

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
ΔG_{RF}	65	dB
ΔG_{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	μV
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$$\frac{S+N}{N} = 26\text{ dB}$$

V_{iRF}	7	μV
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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 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
ΔG_V	38	dB
V_{iRFpd}	2.6	V
V_{iRFrms}	0.5	V
a_{iF}	20	dB
Z_1	2/5	k Ω /pF
Z_1	2.2/1.5	k Ω /pF
Z_1	4.5	k Ω /pF
Z_1	4.5/1.5	k Ω /pF
Z_q	250/4.5	k Ω /pF

IF stage

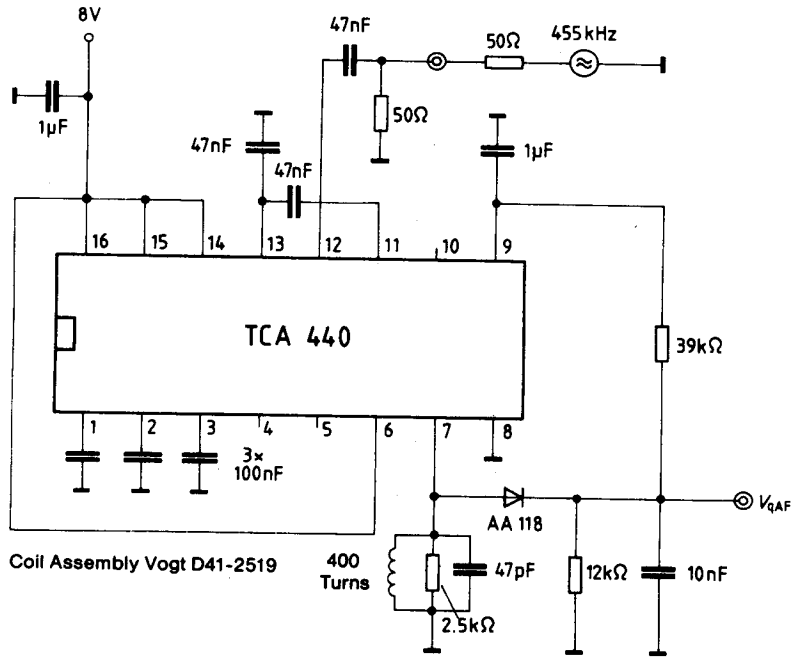
Input frequency range	f_{IF}	0 to 2	MHz
Control range at 460 kHz	ΔG_V	62	dB
Input voltage (mean carrier value) at G_{min} for overdrive ($THD_{AF} = 10\%$), measured at pin 12 (60 Ω to ground, $f_{IF} = 460$ kHz, $m = 80\%$; $f_{mod} = 1$ kHz)	V_{IFrms}	200	mV
AF output voltage for V_{IF} at 60 Ω (pin 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 Ω /pF
IF output impedance	Z_{q7}	200/8,	k Ω /pF

Tuning meter

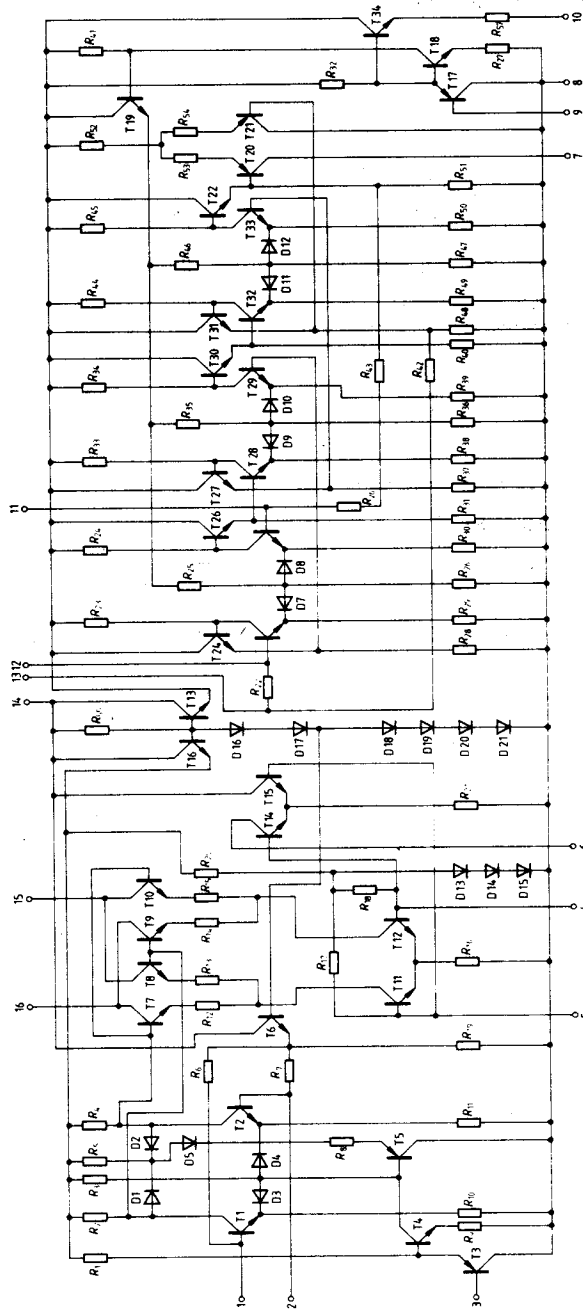
Recommended instruments: 500 μA ($R_i = 800$ k Ω)
or 300 μA ($R_i = 1.5$ k Ω)

The IC offers a tuning meter voltage of 600 mV_{EMF} max. with a source impedance of approx. 400 Ω .

