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TELESTRIDER

# Manual
# For the Use of TS Analyzer
in the Maintenance of Digital Television Networks


2024

TELESTRIDER

# CONTENT

# 1 About This Manual

## 1.1 Intended Audience

This manual is intended for technicians and engineers involved in the maintenance of digital television networks, including satellite, cable, and terrestrial networks. It will also be valuable for those who maintain television networks created using the Internet.

The purpose of this manual is to provide practical material for troubleshooting issues in digital television networks using the ETSI TR 101 290 specification and equipment manufactured by Telestrider (*https://telestrider.com*). **To effectively use this manual, it is required to be familiar with the user manual for the TS Analyzer transport stream analyzer produced by Telestrider (Latvia).**

If you are involved in monitoring the quality of digital television networks, detecting signal defects, troubleshooting, and resolving issues, this manual is for you.

This manual is intentionally written to avoid extensive theory — it is useful in practice, but not essential. However, digital television is a complex technology, so readers are expected to have a basic understanding of computer science, computing, and the fundamentals of radio transmission and reception. Additionally, we will occasionally use simple formulas to facilitate practical calculations.

The level of secondary specialized education should be sufficient to comprehend the material in this manual.

Additionally, the author assumes that the reader is familiar with the purpose of various devices used in digital television networks (e.g., multiplexers) and knows how to configure these devices.

## 1.2 Included in This Manual

The manual focuses on assessing the quality of transport streams to detect potential faults as quickly as possible. The ETSI organization has developed the ETSI TR 101 290 specification, which includes status indicators (often referred to as "errors") that allow for a rapid assessment of the transport stream quality in digital television. Unfortunately, the purpose of these indicators is not always obvious, and their practical application can be challenging.

This manual is written to explain how to use the ETSI TR 101 290 specification and the quality indicators of the TS Analyzer to identify and resolve faults.

This manual contains:

– Description of methods for monitoring radio signals;

– Description of PSI/SI monitoring;

– Description of verification of the quality of PCR, PTS, DTS, and the temporal relationships between them;

– Description of bitrate control methods;

– Description of the use of IPAT and the duplicate packet counter (DPC);

– Description of UTC error control;

– Use of MDI (RFC 4445);

– Methods for monitoring different services (CAS, EPG);

– Verification of fields in PES headers and encoder parameters;

– Detailed unified description of ETSI TR 101 290 metrics ("errors").

## 1.3 Not Included in This Manual

This manual does not describe anything beyond the quality metrics of ETSI TR 101 290 and the quality indicators offered by the TS Analyzer. This is done intentionally to simplify the presentation and focus on the main topic – quality control methods.

This manual does not include:

– Descriptions of the arrangement of signal transmission in broadcast, cable, or the Internet;

– Descriptions of the arrangement of special services, such as the electronic program guide (EPG);

– Descriptions of television studio signals;

– Descriptions of the principles of multiplexers and encoders;

– Descriptions of signal compression principles;

– Descriptions of the functions of devices (receivers, multiplexers, etc.).

## 1.4 Application of This Manual

This manual is intended as an encyclopedia for the practical engineer. It can be used as a reference guide when troubleshooting issues in digital television networks.

You can also use it as an internal regulation for your organization and as an appendix to job descriptions, technical regulations, and other related documents.

# 2 Input Monitoring

## 2.1 Monitoring of IP input

The TS Analyzer provides the ability to view information on the IP input (*Figure 1*). The *Summary* section provides information that allows you to verify the address and port of the stream source. The most practically useful information in this section are the *TS packet size* and *TS packets in payload*.

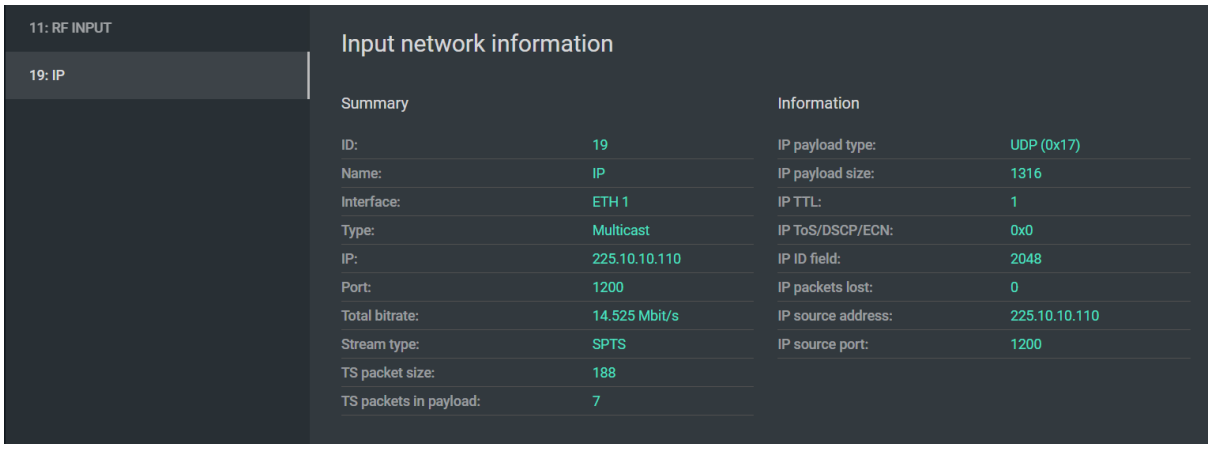



*Figure 1 - IP input information panel*

Using the *TS packet size*, you can verify that the TS packet size corresponds to the established standard. Some devices cannot accept packets of other sizes (192 or 203 bytes). Using packets of different sizes instead of 188 bytes leads to excessive bandwidth consumption, so it is advisable to avoid their use.

The *TS packets in payload* parameter indicates the number of TS packets that are encapsulated in one multicast stream packet. If the network is stable, it is advisable to maximize this number (7) to minimize bandwidth usage for transmitting the UDP header.

Information about the IP packet header is required to verify its compliance with standards (RFC 791 and others). For example, for UDP the payload identifier should be 0x17.

The following can also be practical for troubleshooting:

– TTL (Time to Live). When multicast does not pass through the network, it is necessary to check that this value is sufficient. In the example in *Figure 1*, the TTL value is 1, meaning only one packet retransmission is allowed (since in this example the stream is transmitted over a LAN and is not intended to go beyond the LAN);

– IP ToS/DSCP/ECN (traffic prioritization). Some system administrators may require IP prioritization using this field. Using TS Analyzer, you can check if it is set correctly.

– IP payload size (packet size). It should correspond to *TS packets in payload*. In case of incorrect operation of the Ethernet interface, the value may not match (be larger or smaller than the length of TS packets plus the UDP header).

## 2.2 Monitoring of the RF Input

For the RF input, the TS Analyzer provides a view of basic information on the *Input Network Information* panel (*Figure 2*). This panel is convenient for configuring the TS Analyzer to monitor the input settings (verification of signal reception).

Detailed information about signal parameters, which is useful for network operation, is provided on the radio signal monitoring screen (see section 3).

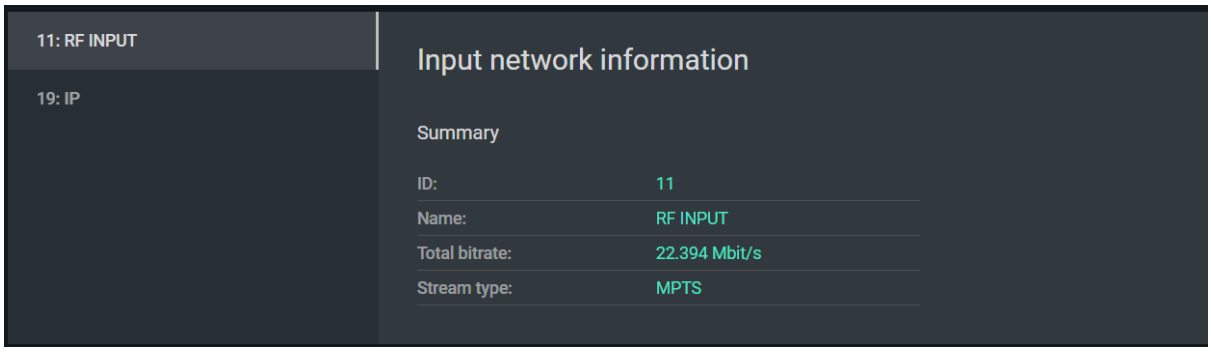



*Figure 2 – RF Input Monitoring Panel*

# 3 Monitoring of the Radio Signal

## 3.1 General Information

There are numerous quality indicators for radio frequency (RF) signals. Measuring some of these indicators requires special and expensive equipment. In this section, we will describe only the indicators that are used for radio reception measurements and implemented in the TS Analyzer. These indicators are sufficient to assess how well the signal is received.

To measure the signal, the same setup is used as for receiving the signal. This setup is shown in *Figure 3*. The black dot marks the point in the signal path to which the measured values pertain.

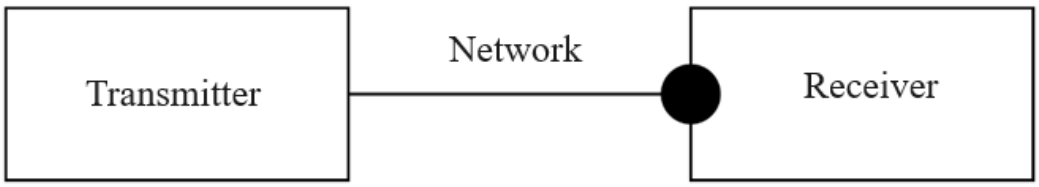



*Figure 3 –Scheme for measuring RF signal quality*

Note that the quality indicators of the RF signal are independent of the information being transmitted within the signal. However, if the RF signal quality is poor, the transmitted information will be corrupted. Therefore, when encountering issues affecting an entire multiplex, it is good practice to start by examining the signal characteristics at the input of the receiving device.

The description of RF signal quality indicators is provided in *Table 1*.

*Table 1 –Indicators of RF signal quality*

| Name of the Indicator | Abbr. | Description of the Indicator | Required Value |
|---|---|---|---|
| Signal Level (Level) | Level | The RF signal level (amplitude or power) at the input of the receiving device. It can be measured in decibels relative to | Depends on the sensitivity of the receiver and the level of |

| Name of the Indicator | Abbr. | Description of the Indicator | Required Value |
|---|---|---|---|
| | | microvolts (amplitude) or milliwatts (power) | modulation. For more details, see Section 3.2 |
| Signal-to-noise radio | SNR | The signal to noise ratio, expressed in decibels | Depends on the selected level of modulation. For more details, see Section 3.3 |
| Bit Error Rate | BER | The number of erroneous bits relative to the total specified number of bits (e.g., per million bits). This value is related to the SNR | Depends on the selected level of modulation. For more details, see Section 3.4 |

If all the indicators listed in *Table 1* are within the normal range, it guarantees that the MPEG TS transport stream and other information within the signal remain intact. The causes of deviations from the standard values are discussed in detail in the subsequent chapters.

## 3.2 Signal Level

Signal level indicates the strength of the signal at the reception point (i.e., where the level is measured). If the signal level is low (weak), the demodulator will not be able to correctly demodulate the signal. Conversely, if the signal level is too high, the demodulator will also fail to function correctly due to overload. Practicing engineers often forget that an excessively strong signal can cause as many problems as a weak one.

To determine the signal level, either amplitude or power can be measured. If amplitude is measured, the values are expressed in dBµV (decibels relative to a microvolt); if power is measured, they are expressed in dBm (decibels relative to

a milliwatt). These values can be converted into each other, so the choice of which to use depends on personal preference and the standards in place at your organization.

To convert signal level values between dBµV and dBm, use the following formulas:

$$L_{\mathrm{dB\mu V}} = L_{dBm} + 108.7$$

$$L_{dBm} = L_{\mathrm{dB\mu V}} - 108.7$$

The specified formulas are applied for an impedance of 75 ohms. What signal levels are considered "correct"? Firstly, there are no strict requirements, unlike for SNR. The signal level must meet two criteria:

– **The signal level must not be too low; otherwise, the demodulator will not be able to demodulate.**

– **The signal level must not be too high to avoid overloading the input stages of the receiver.**

Please note that the minimum signal level is determined by the modulation scheme rather than the synchronization requirements of the demodulator with the input signal. If there is synchronization but the signal level is insufficient for demodulation, the receiver may indicate the presence of a signal but will fail to demodulate it correctly (or may do so with errors). This can lead to a situation where the receiver appears to have a signal but "fails to receive" it (similar situations can arise due to interference).

Errors in demodulation can trigger the TS_sync_loss error (see Section 16.1), indicating disruptions in the transport stream. If the signal level is so weak that synchronization is impossible, the receiver will indicate no signal at all. Such a weak signal can only be detected using a spectrum analyzer.

The value of the minimum required signal level can be estimated using the following formula:

$$L_{req.} = L_{min} + SNR$$

In this formula:

$L_{req.}$ – required signal level at the receiver input;

$L_{min}$ –minimum signal level at the receiver input (sensitivity) or the actual noise level at the input (whichever is greater). This level is determined by the receiver sensitivity (typically around -80 dBm) or the noise level (approximately the same value in rural areas but potentially much higher in urban areas).

SNR –signal-to-noise ratio.

The meaning of the formula is simple: to determine the minimum required level, one must add the receiver sensitivity (or noise level, whichever is greater) to the required signal-to-noise ratio. As you can see, there is considerable uncertainty, as the noise level at the reception point may be unknown and, in general, can vary significantly. The sensitivity of the receiver should be specified in the technical specifications of the receiver.

The provided formula is suitable for measuring the signal level in a cable, where the noise level is low and the receiver sensitivity can be used. In satellite television, this formula can be used if there is confidence that there are no interferences.

If you have the capability to determine the noise level using a spectrum analyzer, use this formula. If this is not possible, follow the recommendations described below.

In the construction of terrestrial digital television networks, planned values for signal levels are used. If the actual signal level is below the planned value, it is considered that there is no reception (even if there actually is). Depending on the selected modulation, these values can be 30 dBμV or higher.

For terrestrial digital television in some countries, a minimum value of 68 dBμV can be used, chosen based on the coverage area that existed before the introduction of digital television.

Note that this value corresponds to measurements under the following conditions of terrestrial reception:

– Antenna gain: 12 dB;

– Receiver input impedance: 75 ohms;

– Feeder losses: 3 dB;

– Air temperature: 18°C.

*Figure 4* shows an example of an RF monitoring panel with a measured signal level in dBm. The value in this example is close to the norm, indicating that the TS Analyzer is receiving a good signal.

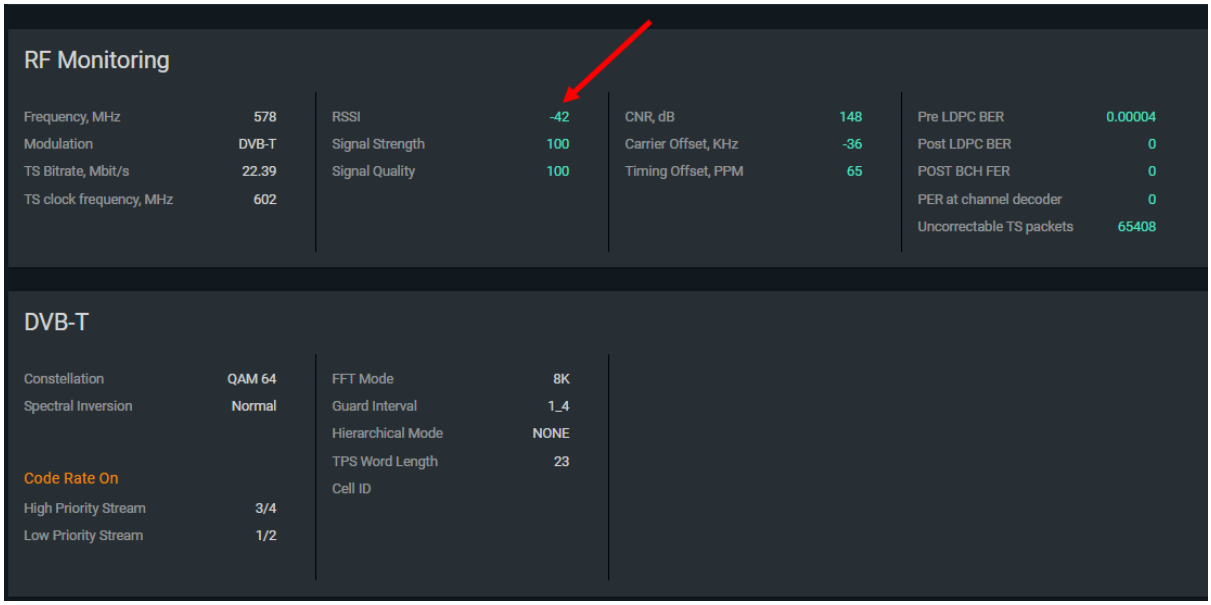



*Figure 4 –Signal level in TS Analyzer interface*

## 3.3 Signal-to-Noise Ratio

The signal-to-noise ratio (SNR) is the most critical characteristic of a received digital signal. When troubleshooting, it is more important to first check the SNR rather than the signal level (unlike in analog television, where signal level was more critical). If the signal-to-noise ratio does not meet the required value, it will lead to increased bit error rate (BER) and the occurrence of TS_sync_loss.

The required signal-to-noise ratio is necessary for correctly demodulating the signal, alongside the required signal level. If the signal level is too low, the SNR will also be low, and the demodulator will not be able to process the signal correctly. Conversely, if the signal level is higher than required, the SNR will also be higher than required, minimizing the number of demodulation errors.

There exists a threshold signal level above which increasing the signal level further will not improve demodulation (because if there are no errors, reducing them further is not possible). This threshold signal level is the minimum required signal level mentioned in Section 3.2.

The English abbreviation SNR (Signal-to-noise ratio) is commonly used to denote the ratio of signal power to noise power. It should not be confused with another abbreviation, CNR (Carrier-to-noise ratio), which represents the ratio of carrier power to noise power. CNR is rarely used and will not be considered here.

For the receiver demodulator to synchronize with the signal, the signal-to-noise ratio may be as low as a few decibels. Unfortunately, this is insufficient for high-quality signal reception but adequate for conducting measurements and identifying issues.

If the signal level is sufficient but the signal-to-noise ratio is low, the presence of interference may be suspected.

The signal-to-noise ratio in dB in the TS Analyzer interface is shown in *Figure 5*.


*Figure 5 –Signal-to-noise ratio*

## 3.4 Bit Error Rate (BER)

Bit Error Rate (BER) is a relative measure of bit errors. The term "relative" indicates that it is calculated in relation to the total number of received bits. For example, a BER value of = 10-9 indicates that one erroneous bit is received per billion bits. Consequently, BER cannot be measured quickly, as it requires gathering sufficient statistical data (at least several tens of millions of bits).

BER is dependent on SNR; the worse one is, the worse the other will be. For monitoring purposes, either measure can be used. If the signal-to-noise ratio is not sufficiently high, the number of errors increases accordingly.

Digital television employs various schemes to ensure the interference protection of radio signals, which involve the sequential application of special algorithms. Typically, BER is determined after the application of each of these

algorithms. This allows for assessing the effectiveness of these algorithms under current interference conditions. Generally, interference protection algorithms work well only if the interference resembles random noise. If the interference is, for example, strong and periodic (such as from radar systems), these algorithms will not be effective. A high signal level combined with a poor BER (i.e., a high number of errors) can indicate the presence of interference.

In DVB-T2, two error correction algorithms are used: LDPC and BCH. The TS Analyzer displays the relative error before and after error correction (*Figure 6*).

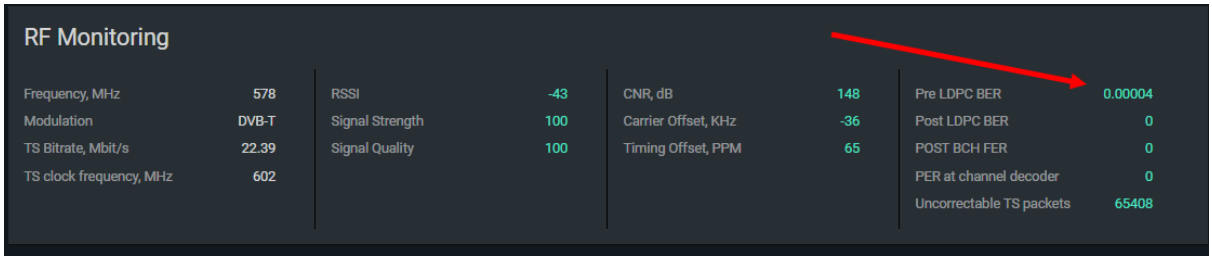



*Figure 6 – BER before and after error correction*

For BER level before correction, an acceptable value is considered to be BER<$10^{-4}$.

After LDPC correction, the BER value should be no worse than $10^{-9}$.

After applying BCH, the relative frame error rate (FER) is shown, but in practice, this value is rarely used. An acceptable FER value for stable operation should be less than $10^{-4}$.

If FER is greater than $10^{-4}$, but LDPC BER is at a "good" level, it can be assumed that the demodulator of the receiving device is not working properly. Similarly, if the device shows that FER is "good" but LDPC BER is "bad". However, such discrepancies between these indicators are rare.

## 3.5 Other Indicators of Quality

*Figure 4* and *Figure 5* show additional indicators of quality described in *Table 2*.

*Table 2 –Other indicators of RF signal quality*

| Name of the indicator | Description of the indicator | Impact, symptoms of deviations, troubleshooting |
|---|---|---|
| Carrier offset | Carrier offset in kHz. It indicates the correction that the AFC makes to the set frequency of the local oscillator. In TS Analyzer, this value is not calibrated and should not be used for measurements required by regulations. | A large deviation (hundreds of kilohertz) will lead to the inability to receive and demodulate the signal. Constant changes in this value may indicate a malfunction of the receiver or transmitter local oscillator. |
| Timing offset | Sync signal offset in parts per million relatives to the local oscillator of the receiving device. In TS Analyzer, this value is not calibrated and should not be used for measurements required by regulations. | A large deviation (thousands of PPM) will lead to the inability to receive and demodulate the signal. Constant changes in this value may indicate a malfunction of the receiver or transmitter local oscillator. |
| PER at channel decoder | Relative TS packet reception error. It is the ratio of the number of erroneous packets to the total number of packets received. This metric is derived from the BER. | A value greater than $10^{-4}$, can lead to a significant number of CC errors (see Section 16.4), and indicates an insufficient BER value (refer to section BER (see Section 3.4 for details on BER). |

| Name of the indicator | Description of the indicator | Impact, symptoms of deviations, troubleshooting |
|---|---|---|
| Uncorrectable TS packets | The number of TS packets that could not be corrected (cumulative). | Constant increase in this value indicates an insufficient BER (see Section 3.4 for details on BER). |

## 3.6 DVB-T2 Monitoring

The TS Analyzer allows monitoring of modulation parameters transmitted in the DVB-T/T2 signaling (*Figure 7*). This information can be useful for:

– Verifying the proper functioning of modulators;

– Verifying the correctness of transmitted network identifiers;

– Determining the required signal-to-noise ratios for monitoring (requirements will vary for different parameters).


*Figure 7 –DVB-T2 modulation parameters*

*Table 3* contains the description of parameters (parameter groups) of modulation and their impact on quality.

*Table 3 –Description of modulation parameters*

| Name of the parameter or group | Description | Impact, symptoms of deviations, troubleshooting |
|---|---|---|
| Network parameters group | Profile (variant of the standard) being used. | Provided for reference. Can be used to verify the selected profile when configuring the modulator. |
| Network ID | Operator ID (assigned by ETSI, see *Figure 8*), an | Used in NIT and EPG tables – all Network IDs |

| Name of the parameter or group | Description | Impact, symptoms of deviations, troubleshooting |
|---|---|---|
| | operator may have multiple networks with different System ID identifiers. | must correspond (in the simplest case, match) each other across different tables. If there is no correspondence, service losses are possible (for example, EPG may not be displayed). In some receivers, this ID is not processed, so any mismatch is ignored. Allows identification of the network operator (you need to obtain the ID distribution table from the ETSI website). |
| System ID | Unique T2 network identifier within all the operator's networks (assigned by the operator), each network can have multiple TS with unique TS IDs. | Allows determining which network is being received (along with the Network ID). The identifier must be set by the operator in accordance with their internal regulations. |
| Cell ID | Identifier of the cell (or of an individual modulator or a cell in a single-frequency network SFN). | Allows determining from which specific modulator (or SFN group) the reception is being |

| Name of the parameter or group | Description | Impact, symptoms of deviations, troubleshooting |
|---|---|---|
| | | conducted. The identifier must be set by the operator in accordance with their internal regulations. |
| Transmission system | Indicates the type of transmission system: SISO – one transmitting antenna and one receiving antenna. MIMO/MISO – multiple transmitting antennas and multiple (or one) receiving antennas (for interference resistance). | Allows determining which type of transmission system is being used and, accordingly, which type of receiver will provide greater interference resistance in this network. However, MIMO/MISO has not gained widespread use in DTV, although it is effectively used in Wi-Fi, for example. |
| T2 Frame parameters group | Modulation parameters (described in ETSI EN 302 755). | Can be used to verify the correct configuration of the modulator. |
| PLP Info parameters group | PLP parameters (described in ETSI EN 302 755) currently being demodulated by the receiver (selected when configuring the TS Analyzer input). | Can be used to verify the correct configuration of the modulator. |

# Network ID

## Network ID Description

| Range | | Network_Name | Network_Operator | App. |
|---|---|---|---|---|
| Start | End | | | code |
| 0x0020 | 0x0020 | ASTRA | Société Européenne des Satellites | 1970-01-01 |
| 0x0021 | 0x0026 | Hispasat Network 1 - 6 | Hispasat S.A . | 1970-01-01 |
| 0x0027 | 0x0029 | Hispasat 30°W | Hispasat FSS | 1970-01-01 |
| 0x002A | 0x002A | Multicanal | Multicanal | 1970-01-01 |
| 0x002B | 0x002B | Telstra Saturn Satellite | TelstraSaturn Limited | 1970-01-01 |
| 0x002C | 0x002C | Orbit Satellite Television and Radio N | Orbit Communications Company | 1970-01-01 |
| 0x002D | 0x002D | Alpha TV | Alpha Digital Synthesis S.A. | 1970-01-01 |
| 0x002E | 0x002E | Xantic | Xantic BU Broadband | 1970-01-01 |
| 0x002F | 0x002F | TVNZ Digital | TVNZ | 1970-01-01 |
| 0x0030 | 0x0030 | Canal+ Satellite Network | Canal+ SA (for Intelsat 601) | 1970-01-01 |
| 0x0031 | 0x0031 | Hispasat – VIA DIGITAL | Hispasat S.A. | 1970-01-01 |
| 0x0032 | 0x0034 | Hispasat Network 7 - 9 | Hispasat S.A. | 1970-01-01 |
| 0x0035 | 0x0035 | TV Africa | Telemedia (PTY) Ltd | 1970-01-01 |
| 0x0036 | 0x0036 | TV Cabo | TV Cabo Portugal | 1970-01-01 |
| 0x0037 | 0x0037 | STENTOR | France Telecom, CNES and DGA | 1970-01-01 |
| 0x0038 | 0x0038 | OTE | Hellenic Telecommunications Organiz | 1970-01-01 |
| 0x0039 | 0x0039 | PMSI | PMSI (Philippines ) | 1970-01-01 |
| 0x003A | 0x003A | Bharat Business Channel | Bharat Business Channel Limited | 2008-01-28 |
| 0x003B | 0x003B | BBC | BBC | 2006-10-31 |
| 0x003C | 0x003C | ICO mim | ICO Satellite Services G.P. | 2008-02-20 |
| 0x003D | 0x003D | Eutelsat satellite system at 3°East | Skylogic Italia S.A. | 2007-07-16 |
| 0x003E | 0x003F | Eutelsat satellite system at 3°East | Eutelsat S.A. | 2007-07-16 |
| 0x0040 | 0x0040 | Hrvatski Telekom d.d | Hrvatski Telekom d.d | 1970-01-01 |
| 0x0041 | 0x0041 | To be defined See Wim Mooij | Mindport | 1970-01-01 |
| 0x0042 | 0x0042 | Demiroren Medya | Demiroren Medya Grubu | 2018-09-10 |
| 0x0042 | 0x0042 | DMG | DTV haber ve Gorsel yayýncilik | 1970-01-01 |
| 0x0044 | 0x0044 | VisionTV | VisionTV LLC | 2007-10-25 |
| 0x0045 | 0x0045 | Vision TV | SES-Sirius | 2007-10-26 |
| 0x0046 | 0x0047 | 1 degree W | Telenor | 1970-01-01 |
| 0x0048 | 0x0048 | STAR DIGITAL | STAR DIGITAL A.S . | 1970-01-01 |

*Figure 8 –Example Network ID registry fragment (maintained by ETSI)*

# 4 Features of PSI/SI Monitoring

## 4.1 PID PSI/SI

The standard PIDs for some PSI/SI tables are listed in *Table 4*. The TS Analyzer uses these PIDs along with the table_id to determine the type of tables. If a certain table is supposed to be present but is not visible in the table tree, check in the multiplexer to see which PID it is assigned to.

*Table 4 – PID of PSI/SI tables*

| Table | PID |
|---|---|
| PAT | 0 |
| PMT | Indicated in PAT (*Figure 9*) |
| SDT | 11 |
| NIT | 10 |
| CAT | 1 |
| TSDT | 2 |
| EIT | 12 |
| RST | 13 |
| TOT | 14 |
| TDT | 14 |

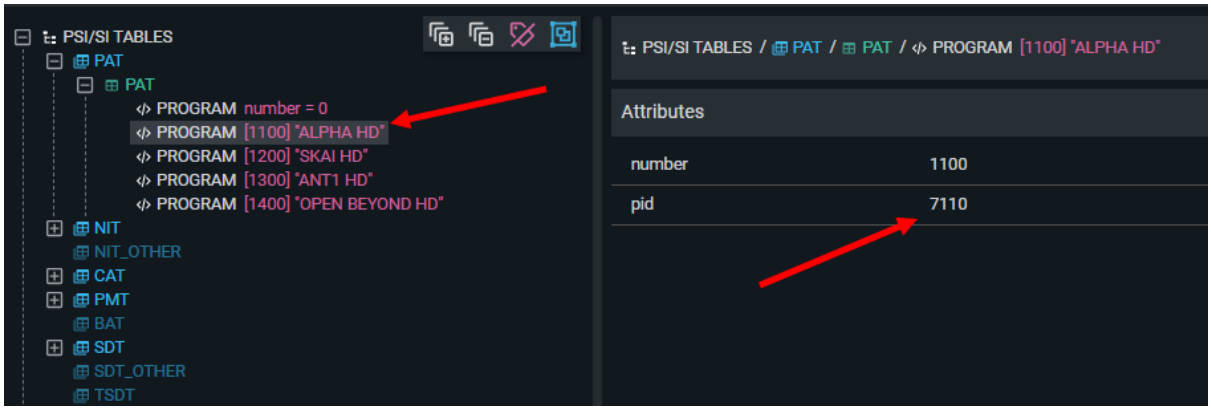



*Figure 9 –Example of PID PMT indication in PAT*

## 4.2 "Manually" Monitoring PSI/SI

To check the content and perform an analysis of the correctness of PSI/SI, it is not obligatory to rely on ETSI TR 101 290 errors. The TS Analyzer provides the user with a large amount of information, which can be analyzed to manually assess the quality of the PSI/SI.

The general procedure is as follows:

– Identify the PID on which the required table is transmitted (*Table 4*);

– In the TS Analyzer, check the PID screen to see if this PID is present and if its repetition period is within the specified limits (sometimes it is convenient to reset the current statistics for this purpose; refer to the TS Analyzer user manual).

– On the PSI/SI screen, verify that the content of the tables meets the required standards (the content requirements are described in ETSI EN 300 468).

Let's consider an example for the NIT table:

– Open the current statistics window, select the required input, then select the required PID=16 and open the Packets tab (*Figure 10*);

– Check the repetition rate readings: the maximum should be 5 seconds, and the minimum should be 67 microseconds.

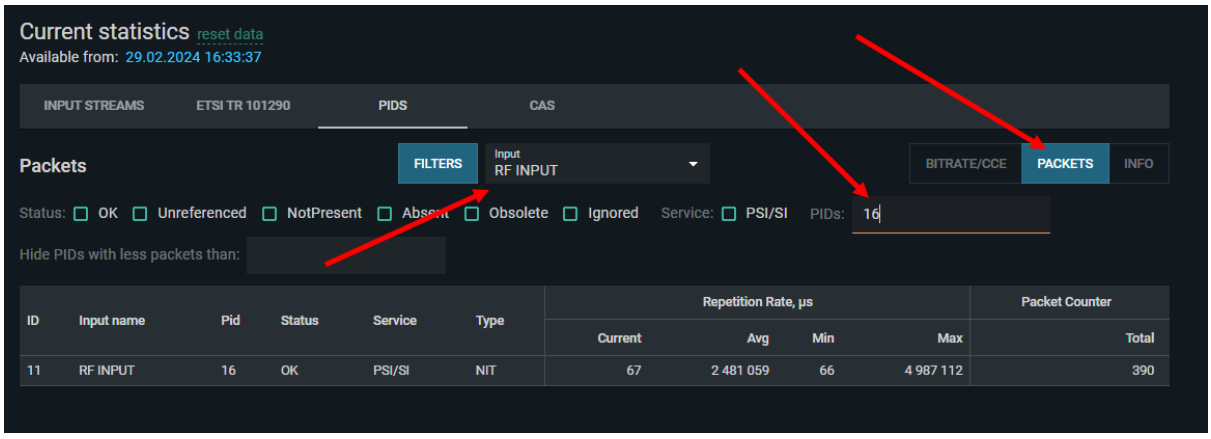



*Figure 10 –Verifying PID interpacket interval*

Conclusion: The minimum repetition period is too short; it is recommended to be no shorter than 25 milliseconds. The likely cause of this issue is a software error in the demodulator, as the stream is fed to the RF input of the analyzer from

the demodulator. While this is not dangerous, it leads to unnecessary bandwidth usage. The maximum period complies with the standard as it is less than 10 seconds. If no service defects are observed, this error can be ignored since the number of packets is small (low bitrate).

Now, let's look at this NIT on the PSI/SI screen (*Figure 11*).

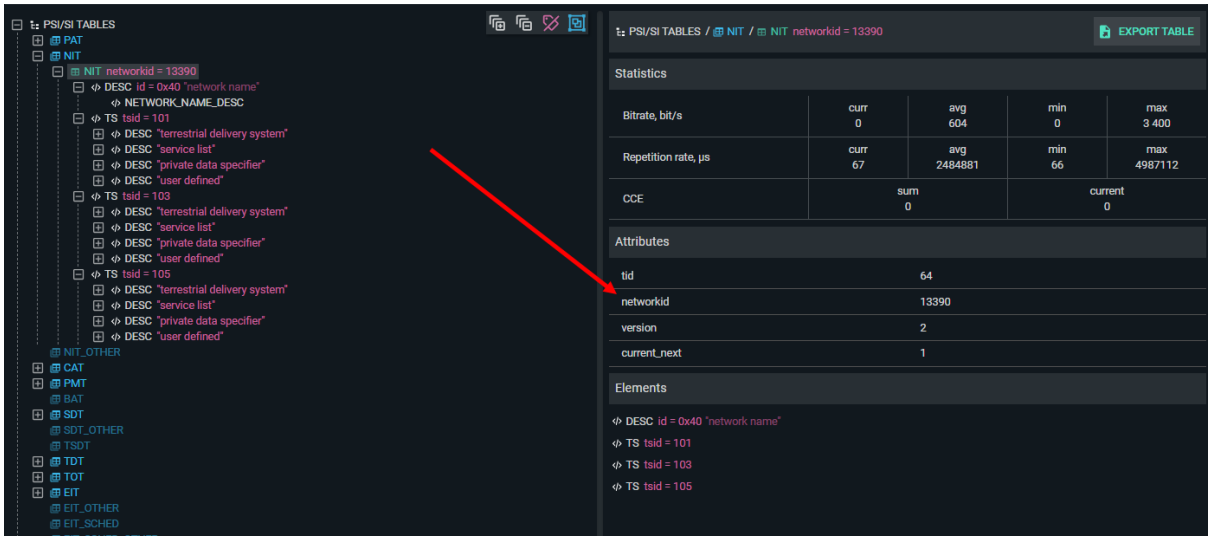



*Figure 11 – Verifying NIT on PSI/SI screen*

We can see that the NIT contains information about three TS (101, 103, 105) in the network with Network ID = 13390. In the top right corner, the bitrate statistics for PID=16, which we examined earlier, are repeated.

