# JPEG Progressive Support Decoder on C64x+

## User's Guide

Literature Number: SPRUEA9
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Preface

# Read This First

## *About This Manual*

This document describes how to install and work with Texas Instruments' (TI) JPEG Progressive Support 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.
- ❑ **Appendix A - Sectional Decoding**, describes sectional decoding details for JPEG Progressive Support Decoder on C64x+.

## 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.

## Related Documentation

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

- *ISO/IEC IS 10918-1 Information Technology - Digital Compression and Coding of Continuous-Tone Still Images -- Part 1: Requirements and Guidelines* | *CCITT Recommendation T.8*1

## Abbreviations

The following abbreviations are used in this document.

Table 1-1. List of Abbreviations

| Abbreviation | Description |
|---|---|
| API | Application Programming Interface |
| COFF | Common Object File Format |
| CSL | Chip Support Library |
| DCT | Discrete Cosine Transform |
| DHT | Define Huffman Table |
| DQT | Define Quantization Table |
| DRI | Define Restart Interval |
| DSP | Digital Signal Processing |
| IJG | Independent JPEG Group |
| JFIF | JPEG File Interchange Format |
| JPEG | Joint Photographic Experts Group |
| MCU | Minimum Coded Unit |
| QDMA | Quick Direct Memory Access |
| SOF | Start Of Frame |
| SOI | Start Of Image |
| SOS | Start Of Scan |
| VLD | Variable Length Decoding |

| Abbreviation | Description |
|---|---|
| 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, quote the product name (JPEG Progressive Support 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.

## Trademarks

Code Composer Studio, DSP/BIOS, eXpressDSP, TMS320, TMS320C64x, TMS320C6000, TMS320DM644x, and TMS320C64x+ are trademarks of Texas Instruments.

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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 JPEG Progressive Support 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

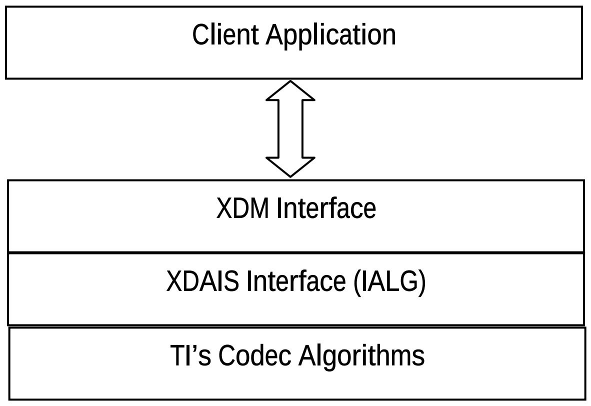
(For example audio, video, image, and speech). The XDM standard defines the following two APIs:

- `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 JPEG Progressive Support Decoder

JPEG is an international standard for color image compression. This standard is defined in the ISO 10918-1 JPEG Draft International Standard | CCITT Recommendation T.81.

From this point onwards, all references to JPEG Decoder means JPEG Progressive Support Decoder only.

## 1.3 Supported Services and Features

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

This version of the codec has the following supported features of the standard:

- Supports baseline sequential mode with both interleaved and non-interleaved input format
- Supports progressive mode
- Supports YUV 444, YUV 422, YUV 420, YUV 411, and Gray scale color sub-sampling formats
- Supports YUV 422 with sampling format ((1,2), (1, 1), (1,1)) for baseline sequential mode with interleaved input format
- Supports RGB16, BGR24, and BGR32 output formats
- Supports a maximum of three components
- Supports a maximum of three quantization tables
- Supports a maximum of four huffman tables each for AC and DC DCT coefficients
- Support arbitrary image size for both sequential and progressive JPEG images
- Supports 8-bit and 16-bit quantization tables
- Does not support source images of 12-bits per sample
- JPEG File Interchange Format (JFIF) header is skipped
- Restart management for bit stream with Define Restart Interval Marker (DRI) and Restart Marker (RST) are enabled

The other explicit features that TI's JPEG Decoder provides are:

- Supports sectional decoding
- Supports sub-region decoding
- Supports up scaling the output image by a factor of 2, 4, and 8
- Supports resizing the output image by a factor of 1/2, 1/4, and 1/8

- Supports on-the-fly resizing with respect to set `maxHeight` and `maxWidth`
- Supports YUV planar or YUV 422 interleaved output format
- Supports frame level decoding of images for sequential mode and scan level decoding for progressive mode
- All the data buffers and tables are placed in the external memory
- eXpressDSP Digital Media (XDM 1.0 IIMGDEC1) compliant

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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 DM6446 EVM with XDS560 JTAG emulator.

This codec works on any of TI's C64x+ based platforms such as DM644x, DM64x, DM643x, OMAP35xx and their derivatives.

### 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 3.3.49.
- **Code Generation Tools:** This project is compiled, assembled, archived, and linked using the code generation tools version 6.0.14.

## 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 directory called 100_I_JPEG_D_2_00, under which another directory named C64XPLUS_PS_001 is created. Figure 2-1 shows the sub-directories created in C64XPLUS_PS_001.

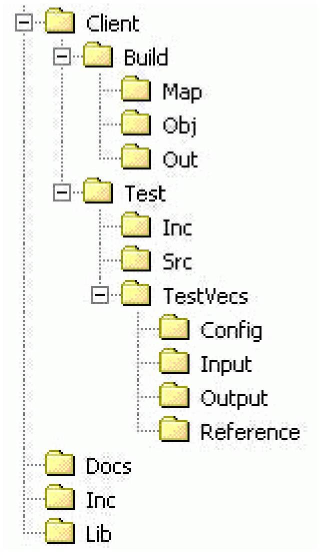
```
Client
    Build
        Map
        Obj
        Out
    Test
        Inc
        Src
        TestVecs
            Config
            Input
            Output
            Reference
Docs
Inc
Lib
```

*Figure 2-1. Component Directory Structure*

**Note:**

If you are installing an evaluation version of this codec, the directory name will be 100E_I_JPEG_D_2_00.

Table 2-1 provides a description of the sub-directories created in the 100_I_JPEG_D_2_00 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 and datasheet |
| \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 2.20.01.

