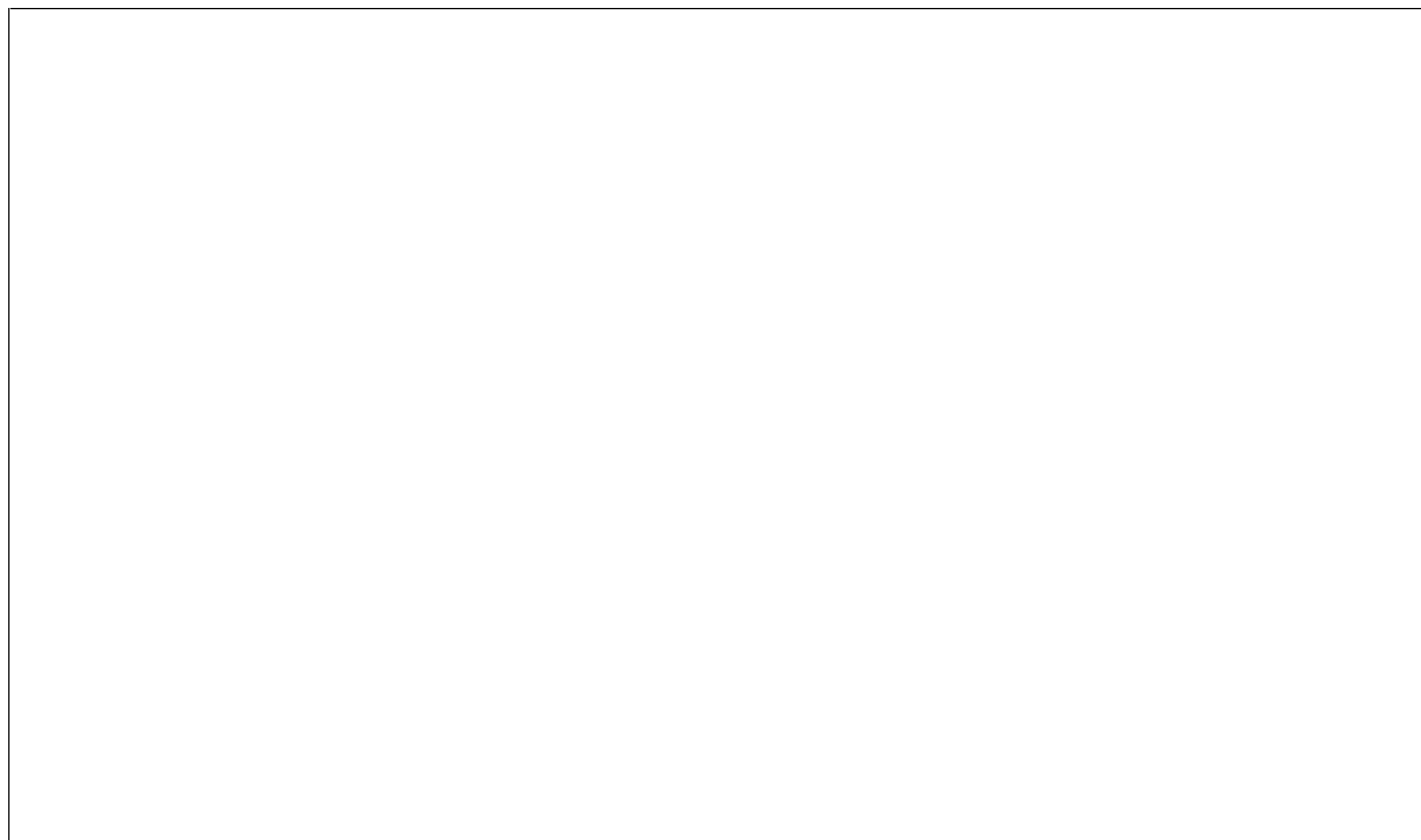


SIEMENS



ICs for Communications

MIXER

PMB 2331 Version 1.2

Preliminary Data Sheet 02.96

T2331-XV12-P1-7600

| | | |
|--------------------------|-----------------------------|--|
| PMB 2331 | | |
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| Page (in Version) | Page (in new Version) | Subjects (major changes since last revision) |
| | | |
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Edition 02.96

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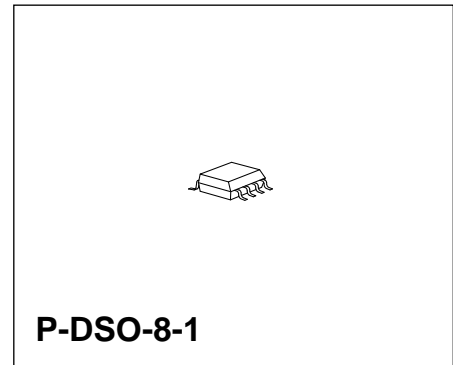
1 Overview

1.1 Functional Description

- New B6HF bipolar technology, 25 GHz f_T
- Reduced external components
- Frequency range up to 2.0 GHz
- 2.7-4.5 V 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



| Type | Ordering Code | Package |
|----------|---------------|-----------|
| PMB 2331 | | P-DSO-8-1 |

