

Introduction

In a DC/DC converter, the auxiliary power supply of multiple switching devices requires independent isolated power supplies. Taking a full-bridge converter as an example, the high-side and low-side MOSFETs (HS-FETs and LS-FETs, respectively) of the bridge arm require isolated power supplies for the gate driver circuit. The traditional scheme uses a bootstrap circuit to power supply both the upper and lower devices with one independent power source. This solution is simple, reliable, and low-cost.

When multiple switch MOSFETs are connected in series in the bridge arm, multiple bootstrap circuits are required for the power supply, leading to challenges with cost. At the same time, in the bootstrap circuit, the supply voltage of the HS-FET is lower than that of the LS-FET, with a difference of a diode's voltage drop. The on-state characteristics of the two MOSFETs are not completely symmetrical.

Figure 1 shows a switched-tank converter (STC), where an auxiliary power supply can be shared for the three LS-FETs on the right side, the three HS-FETs can be powered using the bootstrap circuit, and the corresponding auxiliary power supply is required for the four MOSFETs on the left side.

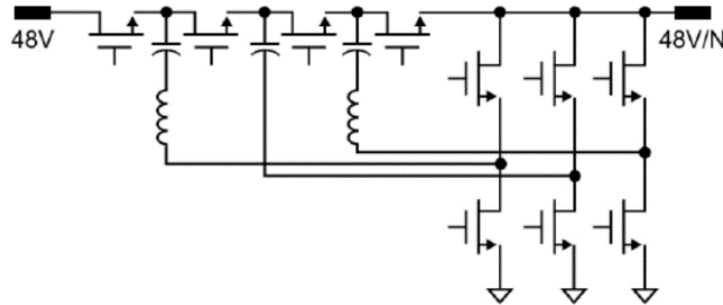


Figure 1: Switched-Tank Converter (STC)

Adopting a bootstrap circuit causes a certain voltage drop in each stage of the circuit, resulting in inconsistent conduction states for the device. Using multiple independent power supplies poses additional costs.

In a modular multilevel converter (MMC), many independent power supplies are required to supply power to the gate-level driver circuits due to the large number of modules. This raises issues with cost and complexity. MPS's [HR1211](#) is a multi-mode PFC and current mode LLC combo controller that can be applied to new auxiliary power supply methods to provide multi-channel, independent power supplies that are mutually isolated and reliable for power electronic converters.

A wireless power supply using an independent power supply at the transmitter can provide multiple independent auxiliary power supplies with magnetic isolation via multiple decoupled receiving coils. Figure 2 shows multiple independent auxiliary power supplies incorporating the HR1211, [MP1907A](#) MOSFET driver, and [MPQ2029-AEC1](#) low-dropout (LDO) regulator. This design scheme uses wireless energy transmission systems to achieve multi-channel magnetic isolation.

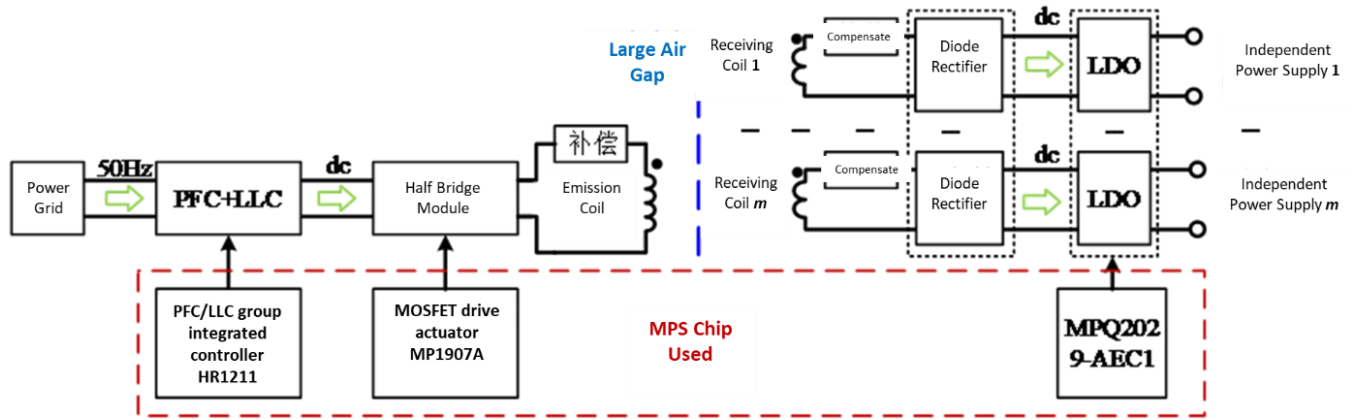


Figure 2: Multiple Independent Auxiliary Power Supplies with the HR1211, MP1907A, and MPQ2029-AEC1

Figure 3 shows the topology of an isolated independent auxiliary power wireless charging system. The parameters in this system are defined below (where $x = 1, 2, 3, \text{ or } 4$):

- V_{INV} is the inverter's DC input voltage
- L_T is the transmitting coil
- L_F is the compensation inductor
- L_{R_x} is the receiving coil
- $C_T, C_F,$ and C_{R_x} are the compensation capacitors
- M_x is the mutual inductance between the transmitting and receiving coils (L_{R_x})
- V_{RECEX} is the DC output voltage of the of N-channel rectifier
- R_{L_x} is the N-channel load resistance.

