# Application Note

# DC-DC Over-Current Protection

## AN-CM-293

## Abstract

*This application note is a user guide, which explains how to use the SLG46585 DC/DC OCP feature if output voltage is 3 V or 3.3 V.*

*This application note comes complete with design files which can be found in the References section.*

# Contents

# Figures

# 1 Terms and Definitions

| | |
|---|---|
| DC/DC | direct current to direct current |
| OCP | over current protection |
| DLY | delay |
| CNT | counter |
| MOSFET | metal-oxide-semiconductor field-effect transistor |

# 2 References

For related documents and software, please visit:

GreenPAK™ Programmable Mixed-Signal Products | Renesas

Download our free GreenPAK™ Designer software [1] to open the .gp files [2] and view the proposed circuit design. Use the GreenPAK development tools [3] to freeze the design into your own customized IC in a matter of minutes. Find out more in complete library of application notes [3] featuring design examples as well as explanations of features and blocks within the GreenPAK IC.

[1] Go Configure™ Software Hub | Renesas, Software Download and User Guide

[2] AN-CM-293 DC-DC Over-Current Protection.gp, GreenPAK Design File

[3] GreenPAK Development Tools, GreenPAK Development Tools Webpage

[4] GreenPAK Application Notes, GreenPAK Application Notes Webpage
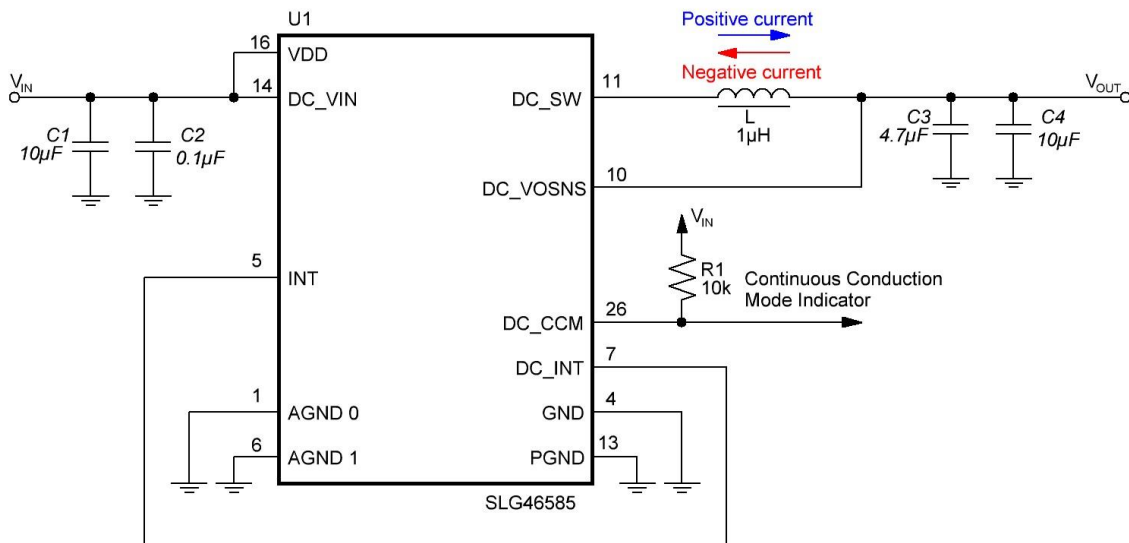
# 3   Background



**Figure 1: Circuit**

When output voltage of DC/DC is 3 V or 3.3 V and the over current protection feature is enabled, there is a specific application circuit that is recommended. During operation, if the inductor current exceeds the OCP threshold, then internally, a high side MOSFET will turn off for 2 us, and the INT output becomes HIGH during the same 2 us.

2us after the high-side MOSFET is turned off and if the VOUT is below the target output voltage, the high side MOSFET will turn on again. At this point, If the inductor current is still greater than the OCP threshold, the high side MOSFET will turn off. This loop will repeat until the OCP event is removed (when the inductor current drops below the OCP threshold), then DC/DC output voltage will finally recover.

However, if DC/DC output voltage is set 3 V or 3.3 V, the DC/DC cannot recover. This happens because of the internal low-side MOSFET. During operation, the low side MOSFET is opened during INT and a capacitor discharges through this MOSFET, meaning the inductor current becomes negative (the inductor's current flows from the output capacitor, C3 and C4, to the power supply). See Figure 2 channel 2 for an example. Due to this, the DC/DC can't recover even if there is no output load. For a given input of 5V, the output will become stuck at 2.5 V and the DC/DC consumes approximately 200 mA.

The recommended workaround is to use the typical application circuit shown in Figure 1 and the internal design circuitry shown in Figure 3.

