WPR1500HVWCRAUG

WPR1500-HV Wireless Charging Receiver Application User's Guide

Rev. 3.0 — 4 July 2022 User Guide

Contents

1 Introduction

This document describes how to use WPR1500-HV receiver reference board designed by NXP. It supports 15W EPP output according to the WPC Qi V1.2.4 specification, and can be extended to support new V1.3.x specification. The power level can also be extended with special TX to up to 30 W. It is a low-cost reference solution that can be easily customized through the FreeMASTER tool.

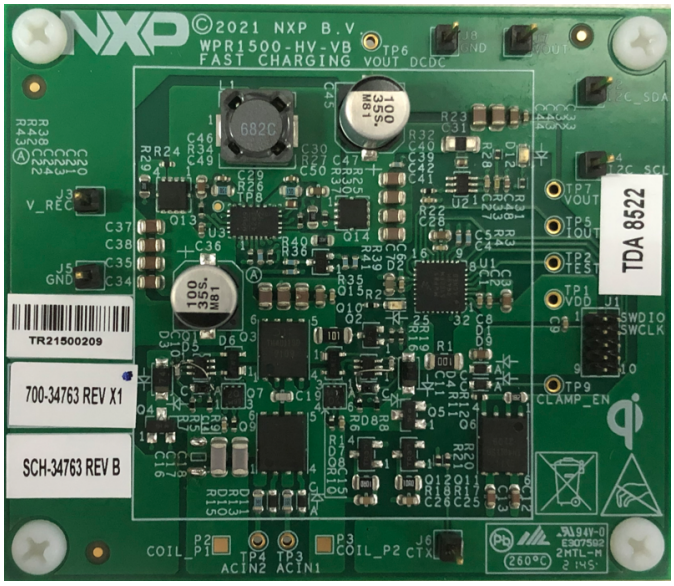

Figure 1. WPR1500-HV Receiver Board

2 System Features

The WPR1500 EPP receiver reference board has the following features:

- Compliant with the EPP WPC Qi V1.2.4 specification, can be extended to V1.3.x.
- Input voltage (3.5 V – 20 V AC peak) from the transmitter through the receiver coil.
- Output voltage range can be set from 3.5 V to 20 V.
- Default output power 15W(12V@1.25A), can be extended up to 30W(20V@1.5A).
- Supports FSK communication with EPP transmitter.
- Hardware protection of rectifier voltage, output voltage, and output current.
- FreeMASTER tool to enable customization and calibration.

3 Abbreviations

The following table provides the abbreviation descriptions in this document.

Table 1. Abbreviations

Abbreviation	Description
WPR	Wireless Power Receiver
DC	Direct Current
JTAG	Joint Test Action Group
SCI	Serial Communications Interface
RX	Receiver
TX	Transmitter
ASK	Amplitude-Shift Keying
FSK	Frequency-Shift Keying
BPP	Baseline Power Profile
EPP	Extended Power Profile
FOD	Foreign Object Detection
MCU	Microcontroller Unit

4 Package Checklist

Table 2. Package checklist

Name	Count
WPR1500-HV Receiver board	1

5 System Block Diagram

The following figure shows the WPR1500 EPP receiver wireless charging system.

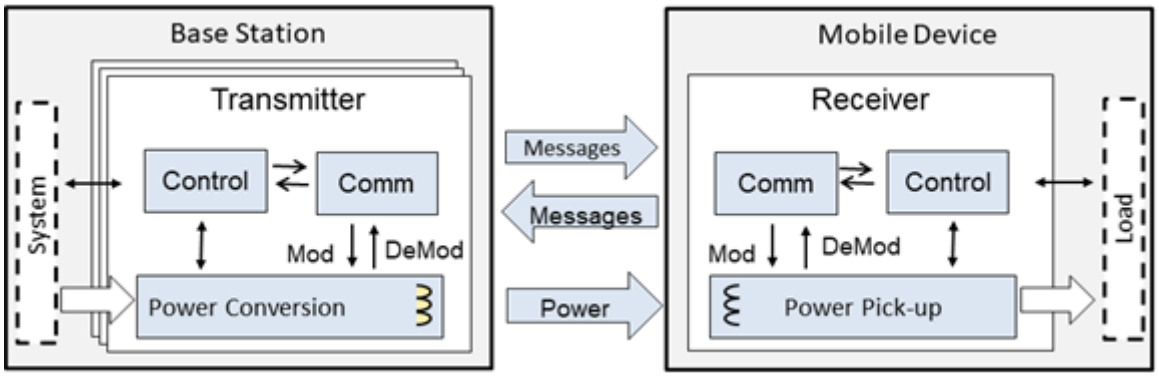

Figure 2. Wireless Charging System Overview

Obtain the WPC Qi information from: www.wirelesspowerconsortium.com/developers/.

