Single-chip FM radio circuit

TDA7021T

GENERAL DESCRIPTION

The TDA7021T integrated radio receiver circuit is for portable radios, stereo as well as mono, where a minimum of periphery is important in terms of small dimensions and low cost. It is fully compatible for applications using the low-voltage micro tuning system (MTS). The IC has a frequency locked loop (FLL) system with an intermediate frequency of 76 kHz. The selectivity is obtained by active RC filters. The only function to be tuned is the resonant frequency of the oscillator. Interstation noise as well as noise from receiving weak signals is reduced by a correlation mute system.

Special precautions have been taken to meet local oscillator radiation requirements. Because of the low intermediate frequency, low pass filtering of the MUX signal is required to avoid noise when receiving stereo. 50 kHz roll-off compensation, needed because of the low pass characteristic of the FLL, is performed by the integrated LF amplifier. For mono application this amplifier can be used to directly drive an earphone. The field-strength detector enables field-strength dependent channel separation control.

Features

- RF input stage
- Mixer
- Local oscillator
- IF amplifier/limiter
- Frequency detector
- Mute circuit
- MTS compatible

- Loop amplifier
- Internal reference circuit
- LF amplifier for
  — mono earphone amplifier or
  — MUX filter
- Field-strength dependent channel separation control facility

QUICK REFERENCE DATA

parameter	conditions	symbol	min.	typ.	max.	unit
Supply voltage (pin 4)		$V_P = V_{4-3}$	1,8	—	6,0	V
Supply current	$V_P = 3$ V	I_4	—	6,3	—	mA
RF input frequency		f_{rf}	1,5	—	110	MHz
Sensitivity (e.m.f.) for −3 dB limiting	source impedance = 75 Ω; mute disabled	EMF	—	4	—	μV
Signal handling (e.m.f.)	source impedance = 75 Ω	EMF	—	200	—	mV
AF output voltage		V_o	—	90	—	mV

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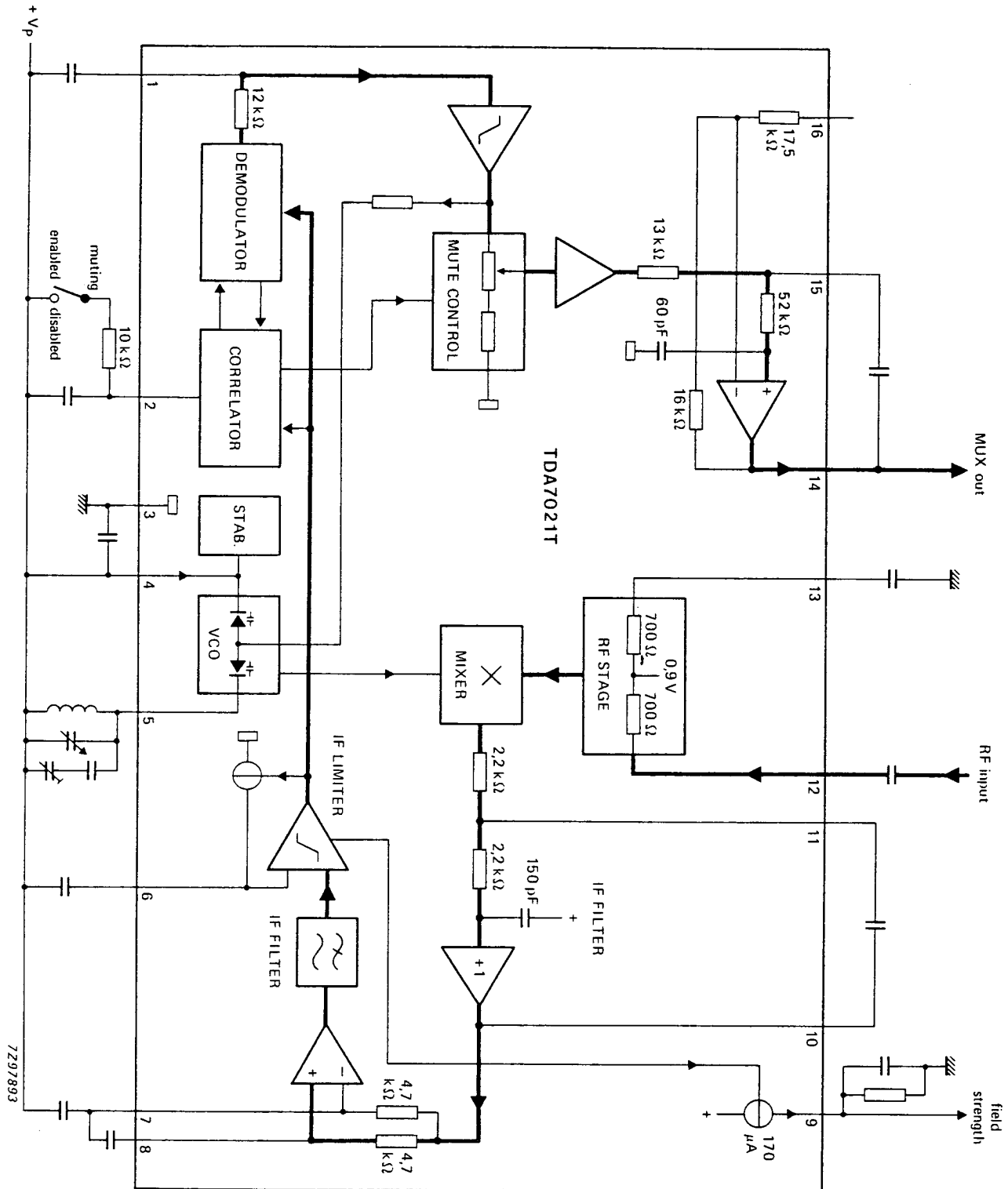