Let's check if the current stream is one of those referenced by this NIT. To do this, we will open the PAT (*Figure 12*). It is evident that this PAT contains TS ID = 101. Therefore, the current stream has TS ID = 101.

Next, we can verify if the SDT (*Figure 13*) and EIT (an example is provided in Section 11) correspond to this TS ID. If these tables contain TS ID = 101, then everything is in order—they match the current TS.

Furthermore, you can manually check the PMT tables, descriptors, etc.

An example of manual PSI/SI analysis for EIT tables is also provided in Section 11.

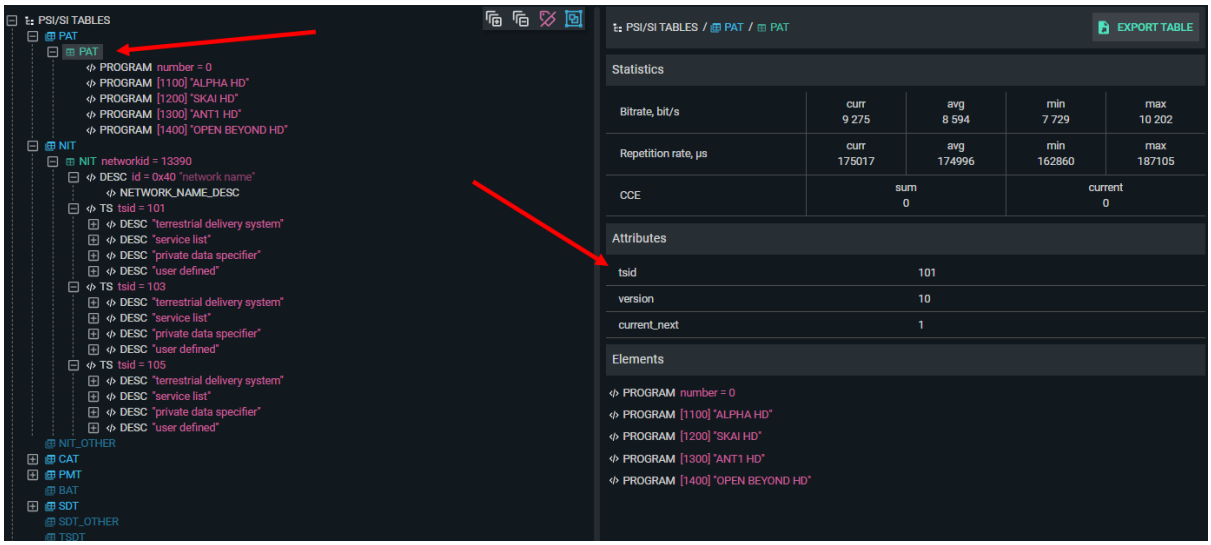



*Figure 12 –Verifying TS ID in PAT*

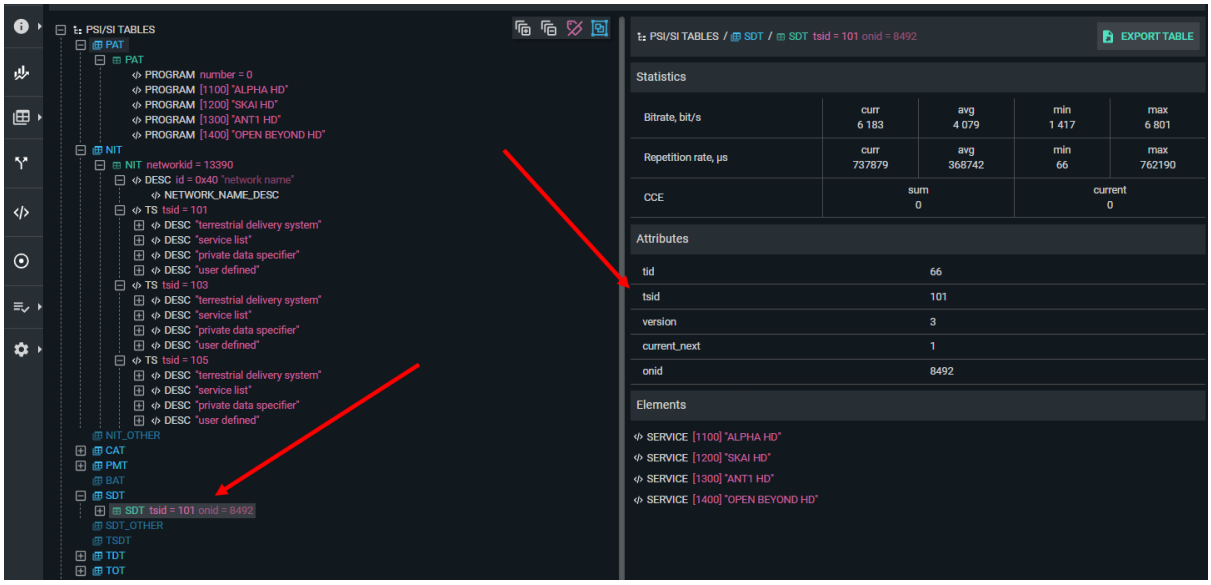



*Figure 13 – Verifying TS ID in SDT*

## 4.3 Impact of Caching PSI/SI

Since PSI/SI changes infrequently, the receiving devices (set-top boxes) may cache it. Each PSI/SI table has a version number (*Figure 14*). Problems may arise if the PSI/SI is updated, but the subscriber device does not refresh its cache.

The set-top box may monitor (or may not, depending on the software) for version number changes and update the cache when the version changes.

Additionally, the software can be implemented to update PSI/SI constantly (it is the most resource-intensive but the most reliable method) or to update only when the set-top box is turned on (the most economical but potentially problematic method).

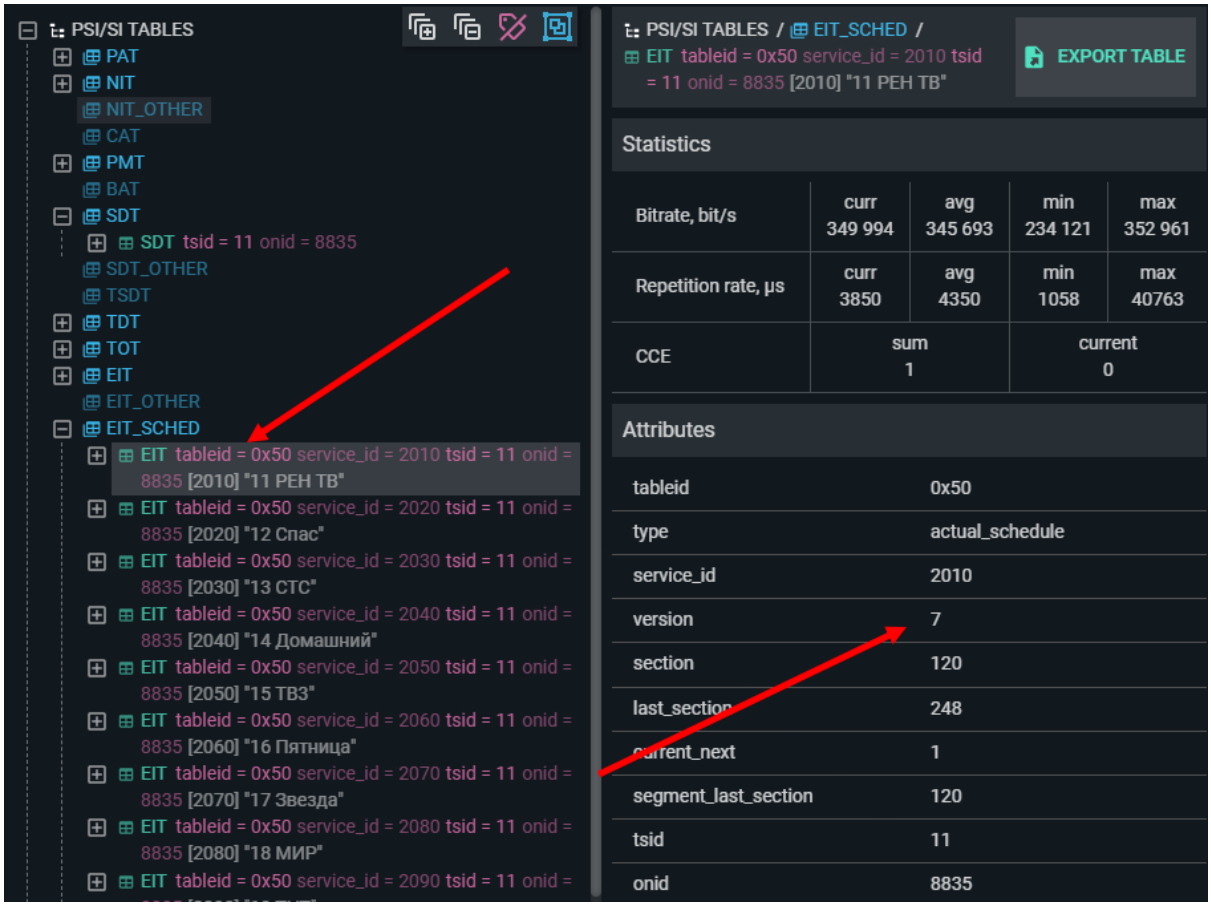



*Figure 14 –Example of EIT table version*

Some symptoms indicating that PSI/SI has been updated but the set-top box has not refreshed its cache may include (one or several):

– Incorrect ("old") names of services;

– Incorrect numbers of channels or their output sequence;

– Errors in EPG;

– Failure to descramble.

Using the TS Analyzer, you can monitor PSI/SI changes and observe how the set-top box responds to these changes. This practice is useful when testing set-top boxes and investigating complaints about incorrect service information.

If the aforementioned issues disappear after rebooting the set-top box, it may confirm the suspicion that the set-top box is not properly handling PSI/SI updates. In such cases, it might be necessary to file a complaint with the manufacturer of the set-top box.

# 5 Control of Bitrates and Time Stamps

## 5.1 Types of Bitrates

When monitoring the quality of transport streams, the following types of bitrates are measured:

– Total bitrate: the full bitrate including stuffing. Typically, this is a constant bitrate;

– Payload bitrate: the full bitrate minus the stuffing. Typically, this is a variable bitrate (even if the fluctuations are small);

– Service bitrate: the bitrate of all components of a single service. Typically, this is a constant bitrate. When transmitted over IP networks or using statistical multiplexing, this bitrate may vary.

– Individual PID bitrate.

The total bitrate and the bitrate without stuffing in the PES are shown in *Figure 15*. The service bitrates are shown in *Figure 17*, and the PID bitrates are shown in *Figure 18*.

Monitor the bitrate to match the multiplexing scheme.

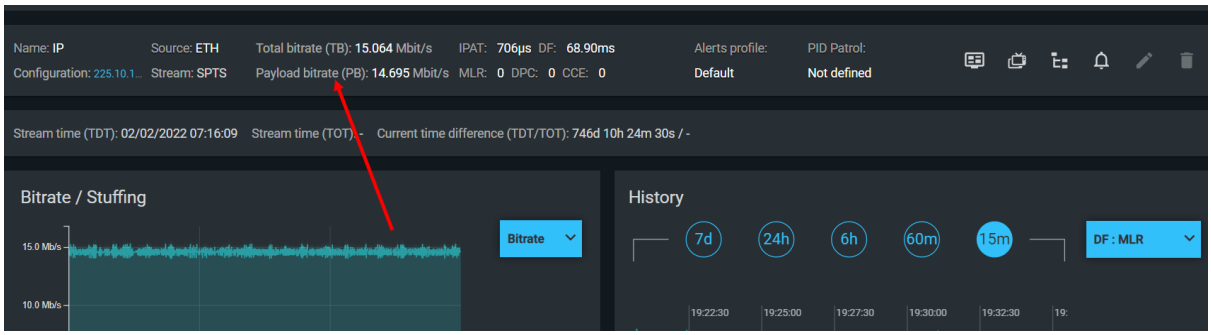



*Figure 15 - Total bitrate (TB) and Payload bitrate (PB)*

The measured bitrate can be either average or instantaneous. The average bitrate shows the bitrate value measured over one second (this is how measurements are implemented in TS Analyzer). The instantaneous bitrate shows the bitrate over a short period of time (TS Analyzer does not measure this bitrate). Instantaneous bitrate spikes may not be noticeable on average bitrate graphs, but they can lead to the overflow of the receiver's buffer (or exceed the bandwidth

limit of the communication channel), resulting in 1.4 Continuity_count_error (see Section 16.4). You can understand that there are "spikes" in the instantaneous bitrate by looking at the bitrate timeline graph (see *Figure 16*). Spikes can cause buffer overflow, leading to information loss. The occurrence of such "spikes" is not necessarily an error. If the receiver has a sufficiently large buffer, the spikes will be processed correctly.

Similarly, a low instantaneous bitrate can lead to buffer underflow and cause the same errors. On the timeline graph, a spike (or dip) in the instantaneous bitrate will appear as a narrow peak or dip (green arrow in *Figure 16*). A low instantaneous bitrate is more dangerous than a high one because, in this case, the buffer size does not matter (if the data did not arrive, then they didn't).

## 5.2 Bitrates by PID and Service Bitrates, Using Histograms

Viewing the measured bitrate by individual PIDs in TS Analyzer can be done on the services screen as shown in *Figure 16*.


*Figure 16 - Individual PID bitrate*

The histogram shows the statistics of bitrate deviations from the average value. The average value is calculated while the panel is open—if you want to get

the average value over a longer period, keep the panel open longer. In the example in *Figure 16* it can be seen that the bitrate for PID=1210 is variable. For a constant bitrate, the histogram contains 1–2 bars, indicating no continuous range of values. Generally speaking, the histogram in *Figure 16* indicates that various small deviating factors (i.e., noise) influence the deviation value. More knowledge about using histograms can be obtained from literature on mathematical statistics.

*Figure 16* the graph at the bottom shows how bitrate fluctuations occur over time—there is no clear pattern, suggesting that the bitrate likely depends on the content of the image.

Is this situation normal? It depends on the chosen multiplexing scheme and encoder mode. Both variable and constant bitrates are acceptable for different applications. Therefore, the question of whether the situation shown in the figure is normal should be addressed to the specialist who designed the multiplexing scheme and what tasks they aimed to solve.

To view the bitrate of all service components individually—click on the service name (*Figure 17*). The Bitrate Summary screen will open. As in the previous case, use this screen to verify the measured bitrates against those specified in the multiplexing scheme and correct any deviations from the scheme.

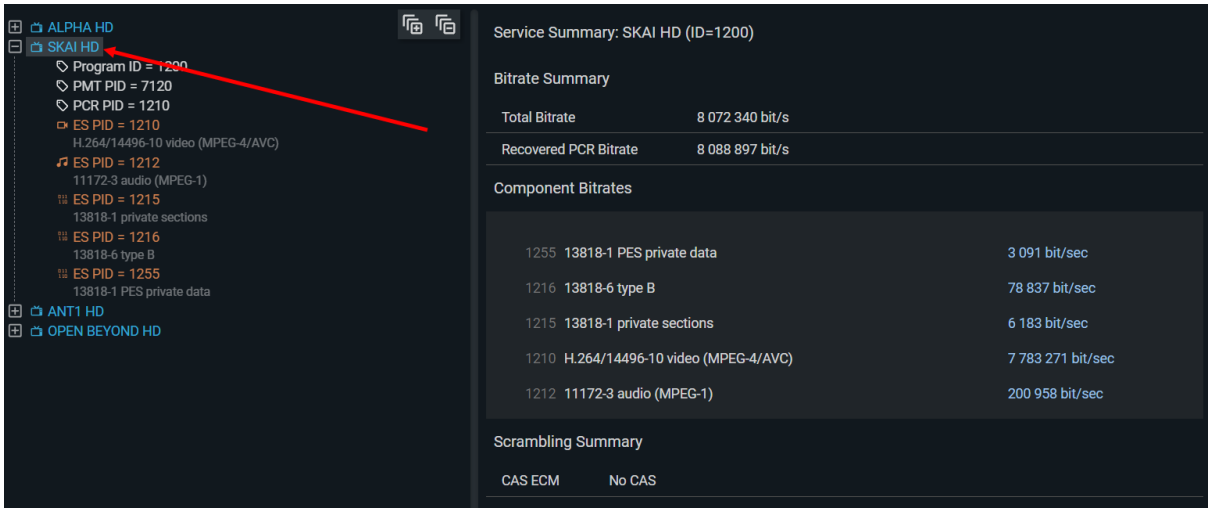
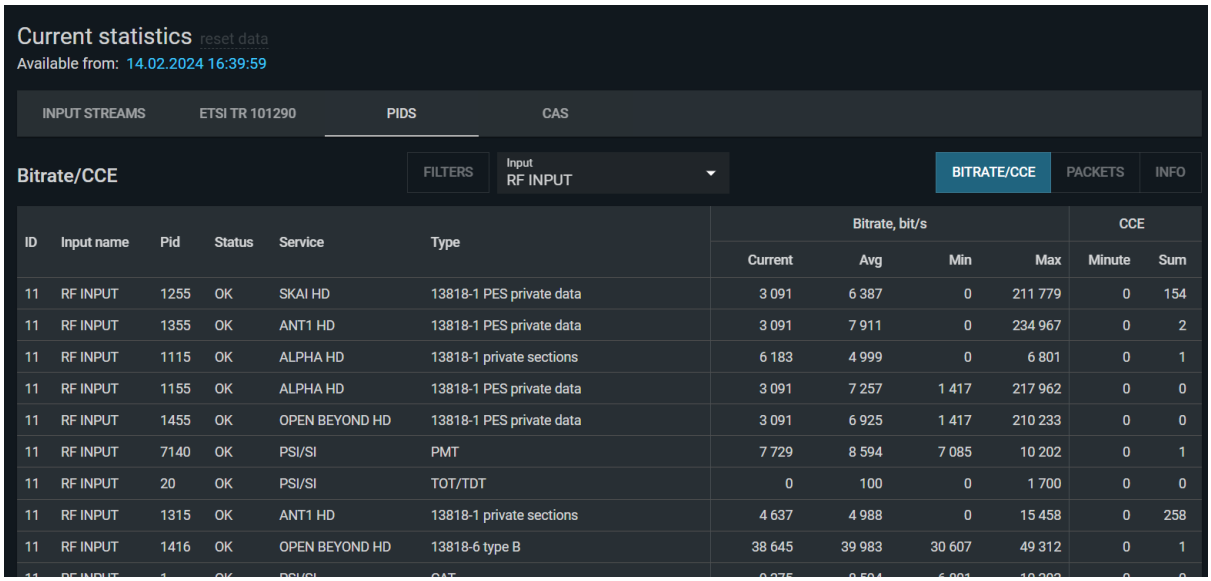



*Figure 17 - Bitrates by all service components*




| ID | Input name | Pid | Status | Service | Type | Bitrate, bit/s | | | | CCE | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Current | Avg | Min | Max | Minute | Sum |
| 11 | RF INPUT | 1255 | OK | SKAI HD | 13818-1 PES private data | 3 091 | 6 387 | 0 | 211 779 | 0 | 154 |
| 11 | RF INPUT | 1355 | OK | ANT1 HD | 13818-1 PES private data | 3 091 | 7 911 | 0 | 234 967 | 0 | 2 |
| 11 | RF INPUT | 1115 | OK | ALPHA HD | 13818-1 private sections | 6 183 | 4 999 | 0 | 6 801 | 0 | 1 |
| 11 | RF INPUT | 1155 | OK | ALPHA HD | 13818-1 PES private data | 3 091 | 7 257 | 1 417 | 217 962 | 0 | 0 |
| 11 | RF INPUT | 1455 | OK | OPEN BEYOND HD | 13818-1 PES private data | 3 091 | 6 925 | 1 417 | 210 233 | 0 | 0 |
| 11 | RF INPUT | 7140 | OK | PSI/SI | PMT | 7 729 | 8 594 | 7 085 | 10 202 | 0 | 1 |
| 11 | RF INPUT | 20 | OK | PSI/SI | TOT/TDT | 0 | 100 | 0 | 1 700 | 0 | 0 |
| 11 | RF INPUT | 1315 | OK | ANT1 HD | 13818-1 private sections | 4 637 | 4 988 | 0 | 15 458 | 0 | 258 |
| 11 | RF INPUT | 1416 | OK | OPEN BEYOND HD | 13818-6 type B | 38 645 | 39 983 | 30 607 | 49 312 | 0 | 1 |

*Figure 18 - Current statistics with bitrates by separate PIDs*

Bitrates for many PIDs can be viewed in the Current Statistics section (*Figure 18*). Here it is convenient to see the current, average, minimum, and maximum bitrates to assess how well they match the multiplexing scheme. In *Figure 18* all bitrates are variable except for the bitrate for PID=1315.

Note that excessively high or low bitrate values may be caused not by the bitrates themselves but by transient processes (buffering) in the receiving devices.

Transient processes can cause unstable network performance for a short time (a few seconds at most) after turning on or changing the configuration of the multiplexer and the TS source (e.g., satellite receiver).

## 5.3 Bitrates and PCR

To determine whether a service's bitrate is constant or variable, you can analyze the PCR histogram. To view it, click on the PCR PID on the services screen (*Figure 19*). In *Figure 19* the histogram corresponds to a normal Gaussian distribution within the range of -200 to +200 nanoseconds from the required value. There is extensive literature on Gaussian distribution and its properties (this branch of mathematics is known as mathematical statistics).

Such a histogram corresponds to a constant service bitrate.

If the service bitrate is constant, deviations from the average value (indicated by 0 on the histogram) should not exceed 200 nanoseconds. However, greater deviations generally do not lead to decoder failures (which is why PCR errors are classified in the second group of importance in ETSI TR 101 290).

If the service bitrate is variable, the histogram will have a chaotic appearance without a visible maximum or with several maxima. Additionally, in this case, the histogram's appearance may constantly change (you can observe this by periodically refreshing the browser window).

Note that PCR relates to the ***overall service bitrate***, including stuffing. Each component of the service may have a variable bitrate, but overall, the service will have a constant bitrate with a corresponding PCR histogram. Achieving a constant bitrate is done through stuffing in the headers of the elementary streams that make up the service (not by using PID=8191 stuffing, which controls the bitrate of the entire stream).

If the multiplexing scheme specifies that the service should have a constant bitrate, but the PCR histogram differs from the one shown in *Figure 19*, it is recommended to check the integrity of the multiplexer. This might require a reset, software restoration, or re-creation of the service from its components, as well as applying PCR restamping to the service's PCR. Restamping is performed by the multiplexer (although not all models on the market may support this feature). I recommend using restamping wherever it is available.

Also, note that a deviation from the "correct" form of the PCR histogram is not related to the network conditions (such as network jitter) because the temporal values of PCR stamps are tied to the stream bytes, not the actual transmission time of the stream. In other words, the PCR will be correct even if the stream is properly recorded and played back without remultiplexing and PCR restamping.

The periodicity of PCR transmission can be checked using the histogram shown in *Figure 20*. The histogram displays the distribution of RR (repetition rate) deviations from the average value. This histogram allows for analyzing potential causes of the 2.3a PCR_repetition_error (see Section 17.4).

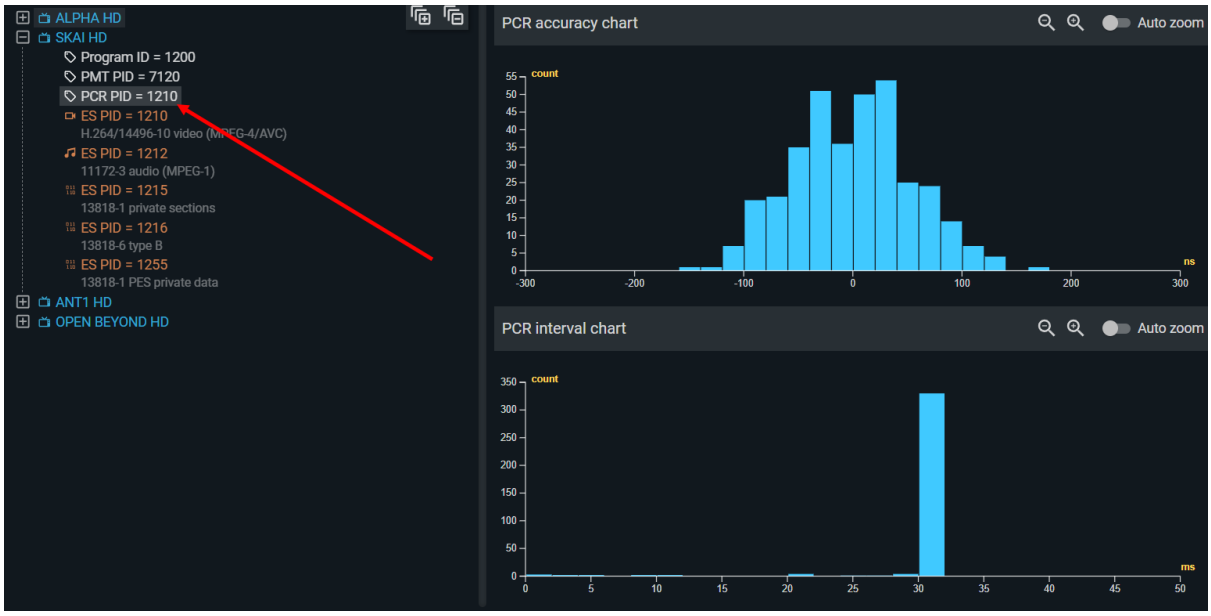



*Figure 19 - Service PCR*

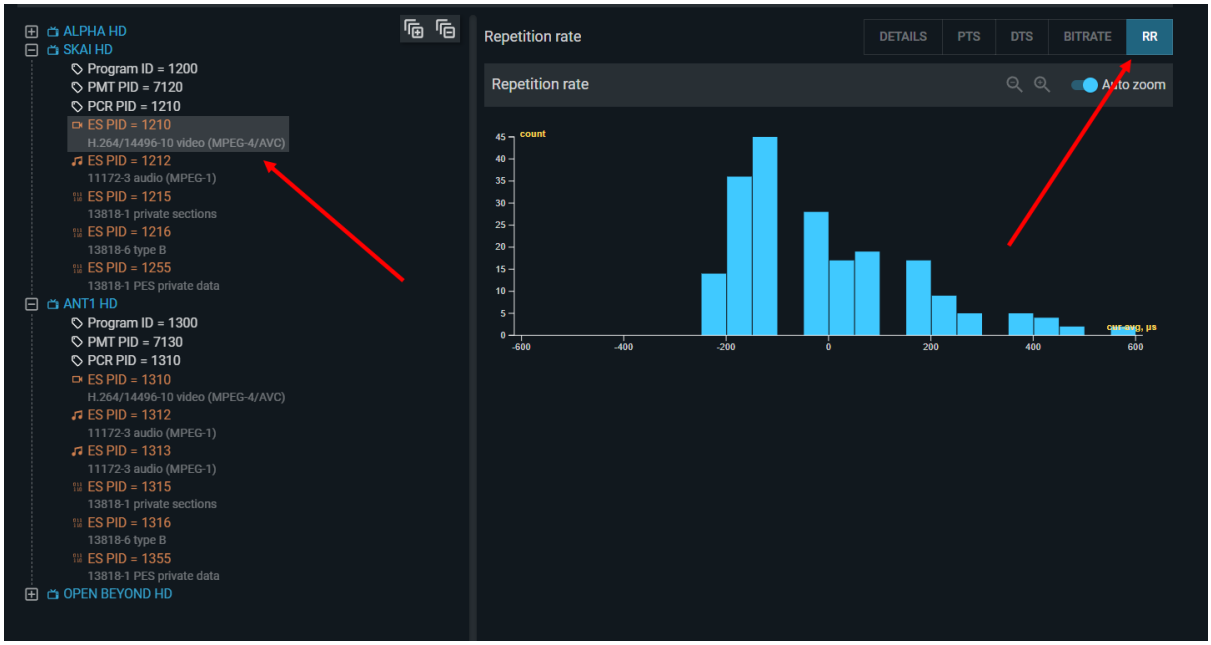



*Figure 20 - Histogram of PCR* periodicity *(RR - repetition rate)*

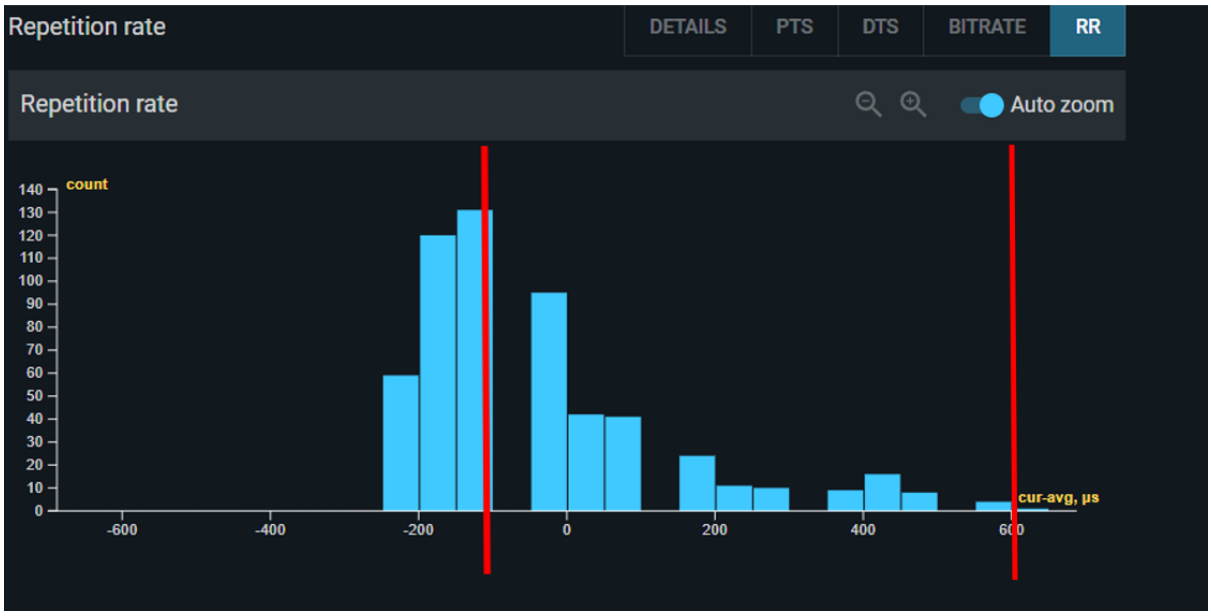



*Figure 21 - Example of PCR offset (average deviation is shown on the left, maximum - on the right)*


*Figure 22 - Histogram of PCR repetition for the example in Figure 20*

For example, from the histogram in *Figure 20* it can be seen that there is a factor that causes the PCR repetition period to shift by approximately 100 microseconds in the downward direction (*Figure 21*). This means that PCR is transmitted more frequently than required (most likely, this is intentionally configured by the service encoder). At the same time, there is another factor (most likely jitter in the service encoder), which causes the histogram to fall off too slowly to the right. Fortunately, in this particular example, this fall-off is minor, not exceeding 600 microseconds, which is significantly less than the PCR repetition period for this service (*Figure 22*). This means that even at the maximum deviation from the average, the PCR repetition period will not cause a 2.3a PCR_repetition_error (since 30ms + 0.6ms < 100ms).

Note that for this example, the encoder is configured with a 30ms repetition period (as seen in *Figure 22*). Until 2020, the standard allowed for a maximum deviation of 40ms. This means that the engineer who configured the encoder was aware of the 600-microsecond deviation (*Figure 21*) and set the encoder with a small buffer to avoid a 2.3a PCR_repetition_error.

Also, this setting was most likely done before 2020, or the company is using equipment that does not support the new standards.

## 5.4 Control of PCR, PTS, and DTS Relationships

PTS is a timestamp of the elementary stream (ES) that indicates the relative time when the current part of the service should be shown to the viewer (strictly speaking, not the "current part" but the "access unit" - however, for operational purposes, this distinction is not important).

DTS and PTS are measured by the same clock, which is set by the PCR.

The use of the PTS is only possible if the service is not scrambled, as otherwise, the timestamp will also be scrambled.

For PCR and PTS relationships, the following requirements must be met:

– The PTS value must not be ahead of the PCR value (obviously, data can only be decoded after it has been delivered);

– The difference between PCR and PTS should not be too large, as the delivered stream needs to be stored somewhere before decoding (and operational memory costs money and may be limited)

These requirements may not be checked by subscriber devices, and the display is performed when the data is actually delivered. However, for some devices, failure to meet these requirements can be critical, and the following symptoms may occur:

– Short-term periodic decoding failure without the appearance of CCE, PCR, and PTS errors;

– Absence of decoding or unstable decoding without the appearance of CCE, PCR, and PTS errors.

CCE, PCR, and PTS errors are described in Sections 16 and 17. Before controlling the PTS and PCR ratio, it is necessary to ensure these errors are absent, and if they are present, they should be corrected.

In the TS Analyzer interface, comparing PCR and PTS for the selected elementary stream can be done using a histogram and graph on the service panel (*Figure 23*).

The zero on the histogram and the time graph corresponds to the average deviation of the PTS from its expected value, calculated based on the PCR (indicated in the header; in the example, it is 984ms). TS Analyzer obtains the PCR values and calculates what the PTS values should be ideally. It then finds the average difference. Each new deviation from the "ideal" is compared with this difference and shown on the histogram. This results in an "offset of the offset." Ideally, the "offset of the offset" should form a Gaussian distribution. Incidentally, in *Figure 23* it does not have this form, indicating problems in the service encoder. However, these problems may not necessarily lead to operational issues.

In practice, a deviation of less than one second does not cause problems during decoding.

