

Developing a Multi-Port Fast-Charge Solution with the HR1211

Introduction

The [HR1211](#) is an integrated, multi-mode PFC and current mode LLC controller solution that was designed to meet the power requirements of the fast-charge adapter market. To achieve a simplified peripheral circuit, the HR1211 integrates a high-voltage current source, a safety-certified X-capacitor discharge circuit, and high-voltage drive circuits for PFC and LLC. In addition, a capacitor resistor is not required because the high-voltage current source can be implemented as an X-capacitor discharger when the AC input is in dropout.

The HR1211 can be configured via the UART interface, and its built-in energy-saving technology optimizes efficiency across the full operating range. The device's PFC controller uses a patented digital current control system to support mixed continuous conduction mode (CCM) and discontinuous conduction mode (DCM). Figure 1 shows the HR1211's typical application circuit.

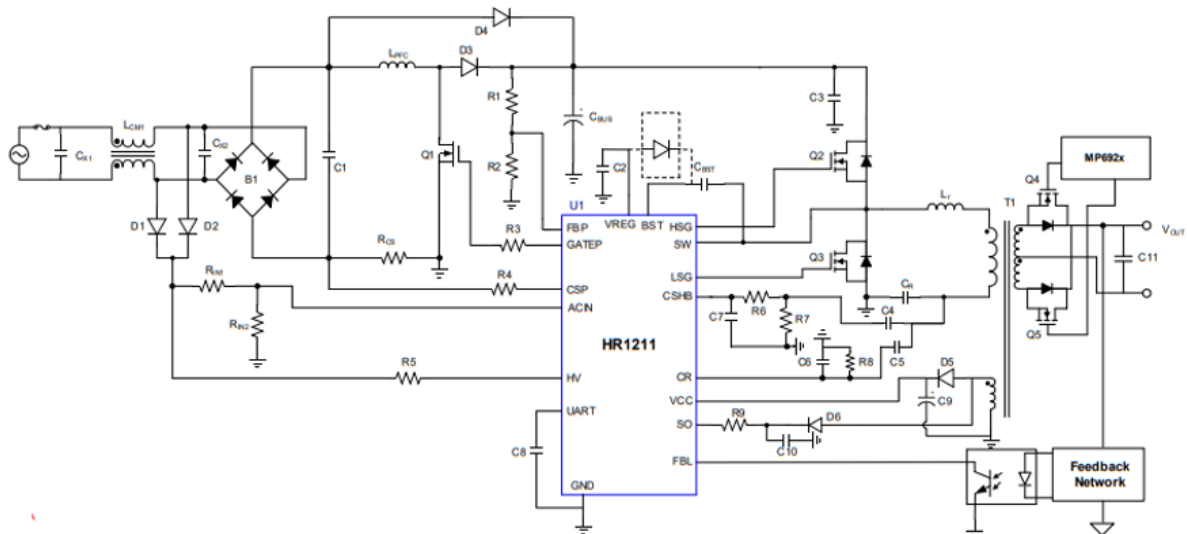


Figure 1: Typical Application Circuit of the HR1211

The trend for 100W, high-power adapters has made this device particularly popular. The HR1211 was recently recognized with a Top 10 Power Product Award as Best Application by [21ic](#), the China Electronics Network.

HR1211 Features

The HR1211's hybrid CCM and DCM operation allows the controller to be used across a wider load range. Under heavy loads, CCM reduces the peak MOSFET current. Under light loads, DCM reduces the switching frequency for better efficiency. Furthermore, current mode control is implemented in the LLC stage to improve stability and achieve a fast response.

Robust protections include thermal shutdown, PFC open-loop protection (OLP), over-voltage protection (OVP), over-current limit (OCL), LLC over-current protection (OCP), SO pin protection, and over-power protection (OPP).

To provide flexibility, the HR1211's digital control core can be combined with multiple-time programmable (MTP) memory for up to 1,000 rewrites. Major functions — including the PFC and LLC two-stage circuit, switching between different control modes, switching frequency, protection thresholds, and the recovery methods of the protection functions — can be freely configured through the UART communication port on a graphic user interface (GUI). Figure 2 shows the HR1211's GUI.

