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.

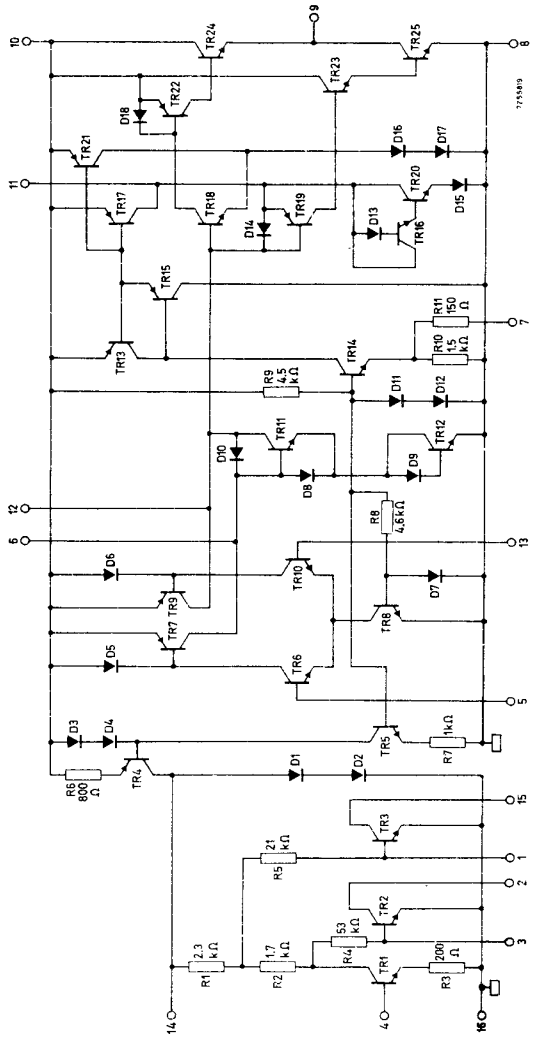
QUICK REFERENCE DATA				
Applicable supply voltage range of receiver	V_{10-8}		2,7 to 12	V [1]
Ambient temperature	T_{amb}		25	°C
Supply voltage	V_P	nom.	9	V
Total quiescent current (inclusive discrete input transistor, exclusive f.m. front end)	I_{tot}	typ.	24,5	mA
A.F. output power at d_{tot} = 10 %, R_L = 8 Ω	P_o	typ.	1000	mW
A.M. performance				
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
F.M. performance				
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).

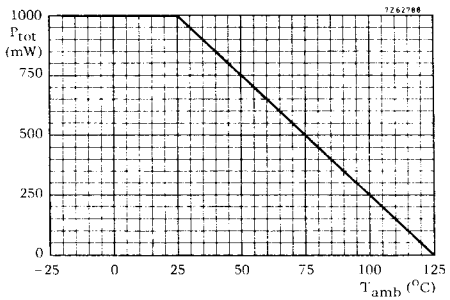
1) The data given in this sheet are based on a receiver with V_P = 9 V; P_o = 1000 mW.

CIRCUIT DIAGRAM



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 °C	P_{tot}	max.	800	mW	
at T_{amb} = 25 °C	P_{tot}	max.	1000	mW	
Temperatures					
Storage temperature	T_{stg}		−55 to +125	°C	
Operating ambient temperature	T_{amb}		−20 to +125	°C	



1) Substrate connected to pin 16.
2) Repetitive peak value; internally limited.

CHARACTERISTICS

D.C. characteristics at $T_{amb} = 25\ ^{o}C$; $V_P = 9$ V

I.F. amplifier

Collector 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 $I_C \leq 2$ mA	V_{CEsat}	<	150	mV
Saturation voltage of i.f. transistor TR3 at $I_C \leq 5$ mA	V_{CEsat}	<	200	mV
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/°C
Bias current (available)	$-I_{14}$	<	100	µA

A.F. amplifier

Input common mode voltage range	V_{5-8}, V_{13-8}		1,0 to 8,5	V [1]
Input base bias current	I_5, I_{13}	<	25	µA

Complete circuit

Total quiescent current with 3,3 kΩ 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}: $< (V_P - 0,5)$ V.

