

# DATA SHEET

## **TEA5551T** 1-chip AM radio

Product specification  
File under Integrated Circuits, IC01

October 1990

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**1-chip AM radio****TEA5551T**

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**GENERAL DESCRIPTION**

The TEA5551T is a 1-chip monolithic integrated radio circuit which is designed for use as a pocket receiver with headphones in a supply voltage range ( $V_S$ ) of 1.8 V to 4.5 V.

The circuit consists of a complete AM part and dual AF amplifier with low quiescent current. The AF part has low radiation (HF noise) and good overdrive performance. The dual AF amplifier makes the device suitable for operation in an AM/FM stereo receiver with or without stereo cassette player. The IC has a 1-pin switch for AM or other applications.

**Features**

- Low voltage operation ( $V_S = 1.8$  V to 4.5 V)
- Low current consumption ( $I_{tot} = 5$  mA at  $V_S = 3$  V)
- All pins provided with ESD protection

## AM part

- High sensitivity ( $V_i = 1.5$   $\mu$ V for  $V_o = 10$  mV)
- Good IF suppression
- Good signal handling ( $V_{i(max)} = 80$  mV)
- Switch for AM or other applications
- Short waveband (> 40 MHz)

## AF part

- A fixed integrated gain of 32 dB
- Few external components required
- Very low quiescent current
- Low HF radiation and good AF overdrive performance
- 0 to 20 kHz limited frequency response
- 25 mW per channel output power in 32  $\Omega$

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QUICK REFERENCE DATA (at  $T_{amb} = 25\text{ }^{\circ}\text{C}$ )

PARAMETER	CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply voltage		$V_S$	1.8	3.0	4.5	V
Supply current		$I_5 + I_{10}$	–	6	–	mA
<b>AM part</b>	$m = 0.3$					
RF sensitivity						
RF input voltage	$V_{o(AF)} = 10\text{ mV}$	$V_{i(RF)}$	–	1.5	–	$\mu\text{V}$
	$S/N = 26\text{ dB}$	$V_{i(RF)}$	–	15	–	$\mu\text{V}$
	$S/N = 50\text{ dB}$	$V_{i(RF)}$	–	10	–	mV
AF output voltage	$V_{i(RF)} = 1\text{ mV}$	$V_{o(AF)}$	–	80	–	mV
Total harmonic distortion	$V_{i(RF)} = 100\text{ }\mu\text{V}$ to $30\text{ mV}$	THD	–	0.8	–	%
Signal handling capability	$m = 0.8$ ; THD = 10%	$V_{i(RF)}$	–	80	–	mV
<b>AF part</b>	both channels driven					
Output power	$R_L = 32\text{ }\Omega$ ; THD = 10%					
at $V_S = 3.0\text{ V}$		$P_o$	–	25	–	mW
at $V_S = 4.5\text{ V}$		$P_o$	–	60	–	mW
Voltage gain	$P_o = 10\text{ mW}$	$G_v$	–	32	–	dB
Channel separation	1 kHz	$\alpha$	–	50	–	dB

## PACKAGE OUTLINE

16-lead mini-pack; plastic (SO16; SOT109A); SOT109-1; 1996 July 25.

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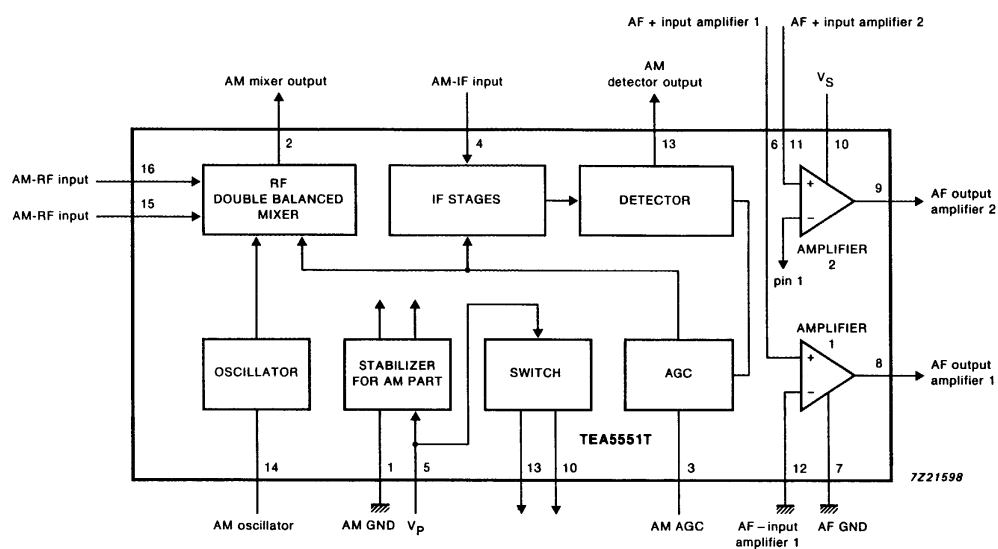


