language descriptor with type greater than '0', the time between two consecutive packets of the same PID may be significantly longer. In principle, a different user specified period could be defined for each PID.

19 4T2 Content-Analyser: TR 101.290 second priority errors

No	Indicator	Description	Reference	4T2 Content-Analyser
2.1	Transport_error	Transport_error_indicator in the TS-Header is set to "1"	ISO/IEC 13818-1 [1]: clauses 2.4.3.2, 2.4.3.3	Implemented
2.2	CRC_error	CRC error occurred in CAT, PAT, PMT, NIT, EIT, BAT, SDT or TOT table	ISO/IEC 13818-1 [1]: clauses 2.4.4, annex B EN 300 468 [7]: clause 5.2	Implemented
2.3	PCR_error (note)	PCR discontinuity of more than 100 ms occurring without specific indication. Time interval between two consecutive PCR values more than 40 ms	ISO/IEC 13818-1 [1]: clauses 2.4.3.4, 2.4.3.5 ISO/IEC 13818-4 [2]: clause 9.11.3 TR 101 154 [4]: clause 4.5.4	Implemented
2.3a	PCR_repetition_error	Time interval between two consecutive PCR values more than 40 ms	TR 101 154 [4]: clause 4.1.5.3	Implemented
2.3b	PCR_discontinuity_indicator_error	The difference between two consecutive PCR values (PCRi+1 – PCRi) is outside the range of 0...100 ms without the discontinuity_indicator set	ISO/IEC 13818-1 [1]: clauses 2.4.3.4, 2.4.3.5 ISO/IEC 13818-4 [2]: clause 9.1.1.3	Implemented
2.4	PCR_accuracy_error	PCR accuracy of selected programme is not within ±500 ns	ISO/IEC 13818-1 [1]: clause 2.4.2.2	Implemented
2.5	PTS_error	PTS repetition period more than 700 ms	ISO/IEC 13818-1 [1]: clauses 2.4.3.6, 2.4.3.7, 2.7.4	Implemented
2.6	CAT_error	Packets with transport_scrambling_control not 00 present, but no section with table_id = 0x01 (i.e. A CAT) present Section with table_id other than 0x01 (i.e. not a CAT) found on PID 0x0001	ISO/IEC 13818-1 [1]: clause 2.4.4	Implemented
NOTE: The old version of PCR_error (2.3) is a combination of the more specific errors PCR_repetition_error (2.3.a) and PCR_discontinuity_indicator_error (2.3.b) by a logical 'or' function.				

Table 2: Second priority: recommended for continuous or periodic monitoring.

Transport_error
The primary Transport_error indicator is Boolean, but there is also a binary counter which counts the erroneous TS packets. This counter is intended for statistical evaluation of the errors.
If an error occurs, no further error indication is derived from the erroneous packet.
CRC_error
The CRC check for the CAT, PAT, PMT, NIT, EIT, BAT, SDT and TOT indicates whether the content of the corresponding table is corrupted. In this case no further error indication is derived from the content of the corresponding table.
PCR_error
The PCRs are used to re-generate the local 27 MHz system clock. If the PCR do not arrive with sufficient regularity then this clock may jitter or drift. The receiver/decoder may even go out of lock. In DVB a repetition period of not more than 40 ms is recommended.
PCR_repetition_error
The PCRs are used to re-generate the local 27 MHz system clock. If the PCR do not arrive with sufficient regularity then this clock may jitter or drift. The receiver/decoder may even go out of lock. In DVB a repetition period of not more than 40 ms is recommended.
PCR_discontinuity_indicator_error
The PCR_discontinuity_indicator_error is set in the case that a discontinuity of the PCR values occurs that has not been signalled appropriately by the discontinuity indicator.

PCR_accuracy_error
The accuracy of ±500 ns is intended to be sufficient for the colour subcarrier to be synthesised from the system clock.
This test should only be performed on a constant bitrate TS as defined in ISO/IEC 13818-1 [1] clause 2.1.7.
PTS_error
The Presentation Time Stamps (PTS) should occur at least every 700 ms. They are only accessible if the TS is not scrambled.
CAT_error
The CAT is the pointer to enable the IRD to find the EMMs associated with the CA system(s) that it uses. If the CAT is not present, the receiver is not able to receive management messages.

20 4T2 Content-Analyser: TR 101.290 third priority errors

No	Indicator	Description	Reference	4T2 Content-Analyser
3.1	NIT_error (note 2)	Section with table_id other than 0x40 or 0x41 or 0x72 (i. e. not an NIT or ST) found on PID 0x0010 No section with table_id 0x40 or 0x41 (i.e. an NIT) in PID value 0x0010 for more than 10 s	EN 300 468 [7]: clause 5.2.1 TR 101 211 [8]: clauses 4.1, 4.4	Implemented
3.1.a	NIT_actual_error	Section with table_id other than 0x40 or 0x41 or 0x72 (i. e. not an NIT or ST) found on PID 0x0010 No section with table_id 0x40 (i.e. an NIT_actual) in PID value 0x0010 for more than 10 s. Any two sections with table_id = 0x40 (NIT_actual) occur on PID 0x0010 within a specified value (25 ms or lower).	EN 300 468 [7]: clause 5.2.1, 5.1.4 TR 101 211 [8]: clauses 4.1, 4.4	Implemented
3.1.b	NIT_other_error	Interval between sections with the same section_number and table_id = 0x41 (NIT_other) on PID 0x0010 longer than a specified value (10s or higher).	ISO/IEC 13818-1 [1]: clauses 2.4.4.3, 2.4.4.4	Implemented
3.2	SI_repetition_error	Repetition rate of SI tables outside of specified limits.	TR 101 154 [4] 4.1.7 ISO/IEC 13818-1 [1]: clauses 2.4.4.3, 2.4.4.4	Not Implemented

