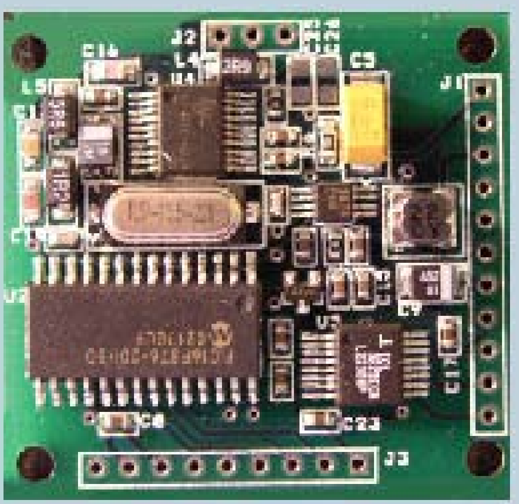

13.56MHz RFID Reader/Writer

ISO-15693 ISO-14443

PRODUCT REFERENCE GUIDE

SkyeRead M1
M1-5
M1-232
M1-5-232

May 2003

SkyeTek
RFID ENGINEERING

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document number RGM1030507.pdf

TABLE OF CONTENTS

1 Product Overview

1.1 General Description

The SkyeRead M1 is a multi-protocol RFID read/write module for use with most industry standard 13.56MHz RFID tags and smart labels including ISO-15693, ISO-14443, Tag-It HF and I·Code 1. Additional tag protocols continue to be added. The FLASH microcontroller unit (MCU) of the M1 guarantees a forward migration path and sound investment as new features and enhancements become available.

The low profile, small footprint and on-board antenna make the M1 a plug and play solution for adding RFID technology into new and existing devices and equipment.

This highly integrated design offers maximum functionality in a very low component-count device, making the M1 a very affordable, easy to use RFID module.

1.2 Highlighted Features

- Low Profile – only 4mm
- Small Footprint – only 38mm x 40mm
- Multi-protocol RFID Tag support including ISO15693, ISO14443 and others
- Flash Upgradable in the field for product updates and future tag protocols
- Four Standard Host Interface options – RS-232, TTL, SPI, and I^2C
- Networkable with up to 255 Reader addresses on a single network (i.e. RS-485)
- On-board antenna with up to 3.5 inches (90mm) range with credit card size tags
- External antenna option with 50 Ohms output
- Low voltage operation down to 1.8V for battery-powered and handheld devices
- Low current – 45mA active mode, 10ma idle mode, and 50uA in standby mode
- Powerful easy to use host interface protocol (SkyeTek Protocol)
- Reads and writes multiple tags simultaneously
- 8 user-configurable I/O – for LEDs, Beepers, or input signal detection
- LCD interface for standard LCD modules

2 Tag Compatibility

Table 1 Tag Compatibility chart

ISO-15693 (-2 and -3 compliant)

Manufacturer	Product	Memory (bits)	Anti-collision	Read	Write
Texas Instruments	Tag-It HF-I	2048	*yes*	*yes*	*yes*
Philips	I·Code SLI (SL2)	1024	*yes*	*yes*	*yes*
Infineon	my-d SRF55V02P	2.5k	*yes*	*yes*	*yes*
	my-d SRF55V02S	2.5k	*yes*	*id only*	*no*
	my-d SRF55V10P	10k	*yes*	*yes*	*yes*
	my-d SRF55V10S	10k	*yes*	*id only*	*no*
ST Microelectronics	LR512	512	*yes*	*yes*	*yes*

ISO-14443 (Type A)

Manufacturer	Product	Memory (bits)	Anti-collision	Read	Write
Philips	Mifare	1024	*no*	*id only*	*no*
Philips	Mifare Ultra-Lite	512	*no*	*yes*	*yes*

Proprietary

Manufacturer	Product	Memory (bits)	Anti-collision	Read	Write
Texas Instruments	Tag-It HF	256	*yes*	*yes*	*yes*
Philips	I·Code1 (SL1)	1024	*yes*	*yes*	*yes*
TagSys	GemWave C210	96	*no*	*yes*	*no*
	GemWave C220	2k	*no*	*no*	*no*
	GemWave C240	192	*maybe*	*yes*	*no*
Inside Contactless (ISO-15693 –2)	PicoTag 2K	2k	*yes*	*Yes*	*yes*
	PicoTag 2KS	2k	*yes*	*id only*	*no*
	PicoTag 16K	16k	*yes*	*yes*	*yes*
	PicoTag 16KS	16k	*yes*	*id only*	*no*

Features shown in grey (grey) in Table 1 are scheduled for upcoming release.

3 Mechanical Specification

Table 2 Dimension Chart

Model	Dimensions	Mass (Weight)
M1-5, M1-5-232	38mm x 40mm x 4.7mm	8g (0.3oz)
M1, M1-232	38mm x 40mm x 3.9mm	7g (0.2oz)

3.1 Dimensioned Drawings

Figure 1 Top View

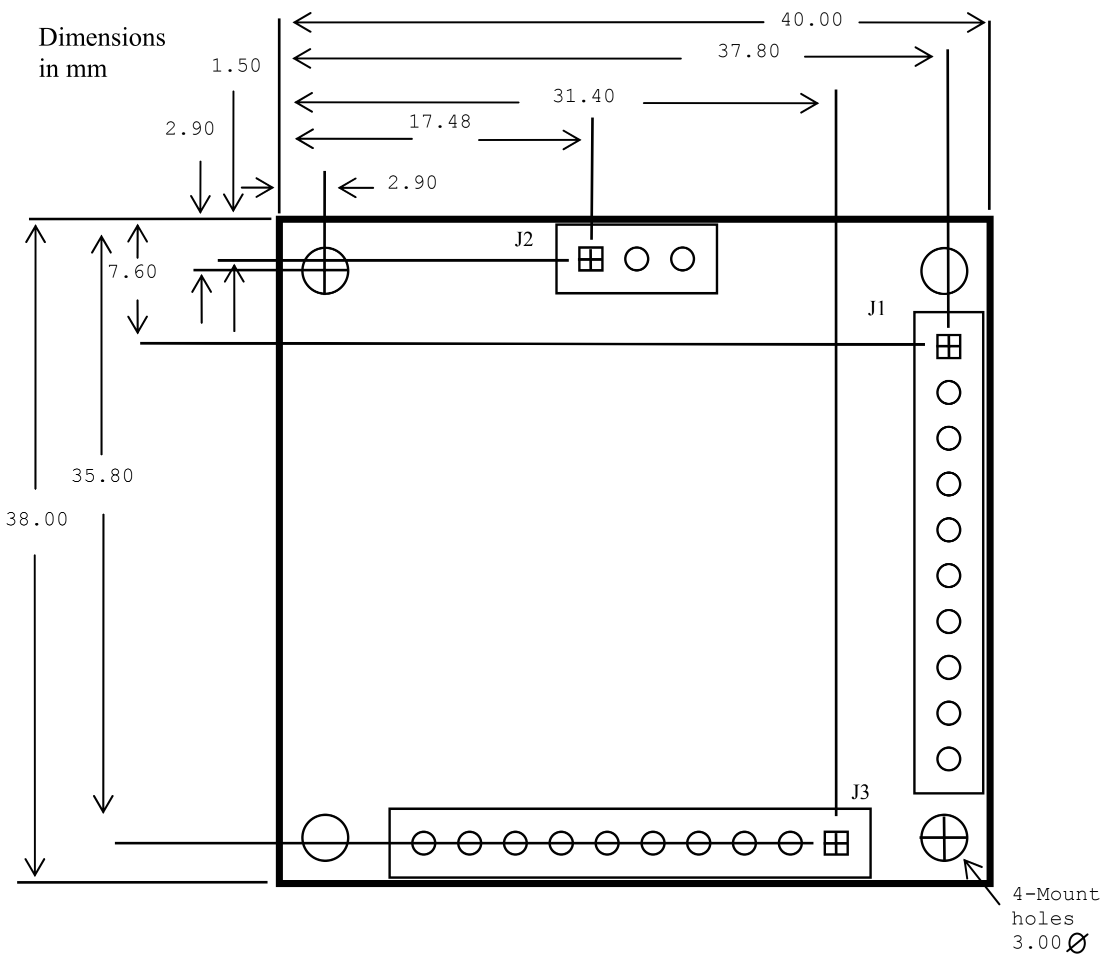


Figure 2 Side View of the M1-5-232

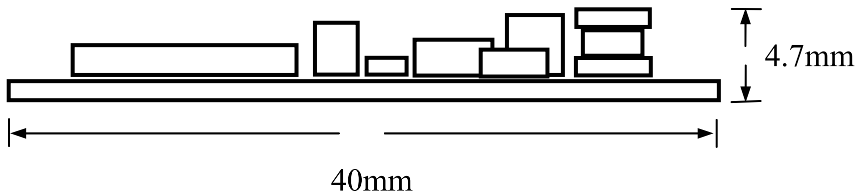
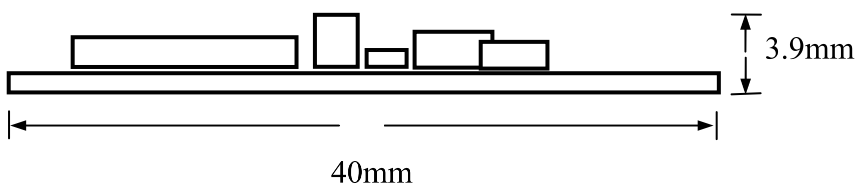


