

# DATA SHEET

## **TDA5330T**

VHF, UHF and Hyperband  
mixer/oscillator for TV and VCR  
3-band tuners

Product specification  
File under Integrated Circuits, IC02

January 1988

## VHF, UHF and Hyperband mixer/oscillator for TV and VCR 3-band tuners

**TDA5330T**

### GENERAL DESCRIPTION

The TDA5330T is a monolithic integrated circuit that performs the band A, band B and band C mixer/oscillator functions in TV and VCR tuners. This device gives the designer the capability to design an economical and physically small 3-band tuner which will be capable of meeting the most stringent requirements e.g. FTZ or FCC. The tuner development time can be drastically reduced by using this device.

### Features

- Balanced mixer with a common emitter input for band A
- Amplitude-controlled oscillator for band A
- Balanced mixer with common base input for band B and C
- Balanced oscillator for band B and C
- Local oscillator buffer output for external prescaler
- SAW filter preamplifier with an output impedance of 100  $\Omega$
- Bandgap voltage stabilizer for oscillator stability
- Electronic bandswitch

### QUICK REFERENCE DATA

| PARAMETER                | CONDITIONS          | SYMBOL         | MIN. | TYP. | MAX. | UNIT       |
|--------------------------|---------------------|----------------|------|------|------|------------|
| Supply voltage           |                     | $V_{19-2, 26}$ | –    | 12   | –    | V          |
| Band A frequency range   |                     | $f_A$          | 48   | –    | 180  | MHz        |
| Band B frequency range   |                     | $f_B$          | 160  | –    | 470  | MHz        |
| Band C frequency range   |                     | $f_C$          | 430  | –    | 860  | MHz        |
| Conversion noise         |                     | F              | 7    | –    | 11   | dB         |
| Band A input voltage     | 1% cross-modulation | $V_{24-26}$    | –    | 100  | –    | dB $\mu$ V |
| Band B and C input power | 1% cross-modulation | $P_I$          | –    | –21  | –    | dBm        |
| Band A voltage gain      |                     | $G_V$          | –    | 24   | –    | dB         |
| Band B voltage gain      |                     | $G_V$          | –    | 37   | –    | dB         |
| Band C voltage gain      |                     | $G_V$          | –    | 36   | –    | dB         |

### PACKAGE OUTLINE

28-lead mini-pack , plastic (SO20; SOT163A); SOT 163-1; 1996 November 28.

VHF, UHF and Hyperband mixer/oscillator  
for TV and VCR 3-band tuners

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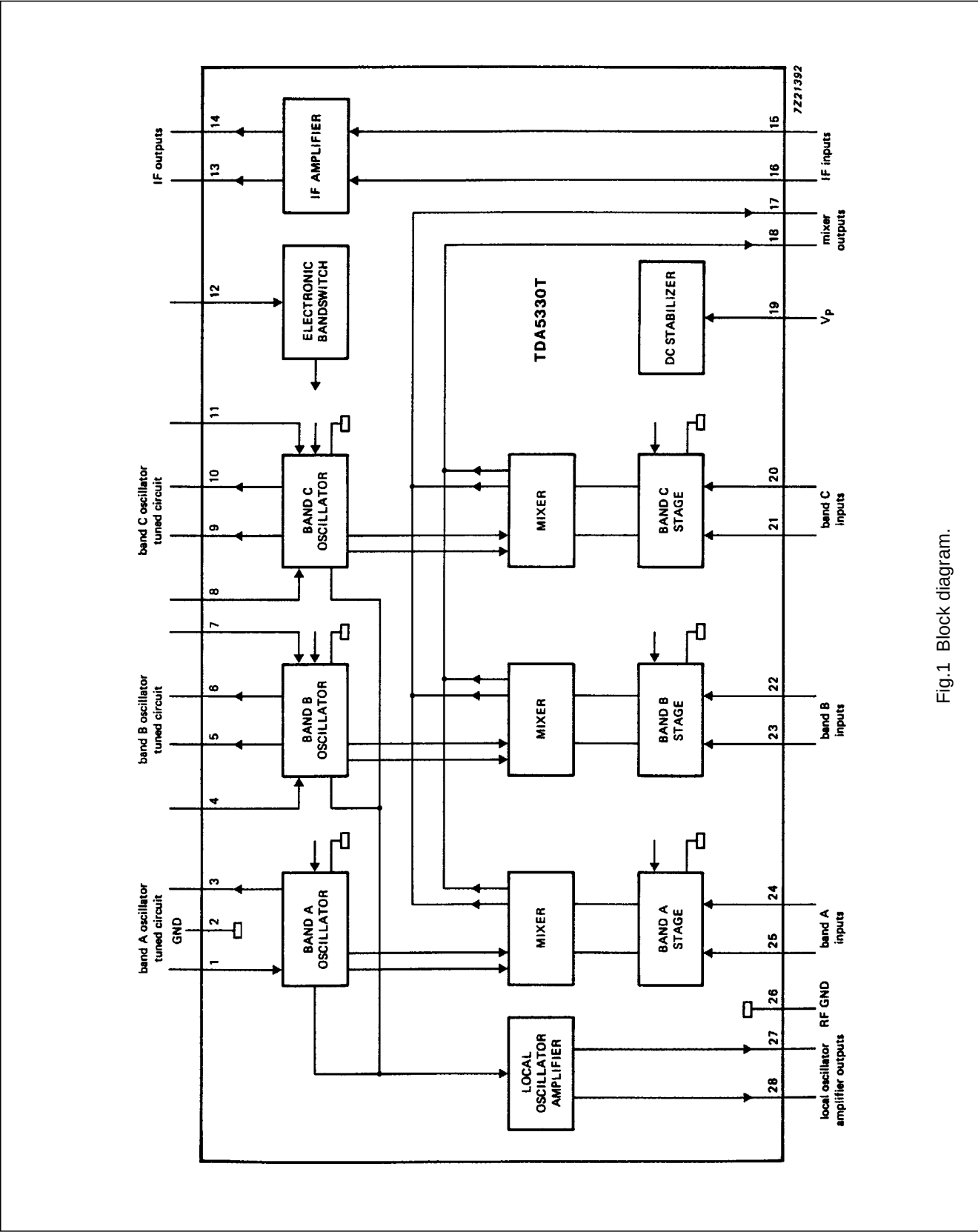


Fig.1 Block diagram.

