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## 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 Atmel Wireless & Microcontrollers' advanced bipolar UHF technology. The U2796B is well suited for the receiver portion of the RF circuit. Single-balanced structure has been chosen for

best noise performance and low current consumption. The IIP3 is programmable.

Electrostatic sensitive device.

Observe precautions for handling.



### Features

- Supply-voltage range: 2.7 V 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 only small space for batteries

### Block Diagram

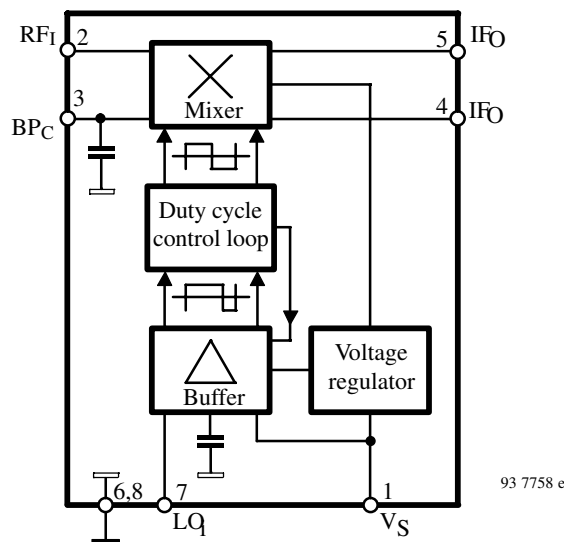
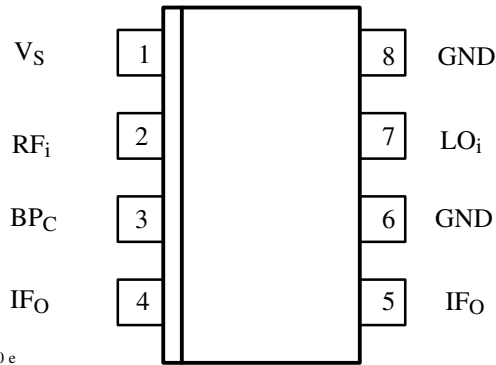


Figure 1. Block diagram

### Ordering Information

Extended Type Number	Package	Remarks
U2796B-MFP	SO8	Tube
U2796B-MFPG3	SO8	Taped and reeled

## Pin Description



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Figure 2. Pinning

Pin	Symbol	Function
1	$V_S$	Supply voltage
2	RF	RF input and IIP3 programming port
3	$BP_C$	Bypass capacitor
4	IFo	IF output
5	IFo	IF output
6	GND	Ground
7	$LO_i$	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):

$V_S = 3$  V,  $f_{LO} = 900$  MHz;  $I_M = 1.2$  mA,  $T_{amb} = 25$ °C. System impedance  $Z_O = 50$  Ω

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	$R_L = 3$ kΩ, $R_{IP3} = \infty$ $f_{LO} = 900$ MHz	$PG_C$		9		dB
	$f_{LO} = 1700$ MHz $f_{IF} = 45$ MHz			9		
Figure 4						

## Electrical Characteristics (continued)

Parameters	Test conditions / Pin	Symbol	Min.	Typ.	Max.	Unit
<b>Isolation</b>						
LO spurious at $RF_{in}$	$Pi_{LO} = -10$ dBm Figure 5 Pin 7 to 2	$IS_{LORF}$			-35	dBm
RF to LO Figure 6	$Pi_{RF} = -25$ dBm Pin 2 to 7 $f_{LO} = 900$ MHz	$IS_{RFLO}$	30	40		dB
	$f_{LO} = 1700$ 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.)	$RL = 50 \Omega$ , Pin 2	$Pi_{RF}$		-15		dBm
3rd-order intercept point	$Pi_{LO} = -10$ dBm, $R_{IP3} = \infty$ Figure 2 Pin 2	IIP3		-4		dBm
LO input	Pin 7	$Pi_{LO}$		-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	$Pi_{LO} = 0$ dBm, $RL > 3$ k $\Omega$ $f_{LO} = 900$ MHz	$NF_{50}$		9		dB
	$f_{LO} = 1700$ MHz			12		
Voltage standing wave ratio LO	Pin 7	VSWR-LO		1.3	2	

