User Manual

Tektronix

MTS4CC
Elementary Stream Compliance Checker

071-2075-00

This document supports software version 1.0

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This product has been classified as Monitoring and Control equipment, and is outside the scope of the 2002/95/EC RoHS Directive. Although not required, this product complies with the RoHS Directive requirements for nonexempt products.

Preface

This manual describes the functions and use of the Tektronix MTS4CC Elementary Stream Compliance Checker. The manual is organized into the following sections:

- Section 1: Getting Started
- Section 2: Operating Basics
- Section 3: Reference
- Appendix A: Tests of MTS4CC
- Glossary

Related Material

Additional documentation, such as ReadMe files, may be included on the installation CD-ROM.

The following URLs access the Web sites for the standards organizations listed (the URLs listed were valid at the time of writing):

- MPEG-2 standards (International Organization for Standards)
  http://www.iso.ch/
- DVB standards (European Technical Standards Institute)
  http://www.etsi.org/
- ATSC standards (Advanced Television Systems Committee)
  http://www.atsc.org/

Manual Conventions

Naming conventions for the interface elements are based on standard Microsoft Windows naming conventions. Naming conventions for MPEG-2, ATSC, and DVB structures follow the conventions derived from the referenced standards documents.

Mono-spaced text can indicate the following:

- Text that you enter from a keyboard
  Example: Enter the network identity (`http://TSMonitor01`)

- Characters that you press on your keyboard
  Example: Press `CTRL+C` to copy the selected text.

- Paths to components on your hard drive
  Example: The program files are installed at the following location:
  `C:\Program Files\Tektronix\`

Number Conventions

Within MTS4CC all numbers are decimal unless they are preceded by 0x, in which case they are hexadecimal.

For example:

- 16 [decimal] = 16 decimal
- 0x16 [hexadecimal] = 22 decimal

User Documentation

The PDF version of this manual can be accessed from MTS4CC Help > User manual (PDF).

Tutorials are supplied as a separate PDF file that is accessible through the Help menu.

The PDF version of this manual and the tutorials are also on the installation CD-ROM.

Getting Started

Overview

MTS4CC ES Compliance Checker is a powerful real-time analytical tool for the investigation of compressed video data that has been encoded using the H.264/AVC, MPEG-1/2, MPEG-4, VC-1, and H.263 video standards.

MTS4CC operates as a standalone software application for use on a personal computer (PC) in a Windows environment. It can also be installed on the MTS400 MPEG Test Systems.

MTS4CC enables the display, analysis, debug, and optimization of the compression algorithm or equipment:

- Next generation (VC-1, H.264/AVC, MPEG-4 and 3GPP) and Legacy (MPEG-2, and H.263) CODEC support
- Frame-by-frame and block-by-block analysis to allow easy CODEC comparison
- Audio decode and waveform display
- Synchronized audio and video displays
- Real-time and non real-time decoding and compliance checking of compressed video streams (dependent on PC performance)
- Batch mode to allow automated testing
- Extraction of elementary stream from transport stream
- Available as single user local license for PC and Tektronix instruments

Applications

This next generation compression ES analysis tool meets the needs of the following:

Equipment Manufacturers

- Semiconductor device designers and manufacturers
- Video codec software and hardware developers and verification engineers
- STB, PVR, and DVD consumer electronics developers and verification engineers for cable, satellite, terrestrial, and IP applications
- Video conferencing and communications equipment developers, and verification engineers
- Mobile video infrastructure and handset developers
- Systems engineering and customer support staff

Video Content Transmission Distribution

- CODEC and equipment evaluation and comparison in cable, satellite, terrestrial, and IP applications
- Network operators
- Network equipment providers
- Application and service providers
- Streaming media applications

Software, Hardware, and User Prerequisites

MTS4CC runs under the Microsoft Windows operating system and has been tested on:

- Windows XP (Home and Professional)
- Windows 2000 Professional

MTS4CC is not supported under any other operating system.

Audio Playout

In order to extract and play audio streams in MTS4CC the PC requires an audio device, correctly configured.

Personal Computer Prerequisites

MTS4CC will work satisfactorily on relatively modest PC systems (for example 800 MHz).

However, in order to decode and display CIF (Common Intermediate Format) video streams in real time the following minimum PC configuration is recommended for MPEG-4 and H.263 format video:

- Processor speed >1.2 GHz
- Memory at least 256 MB RAM
- Screen resolution: 1024 x 768 (recommended)
- 500 MB minimum hard disk space

For H.264/AVC with CIF-size video (and larger) and MPEG-2 with D1-size video (and larger) the processing requirements are significantly higher and therefore a higher performance PC is required to display the video in real time: for these a PC with processor speed of at least 2.5 GHz is recommended.

When writing trace information to the hard disk, the limiting factor is the speed of the hard disk (regardless of the video standard), so the faster the better. Also, the video files can be large (hundreds of MB), so that a large hard disk is needed:

- Hard disk speed: at least - 7200 rpm
- Hard disk size: as required for high-speed access to the video files to be analyzed

CAUTION. *Apart from those specifically authorized by Tektronix, there should be no other applications installed on the PC. If other applications are installed, it is possible that they may interfere with the operation of the MTS4CC software. Software operation cannot be guaranteed under these circumstances.*

MTS400 MPEG Test Systems

You can install the MTS4CC on the Tektronix MTS400 family of MPEG test systems. The installation procedure is described in the Section 4.

User Prerequisites

The MTS4CC is sophisticated compliance checking software, which presents detailed information relating to the video and audio standards.

To operate this software, you should understand audio and video standards in significant detail and be able to interpret the information presented by the MTS4CC.

A list of references are provided (see *Compression Standards and File Types*, Section 2).

MTS4CC Options

Table 1-1: License options

Item	Option	Description	
MTS4CC	-	Base software Compliance Checker. Includes Command line execution with report file output for batch mode operation. All container file types are included as standard. Includes English manual and CD-ROM.	
	PPD	Parallel Port software key (dongle)	Mandatory and mutually exclusive
	USB	USB software key (dongle)	
	LUD	Add MTS4CC to a current MTS400 MPEG Test system software key; please provide serial number of your software key with your order.	
	MPG4	MPEG-4 Simple Profile (Levels 0 to 3), Advanced Simple Profile (Levels 0 to 5), and H.263	
	MPG2	MPEG-2 Main Profile Main Level, 4:2:2 profile at Main Level, MPEG-2 Main Profile High Level, High Level 1440, and 4:2:2 profile at High Level	
	AVC	H.264/AVC Baseline, Main, and Extended Profiles (Levels 1 – 5), High Profile with FRExT (10 bit, 4:2:2, 4:4:4)	
	VC1	VC-1 (all Profiles, all Levels) and ASF extraction	
	FID	Fidelity (PSNR) analysis and visual differencing	

Note 1) At least one of the CODEC options MPG4, MPG2, AVC, and VC1 must be ordered.

Note 2) Full audio decode is enabled for any purchased video CODEC. Supported audio CODECS are MPEG-2 Layer 1 & 2, AAC, HE AAC, and AC-3.

Installation and Licensing

This chapter describes licensing and installation of MTS4CC.

License Types

To run MTS4CC, you will need a software key (dongle) with the correct license permissions.

Two types of software key are available; they perform the same function.

- Parallel port device - This plugs into the parallel port of your PC. If a printer is already attached to the port, the software key should be inserted between the port and the printer connector.
- USB device - This plugs into a standard USB socket.

NOTE. *The software key contains the MTS4CC license. If the software key is lost, you will have to purchase another software key, which may be at full list price of the software.*

All options are visible in the installed MTS4CC menus. Options not enabled by the license will be unavailable (grayed out). The status and scope of the license can be checked at any time by clicking on the Help menu option License manager.

A node-locked license is locked to a particular PC, that is, MTS4CC will only run on the PC on which a software key is installed. When using node-locked licenses, each PC that is to run MTS4CC must have a separate node-locked license.

Installing the MTS4CC Software

1. Insert the MTS4CC installation CD.

NOTE. *If the installation process does not start automatically, run* `setup.exe` *from the root directory of the installation CD.*

2. At the bottom of the window showing the readme file, click the Install button to start the installation.
3. The MTS4CC installation will continue. When finished, reboot the machine.

Ensure that the software key (parallel port or USB) is installed before starting MTS4CC.

Compression Standards and File Types

This chapter provides:

- A description of the standards (and elements within those standards), that the MTS4CC supports, both video and audio
- The file types that the MTS4CC can work with, both video and audio
- The exact titles and numbers of the standards on which the MTS4CC is based

(For details of the given references, refer to the *Standards References* section on page 1-30.)

Supported Video Compression Standards

The video compression standards supported in this version of the MTS4CC are:

- H.264/AVC
- VC-1
- MPEG-4 Part 2
- MPEG-2 Part 2
- H.263

The MTS4CC will open container files (containing the above types of video):

- MPEG-2 Transport Stream (H.264/AVC, VC-1 Advanced profile, MPEG-2 Program Stream, MPEG-2 Packetized Elementary Stream, MPEG-2 Elementary Stream only)
- MP4 (MPEG-4 Part 2, H.263 Baseline only and H.264)
- 3GPP (MPEG-4 Part 2, H.263 Baseline only and H.264)
- VOB/MPEG-2 Program Stream (MPEG-2 only)
- Microsoft ASF files
- RCV files

The MTS4CC will also open uncompressed video files: see *Opening an Uncompressed Video File (any File Extension)* in the *Operating Basics* section for more information.

The MTS4CC will also open audio files of the standards given in *Supported Audio Compression Standards* on page 1-18, and container files that have these types of audio within them.

NOTE. *Not all container files support all types of audio listed under* Supported Audio Compression Standards *on page 1-18, see also* Permitted Audio Types/Format *on page 1-28.*

H.264/AVC

This version of MTS4CC supports the following elements of the H.264/AVC standard (see Reference [13]).

H.264/AVC Profiles, Levels. The following Profiles and Levels are supported:

- Baseline Profile
  - All Levels from 1 to 5.1 inclusive
- Extended Profile
  - All Levels from 1 to 5.1 inclusive
- Main Profile
  - All Levels from 1 to 5.1 inclusive
- High Profile
  - All Levels from 1 to 5.1 inclusive
- High 10-bit Profile
  - All Levels from 1 to 5.1 inclusive
- High 4:2:2 Profile
  - All Levels from 1 to 5.1 inclusive
- High 4:4:4 Profile
  - All Levels from 1 to 5.1 inclusive

H.264/AVC Tools. (See Reference [13] for a description of these tools.)

All tools are supported, as permitted in the H.264/AVC standard, listed below.

Tool	Baseline	Extended	Main	High	High 10	High 4:2:2	High 4:4:4
Profile and level indications:							
profile_idc	66	88	77	100	110	122	144
constraint_set0_flag	1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1
constraint_set1_flag	0 or 1	0 or 1	1	0 or 1	1	1	1
constraint_set2_flag	0 or 1	1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1
constraint_set3_flag	0 or 1	0 or 1	0 or 1	0	0	0	0
level_idc	10 - 51	10 - 51	10 - 51	10 - 51	10 - 51	10 - 51	10 - 51
Slice types:							
I	Yes	Yes	Yes	Yes	Yes	Yes	Yes
P	Yes	Yes	Yes	Yes	Yes	Yes	Yes
B	No	Yes	Yes	Yes	Yes	Yes	Yes
SP	No	Yes	No	No	No	No	No
SI	No	Yes	No	No	No	No	No
NAL unit types:							
1 - coded slice of a non-IDR picture	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2 - coded slice data partition A	No	Yes	No	No	No	No	No
3 - coded slice data partition B	No	Yes	No	No	No	No	No
4 - coded slice data partition C	No	Yes	No	No	No	No	No
5 - coded slice of an IDR picture	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6 - supplemental enhancement information	Yes	Yes	Yes	Yes	Yes	Yes	Yes
7 - sequence parameter set	Yes	Yes	Yes	Yes	Yes	Yes	Yes
8 - picture parameter set	Yes	Yes	Yes	Yes	Yes	Yes	Yes
9 - access unit delimiter	Yes	Yes	Yes	Yes	Yes	Yes	Yes
10 - end of sequence	Yes	Yes	Yes	Yes	Yes	Yes	Yes
12 - end of stream	Yes	Yes	Yes	Yes	Yes	Yes	Yes
13 - filler data	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Structural:							
data partitioning (NALU type 2-4)	No	Yes	No	No	No	No	No
interlace (frame_mbs_only_flag)	No	Yes (L2.1 - 4.1)	Yes (L2.1 - 4.1)	Yes (L1-2 & 4.2 - 5.1)	Yes (L1-2 & 4.2 - 5.1)	Yes (L1-2 & 4.2 - 5.1)	Yes (L1-2 & 4.2 - 5.1)
arbitrary slice order	Yes	Yes	No	No	No	No	No
slice groups (num_slice_groups_minus1)	1 - 8	1 - 8	1	1	1	1	1
redundant coded pictures (redundant_pic_cnt_present_flag)	Yes	Yes	No	No	No	No	No
Weighted prediction:							
weighted_pred_flag	0	=> 0	=> 0	=> 0	=> 0	=> 0	=> 0
weighted_pred_idc	0	=> 0	=> 0	=> 0	=> 0	=> 0	=> 0
Entropy coding (entropy_coding_mode_flag):							
CAVLC	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CABAC	No	No	Yes	Yes	Yes	Yes	Yes

Tool	Baseline	Extended	Main	High	High 10	High 4:2:2	High 4:4:4
B frames:							
direct_8x8_inference_flag	n/a	1	0 (L1-2.2) 1 (L3-5.1)	1 (L3–5.1)	1 (L3–5.1)	1 (L3–5.1)	1 (L3–5.1)
MinLumaBiPredSize	n/a	8x8 L3.1 - 5.1	8x8 L3.1 - 5.1	8x8 L3.1 -5.1	8x8 L3.1 - 5.1	8x8 L3.1 - 5.1	8x8 L3.1 - 5.1
Fidelity range:							
chroma format (chroma_format_idc)	0	0	0	0 - 1	0 - 1	0 - 1	0 - 3
bit depth (bit_depth_luma_minus8, bit_depth_chroma_minus8)	0	0	0	0	0 - 2	0 - 2	0 - 4
transform bypass (qpprime_y_zero_transform_bypass_flag)	0	0	0	0	0	0	0 or 1

No = not allowed; n/a = not applicable

VC-1

This version of MTS4CC supports the following elements of the VC-1 standard (see Reference [17]).

VC-1 Profiles, Levels. The following Profiles and Levels are supported (this is all Profiles and all Levels):

- Simple Profile:
  - Low
  - Medium
- Main Profile:
  - Low
  - Medium
  - High
- Advanced Profile:
  - L0
  - L1
  - L2
  - L3
  - L4

MPEG-4

This version of MTS4CC supports the following elements of the MPEG-4 standard (see Reference [1]).

NOTE. *The MTS4CC support for MPEG-4 has been updated to the 2004 version of the MPEG-4 standard, which has a number of differences from the previous version.*

MPEG-4 Profiles, Levels. The following Profiles and Levels are supported:

- Simple Profile:
  - Level 0 (see note below)
  - Level 1
  - Level 2
  - Level 3
- Advanced Simple Profile:
  - Level 0
  - Level 1
  - Level 2
  - Level 3
  - Level 3b (see Reference [6])
  - Level 4
  - Level 5
- Main Profile:
  - Level 2

NOTE. *Level 0, which is not in the MPEG-4 Standard Reference [1] is an addition to Simple Profile. Level 0 is targeted at mobile applications: for example, with a maximum picture size of QCIF and maximum frame rate of 15 frames per second.*

MPEG-4 tools. (See the following standard for a description of the MPEG-4 tools: MPEG-4 Part 2 (Visual), Reference [1] Table 9-1.)

For MPEG-4 Simple Profile, Advanced Simple Profile and Main Profile, the following tools are supported:

Tool	Simple Profile	Advanced Simple Profile	Main Profile
Basic: ▪ I-VOP ▪ P-VOP ▪ AC/DC prediction ▪ 4 Motion Vectors ▪ Unrestricted Motion Vectors	Y	Y	Y
Short header	Y	Y	Y
Error resilience: ▪ Slice Resynchronization ▪ Data Partitioning ▪ Reversible VLC	Y	Y	Y
B-VOPs		Y	N
Method 1/Method 2 quantization		Y	Y
Global Motion Compensation: ▪ Mode 0 ▪ Mode 1 ▪ Mode 2 ▪ Mode 3		Y	
Quarter Sample Motion Compensation (quarter pel)		Y	
Interlace		Y (L4, 5 only)	N

Means that this tool is not allowed in the profile concerned.

NOTE. *MPEG-4 Simple Profile Short Header is decoded by MTS4CC as H.263 Baseline, as defined by the MPEG-4.*

The following additional tools are not supported for Main Profile:

- P-VOP based temporal scalability:
  - Rectangular
  - Arbitrary shape
- Binary shape
- Gray shape
- Sprite

MPEG-2

This version of MTS4CC supports the following elements of the MPEG-2 standard (see Reference [14]).

MPEG-2 Profiles, Levels. The following Profiles and Levels are supported, subject to the restrictions given under *Permitted Audio Types/Format* on page 1-28.

- Main Profile:
  - Main Level
  - High Level
  - High Level 1440
- 4.2.2 Profile:
  - Main Level
  - High Level

MPEG-2 tools. For MPEG-2 Main Profile at Main Level, at High Level and at High Level 1440, the following tools are supported:

Tool	Main Level	High Level	High Level 1440
I-frames	Y	Y	Y
P-frames	Y	Y	Y
B-frames	Y	Y	Y
Field-coded pictures (Interlaced)	Y	Y	Y
Frame-coded pictures: With field or frame order MacroBlocks	Y	Y	Y

Tool	Main Level	High Level	High Level 1440
Layers: GOP Picture Slice MacroBlock Block	Y	Y	Y

NOTE. *Higher syntactic structures are also supported within MTS4CC - PES and VOB - see* MPEG-2 Higher Syntactic Structures *on page 1-22.*

H.263

The following H.263 standards are supported:

- H.263 baseline standard (see Reference [2]).

Supported Audio Compression Standards

MTS4CC supports audio extraction and playout.

Supported standards are:

- MPEG-1 Part 3 audio (see Reference [23])
- MPEG-2 Part 3 audio (see Reference [19])
- MPEG-2 Part 7 AAC (see Reference [20])
- MPEG-4 Part 3 audio (see Reference [21])
- Dolby Digital (AC-3) (see Reference [25])

MTS4CC also supports audio files in the following container formats:

- MPEG-4 Part 3 ADTS files (see Reference [22])
- MPEG-4 Parts 1 and 14 (see References [11] and [24])
- MPEG-2 Transport, Program, PES streams (see Reference [15])
- 3GPP (see Reference [12])

MPEG-1 Part 3 audio

MTS4CC supports the MPEG-1 Part 3 audio standard, as defined in Reference [23]. MTS4CC supports the following layers of this standard:

- Layer I
- Layer II

MTS4CC supports monophonic and stereophonic streams in this standard.

MPEG-2 Part 3 audio

MTS4CC supports the MPEG-2 Part 3 audio standard, as defined in Reference [19]. MTS4CC supports the extension of MPEG-1 part 3 audio to LSF (Low Sampling Frequency) for the following layers:

- Layer I
- Layer II

MTS4CC supports monophonic and stereophonic streams in this standard.

MPEG-2 Part 7 AAC audio

MTS4CC supports the MPEG-2 Part 7 AAC audio standard, as defined in Reference [20]. MTS4CC supports the following profiles of this standard:

- Main
- LC (Low Complexity)
- LTP (Long Term Prediction)

MTS4CC supports monophonic and stereophonic streams in this standard.

MPEG-4 Part 3 audio

MTS4CC supports the MPEG-4 Part 3 audio standard, as defined in Reference [21]. MTS4CC supports the following profiles of this standard:

- Main
- LC (Low Complexity)
- LTP (Long Term Prediction)
- HE-AAC (High Efficiency, 'AAC plus'), low complexity profile with SBR (Spectral Band Replication)

MTS4CC supports monophonic and stereophonic streams in this standard.

MPEG-4 Part 3 ADTS files

MTS4CC supports the Audio Data Transport Stream (ADTS) for AAC audio, as defined in Reference [22].

Permitted Video Types/Formats

MTS4CC analyzes and displays many file types, such as:

- Video files containing video Elementary Streams
- Container files, such as ASF files, RCV files, MP4/3GPP files, MPEG-2 Transport Streams, and MPEG-2 Program streams, which include video, audio and other data
- MTS4CC Trace files (which have a .vpt file extension)
- Uncompressed video files, such as YUV, RGB or grayscale color models, 8-16 bit sample depth, various chroma sub-sampling formats
- Any data file, using MTS4CC HexView (hexadecimal file viewer, on the Analysis menu)

The primary analysis functions of MTS4CC are performed on video Elementary Streams, and features are provided to extract these from within container files such as MP4 and 3GPP files.

Microsoft ASF Files

ASF files typically contain video, audio and other data. An ASF file can contain more than one video stream (see Reference [18]).

RCV Files

RCV files contain video in the VC-1 format (see Reference [17]).

MP4 Files

MP4 files typically contain video, audio, and other data. An MP4 file can contain more than one video stream; these streams can be located consecutively or split up in many areas of the MP4 file.

The MP4 files that the MTS4CC analyzes should conform to the relevant part of the MPEG-4 standard (see Reference [11]).

By default, the MTS4CC looks for MP4 files with an .mp4 file extension, although any file name can be used. The MTS4CC will determine that it is an MP4 file by looking through the file contents.

The video streams can be extracted from the MP4 file and analyzed directly, or extracted and analyzed later. For information on opening MP4 files, and extracting and saving the video streams, see *Open Stream* in the *Operating Basics* section. The structure of the MP4 file can be examined, using the View file structure option in the Analysis menu (see *View file structure* in the *Operating Basics* section for more information).

3GPP Files

3GPP files are a subset of MPEG-4 files, with an indicator in the file to denote that it is a 3GPP file.

3GPP files should conform to the standard concerned (see Reference [12]).

By default, the MTS4CC looks for 3GPP files with a .3gp file extension, although any file name can be used. The MTS4CC will determine that it is a 3GPP file by looking through the file contents.

The video streams are extracted from 3GPP files and analyzed directly or extracted and analyzed later in the same way as MP4 files. For information on opening 3GPP files and extracting and saving the video streams, see *Open Stream* in the *Operating Basics* section.

The structure of the 3GPP file can be examined, using the View file structure option in the Analysis menu (see *View file structure* in the *Operating Basics* section for more information).

MPEG-2 Transport Stream Files

MPEG-2 Transport Streams typically contain video, audio, and other data. (An MPEG-2 Transport Stream can contain more than one video stream – possibly hundreds. These streams can be located largely consecutively in the transport stream packets or split up in many areas of the transport stream.)

Transport streams with 188 bytes per packet, 196 bytes per packet, 204 bytes per packet, and 208 bytes per packet can be analyzed.

MPEG-2 Higher Syntactic Structures

MPEG-2 Program Stream and PES files. An MPEG-2 Program Stream contains one or more Packetized Elementary Streams (PES), with a common time base. (The Program Stream is designed for use in a relatively error-free environment.)

The format of the Program Stream is defined in Part 1 of the MPEG-2 standard (see Reference [15]).

A Program Stream can contain a complete Elementary Stream, or it can contain only part of an Elementary Stream.

MTS4CC will open MPEG-2 Program Stream files (typically with a file extension of .mpg) and display the structure of the Program Stream, such as the PES packets inside.

In accordance with the MPEG-2 standard (see Reference [15]), the Program Stream file will start with a 32-bit start code: 0x000001ba, 0000 0000 0000 0000 0000 0001 1011 1010.

MPEG-2 VOB files (DVD). VOB files are used on a DVD to store the video and audio; a VOB contains a Program Stream.

A single video Elementary Stream (for example, a movie) is usually distributed among a number of VOB files.

NOTE. *You can specify the different VOBs that contain a single Elementary Stream, so that the MTS4CC can extract the Elementary Stream from the different VOBs.*

MTS4CC will open MPEG-2 VOB files (typically with a file extension of .vob) and display the structure of the Program Stream, such as the PES packets inside (see Reference [16]).

NOTE. *When opening a VOB, there is no requirement that the VOB begins with an I-frame. In this situation, the video will not display correctly until an I-frame is reached.*

Encrypted (scrambled) VOBs cannot be opened.

Uncompressed Video File Format

The general uncompressed video file format is as follows:

- No headers of any kind (no file or frame headers)
- Concatenated planar image data
- Row raster order (top picture row first)
- Unsigned samples

For 8-bit sample depth:

- One byte per sample

For 9-16 bit sample depth:

- Two bytes per sample
- Both little- and big-endian byte orders supported

For YUV format:

- Concatenated Y, U, and V planes
- U and V planes sub-sampled as required
- Y plane samples are unsigned
- U and V plane samples are unsigned with a DC offset of 2^{n-1}, where *n* is the chroma sample bit depth

For RGB format:

- Concatenated R, G, and B planes

For grayscale format:

- Luma plane only

The uncompressed video file format is only applicable where the Fidelity option is licensed (see page 1-7).

Compressed Video File Format

The formats of the raw compressed video data files (for example called Elementary Streams, typically with a file extension of .m4v or .cmp in MPEG-4) that MTS4CC analyzes are defined in the relevant standards. Proprietary file formats are not supported.

This means that the compressed video file to be analyzed should not be an AVI file (which puts a wrapper around the encoded video and audio).

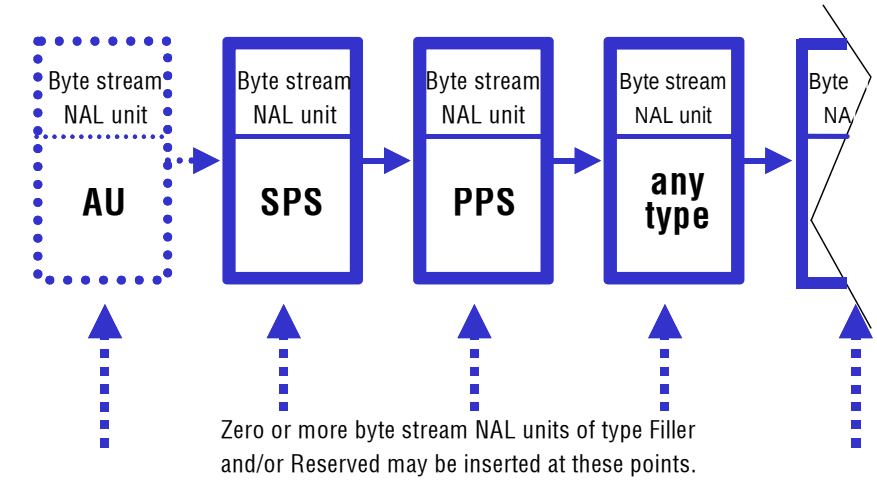
The compressed video elementary stream file cannot contain audio, although the original container file (such as MP4 or 3GPP) may have contained audio.

Once the video is extracted, the MTS4CC will automatically determine the format of the compressed video in the file by searching through the video and looking for the appropriate start codes. Accordingly, the file name does not require a particular file extension to be decoded correctly.

H.264/AVC Byte Stream file format. In accordance with the H.264/AVC standard (see Reference [13]), the video file must start as given in the following diagram.

The abbreviations mean:

AU access_unit_delimiter_rbsp_nal_unit
SPS sequence_parameter_set_nal_unit
PPS picture_parameter_set_nal_unit



For example, if the bitstream does not contain the optional items at the start then the first six bytes in an Extended profile byte stream file will be:
00 00 00 01 67 58 (all values in hexadecimal).

VC-1 Advanced Profile and Elementary Stream file format. Within the VC-1 standard (see Reference [18]), only the Advanced Profile can exist as a separate Elementary Stream. (The Simple and Main Profiles are required to be part of a container file - such as RCV, ASF or MPEG-2 TS - so that the required header information is stored.)

MTS4CC fully supports the VC-1 implementations of the Simple, Main and Advanced Profiles in each standard.

(See the standards in Reference [17] for details of the start codes and syntax permissible for each of these.)

MPEG-4 Elementary Stream file format. In accordance with the MPEG-4 standard (see Reference [1]), the file will start with a valid header start code that contains configuration information such as:

	`visual_object_sequence_start_code`	(0xB0)
or	`visual_object_start_code`	(0xB5)
or	`video_object_layer_start_code`	(0x20 - 0x2F)
or	`video_object_start_code`	(0x00 - 0x1F)

For MPEG-4 Short Header video there is no header code other than the 22-bit start code:

- `video_plane_with_short_header()` (see below)

The start codes actually used will vary from one stream to another.

These start codes (except Short Header) may be followed by further configuration data until the start code for the video data is reached, which must start with one of the following functions:

- `Group_of_VideoObjectPlane()` start code: 0xB3
- `VideoObjectPlane()` start code: 0xB6

See the MPEG-4 standard Reference [1] (in section 6.1.2) for more information.

Note the entry points `MeshObject()` and `fba_object()` also given in section 6.1.2 of the MPEG-4 standard are not supported, but also these are non-allowable tools in the Profiles and Levels supported by MTS4CC.

This means that for

- `Group_of_VideoObjectPlane()`
- `VideoObjectPlane ()`

the 24 bits in the video file before the start code must be the Start Code Prefix: 0000 0000 0000 0000 0000 0001. This is then followed by the 8-bit start code value.

MPEG-2 Elementary Stream file format. In accordance with the MPEG-2 standard (see Reference [15]), the Elementary Stream file will start with a 32-bit start code: Hex: 0x000001b3; Bin: 0000 0000 0000 0000 0000 0001 1011 0011.

H.263+, **H.263 file format**. The first bits in an H.263 compressed file should be the 22-bit PSC (Picture Start Code): 0000 0000 0000 0000 1000 00.

Source Video Format

The compressed video file format means that when the video was encoded, the uncompressed source format of the video file to be encoded should have been YUV 4:2:0; that is, with 4 bytes of Y data (luminance) for every 1 byte of U and 1 byte of V data (color differences). The color difference data is sub-sampled by 2 in horizontal and vertical directions.

For H.264/AVC High Profiles, the following alternative image formats are also supported:

- YUV, RGB or grayscale color models
- Alternative YUV chroma sub-sampling: 4:2:0, 4:2:2, or 4:4:4
- Alternative image sample bit depths: from 8 to 12 bits

It is up to the encoder to take the input data and order it correctly, so that in the compressed bitstream, the pixel data must appear with the top left pixel first, followed by the pixel to the right. If the video data stream input to the encoder does not follow this order then it is up to the encoder to reorder the data.

Video Image Size

The maximum size of the video images that can be analyzed within MTS4CC is effectively 16384x16384 pixels.

For each standard, there is a maximum size and within this limit, MTS4CC will analyze video to the maximum size allowed in the video standard concerned, for example:

- 4096 pixels wide x 2304 pixels high in H.264/AVC
- 1920 pixels wide x 1088 pixels high in MPEG-2 Main Profile @ High Level

There is no minimum size for video images.

Video File Size

The maximum video file size that can be analyzed is effectively limited only by the disk space on your computer.

MTS4CC will open the first part of the video file and start playing and analyzing this immediately if possible. In some cases, MTS4CC must search through a certain amount of the file before there is sufficient data for display.

In addition, the results from analysis of the input video file are cached in MTS4CC memory in the Step-back buffer. If the results for the section of video to be displayed/analyzed are not in the cache, then this is indicated on-screen and MTS4CC will pause while loading the relevant data in the cache.

PAL/NTSC

Both PAL and NTSC format video can be analyzed with MTS4CC.

Permitted Audio Types/Format

Audio is supported under the following container formats, as described in the previous section:

- MPEG-4 Part 3 ADTS files
- MPEG-2 Transport Stream, Program Stream, Packetized Elementary Stream (PES)
- 3GPP
- MP4

MPEG-2 Transport Stream files

MPEG-2 Transport Streams typically contain video, audio, and other data. (An MPEG-2 Transport Stream can contain more than one video stream – possibly hundreds. These streams can be located largely consecutively in the transport stream packets or split up in many areas of the transport stream.)

Transport streams with 188 bytes per packet, 196 bytes per packet, 204 bytes per packet, and 208 bytes per packet can be analyzed.

MPEG-2 Program Stream and PES files

An MPEG-2 Program Stream contains one or more Packetised Elementary Streams (PES), with a common time base. (The Program Stream is designed for use in a relatively error-free environment.)

The format of the Program Stream is defined in Part 1 of the MPEG-2 standard (see Reference [15]).

The MTS4CC will open MPEG-2 Program Stream files (typically with a file extension of .mpg) and display the structure of the Program Stream, such as the PES packets inside.

In accordance with the MPEG-2 standard (see Reference [15]), the Program Stream file will start with a 32-bit start code: 0x000001BA, for example, 0000 0000 0000 0000 0000 0001 1011 1010

3GPP files

3GPP files are a subset of MPEG-4 files, with an indicator in each 3GPP file to denote that it is a 3GPP file.

3GPP files should conform to the standard concerned (see Reference [12]).

By default, the MTS4CC looks for 3GPP files with a .3gp file extension, although any file name can be used; the MTS4CC will determine that it is a 3GPP file by looking through the file contents.

The audio streams are extracted from 3GPP files and analyzed directly or extracted and analyzed later in the same way as for MP4 files. For information on opening 3GPP files, and extracting and saving the audio streams see the *Operating Basics* section.

The structure of the 3GPP file can be examined, using the View file structure option on the Analysis menu: see the *Operating Basics* section for more information.

MP4 files

The MP4 files that the MTS4CC analyzes should conform to the relevant part of the MPEG-4 standard (see Reference [11]).

By default, the MTS4CC looks for MP4 files with an .mp4 file extension, although any file name can be used. The MTS4CC will determine that it is an MP4 file by looking through the file contents.

The audio streams can be extracted from the MP4 file and analyzed directly, or extracted and analyzed later. For information on opening MP4 files and extracting and saving the audio streams see the *Operating Basics* section.

The structure of an MP4 file can be examined, using the View file structure option on the Analysis menu; see the *Operating Basics* section for more information.

Standards References

[1] MPEG-4 Part 2 (Visual): standard number ISO/IEC 14496-2:2004; ISO title: Information technology - Coding of audio-visual objects: Part 2: Visual, 3rd Edition 2004-06-01; plus 14496-2:2004 Technical Corrigendum 1 Published 2004-06-15

[2] H.263: Video Coding for Low Bit Rate Communication. International Telecommunication Union (ITU) 1998

[3] H.261: Video Codec for AudioVisual Services at px64 kbit/s. International Telecommunication Union (ITU) 1994

[4] MPEG-4 Video Verification Model version 18.0: document reference number ISO/IEC JTC1/SC29/WG11 N3908 dated January 2001

[5] MPEG-4 Part 2 (Visual) ISO/IEC 14496-2 Amendment 2, 2002-02-01: Streaming video profile (contains Advanced Simple Profile)

[6] MPEG-4 Part 2 (Visual) ISO/IEC 14496-2:2001 Final Draft Amendment 3 FDAM 3:2003(E): New levels and tools for MPEG-4 visual (contains Advanced Simple Profile Level 3b)

[7] MPEG-4 Part 2 (Visual) ISO/IEC 14496-2 Microsoft reference software: FDAM1-2.3-001213 version 2 dated July 3rd 2000

[8] MPEG-4 Part 4 (Conformance Testing) ISO/IEC Study of CD 14496-4 N3067 1999-03-18, Visual clause w3067_4(v)

[9] MPEG-4 Part 4 (Conformance Testing) ISO/IEC 14496-4 MPEG-4 Normative ISO bitstreams dated 05/11/2001, specified in sections 4.5.3.1 and 4.5.7 of Reference [8]

[10] MPEG-4 Part 4 (Conformance Testing) ISO/IEC 14496-4 MPEG-4 Donated bitstreams dated 14/07/2000, referred to in section 4.5.8 of Reference [8]

[11] MPEG-4 Part 1 (Systems) ISO/IEC 14496-1: Information technology - Coding of audio-visual objects: Part 1: Systems, 3rd Edition dated March 2002

[12] 3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Transparent end-to-end Packet-switched Streaming Service (PSS); Protocols and codecs (Release 5); reference 3GPP TS 26.234 V5.5.0 (2003-06)

[13] H.264/AVC Standard ISO/IEC 14496-10 (First Edition 2003-12-01): Information technology - Coding of audio-visual objects - Part 10: Advanced video coding with document JVT-K051 "Version 3 of H.264/AVC" dated 9 June 2004 (errata and Fidelity Range Extensions) and document JVT-L047d8 "Draft Text of H.264/AVC Fidelity Range Extensions Amendment" (AVC Amendment 1 Fidelity Range Extensions, Draft) dated 28 August 2004

[14] MPEG-2 Part 2 (Visual): ISO/IEC 13818-2 Second edition 2000-12-15 (2000 E): Information technology - Generic coding of moving pictures and associated audio information: Video with Amendment 1: Content description data (2001-12-15, corrected version 2002-08-01) and Technical Corrigendum 1 (published 2002-03-01)

[15] MPEG-2 Part 1 (Systems): ISO/IEC 13818-1 Second edition 2000-12-01 (2000 E): Information technology - Generic coding of moving pictures and associated audio information: Systems with Amendment 1: Carriage of metadata over ITU-T Rec. H.222.0 ¦ ISO/IEC 13818-1 streams (2003-08-01, corrected version 2003-10-15) and Technical Corrigendum 1 (published 2002-03-01) and Technical Corrigendum 2 (published 2002-12-01) and Amendment 3 Transport of AVC video data over ITU-T Rec. H222.0/ ISO/IEC 13818-1 streams, dated 2004-11-01

[16] DVD Standard for Video: DVD-Video Book Part 3: Video Specifications v1.1

[17] SMPTE "Proposed SMPTE Standard for Television: VC-1 Compressed Video Bitstream Format and Decoding Process" committee draft 2, revision 1, reference number SMPTE CD xxxM (otherwise referred to as VC-1)

[18] Advanced Systems Format (ASF) Specification: revision 01.20.02; Microsoft Corporation, June 2004

[19] MPEG-2 audio: ISO/IEC 13818-3:1998 Information technology -- Generic coding of moving pictures and associated audio information -- Part 3: Audio

[20] MPEG-2 AAC: ISO/IEC 13818-7:2004 Information technology -- Generic coding of moving pictures and associated audio information -- Part 7: Advanced Audio Coding (AAC)

[21] MPEG-4 AAC (AAC plus): ISO/IEC 14496-3:2001 Information technology -- Coding of audio-visual objects -- Part 3: Audio plus Cor1:2002, Cor1:2004, Cor2:2004, Amd1:2003, Amd2:2004, Amd3

[22] HE AAC codecs: ISO/IEC 14496-3:2001 Information technology -- Coding of audio-visual objects -- Part 3: Audio plus Cor1:2002, Cor1:2004, Cor2:2004, Amd1:2003, Amd2:2004, Amd3

[23] MPEG-1 audio: ISO/IEC 11172-3:1993 Information technology – Coding of moving pictures and associated audio for digital storage media at up to about 1.5Mbit/s – Part3: Audio

[24] MPEG-4 Part 14: ISO/IEC 14496-14:2003 Information technology -- Coding of audio-visual objects -- Part 14: MP4 file format

[25] Digital Audio Compression Standard (AC-3) ATSC A/52, (1995-12)

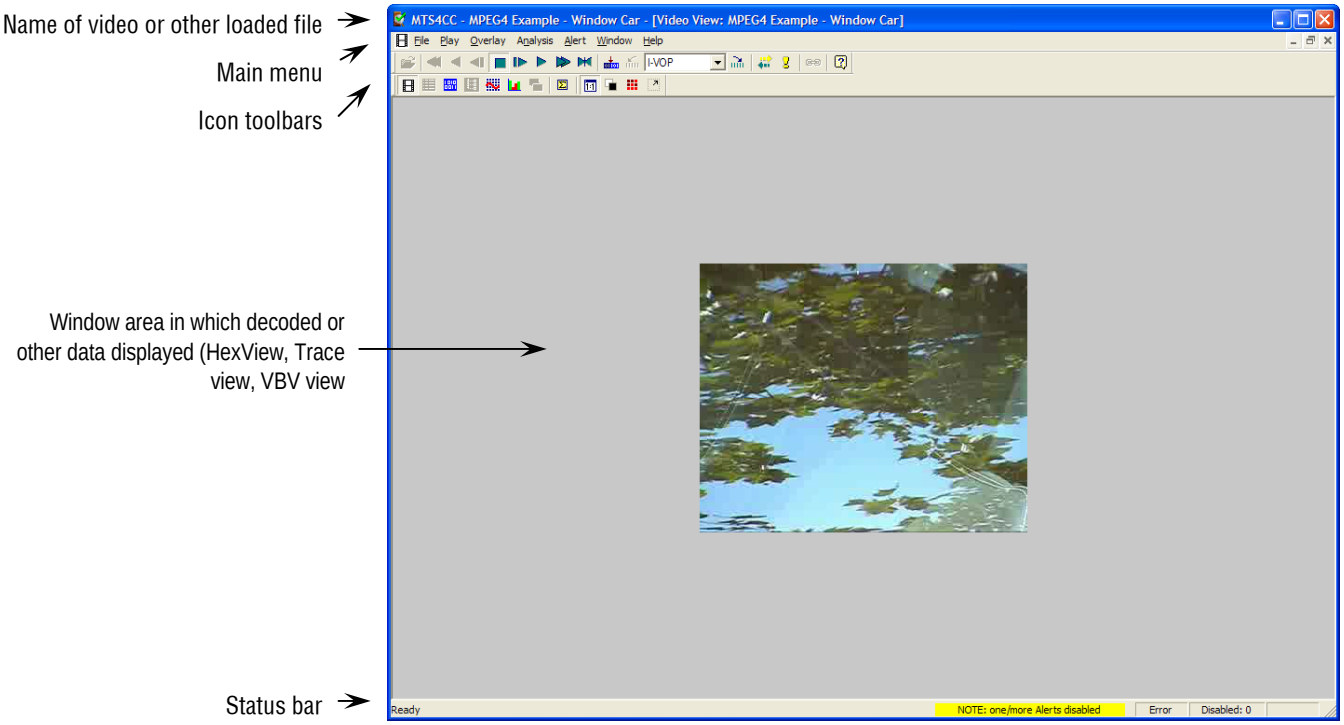
Operating Basics

How to Use the MTS4CC

This chapter:

- Describes the elements of MTS4CC display window (see *Window Elements*, page 2-2 and *Window Menu*, page 2-161)
- Tells how to start using MTS4CC display (see *Starting to Use the MTS4CC*, page 2-3)
- Describes each of the menu items in detail and how to use them
- Explains the use of the command line/batch mode (see *Command Line/Batch Mode Options*, page 3-1)

Window Elements

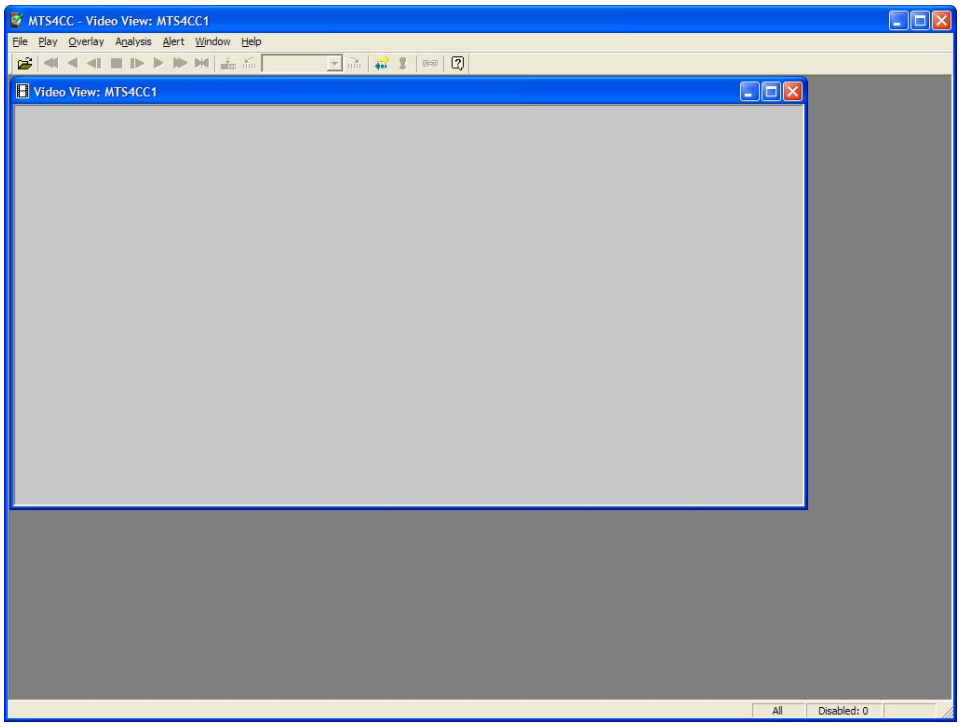


NOTE. *The preceding screenshot was taken with the MTS4CC running under Windows XP. When the MTS4CC is running under Windows 2000, there may be some visual differences in the borders, menus, and the way that pop-up menus appear from those shown in the screenshots. However, there are no functional differences in the way the MTS4CC operates on these different versions of Windows. (The desktop theme in use will also affect the look.)*

Several additional toolbars are visible when particular functions are enabled. Also, some toolbars, tooltips, and menu items are context-sensitive, depending on the video/audio standard being used and/or the function being performed.

Starting to Use the MTS4CC

When the MTS4CC starts, the display looks like the following figure:

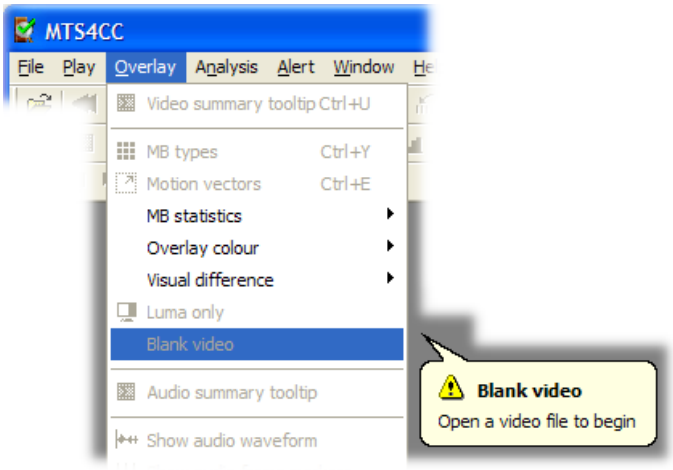


The gray background in the window indicates that no video or other files are loaded. The only icons on the toolbar that are currently enabled are the icons:

- Open stream...
- Help

NOTE. *Some features on some menus may stay permanently grayed out (unavailable). There are two possible reasons for this: the function or feature is never enabled or is not relevant to the standard you are using, or the existing license you have for MTS4CC does not allow all the features to be used.* See *the* Software, Hardware, and User Prerequisites *section for more information.*

When menu items are grayed out, leaving the mouse at the location of the grayed out menu item for a few seconds will display some popup text explaining why the menu item is disabled and/or how it can be enabled. The following example is on the Overlay menu, for the Blank video menu selection:



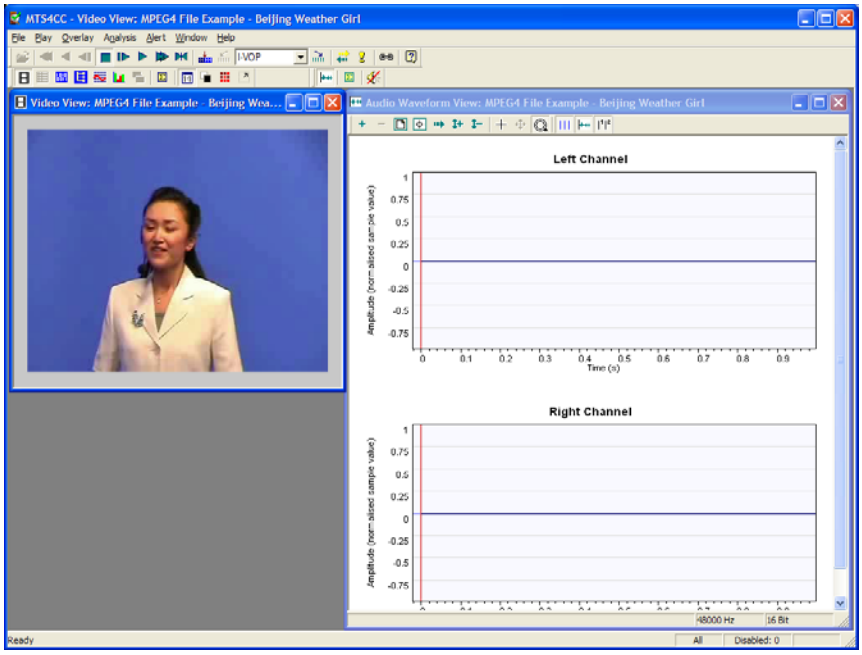
Opening a File

To open a file, do one of the following:

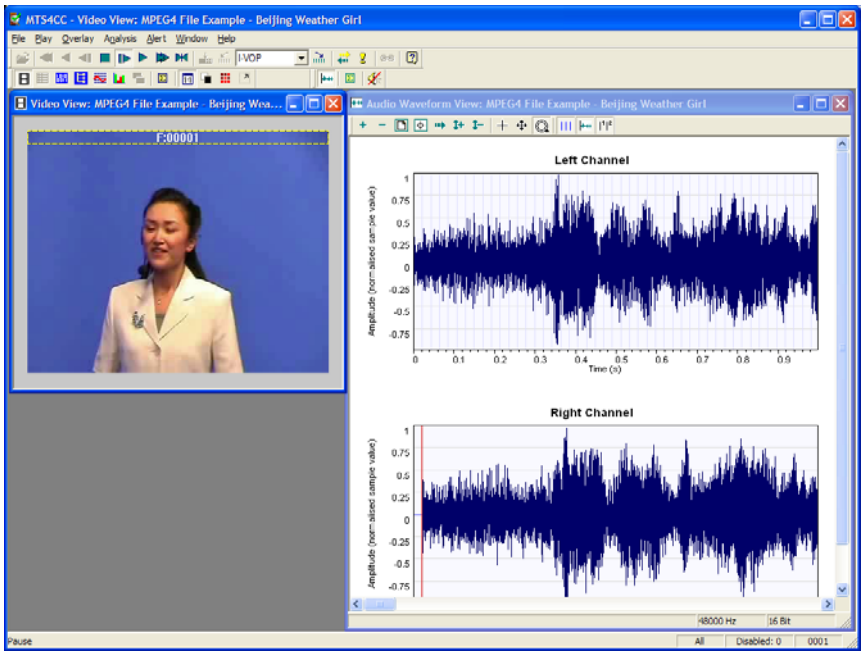
- Click on File > Open stream...
- Click the Open file icon
- Press Ctrl+O

When a stream is loaded, the first frame is decoded and displayed by the MTS4CC. While the first frame of the stream is displayed, the stream itself is not in Play mode, therefore Analysis options can be selected and configured.

