

# Application Note No. 007

DECT (1.9 GHz) Transmit - Receive PIN-Diode  
Switch

RF & Protection Devices



Never stop thinking

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**DECT (1.9 GHz) Transmit - Receive PIN-Diode Switch**

**Revision History: 2006-10-10, Rev. 2.0**

**Previous Version: 2000-07-27**

<b>Page</b>	<b>Subjects (major changes since last revision)</b>
All	Document layout change

## DECT (1.9 GHz) Transmit - Receive PIN-Diode Switch

## 1 DECT (1.9 GHz) Transmit - Receive PIN-Diode Switch

DECT cordless telephones operate at frequencies between 1880 MHz and 1900 MHz. The TDMA system employed requires a non mechanical transmit-receive switch to connect the antenna to the receiver or transmitter in the required time slots. Due to the maximum EIRP of + 24 dBm this switch has to handle up to half a watt RF-power with sufficient isolation to the receiver input to avoid damage to the LNA.

The PIN diode switch configuration shown here has the following advantages:

- No power consumption in receive state, only 3 - 10 mA in transmit state
- No negative voltage and no voltage > 2.7 V required
- Low component count
- Low cost

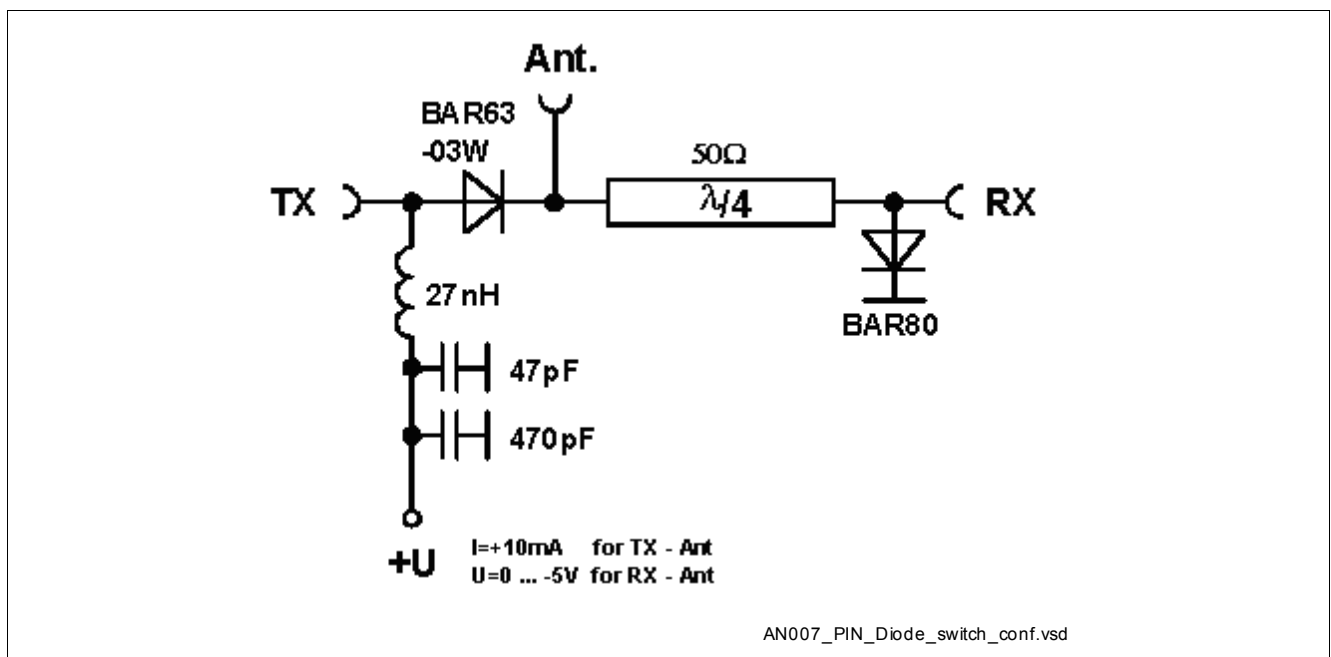


Figure 1 PIN diode switch configuration

Table 1 Data measured on prototype board @  $f = 1.89$  GHz

Transmit-state ( $I = +10$ mA at + U-pin)		Receive-state ( $U = 0 \dots -3$ V at +U-pin)	
TX-Ant. Loss	0.4 dB	RX-Ant. Loss	0.45 dB
TX-RX Isolation	26 dB	TX-RX Isolation	13 dB
RX-Ant. Isolation	24 dB	TX-Ant. Isolation	19 dB

## 2 Harmonic Distortion Characteristics Measurements

### 2.1 Measurement Setup

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

### 2.2 Results

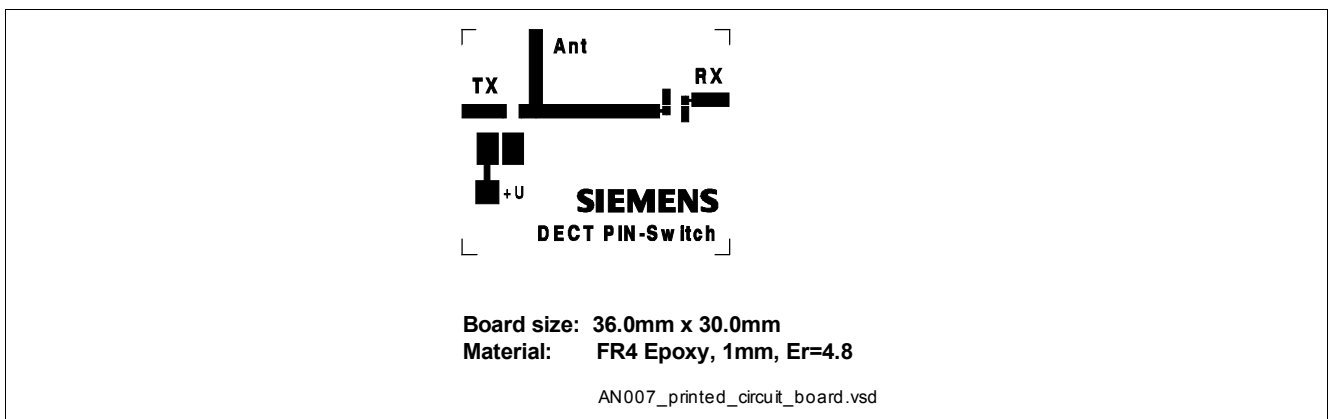
Harmonics referred to TX-Port input level (+27 dBm)

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

**Attention: All ports must be DC-blocked during measurements**

### 2.3 Realization

For practical realization, a printed circuit board on 1 mm Epoxy FR4 material was developed. Simulation has been performed with COMPACT SOFTWARE Microwave Harmonica PC V6.0.



