

Short Form Specification

mifare[®]

MF RC531

ISO 14443 Reader IC

Short Form Specification

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Revision 2.0

ISO 14443A Reader IC**MF RC531**

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1 INTRODUCTION

1.1 Scope

The MF RC531 is member of a new family of highly integrated reader ICs for contactless communication at 13.56 MHz. This reader IC family utilises an outstanding modulation and demodulation concept completely integrated for all kinds of passive contactless communication methods and protocols at 13.56 MHz. The MF RC531 is pin-compatible to the MF RC500, the MF RC530 and the SL RC400.

The MF RC531 supports all layers of the ISO14443 including the type A and type B communication scheme

The MF RC531 supports contactless communication using MIFARE[®] Higher Baudrates. The internal transmitter part is able to drive an antenna designed for proximity operating distance (up to 100 mm) directly without additional active circuitry.

The receiver part provides a robust and efficient implementation of a demodulation and decoding circuitry for signals from ISO14443 compatible transponders.

The digital part handles the complete ISO14443 framing and error detection (Parity & CRC). Additionally it supports the fast MIFARE[®] Classic security algorithm to authenticate MIFARE[®] Classic (e.g. MIFARE[®] Standard, MIFARE[®] Light) products.

A comfortable parallel interface, which can be directly connected to any 8-bit μ -Processor gives high flexibility for the reader/terminal design. Additionally a SPI compatible interface is supported.

1.2 Features

- Highly integrated analog circuitry to demodulate and decode card response
- Buffered output drivers to connect an antenna with minimum number of external components
- Proximity operating distance (up to 100 mm)
- Supports ISO 14443
- Supports MIFARE[®] Dual Interface Card ICs and supports MIFARE[®] Classic protocol
- Supports contactless communication with higher baudrates up to 424kHz
- Crypto1 and secure non-volatile internal key memory
- Pin-compatible to the MF RC500, MF RC530 and the SL RC400
- Parallel μ -Processor interface with internal address latch and IRQ line
- SPI compatible interface
- Flexible interrupt handling
- Automatic detection of the used μ -Processor interface type
- Comfortable 64 byte send and receive FIFO-buffer
- Hard reset with low power function
- Power down mode per software
- Programmable timer
- Unique serial number
- Bit- and byte-oriented framing
- Internal oscillator buffer to connect 13.56 MHz quartz, optimised for low phase jitter
- 3.3 V to 5 V operation for transmitter (antenna driver) in short range and proximity applications
- 3.3 V or 5V operation for the digital part

1.3 Applications

The MF RC531 is tailored to fit the requirements of various applications using contactless communication based on ISO/IEC 14443 standard where cost-effectiveness, small size, high performance with a single voltage supply are important.

- Public transport terminals
- Handheld terminals
- On board units
- Contactless PC terminals
- Metering
- Contactless public phones

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2 BLOCK DIAGRAM

The block diagram shows the main internal parts of the MF RC531.

The parallel µController interface automatically detects the kind of 8 bit parallel interface connected to it. It includes a comfortable bi-directional FIFO buffer and a configurable interrupt output. This gives the flexibility to connect a variety of µC, even low cost devices, still meeting the requirements of high speed contactless transactions.

Additionally a SPI compatible interface will be supported. The MF RC531 acts as a slave during the SPI communication. The SPI clock SCK has to be generated by the master. The SPI interface includes a comfortable bi-directional FIFO buffer.

The Data processing part performs parallel serial conversion of the data. It supports framing including CRC and parity generation / checking. It

operates in full transparent mode thus supporting all layers of ISO 14443 A & B.

The status and control part allows configuration of the device to adapt to environmental influences and to adjust to operate with best performance.

For communication with MIFARE® Classic products like MIFARE® Standard or MIFARE® Light a high speed CRYPTO 1 stream cipher unit and a secure non-volatile key memory is implemented.

The analog circuit includes a transmitting part with a very low impedance bridge driver output. This allows an operating distance up to 100mm. The receiver is able to detect and decode even very weak responses. Due to a highly sophisticated implementation the receiver is no longer a limiting factor for the operating distance.

