



**An API for CBF/imgCIF
Crystallographic Binary Files with ASCII Support**

Version 0.7.1
30 March 2001

by

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Version History

| Version | Date | By | Description |
|---------|--------------|-----|---|
| 0.1 | Apr. 1998 | PJE | This was the first CBFLib release. It supported binary CBF files using binary strings. |
| 0.2 | Aug. 1998 | HJB | This release added ascii imgCIF support using MIME-encoded binary sections, added the option of MIME headers for the binary strings was well. MIME code adapted from mpack 1.5. Added hooks needed for DDL1-style names without categories. |
| 0.3 | Sep. 1998 | PJE | This release cleaned up the changes made for version 0.2, allowing multi-threaded use of the code, and removing dependence on the mpack package. |
| 0.4 | Nov. 1998 | HJB | This release merged much of the message digest code into the general file reading and writing to reduce the number of passes. More consistency checking between the MIME header and the binary header was introduced. The size in the MIME header was adjusted to agree with the version 0.2 documentation. |
| 0.5 | Dec. 1998 | PJE | This release greatly increased the speed of processing by allowing for deferred digest evaluation. |
| 0.6 | Jan. 1999 | HJB | This release removed the redundant information (binary id, size, compression id) from a binary header when there is a MIME header, removed the unused repeat argument, and made the memory allocation for buffering and tables with many rows sensitive to the current memory allocation already used. |
| 0.7 | Mar. 8 2001 | PJE | This release added high-level instructions based on the imgCIF dictionary version 1.1. |
| 0.7.1 | Mar. 30 2001 | PJE | The high-level functions were revised to permit future expansion to files with multiple images. |

Known Problems

This version does not have support for byte-offset or predictor compression. Code is needed to support array sub-sections.

Foreword

In order to work with CBFlib, you need the source code, in the form of a compressed tar, CBFlib.tar.Z. Uncompress this file. Place it in an otherwise empty directory, and unpack it with tar. You will also need Paul Ellis's sample MAR345 image, example.mar2300, as sample data. This file can also be found at <http://biosg1.slac.stanford.edu/biosg1-users/ellis/Public/>. Place that file in the top level directory (one level up from the source code). Adjust the definition of CC in Makefile to point to your C compiler, and then

```
make all  
make tests
```

This release has been tested on an SGI under IRIX 6.4 and on a PowerPC under Linux-ppc 2.1.24.

We have included examples of CBF/imgCIF files produced by CBFlib, an updated version of John Westbrook's DDL2-compliant CBF Extensions Dictionary, and of Andy Hammersley's CBF definition, updated to become a DRAFT CBF/ImgCIF DEFINITION.

This is just a proposal. Please be careful about basing any code on this until and unless there has been a general agreement.

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1. Introduction

CBFlib is a library of ANSI-C functions providing a simple mechanism for accessing Crystallographic Binary Files (CBF files) and Image-supporting CIF (imgCIF) files. The CBFlib API is loosely based on the CIFPARSE API for mmCIF files. Like CIFPARSE, CBFlib does not perform any semantic integrity checks and simply provides functions to create, read, modify and write CBF binary data files and imgCIF ASCII data files.

2. Function descriptions

2.1 General description

Almost all of the CBFLib functions receive a value of type `cbf_handle` (a CBF handle) as the first argument. Several of the high-level CBFLib functions dealing with geometry receive a value of type `cbf_goniometer` (a handle for a CBF goniometer object) or `cbf_detector` (a handle for a CBF detector object).

All functions return an integer equal to 0 for success or an error code for failure.

2.1.1 CBF handles

CBFLib permits a program to use multiple CBF objects simultaneously. To identify the CBF object on which a function will operate, CBFLib uses a value of type `cbf_handle`.

Most functions in the library expect a value of type `cbf_handle` as the first argument.

The function **`cbf_make_handle`** creates and initializes a new CBF handle.

The function **`cbf_free_handle`** destroys a handle and frees all memory associated with the corresponding CBF object.

2.1.2 CBF goniometer handles

To represent the goniometer used to orient a sample, CBFLib uses a value of type `cbf_goniometer`.

A goniometer object is created and initialized from a CBF object using the function **`cbf_construct_goniometer`**.

The function **`cbf_free_goniometer`** destroys a goniometer handle and frees all memory associated with the corresponding object.

2.1.3 CBF detector handles

To represent a detector surface mounted on a positioning system, CBFLib uses a value of type `cbf_detector`.

A goniometer object is created and initialized from a CBF object using the function **`cbf_construct_detector`**.

The function **`cbf_free_detector`** destroys a detector handle and frees all memory associated with the corresponding object.

2.1.4 Return values

All of the CBFLib functions return 0 on success and an error code on failure. The error codes are:

| | |
|---------------------------|---------------------------------|
| <code>CBF_FORMAT</code> | The file format is invalid |
| <code>CBF_ALLOC</code> | Memory allocation failed |
| <code>CBF_ARGUMENT</code> | Invalid function argument |
| <code>CBF_ASCII</code> | The value is ASCII (not binary) |
| <code>CBF_BINARY</code> | The value is binary (not ASCII) |

| | |
|--------------------|--|
| CBF_BITCOUNT | The expected number of bits does not match the actual number written |
| CBF_ENDOFDATA | The end of the data was reached before the end of the array |
| CBF_FILECLOSE | File close error |
| CBF_FILEOPEN | File open error |
| CBF_FILEREAD | File read error |
| CBF_FILESEEK | File seek error |
| CBF_FILETELL | File tell error |
| CBF_FILEWRITE | File write error |
| CBF_IDENTICAL | A data block with the new name already exists |
| CBF_NOTFOUND | The data block, category, column or row does not exist |
| CBF_OVERFLOW | The number read cannot fit into the destination argument. The destination has been set to the nearest value. |
| CBF_UNDEFINED | The requested number is not defined (e.g. 0/0; new for version 0.7). |
| CBF_NOTIMPLEMENTED | The requested functionality is not yet implemented (New for version 0.7). |

If more than one error has occurred, the error code is the logical OR of the individual error codes.

2.2 Reading and writing files containing binary sections

2.2.1 Reading binary sections

The current version of CBFLib only decompresses a binary section from disk when requested by the program.

When a file containing one or more binary sections is read, CBFLib saves the file pointer and the position of the binary section within the file and then jumps past the binary section. When the program attempts to access the binary data, CBFLib sets the file position back to the start of the binary section and then reads the data.

For this scheme to work:

1. The file must be a random-access file opened in binary mode (fopen (, "rb")).
2. The program must not close the file. CBFLib will close the file using fclose () when it is no longer needed.

At present, this also means that a program can't read a file and then write back to the same file. This restriction will be eliminated in a future version.

When reading an imgCIF vs a CBF, the difference is detected automatically.

2.2.2 Writing binary sections

When a program passes CBFLib a binary value, the data is compressed to a temporary file. If the CBF object is subsequently written to a file, the data is simply copied from the temporary file to the output file.

The output file can be of any type. If the program indicates to CBFLib that the file is a random-access and readable, CBFLib will conserve disk space by closing the temporary file and using the output file as the location at which the binary value is stored.

For this option to work:

1. The file must be a random-access file opened in binary update mode (fopen (, "w+b"))).
2. The program must not close the file. CBFLib will close the file using fclose () when it is no longer needed.

If this option is not used:

1. CBFLib will continue using the temporary file.
2. CBFLib will not close the file. This is the responsibility of the main program.

2.2.3 Summary of reading and writing files containing binary sections

1. Open disk files to read using the mode "rb".
2. If possible, open disk files to write using the mode "w+b" and tell CBFLib that it can use the file as a buffer.
3. Do not close any files read by CBFLib or written by CBFLib with buffering turned on.
4. Do not attempt to read from a file, then write to the same file.

2.3 Low-level function prototypes

2.3.1 **cbf_make_handle**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_make_handle (cbf_handle *handle);
```

DESCRIPTION

cbf_make_handle creates and initializes a new internal CBF object. All other CBFLib functions operating on this object receive the CBF handle as the first argument.

ARGUMENTS

handle Pointer to a CBF handle.

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.2 **cbf_free_handle**

2.3.2 **cbf_free_handle**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_free_handle (cbf_handle handle);
```

DESCRIPTION

cbf_free_handle destroys the CBF object specified by the *handle* and frees all associated memory.

ARGUMENTS

handle CBF handle to free.

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.1 **cbf_make_handle**

2.3.3 **cbf_read_file**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_read_file (cbf_handle handle, FILE *file, int headers);
```

DESCRIPTION

cbf_read_file reads the CBF or CIF file *file* into the CBF object specified by *handle*.

headers controls the interpretation of binary section headers of imgCIF files.

| | |
|----------------|--|
| MSG_DIGEST: | Instructs CBFlib to check that the digest of the binary section matches any header value. If the digests do not match, the call will return CBF_FORMAT. This evaluation and comparison is delayed (a "lazy" evaluation) to ensure maximal processing efficiency. If an immediately evaluation is required, see MSG_DIGESTNOW, below. |
| MSG_DIGESTNOW: | Instructs CBFlib to check that the digest of the binary section matches any header value. If the digests do not match, the call will return CBF_FORMAT. This evaluation and comparison is performed during initial parsing of the section to ensure timely error reporting at the expense of processing efficiency. If a more efficient delayed ("lazy") evaluation is required, see MSG_DIGESTNOW, below. |
| MSG_NODIGEST: | Do not check the digest (default). |

CBFlib defers reading binary sections as long as possible. In the current version of CBFlib, this means that:

1. The *file* must be a random-access file opened in binary mode (fopen (, "rb")).
2. The program must not close the *file*. CBFlib will close the *file* using fclose () when it is no longer needed.

These restrictions may change in a future release.

ARGUMENTS

| | |
|----------------|--|
| <i>handle</i> | CBF handle. |
| <i>file</i> | Pointer to a file descriptor. |
| <i>headers</i> | Controls interpretation of binary section headers. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.4 **cbf_write_file**

2.3.4 **cbf_write_file**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_write_file (cbf_handle handle, FILE *file, int readable, int ciforcbf, int headers, int encoding);
```

DESCRIPTION

cbf_write_file writes the CBF object specified by *handle* into the file *file*.

Unlike **cbf_read_file**, the *file* does not have to be random-access.

If the *file* is random-access and readable, *readable* can be set to non-0 to indicate to CBFLib that the *file* can be used as a buffer to conserve disk space. If the *file* is not random-access or not readable, *readable* must be 0.

If *readable* is non-0, CBFLib will close the *file* when it is no longer required otherwise this is the responsibility of the program.

ciforcbf selects the format in which the binary sections are written:

| | |
|-----|--|
| CIF | Write an imgCIF file. |
| CBF | Write a CBF file (default). <i>headers</i> selects the type of header used in CBF binary sections and selects whether message digests are generated. |

The value of *headers* can be a logical OR of any of:

| | |
|----------------|--|
| MIME_HEADERS | Use MIME-type headers (default). |
| MIME_NOHEADERS | Use a simple ASCII headers. |
| MSG_DIGEST | Generate message digests for binary data validation. |
| MSG_NODIGEST | Do not generate message digests (default). |

encoding selects the type of encoding used for binary sections and the type of line-termination in imgCIF files. The value can be a logical OR of any of:

| | |
|--------------|--|
| ENC_BASE64 | Use BASE64 encoding (default). |
| ENC_QP | Use QUOTED-PRINTABLE encoding. |
| ENC_BASE8 | Use BASE8 (octal) encoding. |
| ENC_BASE10 | Use BASE10 (decimal) encoding. |
| ENC_BASE16 | Use BASE16 (hexadecimal) encoding. |
| ENC_FORWARD | For BASE8, BASE10 or BASE16 encoding, map bytes to words forward (1234) (default on little-endian machines). |
| ENC_BACKWARD | Map bytes to words backward (4321) (default on big-endian machines). |
| ENC_CRTERM | Terminate lines with CR. |
| ENC_LFTERM | Terminate lines with LF (default). |

ARGUMENTS

| | |
|-----------------|---|
| <i>handle</i> | CBF handle. |
| <i>file</i> | Pointer to a file descriptor. |
| <i>readable</i> | If non-0: this file is random-access and readable and can be used as a buffer. |
| <i>ciforcbf</i> | Selects the format in which the binary sections are written (CIF/CBF). |
| <i>headers</i> | Selects the type of header in CBF binary sections and message digest generation. |
| <i>encoding</i> | Selects the type of encoding used for binary sections and the type of line-termination in imgCIF files. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.3 **cbf_read_file**

2.3.5 **cbf_new_datablock**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_new_datablock (cbf_handle handle, const char *datablockname);
```

DESCRIPTION

cbf_new_datablock creates a new data block with name *datablockname* and makes it the current data block.

If a data block with this name already exists, the existing data block becomes the current data block.

ARGUMENTS

| | |
|----------------------|---------------------------------|
| <i>handle</i> | CBF handle. |
| <i>datablockname</i> | The name of the new data block. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

- 2.3.6 **cbf_force_new_datablock**
- 2.3.7 **cbf_new_category**
- 2.3.8 **cbf_force_new_category**
- 2.3.9 **cbf_new_column**
- 2.3.10 **cbf_new_row**
- 2.3.11 **cbf_insert_row**
- 2.3.12 **cbf_set_datablockname**
- 2.3.17 **cbf_remove_datablock**

2.3.6 **cbf_force_new_data_block**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_force_new_datablock (cbf_handle handle, const char *datablockname);
```

DESCRIPTION

cbf_force_new_datablock creates a new data block with name *datablockname* and makes it the current data block. Duplicate data block names are allowed.