Figure 3 Side View of the M1-232



4 Electrical Specification

4.1 Absolute Maximum Ratings

4.2 Recommended Operating Conditions

4.3 Timings

5 Product Selection

Four models of the SkyeRead M1 are available

Table 3 Product Selection Chart

Model	Power Supply Options	Host Interface Options
M1*	5V only	TTL, SPI, I^2C
M1-5*	5V or 1.8V-5V	TTL, SPI, I^2C
M1-232	5V only	RS-232, TTL, SPI, I^2C
M1-5-232	5V or 1.8V-5V	RS-232, TTL, SPI, I^2C

6 Pin Descriptions

6.1 J1 Pin Descriptions

Table 4 J1 Pin Descriptions

J1		
Pin	**Name**	**Description**
1	V5	5V Input for M1 versions without 5V boost regulator. 5V Output for M1 versions with 5V boost regulator.
2	GND	Power Supply Ground.
3	VIN	1.8 – 5V Input (low voltage or battery input) for M1 versions with 5V boost regulator.
4	RST	0=resets the M1, 1=normal operation
5	SCK/SCL	SCK is the serial clock input signal for the SPI interface, controlled by the host MCU. SCL is the shift clock signal for the I^2C interface.
6	SDI/SDA/RX_TTL	SDI is the serial data input for the SPI interface, coming from the host MCU. SDA is the bi-directional serial data I/O pin for the I^2C interface, to/from the host MCU. RX_TTL is a 0-5V TTL Transmit signal going to the TTL host (MCU).
7	SDO/TX_TTL	Serial data output for the SPI interface, going to the host MCU. TX_TTL is a 0-5V TTL Receive signal coming from the TTL host (MCU).
8	GND	Signal Ground.
9	TX_232	RS232 Transmit signal going to the RS232 host (PC).
10	RX_232	RS232 Receive signal coming from the RS232 host (PC).

6.2 J2 Pin Descriptions

Table 5 J2 Pin Descriptions

J2		
Pin	**Name**	**Description**
1	GND	Antenna Ground.
2	ANT	Antenna Output pin. ANT provides 50 ohms output for matching an external antenna. Jumper ANT to INT to enable the on-board antenna.
3	INT	Internal Antenna pin. Jumper INT to ANT to enable the on-board antenna. Remove the jumper between INT and ANT to disable the on-board antenna and connect an external antenna.

6.3 J3 Pin Descriptions

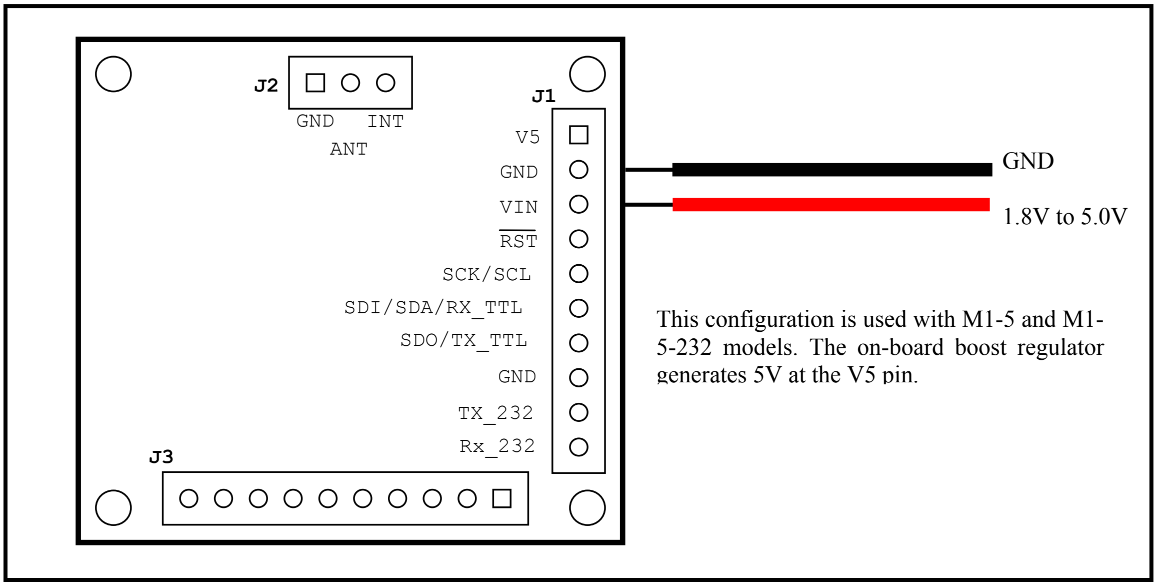
Table 6 J3 Pin Descriptions

J3		
Pin	**Name**	**Description**
1	D7	User-configurable I/O
2	D6	User-configurable I/O
3	D5	User-configurable I/O
4	D4	User-configurable I/O
5	D3	User-configurable I/O
6	D2	User-configurable I/O
7	D1	User-configurable I/O
8	D0	User-configurable I/O
9	V5	Electrically connected to Pin 1 J1
10	GND	Electrically connected to Pin 2 J1

7 Connecting the M1

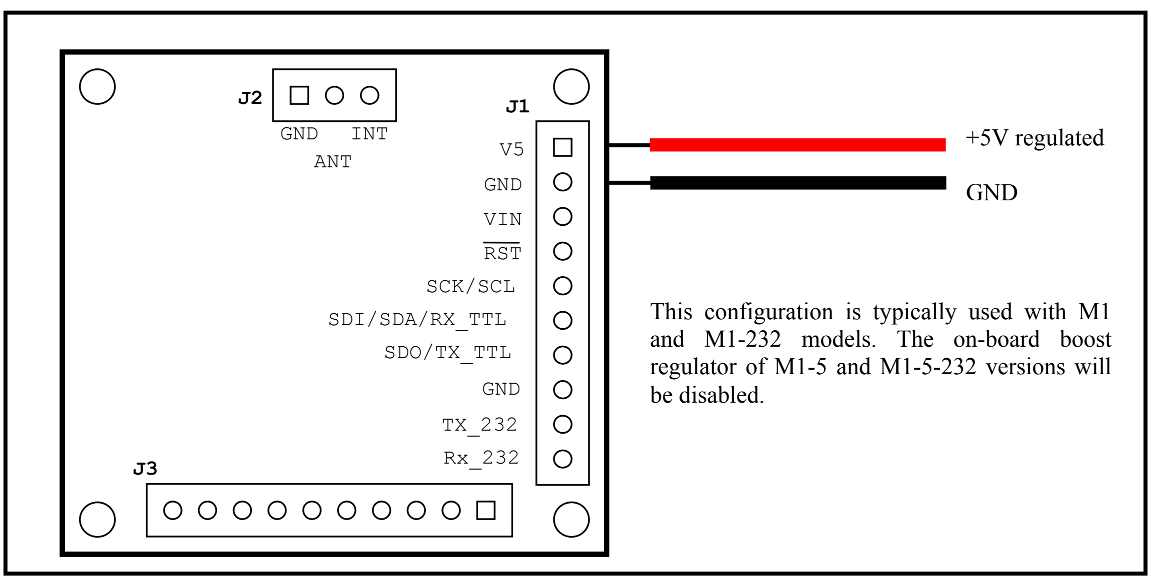
7.1 Power Supply Options

Figure 4 M1-5 and M1-5-232 powered from Battery or VIN ≤ 5V DC



This configuration is used with M1-5 and M1-5-232 models. The on-board boost regulator generates 5V at the V5 pin.

Figure 5 M1 and M1-232 powered from V5 = 5V DC



This configuration is typically used with M1 and M1-232 models. The on-board boost regulator of M1-5 and M1-5-232 versions will be disabled.

7.2 Host Interface Options

RS-232 and TTL are the standard host interface types. SPI and I2C host interface types are available with separate firmware.

7.2.1 RS-232

Use the RS-232 Host Interface to communicate with a PC or other terminal with a standard serial port connection. The RS-232 interface is only available on M1-232 and M1-5-232 models. A 3-wire interface (Rx, Tx, and Gnd) is used.

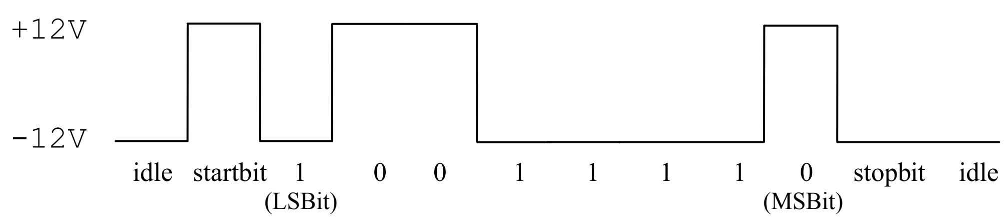
The RS-232 serial data rate is selectable and changeable.

