

038391

The TUA 2000-4 is a monolithically integrated circuit and suitable as a tuner for the VHF range up to 400 MHz, e.g. for TV tuners.

**RF section**

- Few external components
- Stable oscillator frequency and amplitude with very low interference radiation
- Optimal rejection of oscillator and input frequencies at the IF output due to a decoupled active ring mixer circuit
- High interference voltage resistance
- High-impedance mixer input, for symmetrical and asymmetrical connections
- IF post-amplifier for the UHF IF signal

**IF section**

- Optimal cross-talk rejection
- Large signal-modulation range
- Low noise figure with wide minimum over large load-impedance range

**Maximum ratings**

Supply voltage range $V_3 \leq V_S$	$V_S$	-0.3 to 16.5	V
Reference voltage $V_S \geq V_3$	$V_3$	-0.3 to 8.3	V
Voltage at pin 1, 2 $V_3 \leq V_{1,2}$	$V_{1,2}$	-0.3 to 16.5	V
Voltage at pin 8, 9 $V_3 \leq V_{8,9}$	$V_{8,9}$	-0.3 to 16.5	V
Voltage at pin 14 $V_{14} \leq V_S$	$V_{14}$	-0.3 to 16.5	V
AC voltage at pin 4, 5, 6, 11, 12, 13, 15	$V_{rms}$	0 to 0.5	V
Junction temperature	$T_j$	150	°C
Storage temperature range	$T_{stg}$	-40 to 125	°C
Thermal resistance (system-air)	$R_{th SA}$	80	K/W

Only the specified external circuitry may be applied to pins 4, 5, 6, 11, 12, 13, 15.

**Operating range**

Supply voltage	$V_S$	9 to 15	V
Reference voltage	$V_3$	7.2 to 8.2	V
Input frequency — mixer section	$f_{M12/13}$	10 to 400	MHz
Input frequency of the UHF IF amplifier	$f_{UHF11}$	10 to 400	MHz
Input frequency of the SAW amplifier	$f_{IF15}$	10 to 400	MHz
Oscillator amplifier depending on the oscillator circuitry at pin 4, 5	$f_{OSC4,5}$	10 to 400	MHz
Voltage at pin 1, 2, 8, 9	$V_{1,2,8,9}$	9 to 15	V
Output frequency of the mixer/UHF	$f_{IFM/UHF8/9}$	10 to 400	MHz
Output frequency of the SAW amplifier	$f_{IF1,2}$	10 to 400	MHz
Ambient temperature	$T_A$	0 to 70	°C

