

# DATA SHEET

## **TDA5632; TDA5633** 9 V VHF and UHF mixers/oscillators for TV and VCR cable tuners

Product specification  
Supersedes data of March 1995  
File under Integrated Circuits, IC02

1996 Aug 16

## 9 V VHF and UHF mixers/oscillators for TV and VCR cable tuners

### TDA5632; TDA5633

#### FEATURES

- Balanced mixer with a common emitter input for band A
- 2-pin oscillator for band A
- Balanced mixer with a common base input for band C
- 4-pin oscillator for band C
- Local oscillator buffer output for external prescaler
- SAW filter preamplifier with a low output impedance to drive a 75  $\Omega$  load
- Band gap voltage stabilizer for oscillator stability
- Electronic band switch
- External IF filter connected between the mixer output and the IF amplifier input.

#### APPLICATIONS

- Cable tuners for TV and VTR; switched concept for VHF
- Recommended RF bands for Europe:  
48.25 to 105.25 MHz, 112.25 to 294.25 MHz and  
471.25 to 855.25 MHz
- Recommended RF bands for the USA:  
55.25 to 133.25 MHz, 139.25 to 361.25 MHz and  
367.25 to 801.25 MHz.

#### DESCRIPTION

The TDA5632 and TDA5633 are monolithic integrated circuits that perform VHF and UHF mixer/oscillator functions in TV and VCR cable tuners. With correct oscillator application and by using a switchable inductor to split the VHF band into two sub-bands, the full VHF/UHF TV bands can be covered. These low-power mixers/oscillators require a power supply of 9 V and are available in a very small package.

The devices provide the designer with the capability to design an economical and physically small cable tuner.

The tuner development time can be drastically reduced by using this device.

Frequency bands are determined by the external tank circuit. They can be adapted to various standards.

#### QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_P$	supply voltage		–	9.0	–	V
$I_P$	supply current		–	40	–	mA
$f_{RF}$	frequency range (picture carrier)	RF input; band A; note 1	57.5	–	357.5	MHz
		RF input; band C; note 1	469.5	–	887.5	MHz
$G_V$	voltage gain	band A (75 $\Omega$ load)	–	19	–	dB
		band C (75 $\Omega$ load)	–	30	–	dB
NF	noise figure	band A (75 $\Omega$ load)	–	10	–	dB
		band C (75 $\Omega$ load)	–	9.5	–	dB
$V_o$	output voltage to obtain 1% cross modulation in channel	band A (75 $\Omega$ load)	–	110	–	dB $\mu$ V
		band C (75 $\Omega$ load)	–	110	–	dB $\mu$ V

#### Note

1. The limits are related to the tank circuits used in Fig.10 and the intermediate frequency. Frequency bands may be adjusted by the choice of external components. Another UHF frequency range is available by modifying the tank circuit. The modification enables the following frequency range:
  - a) RF frequencies from 361.25 to 801.25 MHz (picture carrier).
  - b) Oscillator frequencies from 407 to 847 MHz. For this UHF range, L4 = 3 turns (diameter = 3.5 mm).

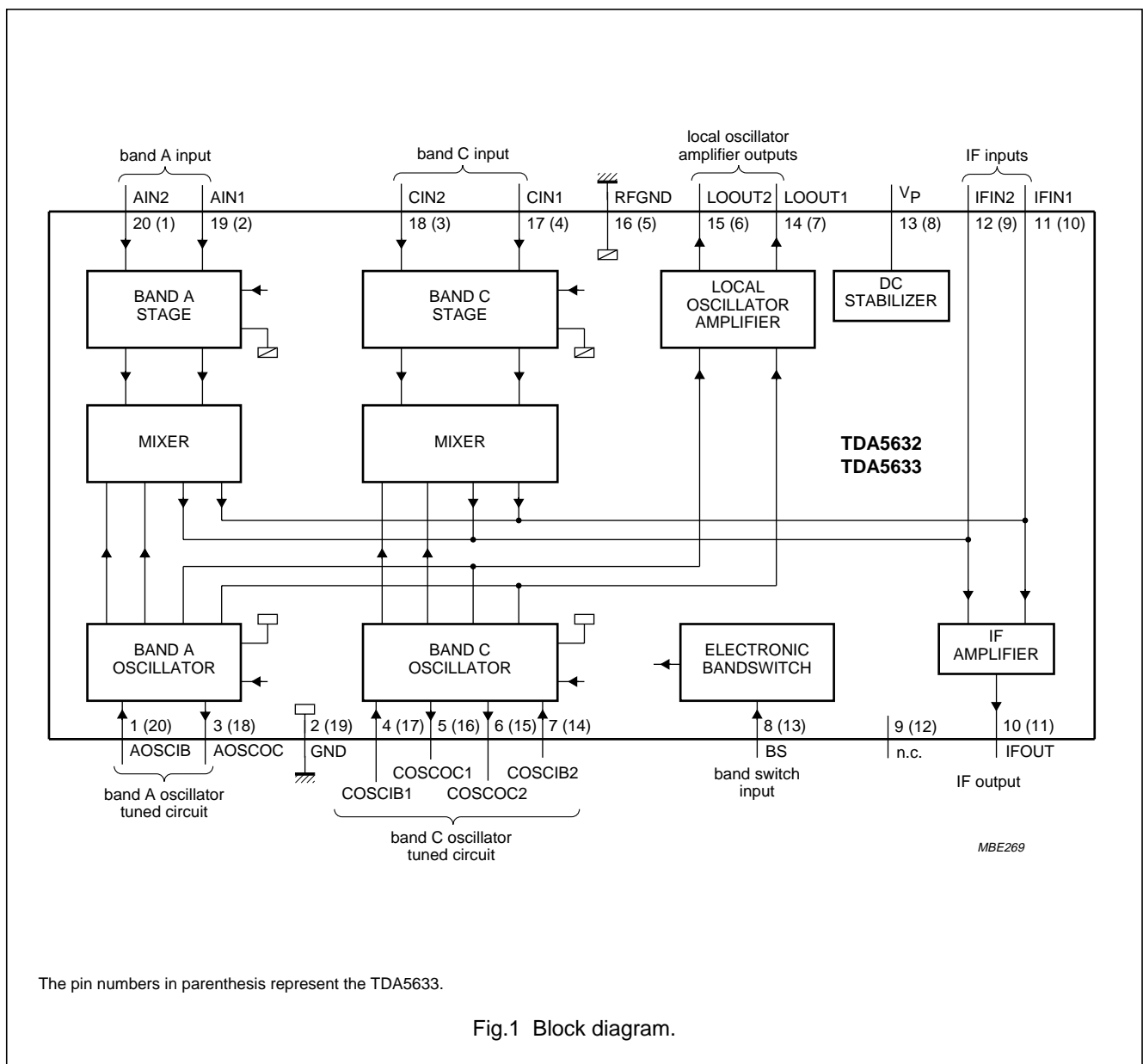
9 V VHF and UHF mixers/oscillators for TV and VCR cable tuners

TDA5632; TDA5633

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TDA5632T	SO20	plastic small outline package; 20 leads; body width 7.5 mm	SOT163-1
TDA5632M	SSOP20	plastic shrink small outline package; 20 leads; body width 4.4 mm	SOT266-1
TDA5633T	SO20	plastic small outline package; 20 leads; body width 7.5 mm	SOT163-1
TDA5633M	SSOP20	plastic shrink small outline package; 20 leads; body width 4.4 mm	SOT266-1

BLOCK DIAGRAM



The pin numbers in parenthesis represent the TDA5633.