Even if a data block with this name already exists, a new data block is created and becomes the current data block.

ARGUMENTS

| | |
|----------------------|---------------------------------|
| <i>handle</i> | CBF handle. |
| <i>datablockname</i> | The name of the new data block. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

- 2.3.5 **cbf_new_datablock**
- 2.3.7 **cbf_new_category**
- 2.3.8 **cbf_force_new_category**
- 2.3.9 **cbf_new_column**
- 2.3.10 **cbf_new_row**
- 2.3.11 **cbf_insert_row**
- 2.3.12 **cbf_set_datablockname**
- 2.3.17 **cbf_remove_datablock**

2.3.7 **cbf_new_category**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_new_category (cbf_handle handle, const char *categoryname);
```

DESCRIPTION

cbf_new_category creates a new category in the current data block with name *categoryname* and makes it the current category.

If a category with this name already exists, the existing category becomes the current category.

ARGUMENTS

| | |
|---------------------|-------------------------------|
| <i>handle</i> | CBF handle. |
| <i>categoryname</i> | The name of the new category. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

- 2.3.5 **cbf_new_datablock**
- 2.3.6 **cbf_force_new_datablock**
- 2.3.8 **cbf_force_new_category**
- 2.3.9 **cbf_new_column**
- 2.3.10 **cbf_new_row**
- 2.3.11 **cbf_insert_row**
- 2.3.18 **cbf_remove_category**

2.3.8 **cbf_force_new_category**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_force_new_category (cbf_handle handle, const char *categoryname);
```

DESCRIPTION

cbf_force_new_category creates a new category in the current data block with name *categoryname* and makes it the current category. Duplicate category names are allowed.

Even if a category with this name already exists, a new category of the same name is created and becomes the current category. This allows for the creation of unlooped tag/value lists drawn from the same category.

ARGUMENTS

| | |
|---------------------|-------------------------------|
| <i>handle</i> | CBF handle. |
| <i>categoryname</i> | The name of the new category. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

- 2.3.5 **cbf_new_datablock**
- 2.3.6 **cbf_force_new_datablock**
- 2.3.7 **cbf_new_category**
- 2.3.9 **cbf_new_column**
- 2.3.10 **cbf_new_row**
- 2.3.11 **cbf_insert_row**
- 2.3.18 **cbf_remove_category**

2.3.9 **cbf_new_column**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_new_column (cbf_handle handle, const char *columnname);
```

DESCRIPTION

cbf_new_column creates a new column in the current category with name *columnname* and makes it the current column.

If a column with this name already exists, the existing column becomes the current category.

ARGUMENTS

| | |
|-------------------|-----------------------------|
| <i>handle</i> | CBF handle. |
| <i>columnname</i> | The name of the new column. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

- 2.3.5 **cbf_new_datablock**
- 2.3.6 **cbf_force_new_datablock**
- 2.3.7 **cbf_new_category**
- 2.3.8 **cbf_force_new_category**
- 2.3.10 **cbf_new_row**
- 2.3.11 **cbf_insert_row**
- 2.3.19 **cbf_remove_column**

2.3.10 **cbf_new_row**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_new_row (cbf_handle handle);
```

DESCRIPTION

cbf_new_row adds a new row to the current category and makes it the current row.

ARGUMENTS

handle CBF handle.

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.5 **cbf_new_datablock**
2.3.6 **cbf_force_new_datablock**
2.3.7 **cbf_new_category**
2.3.8 **cbf_force_new_category**
2.3.9 **cbf_new_column**
2.3.11 **cbf_insert_row**
2.3.12 **cbf_delete_row**
2.3.20 **cbf_remove_row**

2.3.11 **cbf_insert_row**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_insert_row (cbf_handle handle, unsigned int rownumber);
```

DESCRIPTION

cbf_insert_row adds a new row to the current category. The new row is inserted as row *rownumber* and existing rows starting from *rownumber* are moved up by 1. The new row becomes the current row.

If the category has fewer than *rownumber* rows, the function returns CBF_NOTFOUND.

The row numbers start from 0.

ARGUMENTS

| | |
|------------------|--------------------------------|
| <i>handle</i> | CBF handle. |
| <i>rownumber</i> | The row number of the new row. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

- 2.3.5 **cbf_new_datablock**
- 2.3.6 **cbf_force_new_datablock**
- 2.3.7 **cbf_new_category**
- 2.3.8 **cbf_force_new_category**
- 2.3.9 **cbf_new_column**
- 2.3.10 **cbf_new_row**
- 2.3.12 **cbf_delete_row**
- 2.3.20 **cbf_remove_row**

2.3.12 **cbf_delete_row**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_delete_row (cbf_handle handle, unsigned int rownumber);
```

DESCRIPTION

cbf_delete_row deletes a row from the current category. Rows starting from *rownumber* +1 are moved down by 1. If the current row was higher than *rownumber*, or if the current row is the last row, it will also move down by 1.

The row numbers start from 0.

ARGUMENTS

| | |
|------------------|----------------------------------|
| <i>handle</i> | CBF handle. |
| <i>rownumber</i> | The number of the row to delete. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

- 2.3.10 **cbf_new_row**
- 2.3.11 **cbf_insert_row**
- 2.3.17 **cbf_remove_datablock**
- 2.3.18 **cbf_remove_category**
- 2.3.19 **cbf_remove_column**
- 2.3.20 **cbf_remove_row**

2.3.13 **cbf_set_datablockname**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_set_datablockname (cbf_handle handle, const char *datablockname);
```

DESCRIPTION

cbf_set_datablockname changes the name of the current data block to *datablockname*.

If a data block with this name already exists (comparison is case-insensitive), the function returns CBF_IDENTICAL.

ARGUMENTS

| | |
|----------------------|--------------------------|
| <i>handle</i> | CBF handle. |
| <i>datablockname</i> | The new data block name. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.5 **cbf_new_datablock**
2.3.14 **cbf_reset_datablocks**
2.3.15 **cbf_reset_datablock**
2.3.17 **cbf_remove_datablock**
2.3.42 **cbf_datablock_name**

2.3.14 **cbf_reset_datablocks**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_reset_datablocks (cbf_handle handle);
```

DESCRIPTION

cbf_reset_datablocks deletes all categories from all data blocks.

The current data block does not change.

ARGUMENTS

handle CBF handle.

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.15 **cbf_reset_datablock**

2.3.18 **cbf_remove_category**

2.3.15 **cbf_reset_datablock**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_reset_datablock (cbf_handle handle);
```

DESCRIPTION

cbf_reset_datablock deletes all categories from the current data block.

ARGUMENTS

handle CBF handle.

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.14 **cbf_reset_datablocks**

2.3.18 **cbf_remove_category**

2.3.16 **cbf_reset_category**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_reset_category (cbf_handle handle);
```

DESCRIPTION

cbf_reset_category deletes all columns and rows from current category.

ARGUMENTS

handle CBF handle.

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.16 **cbf_reset_category**
2.3.19 **cbf_remove_column**
2.3.20 **cbf_remove_row**

2.3.17 **cbf_remove_datablock**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_remove_datablock (cbf_handle handle);
```

DESCRIPTION

cbf_remove_datablock deletes the current data block.

The current data block becomes undefined.

ARGUMENTS

handle CBF handle.

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.5 **cbf_new_datablock**
2.3.6 **cbf_force_new_datablock**
2.3.18 **cbf_remove_category**
2.3.19 **cbf_remove_column**
2.3.20 **cbf_remove_row**

2.3.18 **cbf_remove_category**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_remove_category (cbf_handle handle);
```

DESCRIPTION

cbf_remove_category deletes the current category.

The current category becomes undefined.

ARGUMENTS

handle CBF handle.

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.7 **cbf_new_category**

2.3.8 **cbf_force_new_category**

2.3.17 **cbf_remove_datablock**

2.3.19 **cbf_remove_column**

2.3.20 **cbf_remove_row**

2.3.19 **cbf_remove_column**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_remove_column (cbf_handle handle);
```

DESCRIPTION

cbf_remove_column deletes the current column.

The current column becomes undefined.

ARGUMENTS

handle CBF handle.

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.9 **cbf_new_column**
2.3.17 **cbf_remove_datablock**
2.3.18 **cbf_remove_category**
2.3.20 **cbf_remove_row**

2.3.20 **cbf_remove_row**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_remove_row (cbf_handle handle);
```

DESCRIPTION

cbf_remove_row deletes the current row in the current category.

If the current row was the last row, it will move down by 1, otherwise, it will remain the same.

ARGUMENTS

handle CBF handle.

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.10 **cbf_new_row**
2.3.11 **cbf_insert_row**
2.3.17 **cbf_remove_datablock**
2.3.18 **cbf_remove_category**
2.3.19 **cbf_remove_column**
2.3.12 **cbf_delete_row**

2.3.21 **cbf_rewind_datablock**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_rewind_datablock (cbf_handle handle);
```

DESCRIPTION

cbf_rewind_datablock makes the first data block the current data block.

If there are no data blocks, the function returns CBF_NOTFOUND.

The current category becomes undefined.

ARGUMENTS

handle CBF handle.

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.22 **cbf_rewind_category**

2.3.19 **cbf_rewind_column**

2.3.24 **cbf_rewind_row**

2.3.25 **cbf_next_datablock**

2.3.22 **cbf_rewind_category**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_rewind_category (cbf_handle handle);
```

DESCRIPTION

cbf_rewind_category makes the first category in the current data block the current category.

If there are no categories, the function returns CBF_NOTFOUND.

The current column and row become undefined.

ARGUMENTS

handle CBF handle.

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.21 **cbf_rewind_datablock**

2.3.19 **cbf_rewind_column**

2.3.24 **cbf_rewind_row**

2.3.26 **cbf_next_category**

2.3.23 **cbf_rewind_column**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_rewind_column (cbf_handle handle);
```

DESCRIPTION

cbf_rewind_column makes the first column in the current category the current column.

If there are no columns, the function returns CBF_NOTFOUND.

The current row is not affected.

ARGUMENTS

handle CBF handle.

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.21 **cbf_rewind_datablock**

2.3.22 **cbf_rewind_category**

2.3.24 **cbf_rewind_row**

2.3.27 **cbf_next_column**

2.3.24 **cbf_rewind_row**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_rewind_row (cbf_handle handle);
```

DESCRIPTION

cbf_rewind_row makes the first row in the current category the current row.

If there are no rows, the function returns CBF_NOTFOUND.

The current column is not affected.

ARGUMENTS

handle CBF handle.

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.21 **cbf_rewind_datablock**

2.3.22 **cbf_rewind_category**

2.3.19 **cbf_rewind_column**

2.3.28 **cbf_next_row**

2.3.25 **cbf_next_datablock**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_next_datablock (cbf_handle handle);
```

DESCRIPTION

cbf_next_datablock makes the data block following the current data block the current data block.

If there are no more data blocks, the function returns CBF_NOTFOUND.

The current category becomes undefined.

ARGUMENTS

handle CBF handle.

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.21 **cbf_rewind_datablock**

2.3.26 **cbf_next_category**

2.3.27 **cbf_next_column**

2.3.28 **cbf_next_row**

2.3.26 **cbf_next_category**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_next_category (cbf_handle handle);
```

DESCRIPTION

cbf_next_category makes the category following the current category in the current data block the current category.

If there are no more categories, the function returns CBF_NOTFOUND.

The current column and row become undefined.

