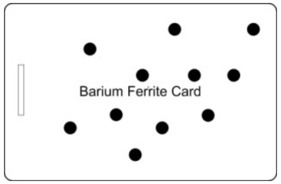
PHYSICAL ACCESS CONTROL SYSTEMS

Are you protected by two screws and a plastic cover?...... Probably!

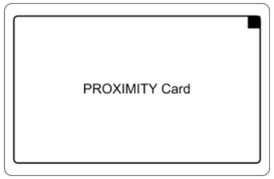
Zac Franken

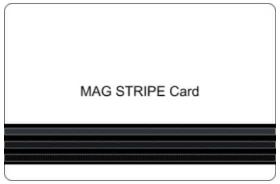
BlackHat DC 2008

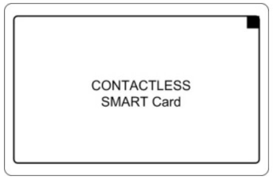
What we are going to cover:

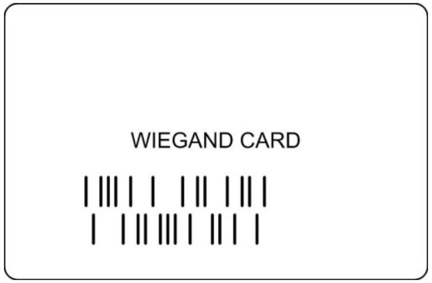


- Overview of physical credentials
- Brief overview of biometric systems
- Biometric worked example
- Overview of attack
- Demo* of attack



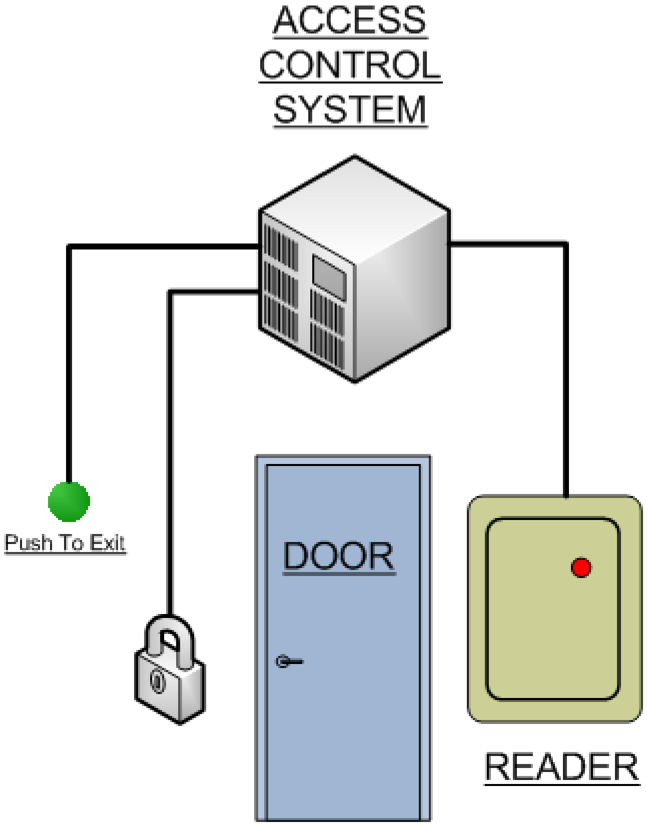




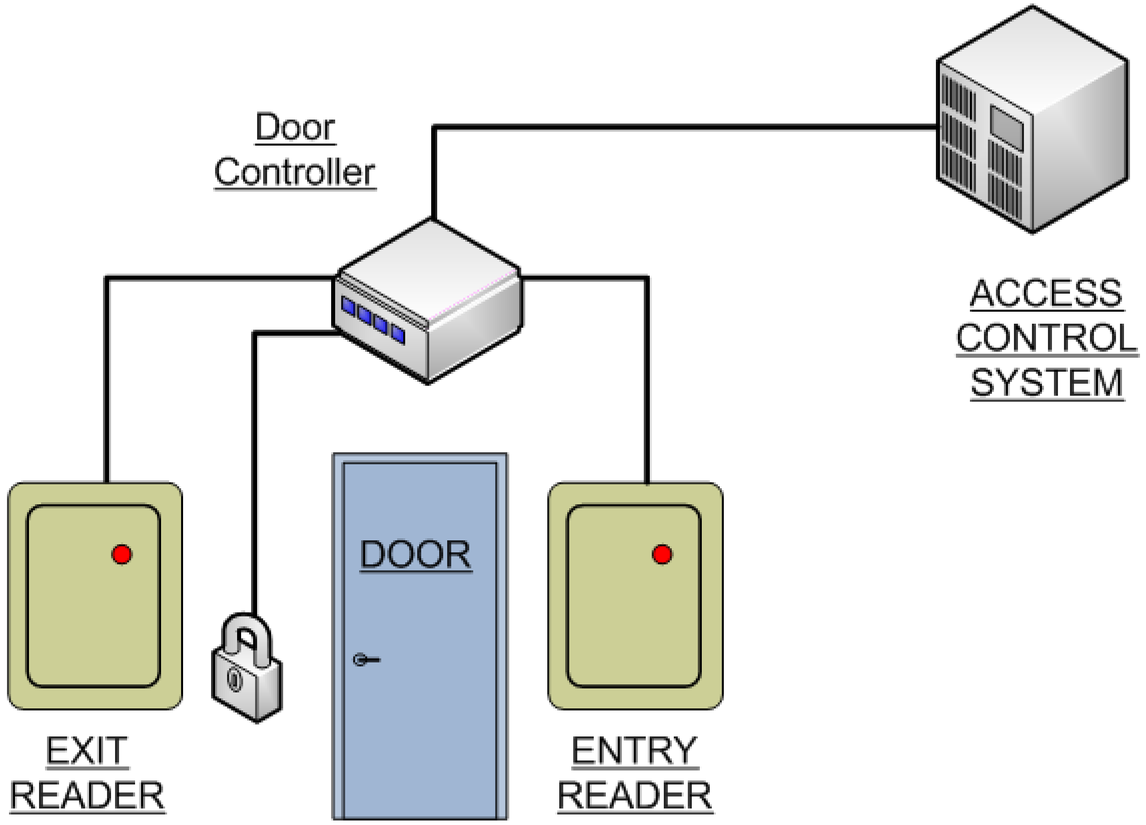


* Standard demo disclaimer applies ☺

Basic system

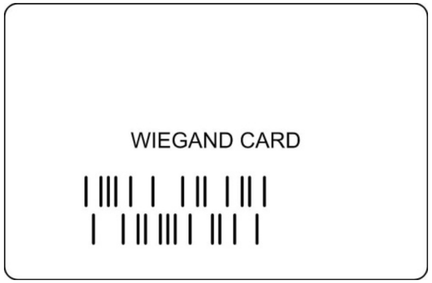


Anti-Passback system

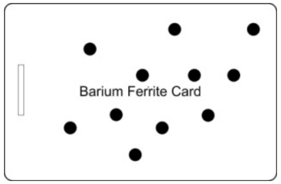


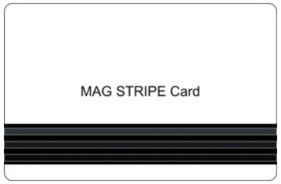
Physical Credential Technologies

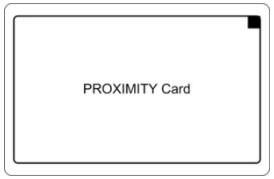
- Magnetic Strip Card
- Wiegand Card
- Proximity Card
- Barium Ferrite Card
- Concealed Barcode Card
- Smart Cards