**Characteristics** $V_S = 12\text{ V}$ ;  $V_3 = 7.5\text{ V}$ ;  $T_A = 25\text{ }^\circ\text{C}$ 

		min	typ	max	
Total current consumption	$I_{10,1,2,8,9,3}$				
$I_{14} = 0$ ; $V_3 = 7.2\text{ V}$ ; $V_S = 9\text{ V}$		37	49	60	mA
$I_{14} = 0$ ; $V_S = 12\text{ V}$		40	52	64	mA
Current consumption at pin 3	$I_3$	14	19	25	mA
$I_{14} = 0$					
Output characteristic	$\Delta I_{8,9}$			100	$\mu\text{A}$
$V_{8,9} = 9\text{--}15\text{ V}$ ; $V_3 = 7.8\text{ V}$					
Output characteristic	$\Delta I_{1,2}$			200	$\mu\text{A}$
$V_{1,2} = 9\text{--}15\text{ V}$ ; $V_3 = 7.8\text{ V}$					
UHF switching voltage	$V_{14\text{ UHF}}$	7		$V_S$	V
$V_{1(u)} = -25\text{ dBm}$					
$V_Q \geq -5\text{ dBm}$ ; $f_{IF} = 36.15\text{ MHz}$					
VHF switching voltage	$V_{14\text{ VHF}}$	0		3	V
$V_{1(u)} = -25\text{ dBm}$					
$V_Q \leq -30\text{ dBm}$ ; $f_{IF} = 36.15\text{ MHz}$					
Mixer gain	$G_{60}$	25	27	29	dB
Bd I; $V_{1(RF)} = -40\text{ dBm}$ ; $f_{RF} = 60\text{ MHz}$ ; $f_{IF} = 36.15\text{ MHz}$ ; $R_{G12/13} = 100\ \Omega$ ; refer to response characteristic page 750					
Mixer gain	$G_{220}$	25	27	29	dB
Bd III; $V_{1(RF)} = -40\text{ dBm}$ ; $f_{IF} = 36.15\text{ MHz}$ ; $R_{G12/13} = 100\ \Omega$ ; refer to response characteristic page 751					
Mixer noise	$NF_{60}$			13	dB
Bd I, white noise $R_{G12/13} = 100\ \Omega$ ; refer to response characteristic page 750					
Mixer noise	$NF_{220}$			14	dB
Bd III; white noise $R_{G12/13} = 100\ \Omega$ ; refer to response characteristic page 751					
Gain UHF input	$V_{UHF}$	31	33	35	dB
$V_{1(u)} = -40\text{ dBm}$ ; $V_{14} = V_S = 12\text{ V}$ $f_{RFU} = f_{IF} = 36.15\text{ MHz}$ ; $R_{G11} = 200\ \Omega$ ; refer to response characteristic page 751					
Noise figure UHF input	$NF_{UHF}$			7	dB
$V_{14} = V_S = 12\text{ V}$ ; white noise $R_{G11} = 200\ \Omega$ ; refer to response characteristic page 751					
Oscillator turn-on drift	$f_{OSC}$	-10		-250	kHz
$V_D = 28\text{ V}$ ; $t = 0\text{--}500\text{ ms}$ ; Bd II; $f_{OSC} = 216\text{ MHz}$					
Oscillator turn-on drift	$f_{OSC}$	-10		-450	kHz
$V_D = 28\text{ V}$ ; $t = 0\text{--}10\text{ s}$ ; Bd II; $f_{OSC} = 216\text{ MHz}$					

**Additional application data**

Differential input resistance<sup>1)</sup>

Differential input capacitance<sup>1)</sup>

IF input resistance<sup>1)</sup>

IF input capacitance<sup>1)</sup>

UHF input resistance<sup>1)</sup>

UHF input capacitance<sup>1)</sup>

Interference voltage resistance Bd I<sup>2)</sup>

$$m_N = 1\%; m_{int} = 80\%;$$

$$f_{int} = f_N \pm 15 \text{ MHz}$$

$$f_{mod} = 1 \text{ kHz}; f_N = 65 \text{ MHz}$$

refer to response characteristic

Interference voltage resistance Bd II<sup>2)</sup>

$$m_N = 1\%; m_{int} = 80\%;$$

$$f_{int} = f_N \pm 15 \text{ MHz}$$

$$f_{mod} = 1 \text{ kHz}; f_N = 220 \text{ MHz}$$

refer to response characteristic

	min	typ	max	
$R_{12/13}$		3		kΩ
$C_{12/13}$		2.7		pF
$R_{15}$		2		kΩ
$C_{15}$		3.9		pF
$R_{11}$		2.2		kΩ
$C_{11}$		3.4		pF
$V_{int(EMF/2) rms}$		38		mV
$V_{int(EMF/2) rms}$		30		mV

**Note on characteristics**

Due to quasi no-load of the transformer output and  $2 \times 50 \Omega$  source impedance, the interference voltage at pins 12/13 is calculated by

$$V_{int12/13} \approx V_{int(source/2)} \times 2 \times \sqrt{2}$$

<sup>1)</sup> Measured S parameter values converted to Y parameters

<sup>2)</sup> See: Measurement configuration to measure cross modulation

**Circuit description**

The TUA 2000-4 contains a symmetrical mixer input, as well as a multiplicative mixer. The oscillator amplitude is regulated. All oscillator operating currents and voltages are stabilized, so that the oscillator's amplitude and frequency are largely independent of temperature and operating voltage changes.

The IF amplifier has been provided with a high impedance input.

The output has two open collector connections.

During UHF operation, oscillator and mixer are switched off and the UHF IF input coupling stage is activated.

