Examples of Connection Circuits

Rev.1.0_00

The S-8471 Series and the S-8474 Series are wireless power ICs.
The S-8471 Series is a receiver control IC (Receiver), and the S-8474 Series is a transmitter control IC (Transmitter).
This application note serves as technical documentation that describes the combined operation and characteristics of the S-8471 Series and S-8474 Series.
Refer to the S-8471 Series and S-8474 Series datasheets for additional details.

Caution 1. Wireless power transfer devices which use the S-8471 Series and S-8474 Series are optimized to operate at LC resonant frequencies of approximately 88kHz to 106kHz. Within the 88kHz to 106kHz LC resonant frequency range, the circuit for detecting the receiver control IC operates, and the transmitter control IC also operates correctly. If the constants of the used coil (L) and capacitor (C) are changed, the LC resonant frequency also will change, so make sure to maintain the LC resonant frequency within the 88kHz to 106kHz range.

2. There is polarity to the receiver coil and transmitter coil in wireless power transfer devices which use the S-8471 Series and S-8474 Series. Combine receiver coils and transmitter coils according to the details in this application note.

5. Examples of Connection Circuits

5. 1 Addition of a step-up switching regulator to transmitter with a single 5V power supply

As shown in **Figure 39**, an external 9V VCC transmission line is no longer necessary if a step-up circuit is added to the 5V VIN line. Also, the regulator IC (S-812C50xxx) is connected in order to stabilize transmitter input voltage (V_{DD}).

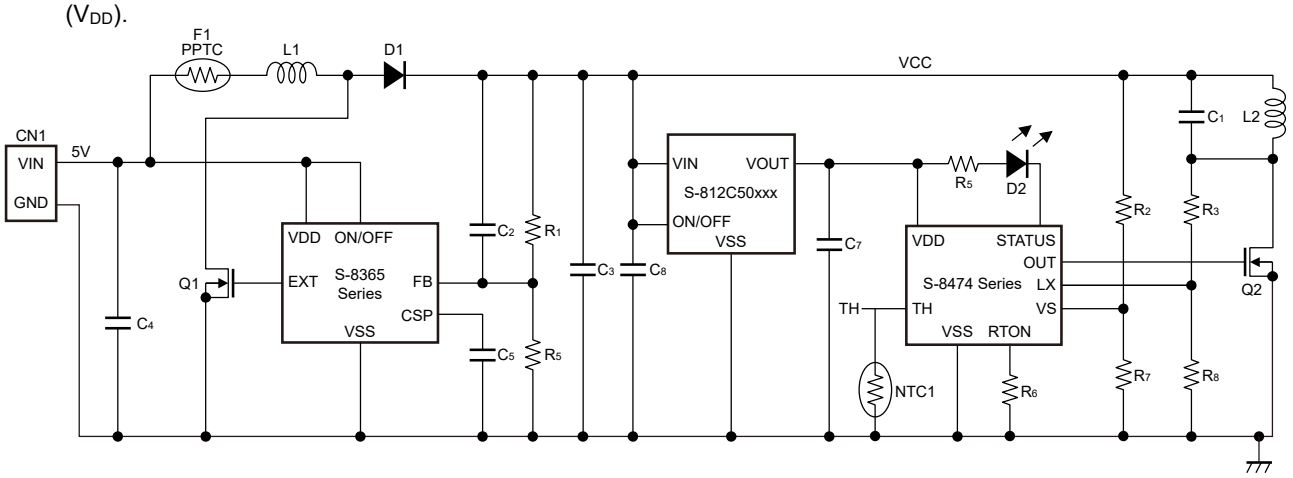

Figure 39 Example of Single Power Supply Input Transmission Circuit with Internal Step-up Circuit

5. 1. 1 PPTC (Resettable fuse)

Abnormal current will flow to VCC if a metal object is caught between the transmitter coil and receiver coil during power transfer. If this abnormal current causes the PPTC resistance to rise, the step-up operation of S-8365 Series will halt. If the step-up operation of S-8365 Series halts, the VIN line 5V will not be stepped up and will be supplied to the VCC as-is, so the VCC will operate at 5V. This results in decreased power transfer capacity, so the distance between coils required for continuous operation will be shorter, and S-8474 Series will switch to intermittent operation when the load current increases. In such cases, either shortening the distance between coils, or keeping the load current low maintains continuous operation. If the load current is low, the power transfer capacity is also low, so heat generation can be limited (Refer to "**Figure 31 Efficiency V_{CC} Dependence**").