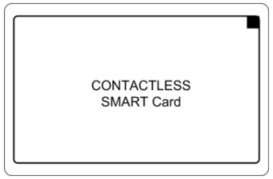


CONCEALED BARCODE CARD



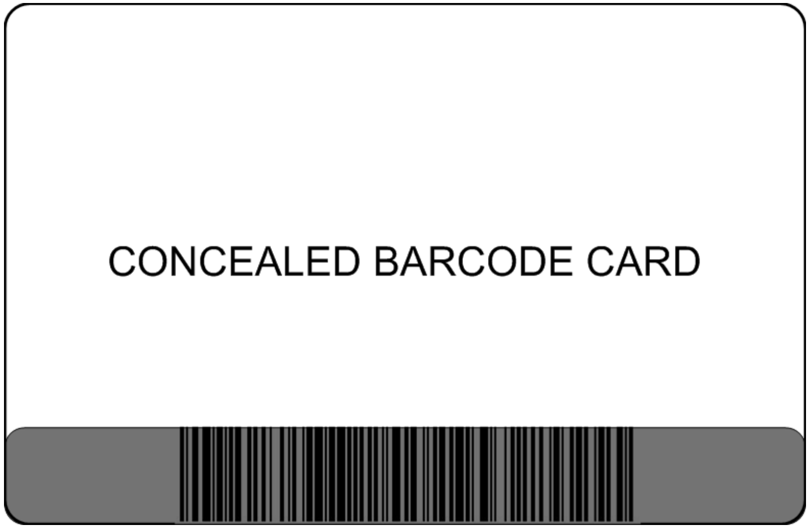




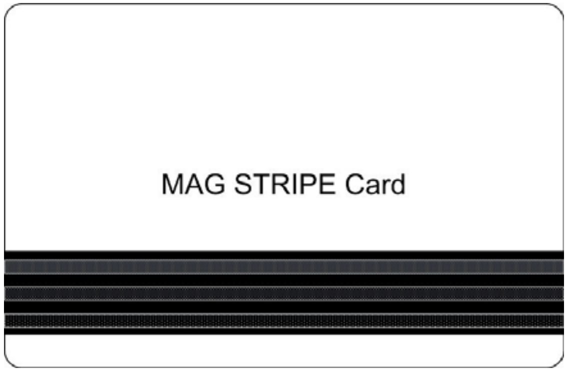


Concealed Barcode

- As crappy as it sounds
- Regular barcode obscured by IR transparent material (a la Remote control)
- Just Fucking Embarrasing