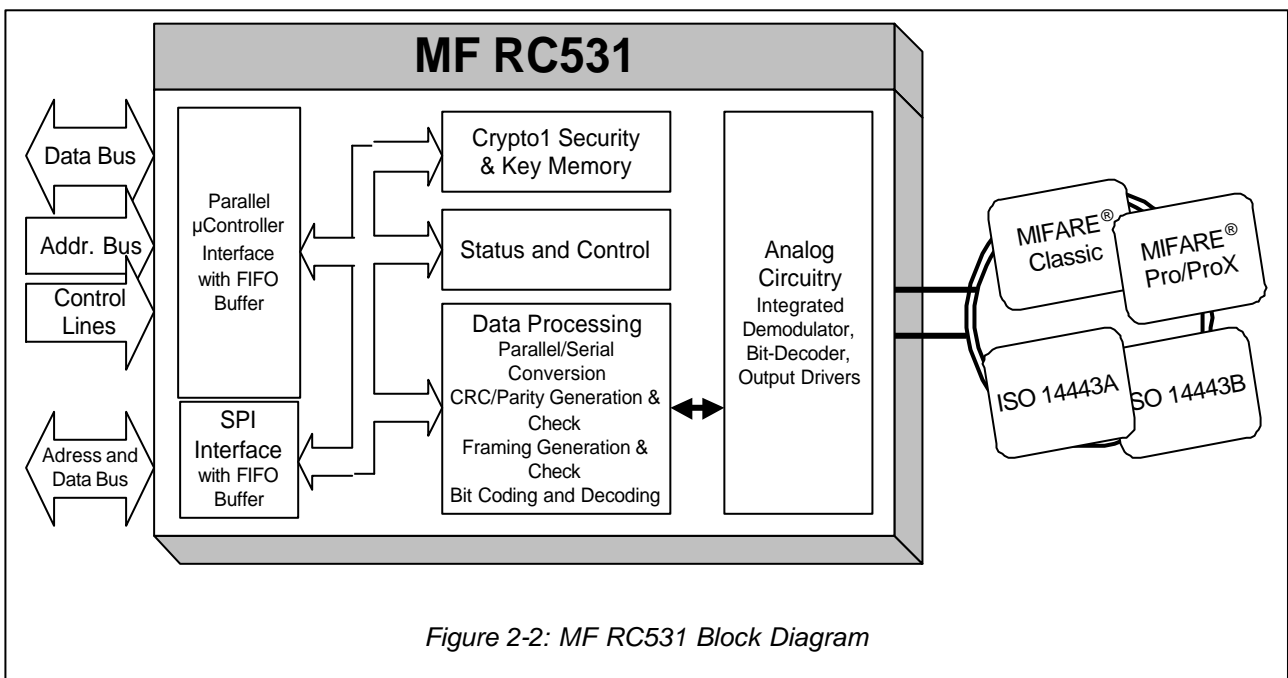


Figure 2-2: MF RC531 Block Diagram

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3 MF RC531 PINNING

3.1 Pinning Diagram

The device is packaged in a 32 pin SO-package.

