DATA SHEET

TDA5630BT
9 V VHF and UHF mixer/oscillator for TV and VCR cable tuners

Product specification
Supersedes data of 1995 Mar 20
File under Integrated Circuits, IC02

1996 Jun 06

Philips Semiconductors

PHILIPS

FEATURES

- Balanced mixer with a common emitter input for band A (single input)
- 2-pin oscillator for band A
- Balanced mixer with a common base input for band C
- 3-pin oscillator for band C
- Local oscillator buffer output for external prescaler
- SAW filter preamplifier with a low output impedance to drive a SAW filter
- Band gap voltage stabilizer for oscillator stability
- Electronic band switch.

APPLICATIONS

- Cable tuners for TV and VCR (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.

GENERAL DESCRIPTION

The TDA5630BT is a monolithic integrated circuit that performs VHF and UHF mixer/oscillator functions in TV and VCR cable tuners. With a proper 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. This low-power mixer/oscillator requires a power supply of 9 V and is available in a very small package.

The device gives the designer 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		–	48	–	mA
f_{RF}	frequency range (picture carrier)	RF input; band A; note 1	45	–	470	MHz
		RF input; band C; note 1	430	–	860	MHz
G_v	voltage gain	band A	–	25	–	dB
		band C	–	36	–	dB
NF	noise figure	band A	–	7.5	–	dB
		band C	–	9.0	–	dB
V_o	output voltage to get 1% cross modulation in channel	band A	–	118	–	dBμV
		band C	–	120	–	dBμV

Note

1. The limits are related to the tank circuits used in Fig.11 and the intermediate frequency. Frequency bands may be adjusted by the choice of external components.

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TDA5630BT	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1

BLOCK DIAGRAM

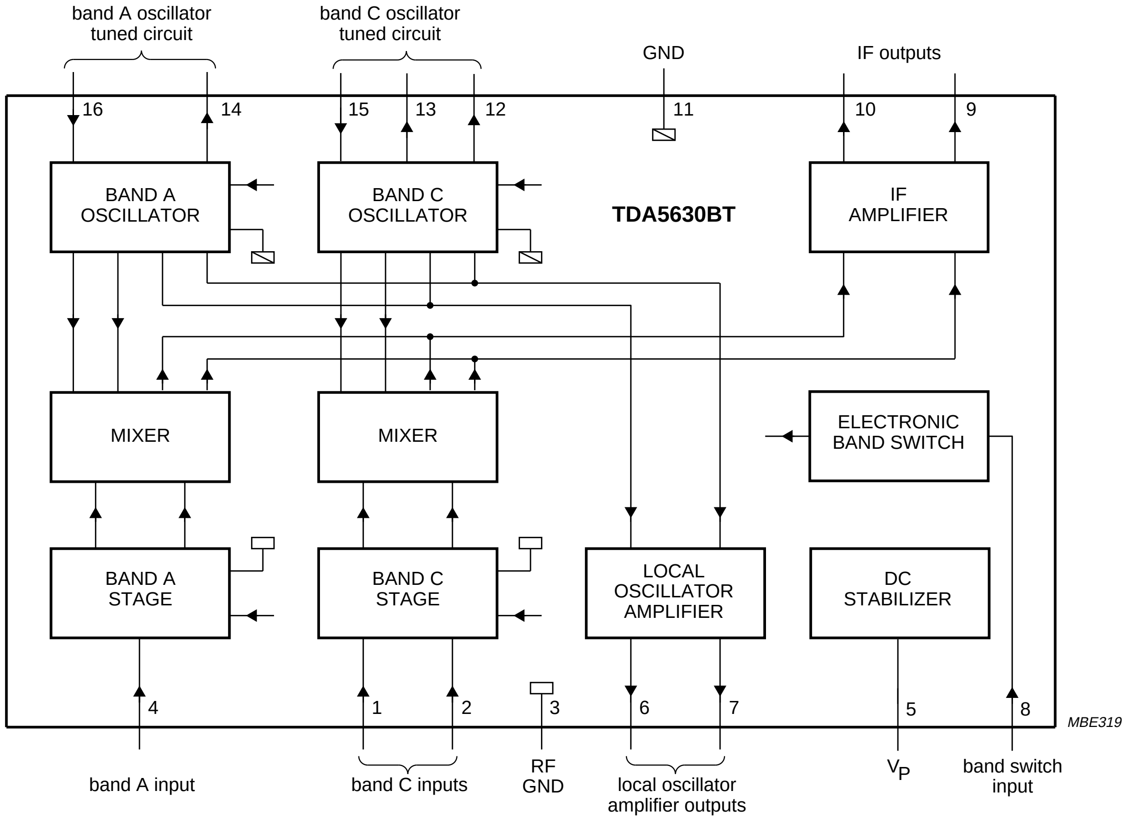


Fig.1 Block diagram.

PINNING

SYMBOL	PIN	DESCRIPTION
CIN1	1	band C input 1
CIN2	2	band C input 2
RFGND	3	ground for RF inputs
AIN	4	band A input
V_P	5	supply voltage
LOOUT1	6	local oscillator amplifier output 1
LOOUT2	7	local oscillator amplifier output 2
BS	8	band switch input
IFOUT1	9	IF amplifier output 1
IFOUT2	10	IF amplifier output 2
GND	11	ground (0 V)
COSCOC1	12	band C oscillator output collector 1
COSCOC2	13	band C oscillator output collector 2
AOSCOC	14	band A oscillator output collector
COSCIB	15	band C oscillator input base
AOSCIB	16	band A oscillator input base

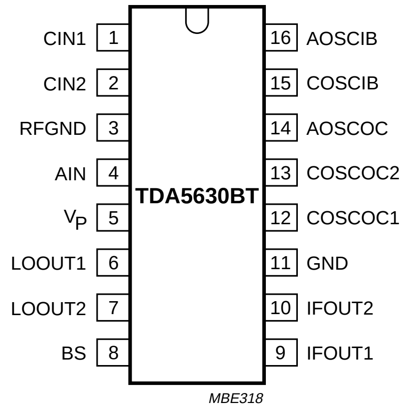


Fig.2 Pin configuration.

