

## 2-GHz Single Balanced Mixer

### Description

The U2796B-FP is a 2-GHz down conversion mixer for telecommunication systems, e.g. cellular radio, CT1, CT2, DECT, PCN, using TEMIC Semiconductors advanced bipolar technology. The U2796B is well suited

for the receiver portion of the RF circuit. Single balanced structure has been chosen for the best noise performance and low current consumption. The IIP3 is programmable.

### Features

- Supply voltage range: 2.7 to 5.5 V
- Excellent isolation characteristics
- Low current consumption: 3.2 mA without  $R_{IP3}$
- IIP3 programmable
- Input frequency operating range up to 2 GHz
- RF characteristic nearly independent of supply voltage

### Benefits

- Stand alone product
- Low current consumption extends talk time
- 3-V operation requires small space for batteries

### Block Diagram

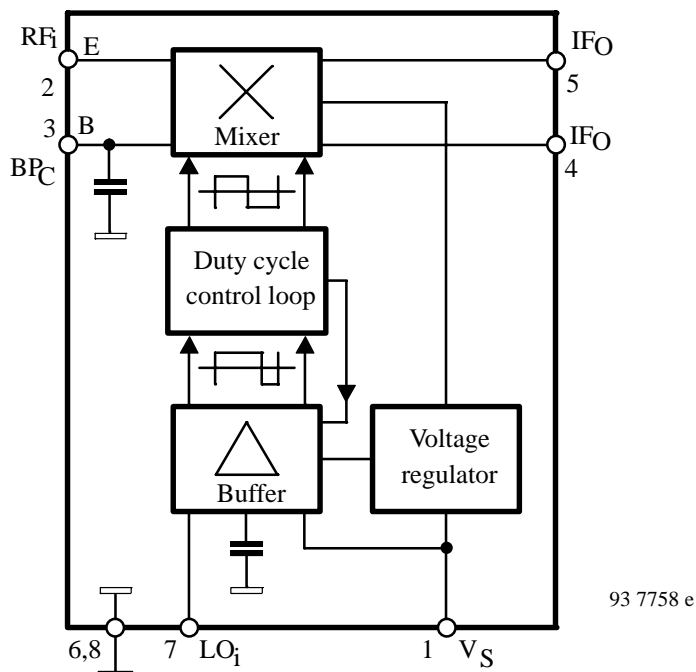
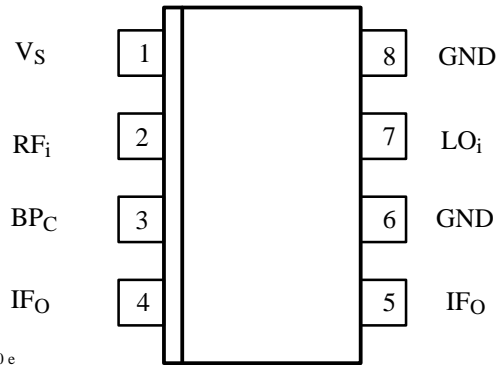


Figure 1.

## Pin Description



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Figure 2.

Pin	Symbol	Function
1	$V_S$	Supply voltage
2	RF	RF input and IIP3 programming port
3	BP <sub>C</sub>	By-pass capacitor
4	IF <sub>o</sub>	IF output
5	IF <sub>o</sub>	IF output
6	GND	Ground
7	LO <sub>i</sub>	Local oscillator input
8	GND	Ground

## Absolute Maximum Ratings

Parameters	Symbol	Value	Unit
Supply voltage Pin 1	$V_S$	6	V
Input voltage Pins 2, 3, 4, 5 and 7	$V_i$	0 to $V_S$	V
Junction temperature	$T_j$	125	°C
Storage temperature	$T_{stg}$	-40 to +125	°C

## Operating Range

Parameters	Symbol	Value	Unit
Supply voltage range Pin 1	$V_S$	2.7 to 5.5	V
Ambient temperature	$T_{amb}$	-40 to +85	°C

## Thermal Resistance

Parameters	Symbol	Value	Unit
Junction ambient SO8	$R_{thJA}$	175	K/W

## Electrical Characteristics

Test conditions (unless otherwise specified):

