INTEGRATED AM/FM RADIO RECEIVER CIRCUIT

The TBA570A is for use in small low-cost a.m. portable receivers as well as in high
quality battery or mains-fed a.m. and a.m./f.m. receivers.
The IC incorporates: a.m. mixer, oscillator, i.f. amplifier, a.g.c. amplifier, a.m.
detector and capacitor, f.m./i.f. limiting amplifier and stable base bias for f.m. front-
end, and an audio preamplifier and driver.
The unique integrated audio part has an internally limited bandwidth (18 kHz) and negli-
gible h.f. radiation back to the ferrite rod. This makes the TBA570A ideally suitable for
small size a.m. receivers because print layout is not critical. The driver stage can
directly drive complementary output stages (P_O = 6 W max.), or operate as a post
amplifier (V_O = 500 mV).
In its standard applications, the TBA570A can replace the TBA570.

| QUICK REFERENCE DATA			
Applicable supply voltage range of receiver	V_P	2,7 to 18	V
Ambient temperature	T_{amb}	25	°C
Supply voltage at pin 8	V_{8-16}	nom. 5,3	V
Total quiescent current except output stages, driver stage TR30 and f.m. front-end	I_{tot}	typ. 9	mA
A.M. performance (at pin 2)			
R.F. input voltage: S/N = 26 dB	V_i	typ. 18	μV
for P_O = 50 mW (adjustable)	V_i	typ. 2	μV
A.G.C. range; change of r.f. input voltage for 10 dB expansion in audio range		typ. 65	dB
R.F. signal handling: d_{tot} = 10%; m = 0,8		typ. 150	mV
F.M. performance (at pin 2)			
R.F. input voltage; 3 dB before limiting	V_i	typ. 50	μV
Audio performance			
Output driver current (peak value)	I_{11M}	< 100	mA
Input impedance (at pin 12)	$|Z_{12-16}|$	typ. 100	kΩ

PACKAGE OUTLINES

TBA570A   : 16-lead DIL: plastic (SOT-38).
TBA570AQ : 16-lead QIL: plastic (SOT-58).

CIRCUIT DIAGRAM
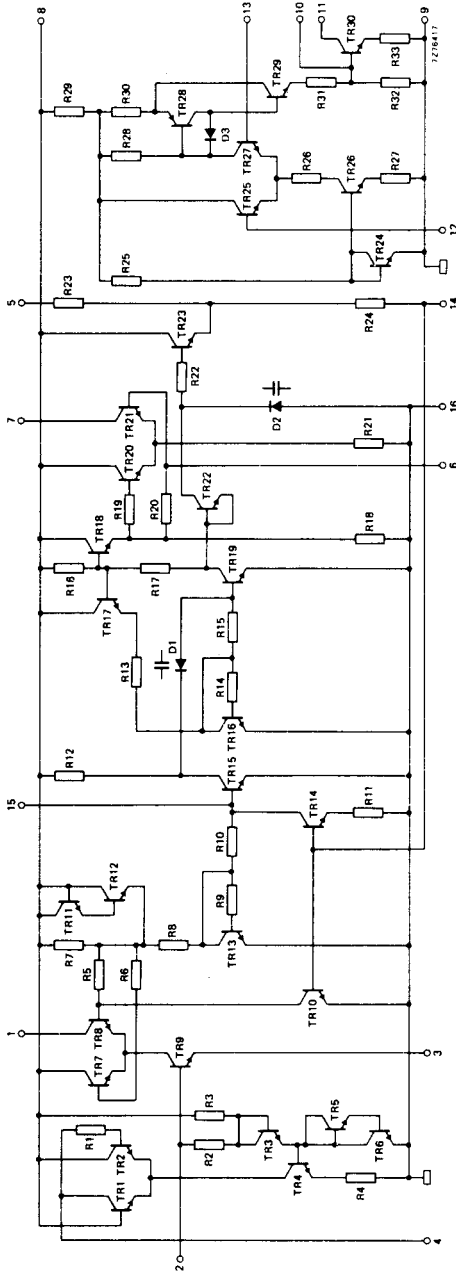
RATINGS Limiting values in accordance with the Absolute Maximum System (IEC 134)

