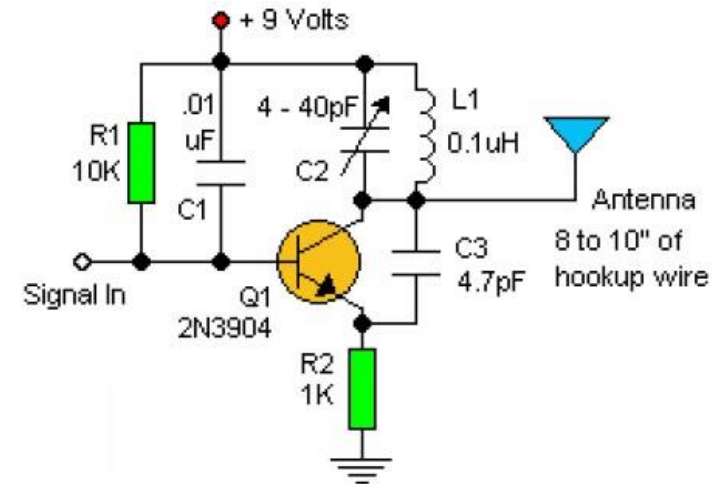
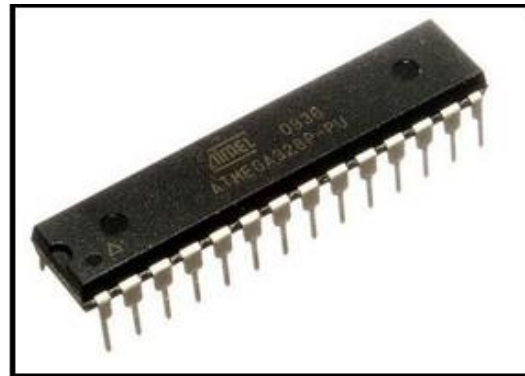
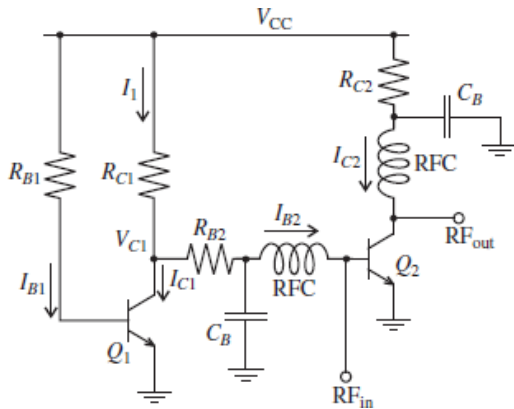


Building Wireless Interfaces for Microcontrollers

Class 3: NFC/RFID Controller



May 24, 2017
Don Wilcher

NFC/RFID Controller



Topics

- What is NFC?
- NFC Basics?
- NFC Encoding Scheme
- The PN532 Module
- Hands-On Project: Exploring the Adafruit NFC/RFID shield

What is NFC?



- NFC stands for Near Field Communications
- Standards based on short range wireless connectivity technology
- Makes life easier and convenient by
 - a) Making it simpler to make transactions
 - b) Exchange digital content
 - c) Easily connect electronic devices with a simple touch on a screen.

Source:

<http://nfc-forum.org/what-is-nfc/>

What is NFC?...



A steady growing number of NFC applications

Creating wide ranging user experiences everywhere



Source:
<http://www.nxp.com/products/identification-and-security/nfc-and-reader-ics/nfc-technology-hub:NFC-TECHNOLOGY>

February 9, 2016 COMPANY PUBLIC 7.

NFC Basics



- Offshoot of Radio-Frequency Identification (RFID)
- Design for electronic devices with close proximity to each other
- Three forms of NFC schemes
 - a) Type A (Corresponds with RFID communications: uses Miller Encoding)

Question 1

Name one method of how NFC makes life easier and convenient.

NFC Basics...



Three forms of NFC schemes...

- b) Type B (Corresponds with RFID communications: uses Manchester Encoding)
- c) Type FeliCA (Commonly found in Japan: faster form of RFID Transmission)

Source:

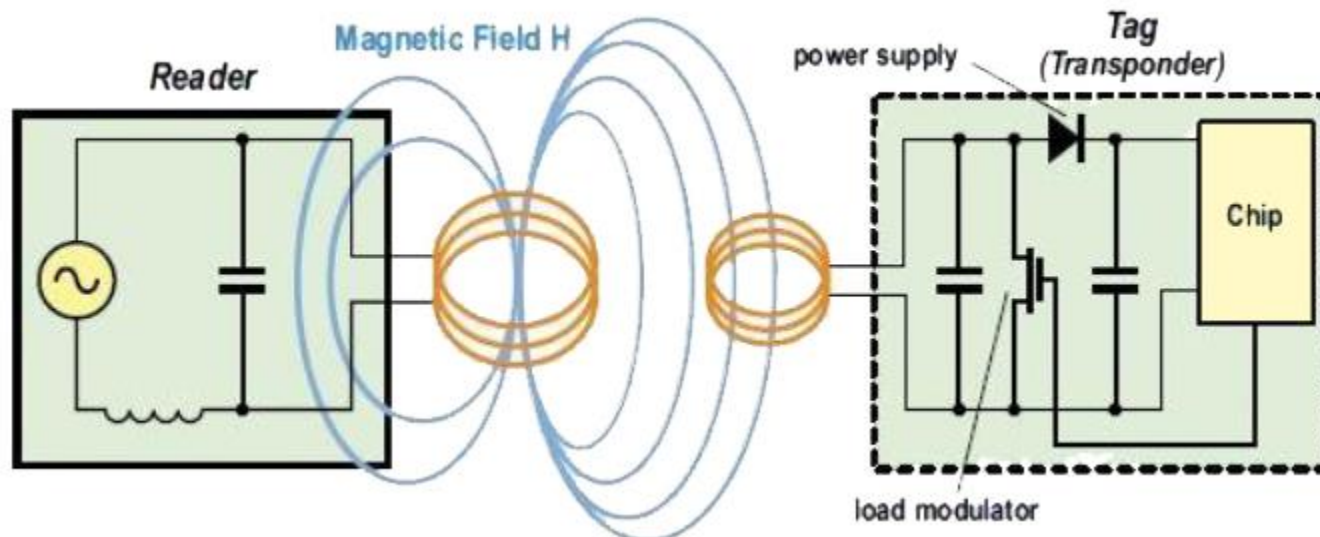
<https://arstechnica.com/gadgets/2011/02/near-field-communications-a-technology-primer/>

NFC Basics...



Operation:

- Active device acts as a reader
- A Passive device acts as a tag



**Basic elements of a NFC Communications Setup.
Magnetic Induction is the underlying electrical
phenomenon used in NFC technology.**

NFC Basics...



Operation:

- The reader generates an RF field – poll to find other nearby devices.
- A tag within the field of the reader will setup commands.
- The reader will poll the tag to find out what signaling technologies (NFC A, B, and F) corresponds to RFID Types A, B, and FeliCA.

Question 2

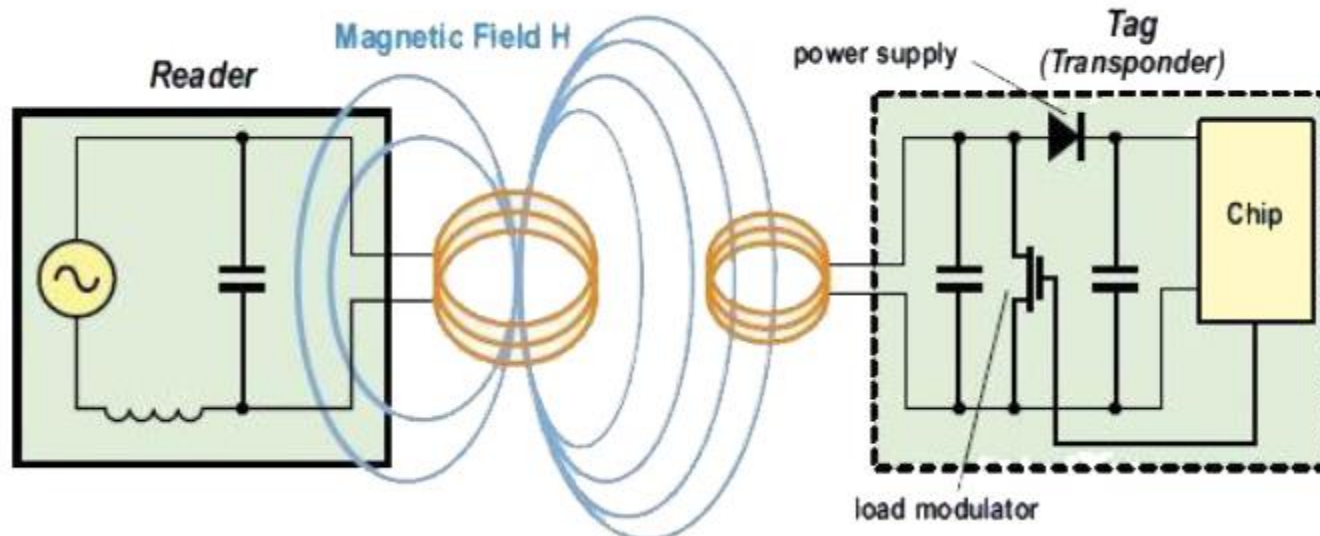
What two basic devices are needed for an NFC application?

NFC Basics...



Operation: ...

- Tag response – reader will proceed to establish a communication link using a modulation scheme.
- Modulation scheme – bit level encoding, bit rates, and other three signaling parameter methods.