### *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_v3.3

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

- Header file, bcache.h available in the <install directory>\CCStudio_v3.3\<bios_directory>\packages\ti\bios\include directory.
- Library file, biosDM420.a64P available in the <install directory>\CCStudio_v3.3\<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_v3.3

The test application and the library use the following header files:

- _alg.h available in the <install directory>\CCStudio_v3.3\framework_components_2_20_01\packages\ti\sdo\fc\utils\api directory.
- alg.h available in the <install directory>\CCStudio_v3.3\framework_components_2_20_01\packages\ti\sdo\fc\utils\api directory
- ialg.h available in the <install directory>\CCStudio_v3.3\framework_components_2_20_01\fctools\packages\ti\xdais directory.

- iimgdec1.h available in the <install directory>\CCStudio_v3.3\framework_components_2_20_01\fctools\packages\ti\xdais\dm directory.
- xdas.h available in the <install directory>\CCStudio_v3.3\framework_components_2_20_01\fctools\packages\ti\xdais directory.
- xdm.h available in the <install directory>\CCStudio_v3.3\framework_components_2_20_01\fctools\packages\ti\xdais\dm 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 development environment. To build and run the sample test application in Code Composer Studio, follow these steps:

1) Verify that you have installed TI's Code Composer Studio version 3.3.49 and code generation tools version 6.0.14.
2) Verify that the codec object library jpegdec_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:
   - "Decoder compliance test passed/failed" (for compliance check mode)
   - "Decoder output dump completed" (for output dump mode)

## 2.5 Configuration Files

This codec is shipped along with:

- ❑ Generic configuration file (Testvecs.cfg) – specifies input and reference files for the sample test application.
- ❑ 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_Inter.cfg
..\..\Test\TestVecs\Input\REMI0003.JPG
..\..\Test\TestVecs\Reference\REMI0003_Interleaved.yuv
0
..\..\Test\TestVecs\Config\Testparams.cfg
..\..\Test\TestVecs\Input\REMI0003.JPG
..\..\Test\TestVecs\Output\REMI0003_planar.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. In addition to the Testparams.cfg, the following config files are included for various input formats as specified:

- Interleaved format - Testparams_Inter.cfg
- Progressive mode - Testparams_Prog.cfg
- Interleaved format and progressive mode - Testparams_Prog_Inter.cfg

A sample Testparams.cfg file is as shown.

```
# New Input File Format is as follows
# <ParameterName> = <ParameterValue> # Comment
############################################################
# Parameters
############################################################
ImageWidth = 2048       # Image width in Pels, must be
                          multiple of 16
ImageHeight = 1600      # Image height in Pels, must be
                           multiple of 16
Scan = 15               # No. of Scan
ChromaFormat = 0        # 0 => JPEGDEC_DEFAULT_CHROMA_
                               FORMAT
                        # 1 => XDM_YUV_420P
                        # 2 => XDM_YUV_422P
                        # 3 => XDM_YUV_422IBE
                        # 4 => XDM_YUV_422ILE
                        # 5 => XDM_YUV_444P
                        # 6 => XDM_YUV_411P
                        # 7 => XDM_GRAY
                        # 8 => XDM_RGB
InputFormat = 0         # 1: Progressive
                        # 0: Sequential
ResizeOption = 0        # 0: No Resize
                        # 1: resize by 1/2
                        # 2: resize by 1/4
                        # 3: resize by 1/8
displayWidth = 0        # displayWidth
RGB_Format = 0          # Select RGB Format
                        # 0: BGR24
                        # 1: BGR32
                        # 2: RGB16
outImgRes = 0           # Select Output Resolution
                        # 0: Even Resolution
                        # 1: Actual Resolution
numAU = 0                # 0=>Default 1,2,3..N
                        # Where N is the maximum number of
                        # MCU's in a Frame
numMCU_row = 0          # 0=>Default 1,2,3..N Where N is
                        # the maximum number of rows in a
                        # Frame
x_org = 0               # 0=>Default start point of the
                        # X-axis in subregion
y_org = 0               # 0=>Default start point of the
                        # Y-axis in subregion
```

```
x_length = 0            # 0=>Default X-length of the
                        # subregion
y_length = 0            # 0=>Default Y-length of the
                        # subregion
alpha_rgb = 0           # 0=> Default value to fill
                        # rgb32
```

**Note:**

The values remain same as in the Testparams file except for the following parameters:

- `ChromaFormat` = 4 ( in Testparams_Inter.cfg file for interleaved format)
- `InputFormat` = 1 and `ChromaFormat` = 0 (in Testparams_Prog.cfg file for planar format)
- `InputFormat` = 1 and `ChromaFormat` = 4 (in Testparams_Prog_Inter.cfg file for interleaved format)

Any field in the `IIMGDEC1_Params` structure (see Section 4.3.1.7) 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:

1) Copy the input files to the \Client\Test\TestVecs\Inputs sub-directory.
2) Copy the reference files to the \Client\Test\TestVecs\Reference sub-directory.
3) 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.
4) Execute the sample test application. On successful completion, the application displays one of the following messages for each frame:
   - “Decoder compliance test passed/failed” (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.

## 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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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 `IIMGDEC1` base class of the JPEG 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.

