

DATA SHEET

UAA3201T UHF/VHF remote control receiver

Product specification
Supersedes data of 1995 May 18
File under Integrated Circuits, IC18

2000 Apr 18

UHF/VHF remote control receiver

UAA3201T

FEATURES

- Oscillator with external Surface Acoustic Wave Resonator (SAWR)
- Wide frequency range from 150 to 450 MHz
- High sensitivity
- Low power consumption
- Automotive temperature range
- Superheterodyne architecture
- Applicable to fulfil FTZ 17 TR 2100 (Germany)
- High integration level, few external components
- Inexpensive external components
- IF filter bandwidth determined by application.

APPLICATIONS

- Car alarm systems
- Remote control systems
- Security systems
- Gadgets and toys
- Telemetry.

GENERAL DESCRIPTION

The UAA3201T is a fully integrated single-chip receiver, primarily intended for use in VHF and UHF systems employing direct AM Return-to-Zero (RZ) Amplitude Shift Keying (ASK) modulation.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V _{CC}	supply voltage		3.5	–	6.0	V
I _{CC}	supply current		–	3.4	4.8	mA
P _{ref}	input reference sensitivity	f _{i(RF)} = 433.92 MHz; data rate = 250 bits/s; BER ≤ 3 × 10 ⁻²	–	–	-105	dBm
T _{amb}	ambient temperature		-40	–	+85	°C

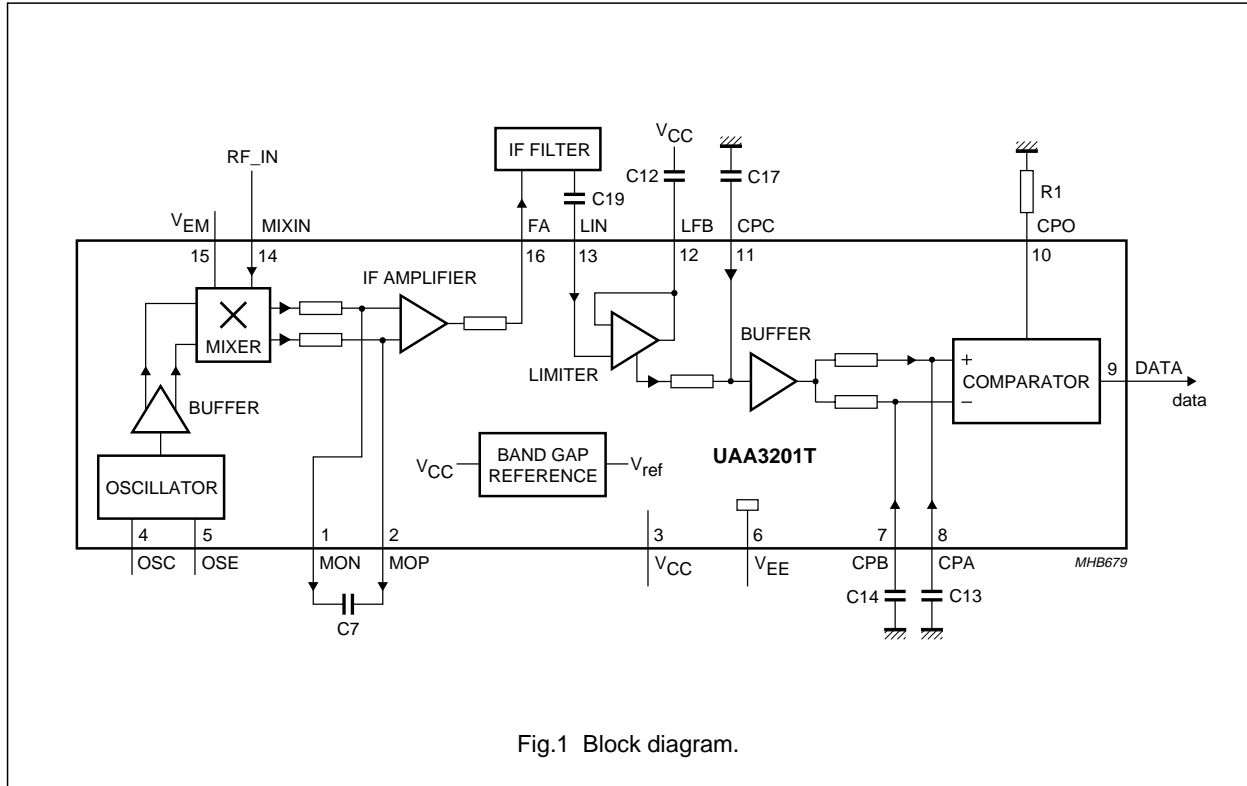
ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
UAA3201T	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1

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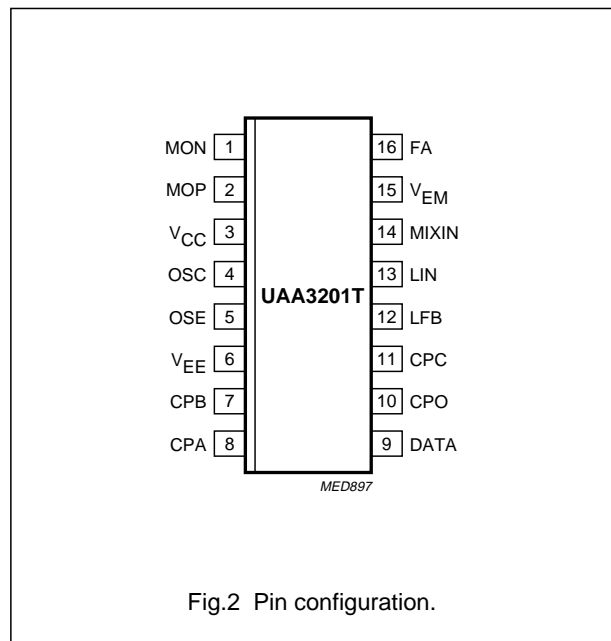
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BLOCK DIAGRAM



PINNING

SYMBOL	PIN	DESCRIPTION
MON	1	negative mixer output
MOP	2	positive mixer output
V _{CC}	3	positive supply voltage
OSC	4	oscillator collector
OSE	5	oscillator emitter
V _{EE}	6	negative supply voltage
CPB	7	comparator input B
CPA	8	comparator input A
DATA	9	data output
CPO	10	comparator offset adjustment
CPC	11	comparator input C
LFB	12	limiter feedback
LIN	13	limiter input
MIXIN	14	mixer input
V _{EM}	15	negative supply voltage for mixer
FA	16	IF amplifier output



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FUNCTIONAL DESCRIPTION

The RF signal is fed directly into the mixer stage where it is mixed down to nominal 500 kHz IF by the integrated oscillator controlled by an external SAWR (see Fig.1). The IF signal is then passed to the IF amplifier which increases the level. A 5th-order elliptic low-pass filter acts as main IF filtering. The output voltage of that filter is demodulated by a limiter that rectifies the incoming IF signal. The demodulated signal passes two RC filter stages and is then limited by a data comparator which makes it available at the data output.

Mixer

The mixer is a single balanced emitter coupled pair with internally set bias current. The optimum impedance is $320\ \Omega$ at 430 MHz. Capacitor C5 (see Fig.9) is used to transform a $50\ \Omega$ generator impedance to the optimum value.

