

# DATA SHEET

## **TDA5732M**

Low power VHF, UHF  
mixer/oscillator for TV and VCR  
2-band tuners

Preliminary specification  
File under Integrated Circuits, IC02

1995 Mar 22

**Philips Semiconductors**



**PHILIPS**

## Low power VHF, UHF mixer/oscillator for TV and VCR 2-band tuners

## TDA5732M

### 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 of 75  $\Omega$
- Band gap voltage stabilizer for oscillator stability
- Electronic band switch
- External IF filter connected between the mixer output and the IF amplifier input.

### DESCRIPTION

The TDA5732M is a monolithic integrated circuit that performs VHF I, VHF III, hyperband and UHF mixer/oscillator functions in TV and VCR tuners. This low-power mixer/oscillator requires a power supply of 5 V and is available in a very small package.

The device gives the designer the capability to design an economical and physically small 2-band tuner.

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

### APPLICATIONS

- 2-band TV tuners
- 2-band VCR tuners.

### QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_P$	supply voltage		–	5.0	–	V
$I_P$	supply current		–	50	–	mA
$f_R$	frequency range	band A	55.25	–	361.25	MHz
		band C	367.25	–	801.25	MHz
N	noise figure	band A	–	9.5	–	dB
		band C	–	10	–	dB
$V_o$	IF output voltage	band A; $R_L = 75 \Omega$ ; 1% cross modulation	–	108	–	$\text{dB}\mu\text{V}$
		band C; $R_L = 75 \Omega$ ; 1% cross modulation	–	108	–	dBm
$G_v$	voltage gain	band A; $R_L = 75 \Omega$	–	19	–	dB
		band C; $R_L = 75 \Omega$	–	29	–	dB

### ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TDA5732M	SSOP20	plastic shrink small outline package; 20 leads; body width 4.4 mm	SOT266-1

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**BLOCK DIAGRAM**

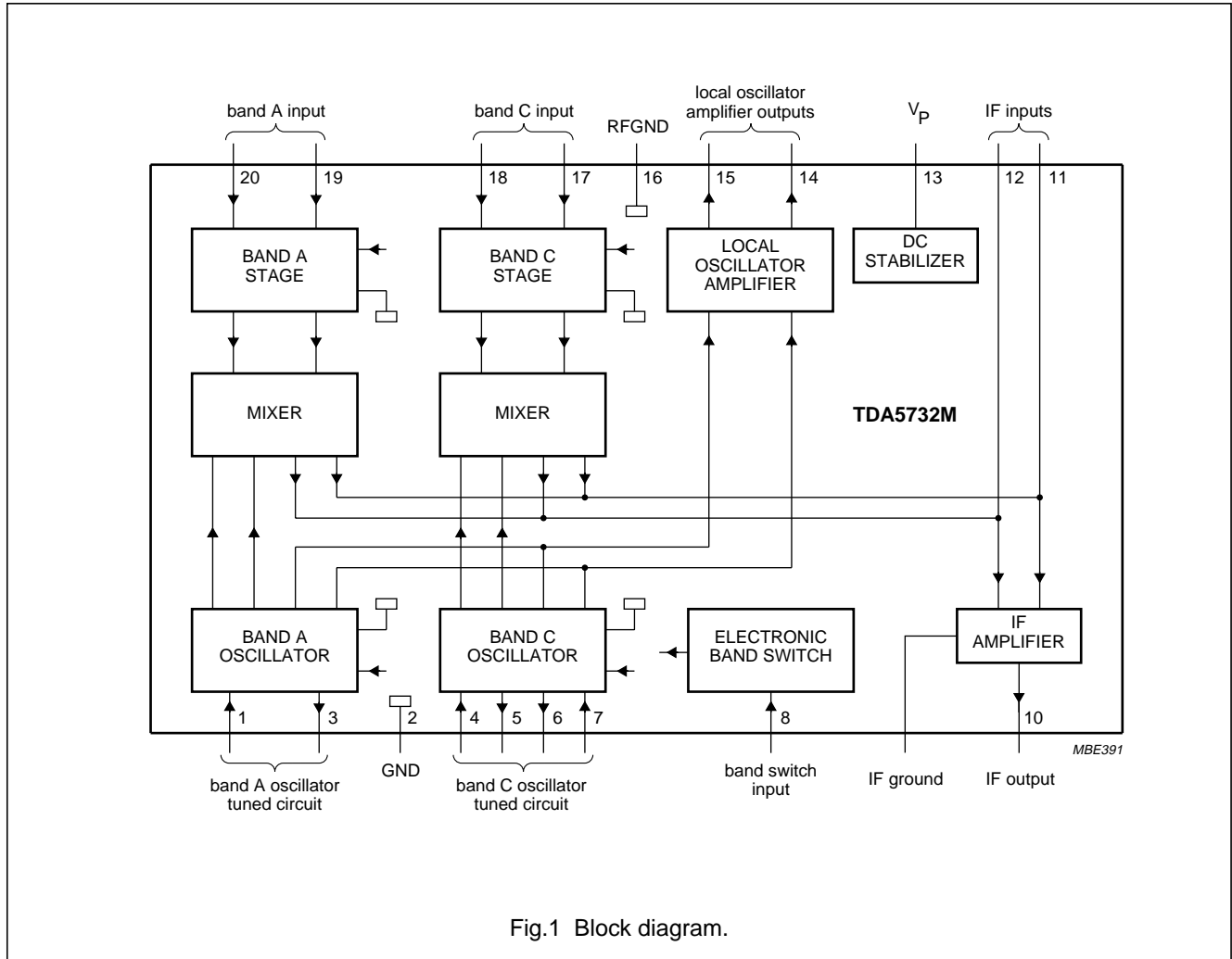


Fig.1 Block diagram.

