H.264 Main Profile Decoder on C64x+

User Guide

TEXAS INSTRUMENTS

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Read This First

About This Manual

This document describes how to install and work with Texas Instruments' (TI) H.264 Main Profile Decoder implementation on the C64x+ platform. It also provides a detailed Application Programming Interface (API) reference and information on the sample application that accompanies this component.

TI's codec implementations are based on the eXpressDSP Digital Media (XDM) standard. XDM is an extension of the eXpressDSP Algorithm Interface Standard (XDAIS).

Intended Audience

This document is intended for system engineers who want to integrate TI's codecs with other software to build a multimedia system based on the C64x+ platform.

This document assumes that you are fluent in the C language, have a good working knowledge of Digital Signal Processing (DSP), digital signal processors, and DSP applications. Good knowledge of eXpressDSP Algorithm Interface Standard (XDAIS) and eXpressDSP Digital Media (XDM) standard will be helpful.

How to Use This Manual

This document includes the following chapters:

❑ **Chapter 1 - Introduction**, provides a brief introduction to the XDAIS and XDM standards. It also provides an overview of the codec and lists its supported features.

❑ **Chapter 2 - Installation Overview**, describes how to install, build, and run the codec.

❑ **Chapter 3 - Sample Usage**, describes the sample usage of the codec.

❑ **Chapter 4 - API Reference**, describes the data structures and interface functions used in the codec.

Related Documentation From Texas Instruments

The following documents describe TI's DSP algorithm standards such as, XDAIS and XDM. To obtain a copy of any of these TI documents, visit the Texas Instruments website at www.ti.com.

❑ *TMS320 DSP Algorithm Standard Rules and Guidelines* (literature number SPRU352) defines a set of requirements for DSP algorithms that, if followed, allow system integrators to quickly assemble production-quality systems from one or more such algorithms.

❑ *TMS320 DSP Algorithm Standard API Reference* (literature number SPRU360) describes all the APIs that are defined by the TMS320 DSP Algorithm Inteface Standard (also known as XDAIS) specification.

❑ *Technical Overview of eXpressDSP - Compliant Algorithms for DSP Software Producers* (literature number SPRA579) describes how to make algorithms compliant with the TMS320 DSP Algorithm Standard which is part of TI's eXpressDSP technology initiative.

❑ *Using the TMS320 DSP Algorithm Standard in a Static DSP System* (literature number SPRA577) describes how an eXpressDSP-compliant algorithm may be used effectively in a static system with limited memory.

❑ *DMA Guide for eXpressDSP-Compliant Algorithm Producers and Consumers* (literature number SPRA445) describes the DMA architecture specified by the TMS320 DSP Algorithm Standard (XDAIS). It also describes two sets of APIs used for accessing DMA resources: the IDMA2 abstract interface and the ACPY2 library.

❑ *eXpressDSP Digital Media (XDM) Standard API Reference* (literature number SPRUEC8)

The following documents describe TMS320 devices and related support tools:

❑ *Design and Implementation of an eXpressDSP-Compliant DMA Manager for C6X1X* (literature number SPRA789) describes a C6x1x-optimized (C6211, C6711) ACPY2 library implementation and DMA Resource Manager.

❑ *TMS320c64x+ Megamodule* (literature number SPRAA68) describes the enhancements made to the internal memory and describes the new features which have been added to support the internal memory architecture's performance and protection.

❑ *TMS320C64x+ DSP Megamodule Reference Guide* (literature number SPRU871) describes the C64x+ megamodule peripherals.

❑ *TMS320C64x to TMS320C64x+ CPU Migration Guide* (literature number SPRAA84) describes migration from the Texas Instruments TMS320C64x™ digital signal processor (DSP) to the TMS320C64x+™ DSP.

❑ *TMS320C6000 Optimizing Compiler v 6.0 Beta User's Guide* (literature number SPRU187N) explains how to use compiler tools

such as compiler, assembly optimizer, standalone simulator, library-build utility, and C++ name demangler.

❑ *TMS320C64x/C64x+ DSP CPU and Instruction Set Reference Guide* (literature number SPRU732) describes the CPU architecture, pipeline, instruction set, and interrupts of the C64x and C64x+ DSPs.

❑ *TMS320DM6446 Digital Media System-on-Chip* (literature number SPRS283)

❑ *TMS320DM6446 Digital Media System-on-Chip Errata (Silicon Revision 1.0)* (literature number SPRZ241) describes the known exceptions to the functional specifications for the TMS320DM6446 Digital Media System-on-Chip (DMSoC).

❑ TMS320DM6443 Digital Media System-on-Chip (literature number SPRS282)

❑ *TMS320DM6443 Digital Media System-on-Chip Errata (Silicon Revision 1.0)* (literature number SPRZ240) describes the known exceptions to the functional specifications for the TMS320DM6443 Digital Media System-on-Chip (DMSoC).

❑ *TMS320DM644x DMSoC DSP Subsystem Reference Guide* (literature number SPRUE15) describes the digital signal processor (DSP) subsystem in the TMS320DM644x Digital Media System-on-Chip (DMSoC).

❑ *TMS320DM644x DMSoC ARM Subsystem Reference Guide* (literature number SPRUE14) describes the ARM subsystem in the TMS320DM644x Digital Media System on a Chip (DMSoC).

❑ *DaVinci Technology - Digital Video Innovation Product Bulletin (Rev. A)* (sprt378a.pdf)

❑ *The DaVinci Effect: Achieving Digital Video Without Complexity White Paper* (spry079.pdf)

❑ *DaVinci Benchmarks Product Bulletin* (sprt379.pdf)

❑ *DaVinci Technology for Digital Video White Paper* (spry067.pdf)

❑ *The Future of Digital Video White Paper* (spry066.pdf)

Related Documentation

You can use the following documents to supplement this user guide:

❑ *ISO/IEC 14496-10:2005 (E) Rec.- Information technology – Coding of audio-visual objects – H.264 (E) ITU-T Recommendation*

Abbreviations

The following abbreviations are used in this document:

Table 1-1. List of Abbreviations

Abbreviation	Description
ASO	Arbitrary Slice Ordering
AVC	Advanced Video Coding
BIOS	TI's simple RTOS for DSPs
CABAC	Context Adaptive Binary Arithmetic Coding
CAVLC	Context Adaptive Variable Length Coding
CSL	Chip Support Library
D1	720x480 or 720x576 resolutions in progressive scan
DCT	Discrete Cosine Transform
DMA	Direct Memory Access
DMAN3	DMA Manager
DPB	Decoded Picture Buffer
EVM	Evaluation Module
FMO	Flexible Macroblock Ordering
HDTV	High Definition Television
HRD	Hypothetical Reference Decoder
I_PCM	Intra-frame pulse code modulation
IDR	Instantaneous Decoding Refresh
ITU-T	International Telecommunication Union
JM	Joint Menu
JVT	Joint Video Team
MB	Macro Block
MBAFF	Macro Block Adaptive Field Frame
MPEG	Moving Pictures Experts Group
MV	Motion Vector
NAL	Network Adaptation Layer

NTSC	National Television Standards Committee
PicAFF	Picture Adaptive Field Frame
POC	Picture Order Count
RTOS	Real Time Operating System
SEI	Supplemental Enhancement Information
VCL	Video Coded Layer
VGA	Video Graphics Array (640 x 480 resolution)
VUI	Video Usability Information
XDAIS	eXpressDSP Algorithm Interface Standard
XDM	eXpressDSP Digital Media
YUV	Color space in luminance and chrominance form

Text Conventions

The following conventions are used in this document:

❑ Text inside back-quotes ('') represents pseudo-code.

❑ Program source code, function and macro names, parameters, and command line commands are shown in a `mono-spaced` font.

Product Support

When contacting TI for support on this codec, please quote the product name (H.264 Main Profile Decoder on C64x+) and version number. The version number of the codec is included in the Title of the Release Notes that accompanies this codec.

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Introduction

This chapter provides a brief introduction to XDAIS and XDM. It also provides an overview of TI's implementation of the H.264 Main Profile Decoder on the C64x+ platform and its supported features.

1.1 Overview of XDAIS and XDM

TI's multimedia codec implementations are based on the eXpressDSP Digital Media (XDM) standard. XDM is an extension of the eXpressDSP Algorithm Interface Standard (XDAIS).

1.1.1 XDAIS Overview

An eXpressDSP-compliant algorithm is a module that implements the abstract interface IALG. The IALG API takes the memory management function away from the algorithm and places it in the hosting framework. Thus, an interaction occurs between the algorithm and the framework. This interaction allows the client application to allocate memory for the algorithm and also share memory between algorithms. It also allows the memory to be moved around while an algorithm is operating in the system. In order to facilitate these functionalities, the IALG interface defines the following APIs:

❑ `algAlloc()`

❑ `algInit()`

❑ `algActivate()`

❑ `algDeactivate()`

❑ `algFree()`

The `algAlloc()` API allows the algorithm to communicate its memory requirements to the client application. The `algInit()` API allows the algorithm to initialize the memory allocated by the client application. The `algFree()` API allows the algorithm to communicate the memory to be freed when an instance is no longer required.

Once an algorithm instance object is created, it can be used to process data in real-time. The `algActivate()` API provides a notification to the algorithm instance that one or more algorithm processing methods is about to be run zero or more times in succession. After the processing methods have been run, the client application calls the `algDeactivate()` API prior to reusing any of the instance's scratch memory.

The IALG interface also defines three more optional APIs `algControl()`, `algNumAlloc()`, and `algMoved()`. For more details on these APIs, see *TMS320 DSP Algorithm Standard API Reference* (literature number SPRU360).

1.1.2 XDM Overview

In the multimedia application space, you have the choice of integrating any codec into your multimedia system. For example, if you are building a video decoder system, you can use any of the available video decoders (such as MPEG4, H.263, or H.264) in your system. To enable easy integration with the client application, it is important that all codecs with similar functionality use similar APIs. XDM was primarily defined as an extension to XDAIS to ensure uniformity across different classes of codecs

(for example audio, video, image, and speech). The XDM standard defines the following two APIs:

❑ `control()`

❑ `process()`

The `control()` API provides a standard way to control an algorithm instance and receive status information from the algorithm in real-time. The `control()` API replaces the `algControl()` API defined as part of the IALG interface. The `process()` API does the basic processing (encode/decode) of data.

Apart from defining standardized APIs for multimedia codecs, XDM also standardizes the generic parameters that the client application must pass to these APIs. The client application can define additional implementation specific parameters using extended data structures.

The following figure depicts the XDM interface to the client application.

```
┌─────────────────────────────────┐
│        Client Application        │
└─────────────────────────────────┘
               ⇕
┌─────────────────────────────────┐
│          XDM Interface           │
├─────────────────────────────────┤
│      XDAIS Interface (IALG)      │
├─────────────────────────────────┤
│       TI's Codec Algorithms      │
└─────────────────────────────────┘
```
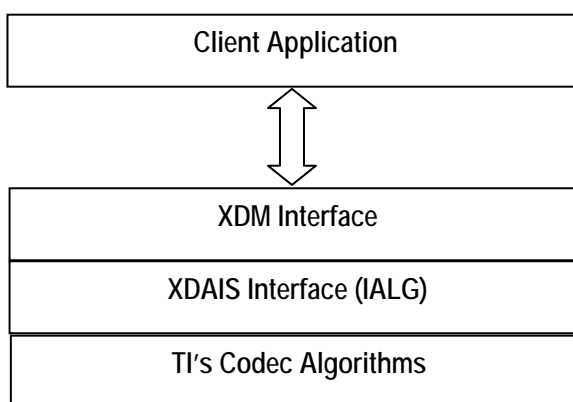
As depicted in the figure, XDM is an extension to XDAIS and forms an interface between the client application and the codec component. XDM insulates the client application from component-level changes. Since TI's multimedia algorithms are XDM compliant, it provides you with the flexibility to use any TI algorithm without changing the client application code. For example, if you have developed a client application using an XDM-compliant MPEG4 video decoder, then you can easily replace MPEG4 with another XDM-compliant video decoder, say H.263, with minimal changes to the client application.

For more details, see *eXpressDSP Digital Media (XDM) Standard API Reference* (literature number SPRUEC8).

1.2 Overview of H.264 Main Profile Decoder

H.264 (from ITU-T, also called as H.264/AVC) is a popular video coding algorithm enabling high quality multimedia services on a limited bandwidth network. H.264 standard defines several profiles and levels that specify restrictions on the bit stream and hence limits the capabilities needed to decode the bit streams. Each profile specifies a subset of algorithmic features and limits that all decoders conforming to that profile may support. Each level specifies a set of limits on the values that may be taken by the syntax elements in that profile.

