MPEG2 Main Profile Decoder on C64x+

User Guide

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TEXAS INSTRUMENTS

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Read This First

About This Manual

This document describes how to install and work with Texas Instruments' (TI) MPEG2 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 Interface 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)
- *MPEG-2 Video Decoder: TMS320C62x DSP Implementation* (literature number SPRA649) describes the implementation of the MPEG-2 video decoder on the TMS320C62x DSP.

Related Documentation

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

- *ISO/IEC 11172-2 Information technology -- Coding of moving pictures and associated audio for digital storage media at up to about 1.5Mbits/s -- Part 2: Video* (MPEG-1 video standard).

- *ISO/IEC 13818-2 Information technology -- Generic coding of moving pictures and associated audio information: Video* (MPEG-2 video standard).

Abbreviations

The following abbreviations are used in this document.

Table 1-1. List of Abbreviations

Abbreviation	Description
API	Application Programming Interface
CBR	Constant Bit Rate
CPB	Constrained Parameters Bit-streams
DCT	Discrete Cosine Transform
DMA	Direct Memory Access
DMAN3	DMA Manager
DSS	Direct Satellite System
DTV	Digital Television
DVB	Digital Video Broadcast
DVD	Digital Versatile Disc
EVM	Evaluation Module
fps	Frames per second
IDCT	Inverse Discrete Cosine Transform
Kbps	Kilo bits per second
MPEG	Motion Picture Expert Group
XDAIS	eXpressDSP Algorithm Interface Standard
XDM	eXpressDSP Digital Media

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 (MPEG2 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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Chapter 1

Introduction

This chapter provides a brief introduction to XDAIS and XDM. It also provides an overview of TI's implementation of the MPEG2 Main Profile Decoder on the C64x+ platform and its supported features.

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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

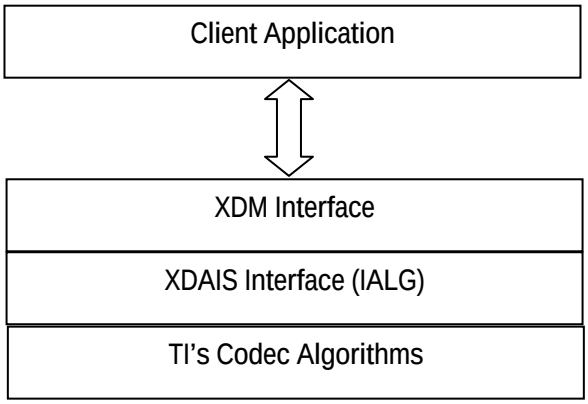
(for example audio, video, image, and speech). The XDM standard defines the following two APIs:

- `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.



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 MPEG2 Main Profile Decoder

The MPEG2 video standard specifies the decompression and coded representation for entertainment-quality digital video. It is widely used in different digital video systems, including DTV (Digital Television), DVB (Digital Video Broadcast), DSS (Direct Satellite System), and DVD (Digital Versatile Disc). The MPEG2 video decoder plays an important role in consumer electronics like DVD players, set-top boxes, and DSS units.

The decoder software implements all the MPEG2 main-profile-at-high-level functionality. For more information on the MPEG2 video decoding algorithm, see *MPEG2 Video Decoder: TMS320C62x (TM) DSP Implementation* application report (literature number SPRA649).

From this point onwards, all references to MPEG2 Decoder means MPEG2 Main Profile Decoder only.

1.3 Supported Services and Features

This user guide accompanies TI's implementation of MPEG2 Decoder on the C64x+ platform. This version of the codec has the following supported features:

- Supports MPEG2 main-profile-at-high-level feature of the ISO/IEC 13818-2 standard
- Compliant as per ISO/IEC 13818-4 conformance standard, based on Inverse Discrete Cosine Transform (IDCT)
- Supports YUV 420 planar and YUV 422 interleaved output formats
- Supports interlace and progressive decoding
- Supports only elementary video stream input formats
- Supports MPEG-1 Constrained Parameters Bit-streams (CPB)
- Supports bottom field reordering in case of non-progressive sequences where bottom field is sent ahead of top field for frame pictures
- Supports trick play and reverse play
- Supports displayWidth feature
- Supports streams which are non-multiples of 16
- Supports feature XDM_PARSE_HEADER. It allows parsing of only the headers, skipping the picture data decoding
- eXpressDSP Digital Media (XDM) compliant

Note:

This version of MPEG2 Decoder does not support sequences with escape bit set in the sequence extension header.

Chapter 2

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.

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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 DRA446 EVM with XDS560 JTAG emulator.

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 version 3.2.40.12.
- **Code Generation Tools:** This project is compiled, assembled, archived, and linked using the code generation tools version 6.0.8.

