AM/FM stereo radio circuit

TEA5711; TEA5711T

FEATURES

- Wide supply voltage range: 1.8 or 2.1 to 12 V
- Low current consumption: 15 mA at AM, 16 mA at FM
- High selectivity with distributed IF gain
- LED driver for stereo indication
- High input sensitivity: 1.6 mV/m (AM), 2.0 µV (FM) for 26 dB S/N
- Good strong signal behaviour: 10 V/m at AM, 500 mV at FM
- Low output distortion: 0.8% at AM, 0.3% at FM
- Signal level output
- Soft mute
- Signal dependent stereo
- Designed for simple and reliable printed-circuit board layout
- High impedance MOSFET input on AM.

APPLICATIONS

- Portable AM/FM stereo radio
- Mini/midi receiver sets
- Personal headphone radio.

DESCRIPTION

The TEA5711 is a high performance Bimos IC for use in AM/FM stereo radios. All necessary functions are integrated: from AM and FM front-end to AM detector and FM stereo output stages.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	TYP.
V_P	dynamic supply voltage		1.8	–	12	V
V_P	static supply voltage		2.1	–	12	V
I_P	supply current					
	AM mode		11.9	15.0	18.9	mA
	FM mode		13.5	16.5	20.2	mA
T_{amb}	operating ambient temperature		−15	–	+60	°C
AM performance						
V_{in1}	RF sensitivity		40	55	70	µV
V_{28}	AF output voltage		36	45	70	mV
THD	total harmonic distortion		–	0.8	2.0	%
FM performance						
V_{in3}	RF sensitivity		1.0	2.0	3.8	µV
V_{28}	AF output voltage		50	61	72	mV
THD	total harmonic distortion		–	0.3	0.8	%
MPX performance						
α_{cs}	channel separation		26	30	–	dB
A_{MPX}	MPX voltage gain	V_{AF-L}/V_{in9}; S5 in position MONO	−1.5	0	+1.0	dB
THD	total harmonic distortion		–	0.5	1.0	%

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TEA5711	SDIP32	plastic shrink dual in-line package; 32 leads (400 mil)	SOT232-1
TEA5711T	SO32	plastic small outline package; 32 leads; body width 7.5 mm	SOT287-1

BLOCK DIAGRAM

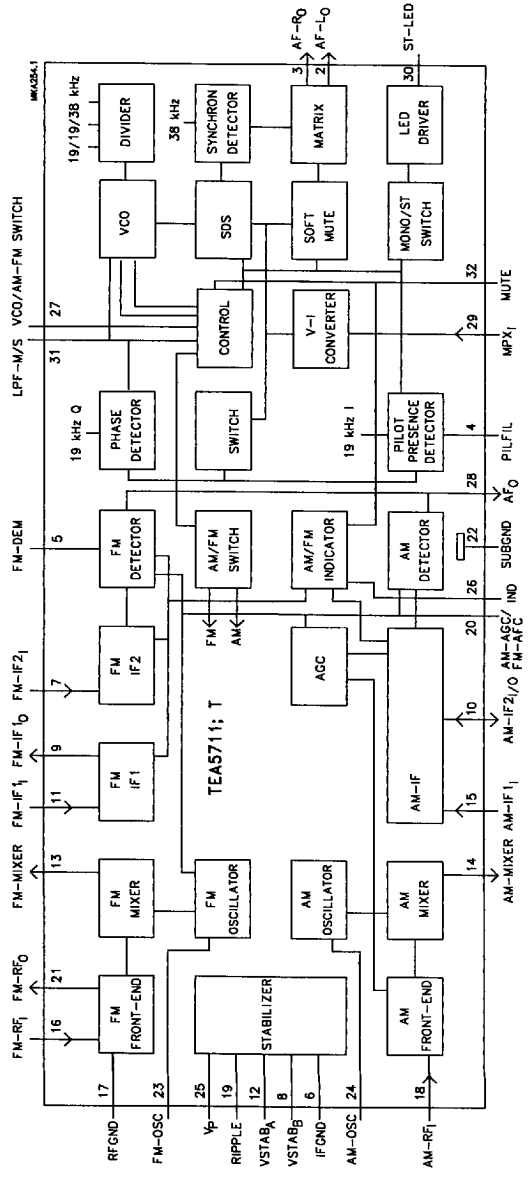


Fig.1 Block diagram.

