WRS-3/18 - User Guide

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Contents

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Revision table

Rev	Date	Author	Comments
0.1	18/02/2013	Benoit Rat Seven Solutions	Initial Version Reviewer: Rodrigo Agis (7S)
0.2	26/03/2013	Benoit Rat Seven Solutions	Adding suggestion from Beck, Dietrich Dr (GSI)
0.3	27/03/2013	Benoit Rat Seven Solutions	Modifying licence to GPL v2.0 to be comptabile with the package
0.4	23/05/2013	Benoit Rat Seven Solutions	Updating 125MHz out to CLK
0.5	26/07/2013	Benoit Rat Seven Solutions	Adding suggestion from Erik Van Der Bij (CERN)
1.0	26/07/2013	Benoit Rat Seven Solutions	Updating for v3.3 release

Glossary

DHCP The Dynamic Host Configuration Protocol to obtain network configuration.

FMC FPGA Mezzanine Card, an ANSI standard for mezzanine card form factor.

HDL Hardware description language.

LM32 LatticeMico32 is a 32-bit microprocessor soft core optimized for field-programmable gate arrays (FPGAs).

NAND NAND Flash Memory, a type of reprogrammable non-volatile computer memory.

PCIe Peripheral Component Interconnect Express, a high-speed serial computer expansion bus standard.

PTP Precise Time Protocol, a time synchronization protocol.

SMC SubMiniature version C, coaxial connector used in radio-frequency circuits.

SFP Small form-factor pluggable transceiver, a hot-pluggable transceiver for optical fiber.

SPEC Simple PCIe FMC carrier.

SVEC Simple VME FMC carrier.

UART Universal Asynchronous Receiver/Transmitter.

WR White Rabbit.

WRS White Rabbit Switch.

1 Introduction

The White Rabbit Switch (WRS) is the key component of the White Rabbit Protocol that provides precision timing and high synchronization over an Ethernet-based network.

1.1 About this Guide

This document is intended as a user guide for quickly setup your switch in a White Rabbit Network. For more details on advanced topics please refers to the Advanced configuration section or to the wr-switch-sw.pdf guide.

2 Product Overview

2.1 Package

The WRS package is composed of various elements:

- The packaging box
- A power cable according to the country of distribution.
- The 18 SFP ports switch.
- SFP LC connectors
  - 16x AXGE-3454-0531 (violet)
  - 2x AXGE-1254-0531 (blue)

Note: *The SFP LC connectors are optional. Consult the SFPs Wiki for more information about the compatibility of SFPs and how to use them.*

2.2 Front panel (Legend)

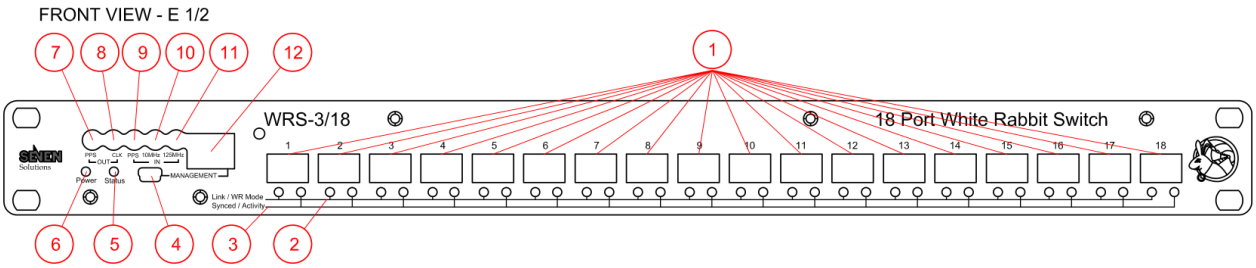

Figure 1: Front Panel of the WRS

1. The 18 SFP ports
2. Synced/Activity LEDs
3. Link/WR Mode LEDs
4. Management Mini-USB (B) port
5. Status LED
6. Power LED
7. PPS output
8. Synced CLK reference Output (62.5 MHz)
9. PPS input (GPS Clock)
10. 10MHz reference clock input (GPS/Cesium)
11. 125MHz reference clock input (Not used)
12. Ethernet 100Mbps Management Port

