**Column #120 April 2005 by Jon Williams:**

# You Can't Touch That: Non-contact Access Control

*Today I had a bit of a headache and was feeling cramped in my office so I decided to escape to the treadmill for a half-hour or so in the complex's private gym. To keep it private, members gain access by waving a security card in front of a small plate adjacent to the front door – if the card is a match, cha-ching, the door unlocks and you're in.*

Okay, what's going on with the card? You've probably seen them, they're everywhere. The cards in question contain technology called RFID: Radio Frequency Identification. Even if you haven't heard of RFID, you may have unknowingly been exposed to it. RFID tags can be as small and nearly as thin as a postage stamp, and are often used to track package movement in retail stores (big companies like Wal-Mart, Target, and others are adopting the technology). Drug companies are even putting RFID tags into their packaging to the prevent piracy of expensive medicines. RFID is big news, and now you can get in on it too.

There are two essential components in an RFID system: a transceiver (reader) and a transponder (tag). If it were only that simple.... Tags can be active (contain their own power source) or be passive (create parasitic power from the reader's RF field). Further, tags can be read-only or read-write. Zoiks. Let's just keep things simple, shall we?

Parallax worked with world-famous hardware hacker and engineer-extraordinaire, Joe Grand (owner of Grand Idea Studio), to create a low-cost RFID reader that would be simple to use in hobbyist and professional projects. The result is a fully integrated reader PCB that contains the required circuitry and matched antenna to work with passive, read-only RFID tags. Note that the reader is specifically designed for tags that contain low-frequency (125 kHz) RFID components from EM Microelectronic. Parallax carries a couple tag types (disc and ISO card) that are manufactured by Sokymat and that meet the requirements of the reader. Figure 120.1 shows a few sample tags from Sokymat that I played with; you can clearly see the disc (far left) and ISO card (far right) tags.

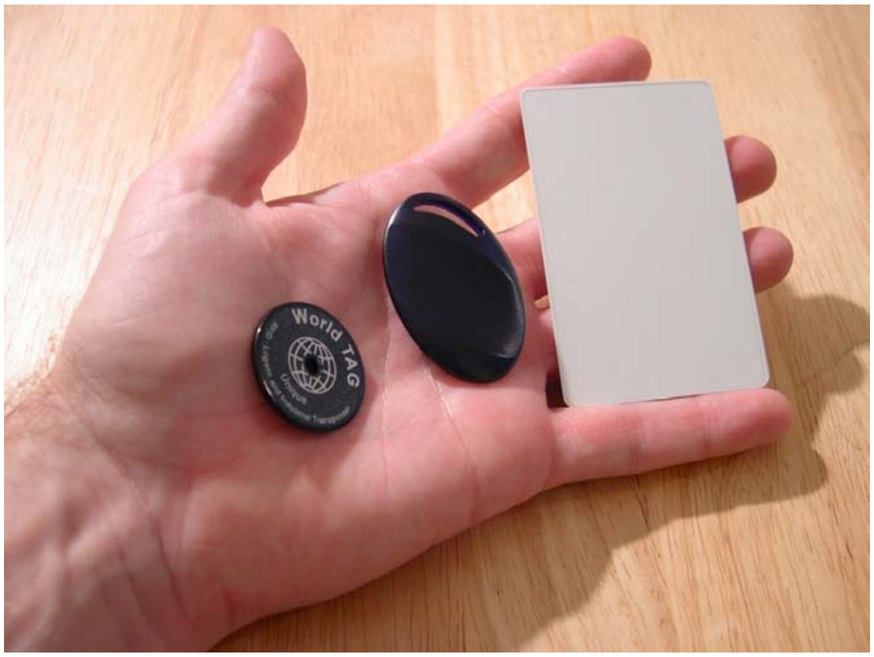


**Figure 120.1: Various Sokymat RFID Tags sold by Parallax**

## Is It Magic?

Okay, how does it work? It's not magic; in fact it's not terribly complicated. When power (5 VDC) is applied to the reader a green LED will indicate that it's ready to function. By pulling the ENABLE pin low, the reader becomes active (LED changes to red) and the antenna broadcasts a modulated signal. If a tag is within range (up to four inches with the Parallax reader), it will harvest the RF energy with its own antenna and modulate its unique identification code in a manner that can be detected by the reader. A microcontroller on the reader tests the bits from the RFID tag to make sure the information is valid, and then the tag number is converted to an ASCII stream to be transmitted on the SOUT pin at 2400 baud.