NFC Basics...



Reader Example:

SkyeModule Nova



- Ultra-small, power efficient, EPC class 1, Gen 2 reader/writer
- ARM Cortex microcontroller and latest UHF transceiver technology
- Reader has an Intelligent Operating system
- PCI Express Mini Half-card form factor- easily used in mobile computing applications
 - a) tablets
 - b) handheld devices: Ex, smartphones

Source:

<http://www.mouser.com/ds/2/372/novabrochure-594472.pdf>

NFC Basics...



Tag Example:



- NFC tags are programmed with just about any sort of information
- Packaged into almost any product.
- You read them with a smartphone or another NFC-capable device.

Source:

<http://nearfieldcommunication.org/nfc-signaling.html>

Question 3

A modulation scheme doesn't include one of these parameters.

- a) Bit level encoding**
- b) Bit rates**
- c) Other 4 signaling parameter methods**

NFC Encoding Schemes...



Two NFC Devices initiate a wireless connection by establishing which communication scheme and signaling methods will be used.



An Encoding Scheme allows two devices to communicate using a common set of rules.

NFC Encoding Schemes...



There are two basic encoding schemes used in NFC technologies:

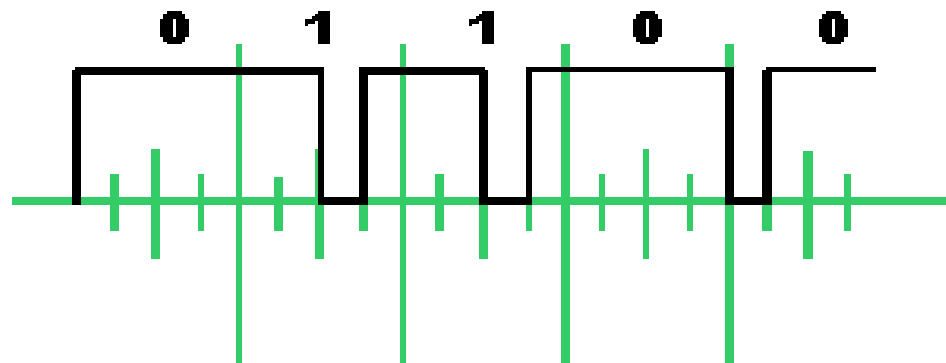
- a) Miller Encoding
- b) Manchester Encoding

NFC Encoding Schemes...

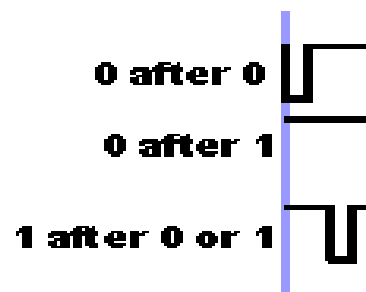


Miller Encoding (Delay Encoding):

- a) Binary 1 causes a transition from one digital level to another.
- b) Occurs in the middle of the bit period transition.
- c) Binary 0 causes no change of signal level unless it is followed by another 0 digital level.



Key:

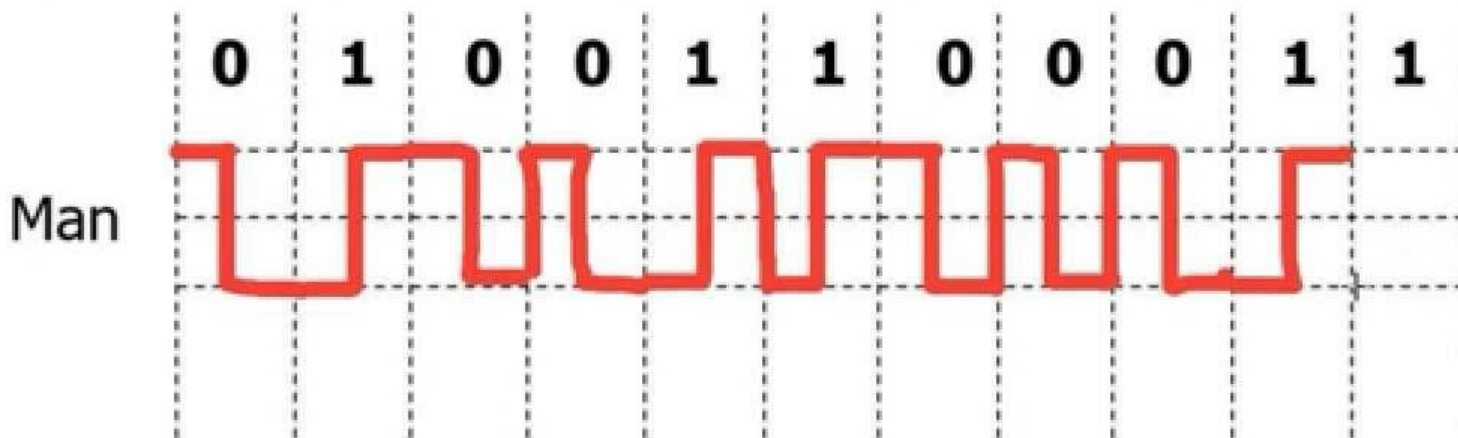
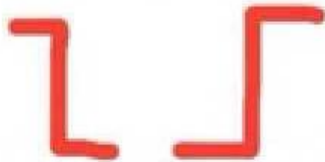


NFC Encoding Schemes...