ARGUMENTS

handle CBF handle.

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.22 **cbf_rewind_category**

2.3.25 **cbf_next_datablock**

2.3.27 **cbf_next_column**

2.3.27 **cbf_next_row**

2.3.27 **cbf_next_column**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_next_column (cbf_handle handle);
```

DESCRIPTION

cbf_next_column makes the column following the current column in the current category the current column.

If there are no more columns, the function returns CBF_NOTFOUND.

The current row is not affected.

ARGUMENTS

handle CBF handle.

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.19 **cbf_rewind_column**

2.3.25 **cbf_next_datablock**

2.3.26 **cbf_next_category**

2.3.28 **cbf_next_row**

2.3.28 **cbf_next_row**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_next_row (cbf_handle handle);
```

DESCRIPTION

cbf_next_row makes the row following the current row in the current category the current row.

If there are no more rows, the function returns CBF_NOTFOUND.

The current column is not affected.

ARGUMENTS

handle CBF handle.

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.24 **cbf_rewind_row**
2.3.25 **cbf_next_datablock**
2.3.26 **cbf_next_category**
2.3.27 **cbf_next_column**

2.3.29 **cbf_find_datablock**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_find_datablock (cbf_handle handle, const char *datablockname);
```

DESCRIPTION

cbf_find_datablock makes the data block with name *datablockname* the current data block.

The comparison is case-insensitive.

If the data block does not exist, the function returns CBF_NOTFOUND.

The current category becomes undefined.

ARGUMENTS

| | |
|----------------------|-------------------------------------|
| <i>handle</i> | CBF handle. |
| <i>datablockname</i> | The name of the data block to find. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

- 2.3.21 **cbf_rewind_datablock**
- 2.3.25 **cbf_next_datablock**
- 2.3.30 **cbf_find_category**
- 2.3.31 **cbf_find_column**
- 2.3.32 **cbf_find_row**
- 2.3.42 **cbf_datablock_name**

2.3.30 **cbf_find_category**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_find_category (cbf_handle handle, const char *categoryname);
```

DESCRIPTION

cbf_find_category makes the category in the current data block with name *categoryname* the current category.

The comparison is case-insensitive.

If the category does not exist, the function returns CBF_NOTFOUND.

The current column and row become undefined.

ARGUMENTS

| | |
|---------------------|-----------------------------------|
| <i>handle</i> | CBF handle. |
| <i>categoryname</i> | The name of the category to find. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

- 2.3.22 **cbf_rewind_category**
- 2.3.26 **cbf_next_category**
- 2.3.29 **cbf_find_datablock**
- 2.3.31 **cbf_find_column**
- 2.3.32 **cbf_find_row**
- 2.3.43 **cbf_category_name**

2.3.31 **cbf_find_column**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_find_column (cbf_handle handle, const char *columnname);
```

DESCRIPTION

cbf_find_column makes the columns in the current category with name *columnname* the current column.

The comparison is case-insensitive.

If the column does not exist, the function returns CBF_NOTFOUND.

The current row is not affected.

ARGUMENTS

| | |
|-------------------|-----------------------------|
| <i>handle</i> | CBF handle. |
| <i>columnname</i> | The name of column to find. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

- 2.3.19 **cbf_rewind_column**
- 2.3.27 **cbf_next_column**
- 2.3.29 **cbf_find_datablock**
- 2.3.30 **cbf_find_category**
- 2.3.32 **cbf_find_row**
- 2.3.44 **cbf_column_name**

2.3.32 **cbf_find_row**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_find_row (cbf_handle handle, const char *value);
```

DESCRIPTION

cbf_find_row makes the first row in the current column with value *value* the current row.

The comparison is case-sensitive.

If a matching row does not exist, the function returns CBF_NOTFOUND.

The current column is not affected.

ARGUMENTS

| | |
|---------------|-------------------------------|
| <i>handle</i> | CBF handle. |
| <i>value</i> | The value of the row to find. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

- 2.3.24 **cbf_rewind_row**
- 2.3.28 **cbf_next_row**
- 2.3.29 **cbf_find_datablock**
- 2.3.30 **cbf_find_category**
- 2.3.31 **cbf_find_column**
- 2.3.33 **cbf_find_nextrow**
- 2.3.46 **cbf_get_value**

2.3.33 **cbf_find_nextrow**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_find_nextrow (cbf_handle handle, const char *value);
```

DESCRIPTION

cbf_find_nextrow makes the makes the next row in the current column with value *value* the current row. The search starts from the row following the last row found with **cbf_find_row** or **cbf_find_nextrow**, or from the current row if the current row was defined using any other function.

The comparison is case-sensitive.

If no more matching rows exist, the function returns CBF_NOTFOUND.

The current column is not affected.

ARGUMENTS

| | |
|---------------|--------------------------|
| <i>handle</i> | CBF handle. |
| <i>value</i> | the value to search for. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

- 2.3.24 **cbf_rewind_row**
- 2.3.28 **cbf_next_row**
- 2.3.29 **cbf_find_datablock**
- 2.3.30 **cbf_find_category**
- 2.3.31 **cbf_find_column**
- 2.3.32 **cbf_find_row**
- 2.3.46 **cbf_get_value**

2.3.34 **cbf_count_datablocks**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_count_datablocks (cbf_handle handle, unsigned int *datablocks);
```

DESCRIPTION

cbf_count_datablocks puts the number of data blocks in **datablocks* .

ARGUMENTS

| | |
|-------------------|--|
| <i>handle</i> | CBF handle. |
| <i>datablocks</i> | Pointer to the destination data block count. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.35 **cbf_count_categories**

2.3.36 **cbf_count_columns**

2.3.37 **cbf_count_rows**

2.3.38 **cbf_select_datablock**

2.3.35 **cbf_count_categories**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_count_categories (cbf_handle handle, unsigned int *categories);
```

DESCRIPTION

cbf_count_categories puts the number of categories in the current data block in **categories*.

ARGUMENTS

| | |
|-------------------|--|
| <i>handle</i> | CBF handle. |
| <i>categories</i> | Pointer to the destination category count. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.34 **cbf_count_datablocks**

2.3.36 **cbf_count_columns**

2.3.37 **cbf_count_rows**

2.3.39 **cbf_select_category**

2.3.36 **cbf_count_columns**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_count_columns (cbf_handle handle, unsigned int *columns);
```

DESCRIPTION

cbf_count_columns puts the number of columns in the current category in **columns*.

ARGUMENTS

| | |
|----------------|--|
| <i>handle</i> | CBF handle. |
| <i>columns</i> | Pointer to the destination column count. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.34 **cbf_count_datablocks**

2.3.35 **cbf_count_categories**

2.3.37 **cbf_count_rows**

2.3.40 **cbf_select_column**

2.3.37 **cbf_count_rows**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_count_rows (cbf_handle handle, unsigned int *rows);
```

DESCRIPTION

cbf_count_rows puts the number of rows in the current category in **rows*.

ARGUMENTS

| | |
|---------------|---------------------------------------|
| <i>handle</i> | CBF handle. |
| <i>rows</i> | Pointer to the destination row count. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.34 **cbf_count_datablocks**

2.3.35 **cbf_count_categories**

2.3.36 **cbf_count_columns**

2.3.41 **cbf_select_row**

2.3.38 **cbf_select_datablock**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_select_datablock (cbf_handle handle, unsigned int datablock);
```

DESCRIPTION

cbf_select_datablock selects data block number *datablock* as the current data block.

The first data block is number 0.

If the data block does not exist, the function returns CBF_NOTFOUND.

ARGUMENTS

| | |
|------------------|-------------------------------------|
| <i>handle</i> | CBF handle. |
| <i>datablock</i> | Number of the data block to select. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.34 **cbf_count_datablocks**

2.3.39 **cbf_select_category**

2.3.40 **cbf_select_column**

2.3.41 **cbf_select_row**

2.3.39 **cbf_select_category**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_select_category (cbf_handle handle, unsigned int category);
```

DESCRIPTION

cbf_select_category selects category number *category* in the current data block as the current category.

The first category is number 0.

The current column and row become undefined.

If the category does not exist, the function returns CBF_NOTFOUND.

ARGUMENTS

| | |
|-----------------|-----------------------------------|
| <i>handle</i> | CBF handle. |
| <i>category</i> | Number of the category to select. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.35 **cbf_count_categories**

2.3.38 **cbf_select_datablock**

2.3.40 **cbf_select_column**

2.3.41 **cbf_select_row**

2.3.40 **cbf_select_column**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_select_column (cbf_handle handle, unsigned int column);
```

DESCRIPTION

cbf_select_column selects column number *column* in the current category as the current column.

The first column is number 0.

The current row is not affected

If the column does not exist, the function returns CBF_NOTFOUND.

ARGUMENTS

| | |
|---------------|---------------------------------|
| <i>handle</i> | CBF handle. |
| <i>column</i> | Number of the column to select. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.36 **cbf_count_columns**
2.3.38 **cbf_select_datablock**
2.3.39 **cbf_select_category**
2.3.41 **cbf_select_row**

2.3.41 **cbf_select_row**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_select_row (cbf_handle handle, unsigned int row);
```

DESCRIPTION

cbf_select_row selects row number *row* in the current category as the current row.

The first row is number 0.

The current column is not affected

If the row does not exist, the function returns CBF_NOTFOUND.

ARGUMENTS

| | |
|---------------|------------------------------|
| <i>handle</i> | CBF handle. |
| <i>row</i> | Number of the row to select. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.37 **cbf_count_rows**
2.3.38 **cbf_select_datablock**
2.3.39 **cbf_select_category**
2.3.40 **cbf_select_column**

2.3.42 **cbf_datablock_name**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_datablock_name (cbf_handle handle, const char **datablockname);
```

DESCRIPTION

cbf_datablock_name sets **datablockname* to point to the name of the current data block.

The data block name will be valid as long as the data block exists and has not been renamed.

The name must not be modified by the program in any way.

ARGUMENTS

| | |
|----------------------|---|
| <i>handle</i> | CBF handle. |
| <i>datablockname</i> | Pointer to the destination data block name pointer. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.29 **cbf_find_datablock**

2.3.43 **cbf_category_name**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_category_name (cbf_handle handle, const char **categoryname);
```

DESCRIPTION

cbf_category_name sets **categoryname* to point to the name of the current category of the current data block.

The category name will be valid as long as the category exists.

The name must not be modified by the program in any way.

ARGUMENTS

| | |
|---------------------|---|
| <i>handle</i> | CBF handle. |
| <i>categoryname</i> | Pointer to the destination category name pointer. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.30 **cbf_find_category**

2.3.44 **cbf_column_name**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_column_name (cbf_handle handle, const char **columnname);
```

DESCRIPTION

cbf_column_name sets **columnname* to point to the name of the current column of the current category.

The column name will be valid as long as the column exists.

The name must not be modified by the program in any way.

ARGUMENTS

| | |
|-------------------|---|
| <i>handle</i> | CBF handle. |
| <i>columnname</i> | Pointer to the destination column name pointer. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.31 **cbf_find_column**

2.3.45 **cbf_row_number**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_row_number (cbf_handle handle, unsigned int *row);
```

DESCRIPTION

cbf_row_number sets **row* to the number of the current row of the current category.

ARGUMENTS

| | |
|---------------|--|
| <i>handle</i> | CBF handle. |
| <i>row</i> | Pointer to the destination row number. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.41 **cbf_select_row**

2.3.46 **cbf_get_value**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_get_value (cbf_handle handle, const char **value);
```

DESCRIPTION

cbf_get_value sets **value* to point to the ASCII value of the item at the current column and row.

If the *value* is not ASCII, the function returns CBF_BINARY.

The *value* will be valid as long as the item exists and has not been set to a new value.

The *value* must not be modified by the program in any way.

ARGUMENTS

| | |
|---------------|---|
| <i>handle</i> | CBF handle. |
| <i>value</i> | Pointer to the destination value pointer. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

- 2.3.47 **cbf_set_value**
- 2.3.48 **cbf_get_integervalue**
- 2.3.50 **cbf_get_doublevalue**
- 2.3.52 **cbf_get_integerarrayparameters**
- 2.3.53 **cbf_get_integerarray**

2.3.47 **cbf_set_value**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_set_value (cbf_handle handle, const char *value);
```

DESCRIPTION

cbf_set_value sets the item at the current column and row to the ASCII value *value*.

ARGUMENTS

| | |
|---------------|--------------|
| <i>handle</i> | CBF handle. |
| <i>value</i> | ASCII value. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.46 **cbf_get_value**
2.3.49 **cbf_set_integervalue**
2.3.51 **cbf_set_doublevalue**
2.3.54 **cbf_set_integerarray**

2.3.48 **cbf_get_integervalue**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_get_integervalue (cbf_handle handle, int *number);
```

DESCRIPTION

cbf_get_integervalue sets **number* to the value of the ASCII item at the current column and row interpreted as a decimal integer.

