

HI-FI F.M./I.F. AMPLIFIER

The TCA420A is a monolithic integrated f.m./i.f. amplifier for car and hi-fi equipment provided with the following functions:

- limiter amplifier
- symmetrical quadrature detector
- symmetrical a.f.c. output
- field-strength indication output
- stereo decoder switching voltage
- adjustable side response suppression
- muting

QUICK REFERENCE DATA

Supply voltage (pin 11)	V_P	typ.	15 V
Supply current (pin 11)	I_P	typ.	26 mA
Input limiting voltage (-3 dB); $f_o = 10,7$ MHz	$V_{i\text{lim}}$	typ.	$20 \mu\text{V}$
A.F. output voltage (pin 5); $\Delta f = \pm 15$ kHz; r.m.s. value	$V_{o(\text{rms})}$	typ.	115 mV
Signal plus noise-to-noise ratio; $V_i > 1$ mV; $\Delta f = \pm 15$ kHz	S+N/N	typ.	72 dB
I.F. input voltage; $\Delta f = \pm 15$ kHz	V_i	typ.	$15 \mu\text{V}$
S + N/N = 26 dB	V_i	typ.	$45 \mu\text{V}$
S + N/N = 46 dB	α	typ.	50 dB
A.M. rejection; $V_i = 10$ mV; $f_m = 1$ kHz (f.m.); $\Delta f = \pm 15$ kHz	d_{tot}	typ.	0,1 %
Total distortion (single tuned circuit); $\Delta f = \pm 15$ kHz	$\Delta f = f_{o1} - f_{o2} $	typ.	7 kHz
Centre shift of f.m. detector curve	ΔV_i	typ.	70 dB
Field-strength indication range			
Supply voltage range (pin 11)	V_P		6 to 18 V
Ambient temperature range	T_{amb}		-30 to $+80$ °C

PACKAGE OUTLINE

16-lead DIL; plastic (SOT-38).

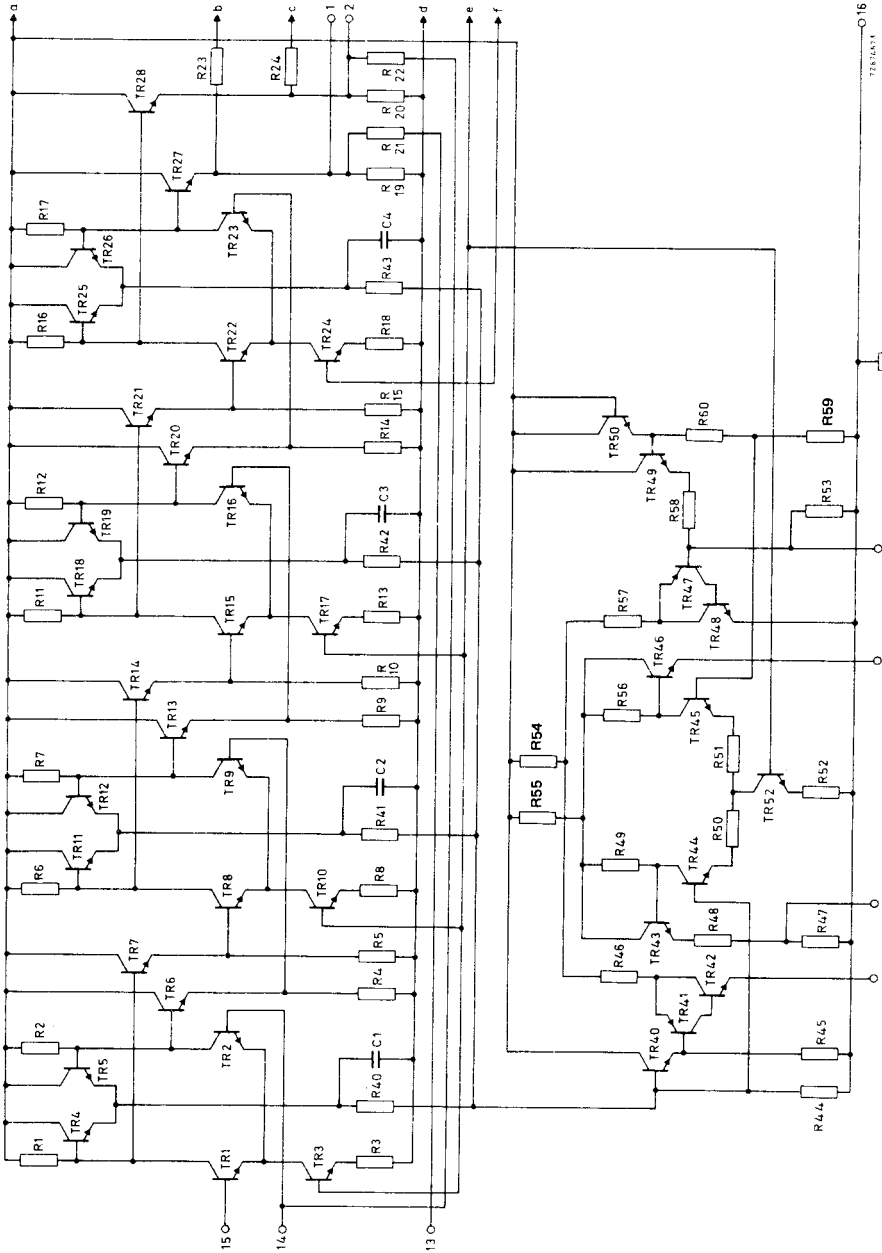


Fig. 1a Part of circuit diagram; other part continued in Fig. 1b.

