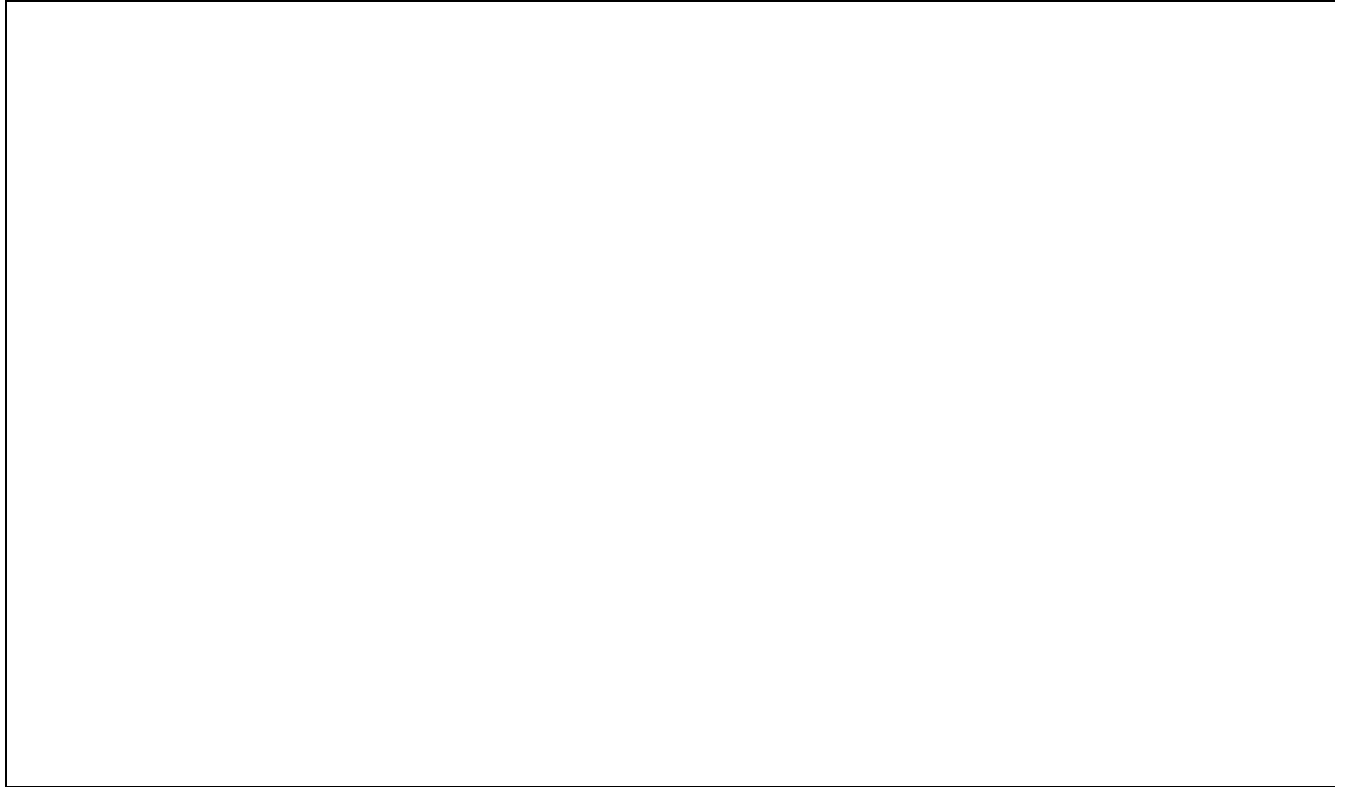


SIEMENS



ICs for Communications

MIXER

PMB 2331 Version 1.2

Preliminary Data Sheet 09.97

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| | | |
|-------------------------------|-------------------------------|---|
| PMB 2331 | | |
| Revision History: | | Current Version: 09.97 |
| Previous Version: | | 11.95 |
| Page (in 11.95 Version) | Page (in 09.97 Version) | Subjects (major changes since last revision) |
| 10 | 10 | Supply Voltage -> 5.0V max. |
| 10 | 10 | Input Voltage $V_{LO/X}$ -> 5.0V max. |
| 10 | 10 | Open Collector Output Voltage $V_{MO/X}$ -> 1.7V min. / 5.0V max. |
| | 10 | ESD Integrity |
| 21 | 21 | General Application |

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| 2.4 | Test Circuits | .14 |
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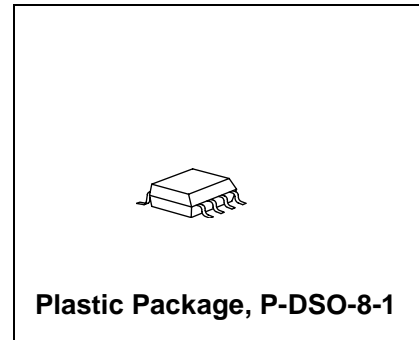
1 Overview

