Application Note 405

Title: **Development Kit EM4095 User's Manual**

Product Family: **RFID**

Part Number: EMDB401
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TABLE OF CONTENT

1 Introduction

The Development Kit EM4095 is designed for a quick step into RFID System design. It contains the EM reader chip EM4095 and a programmed µP with an RS 232 interface. It can be used as a complete reader Module (printed coil on board) or the programmed microcontroller and the reader chip EM4095 can be integrated in customer specific board designs.

The Development Kit EM4095 can communicate with the following types of EM Transponder chips:

- EM4100 / EM4102
- EM4005 / EM4105
- EM4150
- EM4170
- EM4025
- EM4056

It allows the user to communicate with the transponders via serial interface and does not require any knowledge of transponder technology.

2 Transponder Types

2.1 Read Only Transponder EM4102

The Transponder is powered by an electromagnetic field and gets the master clock from the same field. By turning on and off the modulation current, the transponder sends back the 64 bits of information contained in a factory pre-programmed memory array.

2.2 Read Only Transponder EM4005

The Transponder is powered by an electromagnetic field, and gets the master clock from the same field. By turning on and off the modulation current, the transponder sends back the 64 bits of information contained in a factory pre-programmed memory array.

2.3 1kBit Read / Write Transponder EM4150

A transponder is supplied by means of an electromagnetic field induced to the attached coil. The AC voltage is rectified in order to provide a DC internal supply voltage.

When the DC voltage crosses the Power–On level, the chip will enter the Standard Read Mode and send data. The data to be sent in this mode is user defined by storing the first and last addresses to be output. When the last address is sent, the transponder continues with the first address until the transceiver sends a request. In the read mode, a Listen Window (LIW) is generated before each word. During this time, the EM4150 will turn to the Receive Mode (RM) if it receives a valid RM pattern. The Transponder then expects a valid command.

2.4 Crypt Read / Write Transponder EM4170

A transponder is supplied by means of an electromagnetic field induced on the attached coil. The AC voltage is rectified in order to provide a DC internal supply voltage.

When the DC voltage crosses the Power–On level, the chip will enter the Standby Mode and expect commands. In Standby Mode, a continuous sequence of Listen Windows (LIW) is generated. During this time, the Crypt transponder will turn to the Receive Mode (RM) if it receives a valid RM pattern. The chip then expects a command to enter the desired mode of operation.

2.5 Read Only with Anticollision Transponder EM4025

A transponder is supplied by means of an electromagnetic field induced on the attached coil. The AC voltage is rectified in order to provide a DC internal supply voltage. When the DC voltage crosses the Power–On level, the chip will enter the Quit Mode and waits for a command from the reader. The implemented anticollision protocol allows identifying a variety of transponders placed in the reader field by using dedicated commands.

2.6 2kBit Read / Write Anticollision Transponder EM4056

A transponder is supplied by means of an electromagnetic field induced on the attached coil. The AC voltage is rectified in order to provide a DC internal supply voltage. When the DC voltage crosses the Power–On level, the chip will enter the Quit Mode and waits for a command from the reader. The implemented anticollision protocol allows identifying a variety of transponders placed in the reader field by using dedicated commands.

3 Initial Start-up

Before supplying 5V power to the board, connect a serial cable (1:1) to your PC.

With a standard terminal program (9600 baud, 8 data bits, no parity, 1 stop bit) you can send commands to the reader in hex format.

To start the reader, a request message from the Master (PC) must be sent. The reader answers by means of a response message.

4 Interface

4.1 Message structure

A Message starts with byte STX (Start of Text). Its value is always equal to 0x02. The next byte (n) transmits the position of the Checksum byte (called CHK), followed by the command byte and if necessary required data bytes to the reader.

All the commands for all RFID transponders are described in the following tables.

The following 8bit checksum (CHK Byte) for the RS 232 interface is needed for Request and Response messages:

The Checksum is calculated byte per byte with XOR operation since “n” Byte up to CHK Byte.

CRC = $byte_1$ XOR $byte_2$ XOR … $byte_{n-1}$

Send an ETX (End of Text) after the Checksum Byte for completing the data stream. The value of ETX is equal to 0X03.

The response of the transponder reader has the same syntax.

Inside the response message from the RFID transponder, the ACK Byte value is equal to 0X06 and the NACK Byte value is 0X15.

4.2 Communication link

4.2.1 Communication syntax

In the following tables the description of the message syntax which is needed for the communication to the Development Kit EM4095 is given.

configuration of Serial interface	9600 Baud	8 bits	no parity	no stop bit

all values HEX

discription of serial bytes	Color /content
start of Text	STX
position of checksum byte	n
command	0
response ACK or NAK	ACK/ NAK
checksum over byte1 until byte n-1	CHK
end of Text	ETX
error	F
data	ADR

Reader Status	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
STB0 (control byte 0)	0	0	0	0	Antenna fault	Antenna Short	JNQ Channel Reader	Coil ON/OFF
STB1 (control byte 1)	0	0	0	0	0	2 (2k Baud) 3 (3,2k Baud) 4 (4k Baud)		
STB2 (control byte 2)	0	0	0	0	0	0	0	0

Table 1: Message Format

4.2.2 *Request messages to the transponder reader*

	serial data byte																	
command description ->TagReader	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	10
TXP EM4170																		
read ID	STX	n	01h	CHK	ETX													
read UM1	STX	n	02h	CHK	ETX													
Authentication	STX	n	03h	MSB word 9 LSB		MSB word 8 LSB		MSB word 7 LSB		MSB word 6 LSB		MSB word 5 LSB		MSB word 4 LSB		CHK	ETX
write word 0-1	STX	n	04h	ADR	LSB	MSB	CHK	ETX										
write word 12-15	STX	n	04h	ADR	LSB	MSB	CHK	ETX										
write SKEY	STX	n	05h	MSB word 9 LSB		MSB word 8 LSB		MSB word 7 LSB		MSB word 6 LSB		MSB word 5 LSB		MSB word 4 LSB		CHK	ETX
write PIN	STX	n	06h	LSB IDw2 MSB		LSB IDw3 MSB		MSB PINw10 LSB		MSB PINw11 LSB		CHK	ETX				
send PIN	STX	n	07h	LSB IDw2 MSB		LSB IDw3 MSB		MSB PINw10 LSB		MSB PINw11 LSB		CHK	ETX				
read UM2	STX	n	08h	CHK	ETX													
TXP EM4102/4105																		
Read Only Txp read ID 4102	STX	n	10h	CHK	ETX													
Read Only Txp read ID 4105	STX	n	11h	CHK	ETX													
TXP EM4150																		
Login	STX	n	30h	0x01		MSB PW LSB			CHK	ETX								
Write Password	STX	n	31h	0x01		MSB OldPW LSB			MSB NewPW LSB				CHK	ETX				
Write Word*	STX	n	32h	ADR		MSB word LSB			CHK	ETX								
Selective Read Mode[1]	STX	n	33h	XX	XX	XX	LWR	FWR	CHK	ETX								
Reset	STX	n	34h	CHK	ETX													
Read Tag define in Control word[2]	STX	n	35h	CHK	ETX													
TXP EM4025																		
Select - Read (30h) / Toggle (24h)	STX	n	40h	Select		MSB Adress LSB				CHK	ETX							
Select (22h) / Deselect (12h) Customer ID	STX	n	41h	Select	C.ID	CHK	ETX											
General - Read(14h)/Read if Enable(06h)/Reset(35h)	STX	n	42h	Genral	CHK	ETX												
Start Arbitration	STX	n	43h	StartBit*	CHK	ETX		*TAG ID bit address range from D20 (001000) to D92 (100110)										
Stop Arbitration	STX	n	44h	CHK	ETX													
TXP EM4056																		
ReadRom	STX	n	50h	CHK	ETX													
Select - Toggle (04h) / Tag(05h) / DeSelectTag (06h	STX	n	51h	Select		MSB Adress LSB			CHK	ETX								
Protection write	STX	n	52h	Adr	Wp/Rp	CHK	ETX											
Read word	STX	n	53h	Adr	CHK	ETX												
Word Access - Write(0Ch) / Add(0Dh) / Comp(0Eh)	STX	n	54h	Access	Adr	MSB word 9 LSB		CHK	ETX									
Login	STX	n	55h	LSB Pin MSB		CHK	ETX											
Start Arbitration	STX	n	56h	CHK	ETX													
Stop Arbitration	STX	n	57h	CHK	ETX													
Reader command																		
Status Reader (send autom. after Power ON)	STX	n	FDh	CHK	ETX													
switch Coil ON/OFF	STX	n	FEh	ON/OFF	CHK	ETX												
Change Baudrate	STX	n	FFh	BRG[4]	CHK	ETX												