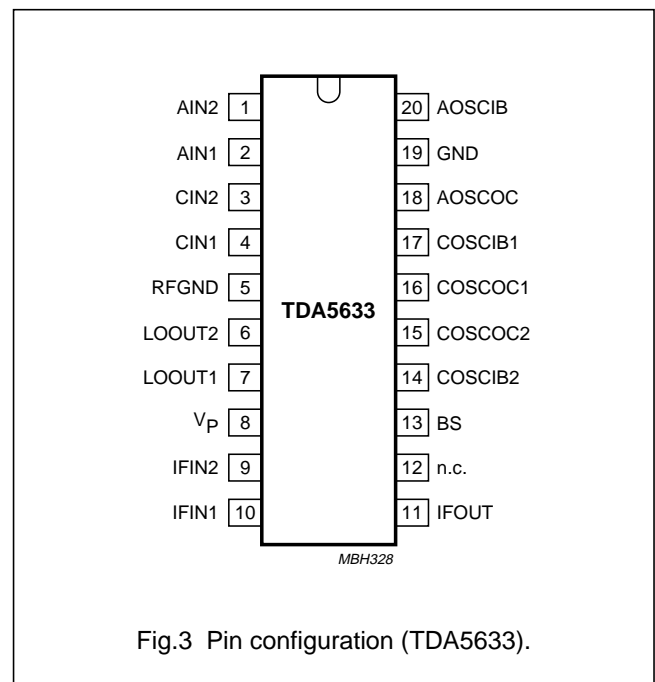
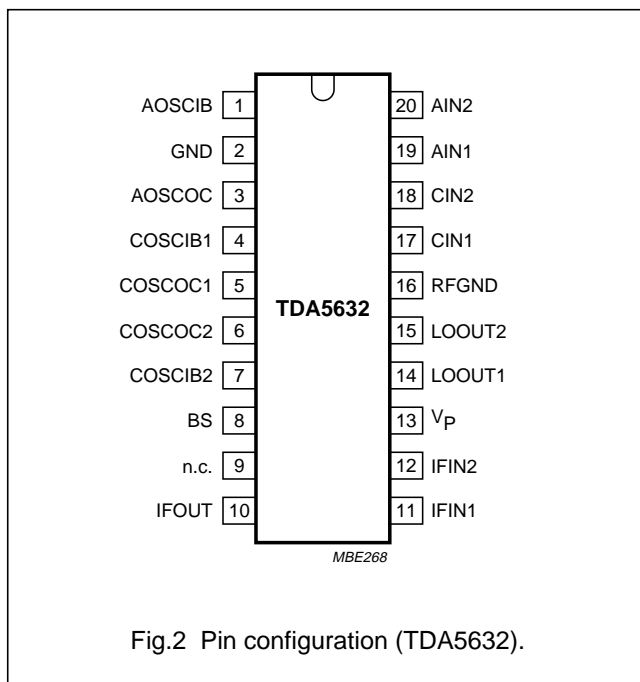
Fig.1 Block diagram.

9 V VHF and UHF mixers/oscillators for TV  
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TDA5632; TDA5633

PINNING

SYMBOL	PIN		DESCRIPTION
	TDA5632	TDA5633	
AOSCIB	1	20	band A oscillator input base
GND	2	19	ground (0 V)
AOSCOC	3	18	band A oscillator output collector
COSCIB1	4	17	band C oscillator input base 1
COSCOC1	5	16	band C oscillator output collector 1
COSCOC2	6	15	band C oscillator output collector 2
COSCIB2	7	14	band C oscillator input base 2
BS	8	13	band switch input
n.c.	9	12	not connected
IFOUT	10	11	IF amplifier output
IFIN1	11	10	IF amplifier input 1
IFIN2	12	9	IF amplifier input 2
V <sub>P</sub>	13	8	supply voltage
LOOUT1	14	7	local oscillator amplifier output 1
LOOUT2	15	6	local oscillator amplifier output 2
RFGND	16	5	ground for RF inputs
CIN1	17	4	band C input 1
CIN2	18	3	band C input 2
AIN1	19	2	band A input 1
AIN2	20	1	band A input 2



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TDA5632; TDA5633

### LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134).

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
$V_P$	supply voltage	-0.3	+10.5	V
$V_{SW}$	switching voltage	0	10.5	V
$I_O$	output current of each pin referenced to ground	-	-10	mA
$t_{sc}$	maximum short-circuit time (all pins)	-	10	s
$T_{stg}$	IC storage temperature	-55	+150	°C
$T_{amb}$	operating ambient temperature	-20	+85	°C
$T_j$	junction temperature	-	+150	°C

### THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th\ j-a}$	thermal resistance from junction to ambient in free air		
	SOT163-1	80	K/W
	SOT266-1	120	K/W

### HANDLING

Human body model: the IC withstands 2000 V in accordance with the "UZW-B0/FQ-A302"; specification equivalent to the "MIL-STD-883C, category B"; R = 1.5 k $\Omega$ ; C = 100 pF.

Machine model: the IC withstands 200 V in accordance with the "UZW-B0/FQ-B302" (date of issue: Nov 6th, 1990); R = 0  $\Omega$ ; C = 200 pF.

### IF AMPLIFIER CHARACTERISTICS

$V_P = 9$  V;  $T_{amb} = 25$  °C; measured at 43.5 MHz; measured in circuit of Fig.10; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$S_{22}$	output reflection coefficient	$f_{IF} = 43.5$ MHz; see Fig.9	-	-13.1	-	dB
		$f_{IF} = 43.5$ MHz; see Fig.9	-	2.9	-	deg
		$f_{IF} = 58.75$ MHz; see Fig.9	-	-13.1	-	dB
		$f_{IF} = 58.75$ MHz; see Fig.9	-	2.2	-	deg
$Z_O$	output impedance	$f_{IF} = 43.5$ MHz; see Fig.9	-	78.4	-	$\Omega$
		$f_{IF} = 43.5$ MHz; see Fig.9	-	1.8	-	$\Omega$
		$f_{IF} = 58.75$ MHz; see Fig.9	-	78.4	-	$\Omega$
		$f_{IF} = 58.75$ MHz; see Fig.9	-	-1.4	-	$\Omega$