Some important H.264 profiles and their special features are:

❑ Baseline Profile:

o Only I and P type slices are present

o Only frame mode (progressive) picture types are present

o Only CAVLC is supported

o ASO/FMO and redundant slices for error concealment is supported

❑ Main Profile:

o Only I, P, and B type slices are present

o Frame and field picture modes (in progressive and interlaced modes) picture types are present

o Both CAVLC and CABAC are supported

o ASO is not supported

H.264 Main Profile Decoder is a completely programmable single-chip solution. The input to the decoder is a H.264 encoded bit stream in the byte-stream syntax. The byte stream consists of a sequence of byte stream NAL unit syntax structures. Each byte stream NAL unit syntax structure contains one start code prefix of size four bytes and value 0x00000001, followed by one NAL unit syntax structure. The encoded frame data is a group of slices each of which is encapsulated in NAL units. The slice consists of the following:

❑ Intra coded data: Spatial prediction mode and prediction error data, which is subjected to DCT and later quantized.

❑ Inter coded data: Motion information and residual error data (differential data between two frames), which is subjected to DCT and later quantized.

The first frame received by the decoder is IDR (Instantaneous Decode Refresh) picture frame. The decoder reconstructs the frame by spatial intra-prediction specified by the mode and by adding the prediction error. The subsequent frames may be intra or inter coded.

In case of inter coding, the decoder reconstructs the bit stream by adding the residual error data to the previously decoded image, at the location specified by the motion information. This process is repeated until the entire bit stream is decoded.

The output of the decoder is a YUV sequence, which can be of format 420 planar and 422 interleaved in little endian.

Figure 1-1 depicts the working of the decoder.
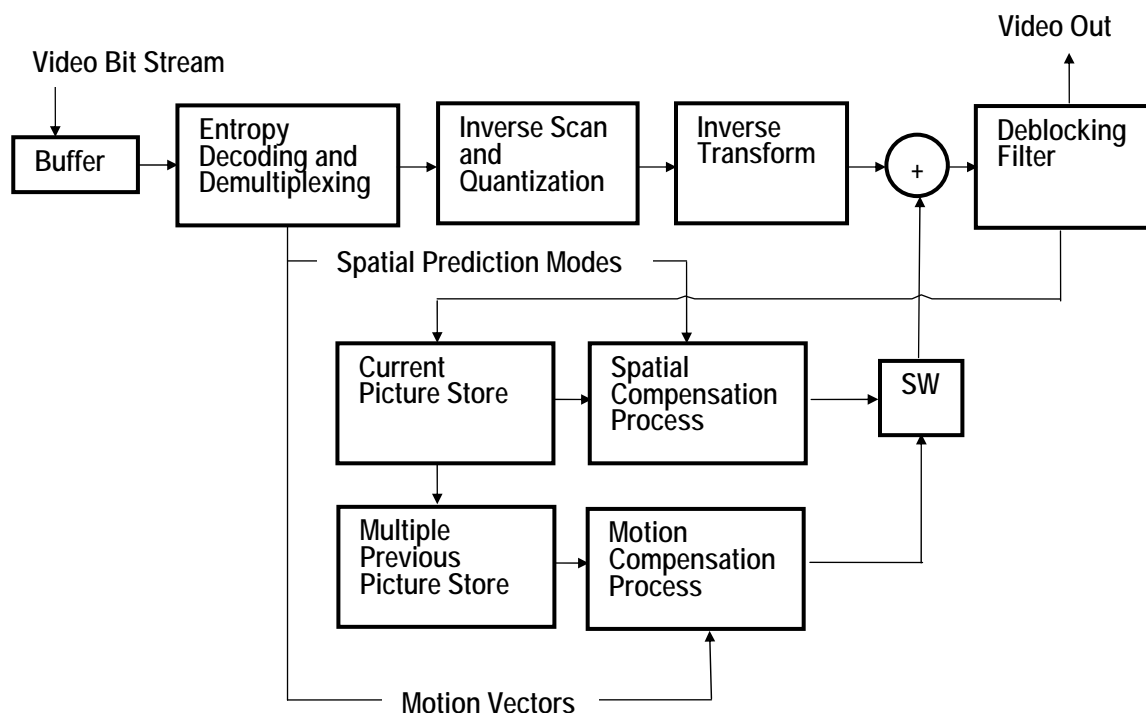
Figure 1-1. Block Diagram of H.264 Decoder

From this point onwards, all references to H.264 Decoder means H.264 Main Profile Decoder only.

1.3   Supported Services and Features

This user guide accompanies TI's implementation of H.264 Decoder on the C64x+ platform.

This version of the codec has the following supported features:

❑   eXpressDSP compliant

❑   eXpressDSP Digital Media (XDM) compliant

❑   Supports up to level 3.0 features of the Main Profile (MP)

❑   Supports progressive, interlaced, Picture Adaptive Frame Field (PicAFF) and Macroblock Adaptive Frame Field (MBAFF) type picture decoding

❑   Supports multiple slices and multiple reference frames

❑   Supports CAVLC and CABAC decoding

❑   Supports all intra-prediction and inter-prediction modes

❑   Supports upto 16 MV per MB

❑ Supports frame based decoding

❑ Supports frame size being non-multiple of 16 through frame cropping

❑ Supports frame width of the range of 32 to 720 pixels

❑ Supports byte-stream syntax for the input bit stream

❑ Supports parsing of Supplemental Enhancement Information (SEI) and Video Usability Information (VUI)

❑ Supports long term reference frame and adaptive reference picture marking

❑ Supports reference picture list reordering

❑ Supports gaps in frame_num

❑ Supports decoding of streams with IPCM coded macroblocks

❑ Supports skipping of non reference pictures

❑ Supports configurable delay for display of frames

❑ Basic error concealment features

❑ Outputs are available in YUV 420 planar and 422 interleaved little endian formats

❑ Tested for compliance with JM version 11.0 reference decoder

❑ Supports dynamic change in the frame size (ability to decode different frame sizes present in the very same stream)

❑ H.264 decoder is fully compliant with Allegro test suites (non HD streams)

Installation Overview

This chapter provides a brief description on the system requirements and instructions for installing the codec component. It also provides information on building and running the sample test application.

2.1   System Requirements

This section describes the hardware and software requirements for the normal functioning of the codec component.

2.1.1   Hardware

This codec has been built and tested on the DM6446 EVM with XDS560 USB.

2.1.2   Software

The following are the software requirements for the normal functioning of the codec:

❑ **Development Environment:** This project is developed using Code Composer Studio (CCS) version 3.3.24.1.

❑ **Code Generation Tools:** This project is compiled, assembled, archived, and linked using the code generation tools version 6.0.7.

2.2   Installing the Component

The codec component is released as a compressed archive. To install the codec, extract the contents of the zip file onto your local hard disk. The zip file extraction creates a top-level directory called 100_V_H264AVC_D_1_10, under which another directory named DM6446_MP_001 is created.

Figure 2-1 shows the sub-directories created in the DM6446_MP_001 directory.

```
Client
  Build
    Map
    Obj
    Out
  Test
    Inc
    Src
    TestVecs
      Config
      Input
      Output
      Reference
  Docs
  Inc
  Lib
```
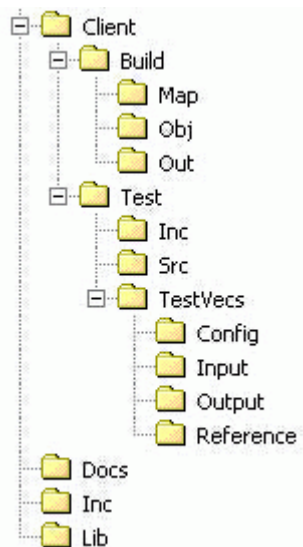
Figure 2-1. Component Directory Structure

> **Note:**
>
> If you are installing an evaluation version of this codec, the directory name will be 100E_V_H264AVC_D_1_10.

Table 2-1 provides a description of the sub-directories created in the DM6446_MP_001 directory.

Table 2-1. Component Directories

Sub-Directory	Description
\Inc	Contains XDM related header files which allow interface to the codec library
\Lib	Contains the codec library file
\Docs	Contains user guide, datasheet, and release notes
\Client\Build	Contains the sample test application project (.pjt) file
\Client\Build\Map	Contains the memory map generated on compilation of the code
\Client\Build\Obj	Contains the intermediate .asm and/or .obj file generated on compilation of the code
\Client\Build\Out	Contains the final application executable (.out) file generated by the sample test application
\Client\Test\Src	Contains application C files
\Client\Test\Inc	Contains header files needed for the application code
\Client\Test\TestVecs\Input	Contains input test vectors
\Client\Test\TestVecs\Output	Contains output generated by the codec
\Client\Test\TestVecs\Reference	Contains read-only reference output to be used for cross-checking against codec output
\Client\Test\TestVecs\Config	Contains configuration parameter files

2.3   Before Building the Sample Test Application

This codec is accompanied by a sample test application. To run the sample test application, you need DSP/BIOS and TI Framework Components (FC).

This version of the codec has been validated with DSP/BIOS version 5.31.02 and Framework Component (FC) version 1.10.01.

2.3.1   Installing DSP/BIOS

You can download DSP/BIOS from the TI external website:

https://www-a.ti.com/downloads/sds_support/targetcontent/bios/index.html

Install DSP/BIOS at the same location where you have installed Code Composer Studio. For example:

<install directory>\CCStudio_v3.2

The sample test application uses the following DSP/BIOS files:

❑   Header file, bcache.h available in the
    <install directory>\CCStudio_v3.2\<bios_directory>\packages
    \ti\bios\include directory.

❑   Library file, biosDM420.a64P available in the
    <install directory>\CCStudio_v3.2\<bios_directory>\packages
    \ti\bios\lib directory.

2.3.2   Installing Framework Component (FC)

You can download FC from the TI external website:

https://www-a.ti.com/downloads/sds_support/targetcontent/FC/index.html

Extract the FC zip file to the same location where you have installed Code Composer Studio. For example:

<install directory>\CCStudio_v3.2

The test application uses the following DMAN3 files:

❑   Library file, dman3.a64P available in the
    <install directory>\CCStudio_v3.2\<fc_directory>\packages
    \ti\sdo\fc\dman3 directory.

❑   Header file, dman3.h available in the
    <install directory>\CCStudio_v3.2\<fc_directory>\packages
    \ti\sdo\fc\dman3 directory.

❑   Header file, idma3.h available in the
    <install directory>\CCStudio_v3.2\<fc_directory>\packages
    \ti\sdo\fc\acpy3 directory.

2.4   Building and Running the Sample Test Application

The sample test application that accompanies this codec component will run in TI's Code Composer Studio (CCS) development environment. To build and run the sample test application in Code Composer Studio(CCS), follow these steps:

1)   Verify that you have an installation of TI's Code Composer Studio version 3.3.24.1 and code generation tools version 6.0.7.

2) Verify that the codec object library, h264mpvdec_ti.l64P exists in the \Lib sub-directory.

3) Open the test application project file, TestAppDecoder.pjt in Code Composer Studio. This file is available in the \Client\Build sub-directory.

4) Select **Project > Build** to build the sample test application. This creates an executable file, TestAppDecoder.out in the \Client\Build\Out sub-directory.

5) Select **File > Load**, browse to the \Client\Build\Out sub-directory, select the codec executable created in step 4, and load it into Code Composer Studio in preparation for execution.

6) Select **Debug > Run** to execute the sample test application.

The sample test application takes the input files stored in the \Client\Test\TestVecs\Input sub-directory, runs the codec, and uses the reference files stored in the \Client\Test\TestVecs\Reference sub-directory to verify that the codec is functioning as expected.

❑ On successful completion, the application displays one of the following messages for each frame:

o "Decoder compliance test passed/failed" (for compliance check mode)

o "Decoder output dump completed" (for output dump mode)

2.5 Configuration Files

This codec is shipped along with:

❑ A generic configuration file (Testvecs.cfg) – specifies input and reference files for the sample test application.

❑ A Decoder configuration file (Testparams.cfg) – specifies the configuration parameters used by the test application to configure the Decoder.

2.5.1 Generic Configuration File

The sample test application shipped along with the codec uses the configuration file, Testvecs.cfg for determining the input and reference files for running the codec and checking for compliance. The Testvecs.cfg file is available in the \Client\Test\TestVecs\Config sub-directory.

