AN759

Interface Control Document for the 13.56 MHz Anti-Collision Interrogator

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SCOPE

This document specifies the external interface requirements for the MCRF4XX and MCRF355/360 Interrogator of the RFID development kits (DV103005 and DV103006). A description of the RS232 interface messages, their bit fields and meanings are described in this document.

Identification

This interface control document is applicable to the Microchip's 13.56 MHz RFID Reader/Writer.

System Overview

The RFID Reader/Writer will support both reading and writing of the MCRF355/360 and MCRF4XX RFID devices. The RFID Reader/Writer will support communication for commands and data via the RS232 interface, using standard protocol settings.

EXTERNAL INTERFACES

Electrical Interfaces

SERIAL COMPUTER INTERFACE

The RFID Reader/Writer communicates with the external host computer via the RS232 interface. The interface settings will be 19.2 Kbaud, 8 bits, no parity and one stop bit. All characters transmitted should be within the ASCII character set, with values less than 127.

TEST INTERFACE

The RFID Reader/Writer provides discrete LEDs that give simple status of the RFID Reader/Writer, independent of an attached PC.

Communication Protocol/Messages

The packet protocol for the RFID Reader/Writer is described in the following paragraphs. The protocol provides a robust, easily managed interface that supports debugging on a simple ASCII terminal, in addition to providing a checksum for message validation.

The general message format is as follows:

EXAMPLE 1: General Message Format

Sync Char	Command	Data	Checksum	CR LF

TABLE 1: GENERAL MESSAGE DETAIL

Sync Char	Single byte character '@', denoting the beginning of a message.
Command	Single byte character defining the command this message represents. See Table 2 for a list of commands.
Data	A variable length field containing additional information support for the command.
Checksum	The two-byte checksum used for the message includes the Sync Char through the end of the Data field. See the following paragraph for more information on the checksum used.
CR LF	This two-byte field is the standard ASCII carriage return '0x0D' and the line feed '0x0A'.

TABLE 2: COMMAND OVERVIEW

Command Char	From	To	Description
'2'	R/W	PC	Data field contains MCRF355 data (14 bytes)
'3'	R/W	PC	Data field contains MCRF355 data (18 bytes)
'4'	R/W	PC	Data field contains MCRF4XX data blocks (Read)
'5'	R/W	PC	Data field contains MCRF4XX data blocks (Write)
'6'	R/W	PC	Data field contains MCRF4XX FRB response data
'7'	R/W	PC	Data field contains MCRF4XX FRR response data
'F'	R/W	PC	Firmware version
'R'	R/W	PC	Response message
'R'	PC	R/W	Reset request command
'M'	PC	R/W	Mode select command
'N'	PC	R/W	No operation
'V'	PC	R/W	Verbose read command
'W'	PC	R/W	Write command
'C'	PC	R/W	Configuration message
'L'	PC	R/W	Load command

CHECKSUM

The checksum is a two-character field. Adding the fields Sync Char through Data into an unsigned byte type, and ignoring any overflow generated, determines this value. The resultant value is then negated to provide a two's complement checksum value. This 8-bit result is then converted to two hex characters to represent the checksum in the message (e.g. checksum byte value 00101100 results in a checksum of two ASCII bytes '2C', represented in the message).

Message Formats

The following paragraphs detail the individual commands and messages.

LOAD MESSAGE

The load command provides a method to update the PIC16F876 firmware in the field via the RS232 interface. The Data Field length is zero. When the load command is received, the RFID Reader/Writer will transition to a 'loader', which will then accept hex record lines to be written to program memory. The format of the hex record should be the format generated by the Microchip assembler/linker. Each hex record line is validated before writing to program memory. The RFID Reader/Writer will either respond with a 'Ready' response message upon successful write or an error message, if unsuccessful. Once the final line of the .HEX file is sent, the newly loaded program is entered using the POR vector at address 0000. See Response Message paragraphs for more information on this.

EXAMPLE 2: Load Message Format

0x40	'L'	Data	Checksum	CR LF

RESPONSE MESSAGE

The response message is used to provide an acknowledge and status response from the R/W to the external PC. The data field contains the specific response encoded as a 2-digit hexadecimal number. The responses supported are listed in Table 3.