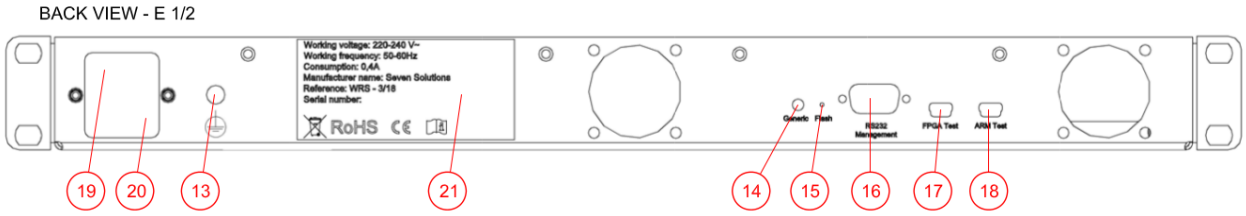

Figure 2: Back Panel of the WRS

2.3 Back panel (Legend)

13. Ground Connector
14. Generic Button
15. Flashing Button (See firmware update)
16. RS232 Management Port (GPRMC)
17. FPGA Mini-USB (B) UART
18. ARM Mini-USB (B) UART
19. Power Switch
20. Power Plug
21. Serial Number and MACs

3 Basics

3.1 Default Setting

The device is factory configured with the following default settings:

- IP configuration is **DHCP**
- MACs are given by the manufacturer; labeled on back panel #21
  - MAC1 corresponds to the managment port (RJ45).
  - MAC2 corresponds to the first SFP port ($wr[0-17] \Leftrightarrow \text{MAC2} + [0-17]$).
- WR mode is **BoundaryClock** (Simple Master)
  - The first two ports (SFPs 1 & 2) are configured as WR slave.
  - The other ports (SFPs [3-18]) are configured as WR master.
- SSH user: **root**
- SSH password: (empty/just press enter)
- Boot method: from Nandflash firmware

3.2 Quick Startup

To get the switch quickly working we recommend you to:

1. Plug an Ethernet cable to the *Ethernet 100Mpbs Management Port*.
2. Plug the power cable to the *Power Plug*.

After all connections have been made, toggle the power-switch on to turn the device on. After the power on, the WRS should behave as follows:

3. The *Power LED* goes green
4. After 15s, the *Status LED* goes orange which means that the WRS's kernel has started.
5. Then the fan start working which means that FPGA has been correctly programmed.
6. Finally, it goes green when everything is succesful (PLL is locked).

You have now the WRS ready to be used in a WR network.

7. Connect the blue SFPs (AXGE-1254-0531) to the SFP port 1 and 2 of the WRS. These SFPs are the ones that will receive synchronization message from another master WRS or from the grandmaster WRS. If you only have one switch in your network you might configure it in the GrandMaster mode.
8. You can plug the other SFP ports [2-16] with violet SFPs (AXGE-3454-0531) to the WR node such as SPEC, SVEC, ...

3.3 USB Connections

The WRS has three different USB ports used to communicate/monitorize through a PC.

a. Management Mini-USB (B) port
b. FPGA Mini-USB (B) UART
c. ARM Mini-USB (B) UART

These ports correspond themselve to different devices on your computer.

a. ttyACM0 (when the *Status LED* is green)
b. ttyUSB0
c. ttyUSB1

To connect to them you need to open a serial console such as minicom[1]

```
## Connecting to the Management USB port
minicom -D /dev/ttyACM0 -b 115200

## Connecting to the FPGA UART
minicom -D /dev/ttyUSB0 -b 115200

## Connecting to the ARM UART
minicom -D /dev/ttyUSB1 -b 115200
```

Note: ttyUSB0 and ttyUSB1 usally correspond respectively to FGPA and ARM UART. However this order can change dependably on how you plug the cable.

