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

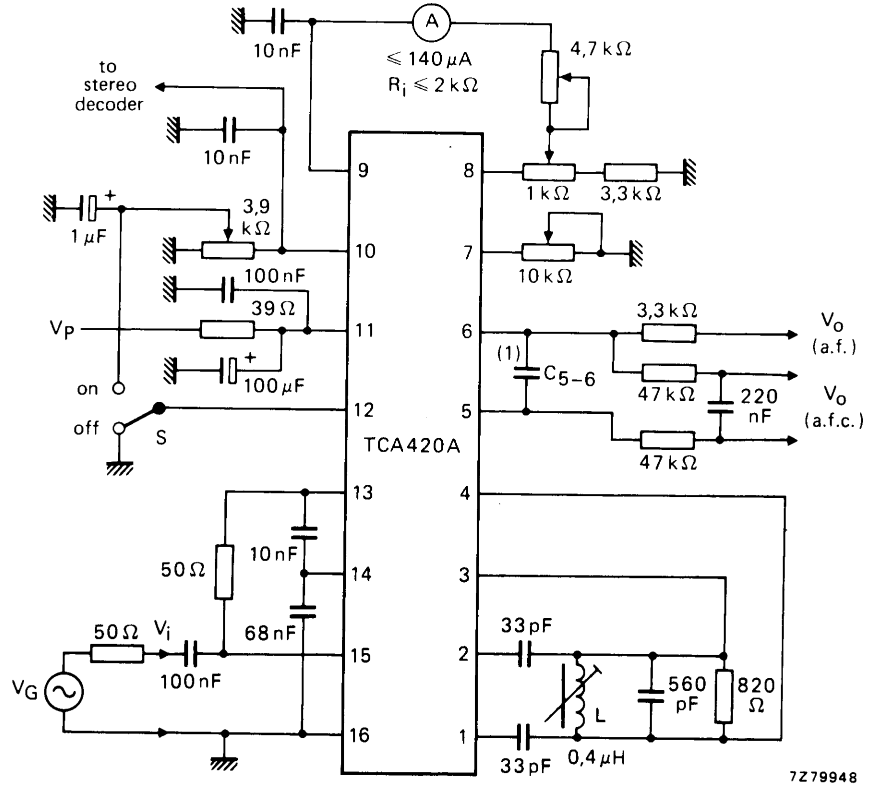
QUICK REFERENCE DATA

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	$V_{i\,lim}$	typ.	20	μV
A.F. output voltage (pin 5); Δf = ±15 kHz; r.m.s. value	$V_{o(rms)}$	typ.	115	mV
Signal plus noise-to-noise ratio; V_i > 1 mV; Δf = ±15 kHz	S+N/N	typ.	72	dB
I.F. input voltage; Δf = ±15 kHz				
S + N/N = 26 dB	V_i	typ.	15	μV
S + N/N = 46 dB	V_i	typ.	45	μV
A.M. rejection; V_i = 10 mV; f_m = 1 kHz (f.m.); Δf = ±15 kHz	α	typ.	50	dB
Total distortion (single tuned circuit); Δf = ±15 kHz	d_{tot}	typ.	0,1	%
Centre shift of f.m. detector curve	$\Delta f = \lvert f_{o1} - f_{o2} \rvert$	typ.	7	kHz
Field-strength indication range	ΔV_i	typ.	70	dB
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).

APPLICATION INFORMATION (continued)



(1) For mono: C_{5-6} = 10 nF.
For stereo: C_{5-6} = 220 pF.

Fig. 22 Application example of using TCA420A.

