

# DATA SHEET

## **UAA2077TS** 2 GHz image rejecting front-end

Preliminary specification  
Supersedes data of 2000 Mar 09  
File under Integrated Circuits, IC17

2000 Apr 17

## 2 GHz image rejecting front-end

## UAA2077TS

### FEATURES

- Low noise, wide dynamic range amplifier
- Very low noise figure
- Dual balanced mixers for over 30 dB on-chip image rejection
- Quadrature 200 MHz IF recombining
- On-chip quadrature network
- Independent SX, RX, power-down control modes and fast power-up switching
- Very small outline packaging
- No image filter required, resulting in a very small application.

### APPLICATIONS

- GSM dual band solution with UAA3522HL
- High frequency front-end for DCS1800/PCS1900 portable hand-held equipment
- Compact mobile digital communication equipment
- Time Division Multiple Access (TDMA) receivers e.g. RF Local Area Networks (RF LANs).

### GENERAL DESCRIPTION

The UAA2077TS contains a 2 GHz front-end receiver intended to be used in mobile telephones. Designed in an advanced BiCMOS process it combines high performance with a low power consumption and high integration, thus reducing external component costs and overall front-end size.

The main advantage of the UAA2077TS is its ability to provide an image rejection over 30 dB. Therefore, an additional image filter between the Low Noise Amplifier (LNA) and the mixer is not required.

Image rejection is achieved internally by two RF mixers in quadrature operation and two all-pass filters in the I and Q IF channels that shift the phase of signals by 45° and 135° respectively. These two phase shifted IF signals are combined and buffered to the front-end IF output signal.

An input signal with a frequency above the Local Oscillator (LO) frequency results in an IF signal, while an input signal with a frequency below the LO frequency is rejected.

The receive section consists of an LNA that drives a quadrature mixer pair. The IF amplifier consists of an on-chip 45° and 135° phase shifting network and an image reject IF recombining. The IF driver has differential open-collector outputs.

The LO part consists of an internal all-pass phase shifting filter to provide the quadrature LO signals for the mixers of the receive section. The all-pass filter output signals are buffered before being fed to the mixers. All RF inputs and IF outputs are balanced.

Pins RXON and SXON allow control of the different active modes and power-down. The SX mode and the RX mode are independent active states of the LO section and the receive section respectively. When the logic level on pin SXON is HIGH, all internal buffers in the LO path of the circuit are turned on, thus minimizing LO pulling during the independent powering up of the receive section. Special care has been taken by design for fast switching from power-down to any of the different active modes.

### QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V <sub>CC</sub>	supply voltage		2.7	2.8	3.3	V
I <sub>CC(pd)</sub>	power-down supply current		–	–	50	µA
I <sub>CC(SRX)</sub>	supply current in SRX mode		–	25	28	mA
T <sub>amb</sub>	ambient temperature		–30	+25	+70	°C

### ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
UAA2077TS/D	SSOP16	plastic shrink small outline package; 16 leads; body width 4.4 mm	SOT369-1