Fig. 1 Block diagram.

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RATINGS

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

parameter	conditions	symbol	min.	max.	unit
Supply voltage (pin 4)		$V_P = V_{4-3}$	–	7,0	V
Oscillator voltage		V_{5-4}	$V_P-0,5$	$V_P + 0,5$	V
Storage temperature range		T_{stg}	–55	+150	°C
Operating ambient temperature range		T_{amb}	–10	+70	°C

THERMAL RESISTANCE

From junction to ambient $R_{th\ j-a}$ 300 K/W

DC CHARACTERISTICS

$V_P = 3$ V, $T_{amb} = 25$ °C, measured in circuit of Fig. 4, unless otherwise specified

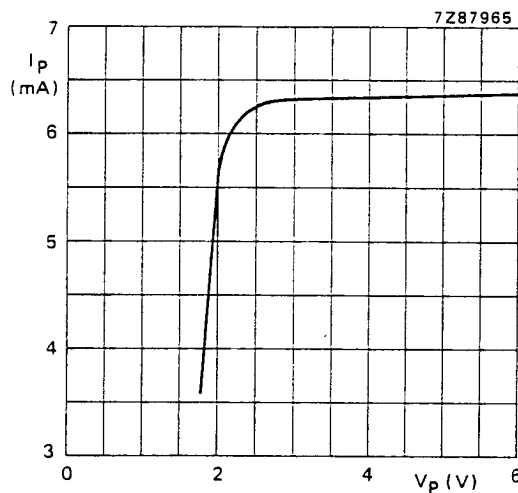| parameter	conditions	symbol	min.	typ.	max.	unit
Supply voltage (pin 4)		$V_P = V_{4-3}$	1,8	3,0	6,0	V
Supply current	$V_P = 3$ V	I_4	–	6,3	–	mA
Oscillator current		I_5	–	250	–	μA
Voltage at pin 13		V_{13-3}	–	0,9	–	V
Output voltage (pin 14)		V_{14-3}	–	1,3	–	V

Fig. 2 Supply current as a function of the supply voltage.