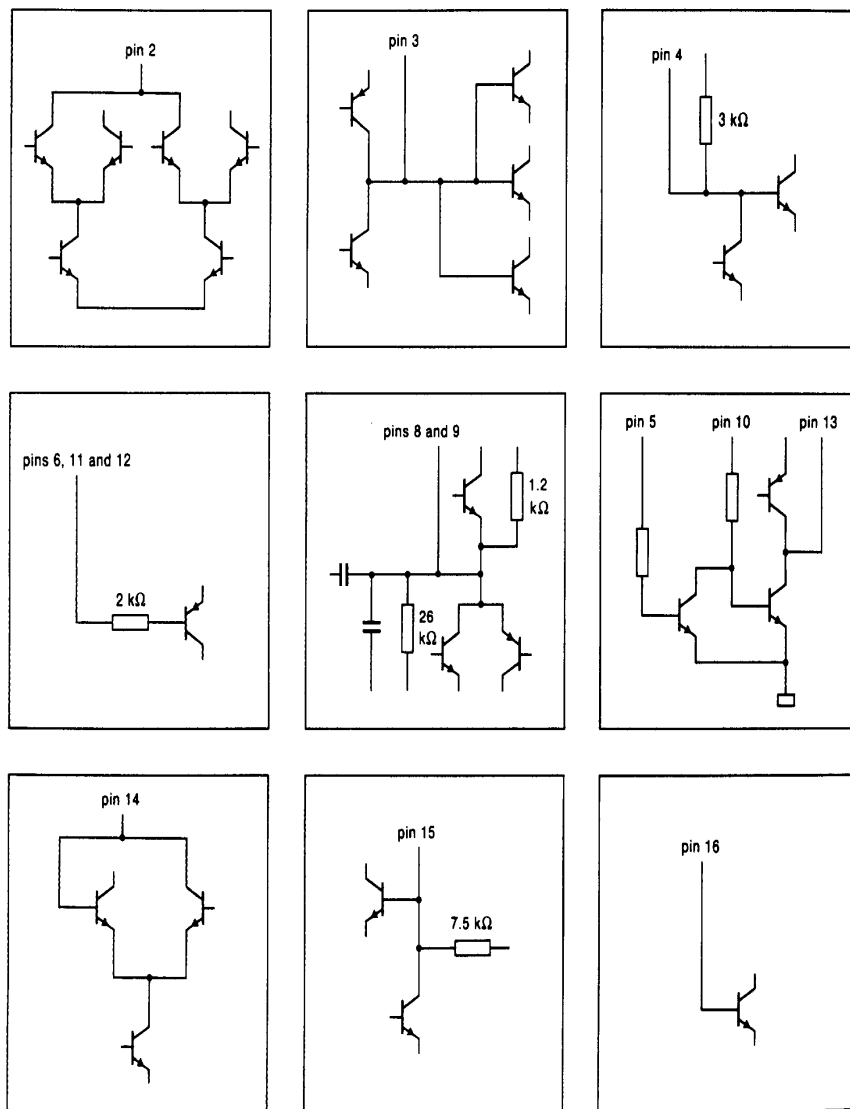
Fig.1 Block diagram.

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**PINNING**

- |   |                             |    |                             |
|---|-----------------------------|----|-----------------------------|
| 1 | AM GND                      | 9  | AF output amplifier 2       |
| 2 | AM mixer output             | 10 | AF supply voltage ( $V_S$ ) |
| 3 | AM AGC                      | 11 | AF + input amplifier 2      |
| 4 | AM-IF input                 | 12 | AF - input amplifier 1      |
| 5 | AM supply voltage ( $V_P$ ) | 13 | AM detector output          |
| 6 | AF + input amplifier 1      | 14 | AM oscillator               |
| 7 | AF GND                      | 15 | AM-RF input                 |
| 8 | AF output amplifier 1       | 16 | AM-RF input                 |



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Fig.2 All pins provided with ESD protection diodes to substrate.

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**RATINGS**

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

PARAMETER	CONDITIONS	SYMBOL	MIN.	MAX.	UNIT
Supply voltage	V <sub>S</sub> = 4.5 V	V <sub>S</sub>	–	6	V
Supply current (peak)		I <sub>M</sub>	–	150	mA
Crystal temperature		T <sub>c</sub>	–	150	°C
Short-circuit protection		t <sub>sc</sub>	–	5	s
Total power dissipation		P <sub>tot</sub>	see Fig.3		
Storage temperature range		T <sub>stg</sub>	–65	+150	°C
Operating ambient temperature range		T <sub>amb</sub>	–25	+60	°C

**QUALITY**

In accordance with UZW-BO/FQ-0601.

