

# README

This is a set of test bit streams for the CCSDS 122.1-B-1 Recommended Standard by the CCSDS Multi-spectral & Hyperspectral Data Compression (MHDC) working group.

These results have been validated under two different software implementations of the compressor:

- Ian Blanes leaded the development of a compressor by the Universitat Autònoma de Barcelona (UAB) under contract by CNES. The implementation is written in C++ code.
- Mark Wong and Penshu Yeh, engineers at the NASA Goddard Space Flight Center (GSFC), have implemented the compressor in a combination of Matlab and C code.

Test bit streams are provided for the following image files.

File Name	Short Name	Origin
airs_gran9-u16be-64x64x64.raw	AIRS_64	Small subset of the AIRS image.
tiny-u16be-7x17x17.raw	tiny	Synthetic image
sixteenblocks-u16be-1x25x25.raw	sixteenblocks	Synthetic image
tall-s16be-15x510x19.raw	tall	Synthetic image
repeat-s16be-2x18x18.raw	repeat	Synthetic image
airs_gran9-u16be-1501x135x90.raw	AIRS	Atmospheric Infrared Sounder (AIRS) image; airs_gran9
f060925t01p00r12_sc00.c.img-s16be-224x512x512.raw	Yellowstone sc0	Hyperspectral AVIRIS image; f060925t01p00r12_sc00.c.img
f060925t01p00r12_sc03.c.img-s16be-224x512x512.raw	Yellowstone sc3	Hyperspectral AVIRIS image; f060925t01p00r12_sc03.c.img
MOD01.A2001222.1200night-u16be-17x2030x1354.raw	MODIS	Multispectral MODIS image; MOD01.A2001222.1200night
toulouse_spot5_xs_extract1-u16be-3x1024x1024.raw	Toulouse	Multispectral SPOT5 image; SPOT5 toulouse_spot5_xs_extract1

The four synthetic images were created from a high entropy random source and fully cover a 16-bits dynamic range. The image “tiny” is a very small image where many parameter combinations could be tested efficiently. The image “sixteenblocks” is used to tests rare CCSDS-122.1-B-1 and CCSDS-122.0-B-2 header combinations. The image “tall” is used to test input variations. The image “repeat” tests a corner case for the AAT.

All image files are header-less sequences of big-endian 16-bit integers. File names describe their dimensions and data type, according to the following pattern:

$$[IMAGE\_REFERENCE]-[SIGNEDNESS]16be-[Z]-[Y]-[X].raw,$$

where  $[IMAGE\_REFERENCE]$  is the original name of the image,  $[SIGNEDNESS]$  is  $u$  for unsigned images and  $s$  for signed images,  $[Z]$  is the number of bands of the image,  $[Y]$  is the number of columns of the image,  $[X]$  is the number of rows of the image. All files are stored in Band-Sequential Order (BSQ).

Along with CCSDS 122.1-B-1 bit streams (files ending in  $.1221$ ), intermediate data files are provided as well. These data files are produced by the UAB implementation.

The following tables summarize the contents of the files provided along with this README file.

**Table 1: File Extensions**

File Extension	Contents
.id.raw	File transformed with the identity transform. Upshift and downshift stages applied. Stored as big-endian 32-bit signed integers.
.iwt.raw	File transformed with the IWT. Upshift and downshift stages applied. Stored as big-endian 32-bit signed integers.
.pot.raw	File transformed with the POT. Upshift and downshift stages applied. Stored as big-endian 32-bit signed integers.
.alt.raw	File transformed with the AAT. Upshift and downshift stages applied. Stored as big-endian 32-bit signed integers.
.dwt2	Coefficients obtained after applying the CCSDS 122.0 wavelet transform; arranged in blocks, in descending order of “elderness”, and in raster-scan order. Stored as little-endian 32-bit integers for the Integer transform and as IEEE 754 doubles for the Float transform.
.si	Side information streams to be embedded in the final .1221 file.
.bpe	Output of the CCSDS 122.0 bitplane encoder. These files are a concatenation valid 122.0 bit streams.
.milestones	Positions and lengths of 122.0 bit streams in .bpe files.
.rd	Possible truncation points and associated distortions for each 122.0 bit stream in .bpe files.
.var	Variance of 2D wavelet coefficients associated with each 122.0 bit stream in .bpe files.
.1221	A CCSDS 122.1 compressed image
.dec	A decoded image.

