

# DATA SHEET

## **TDA5744; TDA5745**

Low power mixers/oscillators for  
hyperband tuners

Preliminary specification  
File under Integrated Circuits, IC02

1998 Mar 09

## Low power mixers/oscillators for hyperband tuners

## TDA5744; TDA5745

### FEATURES

- Mixers/oscillators for hyperband tuners
- Balanced mixer with a common emitter input for VHF (single input)
- Balanced mixer with a common base input for UHF (double input)
- 4-pin common emitter oscillator for VHF
- 4-pin common emitter oscillator for UHF
- Electronic band switch
- IF amplifier with a low output impedance to drive the SAW filter directly ( $\approx 2 \text{ k}\Omega$  load)
- Low power, low radiation and small size
- Pin compatible single-chip synthesizer mixer/oscillator for Full Scale Tuners (FST) are available: TDA6404, TDA6405 and TDA6405A.

### APPLICATIONS

- Hyperband tuners for Europe using a 2-band mixer/oscillator in a switched concept.

### GENERAL DESCRIPTION

The TDA5744 and TDA5745 are 2-band mixers/oscillators intended for VHF/UHF and hyperband tuners (see Fig.1).

The Integrated Circuits (ICs) include two double balanced mixers and two oscillators, for the VHF and UHF band, and an IF amplifier. With proper oscillator application and by using a switchable inductor to split the VHF band into two sub-bands (the full VHF/UHF and hyperband) the TV bands can be covered. Two pins are available between the mixer output and the IF amplifier input to enable IF filtering for improved signal handling. Band selection is made by band switch pin BS.

### QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_{CC}$	supply voltage	operating	4.5	5	5.5	V
$I_{CC}$	supply current		–	58	–	mA
$T_{stg}$	IC storage temperature		–40	–	+150	°C
$T_{amb}$	operating ambient temperature		–20	–	+85	°C
$f_{i(RF)}$	RF input frequency	VHF band	45.25	–	399.25	MHz
		UHF band	407.25	–	855.25	MHz
$G_V$	voltage gain	VHF band	–	27	–	dB
		UHF band	–	38	–	dB
F	noise figure	VHF band	–	8	–	dB
		UHF band	–	8.5	–	dB
$V_o$	output voltage causing 1% cross modulation in channel	VHF band	–	119	–	dB $\mu$ V
		UHF band	–	118	–	dB $\mu$ V

### ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TDA5744TS; TDA5745TS	SSOP24	plastic shrink small outline package; 24 leads; body width 5.3 mm	SOT340-1



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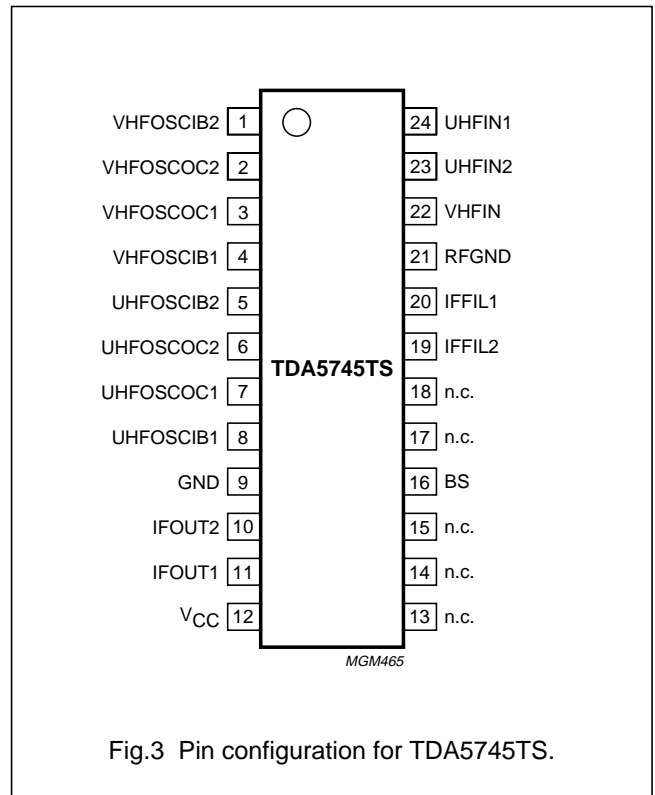
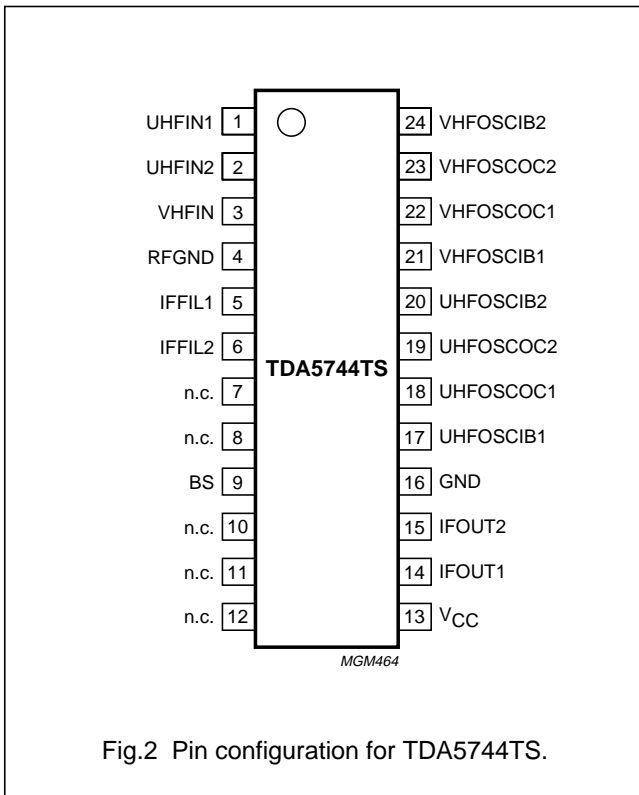
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**PINNING**

