

AM/FM stereo DTS radio circuit**TEA5712; TEA5712T****FEATURES**

- Wide supply voltage range: 1.8 or 2.1 to 12 V
- Low current consumption: 16 mA at AM, 17 mA at FM
- High selectivity with distributed IF gain
- LED driver for stereo indication
- High input sensitivity: 1.6 mV/m (AM), 2.0 μ V (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
- IF output signals available for IF counting

- 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
- Digitally tuned personal headphone radio.

DESCRIPTION

The TEA5712 is a high performance Bimos IC for use in digitally tuned 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		12.8	16.0	20.0	mA
	FM mode		14.3	17.5	21.4	mA
T_{amb}	operating ambient temperature		−15	—	+60	°C
AM performance						
V_{in1}	RF sensitivity		40	55	70	μ V
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	μ V
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
AMPX	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
TEA5712	SDIP32	plastic shrink dual in-line package; 32 leads (400 mil)	SOT232-1
TEA5712T	SO32	plastic small outline package; 32 leads; body width 7.5 mm	SOT287-1

AM/FM stereo DTS radio circuit

TEA5712; TEA5712T

BLOCK DIAGRAM

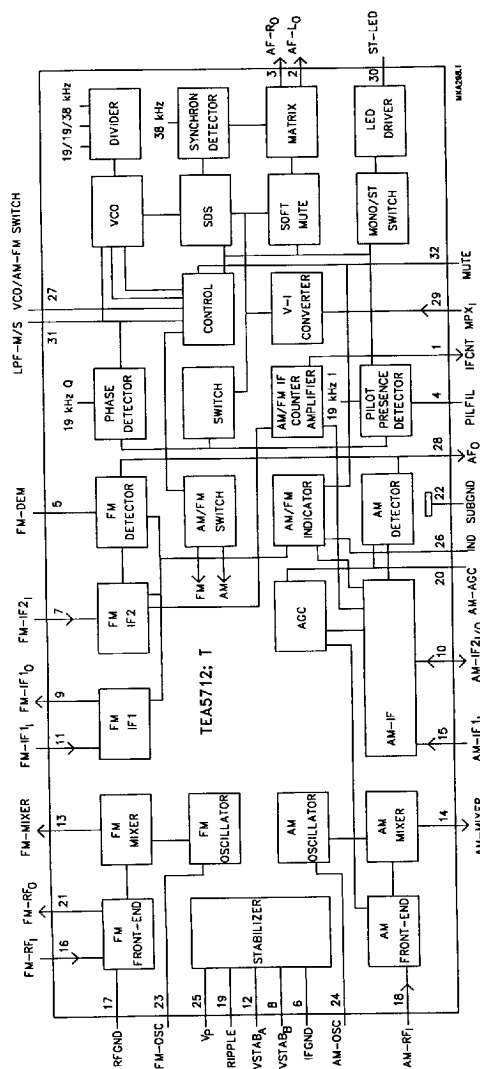


Fig.1 Block diagram.

AM/FM stereo DTS radio circuit

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PINNING

SYMBOL	PIN	DESCRIPTION
IFCNT	1	IF signal output for IF counting
AF-L _O	2	left channel audio output (output impedance typ. 4.3 k Ω)
AF-R _O	3	right channel audio output (output impedance typ. 4.3 k Ω)
PILFIL	4	pilot detector filter pin
FM-DEM	5	ceramic discriminator pin
IFGND	6	ground of IF, detector and MPX stages
FM-IF _{2I}	7	second FM-IF input (input impedance typ. 330 Ω)
VSTAB _B	8	stabilized internal supply voltage (B)
FM-IF _{1O}	9	first FM-IF output (output impedance typ. 330 Ω)
AM-IF _{2I/O}	10	input/output to IFT; output: current source
FM-IF _{1I}	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-IF _{1I}	15	input from IFT or ceramic filter (input impedance typ. 3 k Ω)
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	20	AGC 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	stop signal 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 k Ω)
MPX _I	29	input for stereo decoder (input impedance typ. 180 k Ω)
ST-LED	30	stereo indicator
LPF-M/S	31	pin for loop-filter and mono/stereo switch
MUTE	32	mute pin