$V_S = 3\text{ V}$ ,  $f_{LO} = 900\text{ MHz}$ ;  $I_M = 1.2\text{ mA}$ ,  $T_{amb} = 25^\circ\text{C}$ . System impedance  $Z_O = 50\ \Omega$

Parameters	Test conditions / Pin	Symbol	Min.	Typ.	Max.	Unit
Supply voltage	Pin 1	$V_S$	2.7		5.5	V
Supply current	$R_{IP3} = \infty$ , Pin 1	$I_S$	2.8	3.2	3.7	mA
Conversion power gain  Figure 4	$R_L = 3\text{ k}\Omega$ , $R_{IP3} = \infty$ $f_{LO} = 900\text{ MHz}$	$P_{GC}$		9		dB
	$f_{LO} = 1700\text{ MHz}$ $f_{IF} = 45\text{ MHz}$			9		
<b>Isolation</b>						
LO-spurious at $RF_{in}$	$P_{iLO} = -10\text{ dBm}$ Figure 5 Pin 7 to 2	$IS_{LORF}$			-35	dBm
RF to LO  Figure 6	$P_{iRF} = -25\text{ dBm}$ Pin 2 to 7 $f_{LO} = 900\text{ MHz}$	$IS_{RFLO}$	30	40		dB
	$f_{LO} = 1700\text{ MHz}$			20		
<b>Operating frequencies</b>						
RF frequency	Pin 2	$RF_i$	2000			MHz
$LO_{in}$ frequency	Pin 7	$LO_i$	2000			MHz
$IF_{out}$ frequency	Pins 4 and 5	$IF_o$	300			MHz
<b>Input level</b>						
RF input (-1 dB comp.)	$R_L = 50\ \Omega$ , Pin 2	$P_{iRF}$		-15		dBm
3rd order intercept point	$P_{iLO} = -10\text{ dBm}$ , $R_{IP3} = \infty$ Figure 2 Pin 2	$IIP3$		-4		dBm
LO input	Pin 7	$P_{iLO}$		-6	0	dBm
<b>Impedances</b>						
RF input	Pin 2	$Z_{iRF}$		25		$\Omega$
LO input	Pin 7	$Z_{iLO}$		50		$\Omega$
IF output	Pins 4 and 5	$Z_{oIF}$		> 10 k $\Omega$ // 0.9 pF		
Noise figure (DSB)  Figure 7	$P_{iLO} = 0\text{ dBm}$ , $R_L > 3\text{ k}\Omega$ $f_{LO} = 900\text{ MHz}$	$NF_{50}$		9		dB
	$f_{LO} = 1700\text{ MHz}$			12		
Voltage standing wave ratio LO	Pin 7	VSWR- LO		1.3	2	

Note:  $I_M$  = Internal mixer current (see figure 2)