In the following screenshot, the example file Beijing Girl is loaded with its first frame displayed, but as indicated by the Stop icon and the empty frame counter in the bottom right corner of the screen, the stream is yet to be played. Where there is audio content, the audio waveform view is also displayed.



If the loaded stream is initially advanced by one frame, the first frame is again decoded/played before entering the Pause mode. In this mode, Analysis options are not available. When stopped, the first frame reappears on the display until the stream is advanced/played further.



As is normal with Windows applications, the window can be dragged around within the frame of the application, resized, maximized, and minimized.

If another file is opened, it replaces the file last opened; another window is not opened.

NOTE. *You can open a number of copies of the MTS4CC to allow direct, side-by-side comparisons of multiple streams.*

Playing Mode: Restrictions

There are two Play modes: these are indicated at the lower left corner of the status bar:

- **Stop**: stream is stopped
- **Play**: stream is paused (after Pause/Step forward) or playing at normal speed, Fast forward, Blind, or Silent fast forward.

Certain actions can be performed only when the open file is in the appropriate Play mode. A few such examples are:

- The Trace options on the Analysis menu are only available in Stop mode
- The real-time onscreen image overlays, such as MB types (see *MacroBlock Types* on page 2-74) and motion vector overlay (see *Motion Vectors* on page 2-78) do not update the video window when in Stop mode

See *Audio/Video Synchronization* on page 2-43 for further information and details on playing audio and audio-video synchronization.

Synchronized Views/Navigating the Views

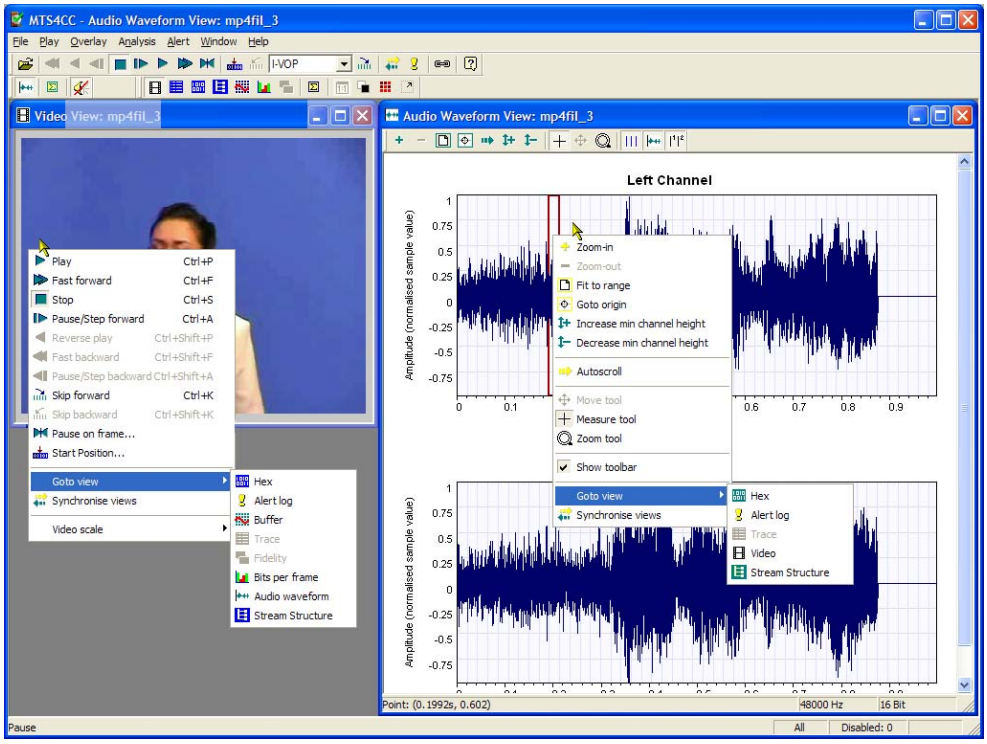
When a video or audio stream is played, MTS4CC has many views of the video, audio and other data:

- Alert log
- Video view
- Video hex view
- Buffer analysis view
- Fidelity view (for example, PSNR analysis)
- Bits per frame view
- Trace views

- Audio waveform views
- File structure view

Some of these views are linked. A right-click in one view will open a context menu with a Goto command that will take you to the corresponding location in another view (provided the file being played has both video and audio streams in order to bring up the Audio waveform view).

Example of Goto view menus:

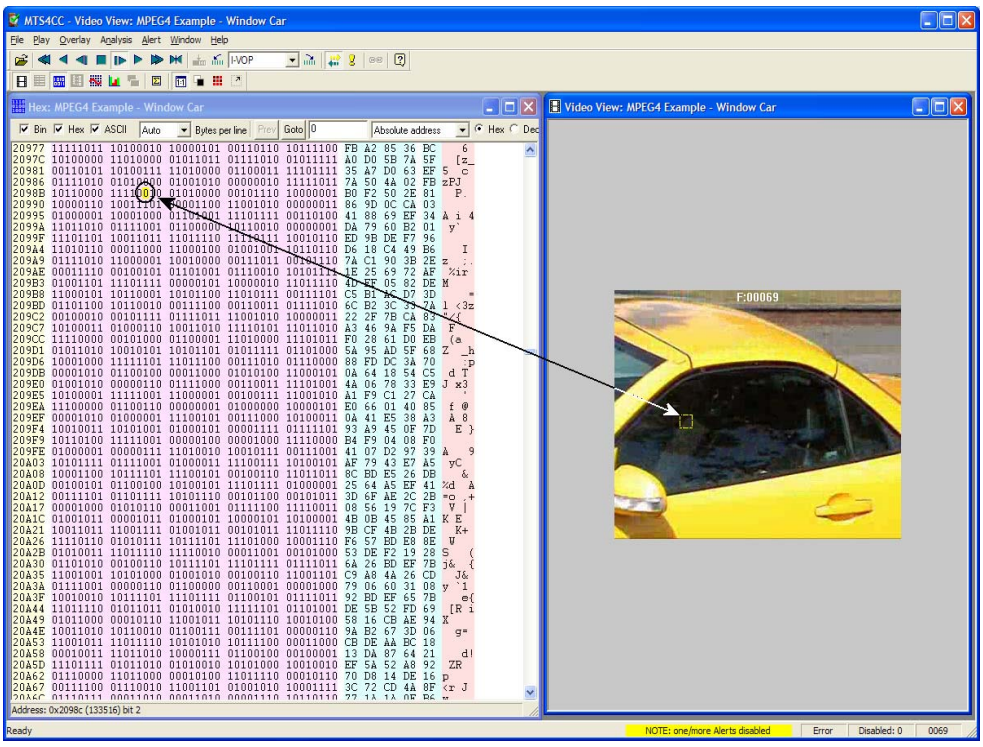


Example of moving between views. For example, when in the video view and using the MacroBlock tooltip, to see the hex/binary data for a specific MacroBlock, right-click at the MacroBlock location of interest, select the Goto option from the context menu, and then select the HexView. The HexView window opens (if it is not already open for this stream) and the first byte of the selected MacroBlock is highlighted.

Selecting a specific byte in the HexView, and then using the right-click context menu to select the Video view, will take the video window to the MacroBlock that contains the selected byte, with the MacroBlock highlighted (see *Highlighting of selected areas in the video view* on page 2-8).

Highlighting of selected areas in the video view. If a data area is selected in a view other than the video view, and the context menu is used to go to the video view, the corresponding area of the video view is highlighted, as follows:

- If the area can be resolved to a single MacroBlock, then a yellow and black dotted box is displayed around the MacroBlock concerned:



- If the area cannot be resolved to a single MacroBlock, then a yellow and black dotted rectangle is displayed surrounding the top row of MacroBlocks in the video frame that contains the first selected area.

- If the selected area is in a frame or file header, not within a specific MacroBlock, then a yellow and black dotted rectangle is displayed surrounding the top row of MacroBlocks in the video frame that immediately follows the frame or file header, see the preceding illustration: the data selected in the HexView window is in the VOP header, so the highlight rectangle is displayed across the top row of MacroBlocks of the corresponding VOP).

When the Black/White digits icon is pushed in, the video plays in black and white.

Highlighting of selected areas in the audio view. Highlighting selected areas in the audio waveform view works in a similar manner to highlighting areas in the video view (see page 2-8).

NOTE. *An audio frame consists of a fixed number (per channel) of audio samples representing a fixed time length of decoded audio. Typically each iteration through the decode loop will output one audio frame of decoded audio.*

Synchronization of views/Synchronize views icon. When the Synchronize views icon  is pushed in, all open windows automatically follow the selection that you made.

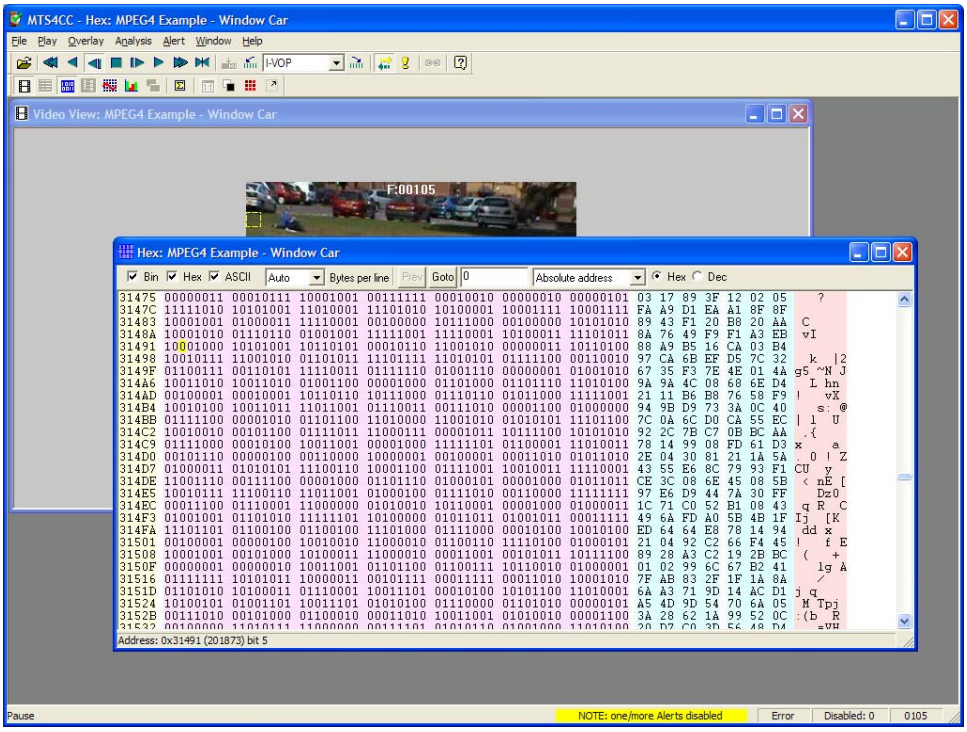
For example, if the Video and Hex views are both open at the same time as the Audio waveform view, and the Synchronize views icon is pushed in, if video is played, all views display the same relative points in the stream at the same time.

NOTE. *This can cause a delay when playing video for some views or when the memory buffers used by the MTS4CC do not contain all the required data and therefore time is taken to decode and interpret the video and refill the buffers.*

Opening Multiple Windows

Within the MTS4CC, it is possible to open many windows at once. These can be:

- A video/audio window with another window, such as a HexView window with a video window (as shown in the following figure):
- Other combinations, such as the video/audio and HexView with the Trace file view and file structure view.



To open windows other than for video files (or files that contain video, such as MP4 or 3GPP files, or MPEG-2 Program/Transport Streams):

- For Trace views, do one of the following:
  - Select File > Open other (or click the icon) to open a Fidelity Trace file that was previously stored or associated with another video stream
  - Select Analysis > View fidelity trace (or Ctrl+Shift+T) to open the current trace file, as named in the Analysis menu - Trace tab
- For HexView, click Analysis > View stream hex... (or click the icon or press Ctrl+H)

- For the stream structure view, click Analysis > View file structure... (or click the  icon or press Ctrl+R)
- For the buffer analysis view, click Analysis > View buffer analysis... (or click the  icon)
- For the fidelity analysis, click Analysis > View fidelity analysis... (or click the  icon)
- For the Alert Log, click Alert > View alert log... (or click the  icon)
- For the Audio waveform view, click the  icon. (If there is audio content, the toolbar and the view will be displayed automatically when the video view is opened.)

NOTE. *The Audio waveform view is available only when an audio stream or file/project containing an audio stream or streams is open.*

Main Menu

The submenu options that are available under each main menu selection (for example, File, Play, Overlay) are described in detail in their respective sections. A summary of each main menu item is given here.

Several of the common functions can be accessed through:

- The icon toolbars (see *Window Menu*, page 2-161)
- Ctrl keys (see *Ctrl Shortcut Keys* on page 2-180)

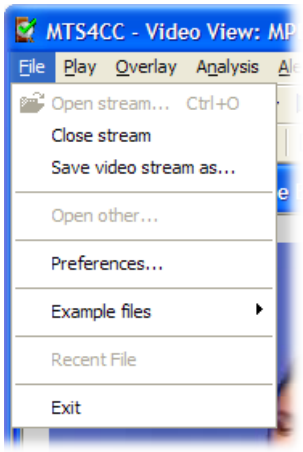
NOTE. *You can open a number of copies of MTS4CC to allow direct, side-by-side comparisons of multiple video streams.*

Summary of Function of each Main Menu Item

Main menu item	Principal functions/sub-options
File	Opening and saving files, recent file list, example files, exit
Play	Play video and audio, stop, pause, fast forward, set decoder options
Overlay	Hide/show video/audio data and tooltips
Analysis	Set Trace and Graph options; view Trace, Graph files, Hex view, file structures, buffer analysis, fidelity analysis
Alert	Enable/disable/configure overall alert levels and individual alerts
Window	Arrange windows and toolbars, view settings, synchronize views, window list
Help	Help topics, PDF help and tutorials, license manager, version info

File Menu

The following paragraphs describe the options that are available in the File menu.



Open Stream

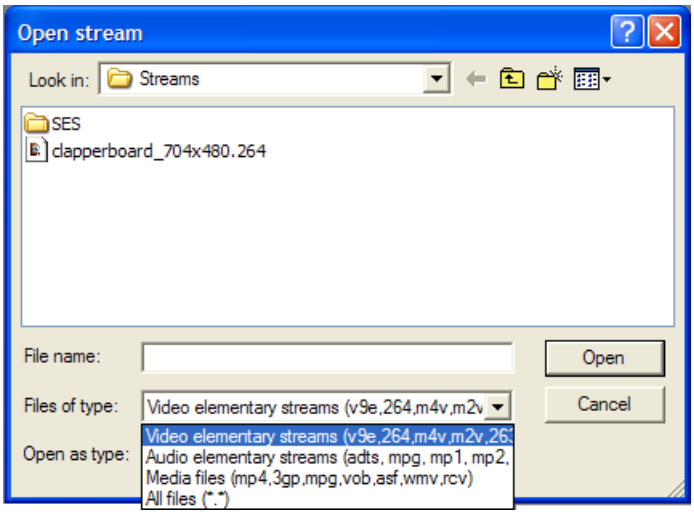
With this option, you can browse the file system to find a file to analyze. This file can be:

- A file containing only audio, for example, an MPG file
- A compressed video file that contains video data only, for example, an MPEG-4 video Elementary Stream (see *Compression Standards and File Types*, section 2).
- A container file that includes audio and transport information as well as video, for example MP4, 3GPP and MPEG-2 (see *Compression Standards and File Types*, section 2).
- An uncompressed video file, see *Opening an Uncompressed Video File (any file extension)* on page 2-24.

Autodetect File Type

When Autodetect is selected in the Open as type drop-down box, the file contents are automatically selected by the MTS4CC.

In this case, the Files of type drop-down list is simply used to narrow the list of file extensions searched for:



The default file extensions that the MTS4CC looks for are:

- For video-only files: .v9e, .264, .m4v, .m2v, .263, .261, .cmp, .bits
- For audio-only files: .adts, .mpg, .mp1, mp2, aac, ac3
- For container or media files including video: .mp4, .3gp, .mpg, .vob, .asf, .wmv, .rcv

With Autodetect selected, the MTS4CC will automatically override the Files of type selection and choose the standard to which the file is compressed.

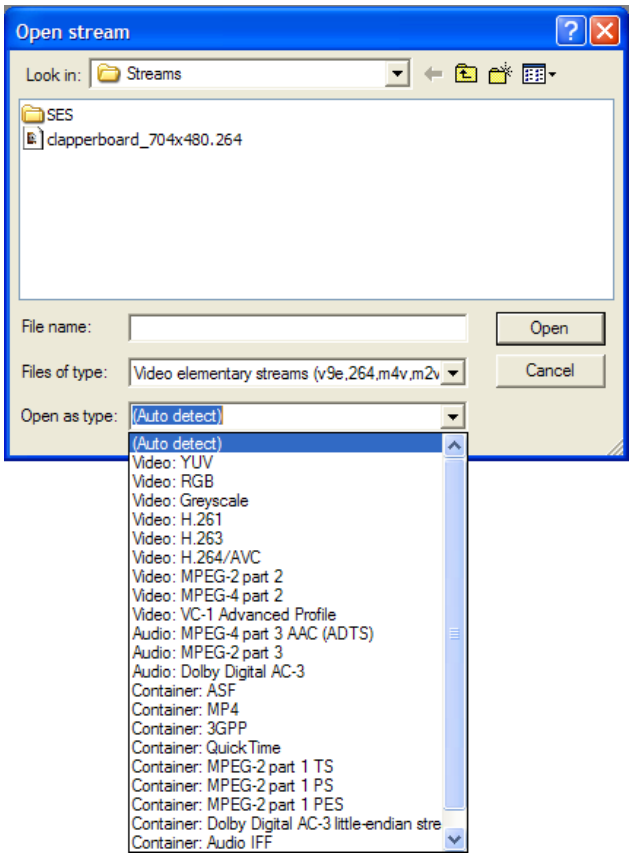
NOTE. *The exceptions to this autodetection are VOB files, where MTS4CC will take different actions due to the VOB extension (see* Open Stream *on page 2-13).*

The selected file extension is reinstated by the MTS4CC the next time a file is opened.

Force to Open as a Specific File Type

Sometimes, particularly if there are errors in a file, the autodetect function of the MTS4CC does not correctly identify the type of data contained in the file.

In this case, the file type can be forced by selecting a file type from the drop-down Open as type list. In this case, the file extension is ignored.



NOTE. *To open an uncompressed video file, select the appropriate item from the list and the MTS4CC will open the file in the appropriate format, regardless of the file extension or the data found in the file.*

Opening a Video/Audio Elementary Stream

When a raw video/audio elementary stream file is opened, initial checks are done on the file for validity and to determine the compression standard.

When the file has been read in correctly, the appearance of the Play icon on the toolbar changes from grayed out  to blue  , to indicate that the file is ready to play.

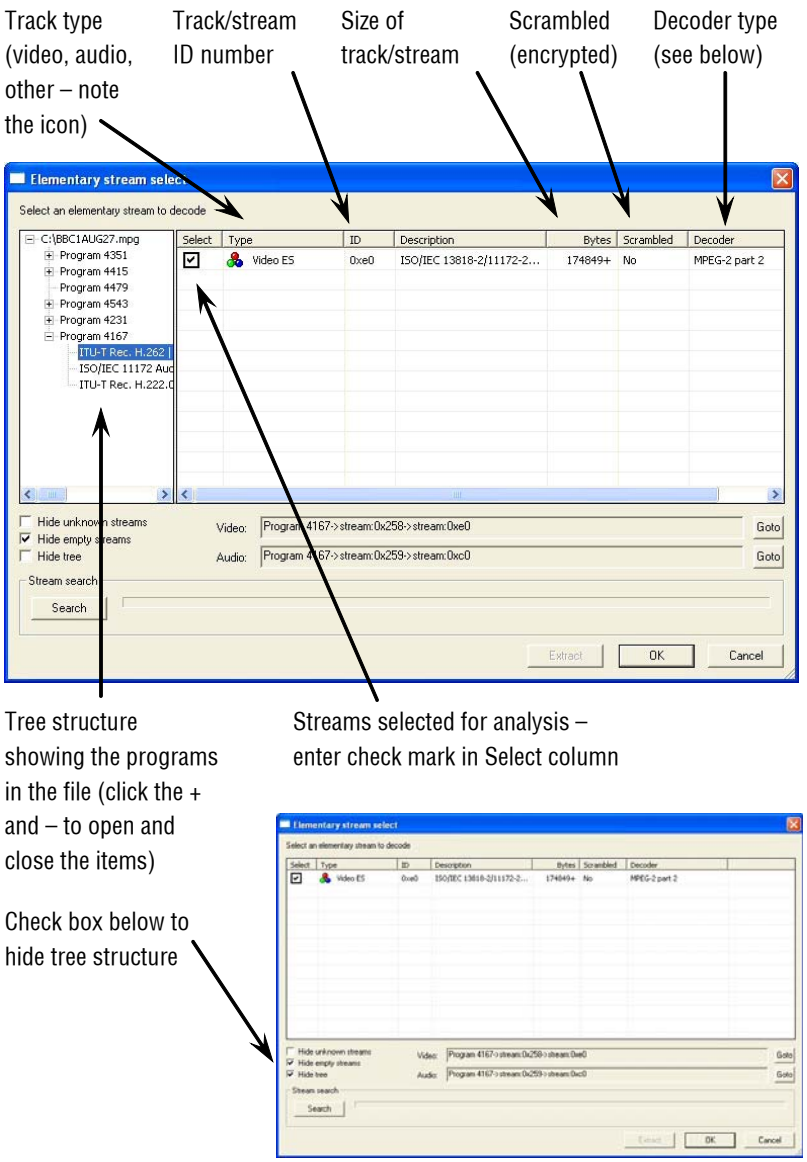
If MTS4CC recognizes that the open file includes an audio stream, the toolbar is displayed.

-  Opens the Audio waveform view (see *Show Audio Waveform*, page 2-91).
-  Turns the sound off/on: the stream continues to play and decode even when sound is disabled (see *Mute audio* on page 2-60).

If the file contains only audio data, the video toolbar will not be displayed. The Synchronize audio icon is also unavailable, because there is no video with which to synchronize (see *Audio/Video Synchronization* on page 2-43).

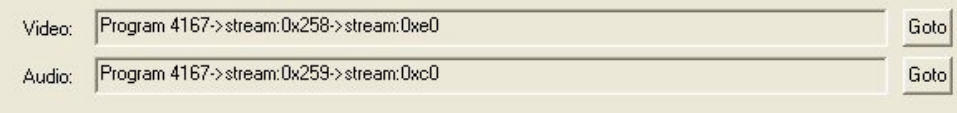
The title of the elementary stream is displayed in the title bar of the video and audio window.

Opening a Container File



When a container file is loaded, the MTS4CC automatically opens the Elementary stream select window (as shown in the preceding figure), which lists all streams, audio and video. The streams can be browsed, individually selected for analysis with your choice of decoder, and either immediately played and analyzed within the MTS4CC or extracted and saved to a file before going on to play/analyze them.

Select. To select an audio or video stream for analysis, enter a check mark in this column beside the desired stream. Its description appears in the Video or Audio fields under the browsing area (as shown in the following screenshot). Only one video and one audio stream can be selected; if a stream is selected and a check mark is subsequently entered beside another stream of the same type, the description will change to show the updated selection.



Clicking Goto will move the view in the browser window to the location in the tree structure containing that stream, where it can be deselected or the Decoder can be chosen from the drop-down menu (see the following definitions).

Type. This is the media stream type as identified by the container signaling information. If insufficient signaling information is present, this may show a general type such as Video ES (Elementary Stream), Audio ES, or, where the type is unknown, no text at all.

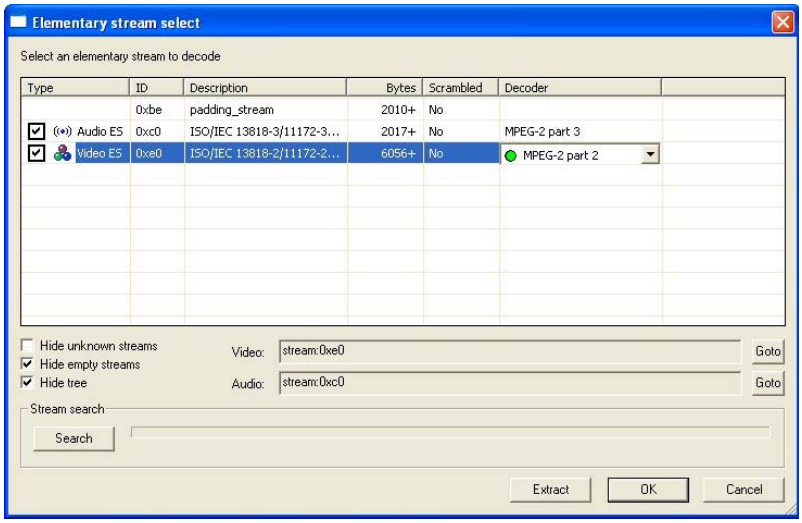
ID. This is the media-stream identifier as dictated by the container signaling information, using appropriate notation for the container standard.

Description. This is a description of the media stream as dictated by the container signaling information, incorporating text from the relevant standard.

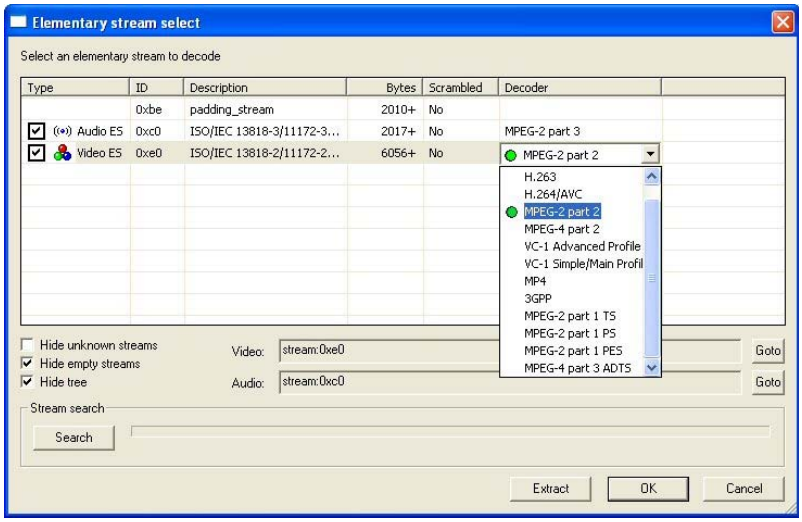
Bytes. This is the number of bytes that will be extracted for the stream. If the value is suffixed by a + sign, the total stream size is not known; without the + sign, this value is the final total.

Scrambled. This column shows Yes if the stream is scrambled or encrypted in some way. Scrambled streams cannot be decoded.

Decoder. Once a stream is selected, the decoder must be chosen. The Decoder column shows the decoder(s) found for the selected stream. There can be multiple streams containing video or audio, each with different decoders. If the Decoder column is empty, then the MTS4CC has been unable to match one of its decoders with the data it found.



Clicking the drop-down arrow shows a list of all the available decoders, with the decoder that has been autodetected shown by a green circle:

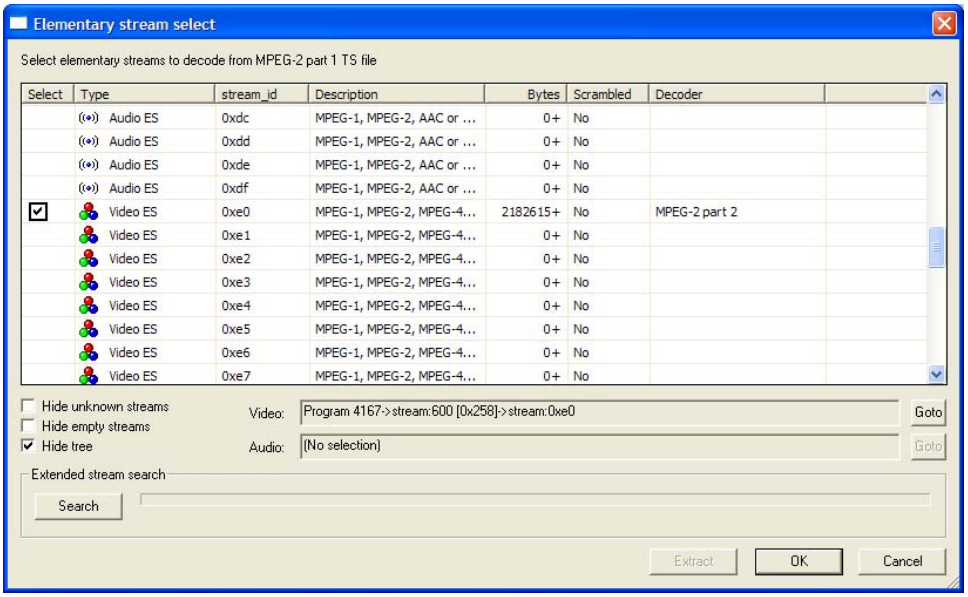


Selecting a different decoder forces the MTS4CC to use that decoder for this track/Elementary Stream.

Hide unknown streams. When Hide unknown streams is selected, the MTS4CC does not show the streams for which it has been unable to match one of its decoders.

When Hide unknown streams is enabled, the empty streams are also hidden, because they will not contain valid data for which the MTS4CC can select a decoder.

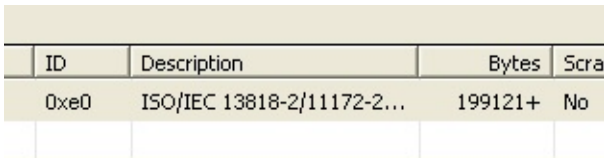
Hide empty streams. By default, this is enabled. When enabled, this hides streams that appear to be 0 bytes in size (note that these can still be searched to see if they are in fact larger - see below, under Search).



Search (Extended stream search). For some standards, the total size of the stream is indicated in the container file - for example, MPEG-4. In this case, the size of the elementary stream is shown.

However, for some container formats, the size of the elementary streams is not indicated in the container file, and the only way to learn the total size is by searching the entire file. (An example of this is MPEG-2 VOBs.)

For these types of files, the MTS4CC reads the first part of the file only, until an MTS4CC decoder can be matched with the data found. In this case, the MTS4CC will display the size in the Bytes column with a + sign to the right of the size, as shown in the following figure:

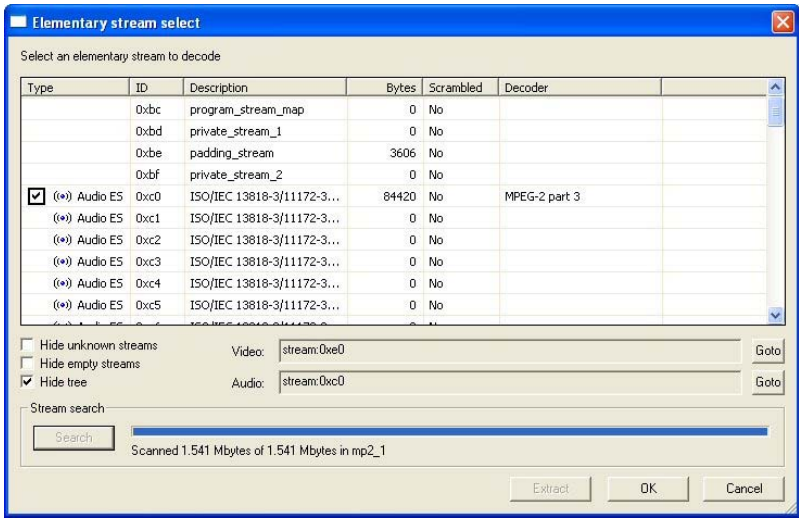


The + sign indicates that only part of the file has been searched and that there may be additional data.

NOTE. *This stream selection also means that other views, such as the HexView, may not show the data from the whole file (in which case, a warning is shown). See* View Video Stream Hex *on page 2-107 for more information.*

In order to find the total size of the whole file, and to search other streams, use the Search button. All streams, including the highlighted, or selected, stream, are then searched.

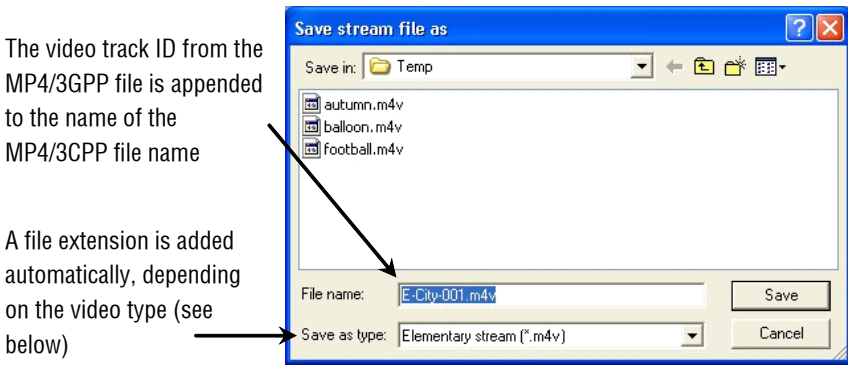
When the search is complete, the display will be similar to the following figure:



During the search, the blue progress bar fills, until the search is complete.

During the search process, the MTS4CC will search through all the linked files, and therefore may find other streams. The additional streams (and their sizes) will be shown in the stream window.

Extract. This allows the highlighted audio or video track to be saved as a separate elementary stream (in the following figure, .m4v is offered as the file type, because the container file is MP4):



NOTE. *If you play and analyze the selected stream immediately, and then decide to save it later, this can be done by clicking the* Save as... *option in the* File *menu (see* Save Video Stream As *on page 2-30).*

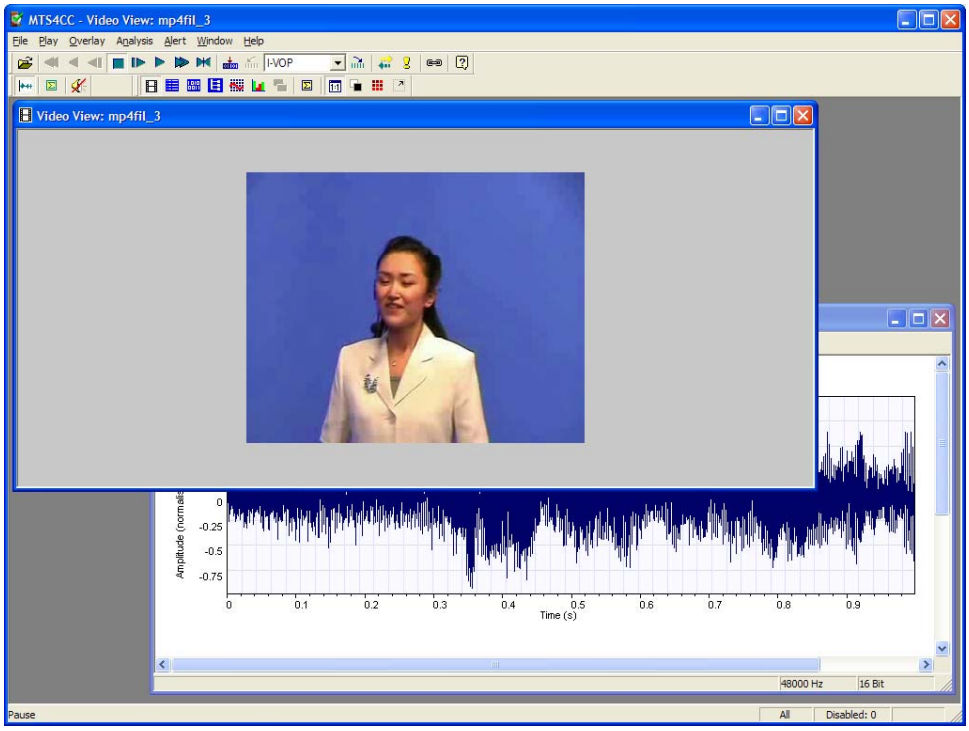
The correct type is automatically added as a file extension, depending upon the data in the file:

- H.264/AVC video format files are given the extension: `.264`
- VC-1 Advanced Profile video files are given the extension: `.v9e`
- MPEG-4 video format files are given the extension: `.m4v`
  (except for MPEG-4 Short Header, with extension `.263`)
- MPEG-2 video format files are given the extension: `.m2v`
- H.263 and MPEG-4 Short Header video format files are given the extension: `.263`

NOTE. *The suggested file name and extension do not have to be accepted - any file name and extension can be entered.*

OK. OK opens the selected stream using the decoder shown; if the OK button is grayed out, then the selected stream cannot be opened.

A window is opened with the title of the container file with the track/stream number.



Because the MTS4CC has recognized that the open file contains both audio and video streams, the video and the audio views are opened. The audio toolbar is also displayed and the synchronize is enabled (see *Synchronize audio*, page 2-60).

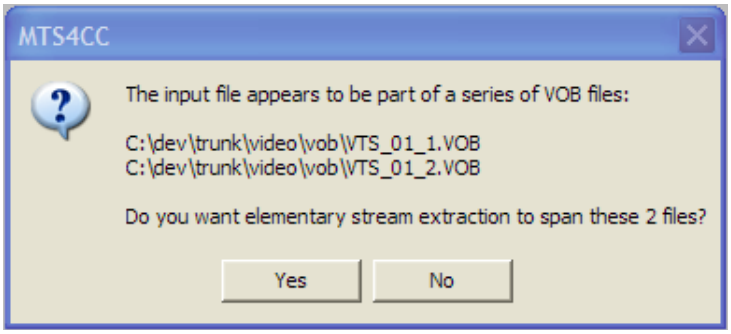
NOTE. *If you play and analyze the selected stream immediately, and then decide to save it later, this can be done by clicking the Save as... option in the File menu (see* Save Video Stream As *on page 2-30).*

To examine the structure of the file, click the View file structure... option on the Analysis menu (see View Video Stream Structure *on page 2-114).*

Opening a VOB/series of VOBs (.vob file extension)

NOTE. *This only applies to files with a VOB extension (the MTS4CC treats these files differently than files with other file extensions).*

If there are two or more VOBs with sequential numbers from the first VOB selected, then MTS4CC will display a message box:



Clicking Yes means that the MTS4CC will extract the video Elementary Stream from all the VOBs indicated; clicking No means that the MTS4CC will only select the Elementary Stream from the VOB selected in the File open dialog box.

After you click Yes or No, the MTS4CC opens the standard stream selection dialog box used for all container files (see *Opening a Container File* on page 2-17).

Opening an Uncompressed Video File (any file extension)

Uncompressed video files can be opened by selecting YUV, RGB, or grayscale in the Open as type list.

In each case the MTS4CC ignores the extension and *does not* look for a compressed video standard within the data - it assumes that the data is in one of the following formats.

The YUV data is either:

- 8 bits per sample, 4:2:0
- More than 8 bits per sample, and/or 4:2:2 or 4:4:4 (as used by H.264/AVC High 10, High 4:2:2 and High 4:4:4 profiles and MPEG-2 4:2:2 profile)

YUV format of 8 bits per sample 4:2:0. The YUV file output is raw YUV with no headers of any kind. This is the same format used by the Microsoft MPEG-4 Part 2 reference encoder Reference [7] (see *Compression Standards and File Types* section) and used commonly by other programs:

- No headers of any kind (no file or frame headers)
- One byte per sample
- Row raster order (top picture row first)
- Planar YUV 4:2:0 subsampled (4 bytes of Y data for each byte of U data and each byte of Y data)
- Y plane values are 0 - 255 unsigned
- U and V plane values are unsigned with a DC offset of 128

Other uncompressed formats. The general uncompressed video file format is as follows:

- No headers of any kind (no file or frame headers)
- Concatenated planar image data
- Row raster order (top picture row first)
- Unsigned samples

For 8-bit sample depth:

- One byte per sample

For 9-16 bit sample depth:

- Two bytes per sample
- Both little- and big-endian byte orders supported

For YUV format:

- Concatenated Y, U and V planes
- U and V planes subsampled as required
- Y plane samples are unsigned
- U and V plane samples are unsigned with a DC offset of 2^{n-1}, where n is the chroma sample bit depth

For RGB format:

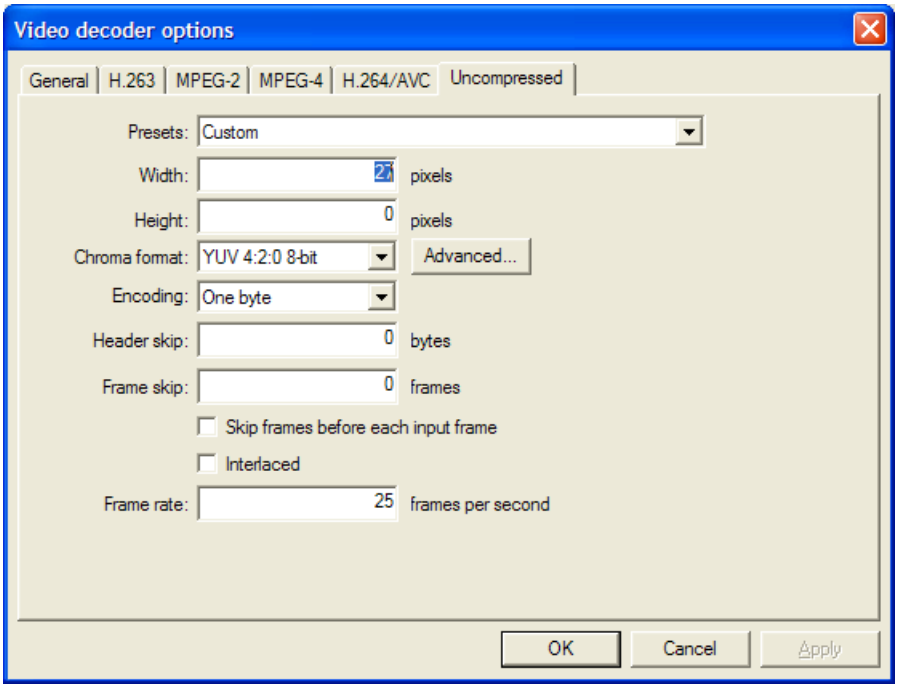
- Concatenated R, G and B planes

For grayscale format:

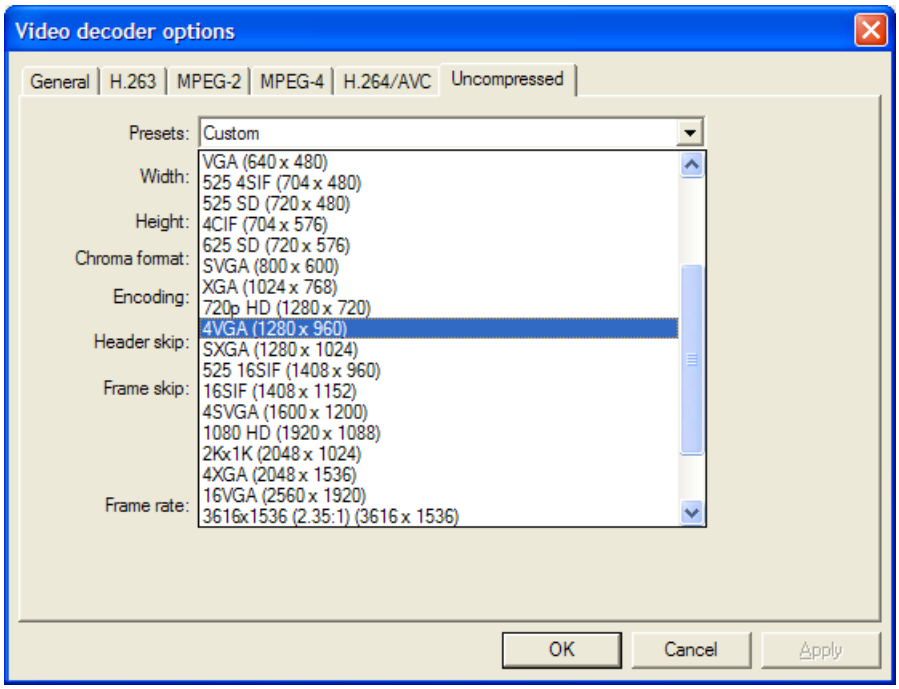
- Luma plane only

When opening an uncompressed video file, by default MTS4CC shows the uncompressed video decoder options, to enter the required parameters.

Setting the uncompressed video frame size. Within an uncompressed video file, there is no place to indicate the frame size, frame rate, and so forth. So when the uncompressed video file is opened, the MTS4CC will display the following screen (this is a tab of the Decoder options, which can also be accessed from the Play menu):



Presets (Width and Height). If there are numbers in the filename that could indicate the frame size, the MTS4CC will attempt to read these and offer these in the Width and Height fields shown in the previous figure. The correct values can be entered or selected using the drop-down list:



Chroma format. This control specifies the color model and format for the uncompressed video data. The combo provides several common combinations, including 8-bit YUV 4:2:0, 8-bit YUV 4:2:2, 8-bit YUV 4:4:4, 8-bit RGB and 8-bit grayscale. Select an entry from the list to use one of these common formats. Other formats can be specified by choosing the Custom entry in the list - this will open the Image format dialog.

Advanced… button. Click this button to specify a custom chroma format - this will open the Image Format dialog (see *Image format dialog box* on page 2-29).

Encoding. This control specifies the encoding of image samples in the file format. The following options are available:

- One byte - this specifies that image samples are stored in one byte per sample. This format is appropriate if all image planes are 8-bits deep.
- Two byte MSB first - this specifies that image samples are stored in a pair of bytes for each sample. The most significant byte occurs first in each pair (big-endian). This format is appropriate if one or more image planes are deeper than 8-bits.

- Two byte LSB first - this specifies that image samples are stored in a pair of bytes for each sample. The least significant byte occurs first in each pair (little-endian). This format is appropriate if one or more image planes are deeper than 8-bits.

Header skip. The number of bytes at the start of the file before the first frame; the MTS4CC will skip past these bytes (ignoring them).

Frame skip and Skip frames before each input frame. Frame skip is the number of frames (not bytes) to skip between each frame that is viewed in the video window.

By default, these frames are skipped after each viewed frame; by selecting the Skip frames box before each input frame, the number of frames is skipped before each viewed frame.

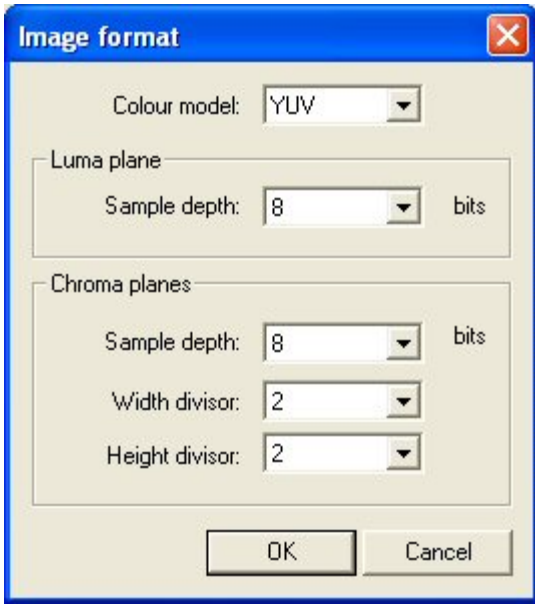
Interlaced. The uncompressed video file has interlaced data in the format of complete frames, with both fields within one frame, top-field first, each field on alternate lines.

Enabling this check box switches on the Interlace toolbar in the MTS4CC, which allows the two fields to be viewed independently, either one above the other (top field above bottom field) or either field with the field lines repeated to full frame height.

Frame rate. The rate at which to display the uncompressed frames, in frames per second.

NOTE. *The number entered in the Frame rate field can be an integer (for example, 30), a fraction (for example, 30000/1001), or a decimal number (for example, 29.97).*

Image format dialog box. The Advanced button opens the following window:



This dialog box allows you to specify a custom image format by choosing a color model, sample depths, and sub-sampling ratios.

Color model. Use this control to choose the class of color model for the image format. Options are YUV, RGB, and grayscale.

Sample depth. The sample depth controls are used to specify the number of bits per sample for each image plane. For RGB and grayscale, only one sample depth is specified. For YUV, the luma and chroma depths can be specified separately.

Width divisor. This control specifies the horizontal sub-sampling factor for YUV chroma planes. This option is only available for YUV color models. The value is the factor by which the image width is divided to find the chroma plane width.

Height divisor. This control specifies the vertical sub-sampling factor for YUV chroma planes. This option is only available for YUV color models. The value is the factor by which the image height is divided to find the chroma plane height.