AM/FM stereo DTS radio circuit

TEA5712; TEA5712T

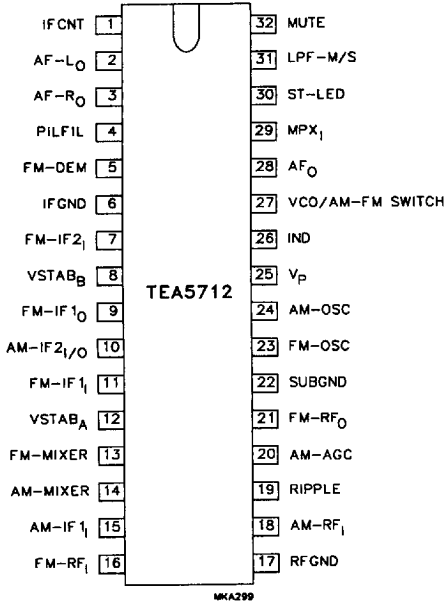


Fig.2 Pin configuration; TEA5712.

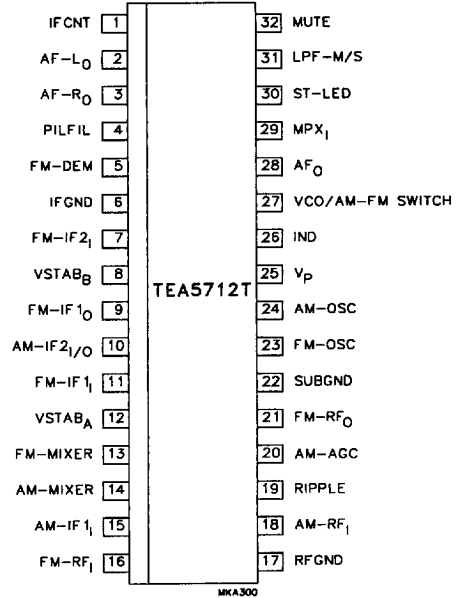


Fig.3 Pin configuration; TEA5712T.

AM/FM stereo DTS radio circuit

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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 TEA5712 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.

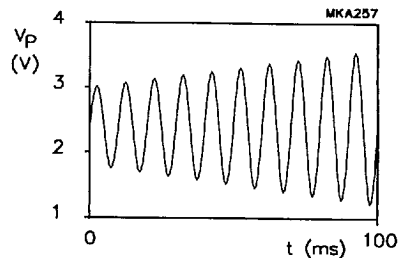


Fig.4 Supply voltage behaviour; V_P as a function of time.

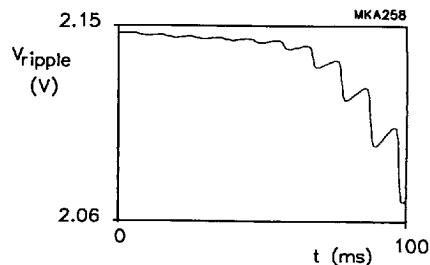


Fig.5 Supply voltage behaviour; V_{ripple} as a function of time.

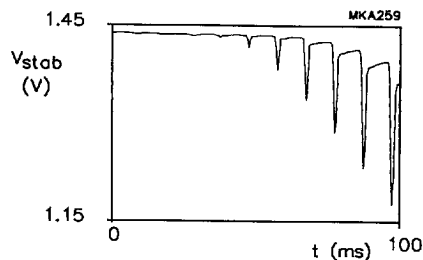


Fig.6 Supply voltage behaviour; V_{stab} as a function of time.

