RF125e - 125kHz RFID OEM Reader Module

DESIGNED IN EUROPE

Features

- Support 125kHz EM4100/4001 compatible format (64 bit, manchester encoding)
- Low power consumption
- Small outline design
- UART 9600 and Wiegand26 Interface
- Read range: up to 8 cm using ISO card

Applications

Access Control

Time Tracking Systems

Inventory Control

Payment Systems

Children's toys

Data protecting devices

Preamble

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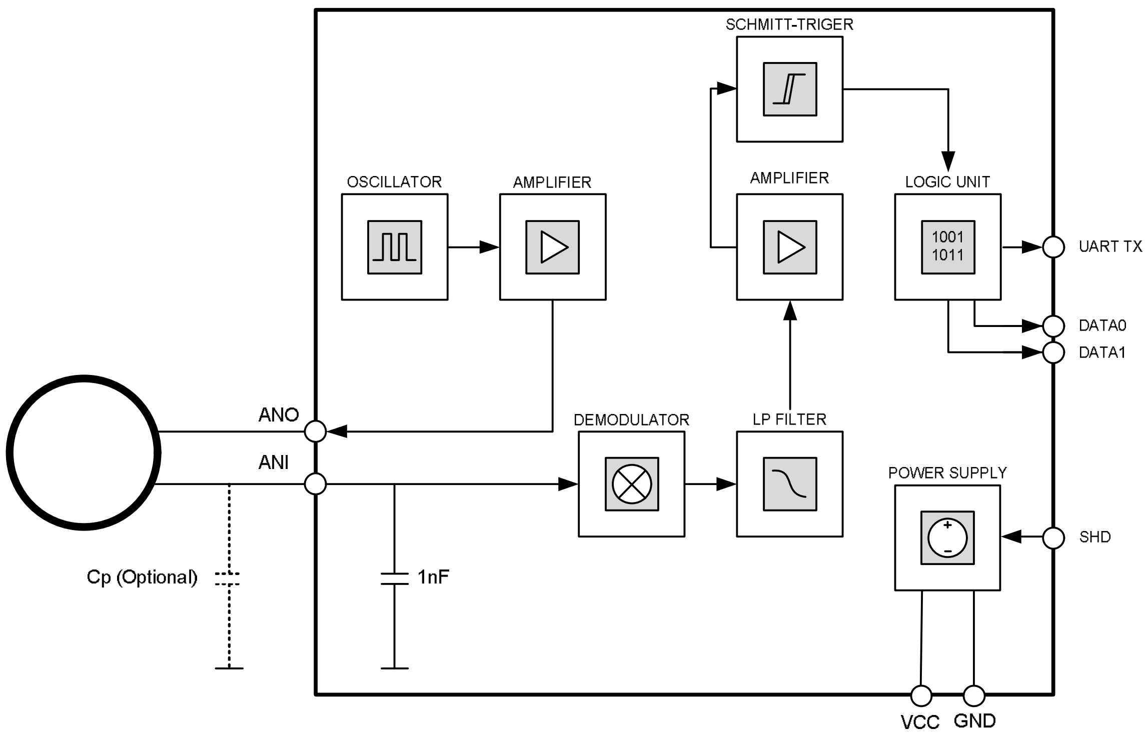
Description

The RF125e is an EM4100 compatible OEM RFID reader module that simplifies the implementation of RFID based solutions, minimizes the software and hardware requirements of the host microcontroller and is thus the ideal solution for applications using any low-cost MCU. The RF125e module reduces development time, lowers manufacturing costs, saves board space, and minimizes the RF expertise required.

Functional Block Diagram



1. Functional block diagram

Theory of Operation

RFID - radio frequency identification is a short range communication technology. The 125kHz RFID technology is wireless communication technology, where passive transponders are supplied with power based on electromagnetic coupling principle.

RFID Readers uses RLC resonator circuits, tuned to a certain frequency. When a transponder is in range of a reader, the transponder begins to modulate the data on carrier signal. Most of EM4100 compatible transponders use 64 bit configuration. The bit rate of the data stream is a 1/64th rate of the carrier signal. The reader is able do detect the ASK signal.