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BLOCK DIAGRAM

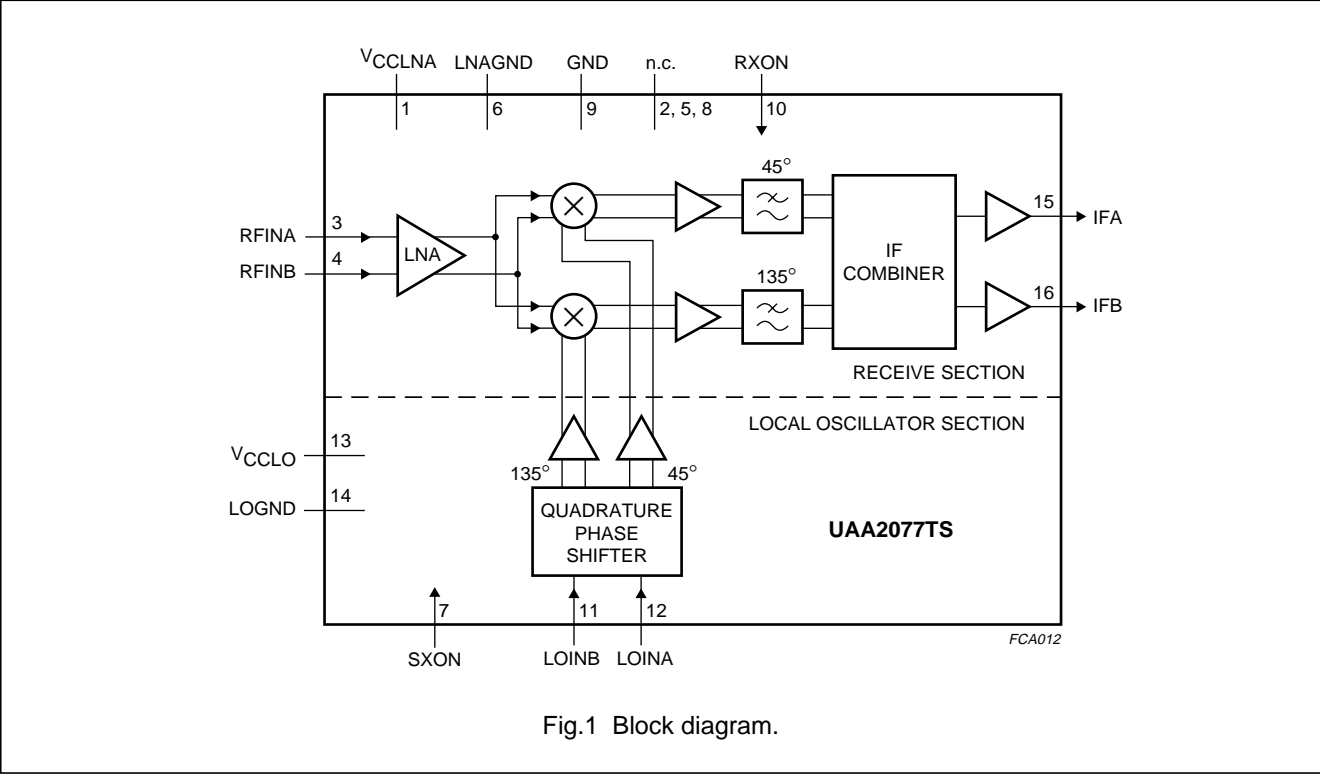


Fig.1 Block diagram.

PINNING

SYMBOL	PIN	DESCRIPTION
V <sub>CCLNA</sub>	1	supply voltage for receive section (LNA and IF parts)
n.c.	2	not connected
RFINA	3	RF input A (balanced)
RFINB	4	RF input B (balanced)
n.c.	5	not connected
LNAGND	6	ground for receive section (LNA and IF parts)
SXON	7	SX mode enable input (see Table 1)
n.c.	8	not connected
GND	9	ground
RXON	10	RX mode enable input (see Table 1)
LOINB	11	LO input B (balanced)
LOINA	12	LO input A (balanced)
V <sub>CCLO</sub>	13	supply voltage for LO section
LOGND	14	ground for LO section
IFA	15	IF output A (balanced)
IFB	16	IF output B (balanced)

