

the barracuda manual

<https://github.com/robitex/barracuda>

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Abstract

Welcome to the barracuda software project devoted to barcode printing.

This manual shows you how to print barcodes in your \TeX documents and how to export such graphic content to an external file, using barracuda.

barracuda is written in Lua programming language and is free software released under the GPL 2 License.

Contents

1	Getting started	2
1.1	Introduction	2
1.2	Manual Content	2
1.3	Required knowledge and useful resources	3
1.4	Running Barracuda	3
1.4.1	A Lua script	3
1.4.2	A Lua \TeX source file	4
1.4.3	A Lua \LaTeX source file	4
1.5	A more deep look	4
1.6	Installing	5
1.6.1	Installing for Lua	5
1.6.2	Installing for TeX Live	5
2	Barracuda \LaTeX Package	5
3	Barcode parameters	6
3.1	Encoder treename	6
3.2	Barcode Reference	6
4	Developer zone	6
4.1	The Barracuda Framework	6
4.2	API reference of Lua modules	6
4.3	ga specification	6
4.3.1	ga reference	10
4.4	ga code examples	11
4.4.1	Example number 1	11
4.4.2	Example number 2	11
5	Example and use cases	13

1 Getting started

1.1 Introduction

Barcode symbols are usually a sequence of vertical lines representing encoded data that can be retrieved with special laser scanner or more simply with a smartphone running dedicated apps. Almost every store item has a label with a printed barcode for automatic identification purpose.

So far, barracuda supported symbologies are as the following:

- Code 39,
- Code 128,
- EAN family (ISBN, ISSN, EAN 8, EAN 13, and the add-ons EAN 2 and EAN 5),
- ITF 2of5, interleaved Two of Five ((ITF14, i2of5 general)).

The package provides different output graphic format. At the moment they are:

- PDF Portable Document Format (a modern \TeX engine is required),
- SVG Scalable Vector Graphic.

The name barracuda is an assonance to the name Barcode. I started the project back in 2016 for getting barcode in my \TeX generated PDF documents, studying the Lua \TeX technology such as direct *pdfliteral node* creation.

At the moment barracuda is in *beta* stage. In this phase the Lua API can change respect to the result of development research.

1.2 Manual Content

The manual is divided into five parts. In part 1.1 introduces the package and gives to the user a proof of concept to how to use it. The next parts present detailed information about option parameter of each barcode symbology and methods description to change the *module* width of a EAN-13 barcode. It's also detailed how the Lua code works internally and how to implement a barcode symbology not already included in the package.

The plan of the manual is (but some sections are not completed yet):

Part 1: Getting started

- general introduction → 2
- print your first barcode → 3
- installing barracuda on your system → 5

Part 2: \LaTeX packages

- barracuda \LaTeX package → 5

Part 3: Barcode Reference and Parameters

- encoder identification rule → 6
- barcode symbologies reference → 6

Part 4: Advanced Work with barracuda

- Lua framework description → 6
- API reference → 6
- ga specification → 6

Part 5: Real examples

- working example and use cases → 13

1.3 Required knowledge and useful resources

barracuda is a Lua package that can be executed by any Lua interpreter. To use it, it's necessary a minimal knowledge of Lua programming language and a certain ability with the terminal of your computer system in order to run command line task or make software installation.

It's also possible to run barracuda directly within a \TeX source file, and compile it with a suitable typesetting engine like \LaTeX . In this case a minimal \TeX system knowledge is required. As an example of this workflow you simply can look to this manual because itself is typesetted with \LaTeX , running barracuda to include barcodes as a vector graphic object.

A third way is to use the \TeX package `barracuda.sty` with its high level macros. A minimal knowledge of the \TeX format is obviously required.

Here is a collection of useful learning resources:

Lua: to learn Lua the main reference is the book called PIL, Programming in Lua from one of the language's Author Roberto Ierusalimsky.

\TeX : ...

\LaTeX : ...

