DATA SHEET

SAA6581T
RDS/RBDS demodulator

Product specification
File under Integrated Circuits, IC01

2001 May 07

Philips
Semiconductors

PHILIPS

FEATURES

- Integrated switched capacitor filter
- Demodulates European Radio Data System (RDS) or the USA Radio Broadcast Data System (RBDS) signals
- Oscillator frequencies: 4.332 or 8.664 MHz
- Integrated ARI clamping
- CMOS device
- Single supply voltage: 5 V
- Extended temperature range: –40 to +85 °C
- Low number of external components.

GENERAL DESCRIPTION

The RDS/RBDS demodulator is a CMOS device with integrated filtering and demodulating of RDS/RBDS signals coming from a multiplexed input data stream. Data signal RDDA and clock signal RDCL are provided as outputs for further processing by a suitable microcomputer, for example CCR921 and CCR922.

The SAA6581T replaces SAA6579 in function and pin-compatibility.

APPLICATIONS

The RDS/RBDS system offers a large range of applications from the many functions that can be implemented. For car radios the most important are:

- Program Service (PS) name
- Traffic Program (TP) identification
- Traffic Announcement (TA) signal
- Alternative Frequency (AF) list
- Program Identification (PI)
- Enhanced Other Networks (EON) information.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
V_{DDA}	analog supply voltage	4.0	5.0	5.5	V
V_{DDD}	digital supply voltage	4.0	5.0	5.5	V
$I_{DD(tot)}$	total supply current	–	6.0	–	mA
$V_{i(MPX)}$	RDS input sensitivity at pin MPX	1	–	–	mV
$f_{i(xtal)}$	crystal input frequency	–	4.332	–	MHz
		–	8.664	–	MHz

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
SAA6581T	SO16	plastic small outline package; 16 leads; body width 7.5 mm	SOT162-1

BLOCK DIAGRAM

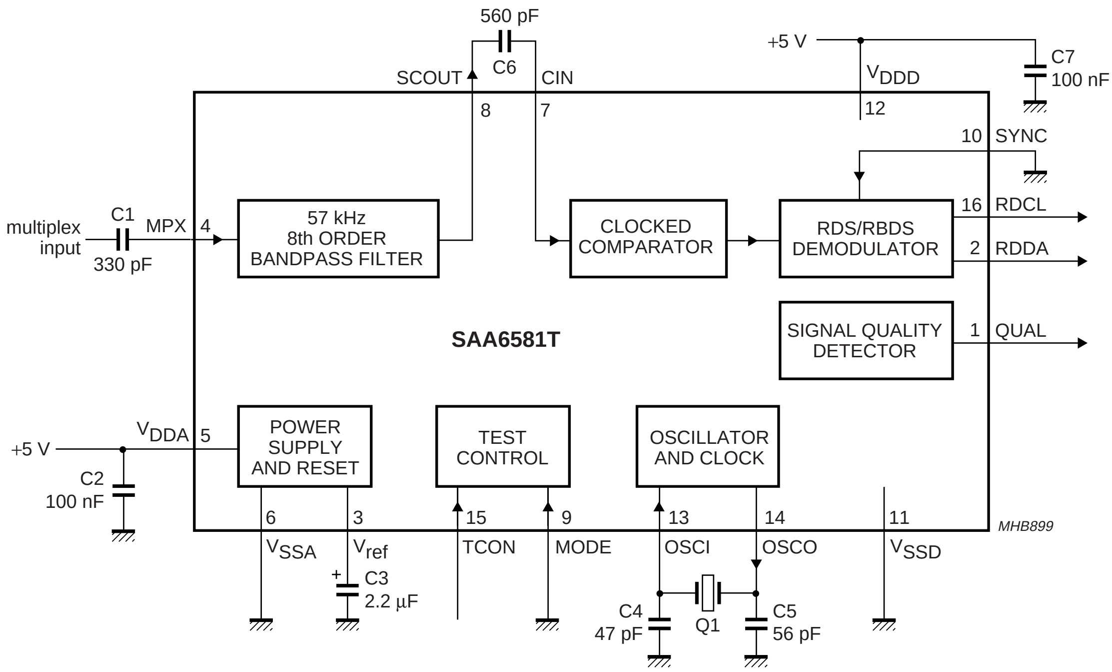


Fig.1 Block diagram.