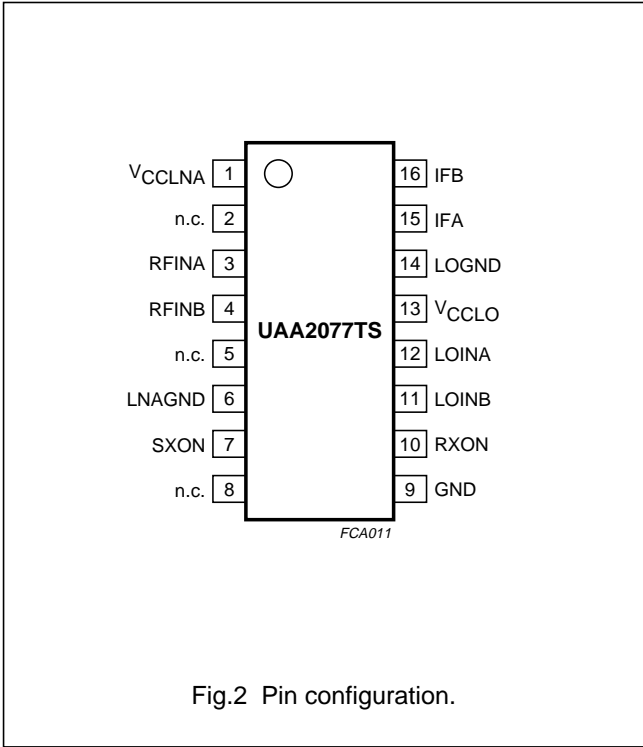


Fig.2 Pin configuration.

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## FUNCTIONAL DESCRIPTION

## Receive section

The circuit contains a low-noise amplifier followed by two high dynamic range mixers (see Fig.3). The mixers are of the Gilbert cell type, the architecture of which is fully differential.

The LO signal is phase shifted into  $45^\circ$  and  $135^\circ$  signals, mixed with the RF input signal to provide the I and Q channel signals. The I and Q channel signals are buffered, phase shifted by  $45^\circ$  and  $135^\circ$  respectively, amplified and internally combined, thus obtaining image rejection.

Balanced signal interfaces are used for minimizing crosstalk from package parasitics.

The IF output is of a differential open collector type.

A typical application consists of pull-up resistors of  $680\ \Omega$  at each IF output and a differential load resistance of  $1\ \text{k}\Omega$  for the IF filter, due to its impedance or its matching network.

The power gain refers to the resulting power into the  $1\ \text{k}\Omega$  load. The path for the DC current from  $V_{CC}$  into the open collector outputs should be realized by the inductors.

The output signal is limited to  $V_{CC} + 3V_{BE}$ .

Fast switching between power-down and the RX mode is controlled by the mode control pin RXON.

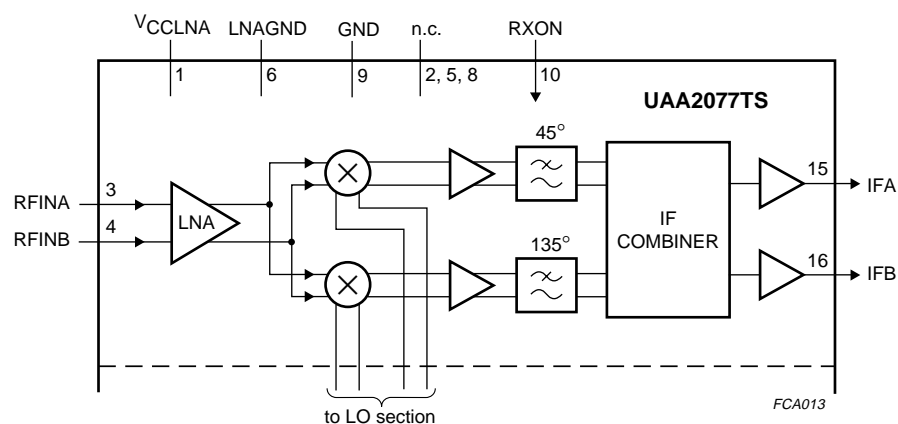


Fig.3 Receive section.

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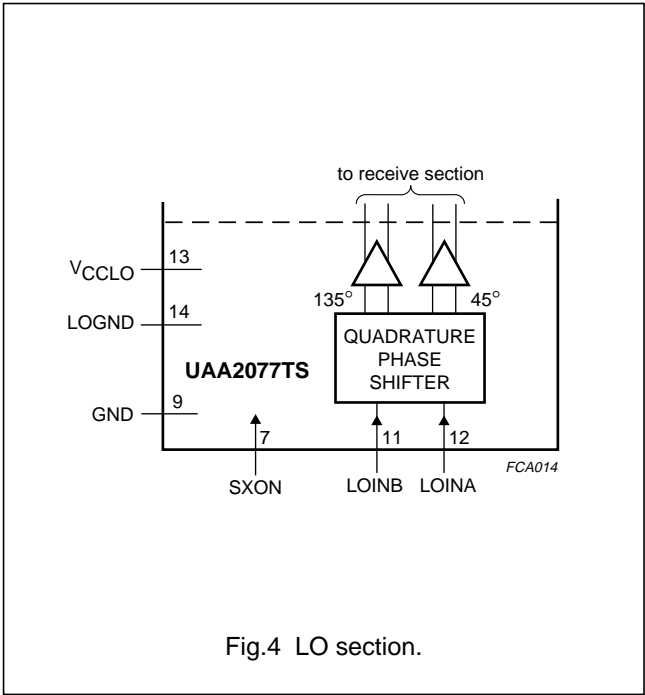
### Local oscillator section

