

# **PNG\_IO Version 4.4**

## **User and Reference Manual**

PNG\_IO is an Ada 95 package for input/output of images and graphics in PNG format. PNG\_IO is released under the GNU General Public License.

**September 10, 2006**

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# Contents

<b>1</b>	<b>Introduction</b>	<b>4</b>
1.1	About PNG . . . . .	4
1.2	New features in version 4 . . . . .	4
<b>2</b>	<b>Detailed description</b>	<b>4</b>
2.1	Prerequisites . . . . .	4
2.2	Functionality . . . . .	5
2.3	Limitations . . . . .	5
2.4	Implementation details and design rationale . . . . .	6
<b>3</b>	<b>Installation</b>	<b>6</b>
<b>4</b>	<b>Comments and bug reports</b>	<b>7</b>
<b>5</b>	<b>Copyright</b>	<b>7</b>
<b>A</b>	<b>PGP and keys</b>	<b>7</b>
<b>B</b>	<b>Release notes</b>	<b>8</b>
B.1	Distribution . . . . .	8
B.2	CVS Access . . . . .	9
B.3	History . . . . .	9
B.4	To do list . . . . .	13
<b>C</b>	<b>GNU Free Documentation License</b>	<b>14</b>

# 1 Introduction

This is the user guide and reference manual for PNG\_IO, a portable Ada 95 package for reading and writing Portable Network Graphics (PNG) files. It is designed to provide Ada 95 programmers with direct access to images and graphics stored in PNG format files, and to be portable across architectures and operating systems<sup>1</sup>. It is not intended to serve as an Ada 95 substitute for `libpng`, the PNG C library, since it provides only high-level reading and writing of images with minimal user-level control. If what you want to do is simply read or write a PNG image from an Ada 95 program, then PNG\_IO may be what you want. If you want to do something fancy like display an image progressively as it is read from a remote location, then `libpng` may be better suited (but you will need to write an Ada 95 binding).

## 1.1 About PNG

PNG is an image file format supporting greyscale and colour images with and without alpha channels. It is patent-free and offers good levels of lossless compression. The PNG format is defined by the PNG Specification which is available from the PNG website at <http://www.libpng.org/pub/png/> and various mirrors. PNG is an ISO standard:

Portable Network Graphics (PNG) Specification (Second Edition)  
Information technology – Computer graphics and image processing – Portable Network Graphics (PNG): Functional specification.  
ISO/IEC 15948:2003 (E)

(available at: <http://www.w3.org/TR/2003/REC-PNG-20031110>)

## 1.2 New features in version 4

PNG\_IO now uses the Ada 95 binding to Zlib known as `Zlib_Ada`. This binding is distributed with Zlib, but a more recent update may be available from <http://zlib-ada.sourceforge.net/><sup>2</sup>. The simple Zlib binding distributed with earlier versions of PNG\_IO is no longer used and neither is the former PNG\_IO CRC code (the Zlib CRC code is now used, accessed through `Zlib_Ada`).

A new generic child package `PNG_IO.Gamma_Encoding` has been added. This is similar to the existing child package `PNG_IO.Standard_RGB_Encodings` in function. It maps from one gamma value to another (including linearised samples if the gamma value is unity).

# 2 Detailed description

## 2.1 Prerequisites

PNG\_IO depends on the Zlib library to perform the compression and decompression of image and text data required by the PNG Specification. Zlib is written in C but an Ada 95 binding for it is available and

<sup>1</sup>PNG\_IO has been used by the author on PCs running Windows and Linux, and on a Mac Powerbook running Mac OS X.

<sup>2</sup>PNG\_IO from version 4.1 onwards requires version 1.3 or later of `Zlib_Ada`.

distributed with Zlib source code. The Zlib website is easily accessed from the PNG website (see above) and the source code or a precompiled Zlib library should be downloaded if not already available on your chosen machine. Any program using PNG\_IO must be linked with Zlib and Zlib\_Ada, or have access to Zlib through a shared library or dynamic link library. The most recent version of Zlib\_Ada is available from <http://zlib-ada.sourceforge.net/>. The earliest version of Zlib\_Ada that will work with PNG\_IO is version 1.3.