1.4 Running Barracuda

The starting point to work with barracuda is always a plain text file with some code processed by a command line program with a Lua interpreter.

The paradigm of barracuda is the Object Oriented Programming. Generally speaking every object must be created with a function called *costructor* and every action must be run calling a *method* of it.

In this section you'll take a taste of barracuda coding in three different execution context: a Lua script, a \LaTeX document and a \TeX source file using the macro package `barracuda.sty` providing an high level interface to Lua code.

High level package like `barracuda.sty` make to write Lua code unnecessary. It will be always possible return to Lua code in order to resolve complex barcode requirements.

1.4.1 A Lua script

As a practical example to produce an EAN 13 barcode, open a text editor of your choice on an empty file and save it as `first-run.lua` with the content of the following two lines of code:

```
----- first-run.lua -----
local barracuda = require "barracuda"
barracuda:save("ean-13", "8006194056290", "my_barcode", "svg")
```

What you have done is to write a *script*. If you have installed a Lua interpreter along with barracuda, open a terminal and run it with the command:

```
$ lua first-run.lua
```

You will see in the same directory of your script, appearing a new file called `my_barcode.svg` with the drawing:



Coming back to the script first of all, it's necessary to load the library `barracuda` with the standard Lua function `require()` that returns an object—more precisely a reference to a table where are stored all the package machinery.

With the second line of code, an EAN 13 barcode is saved as `my_barcode.svg` using the method `save()` of the `barracuda` object. The `save()` method takes in order the barcode symbology identifier called *treename*, an argument as a string or as a whole number that represents data to be encoded, the output file name and the optional output format. With a fifth optional argument we can pass options to the barcode encoder as a Lua table.

Each encoder has an own identifier called *treename* explained at section 3.1. In short, in `barracuda` we can build more encoders of the same symbology with different parameters.

1.4.2 A Lua \TeX source file

`barracuda` can also runs with Lua \TeX and any others Lua powered \TeX engines. The source file is a bit difference respect to the previuos script: the Lua code lives inside the argument of a `\directlua` primitive, moreover we must use an horizontal box register as output destination.

```
% !TeX program = LuaTeX
\newbox\mybox
\directlua{
    local require = "barracuda"
    barracuda:hbox("ean-13", "8006194056290", "mybox")
}\leavevmode\box\mybox
\bye
```

The method `hbox()` works only with Lua \TeX . It takes three¹ arguments: encoder *treename*, encoding data as a string, the \TeX horizontal box name.

1.4.3 A Lua \LaTeX source file

\LaTeX working minimal example would be:

```
% !TeX program = LuaLaTeX
\documentclass{article}
\usepackage{barracuda}
\begin{document}
\baracuda{ean-13}{8006194056290}
\end{document}
```

1.5 A more deep look

`barracuda` is designed to be modular and flexible. For example it is possible to draw different barcodes on the same canvas or tune barcode parameters.

The main workflow to draw a barcode object reveals more details on internal structure. In fact, to draw an EAN 13 barcode we must do at least the following steps:

1. load the library,
2. get a reference to the Barcode abstract class,
3. build an ean encoder of the variant 13,
4. build an EAN 13 symbol passing data to a costructor,
5. get a reference to a new canvas object,
6. draw barcode on the canvas object,

¹A fourth argument is optional as a table with user defined barcode parameters.

7. get a reference of the driver object,
8. print the graphic material saving an external svg file.

Following that step by step procedure the corresponding code is translated in the next listing:

```
-- lua script
local barracuda = require "barracuda" -- step 1
local barcode = barracuda:barcode() -- step 2

local ean13, err_enc = barcode:new_encoder("ean-13") -- step 3
assert(ean13, err_enc)

local symb, err_symb = ean13:from_string("8006194056290") -- step 4
assert(symb, err_symb)

local canvas = barracuda:new_canvas() -- step 5
symb:append_ga(canvas) -- step 6

local driver = barracuda:get_driver() -- step 7
local ok, err_out = driver:save("svg", canvas, "my_barcode") -- step 8
assert(ok, err_out)
```

Late the manual will give objects and methods references at section 4.2.