The format of the Testvecs.cfg file is:

```
X
Config
Input
Output/Reference
```

where:

❑ X may be set as:

o 1 - for compliance checking, no output file is created

o 0 - for writing the output to the output file

❑ `Config` is the Decoder configuration file. For details, see section 2.5.2

❑ `Input` is the input file name (use complete path).

❑ `Output/Reference` is the output file name (if `X` is 0) or reference file name (if `X` is 1).

A sample Testvecs.cfg file is as shown:

```
1
..\..\Test\TestVecs\Config\Testparams.cfg
..\..\Test\TestVecs\Input\foreman_ipb_cabac.264
..\..\Test\TestVecs\Reference\foreman_ipb_cabac_c.yuv
0
..\..\Test\TestVecs\Config\Testparams.cfg
..\..\Test\TestVecs\Input\foreman_ipb_cabac.264
..\..\Test\TestVecs\Output\foreman_ipb_cabac_test.yuv
```

2.5.2 Decoder Configuration File

The decoder configuration file, Testparams.cfg contains the configuration parameters required for the decoder. The Testparams.cfg file is available in the \Client\Test\TestVecs\Config sub-directory.

A sample Testparams.cfg file is as shown:

```
# Input File Format is as follows
# <ParameterName> = <ParameterValue> # Comment
#
###########################################################
Parameters
###########################################################

ImageWidth = 720     # Image width in Pels, must be
                       multiples of 16
ImageHeight = 576    # Image height in Pels, must be
                       multiples of 16
ChromaFormat = 1     # 1 => XDM_YUV_420P,
                       4 => XDM_YUV_422ILE
FramesToDecode = 10 # Number of frames to be decoded
```

Any field in the `IVIDDEC_Params` structure (see Section 4.2.1.5) can be set in the Testparams.cfg file using the syntax shown above. If you specify additional fields in the Testparams.cfg file, ensure to modify the test application appropriately to handle these fields.

2.6 Standards Conformance and User-Defined Inputs

To check the conformance of the codec for the default input file shipped along with the codec, follow the steps as described in Section 2.4.

To check the conformance of the codec for other input files of your choice, follow these steps:

❑ Copy the input files to the \Client\Test\TestVecs\Inputs sub-directory.

❑ Copy the reference files to the \Client\Test\TestVecs\Reference sub-directory.

❑ Edit the configuration file, Testvecs.cfg available in the \Client\Test\TestVecs\Config sub-directory. For details on the format of the Testvecs.cfg file, see section 2.5.1.

❑ Execute the sample test application. On successful completion, the application displays one of the following message for each frame:

   o "Decoder compliance test passed/failed" (if x is 1)

   o "Decoder output dump completed" (if x is 0)

If you have chosen the option to write to an output file (x is 0), you can use any standard file comparison utility to compare the codec output with the reference output and check for conformance.

2.7 Uninstalling the Component

To uninstall the component, delete the codec directory from your hard disk.

2.8 Evaluation Version

If you are using an evaluation version of this codec a Texas Instruments logo will be visible in the output.

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Sample Usage

This chapter provides a detailed description of the sample test application that accompanies this codec component.

3.1 Overview of the Test Application

The test application exercises the IVIDDEC base class of the H.264 Decoder library. The main test application files are TestAppDecoder.c and TestAppDecoder.h. These files are available in the \Client\Test\Src and \Client\Test\Inc sub-directories respectively

Figure 3-1 depicts the sequence of APIs exercised in the sample test application.

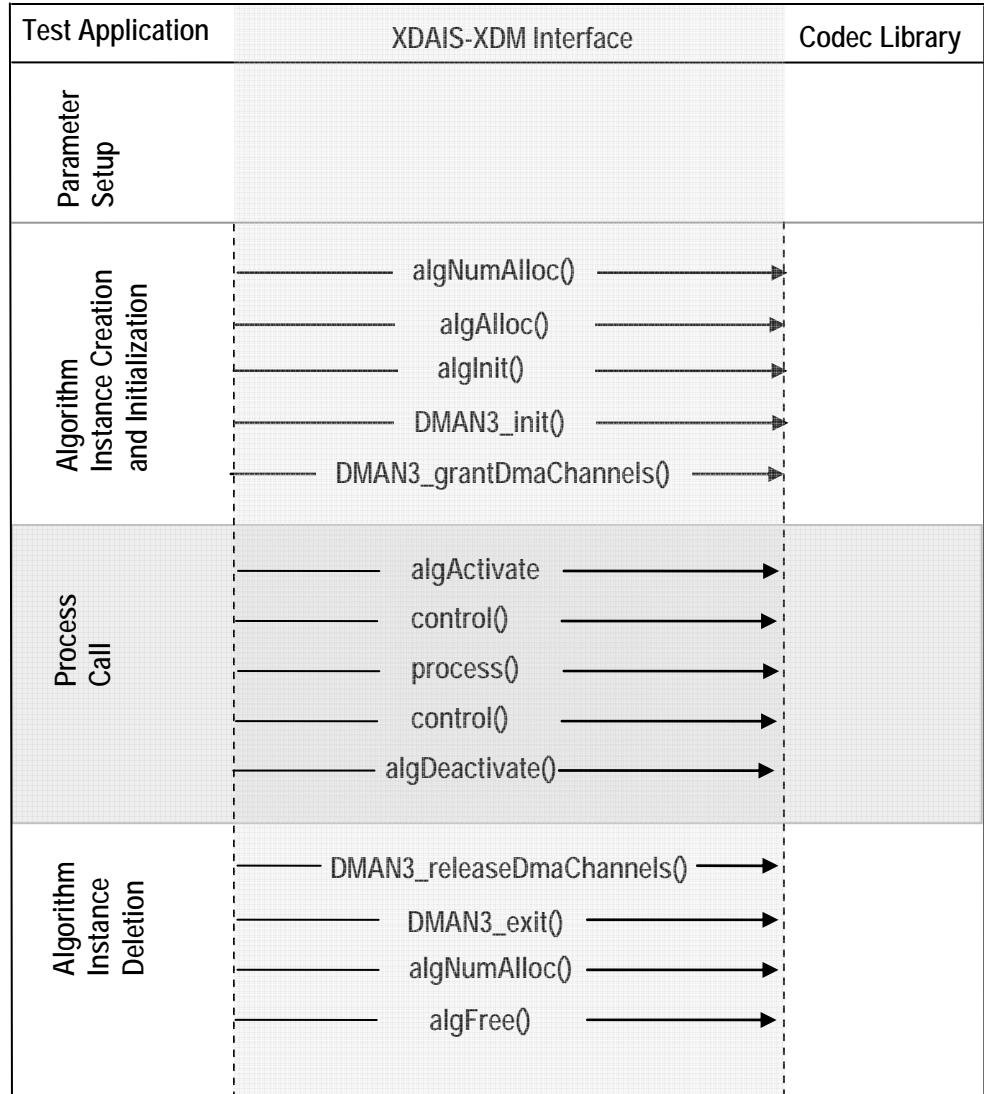| Test Application	XDAIS-XDM Interface	Codec Library
Parameter Setup		
Algorithm Instance Creation and Initialization	algNumAlloc() ———▶ algAlloc() ———▶ algInit() ———▶ DMAN3_init() ———▶ DMAN3_grantDmaChannels() ———▶	
Process Call	algActivate ———▶ control() ———▶ process() ———▶ control() ———▶ algDeactivate() ———▶	
Algorithm Instance Deletion	DMAN3_releaseDmaChannels() ———▶ DMAN3_exit() ———▶ algNumAlloc() ———▶ algFree() ———▶	

Figure 3-1. Test Application Sample Implementation

The test application is divided into four logical blocks:

❑ Parameter setup

❑ Algorithm instance creation and initialization

❑ Process call

❑ Algorithm instance deletion

3.1.1 Parameter Setup

Each codec component requires various codec configuration parameters to be set at initialization. For example, a video codec requires parameters such as video height, video width, etc. The test application obtains the required parameters from the Decoder configuration files.

In this logical block, the test application does the following:

1) Opens the generic configuration file, Testvecs.cfg and reads the compliance checking parameter, Decoder configuration file name (Testparams.cfg), input file name, and output/reference file name.

2) Opens the Decoder configuration file, (Testparams.cfg) and reads the various configuration parameters required for the algorithm.

   For more details on the configuration files, see Section 2.5.

3) Sets the IVIDDEC_Params structure based on the values it reads from the Testparams.cfg file.

4) Initializes the various DMAN3 parameters.

5) Reads the input bit stream into the application input buffer.

After successful completion of the above steps, the test application does the algorithm instance creation and initialization.

3.1.2 Algorithm Instance Creation and Initialization

In this logical block, the test application accepts the various initialization parameters and returns an algorithm instance pointer. The following APIs are called in sequence:

1) algNumAlloc() - To query the algorithm about the number of memory records it requires.

2) algAlloc() - To query the algorithm about the memory requirement to be filled in the memory records.

3) algInit() - To initialize the algorithm with the memory structures provided by the application.

A sample implementation of the create function that calls algNumAlloc(), algAlloc(), and algInit() in sequence is provided in the ALG_create() function implemented in the alg_create.c file.

After successful creation of the algorithm instance, the test application does DMA resource allocation for the algorithm. This requires initialization of DMA Manager Module and grant of DMA resources. This is implemented by calling DMAN3 interface functions in the following sequence:

1) `DMAN3_init()` - To initialize the DMAN module.

2) `DMAN3_grantDmaChannels()` - To grant the DMA resources to the algorithm instance.

Note:

DMAN3 function implementations are provided in dman3.a64P library.

3.1.3 *Process Call*

After algorithm instance creation and initialization, the test application does the following:

1) Sets the dynamic parameters (if they change during run time) by calling the `control()` function with the `XDM_SETPARAMS` command.

2) Sets the input and output buffer descriptors required for the `process()` function call. The input and output buffer descriptors are obtained by calling the `control()` function with the `XDM_GETBUFINFO` command.

3) Calls the `process()` function to encode/decode a single frame of data. The behavior of the algorithm can be controlled using various dynamic parameters (see Section 4.2.1.6). The inputs to the process function are input and output buffer descriptors, pointer to the `IVIDDEC_InArgs` and `IVIDDEC_OutArgs` structures.

The `control()` and `process()` functions should be called only within the scope of the `algActivate()` and `algDeactivate()` XDAIS functions which activate and deactivate the algorithm instance respectively. Once an algorithm is activated, there could be any ordering of `control()` and `process()` functions. The following APIs are called in sequence:

1) `algActivate()` - To activate the algorithm instance.

2) `control()` (optional) - To query the algorithm on status or setting of dynamic parameters etc., using the six available control commands.

3) `process()` - To call the Decoder with appropriate input/output buffer and arguments information.

4) `control()` (optional) - To query the algorithm on status or setting of dynamic parameters etc., using the six available control commands.

5) `algDeactivate()` - To deactivate the algorithm instance.

The do-while loop encapsulates frame level `process()` call and updates the input buffer pointer every time before the next call. The do-while loop breaks off either when an error condition occurs or when the input buffer exhausts. It also protects the `process()` call from file operations by

placing appropriate calls for cache operations as well. The test application does a cache invalidate for the valid input buffers before `process()` and a cache write back invalidate for output buffers after `process()`.

To support frame reordering and B frames, delay is present between decoding of a frame and its display. This delay amount is configurable depending on the application requirement. (see Section 4.2.1.9 for details). The first frame to be displayed is returned after first N+1 frames are decoded by the decoder (N is the configured delay). Hence N buffers are locked within the decoder. On reaching end of sequence the `control()` API '`XDM_FLUSH`' is called. Subsequent process call returns the locked frames as output frame without performing any decoding.

Test application is configured for a delay of 5 frames and it utilizes 7 buffers to store decoded output in order to support frame reordering.

In the sample test application, after calling `algDeactivate()`, the output data is either dumped to a file or compared with a reference file.

3.1.4   Algorithm Instance Deletion

Once encoding/decoding is complete, the test application must release the DMA channels granted by the DMA Manager interface and delete the current algorithm instance. The following APIs are called in sequence:

1) `DMAN3_releaseDmaChannels()` - To remove logical channel resources from an algorithm instance.

2) `DMAN3_exit()` - To free DMAN3 memory resources.

3) `algNumAlloc()` - To query the algorithm about the number of memory records it used.

4) `algFree()` - To query the algorithm to get the memory record information.

A sample implementation of the delete function that calls `algNumAlloc()` and `algFree()` in sequence is provided in the `ALG_delete()` function implemented in the alg_create.c file.

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API Reference

This chapter provides a detailed description of the data structures and interfaces functions used in the codec component.