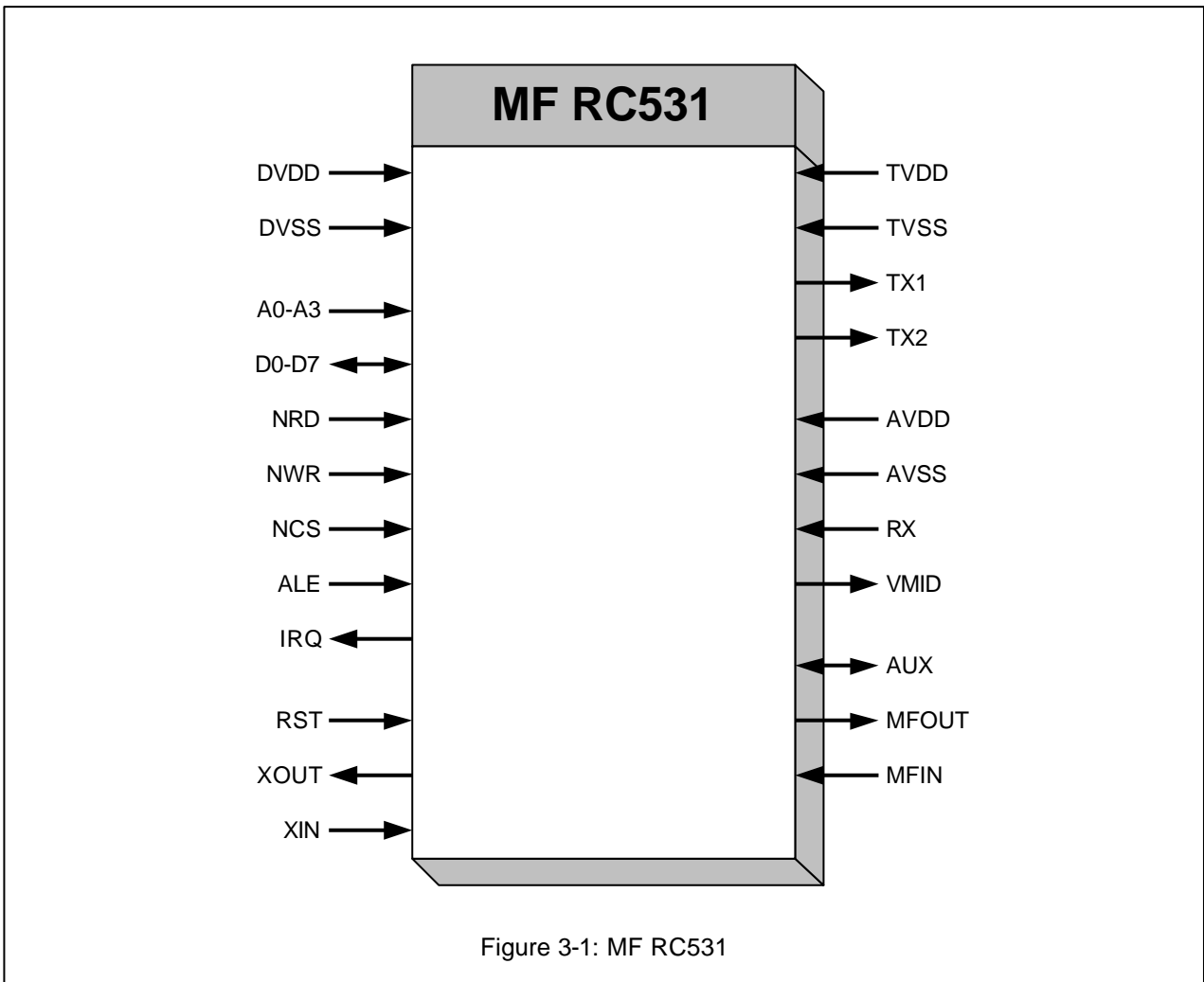


Figure 3-1: MF RC531

The device operates with 3 individual power supplies for best performance in terms of EMC behaviour and signal de-coupling. This gives outstanding RF performance and also maximum flexibility to adapt to different operating voltages of digital and analog part.

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3.2 Pin Description

3.2.1 ANTENNA INTERFACE

The contactless antenna interface basically uses four pins:

Name	Type	Function
TX1, TX2	O Buffered	Antenna Drivers
VMID	Analog	Reference Voltage
RX	I Analog	Antenna Input Signal

To drive the antenna the MF RC531 provides the energy carrier of 13.56 MHz through TX1 and TX2. This signal is modulated by the transmitting data according the register settings.

The card responds with load modulation of the RF field. The resulting signal picked up by the antenna is coupled out from the antenna matching circuit and forwarded to the RX-pin. Inside the MF RC531 the receiver senses and demodulates the signal and processes it according to the register settings. Data is passed further on to the parallel interface where it is accessible by the μ -Controller.

The MF RC531 uses a separate power supply for the driver stage.

Name	Type	Function
TVDD	Power	Transmitter Supply Voltage
TGND	Power	Transmitter Supply Ground

3.2.2 ANALOG SUPPLY

For best performance the MF RC531 analog part has a separate supply. It powers the oscillator, the analog demodulator and decoder circuitry.