AM/FM stereo DTS radio circuit

TEA5712; TEA5712T

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

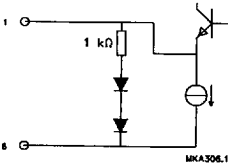
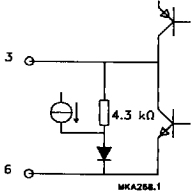
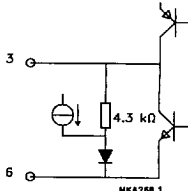
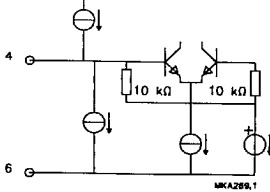
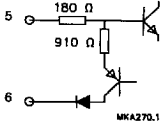
THERMAL CHARACTERISTICS

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

AM/FM stereo DTS radio circuit

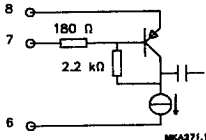
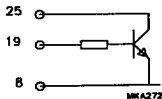
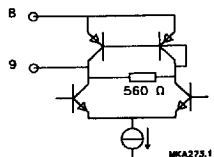
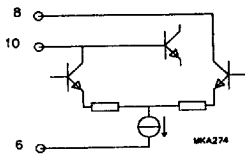
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CIRCUIT DESIGN DATA

PIN NO.	PIN SYMBOL	DC PIN VOLTAGE (V)		EQUIVALENT CIRCUIT
		AM	FM	
1	IFCNT output	0.3	0.3	
2	AF-LO output	0.65	0.65	
3	AF-RO output	0.65	0.65	
4	PILFIL	0.95	0.95	
5	FM-DEM	—	1.0	

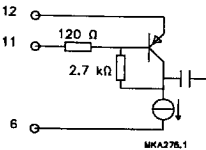
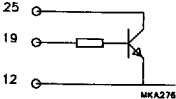
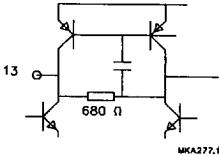
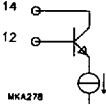
AM/FM stereo DTS radio circuit

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PIN NO.	PIN SYMBOL	DC PIN VOLTAGE (V)		EQUIVALENT CIRCUIT
		AM	FM	
6	IFGND	0	0	
7	FM-IF _{2i} input	—	0.73	
8	VSTAB _B	1.4	1.4	
9	FM-IF _{1o} output	—	0.69	
10	AM-IF _{2i/o} input/output	1.4	1.4	

AM/FM stereo DTS radio circuit

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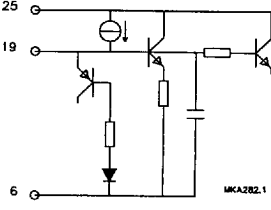
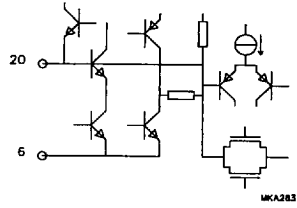
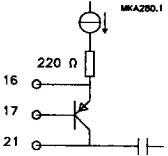
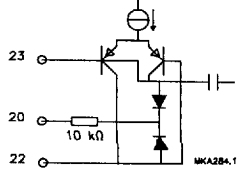
PIN NO.	PIN SYMBOL	DC PIN VOLTAGE (V)		EQUIVALENT CIRCUIT
		AM	FM	
11	FM-IF ₁ input	—	0.73	
12	VSTAB _A	1.4	1.4	
13	FM-MIXER output	—	1.0	
14	AM-MIXER output	1.4	1.4	

TEA5712; TEA5712T

PIN NO.	PIN SYMBOL	DC PIN VOLTAGE (V)		EQUIVALENT CIRCUIT
		AM	FM	
15	AM-IF ₁ input	1.4	1.4	
16	FM-RF ₁ input	—	0.73	
17	RFGND	0	0	
18	AM-RF ₁ input	0	0	

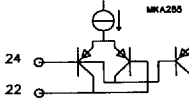
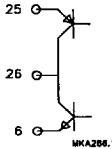
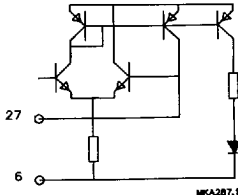
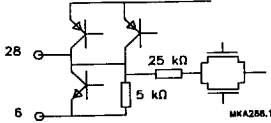
AM/FM stereo DTS radio circuit

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

AM/FM stereo DTS radio circuit

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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	

AM/FM stereo DTS radio circuit

TEA5712; TEA5712T

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/FM stereo DTS radio circuit

