

# WRS-3/18 - Startup Guide

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25 Aug. 2017 - v5.0.1

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## Revision table

Rev	Date	Author	Comments
0.1	18/02/2013	Benoit Rat <a href="#">Seven Solutions</a>	Initial Version Reviewer: Rodrigo Agis (7S)
0.2	26/03/2013	Benoit Rat <a href="#">Seven Solutions</a>	Adding suggestion from Beck, Dietrich Dr (GSI)
0.3	27/03/2013	Benoit Rat <a href="#">Seven Solutions</a>	Modifying licence to GPL v2.0 to be comptabile with the package
0.4	23/05/2013	Benoit Rat <a href="#">Seven Solutions</a>	Updating 125MHz out to CLK
0.5	26/07/2013	Benoit Rat <a href="#">Seven Solutions</a>	Adding suggestion from Erik Van Der Bij (CERN)
1.0	26/07/2013	Benoit Rat <a href="#">Seven Solutions</a>	Updating for v3.3 release
1.1	26/07/2014	Jose Luis Gutierrez <a href="#">Seven Solutions</a>	Adding WMI for v4.0 release
1.2	02/10/2014	Benoit Rat <a href="#">Seven Solutions</a>	Updating for v4.1 release
1.3	05/08/2014	Benoit Rat <a href="#">Seven Solutions</a>	Updating for v4.2 release
1.4	15/05/2017	Benoit Rat <a href="#">Seven Solutions</a>	Updating for v5.0.1 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.

**WMI** Web Management Interface

## 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.

### About this Guide

This document is intended as a **Startup 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 other manuals.

This document will refer only to [WRS](#) with hardware v3.3 and v3.4.

### The Official Manuals

This is the current set of manuals that accompany the [WRS](#):

**WRS Startup Guide:** hardware installation instructions.

This manual is provided by the manufacturer. It describes handling measures, the external connectors, hardware features and the initial bring-up of the device.

**WRS User's Manual:** documentation about configuring the [WRS](#), at software level.

This guide is maintained by software developers. The manual describes configuration in a deployed network, either as a standalone device or as network-booted equipment. The guide also describes how to upgrade the switch, because we'll release new official firmware images over time, as new features are implemented.

**WRS Developer's Manual:** it describes the build procedure and how internals work.

The manual is by developers and for developers. This is the document to check if you need to customize your [WRS](#) rebuild software from new repository commits that are not an official release point, or just install your [WRS](#) with custom configuration values.

## Product Overview

### 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.

### Front panel v3.4 (Legend)

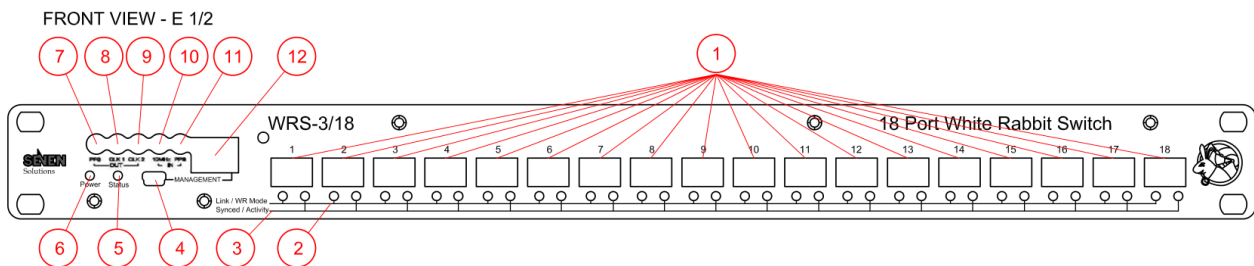


Figure 1: Front Panel of the WRS v3.4

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. CLK1 output (62.5 MHz PLL)
9. CLK2 output (Auxiliary clock, default is 10MHz)
10. 10MHz reference clock input (GPS/Cesium)
11. PPS reference input
12. Ethernet 100Mbps Management Port