SYMBOL	PIN		DESCRIPTION
	TDA5744	TDA5745	
UHFIN1	1	24	UHF input 1
UHFIN2	2	23	UHF input 2
VHFIN	3	22	VHF input
RFGND	4	21	RF ground
IFFIL1	5	20	IF filter output 1
IFFIL2	6	19	IF filter output 2
n.c.	7	18	not connected
n.c.	8	17	not connected
BS	9	16	electronic band switch
n.c.	10	15	not connected
n.c.	11	14	not connected
n.c.	12	13	not connected
V <sub>CC</sub>	13	12	supply voltage
IFOUT1	14	11	IF amplifier output 1
IFOUT2	15	10	IF amplifier output 2
GND	16	9	ground
UHFOSCIB1	17	8	UHF oscillator base input 1
UHFOSCOC1	18	7	UHF oscillator collector output 1
UHFOSCOC2	19	6	UHF oscillator collector output 2
UHFOSCIB2	20	5	UHF oscillator base input 2
VHFOSCIB1	21	4	VHF oscillator base input 1
VHFOSCOC1	22	3	VHF oscillator collector output 1
VHFOSCOC2	23	2	VHF oscillator collector output 2
VHFOSCIB2	24	1	VHF oscillator base input 2

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## LIMITING VALUES

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

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
$I_{O(n)}$	output current of each pin to ground: for TDA5744; pins 1 to 6, 9 and 13 to 24 for TDA5745; pins 1 to 12, 16 and 19 to 24	–	–10	mA
$t_{sc(max)}$	maximum short-circuit time (all pins to $V_{CC}$ and all pins to GND and RFGND)	–	10	s
$T_{stg}$	IC storage temperature	–40	+150	°C
$T_{amb}$	operating ambient temperature	–20	+85	°C
$T_j$	junction temperature	–	150	°C

## THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	119	K/W

## CHARACTERISTICS

 $V_{CC} = 5\text{ V}$ ;  $T_{amb} = 25\text{ °C}$ ; unless otherwise specified; measured in Fig.11.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
<b>Supplies</b>						
$V_{CC}$	supply voltage		4.5	5	5.5	V
$I_{CC}$	supply current		–	58	65	mA
$V_{sw(VHF)}$	VHF band switching voltage		0	–	2	V
$V_{sw(UHF)}$	UHF band switching voltage		3	–	$V_{CC}$	V
$I_{sw(VHF)}$	VHF band switching current		–	–	2	μA
$I_{sw(UHF)}$	UHF band switching current	$V_{sw(UHF)} = 5\text{ V}$	–	4.5	10	μA
<b>IF amplifier</b>						
$S_{22}$	output reflection coefficient	magnitude	–	–12.5	–	dB
		phase	–	1.4	–	deg
$R_s$	real part of $Z_o = R_s + j\omega L_s$		–	81	–	Ω
$L_s$	imaginary part of $Z_o = R_s + j\omega L_s$		–	9.5	–	nH
<b>VHF mixer (including IF amplifier)</b>						
$f_{i(RF)}$	RF input frequency	picture carrier frequency	45.25	–	399.25	MHz
F	noise figure	$f_{RF} = 50\text{ MHz}$ ; see Figs 8 and 9	–	7	9	dB
		$f_{RF} = 150\text{ MHz}$ ; see Figs 8 and 9	–	8	10	dB
		$f_{RF} = 300\text{ MHz}$	–	9	11	dB
$g_{os}$	optimum source conductance for noise figure	$f_{RF} = 50\text{ MHz}$	–	0.7	–	mS
		$f_{RF} = 150\text{ MHz}$	–	0.9	–	mS
		$f_{RF} = 300\text{ MHz}$	–	1.5	–	mS

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SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
g <sub>i</sub>	input conductance	f <sub>RF</sub> = 45.25 MHz	–	0.25	–	mS
		f <sub>RF</sub> = 399.25 MHz	–	0.5	–	mS
C <sub>i</sub>	input capacitance	f <sub>RF</sub> = 45.25 to 399.25 MHz	–	2	–	pF
V <sub>o</sub>	output voltage causing 1% cross modulation in channel	f <sub>RF</sub> = 45.25 MHz; see Fig.6	116	119	–	dBμV
		f <sub>RF</sub> = 399.25 MHz; see Fig.6	116	119	–	dBμV
V <sub>i</sub>	input voltage causing pulling in channel (750 Hz)	f <sub>RF</sub> = 399.25 MHz; note 1	–	88	–	dBμV
G <sub>V</sub>	voltage gain	f <sub>RF</sub> = 45.25 MHz; see Fig.4	24.5	27	29.5	dB
		f <sub>RF</sub> = 399.25 MHz; see Fig.4	24.5	27	29.5	dB
<b>VHF oscillator</b>						
f <sub>osc</sub>	oscillator frequency		84.15	–	438.15	MHz
Δf <sub>osc(V)</sub>	oscillator frequency shift with supply voltage	ΔV <sub>CC</sub> = 5%; note 2	–	100	200	kHz
		ΔV <sub>CC</sub> = 10%; worst case in the frequency range; note 2	–	200	–	kHz
Δf <sub>osc(T)</sub>	oscillator frequency drift with temperature	ΔT = 25 °C without compensation: NP0 capacitors; worst case in the frequency range; note 3	–	1300	tbf	kHz
Δf <sub>osc(t)</sub>	oscillator frequency drift with time	worst case in the frequency range; note 4	–	600	tbf	kHz
Φ <sub>osc</sub>	phase noise, carrier-to-noise sideband	±100 kHz frequency offset; worst case in the frequency range	–	106	–	dBc/Hz
RSC <sub>(p-p)</sub>	ripple susceptibility of V <sub>CC</sub> (peak-to-peak value)	V <sub>CC</sub> = 5 V; worst case in the frequency range; ripple frequency 500 kHz; note 5	15	40	–	mV
<b>UHF mixer (including IF amplifier)</b>						
f <sub>i(RF)</sub>	RF input frequency	picture carrier frequency	407.25	–	855.25	MHz
F	noise figure	f <sub>RF</sub> = 407.25 MHz; see Fig.10	–	8	10	dB
		f <sub>RF</sub> = 855.25 MHz; not corrected for image; see Fig.10	–	9	11	dB
R <sub>s</sub>	real part of Z <sub>i</sub> = R <sub>s</sub> + jωL <sub>s</sub>	f <sub>RF</sub> = 407.25 MHz	–	30	–	Ω
		f <sub>RF</sub> = 855.25 MHz	–	38	–	Ω
L <sub>s</sub>	imaginary part of Z <sub>i</sub> = R <sub>s</sub> + jωL <sub>s</sub>	f <sub>RF</sub> = 407.25 MHz	–	9	–	nH
		f <sub>RF</sub> = 855.25 MHz	–	6	–	nH
V <sub>o</sub>	output voltage causing 1% cross modulation in channel	f <sub>RF</sub> = 407.25 MHz; see Fig.7	116	119	–	dBμV
		f <sub>RF</sub> = 855.25 MHz; see Fig.7	114	117	–	dBμV
V <sub>i</sub>	input voltage causing pulling in channel (750 Hz)	f <sub>RF</sub> = 855.25 MHz; note 1	–	78	–	dBμV
G <sub>V</sub>	voltage gain	f <sub>RF</sub> = 407.25 MHz; see Fig.4	35	38	41	dB
		f <sub>RF</sub> = 855.25 MHz; see Fig.4	35	38	41	dB