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_MPEG2_D_1_11, under which another directory named DRA446_MP_002 is created.

Figure 2-1 shows the sub-directories created in the DRA446_MP_002 directory.

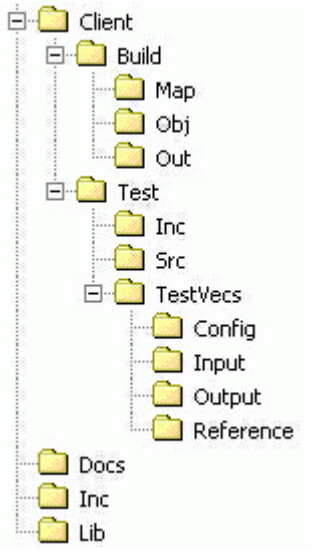

Figure 2-1. Component Directory Structure

Table 2-1 provides a description of the sub-directories created in the DRA446_MP_002 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 manual, 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 verifying 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 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>\fctools\packages \ti\xdais directory.

2.4 Building and Running the Sample Test application

This codec is accompanied by a sample test application. This application will run in TI's Code Composer Studio development environment. To build and run the sample application in Code Composer Studio, follow these steps:

1) Verify that you have an installation of TI's Code Composer Studio version 3.2.40.12 and code generation tools version 6.0.8.

2) Verify that the codec object library, mpeg2vdec_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.