Keep in mind that when the antenna is active (red LED), the device is broadcasting and consuming about 200 mA from the power supply. If you're going to do a project that involves batteries, you may want to add a physical button to activate the reader only when a card is actually present, or use a timeout with SERIN (BS2 family only) to disable the reader periodically and reduce the load on the power supply.

Since RFID is so common in controlled-access and security systems, let's go that direction. And just for fun, let's build a super-simple, single-tag access control device with a BS1. Can we do it? Absolutely. In fact, the code is so simple we can look at the whole thing in one shot:

```
Main:
  LOW Enable
  SERIN RX, T2400, ($0A, "0F0184F20B")
  HIGH Enable

Access_Granted:
  HIGH Latch
  PAUSE 2000
  LOW Latch
  GOTO Main
```

We start by activating the reader (ENABLE pin is pulled low) and then simply waiting the for a specific tag string. And let me correct something I left out: the tag ID string is preceded by a linefeed character ($0A) and followed by a carriage return ($0D). We'll see why this is useful a bit later.

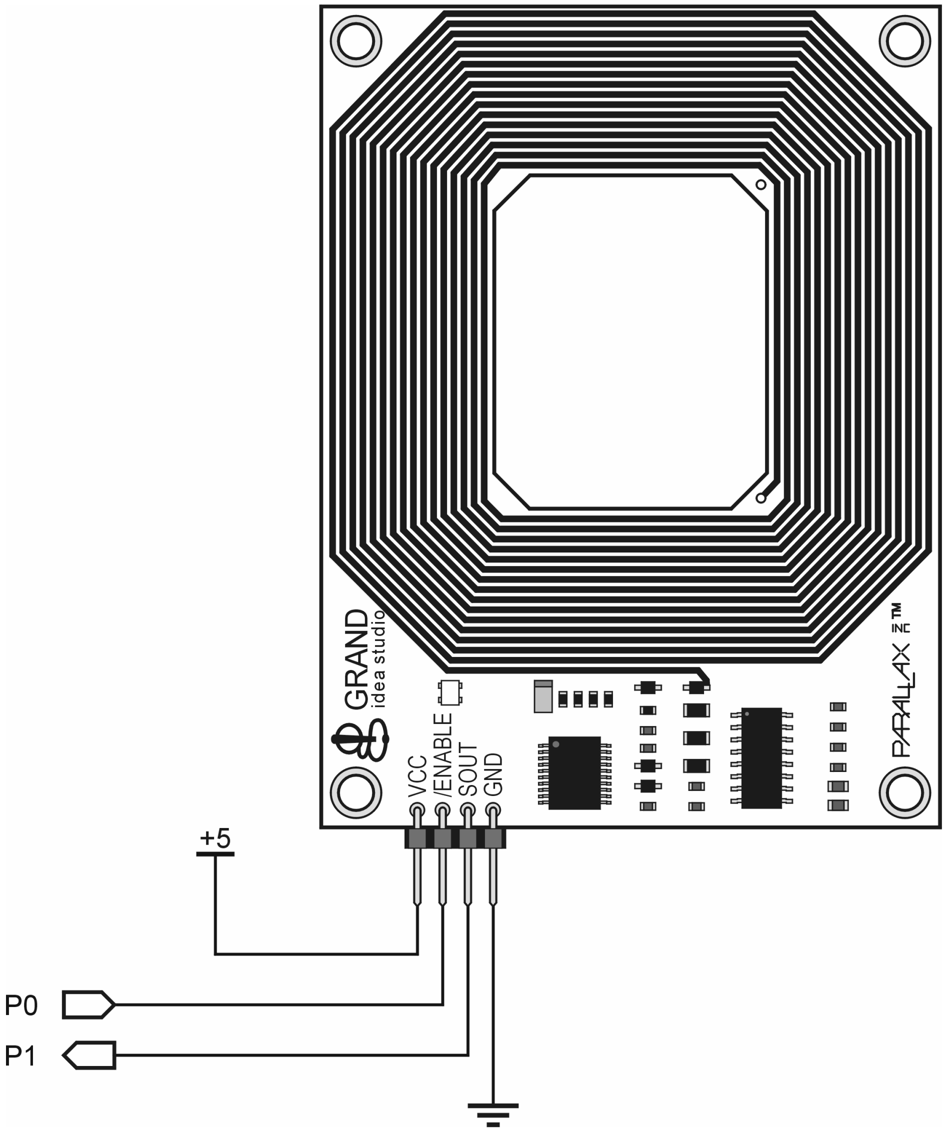


Figure 120.2: RFID to BASIC Stamp Connection

