Application Note No. 049

DECT Transmit - Receiver Switch Using Ultra Small PIN Diodes

RF & Protection Devices

Never stop thinking

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DECT Transmit - Receiver Switch Using Ultra Small PIN Diodes
Revision History: 2006-10-11, Rev. 2.0

Previous Version: 2000-07-28

Page	Subjects (major changes since last revision)
All	Document layout change

1 DECT Transmit - Receive Switch Using Ultra Small PIN Diodes

This application note covers a redesign of a PIN diode switch introduced in application note No. 007. It uses diodes in SCD80 and SOT343 package, 0603 size SMD components and a 0.25 mm high FR4 printed circuit board.

Advantages

- Small real estate consumption on PCB
- Power consumption in transmit-mode only
- Low component count
- Low cost

Schematic

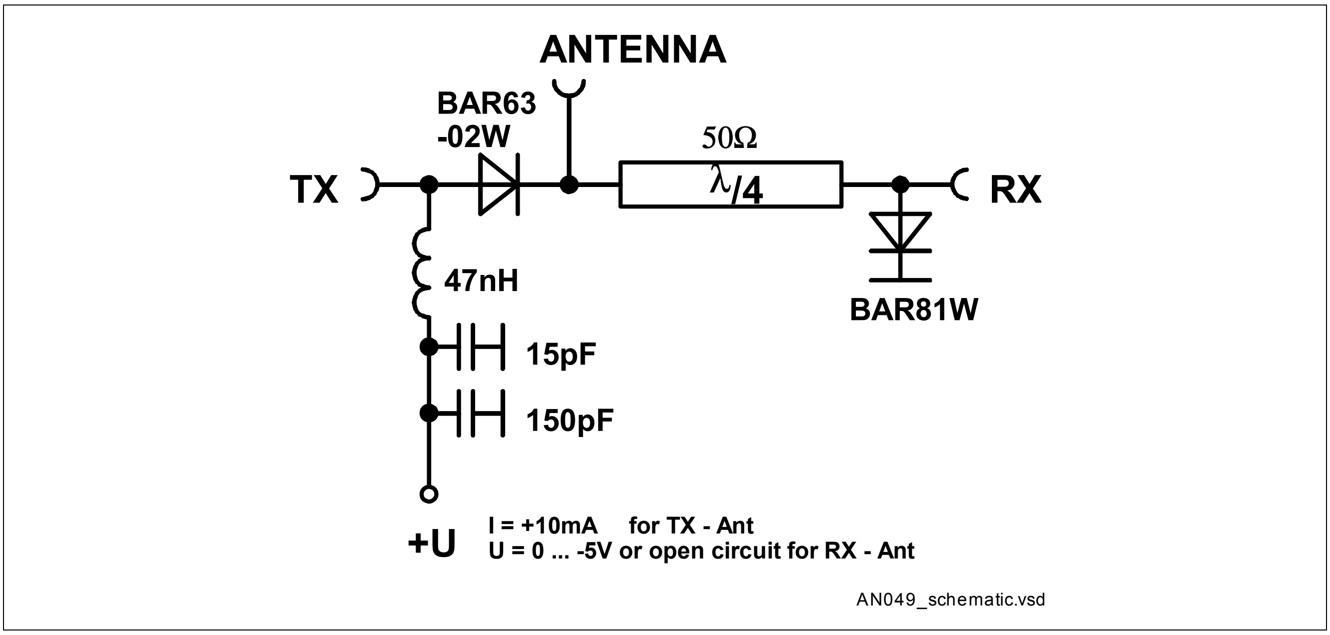

Figure 1 Schematic

Measured Data of Prototype Board

Table 1 Measured data f = 1.89 GHz

Transmit-state (I = +10 mA at +U-pin)		**Receive-state (U = -3 V at +U-pin)**	
TX-Ant. Loss	0.47 dB	RX-Ant. Loss	0.70 dB
TX-RX Isolation	29.4 dB	TX-RX Isolation	19.8 dB
RX-Ant. Isolation	29.7 dB	TX-Ant. Isolation	18.5 dB

Due to the reduced width of a 50 Ω line on the thinner PCB material the losses are slightly higher than in application note No. 007. Please note that TX-RX Isolation is improved by 3 dB in transmit-mode and more than 6 dB in receive-mode.

The applied -3 V at the +U control port for the small-signal measurement are not necessary in ‘real‘ operation. If +U is left open circuit in receive-mode, a small reverse bias is generated by the diodes, if there is still an RF signal from the transmitter.