TEA5712; TEA5712T

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	12.8	16.0	20.0	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	μ V
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 $\leq 8\%$	150	300	—	mV
I_{IND}	indicator current	$V_{in2} = 100$ mV; S1 in position A	120	170	230	μ A
I_{INDOFF}	indicator OFF current	$V_{in2} = 0$ V; S1 in position A	—	0	10	μ A
$V_{IFCNTO(p-p)}$	IF count output signal (peak-to-peak value)	$V_{in2} = 10$ V; S4 open	—	400	—	mV
V_{IFCNT}	IF count signal	$V_{in10} = 3$ V; S4 closed	—	-70	—	dB

FM CHARACTERISTICS

$f_i = 100$ MHz; $\Delta f = 22.5$ 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	14.3	17.5	21.4	mA
V_{in3}	RF limiting sensitivity	$V_{28} = -3$ dB	0.4	1.2	3.8	μ V
V_{in3}	RF sensitivity	S/N = 26 dB	1.0	2.0	3.8	μ V
V_{11}/V_{in3}	front-end voltage gain	$V_{in3} \leq 1$ mV; including ceramic filter K1	12	18	22	dB
V_{in4}	IF sensitivity	S2 in position B; $V_{28} = -3$ dB	—	20	30	μ V
V_{28}	AF output voltage	$V_{in3} = 1$ mV	50	61	72	mV
THD	total harmonic distortion	$V_{in3} = 1$ mV; $\Delta f = 22.5$ kHz	—	0.3	0.8	%
V_{in3}	large signal handling	THD $\leq 5\%$	—	500	—	mV
I_{IND}	indicator current	$V_{in4} = 100$ mV; S2 in position B	190	255	320	μ A
I_{INDOFF}	indicator OFF current	$V_{in4} = 0$ V; S2 in position B	—	0	2	μ A
$V_{IFCNTO(p-p)}$	IF count output signal (peak-to-peak value)	$V_{in4} = 10$ V; S4 open	—	360	—	mV
V_{IFCNT}	IF count signal	$V_{in10} = 3$ V; S4 closed	—	-50	—	dB

AM/FM stereo DTS radio circuit

TEA5712; TEA5712T

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	$V_{in3} = 120 \mu V$	—	30	—	dB
		$V_{in3} = 10 \mu V$	—	1	—	dB
α_{MUTE}	AF output signal suppression	$V_{in3} \leq 2 \mu V$	—	20	—	dB