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
$t_{s(max)}$	maximum short-circuit time (all pins)	–	10	s
T_{stg}	IC storage temperature	–55	+150	°C
T_{amb}	operating ambient temperature	–10	+70	°C
T_j	junction temperature	–	150	°C

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th\ j\text{-}a}$	thermal resistance from junction to ambient in free air	115	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 (2000 V)
(stress reference pins RFGND, GND and V_P short-circuited together).

Machine model: the IC withstands 200 V in accordance with the UZW-B0/FQ-B302 specification
(issue date: Nov 6th, 1990)
(stress reference pins RFGND, GND and V_P short-circuited together).

CHARACTERISTICS

V_P = 9 V; T_{amb} = 25 °C; measured in circuit of Fig.11; unless otherwise specified.

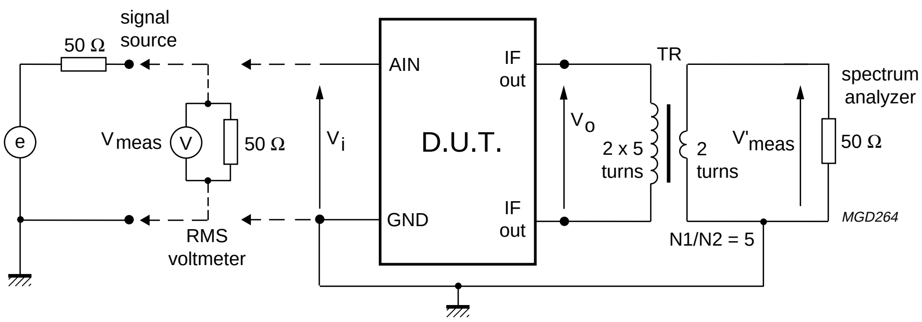
SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply						
V_P	supply voltage		8.1	9.0	9.9	V
I_P	supply current		35	48	55	mA
V_{SW}	switching voltage	band A	0	–	1.1	V
		band C	3.0	–	5.0	V
I_{SW}	switching current	band A	–	–	2	μA
		band C	–	–	10	μA
Band A mixer including IF amplifier						
f_{RF}	frequency range	note 1; V_t = 0.45 to 28 V	45	–	300	MHz
f_{max}	maximum frequency	note 1	–	470	–	MHz
G_v	voltage gain	f_{RF} = 50 MHz; see Fig.3; note 2	22.5	25	27.5	dB
		f_{RF} = 300 MHz; see Fig.3; note 2	22.5	25	27.5	dB
		f_{RF} = 470 MHz; see Fig.3; note 2	–	25	–	dB
NF	noise figure	f_{RF} = 50 MHz; see Figs 4 and 5	–	7.5	8.5	dB
		f_{RF} = 180 MHz; see Figs 4 and 5	–	9	10	dB
		f_{RF} = 300 MHz; see Fig.5	–	10.5	11.5	dB
V_o	output voltage	causing 1% cross modulation in channel; f_{RF} = 300 MHz; see Fig.6	115	118	–	dBμV
V_i	input voltage	causing 10 kHz pulling in channel; f_{RF} = 300 MHz; note 3	–	104	–	dBμV
g_{os}	optimum source conductance for noise figure	f_{RF} = 50 MHz	–	0.5	–	mS
		f_{RF} = 180 MHz	–	1.1	–	mS
g_i	input conductance	f_{RF} = 50 MHz; see Fig.12; note 4	–	0.26	–	mS
		f_{RF} = 180 MHz; see Fig.12; note 4	–	0.35	–	mS
C_i	input capacitance	f_{RF} = 50 to 180 MHz; see Fig.12; note 4	–	2	–	pF
Band A oscillator						
f_{osc}	frequency range	note 5; V_t = 0.45 to 28 V	80	–	336	MHz
f_{shift}	frequency shift	ΔV_P = 10%; note 6	–	–	200	kHz
f_{drift}	frequency drift	ΔT = 25 °C with no compensation; NP0 capacitors; note 7	–	–	500	kHz
		5 s to 15 min after switch on; with no compensation; NP0 capacitors; note 8	–	500	950	kHz
		5 s to 15 min after switch on; with compensation; note 9	–	200	300	kHz

