



# Wireless Components

Mixer

PMB 2335 Version 1.1

Specification March 2000

preliminary

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# Productinfo

## General 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 externally 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.

## Package



**P-TSSOP-10-1**

## Features

- B6HF bipolar technology, 25GHz  $f_T$
- Gilbert cell mixer
- Reduced external components
- Mixer current adjustable with external resistors
- 1.6 mA current consumption typical ( no external resistors used)
- Excellent port isolation
- Low noise

- Low spurious signal content
- Power on pin
- Frequency range up to 3.0 GHz
- Supply voltage 2.7 - 4.5V
- -40°C to +85°C operational temperature range

## Application

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

## Ordering Information

Type	Ordering Code	Package
PMB 2335		P-TSSOP-10-1

# 1

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# 2 Product Description

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## 2.1 Overview

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 externally 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.

## 2.2 Features

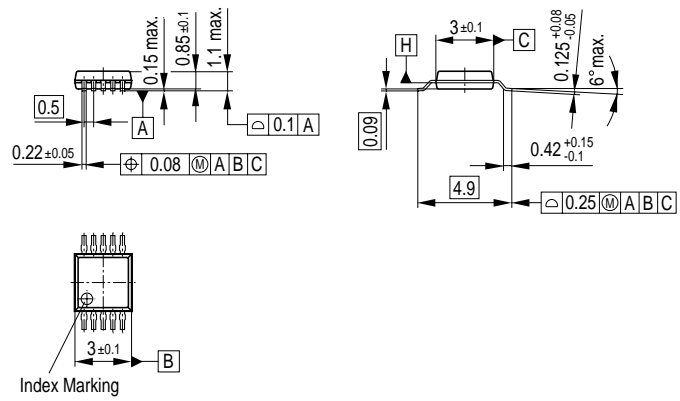
- B6HF bipolar technology, 25GHz  $f_T$
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- Low spurious signal content
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- Frequency range up to 3.0 GHz
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## 2.3 Application

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

## 2.4 Package Outlines

### P- TSSOP-10-1



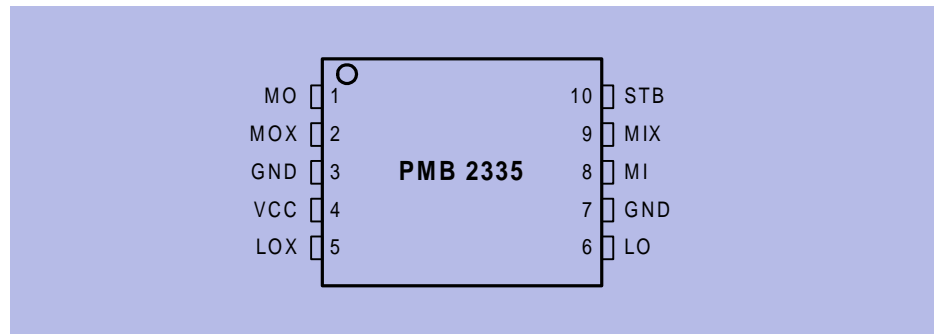
# 3 Functional Description

## Contents of this Chapter

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### 3.1 Pin Configuration



Pin\_config.wmf

Figure 3-1 Pin Configuration

### 3.2 Pin Definition and Function

Table 3-1 Pin Definition and Function			
Pin No.	Symbol	Equivalent I/O-Schematic	Function
1	MO		Mixer signal output, open collector, not inverted
2	MOX		Mixer signal output, open collector, inverted
3	GND		Ground (isolation) internally not connected
4	VCC		Mixer voltage supply
5	LOX		Mixer local oscillator signal base input, inverted
6	LO		Mixer local oscillator signal base input, not inverted
7	GND		Ground
8	MI		Mixer signal emitter input, not inverted
9	MIX		Mixer signal emitter input, inverted
10	STB		Mixer power down

