# Application note

## Seamless supply switchover for sleep modes.

### AN-PM-019


**Abstract**

*An investigation into a seamless switch of input supply to support a low power sleep state when using the Dialog DA9021, DA9022, DA9052, DA9053 or DA9057 PMIC.*

**Seamless supply switchover for sleep modes.**

# Contents



# Figures



# 1 Terms and definitions

| | |
|---|---|
| DA905x | For this document this will be used to represent DA9021, DA9022, DA9052, DA9053 and DA9057 |
| PFM | Pulse Frequency Modulation |
| PWM | Pulse Width Modulation |

# 2 References

[1] DA9053-00-IDS3a_140114.pdf, Datasheet, Dialog Semiconductor

 

# 3 Introduction

It is a requirement for some applications to be able to switch input supply when the system enters a sleep state. This application note investigates the options for having a seamless switchover from DCIN as the main supply to VBUS as a “sleep” supply in systems using the DA9053 with no battery. A seamless switch from either DCIN or VBUS to VBAT is also investigated. The findings are applicable to devices from the DA905x family of PMIC’s from Dialog Semiconductor.

# 4 Evaluation setup description

- A 3F programmed DA9053 part on 11x11 Eval board 44-179-115-03-B
- VBUS supplied by a Hameg HM8143 with the output set to 5 V @ 68 mA current limit.
- DCIN supplied by a TTi PL155 with the output set to 5 V @ 500 mA current limit.
- 50 mA load on VBUCKCORE provided by Hameg CH2 which gives a load on DCIN of 19 mA.

# 5 DCIN to VBUS switchover evaluation

This section investigates the possibility of implementing a seamless switchover from DCIN to VBUS with a 20 mA load on the supply (DCIN/VBUS).

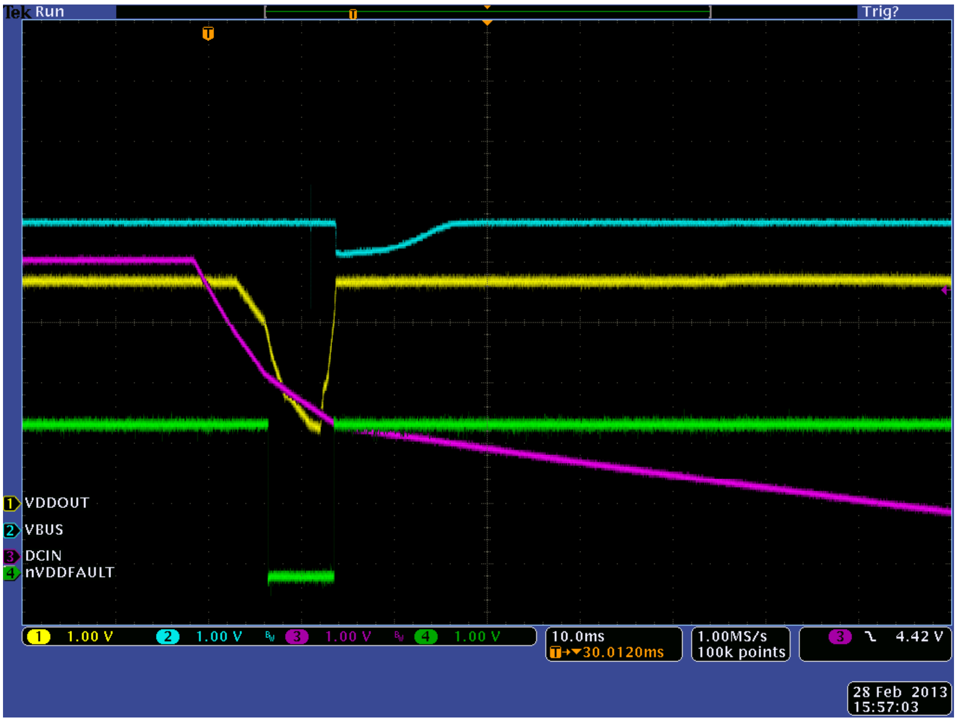


**Figure 1 Disable DCIN supply**

Figure 1 shows VDDOUT (yellow trace) dropping below the VDDFAULT threshold during the switchover from DCIN (pink trace) to VBUS(cyan trace). The result of this would be a reset of the system with a loss of all state information. The green trace shows the nVDDFAULT signal.

 


**Figure 2 No load on VBUCKCORE**

Figure 2 shows the behaviour when the load on VBUCKCORE is reduced to 0 mA. The result of this would be that the system does not reset and stays in the Active state. The green trace shows the nVDDFAULT signal.