EXAMPLE 3: Response Message Format

0x40	'R'	Response Number	Checksum	CR LF

TABLE 3: RESPONSE MESSAGES

Response Number	Equivalent Text	Description
00	"Ready"	Ready for the next message.
01	"EEPROM Burn Failed"	Previous write was read back and validated unsuccessfully.
02	"No Entry Point Specified"	No processor instructions were given for ROM locations 0-3.
03	"Invalid Address"	A write to Program ROM was outside valid range.
04	"Invalid Hex Data"	The characters representing hex data were not in the range 0-9 or A-F.
05	"RS232 Error"	Characters were lost or garbled. Message should be resent.
06	"Invalid Checksum"	Checksum did not verify.
07	"Undefined Command"	Command byte sent is not a known command.
08	"Invalid Parameter"	Contents of a command string are invalid.
09	"Bad Processor"	The slave processor failed to communicate.

RESET MESSAGE

The reset message is sent from the external PC to the Reader/Writer. It instructs the R/W to reset itself and return to the just-powered-up state. In this state, the carrier is off and the R/W is sending 'A' characters over the RS232 line at a 50 Hz rate, looking for a PC-based application to communicate with. See the paragraph on "Auto Detect Support" for a more complete description. The data field length is zero.

EXAMPLE 4: Reset Message Format

0x40	'R'	Data Field	Checksum	CR LF

NOP MESSAGE

The NOP message is a non-operation message. It can be used as a 'heartbeat' message to maintain communication, if needed. The Data Field length is zero. This command returns the "Ready" Response Message ('R'). Note that this, and every, command causes the Reader/Writer to stop its current operations to process the new command. After this command, the Reader/Writer remains in the idle loop, waiting for the next command.

EXAMPLE 5: NOP Message Format

0x40	'N'	Data Field	Checksum	CR LF

MODE SELECT MESSAGE

The mode select message is used to put the RFID Reader/Writer in a specific read mode, as defined below.

EXAMPLE 6: Mode Select Message Format

0x40	'M'	Data Field	Checksum	CR LF

The mode field contains a one-byte character that defines the specific mode to place the reader into. This byte is defined below.

TABLE 4: MODE SELECT CHARACTERS

Mode Char	Description
'0'	Read MCRF355/360 tags, returning the data in Microchip format. No anti-collision – all tag reads are reported.
'1'	Read MCRF355/360 tags, returning raw tag data. No anti-collision – all tag reads are reported.
'2'	Read MCRF355/360 tags, returning the data in Microchip format. Anti-collision enabled – subsequent reads of the same tag are ignored.
'3'	Read MCRF355/360 tags, returning raw tag data. Anti-collision enabled – subsequent reads of the same tag are ignored.
'I'	Inventory read mode (FRR & FRB: tags are put to sleep after being identified).
'C'	Continuous read mode (FRR & FRB).
'A'	Alarm mode (FRR only).
'S'	Stop reading mode (Leave carrier on).
'F'	Reader/writer off (Turn carrier off).

MCRF355 DATA BLOCKS MESSAGE – MICROCHIP FORMAT

This message contains the entire data block from the MCRF355/360 represented in ASCII hex format. It assumes the tag was written in Microchip format, which is: 10-bit header (9 ones and 1 zero), followed by 14 8-bit bytes and a 2-byte checksum, with each byte separated by a zero bit, and written MSB first. The checksum of the block is verified before transmission.

EXAMPLE 7: MCRF355/360 Data Blocks Message

0x40	'2'	Data Block	Checksum	CR LF

The format of the data block is as follows:

Data Block Format

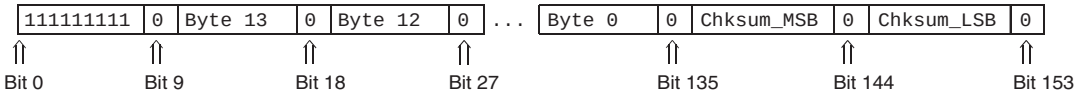
T<time stamp>, <data>

Where:

TABLE 5: MCRF355/360 DATA BLOCKS MESSAGE DETAIL

Field name	Description
Time stamp	The time stamp that indicates when the device was read. This value consists of 2 bytes (4 ASCII hex characters), with the LSB = 819.2 µS. The clock is a free-running counter, with a rollover period of 53.7 seconds. The bytes are sent MSB first.
Data	The 14 data bytes represented in ASCII hex characters. Byte 13 is first; byte 0 is last. The checksum bytes are not transferred.

"Microchip Format" is defined by the MCRF355/360 Contact Programmer and is shown graphically below. Of the 154 bits in the tag, the first 9 are the preamble, and fixed as '1' bits. Following the preamble, and separating each byte, are spacer bits (zeros). All bytes are Most Significant Bit (MSB) first. This format allows 14 data bytes followed by a 16-bit checksum (simple summation of all 14 bytes).