If the value is not ASCII, the function returns CBF_BINARY.

ARGUMENTS

| | |
|---------------|------------------------|
| <i>handle</i> | CBF handle. |
| <i>number</i> | pointer to the number. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.46 **cbf_get_value**
2.3.49 **cbf_set_integervalue**
2.3.50 **cbf_get_doublevalue**
2.3.52 **cbf_get_integerarrayparameters**
2.3.53 **cbf_get_integerarray**

2.3.49 **cbf_set_integervalue**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_set_integervalue (cbf_handle handle, int number);
```

DESCRIPTION

cbf_set_integervalue sets the item at the current column and row to the integer value *number* written as a decimal ASCII string.

ARGUMENTS

| | |
|---------------|----------------|
| <i>handle</i> | CBF handle. |
| <i>number</i> | Integer value. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.46 **cbf_get_value**
2.3.47 **cbf_set_value**
2.3.48 **cbf_get_integervalue**
2.3.49 **cbf_set_integervalue**
2.3.51 **cbf_set_doublevalue**
2.3.54 **cbf_set_integerarray**

2.3.50 **cbf_get_doublevalue**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_get_doublevalue (cbf_handle handle, double *number);
```

DESCRIPTION

cbf_get_doublevalue sets **number* to the value of the ASCII item at the current column and row interpreted as a decimal floating-point number.

If the value is not ASCII, the function returns CBF_BINARY.

ARGUMENTS

| | |
|---------------|------------------------------------|
| <i>handle</i> | CBF handle. |
| <i>number</i> | Pointer to the destination number. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.46 **cbf_get_value**
2.3.48 **cbf_get_integervalue**
2.3.51 **cbf_set_doublevalue**
2.3.52 **cbf_get_integerarrayparameters**
2.3.53 **cbf_get_integerarray**

2.3.51 **cbf_set_doublevalue**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_set_doublevalue (cbf_handle handle, const char *format, double number);
```

DESCRIPTION

cbf_set_doublevalue sets the item at the current column and row to the floating-point value *number* written as an ASCII string with the format specified by *format* as appropriate for the printf function.

ARGUMENTS

| | |
|---------------|------------------------|
| <i>handle</i> | CBF handle. |
| <i>format</i> | Format for the number. |
| <i>number</i> | Floating-point value. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.46 **cbf_get_value**
2.3.47 **cbf_set_value**
2.3.49 **cbf_set_integervalue**
2.3.50 **cbf_get_doublevalue**
2.3.54 **cbf_set_integerarray**

2.3.52 **cbf_get_integerarrayparameters**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_get_integerarrayparameters (cbf_handle handle, unsigned int * compression, int * binary_id,  
size_t * elsize, int * elsigned, int * elunsigned, size_t * elements, int * minelement, int * maxelement);
```

DESCRIPTION

cbf_get_integerarrayparameters sets **compression*, **binary_id*, **elsize*, **elsigned*, **elunsigned*, **elements*, **minelement* and **maxelement* to values read from the binary value of the item at the current column and row. This provides all the arguments needed for a subsequent call to **cbf_set_integerarray**, if a copy of the array is to be made into another CIF or CBF.

If the value is not binary, the function returns CBF_ASCII.

ARGUMENTS

| | |
|--------------------|---|
| <i>handle</i> | CBF handle. |
| <i>compression</i> | Compression method used. |
| <i>elsize</i> | Size in bytes of each array element. |
| <i>binary_id</i> | Pointer to the destination integer binary identifier. |
| <i>elsigned</i> | Pointer to an integer. Set to 1 if the elements can be read as signed integers. |
| <i>elunsigned</i> | Pointer to an integer. Set to 1 if the elements can be read as unsigned integers. |
| <i>elements</i> | Pointer to the destination number of elements. |
| <i>minelement</i> | Pointer to the destination smallest element. |
| <i>maxelement</i> | Pointer to the destination largest element. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.46 **cbf_get_value**
2.3.48 **cbf_get_integervalue**
2.3.50 **cbf_get_doublevalue**
2.3.53 **cbf_get_integerarray**
2.3.54 **cbf_set_integerarray**

2.3.53 **cbf_get_integerarray**

PROTOTYPE

#include "cbf.h"

```
int cbf_get_integerarray (cbf_handle handle, int *binary_id, void *array, size_t elsize, int elsigned,  
size_t elements, size_t *elements_read);
```

DESCRIPTION

cbf_get_integerarray reads the binary value of the item at the current column and row into an integer *array*. The array consists of elements *elements* of *elsize* bytes each, starting at *array*. The elements are signed if *elsigned* is non-0 and unsigned otherwise. **binary_id* is set to the binary section identifier and **elements_read* to the number of elements actually read.

If any element in the binary data can't fit into the destination element, the destination is set the nearest possible value.

If the value is not binary, the function returns CBF_ASCII.

If the requested number of elements can't be read, the function will read as many as it can and then return CBF_ENDOFDATA.

Currently, the destination *array* must consist of chars, shorts or ints (signed or unsigned). If *elsize* is not equal to sizeof(char), sizeof(short) or sizeof(int), the function returns CBF_ARGUMENT.

An additional restriction in the current version of CBFlib is that values too large to fit in an int are not correctly decompressed. As an example, if the machine with 32-bit ints is reading an array containing a value outside the range 0 .. 2³²-1 (unsigned) or -2³¹ .. 2³¹-1 (signed), the array will not be correctly decompressed. This restriction will be removed in a future release.

ARGUMENTS

| | |
|----------------------|--|
| <i>handle</i> | CBF handle. |
| <i>binary_id</i> | Pointer to the destination integer binary identifier. |
| <i>array</i> | Pointer to the destination array. |
| <i>elsize</i> | Size in bytes of each destination array element. |
| <i>elsigned</i> | Set to non-0 if the destination array elements are signed. |
| <i>elements</i> | The number of elements to read. |
| <i>elements_read</i> | Pointer to the destination number of elements actually read. |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.46 **cbf_get_value**
2.3.48 **cbf_get_integervalue**
2.3.50 **cbf_get_doublevalue**
2.3.52 **cbf_get_integerarrayparameters**
2.3.54 **cbf_set_integerarray**

2.3.54 **cbf_set_integerarray**

PROTOTYPE

```
#include "cbf.h"
```

```
int cbf_set_integerarray (cbf_handle handle, unsigned int compression, int binary_id, void *array, size_t elsize, int elsigned, size_t elements);
```

DESCRIPTION

cbf_set_integerarray sets the binary value of the item at the current column and row to an integer *array*. The *array* consists of *elements* of *elsize* bytes each, starting at *array*. The elements are signed if *elsigned* is non-0 and unsigned otherwise. *binary_id* is the binary section identifier.

The *array* will be compressed using the compression scheme specified by *compression*. Currently, the available schemes are:

| | |
|---------------|---|
| CBF_CANONICAL | Canonical-code compression (section 3.3.1) |
| CBF_PACKED | CCP4-style packing (section 3.3.2) |
| CBF_NONE | No compression. NOTE: This scheme is by far the slowest of the three and uses much more disk space. It is intended for routine use with small arrays only. With large arrays (like images) it should be used only for debugging. |

The values compressed are limited to 64 bits. If any element in the *array* is larger than 64 bits, the value compressed is the nearest 64-bit value.

Currently, the source *array* must consist of chars, shorts or ints (signed or unsigned). If *elsize* is not equal to sizeof (char), sizeof (short) or sizeof (int), the function returns CBF_ARGUMENT.

ARGUMENTS

| | |
|--------------------|---|
| <i>handle</i> | CBF handle. |
| <i>compression</i> | Compression method to use. |
| <i>binary_id</i> | Integer binary identifier. |
| <i>array</i> | Pointer to the source array. |
| <i>elsize</i> | Size in bytes of each source array element. |
| <i>elsigned</i> | Set to non-0 if the source array elements are signed. |
| <i>elements</i> | The number of elements in the <i>array</i> . |

RETURN VALUE

Returns an error code on failure or 0 for success.

SEE ALSO

2.3.47 **cbf_set_value**
2.3.49 **cbf_set_integervalue**
2.3.51 **cbf_set_doublevalue**
2.3.52 **cbf_get_integerarrayparameters**
2.3.53 **cbf_get_integerarray**

2.3.55 **cbf_failnez**

DEFINITION

```
#include "cbf.h"
```

```
#define cbf_failnez(f) {int err; err = (f); if (err) return err; }
```

DESCRIPTION

cbf_failnez is a macro used for error propagation throughout CBFLib. **cbf_failnez** executes the function *f* and saves the returned error value. If the error value is non-0, **cbf_failnez** executes a return with the error value as argument. If CBFDEBUG is defined, then a report of the error is also printed to the standard error stream, stderr, in the form

CBFLib error *f* in "symbol"

where *f* is the decimal value of the error and symbol is the symbolic form.

ARGUMENTS

f Integer error value.

SEE ALSO

2.3.56 **cbf_onfailnez**

2.3.56 **cbf_onfailnez**

DEFINITION

```
#include "cbf.h"
```

```
#define cbf_onfailnez(f,c) {int err; err = (f); if (err) {{c; }return err; }}
```

DESCRIPTION

cbf_onfailnez is a macro used for error propagation throughout CBFLib. **cbf_onfailnez** executes the function *f* and saves the returned error value. If the error value is non-0, **cbf_failnez** executes first the statement *c* and then a return with the error value as argument. If CBFDEBUG is defined, then a report of the error is also printed to the standard error stream, stderr, in the form

CBFLib error *f* in "symbol"

where *f* is the decimal value of the error and symbol is the symbolic form.

ARGUMENTS

| | |
|----------|----------------------------------|
| <i>f</i> | integer function to execute. |
| <i>c</i> | statement to execute on failure. |

SEE ALSO

2.3.55 **cbf_failnez**

2.4 High-level function prototypes

2.4.1 **cbf_read_template**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_read_template (cbf_handle handle, FILE *file);
```

DESCRIPTION

cbf_read_template reads the CBF or CIF file *file* into the CBF object specified by *handle* and selects the first datablock as the current datablock.

ARGUMENTS

| | |
|---------------|-------------------------------|
| <i>handle</i> | Pointer to a CBF handle. |
| <i>file</i> | Pointer to a file descriptor. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.2 **cbf_get_diffn_id**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_get_diffn_id (cbf_handle handle, const char **diffn_id);
```

DESCRIPTION

cbf_get_diffn_id sets **diffn_id* to point to the ASCII value of the “diffn.id” entry.

The *diffn_id* will be valid as long as the item exists and has not been set to a new value.

The *diffn_id* must not be modified by the program in any way.

ARGUMENTS

| | |
|-----------------|---|
| <i>handle</i> | CBF handle. |
| <i>diffn_id</i> | Pointer to the destination value pointer. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.3 **cbf_set_diffn_id**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_set_diffn_id (cbf_handle handle, const char *diffn_id);
```

DESCRIPTION

cbf_set_diffn_id sets the “diffn.id” entry of the current datablock to the ASCII value *diffn_id*.

This function also changes corresponding “diffn_id” entries in the “diffn_source”, “diffn_radiation”, “diffn_detector” and “diffn_measurement” categories.

ARGUMENTS

| | |
|-----------------|--------------|
| <i>handle</i> | CBF handle. |
| <i>diffn_id</i> | ASCII value. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.4 **cbf_get_crystal_id**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_get_crystal_id (cbf_handle handle, const char **crystal_id);
```

DESCRIPTION

cbf_get_crystal_id sets **crystal_id* to point to the ASCII value of the “diffn.crystal_id” entry.

If the *value* is not ASCII, the function returns CBF_BINARY.

The *value* will be valid as long as the item exists and has not been set to a new value.

The *value* must not be modified by the program in any way.

ARGUMENTS

| | |
|-------------------|---|
| <i>handle</i> | CBF handle. |
| <i>crystal_id</i> | Pointer to the destination value pointer. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.5 **cbf_set_crystal_id**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_set_crystal_id (cbf_handle handle, const char *crystal_id);
```

DESCRIPTION

cbf_set_crystal_id sets the “diffn.crystal_id” entry to the ASCII value *crystal_id*.

ARGUMENTS

| | |
|-------------------|--------------|
| <i>handle</i> | CBF handle. |
| <i>crystal_id</i> | ASCII value. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.6 **cbf_get_wavelength**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_get_wavelength (cbf_handle handle, double *wavelength);
```

DESCRIPTION

cbf_get_wavelength sets **wavelength* to the current wavelength in Å.