Table 7 RS-232 Data Rates (Baud Rates)

9600 bits/sec	N,8,1*
19200 bits/sec	N,8,1*
38400 bits/sec	N,8,1*
57600 bits/sec	N,8,1*

* N,8,1 means No Parity Bit, 8 Data Bits, 1 Stop Bit

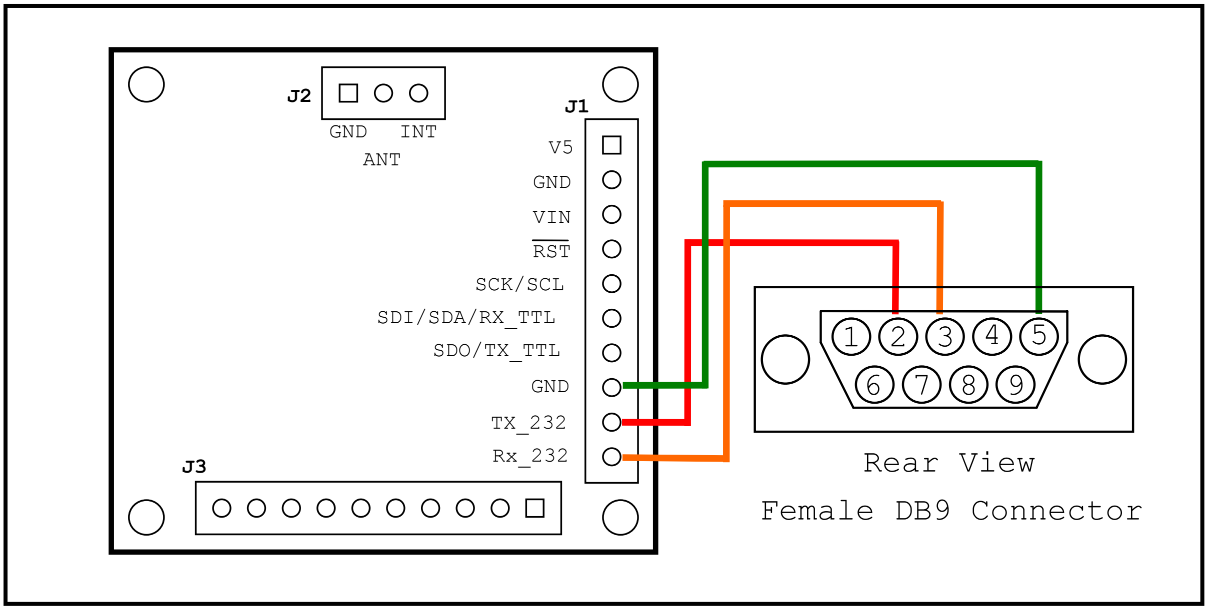
Figure 6 Details of the RS-232 Communication Link



(Example: byte 0x79 transmitted LSBit first via the RS-232 interface)

Going to the PC the signal will appear on Tx_232 (J2 pin9).
Coming from the PC the signal will appear on Rx_232 (J2 pin10)

Figure 7 RS-232 Connection: M1 to PC



Use a standard serial cable to connect from the DB9 connector in Figure 4-4 to an available serial port on a PC. Using a null-modem cable will NOT work.

7.2.2 TTL

Use the TTL Host Interface to communicate with a microcontroller unit (MCU) or other device with a standard 0-5V serial communication interface.

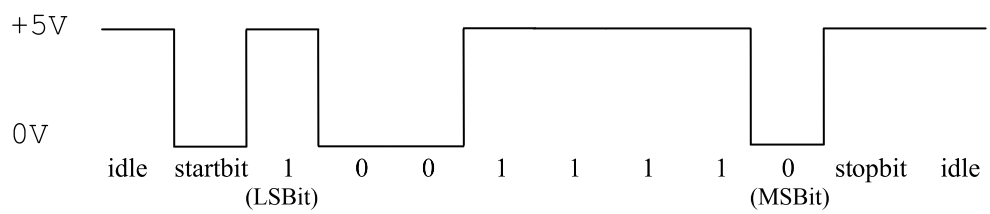
The TTL serial data rate is selectable and changeable.

Table 8 TTL Data Rates (Baud Rates)

9600 bits/sec	N,8,1*
19200 bits/sec	N,8,1*
38400 bits/sec	N,8,1*
57600 bits/sec	N,8,1*

* N,8,1 means No Parity Bit, 8 Data Bits, 1 Stop Bit

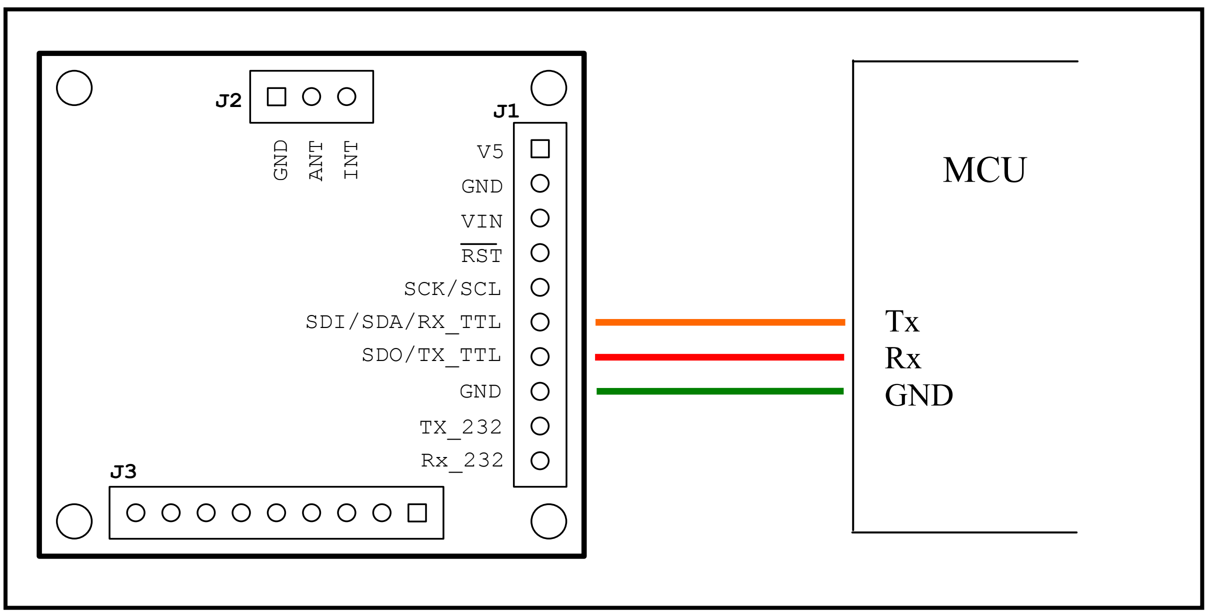
Figure 8 Details of the TTL Communication Link



(Example: byte 0x79 transmitted LSBit first via the TTL interface)

Going to the MCU the signal will appear on Tx_TTL (J2 pin7).
Coming from the MCU the signal will appear on Rx_TTL (J2 pin6)

Figure 9 TTL Connection: M1 to MCU



7.2.3 SPI

The M1 allows use of a standard Serial Peripheral Interface (SPI) for connecting to an embedded microcontroller unit (MCU). The M1 must have proper firmware to enable SPI operation. The M1 operates as an SPI slave device; the clock is always controlled by the host system. Three wires are used for the SPI interface: SCK, SDI, and SDO. SDO is the serial data out (from the M1 to the host system). SDI is the serial data in (to the M1 from the host system). SCK is the serial clock (controlled by the host system). The SkyeRead M1 is set so that data is latched into and sent on the positive edge of the SCK signal. Data is sent from the M1 on the SDO signal at the same time that it is received by the M1 on the SDI signal. The data is sent and received MSB first. Data exchange between the host and the M1 is defined according to the SkyeTek Protocol, Binary Mode.

The SPI provides the highest communication speed between the M1 and the host system, up to 3MHz data rate. Care should be taken to minimize the distance between M1 and host when using the high speed SPI communication (above 400kHz).