Table 2: Request messages to the transponder reader

4.2.3 *Response message from the transponder reader*

	serial data byte																					
response TagReader	0	*1*	*2*	3	4	5	6	7	8	9	A	B	C	D	E	F	10	11	12	13	14	15
TXP EM4170																						
read ID	STX	n	01h	ACK	MSB IDw3 LSB		MSB IDw2 LSB		CHK	ETX												
read UM1	STX	n	02h	ACK	MSB UMw1 LSB		MSB UMw0 LSB		CHK	ETX												
Authentication	STX	n	03h	ACK	CHK	ETX																
write word 0-1	STX	n	04h	ACK	MSB UMw1 LSB		MSB UMw0 LSB		CHK	ETX												
write word 12-15	STX	n	04h	ACK	MSB UMw15 LSB		MSB UMw14 LSB		MSB UMw13 LSB		MSB UMw12 LSB		CHK	ETX								
write SKEY	STX	n	05h	ACK	CHK	ETX																
write PIN	STX	n	06h	ACK	CHK	ETX																
send PIN	STX	n	07h	ACK	CHK	ETX																
read UM2	STX	n	08h	ACK	MSB UMw15 LSB		MSB UMw14 LSB		MSB UMw13 LSB		MSB UMw12 LSB		CHK	ETX								
TXP EM4102/4105																						
Read ID 4102	STX	n	10h	ACK	Customer code	MSB IDw1 LSB		MSB IDw0 LSB		CHK	ETX											
Read ID 4105	STX	n	11h	ACK	MSB IDw7 LSB		MSB IDw6 LSB		MSB IDw5 LSB		MSB IDw4 LSB		MSB IDw3 LSB		MSB IDw2 LSB		MSB IDw1 LSB		MSB IDw0 LSB		CHK	ETX
TXP EM4150																						
Login	STX	n	30h	ACK	CHK	ETX																
Write Password	STX	n	31h	ACK	CHK	ETX																
Write Word*	STX	n	32h	ACK	ADR	MSB word LSB				CHK	ETX											
Selective Read Mode[1]	STX	n	33h	ACK	ADR	MSB word LSB				CHK	ETX											
Reset	STX	n	34h	ACK	CHK	ETX																
Read Tag define in Control word[2]	STX	n	33h[3]	ACK	ADR	MSB word LSB				CHK	ETX											
TXP EM4025																						
Select - Read (30h) Toggle (24h)	STX	n	40h	ACK	BitVal	CHK	ETX															
Select (22h) Deselect (12h) Customer ID	STX	n	41h	ACK	BitVal	CHK	ETX															
General - Read(14h) Read if Enable(06h)	STX	n	42h	ACK	Customer code	MSB IDw1 LSB		MSB IDw0 LSB		CHK	ETX		General - Reset(35h)			STX	n	42h	ACK	BitVal	CHK	ETX
Start Arbitration	STX	n	43h	ACK	Customer code	MSB IDw1 LSB		MSB IDw0 LSB		CHK	ETX											
Stop Arbitration	STX	n	44h	ACK	CHK	ETX																
TXP EM4056																						
ReadRom	STX	n	50h	ACK	MSB Adress LSB				CHK	ETX												
Select - Toggle (04h) Tag(05h) DeSelectTag (06h)	STX	n	51h	ACK	TagStat	CHK	ETX															
Protection write	STX	n	52h	ACK	TagStat	CHK	ETX															
Read word	STX	n	53h	ACK	MSB word 9 LSB		Prot	CHK	ETX													
Write(0Ch) Add(0Dh) Comp(0Eh)	STX	n	54h	ACK	TagStat	CHK	ETX															
Login	STX	n	55h	ACK	TagStat	CHK	ETX															
Start Arbitration	STX	n	56h	ACK	MSB Adress LSB				CHK	ETX												
Stop Arbitratrion	STX	n	57h	ACK	CHK	ETX																
Reader command																						
Status Reader (send autom. after Power ON)	STX	n	FDh	ACK	STB2	STB1	STB0	0	day	month	year	MSB SW_VERSION LSB				CHK	ETX					
switch Coil ON/OFF	STX	n	FEh	ACK	CHK	ETX																
Change Baudrate	STX	n	FFh	ACK	CHK	ETX																

Table 3: Response message from the transponder reader

* Verification automatically

[1] send for each requested word

[2] send for each word defined in the control word

[3] switch automatically to selective read

4.3 Error List

Below you find the Error List sent by the Development Kit EM4095.

Inside the Response message a Status Byte will indicate if the message is correct or if something wrong happens.

In effect, if the Development Kit EM4095 send you a NACK byte (which value is 0X15), you will have to analyze the value of the next byte and refer to the following table.

no.	Description	Error from
0x01	Antenna Fault	Reader Asic
0x02	timout power up	Reader Asic
0x03	timout read Txp	Reader Asic
0x04	10 times IQ changed	Reader Asic
0x10	read ID- Fault	STxp
0x11	read ID checksumm Fault	STxp
0x12	read UM Fault	STxp
0x13	read UM Parity Fault	STxp
0x14	None LIW	4070/4050
0x15	wrong adress	4070/4050
0x16	writing content fault	4070/4050
0x17	wrong data	4050
0x18	parity error	4050
0x19	word write protected	4050
0x1A	NAK receive	4050
0x1B	unknown command after sel.read	4050
0x1C	Logbits not reset	4170
0x1D	Timeout no answer from Tag	4025
0x20	Timeout RF	RF
0x30	Error flag	Uart
0x31	overflow uart buffer	Uart
0x32	wrong inv. Commmand	Uart
0x33	wrong crc	Uart
0x34	unknown command	Uart
0x35	none ETX	Uart
0x36	interbyte error	Uart

Table 4 : Error List

Error Message example sent Dev. Kit EM4095:

Message: 02 05 10 15 10 10 03

0x02: Start of Text
0x05: Position of the Checksum
0x10: Kind of Command
0x15: NACK
0x10: Kind of Error : Problem of reading tag's ID
0x10: Checksum of the Data Stream = 05 XOR 10 XOR 15 XOR 10
0x03: End of Text