Name	Type	Function
AVDD	Power	Analog Positive Supply Voltage
AGND	Power	Analog Supply Ground

3.2.3 DIGITAL SUPPLY

The MF RC531 uses a separate digital supply.

Name	Type	Function
DVDD	Power	Digital Positive Supply Voltage
DGND	Power	Digital Supply Ground

3.2.4 AUXILLARY PIN

Internal signals may be selected to drive this pin. It is used for design-in support and test purpose.

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3.2.5 RESET PIN

The reset pin disables internal current sources and clocks and detaches the MF RC531 virtually from the μC bus. If RST is released, the MF RC531 executes the power up sequence.

3.2.6 OSCILLATOR

Name	Type	Function
XIN	I	Oscillator Buffer Input
XOUT	O	Oscillator Buffer Output

The very fast on-chip oscillator buffer operates with a 13.56 MHz crystal connected to XIN and XOUT. If the device shall operate with an external clock it may be applied to pin XIN.

3.2.7 MIFARE[®] INTERFACE

The MF RC531 supports the active antenna concept of MIFARE[®]. It may handles the base-band signals NPAUSE and KOMP of MIFARE[®] Core Modules (MF CMxxx) at the pins MFIN and MFOUT.

Name	Type	Function
MFIN	I with Schmitt Trigger	MIFARE [®] Interface Input
MFOUT	O	MIFARE [®] Interface Output

The MIFARE[®] interface may be used to communicate with either the analog or the digital part of the MF RC531 separately in the following ways:

- The analog circuit may be used stand-alone via the MIFARE[®] interface. In that case MFIN will be connected to the externally generated NPAUSE signal. The MFOUT pin provides the KOMP signal.
- The digital circuit may be used to drive an external analog circuit via the MIFARE[®] interface. In that case the MFOUT pin provides the internally generated NPAUSE signal and MFIN will be connected to the KOMP signal from the outside.

3.2.8 PARALLEL INTERFACE

16 pins control the parallel interface:

Name	Type	Function
D0 ... D7	I/O with Schmitt Trigger	Bi-directional Data Bus
A0 ... A2	I/O with Schmitt Trigger	Address Lines
NWR / RNW	I/O with Schmitt Trigger	Not Write / Read Not Write
NRD / NDS	I/O with Schmitt Trigger	Not Read / Not Data Strobe
NCS	I/O with Schmitt Trigger	Not Chip Select
ALE	I/O with Schmitt Trigger	Address Latch Enable
IRQ	O	Interrupt Request

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3.2.9 SPI COMPATIBLE INTERFACE

4 pins control the SPI compatible interface.

Name	Type	Function
A0	I/O with Schmitt Trigger	MOSI, master to slave communication
A2	I/O with Schmitt Trigger	SCK, clock to be generated by the master
D0	I/O with Schmitt Trigger	MISO, slave to master communication
ALE	I/O with Schmitt Trigger	NSS, enables the SPI communication

3.3 Applications

3.3.1 CONNECTING DIFFERENT μ CONTROLLER'S

The MF RC531 supports different parallel μ C interfaces and a SPI compatible interface. An intelligent auto-detection logic automatically adapts the parallel interface to the respective bus system. Selection of the device is performed with signal NCS.

To connect μ -Controllers using separated address and data bus pin ALE has to be connected to DVDD.