1.1 Functional Description, Benefits

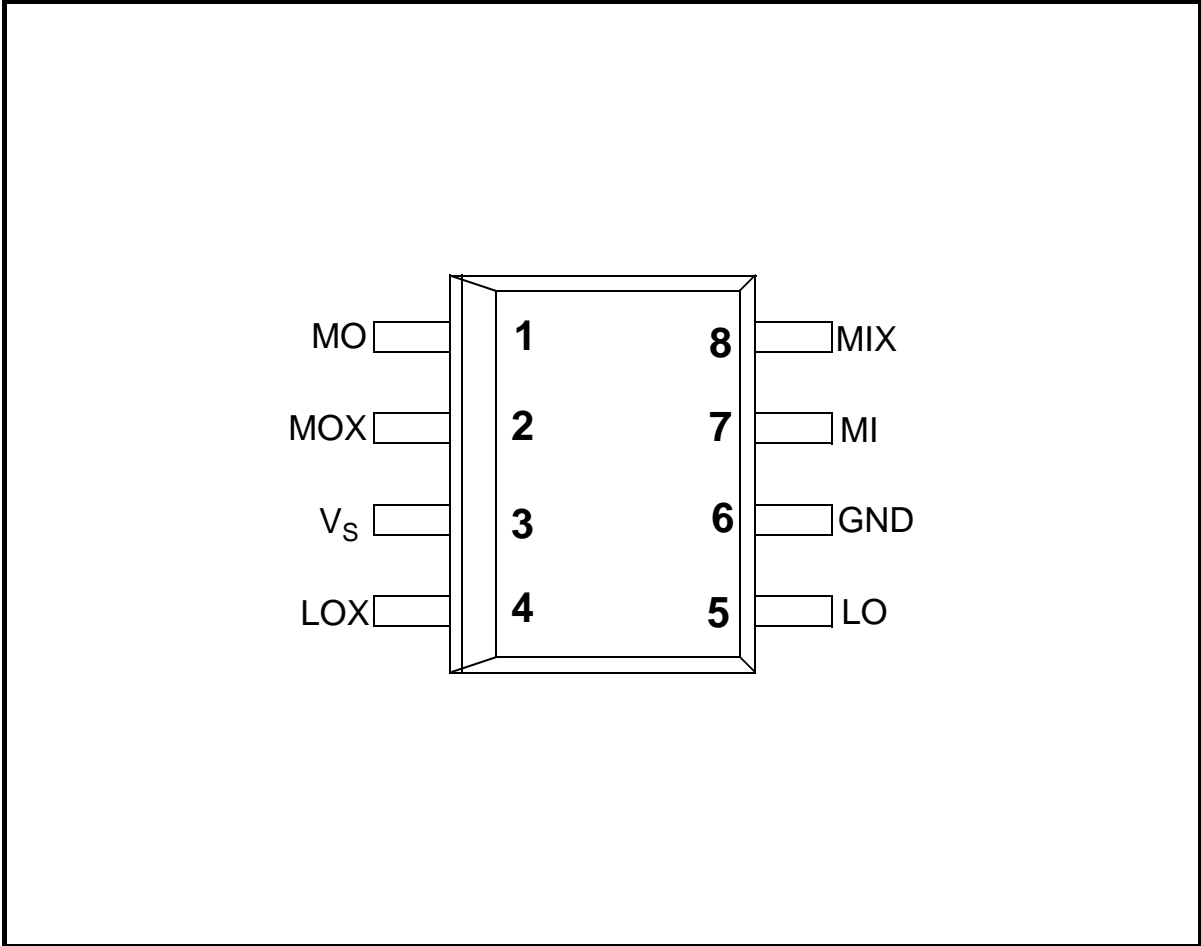
- New B6HF bipolar technology, 25GHz f_T
- Reduced external components
- Frequency range up to 2.0 GHz
- 2.7-4.5V supply voltage
- Mixer current adjustable with external resistors
- 1.6mA current consumption typical
(no external resistors used)
- -40°C to +85°C operational temperature range
- Gilbert cell mixer
- Very highly isolated RF, LO and IF ports
- Good crosstalk performance
- Low noise
- Low spurious signal content

1.2 Applications:

- Cellular radio mixer
- Cordless telephone mixer
- UHF transceiver
- RF data links
- RF/VHF/UHF frequency conversion



