

## TCA 440 AM Receiver Circuit

AM receiver circuit for LW, MW, and SW in battery and line operated radio receivers. It includes an RF prestage with AGC, a balanced mixer, separate oscillator, and an IF amplifier with AGC. Because of its internal stabilization, all characteristics are largely independent of the supply voltage. For use in high quality radio sets the TDA 4001 should be preferred to the TCA 440.

### Features

- Separately controlled prestage
- Multiplicative push-pull mixer with separate oscillator
- High large signal capability from 4.5 V supply voltage on
- 100 dB feedback control range in 5 stages
- Direct connection for tuning meter
- Few external components

### Maximum ratings

Supply voltage	$V_S$	15	V
Storage temperature range	$T_{stg}$	-40 to 125	°C
Junction temperature	$T_j$	150	°C
Thermal resistance (system-air)	$R_{thSA}$	120	K/W

### Operating range

Supply voltage	$V_S$	4.5 to 15	V
Ambient temperature	$T_A$	-15 to 80	°C

**Characteristics**

$V_S = 9\text{ V}$ ;  $T_A = 25\text{ }^\circ\text{C}$ ;  $f_{iRF} = 600\text{ kHz}$ ;  $f_{mod} = 1\text{ kHz}$

Total current consumption

RF level deviation for

$m = 80\%$

$\Delta V_{AF} = 6\text{ dB}$

$\Delta V_{AF} = 10\text{ dB}$

$I_S$	10.5	mA
$\Delta G_{RF}$	65	dB
$\Delta G_{RF}$	80	dB

AF output voltage for  $V_{iRF}$

(symm. measured at 1-2)

for  $m = 80\%$

$V_{iRF} = 20\text{ }\mu\text{V}$

$V_{iRF} = 1\text{ mV}$

$V_{iRF} = 500\text{ mV}$

$V_{AFrms}$	140	mV
$V_{AFrms}$	260	mV
$V_{AFrms}$	350	mV

for  $m = 30\%$

$V_{iRF} = 20\text{ }\mu\text{V}$

$V_{iRF} = 1\text{ mV}$

$V_{iRF} = 500\text{ mV}$

$V_{AFrms}$	50	mV
$V_{AFrms}$	100	mV
$V_{AFrms}$	130	mV

Input sensitivity

(measured at  $60\text{ }\Omega$ ,  $f_{iRF} = 1\text{ MHz}$ ,  $m = 30\%/0\%$ ,  $R_G = 540\text{ }\Omega$ )

at signal-to-noise ratio  $\frac{S+N}{N} = 6\text{ dB}$   
(in acc. with DIN 45405)

$V_{iRF}$	1	$\mu\text{V}$
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$\frac{S+N}{N} = 26\text{ dB}$

$V_{iRF}$	7	$\mu\text{V}$
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$\frac{S+N}{N} = 58\text{ dB}$

$V_{iRF}$	1	mV
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**RF stage**

Input frequency range

Output frequency  $f_{iF} = f_{OSC} - f_{iRF}$

Control range

Input voltage (for  $600\text{ kHz}$ ,  $m = 80\%$ )

for overdrive ( $THD_{AF} = 10\%$ ),

symmetrically measured at pins 1 and 2

(mean carrier value)

IF suppression between 1-2 and 15

RF input impedance

a) unsymmetrical coupling

at  $G_{RFmax}$

at  $G_{RFmin}$

b) symmetrical coupling

at  $G_{RFmax}$

at  $G_{RFmin}$

Mixer output impedance

(pins 15 or 16)

$f_{iRF}$	0 to 50	MHz
$f_{iF}$	460	kHz
$\Delta G_V$	38	dB
$V_{iRFpd}$	2.6	V
$V_{iRFrms}$	0.5	V
$a_{iF}$	20	dB
$Z_1$	2/5	k $\Omega$ /pF
$Z_1$	2.2/1.5	k $\Omega$ /pF
$Z_1$	4.5	k $\Omega$ /pF
$Z_1$	4.5/1.5	k $\Omega$ /pF
$Z_q$	250/4.5	k $\Omega$ /pF

**IF stage**

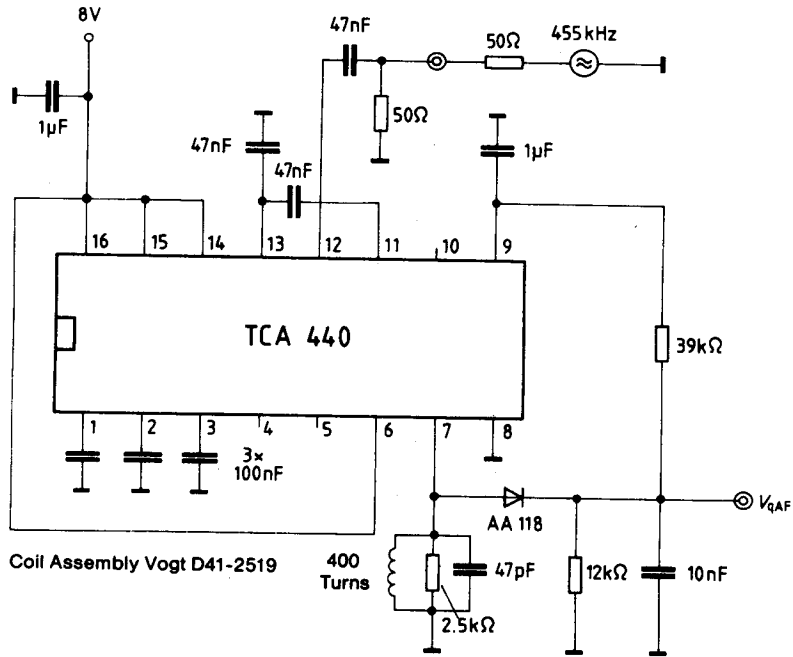
Input frequency range	$f_{IF}$	0 to 2	MHz
Control range at 460 kHz	$\Delta G_V$	62	dB
Input voltage (mean carrier value) at $G_{min}$ for overdrive ( $THD_{AF} = 10\%$ ), measured at pin 12 (60 $\Omega$ to ground, $f_{IF} = 460$ kHz, $m = 80\%$ ; $f_{mod} = 1$ kHz)	$V_{IFrms}$	200	mV
AF output voltage for $V_{IF}$ at 60 $\Omega$ (pin 12)			
$V_{IF} = 30$ $\mu$ V, $m = 80\%$ ; $f_{mod} = 1$ kHz	$V_{7AFrms}$	50	mV
$V_{IF} = 3$ mV, $m = 80\%$ ; $f_{mod} = 1$ kHz	$V_{7AFrms}$	200	mV
$V_{IF} = 3$ mV, $m = 30\%$ ; $f_{mod} = 1$ kHz	$V_{7AFrms}$	70	mV
$V_{IF} = 200$ $\mu$ V; $m = 30\%$ ; $f_{IF} = 455$ kHz; $f_{QAF} = 1$ kHz	$V_{7AFrms}$	35 to 60	mV
IF input impedance (unsymm. coupling)	$Z_i$	3/3	k $\Omega$ /pF
IF output impedance	$Z_{q7}$	200/8,	k $\Omega$ /pF

