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

$V_S = 9$ V; $T_A = 25$ °C; $f_{iRF} = 600$ kHz; $f_{mod} = 1$ kHz

Total current consumption		I_S	10.5	mA
RF level deviation for	$\Delta V_{AF} = 6$ dB	ΔG_{RF}	65	dB
$m = 80\%$	$\Delta V_{AF} = 10$ dB	ΔG_{RF}	80	dB
AF output voltage for V_{iRF} (symm. measured at 1–2)				
for $m = 80\%$	$V_{iRF} = 20$ µV	$V_{AF\,rms}$	140	mV
	$V_{iRF} = 1$ mV	$V_{AF\,rms}$	260	mV
	$V_{iRF} = 500$ mV	$V_{AF\,rms}$	350	mV
for $m = 30\%$	$V_{iRF} = 20$ µV	$V_{AF\,rms}$	50	mV
	$V_{iRF} = 1$ mV	$V_{AF\,rms}$	100	mV
	$V_{iRF} = 500$ mV	$V_{AF\,rms}$	130	mV
Input sensitivity (measured at 60 Ω, $f_{iRF} = 1$ MHz, $m = 30\%/0\%$, $R_G = 540$ Ω)				
at signal-to-noise ratio $\frac{S+N}{N} = 6$ dB (in acc. with DIN 45405)		V_{iRF}	1	µV
	$\frac{S+N}{N} = 26$ dB	V_{iRF}	7	µV
	$\frac{S+N}{N} = 58$ dB	V_{iRF}	1	mV

RF stage

Input frequency range	f_{iRF}	0 to 50	MHz
Output frequency $f_{IF} = f_{OSC} - f_{iRF}$	f_{IF}	460	kHz
Control range	ΔG_V	38	dB
Input voltage (for 600 kHz, $m = 80\%$) for overdrive ($THD_{AF} = 10\%$), symmetrically measured at pins 1 and 2	$V_{iRF\,pp}$	2.6	V
(mean carrier value)	$V_{iRF\,rms}$	0.5	V
IF suppression between 1–2 and 15	a_{IF}	20	dB
RF input impedance			
a) unsymmetrical coupling			
at $G_{RF\,max}$	Z_i	2/5	kΩ/pF
at $G_{RF\,min}$	Z_i	2.2/1.5	kΩ/pF
b) symmetrical coupling			
at $G_{RF\,max}$	Z_i	4.5	kΩ/pF
at $G_{RF\,min}$	Z_i	4.5/1.5	kΩ/pF
Mixer output impedance (pins 15 or 16)	Z_o	250/4.5	kΩ/pF

8

IF stage

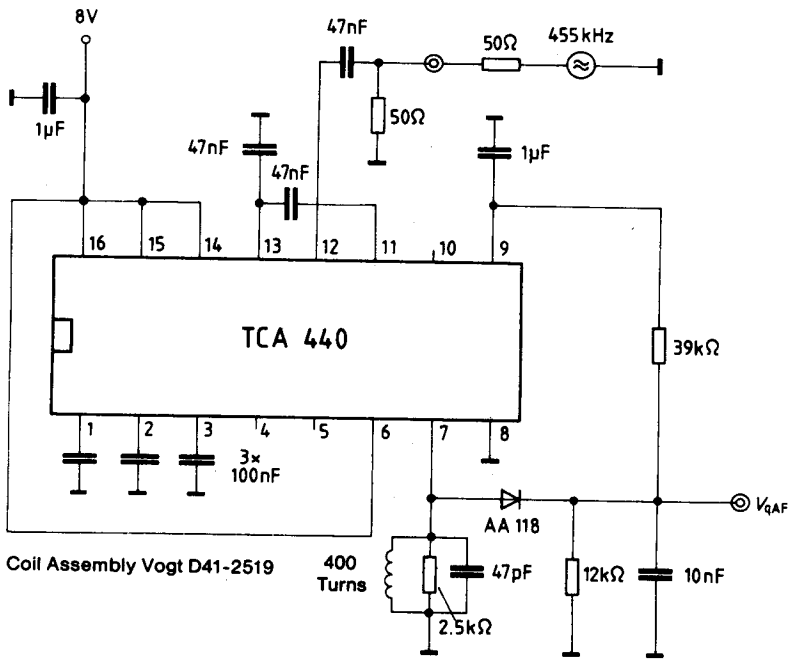
Input frequency range	f_{IIF}	0 to 2	MHz
Control range at 460 kHz	ΔG_V	62	dB
Input voltage (mean carrier value) at G_{min} for overdrive ($THD_{AF} = 10\%$), measured at pin 12 (60 Ω to ground, $f_{IIF} = 460$ kHz, $m = 80\%$; $f_{mod} = 1$ kHz)	$V_{IF\,rms}$	200	mV
AF output voltage for V_{IIF} at 60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

