

DATA SHEET

TEA5591 AM/FM radio receiver circuit

Product specification
File under Integrated Circuits, IC01

June 1989

AM/FM radio receiver circuit**TEA5591****GENERAL DESCRIPTION**

The TEA5591 is an integrated radio circuit which is designed for use in portable receivers and clock radios. The IC is also applicable to mains-fed AM and AM/FM receivers and car radio-receivers. The main advantage of this IC is its ability to operate over a wide range of supply voltages without loss of performance. The AM circuit incorporates a balanced mixer and a 'one-pin' oscillator, which operates in the 0.6 MHz to 30 MHz frequency range, with amplitude control. The circuit also includes an IF amplifier, a detector and an AGC circuit which controls the IF amplifier and the mixer. The FM circuit incorporates an RF amplifier, a balanced mixer and a 'one-pin' oscillator together with two AC coupled IF amplifiers (with distributed selectivity), a quadrature demodulator for the ceramic filter and internal AFC.

Features

- DC AM/FM switch facility
- Three internal separate stabilizers to enable operation over a wide range of supply voltages (1.8 to 15 V)
- All pins (except pin 9) are ESD protected.

QUICK REFERENCE DATA

| PARAMETER | CONDITIONS | SYMBOL | MIN. | TYP. | MAX. | UNIT |
|---------------------------------------|-----------------------|-----------|------|------|------|---------|
| Supply voltage (pin 8) | | V_P | 1.8 | 3.0 | 15 | V |
| Supply current | | | | | | |
| AM part | | $I_P(AM)$ | – | 14 | 19 | mA |
| FM part | | $I_P(FM)$ | – | 17 | 23 | mA |
| Operating ambient temperature range | | T_{amb} | –15 | – | +60 | °C |
| AM performance (pin 13) | $m = 0.3$ | | | | | |
| RF sensitivity | | | | | | |
| RF input voltage | $V_o = 10$ mV | V_i | – | 3.5 | – | μ V |
| RF input voltage | $(S+N)/N = 26$ dB | V_i | – | 17 | – | μ V |
| Signal plus noise-to-noise ratio | $V_i = 1$ mV | $(S+N)/N$ | – | 48 | – | dB |
| AF output voltage | | V_o | – | 50 | – | mV |
| Total harmonic distortion | | THD | – | 0.7 | – | % |
| FM performance (pin 1) | $\Delta f = 22.5$ kHz | | | | | |
| RF sensitivity | | | | | | |
| RF input voltage | | | | | | |
| –3 dB before limiting | | V_i | – | 2.3 | 4.0 | μ V |
| Signal plus noise-to-noise ratio for: | | | | | | |
| RF input signal voltage (V_i) | $V_i = 3.0$ μ V | $(S+N)/N$ | 23 | 26 | – | dB |
| | $V_i = 1$ mV | $(S+N)/N$ | – | 60 | – | dB |
| AF output voltage | $V_i = 100$ μ V | V_o | 75 | 90 | – | mV |
| Total harmonic distortion | | THD | – | 0.8 | – | % |

PACKAGE OUTLINE

20-lead DIL; plastic (SOT146); SOT146-1; 1996 August 14.

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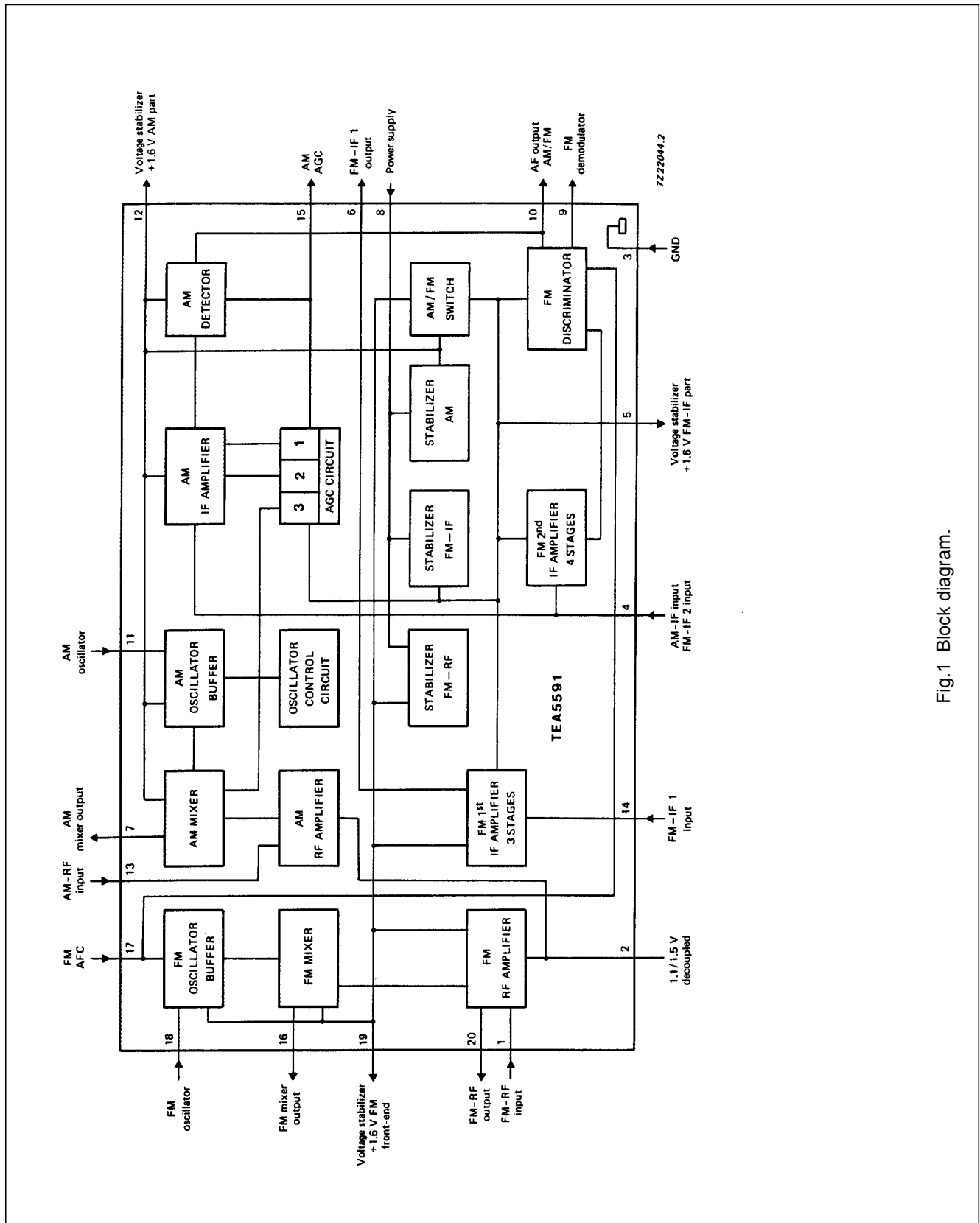


Fig.1 Block diagram.

AM/FM radio receiver circuit

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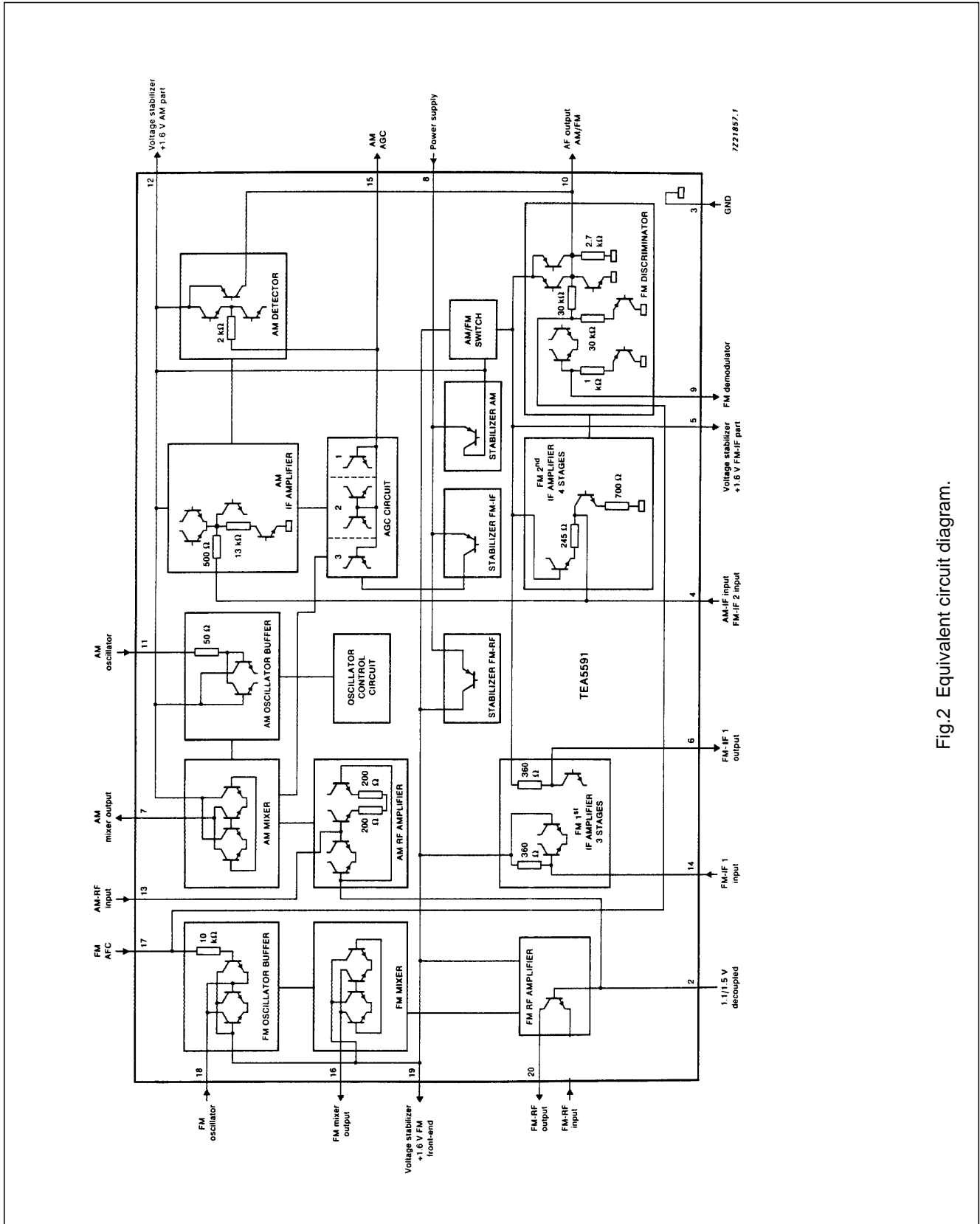