Oscillator

The oscillator consists of a transistor in common base configuration and a tank circuit including the SAWR. Resistor R2 (see Fig.9) is used to control the bias current through the transistor. Resistor R3 is required to reduce unwanted responses of the tank circuit.

IF amplifier

The IF amplifier is a differential input, single-ended output emitter coupled pair. It is used to decouple the first and the second IF filter and to provide some additional gain in order to reduce the influence of the noise of the limiter on the total noise figure.

IF filters

The first IF filter is an RC filter formed by internal resistors and an external capacitor C7 (see Fig.1).

The second IF filter is an external elliptic filter. The source impedance is $1.4\ \text{k}\Omega$ and the load is high-impedance. The bandwidth of the IF filter in the application and test circuit (see Fig.9) is 800 kHz due to the centre frequency spread of the SAWR. It may be reduced when SAWRs with less tolerances are used or temperature range requirements are lower. A smaller bandwidth of the filter will yield a higher sensitivity of the receiver. As the RF signal is mixed down to a low IF signal there is no image rejection possible.

Limiter

The limiting amplifier consists of three DC coupled amplifier stages with a total gain of 60 dB. A Received Signal Strength Indicator (RSSI) signal is generated by rectifying the IF signal. The limiter has a lower frequency limit of 100 kHz which can be controlled by capacitors C12 and C19. The upper frequency limit is 3 MHz.

Comparator

The $2 \times$ IF component in the RSSI signal is removed by the first order low-pass capacitor C17. After passing a buffer stage the signal is split into two paths, leading via RC filters to the inputs of a voltage comparator. The time constant of one path (C14) is compared to the bit duration. Consequently the potential at the negative comparator input represents the average magnitude of the RSSI signal. The second path with a short time constant (C13) allows the signal at the positive comparator input to follow the RSSI signal instantaneously. This results in a variable comparator threshold, depending on the strength of the incoming signal. Hence the comparator output is switched on, when the RSSI signal exceeds its average value, i.e. when an ASK 'on' signal is received.

The low-pass filter capacitor C13 rejects the unwanted $2 \times$ IF component and reduces the noise bandwidth of the data filter.

The resistor R1 is used to set the current of an internal source. This current is drawn from the positive comparator input, thereby applying an offset and driving the output into the 'off' state during the absence of an input signal. This offset can be increased by lowering the value of R1 yielding a higher noise immunity at the expense of reduced sensitivity.

Band gap reference

The band gap reference controls the biasing of the whole circuit. In this block currents are generated that are constant over the temperature range and currents that are proportional to the absolute temperature.

The current consumption of the receiver rises with increasing temperature, because the blocks with the highest current consumption are biased by currents that are proportional to the absolute temperature.

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LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 60134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CC}	supply voltage		-0.3	+8.0	V
T_{amb}	ambient temperature		-40	+85	°C
T_{stg}	storage temperature		-55	+125	°C
V_{es}	electrostatic handling voltage	note 1			
	pins OSC and OSE		-2000	+1500	V
	pins LFB and MIXIN		-1500	+2000	V
	all other pins		-2000	+2000	V

Note

- Human body model: equivalent to discharging a 100 pF capacitor through a 1.5 kΩ series resistor.

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	105	K/W

DC CHARACTERISTICS

$V_{CC} = 3.5$ V; all voltages referenced to V_{EE} ; $T_{amb} = -40$ to $+85$ °C; typical value for $T_{amb} = 25$ °C; for test circuit see Fig.9; SAWR disconnected; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{CC}	supply voltage		3.5	–	6.0	V
I_{CC}	supply current	$R2 = 680 \Omega$	–	3.4	4.8	mA
$V_{OH(DATA)}$	HIGH-level output voltage at pin DATA	$I_{DATA} = -10 \mu A$; note 1	$V_{CC} - 0.5$	–	V_{CC}	V
$V_{OL(DATA)}$	LOW-level output voltage at pin DATA	$I_{DATA} = +200 \mu A$; note 1	0	–	0.6	V

Note

- I_{DATA} is defined to be positive when the current flows into pin DATA.

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AC CHARACTERISTICS

$V_{CC} = 3.5 \text{ V}$; $T_{amb} = 25 \text{ }^\circ\text{C}$; for test circuit see Fig.9; R1 disconnected; for AC test conditions see Section "AC test conditions"; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
P_{ref}	input reference sensitivity	$BER \leq 3 \times 10^{-2}$; note 1	–	–	–105	dBm
$P_{i(max)}$	maximum input power	$BER \leq 3 \times 10^{-2}$	–	–	–30	dBm
P_{spur}	spurious radiation	note 2	–	–	–60	dBm
$IP3_{mix}$	interception point (mixer)		–20	–17	–	dBm
$IP3_{IF}$	interception point (mixer plus IF amplifier)		–38	–35	–	dBm
P_{1dB}	1 dB compression point (mixer)		–38	–35	–	dBm
$t_{on(RX)}$	receiver turn-on time	note 3	–	–	10	ms

Notes


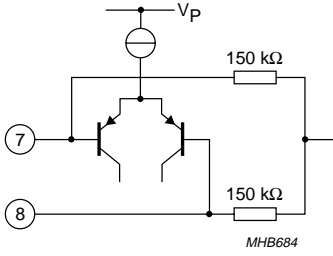
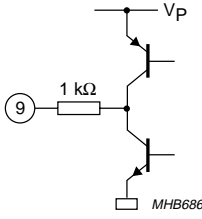
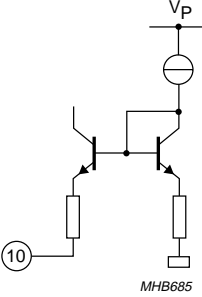
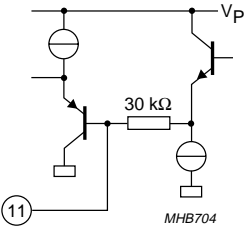
- P_{ref} is the maximum available power at the input of the test board. The Bit Error Rate (BER) is measured using the test facility shown in Fig.8.
- Valid only for the reference PCB (see Figs 10 and 11). Spurious radiation is strongly dependent on the PCB layout.
- The supply voltage V_{CC} is pulsed as explained in Fig.3.

INTERNAL PIN CONFIGURATION

PIN	SYMBOL	EQUIVALENT CIRCUIT
1	MON	
2	MOP	
3	V_{CC}	
4	OSC	
5	OSE	

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PIN	SYMBOL	EQUIVALENT CIRCUIT
6	V_{EE}	
7	CPB	
8	CPA	
9	DATA	
10	CPO	
11	CPC	

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PIN	SYMBOL	EQUIVALENT CIRCUIT
12	LFB	
13	LIN	
14	MXIN	
15	V _{EM}	
16	FA	

TEST INFORMATION**Tuning procedure for AC tests**

1. Turn on the signal generator: $f_{i(RF)} = 433.92$ MHz, no modulation and RF input level = 1 mV.
2. Tune capacitor C6 (RF stage input) to obtain a maximum voltage on pin LIN.
3. Check that data is appearing on pin DATA and proceed with the AC tests.

AC test conditions

The reference signal level P_{ref} for the following tests is defined as the minimum input level in dBm to give a $BER \leq 3 \times 10^{-2}$ (e.g. 7.5 bit errors per second for 250 bits/s).