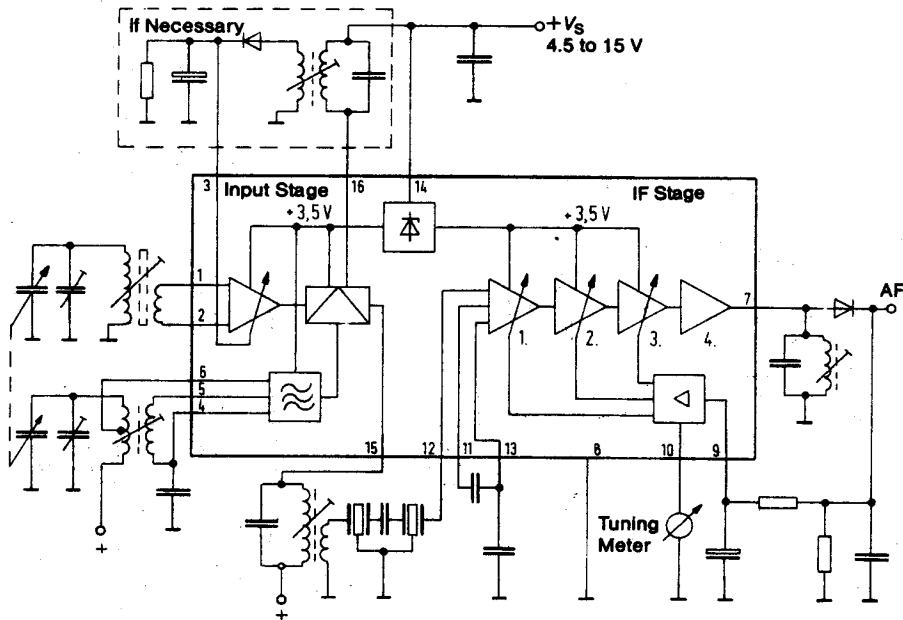
Measurement circuit for output voltage



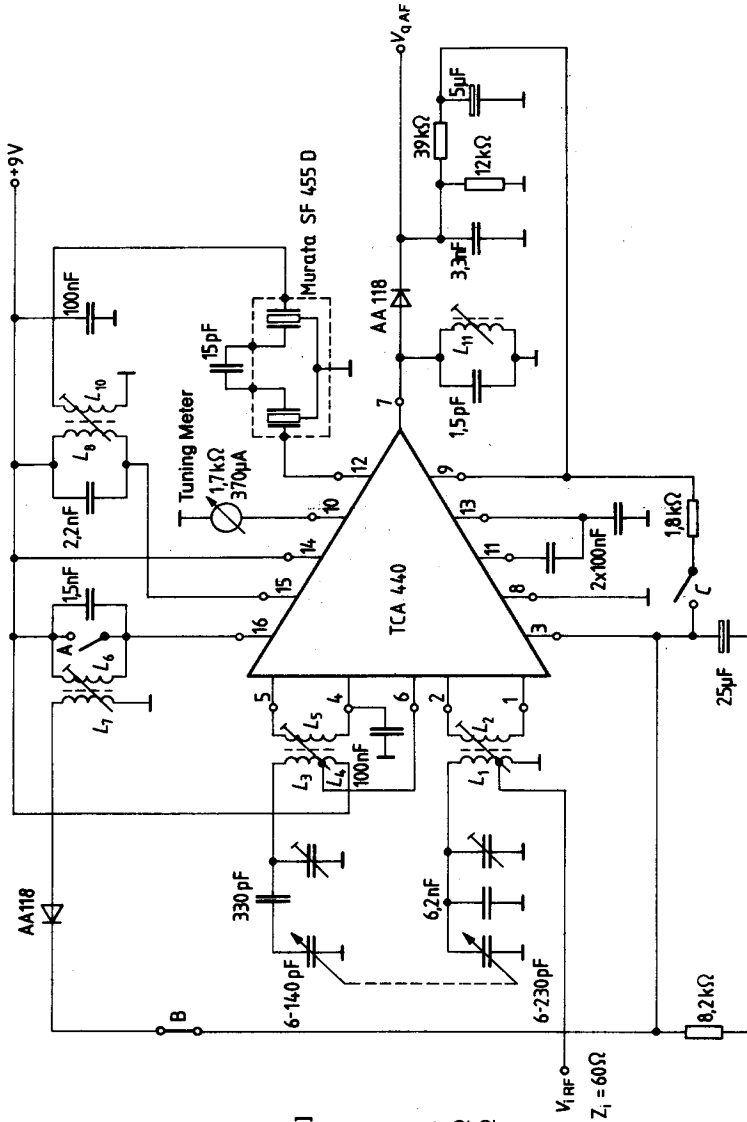
Circuit diagram



Block diagram



Measurement circuit for signal-to-noise ratio



n [turns]	R _G [Ω]
1	15
2	60
4	240
6	540
9	1,2 kΩ
12	2,2 kΩ
18	4,8 kΩ

L₁-L₂ M 25 pot core
 L₃-L₁₁ with coil assembly Vogt D41-2519

L₁ 2+6 turns 6x12x0.04 Cu LS

L₂ n turns 0.15 Cu L