**RF section**

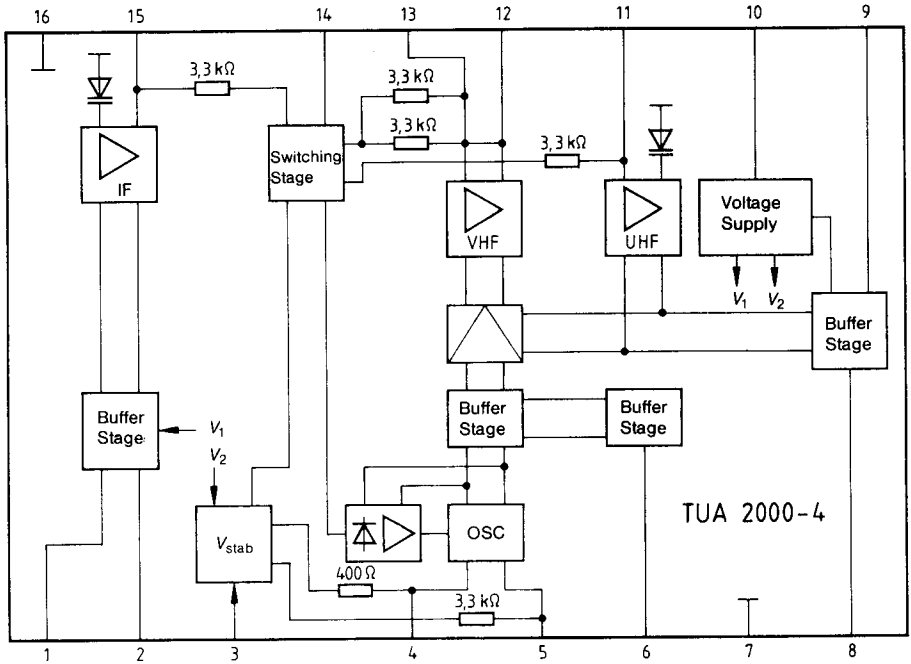
- Few external components
- Stable oscillator frequency and amplitude with very low interference radiation
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**IF section**