Fig.2 Equivalent circuit diagram.

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PINNING

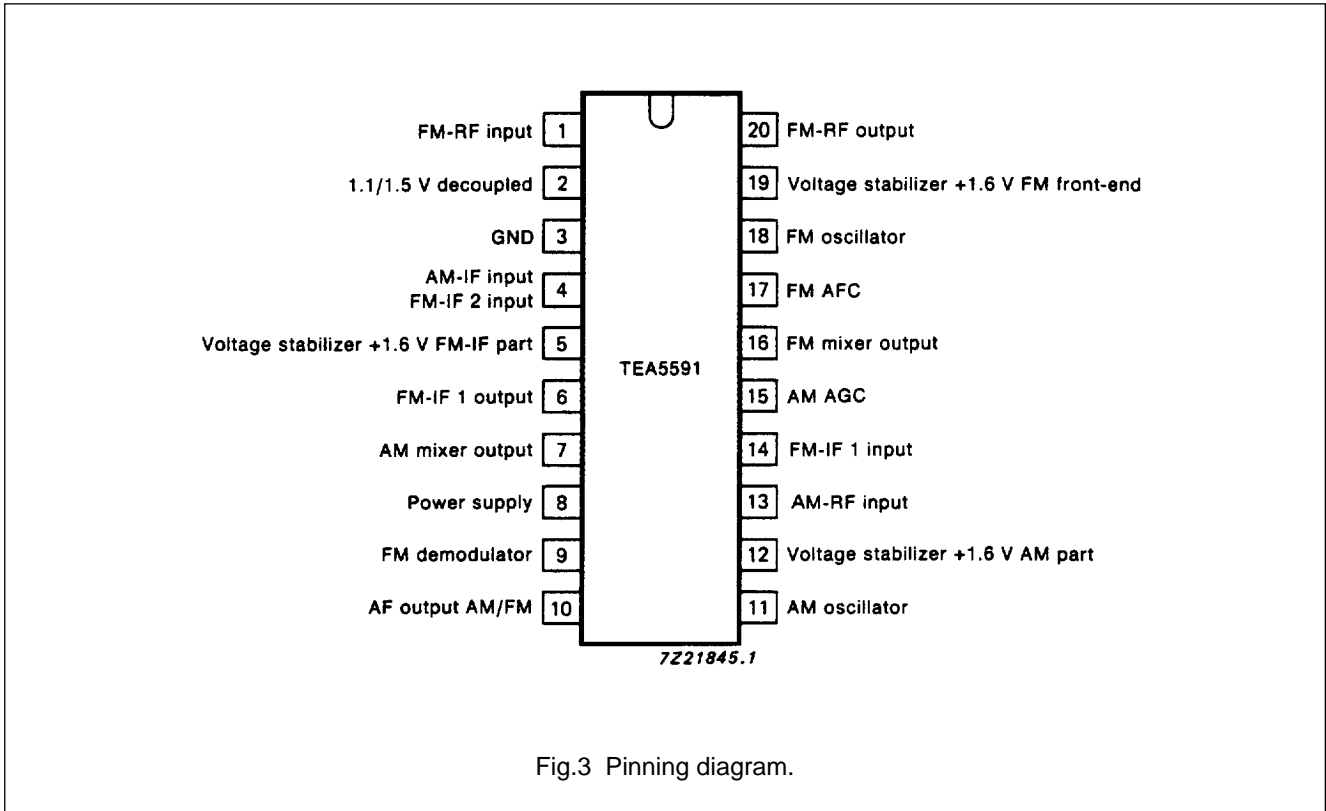


Fig.3 Pinning diagram.

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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 8) | | V_P | – | 18 | V |
| Storage temperature range | | T_{stg} | –65 | + 150 | °C |
| Operating ambient temperature range | | T_{amb} | –15 | + 60 | °C |
| Total power dissipation | | P_{tot} | see Fig.4 | | |

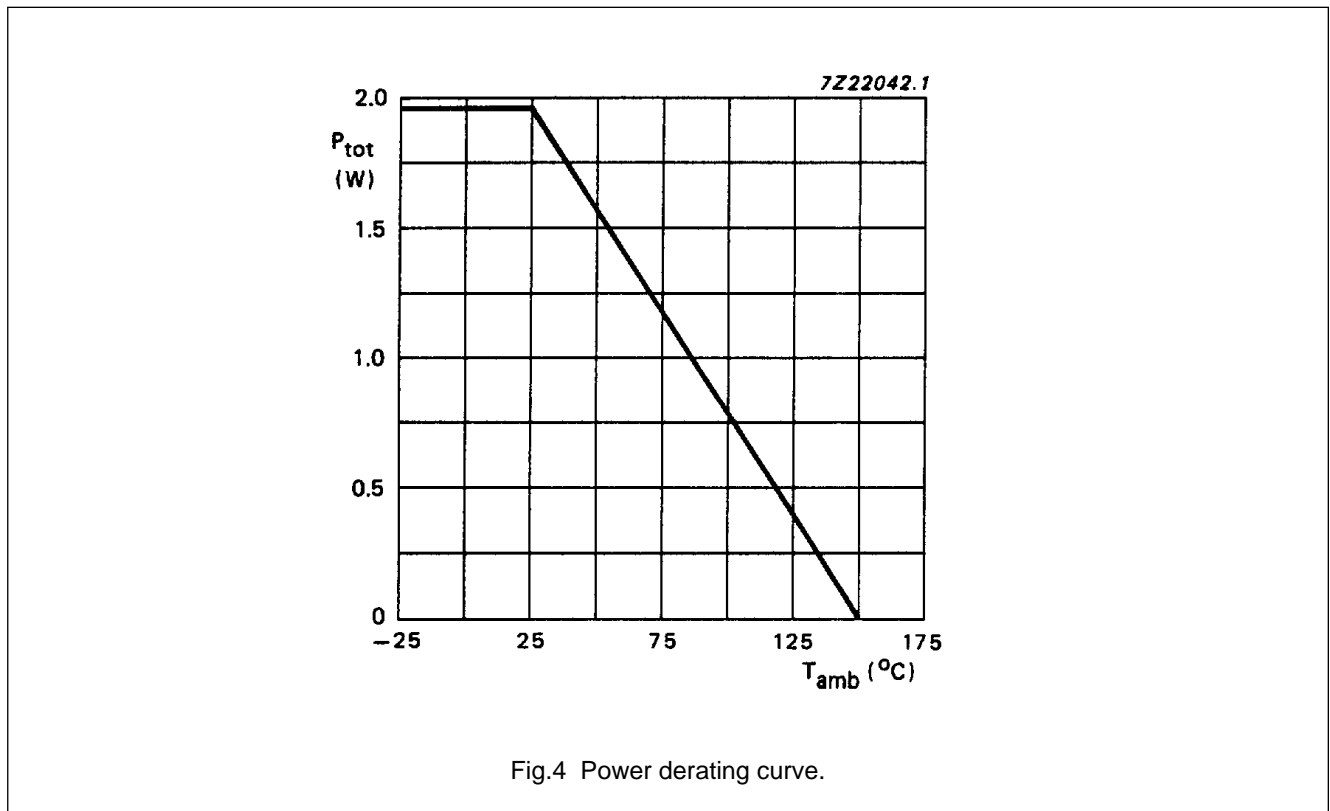


Fig.4 Power derating curve.