PINNING

SYMBOL	PIN	DESCRIPTION
n.c.	1	not connected
AF-L_O	2	left channel audio output (output impedance typ. 4.3 kΩ)
AF-R_O	3	right channel audio output (output impedance typ. 4.3 kΩ)
PILFIL	4	pilot detector filter pin
FM-DEM	5	ceramic discriminator pin
IFGND	6	ground of IF, detector and MPX stages
FM-$IF2_I$	7	second FM-IF input (input impedance typ. 330 Ω)
$VSTAB_B$	8	stabilized internal supply voltage (B)
FM-$IF1_O$	9	first FM-IF output (output impedance typ. 330 Ω)
AM-$IF2_{I/O}$	10	input/output to IFT; output: current source
FM-$IF1_I$	11	first FM-IF input (input impedance typ. 330 Ω)
$VSTAB_A$	12	stabilized internal supply voltage (A)
FM-MIXER	13	output to ceramic IF filter (output impedance typ. 330 Ω)
AM-MIXER	14	open-collector output to IFT
AM-$IF1_I$	15	input from IFT or ceramic filter (input impedance typ. 3 kΩ)
FM-RF_I	16	FM-RF aerial input (input impedance typ. 50 Ω)
RFGND	17	FM-RF ground
AM-RF_I	18	parallel tuned AM aerial circuit to ground (total input capacitance typ. 3 pF)
RIPPLE	19	ripple capacitor pin
AM-AGC/FM-AFC	20	AGC/AFC capacitor pin
FM-RF_O	21	parallel tuned FM-RF circuit to ground
SUBGND	22	substrate and RF ground
FM-OSC	23	parallel tuned FM-oscillator circuit to ground
AM-OSC	24	parallel tuned AM-oscillator circuit to ground
V_P	25	positive supply voltage
IND	26	signal level output
VCO/AM-FM SWITCH	27	VCO and switch terminal: open for AM; ground for FM
AF_O	28	AM/FM AF output (output impedance typ. 5 kΩ)
MPX_I	29	input for stereo decoder (input impedance typ. 180 kΩ)
ST-LED	30	stereo indicator
LPF-M/S	31	pin for loop-filter and mono/stereo switch
MUTE	32	mute pin

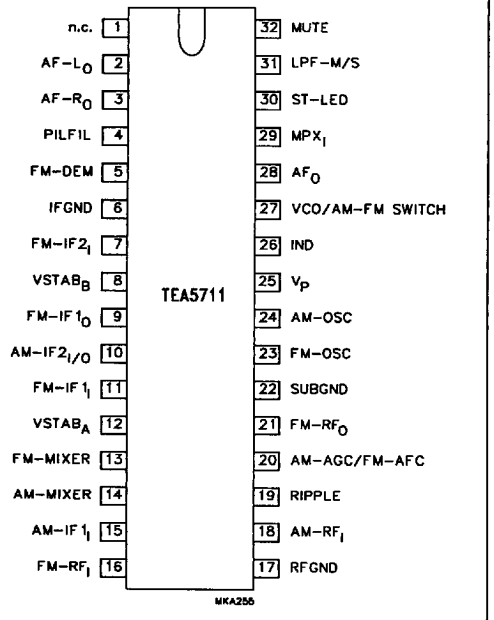


Fig.2 Pin configuration; TEA5711.

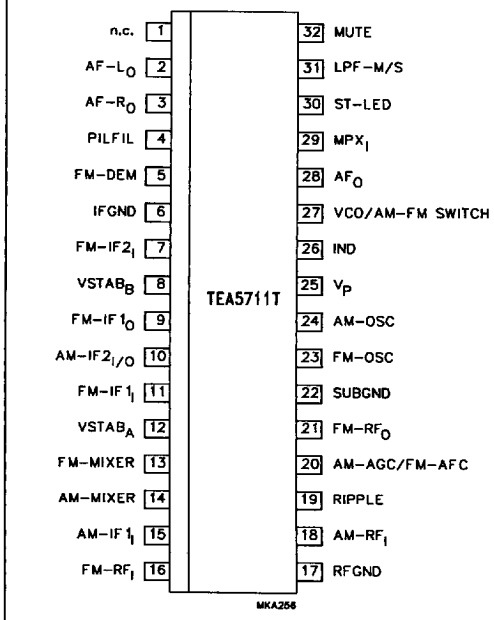


Fig.3 Pin configuration; TEA5711T.

FUNCTIONAL DESCRIPTION

The AM circuit incorporates a double balanced mixer, a one pin low-voltage oscillator (up to 30 MHz) a field-strength indicator output and is designed for distributed selectivity.

The AM input is designed to be connected to the top of a tuned circuit. AGC controls the IF amplification and for large signals it lowers the input impedance.

The first AM selectivity can be an IFT as well as an IFT combined with a ceramic filter; the second one is an IFT.

The FM circuit incorporates a tuned RF stage, a double balanced mixer, a one-pin oscillator, a field-strength indicator output and is designed for distributed IF ceramic filters. The FM quadrature detector uses a ceramic resonator.

The PLL stereo decoder incorporates a signal dependent stereo circuit, a soft-mute circuit and a stereo indicator LED driver.

Supply voltage behaviour

The TEA5711 incorporates internal stabilized power supplies. The maximum supply voltage is 12 V, the minimum voltage can go down temporarily to 1.8 V without any loss in performance.

Due to the capacitor at pin 19 (RIPPLE) the IC gives excellent performance, even when the actual supply voltage at pin 25 (V_P) drops below the voltage at pin 19 (RIPPLE).

Figures 4, 5 and 6 show that V_{stab}, which is dominant for the overall IC performance, remains unaffected, even if V_P drops down to 1.8 V or less. In this typical example the static or average V_P is equal to 2.5 V. Dips in V_{stab} appear only when the peak-to-peak value of the AC-component of $V_P > 2$ V, i.e. when the dynamic value of V_P drops down to 1.5 V for a short moment.

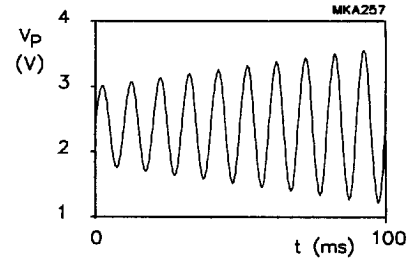


Fig.4 Supply voltage behaviour; V_P as a function of time.