Pin 11 voltage	V_{11-9}	max.	18	V
Pin 8 voltage	V_{8-16}	max.	8	V
Pin 11 current (peak value)	I_{11M}	max.	100	mA
Total power dissipation	see derating curve below			
Storage temperature	T_{stg}	-55 to $+125$		°C
Operating ambient temperature; $V_{8;4;7;1-16} = 8$ V; $I_{11M} = 100$ mA; see also derating curve below	T_{amb}	-20 to $+85$		°C

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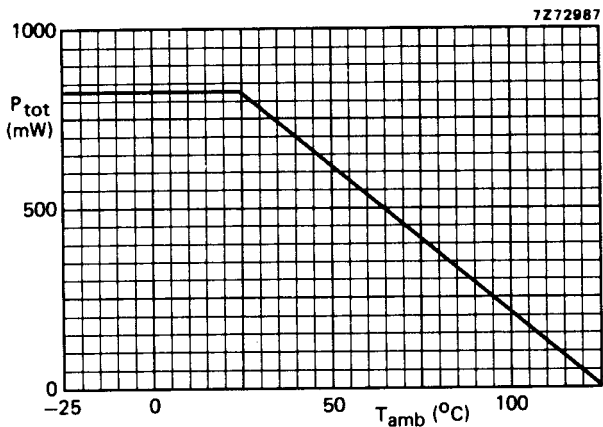
DESIGN DATA

Characteristics of integrated components are determined by process and layout data.

Pins not under measuring condition should not be connected.

Voltages with respect to pin 9 and 16 (tolerated minimum: 0 V)

Pins 1 and 7	$\left.\begin{array}{l} V_{1-9(16)} \\ V_{7-9(16)} \end{array}\right\}$	max.	18	V
Pin 4	$V_{4-9(16)}$	max.	8	V
Pin 8	$V_{8-9(16)}$	max.	8	V
Pin 3	$V_{3-9(16)}$	max.	3	V
Pin 5	$V_{5-9(16)}$	max.	4	V
Pin 14	$V_{14-9(16)}$	max.	1	V

Currents (tolerated minimum: 0 mA)

Pins 2, 6, 12, 13 and 15	$\left.\begin{array}{l} I_2; I_6; I_{12} \\ I_{13}; I_{15} \end{array}\right\}$	max.	80	µA
Pin 10	I_{10}	max.	5	mA

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D.C. CHARACTERISTICS at T_{amb} = 25 $^{\circ}$C

Saturation voltage of driver stage
I_C = 50 mA; I_B = 2,5 mA $\qquad$ $V_{11-16sat}$ $\quad$ typ. $\quad$ 1,0 $\quad$ V
$\qquad$ < $\quad$ 1,5 $\quad$ V

Collector breakdown voltage of driver stage
I_C = 25 mA; R_{BE} = 7 kΩ $\qquad$ $V_{11-16(BR)}$ $\quad$ > $\quad$ 18 $\quad$ V

D.C. current gain of driver stage
I_C = 50 mA $\qquad$ h_{FE} $\quad$ > $\quad$ 25

Total quiescent current
except driver stage collector current;
f. m. front-end;
discrete output stages; V_{8-16} = 5,3 V $\qquad$ I_{tot} $\quad$ typ. $\quad$ 9 $\quad$ mA
$\qquad\qquad\qquad\qquad\quad$ V_{8-16} = 4,2 V $\qquad$ I_{tot} $\quad$ typ. $\quad$ 8 $\quad$ mA

Applicable supply voltage range of receiver $\qquad$ V_P $\qquad$ 2,7 to 18 $\quad$ V [1])

Base bias voltage for f. m. front-end
total external load current at pin 2 : $-I_2$ = 150μA $\quad$ V_{2-16} $\quad$ typ. $\quad$ 1,2 $\quad$ V

A.C. CHARACTERISTICS at T_{amb} = 25 $^{\circ}$C; V_{8-16} = 5,3 V; I_E (TR9) = 1 mA

			0,45	1	10,7	MHz
Input conductance at pin 2	g_{ie}	typ.	–	0,4	0,5	mA/V
Output conductance at pin 1	g_{oe}	typ.	6	–	90	μA/V
Input conductance at pin 15	g_{ie}	typ.	0,35	–	0,7	mA/V