VHF, UHF and Hyperband mixer/oscillator  
for TV and VCR 3-band tuners

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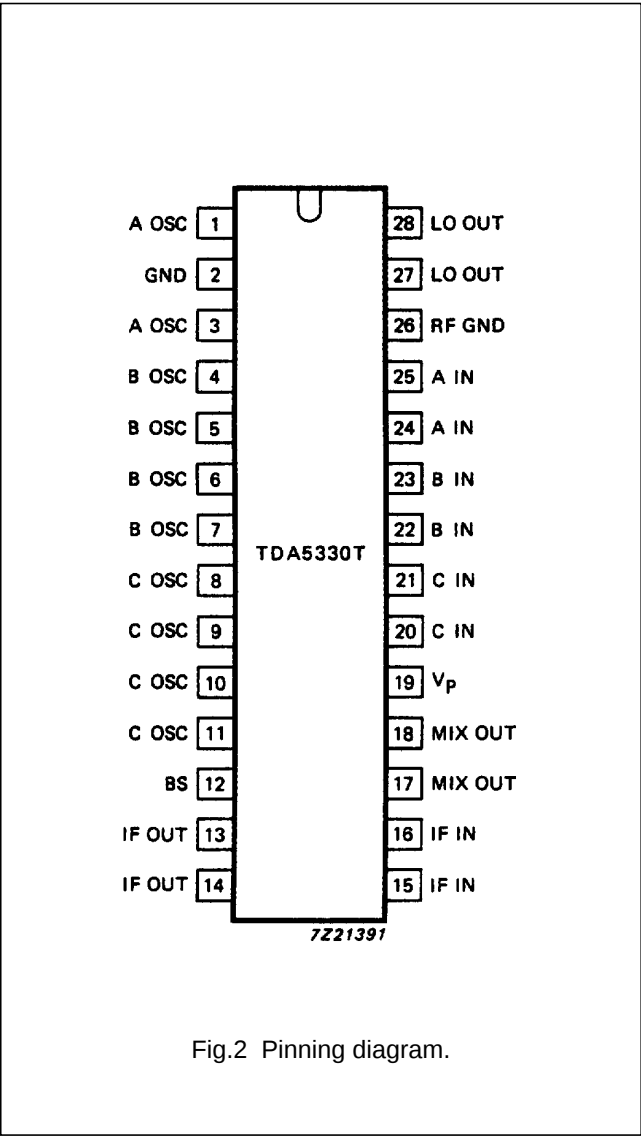


Fig.2 Pinning diagram.

PINNING

|    |                |                                   |
|----|----------------|-----------------------------------|
| 1  | A OSC          | band A oscillator input           |
| 2  | GND            | ground (0 V)                      |
| 3  | A OSC          | band A oscillator output          |
| 4  | B OSC          | band B oscillator input           |
| 5  | B OSC          | band B oscillator output          |
| 6  | B OSC          | band B oscillator output          |
| 7  | B OSC          | band B oscillator input           |
| 8  | C OSC          | band C oscillator input           |
| 9  | C OSC          | band C oscillator output          |
| 10 | C OSC          | band C oscillator output          |
| 11 | C OSC          | band C oscillator input           |
| 12 | BS             | electronic bandswitch             |
| 13 | IF OUT         | IF amplifier output               |
| 14 | IF OUT         | IF amplifier output               |
| 15 | IF IN          | IF amplifier input                |
| 16 | IF IN          | IF amplifier input                |
| 17 | MIX OUT        | mixer output                      |
| 18 | MIX OUT        | mixer output                      |
| 19 | V <sub>P</sub> | positive supply voltage           |
| 20 | C IN           | band C input                      |
| 21 | C IN           | band C input                      |
| 22 | B IN           | band B input                      |
| 23 | B IN           | band B input                      |
| 24 | A IN           | band A input                      |
| 25 | A IN           | band A input                      |
| 26 | RF GND         | ground for RF inputs              |
| 27 | LO OUT         | local oscillator amplifier output |
| 28 | LO OUT         | local oscillator amplifier output |

RATINGS

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

| PARAMETER                             | CONDITIONS | SYMBOL               | MIN. | MAX. | UNIT |
|---------------------------------------|------------|----------------------|------|------|------|
| Supply voltage                        |            | $V_P = V_{19-2, 26}$ | -0.3 | 14   | V    |
| Switching voltage                     |            | $V_{12}$             | 0    | 14   | V    |
| Output current of each pin to ground  |            | $I_O$                | -    | -10  | mA   |
| Maximum short-circuit time (all pins) |            | $t_{SC}$             | -    | 10   | s    |
| Storage temperature range             |            | $T_{stg}$            | -55  | +150 | °C   |
| Operating ambient temperature range   |            | $T_{amb}$            | -25  | +80  | °C   |

THERMAL RESISTANCE

From junction to ambient in free air

$R_{th\ j-a}$

typ. 75 K/W

# VHF, UHF and Hyperband mixer/oscillator for TV and VCR 3-band tuners

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## CHARACTERISTICS

$V_P = 12\text{ V}$ ;  $T_{\text{amb}} = 25\text{ }^{\circ}\text{C}$ ; unless otherwise specified.