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AC CHARACTERISTICS (MONO OPERATION)

V_P = 3 V; T_{amb} = 25 °C; measured in Fig. 5; f_{rf} = 96 MHz modulated with Δf = ± 22,5 kHz; f_m = 1 kHz; EMF = 0,3 mV (e.m.f. at a source impedance of 75 Ω); r.m.s. noise voltage measured unweighted (f = 300 Hz to 20 kHz); unless otherwise specified

parameter	conditions	symbol	min.	typ.	max.	unit

Sensitivity (e.m.f.)
  for −3 dB limiting
  for −3 dB muting
  for (S+N)/N = 26 dB
	see Fig. 3
	muting disabled
		EMF
		EMF
		EMF
			−
			−
			−
				4,0
				5,0
				7,0
					−
					−
					−
						μV
						μV
						μV

Signal handling (e.m.f.)	THD < 10%; Δf = ± 75 kHz	EMF	−	200	−	mV
Signal-to-noise ratio		(S+N)/N	−	60	−	dB
Total harmonic distortion	Δf = ± 22,5 kHz Δf = ± 75 kHz	THD THD	− −	0,7 2,3	− −	% %
AM suppression of output voltage	ratio of AM signal (f_m = 1 kHz; m = 80%) to FM signal (f_m = 1 kHz; Δf = 75 kHz)	AMS	−	50	−	dB
Ripple rejection	ΔV_P = 100 mV; f = 1 kHz	RR	−	30	−	dB
Oscillator voltage (r.m.s. value)		$V_{5-4(rms)}$	−	250	−	mV
Variation of oscillator frequency with temperature	V_P = 1 V	$\dfrac{\Delta f_{osc}}{\Delta T_{amb}}$	−	5	−	kHz/°C
Selectivity	see Fig. 9; no modulation	S_{+300} S_{-300}	− =	46 30	− −	dB dB
AFC range		$\pm\Delta f_{rf}$	−	160	−	kHz
Mute range		$\pm\Delta f_{rf}$	−	120	−	kHz
Audio bandwidth	ΔV_o = 3 dB; measured with 50 μs pre-emphasis	B	−	10	−	kHz
AF output voltage (r.m.s. value)	R_L (pin 14) = 100 Ω	$V_{o(rms)}$	−	90	−	mV

AF output current
  max. d.c. load
  max. a.c. load (peak value)
	THD = 10%	$I_{o(dc)}$
		$I_{o(ac)}$
			−100
			−
				−
				3
					+100
					−
						μA
						mA

