INTEGRATED CIRCUITS

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

Philips Semiconductors

PHILIPS

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 recombiner
- 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 recombiner. 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_{CC}	supply voltage		2.7	2.8	3.3	V
$I_{CC(pd)}$	power-down supply current		–	–	50	μA
$I_{CC(SRX)}$	supply current in SRX mode		–	25	28	mA
T_{amb}	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

BLOCK DIAGRAM

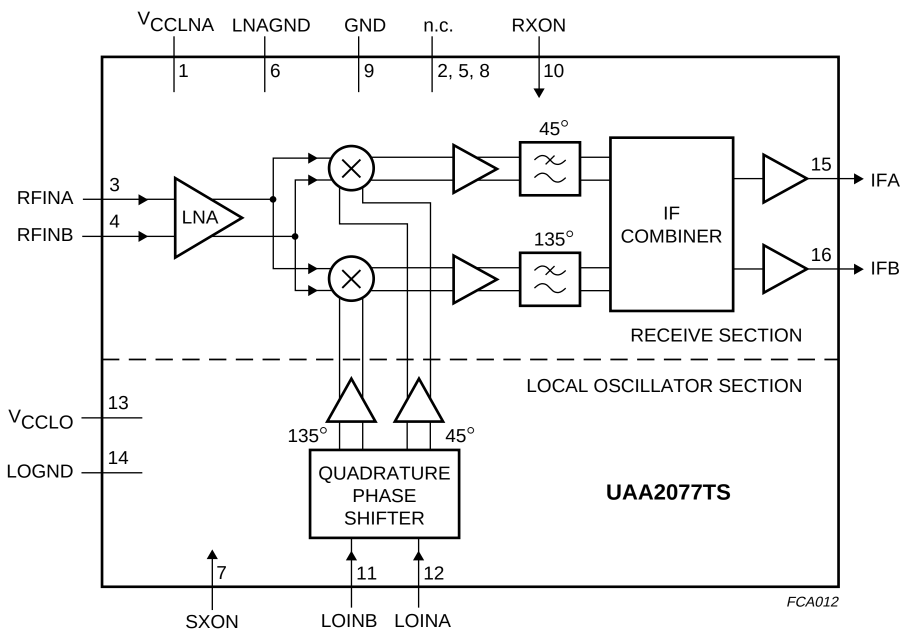


Fig.1 Block diagram.

PINNING

SYMBOL	PIN	DESCRIPTION
V_{CCLNA}	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_{CCLO}	13	supply voltage for LO section
LOGND	14	ground for LO section
IFA	15	IF output A (balanced)
IFB	16	IF output B (balanced)

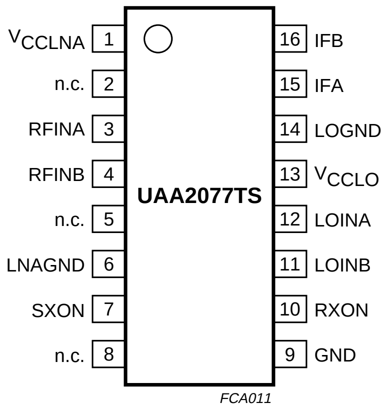


Fig.2 Pin configuration.

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° and 135° 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° and 135° 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 Ω at each IF output and a differential load resistance of 1 kΩ for the IF filter, due to its impedance or its matching network.

The power gain refers to the resulting power into the 1 kΩ 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.