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SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
<b>UHF oscillator</b>						
$f_{osc}$	oscillator frequency		446.15	–	894.15	MHz
$\Delta f_{osc(V)}$	oscillator frequency shift with supply voltage	$\Delta V_{CC} = 5\%$ ; note 2	–	30	80	kHz
		$\Delta V_{CC} = 10\%$ ; worst case in the frequency range; note 2	–	80	tbf	kHz
$\Delta f_{osc(T)}$	oscillator frequency drift with temperature	$\Delta T = 25\text{ }^{\circ}\text{C}$ ; with compensation; worst case in the frequency range; note 3	–	600	tbf	kHz
$\Delta f_{osc(t)}$	oscillator frequency drift with time	worst case in the frequency range; note 4	–	200	tbf	kHz
$\Phi_{osc}$	phase noise, carrier-to-noise sideband	$\pm 100\text{ kHz}$ frequency offset; worst case in the frequency range	–	106	–	dBc/Hz
$RSC_{(p-p)}$	ripple susceptibility of $V_{CC}$ (peak-to-peak value)	$V_{CC} = 5\text{ V}$ ; worst case in the frequency range; ripple frequency 500 kHz; note 5	15	20	–	mV
<b>Rejection at the IF amplifier output</b>						
$INT_{CHX}$	channel x beat	note 6	60	–	–	dBc
$INT_{S02}$	S02 beat	note 7	66	–	–	dBc