4.3.1 Principle Handling of Transponder Reader

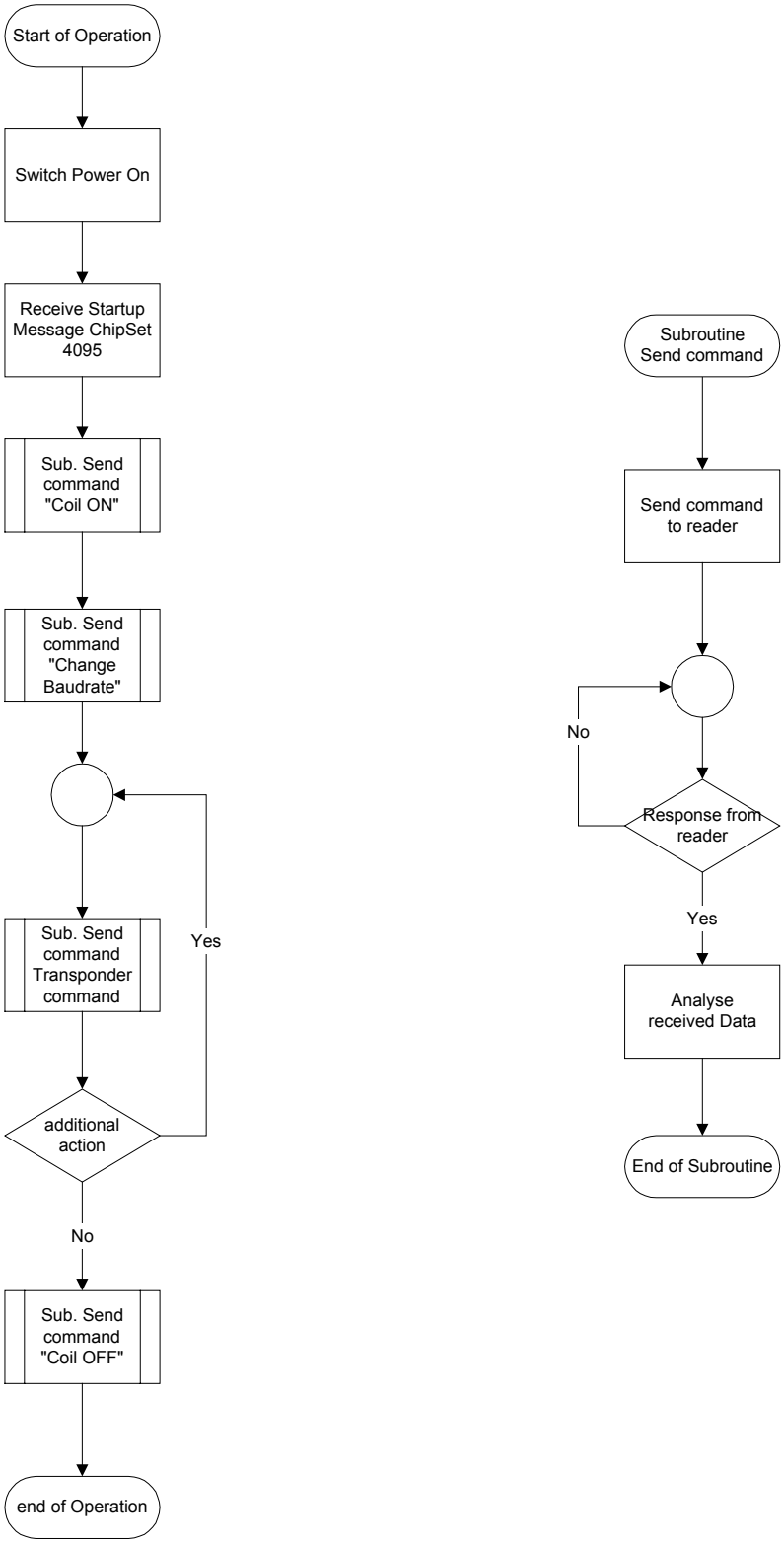


Figure 1 : Principle Handling of Transponder Reader

5 Software

5.1 Reader flow chart Start of Reader and UART communication

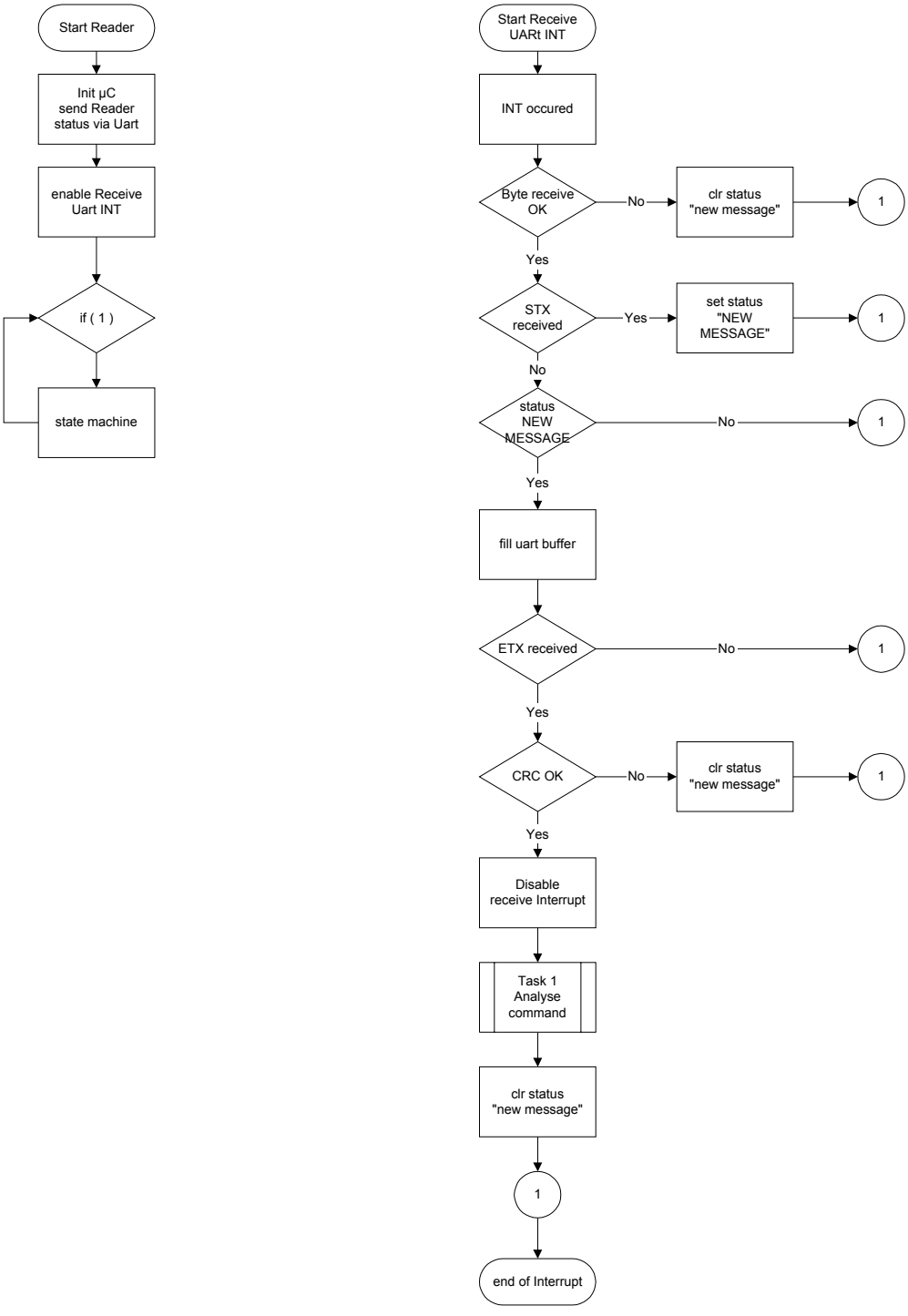


Figure 2: Reader flow chart Start of Reader and UART communication

5.2 Command handling

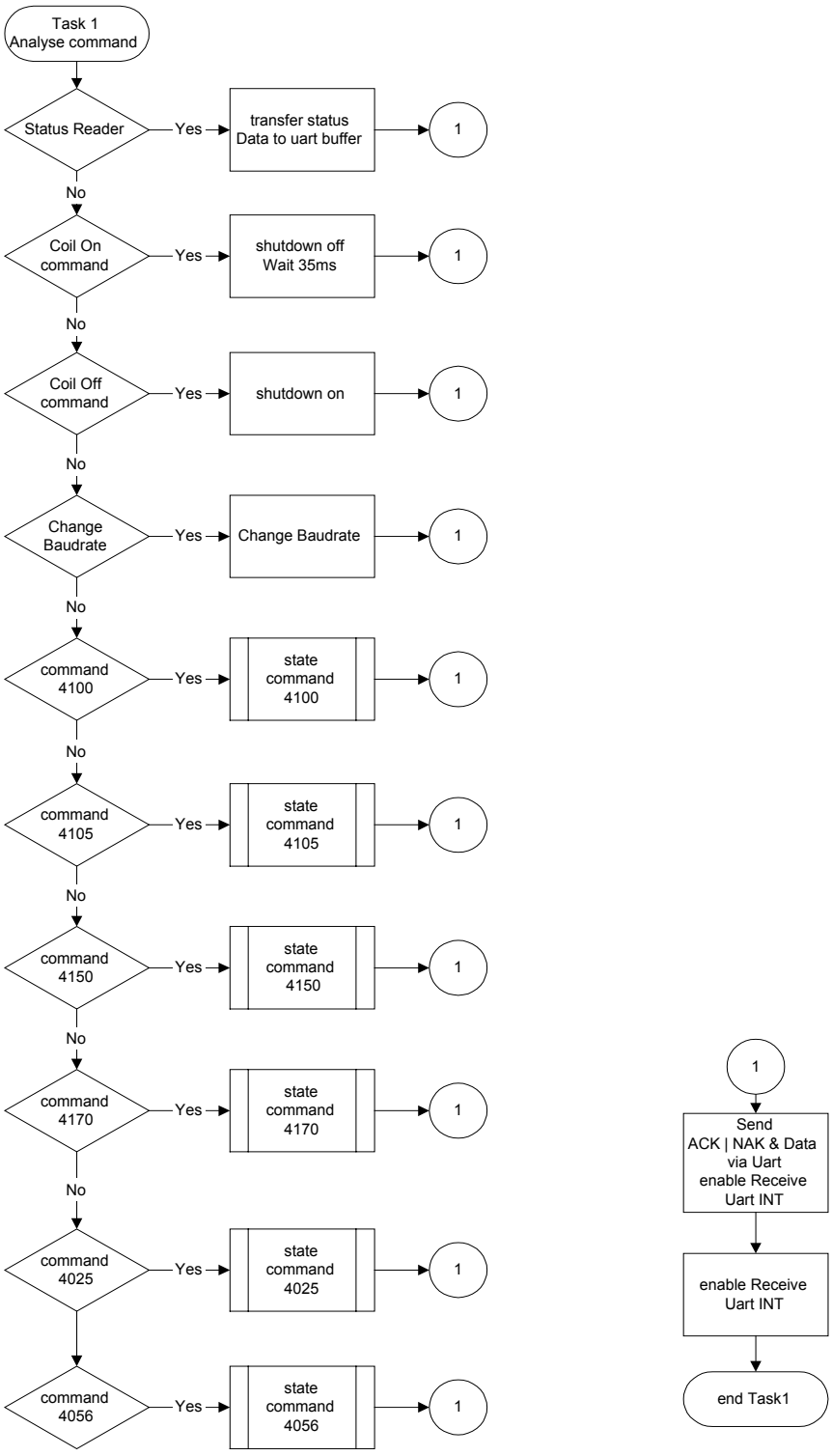


