

# Gowin PicoRV32 PicoRV32 快速设计参考手册

IPUG915-1.0,2020-01-16

#### 版权所有<sup>©</sup>2020 广东高云半导体科技股份有限公司

未经本公司书面许可,任何单位和个人都不得擅自摘抄、复制、翻译本文档内容的部分或全部,并不得以任何形式传播。

#### 免责声明

本文档并未授予任何知识产权的许可,并未以明示或暗示,或以禁止发言或其它方式授予任 何知识产权许可。除高云半导体在其产品的销售条款和条件中声明的责任之外,高云半导体 概不承担任何法律或非法律责任。高云半导体对高云半导体产品的销售和/或使用不作任何 明示或暗示的担保,包括对产品的特定用途适用性、适销性或对任何专利权、版权或其它知 识产权的侵权责任等,均不作担保。高云半导体对文档中包含的文字、图片及其它内容的准 确性和完整性不承担任何法律或非法律责任,高云半导体保留修改文档中任何内容的权利, 恕不另行通知。高云半导体不承诺对这些文档进行适时的更新。

#### 版本信息

日期	版本	说明
2020/01/16	1.0	初始版本。

# 目录

目录…	i
1 Gow	/in_PicoRV32 软件编程设计1
1.1	软件环境1
1.2	参考设计1
1.3	导入软件参考设计1
1.4	SMEM 配置
1.5	编译4
1.6	下载4
1.7	参考手册
2 Gow	/in_PicoRV32 硬件设计6
2.1	硬件环境6
2.2	软件环境6
2.3	导入硬件参考设计6
2.4	综合7
2.5	布局布线
2.5 2.6	布局布线

# 图目录

图 1-1 导入软件参考设计	. 2
图 1-2 MCU boot from ILM 设置	. 2
图 1-3 MCU boot from external flash 设置	. 3
图 1-4 编译	. 4
图 1-5 Device configuration	. 5
图 2-1 导入 Gowin_PicoRV32 硬件参考设计	. 7
图 2-2 综合参考设计	. 8
图 2-3 布局布线	. 8
图 2-4 Configure Device	. 9

表目录

表 <b>2-1</b>	硬件参考设计示例	7
--------------	----------	---

# **1** Gowin\_PicoRV32 软件编程设计

# 1.1 软件环境

GOWIN MCU Designer V1.0

# 1.2 参考设计

Gowin\_PicoRV32 提供 GOWIN MCU Designer 软件环境的软件编程参考设计:

 $Gowin\_PicoRV32\ref\_design\MCU\_RefDesign\GMD\_RefDesign\.$ 

# 1.3 导入软件参考设计

双击打开 GOWIN MCU Designer,选择菜单栏 File\Import 或 Project Explorer 视图中右击选择 Import,导入参考设计,如图 1-1 所示。

#### 🗙 C/C++ - GOWIN MCU Designer File Edit Source Refactor Navigate Se 🐝 Import Import Projects 🎦 Project Explorer 🛛 🕒 🔄 🧏 🗢 🗖 Select a directory to search for existing Eclipse projects. Cm3\_int\_priority 📋 cm3\_keyscan Cm3 led Select root directory: C:\GMD\workspace\picorv32\_demo -Browse... 📋 cm3\_mm Cm3\_retarget Select archive file: Br Cm3\_rtc Projects: 📋 cm3\_spi Cm3\_systick picorv32 demo (C:\GMD\workspace\picorv32 demo) Select All Cm3\_timer Deselect All 📋 cm3\_uart Cm3\_uart0\_int R<u>e</u>fresh 📋 cm3\_ucos\_iii Cm3\_wdog 📋 DigitalSeg free\_rtos 📋 i2c int\_priority 📋 keyscan Options 📋 lcd Search for nested projects 📋 led Copy projects into workspace 📋 mm Hide projects that already exist in the workspace pv32\_wbuart Working sets i retarget 📋 spi Add project to working sets Ne<u>w</u>... 📋 systick 1 timer Working sets: Select.. 📋 uart 📋 uart0\_int 📋 uartes 📋 ucos\_iii 📋 watchdog ? < <u>B</u>ack $\underline{N}ext >$ Einish Cancel 0 items selected

#### 图 1-1 导入软件参考设计

# 1.4 SMEM 配置

如果用户使用 MCU boot from ILM 的启动方式,则设置 Flash 链接器脚本 sections.lds 中指令存储器 SMEM 的起始地址 ORIGIN 为 0x01000000, 如图 1-2 所示。