3.4 Login via USB

Once the device has been correctly started up (*Status LED* is green), It is recommended to use the USB management port to connect to the device instead of the ARM UART.

```
## Connecting to the Management USB port
minicom -D /dev/ttyACM0 -b 115200
```

The ARM UART is usually employed during development and monitoring because the kernel and daemons messages are sent to this console.

3.5 Login via SSH

The Ethernet management port automatically obtains its IP using the DHCP protocol. If you don't have any DHCP router/server in your network please refer to the non-DHCP section.

To obtain the IP of the WRS you can connect to your DHCP server interface and retrieve the IP, or connect to ttyACM0 to retrieve the IP (`ipconfig eth0`).

If the WRS IP is for example `192.168.1.50` you might connect using:

```
ssh root@192.168.1.50
```

And press enter when requesting the password.

[1] In Debian-like distribution you can install minicom by executing `sudo apt-get install minicom`.

3.6 Login using Windows

The process of login to the switch using Windows (XP,Vista,7,8) is pretty similar:

1. You first need to download the Putty Tool and install it.
2. Then you need to list and find out which serial port in Windows corresponds to which interface. A simple way to perform this is to plug only one USB cable at a time, and go to `Device Manager > Ports (COM & LPT)` to check the name of the `COM<X>` port.
3. Finally to connect through the USB you just need to open the Putty tool and configure it as indicated in the figure below. Do not forget to replace the `COM9` port name by the one that corresponds to the USB management.

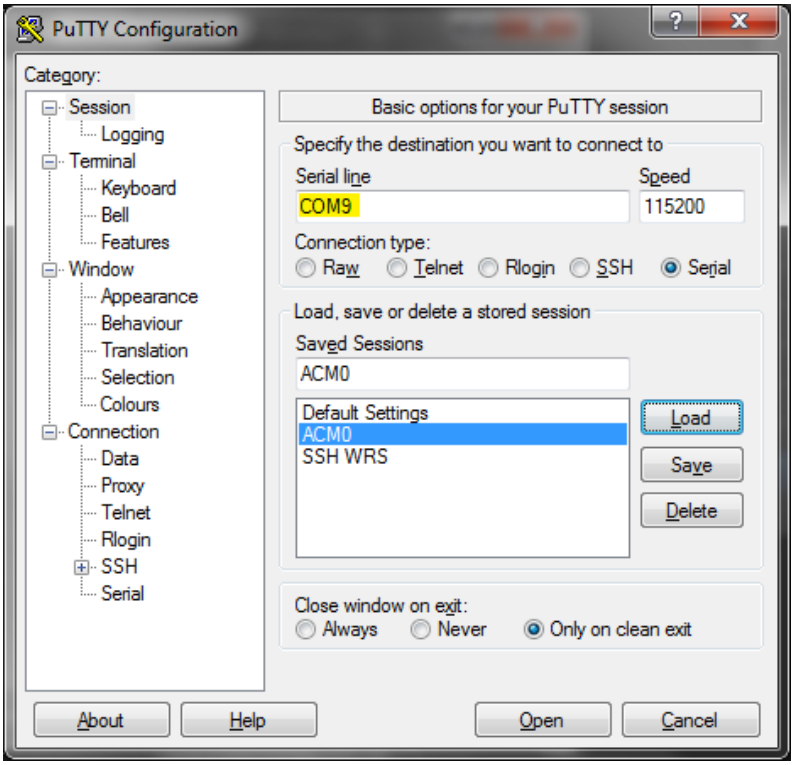

Figure 3: Putty - USB connection

4. Similarly, you can connect to the WRS using the SSH protocol. You should not forget to replace the IP of your WRS (yellow) by the one in your subnetwork.

3.7 After login:

Once you are logged in you can use various tools to monitor the WRS. All these tools are found in `/wr/bin/` which is included in the `$PATH`.

The following list resumes the most interesting commands:

- `shw_ver`: Print information about the SW & HW version of the WRS.
- `rtu_stat`: Routing Table Unit Statistic, returns the routing table information where we can find which MAC needs to be forwarded to which port. It also allows to add and delete entries.
- `wr_mon`: WR Switch Sync Monitor, outputs information about the state of WR syncrhonisation such as Phase Tracking, Master-Slave delay, link asymmetry, etc...