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TDA5632; TDA5633

### CHARACTERISTICS

$V_P = 9\text{ V}$ ;  $T_{\text{amb}} = 25\text{ °C}$ ; measured in circuit of Fig.10; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
<b>Supply</b>						
$V_P$	supply voltage		8.1	9.0	9.9	V
$I_P$	supply current		–	40	48	mA
$V_{\text{SW}}$	switching voltage	band A	0	–	2.0	V
		band C	3.0	–	5.0	V
$I_{\text{SW}}$	switching current	band A	–	–	2	$\mu\text{A}$
		band C	–	–	10	$\mu\text{A}$
<b>Band A mixer including IF amplifier</b>						
$f_{\text{RF}}$	frequency range	note 1	57.5	–	357.5	MHz
$G_v$	voltage gain	$f_{\text{RF}} = 57.5\text{ MHz}$ ; $R_L = 75\ \Omega$ ; see Fig.4	16.5	19	21.5	dB
		$f_{\text{RF}} = 357.5\text{ MHz}$ ; $R_L = 75\ \Omega$ ; see Fig.4	16.5	19	21.5	dB
NF	noise figure	$f_{\text{RF}} = 50\text{ MHz}$ ; $R_L = 75\ \Omega$ ; see Fig.5	–	7.5	9.5	dB
		$f_{\text{RF}} = 150\text{ MHz}$ ; $R_L = 75\ \Omega$ ; see Fig.5	–	8.5	10.5	dB
		$f_{\text{RF}} = 300\text{ MHz}$ ; $R_L = 75\ \Omega$	–	10	12.5	dB
$V_o$	output voltage causing 1% cross modulation in channel	$f_{\text{RF}} = 57.5\text{ MHz}$ ; $R_L = 75\ \Omega$ ; see Fig.6	107	110	–	$\text{dB}\mu\text{V}$
		$f_{\text{RF}} = 357.5\text{ MHz}$ ; $R_L = 75\ \Omega$ ; see Fig.6	107	110	–	$\text{dB}\mu\text{V}$
$V_i$	input voltage causing 10 kHz pulling in channel	$f_{\text{RF}} = 357.5\text{ MHz}$ ; $R_L = 75\ \Omega$ ; see note 2	–	91	–	$\text{dB}\mu\text{V}$
$g_{\text{os}}$	optimum source conductance for noise figure	$f_{\text{RF}} = 50\text{ MHz}$ ; $R_L = 75\ \Omega$	–	0.5	–	mS
		$f_{\text{RF}} = 150\text{ MHz}$ ; $R_L = 75\ \Omega$	–	1.1	–	mS
		$f_{\text{RF}} = 300\text{ MHz}$ ; $R_L = 75\ \Omega$	–	1.9	–	mS
$g_i$	input conductance	$f_{\text{RF}} = 57.5\text{ MHz}$	–	0.27	–	mS
		$f_{\text{RF}} = 357.5\text{ MHz}$	–	0.68	–	mS
$C_i$	input capacitance	$f_{\text{RF}} = 57.5\text{ to }357.5\text{ MHz}$ ; $R_L = 75\ \Omega$	–	2	–	pF
<b>Band A oscillator</b>						
$f_{\text{osc}}$	frequency range	note 3	101	–	401	MHz
$f_{\text{shift}}$	frequency shift	$\Delta V_P = 10\%$ ; note 4	–	–	200	kHz
$f_{\text{drift}}$	frequency drift	$\Delta T = 25\text{ °C}$ with no compensation; NP0 capacitors; note 5	–	–	1200	kHz
		5 s to 15 min after switch on; note 6	–	–	400	kHz

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TDA5632; TDA5633

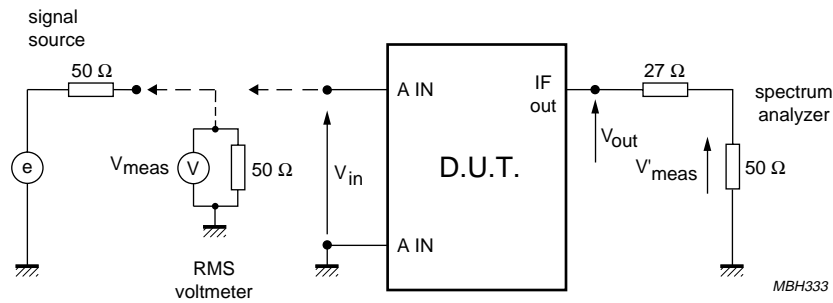
SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
<b>Band C mixer including IF amplifier</b>						
$f_{RF}$	frequency range	note 1	469.5	–	887.5	MHz
$G_v$	voltage gain	$f_{RF} = 469.50$ MHz; $R_L = 75 \Omega$ ; see Fig.7	27	30	33	dB
		$f_{RF} = 887.5$ MHz; $R_L = 75 \Omega$ ; see Fig.7	27	30	33	dB
NF	noise figure (not corrected for image)	$f_{RF} = 469.50$ MHz; $R_L = 75 \Omega$	–	7.5	9.5	dB
		$f_{RF} = 887.5$ MHz; $R_L = 75 \Omega$	–	9.5	11.5	dB
$V_o$	output voltage causing 1% cross modulation in channel	$f_{RF} = 887.5$ MHz; $R_L = 75 \Omega$ ; see Fig.8	107	110	–	dB $\mu$ V
$Z_i$	input impedance ( $R_s + L_s$ )	$R_s$ ; $f_{RF} = 469.50$ MHz	–	30	–	$\Omega$
		$L_s$ ; $f_{RF} = 887.5$ MHz	–	12	–	nH
$V_i$	input voltage causing 10 kHz pulling in channel	$R_L = 75 \Omega$ ; note 2	–	82	–	dB $\mu$ V
<b>Band C oscillator</b>						
$f_{osc}$	frequency range	note 3	513	–	931	MHz
$f_{shift}$	frequency shift	$\Delta V_P = 10\%$ ; note 4	–	–	500	kHz
$f_{drift}$	frequency drift	$\Delta T = 25$ °C with compensation; note 5	–	–	900	kHz
		5 s to 15 min after switching on; note 6	–	–	400	kHz
<b>LO output</b>						
$V_o$	output voltage	$R_L = 50 \Omega$	83	91	100	dB $\mu$ V
SRF	spurious signal on LO output with respect to LO output signal	$R_L = 50 \Omega$ ; note 7	–	–14	–10	dB
SHD	LO signal harmonics with respect to LO signal	$R_L = 50 \Omega$	–	–11	–10	dB

**Notes**

- The RF frequency range is defined by the oscillator frequency range and the intermediate frequency.
- The input level causing 10 kHz detuning at the LO output;  $f_{osc} = f_{RF} + 43.5$  MHz.
- Limits are related to the tank circuit used in Fig.10. Frequency bands may be adjusted by the choice of external components. Another UHF frequency range is available by modifying the tank circuit. The modification enables the following frequency range:
  - RF frequencies from 363.5 to 803.5 MHz.
  - Oscillator frequencies from 407 to 847 MHz. For this UHF range,  $L_4 = 3$  turns (diameter = 3.5 mm).
- The frequency shift is defined as the change in oscillator frequency when the supply voltage varies from  $V_P = 9$  to 8.1 V or  $V_P = 9$  to 9.9 V.
- The frequency drift is defined as the change in oscillator frequency when the ambient temperature varies from  $T_{amb} = 25$  to 0 °C or  $T_{amb} = 25$  to 50 °C.
- Switch on drift is defined as the change in oscillator frequency between 5 s and 15 min after switch on.
- SRF: spurious signal on LO output with respect to LO signal:
  - RF voltage level = 1 V at  $f_{RF} = 57.5$  to 225 MHz.
  - RF level = 2.5 dBm at  $f_{RF} = 225$  to 357.5 MHz.
  - RF level = –10 dBm at  $f_{RF} = 469.5$  to 887.5 MHz.

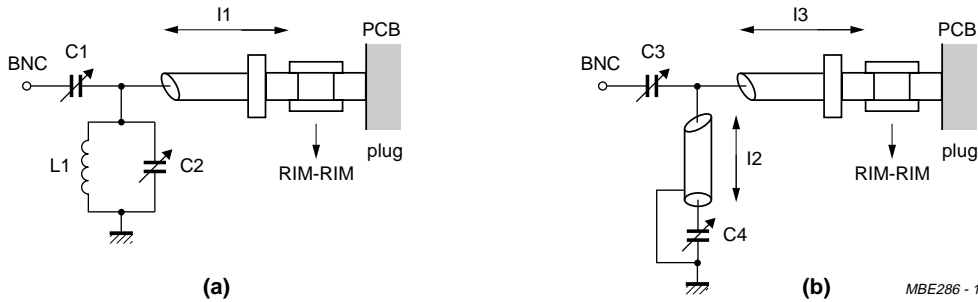
9 V VHF and UHF mixers/oscillators for TV and VCR cable tuners

TDA5632; TDA5633



$Z_i \gg 50 \Omega \Rightarrow V_{in} = 2V_{meas}$  ( $V_{in} = 80 \text{ dB}\mu\text{V}$ );  $V_{out} = V'_{meas} \times \frac{50 + 27}{50}$ ; voltage gain for band A =  $20 \log \frac{V_{out}}{V_{in}}$ .

