ESD205-B1, ESD206-B1 and ESD207-B1 Diodes

General Purpose and Audio ESD Protection with Infineon Ultra-Low Dynamic Resistance TVS Diodes

Application Note AN277

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RF and Protection Devices

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Previous Revision: Rev. 1.1

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1 Overview

Infineon's ESD205-B1, ESD206-B1 and ESD207-B1 are bidirectional general purpose TVS diode series.

ESD205-B1 diode series

The ESD205-B1 is a bidirectional ultra low clamping voltage device suited to protect applications with a maximum working voltage of ±5.5V. With its very low dynamic resistance of less than 0.3Ohm and a resulting clamping voltage of 10V @ 8kV IEC61000-4-2 the ESD205-B1 is able to protect highly sensitive digital and analog interfaces. The line capacitance of 4pf provides a 3dB bandwith of 530MHz. The diodes of this series are available in diminute TSSLP-2-x package (0.6x0.3x0.3mm, EIA 0201) as ESD205-B1-02ELS and in TSLP-2-x package (1.0x0.6x0.3mm, EIA 0402) as ESD205-B1-02EL respectively.

ESD206-B1 diode series

The ESD206-B1 is a bidirectional ultra low clamping voltage device suited to protect applications with a maximum working voltage of ± 5.5V. With its ultra low dynamic resistance of only 0.13Ohm and a resulting clamping voltage of 8V @ 8kV IEC61000-4-2 the ESD206-B1 is able to protect highly sensitive digital and analog interfaces. The line capacitance of 12pf provides a 3dB bandwith of 400MHz. The diodes of this series are available in diminute TSSLP-2-x package (0.6x0.3x0.3mm, EIA 0201) as ESD206-B1-02ELS as well as in TSLP-2-x package (1.0x0.6x0.3mm, EIA 0402) as ESD206-B1-02EL and in SC79 package as ESD206-B1-02V respectively.

ESD207-B1 diode series

The ESD207-B1 is bidirectional ultra low clamping voltage device suited to protect applications with a maximum working voltage of ±3.3V. With its very low dynamic resistance of less than 0.2Ohm and a resulting clamping voltage of 7.7V @ 8kV IEC61000-4-2 the ESD207-B1 series is able to protect highly sensitive digital and analog interfaces. The line capacitance of 14pF provides a 3dB bandwith of 450 MHz. The diodes of this series are available in diminute TSSLP-2-x package (0.6x0.3x0.3mm, EIA 0201) as ESD207-B1-02ELS and in TSLP-2-x package (1.0x0.6x0.3mm, EIA 0402) as ESD207-B1-02EL respectively.

Figures 1, 2 and 3 show the Transmission Line Pulse Measurement (TLP) and dynamic resistance.