Tuning meter

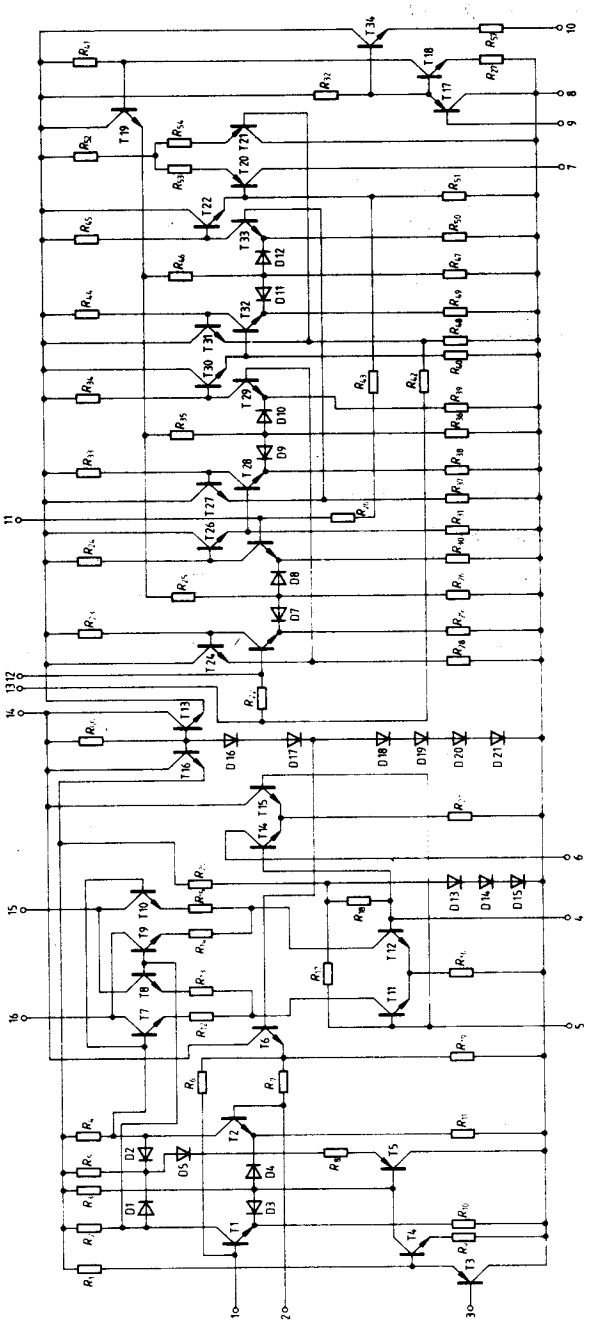
Recommended instruments: 500 µA ($R_i = 800$ kΩ)
or 300 µA ($R_i = 1.5$ kΩ)