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Block diagram

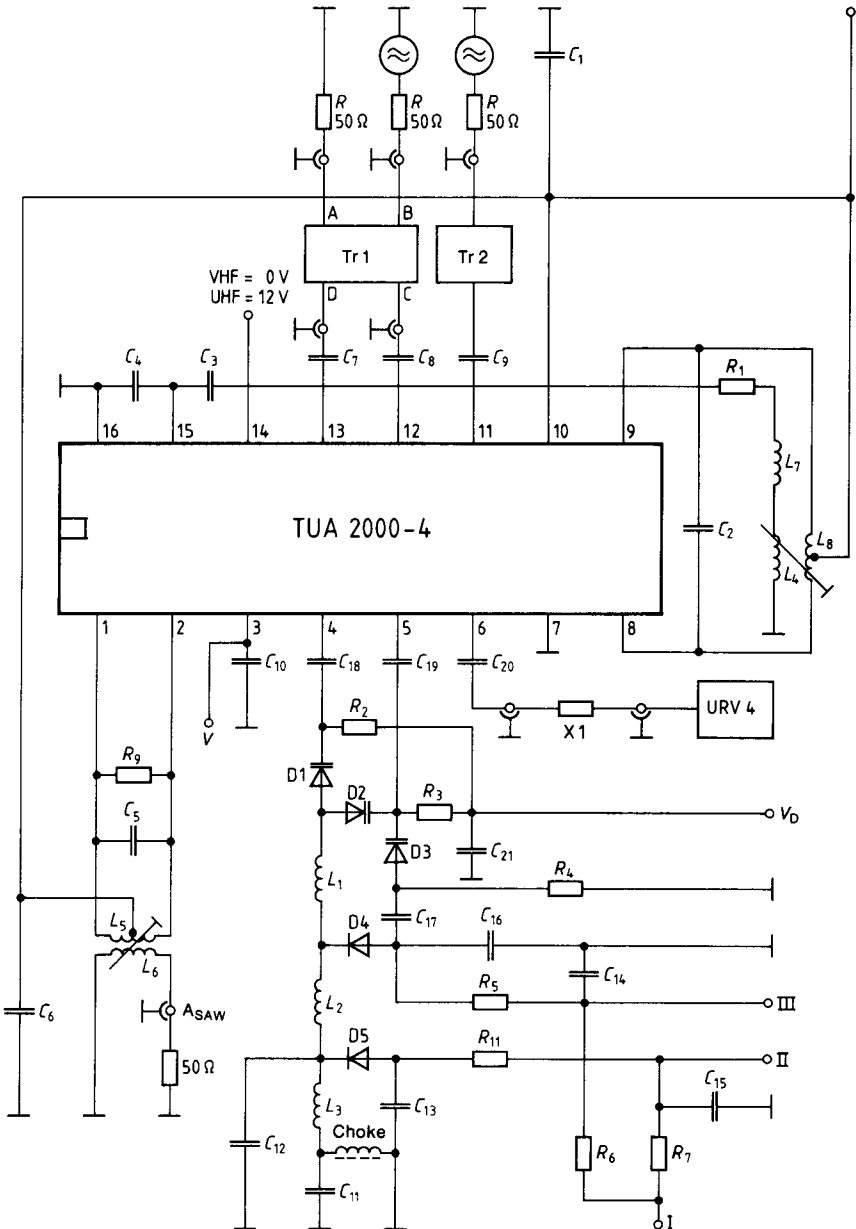


**Pin description**

<b>Pin</b>	<b>Function</b>
1	“Open collector” output of the IF SAW driver
2	“Open collector” output of the IF SAW driver
3	Input for external reference voltage
4	Low-ohmic collector output to the high reference point of a parallel resonant circuit
5	High-ohmic base input to the high reference point of a parallel resonant circuit
6	Oscillator signal output for counter connection
7	GND
8	“Open collector” output of the mixer
9	“Open collector” output of the mixer
10	Supply voltage
11	Asymmetrical IF signal input for the UHF IF signal
12	Mixer high-impedance differential input
13	Mixer high-impedance differential input
14	Switching voltage input for the VHF-UHF switch selection
15	Asymmetrical signal input of the IF SAW amplifier
16	GND



Test and measurement circuit 1

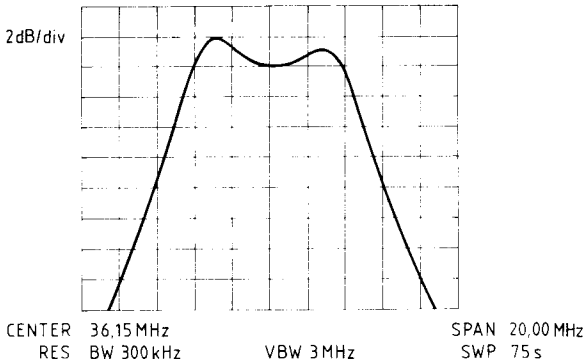


### Notes on test and measurement circuit 1

#### Response of passband curve for operation in VHF band I

$f_{RF} = 60 \text{ MHz} \pm 10 \text{ MHz}$ ;  $V_{i4} = 0 \text{ V}$ ;  $V_{i(REF)} = -40 \text{ dBm}$ ; ref. level =  $-10 \text{ dBm}$

gain test point  $f_{RF} = 60 \text{ MHz}$ ;  $f_{IF} = 36.15 \text{ MHz}$



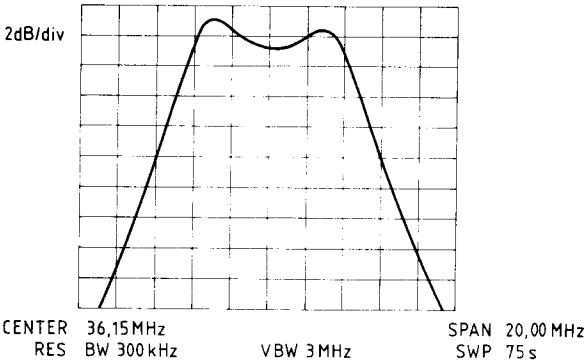
#### Explanations to diagrams

- 2 dB/div            = 2 dB/division of Y axis
- Center 36.15 MHz = center frequency of display at IF = 36.15 MHz
- RES BW 300 kHz   = resolution bandwidth of spectrum analyzer is 300 kHz in its IF section
- VBW 3 MHz        = video bandwidth in IF section of spectrum analyzer is 3 MHz
- SPAN 20.00 MHz   = overall display range of diagram is 20 MHz, i.e. 2 MHz/division on X axis
- SWP 75            = sweep time on X axis is 75 s
- Ref. level         = reference level is top horizontal line of diagram