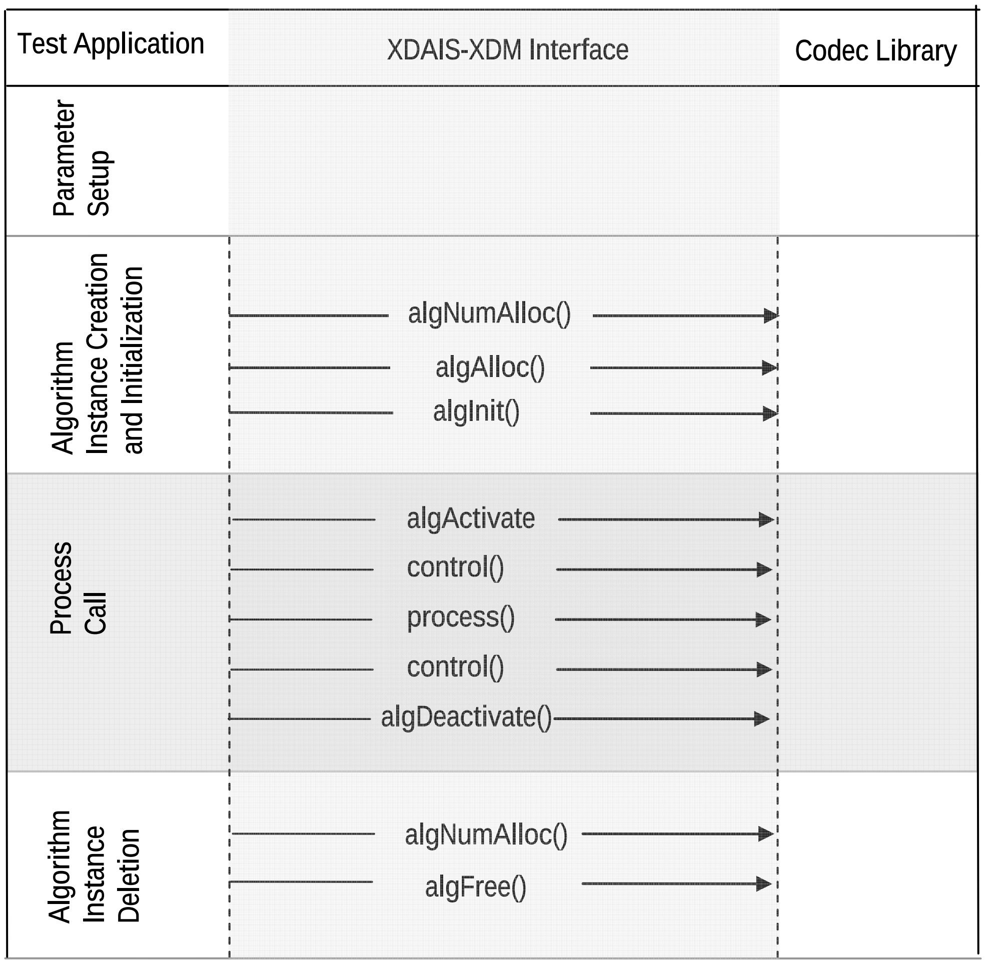

*Figure 3-1. Test Application Sample Implementation*

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,and so on. 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 `IIMGDEC1_Params` structure based on the values it reads from the Testparams.cfg file.

4) Reads the input bit-stream into the application input buffer.

After successful completion of these 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.

### 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 4.3.1.8). The inputs to the process function are input and output buffer descriptors, pointer to the `IIMGDEC1_InArgs` and `IIMGDEC1_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 and so on, 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 and so on, 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.

**Note:**

In the test application, the `process()`should be called twice. First when the decode header is set to `XDM_PARSE_HEADER` it decodes only the header and next with decode header set to `XDM_DECODE_AU` decodes the entire access unit.

### *3.1.4 Algorithm Instance Deletion*

Once encoding/decoding is complete, the test application must delete the current algorithm instance. The following APIs are called in sequence:

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

2) `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.

## 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. For each symbolic constant, the semantics or interpretation of the same is also provided.

*Table 4-1. List of Enumerated Data Types*

| Group or Enumeration Class | Symbolic Constant Name | Description or Evaluation |
|---|---|---|
| `XDM_AccessMode` | `XDM_ACCESSMODE_READ` | JPEG Decoder instance reads from the buffer using the CPU. |
| | `XDM_ACCESSMODE_WRITE` | JPEG Decoder instance writes to the buffer using the CPU. |
| `XDM_DataFormat` | `XDM_BYTE` | Big endian stream. |
| | `XDM_LE_16` | 16-bit little endian stream. |
| | `XDM_LE_32` | 32-bit little endian stream. |
| `XDM_DecMode` | `XDM_DECODE_AU` | Decode entire access unit. |
| | `XDM_PARSE_HEADER` | Performs JPEG header parsing. |
| `XDM_EncMode` | `XDM_ENCODE_AU` | Encode entire access unit, including headers. |
| | `XDM_GENERATE_HEADER` | Encode only header |
| `XDM_ChromaFormat` | `XDM_CHROMA_NA` | Chroma format not applicable |
| | `XDM_YUV_420P` | YUV 4:2:0 planar. |
| | `XDM_YUV_422P` | YUV 4:2:2 planar. |
| | `XDM_YUV_422IBE` | YUV 4:2:2 interleaved (big endian). |
| | `XDM_YUV_422ILE` | YUV 4:2:2 interleaved (little endian). |
| | `XDM_YUV_444P` | YUV 4:4:4 planar. |
| | `XDM_YUV_411P` | YUV 4:1:1 planar. |
| | `XDM_GRAY` | Gray format. |
| | `XDM_RGB` | RGB color format. |
| | `JPEGDEC_DEFAULT_CHROMA_FORMAT` | Output follows input format |
| | `XDM_CHROMAFORMAT_DEFAULT` | YUV 4:2:2 interleaved (little endian). |
| `XDM_CmdId` | `XDM_GETSTATUS` | Query JPEG Decoder instance to fill the `IJPEGDEC_Status` structure. |