1.3 Pin Configuration
(top view)

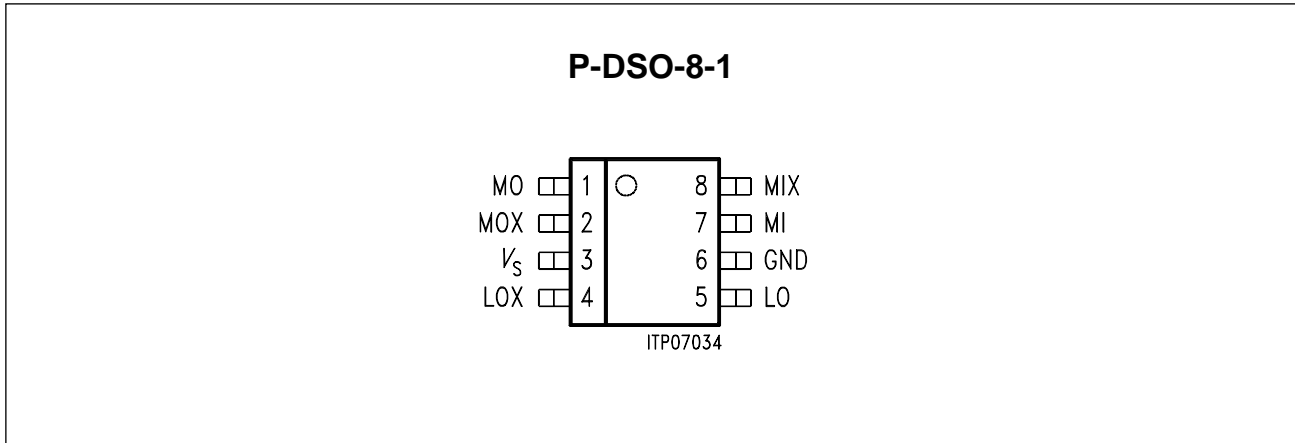


Figure 1

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

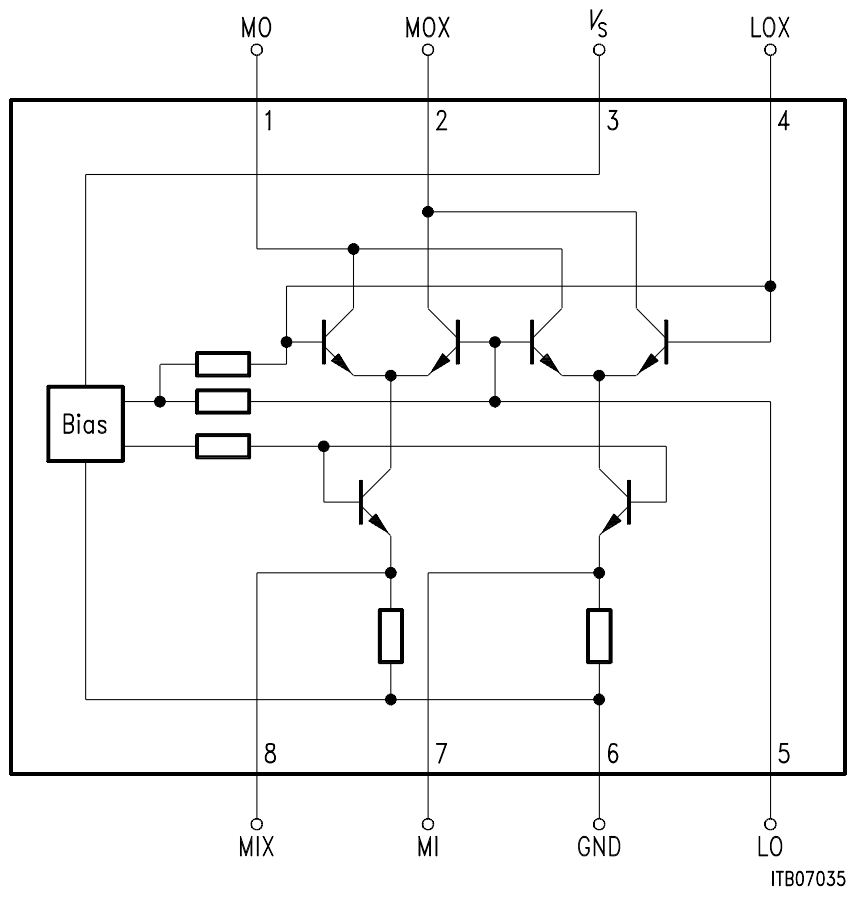


Figure 2

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

$$T_A = -40\text{ °C to }+85\text{ °C}$$

| # | Parameter | Symbol | Limit Values | | Unit | Remarks |
|----|-------------------------------|--------------|--------------|-------------|----------|--------------------|
| | | | min. | max. | | |
| 1 | Supply voltage | V_S | -0.3 | 5.5 | V | |
| 2a | Input voltage MI/MIX | $V_{MI/MIX}$ | -0.3 | 1.9 | V | $V_S = 0\text{ V}$ |
| 2b | Input voltage LO/LOX | $V_{LO/LOX}$ | 0.6 | $V_S + 0.3$ | V | |
| 3 | Open collector output voltage | $V_{MO/MOX}$ | 1.3 | $V_S + 0.3$ | V | |
| 4 | Differential input voltage | V_{DIFF} | | 2.0 | V_{PP} | |
| 5 | Junction temperature | T_j | | 125 | °C | |
| 6 | Storage temperature | T_S | -40 | 125 | °C | |
| 7 | Thermal resistance | R_{thJA} | | 185 | K/W | |

Note: Maximum ratings are absolute ratings; exceeding only one of these values may cause irreversible damage to the integrated circuit.