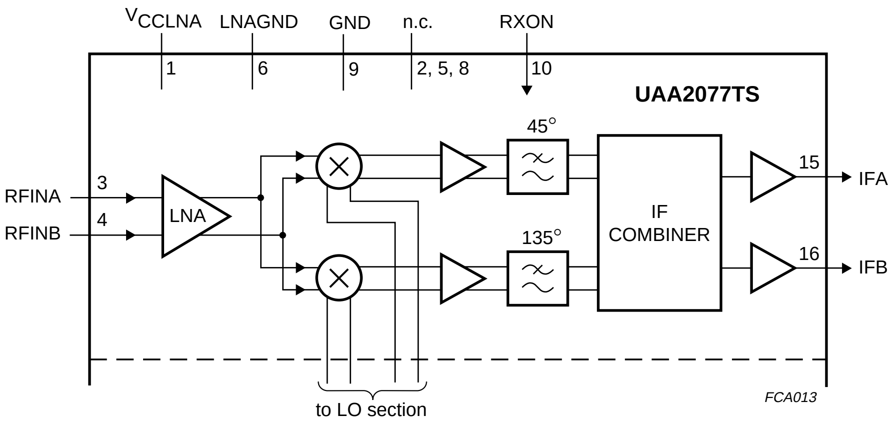


Fig.3 Receive section.

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

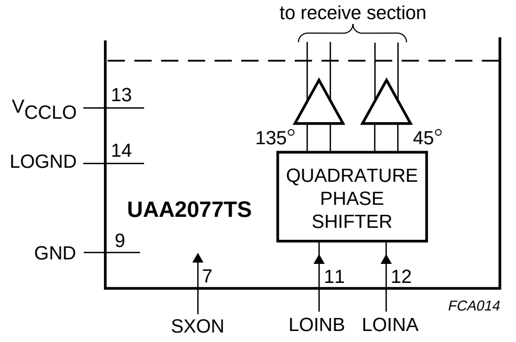


Fig.4 LO section.

LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CC}	supply voltage		–	6	V
ΔV_{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
Supplies						
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
Mode control: pins RXON and SXON						
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

AC CHARACTERISTICS

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Receive section (receive section enabled): DCS mode						
$R_{i(RX)}$	RF input resistance (real part of the parallel input impedance)	balanced; at 1845 MHz	–	50	–	Ω
$C_{i(RX)}$	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
ΔG/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	–	3.5	4.2	dB
		worse case for LO input, power and V_{CC}	–	–	4.4	dB
$Z_{L(RX)}$	typical application IF output load impedance	balanced; note 1	–	1000	–	Ω
$RL_{o(RX)}$	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
Receive section (receive section enabled): PCS mode						
$R_{i(RX)}$	RF input resistance (real part of the parallel input impedance)	balanced; at 1960 MHz	–	tbf	–	Ω
$C_{i(RX)}$	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
ΔG/T	gain variation with temperature		–	–30	–	mdB/K
$CP1_{RX}$	1 dB compression point	referenced to RF input; note 1	–	–20	–	dBm