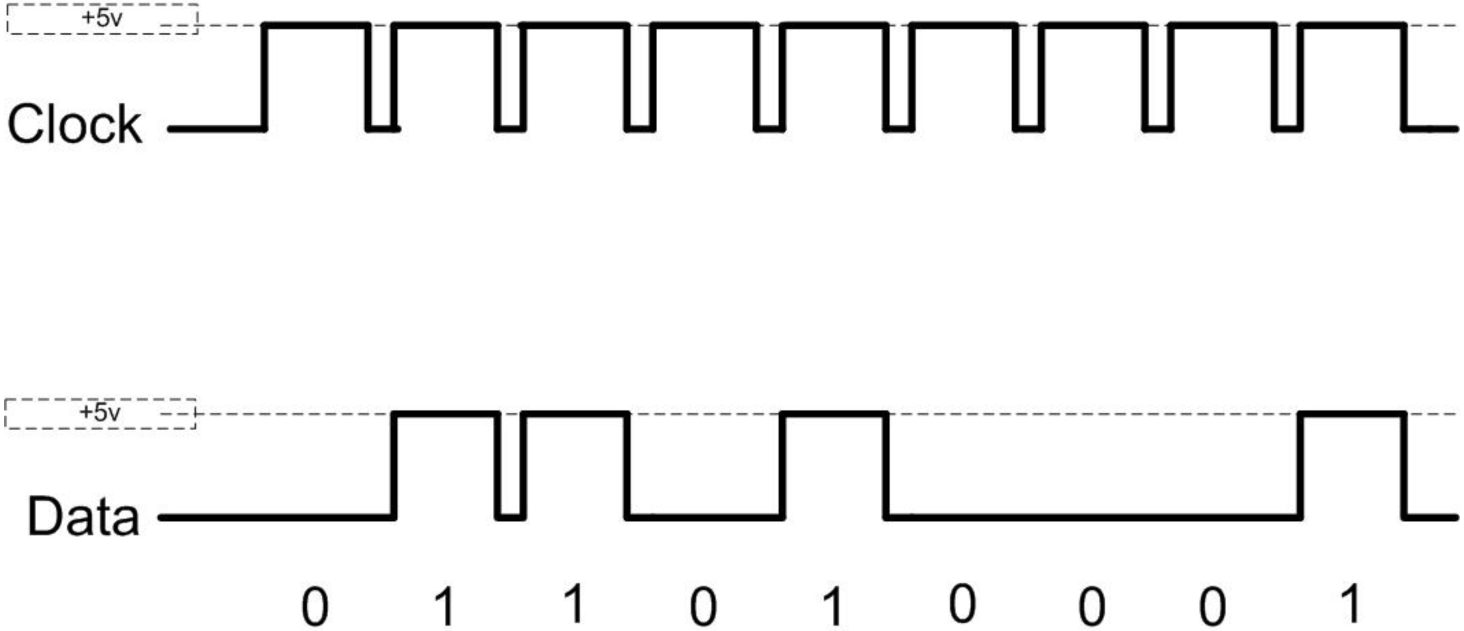
Magnetic stripe



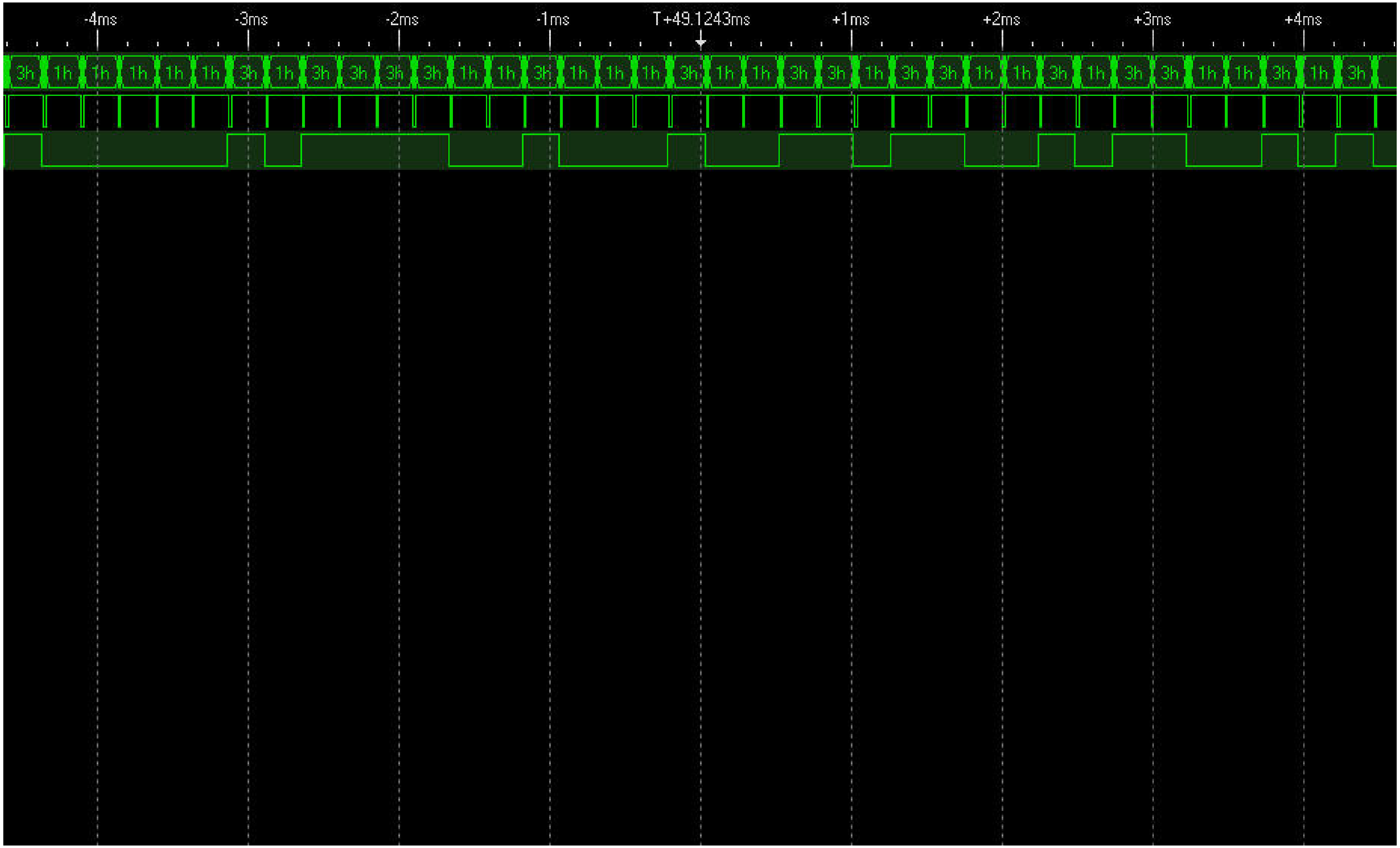
- Normally 3 tracks
- High Coercivity- 4,000 Oersted
- Low Coercivity- 300 Oersted
- Cards are read by an exposed read head in the reader
- “High security” cards can mean simply ofsetting the track

Clock & Data Protocol

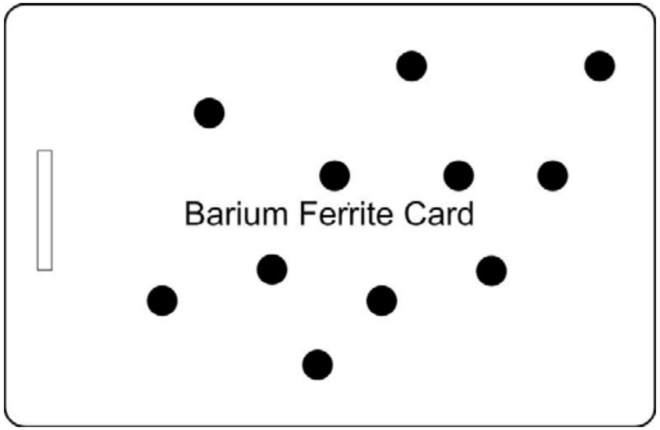
- 3 Wires required: Clock, Data & Ground
- Standard output from a mag stripe reader



Clock & Data

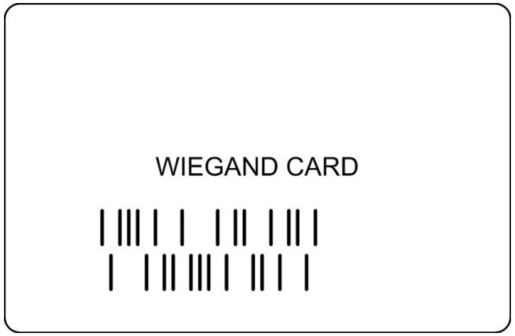

-4ms
-3ms
-2ms
-1ms
T+49.1243ms
+1ms
+2ms
+3ms
+4ms
3h 1h 1h 1h 1h 1h 3h 1h 3h 3h 3h 3h 1h 1h 3h 1h 1h 1h 3h 1h 1h 3h 3h 1h 3h 3h 1h 1h 3h 1h 3h 3h 1h 1h 3h 1h 3h

Barrium Ferrite



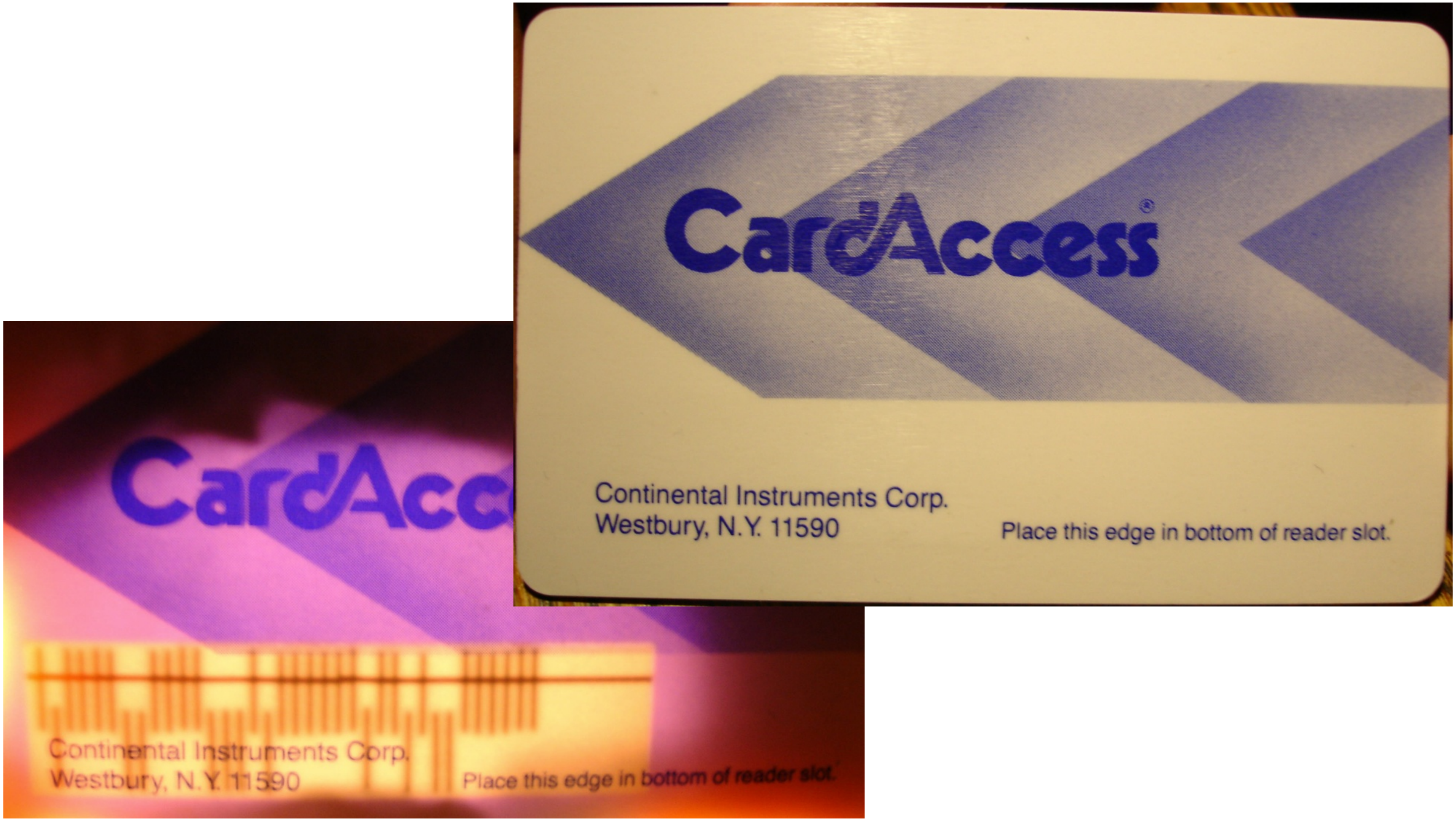
- Tends to use an insertion reader
- Card contains discrete magnetic domains
- Normally encoded in “fridge magnet” type material
- This was the original “Card Key”