| PARAMETER                                        | CONDITIONS                                  | SYMBOL           | MIN. | TYP. | MAX. | UNIT             |
|--------------------------------------------------|---------------------------------------------|------------------|------|------|------|------------------|
| Supply voltage                                   |                                             | $V_{19-2, 26}$   | 10   | —    | 13.2 | V                |
| Supply current                                   |                                             | $I_{19}$         | —    | 42   | 55   | mA               |
| Switching voltage;                               |                                             |                  |      |      |      |                  |
| band A                                           |                                             | $V_{12}$         | 0    | —    | 1.1  | V                |
| band B                                           |                                             | $V_{12}$         | 1.6  | —    | 2.4  | V                |
| band C                                           |                                             | $V_{12}$         | 3.0  | —    | 5.0  | V                |
| Switching current;                               |                                             |                  |      |      |      |                  |
| band C                                           |                                             | $I_{12}$         | —    | —    | 50   | $\mu\text{A}$    |
| <b>Band A Mixer<br/>(including IF amplifier)</b> | measured using<br>circuit shown in<br>Fig.9 |                  |      |      |      |                  |
| Frequency range                                  |                                             | $f_A$            | 48   | —    | 180  | MHz              |
| Noise figure                                     | note 1;                                     |                  |      |      |      |                  |
|                                                  | 50 MHz                                      | NF               | —    | 7.5  | 9    | dB               |
|                                                  | 180 MHz                                     | NF               | —    | 9    | 10   | dB               |
| Optimum source<br>conductance                    | 50 MHz                                      | $G_{24-26}$      | —    | 0.5  | —    | mS               |
|                                                  | 180 MHz                                     | $G_{24-26}$      | —    | 1.1  | —    | mS               |
| Input admittance                                 | see Fig.9                                   |                  |      |      |      |                  |
| Input capacitance                                | 50 - 180 MHz                                | $C_{24-26}$      | —    | 2    | —    | pF               |
| Input voltage                                    | 1% cross-modulation;<br>in channel          | $V_{24-26}$      | 97   | 100  | —    | dB $\mu\text{V}$ |
| Input voltage                                    | 10 kHz pulling;<br>in channel               | $V_{24-26}$      | 100  | 108  | —    | dB $\mu\text{V}$ |
| Voltage gain                                     | 20 log<br>( $V_{13-14}/V_{24}$ )            | $G_v$            | 22.5 | 25.0 | 27.5 | dB               |
| <b>Band A mixer</b>                              |                                             |                  |      |      |      |                  |
| Conversion                                       |                                             |                  |      |      |      |                  |
| transadmittance                                  | $S_c = I_{17}/V_{24}$                       |                  |      |      |      |                  |
| mixer                                            | $= -I_{18}/V_{24}$                          | $S_{c24-17, 18}$ | —    | 3.5  | —    | mS               |
| Mixer output                                     |                                             |                  |      |      |      |                  |
| admittance                                       | pins 15 and 16                              |                  | —    | 0.1  | —    | mS               |
| Mixer output                                     |                                             |                  |      |      |      |                  |
| capacitance                                      |                                             | $C_{17-18}$      | —    | 2    | —    | pF               |

# VHF, UHF and Hyperband mixer/oscillator for TV and VCR 3-band tuners

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| PARAMETER                          | CONDITIONS                                       | SYMBOL     | MIN. | TYP. | MAX. | UNIT |
|------------------------------------|--------------------------------------------------|------------|------|------|------|------|
| <b>Band A oscillator</b>           |                                                  |            |      |      |      |      |
| Frequency range                    |                                                  | $f_A$      | 80   | —    | 216  | MHz  |
| Frequency shift                    | $\Delta V_P = 10\%$                              | $\Delta f$ | —    | —    | 200  | kHz  |
| Frequency drift                    | $\Delta T = 25\text{ }^\circ\text{C}$            | $\Delta f$ | —    | —    | 400  | kHz  |
| Frequency drift                    | 5 s to 15 min after switching on                 | $\Delta f$ | —    | —    | 200  | kHz  |
| <b>Band B mixer (including IF)</b> |                                                  |            |      |      |      |      |
|                                    | measured using circuit shown in Fig.9            |            |      |      |      |      |
|                                    | measurements using hybrid; note 2                |            |      |      |      |      |
| Frequency range                    |                                                  | $f_B$      | 160  | —    | 470  | MHz  |
| Noise figure                       | pins 22 and 23;                                  |            |      |      |      |      |
|                                    | 200 MHz                                          | NF         | —    | 8    | 10   | dB   |
|                                    | 470 MHz                                          | NF         | —    | 8    | 10   | dB   |
| Input admittance                   | see Fig.5                                        |            |      |      |      |      |
| Available input power              | 1% cross-modulation; in channel; pins 22 and 23; |            |      |      |      |      |
|                                    | 200 MHz                                          | $P_{AI}$   | −24  | −21  | —    | dBm  |
|                                    | 470 MHz                                          | $P_{AI}$   | −24  | −21  | —    | dBm  |
| 10 kHz pulling                     | pins 22 and 23; in channel;                      |            |      |      |      |      |
|                                    | 470 MHz                                          |            | —    | −11  | —    | dBm  |
| N+5 – 1 MHz pulling                | note 3;                                          |            |      |      |      |      |
|                                    | 430 MHz                                          |            | —    | −11  | —    | dBm  |
| Voltage gain                       | note 4;                                          |            |      |      |      |      |
|                                    | 200 MHz                                          | $G_V$      | 33   | 36   | 39   | dB   |
|                                    | 470 MHz                                          | $G_V$      | 33   | 36   | 39   | dB   |
| <b>Band B oscillator</b>           |                                                  |            |      |      |      |      |
| Frequency range                    |                                                  | $f_B$      | 200  | —    | 500  | MHz  |
| Frequency shift                    | $\Delta V_P = 10\%$                              | $\Delta f$ | —    | —    | 400  | kHz  |
| Frequency drift                    | $\Delta T = 25\text{ }^\circ\text{C}$            | $\Delta f$ | —    | —    | 500  | kHz  |
| Frequency drift                    | 5 s to 15 min after switching on                 | $\Delta f$ | —    | —    | 200  | kHz  |