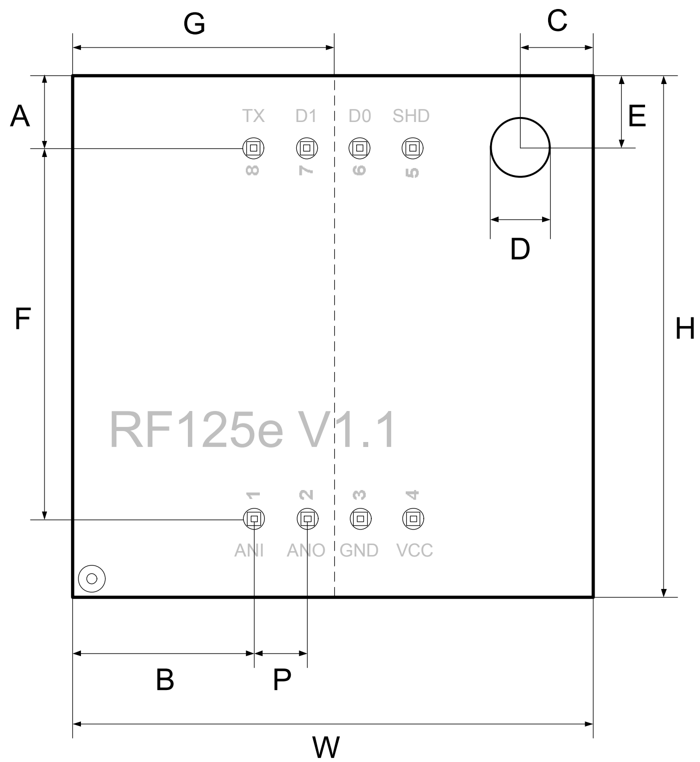
EM4001 compatible transponder sends a defined sync header of nine ones. The reader receives the sync header and begins to receive the rest of the transponder data, the binary data is quality checked for the accuracy by row and column parity bits. The row parity bit is send after each four data bit. A row parity bit becomes one when the count of ones in a nibble (half of a byte) is odd. First transferred byte contains the vendor id, followed by four bytes which are representing the unique ID of a transponder. The transition is closed by four column parity bits and a follower zero stop bit. Column parity bits are generated from payload, while sync header bits are not involved in parity calculation.

					1	
Sync Header: nine ones	1	1	1	1	1	
	1	1	1	1	1	
Vendor ID Byte #0	D00	D01	D02	D03	RP0	
	D04	D05	D06	D07	RP1	
TAG ID Byte #1	D08	D09	D10	D11	RP2	
	D12	D13	D14	D15	RP3	
TAG ID Byte #2	D16	D17	D18	D19	RP4	Row Parity Bits Bits are set if count of ones is odd
	D20	D21	D22	D23	RP5	
TAG ID Byte #3	D24	D25	D26	D27	RP6	
	D28	D29	D30	D31	RP7	
TAG ID Byte #4	D32	D33	D34	D35	RP8	
	D36	D37	D38	D39	RP9	
	CP0	CP1	CP3	CP4	0	Stop Bit, always „0“
	Column Parity Bit	Column Parity Bit	Column Parity Bit	Column Parity Bit		

2. Data structure: EM4100 compatible transponder

Package Information

Mechanical Dimensions



3. RF125e dimensions

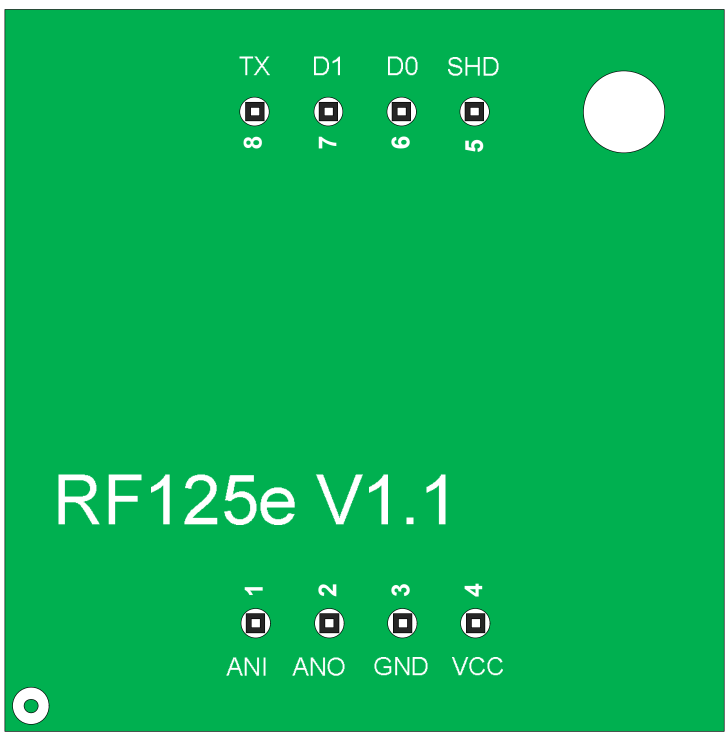
UNITS:mm	Dimensions +/- 0.2
A	3.5
B	8.6
C	3.5
D	2.8
E	3.5
F	17.78 (7x2.54)
G	12.5
H	25.00
P	2.54
W	25.00

