NAME

 rgbds — object file format documentation

DESCRIPTION

 This is the description of the RGB object file format that is output by *rgbasm*(1) and read by *rgblink*(1).

FILE STRUCTURE

 The following types are used:

 LONG is a 32-bit integer stored in little-endian format. BYTE is an 8-bit integer. STRING is a 0-terminated string of BYTE. Brackets after a type (e.g. LONG[n]) indicate n consecutive elements (here, LONGs). All items are contiguous, with no padding anywhere—this also means that they may not be aligned in the file!

 REPT n indicates that the fields between the REPT and corresponding ENDR are repeated n times.

 All IDs refer to objects within the file; for example, symbol ID $0001 refers to the second symbol defined in *this* object file's "Symbols" array. The only exception is the "Source file info" nodes, whose IDs are backwards, i.e. source node ID $0000 refers to the *last* node in the array, not the first one. References to other object files are made by imports (symbols), by name (sections), etc.—but never by ID.

Header

 BYTE *Magic[4]*

  "RGB9"

 LONG *RevisionNumber*

  The format's revision number this file uses. (This is always in the same place in all revisions.)

 LONG *NumberOfSymbols*

  How many symbols are defined in this object file.

 LONG *NumberOfSections*

  How many sections are defined in this object file.

Source file info

 LONG *NumberOfNodes*

  The number of source context nodes contained in this file.

 REPT *NumberOfNodes*

  LONG *ParentID*

   ID of the parent node, -1 meaning that this is the root node.

   Important: the nodes are actually written in **reverse** order, meaning the node with ID 0 is the last one in the list!

  LONG *ParentLineNo*

   Line at which the parent node's context was exited; meaningless for the root node.

  BYTE *Type*

   Bits 0–6 indicate the node's type:

Value	Meaning
0	REPT node
1	File node
2	Macro node

   Bit 7 being set means that the node is "quieted" (see "Excluding locations from backtraces" in *rgbasm*(5)).

  IF *Type* $\neq 0$

   If the node is not a REPT node...

   STRING *Name*

    The node's name: either a file name, or the macro's name prefixed by its definition's file name (e.g. src/includes/defines.asm::error).

  ELSE If the node is a REPT, it also contains the iteration counter of all parent REPTs.

```
                        LONG Depth
                        LONG Iter[Depth]
                                The number of REPT iterations, by increasing depth.
                ENDC
        ENDR
```

Symbols
```
        REPT NumberOfSymbols
                STRING Name
                        This symbol's name. Local symbols are stored as their full name (Scope.symbol).
                BYTE Type
```


Value	Meaning
0	**Local** symbol only used in this file.
1	**Import** of an exported symbol (by name) from another object file.
2	**Exported** symbol visible from other object files.

```
                IF Type ≠ 1
                        If the symbol is defined in this object file...

                        LONG NodeID
                                Context in which the symbol was defined.
                        LONG LineNo
                                Line number in the context at which the symbol was defined.
                        LONG SectionID
                                The ID of the section in which the symbol is defined. If the symbol doesn't be-
                                long to any specific section (i.e. it's a constant), this field contains -1.
                        LONG Value
                                The symbol's value. If the symbol belongs to a section, this is the offset within
                                that symbol's section.
                ENDC
        ENDR
```

Sections
```
        REPT NumberOfSections
                STRING Name
                        The section's name.
                LONG NodeID
                        Context in which the section was defined.
                LONG LineNo
                        Line number in the context at which the section was defined.
                LONG Size
                        The section's size, in bytes.
                BYTE Type
                        Bits 0–2 indicate the section's type:
```

Value	Meaning
0	WRAM0
1	VRAM
2	ROMX
3	ROM0
4	HRAM
5	WRAMX
6	SRAM
7	OAM

Bit 7 being set means that the section is a "union" (see "Unionized sections" in *rgbasm*(5)). Bit 6 being set means that the section is a "fragment" (see "Section fragments" in *rgbasm*(5)). These two bits are mutually exclusive.

LONG *Address*

> Address this section must be placed at. This must either be valid for the section's *Type* (as affected by flags like −t or −d in *rgblink*(1)), or -1 to indicate that the linker should automatically decide (the section is "floating").

LONG *Bank*

> ID of the bank this section must be placed in. This must either be valid for the section's *Type* (with the same caveats as for the *Address*), or -1 to indicate that the linker should automatically decide.

BYTE *Alignment*

> How many bits of the section's address should be equal to *AlignOfs*, starting from the least-significant bit.

LONG *AlignOfs*

> Alignment offset. Must be strictly less than 1 << *Alignment*.

IF *Type* $= 2 \,\|\, Type = 3$

> If the section has ROM type, it contains data.

> BYTE *Data*[Size]
>
> > The section's raw data. Bytes that will be patched over must be present, even though their contents will be overwritten.
>
> LONG *NumberOfPatches*
>
> > How many patches must be applied to this section's *Data*.
>
> REPT *NumberOfPatches*
>
> > LONG *NodeID*
> >
> > > Context in which the patch was defined.
> >
> > LONG *LineNo*
> >
> > > Line number in the context at which the patch was defined.
> >
> > LONG *Offset*
> >
> > > Offset within the section's *Data* at which the patch should be applied. Must not be greater than the section's *Size* minus the patch's size (see *Type* below).
> >
> > LONG *PCSectionID*
> >
> > > ID of the section in which PC is located. (This is usually the same section within which the patch is applied, except for e.g. LOAD blocks, see "RAM code" in *rgbasm*(5).)
> >
> > LONG *PCOffset*
> >
> > > Offset of the PC symbol within the section designated by *PCSectionID*. It is expected that PC points to the instruction's first byte for instruction operands (i.e. jp @ must be an infinite loop), and to the patch's first byte otherwise (db, 'dw', 'dl').
> >
> > BYTE *Type*
> >
> > > | Value | Meaning |
> > > | --- | --- |
> > > | 0 | Single-byte patch |
> > > | 1 | Little-endian two-byte patch |
> > > | 2 | Little-endian four-byte patch |
> > > | 3 | Single-byte 'jr' patch; the patch's value will be subtracted to PC + 2 (i.e. jr @ must be the infinite loop 18 FE). |
> >
> > LONG *RPNSize*
> >
> > > Size of the *RPNExpr* below.
> >
> > BYTE *RPNExpr*[RPNSize]
> >
> > > The patch's value, encoded as a RPN expression (see "RPN expressions").
>
> ENDR

```
            ENDC
```

