

INTEGRATED A.M./F.M. RADIO RECEIVER CIRCUIT

The TBA700 is a monolithic integrated circuit for use in a.m. (including the short-wave band), a.m./f.m. receivers.

It incorporates the class-B audio output stage (1 W), stabilization circuit for quiescent current, driver, pre-amplifier, 2-stage i.f. amplifier, a.g.c. and stabilized bias circuit.

The discrete input stage (for a.m.: mixer-oscillator; for f.m.: 1st i.f.) enables a high flexibility in circuit lay-out with conventional or lumped selectivity.

The internal stabilization ensures negligible loss of sensitivity and cross-over distortion over a wide supply voltage range from 2,7 V to 12 V.

QUICK REFERENCE DATA				
Applicable supply voltage range of receiver	V_{10-8}	2,7 to 12	$V^1)$	
Ambient temperature	T_{amb}	25	$^{\circ}C$	
Supply voltage	V_p	nom. 9	V	

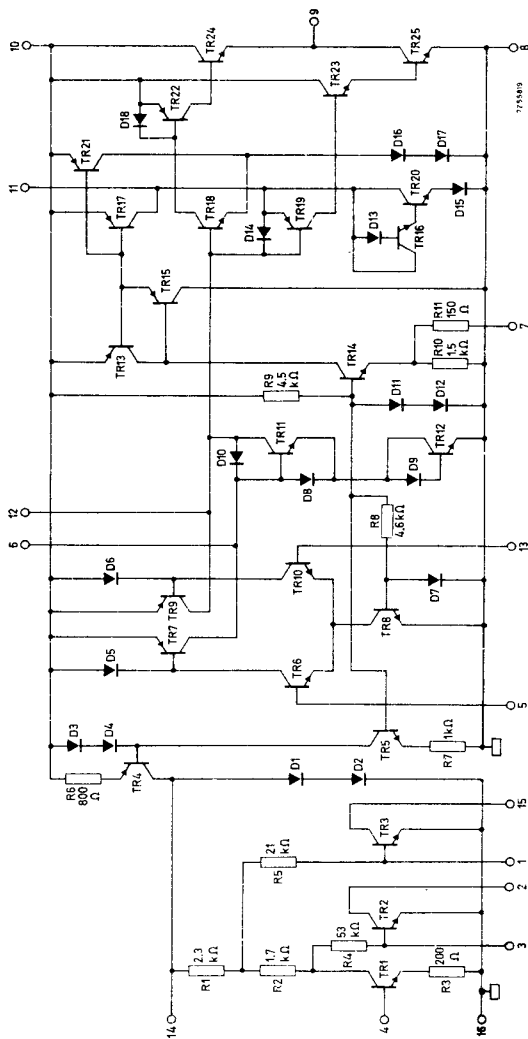
Total quiescent current (inclusive discrete input transistor, exclusive f.m. front end)	I_{tot}	typ. 24,5	mA	
A.F. output power at $d_{tot} = 10\%$, $R_L = 8\ \Omega$	P_o	typ. 1000	mW	
<u>A.M. performance</u>				
R.F. input voltage (S/N = 26 dB) (at base of external mixer-oscillator)	V_i	typ. 15	μV	
A.G.C. range (change of r.f. input voltage for 10 dB expansion in audio range)		typ. 72	dB	
<u>F.M. performance</u>				
R.F. input voltage (at base of external i.f. stage) 3 dB before limiting	V_i	typ. 150	μV	

PACKAGE OUTLINE

16-lead DIL; plastic with internal copper slug (SOT-38).

1) The data given in this sheet are based on a receiver with $V_P = 9\ V$; $P_o = 1000\ mW$.