Manchester Encoding (Phase Encoding):

- a) Each data bit is either low then high
- b) Or high then low of equal time



NFC Encoding Schemes...



- Essentially, the Miller and Manchester bit coding schemes records signal transitions and generates electrical pulses of varying widths based on these binary transitions (HI to LO or LO to HI switching sequences).
- Allows a reader to communicate with a tag using an established set of communication rules.

PN532 Module



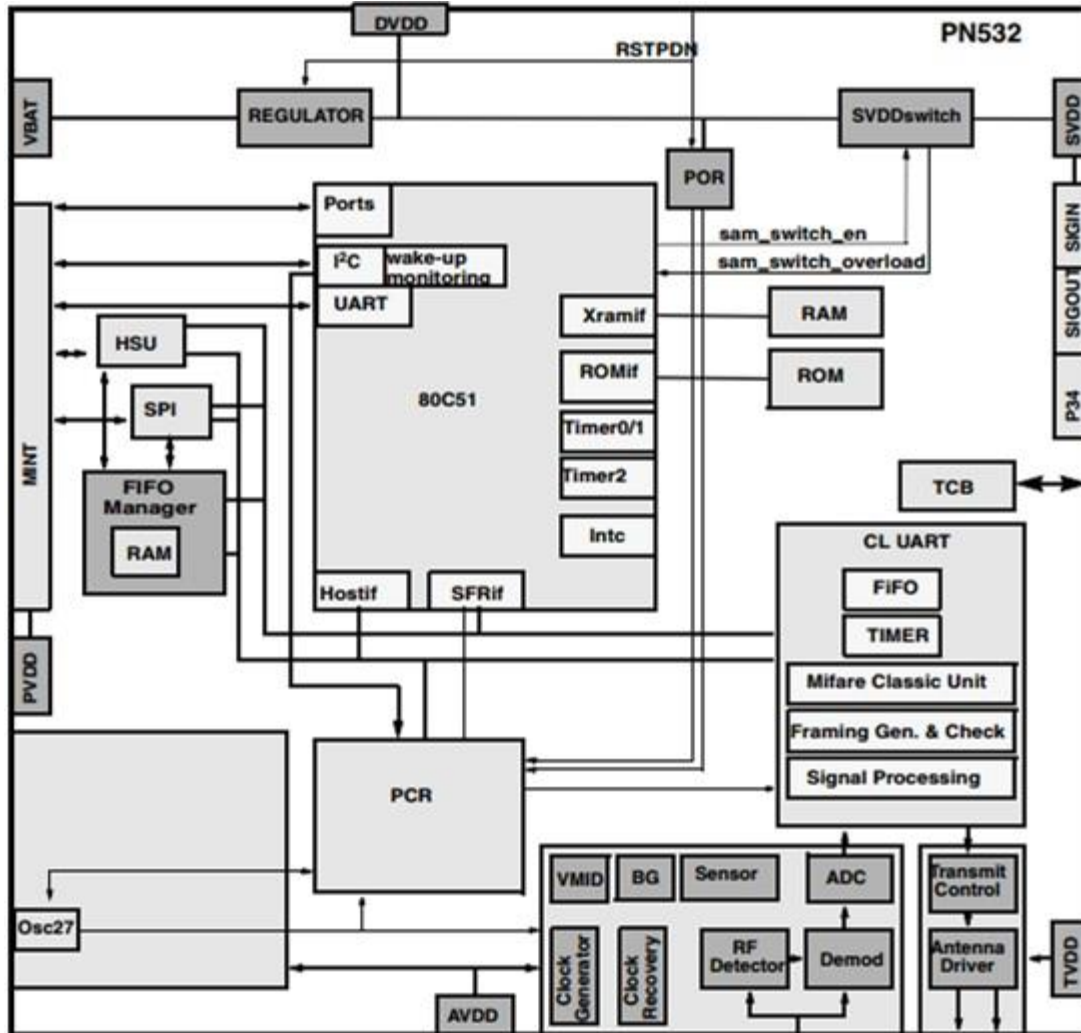
The PN532 Module is

- highly integrated transmission module for contactless communication.
- a contactless communication module operating at 13.56 MHz.
- using a 80C51 microcontroller as its core central processor.
- a contactless communication module with an integrated demodulation and modulation circuits.