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

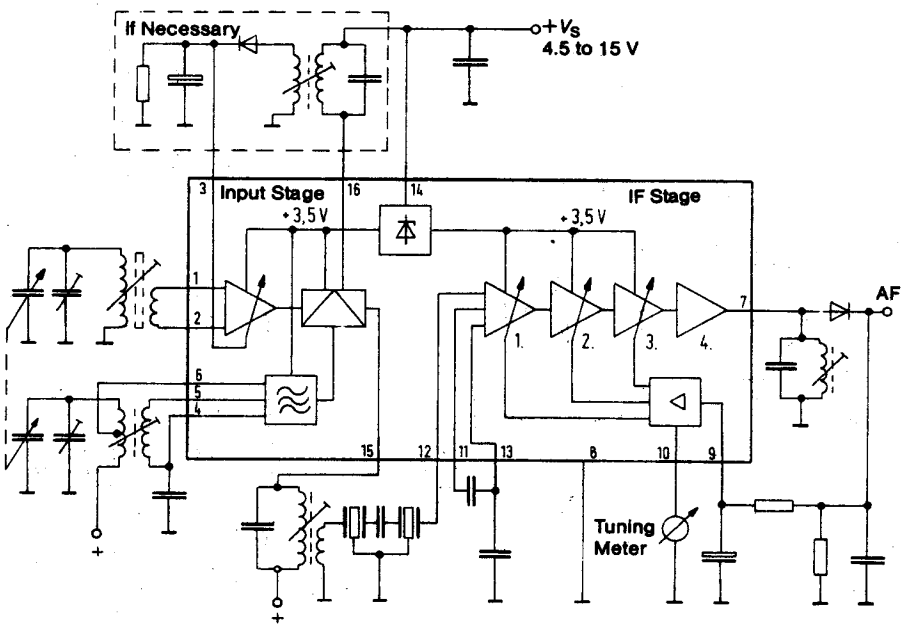
Measurement circuit for output voltage



Circuit diagram



Block diagram



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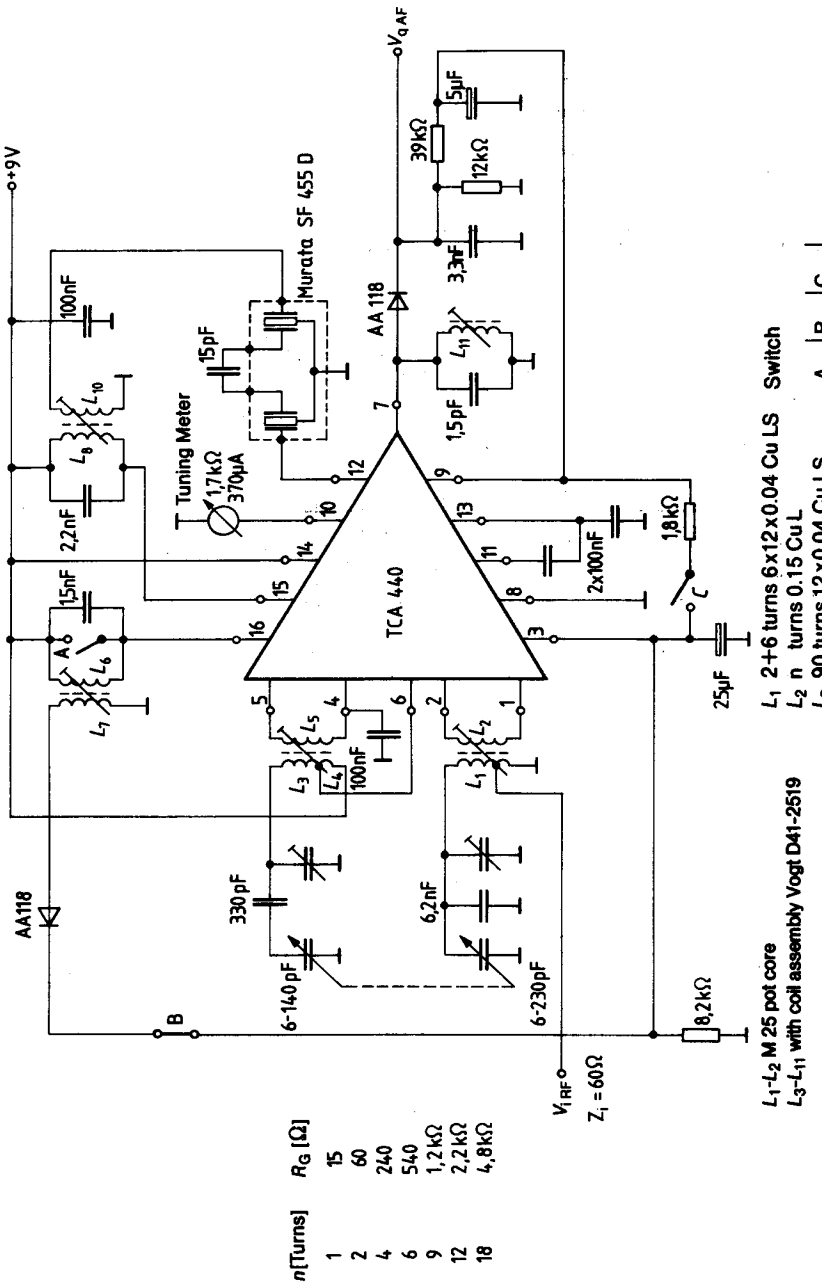
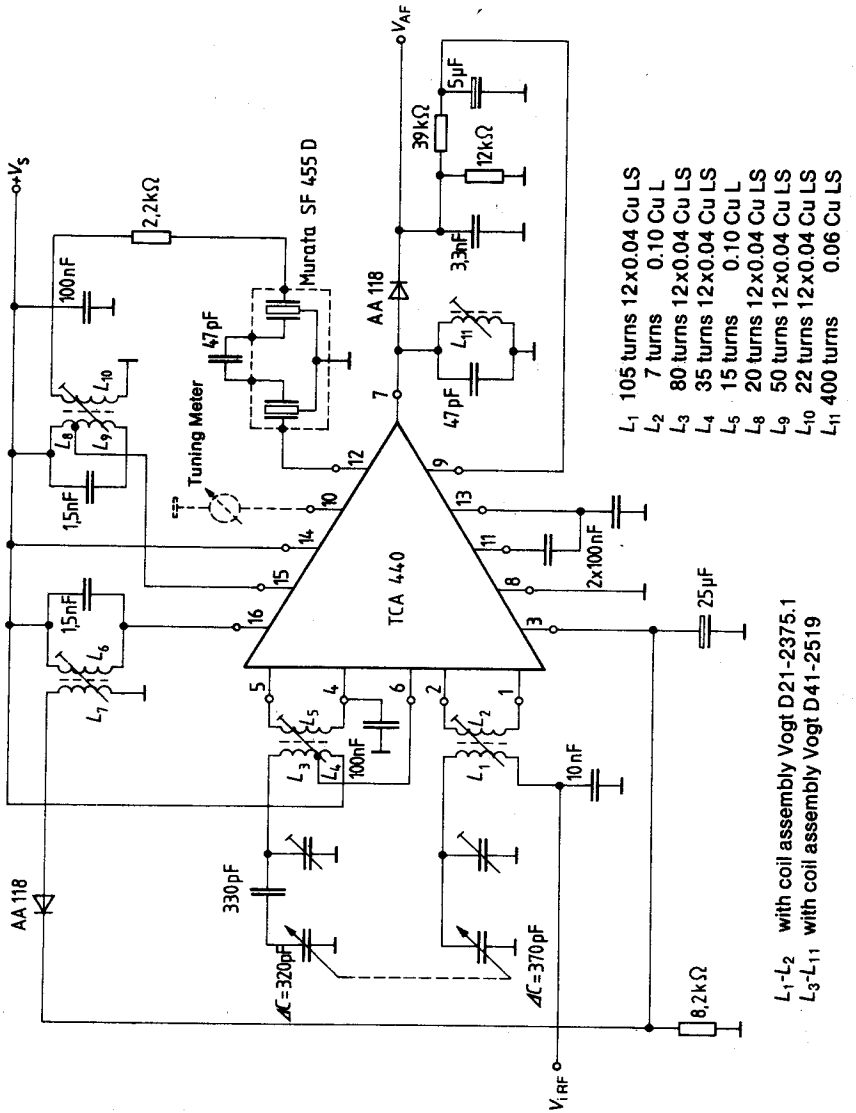
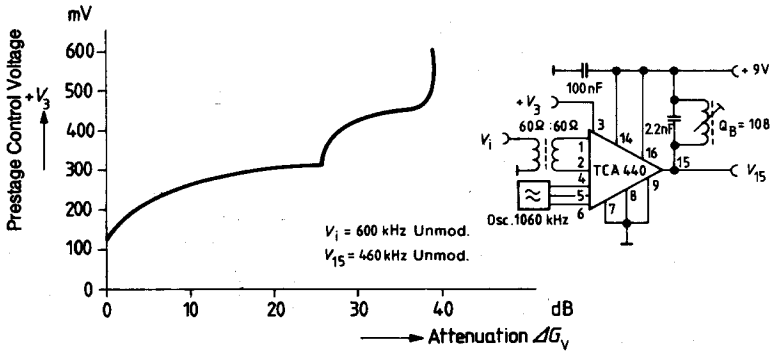
Measurement circuit for signal-to-noise ratio