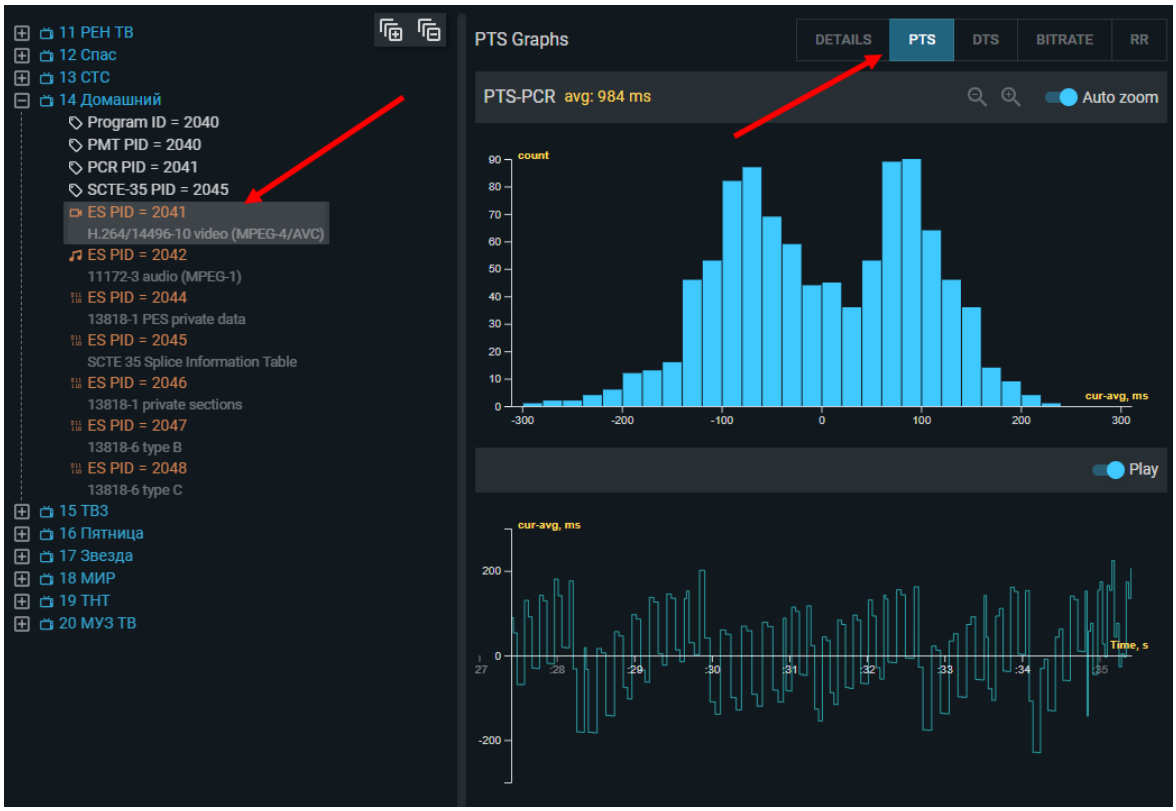



*Figure 23 –Comparison of PCR and PTS*

Additionally, the example in *Figure 23* shows that the histogram and the time graph have an orderly appearance (rather than a chaotic one). The deviation from the average periodically changes within small limits, which seems to be due to the specifics of the encoder's algorithm (most deviations are grouped around ±100ms).

If the changes in deviations had a chaotic appearance, this would indicate incorrect operation of the encoder, which could potentially cause problems when decoding the elementary stream (ES).

In some ES, DTS is also used, indicating the time when the access unit should be decoded (*Figure 24*). Everything mentioned above for PTS applies to DTS as well.

Note that the DTS time differs from the time calculated based on the PCR by a smaller amount than the PTS, indicating an earlier time. This is logical—first, the data must be delivered, then decoded, and only after that displayed. If this temporal order is violated, a decoding failure may occur on subscriber devices. Even if such a failure does not happen (if the set-top box does not process the timestamps to save resources), it is still advisable to investigate the reasons for

the discrepancy. Typically, such mismatches are caused by incorrect operation of the encoder producing the analyzed elementary stream.


*Figure 24 – Comparison of PCR and DTS*

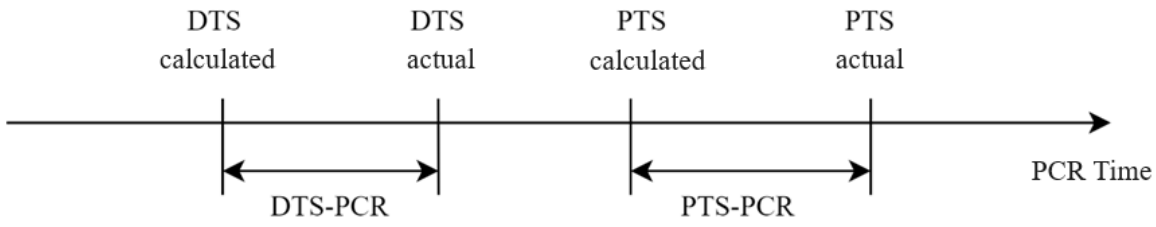



*Figure 25 – Illustration of DTS-PCR and PTS-PCR*

*Figure 25* illustrates the timing relationships described above and the meaning of deviations from the average values of DTS-PCR and PTS-PCR as shown in the graphs and charts in the TS Analyzer. Please note again that the graphs and histograms show deviations from the average values, and not the difference between DTS-PCR and PTS-PCR itself (it is shown in yellow in the title).

## 6 Control of IPAT (Inter-Packet Interval)

The Inter-packet Arrival Time (IPAT) indicates the time between the arrival of the first byte of the headers of two consecutive IP packets containing TS packets. Monitoring the IPAT allows for the evaluation of jitter, which equals the magnitude of IPAT variations. Jitter must be mitigated by buffering. Excessive jitter can lead to buffer overflow or underflow in the receiving device, often resulting in CC errors (Section 16.4) and visible disruptions in image and sound.

IPAT also depends on factors such as:

– Transport type (IP or RF), where RF typically exhibits minimal jitter;

– Total stream bitrate (higher bitrates may increase jitter due to increased network load);

– Number of TS packets in one IP packet (from 1 to 7). More TS packets in one IP packet generally result in a larger IPAT (at the same bitrate). See Section 2 for more details.

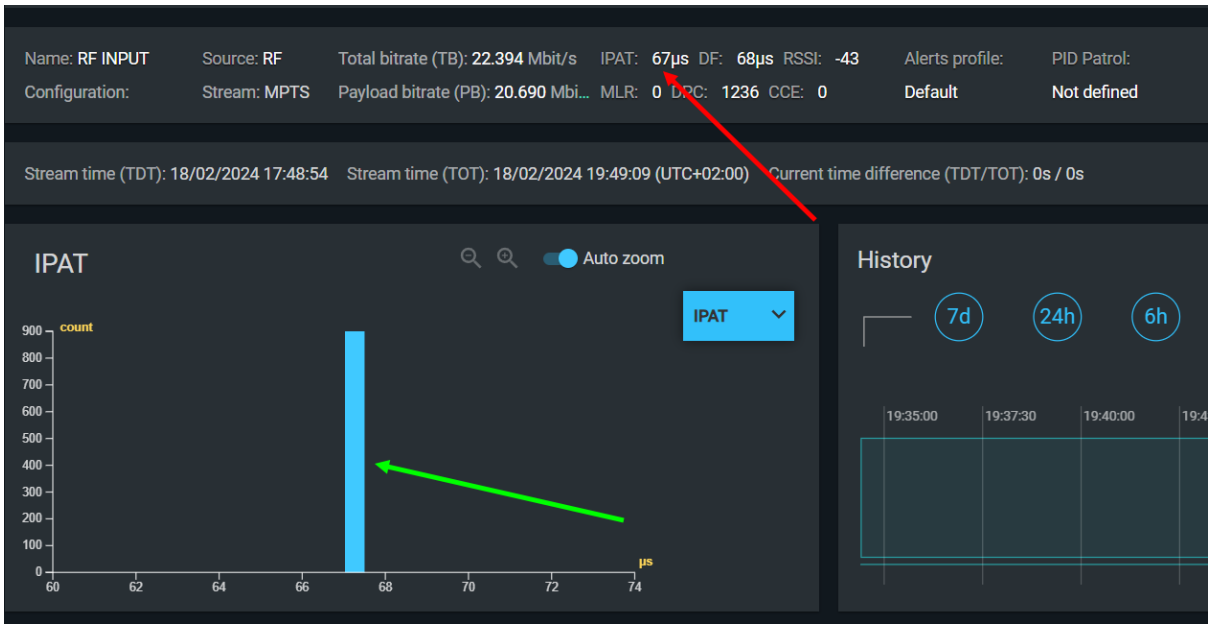



*Figure 26 - IPAT in the GUI of TS Analyzer*

*Figure 26* shows IPAT for the signal transmitted though RF. Since there is no IP in RF, IPAT in this case shows the arrival time of each TS packet at the

demultiplexer interface within the analyzer itself. In RF, the bitrate is determined by modulation, which is highly constant, thus making IPAT constant as well.

The consistency of IPAT can be assessed using the IPAT histogram (see *Figure 26*). It can be seen that in the case of receiving a radio frequency signal (RF INPUT selected), the histogram appears as a single bar (green arrow). If, during RF reception, the histogram does not appear as multiple bars scattered across the histogram, this indicates that there is jitter in the RF path, with the corresponding risks of encountering CCE errors or, in severe cases, complete destruction of the TS.

Additionally, note that in *Figure 26* IPAT the IPAT value coincides with the DF (see Section 9 for DF), indicating the correct operation of the demodulator and demultiplexer. Each incoming packet is delayed in the buffer precisely until the next packet arrives. The demodulator-demultiplexer link may be implemented differently in various devices, but the main point is that the IPAT and DF values should remain constant (this applies only to the case of receiving the TS from an RF input).

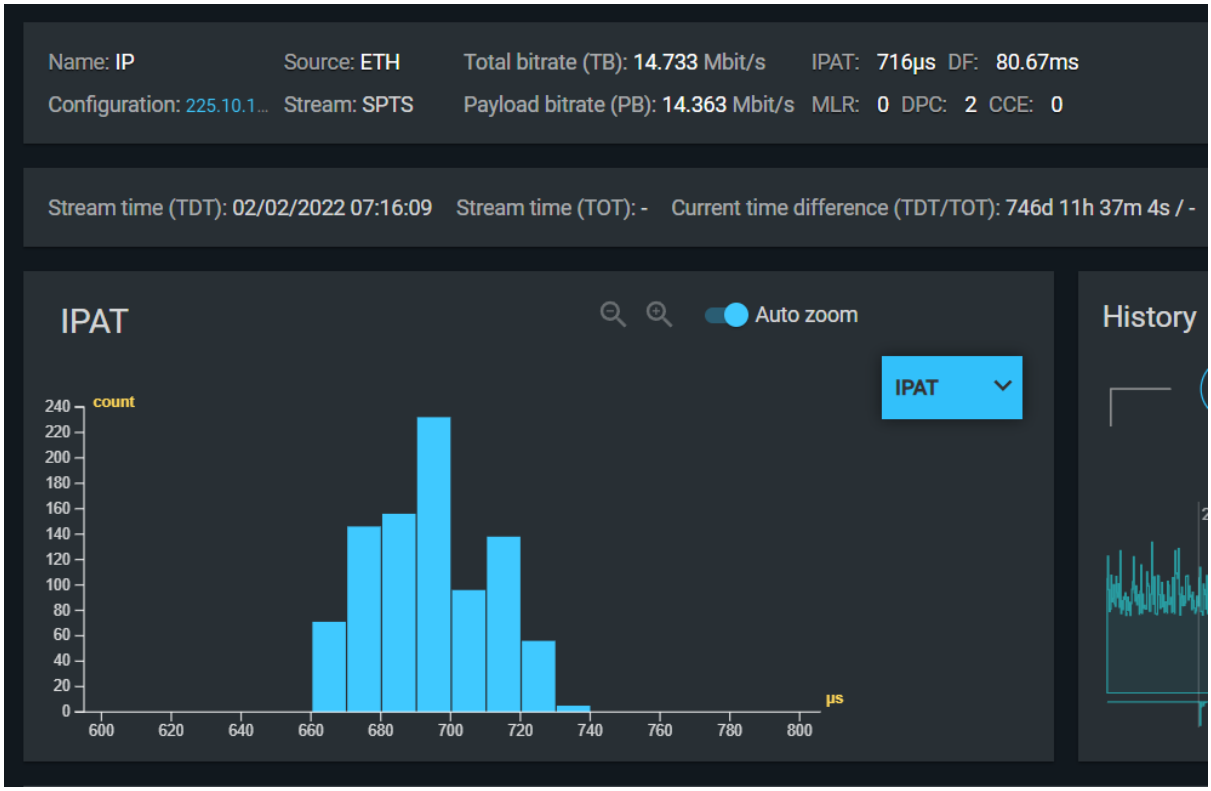



*Figure 27 - IPAT histogram for IP stream*

Now let's look at the appearance of the IPAT histogram for an IP stream (*Figure 27*). In this example, the histogram shows a normal Gaussian distribution ("hill" or "bell curve") with a peak around 720 microseconds. A normal distribution is a sign that the network environment is good, as the arrival of IP packets at the analyzer interface experiences minor random deviations. A bad situation is when the histogram consists of many chaotically scattered bars—in this case, buffer overflows and underflows and the generation of CCEs are possible.

It is recommended to check the appearance of the IPAT histogram in any investigation of the causes of CCEs when they appear throughout the TS.

## 7 Duplicate Packet Counter Error (DPC)

Incorrect operation of the multiplexer or network equipment may result in packets being repeatedly sent. This does not inherently degrade services but can consume bandwidth. In critical cases, this can lead to the appearance of CC errors across all PIDs in the stream because there will be no space left for useful signals.

TS Analyzer includes a duplicate packet counter for the current TS (*Figure 28*). Under normal circumstances, the counter should be zero. If its value is high (thousands of packets), it is recommended to check the integrity of the network equipment.

In the case of multicast streams, it is advisable to verify the absence of "parallel" broadcasting from multiple sources into the same multicast group or network loops.

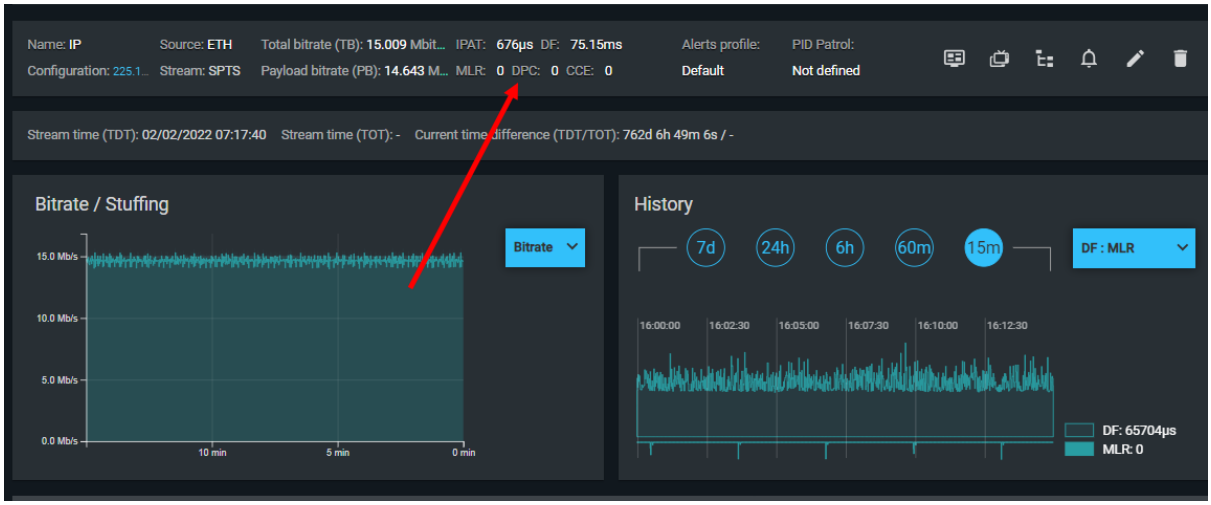



*Figure 28 – Duplicate Packet Counter*

# 8 Errors Related to Universal Time Coordinated (UTC)

In order to accurately identify errors or peculiarities in TS streams related to current time, the TS Analyzer must be synchronized.

For synchronization, enable NTP synchronization (found in the Settings menu, see *Figure 29*) or manually input the time (not recommended). Current time is transmitted in TS using TDT (Time and Date Table) and TOT (Time Offset Table) tables.

Incorrect time information can lead to the following consequences:

– Incorrect time displayed in EPG or complete failure of EPG functionality;

– Malfunction of recording functions on receiving devices;

– Incorrect time display on the receiving device if synchronized via TDT/TOT tables.

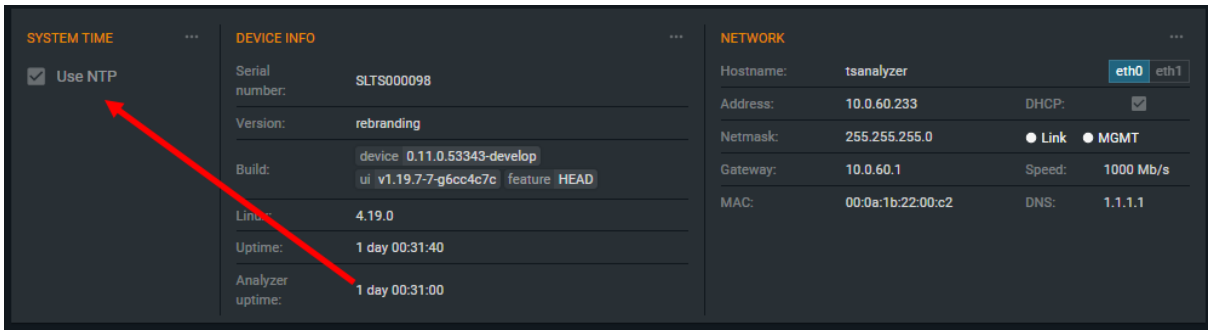



*Figure 29 – Enabling synchronization via NTP*

TS Analyzer calculates the time difference between incoming TS and its internal clock, displaying it in GUI (*Figure 30*, red arrow).

*Figure 30* illustrates an instance of incorrect TS time. The reason for the time difference in this case is that the analyzer receives a stream recorded 743 days prior to the current time. Additionally, the periodic appearance of errors on the right panel in *Figure 30* (lower part of the graph) indicates that the stream is being played in a loop by the player.

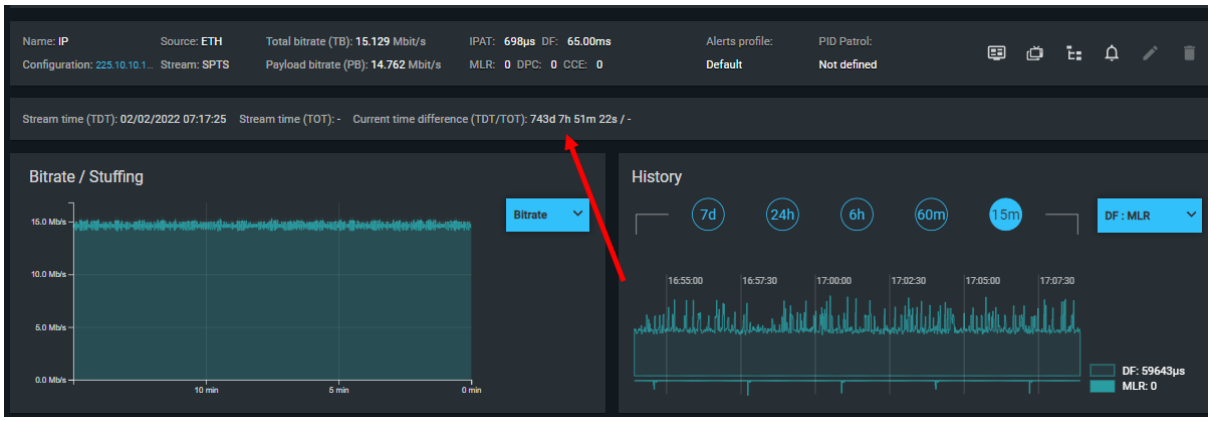



*Figure 30 – Deviation of TS time from current time*

Reasons for the transmitted time deviating from the current time can include:

– Incorrect time configuration on the multiplexer (or PSI/SI generator);

– Malfunctioning clock on the multiplexer (or PSI/SI generator);

– Retransmission of a stream from a different time zone without updating the TOT table;

– Playback of a previously recorded stream without correcting the TDT/TOT;

– Signal processing delays in the transmission path (typically resulting in minor deviations), such as when using satellite communication channels without TDT/TOT correction.

# 9 Using MDI (RFC 4445)

## 9.1 General Information

MDI is described in the RFC 4445 recommendation. It is not widely used due to the fact that different receiving devices may produce different results depending on their design. It is important to keep this in mind when comparing results obtained on different devices. However, the MDI is useful as an additional indicator of quality.

MDI is designed to assess the ability of a receiving device to handle network jitter and serves as an indicator of the network buffer's performance in the receiving device. The MDI is typically used when configuring networks with multicast streams, as jitter can have the greatest impact in such cases (jitter is minimal when transmitting via RF).

MDI is measured only for streams with constant bitrates. For variable bitrate streams, MDI values will fluctuate chaotically (that is another indicator for VBR).

MDI consists of two parts: DF and MLR.

## 9.2 DF (Delay factor)

DF (delay factor) is measured in seconds. DF indicates the maximum time that payload packets (but not the entire RTP or UDP packet, only the payload) remain in the buffer before being processed.

The reason packets remain in the buffer is because they may arrive too quickly at times and need to be stored temporarily before processing. Similarly, packets may also be processed slowly. This phenomenon is known as "jitter" (variation in packet arrival times). If the rate of packet arrival into the buffer and the rate of packet retrieval from the buffer are always the same, the buffer size can be zero, resulting in DF = 0. However, such a situation is ideal and rarely occurs in practice.

For television applications, especially during live broadcasts, it is crucial for DF to be minimized. If the required buffer size (due to jitter) exceeds the actual receiver buffer size, packet loss (CC errors) may occur.

The converse is also true: if packet loss is observed, one possible reason could be that the receiver buffer size is too small to handle network jitter effectively.

To reduce DF, it is necessary to configure the LAN to minimize network jitter (by providing bandwidth reserves, avoiding processing high-priority requests, etc.).

## 9.3 MLR (Media Loss Rate)

Packet Loss Rate indicates the number of RTP/UDP payload packets that were not processed (i.e. were "lost"). Packet loss can occur due to excessive jitter, network failures, or issues with the network interface. The magnitude of MLR depends on the technical implementation of the network interface and can vary between devices from different manufacturers.

MLR does not always correlate with CC errors, as it might initially seem. For example, there could be a situation where a “broken” stream is transmitted within RTP/UDP. In this case, MLR would be =0, but some CC errors might still appear. Conversely, the situation where MLR <> 0 but no CC errors occur seems unlikely and could indicate erroneous MLR generation or incorrect detection of CC errors (i.e., the measuring device itself might be faulty).

A good practice is to eliminate non-zero MLR before investigating the causes of CCE.

# 10 Monitoring of CAS

Symptoms of CAS malfunction include:

– Scrambled ("closed") services no longer being descrambled by subscriber devices. This issue may not affect all services or all devices;

– Services that should be scrambled are transmitted in the clear. This problem may not affect all services or all devices.

These issues can manifest continuously or periodically (for example, a service may be accessible for one minute and inaccessible the next). To isolate the impact of CAS malfunction from other potential issues, it is necessary to:

– Ensure that there are no CC errors on the CAT, ECM, and EMM PID streams (this can be checked in the statistical information menu of the TS Analyzer, see *Figure 31*, and further description in this section);

– Verify that the ECM or EMM stream bitrate does not have short-term bitrate spikes (checking for "spikes" is described in Section 2.1).

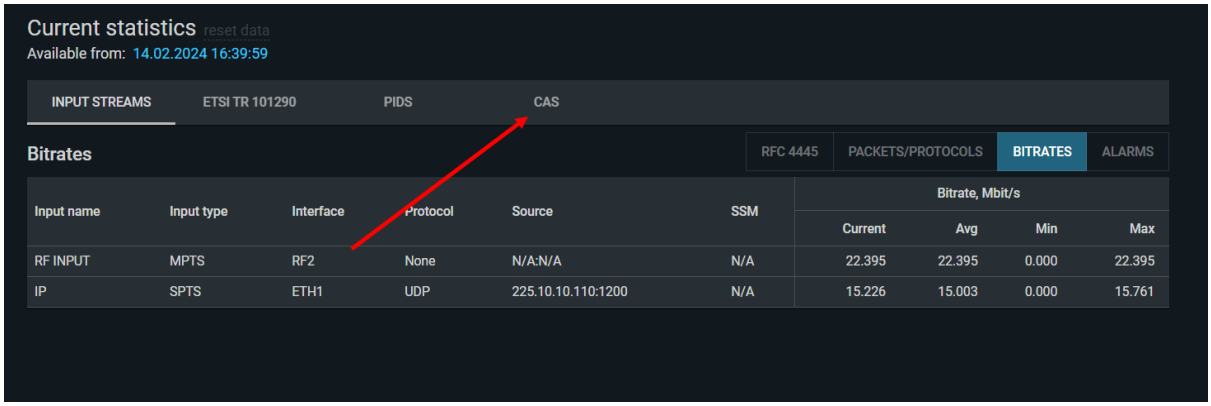



*Figure 31 - Button for accessing the CAS monitoring screen*

Only the provider of CAS can provide a definitive answer regarding CAS malfunctions. CAS is designed to protect services through encryption methods. Therefore, encryption methods are kept confidential and not disclosed to anyone. There is no way to determine whether correct information is being transmitted in the EMM streams without knowledge of how a specific CAS is implemented.

As a result, communication operators typically have agreements with CAS providers for technical support. These agreements include Service Level

Agreements (SLAs), outlining the procedures operators must follow in case of malfunctions.

TS Analyzer offers preliminary methods for analyzing the quality of CAS transmission streams, which may be necessary when contacting CAS provider technical support.

For some CAS implementations not compliant with the Simulcrypt standard (refer to ETSI TS 103 197 for Simulcrypt details), these measures may have limited applicability. In such cases, consultation with CAS providers about the suitability of TS Analyzer is advisable. Fortunately, such non-standard systems are relatively rare.

Methods of analyzing CAS that support Simulcrypt, are described in *Table 5*.

*Table 5 - Methods of CAS diagnostics with the use of TS Analyzer*

| Object and reasons of verification | Verification and possible results |
|---|---|
| Checking for CAT errors. The CAT table indicates which CAS is used and on which PID the EMM is transmitted. Without a CAT, descrambling is impossible. | Checking the CAT is described in Section 17.8.<br>Additionally, from the CAT on the service screen, you can find out the EMM PID for verification. |
| Statistical information on the use of CAS in the selected elementary stream | *Figure 32* shows the CAS statistical information panel for the selected service (in this example, CAS is absent). If CAS is present, you can view the CAS ID and the key rotation period. These values should match the CAS settings. You can also use the CAS ID to determine which CAS is scrambling the service. |
| Statistical information on all scrambled streams | *Figure 33* shows the statistical information screen for all CAS components that the TS Analyzer has detected in the current stream. On this |

| Object and reasons of verification | Verification and possible results |
|---|---|
| | screen, you can check the operation of the scrambler and the CAS management system. |

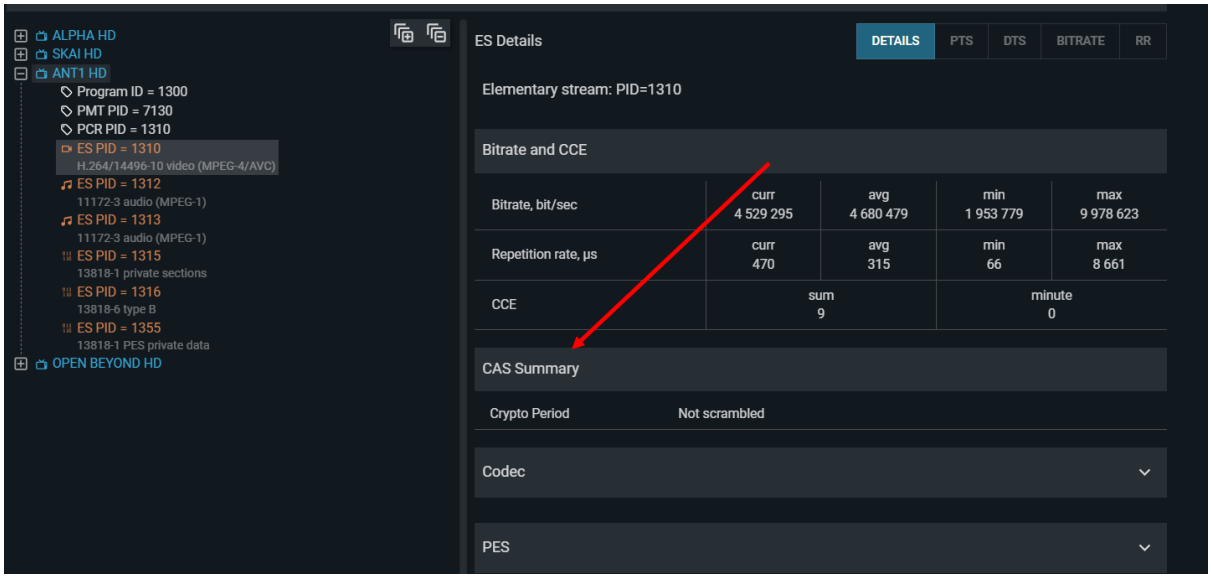
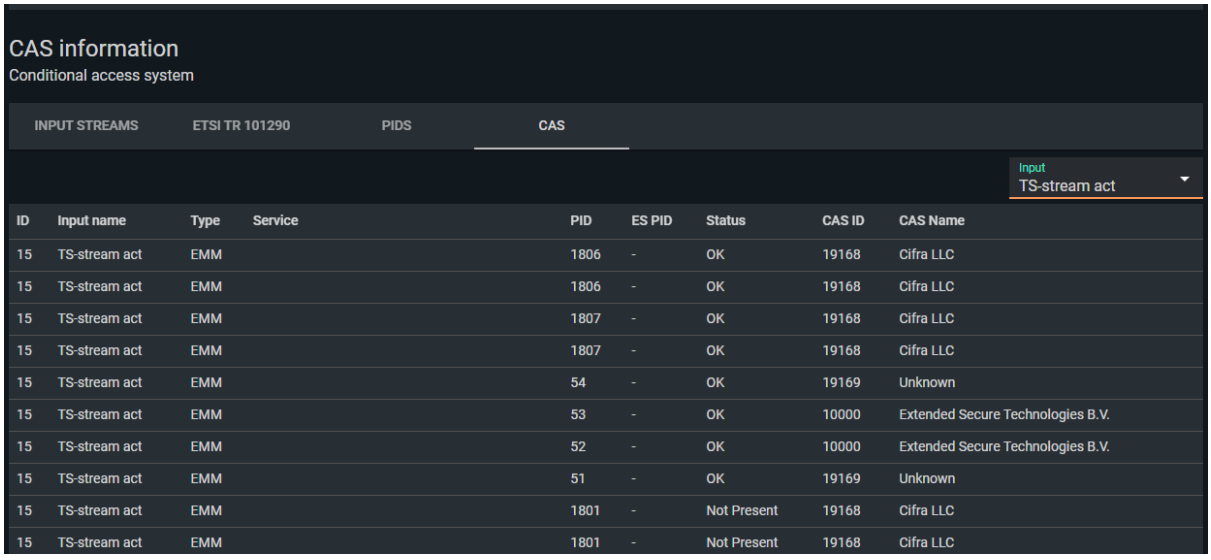



*Figure 32 - Viewing statistics of CAS usage in the selected elementary stream*

You can also find information on scrambled streams on the service screen of TS Analyzer: the service tree will show which components are scrambled. Using this information and a subscriber device with verifiable subscription, it is possible to verify whether the closed channels are actually closed and whether the open channels are open.




| ID | Input name | Type | Service | PID | ES PID | Status | CAS ID | CAS Name |
|---|---|---|---|---|---|---|---|---|
| 15 | TS-stream act | EMM | | 1806 | - | OK | 19168 | Cifra LLC |
| 15 | TS-stream act | EMM | | 1806 | - | OK | 19168 | Cifra LLC |
| 15 | TS-stream act | EMM | | 1807 | - | OK | 19168 | Cifra LLC |
| 15 | TS-stream act | EMM | | 1807 | - | OK | 19168 | Cifra LLC |
| 15 | TS-stream act | EMM | | 54 | - | OK | 19169 | Unknown |
| 15 | TS-stream act | EMM | | 53 | - | OK | 10000 | Extended Secure Technologies B.V. |
| 15 | TS-stream act | EMM | | 52 | - | OK | 10000 | Extended Secure Technologies B.V. |
| 15 | TS-stream act | EMM | | 51 | - | OK | 19169 | Unknown |
| 15 | TS-stream act | EMM | | 1801 | - | Not Present | 19168 | Cifra LLC |
| 15 | TS-stream act | EMM | | 1801 | - | Not Present | 19168 | Cifra LLC |

*Figure 33 - Statistics on all scrambled streams*

# 11 Monitoring of EPG (EIT)

EIT tables EIT_actual and EIT_other are used for transmitting electronic program guides.

Note that transmitting these tables is not mandatory. Specifically, if descriptions for future programs are absent, this is not considered an error but a configuration feature. Therefore, the engineer should independently monitor the composition of EIT tables and the information being transmitted. If EIT tables are not used, you can disable the corresponding error checks in the TS Analyzer profiles.

The EIT_actual table is transmitted as part of PSI/SI for delivering the EPG. EIT_actual contains the program schedule for the TS ***in which it is transmitted.*** EIT_actual consists of three types of sections responsible for:

– Information about current programs ("section 0" on table_id = 0x4E);

– Information about next programs ("section 1" on table_id = 0x4E);

– Information about future programs (table_id = 0x4E - 0x6F).

Information about future programs can be transmitted for any period at the operator's discretion. Sections 0 and 1 on table_id = 0x4E must both be present.

TS Analyzer offers a complete toolkit for monitoring both the content and distribution of EIT.

Content monitoring is performed on the EPG screen (*Figure 34*).

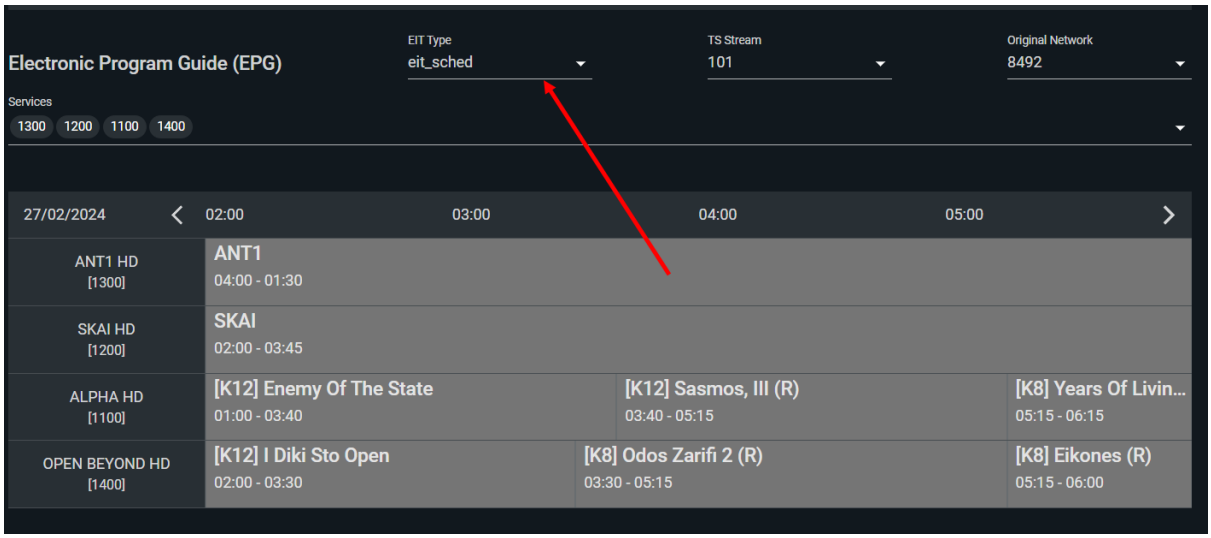



*Figure 34 –EPG screen*

Every EIT must contain information described in *Table 6*.