1.6 Installing

1.6.1 Installing for Lua

Manually copy src folder content to a suitable directory of your system that is reachable to the system Lua interpreter.

1.6.2 Installing for TeX Live

If you have TeX Live installed from CTAN or from DVD TeX Collection, before any modification to your system check if the package is already installed looking for *installed* key in the output of the command:

```
$ tlmgr show barracuda
```

If ‘barracuda’ is not present, run the command:

```
$ tlmgr install barracuda
```

If you have installed TeX Live via Linux OS repository try your distribution’s package management system running a software update.

It’s also possible to install the package manually:

1. Grab the sources from CTAN or <https://github.com/robitex/barracuda>.
2. Unzip it at the root of one or your TDS trees (local or personal).
3. You may need to update some filename database after this, see your TeX distribution’s manual for details.

2 Barracuda L^AT_EX Package

The L^AT_EX package delivered with barracuda is still under an early stage of development. The only macro available is `\barracuda[option]{encoder}{data}`. A simple example is the following source file for LuaL^AT_EX:

```
% !TeX program = LuaLaTeX
\documentclass{article}
\usepackage{barracuda}
\begin{document}
\leavevmode
\barracuda{code39}{123ABC}\\
\barracuda{code128}{123ABC}
\end{document}
```

Every macro `\barracuda` typesets a barcode symbol with the encoder defined in the first argument, encoding data defined by the second.

3 Barcode parameters

3.1 Encoder treename

TODO

3.2 Barcode Reference

TODO

4 Developer zone

4.1 The Barracuda Framework

The barracuda package framework consists in independent modules: a barcode class hierarchy encoding a text into a barcode symbology; a geometrical library called `libgeo` modelling several graphic objects; an encoding library for the `ga` format (graphic assembler) and several driver to *print* a `ga` stream into a file or in a \TeX hbox register.

To implement a barcode encoder you have to write a component called *encoder* defining every parameters and implementing the encoder builder, while a driver must understand `ga` opcode stream and print the corresponding graphic object.

Every barcode encoder come with a set of parameters, some of them can be reserved and can't be edit after the encoder was build. So, you can create many instances of the same encoder for a single barcode type, with its own parameter set.

The basic idea is getting faster encoders, for which the user may set up parameters at any level: barcode abstract class, encoder globally, down to a single symbol object.

The Barcode class is completely independent from the output driver and viceversa.

4.2 API reference of Lua modules

TODO

4.3 `ga` specification

This section defines and explains with code examples the `ga` instruction stream. `ga` stands for *graphic assembler*, a sort of essential language that describes geometrical object like lines and rectangles mainly for a barcode drawing library on a cartesian plane (O, x, y) .

The major goal of any barracuda encoder is to create the `ga` stream corresponding to a vector drawing of a barcode symbol.

In details, a `ga` stream is a numeric sequence that like a program defines what must be draw. It is not a fully binary sequence—which is a byte stream and ideally

is what a ga stream would really be—but a sequence of integers or floating point numbers.

In Lua this is very easy to implement. Simply append a numeric value to a table that behave as an array. Anyway ga must be basically a binary format almost ready to be sent or received by means of a network channel.