Fig.4 Band A gain measurement.



**(a) For  $f_{RF} = 50 \text{ MHz}$ :**  
 mixer A frequency response measured = 57 MHz, loss = 0 dB  
 image suppression = 16 dB.  
 C1 = 9 pF.  
 C2 = 15 pF.  
 L1 = 7 turns (5.5 mm, wire diameter = 0.5 mm).  
 I1 = rigid cable (RIM): 5 cm long  
 (rigid cable (RIM); 33 dB/100 m; 50  $\Omega$ , 96 pF/m).

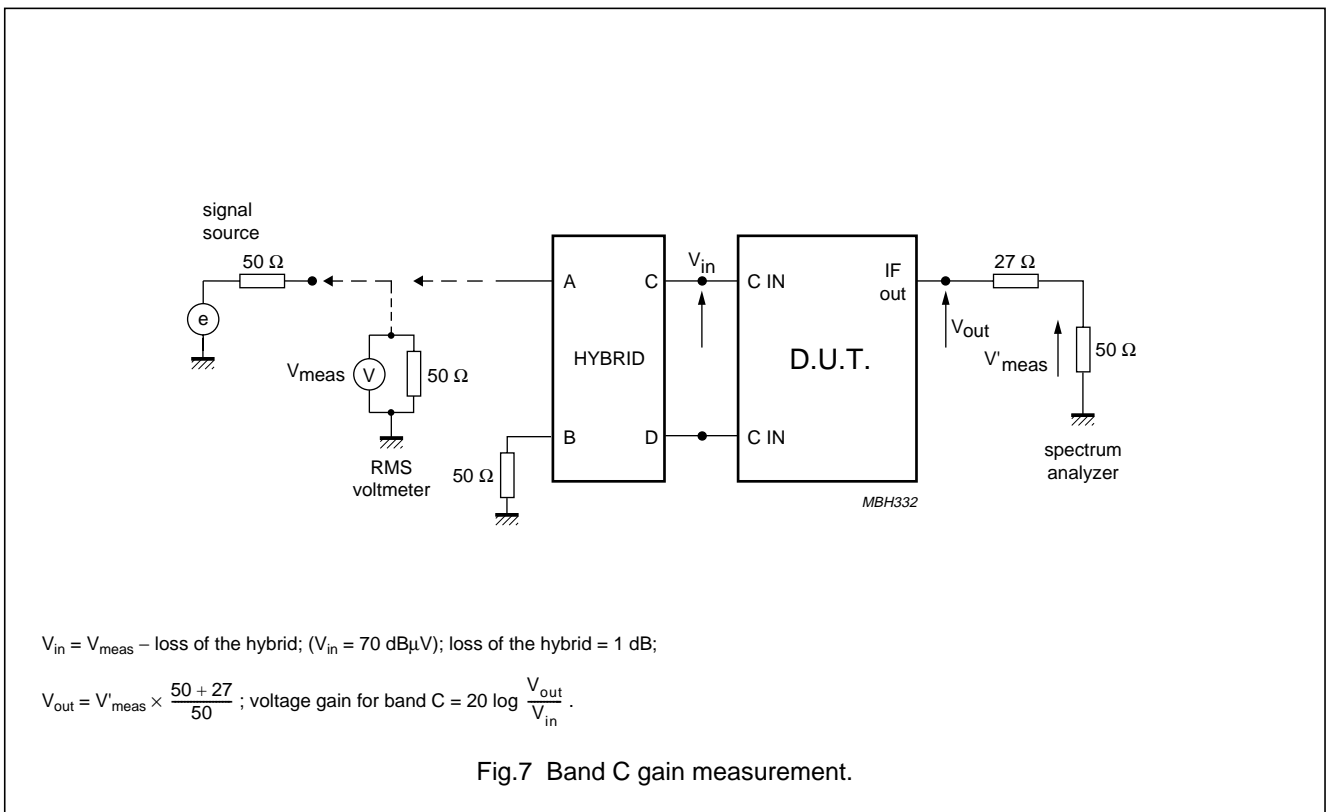
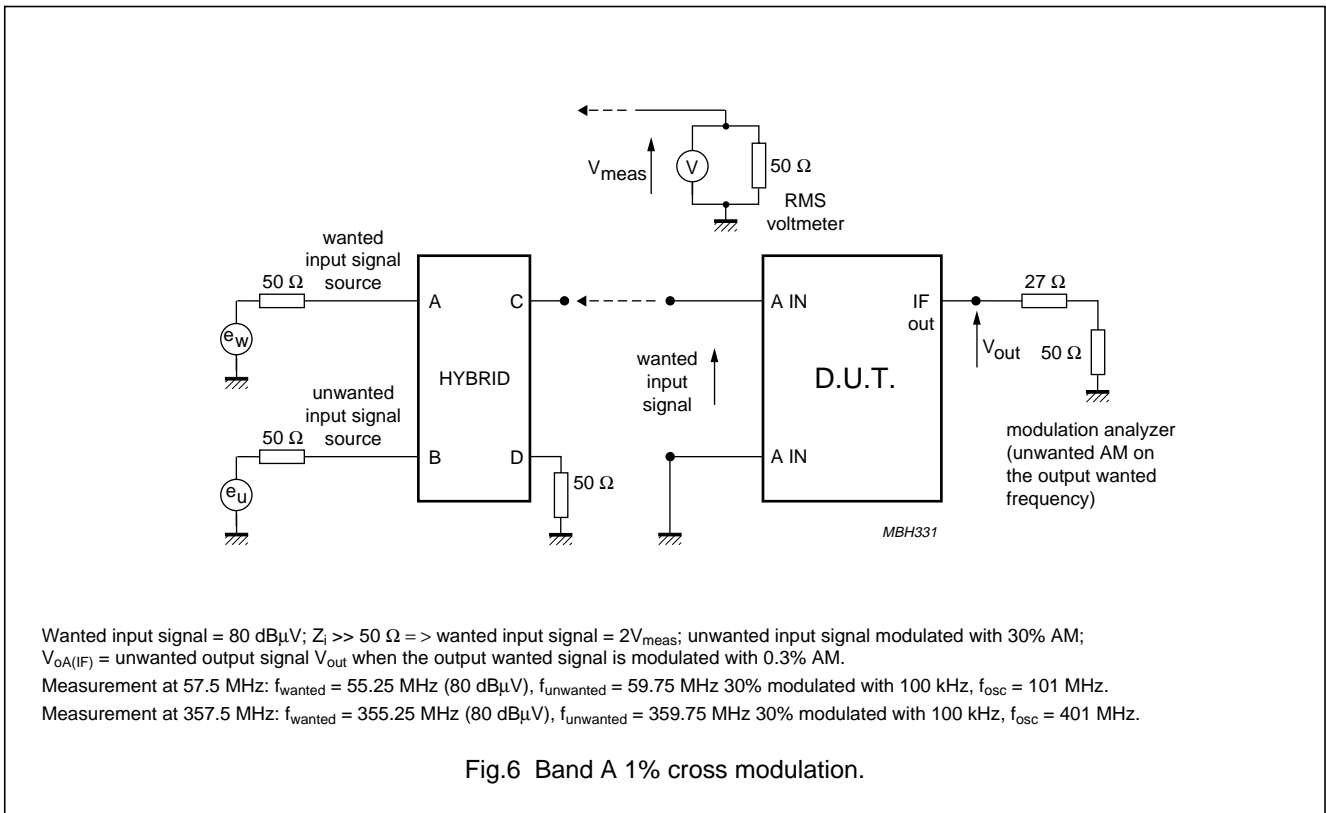
**(b) For  $f_{RF} = 150 \text{ MHz}$ :**  
 mixer A frequency response measured = 150.3 MHz, loss = 1.3 dB  
 image suppression = 13 dB.  
 C3 = 5 pF.  
 C4 = 25 pF.  
 I2 = rigid cable (RIM): 30 cm long.  
 I3 = rigid cable (RIM): 5 cm long  
 (rigid cable (RIM); 33 dB/100 m; 50  $\Omega$ ; 96 pF/m).

