BGF117

High Speed ESD protection and EMI filter for SD- / MicroSD Card

Protection of ESD strikes without violating (µ)SD link timing.
Effective reduction of inbound and outbound EMI.

Application Note AN211

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Page	Subjects (major changes since last revision)

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Last Trademarks Update 2009-10-19

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1 Introduction

1.1 Features

- Bidirectional ESD Protection and EMI Filter for High-Speed Mini-/MicroSD card interfaces
- ESD protection according to IEC61000-4-2: +/-15kV contact discharge on all external pins +/-2kV contact discharge on all internal pins
- Very good EMI filtering and very low cross talk due to small package parasitic
- Suitable for high speed applications due to very low line capacitance of typically 8 p. Tailored for SD, SDHC
- Integrated pull up resistors for proper I/O biasing of controller and SD-card, even without SD Card
- Minimized board-space required, based on application tailored I/O arrangement
- Straight forward layout
- 400um solder ball pitch
- RoHS and WEEE compliant package
- Complies with following standards:
  SD Card Specification V2.0
  MicroSD Card Specification V1.0

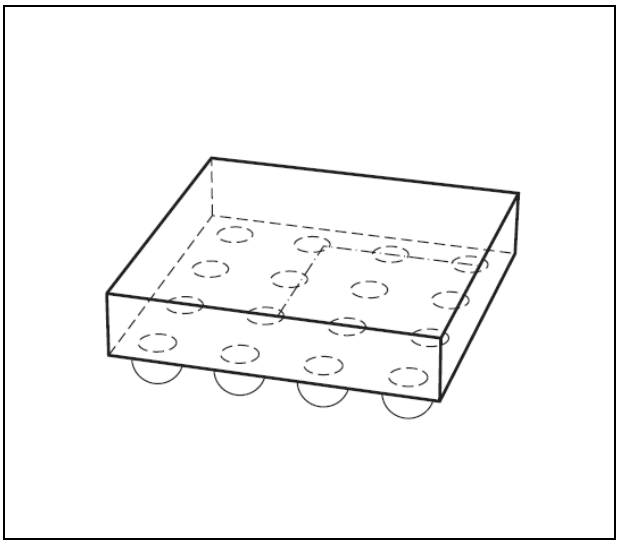

Figure 1 WLP-16-4-N

1.2 Overview

Secure Digital (SD) is a widely used non-volatile memory card format. There are two main variants available, SD Card and MicroSD, see Figure 2. Both types have the same electrical interface but differ in size and shape. SD Card mainly targets on applications like cameras and multi media home entertainment devices, whereas MicroSD is widely used in portable devices such as mobile phones and MP3 players. Memory capabilities reach up to 32GB for the SDHC type. With the announcement of the SDXC (extended capacity) specification in 2009 a capacity of 2TB will be possible. Furthermore read and write speed will be improved significantly for the SDXC.

Infineon's BGF117 Hipac is a one chip solution for SD Card interfaces that provides ESD protection and EMI filters on all lines. Furthermore integrated pull-up resistors avoid floating pins when there is no SD Card connected. The BGF117 comes in an ultra small outline WLP-16-4-N package (Figure 1) to fulfill the requirements of a space saving and straight forward PCB layout (Figure 4 / Figure 5). Its very low package parasitics reduce line crosstalk to a minimum. The SD specification for SDHC requires the overall system capacitance for one SD card to be

$C_{total} \leq 40pF \leq C_{Host} + C_{Bus} + C_{card} + C_{BGF117}$.

With the ultra low line capacitance of 8pF, the BGF117 is suitable for High-Speed applications in SD and MicroSD card interfaces and meets the required total system capacitance.

