DATA SHEET

SLRM900

I-CODE Long range reader
module hardware

Product specification   2002 May 24
Supersedes data of 1999 Oct 01

Philips
Semiconductors

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CONTENTS

I-CODE Long range reader module hardware

SLRM900

1 FEATURES

- 24 V DC power supply
- 13.56 MHz carrier frequency
- RS232 serial interface, 115.2 or 57.6 kbaud data rate
- Regulated RF output power, software adjustable from 2 up to 10 W at 50 Ω
- Software adjustable modulation index from 10% to 20%
- Firmware upgradable via RS232 interface
- Programmable input and output ports (optional)
- Electronic Article Surveillance (EAS) stand-alone mode (EAS output signal optional)
- Anticollision capability
- Support of both standard and fast mode
- BundesAmt fuer Post und Telekommunikation (BAPT) and Federal Communications Commission (FCC) approval
- CE compliant.

2 APPLICATIONS

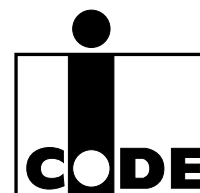- Long range reading appliances in I-CODE[(1)] systems.

3 GENERAL DESCRIPTION

Generally, the SLRM900 can communicate with smart labels based on Philips I-CODE1 label IC SL1ICS3001. It consists of a 2-way communication transmitter and receiver, for generating, transmitting, receiving, and processing identification signals.

(1) I-CODE - is a trademark of Koninklijke Philips Electronics N.V.

Optional input and output ports, and an RS232 interface offer the possibility to connect the unit to a microcontroller or PC.

The SLRM900 is designed to access all types of labels and transponders that are based on the I-CODE1 label IC. Read and write functionality is included, as well as sophisticated ways to use the anticollision capability of I-CODE.

High emphasis is put on long range functionality, which makes the SLRM900 suitable for gate antennas and tunnel reader applications. In order to provide the appropriate output power level for various types of connected antennas, the output power may be adjusted, using simple software configuration commands.

Many reference installations with high demands on anticollision, reading range, and data reliability in noisy environments, have proven the capability of both the reader module and the I-CODE1 label IC.

This document describes the reader hardware, interface, and connection of the antenna.

4 ORDERING INFORMATION

PART NUMBER	NAME	ORDERING CODE (12NC)
SLRM900/AFB	I-CODE Long range reader module	9352 623 27122

I-CODE Long range reader
module hardware

SLRM900

5 BLOCK DIAGRAM

RF BOARD

| power supply +24 V DC | VOLTAGE REGULATION | MODULATOR | TRANSMITTER AMPLIFIER | antenna |

13.56 MHz
CLOCK GENERATOR
(AND DIVIDER)

MODULATION
INDEX
ADJUSTMENT

RF POWER
REGULATION

OPTO COUPLERS

RECEIVER, FILTER
AND DEMODULATOR

MICROCONTROLLER BOARD

ADC

MICROCONTROLLER
UNIT

SW1

SW2

serial
interface

RS232 DRIVER

FLASH
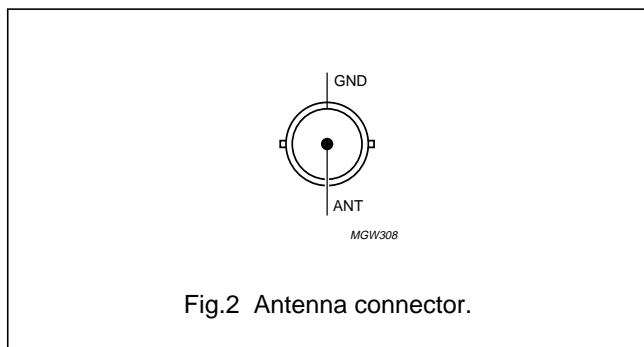EPROM

RAM

I/O
(optional)

