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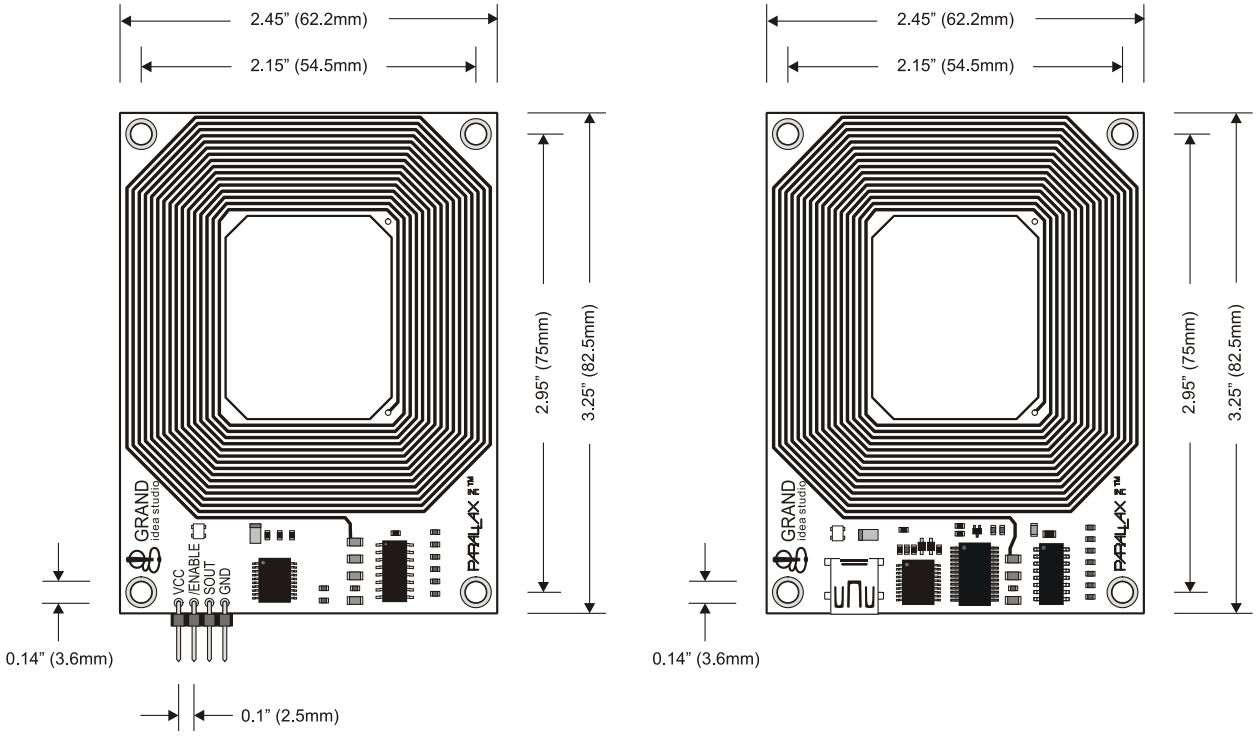
RFID Card Reader, Serial (#28140)
RFID Card Reader, USB (#28340)



Introduction

Designed in cooperation with Grand Idea Studio (www.grandideastudio.com), the Parallax Radio Frequency Identification (RFID) Card Readers provide a low-cost solution to read passive RFID transponder tags up to 4 inches away. The RFID Card Readers can be used in a wide variety of hobbyist and commercial applications, including access control, user identification, robotics navigation, inventory tracking, payment systems, car immobilization, and manufacturing automation. The RFID Card Reader is available in two versions: A TTL-level serial interface for use with a microcontroller and a USB interface for direct connection to a computer.

Features

- Low-cost method for reading passive, 125 kHz RFID transponder tags
- Two easy-to-use versions: Serial interface for microcontrollers and USB for direct connection to PC, Macintosh, or Linux machines
- Bi-color LED for visual indication of status

RFID Compatibility

The Parallax RFID Card Reader works exclusively with the EM Microelectronics EM4100-family of passive read-only transponder tags. Each transponder tag contains a unique, read-only identifier (one of 2^{40}, or 1,099,511,627,776 possible combinations).