L₃ 90 turns 12x0.04 Cu LS

L₄ 35 turns 12x0.04 Cu LS

L₅ 15 turns 0.10 Cu L

L₆ 70 turns 12x0.04 Cu LS

L₇ 35 turns 12x0.04 Cu LS

L₈ 60 turns 12x0.04 Cu LS

L₁₀ 22 turns 12x0.04 Cu LS

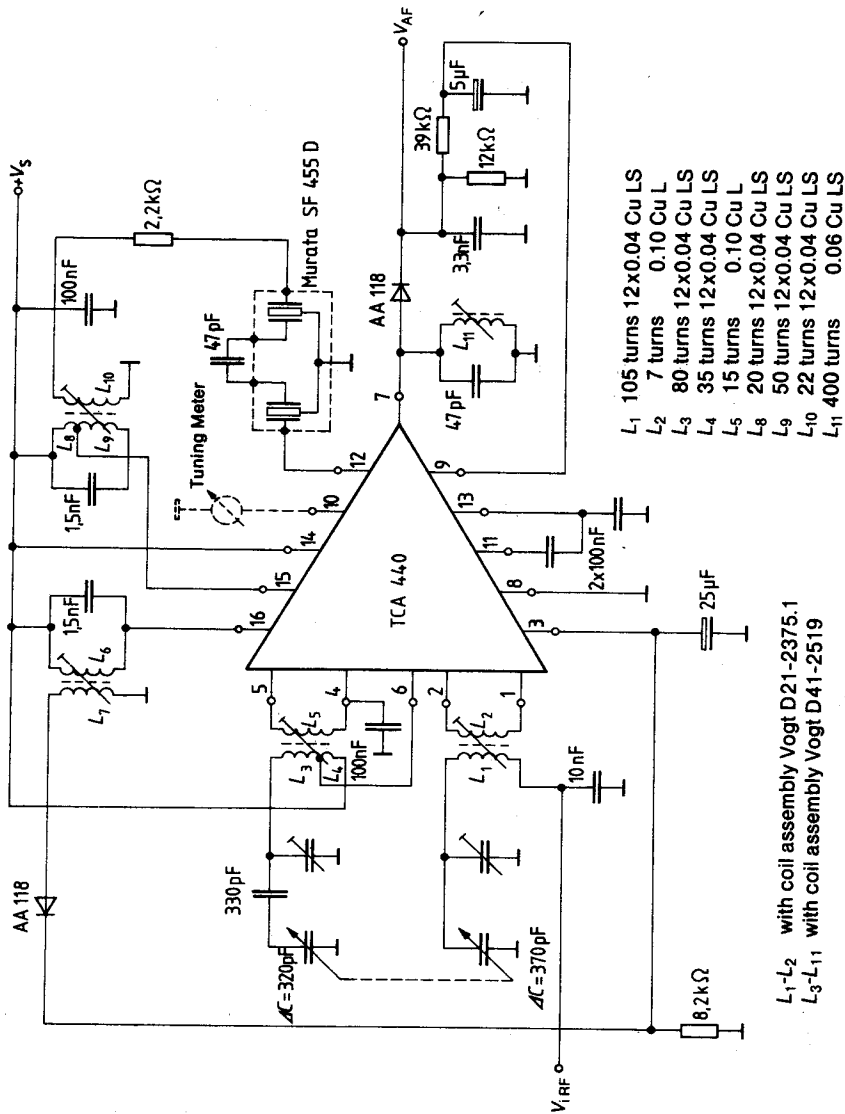
L₁₁ 68 turns 0.06 Cu L

Switch		
A	B	C
off	on	off
on	off	on

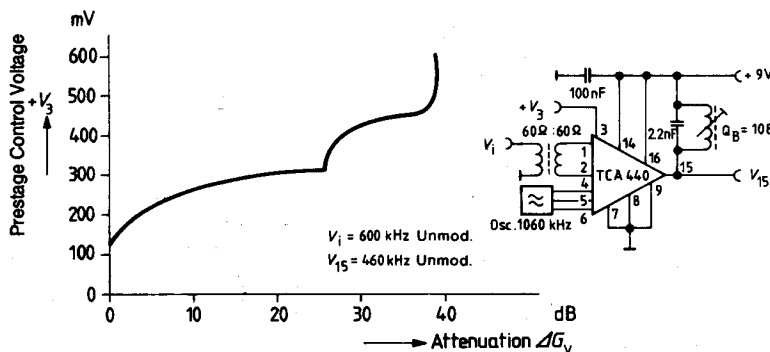
① separate prestage control
 ② prestage control voltage derived from IF control voltage