MGW307
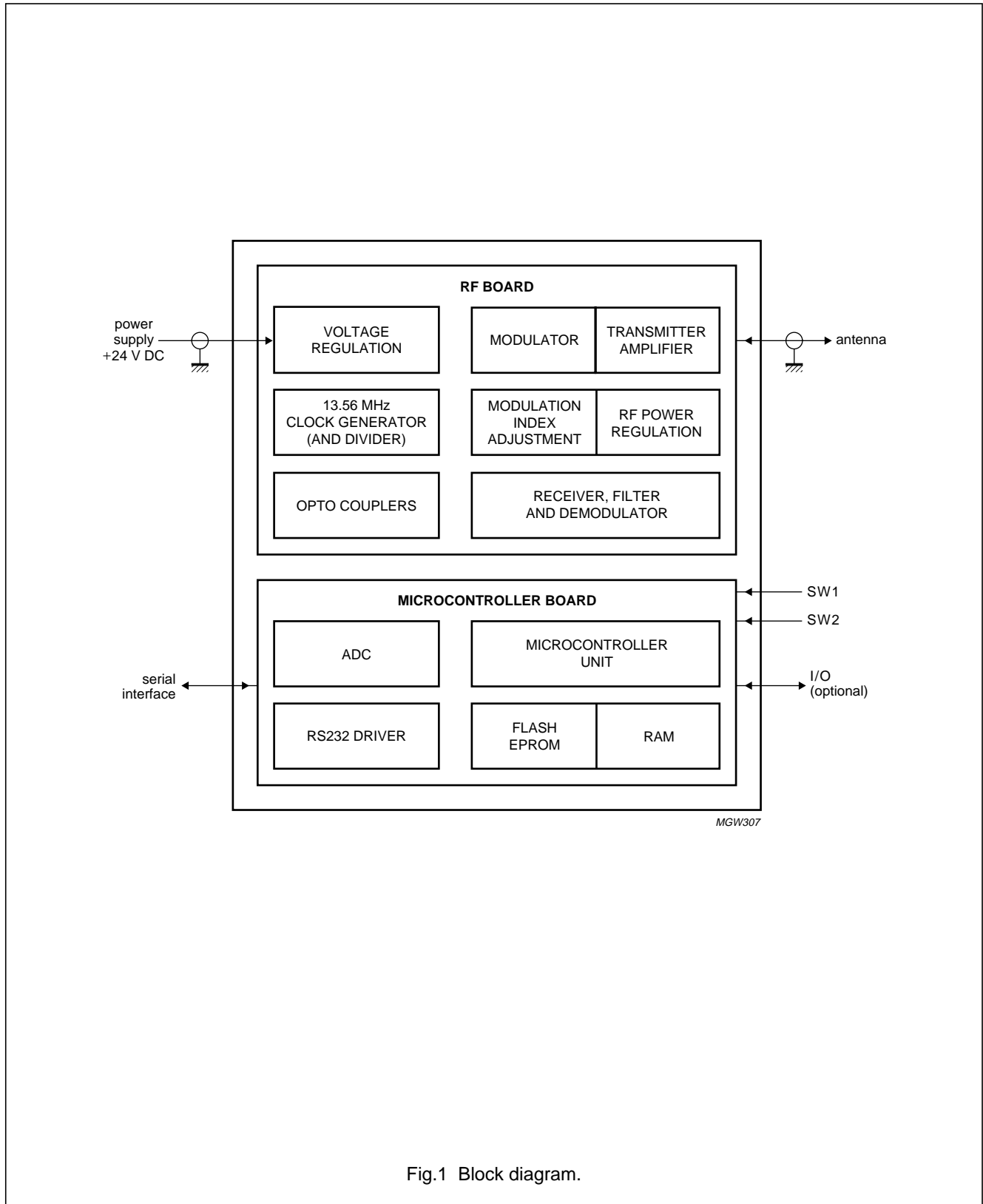
Fig.1 Block diagram.

6 PINNING

The locations of the connectors and switches are shown in Fig.9.

6.1 Antenna connector

ST3 in Fig.8.

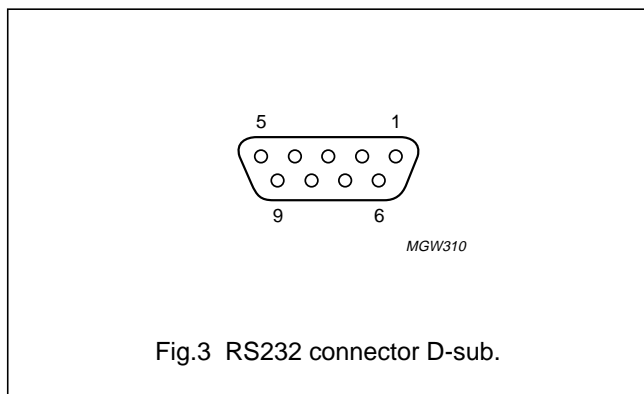| SYMBOL	DESCRIPTION
ANT	antenna input and output; BNC female
GND	antenna ground

Fig.2 Antenna connector.

6.2 Serial interface connector

ST2 in Fig.8; see Fig.3 for front view of connector.

SYMBOL	PIN	DESCRIPTION
I/O	1	internally connected for DCE
TxD	2	output
RxD	3	input
I/O	4	internally connected for DCE
GND	5	ground
I/O	6	internally connected for DCE
I/O	7	internally connected for DCE
I/O	8	internally connected for DCE
RFU	9	ready for use

Fig.3 RS232 connector D-sub.

