Texas Instruments

*Application Report*
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# *Monitoring Load Current With the TPS2549 and TPS254900 CS Pin*

*Benjamin Zhao, Yongqiang Sun*

**ABSTRACT**

In many automotive applications, the host controller must monitor load current in real time and take appropriate measures to protect the system when the load current surpasses a safe threshold. This application note presents how to use the TPS2549 and TPS254900 CS pin to monitor load current.

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## Trademarks

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## 1 Introduction

The TPS2549 and TPS254900 devices are USB host-charging controllers with a supply voltage range from 4.5 V to 6.5 V. The TPS2549 and TPS254900 are widely used in automotive applications. Figure 1 shows the typical application circuit. Typically, the CS pin is used to compensate the voltage drop due to the long cable between the USB connector and end-user devices. The TPS2549 and TPS254900 devices sense the load current and generate a proportional sink current through the CS pin, that can be used to adjust the output voltage of the upstream DC-DC regulator. Figure 2 shows the cable compensation block diagram.

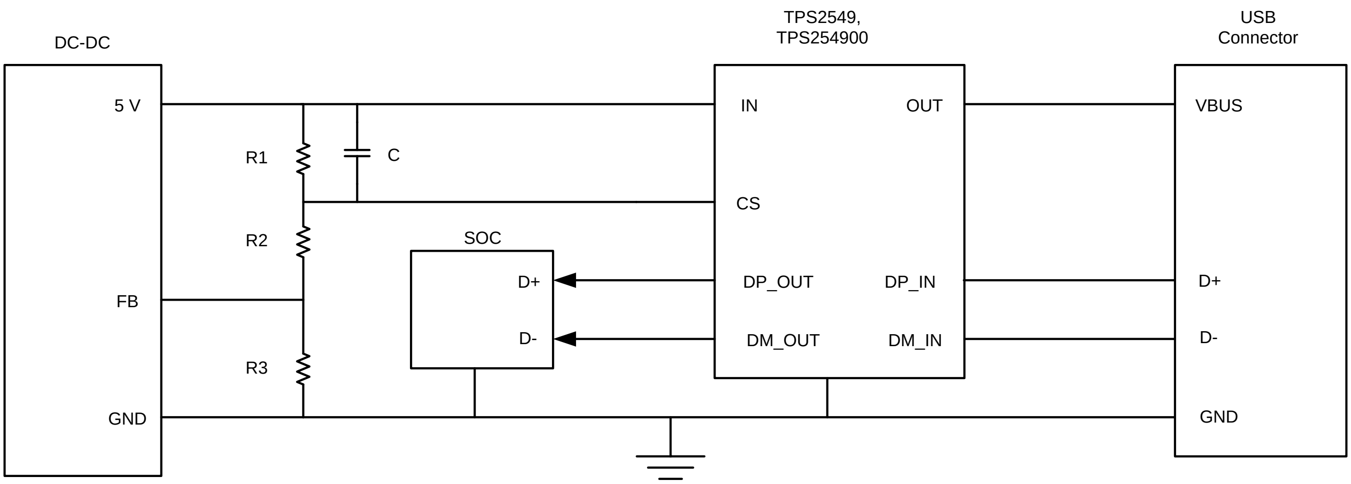




**Figure 1. TPS2549 and TPS254900 Typical Application Circuit**

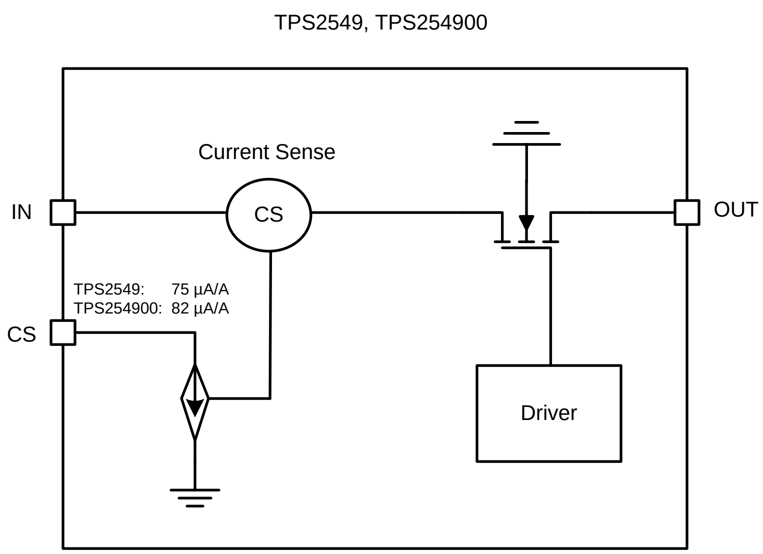




**Figure 2. Cable Compensation Block Diagram**

# 2 Device Overview

## 2.1 Using the CS Pin to Monitor Load Current

The CS pin provides a current sink. By connecting a sample resistor in the cable compensation path, we can use the CS pin to monitor load current, which can avoid any impact by connecting a sense resistor in series with the load, to achieve higher efficiency. Figure 3 shows the scheme for monitoring load current with the CS pin. The current sense amplifier converts the current which flows through $R_S$ to proportional voltage, and this voltage can be sampled by an analog-to-digital converter (ADC).