6 Hardware Description

6.1 Reference Board Block Diagram

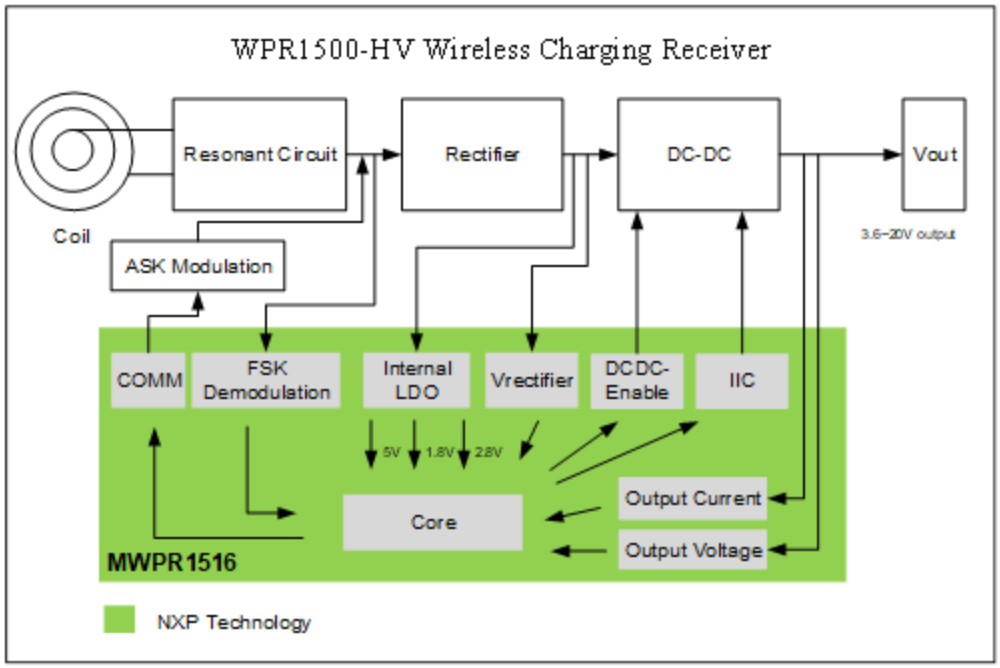

Figure 3. WPR1500-HV receiver board block diagram

6.2 Modules explanation

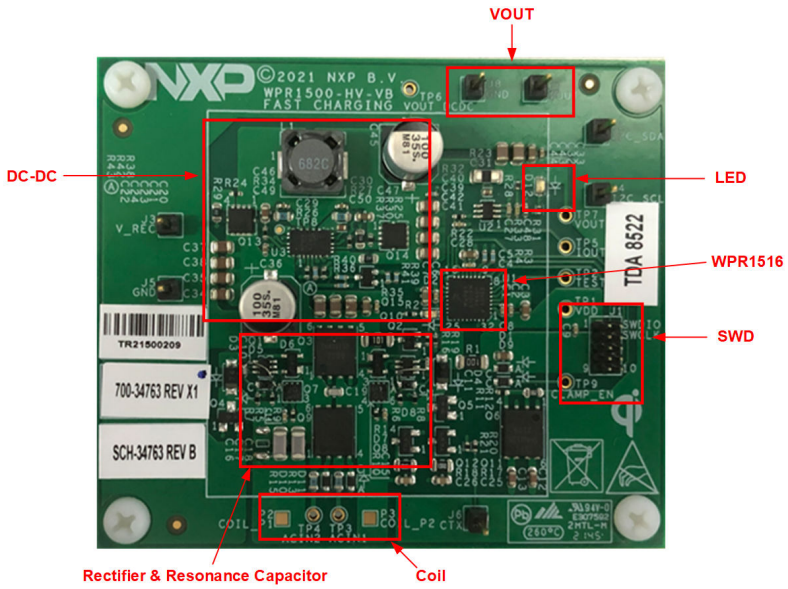

Figure 4. WPR1500-HV receiver board modules overview

- Controller

The NXP MWPR1516 chip is the central controller of the WPR1500-HV receiver board. The chip higher integration receiver controller MCU for wireless power transfer application. The WPR15xx is a Cortex M0+ core ASSP with NXP's UHV technology. It includes the FSK and CNC models that allow easy development for bi-directional communication architecture between the transmitter and receiver.

The following modules are used in this application:

- CNC controls the communication and provides AC protection.
- High-voltage input PMC module with three power modes: Run, Wait, Stop.
- Programmable gain amplifier (PGA) with differential input and output.
- FSK demodulation timer (FSKDT).
- WDOG with independent clock source.

- Rectifier

  The rectifier uses a self-driven sync type. Its characteristics are:

  - Input voltage: 3.5 V - 20 V AC peak.
  - Output voltage: 3.5 V - 20 V DC.

- Communication
  - The ASK differential bi-phase signal is modulated by switching the modulation capacitor.
  - The FSK signal is demodulated by the CNC and FSKDT module.

7 Getting Started

7.1 System developing environment

WPR1500-HV receiver board supports debugging with IAR and FreeMASTER tools. The following figure shows the setup of the debug connection. To download an image onto the WPR1516 chip, connect a debugger (J-LINK or P&E-Multilink FX) to the JTAG port of the receiver board. J3 (V_REC) and J5 (GND) on the board need to be connected to 5 - 12 V DC power supply in order to get power.

To monitor the working status of the WPR1500-HV receiver board by FreeMASTER, remove the external power before putting the WPR1500-HV receiver board on the transmitter panel.

The following figure shows the connection when downloading an image.