1.3 Pin Configuration
(top view)

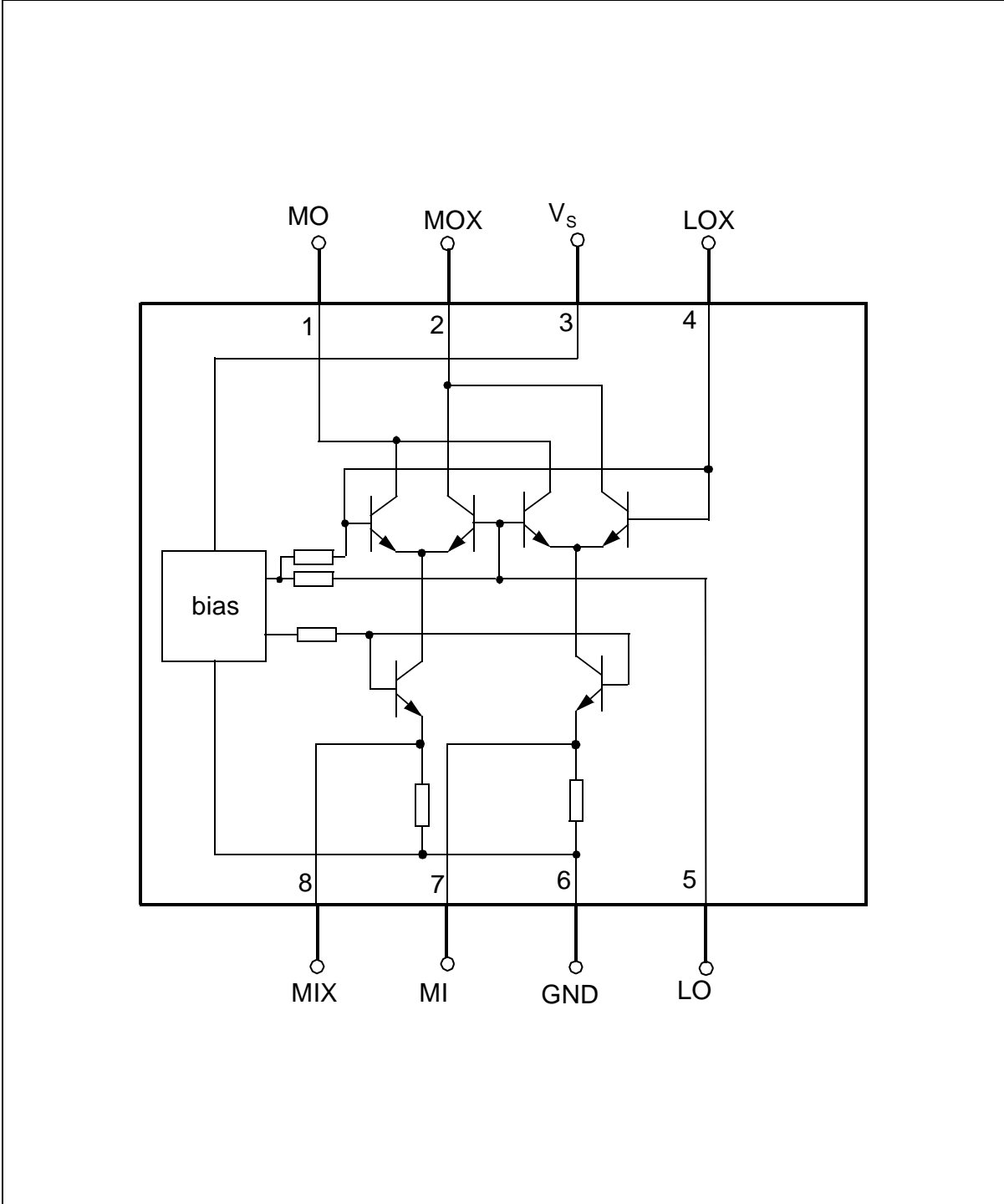


P-DSO-8-1

1.4 Pin Definitions and Functions

| Pin No. | Symbol | Function |
|---------|----------------|--|
| 1 | MO | Mixer signal output, open collector, not inverted |
| 2 | MOX | Mixer signal output, open collector, inverted |
| 3 | V _S | Mixer voltage supply |
| 4 | LOX | Mixer local oscillator signal base input, inverted |
| 5 | LO | Mixer local oscillator signal base input, not inverted |
| 6 | GND | Mixer ground |
| 7 | MI | Mixer signal emitter input, not inverted |
| 8 | MIX | Mixer signal emitter input, inverted |

1.5 Functional Block Diagram



1.6 Circuit Description

The mixer used in this design is a general purpose up-/downconversion gilbert cell mixer. An amplified and filtered RF signal enters the IC via the pins MI/MIX. Using an external supplied local oscillator at LO/LOX a converted output signal is created at the open collector output pins MO/MOX, which have to be connected to an external voltage supply. The RF connections to the mixer inputs may be single ended or balanced, capacitive or inductive coupled.

Voltage supply for the mixer has to be connected to the pins V_S and GND. To increase the mixer current resistors need to be connected between the pins MI and GND, and between the pins MIX and GND.

Differential signals and symmetrical circuits are used throughout the IC.

An internal bias driver generates supply voltage and temperature compensated reference voltages.

All pins with the exception of GND are ESD protected.

2 Electrical Characteristics

2.1 Absolute Maximum Ratings

The maximum ratings may not be exceeded under any circumstances, not even momentarily and individually, as permanent damage to the IC will result.

Ambient temperature $T_{amb} = -40^{\circ}\text{C} \dots +85^{\circ}\text{C}$

| # | Parameter | Symbol | Limit Values | | Units | Remarks |
|----|-------------------------------|--------------|--------------|-----------------------|--------------------|---------------|
| | | | Min | Max | | |
| 1 | Supply Voltage | V_S | -0.3 | 5.0 | V | |
| 2a | Input Voltage MI/MIX | $V_{MI/MIX}$ | -0.3 | 1.9 | V | $V_S = 0V$ |
| 2b | Input Voltage LO/LOX | $V_{LO/LOX}$ | 0.6 | $V_S+0.3$ 5.0 max. | V V | |
| 3 | Open Collector Output Voltage | $V_{MO/MOX}$ | 1.7 | $V_S+0.3$ 5.0 max. | V V | |
| 4 | Differential Input Voltage | V_{DIFF} | | 2.0 | V_{PP} | |
| 5 | Junction Temperature | T_j | | 125 | $^{\circ}\text{C}$ | |
| 6 | Storage Temperature | T_S | -40 | 125 | $^{\circ}\text{C}$ | |
| 7 | Thermal Resistance | R_{thJA} | | 185 | K/W | |
| 8 | ESD integrity | V_{ESD} | -1000 | 1000 | V | ¹⁾ |

1) HBM according to MIL-STD 883D, methode 3015.7

2.2 Operational Range

Within the operational range the IC operates as described in the circuit description. The AC/DC characteristic limits are not guaranteed.

Supply voltage $V_{VCC} = 2.7V...4.5V$, Ambient temperature $T_{amb} = -40^{\circ}C...85^{\circ}C$

| # | Parameter | Symbol | Limit Values | | Units | Remarks |
|---|---------------------------|----------|--------------|------|-------|---------|
| | | | Min | Max | | |
| 1 | MI/X Input Frequency | f_{MI} | | 2000 | MHz | |
| 2 | LO/X Input Frequency | f_{LO} | | 2000 | MHz | |
| 3 | IF Intermediate Frequency | f_{IF} | | 2000 | MHz | |

Note: Power levels refer to 50 Ohms impedance

2.3 AC/DC Characteristics

AC/DC characteristics involve the spread of values guaranteed within the specified supply voltage and ambient temperature range. Typical characteristics are the median of the production.

Supply voltage $V_{VCC} = 2.7V...4.5V$, Ambient temperature $T_{amb} = +25^{\circ}C$

| # | Parameter | Symbol | Limit Values | | | Units | Test Conditions | Test Circuit |
|---|-----------|--------|--------------|-----|-----|-------|-----------------|--------------|
| | | | Min | Typ | Max | | | |

Supply Current

| | | | | | | | | |
|---|--------------------------|-------------|--|-----|--|----|---|------|
| 1 | Supply current, total IC | $I_{1,2,3}$ | | 1.6 | | mA | without external resistors R1,2 | 1a,b |
| 2 | Supply current, total IC | $I_{1,2,3}$ | | 4.6 | | mA | including external resistors R1,2 *(=180Ω) | 1a,b |

MIXER, Signal Input MI/MIX, Down conversion, $R_{1,2} = 180 \text{ Ohm}$

| | | | | | | | | |
|---|--|--------------|------------|-----|--|-----|-------------|----|
| 3 | Input impedance | S_{11M} | Diagram 2a | | | | | |
| 4 | Max. input level, 1 db comp. at MO/MOX, IF=45MHz | P_{MI} | | -16 | | dBm | f=0.9GHz | 1a |
| 5 | Input intercept point, $\Delta f=800\text{kHz}$, IF= 45MHz | $IICP3_{MI}$ | | -2 | | dBm | f=0.9GHz | 1a |
| 6 | Blocking level $\Delta f=800\text{kHz}$, IF= 45MHz | P_{BL} | | -16 | | dBm | f=0.9GHz | 1a |
| 7 | Noise figure, ssb, $(NF_{SSB} \approx NF_{DSB} + 3\text{dB})$ IF = 45MHz | F_{MI} | | 9.5 | | dB | f=0.9GHz ** | 1a |

MIXER, Local Oscillator Input LO/LOX

| | | | | | | | | |
|---|-----------------|------------|------------|----|--|-----|---------------|------|
| 8 | Input impedance | S_{11LO} | Diagram 2b | | | | | |
| 9 | Input level | P_{LO} | | -3 | | dBm | f=0.9GHz, *** | 1a,b |

*minimum value for $R1=R2=33\text{Ohm}$

**matching network used

***referenced for specified mixer performance

AC/DC Characteristics

AC/DC characteristics involve the spread of values guaranteed within the specified supply voltage and ambient temperature range. Typical characteristics are the median of the production.