Note:  $I_M$  = Internal mixer current (see figure 3)

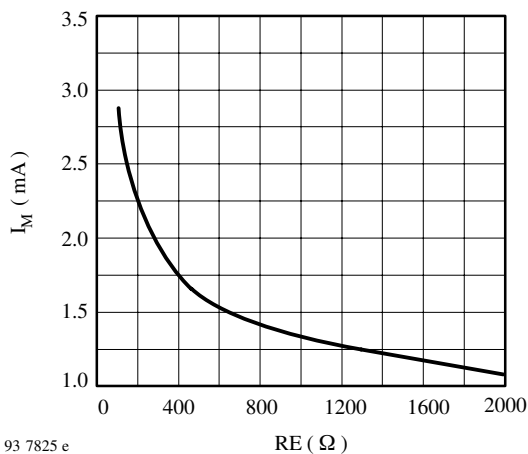


Figure 3. Mixer current ( $I_M$ ) versus RE

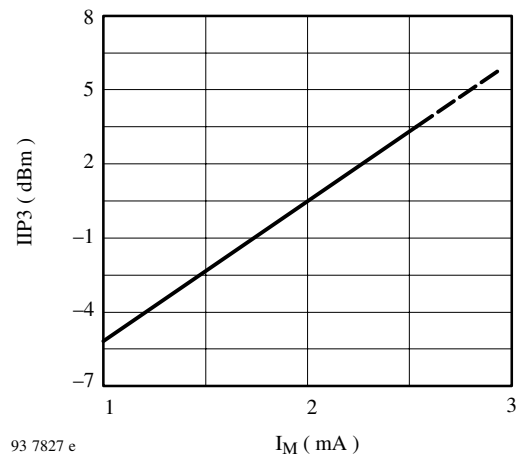


Figure 4. Third-order input intercept IIP3 point versus  $I_M$