Wiegand card



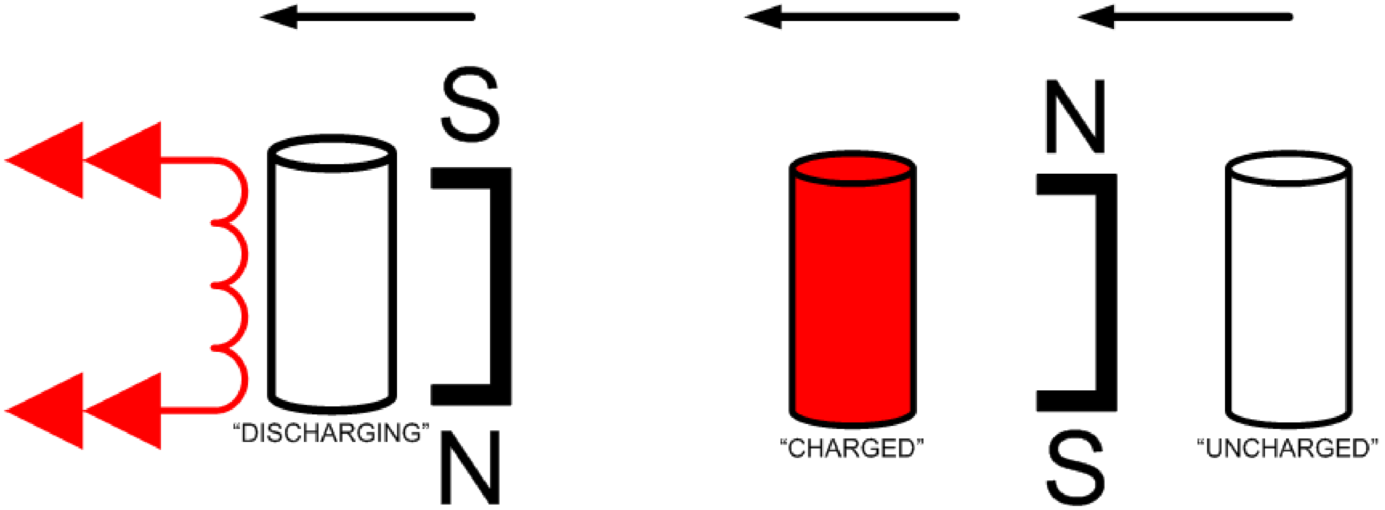
- Special alloy wire is processed in such a way to create two distinct magnetic regions in the same piece of wire when passed over a magnetic field
- Wire is embedded in the card in a distinct order to create an individual code
- Each Wiegand pulse is translated to a digital 0 or 1 depending on wire location

Wiegand card


CardAccess®
Continental Instruments Corp.
Westbury, N.Y. 11590
Place this edge in bottom of reader slot.

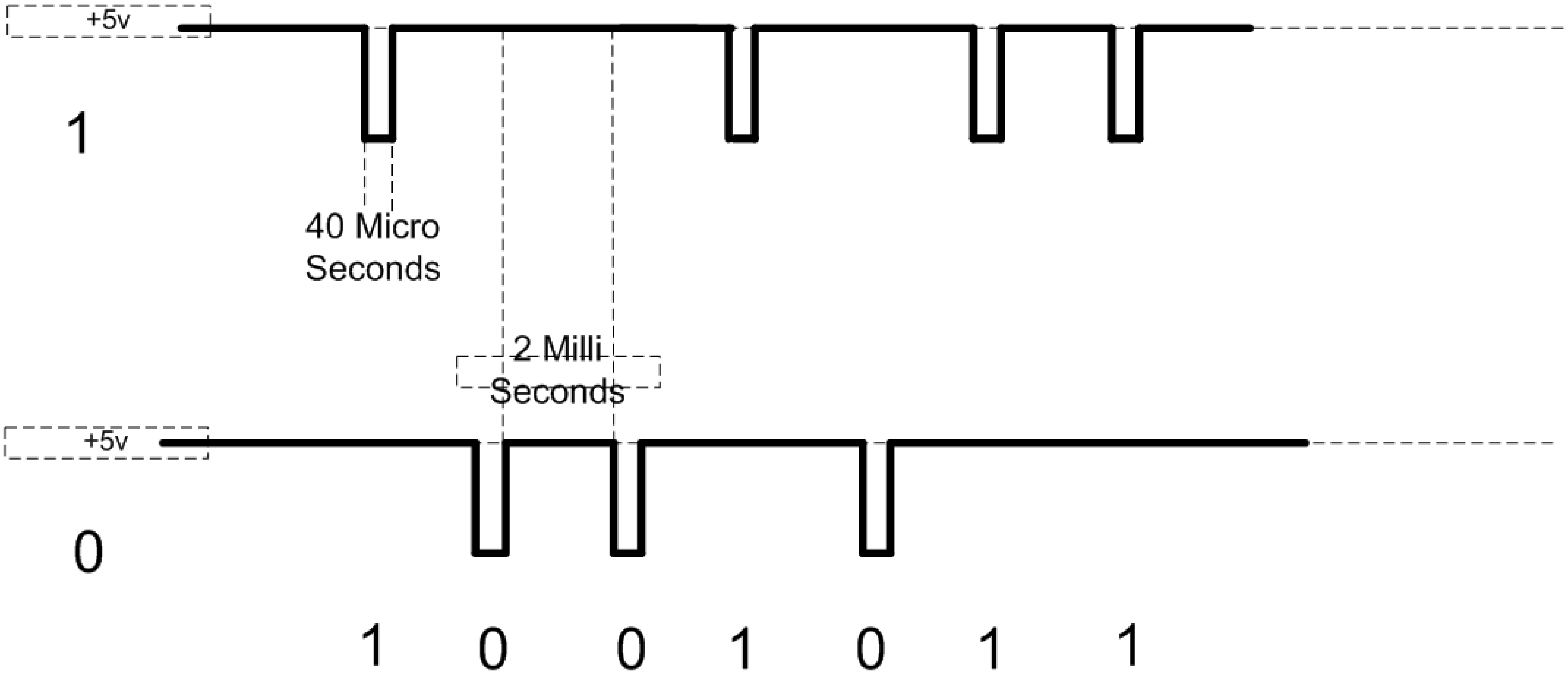
Wiegand Effect

- When Wiegand wires go by a magnet they store the energy from the magnet
- If the wire is passed by an opposite polarity magnet, the wire releases the energy
- If a coil is place near the wire as it releases the energy, you can convert the energy into an electronic pulse.