In this program, SERIN does all the work. We construct the SERIN line to wait for the linefeed character, then the specific characters in the valid RFID tag string. Once that shows up the program drops to the point called Access_Granted where we activate an output that will do what we need it to do. We could, for example, disable an electric door lock that gives us – and just us – access to something special. After a brief delay the lock-control output is enabled and we go back to the top.

The logical question is, "Where did you get the tag ID string?" From the tag, of course. I just mentioned that the (ASCII) tag string is preceded by a linefeed and followed by a carriage return. We can put this to use by connecting the reader to a terminal program. Note that we need to go through an RS-232 line driver (e.g., MAX232, DS275, etc.) as the serial output is at TTL levels. Figure 120.3 shows the connections and Figure 120.4 shows the output when using a manually-opened terminal from the BASIC Stamp IDE (note that the baud rate is set to 2400). In most cases we'll use a BASIC Stamp to work with the reader, but be aware that you can also connect directly to a custom PC application using a simple interface as shown.

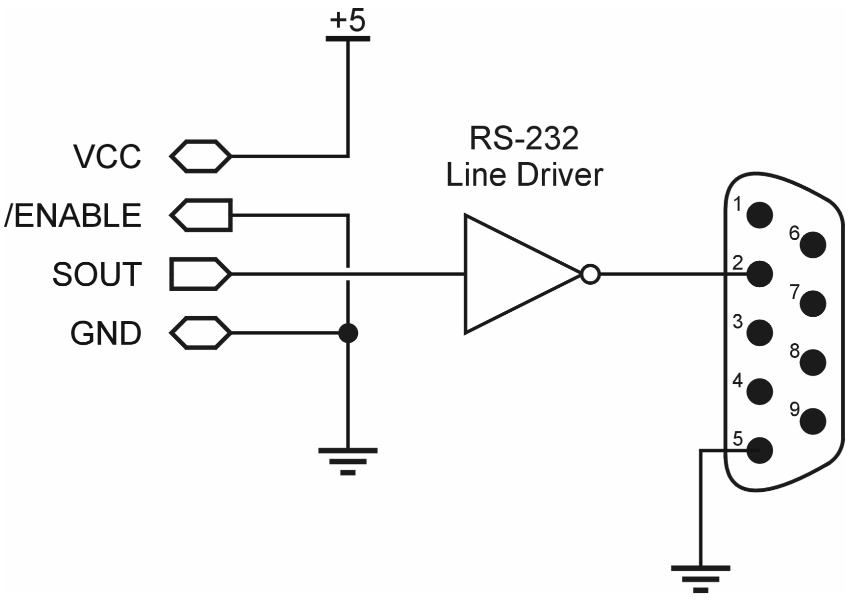
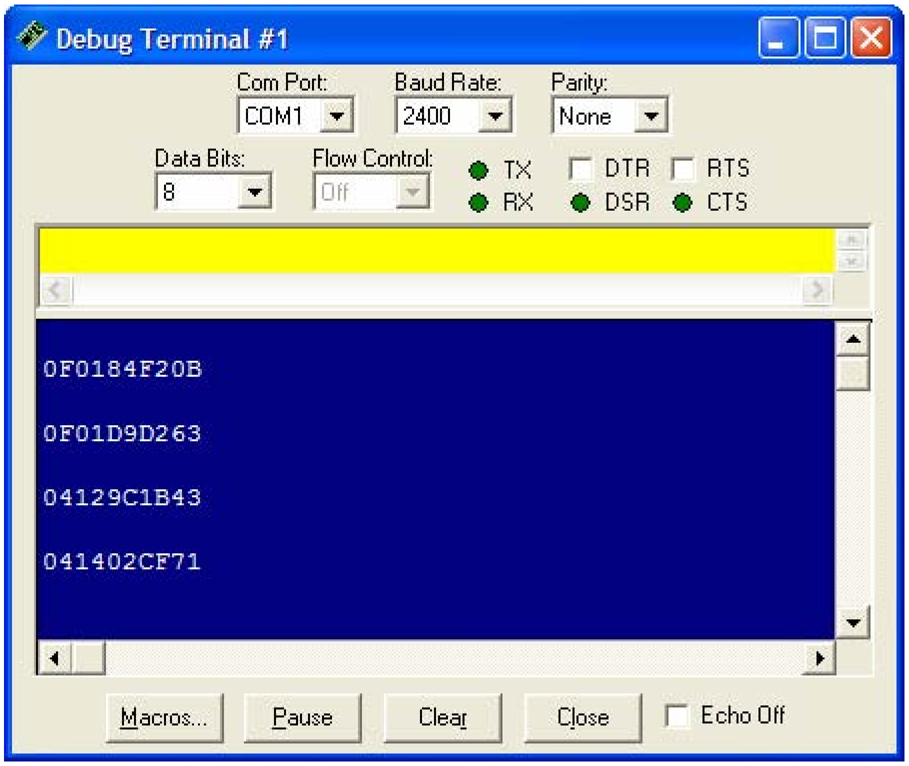