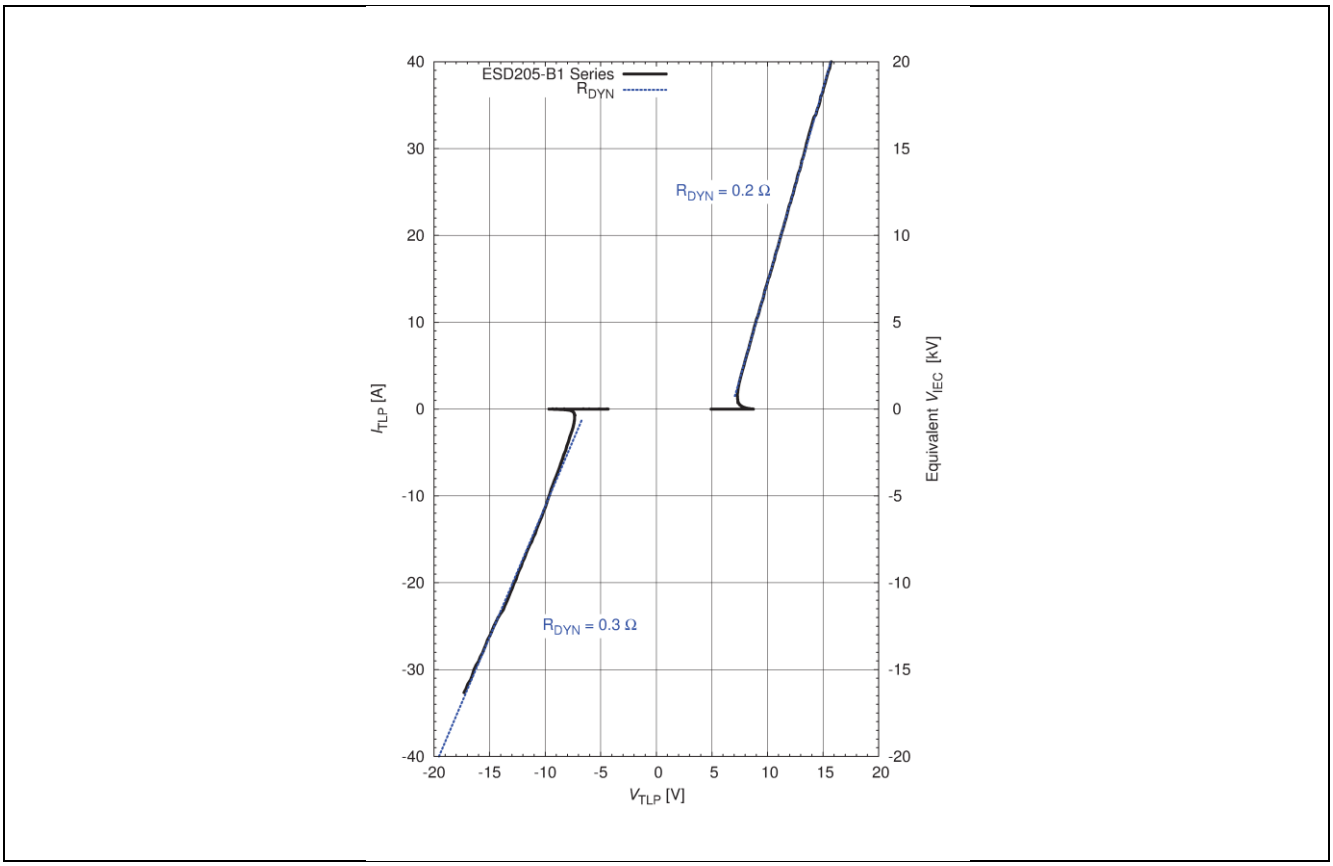

Figure 1 ESD205-B1 TLP Results

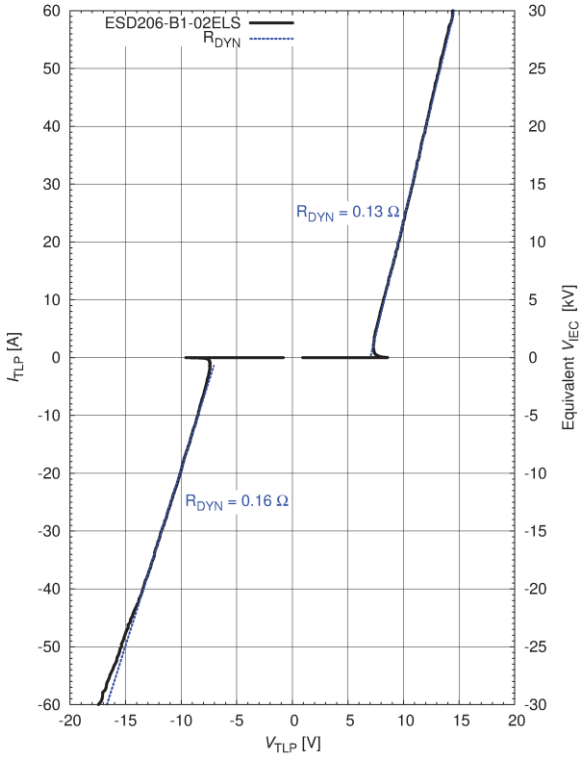

Figure 2 ESD206-B1 TLP Results

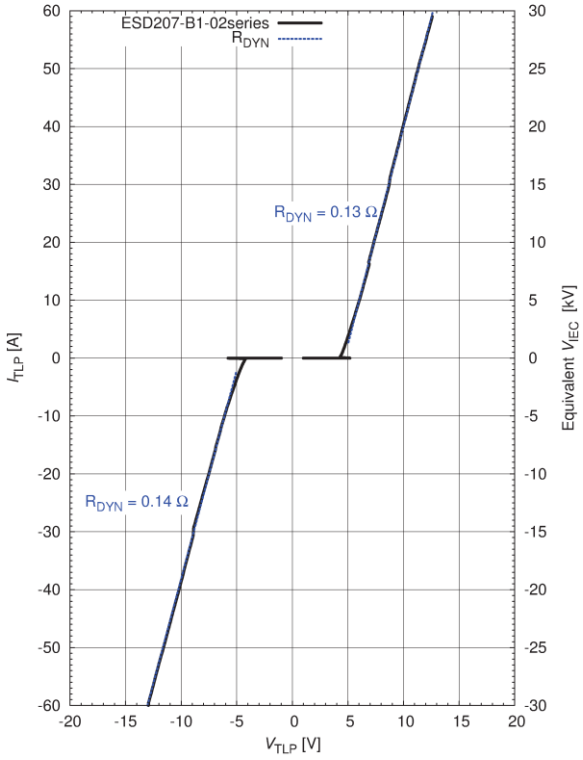

Figure 3 ESD207-B1 TLP Results

1.1 Unidirectional vs. Bidirectional

The ESD205-B1, ESD206-B1 and ESD207-B1 are all bidirectional TVS diodes. Unidirectional ESD diodes can only be used for interfaces where there is no negative voltage swing. If a negative voltage swing occurs the uni directional diode will start to clip the signal which leads to additional losses and harmonic generation. Nevertheless, unidirectional diodes clamp positive and negative ESD strikes as well as bidirectional diodes.

Bi-directional and symmetric TVS diodes have nearly symmetric working voltage for both polarity directions (figure 5 and 6), eg. ESD207-B1 has maximum working voltage of ±3.3V, while ESD205-B1 and ESD206-B1 have ±5.5V. Bi directional diodes shall be used when the desired data or analog signals have a positive and negative peak voltage up to their maximum reverse working voltage. For signals with applied DC offset bi directional diodes also work as long as the DC voltage plus AC peak voltage is smaller or equal to the maximum working voltage:

Vdc ± Vpeak ≤ Vrwm

Figures 4, 5 and 6 show typical usecases for uni and bi-directional ESD protection diodes.