**Table 2: File Checksums**

File Name	SHA256 Checksum
airs_gran9-u16be-64x64x64.raw	b36c82aa778ffcc1b43ac42839f7476c91bc8b4a12d620a2dca5c6c4145eb06e
tiny-u16be-7x17x17.raw	e19307deb66f894ea84779551aea2d6bb594ae4e6e6cf0d4aa89809417c2bbc0
sixteenblocks-u16be-1x25x25.raw	63c7baa9be576d7ac8f3665d366bda54d81962eb7f0ac6ceeef3cdf684d3139b
tall-s16be-15x510x19.raw	7c93de9fe417b025b3367d3897dd293cc30cdd83f343e2c842b8139e7d13defb
repeat-s16be-2x18x18.raw	3281d27829c09ade532cf0f682f591d571f01fc30f787c73bc66712075d3ae11
airs_gran9-u16be-1501x135x90.raw	d91883df4ed43fc6a320c3c59a8afccc41e555932f9f85aa2aa1b3d6fa76a9ff
f060925t01p00r12_sc00.c.img-s16be-224x512x512.raw	a890df5fcb0fb7e98e6fbb12252e0e407cee4130132318161a050477edaa61de
f060925t01p00r12_sc03.c.img-s16be-224x512x512.raw	ecb472c133b591b8d1023a2662eaedef313dfc1da64eb67303aaa2bd97938807
MOD01.A2001222.1200night-u16be-17x2030x1354.raw	b28ad072a984c3bfd38198926a548252d00d265b6cdbc2253b0b4c5cd680c803
toulouse_spot5_xs_extract1-u16be-3x1024x1024.raw	9c7de21dc7d52ec450744a563cd05ff08c6e9a725db08e5ecbae9a4521f959d8

**Table 3: Lossy Tests**

Image Name	$U$	$D$	$S$	$R$	$W$	2D Wavelet	Wavelet Weights	Trans.	$F$	$\Omega$ or $\Psi$	POT mode or AAT $N_{T_z}$	Allocation Method	Target Size (bytes)
repeat	0	0	16	3	1	Integer	Default	Id				Rev. waterfill	512
repeat	0	0	16	3	1	Integer	Default	Id				Rev. waterfill	2048
repeat	0	0	16	3	1	Integer	Default	Id				Rev. waterfill	37777
repeat	0	0	16	3	1	Integer	Default	Id				Rev. waterfill	111512
repeat	0	0	16	3	1	Integer	Default	Id				Rev. waterfill	211111
repeat	0	0	16	3	1	Integer	Default	Id				Lagrange	512
repeat	0	0	16	3	1	Integer	Default	Id				Lagrange	2048
repeat	0	0	16	3	1	Integer	Default	Id				Lagrange	37777
repeat	0	0	16	3	1	Integer	Default	Id				Lagrange	111512
repeat	0	0	16	3	1	Integer	Default	Id				Lagrange	211111
AIRS_64	0	0	16	2	1	Integer	Default	Id				Rev. waterfill	16384
AIRS_64	0	0	16	2	1	Integer	Default	Id				Rev. waterfill	32768
AIRS_64	0	0	16	2	1	Integer	Default	Id				Rev. waterfill	65536
AIRS_64	0	0	16	2	1	Integer	Default	Id				Rev. waterfill	98304
AIRS_64	0	0	16	2	1	Integer	Default	IWT				Rev. waterfill	32768
AIRS_64	0	0	16	2	1	Integer	Default	POT	16	11	Bypass	Rev. waterfill	32768
AIRS	0	0	362880	1	1	Integer	Default	IWT				Lagrange	2279644
AIRS	0	0	362880	1	1	Integer	Default	POT	32	13	Stable	Lagrange	2279644
Yellowstone sc0	0	0	4096	1	1	Integer	Default	POT	16	13	Stable	Lagrange	7340032
Yellowstone sc0	0	0	4096	1	1	Integer	Default	IWT				Lagrange	7340032
Toulouse	0	0	16384	1	1	Integer	Default	POT	32	13	Stable	Lagrange	393216
Toulouse	0	0	16384	1	1	Integer	Default	IWT				Lagrange	393216
Toulouse	1	0	16384	1	1	Integer	Default	AAT	32	31	3	Lagrange	393216
Yellowstone sc0	3	0	4096	1	1	Integer	Default	POT	32	11	Stable	Lagrange	7340032
Yellowstone sc0	8	3	4096	1	1	Integer	Default	AAT	32	13	100	Lagrange	7340032
Toulouse	0	0	16384	1	1	Integer	Default	IWT				Rev. waterfill	393216
Toulouse	0	0	16384	1	1	Integer	Default	POT	8	11	Stable	Rev. waterfill	393216
Yellowstone sc0	0	0	4096	1	1	Integer	Default	IWT				Rev. waterfill	7340032
Yellowstone sc0	0	0	4096	1	1	Integer	Default	POT	8	11	Stable	Rev. waterfill	7340032
Yellowstone sc0	8	3	4096	1	1	Integer	Default	AAT	32	13	100	Rev. waterfill	7340032
Toulouse	0	0	16384	1	1	Float	Default	IWT				Rev. waterfill	393216
Toulouse	0	0	16384	1	1	Float	Default	POT	8	11	Stable	Rev. waterfill	393216
Yellowstone sc0	0	0	4096	1	1	Float	Default	IWT				Rev. waterfill	7340032
Yellowstone sc0	0	0	4096	1	1	Float	Default	POT	8	11	Stable	Rev. waterfill	7340032
Yellowstone sc0	8	3	4096	1	1	Float	Default	AAT	32	13	100	Rev. waterfill	7340032