CIRCUIT DIAGRAM



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RATINGS Limiting values in accordance with the Absolute Maximum System (IEC134)

Voltages

Pin No. 10 voltage	V_{10-8}	max.	12	V
Pins No. 15, 9, 2 voltages	$V_{15-8}, V_{9-8}, V_{2-8}$	max.	11,4	V
Pin No. 16 voltage	V_{16-8}	max.	0	V ¹⁾
Pin No. 7 voltage	$\pm V_{7-8}$	max.	5	V
Pins No. 4, 3, 1 voltages	$-V_{4-16}, -V_{3-16}, -V_{1-16}$	max.	5	V
Pin No. 5 voltage	$\pm V_{5-13}$	max.	5	V
Pin No. 10 voltage	V_{10-9}	max.	11,4	V

Currents

Pins No. 14, 12, 11, 6 currents	$I_{14}, I_{12}, I_{11}, I_6$	max.	5	mA
Pins No. 13, 5, 4, 3, 1 currents	$I_{13}, I_5, I_4, I_3, I_1$	max.	0,5	mA
Pins No. 15, 2 currents	I_{15}, I_2	max.	10	mA
Pin No. 8 current	$-I_{8RM}$	max.	0,8	A ²⁾
Pin No. 9 current	$\pm I_{9RM}$	max.	0,8	A ²⁾
Pin No. 10 current	I_{10RM}	max.	0,8	A ²⁾

Dissipation

Total power dissipation

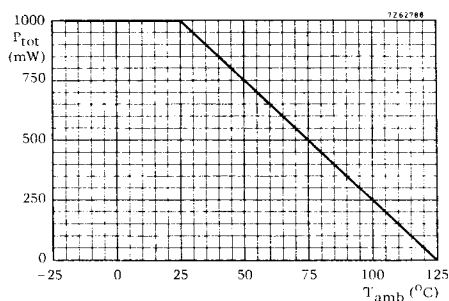
at $T_{amb} = 45^\circ\text{C}$

at $T_{amb} = 25^\circ\text{C}$

P_{tot}	max.	800	mW
P_{tot}	max.	1000	mW

Temperatures

Storage temperature	T_{stg}	-55 to +125	$^\circ\text{C}$
Operating ambient temperature	T_{amb}	-20 to +125	$^\circ\text{C}$



1) Substrate connected to pin 16.

2) Repetitive peak value; internally limited.

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CHARACTERISTICS

D.C. characteristics at $T_{amb} = 25^{\circ}\text{C}$; $V_P = 9\text{ V}$ I. F. amplifierCollector current of i. f. transistor TR2
(a. g. c. transistor "off")

I_C	typ.	1	mA
		0,55 to 1,6	mA

Collector current of i. f. transistor TR3
(a. g. c. transistor "off")

I_C	typ.	2,5	mA
		1,4 to 4,2	mA

Saturation voltage of i. f. transistor TR2
at $I_C \leq 2\text{ mA}$

V_{CEsat}	<	150	mV
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Saturation voltage of i. f. transistor TR3
at $I_C \leq 5\text{ mA}$

V_{CEsat}	<	200	mV
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Bias voltage for mixer and tuner

V_{14-16}	{	typ.	1,4	V
			1,25 to 1,55	V

Temperature dependency of
bias voltage V_{14-16}

T_c	typ.	-3,6	mV/ $^{\circ}\text{C}$
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Bias current (available)

$-I_{14}$	<	100	μA
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A. F. amplifier

Input common mode voltage range

V_{5-8}, V_{13-8}	1,0 to 8,5	V	1)
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Input base bias current

I_5, I_{13}	<	25	μA
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Complete circuitTotal quiescent current with 3,3 k Ω
between pins 7 and 8 (inclusive discrete
input transistor, exclusive f. m. front end)

I_{tot}	typ.	24,5	mA	2)
	<	30,5	mA	2)

1) Maximum input common mode voltage; $V_{5-8}, V_{13-8} < (V_P - 0,5)\text{ V}$.2) In those cases where a lower supply current is required the resistor between pins 7 and 8 (3,3 k Ω) can be avoided, resulting in a total current of 17 mA. In this case however some devices may show a marginal increase of the distortion level.

