MaxID RM100 Operational manual

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1. 0	2005/03/11	Updated product name.
1. 1	2005/03/16	Updated baudrate to 38400, even parity. Added hopping and filter commands. Added repeat read (RR) command. Added debug mode.
1. 2	2005/07/06	Synchronised document.

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Table of Contents

1. Scope ***4***
Introduction 4
Purpose 4
Physical interface 4
Definitions 4
Supporting Documents 5
Limitation of Liability 6
FCC compliance 7
FCC statement 7
Note 7
Label 7

2. Simple interface ***8***
Introduction 8
Commands 8
Modes 9
IPX 9
EPC Class 1 10
EPC 1.19 10

3. Debug mode ***11***
Introduction 11
Commands 11

4. Old compatibility mode ***13***
Introduction 13
Commands 13
Reading mode 14

5. Number conversions ***15***
Introduction 15
EAN numbers 15
EPC 1.19 16
Example 1 17
Example 2 17

1. Scope

Introduction

The RM100 RFID reader/writer makes use of a simple interface at present. The simple interface used at present is sufficient for demonstration and evaluation purposes. The simple interface provides access to the setting up of the RFID reader as well as reading and writing various types of tags.

This interface will be upgraded to the new EPCGlobal Reader interface when this specification is stabilised.

Purpose

This document has been provided as a reference for developers making use of the RM100 RFID reader using the simple protocol.

Physical interface

The RM100 reader is connected via an RS232 serial interface. The parameters for the interface are:

Speed:	38400 bits/sec
Bits per character:	8
Parity:	Even
Stop bits:	1

Definitions

Term	Definition
■	End-of-document marker
EPC	Electronic Product Code
EPC 1.19	Philips' version of EPC tag based on the UCODE tag [7]
EPC Class 1	First generation Class 1 EPC tags based on Auto-Id Centre specification [4]
EPC Gen 2	EPCGlobal Class 1 Generation 2 UHF RFID [6]
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission (USA)
IPX	"Tag talks first" tag [3]
RFID	Radio Frequency Identification (tags)
UCODE	Philips' tags based on ISO18000-6 type B [2]
868 MHz	ETSI frequencies Single channel in 869.4 to 869.65 MHz [10] [11] 15 channels in 865.0 to 868.0 MHz [12]

Term	Definition
915 MHz	FCC frequencies 50 channels from 902.75 MHz to 927.25 MHz in 500 KHz steps using frequency hopping

Supporting Documents

[1] EPCTM Tag Data Standards Version 1.1 Rev.1.24 – EPCglobal Standard Specification – 1 April 2004. http://www.epcglobalinc.org/standards_technology/EPCTagDataSpecification11rev124.pdf

[2] ISO/IEC FDIS 18000-6 Information technology – Radio-frequency identification for item management – Part 6: Parameters for air interface communications at 860 MHz to 960 MHz – Final draft dated 2004.

[3] Multi Frequency Contactless Identification Device – Anti-Collision compatible with BTG's Supertag category Protocols – EM Microelectronic-Marin SA – Rev. D/414 dated January 2002. http://www.emmicroelectronic.com/webfiles/product/rfid/ds/em4022_ds.pdf

[4] EPCGlobal Technical report – 860MHz-930MHz Class 1 Radio Frequency identification Tag Radio & Logical Communication Interface Specification Candidate Recommendation – Version 1.0.1 dated 14 November 2002. http://www.epcglobalinc.org/standards_technology/Secure/v1.0/UHF-class1.pdf

[5] UCODE EPC 1.19 – Implementation of EPC tag data on UCODE PC 1.19 – Philips Application Note – Revision 1.2 dated July 2004. http://www.semiconductors.philips.com/acrobat_download/other/identification/SL099820.pdf

[6] EPCGlobal – EPC Tadio Frequency Identity Protocols – Class-1 Generation-2 UHF RFID – Protocol for communications at 860 MHz – 960 MHz – Version 1.0.9 dated 2 Feb 2005. http://eroom.uc-council.org/eRoom/facility/HAG/0_2f855 (note logon username and password is required)

[7] UCODE EPC 1.19 SL3ICS31 01 – Functional Specification – Philips Data Sheet – Revision 1.4 dated June 2004.

[8] UCODE EPC 1.19 SL3ICS31 01 – Functional Specification – Philips Data Sheet – Revision 1.4 dated June 2004.