Supply voltage $V_{VCC} = 2.7V$ to $4.5V$, Ambient temperature $T_{amb} = +25^{\circ}$

| # | Parameter | Symbol | Limit Values | | | Unit | Test Conditions | Test Circuit |
|---|-----------|--------|--------------|-----|-----|------|-----------------|--------------|
| | | | Min | Typ | Max | | | |

MIXER, Signal Output MO/MOX, Down conversion, $R_{1,2} = 180 \text{ Ohm}$

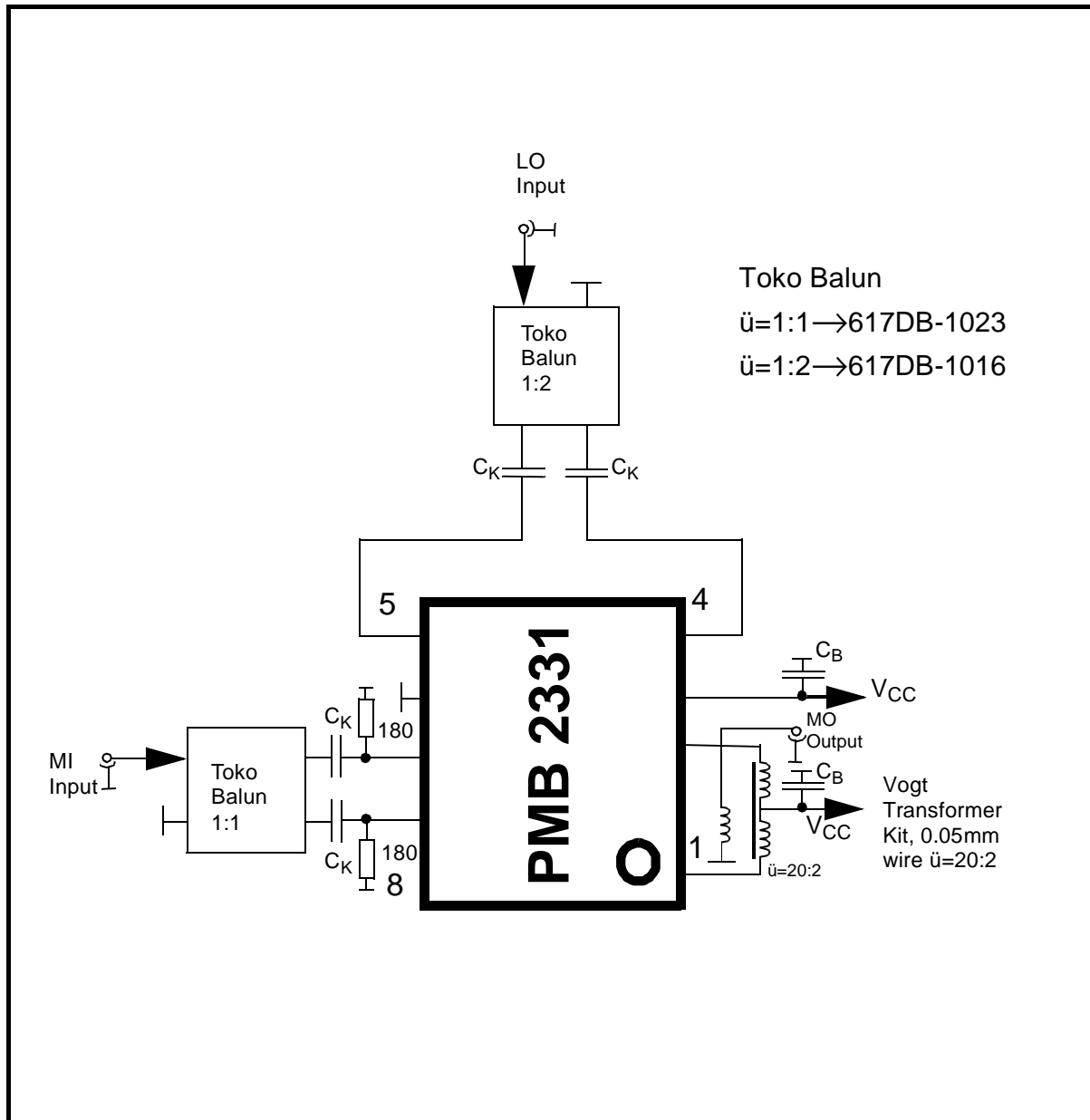
| | | | | | | | | |
|----|-----------------------|--------------|--|------|--|------|-------------------------------------|------|
| 10 | Output current | I_{MO+MOX} | | 4.0 | | mA | including external resistors R1, R2 | 1a,b |
| 11 | Output resistance | R_{MODiff} | | 38 | | kOhm | IF=45MHz | 1a |
| 12 | Output resistance | R_{MODiff} | | 24 | | kOhm | IF=300MHz | 1b |
| 13 | Output capacitance | C_{MODiff} | | 0.34 | | pF | IF=45MHz | 1a |
| 14 | Output capacitance | C_{MODiff} | | 0.38 | | pF | IF=300MHz | 1b |
| 15 | Power gain, IF=45MHz | P_{MI} | | 14 | | dB | f=0.9GHz | 1a |
| 16 | Power gain, IF=300MHz | P_{MI} | | 7 | | dB | f=0.9GHz | 1b |