Pin Description

Pin	Name	Description
Pin1	ANI	Antenna Input
Pin2	ANO	Antenna Output
Pin3	GND	Ground
Pin4	VCC	DC supply voltage
Pin5	SHD	Shut down pin, active low, internally pulled up 1)
Pin6	D0	Wiegand26 DATA0 for transfer of "0" bits 2)
Pin7	D1	Wiegand26 DATA1 for transfer of "1" bits 2)
Pin8	TX	UART TX Output, 9600 Baud, No parity, 1 Stop bit

1) In a noisy environment, use an external Pull-up value of 4.7k-10k. Module is shut down 10mS after the pin is asserted and is ready to operate 100mS after the pin is de-asserted. De-asserting the pin will cause a module re-initialization.

2) Wiegand Interface operates in open drain mode. To enable the Interface, external pull-up resistors are required. Recommended pull-up value is 4.7k-10k.



4. Module Back View

Wiegand26 Interface

Packet size............................26 bits

Pulse width............................50µS

Pulse interval………………....1mS

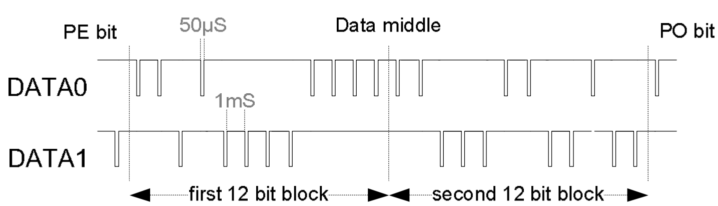
Electrical output.....................Open drain

Data transmit interval............1 second

Wiegand Interface is a simply and common used communication Interface, transmitting data via two wires with a common ground to receiver device. DATA0 wire is used to transfer zero bits of the data, DATA1 for ones. PE is an even parity bit and becomes one if the count of ones in first 12 bits block is odd. PO is an odd parity bin and becomes one if the count of ones in second 12 block bits is even.

PE	TAG ID Byte #2	TAG ID Byte #3	TAG ID Byte #4	PO

5. Wiegand26 Data packet structure



6. Wiegand26 Data Transfer

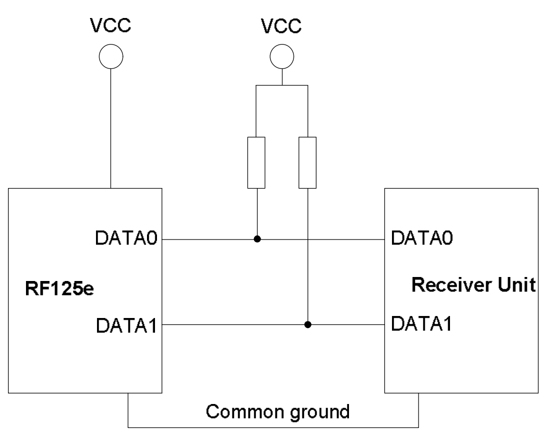
Wiegand26 data packet transfer example

When a RFID tag becomes recognized, only last 3 bytes of the tag ID will be transmitted. Assumed the tag ID is 00002F039B, 2F039B bytes are used for Wiegand26 transfer. The reader module calculates PE – even parity bit for the first 12 bits and PO – odd parity bit for the second 12 bits of data packet.

PE] 0x2F | 0x03 | 0x9B [PO

1] 00101111 0000 | 0011 10011011 [0

Note: Wiegand26 interface requires external pull-up resistors on DATA0 and DATA1. While power-up the module detects if those are present. The Wiegand26 interface will be enabled in case DATA0 and DATA1 are pulled-up to VCC.



