https://www.halvorsen.blog

RFID

Radio Frequency Identification System

Hans-Petter Halvorsen

Contents

Introduction

Hans-Petter Halvorsen

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Different Technologies

- Barcode
- QR Code
- RFID
- NFC
- Beacons

Barcode

- A barcode or bar code is a method of representing data in a visual, machine-readable form.
- Initially, barcodes represented data by varying the widths and spacings of parallel lines.
- These barcodes, now commonly referred to as linear or one-dimensional (1D)
- These can be scanned by special optical scanners, called barcode readers

https://en.wikipedia.org/wiki/Barcode

QR Code

A QR code (abbreviated from Quick Response code) is a type of matrix barcode (or two-dimensional barcode)

RFID

- Radio-frequency identification (RFID)
- RFID is the method of uniquely identifying items using radio waves
- An RFID system comprises a tag, a reader, and an antenna
- Unlike a barcode, the tag does not need to be within the line of sight of the reader

https://en.wikipedia.org/wiki/Radio-frequency_identification

NFC

- NFC - Near Field Communication
- NFC describes a technology which can be used for contactless exchange of data over short distances
- RFID is the process by which items are uniquely identified using radio waves
- NFC is a specialized subset within the family of RFID technology

Beacons

- The concept of beacons is as old as, for example, hand watches. Like lighthouses guide ships and show where the land is, beacon devices provide information and navigation to smartphone users. Beacon technology offers a new context for an old concept.
- Typically use Bluetooth

https://en.wikipedia.org/wiki/Bluetooth_low_energy_beacon

https://www.intellectsoft.net/blog/what-are-beacons-and-how-do-they-work/

RFID Overview

Radio Frequency Identification System

Hans-Petter Halvorsen

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RFID Parts

- An **RFID tag** in its most simplistic form, is comprised of two parts – an antenna for transmitting and receiving signals, and an RFID chip (or integrated circuit, IC) which stores the tag's ID and other information. RFID tags are affixed to items in order to track them using an RFID reader and antenna.
- An **RFID reader** is the brain of the RFID system and is necessary for any system to function
- **RFID Antennas** are necessary elements in an RFID system because they convert the RFID reader's signal into RF waves that can be picked up by RFID tags
- Many RFID readers has an integrated antenna

https://www.atlasrfidstore.com/rfid-beginners-guide/

RFID

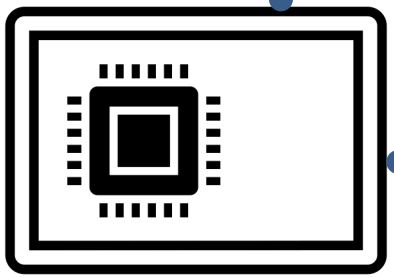
- RFID System is an abbreviation of **Radio Frequency Identification System**.
- It is a system for identification of items
- It uses using wireless communication that transfer data between Tags and the RFID Reader/Antenna
- We get RFID systems with different Frequencies
  - LF (125KHz), HF (13.56MHz), UHF
- We have Active and Passive Tags.
  - Passive tags are powered by energy from the RFID reader
  - Active tags have a battery

RFID System

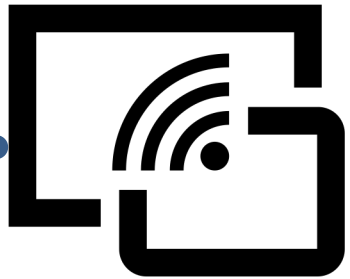
PC (or a Microcontroller, e.g., Arduino, Raspberry Pi)

USB

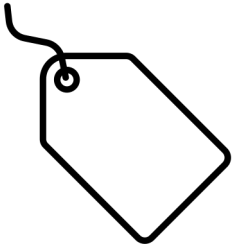
RFID Reader



RFID Antenna



RFID Tag



RFID Applications

How is RFID Used in the Real World? Some Examples:

- Inventory Tracking
- Race Timing
- Attendee Tracking
- Materials Management
- Access Control
- Library System

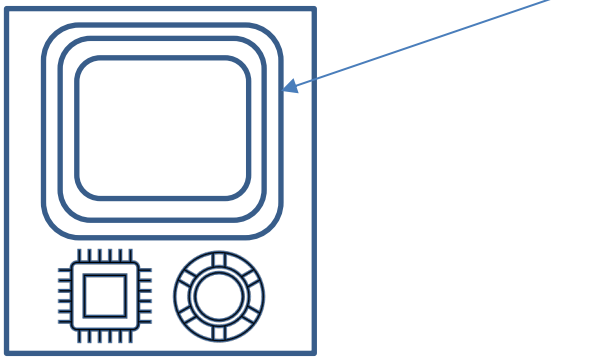
..

https://www.atlasrfidstore.com/rfid-insider/what-is-rfid-used-for-in-applications/?utm_source=RFID-Beginners-Guide&utm_medium=eBook&utm_campaign=Content&utm_content=real-world-applications

RFID System

RFID Reader

RFID Antenna



The RFID Reader is typically a Microcontroller

RFID Tags

RFID Tags exist in many flavors and shapes

The Antenna is typically integrated within the RFID Reader, but you can also get external Antennas for better range

RFID System

PC

RFID Reader

RFID Antenna

USB Cable

RFID Tags

RFID Frequencies

- Low Frequency (LF) - 125KHz
  - Range up to 20cm
  - Read Only
  - It is suitable for applications with a short distance, low transmission rate, and a small amount of data. For example, access control, attendance, electronic billing, electronic wallet, and so on.
- High Frequency (HF) - 13.56MHz
  - Range up to 1m
  - Read/Write
- Ultra High Frequency (UHF) - 433 MHz and higher
  - Range up to 100m
  - Read/Write

https://learn.sparkfun.com/tutorials/rfid-basics/

https://www.asiarfid.com/different-types-of-rfid-tags.html

Parallax USB RFID Reader

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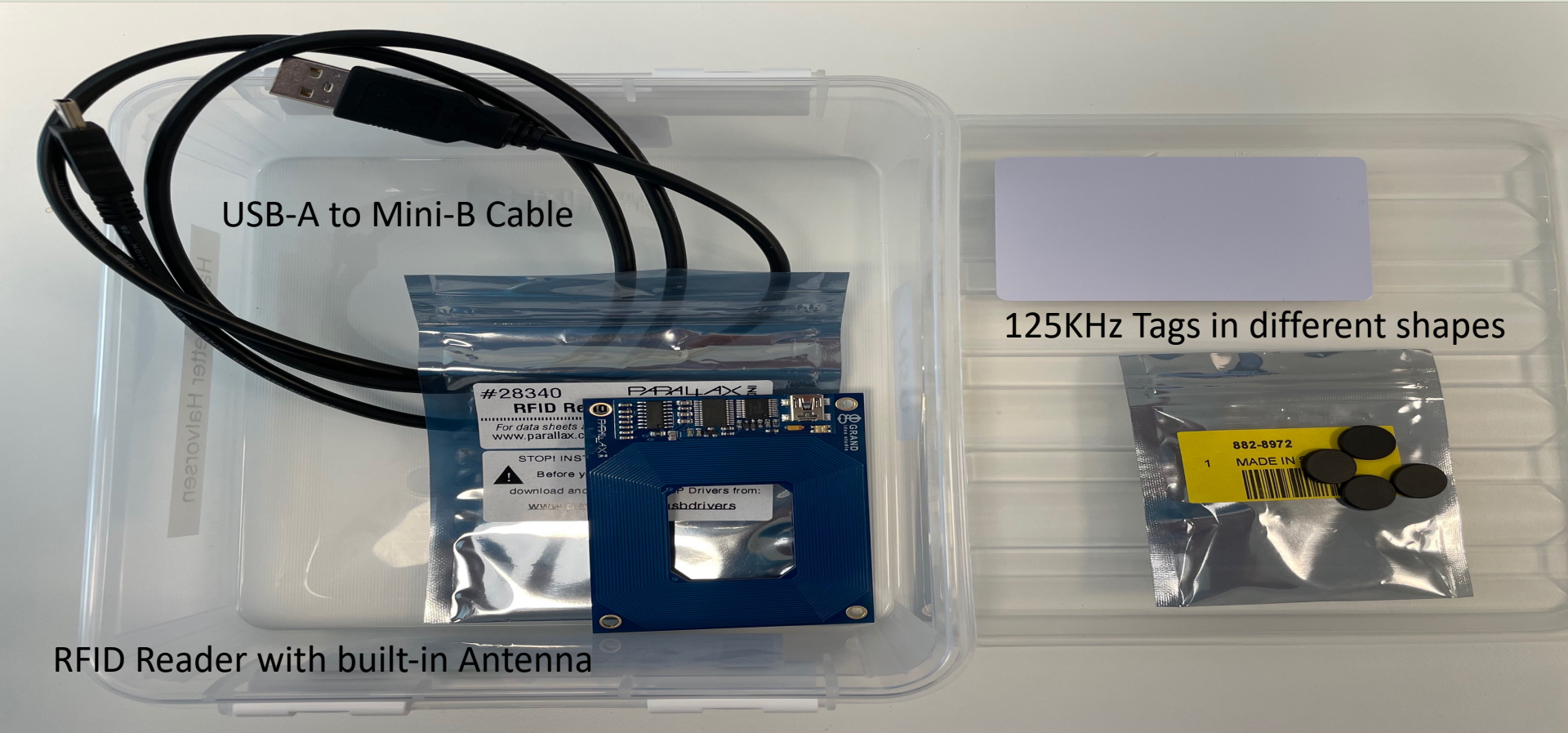
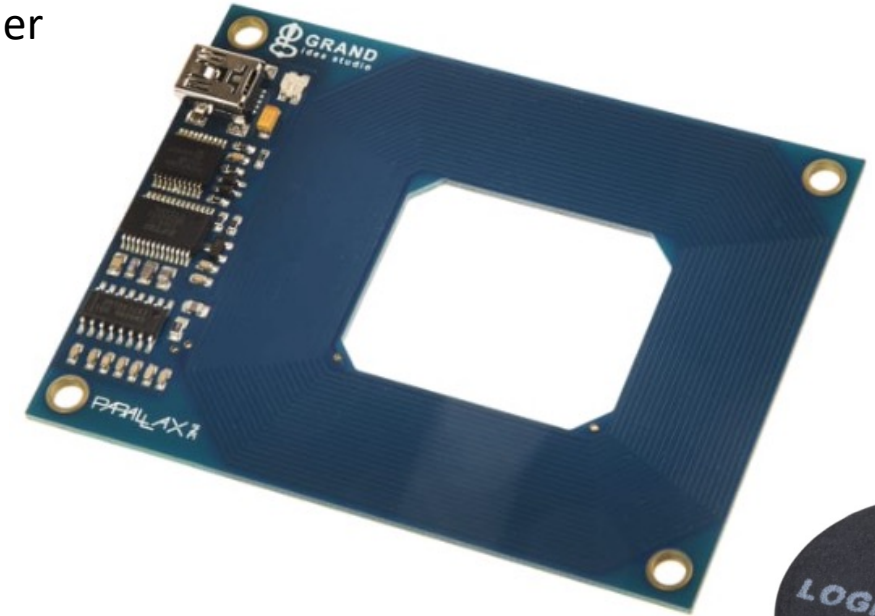
Parallax USB RFID Reader