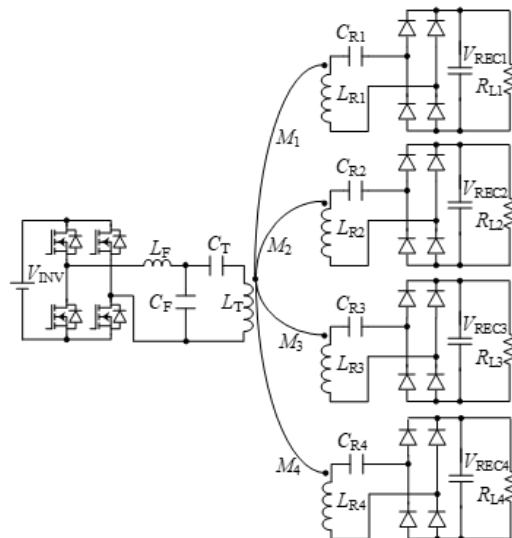


Figure 3: Quad-Receiver Wireless Charging System Topology

Figure 4 shows the coil structure model based on the finite element simulation software.

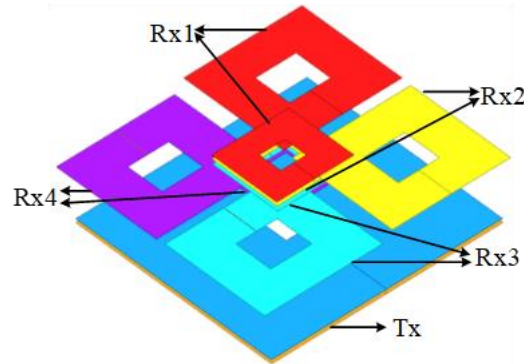


Figure 4: Coupling Mechanism Design

Figure 5 shows the corresponding PCB coils of the four receiving coils that are decoupled from each other.

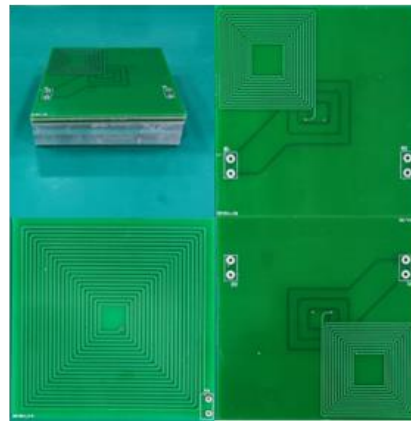


Figure 5: PCB Diagram of Transmitting and Receiving Coils

This scheme is simple, reliable, and meets the electrical isolation and insulation level requirements. MPS products can be widely applied to an auxiliary power supply design with multi-channel isolation across PFC and LCC combo controllers, inverter modules, and LDO regulators.

PFC and LLC Combo Controller

Power factor correction (PFC) converts alternating current (AC) from the power grid into direct current (DC). Energy is transferred from the transmitting side to the receiving side through the transmitting coil.

The HR1211 is configurable via the UART interface. Its integrated power-saving technology helps optimize efficiency over the full operating voltage range. The PFC controller employs a patented digital average current control scheme to enable mixed continuous conduction mode (CCM) and discontinuous conduction mode (DCM).

Under heavy loads, CCM reduces the peak current of the MOSFETs and extends the load range of the controller. Under light loads, DCM reduces the switching frequency for higher efficiency. Burst mode uses configurable, digital soft switching to improve light-load efficiency and reduce audible noise.

Figure 7 shows the MP1907A’s typical application circuit.

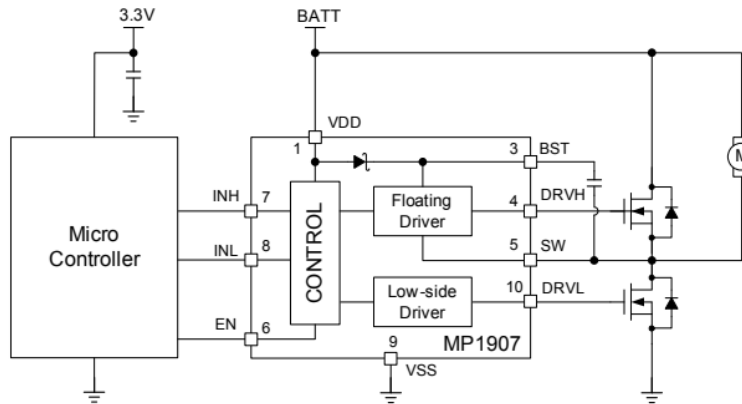


Figure 7: MP1907A Typical Application Circuit

Figure 8 shows the schematic diagram of the inverter circuit design.