No	Indicator	Description	Reference	4T2 Content-Analyser
3.3	Buffer_error	TB_buffering_error overflow of transport buffer (TBn) TBsys_buffering_error overflow of transport buffer for system information (Tbsys) MB_buffering_error overflow of multiplexing buffer (MBn) or if the *vbv_delay method* is used: underflow of multiplexing buffer (Mbn) EB_buffering_error overflow of elementary stream buffer (EBn) or if the *leak method* is used: underflow of elementary stream buffer (Ebn) though low_delay_flag and DSM_trick_mode_flag are set to 0 else (*vbv_delay method*) underflow of elementary stream buffer (EBn) B_buffering_error overflow or underflow of main buffer (Bn) Bsys_buffering_error overflow of PSI input buffer (Bsys)	ISO/IEC 13818-1 [1]: clauses 2.4.3.2, 2.4.3.3	Not Implemented
3.4	Unreferenced_PID	PID (other than PAT, CAT, CAT_PIDs, PMT_PIDs, NIT_PID, SDT_PID, TDT_PID, EIT_PID, RST_PID, reserved_for_future_use PIDs, or PIDs user defined as private data streams) not referred to by a PMT within 0,5 s (note 1).	EN 300 468 [7]: clause 5.1.3	Implemented
3.4.a	Unreferenced_PID	PID (other than PMT_PIDs, PIDs with numbers between 0x00 and 0x1F or PIDs user defined as private data streams) not referred to by a PMT or a CAT within 0,5 s	EN 300 468 [7]: clause 5.1.3	Implemented
3.5	SDT_error (note 3)	Sections with table_id = 0x42 (SDT, actual TS) not present on PID 0x0011 for more than 2 s Sections with table_ids other than 0x42, 0x46, 0x4A or 0x72 found on PID 0x0011	EN 300 468 [7]: clause 5.1.3 TR 101 211 [8]: clauses 4.1, 4.4	Implemented
3.5.a	SDT_actual_error	Sections with table_id = 0x42 (SDT, actual TS) not present on PID 0x0011 for more than 2 s Sections with table_ids other than 0x42, 0x46, 0x4A or 0x72 found on PID 0x0011. Any two sections with table_id = 0x42 (SDT_actual) occur on PID 0x0011 within a specified value (25 ms or lower).	EN 300 468 [7]: clause 5.2.3, 5.1.4 TR 101 211 [8]: clauses 4.1, 4.4	Implemented
3.5.b	SDT_other_error	Interval between sections with the same section_number and table_id = 0x46 (SDT, other TS) on PID 0x0011 longer than a specified value (10s or higher).	TR 101 211 [8] clause 4.4	Implemented
3.6	EIT_error (note 4)	Sections with table_id = 0x4E (EIT-P/F, actual TS) not present on PID 0x0012 for more than 2 s Sections with table_ids other than in the range 0x4E - 0x6F or 0x72 found on PID 0x0012	EN 300 468 [7]: clause 5.1.3 TR 101 211 [8]: clauses 4.1, 4.4	Implemented
3.6.a	EIT_actual_error	Section '0' with table_id = 0x4E (EIT-P, actual TS) not present on PID 0x0012 for more than 2 s Section '1' with table_id = 0x4E (EIT-F, actual TS) not present on PID 0x0012 for more than 2 s Sections with table_ids other than in the range 0x4E - 0x6F or 0x72 found on PID 0x0012. Any two sections with table_id = 0x4E (EIT-P/F, actual TS) occur on PID 0x0012 within a specified value (25ms or lower).	EN 300 468 [7]: clause 5.2.4, 5.1.4 TR 101 211 [8]: clauses 4.1, 4.4	Implemented

No	Indicator	Description	Reference	4T2 Content-Analyser
3.6.b	EIT_other_error	Interval between sections '0' with table_id = 0x4F (EIT-P, other TS) on PID 0x0012 longer than a specified value (10s or higher); Interval between sections '1' with table_id = 0x4F (EIT-F, other TS) on PID 0x0012 longer than a specified value (10s or higher).	TR 101 211 [8] clause 4.4	Implemented
3.6.c	EIT_PF_error	If either section ('0' or '1') of each EIT P/F subtable is present both must exist. Otherwise EIT_PF_error should be indicated	EN 300 468 [7] caluse 5.2.4.	Implemented
3.7	RST_error	Sections with table_id other than 0x71 or 0x72 found on PID 0x0013. Any two sections with table_id = 0x71 (RST) occur on PID 0x0013 within a specified value (25 ms or lower).	EN 300 468 [7]: clause 5.1.3	Implemented
3.8	TDT_error	Sections with table_id = 0x70 (TDT) not present on PID 0x0014 for more than 30 s Sections with table_id other than 0x70, 0x72 (ST) or 0x73 (TOT) found on PID 0x0014. Any two sections with table_id = 0x70 (TDT) occur on PID 0x0014 within a specified value (25 ms or lower).	EN 300 468 [7]: clauses 5.1.3, 5.2.6 TR 101 211 [8]: clauses 4.1, 4.4	Implemented
3.9	Empty_buffer_error	Transport buffer (TBn) not empty at least once per second or transport buffer for system information (TBsys) not empty at least once per second or if the leak method is used multiplexing buffer (MBn) not empty at least once per second.	ISO/IEC 13818-1 [1]: clauses 2.4.2.3, 2.4.2.6 ISO/IEC 13818-9 [3]: annex E ISO/IEC 13818-4 [2]: clauses 9.1.1.2, 9.1.4	Not Implemented
3.10	Data_delay_error	Delay of data (except still picture video data) hrough the TSTD buffers superior to 1 second; or delay of still picture video data through the TSTD buffers superior to 60 s.	ISO/IEC 13818-1 [1]: clauses 2.4.2.3, 2.4.2.6	Not Implemented

NOTE 1: It is assumed that transition states are limited to 0,5 s, and these transitions should not cause error indications.
NOTE 2: The old version of NIT_error (3.1) has been split into the more specific errors NIT_actual_error (3.1.a) and

NIT_other_error (3.1.b). The old version is kept in the document for reasons of consistency of existing implementations. For new implementations it is recommended that the indicators 3.1.a and 3.1.b are used only.

NOTE 3: The old version of SDT_error (3.5) has been split into the more specific errors SDT_actual_error (3.5.a) and SDT_other_error (3.5.b). The old version is kept in the present document for reasons of consistency of existing implementations. For new implementations it is recommended that the indicators 3.5.a and 3.5.b are used only.
NOTE 4: The old version of EIT_error (3.6) has been split into the more specific errors EIT_actual_error (3.6.a), EIT_other_error (3.6.b) and EIT_PF_error (3.6.c). The old version is kept for reasons of consistency of existing implementations. The indicators 3.6.a, 3.6.b and 3.6.c are used also.

Table 3: Third priority: Application dependant monitoring.

NIT_error
Network Information Tables (NITs) as defined by DVB contain information on frequency, code rates, modulation, polarisation etc. of various programs which the decoder can use. It is checked whether NITs are present in the TS and whether they have the correct PID.
NIT_actual_error
Network Information Tables (NITs) as defined by DVB contain information on frequency, code rates, modulation, polarization etc. of various programs which the decoder can use. It is checked whether the NIT related to the respective TS is present in this TS and whether it has the correct PID.
NIT_other_error

Further Network Information Tables (NITs) can be present under a separate PID and refer to other TSs to provide more information on programmes available on other channels. Their distribution is not mandatory and the checks should only be performed if they are present.

SI_repetition_error

For SI tables a maximum and minimum periodicity are specified in EN 300 468 [7] and TR 101 211 [8]. This is checked for this indicator. This indicator should be set in addition to other indicators of repetition errors for specific tables.

Buffer_error

For this indicator a number of buffers of the MPEG-2 reference decoder are checked whether they would have an underflow or an overflow.

Unreferenced_PID

Each non-private program data stream should have its PID listed in the PMTs.

SDT_error

The SDT describes the services available to the viewer. It is split into sub-tables containing details of the contents of the current TS (mandatory) and other TS (optional). Without the SDT, the IRD is unable to give the viewer a list of what services are available. It is also possible to transmit a BAT on the same PID, which groups services into "bouquets".

SDT_actual_error

The SDT (Service Description Table) describes the services available to the viewer. It is split into sub-tables containing details of the contents of the current TS (mandatory) and other TS (optional). Without the SDT, the IRD is unable to give the viewer a list of what services are available. It is also possible to transmit a BAT on the same PID, which groups services into "bouquets".

SDT_other_error

This check is only performed if the presence of a SDT for other Transport-Streams has been established.

EIT_error

The EIT (Event Information Table) describes what is on now and next on each service, and optionally details the complete programming schedule. The EIT is divided into several sub-tables, with only the "present and following" information for the current TS being mandatory.
The EIT schedule information is only accessible if the TS is not scrambled.

EIT_actual_error

The EIT (Event Information Table) describes what is on now and next on each service, and optionally details the complete programming schedule. The EIT is divided into several sub-tables, with only the "present and following" information for the current TS being mandatory. If there are no 'Present' or 'Following' events, empty EIT sections will be transmitted according to TR 101 211 [8].
The EIT schedule information is only accessible if the TS is not scrambled.