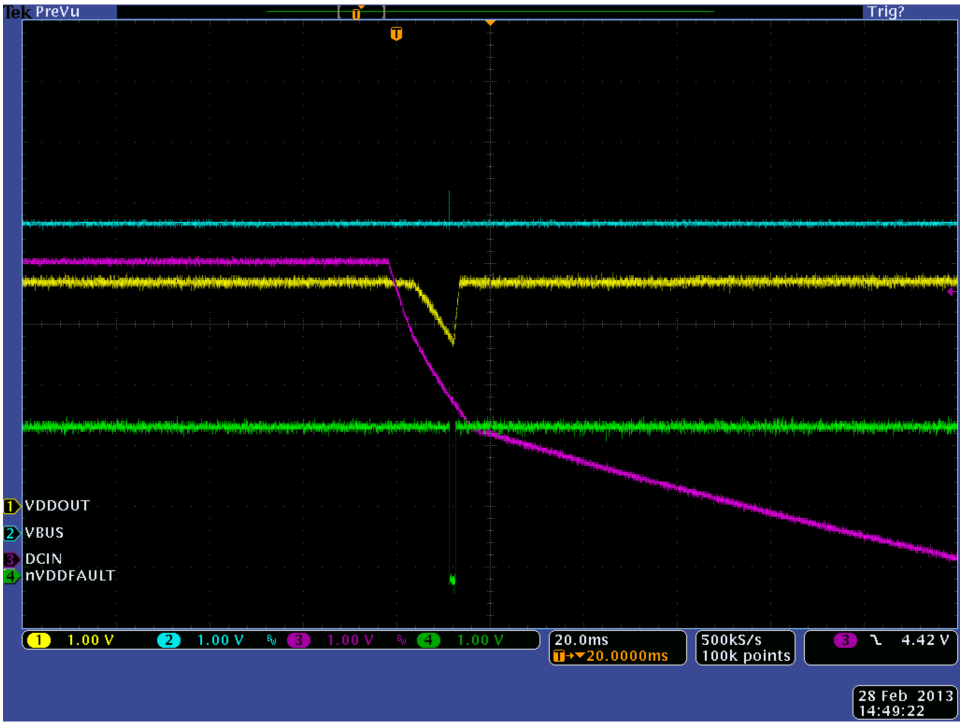


**Figure 3 A 30 mA load is added on VBUCKCORE, 100 µF capacitor on VDDOUT**

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Adding additional capacitance to VDDOUT can help maintain VDDOUT during the switchover. Figure 3 shows that nVDDFAULT is still triggered with a 30 mA load on VBUCKCORE, even though 100 µF of additional capacitance has been added to VDDOUT. VBUCKCORE is set to 1.25 V.