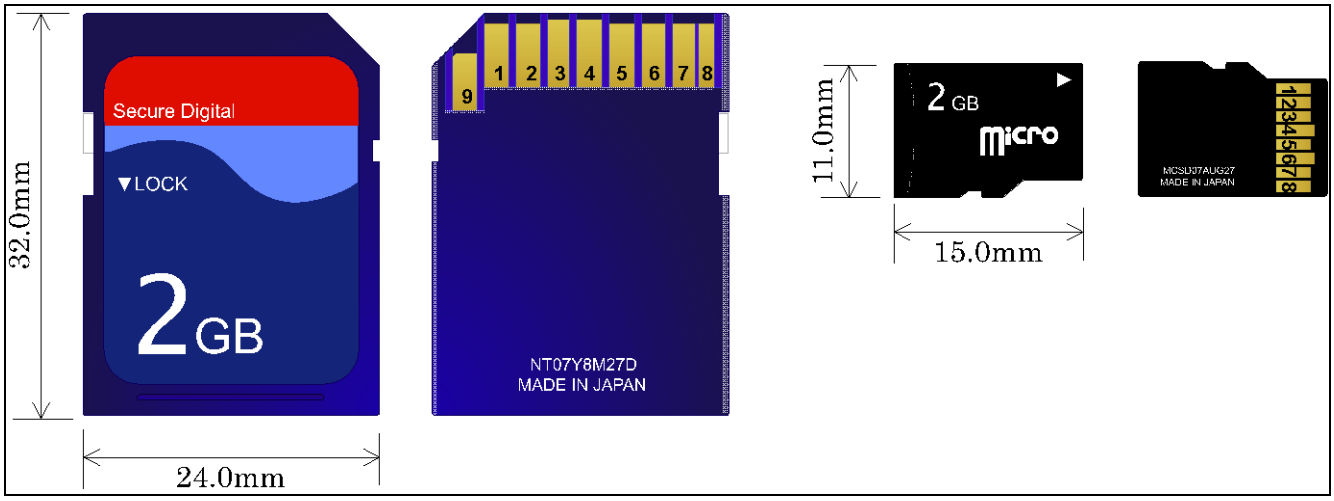

Figure 2 SD Card and MicroSD card

2 ESD Protection

SD Card interfaces are vulnerable to ESD strikes as the contact pins for microSD cards can be easily touched by the user. Figure 3 shows a microSD card slot with the contact pins. To avoid serious damage of the SD host controller the BGF117 provides ESD protection up to +/-15kV on all external pins and +/-2kV on all internal pins according to IEC61000-4-2 contact discharge. Due to the different ESD protection levels on the internal and external pins of SD and MicroSD card interfaces, the PCB layout has to be done in a proper manner otherwise a sufficient ESD protection is not guaranteed, (Figure 4 / Figure 5).