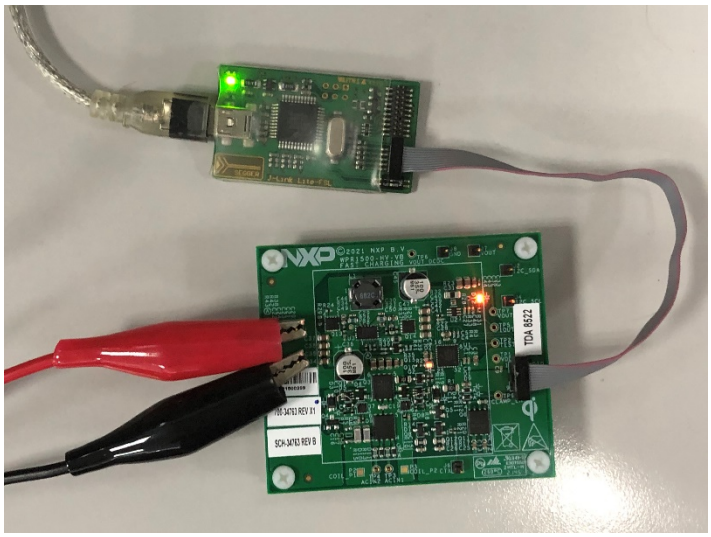

Figure 5. Downloading and debugging connections

The following figure shows the connections when the user needs to monitor the working status by FreeMASTER.

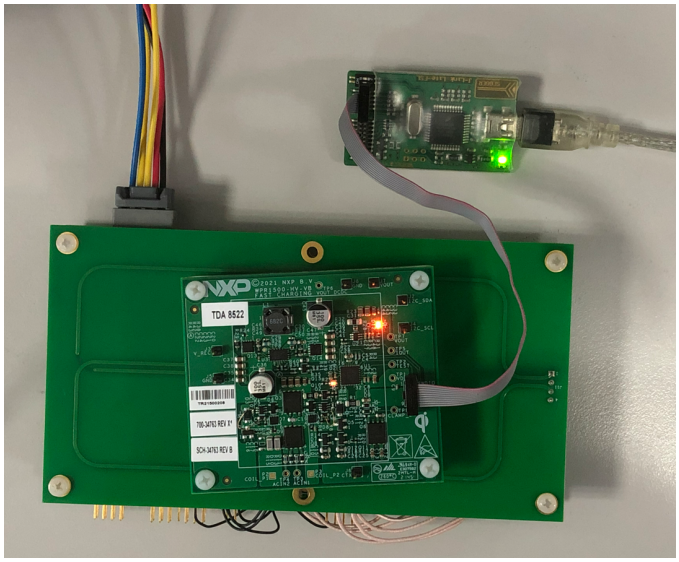

Figure 6. Monitoring by FreeMASTER connections

For details on the J-LINK debugger, visit nxp.com and search for “J-Link”.

7.2 Downloading and debugging firmware

7.2.1 Downloading an existing WPR1500 HVOUT project with IAR

To download an existing WPR1500 project using IAR, perform the following steps:

1. Set the IAR Embedded Workbench.

   The IAR embedded Workbench Tool is required. The IAR version should be 9.10.2 or higher. Because the receiver driver library is already included in the library folder of the wireless charger application project, you can open the application project and build the applications directly whenever the `wpr_lib.a` is ready.

The demo application workspace files are located in:

```
<software_package>/build/wpr1500/iar/WPR1500_HVOUT/WPR1500_HVOUT.eww
```

2. Build a project.

   Click the "Rebuild All" button.

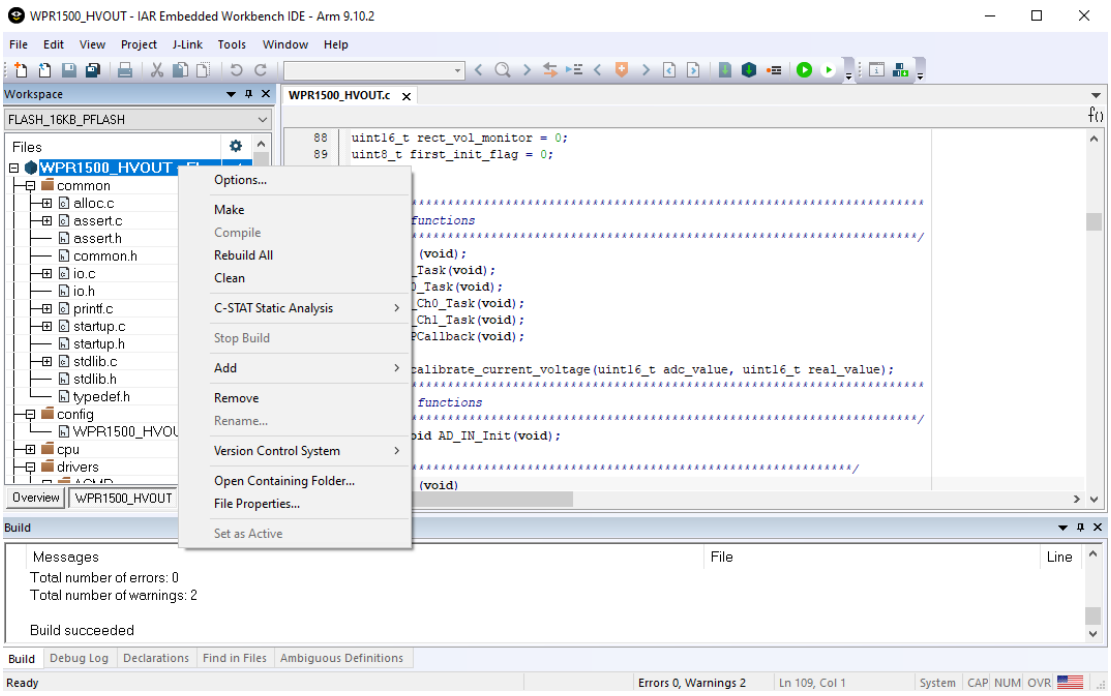

Figure 7. Building the project

3. Ensure that the debugger is configured properly in the project options.

   The flash loader must be selected to support downloading of the binary to the internal flash.