Assertions

```
    LONG NumberOfAssertions
```
         How many assertions this object file contains.

```
    REPT NumberOfAssertions
```
         Assertions are essentially patches with a message.

         `LONG NodeID`
                Context in which the assertions was defined.

         `LONG LineNo`
                Line number in the context at which the assertion was defined.

         `LONG Offset`
                Unused leftover from the patch structure.

         `LONG PCSectionID`
                ID of the section in which PC is located.

         `LONG PCOffset`
                Offset of the PC symbol within the section designated by `PCSectionID`.

         `BYTE Type`
                Describes what should happen if the expression evaluates to a non-zero value.

Value	Meaning
0	Print a warning message, and continue linking normally.
1	Print an error message, so linking will fail, but allow other assertions to be evaluated.
2	Print a fatal error message, and abort immediately.

         `LONG RPNSize`
                Size of the `RPNExpr` below.

         `BYTE RPNExpr[RPNSize]`
                The patch's value, encoded as a RPN expression (see "RPN expressions").

         `STRING Message`
                The message displayed if the expression evaluates to a non-zero value. If empty, a generic message is displayed instead.

```
    ENDR
```

RPN expressions

     Expressions in the object file are stored as RPN, or "Reverse Polish Notation", which is a notation that allows computing arbitrary expressions with just a simple stack. For example, the expression 2 5 − will first push the value "2" to the stack, then "5". The '−' operator pops two arguments from the stack, subtracts them, and then pushes back the result ("3") on the stack. A well-formed RPN expression never tries to pop from an empty stack, and leaves exactly one value in it at the end.

     RGBDS encodes RPN expressions as an array of BYTEs. The first byte encodes either an operator, or a literal, which consumes more BYTEs after it:

Value	Meaning
$00	Addition operator ('+')
$01	Subtraction operator ('−')
$02	Multiplication operator ('∗')
$03	Division operator ('/')
$04	Modulo operator ('%')
$05	Negation (unary '−')
$06	Exponent operator ('∗∗')
$10	Bitwise OR operator ('|')
$11	Bitwise AND operator ('&')

$12	Bitwise XOR operator ('^')
$13	Bitwise complement operator (unary '~')
$21	Logical AND operator ('&&')
$22	Logical OR operator ('||')
$23	Logical complement operator (unary '!')
$30	Equality operator ('==')
$31	Non-equality operator ('!=')
$32	Greater-than operator ('>')
$33	Less-than operator ('<')
$34	Greater-than-or-equal operator ('>=')
$35	Less-than-or-equal operator ('<=')
$40	Left shift operator ('<<')
$41	Arithmetic/signed right shift operator ('>>')
$42	Logical/unsigned right shift operator (>>>)
$50	**BANK**(*symbol*); followed by the *symbol*'s LONG ID.
$51	**BANK**(*section*); followed by the *section*'s STRING name.
$52	PC's **BANK**() (i.e. BANK(@)).
$53	**SIZEOF**(*section*); followed by the *section*'s STRING name.
$54	**STARTOF**(*section*); followed by the *section*'s STRING name.
$55	**SIZEOF**(*sectiontype*); followed by the *sectiontype*'s BYTE value (see the *Type* values in "Sections").
$56	**STARTOF**(*sectiontype*); followed by the *sectiontype*'s BYTE value (see the *Type* values in "Sections").
$60	ldh check. Checks if the value is a valid ldh operand (see "Load Instructions" in *gbz80*(7)), i.e. that it is between either $00 and $FF, or $FF00 and $FFFF, both inclusive. The value is then ANDed with $00FF (& $FF).
$61	rst check. Checks if the value is a valid rst vector (see "RST vec" in *gbz80*(7)), that is, one of $00, $08, $10, $18, $20, $28, $30, or $38. The value is then ORed with $C7 (| $C7).
$62	bit/res/set check; followed by the instruction's BYTE mask. Checks if the value is a valid bit index (see e.g. "BIT u3, r8" in *gbz80*(7)), that is, from 0 to 7. The value is then ORed with the instruction's mask.
$70	HIGH byte.
$71	LOW byte.
$72	BITWIDTH value.
$73	TZCOUNT value.
$80	Integer literal; followed by the LONG integer.
$81	A symbol's value; followed by the symbol's LONG ID.

SEE ALSO

rgbasm(1), *rgbasm*(5), *rgblink*(1), *rgblink*(5), *rgbfix*(1), *rgbgfx*(1), *gbz80*(7), *rgbds*(7)

HISTORY

rgbasm(1) and *rgblink*(1) were originally written by Carsten Sørensen as part of the ASMotor package, and was later repackaged in RGBDS by Justin Lloyd. It is now maintained by a number of contributors at https://github.com/gbdev/rgbds.