In the Backus–Naur form a valid ga stream grammar is described by the following code:

```

<valid ga stream> ::= <instructions>
<instructions> ::= <instruction>
                  | <instruction> <instructions>
<instruction> ::= <opcode>
                  | <opcode> <operands>

<opcode> ::= <state>
             | <object>
             | <func>
<state> ::= 1 .. 31; graphic properties
<object> ::= 32 .. 239; graphic objects
<func> ::= 240 .. 255; functions

<operands> ::= <operand>
              | <operand> <operands>
<operand> ::= <len>
              | <coord>
              | <qty>
              | <char seq>
              | <enum>
              | <abs>
              | <points>
              | <bars>

<len> ::= f64; unit measure scaled point sp = 1/65536pt
<coord> ::= f64; unit measure scaled point sp = 1/65536pt
<qty> ::= u64
<char seq> ::= <chars> 0
<chars> ::= <char>
           | <char> <chars>
<char> ::= u64
<enum> ::= u8
<abs> ::= f64
<points> ::= <point>
            | <point> <points>
<point> ::= <x coord> <y coord>
<x coord> ::= <coord>
<y coord> ::= <coord>
<bars> ::= <bar>
           | <bar> <bars>
<bar> ::= <coord> <len>

; u8 unsigned 8 bit integer
; u64 unsigned 64 bit integer
; f64 floating point 64 bit number

```

Every <instruction> changes the graphic state, for instance the current line width, or defines a graphic object, depending on the opcode value. Every coordinate or dimension must be expressed as *scaled point*, the basic unit of measure of T_EX equivalent to 1/65536 pt.

For example, the opcode for the `<linewidth>` operation is 1, while for the `<hline>` operation is 33. An horizontal line 6pt width from the point (0pt, 0pt) to the point (32pt, 0pt) is represented by this ga stream:


```
1 393216 33 0 2097152 0
```

Introducing `<mnemonic code>` in `<opcode>` place and separate the operations in a multiline fashion, the same sequence become more readable and more similar to an assembler listing:

```
<linewidth> 393216
<hline> 0 2097152 0
```

To prove and visualize the meaning of the stream, we can simply use the native graphic driver of barracuda compiling this LuaTeX source file:

```
% !TeX program = LuaTeX
\newbox\mybox
\directlua{
    local barracuda = require "barracuda"
    local ga = {1, 393216, 33, 0, 2097152, 0}
    local drv = barracuda:get_driver()
    drv:ga_to_hbox(ga, "mybox")
}\leavevmode\box\mybox
\bye
```

The result is: 

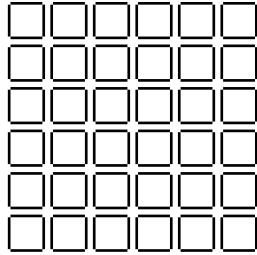
A more abstract way to write a ga stream consists in the `gacanvas` class of the module `libgeo`. Every operation has been mapped to a method named `encode_<mnemonic_opcode>()`:

```
% !TeX program = LuaTeX
\newbox\mybox
\directlua{
    local barracuda = require "barracuda"
    local canvas = barracuda:new_canvas()
    local pt = 65536
    canvas:encode_linewidth(6*pt)
    canvas:encode_hline(0, 32*pt, 0)
    local drv = barracuda:get_driver()
    drv:ga_to_hbox(canvas, "mybox")
    tex.print("[")
    for _, n in ipairs(canvas:get_stream()) do
        tex.print(tostring(n))
    end
    tex.print("]")
} results in \box\mybox
\bye
```

The stream is printed beside the drawing in the output PDF file. Therefore the same ga stream can also generate a different output, for instance a SVG file. For this purpose execute the `save()` method of the Driver class (the drawing is showed in figure 1):

```
% !TeX program = LuaTeX
\newbox\mybox
\directlua{
    local barracuda = require "barracuda"
    local canvas = barracuda:new_canvas()
    local pt = 65536
```


Figure 1: A drawing example that shows how to manually set up the bounding box of the figure, keeping automatic computation disabled for more fast stream processing.



```

local side = 16*pt
local s = side/2 - 1.5*pt
local l = side/2 - 2*pt
local dim = 5
canvas:encode_linewidth(1*pt)
canvas:encode_disable_bbox()
for c = 0, dim do
    for r = 0, dim do
        local x, y = c*side, r*side
        canvas:encode_hline(x-l, x+l, y-s)
        canvas:encode_hline(x-l, x+l, y+s)
        canvas:encode_vline(y-l, y+l, x-s)
        canvas:encode_vline(y-l, y+l, x+s)
    end
end
local b1 = -s - 0.5*pt
local b2 = dim*side + s + 0.5*pt
canvas:encode_set_bbox(b1, b1, b2, b2)
local drv = barracuda:get_driver()
drv:ga_to_hbox(canvas, "mybox")
drv:save("svg", canvas, "grid")
}\leavevmode\box\mybox
\bye