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DC CHARACTERISTICS

All voltages are referenced to pin 3; all input currents are positive; all parameters are measured in Fig.5 at nominal supply voltage $V_P = 3\text{ V}$; $T_{\text{amb}} = 25\text{ °C}$ unless otherwise specified

| PARAMETER | CONDITIONS | SYMBOL | MIN. | TYP. | MAX. | UNIT |
|----------------------|------------|-------------|------|------|------|------|
| Supply voltage | | V_P | 1.8 | 3.0 | 15 | V |
| Voltages (FM) | | | | | | |
| pin 1 | | V_1 | – | 0.90 | – | V |
| pin 2 | | V_2 | – | 1.60 | – | V |
| pin 4 | | V_4 | – | 0.85 | – | V |
| pin 5 | | V_5 | 1.5 | 1.60 | 1.75 | V |
| pin 6 | | V_6 | – | 1.48 | – | V |
| pin 9 | | V_9 | – | 1.05 | – | V |
| pin 14 | | V_{14} | – | 1.63 | – | V |
| pin 17 | | V_{17} | – | 0.60 | – | V |
| pin 19 | | V_{19} | – | 1.60 | – | V |
| Voltages (AM) | | | | | | |
| pin 2 | | V_2 | – | 1.10 | – | V |
| pin 12 | | V_{12} | – | 1.60 | – | V |
| pin 15 | | V_{15} | – | 1.54 | – | V |
| Supply current | | | | | | |
| AM part | | $I_{P(AM)}$ | – | 14 | 19 | mA |
| FM part | | $I_{P(FM)}$ | – | 17 | 23 | mA |

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AC CHARACTERISTICS $V_P = 3\text{ V}$; $T_{amb} = 25\text{ °C}$ unless otherwise specified

| PARAMETER | CONDITIONS | SYMBOL | MIN. | TYP. | MAX. | UNIT |
|---------------------------|--------------|----------|------|------|------|---------------|
| AM PART | | | | | | |
| Input conductance pin 4 | f = 0.5 MHz | g_{ie} | – | 1.7 | – | ms |
| Input capacitance pin 4 | f = 0.5 MHz | C_{ie} | – | 5 | – | pF |
| Input conductance pin 13 | f = 1.0 MHz | g_{ie} | – | 230 | – | μs |
| Input capacitance pin 13 | f = 1.0 MHz | C_{ie} | – | 13 | – | pF |
| Output conductance pin 7 | f = 0.5 MHz | g_{oe} | – | 4 | – | μs |
| Output capacitance pin 7 | f = 0.5 MHz | C_{oe} | – | 4.7 | – | pF |
| Conductance pin 11 | f = 1.5 MHz | g_e | – | –6.8 | – | ms |
| Capacitance pin 11 | f = 1.5 MHz | C_e | – | 25 | – | pF |
| FM PART | | | | | | |
| Input conductance pin 4 | f = 10.7 MHz | g_{ie} | – | 2.7 | – | ms |
| Input capacitance pin 4 | f = 10.7 MHz | C_{ie} | – | 6 | – | pF |
| Input conductance pin 14 | f = 10.7 MHz | g_{ie} | – | 2.8 | – | ms |
| Input capacitance pin 14 | f = 10.7 MHz | C_{ie} | – | 2.5 | – | pF |
| Output conductance pin 6 | f = 10.7 MHz | g_{oe} | – | 2.8 | – | ms |
| Output capacitance pin 6 | f = 10.7 MHz | C_{oe} | – | 3.0 | – | pF |
| Output conductance pin 16 | f = 10.7 MHz | g_{oe} | – | 1.6 | – | μs |
| Output capacitance pin 16 | f = 10.7 MHz | C_{oe} | – | 4.5 | – | pF |
| Conductance pin 9 | f = 10.7 MHz | g_e | – | 880 | – | μs |
| Capacitance pin 9 | f = 10.7 MHz | C_e | – | 3.6 | – | pF |
| Conductance pin 18 | f = 100 MHz | g_e | – | –4 | – | ms |
| Capacitance pin 18 | f = 100 MHz | C_e | – | 10 | – | pF |

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AC CHARACTERISTICS

All parameters are measured in Fig.5 at nominal supply voltage $V_P = 3\text{ V}$; $T_{amb} = 25\text{ °C}$ unless otherwise specified.

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

| PARAMETER | CONDITIONS | SYMBOL | MIN. | TYP. | MAX. | UNIT |
|---|---|-----------------|------|------|------|------------|
| AM PERFORMANCE | | | | | | |
| RF sensitivity AF output voltage for: $V_i = 7.5\ \mu\text{V}$ | no AGC | V_o | 16 | 30 | 40 | mV |
| Noise Signal plus noise-to-noise ratio for: RF input signal voltage of $V_i = 17\ \mu\text{V}$ | | $(S + N)/N$ | 23 | 26 | – | dB |
| $V_i = 1\text{ mV}$ | | $(S + N)/N$ | – | 48 | – | dB |
| Optimum source impedance | | Z_S | – | 1.8 | – | k Ω |
| Noise factor | optimum noise impedance | NF | – | 4 | – | dB |
| AGC Change in RF input voltage for 10 dB change in output voltage | $V_{i1} = 100\text{ mV}$ | V_{i1}/V_{i2} | 80 | 86 | – | dB |
| AF output voltage | $V_i = 100\ \mu\text{V}$ | V_o | 40 | 50 | 60 | mV |
| Total harmonic distortion | $V_i = 100\ \mu\text{V}$ to 10 mV | THD | – | 0.7 | 1.5 | % |
| | $V_i = 100\ \mu\text{V}$ to 10 mV; $m = 0.8$ | THD | – | 3 | 5 | % |
| | $V_i = 80\text{ mV}$; $m = 0.8$ | THD | – | – | 8 | % |

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| PARAMETER | CONDITIONS | SYMBOL | MIN. | TYP. | MAX. | UNIT |
|-----------------------------------|---|-------------------------|------|------|------|------|
| IF suppression (note 1) | $V_o = 30 \text{ mV}$ | α | – | 20 | – | dB |
| Oscillator (pin 11) | | | | | | |
| Input voltage | $f_{\text{osc}} = 1.5 \text{ MHz}$ | V_{osc} | – | 150 | 190 | mV |
| | $f_{\text{osc}} = 30.5 \text{ MHz}$ | V_{osc} | – | 150 | – | mV |
| | $V_P = 1.5 \text{ V}$ | V_{osc} | 100 | – | – | mV |
| Temperature behaviour | $-15 \text{ to } +60 \text{ }^\circ\text{C}$ (only the IC) | | | | | |
| Sensitivity | | ΔV_i | – | –2 | – | dB |
| Output voltage | $V_i = 1 \text{ mV}$ | ΔV_o | – | 1 | – | dB |
| Oscillator frequency | | | | | | |
| LW | | Δf_{osc} | – | 500 | – | Hz |
| MW | | Δf_{osc} | – | 300 | – | Hz |
| SW | | Δf_{osc} | – | 100 | – | kHz |
| Supply voltage behaviour | $V_P = 1.8 \text{ to } 15 \text{ V}$ | | | | | |
| Sensitivity | | ΔV_i | – | 0 | – | dB |
| Output voltage | $V_i = 1 \text{ mV}$ | ΔV_o | – | 0.5 | – | dB |
| Oscillator frequency | | | | | | |
| LW | | Δf_{osc} | – | 6 | – | kHz |
| MW | | Δf_{osc} | – | 0.1 | – | kHz |
| SW | | Δf_{osc} | – | 30 | – | kHz |

Transimpedance (Z_{tr}) = $V_4/I_7 = 900\Omega$.

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AC CHARACTERISTICS

All parameters are measured in Fig.5 at nominal supply voltage $V_P = 3\text{ V}$; $T_{amb} = 25\text{ °C}$ unless otherwise specified
 RF conditions: Input frequency 100 MHz; frequency deviation $f = \pm 22,5\text{ kHz}$ and $f_{mod} = 1\text{ kHz}$

| PARAMETER | CONDITIONS | SYMBOL | MIN. | TYP. | MAX. | UNIT |
|---------------------------------------|---|--------------|------|------|------|---------------|
| FM PERFORMANCE | | | | | | |
| RF sensitivity | | | | | | |
| RF input voltage | -3 dB before limiting | V_{iFM} | - | 2.3 | 4.0 | μV |
| Noise | | | | | | |
| Signal plus noise-to-noise ratio for: | | | | | | |
| RF input signal voltage (V_i) | | | | | | |
| $V_i = 3.0\ \mu\text{V}$ | | $(S + N)/N$ | 23 | 26 | - | dB |
| $V_i = 1\text{ mV}$ | | $(S + N)/N$ | - | 60 | - | dB |
| Optimum source impedance | | Z_{source} | - | 50 | - | Ω |
| Noise factor | optimum noise impedance | NF | - | 6 | - | dB |
| AF output voltage | $V_i = 100\ \mu\text{V}$ | V_o | 75 | 90 | - | mV |
| Total harmonic distortion | $V_i = 30\ \mu\text{V}$ to 50 mV | THD | - | 0.8 | - | % |
| | $V_i = 1\text{ mV}$; $\Delta f = 75\text{ kHz}$ | THD | - | 3 | - | % |
| | $V_i = 100\text{ mV}$; $\Delta f = 75\text{ kHz}$ | THD | - | 3 | - | % |
| AM suppression | note 2 | | | | | |
| RF input signal | $V_i = 100\ \mu\text{V}$ to 10 mV | AMS | - | 50 | - | dB |
| Oscillator voltage (pin 18) | $f_{osc} = 100\text{ MHz}$ $V_P = 1.5\text{ V}$ | V_{osc} | - | 220 | - | mV |
| IF rejection ratio | | V_{osc} | 100 | - | - | mV |
| | | IF_{rr} | - | 60 | - | dB |
| AFC | $f_{osc} = 111.2\text{ MHz}$ | | | | | |
| | $V_{17} = 1.4\text{ V}$ | Δf | - | -620 | - | kHz |
| | $V_{17} = 0.2\text{ V}$ | Δf | - | +420 | - | kHz |