AM/FM stereo DTS radio circuit

TEA5712; TEA5712T

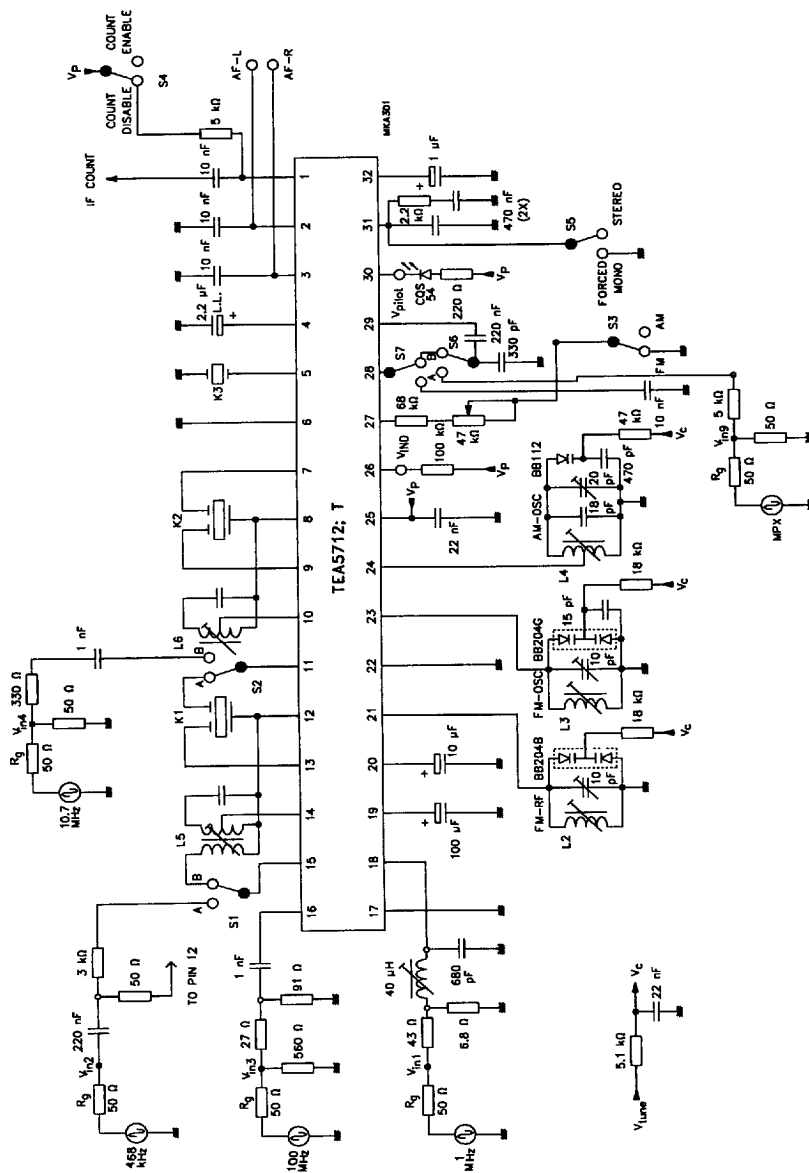


Fig.7 Test circuit.

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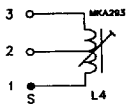
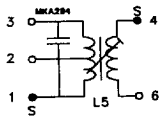
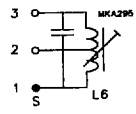
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Fig.8 Application circuit of TEA5712 (AM: 522 to 1611 kHz, FM: 87.5 to 108 MHz) with stereo headphone amplifier TDA7050T.

AM/FM stereo DTS radio circuit

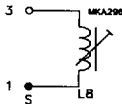
TEA5712; TEA5712T

Components for Fig.8

NUMBER	TYPE	DESCRIPTION	CIRCUIT
Coils			
L1	AM-AERIAL	ferroceptor length = 6 cm L1-2 = 203 μ H unloaded Q	
L2	FM-RF	L1-2 = 90 nH N1-2 = 2.5 turns unloaded Q = 150T TOKO type S18	
L3	FM-OSC	L1-2 = 70 nH N1-2 = 1.5 turns unloaded Q = 150 TOKO type S18	
L4	AM-OSC	L1-3 = 98 μ H N1-2 = 12 N2-3 = 39 unloaded Q = 100 wire diameter 0.07 mm TOKO type 7P material TOKO 7BRS	
L5	AM-IF1	L1-3 = 625 μ H 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 μ H 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	

AM/FM stereo DTS radio circuit

TEA5712; TEA5712T

NUMBER	TYPE	DESCRIPTION	CIRCUIT
L8	AM-RF	test circuit only: L1-3 = 40 μ H 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	
Variable capacitance diodes			
	FM-RF	BB204B	
	FM-OSC	BB204G	
	FM-RF	BB112	
	AM-OSC	BB112	

Application remarks

- Short circuiting: **all** pins are short-circuit proof except **pin 16** (FM-RF_I) with respect to the supply voltage pin.
- Align VCO with aerial signal present.

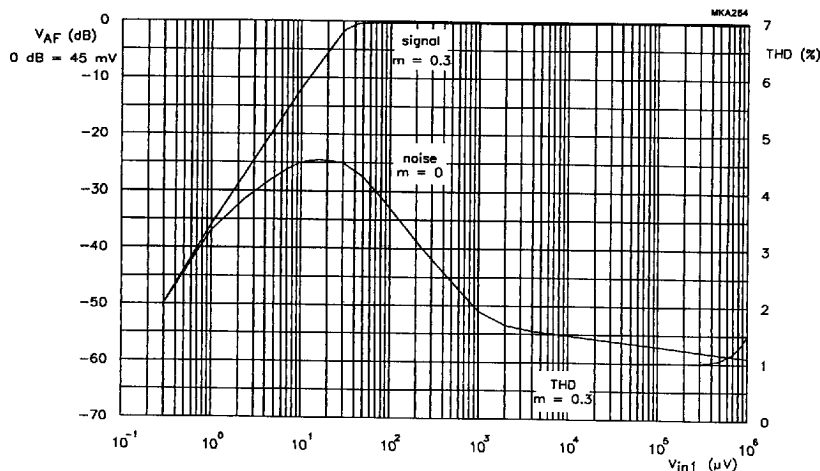


Fig.9 Typical AM audio voltage (V_{AF} ; signal at $m = 0.3$), noise and THD as a function of RF input voltage (V_{in1} ; $f_i = 1$ kHz). Measured in test circuit Fig.7 with $V_P = 3.0$ V.