[9] Federal Communications Commission – Title 47 of the Code of Federal Regulations: Telecommunication – Part 15: Radio Frequency Devices dated 7 January 2005. http://www.fcc.gov/oet/info/rules/part15/part15_11_05_04.pdf

[10] CEPT/ERC Recommendation 70-3 relating to the use of Short Range Devices (SRD) dated October 2004. http://www.ero.dk/documentation/docs/doc98/official/pdf/REC7003E.PDF

[11] ETSI EN 300 220-1 Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Radio equipment to be used in the 25 MHz to 1000 MHz frequency range with power levels ranging up to 500 mW; Part 1: Technical characteristics and test methods – version 1.3.1 dated August 2000. http://pda.etsi.org/pda/queryform.asp

[12] ETSI EN 302 208-1 Electromagnetic compatibility and Radio spectrum Matters (ERM); Radio frequency Identification Equipment operating in the band 865 MHz to 868 MHz with power levels up to 2 W; Part 1: Technical requirements and methods of measurement – version 1.3.1 dated August 2000. http://pda.etsi.org/pda/queryform.asp

Limitation of Liability

In no event shall MaxID or anyone else involved in the creation, production or delivery of the accompanying product (including hardware and software) be liable for any damages whatsoever (including, without limitation, consequential damages including loss of business profits, business interruption or loss of business information) arising out of the use of or the results of use of or inability to use such product, even if MaxID has been advised of the possibility of such damages. Some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

FCC compliance

Federal Communications Commission

This device complies with Part 15 of the FCC Rules [9] . Operation is subject to the following two conditions:(1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

FCC statement

Federal Communications Commission Statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiated radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Changes or modifications not expressly approved by the party responsible for compliance could void the user‘s authority to operate the equipment.

Note

This device and its antenna may not be co-located or operated in conjunction with any other transmitter or transmitter antenna.

Label

2. Simple interface

Introduction The simple interface behaves in a similar manner to the AT commands used by modems. A command is a text string ended with a carriage return. A response is a text string ended with a carriage return and a line feed. Typically, the responses are OK or ERROR n.

Commands The commands that are supported are as follows:

Command	Description	Response
?	Display help screen	Menu
V	Get version	Version
I0	Switch transmitter off	OK
I1	Set mode to IPX at 915 MHz	OK
I2	Set mode to IPX at 868 MHz	OK
I3	Set mode to EPC class 1 at 915 MHz	OK
I4	Set mode to EPC class 1 at 868 MHz with ETSI timings	OK
I5	Set mode to UCODE EPC 1.19 at 40 kb/s mode at 915 MHz	OK
I6	Set mode to UCODE EPC 1.19 at 40 kb/s mode at 868 MHz	OK
I7	Set mode to UCODE EPC 1.19 at 10 kb/s mode at 915 MHz	OK
I8	Set mode to UCODE EPC 1.19 at 10 kb/s mode at 868 MHz	OK
I9	Set mode to EPC class 1 at 868 MHz with FCC timings (Non-standard operation for test purposes only)	OK
R RR	Read tags at current mode setting. R performs one round of reading whereas RR reads until a key is pressed. Note that during an RR, if a space key is pressed, the filter buffer is cleared, a blank line is displayed and tags are read immediately.	<data> OK
W<data>	Write to tag at current mode setting (note that only EPC 1.19 UCODE is enabled at this stage).	ERROR or OK
Fn	Select filter mode (report tags at filtering period only) F0 – no filtering F1 to F9 – filter one to nine seconds (default is two seconds)	OK
Hn	Select hopping mode H0 – Fixed frequency (915 for FCC and 869.4 for ETSI) Hn – Fixed channel (1 to 50 for FCC and 1 to 10 for ETSI) H255 – Select hopping mode (default mode)	OK
P<val>	Set output power (0 to 255). The firmware limits the maximum and minimum power levels.	ERROR or OK

Command	Description	Response
T	Adjust power setting - Decrease by 1 + Increase by 1 < Decrease by 10 > Increase by 10	OK
Obaud	Set old compatibility mode (see below)	None
Gbaud	Set “ghost buster” mode	None
D	Set debug mode – use ? for help screen	None
Q<n><val>	Set FPGA register <n> to value <val> Note that this is for advanced users only.	OK
X Y	Debug commands to switch synthesizer on and off: X=on and Y=off	OK
Z	Switch receiver on and transmitter off. An active mode must be selected before this command is used so that the correct frequency is set up. This command is used for laboratory testing only.	OK
Ctrl-L	Invoke loader	None
Ctrl-C	Reset device	None

Modes

The mode is set using the I command. The modes that are supported are:

- IPX
- EPC Class 1
- EPC 1.19 UCODE or ISO18000-6 at 40 kb/s
- EPC 1.19 UCODE or ISO18000-6 at 10 kb/s

Two frequencies are supported:

- FCC 915 MHz [9] (50 channels from 902.75 MHz to 927.25 MHz in 500 KHz steps using frequency hopping).
- ETSI 868 MHz [12] (10 channels from 865.7 MHz to 867.5 MHz in 200 KHz steps using frequency hopping)

IPX

IPX tags operate on a “tag talks first” basis. When the transmitter is switched on, they randomly respond. Each tag is checked for a correct CRC. The tags numbers are 8 bytes or 64 bits. Further information may be found in reference [3] .