5. 1. 2 Current limit circuit

The method for detecting abnormal current higher than normal resulting from a metal object being caught between the transmitter coil and receiver coil during power transfer is shown in **Figure 40**. A 0.1Ω current sense resistor is used instead of a resettable fuse. Power transfer operation can be halted by detecting the current which flows through the current sense resistor using an operational amplifier or comparator and controlling the thermistor pin of S-8474 Series. Compared to a resettable fuse, this method allows for the detection current to be set arbitrarily, which is effective for reducing heat generation.

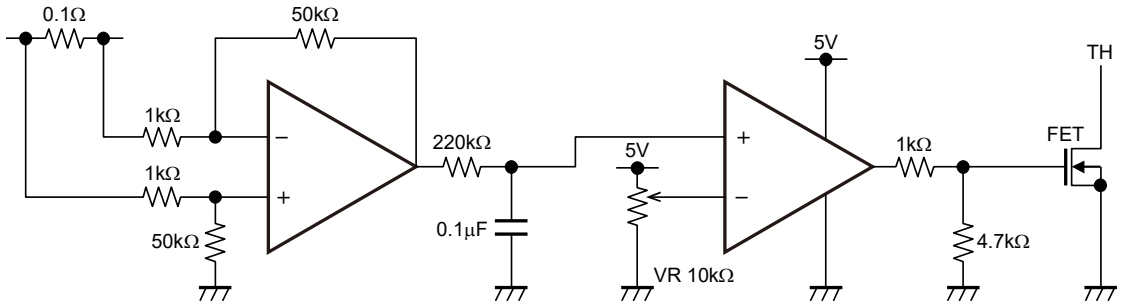

Figure 40 Example of Current Limit Circuit

Caution 1. The above connection diagram will not guarantee successful operation.
Perform thorough evaluation using the actual application to set the constant.
2. Since the transmitter detects reception, pay sufficient attention to the transmitter input voltage (V_{DD}) and the coil L1 voltage (V_{CC}) stabilities when designing a step-up circuit.
3. For transmitter VDD, it is recommended to connect a regulator IC when power is supplied.

5. 2 Application examples depending on load

5. 2. 1 Charging a small lithium-ion rechargeable battery

If the output current is larger than the power capacity of the receiver coil, the receiver VDD voltage does not reach V_{OVP}, and so the receiver FET2 is remains ON. The transmitter will then operate in intermittent mode, and the receiver coil generates heat. If the load current is too low, the transmitter will operate in intermittent mode. Therefore, set the minimum applied load current at operation to 5mA or greater for the receiver.
Configure circuits with current limit resistors to prevent exceeding the charge current for lithium-ion rechargeable batteries and the power capacity of the receiver coils used.

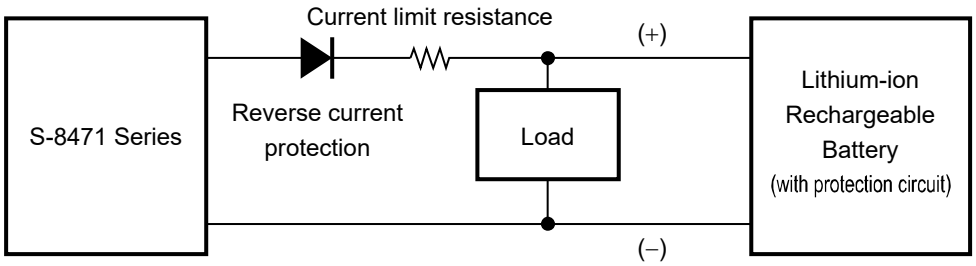

Figure 41 Charge Circuit for Small Lithium-ion Rechargeable Batteries

5. 2. 2 Charging a medium or a large lithium-ion rechargeable battery (combined with a lithium-ion rechargeable battery protection circuit)