Figure 3: Command handling

5.2.1 Flow Chart Transponder EM4102

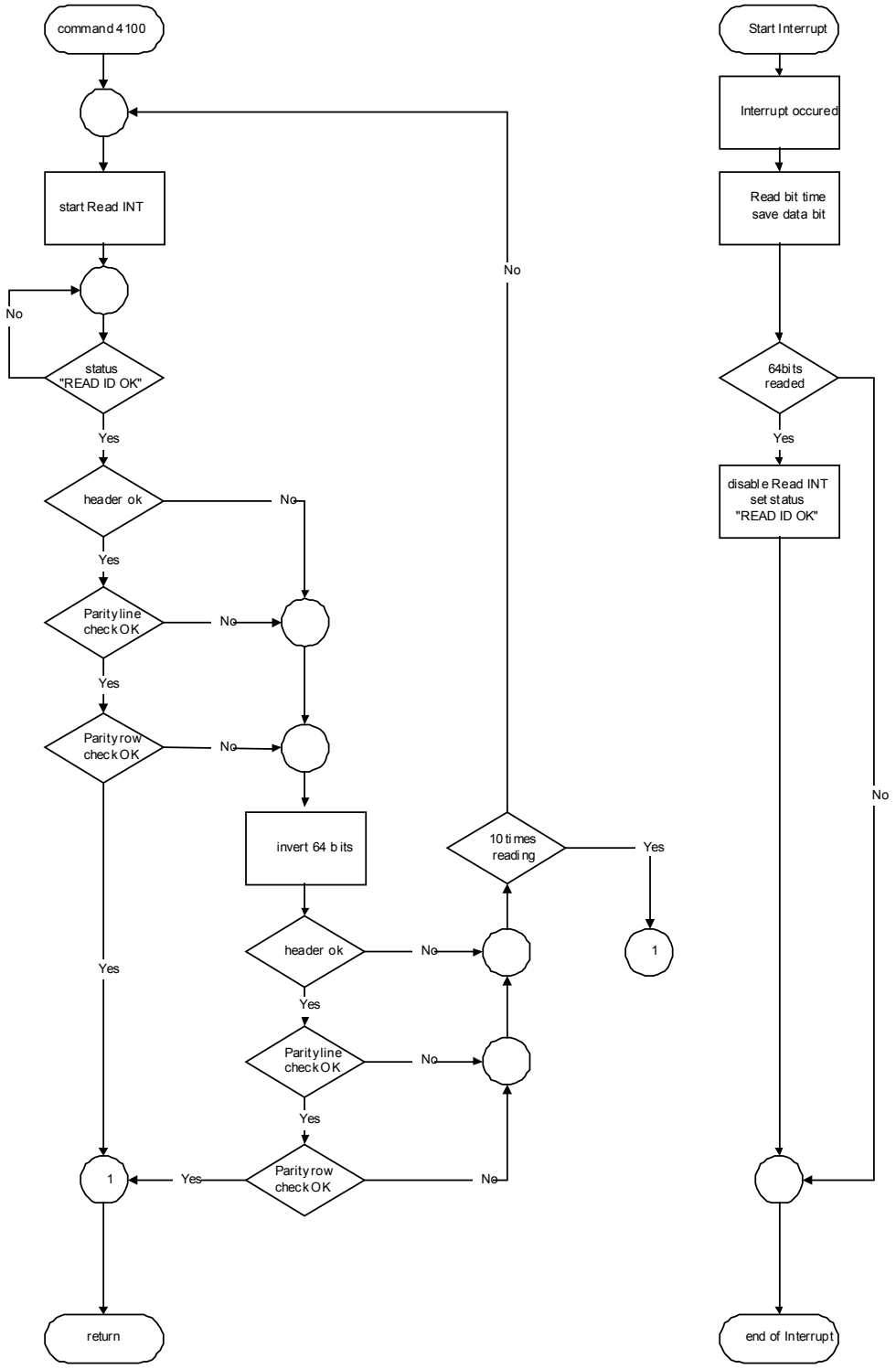


Figure 4: Flow Chart Transponder EM4102

5.2.2 Flow Chart Transponder EM4005

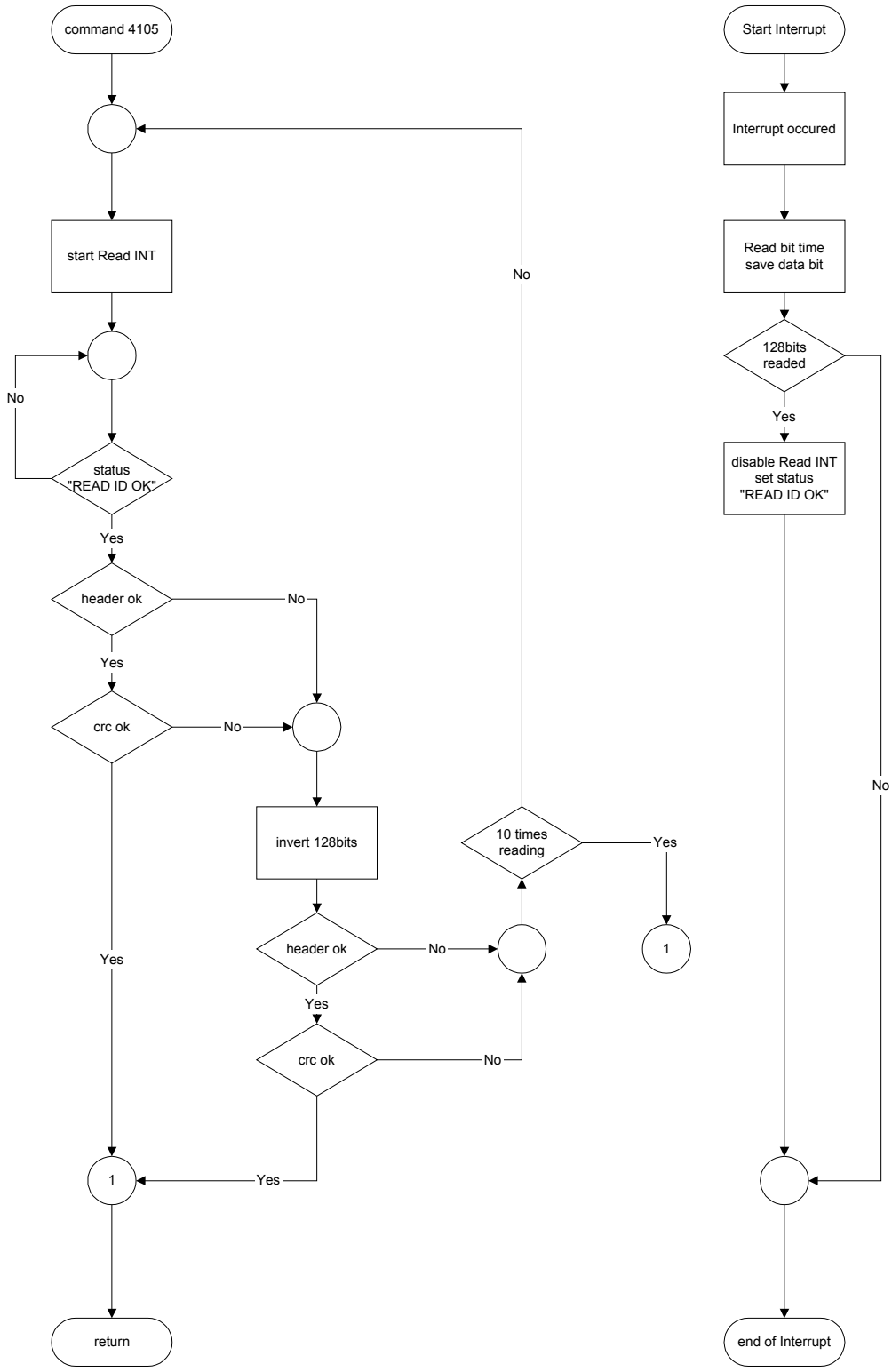


Figure 5: Flow Chart Transponder EM4005

5.2.3 Flow chart Transponder EM4150

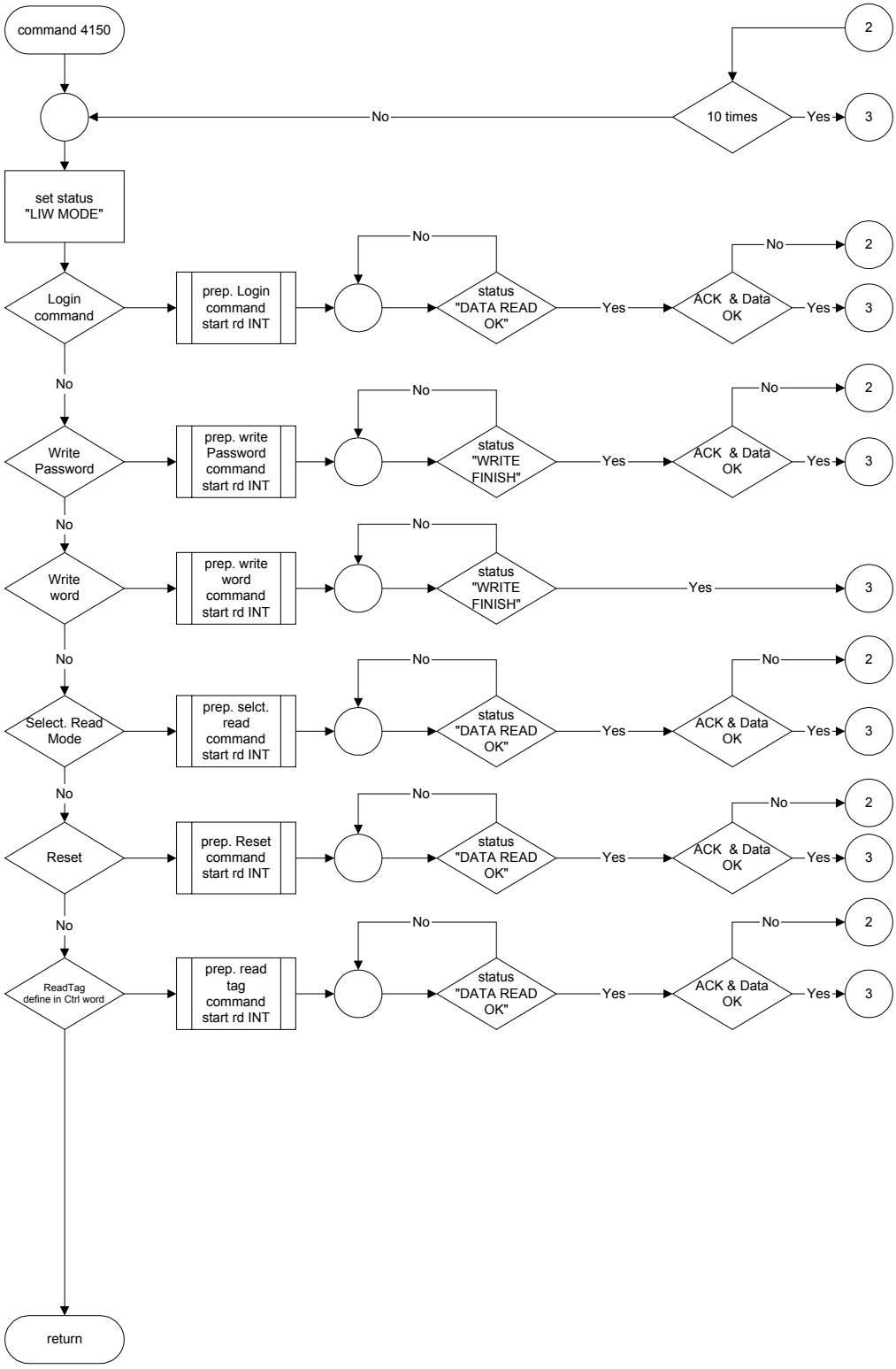


Figure 6: Flow chart Transponder EM4150

5.2.4 Flow chart Transponder EM4170