#### 图 1-2 MCU boot from ILM 设置

📄 sections.lds 🛛			
<pre>1/* 2 * boot from ilm : SMEM start address = 0x01000000 3 * boot from exi flash : SMEM start address = 0x01000080 4 */ 5 6 WEMONY</pre>			
7 {			
9 _ <u>PAM (v</u>			
10 SMEM (x	rw) : ORIGIN = 0x01000000, LENGTH = 32K /* ILM */		
11 FLASH (n 12 }	<pre>kw) : ORIGIN = 0x03000000, LENGTH = 1M</pre>		

如果用户使用 MCU boot from external flash 启动方式,则设置 Flash 链接器脚本 sections.lds 中指令存储器 SMEM 的起始地址 ORIGIN 为 0x01000080,如图 1-3 所示。

图 1-3 MCU boot from external flash 设置

```
📄 sections.lds 🛛
1/*
  2 * boot from ilm : SMEM start address = 0x01000000
  3 * boot from exi flash : SMEM start address = 0x01000080
  4 */
  5
  6 MEMORY
 7 {
  8
                            • ORIGIN = 0x00000000, LENGTH = 32K /* DLM */

• ORIGIN = 0x01000080, LENGTH = 32K /* ILM */
 9
         10
        SMEM (xrw)
                               ORIGIN - 0x00000000, LENGTH = 1M
 11
         PLASII (I XW)
 12 }
 4.5
```

指令存储器 SMEM 的 Size 请根据所选芯片型号、Gowin\_PicoRV32 硬件设计中 ILM Size 设置以及 BSRAM 的实际使用情况进行设置。

# 1.5 编译

单击工具栏编译按钮 5,编译参考设计,输出 Gowin\_PicoRV32 软件 编程二进制 BIN 文件,如图 1-4 所示。

如果使用 MCU boot from ILM 启动方式,请使用 makehex 工具,将二 进制 BIN 文件转换为十六进制映像文件 ram32.hex,作为 ILM 的初始值文件。

图 1-4 编译



# 1.6 下载

单击菜单栏 Run\Programmer 或工具栏 Programmer J 折开 Programmer。

以 MCU boot from external flash 参考设计为例,单击 Programmer 菜 单栏 Edit/Configure Device 或工具栏 Configure Device,打开 Device configuration 对话框, Access Mode 下拉列表选择"External Flash Mode", Operation 下拉列表选择"exFlash C Bin Erase, Program", Firmware/Binary File 中导入需要下载的 Gowin\_PicoRV32 二进制 BIN 文件, External Flash Options 中 Device 根据板载 Flash 芯片类型选择, Start Address 设置为 0x400000,单击"Save",如图 1-5 所示。

*	Device configuration	? <mark>×</mark>	
	Device Operation		
	Access Mode:	External Flash Mode 🔻	
	Operation:	exFlash C Bin Erase, Program 🔹	
	exFlash C Bin Erase(with 4K Alignment), Program		
	-External Flash Options		
	Device:	Winbond W25Q64 🔹	
	Start Address:	0x400000	
	FW/MCV Input Options		
	Firmware/Binary File: /workspace/pv32_wbuart/Debug/pv32_wbuart.bin		
		Save Cancel	

#### 图 1-5 Device configuration

完成 Device configuration 后,单击 Programmer 工具栏

Program/Configure , 完成 Gowin\_PicoRV32 二进制 BIN 文件下载。

# 1.7 参考手册

Gowin\_PicoRV32 软件编程设计方法请参考:

- IPUG911, Gowin\_PicoRV32 软件编程参考手册
- IPUG910, Gowin\_PicoRV32 IDE 软件参考手册
- IPUG913, Gowin\_PicoRV32 软件下载参考手册
- SUG502, Gowin Programmer 用户指南

# **2**Gowin\_PicoRV32硬件设计

# 2.1 硬件环境

#### DK-START-GW2A18 V2.0: GW2A-LV18PG256C8/I7

# 2.2 软件环境

Gowin\_V1.9.3.01Beta

# 2.3 导入硬件参考设计

双击打开 Gowin 云源软件,选择菜单栏 File 列表中 Open 选项,选择高 云提供的 Gowin\_PicoRV32 硬件参考设计 boot\_from\_exi\_flash 或 boot\_from\_ilm,如图 2-1 所示。

或者打开 IP Core Generator,根据用户需求重新配置产生 Gowin\_PicoRV32 硬件设计。

•	Open Project		×
Look in:	/home/liukai/boot_from_exi_flash		1
Compute	r 🛅 impl		
🛅 liukai	src src		
	boot_from_exi_flash.gprj		
File <u>n</u> ame:	boot_from_exi_flash.gprj		<u>Open</u>
Files of type:	GOWIN FPGA Designer Project File (*.gprj)		Cancel