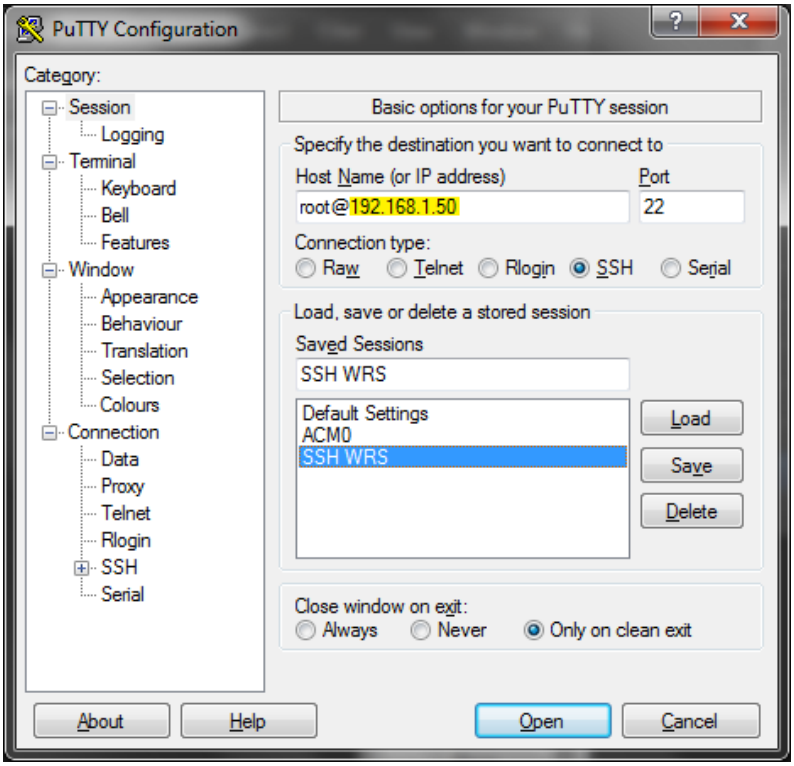

Figure 4: Putty - SSH connection

- `spll_dbg_proxy`: SoftPLL debug proxy, reads out the debug FIFO datastream from the SoftPLL and proxies it via TCP connection to the application running on an outside host, where it can be plotted, analyzed, etc.

Note: More information about each tool can be obtain using the embedded help argument: `--help`, `-h` or `help`.

Warning: The SFP ports are labeled from 1 to 18 on the front panel but their corresponding network interface are named from `wr0` to `wr17`.

4 Configurations

4.1 Booting

After 10 seconds, the bootloader automatically loads the WRS firmware from the Flash NAND memory of the switch. If you connect to the ARM debug port you might see the following message:

```
Welcome on WRSv3 Boot Sequence
     1: boot from nand (default)
     2: boot from TFTP script
     3: edit config
     4: exit to shell
     5: reboot
```

Note: If you want to change how the WRS is booted you can place a `wrboot` script in your TFTP root folder and select the second option or you can edit the configuration (third option). Please find more explanations in the Advanced configuration

4.2 Non-DHCP user

If you have no DHCP server in your network you must connect to the WRS using the login via USB method and then edit the `interfaces` file:

```
vi /etc/network/interfaces
```

for example, in a `192.168.1.x` subnetwork you might replace the `iface eth0 inet dhcp` by

```
iface eth0 inet static
    address 192.168.1.10
    netmask 255.255.255.0
    network 192.168.1.0
    broadcast 192.168.1.255
    gateway 192.168.1.1
```

Note: If you are willing to use TFTP script in a non-DHCP network, you must also statically set the IP in the bootloader configuration.

4.3 GrandMaster mode

In a White Rabbit network, almost all the switches are configured as master (a.k.a SimpleMaster) (default configuration). They transmit the clock signal that cames from other switches. However the "top" switch connected to the GPS signal is called the **GrandMaster** and is configured in a specific way.