92

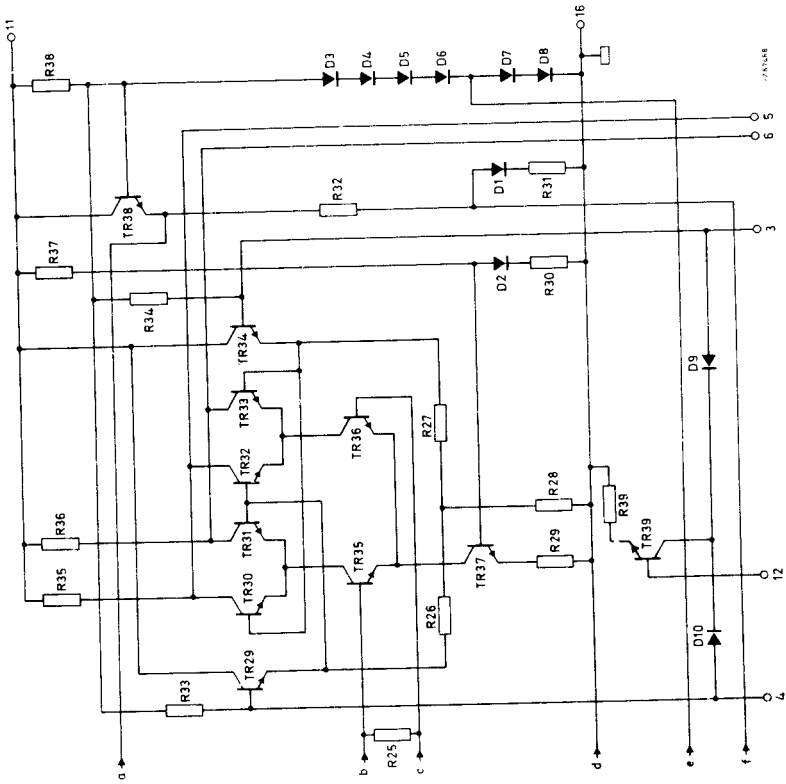


Fig. 1b Part of circuit diagram; continued from Fig. 1a.

RATINGS

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

Supply voltage (pin 11)	$V_P = V_{11-16}$	max.	18 V
Total power dissipation	P_{tot}	max.	720 mW
Storage temperature	T_{stg}		-55 to +150 °C
Operating ambient temperature	T_{amb}		-30 to +80 °C

CHARACTERISTICS

$V_P = 8$ or 15 V; $T_{amb} = 25$ °C; $f_o = 10,7$ MHz; $\Delta f = \pm 15$ kHz; $f_m = 1$ kHz; $R_G = 30$ Ω ; with de-emphasis ($C_{5-6} = 10$ nF); adjustment conforms to adjustment procedure unless otherwise specified; the characteristics are valid for a TCA420A mounted on a printed-circuit board (see Figs 2, 3 and 4).

Supply voltage range (pin 11)		V_P	6 to 18 V	
			$V_P = 8$ V	$V_P = 15$ V
Supply current; $R_{7-16} = 5$ k Ω ; pin 11	I_P	typ.	21	26 mA
		<	—	35 mA
I.F. amplifier/detector				
Input voltages (d.c. value)	$V_{13-16}; V_{14-16}; V_{15-16}$	typ.	2,6	2,8 V
Input limiting voltage (-3 dB)	$V_{i\ lim}$	typ.	20	20 μ V
		<	—	50 μ V
I.F. output voltage (peak-to-peak value)				
$V_i = 5$ mV; $f = 1$ MHz; without detector circuit;	$V_{1-16(p-p)}; V_{2-16(p-p)}$	>	300	320 mV
$Z_{1-16} = Z_{2-16} = 10$ M Ω in parallel with 8 pF		typ.	350	375 mV
Output voltages (d.c. value)	$V_{5-16}; V_{6-16}$	>	4,7	8,3 V
		typ.	5,0	9,5 V
		<	5,3	11,0 V
Output voltage difference (d.c. value)				
$V_i = 1$ mV; $\Delta f = \pm 75$ kHz	$\pm V_{5-6}$	<	180	350 mV
A.F. output voltage; $V_i = 1$ mV (pins 5 and 6)		>	—	95 mV
$\Delta f = \pm 15$ kHz	V_o	typ.	60	115 mV
$\Delta f = \pm 40$ kHz	V_o	typ.	160	307 mV
$\Delta f = \pm 75$ kHz	V_o	typ.	300	575 mV
Total distortion; $V_i = 1$ mV; single tuned circuit; $Q_L = 20$ with de-emphasis; $C_{5-6} = 10$ nF				
$\Delta f = \pm 15$ kHz	d_{tot}	<	0,1	0,1 %
$\Delta f = \pm 40$ kHz	d_{tot}	typ.	0,18	0,18 %
$\Delta f = \pm 75$ kHz	d_{tot}	typ.	0,45	0,45 %
without de-emphasis; $C_{5-6} = 220$ pF				
$\Delta f = \pm 15$ kHz	d_{tot}	<	0,1	0,1 %
$\Delta f = \pm 40$ kHz	d_{tot}	typ.	0,22	0,22 %
$\Delta f = \pm 75$ kHz	d_{tot}	typ.	0,65	0,65 %
		<	1	1 %