CHARACTERISTICS (continued)

A.C. characteristics of i.f. part

y parameters at $f = 450 \text{ kHz}$ ¹⁾

	i.f. transistors: TR2			TR3	
Input conductance	g_{ie}	typ.	0,45	1,15	mA/V
Input capacitance	C_{ie}	typ.	23	36	pF
Output conductance	g_{oe}	typ.	6,0	13,5	$\mu\text{A/V}$
Output capacitance	C_{oe}	typ.	4,0	4,25	pF
Transfer admittance	$ y_{fe} $	typ.	37	82	mA/V
Phase angle of transfer admittance	φ_{fe}	typ.	1°	2°	
Feedback admittance	$ y_{re} $	typ.	2,5	1,8	$\mu\text{A/V}$
Phase angle of feedback admittance	φ_{re}	typ.	90°	90°	

y parameters at $f = 10,7 \text{ MHz}$ ¹⁾

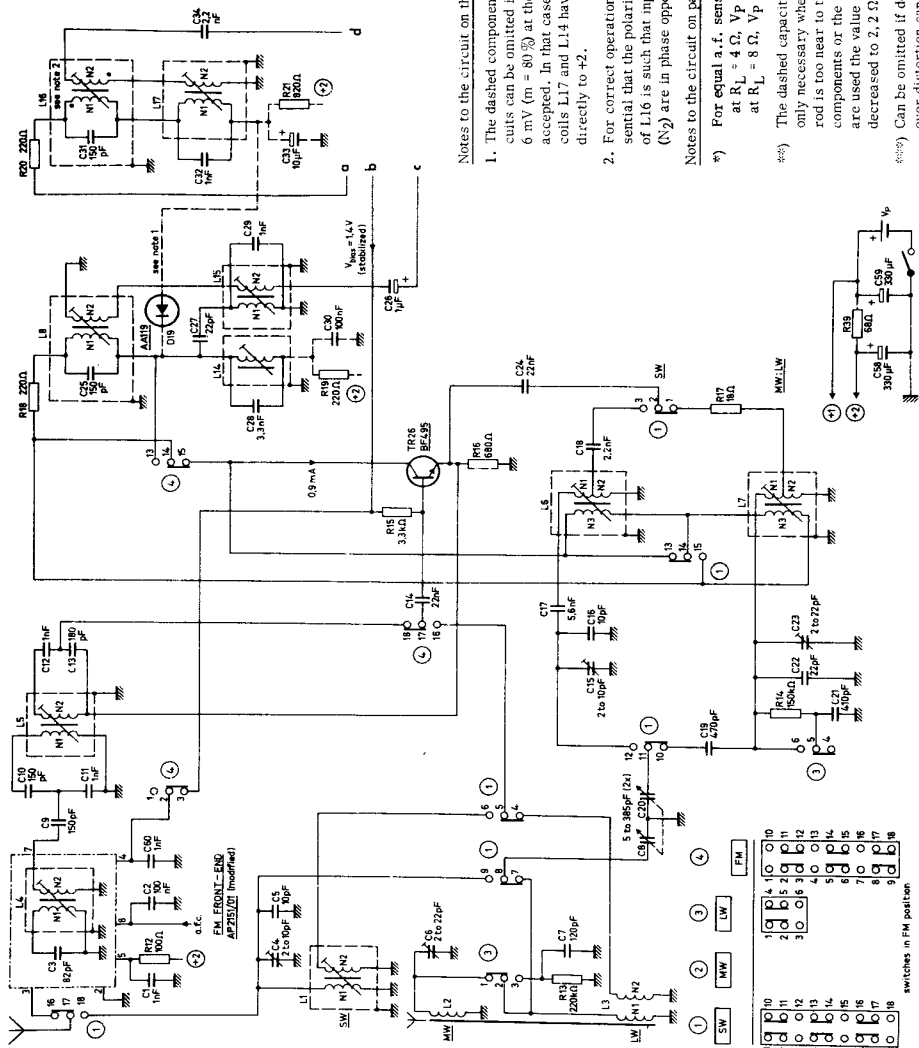
	i.f. transistors: TR2			TR3	
Input conductance	g_{ie}	typ.	0,6	1,5	mA/V
Input capacitance	C_{ie}	typ.	22	35	pF
Output conductance	g_{oe}	typ.	24	30	$\mu\text{A/V}$
Output capacitance	C_{oe}	typ.	4,3	4,7	pF
Transfer admittance	$ y_{fe} $	typ.	35	73	mA/V
Phase angle of transfer admittance	φ_{fe}	typ.	22°	35°	
Feedback admittance	$ y_{re} $	typ.	64	43	$\mu\text{A/V}$
Phase angle of feedback admittance	φ_{re}	typ.	90°	90°	

1) At typical values for h_{fe} and I_C .