**Notes on test and measurement circuit 1**

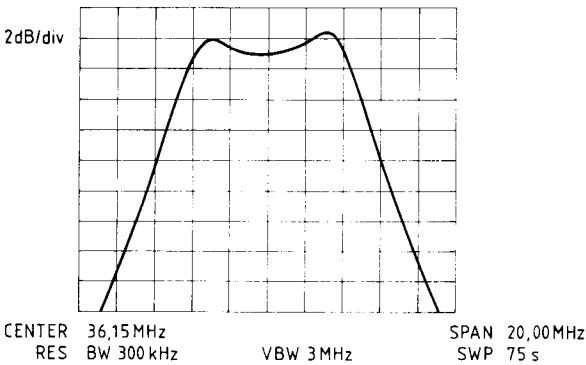
**Response of passband curve for operation in VHF band III**

$f_{RF} = 220 \text{ MHz} \pm 10 \text{ MHz}$ ;  $V_{14} = 0 \text{ V}$ ;  $V_{1(RF)} = -40 \text{ dBm}$ ; ref. level = -10 dBm  
 gain test point  $f_{RF} = 220 \text{ MHz}$ ;  $f_{IF} = 36.15 \text{ MHz}$



**Response of passband curve for operation in VHF IF position**

$f_{RFU} = 36.15 \text{ MHz} \pm 10 \text{ MHz}$ ;  $V_{14} = 12 \text{ V}$ ;  $V_{1(RF)} = -40 \text{ dBm}$ ; ref. level = 0 dBm  
 gain test point  $f_{RFU} = f_{IF} = 36.15 \text{ MHz}$



**Notes on test and measurement circuit 1**

Between pin 4 – C18 – D1 – D2 – C19 – pin 5 ensure minimal lead inductance for the suppression of parasitic series resonance outside the oscillator's useful band.

Transformer Tr 1:

Tr 1 = anzac = HH-109 30 to 500 MHz

C = 0°;  $R_{gC} = 50 \Omega$

D = 180°;  $R_{gD} = 50 \Omega$

Transformer Tr 2:

50/200  $\Omega$  unbalanced

3 turns bifilar on core material

B62152-A7-X1

Attenuator: X1 = 6 dB

Bd I 58 to 85 MHz

Bd II 110 to 216 MHz

Bd III 200 to 400 MHz

	I	II	III
Band I	-12 V	X	X
Band II	-12 V	+12 V	X
Band III	-12 V	+12 V	+12 V

## Notes on test and measurement circuit 1

## Part list

## Resistors:

$R_1$  — 10  $\Omega$   
 $R_2$  — 47 k $\Omega$   
 $R_3$  — 47 k $\Omega$   
 $R_4$  — 10 k $\Omega$   
 $R_5$  — 2.2 k $\Omega$   
 $R_6$  — 100 k $\Omega$   
 $R_7$  — 100 k $\Omega$   
 $R_8$  — 100 k $\Omega$   
 $R_9$  — 400  $\Omega$   
 $R_{11}$  — 2.2 k $\Omega$