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.

$$V_{VCC} = 2.7\text{ V...}4.5\text{ V}, T_A = -40\text{ °C to }85\text{ °C}$$

| # | Parameter | Symbol | Limit Values | | Unit | 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 Ω impedance.

In the operating range the functions given in the circuit description are fulfilled.

2.3 AC/DC Characteristics

$V_{VCC} = 2.7\text{ V to }4.5\text{V}, T_A = 25\text{ }^\circ\text{C}$

| # | Parameter | Symbol | Limit Values | | | Unit | Test Condition | 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 1)(=180 Ω) | 1a,b |

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

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

MIXER, Local Oscillator Input LO/LOX

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

Notes see page 10.

2.3 AC/DC Characteristics (cont'd)

$V_{VCC} = 2.7 \text{ V to } 4.5\text{V}, T_A = 25 \text{ }^\circ\text{C}$

| # | Parameter | Symbol | Limit Values | | | Unit | Test Condition | Test Circuit |
|---|-----------|--------|--------------|------|------|------|----------------|--------------|
| | | | min. | typ. | max. | | | |

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

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

MIXER, Isolation Between In-/Output, 0.9 GHz

| | | | | | | | | |
|----|----------|-------------|--|----|--|----|--|----|
| 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 |

- 1) Minimum value for $R_{41} = R_{2} = 33 \text{ } \Omega$.
- 2) Matching network used.
- 3) Referenced for specified mixer performance.

Note: The listed characteristics are ensured over the operating range of the integrated circuit. Typical characteristics specify mean values expected over the production spread. If not otherwise specified, typical characteristics apply at $T_A = 25^\circ\text{C}$ and the given supply voltage.