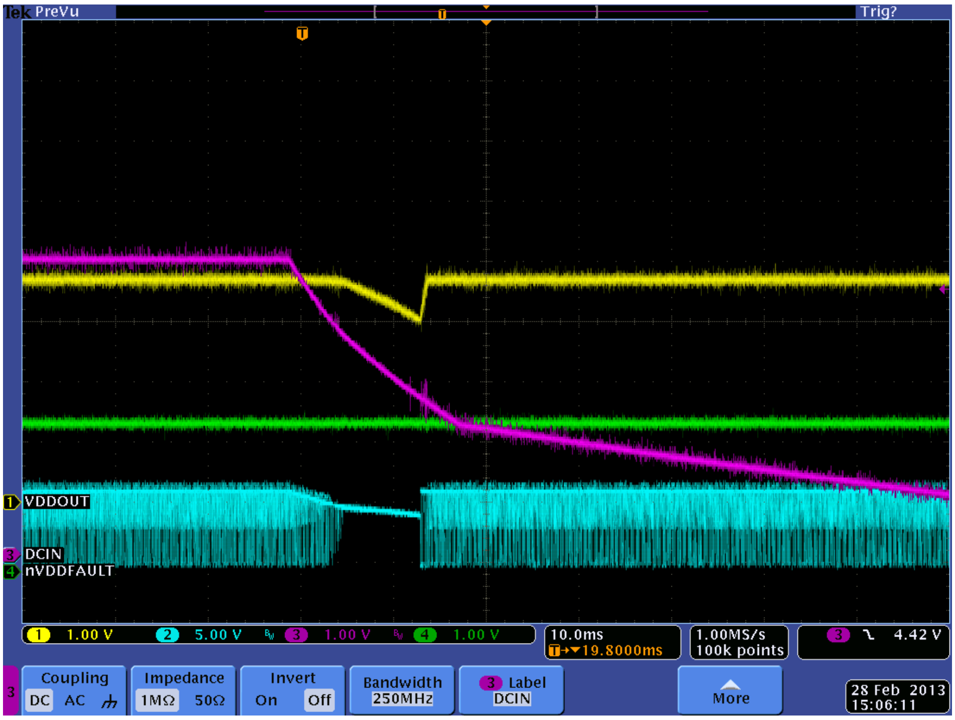


**Figure 4 Switchover showing LX node**

Figure 4 shows that the charger buck stops switching as the voltage on DCIN drops. Following this there is a period of 10 ms while VBUS is detected and validated before the buck starts to switch again. It is this period which is the reason for the droop seen on VDDOUT.

 

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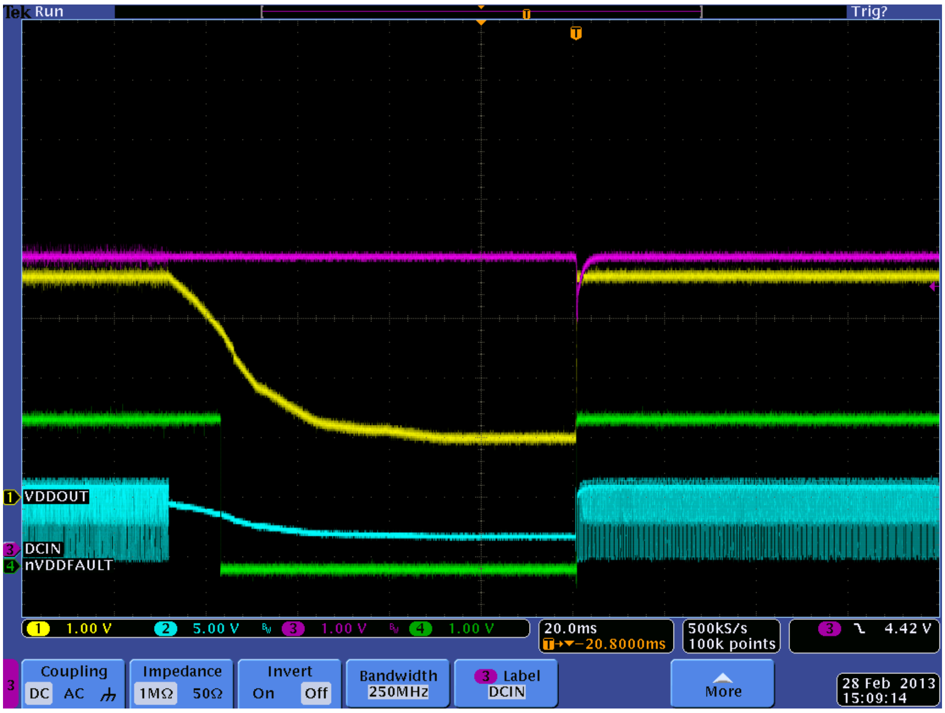


**Figure 5 Switchover by DCIN_SUSP bit in R67**

To investigate alternative options for triggering the switchover, the DCIN input was disabled by setting the DCIN_SUSP bit in R67. As it can be seen from Figure 5, this resulted in a longer switchover period and does not enable a seamless switchover.

 

# 6 DCIN to VBAT seamless switchover

An alternative to switching between DCIN and VBUS is to switch between either DCIN or VBUS and VBAT. In this case it is preferable to reduce the voltage being applied to the VBAT input below the 5 V that would be used for either DCIN or VBUS.

In most cases the sleep supply will be provided by a low power efficient regulator, however in systems where the sleep supply is already configured for 5 V it should be acceptable to use one or two series diodes to drop the 5 V to either 4.3 or 3.6V. As the current consumption should be low in the sleep state, the impact in the overall efficiency when using the diodes should be acceptable.


**Figure 6 Supply sleep current via diode onto VBAT.**

Figure 6 shows the switching behaviour if the Sleep current is provided via a diode onto VBAT. Attaching the sleep supply to VBAT is the safest option as it will avoid any possibility of overdriving VDDOUT which may cause instabilities with the charger buck. The voltage on VBAT is 3.6 V,.which is two diode drops below the 5 V supply.