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Table 1 Test signals

TEST SIGNAL	FREQUENCY (MHz)	DATA SIGNAL	MODULATION	MODULATION INDEX
1	433.92	250 bits/s (square wave)	RZ signal with duty cycle of 66% for logic 1; RZ signal with duty cycle of 33% for logic 0	100%
2	434.02	–	no modulation	–
3	433.92	–	no modulation	–

Test results

P_1 is the maximum available power from signal generator 1 at the input of the test board; P_2 is the maximum available power from signal generator 2 at the input of the test board.

Table 2 Test results

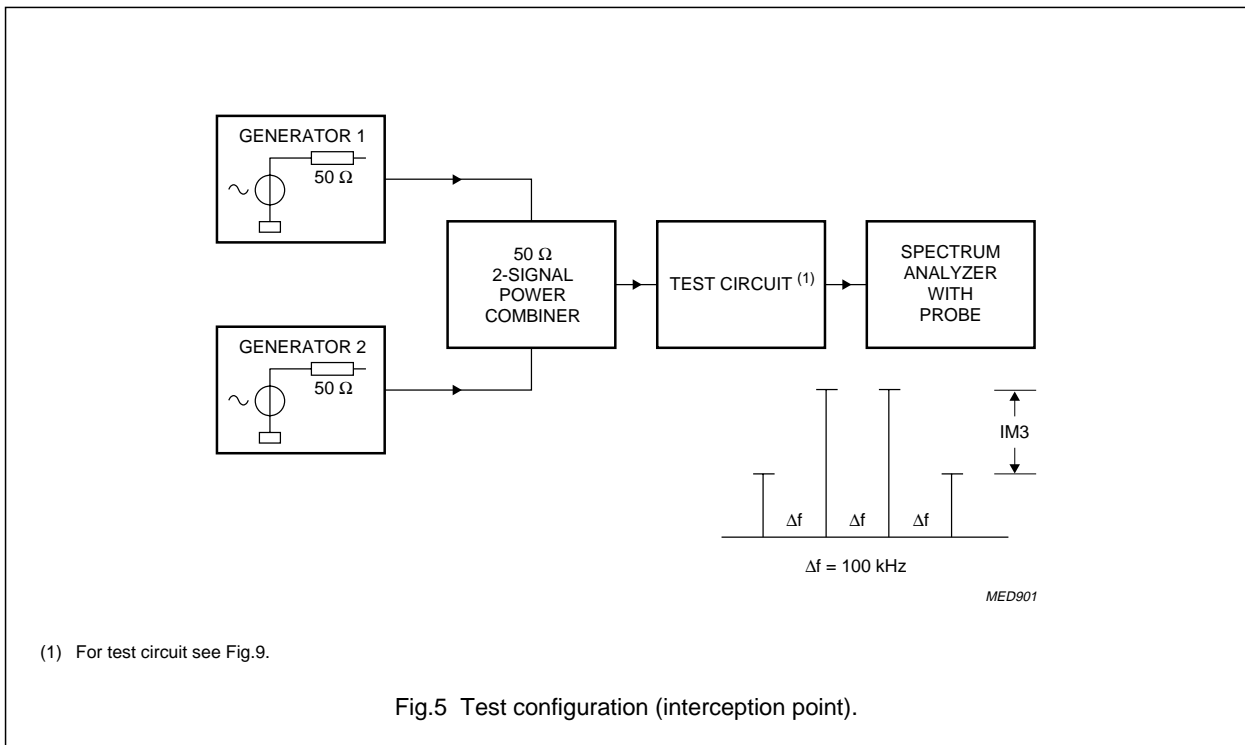
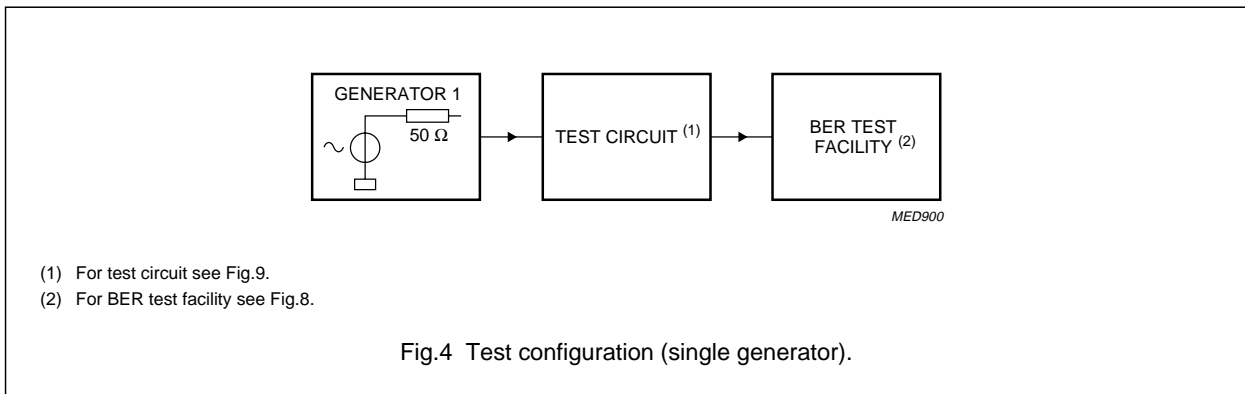
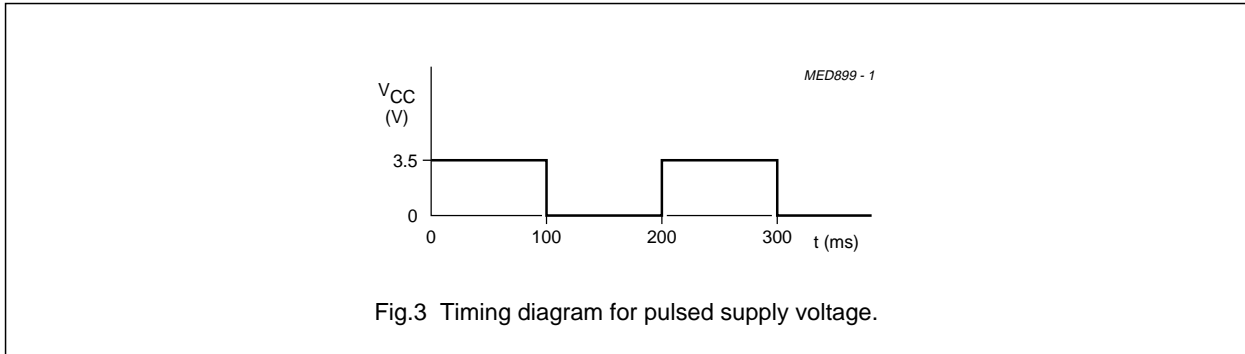
TEST	GENERATOR		RESULT
	1	2	
Maximum input power; see Fig.4	test signal 1; $P_1 = -30$ dBm (minimum P_{max})	–	$BER \leq 3 \times 10^{-2}$ (e.g. 7.5 bit errors per second for 250 bits/s)
Receiver turn-on time; see Fig.4 and note 1	test signal 1; $P_1 = P_{ref} + 10$ dB	–	check that the first 10 bits are correct; error counting is started 10 ms after V_{CC} is switched on
Interception point (mixer); see Fig.5 and note 2	test signal 3; $P_1 = -50$ dBm	test signal 2; $P_2 = P_1$	$IP3 = P_1 + \frac{1}{2} \times IM3$ (dB); minimum value: $IP3_{mix} \geq -20$ dBm
Interception point (mixer plus IF amplifier); see Fig.5 and note 3	test signal 3; $P_1 = -50$ dBm	test signal 2; $P_2 = P_1$	$IP3 = P_1 + \frac{1}{2} \times IM3$ (dB); minimum value: $IP3_{IF} \geq -38$ dBm
Spurious radiation; see Fig.6 and note 4	–	–	no spurious radiation (25 MHz to 1 GHz) with level higher than -60 dBm (maximum P_{spur})
1 dB compression point (mixer); see Fig.7 and note 5	test signal 3; $P_{11} = -70$ dBm; $P_{12} = -38$ dBm (minimum P_{1dB})	–	$(P_{o1} + 70 \text{ dB}) - [P_{o2} + 38 \text{ dB (minimum } P_{1dB})] \leq 1 \text{ dB}$, where P_{o1} is the output power for test signal with P_{11} and P_{o2} is the output power for test signal with P_{12}