*Table 6 – Description of information in EIT*

| Information | Purpose | Results of malfunction and methods of diagnostics |
|---|---|---|
| EIT_type | For transmitting the schedule of currently airing programs, upcoming programs, or future broadcasts. | The corresponding part of the EPG will be missing. By toggling the EIT_type field according to the information content, you can determine which section is missing. |
| TS_Stream | To specify the ID for which TS the given EPG is intended (the TS ID is transmitted in the PAT, see *Figure 35*), | If the EIT contains an incorrect TS ID, the EPG will not be displayed on the subscriber device, as the device will assume it is EPG for a different TS. Additionally, an "alien" EPG might be shown. Some subscriber devices may ignore the TS ID, and if the EIT transmits information for multiple TS, the screen will display a "mishmash" of different EPGs (in simpler terms, the result will be unpredictable). |

| | | |
|---|---|---|
| Original network ID | To specify the Network ID for which the given EPG is intended. This is necessary to avoid mixing EPGs with identical TS IDs from different networks. (The Network ID is transmitted in the NIT, see *Figure 36*). | Similar to the TS ID error described above. |

In case there is an absence of or defects in EPG playback, it is necessary to check that the TS ID and Network ID are correctly specified in the EIT. This can be done on the EPG screen (*Figure 37*). For the correct display of the EPG, the conditions described in *Table 6* – i.e., there must be a correspondence between the Network ID, TS ID, and Original Network ID. Usually, these correspondences are verified by the EPG server (but not necessarily).

In most cases, problems with EIT_actual lead to failures in EPG display, but not always, because if the table was transmitted as part of the stream and then the transmission stopped, the subscriber devices usually cache this table.

Failures can occur for current programs, next programs, or future programs – depending on which section is affected. By selecting different sections on the EPG screen, you can determine where the problem lies.

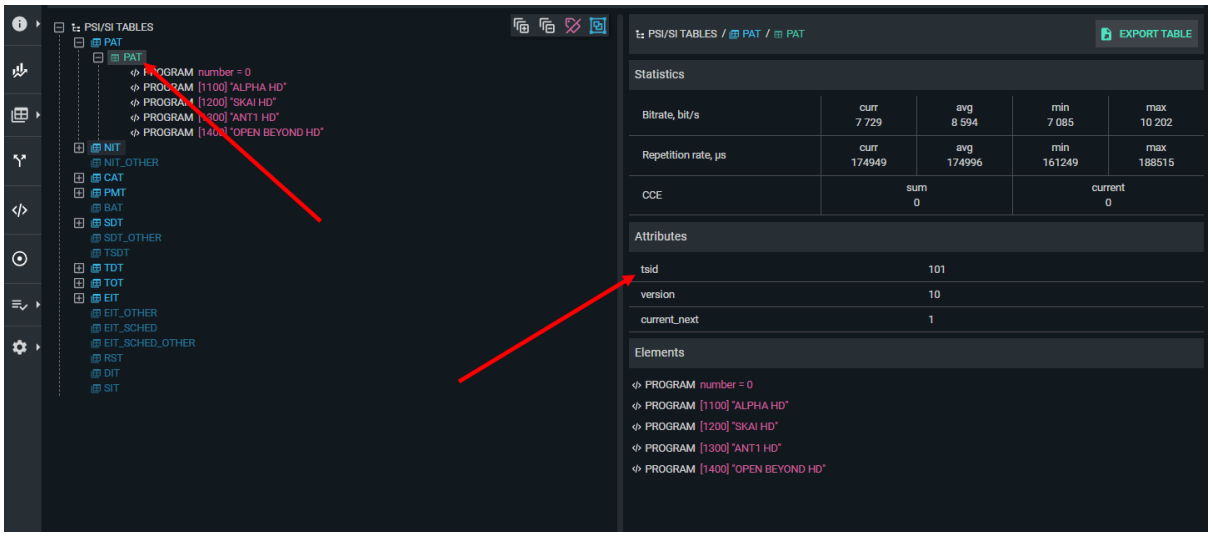



*Figure 35 – Locating TS ID (for EPG diagnostics)*

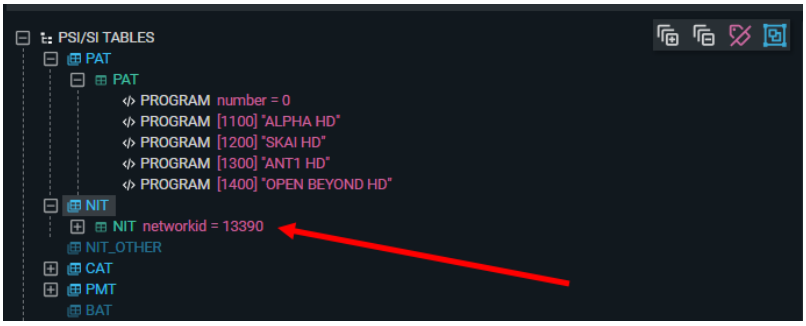



*Figure 36 – Locating Network ID (for EPG diagnostics)*

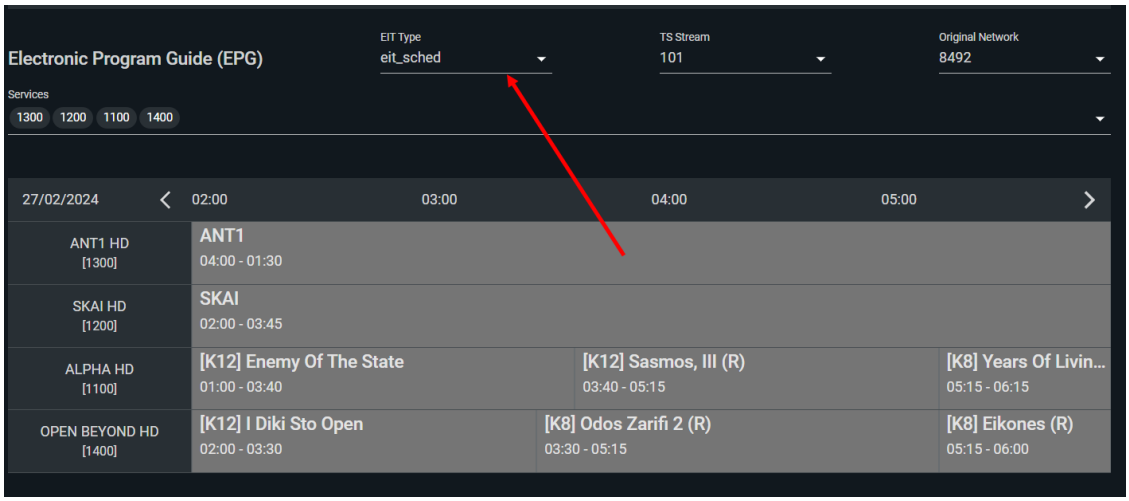



Figure 37 – *Verification of EIT type, TS ID and Original Network ID for EPG diagnostics*

In the TS, EIT ***for other TS*** (EIT_other) can also be transmitted. To monitor them, use error 3.6b EIT_other_error (Section 18.12). The structure of the

EIT_other table is similar to EIT_actual (table_id = 0x4F), but EIT_other does not include information about future programs.

Since EIT tables generally have a high bitrate (which can reach 1 Mbps or more) and are cached by receiving devices, operators often intentionally increase the EIT transmission interval to save bandwidth.

You can check the bitrate and other EPG parameters (TS ID, Original Network ID) in the TS Analyzer on the PSI/SI screen (*Figure 38*).

You can also check the bitrate on the PID screen in the statistics section (*Figure 39*) – select the desired input and specify PID = 0x11 (18) in the filter.

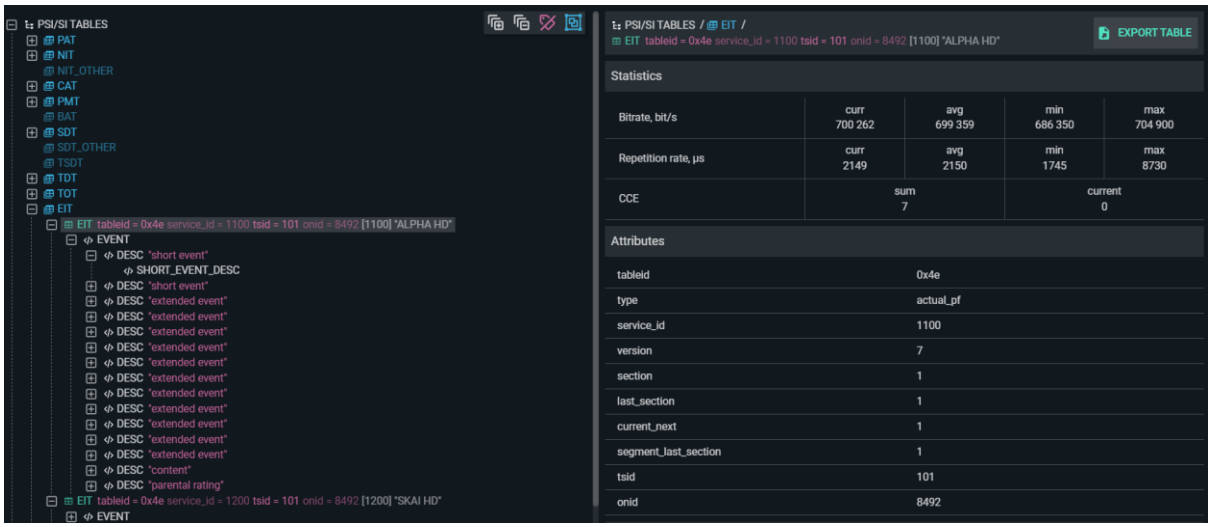



*Figure 38 – EIT on the PSI/SI screen*

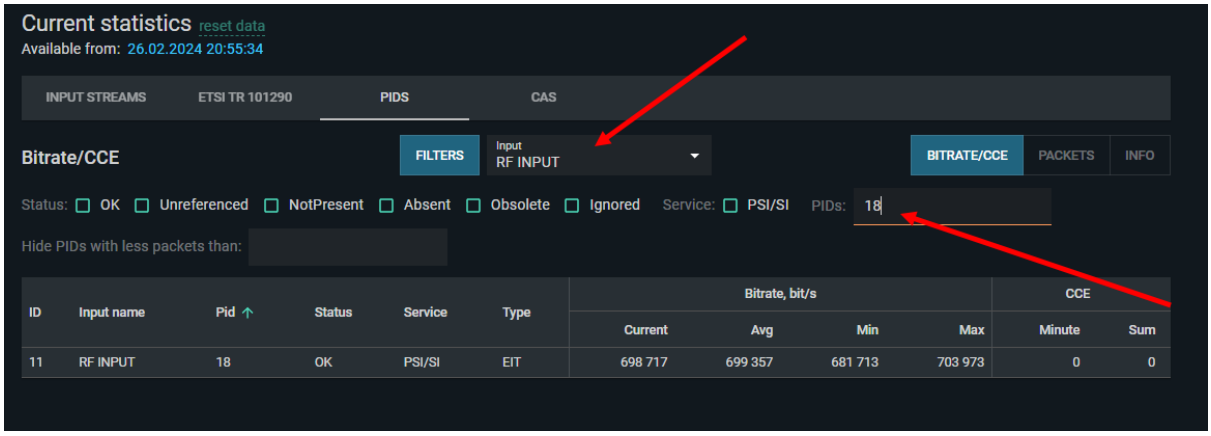



*Figure 39 – Bitrate monitoring by PID EIT*

TS Analyzer allows tracking of EIT errors related to too infrequent or too frequent transmission of EIT tables (see Sections 18.11 for EIT_actual and 18.12 for EIT_other).

Note that the transmission of sections 0 and 1 is mandatory for EIT. The standard prohibits transmitting only section 0 or only section 1. If such a situation occurs, error 3.6c EIT_pf_error will be generated (see Section 18.13).

In some cases, the EPG may be displayed incorrectly if it is cached but the cache is not updated when the EIT is updated. This issue arises because the subscriber device mistakenly does not process the EIT version change or does so incorrectly. An example of displaying the EIT version is shown in *Figure 38* (table on the right). Typically, this problem is resolved by rebooting the subscriber device or adjusting its software. With TS Analyzer, it is easy to check how the subscriber device responds to version changes, as TS Analyzer correctly handles changes (caching is not used).

# 12 Monitoring of Elementary Streams (PES)

TS Analyzer offers tools for monitoring information in the headers of elementary streams. This information is of secondary importance but can be useful when troubleshooting issues that are not detected by the ETSI TR 101 290 errors.

In many subscriber devices, PES information is ignored; however, this situation is not standard. It is recommended to check the correctness of the PES header information if there are problems with decoding elementary streams.

A detailed description of the purpose of PES header fields is provided in ISO 13818-1.

PES header information is available only if the PES is not scrambled. The GUI view indicating the position of the PES section is shown in *Figure 40*.

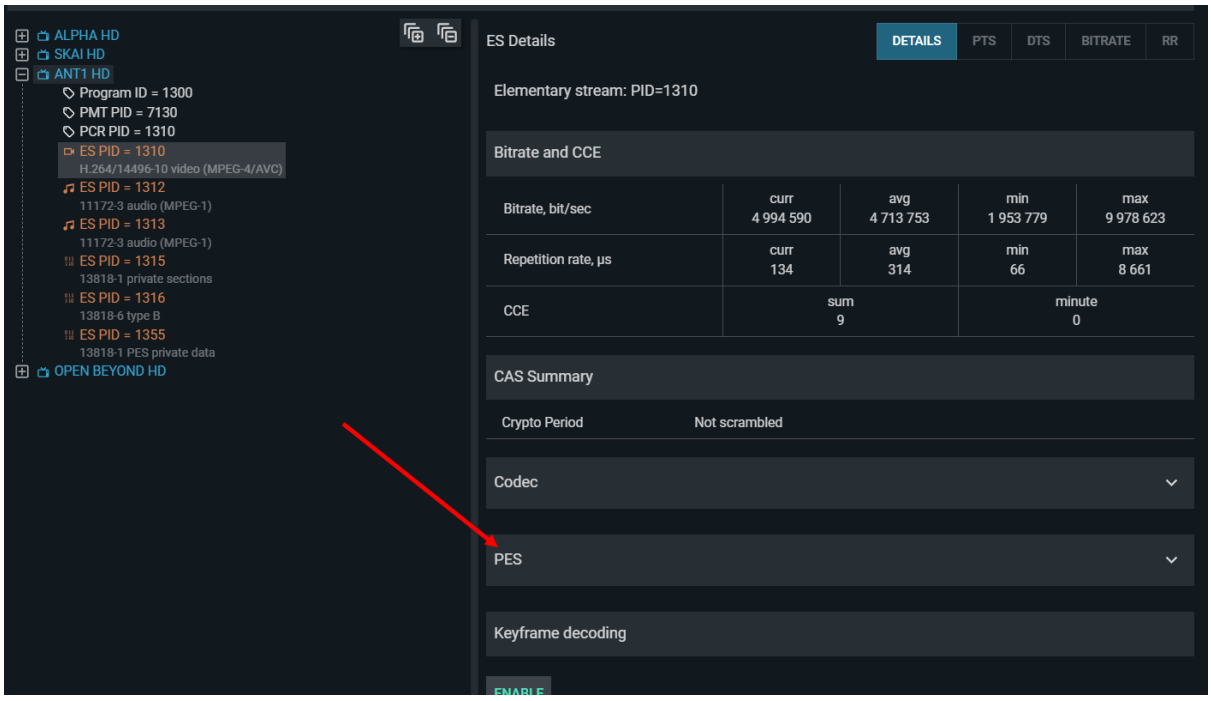



*Figure 40 - Position of the PES information section*

Description of the information provided by TS Analyzer about the PES header is available in *Table 7*. The table only includes the fields analyzing which is meaningful for the operation of DTV networks.

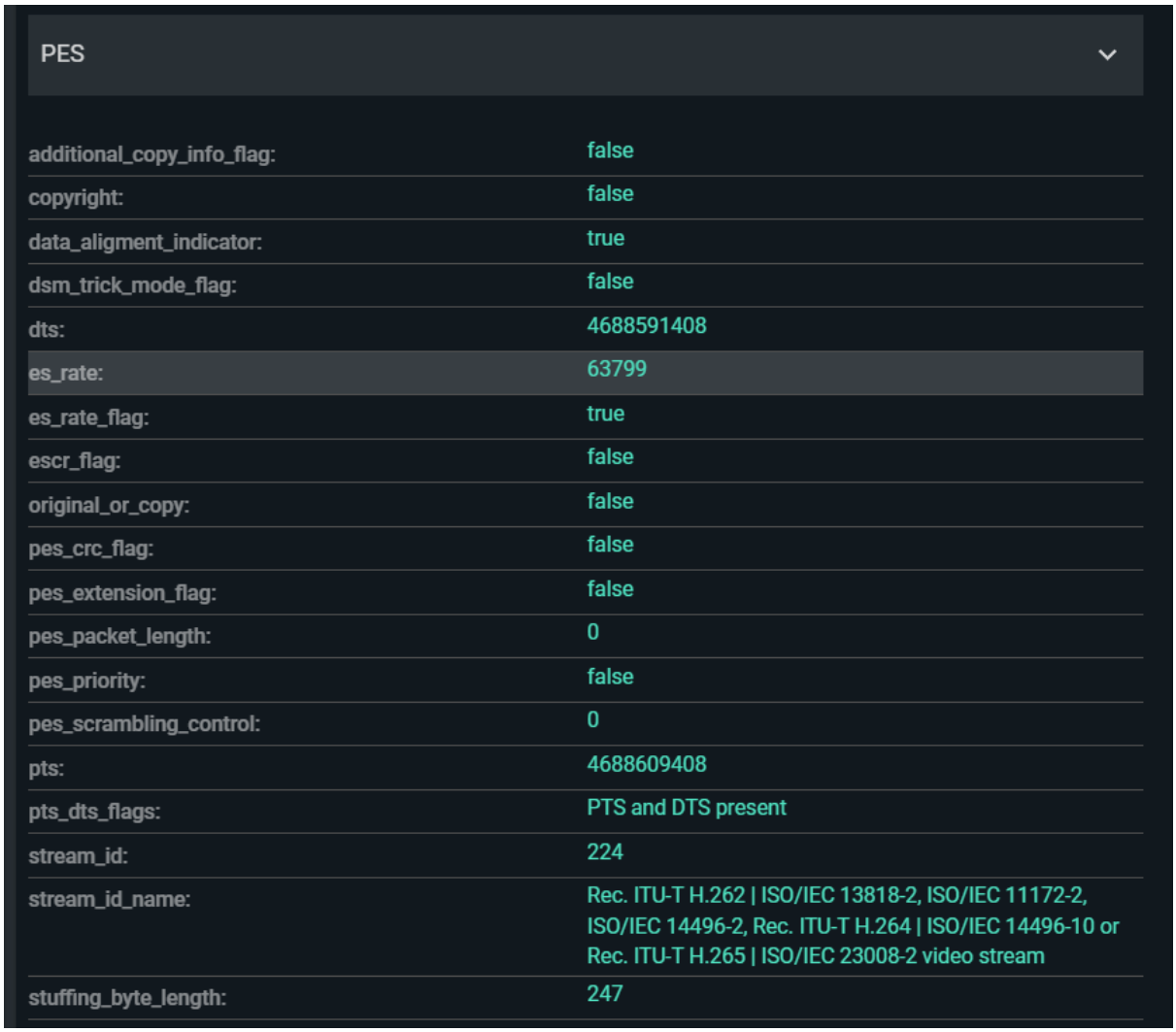



*Figure 41 - Information about the composition of the PES header*

*Table 7 - PES header*

| Field name | Purpose and impact |
|---|---|
| Copyright | If =1, it indicates that the information is copyright protected. |
| Data_alignment_indicator | If =1, it means that the video AU header immediately follows the PES header (i.e., the AU is not split between multiple PES packets). If this indicator does not match the actual structure of the PES or is incorrectly processed by the decoder, decoding may periodically stop or fail entirely. |

| Field name | Purpose and impact |
|---|---|
| DSM_trick_mode_flag | Must be set to 0. If =1, incorrect processing may potentially cause decoding failures (although this is very unlikely). |
| DTS | See PTS below in the table (what is written for PTS is also valid for DTS). DTS can be absent, which is not an error. For DTS, see Section 5.4. |
| ES_rate | Specifies the target bitrate of the decoder for this PES packet. Check the value of this field for compliance with the encoder settings if there are decoding defects. Note that if =0, it is an error (value is prohibited). |
| ES_rate_flag | Flag indicating the presence of the ES_rate field For some (outdated) receiving devices, the presence of the ES_rate field might be required. |
| ESCR_flag | Must be =0. If =1, it means the ES uses its own synchronization scale. Typically, such a scale is not used, and a value of 1 should be considered an error. Some devices may incorrectly process this field. The consequences are similar to those of missing PCR (see Section 17.3). |
| Original_or_copy | =1, if the encoder is set to indicate that the stream is original, and =0 if it is a copy. |
| PES_CRC_flag | Typically =0, indicating that CRC is not used in the PES packet. If =1, it is recommended to disable CRC in the encoder unless CRC was intentionally enabled (it is usually not applied in DTV). |
| PES_extension_flag | Typically =0, indicating that the PES packet does not use an extension field. If =1, it is recommended to disable the extension in the |

| Field name | Purpose and impact |
|---|---|
| | encoder unless the extension was intentionally enabled (it is usually not applied in DTV). |
| PES_packet_length | The length of the PES packet in bytes. For video streams, it is usually =0. If incorrectly specified, periodic decoding errors are possible |
| PES_priority | PES priority. For some decoders, the priority value may matter. If set incorrectly, the decoder might ignore the stream. In most decoders, this flag is ignored. |
| PES_scrambling_control | For modern CAS, it should be =0. If not equal to 0, it indicates scrambling at the PES level (which is not supported by Simulcrypt, see Section 10). If set incorrectly, it may result in a lack of decoding and/or a message that the signal is encrypted (even though it is not encrypted). |
| PTS | Timestamp used for synchronization. The verification of its correctness is described in Section 5.4. The value of this field can be used to check the correctness of the absolute PTS value if the verification per Section 5.4 indicates synchronization errors (the correct PTS value is within the time scale set by the PCR). The PTS value is set by the encoder during stream encoding. |
| PTS_DTS_flag | Flag indicating the presence of PTS and DTS. This value should be checked if the verification per Section 5.4 indicates synchronization errors. The presence or absence of this flag is determined by the encoder settings. |
| Stream_id | Elementary stream type identifier. If the type does not match the actual one, decoding may not |

| Field name | Purpose and impact |
|---|---|
| | occur. The TS Analyzer displays the stream type in the stream_id_name field, while this field shows the type identifier as specified in Table 2–22 of ISO 13818–1. |
| Stream_id_name | The name of the stream type according to the stream_id field and Table 2–22 of ISO 13818–1. Ensure that the description in this field matches the stream type specified by the multiplexing scheme. |
| Stuffing_byte_length | Stuffing length in bytes. Stuffing can be used, for example, to create CBR (constant bit rate). Check this value if there are problems with PCR (stuffing should be present to "equalize" the bitrate). |

## 13 Encoder Monitoring

For elementary streams containing compressed video or audio, TS Analyzer allows to view certain compression parameters that are significant during operation. The encoder information section is found in the properties of the elementary streams (*Figure 42*).

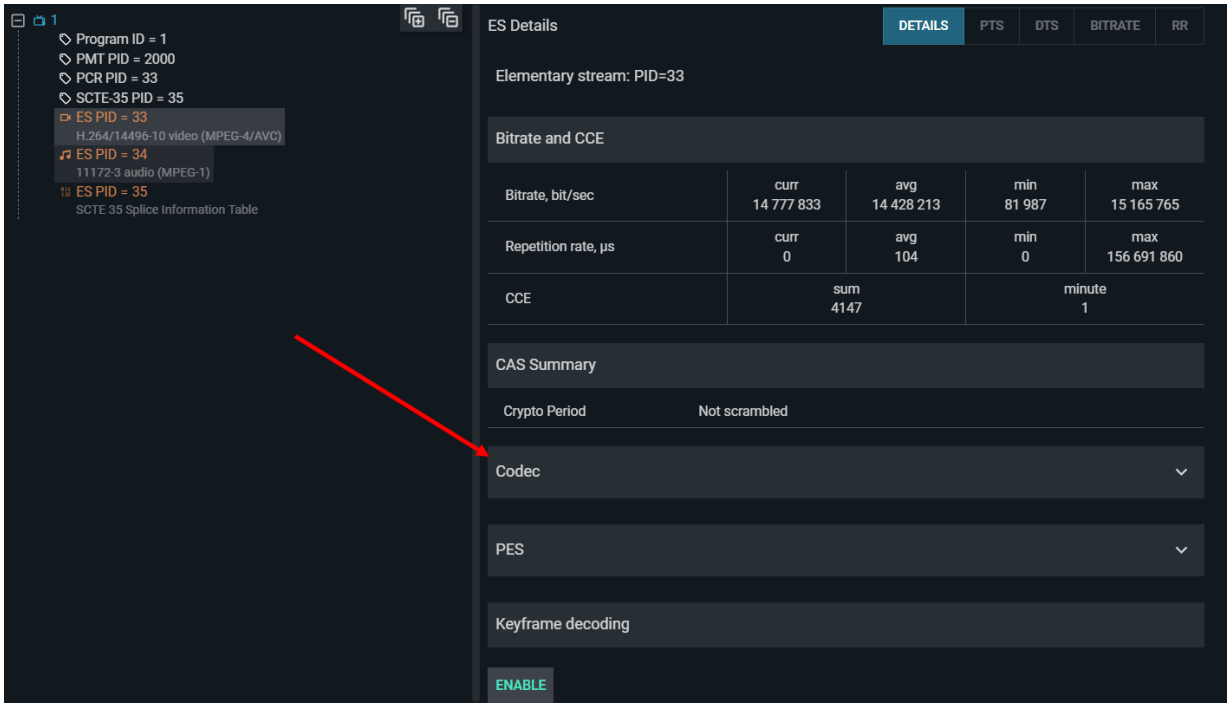



*Figure 42 – Encoder information section (in the ES details panel)*

An example of compressed video properties information is shown in *Figure 43*.

When monitoring compression quality, it is necessary to ensure that the values listed in the properties match the requirements of the multiplexing scheme and the encoder settings. If there is a deviation, check the encoder

settings.

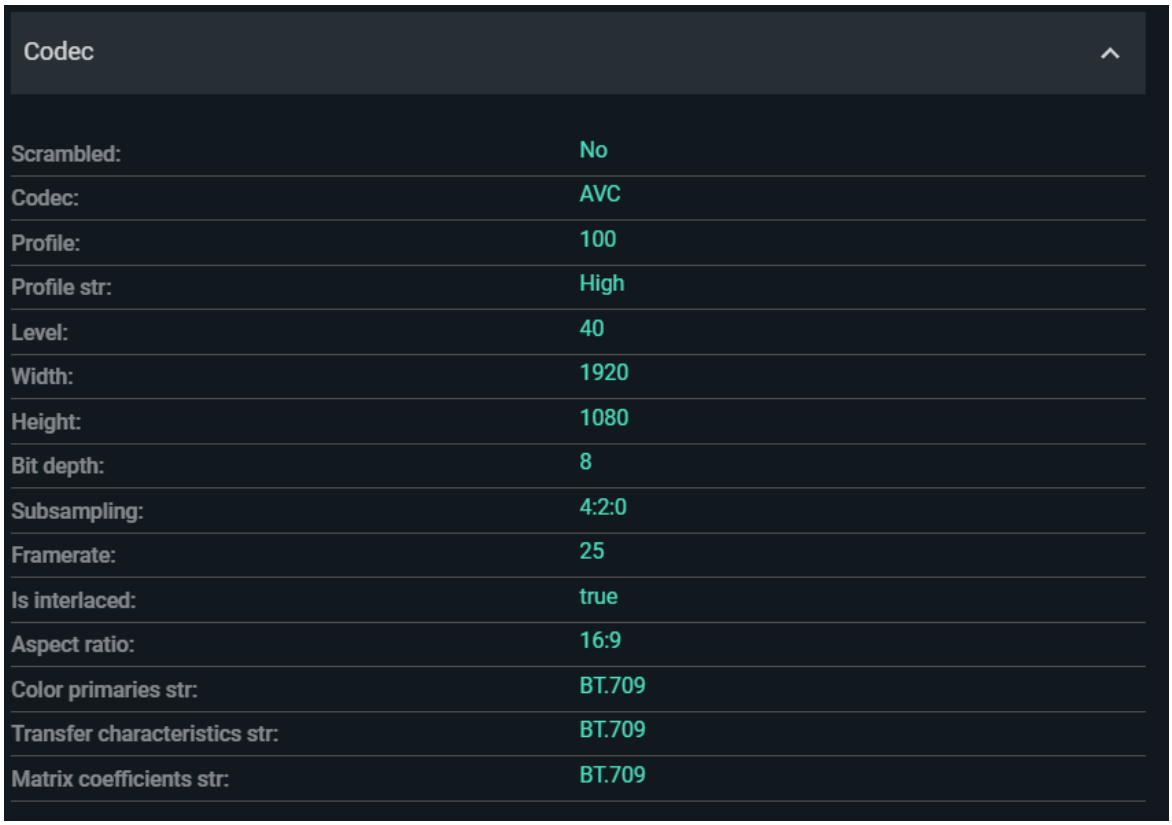



*Figure 43 – Panel of compression properties (for video)*

## 14 Problems with Remultiplexing Streams

Remultiplexing TS can potentially lead to difficult-to-diagnose issues when using ETSI TR 101 290. This can be explained using a simple diagram shown in *Figure 44*. When encapsulating a stream containing Continuity Count Errors (CCE) into a new stream, the content is repackaged into new TS packets with new correct CC numbers. As a result, the receiving device will experience problems with viewing services and PSI/SI information (as if part of the information is missing), but there will be no CCE errors.

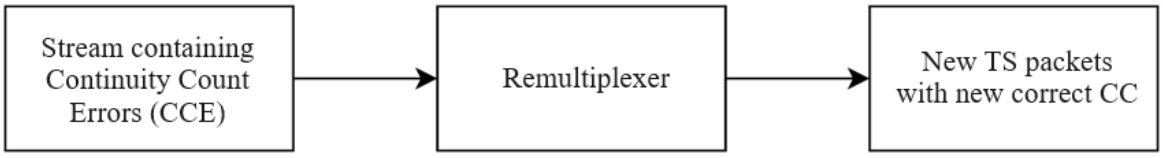



*Figure 44 – Encapsulation of a "broken" stream*

Another extremely adverse scenario is possible—if the remultiplexer does not check the validity of incoming streams or if it is faulty, it can pack a TS stream consisting of a random set of bytes (this is a real case from practice!). Consequently, if you open the list of received PIDs on the TS Analyzer (on the statistics screen), you can get an enormous number of PID values, which will gradually accumulate in the statistics. At the same time, TS Analyzer may show some random PSI/SI tables and random errors. The appearance of "random" PIDs will lead to an avalanche increase in the number of unreferenced PID errors.

Additionally, this can result in the processing of "noise" in the TS (since the receiving device thinks everything is fine) requiring a large amount of computational resources, causing the receiving device to "freeze."

Therefore, if a large number of unreferenced PIDs (see Section 18.6), absence of PAT (see Section 16.3), and a large number of PMT errors (see Section 16.6) appear, it is recommended to check the multiplexer's functionality and the correctness of the remultiplexing function. To conduct this check, you need to feed the remultiplexed signal (i.e., the source) into the TS Analyzer and check for the presence or absence of errors.

# 15 Context of ETSI TR 101 290 MPEG TS Errors

When analyzing ETSI TR 101 290 errors, it is essential to consider the context in which the error occurs. Context plays a crucial role in identifying the source of the problem.

Possible contexts include:

– Entire stream errors;

– Service errors;

– PSI/SI errors;

– Individual PID errors.

The causes of errors for each context are described in *Table 8*. Note that the same error can manifest in different contexts. The most common example is the CCE (Section 16.4) that can appear in any context. A CCE can occur on an individual PID, on the PID of a service, on all PIDs in the stream, and so on. Also, note that errors in one context can be caused by errors in another context. For instance, a CCE error on PID=0 (errors of individual PIDs) can lead to a PAT error (PSI/SI errors). The interrelationship of errors is reflected in their descriptions in Sections 16-18.

*Table 8 – Description of error contexts*

| Context | Description | Causes of occurrence |
|---|---|---|
| Entire stream errors | Errors that affect every element of the TS and/or every service. An example of such an error is a synchronization error (Section 16.1). The appearance of a synchronization error means that no element | Entire stream errors are caused by devices that process the entire stream as a whole (receivers, encoders, transmitters, multiplexers). A common cause of such errors is interference or insufficient bandwidth of the communication channel or device interface. Another cause |

| Context | Description | Causes of occurrence |
|---|---|---|
| | (PID) of the stream is received. | may be network device failures, leading to packet loss. |
| Service errors | Errors that affect only one service. For example, a CCE error may appear only on the PID of one service. | Service errors are caused by network components and devices that generate this service. For instance, if errors occur on a specific TV channel, a possible cause might be the multiplexer forming that channel or the satellite receiver receiving that channel. |
| PSI/SI errors | Errors in the PSI/SI information, such as a PAT error. A PAT error can affect the reception of all services. Another example is a PMT error, which affects only the service it relates to. | The causes of PSI/SI errors are usually errors in the operation of the PSI/SI generator, which is part of the multiplexer. Note that PSI/SI errors can be caused by errors on the PIDs that carry the tables (i.e., errors in the context of "entire stream errors" or "individual PID errors"). |
| Individual PID errors | Errors that occur on individual PIDs (e.g., only on the EMM stream). | The causes of errors on individual PIDs are malfunctions in the devices that generate these PIDs. For example, if an error appears only on the PID with the EMM stream, the problem lies in the CAS server or the communication line from the CAS server to the multiplexer. |

# 16 MPEG TS Errors – Level 1

## 16.1 1.1 TS_sync_loss Error

It is the most critical error in MPEG TS. If synchronization is lost, it means that receiving the TS is impossible, and the stream can be considered absent.

Abbreviation: SYNC_LOSS. Position in TS Analyzer interface is shown in *Figure 45*. Description is provided in *Table 9*.