**Figure 120.3: RFID to Serial Port Connectivity**



```
0F0184F20B

0F01D9D263

04129C1B43

041402CF71
```

Figure 120.4: RFID Debug Output

By the way, if you happen to have the new Parallax Serial LCD module, you can use it as a terminal – and you don't need a level-shifter. Simply set the LCD Mode switches for 2400 baud (1 = Up, 2 = Down) and connect the RFID reader's SOUT pin to the LCD's RX pin. And don't worry if it's not convenient for you to connect the RFID reader to a terminal or LCD – we can always use a BASIC Stamp module to read and display an unknown tag string.

## Open Sesame

Most security systems will have more than one legal user, so let's update the program to work with multiple tags. To be honest with you, I had to go back to the BS1 manual on several occasions for this program because the BS1 – while very cool – is not quite as convenient as its big brother the BS2. It's very inexpensive though (especially with OEM parts), and is worth considering for a low-cost access control system.

After we've recorded our tag IDs we can put them into a simple EEPROM-based table for storage. Here's what my table looks like:

```
Tags:
  EEPROM ("0F0184F20B")
  EEPROM ("0F01D9D263")
  EEPROM ("04129C1B43")
  EEPROM ("0000000000")
  EEPROM ("0000000000")
```

Remember that your table will be different as the RFID tag strings are unique. By using the Memory Map feature of the BASIC Stamp Editor IDE I found I had room for five tags. Since I only had three to work with I padded the table for the unused positions. A program constant will prevent us from searching past the known tag strings.

The next step is to setup our control outputs. For this security program we will turn off the reader and lock the door.

```
Reset:
  HIGH Enable
  LOW Latch
```

After basic setup we drop into the heart of the program where the reader is activated and we wait on a tag ID string. Now you'll see what I was just talking about with the BS1 not being quite as convenient as the BS2 – there is no STR modifier with the BS1 and its memory cannot be treated like an array; everything must be done one byte at a time.

```
Main:
  LOW Enable
  SERIN RX, T2400, ($0A),
                tag0, tag1, tag2, tag3, tag4,
                tag5, tag6, tag7, tag8, tag9
  HIGH Enable
```

Note that the SERIN line is really long, but needs to be on one line to make sure that all 11 bytes (header plus 10) received are in fact received properly. For publication, I've split the line, but you'll find it all together in the downloadable version of the code.

With the tag ID stored in the BS1's RAM, we can compare it to our table entries to determine whether the tag presented is a match or not. Admittedly, this looks a little hairy, but it's really not that bad. To keep things concise, I'm only showing the first and last bytes, but the same code is required for all ten elements of the RFID tag string.

```
Check_List:
  FOR tagNum = 0 TO LastTag
    pntr = tagNum * 10 + 0
    READ pntr, char
    IF char <> tag0 THEN Bad_Char

    ' removed for clarity

    pntr = tagNum * 10 + 9
    READ pntr, char
    IF char <> tag9 THEN Bad_Char
    GOTO Tag_Found
Bad_Char:
  NEXT
```

As you can see, comparing each byte of the RFID string against a table entry requires three steps that are placed in a loop: 1) We create a pointer to the corresponding position of the table entry, 2) We read the character from the table, and then 3) We compare the two bytes. If they don't match the program jumps to the label called Bad_Char and we'll either move to the next table entry, or if at the end of the table we'll fall through the loop.