		$V_p = 8\text{ V}$	$V_p = 15\text{ V}$
I.F. input voltage; with filter: $B = 250\text{ Hz to }16\text{ kHz}$			
$S+N/N = 26\text{ dB}$; with de-emphasis; $C_{5-6} = 10\text{ nF}$	V_i	typ. 15	15 μV
$\Delta f = \pm 15\text{ kHz}$	V_i	typ. 5	5 μV
$\Delta f = \pm 75\text{ kHz}$			
$S+N/N = 26\text{ dB}$; without de-emphasis; $C_{5-6} = 220\text{ pF}$	V_i	typ. 20	20 μV
$\Delta f = \pm 15\text{ kHz}$	V_i	typ. 8	8 μV
$\Delta f = \pm 75\text{ kHz}$			
$S+N/N = 46\text{ dB}$; with de-emphasis; $C_{5-6} = 10\text{ nF}$	V_i	typ. 45	45 μV
$\Delta f = \pm 15\text{ kHz}$	V_i	typ. 20	20 μV
$\Delta f = \pm 75\text{ kHz}$			
$S+N/N = 46\text{ dB}$; without de-emphasis; $C_{5-6} = 220\text{ pF}$	V_i	typ. 65	65 μV
$\Delta f = \pm 15\text{ kHz}$	V_i	typ. 30	30 μV
$\Delta f = \pm 75\text{ kHz}$			
Signal plus noise-to-noise ratio; with filter: $B = 250\text{ Hz to }16\text{ kHz}$; $V_i = 1\text{ mV}$			
with de-emphasis			
$\Delta f = \pm 15\text{ kHz}$	S+N/N	typ. 74	76 dB
$\Delta f = \pm 75\text{ kHz}$	S+N/N	typ. 88	90 dB
without de-emphasis			
$\Delta f = \pm 15\text{ kHz}$	S+N/N	typ. 68	70 dB
$\Delta f = \pm 75\text{ kHz}$	S+N/N	typ. 82	84 dB
Noise output voltage; weighted conform DIN45405			
with de-emphasis			
$V_i = 0$	V_{no}	typ. 7	12 mV
$V_i = 1\text{ mV}$	V_{no}	typ. 30	50 mV
A.M. rejection; with filter: $B = 700\text{ Hz to }5\text{ kHz}$			
$f_m = 70\text{ Hz}$; $\Delta f = \pm 15\text{ kHz}$ (for f.m.);			
$f_m = 1\text{ kHz}$; $m = 0,3$ (for a.m.); simultaneously modulated			
$V_i = 0,3\text{ mV}$	α	typ. 52	52 dB
$V_i = 1\text{ mV}$	α	typ. 40	40 dB
$V_i = 10\text{ mV}$	α	typ. 52	52 dB
$V_i = 100\text{ mV}$	α	typ. 43	43 dB
Zero crossing shift of f.m. detector curve (see note)			
$f_m = 70\text{ Hz}$; $\Delta f = \pm 75\text{ kHz}$ (for f.m.);			
$f_m = 1\text{ kHz}$; $m = 85\%$ (for a.m.)	$\Delta f = f_{o1} - f_{o2} $	typ. 4 < 9	7 kHz 15 kHz
Detector input impedance	Z3-4	4,4 k Ω //2,25 pF	
Output resistance	R5-11;R6-11	typ. 3,3	3,3 k Ω

Note

Zero crossing shift is defined as the difference between frequencies f_{o1} at $V_i = 1\text{ mV}$ and f_{o2} at $V_i = 30\text{ }\mu\text{V}$.

CHARACTERISTICS (continued)

Side response suppression

Input voltage for 10 dB side response suppression at
 S1 = 'on' adjust R1, so $V_{10-16} = 1,3 \text{ V}$ at $V_i = 0$;
 S1 = 'off'; $R_4 = 3,9 \text{ k}\Omega$

		$V_P = 8 \text{ V}$	$V_P = 15 \text{ V}$
$V_{i(\text{rms})}$	typ.	35	$30 \mu\text{V}$

Side response suppression level

$\Delta f = \pm 15 \text{ kHz}$; $V_{i(\text{rms})} = 1 \text{ mV}$
 control voltage for $\Delta V_O = -1 \text{ dB}$
 control voltage for $\Delta V_O = -10 \text{ dB}$

V_{12-16}	typ.	0,7	0,7 V
V_{12-16}	typ.	1,1	1,1 V

Muting

Output signal muting at S2 = 'on';
 reference signal at S2 = 'off';
 $V_{i(\text{rms})} = 1 \text{ mV}$; $\Delta f = \pm 75 \text{ kHz}$; $R_4 = 3,9 \text{ k}\Omega$

ΔV_O	typ.	-80	-80 dB
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Field-strength indication

Output voltages (d.c. value)
 $V_i = 0$; $I_{8-9} = 0$; $R_{8-16} = 4,3 \text{ k}\Omega$

V_{9-16}	typ.	1,75	1,85 V
V_{8-16}	typ.	1,90	2,00 V

Field-strength indicator current

$R_{\text{indicator}} = 2 \text{ k}\Omega$;
 adjust R2 so $I_{8-9} = 0$ at $V_i = 0$ and $R_3 = 0$
 measured at $V_{i(\text{rms})} = 120 \text{ mV}$

I_{8-9}	>	130	$140 \mu\text{A}$
	typ.	190	$210 \mu\text{A}$

Output resistance

R_O	typ.	810	850Ω
R_{9-16}	typ.	3,7	$3,7 \text{ k}\Omega$

Stereo decoder switching voltage

Reference voltage; without load: $I_7 = 0$

V_{7-16}	typ.	2,05	2,25 V
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Output voltage; $I_{10} = I_{10\text{max}}$

V_{10-16}	typ.	1,70	1,90 V
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Available output current

$-I_{10\text{max}}$	typ.	0,45	0,85 mA
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Output voltage as a function of the
 i.f. input voltage

$R_{10-16} = 3,9 \text{ k}\Omega$; $R_1 = 5 \text{ k}\Omega$

$20 \log \frac{\Delta V_{10-16}}{V_{i1}}$	typ.	-0,9	-1,2 V/20 dB
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Input voltage for $V_{10-16} = 0,8 \text{ V}$
 adjust R1 so $V_{10-16} = 1,3 \text{ V}$ at $V_{i(\text{rms})} = 0$

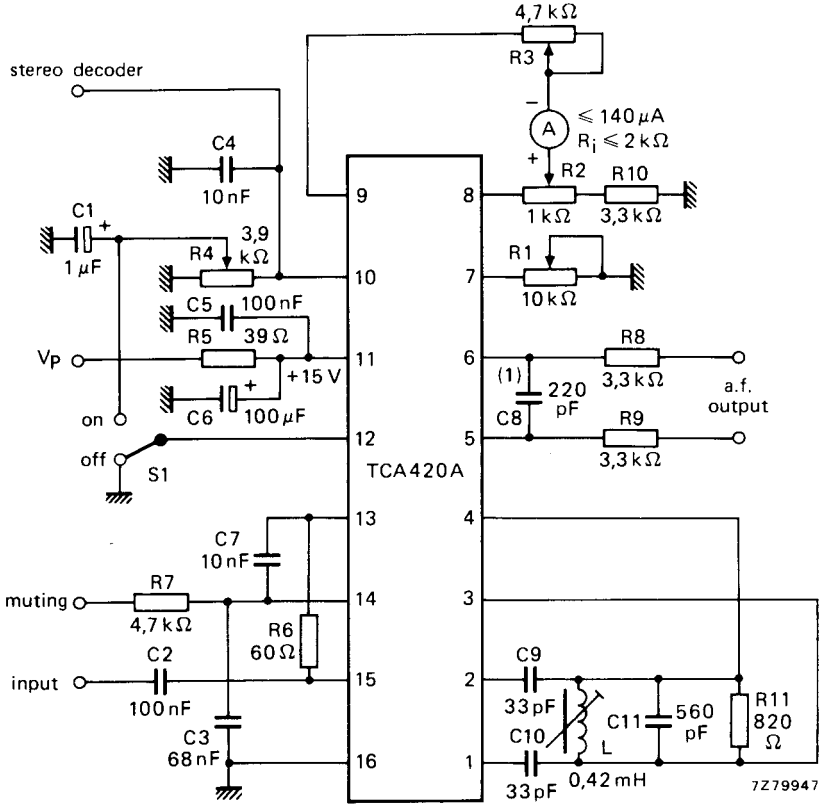
$V_{i(\text{rms})}$	typ.	98	$100 \mu\text{V}$
	<	150	$200 \mu\text{V}$