Fig.5 Input circuit for minimum noise figure.



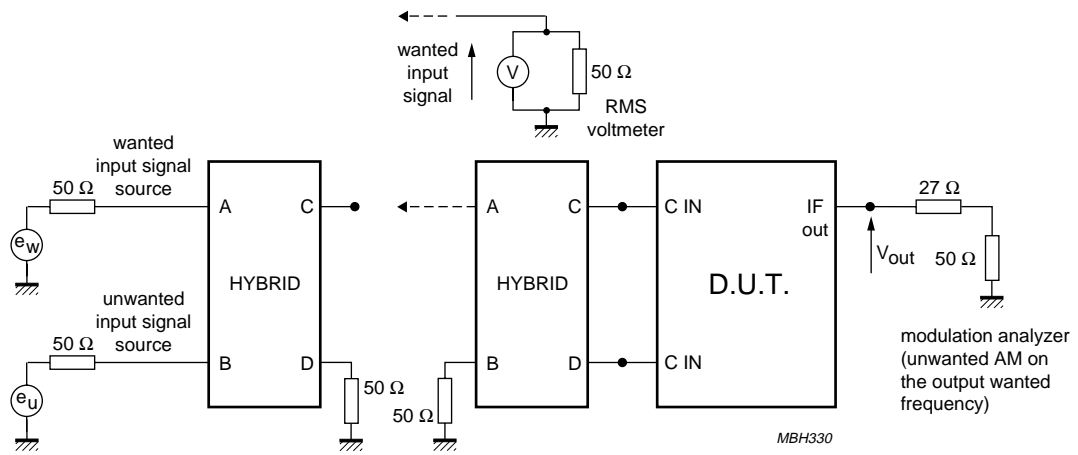
9 V VHF and UHF mixers/oscillators for TV and VCR cable tuners

TDA5632; TDA5633



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TDA5632; TDA5633



Wanted input signal = 70 dB $\mu$ V; unwanted input signal modulated with 30% AM;  $V_{oA(IF)}$  = unwanted output signal  $V_{out}$  when the wanted output signal is modulated with 0.3% AM.  
 Measurement at 887.5 MHz:  $f_{wanted} = 885.25$  MHz (80 dB $\mu$ V),  $f_{unwanted} = 889.75$  MHz 30% modulated with 100 kHz,  $f_{osc} = 931$  MHz.

Fig.8 Band C 1% cross modulation.

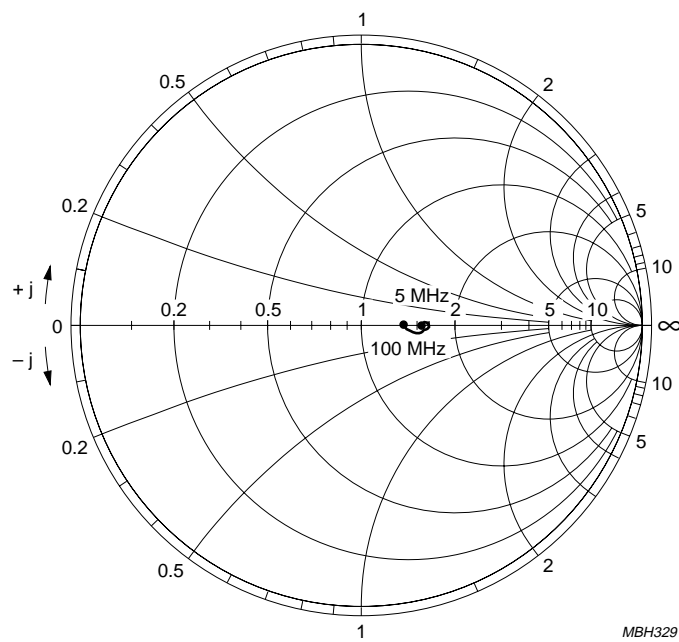
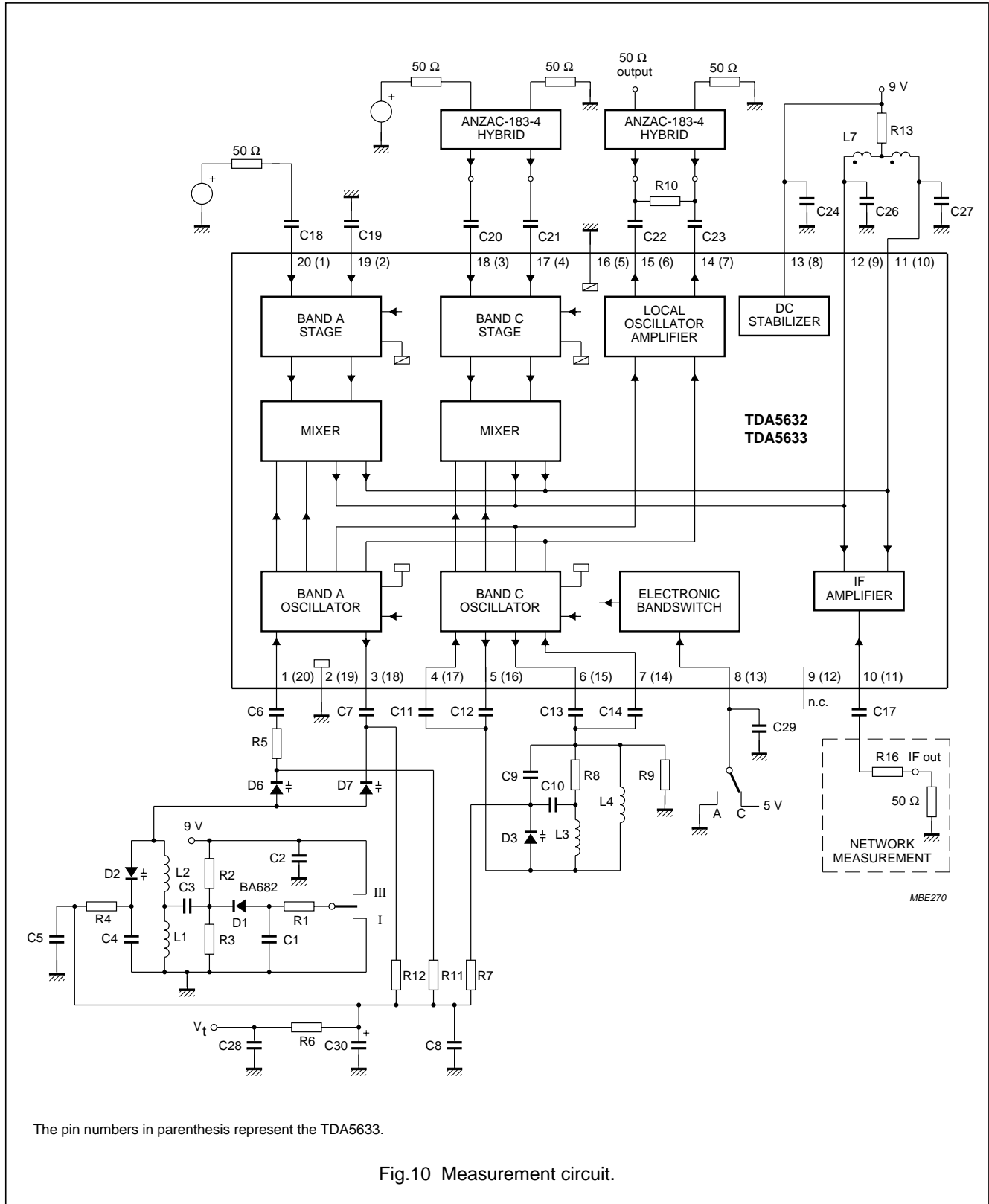


Fig.9 Output impedance (S22) of the IF amplifier (Z chart;  $Z_o = 50 \Omega$ ).