6.3 Power supply connector

See Fig.4 for front view of connector

SYMBOL	DESCRIPTION
+24VDC	power supply voltage; DC-jack (⌀ 2.1 mm)
GND	power supply ground

Fig.4 Power supply connector.
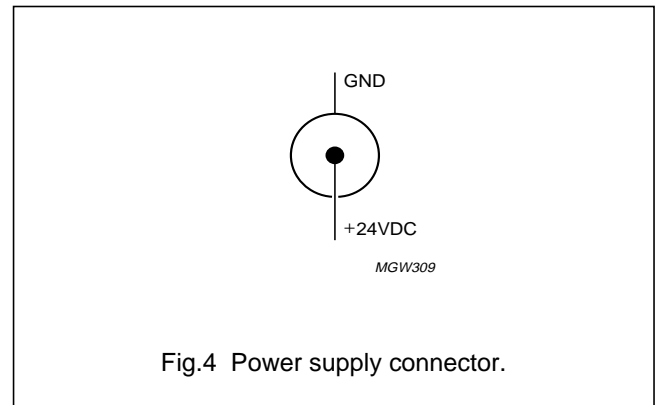
6.4 Switches

See Fig.5 for front view of switches.

SYMBOL	DESCRIPTION
RST	Resets the SLRM900. By resetting the SLRM900, all programmable parameters will be preset to their default values described in data sheet: *"SLRM900 I-CODE Long Range Reader Module, protocol Reader-Host"*, except for stored RF output power and modulation index. The SLRM900 will restart with the mode selected by jumper JP3 (see Table 3).
NMI	Non Maskable Interrupt. To change from the default start-up mode to the alternative mode (see setting of jumper JP3 in Table 3). For switching back to default start-up mode, press switch RST (SW1).

Fig.5 Switches SW1 and SW2.
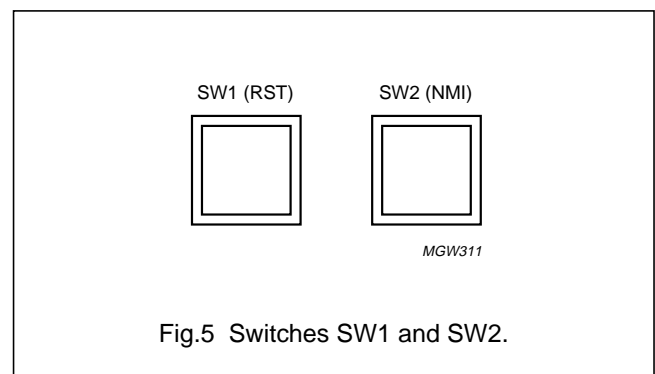
6.5 PCB connector

ST3 in Fig.8**.**

SYMBOL	PIN	DESCRIPTION
RFU	A1 to A31	ready for use
GND	A32	ground
RFU	B1 to B32	ready for use
RFU	C1 to C3	ready for use
IN5	C4	programmable input ports IN5 to IN0; notes 1 and 2
IN4	C5	
IN3	C6	
IN2	C7	
IN1	C8	
IN0	C9	
RFU	C10 to C13	ready for use
OUT3	C14	programmable output ports OUT3 to OUT0; notes 1 and 2
OUT2	C15	
OUT1	C16	
OUT0	C17	
RFU	C18 to C24	ready for use
EAS OUT	C25	programmable EAS alarm output
RFU	C26 to C31	ready for use
OUT	C32	ground

Notes

1. For the electrical characteristics of all input and output ports, please refer to the specification *"SAB-C167CR-LM"*.