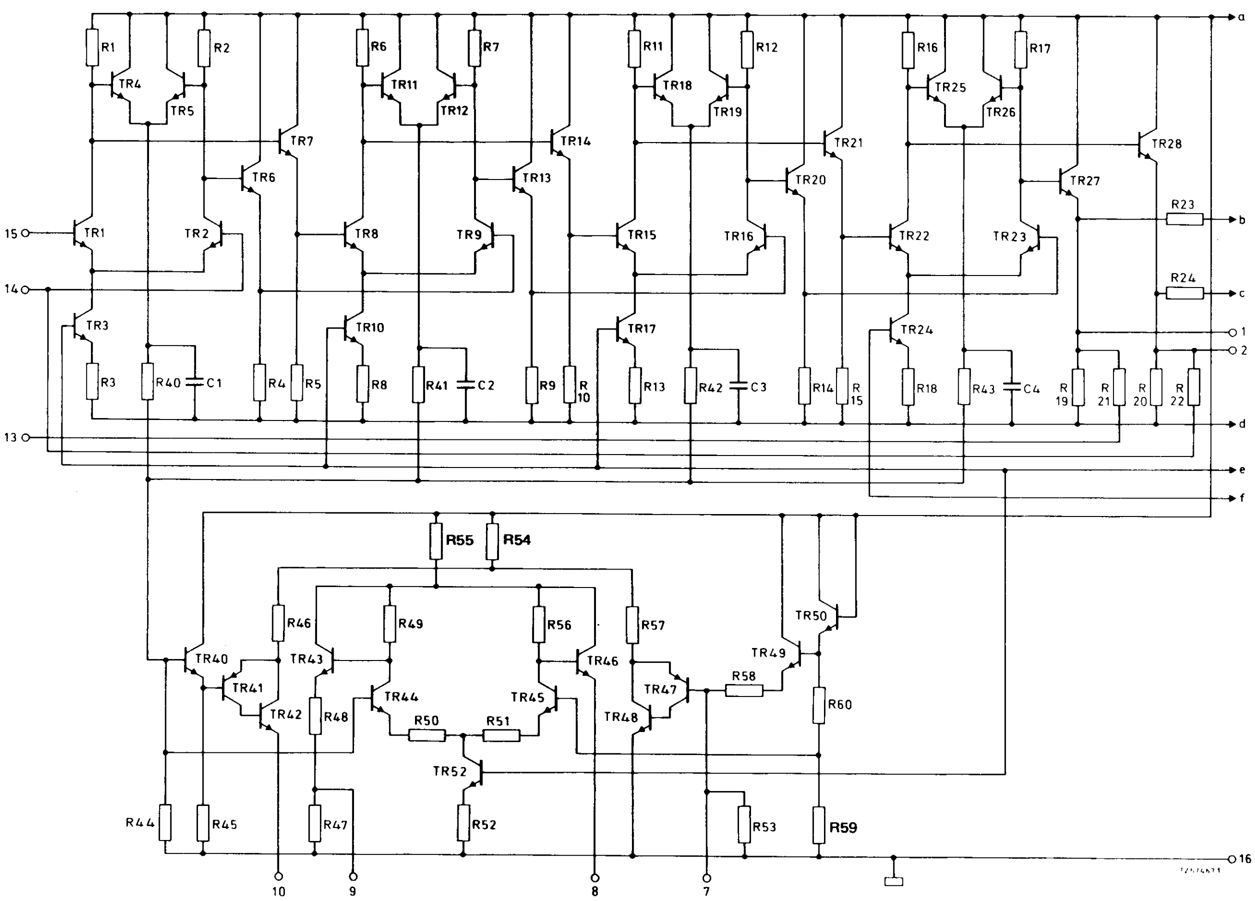


Fig. 1a Part of circuit diagram; other part continued in Fig. 1b.

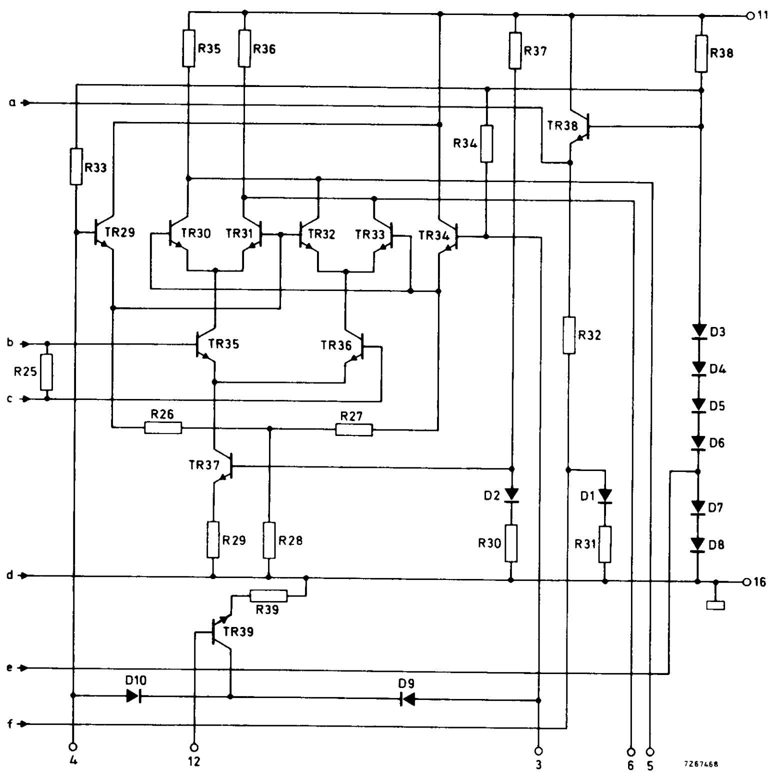


Fig. 1b Part of circuit diagram; continued from Fig. 1a.

RATINGS

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

Supply voltage (pin 11)	$V_P = V_{11\text{-}16}$	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; Δf = ±15 kHz; f_m = 1 kHz; R_G = 30 Ω; with de-emphasis ($C_{5\text{-}6}$ = 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).

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

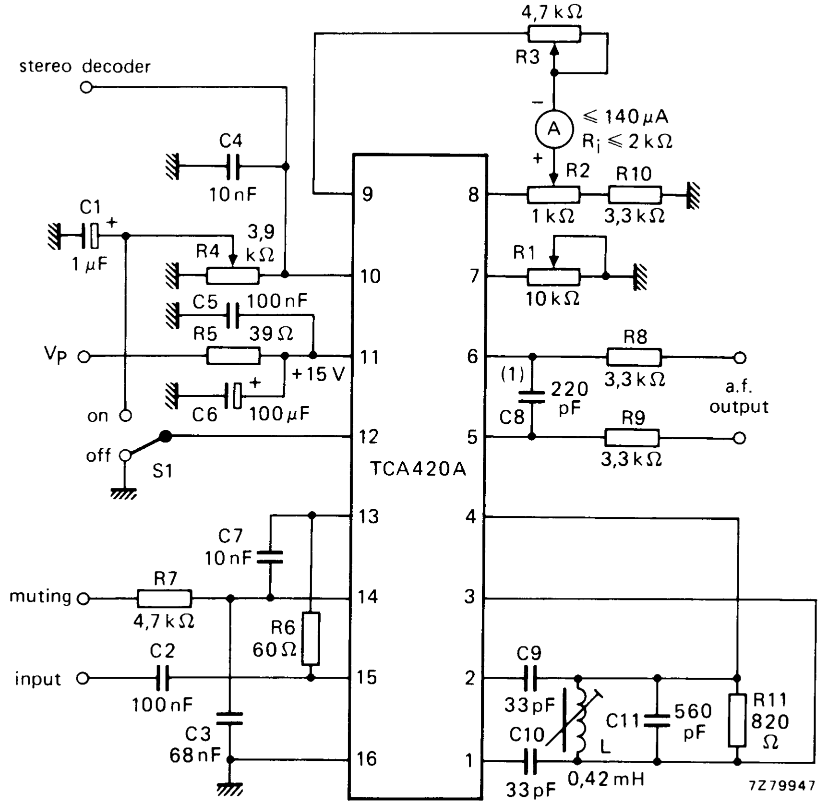
			V_P = 8 V	V_P = 15 V	
I.F. input voltage; with filter: B = 250 Hz to 16 kHz					
S+N/N = 26 dB; with de-emphasis; $C_{5\text{-}6}$ = 10 nF					
Δf = ±15 kHz	V_i	typ.	15	15	μV
Δf = ±75 kHz	V_i	typ.	5	5	μV
S+N/N = 26 dB; without de-emphasis; $C_{5\text{-}6}$ = 220 pF					
Δf = ±15 kHz	V_i	typ.	20	20	μV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