9 V VHF and UHF mixers/oscillators for TV  
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TDA5632; TDA5633

APPLICATION INFORMATION



The pin numbers in parenthesis represent the TDA5633.

Fig.10 Measurement circuit.

## 9 V VHF and UHF mixers/oscillators for TV and VCR cable tuners

TDA5632; TDA5633

### Application diagram component values

**Table 1** Capacitors (all SMD and NP0 except C9, C11 to C14 and C30)

NUMBER	VALUE
C1	1 nF
C2	1 nF
C3	1 nF
C4	56 pF
C5	2.2 nF
C6	2 pF
C7	4 pF
C8	2.2 nF
C9	6 pF (N470)
C10	100 pF
C11	1 pF (N750)
C12	1 pF (N750)
C13	1 pF (N750)
C14	1 pF (N750)
C17	1 nF
C18	1 nF
C19	1 nF
C20	1 nF
C21	1 nF
C22	1 nF
C23	1 nF
C24	1 nF
C26	15 pF
C27	15 pF
C28	2.2 nF
C29	1 nF
C30	1 $\mu$ F (40 V electrolytic capacitor)

**Table 2** Resistors (all SMD)

NUMBER	VALUE
R1	10 $\Omega$
R2	12 k $\Omega$
R3	2.7 k $\Omega$
R4	47 k $\Omega$
R5	56 $\Omega$
R6	47 k $\Omega$
R7	22 k $\Omega$

NUMBER	VALUE
R8	2.2 k $\Omega$
R9	22 k $\Omega$
R10	100 $\Omega$
R11	47 k $\Omega$
R12	47 k $\Omega$
R13	150 $\Omega$
R16	27 $\Omega$

**Table 3** Diodes and coils

NUMBER	VALUE
<b>Diodes</b>	
D1	BA682
D2	BB133
D3	BB134
D6	BB131
D7	BB131
<b>Coils<sup>(1)</sup></b>	
L1	6 t (4 mm)
L2	3 t (3.5 mm)
L3	2 t (2.5 mm)
L4	3 t (2.5 mm)

#### Note

- Wire size for L1 to L4 is 0.4 mm.

#### Transformer (L7 = 2 $\times$ 5 t)

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

9 V VHF and UHF mixers/oscillators for TV  
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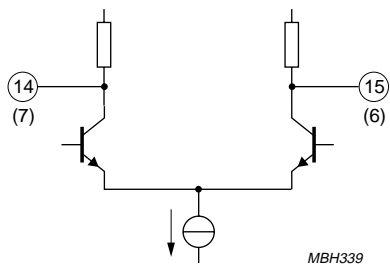
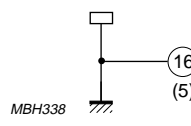
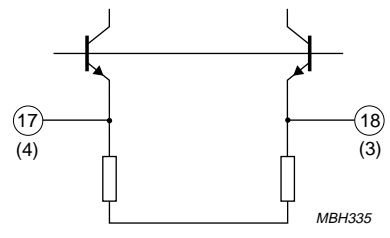
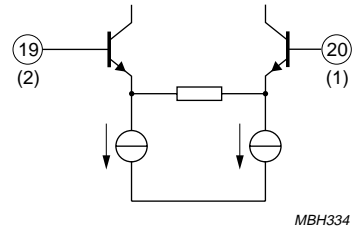
TDA5632; TDA5633

INTERNAL PIN CONFIGURATION

SYMBOL	PIN		DESCRIPTION	AVERAGE DC VOLTAGE (V) <sup>(1)</sup>	
	TDA5632	TDA5633		BAND A	BAND C
AOSCIB	1	20	<p>MBH340</p>	2.20	NR <sup>(2)</sup>
AOSCO	3	18		3.90	NR <sup>(2)</sup>
GND	2	19	<p>MBH342</p>	0	0
COSCIB1	4	17	<p>MBH341</p>	NR <sup>(2)</sup>	2.35
COSCO1	5	16		NR <sup>(2)</sup>	4.30
COSCO2	6	15		NR <sup>(2)</sup>	4.30
COSCIB2	7	14		NR <sup>(2)</sup>	2.35
BS	8	13	<p>MBH336</p>	0.0	5.0
n. c.	9	12		NR <sup>(2)</sup>	NR <sup>(2)</sup>
IFOUT	10	11	<p>MBH337</p>	3.85	3.85
IFIN1	11	10	<p>MBH343</p>	8.36	8.36
IFIN2	12	9		8.36	8.36

9 V VHF and UHF mixers/oscillators for TV  
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TDA5632; TDA5633

SYMBOL	PIN		DESCRIPTION	AVERAGE DC VOLTAGE (V) <sup>(1)</sup>	
	TDA5632	TDA5633		BAND A	BAND C
V <sub>P</sub>	13	8	supply voltage	9.0	9.0
LOOUT1	14	7	 <p>MBH339</p>	7.35	7.35
LOOUT2	15	6		7.35	7.35
RFGND	16	5	 <p>MBH338</p>	0.0	0.0
CIN1	17	4	 <p>MBH335</p>	NR <sup>(2)</sup>	2.20
CIN2	18	3		NR <sup>(2)</sup>	2.20
AIN1	19	2	 <p>MBH334</p>	2.25	NR <sup>(2)</sup>
AIN2	20	1		2.25	NR <sup>(2)</sup>