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[1]) Adjustable by a dropping resistor in the V_P-line; see also maximum tolerated voltages
for pins 1, 4, 7 and 8 in design data on page 3.
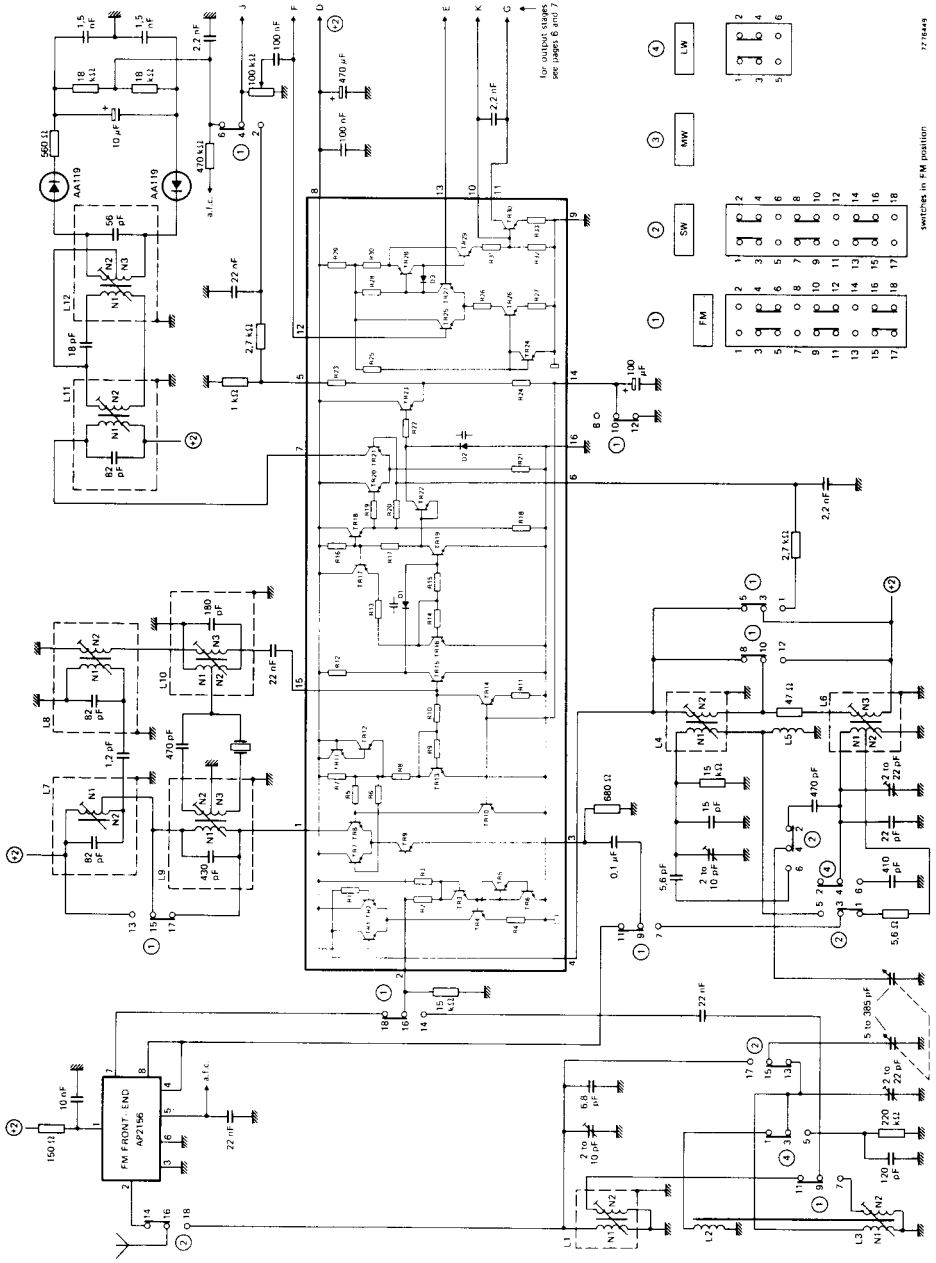
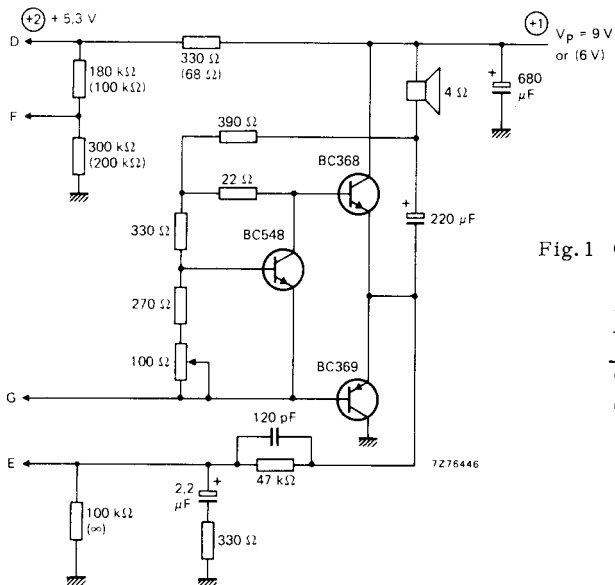H.F. part of a high quality FM/AM (LW; MW; SW) receiver.