Note

Zero crossing shift is defined as the difference between frequencies f_{o1} at V_i = 1 mV and f_{o2} at V_i = 30 μV.

CHARACTERISTICS (continued)

			$V_P = 8\ V$	$V_P = 15\ V$	
Side response suppression					
Input voltage for 10 dB side response suppression at S1 = 'on' adjust R1, so $V_{10\text{-}16} = 1,3\ V$ at $V_i = 0$; S1 = 'off'; R4 = 3,9 kΩ	$V_{i(rms)}$	typ.	35	30	μV
Side response suppression level					
$\Delta f = \pm 15\ kHz$; $V_{i(rms)} = 1\ mV$					
control voltage for $\Delta V_o = -1\ dB$	$V_{12\text{-}16}$	typ.	0,7	0,7	V
control voltage for $\Delta V_o = -10\ dB$	$V_{12\text{-}16}$	typ.	1,1	1,1	V
Muting					
Output signal muting at S2 = 'on'; reference signal at S2 = 'off'; $V_{i(rms)} = 1\ mV$; $\Delta f = \pm 75\ kHz$; R4 = 3,9 kΩ	ΔV_o	typ.	−80	−80	dB
Field-strength indication					
Output voltages (d.c. value)					
$V_i = 0$; $I_{8\text{-}9} = 0$; $R_{8\text{-}16} = 4,3\ k\Omega$	$V_{9\text{-}16}$	typ.	1,75	1,85	V
	$V_{8\text{-}16}$	typ.	1,90	2,00	V
Field-strength indicator current					
$R_{indicator} = 2\ k\Omega$;					
adjust R2 so $I_{8\text{-}9} = 0$ at $V_i = 0$ and R3 = 0		>	130	140	μA
measured at $V_{i(rms)} = 120\ mV$	$I_{8\text{-}9}$	typ.	190	210	μA
Output resistance	R_o	typ.	810	850	Ω
	$R_{9\text{-}16}$	typ.	3,7	3,7	kΩ
Stereo decoder switching voltage					
Reference voltage; without load: $I_7 = 0$	$V_{7\text{-}16}$	typ.	2,05	2,25	V
Output voltage; $I_{10} = I_{10max}$	$V_{10\text{-}16}$	typ.	1,70	1,90	V
Available output current	$-I_{10\,max}$	typ.	0,45	0,85	mA
Output voltage as a function of the i.f. input voltage $R_{10\text{-}16} = 3,9\ k\Omega$; R1 = 5 kΩ	$\dfrac{\Delta V_{10\text{-}16}}{20 \log \frac{V_{i1}}{V_{i2}}}$	typ.	−0,9	−1,2	V/20 dB
Input voltage for $V_{10\text{-}16} = 0,8\ V$		typ.	98	100	μV
adjust R1 so $V_{10\text{-}16} = 1,3\ V$ at $V_{i(rms)} = 0$	$V_{i(rms)}$	<	150	200	μV
Input voltage for $V_{10\text{-}16} = 1,3\ V$		>	–	0,5	mV
adjust R1 so $V_{10\text{-}16} = 0,8\ V$ at $V_{i(rms)} = 3\ mV$	$V_{i(rms)}$	typ.	1,3	1,3	mV
		<	–	1,75	mV
Input resistance (pin 7)	$R_{7\text{-}16}$	typ.	4	4,7	kΩ



(1) $C_8 = C_{5\text{-}6}$ (see Fig. 2).
For mono: C8 = 10 nF.
For stereo: C8 = 220 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.