**Tuning meter**

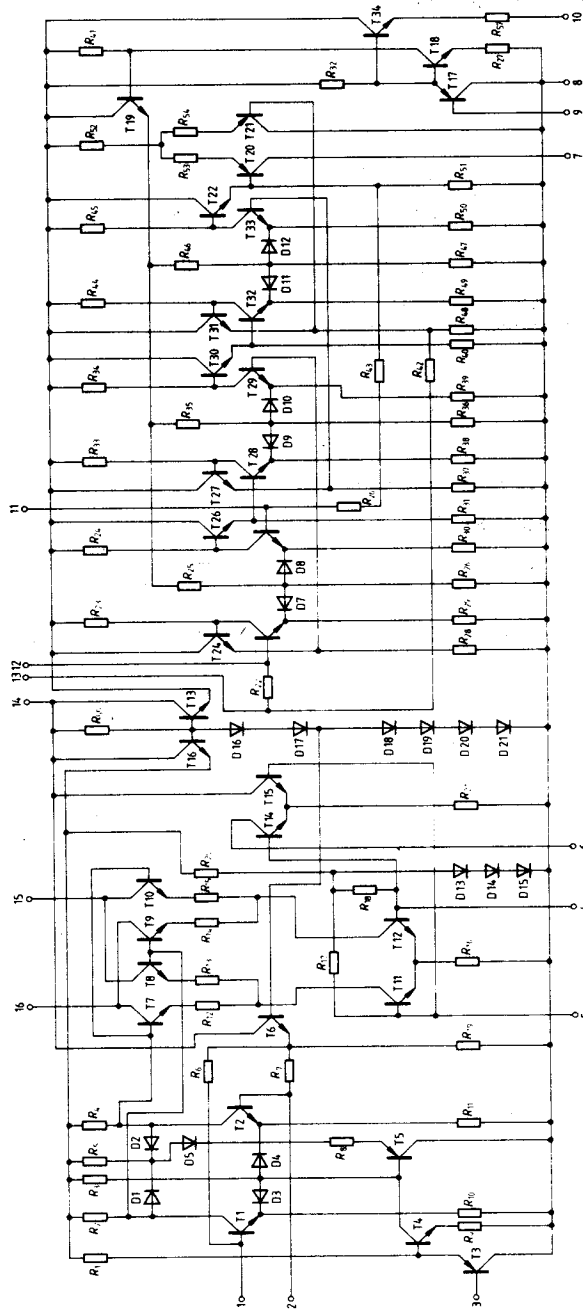
Recommended instruments: 500  $\mu$ A ( $R_i = 800$  k $\Omega$ )  
or 300  $\mu$ A ( $R_i = 1.5$  k $\Omega$ )

The IC offers a tuning meter voltage of 600 mV<sub>EMF</sub> max. with a source impedance of approx. 400  $\Omega$ .