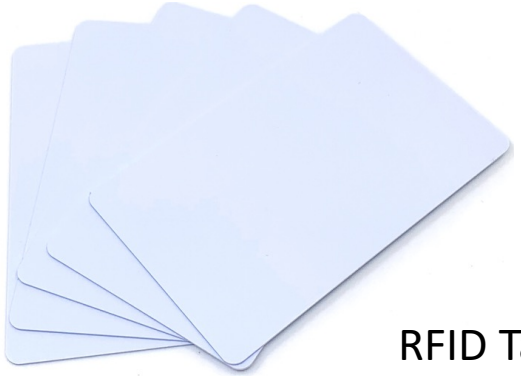
RFID 125KHz

Reads 125kHz Tags with EM4100 protocol

Parallax Inc 28340 RFID Reader



USB RFID Reader



RFID Tags

RFID Tags

https://www.parallax.com/product/rfid-card-reader-usb/

https://no.rs-online.com/web/p/rf-modules/7813061/

Parallax USB RFID Reader

From Parallax USB RFID Reader Documentation

- It reads passive **125 kHz** RFID transponder tags
- 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
- 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 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.
- RFID Tag read distance of approximately 4 inches (**10cm**).

Parallax USB RFID Reader

Communication Protocol:

- The RFID Card Reader USB version transmits the data through the USB Virtual COM Port driver
- All communication is 8 data bits, no parity, 1 stop bit, and least significant bit first (8N1) at 2400 bps.
- 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:

Parallax USB RFID Reader

Communication Protocol:

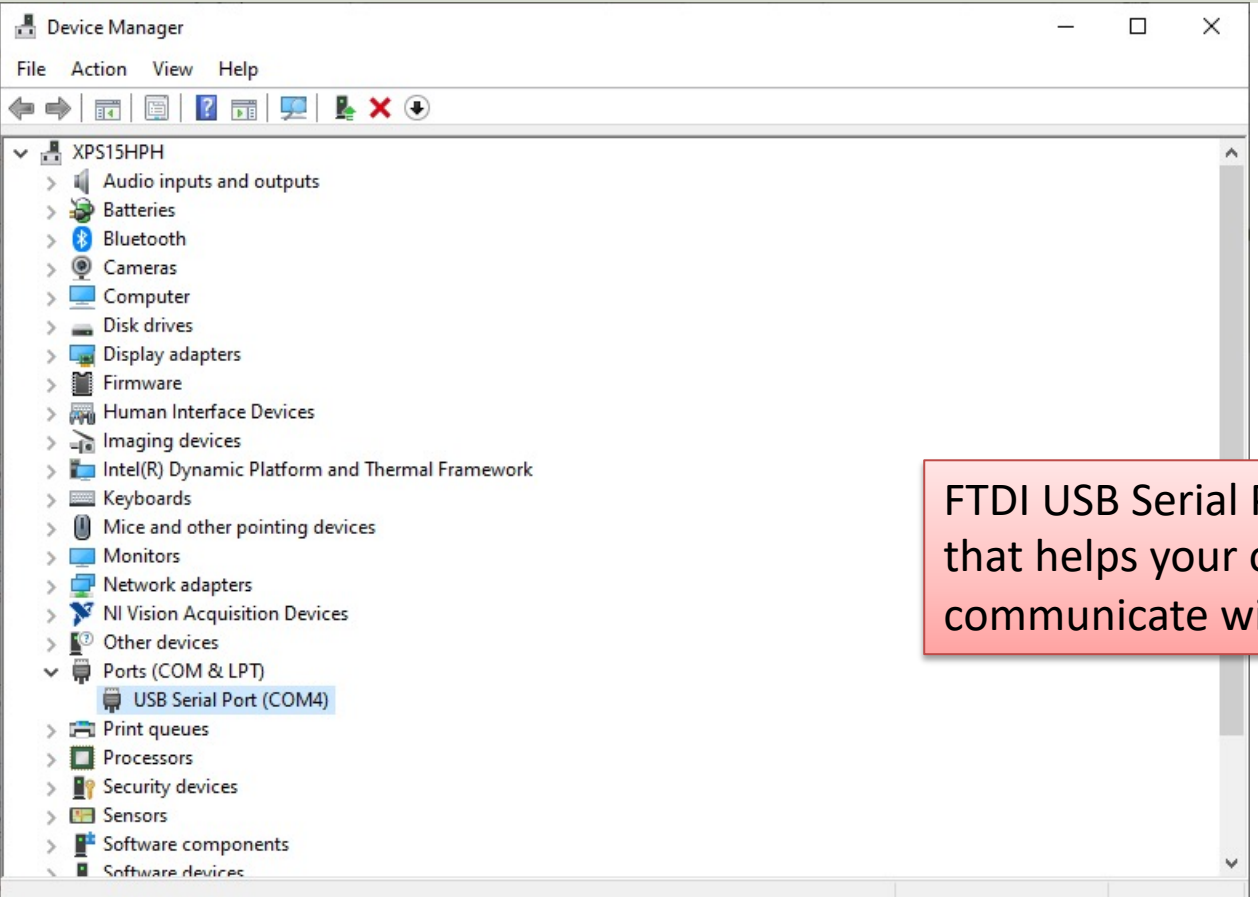
Start Byte (0x0A)	Unique ID Digit 1	Unique ID Digit 2	Unique ID Digit 3	Unique ID Digit 4	Unique ID Digit 5	Unique ID Digit 6	Unique ID Digit 7	Unique ID Digit 8	Unique ID Digit 9	Unique ID Digit 10	Stop Byte (0x0D)

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 (\n)and carriage return (\r) 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.

Setup and Configuration



Device Manager

FTDI USB Serial Port driver is the software that helps your operating system to communicate with USB Serial Port devices

Code Examples

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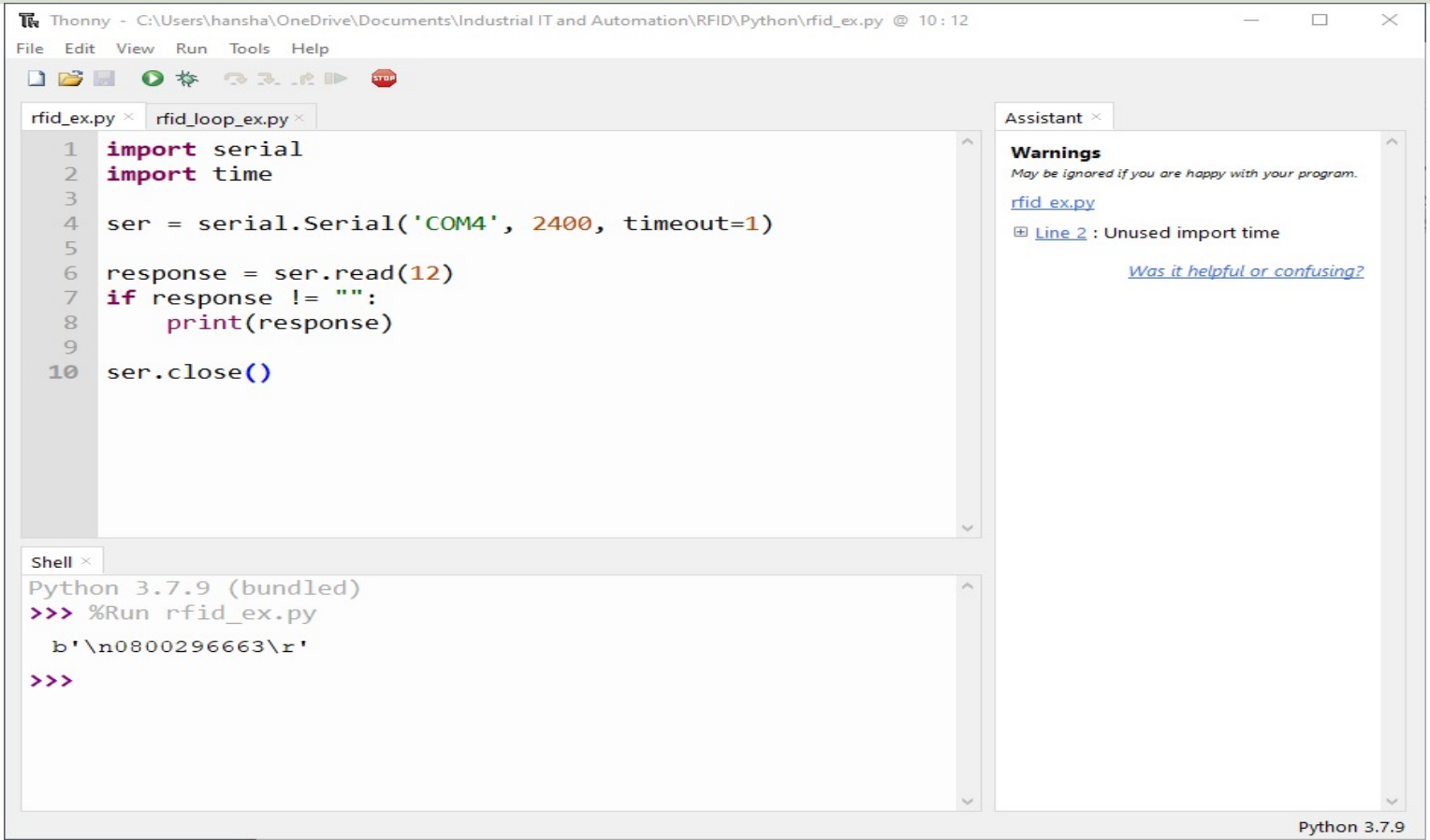
Parallax USB RFID Reader