ARGUMENTS

| | |
|-------------------|-----------------------------|
| <i>handle</i> | CBF handle. |
| <i>wavelength</i> | Pointer to the destination. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.7 **cbf_set_wavelength**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_set_wavelength (cbf_handle handle, double wavelength);
```

DESCRIPTION

cbf_set_wavelength sets the current wavelength in Å to *wavelength*.

ARGUMENTS

| | |
|-------------------|------------------|
| <i>handle</i> | CBF handle. |
| <i>wavelength</i> | Wavelength in Å. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.8 **cbf_get_polarization**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_get_polarization (cbf_handle handle, double *polarizn_source_ratio,  
                        double *polarizn_source_norm);
```

DESCRIPTION

cbf_get_polarization sets **polarizn_source_ratio* and **polarizn_source_norm* to the corresponding source polarization parameters.

Either destination pointer may be NULL.

ARGUMENTS

| | |
|------------------------------|---|
| <i>handle</i> | CBF handle. |
| <i>polarizn_source_ratio</i> | Pointer to the destination <i>polarizn_source_ratio</i> . |
| <i>polarizn_source_norm</i> | Pointer to the destination <i>polarizn_source_norm</i> . |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.9 **cbf_set_polarization**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_set_polarization (cbf_handle handle, double polarizn_source_ratio,  
                        double polarizn_source_norm);
```

DESCRIPTION

cbf_set_polarization sets the source polarization to the values specified by *polarizn_source_ratio* and *polarizn_source_norm*.

ARGUMENTS

| | |
|------------------------------|---|
| <i>handle</i> | CBF handle. |
| <i>polarizn_source_ratio</i> | New value of <i>polarizn_source_ratio</i> . |
| <i>polarizn_source_norm</i> | New value of <i>polarizn_source_norm</i> . |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.10 **cbf_get_divergence**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_get_divergence (cbf_handle handle, double *div_x_source, double *div_y_source,  
                        double *div_x_y_source);
```

DESCRIPTION

cbf_get_divergence sets **div_x_source*, **div_y_source* and **div_x_y_source* to the corresponding source divergence parameters.

Any of the destination pointers may be NULL.

ARGUMENTS

| | |
|-----------------------|--|
| <i>handle</i> | CBF handle. |
| <i>div_x_source</i> | Pointer to the destination <i>div_x_source</i> . |
| <i>div_y_source</i> | Pointer to the destination <i>div_y_source</i> . |
| <i>div_x_y_source</i> | Pointer to the destination <i>div_x_y_source</i> . |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.11 **cbf_set_divergence**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_set_divergence (cbf_handle handle, double div_x_source, double div_y_source,  
                        double div_x_y_source);
```

DESCRIPTION

cbf_set_divergence sets the source divergence parameters to the values specified by *div_x_source*, *div_y_source* and *div_x_y_source*.

ARGUMENTS

| | |
|-----------------------|--------------------------------------|
| <i>handle</i> | CBF handle. |
| <i>div_x_source</i> | New value of <i>div_x_source</i> . |
| <i>div_y_source</i> | New value of <i>div_y_source</i> . |
| <i>div_x_y_source</i> | New value of <i>div_x_y_source</i> . |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.12 **cbf_count_elements**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_count_elements (cbf_handle handle, unsigned int *elements);
```

DESCRIPTION

cbf_count_elements sets **elements* to the number of detector elements.

ARGUMENTS

| | |
|-----------------|-----------------------------------|
| <i>handle</i> | CBF handle. |
| <i>elements</i> | Pointer to the destination count. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.13 **cbf_get_element_id**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_get_element_id (cbf_handle handle, unsigned int element_number, const char **element_id);
```

DESCRIPTION

cbf_get_element_id sets **element_id* to point to the ASCII value of the *element_number*'th "diffn_data_frame.detector_element_id" entry, counting from 0.

If the detector element does not exist, the function returns CBF_NOTFOUND.

The *element_id* will be valid as long as the item exists and has not been set to a new value.

The *element_id* must not be modified by the program in any way.

ARGUMENTS

| | |
|-----------------------|---|
| <i>handle</i> | CBF handle. |
| <i>element_number</i> | The number of the detector element counting from 0 by order of appearance in the "diffn_data_frame" category. |
| <i>element_id</i> | Pointer to the destination. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.14 **cbf_get_gain**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_get_gain (cbf_handle handle, unsigned int element_number, double *gain, double *gain_esd);
```

DESCRIPTION

cbf_get_gain sets **gain* and **gain_esd* to the corresponding gain parameters for element number *element_number*.

Either of the destination pointers may be NULL.

ARGUMENTS

| | |
|-----------------------|---|
| <i>handle</i> | CBF handle. |
| <i>element_number</i> | The number of the detector element counting from 0 by order of appearance in the “diffn_data_frame” category. |
| <i>gain</i> | Pointer to the destination gain. |
| <i>gain_esd</i> | Pointer to the destination gain_esd. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.15 **cbf_set_gain**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_set_gain (cbf_handle handle, unsigned int element_number, double gain, double gain_esd);
```

DESCRIPTION

cbf_set_gain sets the gain of element number *element_number* to the values specified by *gain* and *gain_esd*.

ARGUMENTS

| | |
|-----------------------|---|
| <i>handle</i> | CBF handle. |
| <i>element_number</i> | The number of the detector element counting from 0 by order of appearance in the “diffn_data_frame” category. |
| <i>gain</i> | New gain value. |
| <i>gain_esd</i> | New gain_esd value. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.16 **cbf_get_overload**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_get_overload (cbf_handle handle, unsigned int element_number, double *overload);
```

DESCRIPTION

cbf_get_overload sets **overload* to the overload value for element number *element_number*.

ARGUMENTS

| | |
|-----------------------|---|
| <i>handle</i> | CBF handle. |
| <i>element_number</i> | The number of the detector element counting from 0 by order of appearance in the “diffn_data_frame” category. |
| <i>overload</i> | Pointer to the destination overload. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.17 **cbf_set_overload**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_set_overload (cbf_handle handle, unsigned int element_number, double overload);
```

DESCRIPTION

cbf_set_overload sets the overload value of element number *element_number* to *overload*.

ARGUMENTS

| | |
|-----------------------|---|
| <i>handle</i> | CBF handle. |
| <i>element_number</i> | The number of the detector element counting from 0 by order of appearance in the “diffn_data_frame” category. |
| <i>overload</i> | New overload value. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.18 **cbf_get_integration_time**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_get_integration_time (cbf_handle handle, unsigned int reserved, double *time);
```

DESCRIPTION

cbf_get_integration_time sets **time* to the integration time in seconds. The parameter *reserved* is presently unused and should be set to 0.

ARGUMENTS

| | |
|-----------------|--|
| <i>handle</i> | CBF handle. |
| <i>reserved</i> | Unused. Any value other than 0 is invalid. |
| <i>time</i> | Pointer to the destination time. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.19 **cbf_set_integration_time**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_set_integration_time (cbf_handle handle, unsigned int reserved, double time);
```

DESCRIPTION

cbf_set_integration_time sets the integration time in seconds to the value specified by *time*. The parameter *reserved* is presently unused and should be set to 0.

ARGUMENTS

| | |
|-----------------|--|
| <i>handle</i> | CBF handle. |
| <i>reserved</i> | Unused. Any value other than 0 is invalid. |
| <i>time</i> | Integration time in seconds. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.20 **cbf_get_timestamp**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_get_timestamp (cbf_handle handle, unsigned int reserved, double *time, int *timezone);
```

DESCRIPTION

cbf_get_timestamp sets **time* to the collection timestamp in seconds since January 1 1970. **timezone* is set to timezone difference from UTC in minutes. The parameter *reserved* is presently unused and should be set to 0.

Either of the destination pointers may be NULL.

ARGUMENTS

| | |
|-----------------|--|
| <i>handle</i> | CBF handle. |
| <i>reserved</i> | Unused. Any value other than 0 is invalid. |
| <i>time</i> | Pointer to the destination collection timestamp. |
| <i>timezone</i> | Pointer to the destination timezone difference. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.21 **cbf_set_timestamp**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_set_timestamp (cbf_handle handle, unsigned int reserved, double time, int timezone,  
double precision);
```

DESCRIPTION

cbf_set_timestamp sets the collection timestamp in seconds since January 1 1970 to the value specified by *time*. The timezone difference from UTC in minutes is set to *timezone*. If no timezone is desired, *timezone* should be CBF_NOTIMEZONE. The parameter *reserved* is presently unused and should be set to 0.

The precision of the new timestamp is specified by the value *precision* in seconds. If *precision* is 0, the saved timestamp is assumed accurate to 1 second.

ARGUMENTS

| | |
|------------------|--|
| <i>handle</i> | CBF handle. |
| <i>reserved</i> | Unused. Any value other than 0 is invalid. |
| <i>time</i> | Timestamp in seconds since January 1 1970. |
| <i>timezone</i> | Timezone difference from UTC in minutes or CBF_NOTIMEZONE. |
| <i>precision</i> | Timestamp precision in seconds. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.22 cbf_get_datestamp

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_get_datestamp (cbf_handle handle, unsigned int reserved, int *year, int *month, int *day,  
int *hour, int *minute, double *second, int *timezone);
```

DESCRIPTION

cbf_get_datestamp sets **year*, **month*, **day*, **hour*, **minute* and **second* to the corresponding values of the collection timestamp. **timezone* is set to timezone difference from UTC in minutes. The parameter *reserved* is presently unused and should be set to 0.

Any of the destination pointers may be NULL.

ARGUMENTS

| | |
|-----------------|---|
| <i>handle</i> | CBF handle. |
| <i>reserved</i> | Unused. Any value other than 0 is invalid. |
| <i>year</i> | Pointer to the destination timestamp year. |
| <i>month</i> | Pointer to the destination timestamp month (1-12). |
| <i>day</i> | Pointer to the destination timestamp day (1-31). |
| <i>hour</i> | Pointer to the destination timestamp hour (0-23). |
| <i>minute</i> | Pointer to the destination timestamp minute (0-59). |
| <i>second</i> | Pointer to the destination timestamp second (0-60.0). |
| <i>timezone</i> | Pointer to the destination timezone difference from UTC in minutes. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.23 **cbf_set_datestamp**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_set_datestamp (cbf_handle handle, unsigned int reserved, int year, int month, int day, int hour,  
int minute, double second, int timezone, double precision);
```

DESCRIPTION

cbf_set_datestamp sets the collection timestamp in seconds since January 1 1970 to the value specified by *time*. The timezone difference from UTC in minutes is set to *timezone*. If no timezone is desired, *timezone* should be CBF_NOTIMEZONE. The parameter *reserved* is presently unused and should be set to 0.

The precision of the new timestamp is specified by the value *precision* in seconds. If *precision* is 0, the saved timestamp is assumed accurate to 1 second.

ARGUMENTS

| | |
|------------------|--|
| <i>handle</i> | CBF handle. |
| <i>reserved</i> | Unused. Any value other than 0 is invalid. |
| <i>time</i> | Timestamp in seconds since January 1 1970. |
| <i>timezone</i> | Timezone difference from UTC in minutes or CBF_NOTIMEZONE. |
| <i>precision</i> | Timestamp precision in seconds. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.24 **cbf_set_current_timestamp**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_set_current_timestamp (cbf_handle handle, unsigned int reserved, int timezone)
```

DESCRIPTION

cbf_set_current_timestamp sets the collection timestamp to the current time. The timezone difference from UTC in minutes is set to *timezone*. If no timezone is desired, *timezone* should be CBF_NOTIMEZONE. If no timezone is used, the timestamp will be UTC. The parameter *reserved* is presently unused and should be set to 0.

The new timestamp will have a precision of 1 second.