MIXER, Isolation Between In-/Output, 0.9GHz

| | | | | | | | | |
|----|----------|-------------|--|----|--|----|--|----|
| 17 | MI to MO | A_{MI-MO} | | 30 | | dB | $f_{MI}=945\text{MHz}$ $f_{LO}=900\text{MHz}$ | 1a |
| 18 | LO to MO | A_{LO-MO} | | 50 | | dB | " | 1a |
| 19 | LO to MI | A_{LO-MI} | | 50 | | dB | " | 1a |
| 20 | MO to MI | A_{MO-MI} | | 50 | | dB | " | 1a |
| 21 | MO to LO | A_{MO-LO} | | 60 | | dB | " | 1a |

2.4 Test Circuits

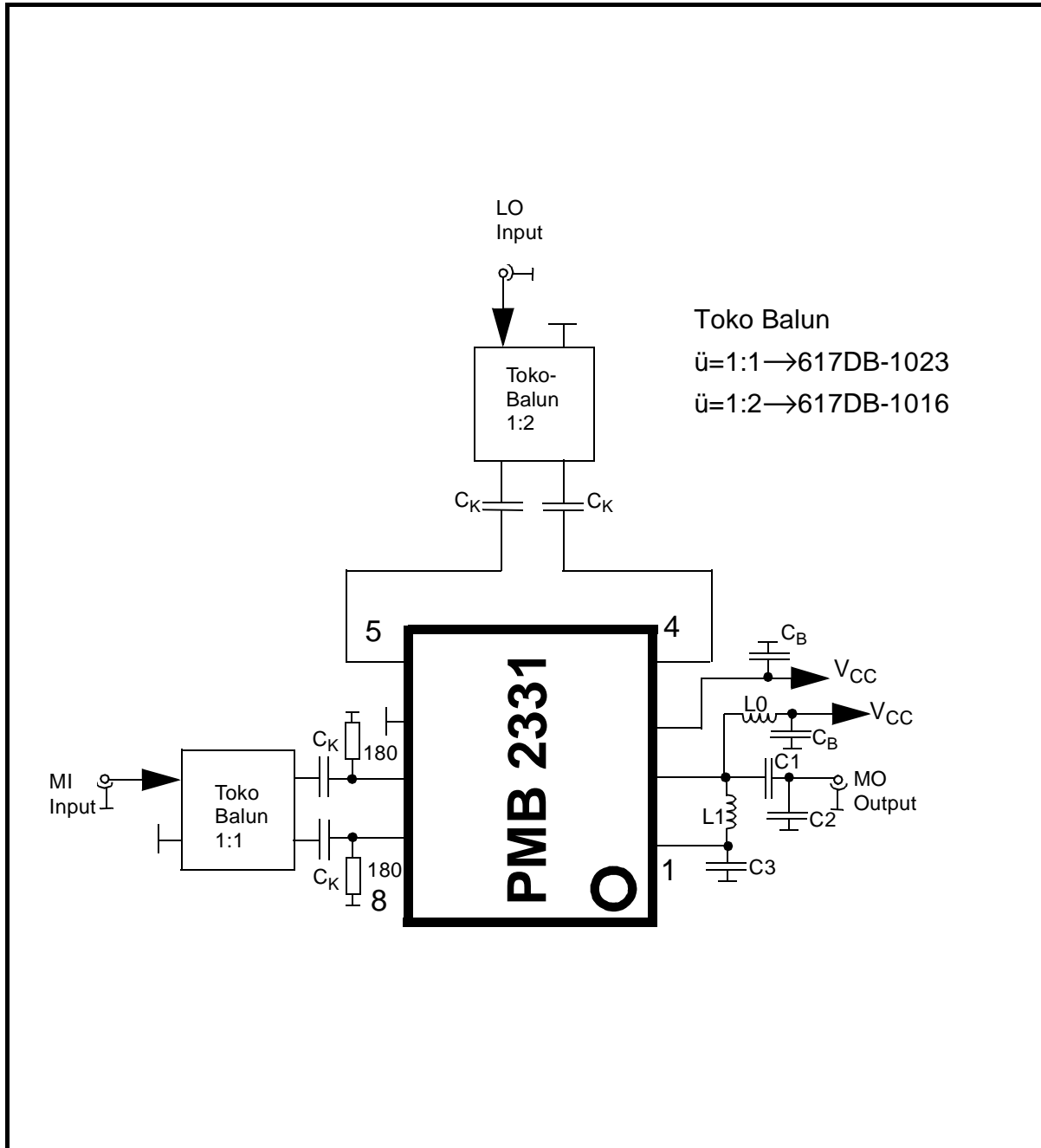
Test Circuit 1a



Test Circuit for 45 MHz Intermediate frequency

| Test Circuit | f_{IF} [MHz] | C_B [pF] | C_K [pF] | X |
|--------------|----------------|------------|------------|---|
| 1a | 45 | 15p/100p | 15p | X |