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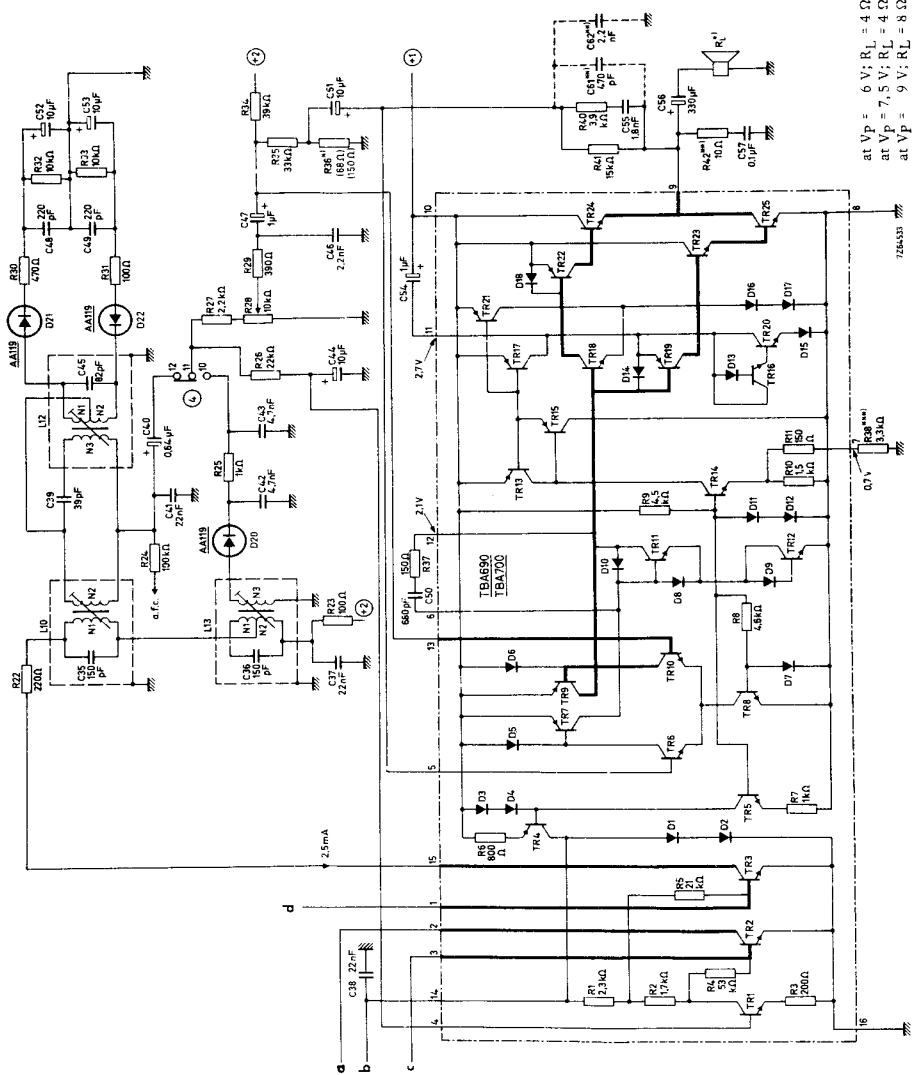


Notes to the circuit on this page

1. The dashed components in the i.f. circuits can be omitted if signal handling of 6 mV ($m = 80\%$) at the base of TR26 is accepted. In that case the cold ends of coils L17 and L14 have to be connected directly to +2.
2. For correct operation on f.m. it is essential that the polarity of the windings of L16 is such that input (N₁) and output (N₂) are in phase opposition.