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Band C mixer including IF amplifier; measurements using hybrid; note 10						
f_{RF}	frequency range	V_t = 0.45 to 28 V; note 1	430	–	860	MHz
G_v	voltage gain	f_{RF} = 430 MHz; see Fig.7; note 2	33	36	39	dB
		f_{RF} = 860 MHz; see Fig.7; note 2	33	36	39	dB
NF	noise figure	not corrected for image				
		f_{RF} = 430 MHz; see Fig.8	–	9	10	dB
		f_{RF} = 860 MHz; see Fig.8	–	11	12	dB
V_o	output voltage	causing 1% cross modulation in channel				
		f_{RF} = 430 MHz; see Fig.9	116	120	–	dBμV
		f_{RF} = 860 MHz; see Fig.9	116	120	–	dBμV
V_i	input voltage	causing 10 kHz pulling in channel; f_{RF} = 860 MHz; note 3	–	84	–	dBμV
		causing N + 5 - 1 MHz pulling; f_{RF} = 820 MHz; see Fig.10	–	63	–	dBμV
Z_i	input impedance ($R_S + jL_S\omega$)	R_S at f_{RF} = 430 MHz; see Fig.13; note 4	–	40	–	Ω
		R_S at f_{RF} = 860 MHz; see Fig.13; note 4	–	53	–	Ω
		L_S at f_{RF} = 430 to 860 MHz; see Fig.13; note 4	–	9	–	nH
Band C oscillator						
f_{osc}	frequency range	note 5; V_t = 0.45 to 28 V	470	–	900	MHz
f_{shift}	frequency shift	ΔV_P = 10%; note 6	–	–	400	kHz
f_{drift}	frequency drift	ΔT = 25 °C with no compensation; NP0 capacitors; note 7	–	–	2.5	MHz
		5 s to 15 min after switch on; with no compensation; NP0 capacitors; note 8	–	1000	1300	kHz
		5 s to 15 min after switch on; with compensation; note 9	–	550	950	kHz
IF amplifier						
s_{22}	output reflection coefficient	magnitude; see Fig.14; note 4	–	–10	–	dB
		phase; see Fig.14; note 4	–	9	–	o
Z_o	output impedance ($R_S + jL_S\omega$)	R_S; see Fig.14; note 4	–	95	–	Ω
		L_S; see Fig.14; note 4	–	45	–	nH

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
LO output; R_L = 100 Ω						
Y_o	output admittance ($G_P + jC_P\omega$)	f_{osc} = 80 MHz; see Fig.15; note 4	–	2.5	–	mS
			–	0.9	–	pF
		f_{osc} = 900 MHz; see Fig.15; note 4	–	3.5	–	mS
			–	0.7	–	pF
V_o	output voltage	R_L = 100 Ω; V_t = 0.45 to 28 V	83	91	100	dBμV
SRF	spurious signal on LO output with respect to LO output signal	note 11	–	–	–10	dBc
SHD	LO signal harmonics with respect to LO signal		–	–	–10	dBc

Notes to the characteristics

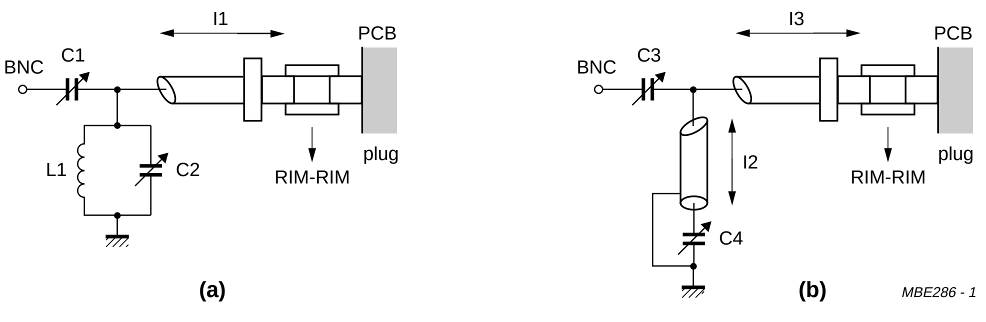
1. The RF frequency range is defined by the oscillator frequency range and the intermediate frequency.
2. The gain is defined as the transducer gain (measured in Fig.11) plus the voltage transformation ratio of L6 to L7 (10 : 2, 15.4 dB including transformer loss).
3. The input level causing 10 kHz frequency detuning at the LO output. $f_{osc} = f_{RF}$ + 33.4 MHz.
4. All s-parameters are referred to a 50 Ω system.
5. Limits are related to the tank circuits used in Fig.11. Frequency bands may be adjusted by the choice of external components.
6. 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 from V_P = 9 to 9.9 V.
7. The frequency drift is defined as the change in oscillator frequency when the ambient temperature varies from T_{amb} = 25 to 0 °C or from 25 to 50 °C. With no compensation, all capacitors are NP0.
8. Switch on drift with no compensation is defined as the change of oscillator frequency between 5 s and 15 min after switch on. All capacitors are NP0.
9. Switch on drift with compensation is defined as the change of oscillator frequency between 5 s and 15 min after switch on. C5 to C11 are N750; C1, C2 and C4 are N470.
10. The values have been corrected for hybrid and cable losses. The symmetrical output impedance of the hybrid is 100 Ω.
11. Measured with RF input voltage:
    a) RF voltage = 120 dBμV at f_{RF} < 180 MHz.
    b) RF voltage = 107.5 dBμV at 180 MHz < f_{RF} < 225 MHz.
    c) RF voltage = 97 dBμV at 225 MHz < f_{RF} < 860 MHz.



Z_{in} (AIN) >> 50 Ω $V_i = 2 \times V_{meas}$.
$V_i = V_{meas}$ + 6 dB.
$V_o = V'_{meas}$ + 15.4 dB (transformer ratio N1/N2 = 5 and transformer loss).

$$G_v = 20 \log \left(\frac{V_o}{V_i}\right)$$

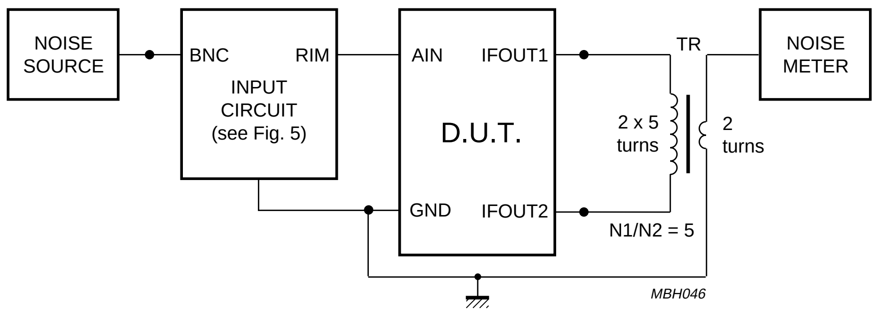
Fig.3 Gain measurement in band A.