Application example for MW with TCA 440

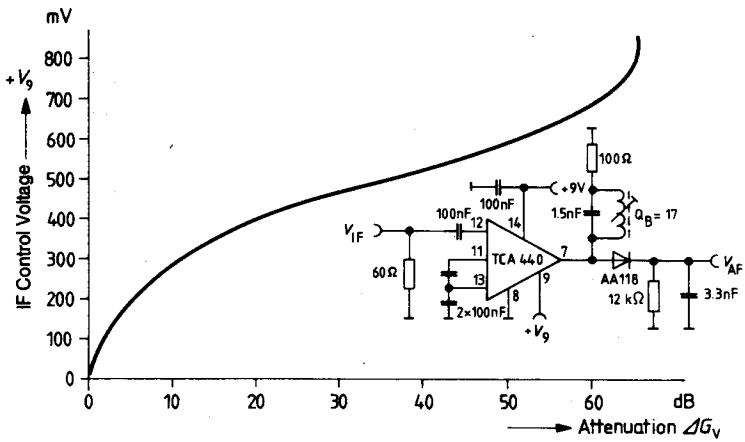


Prestage control TCA 440



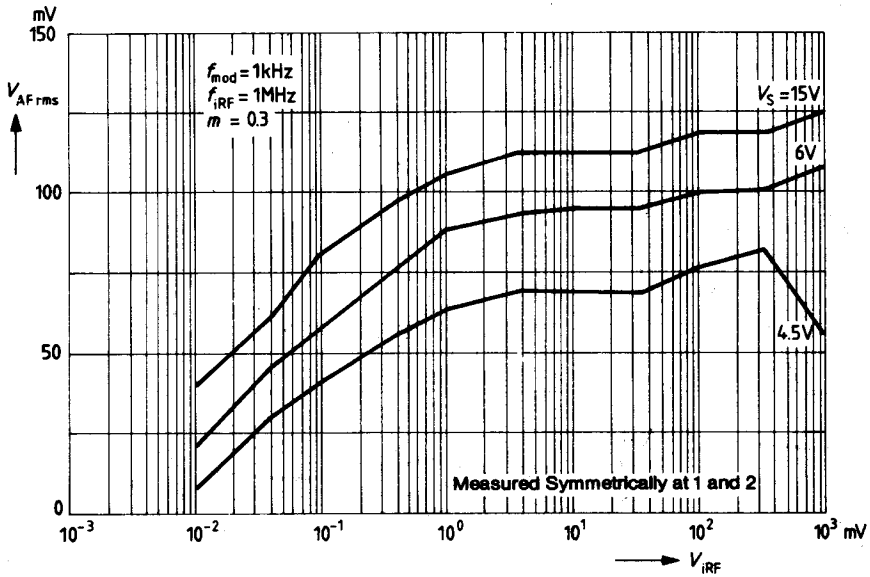
The input ist not power matched and can be driven with a higher resistance. The selected V_i ensures a constant V_{15} (50 mV peak-to-peak).

IF control



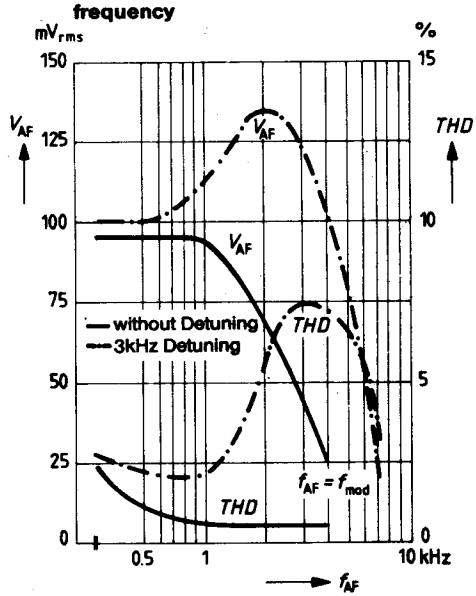
The selected V_{IF} (469 kHz; m = 80%; f_{mod} = 1 kHz) ensures a constant V_{AF} (200 mV, rms).