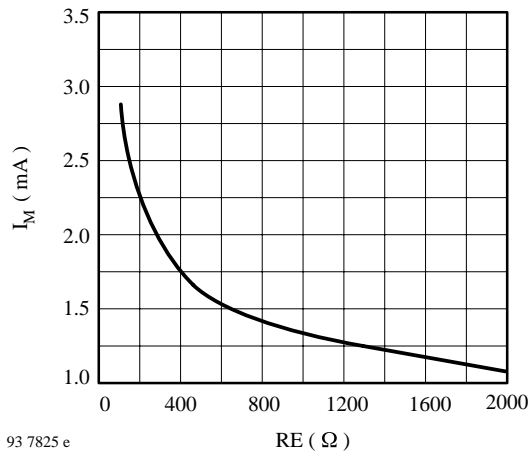


Figure 3. Mixer current (I<sub>M</sub>) versus RE

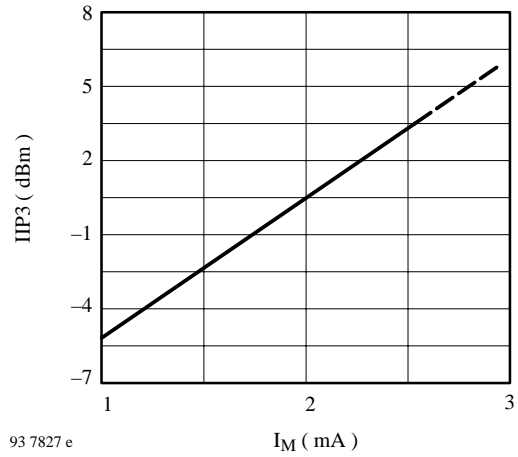


Figure 4. Third-order input intercept IIP3 point versus I<sub>M</sub>

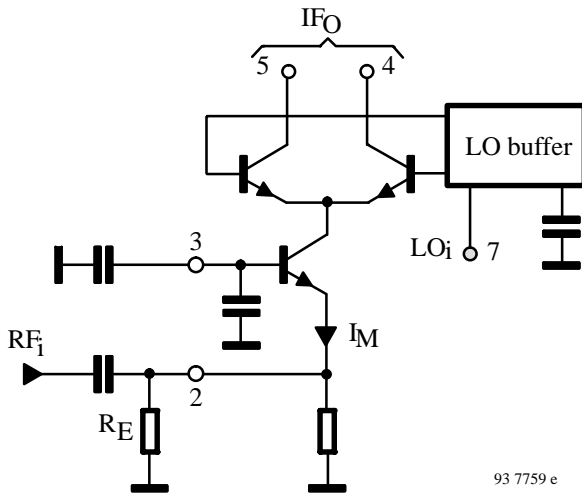
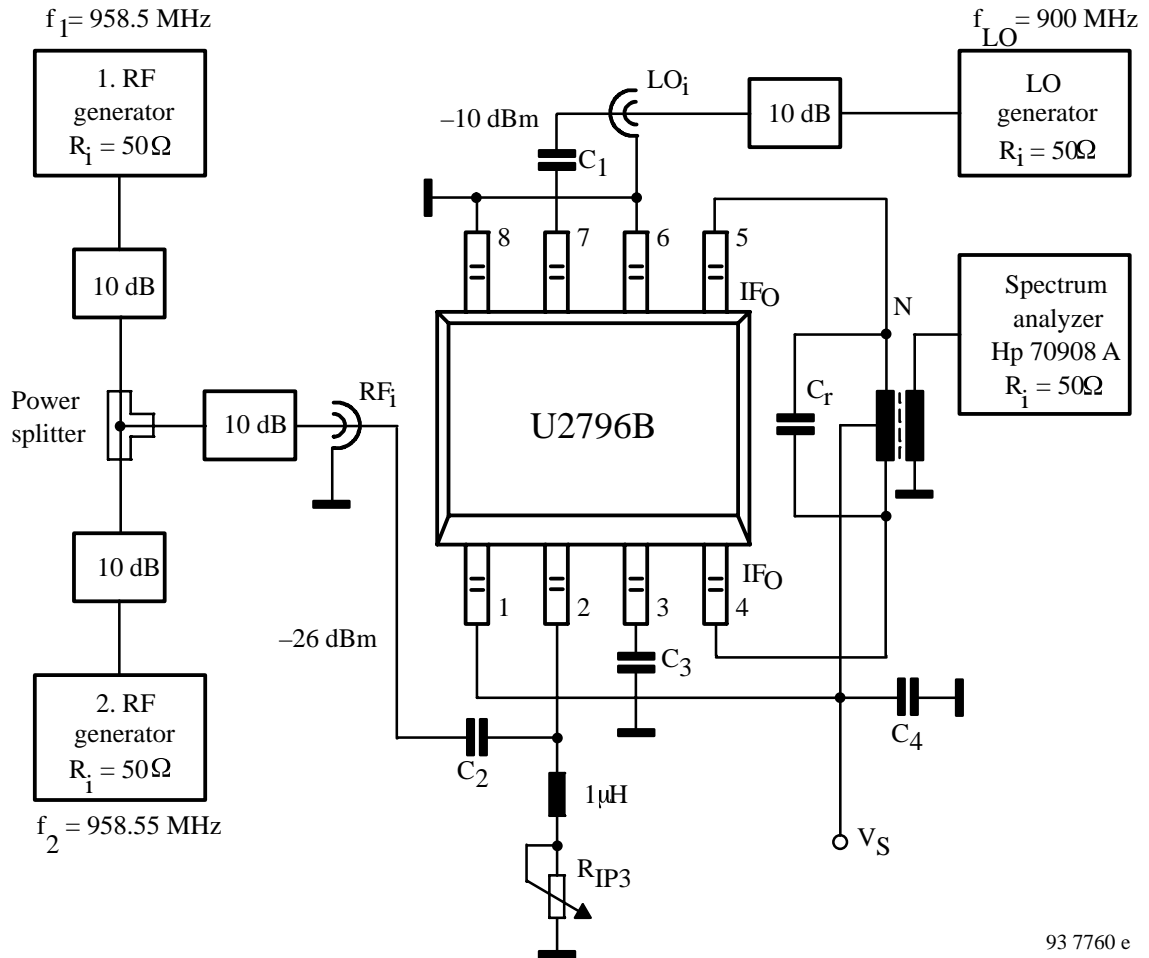