4.1 Symbolic Constants and Enumerated Data Types

This section summarizes all the symbolic constants specified as either #define macros and/or enumerated C data types. Described alongside the macro or enumeration is the semantics or interpretation of the same in terms of what value it stands for and what it means.

Table 4-1. List of Enumerated Data Types

Group or Enumeration Class	Symbolic Constant Name	Description or Evaluation
IVIDEO_FrameType	IVIDEO_I_FRAME	Intra coded frame (default value).
	IVIDEO_P_FRAME	Forward inter coded frame.
	IVIDEO_B_FRAME	Bi-directional inter coded frame.
	IVIDEO_IDR_FRAME	Intra coded frame that can be used for refreshing video content
IVIDEO_ContentType	IVIDEO_PROGRESSIVE	Progressive video content
	IVIDEO_INTERLACED	Interlaced video content.
IVIDEO_FrameSkip	IVIDEO_NO_SKIP	Do not skip the current frame. Default Value
	IVIDEO_SKIP_P	Skip forward inter coded frame. Not supported in this version of H.264 decoder.
	IVIDEO_SKIP_B	Skip non -referenced frame. (See Section 4.2.2.5 for details).
	IVIDEO_SKIP_I	Skip intra coded frame. Not supported in this version of H.264 decoder.
ePicStruct_t	TOP_FIELD	Indicates top field in field picture
	BOTTOM_FIELD	Indicates bottom field in field picture
	FRAME_PICTURE	Indicates frame picture
XDM_DataFormat	XDM_BYTE	Big endian stream
	XDM_LE_16	16-bit little endian stream. Not applicable for H.264 decoder
	XDM_LE_32	32-bit little endian stream. Not applicable for H.264 decoder
XDM_ChromaFormat	XDM_YUV_420P	YUV 4:2:0 planar
	XDM_YUV_422P	YUV 4:2:2 planar. Not applicable for H.264 decoder

Group or Enumeration Class	Symbolic Constant Name	Description or Evaluation
	XDM_YUV_422IBE	YUV 4:2:2 interleaved (big endian). Not applicable for H.264 decoder
	XDM_YUV_422ILE	YUV 4:2:2 interleaved (little endian).
	XDM_YUV_444P	YUV 4:4:4 planar. Not applicable for H.264 decoder
	XDM_YUV_411P	YUV 4:1:1 planar. Not applicable for H.264 decoder
	XDM_GRAY	Gray format. Not applicable for H.264 decoder
	XDM_RGB	RGB color format. Not applicable for H.264 decoder
XDM_CmdId	XDM_GETSTATUS	Query algorithm instance to fill Status structure
	XDM_SETPARAMS	Set run time dynamic parameters via the DynamicParams structure
	XDM_RESET	Reset the algorithm
	XDM_SETDEFAULT	Initialize all fields in Params structure to default values specified in the library
	XDM_FLUSH	Handle end of stream conditions. This command forces algorithm instance to output data without additional input. Subsequent process (decode) call returns the buffer which was locked in decoder without performing any bitstream decoding.
	XDM_GETBUFINFO	Query algorithm instance regarding the properties of input and output buffers
XDM_ErrorBit	XDM_APPLIEDCONCEALMENT	Bit 9 ❑ 1 - Applied concealment ❑ 0 - Ignore
	XDM_INSUFFICIENTDATA	Bit 10 ❑ 1 - Insufficient data ❑ 0 - Ignore
	XDM_CORRUPTEDDATA	Bit 11 ❑ 1 - Data problem/corruption ❑ 0 - Ignore
	XDM_CORRUPTEDHEADER	Bit 12 ❑ 1 - Header problem/corruption ❑ 0 - Ignore

Group or Enumeration Class	Symbolic Constant Name	Description or Evaluation
	XDM_UNSUPPORTEDINPUT	Bit 13 ❑ 1 - Unsupported feature/parameter in input ❑ 0 - Ignore
	XDM_UNSUPPORTEDPARAM	Bit 14 ❑ 1 - Unsupported input parameter or configuration ❑ 0 - Ignore
	XDM_FATALERROR	Bit 15 ❑ 1 - Fatal error (stop encoding) ❑ 0 - Recoverable error

Note:

The remaining bits that are not mentioned in XDM_ErrorBit are interpreted as:

❑ Bit 16-32: Reserved

❑ Bit 8: Reserved

❑ Bit 0-7: Codec and implementation specific. The type of error encountered while decoding the bitstream is returned through extendedError field of outputArgs. Bits 8-15 are set as per XDM convention. Bits 0-7 are used to indicate errors specific to H.264 Decoder. The various error codes returned by the H.264 Decoder (in the lower 8-bits) and their values are given in the table below.

The algorithm can set multiple bits to 1 depending on the error condition.

The following table lists the detailed error codes and their values.

Table 4-2. Error codes and values.

Error codes	Description	Values
NAL Unit specific Semantic Errors		
H264D_ERR_SEM_NALU_EOSTRMREACHED	Additional NALU is received after an End of Stream NALU	0x21
H264D_ERR_SEM_NALU_FORBIDDENBIT	NALU syntax forbidden bit is not zero	0x22
H264D_ERR_SEM_NALU_NALREFIDC	The nal_ref_idc field has a value that violates constraits specified in the standard.	0x23
H264D_ERR_SEM_NALU_NALUTYP	Incorrect NALU type received. It may not be an illegal NALU type, but incorrect based on the type of previous NALU.	0x25
H264D_ERR_SEM_NALU_EOSEQ	End of Seq NALU is incorrectly received when a picture is partially decoded. This is not an error. It is displayed as a warning only.	0x26
SPS specific Semantic Errors		
H264D_ERR_SEM_SPS_INVLD_PROFILE	The profile specified in SPS is invalid or is unsupported by the decoder	0x41
H264D_ERR_SEM_SPS_POCTYPE	The pic_order_cnt_type field decoded as part of SPS has an illegal value.	0x43
H264D_ERR_SEM_SPS_MAXPOCLSB	The log2_max_pic_order_cnt_lsb_minus4 field decoded as part of SPS has an illegal value.	0x44
H264D_ERR_SEM_SPS_NUMREFFRAMESINPOCCYCLE	The num_ref_frames_in_pic_order_cnt_cycle field decoded as part of SPS has an illegal value.	0x45
H264D_ERR_SEM_SPS_DIRECT8X8FLAG	The direct_8x8_inference_flag field decoded as part of SPS has an illegal value.	0x46
H264D_ERR_SEM_SPS_FRAMECROP	The frame cropping parameters decoded as part of SPS have an illegal value.	0x47
H264D_ERR_SEM_SPS_ACTIVESPS_MISMATCH	If in between Access Unit decoding a SPS is received with same seq_parm_set_id as active_sps_id then contents of received_sps should be equal to active_sps. Otherwise this error code is set.	0x48
H264D_ERR_SEM_SPS_SEQID	The field seq_parameter_set_id of SPS has an illegal value.	0x49

Error codes	Description	Values
H264D_ERR_SEM_SPS_UNSUPPORTEDPICWIDTH	The width specified in SPS is not supported by the decoder.	0x4A
H264D_ERR_SEM_SPS_REF_FRAMES_BEYOND_LIMIT	The number of reference frames specified in SPS is beyond the limit allowed by the standard.	0x4B
PPS specific Semantic Errors		
H264D_ERR_SEM_PPS_PPSID	The field pic_parameter_set_id part of PPS has an illegal value	0x61
H264D_ERR_SEM_PPS_SEQID	The seq_parameter_set_id field part of PPS has an illegal value.	0x62
H264D_ERR_SEM_PPS_SLCGRPMAPTYPE	The slice_group_map_type field in PPS has an illegal or incorrect value.	0x63
H264D_ERR_SEM_PPS_TOPLEFT	The field in PPS used for certain type of FMO has a wrong value.	0x64
H264D_ERR_SEM_PPS_BOTRIGHT	The field in PPS used for certain type of FMO has a wrong value.	0x65
H264D_ERR_SEM_PPS_TOPBOTMOD	The field in PPS used for certain type of FMO has a wrong value.	0x66
H264D_ERR_SEM_PPS_RUNLENGTH	The field in PPS used for certain type of FMO has a wrong value.	0x67
H264D_ERR_SEM_PPS_SLCGRPCHNGRATE	The field in PPS used for certain type of FMO has a wrong value.	0x68
H264D_ERR_SEM_PPS_PICSIZEMAPUNITS	The field pic_size_in_map_units_minus1 in PPS has an incorrect value.	0x69
H264D_ERR_SEM_PPS_NUMREFIDXACTIVEL0	The field num_ref_idx_l0_active_minus1 in PPS has an illegal value.	0x6A
H264D_ERR_SEM_PPS_NUMREFIDXACTIVEL1	The field num_ref_idx_l0_active_minus1 in PPS has an illegal value	0x6B
H264D_ERR_SEM_PPS_INITDQP	The field pic_init_qp_minus26 is PPS has a value out of bounds with what is specified by standard.	0x6C
H264D_ERR_SEM_PPS_INITDQS	The field pic_init_qs_minus26 is PPS has a value out of bounds with what is specified by standard.	0x6D
H264D_ERR_SEM_PPS_QPINDEXOFFSET	The field chroma_qp_index_offset in PPS has a value out of bounds with what is specified by standard.	0x6E

Error codes	Description	Values
H264D_ERR_SEM_PPS_ACTIVEPPS_MISMATCH	If in between Access Unit decoding a PPS is received with same pic_parm_set_id as active_pps_id then contents of received_pps should be equal to active_pps. Otherwise this error code is set.	0x6F
H264D_ERR_SEM_PPS_NUMSLCGRP	The num_slice_groups_minus1 field in PPS has an illegal value.	0x70
H264D_ERR_SEM_PPS_SLCGRPID	The field slice_group_id in PPS has an incorrect value (based on num_slice_groups_minus1 field).	0x71
H264D_ERR_SEM_PPS_BIPREDIDC_INVALID	The weighted_bipred_idc field in PPS has an illegal value.	0x72
Slice Header Semantic Errors		
H264D_ERR_SEM_SLCHDR_DELTAPICCNTBOT	The delta_pic_order_cnt_bottom field in slice header has an incorrect value.	0x81
H264D_ERR_SEM_SLCHDR_PICPARAMSETID	The pic_parameter_set_id field in slice header has an illegal value.	0x82
H264D_ERR_SEM_SLCHDR_SLCTYP	Incorrect or unsupported slice type detected.	0x83
H264D_ERR_SEM_SLCHDR_FIRSTMBINSLC	The first_mb_in_slice field is greater than PicSizeInMbs.	0x84
H264D_ERR_SEM_SLCHDR_IDRPICID	The idr_pic_id field in slice header has an illegal value.	0x85
H264D_ERR_SEM_SLCHDR_REDUNDANTPICCNT	The field redundant_pic_cnt in slice header has an illegal value.	0x86
H264D_ERR_SEM_SLCHDR_NUMREFIDXACTIVE L0	The num_ref_idx_l0_active_minus1 decoded in slice header or obtained from PPS (based on num_ref_idx_active_override_flag) has an illegal value.	0x87
H264D_ERR_SEM_SLCHDR_NUMREFIDXACTIVE L1	The num_ref_idx_l1_active_minus1 decoded in slice header or obtained from PPS (based on num_ref_idx_active_override_flag) has an illegal value.	0x88
H264D_ERR_SEM_SLCHDR_CABACINITIDC	The field cabac_init_idc in slice header has an illegal value.	0x89
H264D_ERR_SEM_SLCHDR_SLCQSDELTA	The value of slice_qs_delta+ pic_init_qs_minus is out of bounds with what is specified by standard.	0x8B
H264D_ERR_SEM_SLCHDR_DISABLEDEBLOCKF ILTERIDC	The disable_deblocking_filter_idc field parsed in slice header has an illegal value	0x8C

Error codes	Description	Values
H264D_ERR_SEM_SLCHDR_PICINVAR	This is set if any of the conditions governing syntax elements in slice headers when there are multiple slices per picture is not satisfied.	0x8D
H264D_ERR_SEM_SLCHDR_SLCALPHAC0OFFSE T	The field slice_alpha_c0_offset_div2 has a value out of bounds.	0x8E
H264D_ERR_SEM_SLCHDR_SLCBETAOFFSET	The field slice_beta_offest_div2 has a value out of bounds.	0x8F
H264D_ERR_SEM_SLCHDR_NON_ZERO_FRAME_ NUM_IN_IDR	The frame_num field has non-zero value in an IDR slice.	0x90
H264D_ERR_SEM_SLCHDR_ILLEGAL_PRED_WE IGHT	Any of the variables associated with the computation of prediction weights has an illegal value.	0x91
H264D_ERR_SEM_SLCHDR_UNSUPPORTED_LEV EL	Level specified in bitstream is greater than the supported level.	0x93
H264D_ERR_SEM_SLCHDR_SPS_CHANGE_IN_N ONIDR	Change of IDR detected in a non-IDR picture.	0x94
H264D_ERR_SEM_SLCHDR_WAIT_SYNC_POINT	Decoding is skipping NAL units till a valid SYNC point is found.	0x95