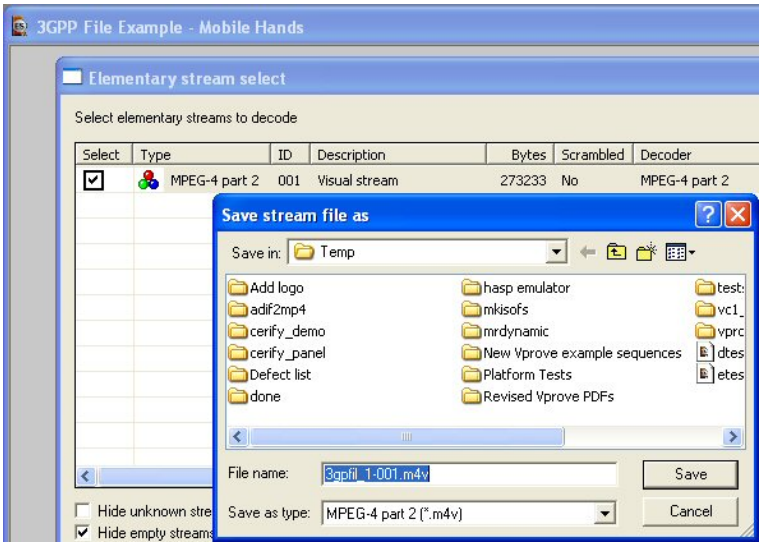
Close Stream

This allows you to close the current stream while keeping the MTS4CC window open.

Save Video Stream As

This allows the active file to be saved to a particular file name.

This is typically used to save a video elementary stream, when this has been extracted from an MP4, 3GPP, MPG (MPEG-2), ASF, or other file type, but was not saved at the time it was extracted
(see *Open Stream* on page 2-13):



In this example, the video elementary stream from E-City.mp4 video track 1 is being saved to an .m4v file: the -001 (for track 1) and .m4v are automatically added by MTS4CC (because MTS4CC knows this is a 3GPP file), although any file name and extension can be entered.

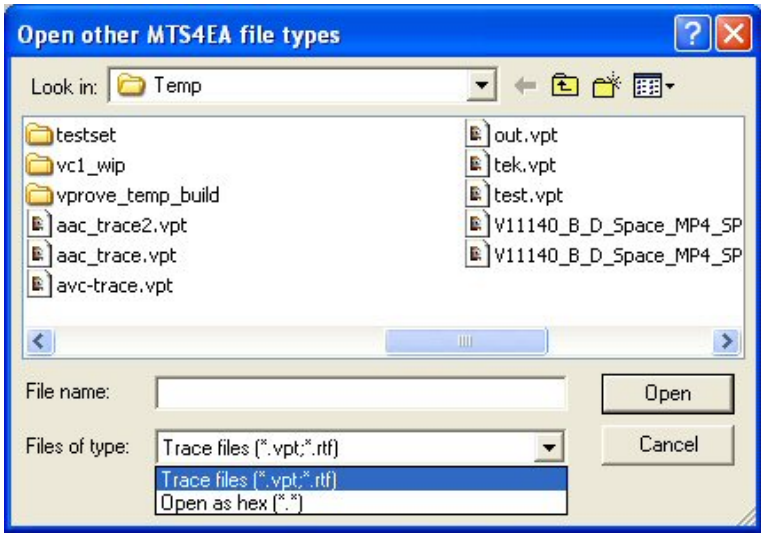
The video can also be saved as an uncompressed video file, in the format given in *Opening an Uncompressed Video File (any file extension)* on page 2-24.

NOTE. *The Save stream as... feature will save uncompressed video only if the input format was also uncompressed.*

Open Other

This allows you to browse the file system to find and open other file types, such as:

- The MTS4CC trace files, with the file extension .vpt or .rtf
- Any other file, to open in the HexView

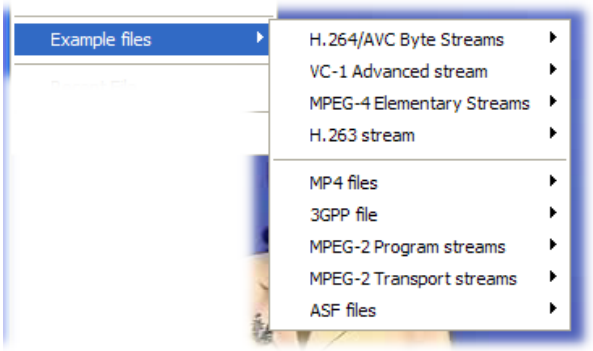


Preferences

The Preferences dialog box allows you to select the audio playback device. Your selection will depend on the your PC setup.

Example Files

Below this option are various example files that can be played/analyzed in the MTS4CC:



These are provided to give examples of various compressed files to experiment with and to compare with your own compressed files. Some of these are without error; others have known errors and generate appropriate Warning/Error messages (both as pop-up alerts and in the Trace files).

H.264/AVC Byte Streams

These are H.264/AVC compressed video Byte Streams; see *Compression Standards and File Types*, Section 2.

Four example files are provided:

Name	H.264 Profile/Level	Warnings/Errors
Neon Night	Baseline/2	- none -
Bus Junction	Baseline/3	Fails HRD conformance error (timing violation)
Grenadier Guards	Main/3	HRD buffer overflow in many frames (starting from frame 8)
Stripey Shirts	High 10	Maximum number of motion vectors per two consecutive MacroBlocks exceeded

NOTE. *A YUV reference file is provided for the first ten frames of the Grenadier Guards bitstream; this YUV reference file can be used for fidelity analysis and visual difference display.*

The filename is automatically filled in for the YUV reference file, but the frame rate must be set to 25.

VC-1 Advanced Profile Elementary Stream

This is a VC-1 format Advanced Profile compressed video Elementary Stream (as described in *Compression Standards and File Types,* Section 2). Advanced Profile of VC-1 is the only profile that can be a stand-alone Elementary Stream; the Simple and Main Profiles can only exist in an ASF file or in an .rcv file.

One example file is provided:

Name	VC-1 Profile	Warnings/Errors
Central Park	Advanced	Invalid value (reserved) and invalid VLC

MPEG-4 Elementary Streams

These are MPEG-4 compressed video Elementary Streams (as described in *Compression Standards and File Types,* Section 2).

Six example files are provided:

Name	MPEG-4 Profile	Warnings/Errors
Woman Drinking	Main	- none -
Train in Station	Main	- none -
Space	Simple	modulo time base Method 1 quant used
Man Walking	Advanced Simple/Level 0 (with B-VOPs, Method 1 quant)	VBV overflow
Synthetic	Advanced Simple/Level 2 (with B-VOPs, Method 1 quant, Quarter Sample)	VCV overflow
Window Car	Advanced Simple/Level 2 (with B-VOPs, Method 1 quant, GMC with 3 warping points, affine model)	stuffing bits VCV overflow

NOTE. *A YUV reference file is provided for the whole Man Walking bitstream; this YUV reference file can be used for fidelity analysis and visual difference display.*

The file name is automatically filled in for the YUV reference file, but the frame rate must be set to 30.

H.263 Streams

These are H.263 compressed video files (as described in *Compression Standards and File Types*, Section 2).

Three example files are provided:

Name	Standard/Annex	Warnings/Errors
Rally (250k)	H.263 baseline	(1) PSUPP is sent when file is H.263 baseline (non-critical warning but PSUPP field values only used in Annex L) (2) Invalid variable length code for MCBPC in the last frame (also causes Out of sync error and other consequential errors)

MP4 Files

These are MPEG-4 `.mp4` container files, containing compressed video and other data (as described in *Compression Standards and File Types*, Section 2).

Four example files are provided:

Name	Standard/Annex	Warnings/Errors
Packet Woman	MPEG-4 Simple Profile/Level 1	Level is set at 1; max. frame size in this Level is 176x144 pixels, but the video is 352x288 VCV overflow and VBV underflow
Piccadilly Circus	MPEG-4 Simple Profile/Level 2	VCV overflow and VBV underflow
Beijing Weather Girl	MPEG-4 Simple Profile/Level 5 (video); AAC LC (audio)	VBV overflow
Las Vegas	H.264/AVC Baseline Profile/Level 1.2	HRD information missing: no pic_timing SEI message

3GPP File

This is a 3GPP `.3gp` container file, containing compressed video and other data (as described in *Compression Standards and File Types*, Section 2).

One example file is provided:

Name	Standard	Warnings/Errors
Mobile Hands	MPEG-4 Simple Profile/Level 1	Reserved value for `Profile and level indication` (set to 0)

MPEG-2 Program Streams

Three MPEG-2 `.mpg` Program Streams are provided, containing compressed video and other data (as described in *Compression Standards and File Types*, Section 2).

These examples contain audio streams, but they are all silent.

Name	Standard	Warnings/Errors
Bus Junction	MPEG-2 Main Profile/Main Level	- none -
Person Track	MPEG-2 Main Profile/Main Level	Bad slice order Invalid VLC for `dct_differential`
Grenadier Guards	MPEG-2 Main Profile/Main Level	Numerator and denominator of `frame_rate_extension` are both set to 1 but, when equal, they must be set to 0: this also generates the errors of invalid values for `frame_rate_extension_d` and `frame_rate_extension_n`

NOTE. *A YUV reference file is provided for the first ten frames of the Grenadier Guards bitstream; this YUV reference file can be used for fidelity analysis and visual difference display.*

MPEG-2 Transport Streams

Two MPEG-2 `.m2t` Program Streams are provided, containing compressed video and other data (as described in *Compression Standards and File Types*, Section 2).

Four example files are provided:

Name	Standard	Warnings/Errors
Golden Gate	H.264/AVC Main Profile	Use of undefined `disable_deblocking_filter_idc` = 3
Mangroves	MPEG-2 Main Profile/Main Level	- none -
Captain Bob	MPEG-2 Main Profile/Main Level (video); MPEG-1 Audio Layer II (audio)	- none -

ASF files

Two Microsoft ASF files are provided, containing compressed video and other data (as described in *Compression Standards and File Types*, Section 2).

Name	Standard	Warnings/Errors
Beach Girl	VC-1 Simple Profile	- none -
Great Wall	VC-1 Simple Profile	- none -

Recent File

The program retains a list of the eight most recently used files, numbered 1 to 8. The recent files can be selected by highlighting them in turn.

Where a particular file could be opened in more than one view - for example, a video bitstream could be opened as a video file (in the video window) or opened in the HexView - the file is stored on the Recent File list with the last view type appended to the end:

filename.m4v [hex]	(this one is opened in the HexViewer)
filename.m4v	(this one is opened as a video file)
filename.adts	(this one is opened as an audio file)
filename.yuv [yuv]	(this one is opened as YUV video)

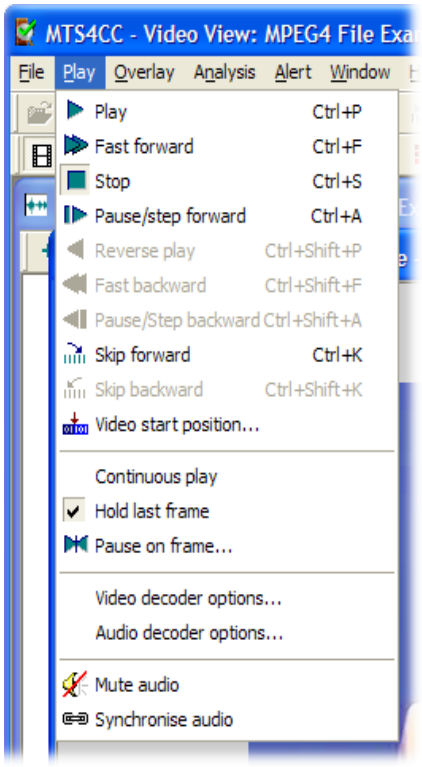
The MTS4CC then uses this information to determine in which window the file should be reopened.

Exit

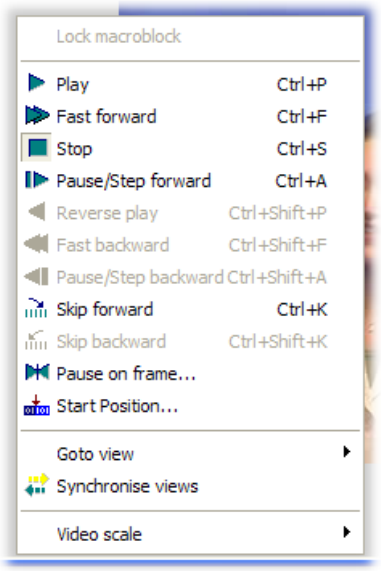
This option exits from the MTS4CC.

Play Menu

The following paragraphs describe the options available in the Play menu.



In addition to the menu selection, there is a right-click pop-up Play menu:

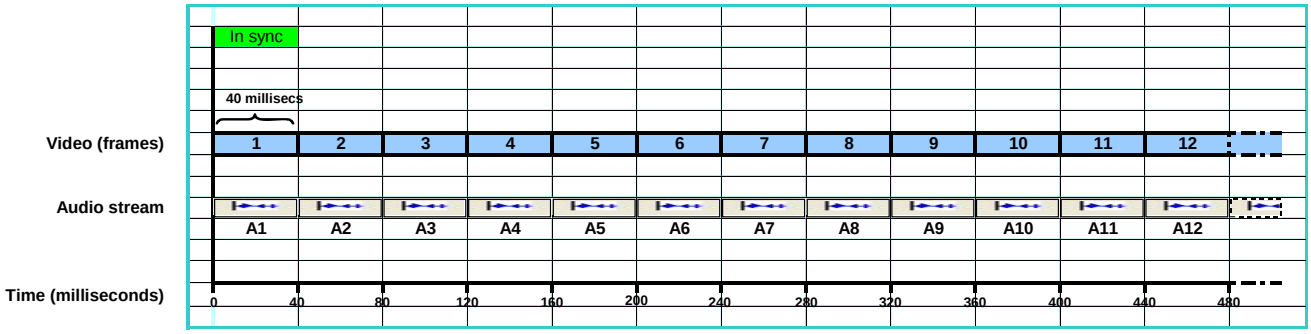


The functions of each of these Play menu items are explained on the following pages. (For an explanation of *Synchronized Views/Navigating the Views*, see page 2-6 and *Video Scale*, see page 2-175.)

Audio Sounds Broken Up

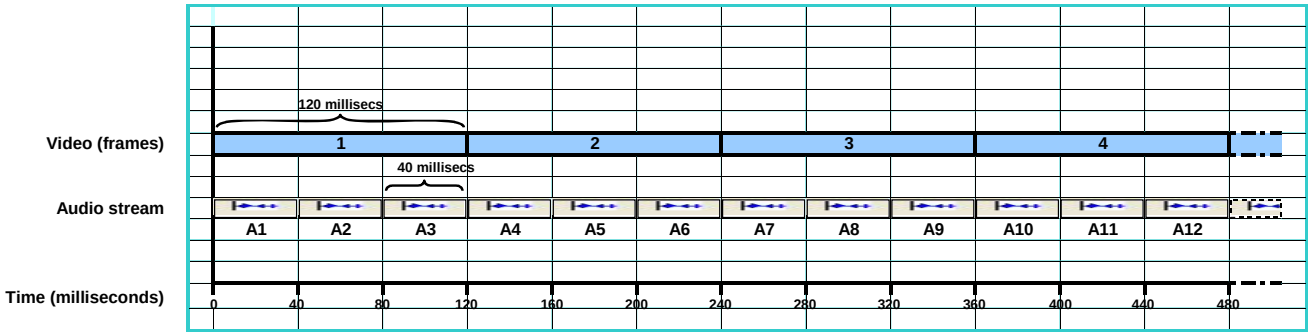
When a file containing both audio and video streams is played and the Audio synchronize function is engaged, if the PC is not sufficiently powerful, synchronization may not be possible and the resultant audio will be broken. The figures below describe, in simplified terms, how audio and video streams interrelate when decoded in the MTS4CC.

When the Synchronize audio icon is selected, and the requested synchronization is successful, the green display appears in the Status bar and the streams run concurrently in real time.



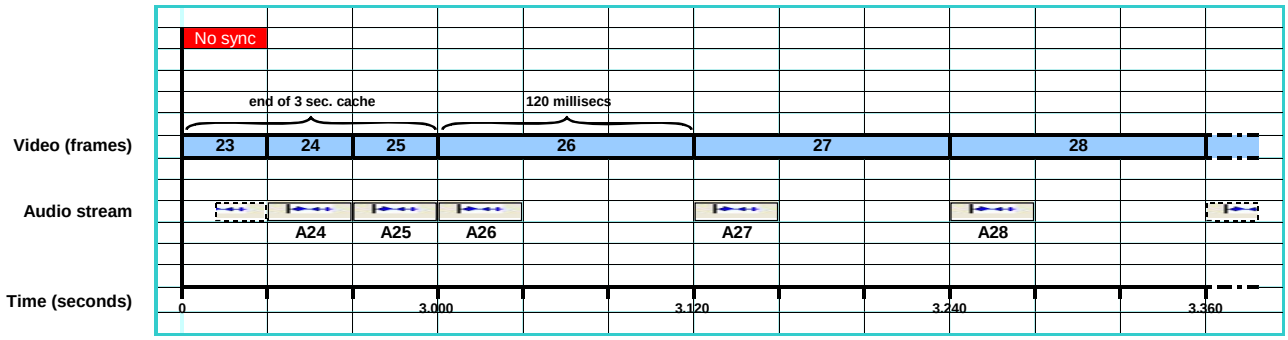
The preceding illustration shows video being decoded at a display rate of one frame every 40 milliseconds. Audio plays, unbroken, at the same rate as the video.

When synchronization is not requested, the Synchronize audio icon is not selected, and audio and video will decode independently.



The preceding illustration shows video playing more slowly, at a display rate of one frame every 120 milliseconds. The audio plays at its own decode rate, outstripping the video.

When the Synchronize audio icon is selected, and the requested synchronization is unsuccessful, the red display appears in the Status bar, the video decodes at a rate determined by available processor power, and the audio is broken.



The preceding illustration shows an unsuccessful attempt to synchronize audio and video: the cached data plays in sync, thereafter, limited processor power causes the audio to fragment (usually more unevenly than suggested in the illustration) because it attempts to keep pace with the video by means of timestamps.

Audio/Video Synchronization

MTS4CC will decode and analyze audio as well as video streams, but the audio will only be played and audible when the stream is in forward play mode.

Icon	Function in video mode	Function in audio mode	Function in synchronous mode		Function in asynchronous mode	
			Video	Audio	Video	Audio
	Plays to end or specified frame or until paused.	Plays to end.	Attempts to play video and audio synchronously. Whenever play is resumed, audio picks up at current location.		Audio and video play independently; no common timing enforced.	
	Plays quickly in forward direction.		Video plays quickly in forward direction.	Audio muted.	Video plays quickly in forward direction.	Audio muted.
	Stops.	Stops.	Stops video and audio at once.		Video stops.	Audio muted.
	Pressed once in Play mode, pauses. Pressed again, or at top of file, steps forward 1 frame.	Pause.	Pressed once in Play mode, pauses. Pressed again, or at top of file, steps forward 1 frame.	Audio muted.	Pressed once in Play mode, pauses. Pressed again, or at top of file, steps forward 1 frame.	Audio muted.
	Plays file backwards, at normal speed.		Plays video file backwards, at normal speed.	Audio muted.	Plays video file backwards, at normal speed.	Audio muted.
	Pressed once in Play mode, pauses. Pressed again, steps back 1 frame.		Pressed once in Play mode, pauses. Pressed again, steps back 1 frame.	Audio muted.	Pressed once in Play mode, pauses. Pressed again, steps back 1 frame.	Audio muted.
	Plays file quickly backwards.		Plays video file quickly backwards.	Audio muted.	Plays video file quickly backwards.	Audio muted.
	Skips on to specified frame/type/time/number of frames.		Skips on to specified frame/type/time/number of frames.		Audio and video play independently; no common timing enforced.	
	Skips back to specified frame/type/time/number of frames.		Skips back to specified frame/type/time/number of frames.		Audio and video play independently; no common timing enforced.	
	Pauses when specified video frame is reached.		Pauses when specified video frame is reached.	Audio muted.	Pauses on specified frame.	Audio muted.

Play

When selected, this plays the compressed video or audio stream until it reaches the end of the data. However, if, when playing a compressed video stream, a frame number has been set in Pause on frame the video will pause at this frame number.

If a file containing both audio and video streams is being played, and the streams are not synchronized, the video and audio will begin to play and continue to play independently. So, if a compressed video file is playing slowly due to the available processing power of the PC, it is likely that the video will lag behind the accompanying audio stream. If audio synchronization is selected, the rate at which the audio data is decoded adjusts and the audio stream keeps pace with the video, by means of timestamps. (See Synchronize audio on page 2-60 for more information about audio synchronization.)

NOTE. *When playing compressed video, depending on the speed of your PC, the standard in use, and the size of the video frames being viewed, there can be a significant delay after pressing the Play or Pause/Step forward button. During this delay, the message Buffering <nnn> (nnn is a number) is displayed near the top of the video window. This indicates that the video decoder is loading the required number of video frames into its internal buffer. This message disappears when the video is ready to display. (This is most likely to be seen with the H.264/AVC video standard, where up to 16 frames are loaded into the decoder buffer before displaying the first frame.)*

At the end of the data, the gray background screen is displayed unless:

- Hold last frame is selected, in which case the last frame stays visible
- Hold first frame is selected, in which case the first frame is redisplayed

Fast Forward

When this option is selected, the compressed file will be played in Fast forward mode, played more quickly than normal. The speed at which this is replayed depends on the speed of the computer you are using.

This command is unavailable when playing audio files.

If a file containing both audio and video streams is being played, regardless of synchronization, the video plays fast forward and the audio is muted.

NOTE. *When playing video forward or backward, the MTS4CC buffers the video and associated data. By default, the MTS4CC allocates a buffer size of 100 MB. The amount of buffer required per frame of video and associated data varies considerably with the video size and the video standard. Typically, 100 MB is sufficient to buffer the video and data for 10-500 frames.*

To change the buffer size, use the Play menu, Decoder options, General tab. See Video Decoder Options *on page 2-51 for more information.*

The video frame count is given in a box at the top of the image, to indicate how far through the video sequence the currently displayed frame is (the frame count is also displayed at the bottom right of MTS4CC window in the status bar).

The frame count is displayed in white text if the option in the Overlay menu is currently set to White, or in black text if this is set to Black (toolbar icon  or Ctrl+W).

The fast forward may be stopped at any time by clicking the Pause/Step forward icon.

If a frame number has been set in Pause on frame, the video will pause at this frame number.

Stop

When this option is selected, it will stop the playing of the compressed file.

The gray background screen is displayed in the video window unless:

- Hold last frame is selected, in which case the last displayed frame stays visible.
- Hold first frame is selected, in which case the first frame is redisplayed.

Pause/Step Forward

This option can be selected from the Play menu, by pressing Ctrl+A, or by clicking the tool bar icon Pause/Step forward .

This command is available when playing audio files, but audio will be heard only when the stream is in forward play mode.

NOTE. *Repeated selection of this option will advance the displayed video one frame at a time.*

This has two functions:

- If the file is playing, selecting this option will pause the decoding of the stream and, in the case of a video file, display the most recently decoded frame
- If the file has stopped or is already paused, selecting this option causes the file to advance by one displayed frame

NOTE. *See the Note under* Fast Forward *on page 2-45 regarding a possible buffering delay immediately after this is selected.*

In H.264/AVC where SI-frames and/or SP-frames are used, when using Pause/Step forward (`Ctrl+A`), at the point of the switch, both the frames used for the switch are displayed, one after the other. These are not fully displayed in the video when it is viewed normally, and so are not displayed when using Play or Fast forward selections.

Reverse Play

Play the file backwards, at normal speed.

This command is unavailable when playing audio files. Audio will be heard only when the stream is in forward play mode.

This option can be selected from the Play menu or by pressing `Ctrl+Shift+P`, or by clicking the tool bar icon Reverse play - .

Fast Backward

Play the file backwards, as fast as possible, while still displaying it.

This command is unavailable when playing audio files. Audio will be heard only when the stream is in forward play mode.

This option can be selected from the Play menu or by pressing `Ctrl+Shift+F`, or by clicking the tool bar icon Fast backward -  .

Pause/Step Backward

Step backwards through the video file one displayed frame at a time.

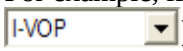
This command is unavailable when playing audio files. Audio will be heard only when the stream is in forward play mode.

See also the notes under *Pause/Step Forward* on page 2-46.

This option can be selected from the Play menu or by pressing `Ctrl+Shift+A`, or by clicking the tool bar icon Pause/Step backward -  .

Skip Forward

This will skip the video to the next frame type/time/number of frames indicated in the drop-down box on the icon toolbar.

For example, if the box next to the skip forward icon has I-VOP in it (for example, 

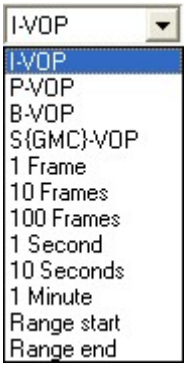
) clicking the Skip forward icon will skip to the next I-VOP.

This option can be selected from the Play menu or by pressing `Ctrl+K`, or by clicking the toolbar icon Pause/Step forward  .

If going to the selected frame type/time/number of frames is beyond the length of the video stream, the stream is advanced to the end.

See also Audio/Video Synchronization on page 2-43 and *Video Decoder Options* on page 2-51 regarding the buffer used to hold the video and associated data. When skipping forward or backward beyond the end of the buffer, the MTS4CC must reload the buffer, so some delay may be experienced.

The possible selections in the drop-down box vary with the selected video standard; the following example is for MPEG-4 Advanced Simple Profile.



This command is unavailable when playing audio files. Audio will be heard only when the stream is in forward play mode.

Skip Backward

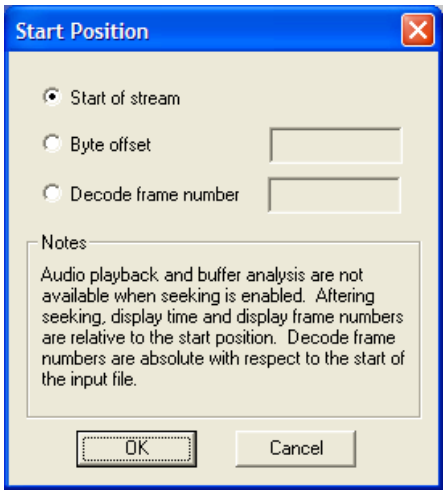
This is the same as Skip forward but in the reverse direction - see page 2-47.

This option can be selected from the Play menu, by pressing Shift+Ctrl+K, or by clicking the tool bar icon Pause/Step backward .

This command is unavailable when playing audio files. Audio will be heard only when the stream is in forward play mode.

Video Start Position

In the Start Position dialog box, you can set either a byte offset or decode frame number as a starting position for decoding.



The byte offset is relative to the start of the file.

Continuous Play

This command is unavailable when playing audio files.

When this option is selected and Play/Fast forward/Blind fast forward/ Reverse play/Fast backward/Blind fast backward is clicked, then the file will be continually played in a loop; the file is decoded until its end, at which point decoding will start again at the beginning of the file, until Stop or Pause is selected.

Audio will be heard only when the stream is in forward play mode.

Hold Last Frame

When this option is selected and the video/audio file is played to the end, the last decoded frame will be displayed. If Hold Last Frame is not selected, the gray background video screen will be displayed when the video is not playing.

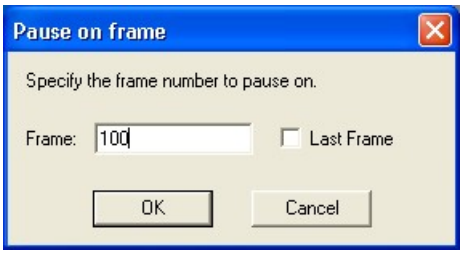
Hold Last Frame is selected as on by default when MTS4CC starts.

This command is not relevant for audio files.

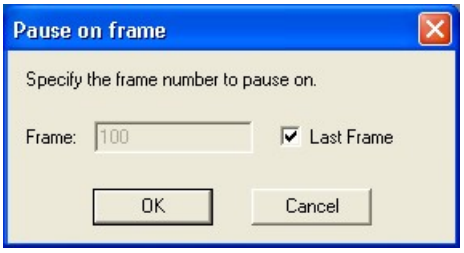
Pause on Frame

This command is only applicable to the playing of video files.

This option allows you to select a frame number to pause on when the video is played. Having selected a frame to pause on, and clicking Play, Fast forward, or Blind fast forward, the video will play until the selected frame number and then pause.



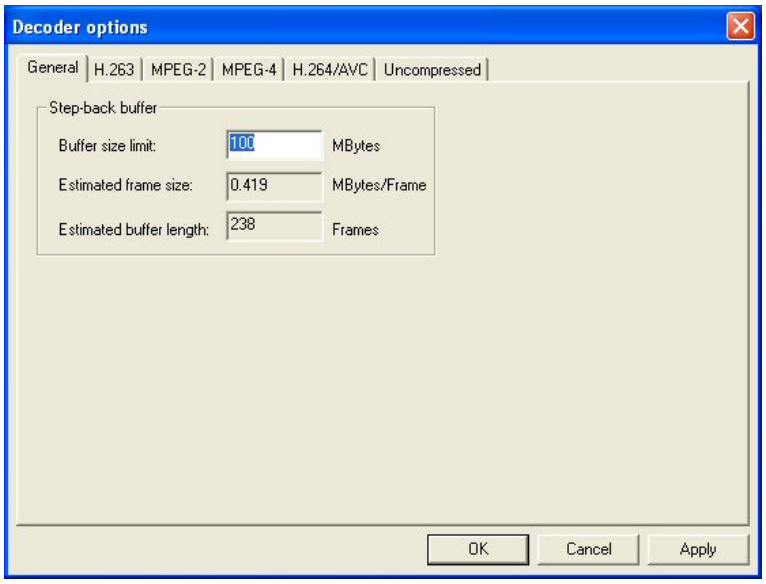
The last frame can be selected by using the Last Frame box. When this is done, the video pauses on the last frame. The previously entered frame number (if there is one) is still stored, and can be enabled again by clearing the Last Frame check box:



Video Decoder Options

The Video Decoder dialog box has tabs that set the video decoder options for each standard. When there are no configurable options for a particular video standard; there is no tab in the dialog box.

General

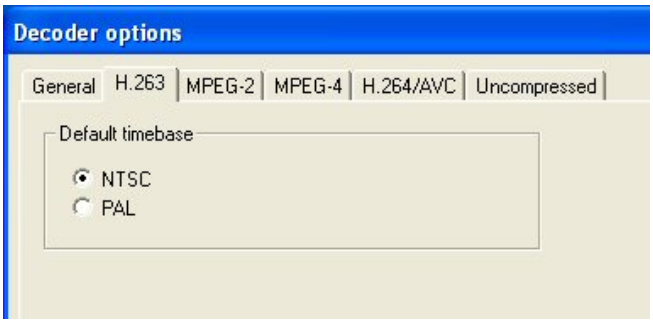


Step-back buffer. This buffer is used to hold the video and associated data, to make video play (forwards and backwards) occur without delay.

NOTE. *The size of the step-back buffer is shown, with an estimation of how many frames of data can be held within this buffer size. When playing video forward or backward, the MTS4CC buffers the video and associated data. By default, MTS4CC allocates a buffer size of 100 MB. The amount of buffer required per frame of video and associated data varies considerably with the video size and the video standard. Typically, 100 MB is sufficient to buffer the video and data for 10 to 500 frames.*

The pop-up alerts (Warnings, Errors, and so forth) that occur when video is decoded by the MTS4CC, are not displayed if the video and associated data is in the Step-back buffer – see Popup alerts in the step-back buffer *on page 2-144 for more information.*

H.263

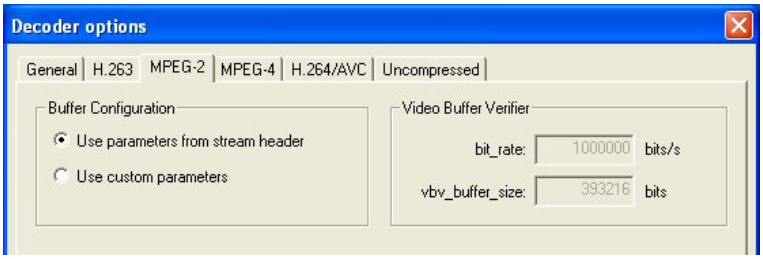


This has no effect and is grayed out for standards other than H.263.

NTSC/PAL option. Within the H.263 standard, the NTSC standard is assumed (frame rate of 29.97 frames per second) and video is played back at this frame rate by default. The NTSC option is selected as standard.

Sometimes H.263 video in PAL format (frame rate of 25 frames per second) does not set these options. In this situation, PAL video would play back at 29.97 frames per second and it would play too quickly. Selecting the PAL option on this tab will play the decoded video at 25 frames per second.

MPEG-2

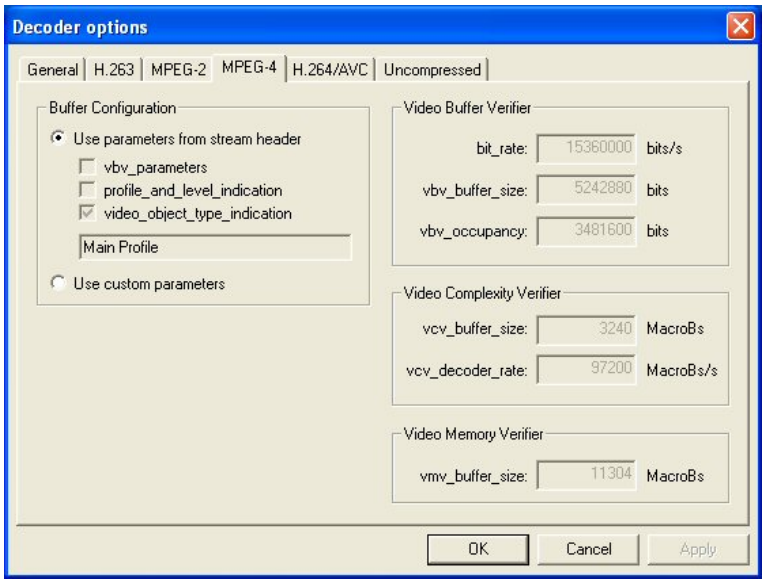


This has no effect and is grayed out for standards other than MPEG-2.

This dialog box relates to the use of parameters for VBV buffer analysis in MPEG-2.

See *Buffer analysis controls: MPEG-4 and MPEG-2* and *Use custom buffer parameters: MPEG-4 and MPEG-2* on page 2-122 for more information.

MPEG-4



This has no effect and is grayed out for standards other than MPEG-4.

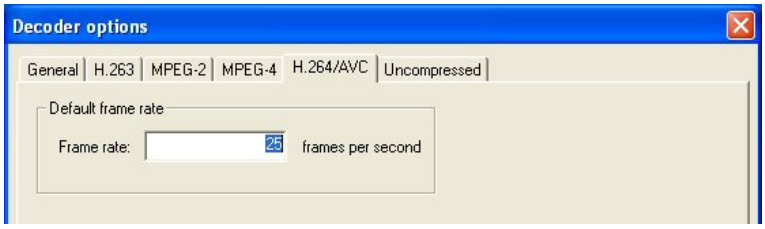
This relates to the use of parameters for buffer analysis (VBV, VCV, VMV) in MPEG-4.

See *Buffer analysis controls: MPEG-4 and MPEG-2* and *Use custom buffer parameters: MPEG-4 and MPEG-2* on page 2-122 for more information.

H.264/AVC

Many H.264/AVC byte streams do not provide the SEI (Supplemental enhancement information) data for specifying a frame rate, because this is optional in the byte stream (and where this happens, the frame play data is typically provided at the systems level for the video decoder).

Therefore the setting is provided on this option tab, so that the stream will play at the correct frame rate when the appropriate SEI data is not present.



Uncompressed Video

The data is one of the following formats::

- 8 bits per sample, 4:2:0
- More than 8 bits per sample, and/or 4:2:2 or 4:4:4 (as used by H.264/AVC High Profile/FREext, High/10, High/4:2:2, High/4:4:4)

YUV format of 8 bits per sample 4:2:0. The YUV file output is raw YUV with no headers of any kind: this is the same format as used by the Microsoft MPEG-4 Part 2 reference encoder (see *Compression Standards and File Types* section) and as used commonly by other programs:

- No headers of any kind (no file or frame headers)
- One byte per sample
- Row raster order (top picture row first)
- Planar YUV 4:2:0 sub-sampled (4 bytes of Y data for each byte of U data and each byte of Y data)
- Y plane values are 0-255 unsigned
- U and V plane values are unsigned with a DC offset of 128

Other uncompressed formats. The general uncompressed video file format is as follows:

- No headers of any kind (no file or frame headers)
- Concatenated planar image data
- Row raster order (top picture row first)
- Unsigned samples

For 8-bit sample depth:

- One byte per sample

For 9-16 bit sample depth:

- Two bytes per sample
- Both little- and big-endian byte orders supported

For YUV format:

- Concatenated Y, U, and V planes
- U and V planes sub-sampled as required
- Y plane samples are unsigned
- U and V plane samples are unsigned with a DC offset of 2^{n-1}, where *n* is the chroma sample bit depth

For RGB format:

- Concatenated R, G and B planes.

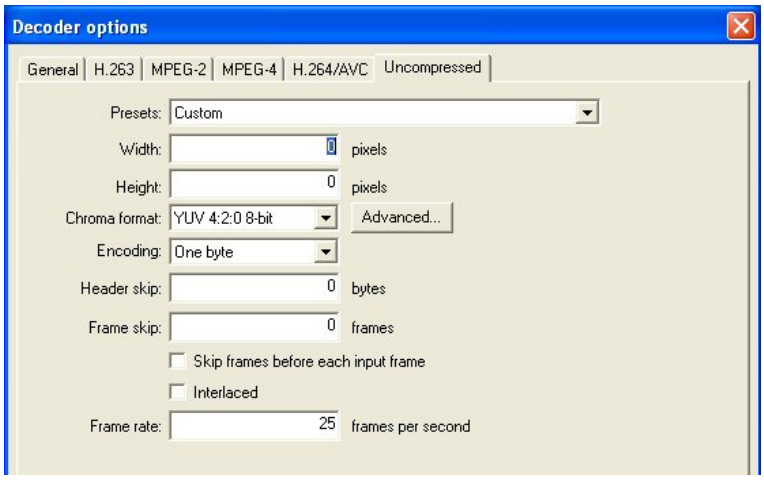
For grayscale format:

- Luma plane only

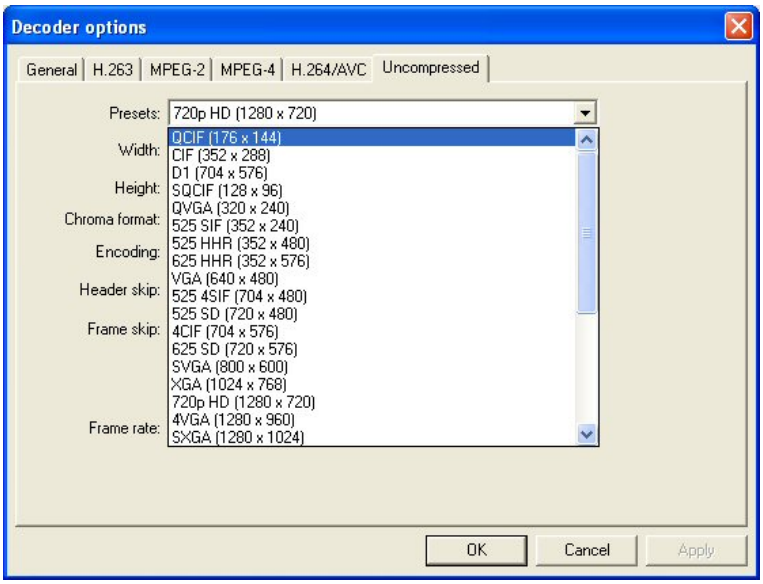
When opening an uncompressed video file, by default the MTS4CC shows the uncompressed video decoder options, to enter the required parameters.

NOTE. *If you try to open an .m4v or .264 or other compressed video file by using Open as uncompressed video, the MTS4CC will not decode the compressed video but will assume it is in uncompressed format.*

Setting the frame size. Within an uncompressed video file, there is no place to indicate the frame size, frame rate, and so forth. When the file is opened, the MTS4CC will display the following screen (this is a tab of the Decoder options, which can also be accessed from the Play menu, Decoder options):



Presets (Width and Height). If there are numbers in the filename that could indicate the frame size, the MTS4CC will attempt to read these and offer these in the Width and Height fields shown in the previous screenshot. The correct values can be entered or selected using the drop-down list:



Chroma format. This control specifies the color model and format for the uncompressed video data. The combo provides several common combinations, including 8-bit YUV 4:2:0, 8-bit YUV 4:2:2, 8- bit YUV 4:4:4, 8-bit RGB and 8-bit grayscale. Select an entry from the list to use one of these common formats. Other formats can be specified by choosing the Custom entry in the list - this will open the Image format dialog.

Advanced button. Click this button to specify a custom chroma format - this will open the Image Format dialog; see *Image format dialog box* on page 2-29.

Encoding. This control specifies the encoding of image samples in the file format. The following options are available:

- One byte - this specifies that image samples are stored as one byte per sample. This format is appropriate if all image planes are 8-bits deep
- Two byte MSB first - this specifies that image samples are stored as a pair of bytes for each sample. The most significant byte occurs first in each pair (big-endian). This format is appropriate if one or more image planes are deeper than 8-bits
- Two byte LSB first - this specifies that image samples are stored as a pair of bytes for each sample. The least significant byte occurs first in each pair (little-endian). This format is appropriate if one or more image planes are deeper than 8-bits

Header skip. The number of bytes at the start of the file before the first frame; MTS4CC will skip past these bytes (ignoring them).

Frame skip and Skip frames before each input frame: Frame skip is the number of frames (not bytes) to skip between each frame that is viewed in the video window.

By default, these frames are skipped after each viewed frame; by selecting the Skip frames box before each input frame, the number of frames are skipped before each viewed frame.

Interlaced: The uncompressed video file has interlaced data in the format of complete frames, with both fields within one frame, top-field first, each field on alternate lines.

Enabling this check box switches on the Interlace toolbar in the MTS4CC which allows the two fields to be viewed independently, either one above the other (top field above bottom field) or either field with the field lines repeated to full frame height.

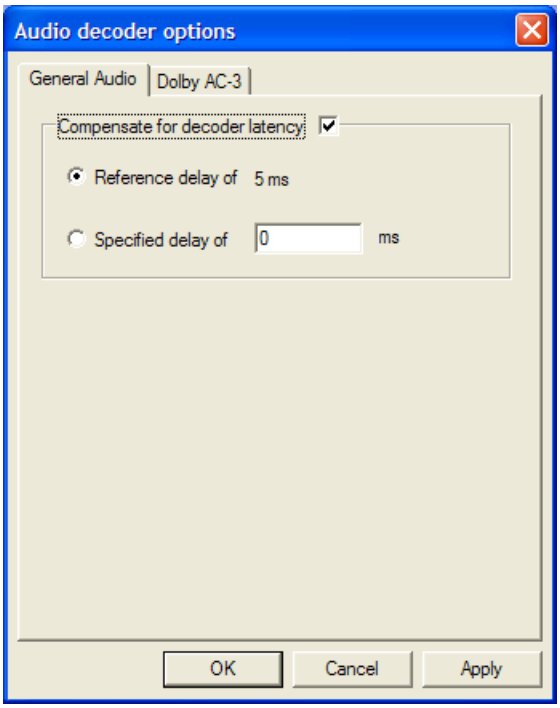
Frame rate. The rate at which to display the uncompressed frames, in frames per second.

NOTE. *The number entered in the Frame rate field can be an integer (for example, 30), or a fraction (for example, 30000/1001) or a decimal number (for example, 29.97).*

Audio Decoder Options

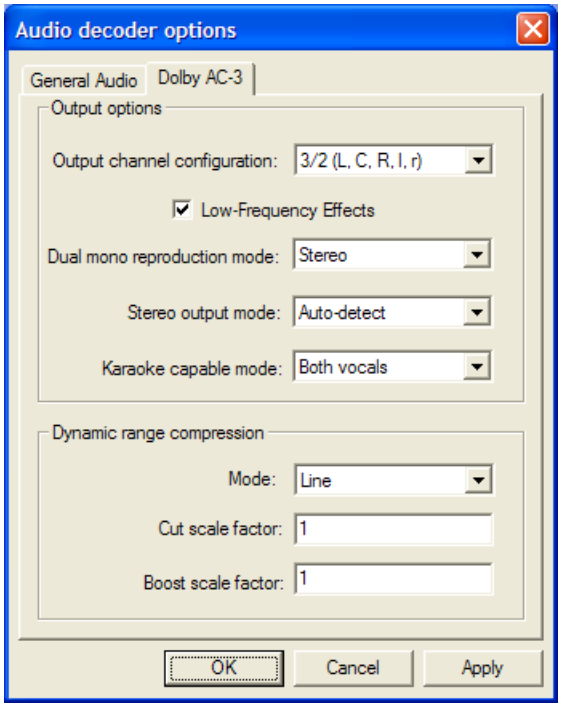
The Audio Decoder option is enabled only when audio is present in a stream.

General Audio. Where a decoder has inherent latency, the MTS4CC can compensate automatically.



With Compensate for decoder latency selected, a reference delay appropriate for the decoder in use is automatically available. If you want to specify a different delay, enter the value in the Specified delay field and select the option.

Dolby AC-3. The Audio Decoder Dolby AC-3 tab allows you to set up output options and dynamic range compression values.



The fields correspond to those used in the Dolby AC-3 development kit. Changes will take effect the next time the stream is played (decoded).

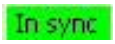
Mute audio

Clicking this button turns the sound on/off. The audio stream will continue to decode, even with sound disabled.

Synchronize audio

Without synchronization enabled, audio and video streams will play independently, at rates determined by the available processing power of your PC, with audio usually playing more quickly than video. When the Synchronize audio icon is depressed, audio data will be played as the video frame to which it pertains is played. Full details can be found under *Audio/Video Synchronization* on page 2-43.

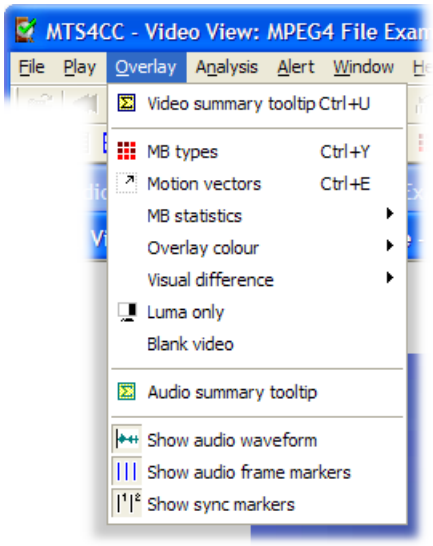
To show whether audio and video streams are successfully synchronized or not, the following displays appear in the Status bar:



This menu item and icon are available only when a file containing both audio and video is loaded.

Overlay Menu

The following paragraphs describe the options available in the Overlay menu. This menu controls the display of overlaid real-time information and statistical information that has been captured over a period of time.