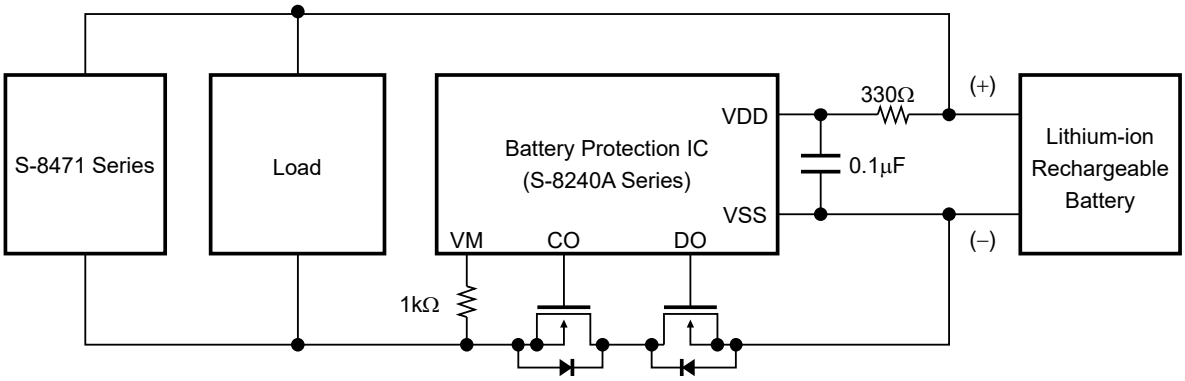

Figure 42 Charge Circuit for Medium and Large Lithium-ion Rechargeable Batteries

5. 2. 3 Storing energy in an electric double-layer capacitor (for overvoltage protection)