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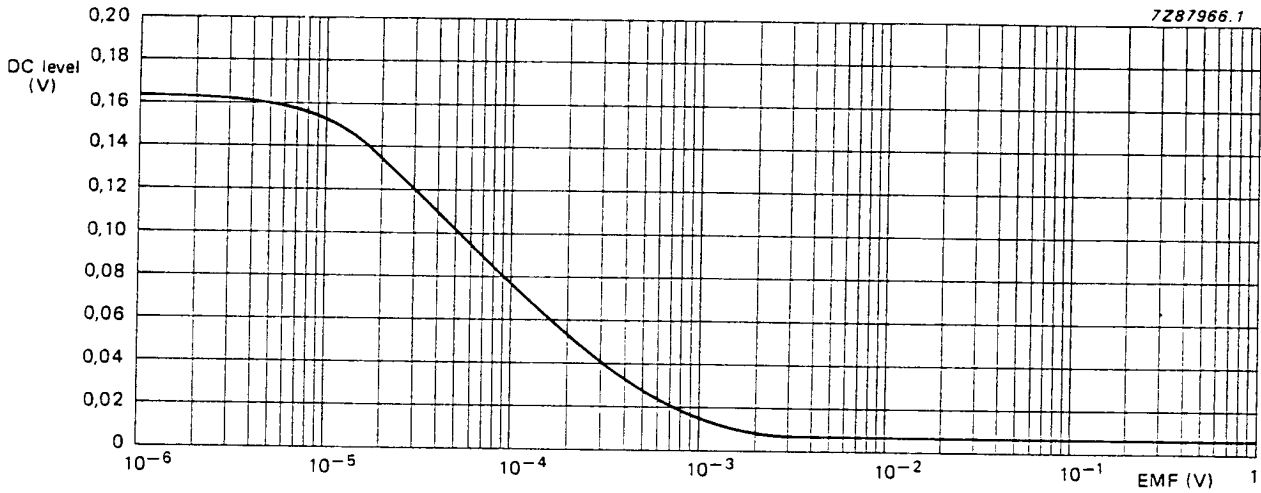Fig. 3 Field strength voltage (V_{9-3}) at R_{source} = 1 kΩ; f = 96,75 MHz; Vp = 3 V.
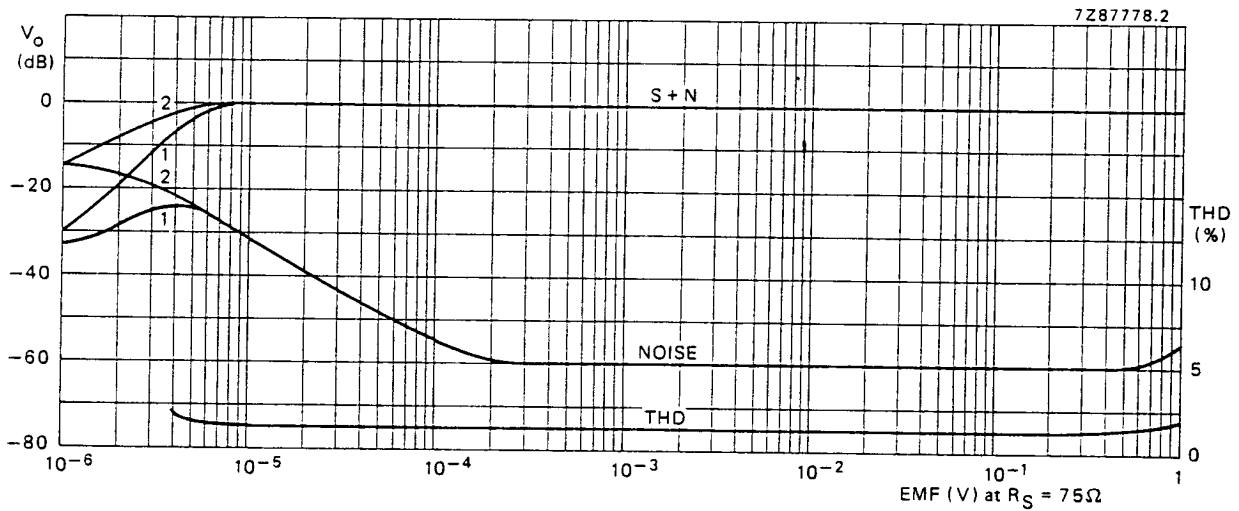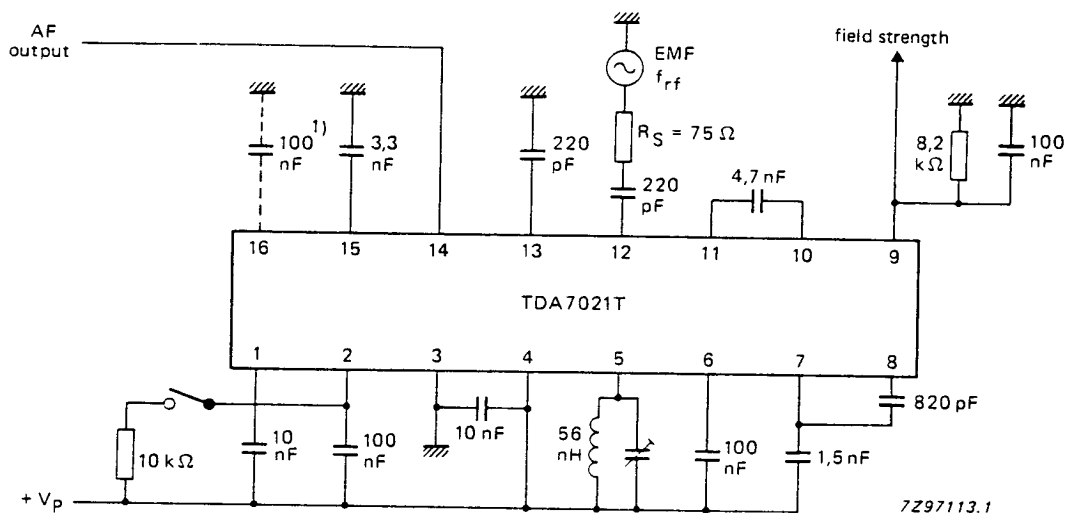