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**PINNING**

SYMBOL	PIN	DESCRIPTION
AOSCIB	1	band A oscillator input base
GND	2	ground (0 V)
AOSCOC	3	band A oscillator output collector
COSCIB1	4	band C oscillator input base 1
COSCOC1	5	band C oscillator output collector 1
COSCOC2	6	band C oscillator output collector 2
COSCIB2	7	band C oscillator input base 2
BS	8	electronic band switch input
IFGND	9	ground for IF inputs
IFOUT	10	IF amplifier output
IFIN1	11	IF amplifier input 1
IFIN2	12	IF amplifier input 2
V <sub>P</sub>	13	supply voltage
LOOUT1	14	local oscillator amplifier output 1
LOOUT2	15	local oscillator amplifier output 2
RFGND	16	ground for RF inputs
CIN1	17	band C input 1
CIN2	18	band C input 2
AIN1	19	band A input 1
AIN2	20	band A input 2

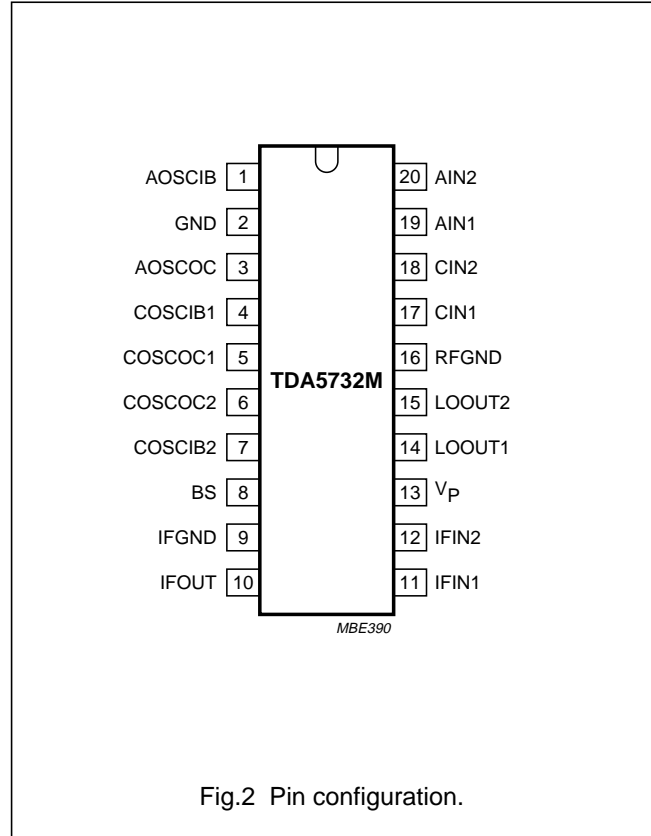


Fig.2 Pin configuration.

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### LIMITING VALUES

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

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
$V_P$	supply voltage range	-0.3	+7.0	V
$V_{P(op)}$	operating supply voltage	4.5	5.5	V
$V_{n(max)}$	maximum voltage on each pin with a 22 k $\Omega$ resistor connected in series	-	35	V
$V_{SW}$	switching voltage	0	7.0	V
$T_{stg}$	storage temperature	-55	+150	$^{\circ}\text{C}$
$T_{amb}$	operating ambient temperature	-20	+85	$^{\circ}\text{C}$
$T_j$	junction temperature	-	+150	$^{\circ}\text{C}$

### THERMAL CHARACTERISTICS

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

### HANDLING

Human body model: the IC withstands 2000 V (except pins 17 and 18 which withstand 1000 V) in accordance with *UZW-BO-FQ-A302*;  $R = 1.5\text{ k}\Omega$ ;  $C = 100\text{ pF}$ .

Machine model: the IC withstands 200 V in accordance with *UZW-BO-FQ-B302*;  $R = 0\ \Omega$ ;  $C = 200\text{ pF}$ .

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**CHARACTERISTICS** $V_P = 5\text{ V}$ ;  $T_{\text{amb}} = 25\text{ }^\circ\text{C}$ ; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
<b>Supply</b>						
$V_P$	supply voltage		4.5	5.0	5.5	V
$I_P$	supply current	$I_{P(\text{max})}$ measured at $V_{P(\text{max})}$	–	50	64	mA
$V_{\text{SW}}$	switching voltage	band A	0	–	2.0	V
		band C	3.0	–	$V_P$	V
$I_{\text{SW}}$	switching current	band A; $V_{\text{SW}} = 0\text{ V}$	–	–	2	$\mu\text{A}$
		band C; $V_{\text{SW}} = 5\text{ V}$	–	4.5	10	$\mu\text{A}$
		$V_{P(\text{max})}$	–	6	–	$\mu\text{A}$
<b>IF amplifier</b>						
$S_{22}$	output reflection coefficient	$f_i = 43.5\text{ MHz}$ ; see Fig.12	–	–13.1	–	dB
		$f_i = 43.5\text{ MHz}$ ; see Fig.12	–	2.9	–	deg
		$f_i = 58.75\text{ MHz}$ ; see Fig.12	–	–13.1	–	dB
		$f_i = 58.75\text{ MHz}$ ; see Fig.12	–	2.2	–	deg
$Z_O$	output impedance	$f_i = 43.5\text{ MHz}$ ; see Fig.12	–	78.4	–	$\Omega$
		$f_i = 43.5\text{ MHz}$ ; see Fig.12	–	1.8	–	$\Omega$
		$f_i = 58.75\text{ MHz}$ ; see Fig.12	–	78.4	–	$\Omega$
		$f_i = 58.75\text{ MHz}$ ; see Fig.12	–	–1.4	–	$\Omega$
SLO	visibility of the LO frequency at the IF output (worst case in the frequency range of band A and band C)	$R_L = 75\ \Omega$	–	85	–	$\text{dB}\mu\text{V}$
<b>Band A mixer (including IF amplifier)</b>						
$f_R$	frequency range	VHFI	55.25	–	127.25	MHz
		VHFIII	133.25	–	361.25	MHz
$N_A$	noise figure	$f_i = 50\text{ MHz}$ ; see Fig.7	–	8.5	9.5	dB
		$f_i = 150\text{ MHz}$ ; see Fig.7	–	8.5	10.5	dB
		$f_i = 300\text{ MHz}$ ; see Fig.7	–	9.5	12.5	dB
$g_{\text{os}}$	optimum source conductance	$f_i = 50\text{ MHz}$ ; see Fig.7	–	0.7	–	mS
		$f_i = 150\text{ MHz}$ ; see Fig.7	–	0.9	–	mS
		$f_i = 300\text{ MHz}$ ; see Fig.7	–	1.5	–	mS
$Y_I$	input admittance ( $G_P//C_P$ )	$G_P$ ; $f_i = 55.25\text{ MHz}$ ; see Fig.9	–	0.25	–	mS
		$G_P$ ; $f_i = 361.25\text{ MHz}$ ; see Fig.9	–	0.5	–	mS
		$C_P$ ; $f_i = 55.25\text{ to }361.25\text{ MHz}$ ; see Fig.9	–	1.3	–	pF
$V_{\text{OA(IF)}}$	IF output voltage	1% cross modulation; in channel; $f_i = 55.25\text{ to }361.25\text{ MHz}$ ; $R_L = 75\ \Omega$ ; wanted frequency sound carrier; unwanted frequency picture carrier; see Fig.5	105	108	–	$\text{dB}\mu\text{V}$