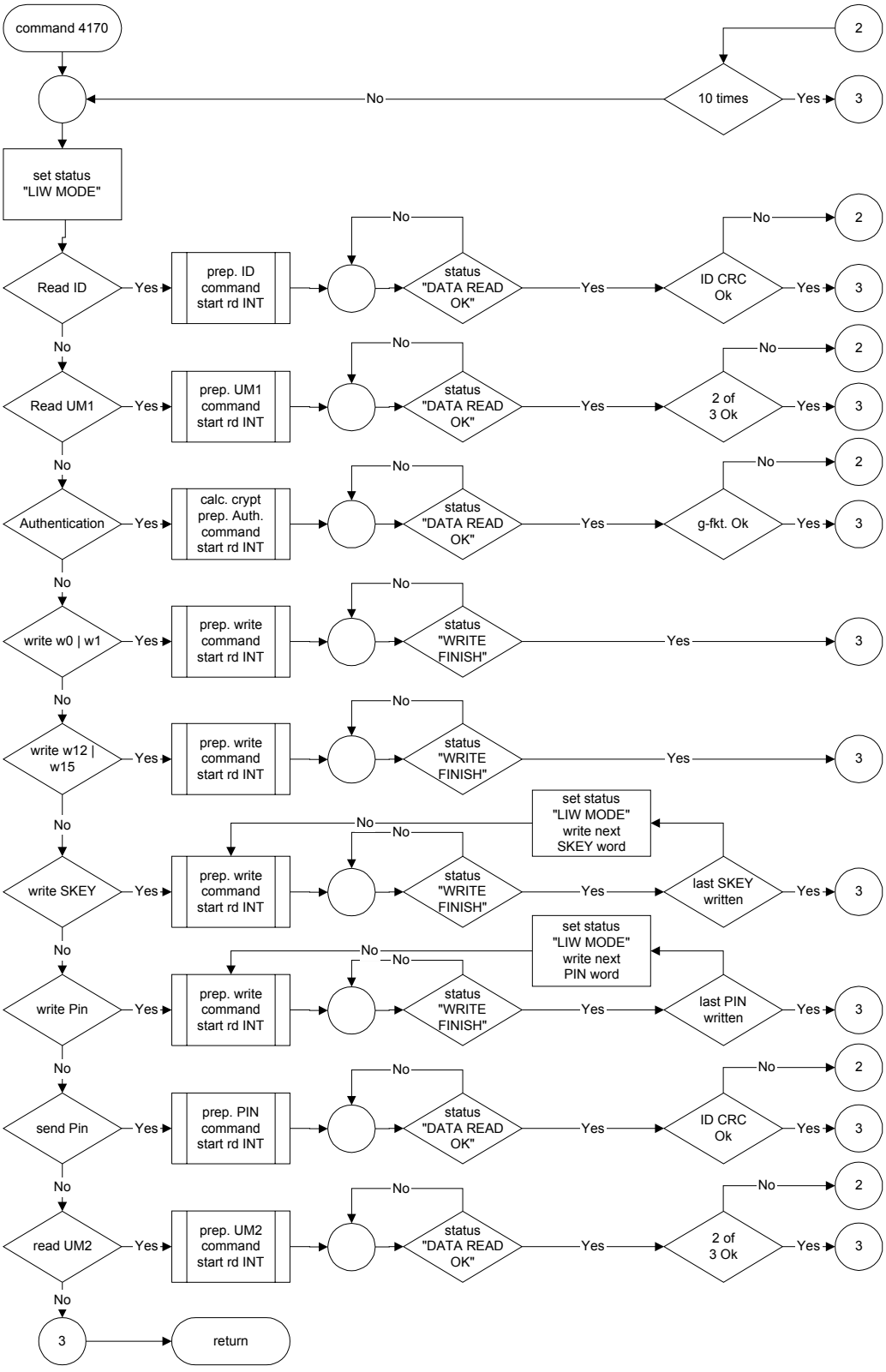


Figure 7: Flow chart Transponder EM4170

5.2.5 Flow chart Transponder EM4025

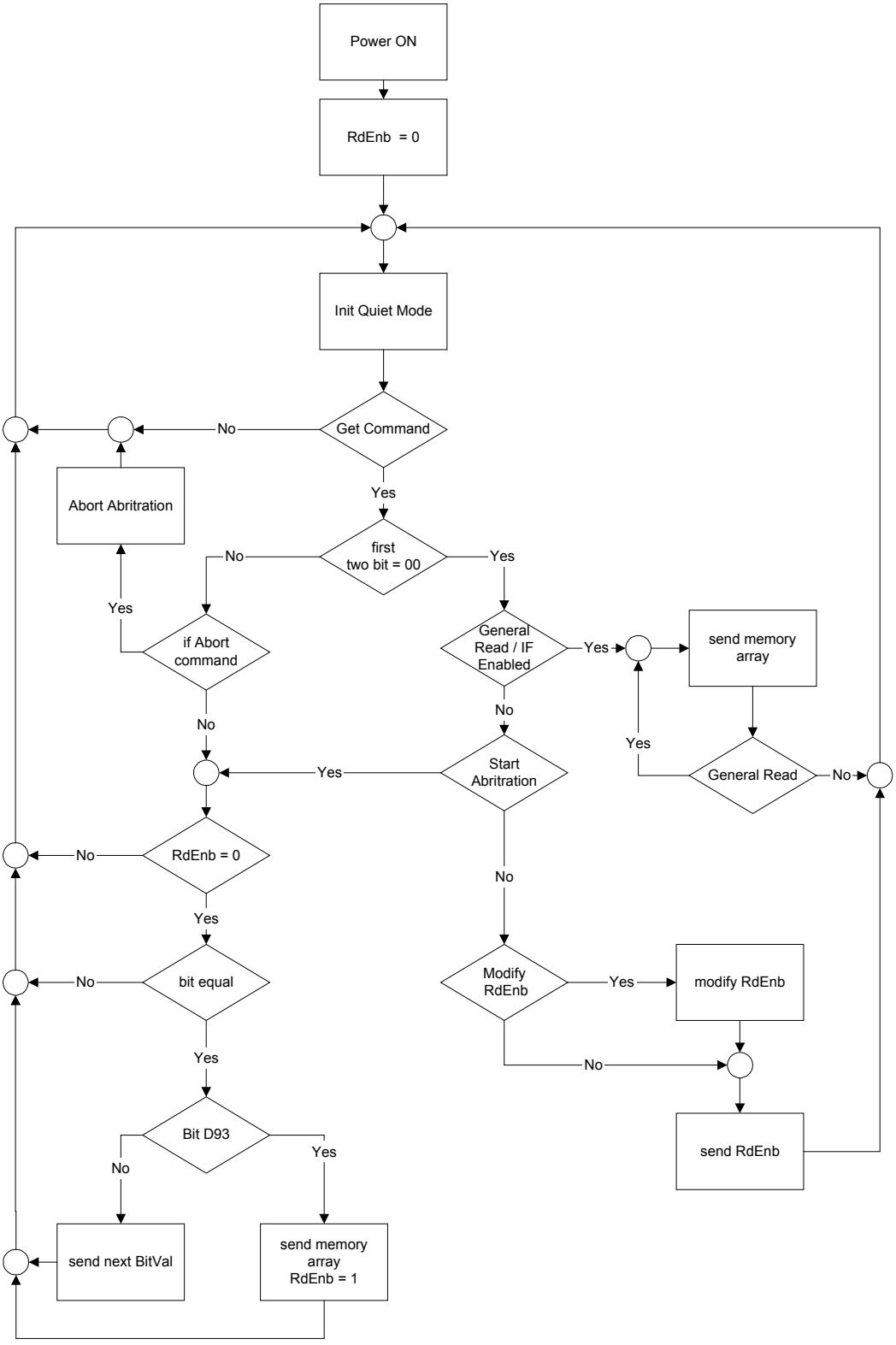


Figure 8: Flow chart Transponder EM4025

5.2.6 Flow chart Transponder EM4056

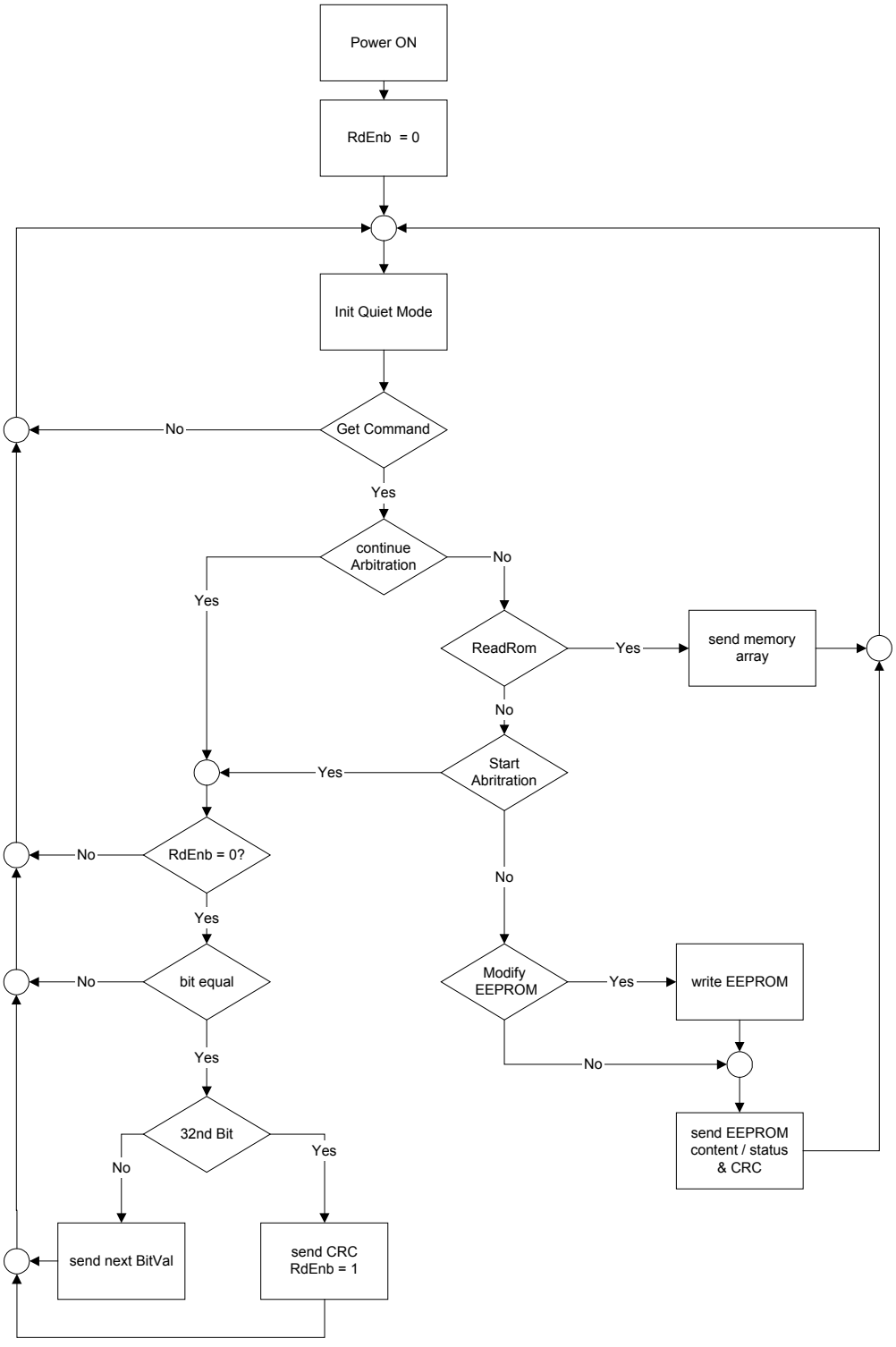


Figure 9: Flow chart Transponder EM4056

5.3 Flow chart communication with Transponder