Input voltage for $V_{10-16} = 1,3 \text{ V}$
 adjust R1 so $V_{10-16} = 0,8 \text{ V}$ at $V_{i(\text{rms})} = 3 \text{ mV}$

$V_{i(\text{rms})}$	>	-	0,5 mV
	typ.	1,3	1,3 mV
	<	-	1,75 mV

Input resistance (pin 7)

R_{7-16}	typ.	4	$4,7 \text{ k}\Omega$
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(1) $C_8 = C_{5-6}$ (see Fig. 2).
 For mono: $C_8 = 10 \text{ nF}$.
 For stereo: $C_8 = 220 \text{ pF}$.

Fig. 3 Circuit diagram showing components arrangement for printed-circuit board (Fig. 4). The circuit is similar to the test circuit of Fig. 2.

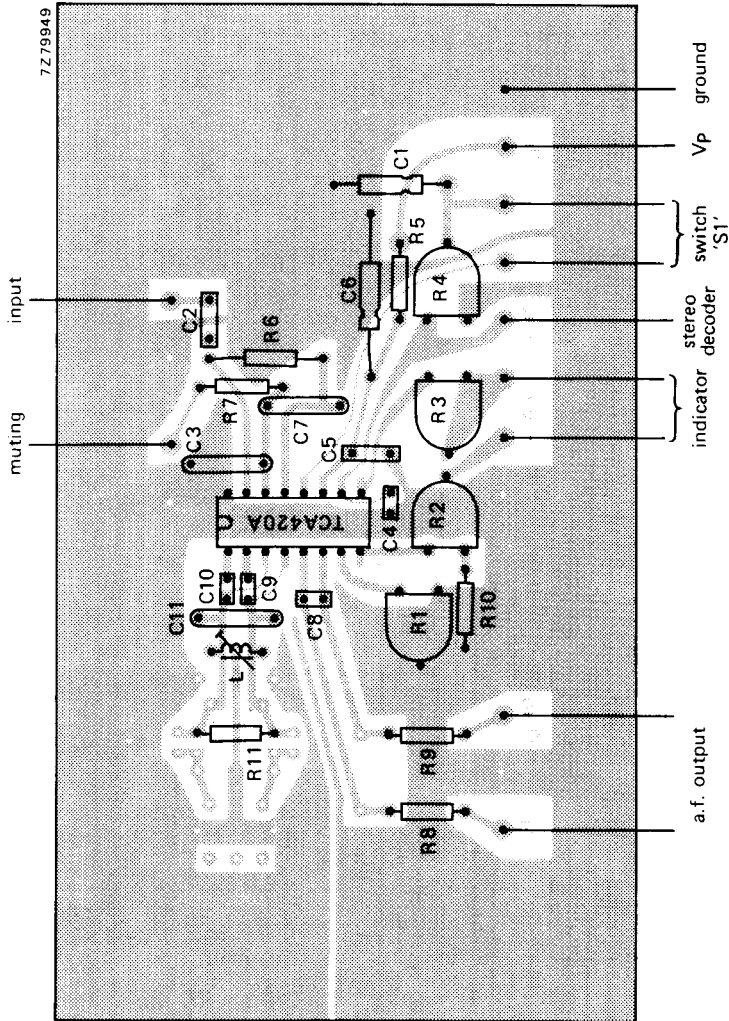


Fig. 4 Printed-circuit board component side, showing component layout. For circuit diagram see Fig. 3.

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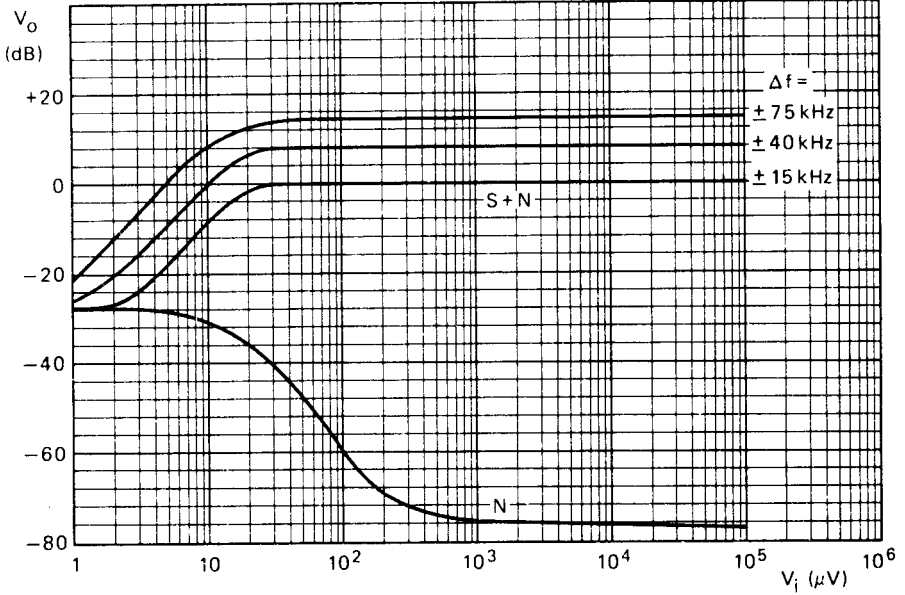


Fig. 5 $V_P = 15$ V; $f_m = 1$ kHz; $B = 250$ Hz to 16 kHz; typical values.