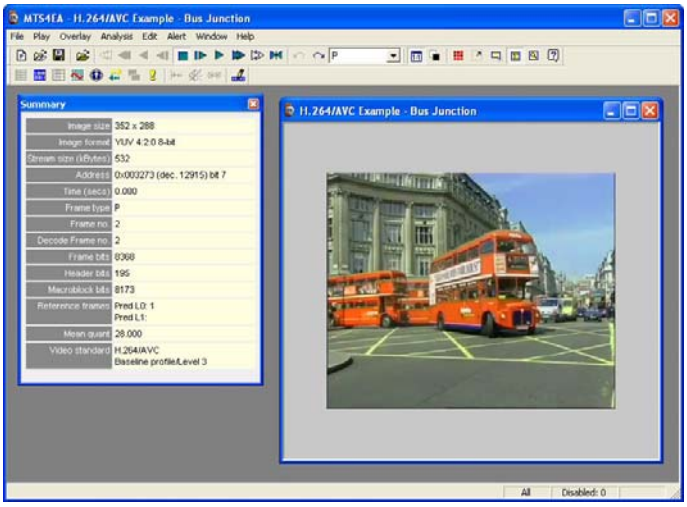


Summary Tooltips Manipulation

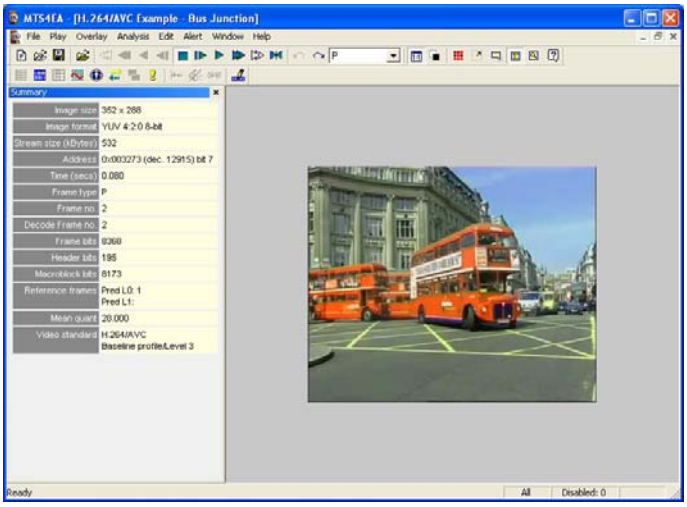
NOTE. *When the tooltips are dragged near the edge of the window, they automatically dock. To force undocking, press and hold the Ctrl key while dragging with the mouse.*

The tooltips bring up independent windows that can be:

- Moved around within the main window and put next to a video window:



- Docked to one of the edges of the main window:



When the Summary tooltip is docked (as in the preceding figure):

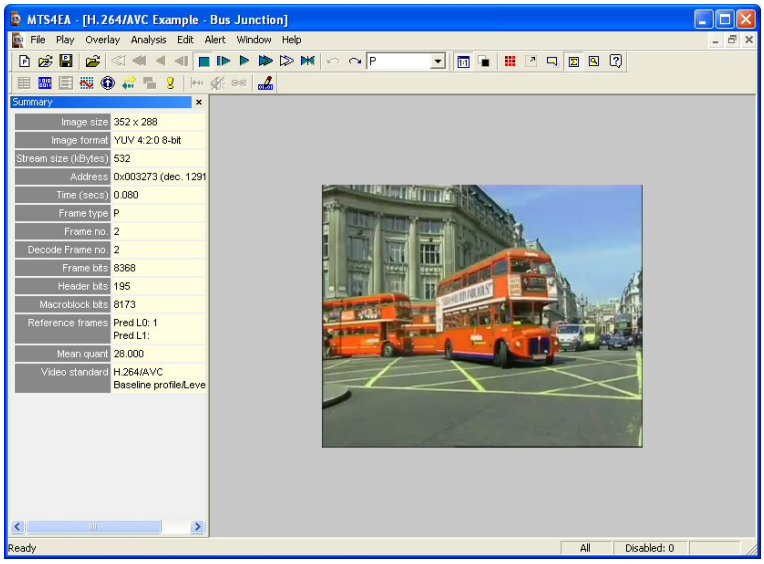
- And the window is maximized, the Summary tooltip remains visible and the other window is only maximized into the space available
- The title bar of the Summary tooltip changes to a pale color to indicate it is docked (and the title text is no longer bold)

Docking/undocking

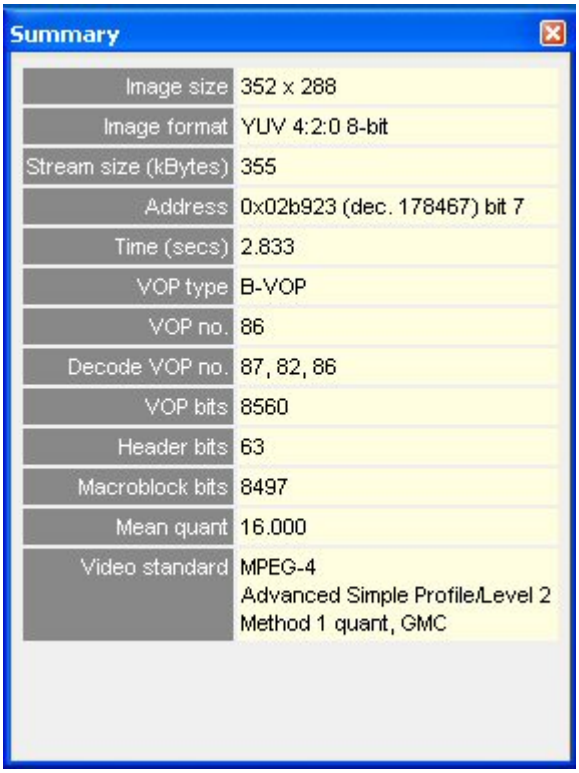
- To dock the Summary tooltip: drag it to one of the edges of the main window (top, left, right, bottom).
- To undock, hold the keyboard control (Ctrl) key and click on the title bar.

Scrolling/scroll bars

When the available area is too small for the whole tooltip to be seen, scroll bars are automatically displayed:



Video Summary Tooltip



When this is switched on, a window is displayed that provides summary information about the frame being displayed or the sequence as a whole. The window can be dragged to any position within the MTS4CC main window.

NOTE. *The titles in the Summary tooltip and the displayed information vary with the selected video standard and the options that have been used in the specific video file.*

If the sequence has not been decoded to the end, the summary up to that point is provided. The following information provides details about the summary contents.

Tref [H.263 only]

Tref is the time to the current frame from the start of the sequence, measured in increments of the base frame time for NTSC or PAL video (~33 milliseconds or 40 milliseconds respectively). Tref has a maximum value of 255; when it reaches this value it wraps back to zero.

Skip [H.263 only]

Skip is the difference in Tref for this frame, compared to Tref for the previous frame.

NOTE. *Skip and Tref are only displayed for H.263.*

For NTSC video at roughly 30 frames per second (actually at 30,000/1,001 Hz), frames are displayed every 0.033 seconds (approximately).

However, many compressed video sequences do not have 30 frames per second of data (although they must of course be displayed at the correct rate, as if they did have 30 frames per second).

For example, if a compressed video sequence had 15 frames per second, the decoder would skip every other frame; Skip would equal two in this case. For example, if NTSC video were displayed at 10 frames per second, Skip would equal three.

For a compressed video sequence at 15 frames per second, it would mean that the displayed frame number would increase by 15 each second.

So, continuing the example of video at 15 frames per second, if there are two Skips before the first frame, the values for the first few frames would be as follows:

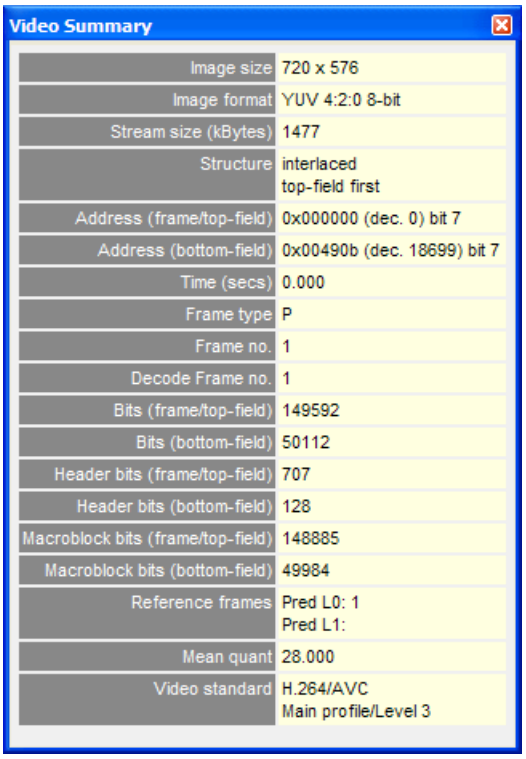
Time approx. (secs)	Tref (Temporal reference)	Skip (increment)	Frame number (count of frames decoded and displayed
0.067	2	2	1
0.133	4	2	2
0.200	6	2	3
0.267	8	2	4

There are many variations to this; often more than one frame is skipped.

NOTE. *Within MTS4CC, for H.263 video, Tref is limited to 8 bits, (a maximum value of 255) because this is how Tref is defined within the H.263 standards (actually TR).*

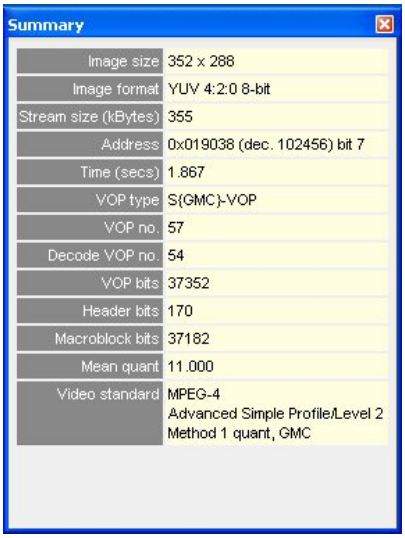
Summary Tooltip Varies by Video Standard

The information provided by the Summary tooltip varies depending upon the video standard that is being analyzed, and the specific options in the selected video file. The following is an example for an H.264/AVC stream:

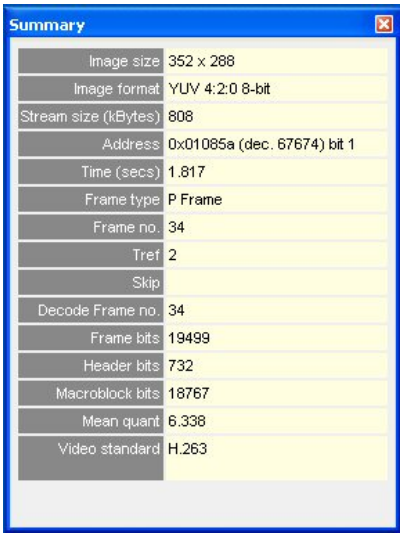


H.264/AVC Summary tooltip example

Here are more examples:



MPEG-4 Advanced Simple Profile



H.263

NOTE. *The information displayed at the end of video sequence is different from the information displayed during processing – see under Summary Tooltip at the end of a Video Sequence on page 2-73.*

Image size [All standards]. Picture size in pixels, Width x Height (pixel Columns x Rows).

For H.264/AVC, where the cropping rectangle feature has been used, the full image size is given and displayed in the video window, but the cropped image size is also given in this field of the tooltip in the form:

Image size	**352x288**	**(cropped: 200x100)**

Image format [All standards]. Format of selected video file

Stream size (kBytes) [All standards]. Size of the video file in KB.

NOTE. *For container files such as MP4, 3GPP, and MPG (MPEG-2), the file size given is the size of the video track that has been selected, not the size of the whole MP4/3GPP/MPG file.*

Structure [H.264/AVC, VC-1 Adv. Profile and MPEG-4 ASP]. For H.264/AVC byte streams and MPEG-4 Advanced Simple Profile, where interlace could be used, the structure of the displayed frame is one of the following:

- Progressive
- Interlaced

Address or Address (frame/top-field) and Address (bottom-field) [Interlace]. The start address of the current video frame/VOP within the video file.

The H.264/AVC byte streams, two address fields are given to display the address of both fields in interlaced streams. If a stream is not interlaced, the Address (bottom field) has no data.

NOTE. *The first byte in the video file is byte 0; the first bit is bit 7 of byte 0.*

The byte address is displayed in hexadecimal first, for example, 0x002681, then in decimal in brackets, for example, (dec. 9857) and finally the bit location within the byte, where bit 7 is the most significant bit (occurs first in the stream).

Time (secs) [All standards]. The time in seconds from the start to that point in the sequence, calculated as if the sequence were playing normally (MTS4CC keeps track of the playing time, regardless of whether the sequence is paused at some point or played in fast forward mode).

This information is calculated from:

- [H.264/AVC]: the SEI parameters if they are present in the bitstream.

NOTE. *Many H.264/AVC bitstreams do not have the relevant SEI values (these are optional) and in this case, MTS4CC will play the video at the frame rate indicated in the H.264/AVC tab of the Decoder options (on the Play menu)*

- [VC-1]: the parameters either in the ASF file, if the video is within this, or within the VC-1 stream
- [MPEG-4]: the parameters such as `modulo_time_base`, `vop_time_increment`, etc.
- [MPEG-2]: the parameters `frame_rate_value`, `frame_rate_extension_n` and `frame_rate_extension_d`
- [H.263]: the time-stamps in the picture header. If the Temporal references [Tref] are not set or are not correctly set, this time may not be the actual playing time from the start of the sequence.

VOP type [MPEG-4] or Frame type [H.264/AVC, MPEG-2, H.263, VC-1].

NOTE. *For interlaced bitstreams, the frame/VOP type reported is that relating to the second field in a frame. This means that if the top field is first in frame/VOP 1 (and this will always be Intra-coded) and the bottom field is Inter [P] coded, then the frame will be reported as P.*

- [MPEG-4] the VOP type, I-VOP or P-VOP or B-VOP or S-GMC VOP (see the following):
  - I-VOP: indicates that this frame is Intra coded (completely coded within itself) without any interpolation from earlier or later frames. The first frame in an MPEG-4 sequence is always an I-VOP
  - P-VOP: P or Predicted VOP: this frame is Inter coded (partly coded based upon earlier frames)
  - B-VOP: *(MPEG-4 Advanced Simple Profile only)* B or Bidirectional Interpolated: this frame is calculated based upon both earlier and later frames. B-VOPs may only be interpolated based upon I-VOPs/P-VOPs (not on other B-VOPs)
  - S-GMC: *(MPEG-4 Advanced Simple Profile only)* the VOP is an S-GMC VOP which uses Global Motion Compensation (GMC)
- [H.264/AVC, VC-1] the Frame type, I-frame or P-frame or B-frame or SI-frame or SP-frame (see below):
  - I-frame: I indicates that this frame is Intra coded (completely coded within itself) without any interpolation from earlier or later frames. The first frame in an H.264/AVC sequence is always an I frame
  - P-frame: P indicates Predicted: this frame is Inter coded (partly coded based upon earlier frames)
  - B-frame: *(Extended Profile only)* B or Bidirectional Interpolated: this frame is calculated based upon both earlier and later frames
  - SI-frame: SI indicates that this frame is a Switching-Intra coded frame - there is a switch between two different streams at this point
  - SP-frame: SP indicates that this frame is a Switching-Inter coded frame - there is a switch between two different streams at this point

NOTE. *For H.264/AVC, the frame type is derived from the most complex slice type present. For example, if any of the slices in the frame are B-slices, the whole frame is reported as a B-frame. If any of the slices in the frame are P-slices, the whole frame is reported as a P-frame. (This is as suggested in the standard.)*

- [MPEG-2] the Frame type, I-frame or P-frame or B-frame (see the following):
  - I-frame: I indicates that this frame is Intra coded (completely coded within itself) without any interpolation from earlier or later frames. The first frame in an MPEG-2 Elementary Stream sequence is always an I frame
  - P-frame: P indicates Predicted: this frame is Inter coded (partly coded based upon earlier frames)
  - B-frame: B or Bidirectional Interpolated: this frame is calculated based upon both earlier and later frames
- [H.263] Frame type: the frame type, I-frame or P-frame or B-frame (see the following):
  - I-frame: I indicates that this frame is Intra coded (completely coded within itself) without any interpolation from earlier or later frames. The first frame in an H.263 sequence is always an I frame
  - P-frame: P indicates Predicted: this frame is Inter coded (partly coded based upon earlier frames)

VOP no. [MPEG-4] or Frame no. [H.264/AVC, MPEG-2, H.263, VC-1] . The number of the displayed VOP [MPEG-4]/frame [H.264/AVC, MPEG-2, H.263] in the sequence.

NOTE. *For sequences with B-VOPs/B-frames and in some other cases, the displayed frame number may be different from the decode for the VOPs/frames - see the following.*

Tref and Skip [H.263 only]: See under *Tref [H.263 only]* on page 2-64.

Decode VOP no. [MPEG-4] or Decode Frame no. [H.264/AVC, MPEG-2, H.263, VC-1]. The data that appears in this field differs from the video standard.

For H.264/AVC, one number is displayed (the current display frame number) as each MacroBlock can be bidirectionally predicted from different frames; to find out which frames are used for prediction, the MacroBlock tooltip is used.

For MPEG-4 Advanced Simple Profile and MPEG-2, when B-VOPs/B-frames are used, the data in these VOPs/frames is calculated from data in preceding and following VOPs/frames stored in the video file.

That is, for sequences with B-VOPs the order in which the VOPs/frames are stored in the video file is different from the order in which the VOPs/frames are displayed.

In this circumstance, this field of the Summary tooltip shows the source VOPs/frames in the video file from which the displayed VOPs/frames are generated.

The three numbers, xxx, bbb, fff, are:

- xxx is the frame number of the decoded VOP
- bbb is the frame number of the backward reference
- fff is the frame number of the forward reference

NOTE. *When B-VOPs are used, it means that the display is different from the decode order in every VOP after the first B-VOP occurs in the bitstream (in the display order).*

VOP bits [MPEG-4] or Bits (frame/top-field) and Bits (bottom-field) [H.264/AVC, VC-1] or Frame bits [H.264/AVC, MPEG-2, H.263, VC-1]. The number of bits used in that:

- [MPEG-4] VOP
- [H.264/AVC, VC-1] frame if progressive coded or top-field if interlaced; data only appears in the Bits (bottom-field) if the frame is interlaced.
- [MPEG-2, H.263, VC-1] frame

NOTE. *For H.264/AVC, if any of the slices in the frame are interlaced, the whole frame is reported as interlaced.*

Header bits [All standards] or Header bits (frame/top-field) and Header bits (bottom-field) [Interlace]. The sum of non-MacroBlock data bits within the frame - , the header bits at the start of a frame that are before the bits specific to the first MacroBlock in the frame.

MacroBlock bits [All standards] or MacroBlock bits (frame/top-field) and MacroBlock bits (bottom-field) [Interlace]. The sum of MacroBlock data bits within the frame - those bits specifically used to encode the MacroBlocks (excluding the header bits at the start of the frame).

PSNR (Y, U, V) [All standards] or PSNR (Y, U, V) (frame/top-field) and PSNR (Y, U, V) (bottom field) [Interlace]. When fidelity analysis is enabled, the selected fidelity analysis values are displayed for the VOP/frame currently being displayed.

The Y, U, and V values given are the average of the values for each MacroBlock.

Mean quant [All standards]. The mean average of all coded MacroBlock quant values for this frame.

Reference frames [H.264/AVC only]. This shows the List 0 and List 1 reference frames to which the current display frame refers.

Video standard [All standards]. The video standard used, with various additional information as appropriate, such as:

- [MPEG-4]:
  - Profile and Level, if this information is given in the file
  - Data partitioning, Resync, RVLC, as appropriate
  - [MPEG-4 Advanced Simple Profile] Interlace, QS, Method 1 quant, as appropriate
- [MPEG-2, VC-1]:
  - Profile and Level
- [H.264/AVC]:
  - Profile and Level
  - Entropy coding mode, CAVLC

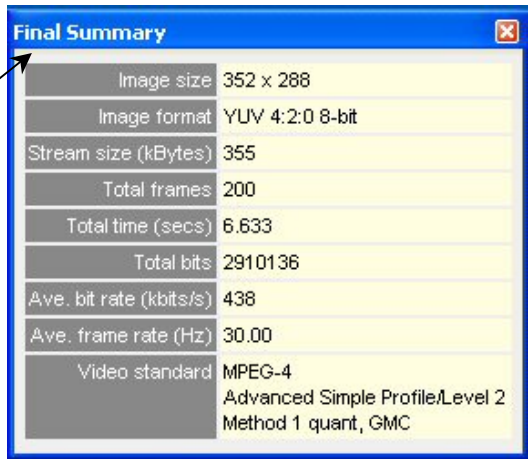
NOTE. *For H.264/AVC, many of the other elements (for example, data partitioning) can vary by frame/slice (and in some cases MacroBlock by MacroBlock), so these other elements are reported in the MacroBlock tooltip.*

- [H.263] Annexes, as appropriate.

Summary Tooltip at the end of a Video Sequence

When the file is completely decoded, the summary tooltip displays as follows:

The title of the tool tip becomes Final Summary



The meanings of Image size, File size (KB) and Standard are the same as described in *Video Summary Tooltip* on page 2-64.

The other items displayed are:

Total frames. The total decoded frames in the sequence.

Total time (secs). The total time in seconds from the start to the end of the sequence, calculated as if the sequence were playing normally (MTS4CC keeps track of the playing time, regardless of whether the sequence is paused at some point or played in fast forward mode).

Total bits. The size of the video file in bits.

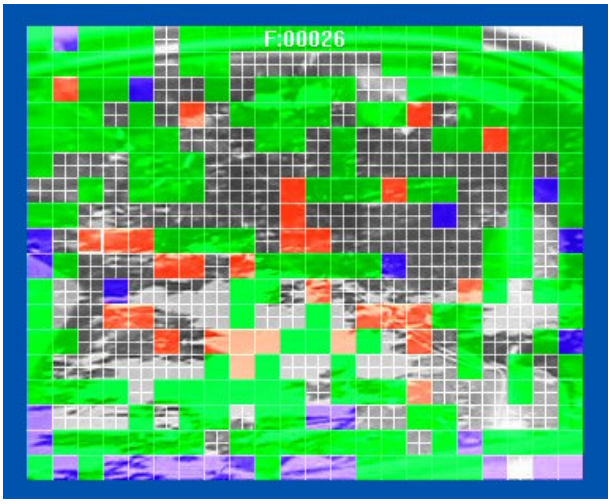
NOTE. *For container files such as MP4 and 3GPP, the size given is the number of bits in the video track that has been selected (not the container file).*

Ave. bit rate (kbits/s). This is Total bits divided by Total time, in k bits per second.

Ave. frame rate (Hz). This is Total frames divided by Total time, in frames/second (Hz).

Ave. PSNR (Y, U, V) [All standards] or Ave. PSNR (Y, U, V) (frame/top-field) and Ave. PSNR (Y, U, V) (bottom field) [Interlace]. When fidelity analysis is enabled, the average of the selected fidelity analysis values across all the VOPs/frames is displayed.

MacroBlock Types



This example is a B-VOP of an MPEG-4 Advanced Simple Profile stream.

This overlay allows you to easily view the MacroBlock types used in the encoding. The types are identified by changing the color of the individual MacroBlocks, by modifying the chrominance while leaving the luminance unchanged, so that the data is still partially visible.

The colors used are dependent on the video compression standard in use. The colors are shown in the following tables and are also displayed on-screen in the MacroBlock types color key tooltip (see *MacroBlock Types Color Key Tooltip* on page 2-173 for more information).

The lines denote the edges of the MacroBlock, and if the MacroBlock has four motion vectors, the lines also divide the MacrBlock into four quadrants. The color of the lines can be changed from white to black by clicking the icon (or clicking the Black menu item on the Overlay menu).

H.264/AVC

H.264/AVC has the following possible coded MacroBlock types (see Reference [13] in *Compression Standards and File Types* section), shown in the following colors:

MB type	Prediction mode	Table index	Sub-MB types	Color	Slice type(s)
I	Intra 16x16 (incl. Intra inferred)	1 - 25	-	Green (Green)	I, P, B, SI, SP
I	Intra 4x4	0	-	Yellow (Yellow)	I, P, B, SI, SP
I	Intra 8x8	0	-	Orange (Orange)	I, P, B, SI, SP
P	Inter list 0	0 - 2	0 - 3	Red (Red)	P, SP
B	Inter list 0	1, 4, 5	1, 4, 5, 10	Red (Red)	B
B	Inter list 1	2, 6, 7	2, 6, 7, 11	Blue (Blue)	B
B	Inter list 0 + 1	3, 20, 21	3, 8, 9, 12	Pink (Pink)	B
B	Inter mixed	8 - 19	-	Light blue (Light blue)	B
B	Inter direct	0	-	Gray (Gray)	B
SI	Intra 4X4 and 16x16	0	-	Green (Green)	SI
SP	Inter list 0	0 - 2	0 - 3	Red (Red)	SP

VC-1

VC-1 has the following possible coded MacroBlock types (see Reference [17] in *Compression Standards and File Types* section), shown in the following colors:

Type	Motion vector	Color	Frame type(s)
Intra	0	Green (Green)	I, P, B, BI
Forward	0, 1, 2, or 4	Red (Red)	P, B
Backward	0, 1, 2, or 4	Blue (Blue)	B
Bi-directional	0, 2, or 4	Pink (Pink)	B

MPEG-4

MPEG-4 has the following possible coded MacroBlock types (see Reference [1] - Table B-1 in *Compression Standards and File Types* section), shown in the following colors:

Index	Type	Dquant/ Dbquant	Motion vector	Color	VOP type(s)
0	Inter		1	Red (Red)	P, S-GMC
1	Inter+Q	✓	1	Blue (Blue)	P, S-GMC
2	Inter4V		4	Pink (Pink)	P, S-GMC
3	Intra			Green (Green)	I, P, S-GMC
4	Intra+Q	✓		Yellow (Yellow)	I, P, S-GMC
-	Direct		8	Gray (Gray)	B
-	Interpolate	✓	2	Green (Green)	B
-	Forward	✓	1	Red (Red)	B
-	Backward	✓	1	Blue (Blue)	B

MPEG-2

MPEG-2 has the following possible coded MacroBlock types (see Reference [14] in *Compression Standards and File Types* section), shown in the following colors:

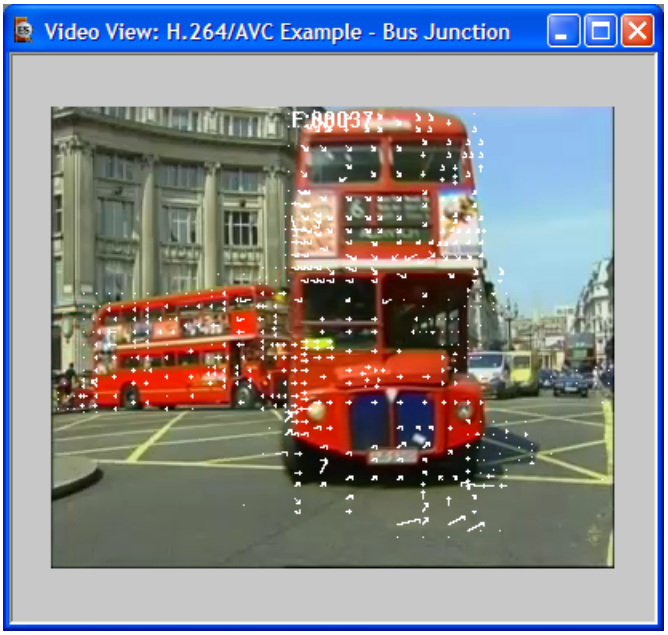
Type	Dquant	Motion vector	Color	Frame type(s)
Intra	✓	1	Green (Green)	I, P, B
Forward	✓	2	Red (Red)	P, B
Backward	✓	2	Blue (Blue)	B
Bi-directional	✓	4	Pink (Pink)	B

H.263

H263 has six possible coded MacroBlock types (see Reference [2] - Table 9/H.263 - in *Compression Standards and File Types* section), shown in the following colors:

Index	Type	Dquant	Motion vector	Color
0	Inter		1	Red (Red)
1	Inter+Q	✓	1	Blue (Blue)
2	Inter4V		4	Pink (Pink)
3	Intra			Green (Green)
4	Intra+Q	✓		Yellow (Yellow)
5	Inter4V+Q	✓	4	Gray (Gray)

Motion Vectors

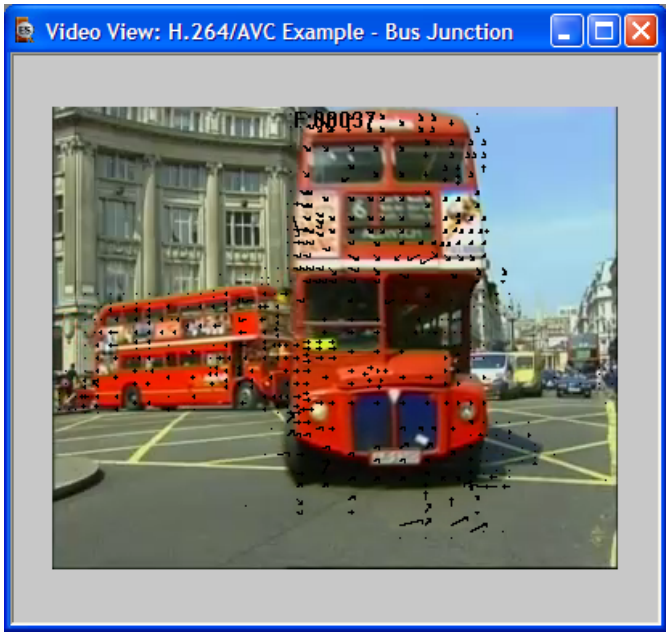


The motion vectors used in relevant video frames can be displayed on the frame currently being viewed. They are switched on and off by doing one of the following:

- From the Overlay menu, select the Motion vectors option
- Click the toolbar icon 
- Press `Ctrl+E`

The motion vectors are drawn in the image in either white or black (the color can be selected using the Black/White Digits button on the Toolbar  see *Overlay Color* on page 2-86) for all frames except B-VOPs/B-frames - see *Motion Vectors in B-VOPs/B-frames* on page 2-80 for information on this.

This is an example of the preceding video frame with the motion vectors plotted in black:



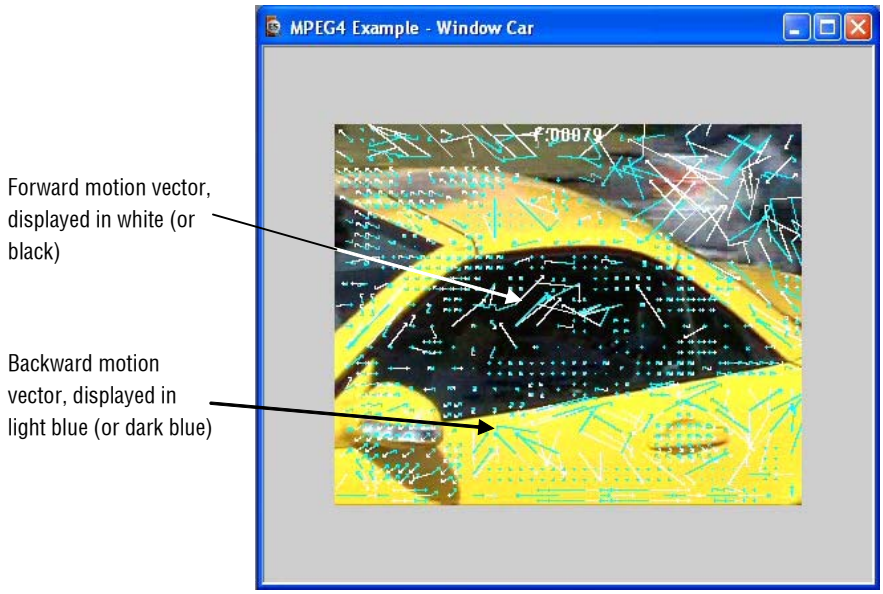
The motion vectors are plotted to the length of that actually used by the decoder.

The vector has an arrowhead at its end and is pointing to the center of the region of pixels in the previous frame that was used for the prediction of the current MacroBlock or sub-MacroBlock.

Some video standards allow motion vectors for an 8x8 region; other video standards (such as H.264/AVC) allow motion vectors for smaller regions as well. In these situations, all the motion vectors are plotted.

Motion Vectors in B-VOPs/B-frames

For frames that are bidirectionally predicted (B-VOPs or B-frames), there can be two motion vectors for each MacroBlock or sub-MacroBlock region, or four MacroBlocks in the case of interlaced video sequences:



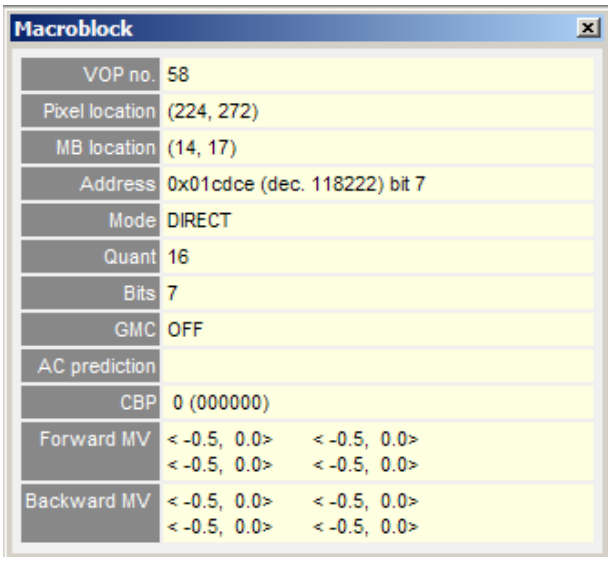
In Interlaced video sequences, the motion vectors are displayed in the following colors:

MV Type	Field	MV color - out	MV color - out
Forward	Top	(White)	Black (Black)
Backward	Top	Light blue (Light blue)	Dark blue (Dark blue)
Forward	Bottom	Yellow (Yellow)	Green (Green)
Backward	Bottom	Magenta (Magenta)	Red (Red)

For H.264/AVC, the white (or black) arrows denote the List 0 motion vectors and the light blue (or dark blue) arrows denote the List 1 motion vectors.

For more information on the motion vector displays in the H.264/AVC standard, see the *Compression Standards and File Types* section.

For MacroBlocks with four (or more) motion vectors, the MacroBlock tooltip is expanded with extra information to display all the motion vectors. The following example is for a MacroBlock in a B-VOP (in MPEG-4 Advanced Simple Profile) where there are four Forward and four Backward motion vectors:



MB Statistics

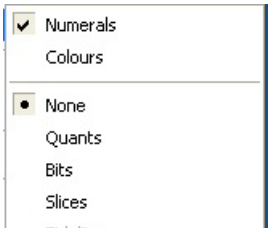
This option displays statistics on a MacroBlock-by-MacroBlock basis, either for the current frame only or averaged over a range of frames.

The top of this submenu allows selection of:

- Numerals (numbers)
- Colors

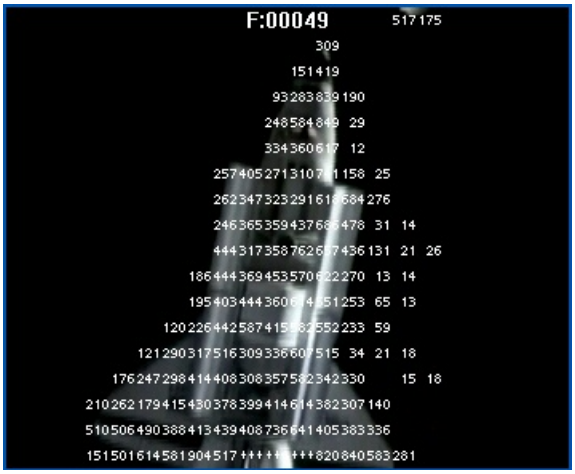
Numerals

When this is selected, numbers are displayed for the MacroBlock statistics, overlaid onto each MacroBlock.

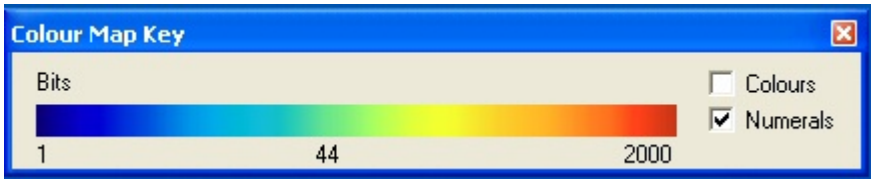


(In the preceding example, Numerals is selected, but None is also selected, so no statistics will be displayed.)

The displayed number is selected from this submenu; the following example shows bits per MacroBlock in frame 49 of the MPEG-4 example file Space (no bits = not coded):



When statistics have been selected to be displayed, the Color Map Key is also displayed:



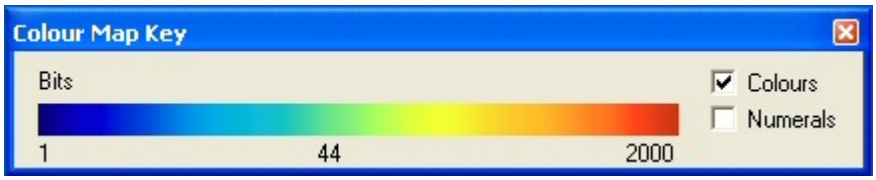
See the next section for a description of the Color Map Key.

NOTE. *In the Color Map Key, selecting the Colors displays the colors as well as the numerals.*

Colors

When this is selected, colors are displayed for the MacroBlock statistics, overlaid onto each MacroBlock.

The colors give a quick visual indication of the values in the video; the smaller the number, the more towards blue, the larger the number, the more towards red:

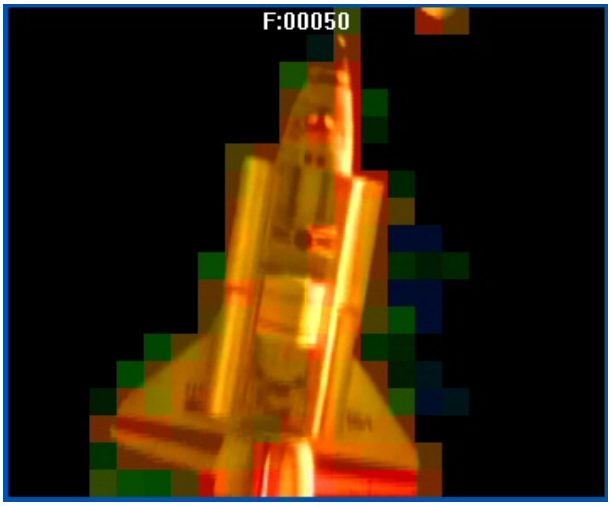


NOTE. *If it is hard to see the colors, the video can be blanked (set to mid gray) by selecting Blank video in the Overlay menu. You can also blank the video by pressing the B key when the video is selected.*

If exact numbers are required, turn on the numerals, instead of, or in addition to, the colors, or use the MacroBlock tooltip.

The Color Map Key can also be displayed from Windows > Toolbars.

The following example shows bits per MacroBlock in frame 50 of the MPEG-4 example file Space (no color = no bits):



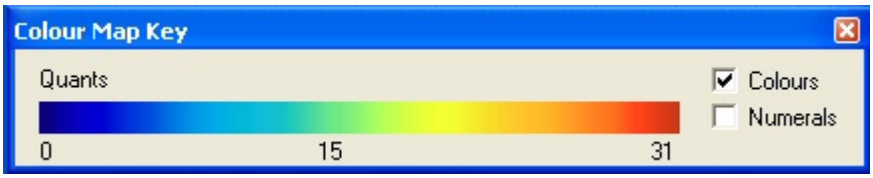
Linear/Logarithmic Scales

Some number ranges are best represented in linear scales (such as quants and slices); others are best in logarithmic scales.

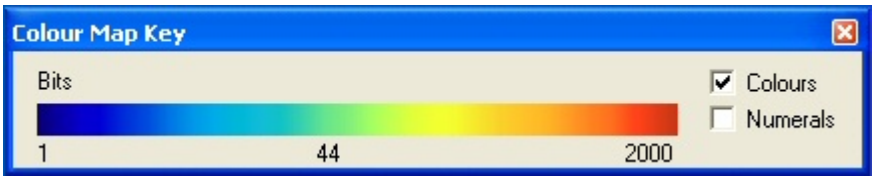
MTS4CC automatically chooses an appropriate scale and displays the values at the bottom, middle, and top of the color range.

The choice of linear/logarithmic scale made by the MTS4CC is indicated by the middle value on the color key. If the value is not numerically the average of the top and bottom values, a logarithmic scale has been chosen by the MTS4CC.

Linear scale (for example, quants, slices):



Logarithmic scale (for example, bits, average bits):



NOTE. *If you use this option with the Hold last frame option in the Play Menu, the total sequence statistics can be viewed in relation to the picture content.*

For interlaced video streams, some of the MB statistics overlays are not visible if the video is displayed in combined view (frame view). To see the statistics in this situation, switch to the separated fields view using the interlace toolbar (see Window Menu *on page 2-161 for more information).*

The MB statistics overlays apply only to the current frame:

- Quants
- Bits
- Fidelity

None. This option switches off any displayed overlaid MacroBlock statistics on the current frame.

NOTE. *The None option does not turn off the motion vector plot or MacroBlock type display.*

Quants. This option shows the quantizer used for the luminance for each decoded MacroBlock.

If the MacroBlock was not coded, no number/color is displayed.

This option can be used with Motion Vectors and/or MacroBlock types, but not with any other digit overlay option.

Bits. This option overlays the number of bits used to encode each MacroBlock in the current frame.

If the MacroBlock was not coded, no bits are shown/no color is shown, even though in MPEG-4 and H.263 a single bit is sent to signify an uncoded MacroBlock.

NOTE. *Because there is only enough space to display three digits, if the MacroBlock used more than 999 bits, +++ is displayed to signify an overflow (a number greater than 999).*

This option can be used with Motion Vectors and/or MacroBlock types, but not with any other digit overlay option.

Fidelity. This option shows the fidelity analysis values for each MacroBlock, for example, PSNR in dB (decibels):

NOTE. *Fidelity is grayed out until fidelity analysis is enabled.*

The type of fidelity analysis done is shown in the Fidelity tab of the Analysis options.

Overlay Color

This item allows the selection of the color of the overlays. You can see the values even if the decoded image is very dark (choose white) or very light (choose black). It affects all the number overlays as well as the motion vector overlay.

In the motion vector overlay, two colors may be used for some video standards - in this case:

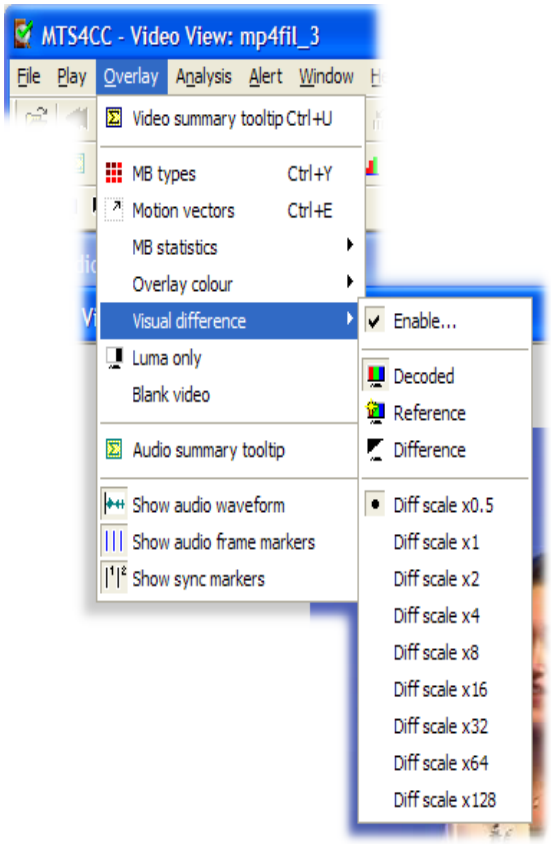
- Black selects black and dark blue colors for overlays
- White selects white and light blue colors for overlays

See *Motion Vectors* on page 2-78 for more information.

Black. This selects a black/dark blue color for the overlays.

White. This selects a white/light blue color for the overlays.

Visual Difference



This menu option enables the visual difference video display; this uses an uncompressed video reference file to show a video view of any of the following:

- The encoded (compressed) bitstream
- The uncompressed video reference bitstream
- The visual difference between the encoded bitstream and the uncompressed video reference file

NOTE. *The visual difference display can be done on a range of frames only, if this range is at the start of a file. For example, only the first ten frames of the YUV reference file are provided for the H.264/AVC and MPEG-2 bitstreams Grenadier Guards.*

When displaying the compressed bitstream, the uncompressed video reference file, or the difference between the two, all the standard MTS4CC video playing controls can be used to play the video forward/backward (although some of the unrelated seek functions be grayed out).

Luma Only

This displays the luma (luminance) of the compressed bitstream, the uncompressed video reference, or the difference between two.

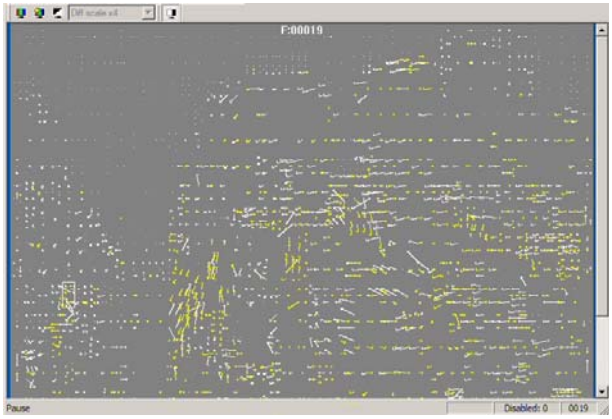
When this option is selected, only the luminance of the image in the video window is shown:

Luma only not selected

Luma only selected

Blank Video

This option will blank the video output to a gray color. It is included so that the motion vectors and other data can be viewed more clearly without the visual interference of the decoded image.

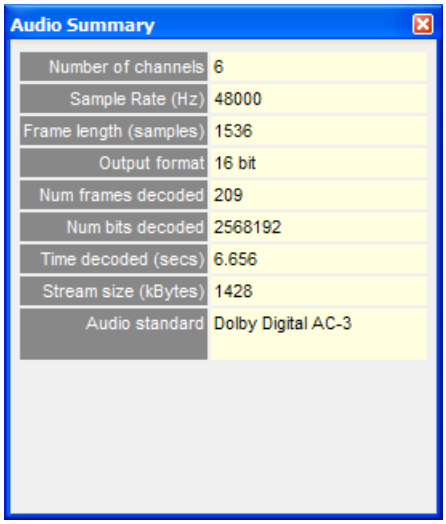


In this example, the motion vector overlay is on and the video is blanked. You can also blank the video by pressing the B key when the video is selected.

NOTE. *The Blank video option is available only when one of the overlays on the Overlay menu is in use; otherwise it is grayed out.*

Audio Summary Tooltip

When this option is selected, a window is displayed that provides summary information about the audio frame being displayed or the sequence as a whole. The displayed information differs depending on whether the stream is playing/paused or is in stop mode. The selection of information provided by the audio summary tooltip is as follows:



Number of Channels

If the audio stream is mono, this number will be one (1); if the stream is stereo, this number will be two or more.

Sample Rate (Hz)

Sample rate of the decoded audio in samples per second (Hz).

Frame Length (samples)

Number of audio samples in each decoded audio frame.

Output Format

The output audio sample format bit depth in bits per sample.

Num Frames Decoded

The running total of decoded frames.

Total Frames

The total number of decoded audio frames in the stream.

Time Decoded (secs)

The time in seconds from the start to the current point in the sequence, calculated as if the sequence were playing normally (the MTS4CC keeps track of the playing time, irrespective of whether the sequence is paused at some point or played in fast forward mode).

Total Time (secs)

The duration of the stream in seconds.

Ave. Bit Rate (kbits/s)

This is total bits (kbits) divided by total time (secs).

Ave. Frame Rate (Hz)

This is total frames divided by total time (secs).

Stream Size (kBytes)

The size of the stream in KB.

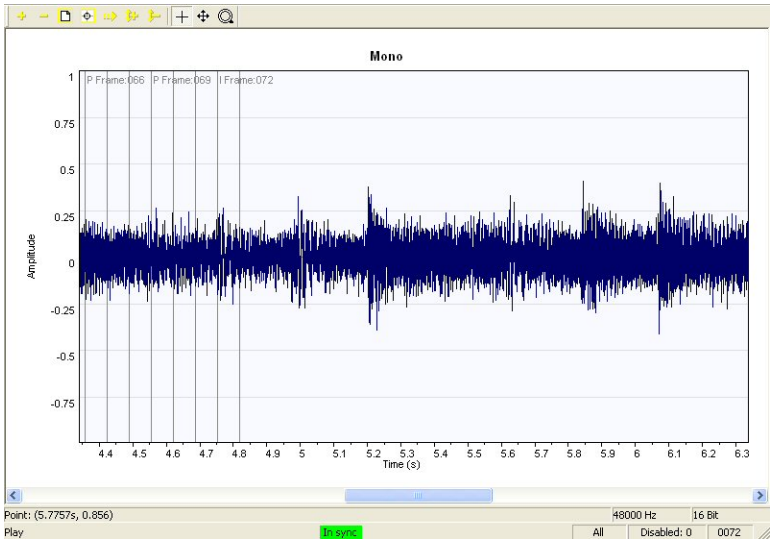
Audio Standard

The audio standard used.

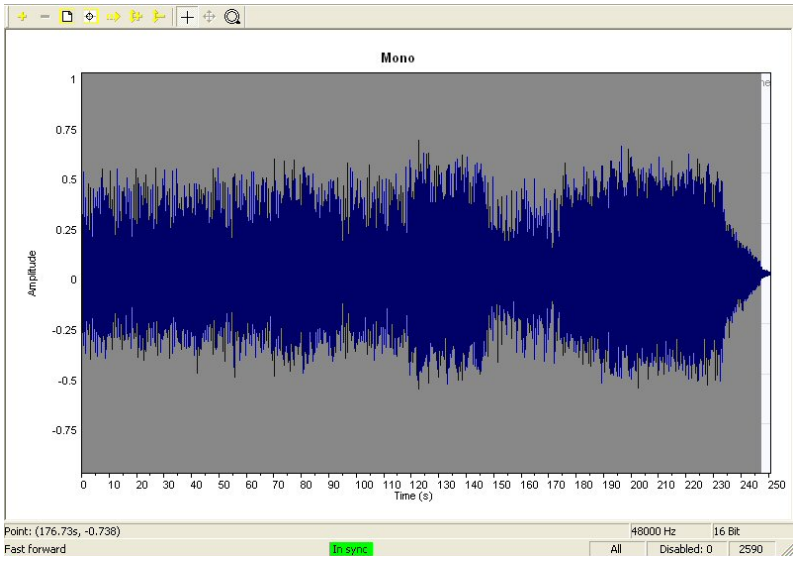
Show Audio Waveform

MTS4CC offers the ability to view an audio streams waveform: the y-axis is normalized amplitude, and the x-axis is time (seconds).