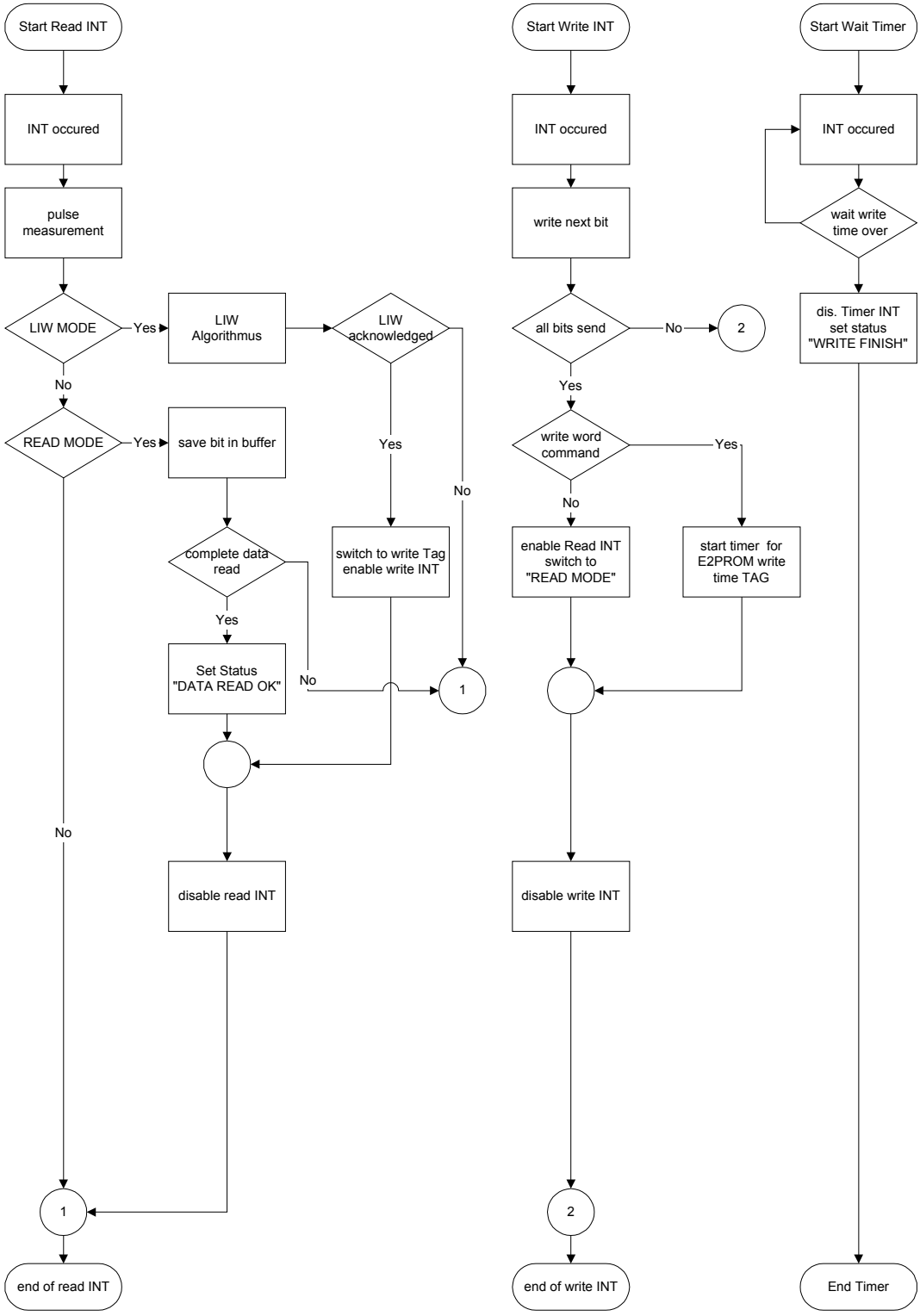


Figure 10: Flow chart communication with Transponder

6 Hardware

6.1 Description

The Development Kit EM4095 is a complete Reader board including coil which only needs an 5 V power supply and communicates with an RS 232 interface. The board can be integrated into a customer specific application or parts of the schematic can be integrated in a customer specific board design.

