SLE 66R35R / SLE 66R35I

Intelligent 1kByte Memory chip with NRG

Short Product Information

Devices

- SLE 66R35R
- SLE 66R35I

Features

- Intelligent 1 kByte Memory Chip with NRG (ISO/IEC 14443-3 type A with CRYPTO1)
- Physical Interface and Anticollision compliant to ISO/IEC14443-2 and -3 Type A
  - Operation frequency 13.56 MHz
  - Data rate 106 kbit/s
- 1 kByte EEPROM
  - Block organization of memory, 16 Sectors with fixed 4 blocks of 16 bytes each
  - User definable access conditions for each memory block
- Security Features
  - SLE 66R35R: 4-byte reused identification number (r-ID), 4-byte UID previously issued
  - SLE 66R35I: 4-byte fixed non-unique number (FNUID)
  - Mutual three-pass authentication between card and reader for basic security
  - Selective memory access control secured by authentication and access conditions
  - Data encryption for RF channel
  - Dedicated Value Counter

About this document

Scope and purpose

This document describes the features of SLE 66R35R/I.

Features

Intelligent 1 kByte Memory Chip with NRG

Contactless Interface

- Physical Interface and Anticollision compliant to ISO/IEC14443-2 and -3 Type A
  – Operation frequency 13.56 MHz; data rate 106 kbit/s
  – Contactless transmission of data and supply energy
  – Anticollision logic: several cards may be operated in the field simultaneously
- Read and Write Distance up to 10 cm and more (influenced by external circuitry i.e. reader and inlay design)
- Short transaction times: typical ticketing transaction < 100 ms; transaction possible when card is moving

1 kByte EEPROM

- Block organization of memory, 16 Sectors with fixed 4 blocks of 16 bytes each
- EEPROM updating time per block < 5 ms
- Endurance > 100.000 erase/write cycles[1]
- Data Retention > 10 years[1]
- User definable access conditions for each memory block

Security Features

- SLE 66R35R: 4-byte reused identification number (r-ID), 4-byte UID previously issued
- SLE 66R35I: 4-byte fixed non-unique number (FNUID)
- Mutual three-pass authentication between card and reader for basic security
  – 48-bit key length
  – 2 keys per sector enabling key management
  – Transport key at chip delivery
- Selective memory access control secured by authentication and access conditions
- Suited to multifunctional applications: Individual key sets are available for each EEPROM sector
- Data encryption for RF channel
- Dedicated Value Counter
- Data integrity supported by CRC, Parity Check, etc.

Electrical characteristics

- On-chip capacitance 18.3 pF + 10 %
- ESD protection typical 2 kV
- Ambient temperature -25 ... +70°C for the chip

[1] Values are temperature dependant

1 Ordering and packaging information

Table 1 Ordering information

Type	Package	Remark
SLE 66R35I C	Die (on wafer)	sawn / unsawn
SLE 66R35I NB	Die (on wafer)	NiAu-bumps, sawn
SLE 66R35I MCC8	MCC8-2-6	
SLE 66R35I MCC2	MCC2-2-1	
SLE 66R35R C	Die (on wafer)	sawn / unsawn
SLE 66R35R NB	Die (on wafer)	NiAu-bumps, sawn
SLE 66R35R MCC8	MCC8-2-6	
SLE 66R35R MCC2	MCC2-2-1	

Note: For further information on technology, delivery forms (wafer thickness or height of NiAu-bump) please contact your local Infineon Technologies sales representative (www.infineon.com).

Figure 1 Pin configuration Module Contactless Card – MCC2 (top view)

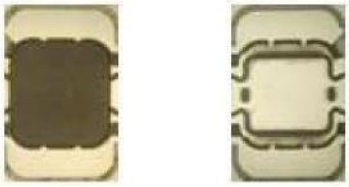

Figure 2 Pin configuration Module Contactless Card – MCC8-2-6 (top / bottom view)

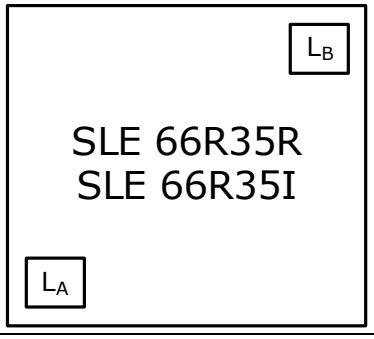

Figure 3 Pad configuration die

Table 2 Pin description and function

Symbol	Function
L_A	Antenna Connection
L_B	Antenna Connection

2 Overview of a NRG system

The SLE 66R35R/I is designed to operate in a NRG system. The system consists of a smart card and a card reader together with an antenna. The card's antenna consists of a simple coil with a few turns embedded in plastic.