Figure 5. Mixer circuitry



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Figure 6. Test circuit-conversion power gain ( $PG_C$ ) and 3rd order input intercept point (IIP3)

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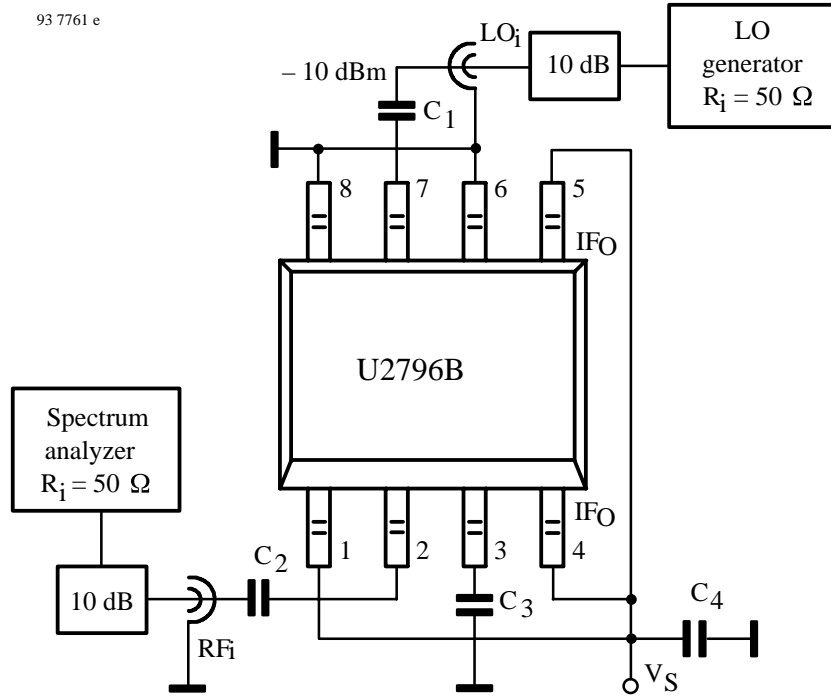
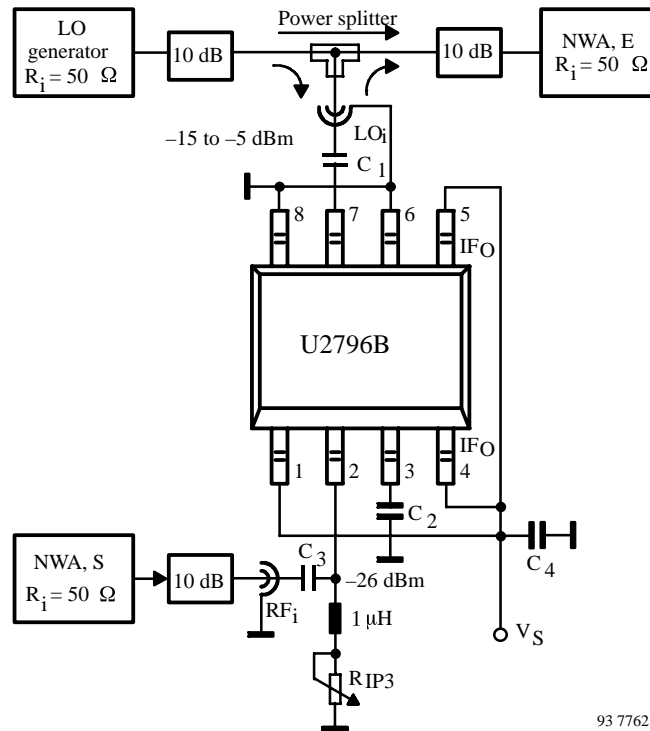
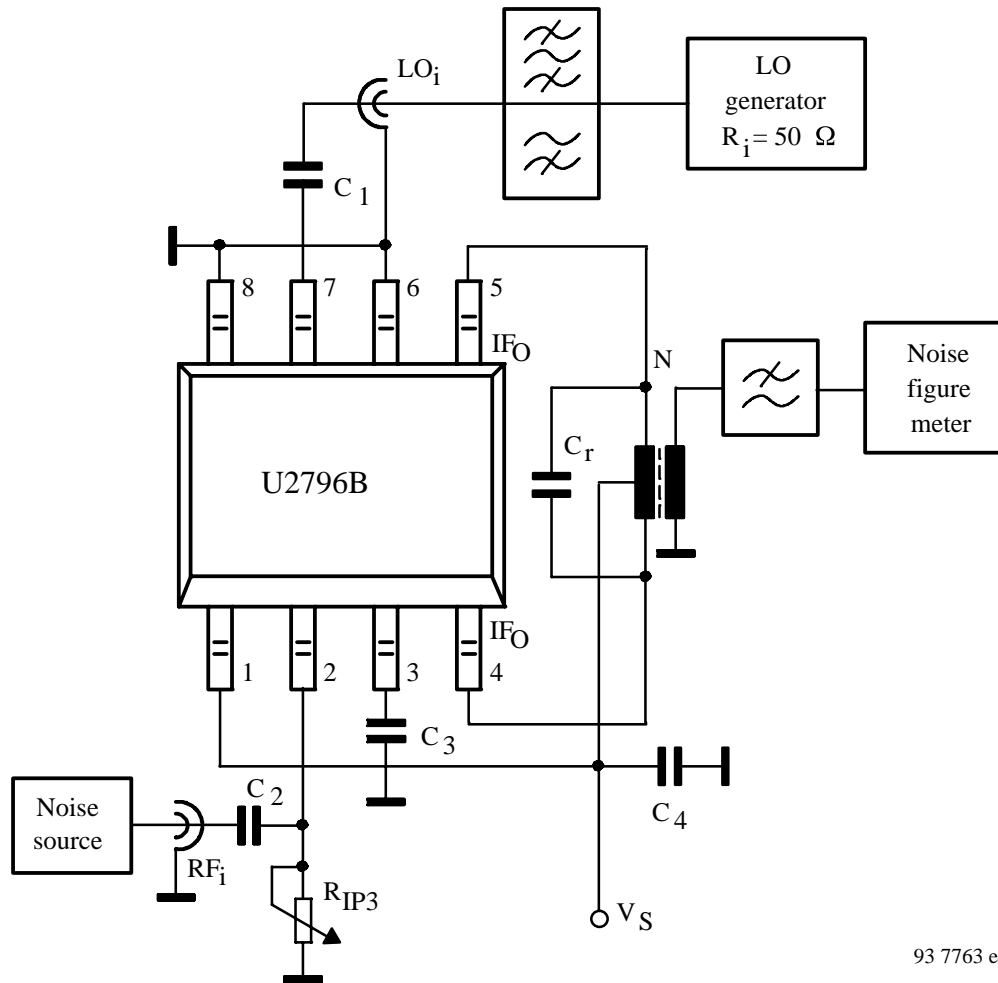


Figure 7. Test circuit-isolation LO to RF



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Figure 8. Test circuit-isolation RF to LO



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Figure 9. Test circuit-noise figure

Note:

1. The noise floor of the LO generator might influence the noise figure test result. In order to avoid this, either a band pass or a high pass filter with  $f_c > f_{IF}$  should be implemented.
2. If IF output network does not provide sufficient suppression of the LO component, a low pass filter should be inserted to avoid overdriving the noise figure meter.
3. For best noise performance 0 dBm LO power level is required.