| Group or Enumeration Class | Symbolic Constant Name | Description or Evaluation |
|---|---|---|
| | `XDM_SETPARAMS` | Set run-time dynamic parameters. |
| | `XDM_RESET` | Reset the decoder.All fields in the internal data structures are reset and all internal buffers are flushed. |
| | `XDM_SETDEFAULT` | Initialize all fields in the param structure to their default values. The application can change specific parameters using `XDM_SETPARAMS`. |
| | `XDM_FLUSH` | Handle end of stream conditions. This command forces JPEG Decoder to output data without additional input. The recommende sequence is to call the control() function (with `XDM_FLUSH`) followed by repeated calls to the process() function until it returns an error. |
| | `XDM_GETBUFINFO` | Query JPEG Decoder instance regarding properties of input and output buffers. |
| | `XDM_GETVERSION` | Query JPEG Decoder instance version. The result will be returned in the data field of the respective `status` structure. |
| `XDM_ErrorBit` | `XDM_APPLIEDCONCEALMENT` | The bit-fields in the 32-bit error code are interpreted as shown.<br><br>Bit 9<br>❑ 1 - Applied concealment<br>❑ 0 - Ignore<br>This bit is not used in this version of JPEG Decoder. |
| | `XDM_INSUFFICIENTDATA` | Bit 10<br>❑ 1 - Insufficient input data<br>❑ 0 - Ignore |
| | `XDM_CORRUPTEDDATA` | Bit 11<br>❑ 1 - Data problem/corruption<br>❑ 0 - Ignore |
| | `XDM_CORRUPTEDHEADER` | Bit 12<br>❑ 1 - Corrupted frame header<br>❑ 0 - Ignore |
| | `XDM_UNSUPPORTEDINPUT` | Bit 13<br>❑ 1 - Unsupported feature/parameter in input<br>❑ 0 - Ignore |

| Group or Enumeration Class | Symbolic Constant Name | Description or Evaluation |
|---|---|---|
| | `XDM_UNSUPPORTEDPARAM` | Bit 14<br>❑ 1 - Unsupported input parameter or configuration<br>❑ 0 - Ignore |
| | `XDM_FATALERROR` | Bit 15<br>❑ 1- Fatal error (stop decoding)<br>❑ 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 Tables under Section 4.2.1)

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

The JPEG 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 decode until you reset the decoder.
- **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. JPEG Decoder Fatal Error Statuses.*

| Group or Enumeration Class | Symbolic Constant Name | Value | Description or Evaluation |
|---|---|---|---|
| None | - | - | - |

*Table 4-3. JPEG Decoder Non-Fatal Bit Stream Error Statuses*

| Group or Enumeration Class | Symbolic Constant Name | Value | Description or Evaluation |
|---|---|---|---|
| `IJPEGDEC_ErrorStatus` | `JPEGDEC_ERROR_UNSUPPORTED_FORMAT` | `01` | SOI not found |
| | `JPEGDEC_ERROR_NOT_BASELINE_INTL` | `03` | Image is not sequential |
| | `JPEGDEC_ERROR_DISPLAY_WIDTH` | `04` | Invalid display width (`displaywidth < imagewidth`) |
| | `JPEGDEC_ERROR_VLD` | `05` | Error in Variable Length Decoding (VLD) |
| | `JPEGDEC_ERROR_SCAN_FREQ` | `06` | Invalid scan frequency |

| Group or Enumeration Class | Symbolic Constant Name | Value | Description or Evaluation |
|---|---|---|---|
| | `JPEGDEC_ERROR_RST_MARKER` | 07 | Missing restart marker |
| | `JPEGDEC_ERROR_MISSING_MARKER` | 08 | Missing either SOS, SOF, DHT, or DQT marker |
| | `JPEGDEC_ERROR_BAD_MARKER_LENGTH` | 09 | Invalid marker length |
| | `JPEGDEC_END_OF_IMAGE` | 10 | Reached end of picture |
| | `JPEGDEC_ERROR_BAD_DQT` | 11 | Error in quantization table |
| | `JPEGDEC_ERROR_DHT ERROR` | 12 | Error in huffman table |
| | `JPEGDEC_ERROR_BAD_DRI_LEN` | 13 | Bad DRI length |
| | `JPEGDEC_ERROR_SOS_NO_SOF` | 14 | Invalid JPEG file structure: SOS before SOF |
| | `JPEGDEC_ERROR_SOF_DUPLICATE` | 15 | Invalid JPEG file structure: two SOF markers |
| | `JPEGDEC_ERROR_BAD_SOF_DATA` | 16 | Bad SOF marker length or component |
| | `JPEGDEC_ERROR_SOS_COMP_ID` | 17 | Invalid component ID in SOS marker |
| | `JPEGDEC_ERROR_BAD_SOS_LEN` | 18 | Invalid length of SOS or bad component numbers |
| | `JPEGDEC_ERROR_SOS_INVALID` | 19 | SOS marker is invalid |
| | `JPEGDEC_ERROR_BAD_PROGRESSION` | 20 | Invalid progressive parameters |
| | `JPEGDEC_ERROR_BAD_PRECISION` | 21 | Sample precision not equal to 8 |
| | `JPEGDEC_ERROR_COMPONENT_COUNT` | 22 | Too many or few color components in the scan or frame |
| | `JPEGDEC_ERROR_BAD_MCU_SIZE` | 23 | Sampling factors too large for interleaved scan |
| | `JPEGDEC_ERROR_EMPTY_IMAGE` | 24 | Invalid image width or height or number of components |

| Group or Enumeration Class | Symbolic Constant Name | Value | Description or Evaluation |
|---|---|---|---|
| | JPEGDEC_ERROR_IMAGE_SIZE | 25 | Input Image size is greater than Maximum set size and resizing factor required is more than 3.<br><br>Note: Resizing factor will be calculated to fit the image in a given output buffer size and decoder outputs the resized image. |
| | JPEGDEC_ERROR_CORRUPTED_BITSTREAM | 26 | Corrupted bit-stream |
| | JPEGDEC_ERROR_OUTSIZE | 27 | Output buffer size is too Small for the image size |
| | JPEGDEC_ERROR_DCTBUFSIZE | 28 | Error in DCT buffer size |
| | JPEGDEC_ERROR_NULL_PTR | 29 | NULL pointer |
| | JPEGDEC_ERROR_INPUT_PARAMETER | 30 | Error occurred in the interface parameter |
| | JPEGDEC_ERROR_MAX_SCAN | 31 | Exceed maximum number of scans |
| | JPEGDEC_ERROR_INVALID_numAU | 32 | Invalid `numAU` to decode in sectional decoding |
| | JPEGDEC_ERROR_INVALID_mcu_multiplication | 33 | Invalid `x_org` or invalid `y_org` for sub-region decoding |
| | JPEGDEC_ERROR_INVALID_Xlength_Ylength | 34 | Invalid X length or invalid Y length for sub-region decoding |

*Table 4-4. JPEG Decoder Non-Fatal Error Statuses*

| Group or Enumeration Class | Symbolic Constant Name | Value | Description or Evaluation |
|---|---|---|---|
| IJPEGDEC_ErrorStatus | JPEGDEC_ERROR_PROG_MEM_ALOC | 2 | Input image is progressive |

### 4.2.2 Recommended Steps to Recover from Error

The categories of JPEG Decoder specific errors and the recommended actions to be performed by the application to recover from these errors are listed in Table 4-5.