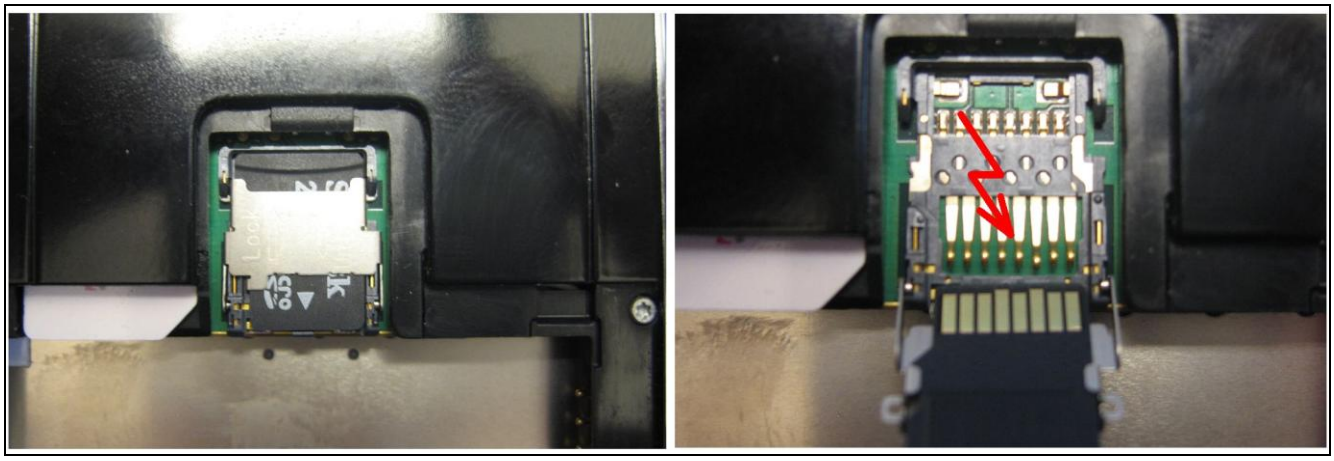

Figure 3 MicroSD Card Slot; external contact pins are exposed to ESD Strikes

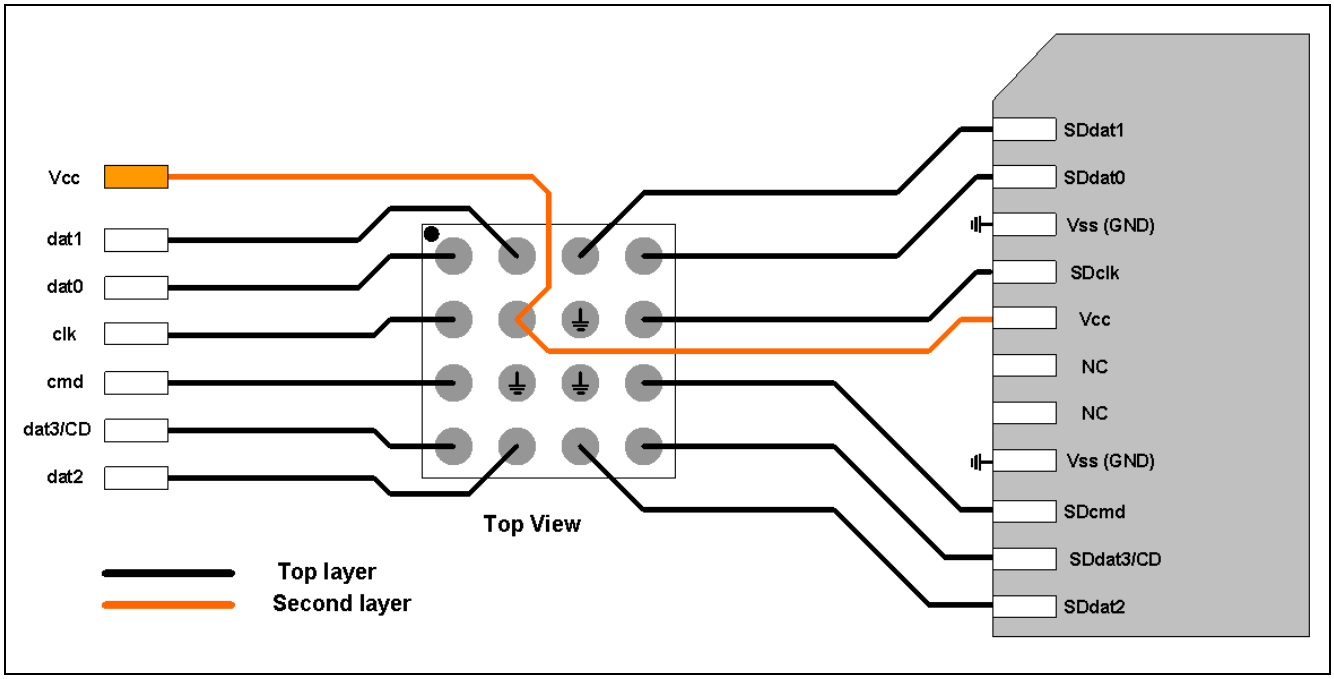

Figure 4 PCB layout suggestion for SD Card with ESD protection

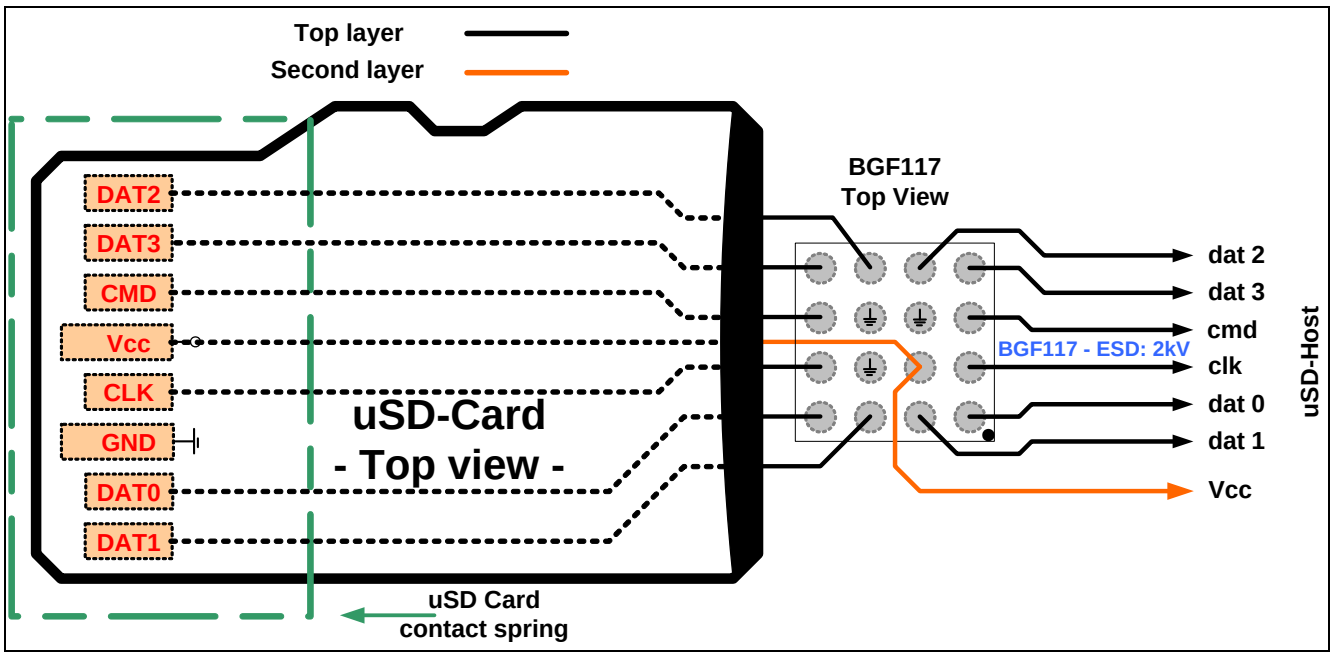

Figure 5 PCB layout suggestion for MicroSD card with ESD protection

3 EMI Filter

Figure 6 shows the circuit of the BGF117. Especially in mobile devices, EMI is a big issue and can have a significant impact on data transfer and data integrity of the whole system. Infineon's BGF117 provides a low pass filter structure (Pi-structure) formed by two ESD diodes and a serial line resistor in between. This filter structure is used for all I/O lines. The low pass filters reduces the susceptibility to EMI generated within the mobile device. This manmade EMI can be the RF noise from GSM-PA, or conducted EMI from all digital circuits. Furthermore EMI emission of the SD card interface itself is reduced.