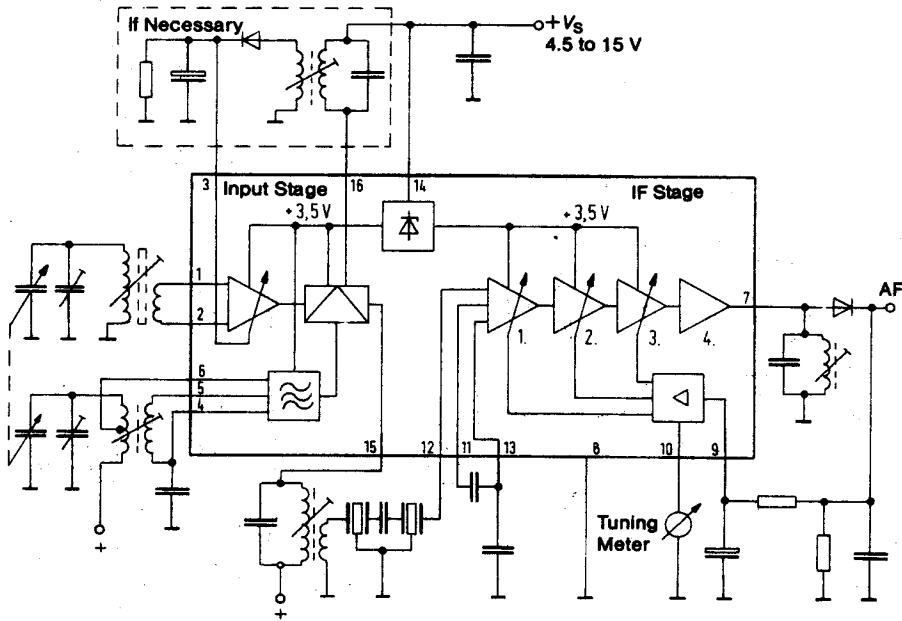
Measurement circuit for output voltage



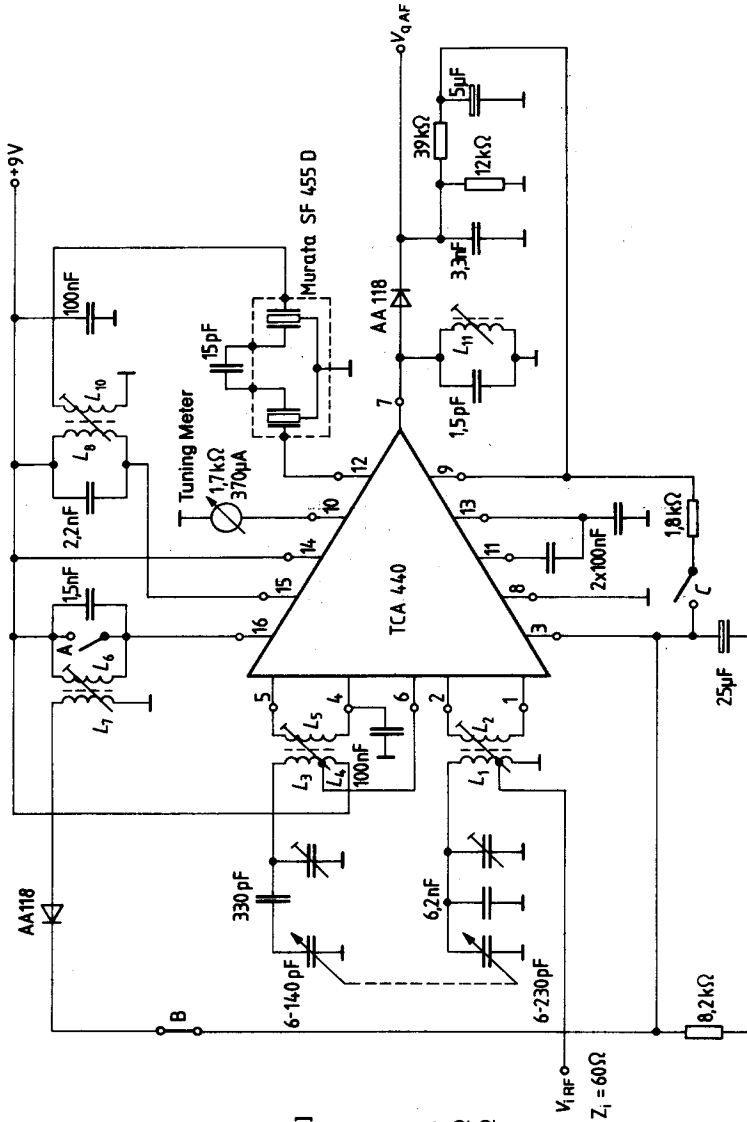
Circuit diagram



Block diagram



Measurement circuit for signal-to-noise ratio



n [turns]	R <sub>G</sub> [Ω]
1	15
2	60
4	240
6	540
9	1,2 kΩ
12	2,2 kΩ
18	4,8 kΩ

V<sub>i</sub> RF = 0  
Z<sub>i</sub> = 60 Ω

L<sub>1</sub>-L<sub>2</sub> M 25 pot core  
L<sub>3</sub>-L<sub>11</sub> with coil assembly Vogt D41-2519