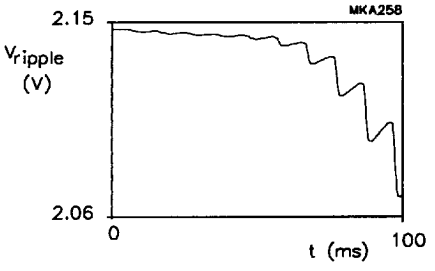


Fig.5 Supply voltage behaviour; V_{ripple} as a function of time.

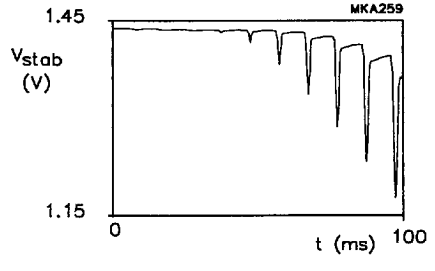


Fig.6 Supply voltage behaviour; V_{stab} as a function of time.

LIMITING VALUES

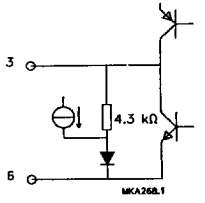
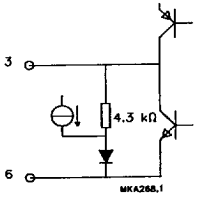
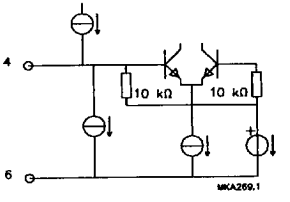
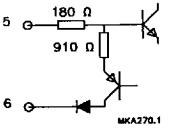
In accordance with the Absolute Maximum Rating System (IEC 134).

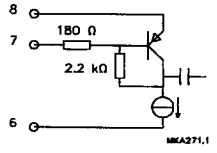
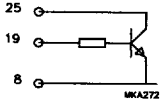
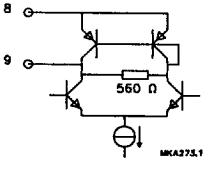
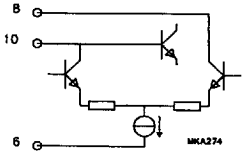
SYMBOL	PARAMETER	MIN.	MAX.	UNIT
V_P	supply voltage	0	12	V
T_{stg}	storage temperature	−55	+150	°C
T_{amb}	operating ambient temperature	−15	+60	°C
T_j	junction temperature	−15	+150	°C

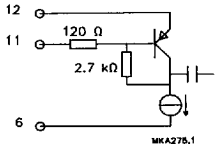
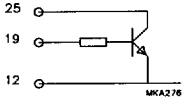
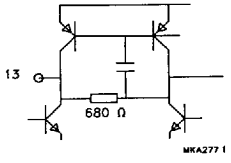
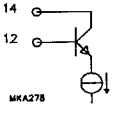
THERMAL CHARACTERISTICS

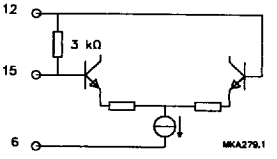
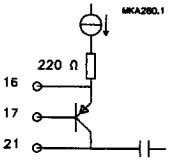
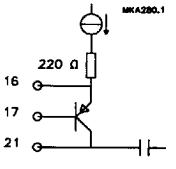
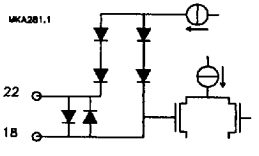
SYMBOL	PARAMETER	VALUE	UNIT
$R_{th\ j\text{-}a}$	thermal resistance from junction to ambient in free air		
	SDIP32	54	K/W
	SO32	68	K/W

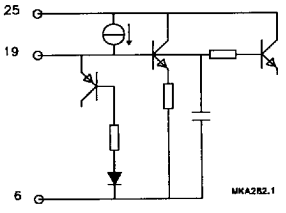
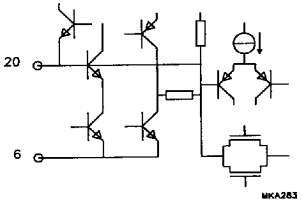
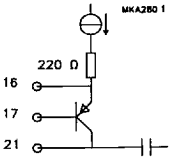
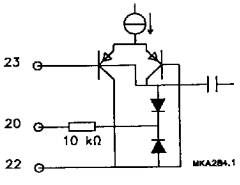
CIRCUIT DESIGN DATA

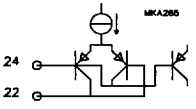
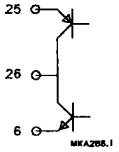
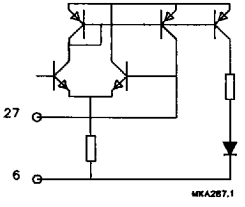
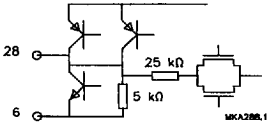
PIN NO.	PIN SYMBOL	DC PIN VOLTAGE (V)		EQUIVALENT CIRCUIT
		AM	FM	
1	n.c.	–	–	
2	AF-L_O output	0.65	0.65	
3	AF-R_O output	0.65	0.65	
4	PILFIL	0.95	0.95	
5	FM-DEM	–	1.0	
6	IFGND	0	0	