EIT_other_error

This check is only performed if the presence of an EIT for other Transport Streams has been established.

RST_error

The RST is a quick updating mechanism for the status information carried in the EIT.

TDT_error

The TDT carries the current UTC time and date information. In addition to the TDT, a TOT can be transmitted which gives information about a local time offset in a given area.
The carriage of the following tables:

- NIT_other
- SDT_other
- EIT_P/F_other
- EIT_schedule_other
- EIT_schedule_actual

is optional and therefore these tests should only be performed when the respective table is present.
When these tables are present this will be done automatically by measuring the interval rather than the occurrence of the first section.
As a further extension of the checks and measurements mentioned above an additional test

concerning the SI is recommended: all mandatory descriptors in the SI tables should be present and the information in the tables should be consistent.

21 4T2 Content-Analyser: Video quality measurements

Name	Unit	Description	Reference	4T2 Content-Analyser
Aspect Ratio	Integer	The horizontal/vertical ratio of the image, e.g. 4/3 (also called 12/9), for standard TV, or 16/9 (letterbox)	ISO 13818-2	implemented
Average Size Received	Bytes	Average packet size received per sample		Planned implementation
B-frame Count	Integer	Number of “B” (Bi-directional) frames for this sample period		Planned implementation
B-frame Rate	Bits/sec	Calculated rate of B-frames in bits per second, based on the B-frame percentage of the MPEG stream		Planned implementation
CAT Error	Integer	Conditional Access (CA) Table not sent on schedule		implemented
Compression Ratio	Float (range 0-1)	I-frameCount / (I-frameCount + BframeCount + P-frameCount)		Planned implementation
Continuity Count Error	Integer	Lost or mis-ordered packet in transport stream		implemented
CRC Error	Integer	Number of errors observed while sending Program ID tables		implemented
Frame Rate		Video frames received per second (24 for USA-NTSC, 30 for World-PAL/SECAM)	ISO 13818-2	implemented
Freezes	Integer	Number of times per sample that the image froze		implemented
Horizontal Size	Integer	The left-right size of the image, in pixels	ISO 13818-2	implemented
I-frame Count	Integer	Number of “I” (Intra) frames for this sample period		Planned implementation
I-frame Rate		Calculated rate of I-frames in bits per second, based on the I-frame percentage of the MPEG stream		Planned implementation
In Sequence	Packets	Number of properly ordered frames delivered		Not implemented
Jitter Maximum	Milliseconds	The highest (usually positive) value for jitter of all packets received during the sample period	RFC 1889	Not implemented
Jitter Minimum	Milliseconds	The lowest (usually positive) value for jitter of all packets received during the sample period	RFC 1889	Not implemented
Jitter	Milliseconds	Estimated inter-arrival jitter as computed by RFC1889 section A.8.	RFC 1889	Not implemented
Jitter Discards	Integer	Number of frames discarded due to jitter		Not implemented
Multi-cast First Time	Seconds	Relative time the first data arrived in the stream, in milliseconds, used for calculations, this is not referenced to a real time clock.		Not implemented
Multi-cast Join Time	Seconds	Relative time the stream was joined, in milliseconds, used for calculations, this is not referenced to a real time clock.		Not implemented
Network Loss Probability	Float (range 0-1)	Statistically accurate predictive calculation of frame loss Note: “1” indicates complete loss.		Not implemented
Number Packets Received	Integer	Number of packets (frames) received during the sample period.		Planned implementation
Out Of Sequence	Integer	Number of miss-ordered frames delivered		Planned implementation
PAT Error	Integer	Program Association Table was not sent on schedule		implemented

Name	Unit	Description	Reference	4T2 Content-Analyser
PAT Error2	Integer	Program Association Table extras were not sent on schedule		implemented
Payload Type	Text	The commonly accepted code for the type of data contained in a Real Time Protocol frame. “MP2T” represents a frame containing a MPEG-2 Transport Stream. The list is contained in RFC 3555.	RFC 3555	Planned implementation
PCR Accuracy Error	Integer	Program Clock Reference (PCR) variation out of range – constant bite rate only		implemented
PCR Discontinuity Indicator Error	Integer	PCR rate variations above specified value		implemented
PCR Error	Integer	Loss of PCR for more than 100 milliseconds		implemented
PCR Overall Jitter	Integer	Jitter of synchronization stream in microseconds	TR 101290, 5.3.2.5	implemented
PCR Repetition Error	Integer	PCR indicator not sent within 40 milliseconds		implemented
P-frame Count	Integer	Number of “P” (Predictive) frames for this sample period		Planned implementation
P-frame Rate	Integer	Calculated rate of P-frames in bits per second, based on the P-frame percentage of the MPEG stream		Planned implementation
PID	Text	Program ID, reflects the decimal equivalent of the Program information in the Program Association and Program Map Tables (PAT/PMT)		implemented
PID Error	Integer	Program ID not sent on schedule		implemented
PID Type	Text	Text representation of the Program Type, usually PAT/PMT (indicates program data tables), or Packetized Elementary Stream (PES) (indicates audio or video content).		implemented
PMT Error	Integer	Program Map Table was not sent on schedule		implemented
PMT Error2	Integer	Program Map Table extras were not sent on Schedule		implemented
Program Rate	Kbps	Transport stream rate in kilobits per second as observed		implemented
PTS Error	Integer	Presentation Time Stamp Repetition period exceeded 700 milliseconds		implemented
Quant Scale Average		For MPEG-2, range is 1-31 and specifies the scale factor of the reconstruction level of the received DCT coefficients. The decoder uses this until it receives a new value at the slice or macroblock level. Used to determine codec impairments – a higher Quant reflects a lower image quality For H264: ranges is 0-99 percent, and specifies the number of macroblocks with a QUANT value greater that a specified threshold (this can be set by the user in the Tunable Parameter Settings, see 6.3.4)		Planned implementation
Receive Rate	Kbps	Speed of frames received in kilobits per second		implemented
Stream Type	Text	Text representation of the PID stream, PROGRAM (for PAT/PMT data tables), or the content codec type, e.g., MPEG-1 Audio, MPEG-2 Video, H.264 /AVC Video		implemented
Sync Byte Error	Integer	Synch byte not sent after specified number of bytes		implemented
Transport Error	Integer	Transport header indicated an error		implemented
TS Sync Loss	Integer	Occurrences of stream synchronization loss		implemented
Vertical Size	Integer	The top-bottom size of the image, in pixels	ISO 13818-2	implemented

Name	Unit	Description	Reference	4T2 Content-Analyser
Video Coding Info	Text	For H.264, text representation of the coding profile, level and type used for the video stream		Planned implementation