2.4 Test Circuits

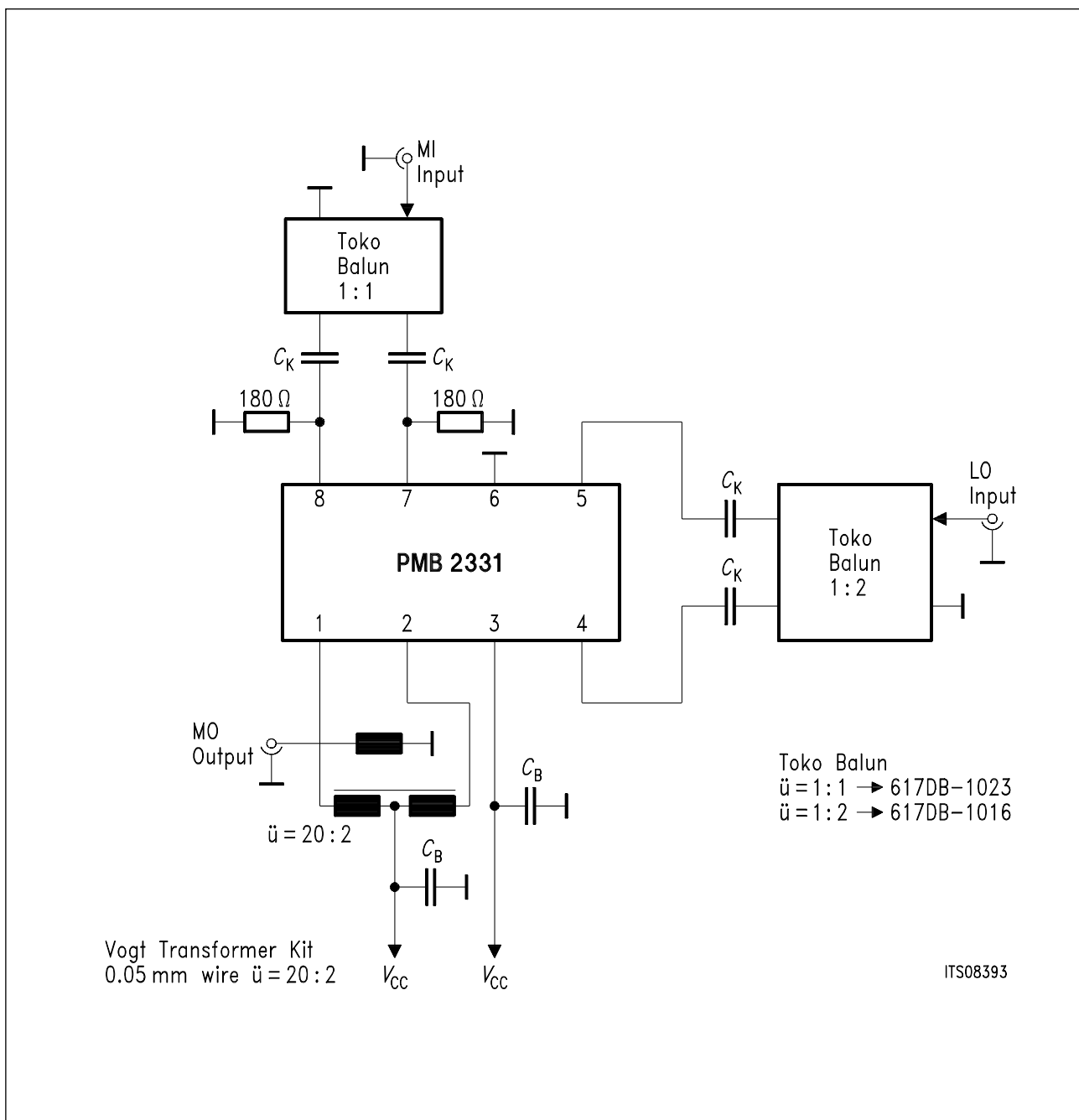


Figure 3
Test Circuit 1a

Test Circuit for 45 MHz Intermediate Frequency

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

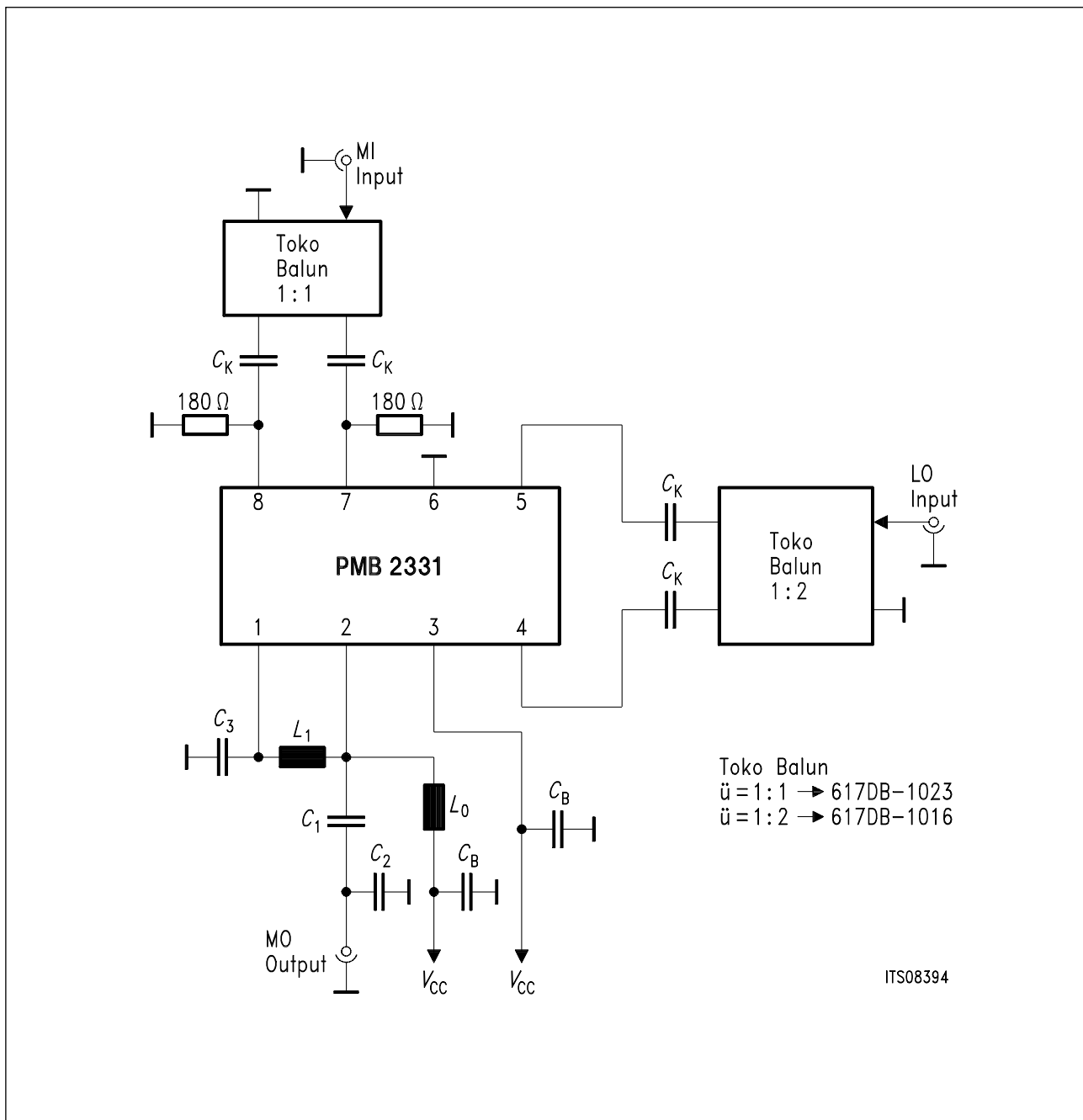


Figure 4
Test Circuit 1b

Test Circuit for 300 MHz Intermediate Frequency

| Test Circuit | f_{IF} [MHz] | L0[nH] | L1[nH] | C1[pF] | C2[pF] | C3[pF] | C_K [pF] |
|--------------|----------------|--------|--------|--------|--------|--------|------------|
| 1b | ≈ 300 | 680 | 150 | 2.7 | 12 | 1.8 | 15p |