The audio streams waveform can be viewed while the stream is playing, showing the frames being marked off on vertical bars as the stream is decoded:

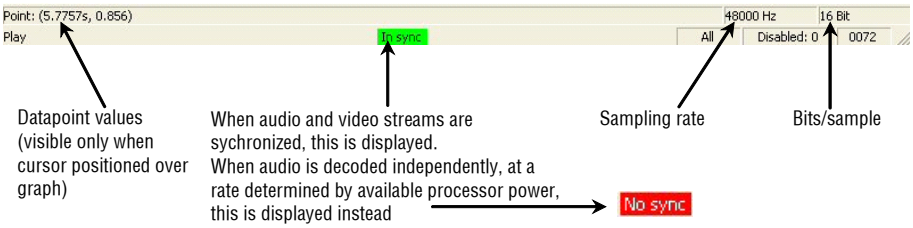


It can also be viewed when the stream has been played through to its end:

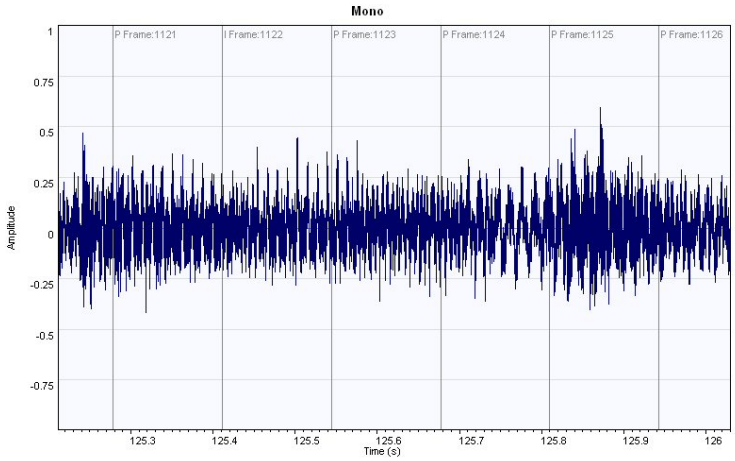


The gray background is due to the density of marked-off frames; when the zoom out icon is used, the spacing between the frame marking increases and the shape of the waveform becomes more easily discernible (see the following figure). At each frame marker, the frame type and number is shown.

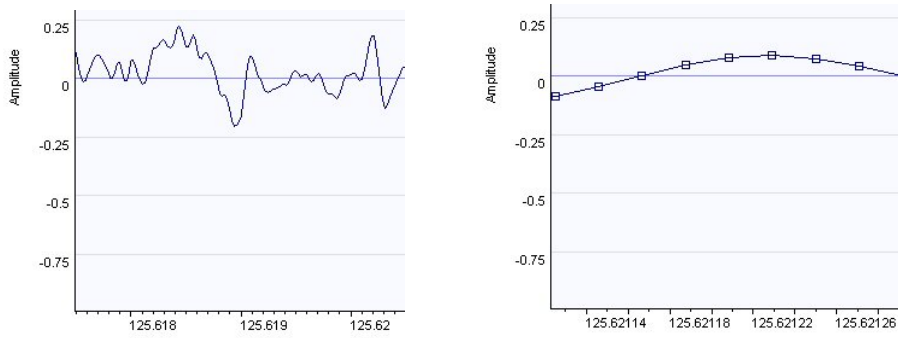
Additional information can be found in the Audio waveform views status bar:



It is possible to zoom in and out on this graph view using the first two icons on the waveform view toolbar, as illustrated below.

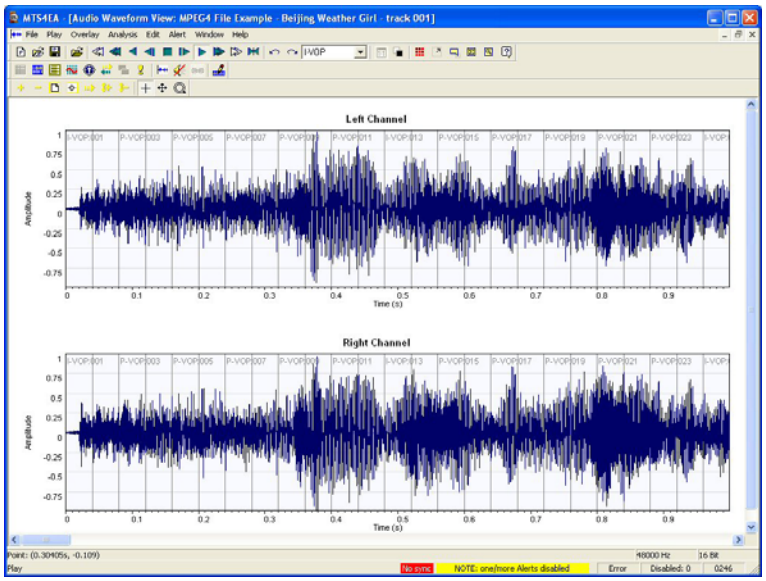


The following two illustrations show that it is possible to zoom in so far as to see the individual data points plotted in the audio waveform.



The functions of the other icons are described under *Audio Waveform Toolbar icons* on page 2-93.

The following screenshot shows the waveform of a stream with multiple channels:



Audio Waveform Toolbar icons

Icon	Function
	Zoom in (+) and zoom out (-) centered on the window (affects scale of x-axis only).
	Fit all data into window.
	Locate origin (zero), for example, start of sequence.

Icon	Function
	Autoscroll, for example, fill the analysis data in real-time as the audio is decoded, and scroll the window to the right.
	Increase channel height (affects scale of y-axis only).
	Decrease channel height (affects scale of y-axis only).
	Measure the data at the cursor. Values are reported in status bar. Hold and drag to measure offsets and angles/slopes of lines.
	Scroll/pan (the cursor changes to show the scroll/pan direction).
	Zoom in/out centered on the cursor. Press <Shift> to zoom out.
	Show or hide audio frame markers.
	Show or hide the audio waveform.
	Show or hide the audio/video synchronization markers.

Show Audio Frame Markers

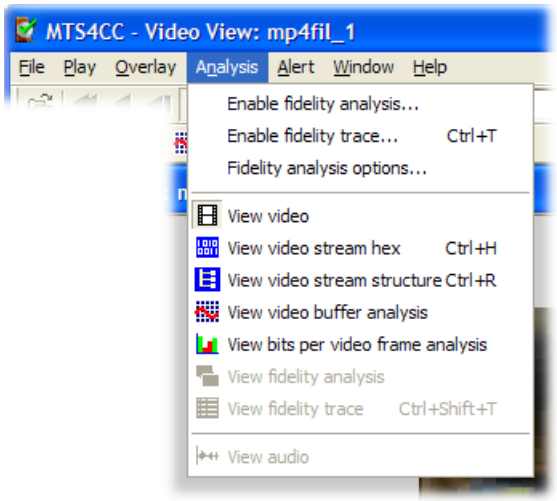
Shows/hides the audio frame markers.

Show Sync Markers

Shows/hides the audio synchronization markers.

Analysis Menu

The following paragraphs describe the options available in the Analysis menu.



This menu controls the collection and display of fidelity analysis and trace information. The menu also displays the following:

- Hex (hexadecimal) view of stream data
- The structure of the file being analyzed
- Analysis of the video buffer usage

NOTE. *Fidelity Analysis and Fidelity Trace cannot be set in pause mode. The video must be stopped, otherwise MTS4CC cannot ensure that the Trace and Fidelity data were collected over the correct range of frames.*

Enable Fidelity Trace

To enable Fidelity Trace, the Fidelity Analysis check box on the Visual Difference/Fidelity tab of the Fidelity Analysis Options dialog box must be selected.

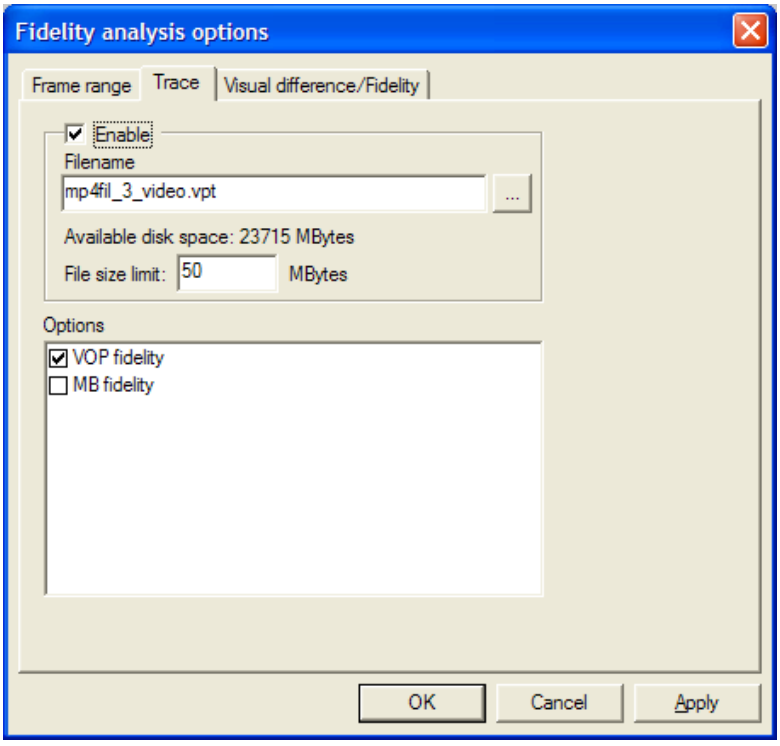
The Trace options provide text outputs that describe the contents of an encoded video stream, to various levels of detail.

The available Trace options vary with each video standard; the following screenshot is for MPEG-4.

NOTE. *Using these options can generate a lot of data - files hundreds of MB or more in size. It is often advisable to collect the data required in a limited range of frames.*

To set the range of frames over which to collect the Trace data, click on the Frame Range Tab, see 2-97.

Alternatively, you can set a maximum file size, after which no more trace data is output to the file concerned.



NOTE. *The video can be stopped and the Trace file opened immediately after going past the last frame number in the frame range – there is no need to wait until the end of the video sequence.*

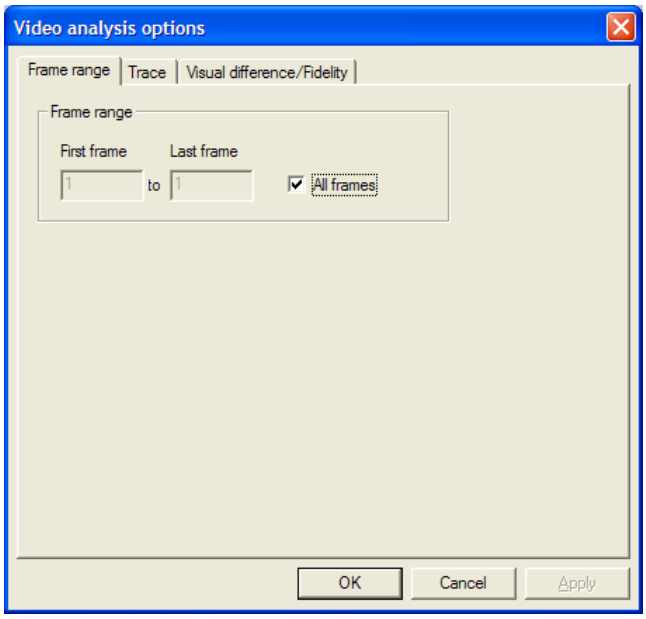
Frame Range Tab

This option allows you to specify the start and end frames between which to gather the Trace and Graphs information.

NOTE. *The frame range set on this tab is the same frame range used for the collection of MacroBlock statistics, where these are collected over a range of frames.*

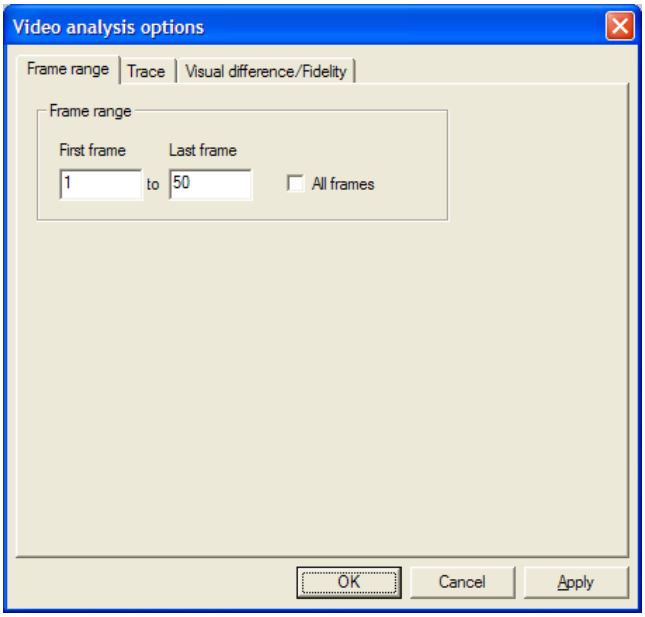
The frame range over which statistics are to be accumulated cannot be changed during pause mode; otherwise the MTS4CC cannot ensure that the Trace and Graph data were collected over the correct range of frames. For example, if the video was paused at frame 23 and Trace was enabled for a range of frames from 20-25, the Trace data would be incorrect.

Clicking on Frame range takes you to the frame range tab:



All frames. This option is the default and calculates the sequence statistics from the start of the sequence until the current frame.

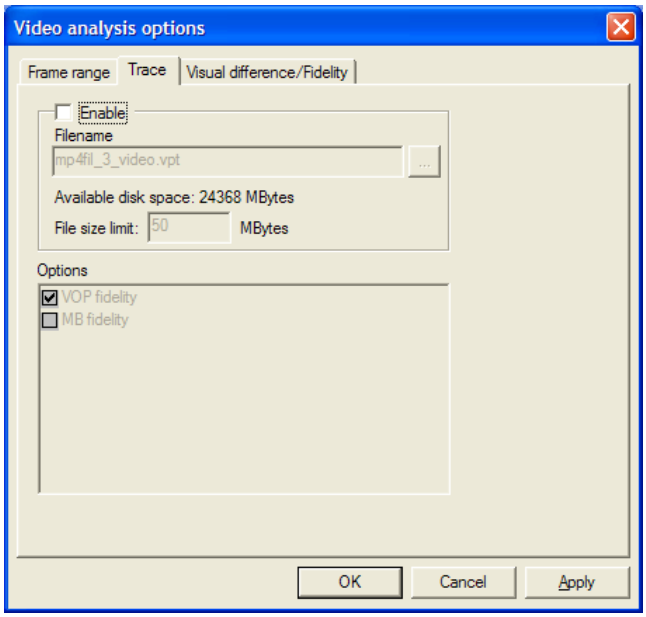
To set a range of frames. If the All frames check box is cleared, then a range of frames can be entered (in this case, frames 1 to 50 inclusive):



When a range of frames has been set, the Frame range item on the MB statistics menu changes, with a check mark to indicate a range of frames has been set:

Trace Tab

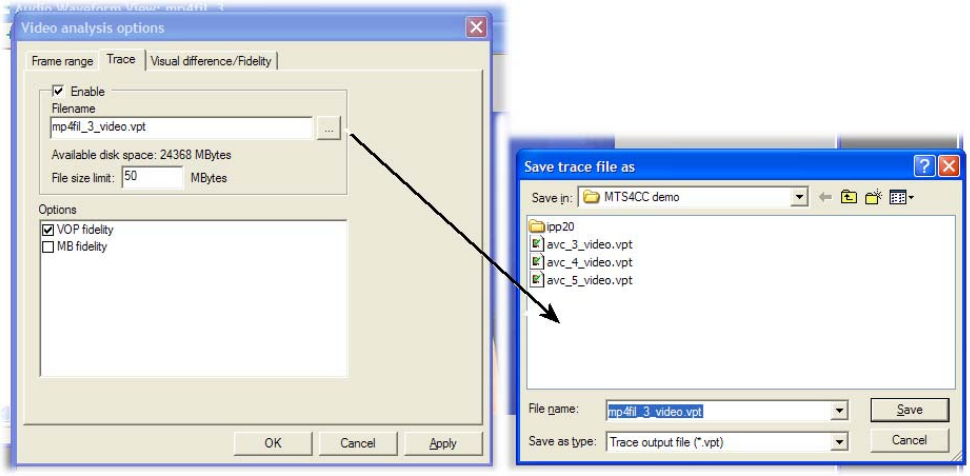
Enable. This option Enables/Disables the Trace output. If the output is disabled, the remaining selections on the Trace tab are unavailable (grayed out) although the values are stored during the current use of the MTS4CC. (They are reset to their default values the next time the MTS4CC is started.)



Filename. By default, the suggested filename is the same as the base name of the input video file (the video filename without the extension).

Any other filename can be entered; the MTS4CC will append a `.vpt` extension to this filename if it does not already end in this. (.vpt = MTS4CC trace).

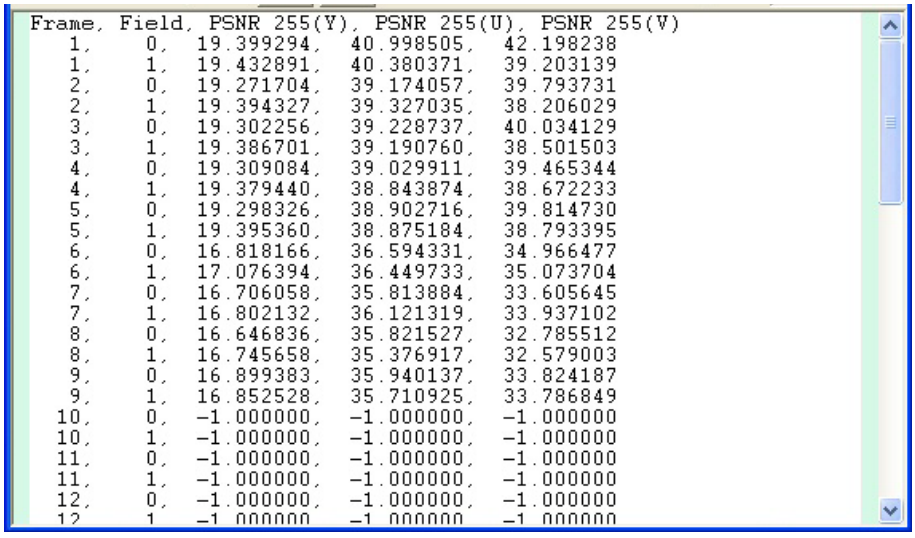
To browse to a specific folder and enter the filename there, click the [...] button:



File size limit (available disk space). This entry allows you to limit the amount of disk space taken by the Trace file.

Once the Trace file reaches this size, it stops writing more data.

Frame fidelity [H.264/AVC, MPEG-2, and H.263] or **VOP fidelity** [MPEG-4]. This provides a Trace output of the fidelity analysis frame-by-frame.

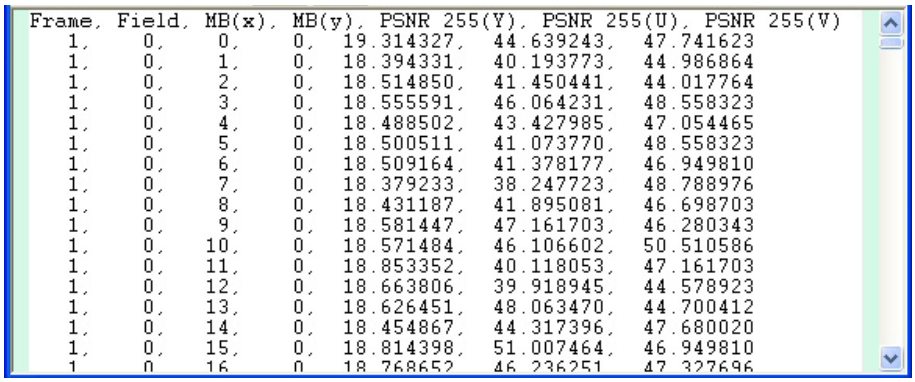


Frame	Field	PSNR 255(Y)	PSNR 255(U)	PSNR 255(V)
1	0	19.399294	40.998505	42.198238
1	1	19.432891	40.380371	39.203139
2	0	19.271704	39.174057	39.793731
2	1	19.394327	39.327035	38.206029
3	0	19.302256	39.228737	40.034129
3	1	19.386701	39.190760	38.501503
4	0	19.309084	39.029911	39.465344
4	1	19.379440	38.843874	38.672233
5	0	19.298326	38.902716	39.814730
5	1	19.395360	38.875184	38.793395
6	0	16.818166	36.594331	34.966477
6	1	17.076394	36.449733	35.073704
7	0	16.706058	35.813884	33.605645
7	1	16.802132	36.121319	33.937102
8	0	16.646836	35.821527	32.785512
8	1	16.745658	35.376917	32.579003
9	0	16.899383	35.940137	33.824187
9	1	16.852528	35.710925	33.786849
10	0	-1.000000	-1.000000	-1.000000
10	1	-1.000000	-1.000000	-1.000000
11	0	-1.000000	-1.000000	-1.000000
11	1	-1.000000	-1.000000	-1.000000
12	0	-1.000000	-1.000000	-1.000000
12	1	-1.000000	-1.000000	-1.000000

NOTE. *The lines in the preceding screenshot for frames 10 and above are empty because the corresponding YUV file stops at this point (there are no more frames in the YUV file). The -1 in the trace file indicates that the YUV file is missing.*

Some of the example files provided have the necessary corresponding YUV files for fidelity analysis.

MacroBlock fidelity. This provides a Trace output of the fidelity analysis for each MacroBlock in the frame range.



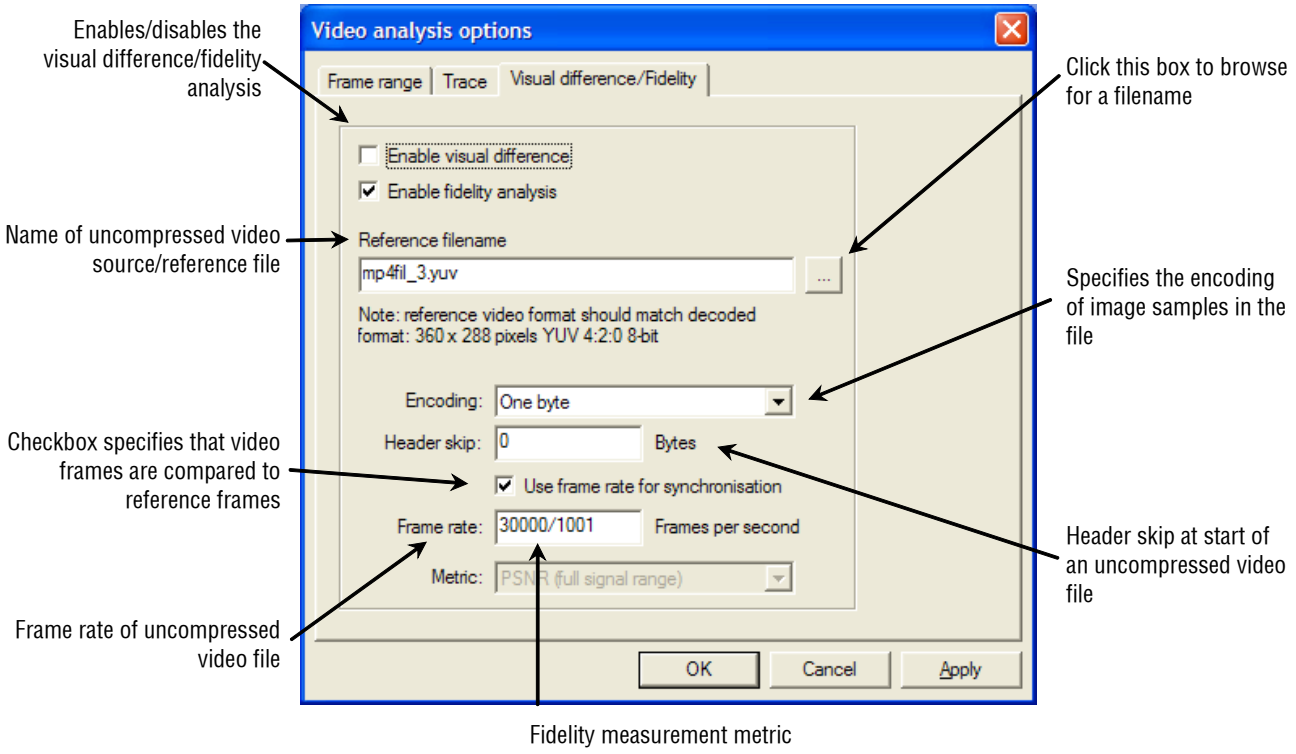
Frame	Field	MB(x)	MB(y)	PSNR 255(Y)	PSNR 255(U)	PSNR 255(V)
1	0	0	0	19.314327	44.639243	47.741623
1	0	1	0	18.394331	40.193773	44.986864
1	0	2	0	18.514850	41.450441	44.017764
1	0	3	0	18.555591	46.064231	48.558323
1	0	4	0	18.488502	43.427985	47.054465
1	0	5	0	18.500511	41.073770	48.558323
1	0	6	0	18.509164	41.378177	46.949810
1	0	7	0	18.379233	38.247723	48.788976
1	0	8	0	18.431187	41.895081	46.698703
1	0	9	0	18.581447	47.161703	46.280343
1	0	10	0	18.571484	46.106602	50.510586
1	0	11	0	18.853352	40.118053	47.161703
1	0	12	0	18.663806	39.918945	44.578923
1	0	13	0	18.626451	48.063470	44.700412
1	0	14	0	18.454867	44.317396	47.680020
1	0	15	0	18.814398	51.007464	46.949810
1	0	16	0	18.768652	46.236251	47.327696

NOTE. *Some of the example files provided have the necessary corresponding YUV files for fidelity analysis.*

Enable Fidelity Analysis

NOTE. *Some options on this tab are different when H.264/AVC High Profile is used.*

This opens the Visual difference/Fidelity analysis tab of the Fidelity Analysis options dialog box:



The results of the fidelity analysis are displayed:

- In the Trace files, when the appropriate Trace option is selected
- As real-time overlays, when the overlay is selected

Reference Filename

The name of the file used as the reference or source of encoding, of the encoded stream.

This file must be one of the following formats:

- 8 bits per sample, 4:2:0
- More than 8 bits per sample, and/or 4:2:2 or 4:4:4 (as used by H.264/AVC High Profile/FREXt, High/10, High/4:2:2, High/4:4:4)

YUV format of 8 bits per sample 4:2:0. The YUV file output is raw YUV with no headers of any kind. This is the same format used by the Microsoft MPEG-4 Part 2 reference encoder Reference [7] in the *Compression Standards and File Types* section and several other programs. The general file format is as follows:

- No headers of any kind (no file or frame headers)
- One byte per sample
- Row raster order (top picture row first)
- Planar YUV 4:2:0 sub-sampled (4 bytes of Y data for each byte of U data and each byte of Y data)
- Y plane values are 0-255 unsigned
- U and V plane values are unsigned with a DC offset of 128

Other uncompressed formats. The general uncompressed video file format is as follows:

- No headers of any kind (no file or frame headers)
- Concatenated planar image data
- Row raster order (top picture row first)
- Unsigned samples

For 8-bit sample depth:

- One byte per sample

For 9-16 bit sample depth:

- Two bytes per sample
- Both little- and big-endian byte orders supported

For YUV format:

- Concatenated Y, U, and V planes
- U and V planes sub-sampled as required
- Y plane samples are unsigned
- U and V plane samples are unsigned with a DC offset of 2^{n-1}, where *n* is the chroma sample bit depth

For RGB format:

- Concatenated R, G, and B planes

For grayscale format:

- Luma plane only

NOTE. *There are built-in example YUV reference files for three of the example bitstreams: for MPEG-4 Man Walking, for H.264/AVC Grenadier Guards and for MPEG-2 Grenadier Guards. When these example streams are selected and fidelity analysis is enabled, the file names are automatically filled in. See* Example Files *on page 2-32 for more information.*

Encoding

This control specifies the encoding of image samples in the file format. The following options are available:

- One byte - this specifies that image samples are stored in one byte per sample. This format is appropriate if all image planes are eight bits deep.
- Two byte MSB first - this specifies that image samples are stored in a pair of bytes for each sample. The most significant byte occurs first in each pair (big-endian). This format is appropriate if one or more image planes are deeper than eight bits.
- Two byte LSB first - this specifies that image samples are stored in a pair of bytes for each sample. The least significant byte occurs first in each pair (little-endian). This format is appropriate if one or more image planes are deeper than eight bits.

Header Skip

The number of bytes at the start of the file before the first frame. The MTS4CC will skip past these bytes (ignoring them).

Use Frame Rate for Synchronization

This check box specifies that decoded video frames should be compared to reference frames according to corresponding time stamps. If this check box is not selected, then corresponding frame numbers are used.

Frame Rate

The rate at which the uncompressed video frames were recorded, in frames per second.

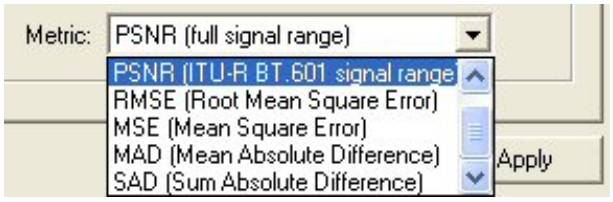
NOTE. *The number entered in the Frame rate field can be an integer (for example, 30), a fraction (for example, 30000/1001), or a decimal number (for example, 29.97).*

Note that this frame rate is often different from the frame rate of the encoded video; for example, there can be frame skipping in the encoder, or a lower frame rate selected (such as encoding 30 frames/second video at 15 frames/second).

The Frame Rate value is used to determine which uncompressed video frame to associate with which encoded frame. The MTS4CC works out the time code for each uncompressed video frame based on the Frame Rate value and associates the uncompressed video frame concerned with the encoded frame with the closest time code.

Metric

This selects the measurement metric to use, which is one of the following:



The objective fidelity metrics provided by MTS4CC measure the degradation of the decoded image with respect to a reference image. The metric is evaluated independently for each image plane in the color space dictated by the video decoder (typically YUV).

The fidelity metrics are calculated either per MacroBlock or overall on the frame as a whole, as per the following equations.

For the explanations of fidelity metrics, the following nomenclature is used:

| … |	Denotes taking the absolute value of an expression
Σ	Denotes the summation of an expression over the range of (x, y) in the image plane
f(x, y)	Is the sample value at the location (x, y) in the reference image plane
g(x, y)	Is the sample value at the location (x, y) in the decoded image plane
N	Is the total number of samples in the image plane

PSNR (full signal range). The PSNR (Peak Signal to Noise Ratio) metric is defined as the ratio between signal power and noise power, on a decibel scale. In the context of image processing, signal power is taken to be the square of the peak image sample value and noise power is taken as the square of RMS error in the image.

$$PSNR = 10 \cdot \log (S2/ RMS2)$$

For PSNR (full signal range) the peak image value is assumed to be the maximum value for the bit-depth in all three image planes. For example, in an 8-bit image, this implies:

$$PSNR255 = 20 \cdot \log (255/ RMS)$$

PSNR (ITU-R BT.601 signal range). For PSNR (ITU-R BT.601 signal range) the PSNR is calculated differently in Y than in U and V:

$$PSNR_Y = 20 \cdot \log (220/ RMS)$$

$$PSNR_{U,V} = 20 \cdot \log (225/ RMS)$$

RMSE (Root Mean Square Error). The RMS is the defined as the square root of MSE.

$$RMS = \sqrt{MSE}$$

MSE (Mean Square Error). The MSE metric is defined as the mean of the squares of differences between samples in the reference and decoded image planes.

$$MSE = 1/N \, \Sigma \, [f(x, y) - g(x, y)]^2$$

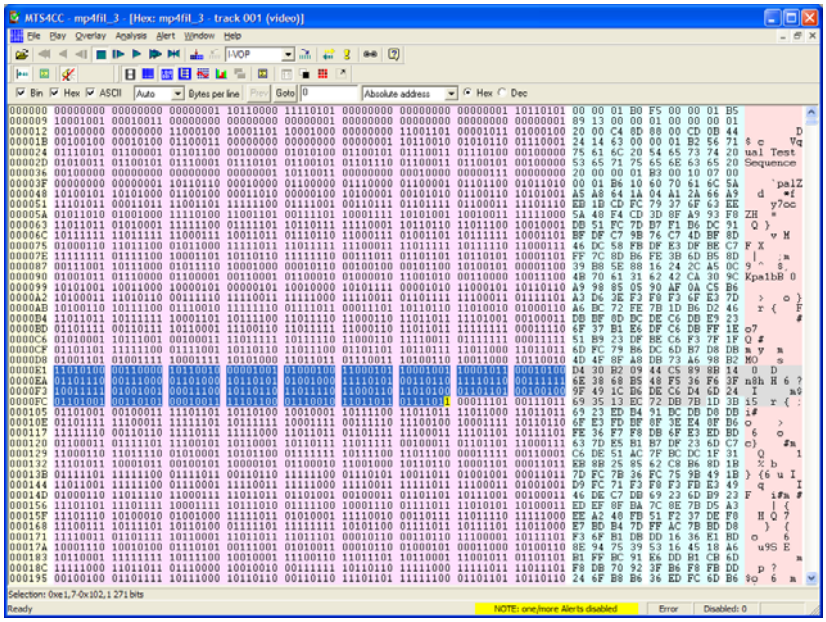
MAD (Mean Absolute Difference). The MAD metric is defined as the mean average of absolute differences between samples in the reference and decoded image planes.

$$MAD = 1/N \, \Sigma \, | f(x, y) - g(x, y) |$$

SAD (Sum Absolute Difference). The SAD metric is defined as the sum of absolute differences between samples in the reference and decoded image planes.

$$SAD = \Sigma \, | f(x, y) - g(x, y) |$$

View Video Stream Hex



This opens the current video file in a hex viewer, which shows the data in binary, hexadecimal, and ASCII data (in any combination of the three).

NOTE. *Multiple hex view windows can be opened at the same time.*

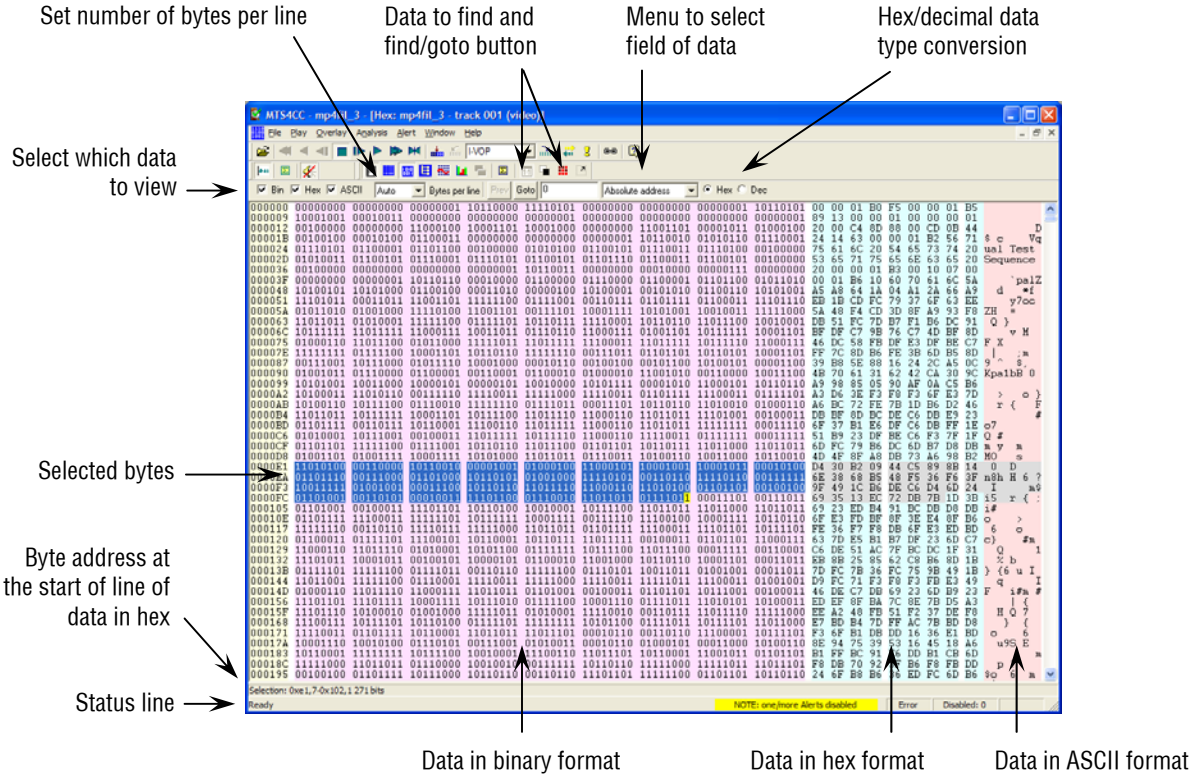
Using HexView, you can scroll through the file, and search for specific:

- Absolute address (from the start of the file)
- Relative address (from the currently selected location)
- Bit patterns
- Hex data
- ASCII data

NOTE. *In the field where the data to find is entered, a wildcard character can be entered - this is . [period]*

Also, entering a hex value, and then clicking Dec will convert this number to decimal (and vice versa).

Sections of HexView Window



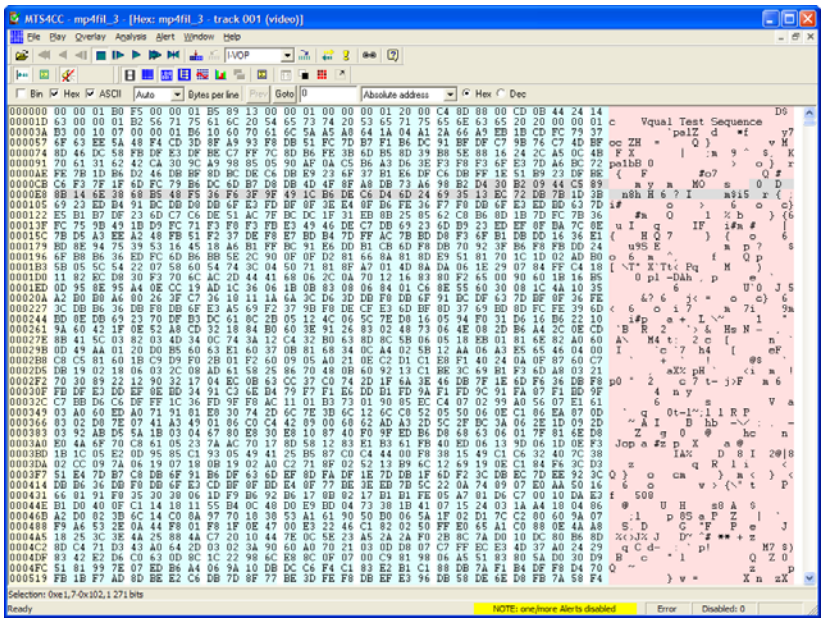
Setting Information Displayed; Window Width

The HexView window can be set (for example, resized) as with any other window in Windows.

In this window, the same data is shown in three sections, in three formats:

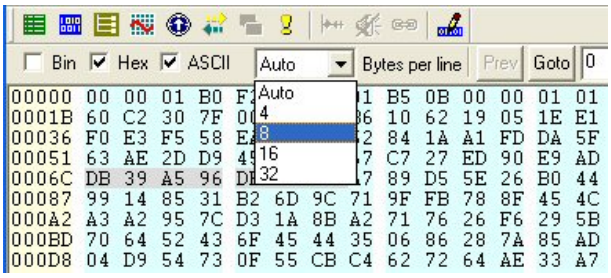
- Binary
- Hexadecimal
- ASCII

Each of these areas can be individually displayed/not displayed by clicking the appropriate check box in the top left. In the following example, the binary display has been switched off, leaving only hex and ASCII.



Setting Bytes per Line

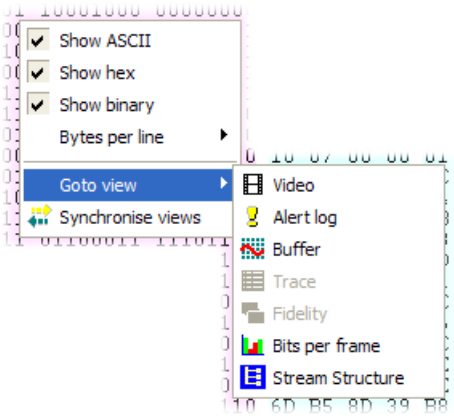
This menu is used to set the number of bytes per line:



If the current width of the window is insufficient to show all the columns, a scroll bar automatically appears at the bottom, allowing left/right scrolling to see all the columns:

Right-Click Pop-up Menu/Goto View

Right-clicking in the HexView window generates this menu:



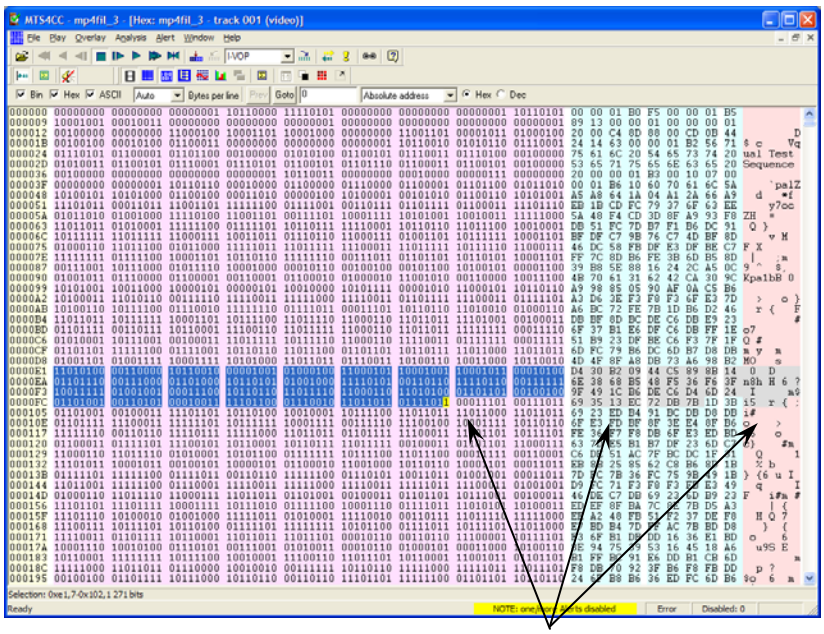
The top four buttons of the menu have the same functions as the buttons given on the top line (and as the HexView settings option in the Window menu).

Goto view. The Goto view takes the focus to the corresponding area in the selected view (see *Synchronized Views/Navigating the Views* on page 2-6 for more information).

Synchronize views. When the Synchronize views icon  is pushed in, all open windows automatically follow the selection (see *Synchronized Views/Navigating the Views* on page 2-6 for more information).

Highlighting a Section

A section of data can be highlighted in any of the (visible) binary, hex or ASCII sections by clicking and dragging the mouse over the area:



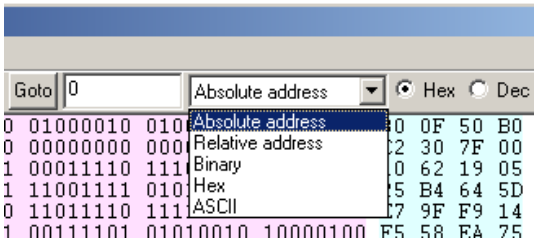
The addresses of the selected area and the number of bytes selected are displayed in the status line

Whichever section is highlighted, the corresponding areas of the other sections are similarly highlighted

One of the following specific addresses can be found in the video stream:

- An absolute address, from the start of the video file
- A relative address, from the first byte of the currently selected area

Find absolute address. To go to an absolute address, select Absolute address from the drop-down menu:



Enter the address to find in the box next to the Goto button. This address can be in hex or decimal. If an invalid character is entered for an address (for example,

entering anything other than 0-9 or a-f for a hexadecimal address) then the Goto button is grayed out.

The Goto button changes to Next for all data to find except for the Absolute address. (When Absolute address is selected, the Prev button is grayed out.)

The Hex/Dec radio button selects the format of the data being searched: Hexademical or Decimal.

Find relative address. An address relative to the currently highlighted address can be found. If no address is highlighted, the address found is the offset from 0.

The address to find is entered in the box next to the Next button. This address can be in hex or decimal. If an invalid character is entered for an address (for example, entering anything other than 0-9 or a-f for a hexadecimal address), the Find button is grayed out.

NOTE. *Tyou can press the F3 key to find next, and the Shift+F3 key to find previous.*

The Hex/Dec radio button selects the format of the data being searched.

Find Binary/Hex/ASCII. These options in the menu find data in the bitstream.

Up to 64 characters can be entered.

NOTE. *The Binary search searches for the bit pattern regardless of byte location; the Hex and ASCII searches are byte aligned.*

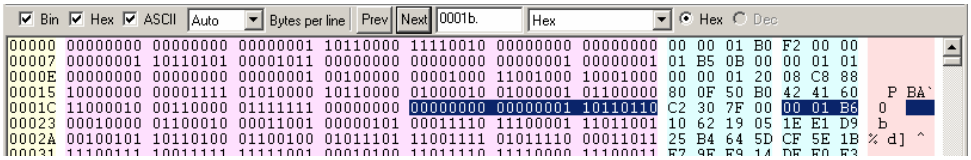
The F3 key can be used, to find next; Shift+F3 key, to find previous.

Wildcard searching using period. A wildcard can be entered in the data to be found - **.** [period].

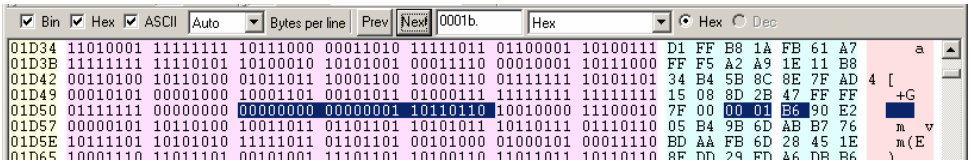
The wildcard matches a single digit in the selected base; the wildcard matches:

- One bit in the binary find
- A hex digit in the hex find
- An ASCII character in the ASCII find

For example, entering ‘0001B.’ as a hex string will find the following patterns in the selected example stream:

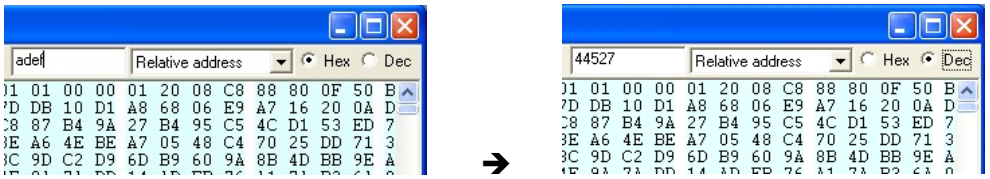


The wildcard can be inserted in any position, for example, ‘03..456.8’ is a valid search string, which will find any 9 consecutive digits where the first two are 03, digits 5-7 are 456, and the last digit is 8.



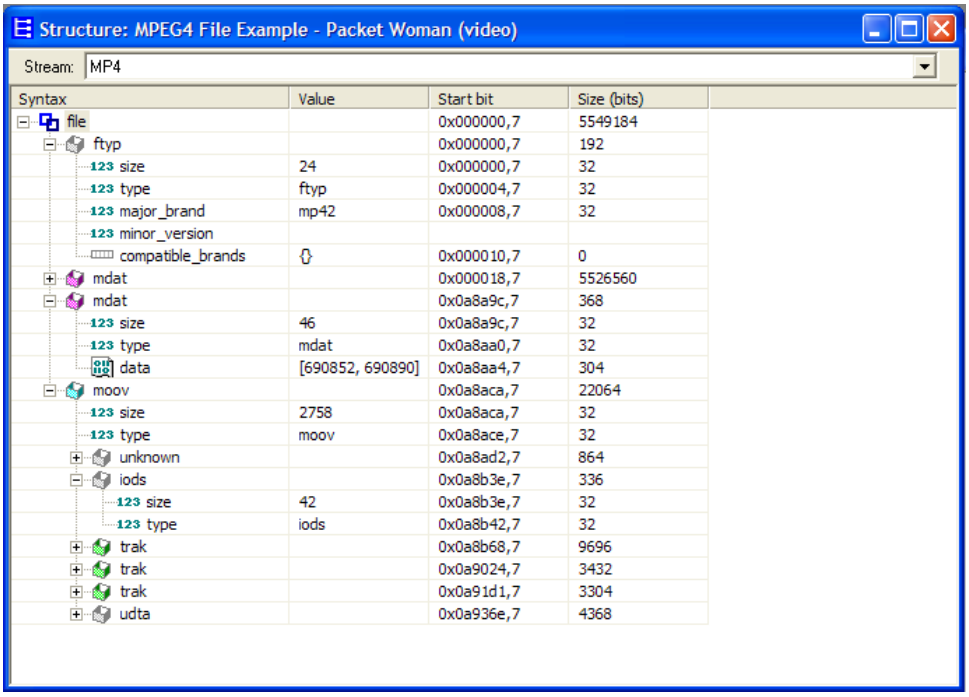
Conversion of Hex<->Decimal

With Hex selected and a hex value entered in the find box, when the Dec button is selected, this value is converted to a decimal value (and vice versa) as shown in the following screenshots:



View Video Stream Structure

This allows the structure of all supported container formats to be viewed and expanded/contracted (by clicking on the - and + symbols at the left end of each line). In addition, for H.264/AVC video elementary stream format, the view shows the top-level structure of the stream.



Syntax	Value	Start bit	Size (bits)
file		0x000000,7	5549184
ftyp		0x000000,7	192
123 size	24	0x000000,7	32
123 type	ftyp	0x000004,7	32
123 major_brand	mp42	0x000008,7	32
123 minor_version			
compatible_brands	{}	0x000010,7	0
mdat		0x000018,7	5526560
mdat		0x0a8a9c,7	368
123 size	46	0x0a8a9c,7	32
123 type	mdat	0x0a8aa0,7	32
data	[690852, 690890]	0x0a8aa4,7	304
moov		0x0a8aca,7	22064
123 size	2758	0x0a8aca,7	32
123 type	moov	0x0a8ace,7	32
unknown		0x0a8ad2,7	864
iods		0x0a8b3e,7	336
123 size	42	0x0a8b3e,7	32
123 type	iods	0x0a8b42,7	32
trak		0x0a8b68,7	9696
trak		0x0a9024,7	3432
trak		0x0a91d1,7	3304
udta		0x0a936e,7	4368

The view is divided into four columns:

- **Syntax**: Shows the stream syntax parse tree, including the names of each syntax element or syntactic structure. Nested syntax structures are shown by nesting nodes of the tree. An icon shows the type of data at each tree node. See *Icons in Stream Structure View*.
- **Value**: Shows the interpreted value of syntax elements in the tree. The content of this field will vary according to the type of data to be shown.
- **Start bit**: Shows the start bit address of the syntax node. The address is given as a hexadecimal byte position followed by a bit position number.
- **Size**: Shows the size in bits of the syntax node. For nodes with children, this shows the total bits of the node and all its children.