Notes

1. The supply voltage V_{CC} of the test circuit alternates between 'on' (100 ms) and 'off' (100 ms); see Fig.3.
2. Differential probe of spectrum analyser connected to pins MOP and MON.
3. Probe of spectrum analyser connected to pin LIN.
4. Spectrum analyser connected to the input of the test board.
5. Probe of spectrum analyser connected to either pin MOP or pin MON.

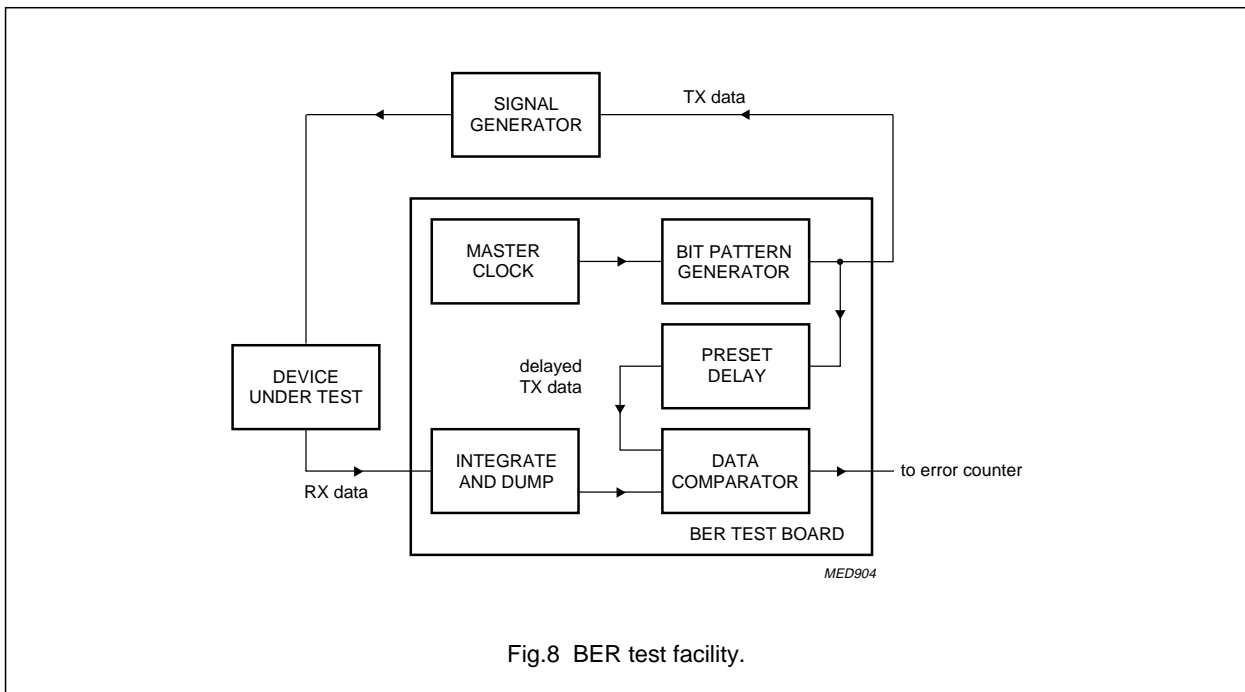
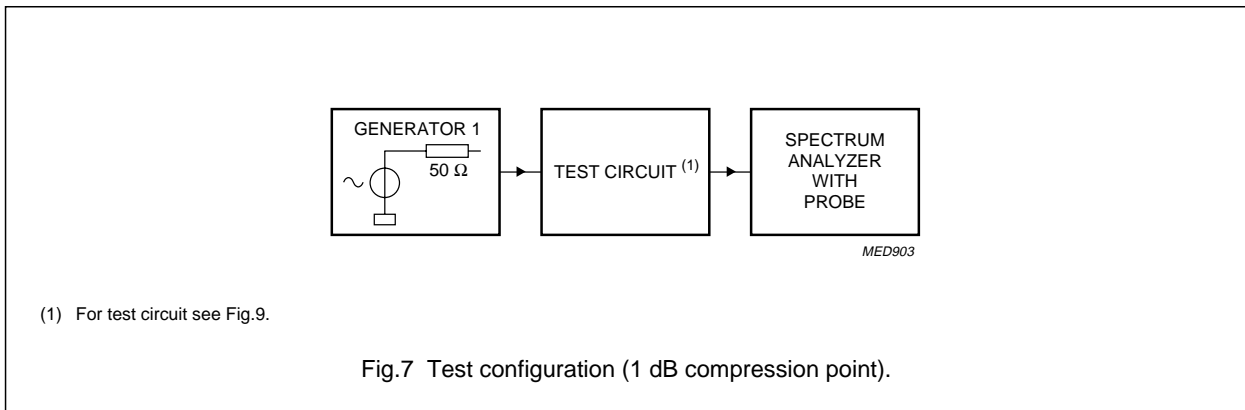
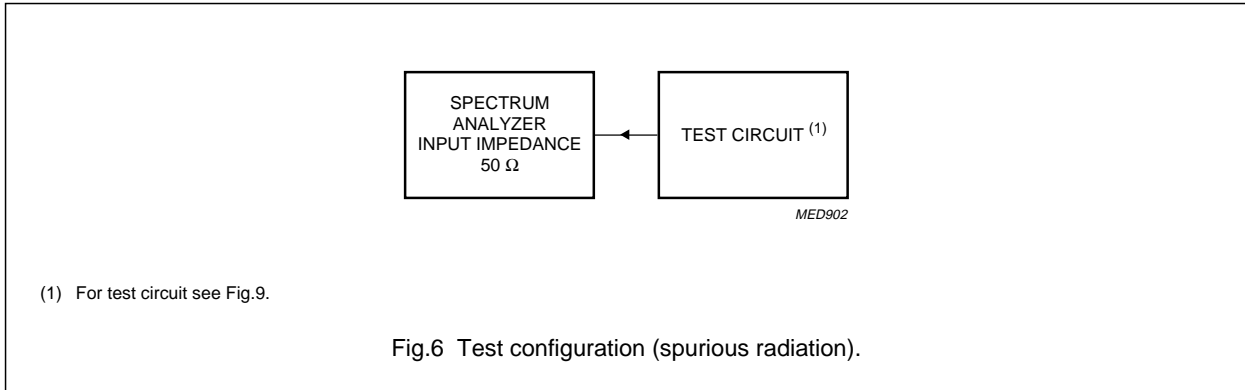
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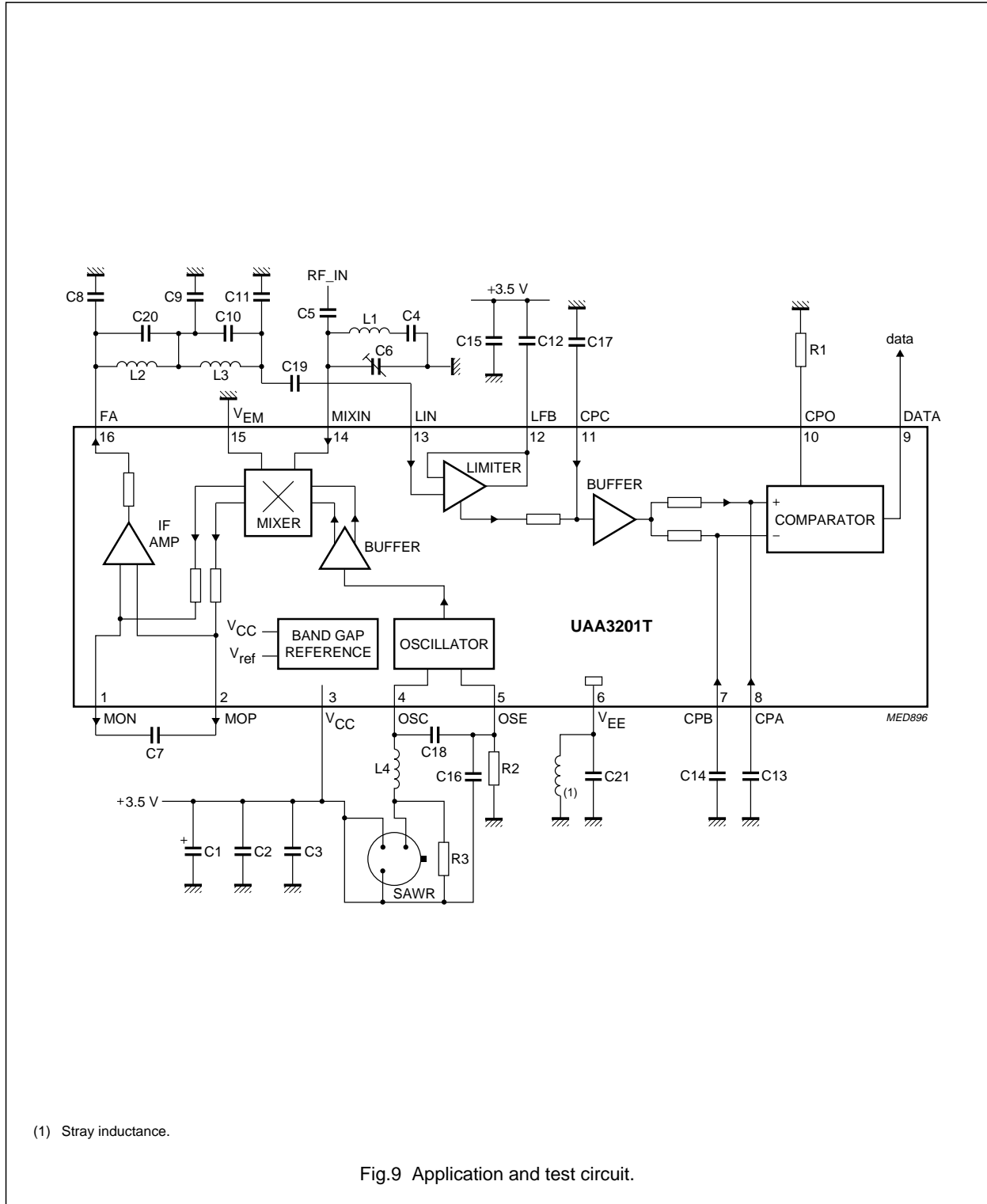
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APPLICATION INFORMATION