To configure a switch as GrandMaster you must edit[2] the `wrsw_hal.conf` file

```
vi /wr/etc/wrsw_hal.conf
```

And uncommenting the timing.mode value the line below:

```
timing = {
   -- other values
   mode = "GrandMaster"; -- grand-master with external reference
};
```

[2]To edit in `vi`: `Ins` Insert text; `Esc` back to normal mode; `:wq` Save and Exit

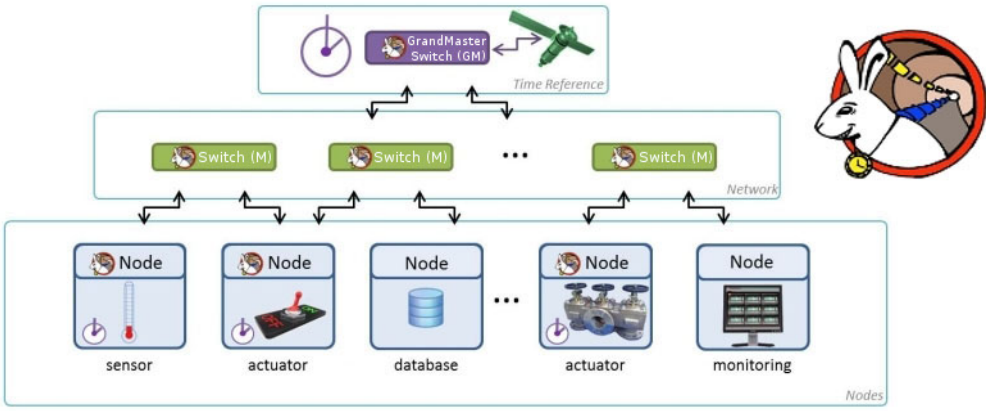

Figure 5: White Rabbit Network

For a more detailed explanation on how to configure and connect the switch as GrandMaster, please consult the wr_external_reference.pdf document.

4.4 Firmware updates

This section proposes a simple way to update the firmware of the WRS by flashing the memory using the *Management Mini-USB*[3].

1. Download the flashing package and extract it.
2. Download the latest stable release of the WRS firmware in a tar.gz package.
3. Connect the *Management Mini-USB* port to the PC[4].
4. Start the flashing procedure by executing in a linux console: `flash-wrs -e -m1 <MAC1> -m2 <MAC2> wr-switch-sw-<latest_version>.tar.gz` where MAC1 and MAC2 are written in the back panel (label #21)
5. At this step you will be asked to restart the WRS, using the *Power Switch*, while pressing the *Flash Button*.
6. The flashing procedure should start and it takes some time to perform.
7. The switch will restart by itself which means that the flashing operation has finished.

4.5 Advanced configuration

Please refer to the White Rabbit Switch: software build scripts manual (wr-switch-sw.pdf) that explains advanced topics such as:

- Advanced flashing options.
- Configuring specific MAC address.
- Modification of the bootloader.
- Changing Slave/Master port type.
- Building from the sources.
- etc.

[3]The flashing operation is only available for linux environment, and it is recommended to use Debian-like distribution such as "Ubuntu"

[4]Please, make sure that the managment USB port (ttyACM0) is not used by another process such as minicom.

5 Safety Notes

Warning: Do not block the air vents which are located on back panel of the WRS, the internal temperature might increase and damage the switch.

Warning: To increase the lifetime of the WRS it is recommended to use the switch in a controlled ambient environment and limit to the ambient condition stated in the Specification Appendix.

Warning: The standard power source for this equipment is designed to work in the range of 110-240V with 50-60Hz.

Warning: This equipment is intended to be grounded using the *Grounded Connector*. Ensure that the host is connected to earth ground during normal use.