Source:

<https://cdn-shop.adafruit.com/datasheets/pn532ds.pdf>

PN532 Module...



PN532 Module Block Diagram

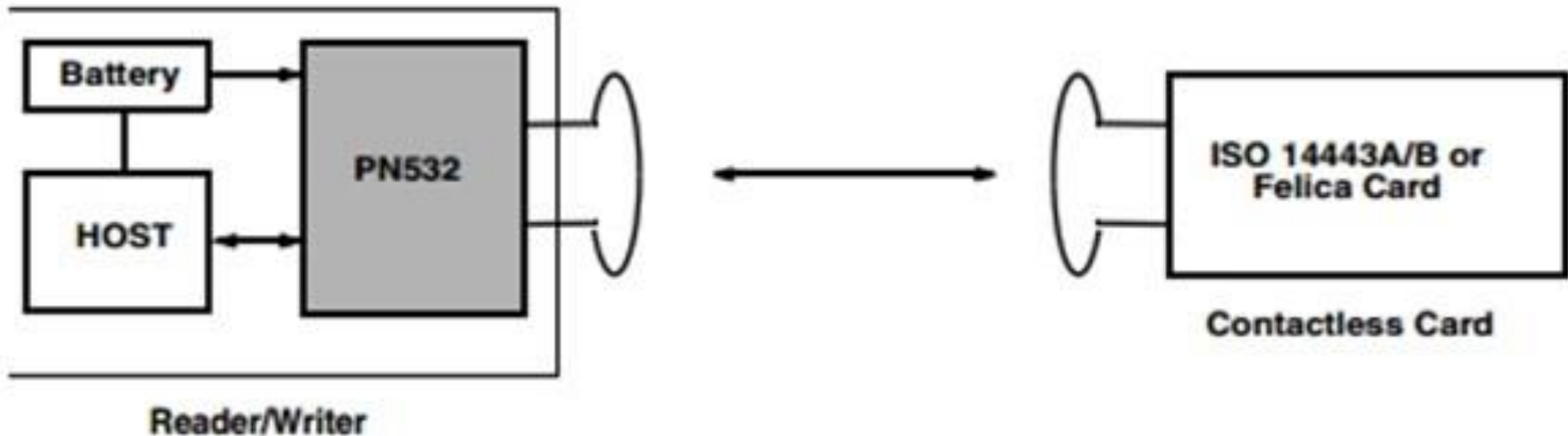
Source:

<https://cdn-shop.adafruit.com/datasheets/pn532ds.pdf>

PN532 Module...



Typical PN532 Module Application



Source:

<https://cdn-shop.adafruit.com/datasheets/pn532ds.pdf>

Question 4

What legacy microcontroller is used as the central processor for the PN532 module?

PN532 Module...



CL (Contact Less) Module

Support 4 different operating modes:

- Reader/writer mode supporting ISO 14443A/MIRE® and FeliCa™ scheme
- Reader/writer mode supporting ISO 14443B
- Card operation mode supporting ISO 14443A/MIRE® and FeliCa™ scheme
- NFCIP mode

Source:

<https://cdn-shop.adafruit.com/datasheets/pn532ds.pdf>

Question 5

CL is the abbreviation for

- a) Closed Loop**
- b) Contact Loop**
- c) Contact Less**
- d) none of the above**

PN532 Module...



Additional Notes:

- NFCIP – Near Field Communication Interface Protocol
- NFCIP specify the radio frequency signal interfacing initialization, anti-collision, protocols for wireless interconnection of closely coupled devices and access to contactless integrated circuit cards operating at 13.56 MHz
- MIFARE® is the NXP Semiconductors owned trademark of a series of chips widely used in contactless smart cards and proximity cards.

Source:

<https://cdn-shop.adafruit.com/datasheets/pn532ds.pdf>

PN532 Module...



Additional Notes:...

- FeliCa – short for Felicity Card
- FeliCa is a contactless RFID smart card system from Sony in Japan.



A FeliCa (EZ-Link) card.