f_i = 1 MHz; m = 30%

Application example for MW with TCA 440

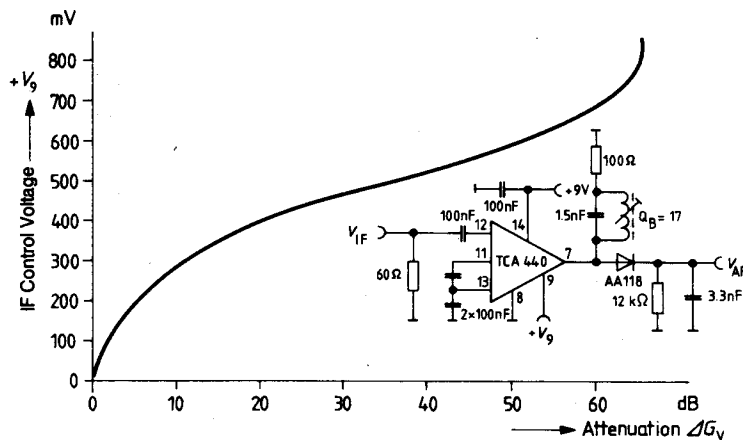


Prestage control TCA 440



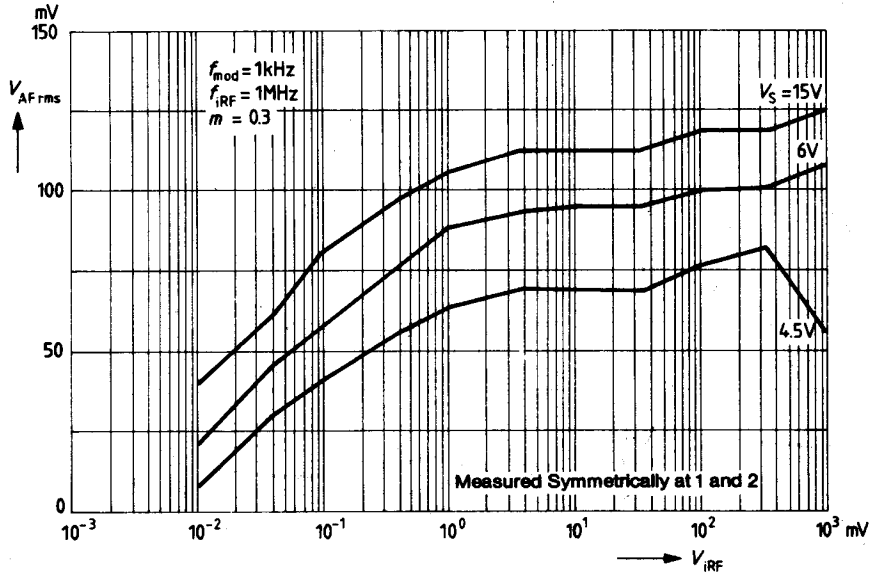
The input is not power matched and can be driven with a higher resistance. The selected V_1 ensures a constant V_{15} (50 mV peak-to-peak).

IF control



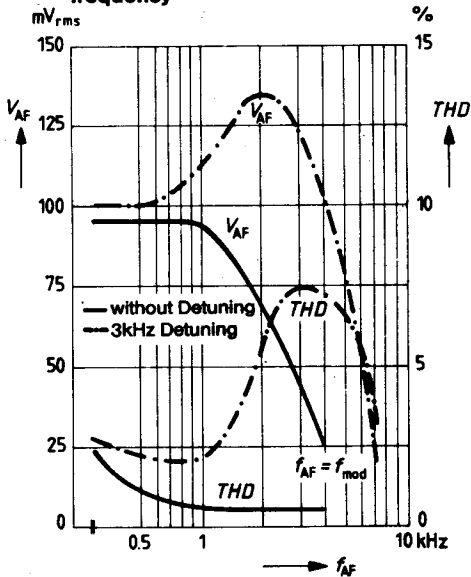
The selected V_{IF} (469 kHz; $m = 80\%$; $f_{mod} = 1 \text{ kHz}$) ensures a constant V_{AF} (200 mV, rms).