**Figure 2** Printed circuit board: (scale: 1:1)

Harmonic Distortion Characteristics Measurements

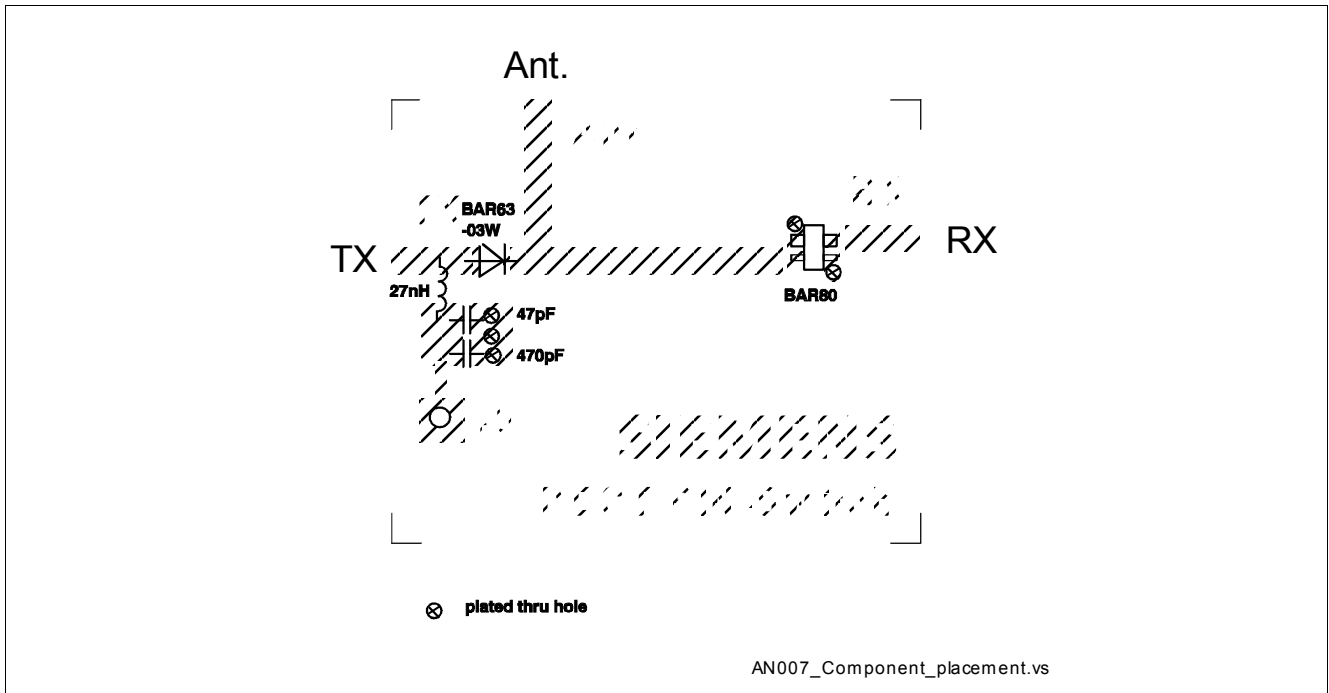


Figure 3 Component placement

Table 2 Part List

BAR80	PIN diode	MW-4	Infineon
BAR63-03W	PIN diode	SOD323	Infineon
47 pF	Cap.	0805	Epcos
470 pF	Cap.	0805	Epcos
27 nH	Ind.	SIMID01 or SIMID02	Epcos
Printed circuit board		FR4, 1.0 mm	Div.

### 2.4 Simulation

For simulation with Microwave Harmonica V6.0, the PIN-Switch structure is divided into several elements:

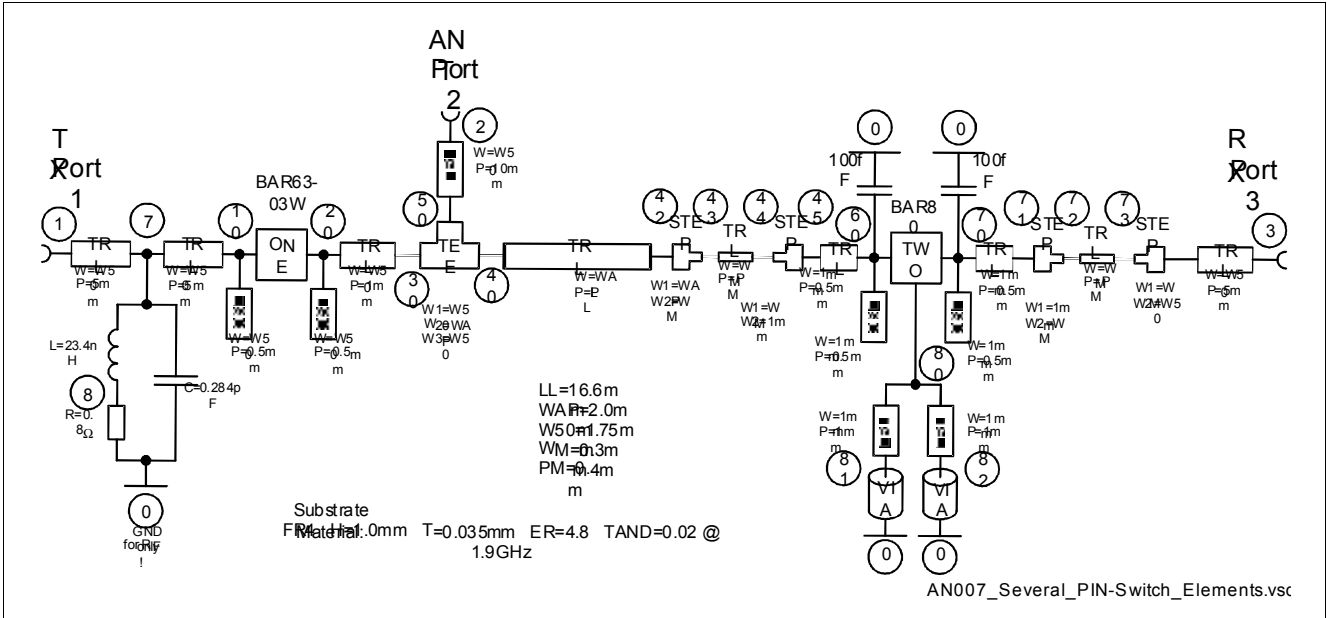


Figure 4 Several PIN-Switch elements for simulation with Microwave Harmonica

These Elements must be placed into a description file:

```

*****
* INFINEON SMALL SIGNAL SEMICONDUCTORS
* APPLICATION NOTE
* DECT T/R-SWITCH WITH BAR80/BAR63-03W
*****
*
*           ANT
*           PORT 2
*           O
*           |
*           +-----+
* TX  O--| > |---O---| LAMBDA/4 |-----O-----O RX
* PORT 1  || |  +-----+          |          PORT 3
*           BAR63
*           -03W
*
*
*           BAR80
*           +-----+
*           |
*           +-----+
*
*           GND
*
* SUBSTRATE MATERIAL:
* FR4, H=1MM, T=0.035MM, ER=4.8, TAND=0.02 @ 1.9GHZ
*****
* 22.11.94 K. BRENNDOERFER DF8CA HL EH PD 1
*****
AN007_Description_file_simulation.vsd

```

Figure 5 Circuit design Simulation

Harmonic Distortion Characteristics Measurements

```

LL: 16.6MM      ; Length of quater lambda line
WAP: 2.0MM     ; Width of quater lambda line
W50: 1.75MM    ; Width of 50 ohm line
WM: 0.3MM     ; Width of match
PM: 0.4MM     ; Width of match

BLK      ; SWITCH IN RX-ANT ON, TX-ANT OFF STATE
  TRL    1   7      W=W50    P=3MM      SUB
  TRL    7   10     W=W50    P=2MM      SUB
  IND    7   8      L=23.4nH          ; Equivalent circuit
  RES    8   0      R=0.8           ; 27nH SIMID01 induct
  CAP    7   0      C=284fF        ; in parallel resonan
  OST    10  20     W=W50    P=0.5MM    SUB
  ONE    10  20     B630F          ; BAR63-03W OFF STATE
  OST    20  30     W=W50    P=0.5MM    SUB
  TRL    20  30     W=W50    P=1MM      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
  STEP   42  43     W1=WAP    W2=WM     SUB
  TRL    43  44     W=WM     P=PM       SUB
  STEP   44  45     W1=WM    W2=1MM     SUB
  TRL    45  60     W=1MM    P=0.5MM    SUB
  OST    60  60     W=1MM    P=0.5MM    SUB
  CAP    60  0      C=100fF
  TWO    60  70   80  B800F          ; BAR80 OFF STATE
  OST    70  70     W=1MM    P=0.5MM    SUB
  CAP    70  0      C=100fF
  VIA    81  81     D=0.6MM          SUB
  TRL    80  81     W=1MM    P=1MM     SUB
  VIA    82  82     D=0.6MM          SUB
  TRL    80  82     W=1MM    p=1MM     SUB
  TRL    70  71     W=1MM    P=0.5MM    SUB
  STEP   71  72     W1=1MM    W2=WM     SUB
  TRL    72  73     W=WM     P=PM       SUB
  STEP   73  75     W1=WM    W2=W50     SUB
  TRL    75  3      W=W50    P=5MM     SUB
RXAN: 3POR 1 2 3          ; 1=TX 2=ANT 3=RX
END