### 3.3 Circuit Description

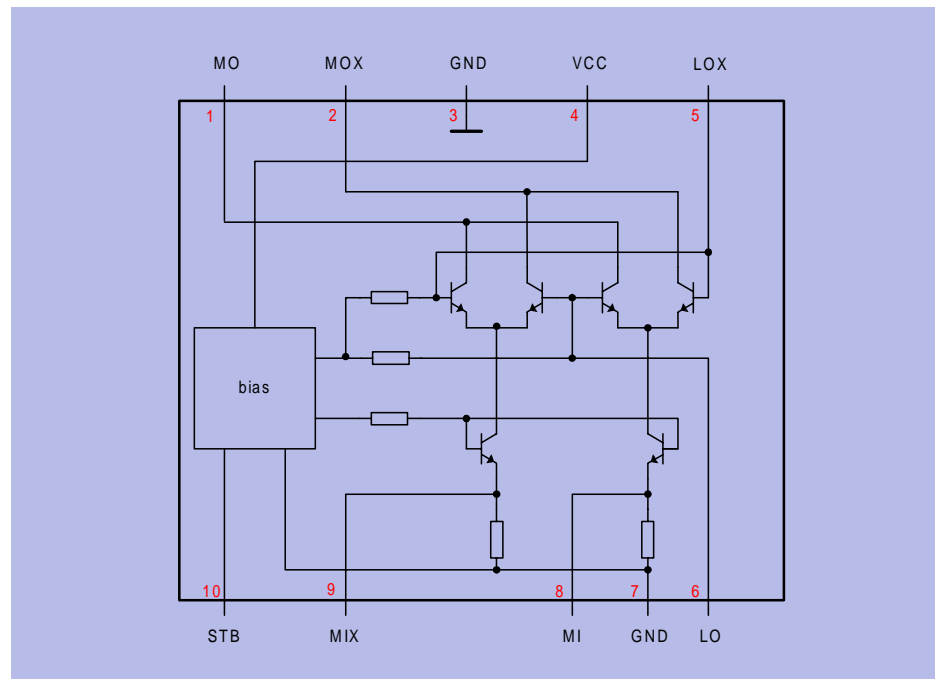
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Voltage supply for the mixer has to be connected to the pins  $V_{CC}$  and GND. To increase the mixer current resistors need to be connected between the pins MI and GND, and between the pins MIX and GND.

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.

### 3.4 Functional Block Diagram



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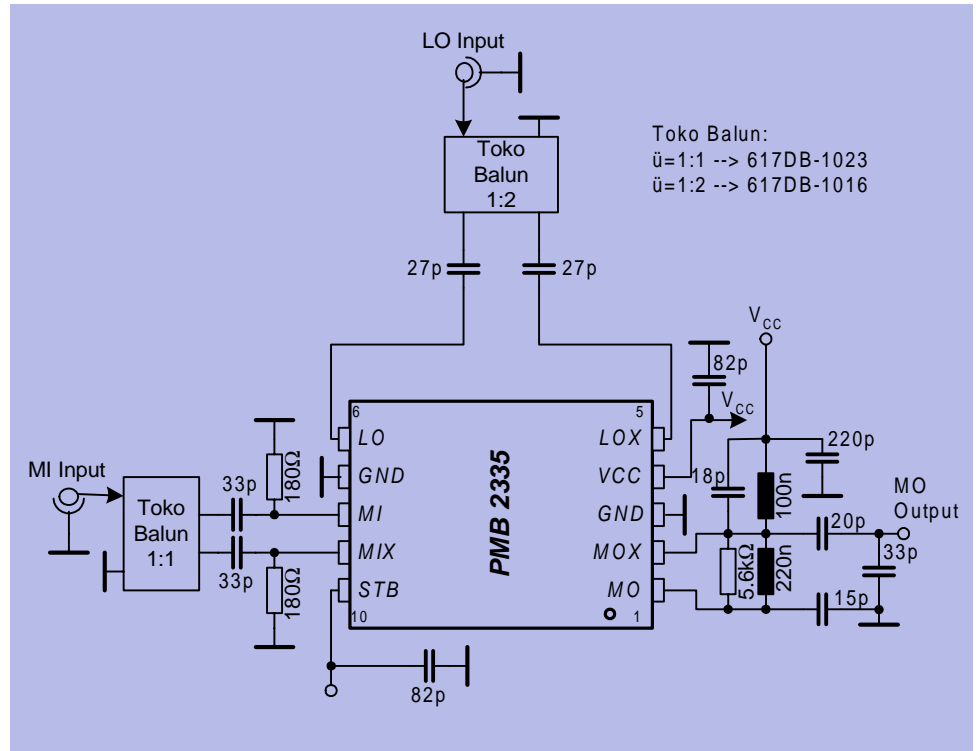
Figure 3-2 Functional Block Diagram