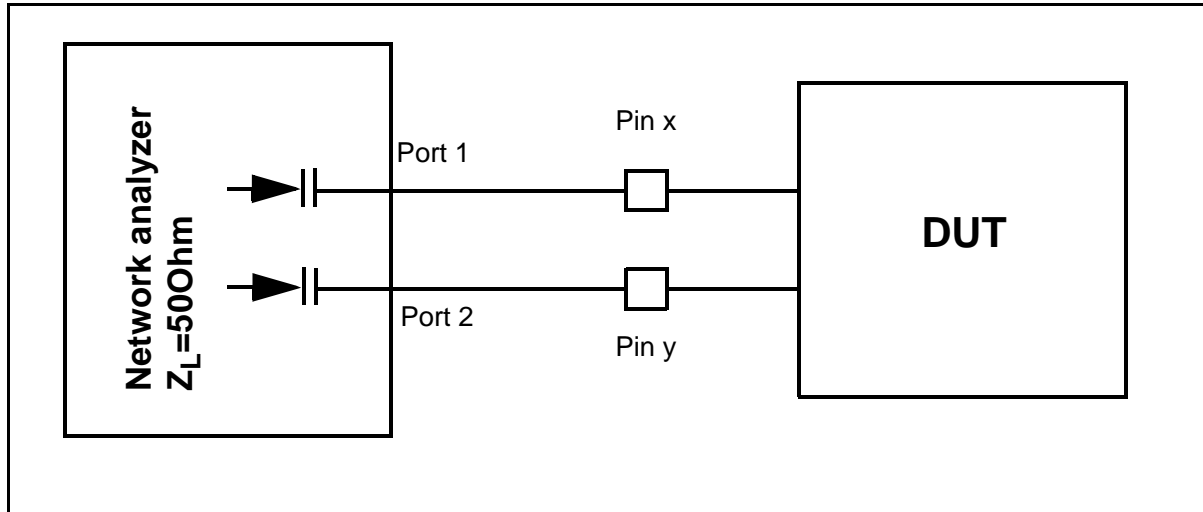
Test Circuit 1b



Test Circuit for 300 MHz intermediate frequency

| Test Circuit | f _{IF} [MHz] | L ₀ [nH] | L ₁ [nH] | C ₁ [pF] | C ₂ [pF] | C ₃ [pF] | C _k [pF] |
|--------------|-----------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| 1b | ≈300 | 680 | 150 | 2.7 | 12 | 1.8 | 15p |

Test Circuit 2



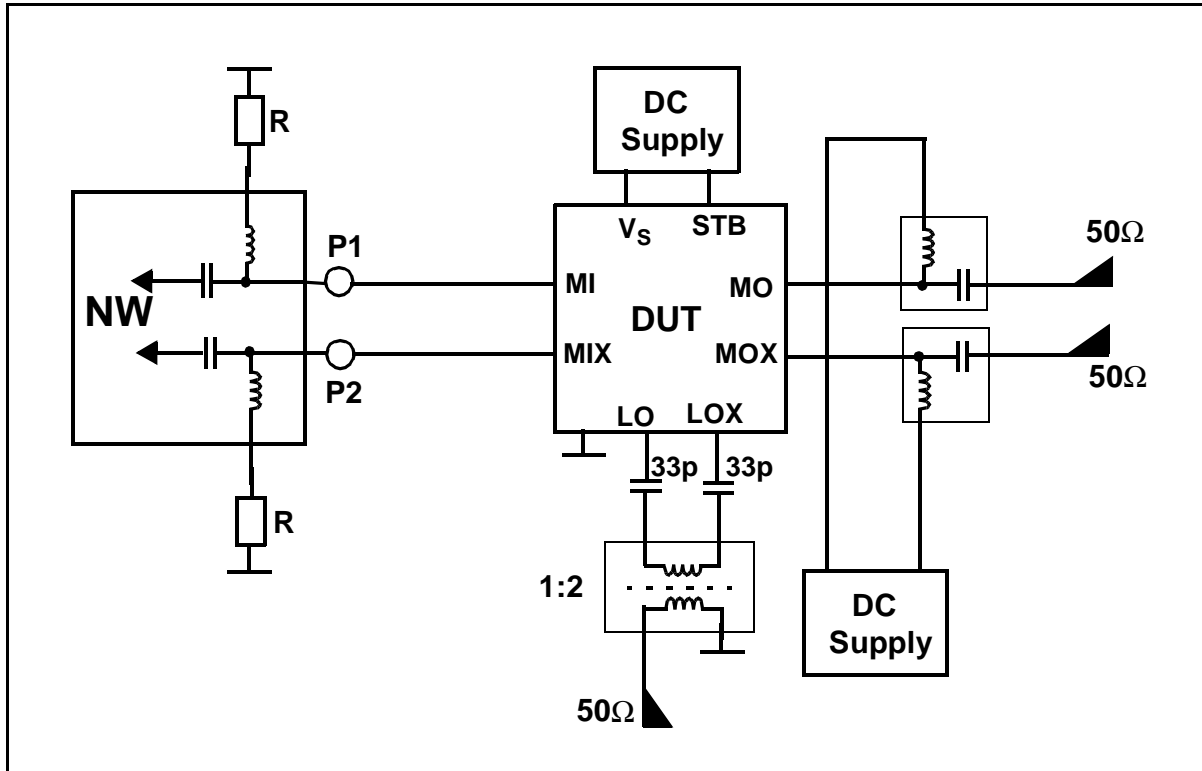
S-Parameter Measurement of Mixer
S11, S12, S21, S2

| Test | Test Frequency [GHz] | Pin X | Pin Y |
|---------------------|----------------------|-------|-------|
| LO-Input impedance | .. - 3.0 | 4 | 5 |
| Mi-Input impedance | .. - 3.0 | 7 | 8 |
| MO-Output impedance | .. - 3.0 | 1 | 2 |

The S-Parameters are tested at the indicated frequency and the equivalent parallel or series circuit is calculated on this base.