Let's say we do have a match. When that occurs we will jump to the label called Tag_Found and execute the door-opening code:

```
Tag_Found:
  DEBUG "Entry: ", #tagNum, CR
  HIGH Latch
  SOUND Spkr, (114, 165)
  LOW Latch
  GOTO Main
```

The latch is activated (to allow entry) and then a beep is played through piezo speaker of amplifier circuit to alert the user. The beep stops after about two seconds and the door relocks. With that we go back to the top of the program.

When the tag presented does not match any of our table entries a one-second groan is played through the speaker:

```
Bad_Tag:
  DEBUG "Unknown Tag", CR
  SOUND Spkr, (25, 80)
  PAUSE 1000
  GOTO Main
```

And that's that. As I told you, it's really very simple – the trickiest part about this program is working around the behaviors of the BS1; but even that wasn't so bad. Okay, let's port this baby to the BS2.

Starting back at the tags table, we're going to add names to each tag. In our demo program we'll just send these to the Debug Terminal window, but we could just as easily put them on an LCD if we ever decide to add one to the project.

```
Tag1            DATA    "0F0184F20B"
Tag2            DATA    "0F01D9D263"
Tag3            DATA    "04129C1B43"

Name0           DATA    "Unauthorized", CR, 0
Name1           DATA    "George W. Bush", CR, 0
Name2           DATA    "Dick Cheney", CR, 0
Name3           DATA    "Condoleeza Rice", CR, 0
```

Note that the name strings are zero-terminated so that we're not restricted to a specific length. We'll get to the printing routine later.

Did you read last month's column? If not, why not?! Okay, I'll put my bruised ego aside and just point out that we're going to take advantage of the lessons on conditional compilation in this program. When I stated above that we would port the program to the BS2, I meant the BS2 family; the entire BS2 family.

The first thing to consider is the RAM required to read the RFID tag string: 10 bytes. This is usually temporary in nature and it would really be nice if we didn't have to use our variable space to handle it. Well, if we use the BS2p or BS2pe we don't have to; we can use the

Scratchpad as a serial buffer. The first thing we have to do, though, is setup the program so that the compiler can detect a BS2p or BS2pe and create a symbol to that effect.

```
#DEFINE __No_SPRAM = ($STAMP < BS2P)
```

With this definition the symbol called __No_SPRAM will be set to True if we're not using a BS2p or BS2pe – hence are forced to define a buffer in our variable RAM space. Let's get to that:

```
#IF __No_SPRAM #THEN
  buf           VAR     Byte(10)
#ELSE
  chkChar       VAR     Byte
#ENDIF
```

Remember that conditional compilation is just that: conditional, and it means that what actually gets compiled and downloaded will change based on the BASIC Stamp module we're using. In the code above, the array called buf is only created when using a BS2, BS2e, or BS2sx. When using a BS2p or BS2pe, we create a variable called chkChar.

And now to the core of the program. What you'll realize is that no matter which BS2-family module we use, receiving the RFID tag string in this program is much easier here than with the BS1. The only question is where those bytes will be stored, and that is determined by the module in use.

```
Main:
  LOW Enable
  #IF __No_SPRAM #THEN
    SERIN RX, T2400, [WAIT($0A), STR buf\10
  #ELSE
    SERIN RX, T2400, [WAIT($0A), SPSTR 10]
  #ENDIF
  HIGH Enable
```

When we're using a BS2, BS2e, or BS2sx the tag string is stored in our variable buffer, otherwise it gets stuffed into the first 10 bytes of the Scratchpad. But see how much easier this is? The STR and SPSTR modifiers are huge timesavers here.

