

# DATA SHEET

## **TEA5594** AM/FM radio receiver circuit

Product specification  
File under Integrated Circuits, IC01

March 1991

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**AM/FM radio receiver circuit****TEA5594**

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**GENERAL DESCRIPTION**

The TEA5594 is a 32-pin integrated radio circuit designed for use in all Electronic Tuned Radio (ETR) sets especially those sets which have to fulfil the immunity requirements of CENELEC.

The AM circuit incorporates:

- A double balanced mixer
- A 'one-pin' oscillator with amplitude control operating in the LW/MW frequency range
- An IF amplifier and AM detector
- An AGC circuit which controls the IF amplifier and mixer

The FM circuit incorporates:

- A front-end (fulfilling the "out of band" CENELEC requirements)
- Two IF amplifiers (for distributed selectivity)
- A quadrature demodulator with a ceramic filter

The TEA5594 also contains:

- Oscillator output buffers for AM and FM
- A combined AM/FM IF counter output buffer with counter "enable" function
- A field strength level detector for AM and FM
- A soft mute circuit at FM, adjustable
- An extra IF amplifier to split up IF filtering

**Features**

- Low distortion on FM
- AM/FM level/indicator circuit
- A DC AM/FM switch facility
- Supply voltages 2.7 to 15 V
- A local distance switch facility (LOCAL-DX) at FM
- All pins are ESD protected

**PACKAGE OUTLINE**

32-lead shrink DIL; plastic (SOT232); SOT232-1; 1996 September 9.

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## QUICK REFERENCE DATA

PARAMETER	CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply voltage (pin 9)		$V_P$	2.7	–	15	V
Total current consumption						
AM part		$I_P$	–	13	–	mA
FM part		$I_P$	–	24	–	mA
Operating ambient temperature range		$T_{amb}$	–40	–	+85	°C
<b>AM performance (pin 22)</b>	note 1					
Sensitivity	$V_o = 10$ mV (S + N)/N = 26 dB	$V_i$	–	3.5	–	μV
		$V_i$	–	16	–	μV
Signal-to-noise ratio	$V_i = 1$ mV	(S + N)/N	–	48	–	dB
AF output voltage		$V_o$	–	50	–	mV
Total harmonic distortion		THD	–	0.8	–	%
Signal handling	m = 80%; THD = 8%	$V_i$	–	100	–	mV
<b>FM performance (pin 30)</b>	note 2					
Limiting sensitivity	–3 dB; note 3	$V_i$	–	2.5	–	μV
Signal-to-noise ratio	$V_i = 3$ μV	(S + N)/N	–	26	–	dB
	$V_i = 1$ mV	(S + N)/N	–	60	–	dB
AF output voltage		$V_o$	–	90	–	mV
Total harmonic distortion		THD	–	0.1	–	%
Maximum signal handling		$V_i$	–	200	–	mV
AM suppression	$100 \mu\text{V} < V_i < 100$ mV	AMS	–	50	–	dB

## Notes to the quick reference data

1. All parameters are measured in the application circuit (see Fig.5) at nominal supply voltage  $V_P = 8.5$  V;  $T_{amb} = 25$  °C; unless otherwise specified. RF conditions: Input frequency 1 MHz; 30% modulated with  $f_{mod} = 1$  kHz; unless otherwise specified.
2. All parameters are measured in the application circuit (see Fig.5) at nominal supply voltage  $V_P = 8.5$  V;  $T_{amb} = 25$  °C; unless otherwise specified. RF conditions: Input frequency 100 MHz; frequency deviation  $\Delta f = 22.5$  kHz and  $f_{mod} = 1$  kHz; unless otherwise specified.
3. Soft mute switched off.