L<sub>1</sub> 2+6 turns 6x12x0.04 Cu LS

L<sub>2</sub> n turns 0.15 Cu L

L<sub>3</sub> 90 turns 12x0.04 Cu LS

L<sub>4</sub> 35 turns 12x0.04 Cu LS

L<sub>5</sub> 15 turns 0.10 Cu L

L<sub>6</sub> 70 turns 12x0.04 Cu LS

L<sub>7</sub> 35 turns 12x0.04 Cu LS

L<sub>8</sub> 60 turns 12x0.04 Cu LS

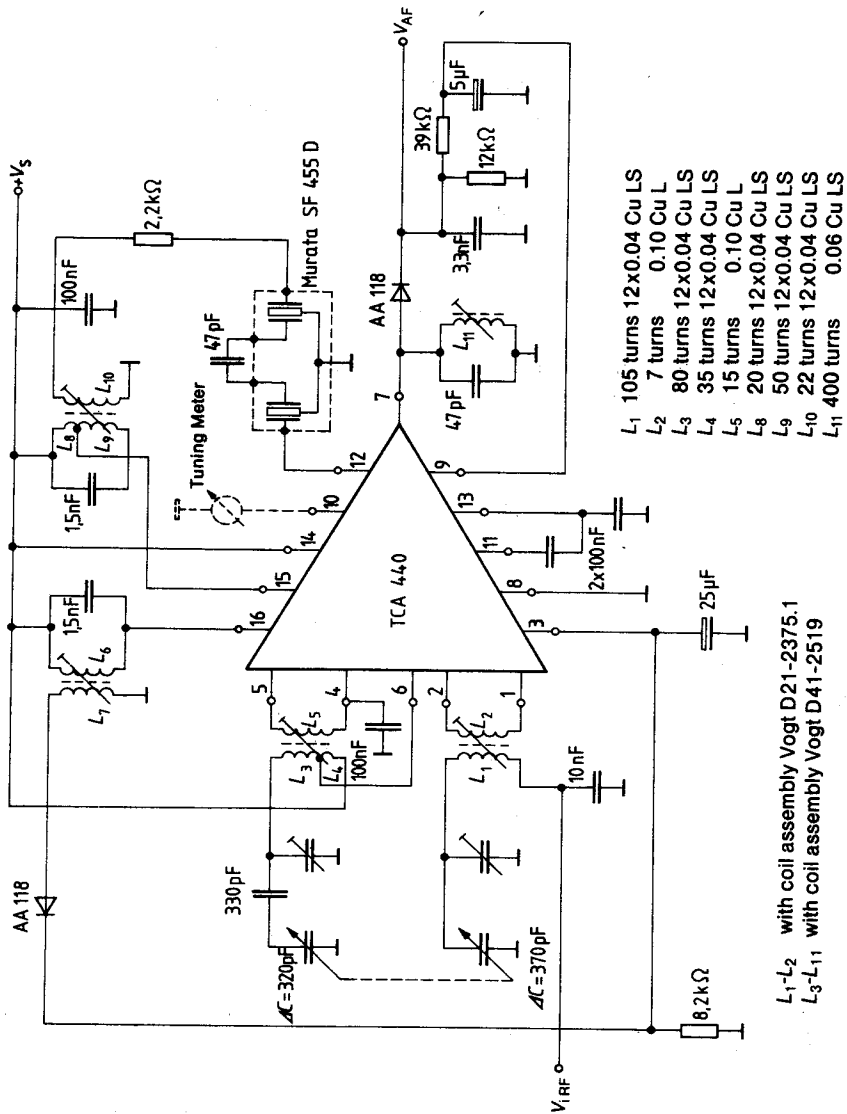
L<sub>10</sub> 22 turns 12x0.04 Cu LS

L<sub>11</sub> 68 turns 0.06 Cu L

Switch		①		②	
A	B	C			
off	on	off	separate prestige control	on	prestige control voltage derived from IF control voltage
on	off	on		on	

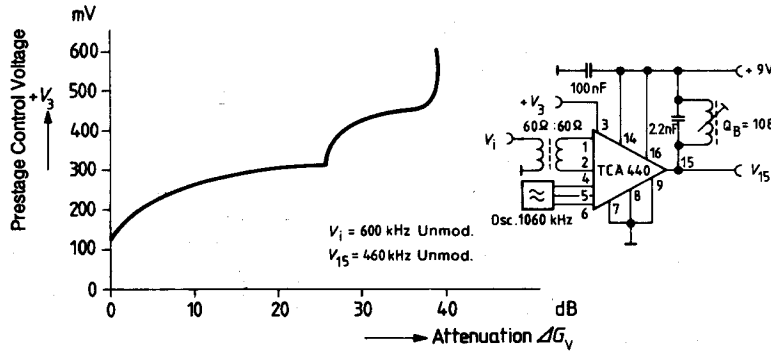
f<sub>i</sub> = 1 MHz; m = 30%

Application example for MW with TCA 440



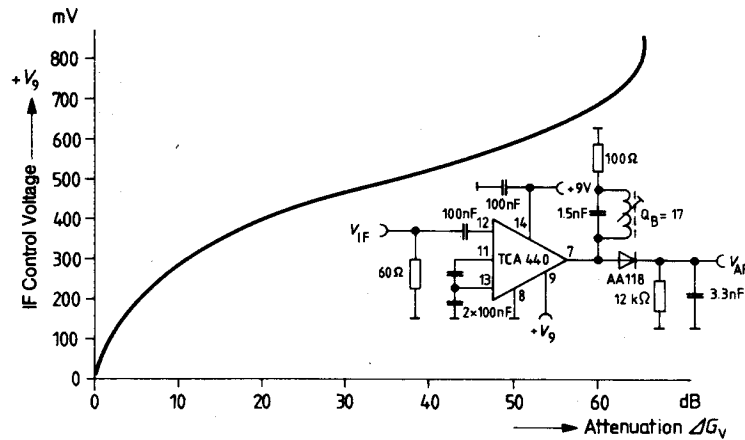


**Prestage control TCA 440**



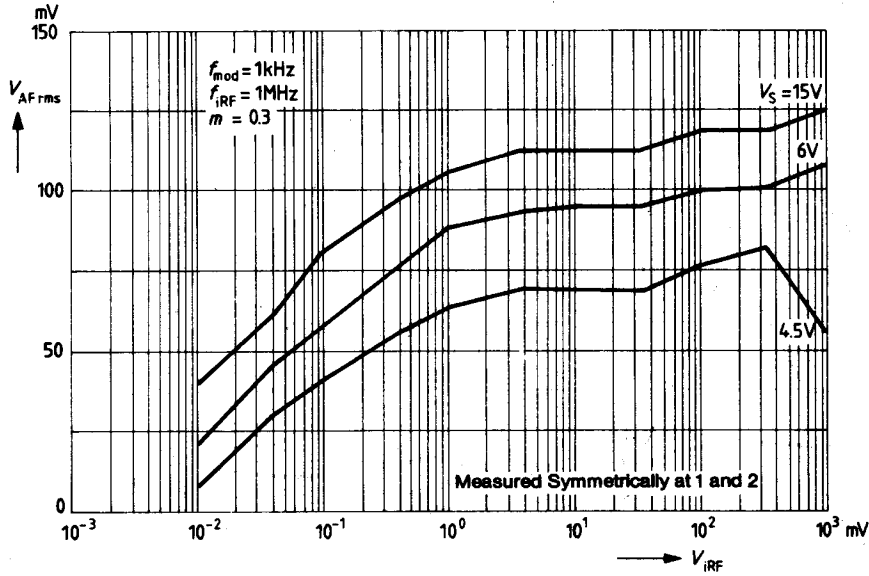
The input is not power matched and can be driven with a higher resistance. The selected  $V_1$  ensures a constant  $V_{15}$  (50 mV peak-to-peak).