**Table 4: Lossless Tests**

Image Name	<i>U</i>	<i>D</i>	<i>S</i>	<i>R</i>	<i>W</i>	2D Wavelet	Wavelet Weights	Trans.	<i>F</i>	$\Omega$ or $\Psi$	POT mode
Test signed pixels exception in subsection 6.3.2.											
tiny	0	0	128	9	1	Integer	0:0:1:0:0:0:2:0:0	Id			
Repeat previous test for IWT (shall not trigger exception).											
tiny	0	0	128	9	1	Integer	0:0:1:0:0:0:2:0:0	IWT			
Test rare header combination for POT.											
tiny	0	0	128	9	4	Integer	0:1:0:1:0:0:2:0:1:0	POT	32	9	Bypass
Test high dynamic range expansion (triggers stable mode sign change too).											
tiny	6	0	18	1	8	Integer	Default	POT	1	10	Stable
A few tests for Upshift ( <i>U</i> ) and Downshift ( <i>D</i> ).											
tiny	6	0	18	1	2	Integer	Default	IWT			
tiny	15	9	21	1	3	Integer	Default	IWT			
tiny	15	15	16	3	4	Integer	Default	Id			
tiny	2	2	24	2	5	Integer	Default	Id			
More value combinations at IWT input.											
tall	0	0	17	3	1	Integer	Default	IWT			
Previous test with destructive downshift, but with enough precision so that it is still lossless.											
tall	4	1	24	2	1	Integer	Default	IWT			
tall	15	9	59049	3	1	Integer	Default	IWT			
More value combinations at POT input.											
tall	0	0	18	4	1	Integer	Default	POT	1	16	Stable
tall	0	0	31	3	2	Integer	Default	POT	8	13	Bypass
Previous test testing also for overflows at region size calculations.											
tall	14	8	1048576	65535	8	Integer	Default	POT	16	15	Bypass
Some AAT tests with high enough precision that for these particular cases it becomes lossless. These tests also overflow region size calculations.											
tall	8	2	1048576	65535	8	Integer	Default	AAT	1	25	
Tests same repeated pattern: this triggers repeat flag in AAT side information and yields one transformed band full of zeros.											
repeat	7	3	16	3	1	Integer	Default	AAT	16	31	
Tests same repeated pattern, but losing one band (still lossless).											
repeat	5	2	16	3	1	Integer	Default	AAT	4	20	
This produces large upshift inside BPE too.											
sixteenblocks	6	0	1048576	65536	6	Integer	3:3:3:3:3:3:3:3:3	POT	16	11	Bypass
Tests the §6.3.2 signed pixels exception.											
sixteenblocks	0	0	1048576	1	7	Integer	Default	Id			
Tests Eq. 5.7.											
sixteenblocks	0	0	1048576	3	1	Integer	Default	IWT			
Tests for lossless compression performance on real images											
AIRS	0	0	362880	1	1	Integer	Default	IWT			
AIRS	0	0	362880	1	1	Integer	Default	POT	32	13	Stable
Yellowstone sc0	0	0	4096	1	1	Integer	Default	POT	16	13	Stable
Yellowstone sc0	0	0	4096	1	1	Integer	Default	IWT			
Toulouse	0	0	16384	1	1	Integer	Default	POT	32	13	Stable
Toulouse	0	0	16384	1	1	Integer	Default	IWT			