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SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_{i(RF)}$	RF input voltage	$f_i = 173$ MHz; note 1	–	91	–	$\text{dB}\mu\text{V}$
		$f_i = 407$ MHz; note 1	–	83	–	$\text{dB}\mu\text{V}$
$G_{V(A)}$	voltage gain at the channel centre	$f_{IF} = 43.5$ MHz; $R_L = 75 \Omega$ ; see Fig.3	16.5	19	21.5	dB
<b>Band A oscillator</b>						
$f_R$	frequency range	VHFI	101	–	173	MHz
		VHFIII	179	–	407	MHz
$f_{\text{shift}}$	frequency shift (worst case in the frequency range)	$\Delta V_P = 5\%$ ; note 2	–	44	100	kHz
		$\Delta V_P = 10\%$ ; note 2	–	220	–	kHz
$\chi_{\text{ripple(p-p)}}$	ripple susceptibility of the supply voltage (peak-to-peak value)	$V_P = 4.75$ to $5.25$ V; $f_i = 101$ MHz; note 3	–	78	–	mV
		$V_P = 4.75$ to $5.25$ V; $f_i = 173$ MHz; note 3	–	34	–	mV
		$V_P = 4.75$ to $5.25$ V; $f_i = 179$ MHz; note 3	–	8.0	–	mV
		$V_P = 4.75$ to $5.25$ V; $f_i = 407$ MHz; note 3	–	10	–	mV
$f_{\text{drift}}$	frequency drift (worst case in the frequency range)	$\Delta T = 25$ °C with no compensation; NP0 capacitors; note 4	–	1800	2200	kHz
		5 s to 15 min after switch on; note 5	–	630	1100	kHz
$\Phi_N$	phase noise, carrier-to-noise sideband (worst case in the frequency range)	$\pm 50$ kHz; frequency offset; $B = 3$ kHz	–	60	–	dBc
<b>Band C mixer (including IF amplifier)</b>						
$f_R$	frequency range, picture carrier		367.25	–	801.25	MHz
$N_C$	noise figure (not corrected for image)	$f_i = 367.25$ MHz	–	9	11	dB
		$f_i = 801.25$ MHz	–	10	12	dB
$Z_I$	input impedance ( $R_S + L_S$ )	$R_S$ ; $f_i = 367.25$ MHz; see Fig.10	–	30	–	$\Omega$
		$L_S$ ; $f_i = 367.25$ MHz; see Fig.10	–	9	–	nH
		$R_S$ ; $f_i = 801.25$ MHz; see Fig.10	–	38	–	$\Omega$
		$L_S$ ; $f_i = 801.25$ MHz; see Fig.10	–	6	–	nH
$V_{oC(IF)}$	IF output voltage	1% cross modulation; in channel; $f_i = 365.25$ to $801.25$ MHz; $R_L = 75 \Omega$ ; wanted frequency sound carrier; unwanted frequency picture carrier; see Fig.6	105	108	–	$\text{dB}\mu\text{V}$
$V_{i(RF)}$	RF input voltage	$f_i = 847$ MHz; note 1	–	66	–	$\text{dB}\mu\text{V}$
$G_{V(C)}$	voltage gain	$f_{IF} = 43.5$ MHz; $R_L = 75 \Omega$ ; see Fig.4	26	29	32	dB

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SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
<b>Band C oscillator</b>						
$f_R$	frequency range		413	–	847	MHz
$f_{\text{shift}}$	frequency shift	$\Delta V_P = 5\%$ ; note 2	–	46	200	kHz
		$\Delta V_P = 10\%$ ; note 2	–	200	–	kHz
$\chi_{\text{ripple(p-p)}}$	ripple susceptibility of the supply voltage (peak-to-peak value)	$V_P = 4.75$ to $5.25$ V; $f_i = 413$ MHz	–	203	–	mV
		$V_P = 4.75$ to $5.25$ V; $f_i = 847$ MHz; note 3	–	22	–	mV
$f_{\text{drift}}$	frequency drift (worst case in the frequency range)	$\Delta T = 25$ °C with compensation; note 4	–	1100	2500	kHz
		5 s to 15 min after switching on; note 5	–	300	1300	kHz
$\Phi_N$	phase noise, carrier-to-noise sideband (worst case in the frequency range)	$\pm 50$ kHz; frequency offset; $B = 3$ kHz	–	64	–	dBc
<b>LO output</b>						
$Y_O$	output admittance ( $G_P/C_P$ )	$G_P$ ; $f_i = 101$ MHz; see Fig.11	–	2.4	–	mS
		$G_P$ ; $f_i = 847$ MHz; see Fig.11	–	3.1	–	mS
		$C_P$ ; $f_i = 101$ to $847$ MHz; see Fig.11	–	0.5	–	pF
$V_O$	output voltage	$R_L = 50$ $\Omega$ ; $V_P = 4.5$ to $5.5$ V; $V_t = 0$ to $28$ V	83	90	100	dB $\mu$ V
SRF	spurious signal on LO output with respect to LO output signal	$R_L = 50$ $\Omega$ ; note 6	–	–15	–10	dB
HLO	LO signal harmonics w.r.t. LO signal	$R_L = 50$ $\Omega$	–	–10.5	–9.5	dB

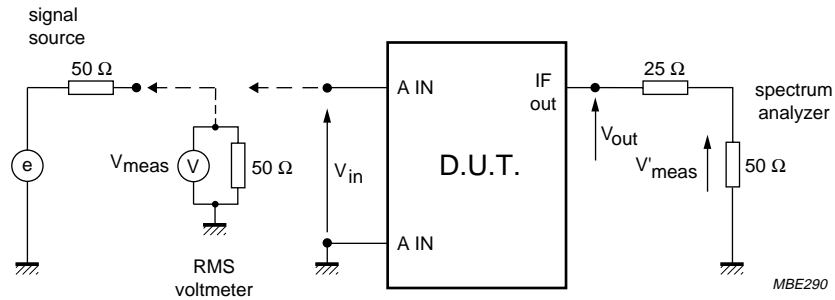
**Notes**

- The RF signal is modulated with 50% AM at 15 kHz: The level of the RF signal is increased until there is a 23 dB difference between the LO carrier and the sideband components.
- The frequency shift is defined as a variation in oscillator frequency when the supply voltage varies from  $V_P = 5$  to  $4.75$  V or from  $V_P = 5$  to  $5.75$  V.
- The ripple susceptibility is measured for a 500 kHz ripple at the LO output with the set-up as illustrated in Fig.8. The level of the ripple signal is increased until there is a 53.5 dB difference between the LO carrier and the sideband components.
- The frequency shift is defined as a variation in oscillator frequency when the supply voltage varies from  $T_{\text{amb}} = 25$ °C to  $0$ °C or from  $T_{\text{amb}} = 25$ °C to  $50$ °C.
- The switching on drift is defined as the variation in oscillator frequency between 5 seconds and 15 minutes after switching on.
- SRF: spurious signal on LO with respect to LO output signal;
  - RF voltage level = 1 V at  $f_i = 55.25$  to  $225$  MHz.
  - RF level = 2.5 dBm at  $f_i = 225$  to  $361.25$  MHz.
  - RF level = –10 dBm at  $f_i = 367.25$  to  $801.25$  MHz.