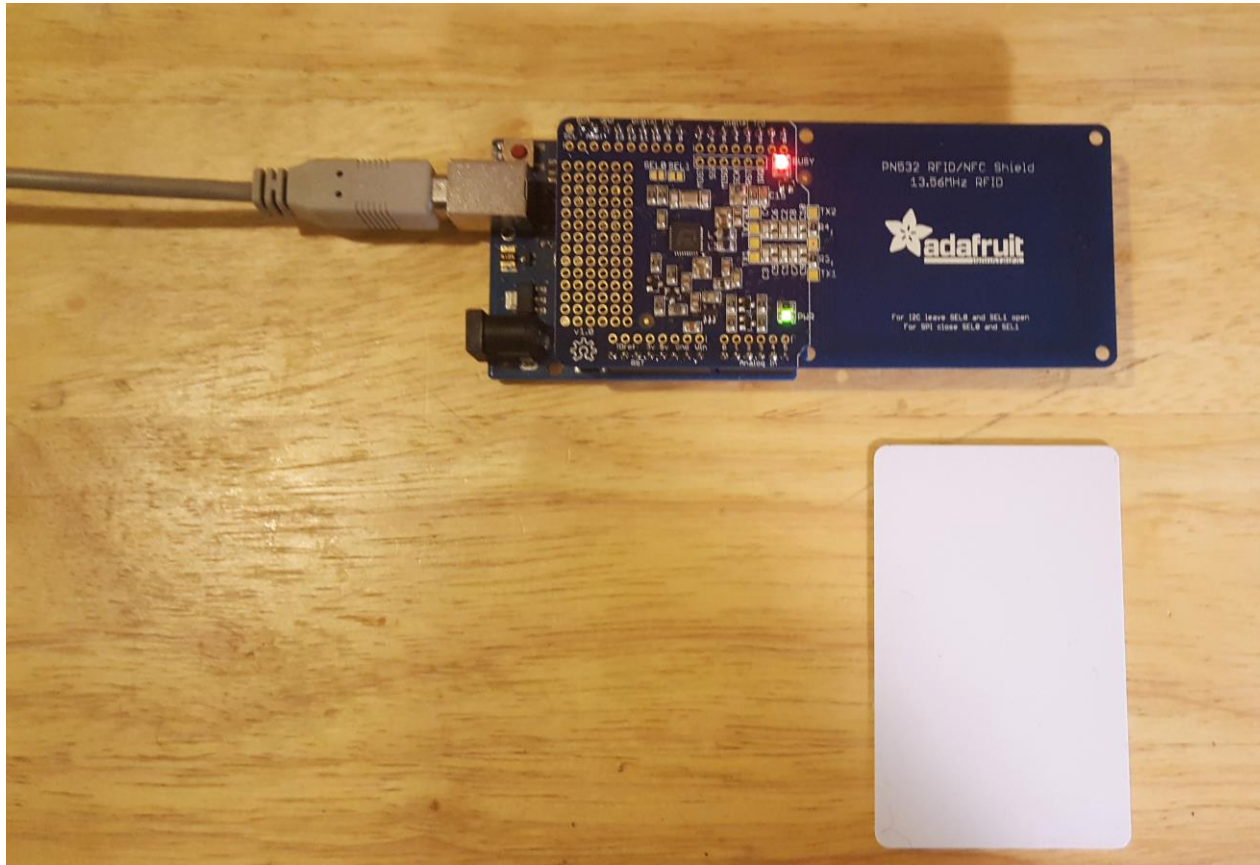
Source:

<https://en.wikipedia.org/wiki/FeliCa>



A defaced FeliCa (EZ-Link) card, revealing its internal circuitry.

Hands-On Project: Exploring the Adafruit NFC/RFID Shield



Hands-On Project: Exploring the Adafruit NFC/RFID Shield...



Project Objectives:

- Soldered in-line header male pins to an Adafruit NFC/RFID shield
- Install PN532 NFC library into Arduino IDE
- Mount Adafruit NFC/RFID shield to the Arduino
- Upload readMiFare software onto Arduino Uno
- Test Arduino Uno with readMiFare software using sample NFC card.

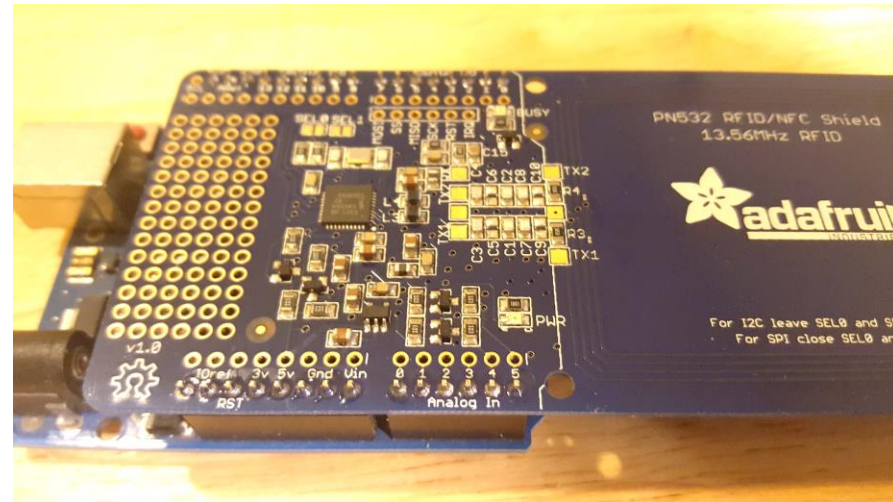
Hands-On Project: Exploring the Adafruit NFC/RFID Shield...



Soldering in-line male header pins to the Adafruit NFC/RFID Shield.