**IF control**



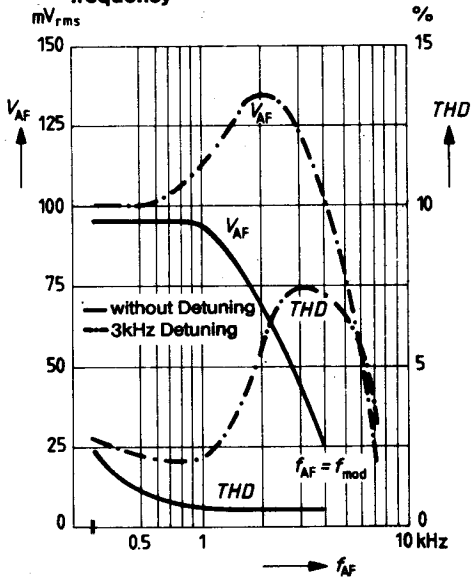
The selected  $V_{IF}$  (469 kHz;  $m = 80\%$ ;  $f_{mod} = 1 \text{ kHz}$ ) ensures a constant  $V_{AF}$  (200 mV, rms).

**AF output voltage versus RF input voltage**

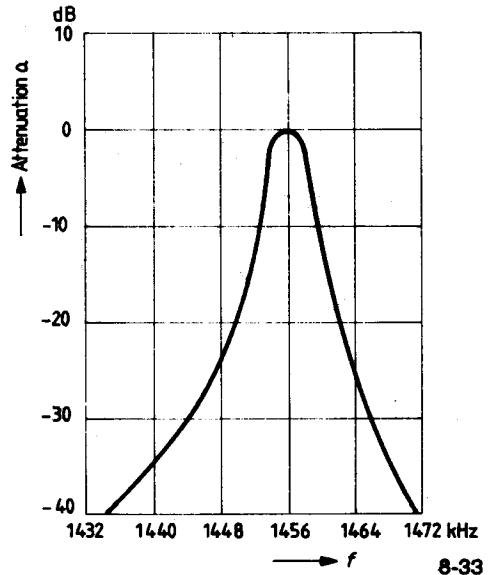


**Example for medium wave applications**

**AF output voltage versus output frequency  
Total harmonic distortion versus modulation frequency**



**Passband characteristic versus input frequency, measured from input to output of the circuit**



Total harmonic distortion versus detuning (parameter: modulation frequency)

$V_s = 9\text{ V}$

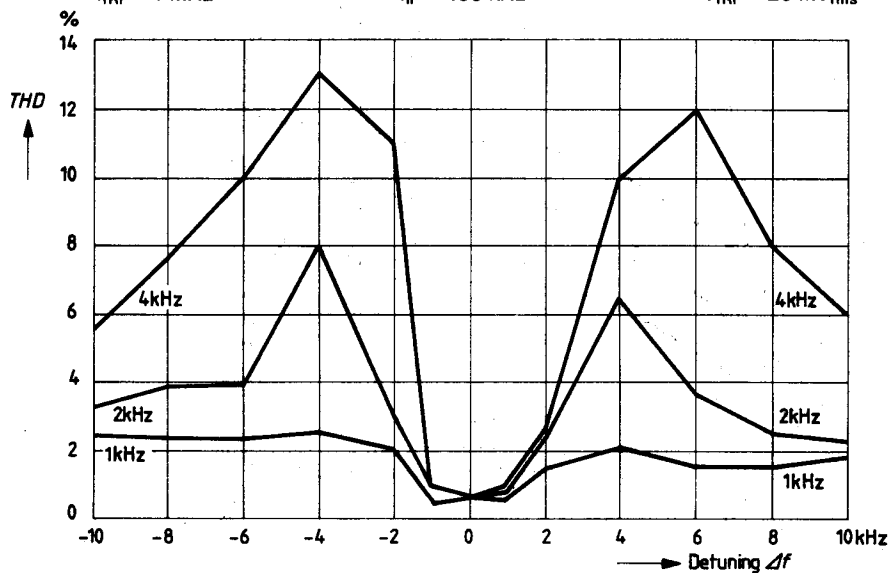
$f_{osc} = 1.455\text{ MHz} \pm \Delta f$