2) In those cases where a lower supply current is required the resistor between pins 7 and 8 (3,3 kΩ) 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.

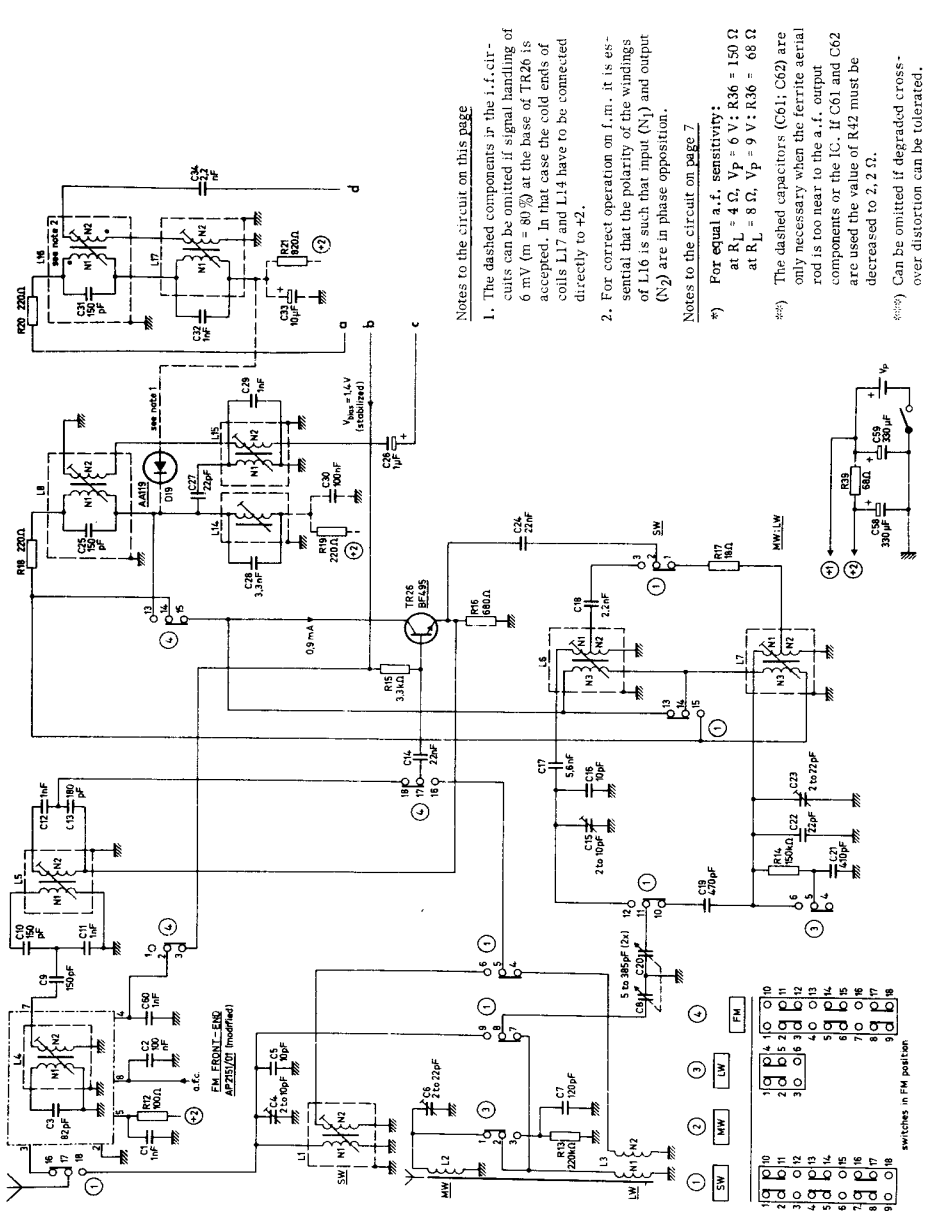
CHARACTERISTICS (continued)