Notes

1. Average DC voltage measured in Fig.10.
2. NR = not relevant.

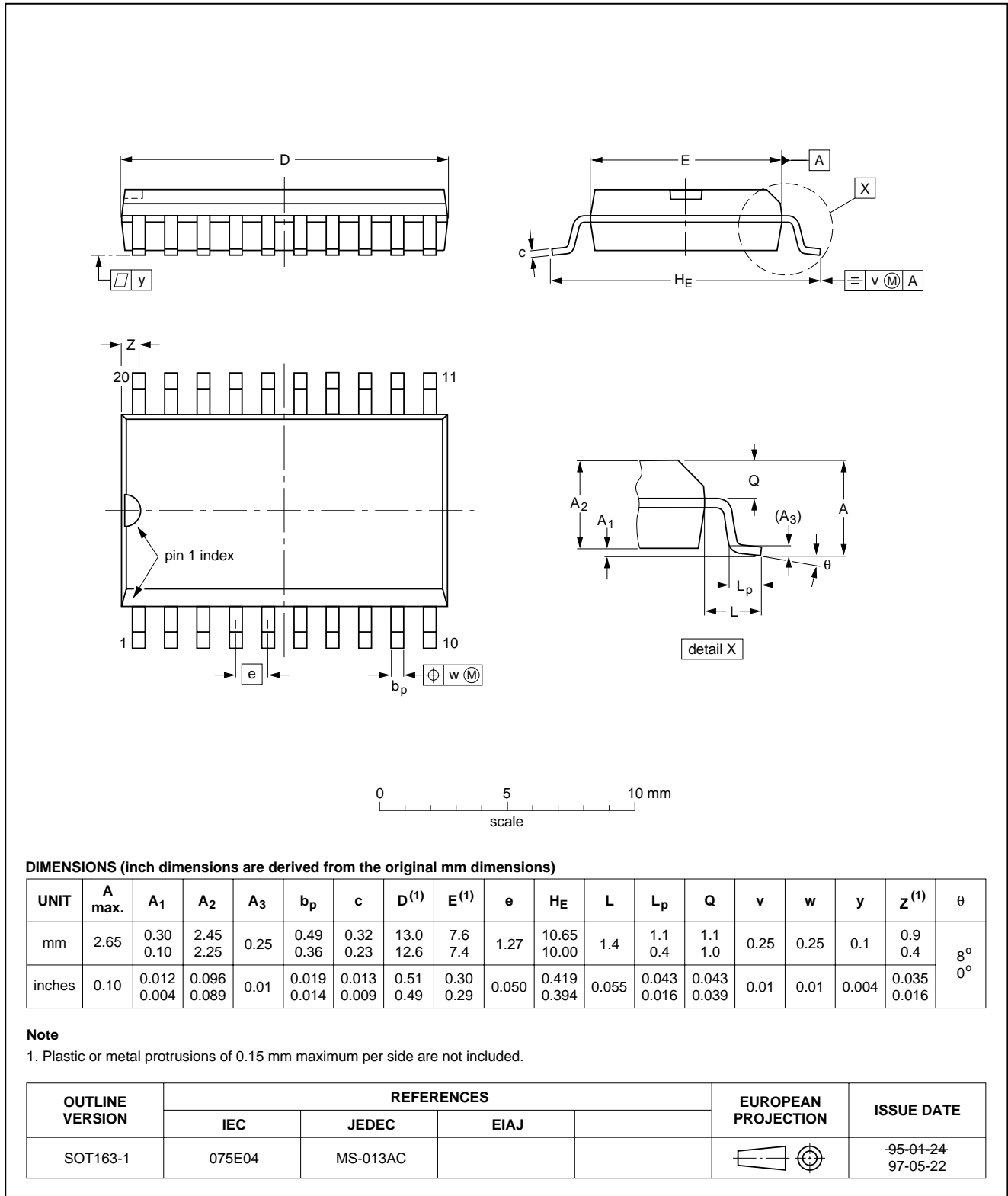
9 V VHF and UHF mixers/oscillators for TV  
and VCR cable tuners

TDA5632; TDA5633

PACKAGE OUTLINES

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

SOT163-1

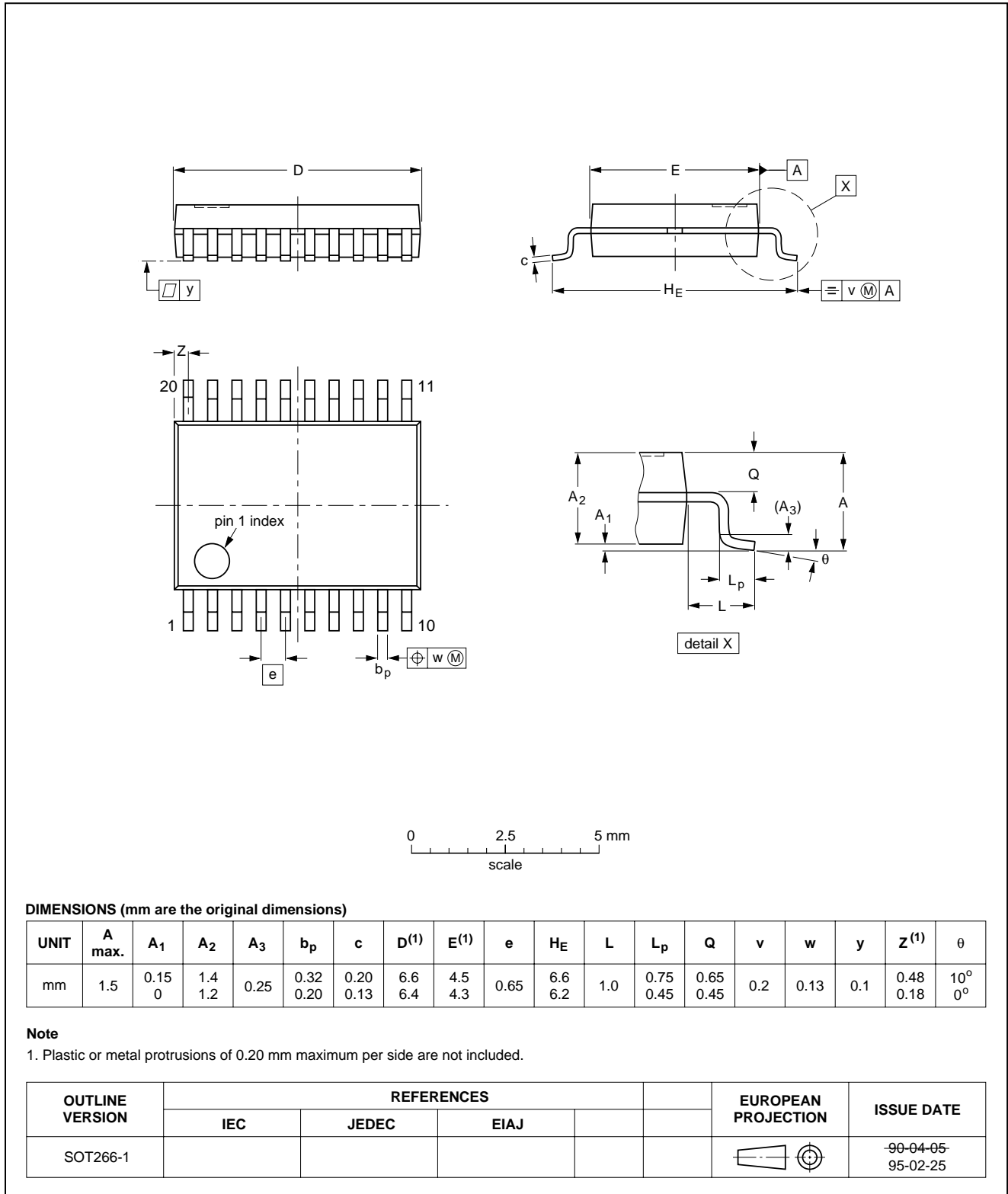


9 V VHF and UHF mixers/oscillators for TV  
and VCR cable tuners

TDA5632; TDA5633

SSOP20: plastic shrink small outline package; 20 leads; body width 4.4 mm

SOT266-1





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TDA5632; TDA5633

### 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 and SSOP 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

##### SO

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.

##### SSOP

Wave soldering is **not** recommended for SSOP packages. This is because of the likelihood of solder bridging due to closely-spaced leads and the possibility of incomplete solder penetration in multi-lead devices.

If wave soldering cannot be avoided, the following conditions must be 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 and must incorporate solder thieves at the downstream end.

Even with these conditions, only consider wave soldering SSOP packages that have a body width of 4.4 mm, that is SSOP16 (SOT369-1) or SSOP20 (SOT266-1).

#### METHOD (SO AND SSOP)

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.