# VHF, UHF and Hyperband mixer/oscillator for TV and VCR 3-band tuners

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| PARAMETER                              | CONDITIONS                                                                                  | SYMBOL          | MIN. | TYP. |       | MAX. | UNIT   |
|----------------------------------------|---------------------------------------------------------------------------------------------|-----------------|------|------|-------|------|--------|
| <b>Band C mixer<br/>(including IF)</b> | measured<br>using circuit shown in<br>Fig.9;<br><br>measurements<br>using hybrid;<br>note 2 |                 |      |      |       |      |        |
| Frequency range                        |                                                                                             | f <sub>C</sub>  | 430  | –    |       | 860  | MHz    |
| Noise figure                           | pins 20 and 21;<br>430 MHz                                                                  | NF              | –    | 9    |       | 11   | dB     |
|                                        | 860 MHz                                                                                     | NF              | –    | 9    |       | 11   | dB     |
| Input admittance                       | see Fig.6                                                                                   |                 |      |      |       |      |        |
| Available input power                  | 1% cross-modulation<br>in channel;<br>pins 20 and 21;<br>430 MHz                            | P <sub>AI</sub> | –25  | –21  |       | –    | dBm    |
|                                        | 860 MHz                                                                                     | P <sub>AI</sub> | –25  | –21  |       | –    | dBm    |
| 10 kHz pulling                         | pins 20 and 21;<br>in channel;<br>860 MHz                                                   |                 | –    | –20  |       | –    | dBm    |
| N+5 – 1 MHz pulling                    | note 3;<br>820 MHz                                                                          |                 | –42  | –35  |       | –    | dBm    |
| Voltage gain                           | note 4;<br>430 MHz                                                                          | G <sub>V</sub>  | 33   | 36   |       | 39   | dB     |
|                                        | 860 MHz                                                                                     | G <sub>V</sub>  | 33   | 36   |       | 39   | dB     |
| <b>Band C oscillator</b>               |                                                                                             |                 |      |      |       |      |        |
| Frequency range                        |                                                                                             | f <sub>C</sub>  | 470  | –    |       | 900  | MHz    |
| Frequency shift                        | ΔV <sub>b</sub> = 10%                                                                       | Δf              | –    | –    |       | 400  | kHz    |
| Frequency drift                        | ΔT = 25 °C                                                                                  | Δf              | –    | –    |       | 800  | kHz    |
| Frequency drift                        | 5 s to 15 min after<br>switching on                                                         | Δf              | –    | –    |       | 200  | kHz    |
| <b>IF Amplifier</b>                    |                                                                                             |                 |      |      |       |      |        |
|                                        | note 5; differentially<br>measured at 36 MHz;<br>see Fig.7                                  |                 |      | mod. | phase |      |        |
| Input reflection<br>coefficient        |                                                                                             | S <sub>11</sub> | –    | –0,5 | –2.0  | –    | dB/deg |
| Reverse transmission<br>coefficient    |                                                                                             | S <sub>12</sub> | –    | –41  | –7    | –    | dB/deg |
| Forward transmission<br>coefficient    |                                                                                             | S <sub>21</sub> | –    | 12   | 160   | –    | dB/deg |
| Output reflection<br>coefficient       | see Fig.8                                                                                   | S <sub>22</sub> | –    | –9   | 10    | –    | dB/deg |

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| PARAMETER                                                     | CONDITIONS              | SYMBOL      | MIN. | TYP. | MAX. | UNIT |
|---------------------------------------------------------------|-------------------------|-------------|------|------|------|------|
| <b>LO output</b>                                              |                         |             |      |      |      |      |
| Output voltage into 50 $\Omega$ resistor                      |                         | $V_{27-28}$ | 14   | 35   | 100  | mV   |
| Spurious signal on LO output with respect to LO output signal | note 6                  | SRF         | —    | —    | −10  | dB   |
| LO signal harmonics with respect to LO signal                 | measured at 50 $\Omega$ | SHD         | —    | —    | −10  | dB   |

Notes

1. Measured with an input circuit for optimum noise. (see Fig.3).
2. The values have been corrected for hybrid and cable losses. The symmetrical output impedance of the circuit is 100  $\Omega$ .
3. The input level of a N+5 – 1 MHz signal (just visible).
4. The gain is defined as the transducer gain (measured in Fig.9) plus the voltage transformation ratio of L6 to L7 (6:1, 16 dB).
5. All S parameters are referred to a 50  $\Omega$  system.
6. Measured with 50  $\Omega$  output impedance on pins 26 and 27 and a RF input signal level of:  
RF level = 1 V at  $f < 180$  MHz  
RF power = 0.5 dBm at  $100 \text{ MHz} < f < 225$  MHz  
RF power = −10 dBm at  $225 \text{ MHz} < f < 860$  MHz