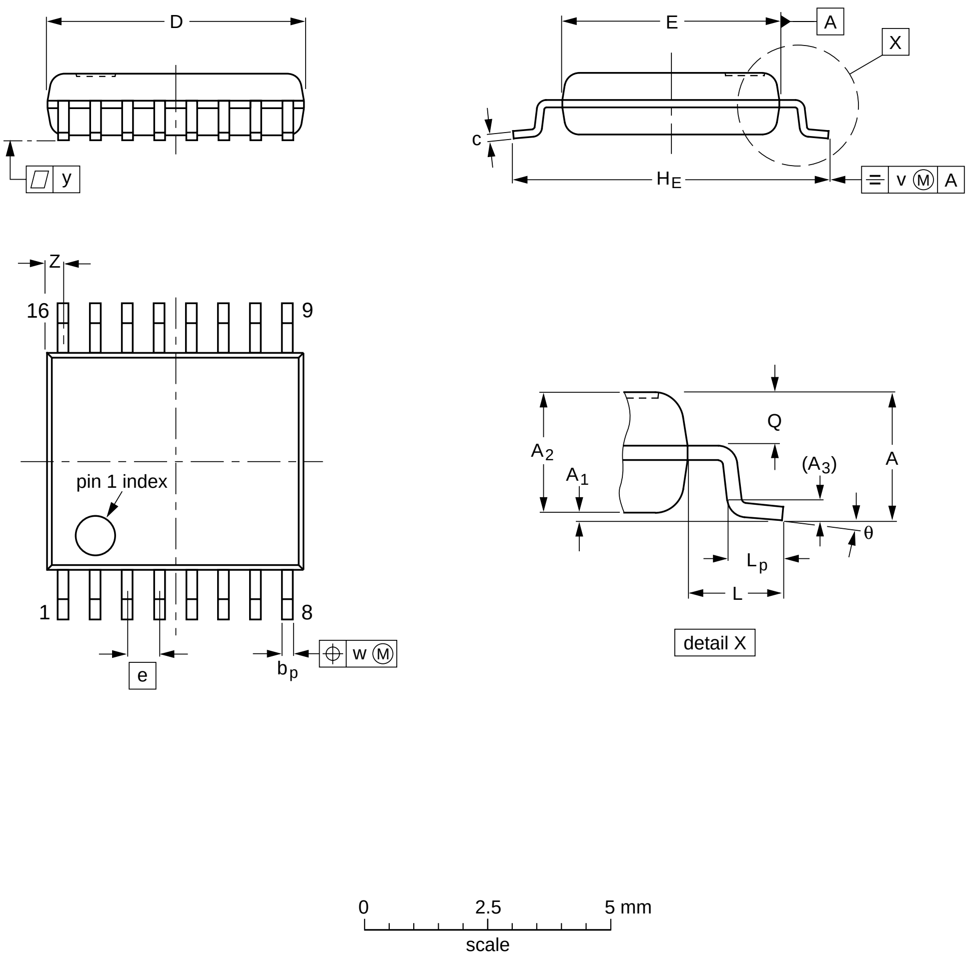
SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
DES3	input referred 3 dB desensitisation	interferer frequency offset is 3 MHz; useful signal is –101 dBm; note 1	–	tbf	–	dBm
$IP3_{RX}$	3rd order intercept point	referenced to RF input; note 1	–	–12	–	dBm
NF_{RX}	overall noise figure	R inputs to IF outputs; note 1	–	3.7	–	dB
$Z_{L(RX)}$	typical application IF output load impedance	balanced; note 1	–	1000	–	Ω
$RL_{o(RX)}$	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	–	38	–	dB
Local oscillator section (receive section enabled)						
$f_{i(LO)}$	LO input frequency		1605	–	1790	MHz
$R_{i(LO)}$	LO input resistance (real part of the parallel input impedance)	balanced; at 1645 MHz	–	50	–	Ω
$C_{i(LO)}$	LO input capacitance (imaginary part of the parallel input impedance)	balanced; at 1645 MHz	–	1.2	–	pF
$RL_{i(LO)}$	return loss on matched input (including standby mode)	note 1	10	15	–	dB
$P_{i(LO)}$	LO power level	note 1	–10	–3	0	dBm
$RI_{(LO)}$	reverse isolation	pins LOIN to RFIN at LO frequency; note 1	40	–	–	dB
Timing						
t_{stu}	start-up time of each block		1	5	20	μs

Notes

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

PACKAGE OUTLINE

SSOP16: plastic shrink small outline package; 16 leads; body width 4.4 mm **SOT369-1**



DIMENSIONS (mm are the original 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	1.5	0.15 0.00	1.4 1.2	0.25	0.32 0.20	0.25 0.13	5.30 5.10	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^o 0^o

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			
SOT369-1		MO-152				~~95-02-04~~ 99-12-27

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 preferable 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.

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.

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.

Application information — Applications that are described herein for any of these products are for illustrative purposes only. Philips Semiconductors make no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

DISCLAIMERS

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 Semiconductors customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips Semiconductors for any damages resulting from such application.

Right to make changes — Philips Semiconductors reserves the right to make changes, without notice, in the products, including circuits, standard cells, and/or software, described or contained herein in order to improve design and/or performance. Philips Semiconductors assumes no responsibility or liability for the use of any of these products, conveys no licence or title under any patent, copyright, or mask work right to these products, and makes no representations or warranties that these products are free from patent, copyright, or mask work right infringement, unless otherwise specified.