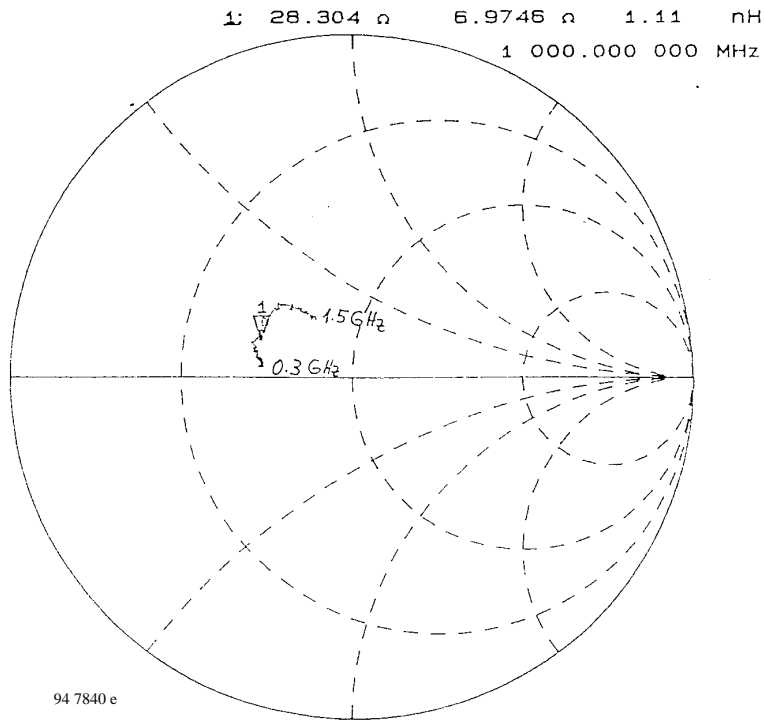


Figure 10. S11 RF input impedance

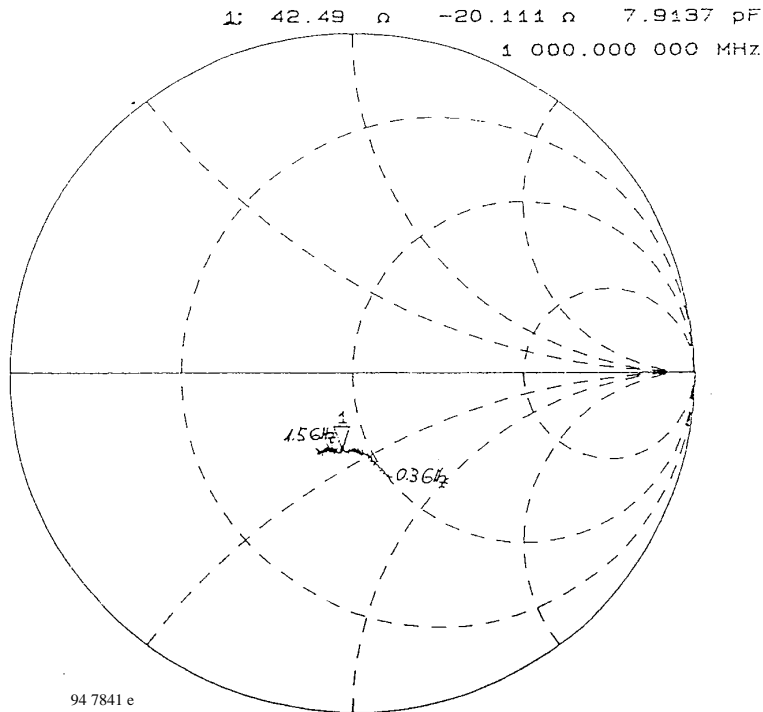


Figure 11. S11 LO input impedance



**Application Circuit**

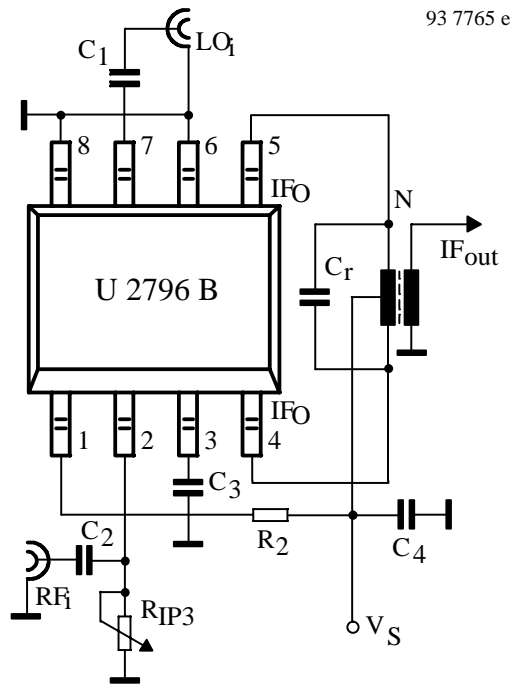


Figure 12.

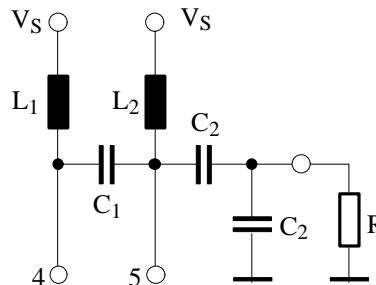
**Recommended Values for the Evaluator**

$C_1$  and  $C_2 = 150$  pF,  $C_3$  and  $C_4 = 100$  nF.  $C_r$  is calculated for resonance with the balun at  $f_{IF}$ , or as a high pass filter for  $f_{LO}$ . The output balun transformer ratio  $> = 8:1$  for  $Z_0 = 50 \Omega$ .  $R_2$  increases the IF output level and is calculated from:

$$R_2 = \frac{V_S(4,5) - V_S(1)}{I_S(1)}$$

For example  $V_S(4,5) = 4$  V,  $V_S(1) = 3$  V,  $I_S(1) = 2.2$  mA  