CAVLC Semantic Errors		
H264D_ERR_SEM_CAVLC_LEVEL_DECODE	Error in CAVLD Level Decoding	0xA1
H264D_ERR_SEM_CAVLC_CTOKEN_YY_AC	Error in CTOKEN for Luma AC coefficients	0xA2
H264D_ERR_SEM_CAVLC_CTOKEN_YY_DC	Error in CTOKEN for Luma DC coefficients	0xA3
H264D_ERR_SEM_CAVLC_CTOKEN_UV_AC	Error in CTOKEN for Chroma AC coefficients	0xA4
H264D_ERR_SEM_CAVLC_CTOKEN_UV_DC	Error in CTOKEN for Chroma DC coefficients	0xA5
H264D_ERR_SEM_CAVLC_LEVEL_YY_AC	Error in Level of Luma AC coefficients	0xA6
H264D_ERR_SEM_CAVLC_LEVEL_YY_DC	Error in Level of Luma DC coefficients	0xA7
H264D_ERR_SEM_CAVLC_LEVEL_UV_AC	Error in Level of Chroma AC coefficients	0xA8
H264D_ERR_SEM_CAVLC_LEVEL_UV_DC	Error in Level of Chroma DC coefficients	0xA9
H264D_ERR_SEM_CAVLC_TOTZERO_YY_AC	Error in Total Zero value for Luma AC coefficients	0xAA
H264D_ERR_SEM_CAVLC_TOTZERO_YY_DC	Error in Total Zero value for Luma DC coefficients	0xAB
H264D_ERR_SEM_CAVLC_TOTZERO_UV_AC	Error in Total Zero value for Chroma AC coefficients	0xAC

Error codes	Description	Values
H264D_ERR_SEM_CAVLC_TOTZERO_UV_DC	Error in Total Zero value for Chroma DC coefficients	0xAD
H264D_ERR_SEM_CAVLC_RUNBEF_YY_AC	Error in Run before value for Luma AC coefficients	0xAE
H264D_ERR_SEM_CAVLC_RUNBEF_YY_DC	Error in Run before value for Luma DC coefficients	0xAF
H264D_ERR_SEM_CAVLC_RUNBEF_UV_AC	Error in Run before value for Chroma AC coefficients	0xB0
H264D_ERR_SEM_CAVLC_RUNBEF_UV_DC	Error in Run before value for Chroma DC coefficients	0xB1
These error codes reports that the specific feature is not available in the decoder, or implementation specific errors.		
H264D_ERR_IMPL_PPSUNAVAIL	The PPS referred to in the slice header is unavailable.	0xC1
H264D_ERR_IMPL_SPSUNAVAIL	The SPS referred by the PPS id specified in slice header is unavailable.	0xC2
H264D_ERR_IMPL_NOMEMORY	Memory insufficient to buffer MMCO commands or HRD CPB Count is greater than available memory.	0xC3
H264D_ERR_IMPL_CORRUPTED_BITSTREAM	Corruption in bit stream	0xC5
H264D_ERR_IMPL_NOTSUPPORTED_REDUNTANT_PICTURE	Redundant picture not supported for this profile	0xCA
H264D_ERR_IMPL_NOTSUPPORTED_ASOFMO	ASO/FMO not supported for this profile.	0xCE
H264D_ERR_IMPL_INSUFFICIENT_DATA	Data insufficient to decode a picture.	0xD1
Annex B and other Semantic Errors		
H264D_ERR_SEM_MBPRED_REFIDXL0	Decoded reference index exceeds the maximum ref_idx	0xE1
H264D_ERR_SEM_RPLR	Reference picture list reordering is executed more than the bound.	0xE6
H264D_ERR_SEM_RPLR_PICNUMSIDC	Value of reordering_of_pic_nums_idc is out of bounds	0xE7
H264D_ERR_SEM_RPLR_ABSDIFFPICNUMMINUS1	Value of abs_diff_pic_num_minus1 is out of bounds	0xE8
H264D_ERR_SEM_MBLAYER_QPDELTA	Decoded MB_QP_Delta is out of bounds	0xEB
H264D_ERR_SEM_MBLAYER_MBTYPE	Decoding of MB_type had an error	0xEC

Error codes	Description	Values
H264D_ERR_SEM_MBLAYER_CBP	Decoding of CBP had an error	0xED
H264D_ERR_SEM_SLCDATA_MBSKIPRUN	Value of mb_skip_run is out of bounds	0xEE
H264D_ERR_SEM_NOT_FRAME_MBS_ONLY	Non-frame MBs are not supported at this level of the standard	0xF1
H264D_ERR_SEM_ILLEGAL_INTRA_PRED_MODE	Decoded value of the chroma intra prediction mode is out of bounds	0xF4
H264D_ERR_SEM_ILLEGAL_VALUE_OCCURED_TERMINATE	Indicates that mb_mode is illegal for the ref-idx decoding	0xF5

4.2　Data Structures

This section describes the XDM defined data structures, that are common across codec classes. These XDM data structures can be extended to define any implementation specific parameters for a codec component.

4.2.1　Common XDM Data Structures

This section includes the following common XDM data structures:

- ❑　XDM_BufDesc
- ❑　XDM_AlgBufInfo
- ❑　IVIDEO_BufDesc
- ❑　IVIDDEC_Fxns
- ❑　IVIDDEC_Params
- ❑　IVIDDEC_DynamicParams
- ❑　IVIDDEC_InArgs
- ❑　IVIDDEC_Status
- ❑　IVIDDEC_OutArgs

4.2.1.1 XDM_BufDesc

‖ **Description**

This structure defines the buffer descriptor for input and output buffers.

‖ **Fields**

Field	Datatype	Input/ Output	Description
**bufs	XDAS_Int8	Input	Pointer to the vector containing buffer addresses
numBufs	XDAS_Int32	Input	Number of buffers
*bufSizes	XDAS_Int32	Input	Size of each buffer in bytes

4.2.1.2 XDM_AlgBufInfo

‖ **Description**

This structure defines the buffer information descriptor for input and output buffers. This structure is filled when you invoke the control() function with the XDM_GETBUFINFO command.

‖ **Fields**

Field	Datatype	Input/ Output	Description
minNumInBufs	XDAS_Int32	Output	Number of input buffers
minNumOutBufs	XDAS_Int32	Output	Number of output buffers
minInBufSize[XDM_ MAX_IO_BUFFERS]	XDAS_Int32	Output	Size in bytes required for each input buffer
minOutBufSize[XDM _MAX_IO_BUFFERS]	XDAS_Int32	Output	Size in bytes required for each output buffer

Note:

For H.264 Main Profile Decoder, the buffer details are:

- ❑ Number of input buffer required is 1.

- ❑ Number of output buffer required is 1 for YUV 422ILE and 3 for YUV420P.

- ❑ There is no restriction on input buffer size except that it should contain atleast one frame of encoded data.

- ❑ The output buffer sizes (in bytes) for worst case 625SD format are:

  For YUV 420P:
  Y buffer = 720 * 576
  U buffer = 360 * 288
  V buffer = 360 * 288

  For YUV 422ILE:
  Buffer = 720 * 576 * 2

  These are the maximum buffer sizes but you can reconfigure depending on the format of the bit stream.

4.2.1.3 IVIDEO_BufDesc

‖ **Description**

This structure defines the buffer descriptor for input and output buffers.

‖ **Fields**

Field	Datatype	Input/Output	Description
numBufs	XDAS_Int32	Input	Number of buffers
width	XDAS_Int32	Input	Padded width of the video data
*bufs[XDM_MAX_IO_BUFFERS]	XDAS_Int8	Input	Pointer to the vector containing buffer addresses
bufSizes[XDM_MAX_IO_BUFFERS]	XDAS_Int32	Input	Size of each buffer in bytes

4.2.1.4 IVIDDEC_Fxns

‖ **Description**

This structure contains pointers to all the XDAIS and XDM interface functions.

‖ **Fields**

Field	Datatype	Input/ Output	Description
ialg	IALG_Fxns	Input	Structure containing pointers to all the XDAIS interface functions.
			For more details, see *TMS320 DSP Algorithm Standard API* Reference (literature number SPRU360).
*process	XDAS_Int32	Input	Pointer to the process() function
*control	XDAS_Int32	Input	Pointer to the control() function

4.2.1.5 IVIDDEC_Params

‖ **Description**

This structure defines the creation parameters for an algorithm instance object. Set this data structure to NULL, if you are unsure of the values to be specified for these parameters.

‖ **Fields**

Field	Datatype	Input/ Output	Description
size	XDAS_Int32	Input	Size of the basic or extended (if being used) data structure in bytes.
maxHeight	XDAS_Int32	Input	Maximum video height to be supported in pixels
maxWidth	XDAS_Int32	Input	Maximum video width to be supported in pixels
maxFrameRate	XDAS_Int32	Input	Maximum frame rate in fps * 1000 to be supported.
maxBitRate	XDAS_Int32	Input	Maximum bit rate to be supported in bits per second. For example, if bit rate is 10 Mbps, set this field to 10485760.
dataEndianness	XDAS_Int32	Input	Endianness of input data. See XDM_DataFormat enumeration for details.

Field	Datatype	Input/Output	Description
forceChromaForma t	XDAS_Int32	Input	Sets the output to the specified format. For example, if the output should be in YUV 4:2:2 interleaved (little endian) format, set this field to XDM_YUV_422ILE. See XDM_ChromaFormat enumeration for details.

> **Note:**
> - ❑ H.264 Decoder does not use the maxFrameRate and maxBitRate fields for creating the algorithm instance.
> - ❑ Maximum video height and width supported are 576 pixels and 720 pixels respectively (for 625SD format).
> - ❑ dataEndianness field should be set to XDM_BYTE.

4.2.1.6 IVIDDEC_DynamicParams

‖ **Description**

This structure defines the run time parameters for an algorithm instance object. Set this data structure to NULL, if you are unsure of the values to be specified for these parameters.

‖ **Fields**

Field	Datatype	Input/Output	Description
size	XDAS_Int32	Input	Size of the basic or extended (if being used) data structure in bytes.
decodeHeader	XDAS_Int32	Input	Number of access units to decode: ❑ 0 (XDM_DECODE_AU) - Decode entire frame including all the headers ❑ 1 (XDM_PARSE_HEADER) - Decode only one NAL unit
displayWidth	XDAS_Int32	Input	If the field is set to: ❑ 0 - Uses decoded image width as pitch ❑ If any other value is given, then this value in pixels is used as pitch.
frameSkipMode	XDAS_Int32	Input	Frame skip mode. See IVIDEO_FrameSkip enumeration for details.

> **Note:**
>
> ❑ If the application requires the decoder to skip decoding of non-reference frames, then the `frameSkipMode` field has to be set to `IVIDEO_SKIP_B` (see section 4.2.2.5 for details).
>
> ❑ If `displayWidth` is non-zero, then it has to be an even number.
>
> ❑ If the specified `displayWidth` is less than the image width, it is still considered and image is written at a resolution equal to `displayWidth`.
>
> ❑ If the `displayWidth` is set to 0 and frame cropping parameters are present in the bit stream, then the cropped image width is taken as the pitch.

4.2.1.7 IVIDDEC_InArgs

‖ **Description**

This structure defines the run time input arguments for an algorithm instance object.

‖ **Fields**

Field	Datatype	Input/ Output	Description
size	XDAS_Int32	Input	Size of the basic or extended (if being used) data structure in bytes.
numBytes	XDAS_Int32	Input	Size of input data (in bytes) provided to the algorithm for decoding
inputID	XDAS_Int32	Input	Application passes this ID to algorithm and decoder will attach this ID to the corresponding output frames. This is useful in case of re-ordering (for example, B frames). If there is no re-ordering, `outputID` field in the `IVIDDEC_OutArgs` data structure will be same as `inputID` field.

4.2.1.8 IVIDDEC_Status

‖ **Description**

This structure defines parameters that describe the status of an algorithm instance object.