## DC-DC Over-Current Protection

Channel 1 (yellow/top line) – V_OUT

Channel 2 (light blue/2nd line) – PIN#11 (DC_SW)

Channel 3 (magenta /3rd line) – PIN#7 (DC_INT)
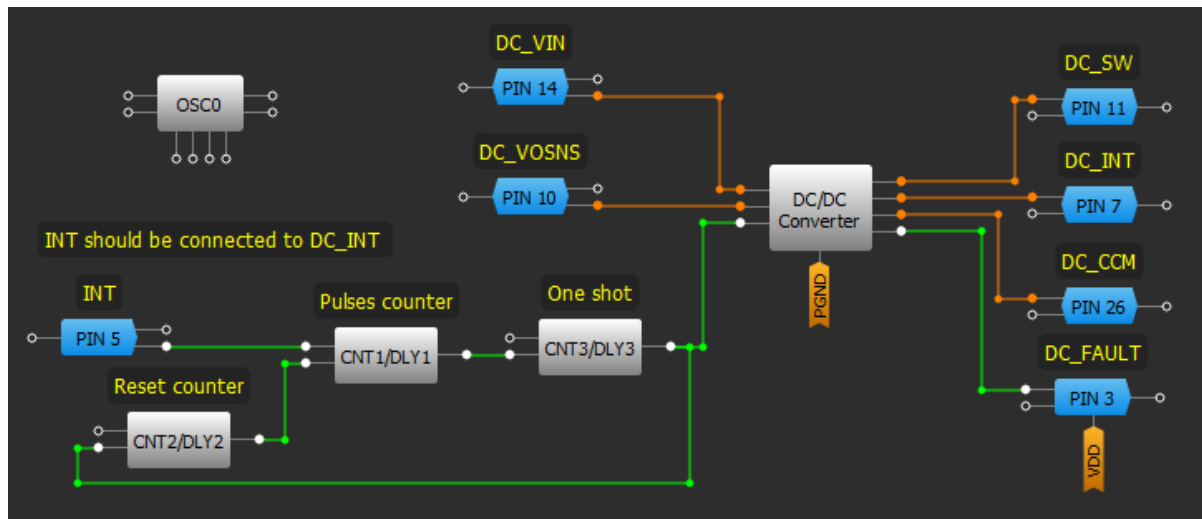


**Figure 2: DC/DC Stuck**



**Figure 3: Circuit of the Design**

If DC/DC output voltage is set to 3 V or 3.3 V, it is recommended to use the application circuit shown in Figure 1 and Figure 3. When the over current condition occurs, CNT1 will start to detect INT edges. If CNT1 counts more than eight interrupts (CNT1 counter data + 2) within a period of time set by CNT 2, the CNT1 will generate a pulse which launches DLY3. DLY3 will generate a one-shot pulse, which turns off the DC/DC. This one-shot pulse also resets CNT2, which, in turn, resets the CNT1. The purpose of CNT2 is to create a window. It will periodically reset CNT1.

## DC-DC Over-Current Protection

When the DC/DC is turned on or a load transient occurs, there can be a few interrupt pulses (usually 1 or 2). Therefore, CNT1 should have a count of at least 3 to filter out false over current conditions. The time of one-shot (DLY3), periodical reset (CNT2) and number of counted interrupts (CNT1) can be adjusted.

Since PIN#7(DC_INT) is open drain, add a pull up resistor. In the design PIN#5(INT) is configured with 10k pull up resistor and the two pins PIN#7(DC_INT) and PIN#5(INT) are tied together.
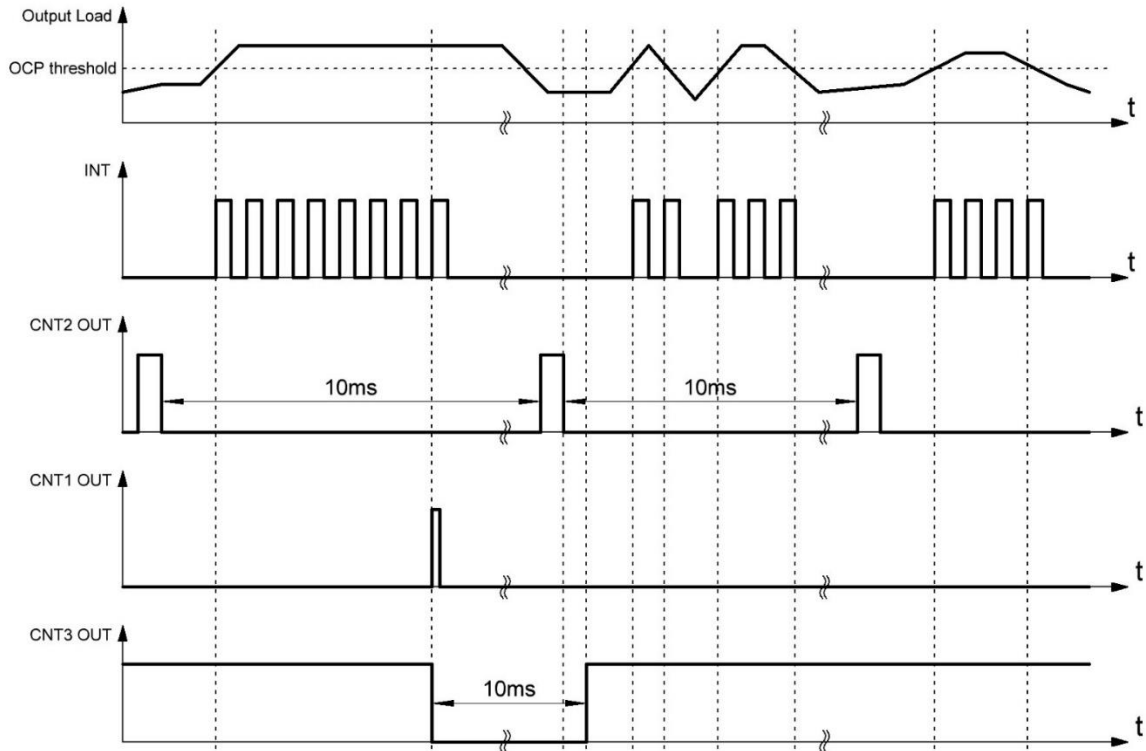