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Components and layout of printed circuit board of test circuit for $f_{i(RF)} = 433.92$ MHz**Table 3** Components list for Fig.9

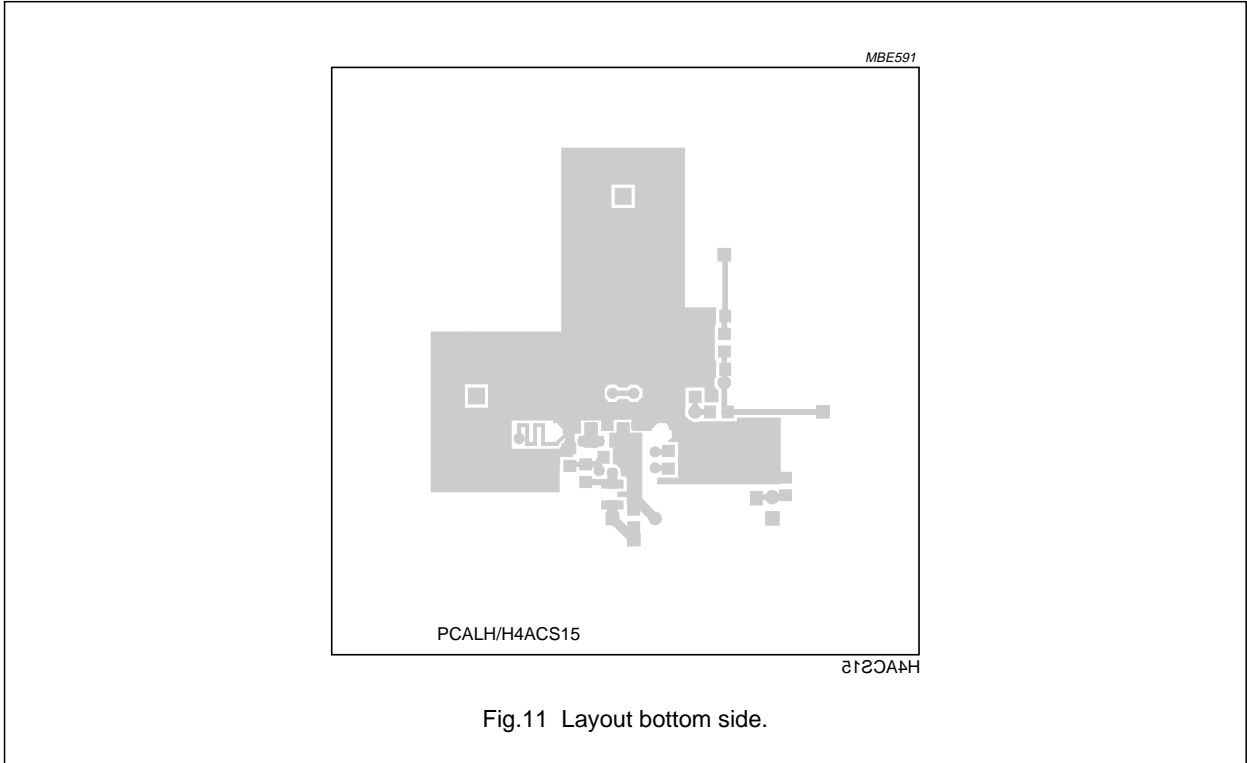
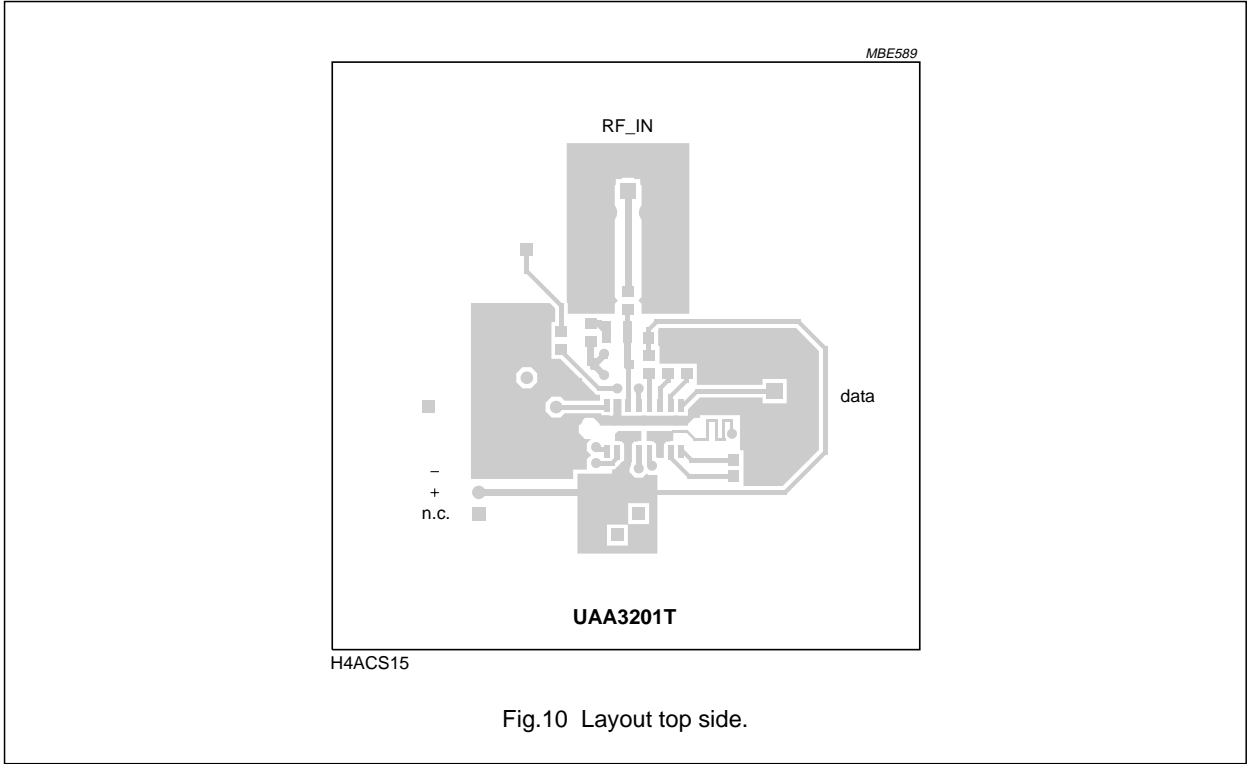
COMPONENT	VALUE	TOLERANCE	DESCRIPTION
R1	27 k Ω	$\pm 2\%$	TC = +50 ppm/K
R2	680 Ω	$\pm 2\%$	TC = +50 ppm/K
R3	220 Ω	$\pm 2\%$	TC = +50 ppm/K
C1	4.7 μ F	$\pm 20\%$	–
C2	150 pF	$\pm 10\%$	TC = 0 ± 30 ppm/K; $\tan \delta \leq 10 \times 10^{-4}$; f = 1 MHz
C3	1 nF	$\pm 10\%$	TC = 0 ± 30 ppm/K; $\tan \delta \leq 10 \times 10^{-4}$; f = 1 MHz
C4	820 pF	$\pm 10\%$	TC = 0 ± 30 ppm/K; $\tan \delta \leq 10 \times 10^{-4}$; f = 1 MHz
C5	3.3 pF	$\pm 10\%$	TC = 0 ± 150 ppm/K; $\tan \delta \leq 30 \times 10^{-4}$; f = 1 MHz
C6	2.5 to 6 pF	–	TC = 0 ± 300 ppm/K; $\tan \delta \leq 20 \times 10^{-4}$; f = 1 MHz
C7	56 pF	$\pm 10\%$	TC = 0 ± 30 ppm/K; $\tan \delta \leq 10 \times 10^{-4}$; f = 1 MHz
C8	150 pF	$\pm 10\%$	TC = 0 ± 30 ppm/K; $\tan \delta \leq 10 \times 10^{-4}$; f = 1 MHz
C9	220 pF	$\pm 10\%$	TC = 0 ± 30 ppm/K; $\tan \delta \leq 10 \times 10^{-4}$; f = 1 MHz
C10	27 pF	$\pm 10\%$	TC = 0 ± 30 ppm/K; $\tan \delta \leq 20 \times 10^{-4}$; f = 1 MHz