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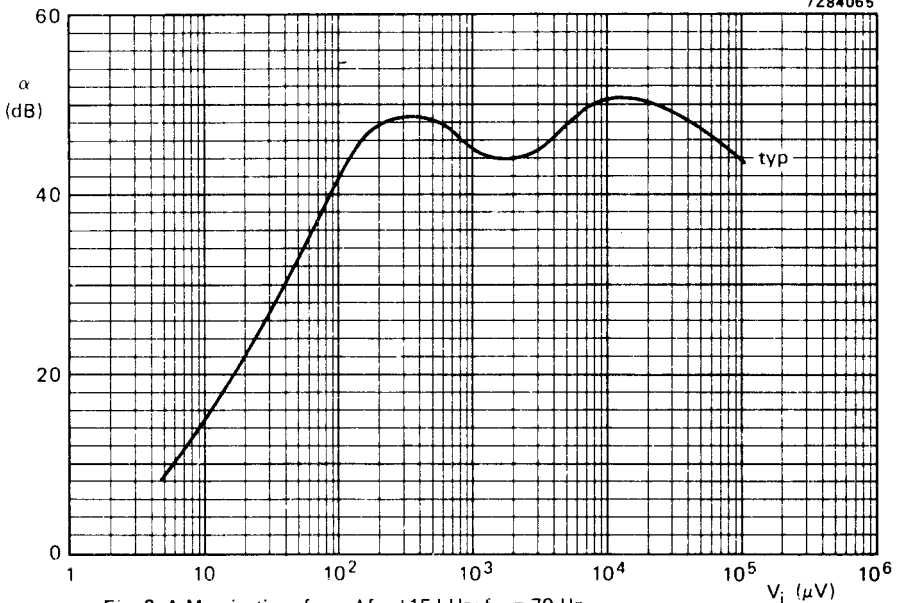


Fig. 6 A.M. rejection; f.m.: $\Delta f = \pm 15$ kHz; $f_m = 70$ Hz.
a.m.: $m = 30\%$; $f_m = 1$ kHz; simultaneously modulated.

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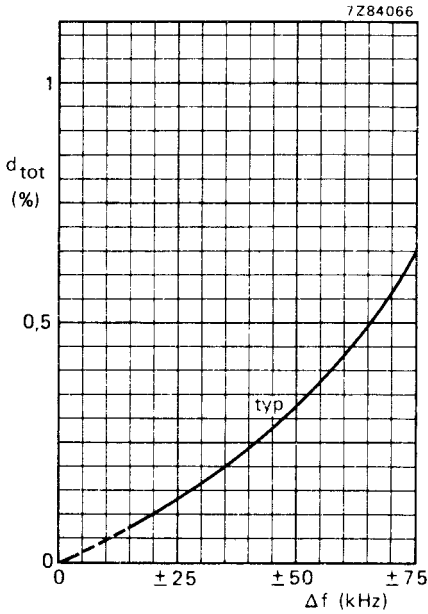


Fig. 7 Total distortion as a function of frequency deviation; single tuned circuit with $Q_L = 20$; $f_m = 1$ kHz; $C_{5-6} = 220$ pF.

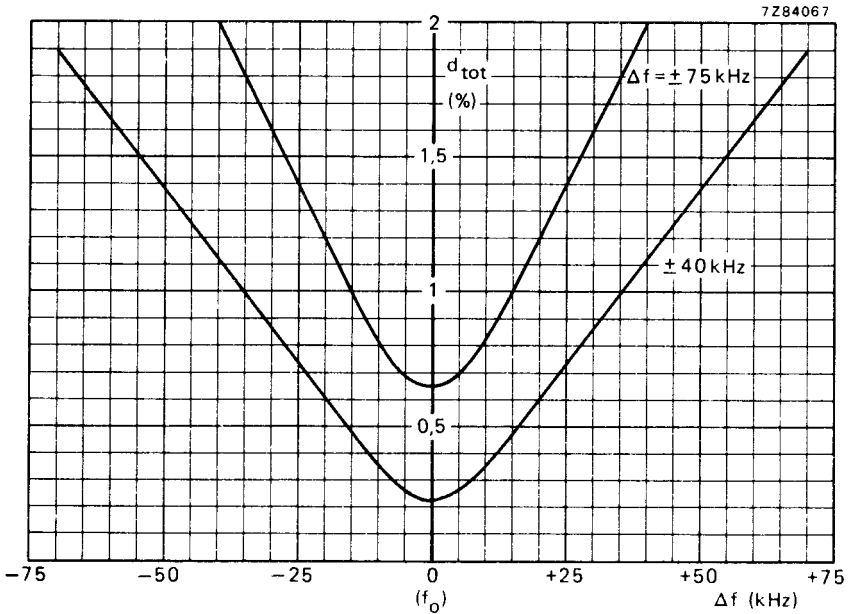


Fig. 8 Total distortion as a function of detuning; single tuned circuit with $Q_L = 20$; $f_m = 1$ kHz; $C_{5-6} = 220$ pF.



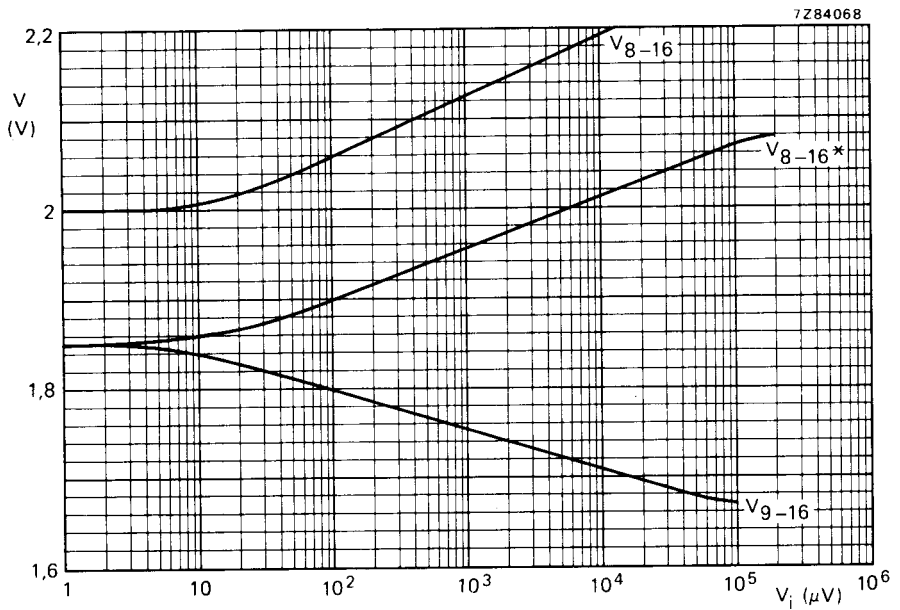


Fig. 9 Field-strength indication output voltages as a function of i.f. input voltage; R_2 adjusted so $V_{8-9} = 0$ at $V_i = 0$; $R_{\text{indicator}} + R_2 = 2 \text{ k}\Omega$; for V_{8-16}^* definition see Fig. 11.