## Capacitors:

$C_1$  — 1 nF Chip capacitor  
 $C_2$  — 15 pF STYROFLEX  
 $C_3$  — 1 nF STYROFLEX  
 $C_4$  — 10 pF STYROFLEX  
 $C_5$  — 47 pF STYROFLEX  
 $C_6$  — 1 nF Chip capacitor  
 $C_7$  — 1 nF Chip capacitor  
 $C_8$  — 1 nF Chip capacitor  
 $C_9$  — 1 nF Chip capacitor  
 $C_{10}$  — 10 nF Chip capacitor  
 $C_{11}$  — 82 pF Chip capacitor  
 $C_{12}$  — 2.2 pF Chip capacitor  
 $C_{13}$  — 1 nF Chip capacitor  
 $C_{14}$  — 1 nF Chip capacitor  
 $C_{15}$  — 1 nF Chip capacitor  
 $C_{16}$  — 150 pF Chip capacitor (Trapezoidal cap.)  
 $C_{17}$  — 27 pF Chip capacitor (Chip capacitor)  
 $C_{18}$  — 6.8 pF Chip capacitor (Chip capacitor)  
 $C_{19}$  — 33 pF Chip capacitor (Chip capacitor)  
 $C_{20}$  — 1 nF Chip capacitor  
 $C_{21}$  — 10 nF Chip capacitor

## Diodes:

$D1$  — BB 505 G  
 $D2$  — BB 609  
 $D3$  — BB 609  
 $D4$  — BA 282  
 $D5$  — BA 282  
 $D6$  — BZX 97 C 75 V

## IC:

TUA 2000-4

## Coils:

$L_1$  — 4 turns; core  $\varnothing$  2 mm; wire  $\varnothing$  0.5 mm; CuL  
 $L_2$  — 5 turns; core  $\varnothing$  4 mm; wire  $\varnothing$  0.5 mm; CuL  
 $L_3$  — 9 turns; core  $\varnothing$  4 mm; wire  $\varnothing$  0.5 mm; CuL  
 $L_1, L_2, L_3$  — air-core coils  
 $L_4$  — 2.5 turns; CuLs wire  $\varnothing$  0.25 mm  
 $L_5$  — 2\*6 turns; CuLs wire  $\varnothing$  0.25 mm  
 $L_7$  — 15 turns; CuLs wire  $\varnothing$  0.25 mm  
 $L_5$  — 2\*4.5 turns; CuLs wire 0.25 mm  
 $L_6$  — 3 turns; CuLs wire  $\varnothing$  0.25 mm  
 Coil formers of  $L_4/L_8, L_7, L_5/L_6$   
 Vogt filter set 10\*12  
 514050000  
 Catalog p. 41-8

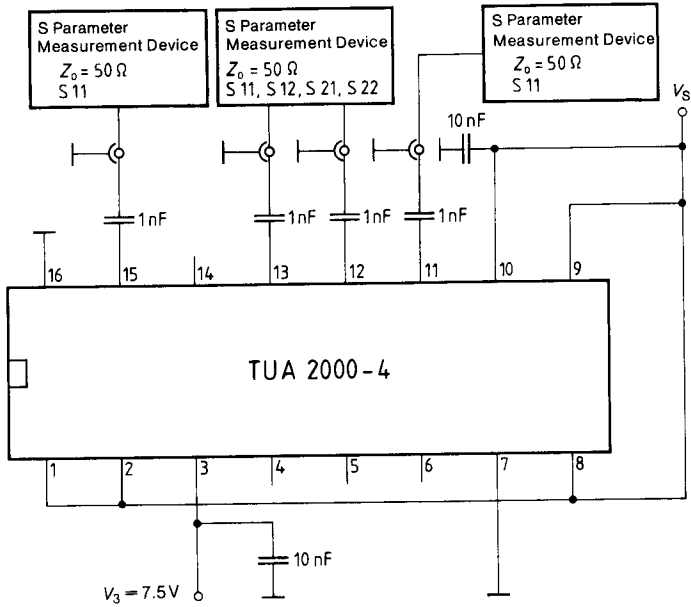
## Chokes:

Ch — 10  $\mu$ H

Please note that the chip capacitors may be damaged if the board is subjected to mechanical stress; thus overall functioning can no longer be guaranteed.

During the operating mode the PC board is adjusted without the socket. When the socket is inserted in the socket connector, the parameters for the oscillator frequency and amplitude as well as gain and noise will change.