## 2.2 Functionality

The main package specification `png_io.ads` contains most of the functionality and has detailed comments.

A PNG file to be read must first be opened. Once this has been done, information about the content of the file is available through functions, and the pixel (and palette values, if any) may be read from the package (they are stored in internal buffers). When all the required information has been read, the file should be closed (this frees the internal storage used to hold the file information).

To write a file, the user must instantiate a generic procedure for the appropriate type of PNG file. One of the parameters supplied to instantiate the procedure is a function that allows PNG\_IO to access the pixel values.

The child package `PNG_IO.Chromaticity_Data` provides standard data on chromaticity for use with the chromaticity chunk handling introduced with version 2. This obviates the need for users to look up this data for standard colour spaces. References are given in the source code to the sources used for the data.

The child package `PNG_IO.Standard_RGB_Encodings` provides functions to implement the encoding and decoding of sRGB samples from linear samples. When reading or writing an sRGB image, PNG\_IO provides the sample data as it is found in the file, or expects the sample data as it is to be written to the file. This behaviour is consistent with that adopted for handling sample values in other cases: the user of PNG\_IO must perform gamma adjustments if the gamma is not unity. For compliance with the sRGB standard the samples must be encoded according to a non-linear encoding, and the new child package provides functions to perform this encoding. It is, however, up to the user to pass the correct chunks and encoded samples to PNG\_IO in order to create a compliant sRGB PNG file. PNG\_IO does not check this.

The child package `PNG_IO.Gamma_Encodings` provides a similar function for mapping from one gamma value to another.

## 2.3 Limitations

The interface to PNG\_IO is not ‘single-step’ (*i.e.* pass an image array and a filename and go). Instead, to read a file, you have to open the file, read the dimensions and type of image, and then call functions in PNG\_IO for each pixel to get the pixel values. You store them into your own image array (or process them on the fly if you wish). The reasoning behind this is that PNG\_IO is stand-alone and independent of any data types for image pixels. It is intended to be used as a foundation to build the single-step image I/O packages that you might want. Thus if you use colour image pixels represented as records and use 2D arrays of these records to represent an image, then you can write a trivial image read routine that calls PNG\_IO to do all

the messy work and provide the pixel values. All you have to do is a type conversion to the component type of your records and store the RGB values into your records, looping over all the pixels in your image. For writing, all you need do is provide functions to access the pixel components of your image. PNG\_IO does the iteration over the whole image.

At present PNG\_IO does not use tasking, and therefore calls on its functions and procedures block until the actual file input/output has been done. A future version may change this to permit I/O to be overlapped with data transfer between the package and the user's code.

## 2.4 Implementation details and design rationale

PNG\_IO consists of a main package and several child packages.

PNG\_IO is independent of other packages, other than Zlib and Zlib\_Ada, which are very widely available. Of course, it uses standard Ada 95 packages too.

Passing of image data to and from the user's code is done with standard integer types. This keeps the design of the package simple, but it does complicate the user interface, as explained in section 2.3. However, if you compare this to what is required to use `libpng` (assuming an Ada 95 binding existed, which is currently not the case), then PNG\_IO provides a relatively straightforward means to read in or write out a PNG file.

A significant difficulty in designing a package to handle image file formats is the existence of different types of image data in the same file format. A PNG file may contain greyscale or colour images, with or without alpha information, and the bit depth can vary from 1 to 16. It is therefore hard to provide a strongly-typed interface, particularly for writing files. The solution adopted was to provide a separate generic write procedure for each type of PNG file. This means the procedure parameters may be tailored to the file type. In the case of application code that intends to handle all the legal file types, this means that a case construct is needed to cope with the different PNG types. The test program provided as part of PNG\_IO illustrates how this is done.

The current version of PNG\_IO makes no attempt to be fast. It was written, above all, for correctness, and it assumes that enough memory is available to hold the whole of the file data at once (on read, this is no longer true on write from version 4.4 onwards). This will work for images of reasonable size (such as may be taken with a digital camera), but it may cause problems on machines with small memory when handling high-resolution images.

PNG\_IO makes some (reasonable) assumptions about the Ada 95 implementation that will compile it. These assumptions are checked by assertions in the code (one is that the default `Integer` type has a 32-bit range, and the other is that `Ada.Streams.Stream_Element` is a byte).