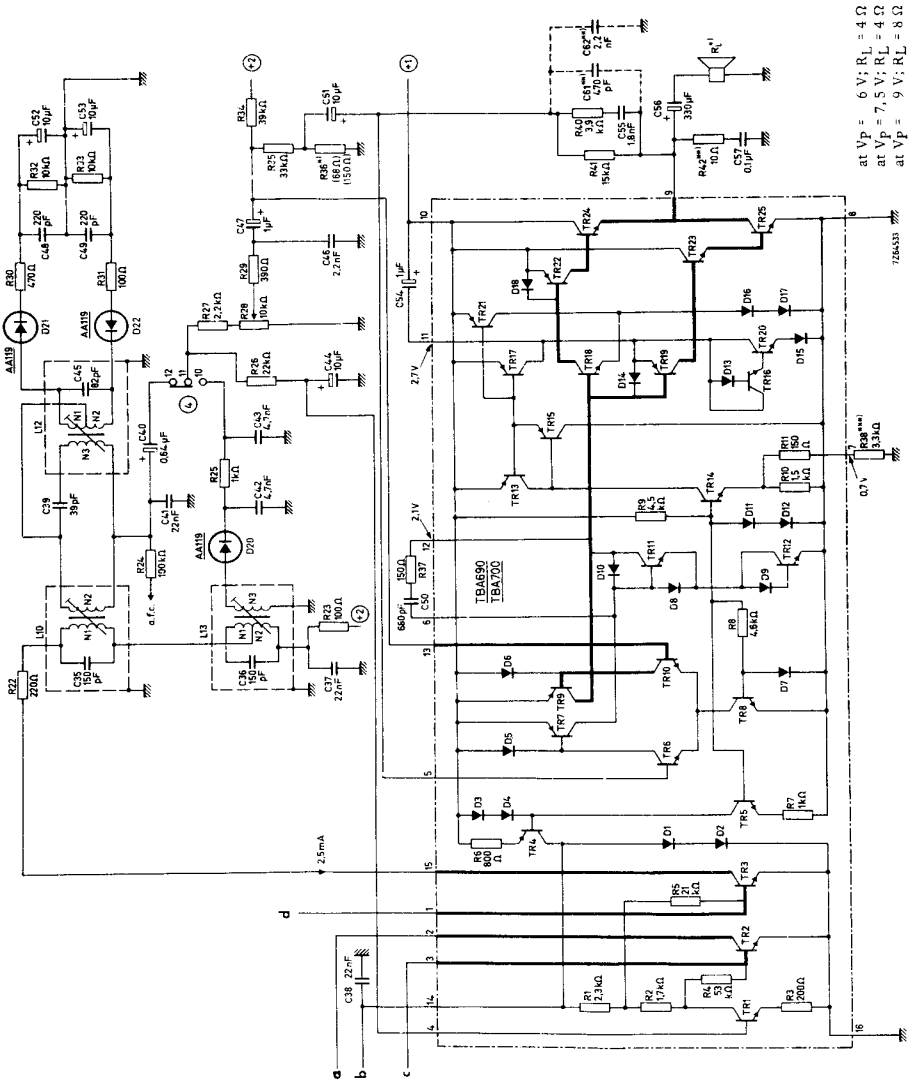
A.C. characteristics of i.f. part

y parameters at f = 450 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	μA/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^o	2^o	
Feedback admittance	$\|y_{re}\|$	typ.	2,5	1,8	μA/V
Phase angle of feedback admittance	φ_{re}	typ.	90^o	90^o	

y parameters at f = 10,7 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	μA/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^o	35^o	
Feedback admittance	$\|y_{re}\|$	typ.	64	43	μA/V
Phase angle of feedback admittance	φ_{re}	typ.	90^o	90^o	

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





Reference numbers L9 and L11 are not used in this circuit.