Notes to the circuit on page 7

- * For equal a.f. sensitivity:
 at $R_L = 4 \Omega$, $V_p = 6 V$; $R_{36} = 150 \Omega$
 at $R_L = 8 \Omega$, $V_p = 9 V$; $R_{36} = 68 \Omega$
- ** The dashed capacitors (C61; C62) are only necessary when the ferrite aerial rod is too near to the a.f. output components of the IC. If C61 and C62 are used the value of R42 must be decreased to 2.2Ω .
- *** Can be omitted if degraded cross-over distortion can be tolerated.



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APPLICATION INFORMATION (continued) at $T_{amb} = 25^{\circ}\text{C}$; $V_P = 9\text{ V}$

See also circuit diagram on pages 6 and 7.

A.M. performance

R.F. input voltage for signal to noise ratio of 26 dB	V_i	typ.	15	μV	$1)^2)$
R.F. input voltage for 10 mV (a.f.) across volume control	V_i	typ.	3	μV	$1)^2)$
A.F. voltage across volume control at 100 μV (r.f.) input voltage	V_o	typ.	100	mV	$1)^2)$
Signal to noise ratio at 1 mV (r.f.) input voltage	S/N	typ.	53, 4	dB	$1)^2)$
A.G.C. range (change in r.f. input voltage for 10 dB expansion in audio range)					
without a.g.c. diode		typ.	42	dB	$1)^2)^3)$
with a.g.c. diode		typ.	72	dB	$1)^2)$
R.F. signal handling capability on base of TR26 80 % modulation ($d_{tot} \leq 10\%$)					
without a.g.c. diode	V_i	typ.	6	mV	$3)$
with a.g.c. diode	V_i	typ.	80	mV	
Harmonic distortion of h.f. part (over most of a.g.c. range)	d_{tot}	typ.	1	%	$1)^2)$
I.F. selectivity	S_9	typ.	30	dB	
I.F. bandwidth	B_{3dB}	typ.	4, 5	kHz	

- 1) a. Negligible influence of supply voltage variations in a range of 2,7 V to 12 V
- b. A.F. signal: measured across volume control.
- c. R.F. signal: measured at base of external mixer-oscillator with the antenna-circuit connected (source resistance R_S of about 1 k Ω).
- d. $f_o = 1\text{ MHz}$, $f_m = 1\text{ kHz}$
- 2) $m = 0,3$
- 3) Dashed parts of circuit diagram on pages 6 and 7 are omitted.

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APPLICATION INFORMATION (continued) See also circuit on pages 6 and 7.

F.M. performance

Sensitivity for an f.m. signal 3 dB

before limiting

at 75 Ω aerial input of f.m. front end

at base of external (first i.f.) stage

at pin 3

V_i	typ.	12	μV	1)
V_i	typ.	150	μV	2)
V_i	typ.	2, 2	mV	2)

Sensitivity for 26 dB S/N ratio

at 75 Ω aerial input of f.m. front end

V_i	typ.	4	μV	1)
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A.F. output voltage across volume

control at an i.f. signal beyond limiting

V_o	typ.	140	mV	2)
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S/N ratio over most of signal range

S/N	typ.	55	dB	2)
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A.M. suppression over most of signal range

>	40	dB	2)3)
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I.F. selectivity

S_{300}	typ.	40	dB	4)
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I.F. bandwidth

B_{3dB}	typ.	180	kHz	4)
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A.F. signal distortion, 3 dB before i.f. limiting

d_{tot}	<	2	%	5)
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Audio performanceA.F. output power at $d_{tot} = 10\%$

at onset of clipping

P_o	typ.	1	W	6)
P_o	typ.	0, 7	W	6)

Distortion before clipping

d_{tot}	typ.	1	%	6)
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A.F. input signal (at pin 13)

at $P_o = 50$ mWat $P_o = 700$ mW

V_i	typ.	6	mV	6)
V_i	typ.	17	mV	6)

Noise output power (volume control at minimum)

P_N	typ.	20	nW	7)
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Typical overall fidelity (flat within 3 dB)

200 Hz to 6	kHz	8)
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Open loop voltage gain

G_v	typ.	60	dB	
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1) Aerial e.m.f. (V_i) at $f_o = 100$ MHz; $R_s = 50 \Omega$ (source resistance; see page 12) $\Delta f = \pm 15$ kHz; $f_m = 1$ kHz.2) $f_o = 10, 7$ MHz; $\Delta f = \pm 15$ kHz; $f_m = 1$ kHz.3) A.M. signal: $m = 0, 3$; $f_m = 400$ Hz (carrier simultaneously modulated with a.m. and f.m.).