$m = 30\%$

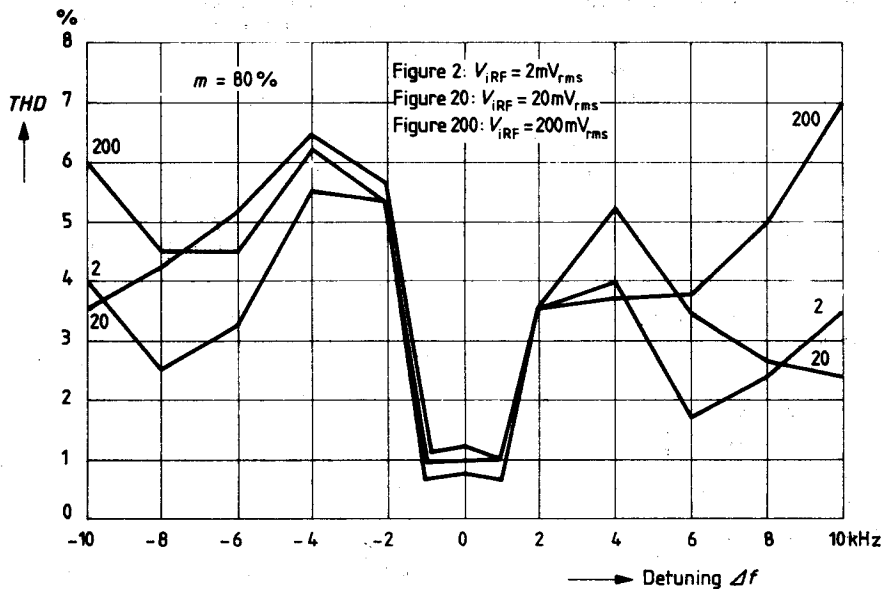
$f_{iRF} = 1\text{ MHz}$

$f_{iF} = 455\text{ kHz}$

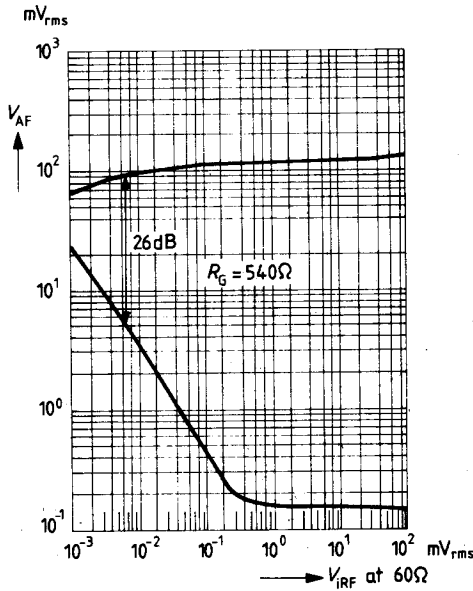
$V_{iRF} = 20\text{ mV}_{rms}$



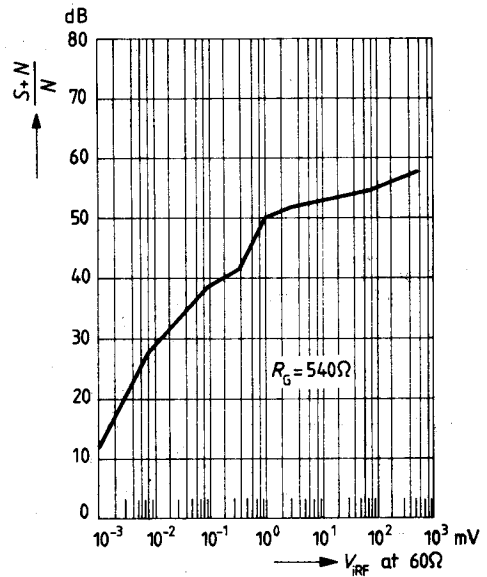
Total harmonic distortion versus detuning (parameter: RF input voltage)



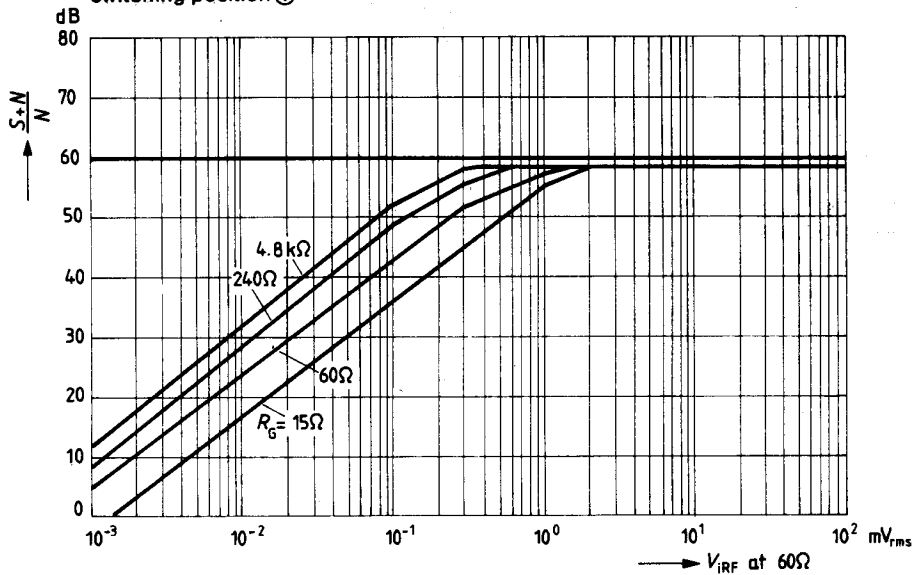
**AF output voltage and noise figure versus RF input voltage switching position ①**



**Signal-to-noise ratio versus RF input voltage switching position ②**



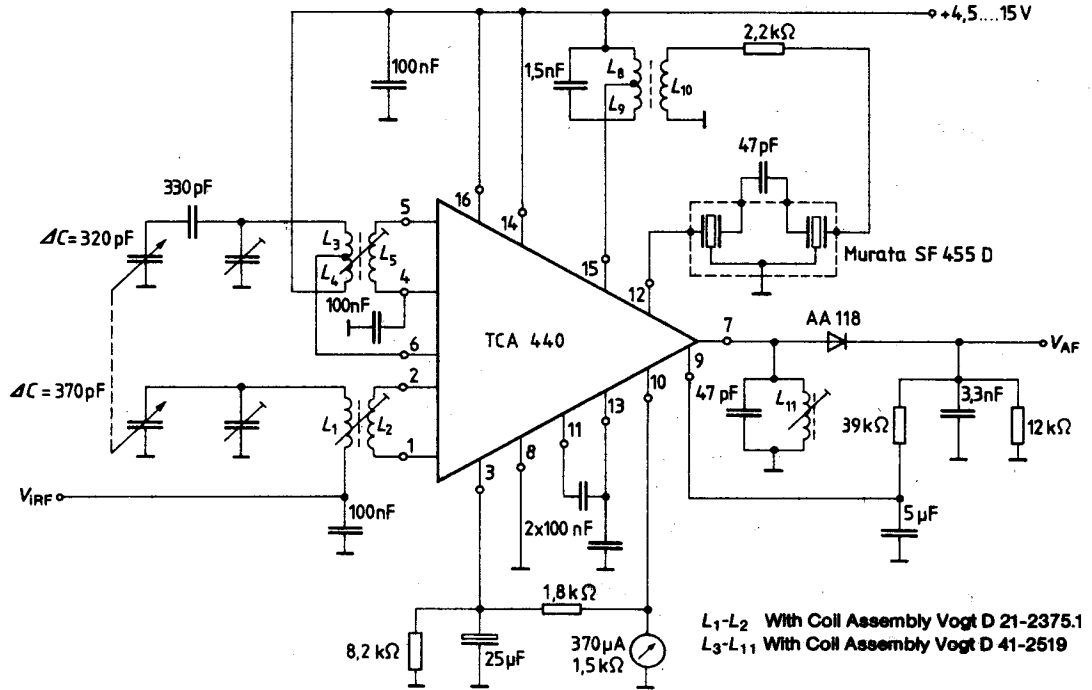
**Signal-to-noise ratio versus RF input voltage (parameter is generator impedance) switching position ①**