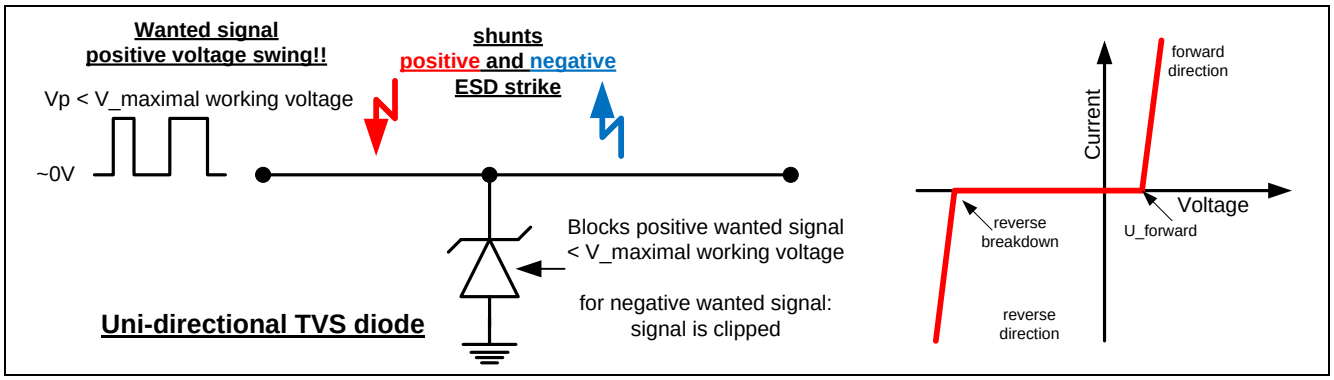

Figure 4 Unidirectional application circuits

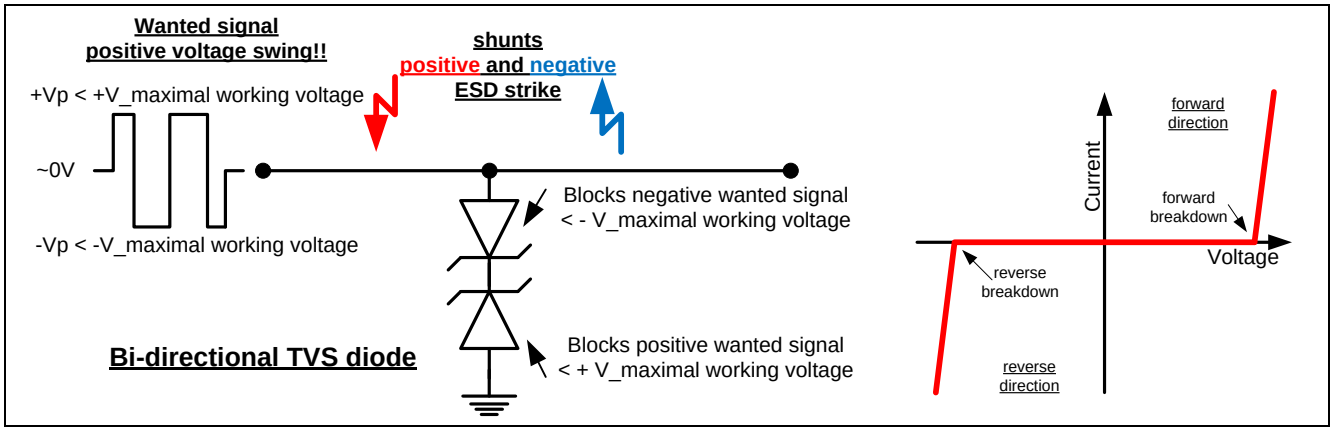

Figure 5 Bidirectional application circuits

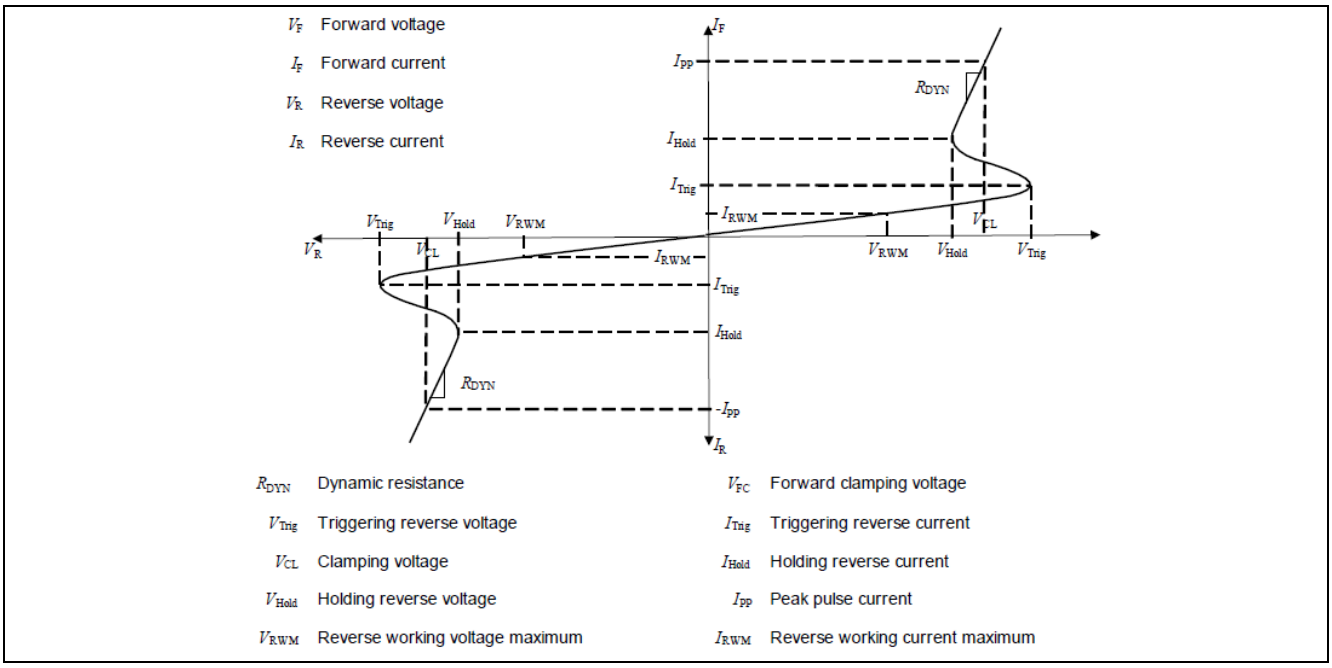

Figure 6 Electrical characteristics of a bidirectional and symmetrical Diode

2 TVS Diodes for Audio Line Driver ESD protection

External connectivity of a mobile phone is very susceptible to ESD strikes. The audio headset itself can trap the ESD strike, or the ESD strike enters the phone directly via the audio jack. For low impedance audio headset, the ear-pieces are one of the most challenging for ESD protection. On one hand power loss and audio distortion caused by the ESD protection method has to be minimized, on the other hand ESD protection has to work safely over a long life-time and over a lot of powerful ESD strikes.

Figure 7 shows the ESD protection of an audio line driver:

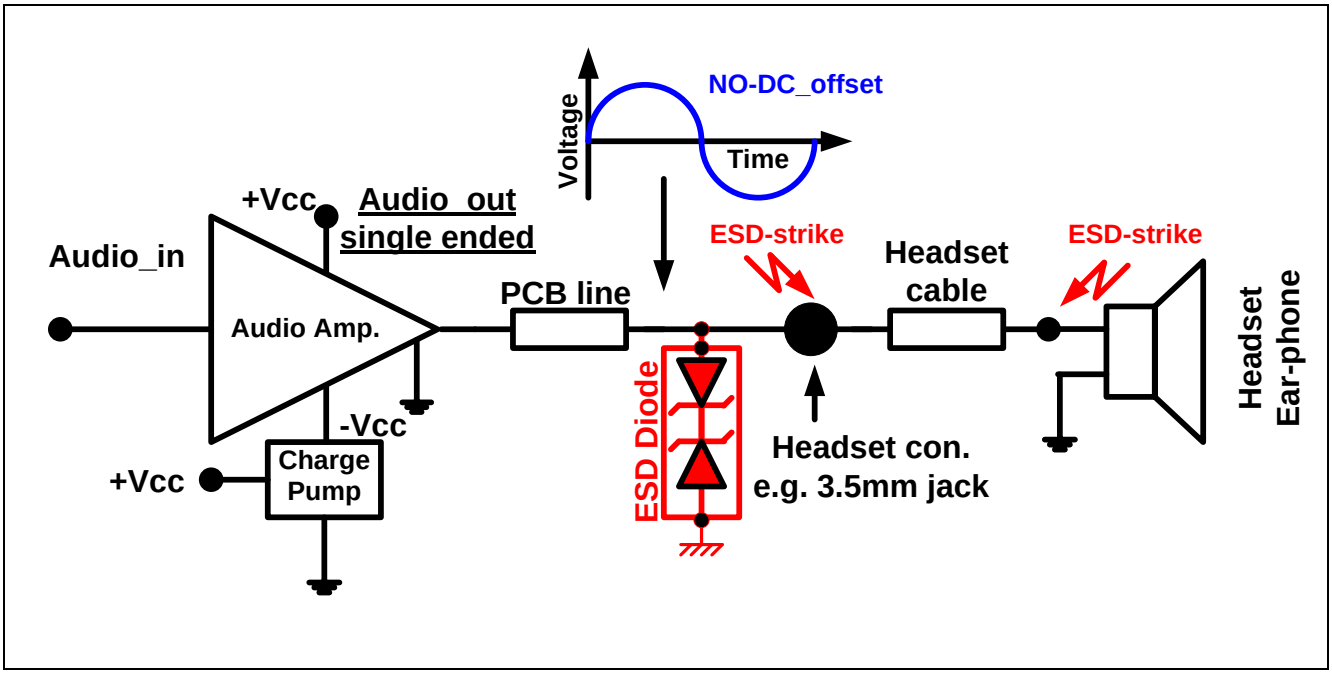

Figure 7 Typical ear-stick driver stage in the audio system

3 RF Performance and Signal Integrity

ESD protection devices must be invisible to the protected system except in case of an ESD event. The parameter to consider when choosing an ESD protection device is besides the clamping voltage the capacitance. The line capacitance of the TVS diode together with the bondwire form a series resonance circuit to ground, figure 8. Figure 9 and 10 show the insertion gain of the ESD205-B1 and the ESD207-B1. It can be seen that the lower capacitance of the ESD205-B1 has a higher cutoff frequency compared to the ESD207-B1. Below 120 MHz both diodes are invisible to the system and won't have any impact on signal integrity. An advantage of the low cut off frequency is that both diodes provide a simple EMI filter function for frequencies above 500 MHz. Furthermore with two additional passive elements a very effective EMI filter can be build up to suppress GSM and other interferres.