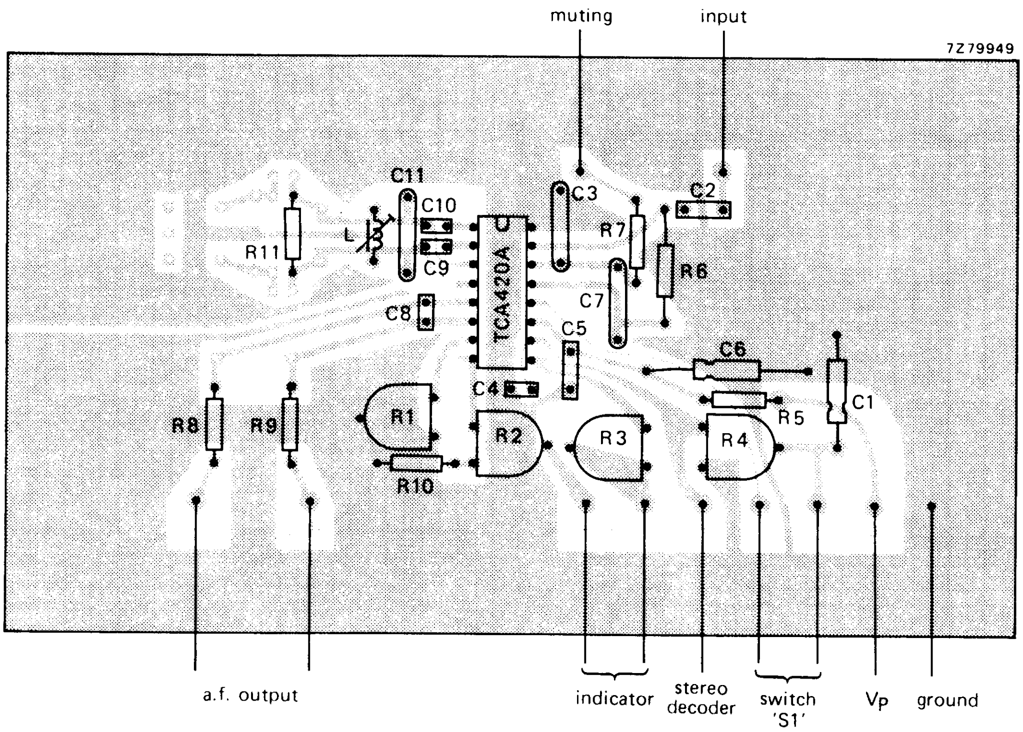


Fig. 4 Printed-circuit board component side, showing component layout. For circuit diagram see Fig. 3.

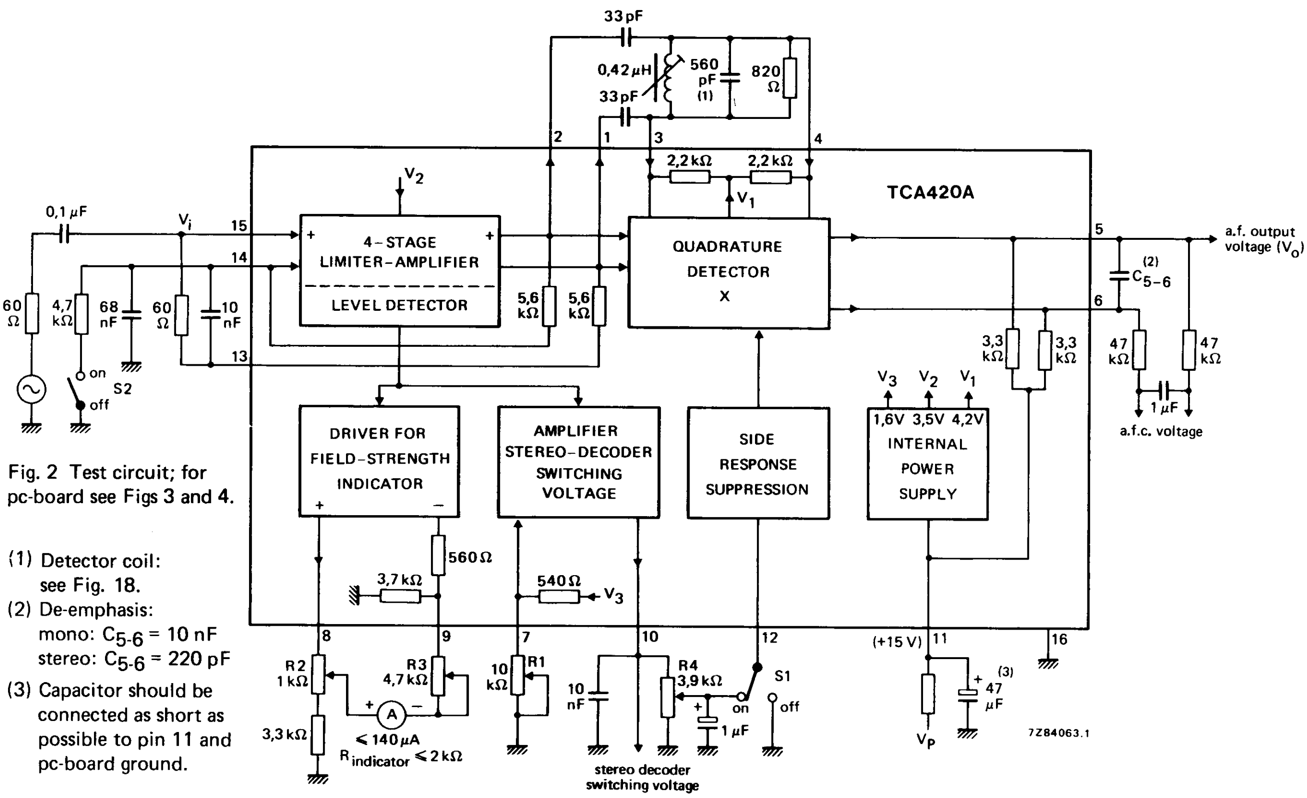


Fig. 2 Test circuit; for pc-board see Figs 3 and 4.

(1) Detector coil: see Fig. 18.

(2) De-emphasis:
mono: $C_{5\text{-}6}$ = 10 nF
stereo: $C_{5\text{-}6}$ = 220 pF

(3) Capacitor should be connected as short as possible to pin 11 and pc-board ground.

R1 = preset potentiometer for adjusting output voltage $V_{10\text{-}16}$ for mono/stereo switching of stereo decoder.
R2 = preset potentiometer for adjusting the zero level of the field-strength indicator current.
R3 = preset potentiometer for adjusting the maximum level of the field-strength indicator current.
R4 = preset potentiometer for adjusting the side response suppression.

S1 = side response suppression switch.
S2 = output signal muting switch.