1.1 Harmonic Distortion Measurements

Measurement Setup

TX-Port	1.9 GHz, +27 dBm power, harmonics more than 100 dB down
RX-Port	50 Ω termination
Ant.-Port	Spectrum analyzer
+U-Pin	I = 5 mA and I = 10 mA

Results

Harmonics referred to TX-Port input level (+27 dBm):

3.8 GHz	-87 dB @ I = 5 mA	-92 dB @ I= 10 mA
5.7 GHz	> -100 dB @ I = 5 mA	> -100dB @ I = 10 mA

Note: All ports must be DC-blocked during measurements

Realization

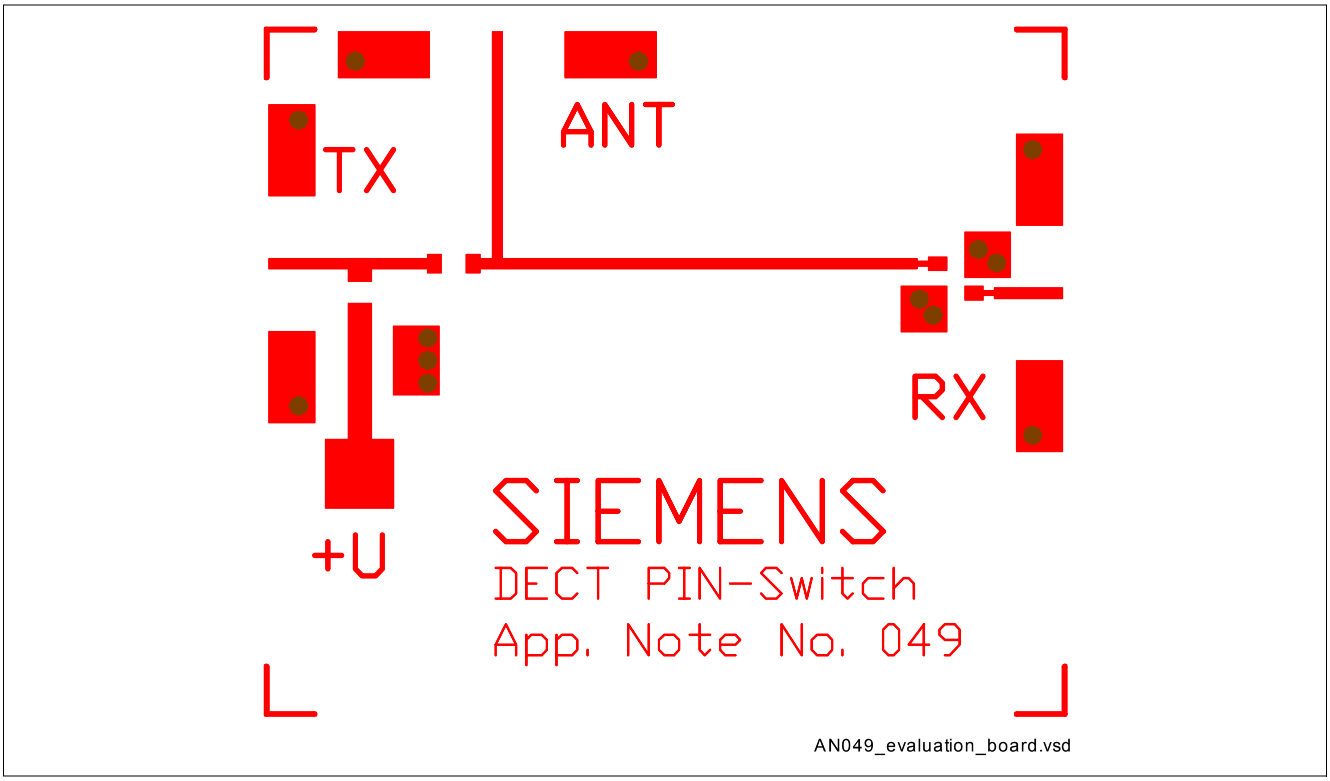

Figure 2 Evaluation Board

Board size: 35 mm x 30 mm, Scale: 3:1

The demo board was made of 0.25 mm FR4 Epoxy material

Component placement

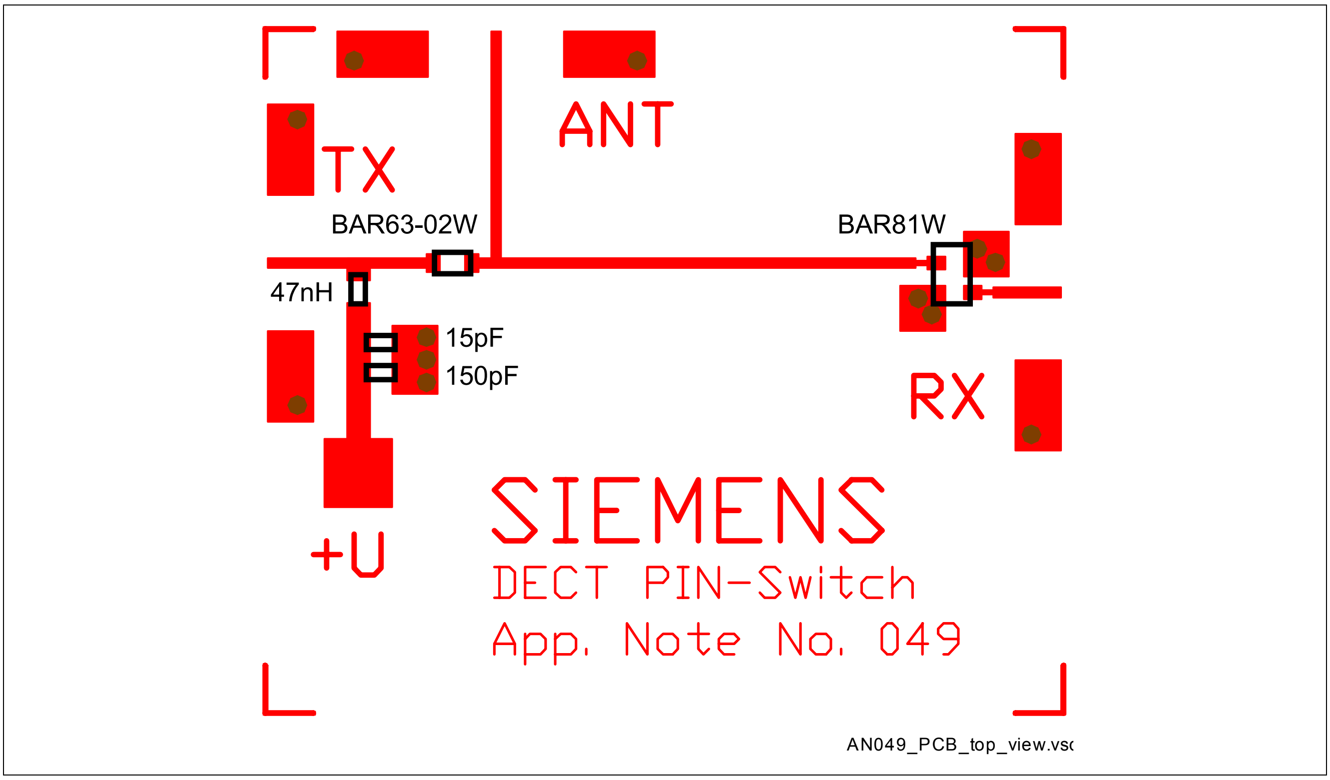

Figure 3 Top view on assembled PCB

Part list

Table 2 Part list

BAR81W	PIN diode	SOT343	Infineon
BAR63-02W	PIN diode	SCD80	Infineon
15 pF	Capacitor	0603	S+M
150 pF	Capacitor	0603	S+M
47 nH	Inductor	0603	S+M
Printed circuit board		FR4, 0.25 mm	Div.

Numeric computation

This circuit was developed using Microwave Harmonica V 7.0. To compute the frequency response of the circuit the freely distributed S-Parameter files of the Infineon diodes were used. For the SMD inductor a simple parallel equivalent circuit was developed.

Circuit file for simulation

```
*******************************************************************
* INFINEON SMALL SIGNAL SEMICONDUCTORS
* APPLICATION NOTE NO. 049
* DECT T/R-SWITCH WITH BAR81W/BAR63-02W
*******************************************************************
*                ANT
*               PORT 2
*                 O
*                 |
*          |\ |   |  +----------------------+
*    TX  O--| >|--O--|       LAMBDA/4       |------O-----O    RX
*  PORT 1  |/ |      +----------------------+      |        PORT 3