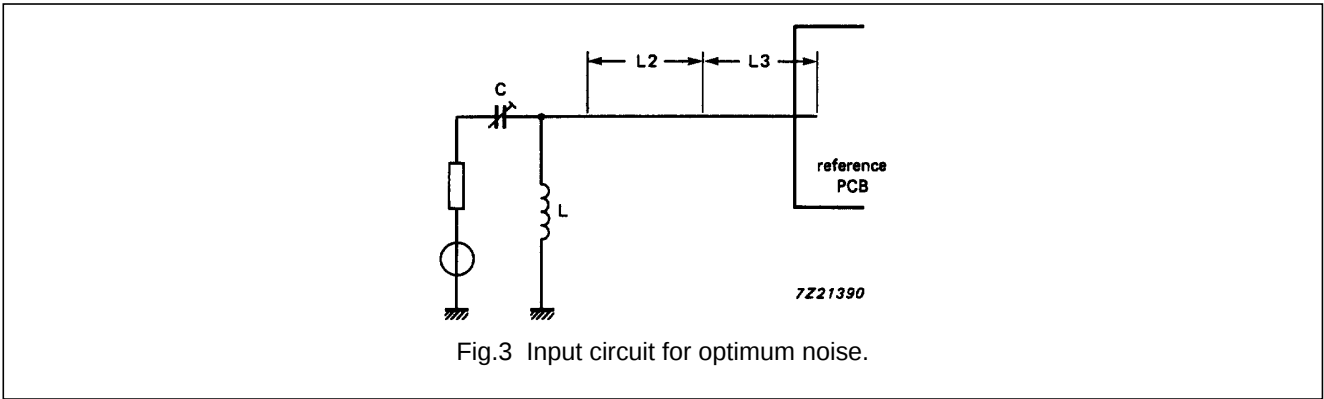


Table 1 Component values

| COMPONENT | F = 50 MHz                              | F = 180 MHz |
|-----------|-----------------------------------------|-------------|
| L         | 13 t, $\varnothing$ 5.5 mm, wire 0.7 mm | (note 1)    |
| L2        | rigid cable, 2.9 cm                     | (note 1)    |
| L3        | rigid cable, 4 cm                       | (note 1)    |
| C         | 9.6 pF                                  | (note 1)    |

Note

1. Value to be fixed.

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**Table 2** Electrical parameters of the circuit (for appropriate impedance and selectivity)

| PARAMETER                        | F = 50 MHz | F = 180 MHz | UNIT |
|----------------------------------|------------|-------------|------|
| Insertion loss                   | 0.3        | (note 1)    | dB   |
| Bandwidth                        | 8          | (note 1)    | MHz  |
| Image suppression                | 15         | (note 1)    | dB   |
| Output impedance (source for IC) | 2          | (note 1)    | kΩ   |

**Note**

1. Value to be fixed.

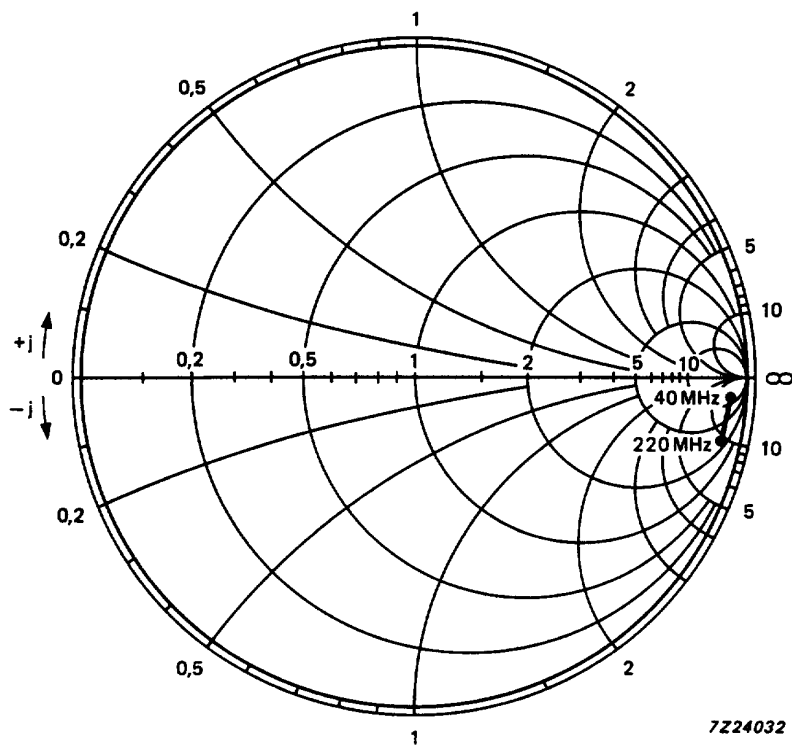


Fig.4 S11 of the band A mixer input (40 to 220 MHz).

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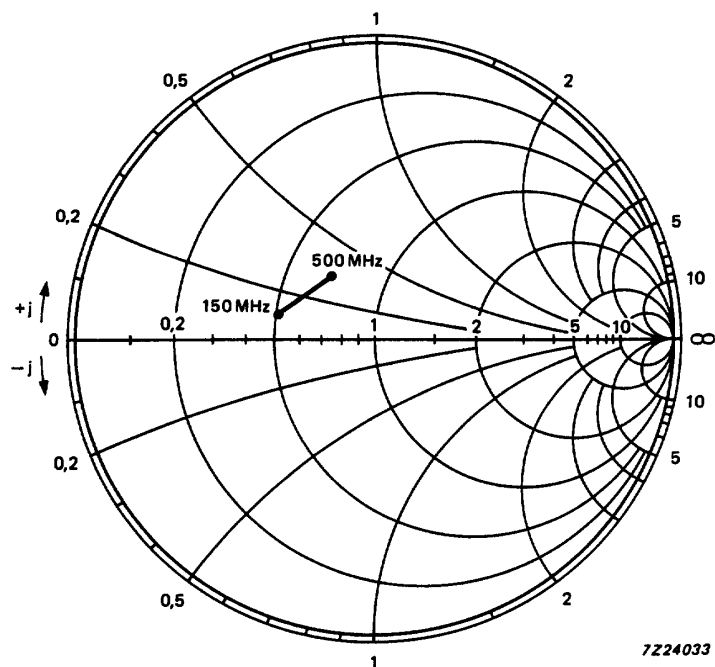


Fig.5 S11 of the band B mixer input (150 to 500 MHz).