2. For programming of the input and output ports, please refer to data sheet *"SLRM900 I-CODE Long Range Reader Module protocol, Reader-Host"*.
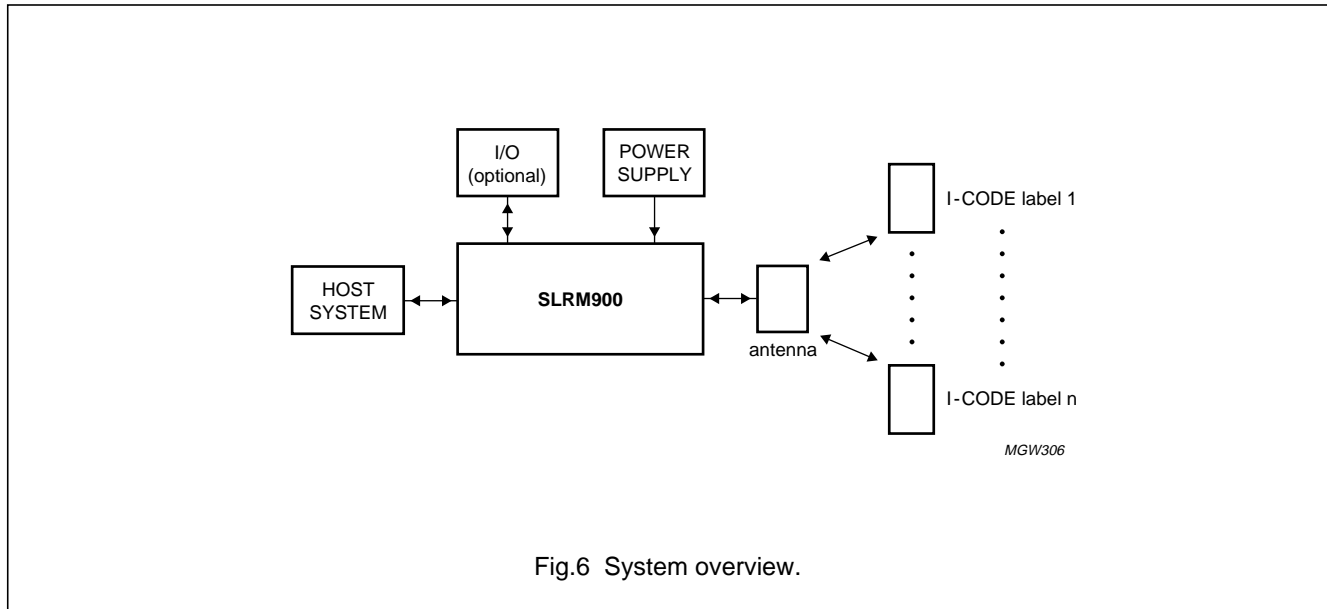
7 FUNCTIONAL DESCRIPTION

Fig.6 System overview.

7.1 System overview

The SLRM900 is part of a complete Radio Frequency Identification (RFID) system (see Fig.6).

The SLRM900 can communicate with I-CODE smart labels. The device consists of a two-way communication transmitter and receiver, for generating, transmitting, receiving, and processing identification signals.

In the transmit mode, the microcontroller board generates data whereas the RF board uses this signal to modulate a carrier. This modulated carrier will be amplified, and transmitted by the antenna to the label. This label will subsequently generate its response, which will be picked-up by the SLRM900 in the receive mode, and processed by the digital hardware.

By using the RS232 serial interface (or the optional input and output ports) the output parameters of the module can be set.

7.1.1 I-CODE labels

The SLRM900 is designed for communication with smart labels based on Philips I-CODE1 label IC SL1ICS3001.

7.1.2 HOST

The connection to the host (e.g. microcontroller or PC) is a serial interface on RS232 level for data transmission. For the protocol please refer to data sheet *"SLRM900 I-CODE Long Range Reader Module, protocol Reader-Host"*.

7.1.3 I/O PORTS

There are 6 input ports, 4 output ports, and one EAS signal output port available on the microcontroller board (see Section 6.5). These ports are software programmable. The input and output ports are not lead out of the metal housing and therefore not ESD protected.

7.1.4 ANTENNA

A 50 Ω antenna has to be connected to the antenna connector. This antenna has to be designed according to application note *"I-CODE design of Read/Write antennas"*.

7.1.5 POWER SUPPLY

To work with the SLRM900, an external linear regulated power supply has to be used. Using the supplied power supply cable is recommended, in order to comply with the EMC and EMI limits (see Section 7.5).

The reader module contains filtering circuitries for the power supply. However, some requirements are to be fulfilled by the power supply. The maximum ripple of the supply voltage must not exceed the maximum values specified in Table 2.

Table 1 DC power supply output voltage

OUTPUT PARAMETER	VALUE
DC supply voltage	+24 V
DC current	2 A

Table 2 DC power supply ripple voltage

RIPPLE FREQUENCY	MAXIMUM RIPPLE VOLTAGE
50 Hz $\leq$ f < 10 MHz	100 mV (p-p)
10 MHz $\leq$ f < 20 MHz	50 mV (p-p)
f $\geq$ 20 MHz	100 mV (p-p)

7.2   Reader software

The available software for the SLRM900 is contained in document *"SLRM900 I-CODE Long Range Reader Module, protocol Reader-Host"*.

7.3   Reader hardware

The internal electronics of the SLRM900 can be divided in two major units:

- RF board (see Fig.7)
- Microcontroller board (see Fig.8).