With the tag string in RAM, we can compare it against the table, and again, it's much easier with the BS2-family.

```
Check_List:
  FOR tagNum = 1 TO LastTag
    FOR idx = 0 TO 9
      READ (tagNum - 1 * 10 + idx), char
      #IF __No_SPRAM #THEN
        IF (char <> buf(idx)) THEN Bad_Char
      #ELSE
        GET idx, chkChar
        IF (char <> chkChar) THEN Bad_Char
      #ENDIF
    NEXT
    GOTO Tag_Found

Bad_Char:
  NEXT
```

As with the BS1, a loop is used to work through the known tag strings. What we're able to do here, however, is use a second loop to test each byte of the received string. The inner loop reads the appropriate byte from the current tag data and compares it against the corresponding tag byte from the reader. Our conditional symbol sets up the code to make the comparison against a byte in the variable array or against a byte from the Scratchpad. Note that the Scratchpad cannot be treated like an array so we are forced to use GET to access the appropriate byte.

Okay, moving on to a good tag we will do the same as before: sound the beeper (with FREQOUT) and disable the security lock. Remember that FREQOUT is one of those instructions that differs from one BASIC Stamp model to another, so conditional compilation constants are used to keep the timing (two seconds) and tone (880 Hz) the same, no matter which module we use.

```
Tag_Found:
  GOSUB Show_Name
  HIGH Latch
  FREQOUT Spkr, 2000 */ TmAdj, 880 */ FrAdj
  LOW Latch
  GOTO Main
```

We've also added the ability to display the name of the person who is assigned to the valid tag. A simple loop will send the characters in the name to a display – we'll keep it easy and use the Debug Terminal.

```
Show_Name:
  DEBUG DEC tagNum, ": "
  LOOKUP tagNum,
         [Name0, Name1, Name2, Name3], idx
  DO
    READ idx, char
    IF (char = 0) THEN EXIT
    DEBUG char
    idx = idx + 1
  LOOP
  RETURN
```

The result of the tag search (in the variable tagNum) will be from one to the number of known tags if the tag string is valid – if not, the search will result in zero. The Show_Name routine uses the result of the tag search to LOOKUP the first character of the corresponding name. After that, each character is printed in a loop until the zero terminator is encountered. We could very easily change the DEBUG line to SEROUT for a serial LCD, or to LCDOUT if we're using a BS2p or BS2pe and have a parallel LCD connected as required.

Well, that's it. That was pretty simple, wasn't it? I think so, and I'm having a lot of fun with the RFID reader. Be sure to check out the web resources listed, there's lots of interesting information on RFID technology, and Joe Grand's web site has some really cool stuff (if you're into hardware hacking, you'll love his books).

Until next time ... Happy Stamping!