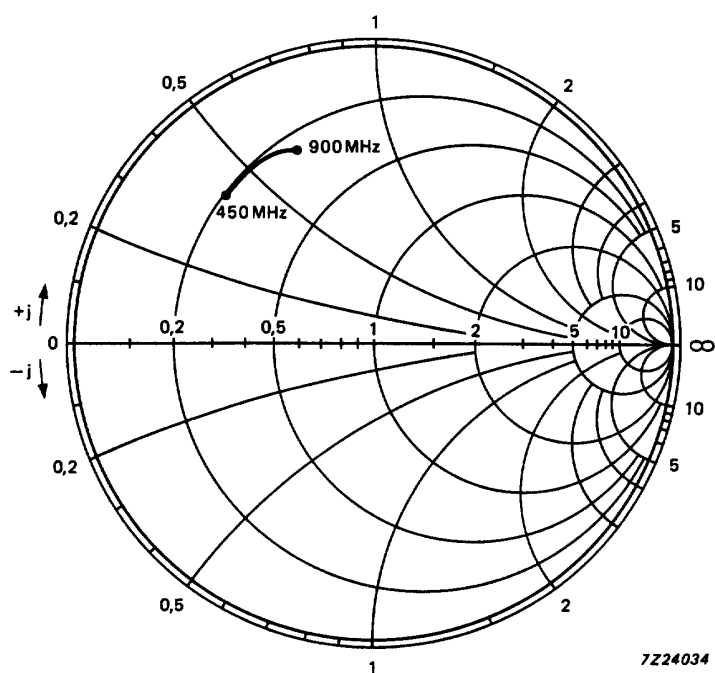


Fig.6 S11 of the band C mixer input (450 to 900 MHz).

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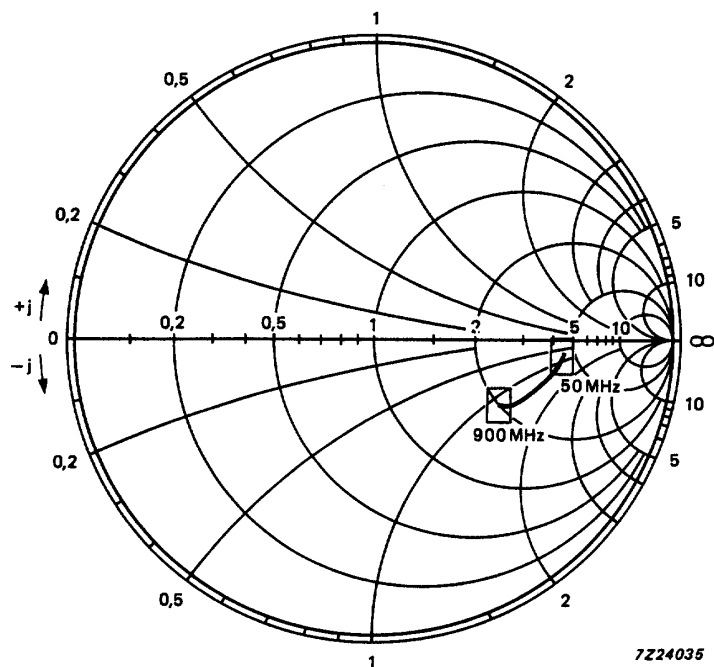


Fig.7 S11 of the LO output (50 to 900 MHz).

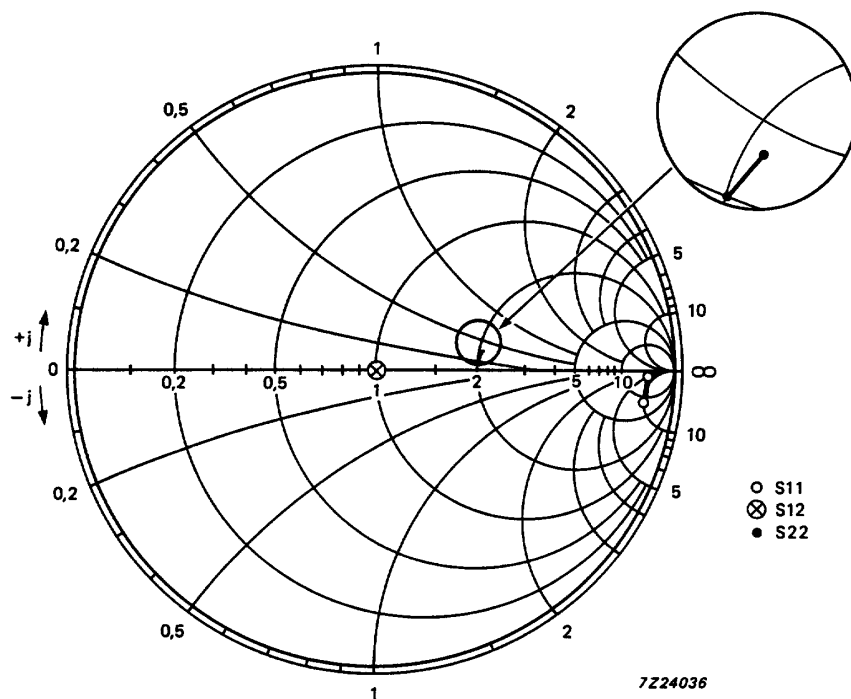


Fig.8 S11, S12 and S22 of the IF amplifier (30 to 60 MHz).