ARGUMENTS

| | |
|-----------------|--|
| <i>handle</i> | CBF handle. |
| <i>reserved</i> | Unused. Any value other than 0 is invalid. |
| <i>timezone</i> | Timezone difference from UTC in minutes or CBF_NOTIMEZONE. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.25 **cbf_get_image_size**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_get_image_size (cbf_handle handle, unsigned int reserved, unsigned int element_number,  
                        size_t *ndim1, size_t *ndim2);
```

DESCRIPTION

cbf_get_image_size sets **ndim1* and **ndim2* to the slow and fast dimensions of the image array for element number *element_number*. If the array is 1-dimensional, **ndim1* will be set to the array size and **ndim2* will be set to 1.

Either of the destination pointers may be NULL.

The parameter *reserved* is presently unused and should be set to 0.

ARGUMENTS

| | |
|-----------------------|---|
| <i>handle</i> | CBF handle. |
| <i>reserved</i> | Unused. Any value other than 0 is invalid. |
| <i>element_number</i> | The number of the detector element counting from 0 by order of appearance in the “diffn_data_frame” category. |
| <i>ndim1</i> | Pointer to the destination slow dimension. |
| <i>ndim2</i> | Pointer to the destination fast dimension. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.26 cbf_get_image

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_get_image (cbf_handle handle, unsigned int reserved, unsigned int element_number, void *array,  
                  size_t elsize, int elsign, size_t ndim1, size_t ndim2);
```

DESCRIPTION

cbf_get_image reads the image array for element number *element_number* into an array. The array consists of $ndim1 \times ndim2$ elements of *elsize* bytes each, starting at *array*. The elements are signed if *elsigned* is non-0 and unsigned otherwise.

If the array is 1-dimensional, *ndim1* should be the array size and *ndim2* should be set to 1.

If any element in the binary data can't fit into the destination element, the destination is set the nearest possible value.

If the value is not binary, the function returns CBF_ASCII.

If the requested number of elements can't be read, the function will read as many as it can and then return CBF_ENDOFDATA.

Currently, the destination *array* must consist of chars, shorts or ints (signed or unsigned). If *elsize* is not equal to sizeof (char), sizeof (short) or sizeof (int), the function returns CBF_ARGUMENT.

An additional restriction in the current version of CBFlib is that values too large to fit in an int are not correctly decompressed. As an example, if the machine with 32-bit ints is reading an array containing a value outside the range $0 \dots 2^{32}-1$ (unsigned) or $-2^{31} \dots 2^{31}-1$ (signed), the array will not be correctly decompressed. This restriction will be removed in a future release.

The parameter *reserved* is presently unused and should be set to 0.

ARGUMENTS

| | |
|-----------------------|--|
| <i>handle</i> | CBF handle. |
| <i>reserved</i> | Unused. Any value other than 0 is invalid. |
| <i>element_number</i> | The number of the detector element counting from 0 by order of appearance in the "diffrn_data_frame" category. |
| <i>array</i> | Pointer to the destination array. |
| <i>elsize</i> | Size in bytes of each destination array element. |
| <i>elsigned</i> | Set to non-0 if the destination array elements are signed. |
| <i>ndim1</i> | Slow array dimension. |
| <i>ndim2</i> | Fast array dimension. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.27 **cbf_set_image**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_set_image (cbf_handle handle, unsigned int reserved, unsigned int element_number,  
                  unsigned int compression, void *array, size_t elsize, int elsign, size_t ndim1, size_t ndim2);
```

DESCRIPTION

cbf_set_image writes the image array for element number *element_number*. The array consists of *ndim1* × *ndim2* elements of *elsize* bytes each, starting at *array*. The elements are signed if *elsigned* is non-0 and unsigned otherwise.

If the array is 1-dimensional, *ndim1* should be the array size and *ndim2* should be set to 1.

The *array* will be compressed using the compression scheme specified by *compression*. Currently, the available schemes are:

| | |
|---------------|--|
| CBF_CANONICAL | Canonical-code compression (section 3.3.1) |
| CBF_PACKED | CCP4-style packing (section 3.3.2) |
| CBF_NONE | No compression. |

The values compressed are limited to 64 bits. If any element in the *array* is larger than 64 bits, the value compressed is the nearest 64-bit value.

Currently, the source *array* must consist of chars, shorts or ints (signed or unsigned). If *elsize* is not equal to sizeof (char), sizeof (short) or sizeof (int), the function returns CBF_ARGUMENT.

The parameter *reserved* is presently unused and should be set to 0.

ARGUMENTS

| | |
|-----------------------|---|
| <i>handle</i> | CBF handle. |
| <i>reserved</i> | Unused. Any value other than 0 is invalid. |
| <i>element_number</i> | The number of the detector element counting from 0 by order of appearance in the “diffn_data_frame” category. |
| <i>compression</i> | Compression type. |
| <i>array</i> | Pointer to the destination array. |
| <i>elsize</i> | Size in bytes of each destination array element. |
| <i>elsigned</i> | Set to non-0 if the destination array elements are signed. |
| <i>ndim1</i> | Slow array dimension. |
| <i>ndim2</i> | Fast array dimension. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.28 **cbf_get_axis_setting**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_get_axis_setting (cbf_handle handle, unsigned int reserved, const char *axis_id, double *start,  
double *increment);
```

DESCRIPTION

cbf_get_axis_setting sets **start* and **increment* to the corresponding values of the axis *axis_id*.

Either of the destination pointers may be NULL.

The parameter *reserved* is presently unused and should be set to 0.

ARGUMENTS

| | |
|------------------|---|
| <i>handle</i> | CBF handle. |
| <i>reserved</i> | Unused. Any value other than 0 is invalid. |
| <i>axis_id</i> | Axis id. |
| <i>start</i> | Pointer to the destination start value. |
| <i>increment</i> | Pointer to the destination increment value. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.29 **cbf_set_axis_setting**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_set_axis_setting (cbf_handle handle, unsigned int reserved, const char *axis_id, double start,  
double increment);
```

DESCRIPTION

cbf_set_axis_setting sets the starting and increment values of the axis *axis_id* to *start* and *increment*.

The parameter *reserved* is presently unused and should be set to 0.

ARGUMENTS

| | |
|------------------|--|
| <i>handle</i> | CBF handle. |
| <i>reserved</i> | Unused. Any value other than 0 is invalid. |
| <i>axis_id</i> | Axis id. |
| <i>start</i> | Start value. |
| <i>increment</i> | Increment value. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.30 **cbf_construct_goniometer**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_construct_goniometer (cbf_handle handle, cbf_goniometer *goniometer);
```

DESCRIPTION

cbf_construct_goniometer constructs a goniometer object using the description in the CBF object *handle* and initialises the goniometer handle **goniometer*.

ARGUMENTS

| | |
|-------------------|---|
| <i>handle</i> | CBF handle. |
| <i>goniometer</i> | Pointer to the destination goniometer handle. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.31 **cbf_free_goniometer**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_free_goniometer (cbf_goniometer goniometer);
```

DESCRIPTION

cbf_free_goniometer destroys the goniometer object specified by *goniometer* and frees all associated memory.

ARGUMENTS

| | |
|-------------------|----------------------------|
| <i>goniometer</i> | Goniometer handle to free. |
|-------------------|----------------------------|

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.32 **cbf_get_rotation_axis**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_get_rotation_axis (cbf_goniometer goniometer, unsigned int reserved, double *vector1,  
                           double *vector2, double vector3);
```

DESCRIPTION

cbf_get_rotation_axis sets **vector1*, **vector2*, and **vector3* to the 3 components of the goniometer rotation axis used for the exposure.

Any of the destination pointers may be NULL.

The parameter *reserved* is presently unused and should be set to 0.

ARGUMENTS

| | |
|-------------------|---|
| <i>goniometer</i> | Goniometer handle. |
| <i>reserved</i> | Unused. Any value other than 0 is invalid. |
| <i>vector1</i> | Pointer to the destination <i>x</i> component of the rotation axis. |
| <i>vector2</i> | Pointer to the destination <i>y</i> component of the rotation axis. |
| <i>vector3</i> | Pointer to the destination <i>z</i> component of the rotation axis. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.33 **cbf_get_rotation_range**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_get_rotation_range (cbf_goniometer goniometer, unsigned int reserved, double *start,  
                           double *increment);
```

DESCRIPTION

cbf_get_rotation_range sets **start* and **increment* to the corresponding values of the goniometer rotation axis used for the exposure.

Either of the destination pointers may be NULL.

The parameter *reserved* is presently unused and should be set to 0.

ARGUMENTS

| | |
|-------------------|---|
| <i>goniometer</i> | Goniometer handle. |
| <i>reserved</i> | Unused. Any value other than 0 is invalid. |
| <i>start</i> | Pointer to the destination start value. |
| <i>increment</i> | Pointer to the destination increment value. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.34 **cbf_rotate_vector**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_rotate_vector (cbf_goniometer goniometer, unsigned int reserved, double ratio, double initial1,  
double initial2, double initial3, double *final1, double *final2, double *final3);
```

DESCRIPTION

cbf_rotate_vector sets **final1*, **final2*, and **final3* to the 3 components of the of the vector (*initial1*, *initial2*, *initial3*) after reorientation by applying the goniometer rotations. The value *ratio* specifies the goniometer setting and varies from 0.0 at the beginning of the exposure to 1.0 at the end, irrespective of the actual rotation range.

Any of the destination pointers may be NULL.

The parameter *reserved* is presently unused and should be set to 0.

ARGUMENTS

| | |
|-------------------|--|
| <i>goniometer</i> | Goniometer handle. |
| <i>reserved</i> | Unused. Any value other than 0 is invalid. |
| <i>ratio</i> | Goniometer setting. 0 = beginning of exposure, 1 = end. |
| <i>initial1</i> | <i>x</i> component of the initial vector. |
| <i>initial2</i> | <i>y</i> component of the initial vector. |
| <i>initial3</i> | <i>z</i> component of the initial vector. |
| <i>vector1</i> | Pointer to the destination <i>x</i> component of the final vector. |
| <i>vector2</i> | Pointer to the destination <i>y</i> component of the final vector. |
| <i>vector3</i> | Pointer to the destination <i>z</i> component of the final vector. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.35 cbf_get_reciprocal

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_get_reciprocal (cbf_goniometer goniometer, unsigned int reserved, double ratio,  
                        double wavelength, double real1, double real2, double real3, double *reciprocal1,  
                        double *reciprocal2, double *reciprocal3);
```

DESCRIPTION

cbf_get_reciprocal sets **reciprocal1*, **reciprocal2*, and **reciprocal3* to the 3 components of the of the reciprocal-space vector corresponding to the real-space vector (*real1*, *real2*, *real3*). The reciprocal-space vector is oriented to correspond to the goniometer setting with all axes at 0. The value *wavelength* is the wavelength in Å and the value *ratio* specifies the current goniometer setting and varies from 0.0 at the beginning of the exposure to 1.0 at the end, irrespective of the actual rotation range.

Any of the destination pointers may be NULL.

The parameter *reserved* is presently unused and should be set to 0.

ARGUMENTS

| | |
|--------------------|---|
| <i>goniometer</i> | Goniometer handle. |
| <i>reserved</i> | Unused. Any value other than 0 is invalid. |
| <i>ratio</i> | Goniometer setting. 0 = beginning of exposure, 1 = end. |
| <i>wavelength</i> | Wavelength in Å. |
| <i>real1</i> | <i>x</i> component of the real-space vector. |
| <i>real2</i> | <i>y</i> component of the real-space vector. |
| <i>real3</i> | <i>z</i> component of the real-space vector. |
| <i>reciprocal1</i> | Pointer to the destination <i>x</i> component of the reciprocal-space vector. |
| <i>reciprocal2</i> | Pointer to the destination <i>y</i> component of the reciprocal-space vector. |
| <i>reciprocal3</i> | Pointer to the destination <i>z</i> component of the reciprocal-space vector. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.36 **cbf_construct_detector**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_construct_detector (cbf_handle handle, cbf_detector *detector, unsigned int element_number);
```

DESCRIPTION

cbf_construct_detector constructs a detector object for detector element number *element_number* using the description in the CBF object *handle* and initialises the detector handle **detector*.

ARGUMENTS

| | |
|-----------------------|---|
| <i>handle</i> | CBF handle. |
| <i>detector</i> | Pointer to the destination detector handle. |
| <i>element_number</i> | The number of the detector element counting from 0 by order of appearance in the “diffn_data_frame” category. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.37 **cbf_free_detector**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_free_detector (cbf_detector detector);
```

DESCRIPTION

cbf_free_detector destroys the detector object specified by *detector* and frees all associated memory.

ARGUMENTS

detector Detector handle to free.

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.38 **cbf_get_beam_center**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_get_beam_center (cbf_detector detector, double *index1, double *index2, double *center1,  
                        double *center2);
```

DESCRIPTION

cbf_get_beam_center sets **center1* and **center2* to the displacements in mm along the detector axes from pixel (0, 0) to the point at which the beam intersects the detector and **index1* and **index2* to the corresponding indices.