C11	150 pF	$\pm 10\%$	TC = 0 ± 30 ppm/K; $\tan \delta \leq 10 \times 10^{-4}$; f = 1 MHz
C12	100 nF	$\pm 10\%$	$\tan \delta \leq 25 \times 10^{-3}$; f = 1 kHz
C13	2.2 nF	$\pm 10\%$	$\tan \delta \leq 25 \times 10^{-3}$; f = 1 kHz
C14	33 nF	$\pm 10\%$	$\tan \delta \leq 25 \times 10^{-3}$; f = 1 kHz
C15	150 pF	$\pm 10\%$	TC = 0 ± 30 ppm/K; $\tan \delta \leq 10 \times 10^{-4}$; f = 1 MHz
C16	3.9 pF	$\pm 10\%$	TC = 0 ± 150 ppm/K; $\tan \delta \leq 30 \times 10^{-4}$; f = 1 MHz
C17	10 nF	$\pm 10\%$	$\tan \delta \leq 25 \times 10^{-3}$; f = 1 kHz
C18	3.3 pF	$\pm 10\%$	TC = 0 ± 150 ppm/K; $\tan \delta \leq 30 \times 10^{-4}$; f = 1 MHz
C19	68 pF	$\pm 10\%$	TC = 0 ± 30 ppm/K; $\tan \delta \leq 10 \times 10^{-4}$; f = 1 MHz
C20	6.8 pF	$\pm 10\%$	TC = 0 ± 150 ppm/K; $\tan \delta \leq 30 \times 10^{-4}$; f = 1 MHz
C21	47 pF	$\pm 5\%$	TC = 0 ± 30 ppm/K; $\tan \delta \leq 10 \times 10^{-4}$; f = 1 MHz
L1	10 nH	$\pm 10\%$	$Q_{\min} = 50$ to 450 MHz; TC = 25 to 125 ppm/K
L2	330 μ H	$\pm 10\%$	$Q_{\min} = 45$ to 800 kHz; $C_{\text{stray}} \leq 1$ pF
L3	330 μ H	$\pm 10\%$	$Q_{\min} = 45$ to 800 kHz; $C_{\text{stray}} \leq 1$ pF
L4	33 nH	$\pm 10\%$	$Q_{\min} = 45$ to 450 MHz; TC = 25 to 125 ppm/K
SAWR	–	–	see Table 4