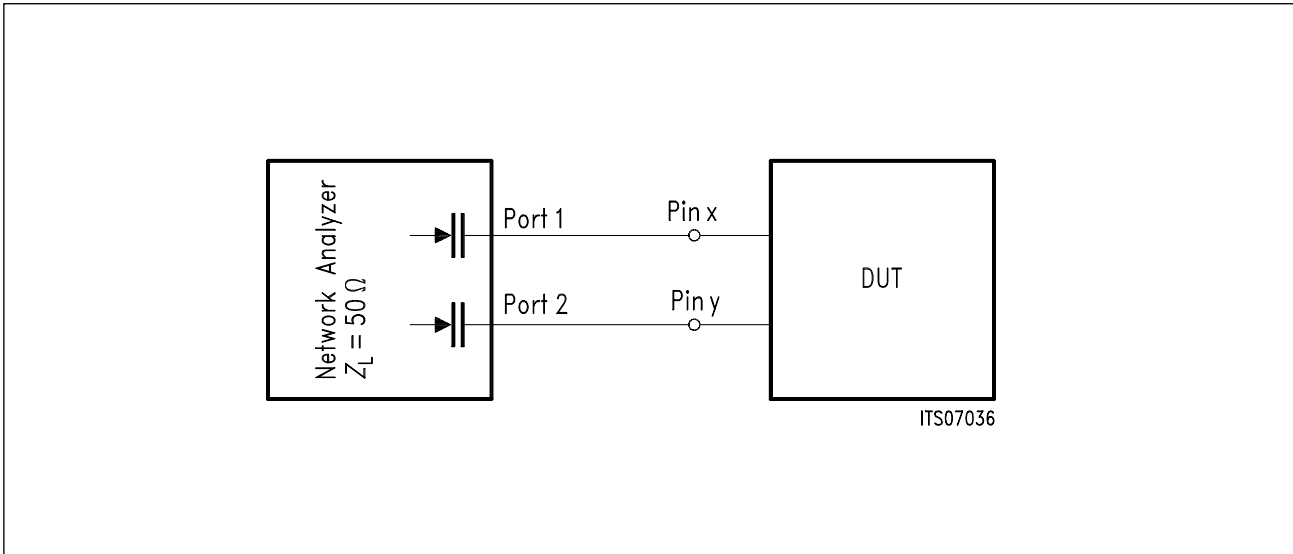


Figure 5
Test Circuit 2
S-Parameter Measurement of Mixer
S11, S12, S21, S2

| 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 V_{CC} . The output levels at port1 and 2 for pin x and y are – 30 dbm for MI and MO-impedances and – 5 dbm for the LO impedance. S-Parameters have to be considered as design hints and are measured with SIEMENS testboards (RT/Duroid 5880 Teflon, $\epsilon = 2.2$).