7.3.1   RF BOARD

7.3.1.1   Voltage regulation

All necessary internal voltages for the module are derived internally from the 24 V DC power supply voltage.

7.3.1.2   Clock generator

This part generates the 13.56 MHz clock frequency for the transmitter amplifier. A divided clock signal is connected to the microcontroller for synchronization purposes.

7.3.1.3   Modulator and transmitter amplifier

To transmit data to the I-CODE labels, the carrier has to be modulated by the modulator with a digital signal from the microcontroller according to data sheet *"SL1ICS3001 I-CODE Label IC, protocol air interface"*. The transmitter amplifier amplifies the modulated carrier signal.

7.3.1.4   Modulation index and RF power regulation

The RF power regulator keeps the antenna output voltage to a level determined by software settings. Also, by using software settings, the modulation index can be set, according to data sheet *"SL1ICS3001 I-CODE Label IC"*. The required modulation index has to be re-adjusted after any change of the RF output power and at large temperature variations.

7.3.1.5   Receiver, filter, demodulator, and ADC

An amplitude modulated signal is received from the I-CODE1 label IC. After filtering, demodulation, and amplification, the analog data signal is converted by the 12-bit ADC for further digital processing.

7.3.1.6   Opto-couplers

All internal analog and digital signals between the RF board and microcontroller board are galvanically separated by opto-couplers.

7.3.2   MICROCONTROLLER BOARD

7.3.2.1   Microcontroller

The microcontroller processes the protocol for the communication between the I-CODE labels and the SLRM900. The serial interface signals are converted in such a way, that the labels are able to process them, and the outgoing signals from the labels are converted into serial interface-compatible signals.