PINNING

SYMBOL	PIN	DESCRIPTION
QUAL	1	signal quality indication output
RDDA	2	RDS data output
V_{ref}	3	reference voltage output ($^1/_2V_{DDA}$)
MPX	4	multiplex signal input
V_{DDA}	5	analog supply voltage (5 V)
V_{SSA}	6	analog ground (0 V)
CIN	7	comparator input
SCOUT	8	switched capacitor filter output
MODE	9	oscillator frequency select input
SYNC	10	ARI clamping control input
V_{SSD}	11	digital ground (0 V)
V_{DDD}	12	digital supply voltage (5 V)
OSCI	13	oscillator input
OSCO	14	oscillator output
TCON	15	test control input
RDCL	16	RDS clock output

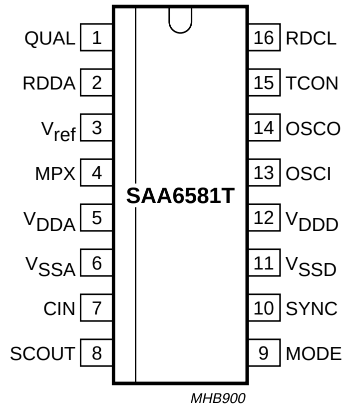


Fig.2 Pin configuration.

FUNCTIONAL DESCRIPTION

RDS/RBDS signal demodulation

BANDPASS FILTER

The bandpass filter has a centre frequency of 57 kHz. It selects the RDS/RBDS sub-band from the multiplex signal MPX and suppresses the audio signal components. The filter block contains an analog anti-aliasing filter at the input followed by an 8^{th} order switched capacitor bandpass filter and a reconstruction filter at the output.

CLOCKED COMPARATOR

The comparator digitizes the output signal from the 57 kHz bandpass filter for further processing by the digital RDS/RBDS demodulator. To attain high sensitivity and to avoid phase distortion, the comparator input stage has automatic offset compensation.

DEMODULATOR

The demodulator provides all functions of the SAA6579 and improves performance under weak signal conditions.

Demodulator functions include:

- 57 kHz carrier regeneration from the two sidebands (Costas loop)
- Symbol integration over one RDS clock period
- Bi-phase symbol decoding
- Differential decoding
- Synchronization of RDS/RBDS output data.

The RDS/RBDS demodulator recovers and regenerates the continuously transmitted RDS/RBDS data stream in the MPX signal and provides clock RDCL for the output signals and data output RDDA for further processing by an RDS/RBDS decoder, for example CCR921 or CCR922.

ARI CLAMP

The demodulator checks the input signal for presence of RDS only, or RDS plus ARI transmissions. After a fixed test period, if the SYNC input is set HIGH the demodulator locks in the ‘verified’ condition (see Table 1). If SYNC is set LOW, the ARI clamping is reset (disabled). After SYNC returns to HIGH, the demodulator resumes checking the input signal.

Table 1 Control pin SYNC

SYNC	ARI CLAMPING
LOW	internal ARI clamping disabled
HIGH	ARI clamping allowed to be logged

SIGNAL QUALITY DETECTION

Output QUAL indicates the safety of the regenerated RDS data (HIGH = ‘good’ data; LOW = ‘unsafe’ data).

Oscillator and system clock generator

For good performance of the bandpass and demodulator stages, the demodulator requires a crystal oscillator with a frequency of 4.332 or 8.664 MHz. The demodulator can operate with either frequency (see Table 2), so that a radio set with a microcontroller can run, in this case, with one crystal only. The demodulator oscillator can drive the microcontroller, or vice versa.

Table 2 Control pins TCON and MODE

TCON	MODE	OSCILLATOR FREQUENCY
HIGH	LOW	4.332 MHz
HIGH	HIGH	8.664 MHz

The clock generator generates the internal 4.332 MHz system clock and timing signal derivatives.

Power supply and internal reset

The demodulator has separate power supply inputs for the digital and analog parts of the device. For the analog functions an additional reference voltage ($\frac{1}{2}V_{DDA}$) is internally generated and available via the output pin V_{ref}. The demodulator requires a defined reset condition. The demodulator generates automatically a reset signal after the power supply V_{DDA} is switched on, or at a voltage-drop.

LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{DD}	supply voltage		0	6.5	V
V_n	voltage at pins 1 to 4, 7 to 10, and 13 to 16 with respect to pins 6 and 11	pins 5 and 12 are connected to V_{DD}	–0.5	V_{DD} + 0.5 ≤ 6.5	V
I_i	input current at pins 1 to 5, 7 to 11 and 13 to 16	pins 6 and 11 are connected to ground	–10	+10	mA
$I_{lu(prot)}$	latch-up protection current in pulsed mode	T_{amb} = –40 to +85 °C with voltage limiting –2 to +10 V	–100	+100	mA
		T_{amb} = 25 °C with voltage limiting –2 to +12 V	–200	+200	mA
		T_{amb} = –40 to +85 °C without voltage limiting	–10	+10	mA
T_{amb}	ambient temperature		–40	+85	°C
T_{stg}	storage temperature		–65	+150	°C
V_{es}	electrostatic handling voltage	note 1	–4000	+4000	V
		note 2	–500	+500	V

Notes

1. Human body model (equivalent to discharging a 100 pF capacitor through a 1.5 kΩ series resistor).
2. Machine model (equivalent to discharging a 200 pF capacitor through a 0 Ω series resistor and 0.75 μH inductance).

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	104	K/W

CHARACTERISTICS: DIGITAL PART

$V_{DDA} = V_{DDD} = 5$ V; $T_{amb} = 25$ °C; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply						
V_{DDD}	digital supply voltage		4.0	5.0	5.5	V
I_{DDD}	digital supply current		–	1.5	–	mA
P_{tot}	total power dissipation		–	30	–	mW
Inputs						
V_{IL}	LOW-level input voltage at pins TCON, OSCI, SYNC and MODE		–	–	$0.3V_{DDD}$	V
V_{IH}	HIGH-level input voltage at pins TCON, OSCI, SYNC and MODE		$0.7V_{DDD}$	–	–	V
$I_{i(pu)}$	input pull-up current at pins TCON and MODE	$V_{IH} = 3.5$ V	–10	–20	–	μA
Outputs						
V_{OL}	LOW-level output voltage at pins QUAL, RDDA and RDCL	$I_{OL} = 2$ mA	–	–	0.4	V
V_{OH}	HIGH-level output voltage at pins QUAL, RDDA and RDCL	$I_{OH} = -0.02$ mA	4.0	–	–	V
Crystal parameters						
$f_{i(xtal)}$	crystal input frequency	TCON = HIGH; MODE = LOW	–	4.332	–	MHz
		TCON = HIGH; MODE = HIGH	–	8.664	–	MHz
$\|\Delta f_{osc}\|$	adjustment tolerance of oscillator frequency		–	–	30×10^{-6}	
$\|\Delta f_{osc(T)}\|$	temperature drift of oscillator frequency	$T_{amb} = -40$ to $+85$ °C	–	–	30×10^{-6}	
C_L	load capacitance		–	30	–	pF
R_{xtal}	crystal resonance resistance		–	–	120	Ω

CHARACTERISTICS: ANALOG PART

$V_{DDA} = V_{DDD} = 5$ V; $T_{amb} = 25$ °C; measurements taken in Fig.1; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply						
V_{DDA}	analog supply voltage		4.0	5.0	5.5	V
$\|V_{DDA} - V_{DDD}\|$	difference between analog and digital supply voltages		–	0	0.5	V
$I_{DD(tot)}$	total supply current		–	6.0	–	mA
V_{ref}	reference voltage	$V_{DDA} = 5$ V	2.25	2.5	2.75	V
$Z_{o(Vref)}$	output impedance at pin V_{ref}		–	25	–	kΩ
MPX input (signal before the capacitor on pin MPX)						
$V_{i(MPX)(rms)}$	RDS amplitude (RMS value)	Δf = ±1.2 kHz RDS-signal; Δf = ±3.2 kHz ARI-signal	1	–	–	mV
$V_{i(max)(p-p)}$	maximum input signal capability (peak-to-peak value)	f = 57 ±2 kHz	200	–	–	mV
		f < 50 kHz	1.4	–	–	V
		f < 15 kHz	2.8	–	–	V
		f > 70 kHz	3.5	–	–	V
$R_{i(MPX)}$	input resistance	f = 0 to 100 kHz	40	–	–	kΩ
57 kHz bandpass filter						
f_c	centre frequency	T_{amb} = –40 to +85 °C	56.5	57.0	57.5	kHz
B_{-3dB}	–3 dB bandwidth		2.5	3.0	3.5	kHz
$G_{SCOUT-MPX}$	signal gain	f = 57 kHz	17	20	23	dB
α_{sb}	stop band attenuation	Δf = ±7 kHz	31	–	–	dB
		f < 45 kHz	40	–	–	dB
		f < 20 kHz	50	–	–	dB
		f > 70 kHz	40	–	–	dB
$R_{o(SCOUT)}$	output resistance at pin SCOUT	f = 57 kHz	–	30	60	Ω
Comparator input (pin CIN)						
$V_{i(min)(rms)}$	minimum input level (RMS value)	f = 57 kHz	–	1	10	mV
R_i	input resistance		70	110	150	kΩ