Icons in Stream Structure View

In the Stream structure view, the icons that appear at the node of each branch of the tree structure denote the type of data contained in that node. There are a number of icons that are common to all standards as described in Table 2-1. Table 2-2 shows icons that are specific to different standards.

Table 2-1: Icons common to all standards

Icon	Meaning
	Video elementary stream
	Audio elementary stream
	Container stream
	Packet or other syntactic grouping (various colors used – see standard specific icons)
	Binary data
	Integer data field
	Binary data field
	Exponential-Golomb coded data field
	String data field
	Identifier data field
	Time data field
	Custom data field
	Unknown data field
	User data
	Array based data structure
	List based data structure
	Video ES slice data
	Video ES macroblock data

Table 2-2: Standard-specific icons

Standard	Icon	Meaning
H.264/AVC		IDR access unit
		Non-IDR access unit
		‘moov’ box type
		‘mdat’ box type
		‘trak’ box type
		Generic MP4 descriptor
MPEG-2 TS		Transport packet
		Program association section
MPEG-2 PS, PES		System header
		Pack header
		Pack syntactic structure
ASF		Header object
		File properties object
		Stream properties object
		Index object

View Video Buffer Analysis

This allows the buffer usage to be analyzed in detail. The analysis varies by video standard:

For H.264/AVC the analysis is of:

- Performance using the Hypothetical Reference Decoder (HRD) (displayed in red)

For MPEG-4 the analysis is of:

- Video Buffer Verifier (displayed in Red)
- Video Complexity Verifier (displayed in Green)
- Video Memory Verifier (displayed in Blue)

For MPEG-2 the analysis is of:

- Video Buffer Verifier (displayed in Red)

The icon controls and general look of the buffer analysis is the same for all standards:

- The buffer analysis controls that are common to all standards are explained in the sections from *Buffer Analysis Toolbar Icons* on page 2-118 to *Buffer analysis alerts/scroll bar area* on page 2-121 (although some of the diagrams in these sections are specific to a standard regarding the titles and data content, the functions are the same across all standards).
- MPEG-4 and MPEG-2 VBV analysis are very similar and are explained in the sections from *Buffer analysis controls: MPEG-4 and MPEG-2* on page 2-122 to *Buffer analysis pop-up alerts: MPEG-4 and MPEG-2* on page 2-124.
- The H.264/AVC HRD analysis is distinct and is explained in the sections from *HRD buffer analysis: H.264/AVC* on page 2-125 to *HRD buffer overflow/underflow indication: H.264/AVC* on page 2-127.

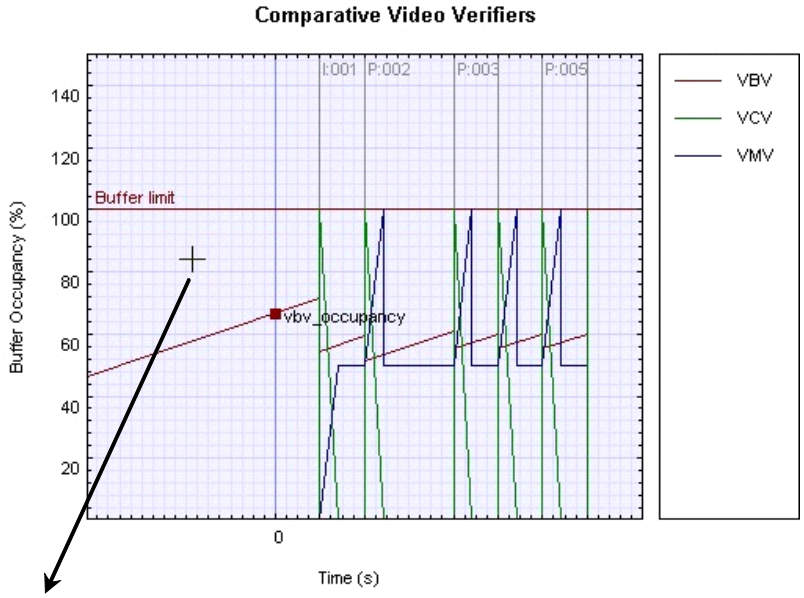
Buffer Analysis Toolbar Icons

Icon	Function
	Zoom in (+) and zoom out (-) centered on the center of the window (affects scale of x-axis only)
	Fit all data into window
	Locate origin (zero), start of sequence
	Lock X/Y zoom in/out and scrolling/panning. For example, when the Lock Y button is pressed, zoom in and zoom out and scroll/pan only affect the X-direction. This allows (for example) you to keep a useful vertical scale, while still viewing the whole length of the video sequence
	Autoscroll (fill the analysis data in real-time) as the video is being decoded and scroll the window to the right
	Increase track height (affects scale of y-axis only)
	Decrease track height (affects scale of y-axis only)
	Measure the data at the cursor. The data values are reported on the status line at the bottom of the analysis window Offsets and angles/slopes of lines can also be measured by holding the mouse and dragging
	Scroll/pan (the cursor changes to show the scroll/pan direction)
	Zoom in/zoom out centered on the location of this cursor. Press the <shift> key to zoom out

These functions are also available on the right-click menu.

Using the Measure Tool

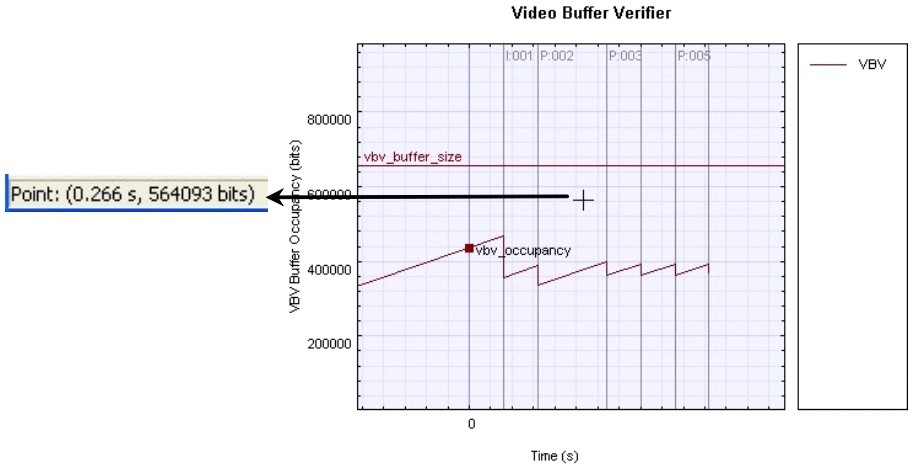
Moving the measure tool over the graph displays the values in the status line:

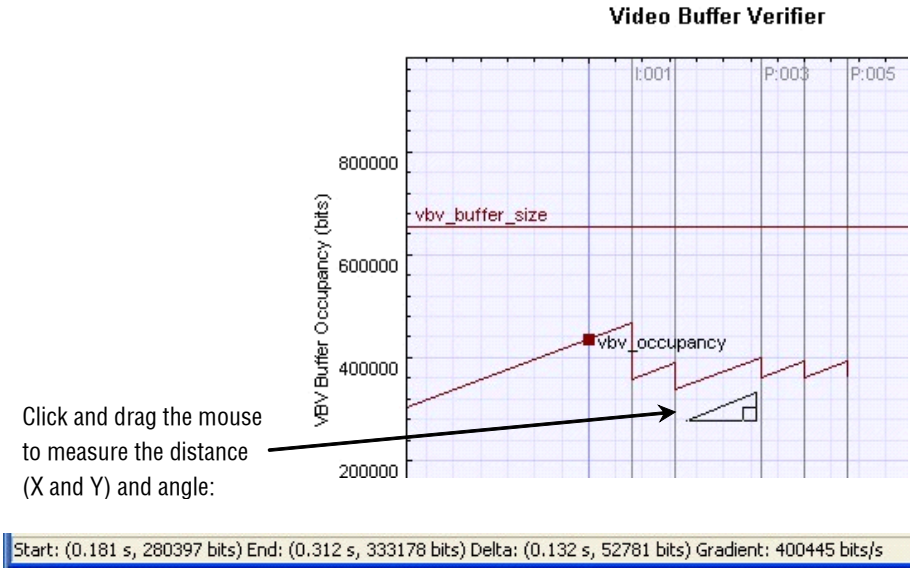


Point: (-0.149 s, 84 %)

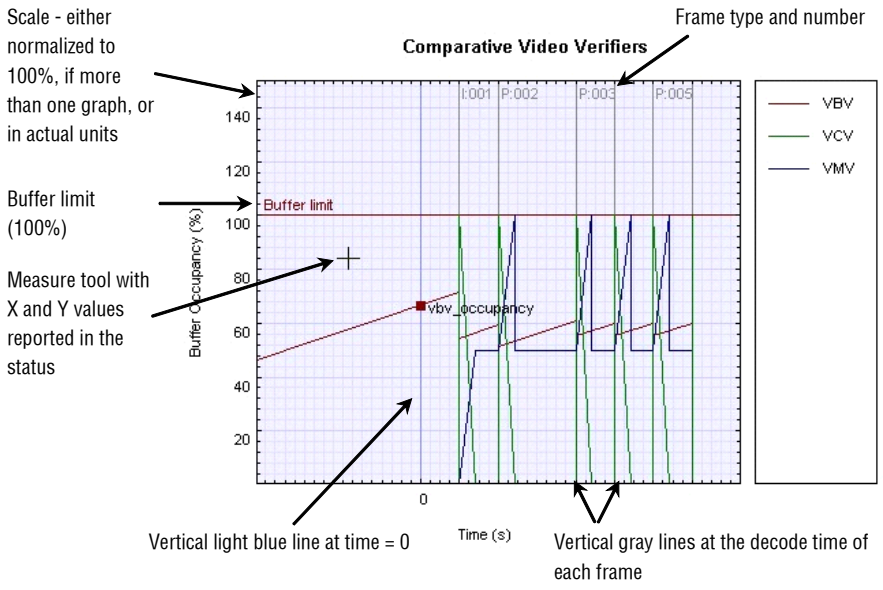
The left-hand value is the X-axis (time) value in seconds, to the nearest millisecond; the right-hand is the Y-axis value: either in percentage terms, if there is more than one graph; or in the correct units, if there is only one graph (as in the following figure)

(Only the VBV is shown here)



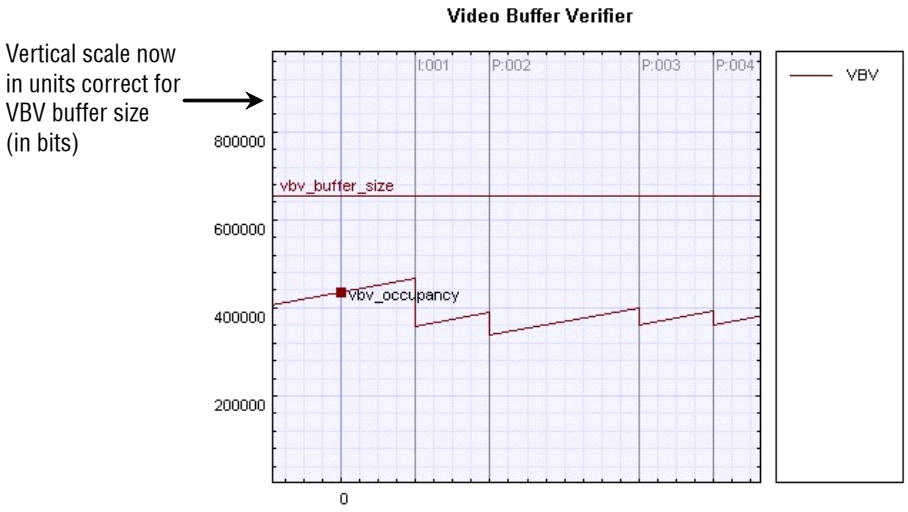


Buffer Analysis Graph Area



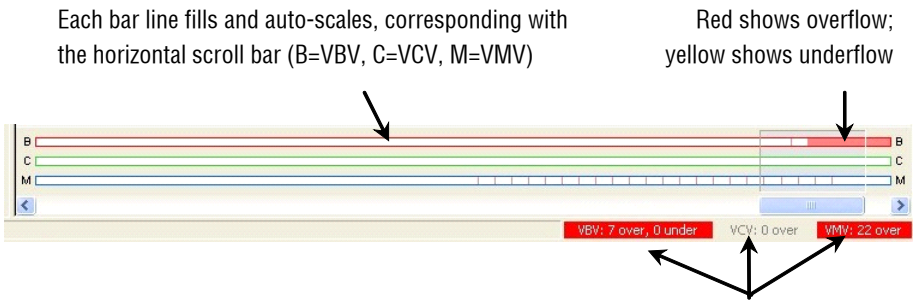
The left axis displays:

- Values normalized to 100% if there is more than one graph
- Values appropriate for that graph (see the following figure)

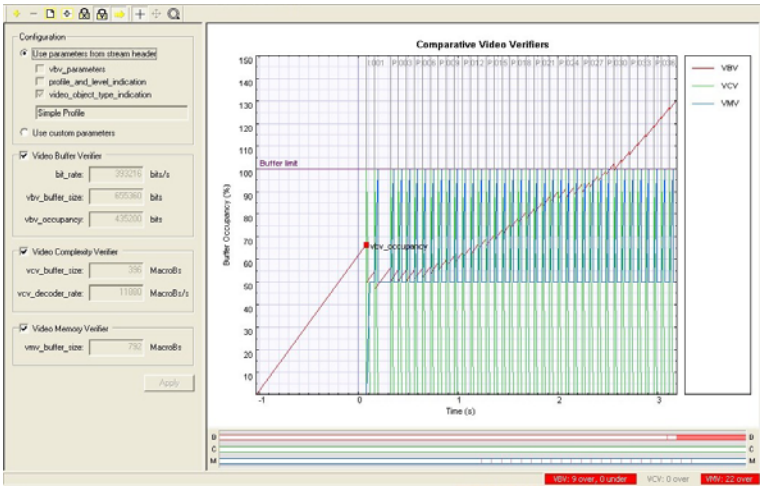


When the buffer data is too wide/too high for the current window, scroll bars appear at the bottom/right (as appropriate).

Buffer analysis alerts/scroll bar area. The buffer overflow/underflow is indicated in the Graph window as shown below:



MPEG-4 and MPEG-2 buffer analysis. The following screenshots and explanations are for MPEG-4; however, similar displays and information are used for MPEG-2.

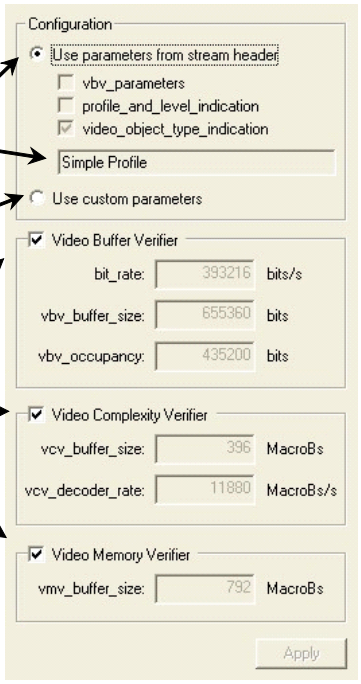


Buffer analysis controls: MPEG-4 and MPEG-2.

Configure the buffer analysis using one of the following methods:

- Use the values supplied in the bitstream (the check box shows from where in the streams the values come).
- Enter custom values to suit the hardware on which the decoder will run.

Individually enable/disable the various buffer displays



The values used for VBV, VCV and VMV are displayed, but cannot be altered unless Use custom parameters is selected.

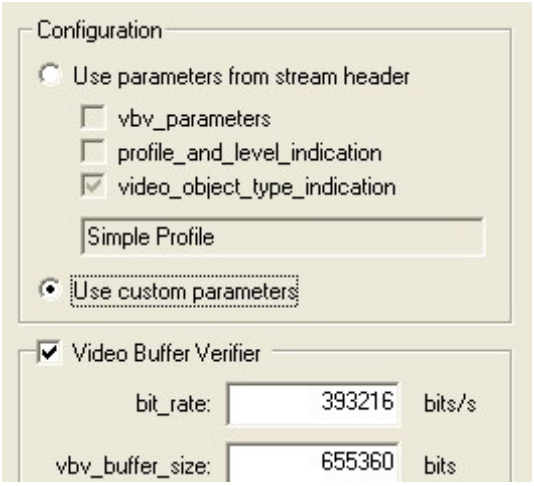
The boxes below the title Use parameters from stream header show where the values used have come from: in the preceding example, there were no values specified in the `vbv_parameters`, nor was there a `profile_and_level_indication`, so the maximum value implied by Simple Profile as given in the `video_object_type_indication` is used.

NOTE. *There is an order of precedence. If the `vbv_parameters` are specified in the bitstream, these values are used; if not, the maximum values are used as allowed in the Profile/Level given by the `profile_and_level_indication`. If there is no `profile_and_level_indication`, then the maximum values are used as implied by the `video_object_type_indication`.*

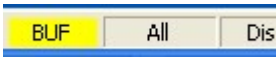
Use custom buffer parameters: MPEG-4 and MPEG-2. Custom parameters can be entered for a variety of reasons, for example:

- The VBV/VCV/VMV parameters have not been specified in the bitstream: in this case MTS4CC will assume the maximum allowable values for the Profile/Level and these may be too large for the particular operation.
- The VBV/VCV/VMV parameters specified in the bitstream do not reflect the actual limitations of the hardware on which the decoder will have to decode the bitstream.
- To try different values to see if the conformance parameters are met with different limits.

Custom parameters are entered as below:



When custom parameters are used, this is indicated in the status bar of the main MTS4CC window by the word BUF:



NOTE. *These values can also be selected/entered from the Decoder options selection on the Play menu (the MPEG-4 tab).*

The values entered as Custom parameters affect both the alert pop-up warnings and the warnings that are reported in the Trace files; the Custom parameters are the values used to trigger these warnings.

To reset the values entered to the values specified by the bitstream, reselect the Use parameters button from the stream header.

Buffer analysis pop-up alerts: MPEG-4 and MPEG-2. Where the bitstream exceeds the values given by:

- `vbv_parameters`
- `profile_and_level_indication`
- The custom parameters

When each of these is selected as the source of the parameters, pop-up alerts occur during video decoding unless disabled in the Alerts menu (the video must be playing for the pop-up alerts to be generated).

NOTE. *When the buffer parameters are implied by* `video_object_type_indication`*, no alert is displayed in the event of exceeding the limits, nor is there a warning in the Trace files. This is in accordance with the implied rules in the MPEG-4 standard.*

HRD buffer analysis: H.264/AVC. The Hypothetical Reference Decoder (HRD) in H.264/AVC provides a complex mechanism for buffer analysis; this is much more complex than the buffer analysis in MPEG-4/MPEG-2.

NOTE. *The HRD analysis is of the Coded Picture Buffer (CPB) only, not of the Decoded Picture Buffer (DPB).*

In order to understand the HRD analysis, you must read and understand Annex C of the H.264/AVC standard, ISO document 14496-10 (E).

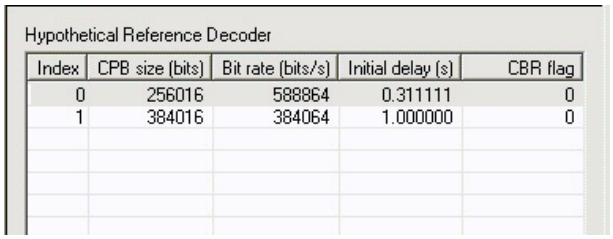
HRD parameters do not have to be specified in a bitstream; many H.264/AVC streams do not have them specified (only the Bus Junction and Grenadier Guards H.264/AVC example streams provided with the MTS4CC have HRD information).

NOTE. *If HRD parameters are not provided in an H.264/AVC bitstream, the icon and menu item for View buffer analysis is grayed out.*

HRD list of schedule indexes (buckets): H.264/AVC. Due to the complexity of HRD analysis, entering custom parameters is not currently possible in MTS4CC; the display shows the list of indexes or buckets that are given in the bitstream.

If the HRD parameters are given in a bitstream, there can be 1 to 31 indexes or buckets, numbered from 0.

In the following example below, there are two indexes/buckets: index 0 is selected and is used for the graph display, as shown. Clicking on the line below would display the data from index 1 in the graph display.


Hypothetical Reference Decoder

Index	CPB size (bits)	Bit rate (bits/s)	Initial delay (s)	CBR flag
0	256016	588864	0.311111	0
1	384016	384064	1.000000	0

The meanings of the column headings are:

Index: The bucket or index number.

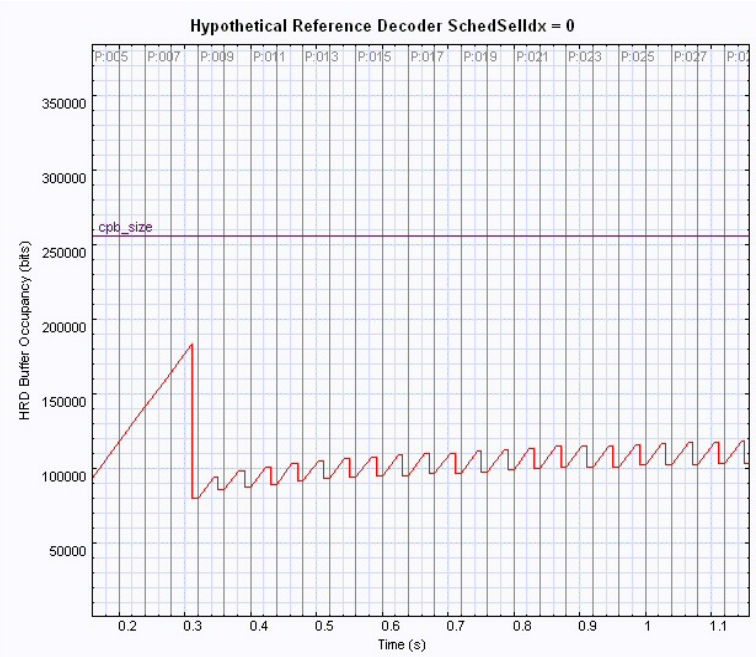
CPB size (bits): The size in bits of the Coded Picture Buffer (CPB).

Bit rate (bits/s): The bit rate of the hypothetical transmission channel.

Initial delay (s): The initial delay of the hypothetical transmission channel before the first frame is decoded.

CBR flag: The status of the Constant Bit Rate (CBR) flag: 0=off; 1 = on.

HRD results display: H.264/AVC. When a bitstream has HRD parameters specified, and the HRD buffer analysis has been done by MTS4CC, clicking on the appropriate index/bucket number displays the graph for that index/bucket (in the following example, index/bucket number 0):



The areas of the graph display are explained in *Buffer Analysis Graph Area* on page 2-120 and *Buffer analysis alerts/scroll bar area* on page 2-121.

As examples:

- Frame type and number is given at the top of the graph (in light gray)
- The vertical lines correspond with the decode times of the relevant frame

HRD buffer overflow/underflow indication: H.264/AVC. HRD buffer analysis overflow and underflow is indicated in the following locations:

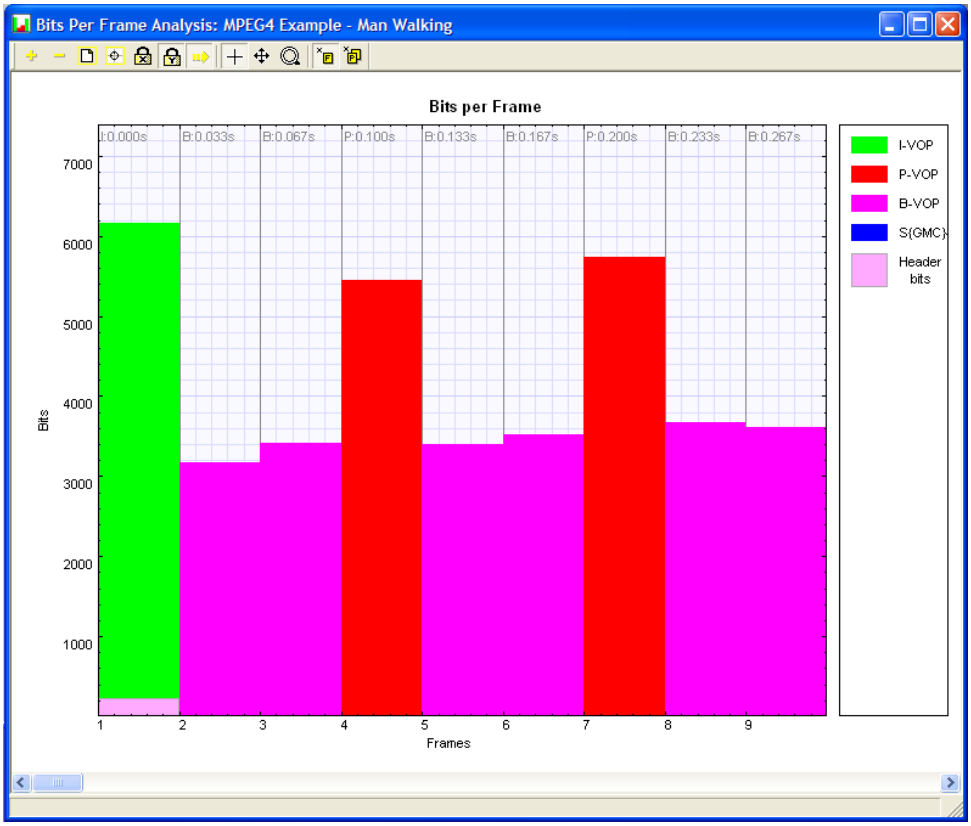
- The bar line below the graph area
- The status bar
- Popup alerts

The bar line and status bar indications are the same as overflow and underflow indications for MPEG-4/MPEG-2 (see *Buffer analysis alerts/scroll bar area* on page 2-121).

The pop-up alerts for HRD buffer overflow/underflow are shown on-screen and enabled/disabled as with any other pop-up alert (see *Explanation of Fatal/Error/Warning/Info Display* on page 2-141).

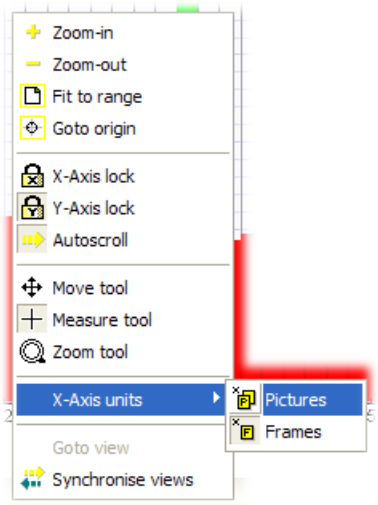
View Bits per Video Frame Analysis

This displays the Bits per Frame Analysis graph.

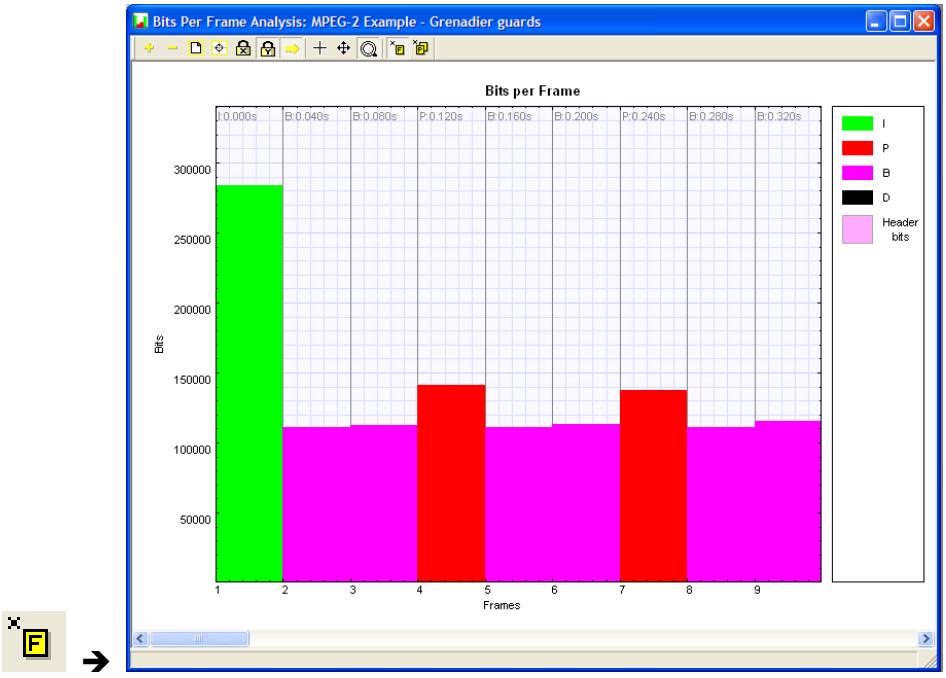


The key (on the right side) gives a color code for the VOP/frame types; for more information see *VOP type [MPEG-4] or Frame type [H.264/AVC, MPEG-2, H.263, VC-1]* on page 2-69.

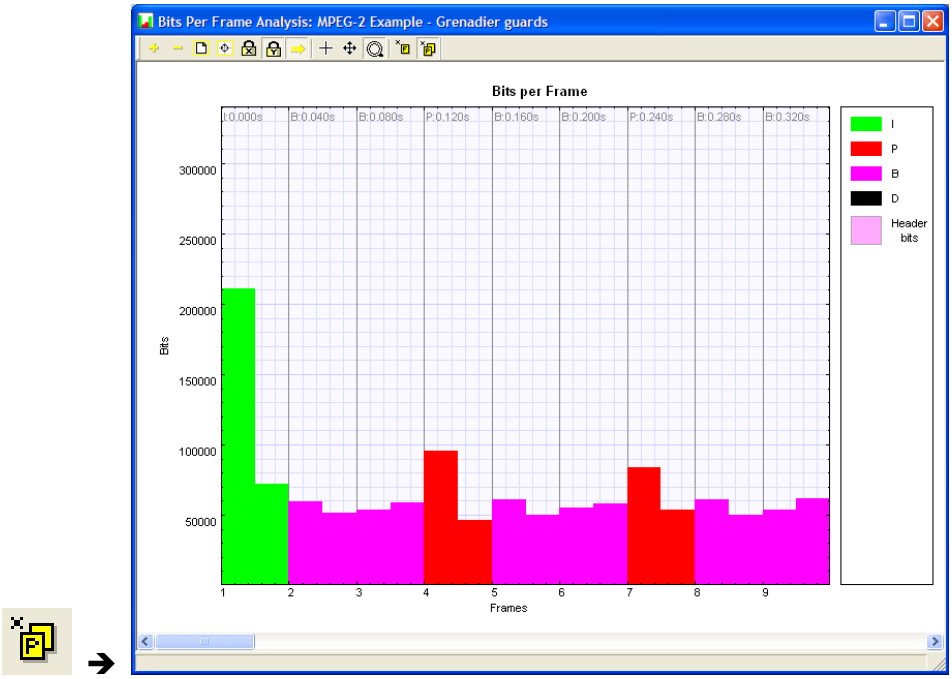
In addition to the standard buttons, the toolbar contains two buttons that allow the X-axis to be either frame or picture oriented:



The Frame unit toolbar button displays the total bits per frame. For interlaced pictures this would be the sum of the picture fields:



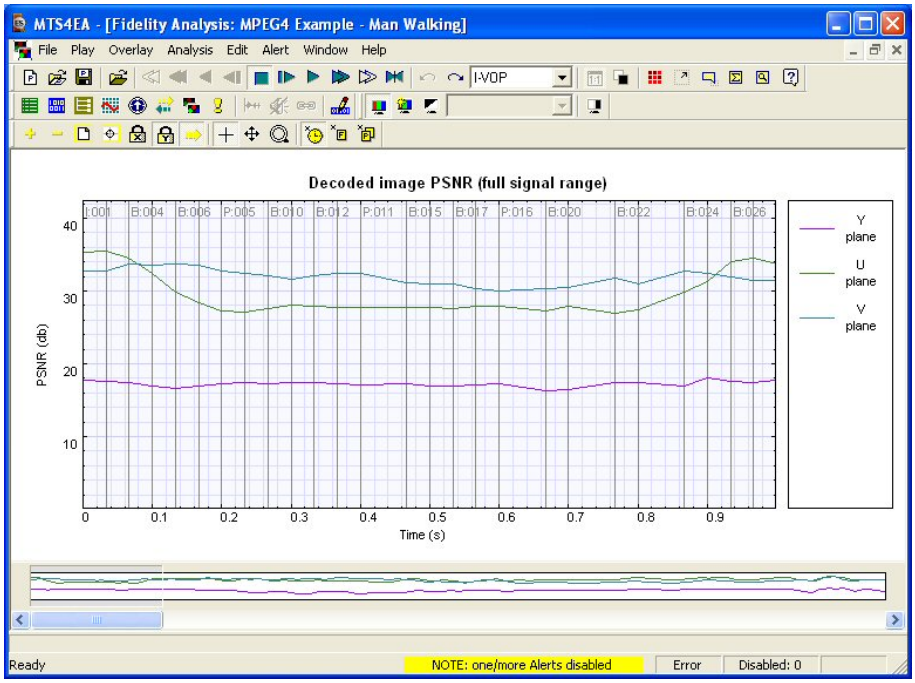
The Picture units toolbar button also displays the total bits per frame, but, in the case of interlaced pictures, each frame contains two picture fields:



The bits per frame can be measured by selecting the toolbar measurement tool, placing the crosshair cursor over the point to be measured, and reading the result from the left side of the status bar.

View Fidelity Analysis

This displays the fidelity analysis graph view:



The fidelity analysis graph view is similar to the graph view used for buffer analysis in MPEG-4, MPEG-2 and H.264/AVC. Both views have the same:

- Control icons - see *Buffer Analysis Toolbar Icons* on page 2-118
- Method of displaying frame types, frame numbers, frame times in the graph area - see *Buffer Analysis Graph Area* on page 2-120
- Means of measuring angles - see *Using the Measure Tool* on page 2-119
- Right-click popup menu

The fidelity analysis results are shown separately for Y, U, and V planes:

- Y-plane in mauve
- U-plane in green
- V-plane in blue

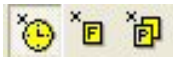
NOTE. *The MPEG-4 example stream Man Walking has the YUV reference file supplied with MTS4CC. Therefore, this is a useful example for examining the fidelity analysis functions.*

The first ten frames of the YUV reference file are supplied for the Grenadier Guards example streams that are provided with MTS4CC both as an H.264/AVC example and as an MPEG-2 example.

Where the frame rate is incorrectly set for the uncompressed video file, the correspondence between the encoded video frames and the uncompressed video source frames is lost; this will substantially reduce the fidelity analysis values.

Fidelity Analysis View Icons Toolbar

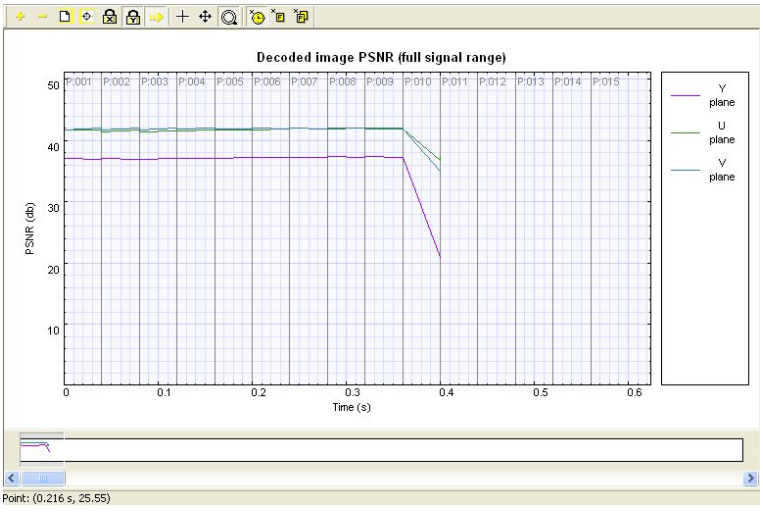
The icons in the toolbar have the same functions as the icons on the buffer analysis toolbar; see *Buffer Analysis Toolbar Icons* on page 2-118. The following icons are unique to the Fidelity analysis view:



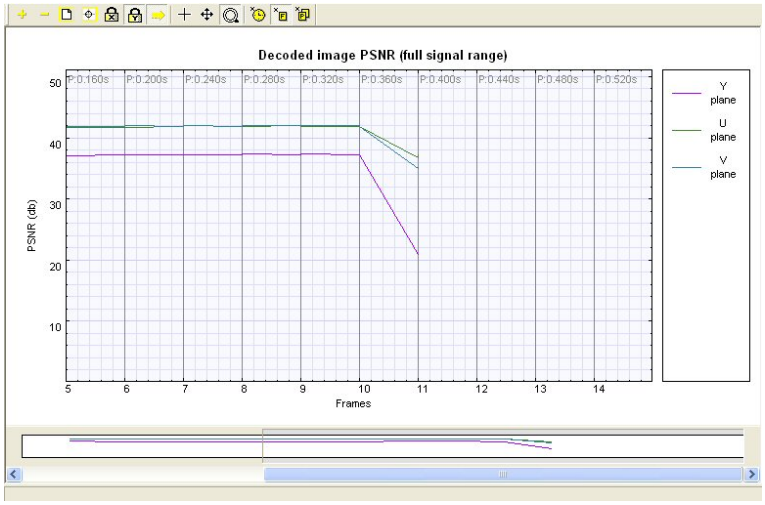
Of these three, the first two are available at all times. The third is only available when interlacing is in use and the picture can be broken down into units; it is grayed out at all other times.

These icons represent the following:

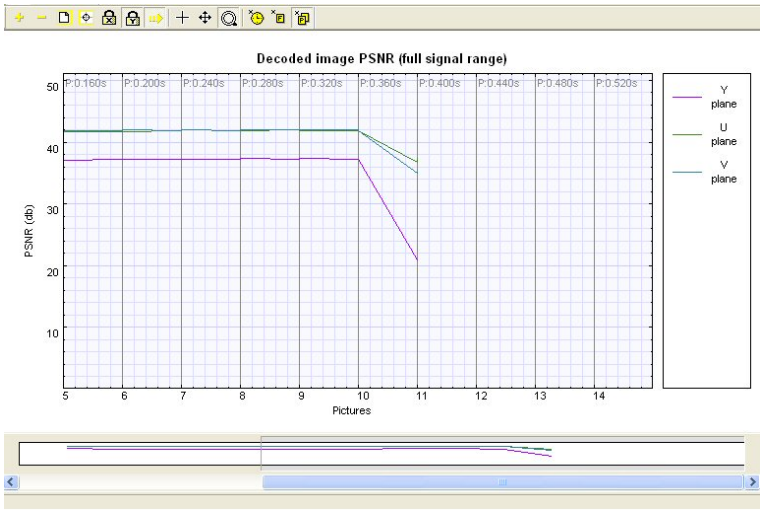
-  The ability to plot time in seconds on the x-axis, as shown:



-  The ability to plot frame number on the x-axis, as shown:



-  The ability to plot picture units on the x-axis, as shown:



Fidelity metrics available. Six fidelity metrics are available:

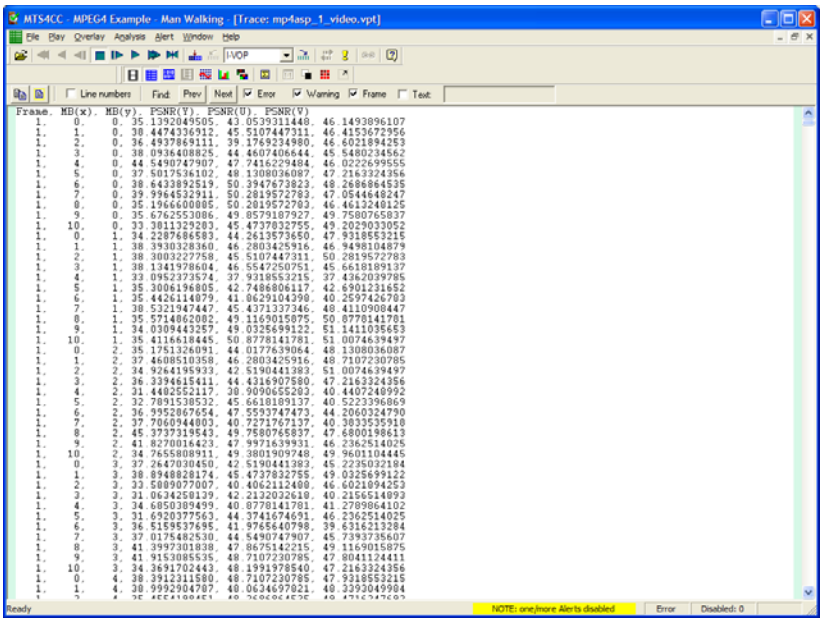
- PSNR (255 signal range)
- PSNR (ITU-R BT.601 signal range)
- RMSE (Root Mean Square Error)

- MSE (Mean Square Error)
- MAD (Mean Absolute Difference)
- SAD (Sum Absolute Difference)

These are described in detail under *Metric* on page 2-105.

View Fidelity Trace

This option opens the Trace view on the current output Trace file, as shown in the Analysis menu Trace tab.



NOTE. *If there is not a current Trace file (and Trace enable is not enabled) then this menu option/toolbar icon is unavailable (grayed out).*

If the video stream has been rerun and a Trace file saved with the same name as that already open, then clicking the View fidelity trace menu option,  *icon, or* `Ctrl+V` *will refresh the open Trace file.*

Copying Text

The contents of the Trace window can be copied to the Windows clipboard.

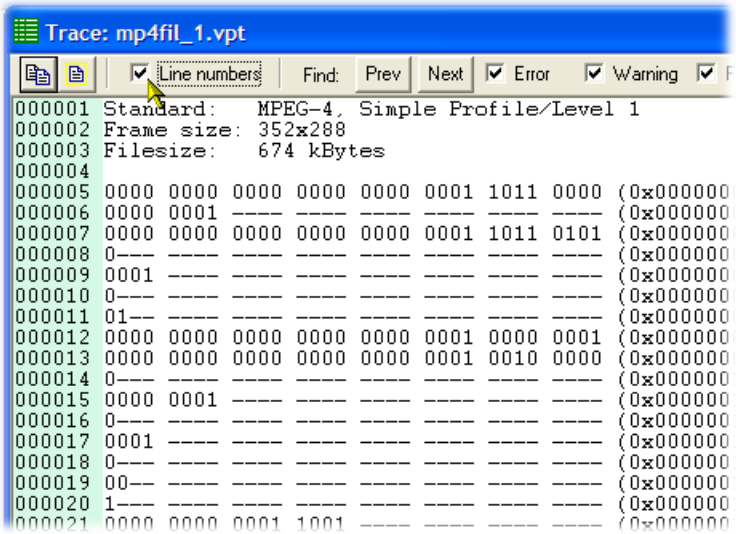
This can be done in a number of ways:

- By pressing `Ctrl+C`
- By right-clicking with the mouse and selecting Copy
- By clicking the copy icon - 

The entire contents can be selected by clicking the Select All icon -  .

Line Numbers

Line numbers can be turned on/off:



Find Data

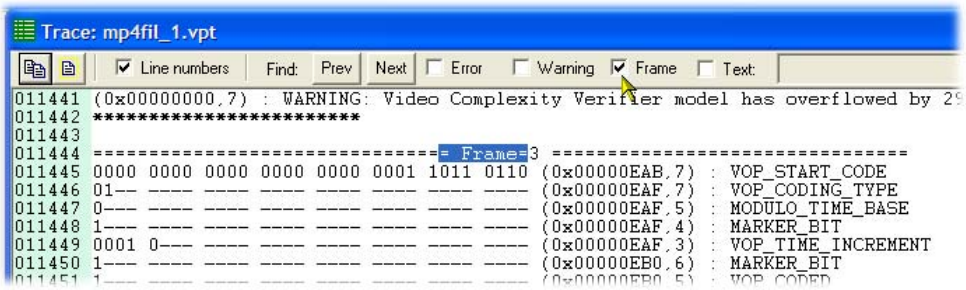
The Trace file can be searched for any data, using the Find: Prev (previous) and Next buttons. This finds the previous/next occurrence of any of the enabled strings.

NOTE. *You can press the F3 key to find next and the Shift+F3 key to find previous.*

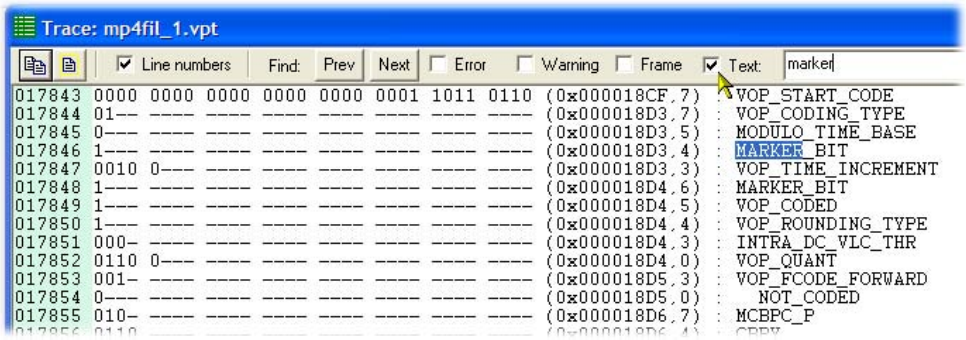
There are some standard strings that can be searched for:

- Error
- Warning
- Frame

These are found by enabling the relevant check box (Frame example below):



To search for any text, select the box next to Text and enter the text in the box (in this example, enter `marker`):



Lines too long for Window Width

If a line is too long to be displayed within the width of the View trace window, a horizontal scroll bar is displayed and a blue arrow is appended to the right side of the View trace window, to indicate that a line extends to the right.

Trace File Format

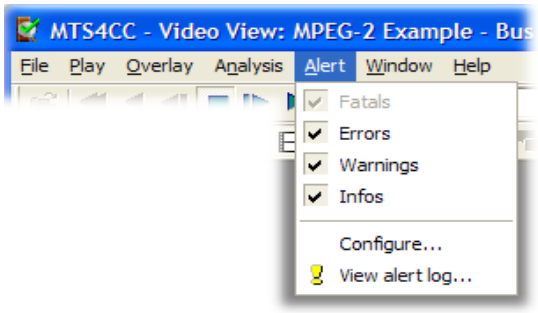
The MTS4CC saves Trace files with a `.vpt` file extension.

Currently, the .vpt file is a standard ASCII file, which can be viewed in any text file viewer. The .vpt file extension is used:

- To associate the file with the MTS4CC in Windows,
- To automatically open the file in MTS4CC when you double-click it in Windows Explorer.

Alert Menu

The following paragraphs describe the options available in the Alert menu.



This menu controls the setting of the overall level of the pop-up alerts. It also allows you to enable and disable individual alerts.

These pop-up alerts occur when the video is being decoded. Consequently:

- The popup alert appears when the frame concerned is decoded, but for bitstreams containing B-frames/B-VOPs the display order of frames/VOPs may be different.
- When seeking backward/forward through a stream, the popup alerts will not appear if that part of the bitstream has already been decoded and is in the step-back buffer cache (see *Pop-up alerts in the step-back buffer* on page 2-144).

NOTE. *For some alerts, extra information is provided about the section of the stream that has generated the error, and about the standard if it is standard-specific. See* General codes used in Trace files and Alerts *in the* Command Line/Batch Mode *section for detailed information.*

Alert Levels

There are four different levels of alerts: Fatal, Error, Warning and Info (in order of decreasing severity). See *Description of Alert Levels*, page 2-148 for more information.

When a less severe alert is set, the more severe alerts are set automatically. (For example, setting Warnings on automatically sets Errors and Fatal on.)

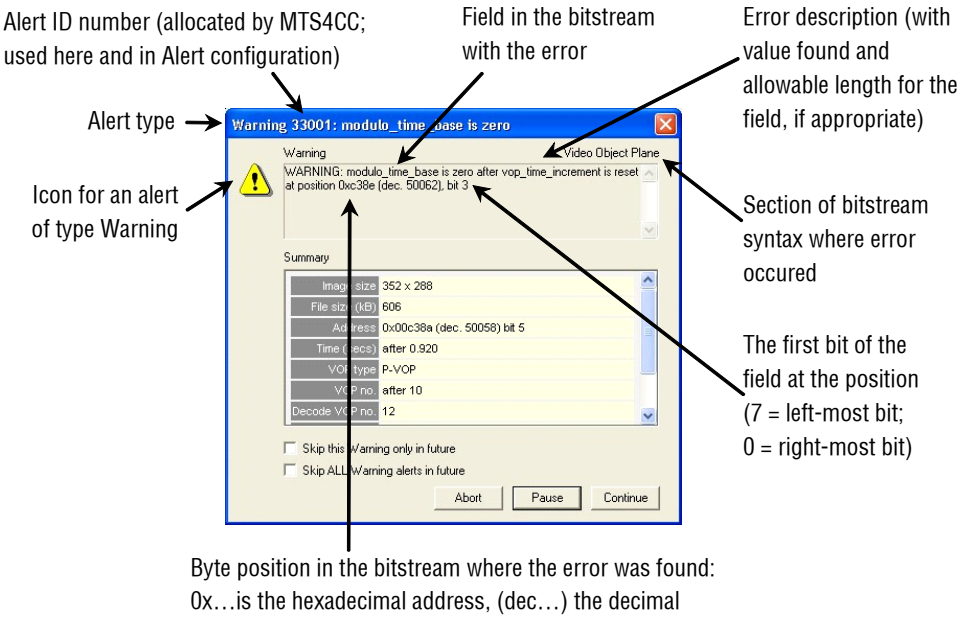
NOTE. *The Fatal alert is always set (and cannot be turned off).*
Each time a video stream is opened in the MTS4CC, the alert level is set to Info (the most strict) and all Alerts are reenabled.