Another important microcontroller task is its control function. Software control offers the possibility to change both the RF-output power and the modulation index.
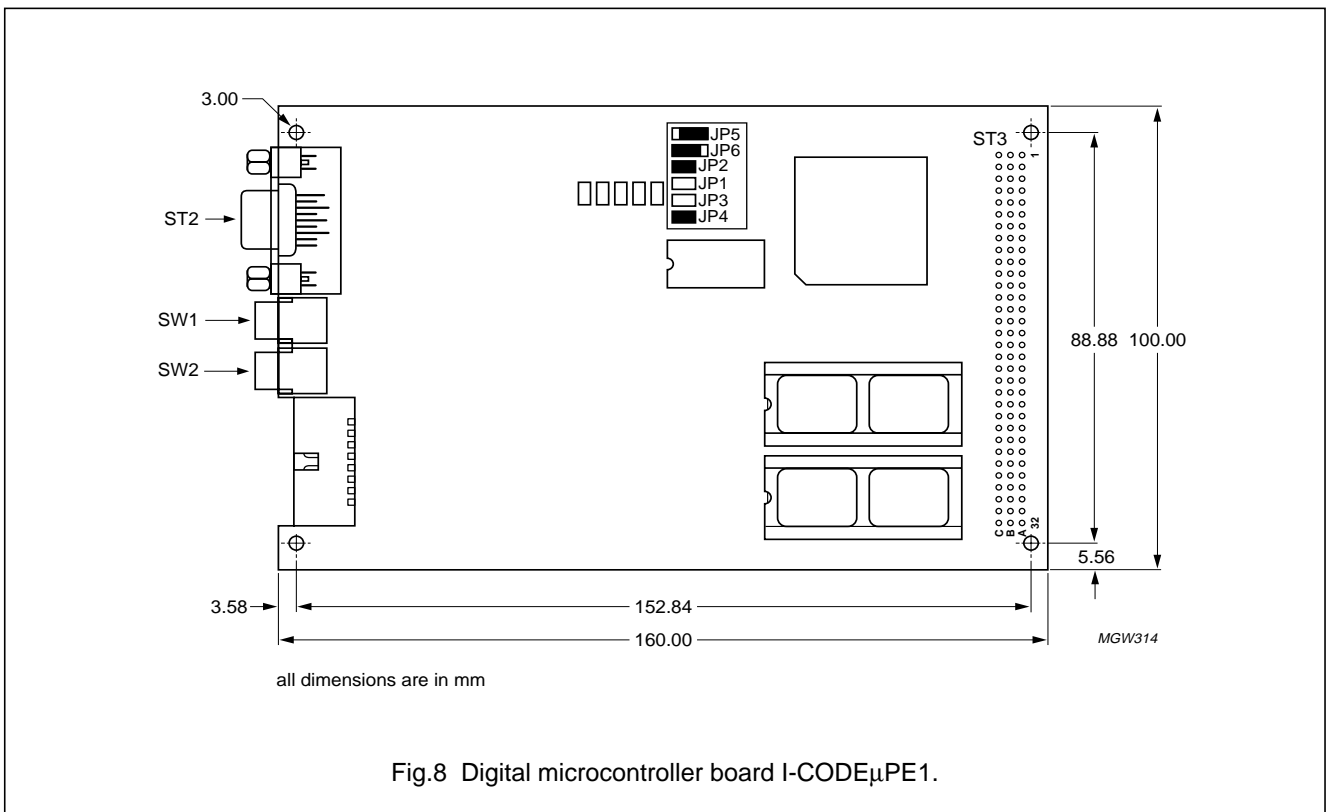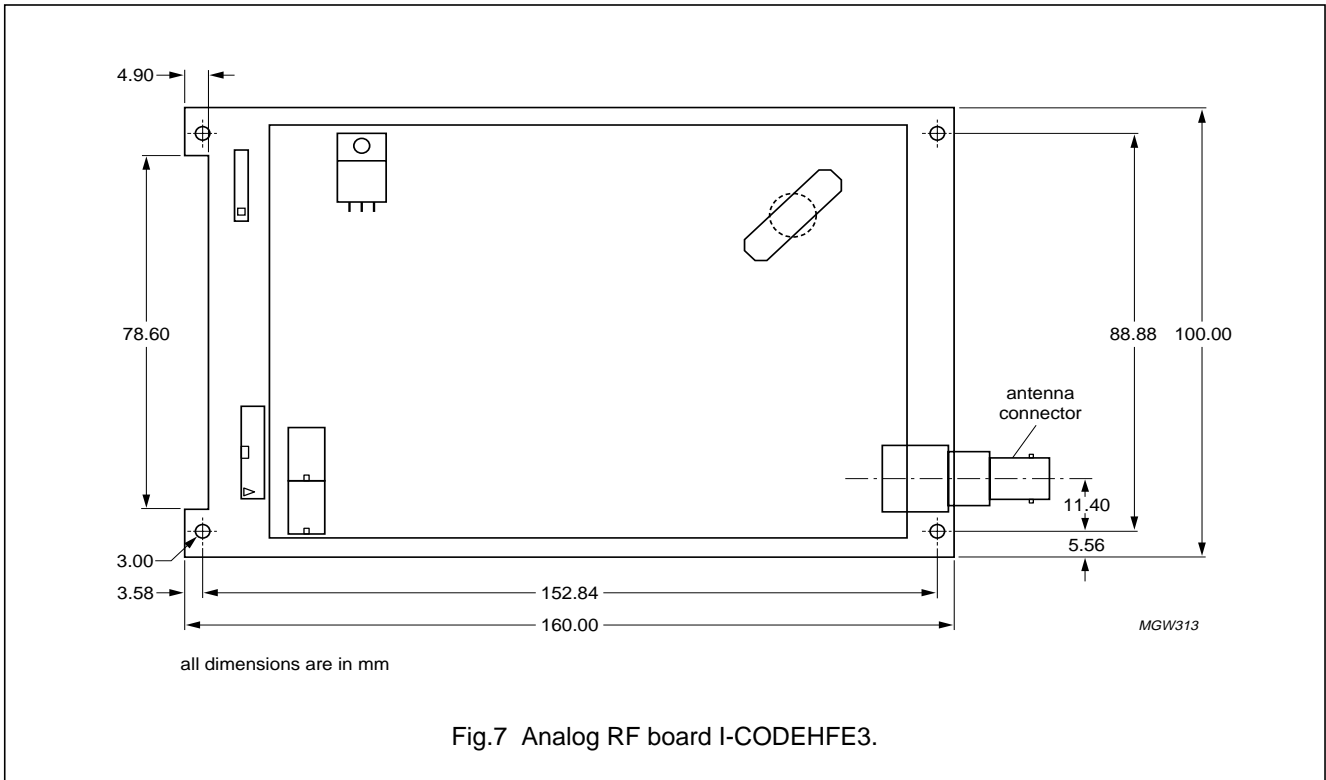
7.3.2.2   RS232 interface

The device communicates with the host (processor or PC) via a serial interface, using a jumper-selectable baud rate of either 57.6 kbaud in standard mode, or 115.2 kbaud in fast mode (see setting for JP4 in Table 3).

7.4 Printed circuit boards

Fig.7 Analog RF board I-CODEHFE3.

Fig.8 Digital microcontroller board I-CODEµPE1.

7.5 EMC and EMI

The SLRM900 is designed in such a way that it is possible to build systems with it, which are in conformance with EMC and EMI standards.

Electromagnetic emissions comply with the guidelines in BAPT 222 ZV 122 and EN 300 330. Electromagnetic immunity complies with the guidelines in ETS 300 683.