The forward transmission (S21 in 50 Ohm environment) of the BGF117 EMI filter circuit is shown in Figure 7.

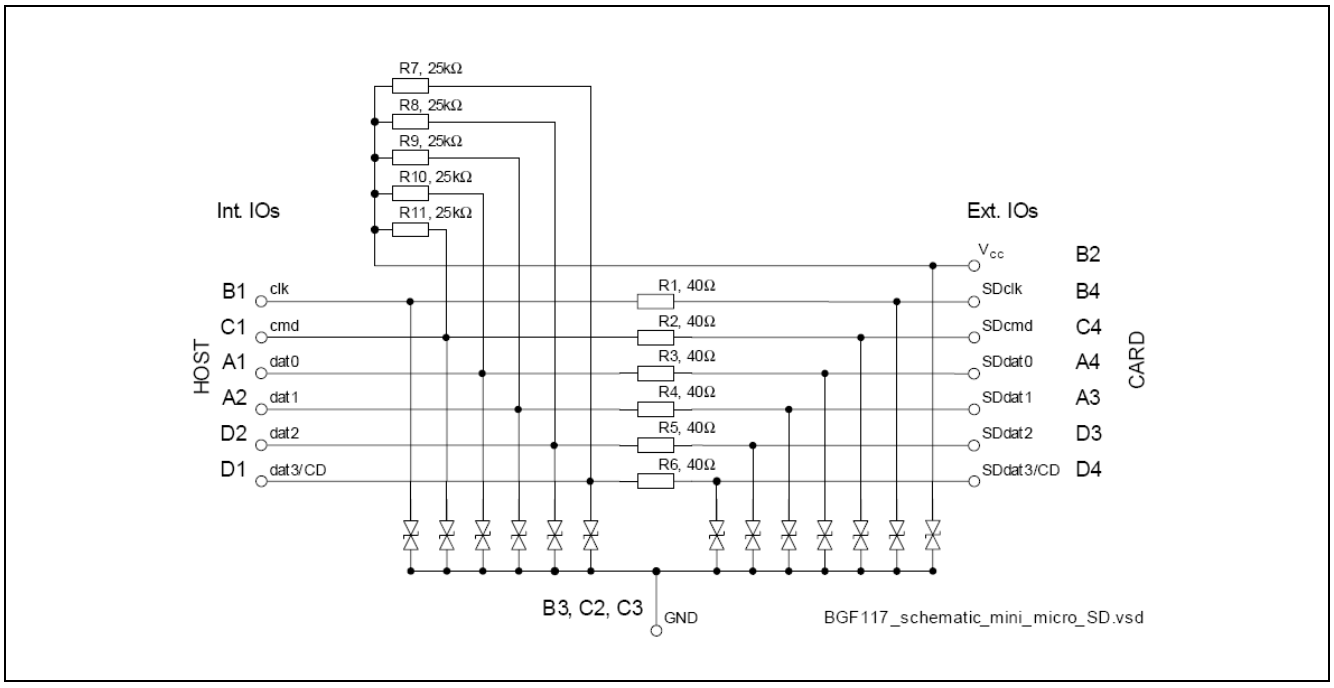

Figure 6 BGF117 Circuit with Low Pass PI Filter structure and Pull up Resistors

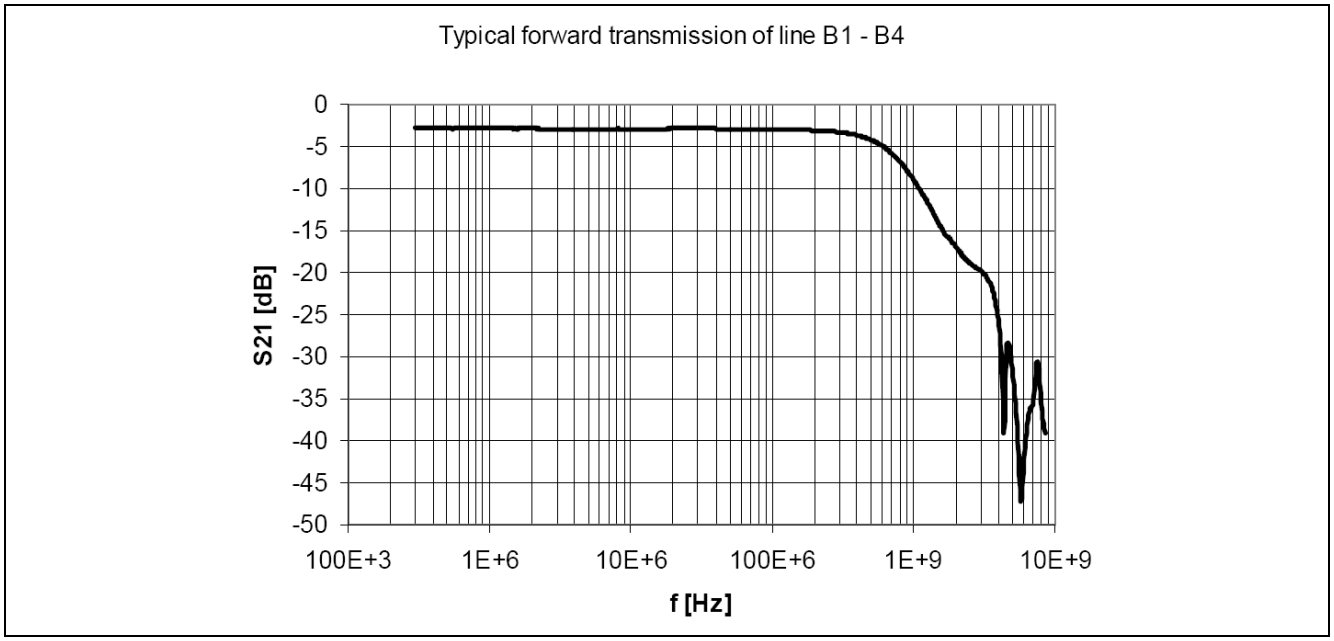

Figure 7 Forward Transmission Measurement of line B1-B4 with Low Pass Characteristic

3.1 BGF117 facing the real application

Characteristic of the BGF117 stand alone is one topic, and the other is BGF117 in the entire SD card link. Therefore the capacitance budget and the driver / receiver characteristic have to be taken into account.

EMI filter performance and signal rise time in the SD Card application depend on driver impedance C_{host}, parasitic (PCB-lines, SD Card holder, BGF117) C_{bus} and C_{card} .

For a SDHC application (HS mode) there are some restrictions for the entire link capacitance: **$C_{total} \leq 40pF$**

$C_{Host} = C_{card} \leq 10pF$ (assumption)
SD card holder 2pF (assumption)
BGF117 provides 8pF

$C_{total} \leq 40pF \leq C_{Host} + C_{Bus} + C_{card} + C_{BGF117}$.

There remains some margin for further parasitic which can be microstrip lines on flex PCB (very capacitive). Furthermore the driver output resistance (50 Ohm vs. 25 Ohm) has a significant impact to signal rise and fall time.

To meet the SDHC high speed mode requirements, t_{rise} and t_{fall} of the clock signal in the application has to be <3nsec. (µ)SD-card signal t_{rise} and t_{fall} is defined dynamically based on the receiver Vdd. Assuming (µ)SD-card signal HIGH =VDD, (µ)SD-card signal LOW =0, t_{rise} and t_{fall} has to checked between 25%-62.5% of the (µ)SD-card signal.

Figure 8 and Figure 9 show the transient analysis simulation setup and simulation results for the SD card system. Here we took the more stringent (20%-80%) requirement for the rise/fall time. t_{rise} and t_{fall} are less than 3nsec in the real world application simulation setup and provides enough security margin for further parasitic to meet the requirements in the SD card specification.

In frequency domain BGF117, provides an EMI low-pass filter characteristic. EMI filter voltage response and simulation setup is shown in Figure 10 and Figure 11.

To achieve SDXC (UHS104) performance, all parasitic have to be minimized significantly to speed up t_{rise} and $t_{fall.}$ To speed up t_{rise} and t_{fall} the SDXC (UHS104) system, the internal serial resistors of the BGF117 should be reduced. This would be possible - on request - in a modified version of BGF117.