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| PARAMETER | CONDITIONS | SYMBOL | MIN. | TYP. | MAX. | UNIT |
|---------------------------------|---------------------------------|-------------------------|------|------|------|------|
| Temperature behaviour | -15 to + 60 °C (only the IC) | | | | | |
| RF sensitivity | -3 dB limiting | ΔV_i | - | -6 | - | dB |
| Output voltage | $V_i = 100 \mu\text{V}$ | ΔV_o | - | -2 | - | dB |
| Oscillator frequency | | Δf_{osc} | - | -0.3 | - | % |
| Supply voltage behaviour | $V_P = 1.8$ to 15 V | | | | | |
| RF sensitivity | -3 dB limiting | ΔV_i | - | 6 | - | dB |
| Output voltage | $V_i = 100 \mu\text{V}$ | ΔV_o | - | 0.5 | - | dB |
| Oscillator frequency | | Δf_{osc} | - | 100 | - | kHz |
| Oscillator voltage | | ΔV_{osc} | - | 1.0 | - | dB |

Notes to the AC characteristics

$$1. \quad \alpha = \frac{V_i \text{ at } f_i = 455 \text{ kHz}}{V_i \text{ at } f_i = 1 \text{ MHz}}$$

2. AM suppression is measured at:
 $f_{\text{mod}} = 400$ Hz, $m = 0.3$ for AM;
 $f_{\text{mod}} = 1$ kHz, $\Delta f = 75$ kHz for FM.

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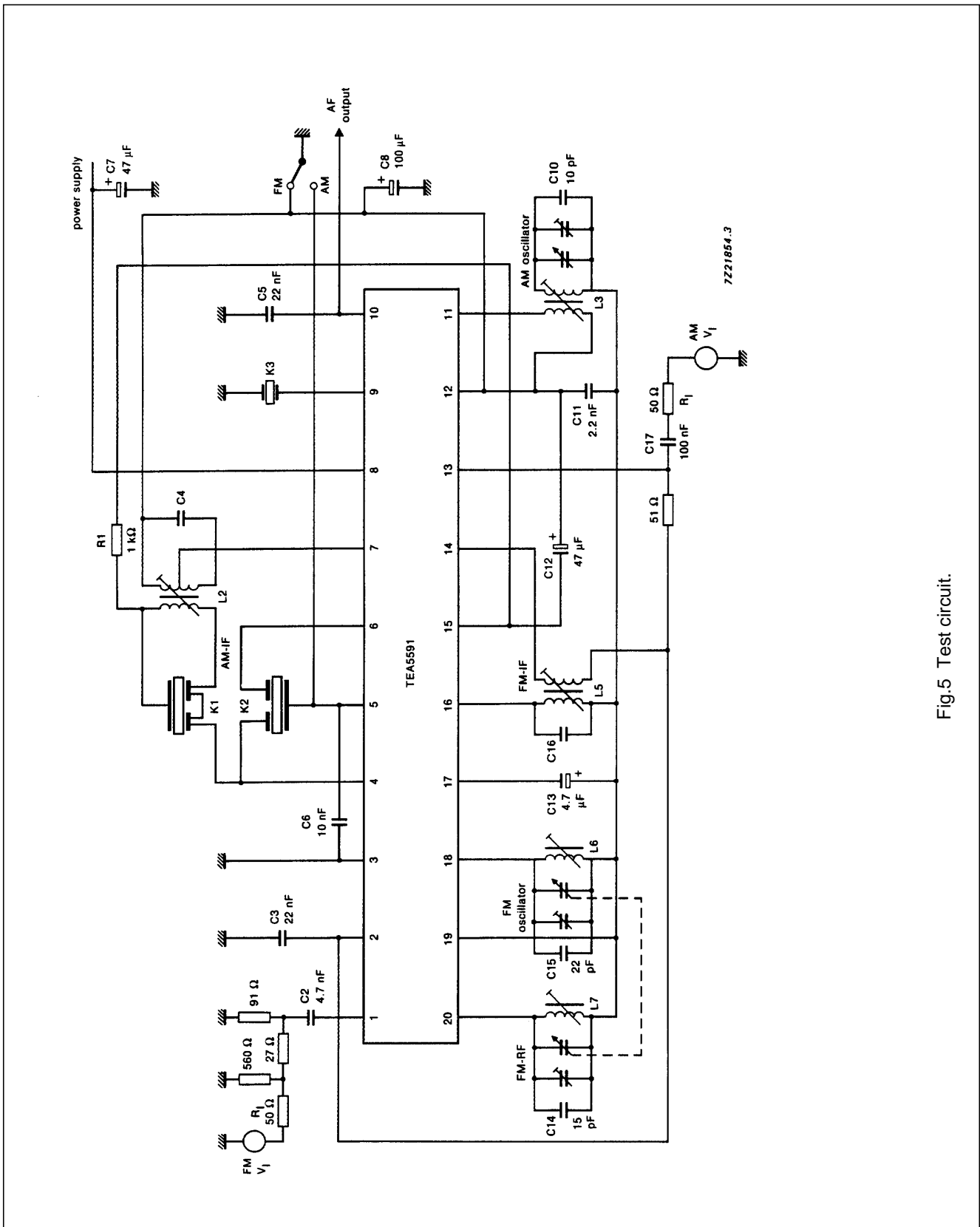


Fig.5 Test circuit.