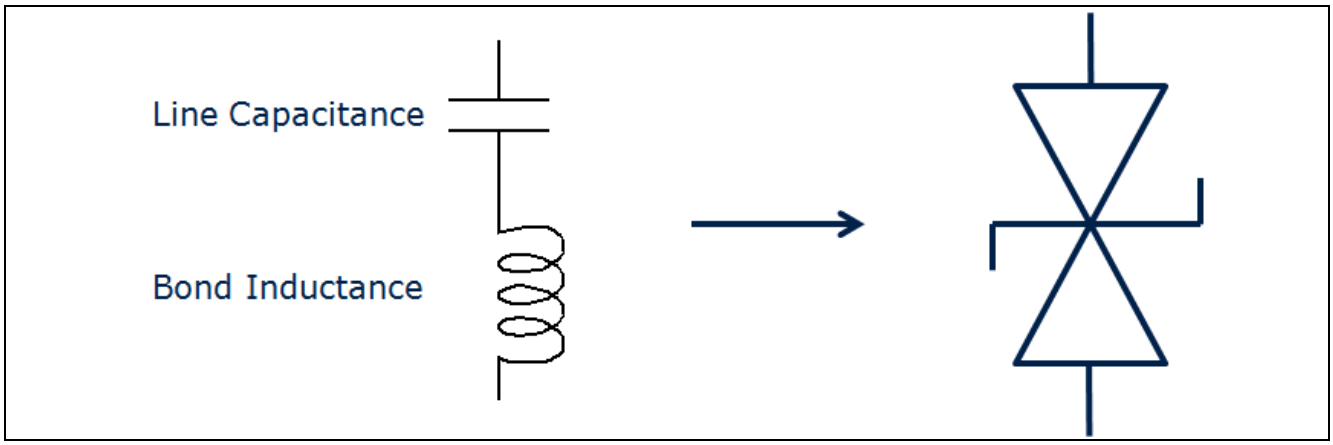

Figure 8 ESD diodes equivalent AC circuit

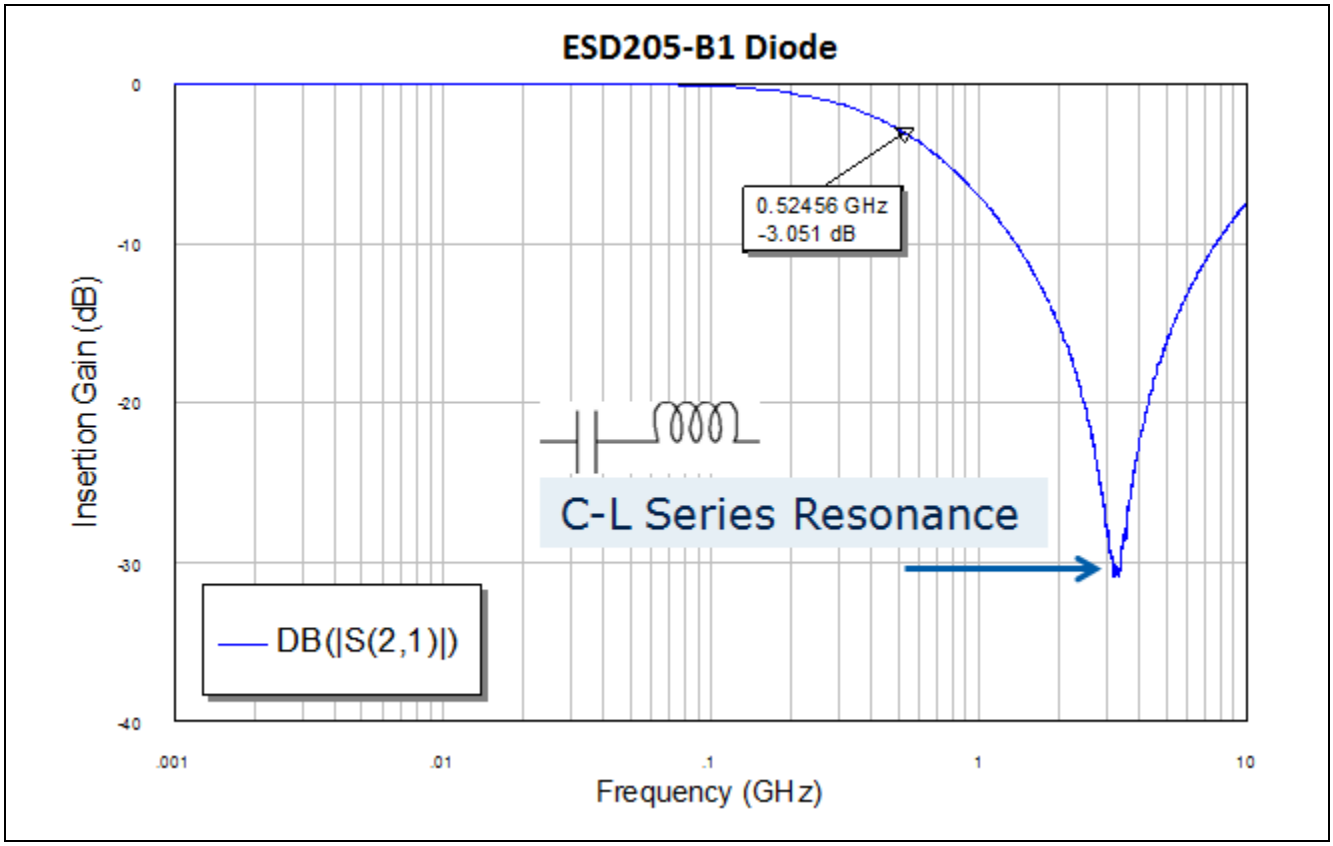

Figure 9 ESD205-B1 3dB Bandwidth

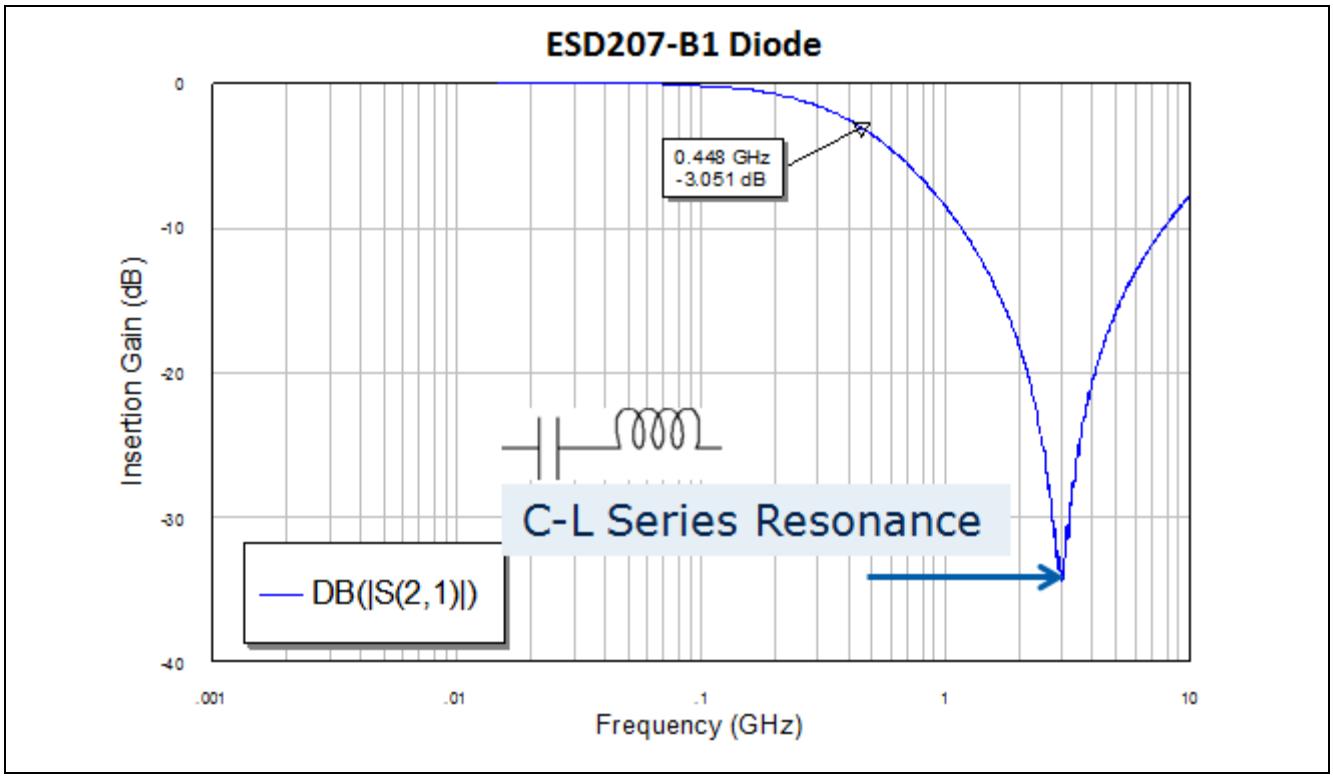

Figure 10 ESD207-B1 3dB Bandwidth

3.1 Application Example: FM Transceiver protection with GSM EMI suppression using Infineon TVS Diodes

A common feature in mobile phones is FM radio receive and transmit. The FM transmit function can be used to stream audio media content from the phone to a car radio and enables the user to listen to his stored music.