Fig. 4 Mono operation: AF output voltage (V_o) and total harmonic distortion (THD) as functions of input e.m.f. (EMF); R_{source} = 75 Ω; f_{rf} = 96 MHz; 0 dB = 90 mV. For S+N and noise curves (1) is with muting enabled and (2) is with muting disabled; signal $\Delta f = \pm$ 22,5 kHz and f_m = 1 kHz. For THD curve, $\Delta f = \pm$ 75 kHz and f_m = 1 kHz.

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1) The AF output can be decreased by disconnecting the 100 nF capacitor from pin 16.

Fig. 5 Test circuit for mono operation.

AC CHARACTERISTICS (STEREO OPERATION)

V_P = 3 V; T_{amb} = 25 °C; measured in Fig. 8; f_{rf} = 96 MHz modulated with pilot Δf = ± 6,75 kHz and AF signal Δf = ± 22,5 kHz; f_m = 1 kHz; EMF = 1 mV (e.m.f. at a source impedance of 75 Ω); r.m.s. noise voltage measured unweighted (f = 300 Hz to 20 kHz); unless otherwise specified

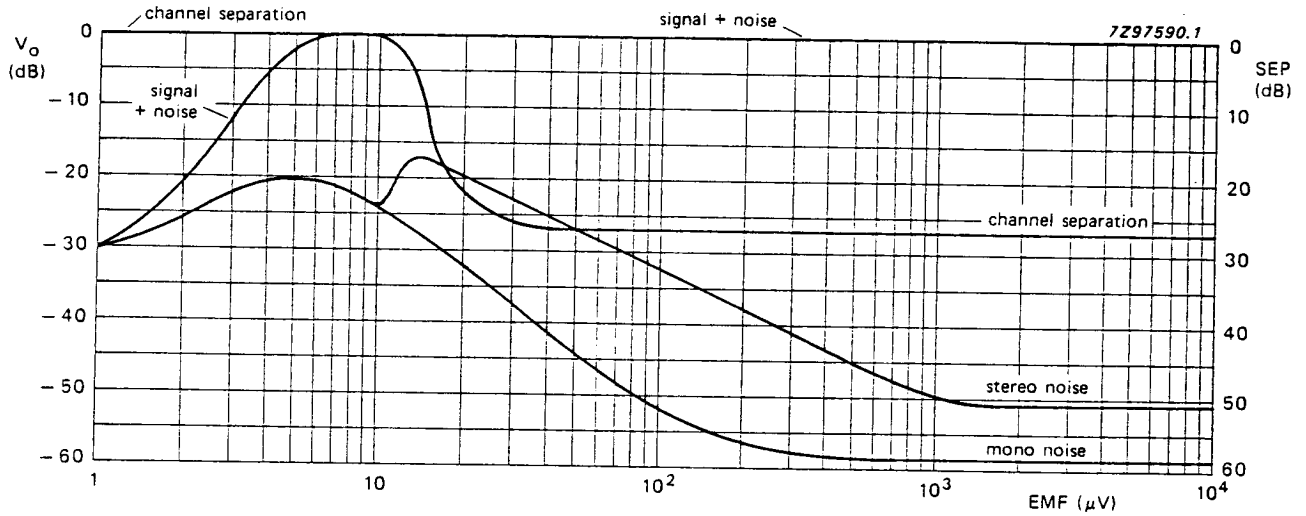| parameter	conditions	symbol	min.	typ.	max.	unit
Sensitivity (e.m.f.) for (S+N)/N = 26 dB	see Fig. 8; pilot off	EMF	–	11	–	μV
Selectivity	see Fig. 9; no modulation	S_{+300}	–	40	–	dB
		S_{-300}	–	22	–	dB
Signal-to-noise ratio		(S+N)/N	–	50	–	dB
Channel separation	V_i = L-signal; f_m = 1 kHz; pilot on:					
	at f_{rf} = 97 MHz	α	–	26	–	dB
	at f_{rf} = 87,5 MHz and 108 MHz	α	–	14	–	dB