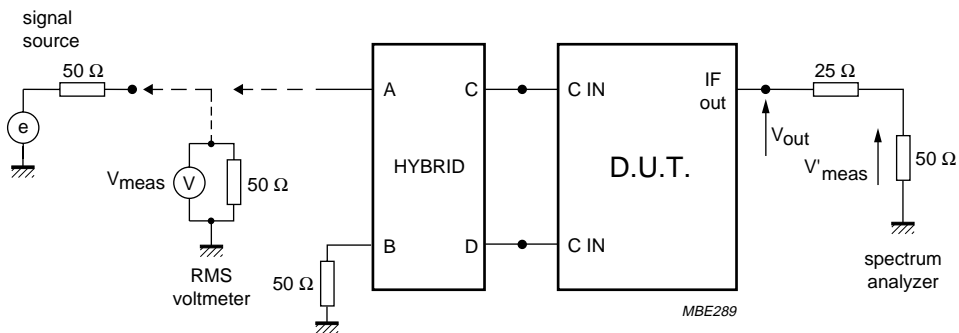
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$Z_i \gg 50 \Omega \geq V_i = 2V_{meas}$  ( $V_i = 80 \text{ dB}\mu\text{V}$ );  $V_o = V'_{meas} \times (50 + 25)/50$ ; voltage gain for band A =  $20\log(V_o/V_i)$ .

Fig.3 Band A gain measurement.

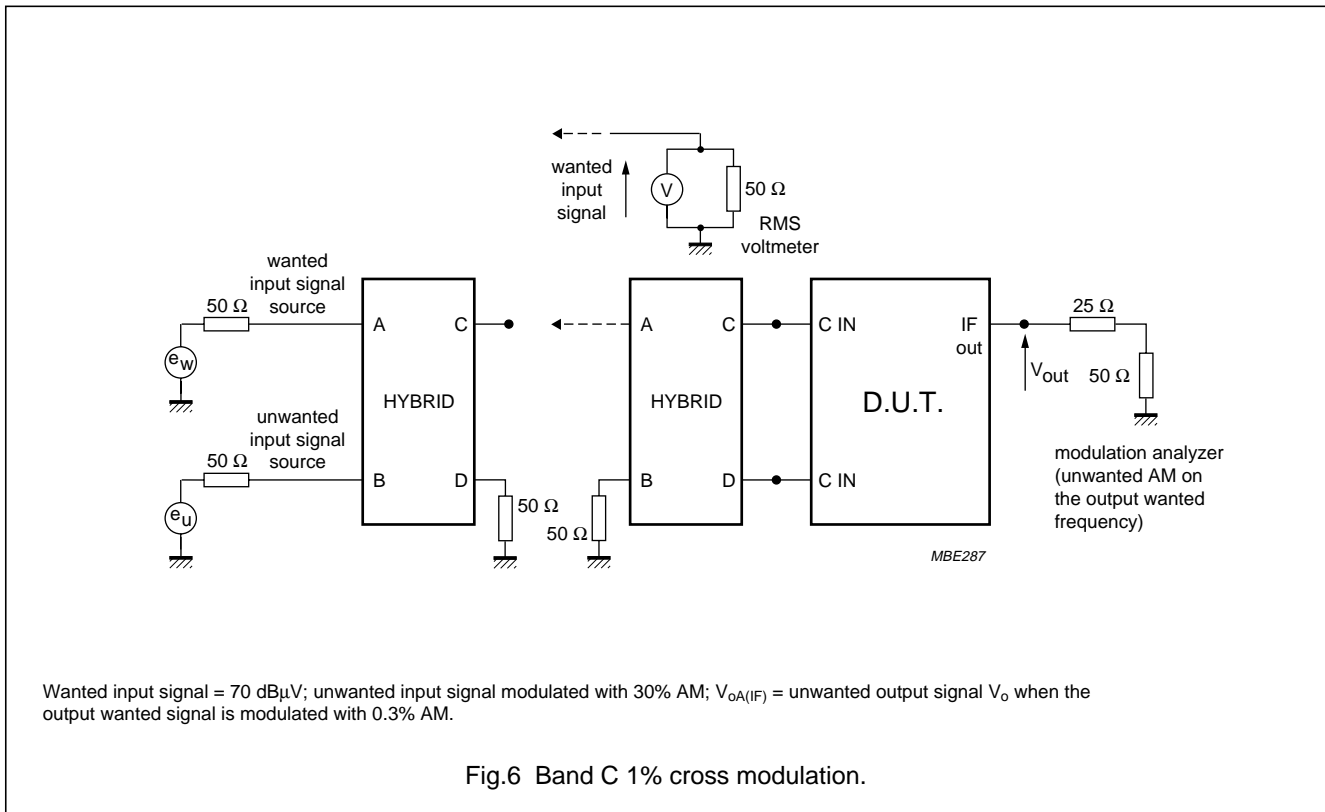
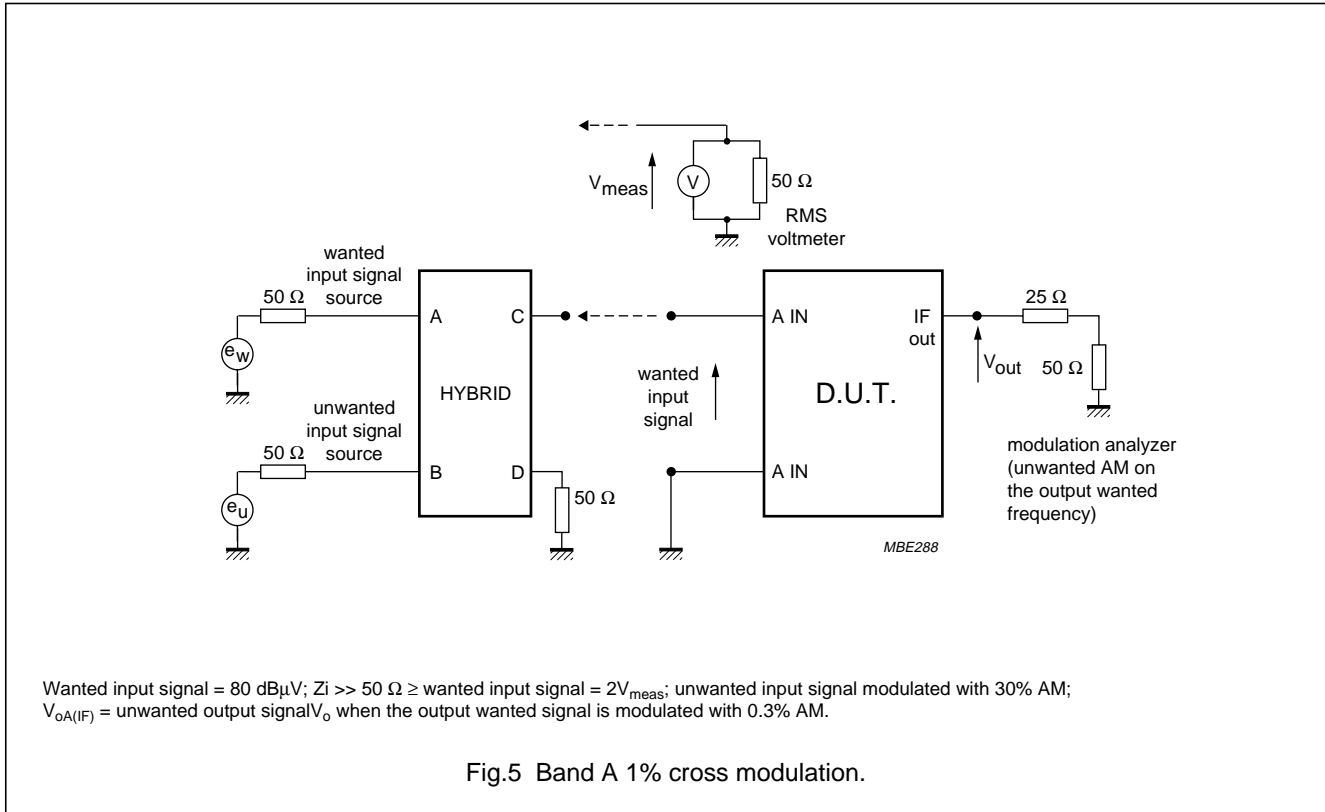