AF output voltage versus RF input voltage

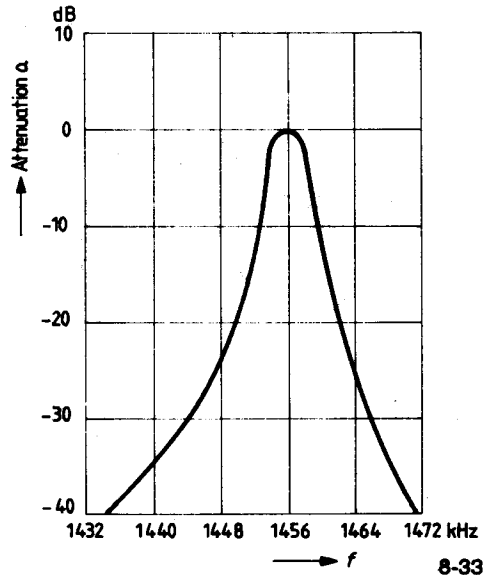


Example for medium wave applications

**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)

$V_S = 9\text{ V}$

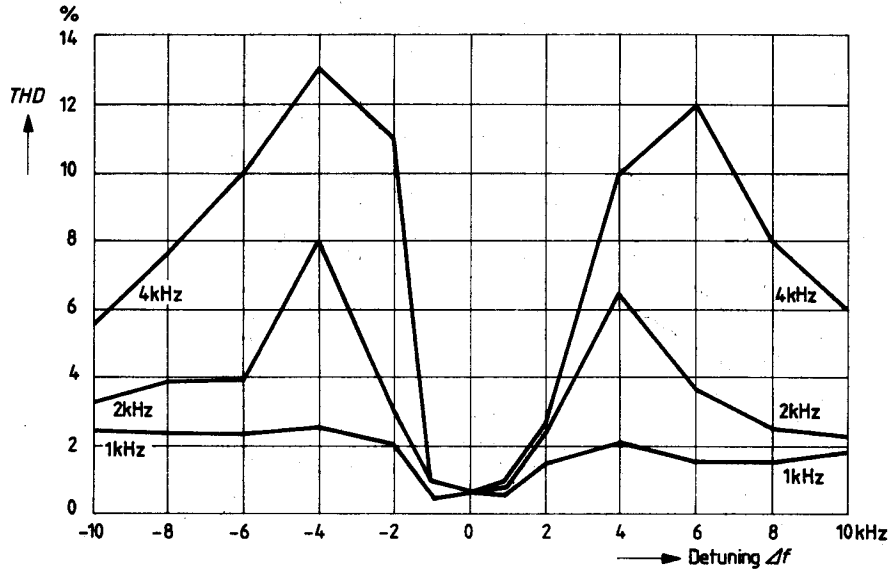
$f_{OSC} = 1.455\text{ MHz} \pm \Delta f$