## 3 Installation

Once you have Zlib and Zlib\_Ada compiled and available for linking, all that you need to do is compile the various units making up PNG\_IO. (Use optimisation.) A simple test program is provided, and the simplest thing to do if your compiler has a make facility is make the test program (but remember to link with Zlib).

The test program reads a PNG file and outputs the same image to another PNG file. If you can view this file and it matches the image content of the file you passed to the test program you are in business!

PNG\_IO has been tested using the PNGSUITE of PNG test images created by Willem van Schaik and correctly reads and writes all the legal PNG images in that test suite<sup>3</sup>. This may be verified by running the program `png_test` (see above) on all the images in the test suite using a batch file or script (not provided). Additionally, the PNG file(s) written by PNG\_IO may be compared pixel-for-pixel with PNG file(s) containing the same image written by another PNG coder using the program `png_compare`.

## 4 Comments and bug reports

Please send comments, suggestions or bug reports to: [S.Sangwine@IEEE.org](mailto:S.Sangwine@IEEE.org) or use the facilities at Sourceforge (<http://png-io.sourceforge.net/>) to log a request or bug.

## 5 Copyright

Each source code file contains a copyright notice (*q.v.*). The code is released under the Gnu General Public License, a copy of which is included with the distribution (in the file `gpl.txt`).

If you wish to use PNG\_IO under terms different to those of the GNU General Public License, please contact the author. A commercial license for PNG\_IO version 4 may be negotiable, but it may require negotiation with the two universities where the author has worked.

## A PGP and keys

PNG\_IO distributed files are accompanied by detached PGP signature files (extension `.sig`). To verify these (and it is not essential to do so) you will need a version of PGP which supports DH encryption (older versions support only RSA), and my public key, which is given below (copy and paste it to a file and import into PGP) and is also available from key servers and from my web page at <http://privatewww.essex.ac.uk/~sjs>.

```
-----BEGIN PGP PUBLIC KEY BLOCK-----
Version: PGPFreeware 6.0.2i
```

```
mQGibDU3GkARBADyn6tgErL8GsO/+UkVIMmMR65FgaFhsUue+/90hIRBqRJGF0Xd
Rb1W9dm8MNB/2v12XAcuGxrvokWzdt1fullfJAUuwa/tKOWX8fXuThUjdfS0GpJS
saqlJf74z1R8FT+YTJe2JCO14vk733ctUGsSYc9hvCgFRsu9e1d9Qvhe8wCg/7Zb
Pazd/WpLuqOfy1WiOzbuN4UEAOOQqo/3Z1/bZeEoCoQNIkSnHzybQLbaZ1N1vhcY
IuslKshJT6Moi4ERPpSUJHRh/B+hHcDb8a0dFYdQ89v8EvSYmFW9hL7geH2Wh27z
4qiDlTpIpsj+cbdbkp9JV7OYDjuFvblvr+T+r04+D9dUQjeFnVVkwyveYTHovwHh
W4ysA/4vMoJMUw2M2hI2dzL61+eL59przRF40s62G6tQUWvLw2+w1SGw4RncG0/p
xKNCm9Sry/EZimygFU8I6ymBWcZ6FLnJON2xyaVp+VV15nSFUhdA1xcSXY2y41zU
UtEg5706gy/K1On7D1nbnrDN/yzjJZ+fLK61R5h3K5Icz6n7Sc7QrU3RldmUgU2Fu
Z3dpbmUgPFMuSi5TYW5nd2luZUBS2WFkaW5nLmFjLnVrPokASwQQEQIACwUCNYpQ
zAQLAwIBAAoJEEGGEV9WsZDtMdsAn1EcqHkoNWUqC6TUZPUQ3S/Az3vGAKDgOdXj
LbvPdh3j/UD8NoDvsqzKmbQpU3RlcGh1biBKLlBTYW5nd2luZSA8Uy5TYW5nd2lu
ZUBJRUVFLm9yZz6JAEsEEBECAsFAjU3GkAECwMCAQAKCRBBhhfFvRCQ7QygAKDC
SBp0U+00JiQBV6WHNWA4YrR6CQCgnliLaMqUuEHbvKs8KA3qs9LPkcu0JlN0ZXZl
IFNhbmdd3aW5lIDxzAnNhbmd3aW5lQGl1ZS5vcmcudWs+iQBLBBARAgALBQI1i1Cg
BAAsDAgEACgkQQYYRX1axkO3zJgCg8XMgd/+0+Us2zfsMDfYXdeiY9oQAOv7Xk5
k20Aw0gdU5TI7/5iVSAAUQINBDU3GkAQCAD2Qle3CH8IF3KiutapQvMF6P1TET1P
tvFuUuS4INoBp1ajfOmPQFXz0AfGy0Op1K33TGSgSfgMg7116RfUodNQ+PVZX9x2
Uk89PY3bzpnV5JZzf24rnRPxfx2vIPFRzBhznzJZv8V+bv9kV7HAarTW56NoKVy
OtQa8L9GAFgr5fSI/VhOSdvNLSd5JEHNmszbDgNRR0PfIizHHxbLY7288kjwEPw
```