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

   - "PASS/FAIL: Pass criteria that more than 99 percent decoded samples should have at the most one-bit difference with reference output is satisfied/NOT satisfied" (for compliance check mode)
   - "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:
  - 1 - for compliance checking, no output file is created
  - 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\akiyo_frame.m2v
..\..\Test\TestVecs\Reference\akiyo_frame_420Ref.yuv
0
..\..\Test\TestVecs\Config\Testparams.cfg
..\..\Test\TestVecs\Input\akiyo_frame.m2v
..\..\Test\TestVecs\Output\akiyo_frame.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 = 1920   # Image width in Pels, must be
                      multiples of 16
ImageHeight = 1088  # Image height in Pels, must be
                      multiples of 16
ChromaFormat = 1    # 1 => XDM_YUV_420P,
                      3 => XDM_YUV_422IBE,
                      4 => XDM_YUV_422ILE
FramesToDecode = 10 # Number of frames to be coded
```

Any field in the `IVIDDEC_Params` structure (see Section 4.3.1.5) 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:
  - "PASS/FAIL: Pass criteria that more than 99 percent decoded samples should have at the most one-bit difference with reference output is satisfied/NOT satisfied" (if X is 1)
  - "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.

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Chapter 3

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 MPEG2 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.

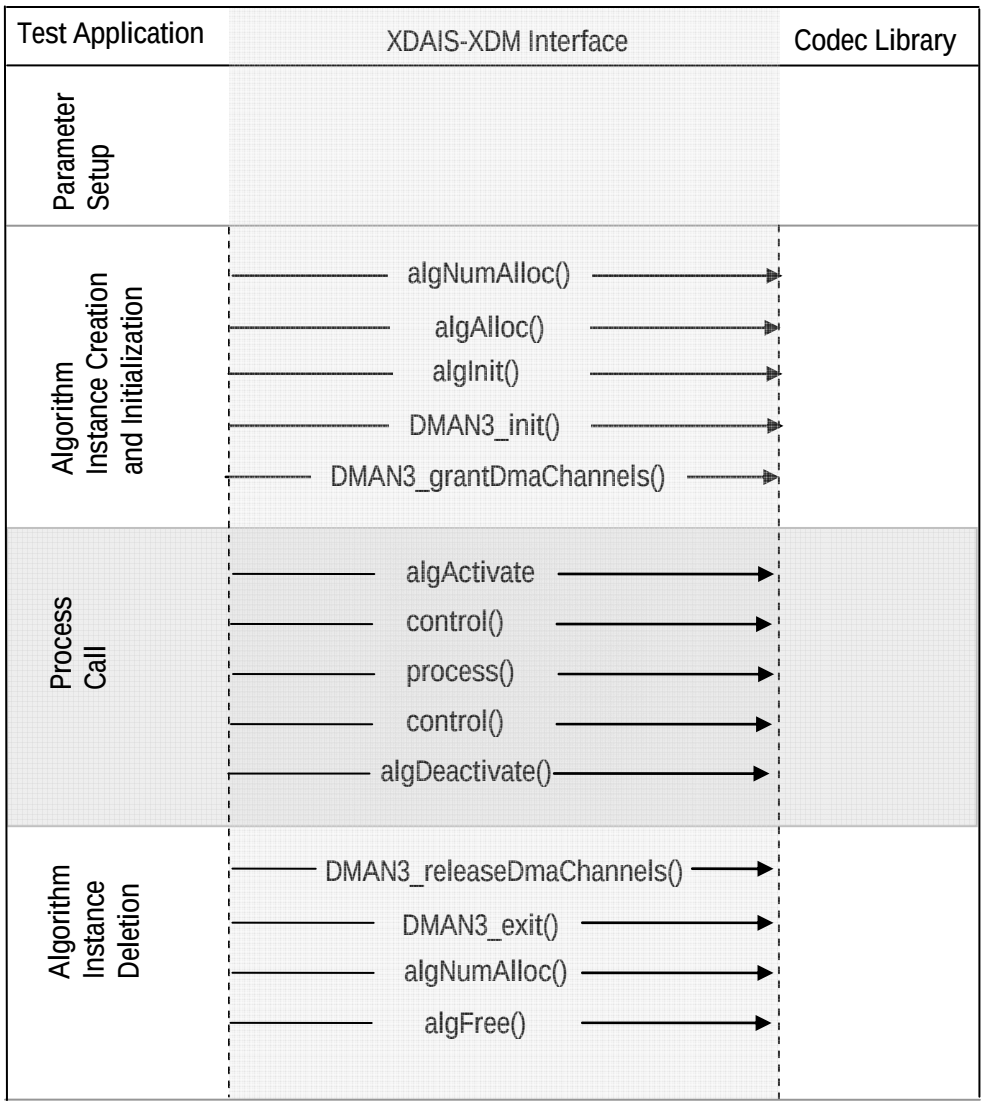

Figure 3-1. Test Application Sample Implementation

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 4.3.1.6). 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()`.

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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Chapter 4

API Reference

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

Topic **Page**

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
	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
	IVIDEO_SKIP_P	Skip forward inter coded frame. Not supported in this version of MPEG2 Decoder.
	IVIDEO_SKIP_B	Skip bi-directional inter coded frame. Not supported in this version of MPEG2 Decoder.
	IVIDEO_SKIP_I	Skip intra coded frame. Not supported in this version of MPEG2 Decoder.
ePicStrFormat	MPEG2VDEC_TOP_FIELD	Indicates top field in field picture
	MPEG2VDEC_BOTTOM_FIELD	Indicates bottom field in field picture
	MPEG2VDEC_FRAME_PICTURE	Indicates frame picture
XDM_DataFormat	XDM_BYTE	Big endian stream
	XDM_LE_16	16-bit little endian stream. Not supported in this version of MPEG2 Decoder.
	XDM_LE_32	32-bit little endian stream
XDM ChromaFormat	XDM_YUV_420P	YUV 4:2:0 planar

Group or Enumeration Class	Symbolic Constant Name	Description or Evaluation
	XDM_YUV_422P	YUV 4:2:2 planar. Not supported in this version of MPEG2 Decoder.
	XDM_YUV_422IBE	YUV 4:2:2 interleaved (big endian). Not supported in this version of MPEG2 Decoder.
	XDM_YUV_422ILE	YUV 4:2:2 interleaved (little endian)
	XDM_YUV_444P	YUV 4:4:4 planar. Not supported in this version of MPEG2 Decoder.
	XDM_YUV_411P	YUV 4:1:1 planar. Not supported in this version of MPEG2 Decoder.
	XDM_GRAY	Gray format. Not supported in this version of MPEG2 Decoder.
	XDM_RGB	RGB color format. Not supported in this version of MPEG2 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.
	XDM_GETBUFINFO	Query algorithm instance regarding the properties of input and output buffers
XDM_DecMode	XDM_DECODE_AU	Decode entire access unit
	XDM_PARSE_HEADER	Decode only header.
XDM_ErrorBit	XDM_APPLIEDCONCEALMENT	Bit 9 ❑ 1 - Applied concealment ❑ 0 - Ignore

Group or Enumeration Class	Symbolic Constant Name	Description or Evaluation
	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
	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 (see Section 4.2.1)

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

The MPEG2 Decoder specific error status messages are listed in Section 4.2.1. The Value column indicates the decimal value of the last 8-bits reserved for codec specific error statuses.

4.2 Behavioral Specification of the Decoder

Behavioral specification defines how the decoder reacts to errors and recommended steps to be taken by the application to recover from such errors.

4.2.1 Classification of Errors

Errors that the decoder returns can be grouped into the following categories:

- **Fatal errors** - These are non-recoverable errors that cause the application to re-initialize, reset, or re-instantiate the decoder for resuming normal operation. The application cannot continue with the decoding until the decoder is reset.