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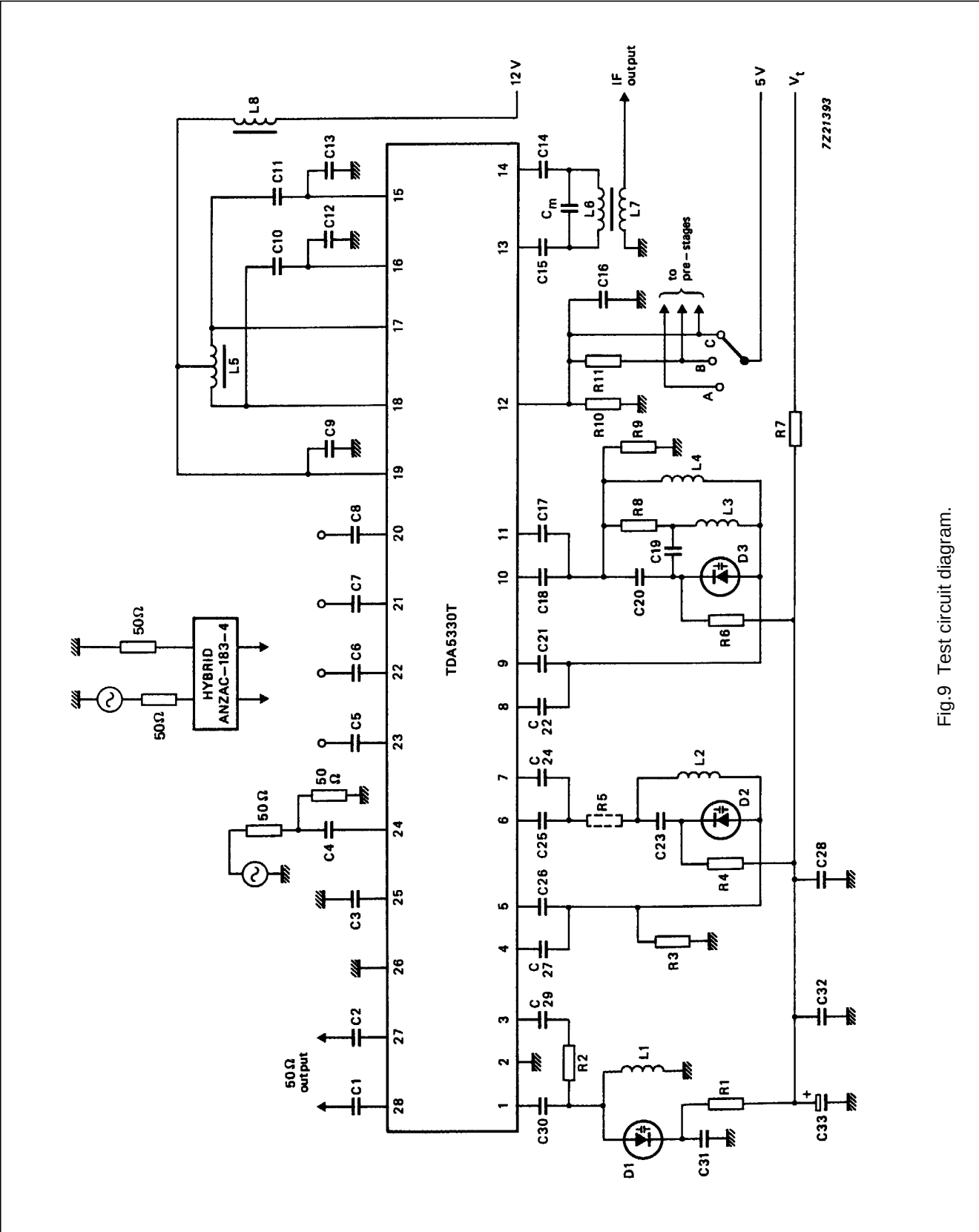


Fig.9 Test circuit diagram.

# VHF, UHF and Hyperband mixer/oscillator for TV and VCR 3-band tuners

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## Component values of the test circuit

### resistors

|                        |                     |                     |                     |
|------------------------|---------------------|---------------------|---------------------|
| R1 = 47 k $\Omega$     | R2 = 18 $\Omega$    | R3 = 22 k $\Omega$  | R4 = 22 k $\Omega$  |
| R5 = 22 $\Omega$ (SMD) | R6 = 22 k $\Omega$  | R7 = 1 k $\Omega$   | R8 = 2.2 k $\Omega$ |
| R9 = 22 k $\Omega$     | R10 = 15 k $\Omega$ | R11 = 22 k $\Omega$ |                     |

### capacitors

|                        |                     |                     |                     |
|------------------------|---------------------|---------------------|---------------------|
| C1 = 1 nF              | C2 = 1 nF           | C3 = 1 nF           | C4 = 1 nF           |
| C5 = 1 nF              | C6 = 1 nF           | C7 = 1 nF           | C8 = 1 nF           |
| C9 = 1 nF              | C10 = 1 nF          | C11 = 1 nF          | C12 = 15 pF (N750)  |
| C13 = 15 pF (N750)     | C14 = 1 nF          | C15 = 1 nF          | C16 = 1 nF          |
| C17 = 0.68 pF (SMD)    | C18 = 1 pF (SMD)    | C19 = 100 pF (SMD)  | C20 = 5.6 pF (SMD)  |
| C21 = 1 pF             | C22 = 0.68 pF (SMD) | C23 = 150 pF (N750) | C24 = 1.8 pF (N750) |
| C25 = 3.3 pF (SMD)     | C26 = 3.3 pF (SMD)  | C27 = 1.8 pF (SMD)  | C28 = 1 nF          |
| C29 = 1 pF (NPO)       | C30 = 1 pF (NPO)    | C31 = 82 pF (N750)  | C32 = 1 nF          |
| C33 = 1 $\mu$ F (40 V) | Cm = 18 pF (N750)   |                     |                     |