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APPLICATION INFORMATION

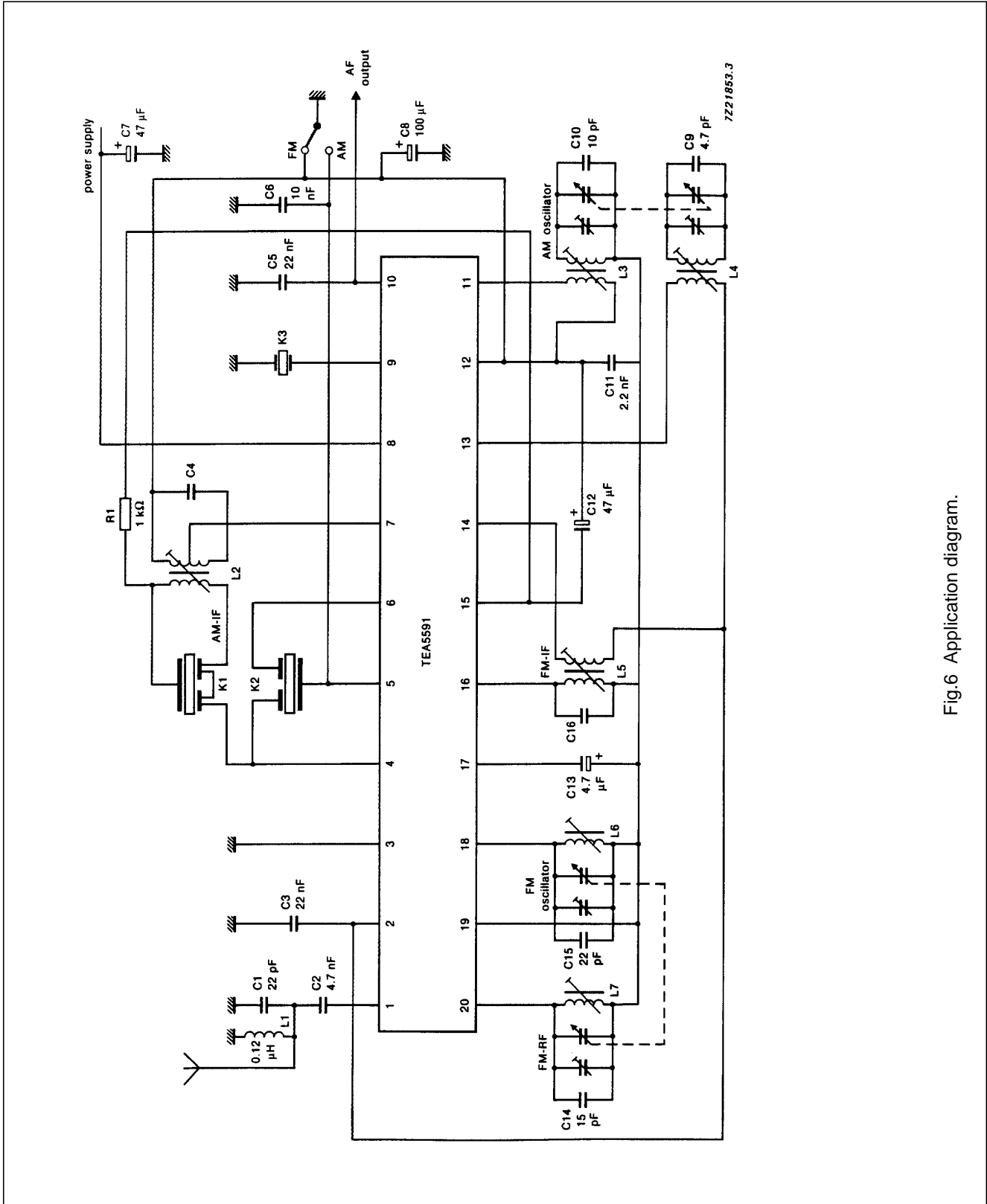
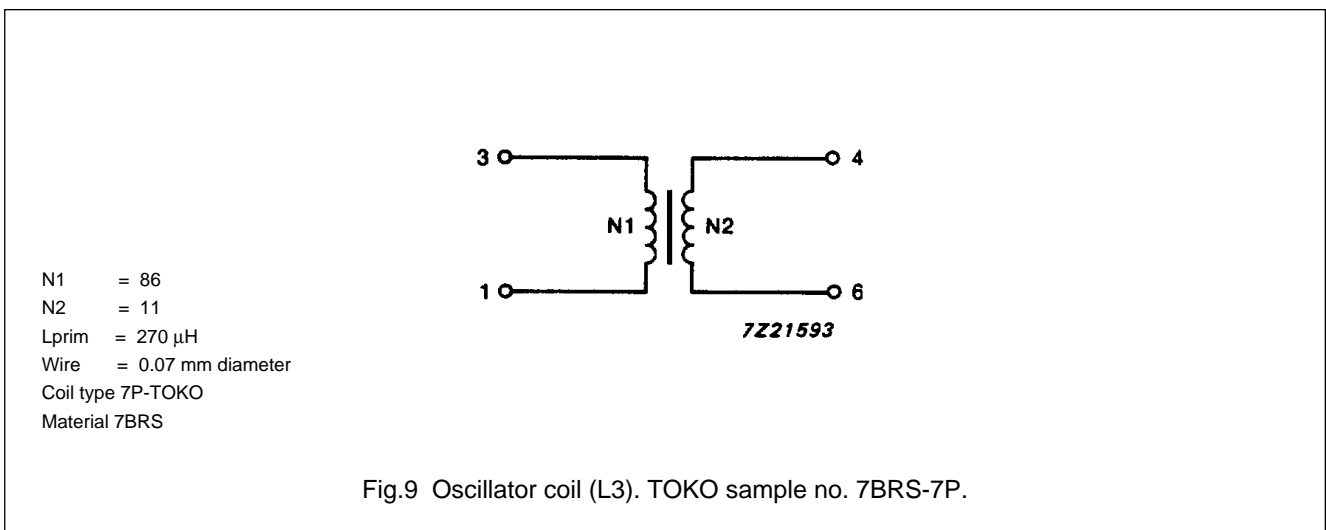
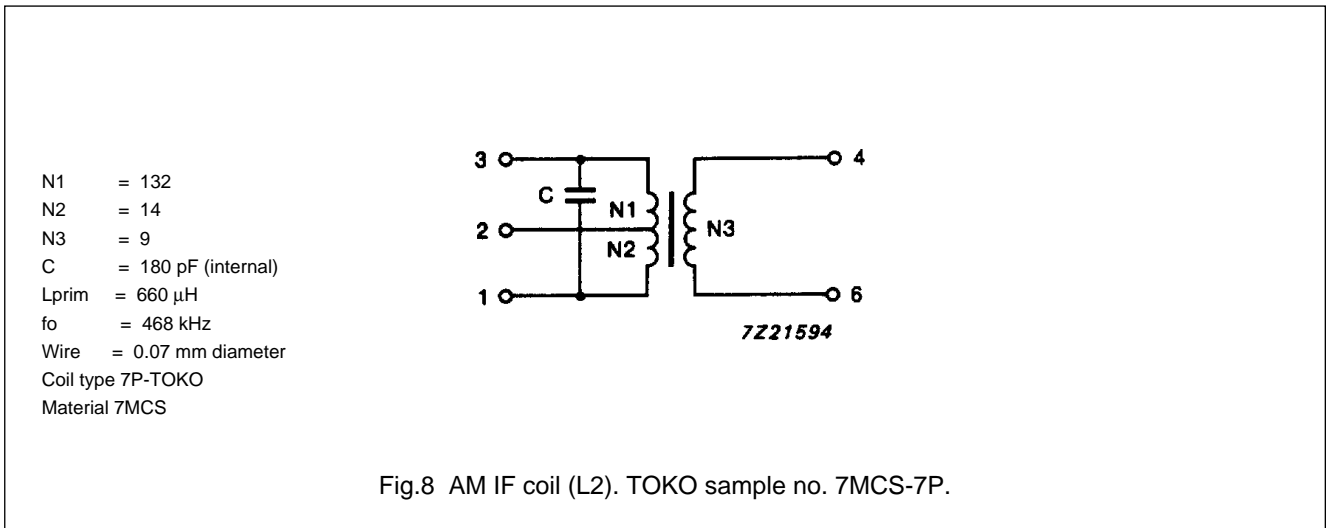
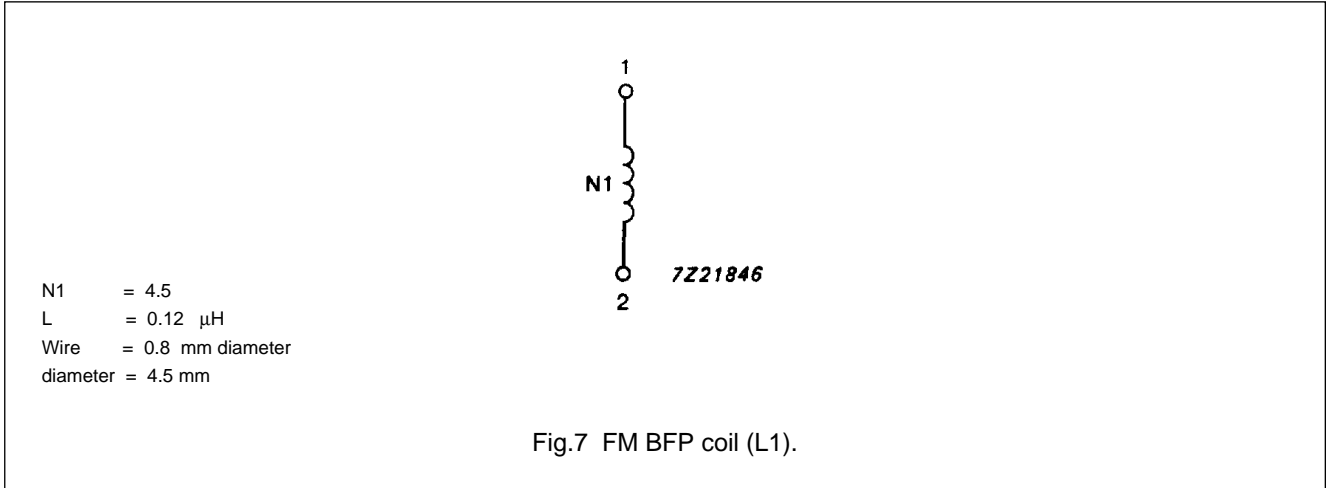


Fig.6 Application diagram.