A variety of different tag types and styles exist, with the most popular made available from Parallax.

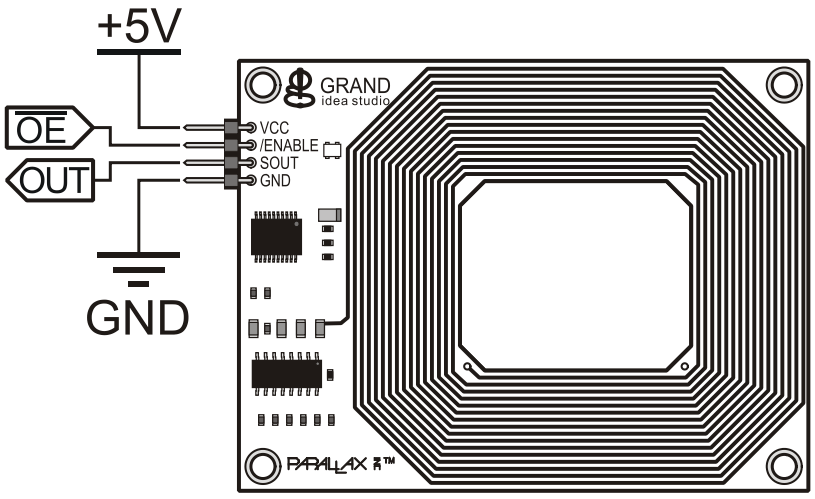
Connections (Serial)

The Parallax RFID Card Reader Serial version easily interfaces to any host microcontroller using only four connections (VCC, /ENABLE, SOUT, GND).

Pin	Pin Name	Type	Function
1	VCC	P	System power. +5V DC input.
2	/ENABLE	I	Module enable pin. Active LOW digital input. Bring this pin LOW to enable the RFID reader and activate the antenna.
3	SOUT	O	Serial output to host. TTL-level interface, 2400 bps, 8 data bits, no parity, 1 stop bit.
4	GND	G	System ground. Connect to power supply's ground (GND) terminal.

Note: Type: I = Input, O = Output, P = Power, G = Ground

Use the following example circuit for connecting the Parallax RFID Card Reader:



Connections (USB)

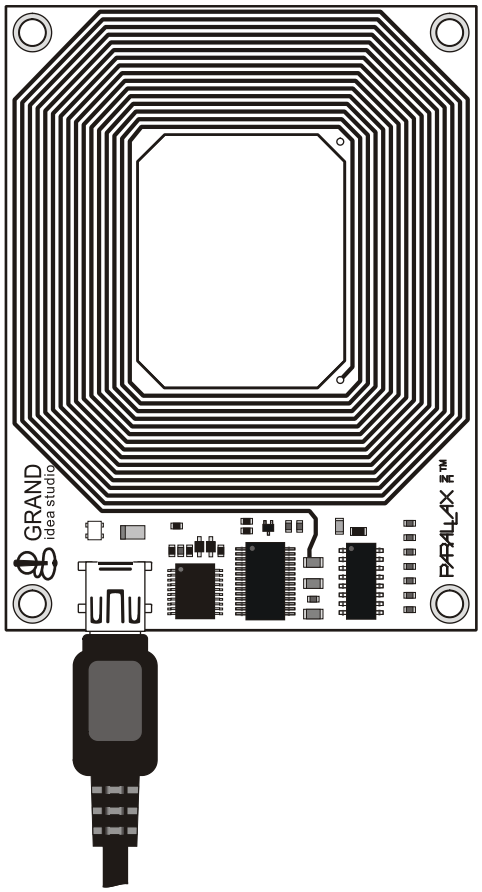
The Parallax RFID Card Reader USB version can be connected directly to any PC, Macintosh, or Linux machine that has a USB port and the appropriate drivers installed. The module is powered from the host computer's USB port and uses an industry-standard FTDI FT232R device to provide the USB connectivity. FTDI drivers are available from www.ftdichip.com/Drivers/VCP.htm.

Signal	Port Name	Function
RX	Serial Receive	Serial output to host. 2400 bps, 8 data bits, no parity, 1 stop bit.
DTR	Data Terminal Ready	Module enable. Bring the DTR line HIGH to enable the RFID reader and activate the antenna. Bring the DTR line LOW to disable the RFID reader.