Table 4: Video quality measurements

22 4T2 Content-Analyser: RTP measurements

Name	Unit	Description	Reference	4T2 Content-Analyser
Average Size Received	Bytes	Average packet size received per sample.		Planned implementation
Average Size Sent	Bytes	Average packet size sent in this sample.		Not implemented
Djitter	Milliseconds	Includes fractional portion	RFC 1889	Not implemented
Jitter Maximum	Milliseconds	The highest (usually positive) value for jitter of all packets received during the sample period	RFC 1889	Not implemented
Jitter Minimum	Milliseconds	The lowest (usually positive) value for jitter of all packets received during the sample period	RFC 1889	Not implemented
Jitter	Milliseconds	Estimated inter-arrival jitter as computed by RFC1889 section A.8. Calculation is based on RTP timestamp, and the RTP time stamp according to RFC is the sampling instance.	RFC 1889	Not implemented
Jitter Discards	Integer	Number of packets discarded due to jitter		Not implemented
Max Loss Episode Length	Integer	Maximum number of lost frames per episode, this count will always reflect the highest number observed in this sample.		Not implemented
Max Loss Episodes	Integer	Count of loss episodes in this sample.		Not implemented
Multi-cast First Time	Seconds	Relative time the first data arrived in the stream, used for calculations, this is not referenced to a real time clock.		Not implemented
Multi-cast Join Time	Seconds	Relative time the stream was joined, in milliseconds, used for calculations, this is not referenced to a real time clock.		Not implemented
Multi-cast Last Time	Seconds	Relative time the last data arrived in the stream, in milliseconds, used for calculations, this is not referenced to a real time clock.		Not implemented
Multi-cast Leave Time	Seconds	Relative time the stream was left (unjoined), in milliseconds, used for calculations, this is not referenced to a real time clock.		Not implemented
MOS	Float	Mean Opinion Score derived from E-model		Not implemented
Network Loss Probability	Float (range 0-1)	Probability of having packet loss, predicted using a two-stage Markov model Note: “1” indicates complete loss.		Not implemented
NumPacketsRcvd	Packets	Total number of RTP data packets received. Calculated after validation of RTP packets is performed		Planned implementation
Out Of Sequence	Integer	Number of miss-ordered frames delivered		Planned implementation
Payload Type	Text	For RTP, the type of traffic contained in each packet. The Payload types are described in RFC 3555.	RFC 1889 RFC 3555	Planned implementation
Receive Rate	Bits/sec	Current receive RTP data rate calculated by receiver		Planned implementation
R-factor	Float	Rfactor computed as specified in E-model	ITU G.107	Not implemented
Send Rate	Bits/sec	Current send RTP data rate calculated by sender.		Not implemented
Sent Packets	Packets	Current sent packets as calculated by sender		Not implemented
Total Delay	Integer	Delay including Network + codec encoding + lookahead + jitter buffer		Not implemented

Table 5: RTP measurements

23 4T2 Content-Analyser in monitoring applications

The 4T2 Content-Analyser is **fully remote capable** using the built-in **SNMP** (Simple Network Monitoring Protocol) support.
In addition to this rather complex way of interaction with the measurement system, local alarming is supported through relay contacts.
The activation of the relays is performed by formulae in the AlarmEvaluation tab. There are 4 indicators R0..R3 in the status line of the application that are corresponding with the status of the relays 0..3 in the Display Relay Unit described below.

There are two hardware modules available in 4T2-Rack instruments:

23.1 Display Relay Unit (standard)

This hardware module contains 4 relay contacts that can be activated through the 4T2 Content-Analyser.

Pin assignment of the relays:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1c	1o		3o	3c			GND		2c	2o		4o	4c	V+
		2			4			1			3			

Legend:
1c: Relay1, closed contact (will open if activated)
1: Relay1, common contact
1o: Relay1, open contact (will close if activated)

23.2 Extended Relay Unit (optional)

This hardware module contains 12 relay contacts that can be activated through the 4T2 Content Analyser.

Pin assignment of the relays:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
	6c		6o	5c		5o	4c		4o	3c		3o	2c		2o	1c		1o	12c		12o	11c		11o	10c		10o	9c		9o	8c		8o	7c		7o
		6			5			4			3			2			1			12			11		10				9			8			7	

Legend:
6c: Relayex 6, closed contact (will open if activated)
6: Relayex 6, common contact
6o: Relayex 6, open contact (will close if activated)

23.3 Relay Control using the expression parser

To allow for a flexible means of controlling the available alarm relays, the 4T2 Content-Analyser uses formulae evaluated by an expression parser.
The user-expressions (formulae), are stored in the applications' ini-file and evaluated at run-time.

At run-time, the system copies status-information and measurement-results (like current time, sync states, levels or TR101290 states, …) into specific variables.
A user-expression can create and use local variables. The content of those variables persists between evaluations.
The expressions write their evaluation-results into predefined variables for each relay.
After the evaluation, the system copies the state of the relay variables into the relay drivers and switches the relays accordingly.

The syntax of the user-expressions is the same as in the "smart packet trigger / filter" in the **TS-Packets** tab-sheet.

Following variables are predefined:

23.3.1 Variables read after evaluation

23.3.1.1 relay0, relay1, relay2, relay3

State of relay contact n of the DisplayAndRelayUnit, written by user-expression to control the relay.
Round(Value) < 0 disabled, no change.
Round(Value) = 0 off. Corresponding LED green.
Round(Value) > 0 on. Corresponding LED red.

23.3.1.2 relayex0..relayex11

State of relay contact n+1 of the Extended Relay Unit, written by-user expression to control the relay.
Round(Value) < 0 disabled, no change.
Round(Value) = 0 off.
Round(Value) > 0 on.

23.3.2 Variables set prior to evaluation

23.3.2.1 cnow

Current UTC Date and Time: The integral part of a the value is the number of days that have passed since 12/30/1899. The fractional part of the value is fraction of a 24 hour day that has elapsed (down to 10ms)
Example: the value 41038.409666 represents 09.May.2012 09:49:55

TR101290 Errors
There exists one overall error flag, three priority group error flags and all detailed error flags. All flags are set by an error event, and persist at least for one second. The alarm evaluation is scheduled every 1/10s of a second (In case of CPU-overload situations this may not be adhered at all time).
Errors will only become active if they are activated in the TR101290 tab-sheet.

Summary errors

23.3.2.2 ctserrorall

Current TS Error overall: range [0..1]. 1 indicates that one of the errors selected in TR101290 are active

23.3.2.3 ctserrorprio1

Current TS Error Priority 1: range [0..1]. 1 indicates that one of the errors selected in TR101290 Priority 1 are active

23.3.2.4 ctserrorprio2

Current TS Error Priority 2: range [0..1]. 1 indicates that one of the errors selected in TR101290 Priority 2 are active

23.3.2.5 ctserrorprio3
Current TS Error Priority 3: range [0..1]. 1 indicates that one of the errors selected in TR101290 Priority 3 are active

Detail errors.
Some error evaluation are not implemented in the 4T2 Content-Analyser, but the variables are declared here for the sake of completeness. Those flags never become set.