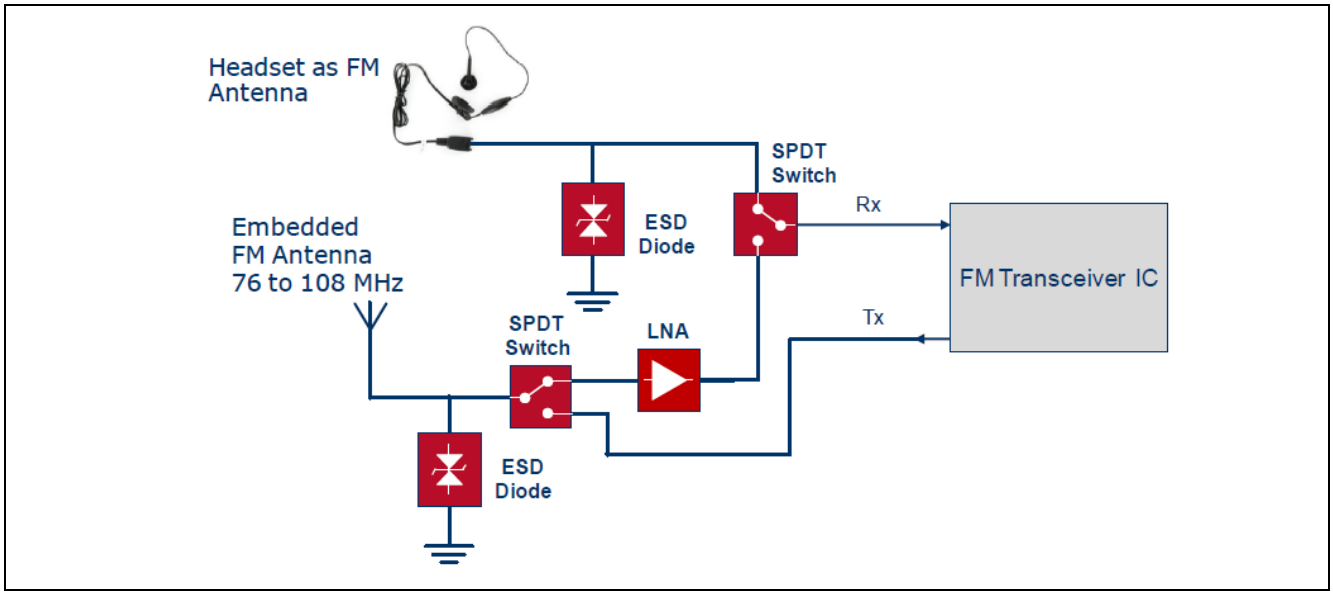

Figure 11 FM Transmit and Receive Circuit in Mobile Handset

Figure 11 shows a FM transmit and receive circuit used in mobile phones. Both devices the LNA at the receiver and the transmitter have to be protected against ESD damage. Therfore the ESD diode is directly placed in front of the transmitt and receive switch. Other problem especially on mobile phones are high power GSM interferres which couple into the receiver or transmiter path. This can lead to distortions for example by driving the LNA into

out of band compression. Another problem occurs when the FM transmitter is sending signals. The power amplifiers output signal levels can be up to 10 dBm. In a 50Ohm environment this wouldn't be an issue but in mobile handsets it is. The FM transmitter must not use an external antenna instead it has to use an internal antenna. These antennas are far away from being a quarter wave transformer and therefore from providing a 50 Ohm termination. Power amplifiers tend to generate strong harmonics when the termination is mismatched. The harmonics generated by the FM signal would interfere with other systems on the mobile handset.