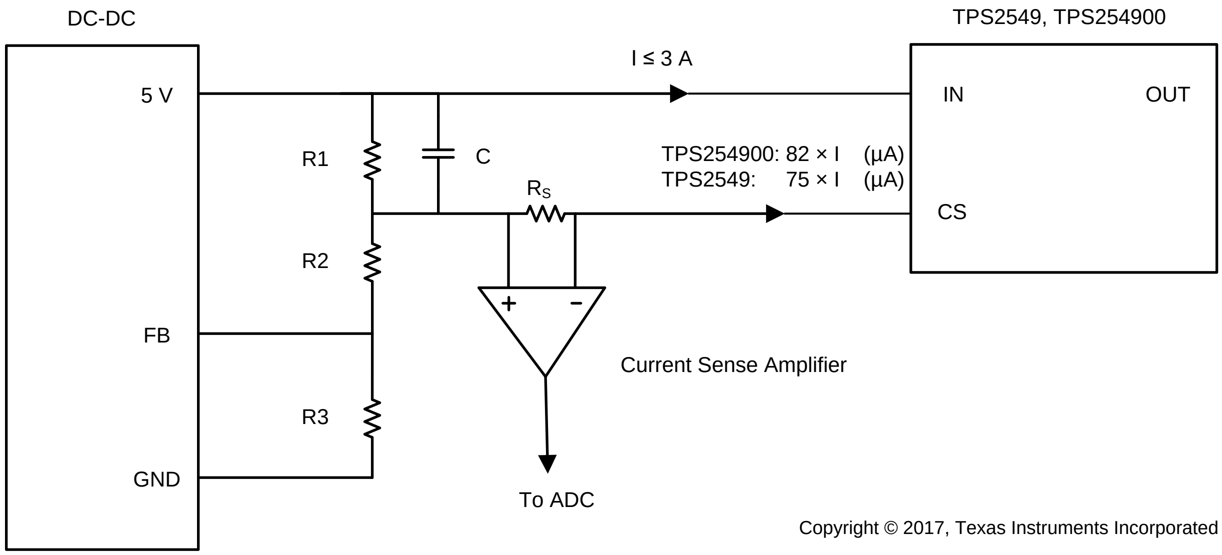


**Figure 3. Current-Sensing Scheme With CS Pin**

To ensure the cable compensation of the TPS2549 and TPS254900 works normally, TI requires that the voltage at the CS pin is larger than 2.5 V.

# 3 Device Description

## 3.1 Example of Monitoring Load Current

Figure 4 shows an example of monitoring the output current of the TPS254900. Using a 1-kΩ sample resistor and an amplifier with a gain of 12.08, the output voltage of the amplifier is described in Equation 1.

$$V = 0.991 \times I \quad (1)$$

Table 1 lists the test results.

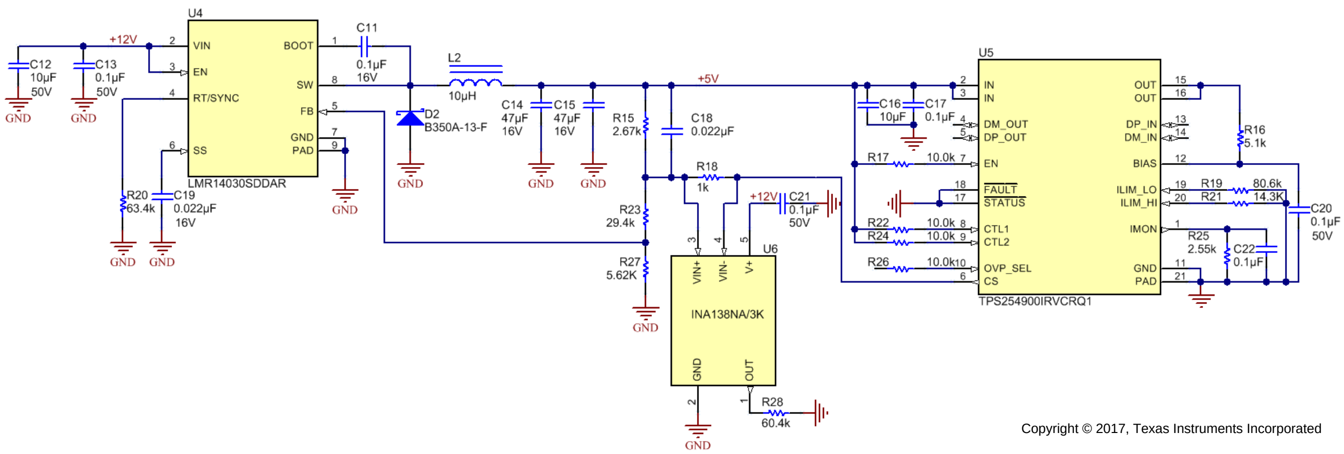


**Figure 4. Current Sensing Example**

**Table 1. Current Sense Test Results**

| Current (A) | Voltage (V) | Gain |
|---|---|---|
| 0.5 | 0.526 | 1.052 |
| 0.8 | 0.822 | 1.028 |
| 1 | 1.019 | 1.019 |
| 1.2 | 1.217 | 1.014 |
| 1.5 | 1.512 | 1.008 |
| 1.8 | 1.808 | 1.004 |
| 2 | 2.005 | 1.003 |
| 2.2 | 2.202 | 1.001 |
| 2.5 | 2.498 | 0.999 |
| 2.8 | 2.795 | 0.998 |
| 3 | 2.994 | 0.998 |

# 4 Conclusion

The guidelines in this application report provide a workable solution for current sensing in USB-charging-based devices. Sensing up to 3-A current is achieved by using proper sample resistors and amplifiers.

## 5 References


- Texas Instruments, TPS2549 USB Charging Port Controller and Power Switch With Cable Compensation, data sheet
- Texas Instruments, TPS254900-Q1 Automotive USB Host Charger With Short-to-VBATT Protection, data sheet
- Texas Instruments, TPS254900Q1EVM-817, user's guide
- Texas Instruments, TPS2549Q1EVM-729, user's guide