Unimplented errors are
3.2 SI_repetition_error (Implementation in progress)
3.3 Buffer_error
3.9 Empty_buffer_error
3.10 Data_delay_error

23.3.2.6 ctssyncloss
Current TS Error 1.1 TS_sync_loss: range [0..1]. 1 indicates that the error is active
23.3.2.7 ctssyncbyteerror
Current TS Error 1.2 Sync_byte_error: range [0..1]. 1 indicates that the error is active
23.3.2.8 ctspaterror2
Current TS Error 1.3.a PAT_error_2: range [0..1]. 1 indicates that the error is active
23.3.2.9 ctscontinuitycounterror
Current TS Error 1.4 Continuity_count_error: range [0..1]. 1 indicates that the error is active
23.3.2.10 ctspmterror2
Current TS Error 1.5.a PMT_error_2: range [0..1]. 1 indicates that the error is active
23.3.2.11 ctspiderror
Current TS Error 1.6 PID_error: range [0..1]. 1 indicates that the error is active
23.3.2.12 ctstransporterror
Current TS Error 2.1 Transport_error: range [0..1]. 1 indicates that the error is active
23.3.2.13 ctscrcerror
Current TS Error 2.2 CRC_error: range [0..1]. 1 indicates that the error is active
23.3.2.14 ctspcrerror
Current TS Error 2.3 PCR_error: range [0..1]. 1 indicates that the error is active
23.3.2.15 ctspcrrepetitionerror
Current TS Error 2.3.a PCR_repetition_error: range [0..1]. 1 indicates that the error is active
23.3.2.16 ctspcrdiscontinuityerror
Current TS Error 2.3.b PCR_discontinuity_indicator_error: range [0..1]. 1 indicates that the error is active
23.3.2.17 ctsPcrAccuracyError
Current TS Error 2.4 PCR_accuracy_error: range [0..1]. 1 indicates that the error is active
23.3.2.18 ctsPtsError
Current TS Error 2.5 PTS_error: range [0..1]. 1 indicates that the error is active
23.3.2.19 ctsCatError
Current TS Error 2.6 CAT_error: range [0..1]. 1 indicates that the error is active
23.3.2.20 ctsNitError
Current TS Error 3.1 NIT_error: range [0..1]. 1 indicates that the error is active
23.3.2.21 ctsNitActualError
Current TS Error 3.1.a NIT_actual_error: range [0..1]. 1 indicates that the error is active
23.3.2.22 ctsNitOtherError
Current TS Error 3.1.b NIT_other_error: range [0..1]. 1 indicates that the error is active
23.3.2.23 ctsSiRepetitionError
(Not implemented) Current TS Error 3.2 SI_repetition_error: range [0..1]. 1 indicates that the error is active
23.3.2.24 ctsBufferError
(Not implemented) Current TS Error 3.3 Buffer_error: range [0..1]. 1 indicates that the error is active
23.3.2.25 ctsUnreferencedPID
Current TS Error 3.4.a Unreferenced_PID: range [0..1]. 1 indicates that the error is active
23.3.2.26 ctsSdtError
Current TS Error 3.5 SDT_error: range [0..1]. 1 indicates that the error is active
23.3.2.27 ctsSdtActualError
Current TS Error 3.5.a SDT_actual_error: range [0..1]. 1 indicates that the error is active

23.3.2.28 ctsSdtOtherError
Current TS Error 3.5.b SDT_other_error: range [0..1]. 1 indicates that the error is active
23.3.2.29 ctsEitError
Current TS Error 3.6 EIT_error: range [0..1]. 1 indicates that the error is active
23.3.2.30 ctsEitActualError
Current TS Error 3.6.a EIT_actual_error: range [0..1]. 1 indicates that the error is active
23.3.2.31 ctsEitOtherError
Current TS Error 3.6.b EIT_other_error: range [0..1]. 1 indicates that the error is active
23.3.2.32 ctsEitPfError
Current TS Error 3.6.c EIT_PF_error: range [0..1]. 1 indicates that the error is active
23.3.2.33 ctsRstError
Current TS Error 3.7 RST_error: range [0..1]. 1 indicates that the error is active
23.3.2.34 ctsTdtError
Current TS Error 3.8 TDT_error: range [0..1]. 1 indicates that the error is active
23.3.2.35 ctsEmptyBufferError
(Not implemented) Current TS Error 3.9 Empty_buffer_error: range [0..1]. 1 indicates that the error is active
23.3.2.36 ctsDataDelayError
(Not implemented) Current TS Error 3.10 Data_delay_error: range [0..1]. 1 indicates that the error is active

23.3.3 XTASI-RF derived measurement results:

23.3.3.1 ctunerlevel
Current tuner level in dBm
23.3.3.2 csyncstat
CurrentSyncStat: range [0..6]. 0=unlocked, 1=AGC, 2=Pilot, 3=L1Pre, 4=L1Post, 5=Demod,6 =Full TS
23.3.3.3 cmer
CurrentMER: range [>= 0.0]
23.3.3.4 csnr
CurrentSNR: range [>= 0.0]
23.3.3.5 ctberbv (DVB-T)
Current BitErrorratio before Viterbi for DVB-T: range [0.0..1.0].
23.3.3.6 ctberav (DVB-T)
Current BitErrorratio after Viterbi for DVB-T: range [0.0..1.0]. (also known as before Reed-Solomon)
23.3.3.7 ctper (DVB-T)
Current Packet Errors/s for DVB-T: range [>= 0].
23.3.3.8 ct2preldper (DVB-T2)
Current pre LDP Error-rate for DVB-T2: range [>= 0].
23.3.3.9 ct2prefecer (DVB-T2)
Current pre FEC Error-rate for DVB-T2: range [>= 0].
23.3.3.10 ct2postfecer (DVB-T2)
Current post FEC Error-rate for DVB-T2: range [>= 0].

24 Content-Analyser.ini

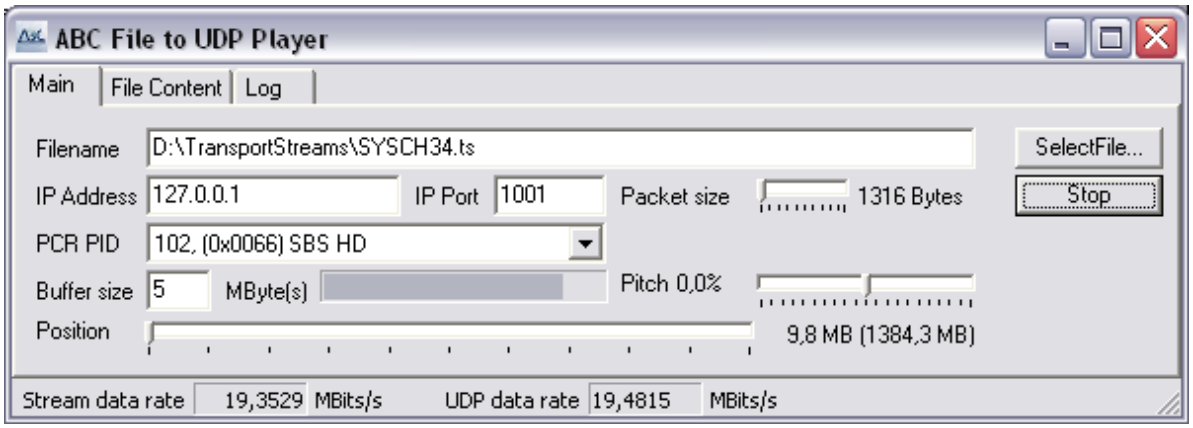
Sample **4T2 Content-Analyser.ini** for setting user interactive mode and analysing from address 127.0.0.1, port 12330, with no SNMP support and a startup delay of one second:

```
; 4T2 Content-Analyser.ini
; Analyser Client application to XTASIStreamer, and BDAComStreamer
; c2005 - 2011 Advanced Broadcast Components  www.4T2.eu
;
; The Program section:
; One or more section(s) may be configured to enable more than one running 4T2 Content-Analyser instance.
; On passing the parameter -app<n> to the 4T2 Content-Analyser.exe executeable, the application will
; read the section specified by the number <n>.
;            Example :
;            4T2 Content-Analyser.exe -app2
;            will read the section [Program2] in this ini file.
;
; If no parameter is passed or the parameter is -app0 then the section [Program] will be read.
;
[Program]
IPAddr=127.0.0.1
IPPort=12330
;
; Caption
; adds an additional caption to the title bar of the analyser application
Caption=TS from RF input
;
; UnattendedMode=0: start analyser in attended mode (user interactive)
; UnattendedMode=1: start analyser in unattended mode (with given parameters specified herein)
UnattendedMode=1
;
; SNMP usage
; SNMPEnabled=0 : SNMP is disabled, settings are read from oid.ini
; SNMPEnabled=1 : SNMP is enabled, settings and results are stored in the snmp servers's database
SNMPEnabled=0
;
; StartupDelay (in seconds)
StartUpDelay=1

; end of 4T2 Content-Analyser.ini
```

25 Extra Application: FileTo UDP Player

This is the application used to play files from disk and encapsulate the data into IP packets.