The LO input directly drives the two internal all-pass networks to provide the quadrature signals for the mixers (see Fig.4).

The SX mode (see Table 1) is used to activate the LO section, thus minimizing pulling of the external Voltage Controlled Oscillator (VCO) when enabling the receive section. The SX mode is active when the logic level on pin SXON is HIGH.

Table 1 Operating modes

LOGIC LEVEL		MODE
PIN RXON	PIN SXON	
LOW	LOW	Power-down mode
HIGH	LOW	RX mode; receive section active
LOW	HIGH	SX mode; LO section active
HIGH	HIGH	SRX mode; both sections active



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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		–	6	V
$\Delta V_{SS}$	difference in voltage between ground pins		–	0.6	V
$P_{i(max)}$	maximum input power		–	20	dBm
$T_{j(max)}$	maximum junction temperature		–	+150	°C
$P_{tot}$	total power dissipation	in free air	–	250	mW
$T_{stg}$	storage temperature		–65	+150	°C

**HANDLING**

All pins withstand 1500 V ESD test in accordance with “MIL-STD-883C class 1 (method 3015.5)”.

**THERMAL CHARACTERISTICS**

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

**DC CHARACTERISTICS**

$V_{CC} = 2.8$  V;  $T_{amb} = 25$  °C; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
<b>Supplies</b>						
$V_{CC}$	supply voltage	full temperature range	2.7	2.8	3.3	V
$I_{CC(pd)}$	power-down supply current		–	–	50	μA
$I_{CC(RX)}$	supply current in RX mode		–	22	24	mA
$I_{CC(SX)}$	supply current in SX mode		–	3	4	mA
$I_{CC(SRX)}$	supply current in SRX mode		–	25	28	mA
<b>Mode control: pins RXON and SXON</b>						
$V_{IH}$	HIGH-level input voltage		1.9	–	$V_{CC}$	V
$V_{IL}$	LOW-level input voltage		–0.3	–	+0.6	V
$I_{IH}$	HIGH-level input current		–1	–	+1	μA
$I_{IL}$	LOW-level input current		–1	–	+1	μA