(a) For f_{RF} = 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 (diameter = 5.5 mm, wire diameter = 0.5 mm)
l1 = semi rigid cable (RIM): 5 cm long
(semi rigid cable (RIM); 33 dB/100 m; 50 Ω; 96 pF/m).

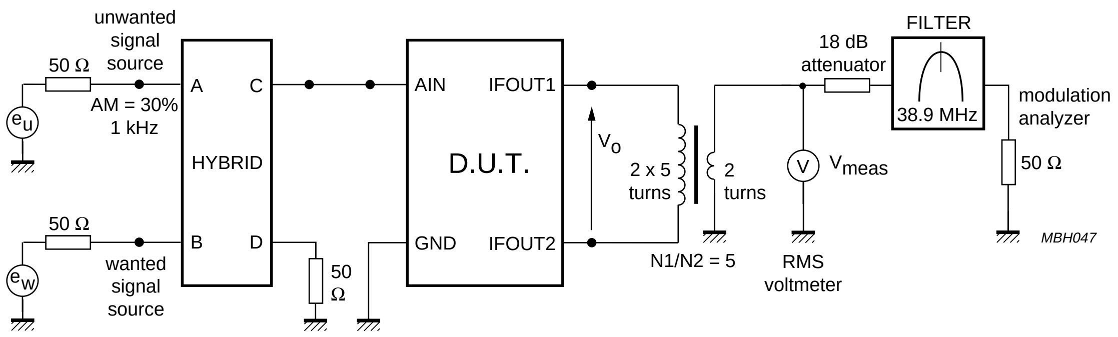
(b) For f_{RF} = 150 MHz:
mixer A frequency response measured = 150.3 MHz, loss = 1.3 dB
image suppression = 13 dB
C3 = 5 pF
C4 = 25 pF
l2 = semi rigid cable (RIM): 30 cm long
l3 = semi rigid cable (RIM): 5 cm long
(semi rigid cable (RIM); 33 dB/100 m; 50 Ω; 96 pF/m).

Fig.4 Input circuit for optimum noise figure in band A.



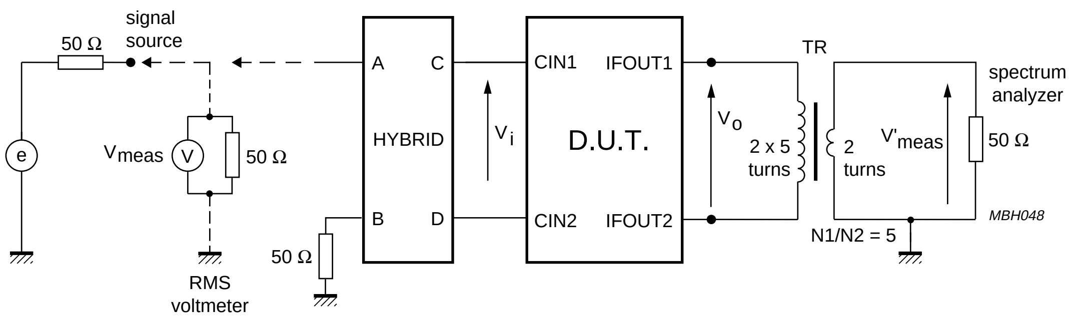
(1) NF = NF_{meas} – loss (input circuit) dB.

Fig.5 Noise figure measurement in band A.



$V_{meas} = V_o$ – 15.4 dB (transformer ratio N1/N2 = 5 and transformer loss).
Wanted output signal at f_{RFW} = 300 MHz: V_{ow} =104 dBμV (V_{meas} = 88.6 dBμV).
We measure the level of the unwanted signal V_{ou} causing 0.3% AM modulation in the wanted output signal; f_{RFU} = 305.5 MHz.
$V_{ou} = V_{meas}$ + 15.4 dB.
f_{osc} = 338.9 MHz.
Filter characteristics: f_c = 38.9 MHz; f_{-3dBBW} = 1.2 MHz; $f_{-30dBBW}$ = 2.64 MHz.

Fig.6 Cross modulation measurement in band A.



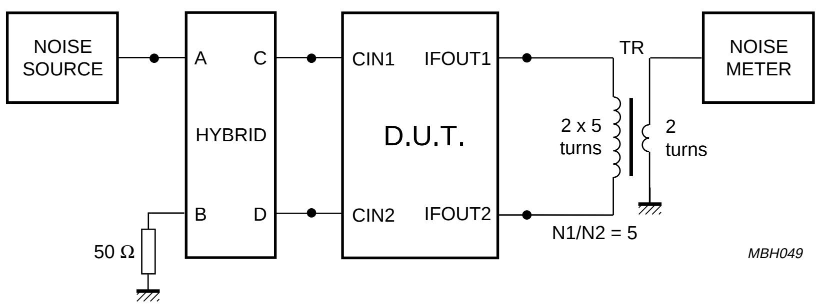
Loss of the hybrid: 1 dB.

$V_i = V_{meas}$ – loss of the hybrid.