*Table 4-5. Recommended Steps on the Application Side*

| **Error Category** | **Recommended Steps** |
|---|---|
| Fatal errors | ❑ The application has to reinstantiate the decoder to continue decoding. |
| Non-fatal bit stream errors | ❑ Application can skip the erroneous frame and continue decoding the other frames.<br>❑ If the application decides to abort the execution of the particular sequence, it should call `reset()` API before it starts decoding the next sequence. |
| Non-fatal errors | ❑ `JPEGDEC_ERROR_NOT_BASELINE_INTL`, indicates that the library does not support progressive images.<br>❑ `JPEGDEC_ERROR_PROG_MEM_ALOC`, application should set the `progressiveDecFlag` in the `IJPEGDEC_Params` data structure to support decoding progressive images in case of extended structures.<br>❑ `JPEGDEC_ERROR_INPUT_PARAMETER`, application should check and set the dynamic input parameters correctly. |
| No extended error is set by the algorithm and `process()` API | Check if you have assigned `NULL` pointers for any of the inputs of the `process()` API like `inBufs`, `outBufs`, `inargs`, `outargs`. |

## 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_SingleBufDesc`
- `XDM1_SingleBufDesc`
- `XDM1_BufDesc`
- `XDM1_AlgBufInfo`
- `IIMGDEC1_Fxns`
- `IIMGDEC1_Params`
- `IIMGDEC1_DynamicParams`
- `IIMGDEC1_InArgs`
- `IIMGDEC1_Status`
- `IIMGDEC1_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 an array containing buffer addresses |
| `numBufs` | `XDAS_Int32` | Input | Number of buffers |
| `*bufSizes` | `XDAS_Int32` | Input | Size of each buffer in 8-bit bytes |

#### *4.3.1.2 XDM_SingleBufDesc*

**|| Description**

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

**|| Fields**

| Field | Datatype | Input/ Output | Description |
|---|---|---|---|
| `*buf` | `XDAS_Int8` | Input | Pointer to a buffer address |
| `bufSize` | `XDAS_Int32` | Input | Size of each buffer in 8-bit bytes |

#### *4.3.1.3 XDM1_SingleBufDesc*

**|| Description**

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

**|| Fields**

| Field | Datatype | Input/ Output | Description |
|---|---|---|---|
| `*buf` | `XDAS_Int8` | Input | Pointer to a buffer address |
| `bufSize` | `XDAS_Int32` | Input | Size of each buffer in 8-bit bytes |
| `accessMask` | `XDAS_Int32` | Output | Mask filled by the algorithm, declaring how the buffer was accessed by the algorithm processor |

### *4.3.1.4 XDM1_BufDesc*

**|| Description**

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

**|| Fields**

| Field | Datatype | Input/ Output | Description |
|---|---|---|---|
| `numBufs` | `XDAS_Int32` | Input | Number of buffers |
| `descs[XDM_MAX_IO_BUFFERS]` | `XDM1_SingleBufDesc` | Input | Array of Buffer descriptors |

### *4.3.1.5 XDM1_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 | Minimum number of input buffers |
| `minNumOutBufs` | `XDAS_Int32` | Output | Minimum number of output buffers |
| `minInBufSize[XDM_MAX_IO_BUFFERS]` | `XDAS_Int32` | Output | Minimum size, in 8-bit bytes, required for each input buffer |
| `minOutBufSize[XDM_MAX_IO_BUFFERS]` | `XDAS_Int32` | Output | Minimum size, in 8- bit bytes, required for each output buffer |

**Note:**

The JPEG Decoder has the following buffer information:

- Number of input buffer required is 1
- Number of output buffers required are 1 for `XDM_YUV_422ILE` and 3 for `XDM_DEFAULT`
- The input buffer size is equal to `(maxHeight` * `maxWidth)`. See `IIMGDEC1_Params` data structure for details.

Algorithm populates output buffer sizes with respect to the maximum height and maximum width if `control()` API is called with

| | |
|---|---|
| | XDM_GETBUFINFO control command. Each output buffer size is equal to a value of 2 * (maxHeight * maxWidth) for XDM_YUV_422ILE and (maxHeight * maxWidth) for XDM_DEFAULT. Algorithm populates actual output buffer sizes with respect to the image format if control() API is called with XDM_GETSTATUS control command after the process() call is made with header parsing. |

### 4.3.1.6 IIMGDEC1_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.<br><br>For more details, see *TMS320 DSP Algorithm Standard API Reference* (SPRU360). |
| *process | XDAS_Int32 | Input | Pointer to the process() function. |
| *control | XDAS_Int32 | Input | Pointer to the control() function. |

### 4.3.1.7 IIMGDEC1_Params

**|| Description**

This structure defines the creation parameters for an algorithm instance object. Set this data structure to NULL, if you are not sure 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.<br>Default: sizeof (IIMGDEC1_Params) |
| maxHeight | XDAS_Int32 | Input | Maximum image height. Set multiples of 16 to support all chromaformat. The default value is 1600. |
| maxWidth | XDAS_Int32 | Input | Maximum image width. Set multiples of 32 to support all chromaformat. The default value is 2048. |

| Field | Datatype | Input/ Output | Description |
|---|---|---|---|
| maxScans | XDAS_Int32 | Input | Maximum number of scans for progressive mode. The default value is 15. |
| dataEndianness | XDAS_Int32 | Input | Endianness of input data. The JPEG decoder implementation supports only XDM_BYTE format. |
| forceChromaFormat | XDAS_Int32 | Input | Force decoding in the given chroma format. See XDM_ChromaFormat enumeration for details.<br>To set Planar / Interleaved / RGB output YUV format:<br>❑ JPEGDEC_DEFAULT_CHROMA_FORMAT - YUV planar (same as the data format in the encoded data).<br>❑ XDM_YUV_422ILE - YUV 422 interleaved.<br>❑ XDM_RGB - RGB output (set RGB_format variable of IJPEGDEC_DynamicParams structure to select RGB format as BGR24 or RGB16 or BGR32)<br>Default: JPEGDEC_DEFAULT_CHROMA_FORMAT |