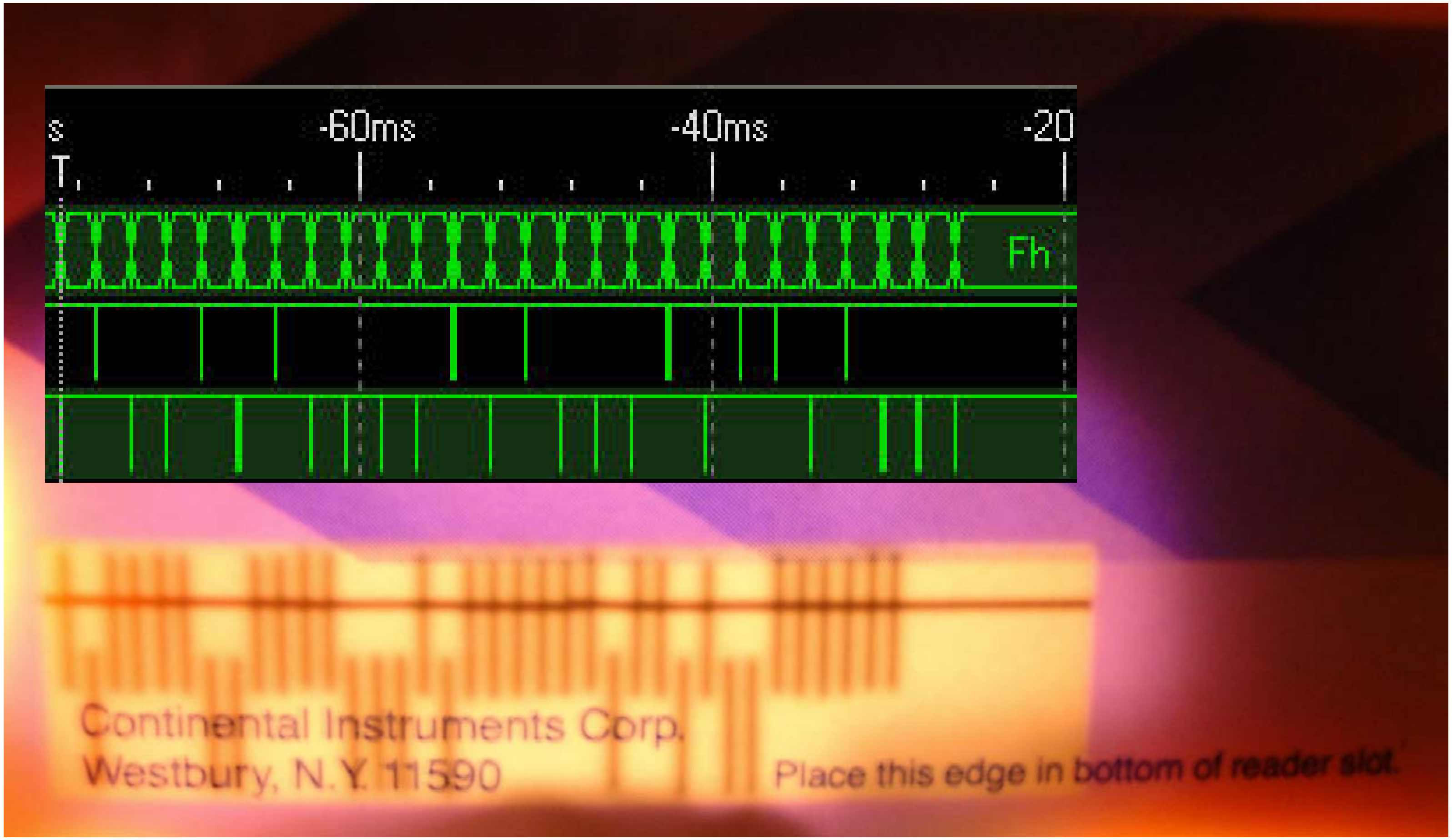


Wiegand Electrical protocol

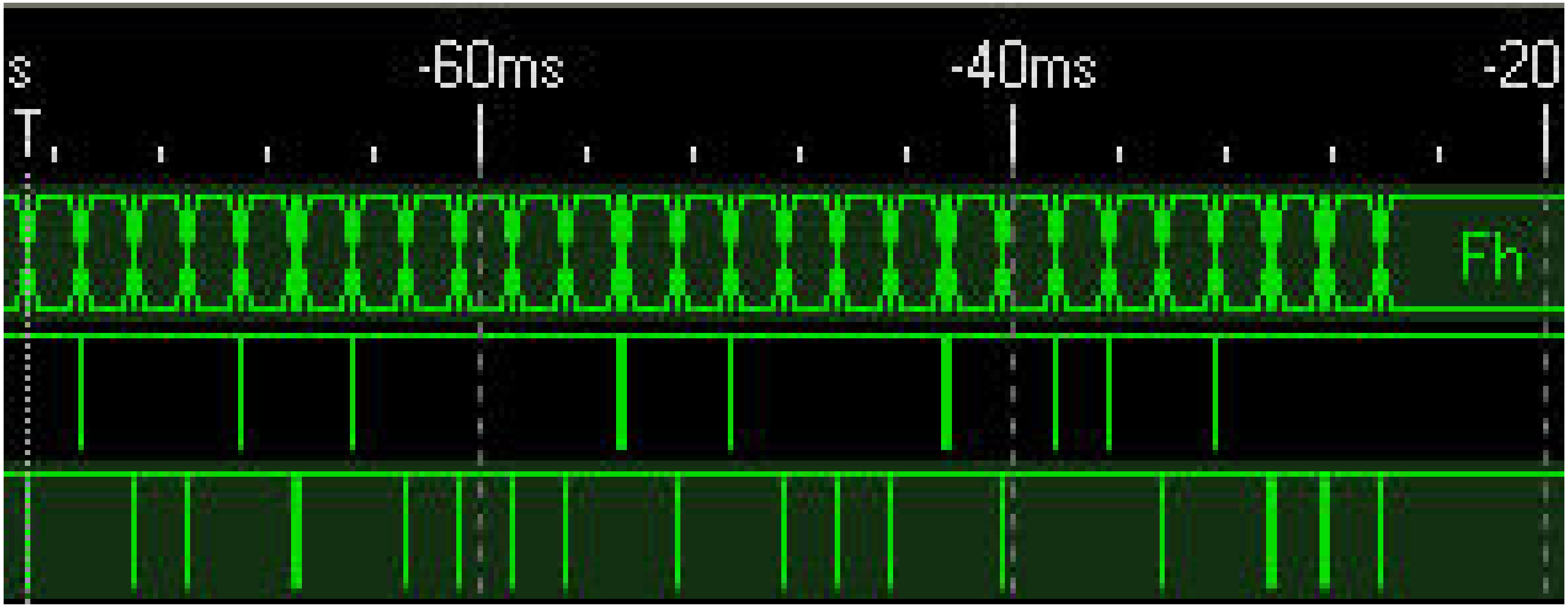
- 3 wires required: Binary 1, Binary 0, Ground



Look familiar?


s
-60ms
-40ms
-20
T
Fh
Continental Instruments Corp.
Westbury, N.Y. 11590
Place this edge in bottom of reader slot.