# 4 Applications

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### 4.1 Test Circuit 1



Test\_Circuit1.wmf

Figure 4-1 Test Circuit for 120 MHz intermediate frequency

## 4.2 Test Circuit 2

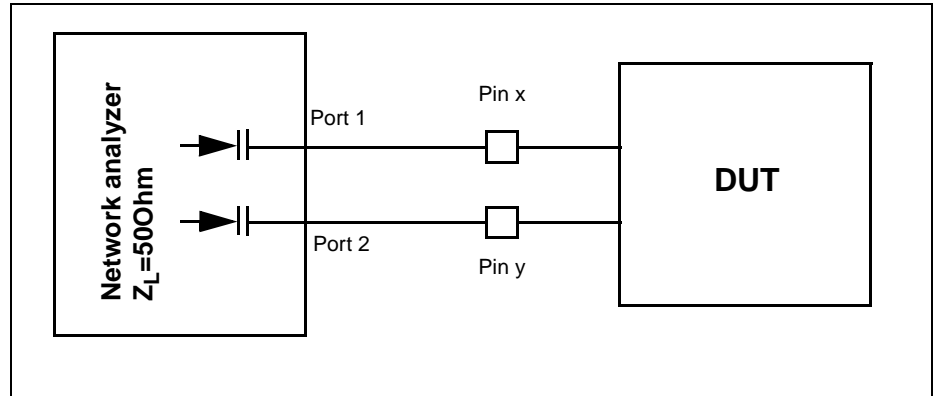


Figure 4-2 S-Parameter Measurement of Mixer S11, S12, S21, S22

Table 4-1			
Test	Test Frequency [GHz]	Pin X	Pin Y
LO-Input impedance	.. - 3.0	5	6
Mi-Input impedance	.. - 3.0	8	9
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 -20dbm for MI and MO-impedances and -3dbm for the LO impedance. S-Parameters have to be considered as design hints and are measured with Infineon test-boards (Compound board: RT/Duroid 3003 - FR4).