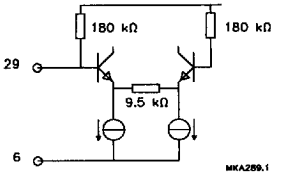
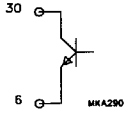
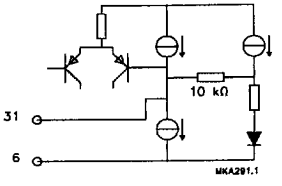
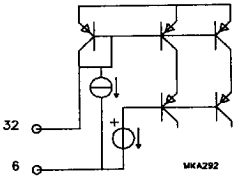
PIN NO.	PIN SYMBOL	DC PIN VOLTAGE (V)		EQUIVALENT CIRCUIT
		AM	FM	
7	$FM\text{-}IF2_I$ input	–	0.73	
8	$VSTAB_B$	1.4	1.4	
9	$FM\text{-}IF1_O$ output	–	0.69	
10	$AM\text{-}IF2_{I/O}$ input/output	1.4	1.4	

PIN NO.	PIN SYMBOL	DC PIN VOLTAGE (V)		EQUIVALENT CIRCUIT
		AM	FM	
11	FM-IF1$_I$ input	–	0.73	
12	VSTAB$_A$	1.4	1.4	
13	FM-MIXER output	–	1.0	
14	AM-MIXER output	1.4	1.4	

PIN NO.	PIN SYMBOL	DC PIN VOLTAGE (V)		EQUIVALENT CIRCUIT
		AM	FM	
15	AM-IF1$_I$ input	1.4	1.4	
16	FM-RF$_I$ input	–	0.73	
17	RFGND	0	0	
18	AM-RF$_I$ input	0	0	

PIN NO.	PIN SYMBOL	DC PIN VOLTAGE (V)		EQUIVALENT CIRCUIT
		AM	FM	
19	RIPPLE	2.1	2.1	
20	AM-AGC/ FM-AFC	0.1	0.7	
21	FM-RF_O	0	0	
22	SUBGND	0	0	
23	FM-OSC	0	0	

PIN NO.	PIN SYMBOL	DC PIN VOLTAGE (V)		EQUIVALENT CIRCUIT
		AM	FM	
24	AM-OSC	0	0	
25	V_P	3.0	3.0	
26	IND output	3.0	3.0	
27	VCO and AM/FM switch	1.3	0.95	
28	AF output	0.6	0.7	

PIN NO.	PIN SYMBOL	DC PIN VOLTAGE (V)		EQUIVALENT CIRCUIT
		AM	FM	
29	MPX input	1.23	1.23	
30	ST-LED	3.0	3.0	
31	LPF-M/S	0.1	0.8	
32	MUTE	0.7	0.7	

AM CHARACTERISTICS

f_i = 1 MHz; m = 0.3; f_m = 1 kHz; V_P = 3.0 V; measured in Fig.7 with S1 in position B, S2 in position A and S7 in position A; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_P	supply current	no input signal	11.9	15.0	18.9	mA
C_i	input capacitance	V_{20} = 0.2 V	–	3	–	pF
G_c	front-end conversion gain	V_{20} = 0.2 V	1.8	3.3	5.0	
V_{in1}	RF sensitivity	S/N = 26 dB	40	55	70	µV
V_{in2}	IF sensitivity	V_{28} = 30 mV; S1 in position A	0.13	0.2	0.45	mV
V_{28}	AF output voltage	V_{in2} = 3.16 mV; S1 in position A	36	45	70	mV
THD	total harmonic distortion	V_{in1} = 1 mV	–	0.8	2.0	%
V_{in1}	large signal handling	m = 0.8; THD ≤ 8%	150	300	–	mV
I_{IND}	indicator current	V_{in2} = 100 mV; S1 in position A	120	170	230	µA
I_{INDOFF}	indicator OFF current	V_{in2} = 0 V; S1 in position A	–	0	10	µA

FM CHARACTERISTICS

f_i = 100 MHz; Δf = 22.5 kHz; f_m = 1 kHz; V_P = 3.0 V; measured in Fig.7 with S1 in position B, S2 in position A and S7 in position A; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_P	supply current	no input signal	13.5	16.5	20.2	mA
V_{in3}	RF limiting sensitivity	V_{28} = –3 dB	0.4	1.2	3.8	µV
V_{in3}	RF sensitivity	S/N = 26 dB	1.0	2.0	3.8	µV
V_{11}/V_{in3}	front-end voltage gain	V_{in3} ≤ 1 mV; including ceramic filter K1	12	18	22	dB
V_{in4}	IF sensitivity	S2 in position B; V_{28} = –3 dB	–	20	30	µV
V_{28}	AF output voltage	V_{in3} = 1 mV	50	61	72	mV
THD	total harmonic distortion	V_{in3} = 1 mV; Δf = 22.5 kHz	–	0.3	0.8	%
V_{in3}	large signal handling	THD ≤ 5%	–	500	–	mV
I_{IND}	indicator current	V_{in4} = 100 mV; S2 in position B	190	255	320	µA
I_{INDOFF}	indicator OFF current	V_{in4} = 0 V; S2 in position B	–	0	2	µA