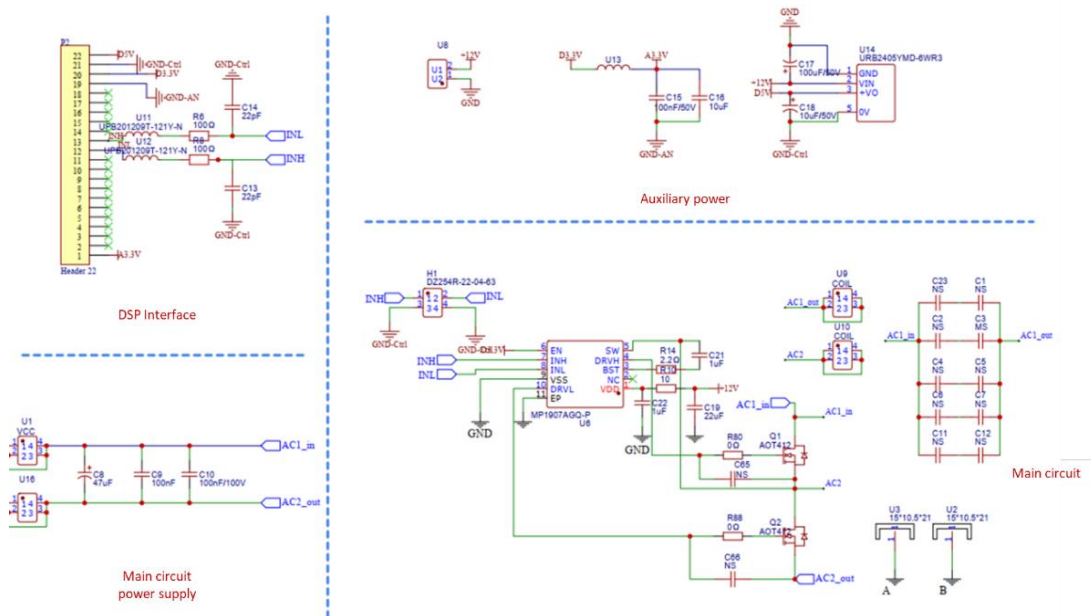


Figure 8: Schematic Diagram of the Inverter Circuit

Low-Dropout (LDO) Regulator

An LDO regulator is a DC step-down linear regulator that maintains a stable output voltage (V_{OUT}) even when the input voltage (V_{IN}) or load current changes. Modern LDO circuits feature small size, low noise, low power consumption, low price, and ease of use.

The MPQ2029-AEC1 is a low-power linear regulator that uses high-voltage batteries to supply power to systems. The device offers a 3V to 40V V_{IN} range, LDO voltage, and low quiescent supply current. The low quiescent current and low dropout voltage allows for operation at extremely low power levels, making the MPQ2029-AEC1 ideal for low-power microcontrollers and battery-operated equipment.

The MPQ2029-AEC1 provides an adjustable V_{OUT} range between 1.25V and 15V. The regulator's output current is limited internally, and the device is protected against short-circuit, overload, and over-temperature conditions. The MPQ2029-AEC1 is available in an SOIC-8EP package.

Figure 9 shows the MPQ2029-AEC1’s typical application circuit.

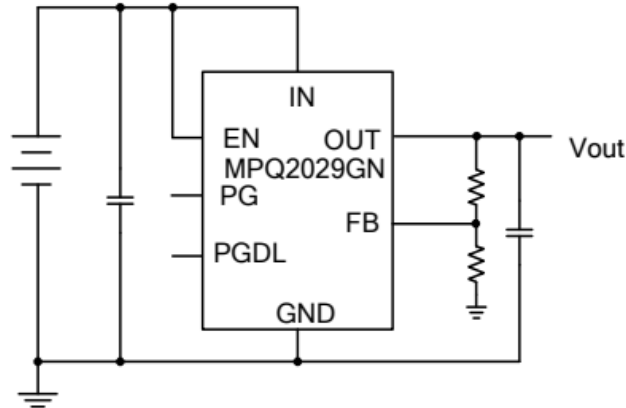


Figure 9: MPQ2029 Typical Application Circuit

Conclusion

This article explored designing multiple independent auxiliary power supplies and wireless power transmission systems to achieve a multi-channel, magnetically isolated, independent auxiliary power supply scheme using the [HR1211](#), [MP1907A](#), and [MPQ2029-AEC1](#). Compared to traditional schemes that use a bootstrap circuit to power the auxiliary power supply, using an independent power supply provides the advantages of being simple, reliable, and low-cost.

For more details, explore MPS’s broader selection of [PFC/LLC controllers](#), [MOSFET drivers](#), and [LDOs](#).