‖ **Fields**

Field	Datatype	Input/ Output	Description
size	XDAS_Int32	Input	Size of the basic or extended (if being used) data structure in bytes.
extendedError	XDAS_Int32	Output	Extended error code. See XDM_ErrorBit enumeration for details.
outputHeight	XDAS_Int32	Output	Output height in pixels
outputWidth	XDAS_Int32	Output	Output width in pixels
frameRate	XDAS_Int32	Output	Average frame rate in fps * 1000. The average frame rate for all video decoders is 30 fps.
bitRate	XDAS_Int32	Output	Average bit rate in bits per second
contentType	XDAS_Int32	Output	Video content. See IVIDEO_ContentType enumeration for details.
outputChromaForma t	XDAS_Int32	Output	Output chroma format. See XDM_ChromaFormat enumeration for details.
bufInfo	XDM_AlgBufInf o	Output	Input and output buffer information. See XDM_AlgBufInfo data structure for details.

Note:

❑ If cropping of pixels is specified in the bit stream, then the outputHeight and outputWidth returned is equal to the cropped image size. outputWidth returned is independent of the display width, given in the DynamicParams.

❑ Algorithm sets the frameRate and bitRate fields to zero.

❑ contentType is returned as IVIDEO_PROGRESSIVE or IVIDEO_INTERLACED.

4.2.1.9 IVIDDEC_OutArgs

‖ **Description**

This structure defines the run time output arguments for an algorithm instance object.

‖ **Fields**

Field	Datatype	Input/ Output	Description
size	XDAS_Int32	Input	Size of the basic or extended (if being used) data structure in bytes.
extendedError	XDAS_Int32	Output	Extended error code. See XDM_ErrorBit enumeration for details.
byteConsumed	XDAS_Int32	Output	Bytes consumed per decode call
decodedFrameType	XDAS_Int32	Output	Decoded frame type. See IVIDEO_FrameType enumeration for more details.
outputID	XDAS_Int32	Output	Output ID. See inputID field description in IVIDDEC_InArgs data structure for details.
displayBufs	IVIDEO_Buf Desc	Output	Decoder fills this structure to denote the buffer pointers for current frames. In case of sequences having I and P frames only, these values are identical to the output buffers (outBufs) passed using the process call.

Note:

❑ With frame reordering, the display order is independent of decode order. When the algorithm is ready for display it copies the inputID value of a given decoded frame to the outputID value of IVIDDEC_OutArgs structure. The algorithm sets displayBufs pointers accordingly.

❑ When there is no frame ready to be displayed after a given decode call, the first pointer of displayBufs structure is set to NULL.

❑ To support frame reordering and B frames, delay is present between decoding of a frame and its display. This delay amount is configurable depending on the application scenario. The delay needs to be specified in maxDisplayDelay (element of IH264MPVDEC_InArgs).

❑ The first frame to be displayed is returned after first N+1 frames are decoded by the decoder (N is the configured delay). Hence N buffers are locked within the decoder. However if the maxDisplayDelay specified by the client is more than what is actually required for decoding of that stream(This is calculated by the decoder looking at the level and frame resolution), the decoder will lock only the

---

required number of frames within.

❑ For MP decoder, in order to handle B-frames a delay of one frame is mandatory. Due to reordering of frames allowed in H264 standard, the delay requirement can be in the range 5 -16 (Depending on the resolution of the image).

❑ Based on the application scenario, this delay should be configured. However, for most of the used case scenarios of BP and MP, a delay of 0 and 1 frames respectively should suffice.

❑ In case of interlaced content (`IVIDEO_ContentType` is `IVIDEO_INTERLACED`), the decoder decodes one field (top or bottom field) in one decode call. Hence, there will be 2 decode calls to decode complete frame comprising top and bottom fields.

4.2.2 H.264 Decoder Data Structures

This section includes the following H.264 decoder specific data structures:

❑ IH264MPVDEC_Params

❑ IH264MPVDEC_DynamicParams

❑ IH264MPVDEC_InArgs

❑ IH264MPVDEC_Status

❑ IH264MPVDEC_OutArgs

4.2.2.1 IH264MPVDEC _Params

‖ **Description**

This structure defines the creation parameters and any other implementation specific parameters for the H.264 Decoder instance object. The creation parameters are defined in the XDM data structure, IVIDDEC_Params.

‖ **Fields**

Field	Datatype	Input/Output	Description
viddecParams	IVIDDEC_Params	Input	See IVIDDEC_Params data structure for details.

4.2.2.2 IH264MPVDEC_DynamicParams

‖ **Description**

This structure defines the run time parameters and any other implementation specific parameters for the H.264 Decoder instance object. The run time parameters are defined in the XDM data structure, IVIDDEC_DynamicParams.

‖ **Fields**

Field	Datatype	Input/Output	Description
viddecDynamicParams	IVIDDEC_DynamicParams	Input	See IVIDDEC_DynamicParams data structure for details.

4.2.2.3 IH264MPVDEC_InArgs

‖ **Description**

       This structure defines the run time input arguments for the H.264 Decoder instance object.

‖ **Fields**

Field	Datatype	Input/ Output	Description
viddecInArgs	IVIDDEC_InArgs	Input	See `IVIDDEC_InArgs` data structure for details.
maxDisplayDelay	XDAS_Int32	Input	Maximum delay between decode and display of a frame. (See section 4.2.1.9 for details).
Sei_Vui_parse_flag	XDAS_Int32	Input	If the application is interested in SEI or VUI information, then this needs to be set to 1. Otherwise this needs to be set to 0.
SeiVui_buffer_ptr	sSeiVuiParams_t*	Input	Pointer to the buffer, where the SEI and VUI information will be written by the decoder.

4.2.2.3.1 sSeiVuiParams_t

‖ **Description**

       This structure defines Supplemental Enhancement Information (SEI) messages and parameters that describe the values of various Video Usability parameters(VUI).

‖ **Fields**

Field	Datatype	Input/ Output	Description
parsed_flag	unsigned int	Output	❑ 1 - Indicates that in the current process call, contents of the structure is updated ❑ 0 - Indicates contents of the structure is not updated
vui_params	sVSP_t	Output	Video Usability Information
sei_messages	sSeiMessages_t	Output	Supplemental Enhancement Information

> **Note:**
>
> A brief description of SEI and VUI contents are given below. For details see H.264 standard (*ISO/IEC 14496-10:2005 (E) Rec.- Information technology – Coding of audio-visual objects – H.264 (E) ITU-T Recommendation.)*

4.2.2.3.2 sSeiMessages_t

|| **Description**

Structure containing supplemental enhancement information messages.

|| **Fields**

Field	Datatype	Input/ Output	Description
parsed_flag	unsigned int	Output	❑ 1 - Indicates that in the current process call, contents of the structure is updated ❑ 0 - Indicates contents of the structure is not updated
frame_freeze_rep etition	sFullFrameFreezeRepet ition_t	Output	Specifies the persistence of the full-frame freeze SEI message and may specify a picture order count interval within which another full-frame freeze SEI message or a full-frame freeze release SEI or the end of the coded video sequence shall be present in the bitstream.
frame_freeze_rel ease	sFullFrameFreezeRelea se_t	Output	Cancels the effect of any full-frame freeze SEI message sent with pictures that precede the current picture in output order.
prog_refine_star t	sProgRefineStart_t	Output	Specifies the beginning of a set of consecutive coded pictures that is labelled as the current picture followed by a sequence of one or more pictures of refinement of the quality of the current picture, rather than as a representation of a continually moving scene.
prog_refine_end	sProgRefineEnd_t	Output	Specifies end of progressive refinement.
recovery_pt_info	sRecoveryPointInfo_t	Output	The recovery point SEI message

Field	Datatype	Input/Output	Description
			assists a decoder in determining when the decoding process will produce acceptable pictures for display after the decoder initiates random access or after the encoder indicates a broken link in the sequence.
pic_timing	sPictureTiming_t	Output	Specifies timing information regarding cpb delays, dpb output delay etc.

4.2.2.3.3 sFullFrameFreezeRepetition_t

‖ **Description**

Structure contains information regarding frame freeze.

‖ **Fields**

Field	Datatype	Input/Output	Description
parsed_flag	unsigned int	Output	❑ 1 - Indicates that in the current process call, contents of the structure is updated ❑ 0 - Indicates contents of the structure is not updated
full_frame_freeze_repetition_period	unsigned int	Output	Specifies the persistence of the full-frame freeze SEI message

4.2.2.3.4 sFullFrameFreezeRelease_t

‖ **Description**

Structure contains information regarding frame freeze.

‖ **Fields**

Field	Datatype	Input/Output	Description
parsed_flag	unsigned int	Output	❑ 1 - Indicates that in the current process call, contents of the structure is updated ❑ 0 - Indicates contents of the structure is not updated
full_frame_freeze_release_flag	unsigned char	Output	Cancels the effect of any full-frame freeze SEI message sent with pictures that precede the current picture in output order.

4.2.2.3.5 sProgRefineStart_t

‖ **Description**

Structure contains information regarding progressive refinement.

‖ **Fields**

Field	Datatype	Input/ Output	Description
parsed_flag	unsigned int	Output	❑ 1 - Indicates that in the current process call, contents of the structure is updated ❑ 0 - Indicates contents of the structure is not updated
progressive_refinem ent_id	unsigned int	Output	Specifies an identification number for the progressive refinement operation.
num_refinement_step s_minus1	unsigned int	Output	Specifies the number of reference frames in the tagged set of consecutive coded pictures

4.2.2.3.6 sProgRefineEnd_t

‖ **Description**

Structure contains information regarding progressive refinement.

‖ **Fields**

Field	Datatype	Input/ Output	Description
parsed_flag	unsigned int	Output	❑ 1 - Indicates that in the current process call, contents of the structure is updated ❑ 0 - Indicates contents of the structure is not updated
progressive_ refinement_id	unsigned int	Output	Specifies an identification number for the progressive refinement operation.

4.2.2.3.7 sRecoveryPointInfo_t

‖ Description

Structure contains information regarding recovery points.

‖ Fields

Field	Datatype	Input/Output	Description
parsed_flag	unsigned int	Output	❑ 1 - Indicates that in the current process call, contents of the structure is updated ❑ 0 - Indicates contents of the structure is not updated
recovery_frame_cnt	unsigned int	Output	Specifies the recovery point of output pictures in output order.
exact_match_flag	unsigned char	Output	Indicates whether decoded pictures at and subsequent to the specified recovery point in output order derived by starting the decoding process at the access unit associated with the recovery point SEI message shall be an exact match to the pictures that would be produced by starting the decoding process at the location of a previous IDR access unit in the NAL unit stream.
broken_link_flag	unsigned char	Output	Indicates the presence or absence of a broken link in the NAL unit stream
changing_slice_group_idc	unsigned char	Output	Indicates whether decoded pictures are correct or approximately correct in content at and subsequent to the recovery point in output order when all macroblocks of the primary coded pictures are decoded within the changing slice group period.

4.2.2.3.8 sPictureTiming_t

‖ Description

Structure contains timing information such as DPB delay and CPD delay.

‖ Fields

Field	Datatype	Input/Output	Description
parsed_flag	unsigned int	Output	❑ 1 - Indicates that in the current process call, contents of the structure is

Field	Datatype	Input/ Output	Description
			updated ❑ 0 - Indicates contents of the structure is not updated
cpb_removal_delay	unsigned int	Output	Specifies how many clock ticks to wait after removal from the CPB of the access unit associated with the most recent buffering period SEI message before removing from the buffer the access unit data associated with the picture timing SEI message.
dpb_output_delay	unsigned int	Output	Used to compute the DPB output time of the picture.
pic_struct	unsigned int	Output	Indicates whether a picture should be displayed as a frame or field
clock_timestamp_fl ag	unsigned int	Output	❑ 1 - Indicates number of clock timestamp syntax elements present and follow immediately ❑ 0 – Indicates associated clock timestamp syntax elements not present
ct_type	unsigned int	Output	Indicates the scan type(interlaced or progressive) of the source material
nuit_field_based_f lag	unsigned int	Output	Used to calculate the clockTimestamp
counting_type	unsigned int	Output	Specifies the method of dropping values of n_frames
full_timestamp_fla g	unsigned int	Output	❑ 1 - Specifies that the n_frames syntax element is followed by seconds_value, minutes_value, and hours_value. ❑ 0 - Specifies that the n_frames syntax element is followed by seconds_flag
discontinuity_flag	unsigned int	Output	Indicates whether the difference between the current value of clockTimestamp and the value of clockTimestamp computed from the previous clockTimestamp in output order can be interpreted as the time difference between the times of origin or capture of the associated frames or fields.
cnt_dropped_flag	unsigned int	Output	Specifies the skipping of one or more values of n_frames using the counting method
n_frames	unsigned int	Output	Specifies the value of nFrames used to compute clockTimestamp.
seconds_value	unsigned int	Output	Specifies the value of sS used to compute clockTimestamp.