### Front panel v3.3 (Legend)

1. The 18 SFP ports



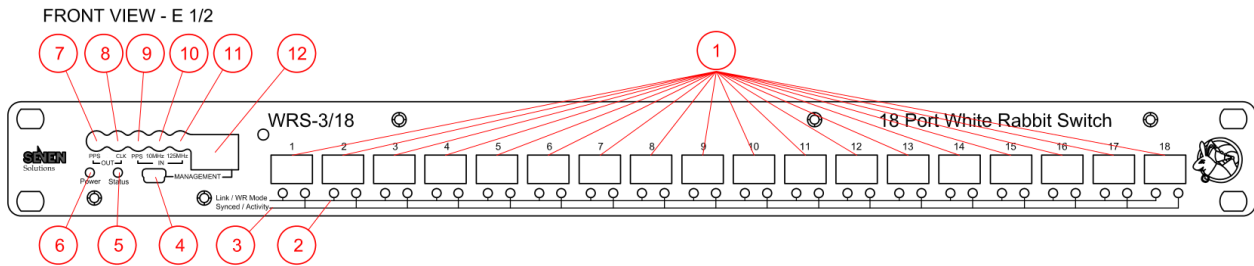


Figure 2: Front Panel of the WRS v3.3

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

### Back panel (Legend)

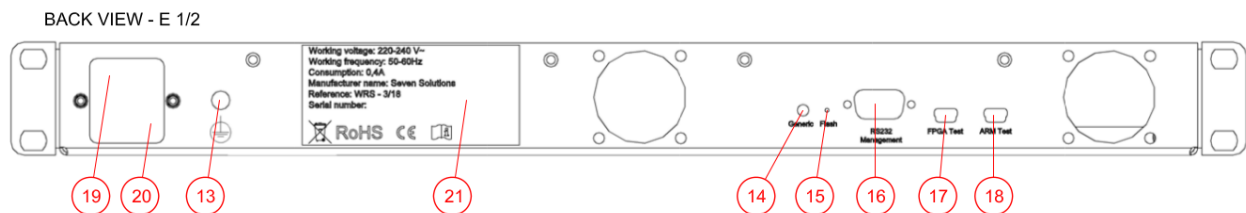


Figure 3: Back Panel of the WRS

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

## Basics

### 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 management 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 port (SFP 1) is configured as WR slave.
  - The other ports (SFPs [2-18]) are configured as WR master.
- SSH user: **root**
- SSH password: (empty/just press enter)
- Boot method: from Nandflash firmware
- Web Management Interface user: **root**
- Web Management Interface password: (empty)

### Quick Startup

To quickly get the switch working we recommend you to:

1. Plug the *Ethernet 100Mbps Management Port* of the switch to a DHCP network using RJ45 patch-cord.
2. Plug the power cable to the *Power Plug*.

After these 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 successful (PLL is locked).

You have now the [WRS](#) ready to be used in a WR network.

7. Connect the blue SFP (AXGE-1254-0531) to the SFP port 1 of the [WRS](#). This port is the one that will receive synchronization from another [WRS](#) master or from the [WRS](#) grandmaster. If you only have one switch in your network you might configure it in [GrandMaster mode](#).
8. You can plug the other SFP ports [2-18] with violet SFPs (AXGE-3454-0531) to the WR node such as [SPEC](#), [SVEC](#), ...

## Obtain the WRS IP

In order to login to the [WRS](#) using SSH or through the web interface you need to obtain the IP of the ethernet management port. By default, this port automatically gets an IP using the DHCP protocol. If you don't have any DHCP router/server in your network, please refer to the [non-DHCP](#) section.

Then to retrieve the management IP of the [WRS](#) you can:

- [Connect to ttyACM0](#) to retrieve the IP (`ipconfig eth0`).
- Open the interface of your DHCP server, and find the IP associated to your [WRS](#) MAC address.
- Scan your local network using nmap (i.e, `sudo nmap -sP 192.168.1.0/24`) and read the output `arp -n` to associate the corresponding IP of the [WRS](#) to its MAC address.

## Login using the Web Management Interface (WMI)

The easiest way to access and manage the [WRS](#) is through its web interface by using the ethernet management port.

The access should be carried out by a network browser (Mozilla Firefox and Google Chrome supported) as it follows:

1. First you need to obtain the IP of [WRS](#) as explained [previously](#).
  2. Open your browser and type the IP address (i.e. 192.168.1.50) of the [WRS](#).
1. After accessing the **WMI**, you should enter the login using *root*'s password, otherwise you will be only able to see the Dashboard info. By default there is no password, so you should leave this **field empty**. For this reason it is strongly recommended to change the password.

### Changing root password.

In order to change the **WMI** password you just need to login, then click on “**User: root**” on the left side of the webpage.