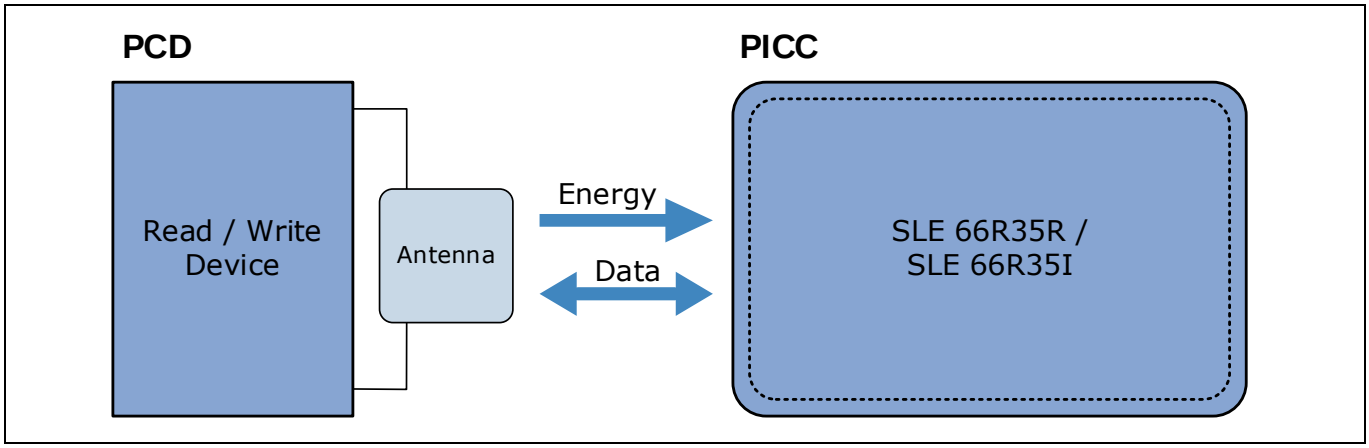

Figure 4 System overview

The operating distance between card and reader antenna is up to 10 cm and more (influenced by external circuitry i.e. reader-antenna configuration).

The RF communication interface transmits at 106 kbit/s resulting in short transaction times, the effect being that a card user can move freely through a reader gate with minimum disruption. A typical ticketing transaction can be handled in less than 100 ms. Robust contactless transmission means that the card with SLE 66R35R/I may also remain in the wallet of the user even if there are coins in it.

An intelligent anticollision function based on the chip's single size unique identifier (uid0-uid3) enables more than one card in the field to operate simultaneously. The anticollision algorithm selects each card individually and enables the execution of a transaction with a selected card is performed correctly without data corruption resulting from other cards in the field.

Access to SLE 66R35R/I is only allowed after a three-pass authentication. The serial number is unique for each card and cannot be changed. Each data transmission is enciphered. Protection from misuse is done by configurable access conditions that are protected by secret keys used for memory operations such as read or write.

Multi-Application Functionality

The SLE 66R35R/I is suited for the use in multi-application schemes, for example combining a transportation fare collection scheme and a ticketing system such as a stadium ticketing. Both applications can be performed with the same card, as hierarchical key management is supported. This means that two different keys for each memory sector can be assigned to enable authentication to that sector.

2.1 Supported standards

The SLE 66R35R/I supports the following standards:

- ISO/IEC 14443-1, -2 and -3 Type A [1]
- Tested according to ISO/IEC 10373-6 [2]

2.2 Command set

A set of standard ISO/IEC 14443-3 Type A commands is implemented to operate the chip.

Additionally the SLE 66R35R/I specific command set is implemented. This facilitates the access to the on-chip integrated memory, supports the execution of authentication, encryption and decryption data as well as an increment or a decrement of a dedicated value counter.

3 Circuit Description

SLE 66R35R/I consists of an EEPROM memory of 1 kByte organized in 16 sector with 4 blocks each containing 16 bytes, an analog interface for contactless energy and data transmission and a control unit.

The power supply and data are transferred to SLE 66R35R/I via an antenna, which consists of a coil with few turns directly connected to the module. No further external components are necessary. The circuit is designed to communicate with a card-reader at an operating distance of up to 10 cm (or more) depending on the reader-antenna configuration.

The chip is designed to meet the cost-optimized requirements of a basic security level. The targeted applications are transport, corporate access, events and loyalty cards with basic security requirements.