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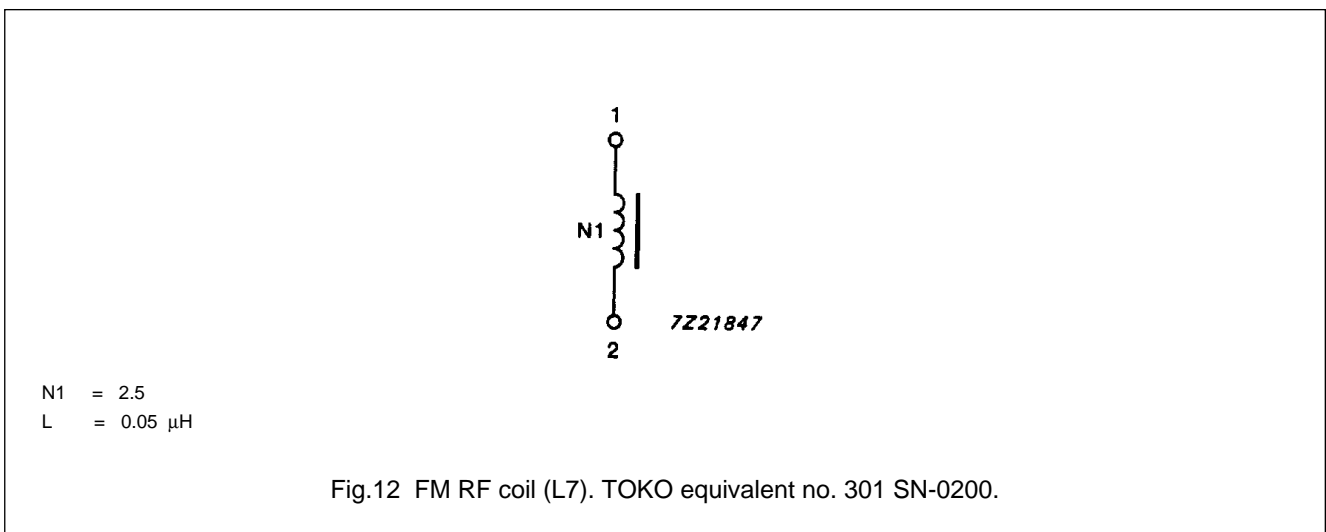
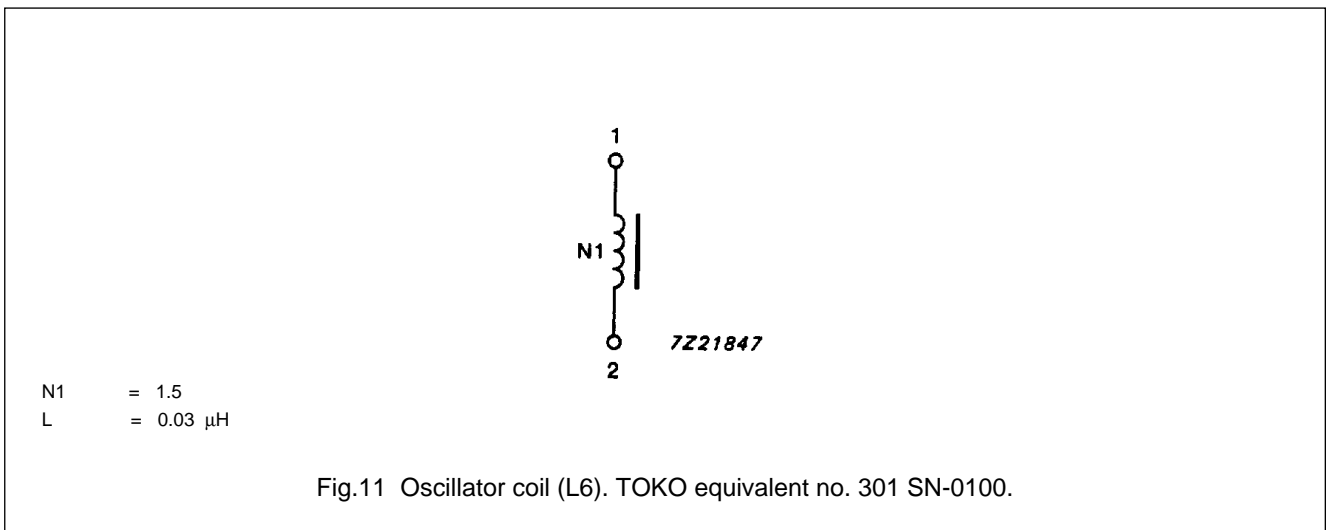
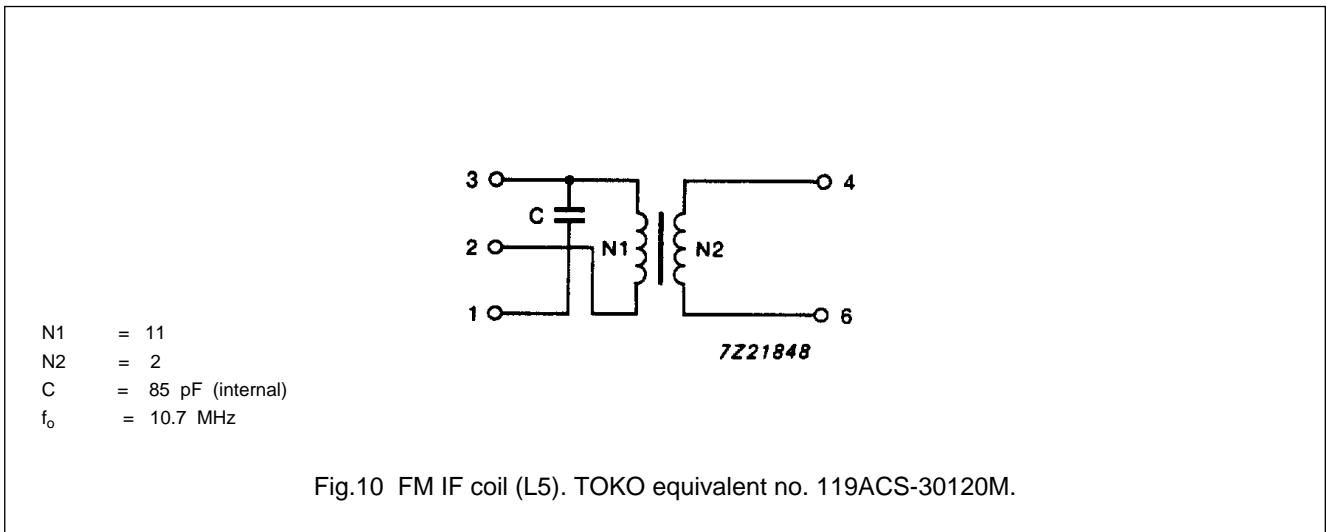
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Component data



AM/FM radio receiver circuit

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FERROCEPTOR COIL

L4: N1 = 105; N2 = 10; L = 625 μ H

CERAMIC FILTERS

AM IF (K1). SFZ468 HL.

FM IF (K2). SFE10 . 7 MS2.

FM detector (K3). CDA10 . 7 MC1.

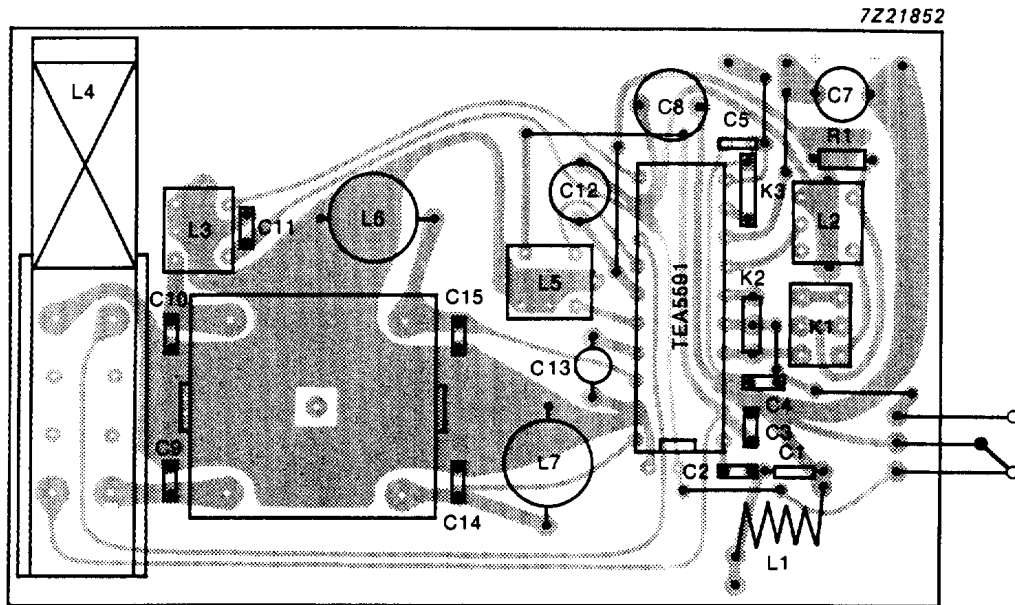
TUNING CAPACITORS

AM 140/82 pF

FM 2 \times 20 pF

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Physical dimensions of the printed circuit board = 5.0 x 8.1 cm.

Fig.13 Printed-circuit board component side, showing component layout. For circuit diagram see Fig.6.