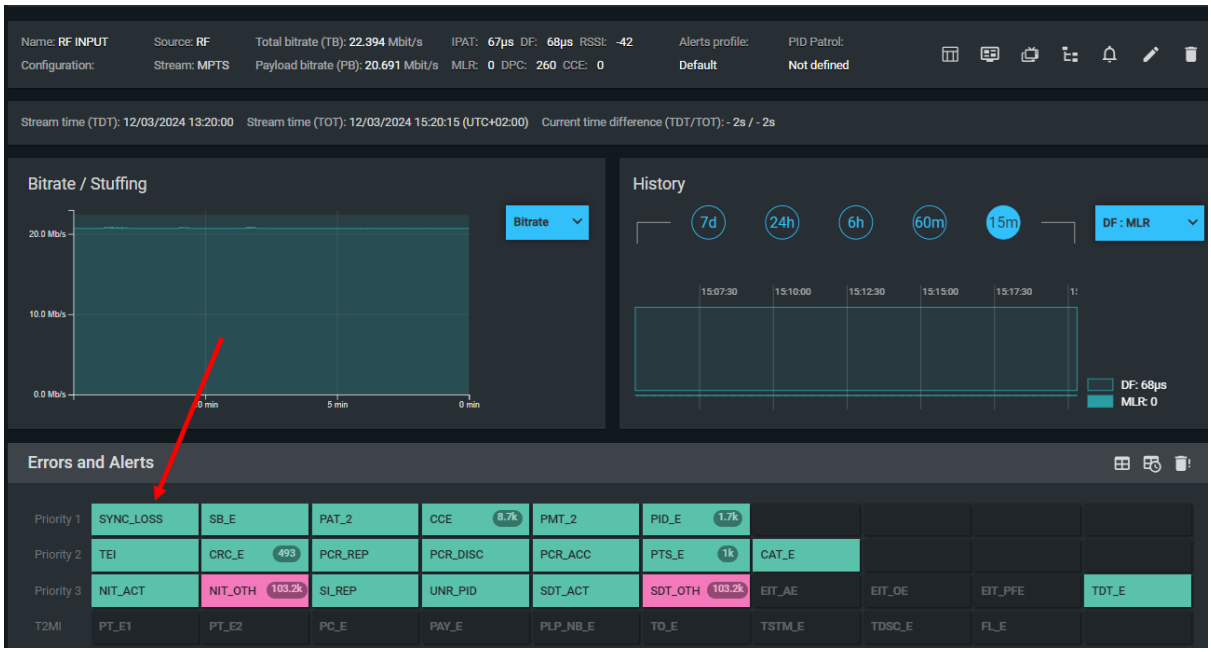



*Figure 45 –1.1 TS_sync_loss error in TS Analyzer interface*

*Table 9 – Description of 1.1 TS_sync_loss*

| Parameter | Description |
|---|---|
| Priority | Level 1 |
| Number | 1.1 |
| Name | Synchronization error |
| Importance | Very high, this indicator affects the overall quality of the entire stream. All other indicators are meaningless if the stream synchronization is absent or poor. |
| Purpose | To determine the presence of an MPEG TS (ISO 13818-1) transport stream. |

| Parameter | Description |
|---|---|
| Frequency of occurrence | Often |
| How to use (briefly) | If the error is not active, it means synchronization is present and the TS is available. If active, it means the stream is absent. If it blinks randomly, the stream is unstable, with random packet loss. If it blinks at regular intervals, it indicates a periodic stream failure (usually related to buffering or interference in the air or in the Internet). |
| Conditions for application | The use of the indicator makes sense if there is correct demodulation of the signal or the presence of transport protocols (usually UDP). If demodulation is not performed, then there is no TS (and no synchronization). The same is true for IP networks. If transport protocols (usually UDP) do not arrive, there is no TS, and using the indicator is pointless. |
| Theory | When feeding a TS to any device or functional block, the first task is to determine whether the given TS is an MPEG TS (ISO 13818–1) stream.<br>To make this determination, the device uses the following provisions of the ISO 13818–1 standard:<br>– TS consists of packets with a fixed length of 188 or 203 bytes;<br>– The first byte of each TS packet (called the sync byte) must have a value of 0x47.<br>The term "synchronization" here refers to the synchronization of the stream with the TS decoder. The TS decoder expects to receive a sync byte every 188 bytes, and if this does not occur, it cannot function. |

| Parameter | Description |
|---|---|
| | Furthermore, the standard specifies that if 5 (five) consecutive TS packets arrive, this is sufficient for stream decoding. The number 5 was chosen by the standard's developers based on scientific research and cannot be altered.<br>Note that TS_sync_loss is measured cumulatively across all PIDs transmitted in the TS. If synchronization is lost, it is a "global" issue affecting the entire stream, not just individual elements (services). |
| Principle of activation | In a normal situation, the value 0x47 should repeat every 188 bytes of the stream. If this occurs 5 times in a row, synchronization is confirmed. If even one byte differs, the indicator will trigger. The indicator will turn off when 5 consecutive sync bytes appear again (i.e., every 188 bytes). Note that if the sync byte is missing, the analyzer starts scanning each byte to find the sync byte, as the principle of repetition every 188 bytes no longer applies because the stream might be disrupted. Additionally, keep in mind that if the stream stops and no bytes are received at all, the analyzer will not wait indefinitely for the next byte (this wait could be indefinite). The analyzer uses a timeout – if no stream is received for a certain period, the indicator will trigger even without any bytes. The duration of the timeout depends on the speed of the stream that was previously there, but it is very short – less than 1 second.<br>When the stream first appears (or after a long absence), the analyzer checks for the sequential arrival of more than 6 sync bytes to avoid erratic triggering of the indicator until the stream stabilizes. |

| Parameter | Description |
|---|---|
| If the indicator is active | This situation can be considered as a stream interruption and loss of information (temporary or permanent). When the stream stops, it becomes impossible to decode services.<br>It is important to remember that the MPEG TS standard does not include methods for recovering lost information. If a packet is lost, it cannot be recovered. However, the loss of several packets may be visually unnoticeable as the loss will be "scattered" in small parts across the screen due to the use of technology such as interleaving. |
| If the indicator is not active | This means that according to the standard, the transport stream decoder receives all packets for decoding without any losses. |
| Causes of occurrence | Any reasons leading to signal loss: from poor contacts to poor signal-to-noise ratio in the transmission path (in the cable or over the air). Periodic activation of the indicator may indicate that a buffer is overflowing on some device in the network. Buffer overflow, in turn, can be caused by sharp changes in bitrate. |
| Connection with other errors | When this error appears, it doesn't make sense to check any other TS errors because the TS is either corrupted or absent. However, the presence of this error does not necessarily indicate issues with the signal or modulation (although this is highly likely) since the corrupted stream might originate from the signal source (see examples in Section 14). |
| Recommendations for addressing issues that | It is recommended to first check for the presence of this error at the signal source (e.g., satellite receiver output) and then proceed along the transmission path to identify the component where the error occurs. The |

| Parameter | Description |
|---|---|
| triggered indicator activation | identified component will be the source of the malfunction.<br>If the error is already present at the network input, it is necessary to check the receiver settings and reception quality. If the error exists at the receiver but reception quality is good, the issue lies at the transmitting station. In this case, it is advisable to contact the telecommunication or broadcasting organization personnel who operate or maintain the signal source.<br>Often, errors may occur due to brief disruptions in communication channels caused by phenomena such as solar interference, interference from other transmitters, or heavy precipitation.<br>If other TS errors (excluding errors in the communication channel described, for example, in Sections 3, 6, 9) are simultaneously detected with this error, the focus should initially be on resolving this specific error before investigating the causes of the remaining errors.<br>With a small number of errors, symptoms may be visually imperceptible; however, the presence of TS_sync_loss always indicates a malfunction, so ignoring it is strongly discouraged. |
| Symptoms | Persistent or brief absence of image and sound, pixelation of the image, and audio defects. If the number of TS_sync_loss errors is low, pixelation may be practically unnoticed. In practice, the loss of 1-2 TS packets per second typically does not lead to noticeable degradation of the "picture." |

| Parameter | Description |
| --- | --- |
| | Note that pixelation of the image can also occur due to other reasons, such as the occurrence of Continuity_count_error.<br>A quick visual distinction between Continuity_count_error and TS_sync_loss can be made by remembering that TS_sync_loss affects the entire stream. When switching between services and observing image quality, if pixelation is not observed across all services, Continuity_count_error may be suspected rather than TS_sync_loss. If TS_sync_loss is present, pixelation may be noticeable across all channels. When visually assessing, it's also important to consider that lower bitrate services may exhibit more pronounced manifestations of TS_sync_loss. |

### 16.1 1.2 Sync_byte_error

A very rare error occurring when the TS has an "incorrect" sync byte.

Abbreviation: SB_E. Position in TS Analyzer interface is shown in *Figure 46*. Description is provided in *Table 10*.

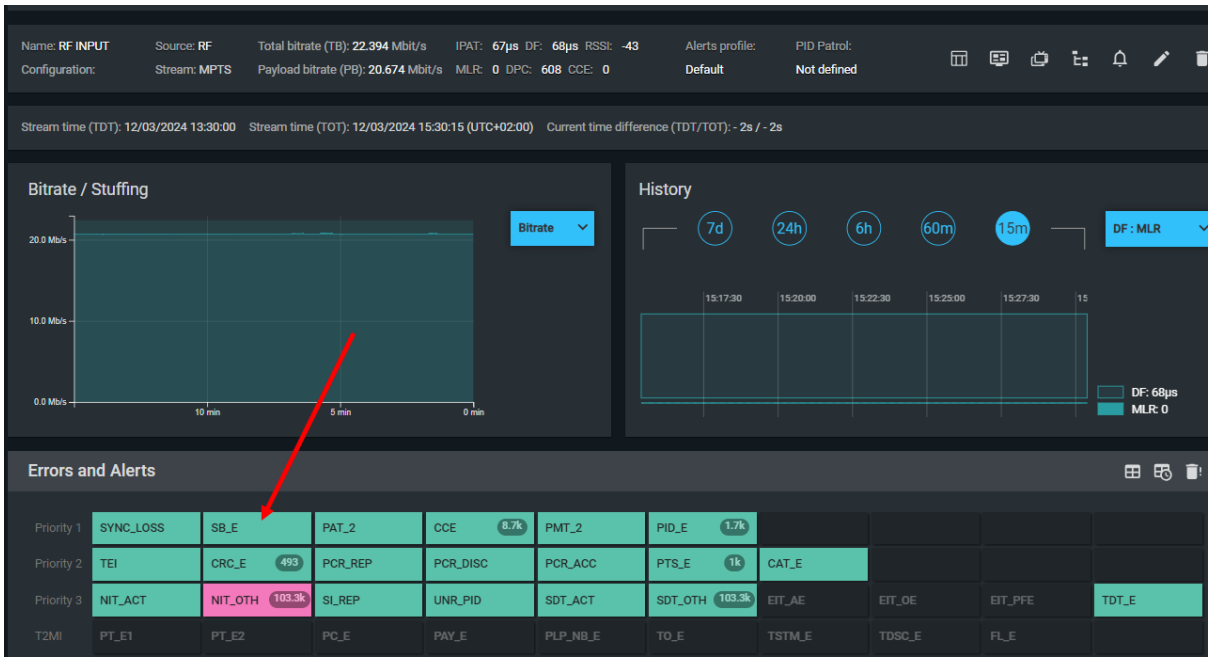



*Figure 46 – 1.2 Sync_byte_error in TS Analyzer interface*

*Table 10 – Description of 1.2 Sync_byte_error*

| Parameter | Description |
|---|---|
| Priority | Level 1 |
| Number | 1.2 |
| Name | Synchronization error |
| Importance | High, as a sync byte error can lead (but not necessarily) to the cessation of TS processing. |
| Purpose | It is necessary to determine whether the sync byte value of the MPEG TS transport stream (ISO 13818–1) is correct. |
| Frequency of occurrence | Very rarely |

| Parameter | Description |
|---|---|
| How to use (briefly) | If the indicator is not active, it means the sync byte value of the TS is 0x47 (or 71 in decimal). If the indicator is active, it means the sync byte value is different and does not comply with the standard. |
| Conditions for application | This error can be used in the absence of TS_sync_loss |
| Theory | The TS sync byte, which repeats every 188 bytes of the stream, must have the value specified by the ISO 13818-1 standard. This value is 0x47 (hexadecimal). This indicator pertains to the entire transport stream (not to a specific service or PID). The error is quite rare because its occurrence is usually associated with specific software errors in the multiplexer. Monitoring this error is more important for equipment developers than for those who operate it. |
| Principle of activation | The TS decoder looks for the value 0x47 and checks that it repeats every 188 bytes. If a different value repeats, the Sync_byte_error indicator will be activated. |
| If the indicator is active | This means that the value of the sync byte differs from the standard-defined value. Theoretically, this should not hinder the processing of the transport stream. However, the activation of this indicator may cause the transport stream processing to stop, which will affect the quality of all services in this transport stream. |
| If the indicator is not active | This means that the found value of the MPEG TS transport stream sync byte matches the standard (0x47). |
| Causes of occurrence | The cause of this issue may be a malfunction in the transport stream multiplexer (including multiplexers that are part of encoders, receivers, etc.). Another cause could be interference, which makes the sync byte |

| Parameter | Description |
|---|---|
| | values take random values (in this case, TS_sync_loss will also be activated). |
| Connection with other errors | The error might activate randomly if there are many Continuity_count_error issues in the stream. Activation of this indicator separately from the activation of Continuity_count_error or TS_sync_loss is extremely rare, as it is usually caused by a malfunction in the embedded software of the equipment. |
| Recommendations for addressing issues that triggered indicator activation | First, ensure that Continuity_count_error or TS_sync_loss is not active. If they are, focus on deactivating them first. In most cases, this will also deactivate Sync_byte_error.<br>To address the issue causing Sync_byte_error itself, normalize the operation of the multiplexer that formed the transport stream. Keep in mind that the multiplexer could be part of encoders or receivers. Generally, you should restart the device causing the activation, restore the software on that device (perform a firmware update). |
| Symptoms | Activation of this indicator may not lead to any service defects. In other cases, the symptoms will be similar to those described for TS_sync_loss in *Table 9*. |

## 16.2 1.3 PAT_error

This error is outdated and not in use. Instead, use 1.3a PAT_error_2.

## 16.3 1.3a PAT_error_2

A critically important error, as issues with the PAT will result in the loss of information about the services contained in the TS.

Abbreviation: PAT_2. Position in TS Analyzer interface is shown in *Figure 47*. Description is provided in *Table 11*.

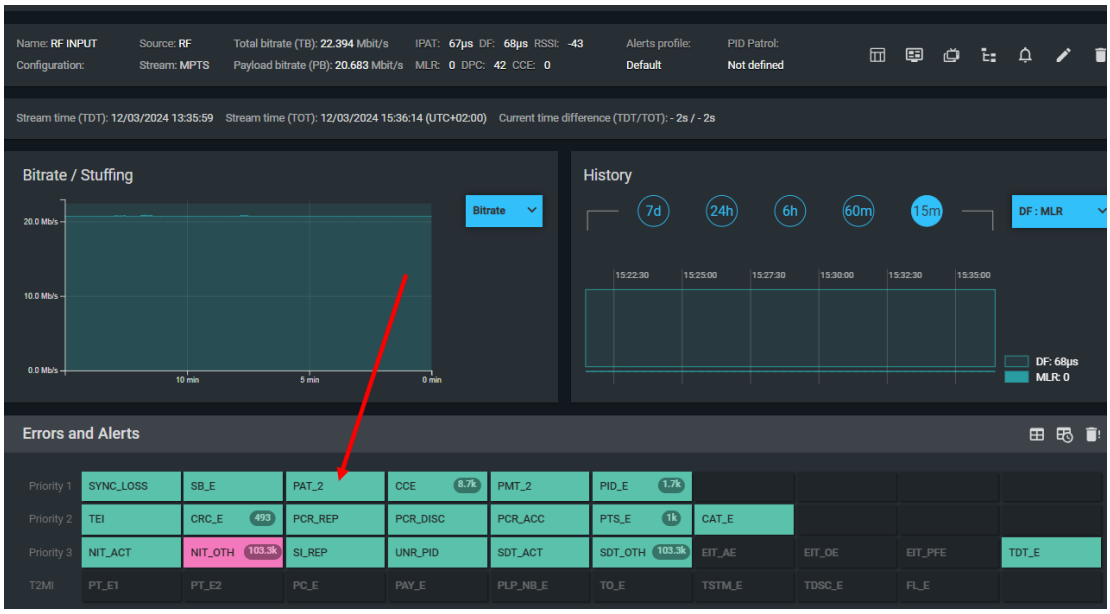



*Figure 47 –1.3a PAT_error_2 in TS Analyzer interface*

*Table 11 – Description of PAT_error_2*

| Parameter | Description |
|---|---|
| Priority | Level 1 |
| Number | 1.3 |
| Name | PAT error |
| Importance | High |
| Purpose | To detect issues in the transmission of the Program Allocation Table, but not its content, as the content varies among different operators. To check the content of the table, use the PSI/SI screen in the TS Analyzer. |
| Frequency of occurrence | Often |
| How to use (briefly) | Used to determine if there is a problem in transmitting information about the number of services and the RMT for these services. |

| Parameter | Description |
|---|---|
| Conditions for application | To apply, there should be no TS_sync_loss and Continuity_counter_error errors on PID=0. |
| Theory | PAT contains information (references) about the PMT tables, which in turn contain information about the components that make up the service (video, audio, etc.). When the subscriber device is turned on, the PAT is read from the TS, and then updated (either continuously or when the PSI/SI version changes). |
| Principle of activation | If the error is active, one of three situations may occur:<br>– PAT is not transmitted (critical error, not common);<br>– The repetition period of PAT sections is longer than required (non-critical error, but common);<br>The encryption field in the TS packet header with PAT indicates that PAT is encrypted. If PAT is indeed encrypted, rather than the encryption field being incorrectly set, it is a critical error (very rare).<br>The indicator is activated if:<br>– No table with table_id=0 appears on PID=0 for 0.5 seconds;<br>– A "foreign section" appears on PID=0;<br>– An encryption indicator is set on PID=0 (even if encryption is not actually used) |
| If the indicator is active | If the indicator is active, it means one of the activation criteria listed above has been met, and PAT is being transmitted in a non-standard manner |
| If the indicator is not active | The indicator is not active if PAT is being transmitted according to the standard protocol. |
| Causes of occurrence | Error in the operation of multiplexer software. |
| Connection with other errors | If PAT is not transmitted, information about service composition will be lost, resulting in PMT_error for all |

| Parameter | Description |
|---|---|
| | PMTs in the stream and 3.4 Unreferenced_PID for each PID mentioned in PMT. |
| Recommendations for addressing issues that triggered indicator activation | If the PAT section transmission period exceeds 0.5 seconds and does not lead to service information loss, no action may be necessary. Some operators intentionally extend PAT transmission intervals to conserve multiplex bitrate, especially on satellite channels where frequency resources are limited and costly. However, if channel information loss is observed, reduce the PAT transmission interval to less than 0.5 seconds. This adjustment can be made in the multiplexer or PSI/SI generator settings (the latter is less common, as PSI/SI generators typically form part of the multiplexer software).<br>Typically, multiplexer or scrambler software checks to prevent accidental commands to encrypt PAT on PID=0. Therefore, instances where the indicator in the TS packet header indicates encryption are extremely rare and indicate that:<br>– The software of the multiplexer or scrambler is faulty;<br>– PAT is encrypted and it is required to adjust the settings of the scrambler to remove encryption on PID=0. |
| Symptoms | In most cases, activating this error does not lead to noticeable service defects or receiver device operation issues. Consequences of error activation may include (but are not obligatory):<br>– Absence of services despite the presence of transport stream (i.e., TS_sync_loss indicator not active); |

| Parameter | Description |
|---|---|
| | – Inability to switch services;<br>– Loss of service list or incorrect information in the list;<br>– Service information not updated after multiplexer settings are applied (service names not updated, newly added services not appearing, deleted services not disappearing promptly). |

## 16.4 1.4 Continuity_count_error

Arguably the most important and most common error from ETSI TR 101 290, as it helps to identify a wide range of issues within the DTV network.

Abbreviation in TS Analyzer: CCE

*Figure 48* shows the position of the indicator and error counter 1.4 Continuity_count_error in the TS Analyzer interface (red arrow). By clicking on the indicator, the error log Continuity_count_error is displayed at the bottom (green arrow), showing the PID where the error occurred. This helps determine the context in which the error appears, which is particularly important for this error (for context, see Section 15).

On the right panel, you can view the graph of the total number of Continuity_count_errors over time by selecting PB:CCE or DF:CCE mode (blue arrow). This graph allows you to determine the periodicity of the error occurrence, helping to select the appropriate troubleshooting method.

Description of Continuity_count_error is provided in *Table 12*.

The CCE error can have a variety of causes, which are described in a separate *Table 13*.

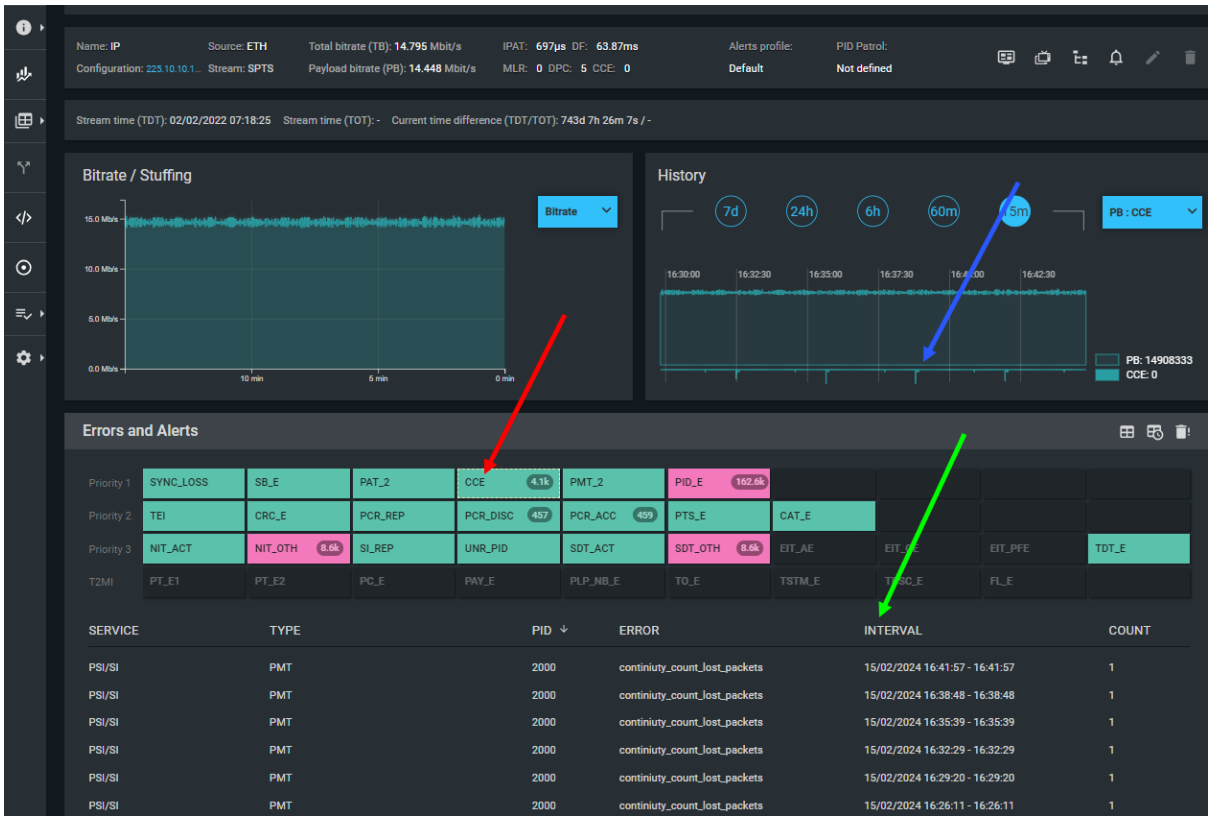



*Figure 48 –Continuity_count_error in TS Analyzer interface*

*Table 12 - Description of 1.4 Continuity_count_error*

| Parameter | Description |
|---|---|
| Priority | Level 1 |
| Number | 1.4 |
| Name | Continuity error |
| Importance | Very high |
| Purpose | This error allows for the detection of transport stream packet losses even if these losses do not lead to noticeable quality degradation. In a properly functioning communication network, there should be no continuity errors, or their number should be minimal and not increase over time. If the error is inactive, it means no packet loss has been recorded. If the error is active, packet losses are occurring, and defects in the picture and sound may be observed. |

| Parameter | Description |
|---|---|
| Frequency of occurrence | Very often |
| How to use (briefly) | Packet losses can occur across many PIDs (or all PIDs in the stream) or only a few. Depending on this, the fault can be localized: it will be either related to the entire stream or to the devices responsible for forming services. This situation is discussed in more detail in Section 15. It is also important to note whether the error is periodic or occurs randomly. |
| Conditions for application | This error is relevant if there is no TS_sync_loss error. |
| Theory | To analyze continuity in MPEG TS, a cyclic counter from 0 to 15 is used for each PID. The TS Analyzer checks that this sequence is maintained. If the sequence is disrupted, the TS Analyzer calculates how many packets are lost and increments the CCE counter by that number. It also records on which PID the packet loss occurred.<br>The CCE may not show an accurate value if the number of consecutively lost packets exceeds 16. However, in this case, a TS_sync_loss error is likely to be triggered (and with this error, using the Continuity_count_error is meaningless). For the stuffing stream with PID=8191, the CCE error is not determined (if it occurs, it is ignored). The CCE is also generated if the cyclic counter number is repeated (an error of repetition rather than packet loss). |
| Principle of activation | The error occurs when the loss of one or more transport stream packets is detected on any PID. |
| If the indicator is active | If the indicator is active, it means transport stream packet loss is occurring. This can happen for a wide |

| Parameter | Description |
|---|---|
| | variety of reasons. Packet loss does not necessarily lead to visible degradation of service quality, but it indicates problems in the communication network or equipment operation that require attention. It is recommended to determine the cause of the error and decide if it can be ignored without compromising the communication network's quality. |
| If the indicator is not active | If there is no CCE error, it means that all packets from all PIDs of the transport stream are reaching the receiver. |
| Causes of occurrence | The causes of CCE errors are diverse and are described in detail in *Table 13*.<br>In the error description in the TS Analyzer log, it specifies the reason for the error occurrence:<br>– loss of packets;<br>– packet repetition, |
| Connection with other errors | CCE error can trigger the appearance of any other errors (except TS_sync_loss), so it is recommended to take measures to eliminate CCE before investigating the causes of other errors. |
| Recommendations for addressing issues that triggered indicator activation | Recommendations for troubleshooting are provided in a separate *Table 13*, as they are rather varied. |
| Symptoms | Visible symptoms of CCE depend on the frequency of these errors per PID over time. These symptoms can vary widely, ranging from subtle "blocks" on the screen to complete service loss. The severity depends on which PIDs are affected and the extent of the impact.<br>Typically, if the number of errors is less than 10 per second per PID for SD video streams, the degradation in |

| Parameter | Description |
|---|---|
| | image quality may not be noticeable. However, if a lost packet affects a key frame, it may cause partial disruption on a limited area of the screen or in several different restricted areas. The defect can also manifest as "blurring" in various parts of the image, loss of details in shadows ("plastic-like image"), and so on. As the number of CCE increases, these defects become more pronounced, potentially leading to complete degradation of the image.<br>Additionally, when CCE occurs on a PID with video streams, it may activate decoder synchronization errors such as PCR errors (see Section 17.3).<br>If CCE occurs on a PID with audio streams, audible defects such as "clicks", brief silence, and others may be heard. As the number of CCE increases, these audio defects become more noticeable, potentially leading to unintelligible sound.<br>When CCE errors occur on PIDs carrying PSI/SI information, some information in the tables may be lost. This loss could potentially trigger errors such as PAT_error2, PMT_error2, and similar errors, though this is not mandatory if CCE errors are few. CCE errors on PIDs containing EIT (EPG) information can cause electronic program guide disappearance.<br>If the activation of CCE is caused by packet repetitions, it generally does not lead to visible service degradation. An exception is when there are many identical packets in the stream, consuming bandwidth. In such cases, along with CCE caused by repetitions, CCE caused by packet loss may also occur. While "CCE with repetitions" can occur on any number of PIDs, "CCE with losses" will |

| Parameter | Description |
|---|---|
| | affect the entire TS (since bandwidth is shared among all PIDs). |

*Table 13 – Causes of CCE occurrences and recommendations for troubleshooting*

| Symptom | Causes | Recommendations |
|---|---|---|
| CCE error appears sporadically across all PIDs in the transport stream. | Possible causes:<br>– Constant interference affecting the radio signal (satellite, terrestrial, relay communication lines, etc.);<br>– Low radio signal level or low signal-to-noise ratio;<br>– **Insufficient bandwidth of the communication channel (radio channel, Internet, LAN);**<br>– Artificially limited bandwidth of communication channels;<br>– Malfunctioning receiving or | If such symptoms occur, it is recommended to sequentially check for CCE errors at the outputs of devices, starting from the beginning of the path. Check for CCE errors at the outputs of receiving devices. If they are detected, check the quality of communication channels and connections, and eliminate any found issues.<br>Restore the functionality of the equipment where CCE errors occur (restart, reflash, etc.)<br>Verify that the bandwidth of the communication channels is sufficient. Consider |

| Symptom | Causes | Recommendations |
|---|---|---|
| | transmitting equipment;<br>– Malfunction of the multiplexer;<br>– **Poor contact in connectors on receivers, transmitters, Ethernet switches;**<br>– Lack of or defective grounding;<br>– Insulation defects. | possible bitrate fluctuations, including instantaneous ones.<br>Increase the bandwidth if necessary.<br>Check the integrity of grounding systems and cable insulation. |
| CCE error appears at regular intervals (or approximately regular intervals) simultaneously across all PIDs in the transport stream | Such periodic errors are uncommon.<br>Possible causes:<br>– A looped TS recording is being played back;<br>– **Insufficient buffer size in the receiving or transmitting device;**<br>– Insufficient bandwidth of the communication channel;<br>– **Periodic interference in the communication channel (e.g., from microwave relay links or navigation systems;** | First, ensure that there are no interferences in the radio frequency path, as they are the most common cause of periodic errors. Upon detection, take measures to eliminate the interference (including partial shielding of receiving antennas if necessary).<br>Check if the buffer size in the receiving and transmitting devices is sufficient. If the buffer size cannot be verified, it might be useful to analyze the DF (Delay |

| Symptom | Causes | Recommendations |
|---|---|---|
| | – Malfunctioning receiving or transmitting equipment, multiplexer | Factor) in MDI (see Section 9). If the DF experiences synchronous fluctuations with CCE, the cause may be network jitter, and adjustments to the LAN to reduce jitter may be required (such jitter can be caused by a device with a large instantaneous bitrate or a group of devices responding to a request simultaneously). |
| CCE error appears sporadically across PIDs that belong to the same service | Such errors are uncommon and are caused by equipment or communication channels related to that particular service. For instance, this could be a satellite receiver that receives the service and forwards it to the multiplexer.<br>Other possible causes include:<br>– Malfunctioning encoder (if the service is generated by an encoder); | It is necessary to locate and inspect the equipment and communication channel associated with the affected service. If the service is received by a separate receiver, the signal quality on that receiver should be checked. If a dedicated communication channel (or VPN) is used to transmit the service to the multiplexer, the quality of the connection |

| Symptom | Causes | Recommendations |
|---|---|---|
| | – Malfunctioning multiplexer (in rare cases). **Typically, errors of this nature should trigger emergency messages from the multiplexer, providing additional information for diagnostics.** | on that channel should be checked and restored (check switching, bandwidth, etc.). In rare cases, it may be necessary to restore the functionality of the encoder or multiplexer |
| CCE error appears at regular intervals across multiple PIDs that belong to the same service | CCE errors appear at regular intervals across multiple PIDs that belong to the same service. This error is typically related only to the part of the transmission path where the streams with the affected PIDs are being transmitted. The causes of this issue can be similar to those of periodic CCE errors for the entire TS. The most common cause is significant network jitter due to the influence of network devices, leading to buffer overflows in the receiving devices. | It is necessary to identify the part of the network transmitting the affected PIDs using the network and multiplexing diagrams. Then, follow the recommendations given above for the case of periodic CCE errors for the entire stream. |

| Symptom | Causes | Recommendations |
|---|---|---|
| CCE error appears randomly on a single PID | The causes are similar to those of random CCE errors on a group of PIDs for one service. In this case, the issue lies with the part of the network, software, or device related to the affected PID.<br>In practice, this error may occur more frequently than it seems. For example, if separate table generators (such as an electronic program guide server) are used for forming PSI/SI, an error on the PID of the table could be caused by a malfunction of this generator. | The recommendations are the same as those for CCE on a group of PIDs, as outlined above.<br>It is necessary to identify the equipment related to the affected PID and follow the specified recommendations. |
| CCE error appears periodically on a single PID | The causes are similar to those of periodic CCE errors on a group of PIDs for one service | The recommendations are the same as those for CCE on a group of PIDs, as outlined above.<br>It is necessary to identify the equipment related to the affected PID and follow the specified recommendations. |

| Symptom | Causes | Recommendations |
|---|---|---|
| CCE error caused by packet repetition, whether periodic or not and regardless of the number of PIDs | This error is caused by the device generating or transmitting the stream (multiplexer, network switch, etc.). If the error occurs on a single PID, the problem lies with the device generating that PID. If the error appears across the entire TS, the issue might be with the multiplexer or a network device (numerous UDP repetitions and the PIDs contained in these UDP packets). | It is necessary to restore the functionality of the multiplexer or network device (at minimum, reboot or restart the stream/service generation). |

## 16.5 1.5 PMT_error

This error is outdated and not in use. Instead, use 1.5a PMT_error_2.

## 16.6 1.5a PMT_error_2

This error does not affect the entire TS, but only the service associated with the PMT where it occurs. The error can cause the service to be unavailable to the viewer.

In the TS Analyzer, the error is abbreviated as PMT_2 (*Figure 49*). Description is provided in *Table 14*.