- **Non-Fatal bit stream errors** - These are errors for which the application can proceed with the decoding without resetting the decoder. The current frame is erroneous and hence decoder can continue with the decoding skipping the erroneous frame. The `process()` function returns FAILURE.
- **Non-Fatal errors** – These are errors for which the decoder can continue decoding the current frame. The error does not affect the decoding process. The `process()` function returns SUCCESS and sets the extended error status accordingly.

Table 4-2. MPEG2 Decoder Fatal Error Statuses

Group or Enumeration Class	Symbolic Constant Name	Value	Description or Evaluation
`MPEG2VDEC_ERROR`	`MPEG2VDEC_ERROR_Failure`	`1`	Decoding failed. Not supported in this version of MPEG2 Decoder.

Table 4-3. MPEG2 Decoder Non-Fatal Bit stream Error Statuses

Group or Enumeration Class	Symbolic Constant Name	Value	Description or Evaluation
`IMPEGDEC_ErrorStatus`	`MPEG2VDEC_ERROR_bitstream_Overrun`	`2`	Decoder has exhausted the given bit stream and run past available number of bits. This indicates either erroneous bit stream or insufficient data to decoder.
	`MPEG2VDEC_ERROR_unsupportedpictureSpatialScalableExtension`	`3`	Unsupported picture spatial scalable extension
`IMPEGDEC_ErrorStatus`	`MPEG2VDEC_ERROR_unSupportedpictureTemporalScalableExtension`	`4`	Unsupported picture temporal scalable extension

Group or Enumeration Class	Symbolic Constant Name	Value	Description or Evaluation
	MPEG2VDEC_ERROR_errorneousBitstream	5	Erroneous bit stream
	MPEG2VDEC_ERROR_sliceVerticalPosition	6	Slice position is outside the permissible range, and hence error in decoding.
	MPEG2VDEC_ERROR_corruptedHeader	7	Corrupted frame header
	MPEG2VDEC_ERROR_unsupportedInput	8	Unsupported input stream
	MPEG2VDEC_ERROR_incorrectWidthHeight	9	Width and height of the input sequence is not in accordance with the maximum width and height
	MPEG2VDEC_ERROR_nullOutputBufPtrs	10	Output buffer pointers passed by the application are NULL
	MPEG2VDEC_ERROR_brokenLinkSet	11	Frame cannot be decoded properly as the reference frame that is used for prediction is not available due to the action of editing
	MPEG2VDEC_ERROR_droppedFrame	12	Frame dropped and is not decoded. See Note for details.
	MPEG2VDEC_ERROR_noValidReferences	13	Frame not decoded as the valid references required to decode it are unavailable due to dropped frame
	MPEG2VDEC_ERROR_noRefBufferToFlush	14	Reference buffer is not available to flush on calling control() API with FLUSH command
	MPEG2VDEC_ERROR_nullInputBufPtr	17	Input buffer pointer passed by the application is NULL
	MPEG2VDEC_ERROR_insufficientoutBufSize	18	Output buffer size(s) provided by the application is not sufficient
	MPEG2VDEC_ERROR_nullPointer	19	NULL pointer is passed by the application
	MPEG2VDEC_ERROR_invalidStructSize	20	Size of XDM structure(s) passed by the application is invalid

Table 4-4. MPEG2 Decoder Non-Fatal Error Statuses

Group or Enumeration Class	Symbolic Constant Name	Value	Description or Evaluation
	MPEG2VDEC_ERROR_insufficientUserDataBuffer	15	Size of the user buffer provided by the application is not sufficient to completely parse the user data
	MPEG2VDEC_ERROR_nullDisplayHdrBufPtrs	16	Display header pointers namely user data, sequence display extension, and picture display extension passed by the application are NULL.
	MPEG2VDEC_ERROR_invalidDisplayHdrSizes	21	Size of display header structure(s) namely user data, sequence display extension, and picture display extension passed by the application are invalid.

Note:

The error MPEG2VDEC_ERROR_droppedFrame is applicable only for the trick play feature. Decoder returns -1(IALG_EFAIL) when this error is set. But, the application can continue decoding waiting for the valid frame.

Trick play includes the following three commands:

- Goto Next I Frame (P and B pictures are dropped)
- Skip B Frame (B pictures are dropped)
- Skip Current Frame (I/P/B picture is dropped)

For the non-fatal bitstream error MPEG2VDEC_ERROR_sliceVerticalPosition, extended error is set but the decoder returns SUCCESS.

4.2.2 Recommended Steps to Recover from Error

The various categories of MPEG2 Decoder specific errors and the recommended actions to be performed by the application to recover from these errors are listed in this section.

- In case of errors, the decoder returns current erroneous frame as `NULL`. The application can call `control()` API with `FLUSH` command to retrieve the valid reference buffer stored inside the decoder.
- In case of erroneous B frames, the application should not call `control()` API with `FLUSH` command if application intends to continue decoding.
- If the flags `goto_next_I_frame` or `reverse_play` of `IMPEG2VDEC_InArgs` structure is set to 1, the application should not call `control()` API with `FLUSH` command.