```

AN007\_Description\_file\_simulation1.vsd

Figure 6 Simulation Data 1



Harmonic Distortion Characteristics Measurements

```

BLK      ; SWITCH IN RX-ANT OFF, TX-ANT ON STATE
  TR1    1 7      W=W50    P=3MM      SUB
  TR1    7 10     W=W50    P=2MM      SUB
  IND    7 8      L=23.4nH                      ; Equivalent circuit
  RES    8 0      R=0.8                      ; 27nH SIMID01 induc
  CAP    7 0      C=284fF                      ; in parallel resona
  OST    10      W=W50    P=0.5MM      SUB
  ONE    10 20    B63ON                      ; BAR63-03W ON STATE
  OST    20      W=W50    P=0.5MM      SUB
  TR1    20 30    W=W50    P=1MM      SUB
  TEE    30 40 50 W1=W50    W2=WAP    W3=W50  SUB
  TR1    50 2     W=W50    P=10MM     SUB
  TR1    40 42    W=WAP    P=LL       SUB
  STEP   42 43    W1=WAP    W2=WM     SUB
  TR1    43 44    W=WM     P=PM       SUB

  STEP   44 45    W1=WM     W2=1MM     SUB
  TR1    45 60    W=1MM     P=0.5MM    SUB
  OST    60      W=1MM     P=0.5MM    SUB
  CAP    60 0     C=100fF
  TWO    60 70 80 B80ON                      ; BAR80 ON STATE
  OST    70      W=1MM     P=0.5MM    SUB
  CAP    70 0     C=100fF
  VIA    81      D=0.6MM
  TR1    80 81    W=1MM     P=1MM     SUB
  VIA    82      D=0.6MM
  TR1    80 82    W=1MM     p=1MM     SUB
  TR1    70 71    W=1MM     P=0.5MM    SUB
  STEP   71 72    W1=1MM    W2=WM     SUB
  TR1    72 73    W=WM     P=PM       SUB
  STEP   73 75    W1=WM     W2=W50    SUB
  TR1    75 3     W=W50    P=5MM     SUB
  TXAN:  3POR 1 2 3                          ; 1=TX 2=ANT 3=RX
END

FREQ
  STEP   100MHZ 3GHZ 100MHZ
END

DATA
  SUB:  MS  H=1MM  ER=4.8  TAND=0.02  MET1=CU 35UM
  B80OF:DUMMY          FILE=A:\BAR80\MW1V0U00.S2P
  B80ON:DUMMY          FILE=A:\BAR80\MWV003M0.S2P
  B63OF:DUMMY          FILE=A:\BAR63-3W\AC1V0U00.S1P
  B63ON:DUMMY          FILE=A:\BAR63-3W\ACV005M0.S1P
END

```

AN007\_Description\_file\_simulation2.vsd

Figure 7 Simulation Data 2

Harmonic Distortion Characteristics Measurements

Notes:

- Simulation of the bias inductance was done by selecting a value which is parallel resonant at 1.85 GHz and then optimizing a equivalent circuit to the same performance. The circuit can be found in the circuit file.
- The S-Parameter-file accessed in the DATA-block can be found on the INFINEON CD which is available at your local INFINEON distributor or sales office.
- The BAR63-03W files are one-port files (S1P) which are used as two port data, the BAR80 S-parameters are two-port files (S2P) which are used as three-port data for additional simulation of the ground inductance.
- The 47 pF and 470 pF blocking capacitors are not simulated, they are replaced by a SHORT. In practice, the SMD-capacitors should be 0805 type and for blocking, 47 pF is recommended, because this value is nearly in series resonance at 1.9 GHz.