The CryptCo microcontroller which calculates the crypt functions for the EM4170 Crypt Transponder is only needed for this type of transponder.

On the following pages the circuit diagram of the chip set board, and the layout is documented. The board can be used with the printed reading coil or an external coil can be connected; in this case the connection to the printed coil should be disabled. When using an external coil the resonance capacitors should be changed, so that the circuit is tuned to resonance. Details are described in the EM4095 application note.

So, if you want to connect your own antenna to the Development Kit EM4095, you will have to:

- Disconnect the integrated coil by cutting the two nets, which are connected, to LB1 & LB2.
- Connect your antenna to X6 & X7.
- Use the EM4095 Excel worksheet to calculate the value of capacitors C1, C2 & C3. This sheet can be found on EM's website www.emmicroelectronic.com.

To calculate these 3 capacitor values, you will have to measure previously some specifications of your antenna:

- Coil value in Henry to determine the value of C1.
- Q Quality factor: Q = (L * W) / Rs. Rs is the serial resistor of the Antenna.

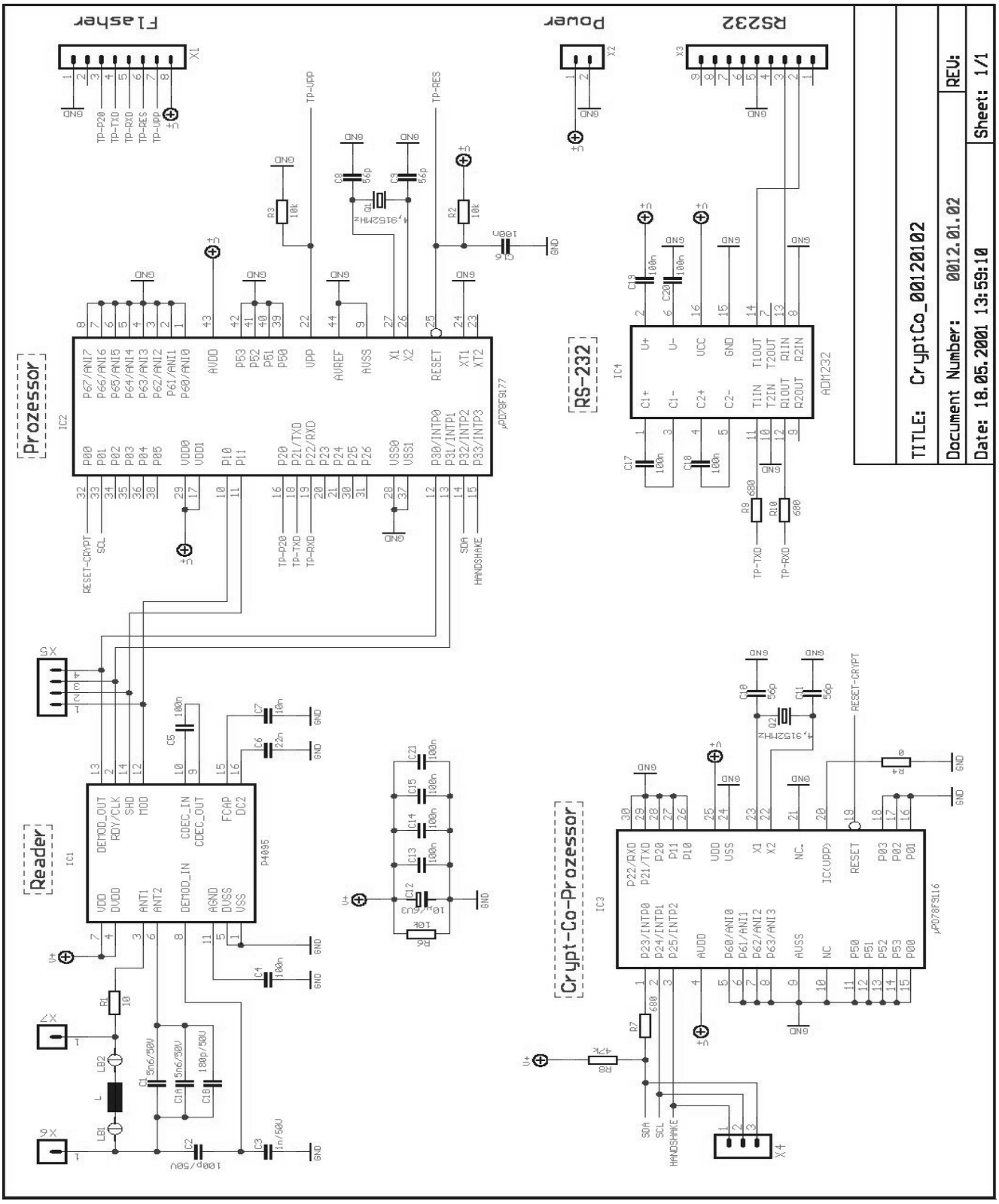
With the Development Kit EM4095, you can also boost or reduce the Antenna current by changing the value of the resistance R1.

For example, if you decide to reduce the R1 value, you can increase the Reading and/or Writing distance.

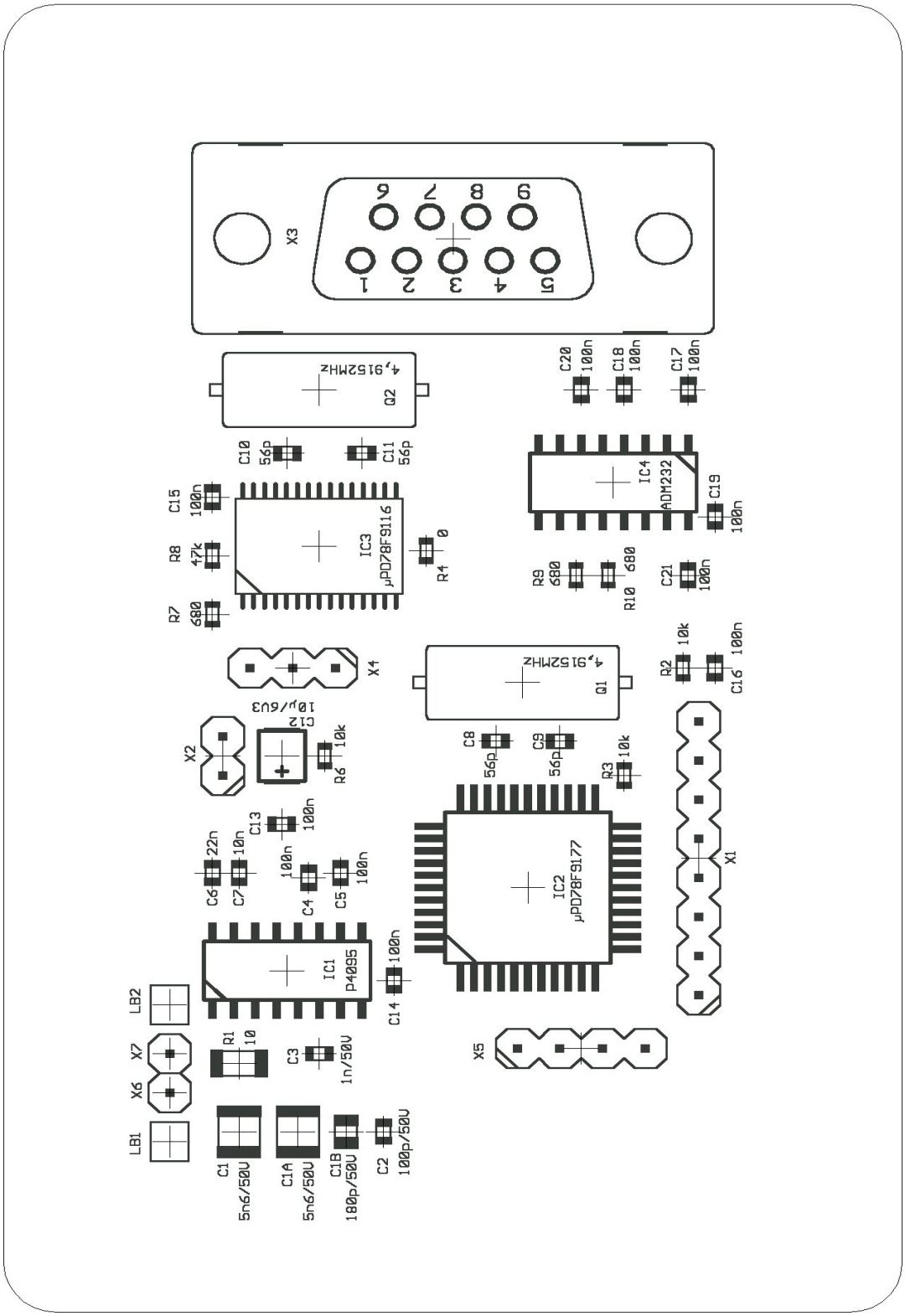
Caution: The Antenna current has to be lower than 200mA (EM4095 maximum AC peak current on ANT1 and ANT2 pads).