Real Wiegand Data

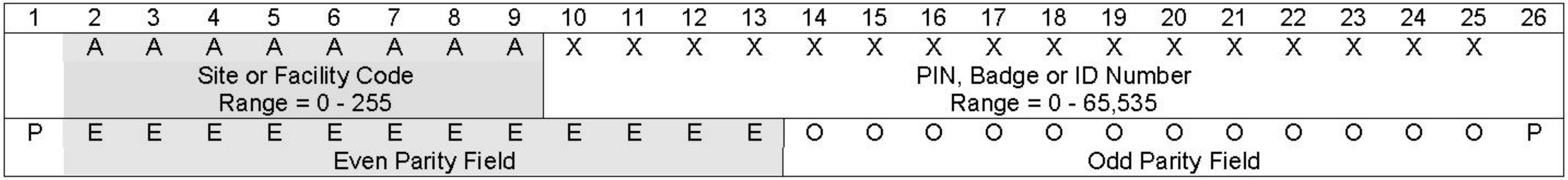


Wiegand format

- 0s and 1s are divided into bit fields known as Wiegand format
- 26 bit is a “universal format”
- Most access card manufacturers have proprietary formats which they sell at additional cost

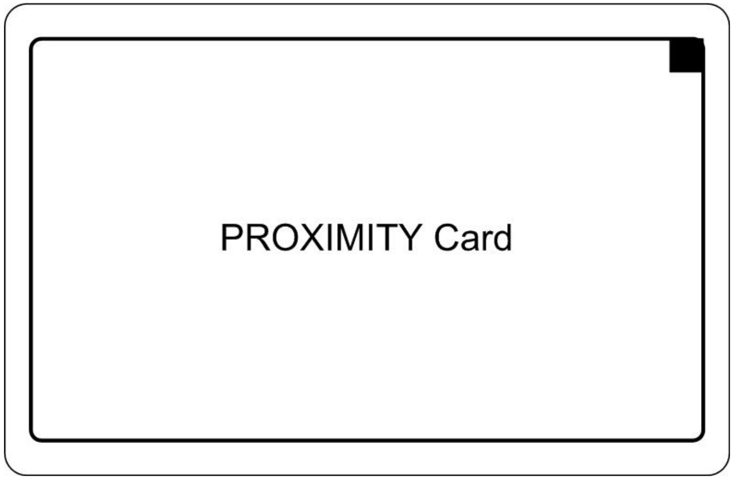
Most Significant Bit

Least Significant Bit



1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
	A	A	A	A	A	A	A	A	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	Site or Facility Code Range = 0 - 255								PIN, Badge or ID Number Range = 0 - 65,535																
P	E	E	E	E	E	E	E	E	E	E	E	E	O	O	O	O	O	O	O	O	O	O	O	O	P
	Even Parity Field												Odd Parity Field												

PROXIMITY



- Passive
- Reader emits an RF field that powers the card
- Card sends its data back to the reader where it is read by the host system
- An active card emits a field to the reader

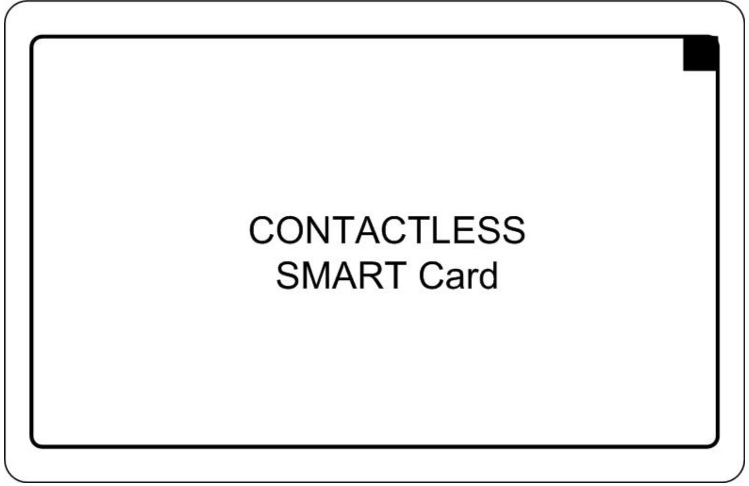
Proximity and RFID

- Proximity cards are MAGNETICALLY coupled.
  - Short read range
  - Transmit response by shorting out own receive coil and causing minute power drops in readers transmit coil.
- RFID cards can have longer read range
  - Energised by signal on frequency X
  - Transmit response on a fraction of frequency ½ X

Proximity ID cards

- Barf back a single bitstream
- Nominally 26 bits
- “high security” can be 40 bits, though there are rumours of up to 84 bit versions.
- Security by manufacturers restricting “sitecodes”
- The world generally uses 26 bits

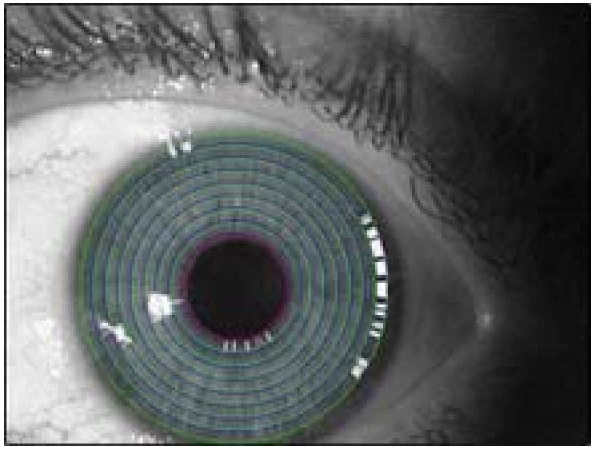
Contactless Smart Card

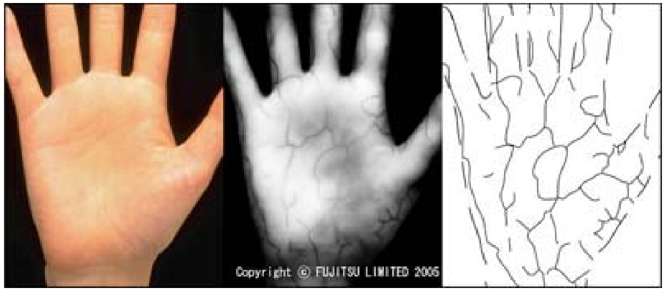


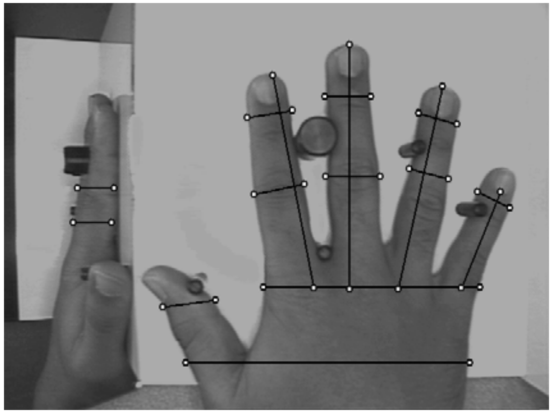
- The way to go
- Authentication between reader & card
- Strong Crypto