Operating life endurance verified 2000 hours at T<sub>j</sub> = 85 °C.

The product meets the 600 V ESD on all pins (HBM specification UZW-BO/FQ-A302).

**THERMAL RESISTANCE**

From junction to ambient

$$R_{th\ j-a} = 110\ K/W$$

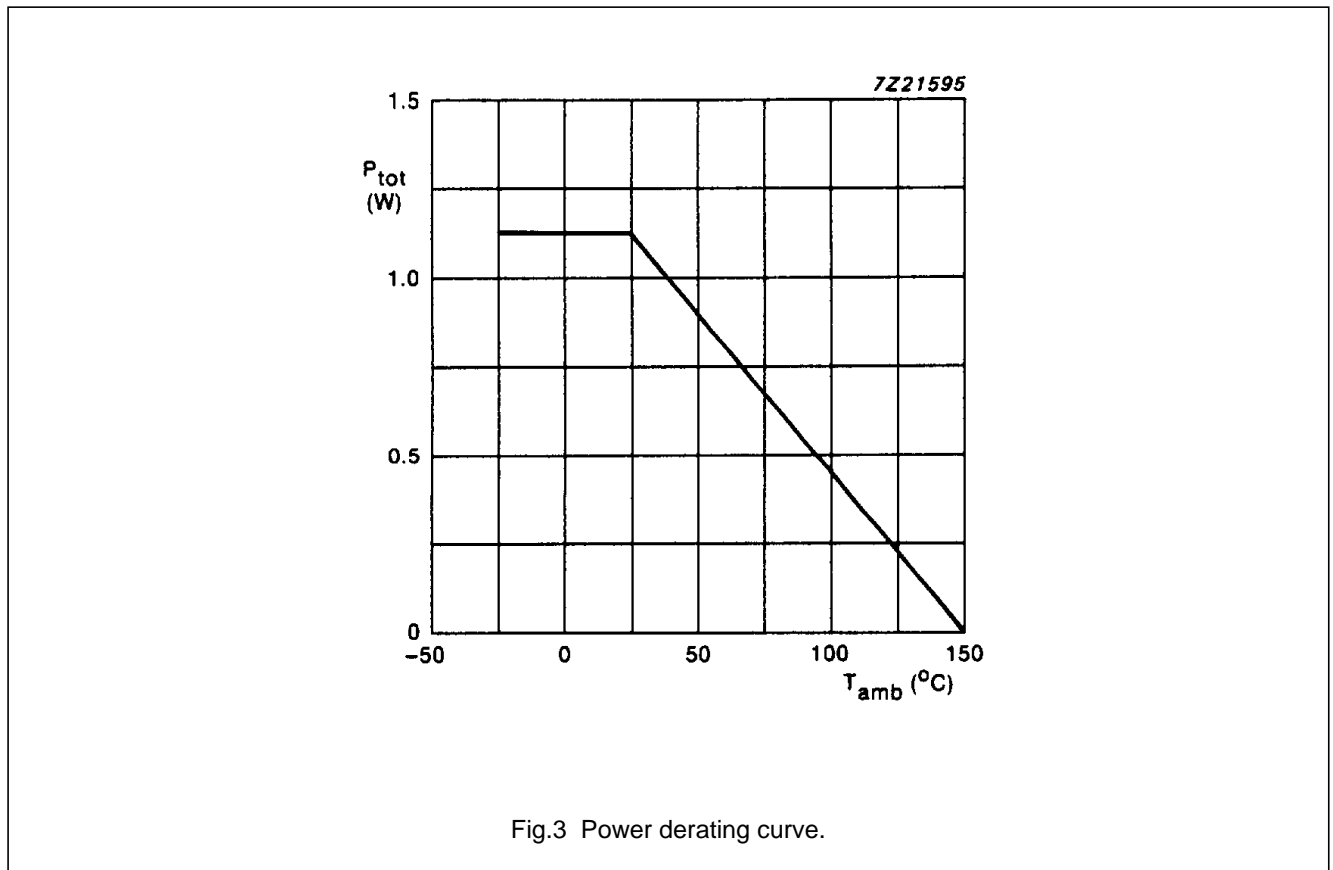


Fig.3 Power derating curve.