 $R_2 \approx 470 \Omega$ , where  $I_S(1)$  is the current consumption without the mixer stage.

impedance of a subsequent filter is  $1 \text{ k}\Omega$ , the capacitive voltage divider may be left out.



**Application Hint**

The output transformer at the pins 4 and 5 can be replaced by LC-circuits like one of the following proposals, which are saving space compared to the transformer and are suitable for higher IF frequencies. When applying one of these solutions, it has to be checked whether the requirements on noise figure and gain can be achieved.

The second circuit was dimensioned for approximately 130 MHz and a load resistance of  $50 \Omega$ . If for instance the

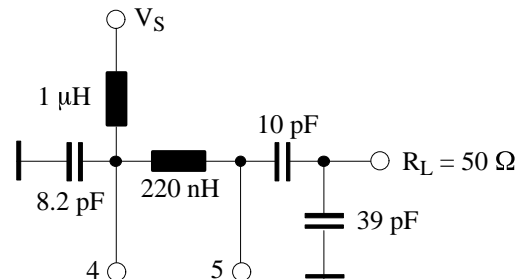
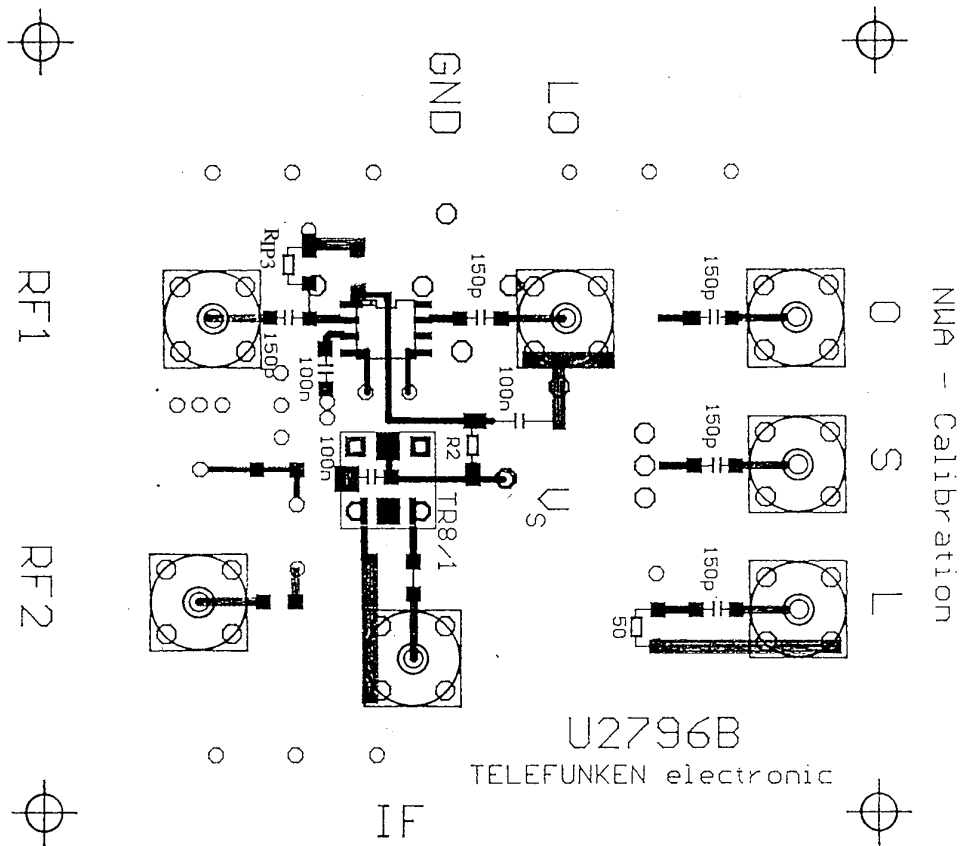