$V_i = V_{meas}$  ( $V_i = 70 \text{ dB}\mu\text{V}$ );  $V_o = V'_{meas} \times (50 + 25)/50$ ; voltage gain for band C =  $20\log(V_o/V_i)$ .

Fig.4 Band C gain measurement.

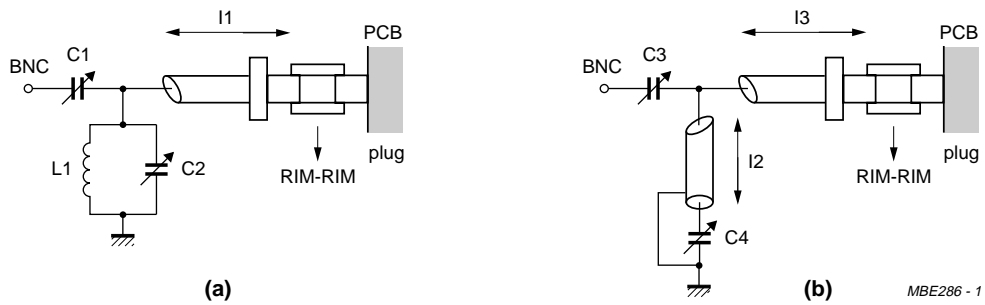
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**(a) For  $f_R = 50$  MHz:**

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

**(b) For  $f_R = 180$  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.7 Input circuit for minimum noise figure.

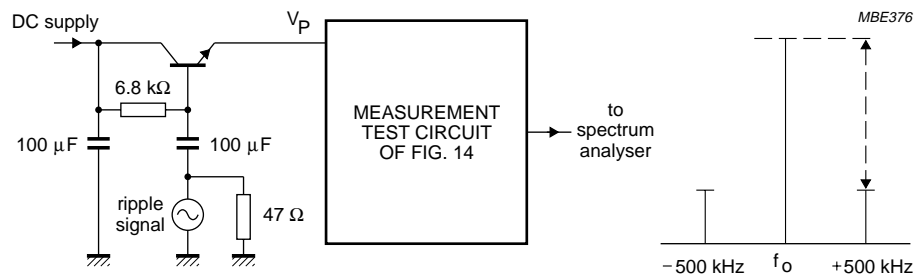


Fig.8 Measurement set-up for ripple measurement,

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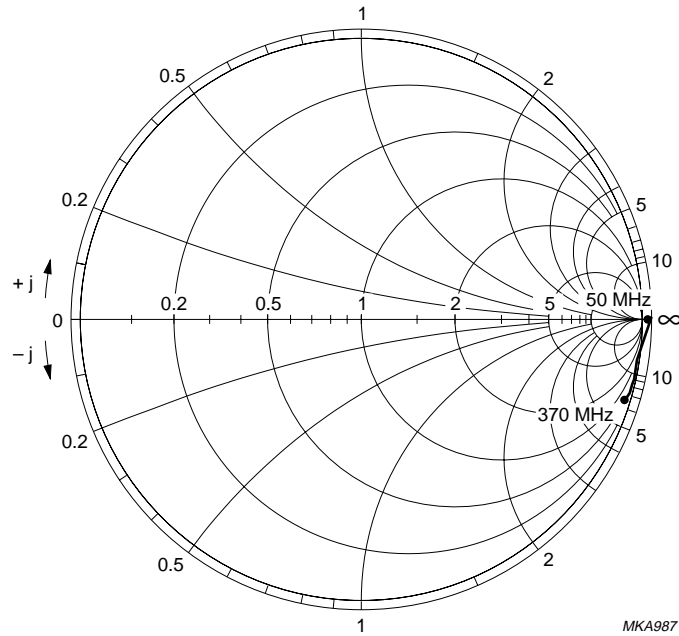


Fig.9  $S_{11}$  on VHF mixer input (Z chart;  $Z_0 = 50 \Omega$ ).