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**DC CHARACTERISTICS**

All voltages are referenced to pin 1 and pin 7; all input currents are positive; all parameters are measured in test circuit of Fig.6 at  $V_S = 3\text{ V}$ ;  $T_{\text{amb}} = 25\text{ }^\circ\text{C}$  unless otherwise specified

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply voltage	$V_S$	1.8	3.0	4.5	V
Voltages					
pin 5	$V_5$	1.6	2.8	4.3	V
pin 10	$V_{10}$	1.8	3.0	4.5	V
<b>HF part</b>					
Total current consumption (pin 5)	$I_5$	–	2.2	–	mA
Oscillator current (pin 14)	$I_{14}$	–	100	–	$\mu\text{A}$
Mixer current (pin 2)	$I_2$	–	200	–	$\mu\text{A}$
Voltages					
pin 3	$V_3$	–	150	–	mV
pin 13	$V_{13}$	–	600	–	mV
pin 15	$V_{15}$	–	1.1	–	V
pin 16	$V_{16}$	–	1.1	–	V
<b>AF part</b>					
Total current consumption (pin 10)	$I_5$	–	4.0	–	mA
Input bias current (pin 11 connected to pin 16)	$I_{11} + I_{16}$	–	40	–	nA
DC output voltage					
pin 8	$V_8$	–	1.5	–	V
pin 9	$V_9$	–	1.5	–	V

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**AC CHARACTERISTICS**

All parameters are measured in test circuit of Fig.6 at  $V_S = 3\text{ V}$ ;  $T_{\text{amb}} = 25\text{ }^\circ\text{C}$  unless otherwise specified.

RF conditions: Input frequency 1 MHz; 30% modulation where  $f_{\text{mod}} = 1\text{ kHz}$ ; unless otherwise specified.

PARAMETER	CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
<b>RF sensitivity</b>						
RF input voltage	$V_{o(\text{AF})} = 10\text{ mV}$	$V_{i(\text{RF})}$	–	1.5	–	$\mu\text{V}$
Loss in sensitivity	$V_{o(\text{AF})} = 10\text{ mV};$ $V_S = 1.8\text{ V}$	$\Delta V_{i(\text{RF})}$	–	6	–	dB
<b>Noise</b>						
Signal-to-noise ratio for RF input signal voltage of						
$V_{i(\text{RF})} = 2\text{ }\mu\text{V}$		S/N	–	6	–	dB
$V_{i(\text{RF})} = 15\text{ }\mu\text{V}$		S/N	–	26	–	dB
$V_{i(\text{RF})} = 1\text{ mV}$		S/N	–	46	–	dB
<b>AF output voltage</b>						
	$V_{i(\text{RF})} = 1\text{ mV}$	$V_{o(\text{AF})}$	–	80	–	mV
	$V_{i(\text{RF})} = 1\text{ mV};$ $V_S = 1.8\text{ V}$	$V_{o(\text{AF})}$	–	55	–	mV
<b>Total harmonic distortion</b>						
	$V_{i(\text{RF})} = 100\text{ }\mu\text{V}$ to 30 mV	THD	–	0.8	–	%
	$V_{i(\text{RF})} = 80\text{ mV};$ $m = 0.8$	THD	–	10	–	%
<b>AGC range</b>						
Change in RF input voltage for 10 dB change in AF output voltage	$V_{i(\text{RF1})} = 50\text{ mV}$	$V_{i(\text{RF1})}/$ $V_{i(\text{RF2})}$	–	86	–	dB
<b>Optimum source impedance</b>		$Z_{\text{source}}$	–	3	–	$\text{k}\Omega$
<b>IF suppression</b>						
at $V_{o(\text{AF})} = 10\text{ mV}$	note 1	$\alpha$	–	20	–	dB
<b>Oscillator</b> (pin 14)	$f_{\text{osc}} = 1468\text{ kHz}$					
Oscillator voltage		$V_i$	–	100	–	mV
	$V_5 = 1.5\text{ V}$	$V_i$	–	*	–	mV

**Note to the AC characteristics**

$$1. \quad \alpha = \frac{V_i \text{ at } f_i = 468\text{ kHz}}{V_i \text{ at } f_i = 1\text{ MHz}}$$

\* Value to be fixed.



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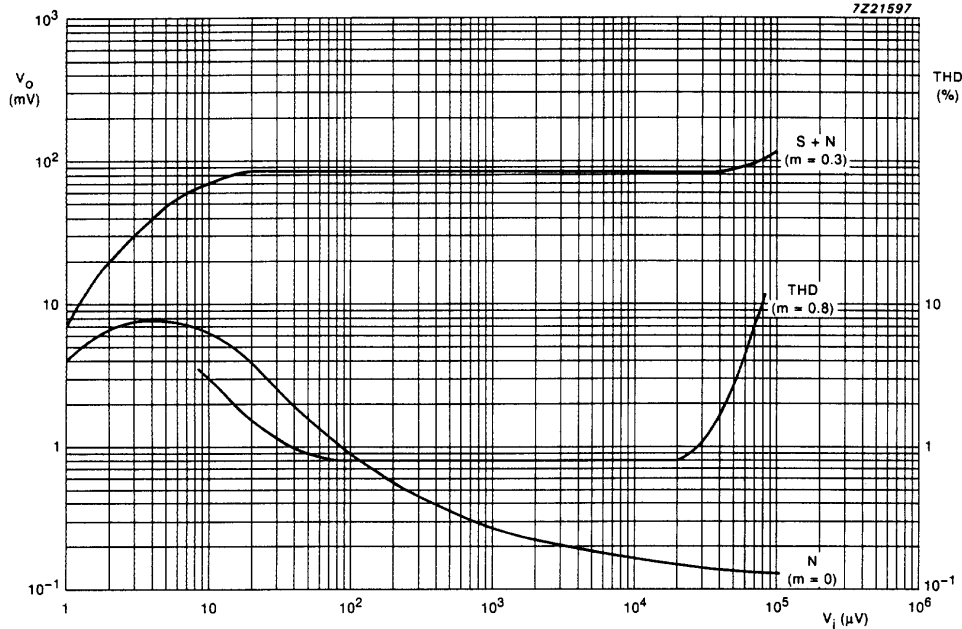
**AC CHARACTERISTICS**