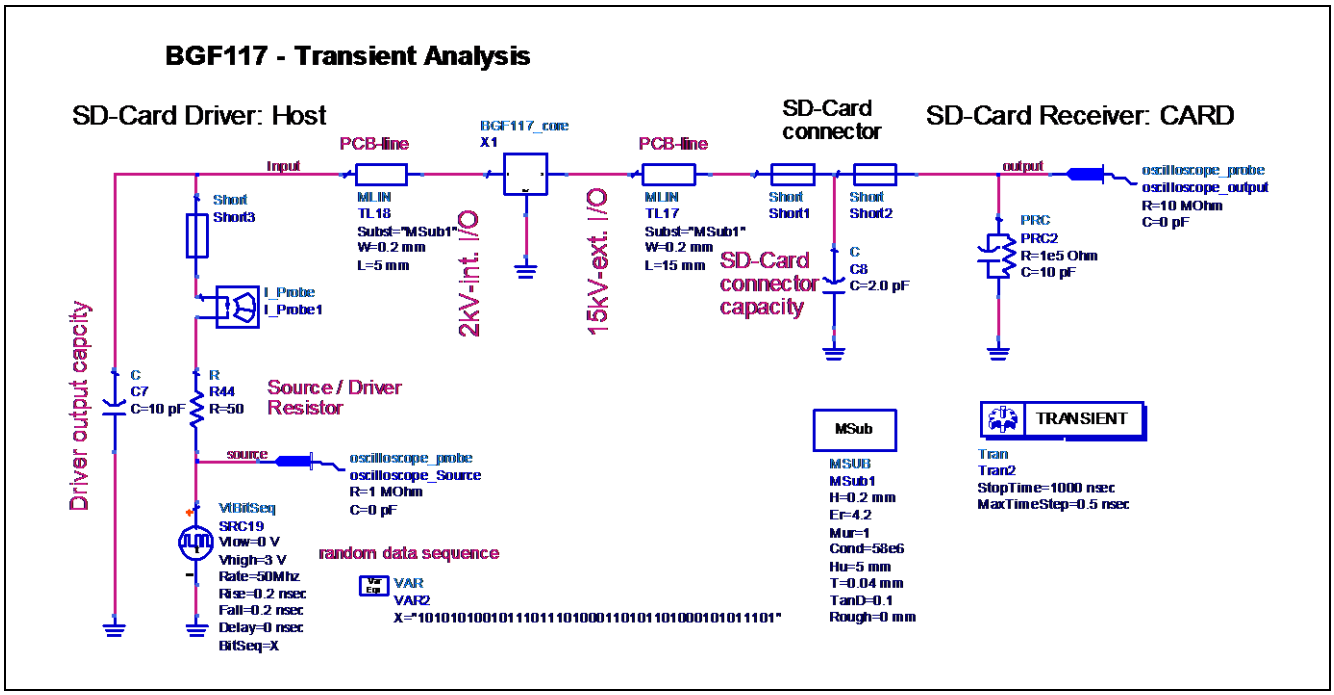

Figure 8 Time domain simulation Setup for the one SD Card data/clock link (e.g. SDClk line), including parasitic effects and EMI filter (BGF117)

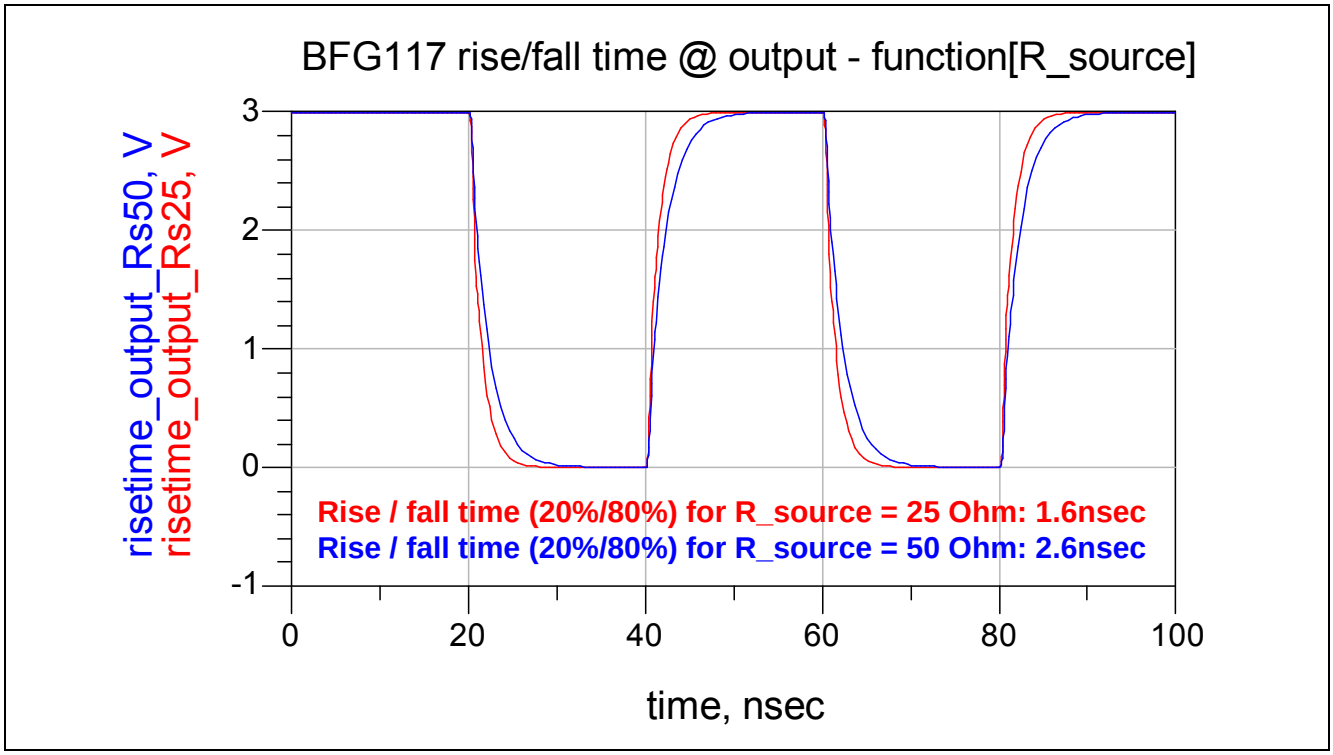

Figure 9 SDClk link transient analysis including source/load capacitance and EMI filter (BGF117)