STEREO DECODER CHARACTERISTICS

f_i = 1 kHz; $V_{in9(L+R)}$ = 195 mv; pilot = 20 mV; V_P = 3.0 V; measured in Fig.7 with S1 in position B, S2 in position A, S6 in position A, S7 in position A and S5 in position STEREO; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
A_{MPX}	MPX voltage gain V_{AF-L}/V_{in9}	S5 in position MONO	–1.5	0	+1.0	dB
THD	total harmonic distortion		–	0.5	1.0	%
(S+N)/N	signal plus noise-to-noise ratio	pilot = 20 mV	–	74	–	dB
α_{cs}	channel separation	L = 1; R = 0 or L = 0; R = 1	26	30	–	dB
SC	stereo control	V_{in3} = 120 µV	–	30	–	dB
		V_{in3} = 10 µV	–	1	–	dB
α_{MUTE}	AF output signal suppression	V_{in3} ≤ 2 µV	–	20	–	dB

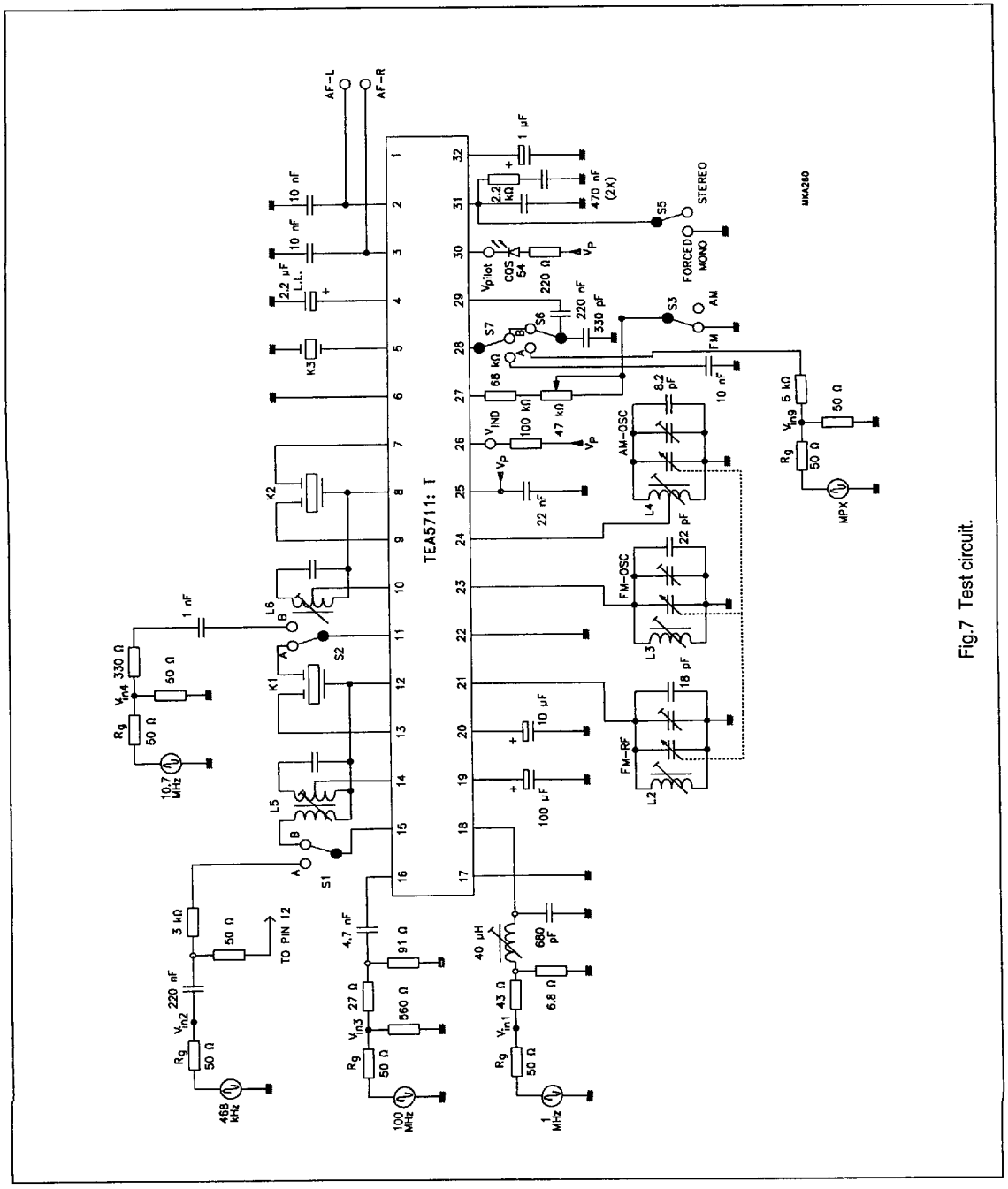


Fig.7 Test circuit.