AF output voltage versus RF input voltage

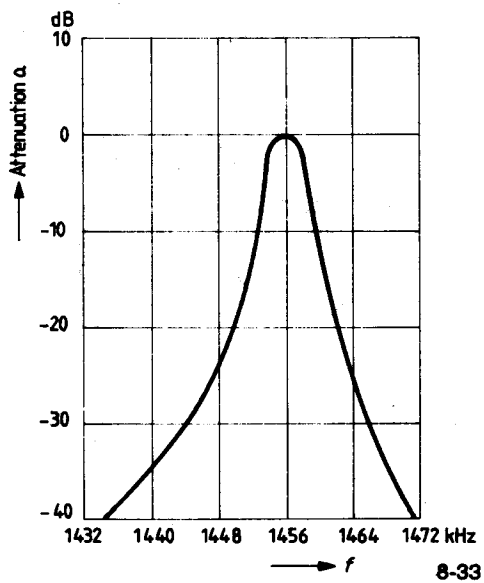


Example for medium wave applications

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



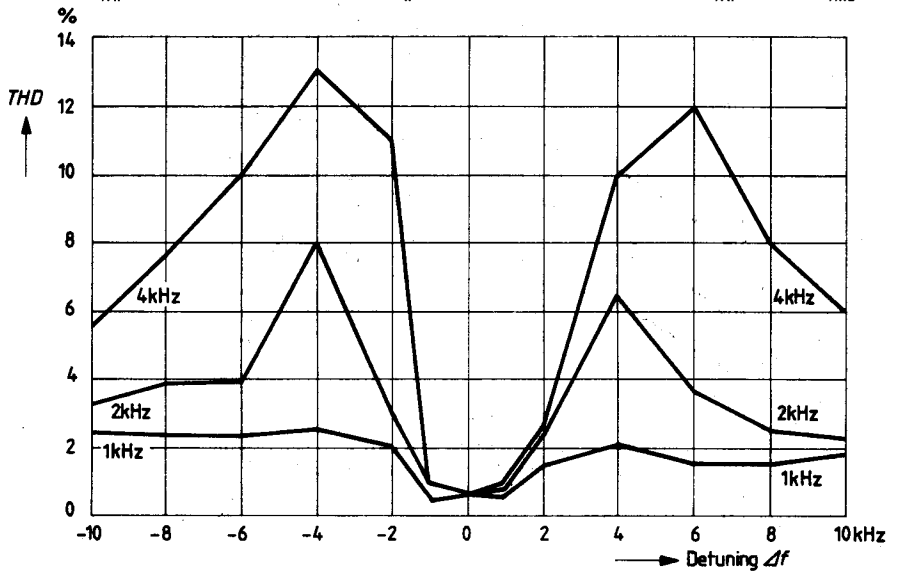
Passband characteristic versus input frequency, measured from input to output of the circuit



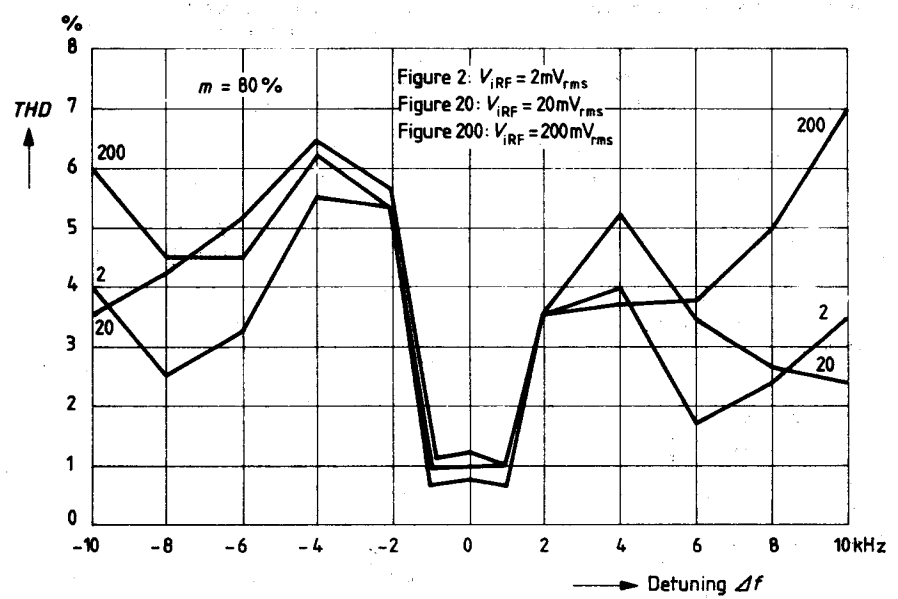
8

Total harmonic distortion versus detuning (parameter: modulation frequency)