All parameters are measured in test circuit of Fig.6 at  $V_S = 3\text{ V}$ ;  $T_{\text{amb}} = 25\text{ °C}$  unless otherwise specified. RF conditions:  $f = 1\text{ kHz}$ ;  $R_L = 32\text{ }\Omega$ ; unless otherwise specified.

PARAMETER	CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
<b>Output power</b>	THD = 10%	$P_o$	–	25	–	mW
	THD = 10%; $V_S = 1.8\text{ V}$	$P_o$	–	8	–	mW
	THD = 10%; $V_S = 4.5\text{ V}$	$P_o$	–	60	–	mW
<b>Total harmonic distortion</b>	$P_o = 10\text{ mW}$	THD	–	0.5	–	%
<b>Voltage gain</b>	$P_o = 10\text{ mW}$	$G_v$	–	32	–	dB
<b>Noise</b>						
Noise output voltage	$R_S = 5\text{ k}\Omega$ ; $B = 15\text{ kHz}$	$V_{no}$	–	240	–	$\mu\text{V}$
HF noise output voltage	$R_S = 5\text{ k}\Omega$ ; $B = 5\text{ kHz}$ ; $f = 500\text{ kHz}$	$V_{no(RF)}$	–	20	–	$\mu\text{V}$
<b>Input circuit</b>						
Input impedance	pin 11 connected to pin 12	$Z_i$	–	3	–	$\text{M}\Omega$
<b>Mute switch</b>						
AC impedance (pin 13 to ground)	$V_5 = 0\text{ V}$ ; $I_{13} = 0.32\text{ mA}$	$R_S$	–	200	–	$\Omega$

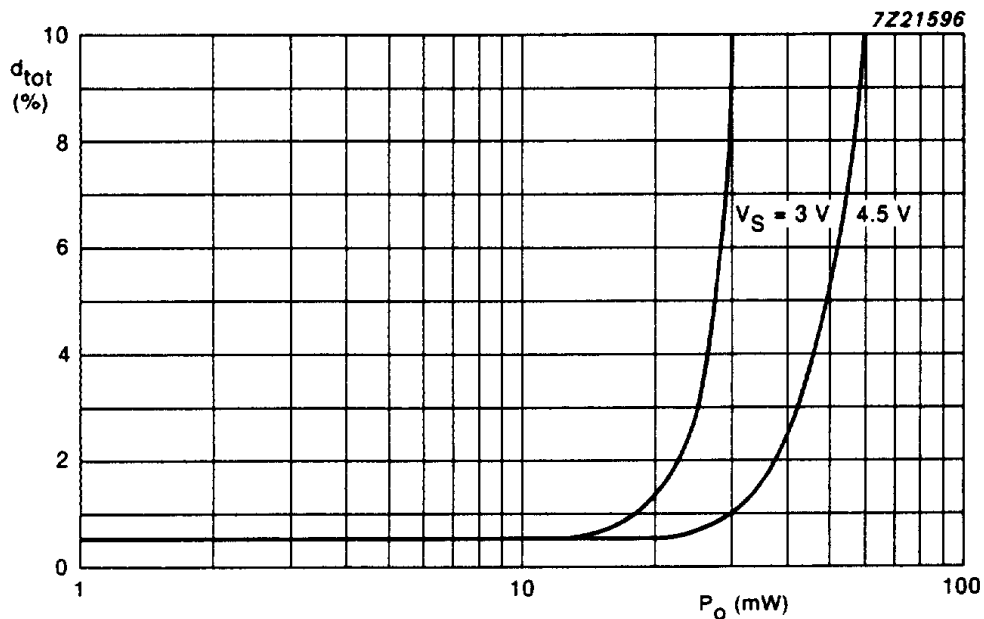
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Conditions:  $f_o = 1 \text{ MHz}$ ;  $f_m = 1 \text{ kHz}$ ;  $V_S = 3 \text{ V}$ ;  $R_g = 50 \text{ }\Omega$ ;  $m = 0.3$  (unless otherwise specified).