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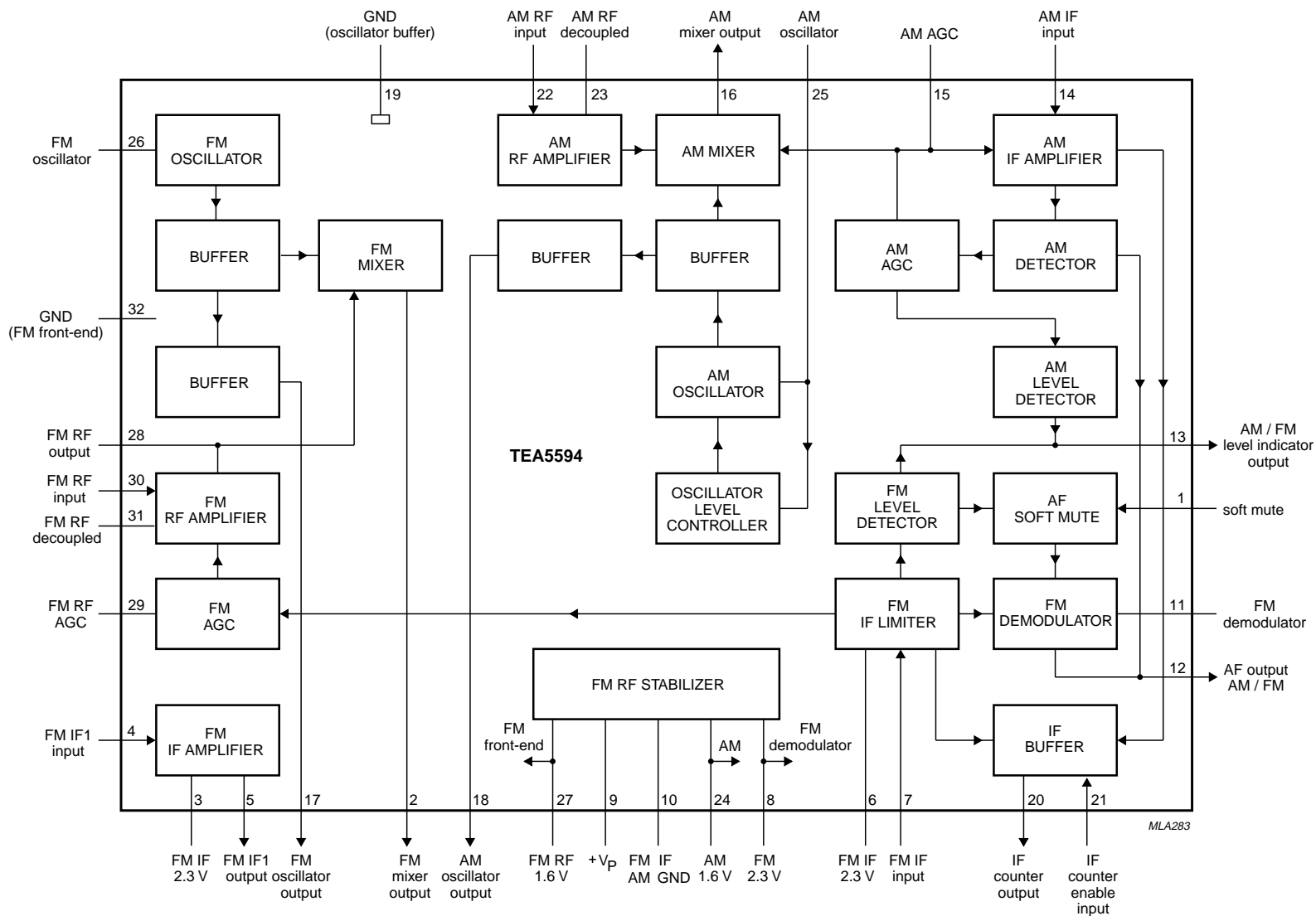


Fig.1 Block diagram.