#### 4.3.1.8 IIMGDEC1_DynamicParams

**|| Description**

This structure defines the run-time parameters for an algorithm instance object. Set this data structure to NULL, if you are not sure 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.<br>Default: sizeof (IIMGDEC1_DynamicParams) |
| numAU | XDAS_Int32 | Input | Number of access units to decode. Setting this field to XDM_DEFAULT decodes the complete frame. Any value other than XDM_DEFAULT will decode that many number of MCUs. The minimum value should be number of MCUs per row. |
| decodeHeader | XDAS_Int32 | Input | Flag indicating if only header parsing needs to be done. See XDM_DecMode enumeration for details.<br>❑ XDM_PARSE_HEADER - Return after header parsing is done.<br>❑ XDM_DECODE_AU - Return after complete frame decoding.<br>Default: XDM_DECODE_AU |

| Field | Datatype | Input/ Output | Description |
|---|---|---|---|
| `displayWidth` | `XDAS_Int32` | Input | ❑ `XDM_DEFAULT` - Use the decoded image width as pitch.<br>❑ `If` any other value greater than the decoded image width is provided, then this value (in pixels) is used as pitch.<br>Note: `displayWidth` should be => `imageWidth` |

#### 4.3.1.9 IIMGDEC1_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 | Number of valid input data in bytes in input buffer. |

#### 4.3.1.10 IIMGDEC1_Status

**‖ Description**

This structure defines parameters that describe the status of the algorithm.

**‖ 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 enumeration. See `XDM_ErrorBit` enumeration for details. |
| `data` | `XDM1_SingleDesc` | Output | Buffer descriptor for data passing |
| `outputHeight` | `XDAS_Int32` | Output | Decoded image height. |
| `outputWidth` | `XDAS_Int32` | Output | Decoded image width. |
| `imageWidth` | `XDAS_Int32` | Output | Actual image width. |

| **Field** | **Datatype** | **Input/ Output** | **Description** |
|---|---|---|---|
| `outChromaformat` | `XDAS_Int32` | Output | `Outputchromaformat`. See `XDM_ChromaFormat` enumeration for details. |
| `totalAU` | `XDAS_Int32` | Output | Total number of MCUs. |
| `totalScan` | `XDAS_Int32` | Output | Total number of scans in the progressive image. |
| `bufInfo` | `XDM_AlgBufInfo` | Output | Input and output buffer information. See `XDM_AlgBufInfo` data structure for details. |

### *4.3.1.11 IIMGDEC1_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 enumeration. See `XDM_ErrorBit` enumeration for details. |
| `bytesconsumed` | `XDAS_Int32` | Output | The numbers of input bytes consumed per decode call. |
| `currentAU` | `XDAS_Int32` | Output | Current MCU number. |
| `currentScan` | `XDAS_Int32` | Output | Current scan number (for progressive mode). |

**Note:**

Total AU and Current AU are used in case of sectional decoding and are updated correctly. In other cases, the values returned may not be correct.

### 4.3.2 JPEG Decoder Data Structures

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

- ❑ `IJPEGDEC_Params`
- ❑ `IJPEGDEC_fxns`
- ❑ `IJPEGDEC_DynamicParams`
- ❑ `IJPEGDEC_InArgs`
- ❑ `IJPEGDEC_Status`
- ❑ `IJPEGDEC_OutArgs`

#### 4.3.2.1 IJPEGDEC_Params

**|| Description**

This structure defines the creation parameters and any other implementation specific parameters for JPEG Decoder instance object. The creation parameters are defined in the XDM data structure, `IIMGDEC1_Params`.

**|| Fields**

| Field | Datatype | Input/ Output | Description |
|---|---|---|---|
| `imgdecParams` | `IIMGDEC1_Params` | Input | See `IIMGDEC1_Params` data structure for details. |
| `progressiveDecFlag` | `XDAS_Int32` | Input | Set flag value 1 if progressive decoding is required in addition to baseline sequential mode. |
| `outImgRes` | `XDAS_Int32` | Input | Set the output image resolution<br>❑ 0 - Always Even Image resolution<br>❑ 1 - Outputs Actual Image resolution |

**Note**:

- ❑ For `outImgRes` set resolution as even, for non-standard images, output resolution will be as follows:
  - In case of 422ILE, 422P, 420P, 444P format, output resolution will be in multiple of 2 (example: 227*149 => 226*148)
  - In case of 411 format output resolution will be in multiple of 4 (example: 227*149 => 224*148)
- ❑ For `outImgRes` set resolution as actual, for non-standard images, output resolution will be as follows:
  - In case of 422ILE, 422P, 420P format, output resolution will be in multiple of 2 (example: 227*149 => 226*148)

- In case of 411 format, output resolution will be in multiple of 4 (example: 227*149 => 224*148)
- In case of 444P and all RGB output format, output resolution will be actual image resolution

#### *4.3.2.2 IJPEGDEC_fxns*

**|| Description**

This structure defines all of the operations on JPEG Decoder instance object.

**|| Fields**

| Field | Datatype | Input/ Output | Description |
|---|---|---|---|
| `iimgdec` | `IIMGDEC1_fxns` | input | See `IIMGDEC1_fxns` data structures for details |

#### *4.3.2.3 IJPEGDEC_DynamicParams*

**|| Description**

This structure defines the run-time parameters and any other implementation specific parameters for JPEG Decoder instance object. The run-time parameters are defined in the XDM data structure, `IIMGDEC1_DynamicParams`.