7. Wiegand Connection

UART Interface

Baud rate..............................9600 bps

Data size...............................8 Bit

Parity....................................none

Stop bit.................................1

Data transmit interval............1 second

Output Data Format

In case Wiegand26 Interface is enabled the module provides a serial number output in ASCII format. While Wiegand26 interface is disabled the module sends the tag ID as a HEX ASCII Output.

Output Format – Wiegand26 Interface is enabled

10 ASCII Chars of Serial Number	CR 0x0D	LF 0x0A

8. UART Output: Wiegand26 is enabled

Example: 0003081115 0x0D 0x0A

Output Format – Wiegand26 Interface is disabled

STX 0x02	10 Chars of HEX Data	2 Chars of HEX XOR-Checksum	CR 0x0D	LF 0x0A	ETX 0x03

9. UART Output: Wiegand26 is disabled

Example: 0x02 00002F039BB7 0x0D 0x0A 0x03

Antenna Design

The reader module requires an external coil antenna. The circuit is designed to operate with an antenna of 1.62mH.

Recommended Antenna Dimensions for 1.62mH

Coil turns.................................160

Diameter..................................40mm

Wire diameter...........................0.2mm

Coil height................................4mm

Coil width.................................4mm

Other antenna values (lower than 1.62mH) can be used by connecting of an additional external capacitor. The Capacitor shall be placed between ANI pin and ground.

Resonance Circuit Frequency Calculation

$$f = \frac{1}{2\pi * \sqrt{L * C}}$$

Where:

C: Tuning capacitance

L: Inductance of antenna coil

f: Frequency, here 125kHz

In case an antenna of value lower than 1.62mH is used, the Cp can be calculated by rearranging the equation:

$$f = \frac{1}{2\pi * \sqrt{L * (Cc + Cp)}} \rightarrow Cp = \left(\frac{1}{(2\pi)^2 * f^2 * L} \right) - 1nF$$

Where:

Cc is 1nF on circuit capacitor.

Example:

External antenna of 500µH is used, the on circuit capacitor is 1nF, calculated Cp is:

$$Cp = \left(\frac{1}{(2 * 3.14)^2 * 125000^2 * 500E-6} \right) - 1E-9 = 2.24E-9$$

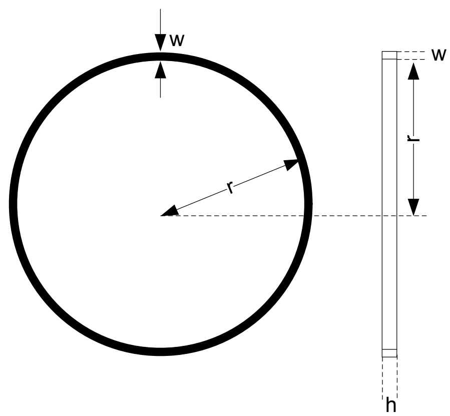
Next available capacitor value is 2.2nF

Combination table of possible air coil antennas and parallel capacitors

Cp	Coil Value
560pF	1mH
680pF	960µH
750pF	920µH
820pF	890µH
1.0nF	800µH
1.5nF	650µH
2.0nF	540µH
2.2nF	500µH

Air Coil Calculation

$$L = \frac{0.31*(r*N)^2}{6r+9h+10w} \quad (\mu H)$$



Where:

h: Coil height in cm

N: Number of turns

r: Radius of the coil in cm

w: Coil thickness in cm

Assuming the coil value is 1620µH, the coil thickness and the coil height are 0.4cm and the radius is 2cm. The number of turns can be calculated easily by rearranging the equation:

$$N = \sqrt{\frac{L*(6r+9h+10w)}{0.31}} \Big/ r \;\Rightarrow\; N = \sqrt{\frac{1620*(6*2+9*0.4+10*0.4)}{0.31}} \Big/ 2 = 160 \text{ Turns}$$