EPC Class 1

The EPC Class 1 (Generation 1) tags can be either 64 or 96 bits (8 or 12 bytes). The tags are searched in a tree fashion, until all responding tags are identified.

Note that for ETSI operation, a separate mode has been added for FCC timings. This mode is used to support non-standard tags that operate at ETSI frequencies and not at the ETSI timings.

Further information on the Class 1 tags may be found in reference [4] .

EPC 1.19

The EPC 1.19 UCODE tags are based on the ISO 18000-6 type B specification. These tags are searched using the automated backing off as built into the standard.

The tag number that is returned comprises bytes 0 to 7 and bytes 10 to 17, making up a 16 byte number. The matching of EPC numbers to this data is done according to reference [5] .

The RM100 also supports the writing of these tags.

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3. Debug mode

Introduction

This mode is used for development and testing purposes. This mode should not be used for applications.

The serial port is set to 38400 b/s, 8 bits even parity and no hardware flow control. On entry the reader sends a header to the PC:

Debug mode

Commands

The commands are usually single keystrokes as follows:

Command	Description	Response
?	Display help screen	Menu
V	Get version	Version
0	Switch transmitter off	
1	Set mode to IPX at 915 MHz	
2	Set mode to IPX at 868 MHz	
3	Set mode to EPC class 1 at 915 MHz	
4	Set mode to EPC class 1 at 868 MHz with ETSI timings	
5	Set mode to UCODE EPC 1.19 at 40 kb/s mode at 915 MHz	
6	Set mode to UCODE EPC 1.19 at 40 kb/s mode at 868 MHz	
7	Set mode to UCODE EPC 1.19 at 10 kb/s mode at 915 MHz	
8	Set mode to UCODE EPC 1.19 at 10 kb/s mode at 868 MHz	
9	Set mode to EPC class 1 at 868 MHz with FCC timings (Non-standard operation for test purposes only)	
A	Get EPC tags (single round)	Tags
D	Toggle debug mode	
E	Read ISO tags (single round)	Tags
F	Set filter mode	
I	Modulate ISO	
H	Set hopping mode	
J	Modulate ISO with reset	
K	Modulate ISO for EF04 tags	
L	Repeat K command	
M	Modulate EPC	
N	Receive mode	
P	Set output power	
Q	Write value to FPGA (user is prompted for values)	
R	Toggle RESET_RX signal	
S	Toggle show mode	
T	Toggle TX_MOD signal	

Command	Description	Response
X Y	Test EPC	
$	Modulate 0 to 255 repeatedly	
@ !	Modulate EPC with/without receiving	(Tags)
%	Random modulation at current mode	
.	Repeat last command until a key is pressed	
Esc	Exit debug mode	
Ctrl-L	Invoke loader	Message
Ctrl-C	Reset device	Message

When tags are read, they are reported in the following fashion:

IPX: 123456789ABCDEF0	IPX tags
EPC: 123456789ABCDEF012345678	EPC Class 1 tags
UCODE: 123456789ABCDEF0123456789123456	EPC 1.19 tags

4. Old compatibility mode

Introduction

There is another interface that can be used. At the main menu, the O command is used to obtain the old compatibility mode. An optional parameter allows the baudrate to be changed.

Note that this mode is not recommended.

Commands

All commands are single character commands, except for the W command. This is followed by the data and a carriage return. When the transmitter is turned on, or set via a mode, the RM100 reads tags at the current read interval, and reports any tags that are found.