Fig.4 Typical signal (S) and noise (N) output voltages, where  $V_o$  is the AF output voltage at pin 13, as a function of the input voltage  $V_i$ .  $V_i$  is the input voltage at pin 16. Also shown is the total harmonic distortion (THD).

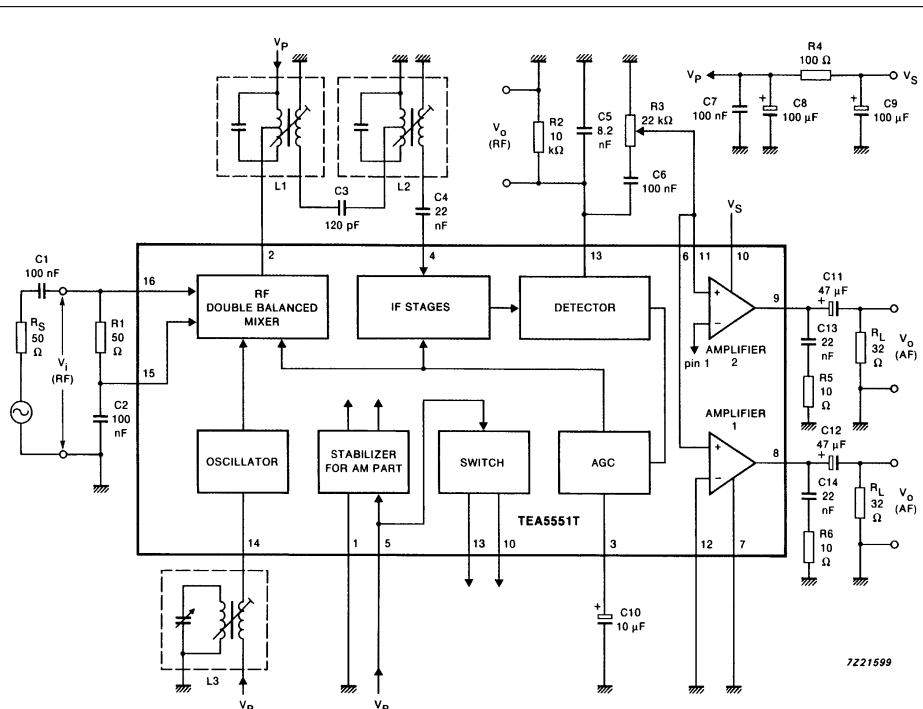


Conditions:  $V_S = 3 \text{ V}$  and  $4.5 \text{ V}$ ;  $R_L = 32 \text{ }\Omega$ ;  $f = 1 \text{ kHz}$ .

Fig.5 Total distortion ( $d_{tot}$ ) as a function of output power ( $P_o$ ).

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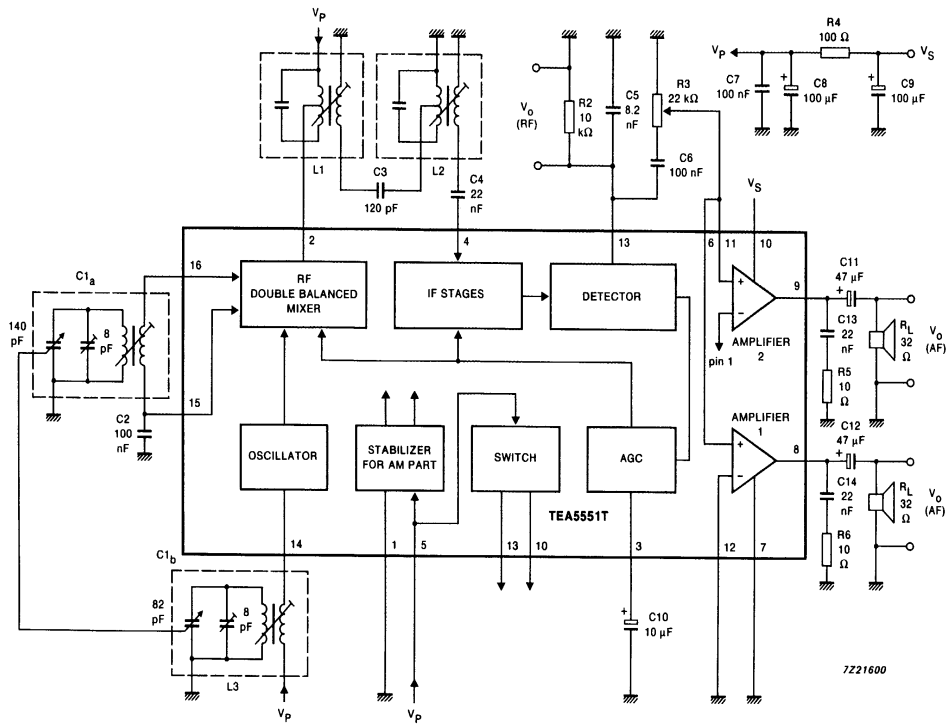
Coil data: L1 7MCS2199  
 L2 7MCS2197  
 L3 7BRS10869X

Fig.6 Test circuit.