### 4.3 Test Circuit 2a

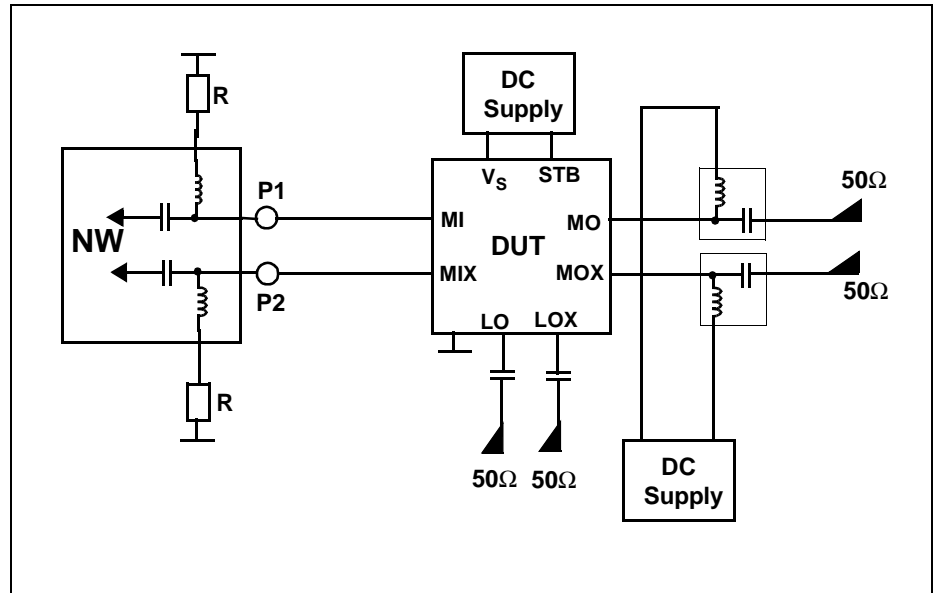


Figure 4-3 Mixer Input Impedance Measurement

### 4.4 Test Circuit 2b

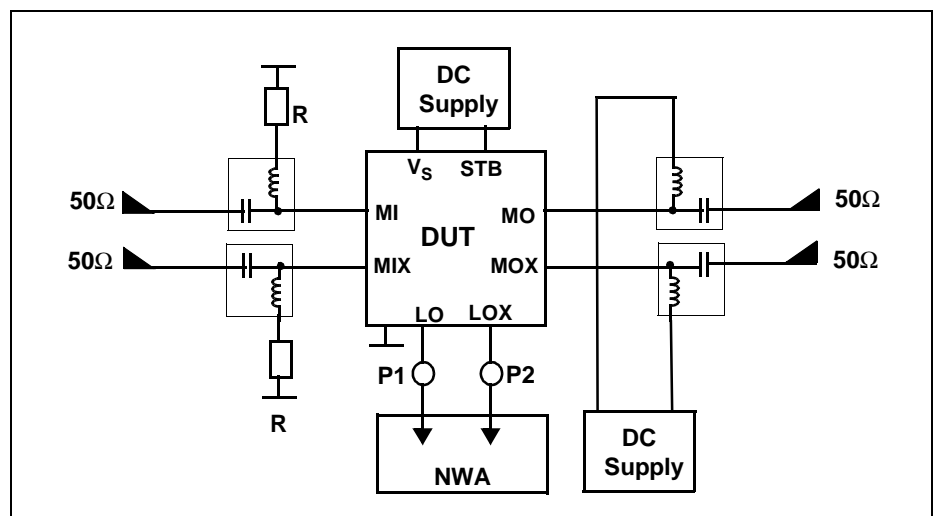


Figure 4-4 Mixer Local Oscillator Impedance Measurement

### 4.5 Test Circuit 2c

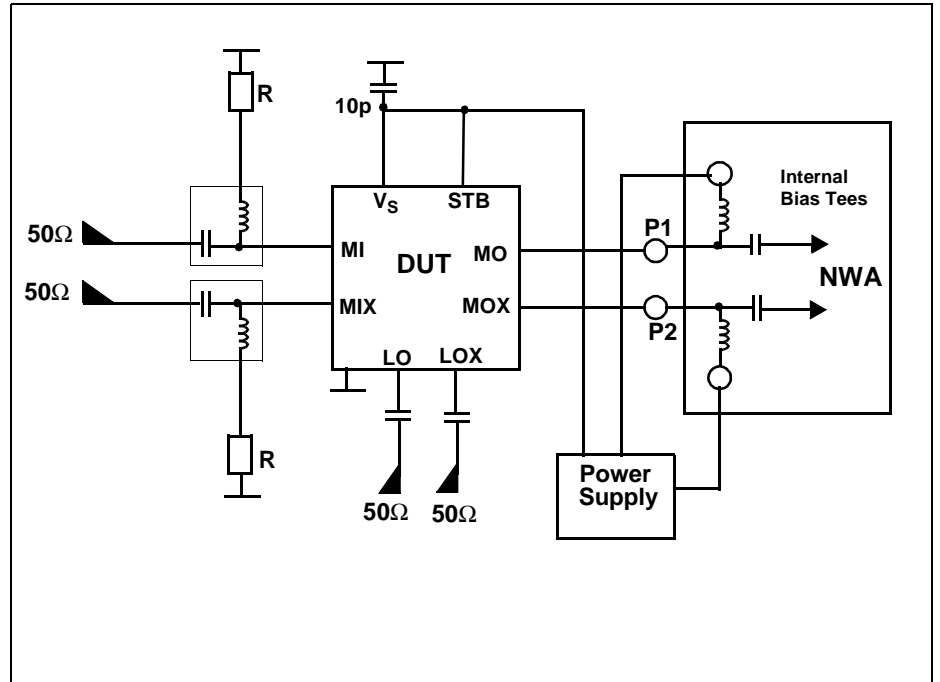


Figure 4-5 Mixer Output Impedance Measurement

# 5 Reference

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## 5.1 Absolute Maximum Ratings



### WARNING

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

**Table 5-1 Absolute Maximum Ratings**, Ambient temperature  $T_{amb} = -40 \dots 85^{\circ}\text{C}$

#	Parameter	Symbol	Limit Values		Unit	Remarks
			min	max		
1	Supply Voltage	$V_{VCC}$	-0.3	5.0	V	
2	Input Voltage STB	$V_{STB}$	-0.3	$V_S+0.3$ 5.0 max.	V V	
3	Input Voltage MI/MIX	$V_{MI/MIX}$	-0.3	1.9	V	$V_S = 0V$
4	Input Voltage LO/LOX	$V_{LO/LOX}$	0.6	$V_S+0.3$ 5.0 max.	V V	
5	Open Collector Output Voltage	$V_{MO/MOX}$	1.7	$V_S+0.3$ 5.0 max.	V V	
6	Open Collector Output Current	$I_{MO+MOX}$		13	mA	
7	Differential Input Voltage	$V_{DIFF}$		2.0	$V_{PP}$	
8	Junction Temperature	$T_j$		125	$^{\circ}\text{C}$	
9	Storage Temperature	$T_S$	-40	125	$^{\circ}\text{C}$	
10	Thermal Resistance	$R_{thJA}$		210	K/W	1)
11	ESD integrity	$V_{ESD}$	-1250	+1250	V	2)