图 2-1 导入 Gowin\_PicoRV32 硬件参考设计

硬件参考设计工程主要文件,如表 2-1 所示。

表 2-1 硬件参考设计示例

文件	描述
clk_unit.v	用于产生系统时钟的 PLL 模块
gowin_picorv32.v	Gowin_PicoRV32 硬件设计
mcu_top.v	Gowin_PicoRV32 实例化和用户设计
wb_ext_branch.v	Gowin_PicoRV32 的 Wishbone 总线扩展接口分支器模块
wb_reg_demo.v	wishbone 外设示例,包含可读可写的寄存器
mcu_top.cst	物理约束

# 2.4 综合

运行综合工具 Synplify\_Pro 或 GowinSynthesis,综合参考设计生成网表 文件,如图 2-2 所示。

图 2-2 综合参考设计



#### GOWIN FPGA Designer - [/home/liukai/gowin\_picorv32/impl/synthesize/rev\_1/gowin\_picorv32.htm] File Edit Project Tools Window He 🗋 🖻 🗄 🖷 🖛 🔺 🏃 🕒 🛍 🖌 S 🔀 👶 👫 B B govin\_picorv32 (rev 1) Synthesis Somplie: Report Complie: Report Complie: Report Constraint Applicator Pre-mapping: Report Clock Summary Clock Summary Clock Conversion Manper Report Process #Build: Synplify Pro (R) P-2019.036-1-Beta1, Build 387R, Dec 3 2019 #install: /share/gwsw/gowin\_new/Gowin/Gowin\_YunYuan\_V1.9.xBeta/SynplifyPro #OS: Linux #iostname: JINAN9100.sdgowin.com 📗 Design Summary 🛛 🗾 User Constraints FloorPlanner 🔀 Timing Constraints Editor # Mon Dec 16 10:11:04 2019 🗄 📀 Synthesize Clock Conversion Mapper Report Triming Report Performance Summary Clock Relationships Interface Information Detailed Repo for Clocks #Implementation: rev 1 📄 Synthesis Report Copyright (C) 1994-2019 Synopsys, Inc. This Synopsys software and all associated documentation are proprietary to Synopsys, Inc. and may only be used pursuant to the terms and conditions of a written license agreement with Synopsys, Inc. All other use, reproduction, modification, or distribution of the Synopsys software or the associated documentation is strictly prohibited. Tool: Synplify Pro (R) Build: P-2019.0836-1-Beta1 Instal: /share/ysw?yowin\_new/Gowin/Gowin\_YunYuan\_V1.9.xBeta/SynplifyPro OS: CentOS release 6.8 (Final) Hostname: JNAK9109.63(gowin.com max virtual memory: unlimited (bytes) max user processes: 1024 max stack size: 10485760 (bytes) 📄 Netlist File Place & Route 📃 Place & Route Report 📃 Timing Analysis Report Ports & Pins Report Power Analysis Report <u>for Clocks</u> <u>Resource</u> <u>Utilization</u> <u>Constraint Checker</u> 📲 Program Device Report (10:11 16-Dec sion Log (10:11 16-Implementation : rev\_1 Synopsys HDL Compiler, Version comp2019q1p1, Build 391R, Built Dec 3 2019 09:36:30 @N: : | Running in 64-bit mode Copyright (C) 1994-2019 Synopsys, Inc. This Synopsys software and all associated documentation are proprietary to Synopsys, Inc. and may only be used pursuant to the terms and conditions of a written license agreement Design Process Hierarchy 😯 Start Page 💥 🔥 IP Core Generator 💥 Design Summary 💥 📿 gowin\_picorv32.v 💥 📿 gowin\_picorv32.htm 💥 Output Output @N: MF248 [Running in 64-bit mode. @N: MF268 [Clock conversion enabled. (Command "set\_option -fix\_gated\_and\_generated\_clocks 1" in the project file.) @N: MF266 [Clock conversion enabled. (Command "set\_option -fix\_gated\_and\_generated\_clocks 1" in the project file.) @N: MF266 [Auto Constrain mode is enabled. @N: FX164 [The option to pack registers in the IOB has not been specified. Please set syn\_useioff attribute. @N: FX164 [The option to pack registers in the IOB has not been specified. Please set syn\_useioff attribute. @N: FX164 [The option to pack registers in the IOB has not been specified. Please set syn\_useioff attribute. @N: FX164 [The option to pack registers in the IOB has not been specified. Please set syn\_useioff attribute. @N: FX164 [The option to pack registers in the IOB has not been specified. Please set syn\_useioff attribute. @N: FX164 [The option to pack register.com using default value of IpF @N: MT320 [Found inferred clock Gowin\_PlcoRV32\_Top|clk\_in with period 14.31ns. Please declare a user-defined clock on port clk\_in. @N: MT322 [Clock constraints include only register-to-register paths associated with each individual clock.