Fig. 1 Output stage for V_P = 9 V or 6 V (resistor values between parentheses).

V_P	R_L	P_O at d_{tot} = 10%
9 V	4 Ω	1,8 W
6 V	4 Ω	0,6 W
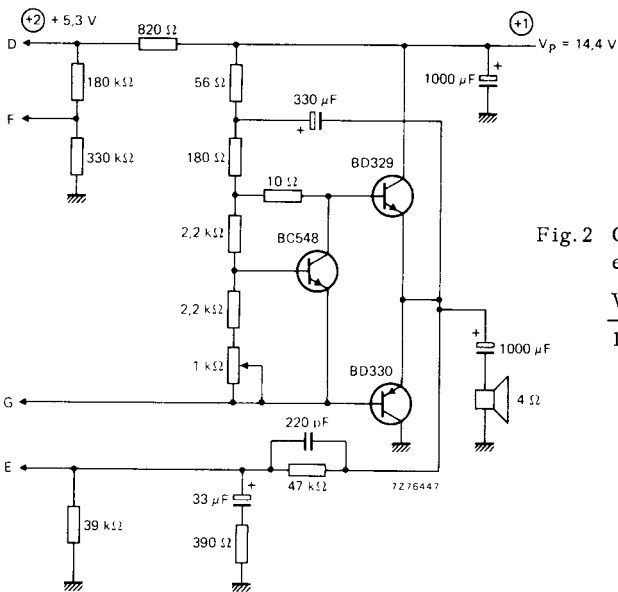
Fig. 2 Output stage for V_P = 14,4 V; especially used in car radios.

V_P	R_L	P_O at d_{tot} = 10%
14,4 V	4 Ω	5,5 W
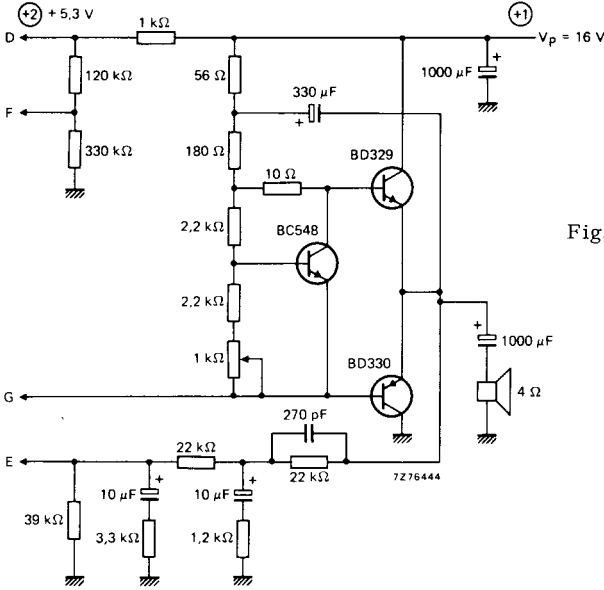
Fig. 3 Output stage for $V_P = 16$ V.