AM/FM stereo DTS radio circuit

TEA5712; TEA5712T

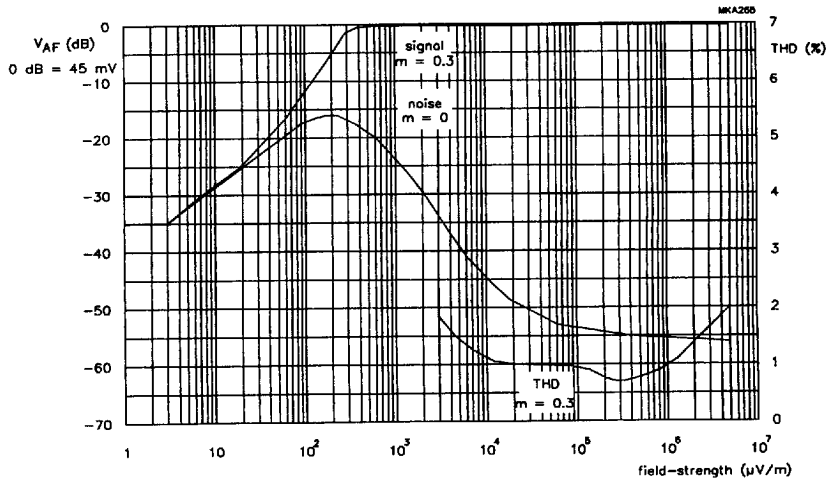


Fig.10 Typical AM audio voltage (V_{AF} ; signal at $m = 0.3$), noise and THD as a function of field-strength ($f_i = 1$ kHz). Measured in application circuit Fig.8 with $V_P = 3.0$ V.

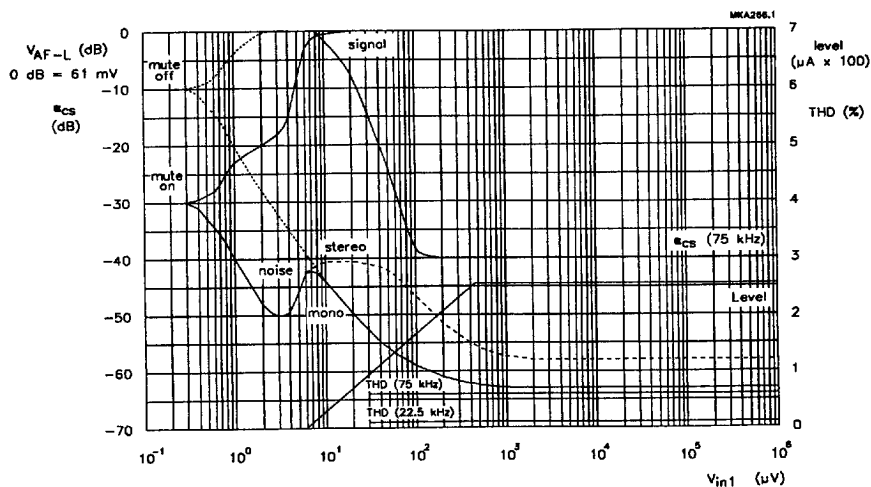


Fig.11 Typical FM audio voltage (V_{AF} ; signal), noise, THD (at $\Delta f = 22.5$ kHz and $\Delta f = 75$ kHz) and indicator current (level) as a function of RF input voltage (V_{in1} ; $\Delta f = 22.5$ kHz). Curves are shown without mute (mono) and with mute (mono and stereo). Channel separation at $\Delta f = 75$ kHz. Measured in test circuit Fig.7 with $V_P = 3.0$ V.