In the *USER ADMINISTRATION* panel, you have to enter your old password, the new password and its confirmation. Once you submit the new password you will be redirected to the main screen and logged out.

**Notes:** *By changing the password through the WMI you will also change the root user password to connect through SSH.*

## Login via SSH

If the [WRS](#) IP is for example 192.168.1.50 you might connect using:

```
ssh root@192.168.1.50
```

By default there is no password, therefore you should just press enter when a password is requested.

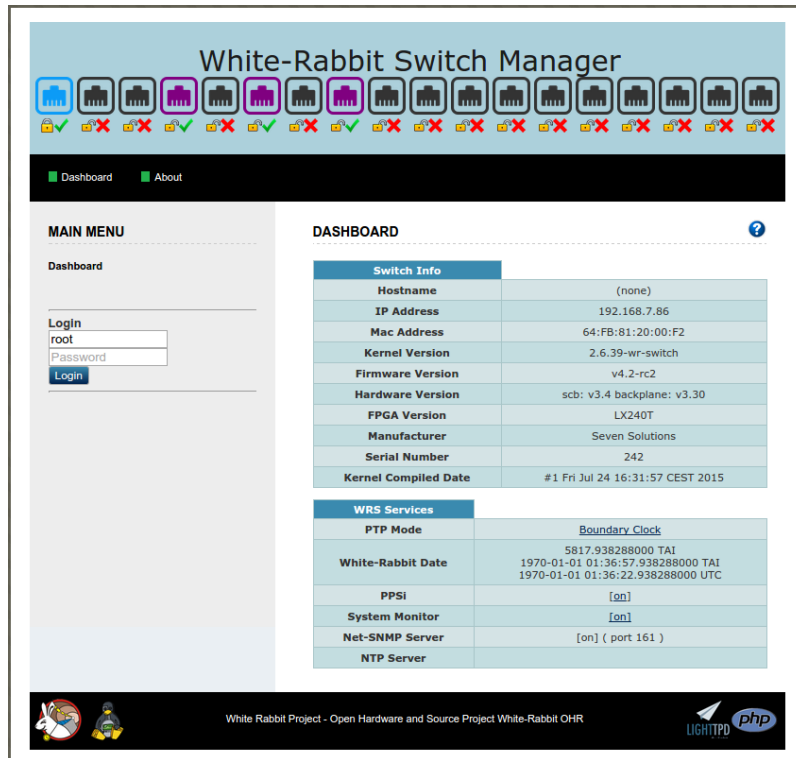


Figure 4: Web Management Interface - Login/Dashboard

## 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

Under a linux system, these ports correspond themselves 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<sup>1</sup>

```
## 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
```

<sup>1</sup>In Debian-like distribution you can install minicom by executing `sudo apt-get install minicom`.

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

## 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 for development or monitoring because the log messages are usually printed to this console.