$V_o = V'_{meas}$ + 15.4 dB (transformer ratio N1/N2 = 5 and transformer loss).

$$G_v = 20 \log \left(\frac{V_o}{V_i} \right)$$

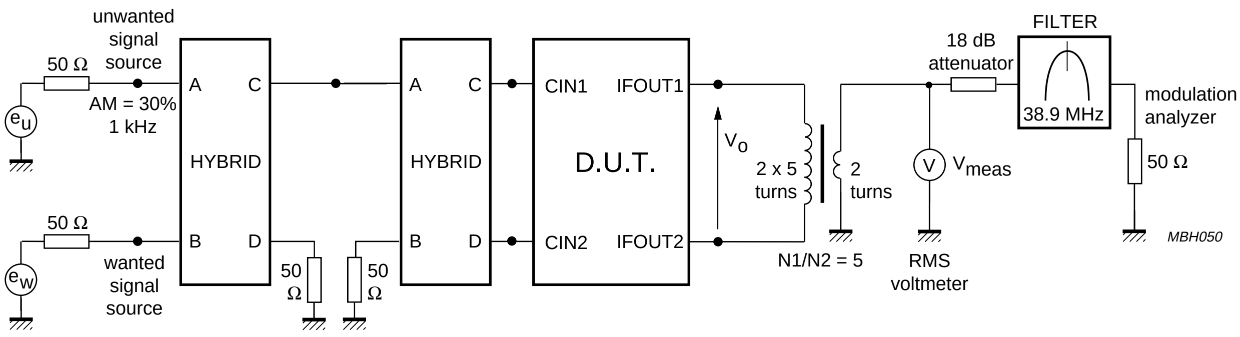
Fig.7 Gain measurement in band C.



Loss of the hybrid: 1 dB.

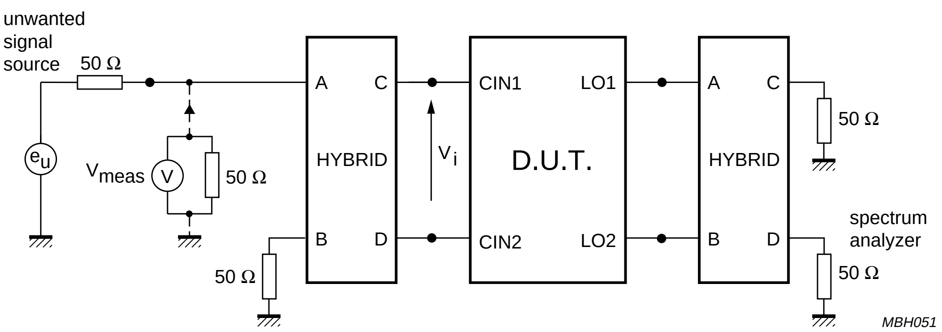
$NF = NF_{meas}$ – loss of the hybrid.

Fig.8 Noise figure measurement in band C.



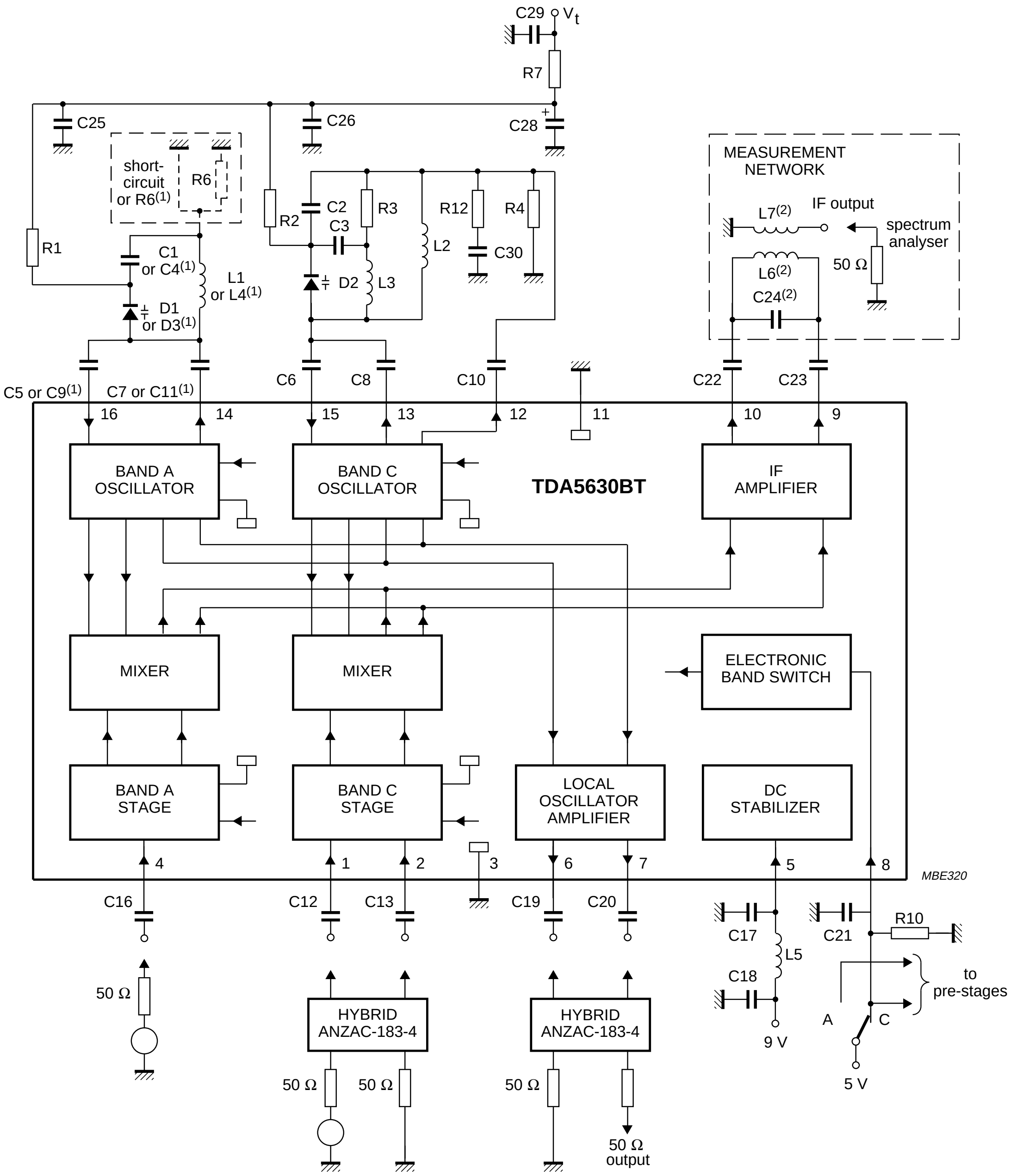
$V_{meas} = V_o - 15.4$ dB (transformer ratio N1/N2 = 5 and transformer loss).
Wanted output signal at f_{RFW}: $V_{ow} = 108$ dBμV, $V_{meas} = 92.6$ dBμV.
We measure the level of the unwanted output signal V_{ou} causing 0.3% AM modulation in the wanted output signal.
$V_{ou} = V_{meas} + 15.4$ dB.
$f_{RFU} = f_{RFW} + 5.5$ MHz; $f_{osc} = f_{RF} + 38.9$ MHz.
Filter characteristics: $f_c = 38.9$ MHz; $f_{-3dBBW} = 1.2$ MHz; $f_{-30dBBW} = 2.64$ MHz.