Table 4 SAWR data

DESCRIPTION	SPECIFICATION
Type	one-port (e.g. RFM R02112)
Centre frequency	433.42 MHz ± 75 kHz
Maximum insertion loss	1.5 dB
Typical loaded Q	1600 (50 Ω load)
Temperature drift	0.032 ppm/K ²
Turnover temperature	43 $^{\circ}$ C

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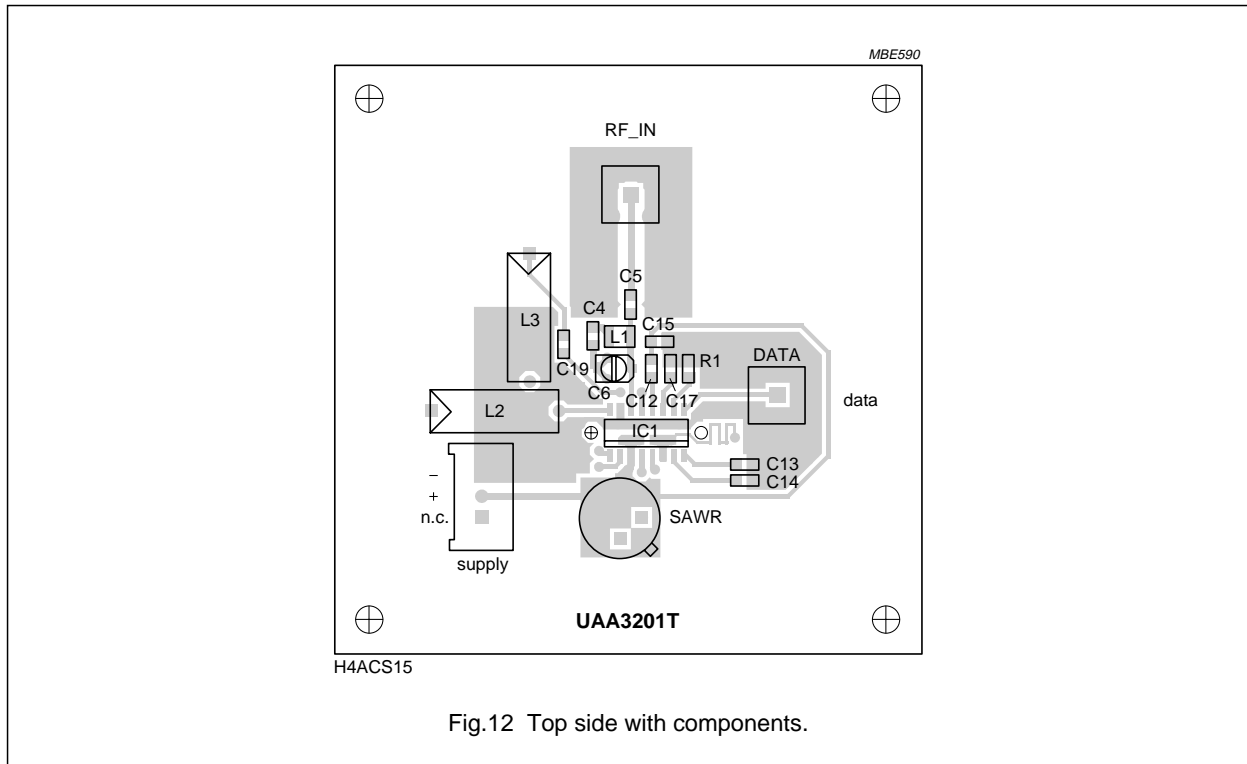


Fig.12 Top side with components.

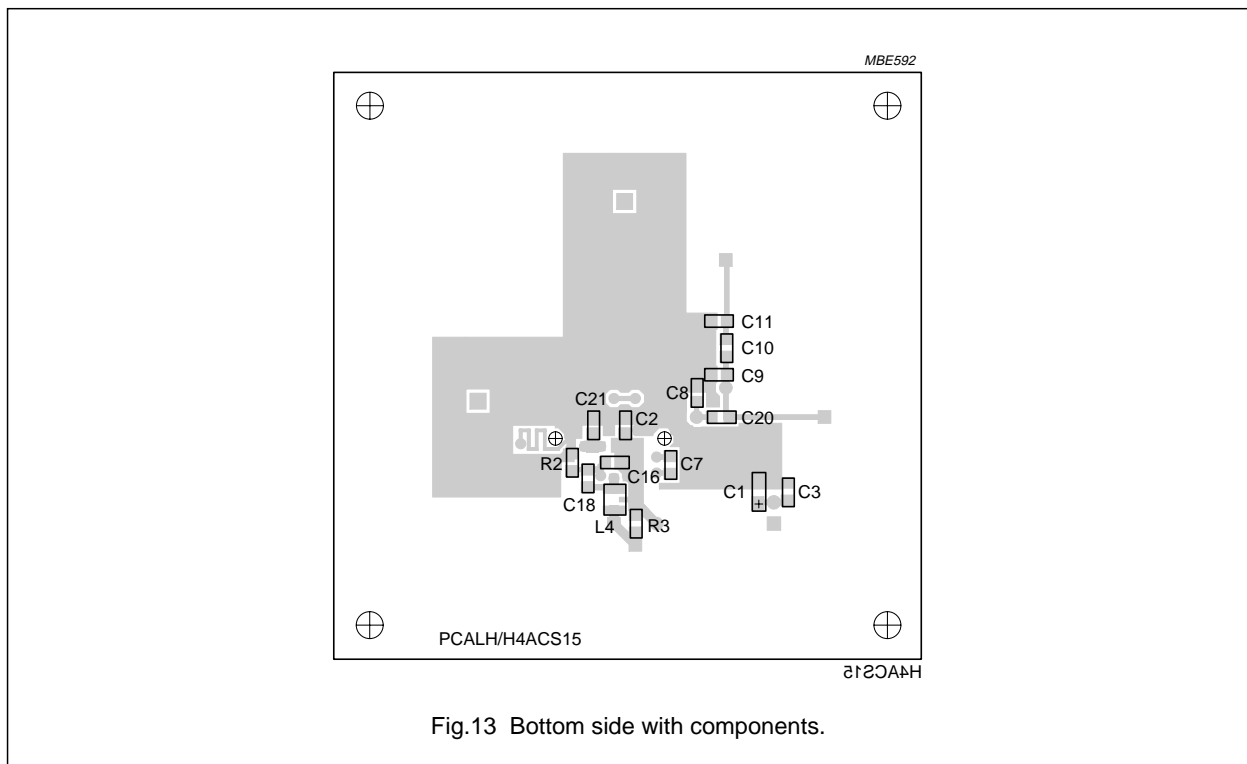


Fig.13 Bottom side with components.