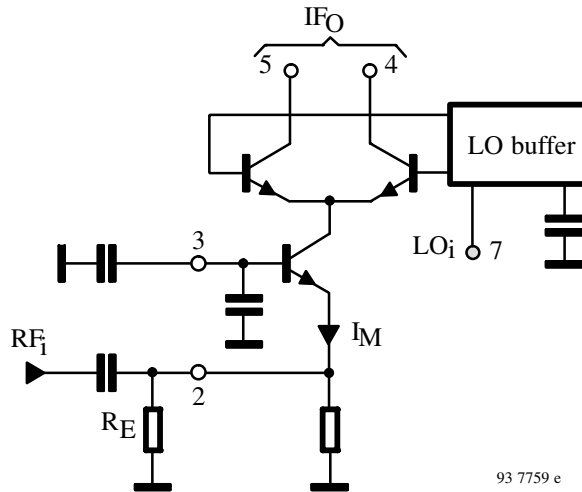


Figure 5. Mixer circuitry

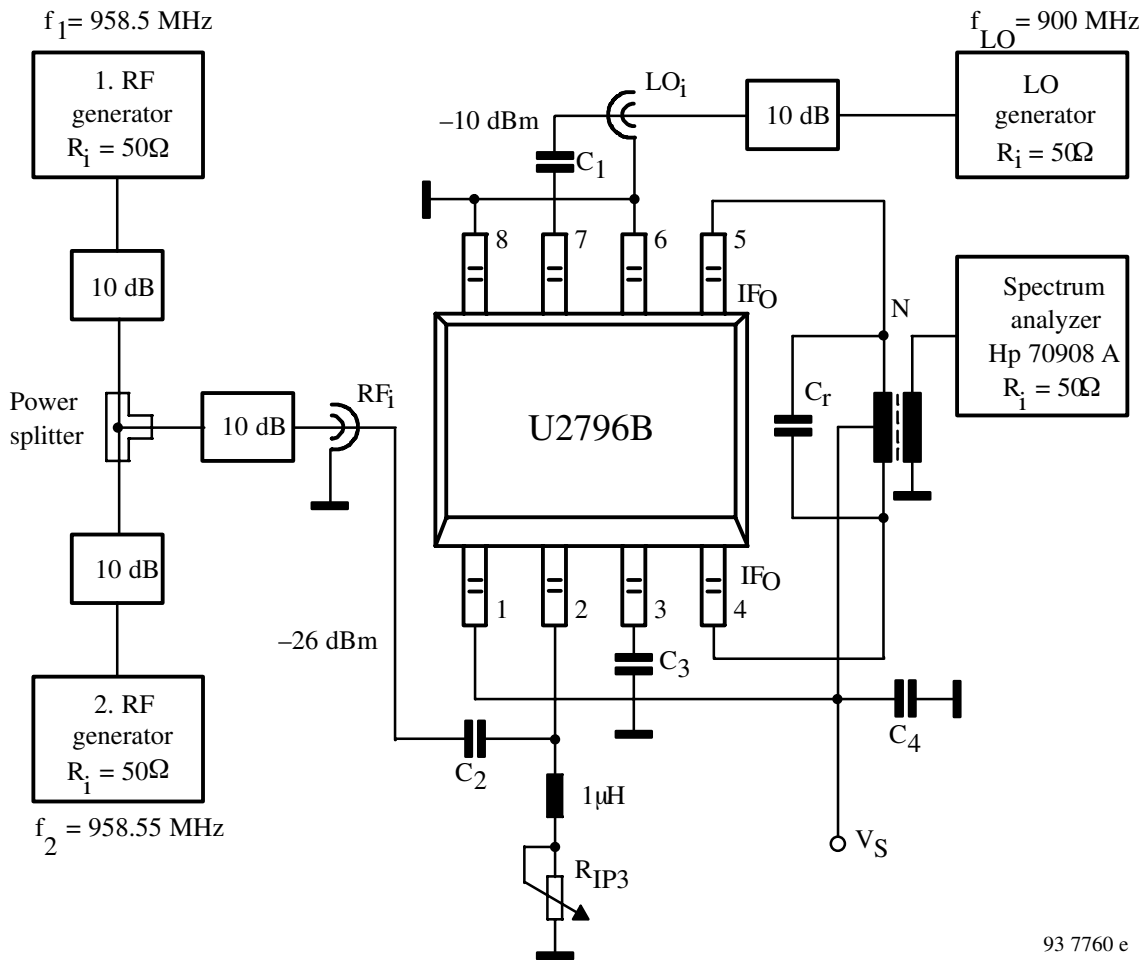


Figure 6. Test circuit conversion power gain ( $PG_C$ ) and 3rd-order input intercept point ( $IIP_3$ )