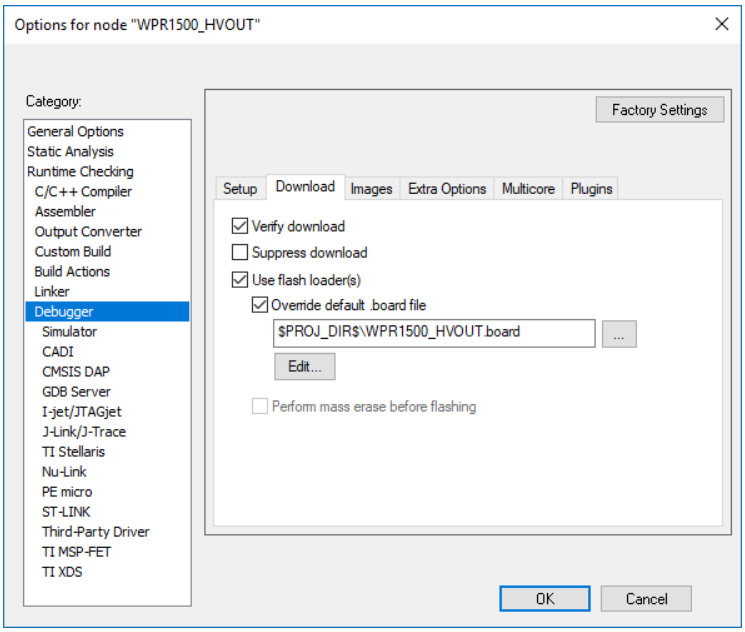

Figure 8. Flash loader configuration

When using the J-Link as the debugger, select J-link/J-Trace.

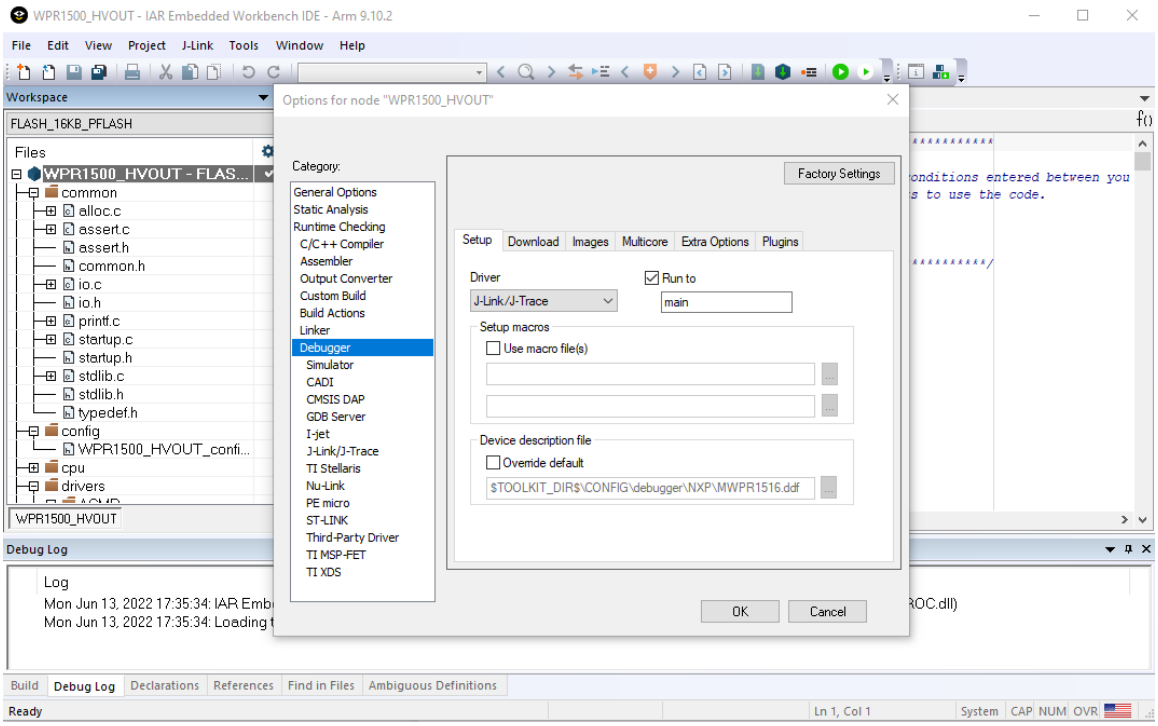

Figure 9. Debugger driver configuration for J-Link

When using P&E Multilink as the debugger, select PE micro.