*         BAR63                                  +-----+
*         -02W                                    \   /
*                                    BAR81W        \ /
*                                                ---+---
*                                                   |
*                                                ---+---   GND
*  SUBSTRATE MATERIAL:
*  FR4, H=0.25MM, T=0.018MM, ER=4.4, TAND=0.024
*******************************************************************
*  NOV. 1997   J.P. Schaffer
*******************************************************************
```

AN049_simulation_file1.vsd

Figure 4 Simulation file 1

```
LL:   18.3MM
WAP:  0.46MM
W50:  0.46MM
WM:   0.20MM     ; Width of match
PM:   0.50MM     ; Length of match

BLK
   STEP    1   43       W1=WAP    W2=WM              SUB
   TRL    43   44       W=WM      P=PM               SUB
   STEP   44   45       W1=WM     W2=0.6MM           SUB
   TRL    45   60       W=0.6MM   P=0.4MM            SUB
   OST    60            W=0.6MM   P=0.4MM            SUB
   CAP    60    0       C=50fF
   TWO    60   70   80  B81OF                        ; BAR81W OFF ST
   OST    70            W=0.6MM   P=0.4MM            SUB
   CAP    70    0       C=50fF
   TRL    80   81       W=1MM     P=1MM              SUB
   VIA    81            D=0.5MM                      SUB
   TRL    80   82       W=1MM     p=1MM              SUB
   VIA    82            D=0.5MM                      SUB
   TRL    70   71       W=0.6MM   P=0.8MM            SUB
   STEP   71   72       W1=0.6MM  W2=WM              SUB
   TRL    72   73       W=WM      P=PM               SUB
   STEP   73    2       W1=WM     W2=W50             SUB
   S_OFF:  2POR    1   2
END
```