```

An automatic process updates the bounding box of the figure meanwhile the stream is read instruction after instruction. The `<disable_bbox>` operation produce a more fast execution and the figure will get the bounding box computed until that instruction. The `<set_bbox>` operation imposes a minimal bounding box comparing to the current figure dimensions.

The initial bounding box is simply an empty figure. As a consequence, different strategies can be used to optimize runtime execution, such as in the previous code example, where bounding box is always disabled and it is set up at the last canvas method call. More often than not, we know the bounding box of the barcode symbol including quiet zones.

Every encoding method of `gaCanvas` class gives two output result: a boolean value called `ok` plus an error `err`. If `ok` is true then `err` is nil and, viceversa, when `ok` is false then `err` is a string describing the error.

The error management is a responsibility of the caller. For instance, if we decide to stop the execution this format is perfectly suitable for the Lua function `assert()`, otherwise we can explicitly check the output pair:

```

local pt = 65536
assert(canvas:encode_linewidth(6*pt)) --> true, nil
local ok, err = canvas:encode_hline(nil, 32*pt, 0)
-- ok = false

```

```
-- err = "[ArgErr] 'x1' number expected"
```

4.3.1 ga reference

Properties of the graphic state			
OpCode	Mnemonic key	Graphic property	Operands
1	linewidth	Line width	w <len>
2	linecap	Line cap style	e <enum> 0: Butt cap 1: Round cap 2: Projecting square cap
3	linejoin	Line join style	e <enum> 0: Miter join 1: Round join 2: Bevel join
29	enable_bbox	Compute bounding box	-
30	disable_bbox	Do not compute bounding box	-
31	set_bbox	Overlap a bounding box	x1 y1 <point> x2 y2 <point>

Lines			
OpCode	Mnemonic key	Graphic object	Operands
32	line	Line	x1 y1 <point> x2 y2 <point>
33	hline	Horizontal line	x1 x2 <point> y <coord>
34	vline	Vertical line	y1 y2 <point> x <coord>

Group of bars			
OpCode	Mnemonic key	Graphic object	Operands
36	vbar	Vertical bars	y1 <coord> y2 <coord> b <qty> xi wi <bars> y1: bottom y-coord y2: top y-coord b: number of bars xi: axis x-coord of bars number i wi: width of bars number i
37	hbar	Horizontal bars	x1 <coord> x2 <coord> b <qty> yi wi <bars> unimplemented
38	polyline	Opened polyline	n <qty> xi yi <points> n: number of points xi: x-coord of point i yi: y-coord of point i
39	c_polyline	Closed polyline	n <qty> xi yi <points> unimplemented

Rectangles			
OpCode	Mnemonic key	Graphic object	Operands
48	rect	Rectangle	x1 y1 <point> x2 y2 <point>
49	f_rect	Filled rectangle	x1 y1 <point> x2 y2 <point> unimplemented
50	rect_size	Rectangle	x1 y1 <point> w <len> h <len> unimplemented
51	f_rect_size	Filled rectangle	x1 y1 <point> w <len> h <len> unimplemented

Text		
OpCode	Mnemonic key	Graphic object/Operands
130	text	A text with several glyphs ax <abs> ay <abs> xpos ypos <point> c <chars>
131	text_xspaced	A text with glyphs equally spaced on its vertical axis x1 <coord> xgap <len> ay <abs> ypos <coord> c <chars>
132	text_xwidth	Glyphs equally spaced on vertical axis between two x coordinates ay <abs> x1 <coord> x2 <coord> y <coord> c <chars>
140	_text_group	Texts on the same baseline ay <abs> y <coord> n <qty> xi <coord> ai <abs> ci <chars> unimplemented

4.4 ga code examples

To support a better understanding and provide some ga stream examples, this section discusses some code examples, each of which must be compiled with LuaTeX.