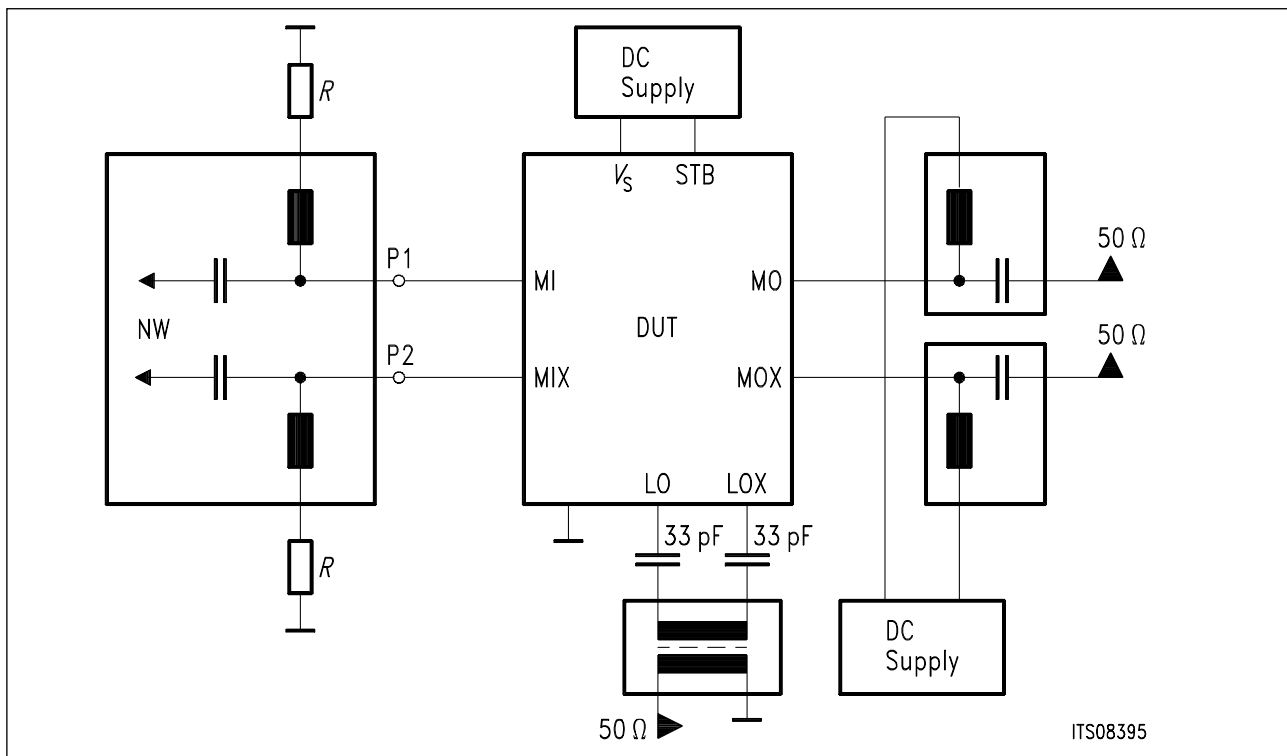


Figure 6
Test Circuit 2a
Mixer Input Impedance Measurement

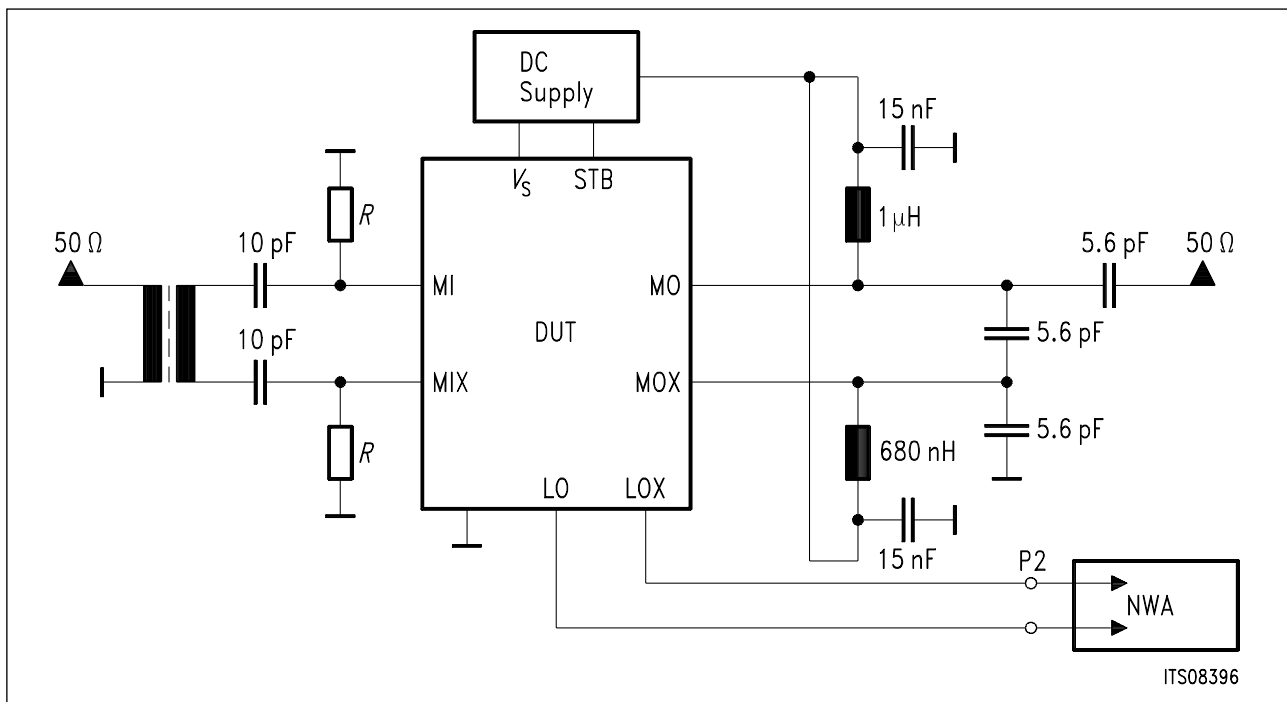


Figure 7
Test Circuit 2b