# 2.5 布局布线

完成综合后,运行布局布线工具 Place & Route,布局布线产生包括软件编程设计输出和硬件设计输出的码流文件,如图 2-3 所示。

#### GOWIN FPGA Designer - [/home/liukai/gowin\_picorv32/impl/pnr/gowin\_picorv32.rpt.html] 🔀 Eile Edit Project Tools Window Help 🗋 📂 🗑 👘 🖛 🔺 🖒 🛍 👪 🥌 🖊 o x Process E Design Summary PnR Messages 🖻 📝 User Constraints PnR Messages - 📊 FloorPlanner PnR Details 🔀 Timing Constraints Editor Placer Report Title Gowin PnR Report 🗄 🥝 Synthesize Resource Usage Summary Design File /home/liukai/gowin\_picorv32/impl/synthesize/rev\_1/gowin\_picorv32.vm Synthesis Report I/O Bank Usage Summary Physical Constraints File Netlist File Timing Constraints File Router 🗄 📀 Place & Route Place & Route Report Global Clock Usage Summary GOWIN Version V1.9.3Beta Timing Analysis Report Ports & Pins Report Global Clock Signals Part Number GW2A-LV18PG256C8/I7 • Pinout by Port Name Created Time Mon Dec 16 10:26:48 2019 Power Analysis Report All Package Pins Legal Announcement Copyright (C)2014-2019 Gowin Semiconductor Corporation. All rights reserved. Program Device Memory Usage **PnR Details** Placer: Starting Placer: Placement Phase 0 ... REAL time: 8.05 secs Placement Phase 1 ... REAL time: 5.35 secs Placement Phase 2 ... REAL time: 80.9 secs Design Process Hierarchy 🗸 Start Page 🕱 👶 IP Core Generator 🕱 Design Summary 🕱 🙋 gowin\_picorv32.vv 💥 👂 gowin\_picorv32.rpt Output 30001) : Bitstream generation in progress..... 30002) : Bitstream generation completed. 400031 : Fower analysis completed. 400083 : Generate '/home/liukai/gowin\_picorv32/impl/pnr/gowin\_picorv32.pin.html' file complete 400083 : Generate '/home/liukai/gowin\_picorv32/impl/pnr/gowin\_picorv32.pin.html' file completed 400083 : Generate '/home/liukai/gowin\_picorv32/impl/pnr/gowin\_picorv32.pt.html' file completed 400083 : Generate '/home/liukai/gowin\_picorv32/impl/pnr/gowin\_picorv32.pt.html' file completed 400083 : Generate '/home/liukai/gowin\_picorv32/impl/pnr/gowin\_picorv32.pt.html' file completed 400083 : Generate '/home/liukai/gowin\_picorv32/impl/pnr/gowin\_picorv32.tr.html' file completed Info Info Info Info Info Info Info

#### 图 2-3 布局布线

# 2.6 下载

运行 Gowin 云源软件的下载工具 Programmer,完成码流文件的下载。

以 DK-START-GW2A18 V2.0 和 MCU boot from external flash 参考设 计为例,单击 Programmer 菜单栏 Edit/Configure Device 或工具栏 Configure Device Jan 打开 Device configuration 对话框, Access Mode 下拉列表中 选择"External Flash Mode", Operation 下拉列表中选择"exFlash Erase, Program", Programming Options 中导入需要下载的码流文件, External Flash Options 中 Device 根据板载 Flash 芯片选择, Start Address 选择 0x000000,单击"Save",如图 2-4 所示。

图 2-4 Configure Device

Device configuration			
Device Operation			
Access Mode:	External Flash Mode 🔹		
Operation:	exFlash Erase, Program 🔻		
Erase(with 4K Alignment) and program the external SPI flash. Make sure the config mode is "O11". Make sure the config frequency in fs-file is less than 60Mhz ( >30Mhz must set FASTREAD_N pin ).			
Programming Options			
File name: Users/root/I	)esktop/fpga_project/impl/pnr/gowin_picorv32.		
User Flash Initialization			
External Flash Options			
Device:	Winbond W25Q64 🗸		
Start Address:	0x000000		
	Save Cancel		

完成 Device configuration 后,单击 Programmer 工具链 Program/Configure ,完成码流文件的下载。

# 2.7 参考手册

Gowin\_PicoRV32 硬件设计请参考:

- IPUG914, Gowin\_PicoRV32 硬件设计参考手册
- <u>SUG100</u>, Gowin 云源软件用户指南
- <u>SUG101</u>, Gowin 设计约束指南
- SUG502, Gowin Programmer 用户指南