Any of the destination pointers may be NULL.

ARGUMENTS

| | |
|-----------------|--|
| <i>detector</i> | Detector handle. |
| <i>index1</i> | Pointer to the destination slow index. |
| <i>index2</i> | Pointer to the destination fast index. |
| <i>center1</i> | Pointer to the destination displacement along the slow axis. |
| <i>center2</i> | Pointer to the destination displacement along the fast axis. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.39 **cbf_get_detector_distance**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_get_detector_distance (cbf_detector detector, double *distance);
```

DESCRIPTION

cbf_get_detector_distance sets **distance* to the nearest distance from the sample position to the detector plane.

ARGUMENTS

| | |
|-----------------|--------------------------------------|
| <i>detector</i> | Detector handle. |
| <i>distance</i> | Pointer to the destination distance. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.40 **cbf_get_detector_normal**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_get_detector_normal (cbf_detector detector, double *normal1, double *normal2,  
                             double *normal3);
```

DESCRIPTION

cbf_get_detector_normal sets **normal1*, **normal2*, and **normal3* to the 3 components of the of the normal vector to the detector plane. The vector is normalized.

Any of the destination pointers may be NULL.

ARGUMENTS

| | |
|-----------------|---|
| <i>detector</i> | Detector handle. |
| <i>normal1</i> | Pointer to the destination <i>x</i> component of the normal vector. |
| <i>normal2</i> | Pointer to the destination <i>y</i> component of the normal vector. |
| <i>normal3</i> | Pointer to the destination <i>z</i> component of the normal vector. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.41 **cbf_get_pixel_coordinates**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_get_pixel_coordinates (cbf_detector detector, double index1, double index2, double *coordinate1,  
double *coordinate2, double *coordinate3);
```

DESCRIPTION

cbf_get_pixel_coordinates sets **coordinate1*, **coordinate2*, and **coordinate3* to the vector position of pixel (*index1*, *index2*) on the detector surface. If *index1* and *index2* are integers then the coordinates correspond to the center of a pixel.

Any of the destination pointers may be NULL.

ARGUMENTS

| | |
|--------------------|--|
| <i>detector</i> | Detector handle. |
| <i>index1</i> | Slow index. |
| <i>index2</i> | Fast index. |
| <i>coordinate1</i> | Pointer to the destination <i>x</i> component. |
| <i>coordinate2</i> | Pointer to the destination <i>y</i> component. |
| <i>coordinate3</i> | Pointer to the destination <i>z</i> component. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.42 **cbf_get_pixel_normal**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_get_pixel_normal (cbf_detector detector, double index1, double index2, double *normal1,  
double *normal2, double *normal3);
```

DESCRIPTION

cbf_get_detector_normal sets **normal1*, **normal2*, and **normal3* to the 3 components of the of the normal vector to the pixel at (*index1*, *index2*). The vector is normalized.

Any of the destination pointers may be NULL.

ARGUMENTS

| | |
|-----------------|---|
| <i>detector</i> | Detector handle. |
| <i>index1</i> | Slow index. |
| <i>index2</i> | Fast index. |
| <i>normal1</i> | Pointer to the destination <i>x</i> component of the normal vector. |
| <i>normal2</i> | Pointer to the destination <i>y</i> component of the normal vector. |
| <i>normal3</i> | Pointer to the destination <i>z</i> component of the normal vector. |

RETURN VALUE

Returns an error code on failure or 0 for success.

2.4.43 **cbf_get_pixel_area**

PROTOTYPE

```
#include "cbf_simple.h"
```

```
int cbf_get_pixel_area (cbf_detector detector, double index1, double index2, double *area,  
                        double *projected_area);
```

DESCRIPTION

cbf_get_pixel_area sets **area* to the area of the pixel at (*index1*, *index2*) on the detector surface and **projected_area* to the apparent area of the pixel as viewed from the sample position.

Either of the destination pointers may be NULL.

ARGUMENTS

| | |
|-----------------------|---|
| <i>detector</i> | Detector handle. |
| <i>index1</i> | Slow index. |
| <i>index2</i> | Fast index. |
| <i>area</i> | Pointer to the destination area in mm ² . |
| <i>projected_area</i> | Pointer to the destination apparent area in mm ² . |

RETURN VALUE

Returns an error code on failure or 0 for success.

3. File format

3.1 General description

With the exception of the binary sections, a CBF file is an mmCIF-format ASCII file, so a CBF file with no binary sections is a CIF file. An imgCIF file has any binary sections encoded as CIF-format ASCII strings and is a CIF file whether or not it contains binary sections. In most cases, CBFlib can also be used to access normal CIF files as well as CBF and imgCIF files.

3.2 Format of the binary sections

Before getting to the binary data itself, there are some preliminaries to allow a smooth transition from the conventions of CIF to those of raw or encoded streams of "octets" (8-bit bytes). The binary data is given as the essential part of a specially formatted semicolon-delimited CIF multi-line text string. This text string is the value associated with the tag `"_array_data.data"`.

The specific format of the binary sections differs between an imgCIF and a CBF file.

3.2.1 Format of imgCIF binary sections

Each binary section is encoded as a ;-delimited string. Within the text string, the conventions developed for transmitting email messages including binary attachments are followed. There is secondary ASCII header information, formatted as Multipurpose Internet Mail Extensions (MIME) headers (see RFCs 2045-49 by Freed, et. al). The boundary marker for the beginning of all this is the special string

--CIF-BINARY-FORMAT-SECTION--

at the beginning of a line. The initial "--" says that this is a MIME boundary. We cannot put "###" in front of it and conform to MIME conventions. Immediately after the boundary marker are MIME headers, describing some useful information we will need to process the binary section. MIME headers can appear in different orders, and can be very confusing (look at the raw contents of a email message with attachments), but there is only one header which is has to be understood to process an imgCIF: "Content-Transfer-Encoding". If the value given on this header is "BINARY", this is a CBF and the data will be presented as raw binary, containing a count (in the header described in 3.2.2 Format of CBF binary sections) so we'll know when to start looking for more information.

If the value given for "Content-Transfer-Encoding" is one of the real encodings: "BASE64", "QUOTED-PRINTABLE", "X-BASE8", "X-BASE10" or "X-BASE16", the file is an imgCIF, and we'll need some other the other headers to process the encoded binary data properly. It is a good practice to give headers in all cases. The meanings of various encodings is given in the CBF extensions dictionary, cbfext98.dic.

The "Content-Type" header tells us what sort of data we have (currently always "application/octet-stream" for a miscellaneous stream of binary data) and, optionally, the conversions that were applied to the original data. In this case we have compressed the data with the "CBF-PACKED" algorithm.

The "X-Binary-ID" header should contain the same value as was given for `"_array_data.binary_id"`.

The "X-Binary-Size" header gives the expected size of the binary data. This is the size after any compressions, but before any ascii encodings. This is useful in making a simple check for a missing portion of this file. The 8 bytes for the Compression type (see below) are not counted in this field, so the value of "X-Binary-Size" is 8 less than the quantity in bytes 12-19 of raw binary data (3.2.2 Format of CBF binary

sections).

The optional "Content-MD5" header provides a much more sophisticated check on the integrity of the binary data. Note that this check value is applied to the data after the 8 bytes for the Compression type.

A blank line separator immediately precedes the start of the encoded binary data. Blank spaces may be added prior to the preceding "line separator" if desired (e.g. to force word or block alignment).

Because CBFLIB may jump forward in the file from the MIME header, the length of encoded data cannot be greater than the value defined by "X-Binary-Size" (except when "X-Binary-Size" is zero, which means that the size is unknown). At exactly the byte following the full binary section as defined by the length value is the end of binary section identifier. This consists of the line-termination sequence followed by:

```
--CIF-BINARY-FORMAT-SECTION----  
;
```

with each of these lines followed by a line-termination sequence. This brings us back into a normal CIF environment. This identifier is, in a sense, redundant because the binary data length value tells the a program how many bytes to jump over to the end of the binary data. This redundancy has been deliberately added for error checking, and for possible file recovery in the case of a corrupted file and this identifier must be present at the end of every block of binary data.

3.2.2 Format of CBF binary sections

In a CBF file, each binary section is encoded as a ;-delimited string, starting with an arbitrary number of pure-ASCII characters.

Note: For historical reasons, CIFlib has the option of writing simple header and footer sections: "START OF BINARY SECTION" at the start of a binary section and "END OF BINARY SECTION" at the end of a binary section, or writing MIME-type header and footer sections (3.2.1 Format of imgCIF binary sections). If the simple header is used, the actual ASCII text is ignored when the binary section is read. Use of the simple binary header is deprecated.

The MIME header is recommended.

Between the ASCII header and the actual CBF binary data is a series of bytes ("octets") to try to stop the listing of the header, bytes which define the binary identifier which should match the "*binary_id*" defined in the header, and bytes which define the length of the binary section.

| Octet | Hex | Decimal | Purpose |
|----------|-----|---------|----------------------------------|
| 1 | 0D | 12 | (ctrl-L) End of Page |
| 2 | 1A | 26 | (ctrl-Z) Stop listings in MS-DOS |
| 3 | 04 | 04 | (Ctrl-D) Stop listings in UNIX |
| 4 | D5 | 213 | Binary section begins |
| 5..5+n-1 | | | Binary data (n octets) |

NOTE: When a MIME header is used, only bytes 5..5+n-1 are considered in computing the size and the message digest, and only these bytes are encoded for the equivalent imgCIF file using the indicated Content-Transfer-Encoding.

If no MIME header has been requested (a deprecated use), then bytes 5 through 28 are used for three 8-byte words to hold the *binary_id*, the size and the compression type:

| | |
|--------|---|
| 5..12 | Binary Section Identifier (See <code>_array_data.binary_id</code>) 64-bit, little endian |
| 13..20 | The size (n) of the binary section in octets (i.e. the offset from octet 29 to the first byte following the data) |
| 21..28 | Compression type: |
| | CBF_NONE 0x0040 (64) |
| | CBF_CANONICAL 0x0050 (80) |
| | CBF_PACKED 0x0060 (96) |
| | CBF_BYTE_OFFSET 0x0070 (112) |
| | CBF_PREDICTOR 0x0080 (128) |
| ... | |

The binary data then follows in bytes 29 through 29+n-1.

The binary characters serve specific purposes:

- * The Control-L (from-feed) will terminate printing of the current page on most operating systems.
- * The Control-Z will stop the listing of the file on MS-DOS type operating systems.
- * The Control-D will stop the listing of the file on Unix type operating systems.
- * The unsigned byte value 213 (decimal) is binary 11010101. (Octal 325, and hexadecimal D5). This has the eighth bit set so can be used for error checking on 7-bit transmission. It is also asymmetric, but with the first bit also set in the case that the bit order could be reversed (which is not a known concern).
- * (The carriage return, line-feed pair before the `START_OF_BIN` and other lines can also be used to check that the file has not been corrupted e.g. by being sent by ftp in ASCII mode.)

At present three compression schemes are implemented are defined: CBF_NONE (for no compression), CBF_CANONICAL (for and entropy-coding scheme based on the canonical-code algorithm described by Moffat, et al. (International Journal of High Speed Electronics and Systems, Vol 8, No 1 (1997) 179-231)) and CBF_PACKED for a CCP4-style packing scheme. Other compression schemes will be added to this list in the future.