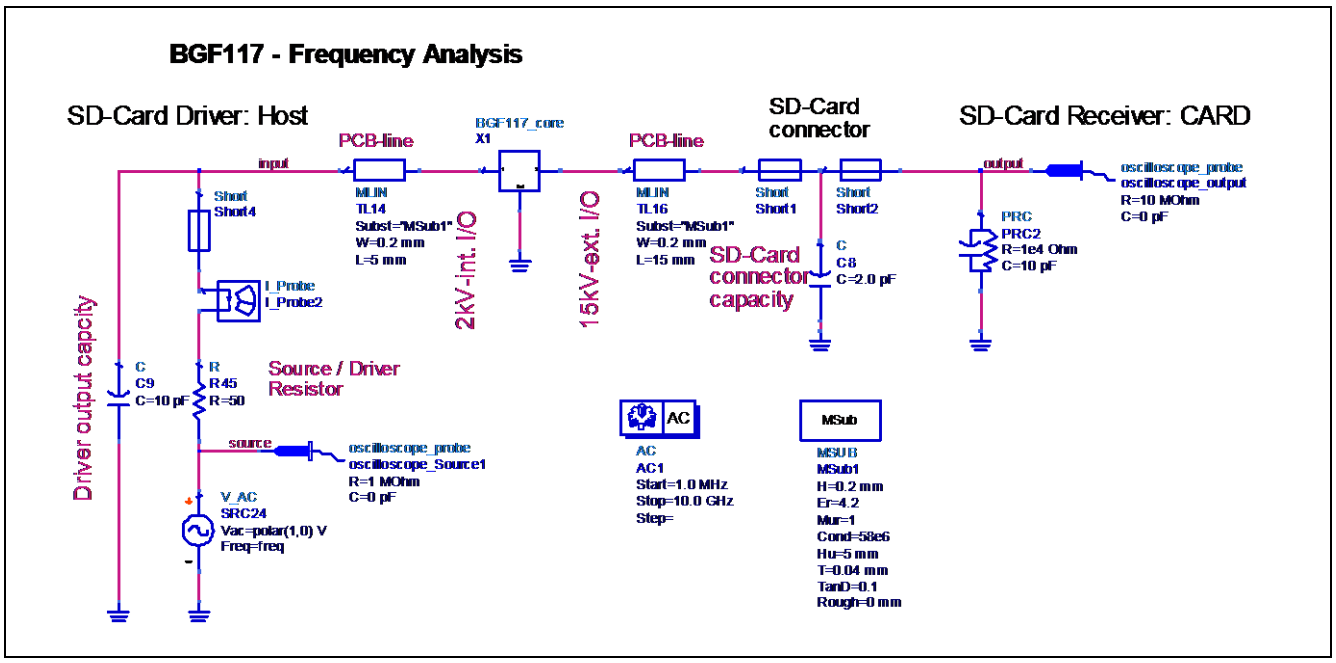

Figure 10 Frequency domain simulation Setup for the one SD Card data/clock link (e.g. SDClk line), including parasitic effects and EMI filter (BGF117)