Code Examples

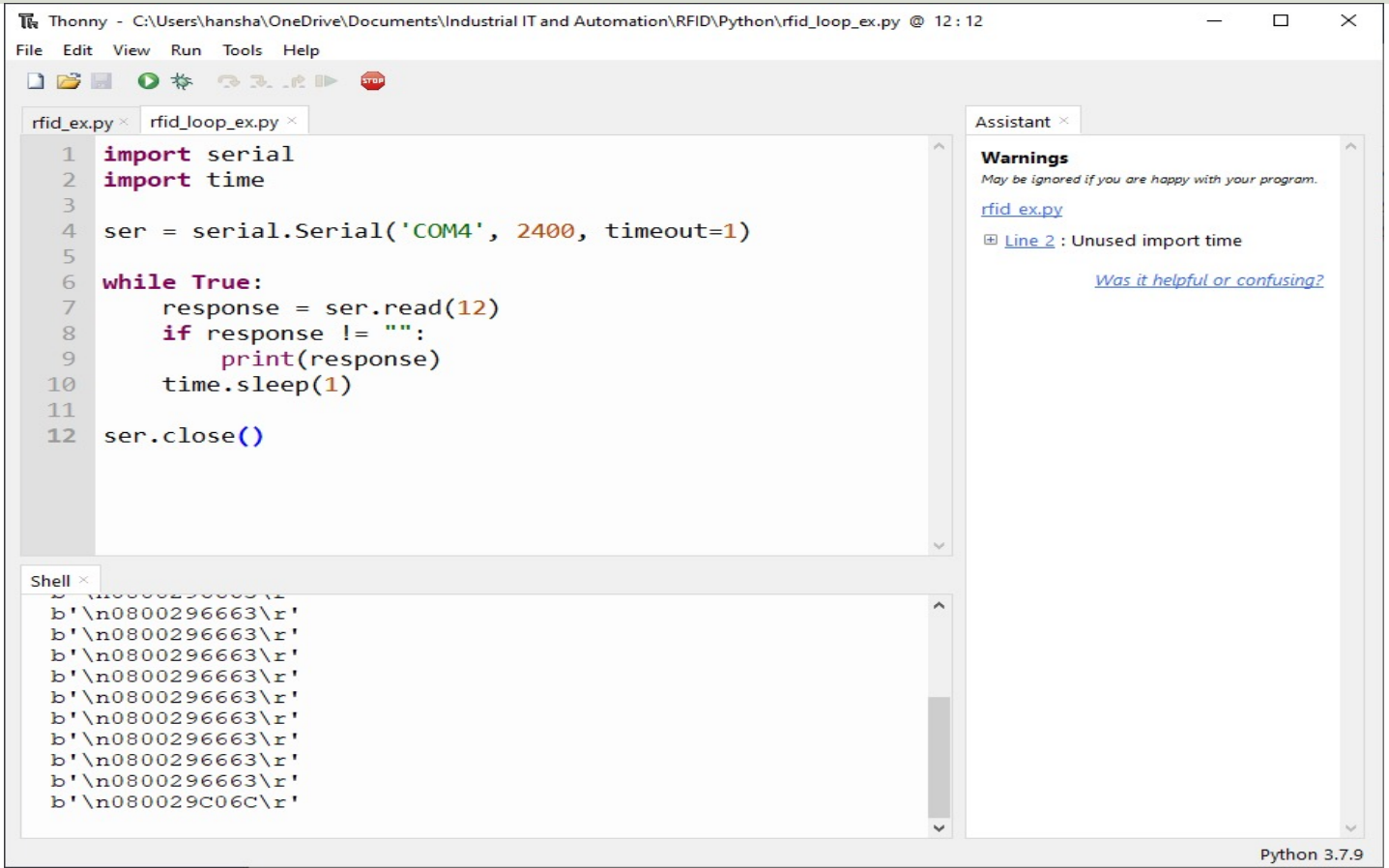
Note!

- The examples provided can be considered as a “proof of concept”
- The sample code is very simplified for clarity and doesn't necessarily represent best practices.