The conformance to EMC and EMI standards can only be granted for systems, not for components.

The following measurements have been passed:

• EMI: EN 300 330, BAPT 222 ZV 122, FCC 47 part 15

• Immunity: ETS 300 683.

The following configuration is in compliance with the telecommunication standards:

• SLRM900: output power 4 W at 50 Ω; modulation index m = 15%; standard mode

• Linear power supply (according to the recommendations in Table 1), connected via the supplied power supply cable

• Antenna from the I-CODE evaluation kit:

  – size: 38 cm $\times$ 28 cm

  – number of turns: N = 1

  – quality factor: Q = 30

  – impedance: $|Z| = 50\ \Omega$

  – $\varphi = 0°$

  – according to application note *"I-CODE, Design of Read/Write antennas"*.

7.6 Safety and reliability considerations

The SLRM900 has implemented measures for high reliability.

7.6.1 ANTENNA RUPTURE AND ANTENNA SHORT-CIRCUIT

The SLRM900 does not immediately get damaged in case of either an antenna short-circuit, or an antenna rupture with short duration. However, permanent antenna short-circuit, or antenna rupture, will definitely damage the SLRM900. The supply current of the SLRM900 will be limited at typical 1.6 A.

7.6.2 SUPPLY VOLTAGE

The SLRM900 is protected against short supply voltage peaks and incorrect polarity for a short time, but permanent incorrect supply will definitely damage the device.

8 LIMITING VALUES

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

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
V_{dd}	supply voltage	−0.6	+27	V
T_{amb}	ambient temperature	0	70	°C
T_{case}	operating in-case temperature	0	85	°C
T_{stg}	storage temperature	−25	+85	°C

9 ELECTRICAL SPECIFICATIONS

T_{amb} = 0 to 70 °C; antenna load is 50 Ω; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.[1]	MAX.	UNIT
V_{dd}	DC supply voltage		23	24	25	V
I_{dd}	DC supply current	P_o = 4 W; note 2	–	0.975	1.100	A
		P_o = 8 W; note 2	–	1.215	1.350	A
P_{out}	RF output power	calculated: note 3				
		minimum	–	2	4[4]	W
		maximum	8	10	–	W
m	adjustable modulation index	note 5	10	15[4]	20	%

Notes

1. Typical ratings are not guaranteed. These values listed are at T_{amb} = 25 °C.

2. Values listed above are continuous currents; peak values can be up to 650 mA higher, by switching, or modulating the RF carrier.

3. Calculated from the measured RF output voltage across a 50 Ω load; RF output voltage measured with Tektronix TDS520B oscilloscope.

4. Default value, adjusted at delivery.

5. Definition: $m = \dfrac{V_{max} - V_{min}}{V_{max} + V_{min}}$ where V_{max} is RF level without modulation and V_{min} is RF level during modulation.

   Modulation method is Amplitude Shift Keying (ASK).