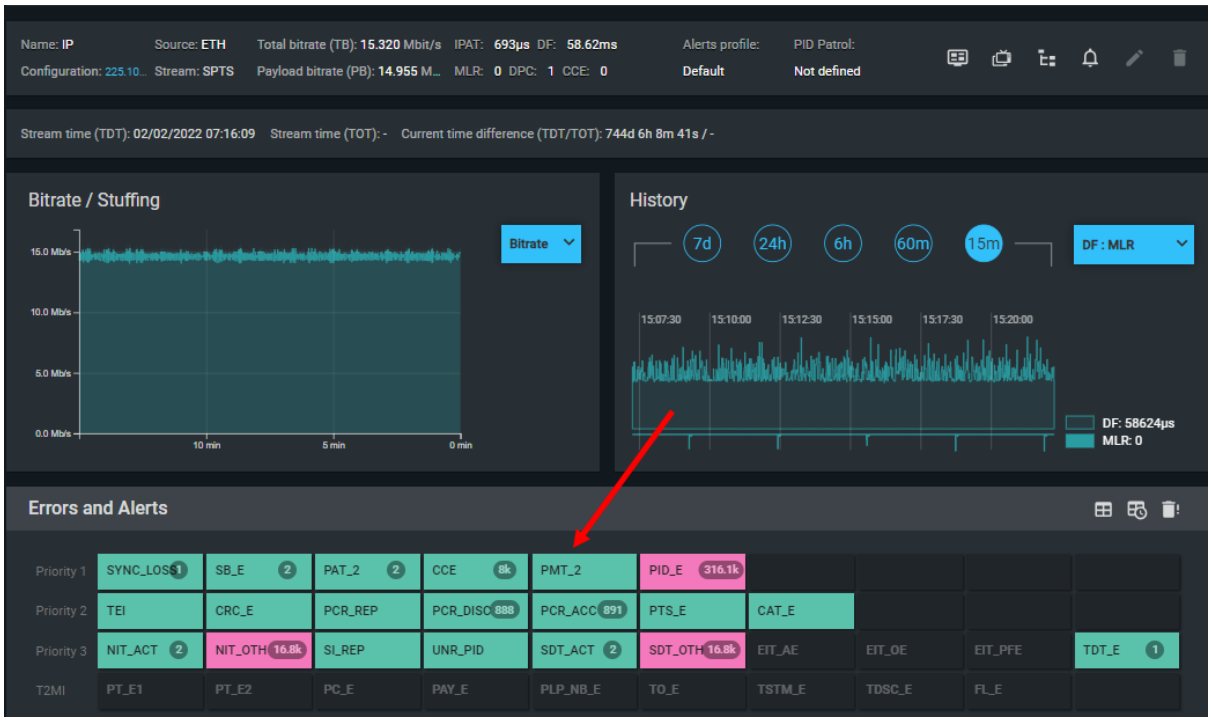
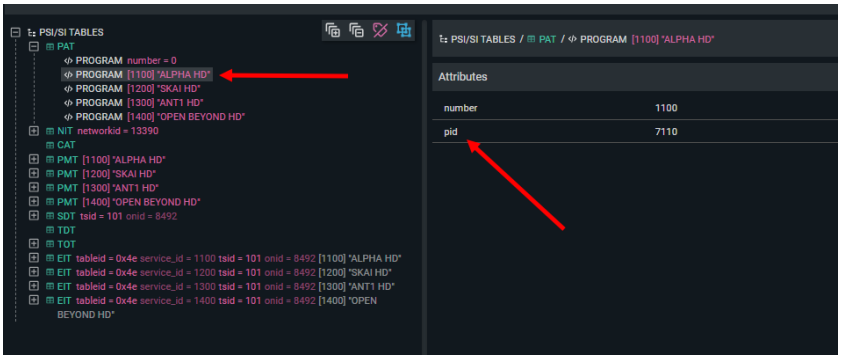



*Figure 49 –1.5a PMT_error_2 in TS Analyzer interface*

*Table 14 - Description of PMT_error_2*

| Parameter | Description |
|---|---|
| Priority | Level 1 |
| Number | 1.5a |
| Name | PMT error |
| Importance | High |

| Parameter | Description |
|---|---|
| Purpose | The indicator is used to ensure that the information about the composition of services (service components) is transmitted according to the standard requirements (completely and at the required intervals). Note that the content of the tables is not analyzed, as it varies between operators. This can be done manually on the PSI/SI screen. |
| Frequency of occurrence | Often |
| How to use (briefly) | If the error is active, it means that PMT tables are transmitted in violation of the standard, which can cause problems with subscriber access to services. |
| Conditions for application | This error is relevant if there are no CCE errors on the PIDs where the PMT is transmitted. You can find out which PIDs transmit the PMT in the PSI/SI menu of TS Analyzer (*Figure 50*, red arrows show an example of how to find the PID for the ALPHA HD service).<br>  <br><br>*Figure 50 – PID PMT information*<br><br>Note that if the PAT is missing for any reason, the PMT_error2 is not generated, as it is assumed that the PMT does not exist (see also Section 16.3 on PAT error). |
| Theory | In accordance with MPEG TS standards, the PMT must be transmitted under the following conditions: |

| Parameter | Description |
|---|---|
| | – PMT is transmitted in sections with table_id=0x02;<br>– **Sections must be transmitted within a period shorter than 0.5 seconds;**<br>– Sections must not be scrambled (encrypted by CAS). |
| Principle of activation | The error is activated if:<br>– PMT sections are transmitted with a period longer than 0.5 seconds (or are missing);<br>– Sections are scrambled (encrypted by CAS).<br>**Note that if the PAT is missing, this error is not generated, as it is unknown on which PIDs the PMT is transmitted (it is assumed that the PMT does not exist).** |
| If the indicator is active | This means that the PMT is transmitted with violations (one of the criteria listed above has been triggered) and access to the corresponding service may be unstable. |
| If the indicator is not active | This means that the PMT is transmitted in accordance with the standard. |
| Causes of occurrence | The cause of the error is a malfunction in the multiplexer software or the PSI/SI generator. |
| Connection with other errors | This error can lead to the appearance of 3.4a Unreferenced PID errors, as the PIDs of individual streams must be specified in the PMT. If there is no PMT, these references do not exist. |
| Recommendations for addressing issues that triggered indicator activation | To eliminate the error, it is necessary to restore the proper functioning of the multiplexer or PSI/SI generator. The most common method is to restart the service where the error is observed. Additionally, you can reboot the multiplexer, restore the software, etc. |

| Parameter | Description |
| --- | --- |
| Symptoms | Appearance of 3.4a Unreferenced PID errors (usually several at once, as there are multiple components in each service).<br>Inability to receive the service where the error is observed.<br>Absence of image or sound on the service. |

## 16.7 1.6 PID_error (PID Patrol)

TS Analyzer provides the PID Patrol function (*Figure 51*) in the input configuration panel for working with PID_error. With this function, the user can set up monitoring for a PID at their discretion: specify the PID number and time interval. If the interval between successive occurrences of the packet with the specified PID is exceeded, a 1.6 PID_error will be generated. The PID_error in the TS Analyzer interface is shown in *Figure 52*. The description of using PID_error is provided in *Table 15*.

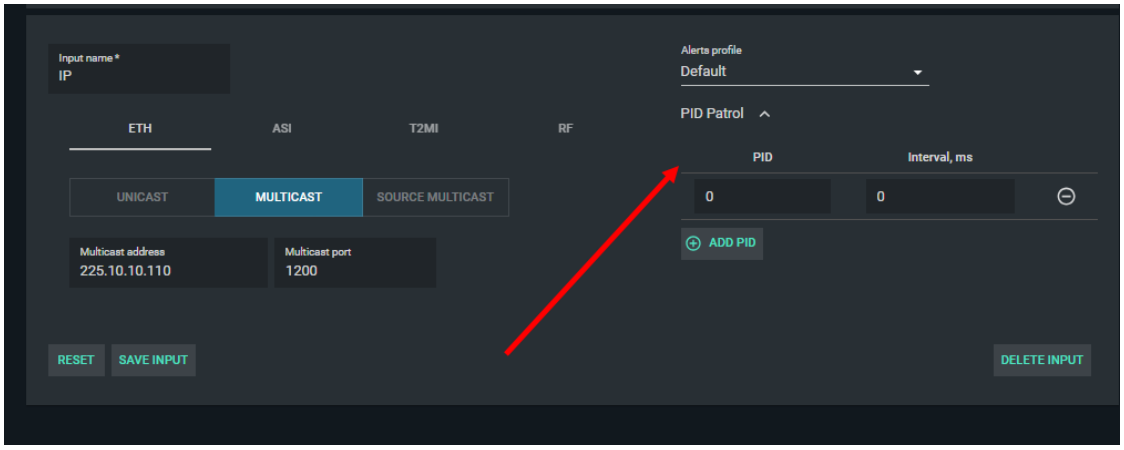



*Figure 51 – PID Patrol function for configuration of PID_error*

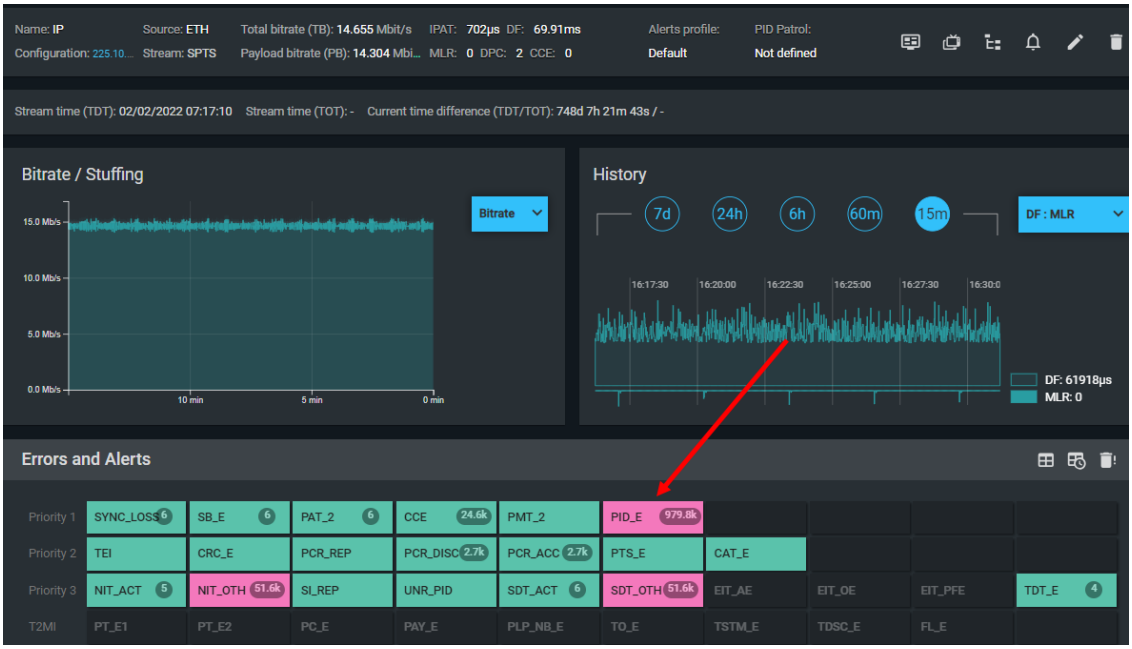



*Figure 52 –PID_error in TS Analyzer interface*

*Table 15 – Description of 1.6 PID_error*

| Parameter | Description |
|---|---|
| Priority | Level 1 |
| Number | 1.6 |
| Name | PID error |
| Importance | High |
| Purpose | For monitoring the arrival intervals of PID when troubleshooting or configuring the communication network. The PID is set using the PID Patrol function. |
| Frequency of occurrence | Often |
| How to use (briefly) | To monitor any PID, use the PID Patrol function.<br>Monitoring PID is useful for many tasks, such as:<br>– Detecting search for “floating” PID losses (for example, for an upgrade service over the air or CAS);<br>– **When configuring PID injection, ensuring the PID arrives at the required interval (e.g., when controlling external devices through a DTV network as in alert systems).** |
| Conditions for application | There should be no CCE on the monitored PID. |
| Theory | Information in the TS is transmitted in packets of 188 bytes, marked by PIDs, which form a logical "stream within a stream" structure. There is a time interval between packets of the same PID, which depends on the bitrate of the "logical" stream. For some applications, it is important that this time interval does not exceed a specified time value. |
| Principle of activation | The error is activated for PIDs specified in the PID Patrol panel if the time interval between successive packets of this PID exceeds the specified time. If the PID is missing |

| | |
|---|---|
| | from the start, the TS Analyzer will begin generating an error after a time equal to the specified interval. |
| If the indicator is active | If the indicator is active, it usually means that the PID is missing. The indicator will also be active if the PID arrives less frequently than specified in the PID Patrol. |
| If the indicator is not active | If the indicator is not active, then:<br>– No PID is specified in the PID Patrol;<br>– **The PIDs specified in the PID Patrol arrive within the specified time intervals** |
| Causes of occurrence | If the PID is supposed to be present but is missing (or arrives at intervals longer than specified), the cause could be:<br>– Faulty equipment generating the PID;<br>– PID is not added to the stream in the multiplexer;<br>– **PID being filtered out by the multiplexer during remultiplexing;**<br>– Faulty multiplexer. |
| Connection with other errors | PID_Error may coincide with the appearance of other errors related to time intervals (e.g., PMT_error2), if the corresponding PIDs are specified in PID Patrol. |
| Recommendations for addressing issues that triggered indicator activation | To resolve the error, check and, if necessary, restore the functionality of the equipment generating the PID. Also, verify that the PID is added in the multiplexer. If the PID is added, the multiplexer itself might be faulty. |
| Symptoms | Symptoms are specific to the given PID. For example, if the PID is supposed to activate a device, that device will not turn on. |

# 17 MPEG TS Quality Indicators –Level 2

## 17.1 2.1 Transport_error

This is a relatively rare error that receivers typically ignore. However, its presence indicates a malfunction in the transmitting device (usually the multiplexer).

Abbreviation: TEI. Position in the TS Analyzer interface is shown in *Figure 53*. Description is provided in *Table 16*.

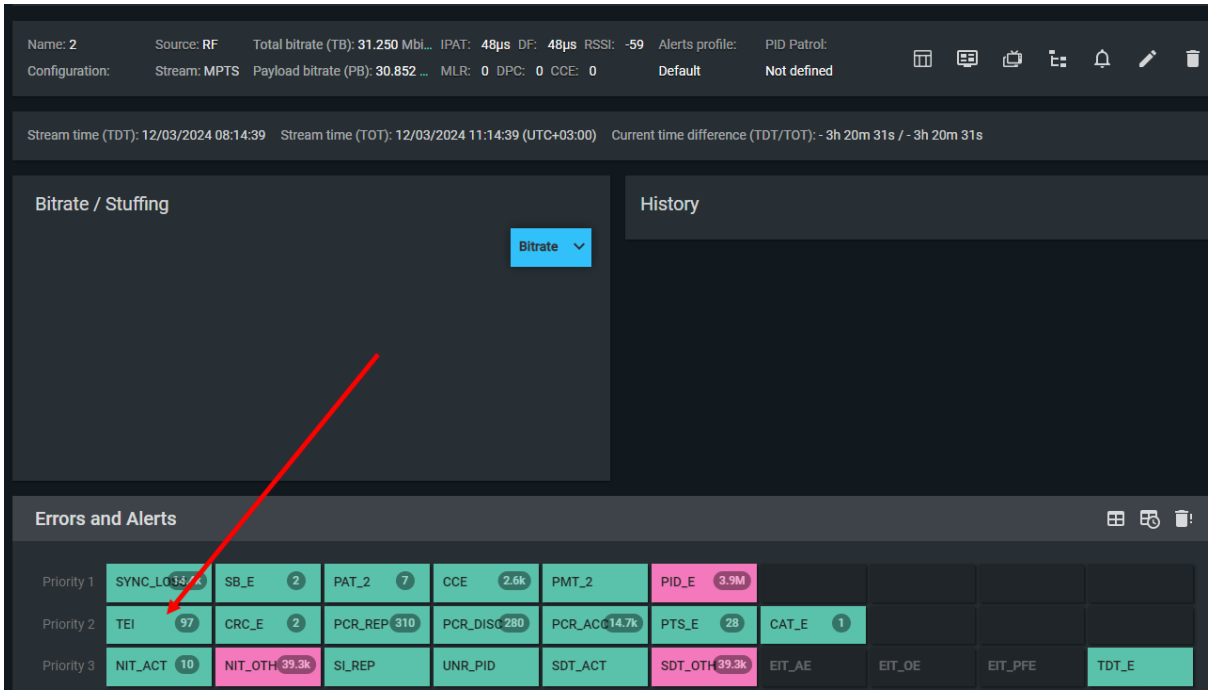



*Figure 53 –2.1 Transport_error in TS Analyzer interface*

*Table 16 – Description of 2.1 Transport_error*

| Parameter | Description |
|---|---|
| Priority | Level 2 |
| Number | 2.1 |
| Name | Transport error |
| Importance | Low |

| Parameter | Description |
|---|---|
| Purpose | Used to check the setting of the TEI indicator in the headers of transport stream packets. If the TEI indicator is set, the packet must be ignored. |
| Frequency of occurrence | Very rarely |
| How to use (briefly) | Use this error to verify that TS packets on the specified PID are not marked as defective. |
| Conditions for application | There should be no CCE on PID |
| Theory | To mark "defective" TS packets, the TEI indicator is provided in the packet header. If this indicator is set to 1, it means the packet contains "defective" information and should be discarded without causing other errors. To set the TEI flag, the TS stream must pass through a device that analyzes the packet content and sets the TEI indicator if the packet has "defects." This function can be implemented in a multiplexer. |
| Principle of activation | TS Analyzer checks the TEI flag value in the transport stream packet header and activates an error if the flag is set to 1. |
| If the indicator is active | If the indicator is active, it means the TEI flag (transport error) is set in the packet header. |
| If the indicator is not active | If the indicator is not active, it means the TEI flag (transport error) is cleared in the packet header. |
| Causes of occurrence | Result of TS corruption (see causes of CCE in Section 16.4).<br>Set by the multiplexer or another device due to detected errors in the packet's payload. |
| Connection with other errors | According to the standard, the receiver should not analyze packets with the TEI set and consequently, no |

| Parameter | Description |
|---|---|
| | other errors should be generated. However, this functionality might not be implemented in practice.<br><br>If the receiving device discards packets with TEI (such a function may not be implemented in all receivers), errors related to information loss may occur (similar to the effect of CCE errors, even though the CCE errors themselves may not be present, which again depends on the stream processing implementation in a specific receiver model).<br><br>If the receiving device processes packets with TEI that actually contain incorrect information, errors similar to those caused by CCE may appear (with the CCE errors themselves potentially absent for the reasons stated above). |
| Recommendations for addressing issues that triggered indicator activation | It is necessary to identify the device that set the TEI flag and refer to the documentation for that device to find the reasons why the indicator might have been set. Such a device could be a multiplexer. |
| Symptoms | Symptoms may be absent or similar to those caused by CCE errors (see Section 16.4). Also, consider the discussions mentioned above in the "Connection with other errors" section. |

## 17.2 2.2 CRC_error

An error that may affect the correctness of PSI/SI reception.

Abbreviation CRC_E. Position in the TS Analyzer interface is shown in *Figure 54*. Description is provided in *Table 17*.

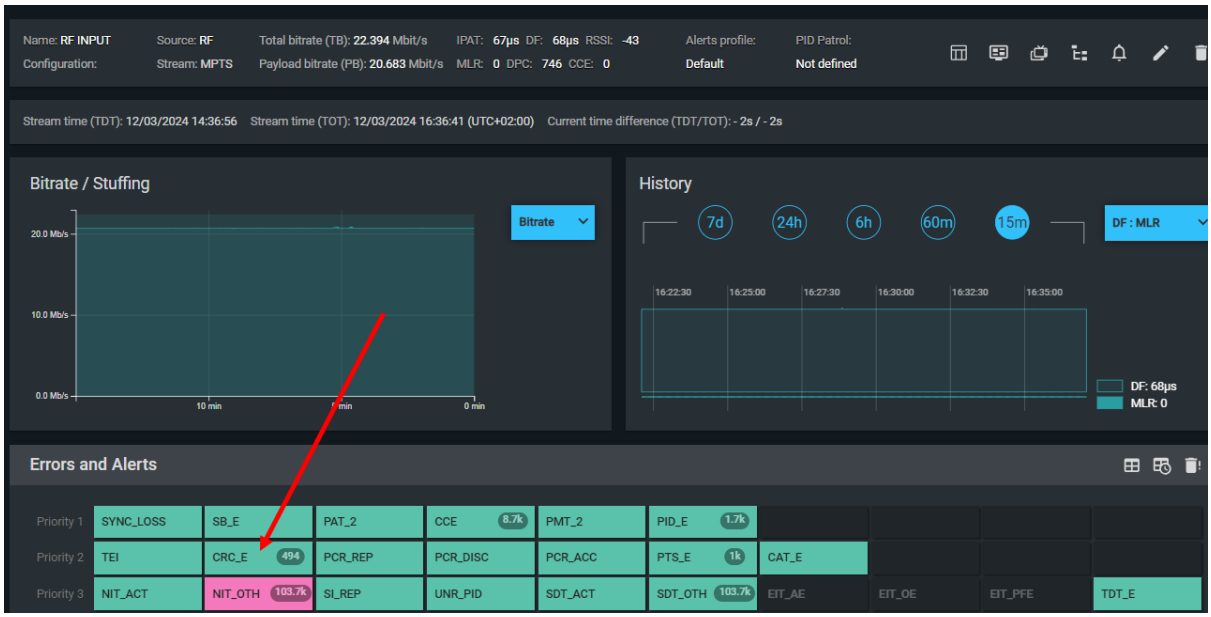



*Figure 54 –2.2 CRC_error in TS Analyzer interface*

*Table 17 – Description of 2.2 CRC_error*

| Parameter | Description |
|---|---|
| Priority | Level 2 |
| Number | 2.2 |
| Name | PSI/SI checksum error |
| Importance | Low |
| Purpose | For verifying CRC checksums on PSI/SI tables |
| Frequency of occurrence | Rarely |
| How to use (briefly) | The error indicator is used to check the correctness of the content of PSI/SI tables |
| Conditions for application | There should be no CCE errors on PID with PSI/SI |
| Theory | CRC is used for the CAT, PAT, PMT, NIT, EIT, BAT, SDT, and TOT tables. If a CRC error is detected on these tables, they should be excluded from analysis and should not generate further errors. This requirement seems contradictory because excluding the table might |

| Parameter | Description |
|---|---|
| | cause errors related to violating the table repetition period requirements (e.g., PMT_error2 for PMT tables). |
| Principle of activation | TS Analyzer calculates the CRC checksums for PSI/SI tables and compares them with the checksums transmitted in the tables. If the calculated checksum does not match the transmitted checksum, an error is generated. |
| If the indicator is active | The error is activated if a CRC checksum mismatch is detected for a PSI/SI table (or tables), indicating that the table contents may be incorrect. |
| If the indicator is not active | If the error is not activated, it means the CRC of the PSI/SI tables is correct. |
| Causes of occurrence | A malfunctioning PSI/SI generator (either standalone or part of a multiplexer). In rare cases, the error could be caused by re-encapsulation of a "broken" TS (see Section 14).<br>This error can also be caused by interference during TS transmission, which can result in individual bits within the TS payload being replaced. |
| Connection with other errors | This error can cause PAT_error2, PMT_error2, CAT_error, NIT_error (all variants), SDT_error (all variants), EIT_error (all variants). |
| Recommendations for addressing issues that triggered indicator activation | To resolve the error, it is necessary to restore the functionality of the PSI/SI generator (by rebooting, re-flashing, reconfiguring).<br>Additionally, it is necessary to check for the presence of noise interference in the transmission path where the TS is transmitted in an unprotected manner, such as in an IP stream via RF link (some RF link models do not provide protection). |

| Parameter | Description |
|---|---|
| Symptoms | The symptoms coincide with those of errors mentioned in the "Connection with other errors" section. However, in most cases, the symptoms are subtle and may be identified through prolonged monitoring. |

## 17.3 2.3 PCR_error

This error is outdated and not in use. Instead, use 2.3a PCR_repetition_error and 2.3b PCR_discontinuity_indicator_error.

## 17.4 2.3a PCR_repetition_error

A common synchronization error between the encoder-decoder pair (one of the 4 specified in ETSI TR 101 290). It can potentially lead to decoding problems. For more details on synchronization, see Section 5. Additional information on PCR errors is also provided there.

Abbreviation: PCR_REP. Position in the TS Analyzer interface is shown in *Figure 55*. Description is provided in *Table 18*.

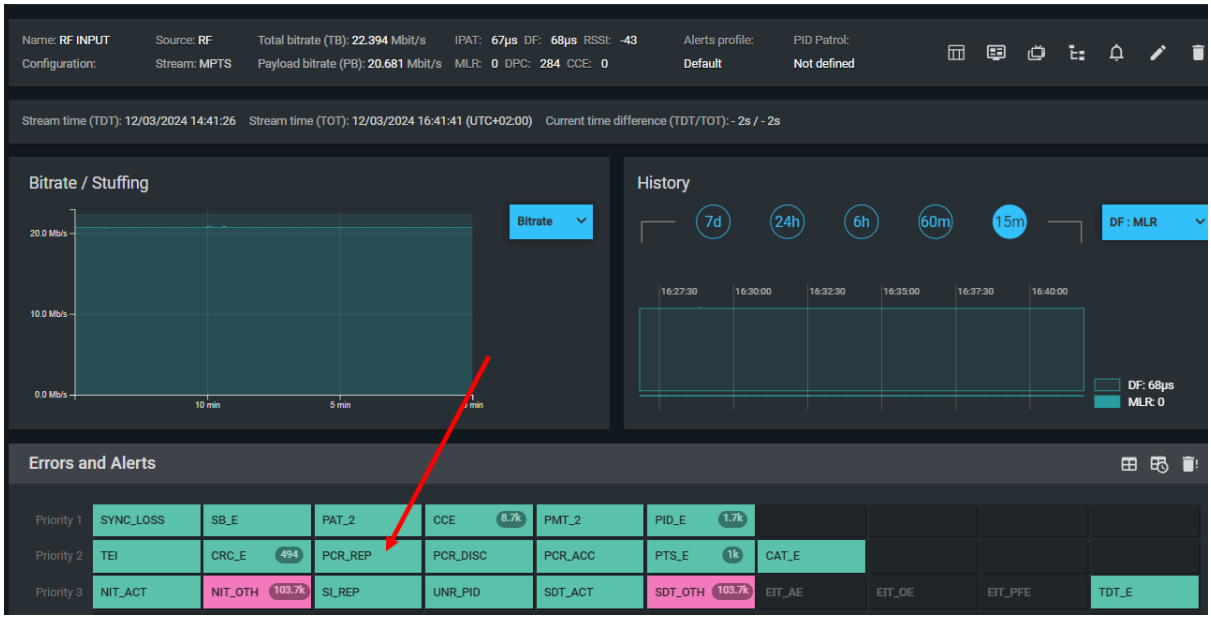



*Figure 55 –2.3a PCR_repetition_error in TS Analyzer interface*

*Table 18 – Description of 2.3a PCR_repetition_error*

| Parameter | Description |
|---|---|
| Priority | Level 2 |
| Number | 2.3a |
| Name | PCR repetition error |
| Importance | Low |
| Purpose | Used to monitor the quality of PCR generation and transmission on the PCR PID of a service (typically the video PID). |
| Frequency of occurrence | Very often |
| How to use (briefly) | Use this error to verify the synchronization quality between the encoder and decode.r |
| Conditions for application | There should be no CC errors or TEI indicators on the PCR PID.<br>The service should have a constant bitrate (CBR) |
| Theory | For synchronizing the service decoder with the service encoder, the regular transmission of PCR is necessary. The time between two consecutive PCR values should not exceed 0.1 seconds according to the receiver's clock. Otherwise (in theory, not in practice), jitter or a change in the frequency of the decoder's internal clock, which generates the 25 MHz sync signal, might occur. |
| Principle of activation | TS Analyzer measures the time between the arrival of two consecutive PCR values on the PCR PID using its internal clock. If this time exceeds 0.1 seconds, an error is generated. |
| If the indicator is active | If the indicator is active, it means PCR values are transmitted less frequently than every 0.1 seconds, which can cause a malfunction in the decoder's internal clock. |

| | |
|---|---|
| If the indicator is not active | If the indicator is not active, it means PCR values are transmitted more frequently than every 0.1 seconds. |
| Causes of occurrence | The PCR transmission period is configured on the multiplexer. This period can be intentionally set to a time longer than 0.1 seconds to conserve bandwidth.<br>Another reason could be significant network jitter (bitrate fluctuations). This can be checked by analyzing IPAT, as described in Section 6.<br>Another cause might be a variable bitrate service according to the multiplexing scheme. In this case, PCR is not used (ignored). |
| Connection with other errors | Does not lead to other errors |
| Recommendations for addressing issues that triggered indicator activation | If the error does not result in visible symptoms, it can be ignored. If symptoms are observed, the PCR transmission period on the multiplexer should be reduced to 0.1 seconds or shorter.<br>If the service should have a CBR, the encoder needs to be reconfigured to ensure a constant bitrate for the service. |
| Symptoms | Periodic image distortion (in very rare cases) |

## 17.5 2.3b PCR_discontinuity_indicator_error

A rarely encountered (almost never) synchronization error between the encoder-decoder pair (one of the 4 specified in ETSI TR 101 290). It can potentially lead to decoding problems. For more details on synchronization, see Section 5. Additional information on PCR errors is also provided there.

Abbreviation: PCR_DISC. Position in the TS Analyzer interface is shown in *Figure 56*. Description is provided in *Table 19*.

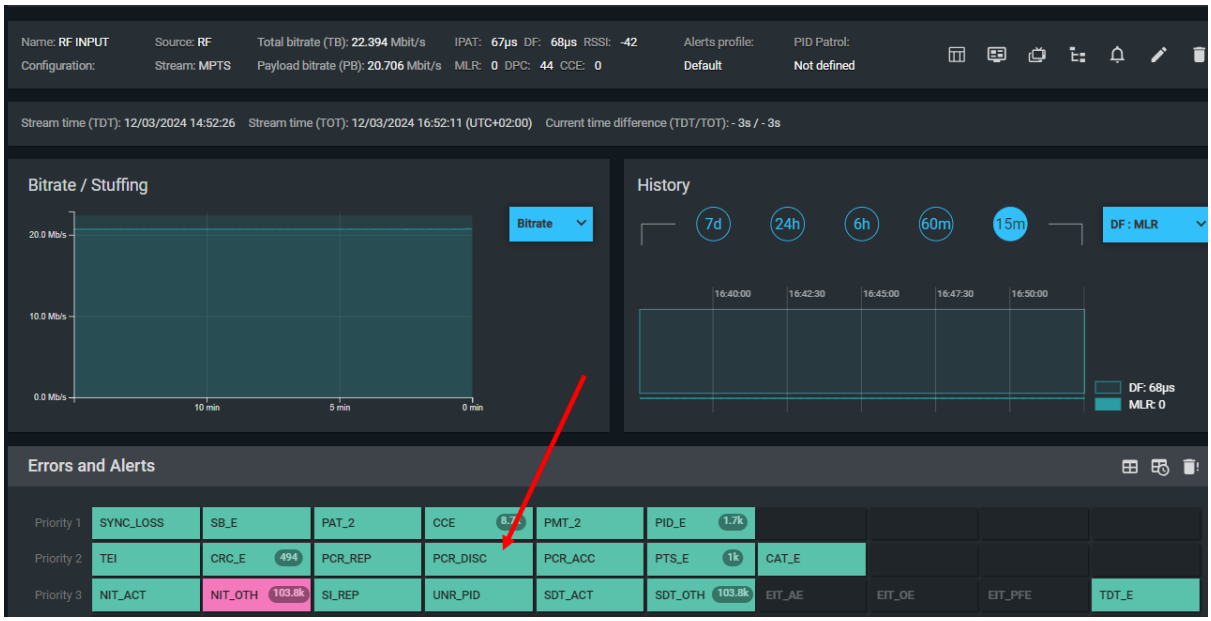



*Figure 56 –2.3b PCR_discontinuity_indicator_error in TS Analyzer interface*

*Table 19 – Description of 2.3b PCR_discontinuity_indicator_error*

| Parameter | Description |
|---|---|
| Priority | Level 2 |
| Number | 2.3b |
| Name | PCR Continuity Indicator Error |
| Importance | Low |
| Purpose | To monitor the correctness of PCR changes when the service configuration is modified.<br>To check the correct application of the PCR continuity flag. |
| Frequency of occurrence | Very rare |
| How to use (briefly) | Used to check the signaling of PCR changes when configuring the service (encoder). |
| Conditions for application | There should be no CCE errors on the PCR PID.<br>The service should have a constant bitrate (CBR). |
| Theory | When compression parameters or other encoder settings change, the PCR may change. Such a change |

| Parameter | Description |
|---|---|
| | should not lead to errors; the receiving device should handle this situation correctly. To indicate a "normal" change in PCR, a special flag, PCR_discontinuity_indicator, is transmitted. If this indicator is set to 1, PCR errors should be ignored. |
| Principle of activation | The error is activated if there is a sudden change in the PCR value (at least more than 500 nanoseconds) without the PCR_discontinuity_indicator being set. The error is also activated if the indicator was set, but no "jump" in PCR values occurred (false indicator setting). |
| If the indicator is active | If the error is active, it means there was a sudden change in the PCR value without the PCR_discontinuity_indicator being set. |
| If the indicator is not active | If the error is inactive, it means the PCR_discontinuity_indicator was not set or was set along with a sudden change in PCR. |
| Causes of occurrence | The most likely cause of this error is the absence of PCR change handling in the service encoder or multiplexer. The error may also arise due to incorrect software operation of the encoder or multiplexer. |
| Connection with other errors | If the error occurs simultaneously with PCR_accuracy_error, the latter should be ignored. |
| Recommendations for addressing issues that triggered indicator activation | Restoring the functionality of the encoder or multiplexer software involves restarting the service on the multiplexer. |
| Symptoms | In some cases, brief intermittent image distortion may occur. |

### 17.6 2.4 PCR_accuracy_error

A very frequently encountered synchronization error between encoder-decoder pairs (one of the 4 types specified in ETSI TR 101 290). Potentially can lead to decoding issues. For more details on synchronization, see Section 5. Additional information about PCR errors is also provided there.

This error can serve as a "quick" indicator that the service's bitrate is variable. In this case, the appearance of the error is a normal occurrence (and it can be disabled in the profile).

Abbreviation: PCR_ACS. Position in the TS Analyzer interface is shown in *Figure 57*. Description is provided in *Table 20*.

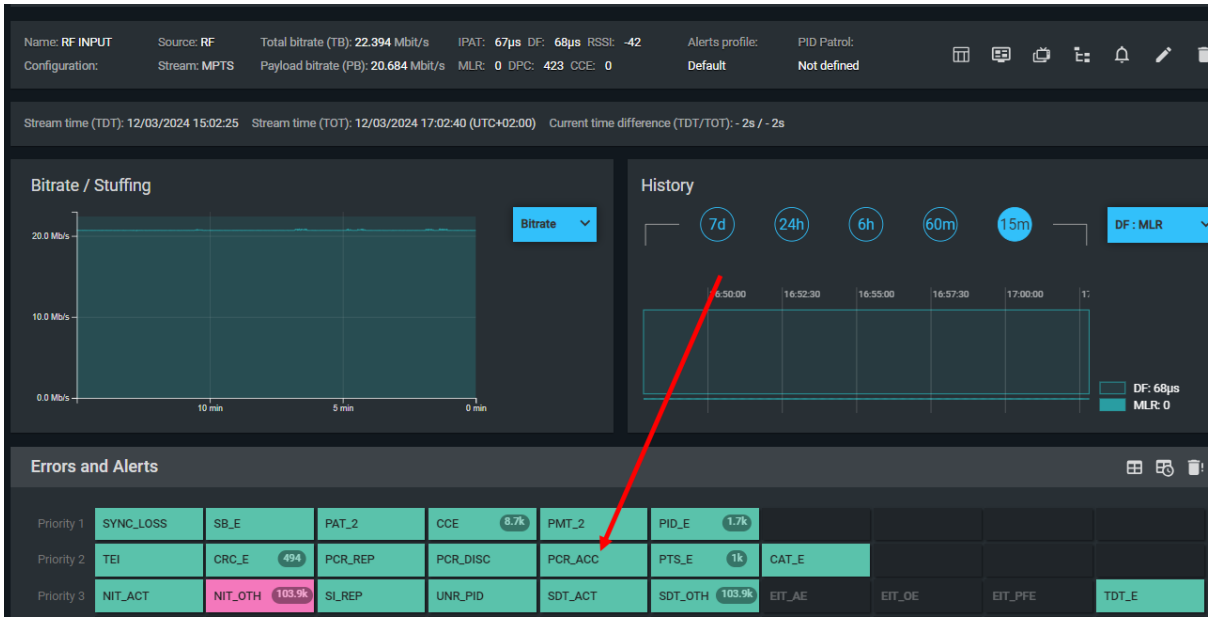



*Figure 57 –2.4 PCR_accuracy_error in TS Analyzer interface*

*Table 20 – Description of 2.4 PCR_accuracy_error*

| Parameter | Description |
|---|---|
| Priority | Level 2 |
| Number | 2.4 |
| Name | PCR accuracy error |
| Importance | Low |
| Purpose | To monitor the accuracy of the PCR sync signal. |

| Parameter | Description |
|---|---|
| Frequency of occurrence | Very often |
| How to use (briefly) | Usually, the results of the monitoring are presented as a histogram, which allows determining the accuracy of PCR. Working with the PCR histogram is described in Section 5. |
| Conditions for application | There should be no CC errors on the PCR PID<br>If there is a PCR_discontinuity_indicator_error, this error should be ignored.<br>The service must have a Constant Bit Rate (CBR), otherwise, the PCR values will fluctuate chaotically. |
| Theory | The PCR accuracy should be no worse than 500 nanoseconds. Accuracy is determined by comparing the expected PCR value with the actual received value. The expected PCR value is calculated based on the measured Constant Bit Rate (CBR). It's important to note that internal clocks of the receiving device do not affect PCR accuracy because PCR values are tied to service bytes rather than real-time clocks. |
| Principle of activation | TS Analyzer calculates the expected PCR value and compares it with the actual PCR value. If the deviation is ±500 nanoseconds, an error is activated. |
| If the indicator is active | If the error is active, it indicates that the reference generator of the encoder lacks sufficient accuracy, or the encoder incorrectly places PCR in the stream. |
| If the indicator is not active | If the error is not active, it means the PCR accuracy meets the standard requirements. |
| Causes of occurrence | The error can occur due to faults in the reference generator (built-in clocks) of the encoder or multiplexer, which could result from CPU overload, overheating, etc. Software issues in the encoder or multiplexer could also |

| Parameter | Description |
|---|---|
| | contribute to this error. Additionally, if the bitrate is variable, this error will persist (in this case it can be disabled in the TS Analyzer profile). |
| Connection with other errors | Does not lead to other errors. |
| Recommendations for addressing issues that triggered indicator activation | To resolve the error, it is necessary to restore the proper operation of the encoder or multiplexer clocks. Ensure there is no overheating, verify the power supply meets requirements, and check for CPU overload. If the service requires a Constant Bit Rate, it is necessary to restore the Constant Bit Rate. |
| Symptoms | Typically, this error does not lead to visible service issues. In some cases, brief intermittent image distortion or chaotic occurrences may be observed. |

## 17.7 2.5 PTS_error

A very rare synchronization error between encoder-decoder pairs (one of the 4 types specified in ETSI TR 101 290). Potentially can lead to decoding issues. For more details on synchronization, refer to Section 5. Additional information about the relationship between PTS and PCR is also provided there.