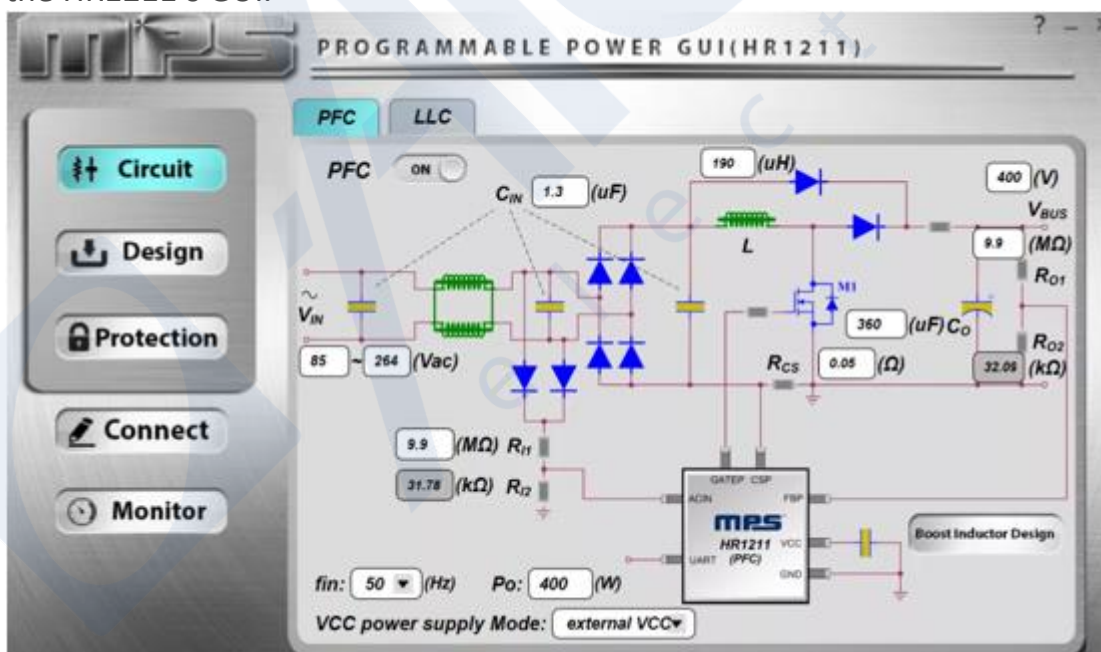


Figure 2: HR1211 GUI

A power supply based on the HR1211 can adapt to the performance requirements of different applications and designs. The unique, extensive flexibility of this digital control solution simplifies 100W to 200W designs. In particular, the HR1211 is well-suited for laptops, GaN fast chargers, e-bike chargers, desktop power supplies, streetlights, and TVs.

Figure 3 shows a reference design for a [600W battery charging solution](#). The simple design is recommended for e-bikes, which are gaining popularity as an alternative to rideshares, and is completed with the following MPS products: the HR1211; the [HF500-15](#), a fixed-frequency flyback regulator; the [MP6925A](#), a synchronous rectifier (SR) controller; and the [MP2009](#), a low-dropout (LDO) voltage regulator.



Figure 3: 600W Electric Bike Charging Solution using the HR1211

Challenges of Multi-Port Fast-Charge Solution

The HR1211 can simultaneously charge laptops, cellphones, tablets, and hand-held devices, while providing an excellent user experience. However, when multiple ports are connected at the same time, a single port's maximum output power can drop from 65W or 45W, which cannot meet the 20V/5A charging requirements.

To mitigate this issue, Innosecco developed a 200W, high power density, GaN multi-port fast-charge solution based on the HR1211 and the [MP6924](#).

The MP6924 is a dual, fast turn-off, intelligent rectifier for SR in LLC resonant converters. It latches off the gate driver under light-load conditions, provides a low 175 μ A quiescent current, and can operate in both CCM and DCM.

Figure 4 shows the MP6924's functional block diagram.