**Notes**

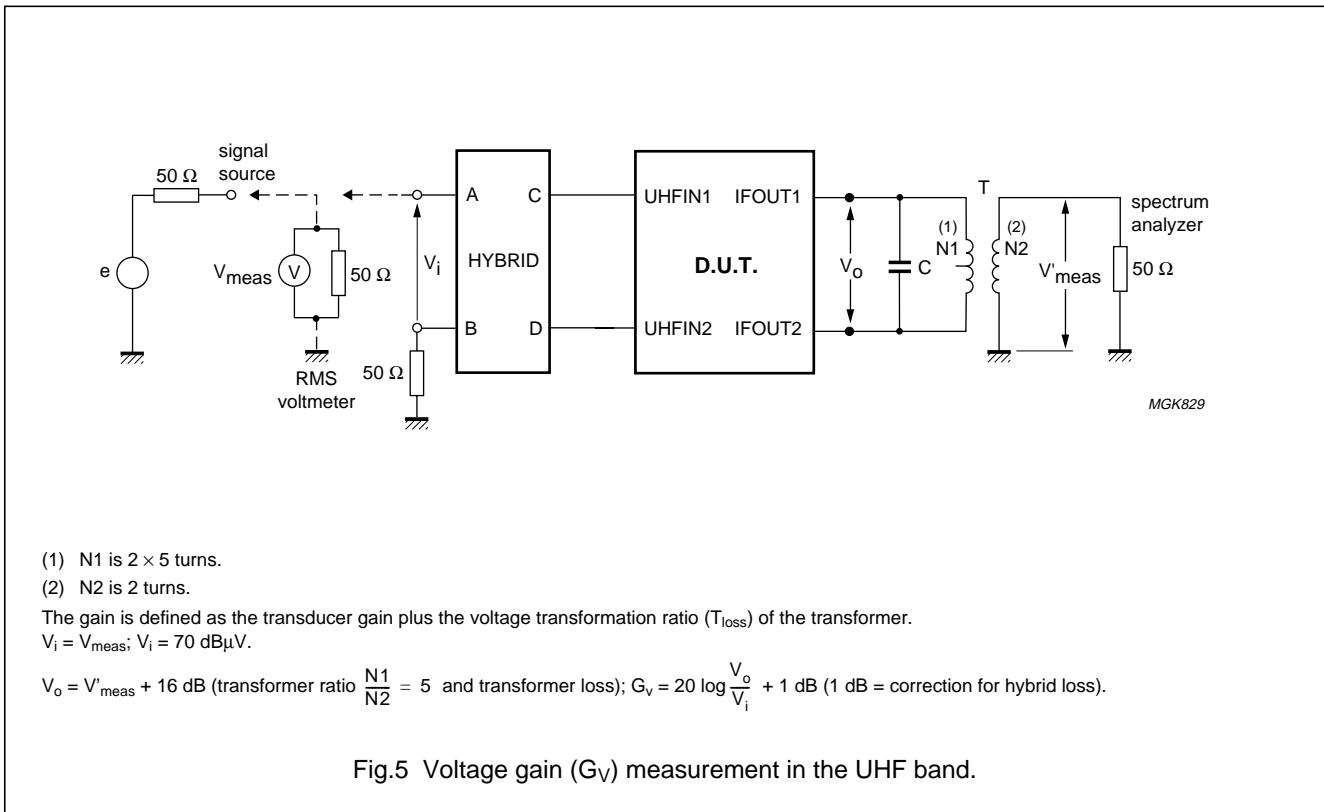
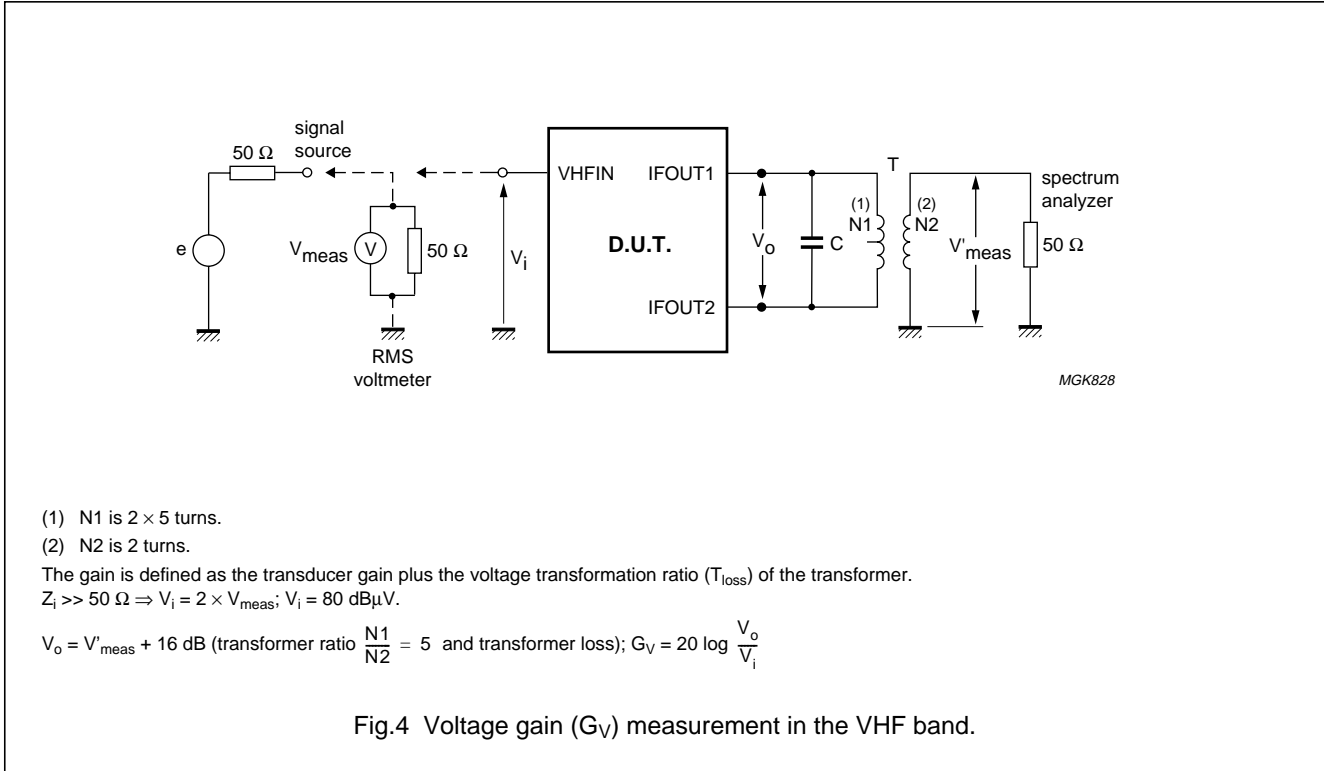
- This is the level of the RF signal (100% amplitude modulated with 11.89 kHz) that causes a 750 Hz frequency deviation on the oscillator signal; it produces sidebands 30 dB below the level of the oscillator signal.
- The frequency shift is defined as the change of the oscillator frequency when the supply voltage varies from  $V_{CC} = 5$  to 4.5 V or from  $V_{CC} = 5$  to 5.25 V. The oscillator is free-running during this measurement.
- The frequency drift is defined as the change of the oscillator frequency when the ambient temperature varies from  $T_{amb} = 25$  to 0 °C or from  $T_{amb} = 25$  to 50 °C. The oscillator is free-running during this measurement.
- The switching on drift is defined as the change of the oscillator frequency between 5 seconds and 15 minutes after switching on. The oscillator is free-running during this measurement.
- The ripple susceptibility is measured for a 500 kHz ripple at the IF amplifier output using the measurement circuit; the level of the ripple signal is increased until a difference of 53.5 dB between the IF carrier set at 100 dB $\mu$ V and the sideband components is reached.
- Channel x beat: picture carrier frequency ( $f_{pc}$ ) and sound carrier frequency ( $f_{sc}$ ) both at 80 dB $\mu$ V. The rejection of the interfering product  $f_{pc(RF)} + f_{sc(RF)} - f_{osc}$  at 35.35 MHz should be >60 dB.
- Channel S02:  $f_{pc}$  is 76.25 MHz at 70 dB $\mu$ V;  $f_{osc} = 115.15$  MHz. The rejection of  $f_{osc} - 2 \times f_{IF} = 37.35$  MHz should be >66 dB.