<sup>3</sup>The test suite images are available from <http://www.schaik.com/pngsuite/pngsuite.html>.

```
pVsYjY67VYy4XTjTNP18F1dDox0YbN4zISy1Kv884bEpQBGRjXyEpwpylObEAxnI
Byl6ypUM2Zafq9AKUJsCRtMIPWakXUGfnHy9iUsiGSa6q6Jew1XpMgs7AAICB/9P
24ofRoqQVvyRv1julDbGThnmv7BJhxItOh5U1/MVksv9I6WktzgFWqMzSASoEzfs
tc2DSnmKR9yIiX1jESFHHYkZE9ba6sPM1+de57p301isU6FaTcbcwHOv1lHXG0T
0xz4H4sBw0ZQ+3DzpMoXN248/BZWEaP96WyV1JGNEs9ijc4krDZKY8XwvGDWwc6E
t1XofqiOsR6+QkurMgdg9RrR2001W4FEraion7/RMPFn1GAz/kcds7VwUuAFs1GK
zkyHDLH7NrElRtg4rLCHRbt++zIWN7ng7pMY0T3UwBEIQFR5+Xo2/2+MMOKpkYvX
jxu10TEA+80diyGIGfOmiQBGBBgRagAGBQI1NxpAAaoJEEGGEV9WsZDtLYkAnjDa
hdvZazzXkJ2ZUzNZpViY5AcqAJ988JCPvUIngaxYHvMxZV2LLdszYg==
=hhOI
-----END PGP PUBLIC KEY BLOCK-----
```

The key signature is given on my web page at <http://privatewww.essex.ac.uk/~sjs>.

## B Release notes

PNG\_IO is available from <http://png-io.sourceforge.net/> and was written by Steve Sangwine at the University of Reading, UK. From January 2001, fixes and enhancements have been made at the University of Essex, UK, where Steve now works.

PNG\_IO is distributed in zip format<sup>4</sup>.

If your machine or operating system does not have an unzip utility already installed, then note that free software is available from the Info-Zip site for nearly all operating systems.

See: <http://www.info-zip.org/pub/infozip/>.

### B.1 Distribution

The distributed files of PNG\_IO are accompanied by detached [PGP](#) signatures so that the integrity and authenticity of the code can be verified, if desired. See section [A](#) for information about [PGP](#) and keys.

The PNG\_IO distribution consists of the following 20 files, plus this manual:

---

<sup>4</sup>Earlier versions were also distributed in tar format, but since nearly all operating systems now have support or free software for the zip format, I don't intend to make PNG\_IO available in tar format in future.



gpl.txt	Copy of the GNU General Public License
png_io.ads	Package spec
png_io.adb	Package body
png_io-open.adb	Separate body
png_io-chunk_ordering.adb	Separate body
png_io-adam7.ads	Child package spec
png_io-adam7.adb	Child package body
png_io-adaptive_filter.adb	Separate body
png_io-write_png_type_0.adb	Separate body
png_io-write_png_type_2.adb	Separate body
png_io-write_png_type_3.adb	Separate body
png_io-write_png_type_4.adb	Separate body
png_io-write_png_type_6.adb	Separate body
png_io-chromaticity_data.ads	Child package spec
png_io-standard_rgb_encodings.ads	Child package spec
png_io-standard_rgb_encodings.adb	Child package body
png_io-gamma_encoding.ads	Child package spec
png_io-gamma_encoding.adb	Child package body
png_test.adb	Simple test program
png_compare.adb	Simple pixel-for-pixel comparison

The files listed above are distributed with [PGP](#) detached signature files to allow you to verify the integrity of the code. Thus you should have 41 files in all, 20 of them small signature files. It is not essential to check the signatures but if you wish to do so see section [A](#).