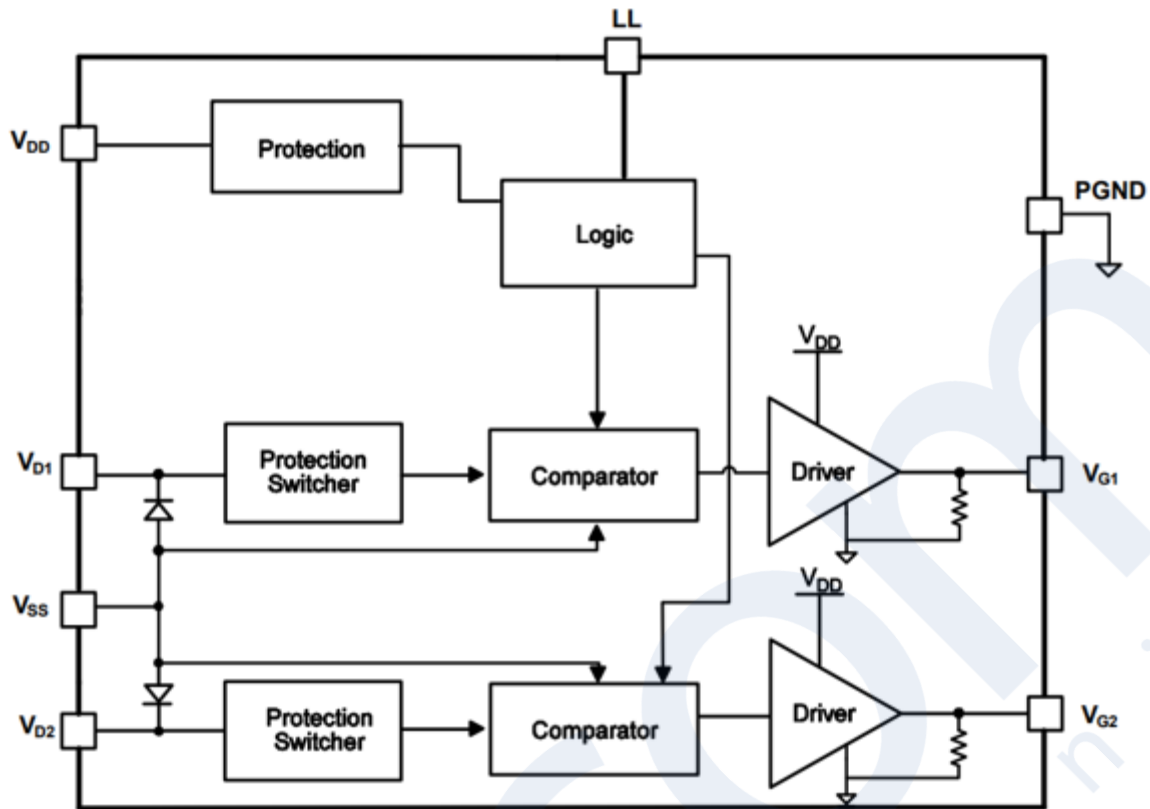


Figure 4: MP6924 Functional Block Diagram

By combining the HR1211 with Innosecco's GaN devices (the INN650D150A and INN650D260A) and the MP6924, the overall solution can achieve ultra-high power density and excellent efficiency. The layout is 75mmx75mmx23.5mm, and the power density reaches a maximum of 24W/in³.

Figure 5 shows the solution's tests results, where the peak efficiency reaches up to 96.5%, and the average efficiency exceeds 93%. The HR1211 effectively improves efficiency while boosting the maximum output power.

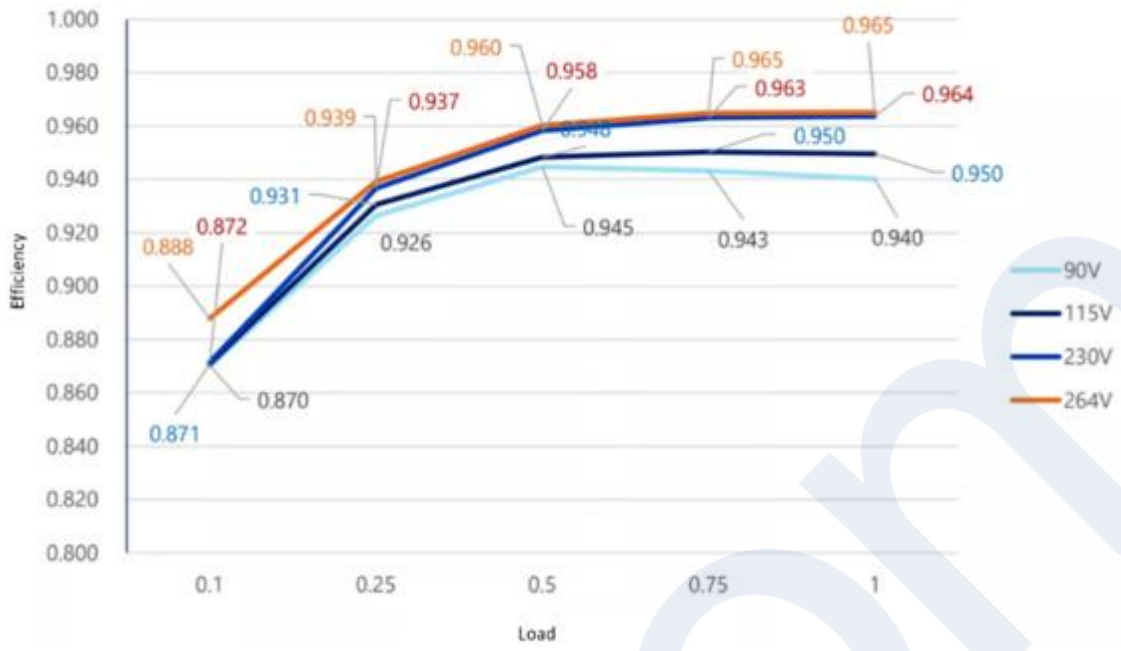


Figure 5: PFC + LLC Efficiency Curve