### diodes and IC

|               |             |             |
|---------------|-------------|-------------|
| D1 = BB911    | D2 = BB909B | D3 = BB405B |
| IC = TDA5330T |             |             |

### coils

|                              |                        |                          |                             |
|------------------------------|------------------------|--------------------------|-----------------------------|
| L1 = 6.5 t ( $\phi$ 3)       | L2 = 1.5 t ( $\phi$ 3) | L3 = 1.5 t ( $\phi$ 3)   | L4 = 1.5 t ( $\phi$ 3)      |
| L5 = 2 $\times$ 6 t (note 1) | L6 = 12 t (note 1)     | L7 = 2 t (mounted on L6) | L8 = 5 $\mu$ H (choke coil) |

wire size for L1 to L4 = 0.4 and for L5 to L7 = 0.1 mm.

## Note

1. Coil type: TOKO 7 kN; material: 113 kN, screw core (03-0093), pot core (04-0026).

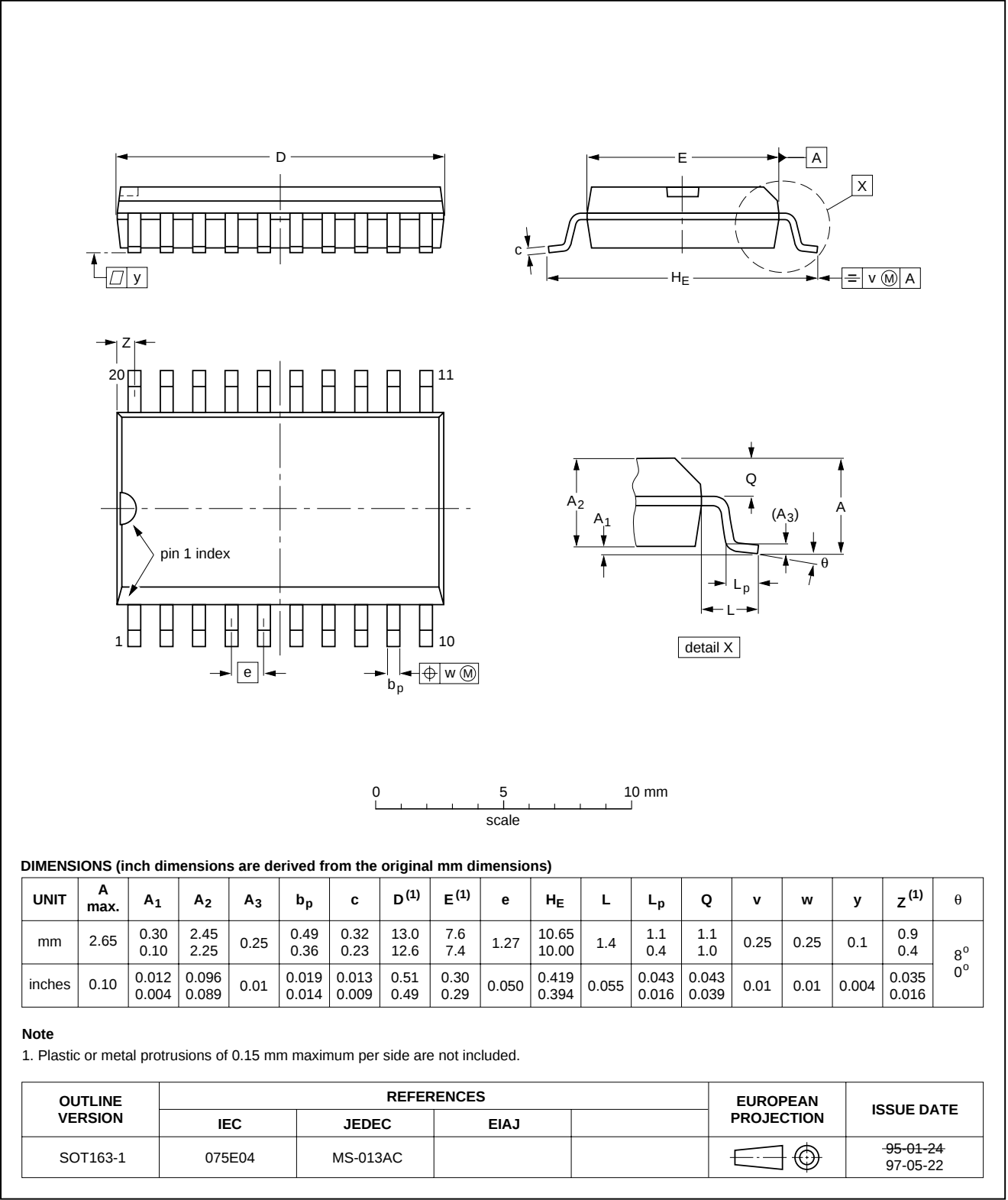
VHF, UHF and Hyperband mixer/oscillator  
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PACKAGE OUTLINE

SO20: plastic small outline package; 20 leads; body width 7.5 mm

SOT163-1



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## VHF, UHF and Hyperband mixer/oscillator for TV and VCR 3-band tuners

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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.

# VHF, UHF and Hyperband mixer/oscillator for TV and VCR 3-band tuners

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## 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.