AM/FM radio receiver circuit

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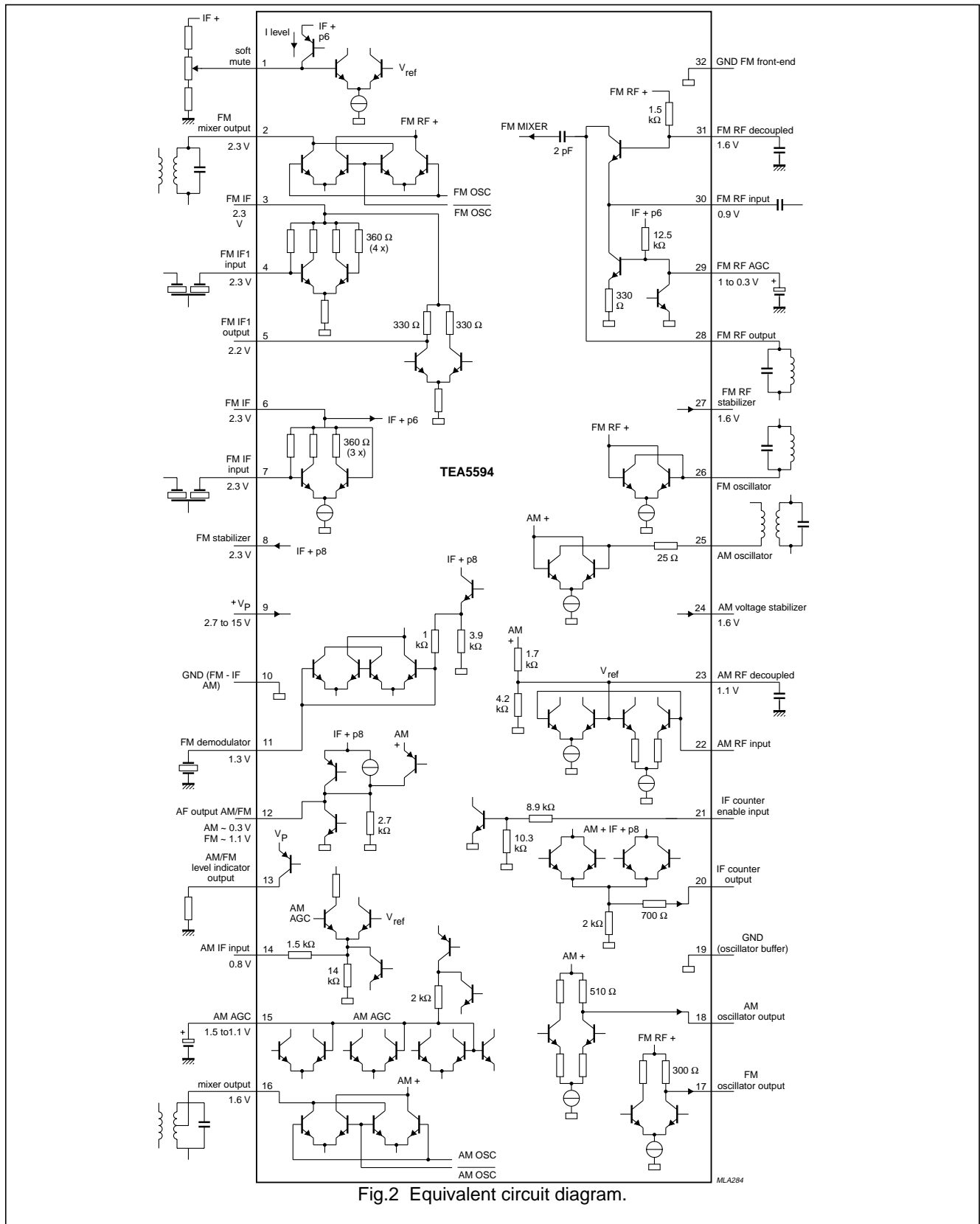
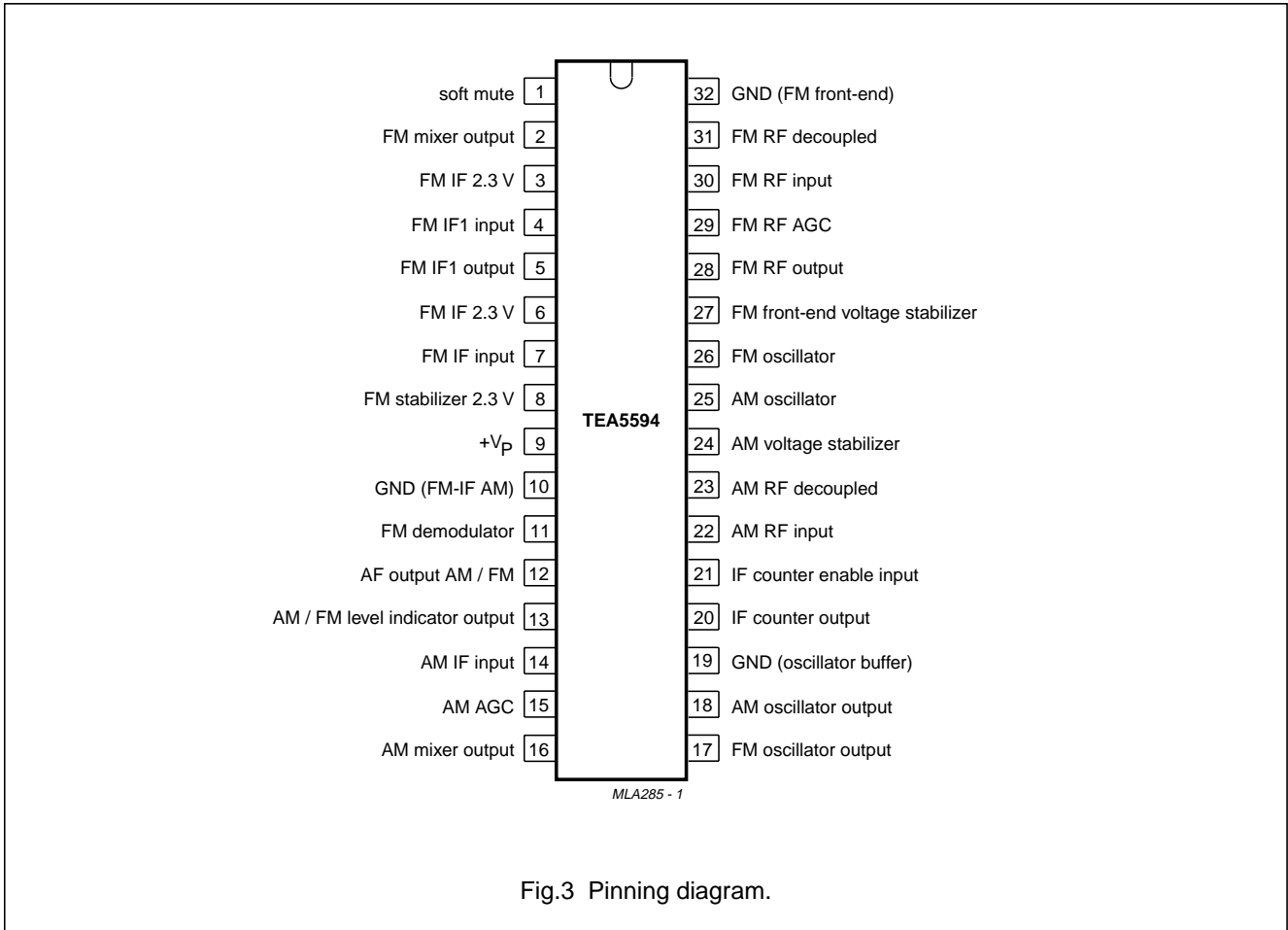


Fig.2 Equivalent circuit diagram.

AM/FM radio receiver circuit

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PINNING



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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 9)		$V_P$	-	18	V
Total power dissipation		$P_{tot}$	see Fig.4		
Storage temperature range		$T_{stg}$	-65	+150	°C
Operating ambient temperature range		$T_{amb}$	-40	+85	°C
Electrostatic handling <sup>(1)</sup>		$V_{es}$	-2000	+2000	V

**Note**

1. Equivalent to discharging a 200 pF capacitor through a 1.5 kΩ series resistor.

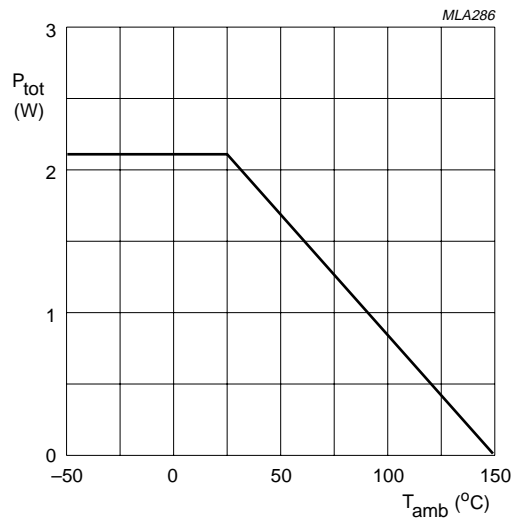


Fig.4 Power derating curve.

