

**NAME**

rgbds — object file format documentation

**DESCRIPTION**

This is the description of the object files used by *rgbasm*(1) and *rgblink*(1). *Please note that the specification is not stable yet.* RGBDS is still in active development, and some new features require adding more information to the object file, or modifying some fields, both of which break compatibility with older versions.

**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
        

| Value | Meaning    |
|-------|------------|
| 0     | REPT node  |
| 1     | File node  |
| 2     | Macro node |


    IF Type ≠ 0
        If the node is not a REPT node...
        STRING Name
            The node's name: either a file name, or the macro's name prefixes 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 belong 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 *rgbasn(5)*). Bit 6 being set means that the section is a "fragment" (see "Section fragments" in *rgbasn(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 rgbldk(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  $1 \ll \text{Alignment}$ .

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 sec-
            tion 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<br>PC + 2 (i.e. <code>jr @</code> must be the infinite loop <code>18 FE</code> ). |



        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.
- \$80 Integer literal; followed by the LONG integer.
- \$70 HIGH byte.
- \$71 LOW byte.
- \$72 BITWIDTH value.
- \$73 TZCOUNT value.
- \$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>.