- If application calls `control()` API with `FLUSH` command and references are not available to flush, decoder returns error `MPEG2VDEC_ERROR_noRefBufferToFlush`. This error will overwrite any previous extended error, if exists.
- Normally, on encountering the end of sequence code, decoder returns the last valid reference buffer locked inside. If the end of sequence is not present, the application can retrieve the last valid reference frame stored inside the decoder using the `control()` API with `FLUSH` command.
- If end of sequence code is encountered and application calls `control()` API with `FLUSH` command, decoder returns error `MPEG2VDEC_ERROR_noRefBufferToFlush` as no valid references are available to flush.
- At end of sequence, all the parameters of `outArgs` structure retain the previous values except `frameIdentifier`, `frame_num`, `displayBufs` and `outputID` parameters that represent the last valid reference frame that is output by the decoder in display order.
- Both incase of error or non-error, to extract the information from the buffers maintained inside the decoder, the structure `Buffer_Entry` can be used. This structure indicates the accepted buffer (Y) address and ID that is output by the decoder in display order at some point of time. The number of valid reference buffers stored is given by the `valid_buff_entries` parameter.
- The `inbuf_status` field in `IMPEG2VDEC_OutArgs` indicates the status of the input buffers passed by the application to the decoder.

The value of inbuf_status field indicates:

- **0 - Under Progress**. The buffer is being used by the decoder but not yet accepted. This happens for field pictures. Decode is called twice to generate one frame output. The status of the buffer accepted or rejected is determined at the end of two decode calls. Hence when the first call to decode returns `inbuf_status` value as 0 the same buffer should be passed again.

- **1 - Accepted**. Buffer is accepted.
- -**1 - Rejected**. Buffer is rejected. The decoder rejects the buffer on encountering end of sequence, `XDM_PARSE_HEADER`, or an error.

Note:

- For non-erroneous field pictures, if the input ID of the second decode call is different from the input ID of the first, `inbuf_status` field contains value –1 (Rejected) during the second decode call. This indicates that the second buffer is rejected. However the decoder will output the first buffer in display order.
- If the application encounters skipped frames, it may continue to repeatedly display the last buffer given out by the decoder skipped frame number of times. The output buffer descriptor contains the address of the next buffer to be displayed in sequence after the skipped frames.
- On encountering the following non-fatal errors, the application should take necessary corrective action before decoding further:

  `MPEG2VDEC_ERROR_nullInputBufPtr`

  `MPEG2VDEC_ERROR_nullOutputBufPtrs`

  `MPEG2VDEC_ERROR_insufficientoutBufSize`

  `MPEG2VDEC_ERROR_incorrectWidthHeight`
- The mandatory corrective actions could be to pass valid input/output buffer pointer(s) or output buffer size(s) or modify the maximum height and width according to the maximum resolution (D1, HDTV_720p, HDTV_1080I etc.) supported.
- For non-multiple of 16 streams, the decoded output is provided by the decoder in multiple of 16 resolution. Patch is present in the decoded stream that should be cropped by the application. The decoder does not do any padding. Hence the patch shall contain invalid data.

4.3 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.

4.3.1 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`

4.3.1.1 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

4.3.1.2 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 MPEG2 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.
- Padding of 128 bytes of zeroes should be done by the application at the end of the input buffer for decoding error streams. This is

recommended to avoid decoder from accessing beyond numBytes provided, due to corrupted bitstream

- The output buffer sizes (in bytes) for worst case HDTV_1080I format are:

  For YUV 420P:
  Y buffer = 1920 * 1080
  U buffer = 960 * 544
  V buffer = 960 * 544

  For YUV 422ILE:
  Buffer = 1920 * 1080 * 2

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

4.3.1.3 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

4.3.1.4 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

4.3.1.5 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. Default value is 1088.
maxWidth	XDAS_Int32	Input	Maximum video width to be supported in pixels. Default value is 1920.
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

Field	Datatype	Input/ Output	Description
			XDM_DataFormat enumeration for details. Default value is XDM_BYTE.
forceChromaFormat	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. Default value is XDM_YUV_422ILE.

Note:

- MPEG2 Decoder does not use the maxFrameRate and maxBitRate fields for creating the algorithm instance.
- Maximum video height and width supported are 1088 pixels and 1920 pixels respectively (for HDTV_1080I format).

4.3.1.6 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 Default value is 0.
`displayWidth`	`XDAS_Int32`	Input	If the field is set to: ❑ 0 - Uses decoded image width as pitch ❑ If any other value greater than the decoded image width is given, then this value in pixels is used as pitch. Default value is 0.
`frameSkipMode`	`XDAS_Int32`	Input	Frame skip mode. See `IVIDEO_FrameSkip` enumeration for details.

Note:

❑ Frame skip is not supported. Set the `frameSkipMode` field to `IVIDEO_NO_SKIP`.

4.3.1.7 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.

Note:

For B-frames, MPEG2 Decoder copies the current inputID value to the outputID value of IVIDDEC_OutArgs structure. However, for I and P frames, inputID value of the previous reference frame is copied to the outputID value of IVIDDEC_OutArgs structure.

4.3.1.8 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

Field	Datatype	Input/ Output	Description
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.
outputChromaFormat	XDAS_Int32	Output	Output chroma format. See XDM_ChromaFormat enumeration for details.
bufInfo	XDM_AlgBufInfo	Output	Input and output buffer information. See XDM_AlgBufInfo data structure for details.

Note:

The output chroma format for YUV 4:2:2 interleaved is as shown:

u00	y00	v00	y01	u02	y02	v02	y03	.	.
u00	y10	v00	y11	u02	y12	v02	y13	.	.
u20	y20	v20	y21	u22	y22	v22	y23	.	.
u20	y30	v20	y31	u22	y32	v22	y33	.	.
u40	y40	v40	y41	u42	y42	v42	y43	.	.
u40	y50	v40	y51	u42	y52	v42	y53	.	.
u60	y60	v60	y61	u62	y62	v62	y63	.	.
u60	y70	v60	y71	u62	y72	v62	y73	.	.
.	.	.	.	.	.	.	.	.	.

4.3.1.9 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.
bytesConsumed	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_BufDesc	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:

For B-frames, MPEG2 Decoder copies the current inputID value to the outputID value of IVIDDEC_OutArgs structure. However, for I and P frames, inputID value of the previous reference frame is copied to the outputID value of IVIDDEC_OutArgs structure.

4.3.2 MPEG2 Decoder Data Structures

This section includes the following MPEG2 Decoder specific extended data structures:

- `IMPEG2VDEC_Params`
- `IMPEG2VDEC_DynamicParams`
- `IMPEG2VDEC_InArgs`
- `IMPEG2VDEC_Status`
- `IMPEG2VDEC_OutArgs`

4.3.2.1 IMPEG2VDEC_Params

Description

This structure defines the creation parameters and any other implementation specific parameters for the MPEG2 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.

4.3.2.2 IMPEG2VDEC_DynamicParams

Description

This structure defines the run time parameters and any other implementation specific parameters for the MPEG2 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.

Field	Datatype	Input/ Output	Description
ppNone	XDAS_Int32	Input	❑ 1 - Indicates no post processing is done on decoded output and the output will always be in 4:2:0 planar format. The decoder reference buffers are exposed as output buffers. Hence instead of output buffers being passed to algorithm, it returns reference buffers. ❑ 0 - Indicates post processing can be done on the decoded output. Algorithm uses the application provided display buffers for outputting decoded data. Default value is 0.
dyna_chroma_format	XDAS_Int32	Input	Sets the output to the specified format at the frame level. To use this feature, forceChromaFormat of IVIDDEC_Params structure should be set to XDM_YUV_422ILE. See XDM_ChromaFormat enumeration for details. Default value is XDM_YUV_422ILE.

Note:

- If dyna_chroma_format is not used, it should always be set same as forceChromaFormat of IVIDDEC_Params structure.
- If dyna_chroma_format is used, "GETBUFINFO" should be invoked after calling "SETPARAMS" to get the buffer allocation information accordingly.
- If ppNone = 1, forceChromaFormat of IVIDDEC_Params structure and dyna_chroma_format of IMPEG2VDEC_DynamicParams structure should always be set to XDM_YUV_420P.
- If ppNone = 0, the post processing that can be done on the decoded output is conversion from XDM_YUV_420P to XDM_YUV_422ILE.

4.3.2.3 IMPEG2VDEC_InArgs

‖ Description

This structure defines the run time input arguments for the MPEG2 Decoder instance object.

‖ Fields

Field	Datatype	Input/ Output	Description
viddecInArgs	IVIDDEC_InArgs	Input	See IVIDDEC_InArgs data structure for details.
displayFieldReorder	XDAS_UInt32	Input	❑ 1 - Reorder the bottom field in case of non-progressive sequences where bottom field is sent ahead of top field for frame pictures. ❑ 0 - No reordering. Default value is 0.