TIMING DATA

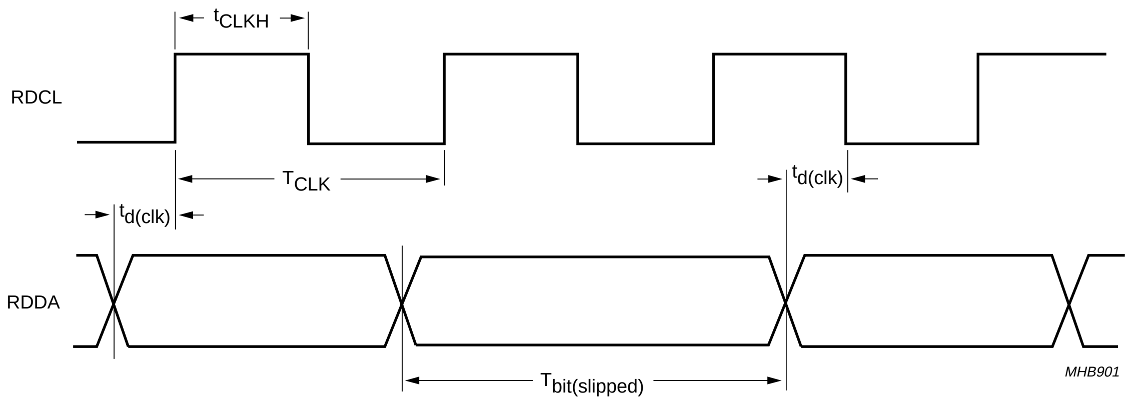


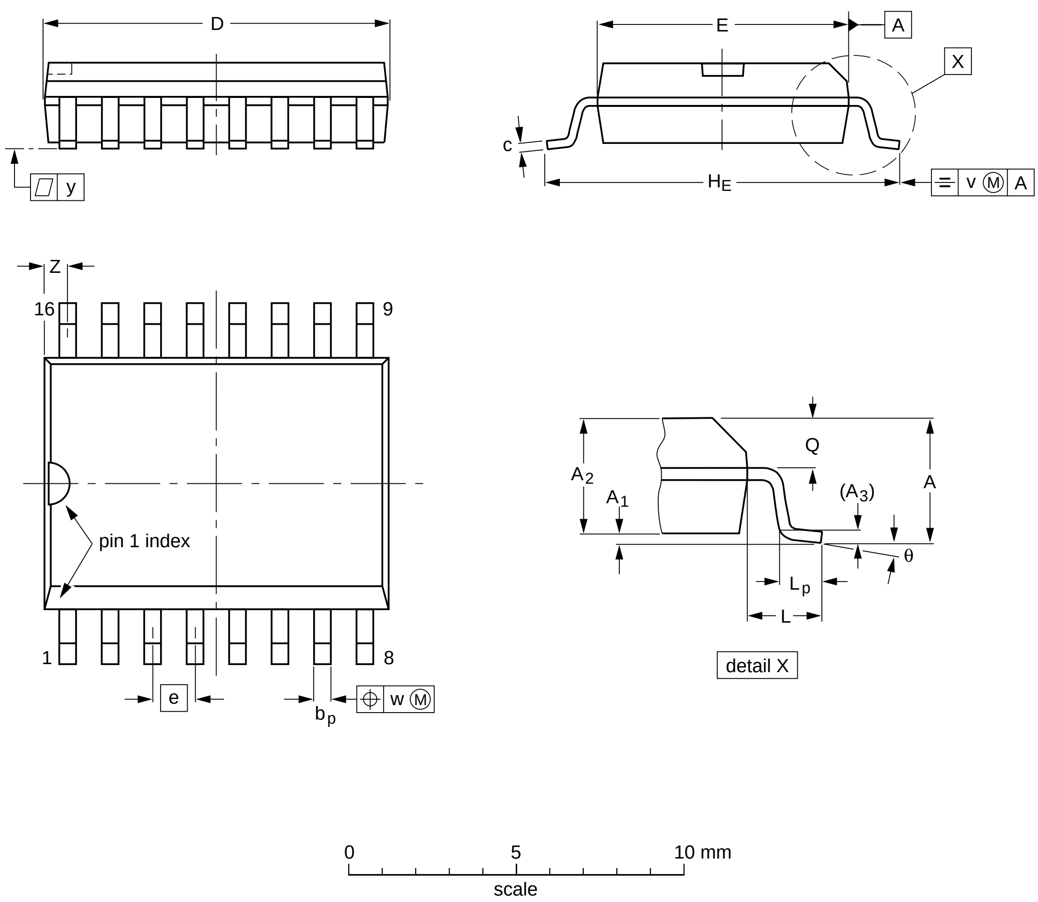
Fig.3 RDS timing diagram including a phase change.