4) Including ratio detector.

5) $f_o = 100$ MHz; $\Delta f = \pm 40$ kHz; $f_m = 1$ kHz.6) Measured at 1 kHz, a negative feedback of 15 dB and a loudspeaker of 8 Ω ; $V_p = 9$ V.7) Measured at a bandwidth of 200 Hz to 6 kHz, pin 13 being connected via a capacitor of 32 μF to pin 16; loudspeaker impedance 8 Ω .

8) Depending on values of capacitors C51 and C55, 50 Hz to 15 kHz is possible.

COIL DATA See also circuit on pages 6 and 7.

1. A.M.-I.F. coils ($f_0 = 452 \text{ kHz}$)

<u>First i.f. bandpass filter</u>	<u>Single tuned coil</u>	<u>Detector coil</u>
Primary : L14 = $38 \mu\text{H}$ C _p = 3300 pF Q ₀ = 90	L17 (N ₁) = $125 \mu\text{H}$ C _p = 1000 pF Q ₀ = 80 N ₁ /N ₂ = 30	L13 (N ₁ +N ₂) = $0,84 \text{ mH}$ C _p = 150 pF Q ₀ = 130 N ₁ /N ₂ = 3,1 (N ₁ +N ₂)/N ₃ = 4
Secondary : L15 (N ₁) = $125 \mu\text{H}$ C _p = 1000 pF Q ₀ = 80 N ₁ /N ₂ = 18 k _{QL14-L15} = 1		

2. F.M.-I.F. coils ($f_0 = 10,7 \text{ MHz}$)

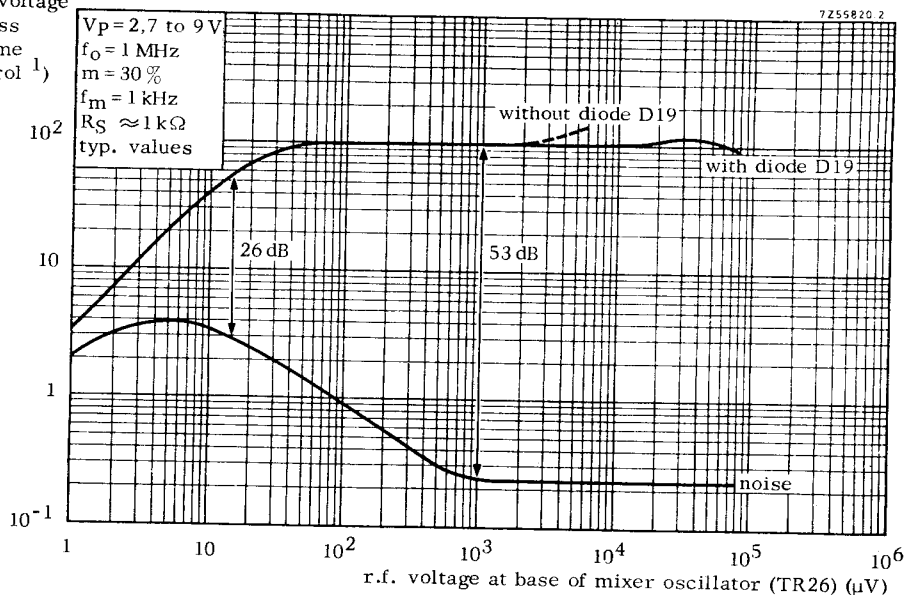
<u>First i.f. bandpass filter</u>	<u>First single tuned filter</u>	<u>Second single tuned filter</u>
Primary : L4 (N ₁) = $2,6 \mu\text{H}$ C _p = 82 pF Q ₀ = 90 N ₁ /N ₂ = 10	L8 (N ₁) = $1,44 \mu\text{H}$ C _p = 150 pF Q ₀ = 45 N ₁ /N ₂ = 5,7	L16 (N ₁) = $1,44 \mu\text{H}$ C _p = 150 pF Q ₀ = 45 N ₁ /N ₂ = 5,7
Secondary : L5 (N ₁) = $1,44 \mu\text{H}$ C _p = 150 pF Q ₀ = 55 N ₁ /N ₂ = 5,7 k _{QL4-L5} = 1,2		