APPLICATION INFORMATION (continued) at T_{amb} = 25 °C; V_P = 9 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 kΩ).
   d. f_o = 1 MHz, f_m = 1 kHz
2) m = 0.3
3) Dashed parts of circuit diagram on pages 6 and 7 are omitted.

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	V_i	typ.	12	μV	1)
at base of external (first i.f.) stage	V_i	typ.	150	μV	2)
at pin 3	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)
A.F. output voltage across volume control at an i.f. signal beyond limiting	V_o	typ.	140	mV	2)
S/N ratio over most of signal range	S/N	typ.	55	dB	2)
A.M. suppression over most of signal range		>	40	dB	2)3)
I.F. selectivity	S_{300}	typ.	40	dB	4)
I.F. bandwidth	B_{3dB}	typ.	180	kHz	4)
A.F. signal distortion, 3 dB before i.f. limiting	d_{tot}	<	2	%	5)

Audio performance

A.F. output power at d_{tot} = 10 %	P_o	typ.	1	W	6)
at onset of clipping	P_o	typ.	0,7	W	6)
Distortion before clipping	d_{tot}	typ.	1	%	6)
A.F. input signal (at pin 13)					
at P_o = 50 mW	V_i	typ.	6	mV	6)
at P_o = 700 mW	V_i	typ.	17	mV	6)
Noise output power (volume control at minimum)	P_N	typ.	20	nW	7)
Typical overall fidelity (flat within 3 dB)		200 Hz to	6	kHz	8)
Open loop voltage gain	G_v	typ.	60	dB	

1) Aerial e.m.f. (V_i) at f_o = 100 MHz; R_S = 50 Ω (source resistance; see page 12) Δf = ± 15 kHz; f_m = 1 kHz.
2) f_o = 10,7 MHz; Δf = ± 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; Δf = ± 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_o = 452 kHz)

First i.f. bandpass filter

Primary : L14 = 38 μH
C_p = 3300 pF
Q_0 = 90

Secondary : L15 (N_1) = 125 μH
C_p = 1000 pF
Q_0 = 80
N_1/N_2 = 18
$kQ_{L14\text{-}L15}$ = 1

Single tuned coil

L17 (N_1) = 125 μH
C_p = 1000 pF
Q_0 = 80
N_1/N_2 = 30

Detector coil

L13 (N_1+N_2) = 0,84 mH
C_p = 150 pF
Q_0 = 130
N_1/N_2 = 3,1
$(N_1+N_2)/N_3$ = 4

2. **F.M.–I.F. coils** (f_o = 10,7 MHz)

First i.f. bandpass filter

Primary : L4 (N_1) = 2,6 μH
C_p = 82 pF
Q_0 = 90
N_1/N_2 = 10

Secondary : L5 (N_1) = 1,44 μH
C_p = 150 pF
Q_0 = 55
N_1/N_2 = 5,7
$kQ_{L4\text{-}L5}$ = 1,2

First single tuned filter

L8 (N_1) = 1,44 μH
C_p = 150 pF
Q_0 = 45
N_1/N_2 = 5,7

Second single tuned filter

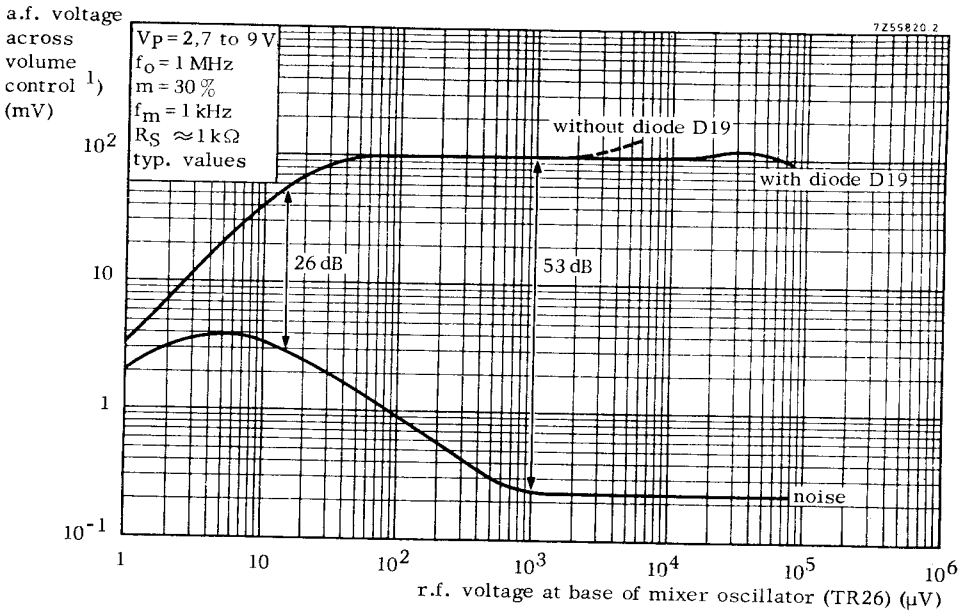
L16 (N_1) = 1,44 μH
C_p = 150 pF
Q_0 = 45
N_1/N_2 = 5,7