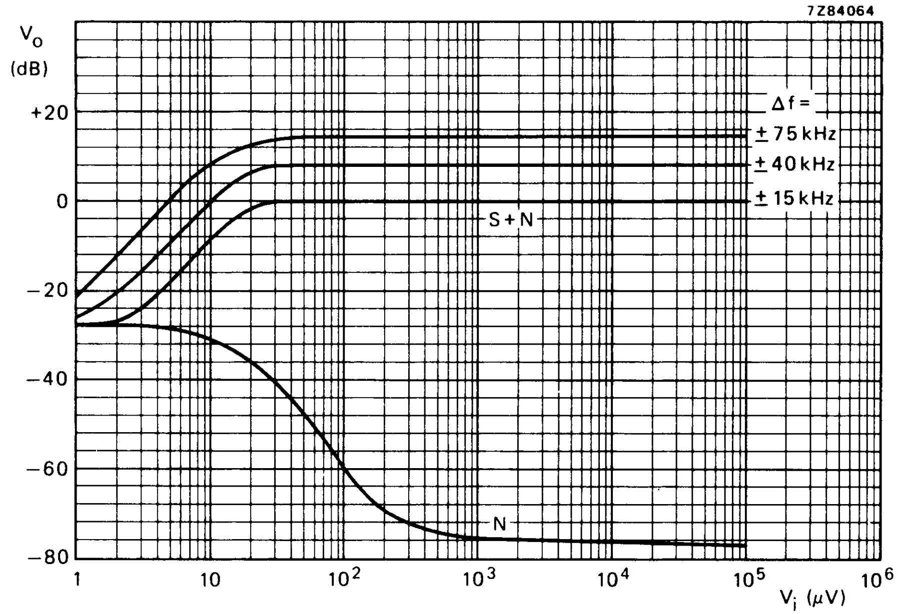


Fig. 5 V_P = 15 V; f_m = 1 kHz; B = 250 Hz to 16 kHz; typical values.

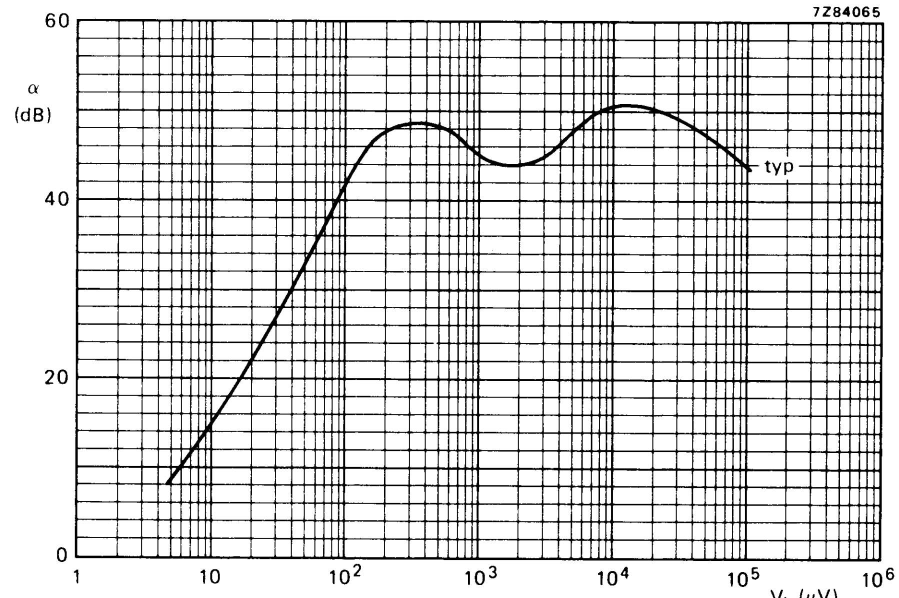


Fig. 6 A.M. rejection; f.m.: Δf = ±15 kHz; f_m = 70 Hz.
a.m.: m = 30%; f_m = 1 kHz; simultaneously modulated.

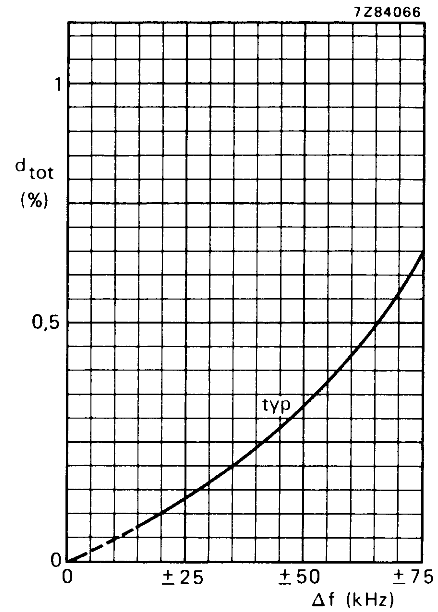


Fig. 7 Total distortion as a function of frequency deviation; single tuned circuit with Q_L = 20; f_m = 1 kHz; $C_{5\text{-}6}$ = 220 pF.

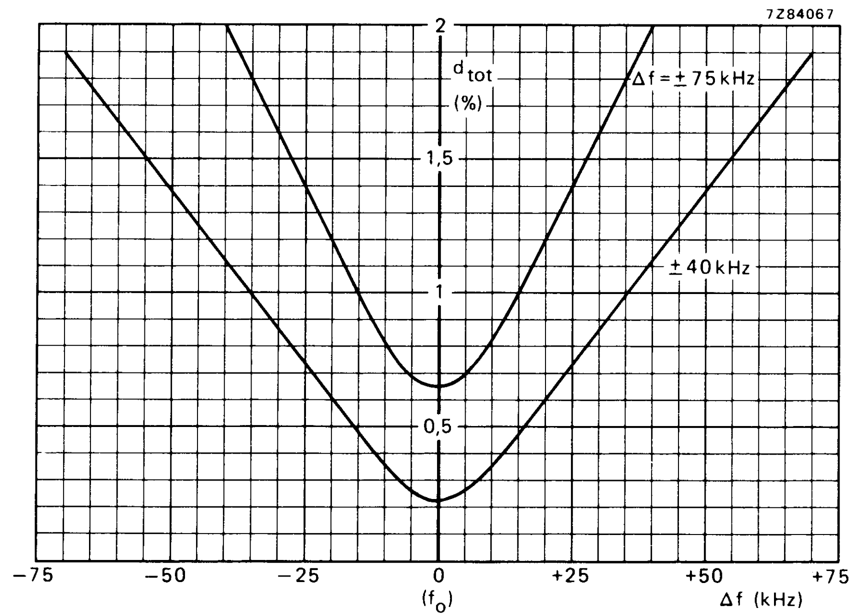


Fig. 8 Total distortion as a function of detuning; single tuned circuit with Q_L = 20; f_m = 1 kHz; $C_{5\text{-}6}$ = 220 pF.