$m = 30\%$

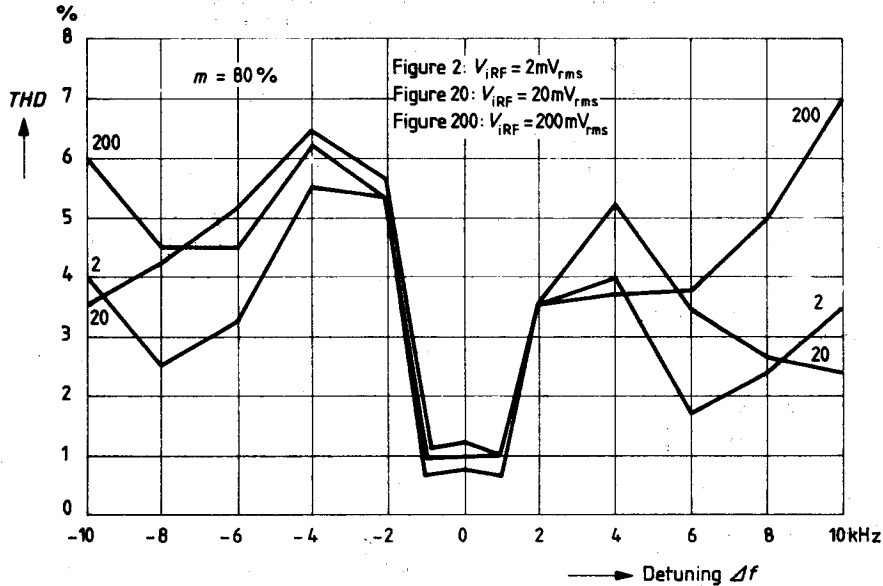
$f_{iRF} = 1\text{ MHz}$

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

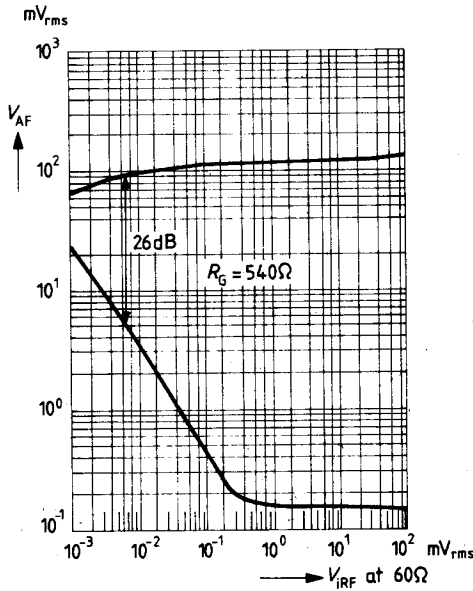
$V_{iRF} = 20\text{ mV}_{rms}$



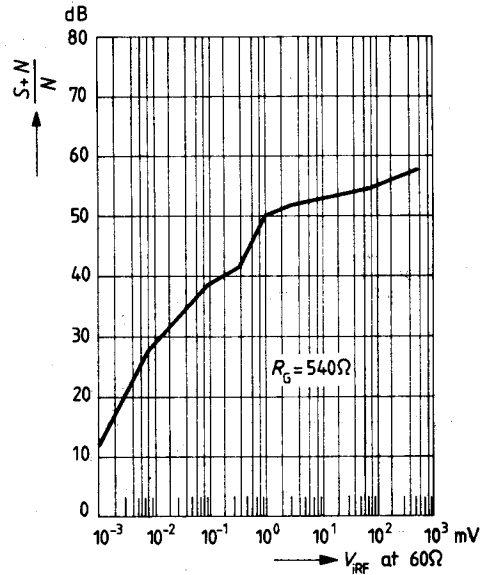
Total harmonic distortion versus detuning (parameter: RF input voltage)



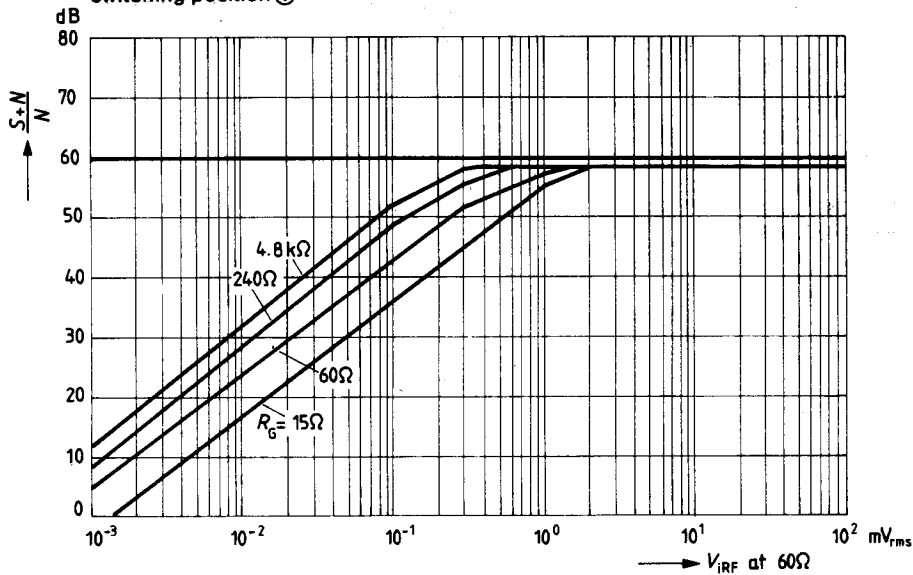
AF output voltage and noise figure versus RF input voltage switching position ①



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



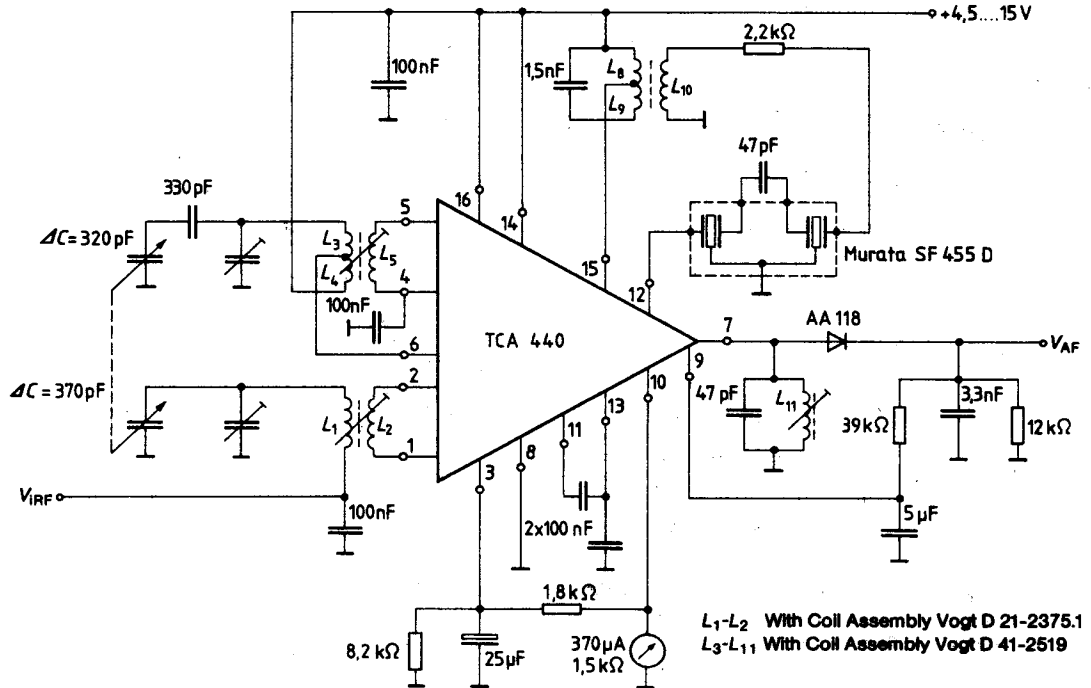
Signal-to-noise ratio versus RF input voltage (parameter is generator impedance) switching position ①