## 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.
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.

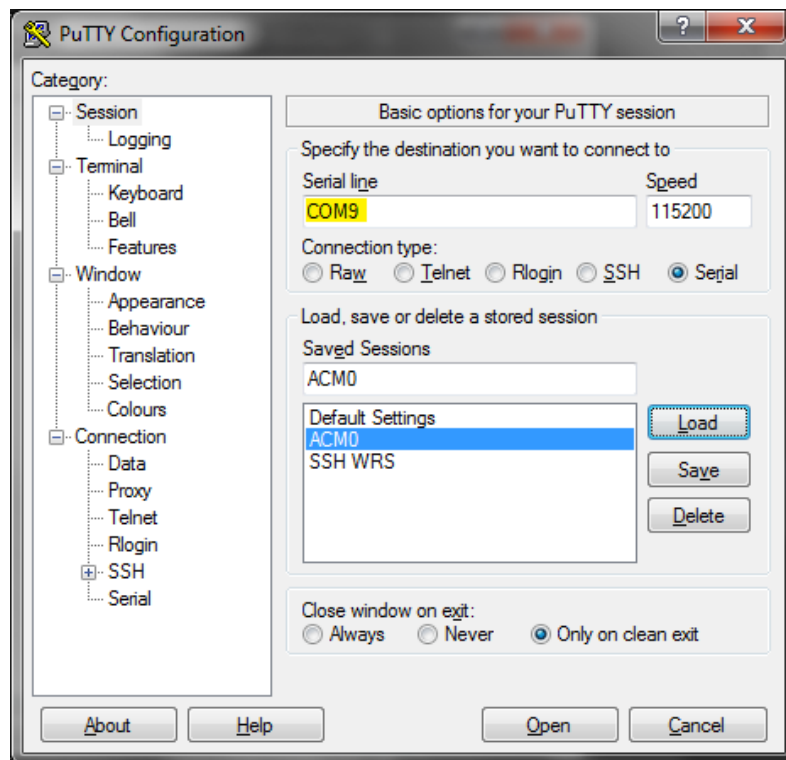


Figure 5: Putty - USB connection

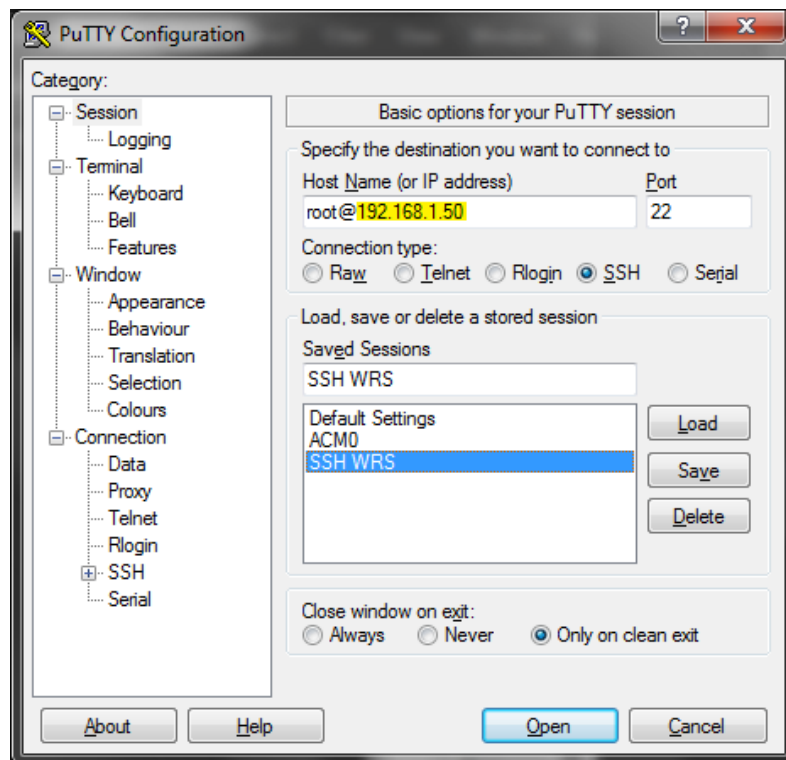


Figure 6: Putty - SSH connection

## Configurations

We strongly suggest you to configure the switch using the Web Management Interface.

### Web Management Interface Features:

WMI is a web interface that allows the WRS management from a web browser. It displays the configuration and status of the main services and programs that are available for the switch.

It acts as an abstraction layer between the dot-config file and the programs in /wr/bin/ folder, making the WR switch management easier for the user. It also gives the possibility to restore/backup a specific configuration by saving/loading the dot-config file.

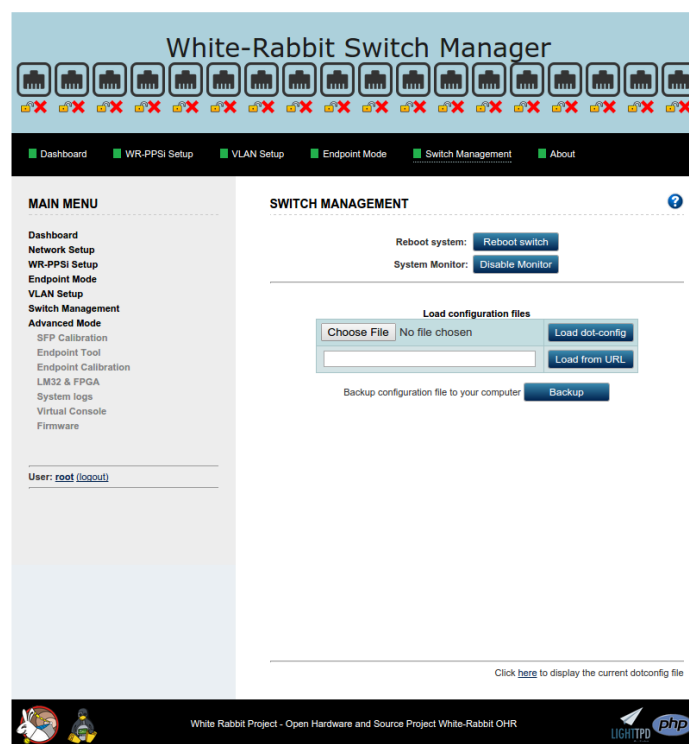


Figure 7: Web Management Interface - Switch Management

List of all the actions that can be performed by using the WMI:

- **Dashboard** : Display info about the WRS such as HW information, services status and main configuration.
- **Network Setup**: Configuration of the ethernet management port (DHCP, Static, etc.)
- **WR-PPSi Setup**: Configuration about the timing network: WR mode, NTP server, PPSi clock class, etc.
- **Endpoint Mode**: Modify the mode for each port (wr\_master/wr\_slave/auto/none).
- **VLAN setup** : Let the user configure specific VLANs for different ports.
- **Switch Managment**: Let the user load/backup a specific configuration, reboot switch, disable system monitor.
- **Advanced Tab** :

- Calibrate the SFP
- Configure the endpoint
- Calibrate the endpoint
- Load lm32 and FPGA binaries into the switch.
- Configure the files for the login system.
- Open a virtual console that emulate a terminal connection.
- **Flash a new firmware**

**Notes:** If you want to know more about each section you can click the help icon that you will find on the top-right corner of each page.

## GrandMaster mode

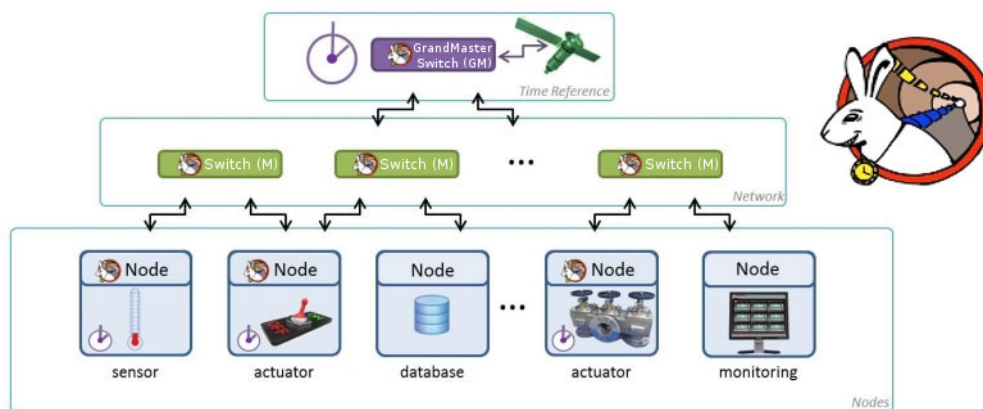


Figure 8: White Rabbit Network

In a White Rabbit network, almost all the switches are configured as boundary clock (a.k.a Simple Master) which is the default configuration. They receive a clock from an upper layer, and transmit it to other switches or nodes (lower layer). However the “top” switch connected to the GPS signal is called the **GrandMaster** and is configured in a specific way.

First you need to connect the 10MHz and PPS from a clock source to the switch SMC inputs. Please consult the [wr\\_external\\_reference.pdf](#) document to understand what kind and shape of signals is needed as input for grand master mode.

Then to configure a [WRS](#) as GrandMaster you must:

### Using the web-interface

You can find the option to select the switch in grandmaster mode in the configuration panel under the **WR-PPSi** tab. Once you have change the option, you should click on *Save new configuration*, and wait until the WRS has reboot.