Figure 10 Details of the SPI Communication Link

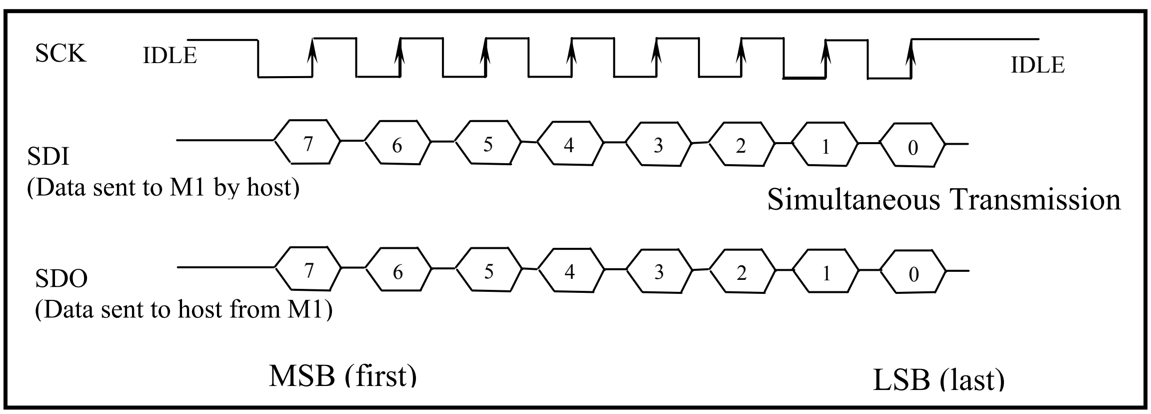
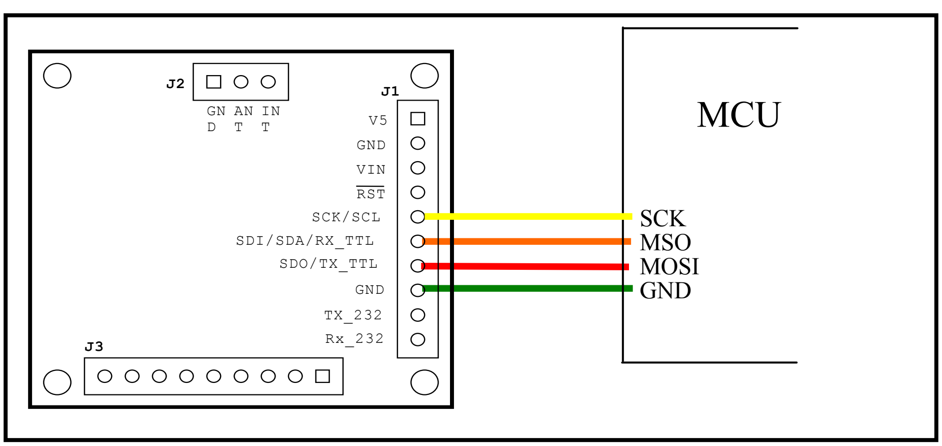


Figure 11 SPI Connection: M1 to MCU

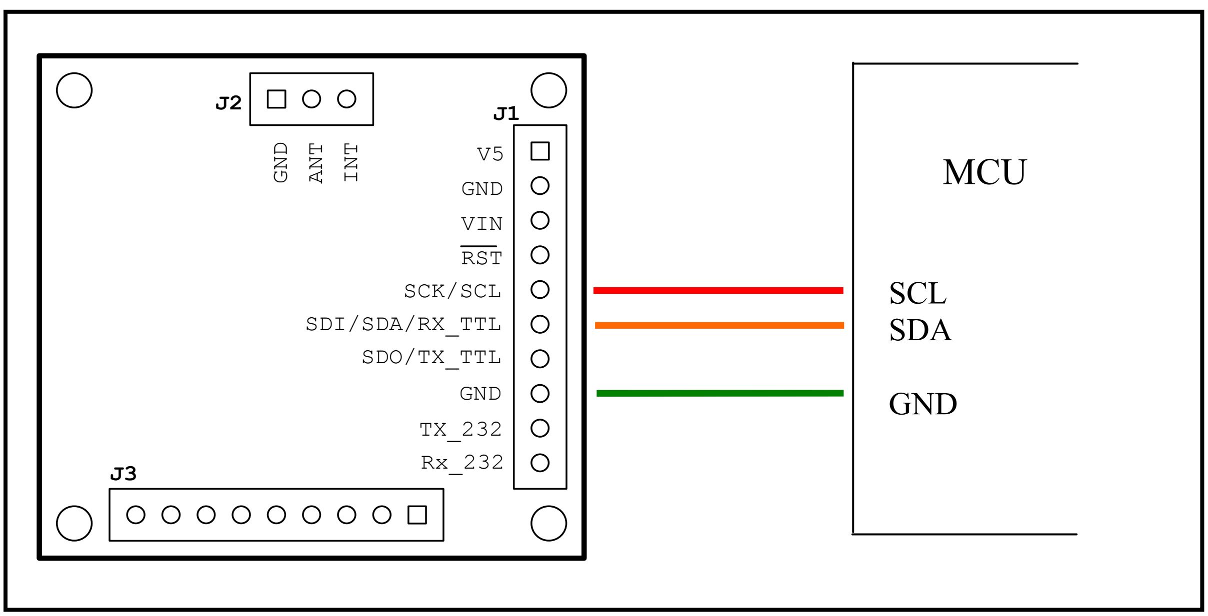


7.2.4 I²C

The M1 supports standard I²C for connecting to an embedded microcontroller unit (MCU). The M1 operates in I²C master mode. Standard 2-wire connection is used with SCL and SDA. SCL is the bi-directional system clock line. SDA is the bi-directional serial data line. The M1 must have proper firmware to enable I²C operation. I²C fast mode is supported to provide a 400kHz data rate. The data is sent and received MSB first. Data exchange between the host and the M1 is defined according to the SkyeTek Protocol, Binary Mode.

Figure 12 Details of the I²C Communication Link

Figure 13 I²C Connection: M1 to MCU



7.3 Network Configurations

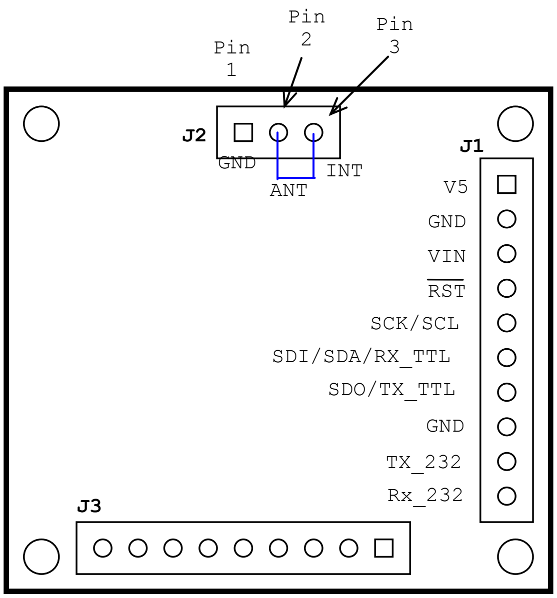
Up to 255 SkyeRead M1 devices can be connected on a single network.

7.4 Antenna Connections

7.4.1 Internal Antenna

All models of the SkyeRead M1 have an internal antenna that can be enabled by connecting pin2 and pin3 of J2. No tuning or adjustments are required.

Figure 14 Connecting the Internal Antenna

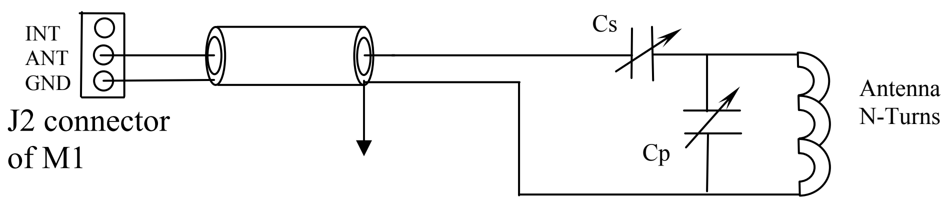


The internal antenna is a single PCB trace that outlines the perimeter of the back side of the SkyeRead M1 PCB.

7.4.2 External Antenna

An external antenna can be connected at J2. Remove the jumper between ANT and INT to disable the on-board antenna. Connect the external antenna between ANT and GND as shown in the diagram.

Figure 15 External Antenna Circuit



Connect the M1 directly to the external antenna
Connect the M1 to an external antenna less than 10cm away using twisted pair cable
Connect the M1 to an external antenna more than 10cm away using 50-ohm coaxial cable

See the ***SkyeRead M1 Antenna Design Guide*** for more information.

8 SkyeTek Protocol

SkyeRead M1 devices communicate with a host controller according to the SkyeTek Protocol no matter what type of host interface. The following sections of this document contain examples of the REQUEST and RESPONSE exchange between a host and the M1. Refer to the ***SkyeTek Protocol*** document for detailed protocol information.

The ***SkyeTek Protocol Command Builder*** software is a tool to show the software developer exactly how a REQUEST is sent to the M1 and the exact RESPONSE from the M1.

The ***SkyeWare RFID Demo Software*** is built on the SkyeTek Protocol and is used to create presentations that demonstrate the features, functions and benefits of RFID technology.

The SkyeRead M1 has a common API that is supported over a wide variety of platforms and operating systems including:

Windows 98, 2000, XP
Unix
Linux
Windows CE, PocketPC 2002
Palm OS

The Software drivers and libraries are available in C, Visual Basic, and Java.

A DLL is available for the Windows PC Operating Systems.

9 System Parameters

The SkyeRead M1 has 256 bytes of EEPROM available to the user. The first 16 bytes of memory are reserved for System Parameters.