The source code files use the ISO-8859-1 Latin 1 character set, but the actual Ada code (outside comments) is restricted to the ISO-646 subset (originally known as ASCII).

The files formerly used the DOS end of line convention (carriage return + line feed) but now are likely to have UNIX line endings (line feed). (This is because I now use a Mac Powerbook whereas I used to use a Toshiba PC.)

## B.2 CVS Access

The PNG\_IO distribution site at <http://png-io.sourceforge.net/> also allows access to updated versions of individual source code files through CVS. These updates eventually get incorporated into a release.

## B.3 History

PNG\_IO Version 1.1 was the first publicly-released version.

PNG\_IO Version 1.1a incorporated a fix to prevent PNG\_IO rejecting a PNG file in which the compressed image data is larger than the uncompressed data.

PNG\_IO Version 1.2 had a cleaner interface to Zlib (an internal change with no impact on functionality).

PNG\_IO Version 1.3 incorporated a number of fixes:

**Buffer allocation in write procedures.** The buffers in the write procedures and the procedure to write an IDAT chunk now use dynamic allocation rather than stack variables, as has always been done when allocating buffers for read.

**Exact handling of IDAT sizes on read.** The fix included in Version 1.1a (see above) has been replaced by a much better solution. The buffer allocated to hold compressed data read from IDAT chunk(s) is now sized exactly by reading the IDAT chunk size(s) from the file before reading the IDAT data.

Adding this fix exposed a latent bug in which Type 4 PNG images (greyscale with alpha) were read incorrectly (the alpha information was read from the next pixel, and the alpha information for the last pixel in the image was garbage). This was because the implementation of the function `Alpha_Value` assumed a RGBA image (Type 6) and failed to check for a Type 4. This has been fixed.

**Legality of Zlib compressed data.** A check has been inserted on the validity of Zlib compressed data (in IDAT and zTXt chunks) by verifying the first two bytes.

**IEND CRC now verified.** It was noticed that the IEND chunk data was skipped, even though the length of this data is always zero. The redundant code was removed, and it was also noticed that the CRC of the IEND chunk was not verified. This has been fixed.

**Calculation of compressed buffer sizes.** The calculation of the size of a Zlib compressed data buffer was incorrect for uncompressed buffer sizes greater than 4,290,676 bytes. (Zlib requires the buffer to be 0.1% plus 12 bytes larger than the uncompressed data.) The calculation is now provided in a more robust manner by a new function in the package `generic_zlib`, and this function is now called wherever PNG\_IO needs to calculate a buffer size. (The package `generic_zlib` was removed with PNG\_IO version 4, and the calculation was moved into the main package body.)

**Handling of text chunks is incorrect.** The code for allocating buffers for compressed text chunks was incorrect. There is no perfect fix for this, as there is no way of knowing the size of the uncompressed text. (The size could easily have been inserted in the zTXt chunk and this would have solved the problem.) The code in version 1.3 allocates a buffer three times the size of the compressed text. Whether this is large enough is not known.

Also the keyword was not checked for legality as per the PNG Specification section 4.2.3. This has been rectified.

PNG\_IO Version 2.1 incorporated several new features. The specification was changed (but it preserved backward compatibility with version 1). Support was added on output for handling ancillary chunks, including chunks like gamma and chromaticity which were previously supported for reading only. The generic write procedures were given an additional parameter for passing a list of ancillary chunks, and functions were introduced for creating the commonly used chunks and appending them to a list. Since the extra parameter appears last, and defaults to an empty list, code written for version 1.x did not need modification. Any unrecognised (by PNG\_IO) chunks found in a file on read were made available to user code, using an interface similar to that already provided for text chunks. Of course, the user's code has to interpret the array of bytes passed by PNG\_IO since PNG\_IO does not understand the content of the chunk. An important aspect of the way the ancillary chunks are handled is that it is possible to extend PNG\_IO with child packages, which have full visibility of the ancillary chunk implementation.