APPLICATION INFORMATION

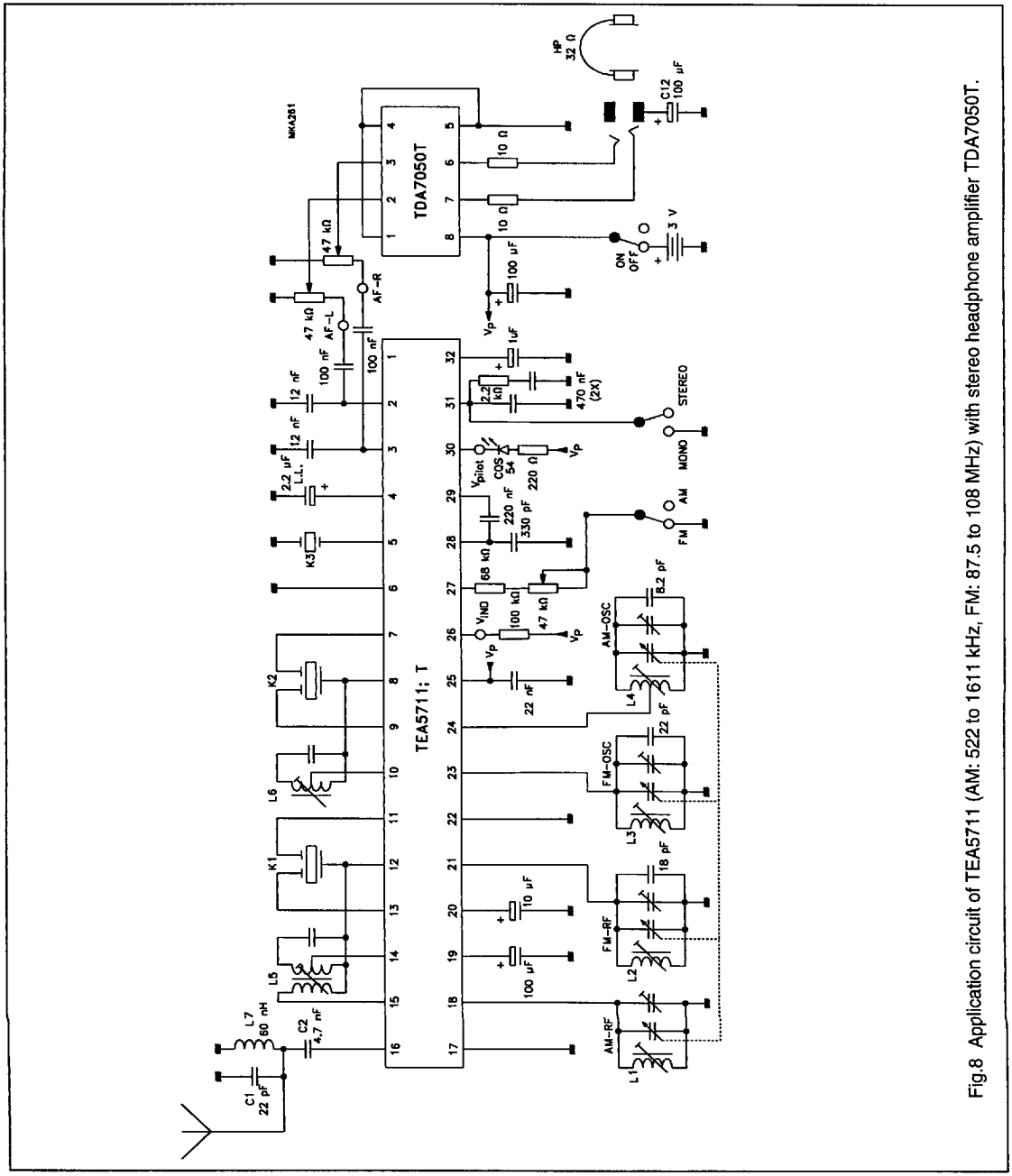


Fig.8 Application circuit of TEA5711 (AM: 522 to 1611 kHz, FM: 87.5 to 108 MHz) with stereo headphone amplifier TDA7050T.

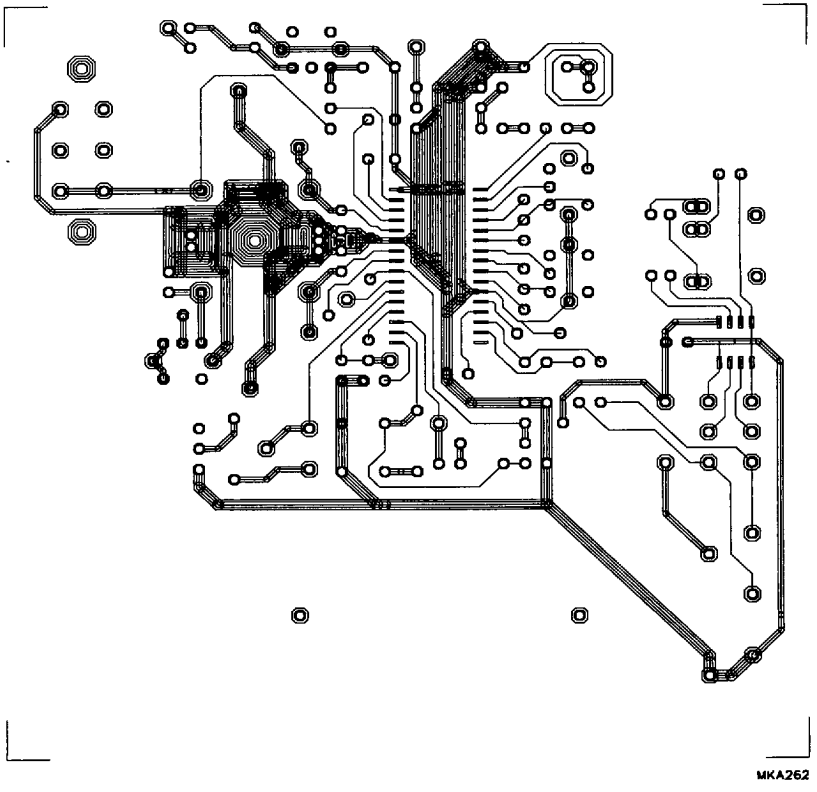


Fig.9 Printed-circuit board layout (track side) for application circuit of Fig.8.