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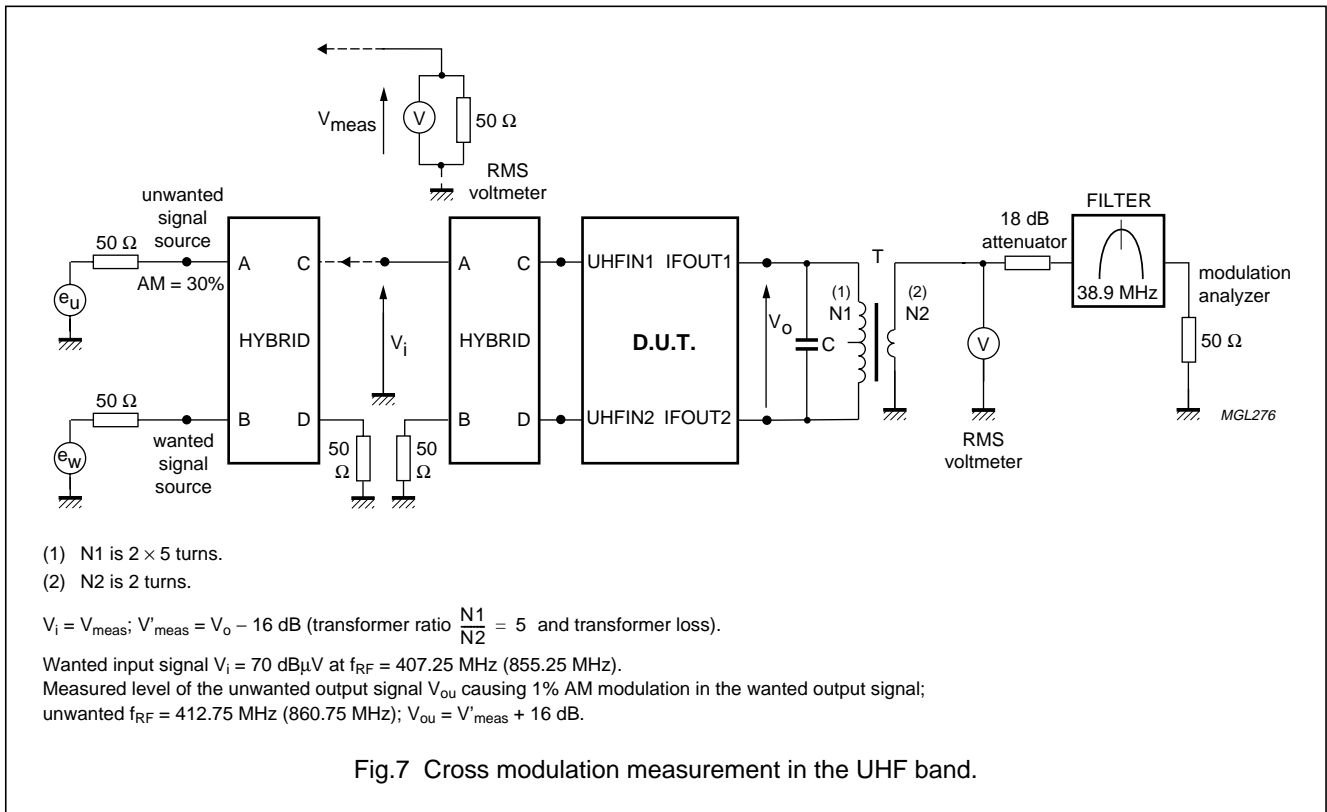
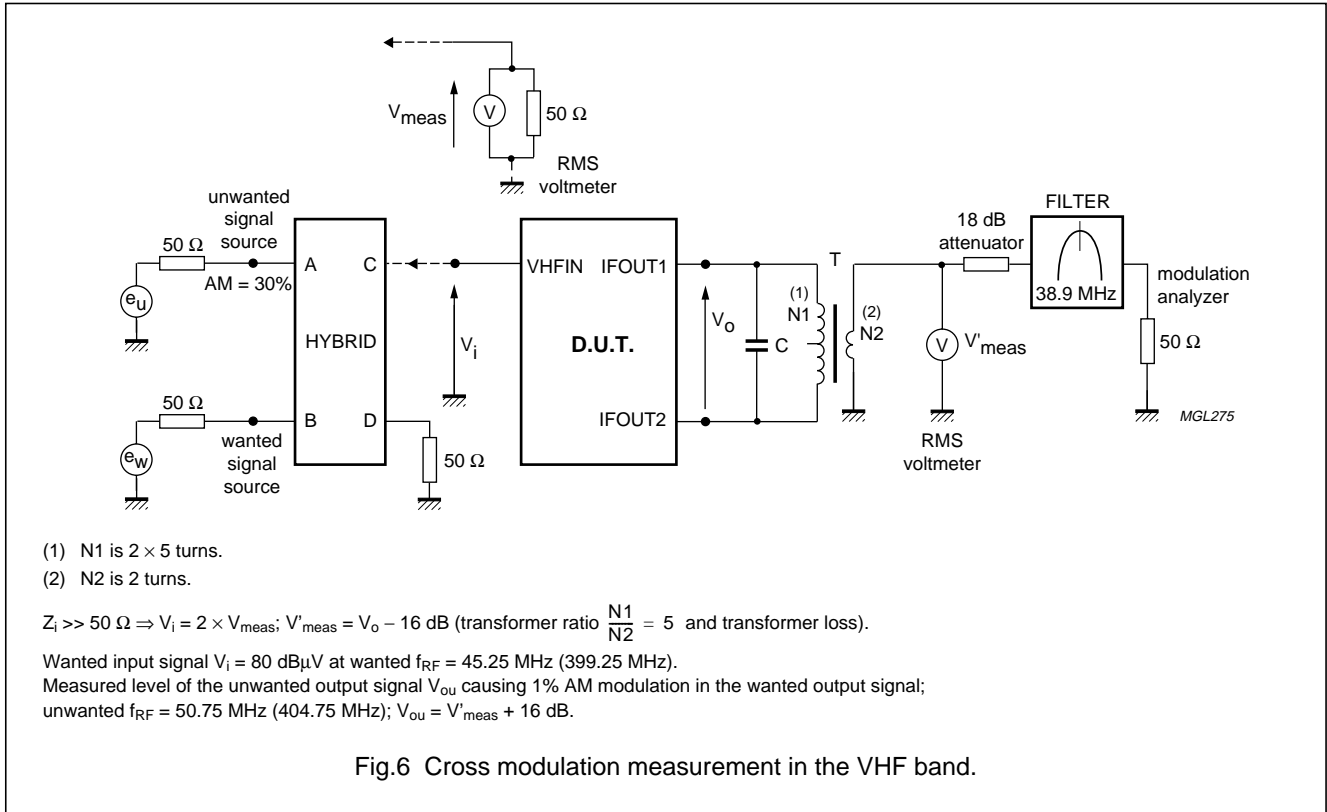
TDA5744; TDA5745