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Application example for MW

Prestage control is derived from IF control

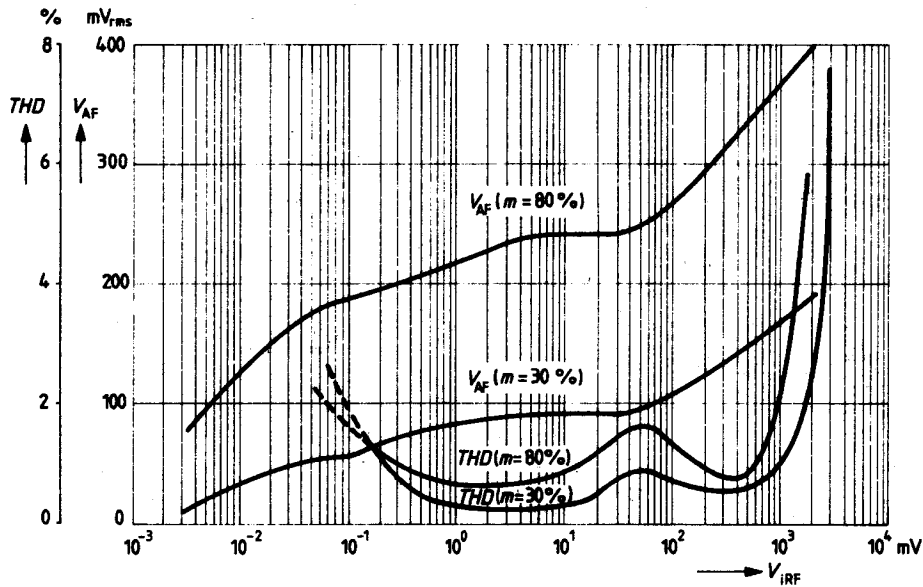


- L_1 105 turns 12x0.04 Cu LS
- L_2 7 turns 0.10 Cu L
- L_3 80 turns 12x0.04 Cu LS
- L_4 35 turns 12x0.04 Cu LS
- L_5 15 turns 0.10 Cu L
- L_8 20 turns 12x0.04 Cu LS
- L_9 50 turns 12x0.04 Cu LS
- L_{10} 22 turns 12x0.04 Cu LS
- L_{11} 400 turns 0.04 Cu L

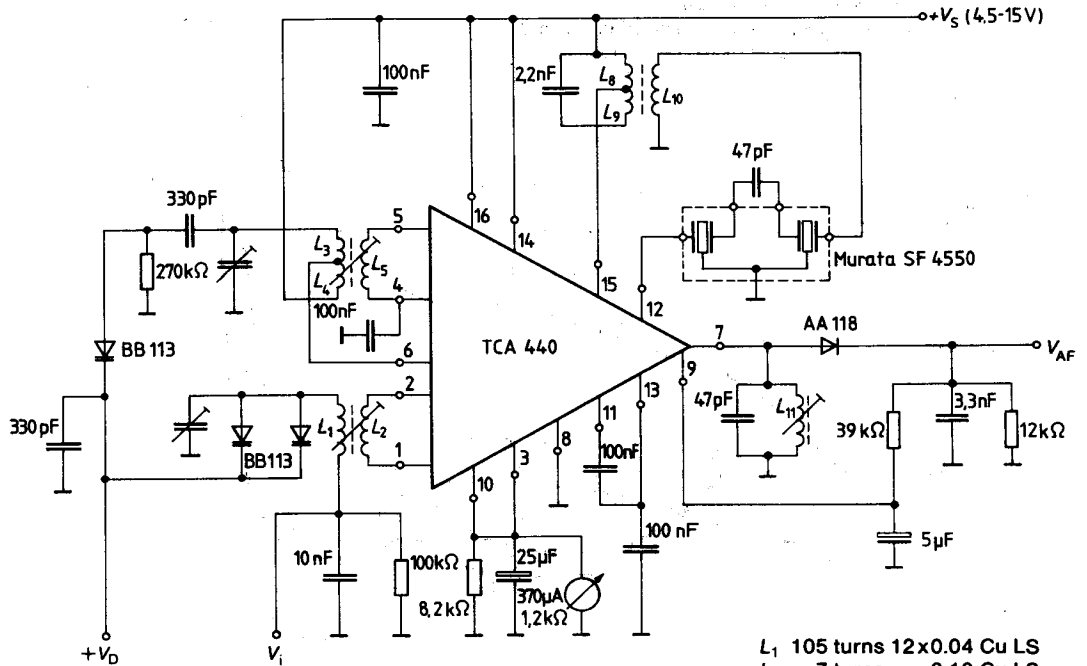
Test figures for application example for MW