After selecting the file to play, clicking ***Run*** starts streaming the content to the specified IP-Address, and Port.

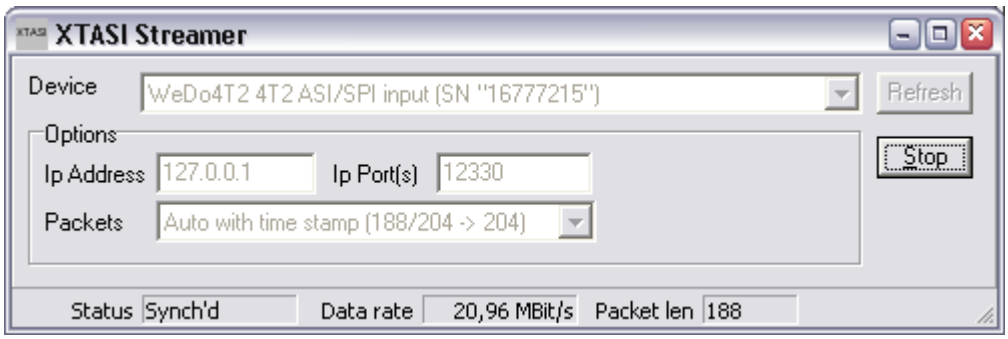
A ***PCR PID*** needs to be selected to enable the right data timing.

The ***Position*** bar allows for navigation within the file.

File Content shows the basic SI information of the file.

26 Extra Application XTASI Streamer

This is the application used to encapsulate Transport Stream data into IP packets.



The XTASIStreamer supports udp packets and allows to open a range of ports on a single IP-address. With this function a number of listeners can be configured in order to support analysis and visualisation at the same time.

Example Setting:

IP-Address 127.0.0.1 IP Port(s) 1001-1003

Allows for:

ABC Content-Analyser	IP-Address 127.0.0.1	IP Port 1001	Analysis
VideoLan	IP-Address 127.0.0.1	IP Port 1002	Content Decoding

The XTASIStreamer supports attended and unattended modes of operation. In monitoring applications, the streamer is operating in unattended mode. In this mode, the user is not allowed to change parameters, such as transmitting udp address and port, or to alter the time-stamping options.

In unattended mode, the XTASIStreamer is controlled through an initialisation-file, called XTASIStreamer.ini. It is located in the same subfolder like the streamer application itself, c:\program **files\ABC** by default.

26.1 XTASIStreamer.ini

Sample **XTASIStreamer.ini** for setting user interactive mode and streaming time-stamped 188 byte packets to ip address 127.0.0.1, port 12330:

```
; XTASIStreamer.ini
; Streamer server application to XTASI ASI input module
; c2005 - 2010 Advanced Broadcast Components  www.4T2.eu
;
; The Streamer section:
; One or more section(s) may be configured to enable more than a single running streamer instance.
; On passing the parameter -app<n> to the XTASIStreamer.exe executeable, the application will
; read the section specified by the number <n>.
;           Example :
;           XTASIStreamer.exe -app2
;           will read the section [Streamer2] in this ini file
;
; If no parameter is passed or the parameter is -app0 then the section [Streamer] will be read
;
[Streamer]
IPAddr=127.0.0.1
IPPort=12330
;
;PacketMode=0: Raw, transmits raw data without any change
;PacketMode=1: Auto, try to find sync on 188 or 204 bytes, transmits synched packets with 188 or 204 byte
length
;PacketMode=2: AutoTimeStamp, same as auto but adds time-stamp on 188 packets or overwrites bytes 189-
204 on 204 byte packets, transmits 204 byte packets
;PacketMode=3: fixed 188 byte, sync only to 188 bytes packets, transmits synched packets
;PacketMode=4: fixed 204 byte, sync only to 204 byte packets, transmits synched packets
;PacketMode=5: fixed 188 byte plus time stamp, sync only to 188 bytes packets, add time-stamp, transmits
synched packets
;PacketMode=6: fixed 204 byte plus time stamp, sync only to 204 byte packets, overwrite byte 189-204 with
time-stamp, transmits synched packets
PacketMode=2
;
;UnattendedMode=0: start streamer in attended mode (user interactive)
;UnattendedMode=1: start streamer in unattended mode (with given parameters specified herein)
UnattendedMode=0
;
; Device specifies a sub string in the devicename
; Use the serial number to identify different devices in different sections.
; If left empty, the device index from the -app parameter is used
Device=

; end of XTASIStreamer.ini
```

27 Video and Audio Decoding: Installing filters for the 4T2 Content Analyser

In order to decode the audio and video content embedded in the transport stream, the 4T2 Content Analyser requires decoders.

In the Windows operating system world, these decoders (or more commonly: 'CODECs') are called 'filters'.

These filters in Windows need to follow the 'DIRECT-Show' conventions and are required to be properly registered in the system.

While instruments leaving Advanced Broadcast Components are fully configured, the installation on third party computers for demonstration or other purposes will require manual configuration.

This chapter explains how to install and configure the filters for audio and video content.
We recommend the AC3-Audio filter and the ffdshow Video filter. In addition to these filters, an MPEG transport stream demultiplexer is required to split the services off a multiplex.
Likewise, to put the decoded video to the display a renderer is required.

Suitable demultiplexer and renderer are already installed by through the DirectShow framework. The first two components require to be installed and configured. How this is done is explained in the following chapters.

27.1 Installing the AC3-Audio filter

The AC3-Audio filter is an open source direct-show filter to decode several audio formats, including MPEG-audio and AC3. The filter is used by the 4T2 Content Analyser to decode and analyse audio signals.

If the filter is not present on the target machine, audio analysis is disabled.

The latest version of the filter is 2.6.0b, earlier versions should not be used, later versions may differ in functionality.

> If not already installed, please download from
> “http://www.ac3filter.net/wiki/Projects/ac3filter/releases“

For installation, just follow the steps of the wizard. There is no need to alter anything at this point.