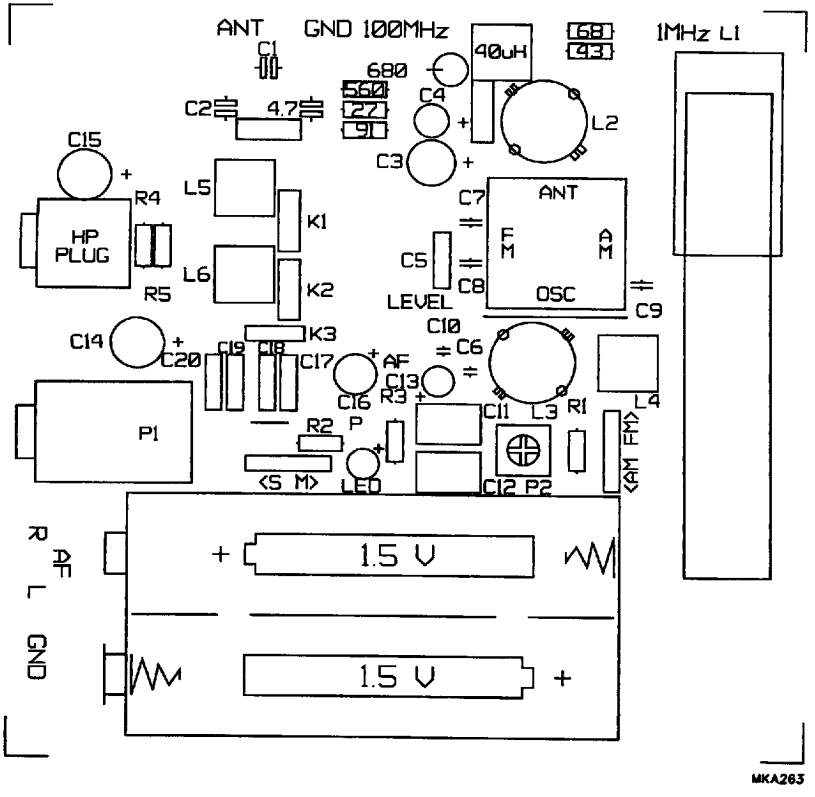
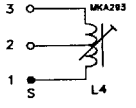
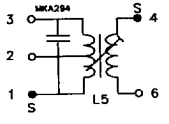
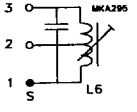
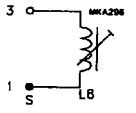


Fig.10 Printed-circuit board layout (component side) for application circuit of Fig.8.

Components for Figs 7 and 8

NUMBER	TYPE	DESCRIPTION	CIRCUIT
Coils			
L1	AM-AERIAL	ferroceptor length = 6 cm L1-2 = 625 µH N1-2 = 105 turns unloaded Q	
L2	FM-RF	L1-2 = 66 nH N1-2 = 2.5 turns unloaded Q = 150T TOKO type S18 TOKO number 301SS-0200	
L3	FM-OSC	L1-2 = 40 nH N1-2 = 1.5 turns unloaded Q = 150 TOKO type S18 TOKO number 301SS-0100	
L4	AM-OSC	L1-3 = 270 µH N1-2 = 18 N2-3 = 70 unloaded Q = 100 wire diameter 0.07 mm TOKO type 7P material TOKO 7BRS	
L5	AM-IF1	L1-3 = 625 µH N1-2 = 17 turns N2-3 = 141 turns N4-6 = 10 turns C1-3 = 180 pF unloaded Q = 90 wire diameter 0.07 mm TOKO type 7P material TOKO 7MCS	
L6	AM-IF2	L1-3 = 625 µH N1-2 = 28 turns N2-3 = 130 turns C1-3 = 180 pF unloaded Q = 90 wire diameter 0.07 mm TOKO type 7P material TOKO 7MCS	
L7	FM-AERIAL	printcoil L1-2 = 60 nH N1-2 = 2.5 turns	

NUMBER	TYPE	DESCRIPTION	CIRCUIT
L8	AM-RF	test circuit only: L1-3 = 40 µH N1-3 = 34 turns unloaded Q = 85 wire diameter 0.09 mm TOKO type 7P material TOKO 7BRS	
Ceramic filters			
K1	FM-IF1	Murata SFE 10.7 MS 2	
K2	FM-IF2	Murata SFE 10.7 MS 2	
K3	FM-DET	Murata CDA 10.7 MC 40	
Capacitors			
C1	VARICON	AM: 140/82 pF FM: 2 × 20 pF trimmer: 4 × 8 pF TOKO type number HU-22124	

Application remarks

- Short circuiting: **all** pins are short-circuit proof except **pin 16** (FM-RF$_I$) with respect to the supply voltage pin.
- For an example of printed-circuit board layout: see Figs 9 and 10.
- Align VCO with aerial signal present.