Field	Datatype	Input/Output	Description
`minutes_value`	`unsigned int`	Output	Specifies the value of mM used to compute `clockTimestamp`.
`hours_value`	`unsigned int`	Output	Specifies the value of hH used to compute `clockTimestamp`.
`time_offset`	`unsigned int`	Output	Specifies the value of tOffset used to compute `clockTimestamp`

4.2.2.3.9 sVSP_t

‖ **Description**

This structure defines parameters that describe the values of various video usability parameters that come as a part of Sequence Parameter Set in the bit-stream.

‖ **Fields**

Field	Datatype	Input/Output	Description
`parsed_flag`	`unsigned int`	Output	❑ 1 - Indicates that in the current process call, contents of the structure is updated ❑ 0 - Indicates contents of the structure is not updated
`aspect_ratio_info_present_flag`	`unsigned int`	Output	Indicates whether aspect ratio idc is present or not.
`aspect_ratio_idc`	`unsigned int`	Output	Aspect ratio of Luma samples
`sar_width`	`unsigned int`	Output	Horizontal size of sample aspect ratio
`sar_height`	`unsigned int`	Output	Vertical size of sample aspect ratio
`overscan_info_present_flag`	`unsigned int`	Output	Overscan_appropriate_flag
`overscan_appropriate_flag`	`unsigned int`	Output	Cropped decoded pictures are suitable for display or not.
`video_signal_type_present_flag`	`unsigned int`	Output	This flag tells whether `video_format`, `video_full_range_flag` and `colour_description_present_flag` are present or not
`video_format`	`unsigned int`	Output	Video format indexed by a table. For example, PAL/NTSC
`video_full_range_flag`	`unsigned int`	Output	Black level, luma and chroma ranges. It should be used for BT.601 compliance

Field	Datatype	Input/ Output	Description
`colour_description_ present_flag`	`unsigned int`	Output	Indicates whether `colour_primaries`, `transfer_characteristics` and `matrix_coefficients` are present.
`colour_primaries`	`unsigned int`	Output	Chromaticity co-ordinates of source primaries
`transfer_characteri stics`	`unsigned int`	Output	Opto-electronic transfer characteristics of the source picture
`matrix_coefficients`	`unsigned int`	Output	Matrix coefficients for deriving Luma and chroma data from RGB components.
`chroma_location_inf o_present_flag`	`unsigned int`	Output	This flag tells whether `chroma_sample_loc_type_top field` and `chroma_sample_loctype bottom_field` are present.
`chroma_sample_loc_t ype_top_field`	`unsigned int`	Output	Location of `chroma_sample` top field
`chroma_sample_loc_t ype_bottom_field`	`unsigned int`	Output	Location of `chroma_sample` bottom field
`timing_info_present _flag`	`unsigned int`	Output	It indicates whether `num_units_in_tick`, `time_scale`, and `fixed_frame_rate_flag` are present.
`num_units_in_tick`	`unsigned int`	Output	number of units of a clock that corresponds to 1 increment of a clock tick counter
`time_scale`	`unsigned int`	Output	Indicates actual increase in time for 1 increment of a clock tick counter
`fixed_frame_rate_fl ag`	`unsigned int`	Output	It tells how the temporal distance between HRD output times of any two output pictures is constrained
`nal_hrd_parameters_ present_flag`	`unsigned int`	Output	Indicates whether `nal_hrd_parameters` are present
`nal_hrd_parameters`	`sHrdParm_t`	Output	See `sHrdParm_t datastructure` for details.
`vcl_hrd_parameters_ present_flag`	`unsigned int`	Output	Indicates whether `vcl_hrd_parameters` are present
`vcl_hrd_parameters`	`sHrdParm_t`	Output	See `sHrdParm_t datastructure` for details.
`low_delay_hrd_flag`	`unsigned int`	Output	HRD operational mode as in Annex C of the standard
`pic_struct_present_ flag`	`unsigned int`	Output	Indicates whether picture timing SEI messages are present

Field	Datatype	Input/Output	Description
`bitstream_restriction_flag`	unsigned int	Output	Indicates if the bitstream restriction parameters are present
`motion_vectors_over_pic_boundaries_flag`	unsigned int	Output	Specifies whether motion vectors can point to regions outside the picture boundaries
`max_bytes_per_pic_denom`	unsigned int	Output	Maximum number of bytes not exceeded by the sum of sizes of all VCL NAL units of a single coded picture
`max_bits_per_mb_denom`	unsigned int	Output	Maximum number of bits taken by any coded MB
`log2_max_mv_length_vertical`	unsigned int	Output	Maximum value of any motion vector's vertical component
`log2_max_mv_length_horizontal`	unsigned int	Output	Maximum value of any motion vector's horizontal component
`num_reorder_frames`	unsigned int	Output	Maximum number of frames that need to be re-ordered
`max_dec_frame_buffering`	unsigned int	Output	Size of HRD decoded buffer (DPB) in terms of frame buffers

4.2.2.3.10   sHrdParm_t

‖ **Description**

This structure defines the HRD parameters that come in a H264 bit-stream as a part of video usability Information.

‖ **Fields**

Field	Datatype	Input/Output	Description
`cpb_cnt`	unsigned int	Output	Number of alternative CPB specifications in the bitstream
`bit_rate_scale`	unsigned int	Output	Together with `bit_rate_value[i]`, it specifies the maximum input bitrate for the ith CPB.
`cpb_size_scale`	unsigned int	Output	Together with `cpb_size_value[i]`, specifies the maximum CPB size for the ith CPB.
`bit_rate_value[i]`	unsigned int	Output	Maximum `input bitrate` for the ith CPB
`cpb_size_value[i]`	unsigned int	Output	Maximum `CPB size for` the ith CPB

Field	Datatype	Input/ Output	Description
vbr_cbr_flag[i]	unsigned int	Output	Specifies the ith CPB is operated in Constant Bit-rate mode or variable bit-rate mode
initial_cpb_removal _delay_length_minus 1	unsigned int	Output	Length in bits of initial_cpb_removal_length syntax element
cpb_removal_delay_l ength_minus1	unsigned int	Output	Length in bits of cpb_removal_delay_length syntax element
dpb_output_delay_le ngth_minus1	unsigned int	Output	Length in bits of dpb_output_delay_length syntax element
time_offset_length	unsigned int	Output	Length in bits of time_offset syntax element

Note:

SEI / VUI parsing is handled by the decoder as follows:

If the application is interested in SEI / VUI, then the sei_Vui_parse_flag (element of IH264MPVDEC_InArgs) needs to be set to one and the buffer(structure) pointer needs to be passed in seiVui_buffer_ptr (element of IH264MPVDEC_InArgs). When the sei_Vui_parse_flag is set to 1, the decoder parses the SEI / VUI information and updates the buffer allotted by the application.

A flag "parsed_flag" is present as the first element of structure of every SEI message, VUI structure and the SEI_VUI structure. This flag when set to one by the decoder indicates that in the current process call, contents of this structure was updated. The pointer of the buffer is simply copied to the pointer in the IH264MPVDEC_OutArgs.

Currently parsing of the following SEI messages are supported.

❑ Full-frame freeze SEI message

❑ Full-frame freeze release

❑ Progressive refinement segment start

❑ Progressive refinement segment end

❑ Recovery point SEI message

❑ Picture timing SEI message

Other types of SEI messages will be simply skipped by the decoder.

4.2.2.4 IH264MPVDEC_Status

‖ **Description**

This structure defines parameters that describe the status of the H.264 Decoder and any other implementation specific parameters. The status parameters are defined in the XDM data structure, `IVIDDEC_Status`.

‖ **Fields**

Field	Datatype	Input/ Output	Description
viddecStatus	IVIDDEC_Status	Output	See `IVIDDEC_Status` data structure for details
profile	eH264MPVDEC_Profile	Output	Profile of the bit stream. The H.264 decoder supports only main profile.
level	eLevelNum_t	Output	Level number of the bit stream. The H.264 decoder supports only upto Level 3.
Qp	XDAS_Int32	Output	Frame quantization parameter
last_decoded_mb_addr	XDAS_UInt32	Output	Raster scan address of the last decoded MB.
slice_header_frame_num	XDAS_UInt32	Output	Frame number present in the slice header.
full_frame_decoded	XDAS_UInt32	Output	The flag indicates whether the full frame is decoded without any errors.
poc_num	XDAS_UInt32	Output	POC number of the current frame.

Note:

Following is the decoder behavior for supporting frame size being non-multiple of 16 through frame cropping:

❑ The decoder populates the output buffers at a resolution equal to the size of the cropped image. Also, it returns status parameters for picture resolution (`outputHeight` and `outputWidth`) as equal to the cropped values.

❑ If the `displayWidth` (element in `DynamicParams`) is lesser than the cropped image width, then the decoder writes at a width equal to the display width.

4.2.2.5 IH264MPVDEC_OutArgs

‖ **Description**

This structure defines the run time output arguments for the H.264 Decoder instance object.

‖ **Fields**

Field	Datatype	Input/ Output	Description

Field	Datatype	Input/ Output	Description
`viddecOutArgs`	`IVIDDEC_OutArgs`	Output	See `IVIDDEC_OutArgs` data structure for details.
`pict_struct`	`ePicStruct_t`	Output	This argument returns enumeration indicating the decoded picture is frame, top field, or bottom field. See `ePicStruct_t` enumeration for details.
`display_frame_ skip_flag`	`XDAS_Int32`	Output	This flag, when set to one indicates that the frame returned in this call was skipped and hence nothing was written into this buffer.
`SeiVui_buffer_ ptr`	`sSeiVuiParams_t *`	Output	SEI, VUI Buffer pointer given by the application is simply replicated here.

Note:

Following is the behavior of the decoder to handle skipping of non-reference frames.

❑ If the application needs the decoder to skip non-reference frames, then it has to set `frameSkipMode` (element in `dynamicParams`) equal to `IVIDEO_SKIP_B` and call the control API with "`XDM_SETPARAMS`" option.

❑ Decoder skips decoding only when `frameSkipMode` is set to `IVIDEO_SKIP_B` and the current frame is not referenced in the future. The buffer allotted during frame skip mode will be locked inside the decoder irrespective of whether the frame was actually skipped or not.

❑ When the buffer pointer of skipped frame is returned by the decoder, the display_frame_skip_flag(element in `IH264MPVDEC_OutArgs`) will be set to one indicating that nothing was written into this buffer.

❑ In order to come out of the frame skip mode, the application has to set `frameSkipMode` (element in `dynamicParams`) equal to `IVIDEO_NO_SKIP` and call the control API with "`XDM_SETPARAMS`" option.

Important:

In skip mode, the decoder skips non-reference frames irrespective of whether it is B or P frame as the H264 standard allows both P and B frames to be non-reference frames.

4.3 Interface Functions

This section describes the Application Programming Interfaces (APIs) used in the H.264 Decoder. The APIs are logically grouped into the following categories:

- ❑ **Creation** – `algNumAlloc(), algAlloc()`

- ❑ **Initialization –** `algInit()`

- ❑ **Control** – `control()`

- ❑ **Data processing** – `algActivate(), process(), algDeactivate()`

- ❑ **Termination** – `algFree()`

You must call these APIs in the following sequence:

1) `algNumAlloc()`
2) `algAlloc()`
3) `algInit()`
4) `algActivate()`
5) `process()`
6) `algDeactivate()`
7) `algFree()`

`control()` can be called any time after calling the `algInit()` API.

`algNumAlloc(), algAlloc(), algInit(), algActivate(), algDeactivate()`, and `algFree()` are standard XDAIS APIs. This document includes only a brief description for the standard XDAIS APIs. For more details, see *TMS320 DSP Algorithm Standard API Reference* (literature number SPRU360).

4.3.1 Creation APIs

Creation APIs are used to create an instance of the component. The term creation could mean allocating system resources, typically memory.

‖ **Name**

algNumAlloc() – determine the number of buffers that an algorithm requires

‖ **Synopsis**

XDAS_Int32 algNumAlloc(Void);

‖ **Arguments**

Void

‖ **Return Value**

XDAS_Int32; /* number of buffers required */

‖ **Description**

algNumAlloc() returns the number of buffers that the algAlloc() method requires. This operation allows you to allocate sufficient space to call the algAlloc() method.

algNumAlloc() may be called at any time and can be called repeatedly without any side effects. It always returns the same result. The algNumAlloc() API is optional.