NOTES

NOTES

NOTES

Philips Semiconductors – a worldwide company

Argentina: see South America

Australia: 3 Figtree Drive, HOMEBUSH, NSW 2140,
Tel. +61 2 9704 8141, Fax. +61 2 9704 8139

Austria: Computerstr. 6, A-1101 WIEN, P.O. Box 213,
Tel. +43 1 60 101 1248, Fax. +43 1 60 101 1210

Belarus: Hotel Minsk Business Center, Bld. 3, r. 1211, Volodarski Str. 6,
220050 MINSK, Tel. +375 172 20 0733, Fax. +375 172 20 0773

Belgium: see The Netherlands

Brazil: see South America

Bulgaria: Philips Bulgaria Ltd., Energoproject, 15th floor,
51 James Bourchier Blvd., 1407 SOFIA,
Tel. +359 2 68 9211, Fax. +359 2 68 9102

Canada: PHILIPS SEMICONDUCTORS/COMPONENTS,
Tel. +1 800 234 7381, Fax. +1 800 943 0087

China/Hong Kong: 501 Hong Kong Industrial Technology Centre,
72 Tat Chee Avenue, Kowloon Tong, HONG KONG,
Tel. +852 2319 7888, Fax. +852 2319 7700

Colombia: see South America

Czech Republic: see Austria

Denmark: Sydhavnsgade 23, 1780 COPENHAGEN V,
Tel. +45 33 29 3333, Fax. +45 33 29 3905

Finland: Sinikalliontie 3, FIN-02630 ESPOO,
Tel. +358 9 615 800, Fax. +358 9 6158 0920

France: 51 Rue Carnot, BP317, 92156 SURESNES Cedex,
Tel. +33 1 4099 6161, Fax. +33 1 4099 6427

Germany: Hammerbrookstraße 69, D-20097 HAMBURG,
Tel. +49 40 2353 60, Fax. +49 40 2353 6300

Hungary: see Austria

India: Philips INDIA Ltd, Band Box Building, 2nd floor,
254-D, Dr. Annie Besant Road, Worli, MUMBAI 400 025,
Tel. +91 22 493 8541, Fax. +91 22 493 0966

Indonesia: PT Philips Development Corporation, Semiconductors Division,
Gedung Philips, Jl. Buncit Raya Kav.99-100, JAKARTA 12510,
Tel. +62 21 794 0040 ext. 2501, Fax. +62 21 794 0080

Ireland: Newstead, Clonskeagh, DUBLIN 14,
Tel. +353 1 7640 000, Fax. +353 1 7640 200

Israel: RAPAC Electronics, 7 Kehilat Saloniki St, PO Box 18053,
TEL AVIV 61180, Tel. +972 3 645 0444, Fax. +972 3 649 1007

Italy: PHILIPS SEMICONDUCTORS, Via Casati, 23 - 20052 MONZA (MI),
Tel. +39 039 203 6838, Fax +39 039 203 6800

Japan: Philips Bldg 13-37, Kohnan 2-chome, Minato-ku,
TOKYO 108-8507, Tel. +81 3 3740 5130, Fax. +81 3 3740 5057

Korea: Philips House, 260-199 Itaewon-dong, Yongsan-ku, SEOUL,
Tel. +82 2 709 1412, Fax. +82 2 709 1415

Malaysia: No. 76 Jalan Universiti, 46200 PETALING JAYA, SELANGOR,
Tel. +60 3 750 5214, Fax. +60 3 757 4880

Mexico: 5900 Gateway East, Suite 200, EL PASO, TEXAS 79905,
Tel. +9-5 800 234 7381, Fax +9-5 800 943 0087

Middle East: see Italy

Netherlands: Postbus 90050, 5600 PB EINDHOVEN, Bldg. VB,
Tel. +31 40 27 82785, Fax. +31 40 27 88399

