


# Alternative languages for safe and secure RISC-V programming

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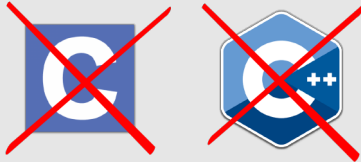
 GitHub : Fabien-Chouteau

 Hackaday.io: Fabien.C

## What do I mean by “alternative”?

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# What do I mean by “alternative”?



**BUT WHY?!**





**Ada**  
2012



**SPARK**





**Ada**  
2012



**SPARK**



# Functional Safety

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# Specifications

```
type Servo_Angle is new Float range -90.0 .. 90.0
-- Servo rotation angle in degree

procedure Set_Angle (Angle : Servo_Angle);
-- Set desired angle for the servo motor
```



# Contracts

```
type Stack is tagged private;

function Empty (S : Stack) return Boolean;
function Full (S : Stack) return Boolean;

procedure Push (S : in out Stack; Val : Integer)
  with Pre => not S.Full,
       Post => not S.Empty;

procedure Pop (S : in out Stack; Val : out Integer)
  with Pre => not S.Empty,
       Post => not S.Full;
```

- At run-time
  - Checks inserted in the code
  - For debug or testing
- At Compile time
  - Compiler
  - Static analyzer
  - Formal verification (SPARK)

# Hardware mapping

```
-- High level view of the Sense field
type Pin_Sense is
  (Disabled,
   High,
   Low)
  with Size => 2;

-- Hardware representation of the Sense field
for Pin_Sense use
  (Disabled => 0,
   High     => 2,
   Low      => 3);
```

# Hardware mapping

```
-- High level view of the register
type IO_Register is record
  Reserved_A : UInt4;
  SENSE      : Pin_Sense;
  Reserved_B : UInt2;
end record with Size => 32;

-- Hardware representation of the register
for IO_Register use record
  Reserved_A at 0 range 0 .. 3;
  SENSE      at 0 range 4 .. 5;
  Reserved_B at 0 range 6 .. 7;
end record;
```

# Hardware mapping

```
#define SENSE_MASK      (0x30)
#define SENSE_POS      (4)

#define SENSE_DISABLED (0)
#define SENSE_HIGH     (2)
#define SENSE_LOW      (3)

uint8_t *register = 0x80000100;

// Clear Sense field
*register &= ~SENSE_MASK;
// Set sense value
*register |= SENSE_DISABLED << SENSE_POS;
```

# Hardware mapping

```
Register : IO_Register  
  with Address => 16#8000_0100#;
```

```
Register.SENSE := Disabled;
```

```
<field>
  <name>SENSE</name>
  <description>Pin sensing mechanism.</description>
  <lsb>16</lsb> <msb>17</msb>
  <enumeratedValues>
    <enumeratedValue>
      <name>Disabled</name>
      <description>Disabled.</description>
      <value>0x00</value>
    </enumeratedValue>
  </enumeratedValues>
  [...]

```

[github.com/AdaCore/svd2ada](https://github.com/AdaCore/svd2ada)

## Interfacing with C / Assembly

```
with Interfaces.C; use Interfaces.C;

[...]
```

```
function My_C_Function (A : int) return int
  with Pre => A /= 0;
```

```
pragma Import (C, My_C_Function, "my_c_function");
```

```
function My_Ada_Function (A : int) return int;
```

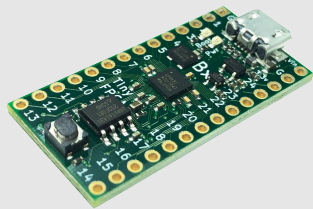
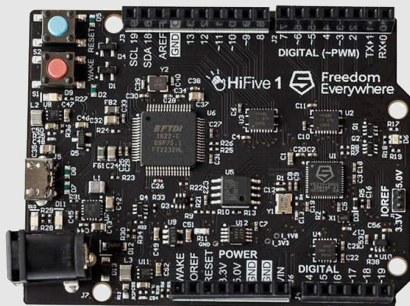
```
pragma Export (C, My_Ada_Function, "my_ada_function");
```



# Getting started on RISC-V

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# Hardware



# Download and install the tools: [adacore.com/community](https://adacore.com/community)

## Download GNAT Community Edition

For free software developers, hobbyists, and students.