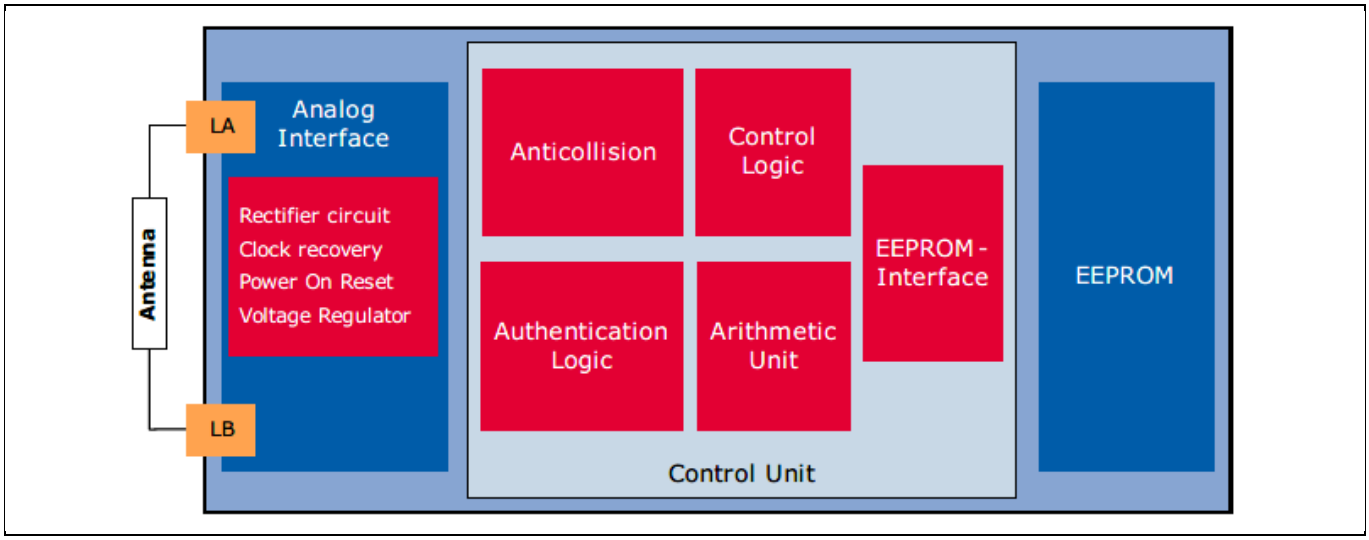

Figure 5 Block diagram

- **Analog Contactless Interface:**
  - The Analog Contactless Interface comprises the voltage rectifier, voltage regulator and system clock to supply the IC with appropriate power. Additionally the data stream is modulated and demodulated.
- **Anticollision**
  - Internal logic of SLE 66R35R/I ensures the recognition of several cards in the field which may be selected and operated in sequence.
- **Authentication Logic**
  - Correct execution of any memory operation can only occur after the authentication procedure with a specific key.
- **Control Logic**
  - Access to a block is defined by the associated access conditions for that block. These are programmed individually for each block in a sector.
- **Arithmetic Unit**
  - Arithmetic Capability: increment and decrement of values stored in a special redundant format.
- **EEPROM:**
  - 1 kByte organized in 16 sectors with 4 blocks by 16 bytes each. The last block of each sector is called "Sector Trailer" and is used to store for a pair of secret keys and programmable access conditions for each block.

4 SLE 66R35x options

SLE 66R35R / SLE66R35I support systems based on single size UIDs:

- SLE 66R35R: 4-byte reused ID (r-ID), 4-byte UID previously issued
- SLE 66R35I: 4-byte fixed non-unique number (FNUID) according to ISO/IEC 14443-3 Type A

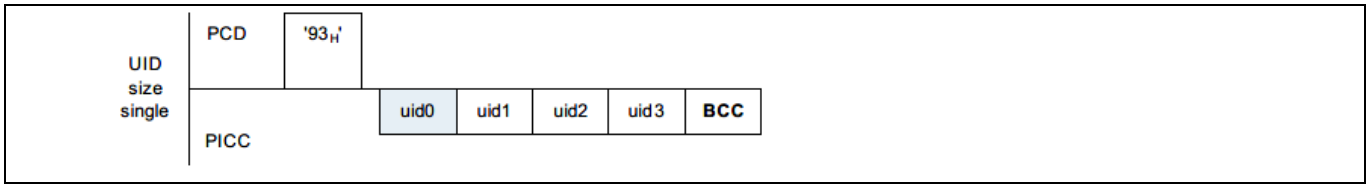

Figure 6 UIDs according to ISO/IEC 14443-3 Type A

4.1 Product overview

Following memory chips with NRG are available (see Table 3):