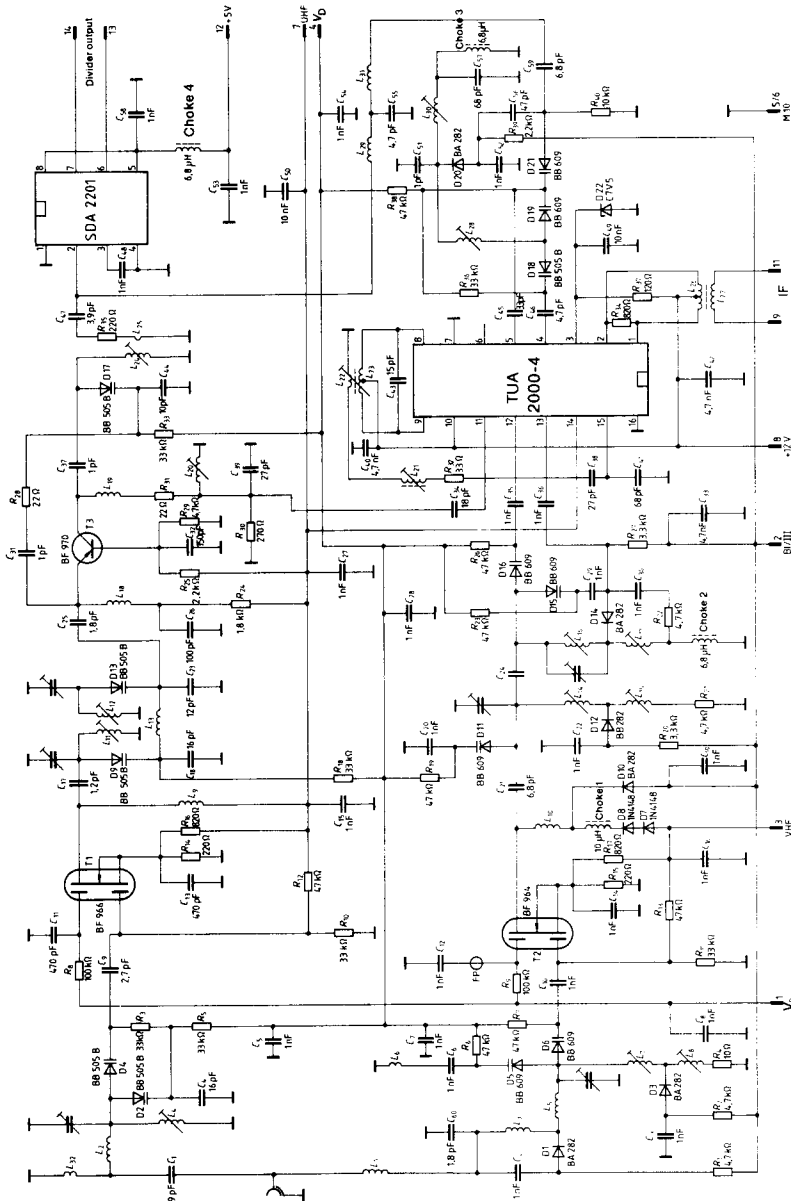
## Test and measurement circuit 2



For the determination of the input admittance values of pins 11, 12, 13, 15



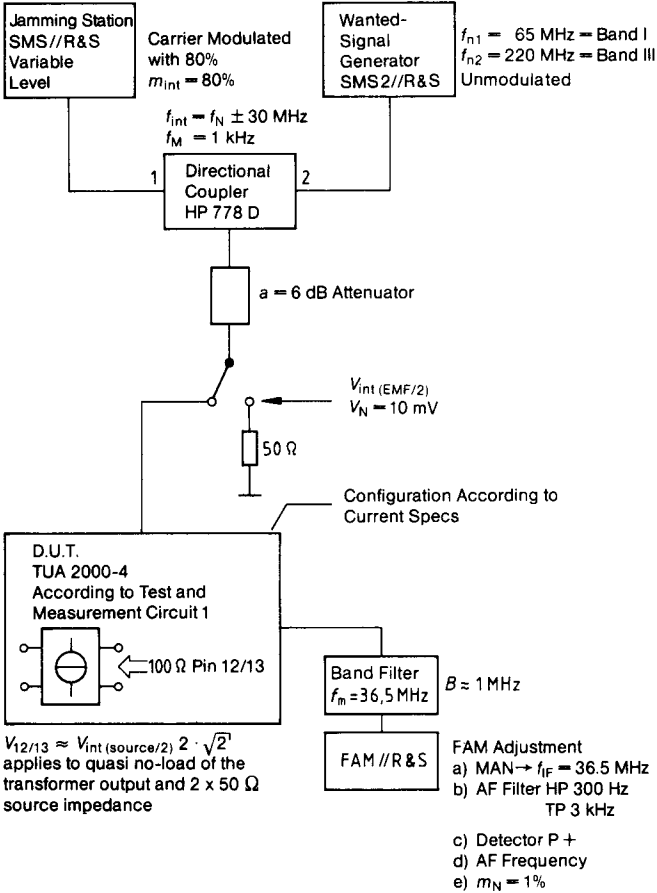
## Application circuit 2





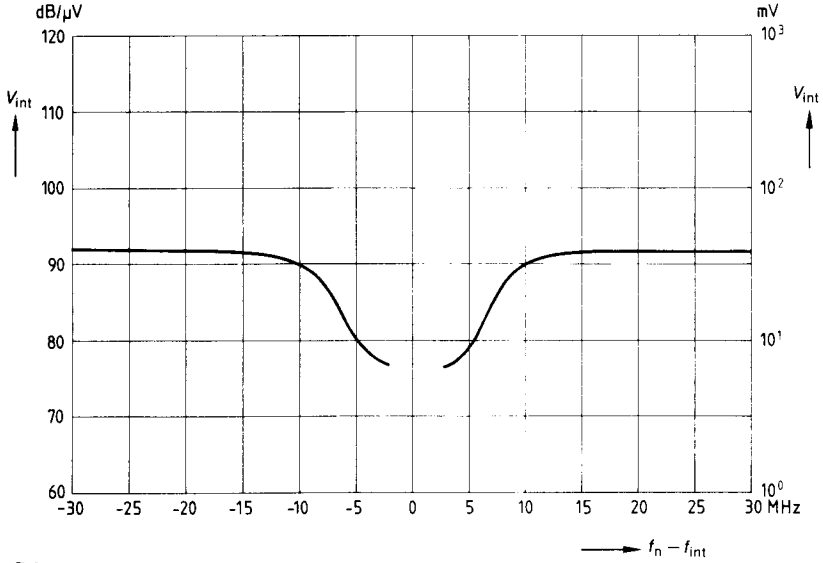