## Web Resources

www.parallax.com
www.grandideastudio.com
www.rfidjournal.com
www.emmicroelectronic.com
www.sokymat.com

```
' =========================================================================
'
'   File....... RFID_Reader.BS1
'   Purpose.... RFID Tag Reader
'   Author..... Jon Williams, Parallax
'   E-mail..... jwilliams@parallax.com
'   Started....
'   Updated.... 07 FEB 2005
'
'   {$STAMP BS1}
'   {$PBASIC 1.0}
'
' =========================================================================


' -----[ Program Description ]---------------------------------------------
'
' Reads and displays RFID tag strings.


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


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

SYMBOL  Enable          = 0                     ' low = reader on
SYMBOL  RX              = 1                     ' serial from reader


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


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


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


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


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

Main:
  LOW Enable

  ' wait for header ($0A), then accept 10 RFID bytes

  SERIN RX, T2400, ($0A),B0,B1,B2,B3,B4,B5,B6,B7,B8,B9
  HIGH Enable
```

```
Show_Tag:
  DEBUG "Tag ID: ", #@B0,#@B1,#@B2,#@B3,#@B4,#@B5,#@B6,#@B7,#@B8,#@B9
  DEBUG CR
  PAUSE 1000                                    ' time to remove tag
  GOTO Main


' -----[ Subroutines ]-----------------------------------------------------
' =========================================================================
'
'   File....... RFID_Single.BS1
'   Purpose.... Single-tag RFID Tag Reader
'   Author..... Jon Williams, Parallax
'   E-mail..... jwilliams@parallax.com
'   Started....
'   Updated.... 07 FEB 2005
'
'   {$STAMP BS1}
'   {$PBASIC 1.0}
'
' =========================================================================


' -----[ Program Description ]---------------------------------------------
'
' Looks for a specific RFID tag and when found, opens an electric lock


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


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

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


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


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


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


' -----[ 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, "0F0184F20B")          ' wait for header & tag
  HIGH Enable                                       ' deactivate reader

Access_Granted:
  HIGH Latch                                        ' open the lock
  PAUSE 2000                                        ' -- for two seconds
  LOW Latch                                         ' relock
  GOTO Main


' -----[ Subroutines ]-----------------------------------------------------
' =========================================================================
'
'   File....... RFID.BS1
'   Purpose.... RFID Tag Reader / Simple Security System
'   Author..... Jon Williams, Parallax
'   E-mail..... jwilliams@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  Latch           = 2                     ' lock/latch control
SYMBOL  Spkr            = 3                     ' speaker output


' -----[ 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")
  EEPROM ("0000000000")


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

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


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

Main:
  LOW Enable

  ' wait for header, then accept 10 RFID bytes

  SERIN RX, T2400, ($0A),tag0,tag1,tag2,tag3,tag4,tag5,tag6,tag7,tag8,tag9
  HIGH Enable

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:
  DEBUG "Unknown Tag", CR
  SOUND Spkr, (25, 80)                          ' groan
  PAUSE 1000
  GOTO Main

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

  END


' -----[ Subroutines ]-----------------------------------------------------
' =========================================================================
'
'   File....... RFID.BS2
'   Purpose.... RFID Tag Reader / Simple Security System
'   Author..... Jon Williams, Parallax
'   E-mail..... jwilliams@parallax.com
'   Started....
'   Updated.... 07 FEB 2005
'
'   {$STAMP BS2e}
'   {$PBASIC 2.5}
'
' =========================================================================


' -----[ Program Description ]---------------------------------------------
'
' Reads and displays RFID tag strings.


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


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

Enable          PIN     0                       ' low = reader on
RX              PIN     1                       ' serial from reader


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

#SELECT $STAMP
  #CASE BS2, BS2E, BS2PE
    T2400       CON     396
  #CASE BS2SX, BS2P
    T2400       CON     1021
#ENDSELECT


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

buf             VAR     Byte(10)                ' RFID bytes buffer


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


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


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

```
Main:
  LOW Enable                                        ' activate the reader
  SERIN RX, T2400, [WAIT($0A), STR buf\10]          ' wait for hdr + ID
  HIGH Enable                                       ' deactivate reader

Show_Tag:
  DEBUG "Tag ID: ", STR buf\10, CR                  ' display ID
  PAUSE 1000                                        ' time to remove tag
  GOTO Main


' -----[ Subroutines ]-----------------------------------------------------
' =========================================================================
'
'   File....... RFID.BS2
'   Purpose.... RFID Tag Reader / Simple Security System
'   Author..... Jon Williams, Parallax
'   E-mail..... jwilliams@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
Latch           PIN     2                       ' lock/latch control
Spkr            PIN     3                       ' speaker output


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

#SELECT $STAMP
  #CASE BS2, BS2E
    T2400       CON     396                     ' reader baud rate
    TmAdj       CON     $100                    ' x 1.0 (time adjust)
    FrAdj       CON     $100                    ' x 1.0 (freq adjust)
  #CASE BS2SX
    T2400       CON     1021
    TmAdj       CON     $280                    ' x 2.5
    FrAdj       CON     $066                    ' x 0.4
  #CASE BS2P
    T2400       CON     1021
    TmAdj       CON     $3C5                    ' x 3.77
    FrAdj       CON     $044                    ' x 0.265
  #CASE BS2PE
    T2400       CON     396
    TmAdj       CON     $100                    ' x 1.0
    FrAdj       CON     $0AA                    ' x 0.665
```

```
#ENDSELECT

LastTag         CON     3                       ' three known tags


#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 W. Bush", CR, 0
Name2           DATA    "Dick Cheney", CR, 0
Name3           DATA    "Condoleeza Rice", 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


' -----[ Subroutines ]-----------------------------------------------------

' Prints name associated with RFID tag

Show_Name:
  DEBUG DEC tagNum, ": "
  LOOKUP tagNum,
         [Name0, Name1, Name2, Name3], idx      ' point to first character
  DO
    READ idx, char                              ' read character from name
    IF (char = 0) THEN EXIT                     ' if 0, we're done
    DEBUG char                                  ' otherwise print it
    idx = idx + 1                               ' point to next character
  LOOP
  RETURN
```