Mixer Local Oscillator Impedance Measurement

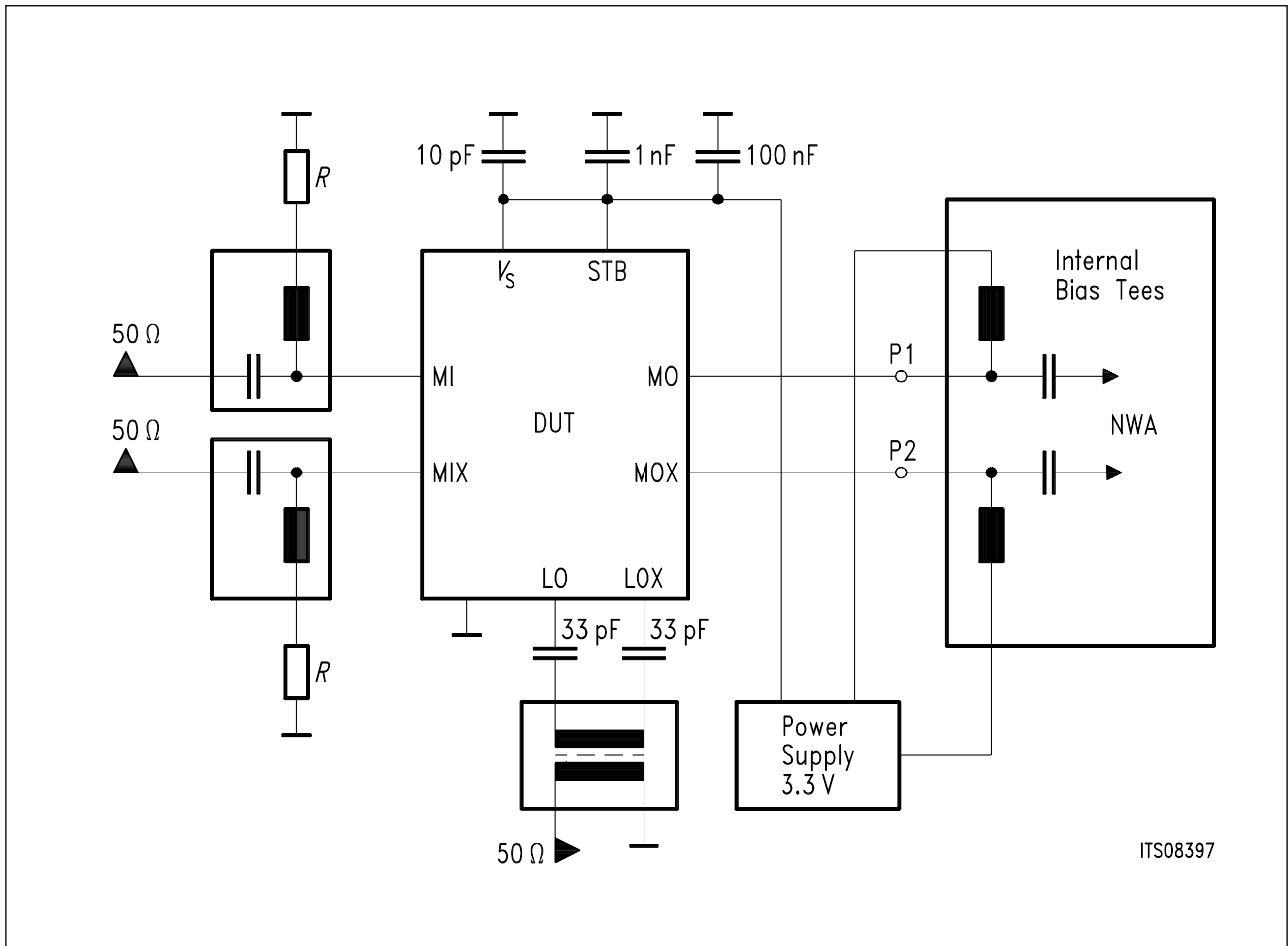
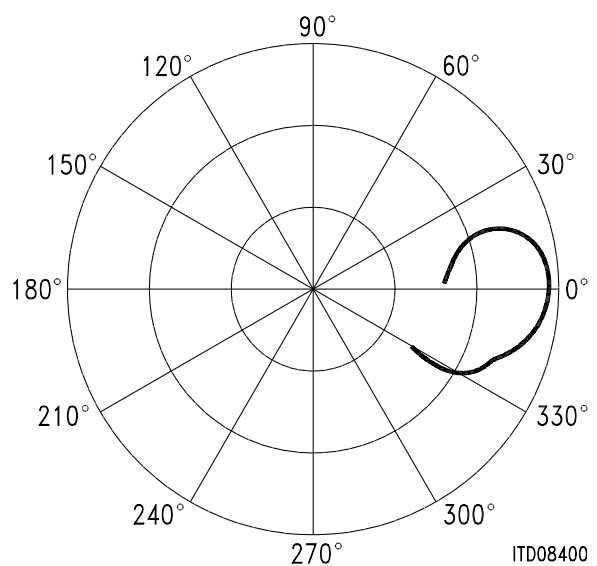
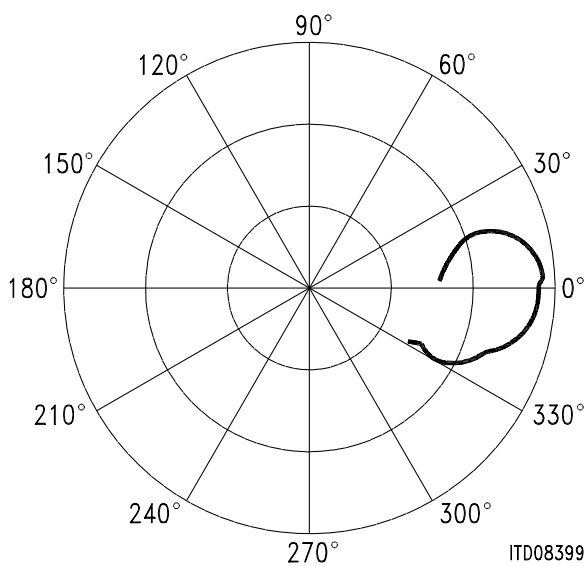
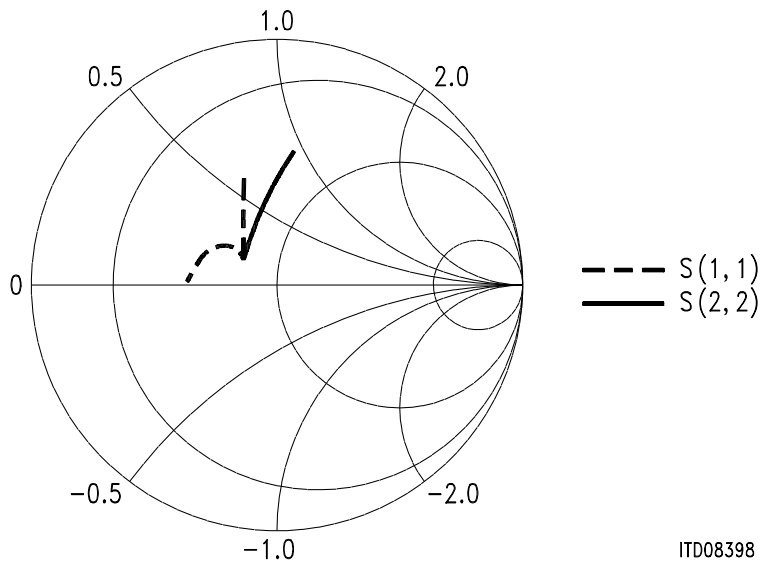