27.2 Installing ffdshow (tryouts) filters

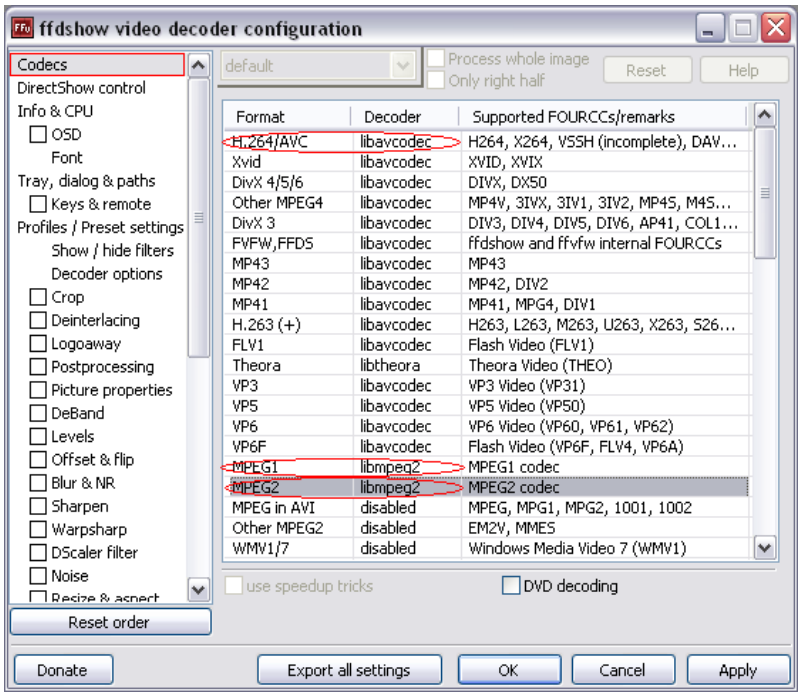
The ffdshow (tryouts) project is an open-source direct show video and audio decoder filter.

The installer can be found at “http://ffdshow-tryout.sourceforge.net/”.

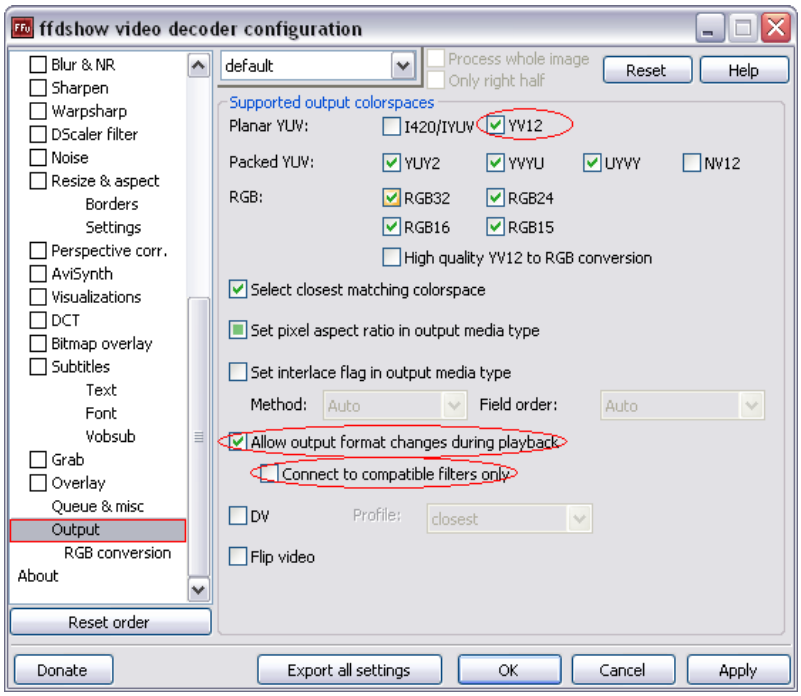
For installation, just follow the steps of the wizard. There is no need to alter anything at this point.

After the installation start the filter configuration. The file is located below “Start->ffdshow-> Video decoder configuration”.

There are several settings to modify. Select the section on the left side (use the scrollbar to scroll down if needed), the content is shown on the right side



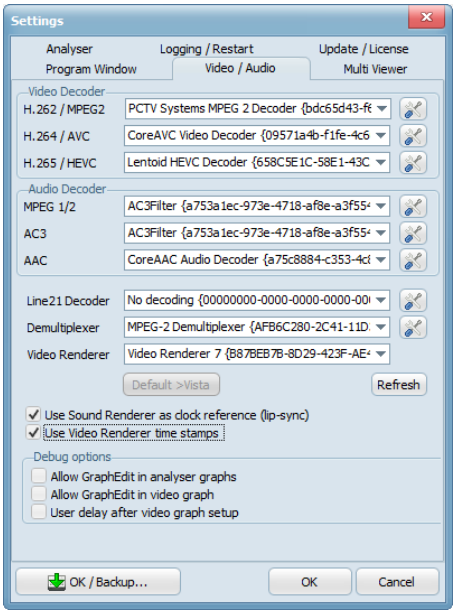
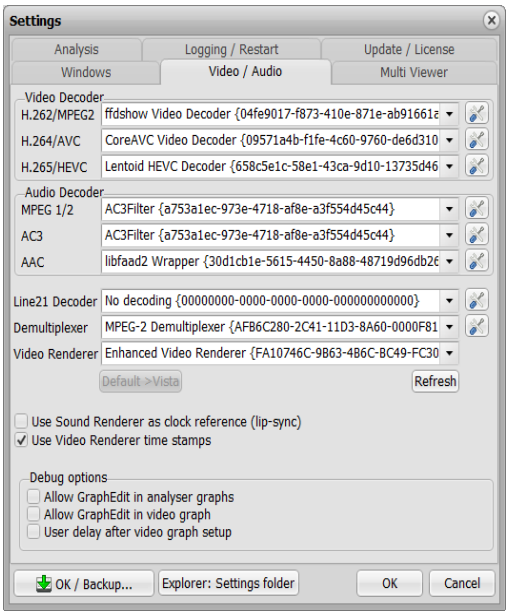
In the „Codecs“ section select “libmpeg2” as decoder for the MPEG1 and MPEG2 format. Verify that “libavcodec” is selected for the H.264/AVC format.



In the “Output” section check “Allow output format changes during playback” and uncheck “Connect to compatible filters”. Now the “YV12” checkbox in the “Planar YUV” section should be no longer grayed. Verify that “YV12” is checked

Click to “Apply” to store the changes and “Ok” to leave the configuration dialog. The changes come to effect after the 4T2 Content Analyser (or any other software using the filter) is restarted.

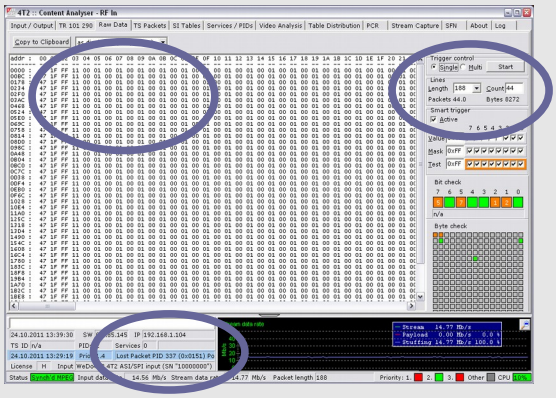
27.3 Configure Content Analyser to work with Direct-Show filters

Windows XP Please note that *Video Renderer 7* is used.	
Windows 7, 8, 10 (64bit settings) Please note that *Enhanced Video Renderer* is used.	

Open the settings dialogue in the 4T2 Content Analyser. You can find it by opening the main menu with [ALT]+[SPACE]

Under Video/Audio, you will find the settings above. The settings above should work for 99% of the cases.
Depending on your system, there may be more CODECs available for selection in the drop-down list. Should some of the video content not display properly, it is likely that a different Video Renderer setting solves the problem. Windows has 4 different renderers on board, each with slightly different interfaces to CODECs .