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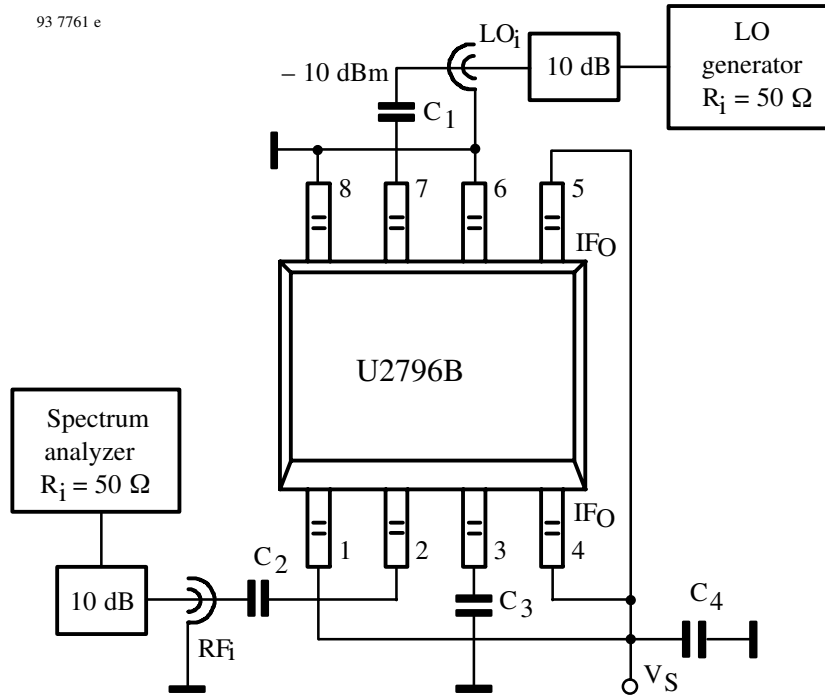
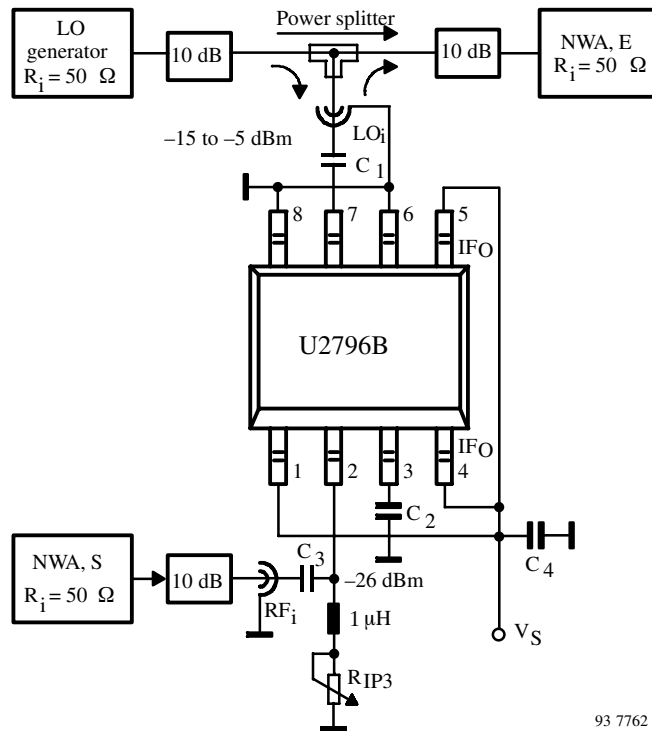


Figure 7. Test circuit isolation LO to RF



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Figure 8. Test circuit isolation RF to LO