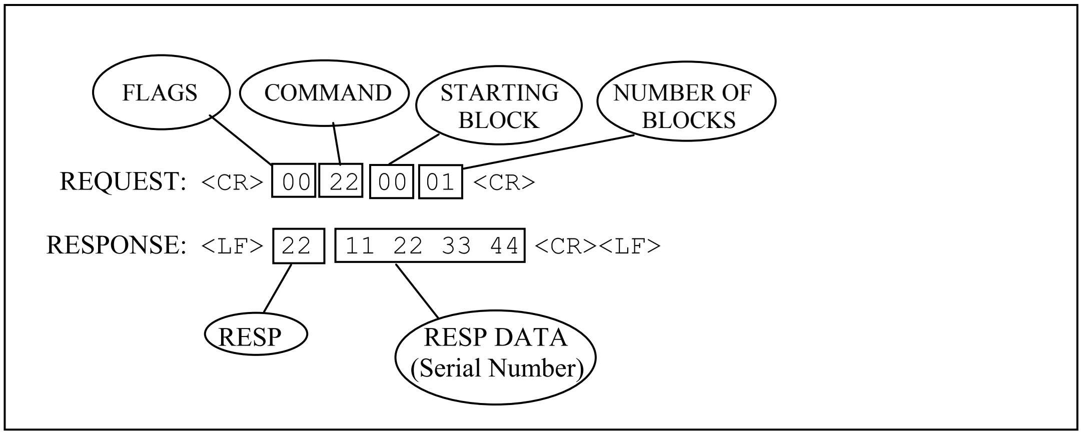
Figure 16 – System Parameter Memory Space

System Parameters						
Name	**Param Addr**	**Param Val**	**Specifies**	**Supported Commands**		
				SELECT	**READ**	**WRITE**
SERIAL NUMBER	0x00	0x00000000-0xFFFFFFFF	4 bytes unique serial number		√	
FIRMWARE VERSION	0x01	0x0000-0xFFFF	2 bytes for firmware version		√	
READER ID (RID)	0x02	0x00-0xFF	Reader Network ID		√	√
BAUD RATE	0x03	0x00 0x01 0x02 0x03 0x04-0xFF	9600 19200 38400 57600 N/A			√
OPERATING MODE	0x04	0x00 0x01-0xFF	sleep active			√
LED	0x05			-	-	-
BEEPER	0x06			-	-	-
USER PORT DIRECTION	0x07		Defines pins as inputs or outputs		√	√
USER PORT VALUE	0x08		Defines values of output pins		√	√
BATTERY STATUS	0x09	0x00-0x50(BCD)	Provides A/D reading of VIN		√	
LCD	0x0A	(special)	(see examples)			√
RFU	0x0B-0x0F				√	√

9.1 Reader Serial Number

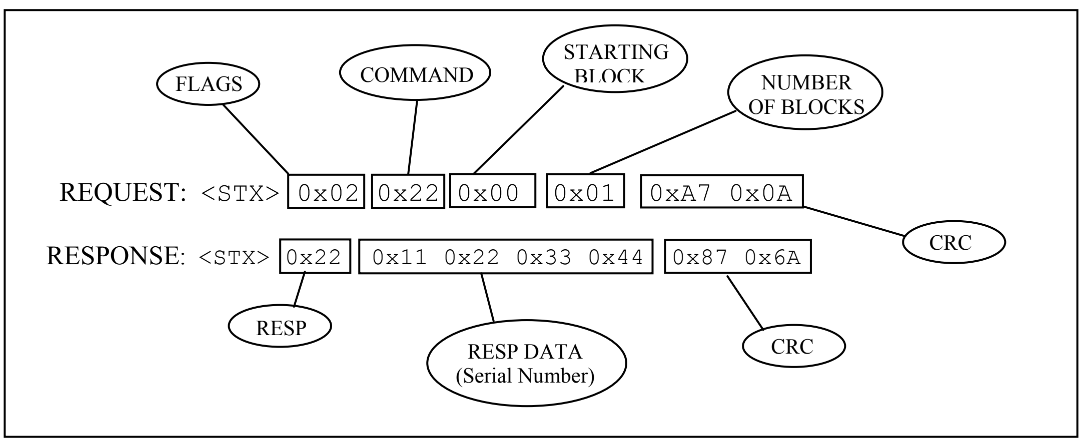
All SkyeRead M1 devices contain a unique 32-bit serial number. This number is fixed and will not change after a firmware upgrade. This is a read only parameter. The serial number is accessed with a Read System command.

ASCII Mode



The fictitious Reader Serial Number in this example is 11223344

Binary Mode

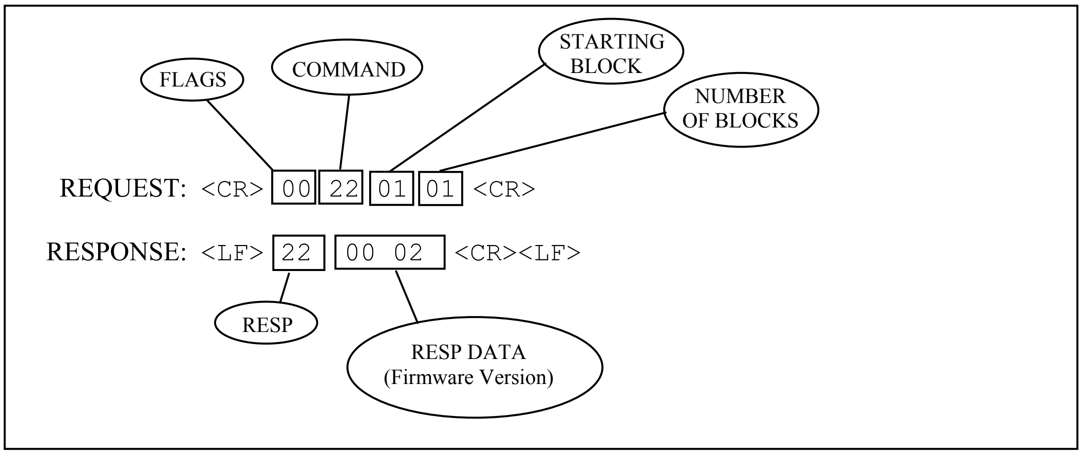


The REQUEST specifies NUMBER OF BLOCKS parameter is 1. One block of serial number information is 4 bytes. Thus the RESP DATA field of the RESPONSE contains 4 bytes.

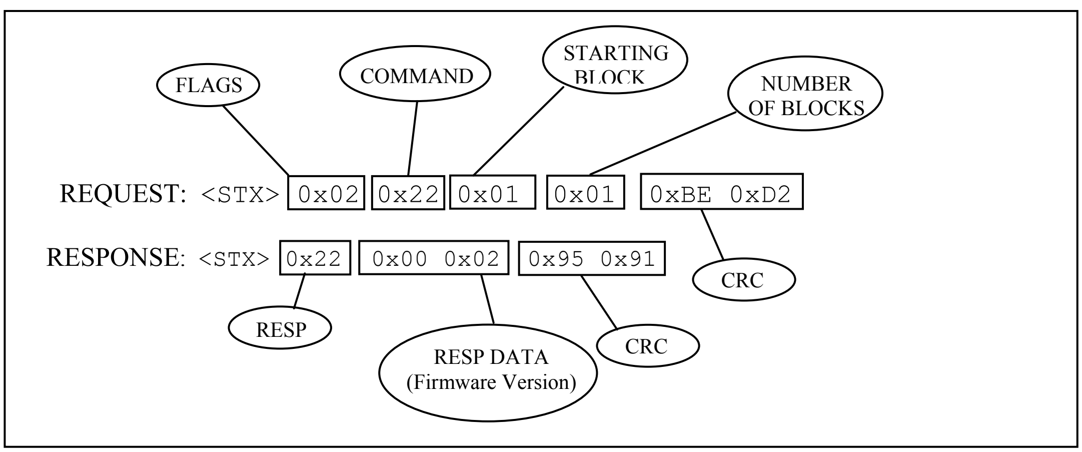
9.2 Firmware Version

System Parameter 0x01 is a read only parameter that contains a 16-bit firmware version number. The firmware version number can change only be changed after a firmware upgrade. The firmware version number is accessed with a Read System command.

ASCII Mode



Binary Mode

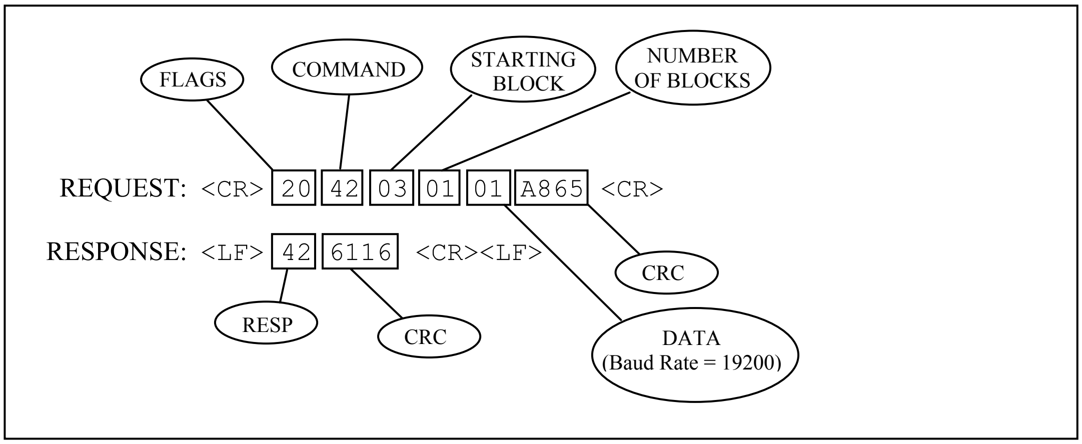


The REQUEST specifies NUMBER OF BLOCKS parameter is 1. One block of Firmware Version Number is 2 bytes. Thus the RESP DATA field of the RESPONSE contains 2 bytes.