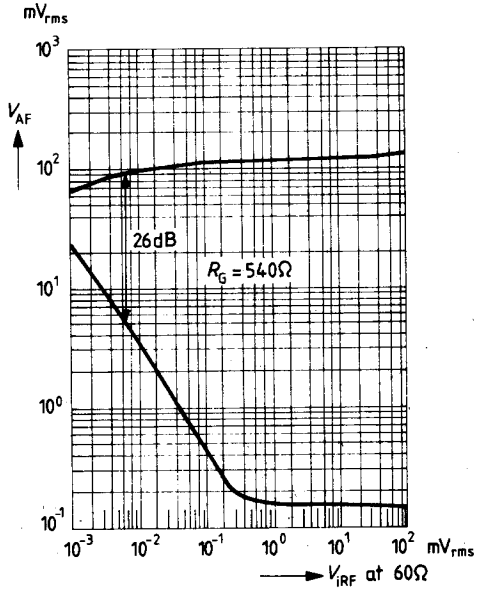
$V_S = 9$ V $f_{OSC} = 1.455$ MHz $\pm \Delta f$ $m = 30\%$
$f_{iRF} = 1$ MHz $f_{IF} = 455$ kHz $V_{iRF} = 20$ mV$_{rms}$



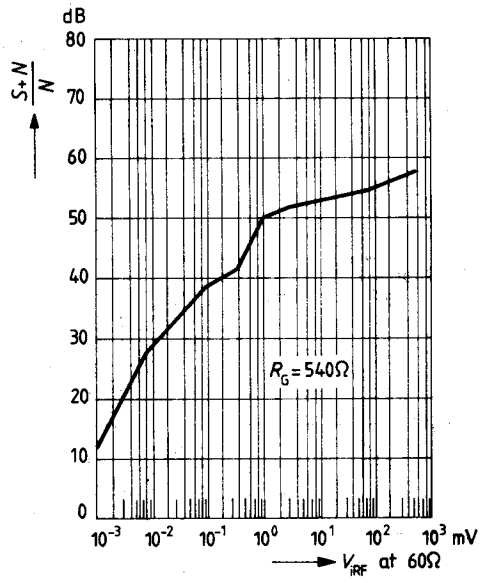
Total harmonic distortion versus detuning (parameter: RF input voltage)



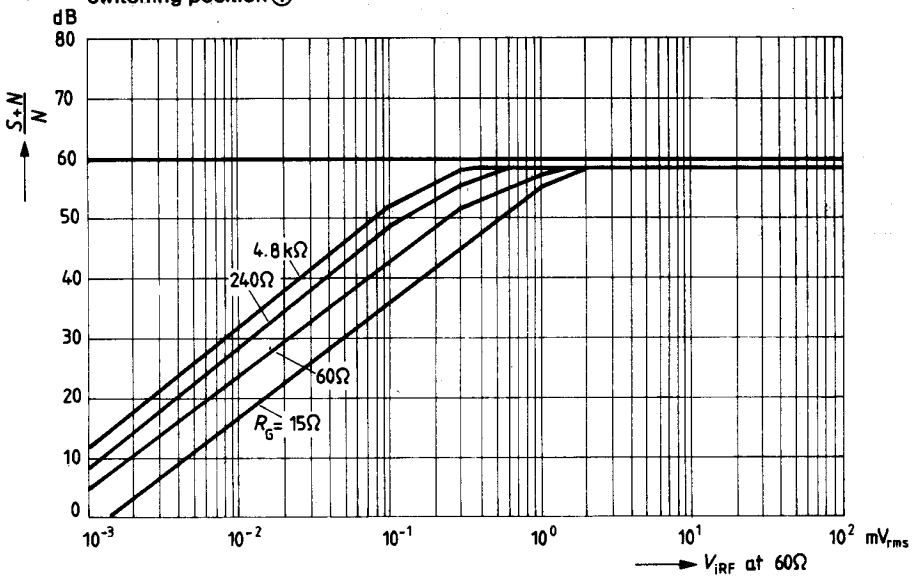
AF output voltage and noise figure versus RF input voltage
switching position ①



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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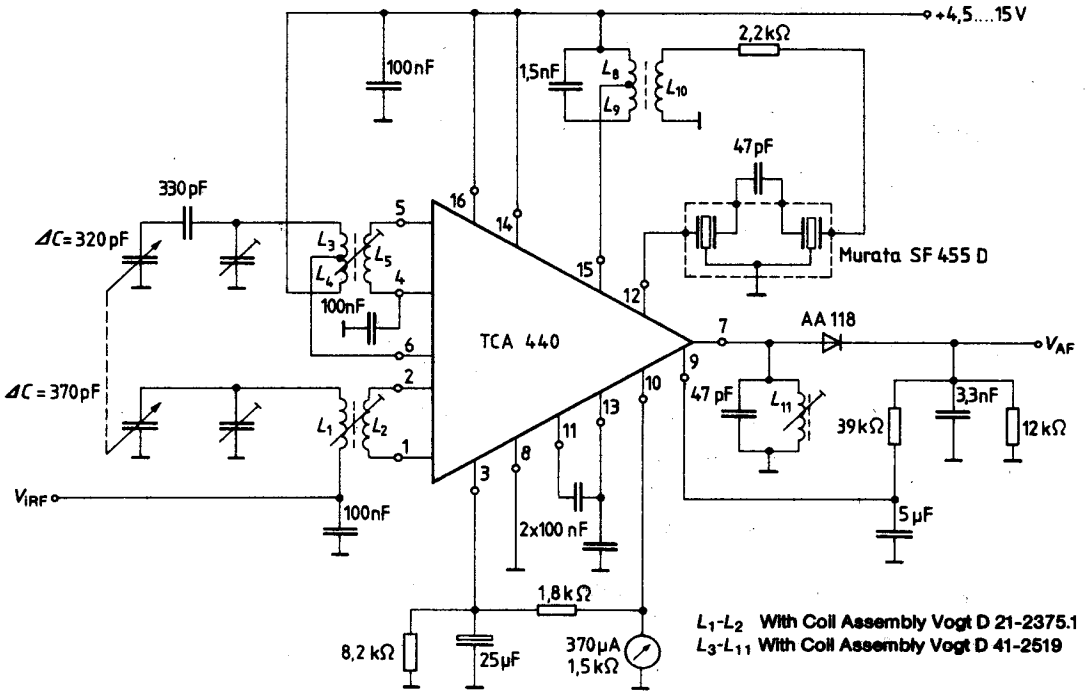
Application example for MW