Command	Description	Response
H or ?	Display help menu	Menu
0	Switch transmitter off	None
1	Switch transmitter on (in current mode)	Reading mode
8	Select 868 MHz	Reading mode
9	Select 915 MHz	Reading mode
I	Set IPX mode	Reading mode
E	Set EPC Class 1 mode	Reading mode
U	Set UCODE EPC 1.19 mode	Reading mode
V	Get version of firmware	Version
Wdata	Wrtite tag with data (must be followed with a carriage return. Mode should be set to U and transmitter should be turned off	ERROR or OK
+	Increase scan delay by 100 msec (default is 500 msec)	Current setting
-	Decrease scan delay by 100 msec (default is 500 msec)	Current setting
P<val>	Set output power (0 to 255). The firmware limits the maximum and minimum power levels.	Confirmation message
Q<n><val>	Set FPGA register <n> to value <val> Note that this is for advanced users only.	Confirmation message
Ctrl-L	Invoke loader	None
Ctrl-C	Reset reader	None

Reading mode

While in the reading mode, the tags are read (1 second for IPX, one round for EPC and UCODE EPC 1.19), and then the transmitter is switched off or the scan delay period. Tags are reported as follows:

- IPX: <ipx number>
- EPC: <epc number>
- UCODE: <ucode number>

5. Number conversions

Introduction

The RM100 supports the writing of EPC 1.19 tags. In order to perform the conversions between UPC/EAN numbers, EPC and EPC 1.19 various conversions need to be made. EPC numbers can be 64 or 96 bits but only 96 bits are shown in the examples below.

- EAN (12 to 14 digits) to EPC (96 bits)
- EPC (96 bits) to UCODE EPC 1.19 (128 bits)

EAN numbers

The conversion of EAN numbers to EPC numbers is described in reference [1] .

A UPC/EAN number can range from 12 digits (UPC), 13 (EAN) to 14 (EAN with an indicator digit in front). This number contains four fields:

- Indicator digit (present in 14 digit EAN, otherwise it is zero)
- Company prefix – 6 to 12 digits long
- Item reference – 1 to 7 digits long (including indicator digit)
- Check digit – 1 digit (last digit)

The length of the company prefix is required to extract the fields. Extraction is performed as follows:

- Zeroes are pre-pended until the number is 14 digits long
- Digits 2 to <prefix_length+1> is the company prefix
- Digit 1 and <prefix_length+2> to digit 13 form the item reference

For example:

Number	Prefix length	Company prefix	Item reference
123456789012	8	01234567	08901
123456789012	12	012345678901	0
1234567890123	8	12345678	09012
12345678901234	8	23456789	10123
12345678901234	6	234567	1890123
12345678901234	12	234567890123	1

When generating the EPC (SGTIN-96t) number, each filed is converted to binary. The complete EPC number is generated as follows:

Bits	Name	Description
8	Header	0x30 in hexadecimal
3	Filter value	This is not part of EPC identifier but is used for fast filtering and pre-selection (case, pallet etc)
3	Partition	Denotes number of digits used for company prefix and for item code (see below)
20 to 40	Company prefix	Value as calculated above
24 to 4	Item reference	Value as calculated above
38	Serial number	Serial number of the tag

The partition denotes the separation between the company prefix and the item code as follows:

Partition	Digits		Bits	
	Company prefix	Item reference	Company prefix	Item reference
0	12	1	40	4
1	11	2	37	7
2	10	3	34	10
3	9	4	30	14
4	8	5	27	17
5	7	6	24	20
6	6	7	20	24

EPC 1.19

EPC 1.19 makes use of 8 bytes of user data, 1 header byte and 5 serial number bytes to hold the EPC number. This is described in reference [5] . The conversion is as follows:

EPC	EPC 1.19	Description
	Bytes 1 to 2	0xEF 0x04 (in hexadecimal)
Bits 89 to 96	Byte 3	Portion A – EPC header byte (0x30)
Bits 1 to 38	Bytes 4 to 8	Serial number of tag (read only)
Bits 39 to 80	Bytes 16 to 21	Company prefix and item reference
Bits 81 to 88	Bytes 22 to 23	Partition and filter values

Example 1

For a tag to be written these fields are supplied:
EPC1.19 tag is read: EF04020000A942660000000000000000
EAN barcode is read: 6001574308022
Prefix length is: 6

The EAN number is processed:
Company prefix: 600157 (0x9285D)
Item reference: 0430802 (0x692D2)
The serial number is obtained from the tag number: 0xA94266
The EPC-96 number is: 301A4A1741A4B48000A94266
The EPC.19 number is: EF04300000A9426609285D0692D20600

Example 2

For a tag to be written these fields are supplied:
EPC1.19 tag is read: EF04020000A957F50000000000000000
EAN barcode is read: 6002866004813
Prefix length is: 6

The EAN number is processed:
Company prefix: 600286 (0x928DE)
Item reference: 0600481 (0x929A1)
The serial number is obtained from the tag number: 0xA957F5
The EPC-96 number is: 301A4A37824A684000A957F5
The EPC.19 number is: EF04300000A957F50928DE0929A10600

■