MCRF355 DATA BLOCKS MESSAGE – RAW FORMAT

This message contains the data block from the MCRF355/360 represented in ASCII hex format. It assumes the tag was written in Microchip format, however, the spacer bits which exist between every byte are not removed. Internally, the data is converted to Microchip format so that the block checksum can be calculated and verified before transmission.

EXAMPLE 8: MCRF355/360 Data Blocks Message Format

0x40	'3'	Data Block	Checksum	CR LF

The format of the Data Block is as follows:

Data Block Format

T<time stamp>, <data>

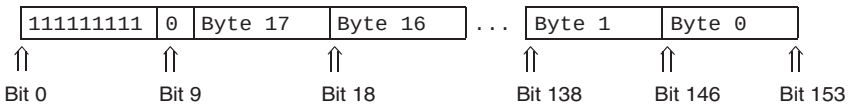
Where:

TABLE 6: MCRF355/360 DATA BLOCKS MESSAGE DETAIL

Field name	Description
Time stamp	The time stamp that indicates when the device was read. This value consists of 2 bytes (4 ASCII hex characters), with the LSB = 819.2 μS. The clock is a free-running counter with a rollover period of 53.7 seconds. The bytes are sent MSB first.
Data	The 18 data bytes represented in ASCII hex characters. Byte 17 is sent first.

For purposes of displaying it in 'Raw Format', the tag data is assumed to be as shown graphically below. It is similar to the Microchip Format in that all bytes are Most Significant Bit (MSB) first, and the first 10 bits are the fixed preamble (9 one-bits followed by a zero bit). The remaining 143 bits make up the 18 8-bit bytes.

Note: The last byte has one missing bit. Its Least Significant Bit (LSB) is fixed at zero.



MCRF4XX DATA BLOCKS MESSAGE

EXAMPLE 9: MCRF4XX Data Blocks Message Format

0x40	'4'	Data Block	Checksum	CR LF

This message contains the data blocks returned from the MCRF4XX in response to a Verbose Read command. All 32 blocks of the MCRF4XX tag are included. The message elements are defined below. The format of the Data Block is:

Data Block Format

I<id>,<block>:<data>,<block>:<data>,...<block>:<data>

Where:

TABLE 7: MCRF4XX DATA BLOCKS MESSAGE DETAIL

Field name	Description
I<id>	The ASCII hex representation of the 4-byte tag ID. LSB first.
Block	Block number, represented by 2 ASCII hex characters. Its value ranges from 00 to 1F (31 decimal). Block numbers are followed by a colon.
Data	One data block (4 bytes) from the tag, represented in ASCII hex characters. Data blocks are separated by commas. A block that is unreadable (invalid CRC) will return "XXXX" for the data. In this case, it will be 4 characters instead of 8. The data is LSB first.

MCRF4XX DATA BLOCKS WRITTEN MESSAGE

EXAMPLE 10: MCRF4XX Data Blocks Message Format

0x40	'5'	Data Block	Checksum	CR LF

This message contains the data blocks returned from the MCRF4XX in response to a Verbose Write command. One message is returned per tag written. The message elements are defined below. The format of the Data Block is:

Where:

TABLE 8: MCRF4XX DATA BLOCKS MESSAGE DETAIL

Field name	Description
I<id>	The ASCII hex representation of the 4-byte tag ID. LSB first.
Block	Block number, represented by 2 ASCII hex characters. Its value ranges from 00 to 1F (31 decimals). Block numbers are followed by a colon.
Data	One data block (4 bytes) from the tag, represented in ASCII hex characters. This data is what the tag returns following the write to this block. A block which is write-protected will return to "RO" for the data. In this case, it will be 2 characters instead of 8. A block that is unreadable (invalid CRC) will return "XXXX" for the data. The data is LSB first.

MCRF4XX FRB RESPONSE MESSAGE

EXAMPLE 9: MCRF4XX FRB Response Message Format

0x40	'6'	Data Block	Checksum	CR LF

This message contains the data returned from the MCRF4XX in response to an FRB command. The message elements are defined below. The format of the Data Block is:

Data Block Format

T<time stamp>,<TC/TP>,<ID>,<FRF>

Where:

TABLE 9: MCRF4XX FRB RESPONSE MESSAGE DETAIL

Field name	Description
Time stamp	The time stamp which indicates when the device was read. This value consists of 2 bytes (4 ASCII hex characters), with the LSB = 819.2 μS. The clock is a free-running counter with a rollover period of 53.7 seconds. The bytes are sent MSB first.
ID	One data block (4 bytes) represented in ASCII hex characters. The data is from Block #1, the tag's ID. The data is sent LSB first.