When an alert is triggered, a message box is displayed. At the same time, decoding is suspended.

The message box will provide you with the reason that decoding was interrupted - see the following section.

Explanation of Fatal/Error/Warning/Info Display

Information at Top of Alert Pop-up



For bitstreams that contain B-VOPs/B-frames, it is vital to understand that the pop-up alert relates to the decode frame number, not the displayed frame number - see *Decode/display frame/VOP numbers in bitstreams with B-frames/B-VOPs* on page 2-142 for more information.

For all Fatal, Error, Warning and Info displays:

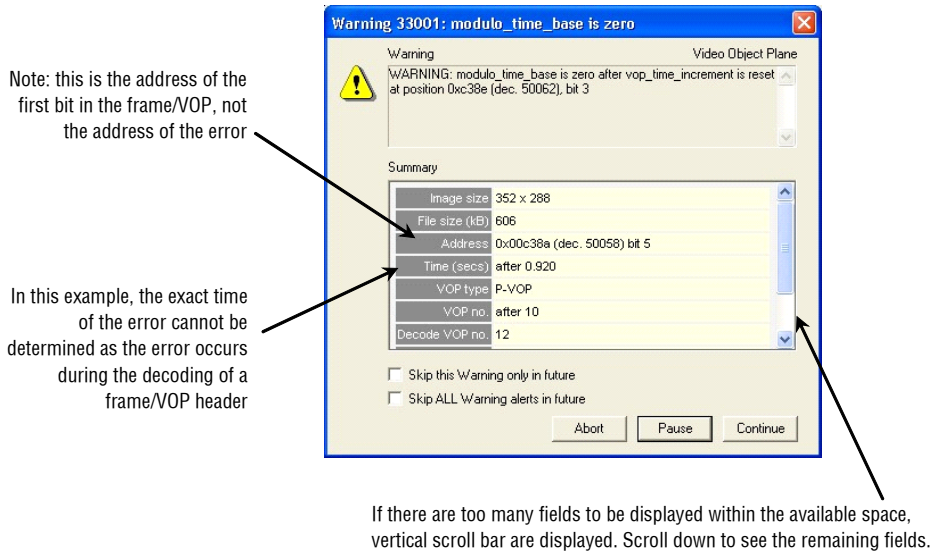
- The bitstream position of the error is the number of bytes from the beginning of the video bitstream, where the first byte is byte zero.
- The position is displayed in hexadecimal (0x...) and decimal (dec. ...).
- The bit start is the first bit of this bitstream field, where bit 7 is the most significant bit in a byte and bit 0 the least. This means that bit 7 is the first bit in each byte of the bitstream.

In each of the compression standards, there are many bitstream fields that give values that are least significant bit first (lsbf) and many others that are most significant bit first (msbf). There are also many others that are simply bit-patterns; they do not have a direct numeric value.

For msbf bitstream fields, numbering bit 7 as the first bit in each byte is correct. For lsbf bitstream fields, the bit order has to be reversed when calculating the given value. See *Explanation of bit/bitstart* in the *Command Line/Batch Mode* section for more information.

Information in Summary Box

The information provided in the Summary box is the same as that provided in the Summary tooltip; see *Video Summary Tooltip* on page 2-64 for a detailed explanation of the fields and provided data.



Decode/display frame/VOP numbers in bitstreams with B-frames/B-VOPs. The pop-up alert relates to the Warnings and Errors that the MTS4CC finds during decoding.

This means that for bitstreams that contain B-frames/B-VOPs (where the decode order is different from the display order) it can appear that the pop-up alerts are out of sequence. In this case, it is very important to look carefully at the data in the Summary box, which shows the Decode and Display frame numbers.

As an example:

- Order of data in the bitstream (the decode order):

Decode frame number	1	2	3	4	5
Frame type	I	**P**	B	B	P
Error occurs in frame	a	**b**	c	d	e

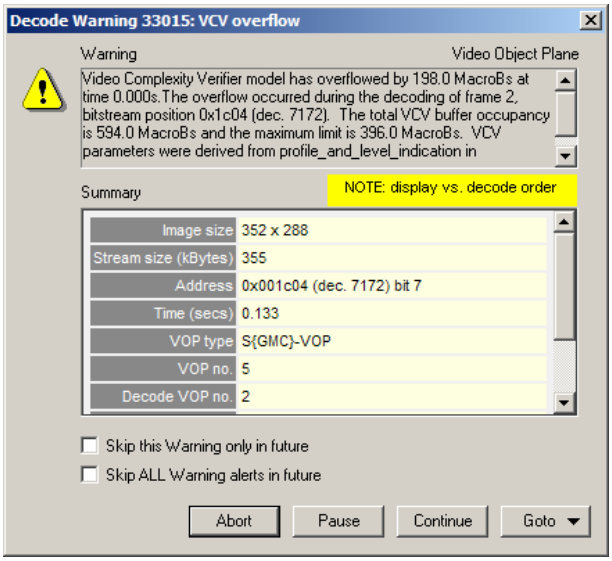
- Order of data in displayed:

Display frame number	-	1	2	3	4	5
Frame type	-	I	B	B	**P**	P
Error displayed in frame	-	a, **b**	c	d	-	e

NOTE: *Frame display delayed by one frame*

In these diagrams, it can be seen that for the first P-frame, the error associated with decoding it is displayed before it appears on-screen - at the same time as the first frame is displayed.

If this has happened, text in a yellow warning rectangle will appear in the pop-up alert, as shown in the following figure:



The difference between decode and display order:

- Can occur in any bitstream that has B-frames/B-VOPs
- And can happen in any frame/VOP in the bitstream concerned, where the frame/VOP is a B-frame/B-VOP

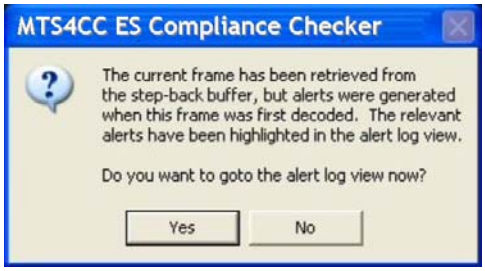
NOTE. *Note that the yellow warning can also appear in other circumstances, where the alert has occurred some time after a displayed frame.*

Pop-up alerts in the step-back buffer. When a stream is decoded, popup alerts may occur. The results of the decoding are stored in a cache, the Step-back buffer - see *General* on page 2-51 for more information.

It is possible to step forward/backward over the frames where these alerts occur. To avoid a continual repetition of the popups (and potentially many such alerts appearing), the pop-up alerts are not displayed when seeking forward/backward in these situations.

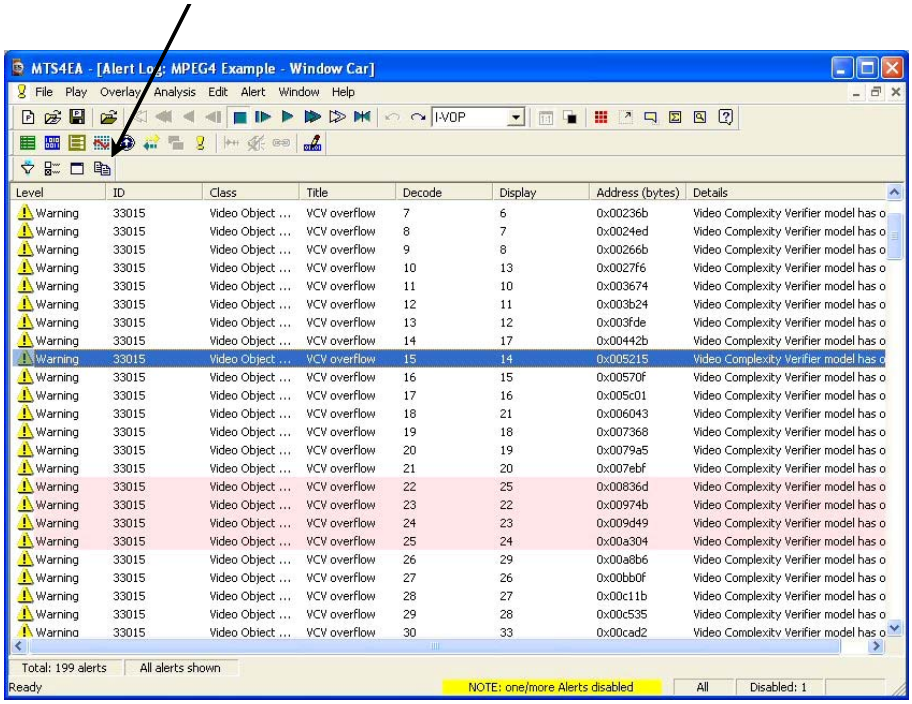
If one or more pop-up alerts would have occurred, then this is indicated in one of two ways:

- There may be a pop-up message, at most once per seek forward or backward:

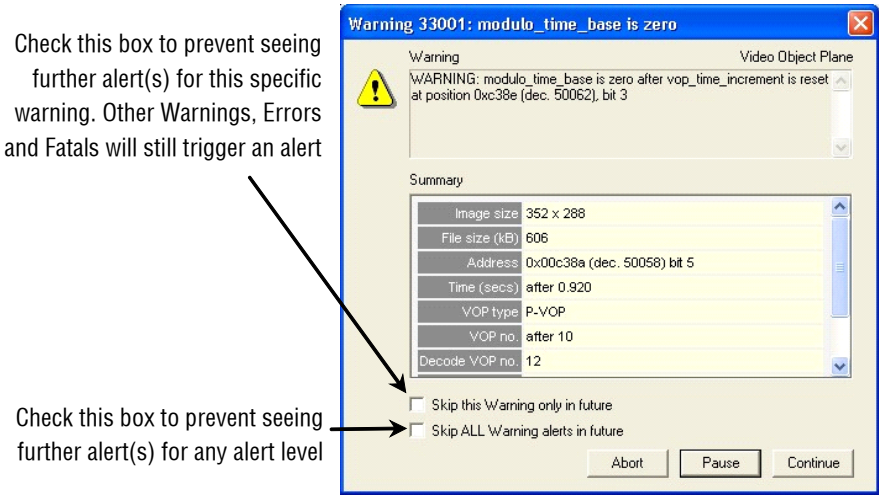


- If the Alert log window is open, the alerts that would have been displayed are highlighted in the Alert log window (see *View Alert Log* on page 2-152 for more information).

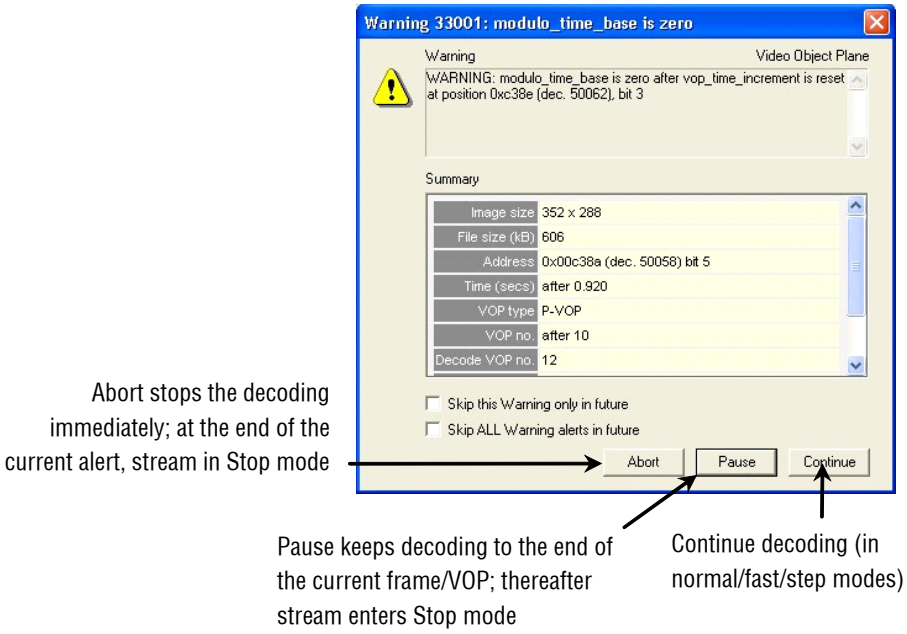
Copy alert details to the Windows clipboard. The details of an alert can be copied using `Ctrl+C` or the copy icon.



Check box options.

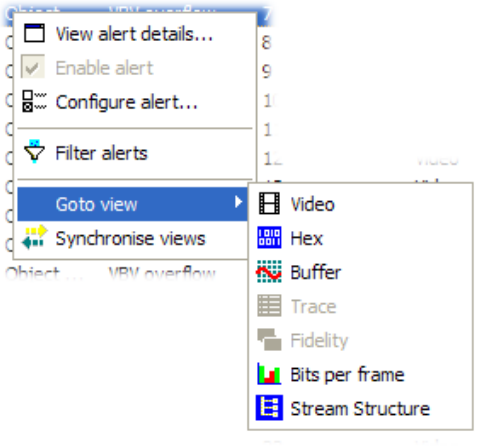


Abort, Pause, Continue.



NOTE. *Abort can also be requested by pressing the Esc key.*

Goto button. This takes the focus to the position in the selected view that corresponds most closely to the location of the error. See *Synchronized Views/Navigating the Views* on page 2-6 for more information.



In these views, selecting Goto takes the focus to the following locations:

View	Location taken to	
Video	If the error can be located to within a particular MacroBlock…	…to the MacroBlock containing the error (highlighted with a yellow/black dotted square)
	If not (the error is in a frame header or file header)…	…to the top of the frame that immediately follows the error, indicated by a yellow/black dotted rectangle around the first row of MacroBlocks
Hex	The byte where the error is	
Alert log	The log of alert popups that have occurred (not those filtered/not shown)	
Buffer	The frame containing the error or the frame that immediately follows the error (if the error is in a header)	
Fidelity	Graph of fidelity analysis (such as PSNR)	
Audio waveform	Graph of audio stream: Y-axis is normalized amplitude; X-axis is time (seconds)	
Bits per frame	Bits per frame graph – the frame containing the error	
Stream Structure	Stream structure – highlight node containing error	

Description of Alert Levels

Fatal

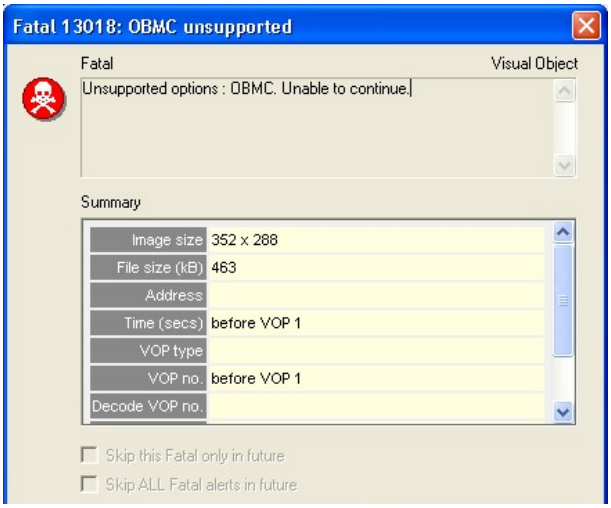
A Fatal error occurs when there is something encountered in the bitstream that cannot be decoded by the MTS4CC.

This selection cannot be turned off, and the decoder cannot continue after a Fatal error.

Fatal errors in the MTS4CC are commonly caused by:

- Severe errors in the syntax of the bitstream, which make it completely unintelligible to MTS4CC
- Options being selected in the video bitstream that are not yet supported by MTS4CC

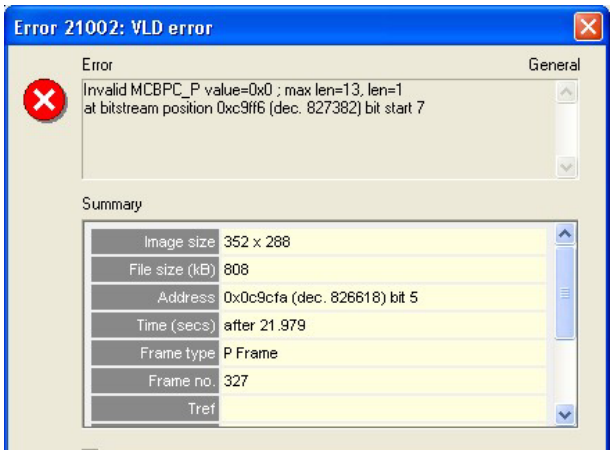
For example, the Fatal error below was caused by the OBMC flag in an MPEG-4 bitstream being set (on), that the video bitstream in question is using overlapped block motion compensation. (OBMC = Overlapped Block Motion Compensation: although it is in the current MPEG-4 standard, none of the MPEG-4 profiles or levels defined currently support OBMC.)



Error

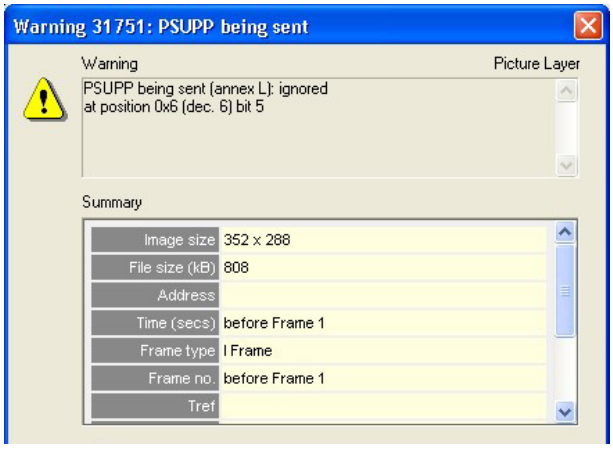
When this item is selected, the decoder will stop at any point where there is an Error in the bitstream.

These occur commonly where out-of-range values have been used in the bitstream, or invalid codes (the example below in an H.263 stream):



Warning

When selected, this item will provide a number of warnings that indicate behavior that is not correct, but does not necessarily damage the decoding of the bitstream. Items such as too many leading zeros before picture start codes, temporal references not set, and MacroBlocks not updated in Intra mode will cause such warnings (the example below in an H.263 stream):



Info

When checked, this item will provide information pop-ups if relevant:

- It may be that the behavior is within the acceptable bounds of the standard concerned (and the relevant Profile/Level), but perhaps is used in a non-recommended manner or at the limits
- It is felt that additional information would be useful

Configure Alerts

This determines which specific alerts are enabled/disabled.

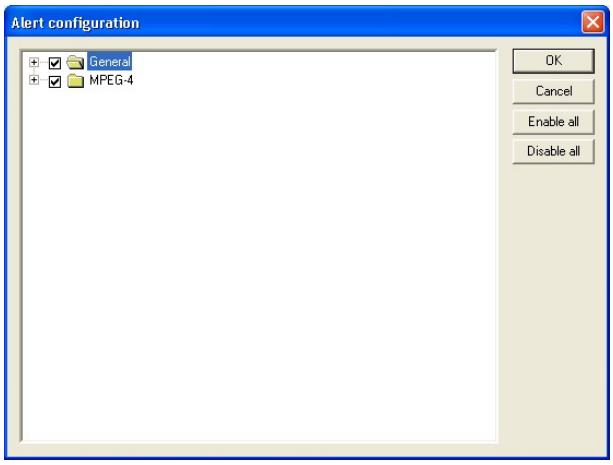
NOTE. *The overall alert level is set from the Alerts menu options Errors, Warnings and Infos, and this the enabling of specific alerts but not the disabling of specific alerts.*

This means, for example:

- That a specific Warning alert can be enabled/disabled, but trigger a Warning alert if the overall alert level is set to Errors or Fatal only. This is indicated in the status bar; see *Status Bar Indication of Alert Status* on page 2-159
- But if the overall alert level is Info and an individual Error alert is disabled, an alert will not be triggered for this individual error
- Examples of different combinations of overall and individual alerts and the consequential status bar displays are given under *Status Bar Indication of Alert Status* on page 2-159

NOTE. *Depending on the standard, all the alerts that MTS4CC tests for are not necessarily currently available on-screen to be individually enabled/ disabled. Access to more of these will be provided in future versions of MTS4CC.*

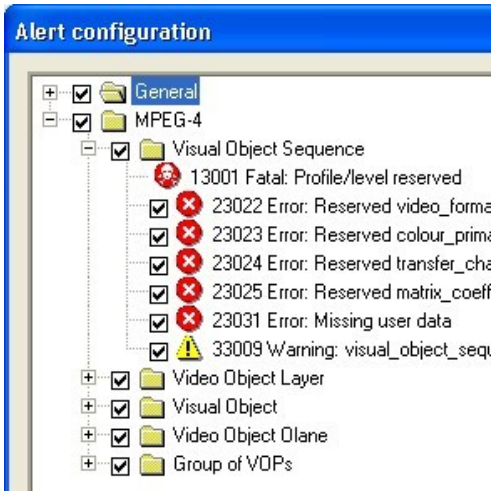
Enable/disable Specific Alerts



This displays two folders at the top level:

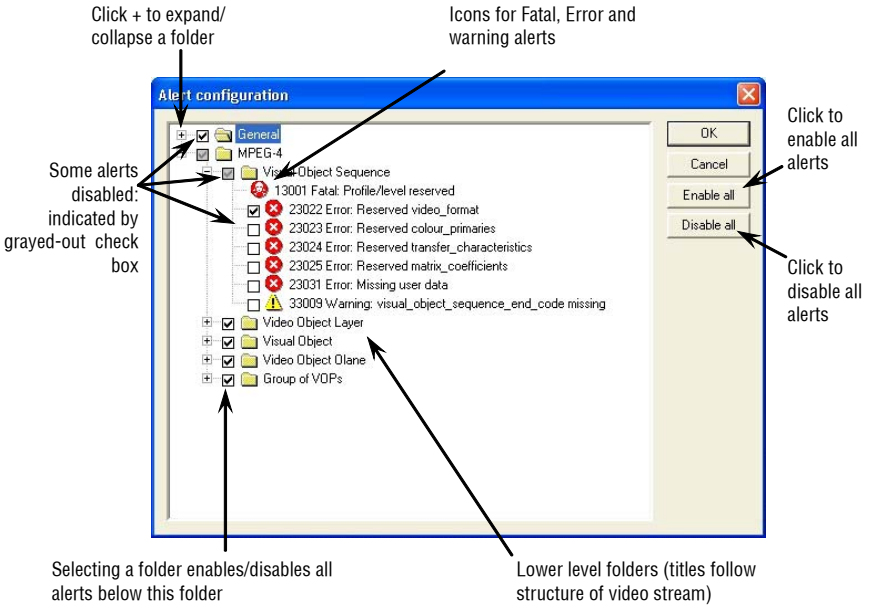
- General alerts, which can apply regardless of the standard concerned
- A standard folder (MPEG-4, H.263) that contains alerts specific to the standard concerned

The + next to each folder can be clicked to reveal lower levels:



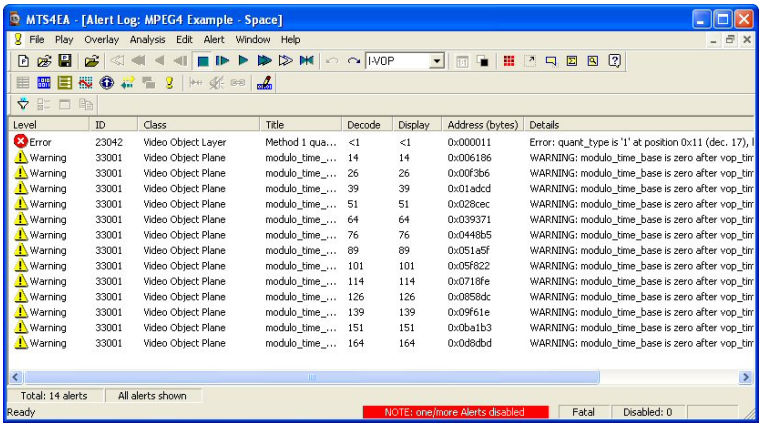
Elements of the Alert Configuration Window

NOTE. *This window is used to configure the individual alerts. Even if an alert is enabled here, if the overall alert level is set higher, the alert will not trigger a pop-up.*



View Alert Log

The Alert log keeps a list of the pop-up alerts that have occurred during the decoding of the bitstream:



The Alert log window icons and column titles are as follows:

Alert filter icon. See *Showing/Hiding Alerts (Alert Filter)* on page 2-154

Show/hide video alerts.

Configure alerts icon. Clicking on this icon opens the Alert configuration dialog box - see *Configure Alerts* on page 2-150. If this icon is clicked, then the Alert configuration dialog box is opened with the error selected in the Alert log window highlighted in the Alert configuration dialog box. If this icon is grayed out, it can be enabled by selecting any alert that is shown.

View alert details icon. See *View details of the alerts* on page 2-155. If this icon is grayed out, it can be enabled by selecting any alert that is shown.

Copy. This icon becomes available only once an alert is highlighted. This function allows the selected alert to be copied to the Windows clipboard for pasting into any Windows application. Copying can also be done by pressing `Ctrl+C`.

Level. The error level: Fatal or Error or Warning or Info.

ID. The unique ID number assigned to this error type within MTS4CC.

Class. The area within the hierarchy of the compressed standard; see the screenshot above which shows an error in the Video Object Layer and seven warnings in the Video Object Plane within the MPEG-4 bitstream. The classes vary with the video standards.

Title. The title assigned to this error type.

Decode. The number of the decoded frame in which this error was found.

See *Decode/display frame/VOP numbers in bitstreams with B-frames/B-VOPs* on page 2-142 for more information on decoded versus displayed frame numbers, in bitstreams that include B-frames/B-VOPs.

NOTE. *If <1 is displayed, the error occurred before the decode of the first frame - the error occurred in the header.*

Display. The number of the displayed frame in which this error is shown.

See *Decode/display frame/VOP numbers in bitstreams with B-frames/B-VOPs* on page 2-142 for more information on decoded versus displayed frame numbers, in bitstreams that include B-frames/B-VOPs.

NOTE. *If <1 is displayed, this means that the error has occurred before the decode of the first frame, the error has occurred in the header.*

Address (bytes). The byte address in the bitstream where this error was found.

NOTE. *For video bitstreams that have been extracted from container files (for example, MP4 files, 3GPP files, MPEG-2 Packet Streams) this address is the byte address in the extracted video stream, not in the overall container file.*

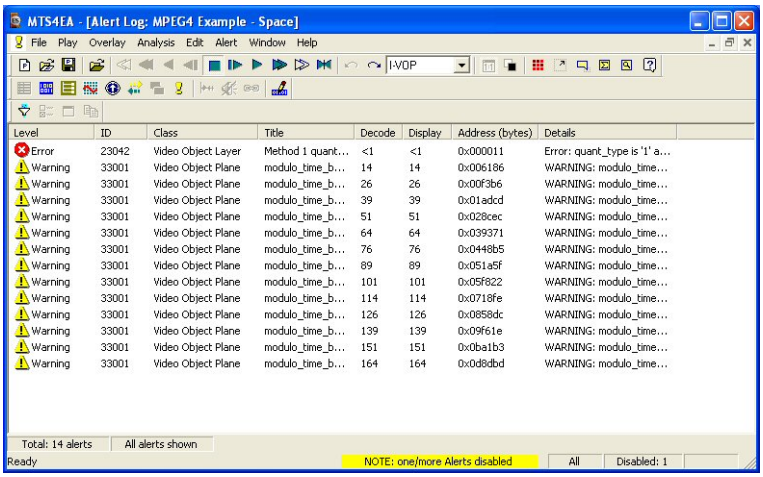
Details. This is the description text that is shown when the pop-up alert is displayed.

Showing/Hiding Alerts (Alert Filter)

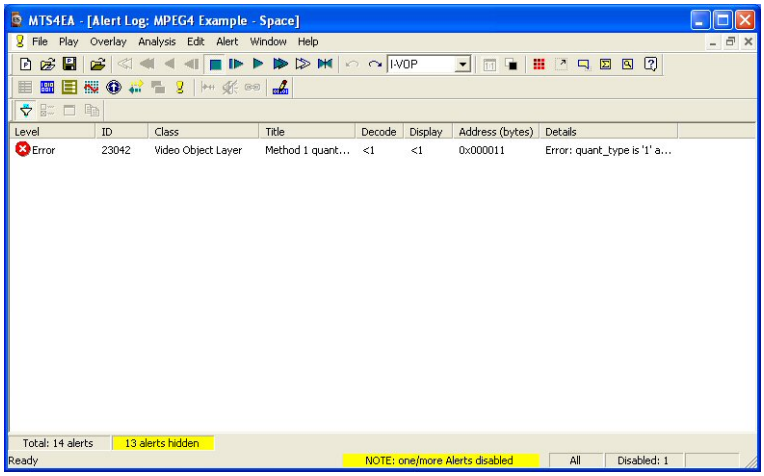
In some cases there can be hundreds or thousands of alerts. These might be known issues and you do not want to list them in the Alert log window (because they would clutter the window unnecessarily).

Therefore, the alerts that are shown in the Alert log window can be filtered. The filtering is based on the setting of the alert popup enable in the Alert configuration (see *Configure Alerts* on page 2-150 regarding the Alert configuration dialog box):

- If the filter icon is out  , all alerts are shown, regardless of whether they are enabled for a pop-up alert:



- If the filter icon is pushed in  , only those alerts that are enabled are shown:



(In this example, 13 alerts are hidden out of the total of 14 alerts)

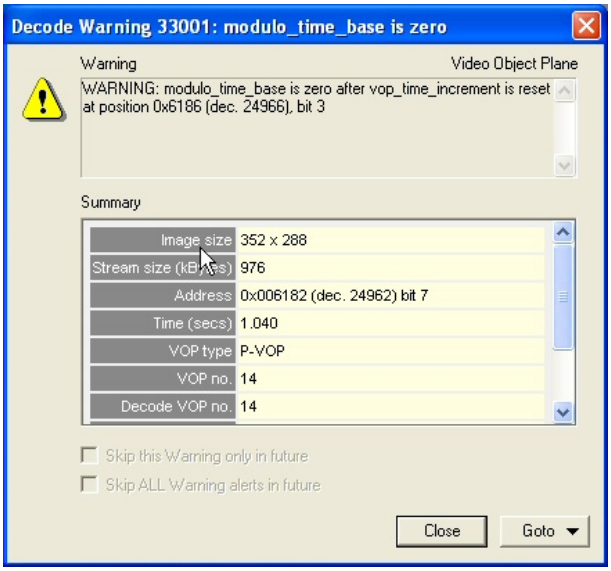
The Alert log filter can also be turned on/off by right-clicking and selecting the option from the pop-up menu.

NOTE. *When the filter icon is grayed out, all the alerts are enabled for display, so that there are no alerts to filter.*

View details of the alerts. This can be done in a number of ways:

- Double-click an alert in the Alert log window
- Single-click an alert, right-clicking to get the pop-up menu, and then click View alert details
- Select an alert by single-clicking an alert, and then clicking the icon

When this is done, a display very similar to the original pop-up alert display is shown:

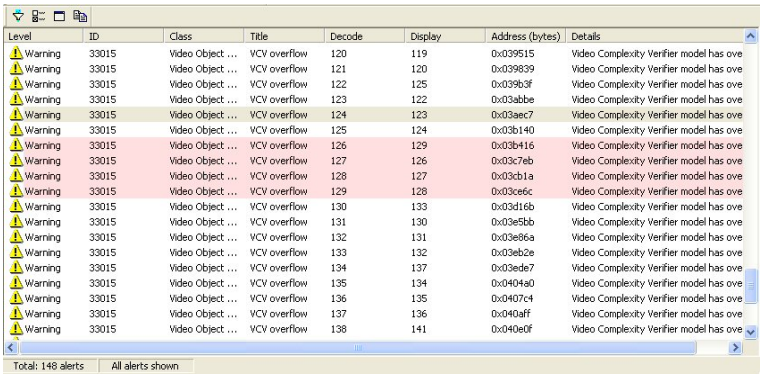


Alert highlighting when seeking forward/backward through video in the step-back buffer. The MTS4CC buffers video (and the data associated with each video frame) in a step-back buffer or cache, see *General* on page 2-51 for more information.

When stepping backward/forward through video that is held in the step-back buffer, to avoid continually having known alerts appear. The MTS4CC only highlights the alerts relevant to the area being skipped in the Alert log.

For example, if you skip forward 100 frames, and there would normally be four pop-up alerts during the decoding of these frames, the MTS4CC will highlight the four alerts in the Alert log. (If the alerts have been skipped and are hidden in the Alert log, as indicated by the status bar of the Alert log, the MTS4CC cannot highlight the alerts.)

An example of the highlighting of alerts is shown in the following screenshot:



Level	ID	Class	Title	Decode	Display	Address (bytes)	Details
Warning	33015	Video Object ...	VCV overflow	120	119	0x039515	Video Complexity Verifier model has ove
Warning	33015	Video Object ...	VCV overflow	121	120	0x039839	Video Complexity Verifier model has ove
Warning	33015	Video Object ...	VCV overflow	122	125	0x039b3f	Video Complexity Verifier model has ove
Warning	33015	Video Object ...	VCV overflow	123	122	0x03abbe	Video Complexity Verifier model has ove
Warning	33015	Video Object ...	VCV overflow	124	123	0x03aec7	Video Complexity Verifier model has ove
Warning	33015	Video Object ...	VCV overflow	125	124	0x03b140	Video Complexity Verifier model has ove
Warning	33015	Video Object ...	VCV overflow	126	129	0x03b416	Video Complexity Verifier model has ove
Warning	33015	Video Object ...	VCV overflow	127	126	0x03c7eb	Video Complexity Verifier model has ove
Warning	33015	Video Object ...	VCV overflow	128	127	0x03cb1a	Video Complexity Verifier model has ove
Warning	33015	Video Object ...	VCV overflow	129	128	0x03ce6c	Video Complexity Verifier model has ove
Warning	33015	Video Object ...	VCV overflow	130	133	0x03d16b	Video Complexity Verifier model has ove
Warning	33015	Video Object ...	VCV overflow	131	130	0x03e5bb	Video Complexity Verifier model has ove
Warning	33015	Video Object ...	VCV overflow	132	131	0x03e86a	Video Complexity Verifier model has ove
Warning	33015	Video Object ...	VCV overflow	133	132	0x03eb2e	Video Complexity Verifier model has ove
Warning	33015	Video Object ...	VCV overflow	134	137	0x03ede7	Video Complexity Verifier model has ove
Warning	33015	Video Object ...	VCV overflow	135	134	0x0404a0	Video Complexity Verifier model has ove
Warning	33015	Video Object ...	VCV overflow	136	135	0x0407c4	Video Complexity Verifier model has ove
Warning	33015	Video Object ...	VCV overflow	137	136	0x040aff	Video Complexity Verifier model has ove
Warning	33015	Video Object ...	VCV overflow	138	141	0x040e0f	Video Complexity Verifier model has ove

Total: 148 alerts | All alerts shown

If the Alert log is closed, then the MTS4CC displays a warning, as shown in the following figure:

This is displayed only once for all the Alerts between the relevant frames.

Right-click popup menu

The available functions in the Alert log can be selected by right-clicking and selecting the function from the pop-up menu:

The functions of this menu are as follows:

View alert details…. See *View details of the alerts* on page 2-155.

Enable alert. An individual alert can be enabled or disabled by clicking on this menu selection:

Alert disabled

Alert enabled

NOTE. *This allows an individual alert to be enabled/disabled from this menu, without having to open the Alert configuration dialog box.*

Configure alert… See *Configure Alerts* on page 2-150.

Filter alerts. See *Showing/Hiding Alerts (Alert Filter)* on page 2-154.

Go to view. See *Synchronized Views/Navigating the Views* on page 2-6.

Synchronize views. See *Synchronized Views/Navigating the Views* on page 2-6.

Status Bar Indication of Alert Status

The status bar displays the status of the alerts.

Overall alert level enabled,
- All = all levels, including Infos
- Warning = Warnings, Errors, Fatals
- Error = Errors and Fatals
- Fatal = Fatals only

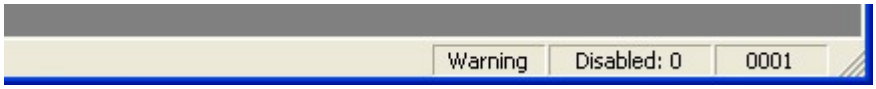
Number of specific alerts disabled

One or more alerts disabled

When one or more alerts are disabled, either because:

- The overall alert level does not include Warnings, Errors and Fatals
- One or more of the specific alerts have been disabled

The status bar changes as shown:



Overall alert level: Infos disabled (all other levels enabled)

Overall alert level: Warnings disabled (Errors and Fatals enabled)

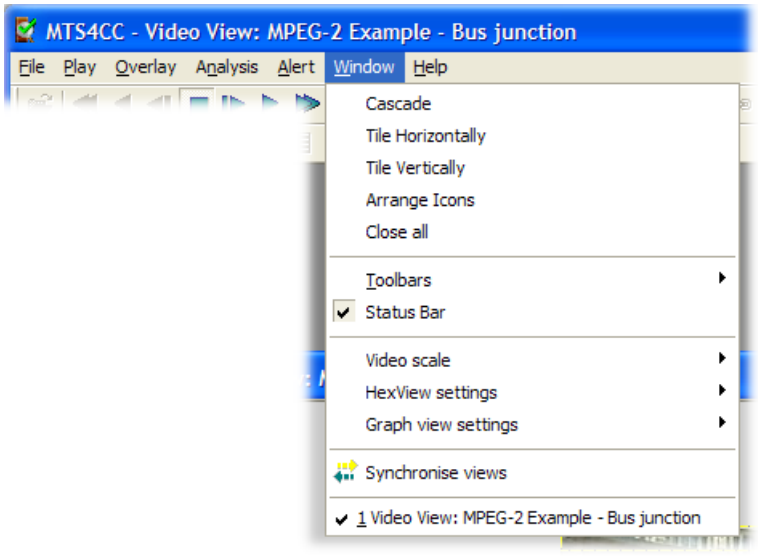
Overall alert level: Errors disabled

Overall alert level: All disabled - except one/more specified Warning alerts

Overall alert level: All disabled - except one/more specific Error alerts

Window Menu

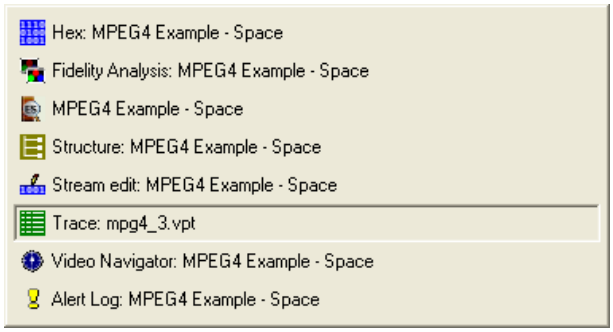
The following paragraphs describe the options available in the Window menu.



The commands in this menu are typical of a standard Windows application, including arranging windows and listing open windows.

Quickly Switch Windows

Pressing `Ctrl+Tab` together displays a list of open MTS4CC windows:

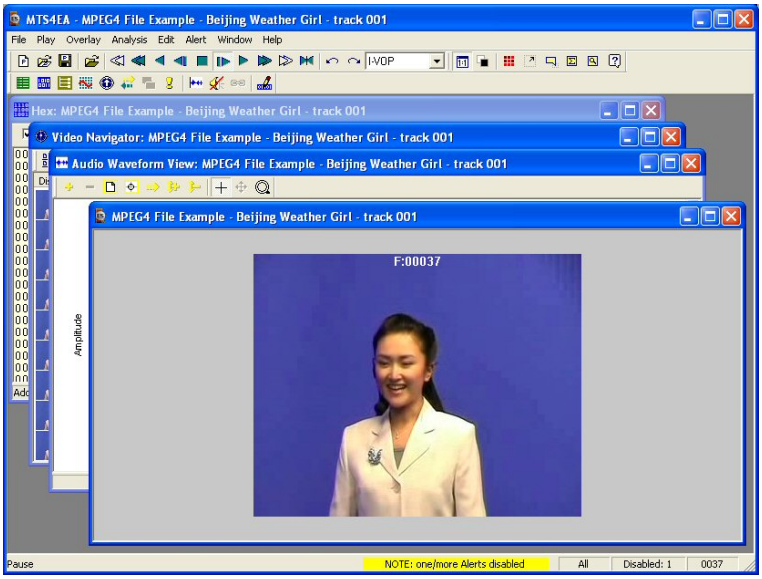


Repeatedly pressing Ctrl+Tab steps through all the open windows. Alternatively, the mouse can be used to select a window.

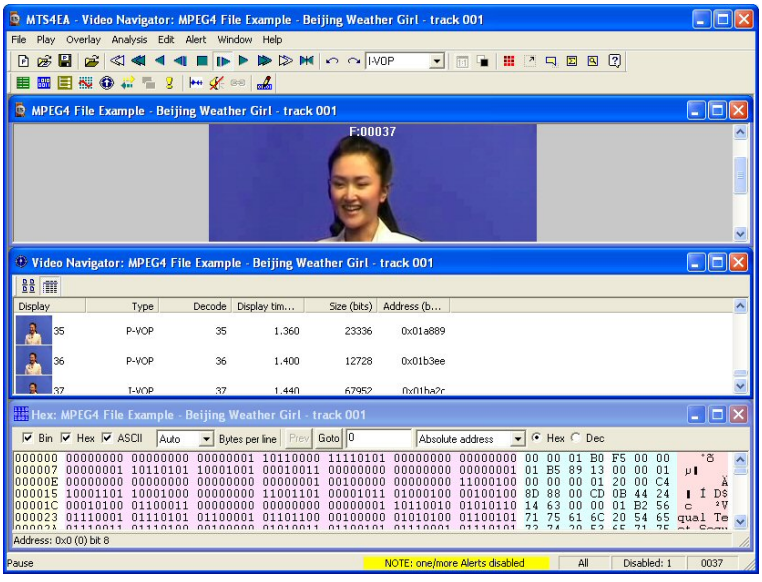
Cascade, Tile, Arrange Icons, Close All

These commands are standard Windows commands:

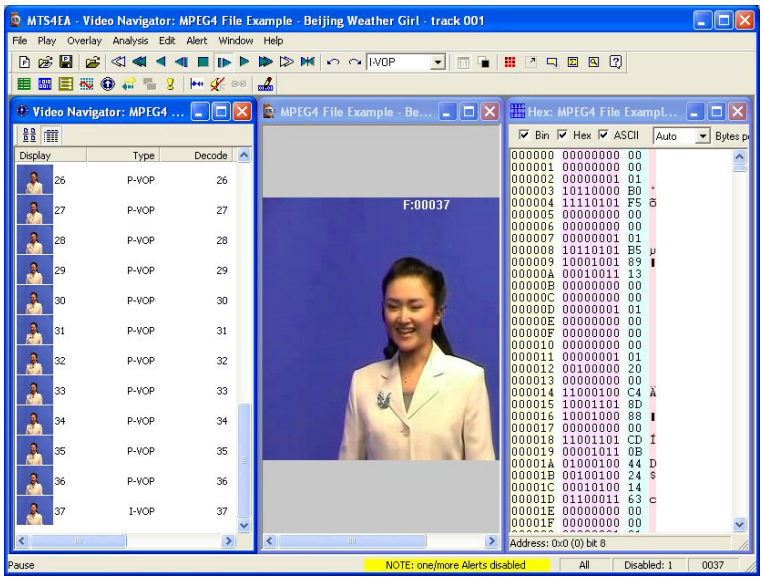
- Cascade arranges the open windows in a cascade:



- Tile Horizontally arranges the open windows as shown:



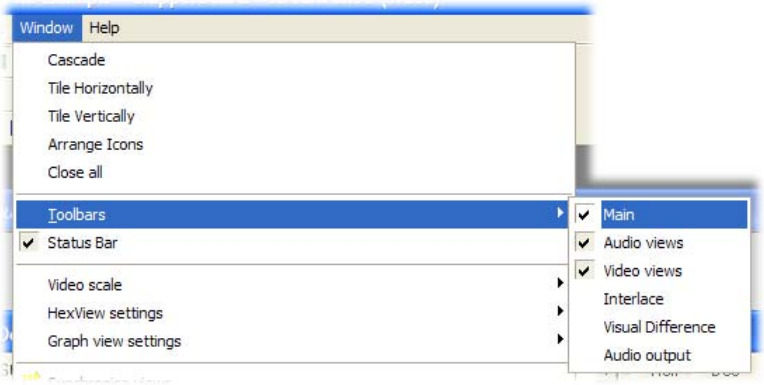
- Tile Vertically arranges the open windows as shown:



- Arrange Icons lines up the windows when they are minimized
- Close all closes all windows in the MTS4CC

Toolbars

In the following example, the Main and Views toolbars are currently displayed, but not the Interlace, Visual Difference or Audio output toolbars. When selected, a toolbar is displayed with the visible icons. This is indicated by the check mark in the Window menu. Toolbar buttons may be grayed out when a function is inactive.



The default display position for a toolbar is docked at the top of the main MTS4CC window. A toolbar can be dragged and docked with any edge of the main window or left floating; click and drag the vertical line at the left end of the toolbar.

When a toolbar icon looks as though it is pressed in, it is active (selected). At various times, some of the toolbar buttons are grayed out, indicating that they are disabled because that function cannot be active at the time.

Main

Each of the Main toolbar buttons provides quick access to a specific function of the MTS4CC, as follows:

Toolbar icon	Ctrl +	Name	Description
	O	Open stream	Open a video/audio file
	Shift + F	Fast backward	Fast backward a video file
	Shift + P	Play backward	Play a video file backwards
	Shift + A	Pause/Step backward	Pause a video file/ step back by one frame
	S	Stop	Stop playing a video/audio file
	A	Pause/Step forward	Pause a video file/advance by one frame
	P	Play forward	Play a video/audio file (forwards)
	F	Fast forward	Fast forward a video file
		Pause on frame	Pause on specific frame number
	-	Video start position	Set either a byte offset or decode frame number as a starting position for decoding
	Shift + K	Skip forward	Skip forward to next video frame type/time/number of frames indicated in the adjacent drop-down box
			Specifiy the skip forward/backward step
	K	Skip backward	Skip backward to next video frame type/time/number of frames indicated in the adjacent drop-down box
		Synchronize views	Synchronize all open views
		View alert log	Display log of alerts
		Synchronize audio	Synchronize audio and video streams
	F1	Help	Go to Help topics

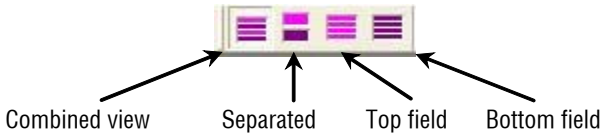
Video Views

Each of the Views toolbar buttons provides quick access to a specific function of MTS4CC.

Toolbar icon	Ctrl +	Name	Description
	Shift+T	View fidelity trace	View the currently selected Trace file
	H	View video stream hex	Open the current steam in the HexView
	R	View video stream structure	Open the current video/container file and view the structure in navigable tree form
		View video buffer analysis	Graphs of VBV/VCV/VMV (depends upon standard)
		View bits per video frame analysis	
		View fidelity analysis	Show fidelity analysis
	U	Summary tooltip	Open/close the Summary tooltip
	1	1:1	Set video scale: Best fit or 1:1
	W	Black/White	Set overlay digits to black/white
	Y	MB types	MacroBlock type overlay
	E	Motion vectors	Overlay motion vectors display

Interlace

The Interlace toolbar is not shown by default; it is always turned on when a stream that is interlaced (or could be interlaced - in H.264/AVC this may not be known until later in the stream) is opened.



Only one of these four buttons is selected at any time.

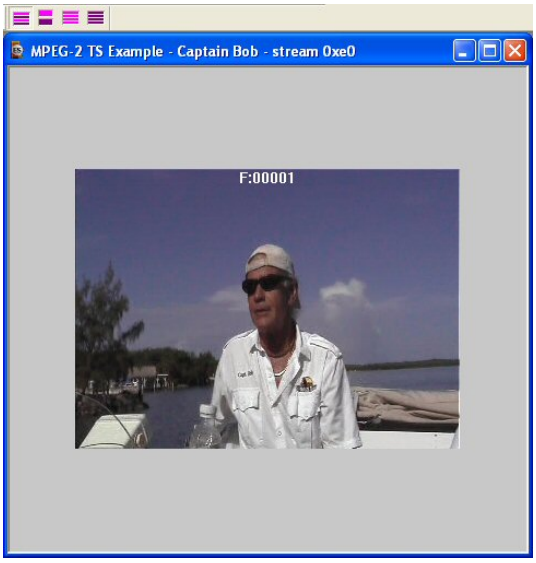
NOTE. *The Interlace toolbar only appears when a bitstream could have Interlace within it. The fact that the Interlace toolbar is there does not necessarily mean that the bitstream is interlaced – only that interlace is permissible/possible in the given standard, Profile, and Level.*

These are examples of video streams where the Interlace toolbar can appear (this is not a complete list):

- H.264/AVC (All supported profiles)
- VC-1 Advanced profile
- MPEG-4 Advanced simple profile, levels 4 and 5
- MPEG-2 Main profile, Main level

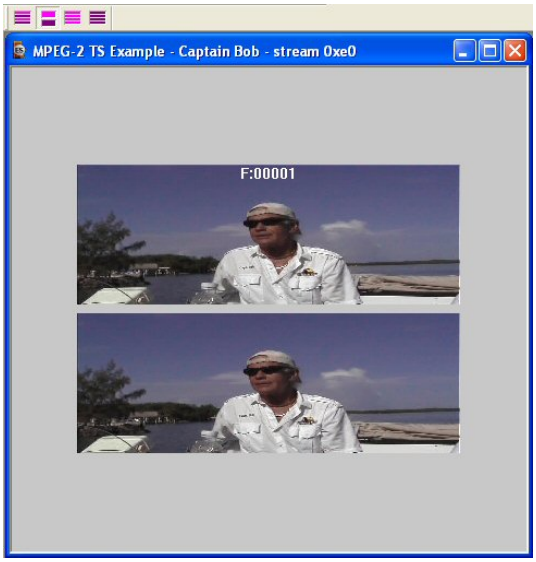
NOTE. *When the Interlace toolbar has not been automatically displayed by the MTS4CC (or it has been closed), it can be displayed by clicking the Windows menu, and then selecting Toolbars, Interlace.*

Combined frame view. Both fields are shown together, as a single image:



NOTE. *Some data and functions are not available when the video is displayed in this view. For example, the MacroBlock tooltip is empty and cannot be used, and motion vectors, MacroBlock Types and other overlaid data do not appear.*

Separated fields view. The top and bottom fields are shown separately, one above the other:



Top-field view. Only the top-field image data is displayed. For field coded MacroBlocks, the MB tooltip and overlays show data relevant to the top field. For frame coded MacroBlocks, the MB tooltip and overlays show data relevant to the frame.