Fig.9 Cross modulation measurement in band C.



Loss of the hybrid: 1 dB.
$f_{RFW} = 781$ MHz. This wanted signal is not used during the measurement.
$f_{osc} = 819.9$ MHz.
$f_{RFU} = 820$ MHz $= f_{RFW} + 5 \times 8$ MHz $- 1$ MHz.
We measure the level of the unwanted signal V_{iu} causing FM sidebands 30 dB below the oscillator carrier at the LO output.
$V_{iu} = V_{meas}$ – loss of the hybrid.

Fig.10 N + 5 – 1 MHz pulling measurement in band C.



(1) There are two applications for the band A oscillator:
- from 80 to 216 MHz: the band A tank circuit is built with C1, D1, L1, C5 and C7. R6 is a short-circuit.
- from 180 to 506 MHz: the band A tank circuit is built with R6, C4, D3, L4, C9 and C11.

(2) L6, L7 and C24 are only required for measurement purposes; they are not used in a tuner.

Fig.11 Measurement circuit.

Component values for measurement circuit

Table 1 Capacitors (all SMD and NP0 except C28)

COMPONENT	VALUE
C1	82 pF
C2	5.6 pF
C3	100 pF
C4	150 pF
C5	2.2 pF
C6	1 pF
C7	2.2 pF
C8	1 pF
C9	1.8 pF
C10	2.2 pF
C11	3.9 pF
C12	1 nF
C13	1 nF
C16	1 nF
C17	1.5 nF
C18	1.5 nF
C19	1 nF
C20	1 nF
C21	1.5 nF
C22	1 nF
C23	1 nF
C24	18 pF
C25	1.5 nF
C26	1.5 nF
C28	1 μF; 40 V electrolytic
C29	1.5 nF
C30	0.56 pF

Table 2 Resistors (all SMD)

COMPONENT	VALUE
R1	47 kΩ
R2	22 kΩ
R3	2.2 kΩ
R4	22 kΩ
R6	22 Ω
R7	1 kΩ
R12	470 Ω

Table 3 Diodes and IC

COMPONENT	VALUE
D1	BB911
D2	BB405 or BB215
D3	BB909 or BB219
IC	TDA5630BT

Table 4 Coils (wire size 0.4 mm)

COMPONENT	VALUE
L1	7.5 turns; diameter 3 mm
L2	2.5 turns; diameter 3 mm
L3	1.5 turns; diameter 2.5 mm
L4	1.5 turns; diameter 4 mm
L5	4.7 μH; choke coil

Table 5 Transformers; note 1

COMPONENT	VALUE
L6	2 × 5 turns
L7	2 turns

Note

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

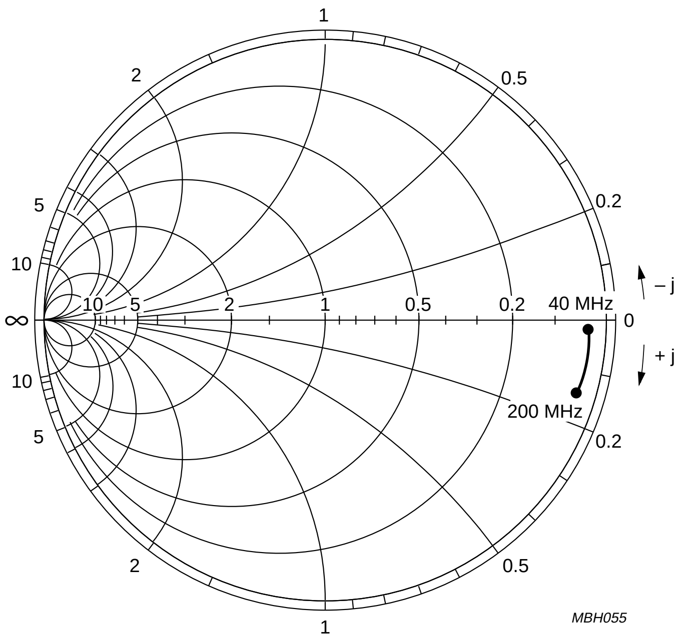


Fig.12 Input admittance (s_{11}) of the band A mixer input (40 to 200 MHz); Y_0 = 20 mS.