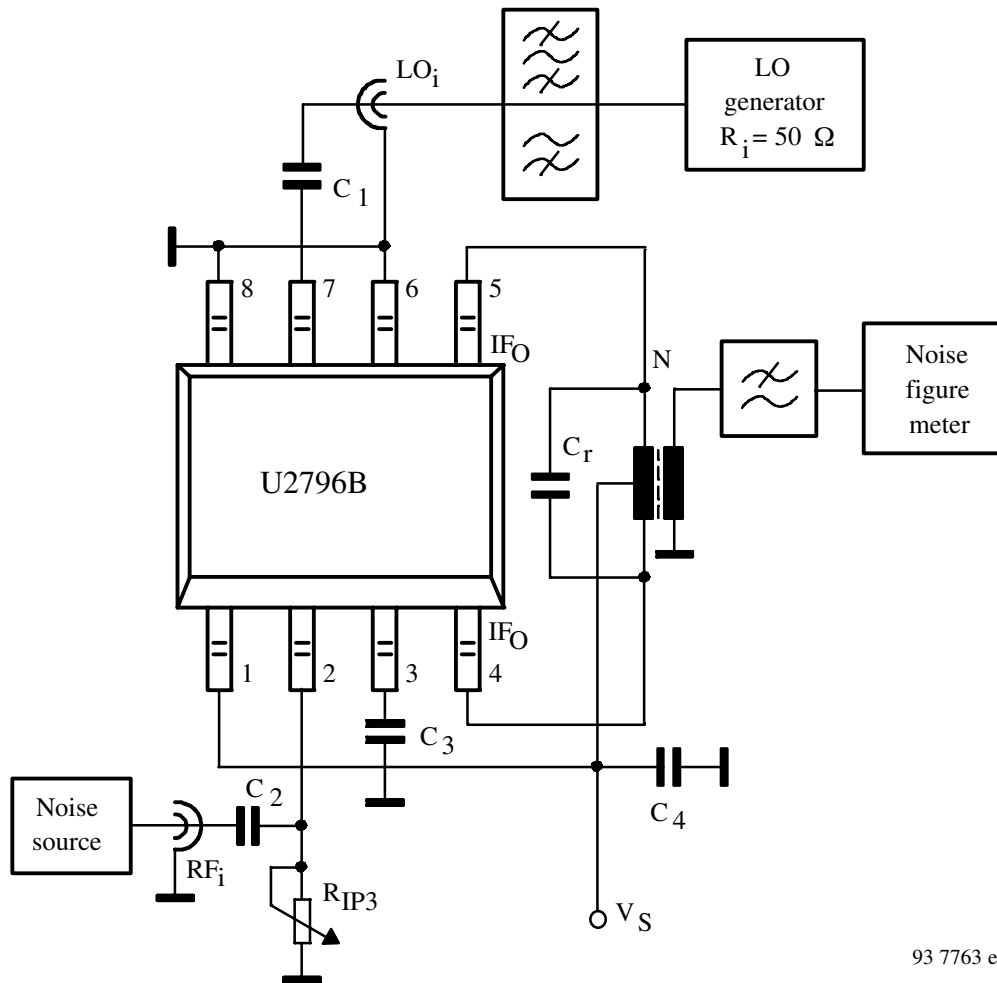


Figure 9. Test circuit noise figure

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Note:

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

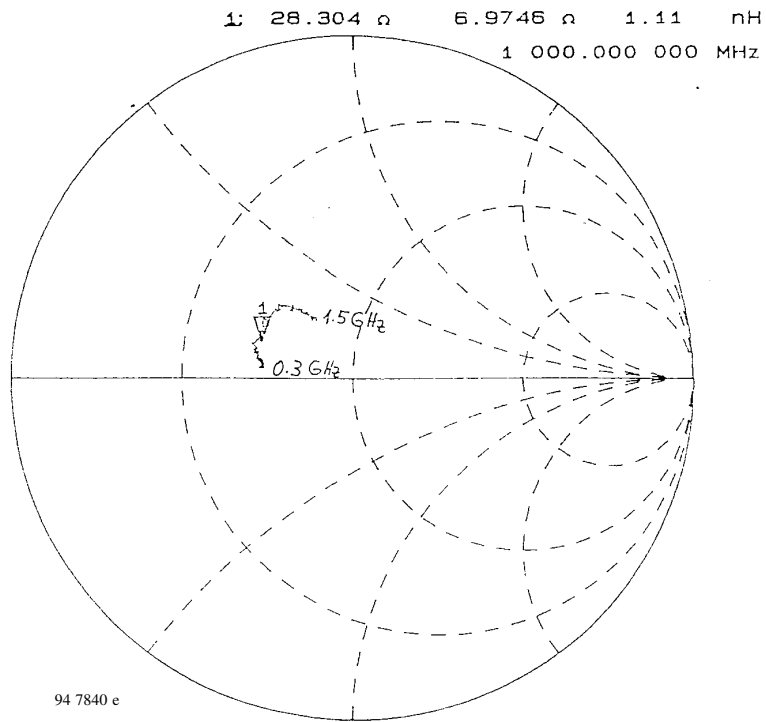


Figure 10. S11 RF input impedance

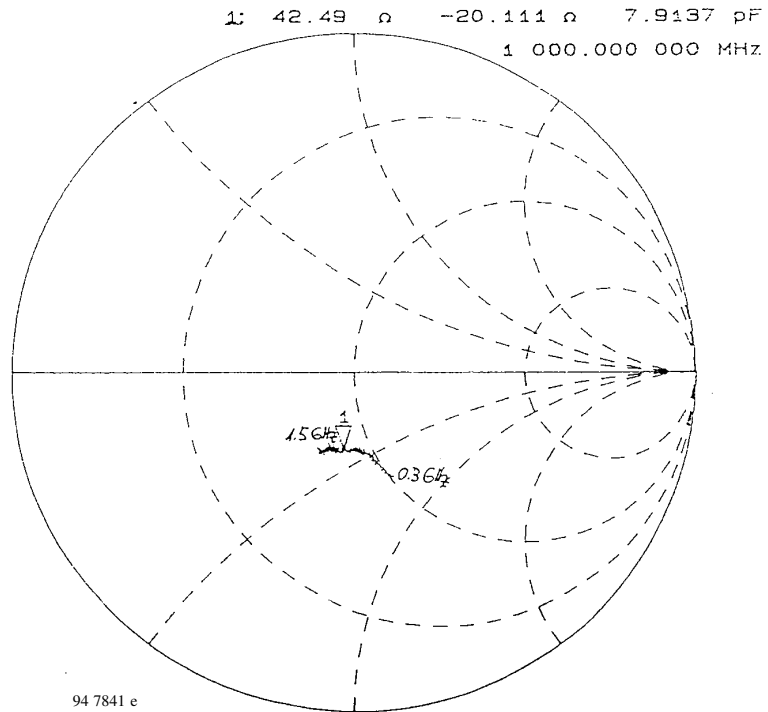


Figure 11. S11 LO input impedance



## Application Circuit

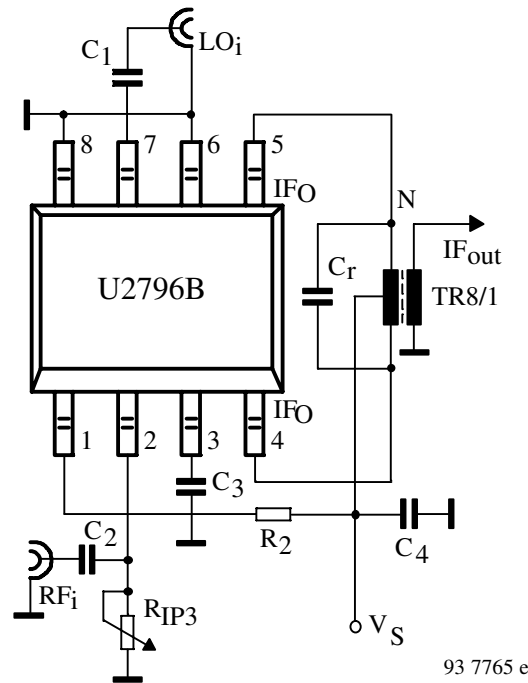


Figure 12. Application circuit

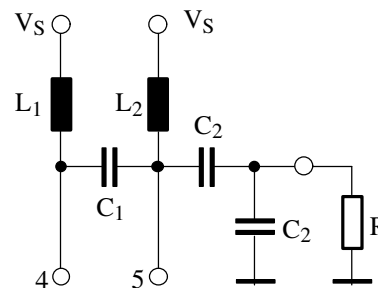
## Recommended Values for the Evaluator

$C_1$  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 highpass filter for  $f_{LO}$ . The output balun transformer ratio  $> = 8:1$  for  $Z_O = 50 \Omega$ .  $R_2$  increases the IF output level and is calculated from:

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

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.