**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

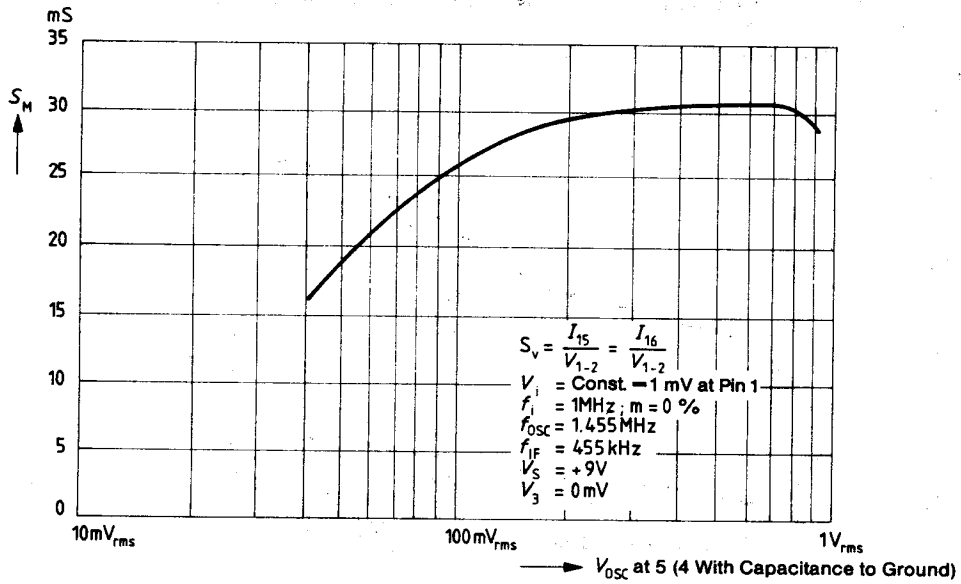
$L_3 - L_{11}$ With Coil Assembly Vogt D41-2519

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

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

- 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.

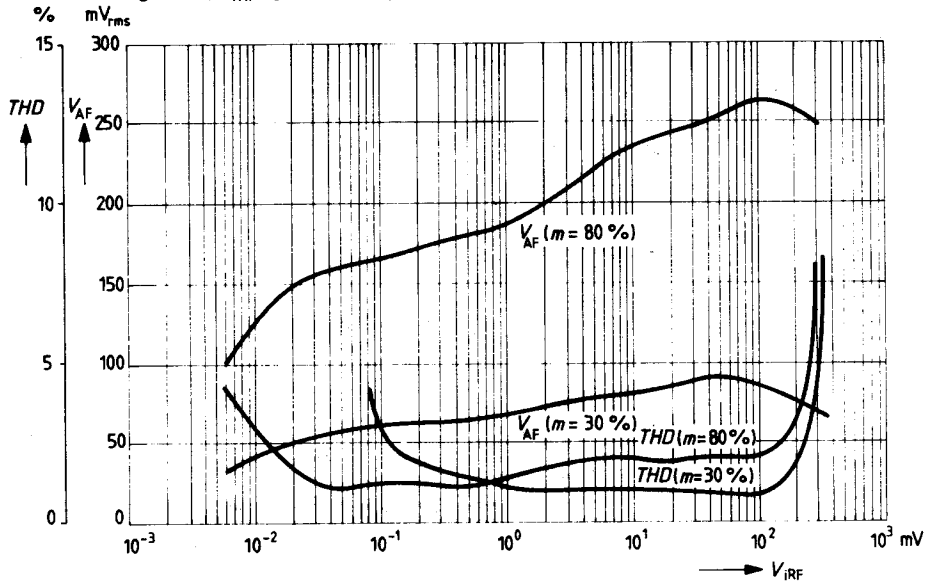


Measured values for application example for MW using diode BB 113

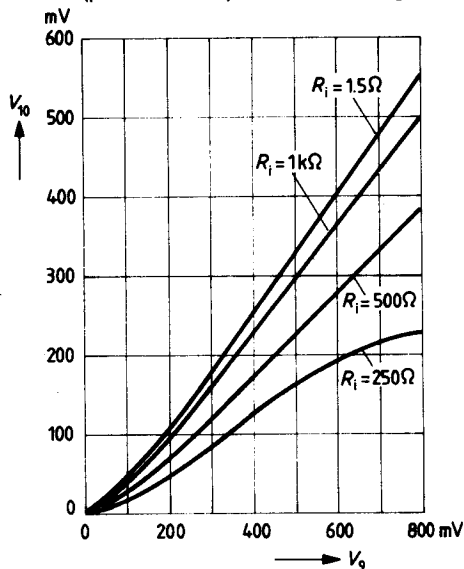
AF output voltage and total harmonic distortion versus RF input voltage

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

$V_S = 9 \text{ V}$; V_{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 Ω	100 μA
1.5 k Ω	170 μA
2 k Ω	200 μA
350 Ω	500 μA