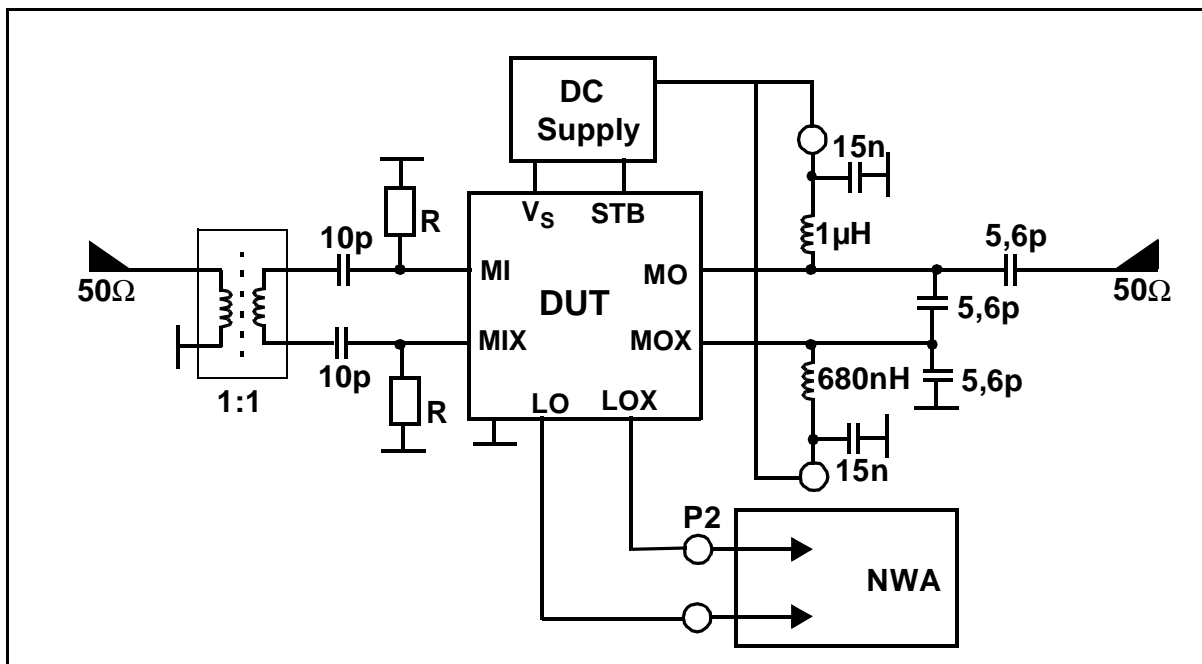
Via the NWA the capacitive coupling is done and the open collector pins are connected to VCC. The output levels at port1 and 2 for pin x and y are -30dbm for MI and MO-impedances and -5dbm for the LO impedance. S-Parameters have to be considered as design hints and are measured with SIEMENS testboards. (RT/Duroid 5880 Teflon, $\epsilon=2.2$)

Test Circuit 2a



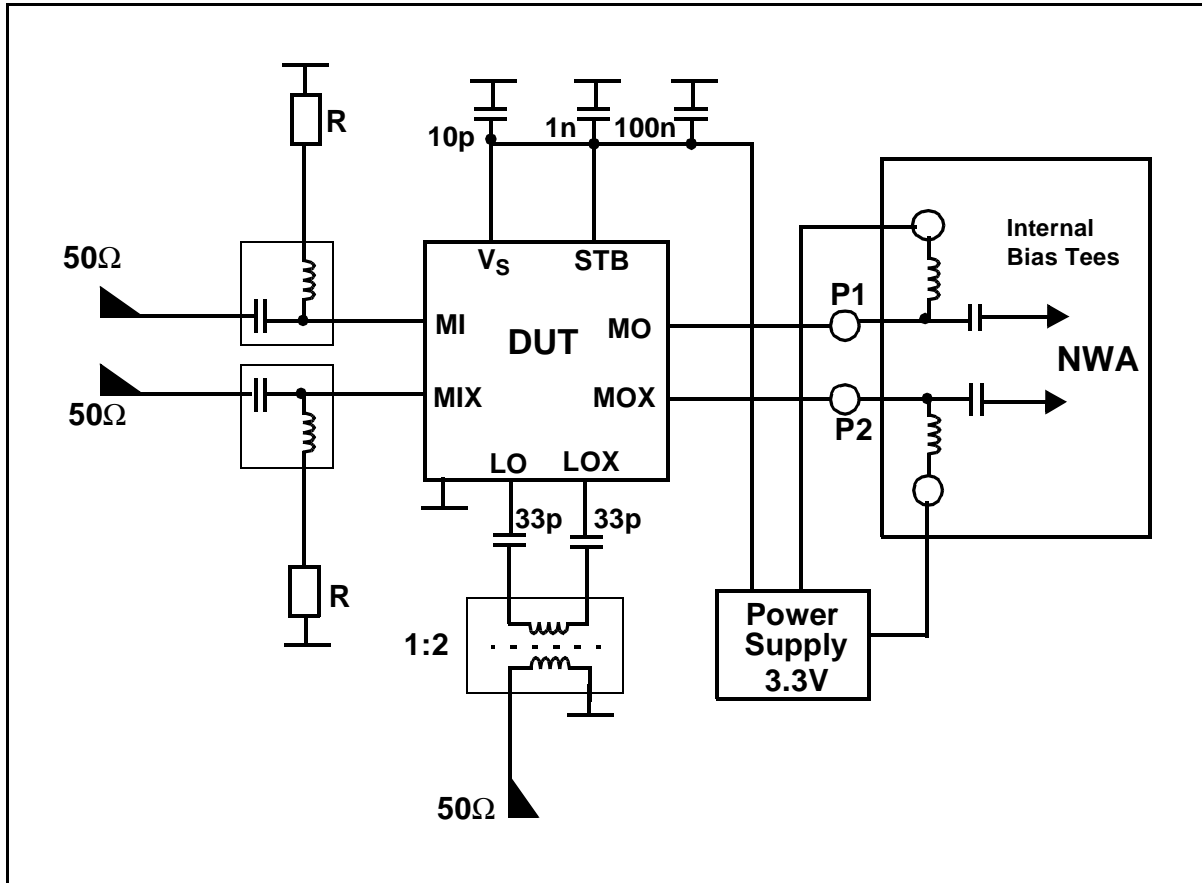
Mixer Input Impedance Measurement

Test Circuit 2b



Mixer Local Oscillator Impedance Measurement

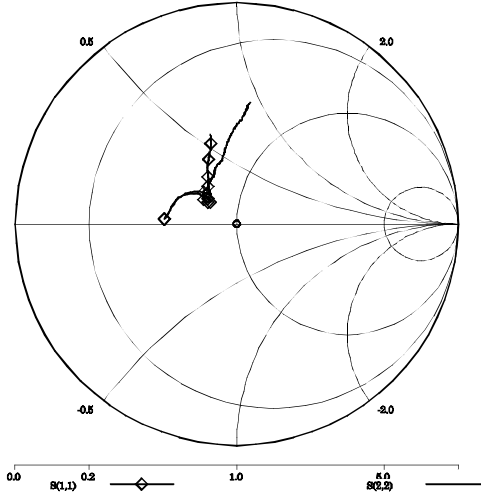
Test Circuit 2c



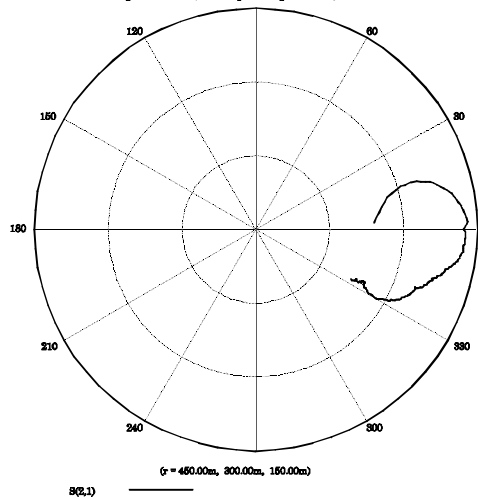
Mixer Output Impedance Measurement

Diagram 2a
 S-Parameter Mixer Input MI Impedance, $I_{MO/MOX} = 4mA$; $f = ..3GHz$