Biometrics

- Retina Scan
- Iris Scan
- Venial hand/finger map
- Hand Geometry
- Fingerprint



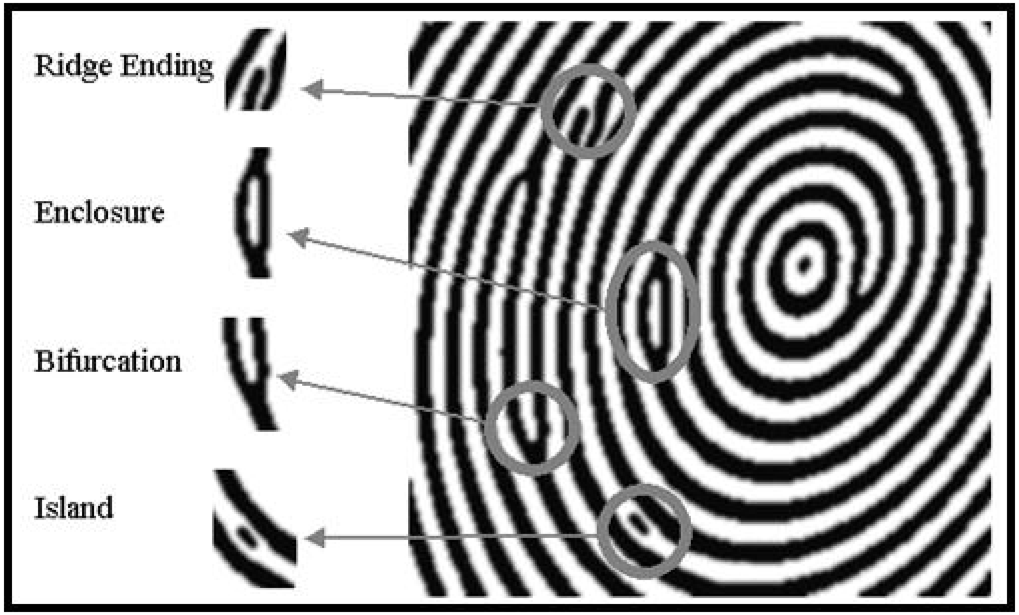


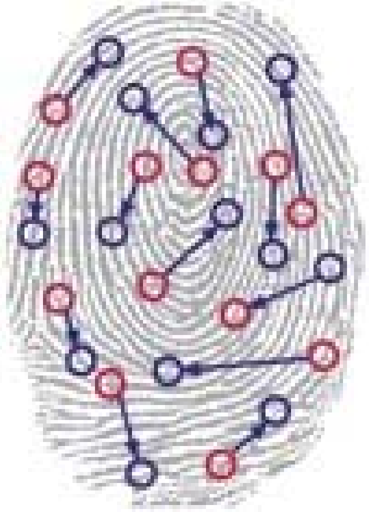


Fingerprint

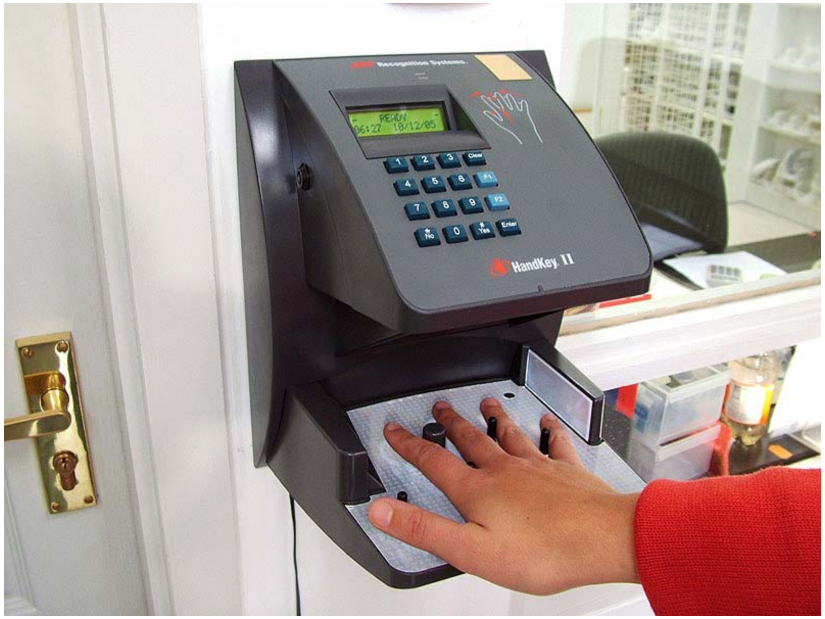
- image capture & feature compare
- 2 technologies
  - Optical
  - Capacitive (semiconductor)
- Easily defeated
- Gummy bears
- Licked photocopies
- Silicone fingertips etc

Fingerprint Feature Analysis

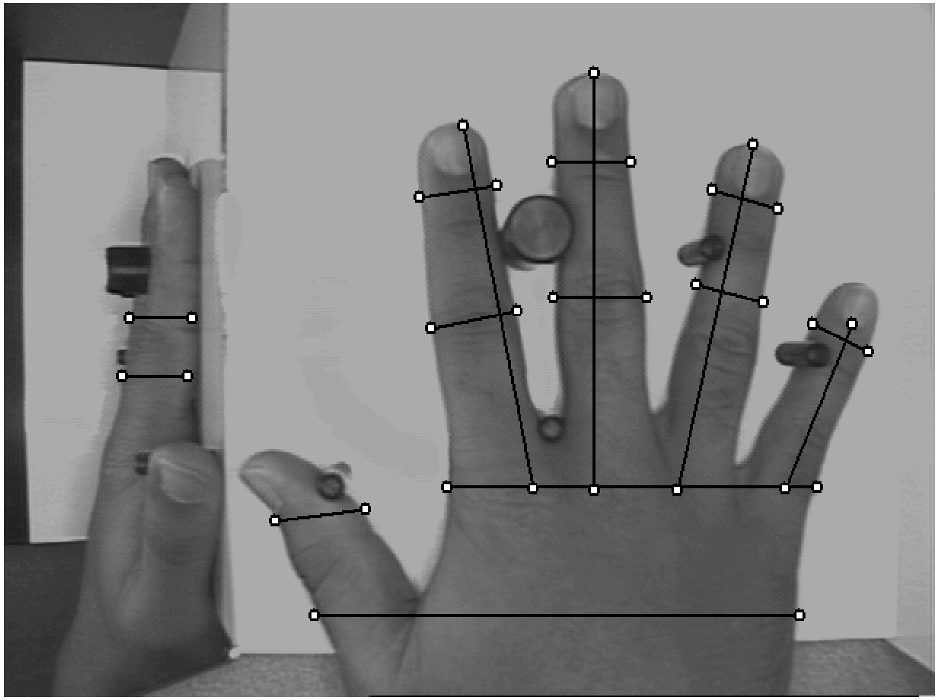




Hand Geometry



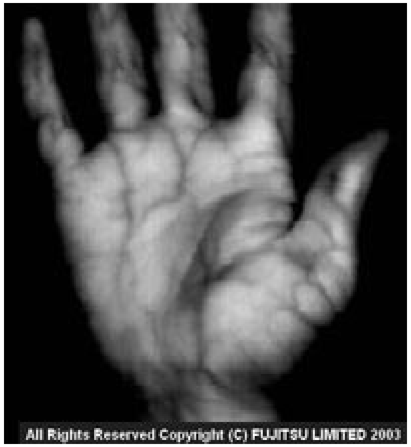
- Images again
- Note the pegs to center the hand



The addition of a 45 degree mirror allows them to add a check on the 3rd dimension.