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**AC CHARACTERISTICS**

$V_{CC} = 2.8 \text{ V}$ ;  $T_{amb} = 25 \text{ }^{\circ}\text{C}$ ;  $f_{o(RX)} = 200 \text{ MHz}$ ; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
<b>Receive section (receive section enabled): DCS mode</b>						
$R_{i(RX)}$	RF input resistance (real part of the parallel input impedance)	balanced; at 1845 MHz	–	50	–	$\Omega$
$C_{i(RX)}$	RF input capacitance (imaginary part of the parallel input impedance)	balanced; at 1845 MHz	–	0.5	–	pF
$f_{i(RX)}$	RF input frequency		1805	–	1880	MHz
$RL_{i(RX)}$	return loss on matched RF input	balanced; note 1	10	15	–	dB
$G_{CP(RX)}$	conversion power gain	RF inputs to IF outputs; note 1	20	23	26	dB
$G_{rip}$	gain ripple as a function of RF frequency	over DCS frequency range; note 1	–	–1	–1.5	dB/100 MHz
$\Delta G/T$	gain variation with temperature		–60	–30	–	mdB/K
$CP1_{RX}$	1 dB compression point	referenced to RF input; note 1	–23.5	–20	–	dBm
DES3	input referred 3 dB desensitisation	interferer frequency offset is 3 MHz; useful signal is –101 dBm; note 1	–25	–	–	dBm
$IP3_{RX}$	3rd order intercept point	referenced to RF input; note 1	–15	–12	–	dBm
$NF_{RX}$	overall noise figure	RF inputs to IF outputs; note 1 normal case worse case for LO input, power and $V_{CC}$	– –	3.5 –	4.2 4.4	dB dB
$Z_{L(RX)}$	typical application IF output load impedance	balanced; note 1	–	1000	–	$\Omega$
$RL_{o(RX)}$	return loss on matched IF output	note 1	10	15	–	dB
$f_{o(RX)}$	IF frequency range	$f_{RF} > f_{LO}$	–	200	–	MHz
IR	rejection of image frequency	$f_{RF} > f_{LO}$ ; $f_{RF}$ is the frequency of the wanted signal; note 1	30	38	–	dB
<b>Receive section (receive section enabled): PCS mode</b>						
$R_{i(RX)}$	RF input resistance (real part of the parallel input impedance)	balanced; at 1960 MHz	–	tbf	–	$\Omega$
$C_{i(RX)}$	RF input capacitance (imaginary part of the parallel input impedance)	balanced; at 1960 MHz	–	tbf	–	pF
$f_{i(RX)}$	RF input frequency		1930	–	1990	MHz
$RL_{i(RX)}$	return loss on matched RF input	balanced; note 1	10	15	–	dB
$G_{CP(RX)}$	conversion power gain	RF inputs to IF outputs; note 1	–	22	–	dB
$G_{rip}$	gain ripple as a function of RF frequency	over PCS frequency range; note 1	–	–1	–	dB/100 MHz
$\Delta G/T$	gain variation with temperature		–	–30	–	mdB/K
$CP1_{RX}$	1 dB compression point	referenced to RF input; note 1	–	–20	–	dBm

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SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
DES3	input referred 3 dB desensitisation	interferer frequency offset is 3 MHz; useful signal is −101 dBm; note 1	–	tbF	–	dBm
IP3 <sub>RX</sub>	3rd order intercept point	referenced to RF input; note 1	–	−12	–	dBm
NF <sub>RX</sub>	overall noise figure	R inputs to IF outputs; note 1	–	3.7	–	dB
Z <sub>L(RX)</sub>	typical application IF output load impedance	balanced; note 1	–	1000	–	Ω
RL <sub>O(RX)</sub>	return loss on matched IF output	note 1	10	15	–	dB
f <sub>O(RX)</sub>	IF frequency range	f <sub>RF</sub> > f <sub>LO</sub>	–	200	–	MHz
IR	rejection of image frequency	f <sub>RF</sub> > f <sub>LO</sub> ; f <sub>RF</sub> is the frequency of the wanted signal; note 1	–	38	–	dB
<b>Local oscillator section (receive section enabled)</b>						
f <sub>i(LO)</sub>	LO input frequency		1605	–	1790	MHz
R <sub>i(LO)</sub>	LO input resistance (real part of the parallel input impedance)	balanced; at 1645 MHz	–	50	–	Ω
C <sub>i(LO)</sub>	LO input capacitance (imaginary part of the parallel input impedance)	balanced; at 1645 MHz	–	1.2	–	pF
RL <sub>i(LO)</sub>	return loss on matched input (including standby mode)	note 1	10	15	–	dB
P <sub>i(LO)</sub>	LO power level	note 1	−10	−3	0	dBm
RI <sub>(LO)</sub>	reverse isolation	pins LOIN to RFIN at LO frequency; note 1	40	–	–	dB
<b>Timing</b>						
t <sub>stu</sub>	start-up time of each block		1	5	20	μs