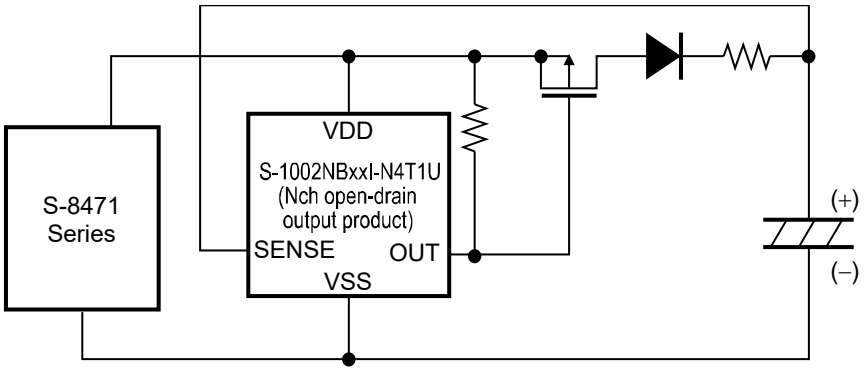

Figure 43 Storage Circuit for Electric Double-layer Capacitors

5. 2. 4 Direct drive circuit for microcontroller system

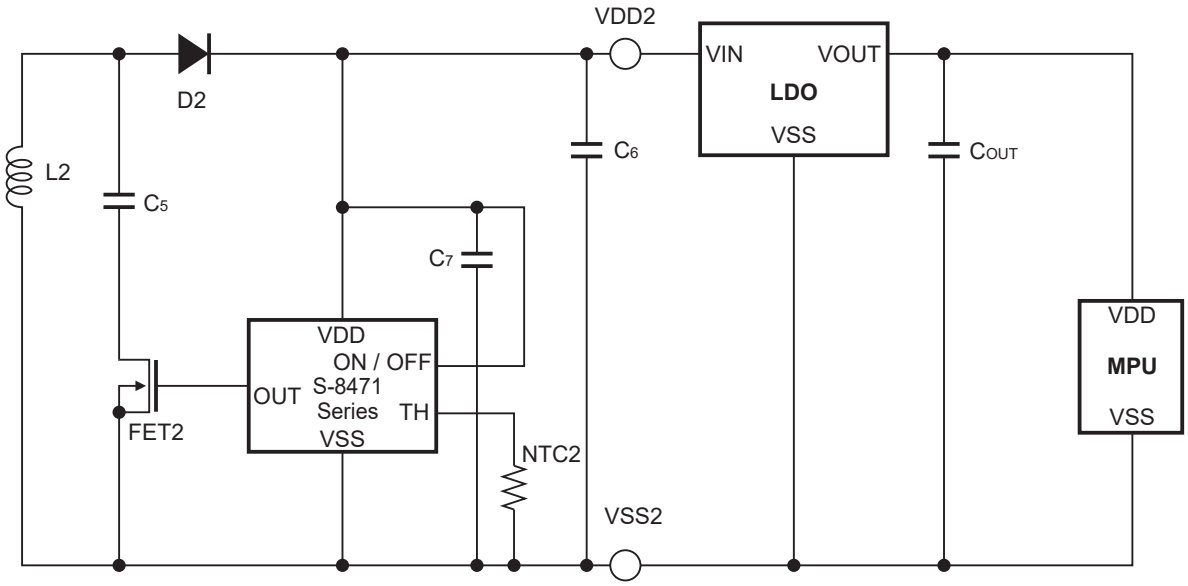

Figure 44

5. 2. 5 Batteryless direct drive circuit for microcontroller systems (C_6 enhancement)

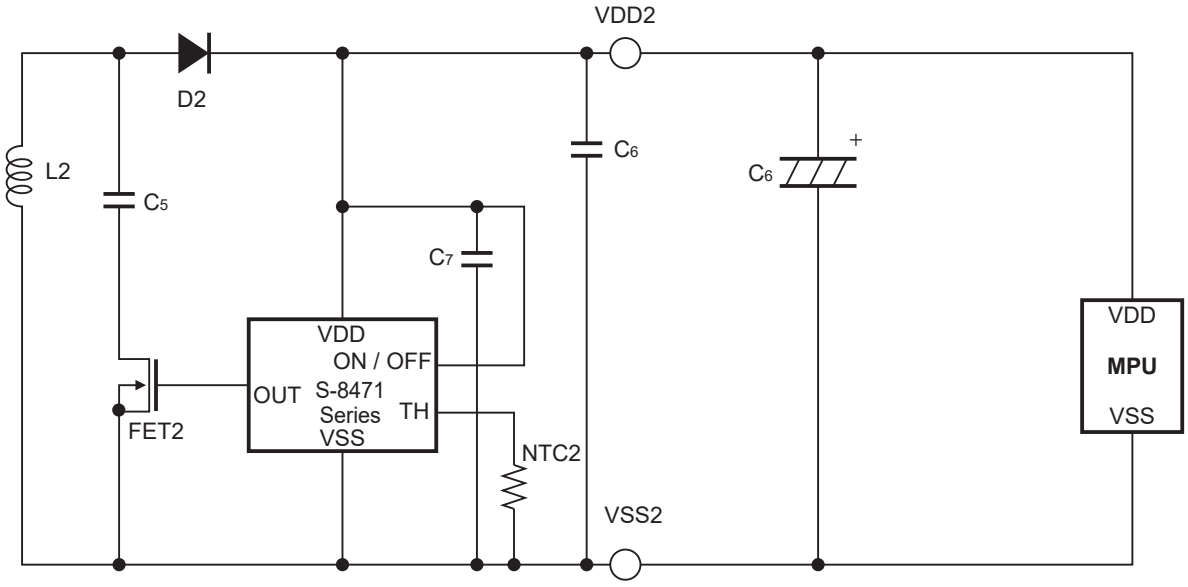

Figure 45

Caution **The above connection diagrams will not guarantee successful operation.**
Perform thorough evaluation using the actual application to set the constants.