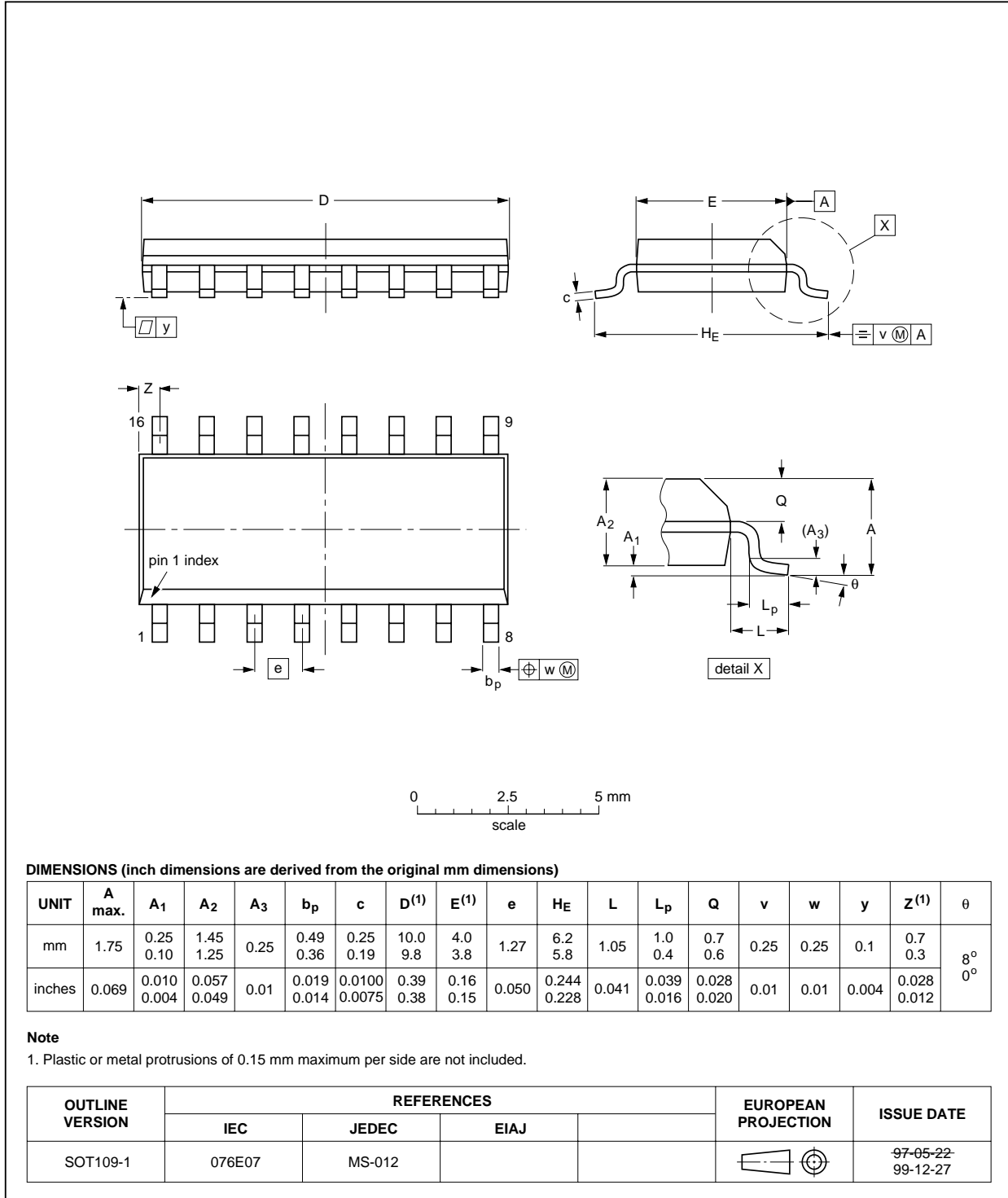
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PACKAGE OUTLINE

SO16: plastic small outline package; 16 leads; body width 3.9 mm

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SOLDERING

Introduction to soldering surface mount packages

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our *"Data Handbook IC26; Integrated Circuit Packages"* (document order number 9398 652 90011).

There is no soldering method that is ideal for all surface mount IC packages. Wave soldering is not always suitable for surface mount ICs, or for printed-circuit boards with high population densities. In these situations reflow soldering is often used.

Reflow soldering

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 methods exist for reflowing; for example, infrared/convection heating in a conveyor type oven. Throughput times (preheating, soldering and cooling) vary between 100 and 200 seconds depending on heating method.

Typical reflow peak temperatures range from 215 to 250 °C. The top-surface temperature of the packages should preferably be kept below 230 °C.

Wave soldering

Conventional single wave soldering is not recommended for surface mount devices (SMDs) or printed-circuit boards with a high component density, as solder bridging and non-wetting can present major problems.

To overcome these problems the double-wave soldering method was specifically developed.

If wave soldering is used the following conditions must be observed for optimal results:

- Use a double-wave soldering method comprising a turbulent wave with high upward pressure followed by a smooth laminar wave.
- For packages with leads on two sides and a pitch (e):
 - larger than or equal to 1.27 mm, the footprint longitudinal axis is **preferred** to be parallel to the transport direction of the printed-circuit board;
 - smaller than 1.27 mm, the footprint longitudinal axis **must** be parallel to the transport direction of the printed-circuit board.

The footprint must incorporate solder thieves at the downstream end.

- For packages with leads on four sides, the footprint must be placed at a 45° angle to the transport direction of the printed-circuit board. The footprint must incorporate solder thieves downstream and at the side corners.

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.

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.

Manual soldering

Fix the component by first soldering two diagonally-opposite end leads. Use a low voltage (24 V or less) soldering iron 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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Suitability of surface mount IC packages for wave and reflow soldering methods

PACKAGE	SOLDERING METHOD	
	WAVE	REFLOW ⁽¹⁾
BGA, LFBGA, SQFP, TFBGA	not suitable	suitable
HBCC, HLQFP, HSQFP, HSOP, HTQFP, HTSSOP, SMS	not suitable ⁽²⁾	suitable
PLCC ⁽³⁾ , SO, SOJ	suitable	suitable
LQFP, QFP, TQFP	not recommended ⁽³⁾⁽⁴⁾	suitable
SSOP, TSSOP, VSO	not recommended ⁽⁵⁾	suitable

Notes

1. All surface mount (SMD) packages are moisture sensitive. Depending upon the moisture content, the maximum temperature (with respect to time) and body size of the package, there is a risk that internal or external package cracks may occur due to vaporization of the moisture in them (the so called popcorn effect). For details, refer to the Drypack information in the *"Data Handbook IC26; Integrated Circuit Packages; Section: Packing Methods"*.
2. These packages are not suitable for wave soldering as a solder joint between the printed-circuit board and heatsink (at bottom version) can not be achieved, and as solder may stick to the heatsink (on top version).
3. If wave soldering is considered, then the package must be placed at a 45° angle to the solder wave direction. The package footprint must incorporate solder thieves downstream and at the side corners.
4. Wave soldering is only suitable for LQFP, TQFP and QFP packages with a pitch (e) equal to or larger than 0.8 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.65 mm.
5. Wave soldering is only suitable for SSOP and TSSOP packages with a pitch (e) equal to or larger than 0.65 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.5 mm.

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DATA SHEET STATUS

DATA SHEET STATUS	PRODUCT STATUS	DEFINITIONS ⁽¹⁾
Objective specification	Development	This data sheet contains the design target or goal specifications for product development. Specification may change in any manner without notice.
Preliminary specification	Qualification	This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.
Product specification	Production	This data sheet contains final specifications. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.

Note

1. Please consult the most recently issued data sheet before initiating or completing a design.

DEFINITIONS

Short-form specification — The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

Limiting values definition — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). 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.

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Printed in The Netherlands

03/pp20

Date of release: 2000 Apr 18

Document order number: 9397 750 06929

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