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**Application example for MW**

Prestage control is derived from IF control



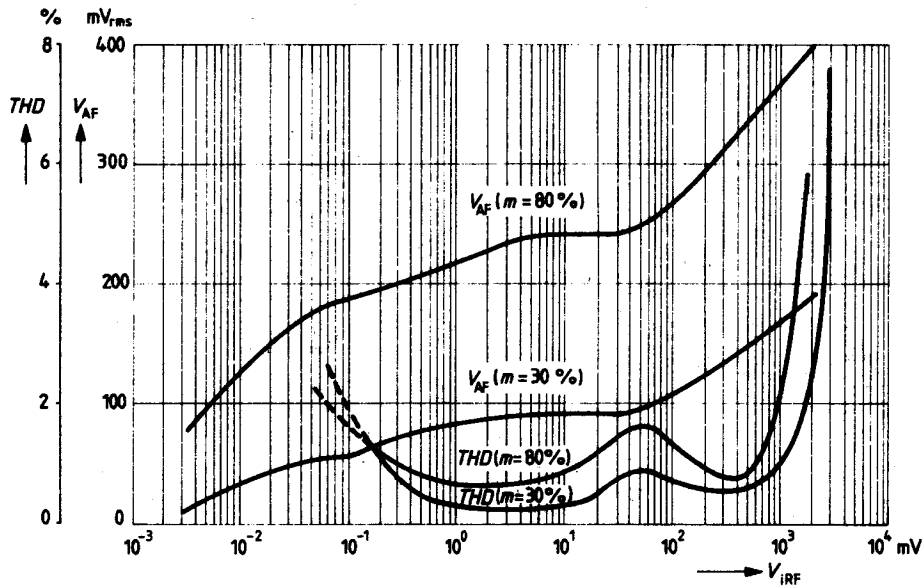
L<sub>1</sub>-L<sub>2</sub> With Coil Assembly Vogt D 21-2375.1  
 L<sub>3</sub>-L<sub>11</sub> With Coil Assembly Vogt D 41-2519

- L<sub>1</sub> 105 turns 12x0.04 Cu LS
- L<sub>2</sub> 7 turns 0.10 Cu L
- L<sub>3</sub> 80 turns 12x0.04 Cu LS
- L<sub>4</sub> 35 turns 12x0.04 Cu LS
- L<sub>5</sub> 15 turns 0.10 Cu L
- L<sub>8</sub> 20 turns 12x0.04 Cu LS
- L<sub>9</sub> 50 turns 12x0.04 Cu LS
- L<sub>10</sub> 22 turns 12x0.04 Cu LS
- L<sub>11</sub> 400 turns 0.04 Cu L

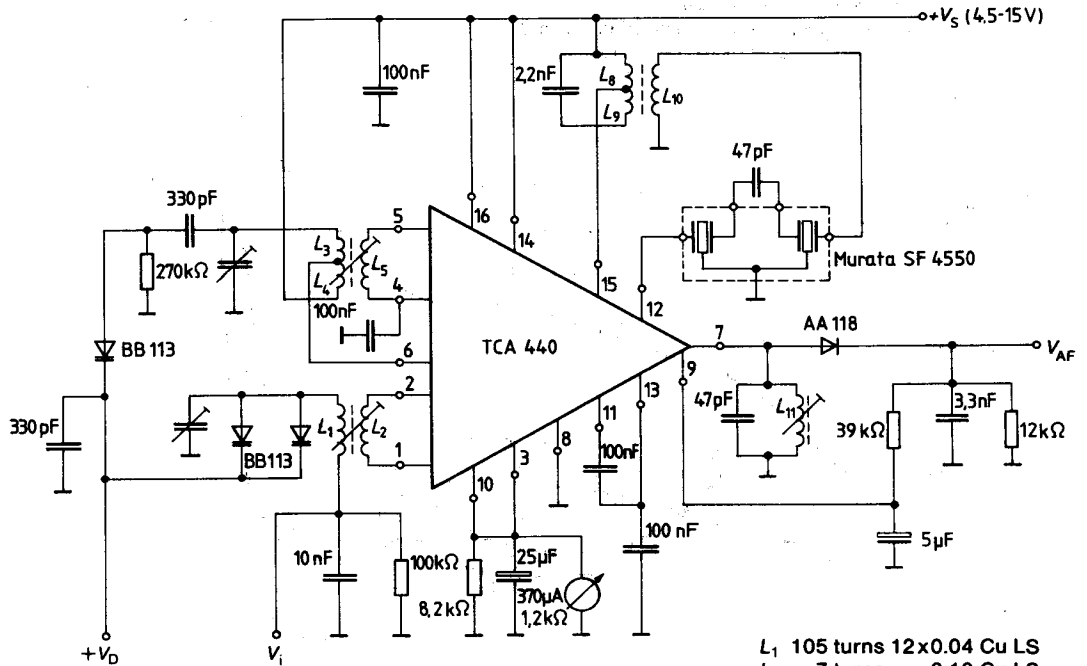
### Test figures for application example for MW

**Total harmonic distortion and AF output voltage  
versus RF input voltage  
measured symmetrically at pins 1 and 2**

$f_i = 1 \text{ MHz}$ ,  $f_{\text{mod}} = 1 \text{ kHz}$ ,  $f_{\text{IF}} = 455 \text{ kHz}$ ,  $V_S = 9 \text{ V}$