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**DC CHARACTERISTICS**

All voltages are referenced to pin 10, pin 19 and pin 32; all input currents are positive; all parameters are measured in application circuit (see Fig.5) at nominal supply voltage  $V_P = 8.5 \text{ V}$ ;  $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$  unless otherwise specified.

PARAMETER	CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply voltage		$V_P$	2.7	8.5	15	V
<b>Voltages (FM)</b>						
Pin 4		$V_4$	–	2.3	–	V
Pin 5		$V_5$	–	2.2	–	V
Pin 7		$V_7$	–	2.3	–	V
Pin 8		$V_8$	–	2.3	–	V
Pin 12		$V_{12}$	–	1.15	–	V
Pin 27		$V_{27}$	–	1.6	–	V
Pin 29		$V_{29}$	–	1.0	–	V
Pin 30		$V_{30}$	–	0.9	–	V
Pin 31		$V_{31}$	–	1.6	–	V
<b>Voltages (AM)</b>						
Pin 12		$V_{12}$	–	0.2	–	V
Pin 14		$V_{14}$	–	0.8	–	V
Pin 15		$V_{15}$	–	1.54	–	V
Pins 22 and 23		$V_{22}, V_{23}$	–	1.1	–	V
Pin 24		$V_{24}$	–	1.6	–	V
<b>Total current consumption</b>						
AM part		$I_P$	–	13	(1)	mA
FM part		$I_P$	–	24	(1)	mA

**Note**

1. Value to be fixed.



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**AC CHARACTERISTICS**

All parameters are measured in test circuit (see Fig.6) at nominal supply voltage  $V_P = 6\text{ V}$ ;  $T_{\text{amb}} = 25\text{ °C}$  unless otherwise specified.

PARAMETER	CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
<b>AM SECTION</b>						
<b>AM front end</b>						
Conversion transconductance	note 1 $V_i = 10\text{ mV}$ $V_{\text{AGC}} (\text{pin } 15)$ $= V_{24} - 0.1\text{ V}$ $V_{\text{AGC}} = V_{24} - 0.45\text{ V}$	$S_C$	<sup>(9)</sup>	13.5	<sup>(9)</sup>	mA/V
		$S_C$	<sup>(9)</sup>	1.2	<sup>(9)</sup>	mA/V
IF suppression	note 2	$\alpha$	20	30	–	dB
<b>Oscillator (pin 25)</b>						
Voltage	$f = 1.5\text{ MHz}$	$V_{\text{osc}}$	–	160	<sup>(9)</sup>	mV
<b>Oscillator buffer</b>						
Output voltage (peak-to-peak value)		$V_{18}$	<sup>(9)</sup>	140	–	mV
<b>IF and detector part</b>						
IF sensitivity; AF output voltage	note 3 no AGC; $V_{i(\text{IF})} = 90\text{ }\mu\text{V}$	$V_o$	30	40	60	mV
Signal + noise to noise ratio for an IF input AF output voltage	no AGC; $V_{i(\text{IF})} = 90\text{ }\mu\text{V}$ $V_{i(\text{IF})} = 1\text{ mV}$	S+N/N $V_o$	22 35	24 50	30 70	dB mV
Total harmonic distortion	$V_{i(\text{IF})} = 10\text{ mV}$ ; $m = 80\%$ $V_{i(\text{IF})} = \text{(9) to (9) mV}$ ; $m = 30\%$	THD THD	0.75 –	2 <sup>(9)</sup>	5 –	% %
<b>Indicator/level detector</b>						
Output voltage	$V_{i(\text{IF})} = 0\text{ V}$ $V_{i(\text{IF})} = 200\text{ }\mu\text{V}$ $V_{i(\text{IF})} = 10\text{ mV}$	$V_{13}$ $V_{13}$ $V_{13}$	<sup>(9)</sup> <sup>(9)</sup> <sup>(9)</sup>	560 3200 6600	<sup>(9)</sup> <sup>(9)</sup> <sup>(9)</sup>	mV mV mV
<b>AM IF counter output buffer</b>						
Counter “enable” Output voltage (peak-to-peak value)		$V_{20}$	100	125	–	mV
Counter “disable” Suppression of 468 kHz		$V_{20}$	–40	–	–	dB
<b>Overall performance</b>						
Total harmonic distortion	note 4 $V_{i(\text{RF})} = 50\text{ mV}$	THD	–	–	8	%
Signal handling	THD = <sup>(9)</sup> %; $m = 0.8\%$		–	<sup>(9)</sup>	–	