For more details, see *TMS320 DSP Algorithm Standard API Reference* (literature number SPRU360).

‖ **See Also**

algAlloc()

algAlloc() – determine the attributes of all buffers that an algorithm requires

```
XDAS_Int32 algAlloc(const IALG_Params *params, IALG_Fxns
**parentFxns, IALG_MemRec memTab[]);
```

```
IALG_Params *params; /* algorithm specific attributes */
```

```
IALG_Fxns **parentFxns;/* output parent algorithm
functions */
```

```
IALG_MemRec memTab[]; /* output array of memory records */
```

```
XDAS_Int32 /* number of buffers required */
```

algAlloc() returns a table of memory records that describe the size, alignment, type, and memory space of all buffers required by an algorithm. If successful, this function returns a positive non-zero value indicating the number of records initialized.

The first argument to algAlloc() is a pointer to a structure that defines the creation parameters. This pointer may be NULL; however, in this case, algAlloc() must assume default creation parameters and must not fail.

The second argument to algAlloc() is an output parameter. algAlloc() may return a pointer to its parent's IALG functions. If an algorithm does not require a parent object to be created, this pointer must be set to NULL.

The third argument is a pointer to a memory space of size nbufs * sizeof(IALG_MemRec) where, nbufs is the number of buffers returned by algNumAlloc() and IALG_MemRec is the buffer-descriptor structure defined in ialg.h.

After calling this function, memTab[] is filled up with the memory requirements of an algorithm.

For more details, see *TMS320 DSP Algorithm Standard API Reference* (literature number SPRU360).

```
algNumAlloc(), algFree()
```

4.3.2   Initialization API

Initialization API is used to initialize an instance of the algorithm. The initialization parameters are defined in the Params structure (see Data Structures section for details).

|| Name

    `algInit()` – initialize an algorithm instance

|| Synopsis

    `XDAS_Int32 algInit(IALG_Handle handle, IALG_MemRec`
    `memTab[], IALG_Handle parent, IALG_Params *params);`

|| Arguments

    `IALG_Handle handle; /* algorithm instance handle*/`

    `IALG_memRec memTab[]; /* array of allocated buffers */`

    `IALG_Handle parent; /* handle to the parent instance */`

    `IALG_Params *params; /* algorithm initialization`
    `parameters */`

|| Return Value

    `IALG_EOK; /* status indicating success */`

    `IALG_EFAIL; /* status indicating failure */`

|| Description

`algInit()` performs all initialization necessary to complete the run time creation of an algorithm instance object. After a successful return from `algInit()`, the instance object is ready to be used to process data.

The first argument to `algInit()` is a handle to an algorithm instance. This value is initialized to the base field of `memTab[0]`.

The second argument is a table of memory records that describe the base address, size, alignment, type, and memory space of all buffers allocated for an algorithm instance. The number of initialized records is identical to the number returned by a prior call to `algAlloc()`.

The third argument is a handle to the parent instance object. If there is no parent object, this parameter must be set to `NULL`.

The last argument is a pointer to a structure that defines the algorithm initialization parameters.

For more details, see *TMS320 DSP Algorithm Standard API Reference* (literature number SPRU360).

|| See Also

    `algAlloc(), algMoved()`

4.3.3   Control API

Control API is used for controlling the functioning of the algorithm instance during run time. This is done by changing the status of the controllable parameters of the algorithm during run time. These controllable parameters are defined in the `Status` data structure (see data structures section for details).

| | Name

    control() – change run time parameters and query the status

| | Synopsis

```
XDAS_Int32 (*control) (IVIDDEC_Handle handle, IVIDDEC_Cmd
id, IVIDDEC_DynamicParams *params, IVIDDEC_Status
*status);
```

| | Arguments

```
IVIDDEC_Handle handle; /* algorithm instance handle */

IVIDDEC_Cmd id; /* algorithm specific control commands*/

IVIDDEC_DynamicParams *params /* algorithm run time
parameters */

IVIDDEC_Status *status /* algorithm instance status
parameters */
```

| | Return Value

```
IALG_EOK; /* status indicating success */

IALG_EFAIL; /* status indicating failure */
```

| | Description

This function changes the run time parameters of an algorithm instance and queries the algorithm's `status`. control() must only be called after a successful call to algInit() and must never be called after a call `to` `algFree()`.

The first argument to `control()` is a handle to an algorithm instance.

The second argument is an algorithm specific control command. See `XDM_CmdId` enumeration for details.

The third and fourth arguments are pointers to the `IVIDDEC_DynamicParams` and `IVIDDEC_Status` data structures respectively.

Note:

If you are using extended data structures, the third and fourth arguments must be pointers to the extended `DynamicParams` and `Status` data structures respectively. Also, ensure that the `size` field is set to the size of the extended data structure. Depending on the value set for the `size` field, the algorithm uses either basic or extended parameters.

‖ Preconditions

The following conditions must be true prior to calling this function; otherwise, its operation is undefined.

❑ `control()` can only be called after a successful return from `algInit()` and `algActivate()`.

❑ If algorithm uses DMA resources, `control()` can only be called after a successful return from `DMAN3_init()`.

❑ `handle` must be a valid handle for the algorithm's instance object.

‖ Postconditions

The following conditions are true immediately after returning from this function.

❑ If the control operation is successful, the return value from this operation is equal to `IALG_EOK`; otherwise it is equal to either `IALG_EFAIL` or an algorithm specific return value.

❑ If the control command is not recognized, the return value from this operation is not equal to `IALG_EOK`.

‖ Example

See test application file, TestAppDecoder.c available in the \Client\Test\Src sub-directory.

‖ See Also

`algInit(), algActivate(), process()`

4.3.4 Data Processing API

Data processing API is used for processing the input data.

‖ Name

algActivate() – initialize scratch memory buffers prior to processing.

‖ Synopsis

Void algActivate(IALG_Handle handle);

‖ Arguments

IALG_Handle handle; /* algorithm instance handle */

‖ Return Value

Void

‖ Description

algActivate() initializes any of the instance's scratch buffers using the persistent memory that is part of the algorithm's instance object.

The first (and only) argument to algActivate() is an algorithm instance handle. This handle is used by the algorithm to identify various buffers that must be initialized prior to calling any of the algorithm's processing methods.

For more details, see *TMS320 DSP Algorithm Standard API Reference.* (literature number SPRU360).

‖ See Also

algDeactivate()

|| **Name**

process() – basic encoding/decoding call

|| **Synopsis**

```
XDAS_Int32 (*process)(IVIDDEC_Handle handle, XDM_BufDesc
*inBufs, XDM_BufDesc *outBufs, IVIDDEC_InArgs *inargs,
IVIDDEC_OutArgs *outargs);
```

|| **Arguments**

```
IVIDDEC_Handle handle; /* algorithm instance handle */

XDM_BufDesc *inBufs; /* algorithm input buffer descriptor
*/

XDM_BufDesc *outBufs; /* algorithm output buffer
descriptor */

IVIDDEC_InArgs *inargs /* algorithm runtime input
arguments */

IVIDDEC_OutArgs *outargs /* algorithm runtime output
arguments */
```

|| **Return Value**

```
IALG_EOK; /* status indicating success */

IALG_EFAIL; /* status indicating failure */
```

|| **Description**

This function does the basic encoding/decoding. The first argument to process() is a handle to an algorithm instance.

The second and third arguments are pointers to the input and output buffer descriptor data structures respectively (see XDM_BufDesc data structure for details).

The fourth argument is a pointer to the IVIDDEC_InArgs data structure that defines the run time input arguments for an algorithm instance object.

The last argument is a pointer to the IVIDDEC_OutArgs data structure that defines the run time output arguments for an algorithm instance object.

Note:

If you are using extended data structures, the fourth and fifth arguments must be pointers to the extended InArgs and OutArgs data structures respectively. Also, ensure that the size field is set to the size of the extended data structure. Depending on the value set for the size field, the algorithm uses either basic or extended parameters.

|| **Preconditions**

The following conditions must be true prior to calling this function; otherwise, its operation is undefined.

❑ process() can only be called after a successful return from algInit() and algActivate().

❑ If algorithm uses DMA resources, `process()` can only be called after a successful return from `DMAN3_init()`.

❑ `handle` must be a valid handle for the algorithm's instance object.

❑ Buffer descriptor for input and output buffers must be valid.

❑ Input buffers must have valid input data.

‖ Postconditions

The following conditions are true immediately after returning from this function.

❑ If the process operation is successful, the return value from this operation is equal to `IALG_EOK`; otherwise it is equal to either `IALG_EFAIL` or an algorithm specific return value.

❑ After successful return from `process()` function, `algDeactivate()` can be called.

‖ Example

See test application file, TestAppDecoder.c available in the \Client\Test\Src sub-directory.

‖ See Also

`algInit(), algDeactivate(), control()`

Note:

A video encoder or decoder cannot be pre-empted by any other video encoder or decoder instance. That is, you cannot perform task switching while encode/decode of a particular frame is in progress. Pre-emption can happen only at frame boundaries and after `algDeactivate()` is called.

|| **Name**

> algDeactivate() – save all persistent data to non-scratch memory

|| **Synopsis**

> ```
> Void algDeactivate(IALG_Handle handle);
> ```

|| **Arguments**

> ```
> IALG_Handle handle; /* algorithm instance handle */
> ```

|| **Return Value**

> ```
> Void
> ```

|| **Description**

> algDeactivate() saves any persistent information to non-scratch buffers using the persistent memory that is part of the algorithm's instance object.
>
> The first (and only) argument to algDeactivate() is an algorithm instance handle. This handle is used by the algorithm to identify various buffers that must be saved prior to next cycle of algActivate() and processing.
>
> For more details, see *TMS320 DSP Algorithm Standard API Reference* (literature number SPRU360).

|| **See Also**

> ```
> algActivate()
> ```

4.3.5 Termination API

Termination API is used to terminate the algorithm instance and free up the memory space that it uses.

‖ Name

algFree() – determine the addresses of all memory buffers used by the algorithm

‖ Synopsis

```
XDAS_Int32 algFree(IALG_Handle handle, IALG_MemRec
memTab[]);
```

‖ Arguments

```
IALG_Handle handle; /* handle to the algorithm instance */
```

```
IALG_MemRec memTab[]; /* output array of memory records */
```

‖ Return Value

```
XDAS_Int32; /* Number of buffers used by the algorithm */
```

‖ Description

algFree() determines the addresses of all memory buffers used by the algorithm. The primary aim of doing so is to free up these memory regions after closing an instance of the algorithm.

The first argument to algFree() is a handle to the algorithm instance.

The second argument is a table of memory records that describe the base address, size, alignment, type, and memory space of all buffers previously allocated for the algorithm instance.

For more details, see *TMS320 DSP Algorithm Standard API Reference* (literature number SPRU360).

‖ See Also

algAlloc()

4.4 Error Handling

This section describes the errors in the bit stream, the expected behavior of the decoder, and the recommended actions on the application side.

❑ When the decoder detects an error in the bitstream, the return value from the process call will be `IALG_EFAIL`.

❑ The type of the detected error will be indicated in the `extendedError` field of `OutArgs`. See `XDM_ErrorBit` enumeration for details.

❑ In any type of error scenario, there is no need for the application to reset the decoder.

❑ Ouput/display buffer handling in error scenarios:

   o If the `maxDisplayDelay` is zero, then the decoder always returns back the same display buffer passed by the system in the current process call

   o If the `maxDisplayDelay` is greater than zero, then the decoder returns display buffers in an order based on the display order logic specified by the standard. However if the display order logic cannot be executed due to error `XDM_CORRUPTEDHEADER`, then decoder simply returns back the display buffer given by the system in the current process call. Note that the decoder attempts to return a non-`NULL` pointer for display in all scenarios, when the initial pipeup for `maxDisplayDelay` is completed.

❑ When the error type is `XDM_CORRUPTEDHEADER`, the output height and width information present in the `OutArgs` or `Status` structure might not be reliable.

Note:

In certain scenarios, the decoder returns a non-zero `extendedError`, with the process call returning `IALG_EOK`. This happens, if decoder detects errors in the bit stream, which do not obstruct the further decoding and reconstruction. For example: An error detected during parsing of a PPS which is never referenced, will be reported in the `extendedError`, but the process call will still return `IALG EOK`.