28 Application example: Raw Data Fault Finding



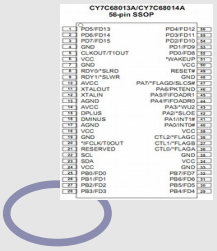
Finding faults in transmission equipment (here a faulty XTASI-ASI module):

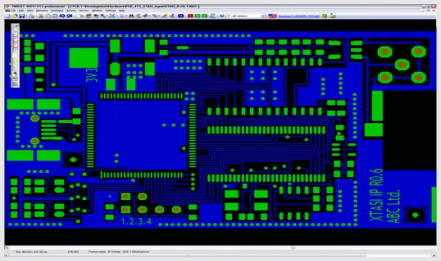
The XTASI module was not functioning properly, although the data rates seemed to be displaying fine. There were a lot of missing packets, or incorrect order faults reported in the Prio/Errors section on the main screen

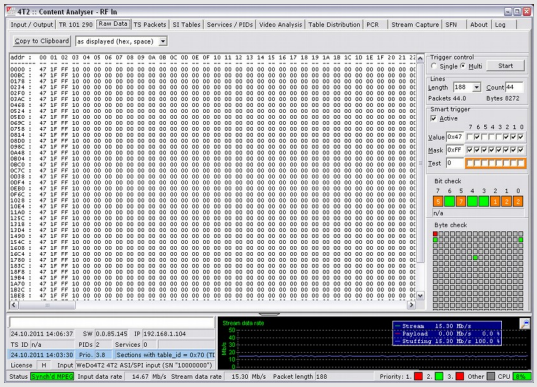
With an empty Transport Stream that is containing stuffing bits only, one can find a repetitive pattern of 01 instead of 00 every second pattern.

Knowing the XTASI data format of 16 bits with odd and even MPEG-TS packets transferred as one USB-word, it is clear that the fault has to be in the logic-to-controller interconnection.

It is most possibly a short to VCC of the LSB.







The controller chip pinout shows VCC adjacent to FD0, the Fifo input for bit 0.

With a microscope there was no short visible, but we used a needle to scratch the area between the pins to be sure.

After this treatment, the Content Analyser showed the results to the left.

A valid transport stream was now displaying fine.

29 Application example: Complex Alarm Relay Setting

Below is an example expressions-setting to measure three multiplexes in the RF- and Transport Stream-domains.

This is the client requirement for local alarming, using he relays of the 4T2-Rack extended relay interface:

MUX 1 and MUX 3
1. -2dB power reducing at least 1 sec
2. BER after Viterbi > 2.10-4,
3. Not sequenced packets,
4. TS not synchronized.

MUX – 2
1. - 6dB power reducing at least 1 sec
2. - 3dB power reducing at least 30sec
3. (Modulation Error Ratio) < 22dB at least 60 sec

Expression listing to implement the functions above:

```
[Program1/AlarmExpressions]
; Remarks on Evaluations
; All expressions must be declared as numbered keys in this section
; no dublicates are allowed. The expressions are evaluated in the order of the
; key numbers, not in the order of appearance in this file!
;
; Relay 0 control
0=relay0:=ctserrorall;
; RelayEx0 control (Level for Mux1)
; same as above but -2dB and 1 second
1=reflvl:=0;
2=startLvlc:=if((startLvlc <> 0) and (ctunerlevel < reflvl-2.0); startLvlc; cnow);
3=stopLvlc:=if((stopLvlc <> 0) and (ctunerlevel >= reflvl-2.0); stopLvlc; cnow);
4=relayex0:=if(relayex0<=0;cnow-startLvlc>(1/(24*60*60));cnow-stopLvlc<(1/(24*60*60)));
; RelayEx1 control BERaV > 2*10E-4
5=relayex1:=(ctberav > 2e-4);
; RelayEx2 control Continuity Counter Error
6=relayex2:=ctscontinuitycounterror;
; RelayEx3 control TS Syncloss
7=relayex3:=ctssyncloss;

[Program3/AlarmExpressions]
; Remarks on Evaluations
; A detailed explanation is given in the file "AlarmExpressions.txt"
; All expressions must be declared as numbered keys in this section
; no dublicates are allowed. The expressions are evaluated in the order of the
; key numbers, not in the order of appearance in this file!
;
; Relay 3 control
0=relay2:=ctserrorall;
; Relayex 8 control (Level for Mux3)
; same as above but -2dB and 1 second
1=reflvl:=0;
2=startLvlc:=if((startLvlc <> 0) and (ctunerlevel < reflvl-2.0); startLvlc; cnow);
3=stopLvlc:=if((stopLvlc <> 0) and (ctunerlevel >= reflvl-2.0); stopLvlc; cnow);
4=relayex8:=if(relayex0<=0;cnow-startLvlc>(1/(24*60*60));cnow-stopLvlc<(1/(24*60*60)));
; Relayex 9 control BERaV > 2*10E-4
5=relayex9:=(ctberav > 2e-4);
; Relayex 10 control Continuity Counter Error
6=relayex10:=ctscontinuitycounterror;
; Relayex 11 control TS Syncloss
7=relayex11:=ctssyncloss;

[Program2/AlarmExpressions]
; Remarks on Evaluations
; A detailed explanation is given in the file "AlarmExpressions.txt"
; All expressions must be declared as numbered keys in this section
; no dublicates are allowed. The expressions are evaluated in the order of the
; key numbers, not in the order of appearance in this file!
;
; Relay 0 control
0=relay1:=ctserrorall;
; a reference level is set to 0dBm
1=reflvl:=0.0;
; Relayex 4 control (Level)
; same as above but -6dB and 1 second
2=startLvlb:=if((startLvlb <> 0) and (ctunerlevel < reflvl-6.0); startLvlb; cnow);
3=stopLvlb:=if((stopLvlb <> 0) and (ctunerlevel >= reflvl-6.0); stopLvlb; cnow);
```

```
4=relayex4:=if(relay2<=0;cnow-startLvlb>(1/(24*60*60));cnow-stopLvlb<(5/(24*60*60)));
; Relayex 5 control (Level)
; if tuner level is less than the refernce level minus 3dB for more than 30 second
;    the alarm is set
; if condition is cleared for more than 5 seconds the alarm is cleared
; you may change the values below
5=startLvla:=if((startLvla <> 0) and (ctunerlevel < reflvl-3.0); startLvla; cnow);
6=stopLvla:=if((stopLvla <> 0) and (ctunerlevel >= reflvl-3.0); stopLvla; cnow);
7=relayex5:=if(relay1<=0;cnow-startLvla>(30/(24*60*60));cnow-stopLvla<(5/(24*60*60)));
; Relayex 6 control (MER)
; if MER is less than 22dB for more than 60 seconds the alarm is generated
; if the MER is more than 22dB for more than 5 seconds the alarm is cleared
8=startMer:=if((startMer <> 0) and (cmer < 22.0); startMer; cnow);
9=stopMer:=if((stopMer <> 0) and (cmer >= 22.0); stopMer; cnow);
10=relayex6:=if(relay3<=0;cnow-startMer>(60/(24*60*60));cnow-stopMer<(5/(24*60*60)));
; Relayex 7 control TS Syncloss
11=relayex7:=ctssyncloss;
```

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31 Miscellaneous

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31.2 Document History

Date	Release	Status
01.02.10	1.0.0	Approved
26.05.10	1.0.1	Approved
15.10.10	1.0.2	Preliminary
07.12.11	1.0.3	Preliminary
29.02.12	1.0.4	Preliminary
14.05.12	1.0.5	includes alarm parser
02.08.12	1.0.6	Preliminary
15.02.13	1.0.7	Preliminary
27.08.13	1.0.8	Preliminary
01.03.2015	1.0.9	Preliminary
20.07.2015	1.1.0	Approved
20.06.2016	1.1.1	Approved
26.07.2017	1.1.2	Approved