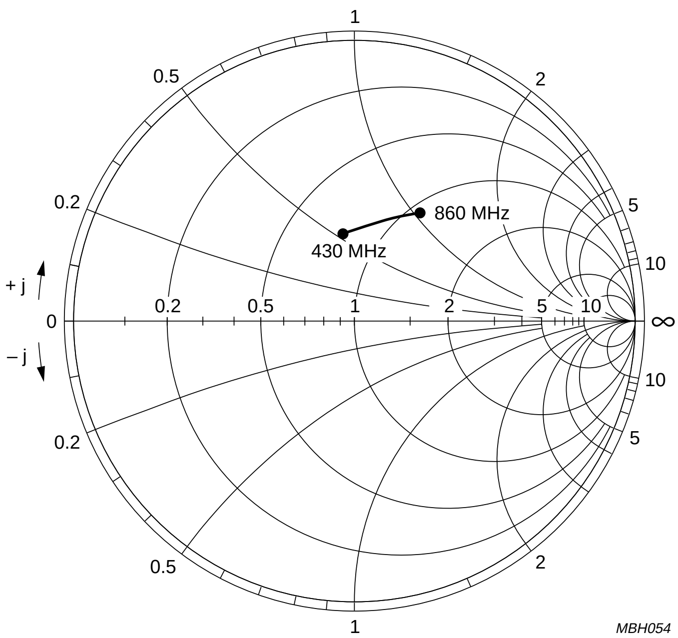


Fig.13 Input impedance (s_{11}) of the band C mixer input (430 to 860 MHz); Z_0 = 50 Ω.

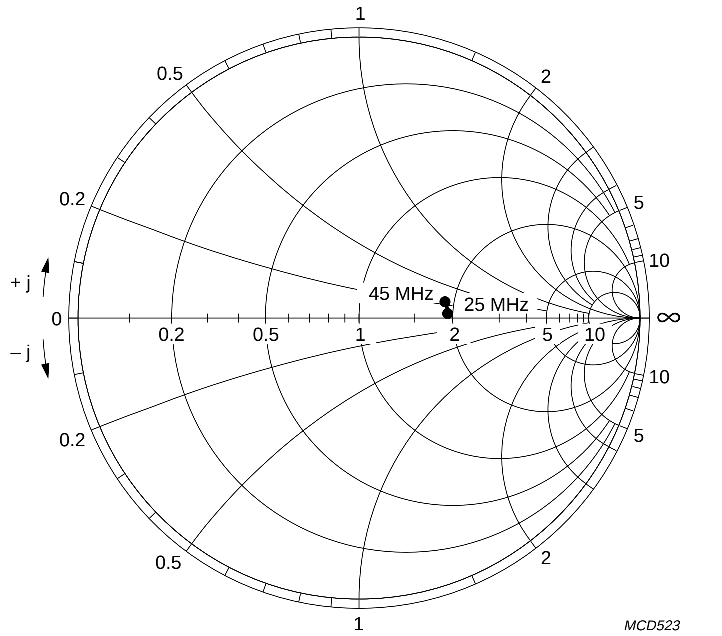


Fig.14 Output impedance (s_{22}) of the IF amplifier (25 to 45 MHz); Z_0 = 50 Ω.

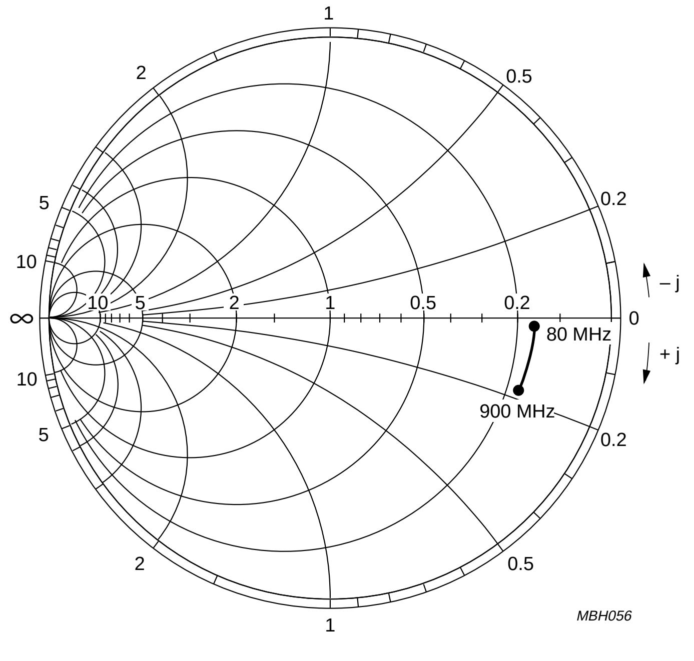
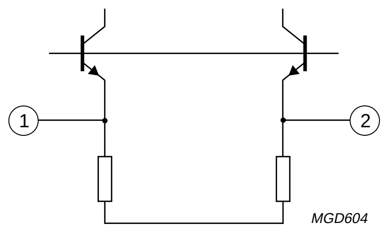
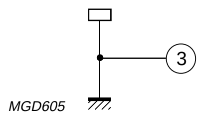
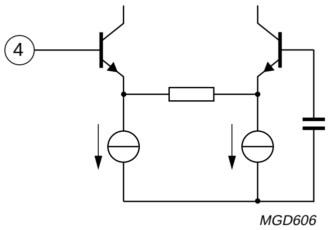
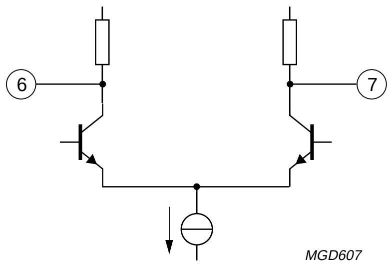
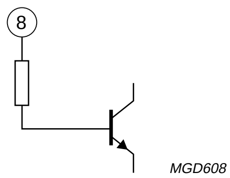
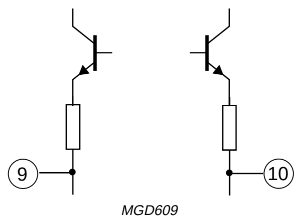
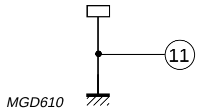
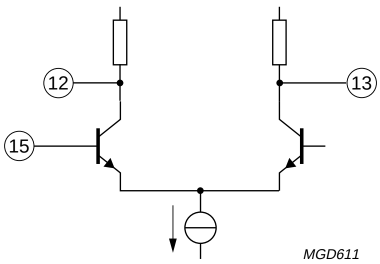
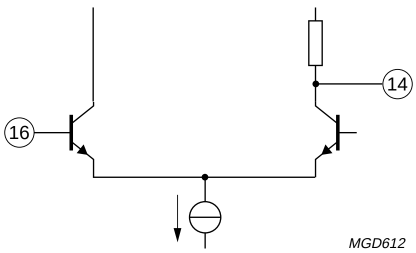