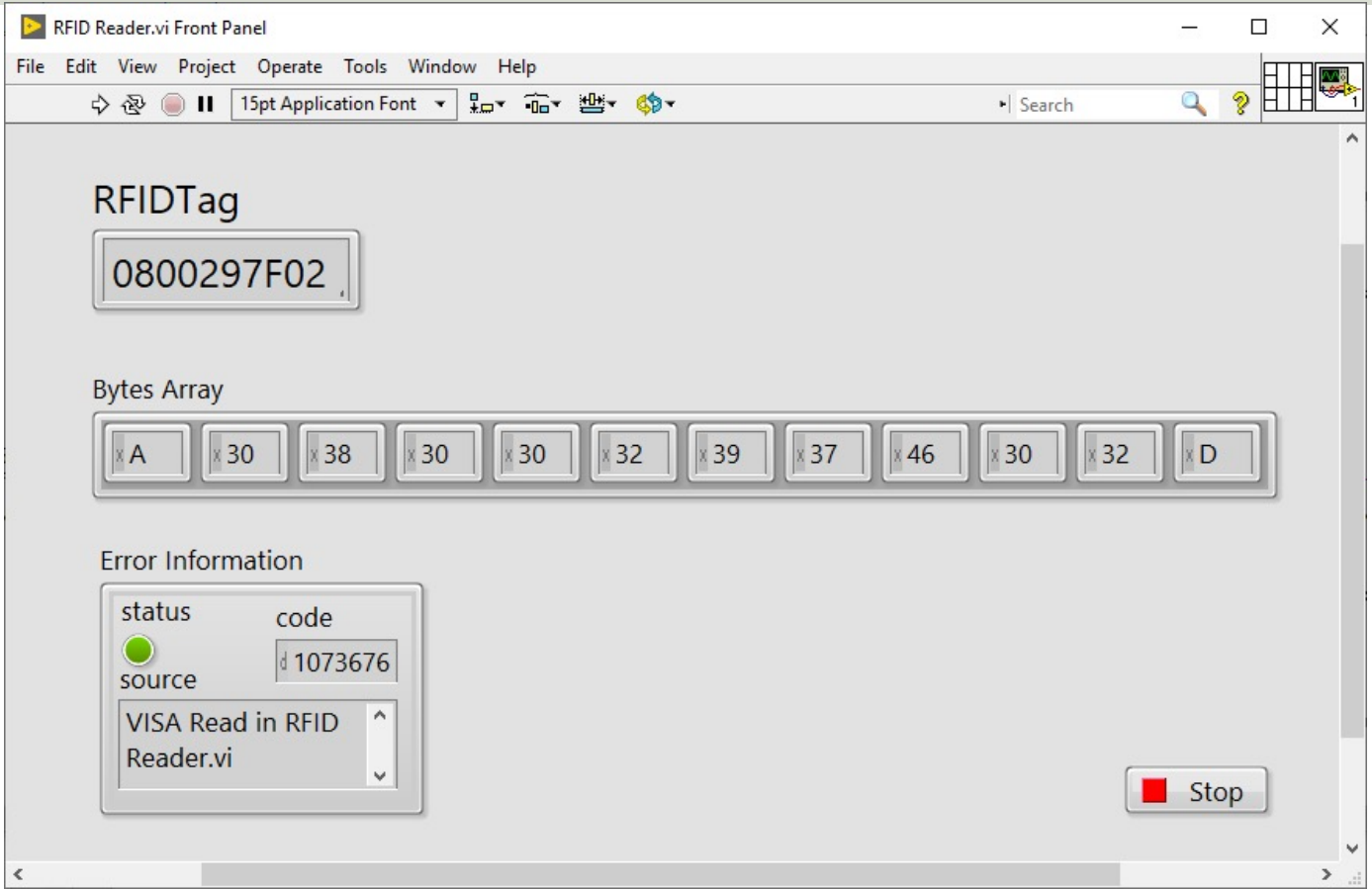
Python Example



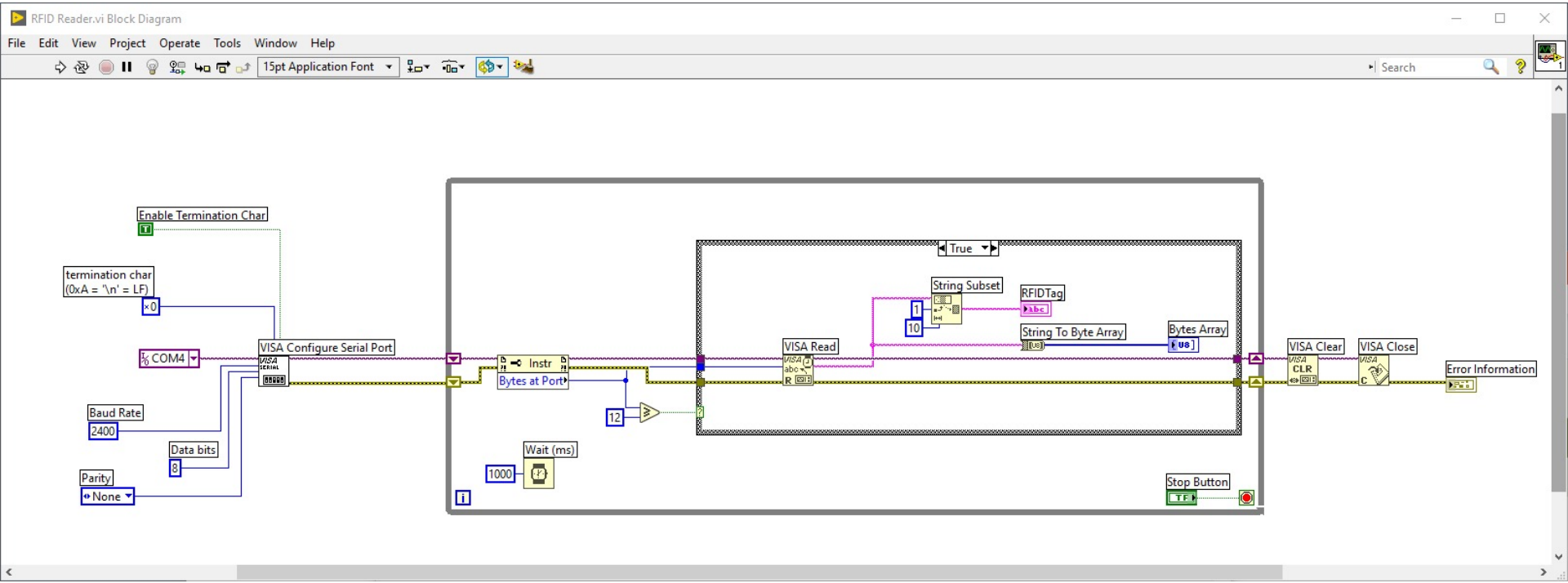
Python Example



LabVIEW Example



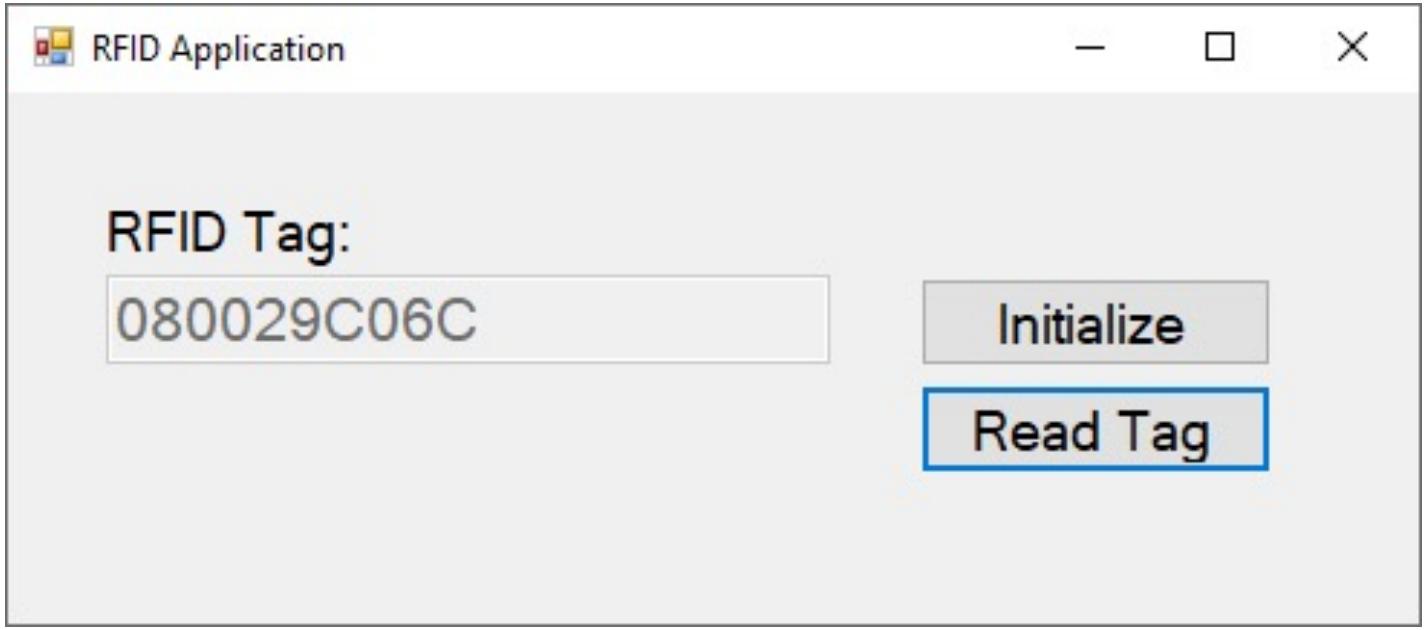
LabVIEW Example



Read RFID Tag with C#

```
using System.IO.Ports;

SerialPort port = new System.IO.Ports.SerialPort("COM4", 2400, System.IO.Ports.Parity.None,
                                                 8, System.IO.Ports.StopBits.One);

port.Open();
port.DtrEnable = true;

int numberBytesToRead = 12;
byte[] data = new byte[numberBytesToRead];
port.ReadTimeout = 1000;
port.Read(data, 0, numberBytesToRead);

string rfidTag;
rfidTag = System.Text.Encoding.UTF8.GetString(data, 0, data.Length);

rfidTag = rfidTag.Replace("\n", "");
rfidTag = rfidTag.Replace("\r", "");

port.Close();
```

Visual Studio/C# Example



C# Example

```
using System;
using System.IO.Ports;
using System.Windows.Forms;


namespace ReadRfidApp
{
   public partial class Form1 : Form
   {
      string rfidTag;
      SerialPort port = new System.IO.Ports.SerialPort("COM4", 2400, System.IO.Ports.Parity.None, 8, System.IO.Ports.StopBits.One);

      public Form1()
      {
         InitializeComponent();
      }

      private void Form1_Load(object sender, EventArgs e)
      { }

      private void btnInitialize_Click(object sender, EventArgs e)
      {
         port.Open();
         port.DtrEnable = true;

         txtTagData.Text = "";
      }

      private void btnReadTag_Click(object sender, EventArgs e)
      {
         int numberBytesToRead = 12;
         byte[] data = new byte[numberBytesToRead];
         port.ReadTimeout = 1000;
         port.Read(data, 0, numberBytesToRead);

         rfidTag = System.Text.Encoding.UTF8.GetString(data, 0, data.Length);

         rfidTag = rfidTag.Replace("\n", "");
         rfidTag = rfidTag.Replace("\r", "");

         txtTagData.Text = rfidTag;

         port.Close();
      }
   }
}
```

Eccel Technology Ltd OEM-MICODE-USB RFID Reader

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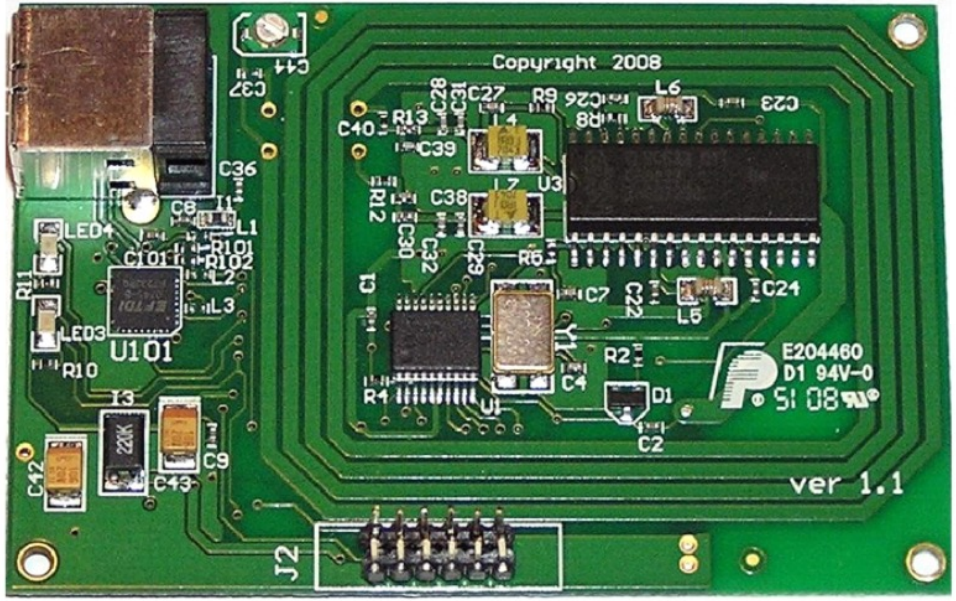
RFID 13.56MHz

Eccel Technology Ltd OEM-MICODE-USB (000128) RFID Reader



Board Case

RFID Tags

RFID standard:
13.56MHz ISO14443-A
MIFARE Classic Card 1K 13.56mhz

USB A-B Male Cable 1m

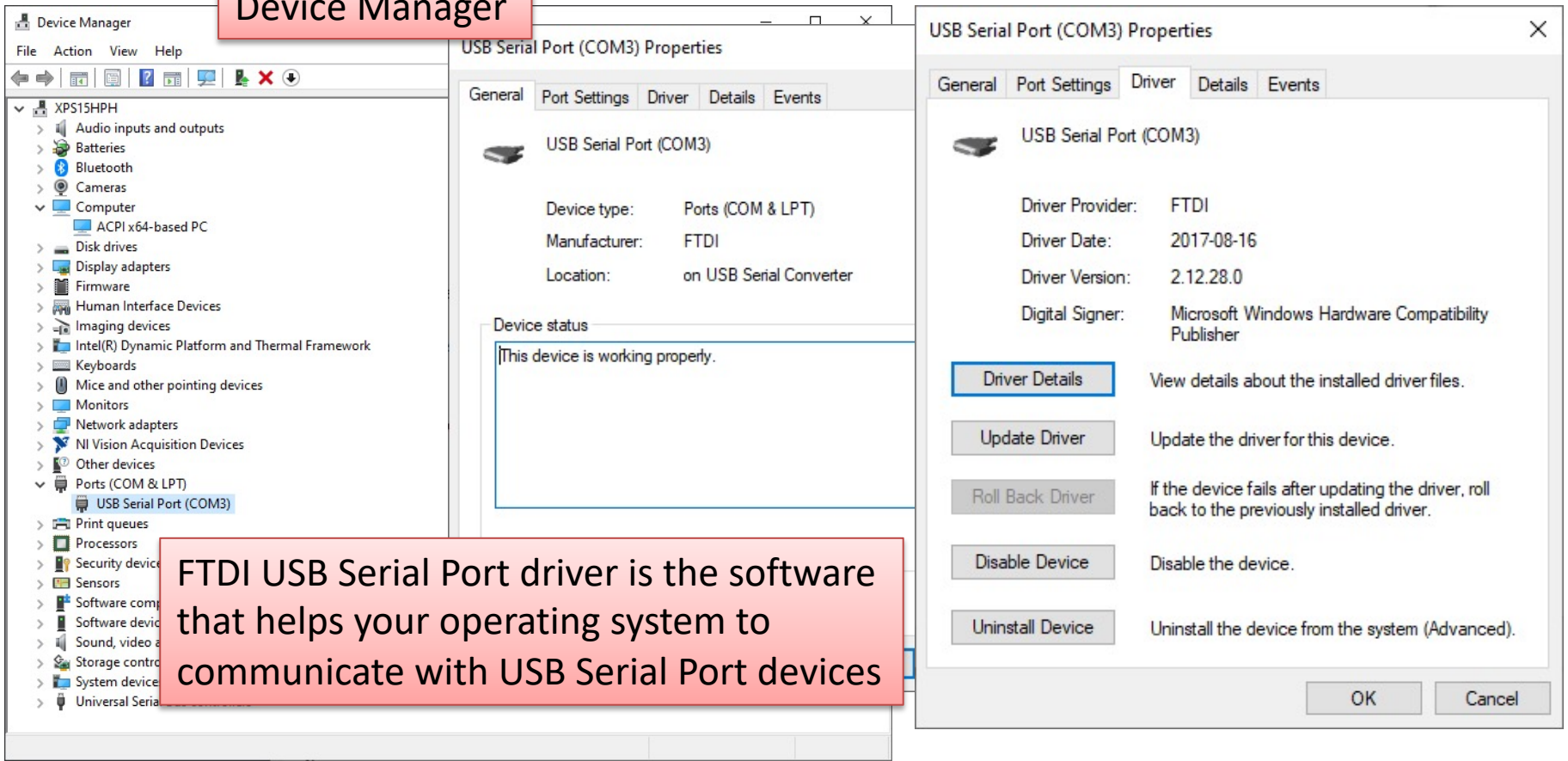
RS Online: https://no.rs-online.com/web/p/rf-modules/1262181/