**Figure 4: Timing Diagram of Design Functionality**

## DC-DC Over-Current Protection

Channel 1 (yellow/top line) – PIN#11 (DC_SW)

Channel 2 (light blue/2nd line) – CNT3 OUT/DC-DC ENABLE

Channel 3 (magenta /3rd line) – PIN#7 (DC_INT)
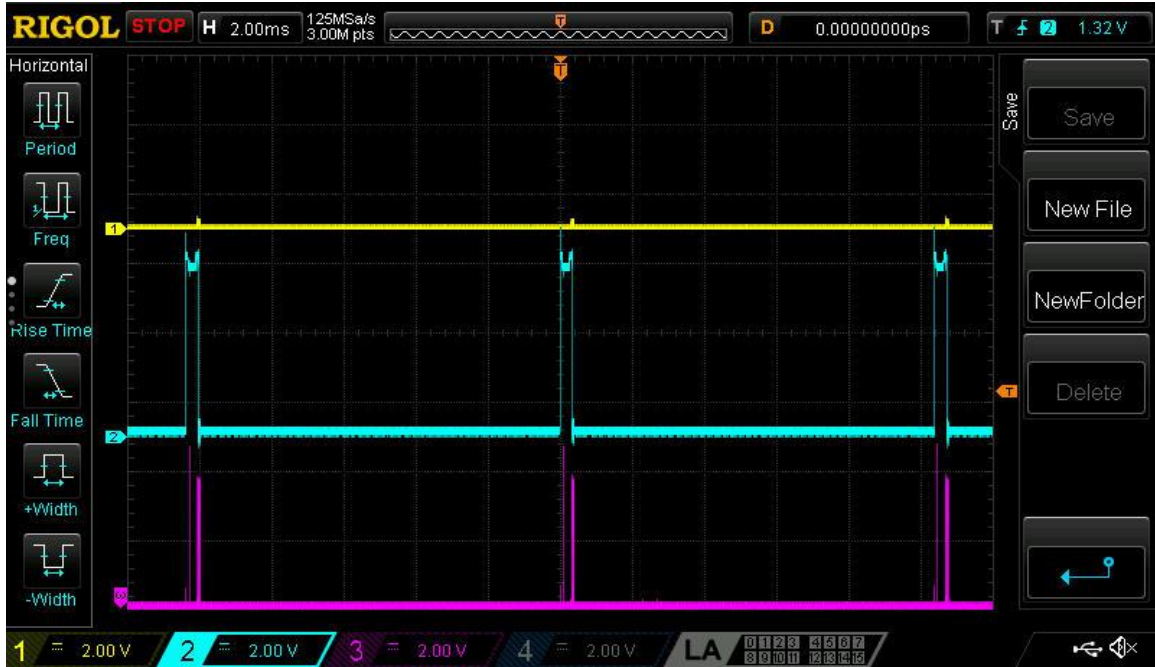


**Figure 5: The Design Functionality**



**Figure 6: Zoomed the Design Functionality**

# 4 Conclusion

This application note explains how to use the OCP in SLG46585's DC/DC, when DC/DC output voltage is set to 3 V or 3.3 V. Here is a typical circuit which is recommended to use with the DC/DC.

# Revision History

| Revision | Date | Description |
|----------|------|-------------|
| 1.0 | 31-Mar-2020 | Initial Version |

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TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

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