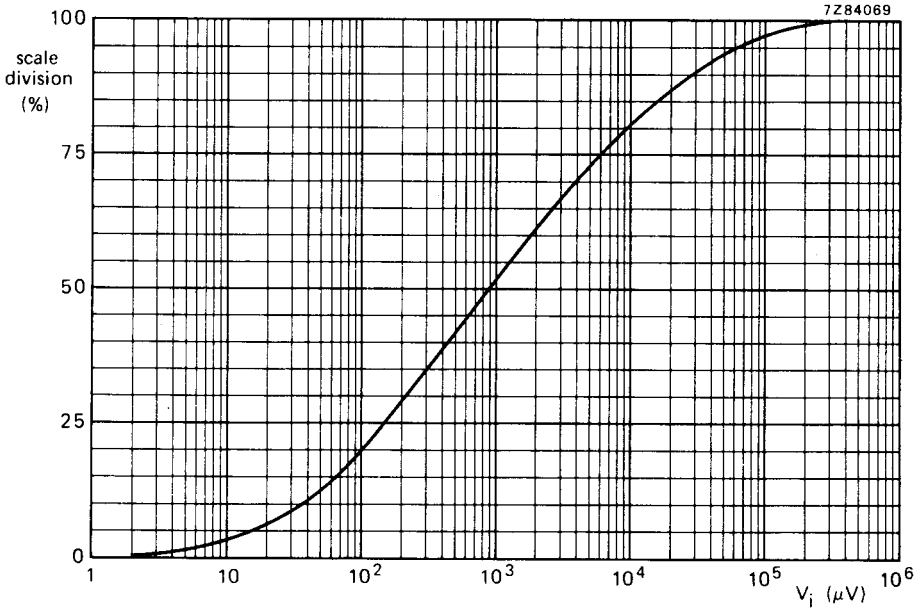


Fig. 9 Scale division of indicator as a function of i.f. input voltage; R2 adjusted so $V_{g.g} = 0$ at $V_i = 0$; $R_{\text{indicator}} = 2 \text{ k}\Omega$; R3 adjusted at indication 100%; indicator current = $140 \mu\text{A}$; see Fig. 11.

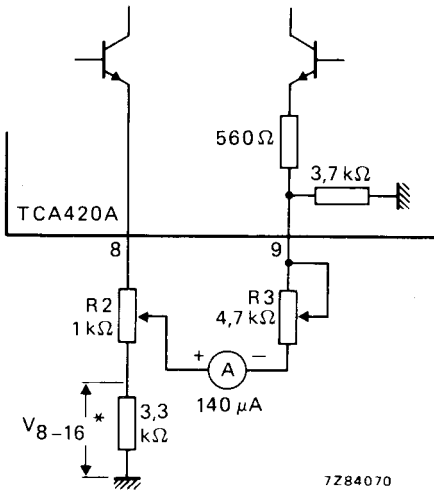


Fig. 11 Circuit diagram showing field-strength indicator adjustment components.

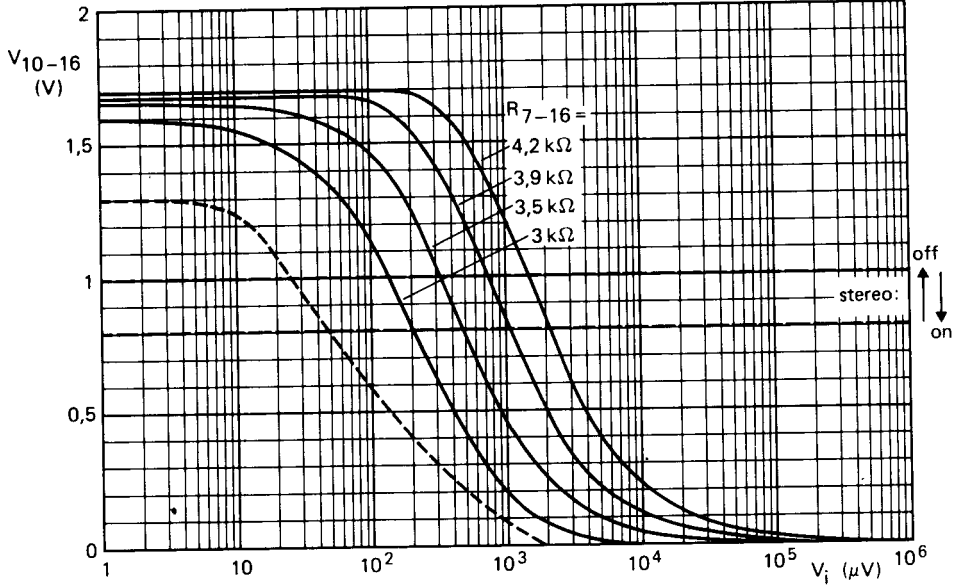


Fig. 12 Stereo decoder switching voltage as a function of i.f. input voltage; $R_4 = 3,9\text{ k}\Omega$; ----- R_1 adjusted so $V_{10-16} = 0$ at $V_i = 0$; see Fig. 13.