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PARAMETER	CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
<b>Counter enable circuit</b>						
IF counter output OFF		$V_{21}$	–	–	0.8	V
IF counter output ON		$V_{21}$	2	–	$V_P$	V
<b>FM SECTION</b>						
<b>FM front end</b>						
	note 5					
Conversion transconductance	$V_{i(RF)} = 1 \text{ mV};$ $V_{AGC} = 1.1 \text{ V}$	$S_c$	16	24	32	mA/V
	$V_{i(RF)} = 1 \text{ mV};$ $V_{AGC} = 0.8 \text{ V}$	$S_c$	5	10	15	mA/V
<b>Oscillator (pin 26)</b>						
Voltage		$V_{osc}$	–	250	–	mV
<b>Oscillator buffer</b>						
Output voltage (peak-to-peak value)		$V_{17}$	<sup>(9)</sup>	270	–	mV
<b>IF and demodulator part</b>						
	note 6					
IF sensitivity	note 7					
AF output voltage	$V_{i(IF)} = 40 \mu\text{V}$					
	no mute	$V_o$	–3	–1	0	dB
	with mute	$V_o$	–20	–30	–40	dB
AM suppression	note 8	$\alpha$	–	<sup>(9)</sup>	–	dB
Signal + noise-to-noise ratio for an IF input	no mute; $V_{i(IF)} = 40 \mu\text{V}$	S+N/N	28	46	50	dB
	$V_{i(IF)} = 1 \text{ mV}$	S+N/N	–	<sup>(9)</sup>	–	dB
AF output voltage	$V_{i(IF)} = 1 \text{ mV}$	$V_o$	<sup>(9)</sup>	85	<sup>(9)</sup>	mV
Total harmonic distortion	$V_{i(IF)} = 50 \text{ mV}$					
	$\Delta f = 75 \text{ kHz}$	THD	–	1	–	%
	$\Delta f = 22.5 \text{ kHz}$	THD	–	<sup>(9)</sup>	–	%
<b>Indicator/level detector</b>						
Output voltage	$V_{i(IF)} = 0 \text{ V}$	$V_{13}$	<sup>(9)</sup>	2600	<sup>(9)</sup>	mV
	$V_{i(IF)} = 50 \mu\text{V}$	$V_{13}$	<sup>(9)</sup>	5750	<sup>(9)</sup>	mV
	$V_{i(IF)} = 1 \text{ mV}$	$V_{13}$	<sup>(9)</sup>	6250	<sup>(9)</sup>	mV
<b>AM/FM IF counter output buffer</b>						
Counter “enable”	note 5					
Output voltage (peak-to-peak value)		$V_{20}$	–	130	–	mV
Counter “disable”						
Suppression of 10.7 MHz		$V_{20}$	–40	–	–	dB

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PARAMETER	CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
<b>Counter enable circuit</b>						
IF counter output OFF		$V_{21}$	–	–	0.8	V
IF counter output ON		$V_{21}$	2	–	$V_P$	V
<b>AM/FM switch</b>						
FM OFF/AM ON		$V_{8-10}$	–	0	0	V
FM ON/AM OFF		$V_{24-10}$	–	0	0	V

**Notes to the characteristics**

1. Input frequency = 1 MHz, output frequency = 468 kHz;

$$S_C = \frac{V_{o(IF)}}{V_{i(RF)}} \times \frac{N2/N3}{R} \text{ (see TR2 Component data)}$$

Where R = 1.2 k $\Omega$  (total impedance at pin 16).

2.  $\alpha = 20 \log (V_i \text{ at } f_i = 468 \text{ kHz}) / (V_i \text{ at } f_i = 1 \text{ MHz})$ ;  $V_o = 10 \text{ mV}$ ; no AGC.
3. Input frequency = 468 kHz; m = 30% modulated with  $f_{mod} = 1 \text{ kHz}$ ;  $R_{source} = 800 \Omega$  unless otherwise specified.
4. Front-end connected to IF plus detector part (see Fig.5). Input frequency = 1 MHz; m = 80% modulated with  $f_{mod} = 1 \text{ kHz}$ .
5. Input frequency = 100 MHz, output frequency = 10.7 MHz;

$$S_C = \frac{V_{o(IF)}}{V_{i(RF)}} \times \frac{N1/N2}{R} \text{ (see TR3 Component data)}$$