Electrical Characteristics

Absolute Maximum Ratings

Maximum Operating Voltage 5.5V

DC Current per I/O Pin ....25 mA

Voltage on any Pin..-0.5V to VCC+0.5V

Operating Temperature..................................-40°C to +85°C

Storage Temperature ....-60°C to +100°C

DC Characteristics

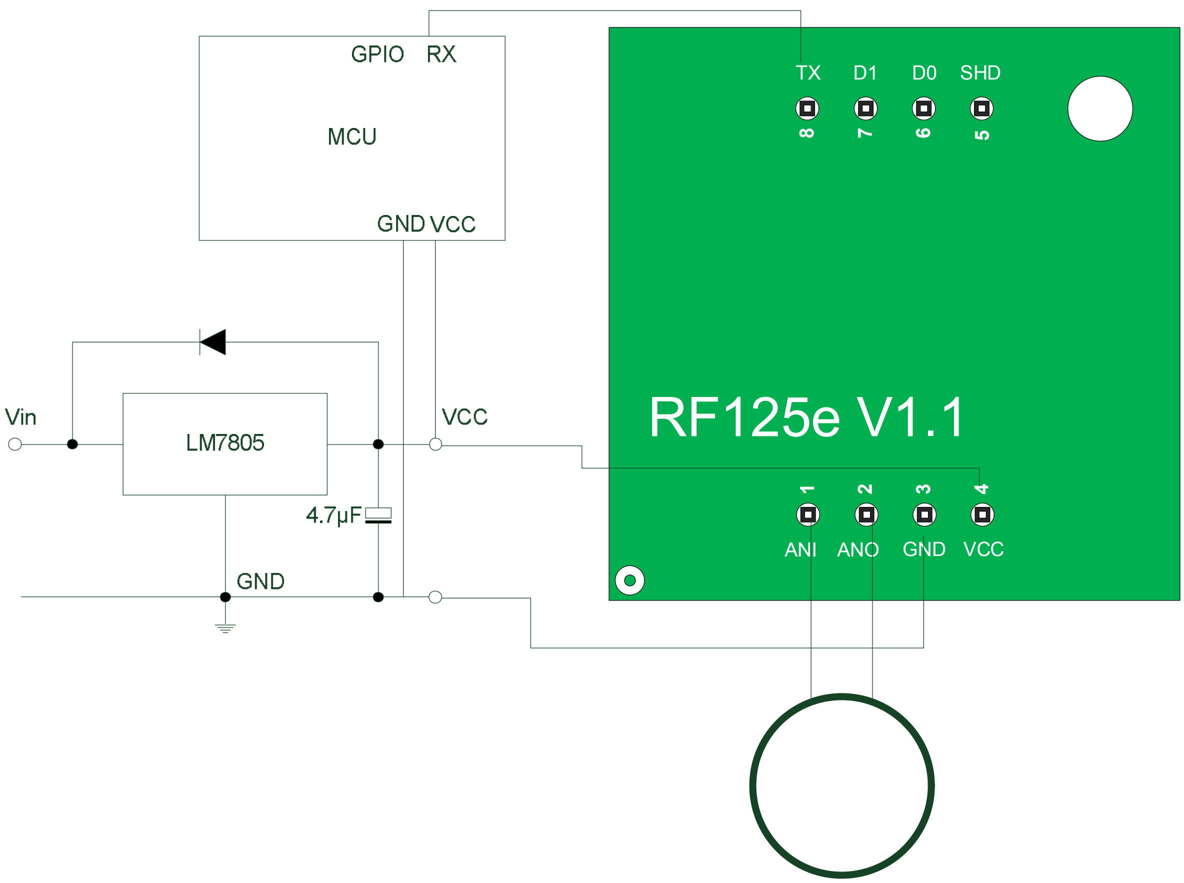
Symbol	Parameter	Min	Typ	Max	Unit
VI	Operating supply voltage	4.0	5	5.3	V
svN	Input voltage noise	-	-	100	µV
ISC	Operating supply current	-			mA
VOL	Output Low-voltage, Vcc = 5.0V	-	-	0.5	V
VOH	Output High-voltage, Vcc = 5.0V	4.2	-	-	V
VIL- SHD	Input Low-voltage on SHD pin	-0.5		0.2VCC	V
VIH- SHD	Input High-voltage on SHD pin	0.8VCC		VCC	V
SHDRp	Shut down pull up registor, Vcc = 5.0V	-	40	-	kOhm

Typical values at 25°C.

Minimal Setup

Minimal setup requires a supply voltage of ~5V DC and a connection to MCU for data output on UART TX Pin. Best choose to supply the RF125e is a linear regulator with an output noise voltage lower than 100µV.

Note: Switching power supply with a frequency of x*125kHz is not recommended. External diode between Vin and Vcc is not required but can protect the device against input short circuit. Stable power supply will improve the read range of the module. For supply stabilization a polcap of 4.7µF/10V is recommended.



10. Minimal RF125e Setup