Contents of Adafruit NFC/RFID Shield kit



Male header pins soldered to NFC Shield

Hands-On Project: Exploring the Adafruit NFC/RFID Shield...



Install PN532 Library to Arduino IDE:

Library Installation

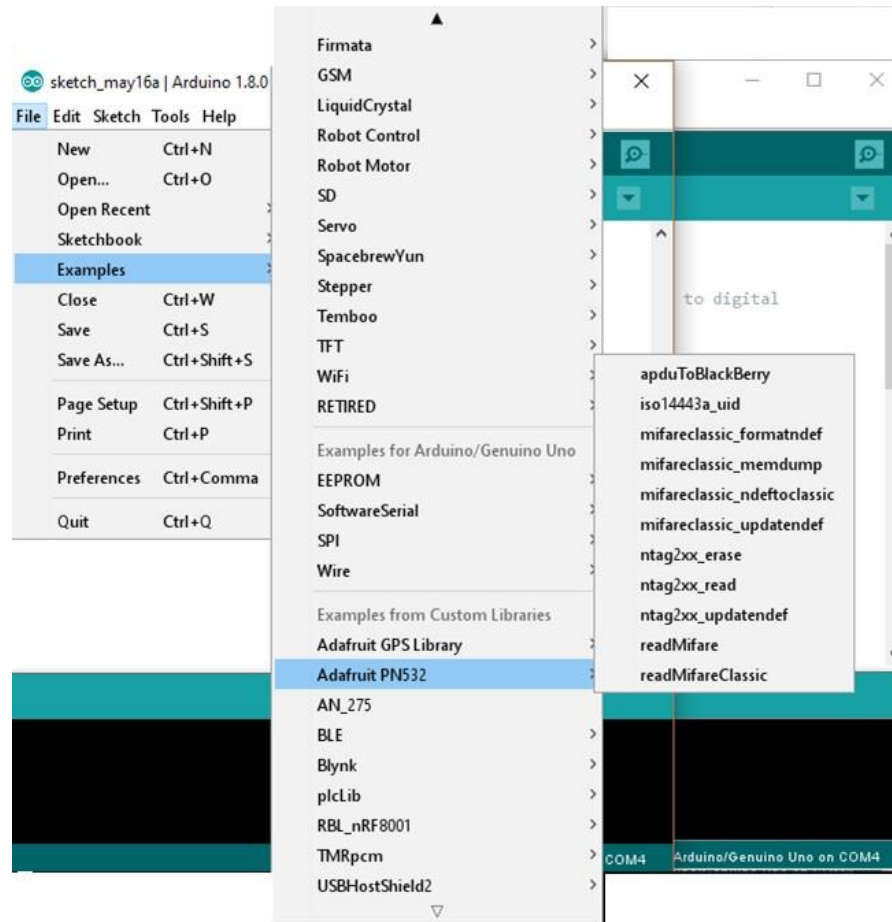
[Download the Adafruit PN532 library from github \(http://adafru.it/aSX\)](http://adafru.it/aSX). Uncompress the folder and rename the folder **Adafruit_PN532**. Inside the folder you should see the **Adafruit_PN532.cpp** and **Adafruit_PN532.h** files. Install the **Adafruit_PN532** library folder by placing it in your **arduinofolder/libraries** folder. You may have to create the **libraries** subfolder if this is your first library. [You can read more about installing libraries in our tutorial \(http://adafru.it/aYG\)](http://adafru.it/aYG).

Restart the Arduino IDE. You should now be able to select **File > Examples > Adafruit_PN532 > readMifare** sketch.

Hands-On Project: Exploring the Adafruit NFC/RFID Shield...