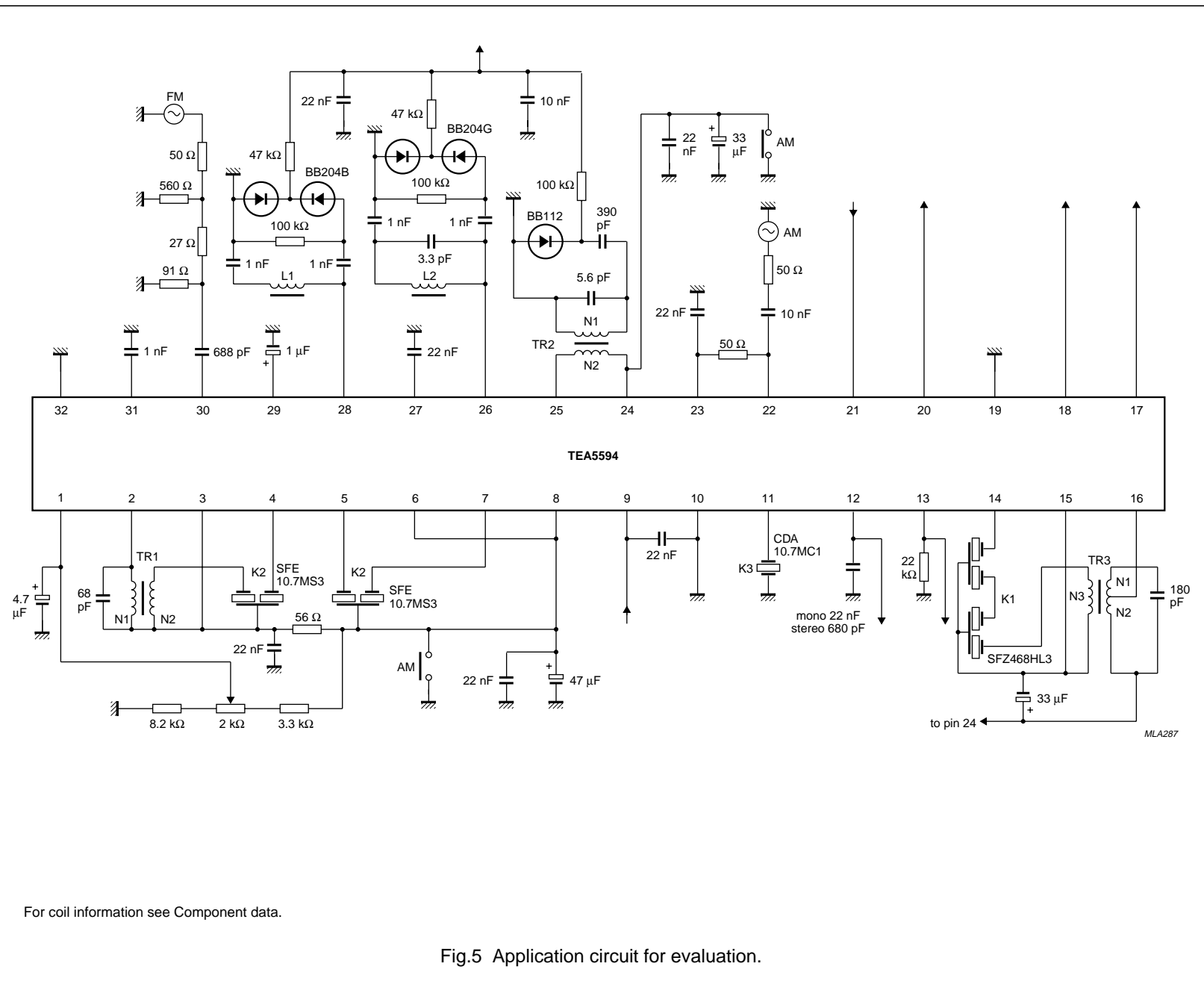
Where R = 6.6 k $\Omega$  (total impedance at pin 2).

6. Input frequency = 10.7 MHz; frequency deviation,  $\Delta f = 22.5 \text{ kHz}$  and  $f_{mod} = 1 \text{ kHz}$ ; unless otherwise specified.
7. Reference: AF output voltage = 0 dB at  $V_{i(IF)} = 1 \text{ mV}$ ;  
No mute:  $V_1 = V_8$ ;  
With mute:  $V_1 = 0 \text{ V}$ .
8. AM suppression is measured with AM only: m = 0.8% and  $f_{mod} = 1 \text{ kHz}$  referred to AF output at FM only:  $\Delta f = 75 \text{ kHz}$  and  $f_{mod} = 1 \text{ kHz}$ .
9. Value to be fixed.

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APPLICATION AND TEST INFORMATION