Abbreviation: PTS_E. Position in the TS Analyzer interface is shown in *Figure 58*. Description is provided in *Table 21*.

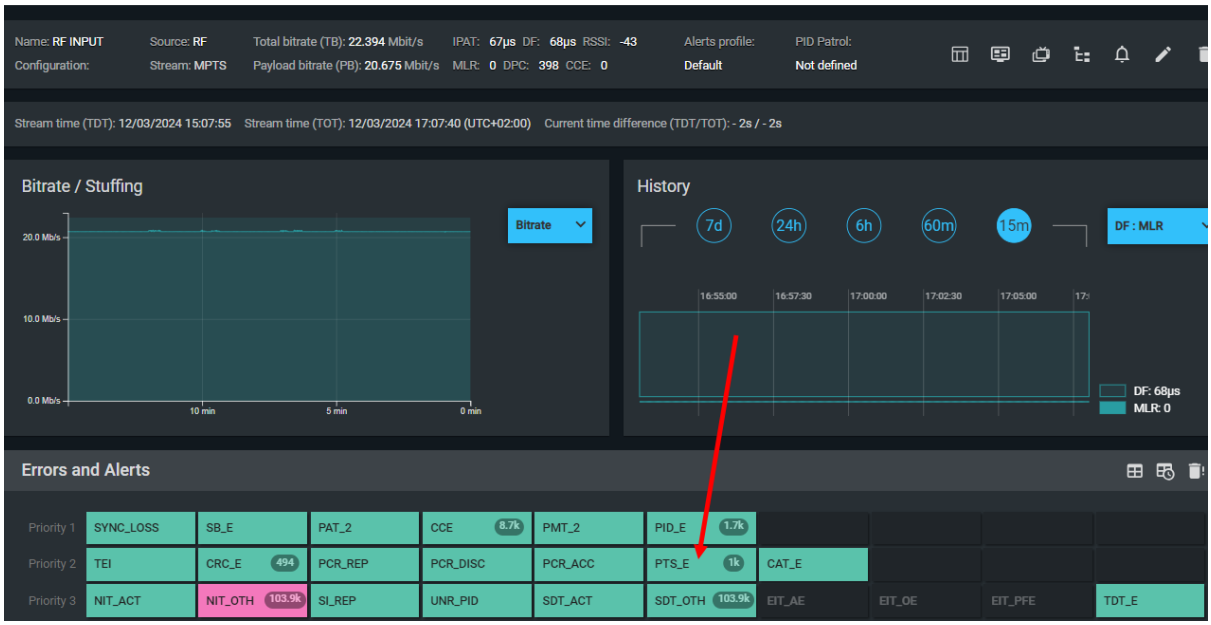



*Figure 58 –2.5 PTS_error in TS Analyzer interface*

*Table 21 – Description of 2.5 PTS_error*

| Parameter | Description |
|---|---|
| Priority | Level 2 |
| Number | 2.5 |
| Name | PTS error |
| Importance | Low |
| Purpose | For verifying the presence of a PTS timestamp. Only the presence, not the correctness. For checking the correctness of PTS, see Section 5.4. |

| Parameter | Description |
|---|---|
| Frequency of occurrence | Very rare |
| How to use (briefly) | If the indicator is active, it means that PTS is either absent in the unscrambled elementary stream or transmitted too infrequently. This situation can potentially lead to decoding failure. |
| Conditions for application | Checked only on elementary streams (PIDs with elementary streams).<br>There should be no CCE on the PID.<br>The PID should not be scrambled. |
| Theory | PTS is transmitted in the header of the elementary stream and indicates the PCR time when the playback of the decoded information from the current packet (access unit) should begin. ETSI TR 101 290 requires that PTS be transmitted at least once every 0.7 seconds. PTS is only available if the stream is not scrambled, as ES headers are scrambled along with the stream. |
| Principle of activation | TS Analyzer for unscrambled elementary streams locates PTS in the access unit header and checks the time between consecutive PTS arrivals. If this time exceeds 0.7 seconds, the error is activated. Note that for error activation according to ETSI TR 101 290, it is not necessary to check the value of PTS (it can have any value, even zero). However, TS Analyzer provides methods for checking PTS that go beyond the scope of ETSI TR 101 290. These methods are described in Section 5.4. |
| If the indicator is active | The stream on the current PID is (simultaneously):<br>– Unscrambled;<br>– **Contains an elementary stream;** |

| Parameter | Description |
|---|---|
| | – **PTS arrives less frequently than once every 0.7 seconds.** |
| If the indicator is not active | The stream is scrambled, so PTS is not analyzed.<br>The stream on the current PID does not contain an elementary stream.<br>The stream is not scrambled, and PTS arrives more frequently than once every 0.7 seconds. |
| Causes of occurrence | Faulty encoder or incorrect PTS configuration in the encoder settings (if this feature is implemented in the encoder settings). |
| Connection with other errors | Does not lead to other errors. |
| Recommendations for addressing issues that triggered indicator activation | Restore the encoder's functionality (restart, reflash, etc.).<br>If the PTS interval can be set in the encoder settings, configure the interval to 0.7 seconds or more. |
| Symptoms | Generally, this error does not lead to visible problems. In rare cases, brief, periodic, or one-time image distortion may occur. |

## 17.8 2.6 CAT_error

An important Conditional Access System (CAS) monitoring error. It is classified as a Level 2 error, although it would be more appropriate to classify it as Level 1, because a problem in the CAT table can lead to the unavailability of all services in the stream (if scrambling is used). If scrambling is not used (FTA stream), this error should be ignored.

Information on CAS monitoring is provided in Section 10.

Abbreviation: CAT_E. Position in the TS Analyzer interface is shown in *Figure 59*. Description is provided in *Table 22*.

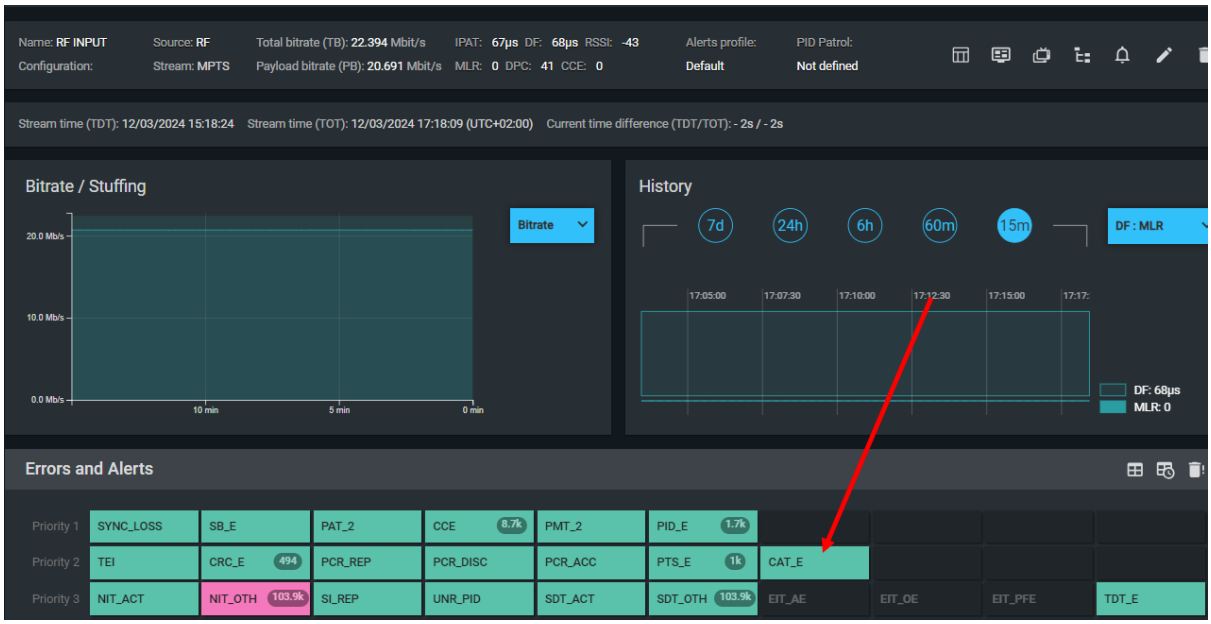



*Figure 59 –2.6 CAT_error in TS Analyzer interface*

*Table 22 – Description of 2.6 CAT_error*

| Parameter | Description |
|---|---|
| Priority | Level 2 |
| Number | 2.6 |
| Name | CAT error |
| Importance | High |
| Purpose | For monitoring CAT transmission when using CAS. Note that the presence of CAT does not guarantee the proper |

| Parameter | Description |
|---|---|
| | functioning of CAS. For more details on monitoring CAS using TS Analyzer, see Section 10. |
| Frequency of occurrence | Rarely |
| How to use (briefly) | Used for diagnosing conditional access system issues by checking for the presence of the CAT table. |
| Conditions for application | There should be no CCE on PID=0x01.<br>Scrambling should be used on at least one component of the TS |
| Theory | To enable a subscriber device to find EMM streams containing access keys, the CAT table is transmitted in the stream.<br>For each CAS used in the service, a separate CAT (CAT section) is transmitted with the EMM stream address.<br>Standards do not specify a time period for transmitting the CAT. In TS Analyzer, a period of 1 second is selected.<br>If the CAT is absent for longer, an error will be activated. |
| Principle of activation | The error is activated if:<br>– There is at least one PID with the scrambling flag set in the packet header, but the CAT is absent (for more than 1 second);<br>– A section with a table_id other than 0x01 appears on PID=0x01.<br>**Note: It is not checked whether the CAT references a correct EMM stream. This needs to be verified manually (see Section 10).** |
| If the indicator is active | If the indicator is active, it means that there are scrambled PIDs in the stream, but either the CAT is not being transmitted or it is transmitted infrequently. In very rare cases, it's possible that another table occupies the PID intended for CAT. |

| Parameter | Description |
|---|---|
| If the indicator is not active | It indicates that there are no scrambled PIDs.<br>This signifies the presence of scrambled streams and the presence of CAT. |
| Causes of occurrence | CAS server error, multiplexer error. |
| Connection with other errors | Does not lead to other errors. |
| Recommendations for addressing issues that triggered indicator activation | It is necessary to restore the functionality of the multiplexer or CAS server. Restoration should be carried out according to the technical instructions provided by the CAS equipment. It is considered good practice to contact the technical support of the CAS provider. |
| Symptoms | If there are scrambled services, they will not be descrambled (either permanently or for a certain period of time). |

# 18 MPEG TS Quality Indicators – Level 3

## 18.1 3.1 NIT_error

This error is outdated and not in use. Instead, use 3.1a NIT_actual_error and 3.1b NIT_other_error.

## 18.2 3.1a NIT_actual_error

A common error that can sometimes have unpleasant consequences. For example, the TS may not be recognized or an incorrect program guide may be displayed. If these symptoms are not present, the error can be ignored.

Abbreviation: NIT_ACT. Position in the TS Analyzer interface is shown in *Figure 60*. Description is provided in *Table 23*.

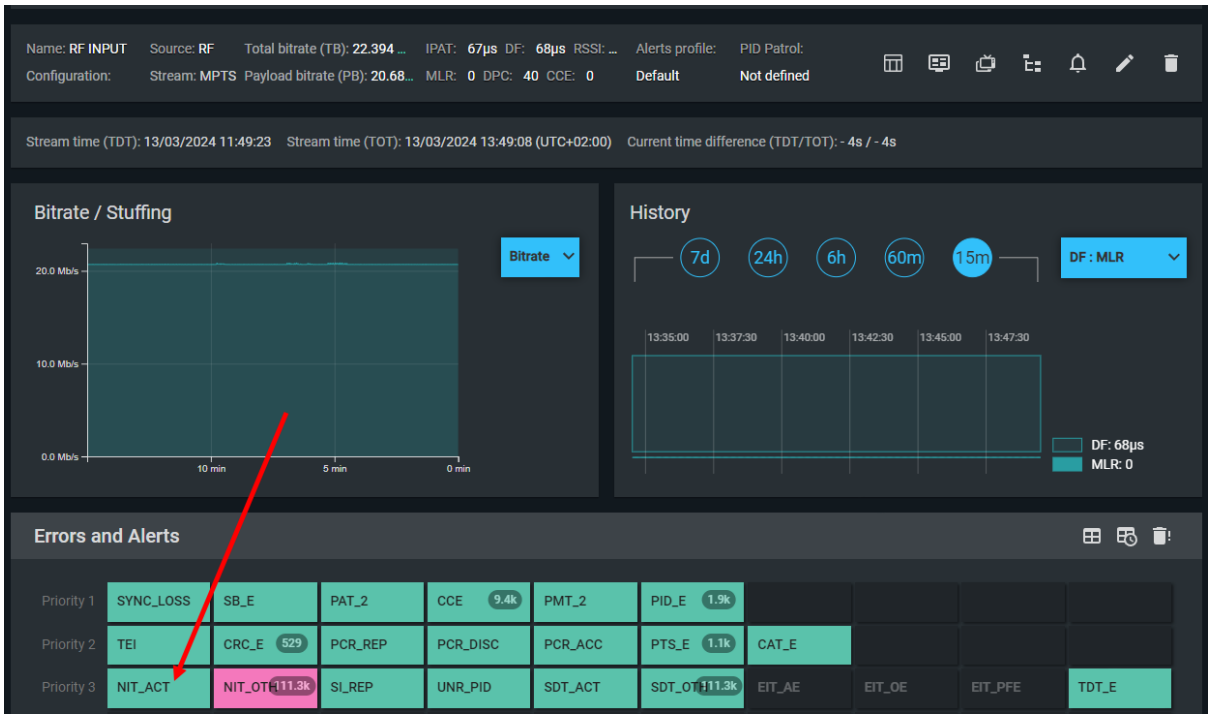



*Figure 60 –3.1a NIT_actual_error in TS Analyzer interface*

*Table 23 – Description of 3.1a NIT_actual_error*

| Parameter | Description |
|---|---|
| Priority | Level 3 |
| Number | 3.1a |
| Name | NIT_actual error |
| Importance | Low |
| Purpose | To determine deviations in the transmission of the PSI/SI table NIT_actual from the standard. |
| Frequency of occurrence | Often |
| How to use (briefly) | The error is used to verify the transmission of the NIT table. The content itself is not checked because it varies among different operators. To manually check the content, use the PSI/SI screen. |
| Conditions for application | No CCE on PID = 0x10 |
| Theory | The NIT_actual table transmits service information about the current communication network, with the network_id being one of the most important parameters distributed by the DVB consortium. However, there are no technical restrictions for an operator to set the network_id at their discretion. Many set-top boxes ignore NIT_actual altogether. However, other subscriber devices consider the absence of NIT_actual as an indication that the transport stream (TS) is not a standard DVB stream.<br>In TS used for IP television, NIT_actual is typically absent. In some receiving devices, users can select the Non-DVB stream type, which forcibly ignores NIT_actual. |

| Parameter | Description |
|---|---|
| | NIT_actual is usually transmitted at long intervals, typically around every 10 seconds, to conserve channel bandwidth. |
| Principle of activation | The error is activated if:<br>– On PID = 0x10, the PSI/SI tables with table_id=0x40, 0x41, 0x72 are not transmitted for more than 10 seconds, or if table_ids other than those specified appear on this PID;<br>– NIT_actual is transmitted too frequently (time between sections is less than 25 milliseconds). |
| If the indicator is active | If the indicator is active, then the NIT is most likely absent. Rarely, incorrect table_ids or overly frequent transmission of NIT may occur. |
| If the indicator is not active | If the indicator is not active, it confirms that NIT is present in the TS and is transmitted according to the standard. |
| Causes of occurrence | If the error is active, the possible reasons could be:<br>– The operator intentionally excluded NIT from the TS;<br>– **The operator intentionally increased the time between transmission of NIT sections;**<br>– Software malfunction in the multiplexer or PSI/SI generator. |
| Connection with other errors | Does not lead to other errors.<br>If the Network ID in the NIT is incorrectly specified, it may result in incorrect EPG display on subscriber devices (but there will not be ETSI TR 101 290 error). |
| Recommendations for addressing issues that | Enable NIT in the Multiplexer or PSI/SI Generator with repetition period less than 10 seconds and more than 25 milliseconds (optimally 9.9 seconds).<br>Restore the Functionality of the Multiplexer software. |

| Parameter | Description |
|---|---|
| triggered indicator activation | |
| Symptoms | Some devices cannot detect the signal if the NIT is absent.<br>In some cases, certain devices verify that the network_id in the EIT matches the network_id in the NIT. If the NIT is missing, such devices will not display the Electronic Program Guide.<br>Additionally, in some conditional access systems, the absence of NIT may lead to the cessation of descrambling on subscriber devices. |

## 18.3 3.1b NIT_other_error

A secondary, yet fairly common error. It may affect the switching speed of some services or the tuning speed of subscriber devices. If monitoring this error is not necessary, it can be disabled using the TS Analyzer profile mechanism.

Abbreviation: NIT_OTH. Position in the TS Analyzer interface is shown in *Figure 61*. Description is provided in *Table 24*.

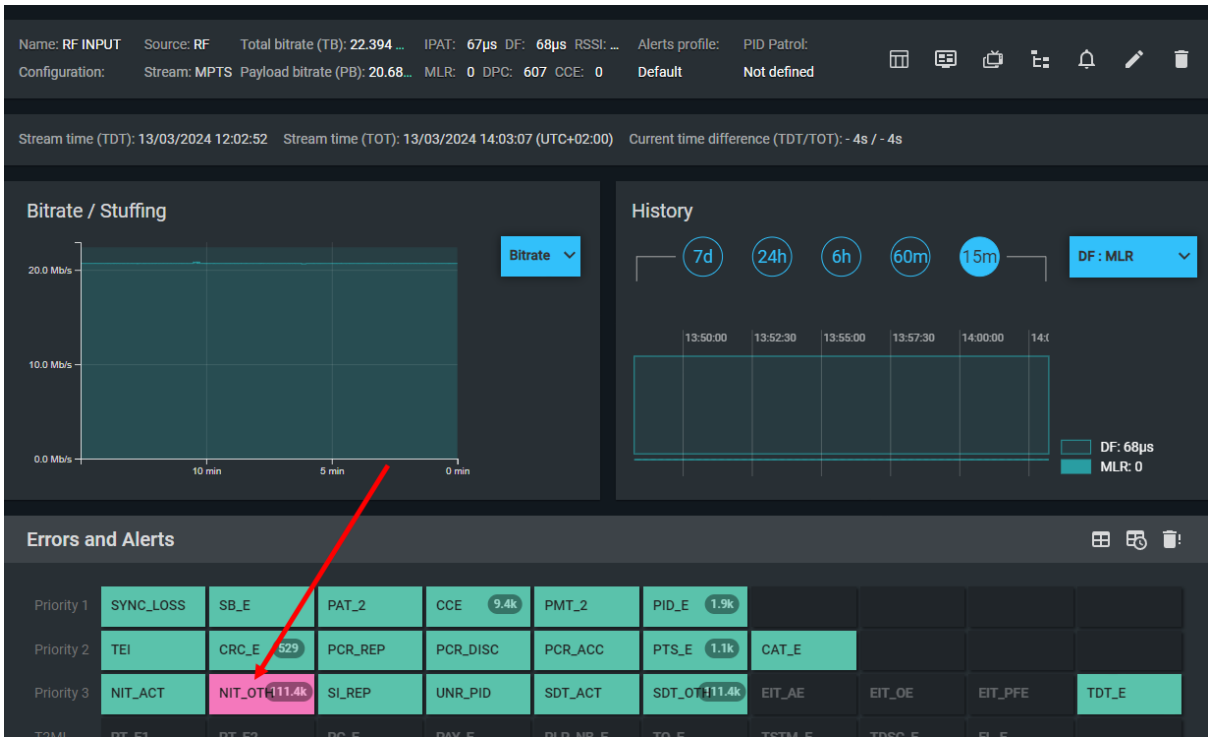



*Figure 61 –3.1b NIT_other_error*

*Table 24 – Description of 3.1b NIT_other_error*

| Parameter | Description |
|---|---|
| Priority | Level 3 |
| Number | 3.1b |
| Name | NIT_other transmision error |
| Importance | Very low |
| Purpose | To identify deviations in the transmission of the PSI/SI table NIT_other from the standard. The content is not checked because it varies between different operators. To manually verify the content, use the PSI/SI screen. |
| Frequency of occurrence | Often |
| How to use (briefly) | If the error is active, it means that the NIT_other table has been absent for more than 10 seconds. |
| Conditions for application | There should be no CCE on PID=0x10 |

| Parameter | Description |
|---|---|
| Theory | The NIT_other table is designed to transmit information about other multiplexes operated by the service provider. For example, it is used by satellite operators who have multiple transport streams (TS) on a single satellite. The practical purpose of using this table is to reduce the time it takes for subscriber devices to switch between different TS (as they do not need to retrieve NIT information).<br>NIT_other is transmitted on PID=0x10 with table_id=0x41. |
| Principle of activation | The error is activated if NIT_other is absent for more than 10 seconds. |
| If the indicator is active | If the indicator is active, it typically means that NIT_other is missing. |
| If the indicator is not active | If the indicator is not active, it indicates that NIT_other is being transmitted according to the standard requirements. |
| Causes of occurrence | In most cases, NIT_other is not used. If NIT_other is expected to be present, the error may occur for reasons similar to the appearance of NIT_actual (see Section 18.2). |
| Connection with other errors | Does not lead to other errors.<br>If the Network ID in the NIT is incorrectly specified, it may result in incorrect EPG display on subscriber devices. |
| Recommendations for addressing issues that triggered indicator activation | Similar to NIT_actual (see Section 18.2) |

| Parameter | Description |
|---|---|
| Symptoms | In rare cases, there may be a slight delay when switching between channels if these channels are on different multiplexes. |

## 18.4 3.2 SI_repetition_error

A common and important error, characterizing the correct operation of the PSI/SI generator.

Data on the minimum and maximum repetition periods of SI tables, collected from various standards (as of 2024), are provided in *Table 24*. The periods not set by the standard but chosen in the TS Analyzer for generating 3.2 SI_repetition_error is shown in bold italics.

*Table 24 - Minimal and maximal repetition periods for SI*

| Table | Min, milliseconds (only if the flow rate is less than 100 Mbit/s, otherwise not checked) | Max, seconds | Mandatory table |
|---|---|---|---|
| PAT | ***25*** | 0.5 | Yes |
| PMT | ***25*** | 0.5 | Yes |
| CAT | ***25*** | 0.5 | No |
| SDT actual | 25 | 2 | No |
| SDT other | 25 | 10 | No |
| NIT | 25 | 10 | No |
| NIT other | 25 | 10 | No |
| BAT | 25 | 10 | No |
| EIT_p/f actual | 25 | 2 | No |
| EIT_p/f other | 25 | 10 | No |
| TDT | 25 | 30 | No |
| TOT | 25 | 30 | No |
| RST | 25 | ***30*** | No |
| ST | 25 | ***30*** | No |
| DIT | 25 | ***30*** | No |
| SIT | 25 | ***30*** | No |

Abbreviation: SI_REP. Position in TS Analyzer interface is shown in *Figure 62*. Description is provided in *Table 25*.

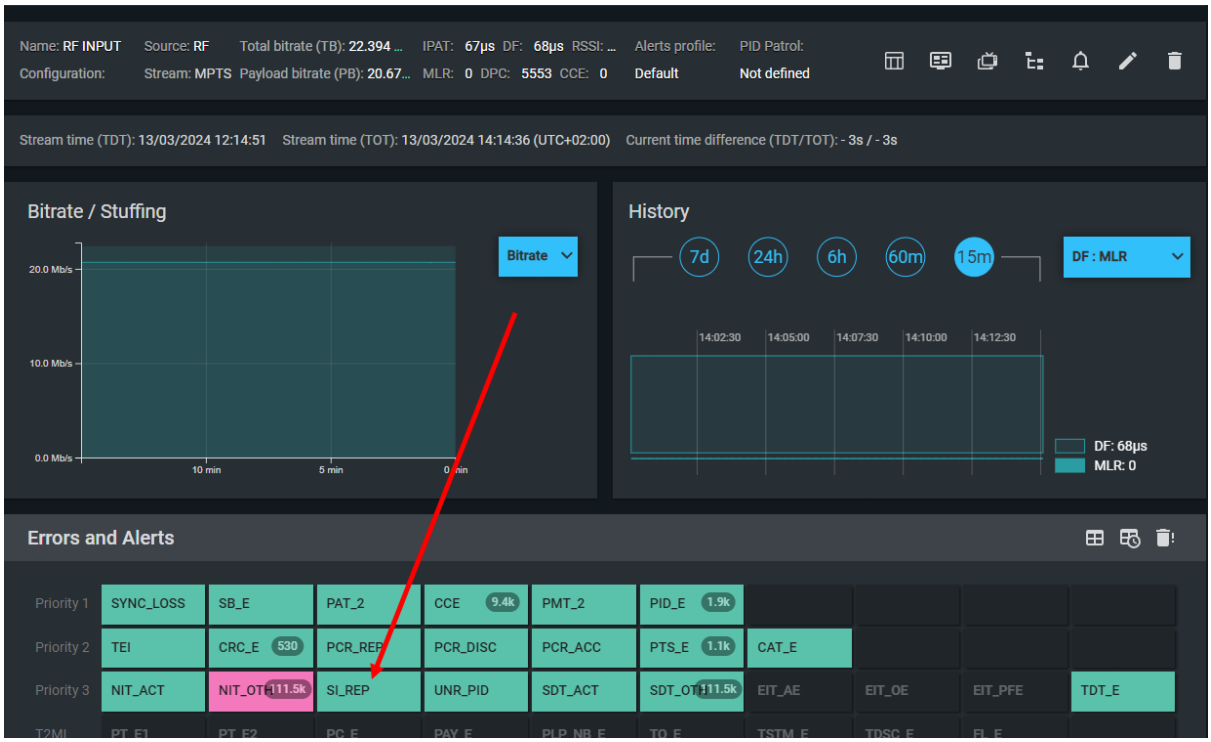



*Figure 62 –3.2 SI_repetition_error in TS Analyzer interface*

*Table 25 – Description of 3.2 SI_repetition_error*

| Parameter | Description |
|---|---|
| Priority | Level 3 |
| Number | 3.2 |
| Name | SI repetition error |
| Importance | High |
| Purpose | Used to verify that service information is transmitted within specified timing constraints (neither too infrequently nor too frequently). |
| Frequency of occurrence | Often |
| How to use (briefly) | Used to check the timing characteristics of PSI/SI tables (tables, depending on their type, should be transmitted neither too infrequently nor too frequently). |
| Conditions for application | There should be no CCE on PIDs where tables are transmitted. |

| Parameter | Description |
|---|---|
| Theory | The requirements from various standards regarding the periodicity of PSI/SI table transmission are compiled in *Table 24*. Bold italics indicate periods that are not specified by the standard but are chosen in TS Analyzer for generating the 3.2 SI_repetition_error. |
| Principle of activation | TS Analyzer verifies the intervals at which PSI/SI tables arrive. If these intervals fall outside the values listed in *Table 24*, the error is activated.<br>The error description specifies for which PID it is activated (and consequently, for which table). |
| If the indicator is active | If the error is active, it indicates that the specified PSI/SI table is transmitted either too frequently or too infrequently, as described in the error message. |
| If the indicator is not active | If the error is not active, it means that the PSI/SI tables are being transmitted according to the periodicity specified in the standards. |
| Causes of occurrence | The reasons for these errors can stem from faults or incorrect configurations in the multiplexer or PSI/SI generator (for example, the generator included in the Conditional Access System for generating EIT tables). |
| Connection with other errors | These errors may occur simultaneously with errors related to other tables such as PAT (PAT_error2), PMT (PMT_error2), SDT (SDT_actual, etc.), CAT (CAT_error), EIT (EIT_actual_error, etc.). |
| Recommendations for addressing issues that triggered indicator activation | To resolve the error:<br>– Check that the transmission characteristics of PSI/SI in the configuration of the multiplexer or PSI/SI generator comply with the values specified in<br>–<br>– *Table 24*; |

| Parameter | Description |
|---|---|
| | – Restore Functionality of PSI/SI Generator or Multiplexer (restart, reboot etc.). |
| Symptoms | In most cases, the occurrence of this error will not lead to visible degradation of services because PSI/SI is typically cached.<br>Possible symptoms align with those described for tables like PAT (PAT_error2), PMT (PMT_error2), SDT (SDT_actual and others), CAT (CAT_error), EIT (EIT_actual_error and others).<br>If tables are transmitted too frequently, it may lead to Continuous Stream Errors (CCE) across the entire stream. |

## 18.5 3.3 Buffer_error

In TS Analyzer, this error is not analyzed due to its secondary nature in relation to CCE.

This error is one of the causes of the 1.4 Continuity_count_error and can be used for more detailed diagnostics of equipment software.

The occurrence of this error indicates that one or more buffers in the TS receiving device (such as a multiplexer receiving the TS input) are underfilled or overfilled. Such underflow or overflow can result from incorrect bitrate determination by the software, abrupt network jitter, and other factors. The result of this error will be the appearance of CCE (most often periodic). Symptoms, causes, and solutions for CCE can be found in Section 16.4.

## 18.6 3.4 Unreferenced_PID

An important and frequently occurring error (despite being classified as third-level importance). It usually does not affect the quality of services but

indicates issues in the multiplexer or in the PMT configuration (even if there is no PMT error).

In TS Analyzer, the 3.4 Unreferenced_PID error is denoted as UNR_PID (*Figure 63*). The description of usage of the 3.4 Unreferenced_PID error are provided in *Table 26*.

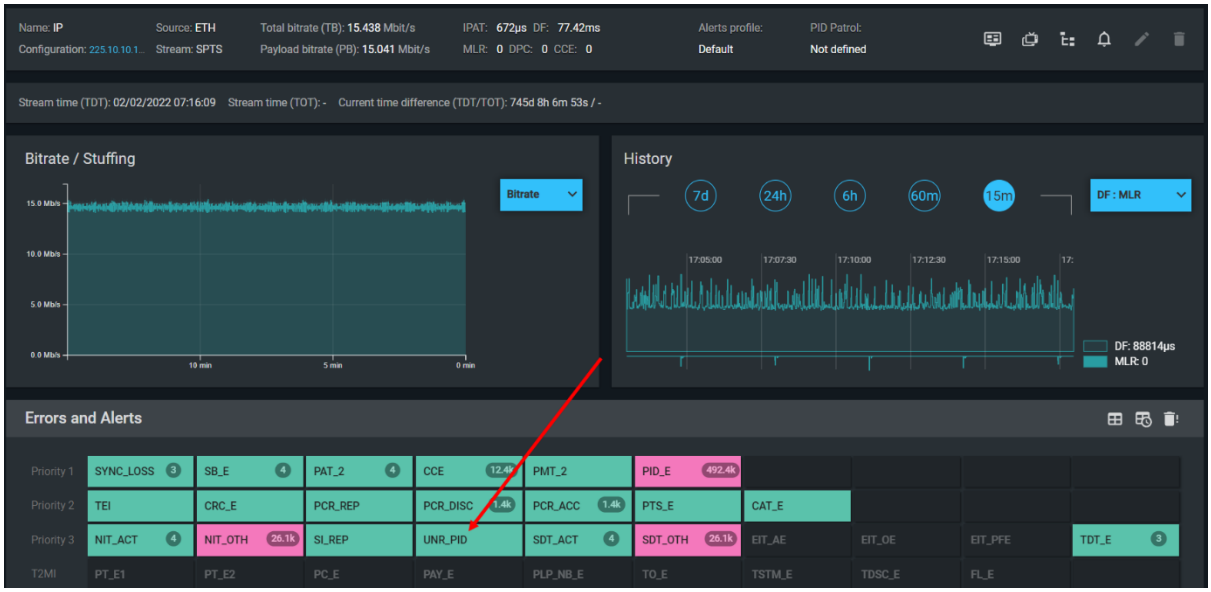



*Figure 63 –3.4 Unreferenced_PID in TS Analyzer interface*

*Table 26 – Description of 3.4 Unreferenced_PID*

| Parameter | Description |
|---|---|
| Priority | Level 3 |
| Number | 3.4 |
| Name | Unreferenced PID |
| Importance | High |
| Purpose | Allows detecting a stream with a PID that has no reference in PSI/SI. |
| Frequency of occurrence | Often |
| How to use (briefly) | Used to verify that all PIDs have references in PSI/SI. If this error is generated for any PID, it means that the PID does not have a reference in PSI/SI. This situation can be caused by certain devices (for example, set-top box |

| Parameter | Description |
|---|---|
| | update systems) that do not describe their streams in PSI/SI. |
| Conditions for application | It is necessary to ensure that the PAT and PMT tables are present in the stream and there are no errors in them. These tables contain references to PIDs. References to PIDs can also be found in tables such as AIT and CAT, but the absence of these tables by itself is not an error. To determine which PSI/SI and PIDs should be in the TS, refer to the TS multiplexing scheme. |
| Theory | All PIDs present in the TS must be referenced in PSI/SI or be described in the standards of DTV. |
| Principle of activation | TS Analyzer monitors that all PIDs present in the TS are listed in PSI/SI.. If a PID is found that is not listed anywhere, an error is triggered for that PID.<br>The check is performed once per second; if a PID reference is missing for a shorter period, no error will be detected. |
| If the indicator is active | If such an error occurs, it means that an "unknown" PID has appeared in the stream – it is not a standard PID or is not described in the transmitted PSI/SI. Such a PID typically cannot be detected by the receiving device and, consequently, is useless and leads to unnecessary bitrate consumption. An exception is when a PID is intentionally injected into the stream without description. Such PIDs may be used by over-the-air update systems or device management systems via control signals (e.g., emergency alert systems). |
| If the indicator is not active | All PIDs present in the stream are described in PSI/SI or in the standards of DTV. Therefore, every PID can be processed by the receiving device. |

| Parameter | Description |
|---|---|
| Causes of occurrence | If the "lost" PID is not intentionally inserted, the reasons for its appearance could be:<br>– Incorrect operation of the multiplexer (normally, a multiplexer does not allow placing PIDs without including them in PSI/SI);<br>– Errors in PAT, PMT, CAT, or AIT. |
| Connection with other errors | This error may be generated if there are transmission errors in PAT, PMT, CAT, AIT (for example, PMT_error2 or CCE), as these tables contain references to PIDs. |
| Recommendations for addressing issues that triggered indicator activation | It is necessary to ensure that the "lost" PID is not used for specific purposes such as:<br>– Transmitting updates to devices (set-top boxes);<br>– **Transmitting conditional access information for CAS systems that do not support Simulcrypt;**<br>– Sending control signals to external devices (e.g., alerting devices).<br>This can be verified in the following ways:<br>– Contacting the telecom operator or company responsible for the stream formation;<br>– **Checking if the presence of the "lost PID" is planned in the multiplexing scheme.**<br>**If the "lost" PID did not appear intentionally, it is recommended to perform the following actions:**<br>– **If this PID is in the input stream at the multiplexer, it can be removed during multiplexing:**<br>– Restore the functionality of the multiplexer;<br>– **Perform re-multiplexing (stop the multiplexing process and restart it after some time);** |

| Parameter | Description |
|---|---|
| | – **Include this PID in one of the tables (if a multiplexing scheme violation is detected).** |
| Symptoms | This error does not disrupt service operations. However, the erroneous appearance of the "lost" PID can lead to insufficient line bandwidth (as it unexpectedly consumes bitrate) and, consequently, the appearance of CCE errors and related issues. |

## 18.7 3.5 SDT_error

This error is outdated and not in use. Instead, use 3.5a SDT_actual_error and 3.5b SDT_other_error.