**|| Fields**

| Field | Datatype | Input/ Output | Description |
|---|---|---|---|
| `imgdecDynamicParams` | `IIMGDEC1_DynamicParams` | Input | See `IIMGDEC1_DynamicParams` data structure for details. |
| `Frame_numbytes` | `XDAS_Int32` | Input | Total number of bytes used for sectional decoding |
| `progDisplay` | `XDAS_Int32` | Input | Set the display option for progressive mode:<br>❑ 1 - Output buffer contains the partially (progressively) decoded image after each scan is decoded.<br>❑ 0 - Output buffer contains the decoded image only after all the scans are decoded. |

| Field | Datatype | Input/ Output | Description |
|---|---|---|---|
| `resizeOption` | `XDAS_Int32` | Input | Resize output image<br>❑ 0 - No resizing<br>❑ 1 - Resize output image by 1/2<br>❑ 2 - Resize output image by 1/4<br>❑ 3 - Resize output image by 1/8<br>❑ 4 - Up-scale output image by 2<br>❑ 5 - Up-scale output image by 4<br>❑ 6 - Up-scale output image by 8 |
| `RGB_Format` | `XDAS_Int32` | Input | Set the output RGB format<br>❑ 0 - BGR24<br>❑ 1 - BGR32<br>❑ 2 - RGB16 |
| `numMCU_row` | `XDAS_Int32` | Input | Number of rows of access units to decode. Setting this field to `XDM_DEFAULT` decodes the complete frame. Any value other than `XDM_DEFAULT` will decode that many number of rows<br>Set `numMCU`_row to any integer value other then zero for sectional decoding |
| `x_org` | `XDAS_Int32` | Input | start point of the X-axis of the sub-region |
| `y_org` | `XDAS_Int32` | Input | start point of the Y-axis of the sub-region |
| `x_length` | `XDAS_Int32` | Input | X-length of the sub-region |
| `y_length` | `XDAS_Int32` | Input | Y-length of the sub-region |
| `alpha_rgb` | `XDAS_UInt8` | Input | Alpha value to fill `rgb32`<br>Default value: 0 |

**Note:**

- ❑ If input image size is greater than maximum set size, resizing factor will be calculated to fit the image within a given output buffer size and decoder outputs the resized image. The `resizeOption` field will be set accordingly.
- ❑ To support RGB output format, set `forceChromaFormat` in `IIMGDEC1_Params` as `XDM_RGB and` set the value for `RGB_format` accordingly.
- ❑ `numAU` in `IIMGDEC1_DynamicParams` or `numMCU_row` should be set

for sectional decoding

- x_org and y_org should set as multiples of the number specified in the following table based on the inputchromaformat

| Input Format | Multiplication Factor | |
|---|---|---|
| | x_org | y_org |
| XDM_YUV_420 | 16 | 16 |
| XDM_YUV_422 | 16 | 8 |
| XDM_YUV_444 | 8 | 8 |
| XDM_YUV_411 | 32 | 8 |
| XDM_GRAY | 8 | 8 |

- x_org + x_length should be less then the original width
- y_org + y_length should be less then the original height

### 4.3.2.4 IJPEGDEC_InArgs

**|| Description**

This structure defines the run-time input arguments for a JPEG Decoder instance object.

**|| Fields**

| Field | Datatype | Input/ Output | Description |
|---|---|---|---|
| imgdecInArgs | IIMGDEC1_InArgs | Input | See IIMGDEC1_InArgs data structure for details. |

### 4.3.2.5 IJPEGDEC_Status

**|| Description**

This structure defines parameters that describe the status of the JPEG Decoder and any other implementation specific parameters. The status parameters are defined in the XDM data structure, IIMGDEC1_Status.

**|| Fields**

| Field | Datatype | Input/ Output | Description |
|---|---|---|---|
| imgdecStatus | IIMGDEC1_Status | Output | See IIMGDEC1_Status data structure for details. |
| mode | XDAS_Int32 | Output | Mode of operation:<br>❑ 0 - Baseline sequential interleave<br>❑ 1 - Baseline sequential non interleave<br>❑ 2 - Progressive |

| Field | Datatype | Input/ Output | Description |
|---|---|---|---|
| `imageHeight` | `XDAS_Int32` | Output | Actual height of the image. |
| `decImageSize` | `XDAS_Int32` | Output | Size of the decoded image in bytes. |
| `lastMCU` | `XDAS_Int32` | Output | Flag indicating that the last Minimum Coded Unit (MCU) has been processed:<br>❑ 1 – Decoded all MCU's<br>❑ 0 – Decoding not completed |
| `hSampleFreq` | `XDAS_Int32` | Output | Horizontal Sampling frequency for `chroma` component |
| `vSampleFreq` | `XDAS_Int32` | Output | Vertical Sampling frequency for `chroma` component |
| `End_of_seq` | `XDAS_Int8` | Output | End of sequence |
| `End_of_scan` | `XDAS_Int8` | Output | End of scan |
| `Bytesgenerated[3]` | `XDAS_Int32` | Output | Slice decoded image after each call |

### 4.3.2.6 IJPEGDEC_OutArgs

**‖ Description**

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

**‖ Fields**

| Field | Datatype | Input/ Output | Description |
|---|---|---|---|
| `imgdecOutArgs` | `IIMGDEC1_OutArgs` | Output | See `IIMGDEC1_OutArgs` data structure for details. |

## 4.4 Interface Functions

This section describes the Application Programming Interfaces (APIs) used in the JPEG 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) (IIMGDEC1_Handle handle,
IIMGDEC1_Cmd id, IIMGDEC1_DynamicParams *params,
IIMGDEC1_Status *status);
```

**|| Arguments**

```
IIMGDEC1_Handle handle; /* algorithm instance handle */

IIMGDEC1_Cmd id; /* algorithm specific control commands*/

IIMGDEC1_DynamicParams *params /* algorithm run-time
parameters */

IIMGDEC1_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 `IIMGDEC1_DynamicParams` and `IIMGDEC1_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)(IIMGDEC1_Handle handle, XDM1_BufDesc
*inBufs, XDM1_BufDesc *outBufs, IIMGDEC1_InArgs *inargs,
IIMGDEC1_OutArgs *outargs);
```

## ‖ Arguments

```
IIMGDEC1_Handle handle; /* algorithm instance handle */

XDM1_BufDesc *inBufs; /* algorithm input buffer descriptor
*/

XDM1_BufDesc *outBufs; /* algorithm output buffer descriptor
*/

IIMGDEC1_InArgs *inargs /* algorithm runtime input arguments
*/

IIMGDEC1_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 `XDM1_BufDesc` data structure for details).