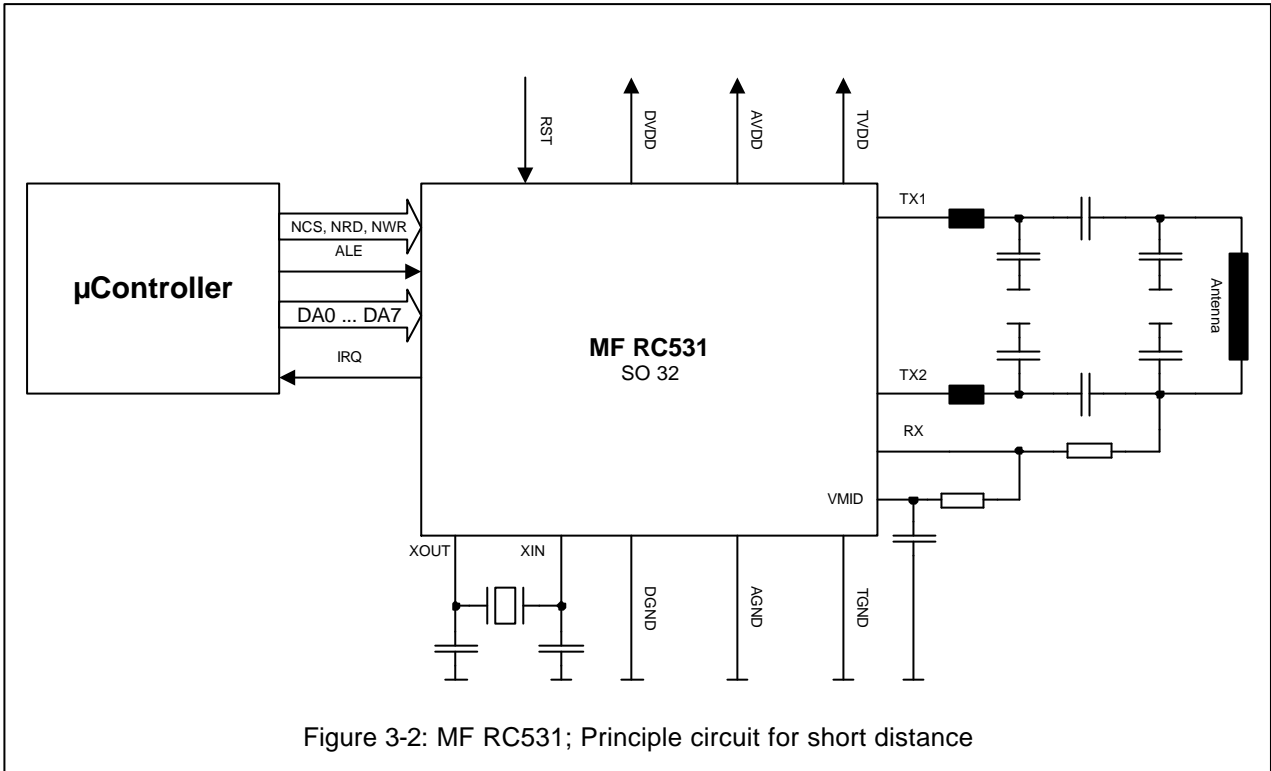
To connect μ -Controllers using multiplexed address and data bus pin ALE has to be connected to the signal ALE of the μ -Controller

To connect μ -Controllers using RNW and NDS (instead of NWR and NRD) the μ -Controller's RNW has to be connected to pin NWR and NDS to pin NRD.

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3.3.2 APPLICATION EXAMPLE



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4 MIFARE® CLASSIC RELATED ITEMS**4.1 CRYPTO I: Card Authentication**

For correct authentication of MIFARE® Classic products the fast CRYPTO 1 stream cipher is available. The corresponding keys have to be programmed into the secure non-volatile key memory of the MF RC531.

Only two commands need to be sent by application software to turn on CRYPTO 1 secured communication.

4.1.1 INITIATING CARD AUTHENTICATION

The correct key for the authentication has to be selected from the secure internal non-volatile key memory and loaded into the internal CRYPTO1 register. Next the authentication command is transmitted to the card.

After receiving the first message token from the card, the μ -Controller has to check the

communication status flags. If communication so far has been successful the second part of the authentication procedure can be started.

4.1.2 SECOND PART OF CARD AUTHENTICATION

Data to be transmitted to the card in this phase are generated automatically by the internal CRYPTO 1 unit inside the MF RC531. To request this action the according command has to be triggered.

The card will respond with the second message token. Then the communication status flags have to be checked by the μ -Controller. If authentication has been successful further communication with a MIFARE® Classic card continues CRYPTO 1 enciphered.