**Test and measurement circuit 3**

**Measurement configuration to measure cross modulation**

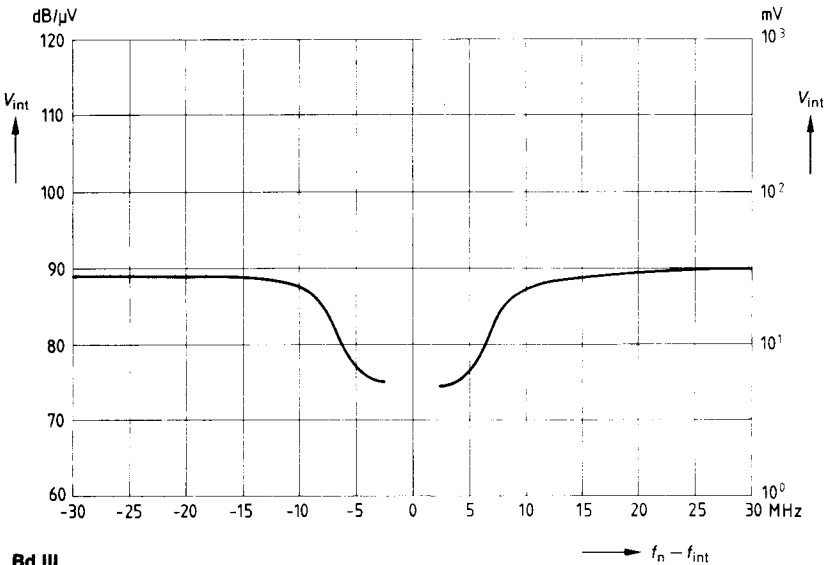


**Interference voltage for 1% cross modulation**

$V_{int} = EMF/2; m_{int} = 80\%$



**Bd I**



**Bd III**