**Notes**

1. Measured and guaranteed only on demonstration board including PCB and balun.



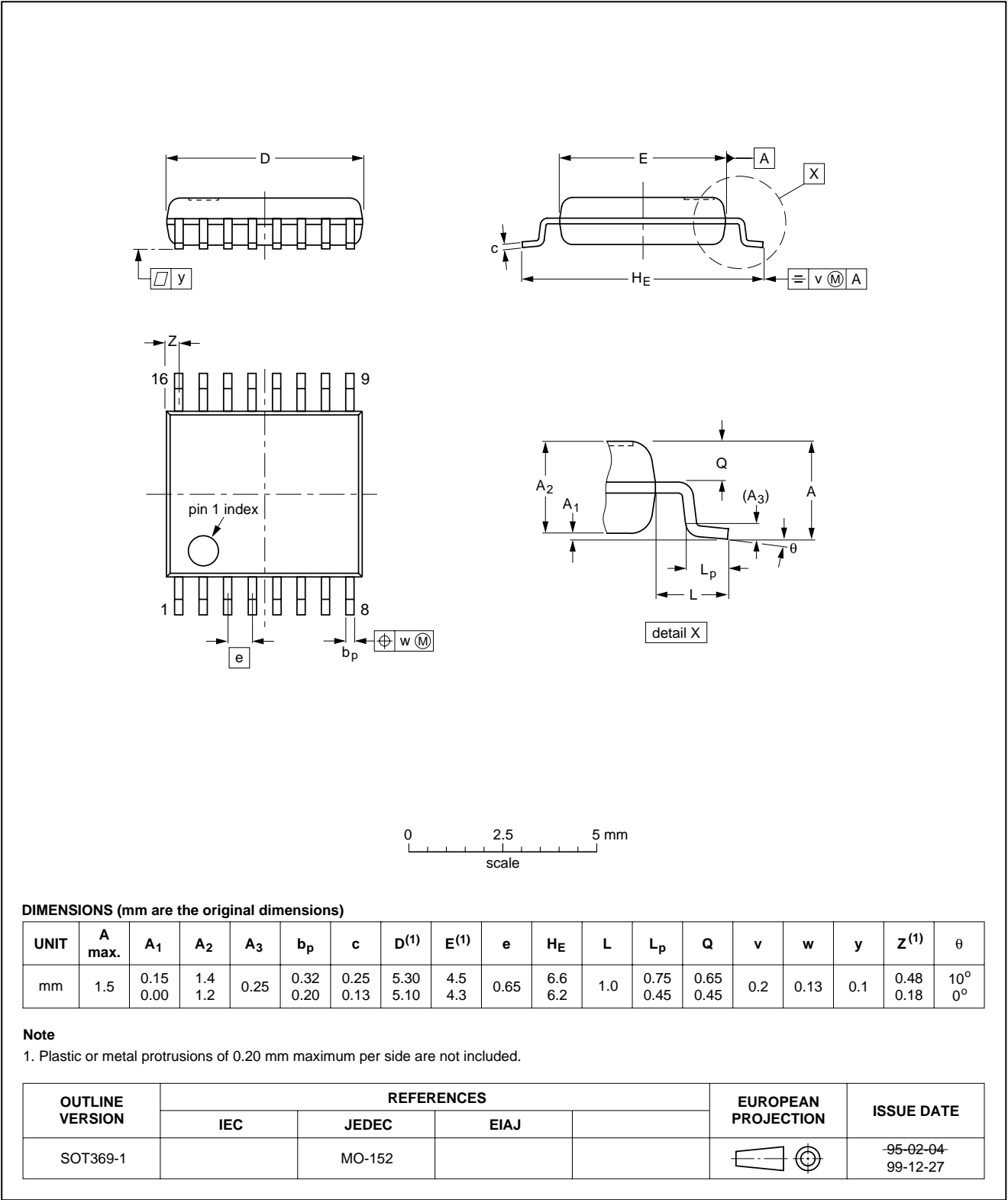
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PACKAGE OUTLINE

SSOP16: plastic shrink small outline package; 16 leads; body width 4.4 mm

SOT369-1



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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 <sup>(1)</sup>
BGA, LFBGA, SQFP, TFBGA	not suitable	suitable
HBCC, HLQFP, HSQFP, HSOP, HTQFP, HTSSOP, SMS	not suitable <sup>(2)</sup>	suitable
PLCC <sup>(3)</sup> , SO, SOJ	suitable	suitable
LQFP, QFP, TQFP	not recommended <sup>(3)(4)</sup>	suitable
SSOP, TSSOP, VSO	not recommended <sup>(5)</sup>	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 <sup>(1)</sup>
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.

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