When the Parallax RFID Card Reader is connected to the host computer, it will appear as a Virtual COM port and will have a COM port number automatically assigned to it. This COM port can be accessed by any software application, programming language, or interface that provides COM port connectivity and will allow you to read the data stream transmitted by the module.

An example program, including Visual Basic/VB.net source code, for reading tags in Windows XP/Vista is available from the 28340 product page at www.parallax.com.

The Debug Terminal within the Parallax BASIC Stamp Editor (www.parallax.com/basicstampsoftware) provides functionality to set the state of a COM port's DTR line. Checking the DTR box in the toolbar will activate the RFID Card Reader.



Usage

A visual indication of the state of the RFID Card Reader is given with the on-board LED. When the module is successfully powered-up and is in an idle state, the LED will be GREEN. When the module is in an active state searching for or communicating with a valid tag, the LED will be RED.

The RFID Card Reader Serial version is activated via the /ENABLE pin on the module's 4-pin header. When the RFID Card Reader is powered and /ENABLE is pulled LOW, the module will enter the active state. When /ENABLE is pulled HIGH or left unconnected, the module will enter the idle state.

The RFID Card Reader USB version is activated via the DTR line of the USB Virtual COM port. When the DTR line is set HIGH, the module will enter the active state. When the DTR line is set LOW, the module will enter the idle state.

The face of the RFID tag should be held parallel to the front or back face of the antenna (where the majority of RF energy is emitted). If the tag is held sideways (for example, perpendicular to the antenna), you'll either get no reading or a poor reading distance. Only one transponder tag should be held up to the antenna at any time. The use of multiple tags at one time will cause tag collisions and the reader may not detect any of them. The tags available in the Parallax store have a read distance of approximately 4 inches. Actual distance may vary slightly depending on the size of the transponder tag and environmental conditions of the application.

Communication Protocol

All communication is 8 data bits, no parity, 1 stop bit, and least significant bit first (8N1) at 2400 bps.

The RFID Card Reader Serial version transmits data as 5 V TTL-level, non-inverted asynchronous serial.

The RFID Card Reader USB version transmits the data through the USB Virtual COM Port driver. This allows easy access to the serial data stream from any software application, programming language, or interface that can communicate with a COM port.

When the RFID Card Reader is active and a valid RFID transponder tag is placed within range of the activated reader, the tag's unique ID will be transmitted as a 12-byte printable ASCII string serially to the host in the following format:

Error! Objects cannot be created from editing field codes.

The start byte and stop byte are used to easily identify that a correct string has been received from the reader (they correspond to line feed and carriage return characters, respectively). The middle ten bytes are the actual tag's unique ID. For example, for a tag with a valid ID of 0F0184F07A, the following bytes would be sent: 0x0A, 0x30, 0x46, 0x30, 0x31, 0x38, 0x34, 0x46, 0x30, 0x37, 0x41, 0x0D.

Interference

The Parallax RFID Card Reader, like many RF devices, may experience RF noise in its frequency range. This may cause the reader to transmit a spurious tag response when no tag is near the unit. This will not affect most uses of the RFID Card Reader. To avoid treating spurious responses as legitimate tags, it is recommended to read two responses in a row within a given amount of time (for example, one second) to ensure that you are reading a valid tag and not a "tag" generated by noise.

DC Characteristics

At V_{CC} = +5.0V and T_A = 25ºC unless otherwise noted

Parameter	Symbol	Test Conditions	Specification			Unit
			Min.	Typ.	Max.	
Supply Voltage	V_{CC}	---	4.5	5.0	5.5	V
Supply Current, Idle	I_{IDLE}	---	---	10	---	mA
Supply Current, Active	I_{CC}	---	---	100	200	mA
Input LOW voltage	V_{IL}	+4.5V <= V_{CC} <= +5.5V	---	---	0.8	V
Input HIGH voltage	V_{IH}	+4.5V <= V_{CC} <= +5.5V	2.0	---	---	V
Output LOW voltage	V_{OL}	V_{CC} = +4.5V	---	---	0.6	V
Output HIGH voltage	V_{OH}	V_{CC} = +4.5V	V_{CC} - 0.7	---	---	V

Absolute Maximum Ratings

Condition	Value
Operating Temperature	-40ºC to +85ºC
Storage Temperature	-55ºC to +125ºC
Supply Voltage (V_{cc})	+4.5V to +5.5V
Ground Voltage (V_{ss})	0V
Voltage on any pin with respect to V_{ss}	-0.3V to +7.0V

NOTICE: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

RFID Technology Overview

Material in this section is based on information provided by the RFID Journal (www.rfidjournal.com).