AN049_simulation_file2.vsd

Figure 5 Simulation file 2

```
BLK
    STEP   1  43       W1=WAP   W2=WM              SUB
    TRL   43  44       W=WM     P=PM               SUB
    STEP  44  45       W1=WM    W2=0.6MM           SUB
    TRL   45  60       W=0.6MM  P=0.4MM            SUB
    OST   60           W=0.6MM  P=0.4MM            SUB
    CAP   60   0       C=50fF
    TWO   60  70  80   B81ON                      ; BAR81W ON STATE
    OST   70           W=0.6MM  P=0.4MM            SUB
    CAP   70   0       C=50fF
    TRL   80  81       W=1MM    P=1MM              SUB
    VIA   81           D=0.5MM                     SUB
    TRL   80  82       W=1MM    p=1MM              SUB
    VIA   82           D=0.5MM                     SUB
    TRL   70  71       W=0.6MM  P=0.8MM            SUB
    STEP  71  72       W1=0.6MM W2=WM              SUB
    TRL   72  73       W=WM     P=PM               SUB
    STEP  73   2       W1=WM    W2=W50             SUB
    S_ON:  2POR  1  2
END

BLK     ; SWITCH IN RECEIVE-MODE: TX-ANT OFF, RX-ANT ON
    TRL    1   7       W=W50    P=4MM              SUB
    TRL    7  10       W=W50    P=3MM     SUB
    IND    7   8       L=47nH                    ; Equivalent circuit of
    RES    8   0       R=2.0                     ; 47nH S+M 0603 SMD inducto
    CAP    7   0       C=140fF                   ; in parallel resonance
    OST   10           W=W50    P=0.6MM            SUB
    ONE   10  20       B63OF                      ; BAR63-02W OFF STATE
    OST   20           W=W50    P=0.6MM            SUB
    TRL   20  30       W=W50    P=0.54MM           SUB
    TEE   30  40  50   W1=W50   W2=WAP   W3=W50    SUB
    TRL   50   2       W=W50    P=10MM             SUB
    TRL   40  42       W=WAP    P=LL               SUB
    S_OFF 42  75                                 ; Shunt Diode ON-State
    TRL   75   3       W=W50    P=3MM              SUB
    RXAN:  3POR  1  2  3                          ; 1=TX  2=ANT  3=RX
END
```

AN049_simulation_file3.vsd

Figure 6 Simulation file 3

```
BLK      ; SWITCH IN TRANSMIT-MODE: TX-ANT ON, RX-ANT OFF
   TRL     1    7       W=W50     P=4MM               SUB
   TRL     7   10       W=W50     P=3MM     SUB
   IND     7    8       L=47nH                      ; Equivalent circuit of
   RES     8    0       R=2.0                       ; 47nH S+M 0603 SMD inducto
   CAP     7    0       C=140fF                     ; in parallel resonance
   OST    10            W=W50     P=0.6MM             SUB
   ONE    10   20       B63ON                         ; BAR63-02W ON STATE
   OST    20            W=W50     P=0.6MM             SUB
   TRL    20   30       W=W50     P=0.54MM            SUB
   TEE    30   40   50  W1=W50    W2=WAP   W3=W50     SUB
   TRL    50    2       W=W50     P=10MM              SUB
   TRL    40   42       W=WAP     P=LL                SUB
   S_ON   42   75                                   ; Shunt Diode OFF-State
   TRL    75    3       W=W50     P=3MM               SUB
   TXAN:   3POR  1  2  3                              ; 1=TX  2=ANT  3=RX
END

FREQ
   STEP    100MHZ   3GHZ    10MHZ
END

DATA
   SUB:  MS  H=0.25MM  ER=4.4  TAND=0.024  MET1=CU 18UM
   B81OF:DUMMY                 FILE=MU5V00U0.S2P
   B81ON:DUMMY                 FILE=MUV0010M.S2P
   B63OF:DUMMY                 FILE=PT5V00U0.S1P
   B63ON:DUMMY                 FILE=PTV0010M0.S1P
END
```