Table 3 Overview on chip types using NRG technology

Type	UID size	UID type	uid0	Description
SLE 66R35[1] [2]	4-byte	UID	xM_H $P8_H$	Fixed unique number programmed by manufacturer ($M = 1_H, 5_H, 7_H, 9_H$) and ($P = 1_H, 2_H, 3_H, 4_H, 5_H$)
SLE 66R35I	4-byte	FNUID	xF_H	Fixed number, non-unique programmed by manufacturer
SLE 66R35R	4-byte	r-ID	xM_H $P8_H$	Fixed reused identity number programmed by manufacturer ($M = 1_H, 5_H, 7_H, 9_H$) and ($P = 1_H, 2_H, 3_H, 4_H, 5_H$)
SLE 66R35E7(H)	7-byte	UID	05_H	Fixed unique number programmed by manufacturer (delivery default)
	4-byte	FNUID	xF_H	Fixed number, non-unique derived from 7-byte UID (personalization option). The FNUID is not stored in Block 00_H, it is derived from the 7-byte UID stored in Block 00_H. The derived value for the uid0 byte is logically OR-ed with $1F_H$; due to that x may have following values: $1_H, 3_H, 5_H, 7_H, 9_H, B_H, D_H, F_H$
	4-byte	RND-ID	08_H	uid1 to uid3 is a random number (RND1 - RND3) (personalization option). The RND-ID is not stored in Block 00_H; a new RND-ID is generated with every power-up.

[1] The available numbers are already exhausted.

[2] Discontinued. Consider to use successor products SLE 66R35I, SLE 66R35R, SLE 66R36E7, SLE 66R35E7H.

5 Operational Characteristics

The electrical characteristics ensure the operation of the SLE 66R35R/I over the listed range.

Typical characteristics specify mean values expected over the production spread. If not otherwise specified typical characteristics apply at $T_{ambient}$ = 25° C and the given supply voltage.

5.1 Electrical Characteristics

f_{CAR} = 13.56 MHz sinusoidal waveform, voltages refer to V_{SS}.

Table 4 Electrical Characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Chip input capacitance L_A – L_B	C_{IN}	16.5	18.3	20.1	pF	$V_{AB\ RMS}$ = 2.3 V, f_{CAR} = 13.56 MHz, $T_{ambient}$ = 25 °C Tolerance +/- 10%
Chip load resistance L_A – L_B	R_{IN}		17		kΩ	$V_{AB\ RMS}$ = 2.3 V, f_{CAR} = 13.56 MHz, $T_{ambient}$ = 25 °C Tolerance +/- 20%
Internally limited supply voltage	V_{DD}			3.3	V	Internal value
Supply current (idle mode)	I_{DD}		200	300	µA	Estimated value, not externally measured! f_{CAR} = 13.56 MHz, no modulation
Endurance (erase / write cycles)[1]		10^5				–
Data retention[4]		10			years	
EEPROM Erase and Write time	t_{prog}			5	ms	Combined erase + write; excluding time for command / response transfer between interrogator and chip, $T_{ambient}$ = 25 °C
ESD Protection voltage (L_A, L_B pins)	V_{ESD}	2			kV	EIA / JESD22 A114-B
Ambient temperature	$T_{ambient}$	-25		+70	°C	for chip
Junction temperature	$T_{junction}$	-25		+110	°C	for chip

[1] Values are temperature dependent.

5.2 Absolute Maximum Ratings

Stresses above the maximum values listed here may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability, including EEPROM data retention and erase/write endurance. Maximum ratings are absolute ratings; exceeding only one of these values may cause irreversible damage to the integrated circuit. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this document is not implied.

Table 5 Absolute Maximum Ratings

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input voltage between $L_A - L_B$	V_{INpeak}	-7		+7	V	On chip limitation by voltage regulator
Input current through $L_A - L_B$	I_{IN}			+50	mA	Maximal current
Storage temperature	$T_{storage}$	-40		+125	°C	

References

[1] ISO/IEC 14443 Identification cards – Contactless integrated circuit(s) cards Proximity cards, Parts 1, 2 and 3

[2] ISO/IEC 10373-6 Identification cards – Test methods – Proximity cards

Revision history

Reference	Description
Revision 1.0, 2021-06-07	
all	Initial version

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