MCRF4XX FRR RESPONSE MESSAGE

EXAMPLE 6: MCRF4XX FRR Response MessagE

0x40	'7'	Data Block	Checksum	CR LF

This message contains the data returned from the MCRF4XX in response to an FRR command. The message elements are defined below. The format of the Data Block is:

Data Block Format

```
T<time stamp>,<TC/TP>,<ID>,<FRF>
```

Where:

TABLE 10: MCRF4XX FRR RESPONSE MESSAGE DETAIL

Field name	Description
Time stamp	The time stamp indicates when the device was read. This value consists of 2 bytes (4 ASCII hex characters), with the LSB = 819.2 μS. The clock is a free-running counter with a rollover period of 53.7 seconds. The bytes are sent MSB first.
TC/TP	One byte containing the TC and TP values from the tag, represented in ASCII hex characters. Bits 0-2 are the TC value; bits 3-7 are the TP (tag parameters) value. See the MCRF4XX Data Sheet on the format of the TP field.
ID	One data block (4 bytes) represented in ASCII hex characters. The data is from Block #1, the tag's ID. The data is sent LSB first.
FRF	The Fast Read Field, represented in ASCII hex characters. The data is from Blocks #3 through 5. The exact number of bytes in the FRF depends upon the 2 DF bits within the TP field and can be 4, 6, 8 or 12. The LSB is sent first.

FIRMWARE VERSION RESPONSE MESSAGE

EXAMPLE 7: Firmware Version Response Message Format

0x40	'F'	Data Block	Checksum	CR LF

This message is sent once, immediately following connection establishment. The format of the Data Block is 2 ASCII digits, indicating the major and minor revision numbers. The range of revision numbers supported is 1.0 through 9.9.

VERBOSE READ MESSAGE

This message will terminate continuous read mode and initiate a read of a specific ID tag in the field. Use the second form of the message to read any tag which comes into the field. The response to this message will be a MCRF4XX Data Block message ('4').

EXAMPLE 8: Verbose Read Message Format

0x40	'V'	Data Block	Checksum	CR LF

The Data Block has the following format when reading from one selected tag. All characters not between braces ('<' '>') are necessary for a valid message. The <start> and <end> values range from 00 to 1F, covering the 32 Blocks of the tag.

Data Block Format

```
I<id>,<start>,<end>
```

Where:

TABLE 11: VERBOSE READ MESSAGE DETAIL

I<id>	The ASCII hex representation of the 4-byte tag ID (LSB first).
<start block>	The beginning block number to read, represented in ASCII hex.
<end block>	The final block number to read, in ASCII hex representation.

The Data Block has the following format to read data blocks from all devices in the R/W field.

Data Block Format

```
I<id>,<start>,<end>
```

Where

TABLE 12: VERBOSE READ MESSAGE DETAIL

*	Replacing the I<id> field with a star character denotes all tags.
<start block>	The beginning block number to read, represented in ASCII hex
<end block>	The final block number to read, in ASCII hex representation

WRITE MESSAGE

The write message provides the capability to program one, or all, MCRF4XX devices with 1 to 16 blocks of data. If 'write-all-tags' is selected, the Reader/Writer will look for all FRR and FRB parts in the field, writing them as soon as they are found, until the user places the Reader/Writer into another mode (or idle state). If 'one-tag-write' is selected, the carrier is turned off once the selected tag is found and written. The response to this message will be one or more MCRF4XX Data Blocks Written message ('5') - one per tag.

Block 1 (the tag ID) should not be written.

If the starting block number is 0 or 2, the number of data blocks to be written is limited to 1 block.

In order to prevent an FRR part from becoming inaccessible in the case of a failed write to blocks 0, 3, 4 or 5, the Reader/Writer will turn an FRR part into an FRB part prior to writing these blocks. Only if all blocks were written correctly will it turn back into an FRR part. When writing to block 0, Bit 31 should be kept clear to keep from flagging a special case.

Two special cases of the Write Command exist: converting FRR tags into FRBs, and converting FRB tags into FRRs.

To turn devices into FRR parts, issue the Write Message for data block 0, with the two most significant bits of the data (Fast Read and Talk First bits) set to '1'. The remaining 30 data bits are 'don't cares'. When the Reader/Writer sees this situation, it will calculate the correct FRR response CRC for the tag and write it to the lower 16 bits of block 0. Upon a successful write, it then sets the FR bit. A MCRF4XX Data Blocks Written message ('5') is returned for each tag that is changed from an FRB part to an FRR part.