## TEST AND APPLICATION INFORMATION



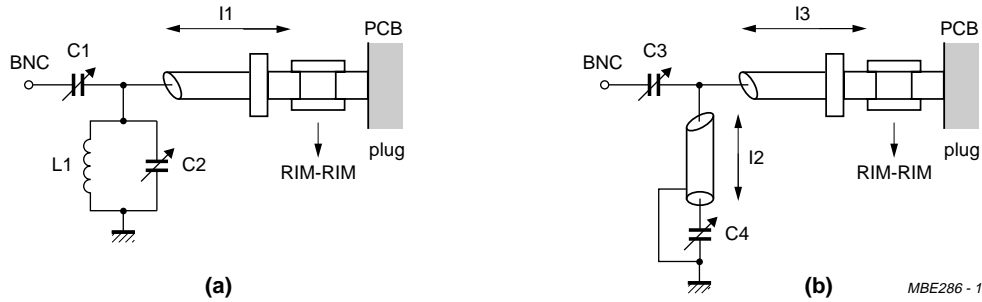
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Low power mixers/oscillators for hyperband tuners

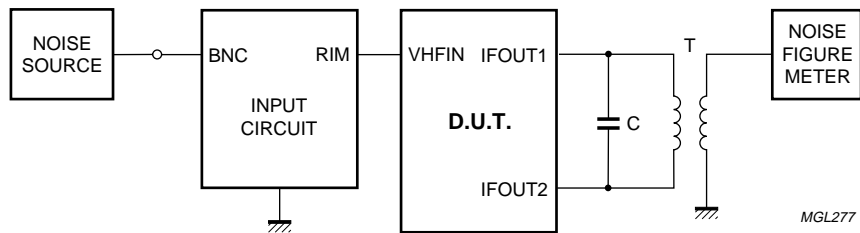
TDA5744; TDA5745



(a) For  $f_{RF} = 50$  MHz:  
 VHF mixer frequency response measured = 57 MHz;  
 loss = 0 dB.  
 Image suppression = 16 dB.  
 C1 = 1 nF; C2 = 2.2 pF.  
 L1 = 7 turns ( $\varnothing$  5.5 mm; wire  $\varnothing$  = 0.5 mm).  
 I1 = semi rigid cable (RIM): 5 cm long.  
 (semi rigid cable (RIM); 33 dB/100 m; 50  $\Omega$ ; 96 pF/m).

(b) For  $f_{RF} = 150$  MHz:  
 VHF mixer frequency response measured = 150.3 MHz;  
 loss = 1.3 dB.  
 Image suppression = 13 dB.  
 C3 = 1 nF; C4 = 2.2 pF.  
 I2 = semi rigid cable (RIM): 30 cm long.  
 I3 = semi rigid cable (RIM): 5 cm long.  
 (semi rigid cable (RIM); 33 dB/100 m; 50  $\Omega$ ; 96 pF/m).

Fig.8 Input circuit for optimum noise figure in the VHF band.

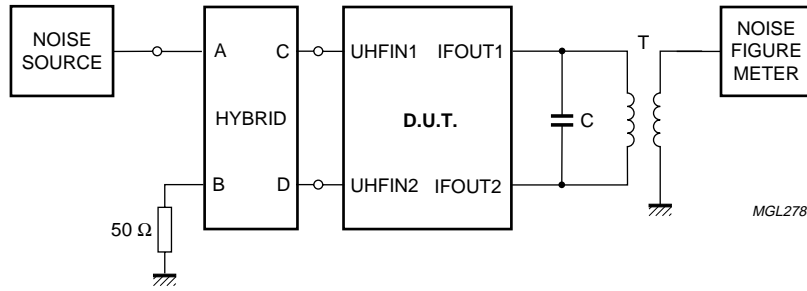


$F = F_{meas} - \text{loss (of input circuit) (dB)}$ .

Fig.9 Noise figure (F) measurement in the VHF band.