frameLevelByteSwap	XDAS_UInt32	Input	❑ 1 - Enable byte swap inside the decoder only for the current frame number of bytes. This flag restricts the byte swap at the frame level for optimization. ❑ 0 - Byte swap the input buffer up to the numBytes provided by the application. Default value is 0.
no_delay_display	XDAS_UInt32	Input	❑ 1 - Decoded output of the first I frame of the sequence is given back immediately to the application for display. ❑ 0 - Normal operation. There is one frame delay before providing the first I frame to the application. Default value is 0.
goto_next_I_frame	XDAS_UInt32	Input	❑ 1 - Only I frames are decoded until the flag is reset. ❑ 0 - All the frames are decoded. Default value is 0.
skip_B_frame	XDAS_UInt32	Input	❑ 1 - B frames are skipped until the flag is reset. ❑ 0 – B frames are decoded. Default value is 0.
skip_curr_frame	XDAS_UInt32	Input	❑ 1 - Current frame is skipped until the flag is reset. ❑ 0 - No skip. Default value is 0.
seek_frame_end	XDAS_UInt32	Input	Controls the behavior of the decoder in case of dropped frame. ❑ 1 - Decoder seeks to the end of the frame, updates bytes consumed accordingly and returns to the application. ❑ 0 - Decoder returns with bytes consumed set to zero.
getDisplayHdrInfo	XDAS_UInt32	Input	❑ 1 - Decoder exposes the headers user data, sequence display extension, and picture display extension.

Field	Datatype	Input/ Output	Description
			❑ 0 - Display headers are not exposed. Default value is 0.
*user_data	XDM_BufDesc	Input	Pointer to User_Data structure
*seq_display_ext	XDM_BufDesc	Input	Pointer to Sequence_Display_Extension structure
*pict_display_ext	XDM_BufDesc	Input	Pointer to Picture_Display_Extension structure
reverse_play	XDAS_UInt32	Input	❑ 1 - Decoder uses the reference buffers that the application provides for reconstruction instead of the internal reference buffers. This command starts the decoder in reverse play mode. ❑ 0 - Normal decoding. Internal reference buffers are used for reconstruction. Default value is 0.
*forwd_ref	XDM_BufDesc	Input	If reverse_play is set to 1, forward reference frame pointer
*backwd_ref	XDM_BufDesc	Input	If reverse_play is set to 1, backward reference frame pointer
robustness_level	XDAS_UInt32	Input	Indicates level of robustness of the decoder. ❑ 1 - Current level of robustness ❑ 0 - Robustness level is less with the risk of little system instability. Default value is 1.

Note:

- The flag seek_frame_end is always used in conjunction with one of the flags goto_next_I_frame, skip_B_frame, or skip_curr_frame.
- Flag no_delay_display should always be set to 1 if goto_next_I_frame or reverse_play is set to 1.

For reverse play, reference buffers should be provided by the application in 420 planar format only. In other words, decoder requires three forward reference buffers and three backward reference buffers for reconstruction.

4.3.2.3.1 User_Data

‖ Description

This structure contains user data bytes.

‖ Fields

Field	Datatype	Input/ Output	Description
size	XDAS_Int32	Output	Size of user buffer in bytes
*userBuf	XDAS_Int8	Output	Start address of user buffer

4.3.2.3.2 Sequence_Display_Extension

‖ Description

This structure defines the sequence level display information.

‖ Fields

Field	Datatype	Input/ Output	Description
video_format	XDAS_Int32	Output	Representation of the pictures before being coded like NTSC, PAL and so forth
display_hor_size	XDAS_Int32	Output	Display horizontal size
display_ver_size	XDAS_Int32	Output	Display vertical size

4.3.2.3.3 Picture_Display_Extension

‖ Description

This structure defines the picture level display information.

‖ Fields

Field	Datatype	Input/ Output	Description
*frm_cen_hor_offset	XDAS_Int32	Output	Pointer to array of horizontal offsets
*frm_cen_ver_offset	XDAS_Int32	Output	Pointer to array of vertical offsets
frm_cen_offsets	XDAS_Int32	Output	Number of frame center offsets present. The maximum value is 3.

Note:

- Application has to allocate memory for the structures `User_Data`, `Sequence_display_extension`, and `Picture_display_extension` using `IMPEG2VDEC_InArgs`.
- The updated structures are provided by the decoder using extended structure `IMPEG2VDEC_OutArgs`.
- Both horizontal offsets and vertical offsets are in units of 1/16th sample.
- The number of horizontal and vertical offsets depends on the value `frm_cen_offsets`.
- If the memory allocated to any one of the structures `User_Data`, `Sequence_Display_Extension`, and `Picture_Display_Extension` is `NULL`, decoder returns error `MPEG2VDEC_ERROR_nullDisplayHdrBufPtrs`. None of the display headers are parsed. These updated `IMPEG2VDEC_OutArgs` structures may contain invalid data.

4.3.2.3.4 Buffer_Entry

‖ Description

This structure provides the buffer address accepted and held by the decoder.

‖ Fields

Field	Datatype	Input/ Output	Description
inBuf_address	XDAS_UInt32	Output	Accepted buffer (Y) address that will be output by the decoder in display order