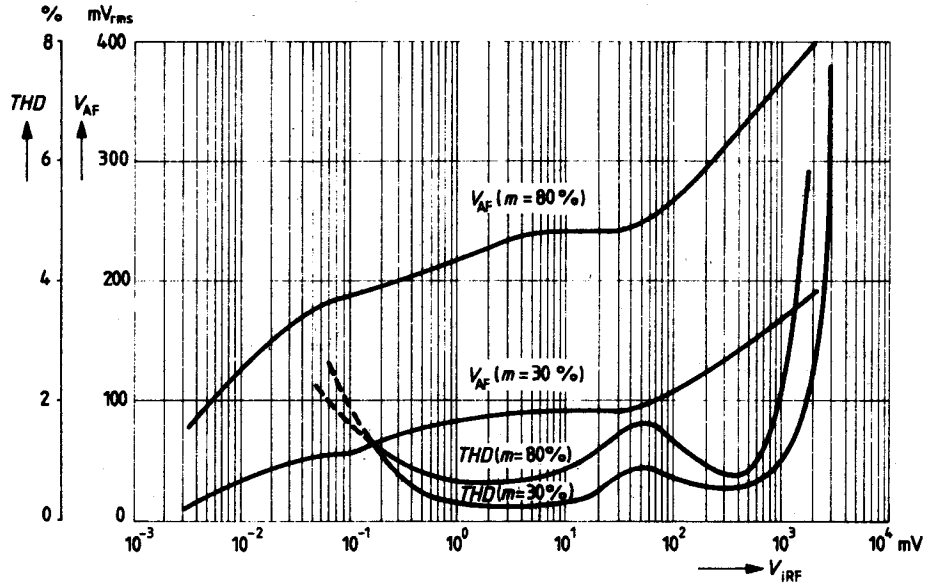
Prestage control is derived from IF control



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



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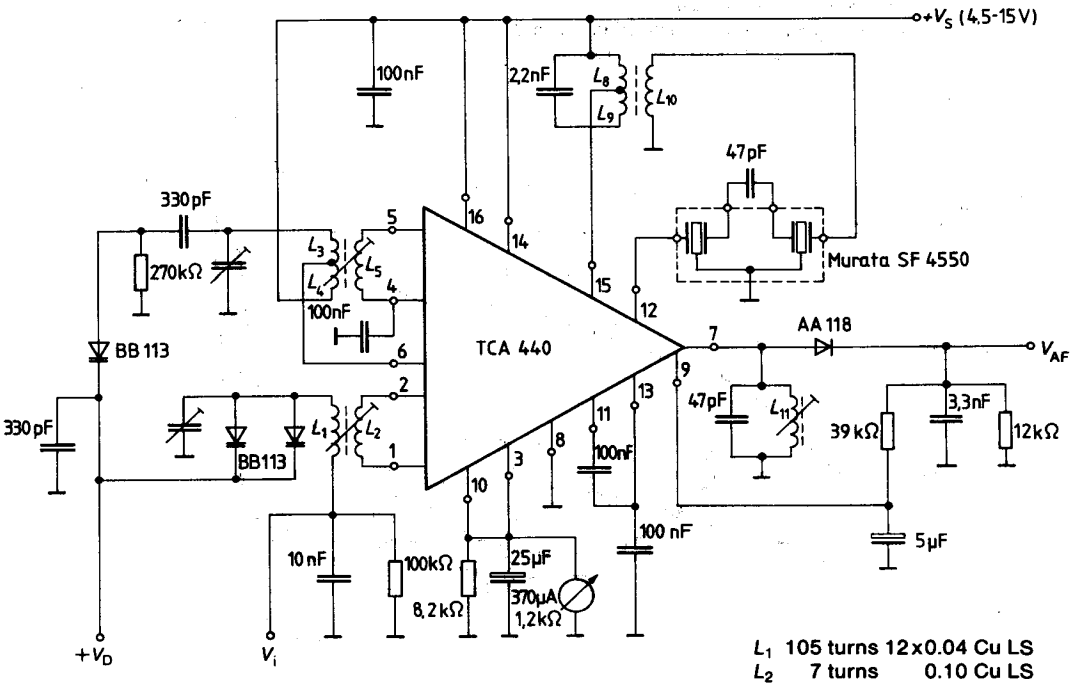
Application example for MW using BB 113 varicap diodes