6 Appendix

6.1 Specification

FPGA	
Type	Xilinx Virtex-6 (LX240T)
Package	1156-pin BGA
Slices	37,680 (4 LUTs and 8 flip-flops)
Memories	416x36Kb (9,504Kb) Block RAM 32MB NOR Flash
Softcore	LatticeMico32 (LM32)
I/O	20 GTX transceivers for SFP links 40 GPIO for generic purpose (LEDs, SFP detection, ...)
Monitoring	Monitoring power supply
Temperature	Sensor control

CPU	
Type	ARM Atmel AT91 SAM9G45
Core	400MHz (ARM926E)
Memories	64MB DDR2 (16-bit bus chip) 256MB NAND flash chip 8MB boot flash
I/O	32bit Async Bridge with FPGA 100Base-T Ethernet
OS	Linux (Kernel v2.6.39)

OnChip Clock	
PLL	AD9516 (14-Output Clock Generator with Integrated 1.6 GHz VCO)
Synthesizer	TI CDCM61002RHBT (28-683MHz)
DAC	2xAD5662BRJ (16bit; 2.7-5.54V)

Others	
Soldering	IPC- 610 Rev E Class 2
Certification	ISO-9001, ISO-14001, CE, RoHS
Power Supply	100-240VAC, 2.0A 50-60 Hz 12V DC, 6.66A – 80W max
Environmental Conditions	Temperature: -10ºC ~ +50ºC Humidity: 0% ~ 90% RH

6.2 Features

- PTPv2 (IEEE 1588-2008)
- WRP daemon (node discovery, etc.)
- DHCP client
- SSH server
- Python Support
- NTP Client/Relay/Server
- ARP/ DNS / EtherWake protocol

6.3 Warranty

The WRS is fully factory tested and warranted against manufacturing defects for a period of one year. As the circumstances under which this WRS is installed can not be controlled, failure of the WRS due to installation problems can not be warranted. This includes misuse, miswiring, overheating, operation under loads beyond the design range of the WRS. For warranty or non-warranty replacement send the WRS to:

Seven Solutions
C/ Baza, parcela 19, nave 3
Polígono Industrial Juncaril,
18210 Peligros
(Granada), SPAIN.

6.4 FAQs & Troubleshooting

If you are experiencing some issues please look first at the WRS FAQ wiki page if you can find an answer.

You can also reach out the wiki to see if your issue is a known bug and if a solution was found: `http://www.ohwr.org/projects/wr-switch-sw/wiki/Bugs`

You can also request Technical Support by contacting our company

Bug report

Feel free to send us a bug report with the full state of the WRS by executing the following command:

```
#On the WRS
shw_ver > /tmp/bug_report.txt
rtu_stat >> /tmp/bug_report.txt
dmesg >> /tmp/bug_report.txt

#Obtain the IP of the switch
ifconfig eth0 | grep addr
```

And retrieving the file from your computer by using SSH:

```
#On your client
scp root@<IP_of_the_switch>:/tmp/bug_report.txt ~
```

6.5 Contact-Us

To contact Seven Solutions company please use:

- info@sevensols.com
- (+34) 958 285 024
- http://www.sevensols.com

6.6 Save Our Environment

This symbol means that when the equipment has reached the end of its life cycle, it must be taken to a recycling centre and processed separate from domestic waste.

The cardboard box, the plastic contained in the packaging, and the parts that make up this device can be recycled in accordance with regionally established regulations.

Never throw this electronic equipment out along with your household waste. You may be subject to penalties or sanctions under the law. Instead, ask for instructions from your municipal government on how to correctly dispose of it. Please be responsible and protect our environment.

7 References

- wrs-3/18.pdf: Datasheet for the White Rabbit Switch v3 - 18 SFPs
- wr-switch-sw.pdf: Advanced documentation on how using the software
- wr_external_reference.pdf: Connect the WRS in GrandMaster mode.
- whiterabbitsolution: White Rabbit as a complete timing solutions
- WRS Wiki: White Rabbit Switch Wiki on ohwr.org
- WRS FAQ: WR-Switch Frequently Added Questions
- wr-switch-testing: Project for testing the switch itself
- SFPs Wiki: Type of SFP supported by the WRS
- latest stable release: http://www.sevensols.com/dl/wr-switch-sw/bin/latest_stable.tar.gz
- flashing package: http://www.sevensols.com/dl/wrs-flashing/latest_stable.tar.gz