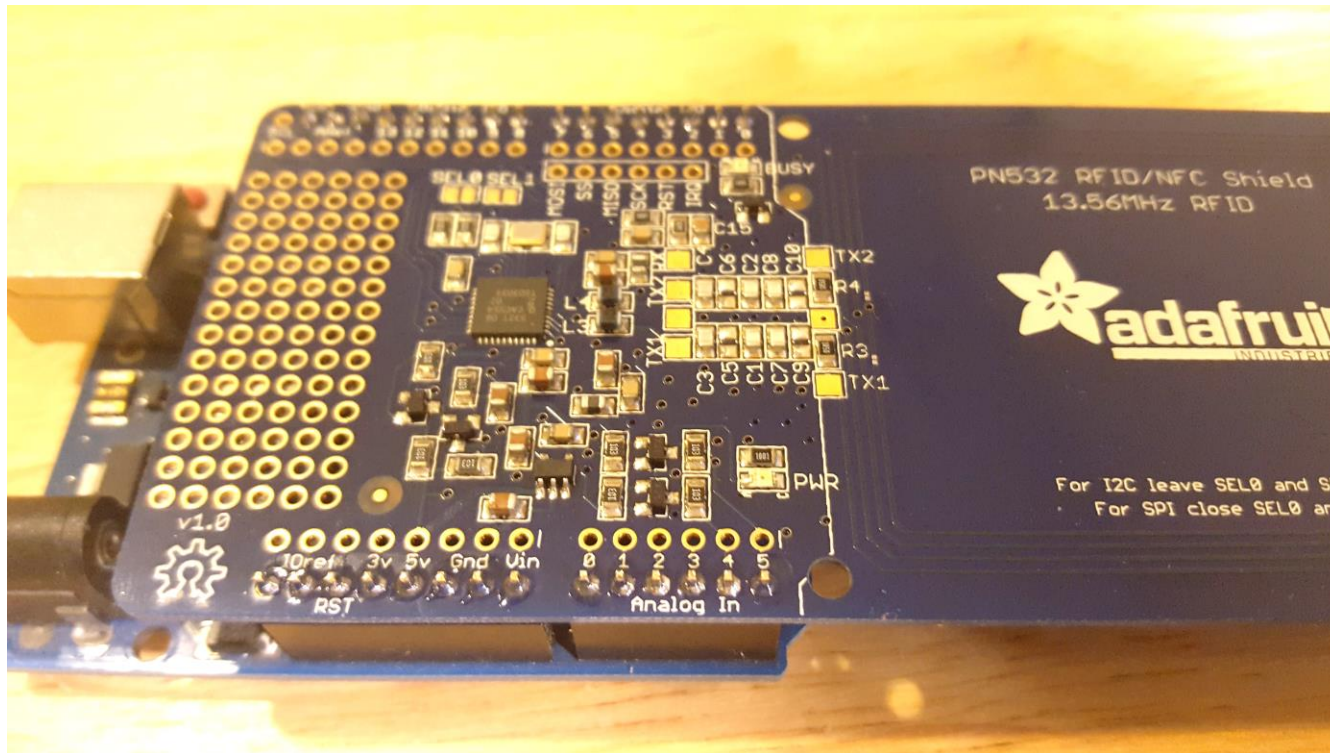
Upload the readMiFare software to the Arduino Uno :



Hands-On Project: Exploring the Adafruit NFC/RFID Shield...



Mount the Adafruit NFC/RFID Shield to the Arduino Uno:



Hands-On Project: Exploring the Adafruit NFC/RFID Shield...



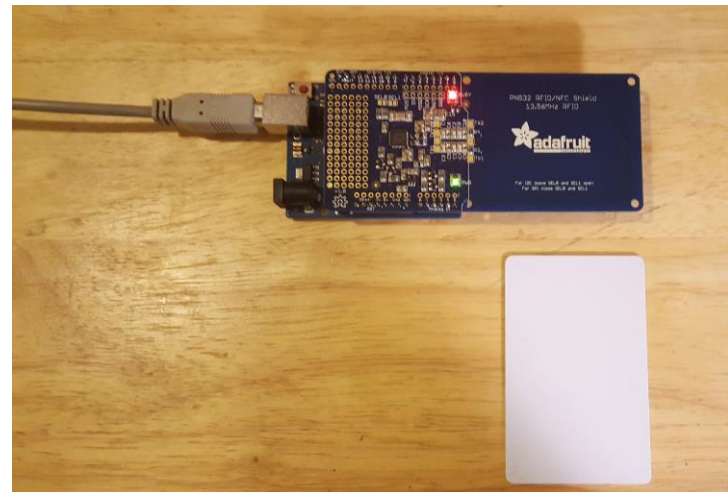
Test Arduino Uno with readMiFare software using sample NFC card:

COM4 (Arduino/Genuino Uno)

```
Hello!  
Found chip PN532  
Firmware ver. 1.6  
Waiting for an ISO14443A Card ...  
Found an ISO14443A card  
  UID Length: 4 bytes  
  UID Value: 0xD2 0xA3 0x40 0xD4  
  
Seems to be a Mifare Classic card (4 byte UID)  
Trying to authenticate block 4 with default KEYA value  
Sector 1 (Blocks 4..7) has been authenticated  
Reading Block 4:  
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
```

```
Found an ISO14443A card  
  UID Length: 4 bytes  
  UID Value: 0xD2 0xA3 0x40 0xD4  
  
Seems to be a Mifare Classic card (4 byte UID)  
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Sector 1 (Blocks 4..7) has been authenticated  
Reading Block 4:  
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
```

```
Found an ISO14443A card  
  UID Length: 4 bytes  
  UID Value: 0xD2 0xA3 0x40 0xD4
```



Hands-On Project: Exploring the Adafruit NFC/RFID Shield...



Additional information on the Adafruit NFC/RFID shield may be found at the link below:

<https://learn.adafruit.com/adafruit-pn532-rfid-nfc>

Question 6

What is the register name owned by NXP Semiconductor for a specific type of NFC Card?