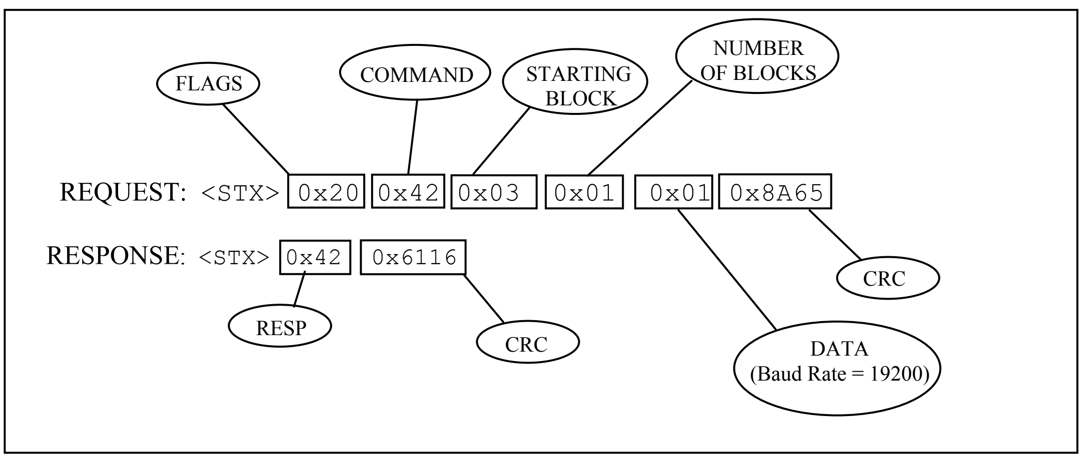
9.3 Baud Rate

System Parameter 0x03 controls the Baud Rate for serial data communication. Use a Write System or a Write Memory command to change the baud rate.

ASCII Mode



Binary Mode

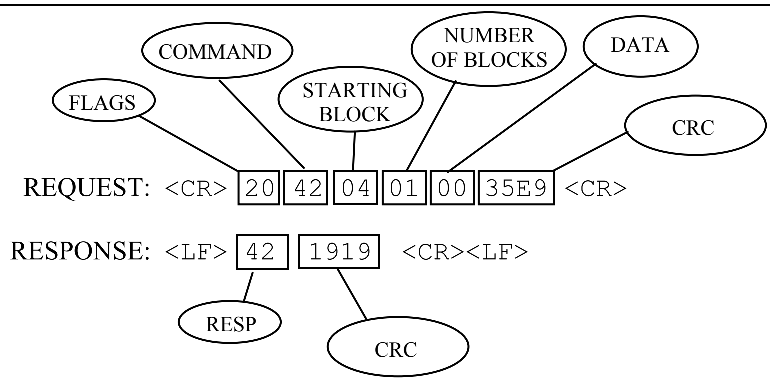


The RESPONSE is sent at the original baud rate and ***then*** the reader changes baud rates so that the next host REQUEST must be sent at the new updated baud rate. The change occurs in the reader's EEPROM and is loaded at reset or power-up.

9.4 Sleep Mode

The SkyeRead M1 has a low power sleep mode that can be used to conserve battery or system power. The Write System command is used to activate SLEEP Mode. System Parameter 0x04 is the target location for setting the operating mode.

ASCII Mode



After the target SkyeRead device gives a positive response, it will enter SLEEP mode. Any command can be used to wake the target SkyeRead device from SLEEP mode. Even sending a single byte to the target reader will wake the reader from SLEEP mode. The SkyeRead device will give the same positive response upon waking from SLEEP mode as it gives upon entering into SLEEP mode.

REQUEST: <CR>

RESPONSE: <LF> 42 6116 <CR><LF>

Binary Mode

Binary Mode works similar to ASCII Mode.

9.5 LED

This System Parameter is ***not*** supported by the SkyeRead M1 because all 8 user port pins are available. External LEDs can be connected in this way.

9.6 Beeper

This System Parameter is ***not*** supported by the SkyeRead M1 because all 8 user port pins are available. External Beepers can be connected in this way.

9.7 User Port

The SkyeRead M1 has 8 pins available for user-configurable I/O. The host can configure the pins of the User Port as any combination of Inputs and Outputs. The User Port can be used to control LEDs, beepers, LCDs, relays and to detect inputs and sensors .

The host can read the values of the User Port pins that are configured as inputs. Similarly, the host can set the values of the User Port pins that are configured as outputs.

The value stored in System Parameter 0x07 controls the IN/OUT directions of the User Port pins. Use the Write System command to the Write Memory command to set the direction of the User Port pins. Changes to the User Port direction makes the changes to the pin states take effect immediately and remain.

System Parameter 0x08 controls the ON/OFF states of the User Port pins that are outputs. Use the Read System command to get the values of the User Port pins that are configured as Inputs. Use the Write System command or the Write Memory command to set the values of the User Port pins. Note you can only control the pin states of pins that have their direction set as outputs.

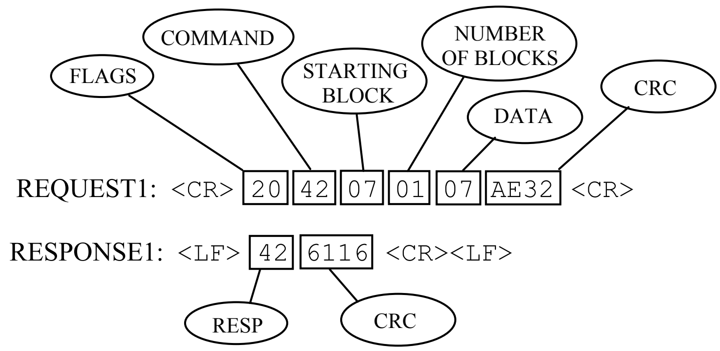
Example of Fictitious User Port Configuration

Pin	Pin State	Use
D7 (J3-1)	1	Green LED
D6 (J3-2)	0	Red LED
D5 (J3-3)	1	Yellow LED
D4 (J3-4)	0	Relay for door strike
D3 (J3-5)	1	Enable for CCTV
D2 (J3-6)	Input	Door Open Detector
D1 (J3-7)	Input	Motion Detector
D0 (J3-8)	Input	Temperature Sensor

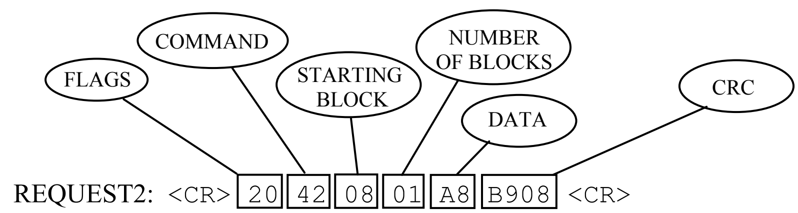
Here is how to implement the above example:

ASCII Mode

REQUEST1 sets the User Port pin directions as inputs or outputs by writing to System Parameter 0x07.



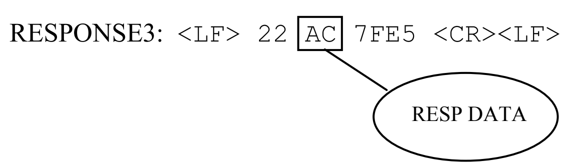
REQUEST2 sets the values of the User Port pins that are outputs by writing to System Parameter 0x08 .



RESPONSE2: <LF> 42 6116 <CR><LF>

REQUEST3 reads the current states of the User Port pins that are inputs by reading from System Parameter 0x08. The values of the inputs are read from the RESP DATA in the RESPONSE3. D2=1, D1=0, D0=0.

REQUEST3: <CR> 00 22 08 01 <CR>

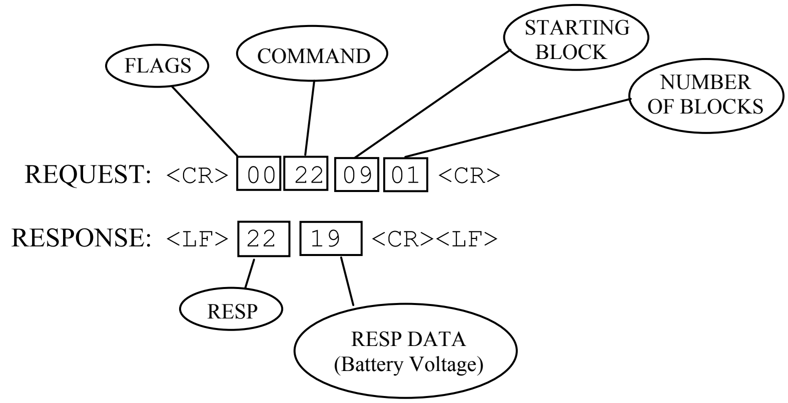


Binary Mode

Binary mode is similar to ASCII mode.