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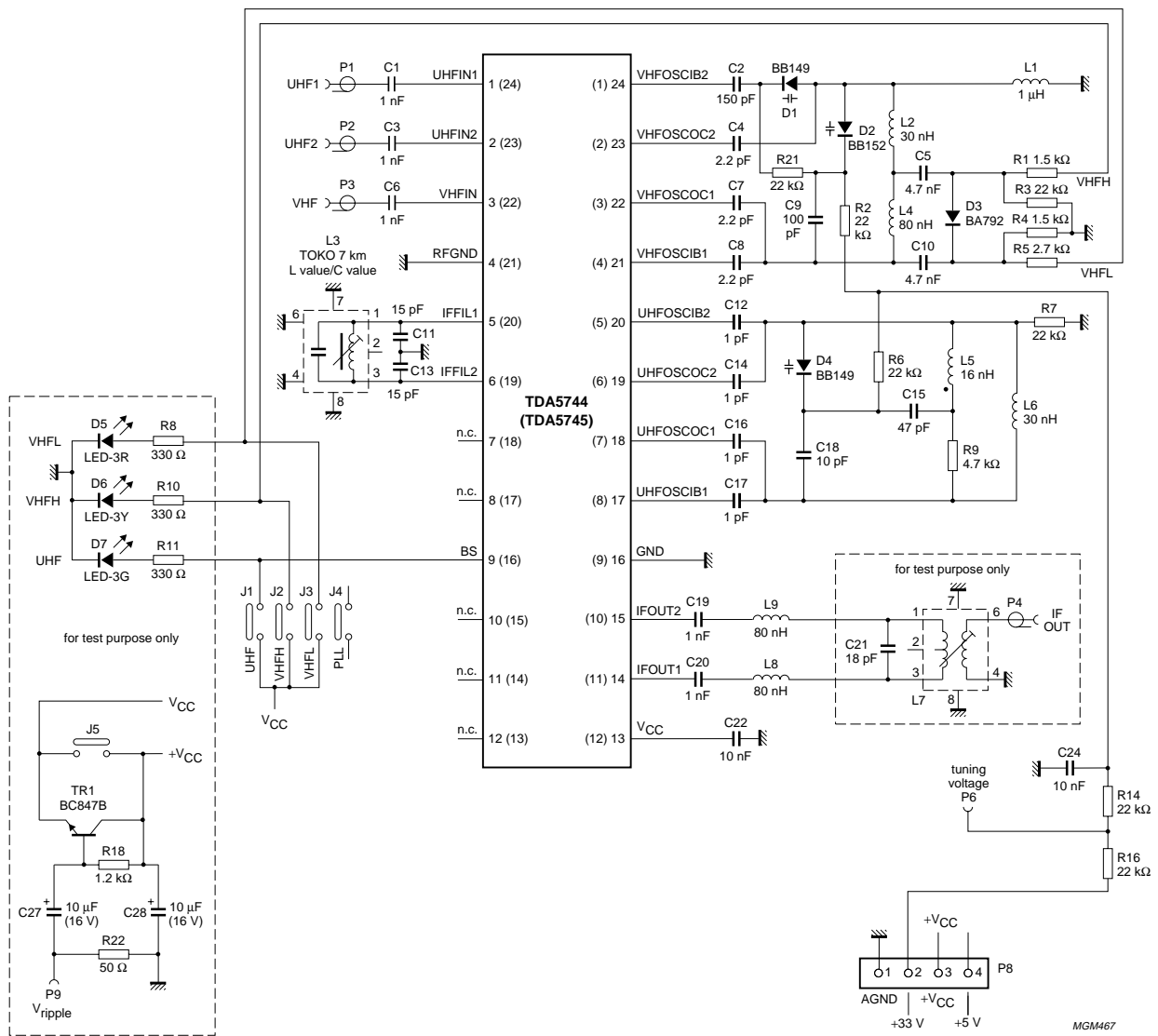


Loss (in hybrid) = 1 dB;  $F = F_{meas} - \text{loss (in hybrid)}$ .

Fig.10 Noise figure (F) measurement in the UHF band.

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The pin numbers in parenthesis represent the TDA5745.

Fig.11 Measurement circuit.

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### Component values for measurement circuit

**Table 1** Capacitors (all SMD and NP0 unless otherwise specified)

COMPONENT	VALUE
C1	1 nF
C2	150 pF
C3	1 nF
C4	2.2 pF (N750)
C5	4.7 nF
C6	1 nF
C7	2.2 pF (N750)
C8	2.2 pF (N750)
C9	100 pF (N750)
C10	4.7 nF
C11	15 pF
C12	1 pF (N750)
C13	15 pF
C14	1 pF (N750)
C15	47 pF
C16	1 pF (N750)
C17	1 pF (N750)
C18	10 pF (N750)
C19	1 nF
C20	1 nF
C21	18 pF
C22	10 nF
C24	10 nF
C27	10 $\mu$ F (16 V; electrolytic)
C28	10 $\mu$ F (16 V; electrolytic)

**Table 2** Resistors (all SMD)

COMPONENT	VALUE
R1	1.5 k $\Omega$
R2	22 k $\Omega$
R3	22 k $\Omega$
R4	1.5 k $\Omega$
R5	2.7 k $\Omega$
R6	22 k $\Omega$
R7	22 k $\Omega$
R8	330 $\Omega$
R9	4.7 k $\Omega$

COMPONENT	VALUE
R10	330 $\Omega$
R11	330 $\Omega$
R14	22 k $\Omega$
R16	22 k $\Omega$
R18	1.2 k $\Omega$
R21	22 k $\Omega$
R22	50 $\Omega$

**Table 3** Diodes and ICs

COMPONENT	VALUE
D1	BB149
D2	BB152
D3	BA792
D4	BB149
D5	LED-3R
D6	LED-3Y
D7	LED-3G
IC	TDA5744; TDA5745

**Table 4** Coils

COMPONENT	VALUE
L1	1 $\mu$ H (inductor)
L2	30 nH
L4	80 nH
L5	16 nH
L6	30 nH
L8	80 nH
L9	80 nH

**Table 5** Transformer

COMPONENT	VALUE
L3	23 turns (TOKO, wire 0.07 mm)
L7	N1 = 2 $\times$ 5 turns; N2 = 2 turns (TOKO, wire 0.09 mm)

**Table 6** Transistors

COMPONENT	VALUE
TR1	BC847B

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INTERNAL PIN CONFIGURATION

SYMBOL	PIN		CONFIGURATION <sup>(1)</sup>	AVERAGE DC VOLTAGE (V)	
	TDA5744	TDA5745		VHF	UHF
UHFIN1	1	24		note 2	1.0
UHFIN2	2	23			
VHFIN	3	22		1.9	note 2
RFGND	4	21		0.0	0.0
IFFIL1	5	20		3.4	3.4
IFFIL2	6	19			
n.c.	7	18	not connected	note 2	note 2
	8	17			
	10	15			
	11	14			
	12	13			
BS	9	16	electronic band switch	0.0	5.0
V <sub>CC</sub>	13	12	supply voltage	5.0	5.0