## 18.8 3.5a SDT_actual_error

An important and frequently occurring error. Its consequences include incorrect information about services (e.g., incorrect or missing service names in the subscriber device menu). It does not affect the quality of reception.

Abbreviation: SDT_ACT. Position in the TS Analyzer interface is shown in *Figure 64*. Description is provided in *Table 27*.

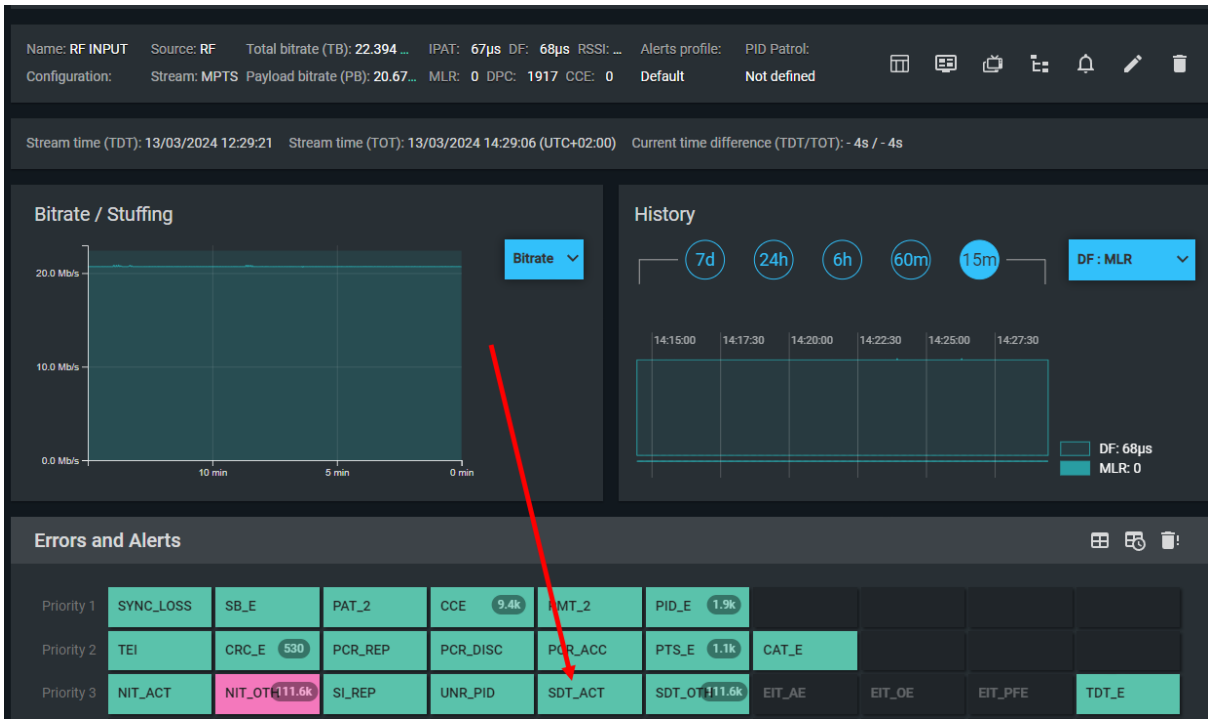



*Figure 64 –3.5a SDT_actual_error in TS Analyzer interface*

*Table 27 – Description of 3.5a SDT_actual_error*

| Parameter | Description |
|---|---|
| Priority | Level 3 |
| Number | 3.5a |
| Name | SDT error |
| Importance | High |
| Purpose | Used to monitor the correct transmission of the SDT table for TS that it is located in. The content is not verified because it varies among operators. To manually check the content, use the PSI/SI screen. |
| Frequency of occurrence | Often |
| How to use (briefly) | If this error is active, there may be issues on subscriber devices with service names and descriptions because the SDT table is transmitted incorrectly (either too frequently or too infrequently). |
| Conditions for application | There should be no CCE errors on PID=0x11 |

| Parameter | Description |
|---|---|
| Theory | Table SDT is transmitted as part of PSI/SI to deliver descriptive information about services. SDT _actual contains service descriptions for the TS in which it is transmitted.<br>In most cases, issues with this table do not lead to visible defects. Even if the table was transmitted as part of the stream and transmission later stopped, subscriber devices typically cache this table.<br>SDT for other streams can also be transmitted in TS (SDT_other). To monitor them, use 3.5b SDT_other_error (Section 18.9). |
| Principle of activation | The error is activated in the following situations:<br>– On the "standard" PID=0x11, if for more than 2 seconds there is no section with table_id=0x42 (typically indicating absence of SDT_actual);<br>– A very rare situation: Sections appear on PID=0x11 with foreign table_id values (not 0x42, 0x46, 0x4A, 0x72);<br>– SDT_actual is transmitted too frequently (more often than every 25 milliseconds). |
| If the indicator is active | If the indicator is active, it means one of the criteria described in the "Activation Principle" section has been met, and the transmission of SDT_actual cannot be considered correct.<br>Please note that the error is not generated if the content of SDT is incorrect. Only compliance with transmission rules is checked. |
| If the indicator is not active | If the error is not active, it means SDT is being transmitted according to the standard. Please note that this does not imply that the information contained in SDT is correct. |

| Parameter | Description |
|---|---|
| Causes of occurrence | The SDT error is caused by incorrect configuration of the multiplexer, PSI/SI generator, or faults in their software. |
| Connection with other errors | Does not lead to other errors. |
| Recommendations for addressing issues that triggered indicator activation | To resolve the SDT error, ensure that the transmission time of SDT_actual on the multiplexer or PSI/SI generator is set within 25 milliseconds to 2 seconds. It's better to set it closer to 2 seconds, as subscriber devices typically cache this table.<br>If there are extraneous sections being transmitted, restore the multiplexer's functionality (reboot, reflash, etc.). In some multiplexers, it may be possible to mistakenly configure the transmission of extraneous tables on PID=0x11. If such tables are found, they should be removed from this PID. |
| Symptoms | The most common symptom of SDT table issues is the absence of service names or periodic disappearance of names (while the services themselves play without issues). Also, if the table is misconfigured, service names may not correspond to the actual services.<br>There may be a delay in displaying service names (for example, when switching channels, the name may not appear immediately and/or not on the first switch).<br>If SDT_actual is transmitted too frequently, this leads to a reduction in useful bandwidth (and, for example, may cause appearance of CCE across the stream). |

## 18.9 3.5b SDT_other_error

Error 3.5b SDT_other_error is practically analogous to error 3.5a SDT_actual_error. The difference lies in its application to the SDT_other table, which transmits SDT for TS other than the one it is located in. Operators typically add SDT_other for all their TS because it reduces the time to obtain descriptive service information when switching channels (when a viewer switches from a service on one TS to a service on another TS).

Abbreviation: SDT_OTH. Position in the TS Analyzer interface is shown in *Figure 65*. Description is provided in *Table 28*.

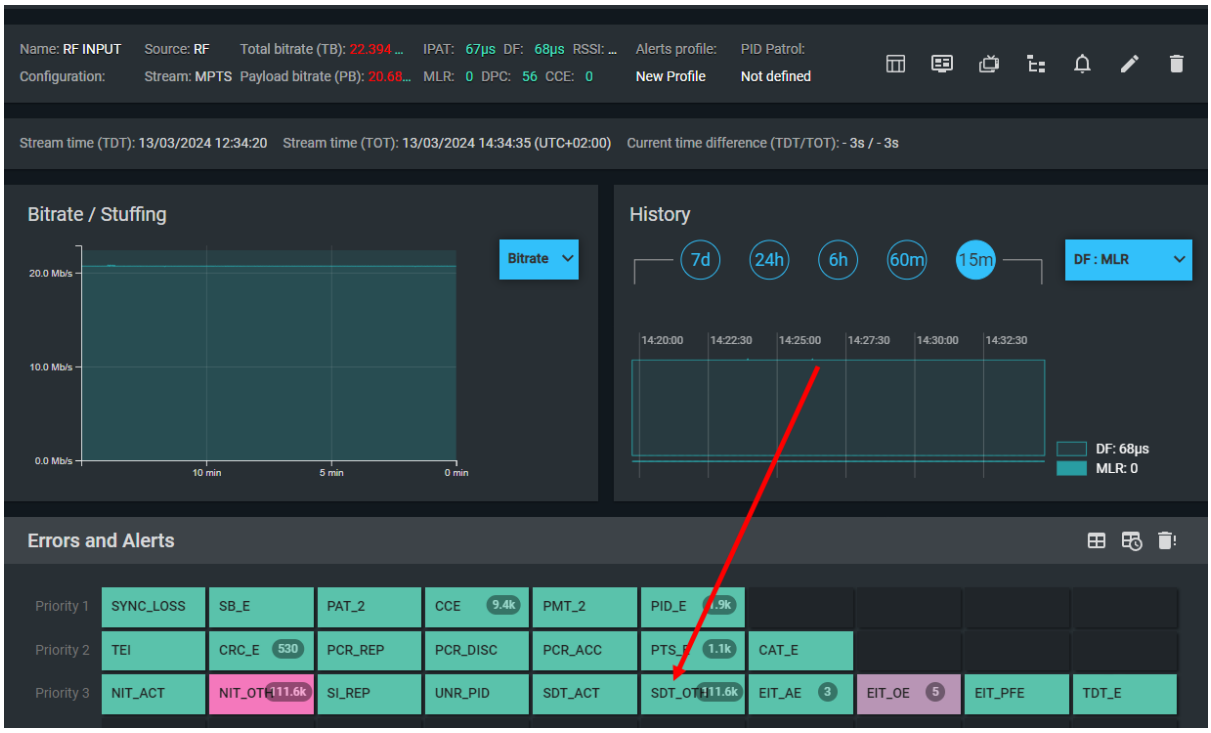



*Figure 65 –3.5b SDT_other_error in TS Analyzer interface*

*Table 28 – Description of 3.5b SDT_other_error*

| Parameter | Description |
|---|---|
| Priority | Level 3 |
| Number | 3.5a |
| Name | SDT error |
| Importance | Low |

| Parameter | Description |
|---|---|
| Purpose | Error SDT_other_error is used to monitor the correct transmission of the SDT table for another TS, not the one it is located in. The content is not verified because it varies among operators. To manually check the content, use the PSI/SI screen. |
| Frequency of occurrence | Rarely |
| How to use (briefly) | If this error is active, there may be issues on subscriber devices with service names and descriptions because the SDT table is transmitted incorrectly (either too frequently or too infrequently). |
| Conditions for application | There should be no CCE errors on PID=0x11 |
| Theory | Table SDT_other is transmitted as part of PSI/SI to deliver descriptive information about services.<br>SDT_other contains service descriptions for other TS, not the one in which it is transmitted.<br>In most cases, issues with this table do not lead to visible defects. Even if the table was transmitted as part of the stream and transmission later stopped, subscriber devices typically cache this table. |
| Principle of activation | The error is activated if, on the "standard" PID=0x11, a section with table_id=0x46 does not appear for more than 10 seconds (typically indicating the absence of SDT_other). |
| If the indicator is active | If the indicator is active, it means that SDT_other has not been transmitted for more than 10 seconds (typically indicating its complete absence).<br>Note that the error is not generated if the content of SDT is incorrect. Only compliance with transmission rules is checked. |

| Parameter | Description |
|---|---|
| If the indicator is not active | If the error is not active, it means SDT_other is being transmitted according to the standard. Note that this does not imply that the information contained in SDT_other is correct. |
| Causes of occurrence | The SDT_other error is caused by incorrect configuration of the multiplexer, PSI/SI generator, or faults in their software. |
| Connection with other errors | Does not lead to other errors. |
| Recommendations for addressing issues that triggered indicator activation | To resolve the SDT_other error, ensure that the transmission time of SDT_other on the multiplexer or PSI/SI generator is set within 10 seconds. It's better to set it closer to 10 seconds because subscriber devices typically cache this table. |
| Symptoms | Delays in displaying the service name (for example, when switching channels, the name may not appear immediately and/or not on the first switch). |

## 18.10 3.6 EIT_error

This error is outdated and not in use. Instead, use 3.6a EIT_actual_error, 3.6b EIT_actual_error and 3.6c EIT_PF_error.

## 18.11 3.6a EIT_actual_error

Error affecting the accuracy of Electronic Program Guide (EPG) playback for programs broadcasted at the current time.

Abbreviation: EIT_AE. Position in the TS Analyzer interface is shown in *Figure 66*. Description is provided in *Table 29*.

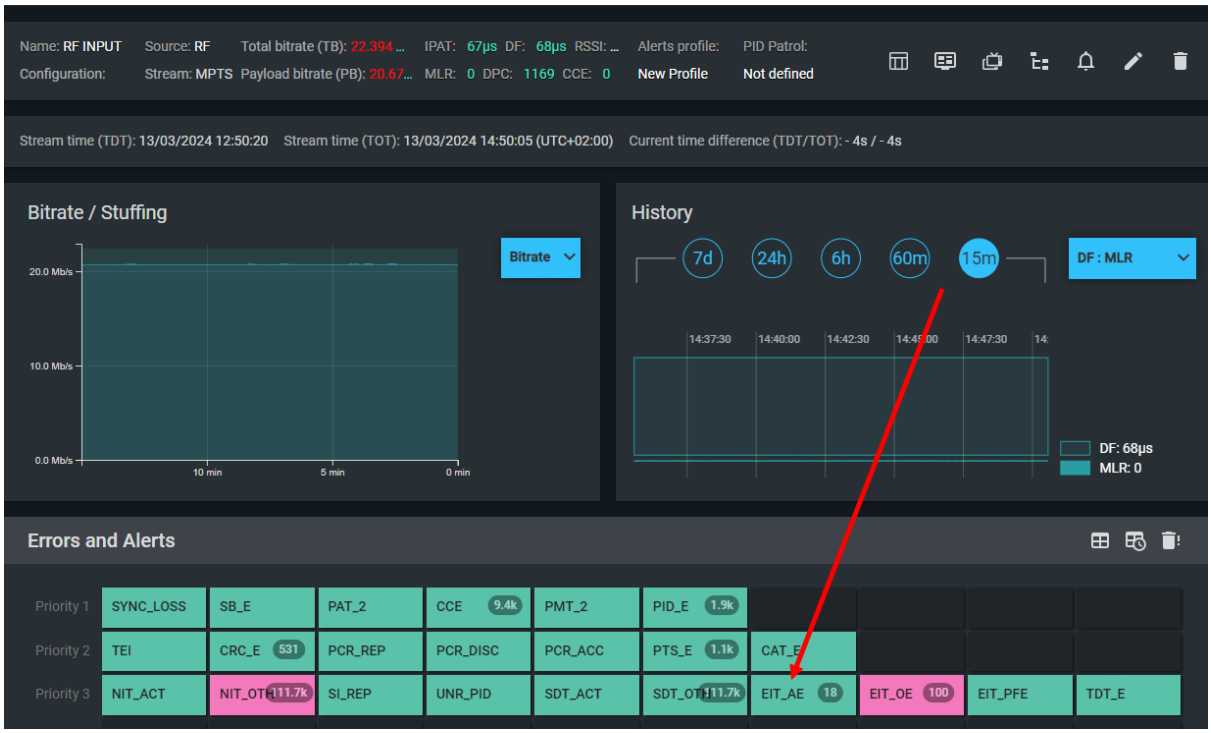



*Figure 66 –3.6a EIT_actual_error in TS Analyzer interface*

*Table 29 – Description of 3.6a EIT_actual_error*

| Parameter | Description |
|---|---|
| Priority | Level 3 |
| Number | 3.6a |
| Name | EIT_actual error |
| Importance | Low |
| Purpose | Used to monitor the correctness of the EIT table transmission for the TS in which it resides. The content itself is not checked as it varies between operators. To manually check the content, use the PSI/SI screen. |
| Frequency of occurrence | Often |
| How to use (briefly) | If this error is active, viewing problems with the Electronic Program Guide on subscriber devices may occur. |
| Conditions for application | There should be no CCE errors on PID=0x12 |

| Parameter | Description |
|---|---|
| Theory | See section 11 |
| Principle of activation | The error is activated in the following situations:<br>– On the "standard" PID=0x12, if within more than 2 seconds, section 0 with table_id=0x4E (section for current program) does not appear;<br>– Same as the above, but for section 1 (section for next program);<br>– **Very rare situation: Sections with "foreign" table_id appear on PID=0x12 (Multiplexer software should automatically block attempts to configure the multiplexer in this way);**<br>– EIT_actual is transmitted too frequently (more frequently than every 25 milliseconds). |
| If the indicator is active | If the indicator is active, it means that one of the criteria described in the "Activation Principle" section has been met, and the transmission of EIT_actual cannot be considered correct.<br>Please note that the error is not generated if the content of EIT is incorrect. Only compliance with transmission rules is checked. |
| If the indicator is not active | If the error is not active, it means that EIT_actual is being transmitted according to the standard. However, this does not imply that the information contained in EIT_actual is correct. |
| Causes of occurrence | The EIT_actual error is caused by incorrect configuration of the multiplexer, PSI/SI generator, EPG server, or faults in their software.<br>Additionally, the transmission period of EIT_actual may be intentionally increased by the operator to "save bitrate". |

| Parameter | Description |
|---|---|
| Connection with other errors | Does not lead to other errors. |
| Recommendations for addressing issues that triggered indicator activation | To resolve the EIT_actual error, ensure that the transmission period of EIT_actual on the multiplexer or PSI/SI generator (or EPG server) is set within the range of 25 milliseconds to 2 seconds. It's better to set it closer to 2 seconds because subscriber devices typically cache this table.<br>If extraneous table_ids are being transmitted, restore the proper functioning of the multiplexer (reboot, reflash, etc.). In some multiplexers, there may be misconfigurations allowing the transmission of extraneous tables on PID=0x12. If such tables are detected, they should be removed from this PID. |
| Symptoms | The most common symptom of issues with the EIT_actual table is the constant or periodic absence of EPG on the receiving device (set-top box). This could mean missing information for both the current program (if there's an issue with section 0) and the next program (if there's an issue with section 1).<br>If EIT_actual is transmitted too frequently, it reduces the useful bandwidth (and may lead to CCE appearing across the stream). |

## 18.12 3.6b EIT_other_error

A very common secondary error affecting EPG display in streams other than the current one.

Abbreviation: EIT_OE. Position in the TS Analyzer interface is shown in *Figure 67*. Description is provided in *Table 30*.

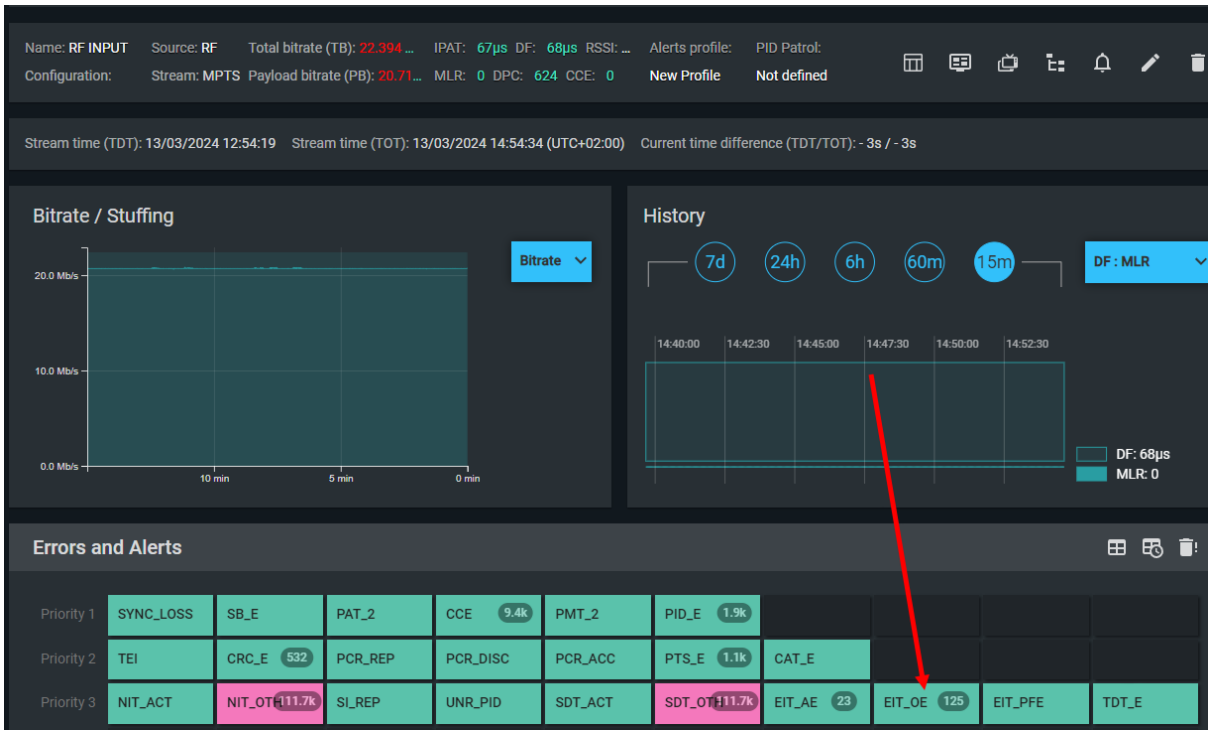



*Figure 67 –3.6b EIT_other_error in TS Analyzer interface*

*Table 30 – Description of 3.6b EIT_other_error*

| Parameter | Description |
|---|---|
| Priority | Level 3 |
| Number | 3.6b |
| Name | EIT_other |
| Importance | Low |
| Purpose | It is used to monitor the correct transmission of the EIT table for TS with the specified TS ID (not the one in which it is transmitted). The content is not checked because it varies among different operators. To check the content manually, use the PSI/SI screen. |
| Frequency of occurrence | Very often |
| How to use (briefly) | If this error is active, there may be issues with viewing the electronic program guide on subscriber devices. |
| Conditions for application | There should be no CCE errors on PID=0x12 |

| Parameter | Description |
|---|---|
| Theory | See section 11 |
| Principle of activation | The error is activated in the following situations:<br>– On the "standard" PID=0x12, a section 0 with table_id=0x4F (section for the current schedule) does not appear for more than 10 seconds;<br>– Same as above, but for section 1 (section for the future schedule). |
| If the indicator is active | If the indicator is active, it means that one of the criteria described in the "Activation Principle" section has been triggered, and the EIT_other transmission cannot be considered correct.<br>Note that the error is not generated if the EIT content is incorrect. Only the compliance with transmission rules is checked. |
| If the indicator is not active | If the error is not active, it means EIT_other is transmitted according to the standard. Note – this does not mean that the information contained in EIT_other is correct. |
| Causes of occurrence | The EIT_other error is caused by incorrect configuration of the multiplexer, PSI/SI generator, EPG server, or their software malfunction.<br>Additionally, the transmission period of EIT_other may be intentionally increased by the operator to "save bitrate."<br>Note that the presence of EIT_other is not mandatory. If this table is not needed, disable the error in the TS Analyzer profile. |
| Connection with other errors | Does not lead to other errors. |
| Recommendations for addressing | To resolve the EIT_other error, ensure that the transmission time of EIT_actual on the multiplexer or |

| Parameter | Description |
|---|---|
| issues that triggered indicator activation | PSI/SI generator (or EPG server) is set within 10 seconds. It is better to set it closer to 10 seconds since subscriber devices usually cache this table. |
| Symptoms | A symptom of issues with the EIT_other table is excessively long waiting times for EPG display when switching between TS (for example, when you want to view EPG for services included in different TS). This symptom may be rare since EIT is usually cached on the subscriber device. |

## 18.13 3.6c EIT_PF_error

A very common secondary error affecting the display of EPG information about current or scheduled programs.

Abbreviation: EIT_PFE. Position in the TS Analyzer interface is shown in *Figure 68*. Description is provided in *Table 31*.

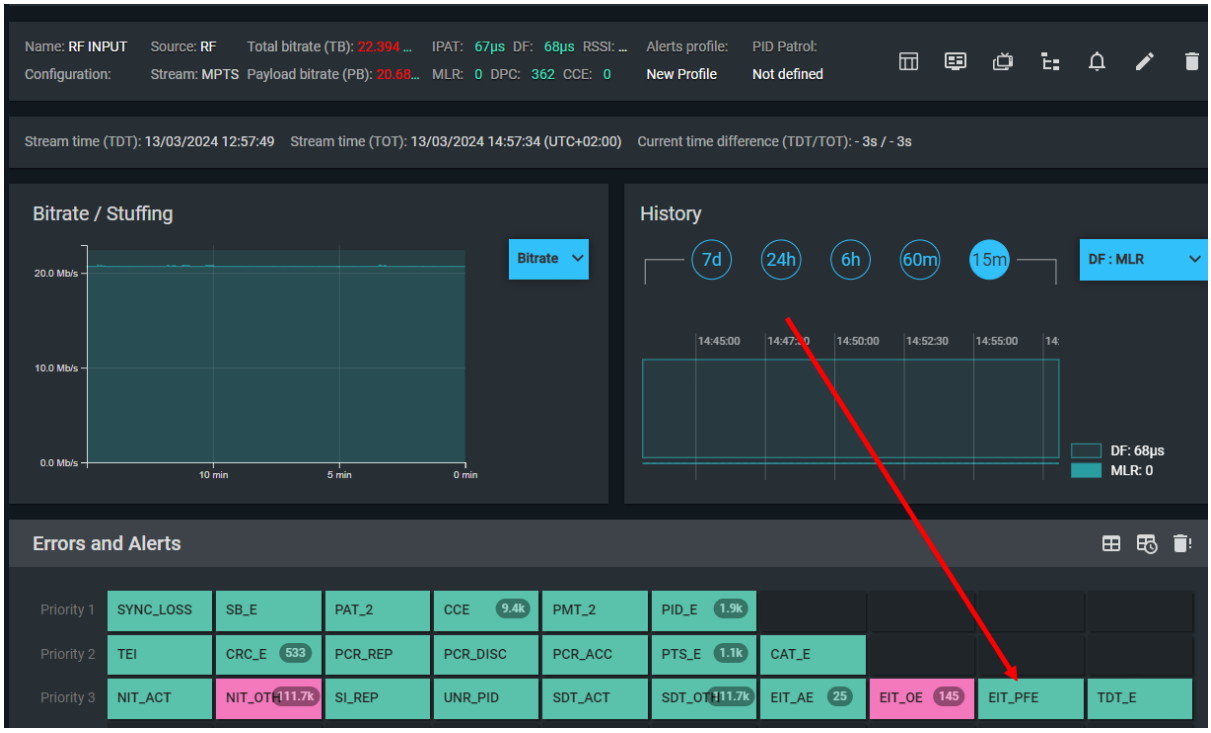



*Figure 68 –3.6c EIT_PF_error in TS Analyzer interface*

*Table 31 – Description of 3.6c EIT_PF_error*

| Parameter | Description |
|---|---|
| Priority | Level 3 |
| Number | 3.6c |
| Name | EIT_pf error |
| Importance | Low |
| Purpose | Used to monitor the presence of sections for current and next programs in the EIT. The content is not checked since it varies among different operators. To manually check the content, use the PSI/SI screen. |
| Frequency of occurrence | Very often |
| How to use (briefly) | It verifies that the EIT contains both type 0 and type 1 sections (as required by the standard). |
| Conditions for application | There should be no CCE errors on PID=0x12 |
| Theory | See section 11 |
| Principle of activation | The presence of both section 0 (current programs) and section 1 (next programs) is checked within 2 seconds (for EIT_actual) and 10 seconds (for EIT_other). If section 0 or section 1 is missing within the specified time, an error is activated. |
| If the indicator is active | The EIT lacks information about current or upcoming programs, or this information is transmitted with unacceptable delays (from the standard's perspective). |
| If the indicator is not active | The EIT contains information about current and upcoming programs. |
| Causes of occurrence | Malfunction of the EPG server software or multiplexer. |
| Connection with other errors | Does not lead to other errors. |

| Parameter | Description |
|---|---|
| Recommendations for addressing issues that triggered indicator activation | It is necessary to restore the functionality of the EPG server or multiplexer software (restart, reboot the service, reflash, etc.). |
| Symptoms | When displaying the EPG, information about current or upcoming programs is permanently or temporarily missing. This symptom occurs if the EPG is not cached by the subscriber's device. |

## 18.14 3.7 RST_error

Error detection for the RST table is not implemented in TS Analyzer because the RST table is rarely used. This table is intended to transmit information about changes in the broadcast times of TV programs compared to the schedule set by EIT.

An RST error occurs when a "foreign" table (not RST) appears on PID=0x13 or when the RST is transmitted too frequently (more than once every 25 milliseconds).

TS Analyzer does not implement automatic RST_error detection since this table is extremely rarely used. If the RST table is transmitted, its quality can be checked “manually”. To do this, find PID=0x13 in the list of PIDs on the statistics screen. If it is present and there is traffic on it, then RST is being transmitted.

## 18.15 3.8 TDT_error

A rare but important error affecting the correct display of EPG and the setting of the current time on the set-top box (and, consequently, the recording by time function). For more details on the consequences of incorrect time on the subscriber device and ways to monitor it, see Section 8.

Abbreviation TDT_E. Position in the TS Analyzer interface is shown in *Figure 69*. Description is provided in *Table 32*.

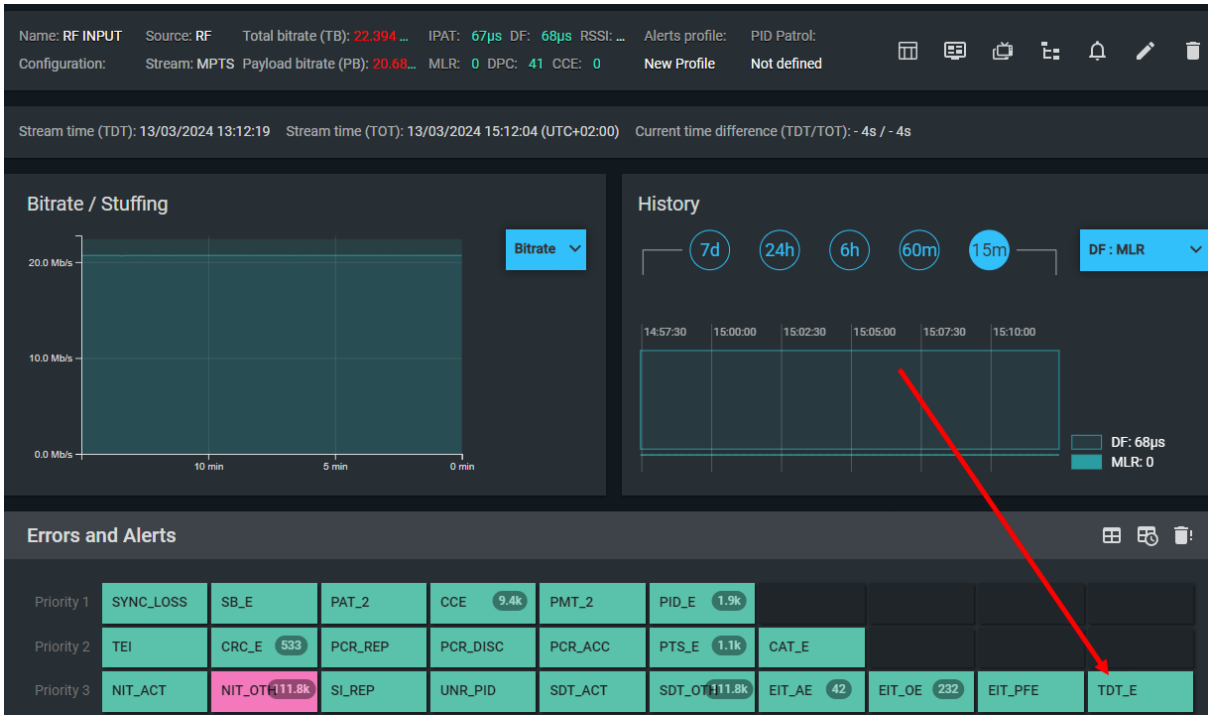



*Figure 69 –3.8 TDT_error in TS Analyzer interface*

*Table 32 – Description of 3.8 TDT_error*

| Parameter | Description |
|---|---|
| Priority | Level 3 |
| Number | 3.8 |
| Name | TDT error |
| Importance | High |
| Purpose | For verifying the transmission of UTC through TS. |
| Frequency of occurrence | Rarely |
| How to use (briefly) | Used to monitor the accuracy of time transmission parameters through TS (for details on how to check the time itself, see Section 8). |
| Conditions for application | There should be no CCE on PID=14 |

| Parameter | Description |
|---|---|
| Theory | The TDT table is intended for transmitting information about universal time (while the optional TOT table provides information about time offset). he TDT table must be transmitted on PID=14. |
| Principle of activation | The error indicator is activated when one or more of the following events occur:<br>– There is no section with table_id = 0x70 on PID=14 for more than 30 seconds;<br>– Unrelated sections that should not be present appear on PID=14;<br>– TDT is transmitted more frequently than once every 25 milliseconds. |
| If the indicator is active | If the indicator is active, it means one of the criteria listed above has been triggered. Most often, this indicates that the TDT is missing. |
| If the indicator is not active | If the indicator is not active, it means the TDT is being transmitted in accordance with the standard. |
| Causes of occurrence | Error in the configuration of the PSI/SI generator (part of the multiplexer or separate), clock error (if using external clocks such as GPS or GLONASS). |
| Connection with other errors | Does not lead to other errors. |
| Recommendations for addressing issues that triggered indicator activation | It is necessary to ensure that the TDT repetition period in the PSI/SI generator settings is set no longer than 30 seconds and no shorter than 25 milliseconds.<br>Restore the proper functioning of the multiplexer software (restart PSI/SI generation, reboot, firmware update). |
| Symptoms | Incorrect time on the subscriber device clock.<br>EPG shows the schedule for the incorrect time. |

| Parameter | Description |
|---|---|
| | Time-based recording functions on the subscriber device trigger at the wrong time. |

## 19 Glossary of Abbreviations

AU – access unit, a syntactic unit of a video or audio data stream

CAS – conditional access system

DTS – decoding time stamp of an AU on the PCR scale

FTA – free-to-air channels (services), which are transmitted without encryption (i.e., without scrambling)

PCR – time stamp of the service encoder clock

PTS – presentation time stamp of an AU on the PCR scale

SFN – single-frequency network

TEI – transport error indicator (flag) in the TS packet header

TS – MPEG transport stream (ISO 13818-1)

UTC – Universal Time Coordinated ("atomic" time)

APCH – automatic frequency control of the local oscillator

GUI – graphical user interface

RRL – radio relay line (communication)

RF – radio frequency

CCE – continuity counter error (Section 16.4)

DTV –digital television using TS