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5 ELECTRICAL SPECIFICATION

5.1 DC Characteristics

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
--------	-----------	------------	-----	-----	-----	------

Voltage Supply

DVDD	Digital Supply Voltage		4.5	5.0	5.5	V
			3.0	3.3	3.6	
AVDD	Analog Supply Voltage		4.5	5.0	5.5	V
TVDD	Transmitter Supply Voltage		3.3	5.0	5.5	V

Current Consumption

I _{DVDD}	Operating Digital Supply Current	Idle Command		6		mA
I _{AVDD}	Operating Analog Supply Current	Idle Command, Receiver On		25		mA
I _{TVDD}	Operating Buffered Antenna Driver Supply Current	continuous wave			50	mA

5.2 Start up Characteristics

Mode	CONDITIONS	Current	UNIT	Time	UNIT
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Startup times and current consumption

Power on		-	-	< 1000	μs
Hard Reset via Reset Pin		1	μA	< 1000	μs
Soft Reset via Register Setting		1	μA	< 1000	μs

Definitions

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics section of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

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

Philips Semiconductors - a worldwide company

Argentina: see South America

Australia: 34 Waterloo Road, NORTHRYDE, NSW 2113,
Tel. +612 9805 4455, Fax. +612 9805 4466

Austria: Computerstraße 6, A-1101 WIEN, P.O.Box 213,
Tel. +431 60 101, Fax. +431 30 101 1210

Belarus: Hotel Minsk Business Centre, Bld. 3, r.1211, Volodarski Str. 6,
220050 MINSK, Tel. +375172 200 733, Fax. +375172 200 773

Belgium: see The Netherlands

Brazil: see South America

Bulgaria: Philips Bulgaria Ltd., Energoproject, 15th floor,
51 James Bourchier Blvd., 1407 SOFIA
Tel. +3592 689 211, Fax. +3592 689 102

Canada: Philips Semiconductors/Components,
Tel. +1800 234 7381

China/Hong Kong: 501 Hong Kong Industrial Technology Centre,
72 Tat Chee Avenue, Kowloon Tong, HONG KONG,
Tel. +85223 19 7888, Fax. +85223 19 7700

Colombia: see South America

Czech Republic: see Austria

Denmark: Prags Boulevard 80, PB 1919, DK-2300 COPENHAGEN S,
Tel. +4532 88 2636, Fax. +4531 57 1949

Finland: Sinikalliontie 3, FIN-02630 ESPOO,
Tel. +3589 61 5800, Fax. +3589 61 580/xxx

France: 4 Rue du Port-aux-Vins, BP 317, 92156 SURESNES Cedex,
Tel. +331 40 99 6161, Fax. +331 40 99 6427

Germany: Hammerbrookstraße 69, D-20097 HAMBURG,
Tel. +4940 23 53 60, Fax. +4940 23 536 300

Greece: No. 15, 25th March Street, GR 17778 TAVROS/ATHENS,
Tel. +301 4894 339/239, Fax. +301 4814 240

Hungary: see Austria

India: Philips INDIA Ltd., Shivsagar Estate, A Block, Dr. Annie Besant Rd.
Worli, MUMBAI 400018, Tel. +9122 4938 541, Fax. +9122 4938 722

Indonesia: see Singapore

Ireland: Newstead, Clonskeagh, DUBLIN 14,
Tel. +3531 7640 000, Fax. +3531 7640 200

Israel: RAPAC Electronics, 7 Kehilat Saloniki St., TEL AVIV 61180,
Tel. +9723 645 0444, Fax. +9723 649 1007

Italy: Philips Semiconductors, Piazza IV Novembre 3,
20124 MILANO, Tel. +392 6752 2531, Fax. +392 6752 2557

Japan: Philips Bldg. 13-37, Kohnan 2-chome, Minato-ku, TOKYO 108,
Tel. +813 3740 5130, Fax. +813 3740 5077

Korea: Philips House, 260-199, Itaewon-dong, Yonsan-ku, SEOUL,
Tel. +822 709 1412, Fax. +822 709 1415