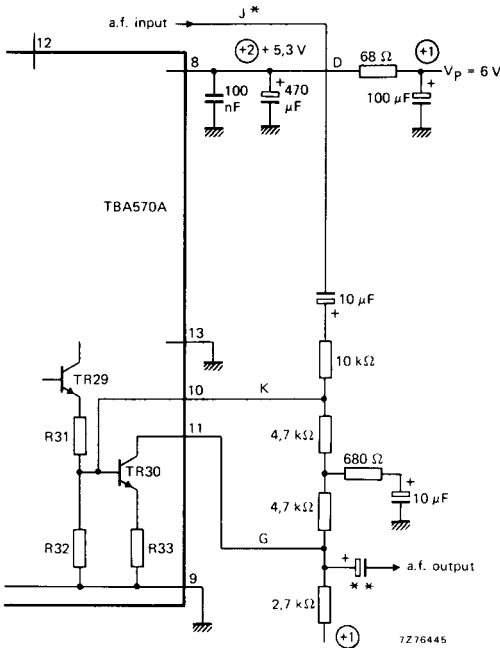| V_P	R_L	P_O at $d_{tot} = 10\%$
16 V	4 Ω	6,8 W

Fig. 4 Post amplifier for
$V_O = 500$ mV and $V_P = 6$ V.

   *In circuit on page 5
   volume control resistor
   (100 kΩ) and capacitor
   (100 nF) on pin 12
   should be omitted.

   **Capacitor value depends
   on load.

COIL DATA (in circuit on page 5)

High quality AM/FM receiver (for portable and mains-fed applications)

<u>A.M.-I.F. coils</u> (f_0 = 455 kHz)

I.F. bandpass filter:

L9 $N1 = 284,5\,\mu H$ **L10** $N1 = 680\,\mu H$
    $Q_0 = 100$ $Q_0 = 100$
    $N1/N2 = 40$ $N2/N1 = 74$
    $N2/N3 = 1$ $(N2 + N1)/N3 = 10,7$
    $|Z_T| = 3\,k\Omega$

<u>F.M.-I.F. coils</u> (f_0 = 10,7 MHz)

Second i.f. bandpass filter: Ratio detector:

L7 $N1 + N2 = 2,7\,\mu H$ **L8** $N1 = 2,7\,\mu H$ **L11** $N1 = 2,7\,\mu H$ **L12** $N2 + N3 = 3,25\,\mu H$
    $Q_0 = 100$ $Q_0 = 90$ $Q_0 = 85$ $Q_0 = 85$
    $kQ_{L6-L7} = 1,2$ $N1/N2 = 5,5$ $kQ_{L11-L12} = 0,7$ $(N2 + N3)/N1 = 6$
    $N1/N2 = 1,75$ $N1/N2 = 2,2$ $N2 = N3$

Low-cost 2-band AM portable receiver (see page 9)

L1 $N1 = 11$ **L2** $N1 = 60$ L1 and L2 on ferrite
                 $N2 = 2$ $N2 = 4$ rod; 10 mm$\emptyset$;
                 wire : 1,1 $\emptyset$ wire : 20 x 0,03   length = 10 cm
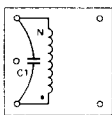
L3 $N = 284,5\,\mu H$ $f_m = 452\,kHz$ **L4** $N_P = 284,5\,\mu H$ $f_m = 452\,kHz$
                 $C1 = 430\,pF$ $Q_0 = 100$ $N_P/N_S = 16,7$ $Q_0 = 100$
                 wire : 0,1 $\emptyset$ $C1 = 430\,pF$
                                             wire : 0,1 $\emptyset$
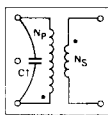
                 core material : 7 MN(C)   core material : 7 MN(C)
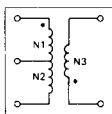
L5 $N1 + N2 = 127\,\mu H$ $f_m = 1\,MHz$ **L6** $N1 + N2 = 13\,\mu H$ $f_m = 7\,MHz$
                 $(N1 + N2)/N2 = 58$ $Q_0 = 100$ $(N1 + N2)/N2 = 20$ $Q_0 = 90$
                 $(N1 + N2)/N3 = 4,8$ $C_p = 200\,pF$ $(N1 + N2)/N3 = 4$ $C_p = 40\,pF$
                 wire : 0,1 $\emptyset$ wire : 0,1 $\emptyset$

   core material : 7 BR   core material : 119 AM(C)

<u>Note</u>

In the circuit on page 9 for L3 and L4 a similar coil to L9 in the circuit on page 5 can be used with the following exceptions:
L3 : secondary windings N2 and N3 are not used.
L4 : secondary windings N2 and N3 are connected in series.