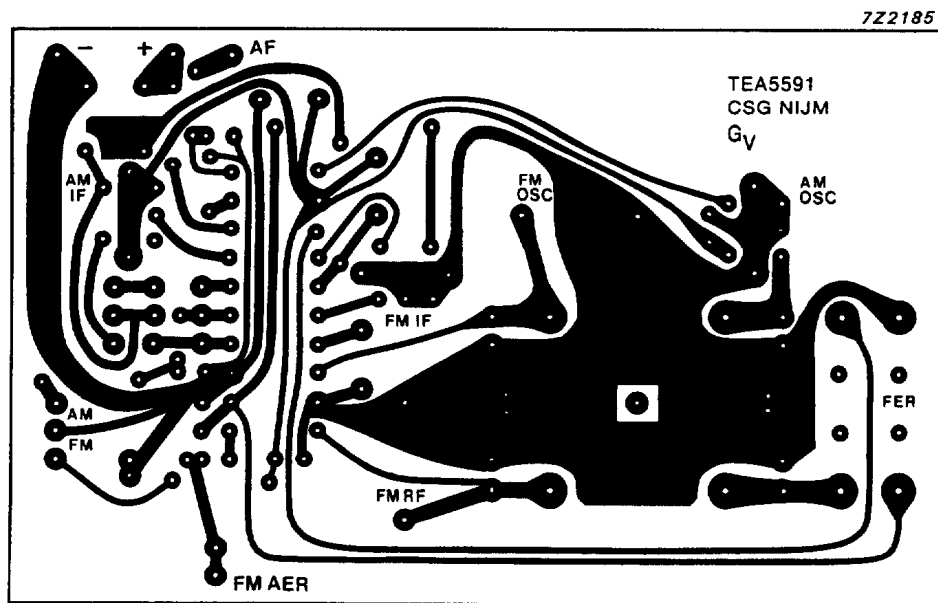


Fig.14 Printed-circuit board showing track side.

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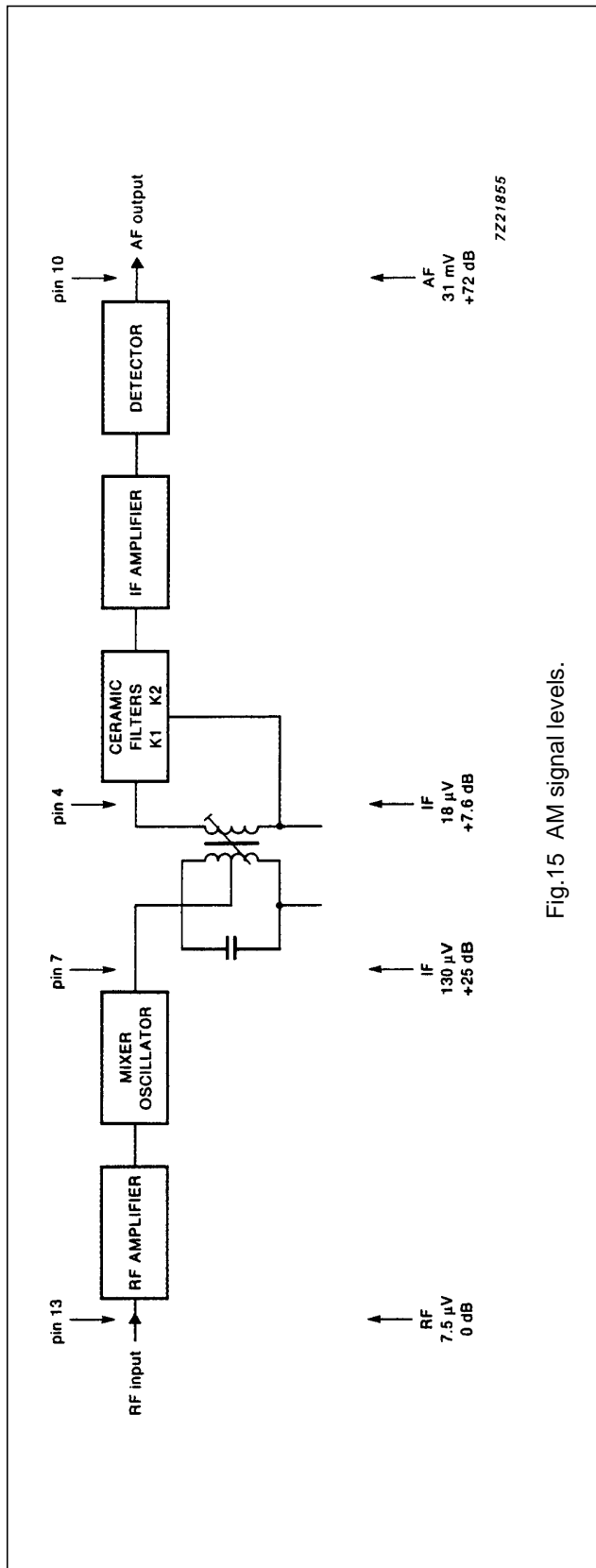


Fig.15 AM signal levels.

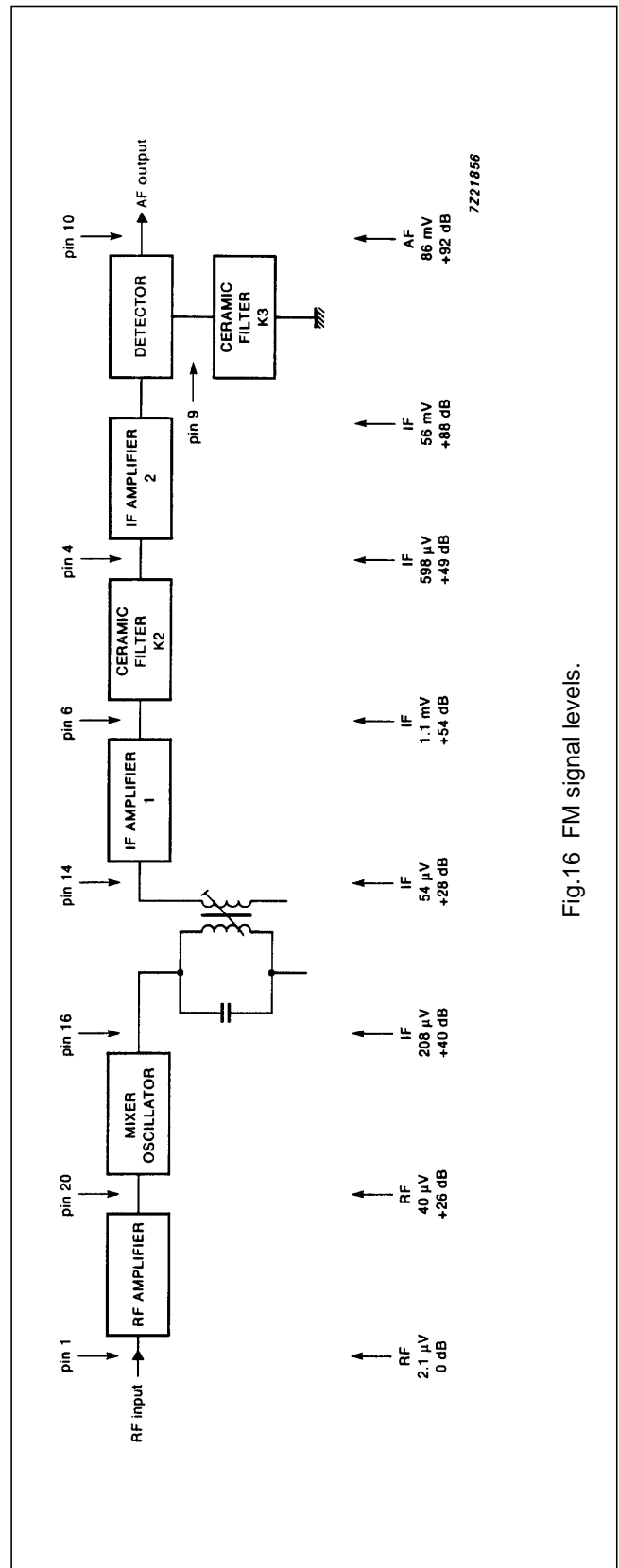


Fig.16 FM signal levels.

AM/FM radio receiver circuit

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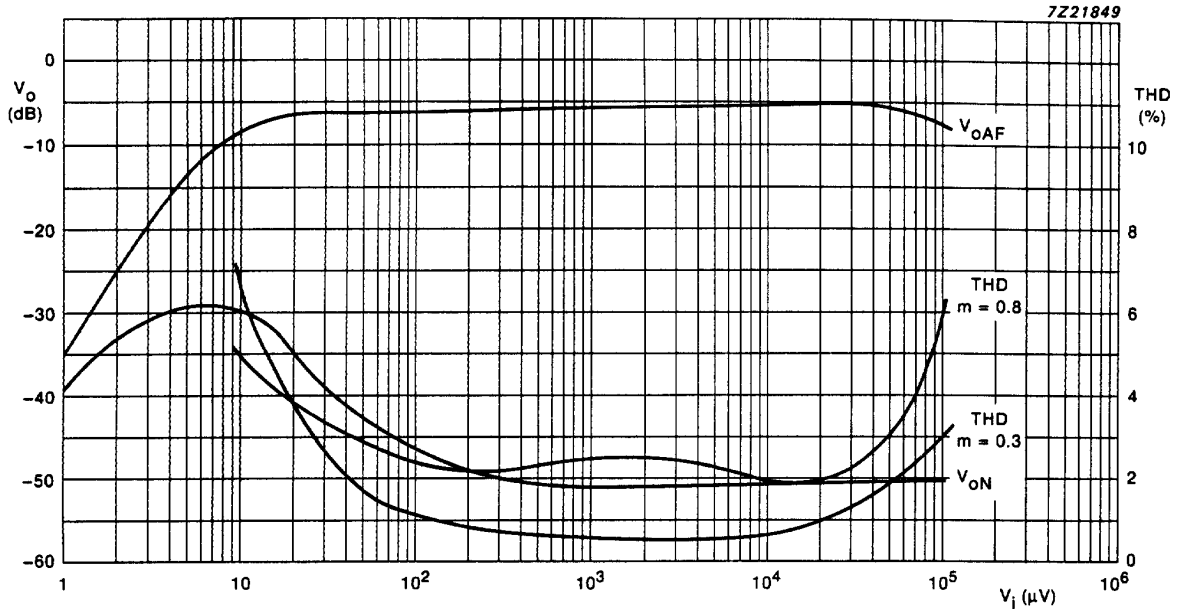


Fig.17 Signal and noise (V_{oAF}), noise (V_{oN}); reference level 0 dB = 100 mV, and total harmonic distortion (THD) as a function of input voltage (V_i) at pin 13. Measured in test circuit Fig.5. AM AGC is measured at $f_i =$ MHz; $f_{mod} = 1$ kHz; $m = 0.3$. AM distortion is measured at $f_i = 1$ MHz; $f_{mod} = 1$ kHz.