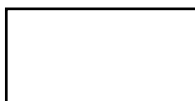
4.4.1 Example number 1

Suppose we want to draw a simple rectangle. In the ga reference at section 4.3.1 there is a dedicated instruction <rect>. Let's give it a try:

```
% !TeX program = LuaTeX
\newbox\mybox
\directlua{
    local barracuda = require "barracuda"
    local pt = 65536
    local side = 36*pt
    local ga = {48, 0, 0, 2*side, side}
    local drv = barracuda:get_driver()
    drv:ga_to_hbox(ga, "mybox")
}\leavevmode\box\mybox
\bye
```

Dealing with low level ga stream is not necessary. We can use a gaCanvas object:

```
% !TeX program = LuaTeX
\newbox\mybox
\directlua{
    local barracuda = require "barracuda"
    local pt = 65536
    local side = 36*pt
    local canvas = barracuda:new_canvas()
    canvas:encode_rect(0, 0, 2*side, side)
    local drv = barracuda:get_driver()
    drv:ga_to_hbox(canvas, "mybox")
}\leavevmode\box\mybox
\bye
```



In both cases the drawing looks like:

4.4.2 Example number 2

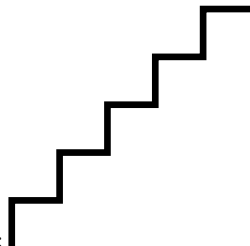
A drawing of a zig zag staircase can be represented by a ga stream with a <polyline> operation. The gaCanvas method we have to call is encode_polyline() that accept

a Lua table as a flat structure with the coordinates of every point of the polyline:

```
{ x1, y1, x2, y2, ..., xn, yn }
```

It is what we do with this code:

```
% !TeX program = LuaTeX
\newbox\mybox
\directlua{
  local barracuda = require "barracuda"
  local pt = 65536
  local side = 18*pt
  local dim = 5
  local x, y = 0, 0
  local point = {x, y}
  local i = 3
  for _ = 1, dim do
    y = y + side
    point[i] = x; i = i + 1
    point[i] = y; i = i + 1
    x = x + side
    point[i] = x; i = i + 1
    point[i] = y; i = i + 1
  end
  local canvas = barracuda:new_canvas()
  canvas:encode_linewidth(2.5*pt)
  canvas:encode_polyline(point)
  local drv = barracuda:get_driver()
  drv:ga_to_hbox(canvas, "mybox")
}\leavevmode\box\mybox
\bye
```



The result is:

A feature of `encode_<opcode>` methods is a *polymorphic* behaviour. They accept different types for own arguments. `encode_polyline` is not an exception: it accept also a `Polyline` object of the `libgeo` module instead of a flat array of coordinates. This feature is showed by the following code that re-implement the previous version:

```
% !TeX program = LuaTeX
\newbox\mybox
\directlua{
  local barracuda = require "barracuda"
  local pt = 65536
  local side = 18*pt
  local dim = 5
  local Polyline = barracuda:libgeo().Polyline
  local pl = Polyline:new()
  pl:add_point(0, 0)
  for _ = 1, dim do
    pl:add_relpoint(0, side)
    pl:add_relpoint(side, 0)
  end
  local canvas = barracuda:new_canvas()
```

```
    canvas:encode_linewidth(2.5*pt)
    canvas:encode_polyline(pl)
    local drv = barracuda:get_driver()
    drv:ga_to_hbox(canvas, "mybox")
  }\leavevmode\box\mybox
\bye
```

Pretty sure that this new version is more clear and intuitive.

5 Example and use cases

TODO