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SYMBOL	PIN		CONFIGURATION <sup>(1)</sup>	AVERAGE DC VOLTAGE (V)	
	TDA5744	TDA5745		VHF	UHF
IFOUT1	14	11		2.2	2.2
IFOUT2	15	10			
GND	16	9		0.0	0.0
UHFOSCIB1	17	8		note 2	1.9
UHFOSCO1	18	7			2.5
UHFOSCO2	19	6			2.5
UHFOSCIB2	20	5			1.9
VHFOSCIB1	21	4		note 2	2.0
VHFOSCO1	22	3			2.7
VHFOSCO2	23	2			2.7
VHFOSCIB2	24	1			2.0

Notes

1. The pin numbers in parenthesis represent the TDA5745.
2. Not applicable.



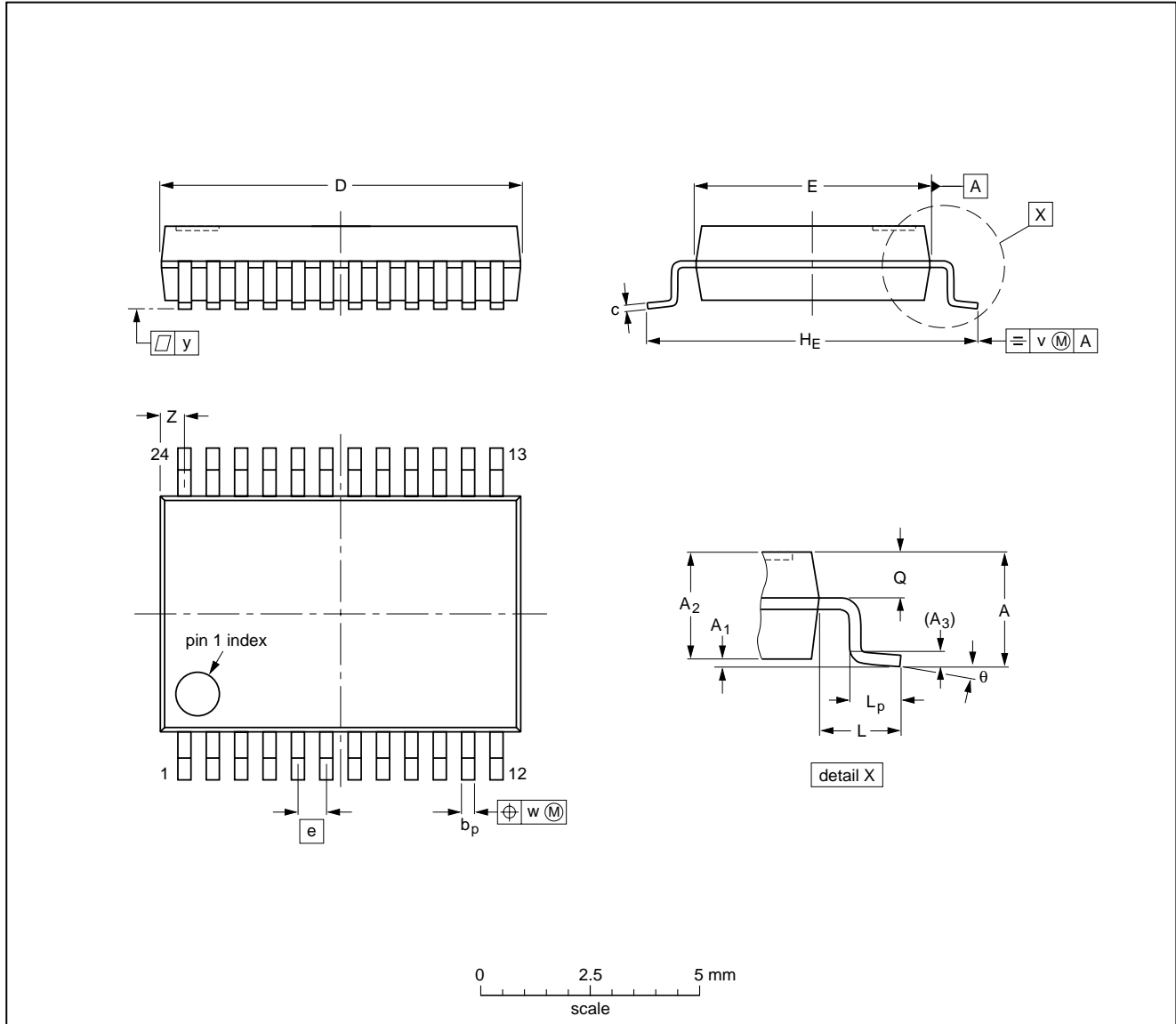
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PACKAGE OUTLINE

SSOP24: plastic shrink small outline package; 24 leads; body width 5.3 mm

SOT340-1



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	2.0	0.21 0.05	1.80 1.65	0.25	0.38 0.25	0.20 0.09	8.4 8.0	5.4 5.2	0.65	7.9 7.6	1.25	1.03 0.63	0.9 0.7	0.2	0.13	0.1	0.8 0.4	8° 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			
SOT340-1		MO-150AG				93-09-08 95-02-04

## Low power mixers/oscillators for hyperband 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 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

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).**

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.

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### DEFINITIONS

<b>Data sheet status</b>	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
<b>Limiting values</b>	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	
<b>Application information</b>	
Where application information is given, it is advisory and does not form part of the specification.	

### LIFE SUPPORT APPLICATIONS

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.

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