New Zealand: 2 Wagener Place, C.P.O. Box 1041, AUCKLAND,
Tel. +64 9 849 4160, Fax. +64 9 849 7811

Norway: Box 1, Manglerud 0612, OSLO,
Tel. +47 22 74 8000, Fax. +47 22 74 8341

Pakistan: see Singapore

Philippines: Philips Semiconductors Philippines Inc.,
106 Valero St. Salcedo Village, P.O. Box 2108 MCC, MAKATI,
Metro MANILA, Tel. +63 2 816 6380, Fax. +63 2 817 3474

Poland: Al.Jerozolimskie 195 B, 02-222 WARSAW,
Tel. +48 22 5710 000, Fax. +48 22 5710 001

Portugal: see Spain

Romania: see Italy

Russia: Philips Russia, Ul. Usatcheva 35A, 119048 MOSCOW,
Tel. +7 095 755 6918, Fax. +7 095 755 6919

Singapore: Lorong 1, Toa Payoh, SINGAPORE 319762,
Tel. +65 350 2538, Fax. +65 251 6500

Slovakia: see Austria

Slovenia: see Italy

South Africa: S.A. PHILIPS Pty Ltd., 195-215 Main Road Martindale,
2092 JOHANNESBURG, P.O. Box 58088 Newville 2114,
Tel. +27 11 471 5401, Fax. +27 11 471 5398

South America: Al. Vicente Pinzon, 173, 6th floor,
04547-130 SÃO PAULO, SP, Brazil,
Tel. +55 11 821 2333, Fax. +55 11 821 2382

Spain: Balmes 22, 08007 BARCELONA,
Tel. +34 93 301 6312, Fax. +34 93 301 4107

Sweden: Kottbygatan 7, Akalla, S-16485 STOCKHOLM,
Tel. +46 8 5985 2000, Fax. +46 8 5985 2745

Switzerland: Allmendstrasse 140, CH-8027 ZÜRICH,
Tel. +41 1 488 2741 Fax. +41 1 488 3263

Taiwan: Philips Semiconductors, 6F, No. 96, Chien Kuo N. Rd., Sec. 1,
TAIPEI, Taiwan Tel. +886 2 2134 2886, Fax. +886 2 2134 2874

Thailand: PHILIPS ELECTRONICS (THAILAND) Ltd.,
209/2 Sanpavuth-Bangna Road Prakanong, BANGKOK 10260,
Tel. +66 2 745 4090, Fax. +66 2 398 0793

Turkey: Yukari Dudullu, Org. San. Blg., 2.Cad. Nr. 28 81260 Umraniye,
ISTANBUL, Tel. +90 216 522 1500, Fax. +90 216 522 1813

Ukraine: PHILIPS UKRAINE, 4 Patrice Lumumba str., Building B, Floor 7,
252042 KIEV, Tel. +380 44 264 2776, Fax. +380 44 268 0461

United Kingdom: Philips Semiconductors Ltd., 276 Bath Road, Hayes,
MIDDLESEX UB3 5BX, Tel. +44 208 730 5000, Fax. +44 208 754 8421

United States: 811 East Arques Avenue, SUNNYVALE, CA 94088-3409,
Tel. +1 800 234 7381, Fax. +1 800 943 0087

Uruguay: see South America

Vietnam: see Singapore

Yugoslavia: PHILIPS, Trg N. Pasica 5/v, 11000 BEOGRAD,
Tel. +381 11 3341 299, Fax.+381 11 3342 553

For all other countries apply to: Philips Semiconductors,
International Marketing & Sales Communications, Building BE-p, P.O. Box 218,
5600 MD EINDHOVEN, The Netherlands, Fax. +31 40 27 24825

Internet: http://www.semiconductors.philips.com

SCA69

Printed in The Netherlands 403506/02/pp16 Date of release: 2000 Apr 17 Document order number: 9397 750 07033

Let's make things better.

Philips Semiconductors

PHILIPS