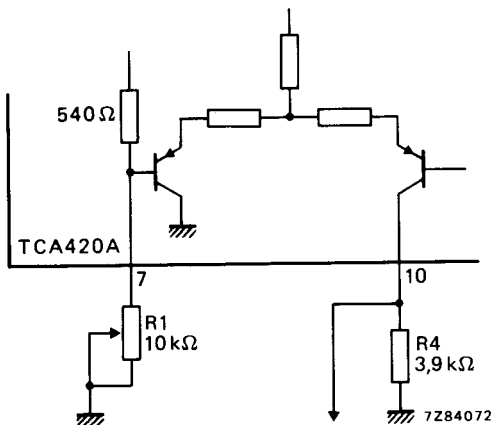


Fig. 13 Circuit diagram showing stereo decoder switching voltage adjustment.

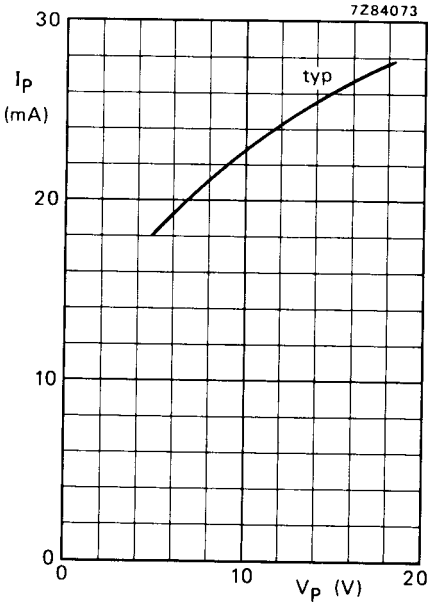


Fig. 14 Supply current consumption.

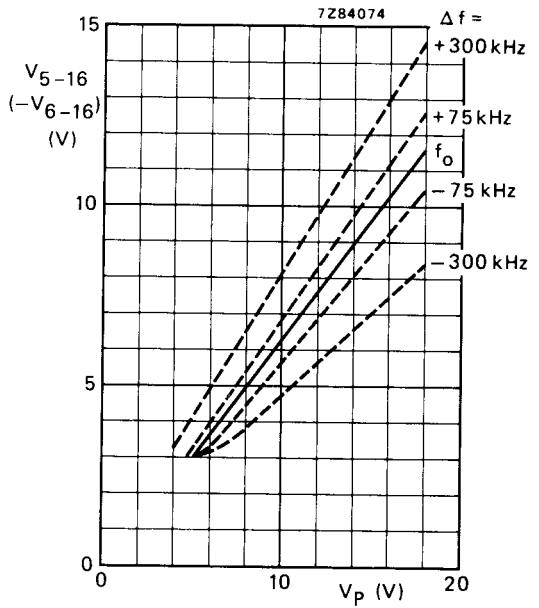


Fig. 15 Output voltage range.

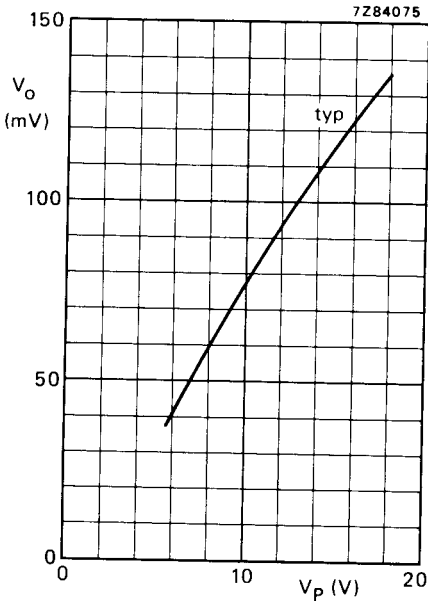


Fig. 16 A.F. output voltage; $\Delta f = \pm 15$ kHz; $f_m = 1$ kHz; $V_i = 1$ mV.

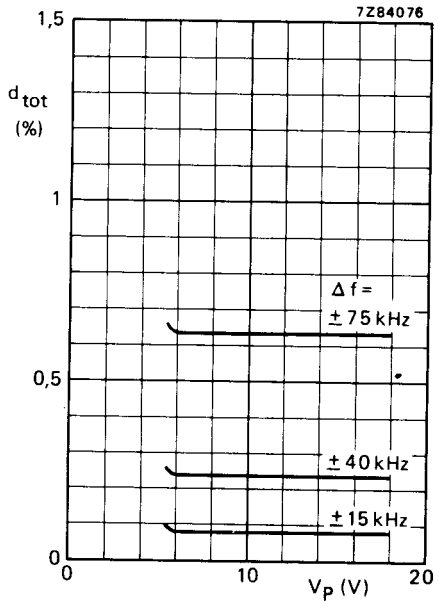


Fig. 17 Total distortion; $f_m = 1$ kHz; $V_i = 1$ mV; $C_{5-6} = 220$ pF.

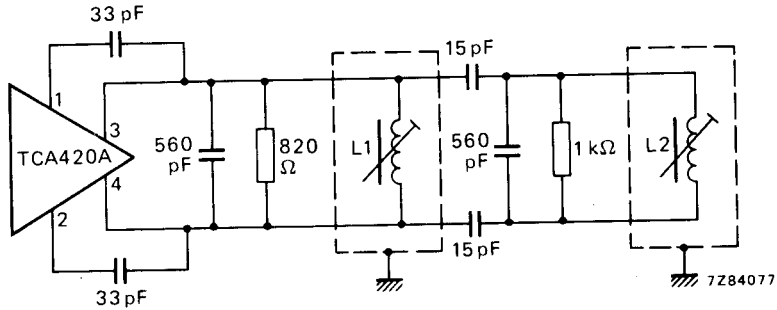


Fig. 18 Example of the TCA420A when using a detector with two tuned circuits; $f_0 = 10,7$ MHz; $L1 = L2 \approx 0,4 \mu\text{H}$; $Q_0 = 70$.

Adjustment of the detector:

When having an i.f. input signal on top of the limiter capability, L2 should be detuned, L1 should be adjusted to minimum distortion, and then L2 to minimum distortion.