For historical reasons, CBFlib can read or write a binary string without a MIME header. The structure of a binary string with simple headers is:

| Byte | ASCII Symbol | Decimal Value | Description |
|------|-----------------|---------------|---|
| 1 | ; | 59 | Initial ; delimiter |
| 2 | carriage-return | 13 | The CBF new-line code is carriage-return, line-feed |
| 3 | line-feed | 10 | |
| 4 | S | 83 | |
| 5 | T | 84 | |
| 6 | A | 65 | |

| | | | |
|---------------|---------------------|-----------------------|--|
| 7 | R | 83 | |
| 8 | T | 84 | |
| 9 | | 32 | |
| 10 | O | 79 | |
| 11 | F | 70 | |
| 12 | | 32 | |
| 13 | B | 66 | |
| 14 | I | 73 | |
| 15 | N | 78 | |
| 16 | A | 65 | |
| 17 | R | 83 | |
| 18 | Y | 89 | |
| 19 | | 32 | |
| 20 | S | 83 | |
| 21 | E | 69 | |
| 22 | C | 67 | |
| 23 | T | 84 | |
| 24 | I | 73 | |
| 25 | O | 79 | |
| 26 | N | 78 | |
| 27 | carriage-return | 13 | |
| 28 | line-feed | 10 | |
| 29 | form-feed | 12 | |
| 30 | substitute | 26 | Stop the listing of the file in MS-DOS |
| 31 | end-of-transmission | 4 | Stop the listing of the file in unix |
| 32 | | 213 | First non-ASCII value |
| 33 .. 40 | | | Binary section identifier (64-bit little-endian) |
| 41 .. 48 | | | Offset from byte 57 to the first ASCII character following the binary data |
| 49 .. 56 | | | Compression type |
| 57 .. 57+ n-1 | | Binary data (n bytes) | |
| 57 + n | carriage-return | 13 | |
| 58 + n | line-feed | 10 | |
| 59 + n | E | 69 | |
| 60 + n | N | 78 | |
| 61 + n | D | 68 | |
| 62 + n | | 32 | |
| 63 + n | O | 79 | |
| 64 + n | F | 70 | |
| 65 + n | | 32 | |
| 66 + n | B | 66 | |
| 67 + n | I | 73 | |
| 68 + n | N | 78 | |
| 69 + n | A | 65 | |
| 70 + n | R | 83 | |
| 71 + n | Y | 89 | |
| 72 + n | | 32 | |
| 73 + n | S | 83 | |
| 74 + n | E | 69 | |
| 75 + n | C | 67 | |
| 76 + n | T | 84 | |
| 77 + n | I | 73 | |
| 78 + n | O | 79 | |

| | | | |
|--------|---------------------|----|-------------------|
| 79 + n | N | 78 | |
| 80 + n | carriage- return | 13 | |
| 81 + n | line-feed | 10 | |
| 82 + n | ; | 59 | Final ; delimiter |

3.3 Compression schemes

Two schemes for lossless compression of integer arrays (such as images) have been implemented in this version of CBFlib:

1. An entropy-encoding scheme using canonical coding
2. A CCP4-style packing scheme.

Both encode the difference (or error) between the current element in the array and the prior element. Parameters required for more sophisticated predictors have been included in the compression functions and will be used in a future version of the library.

3.3.1 Canonical-code compression

The canonical-code compression scheme encodes errors in two ways: directly or indirectly. Errors are coded directly using a symbol corresponding to the error value. Errors are coded indirectly using a symbol for the number of bits in the (signed) error, followed by the error itself.

At the start of the compression, CBFlib constructs a table containing a set of symbols, one for each of the 2^n direct codes from $-2^{(n-1)}$.. $2^{(n-1)}-1$, one for a stop code, and one for each of the $\text{maxbits}-n$ indirect codes, where n is chosen at compress time and maxbits is the maximum number of bits in an error. CBFlib then assigns to each symbol a bit-code, using a shorter bit code for the more common symbols and a longer bit code for the less common symbols. The bit-code lengths are calculated using a Huffman-type algorithm, and the actual bit-codes are constructed using the canonical-code algorithm described by Moffat, et al. (International Journal of High Speed Electronics and Systems, Vol 8, No 1 (1997) 179-231).

The structure of the compressed data is:

| Byte | Value |
|---------------------------------------|--|
| 1 .. 8 | Number of elements (64-bit little-endian number) |
| 9 .. 16 | Minimum element |
| 17 .. 24 | Maximum element |
| 25 .. 32 | (reserved for future use) |
| 33 | Number of bits directly coded, n |
| 34 | Maximum number of bits encoded, maxbits |
| 35 .. $35+2^n-1$ | Number of bits in each direct code |
| $35+2^n$ | Number of bits in the stop code |
| $35+2^{n+1}$.. | Number of bits in each indirect code |
| $35+2^n+\text{maxbits}-n$ | |
| $35+2^n +$ $\text{maxbits}-n+1$.. | Coded data |

3.3.2 CCP4-style compression

The CCP4-style compression writes the errors in blocks . Each block begins with a 6-bit code. The number of errors in the block is 2^n , where n is the value in bits 0 .. 2. Bits 3 .. 5 encode the number of bits in each error:

| Value in bits 3 .. 5 in each error | Number of bits |
|---|-----------------------|
| 0 | 0 |
| 1 | 4 |
| 2 | 5 |
| 3 | 6 |
| 4 | 7 |
| 5 | 8 |
| 6 | 16 |
| 7 | 65 |

The structure of the compressed data is:

| Byte | Value |
|-------------|--|
| 1 .. 8 | Number of elements (64-bit little-endian number) |
| 9 .. 16 | Minumum element (currently unused) |
| 17 .. 24 | Maximum element (currently unused) |
| 25 .. 32 | (reserved for future use) |
| 33 .. | Coded data |

4. Installation

CBFLib should be built on a disk with at least 40 megabytes of free space. First create the top-level directory (called, say, CBFLib_0.6). CBFLib_0.6.tar.Z is a compressed tar of the code as it now stands. Uncompress this file, place it in the top level directory, and unpack it with tar:

```
tar xvf CBFLIB_0.6.tar
```

To run the test programs, you will also need to put the MAR345 image example.mar2300 in the top-level directory. The image can also be found at

<http://biosgl.slac.stanford.edu/biosgl-users/ellis/Public/>

After unpacking the archive, the top-level directory should contain a makefile:

```
Makefile          Makefile for unix
```

and the subdirectories:

| | |
|--------------|--|
| src/ | CBFLIB source files |
| include/ | CBFLIB header files |
| examples/ | Example program source files |
| doc/ | Documentation |
| lib/ | Compiled CBFLIB library |
| bin/ | Executable example programs |
| html_images/ | JPEG images used in rendering the HTML files |

For instructions on compiling and testing the library, go to the top-level directory and type:

```
make
```

The CBFLIB source and header files are in the "src" and "include" subdirectories. The files are:

| src/ | include/ | Description |
|-------------------|-------------------|---|
| cbf.c | cbf.h | Low-level CBFLIB API functions |
| cbf_simple.c | cbf_simple.h | High-level CBFLIB API functions |
| cbf_alloc.c | cbf_alloc.h | Memory allocation functions |
| cbf_ascii.c | cbf_ascii.h | Function for writing ASCII values |
| cbf_binary.c | cbf_binary.h | Functions for binary values |
| cbf_byte_offset.c | cbf_byte_offset.h | Byte-offset compression (not implemented) |
| cbf_canonical.c | cbf_canonical.h | Canonical-code compression |
| cbf_codes.c | cbf_codes.h | Encoding and message digest functions |
| cbf_compress.c | cbf_compress.h | General compression routines |
| cbf_context.c | cbf_context.h | Control of temporary files |
| cbf_file.c | cbf_file.h | File in/out functions |
| cbf_lex.c | cbf_lex.h | Lexical analyser |
| cbf_packed.c | cbf_packed.h | CCP4-style packing compression |
| cbf_predictor.c | cbf_predictor.h | Predictor-Huffman compression (not implemented) |
| cbf_read_binary.c | cbf_read_binary.h | Read binary headers |
| cbf_read_mime.c | cbf_read_mime.h | Read MIME-encoded binary sections |
| cbf_string.c | cbf_string.h | Case-insensitive string comparisons |
| cbf_stx.c | cbf_stx.h | Parser |

| | | |
|--------------------|--------------------|---|
| cbf_tree.c | cbf_tree.h | CBF tree-structure functions |
| cbf_uncompressed.c | cbf_uncompressed.h | Uncompressed binary sections |
| cbf_write.c | cbf_write.h | Functions for writing |
| cbf_write_binary.c | cbf_write_binary.h | Write binary sections |
| cbf.stx | | bison grammar to define cbf_stx.c (see WARNING) |
| md5c.c | md5.h, global.h | RSA message digest software from mpack |

WARNING: Do not rebuild the parser, cbf_stx.c, from the bison grammar, cbf.stx, unless absolutely necessary. There is a problem with the file bison.simple in the standard bison release. If you must rebuild cbf_stx.c using bison, you will need cbf_PARSER.simple as a replacement for bison.simple. See the cbf_PARSER.simple instructions. In the "examples" subdirectory, there are 2 additional files used by the example program (section 5) for reading MAR300, MAR345 or ADSC CCD images:

| | | |
|-------|-------|----------------------|
| img.c | img.h | Simple image library |
|-------|-------|----------------------|

and the example programs themselves:

| | |
|-----------|-------------------------------------|
| makecbf.c | Make a CBF file from an image |
| img2cif.c | Make an imgCIF or CBF from an image |
| cif2cbf.c | Copy a CIF/CBF to a CIF/CBF |

The documentation files are in the "doc" subdirectory:

| | |
|-------------------------|--|
| CBFlib.html | This document (HTML) |
| CBFlib.txt | This document (ASCII) |
| CBFlib_NOTICES.html | Important NOTICES -- PLEASE READ |
| CBFlib_NOTICES.txt | Important NOTICES -- PLEASE READ |
| CBFlib.ps | CBFLIB manual (PostScript) |
| CBFlib.pdf | CBFLIB manual (PDF) |
| CBFlib.rtf | CBFLIB manual (RTF) |
| cbf_definition_rev.txt | Draft CBF/ImgCIF definition (ASCII) |
| cbf_definition_rev.html | Draft CBF/ImgCIF definition (HTML) |
| cbfext98.html | Draft CBF/ImgCIF extensions dictionary (HTML) |
| cbfext98.dic | Draft CBF/ImgCIF extensions dictionary (ASCII) |
| ChangeLog | Summary of change history |
| MANIFEST | List of files in this kit |

5. Example programs

The example programs `makecbf.c` and `img2cif.c` read an image file from a MAR300, MAR345 or ADSC CCD detector and then uses CBFLib to convert it to CBF format (`makecbf`) or either `imgCIF` or CBF format (`img2cif`). `makecbf` writes the CBF-format image to disk, reads it in again, and then compares it to the original. `img2cif` just writes the desired file. `makecbf` works only from stated files on disk, so that random I/O can be used. `img2cif` includes code to process files from stdin and to stdout.

`makecbf.c` is a good example of how many of the CBFLib functions can be used. To compile `makecbf` on an alpha workstation running Digital unix or a Silicon Graphics workstation running irix (and on most other unix platforms as well), go to the `src` subdirectory of the main CBFLib directory and use the Makefile:

```
make all
```

An example MAR345 image can be found at:

<http://biosg1.slac.stanford.edu/biosg1-users/ellis/Public/>

To run `makecbf` with the example image, type:

```
./bin/makecbf example.mar2300 test.cbf
```

The program `img2cif` has the following command line interface:

```
img2cif      [-i input_image]                                \
              [-o output_cif]                                \
              [-c {p[acked]|c[anonical]|n[one]}]             \
              [-m {h[eaders]|n[oheaders]}]                   \
              [-d {d[igest]|n[odigest]}]                     \
              [-e {b[ase64]|q[uoted-printable]|               \
                  d[ecimal]|h[exadecimal]|o[ctal]|n[one]}]   \
              [-b {f[orward]|b[ackwards]}]                   \
              [input_image] [output_cif]
```

the options are:

- i input_image (default: stdin)
the input_image file in MAR300, MAR345 or ADSC CCD detector format is given. If no input_image file is specified or is given as "-", an image is copied from stdin to a temporary file.
- o output_cif (default: stdout)
the output cif (if base64 or quoted-printable encoding is used) or cbf (if no encoding is used). if no output_cif is specified or is given as "-", the output is written to stdout
- c compression_scheme (packed, canonical or none, default packed)
- m [no]headers (default headers for cifs, noheaders for cbfs)
selects MIME (N. Freed, N. Borenstein, RFC 2045, November 1996) headers within binary data value text fields.
- d [no]digest (default md5 digest [R. Rivest, RFC 1321, April

1992 using "RSA Data Security, Inc. MD5 Message-Digest Algorithm"] when MIME headers are selected)

- e encoding (base64, quoted-printable, decimal, hexadecimal, octal or none, default: base64) specifies one of the standard MIME encodings (base64 or quoted-printable) or a non-standard decimal, hexadecimal or octal encoding for an ascii cif or "none" for a binary cbf
- b direction (forward or backwards, default: backwards) specifies the direction of mapping of bytes into words for decimal, hexadecimal or octal output, marked by '>' for forward or '<' for backwards as the second character of each line of output, and in '#' comment lines.

The test program cif2cbf uses the same command line options as img2cif, but accepts either a CIF or a CBF as input instead of an image file.