AN049_simulation_file4.vsd

Figure 7 Simulation file 4

Computation and measurement results

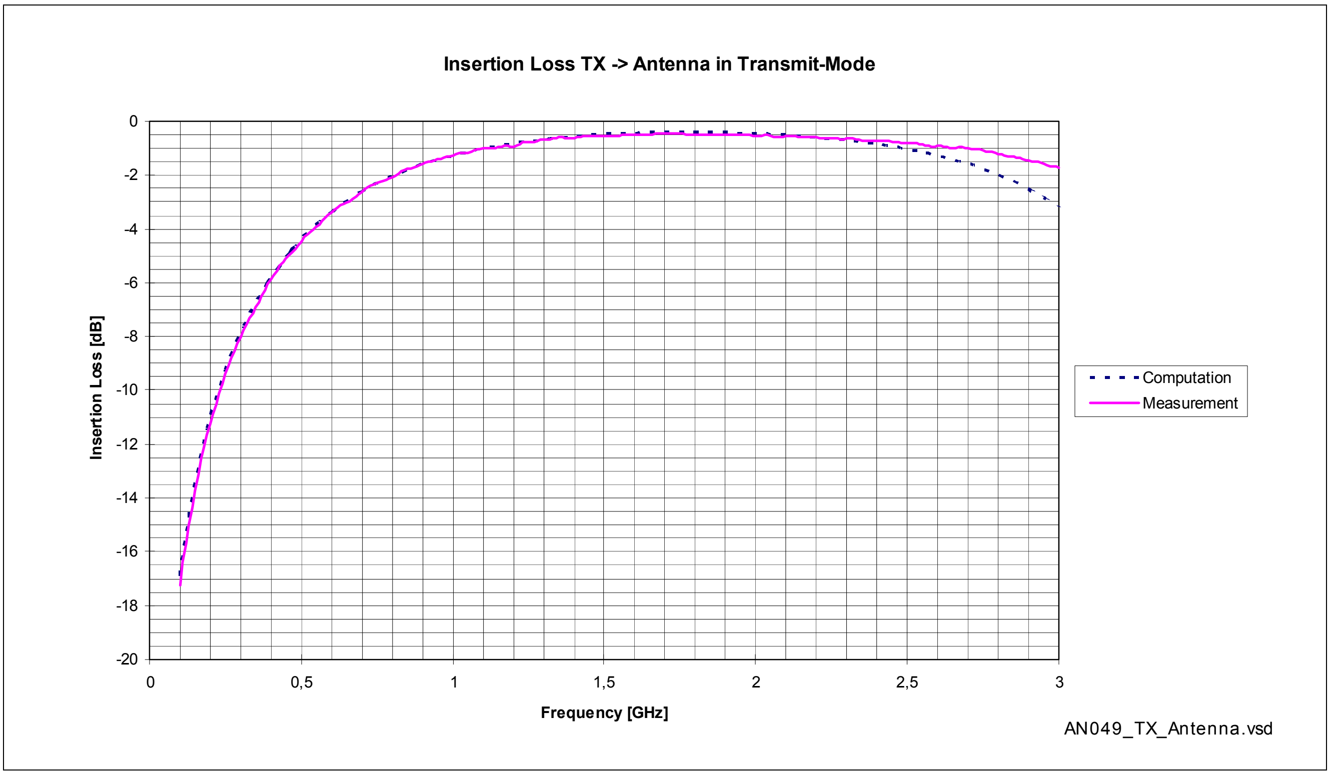

Figure 8 **Insertion Loss TX → Antenna in Transmit-Mode**