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Fig. 6 Stereo operation: signal/noise and channel separation of TDA7021T when used in the circuit of Fig. 8.
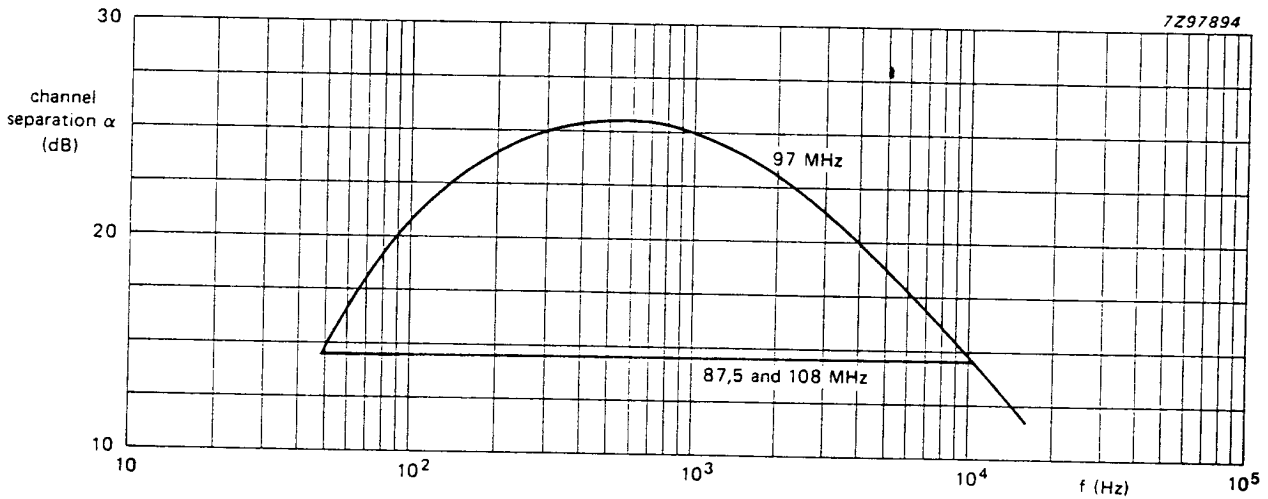
Fig. 7 Stereo operation: channel separation as a function of audio frequency in the circuit of Fig. 8.
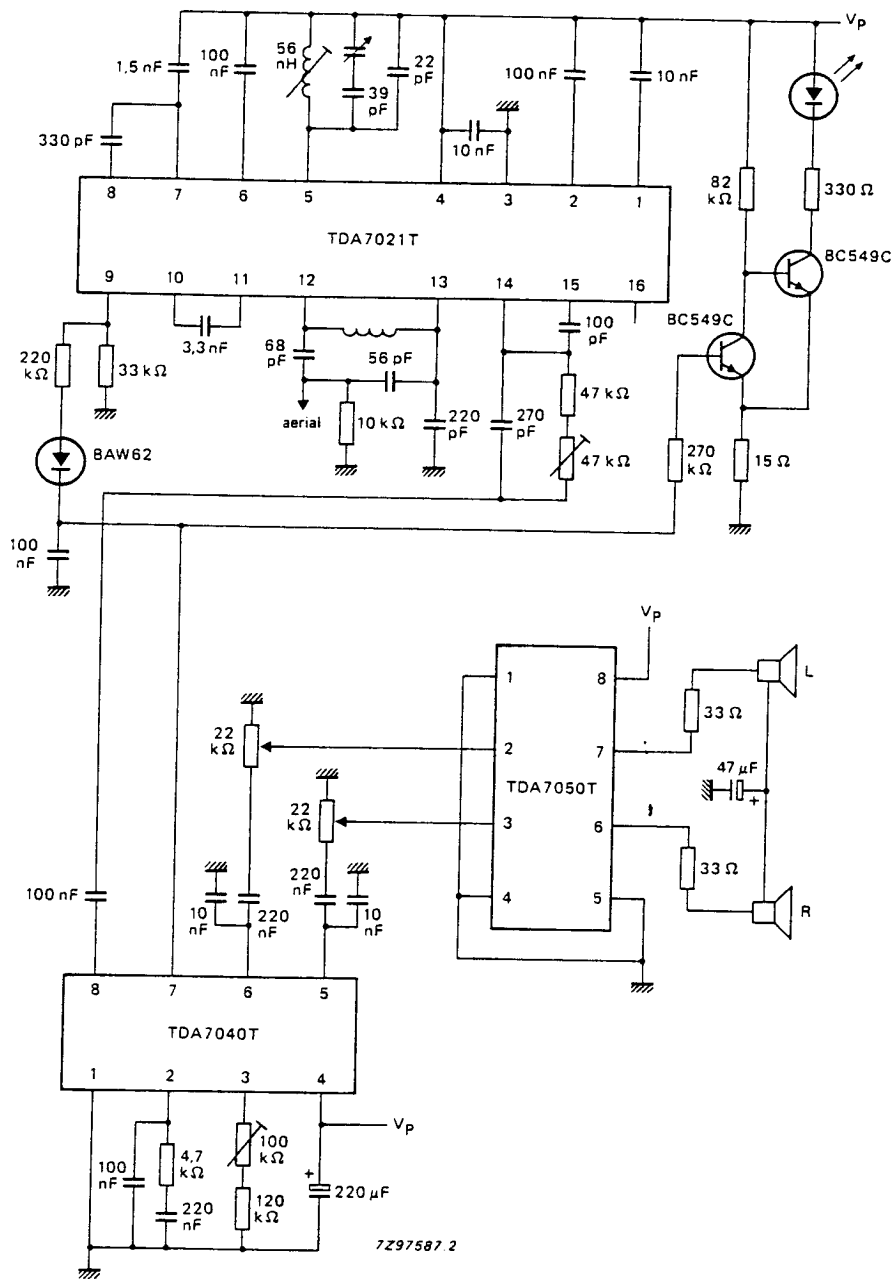
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Fig. 8 Stereo application in combination with a low voltage PLL stereo decoder (TDA7040T) and a low voltage mono/stereo power amplifier (TDA7050T).
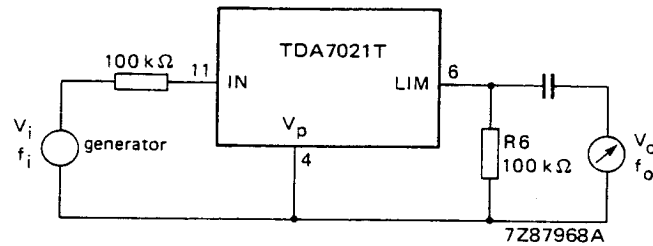
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Fig. 9 Test set-up, $V_i = 30$ mV; $f_i = 76$ kHz; selective voltmeter at output has $R_i \geqslant 1$ MΩ and $C_i \leqslant 8$ pF; $f_o = f_i$.

Note to Fig. 9

This test set-up is to incorporate the circuit of Fig. 5 for mono operation or the circuit of Fig. 8 for stereo operation. For either circuit, replace the 100 nF capacitor at pin 6 with R6 (100 kΩ) as shown above.

Selectivity

$$S_{+300} = 20 \log \frac{V_o \mid (300 \text{ kHz} - f_i)}{V_o \mid f_i}$$

$$S_{-300} = 20 \log \frac{V_o \mid (300 \text{ kHz} + f_i)}{V_o \mid f_i}$$