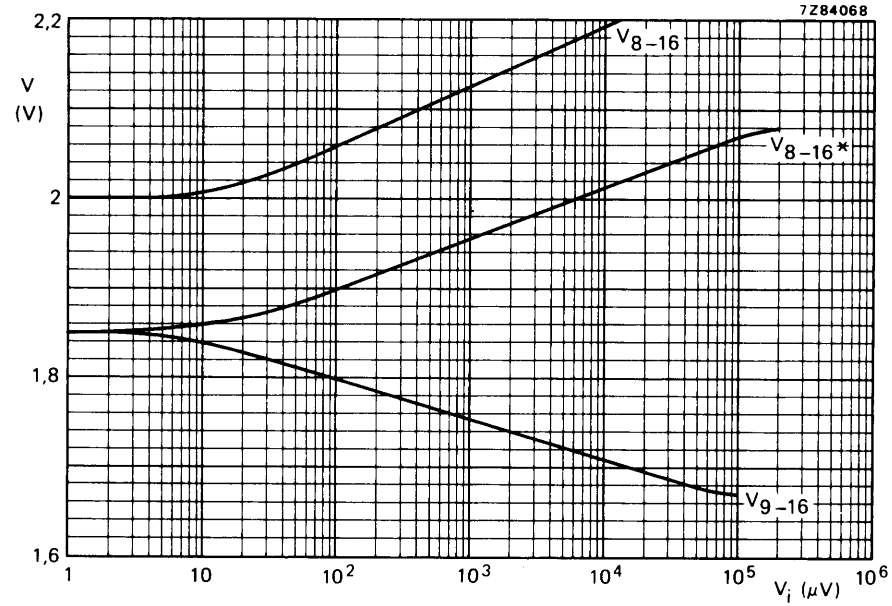


Fig. 9 Field-strength indication output voltages as a function of i.f. input voltage; R2 adjusted so $V_{8\text{-}9} = 0$ at $V_i = 0$; $R_{indicator} + R2 = 2\ k\Omega$; for $V_{8\text{-}16}{}^*$ definition see Fig. 11.

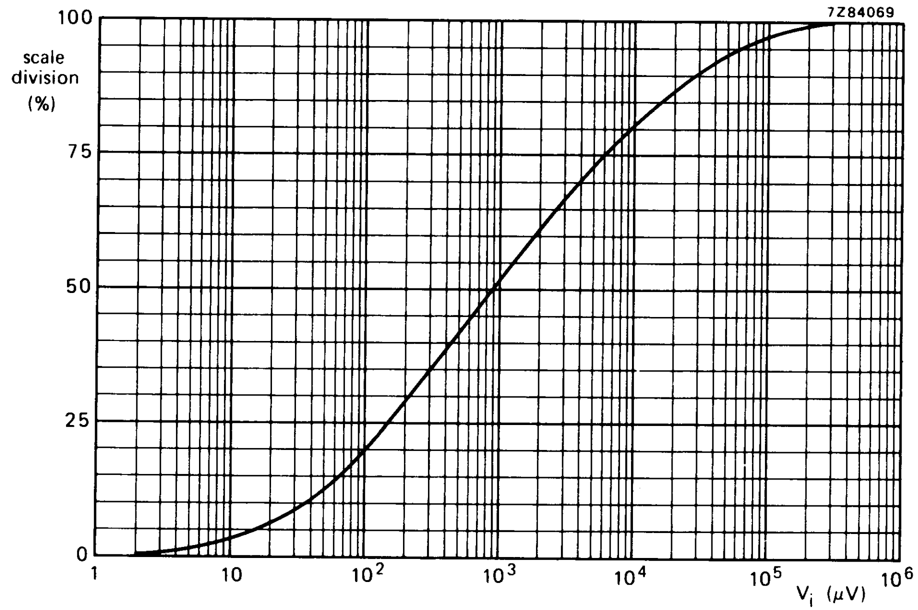


Fig. 9 Scale division of indicator as a function of i.f. input voltage; R2 adjusted so $V_{8\text{-}9} = 0$ at $V_i = 0$; $R_{indicator} = 2\ k\Omega$; R3 adjusted at indication 100%; indicator current = 140 μA; see Fig. 11.

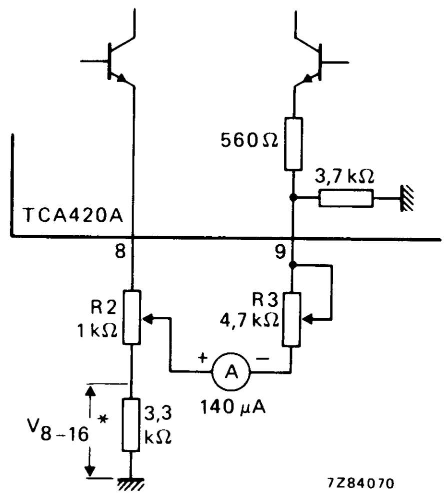


Fig. 11 Circuit diagram showing field-strength indicator adjustment components.