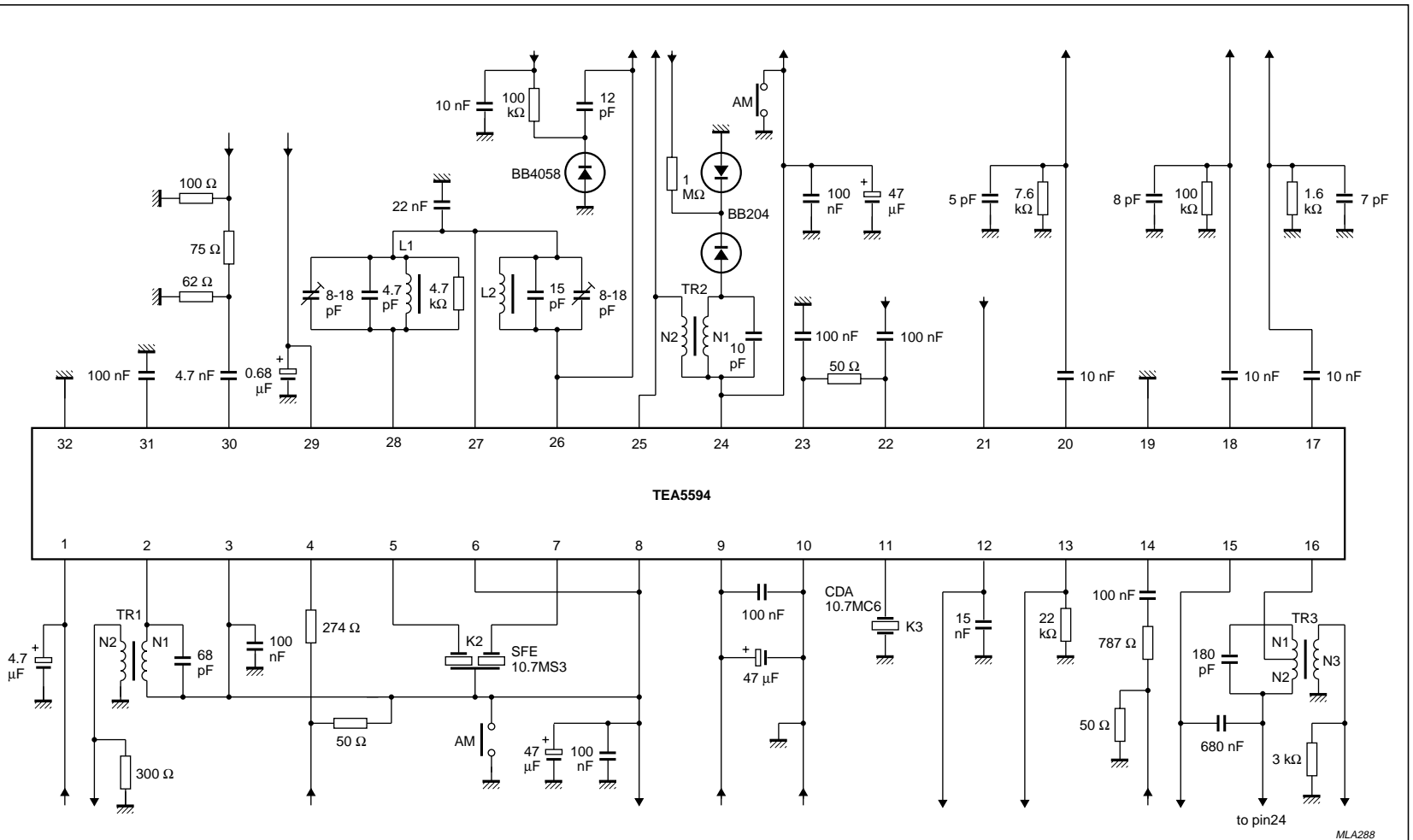


For coil information see Component data.

Fig.5 Application circuit for evaluation.

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For coil information see Component data.

Fig.6 Factory test circuit.

MLA288

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Component data

COILS

$N1 = 4.5$   
 $L = 100 \mu\text{H}$

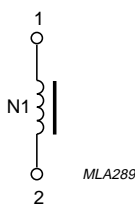


Fig.7 FM-RF coil (L1). TOKO equivalent no. MC115.

$N1 = 4.5$   
 $L = 94 \mu\text{H}$

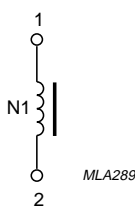


Fig.8 FM oscillator coil (L2). TOKO equivalent no. A294SNS-1004NK.

$N1 = 12$   
 $N2 = 2$   
 $C = 68 \text{ pF (internal)}$   
 $f_o = 10.7 \text{ MHz}$   
 Wire = 0.07 mm diameter  
 Coil type TOKO 119BCS-A6515BQG

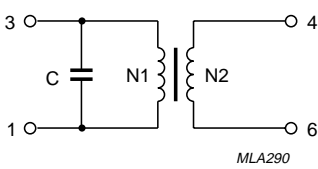


Fig.9 FM-IF coil (TR1).

$N1 = 55$   
 $N2 = 55$   
 $L_{\text{prim}} = 106 \mu\text{H}$   
 Wire = 0.05 mm diameter  
 Coil type TOKO 7MCS

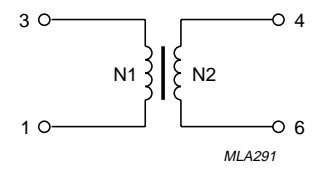
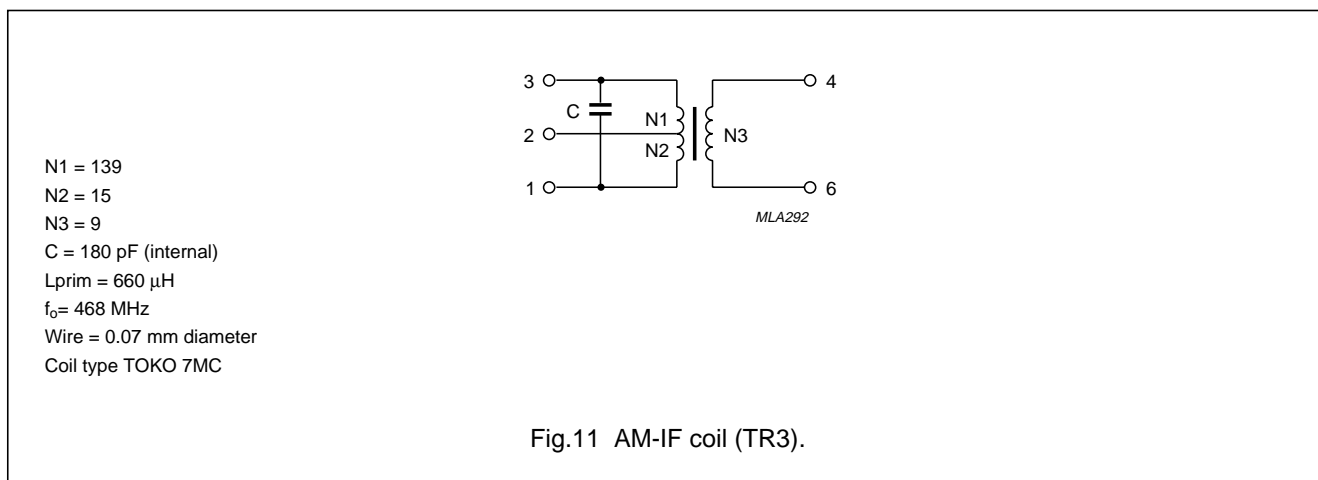


Fig.10 AM oscillator coil (TR2).

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**CERAMIC FILTERS**

AM-IF (K1). SFZ468HL3.

FM-IF (K2). SFE10.7MS3.

FM detector (K3). CDA10.7MC1 (MC6).