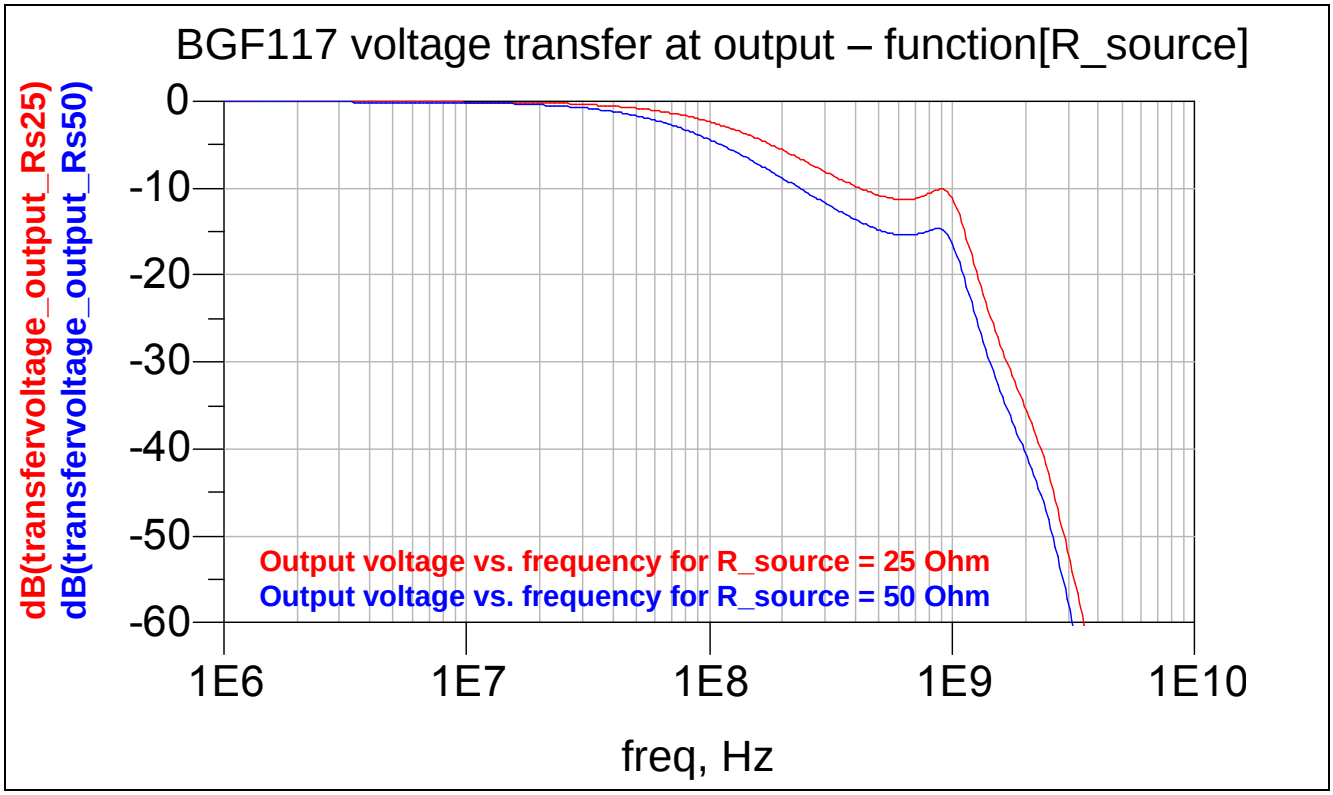

Figure 11 Entire SDClk link frequency response including EMI filter (BGF117)

4 Evaluation Board and layout Information

The BGF117 RF evaluation board is available from Infineon and is especially designed to measure and evaluate the RF and ESD performance of the BGF117.

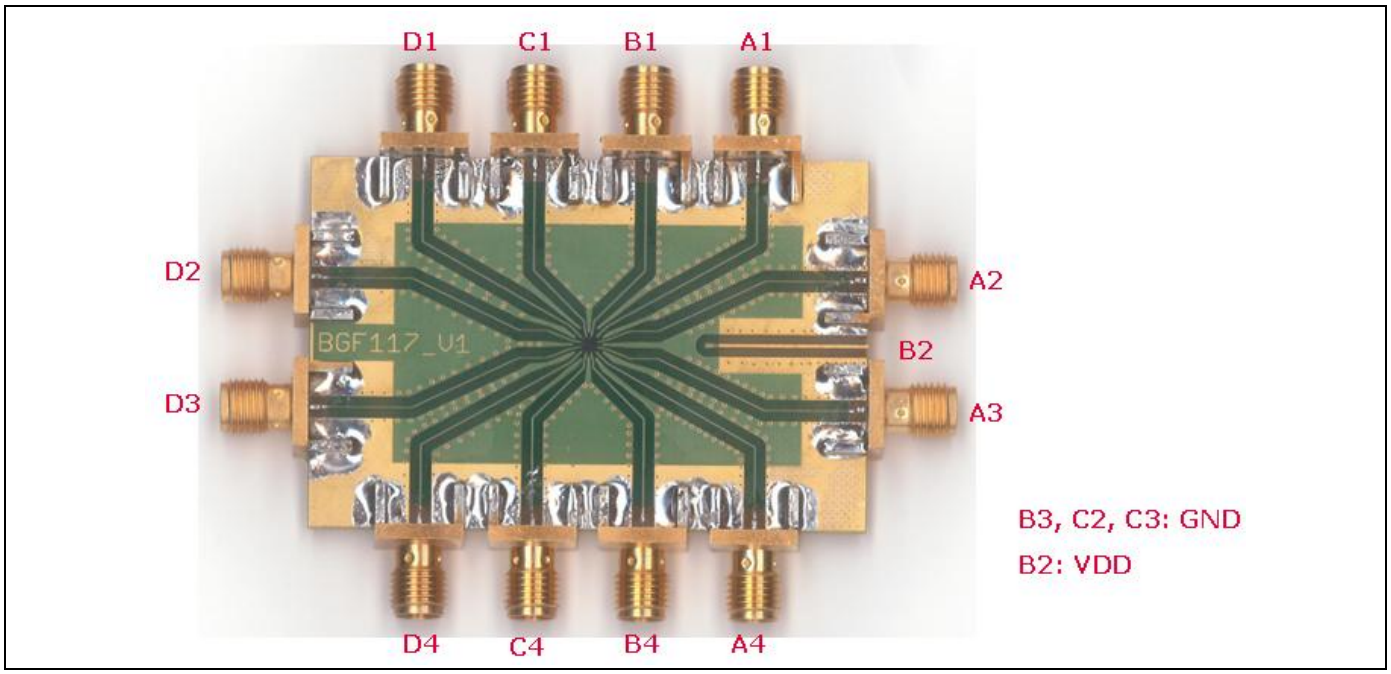

Figure 12 BGF117 RF Evaluation Board

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