When using a resistor between pins 2 and 15 (see dashed resistor in circuit on page 9), signal handling is improved.

Low-cost 2-band (SW-MW) AM portable receiver (P_O = 250 mW)
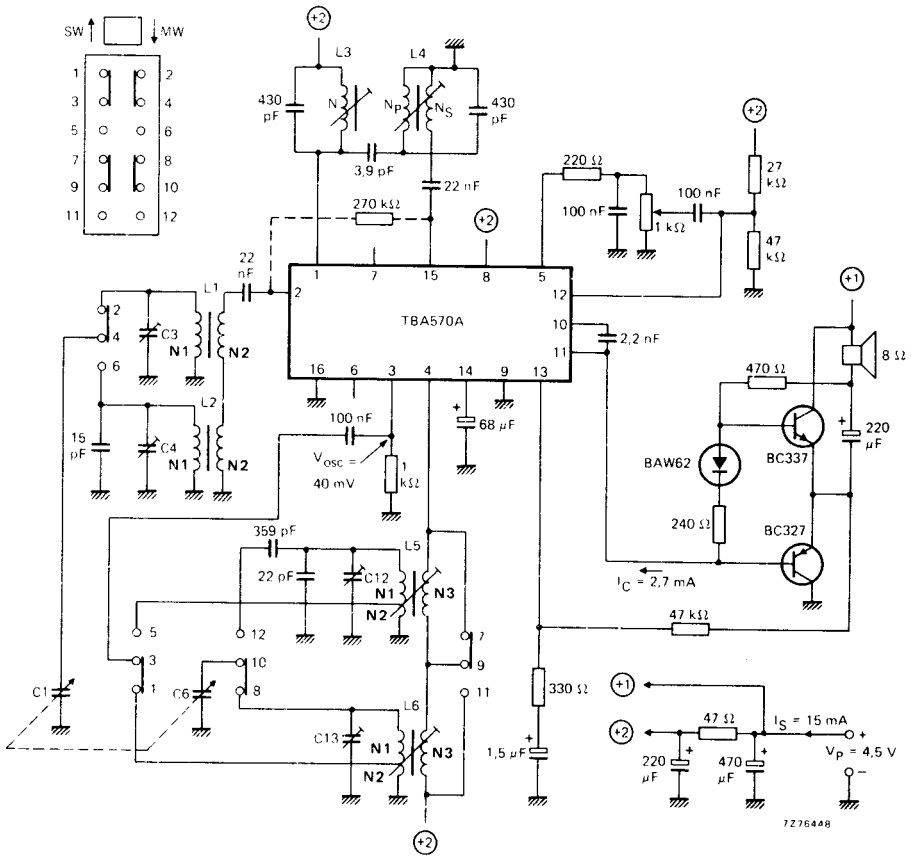
Note : C1 and C6 max. 385 pF.

APPLICATION INFORMATION at T_{amb} = 25 ^{o}C

A.M. performance			V_{8-16}	5,3 V [1]	4,2 V [2]	
R.F. input voltage : S/N = 26 dB (notes 3 and 4) for P_o = 50 mW (adjustable):	V_i	typ.	18		10	µV
notes 3,4 and 5	V_i	typ.	2		2	µV
R.F. input voltage for 10 mV (a.f.) across volume control (notes 3 and 4)	V_i	typ.	2,7		4,5	µV
A.F. voltage across volume control at 100 µV (r.f.) input voltage (notes 3 and 4)	V_o	typ.	70		70	mV
Signal-to-noise ratio at 1 mV (r.f.) input voltage (notes 3 and 4)	S/N	typ.	46		47	dB
A.G.C. range (change in r.f. input voltage for 10 dB expansion in audio range); notes 3 and 4		typ.	60		60	dB
R.F. signal handling capability at 80% modulation; d_{tot} < 10% (note 3)	V_i	typ.	150		7	mV
Harmonic distortion of h.f. part over most of a.g.c. range; m = 0,3; f_m = 1 kHz (note 6)	d_{tot}	typ.	1		1	%
I.F. selectivity	S_9	typ.	33		16	dB
I.F. bandwidth (3 dB)	B	typ.	5		5,5	kHz

Notes

1. See circuits on pages 5,6 and 7 (high quality AM/FM receiver).

2. See circuit on page 9 (low-cost 2-band AM portable receiver).

3. a. A.F. signal : measured across volume control.
   b. R.F. signal : measured at pin 2 with the aerial circuit connected (source resistance about 1 kΩ).
   c. f_o = 1 MHz; f_m = 1 kHz.