Setup and Configuration

- Connect the Device to your PC using the USB Cable
- Open the **Device Manager** in Windows and find the allocated **COM Port** for the device
- Make sure the Device and the **FTDI USB Serial Port driver** is installed properly
- Install the Configuration and Test Software (Micro RWD MFIC) from https://eccel.co.uk/product/oem-micode-usb/
- Read the Datasheet
- Start developing a Test application that can read data from the RFID reader

Setup and Configuration

Device Manager

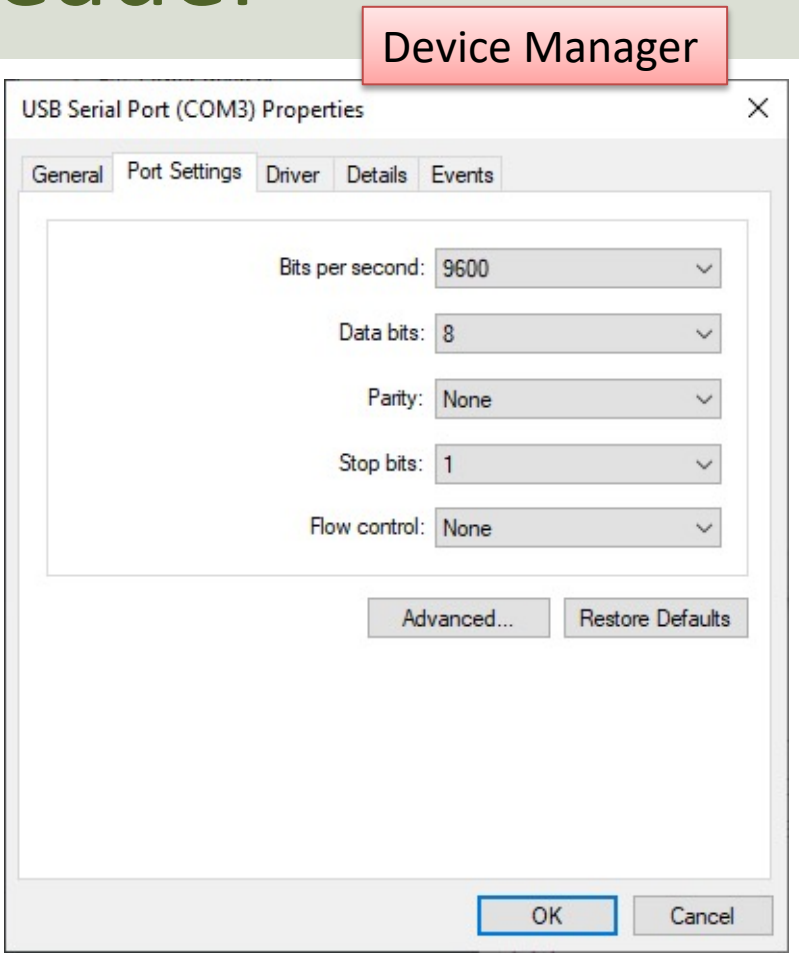


FTDI USB Serial Port driver is the software that helps your operating system to communicate with USB Serial Port devices

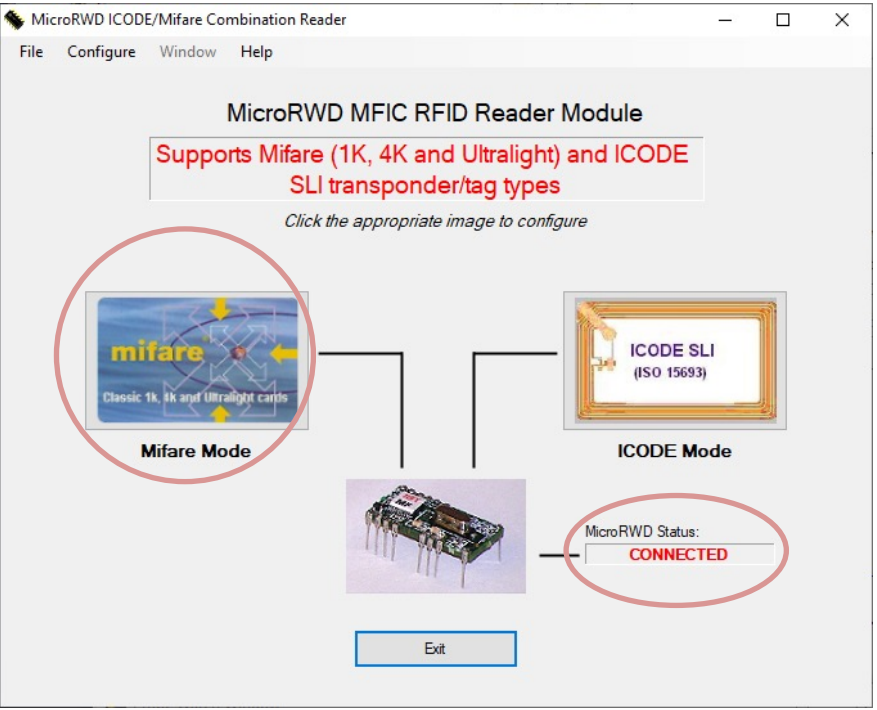
Eccel RFID Reader

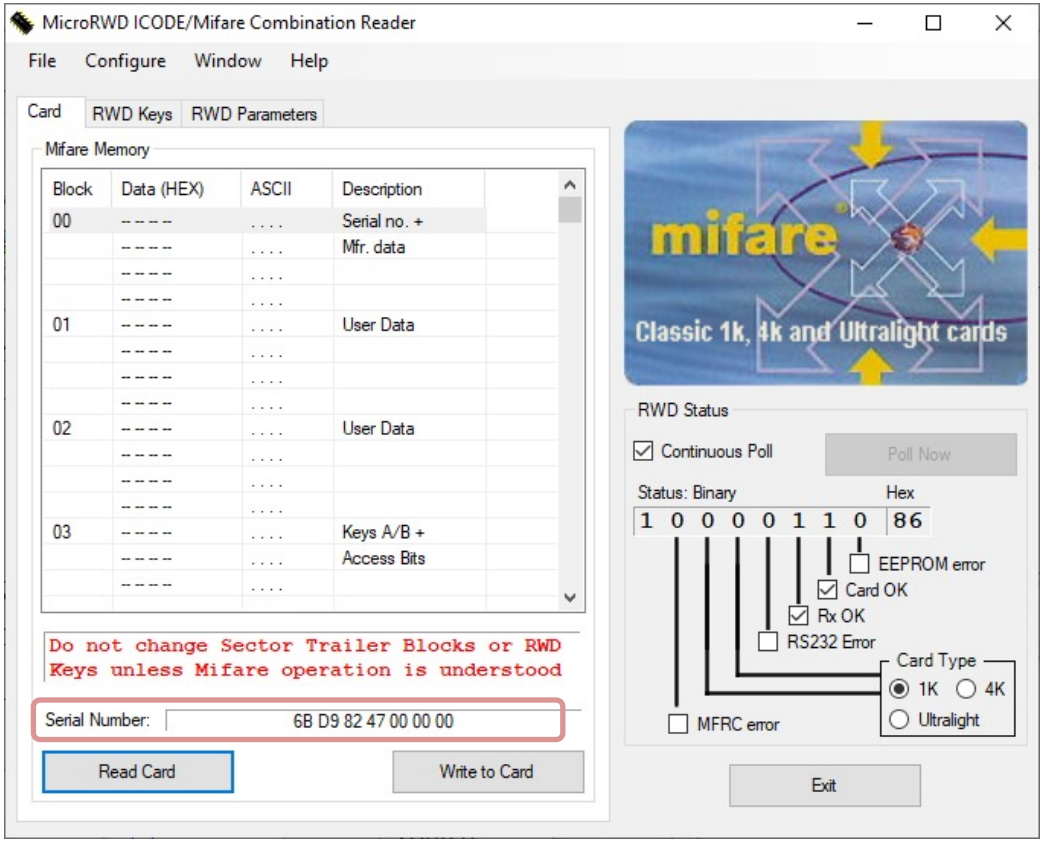
Communication (from the Datasheet):