5. 3 Examples of multiple reception circuits

5. 3. 1 Example of operation of 2 reception circuits with 1 transmission circuit

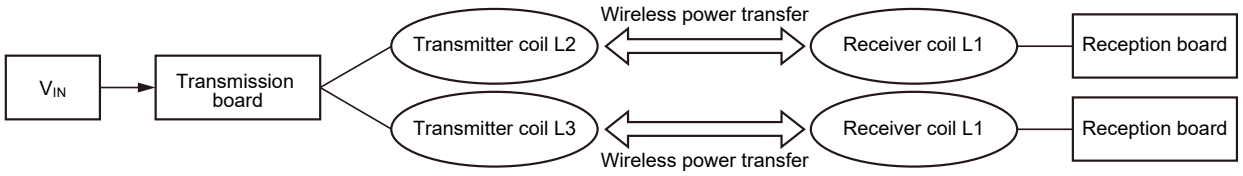

Figure 46

As shown in **Figure 47**, the 2 transmitter LC are connected in parallel (Recommended values: L2, L3 = 21μH, C1, C9 = 0.1μF).
Continuous operation continues if one receiver continues to fulfill the continuous operation conditions when the other receiver is at no load.

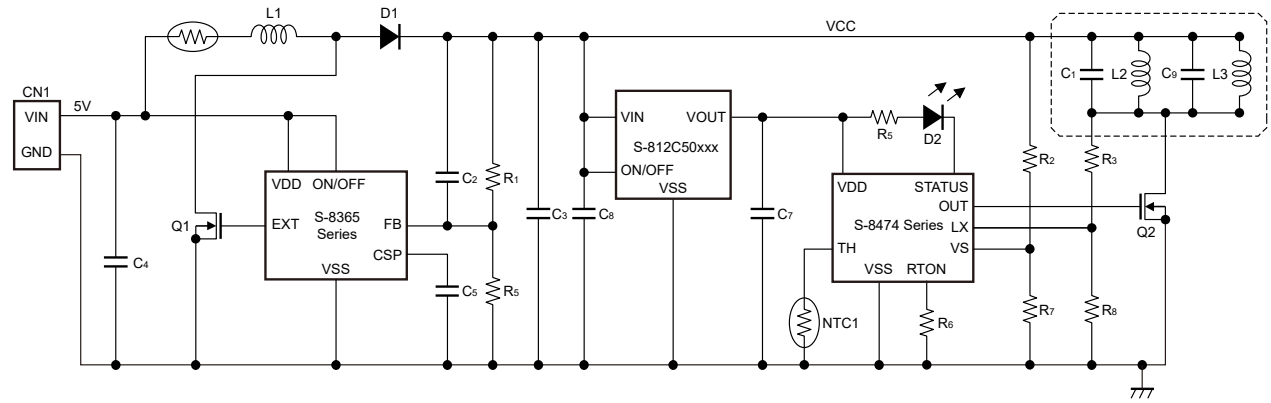

Figure 47

5. 3. 2 Example of operation of 2 reception circuits with a Hall effect IC and 1 transmission circuit connected to 2 transmitter coils

As shown in **Figure 48**, driving Q2 and Q3 with logical product output signal of the Hall effect IC (S-5716ACDH1-M3T1U) output and S-8474 Series output allows for power transfer only when the positions of the transmitter Hall effect IC and receiver magnet are aligned.