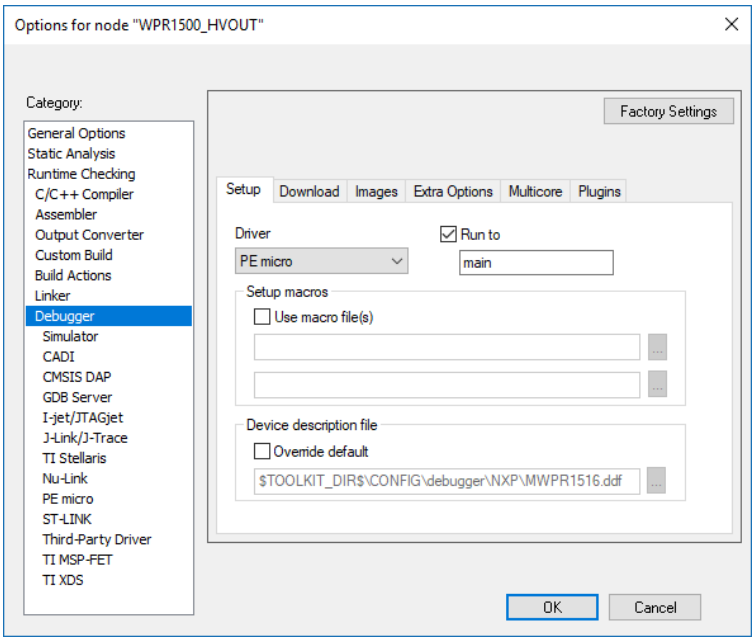

Figure 10. Debugger driver configuration for PE micro

4. Download the project.

   After the application is built successfully, click the "Download and Debug" button to download the application to the target device.

Figure 11. Download and Debug Button

The following figure shows the programming of a project.

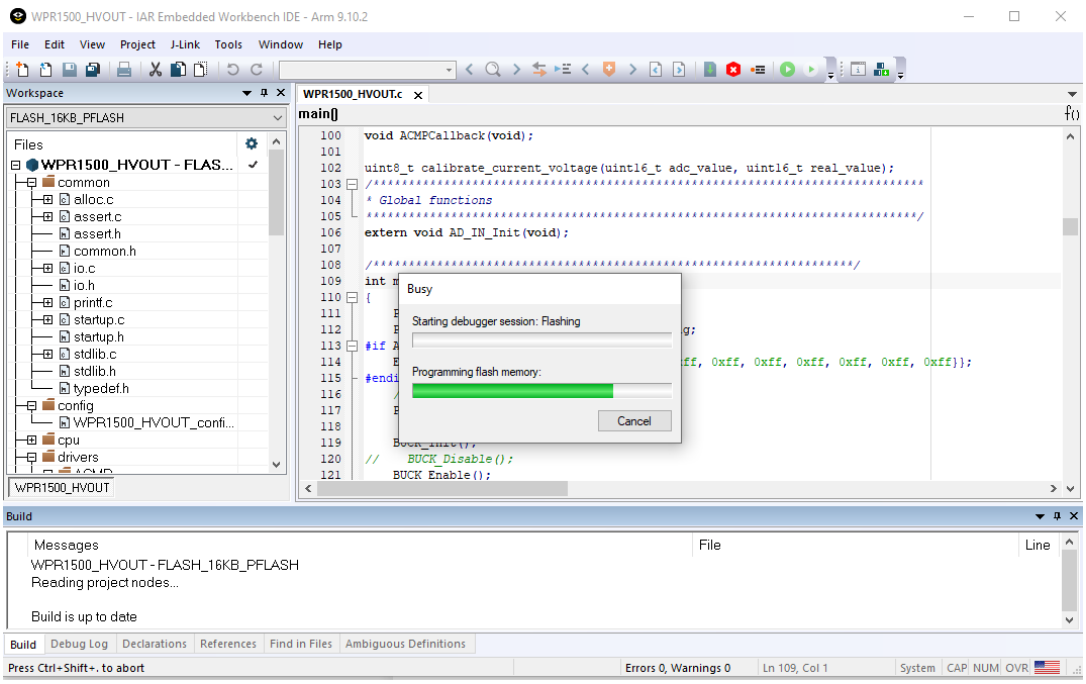

Figure 12. Programming a project

5. After the application is downloaded to the target device, the debugger stops executing at the start of the `main()` function:

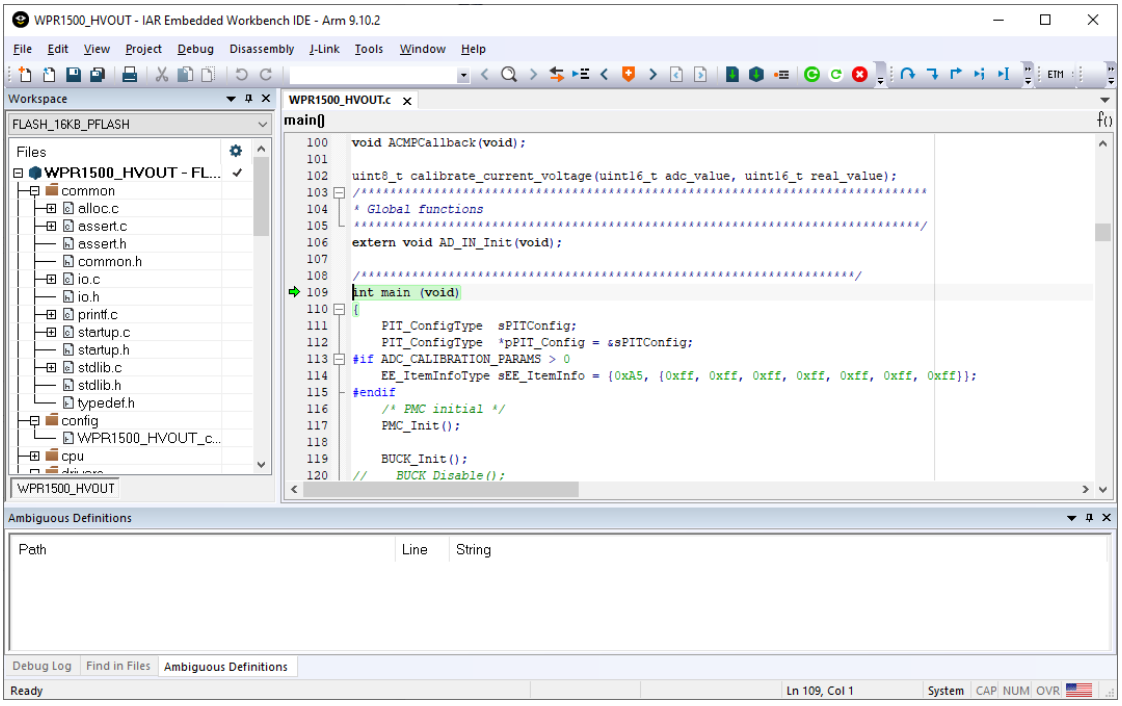

Figure 13. Stopping at main() when run debugging

7.3 Debugging with FreeMASTER

7.3.1 Connecting the Debugging cable

The FreeMASTER debug connection uses J-Link, as shown in the following figure. The J-Link tool can be connected through the connector J1. The FreeMASTER version should be V3.1 or higher.

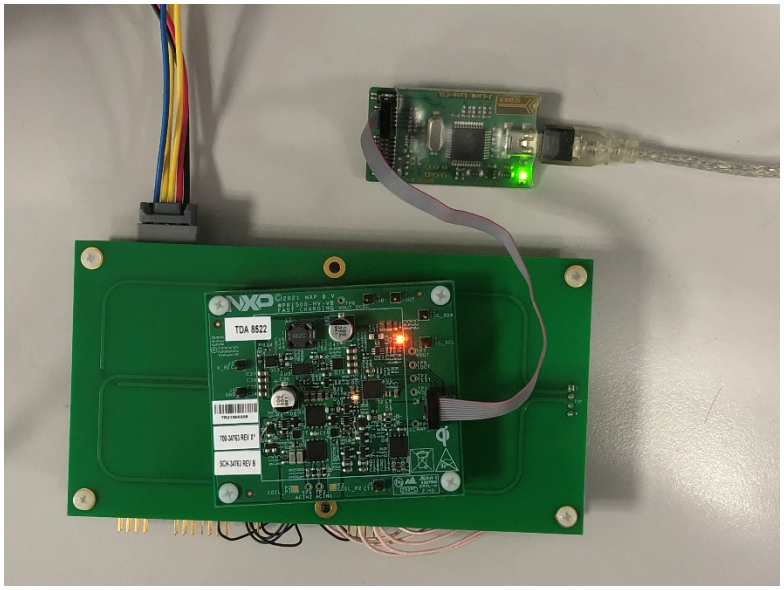

Figure 14. FreeMASTER debugging connection

7.3.2 FreeMASTER project options setting

1. Set the symbol file for your project. Select the symbol file in **FreeMASTER Project** –> **Options** –> **MAP Files**, as shown below.

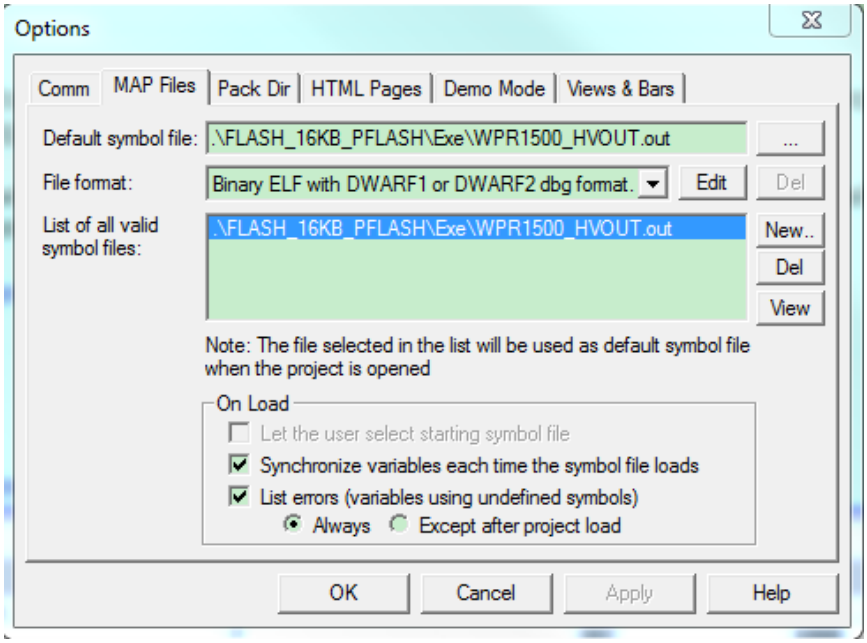

Figure 15. Select Symbol File

2. Select the communication interface for Freemaster: Select "Plug-in Module" in **Freemaster Project** –> **Options** –> **Comm** as shown below. Then select "FreeMASTER Segger/Jlink Communication Plug-in".