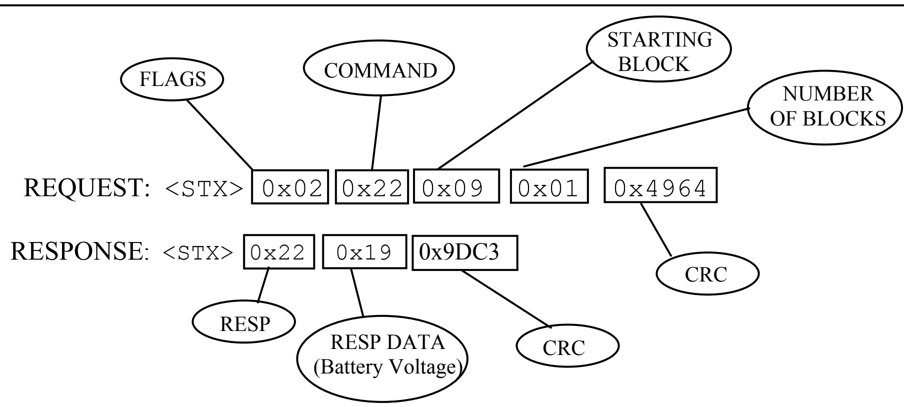
9.8 Battery Status and A/D

ASCII Mode



This Response corresponds to a battery voltage of 1.9 V

Binary Mode



This Response corresponds to a battery voltage of 1.9 V

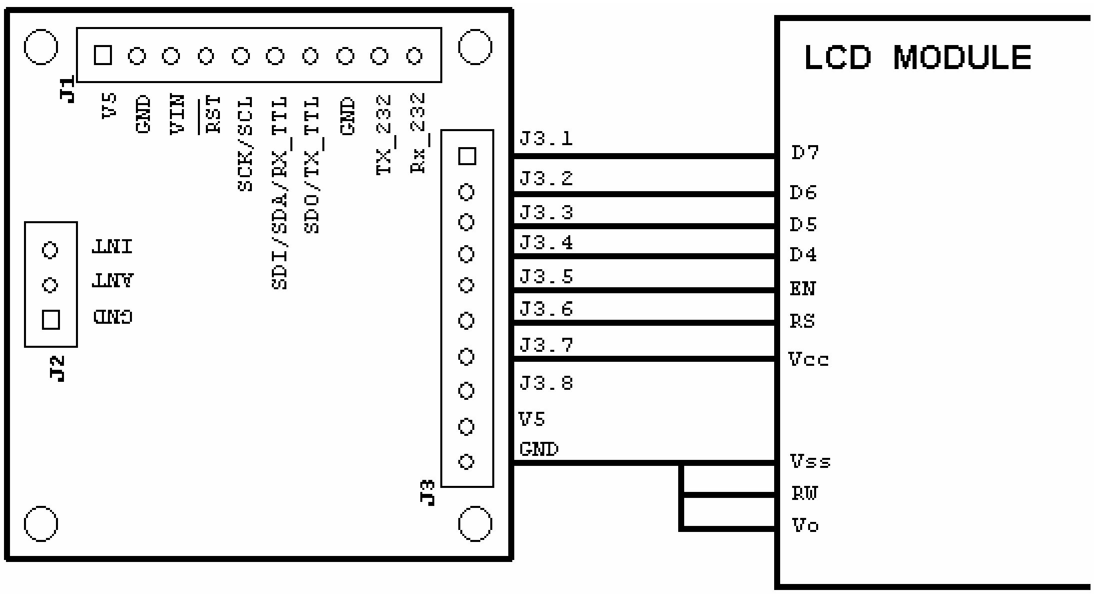
The M1-232 has no 5V boost regulator circuit so there is a general purpose A/D input available to measure thermistors or other external signals between 0 and 5V with a 100mV resolution.

9.9 LCD Interface

Standard 1-Line, 2-Line, and 4-Line LCD modules can be directly connected to J3 on the M1. LCDs with display widths ranging from 8 – 64 characters are supported.

9.9.1 Hardware Configuration

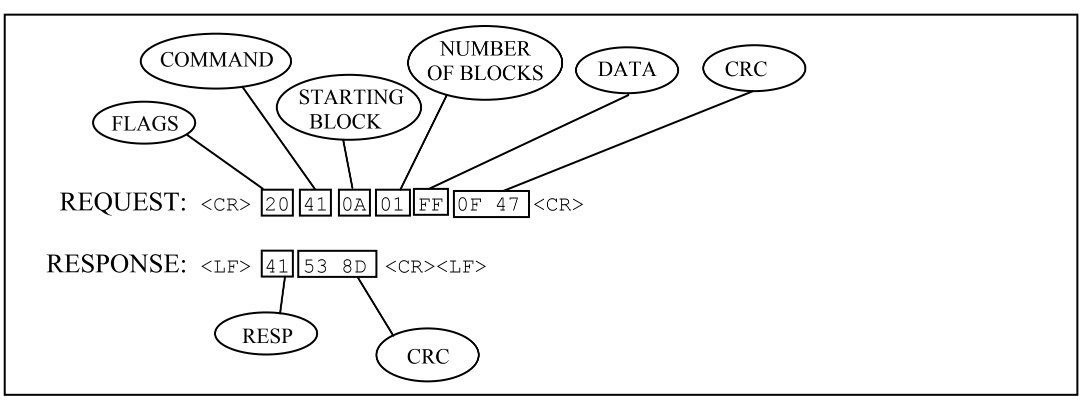
Connect your LCD to the M1 as shown here



9.9.2 Software Configuration

The user must configure J3 for use as the LCD Interface by writing value 0xFF to System Memory address 0x0A. The change becomes the default startup condition (until J3 is re-configured). When J3 is configured as an LCD interface the User Port (section 9.7) is disabled. Here is an example of how to configure the LCD Interface:

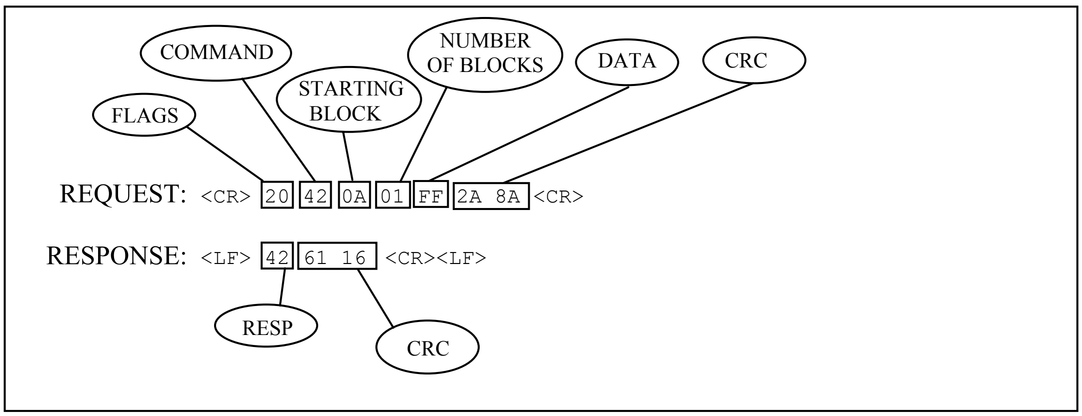
ASCII Mode



9.9.3 Software Control

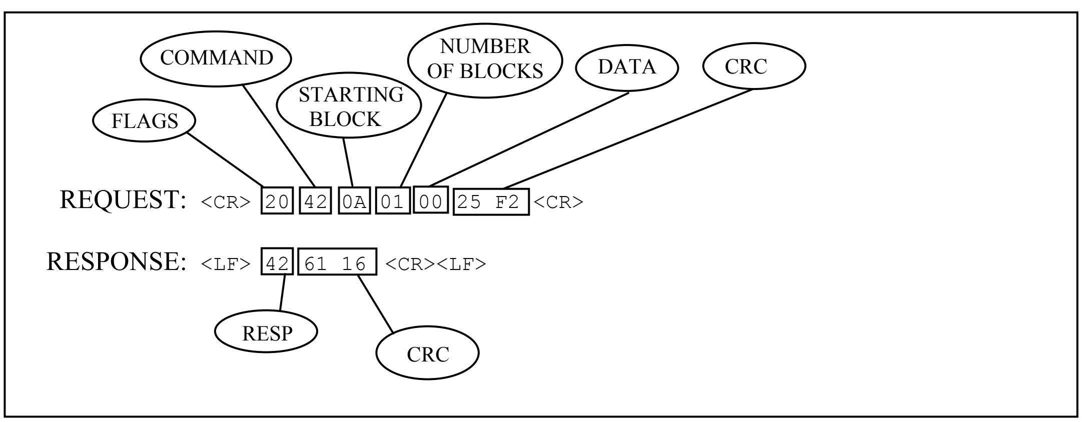
Switch On the LCD:
The user can switch on the LCD by writing the value ‘0xFF’ to the LCD system parameter i.e. 0x0A.

ASCII Mode



Switch Off the LCD:
The user can switch off the LCD by writing the value ‘0x00’ to the LCD system parameter i.e. 0x0A.