The simulation shows the following results:

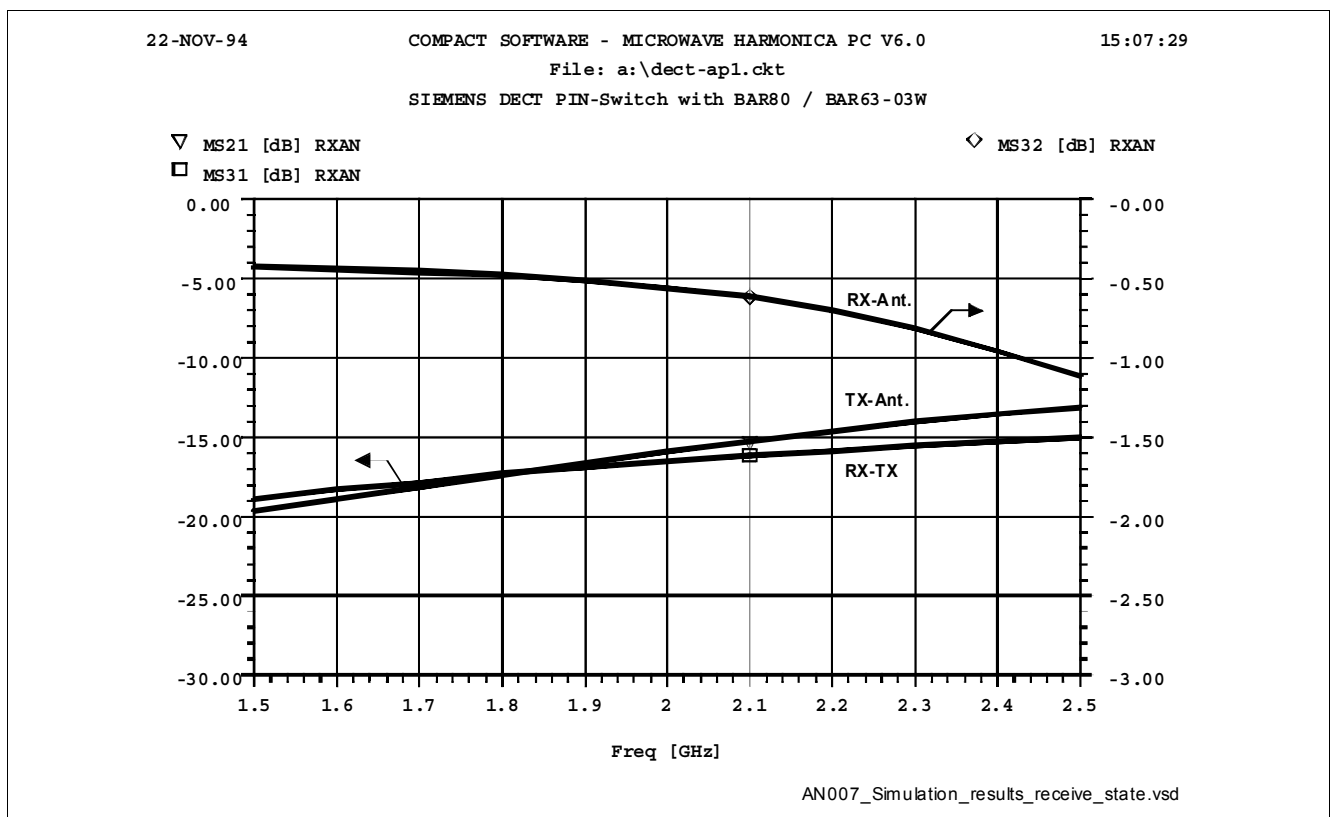


Figure 8 Simulation results, receive state (U = 0...-3 V)