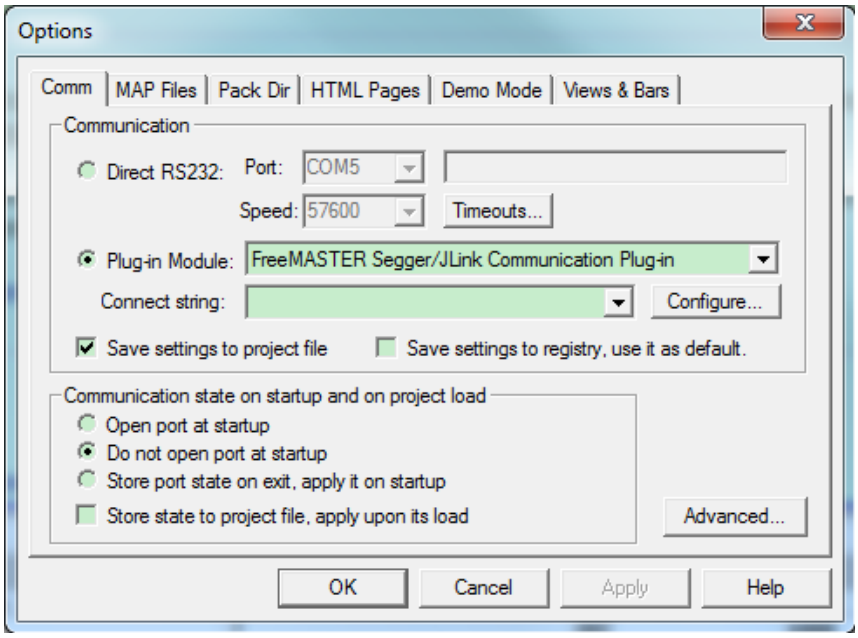

Figure 16. Communication interface setting

7.3.3 Debugging with FreeMASTER

NXP provides the FreeMASTER GUI tool for system working status monitor. The following figure shows the FreeMASTER GUI Tool. Users need to open `WPR1500_HVOUT.pmp` with this tool and then click the red Start/Stop button. For the FreeMASTER tool, visit nxp.com/Freemaster.

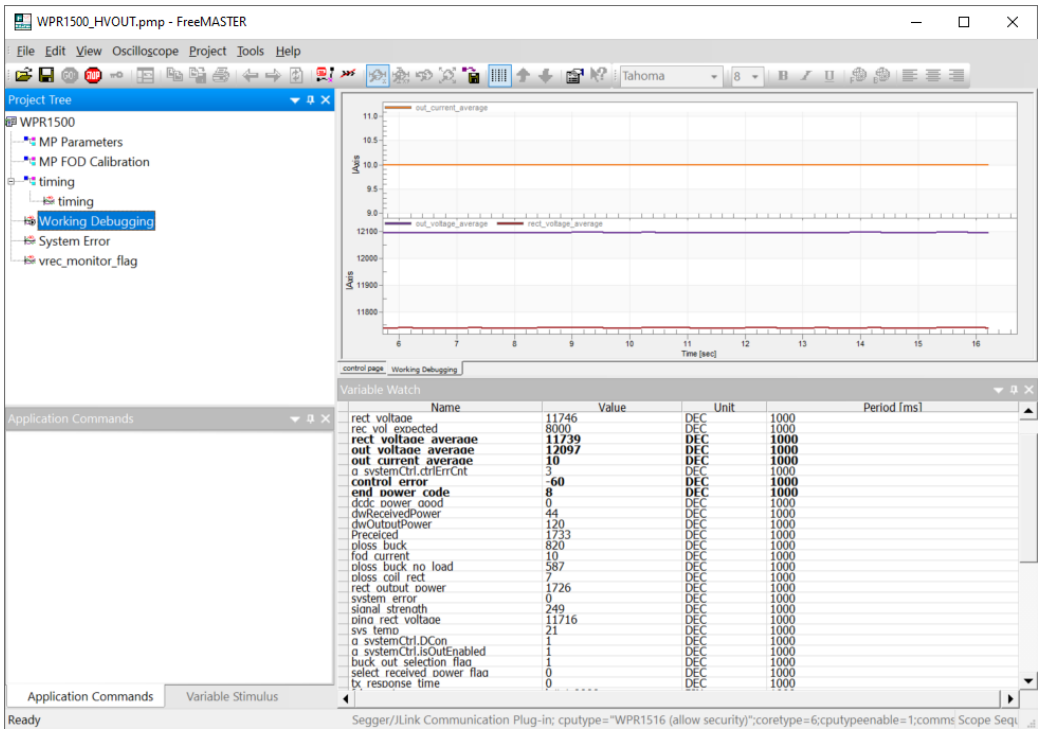

Figure 17. FreeMASTER GUI Tool

7.4 Testing

7.4.1 Signals on the Board

The following figure shows the main signals on the WPR1500-HV EPP receiver board.