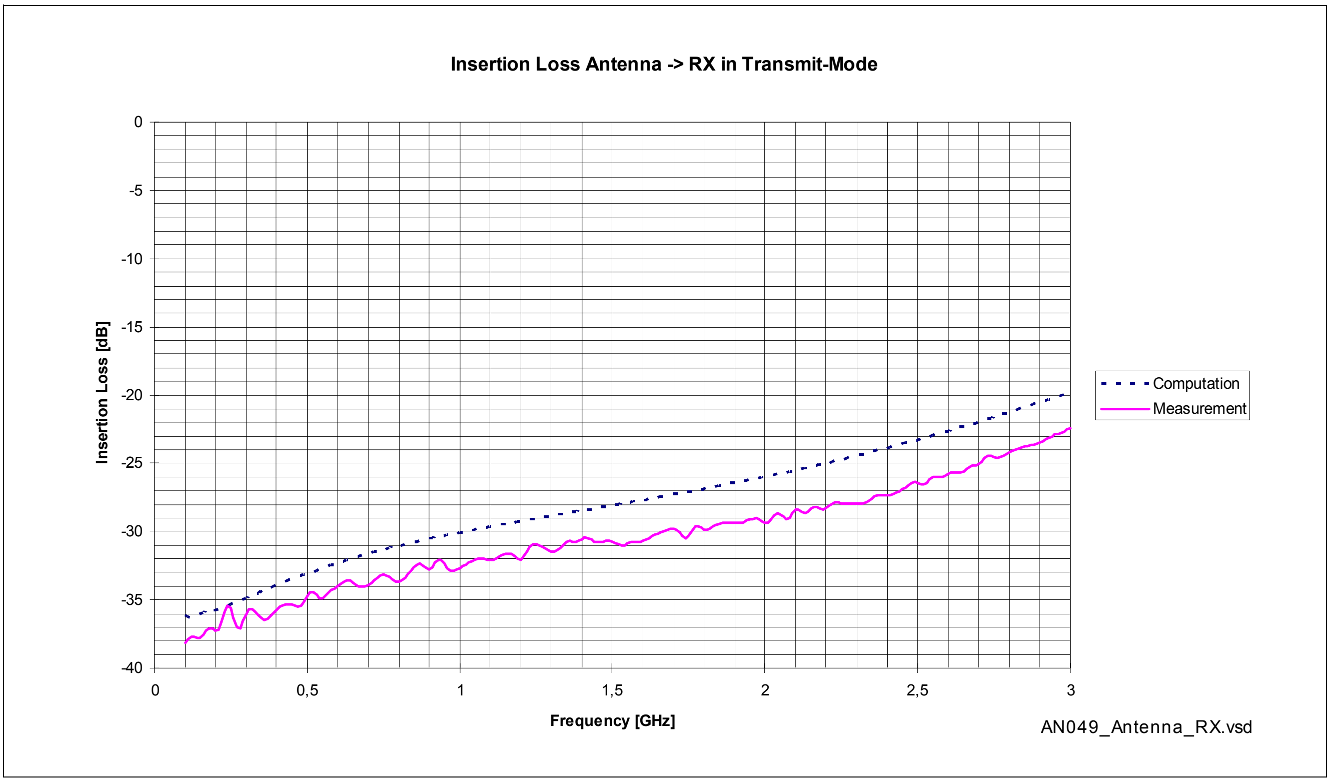

Figure 9 **Insertion Loss Antenna → RX in Transmit-Mode**

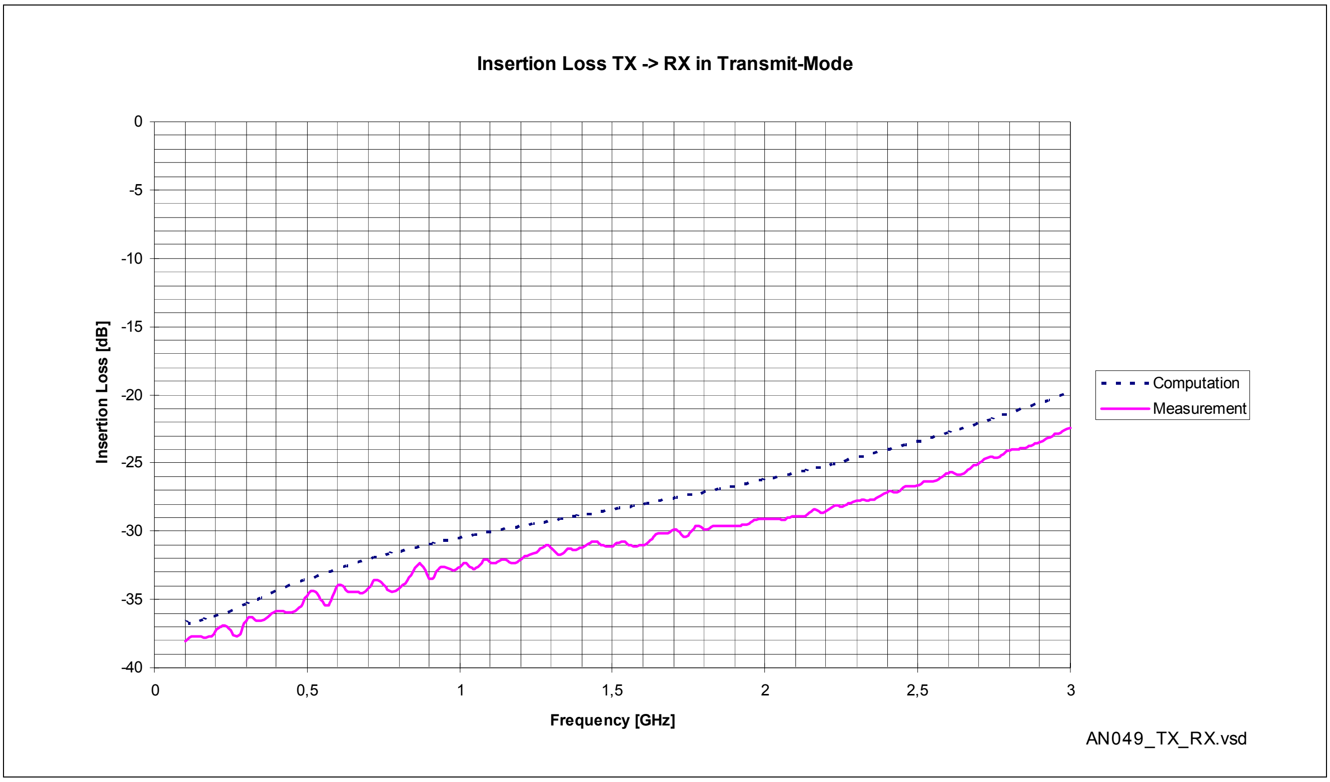

Figure 10 Insertion Loss TX → RX in Tranmit-Mode

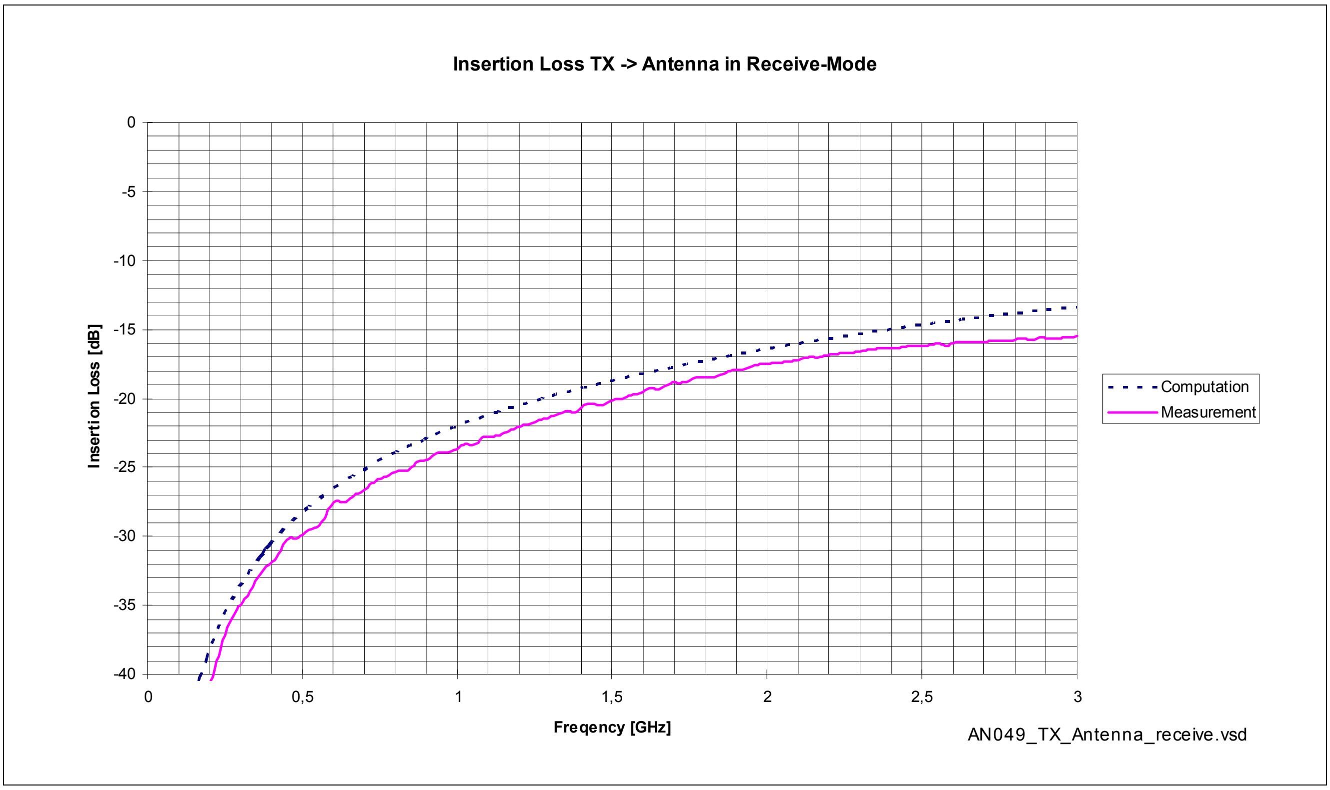