1) Junction to Ambient

2) HBM according to MIL STD 883D, method 3015.7 and ESD Assn. Standard S5.1-1993

## 5.2 Operating Range

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

**Table 5-2 Operating Range**, Supply voltage  $V_{VCC} = 2.7V \dots 4.5V$ , Ambient temperature  $T_{amb} = -40 \dots 85^{\circ}\text{C}$

#	Parameter	Symbol	Limit Values		Unit	Test Conditions	L	Item
			min	max				
1	MI/X Input Frequency	$f_{MI}$		3000	MHz		■	
2	LO/X Input Frequency	$f_{LO}$		3000	MHz		■	
3	IF Intermediate Frequency	$f_{IF}$		3000	MHz		■	

Note: Power levels refer to  $50 \Omega$  impedance

Note: ■ This value is guaranteed by design

## 5.3 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.

**Table 5-3 AC/DC Characteristics with Supply voltage  $V_{VCC} = 2.7V \dots 4.5V$ , Ambient temperature  $T_{amb} = +25^{\circ}C$** 

#		Symbol	Limit Values			Unit	Test Conditions	L	Test Circuit
			min	typ	max				
<b>Supply Current</b>									
1	Supply current, total IC	$I_{1,2,4}$	1.1	1.6	2.1	mA	without external resistors $R_{1,2}$		1
2	Supply current, total IC	$I_{1,2,4}$		4.6		mA	including external resistors $R_1=R_2$ (=180 $\Omega$ )	■	1
<b>Minimum value for external resistors at MI/MIX <math>R_1=R_2=47\Omega</math>.</b>									
<b>MIXER, Signal Input MI/MIX, Down conversion, <math>R_1=R_2=180\Omega</math></b>									
3	Input impedance	$S_{11M}$	Diagram 2a					■	
4	Max. input level, 1 db comp. at MO/MOX, IF=120MHz	$P_{MI}$		-6		dBm	$f_{MI}=0.9GHz$	■	1
5	Max. input level, 1 db comp. at MO/MOX, IF=120MHz	$P_{MI}$		-7		dBm	$f_{MI}=1.8GHz$	■	1
6	Input intercept point, $\Delta f=800kHz$ , IF= 120MHz	$IICP3_{MI}$		3.5		dBm	$f_{MI}=0.9GHz$	■	1
7	Input intercept point, $\Delta f=800kHz$ , IF= 120MHz	$IICP3_{MI}$		2.5		dBm	$f_{MI}=1.8GHz$	■	1
8	Noise figure, dsb IF = 120MHz	$F_{MI}$		7.5		dB	$f_{MI}=0.9GHz$ *	■	1
9	Noise figure, dsb IF = 120MHz	$F_{MI}$		9.0		dB	$f_{MI}=1.8GHz$ *	■	1
<b>MIXER, Local Oscillator Input LO/LOX, <math>R_1=R_2=180\Omega</math></b>									
10	Input impedance	$S_{11LO}$	Diagram 2b					■	
11	Input level	$P_{LO}$		-5		dBm	$f_{MI}=0.9GHz$ , **	■	1
12	Input level	$P_{LO}$		-5		dBm	$f_{MI}=1.8GHz$ , **	■	1
<b>MIXER, Signal Output MO/MOX, Down conversion, <math>R_1=R_2=180\Omega</math></b>									
13	Output current	$I_{MO+MOX}$		4.0		mA		■	1
14	Output resistance	$R_{MODiff}$		31		k $\Omega$	$f_{MO} = 120\text{ MHz}$	■	1

\* ) matching network used

\*\* ) referenced for specified mixer performance

■ This value is guaranteed by design

**Table 5-3 AC/DC Characteristics with Supply voltage  $V_{VCC} = 2.7V \dots 4.5V$ , Ambient temperature  $T_{amb} = +25^{\circ}C$**   
 (continued)

	Symbol	Limit Values			Unit	Test Conditions	L	Test Circuit	
		min	typ	max					
15	Output capacitance	$C_{MODiff}$		0.41		pF	$f_{MO} = 120 \text{ MHz}$	■	1
16	Power gain, $f_{MI} = 0.9 \text{ MHz}$	$P_{MI}$		4.3		dB	$f_{MO} = 120 \text{ MHz}$	■	1
17	Power gain, $f_{MI} = 1.8 \text{ MHz}$	$P_{MI}$		4.3		dB	$f_{MO} = 120 \text{ MHz}$	■	1