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APPLICATION INFORMATION



Coil data: L1 7MCS2199  
 L2 7MCS2197  
 L3 7BRS10869X

Fig.7 Application circuit.

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COIL DATA

AM coils (Figs 6 and 7)

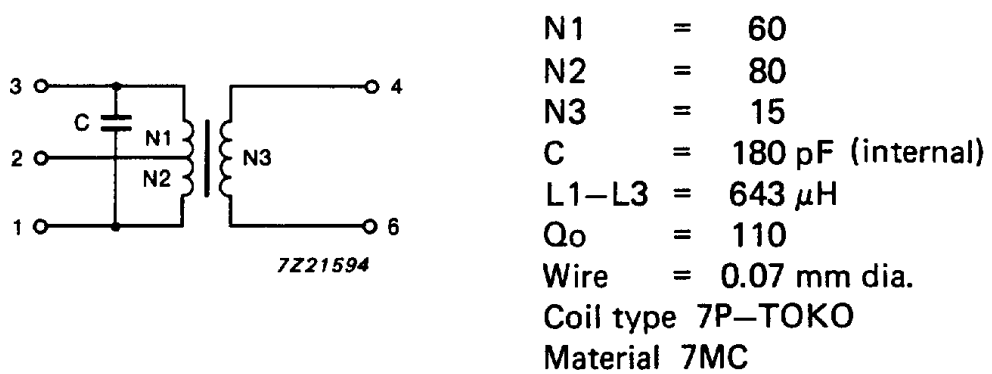


Fig.8 IF bandpass filter (L1). TOKO sample no. 7MCS2199.

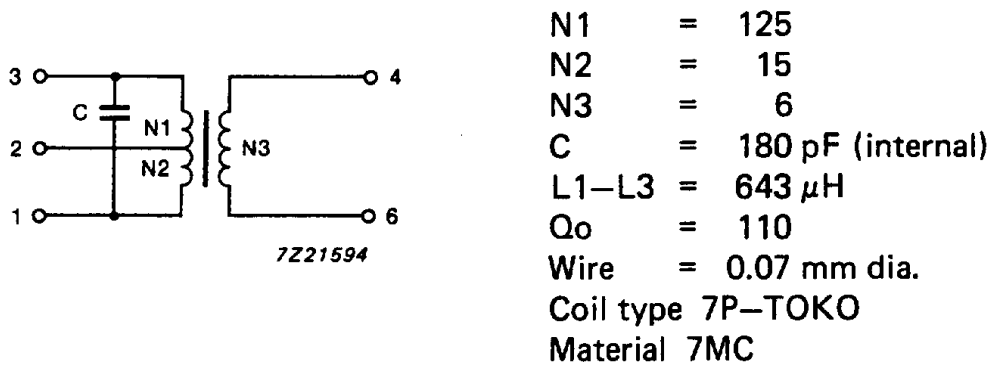
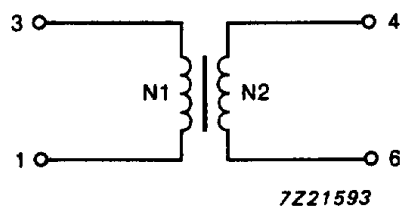


Fig.9 IF bandpass filter (L2). TOKO sample no. 7MCS2197.

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N1 = 90  
N2 = 6  
L1-L3 = 295  $\mu$ H  
Qo = 110  
Wire = 0.07 mm dia.  
Coil type 7P-TOKO  
Material 7BR

Fig.10 Oscillator coil (L3). TOKO sample no. 7BRS10869X.