4. m = 0,3.

5. A.M. sensitivity for P_o = 50 mW can be adjusted by means of the a.c. feedback network in the audio part e.g. : V_i = 1,5 µV for P_o = 50 mW (S/N ≈ 4 dB).

6. Distortion can be decreased to 0,7% by connecting a resistor of 270 kΩ between pins 2 and 15.

APPLICATION INFORMATION (continued) at $T_{amb} = 25\ ^oC$; $V_{8-16} = 5,3$ V

Measured in the circuit on page 5

F.M. performance

Sensitivity for an f.m. signal 3 dB before limiting				
at 75 Ω aerial input of f.m. front-end (note 1)	V_i	typ.	3,5	µV
at pin 2; first i.f. (notes 2 and 6)	V_i	typ.	50	µV
Sensitivity for 26 dB S/N ratio				
at 75 Ω aerial input of f.m. front-end (note 1)	V_i	typ.	2,5	µV
A.F. output voltage across volume control				
at an i.f. signal beyond limiting (note 2)	V_o	typ.	120	mV
Signal-to-noise ratio				
over most of signal range (note 2)	S/N	typ.	65	dB
A.M. suppression over most of signal range (note 3)		typ.	60	dB
I.F. selectivity (note 4)	S_{300}	typ.	43	dB
I.F. bandwidth (3 dB; note 4)	B	typ.	150	kHz
A.F. signal distortion				
3 dB before i.f. limiting (note 5)	d_{tot}	typ.	0,8	%

Notes

1. Aerial e.m.f. (V_i) at $f_o = 98$ MHz; $R_S = 50\ \Omega$; $\Delta f = \pm 22,5$ kHz; $f_m = 1$ kHz.

2. $f_o = 10,7$ MHz; $\Delta f = \pm 22,5$ kHz; $f_m = 1$ kHz.

3. A.M. signal: m = 0,3; $f_m = 1000$ Hz.
   F.M. signal: $f_o = 10,7$ MHz; $\Delta f = \pm 75$ kHz; $f_m = 400$ Hz.
   Carrier simultaneously modulated with a.m. and f.m.

4. Including ratio detector.

5. $f_o = 98$ MHz; $\Delta f = \pm 40$ kHz; $f_m = 1$ kHz.

6. Pin 3 by-passed to ground with a capacitor of 220 nF.

AUDIO PERFORMANCE

Distortion before clipping (note 1)	d_{tot}	typ.	0,5	%
Input impedance (note 2)	$|Z_i|$	typ.	90	kΩ
Noise output power: volume control at min. (note 3)	P_n	typ.	10	nW
Overall fidelity: flat within 3 dB (obtainable values)			35 Hz to 15	kHz
Open loop voltage gain	G_v	typ.	62	dB

V_P	V	4,5	6	9	14,4	16
R_L	Ω	8	4	4	4	4
P_O at $d_{tot} = 10\%$	W	0,22	0,6	1,8	5,5	6,8
P_O at onset of clipping: $d_{tot} = 1\%$	W	0,15	0,4	1,2	4	4,8
V_i for $d_{tot} = 10\%$ (pin 12)	mV	14	16	25	50	45
V_i for $P_O = 50$ mW (pin 12)	mV	5,5	4,5	4	3,5	3,5
Output transistors		BC327 BC337	BC368 BC369	BC368 BC369	BD329 BD330	BD329 BD330
Circuit diagrams on page 6,7 or 9		page 9	Fig. 1	Fig. 1	Fig. 2	Fig. 3

Post-amplifier (see Fig. 4 on page 7)