**Notes:** A NTP server should be provided for the grandmaster switch so that we can distribute the current TAI seconds to the whole WR network



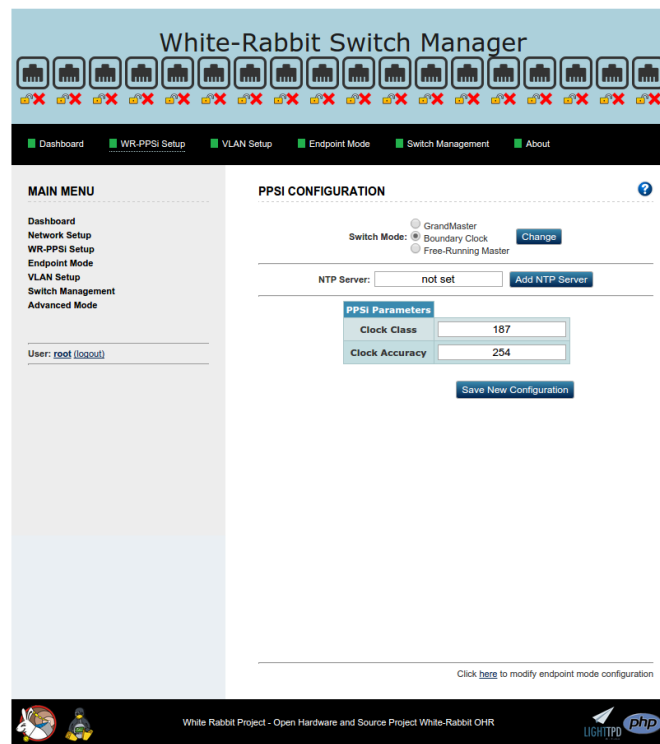


Figure 9: Web Management Interface - WR-PPSi configuration

### Using menuconfig

Another way to modify the parameters to configure the WRS in Grandmaster is by [opening an SSH terminal](#) and then run the command:

```
make -C /wr/etc/ menuconfig
```

You will get a menu to directly modify the dot-config but with a more friendly<sup>2</sup> interface. Then just go to Timing Mode, select Grand-Master, Save, Exit. Your WRS is now ready to be in GM mode at next reboot.

### By editing the dot-config file in a terminal

If you prefer to configure the WRS using a terminal you should open the dot-config file

```
nano /wr/etc/dot-config
```

And replace the following lines:

```
# CONFIG_TIME_GM is not set
# CONFIG_TIME_FM is not set
CONFIG_TIME_BC=y
```

by

<sup>2</sup>With some small terminal size, or while using minicom the ncurses interface does not behave well, and the menuconfig is not properly displayed.

```
CONFIG_TIME_GM=y
# CONFIG_TIME_FM is not set
# CONFIG_TIME_BC is not set
```

and finally you need to **reboot** the switch.

## 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 edit the dot-config file:

```
nano /wr/etc/dot-config
```

for example, in a 192.168.1.x subnetwork you might replace the CONFIG\_ETH0\_DHCP=y by

```
#
# Local Network Configuration
#
# CONFIG_ETH0_DHCP is not set
# CONFIG_ETH0_DHCP_ONCE is not set
CONFIG_ETH0_STATIC=y
#
# Management port (eth0) Address
#
CONFIG_ETH0_IP="192.168.1.254"
CONFIG_ETH0_MASK="255.255.255.0"
CONFIG_ETH0_NETWORK="192.168.1.0"
CONFIG_ETH0_BROADCAST="192.168.1.255"
CONFIG_ETH0_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.

## Console tools:

If you are logged via a terminal you can use various tools to monitor/configure the [WRS](#). All these tools are found in /wr/bin/ which is included in the \$PATH.

The following list resumes the most interesting commands:

- `wrs_version -t`: 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 synchronisation such as Phase Tracking, Master-Slave delay, link asymmetry, etc...
- `wrs_vlans`: Creation and configuration of VLANs.

**Note:** More information about the tools are explained in the [wrs-user-manual.pdf](#) or can be obtain using the embedded help argument: `--help`, `-h` or `help`.

**Note:** The SFP ports are labeled from 1 to 18 on the front panel, their corresponding network interface are named from `wri1` to `wri18`.

## Firmware updates

Since the firmware v4.1 we have improved the update procedure and the switch is able to upgrade by itself.

Just copy the firmware you have downloaded to the `/update/wrs-firmware.tar` in the [WRS](#) switch. For instance you can do:

```
scp wr-switch-sw-v<X.X-YYYYMMDD>_binaries.tar root@192.168.1.50:/update/wrs-firmware.tar
```

and then reboot the switch.

You can also use the `Advanced Mode > Firmware` menu in the Web Interface to perform this step.

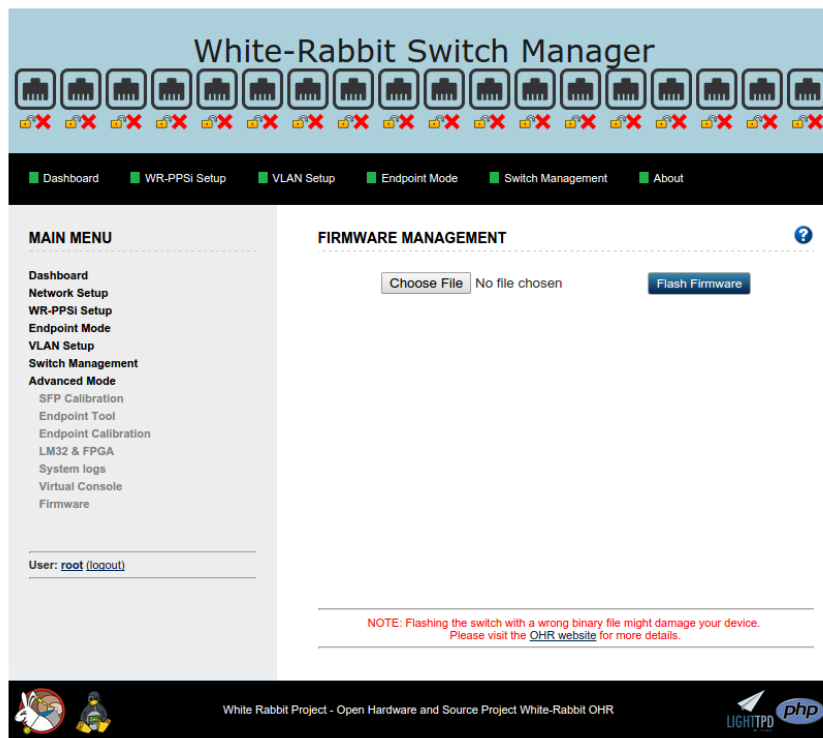


Figure 10: Web Management Interface - Updating the firmware

**Note:** If you are upgrading from v3.3 or v4.0 please refer to [wrs-user-manual.pdf](#).

## 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 [wrs-user-manual.pdf](#)

## Advanced configuration

Please refer to the White Rabbit Switch: software build scripts manual ([wrs-user-manual.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.

## 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.

## Appendix

### Specification

---

#### *FPGA*

---

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

---

#### *CPU*

---

<b>Type</b>	ARM Atmel AT91 SAM9G45
<b>Core</b>	400MHz (ARM926E)
<b>Memories</b>	64MB DDR2 (16-bit bus chip) 256MB NAND flash chip 8MB boot flash
<b>I/O</b>	32bit Async Bridge with FPGA 100Base-T Ethernet
<b>OS</b>	Linux (Kernel v3.16.38)

---

#### *OnChip Clock*

---

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

---

#### *SMC I/O*

---

<b>PPS input</b>	TTL Level (2-5V High); 0.4mA (50Ohm disabled by default) / 4.4mA (when 50Ohm enabled)
<b>10MHz input</b>	250mV (rms) @ 50Ohm -> ~1dB

---

#### *Others*

---

<b>Soldering</b>	IPC- 610 Rev E Class 2
<b>Certification</b>	ISO-9001, ISO-14001, CE, RoHS
<b>Power Supply</b>	100-240VAC, 2.0A 50-60 Hz 12V DC, 6.66A – 80W max

---

**Others**

---

<b>Environmental Conditions</b>	Temperature: -10°C ~ +50°C Humidity: 0% ~ 90% RH
---------------------------------	---

---

**Features**

- PTPv2 (IEEE 1588-2008) with PPSi
- WRP daemon (node discovery, etc.)
- VLANs
- DHCP client
- SSH server
- Web Management Interface
- SNMP
- Rsyslog
- Python Support
- NTP Client/Relay/Server
- ARP/ DNS / EtherWake protocol

**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.*

**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
wrs_version -t > /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 ~
```

## Contact-Us

To contact Seven Solutions company please use:

- [support@sevensols.com](mailto:support@sevensols.com)
- (+34) 958 285 024
- <http://www.sevensols.com>

## 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.



## References

- [wrs-3/18.pdf](#) : Datasheet for the White Rabbit Switch v3 - 18 SFPs
- [wrs-user-manual.pdf](#) : User manual documentation of the tools.
- [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](http://www.sevensols.com/dl/wr-switch-sw/bin/latest_stable.tar.gz)