10 MECHANICAL SPECIFICATIONS

105

ST2   SW1 SW2

INTERFACE   RST NMI

84

11

FRONT VIEW

antenna connector

power supply connector

24V DC

ANTENNA

REAR VIEW

164

antenna
connector

MGW312

SIDE VIEW

all dimensions are in mm
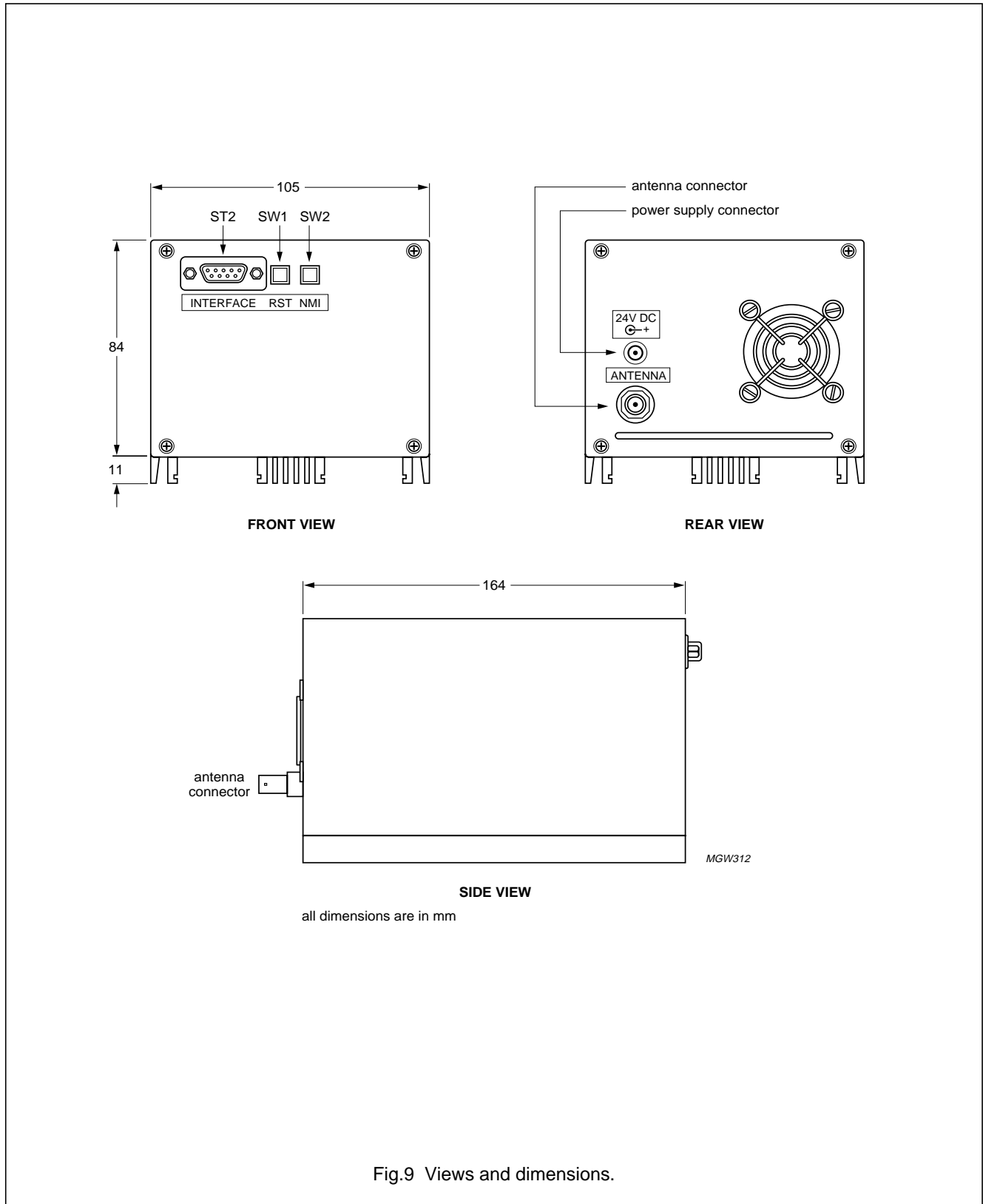
Fig.9 Views and dimensions.

11   APPLICATION INFORMATION

11.1   Jumper settings

Table 3   Jumper settings on microcontroller board I-CODEμPE1 (see Fig.8)

NAME	FUNCTION	SETTING	DESCRIPTION
JP2	bootstrap loader mode	not set	bootstrap loader mode disabled (default)
		set	for firmware update via RS232
JP3	start-up mode	not set	PC mode (default); the reader starts up expecting commands from the host
		set	stand-alone EAS mode; the reader is transmitting EAS commands continuously after start-up; if a label with EAS bits set is detected, the EAS Out port will change to HIGH level
JP4	baud rate	not set	serial communication interface baud rate at 57.6 kbaud (default)
		set	serial communication interface baud rate at 115.2 kbaud

The settings of JP1, JP5 and JP6 must not be changed.

11.2   Hints for system integration

The following list should be checked if any problem (e.g. reduced read and write distances) occurs:

- Power supply cable is not correctly plugged into the power supply

- Power supply is out of specification (see Table1)

- Serial interface not properly connected

- Serial interface cable, power supply cable or antenna cable are too close to the antenna

- Interference received by the antenna because of an external noise source; the remedy is the removal of the antenna from the interfering area and execute the command CRM_config(CFG_INIT,0). See data sheet *"SLRM900; I-CODE Long Range Reader Module, protocol Reader-Host"*

- Antenna is mounted in metal environment; the remedy is to place a non-metal space keeper between the antenna and the metal

- Antenna is not designed according to application note *"I-CODE, Design of Read/Write antennas"*.

12   REFERENCE DOCUMENTS

Table 4   Survey of reference documents

CATEGORY	NUMBER OR TITLE
Application note	*"I-CODE, Design of Read/Write antennas"*
Specification	*"SAB-C167CR-LM"*
Data sheet	*"SLRM900; I-CODE Long Range Reader Module, protocol Reader-Host"*
Data sheet	*"SL1ICS3001; I-CODE1 Label IC"*
Data sheet	*"SL1ICS3001; I-CODE1 Label IC, protocol air interface"*

13 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.
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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.

14 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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NOTES

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