Figure 13.

## Evaluation Board



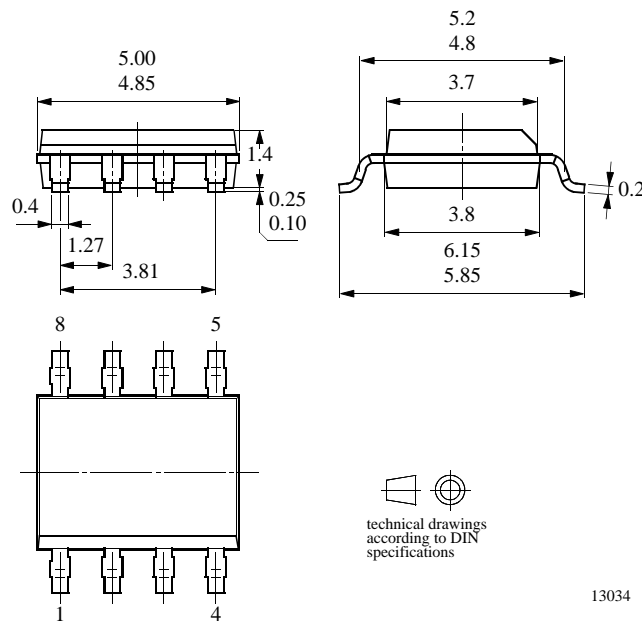
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Figure 14.

## Dimensions in mm

Package SO8

Dimensions in mm



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## Ozone Depleting Substances Policy Statement

It is the policy of **TEMIC Semiconductor GmbH** to

1. Meet all present and future national and international statutory requirements.
2. Regularly and continuously improve the performance of our products, processes, distribution and operating systems with respect to their impact on the health and safety of our employees and the public, as well as their impact on the environment.

It is particular concern to control or eliminate releases of those substances into the atmosphere which are known as ozone depleting substances (ODSs).

The Montreal Protocol (1987) and its London Amendments (1990) intend to severely restrict the use of ODSs and forbid their use within the next ten years. Various national and international initiatives are pressing for an earlier ban on these substances.

**TEMIC Semiconductor GmbH** has been able to use its policy of continuous improvements to eliminate the use of ODSs listed in the following documents.

1. Annex A, B and list of transitional substances of the Montreal Protocol and the London Amendments respectively
2. Class I and II ozone depleting substances in the Clean Air Act Amendments of 1990 by the Environmental Protection Agency (EPA) in the USA
3. Council Decision 88/540/EEC and 91/690/EEC Annex A, B and C (transitional substances) respectively.

**TEMIC Semiconductor GmbH** can certify that our semiconductors are not manufactured with ozone depleting substances and do not contain such substances.

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