Ratio detector

Primary : L10 (N ₁) = $1,44 \mu\text{H}$ C _p = 150 pF Q ₀ = 95 N ₁ /N ₂ = 2	Secondary : L12 (N ₁ +N ₂) = $2,6 \mu\text{H}$ C _p = 82 pF Q ₀ = 110 N ₁ /N ₂ = 1 (N ₁ +N ₂)/N ₃ = 5,4 k _{QL10-L12} = 0,7
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APPLICATION INFORMATION (continued)

a.f. voltage
across
volume
control ¹⁾
(mV)



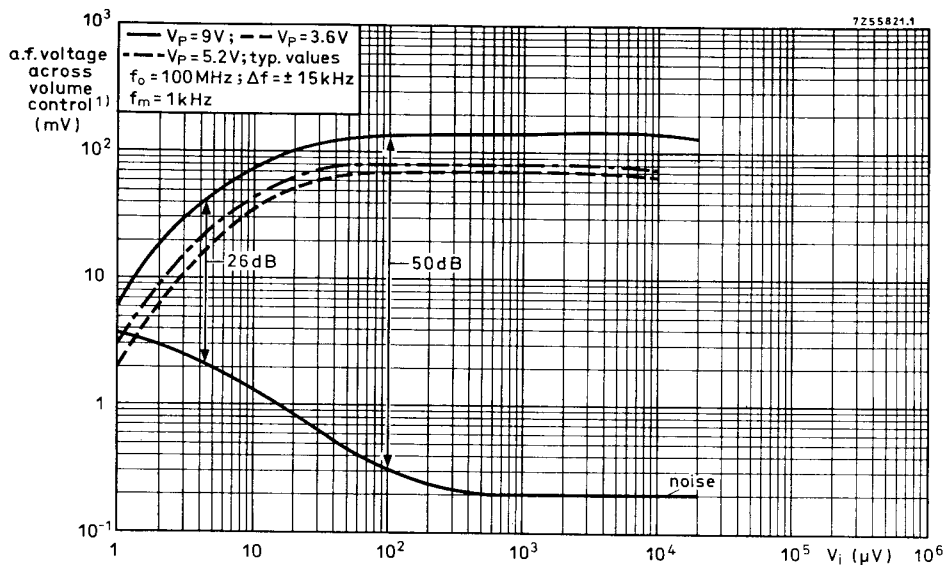
Typical a.g.c. curves at a.m. reception

A.F. voltages across volume control versus r.f. voltage at base of mixer-oscillator.

1) Slider at lower end.

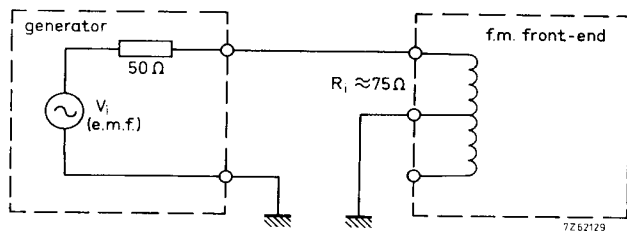


APPLICATION INFORMATION (continued)



Typical S/N curves at f.m. reception

A.F. voltage across volume control versus aerial e.m.f. represented by the generator voltage V_i (e.m.f.) connected to the $75\ \Omega$ input of the f.m. front-end.

Test circuit

¹⁾ Slider at lower end.