### RISC-V ELF (hosted on linux64)

#### GNAT Community

[README.txt](#)

SHA-1: f48a0f0edd581f60fd35023ee358e7d3be4f0d8c

2.1 KIB

Jul 10 2018

[gnat-community-2018-20180524-riscv32-elf-linux64-bin](#)

SHA-1: e2dfca056b3d427f26c1e4337cbe25185c49ebf5

137.2 MiB

May 28 2018

### x86-64 GNU Linux (64 bits)

#### GNAT Community

[README.txt](#)

SHA-1: f48a0f0edd581f60fd35023ee358e7d3be4f0d8c

2.1 KIB

Jul 10 2018

[gnat-community-2018-20180528-x86\\_64-linux-bin](#)

SHA-1: 103b0eb85955d40f340f672441e8415cb0877fcc

430.8 MiB

May 29 2018

### ARM ELF (hosted on linux64)

#### GNAT Community

[README.txt](#)

SHA-1: f48a0f0edd581f60fd35023ee358e7d3be4f0d8c

2.1 KIB

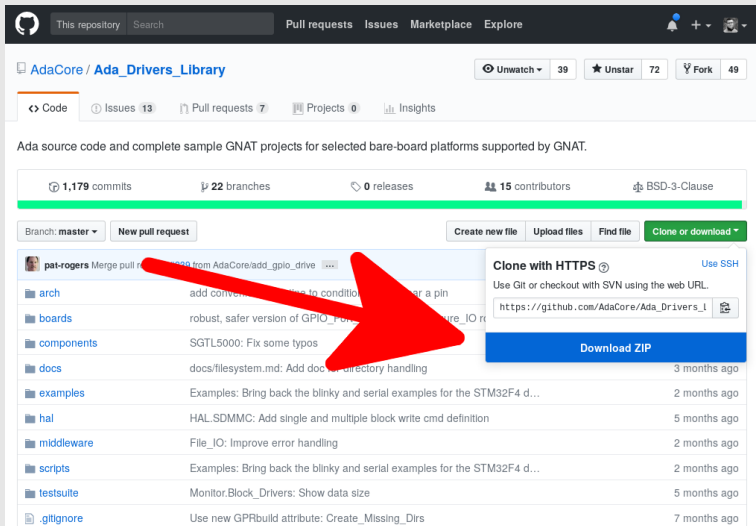
Jul 10 2018

[gnat-community-2018-20180524-arm-elf-linux64-bin](#)

199.6 MiB

May 28 2018

# Download Ada Drivers Library



This repository Search Pull requests Issues Marketplace Explore

AdaCore / **Ada\_Drivers\_Library** Unwatch 39 Unstar 72 Fork 49

Code Issues 13 Pull requests 7 Projects 0 Insights

Ada source code and complete sample GNAT projects for selected bare-board platforms supported by GNAT.

1,179 commits 22 branches 0 releases 15 contributors BSD-3-Clause

Branch: master New pull request Create new file Upload files Find file Clone or download

File	Description	Updated
pat-rogers Merge pull request #220 from AdaCore/add_gpio_drive		
arch	add conversion of gpio to conditionals for a pin	3 months ago
boards	robust, safer version of GPIO_PullUp for STM32F4	3 months ago
components	SGTL5000: Fix some typos	3 months ago
docs	docs/filesystem.md: Add doc for directory handling	3 months ago
examples	Examples: Bring back the blinky and serial examples for the STM32F4 d...	2 months ago
hal	HAL.SDMMC: Add single and multiple block write cmd definition	5 months ago
middleware	File_IO: Improve error handling	2 months ago
scripts	Examples: Bring back the blinky and serial examples for the STM32F4 d...	2 months ago
testsuite	Monitor.Block_Drivers: Show data size	5 months ago
.gitignore	Use new GPRbuild attribute: Create_Missing_Dirs	7 months ago

Clone with HTTPS Use SSH

Use Git or checkout with SVN using the web URL.

[https://github.com/AdaCore/Ada\\_Drivers\\_Library](https://github.com/AdaCore/Ada_Drivers_Library)

Download ZIP

# MAKE *with* Ada

- Embedded programming competition
- Open to everyone
- \$8000 in prizes

# Keep the door open

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# What as already been done

- Open specs and documentation
- RISC-V support in open-source tools:
  - Compilers (GCC, LLVM)
  - Debuggers (Gdb, openocd)
  - Simulators (QEMU)

- Complexity of extension combinations  
RV(32|64|128) I M A C B [F|D|Q] ...
- Deviation from the standard
- Custom/proprietary extensions



Do we need to go beyond SVD?

- Registers ✓
- Interrupts ✓
- CPU specs ?
- RAM and ROM banks ?
- Modular representation ?
- A mix between Device Tree and SVD?
- Tools that generate SVD from custom design ?

- [learn.adacore.com](http://learn.adacore.com) : interactive learning website
- Competition: [makewithada.org](http://makewithada.org)
- Twitter : @AdaProgrammers
- Reddit : [r/ada](https://www.reddit.com/r/ada)