Fig.15 Output admittance (s_{22}) of the LO output (80 to 900 MHz); Y_0 = 20 mS.

INTERNAL PIN CONFIGURATION

SYMBOL	PIN	DESCRIPTION	AVERAGE DC VOLTAGE IN (V) measured in circuit of Fig.11	
			BAND A	BAND C
CIN1	1		NR(1)	2.2
CIN2	2		NR(1)	2.2
RFGND	3		0.0	0.0
AIN	4		2.2	NR(1)
V_P	5	supply voltage	9.0	9.0
LOOUT1	6		7.3	7.3
LOOUT2	7		7.3	7.3
BS	8		0.0	5.0

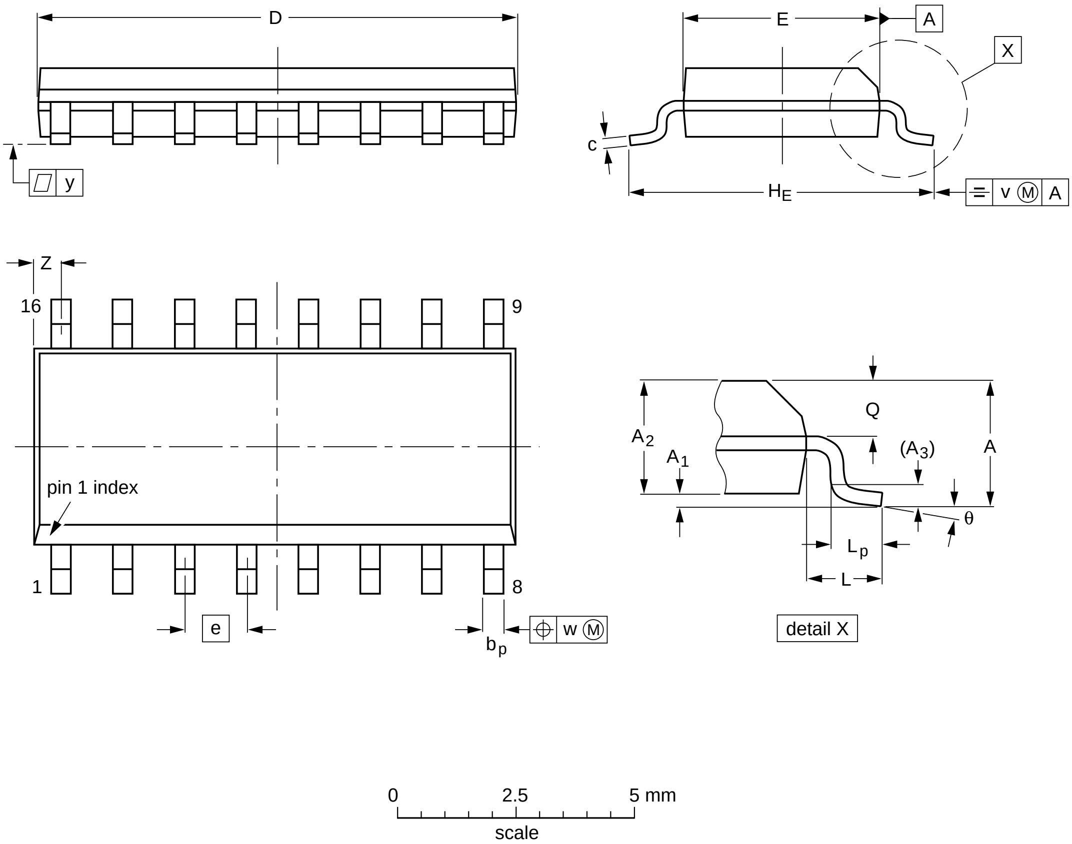
SYMBOL	PIN	DESCRIPTION	AVERAGE DC VOLTAGE IN (V) measured in circuit of Fig.11	
			BAND A	BAND C
IFOUT1	9		4.0	4.0
IFOUT2	10		4.0	4.0
GND	11		0	0
COSCOC1	12		NR(1)	4.4
COSCOC2	13		NR(1)	4.4
COSCIB	15		NR(1)	2.3
AOSCOC	14		4.0	NR(1)
AOSCIB	16		2.2	NR(1)

Note

1. NR = not relevant.

PACKAGE OUTLINE

SO16: plastic small outline package; 16 leads; body width 3.9 mm **SOT109-1**



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

UNIT	A max.	A_1	A_2	A_3	b_p	c	D (1)	E (1)	e	H_E	L	L_p	Q	v	w	y	Z (1)	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	10.0 9.8	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8^o 0^o
inches	0.069	0.0098 0.0039	0.057 0.049	0.01	0.019 0.014	0.0098 0.0075	0.39 0.38	0.16 0.15	0.050	0.24 0.23	0.041	0.039 0.016	0.028 0.020	0.01	0.01	0.004	0.028 0.012	

Note

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT109-1	076E07S	MS-012AC				~~91-08-13~~ 95-01-23

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.

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	
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