Ratio detector

Primary : L10 (N_1) = 1,44 μH
C_p = 150 pF
Q_0 = 95
N_1/N_2 = 2

Secondary : L12 (N_1+N_2) = 2,6 μH
C_p = 82 pF
Q_0 = 110
N_1/N_2 = 1
$(N_1+N_2)/N_3$ = 5,4
$kQ_{L10\text{-}L12}$ = 0,7

APPLICATION INFORMATION (continued)

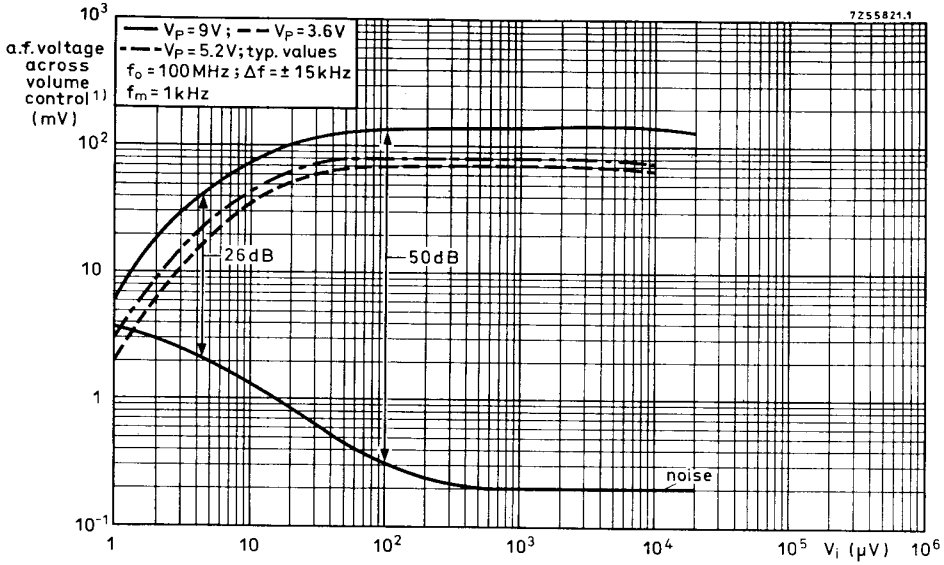


Typical a.g.c. curves at a.m. reception

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

1) Slider at lower end.

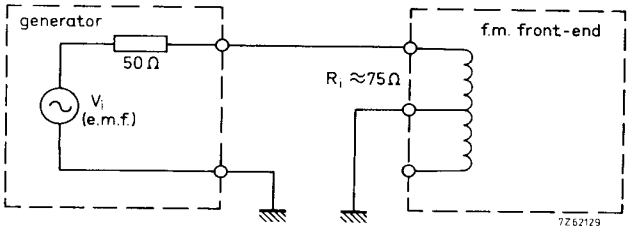
APPLICATION INFORMATION (continued)



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 Ω input of the f.m. front-end.

Test circuit



1) Slider at lower end.