PMB 2331 S-parameter /MI input impedance /Mixer Current I=4mA



PMB 2331 S-parameter /MI input impedance /Mixer Current I=4mA



PMB 2331 S-parameter /MI input impedance /Mixer Current I=4mA

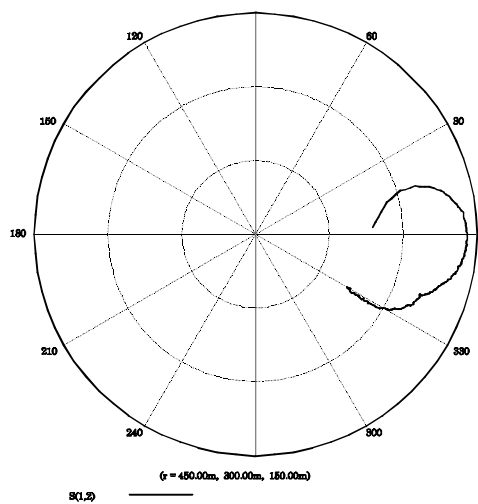
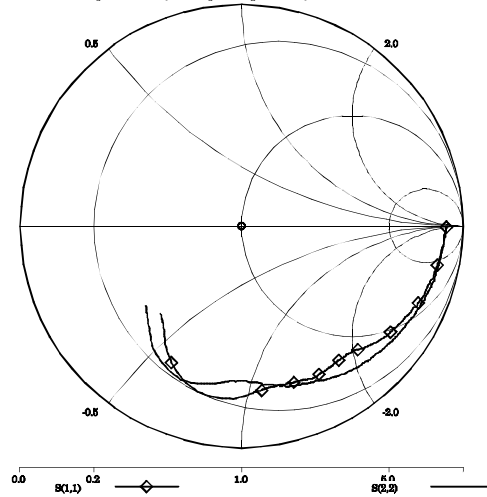


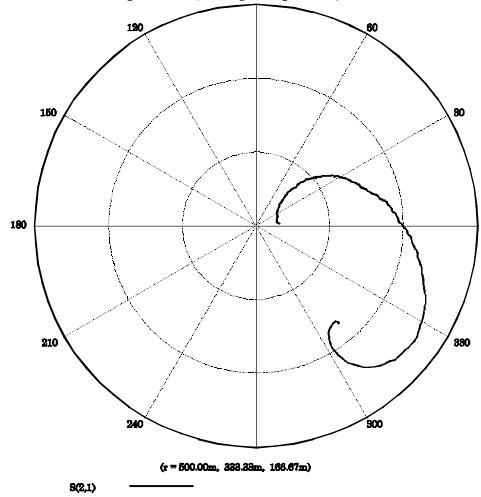
Diagram 2b

S-Parameter Mixer Input LO Impedance, $I_{MO/MOX} = 4mA$; $f = 3GHz$

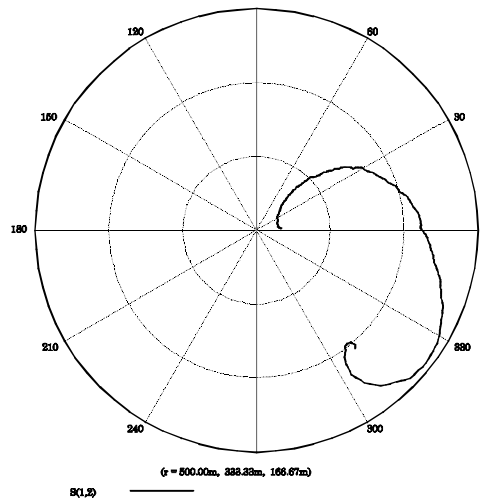
PMB 2331 S-parameter /LO input impedance /Mixer Current I=4mA



PMB 2331 S-parameter /LO input impedance /Mixer Current I=4mA



PMB 2331 S-parameter /LO input impedance /Mixer Current I=4mA

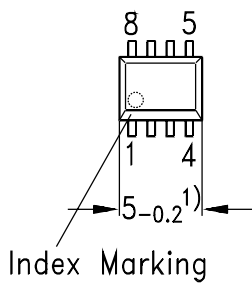
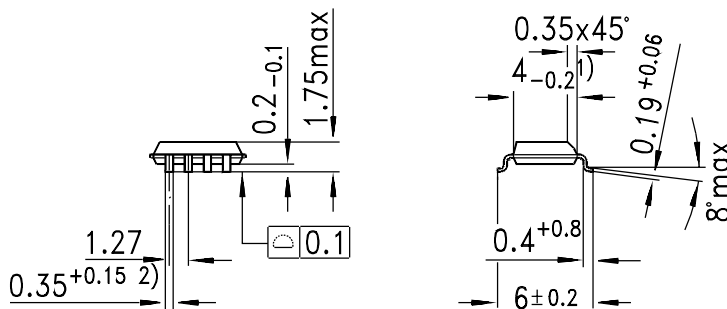


Application Circuit

General applications refer to the PMB 2330 application note (different values)

3 Package Outlines

Plastic Package, P-DSO-8-1
(Plastic Dual Small Outline)



Index Marking

- 1) Does not include plastic or metal protrusions of 0.15 max per side
- 2) Does not include dambar protrusion of 0.05 max per side

Sorts of Packing

Package outlines for tubes, trays etc. are contained in our Data Book "Package Information".

SMD = Surface Mounted Device

Dimensions in mm