Output voltage : 500 mV

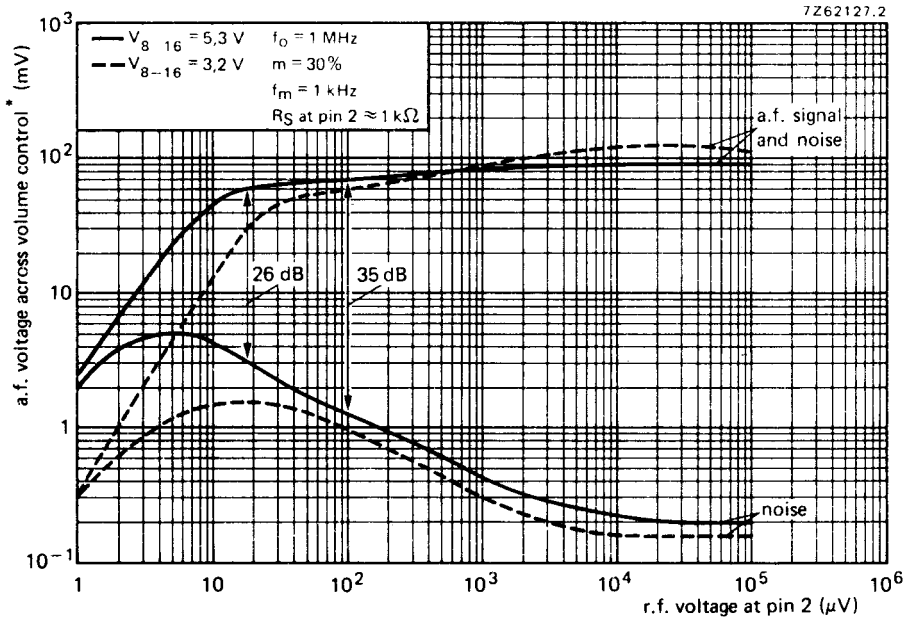Audio gain (adjustable): 5

Distortion : 0,2%

Notes

1. Measured at 1 kHz and a negative feedback of 16 dB.

2. At the maximum tolerated value of resistance-tap/bleeder at pin 12.

3. Measured at a bandwidth of 60 Hz to 15 kHz, pin 12 being connected via a capacitor of 32 µF to pin 9: $R_L = 4$ Ω.

APPLICATION INFORMATION (continued)

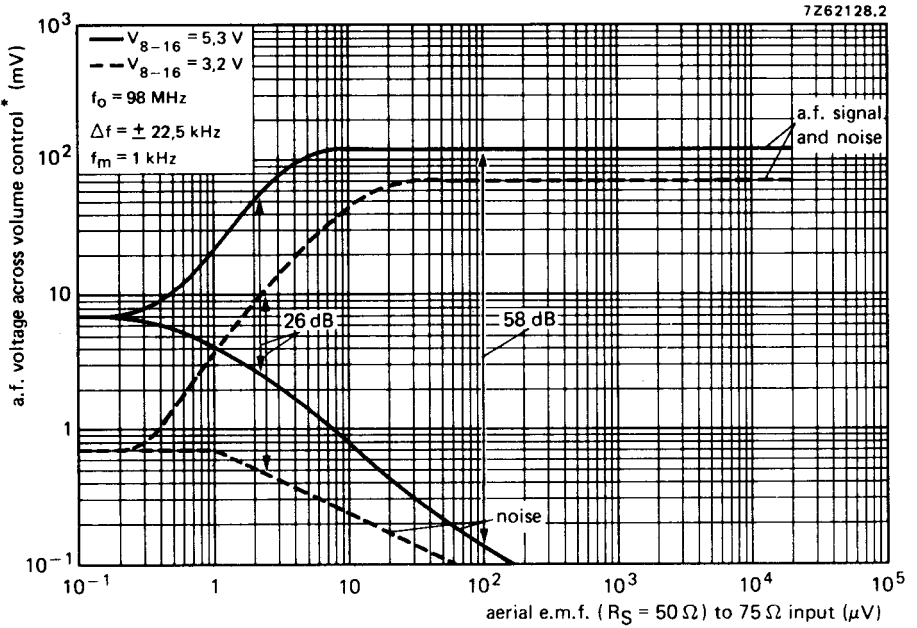**Typical a.g.c. curves for AM reception** (circuit diagram on page 5)

A.F. voltage across volume control as a function of r.f. voltage at pin 2.

*) Slider at lower end.

APPLICATION INFORMATION (continued)

Typical S/N curves for FM reception (circuit diagram on page 5)

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A.F. voltage across volume control as a function of aerial e.m.f. from a source with $R_S = 50\ \Omega$ to the 75 Ω input of the f.m. front-end.

*) Slider at lower end.