**MIXER, Isolation Between In-/Output,  $R_1 = R_2 = 180 \Omega$** 

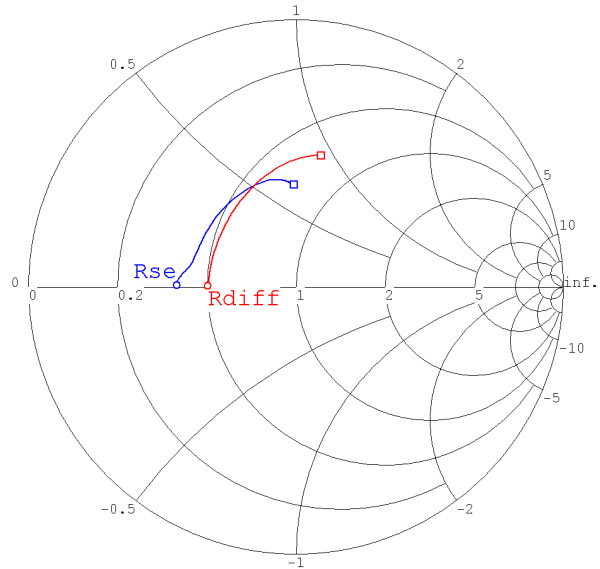
18	MI to MO	$A_{MI-MO}$		46		dB	$f_{MI} = 0.9 \text{ GHz}$	■	1
19	MI to MO	$A_{MI-MO}$		24		dB	$f_{MI} = 1.8 \text{ GHz}$	■	1
20	LO to MO	$A_{LO-MO}$		38		dB	$f_{LO} = 0.9 \text{ GHz}$	■	1
21	LO to MO	$A_{LO-MO}$		26		dB	$f_{LO} = 1.8 \text{ GHz}$	■	1
22	LO to MI	$A_{LO-MI}$		59		dB	$f_{LO} = 0.9 \text{ GHz}$	■	1
23	LO to MI	$A_{LO-MI}$		48		dB	$f_{LO} = 1.8 \text{ GHz}$	■	1
24	MO to MI	$A_{MO-MI}$		64		dB	$f_{MO} = 120 \text{ MHz}$	■	1
25	MO to LO	$A_{MO-LO}$		68		dB	$f_{MO} = 120 \text{ MHz}$	■	1

■ This value is guaranteed by design

Specification values without input transformer loss, ( $\approx 1 \text{ dB} @ 900 \text{ MHz}$ ;  $\approx 1.5 \text{ dB} @ 1.8 \text{ GHz}$ )

### 5.4 Input Impedance

◦ FMin = 10.00 MHz      Z0 = 50 Ohms

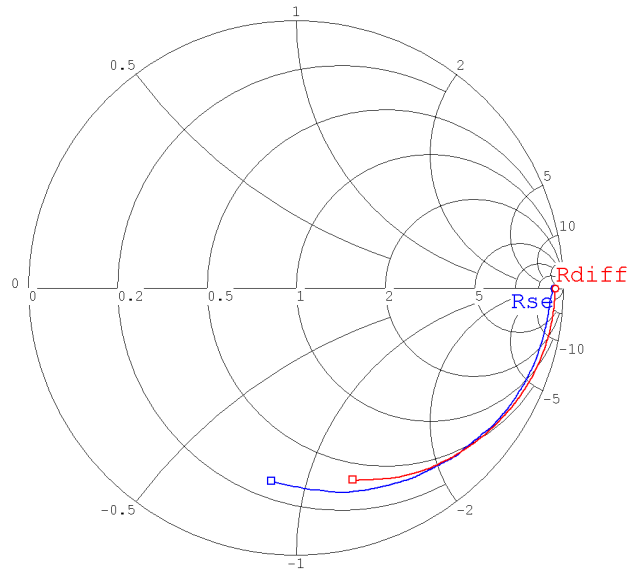


◻ FMax = 3000.00 MHz

mi5m02v7.wmf

Figure 5-1 Diagram 2a, MI/MIX- Input Impedance at 5mA, 2.7V

◦ FMin = 10.00 MHz      Z0 = 50 Ohms



◻ FMax = 3000.00 MHz

lo5m02v7.wmf

Figure 5-2 Diagram 2b, LO/LOX- Input Impedance at 5mA, 2.7V