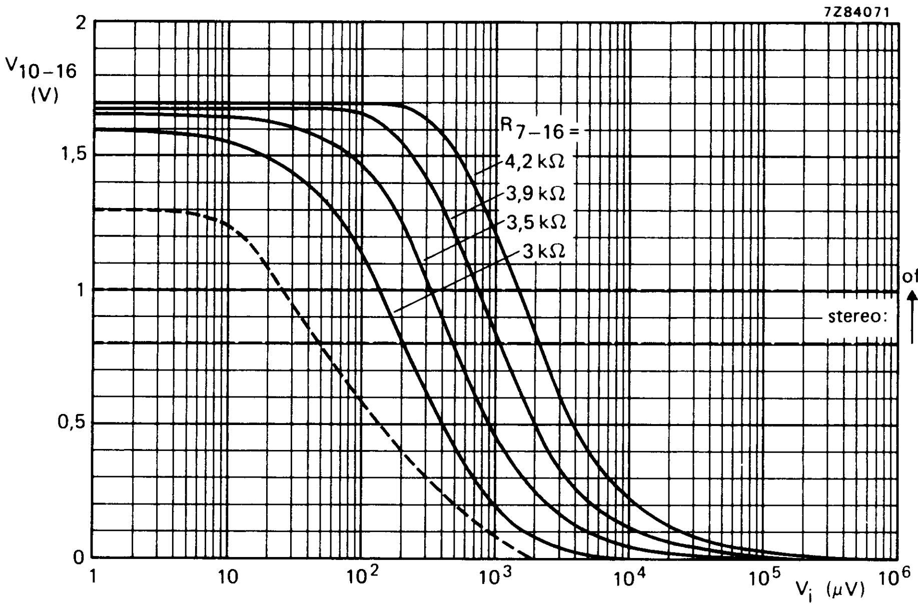


Fig. 12 Stereo decoder switching voltage as a function of i.f. input voltage; R4 = 3,9 kΩ; – – – – R1 adjusted so $V_{10\text{-}16}$ = 0 at V_i = 0; see Fig. 13.

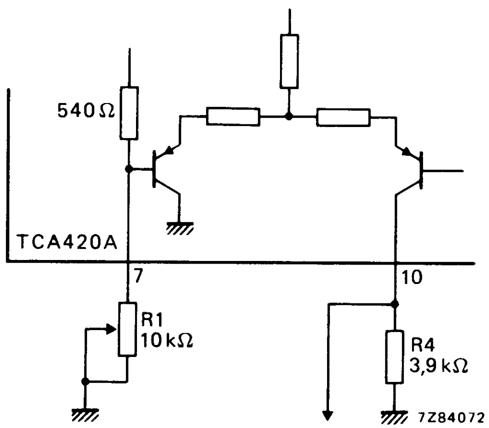


Fig. 13 Circuit diagram showing stereo decoder switching voltage adjustment.

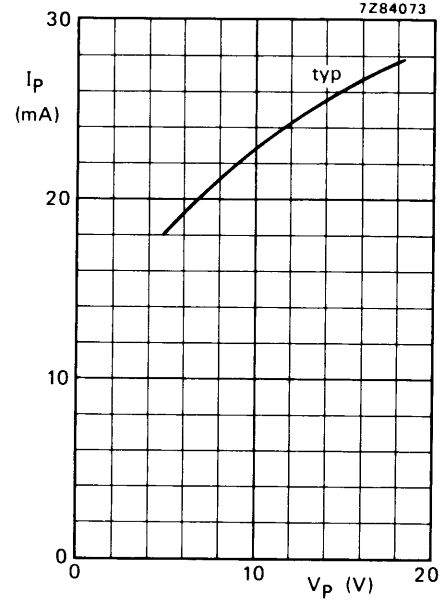


Fig. 14 Supply current consumption.

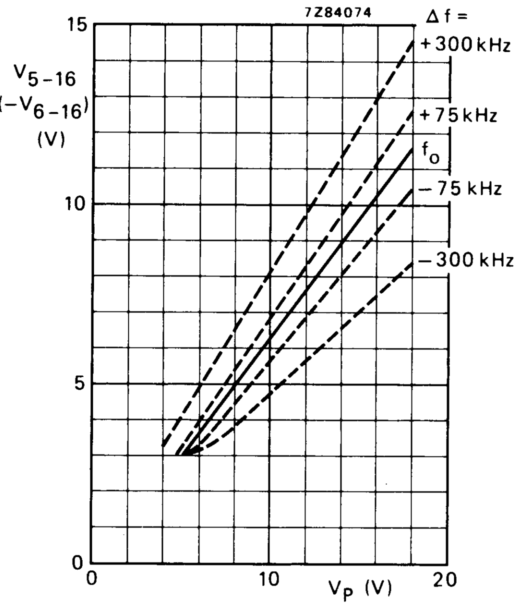


Fig. 15 Output voltage range.

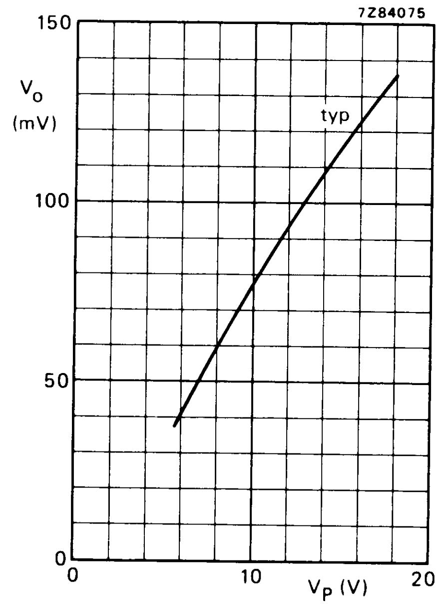


Fig. 16 A.F. output voltage; Δf = ±15 kHz; f_m = 1 kHz; V_i = 1 mV.