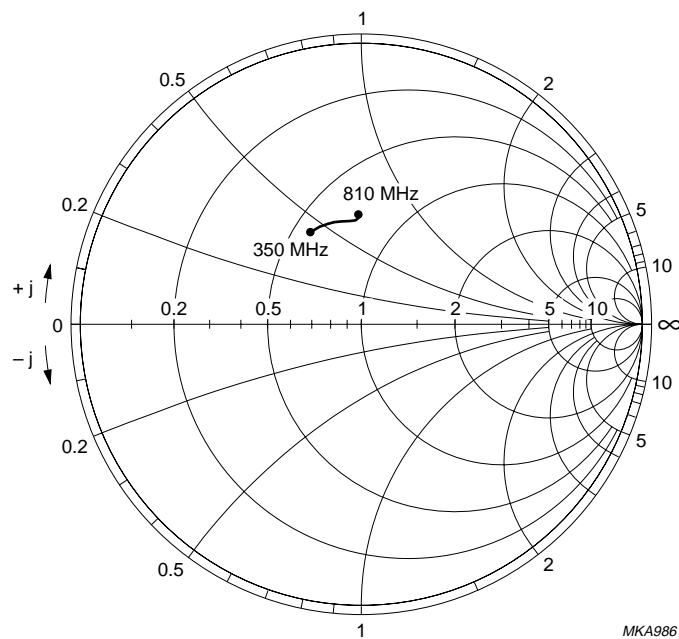


Fig.10  $S_{11}$  on UHF mixer input (Z chart;  $Z_0 = 50 \Omega$ ).

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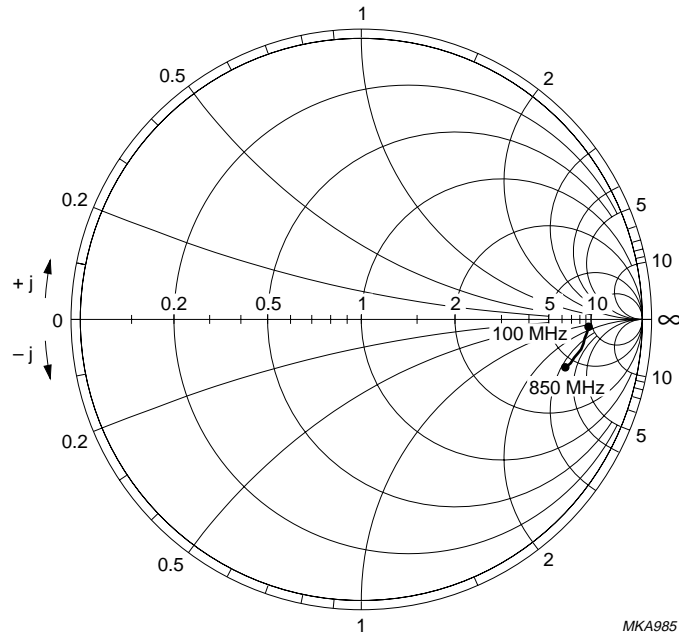


Fig.11  $S_{22}$  on LO output (Z chart;  $Z_0 = 50 \Omega$ ).

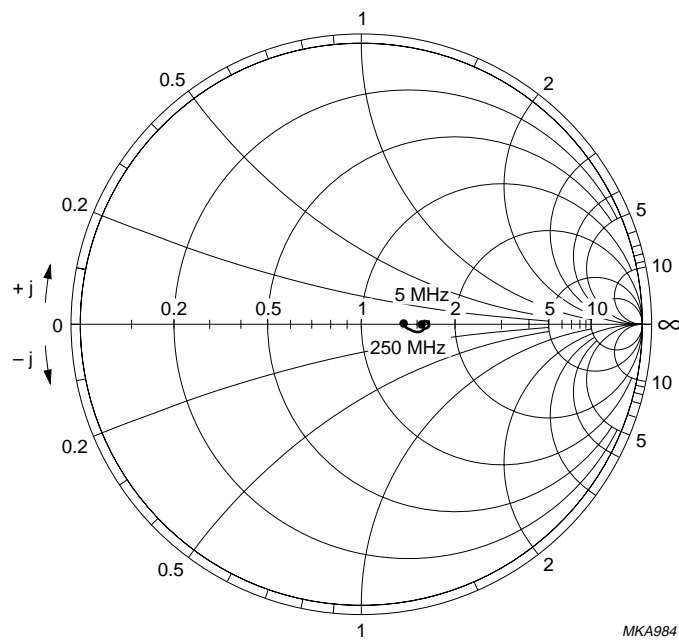


Fig.12  $S_{22}$  on IF output (Z chart;  $Z_0 = 50 \Omega$ ).