## 9 V VHF and UHF mixers/oscillators for TV and VCR cable tuners

TDA5632; TDA5633

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<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>	
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# Philips Semiconductors – a worldwide company

**Argentina:** see South America

**Australia:** 34 Waterloo Road, NORTH RYDE, NSW 2113,  
Tel. +61 2 9805 4455, Fax. +61 2 9805 4466

**Austria:** Computerstr. 6, A-1101 WIEN, P.O. Box 213,  
Tel. +43 1 60 101, Fax. +43 1 60 101 1210

**Belarus:** Hotel Minsk Business Center, Bld. 3, r. 1211, Volodarski Str. 6,  
220050 MINSK, Tel. +375 172 200 733, Fax. +375 172 200 773

**Belgium:** see The Netherlands

**Brazil:** see South America

**Bulgaria:** Philips Bulgaria Ltd., Energoproject, 15th floor,  
51 James Bourchier Blvd., 1407 SOFIA,  
Tel. +359 2 689 211, Fax. +359 2 689 102

**Canada:** PHILIPS SEMICONDUCTORS/COMPONENTS,  
Tel. +1 800 234 7381

**China/Hong Kong:** 501 Hong Kong Industrial Technology Centre,  
72 Tat Chee Avenue, Kowloon Tong, HONG KONG,  
Tel. +852 2319 7888, Fax. +852 2319 7700

**Colombia:** see South America

**Czech Republic:** see Austria

**Denmark:** Prags Boulevard 80, PB 1919, DK-2300 COPENHAGEN S,  
Tel. +45 32 88 2636, Fax. +45 31 57 1949

**Finland:** Sinikalliontie 3, FIN-02630 ESPOO,  
Tel. +358 615 800, Fax. +358 615 80920

**France:** 4 Rue du Port-aux-Vins, BP317, 92156 SURESNES Cedex,  
Tel. +33 1 40 99 6161, Fax. +33 1 40 99 6427

**Germany:** Hammerbrookstraße 69, D-20097 HAMBURG,  
Tel. +49 40 23 53 60, Fax. +49 40 23 536 300

**Greece:** No. 15, 25th March Street, GR 17778 TAVROS,  
Tel. +30 1 4894 339/911, Fax. +30 1 4814 240

**Hungary:** see Austria

**India:** Philips INDIA Ltd, Shivsagar Estate, A Block, Dr. Annie Besant Rd.  
Worli, MUMBAI 400 018, Tel. +91 22 4938 541, Fax. +91 22 4938 722

**Indonesia:** see Singapore

**Ireland:** Newstead, Clonskeagh, DUBLIN 14,  
Tel. +353 1 7640 000, Fax. +353 1 7640 200

**Israel:** RAPAC Electronics, 7 Kehilat Saloniki St, TEL AVIV 61180,  
Tel. +972 3 645 0444, Fax. +972 3 649 1007

**Italy:** PHILIPS SEMICONDUCTORS, Piazza IV Novembre 3,  
20124 MILANO, Tel. +39 2 6752 2531, Fax. +39 2 6752 2557

**Japan:** Philips Bldg 13-37, Kohnan 2-chome, Minato-ku, TOKYO 108,  
Tel. +81 3 3740 5130, Fax. +81 3 3740 5077

**Korea:** Philips House, 260-199 Itaewon-dong, Yongsan-ku, SEOUL,  
Tel. +82 2 709 1412, Fax. +82 2 709 1415

**Malaysia:** No. 76 Jalan Universiti, 46200 PETALING JAYA, SELANGOR,  
Tel. +60 3 750 5214, Fax. +60 3 757 4880

**Mexico:** 5900 Gateway East, Suite 200, EL PASO, TEXAS 79905,  
Tel. +9-5 800 234 7381

**Middle East:** see Italy

**Netherlands:** Postbus 90050, 5600 PB EINDHOVEN, Bldg. VB,  
Tel. +31 40 27 82785, Fax. +31 40 27 88399

**New Zealand:** 2 Wagener Place, C.P.O. Box 1041, AUCKLAND,  
Tel. +64 9 849 4160, Fax. +64 9 849 7811

**Norway:** Box 1, Manglerud 0612, OSLO,  
Tel. +47 22 74 8000, Fax. +47 22 74 8341

**Philippines:** Philips Semiconductors Philippines Inc.,  
106 Valero St. Salcedo Village, P.O. Box 2108 MCC, MAKATI,  
Metro MANILA, Tel. +63 2 816 6380, Fax. +63 2 817 3474

**Poland:** Ul. Lukiska 10, PL 04-123 WARSZAWA,  
Tel. +48 22 612 2831, Fax. +48 22 612 2327

**Portugal:** see Spain

**Romania:** see Italy

**Russia:** Philips Russia, Ul. Usatcheva 35A, 119048 MOSCOW,  
Tel. +7 095 926 5361, Fax. +7 095 564 8323

**Singapore:** Lorong 1, Toa Payoh, SINGAPORE 1231,  
Tel. +65 350 2538, Fax. +65 251 6500

**Slovakia:** see Austria

**Slovenia:** see Italy

**South Africa:** S.A. PHILIPS Pty Ltd., 195-215 Main Road Martindale,  
2092 JOHANNESBURG, P.O. Box 7430 Johannesburg 2000,  
Tel. +27 11 470 5911, Fax. +27 11 470 5494

**South America:** Rua do Rocio 220, 5th floor, Suite 51,  
04552-903 São Paulo, SÃO PAULO - SP, Brazil,  
Tel. +55 11 821 2333, Fax. +55 11 829 1849

**Spain:** Balmes 22, 08007 BARCELONA,  
Tel. +34 3 301 6312, Fax. +34 3 301 4107

**Sweden:** Kottbygatan 7, Akalla, S-16485 STOCKHOLM,  
Tel. +46 8 632 2000, Fax. +46 8 632 2745

**Switzerland:** Allmendstrasse 140, CH-8027 ZÜRICH,  
Tel. +41 1 488 2686, Fax. +41 1 481 7730

**Taiwan:** PHILIPS TAIWAN Ltd., 23-30F, 66,  
Chung Hsiao West Road, Sec. 1, P.O. Box 22978,  
TAIPEI 100, Tel. +886 2 382 4443, Fax. +886 2 382 4444

**Thailand:** PHILIPS ELECTRONICS (THAILAND) Ltd.,  
209/2 Sanpavuth-Bangna Road Prakanong, BANGKOK 10260,  
Tel. +66 2 745 4090, Fax. +66 2 398 0793

**Turkey:** Talatpasa Cad. No. 5, 80640 GÜLTEPE/ISTANBUL,  
Tel. +90 212 279 2770, Fax. +90 212 282 6707

**Ukraine:** PHILIPS UKRAINE, 4 Patrice Lumumba str., Building B, Floor 7,  
252042 KIEV, Tel. +380 44 264 2776, Fax. +380 44 268 0461

**United Kingdom:** Philips Semiconductors Ltd., 276 Bath Road, Hayes,  
MIDDLESEX UB3 5BX, Tel. +44 181 730 5000, Fax. +44 181 754 8421

**United States:** 811 East Arques Avenue, SUNNYVALE, CA 94088-3409,  
Tel. +1 800 234 7381

**Uruguay:** see South America

**Vietnam:** see Singapore

**Yugoslavia:** PHILIPS, Trg N. Pasica 5/v, 11000 BEOGRAD,  
Tel. +381 11 825 344, Fax. +381 11 635 777

**For all other countries apply to:** Philips Semiconductors, Marketing & Sales Communications,  
Building BE-p, P.O. Box 218, 5600 MD EINDHOVEN, The Netherlands, Fax. +31 40 27 24825

**Internet:** <http://www.semiconductors.philips.com>

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