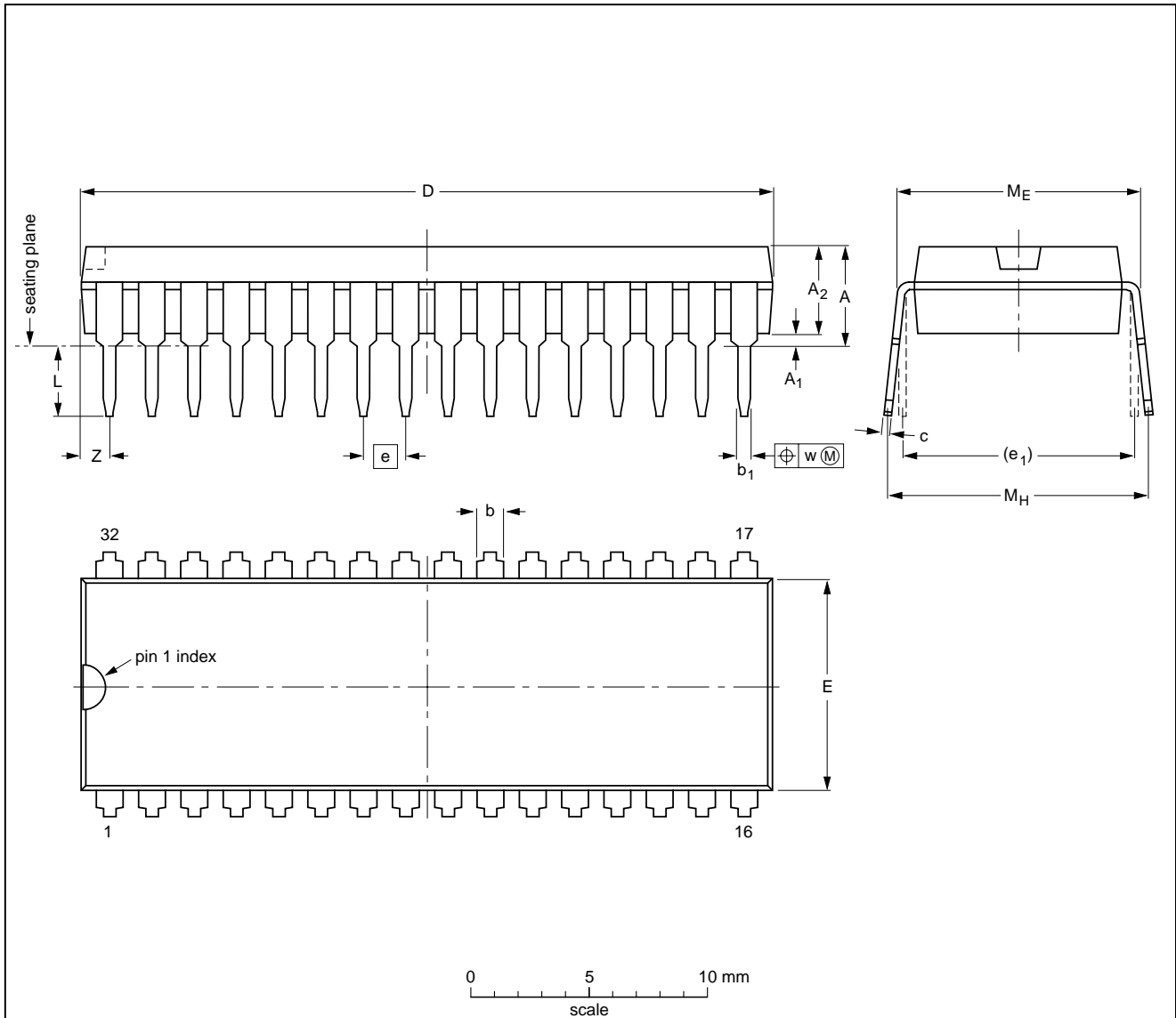
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PACKAGE OUTLINE

SDIP32: plastic shrink dual in-line package; 32 leads (400 mil)

SOT232-1



DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A <sub>1</sub> min.	A <sub>2</sub> max.	b	b <sub>1</sub>	c	D <sup>(1)</sup>	E <sup>(1)</sup>	e	e <sub>1</sub>	L	M <sub>E</sub>	M <sub>H</sub>	w	Z <sup>(1)</sup> max.
mm	4.7	0.51	3.8	1.3 0.8	0.53 0.40	0.32 0.23	29.4 28.5	9.1 8.7	1.778	10.16	3.2 2.8	10.7 10.2	12.2 10.5	0.18	1.6

Note

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT232-1						92-11-17 95-02-04



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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).

**Soldering by dipping or by wave**

The maximum permissible temperature of the solder is 260 °C; solder at this temperature must not be in contact with the joint for more than 5 seconds. The total contact time of successive solder waves must not exceed 5 seconds.

The device may be mounted up to the seating plane, but the temperature of the plastic body must not exceed the specified maximum storage temperature ( $T_{stg\ max}$ ). If the printed-circuit board has been pre-heated, forced cooling may be necessary immediately after soldering to keep the temperature within the permissible limit.

**Repairing soldered joints**

Apply a low voltage soldering iron (less than 24 V) to the lead(s) of the package, below the seating plane or not more than 2 mm above it. If the temperature of the soldering iron bit is less than 300 °C it may remain in contact for up to 10 seconds. If the bit temperature is between 300 and 400 °C, contact may be up to 5 seconds.

**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**

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