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INTERNAL PIN CONFIGURATION

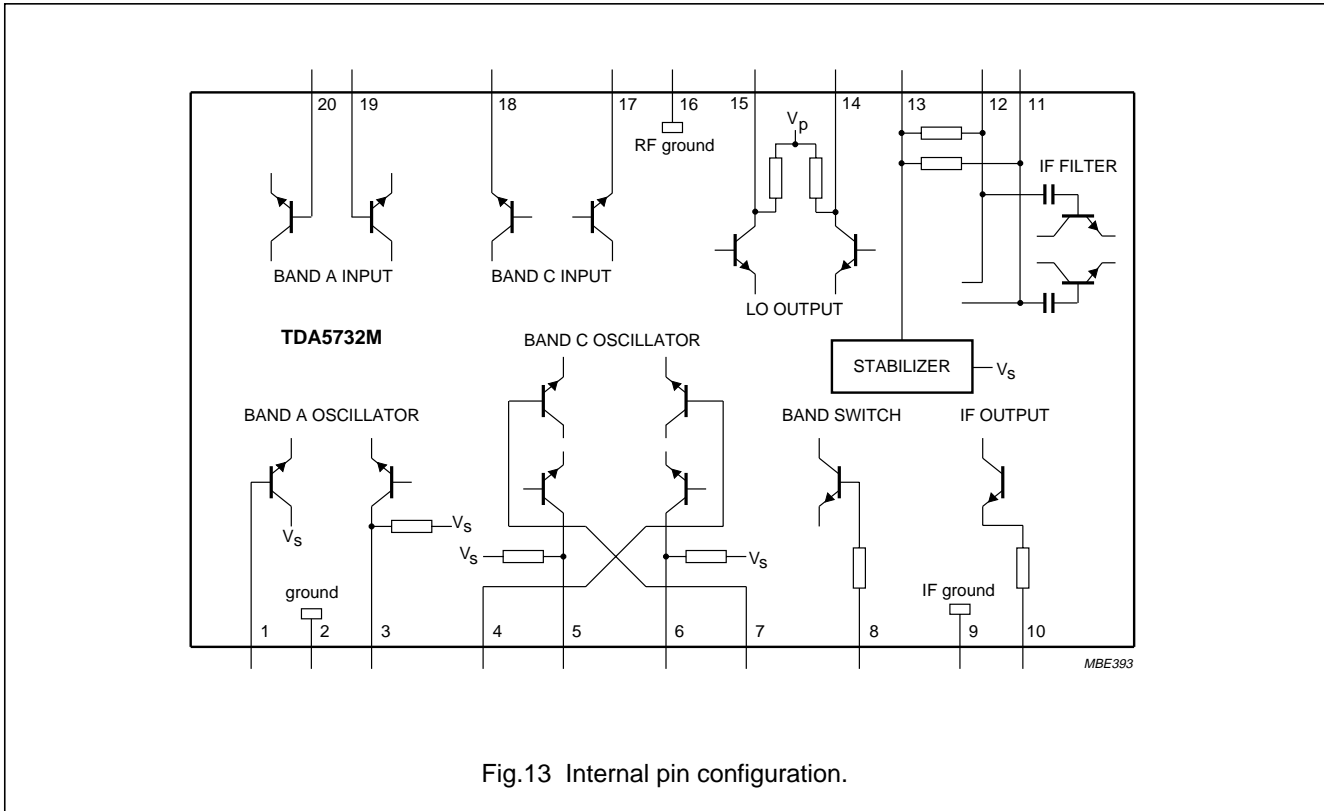


Fig.13 Internal pin configuration.

Table 1 Average DC voltage on pins

UHF/ VHF	PINS																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
VHF	1.8	0	3	-	3.6	3.6	-	0	0	2.1	3.6	3.6	5	4.2	4.2	0	-	-	1.8	1.8
UHF	-	0	3.6	1.9	2.9	2.9	1.9	5	0	2.1	3.6	3.6	5	4.2	4.2	0	1	1	-	-

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APPLICATION INFORMATION

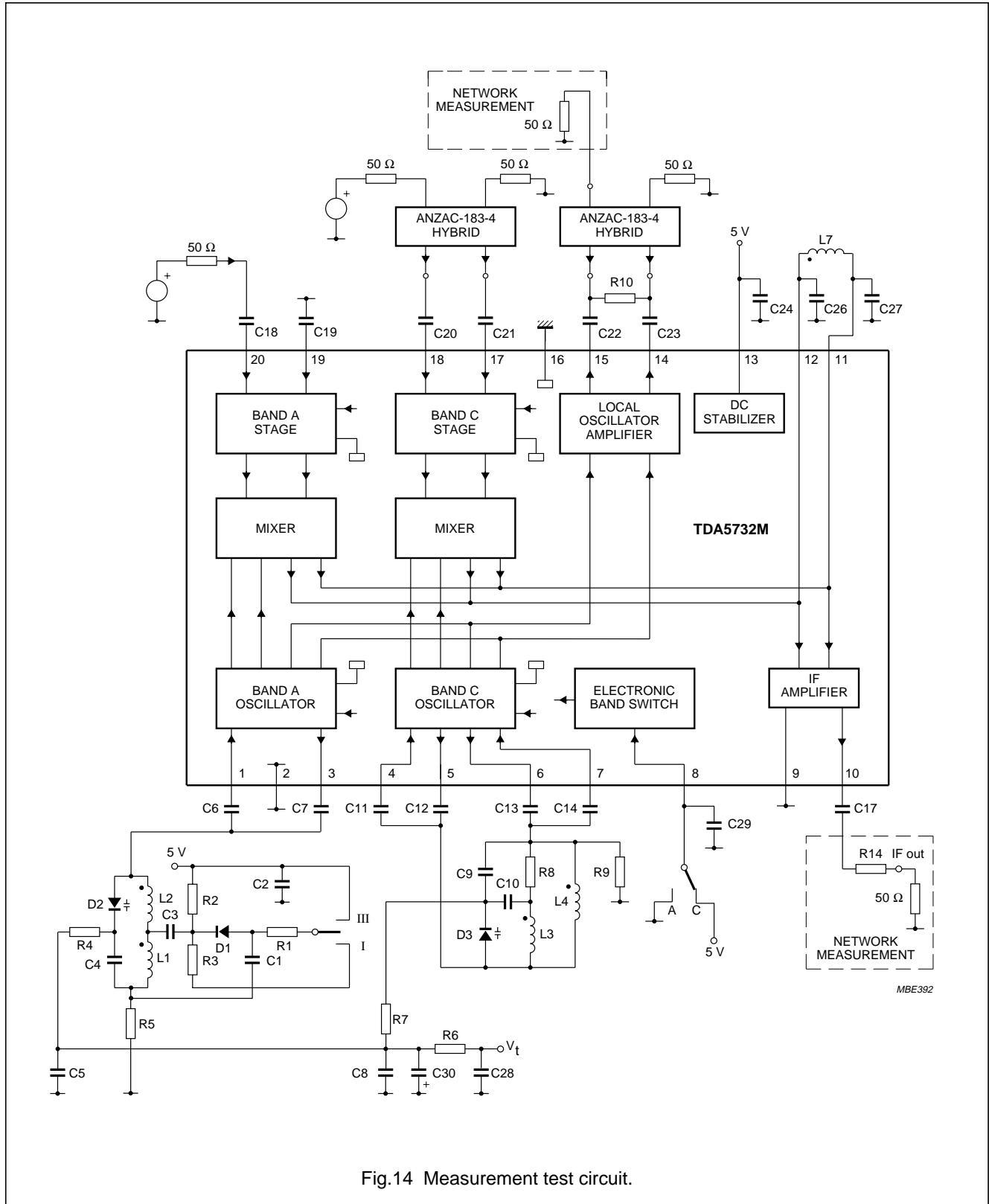


Fig.14 Measurement test circuit.