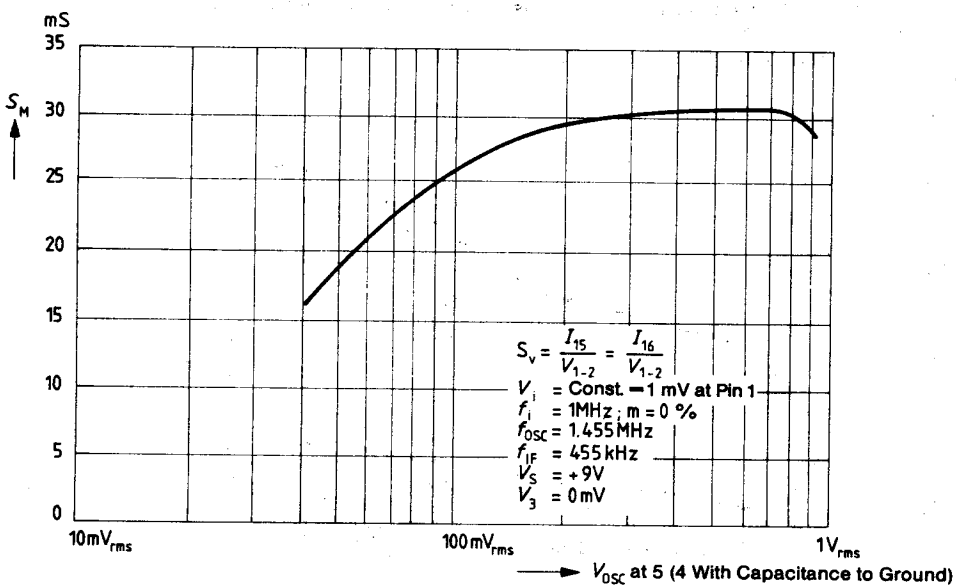


L_1-L_2 With Coil Assembly Vogt D21-2375.1
L_3-L_{11} With Coil Assembly Vogt D41-2519

V_{tun} = 8.5 V ⟶ f_i = 800 kHz
V_{tun} = 30 V ⟶ f_i = 1620 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



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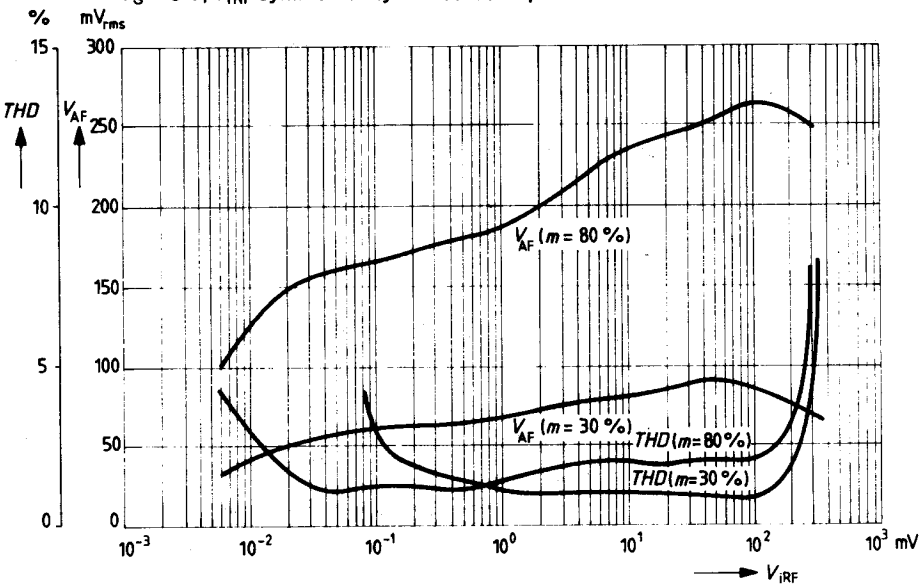
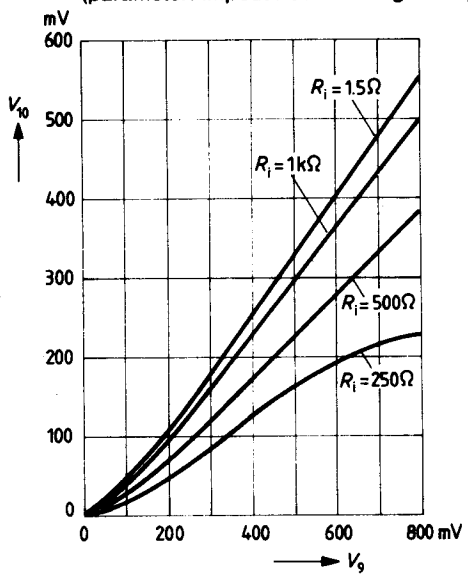
Measured values for application example for MW using diode BB 113

AF output voltage and total harmonic distortion versus RF input voltage
$f_i = 1$ MHz; $f_{mod} = 1$ kHz; $f_{IF} = 455$ kHz
$V_S = 9$ 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 kΩ	100 µA
1.5 kΩ	170 µA
2 kΩ	200 µA
350 Ω	500 µA