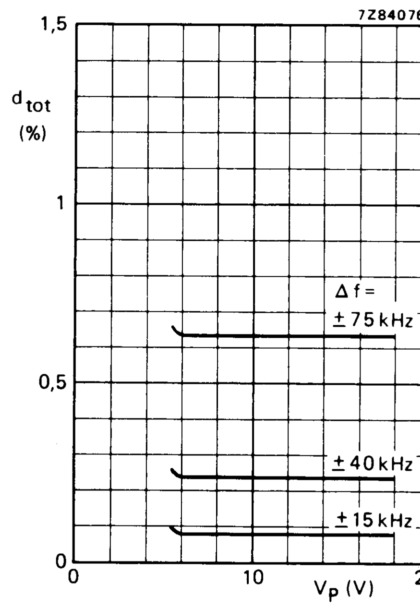


Fig. 17 Total distortion; f_m = 1 kHz; V_i = 1 mV; $C_{5\text{-}6}$ = 220 pF.

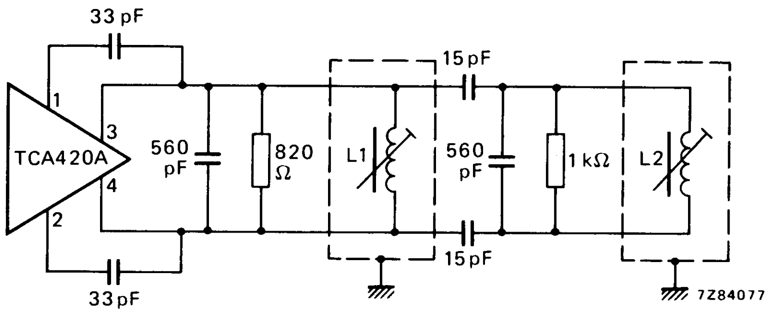


Fig. 18 Example of the TCA420A when using a detector with two tuned circuits; f_o = 10,7 MHz; L1 = L2 ≈ 0,4 μH; Q_o = 70.

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.

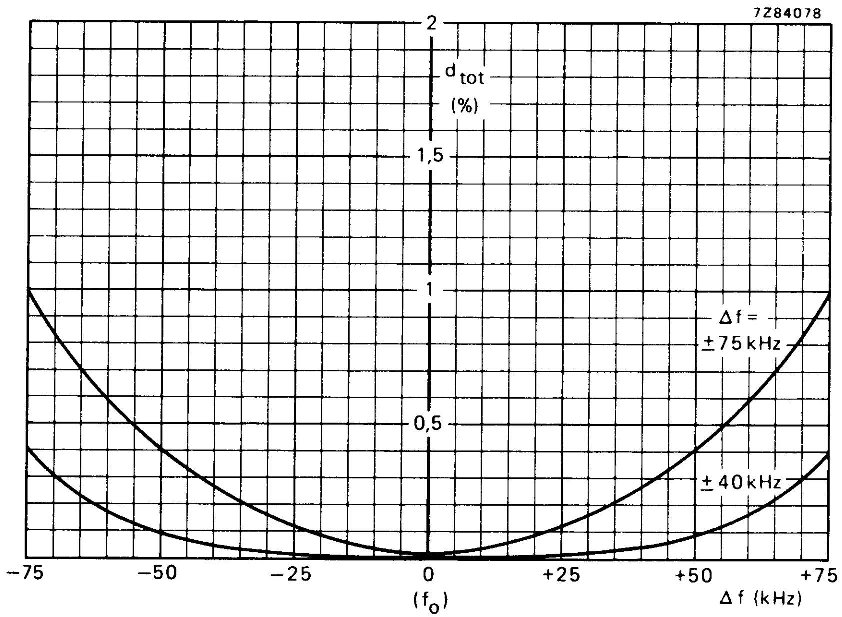


Fig. 19 Total distortion as a function of detuning; circuit as Fig. 18; f_m = 1 kHz; $C_{5\text{-}6}$ = 220 pF. V_o = 500 mV for a frequency deviation Δf = ±75 kHz and d_{tot} < 0,1%.

APPLICATION INFORMATION

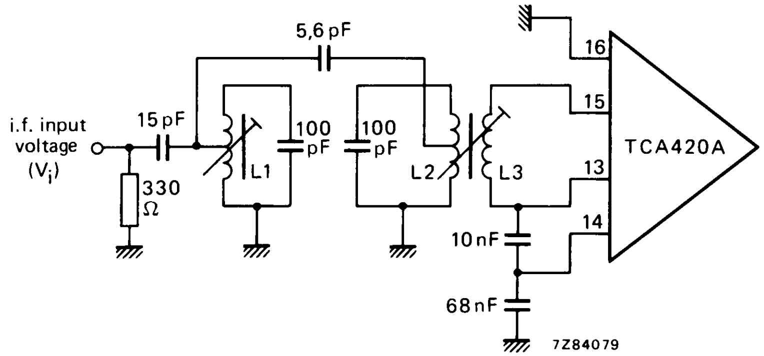


Fig. 20 I.F. coupling circuit, using LC filter; L1 = L2 = 7 + 7 turns h.f. litz wire (5 x 0,04); L3 = 3 turns h.f. litz wire wound on L2 (5 x 0,04).

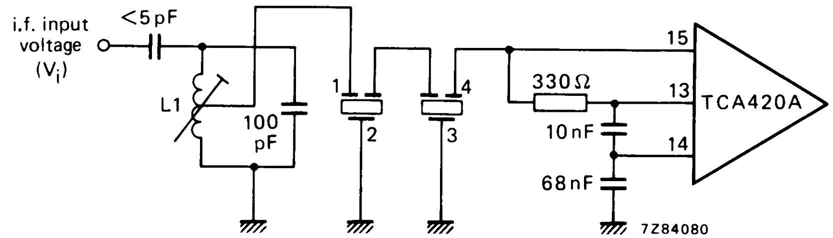


Fig. 21 I.F. coupling circuit, using ceramic filter; L1 = 14 turns h.f. litz wire (5 x 0,04), tab at 3 turns.