- 9600 baud
- 8 bits
- 1 stop
- No parity



Configuration and Test Software



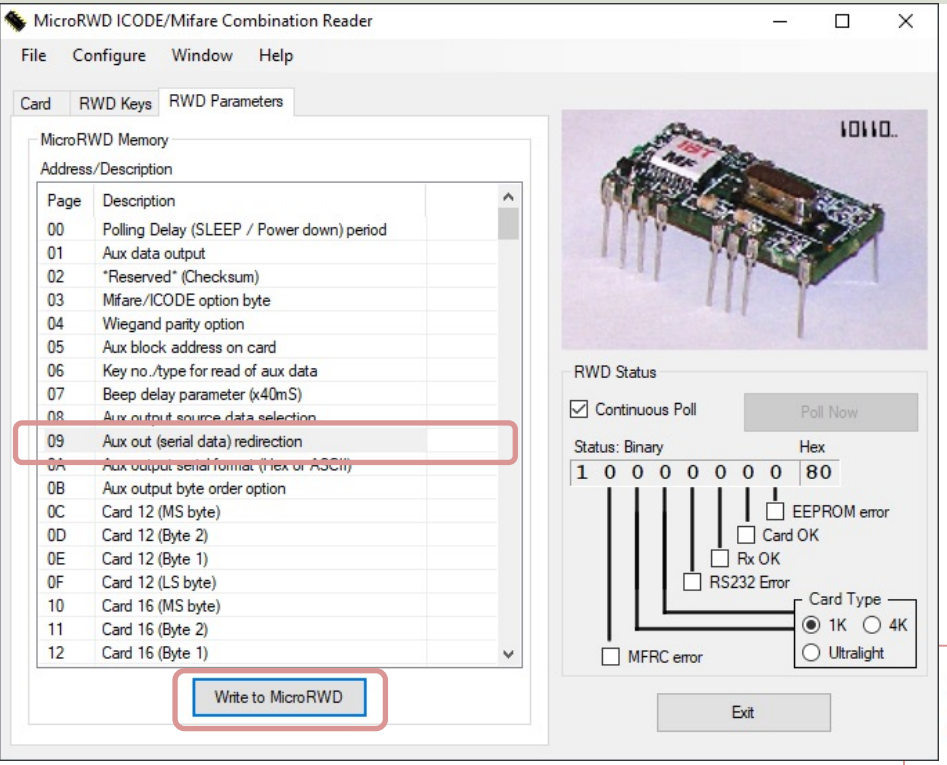


Configure Tx Output

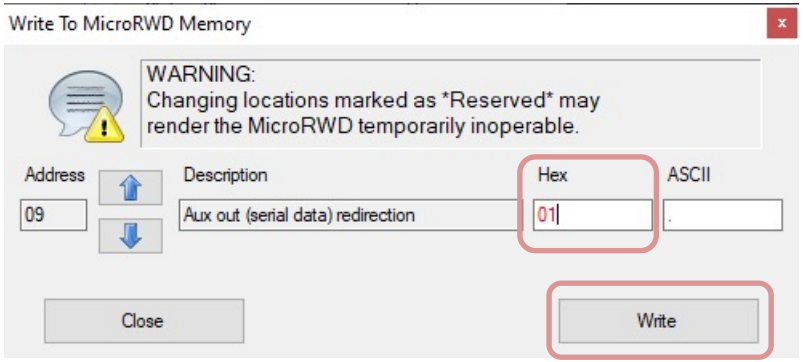
- The default for the OEM-Micode and RWD products is to output the received UID number on the OP0 pin. (Connector J2, Pin 2 on the OEM products).
- If you want the automatic output to be redirected to the TX pin of the serial port instead, then you must program a control byte from its factory default to do this.
- See datasheet, page 12). Link to Datasheet: https://eccel.co.uk/wp-content/uploads/2018/05/MF_ICBprot_030518.pdf
- If the UID automatic output is redirected to the TX pin, then there will be no acknowledge byte sent by the reader after you send any commands to it. This is to avoid data clashes with the automatic UID transmission.
- To change the direction of the UID output to the TX pin you have to program byte 9 of the EEPROM control registers to 0x01.
- So, send a command string as follows : 0x50, 0x09, 0x01.
- You will receive no acknowledge but after presenting a card/tag, you should receive the UID back on your terminal screen.

!

Configure Tx Output



To change the direction of the UID output to the TX pin you have to program byte 9 of the EEPROM control registers to 0x01



From the Datasheet:

Byte 9: Auxiliary output switch (redirects serial o/p)

0x00 = Aux output from OP0 pin (default)

0x01 = Aux output from Tx pin

RealTerm

- RealTerm is a tool for capturing, entering and debugging Serial Communication
- RealTerm is a very old program
- RealTerm is available to download from SourceForge: https://sourceforge.net/projects/realterm/files/Realterm/
- Use RealTerm in combination with the Datasheet for the device to learn more about the communication protocol used for the device

https://learn.sparkfun.com/tutorials/terminal-basics/real-term-windows

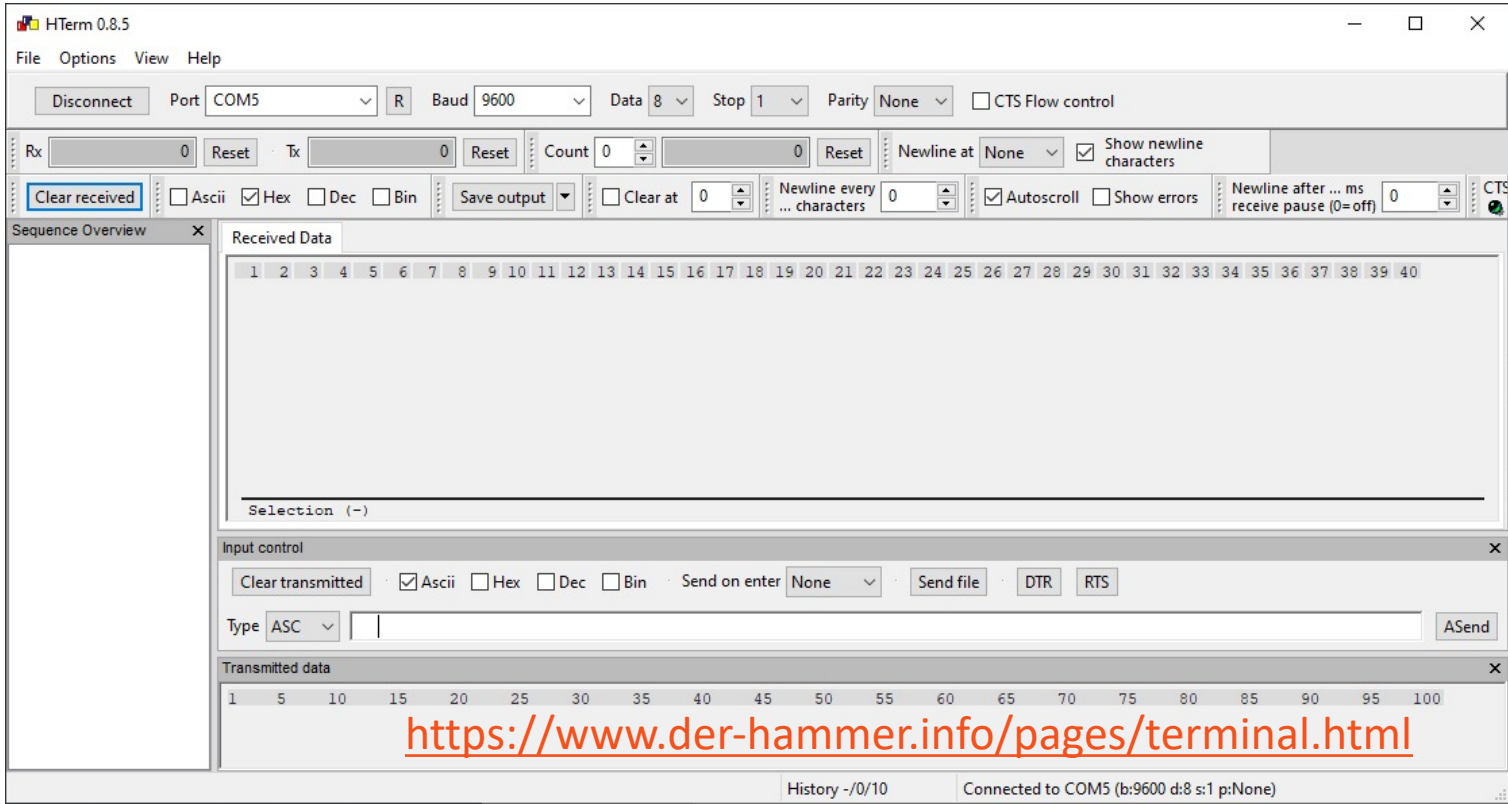
YAT

- Another program is YAT. It as a more modern graphical interface than RealTerm.
- YAT is a tool for capturing, entering and debugging Serial Communication, etc.
- YAT is available to download from SourceForge: https://sourceforge.net/projects/y-a-terminal/files/
- Use YAT in combination with the Datasheet for the device to learn more about the communication protocol used for the device

https://learn.sparkfun.com/tutorials/terminal-basics/yat---yet-another-terminal-windows

HTerm

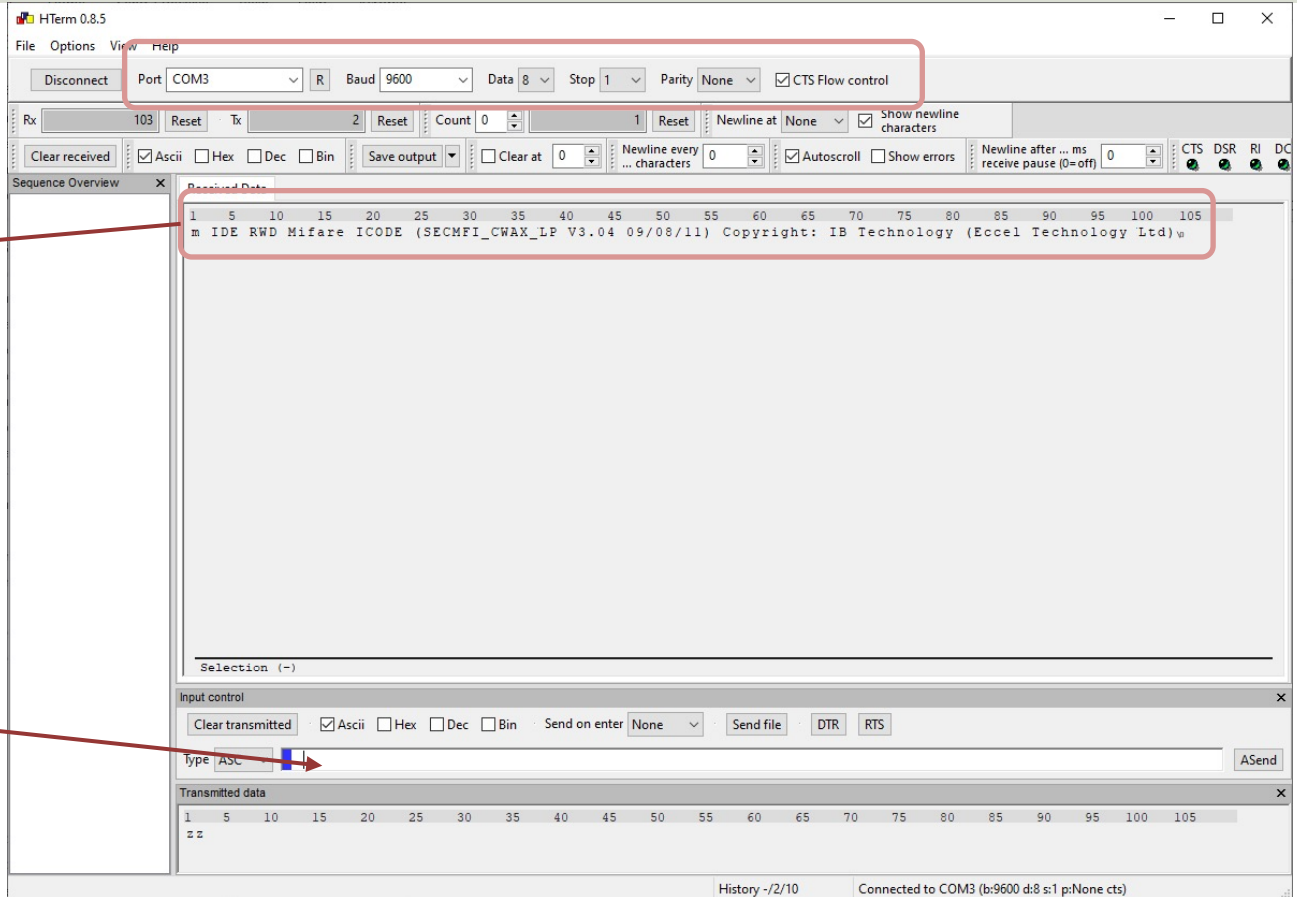
Another Terminal Program like RealTerm and YAT