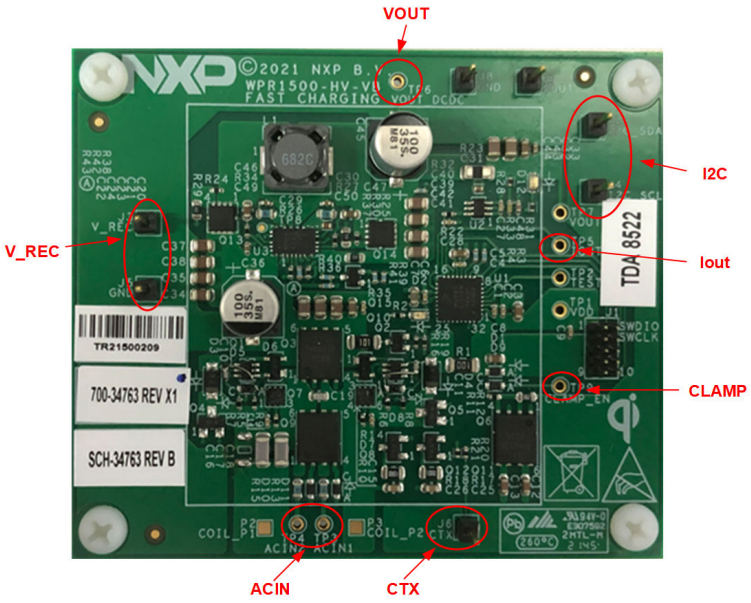

Figure 18. Important test points on WPR1500-HV board

The following table lists the testing points on the WPR1500 BUCK board.

Table 3. Test Points list

TP1 : VDD	TP9: CLAMP_EN
TP2 : TEST	J2 & J4: I2C
TP3 & TP4 : ACIN	J3: V_REC
TP5 : IOUT	J6: CTX
TP7 & J7: VOUT	J5 & J8: GND

The following examples show how to measure and debug the board.

The following figure shows the input voltage and communication signal from the ping phase to power transfer setup. The loading is 10.5W(12V@0.875A)

- Channel 1: Rectifier voltage VREC
- Channel 2: Output current I_out
- Channel 3: Output voltage V_out
- Channel 4: Communication signal CTX

Figure 19. WPR1500-HV board system start wave

The following figure shows the load step and load dump from 7.5W(12V@0.625A) to 15W(12V@1.25A).

- Channel 1: Rectifier voltage VREC
- Channel 2: Output current I_out
- Channel 3: Output voltage V_out

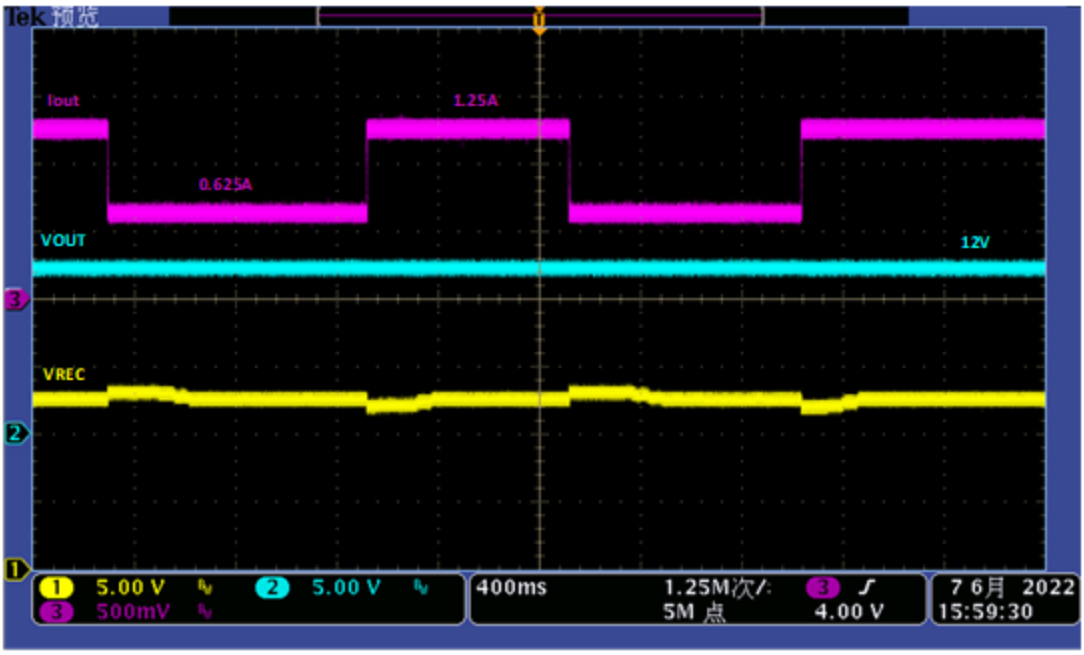

Figure 20. WPR1500-HV board load Step/Dump wave

8 References

- NXP wireless charging solution page:

  nxp.com/products/power-management/wireless-charging-ics
- NXP Freemaster tool page:

  nxp.com/products/power-management/wireless-charging-ics/freemaster-run-time-debugging-tool:FREEMASTER
- WPC page:

  www.wirelesspowerconsortium.com

9 Revision History

Table 4. Revision history

Revision number	Date	Substantive changes
GA 3.0	07/2022	Initial release.

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