The sRGB chunk was supported for both reading and writing, making use of the ancillary chunk mechanism just described, and the other chunks formerly supported on read (gamma, chromaticity, physical, text) were also supported on write.

A new exception, `Argument_Error` was introduced to represent cases where incorrect data is passed to a PNG\_IO subprogram (example: invalid keyword string when creating a text chunk).

PNG\_IO Versions 3.1, 3.2, 3.3 and 3.4 include enhancements and fixes as listed below (version 3.1 was used for some time without a public release and 3.2 was the first public release of version 3.x):

**Interlace output is now supported** Versions 3.3 onward support interlaced output for all PNG image types.

**Incorrect alpha values in PNG Type 6** Version 3.3 fixed a bug in which PNG Type 6 images with 16-bit depth had incorrect alpha values written to the file in some pixel positions.

**Default value for gamma** The `Gamma_Chunk` function now has a default value for the parameter `Gamma`. This default value corresponds to a gamma of unity.

**A bug in the program PNG\_Compare was fixed** This program was introduced to provide a simple way of comparing the pixel data in two PNG files, but it contained a stupid error: the first file was read twice and the second was ignored. Even Ada can't detect errors of that stupidity, and the program was not properly tested.

**New child packages** Two new child packages were added to handle sRGB encoding and to provide standard chromaticity data for use with chromaticity chunks. Details are given in section [1.2](#)

**A bug with tEXt chunks was fixed** tEXt chunks with a zero length text string raised the exception `Constraint_Error` when in fact the zero length string is legal (PNG Specification version 1.2, section 4.2.3.1). The change needed was to replace `Positive` by `Natural` to allow a value of zero to be computed and used for the string length. The rest of the code was already correct.

**New function Sample\_Depth** A new function `Sample_Depth` has been added to the visible part of the specification. This function returns the number of bits per sample which is normally the number of bits stored per sample in the IDAT chunks, but in the case of palette images, the number of bits per sample is always 8, because this is the number of bits per sample in the palette. This function has been found useful in several programs written by the author which use PNG\_IO and it seemed sensible to put it in the package itself as it could be generally useful.

**Detection of attempt to close unopen file** The procedure `Close` now raises `Status_Error` on an attempt to close a PNG file which has not been opened or which has already been closed. This behaviour is modelled on that of standard Ada packages like `Direct_IO`. Previously, `Close` would raise `Constraint_Error` in this situation.

**Some variables which were not modified are now declared as constants** The variables were flagged by compiler warnings in later versions of Gnat and were reported by a user. The changes were made in version 3.4 and eliminate the warnings, but obviously have no effect on the correctness of the code.

**Some Inline pragmas have been removed** Some functions had `Inline` pragmas applied alongside their bodies. Moving these to the corresponding spec was considered after a user reported an issue with them, but on review, it appeared that the functions didn't need a pragma `Inline` as the number of likely calls did not justify the effort to get the code inlined. From version 3.4 on the pragmas were removed.

PNG\_IO version 4.0 includes the following fixes and enhancements.

**The function `Palette` has been corrected** This function previously returned `True` only if the image was of colour type 3. It now also returns `True` if a palette is present (this is legal for colour PNG file types, where the palette is advisory). The code already verified that the presence of the palette was legal when it was encountered in the file (`Format_Error` is raised if it is not legal).

**New child package** A new child package has been added for handling gamma encoding.

**Zlib\_Ada is now used** The interface to Zlib is now through the Ada 95 binding `Zlib_Ada`. The former PNG\_IO code for interfacing to Zlib and for computing CRCs has been removed.

**IDAT data is no longer stored in an internal buffer before decompression.** In previous versions all of the IDAT data in a PNG file was read into a buffer before decompression. In version 4 onwards, the data from each IDAT chunk is passed to Zlib for decompression using a temporary buffer. (If the file contains only one IDAT chunk the behaviour is similar to the previous code, but if there are multiple IDAT chunks the memory usage will be lowered compared to the previous code, since the compressed data will be read one chunk at a time, and decompressed one chunk at a time.)