Application example for MW using BB 113 varicap diodes



$L_1 - L_2$  With Coil Assembly Vogt D21-2375.1

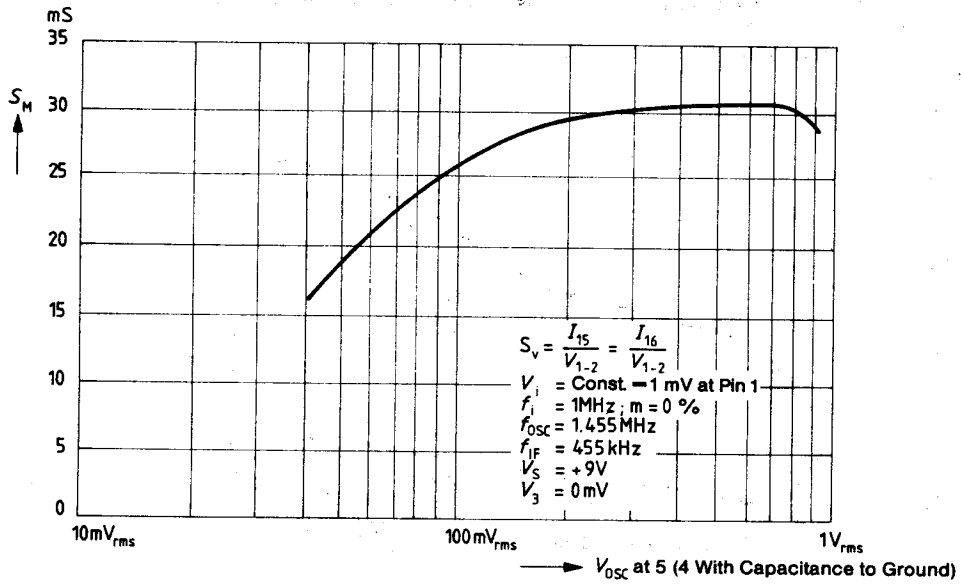
$L_3 - L_{11}$  With Coil Assembly Vogt D41-2519

$V_{un} = 8.5V \rightarrow f_1 = 800\text{ kHz}$

$V_{un} = 30V \rightarrow f_1 = 1620\text{ kHz}$

- $L_1$  105 turns 12x0.04 Cu LS
- $L_2$  7 turns 0.10 Cu LS
- $L_3$  80 turns 12x0.04 Cu LS
- $L_4$  35 turns 12x0.04 Cu LS
- $L_5$  15 turns 0.10 Cu LS
- $L_8$  20 turns 12x0.04 Cu LS
- $L_9$  50 turns 12x0.04 Cu LS
- $L_{10}$  22 turns 12x0.04 Cu LS
- $L_{11}$  400 turns 0.06 Cu L

## Conversion transconductance versus oscillator voltage.



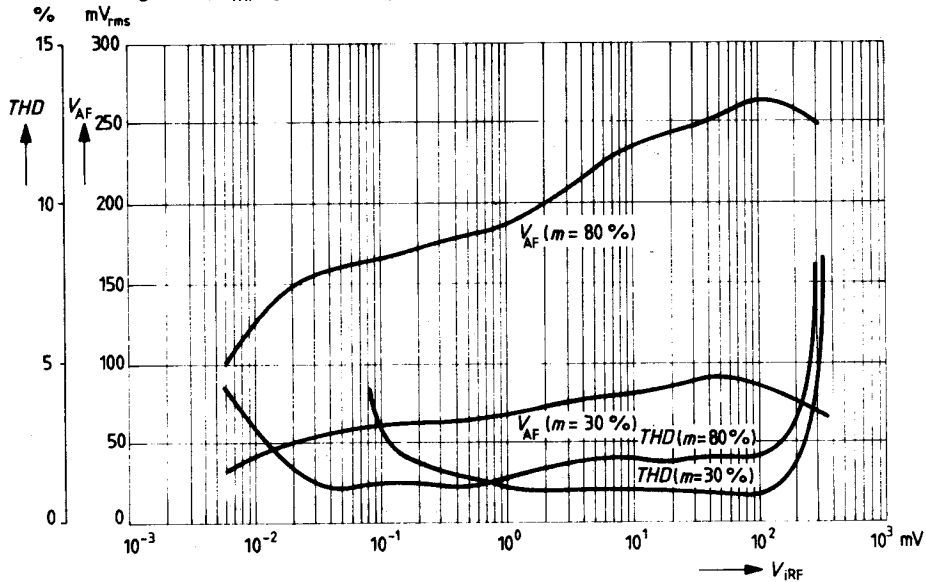


**Measured values for application example for MW using diode BB 113**

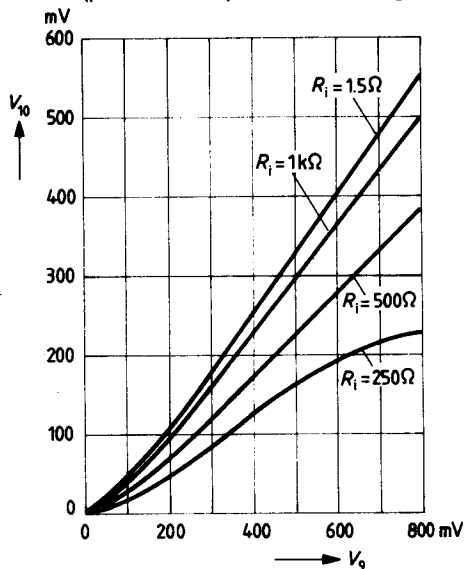
**AF output voltage and total harmonic distortion versus RF input voltage**

$f_i = 1 \text{ MHz}$ ;  $f_{\text{mod}} = 1 \text{ kHz}$ ;  $f_{\text{IF}} = 455 \text{ kHz}$

$V_S = 9 \text{ V}$ ;  $V_{\text{IRF}}$  symmetrically measured at pins 1 and 2



**Tuning meter voltage versus IF control voltage**  
(parameter: impedance of tuning meter)



**Example for moving coil instruments**

$R_i$	Full-service deflection
1.5 k $\Omega$	100 $\mu\text{A}$
1.5 k $\Omega$	170 $\mu\text{A}$
2 k $\Omega$	200 $\mu\text{A}$
350 $\Omega$	500 $\mu\text{A}$