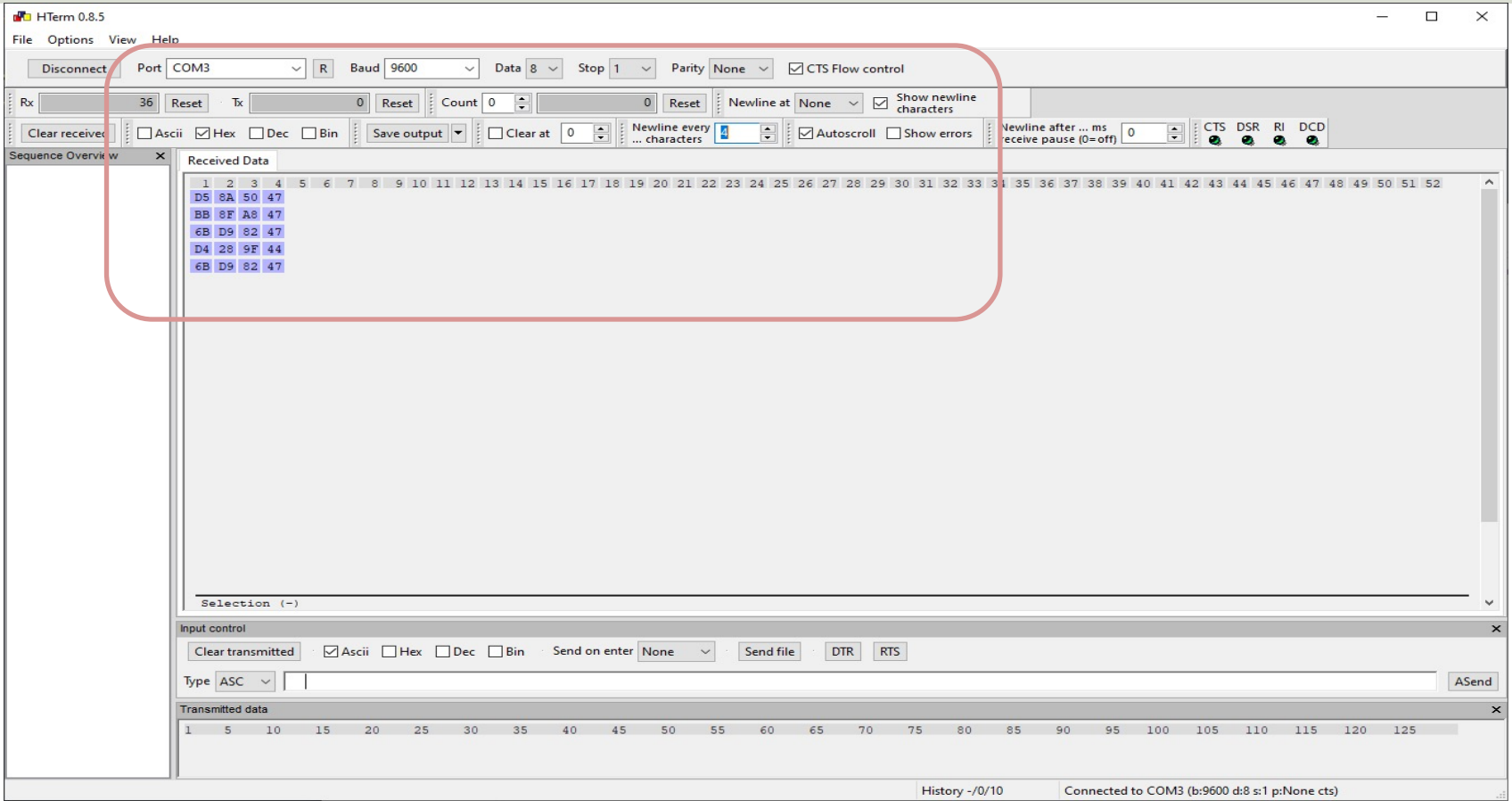
Hterm – Check Device

The RFID reader then respond with information about him self

Enter “z”



Hterm – Retrieving Tag Id



Code Examples

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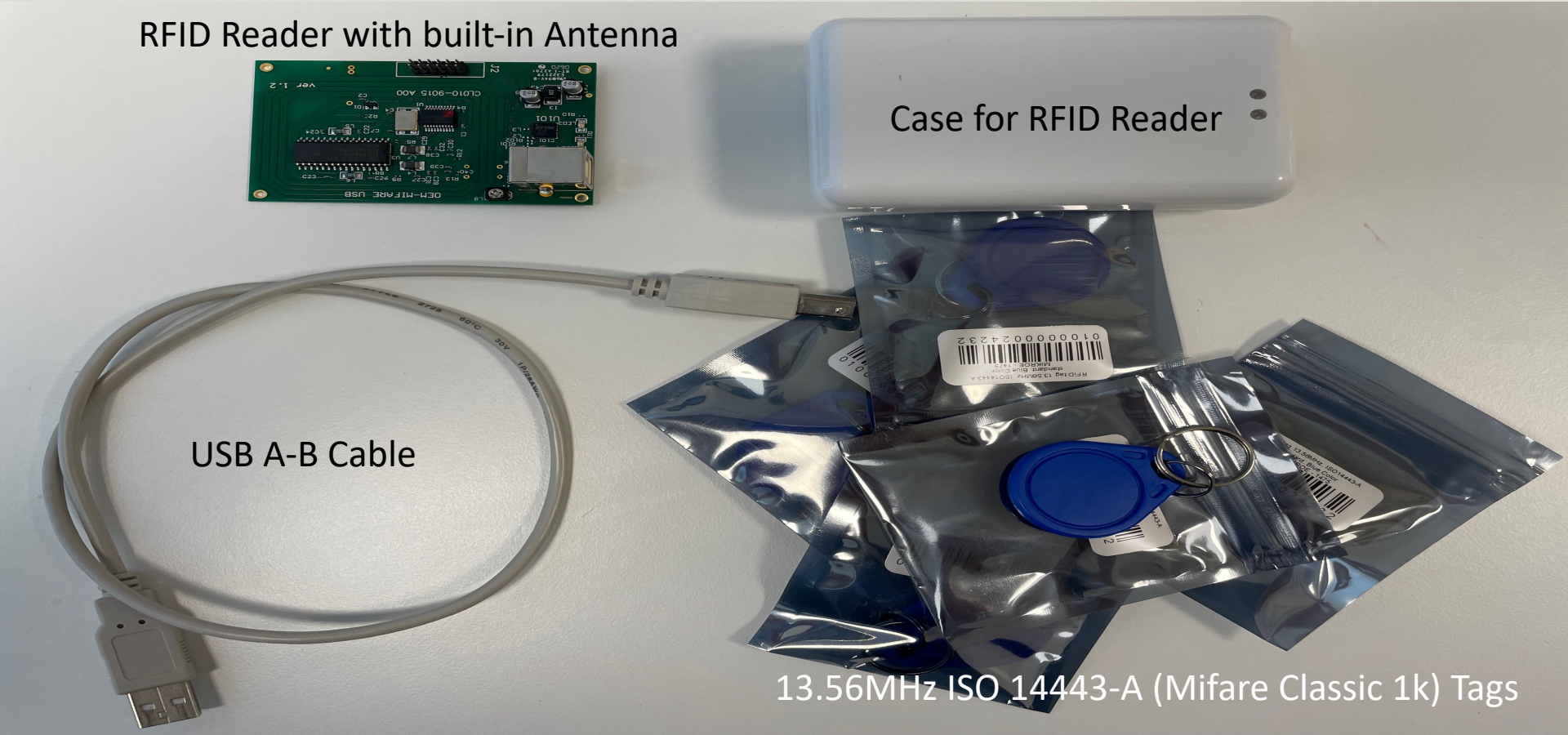
Eccel OEM-MICODE-USB RFID Reader