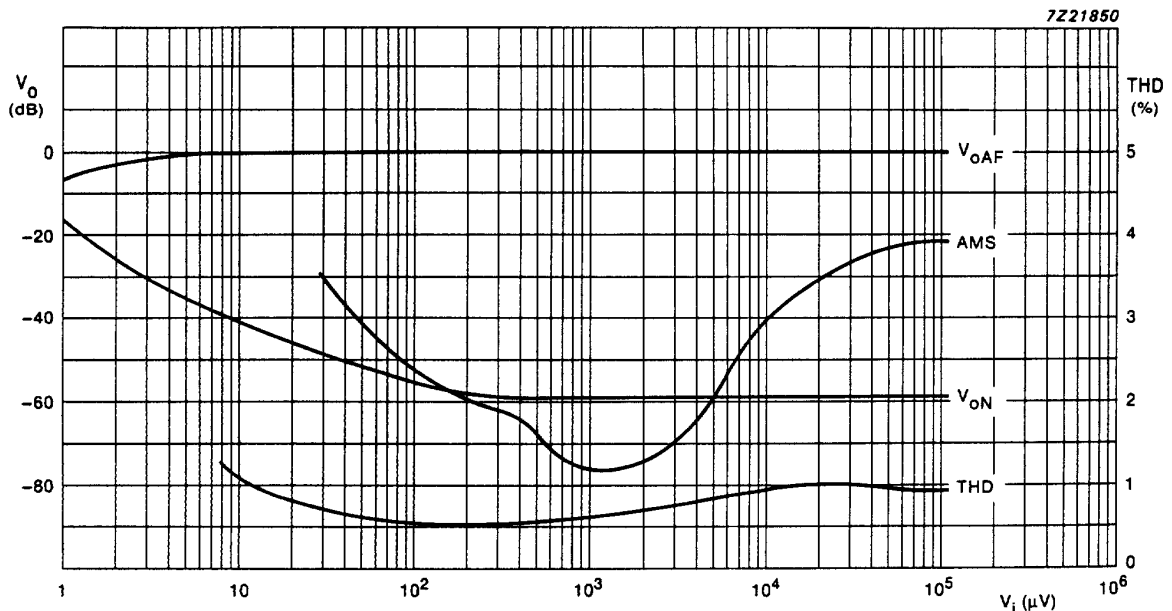


Fig.18 Signal and noise (V_{oAF}), noise (V_{oN}); reference level 0 dB = 100 mV; AM suppression (AMS) and total harmonic distortion (THD) as a function of input voltage (V_i) at pin 1. Measured in test circuit Fig.5 at $f_i = 98$ MHz; $f_{mod} = 1$ kHz; $\Delta f = 22.5$ kHz. AM suppression is measured at $f_{mod} = 400$ Hz, $m = 0.3$ for AM; $f_{mod} = 1$ kHz, $\Delta f = 75$ kHz for FM.

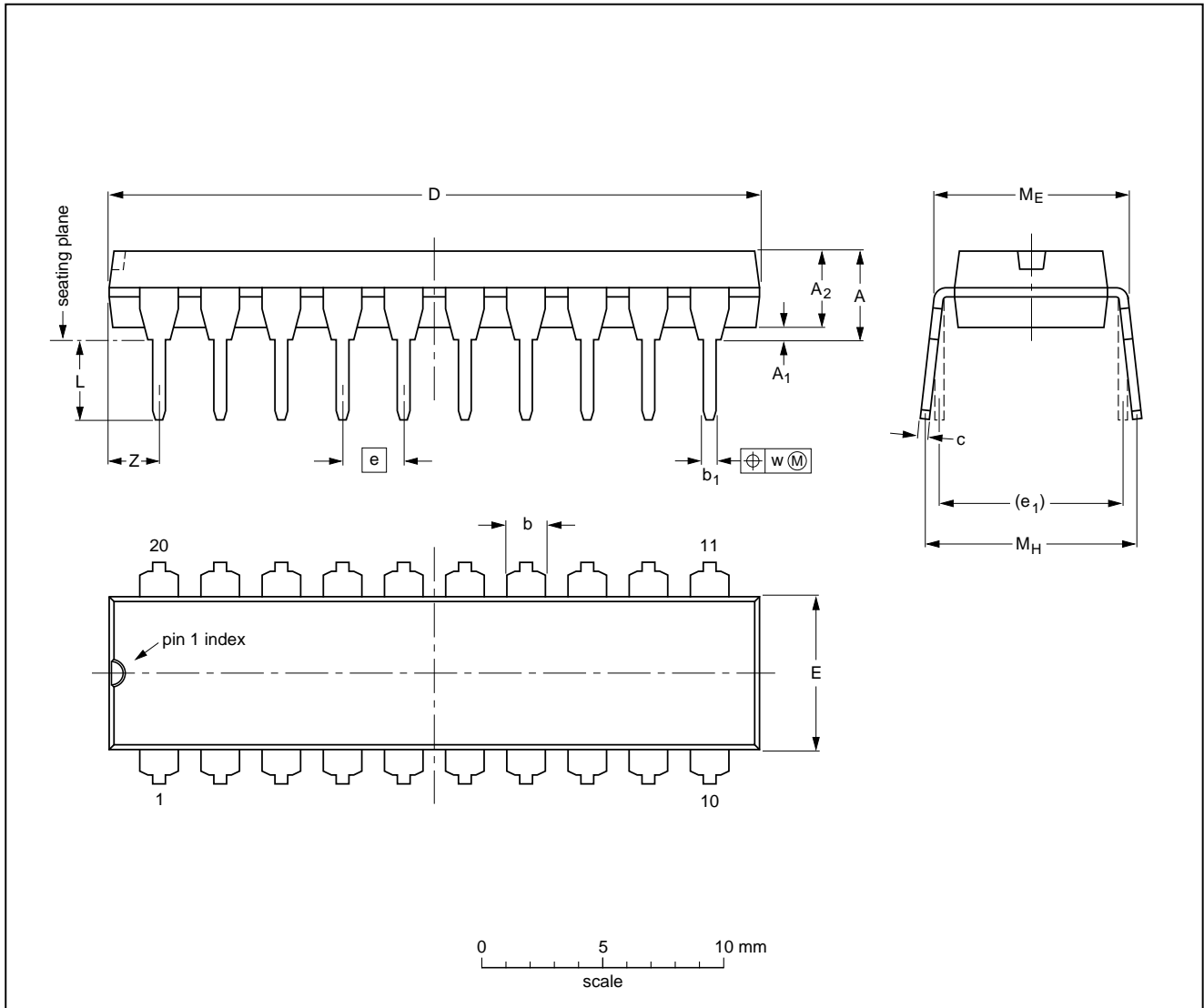
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PACKAGE OUTLINE

DIP20: plastic dual in-line package; 20 leads (300 mil)

SOT146-1



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

| UNIT | A max. | A ₁ min. | A ₂ max. | b | b ₁ | c | D ⁽¹⁾ | E ⁽¹⁾ | e | e ₁ | L | M _E | M _H | w | Z ⁽¹⁾ max. |
|--------|--------|---------------------|---------------------|----------------|----------------|----------------|------------------|------------------|------|----------------|--------------|----------------|----------------|-------|-----------------------|
| mm | 4.2 | 0.51 | 3.2 | 1.73 1.30 | 0.53 0.38 | 0.36 0.23 | 26.92 26.54 | 6.40 6.22 | 2.54 | 7.62 | 3.60 3.05 | 8.25 7.80 | 10.0 8.3 | 0.254 | 2.0 |
| inches | 0.17 | 0.020 | 0.13 | 0.068 0.051 | 0.021 0.015 | 0.014 0.009 | 1.060 1.045 | 0.25 0.24 | 0.10 | 0.30 | 0.14 0.12 | 0.32 0.31 | 0.39 0.33 | 0.01 | 0.078 |

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 | | | |
| SOT146-1 | | | SC603 | | | 92-11-17 95-05-24 |

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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

| Data sheet status | |
|---|---|
| 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. |
| Limiting values | |
| 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. | |
| Application information | |
| 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.