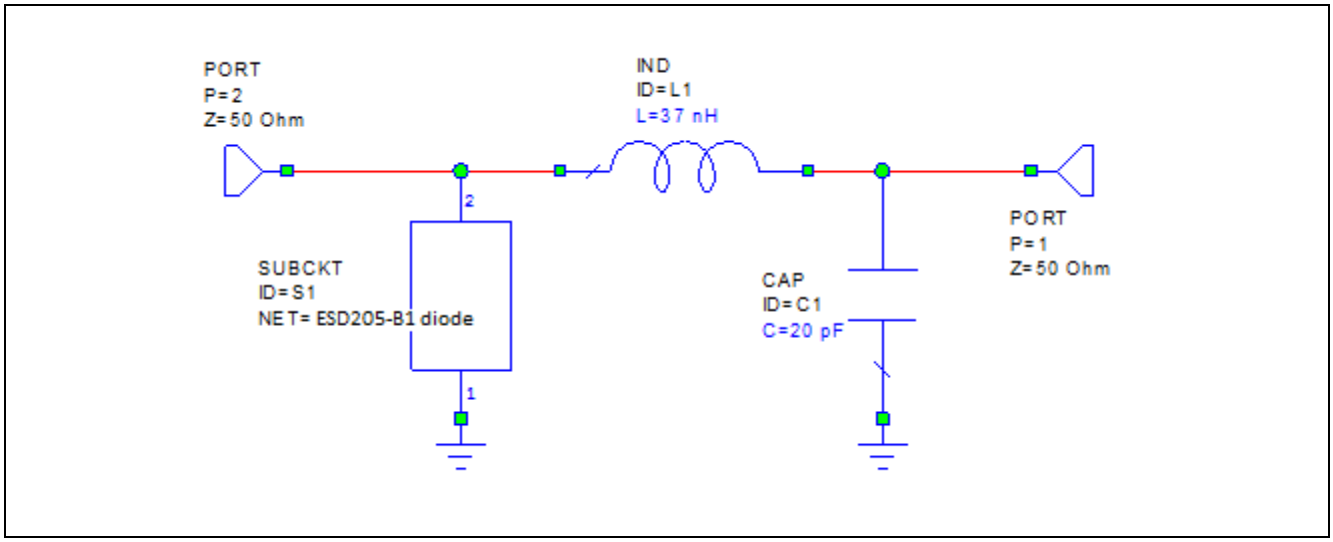

Figure 12 Low Cost High Supression EMI Filter using ESD205-B1 for FM Applications

Figure 12 shows a simple EMI filter for FM transmit and receive. It consists of the ESD205-B1, a 37nH inductor and a 20pF capacitance to form a PI lowpass filter. This simple EMI filter provides strong suppression of GSM interferres of more than 30dB as well as an improved ESD performance due to the series inductance. In case of an ESD strike an additional voltage drop will occur at the 37nH inductor and further reduce the residual clamping voltage at the LNA and FM transmitter. For applications without a need for a DC pass across the filter, further ESD protection can be implemented by a capacitor serial to the inductor. This capacitor acts as a highpass for low frequency and blocks the slow part of the residual ESD strike. Capacitance value should be about 180pF…220pF to be unvisible for the FM band. Going to lower values the inductor has to be adjusted slightly.

To avoid an ESD damage of the capacitor C1, TVS diode should be orientated towards the antenna. ESD strike faces the TVS diode first and is conducted to GND. Only the residual clamping voltage affects L1 and C1.

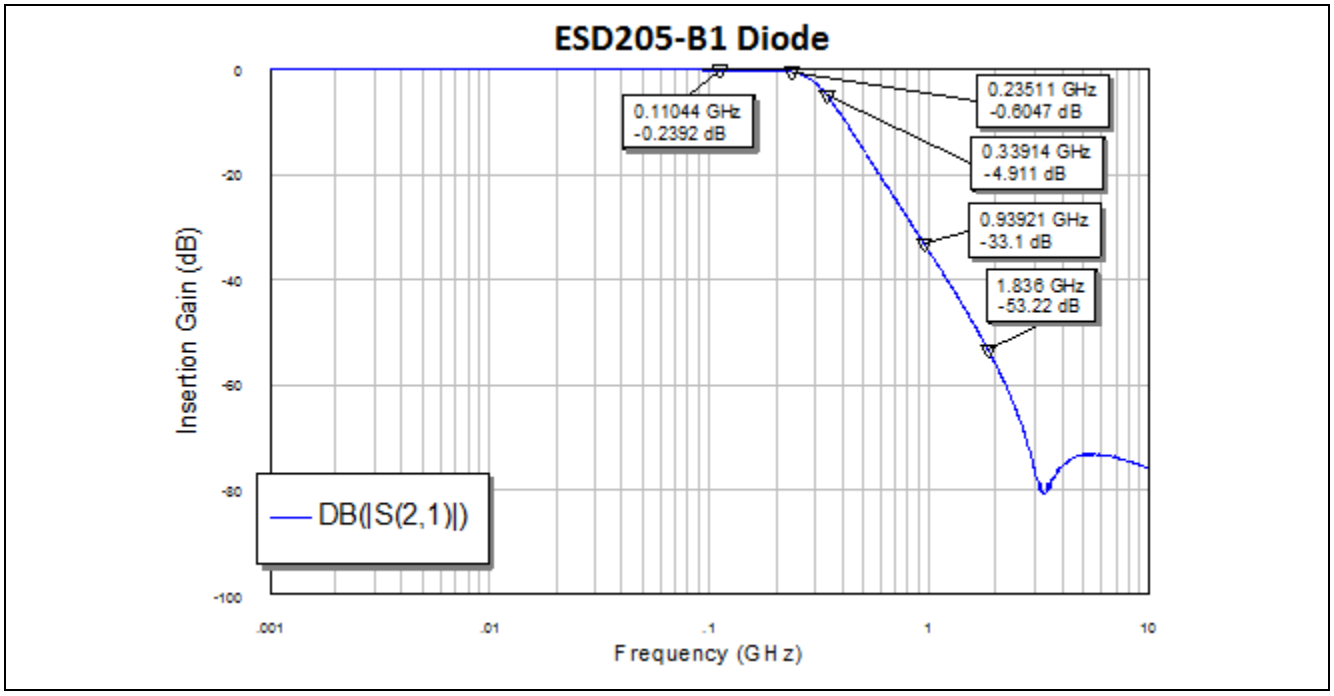

Figure 13 Insertion Gain ESD205-B1 FM TX/RX EMI Filter Application

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