The fourth argument is a pointer to the `IIMGDEC1_InArgs` data structure that defines the run-time input arguments for an algorithm instance object.

The last argument is a pointer to the `IIMGDEC1_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()`

**‖ 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()`

Appendix A

# Sectional Decoding

This appendix contains Sectional Decoding details for JPEG Progressive Support Decoder on C64x+.

## A.1 Overview

Sectional decoding is same as slice based JPEG decoding. The decoder decodes N number of rows of MCUs, where N is less than or equal to the total number of rows of MCUs in the image. Decoding starts from top left image corner and progresses towards the bottom until the entire image is decoded.

The following parameters are used for sectional decoding:

- `IIMGDEC1_DynamicParams. numAU`
- `IJPEGDEC_DynamicParams. numMCU_row`

### *A.1.1 IIMGDEC1_DynamicParams. numAU*

Number of MCUs to be decoded for each slice, `numAU` should be in the multiples of MCUs per line. If any other value is set, then the algorithm recalculates the next MCUs per line and then will round it to the next MCUs per line. (See section 4.3.1.8).

### *A.1.2 IJPEGDEC_DynamicParams. numMCU_row*

Number of Line or row to be decoded for each slice. For example, if set to 1, then for each process call, it decodes 1 line or row (See section 4.3.2.3).

**Note:**

If both the values are set, then algorithm will consider the highest value and calculate accordingly.

### *A.1.3 Input Buffer Requirement*

Sufficient input buffer is required for sectional decoding. If the data is less than or equal to input data, then the algorithm will return error.

To calculate input buffer size:

```
Size = IJPEGDEC_DynamicParams. numMCU_row * WIDTH * X
```

where, `WIDTH` is the image width.

The application takes care of the value of `X`, so that `Size` would be sufficient to decode `IJPEGDEC_DynamicParams. numMCU_row`.

The pseudo code to calculate input buffer size is as shown.

```
inputsize = 5000;
   if(status_one.imgdecStatus.imageWidth > 1000)
   {
      inputsize =  status_one.imgdecStatus.imageWidth * 20;
   }

   if(dynamiparams.numMCU_row !=0) // for sliced
       {
              if(byteremain <=(inputsize*
dynamiparams.numMCU_row))
       inargs.imgdecInArgs.numBytes = byteremain;
              else

              inargs.imgdecInArgs.numBytes  = inputsize*
dynamiparams.numMCU_row;
              if(inargs.imgdecInArgs.numBytes >
inargs.frame_numbytes)
                     inargs.imgdecInArgs.numBytes =
inargs.frame_numbytes;

       }

 ret =JPEGDEC_decode(handle_one,( XDM_BufDesc *)&inBufs,
                     (XDM_BufDesc *)&outBufs_one,
(IIMGDEC_InArgs *)&inargs,
                     (IIMGDEC_OutArgs *)&outargs_one);
 byteremain -= outargs_one.imgdecOutArgs.bytesconsumed;

 if(dynamiparams.numMCU_row )
 {
         inBufs.bufs[0] +=
outargs_one.imgdecOutArgs.bytesconsumed;
                inargs.imgdecInArgs.numBytes -=
outargs_one.imgdecOutArgs.bytesconsumed;

 }
```

**Note:**

The pseudo code should repeat until end of sequence.

## A.2 Sub-region Decoding

The decoder decodes only a particular region of the image. The application passes the (x,y) coordinates and the corresponding x-length and y-length fields from the upper layers (exact details to be specified by the algorithm owner). The algorithm decodes all rows of MCUs contained within that region (sub-optimal from a memory/performance standpoint, but easier to implement), or decode the region itself (optimal solution, but more complex). If the implementation decodes only a region, there are restrictions imposed on the upper layers to ensure that the input data passed is aligned on proper MCU boundaries (example, 16x16 in case of 4:2:0 input data).

The following parameters are used for sub-region decoding:

- ❑ `IJPEGDEC_DynamicParams. x_org`
- ❑ `IJPEGDEC_DynamicParams. y_org`
- ❑ `IJPEGDEC_DynamicParams. x_length`
- ❑ `IJPEGDEC_DynamicParams. y_length`

Any part of the image can be selected for decoding.

Example 1: Consider the VGA (640x480) resolution

```
x_org  =  0

y_org = 0

x_length = 128

y_length = 128
```

The output of the decoder is 128 x 128 starting origin for the decoder is (0, 0)

Example 2: Consider the VGA (640x480) resolution

```
x_org  =  16

y_org = 8

x_length = 176

y_length = 144
```

The output of the decoder would be 176 x 144 starting origin for the decoder is (16, 8).

The values of `x_org` and `y_org` depends on the format of `input chromaformat(`See the note in section 4.3.2.3).

## A.3 Sub-region Scaling

The following parameters are used for sub-region scaling:

- ❑ `IJPEGDEC_DynamicParams. resizeOption`
- ❑ `IJPEGDEC_DynamicParams. x_org`
- ❑ `IJPEGDEC_DynamicParams. y_org`
- ❑ `IJPEGDEC_DynamicParams. x_length`
- ❑ `IJPEGDEC_DynamicParams. y_length`

Example 1: Consider the VGA (640x480) resolution

```
resizeOption = 1

x_org  =  0

y_org = 0

x_length = 128

y_length = 128
```

The output of the decoder would be 64 x 64 (resized by 2) starting origin for the decoder is (0,0).

Example 2: Consider the VGA (640x480) resolution

```
resizeOption = 4
```

```
x_org  =  0
```

```
y_org = 0
```

```
x_length = 128
```

```
y_length = 128
```

The output of the decoder is 256 x 256 (up scaled by 2) starting origin for the decoder is (0,0).