Radio Frequency Identification (RFID) is a generic term for non-contacting technologies that use radio waves to automatically identify people or objects. There are several methods of identification, but the most common is to store a unique serial number that identifies a person or object on a microchip that is attached to an antenna. The combined antenna and microchip are called an "RFID transponder" or "RFID tag" and work in combination with an "RFID reader" (sometimes called an "RFID interrogator").

An RFID system consists of a reader and one or more tags. The reader's antenna is used to transmit radio frequency (RF) energy. Depending on the tag type, the energy is "harvested" by the tag's antenna and used to power up the internal circuitry of the tag. The tag will then modulate the electromagnetic waves generated by the reader in order to transmit its data back to the reader. The reader receives the modulated waves and converts them into digital data.

There are two major types of tag technologies. "Passive tags" are tags that do not contain their own power source or transmitter. When radio waves from the reader reach the chip's antenna, the energy is converted by the antenna into electricity that can power up the microchip in the tag (typically via inductive coupling). The tag is then able to send back any information stored on the tag by modulating the reader's electromagnetic waves. "Active tags" have their own power source and transmitter. The power source, usually a battery, is used to run the microchip's circuitry and to broadcast a signal to a reader. Due to the fact that passive tags do not have their own transmitter and must reflect their signal to the reader, the reading distance is much shorter than with active tags. However, active tags are typically larger, more expensive, and require occasional service.

Frequency refers to the size of the radio waves used to communicate between the RFID system components. Just as you tune your radio to different frequencies in order to hear different radio stations, RFID tags and readers must be tuned to the same frequency in order to communicate effectively. RFID systems typically use one of the following frequency ranges: low frequency (or LF, around 125 kHz), high frequency (or HF, around 13.56 MHz), ultra-high frequency (or UHF, around 868 and 928 MHz), or microwave (around 2.45 and 5.8 GHz).

The read range of a tag ultimately depends on many factors: the frequency of RFID system operation, the power of the reader, and interference from other RF devices. Balancing a number of engineering trade-offs (antenna size v. reading distance v. power v. manufacturing cost), the Parallax RFID Card Reader's antenna was designed specifically for use with low-frequency (125 kHz) passive tags with a read distance of around 4 inches.