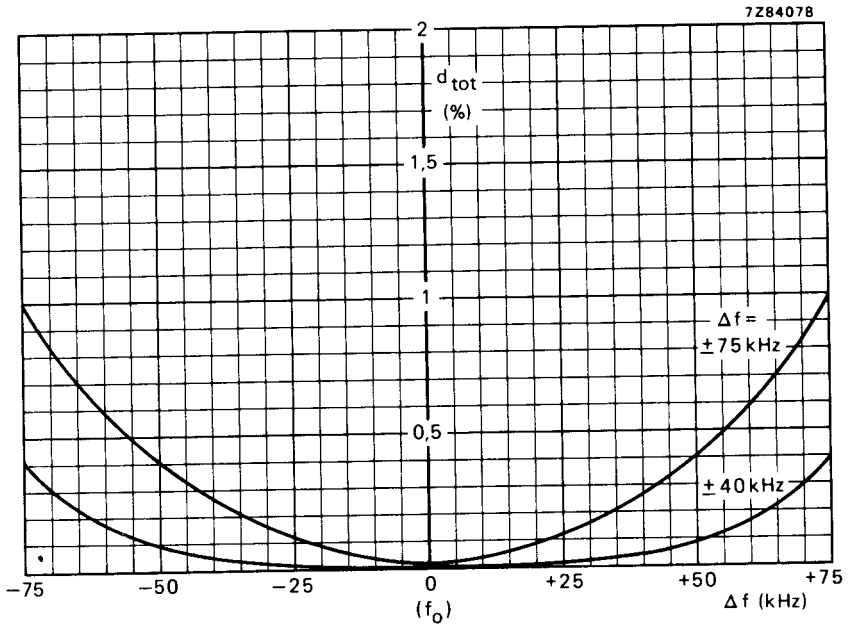


Fig. 19 Total distortion as a function of detuning; circuit as Fig. 18; $f_m = 1$ kHz; $C_{5-6} = 220$ pF. $V_0 = 500$ mV for a frequency deviation $\Delta f = \pm 75$ kHz and $d_{tot} < 0,1\%$.

APPLICATION INFORMATION

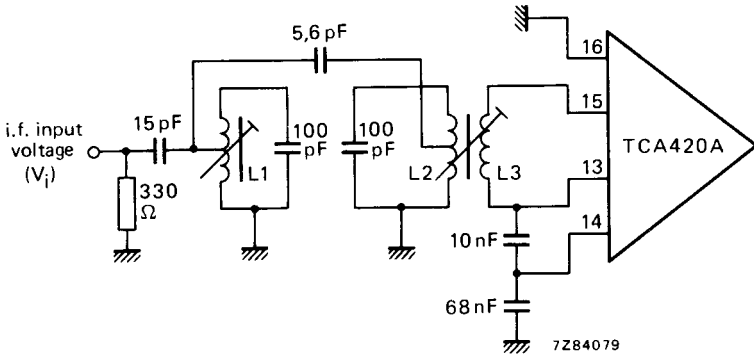


Fig. 20 I.F. coupling circuit, using LC filter; L1 = L2 = 7 + 7 turns h.f. litz wire (5 x 0,04); L3 = 3 turns h.f. litz wire wound on L2 (5 x 0,04).

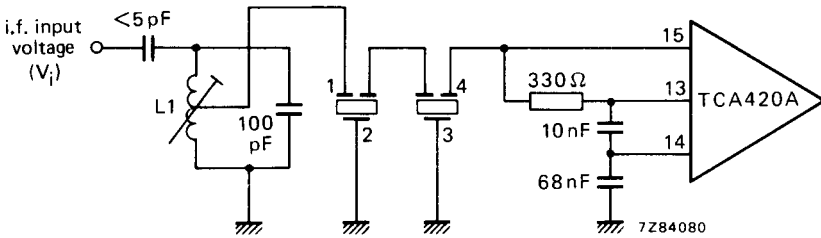
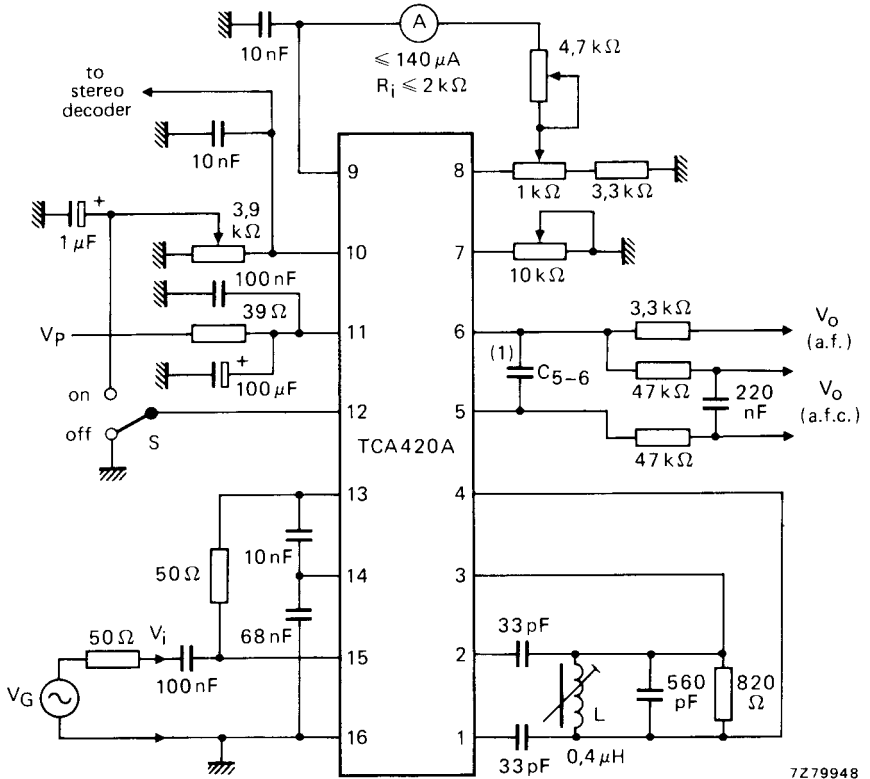


Fig. 21 I.F. coupling circuit, using ceramic filter; L1 = 14 turns h.f. litz wire (5 x 0,04), tab at 3 turns.

APPLICATION INFORMATION (continued)



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(1) For mono: $C_{5,6} = 10 \text{ nF}$.
 For stereo: $C_{5,6} = 220 \text{ pF}$.

Fig. 22 Application example of using TCA420A.

106