ASCII Mode

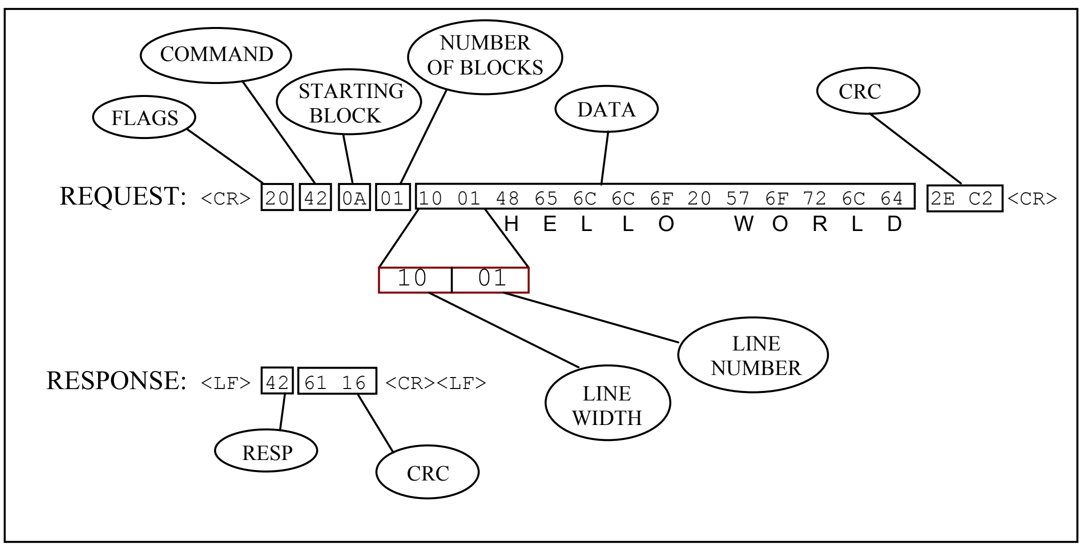


Writing to the LCD:

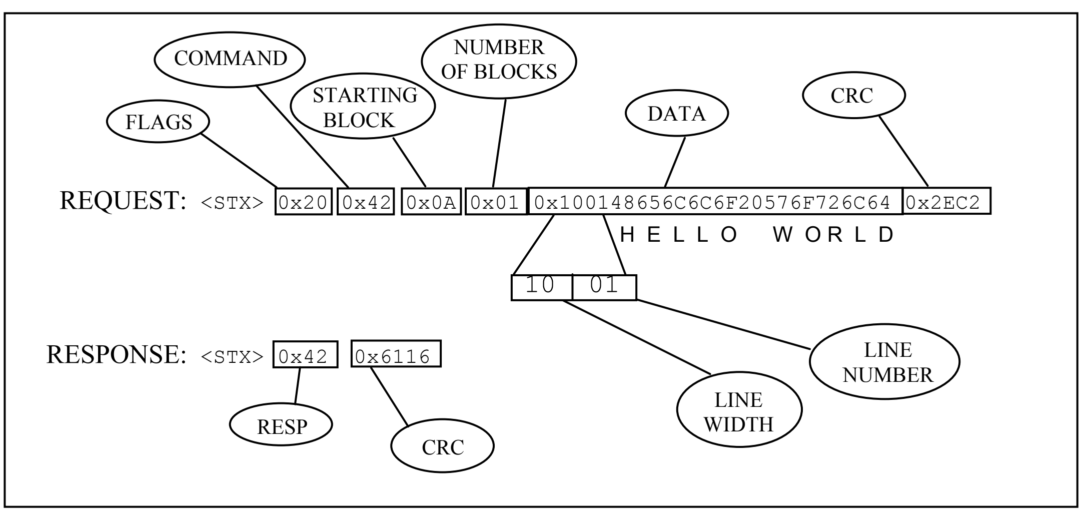
In order to write to the LCD, the user needs to provide the width (number of characters per line) of the LCD as well as the line number to which the string is to be written. The string should not be longer than the line width of the LCD because the M1 does not perform any error checking. To display sentences larger than the width of a line, the sentence should be appropriately split and then displayed on separate lines using separate host REQUESTs.

The LCD module is written to with a Write System command. The target System Parameter for the LCD is located at memory address “0A”. CRC_F=1 (set) in the FLAGS field is required for all Write System Commands (“42”). The Starting Block is “0A” and the number of blocks is “01”. The first 2 bytes of the Data field contain the line width (number of characters per line) and the line number (the line on which the string is to be displayed) respectively and should be followed by the String to be displayed.

ASCII Mode

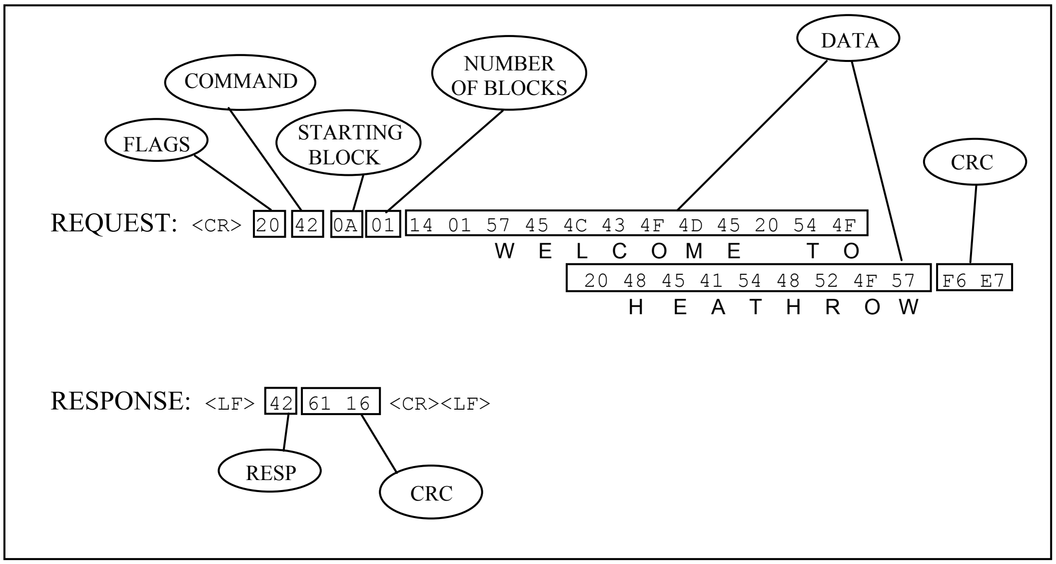


Binary Mode



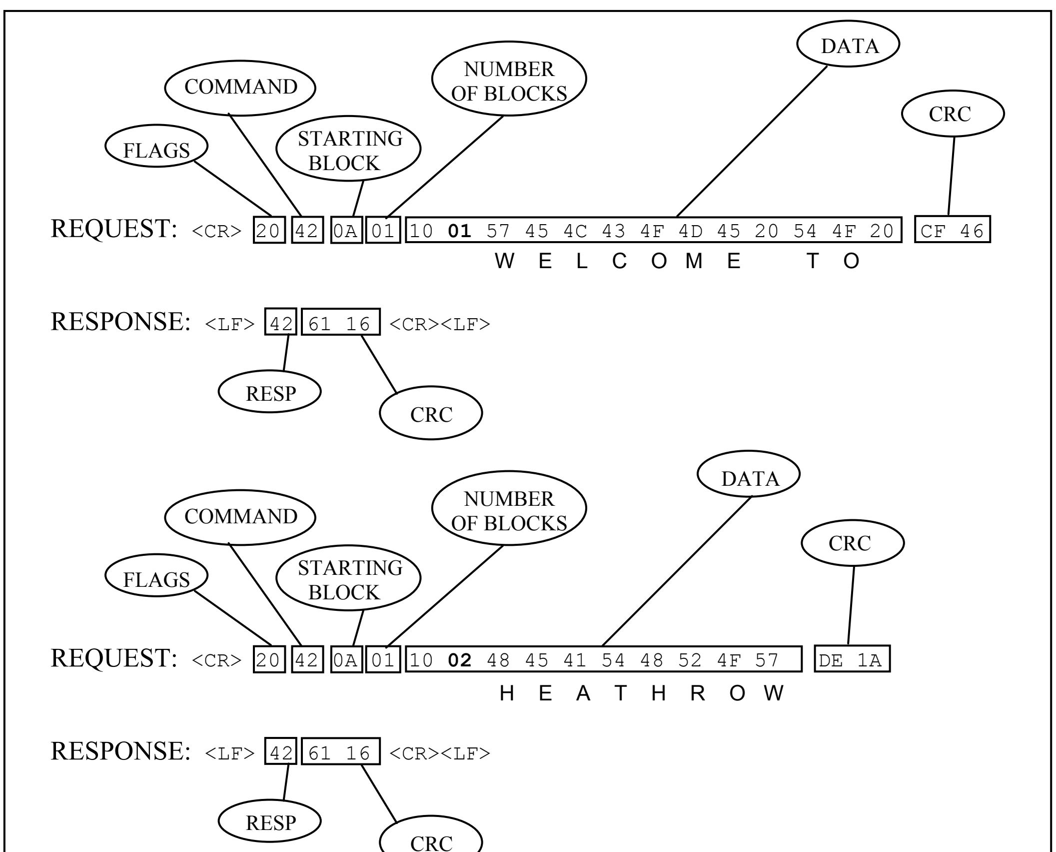
Example: 4x20 LCD

ASCII Mode



Example: 4x16 LCD

ASCII Mode



Note: Write a null or a string of one or more spaces in order to clear the LCD.

10 Memory

The SkyeRead M1 has 256 Bytes of EEPROM Memory. The first 16 bytes (addresses 0x00-0x0F) are reserved for System Parameters and default startup configuration data. The user has access to the remaining 240 bytes are available as general purpose non-volatile memory (addresses 0x10-0xFF).

Read and Writing to the User Memory area can be done via the Read Memory and Write Memory commands, respectively. See the ***SkyeTek Protocol*** document for details.