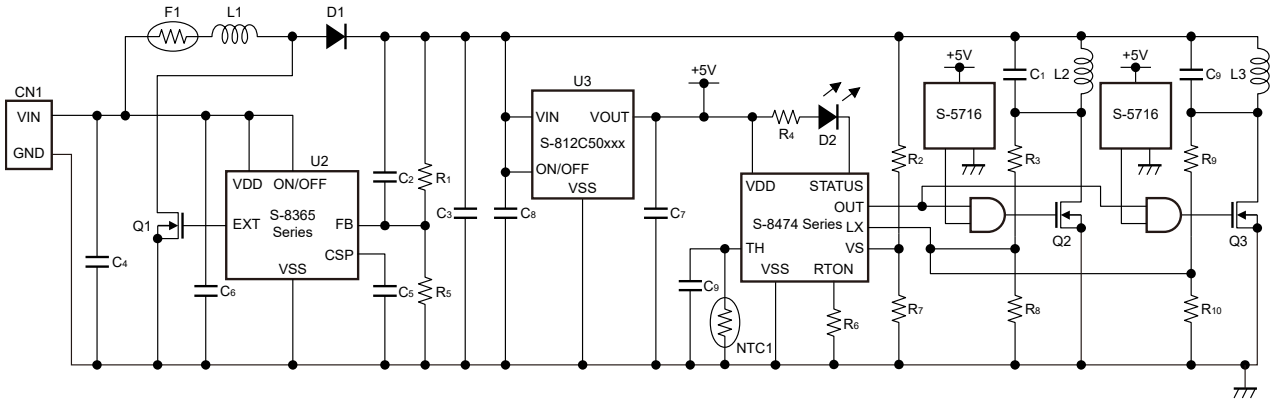

Figure 48

6. Board Design Considerations

- When wiring a board, make a single GND as described in the S-8471 Series and the S-8474 Series datasheets.
- To protect from overheat, be sure to connect an NTC thermistor to the TH pin for its use.
- For VCC in **Figure 49**, do not use a power supply which might cause frequency component amplitude of 1kHz to 110kHz (LC resonant frequency). It may result in a malfunction.
- For VDD in **Figure 49,** do not use a power supply which might cause frequency component amplitude to prevent from malfunction.
- When designing the board in **Figure 49**, for the following reasons, do not place a wiring near the RTON pin, the VS pin, and the TH pin. Layout so that resistor R_{TON} is as close to the RTON pin as possible.
  (1) Due to coil L1 and resonant capacitor (C_1), large voltage fluctuation is generated at point C.
  (2) Since impedance in the RTON pin, the VS pin, and the TH pin is high, they are easily affected by an extraneous signal.

  By connecting C_{RTON} (approximately 100pF to 1000pF) between the RTON pin and GND, C_{VS} (approximately 100pF to 1000pF) between the VS pin and GND and C_{NTC} (approximately 100pF to 1000pF) between the TH pin and GND, the influence of extraneous signal can be reduced.
  When detecting the coil temperature using an NTC thermistor in particular, the detection temperature may shift to the high temperature side as a result of the effect of the coil signal. It is recommended that C_{NTC} be connected between the TH pin and GND.

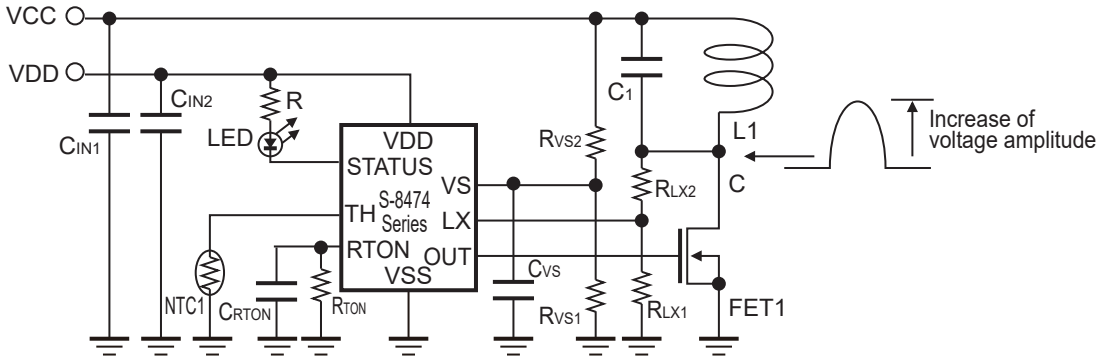

Figure 49

7. Precautions

- The usages described in this application note are typical examples using ABLIC Inc. ICs. Perform thorough evaluation before use.
- When designing for mass production using an application circuit described herein, the product deviation and temperature characteristics of the external components should be taken into consideration. ABLIC Inc. bears no responsibility for any patent infringements related to products using the circuits described herein.
- ABLIC Inc. claims no responsibility for any and all disputes arising out of or in connection with any infringement by products including this IC of patents owned by a third party.

8. Related Sources

Refer to the following datasheets for details of the S-8471 Series and the S-8474 Series.

S-8471 Series Datasheet
S-8474 Series Datasheet

The information described herein is subject to change without notice.
Please contact our sales representatives for information regarding the latest product version / revision.