# Low power VHF, UHF mixer/oscillator for TV and VCR 2-band tuners

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## Application diagram components values

**Table 2** Capacitors (all SMD and NP0 except C9 to C11 to C14 and C29)

NUMBER	VALUE
C1	1 nF
C2	1 nF
C3	1 nF
C4	82 pF
C5	2.2 nF
C6	2.2 nF
C7	1.5 pF
C8	2.2 nF
C9	6 pF (N750)
C10	100 pF
C11	1 pF (N1500)
C12	2 pF (N750)
C13	2 pF (N750)
C14	1 pF (N1500)
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 3** Resistors (all SMD)

NUMBER	VALUE
R1	10 $\Omega$
R2	12 k $\Omega$
R3	2.7 k $\Omega$
R4	47 k $\Omega$
R5	10 $\Omega$
R6	47 k $\Omega$
R7	22 k $\Omega$
R8	2.2 k $\Omega$
R9	22 k $\Omega$
R10	100 $\Omega$
R14	27 $\Omega$

**Table 4** Diodes and coils

NUMBER	VALUE
<b>Diodes</b>	
D1	BA792
D2	BB133
D3	BB134
<b>Coils<sup>(1)</sup></b>	
L1	6 t (3.5 mm)
L2	3 t (2.5 mm)
L3	2 t (2.5 mm)
L4	3 t (3 mm)

### Note

- Wire size for L1 to L4 is 0.4 mm

### Transformer (L7 = 2 turns)

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



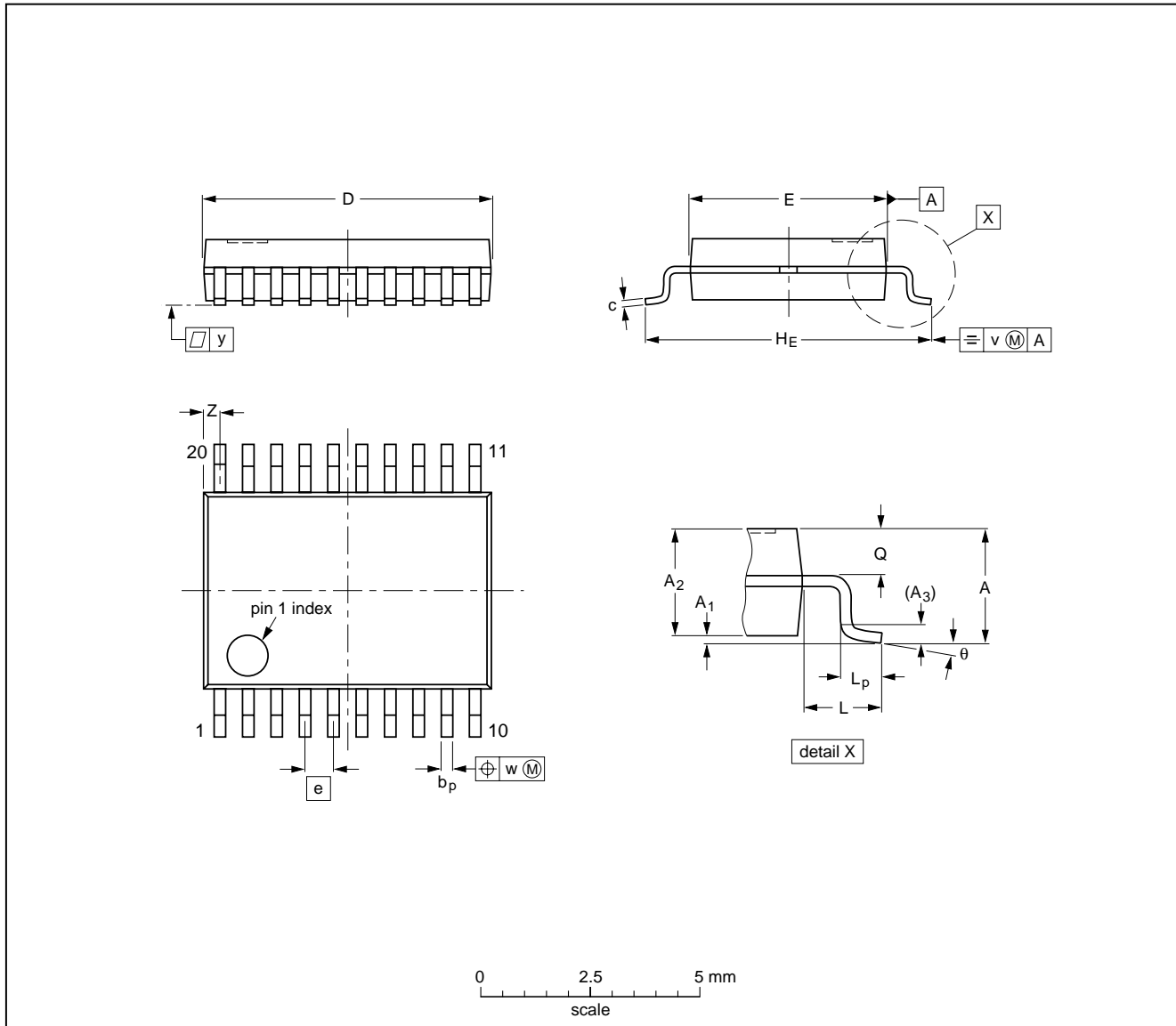
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PACKAGE OUTLINE

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

SOT266-1



DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(1)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	Z <sup>(1)</sup>	θ
mm	1.5	0.15 0	1.4 1.2	0.25	0.32 0.20	0.20 0.13	6.6 6.4	4.5 4.3	0.65	6.6 6.2	1.0	0.75 0.45	0.65 0.45	0.2	0.13	0.1	0.48 0.18	10° 0°

Note

1. Plastic or metal protrusions of 0.20 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT266-1						90-04-05 95-02-25

## Low power VHF, UHF mixer/oscillator for TV and VCR 2-band tuners

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### SOLDERING

#### Plastic small outline packages

##### BY WAVE

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

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

A modified wave soldering technique is recommended using two solder waves (dual-wave), in which a turbulent wave with high upward pressure is followed by a smooth laminar wave. Using a mildly-activated flux eliminates the need for removal of corrosive residues in most applications.

##### BY SOLDER PASTE REFLOW

Reflow soldering requires the solder paste (a suspension of fine solder particles, flux and binding agent) to be

applied to the substrate by screen printing, stencilling or pressure-syringe dispensing before device placement.

Several techniques exist for reflowing; for example, thermal conduction by heated belt, infrared, and vapour-phase reflow. Dwell times vary between 50 and 300 s according to 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 min at 45 °C.

#### REPAIRING SOLDERED JOINTS (BY HAND-HELD SOLDERING IRON OR PULSE-HEATED SOLDER TOOL)

Fix the component by first soldering two, diagonally opposite, end pins. Apply the heating tool to the flat part of the pin only. Contact time must be limited to 10 s at up to 300 °C. When using proper tools, all other pins can be soldered in one operation within 2 to 5 s at between 270 and 320 °C. (Pulse-heated soldering is not recommended for SO packages.)

For pulse-heated solder tool (resistance) soldering of VSO packages, solder is applied to the substrate by dipping or by an extra thick tin/lead plating before package placement.

### 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

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