To turn devices into FRB parts, issue the Write Message for data block 0, with Bit 31 of the data (Fast Read) set to '1', and bit 30 (Talk First) set to '0'. The remaining 30 data bits are 'don't cares'. The Reader/Writer will clear the FR bit (Bit 31 of block 0) without affecting any other tag memory bits. A MCRF4XX Data Blocks Written message ('5') is returned for each tag that is changed from an FRR part to an FRB part.

The format of the message is as follows.

EXAMPLE 9: Write Message Format

0x40	'W'	Data Block	Checksum	CR LF

The Data Block has the following format when writing to one selected tag. All characters not between braces ('<' '>') are necessary for a valid message. The total number of <data> fields must be 16 or less.

Data Block Format

```
I<id>, <block number>,<data>,...,<data>
```

Where:

TABLE 1: WRITE MESSAGE DETAIL

Field Name	Description
I<id>	The ASCII hex representation of the 4-byte tag ID (LSB first).
<block number>	The beginning block number to write, represented in ASCII hex.
<data>	A 4-byte block of data, LSB first, in ASCII hex representation.

The Data Block has the following format to write to all devices in the R/W field. The total number of <data> fields must be 16 or less.

Data Block Format

```
*,<block number>,<data>,<data>,....,<data>
```

Where:

TABLE 13: WRITE MESSAGE DETAIL

Field name	Description
*	Replacing the I<id> field with a star character denotes all tags.
<block number>	The beginning block number to write, represented in ASCII hex.
<data>	A 4-byte block of data, LSB first, in ASCII hex representation.

CONFIGURATION MESSAGE

The configuration message provides a method to set specific attributes within the RFID Reader/Writer firmware. The format of the message is as follows:

EXAMPLE 10: Configuration Message

0x40	'C'	Data Block	Checksum	CR LF

The Data Block consists of up to 7 parameters that can be set. The parameters are separated by commas and begin with an identifying character. Any parameter not included in the command retains the value it had before the Configuration Message. The order of the parameters is not important.

Data Block Format

```
T<ts>,M<tcmax>,S<speed>,P<ppm timing>,G<gap timing>,V<vpp>,I<audio>
```

Where:

TABLE 14: CONFIGURATION MESSAGE DETAIL

Field	POR Value	Description
T<ts>	16	The ASCII hex representation of 1 byte. The number of Time Slots used in the tag's FRR command. Valid values are: 1, 16, 64.
M<tcmax>	1	The ASCII hex representation of 1 byte. The TCMAX value to use in the tag's FRR command. Valid values are: 1, 2, 4. If TS = 64, then TCMAX must be 1.
S<speed>	0	The ASCII hex representation of 1 byte. Whether to modulate the carrier at Normal Speed or Fast Speed for the PPM symbols. A value of 0 sets Normal Speed while a value of 1 sets Fast Speed.
P<ppm timing>	0	The ASCII hex representation of an 8-bit signed integer. The relative timing to use for gap periods. Valid range is -6 to +6, with 0 being nominal (175 μS Normal Speed/10 μS Fast Speed). -6 corresponds to 20% reduction in time, and +6 corresponds to 20% increase in time. +/- 3 corresponds to +/-10%, etc.
G<gap timing>	0	The ASCII hex representation of an 8-bit signed integer. The relative timing to use for gap widths. Valid range is -6 to +6, with 0 being nominal (100 μS Normal Speed/6 μS Fast Speed). -6 corresponds to 20% reduction in time, and +6 corresponds to 20% increase in time. +/- 3 corresponds to +/-10%, etc.
V<vpp>	FFh	The ASCII hex representation of 1 byte: The relative strength of the carrier signal. A value of 0 sets no carrier while a value of FFh sets maximum carrier field strength.
I<audio>	1	The ASCII hex representation of 1 byte: A value of 1 enables beeps when each tag is detected. A value of 0 disables audible indication.

AUTO DETECT SUPPORT

At power-up of the RFID Reader/Writer, the character 'A' will be continuously transmitted at a 50 Hz rate over the serial port. This provides a serial stream to support auto-detection of the device by a PC. When the Reader/Writer receives a 'B' character from the PC, it will cease transmission of the 'A' characters, and return a type 'F' Response Message (Firmware Version), thus establishing a positive confirmation of communication. The RS232 parameters are: 19.2 Kbaud, 8 bits, no parity and 1 stop bit.

REFERENCED DOCUMENTS

The following references are used for this document:

1. EIA Standard RS232-C
2. RS232A Specification

REVISION HISTORY

7/10/02 - Changed ‘V’ message to reflect:

a) all tags
b) range of blocks

NOTES:

ON-LINE SUPPORT

Microchip provides on-line support on the Microchip World Wide Web (WWW) site.

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