Harmonic Distortion Characteristics Measurements

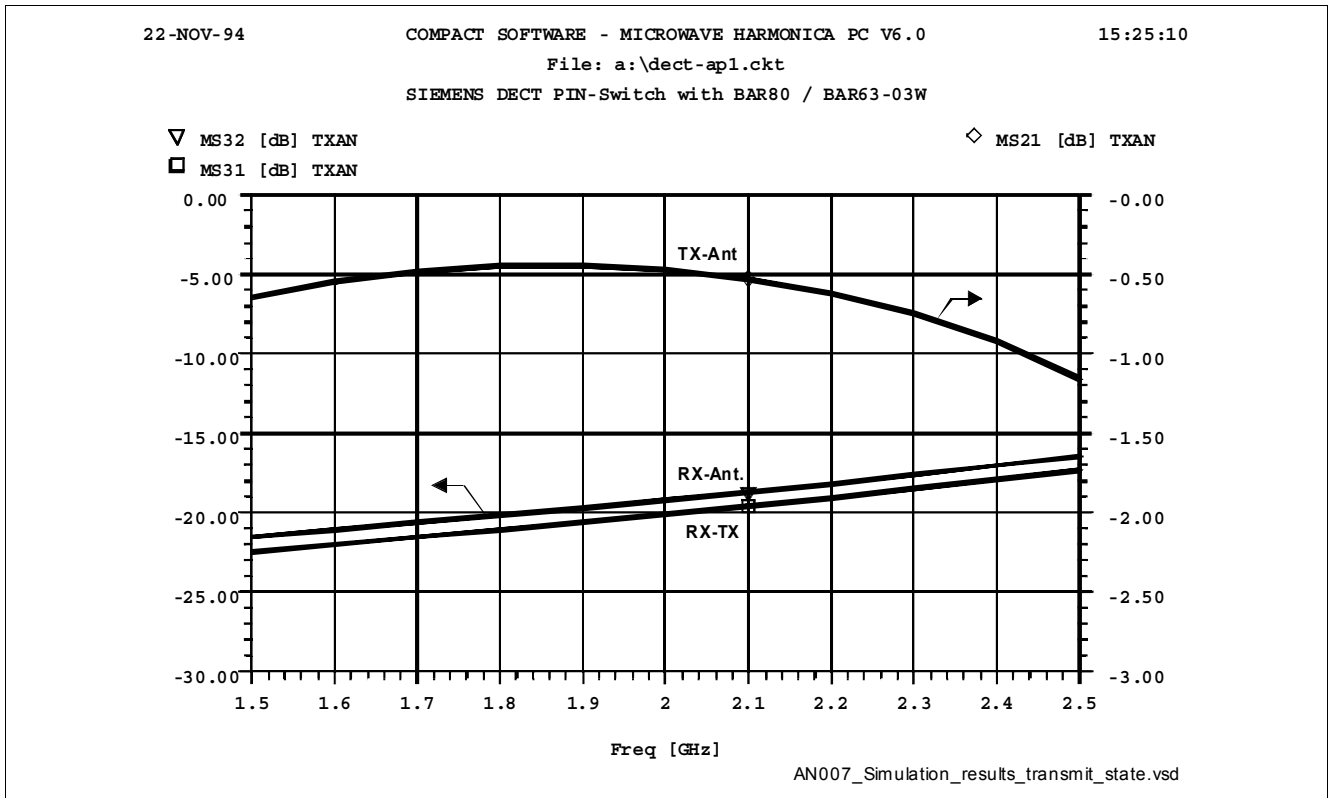


Figure 9 Simulation results, transmit state ( $I = +10$  mA)