**Multiple IDAT chunks are now written on output.** The change to `Zlib_Ada` has made it natural to output multiple IDAT chunks as the compressed data is passed back from Zlib to avoid the complexity of storing the data in a buffer. This results in variable lengths of IDAT chunks depending on the compression. This may result in slightly larger file sizes, but it does not result in invalid output since the PNG specification explicitly permits arbitrary division of the IDAT stream into chunks.

PNG\_IO version 4.1 has only minor changes, and is the first release hosted at Sourceforge. Version 4.2 is identical – the version number in the code was set to 4.2 when it should have been 4.1. Release 4.2 simply corrects this minor error. Only the manual and the release number have changed.

PNG\_IO version 4.3 includes the following refinements:

**Formal parameter relaxations** The formal parameter `Sample` of the generic `Write_PNG_Type_x` procedures has been relaxed. Previously this parameter was defined as:

```
type Sample is range <>
```

but this did not allow the actual to be a modular type. The new version defines the parameter as `(<>)` (discrete) thus allowing modular, integer, or enumerated types to be supplied as actuals. There is no impact on existing code, because integer types are still supported as actuals.

The formal parameter `Image_Handle` has also been relaxed and now permits unconstrained formals. Again, this has no impact on existing code because a constrained formal (the previous requirement) is still permitted. Thanks to Samuel Tardieu for pointing out this possibility.

A similar change has been made to the input and output sample types in the two child packages:

```
png_io.gamma_encoding and  
png_io.standard_rgb_encodings.
```

These parameters are now discrete rather than modular, permitting integer subtypes to be used (as a side-effect enumerated types are also permitted, although this is not likely to be useful). There is no impact on existing code because modular types will still be accepted and will give the same results.

**Ravenscar profile** A very small change to the package body has made the package compliant with the Ravenscar profile (see section D.13.1 of the LRM 2005). Thanks to Samuel Tardieu for pointing out that the package was almost Ravenscar compliant, and that a change was needed to the declaration of `Package_Identifier`.

**User control over Zlib compression level** An additional parameter has been added to the `Write_PNG_Type_x` procedures to permit the user control over the Zlib compression level. Of course, a default is provided that results in the same behaviour as before. A consequent change is that Zlib is now with'ed from the spec rather than the body of `png_io.adb` in order to allow visibility of some Zlib types and constants.

PNG\_IO version 4.4 includes the following improvements:

- When writing a PNG file, the package no longer uses a buffer to store all the uncompressed (but filtered) pixel data. Instead, each complete scan line is passed into Zlib for compression immediately after scan line filtering and any compressed data passed back from Zlib is immediately output to an IDAT chunk (with one exception - next bullet point). This improvement means that PNG file output is faster, and it uses less memory. In particular, for very large files where the buffer would have been the same size as the uncompressed pixel data, the memory usage for buffering is now drastically cut to a few kilobytes.
- The change to Zlib\_Ada with version 4 introduced a small quirk - the first two bytes of Zlib compressed data (the header) were output in their own IDAT chunk. With the considerable tidying of the code resulting from using on-the-fly compression of each scan line (previous bullet point) it was simple to fix this so that the two bytes are now cached and added to the front of the second buffer of data passed back from Zlib. The two header bytes are therefore now output in the first IDAT chunk, but this chunk no longer contains just the two header bytes.
- The program `png_compare` has been modified to set the exit status, so that if called from a script (e.g. under Unix/Linux/Mac OS X Darwin) a failure to compare exactly can be detected. This facilitates running a script to test PNG\_IO on a large library of PNG test images.

## B.4 To do list

Add support for the international text chunk. This is not trivial, as there is no standard Ada binding to UTF-8.

The current implementation on reading a file requires the user code to read the pixels from PNG\_IO. A possibly better method would be for PNG\_IO to 'push' the pixels to the user code – this would require the user to instantiate a generic read procedure similar to the current generic write procedures, with a procedure parameter to be called by PNG\_IO to pass pixels to the user's code. The benefit of this arrangement would be the removal of the uncompressed pixel data buffer from the internal descriptor used inside PNG\_IO which would reduce the memory usage drastically. In order to support the previous method, a child package could be added preserving the current functionality.



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