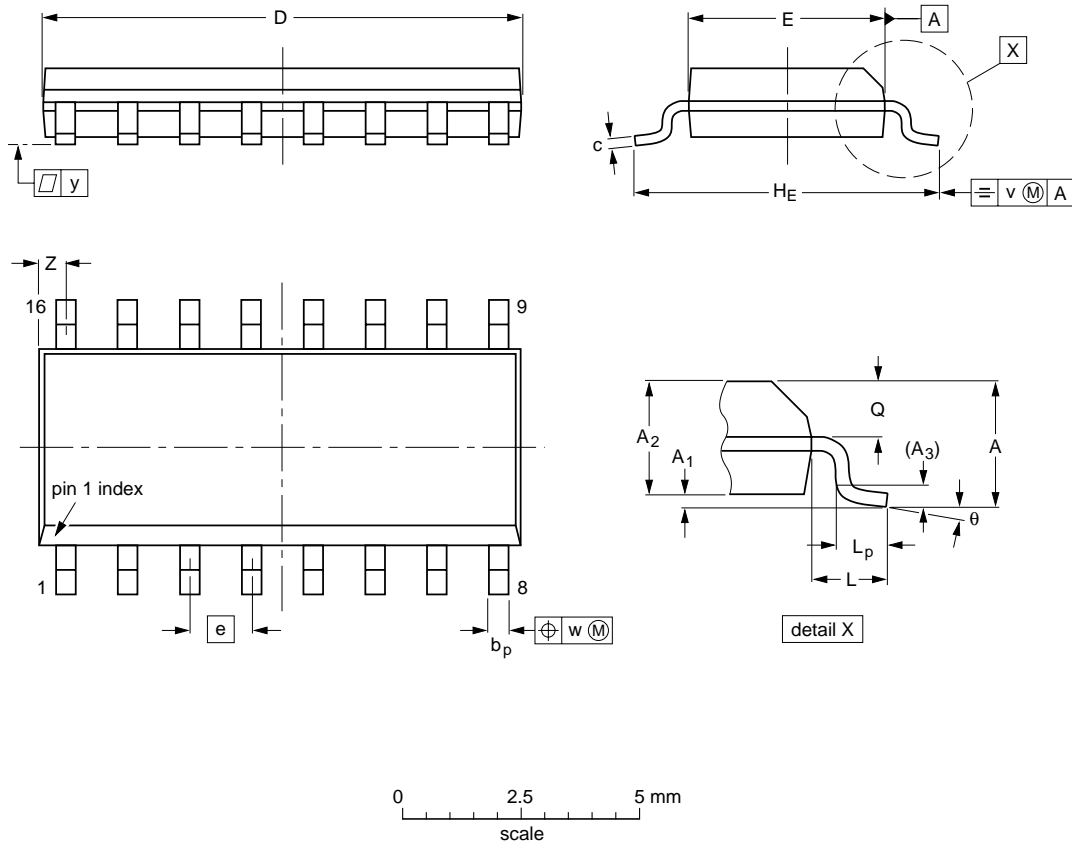
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PACKAGE OUTLINE

SO16: plastic small outline package; 16 leads; body width 3.9 mm

SOT109-1



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(1)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	Z <sup>(1)</sup>	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	10.0 9.8	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8° 0°
inches	0.069	0.010 0.004	0.057 0.049	0.01	0.019 0.014	0.0100 0.0075	0.39 0.38	0.16 0.15	0.050	0.244 0.228	0.041	0.039 0.016	0.028 0.020	0.01	0.01	0.004	0.028 0.012	

Note

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES			EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ		
SOT109-1	076E07S	MS-012AC			95-01-23 97-05-22

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## 1-chip AM radio

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### SOLDERING

#### Introduction

There is no soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and surface mounted components are mixed on one printed-circuit board. However, wave soldering is not always suitable for surface mounted ICs, or for printed-circuits with high population densities. In these situations reflow soldering is often used.

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our *"IC Package Databook"* (order code 9398 652 90011).

#### Reflow soldering

Reflow soldering techniques are suitable for all SO packages.

Reflow soldering requires solder paste (a suspension of fine solder particles, flux and binding agent) to be applied to the printed-circuit board by screen printing, stencilling or pressure-syringe dispensing before package placement.

Several techniques exist for reflowing; for example, thermal conduction by heated belt. Dwell times vary between 50 and 300 seconds depending on heating method. Typical reflow temperatures range from 215 to 250 °C.

Preheating is necessary to dry the paste and evaporate the binding agent. Preheating duration: 45 minutes at 45 °C.

#### Wave soldering

Wave soldering techniques can be used for all SO packages if the following conditions are observed:

- A double-wave (a turbulent wave with high upward pressure followed by a smooth laminar wave) soldering technique should be used.
- The longitudinal axis of the package footprint must be parallel to the solder flow.
- The package footprint must incorporate solder thieves at the downstream end.

During placement and before soldering, the package must be fixed with a droplet of adhesive. The adhesive can be applied by screen printing, pin transfer or syringe dispensing. The package can be soldered after the adhesive is cured.

Maximum permissible solder temperature is 260 °C, and maximum duration of package immersion in solder is 10 seconds, if cooled to less than 150 °C within 6 seconds. Typical dwell time is 4 seconds at 250 °C.

A mildly-activated flux will eliminate the need for removal of corrosive residues in most applications.

#### Repairing soldered joints

Fix the component by first soldering two diagonally-opposite end leads. Use only a low voltage soldering iron (less than 24 V) applied to the flat part of the lead. Contact time must be limited to 10 seconds at up to 300 °C. When using a dedicated tool, all other leads can be soldered in one operation within 2 to 5 seconds between 270 and 320 °C.



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**DEFINITIONS**

<b>Data sheet status</b>	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
<b>Limiting values</b>	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	
<b>Application information</b>	
Where application information is given, it is advisory and does not form part of the specification.	

**LIFE SUPPORT APPLICATIONS**

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.