For more information, please, contact **cid@emmicroelectronic.com** Internet email address.

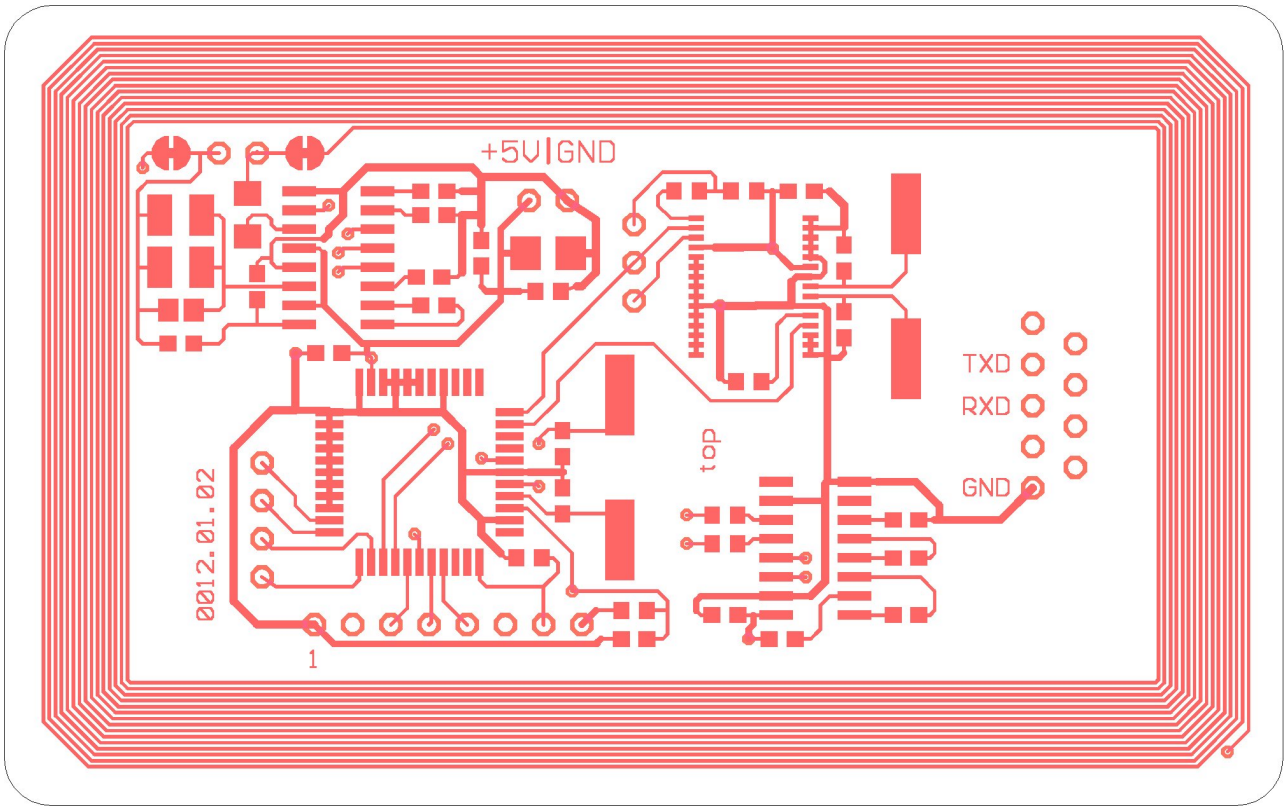
6.2 Development Kit EM4095 Circuit Diagram



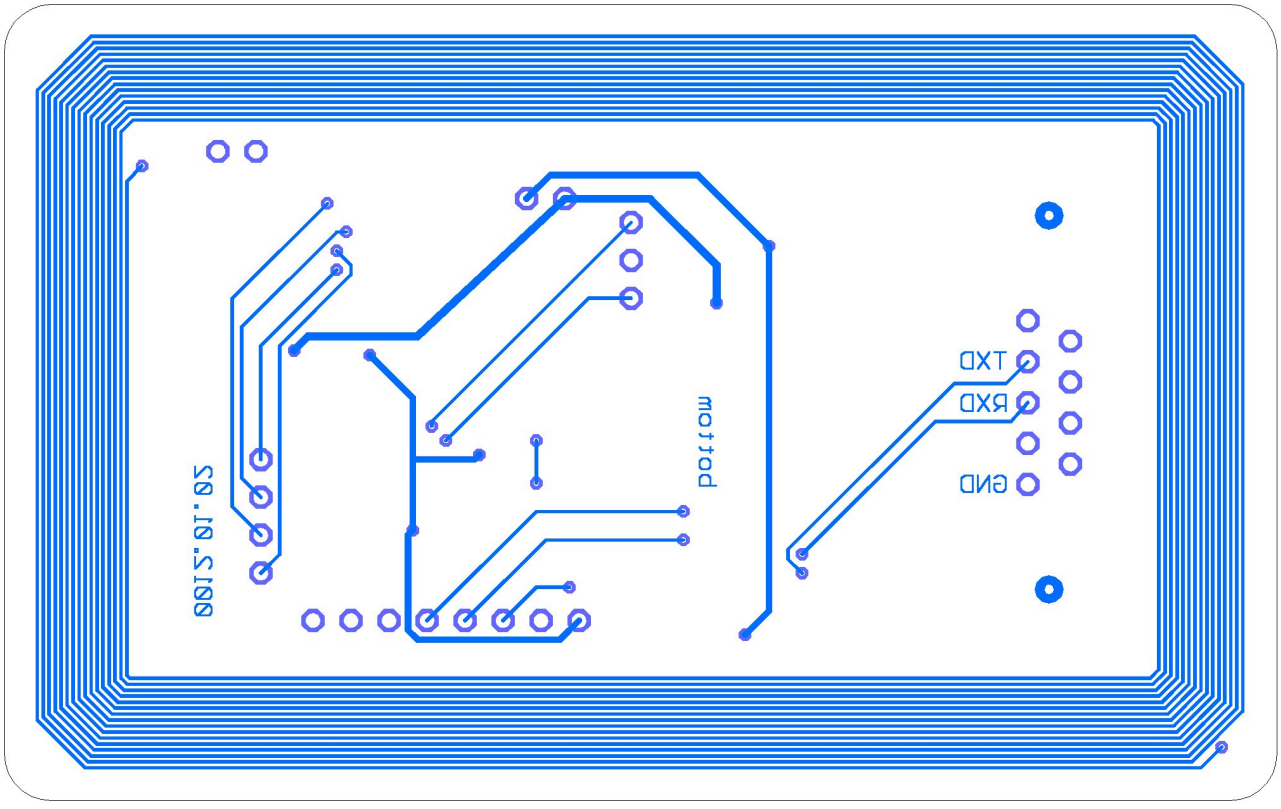
6.3 Development Kit EM4095 Board image



6.4 Development Kit EM4095 top Layer Image



6.5 Development Kit EM4095 bottom layer image



7 Appendix

For further information see also:

Datasheet
EM4095 Read/Write analog front end for 125kHz RFID Basestation
EM Microelectronic-Marin SA, Marin, 2000

Datasheet
EM4170 Crypto Contactless Identification Device
EM Microelectronic-Marin SA, Marin, 2001

Datasheet
EM4150 Read / Write 1Kbit Identification Device
EM Microelectronic-Marin SA, Marin, 2001

Datasheet
EM 4056 Read / Write with Anticollision Identification Device
EM Microelectronic-Marin SA, Marin, 2001

Datasheet
EM4025 Read Only with Anticollision Identification Device
EM Microelectronic-Marin SA, Marin, 2001

Datasheet
EM 4102 Read Only 64 bit Identification Device
EM Microelectronic-Marin SA, Marin, 2001