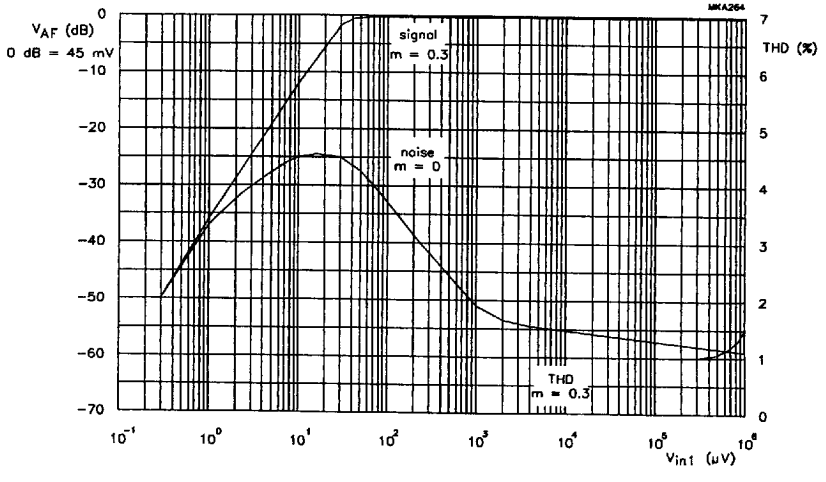


Fig.11 Typical AM audio voltage (V_{AF}; signal at m = 0.3), noise and THD as a function of RF input voltage (V_{in1}; f_i = 1 kHz). Measured in test circuit Fig.7 with V_P = 3.0 V.

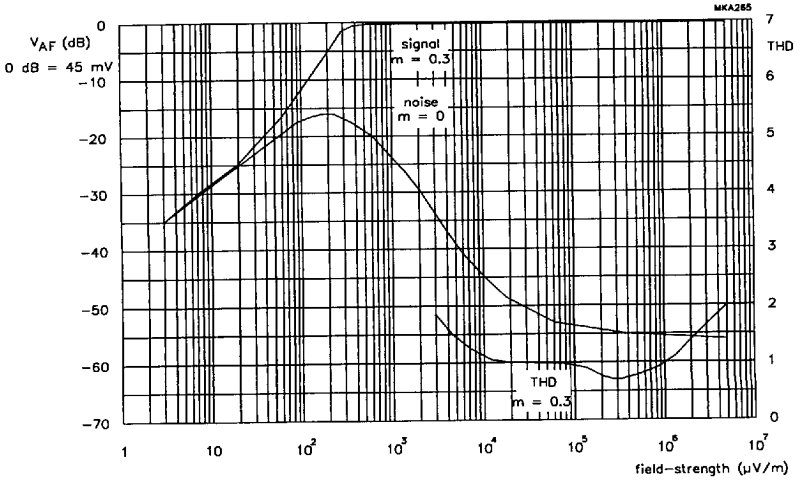


Fig.12 Typical AM audio voltage (V_{AF}; signal at m = 0.3), noise and THD as a function of field-strength (f_i = 1 kHz). Measured in application circuit Fig.8 with V_P = 3.0 V.

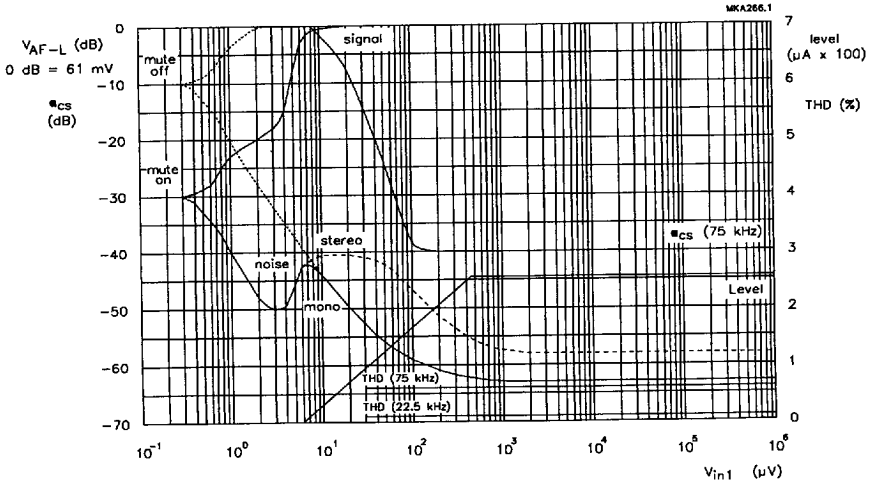


Fig.13 Typical FM audio voltage (V_{AF}; signal), noise, THD (at Δf = 22.5 kHz and Δf = 75 kHz) and indicator current (level) as a function of RF input voltage (V_{in1}; Δf = 22.5 kHz). Curves are shown without mute (mono) and with mute (mono and stereo). Channel separation at Δf = 75 kHz. Measured in test circuit Fig.7 with V_P = 3.0 V.