Each row is shown twice (duplicated) to produce an image to the full image height:

Bottom-field view. This view is the same as for the Top-field view, except that it is for the bottom field.

Visual Difference

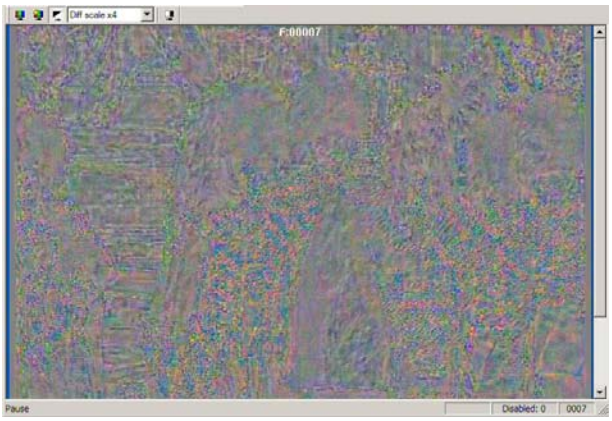
The Visual Difference toolbar is not shown by default; it is not shown until Visual Difference is enabled on the Overlay menu.

The functions of the icons are as follows:

Show encoded (compressed). Selecting this menu option (or clicking on the  icon) displays the standard video window (shows the compressed bitstream that was decoded by the MTS4CC):

Show uncompressed video reference. Selecting this menu option (or clicking on the  icon) displays the frame in the YUV reference file that corresponds most closely in time to the corresponding frame in the compressed bitstream:

Show difference. Selecting this menu option (or clicking on the icon) subtracts the uncompressed video reference video from the compressed video, frame-by-frame:



The MTS4CC uses the timing given in the:

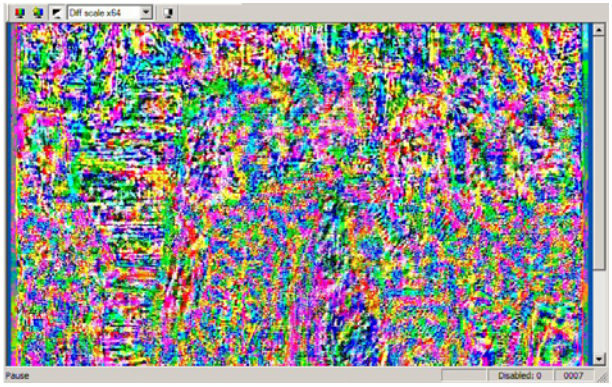
- Compressed bitstream itself for the displayed frame times of the compressed bitstream
- Uncompressed video reference set-up tab of the MTS4CC (the frame rate) for the uncompressed video reference file

When doing the subtraction, the MTS4CC uses the uncompressed video reference file and the corresponding frames from the compressed bitstream that are closest to each other in time.

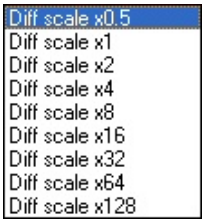
NOTE. *The visual difference view can be used to display the difference between two uncompressed video files; to do this, open the first uncompressed video file using the standard File-open (selecting Open as type) and then select the second uncompressed video as the reference file.*

If the frame rate of the uncompressed video reference file is set incorrectly, the visual differences will appear to be much greater than they should be.

Magnify visual difference by X. This menu selection or drop-down menu can be used to magnify the visual differences on-screen, so that they are easier to see:



The magnification (multiplication factor) can be any of the factors shown:



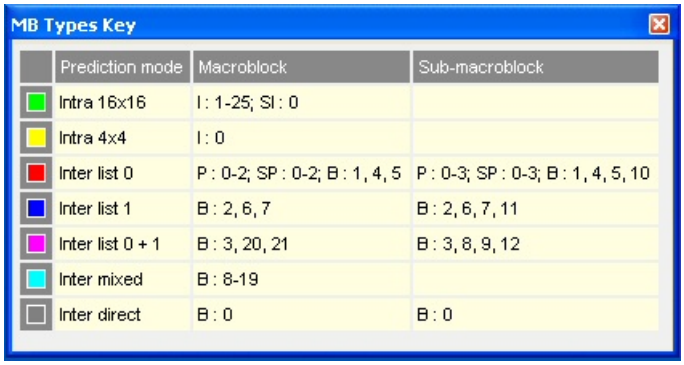
MacroBlock Types Color Key Tooltip

This is an information tooltip that appears when the MacroBlock Types overlay is on. Its function is to explain the colors used. This appears when the MB types overlay is on; the  icon is active.

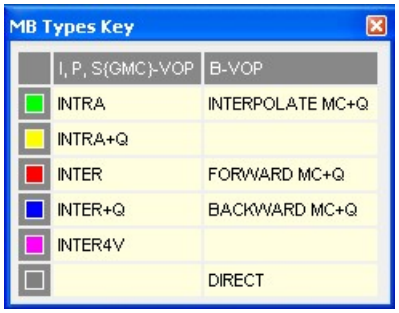
NOTE. *To force undocking of the MB types color key tooltip, hold the Ctrl key while dragging with the mouse.*

The MB types color key tooltip can also be turned on again by going to the Window menu, selecting Toolbars, and then clicking the MB types key.

This tooltip can be closed by clicking on the X at the top of the tooltip; to redisplay it click the MB types overlay icon off, and then on.



H.264/AVC example



MPEG-4 example

Status Bar

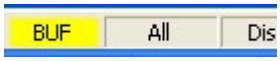
When selected (which is the default setting), the Status Bar is displayed at the bottom of the window. When not selected, it is hidden.

The status bar provides:

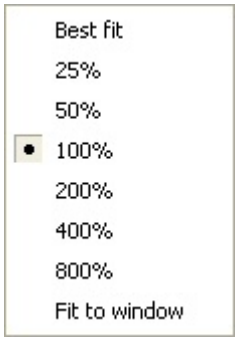
- A one-sentence description of each menu item, as the mouse is moved over the menu item
- The stream Play mode (see *Playing Mode: Restrictions* on page 2-6)
- Context-sensitive information. The information displayed depends on which window type is open and the current status of the file within that window

The status bar can be displayed or hidden from within the Window menu, in the same way as the icons toolbar:

For more information on status bar indications of:

Alert levels, alert warnings, alerts disabled:  	See page 2-159
Frame range (in/out): 	See page 2-97
When custom parameters are used for buffer analysis, this is indicated in the status bar of the main MTS4CC window by the word BUF: 	See pages 2-122 and 2-123

Video Scale



This sets the size that the decoded video appears in the video window.

Best Fit

This zooms the displayed video as far as is possible within the video window, while still maintaining the original aspect ratio of decoded video.

50%; 100% (1:1); 200%; 400%; 800%

These set the displayed video to the selected size in the video window.

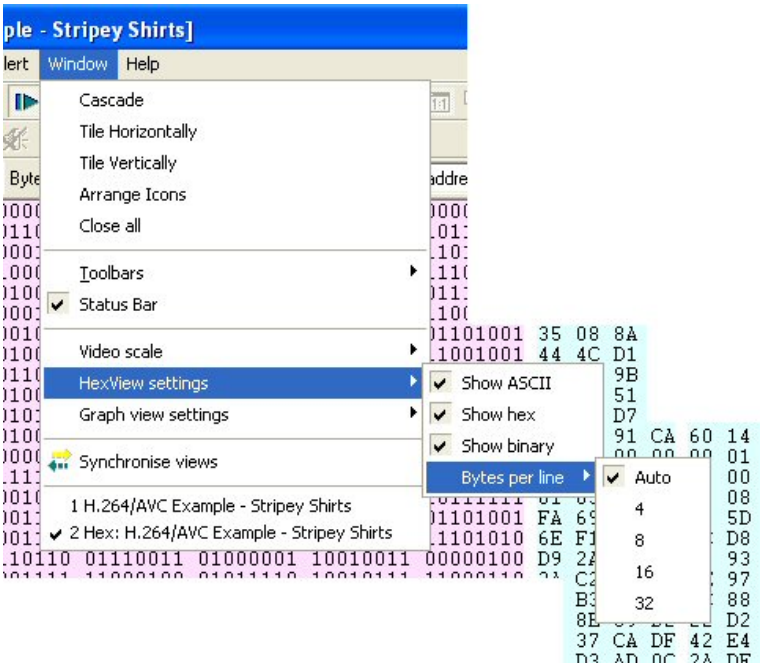
If the selected size is larger than the available window area, a section of the video window will be displayed, with scroll bars:

When the MTS4CC starts, it is set by default to 100% or 1:1; the video displays at its actual size with one screen pixel equaling one pixel in the displayed video.

Fit to Window

This zooms the displayed video to completely fill the video window; it does not maintain the original aspect ratio of decoded video.

HexView Settings



The HexView menu has four options:

- Show ASCII
- Show hex
- Show binary
- Bytes per line

Show ASCII, Show hex, Show binary

These options individually turn on/off the display of the specified area of the HexView.

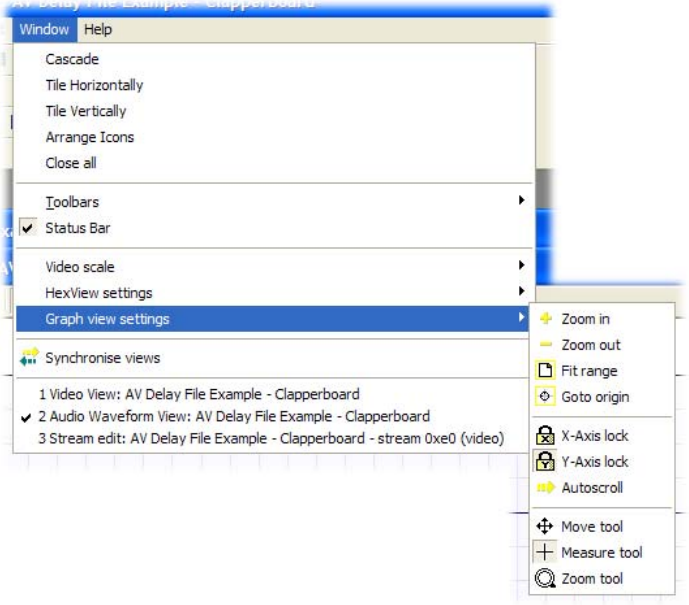
They can be turned on/off from either this menu or from the top line of the HexView window.

Bytes per line

This sets the displayed number of bytes per line:

- Auto sets the maximum number of bytes that will fit within the active HexView window, allowing for the visible ASCII/hex/binary areas.
- When 4, 8, 16 or 32 is selected, the given number of bytes are displayed, and if the display is too wide for the active HexView window, a horizontal scroll bar is displayed along the lower edge of the HexView window.

Graph View Settings



The Graph view menu has ten options, which control how the data appears on the Buffer analysis graph. These options are described in the following table:

Icon	Equivalent toolbar icon	Function
Zoom-in		Zoom in (centered on current window)
Zoom-out		Zoom out (centered on current window)
Fit to range		Fit all data into the visible window
Goto origin		Go to the origin (time = 0)
X-Axis lock		Lock the X-axis when zooming/scrolling
Y-Axis lock		Lock the Y-axis when zooming/scrolling
Autoscroll		Autoscroll to follow frames as decoded
Move tool		Move window left/right/up/down
Measure tool		Measure the values at center point of +
Zoom tool		Zoom in/out, centered on cursor
Goto view Synchronise views	n/a n/a	See *Synchronized Views/Navigating the Views* on page 2-6

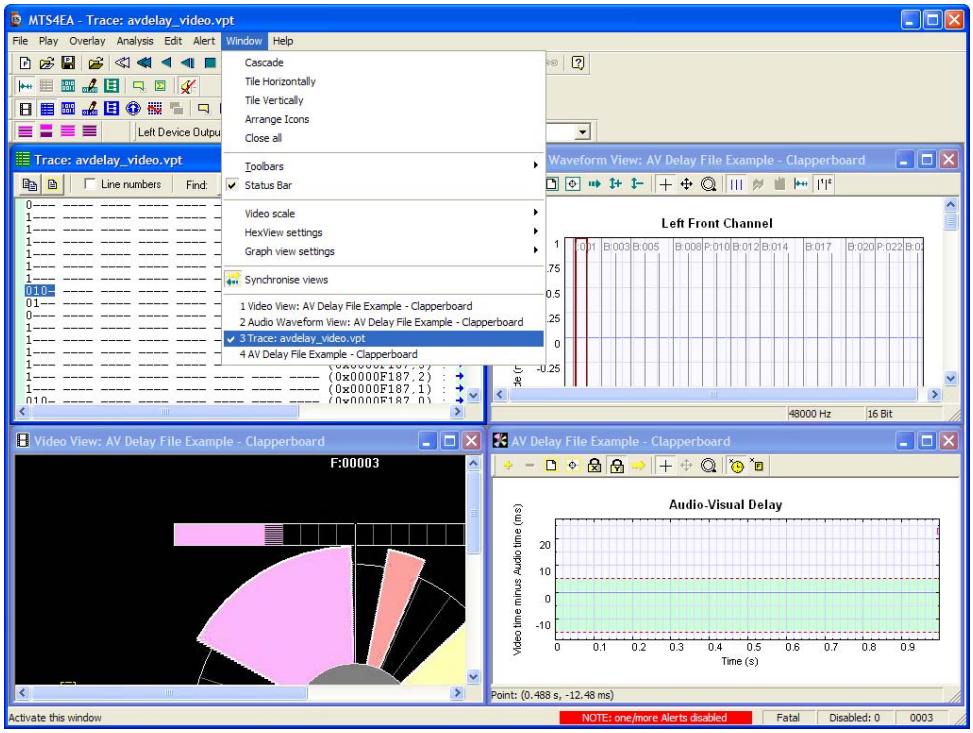
Synchronize views

When Window > Synchronise Views ( ) is selected, all open windows synchronize automatically.

For example, if the Video and Hex views are both open at the same time as the Audio waveform view, the Synchronize views icon is selected and the stream is played, all views display the same relative point in the stream at any one time.

Active Views

A list of all of the open views is displayed at the bottom of the Windows menu. A check mark appears next to the currently selected view. Highlight an entry to change the selection.



Ctrl Shortcut Keys

All shortcut keys are accessed by holding the Ctrl key and pressing the letter given in the following table, except the F1 key:

Toolbar icon	Ctrl +	Name	Description
	mouse	Force undock	Force undocking of tooltip (for example, Summary/MacroBlock)
	1	1:1	Set video scale: Best fit or 1:1
	A	Pause/Step forward	Pause a video file/advance by one frame
	Shift + A	Pause/Step backward	Pause a video file/ step back by one frame
	C	Copy	Copy highlighted selection
	E	Motion vectors	Overlay motion vectors display
	F	Fast forward	Fast forward a video file
	Shift + F	Fast backward	Fast backward a video file
	G	Graph enable	Enable the graph output
	H	View stream hex	Open the current steam in the HexView
	I	Image inspector	Open/close the Image inspector
	K	Skip forward	Skip to next I-frame/forward n frames/forward n seconds
	Shift + K	Skip backward	Skip to previous I-frame/backward n frames/backward n seconds
	M	MB tooltip	Open/close the MacroBlock tooltip
	O	Open stream	Open a video/audio file
	P	Play forward	Play a video/audio file (forwards)
	Shift + P	Play backward	Play a video file backwards
	R	View file structure	Open the current video/container file and view the structure in navigable tree form
	S	Stop	Stop playing a video/audio file
	T	Trace enable	Enable the Trace output
	Shift+T	View trace	View the currently selected Trace file
	U	Summary tooltip	Open/close the Summary tooltip
	W	Black/White	Set overlay digits to black/white
	Y	MB types	MacroBlock type overlay

Toolbar icon	Ctrl +	Name	Description
	Tab	Switch windows	Quickly switch between open windows
	F1	Help *	Go to Help topics
	F3	Find next *	In Trace and HexView only
	Shift+F3	Find previous *	In Trace and HexView only

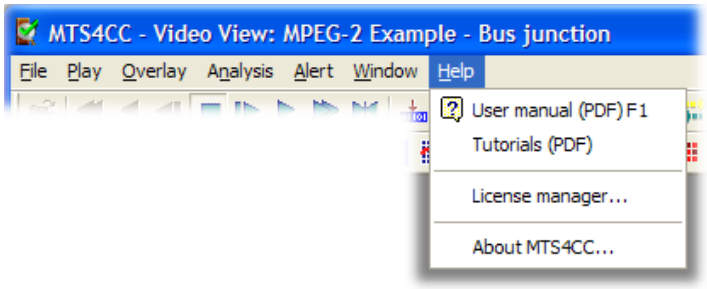
* The F1, F2 & F3 keys are pressed without pressing the Ctrl key

Alt Menu Keys

Menus can be selected by pressing the Alt key and the letter underlined in the menu option name. For example, pressing Alt+f will open the File menu. The cursor keys (or the mouse) can be used to select the required option.

Help Menu

The following paragraphs describe the options available in the Help menu.



This menu provides access to the Help information (on-line, PDF), the tutorials, configuration information, and license information (including licensed options).

User manual (PDF) F1

This menu choice displays a PDF version of this user manual.

Refer to the Adobe Acrobat documentation for details of how to navigate through the document.

Tutorials (PDF)

This displays a PDF version of the tutorials on how to optimize your use of the MTS4CC. It is strongly recommended that you work through the tutorials. The tutorials are also included in the standard Help (accessed by pressing the F1 key), although the PDF version is easier to print out.

License manager

This displays the MTS4CC License manager, including:

- Current license status information
- Other possible MTS4CC options that can be licensed
- Option to update the license key

See *Installation and Licensing* in chapter 1 for more information on the license manager.

About MTS4CC

This displays the exact version number of the MTS4CC and the copyright message, and allows access to the MTS4CC build options.

Reference

Command Line/Batch Mode

This feature allows the MTS4CC to be run in one of two ways:

- Command line mode
- Batch mode

Command line mode

In command line mode, the MTS4CC opens with the Windows display as usual, except that it uses the files and flags specified in the command line.

Batch mode

In batch mode, there is no Windows display (the window is minimized and not activated) and the input file, flags and output files are specified in the command line.

The exception to this in batch mode is when no input file is specified. In this case, the MTS4CC opens in Windows mode, allows you to specify a bitstream file name, and then closes Windows mode and goes back to batch mode.

The MTS4CC exits automatically from batch mode when the last selected frame has been decoded.

NOTE. *Remember the –b option to run MTS4CC in batch mode (rather than command-line mode).*

Running the MTS4CC in command line/batch mode

To use command line or batch mode:

- Use Windows Start/Run and type in the line
- Open a command prompt window (typically from Windows Start/Programs/Accessories) and enter the line

The format of the line to be entered is:

`MTS4CC [options...] <filename>` where:

- `[options...]` is zero or more of the options listed in 0
- `<filename>`is the input video file to be decoded

Specification of Filename (input video file)

The input video filename must be the full filename (including any file extension after the . [period]).

Using demonstration sequences in batch mode. To use batch mode with the demonstration tutorial video sequences provided on the File menu, the filename for these sequences is specified in the following table:

Demo sequence	Standard	Filename
H.264/AVC byte streams		
Neon Night	H.264/AVC Baseline Profile/Level 2	avc_1
Bus Junction	H.264/AVC Baseline Profile/Level 3	avc_3
Grenadier Guards	H.264/AVC Main Profile/Level 3	avc_4
Stripey Shirts	H.264/AVC High Profile/10	avc_5
VC-1 Advanced stream		
Central Park	VC-1 Advanced	wmv9_1
MPEG-4 Elementary Streams		
Woman Drinking	MPEG-4 Main Profile	mpg4_1
Train in Station	MPEG-4 Main Profile	mpg4_2
Space	MPEG-4 Simple Profile	mpg4_3
Man Walking	MPEG-4 Advanced Simple Profile	mp4asp_1
Synthetic	MPEG-4 Advanced Simple Profile	mp4asp_2
Window Car	MPEG-4 Advanced Simple Profile	mp4asp_3
H.263 streams		
Rally (250k)	H.263 Baseline/MPEG-4 Short Header	h263_1
MP4 files		
Packet Woman	MP4 file containing MPEG-4 Simple Profile/ Level 1	mp4fil_1
Piccadilly Circus	MP4 file containing MPEG-4 Simple Profile/ Level 2	mp4fil_2
Beijing Weather Girl	MP4 file containing MPEG-4 Simple Profile/ Level 5 (with audio)	mp4fil_3
Las Vegas	H.264/AVC Baseline Profile/Level 1.2	mp4fil_4

Demo sequence	Standard	Filename
3GPP file		
Mobile Hands	3GPP file containing MPEG-4 Simple Profile/ Level 1	3gpfil_1
MPEG-2 Program Streams		
Bus Junction	MPEG-2 Main Profile/ Main Level	mp2_1
Person Track	MPEG-2 Main Profile/ Main Level	mp2_2
Grenadier Guards	MPEG-2 Main Profile/ Main Level	mp2_3
MPEG-2 Transport Streams		
Golden Gate	H.264/AVC Main Profile	mp2ts_1
Mangroves	MPEG-2 MP@ML	mp2ts_2
Captain Bob	MPEG-2 MP@ML (with MPEG-1 Audio Layer II)	mp2ts_3
Microsoft® ASF files		
Beach Girl	Simple Profile	asf_1
Great Wall	Main Profile	asf_2

To use these demonstration sequences, the option `-d` is used; see *List of options* on page 3-4.

In addition, the following YUV files are provided for fidelity analysis and visual differencing with the example streams:

YUV files	Use with compressed demo sequence	Frame rate	Number of frames
`guards_yuv`	H.264/AVC Grenadier Guards MPEG-2 Grenadier Guards	25	10
`man_walking_yuv`	MPEG-4 Man Walking	30	All

Command Line/Batch Mode Options

Form of options. All options take the following form:

```
-x <value>
```

(Where `x` is the option and `<value>` is the value entered; for some options there is no value.)

NOTE. *All options must be entered in lower case.*

If there is a value, there is always a <space> between the `-x` and the value.

All options must be separated by spaces.

NOTE. *Where filenames or folders have spaces in the path or name, these must be put inside double quotes.*

There is limited checking on the options/option values.

List of options.

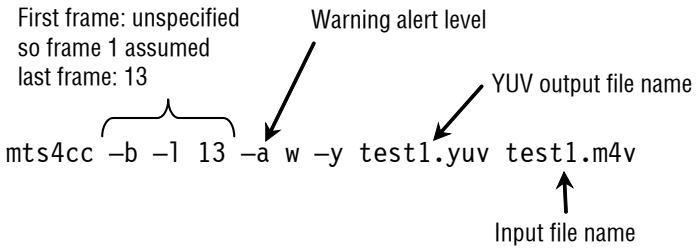
Option	Value (if any)	Description
-a	<alertlevel>	Alert level, which must be one of the following text strings: error warning fatal As with MTS4CC run in Windows mode, if the warning alert level is on, trace outputs will also include error and fatal level alerts. Fatal level alerts are always on.
-b		When present, enable batch mode. If not present, command line mode is used.
-d		When this flag is present, it signifies that one of the demonstration tutorial video sequences as provided with the MTS4CC is to be used as the input video file. The particular demonstration sequence to be used is specified by the filename as listed under *Using demonstration sequences in batch mode* on page 3-2. (This filename is given at the end of the command line, like any other input filename.)
-f	<firstframe>	Integer value specifying the first frame to be used for the YUV and Trace outputs. If this option is not specified, then frame number 1 (the first frame in the video sequence) is used.
-h		Displays help Window (MTS4CC opens after OK is clicked).
-i	<trackID>	Where the input file is a container file, such as an MP4, 3GPP, or MPEG-2 Program Stream, there can be more than one video track in the file. If -i is not specified, the first video track found is used. If the track ID specified is not present, a file missing error is given.

Option	Value (if any)	Description
-l	<lastframe>	Integer value specifying the last frame to be used for the YUV and Trace outputs. If this option is not specified, the last frame in the video sequence is used.
-m	<size>	Integer value specifying the maximum trace file size, in MB. If -m is not given or the value is set to 0, there is no limit on the size of the trace file (other than the available disk space).
-o	<options>	The Trace file options are any combination of the following letters with no spaces between them: Option — Trace output generated v — vop (frame) fidelity a — macroblock fidelity
-r	<yuvfile>	Full name of the YUV reference file used for fidelity analysis. (See also the options -s, -u and -v.)
-s	<size>	Header skip of the YUV reference file used for fidelity analysis. (See also the options –r, -u and -v.)
-t	<tracefile>	Full name of the Trace output file. If no Trace output file is specified, the trace options are ignored.
-u	<number>	Frame rate of the YUV reference file used for fidelity analysis. The number can be an integer, a fraction expressed as a/b (where a and b are integers), or a decimal number. (See also the –r, -s, and –v options.)
-v	<string>	Metric used for fidelity analysis: the string value must be one of the following: psnr — PSNR with 255 signal range psnritu — PSNR with ITU-R BT.601 signal range rmse — Root Mean Square Error mse — Mean Square Error mad — Mean Absolute Differences sad — Mean Absolute Differences (See also the –r, -s, and –u options.)

Option	Value (if any)	Description
-w	<error_file>	Output trace file with warnings/errors/fatal alerts only - no other trace information. <error_file> is the name of the file that holds the warnings/errors/fatal alerts. If there are no warnings/errors/fatal alerts, the <error_file> is zero length
-x	<options>	The format of image samples in uncompressed video files for input. This option is used when working with H.264/AVC High Profile to denote: The correct format for the uncompressed input when doing PSNR analysis The format option is one of the following codes: 1 - one byte per sample 2le - two bytes per sample, little-endian 2be - two bytes per sample, big-endian
-y	<yuvfile>	Full name of the YUV output file (see *Format of Uncompressed Video File Output from Batch Mode* on page 3-7).

Example Command Line

An example of a valid command line is:



Format of Uncompressed Video File Output from Batch Mode

NOTE. *The uncompressed video output file in this section is the uncompressed video output resulting from decoding the compressed video; this is a different file than the uncompressed video reference file that is used when performing fidelity analysis.*

The YUV data is either:

- 8 bits per sample, 4:2:0
- More than 8 bits per sample, and/or 4:2:2 or 4:4:4 (as used by H.264/AVC High Profile/FRExt, High/10, High/4:2:2, High/4:4:4)

YUV format o 8 bits per sample 4:2:0. The YUV file output is raw YUV with no headers of any kind. This is the same format as used by the Microsoft MPEG-4 Part 2 reference encoder Reference [7] (see *Compression Standards and File Types* section) and as used commonly by other programs:

- No headers of any kind (no file or frame headers)
- One byte per sample
- Row raster order (top picture row first)
- Planar YUV 4:2:0 sub-sampled (4 bytes of Y data for each byte of U data and each byte of Y data)
- Y plane values are 0-255 unsigned
- U and V plane values are unsigned with a DC offset of 128

Other uncompressed formats. The general uncompressed video file format is as follows:

- No headers of any kind (no file or frame headers)
- Concatenated planar image data
- Row raster order (top picture row first)
- Unsigned samples

For 8-bit sample depth:

- One byte per sample

For 9-16 bit sample depth:

- Two bytes per sample
- Both little- and big-endian byte orders supported

For YUV format:

- Concatenated Y, U, and V planes
- U and V planes sub-sampled as required
- Y plane samples are unsigned
- U and V plane samples are unsigned with a DC offset of 2^{n-1}, where n is the chroma sample bit depth

For RGB format:

- Concatenated R, G, and B planes

For grayscale format:

- Luma plane only

Decoder Plugins for MTS4CC

This section covers use of MTS4CC decoder Plugins.

Purpose of MTS4CC Decoder Plugins

The MTS4CC Decoder Plugins allow the advanced user to substitute various elements of the MTS4CC decoder with custom/alternate elements.

There are a number of reasons that you may want to do this:

- The outputs of decoders vary due to rounding errors or different floating-point arithmetic being used, because the video standards do not completely define them. The differences mean that the output given by the MTS4CC - particularly using the YUV output in batch mode (see *Command Line/Batch Mode* in the *Operating Basics* section for more information) - cannot be exactly compared with the output from another decoder. If you substitute your own part of the codec for that section of the decoder, the YUV outputs generated should exactly match yours. See *`idct` Plugin* on page 3-12 for an example.
- If the video standard has errors and differs from common implementations. Many implementations differ from the standard in this way. See *`idct` Plugin* on page 3-12 for an example.
- To use the MTS4CC function within your own decoder, to obtain numerically identical results from the MTS4CC decoder and your own.

NOTE. *The DLLs provided by Tektronix are provided and licensed solely for the purposes of test and may not be redistributed under any circumstances.*

Support of Decoder Plugins

Use of the Decoder Plugins assumes a considerable and detailed understanding of the video standard(s) concerned, as well as a thorough understanding of how to write Windows DLLs, and are provided for use by advanced developers only.

NOTE. *Other than the documentation provided here and in the files provided on the CD in the folder of the Decoder Plugins, no technical support will be provided to developers in developing their own Decoder Plugins.*

Decoder Plugin File Layout on the CD

All the Decoder Plugins are on the CD in the folder: `\Decoder plugins`

Below this are three folders:

`\bin` : contains the DLLs

`\docs` : contains the documentation

`\include` : contains the .h files to include in your programs

bin folder

Below this folder are the DLLs provided by the MTS4CC. The DLLs are organized in their own folders.

If a DLL is not dependent upon a particular video standard, this folder resides directly below the `bin` folder. If there are standards dependencies, the DLL folders reside below the folder of the standard concerned.

Examples are:

Folder	Files	Description

`\Decoder plugins\bin\idct\`	`tekIdct.dll`
	`tekIdct.exp`
	`tekIdct.lib`
		IDCT DLL file
		} export LIB files to link to
		} the MTS4CC IDCT DLL

`\Decoder plugins\bin\mpeg4\gmc`	`tekGmc.dll`
	
	`tekGmc.exp`
	`tekGmc.lib`
		GMC (Global Motion Compensation) DLL file
		} export LIB files to link to
		} the MTS4CC GMC DLL

`\Decoder plugins\bin\mpeg4\qs`	`tekQs.dll`
	`tekQs.exp`
	`tekQs.lib`
		Quarter Sample (QS) DLL file
		} export LIB files to link to
		} the MTS4CC QS DLL

docs folder

This folder contains the documentation for each supplied DLL.

To view the documentation, open the file: `index.html` using a browser.

The API to the DLLs, file lists, structures, data fields, and globals are all accessed by clicking on the related links.

include folder

This folder contains all the `.h` files that contain the declarations of the interface for each plugin.

For each plugin, only one include is required: that is for the related DLL. For example, for the IDCT plugin, only the `vpIdct.h` file needs to be included in your own source files.

NOTE. *Any other `.h` files that are listed in the include folder, and that are also needed by the included `.h` file, will be included within the `.h` file.*

An example of this is the 'vpIdct.h', which includes 'MTS4CC.h'.

Format for Generating Decoder Plugins

The Decoder Plugins were written using Microsoft Visual C 6.0.

The Plugins are all Microsoft Windows DLLs.

The only supported versions of Windows are listed in the *Software, Hardware, and User Prerequisites* section.

NOTE. *No other development tools or variants to these are supported for the Decoder Plugins.*

Use of Decoder Plugins

To use a specific Plugin, copy it from the plugin folder to the folder where the MTS4CC executable is (typically `C:\Program files\Tektronix\MTS4CC\`).

There will already be a DLL of the same name within the MTS4CC executable folder; the copied Plugin should overwrite this.

As delivered, all the Plugins that are in the MTS4CC executable folder are MTS4CC variants of these.

Decoder Plugins

`idct` Plugin

This allows you to substitute your own IDCT function instead of using the one provided with the MTS4CC.

By using the same IDCT function in the MTS4CC and in your own decoder, the YUV outputs from the MTS4CC should be numerically identical to the YUV outputs provided by your own decoder.

`qs` Plugin

The MPEG-4 standard (Reference [1], see *Compression Standards and File Types* section) specifies the recommended method for calculating quarter sample accuracy predicted blocks (relating to motion vectors). However, the standard is nonoptimal in the way that these are calculated (for example, it introduces more rounding errors than necessary) and is not as clear as it might be. Consequently, common implementations of the quarter sample functions implement the calculations slightly differently (typically in a different order) to that given in the standard.

The Microsoft reference decoder (Reference [7], see *Compression Standards and File Types* section), although it is (theoretically) normative, is one such implementation that does not actually implement the quarter sample calculations in accordance with the standard; it takes a better approach. There has been some debate about this within the MPEG committee, and the prevailing conclusion seems to be that the Microsoft implementation may be the preferred version and that the standard should at some point be changed to reflect this.

The MTS4CC uses the version as specified in the standard, and the MTS4CC will continue to track the standard and so will change only if the standard is changed. However, you can substitute your own quarter sample Plugin DLL, to use your own or emulate the one used by Microsoft.

`gmc` Plugin

This allows you to substitute your own GMC (Global Motion Compensation) function instead of using the one provided with the MTS4CC.

The Microsoft reference decoder software (Reference [7], see *Compression Standards and File Types* section) differs from the MPEG-4 standard (Reference [1], see *Compression Standards and File Types* section) in several respects, for example, rounding differences and differences in coordinate calculations. This means that the results of the YUV outputs from a Microsoft decoder will be different than the standard if GMC is used. (These differences are reflected in the Microsoft encoder, so that the Microsoft software is

self-consistent.) There is no indication from the MPEG-4 committee of any planned change in the standard. This is simply a variance between the standard and the reference software.

MTS4CC follows the standard. However, if you want to follow the Microsoft version of the implementation of GMC or use your own, then you may substitute your own GMC DLL.

Appendices

Tests of MTS4CC

This section covers a report on the MTS4CC tests of the MPEG-4 Normative bitstreams and Donated bitstreams (see *Compression Standards and File Types* section).

Tests with MPEG-4 normative and donated bitstreams

Many of the MPEG-4 Normative bitstreams and Donated bitstreams have errors: some of these errors are clear non-conformance to the standard; others are errors in the data encoded in the bitstreams.

Also, in a number of cases, the Microsoft reference decoder software will not decode these bitstreams at all or does so incorrectly.

These divergences are listed below. Many of them are recognized and documented by the MPEG committee as errors, but they have yet to be corrected in the Standard and/or bitstreams and/or Microsoft reference decoder software.

Notes on versions used:

- MTS4EA: v2.0.0.0
- Microsoft reference software: FDAM1-2.3-001213 version 2 dated July 3rd 2000 (note: this reference software has been updated since these tests, so the current reference software may behave differently)
- MPEG-4 Normative ISO bitstreams: dated 05/11/2001, see *Compression Standards and File Types* section
- MPEG-4 Donated bitstreams: referred to in section 4.5.8 in document N3067 dated 1999-03-18; streams dated 14/07/2000, see *Compression Standards and File Types* section

n/a = not applicable

Bitstreams: Normative ISO

Stream name	Decodes with MTS4CC?	Notes
vcon-ge1	n/a	Interlace not allowed in Simple Profile
vcon-ge2	n/a	Interlace not allowed in Simple Profile
vcon-ge3	n/a	Interlace not allowed in Simple Profile
vcon-ge4	n/a	Interlace not allowed in Simple Profile
vcon-ge6	n/a	Interlace not allowed in Simple Profile
vcon-ge8	n/a	OBMC not allowed in Simple, Advanced Simple, or Main Profiles
vcon-ge10	n/a	Interlace not allowed in Simple Profile
vcon-ge11	n/a	Interlace not allowed in Simple Profile
vcon-ge12	n/a	Interlace not allowed in Simple Profile
vcon-ge13-L1	Yes	
vcon-ge13-L2	Yes	
vcon-ge13-L3	Yes	
vcon-ge14	n/a	OBMC not allowed in Simple, Advanced Simple, or Main Profiles
vcon-ge16-L1	Yes	MS reference software cannot decode
vcon-ge16-L2	Yes	MS reference software cannot decode
vcon-ge16-L3	Yes	MS reference software cannot decode
vcon-ge18	n/a	Interlace not allowed in Simple Profile
vcon-ge19	n/a	OBMC not allowed in Simple, Advanced Simple, or Main Profiles
vcon-ge23	n/a	Interlace not allowed in Simple Profile
vcon-ge24	n/a	OBMC not allowed in Simple, Advanced Simple, or Main Profiles
vcon-ge25	n/a	OBMC not allowed in Simple, Advanced Simple, or Main Profiles

Bitstreams: Donated \ I-VOP

Stream name	Decodes with MTS4CC?	Notes
hit000.m4v	Yes	Single frame. Time listed incorrectly in MPEG-4 part 4: time is actually 33 ms (vop_time_increment = 30).
jvc000.m4v	Yes	
mit000.m4v	Yes	Uses error resilience tool (data partitioning)
mit001.m4v	Yes	Uses error resilience tool (resynchronization)
mit002.m4v	Yes	Uses error resilience tool (resynchronization)
mit003.m4v	Yes	Uses error resilience tool (resynchronization)
mit004.m4v	Yes	Uses error resilience tool (data partitioning)
mit005.m4v	Yes	Uses error resilience tool (data partitioning)
mit006.m4v	Yes	Uses error resilience tool (data partitioning)
san000.m4v	Yes	
san001.m4v	Yes	

Bitstreams: Donated \ Overall

Stream name	Decodes with MTS4CC?	Notes
hit016.m4v	Yes	
hit017.m4v	Yes	Visible artifacts are in bitstream (plays the same with MS software)
hit018.m4v	Yes	
hit019.m4v	Yes	
hit020.m4v	Yes	
hit021.m4v	Yes	
hit022.m4v	Yes	
hit023.m4v	Yes	
hit024.m4v	Yes	
mit030.m4v	Yes	
mit031.m4v	Yes	Uses error resilience tool (data partitioning)

Bitstreams: Donated \ Short Header

Stream name	Decodes with MTS4CC?	Notes
hit031.m4v	Yes	
hit032.m4v	Yes	Visible errors but these are encoded in the bitstream (MS software plays the same)
hit033.m4v	Yes	
hit034.m4v	Yes	
hit035.m4v	Yes	MPEG committee reports that MS software fails to decode (not tested)
hit036.m4v	Yes	Not short_header compliant as Pspare is sent (H.263+ compliant)
hit037.m4v	Yes	
hit038.m4v	Yes	
hit039.m4v	Yes	
hit040.m4v	Yes	
jvc022.m4v	Yes	
jvc023.m4v	Yes	
jvc024.m4v	Yes	
jvc025.m4v	Yes	
mit020.m4v	Yes	
mit021.m4v	Yes	MPEG committee reports that MS software fails to decode (not tested)
mit022.m4v	Yes	MPEG committee reports that MS software fails to decode (not tested)
mit023.m4v	Yes	MPEG committee reports that MS software fails to decode (not tested)
mit024.m4v	Yes	MPEG committee reports that MS software fails to decode (not tested)
san021.m4v	Yes	
san022.m4v	Yes	Poor frames are encoded in bitstream (MS software plays the same)
san023.m4v	Yes	Non-smooth motion is encoded in bitstream (MS software plays the same)
san024.m4v	Yes	Non-smooth motion is encoded in bitstream (MS software plays the same)

Bitstreams: Donated \ P-VOP

Stream name	Decodes with MTS4CC?	Notes
hit001.m4v	Yes	Some visible errors, for example, frame 1, GOB 2, MB 15 block Y3 but these are in bitstream (MS software plays the same)
hit002.m4v	Yes	Some visible errors, for example, in frame 2, GOB4, MB 1 and in frame 3 - several MBs down left side, for example, MB 0 at GOB 14, 15, 16 - these are errors in the encoded bitstream (MS software plays the same)
hit003.m4v	Yes	Errors in bitstream, for example, in MB 0 GOB 6 frame 4. It seems that MVs were not correctly calculated in encoded stream. (MS software plays the same)
hit004.m4v	Yes	
hit005.m4v	Yes	Some visible artifacts in bitstream (MS software plays the same)
hit006.m4v	Yes	
hit007.m4v	Yes	
hit008.m4v	Yes	
hit009.m4v	Yes	
hit010.m4v	Yes	
hit011.m4v	Yes	
hit012.m4v	Yes	
hit013.m4v	Yes	
hit014.m4v	Yes	
jvc001.m4v	Yes	
jvc002.m4v	Yes	
jvc003.m4v	Yes	
jvc004.m4v	Yes	
jvc005.m4v	Yes	
jvc006.m4v	Yes	
jvc007.m4v	Yes	
jvc008.m4v	Yes	
jvc009.m4v	Yes	
jvc010.m4v	Yes	
jvc011.m4v	Yes	
jvc012.m4v	Yes	

Stream name	Decodes with MTS4CC?	Notes
jvc013.m4v	Yes	
jvc014.m4v	Yes	Non-smooth motion is encoded in bitstream (MS software plays the same)
jvc015.m4v	Yes	
jvc016.m4v	Yes	
jvc017.m4v	Yes	
jvc018.m4v	Yes	
jvc019.m4v	Yes	
jvc020.m4v	Yes	
jvc021.m4v	Yes	
mit007.m4v	Yes	Syntax error in bitstream: video_object_type_indicator is 0 at byte: 8. bit start=0. This is defined as a RESERVED value (MPEG-4 std. p.110 Table 6-10). MTS4CC Plays this stream, assuming it is Simple Profile (an Error message is given to this effect)
mit008.m4v	Yes	
mit009.m4v	Yes	Visible artifacts are encoded in bitstream (MS software plays the same)
mit010.m4v	Yes	Uses error resilience tool (data partitioning)
mit011.m4v	Yes	Visible artifacts are in bitstream, for example, frame 4 halo above head in GOB 0 MBs 3,4,5 and poor MBs with hand movement, for example, frame 4, GOB,MB: 10,8 11,8 (MS software plays the same)
mit012.m4v	Yes	Uses error resilience tool (data partitioning)
mit013.m4v	Yes	Uses error resilience tool (data partitioning). Stream not decoded correctly by MS software - occasional green lines in some MBs
mit014.m4v	Yes	Uses error resilience tool (data partitioning)
mit015.m4v	Yes	Uses error resilience tool (data partitioning)
mit016.m4v	Yes	Uses error resilience tool (data partitioning)
mit017.m4v	Yes	Uses error resilience tool (data partitioning)
mit018.m4v	Yes	Uses error resilience tool (data partitioning)
mit019.m4v	Yes	
san002.m4v	Yes	
san003.m4v	Yes	
san004.m4v	Yes	
san005.m4v	Yes	Non-smooth motion is encoded in bitstream (MS software plays the same)

Stream name	Decodes with MTS4CC?	Notes
san006.m4v	Yes	Non-smooth motion is encoded in bitstream (MS software plays the same)
san007.m4v	Yes	Non-smooth motion is encoded in bitstream (MS software plays the same)
san008.m4v	Yes	Non-smooth motion is encoded in bitstream (MS software plays the same)
san009.m4v	Yes	Non-smooth motion is encoded in bitstream (MS software plays the same)
san010.m4v	Yes	Non-smooth motion is encoded in bitstream (MS software plays the same)
san011.m4v	Yes	Non-smooth motion is encoded in bitstream (MS software plays the same)
san012.m4v	Yes	Non-smooth motion is encoded in bitstream (MS software plays the same)
san013.m4v	Yes	
san014.m4v	Yes	
san015.m4v	Yes	Graininess, visible artifacts, and intermediate lower resolution frames are encoded in the bitstream (MS software plays the same)
san016.m4v	Yes	Visible artifacts and intermediate lower resolution frames are encoded in the bitstream (MS software plays the same)
san017.m4v	Yes	
san018.m4v	Yes	
san019.m4v	Yes	
san020.m4v	Yes	

Bitstreams: Donated \ Error

Stream name	Decodes with MTS4CC?	Notes
hit025.m4v	Yes	Use of resync markers
hit026.m4v	Yes	Use of resync markers
hit027.m4v	Yes	Uses error resilience tool (data partitioning)
hit028.m4v	Yes	Uses error resilience tool (data partitioning)
hit029.m4v	Yes	Uses error resilience tool (data partitioning)
hit030.m4v	Yes	Uses error resilience tool (data partitioning)
mit025.m4v	Yes	Use of resync markers
mit026.m4v	Yes	Use of resync markers
mit027.m4v	Yes	Uses error resilience tool (data partitioning) Poor quality picture (MS software plays the same)
mit028.m4v	Yes	Uses error resilience tool (data partitioning)
mit029.m4v	Yes	Uses error resilience tool (data partitioning). Artifacts in frames 5 and 6 are errors in the encoded bitstream: seems to be motion vectors incorrectly calculated when the stream was encoded (MS software plays the same)

Glossary

Glossary

AC coefficient	Any DCT coefficient for which the frequency in one or both dimensions is non-zero
B-VOP	A VOP that is coded using motion compensated prediction from past and/or future reference VOPs
Backward motion vector	A motion vector that is used for motion compensation from a reference VOP at a later time in display order
Backward prediction	Prediction from the future reference VOP
Bitstream	A compressed data entity where each binary digit has a specific meaning that is defined by the compression standard
Block	An 8-row by 8-column matrix of samples, or 64 DCT coefficients (source, quantized or dequantized)
Buffer analysis	Analysis of use of processor, memory and/or other resources by a particular video decoder standard
Coded Block Pattern (cbp)	A word used in compression to identify which blocks of a MacroBlock are coded
Coefficients	The Discrete Cosine Transform transforms data from a spatial domain (pixels or pixel differences) into the frequency domain, because it makes the data easier to compress. In the standards used here, transforms turn a block of 8x8 pixel data (or pixel differences) into a block of 8x8 transform coefficients
CSV file	A file format which contains data separated by commas (Comma Separated Variable)
DC coefficient	The DCT coefficient for which the frequency is zero in both directions
DCT	Discrete Cosine Transform - the mathematical transform that all these compression standards use as their basis

DCT coefficient	Amplitude of the specific DCT basis function
Dequantization	Process of rescaling the quantized DCT coefficients after their representation in the bitstream has been decoded and before they are presented to the inverse DCT
Filter	A mathematical transform designed to remove certain frequencies from a signal. Here mainly used either within the coding loop (as in H.261) to try and avoid some of the coding artifacts and reduce bit-rate, or used as a post-process to improve the subjective quality
Frame	An individual picture from a video sequence
Forward motion vector	A motion vector that is used for motion compensation from a reference frame VOP at an earlier time in the display order
Forward prediction	Prediction from a past reference VOP
Global Motion Compensation	Use of global spatial transformation to improve the efficiency of the prediction of sample values by providing offsets into the past reference VOPs containing previously decoded sample values that are used to form the prediction error
GMC	Global Motion Compensation
GOB	Group Of Blocks - an entity defined within some of the standards in order to subdivide a frame into more manageable units
Histogram	A graph of the frequency of occurrence of a variable
I-VOP, intra-coded VOP	A VOP coded using information only from itself
Intra coding	Coding of a MacroBlock or VOP using information only from that MacroBlock or VOP
MacroBlock, MB	Basic coding unit of the standards used in this program. It consists of four blocks of 8x8 luminance data (arranged in a 16x16 manner) together with the two chrominance components U and V, which are also 8x8 blocks, but which cover the same area of the picture as the 16x16

	luminance pixels - part of the compression is that chrominance can be sampled at a lower frequency than luminance
MacroBlock Type	The mode, according to the Standard, in which the MacroBlock is encoded
Mode	Classification of the coding type of the MacroBlock
Motion Vector	Two-dimensional vector that points from the current MacroBlock to an area in the previous frame that is used to predict the current data
Motion compensation	Use of motion vectors to improve the efficiency of the prediction of sample values, where the motion vectors provide offsets into the past and/or future reference VOPs containing previously decoded sample values that are used to form the prediction error
Motion estimation	Process of estimating motion vectors during the encoding process
Parse Bitstream	The process of parsing a bitstream into the constituent words that are allowed within the standard
Quantizer	The discrete value that is used to reduce the amount of information present in the DCT of a block. It can vary from 1 to 31 in most standards, where 1 is the finest level (most accurate coding) and 31 is the coarsest level (least accurate coding)
Quantization matrix	Set of sixty-four 8-bit values used by the dequantizer
Quantized DCT coefficients	DCT coefficients before Dequantization, represented in variable-length coded form in the bitstream
Quantizer scale	Scale factor coded form in the bitstream and used by the decoding process to scale the dequantization
Slice	A subdivision of a picture that is used as a unit of encoding, as used in H.263 and MPEG-2

SEI	Supplemental enhancement information
VOP	Effectively a frame of video (MPEG-4)

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