BASIC Stamp® 1 Program

The following code examples read tags from a RFID Card Reader and compare the values to known tags (stored in an EEPROM table).

```
' =============================================================================
'
'   File....... RFID.BS1
'   Purpose.... RFID Tag Reader / Simple Security System
'   Author..... (c) Parallax, Inc. -- All Rights Reserved
'   E-mail..... support@parallax.com
'   Started....
'   Updated.... 07 FEB 2005
'
'   {$STAMP BS1}
'   {$PBASIC 1.0}
'
' =============================================================================


' -----[ Program Description ]---------------------------------------------
'
' Reads tags from a Parallax RFID reader and compares to known tags (stored
' in EEPROM table).  If tag is found, the program will disable a lock.


' -----[ Revision History ]------------------------------------------------


' -----[ I/O Definitions ]-------------------------------------------------

SYMBOL  Enable          = 0                     ' low = reader on
SYMBOL  RX              = 1                     ' serial from reader
SYMBOL  Spkr            = 2                     ' speaker output
SYMBOL  Latch           = 3                     ' lock/latch control


' -----[ Constants ]-------------------------------------------------------

SYMBOL  LastTag         = 2                     ' 3 tags; 0 to 2


' -----[ Variables ]-------------------------------------------------------

SYMBOL  tag0            = B0                    ' RFID bytes buffer
SYMBOL  tag1            = B1
SYMBOL  tag2            = B2
```

```
SYMBOL  tag3            = B3
SYMBOL  tag4            = B4
SYMBOL  tag5            = B5
SYMBOL  tag6            = B6
SYMBOL  tag7            = B7
SYMBOL  tag8            = B8
SYMBOL  tag9            = B9

SYMBOL  tagNum          = B10                   ' from EEPROM table
SYMBOL  pntr            = B11                   ' pointer to char in table
SYMBOL  char            = B12                   ' character from table


' -----[ EEPROM Data ]----------------------------------------------------

Tags:
  EEPROM ("0F0184F20B")                         ' valid tags
  EEPROM ("0F01D9D263")
  EEPROM ("04129C1B43")
  EEPROM ("0000000000")                         ' space for other tags
  EEPROM ("0000000000")


' -----[ Initialization ]-------------------------------------------------

Reset:
  HIGH Enable                                   ' turn of RFID reader
  LOW Latch                                     ' lock the door!


' -----[ Program Code ]---------------------------------------------------

Main:
  LOW Enable                                    ' activate the reader
  SERIN RX, T2400, ($0A)                        ' wait for header
  SERIN RX, T2400, tag0, tag1, tag2, tag3, tag4 ' get tag bytes
  SERIN RX, T2400, tag5, tag6, tag7, tag8, tag9
  HIGH Enable                                   ' deactivate reader

Check_List:
  FOR tagNum = 0 TO LastTag                     ' scan through known tags
    pntr = tagNum * 10 + 0 : READ pntr, char    ' read char from DB
    IF char <> tag0 THEN Bad_Char               ' compare with tag data
    pntr = tagNum * 10 + 1 : READ pntr, char
    IF char <> tag1 THEN Bad_Char
    pntr = tagNum * 10 + 2 : READ pntr, char
    IF char <> tag2 THEN Bad_Char
    pntr = tagNum * 10 + 3 : READ pntr, char
    IF char <> tag3 THEN Bad_Char
    pntr = tagNum * 10 + 4 : READ pntr, char
    IF char <> tag4 THEN Bad_Char
    pntr = tagNum * 10 + 5 : READ pntr, char
    IF char <> tag5 THEN Bad_Char
    pntr = tagNum * 10 + 6 : READ pntr, char
    IF char <> tag6 THEN Bad_Char
    pntr = tagNum * 10 + 7 : READ pntr, char
    IF char <> tag7 THEN Bad_Char
    pntr = tagNum * 10 + 8 : READ pntr, char
    IF char <> tag8 THEN Bad_Char
    pntr = tagNum * 10 + 9 : READ pntr, char
    IF char <> tag9 THEN Bad_Char
    GOTO Tag_Found                              ' all match -- good tag
Bad_Char:
```

```
  NEXT

Bad_Tag:
  SOUND Spkr, (25, 80)                          ' groan
  PAUSE 1000
  GOTO Main

Tag_Found:
  DEBUG #tagNum, CR                             ' for testing
  HIGH Latch                                    ' remove latch
  SOUND Spkr, (114, 165)                        ' beep
  LOW Latch                                     ' restore latch
  GOTO Main

  END
```