Malaysia: No. 76 Jalan Universiti, 46200 PETALING JAYA, Selangor,
Tel. +60 3750 5214, Fax. +603 757 4880

Mexico: 5900 Gateway East, Suite 200, EL PASO, Texas 79905,
Tel. +9 5800 234 7381

Middle East: see Italy

Netherlands: Postbus 90050, 5600 PB EINDHOVEN, Bldg. VB,
Tel. +3140 27 82785, Fax +3140 27 88399

New Zealand: 2 Wagener Place, C.P.O. Box 1041, AUCKLAND,
Tel. +649 849 4160, Fax. +649 849 7811

Norway: Box 1, Manglerud 0612, OSLO,
Tel. +4722 74 8000, Fax. +4722 74 8341

Philippines: Philips Semiconductors Philippines Inc.,
106 Valero St. Salcedo Village, P.O.Box 2108 MCC, MAKATI,
Metro MANILA, Tel. +632 816 6380, Fax. +632 817 3474

Poland: Ul. Lukiska 10, PL 04-123 WARSZWA,
Tel. +4822 612 2831, Fax. +4822 612 2327

Portugal: see Spain

Romania: see Italy

Russia: Philips Russia, Ul. Usatcheva 35A, 119048 MOSCOW,
Tel. +7095 247 9145, Fax. +7095 247 9144

Singapore: Lorong 1, Toa Payoh, SINGAPORE 1231,
Tel. +65350 2538, Fax. +65251 6500

Slovakia: see Austria

Slovenia: see Italy

South Africa: S.A. Philips Pty Ltd., 195-215 Main Road Martindale,
2092 JOHANNESBURG, P.O.Box 7430 Johannesburg 2000,
Tel. +2711 470 5911, Fax. +2711 470 5494

South America: Rua do Rocio 220, 5th floor, Suite 51,
04552-903 Sao Paulo, SAO PAULO - SP, Brazil,
Tel. +5511 821 2333, Fax. +5511 829 1849

Spain: Balmes 22, 08007 BARCELONA,
Tel. +343 301 6312, Fax. +343 301 4107

Sweden: Kottbygatan 7, Akalla, S-16485 STOCKHOLM,
Tel. +468 632 2000, Fax. +468 632 2745

Switzerland: Allmendstraße 140, CH-8027 ZÜRICH,
Tel. +411 488 2686, Fax. +411 481 7730

Taiwan: Philips Taiwan Ltd., 2330F, 66,
Chung Hsiao West Road, Sec. 1, P.O.Box 22978,
TAIPEI 100, Tel. +8862 382 4443, Fax. +8862 382 4444

Thailand: Philips Electronics (Thailand) Ltd.,
209/2 Sanpavuth-Bangna Road Prakanong, BANGKOK 10260,
Tel. +662 745 4090, Fax. +662 398 0793

Turkey: Talapasa Cad. No. 5, 80640 GÜLTEPE/ISTANBUL,
Tel. +90212 279 2770, Fax. +90212 282 6707

Ukraine: Philips Ukraine, 4 Patrice Lumumba Str., Building B, Floor 7,
252042 KIEV, Tel. +38044 264 2776, Fax. +38044 268 0461

United Kingdom: Philips Semiconductors Ltd., 276 Bath Road, Hayes,
MIDDLESEX UM3 5BX, Tel. +44181 730 5000, Fax. +44181 754 8421

United States: 811 Argues Avenue, SUNNYVALE, CA94088-3409,
Tel. +1800 234 7381

Uruguay: see South America

Vietnam: see Singapore

Yugoslavia: Philips, Trg N. Pasica 5/v, 11000 BEOGRAD,
Tel. +38111 625 344, Fax. +38111 635 777

Published by:

Philips Semiconductors Gratkorn GmbH, Mikron-Weg 1, A-8101 Gratkorn, Austria Fax: +43 3124 299 - 270

For all other countries apply to: Philips Semiconductors, Marketing & Sales Communications, Internet: <http://www.semiconductors.philips.com>
Building BE-p, P.O.Box 218, 5600 MD EINDHOVEN, The Netherlands, Fax: +3140 27 24825

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