Figure 11 Insertion Loss TX → Antenna in Receive-Mode

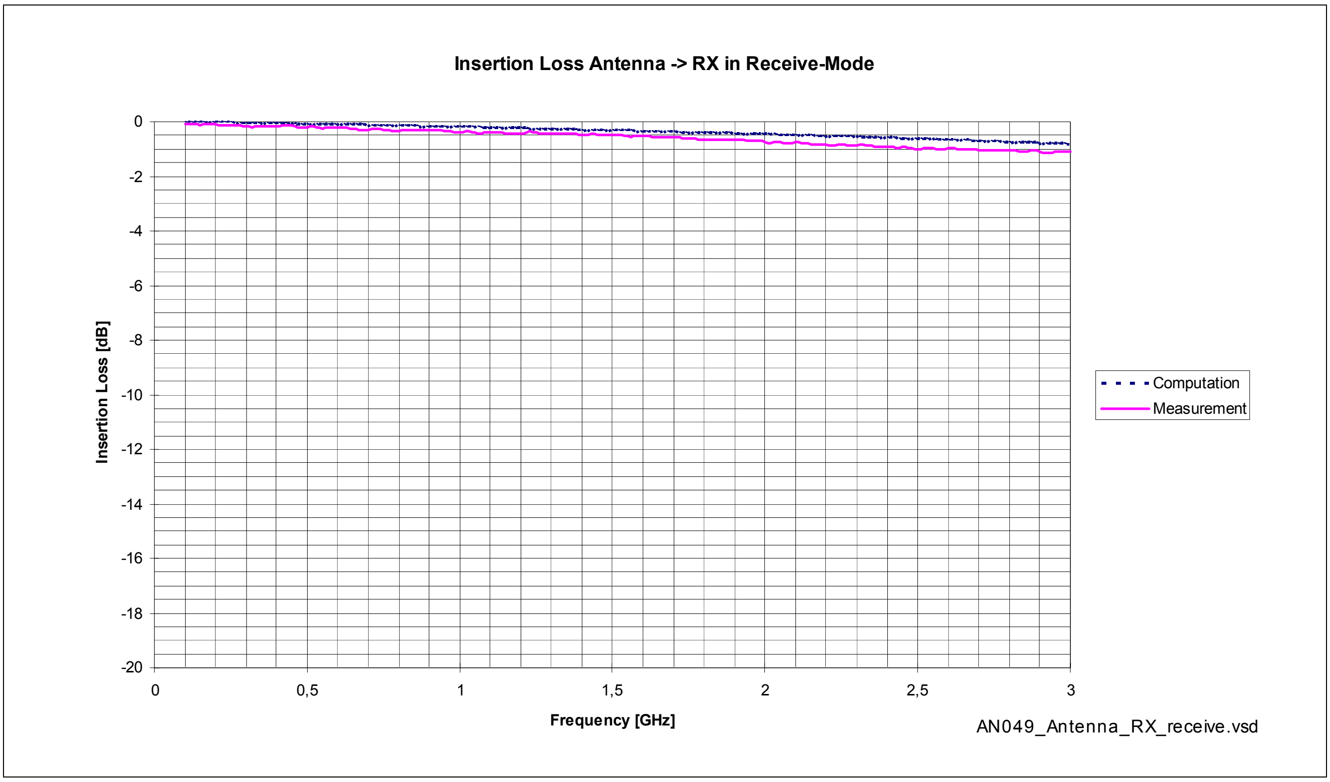

Figure 12 Insertion Loss Antenna → RX in Receive-Mode

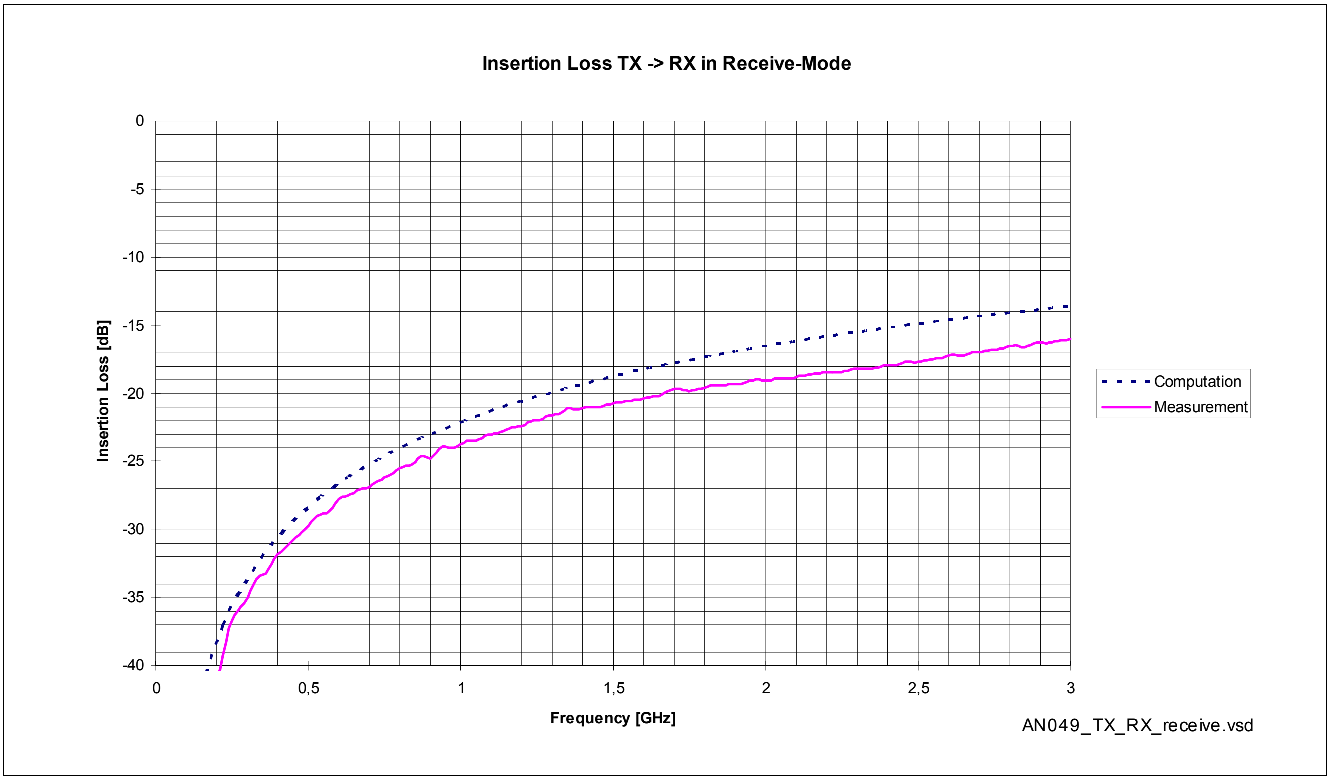

Figure 13 Insertion Loss TX → RX in Receive-Mode

The computed isolation parameters are worse than measured. This is due to the dielectric losses of the material, which seem to be lower than assumed for simulation.