BASIC Stamp® 2 Program

The following code examples read tags from a RFID Card Reader and compare the values to known tags (stored in an EEPROM table).

```
' =============================================================================
'
'   File....... RFID.BS2
'   Purpose.... RFID Tag Reader / Simple Security System
'   Author..... (c) Parallax, Inc. -- All Rights Reserved
'   E-mail..... support@parallax.com
'   Started....
'   Updated.... 07 FEB 2005
'
'   {$STAMP BS2}
'   {$PBASIC 2.5}
'
' =============================================================================


' -----[ Program Description ]---------------------------------------------
'
' Reads tags from a Parallax RFID reader and compares to known tags (stored
' in EEPROM table).  If tag is found, the program will disable a lock.


' -----[ Revision History ]------------------------------------------------


' -----[ I/O Definitions ]-------------------------------------------------

Enable          PIN     0                     ' low = reader on
RX              PIN     1                     ' serial from reader
Spkr            PIN     2                     ' speaker output
Latch           PIN     3                     ' lock/latch control


' -----[ Constants ]-------------------------------------------------------

#SELECT $STAMP
  #CASE BS2, BS2E, BS2PE
    T1200       CON     813
    T2400       CON     396
    T4800       CON     188
    T9600       CON     84
    T19K2       CON     32
```

```
    TMidi       CON     12
    T38K4       CON     6
  #CASE BS2SX, BS2P
    T1200       CON     2063
    T2400       CON     1021
    T4800       CON     500
    T9600       CON     240
    T19K2       CON     110
    TMidi       CON     60
    T38K4       CON     45
  #CASE BS2PX
    T1200       CON     3313
    T2400       CON     1646
    T4800       CON     813
    T9600       CON     396
    T19K2       CON     188
    TMidi       CON     108
    T38K4       CON     84
#ENDSELECT

SevenBit        CON     $2000
Inverted        CON     $4000
Open            CON     $8000
Baud            CON     T2400


#SELECT $STAMP
  #CASE BS2, BS2E
    TmAdj       CON     $100                ' x 1.0 (time adjust)
    FrAdj       CON     $100                ' x 1.0 (freq adjust)
  #CASE BS2SX
    TmAdj       CON     $280                ' x 2.5
    FrAdj       CON     $066                ' x 0.4
  #CASE BS2P
    TmAdj       CON     $3C5                ' x 3.77
    FrAdj       CON     $044                ' x 0.265
  #CASE BS2PE
    TmAdj       CON     $100                ' x 1.0
    FrAdj       CON     $0AA                ' x 0.665
  #CASE BS2Px
    TmAdj       CON     $607                ' x 6.03
    FrAdj       CON     $2A                 ' x 0.166
#ENDSELECT


LastTag         CON     3


#DEFINE __No_SPRAM = ($STAMP < BS2P)        ' does module have SPRAM?


' -----[ Variables ]-------------------------------------------------------

#IF __No_SPRAM #THEN
  buf           VAR     Byte(10)            ' RFID bytes buffer
#ELSE
  chkChar       VAR     Byte                ' character to test
#ENDIF

tagNum          VAR     Nib                 ' from EEPROM table
idx             VAR     Byte                ' tag byte index
char            VAR     Byte                ' character from table
```

```
' -----[ EEPROM Data ]---------------------------------------------------

Tag1            DATA    "0F0184F20B"            ' valid tags
Tag2            DATA    "0F01D9D263"
Tag3            DATA    "04129C1B43"

Name0           DATA    "Unauthorized", CR, 0
Name1           DATA    "George Johnston", CR, 0
Name2           DATA    "Dick Miller", CR, 0
Name3           DATA    "Mary Evans", CR, 0


' -----[ Initialization ]-------------------------------------------------

Reset:
  HIGH Enable                                   ' turn of RFID reader
  LOW Latch                                     ' lock the door!


' -----[ Program Code ]---------------------------------------------------

Main:
  LOW Enable                                    ' activate the reader
  #IF __No_SPRAM #THEN
    SERIN RX, T2400, [WAIT($0A), STR buf\10]    ' wait for hdr + ID
  #ELSE
    SERIN RX, T2400, [WAIT($0A), SPSTR 10]
  #ENDIF
  HIGH Enable                                   ' deactivate reader

Check_List:
  FOR tagNum = 1 TO LastTag                     ' scan through known tags
    FOR idx = 0 TO 9                            ' scan bytes in tag
      READ (tagNum - 1 * 10 + idx), char        ' get tag data from table
      #IF __No_SPRAM #THEN
        IF (char <> buf(idx)) THEN Bad_Char     ' compare tag to table
      #ELSE
        GET idx, chkChar                        ' read char from SPRAM
        IF (char <> chkChar) THEN Bad_Char      ' compare to table
      #ENDIF
    NEXT
    GOTO Tag_Found                              ' all bytes match!

Bad_Char:                                       ' try next tag
  NEXT

Bad_Tag:
  tagNum = 0
  GOSUB Show_Name                               ' print message
  FREQOUT Spkr, 1000 */ TmAdj, 115 */ FrAdj     ' groan
  PAUSE 1000
  GOTO Main

Tag_Found:
  GOSUB Show_Name                               ' print name
  HIGH Latch                                    ' remove latch
  FREQOUT Spkr, 2000 */ TmAdj, 880 */ FrAdj     ' beep
  LOW Latch                                     ' restore latch
  GOTO Main

  END
```