Figure 8
Test Circuit 2c
Mixer Output Impedance Measurement

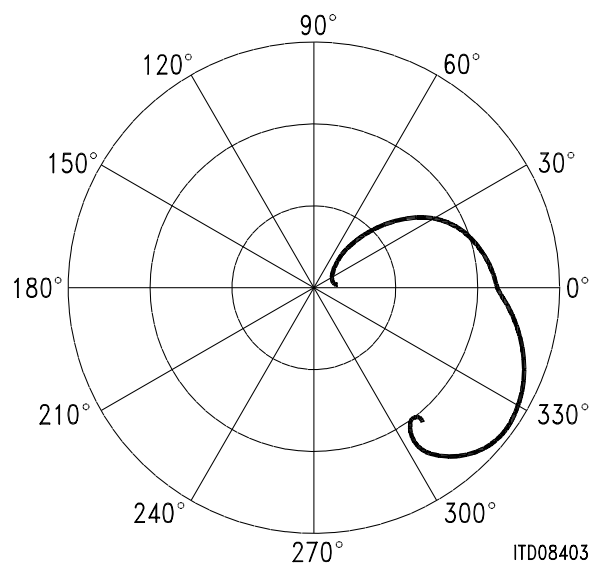
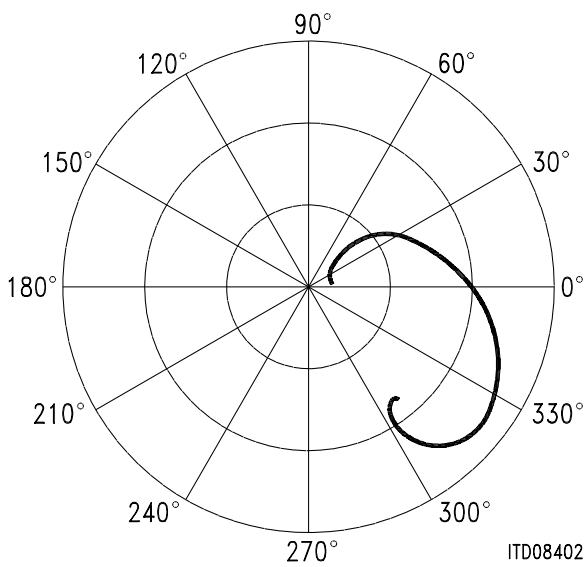
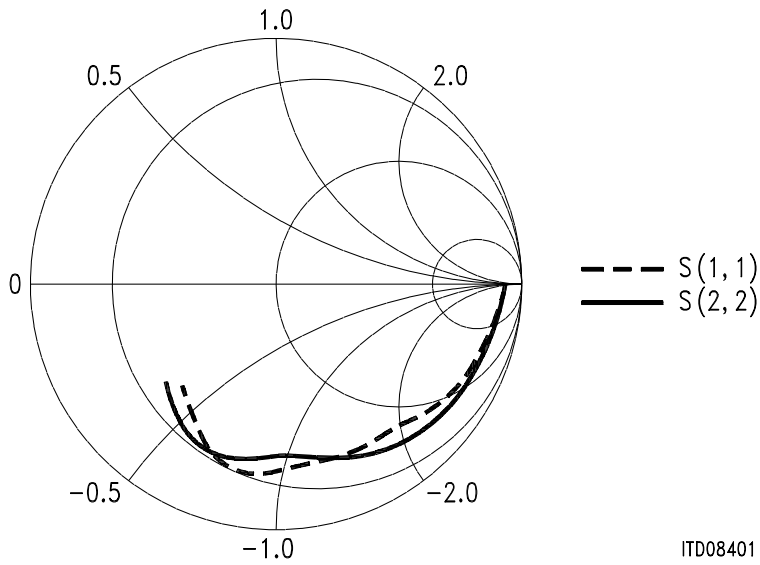
Electrical Characteristics

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



Electrical Characteristics

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



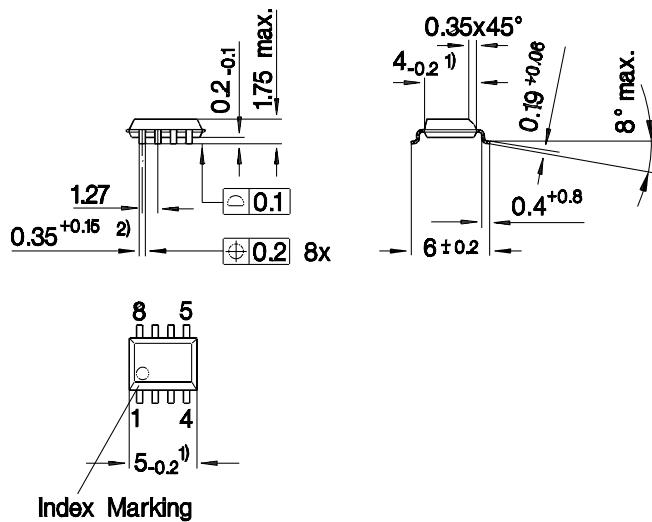
Application Circuit

Application circuit: In evaluation

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

3 Package Outlines

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



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

GPS05121

Sorts of Packing

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

SMD = Surface Mounted Device

Dimensions in mm