inputID	XDAS_Int32	Output	Input ID of the accepted buffer

4.3.2.4 IMPEG2VDEC_Status

‖ Description

This structure defines parameters that describe the status of the MPEG2 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
`displayBufinfo`	`IVIDEO_BufDesc`	Output	Buffer information for current displayable frame. See `IVIDEO_BufDesc` data structure for details. If the `control()` API is called with `FLUSH` command, decoder returns the buffer information for the valid reference frame stored inside the decoder.
`outputID`	`XDAS_Int32`	Output	See `IVIDDEC_OutArgs` data structure for details. If the `control()` API is called with `FLUSH` command, this ID indicates the valid reference frame stored inside the decoder.
`acceptedBufs[XDM_MAX_IO_BUFFERS]`	`Buffer_Entry`	Output	Accepted buffer addresses stored internally by the decoder
`valid_buff_entries`	`XDAS_UInt8`	Output	Valid number of structures in the array `acceptedBufs`

Note:

If the `control()` API is called with `FLUSH` command, decoder updates only the fields `extendedError` of the `IVIDDEC_Status` structure, `displayBufinfo`, and `OutputID` of the `IMPEG2VDEC_Status` structure.

4.3.2.5 IMPEG2VDEC_OutArgs

‖ Description

This structure defines the run time output arguments for the MPEG2 Decoder instance object.

‖ Fields

Field	Datatype	Input/ Output	Description
viddecOutArgs	IVIDDEC_OutArgs	Output	See IVIDDEC_OutArgs data structure for details.
frameIdentifier	XDAS_UInt32	Output	Timestamp of the frame returned by the decoder in the display order. This parameter is set based on the inputID.
is_mpeg2	XDAS_Int8	Output	Indicates MPEG2 streams. This field is set to zero for MPEG1 streams.
topfirst	XDAS_Int8	Output	Set to one if top field comes before bottom field
end_of_seq	XDAS_Int8	Output	End of sequence flag, may be used for displaying the last frame stored in buffer
repeatfield	XDAS_Int8	Output	Repeat first field. This field is applicable only for frame pictures. For a field picture, this field is set to zero. Not supported in this version of MPEG2 Decoder.
stepSize	XDAS_Int8	Output	Quantization step size used in the frame
display_width	XDAS_Int32	Output	Display width in pixels
display_height	XDAS_Int32	Output	Display height in pixels
pict_struct	ePicStrFormat	Output	Indicates decoded picture type. In case of field picture, the TOP or BOTTOM field can be identified by looking at this. See Table 4-1 (ePicStrFormat) for details.
progressive_frame	XDAS_Int8	Output	Frame type: ❑ 1 - Progressive ❑ 0 - Interlaced
progressive_sequence	XDAS_Int8	Output	Sequence type: ❑ 1 - Progressive ❑ 0 - Non-progressive
closed_gop	XDAS_Int8	Output	B-pictures encoded using only backward prediction or intra coding
broken_link	XDAS_Int8	Output	B-pictures cannot be correctly decoded

Field	Datatype	Input/ Output	Description
frame_num	XDAS_Int32	Output	Frame number of the decoded picture in the display order. This parameter is parsed from the bit stream. It corresponds to the field “temporal_reference” of the “Picture Header”.
inbuf_status	XDAS_Int8	Output	Status of the display buffer passed by the application to the decoder: ❑ 0 - Under progress ❑ 1 - Buffer is accepted ❑ -1 - Buffer is rejected
new_user_data	XDAS_Int8	Output	Set to 1 if user data is parsed from the current frame
new_seq_display	XDAS_Int8	Output	Set to 1 if sequence display extension is parsed from the current frame
new_pict_display	XDAS_Int8	Output	Set to 1 if picture display extension is parsed from the current frame
*user_data	XDM_BufDesc	Output	Pointer to the User_Data structure
*seq_display_ext	XDM_BufDesc	Output	Pointer to the Sequence_Display_Extension structure
*pict_display_ext	XDM_BufDesc	Output	Pointer to the Picture_Display_Extension structure
aspect_ratio	XDAS_Int8	Output	Aspect ratio information

4.4 Interface Functions

This section describes the Application Programming Interfaces (APIs) used in the MPEG2 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).

4.4.1 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()`

‖ Name

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

‖ Synopsis

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

‖ Arguments

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

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

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

‖ Return Value

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

‖ Description

`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).

‖ See Also

`algNumAlloc(), algFree()`

4.4.2 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()
```

4.4.3 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()`

4.4.4 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 preempted by any other 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()`

4.4.5 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()`