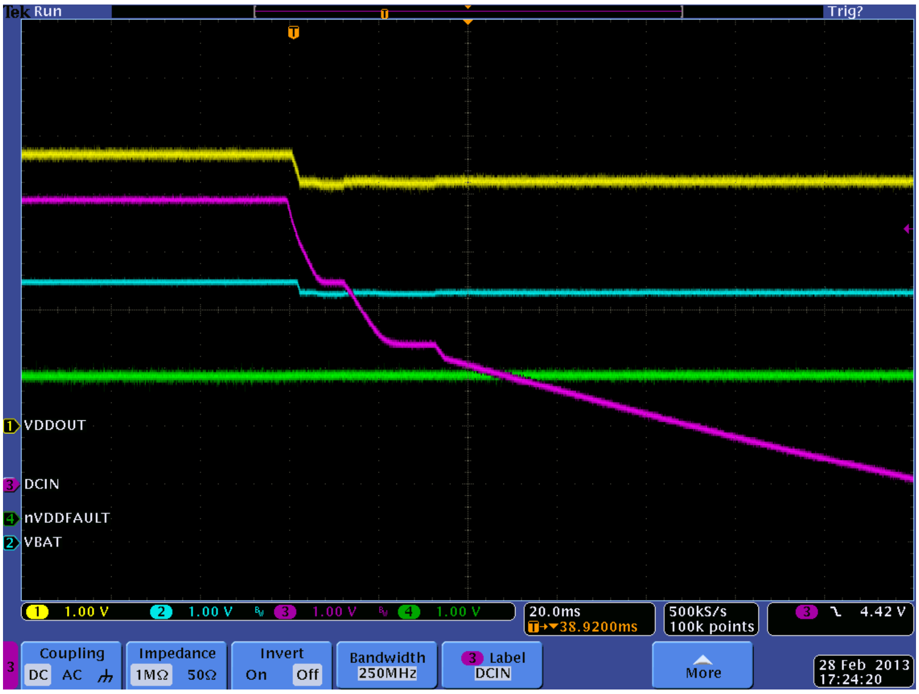


**Figure 7 Supply via single diode to provide 4.3V on VBAT**

Figure 7 shows the same behaviour but this time the voltage supplied to VBAT is 4.3 V, which is a single diode drop from the 5 V supply. During the period that both DCIN and VBUS are present, the charger buck will regulate to 250 mV above VBAT, so approximately 4.6 V.

 

# 7 Energy efficiency

The goal of implementing a sleep mode in any system is to minimise the energy consumption when the system is not required to be active. In the following discussion, it is assumed that the target is to consume less than 100 mW from the 5 V sleep supply. This translates to a target current of 20 mA.

If the system is to use the charger buck to provide the system current in sleep then the buck will be running and consuming its quiescent current. Although the charger buck does support a PFM low power mode, it does not support automatic mode switching. This causes a problem in that the host processor would have to be operating to perform the I2C write to set the buck into PFM mode. To achieve this, the host would have to be consuming less than 100 mA. This is likely to be difficult to achieve. The wake-up procedure would also have to be carefully managed so that the current did not exceed 100 mA until the buck was back in PWM mode. Assuming that this mode transition is not possible, the buck will only operate in PWM mode.

In PWM mode the buck has a quiescent current of around 6 mA. So, with a 5 V input voltage, the buck will consume approximately 30 mW.

In the system with two diodes, there will be a voltage drop of approximately 1.4 V across the diodes. With the maximum 20 mA flowing there will be 28 mW dissipated in the diodes.

In the case of the single diode the dissipation in the diodes will be reduced to 14 mW.

If we compare the option with the two diodes to the option using the charger buck there is little difference. The option with the single diode may be more efficient.

# 8 Conclusion

From the above measurements it can be concluded that it is not possible to have a seamless switchover from DCIN to VBUS without a battery connected to the system. The recommended solution when a system calls for a switch over to a sleep supply is to connect the main 5 V supply to DCIN( or VBUS), while the 5 V sleep supply should be connected via a diode to VBAT (~4.3 V on VBAT).

## Revision history

| Revision | Date | Description |
|---|---|---|
| 1.0 | 04-Mar-2013 | Initial version. |
| 1.1 | 20-Jul-2015 | Updated to new template. |
| 1.2 | 17-Nov-2015 | Minor update of wording. Changed filename to make clearer |
| 1.3 | 18-Nov-2015 | Added other relevant Dialog devices to Abstract. |
| | | |

 

# Seamless supply switchover for sleep modes.

## Status definitions

| Status | Definition |
|---|---|
| DRAFT | The content of this document is under review and subject to formal approval, which may result in modifications or additions. |
| APPROVED or unmarked | The content of this document has been approved for publication. |

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