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



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## Application Hint

The output transformer at the Pins 4 and 5 can be replaced by LC circuits as shown in figure 13. Compared to transformer, LC circuits save space 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,

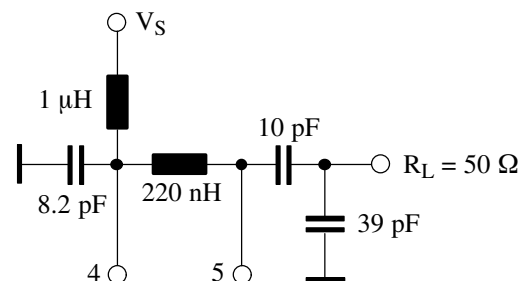


Figure 13.

**Evaluation Board**

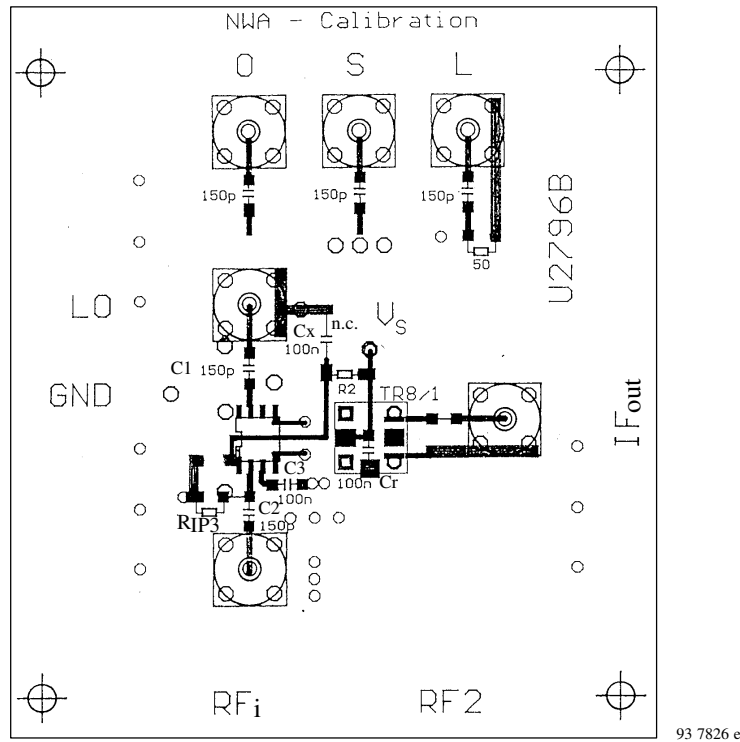
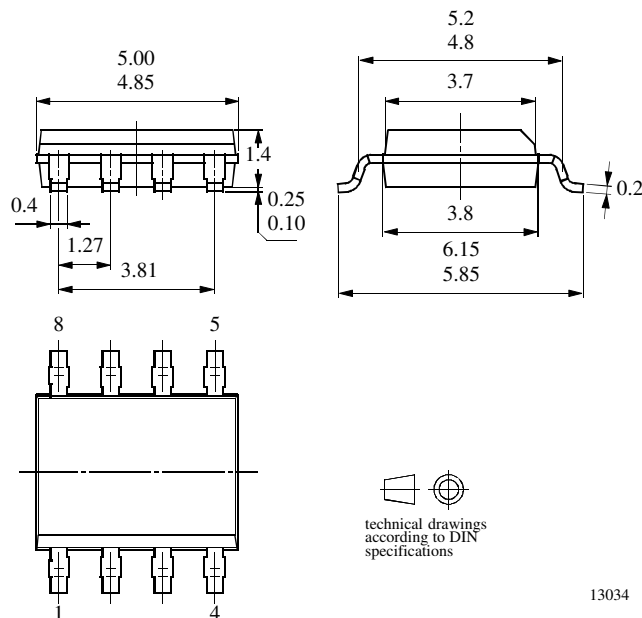


Figure 14. Evaluation board with application circuit

**Package Information**

Package SO8  
Dimensions in mm



## Ozone Depleting Substances Policy Statement

It is the policy of **Atmel Germany 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.

**Atmel Germany 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.

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

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