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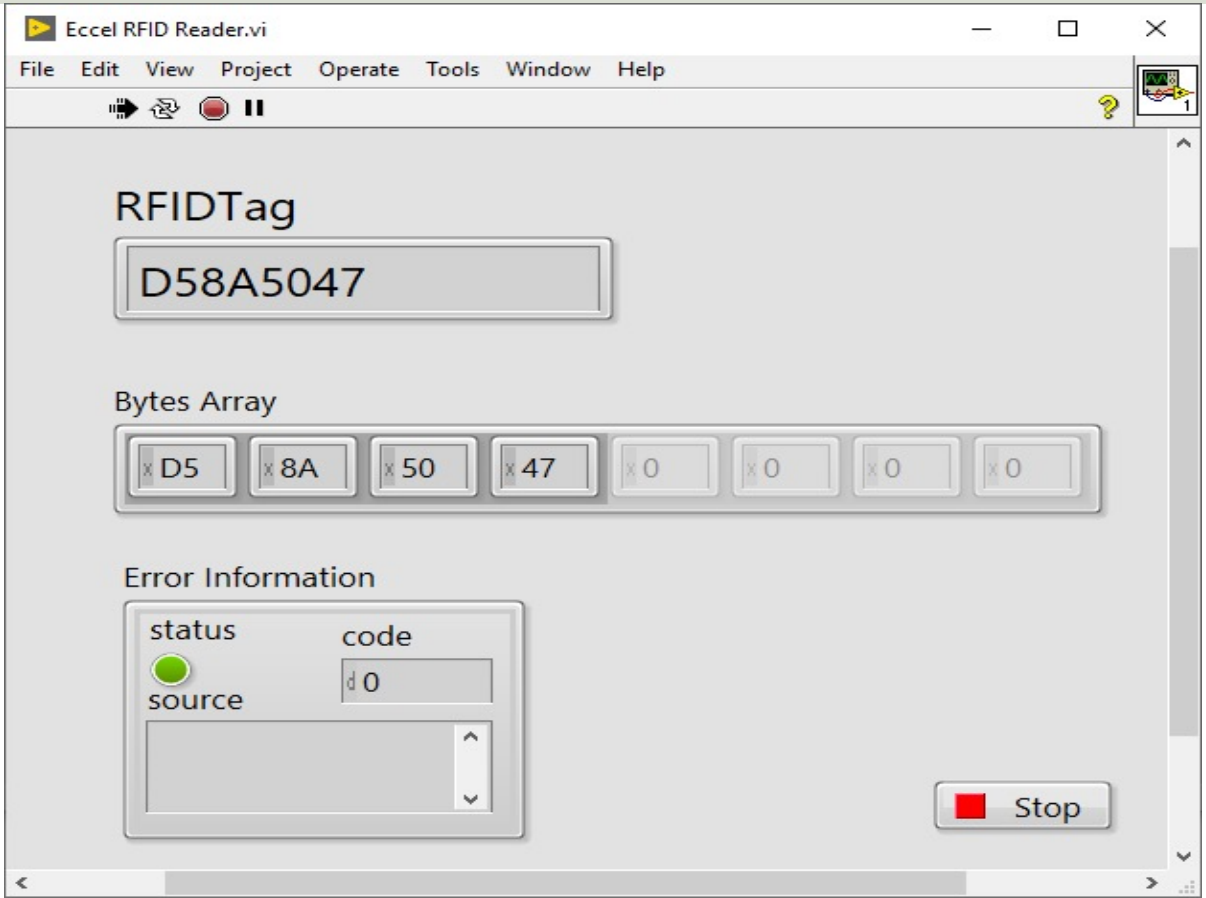
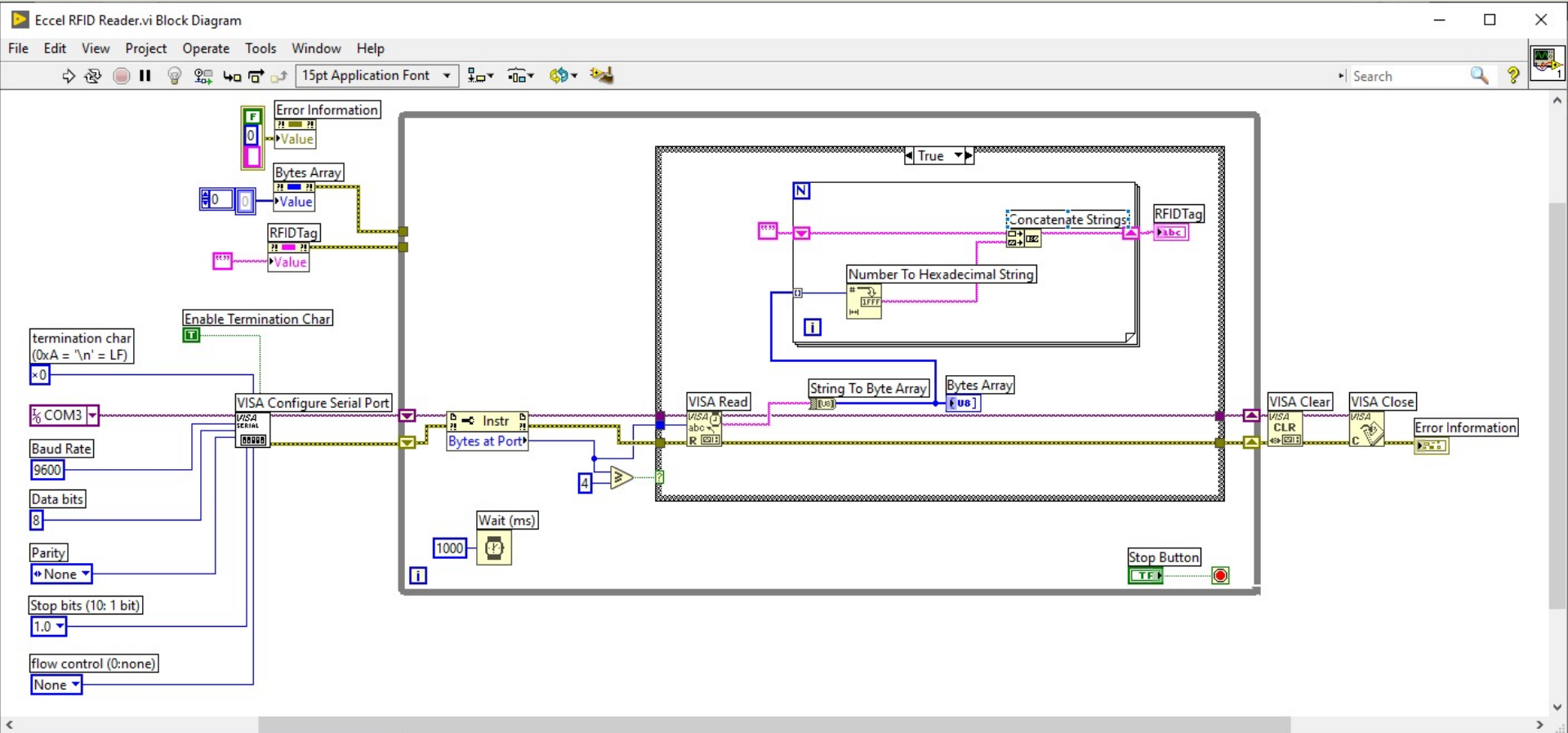
LabVIEW


Eccel RFID Reader.vi
File Edit View Project Operate Tools Window Help
RFIDTag
D58A5047
Bytes Array
D5 8A 50 47 0 0 0 0
Error Information
status
code
0
source
Stop

LabVIEW


Eccel RFID Reader.vi Block Diagram
File Edit View Project Operate Tools Window Help
15pt Application Font
Search
Error Information
Value
Bytes Array
Value
RFIDTag
Value
Enable Termination Char
termination char
(0xA = '\n' = LF)
COM3
Baud Rate
9600
Data bits
8
Parity
None
Stop bits (10: 1 bit)
1.0
flow control (0:none)
None
VISA Configure Serial Port
Instr
Bytes at Port
4
Wait (ms)
1000
True
Concatenate Strings
RFIDTag
Number To Hexadecimal String
VISA Read
String To Byte Array
Bytes Array
Stop Button
VISA Clear
VISA Close
Error Information

Python

Thonny - C:\Users\hansha\OneDrive\Programming\Visual Studio Examples\RFID\Eccel RFID Reader\Python\rfid_lo...

File Edit View Run Tools Help

rfid_loop_ex.py × test.py ×

```
1  import serial
2  import time
3
4  ser = serial.Serial('COM3', 9600, timeout=1)
5
6  while True:
7      response = ser.read(4)
8
9      if response != "":
10         hexvalue = "".join(map(hex, response))
11         hexvalue = hexvalue.replace("0x", "", 4)
12         hexvalue = hexvalue.upper()
13         print(hexvalue)
14
15     time.sleep(1)
16
17 ser.close()
```

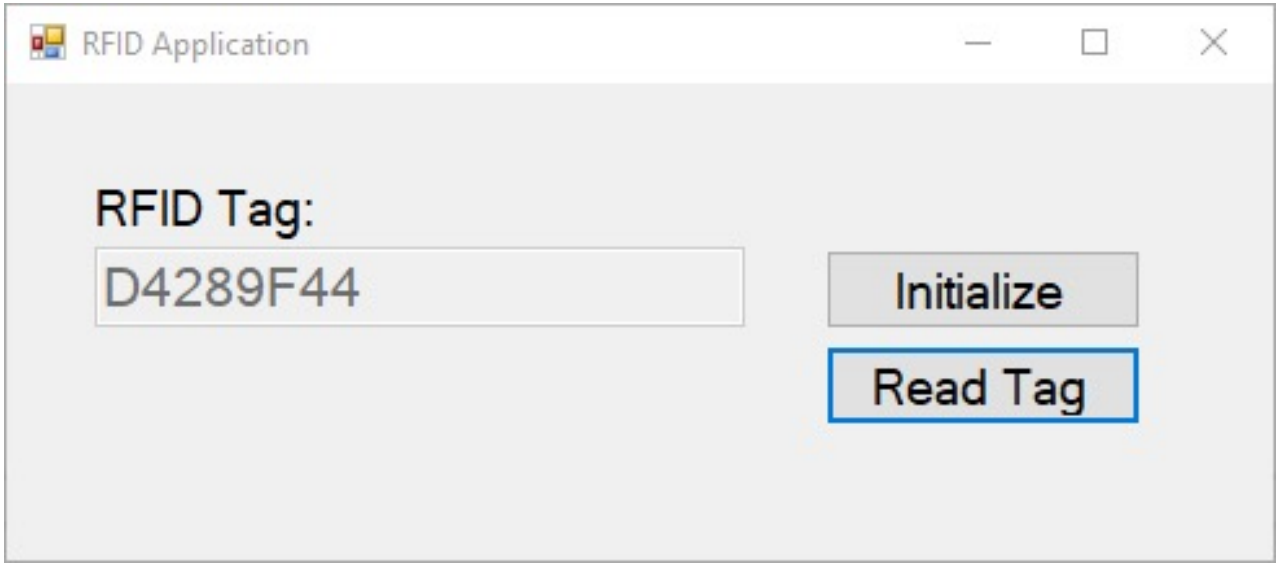
Shell ×

```
Python 3.7.9 (bundled)
>>> %Run rfid_loop_ex.py

  D58A5047
  6BD98247
  BB8FA847
```

Python 3.7.9

Visual Studio/C#



```
using System;
using System.IO.Ports;
using System.Windows.Forms;

namespace ReadRfidApp
{
   public partial class Form1 : Form
   {
      string rfidTag;
      SerialPort port = new System.IO.Ports.SerialPort("COM3", 9600, System.IO.Ports.Parity.None, 8, System.IO.Ports.StopBits.One);

      public Form1()
      {
         InitializeComponent();
      }

      private void Form1_Load(object sender, EventArgs e)
      {
      }

      private void btnInitialize_Click(object sender, EventArgs e)
      {
         port.Open();
         port.DtrEnable = true;
         txtTagData.Text = "";
      }

   }
}
```

```
private void btnReadTag_Click(object sender, EventArgs e)
{
    int numberBytesToRead = 4;
    byte[] data = new byte[numberBytesToRead];
    port.ReadTimeout = 1000;
    port.Read(data, 0, numberBytesToRead);

    rfidTag = "";
    for (int i = 0; i < numberBytesToRead; i++)
    {
        rfidTag = rfidTag + data[i].ToString("X");
    }

    txtTagData.Text = rfidTag;

    port.Close();
}
```

Resources

- https://en.wikipedia.org/wiki/Barcode
- https://en.wikipedia.org/wiki/Radio-frequency_identification
- https://www.atlasrfidstore.com/rfid-beginners-guide/
- https://no.rs-online.com/web/p/rf-modules/1262181/
- https://eccel.co.uk/product/oem-micode-usb/

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