Table 3 RDS timing (see Fig.3)

SYMBOL	PARAMETER	TYP.	UNIT
$t_{d(clk)}$	clock-data delay	4	µs
T_{CLK}	clock period	842	µs
t_{CLKH}	clock HIGH time	421	µs
$T_{bit(slipped)}$	slipped data bit period	1263	µs

PACKAGE OUTLINE

SO16: plastic small outline package; 16 leads; body width 7.5 mm **SOT162-1**

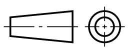


DIMENSIONS (inch dimensions are derived from the original mm dimensions)

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	2.65	0.30 0.10	2.45 2.25	0.25	0.49 0.36	0.32 0.23	10.5 10.1	7.6 7.4	1.27	10.65 10.00	1.4	1.1 0.4	1.1 1.0	0.25	0.25	0.1	0.9 0.4	8^o 0^o
inches	0.10	0.012 0.004	0.096 0.089	0.01	0.019 0.014	0.013 0.009	0.41 0.40	0.30 0.29	0.050	0.419 0.394	0.055	0.043 0.016	0.043 0.039	0.01	0.01	0.004	0.035 0.016	

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			
SOT162-1	075E03	MS-013				~~97-05-22~~ 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 can still be used for certain surface mount ICs, but it is not suitable for fine pitch SMDs. In these situations reflow soldering is recommended.

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, convection or convection/infrared 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 220 °C for thick/large packages, and below 235 °C for small/thin packages.

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, HBGA, LFBGA, SQFP, TFBGA	not suitable	suitable
HBCC, HLQFP, HSQFP, HSOP, HTQFP, HTSSOP, HVQFN, 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(1)	PRODUCT STATUS(2)	DEFINITIONS
Objective data	Development	This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice.
Preliminary data	Qualification	This data sheet contains data from the preliminary specification. Supplementary data will be published at a later date. Philips Semiconductors reserves the right to change the specification without notice, in order to improve the design and supply the best possible product.
Product data	Production	This data sheet contains data from the product specification. Philips Semiconductors reserves the right to make changes at any time in order to improve the design, manufacturing and supply. Changes will be communicated according to the Customer Product/Process Change Notification (CPCN) procedure SNW-SQ-650A.

Notes

1. Please consult the most recently issued data sheet before initiating or completing a design.
2. The product status of the device(s) described in this data sheet may have changed since this data sheet was published. The latest information is available on the Internet at URL http://www.semiconductors.philips.com.

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: 7 - 9 Rue du Mont Valérien, BP317, 92156 SURESNES Cedex, Tel. +33 1 4728 6600, Fax. +33 1 4728 6638

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

Hungary: Philips Hungary Ltd., H-1119 Budapest, Fehervari ut 84/A, Tel: +36 1 382 1700, Fax: +36 1 382 1800

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, 5F, No. 96, Chien Kuo N. Rd., Sec. 1, TAIPEI, Taiwan Tel. +886 2 2134 2451, Fax. +886 2 2134 2874

Thailand: PHILIPS ELECTRONICS (THAILAND) Ltd., 60/14 MOO 11, Bangna Trad Road KM. 3, Bagna, BANGKOK 10260, Tel. +66 2 361 7910, Fax. +66 2 398 3447

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, Marketing Communications, Building BE-p, P.O. Box 218, 5600 MD EINDHOVEN, The Netherlands, Fax. +31 40 27 24825

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

Printed in The Netherlands 753503/01/pp16 Date of release: 2001 May 07 Document order number: 9397 750 08148

Let's make things better.

Philips Semiconductors

PHILIPS