Veinal hand Scan

- Another image capture, this time with an infra-red camera.



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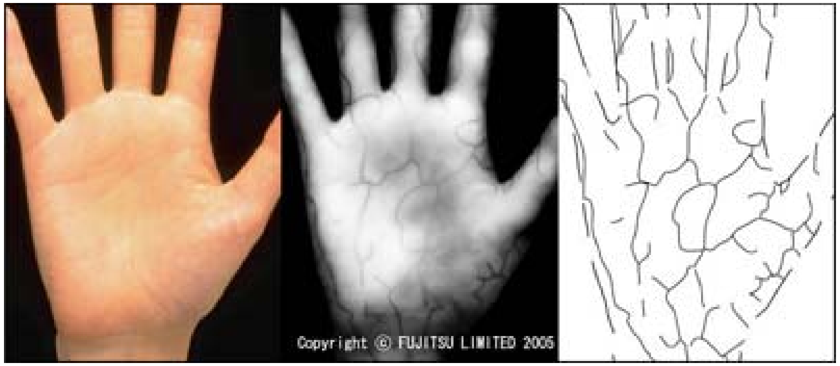

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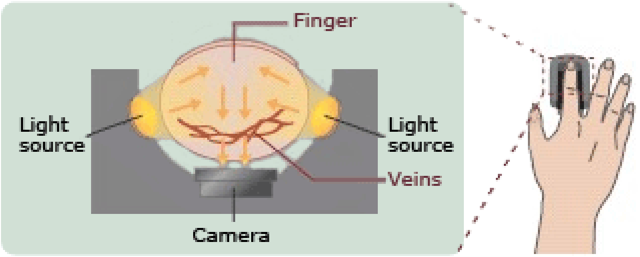
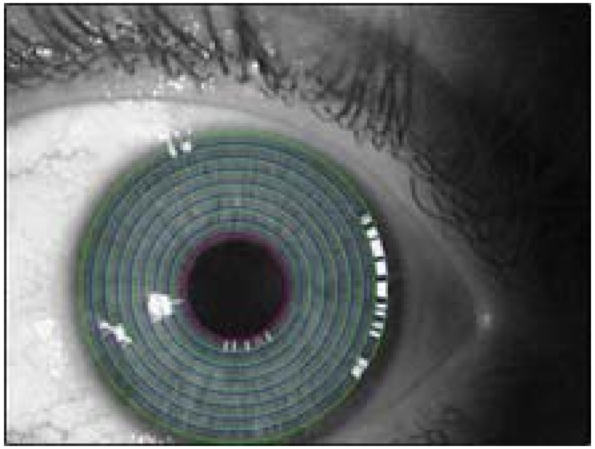


Iris Scan

- Just an image!
- Potential for walk by capture!
- All biometric devices on the market today are basically image capture devices.



Retina Scan

- More secure
  - Hard to “steal credential”
- Hard to use
  - Needs training & practise
- Manufacturer went bust
  - ☹

This is actually a good example of how biometrics work and the challenges of getting them to work at all!

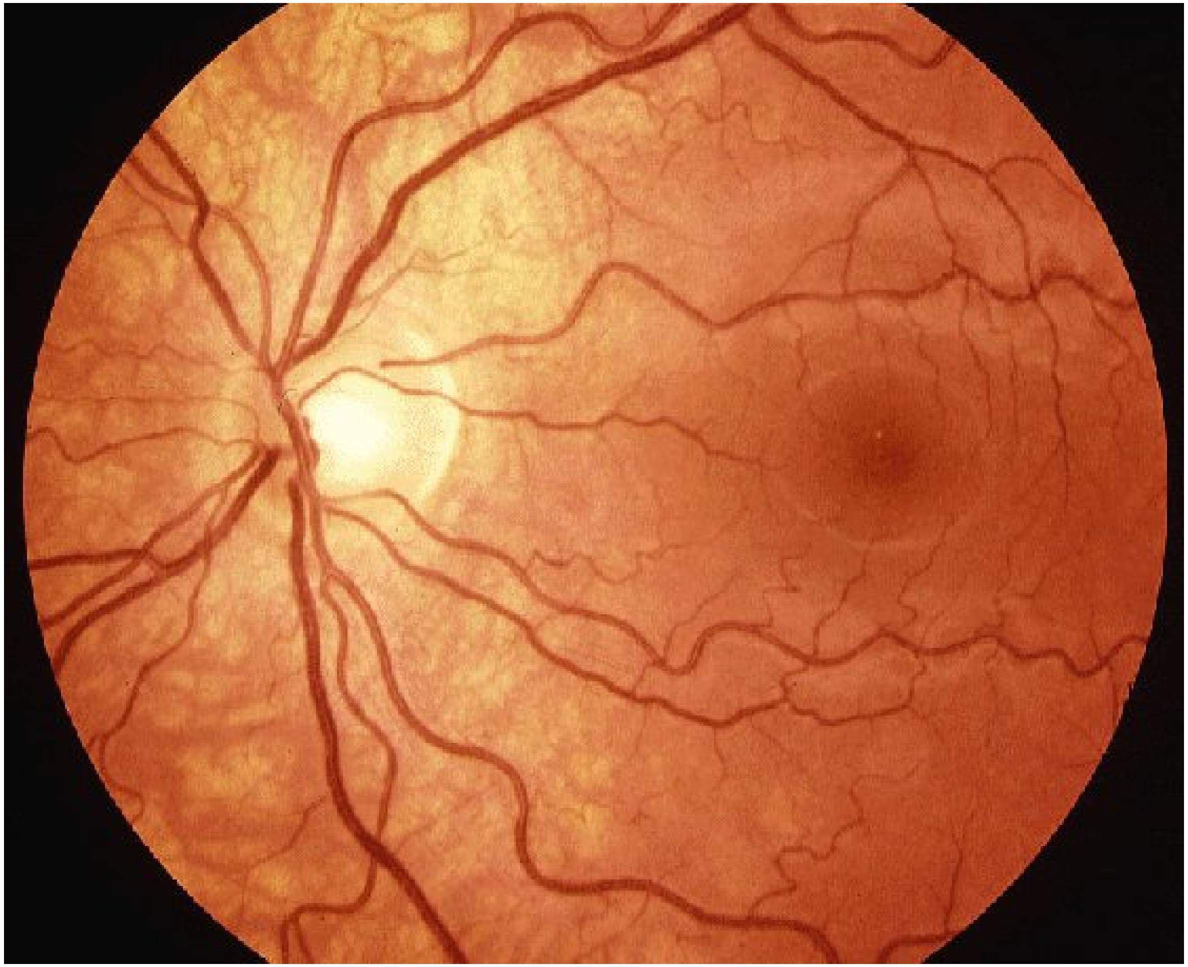
An Example of how it works

- First the user enters code on reader
- Visual dot and target is displayed in eyepiece
- (Tip: put finger on scan button)
- look into eyepiece
- move head to align dot onto target
- Once you have correct alignment user presses scan button.
- HOLD STILL!!!

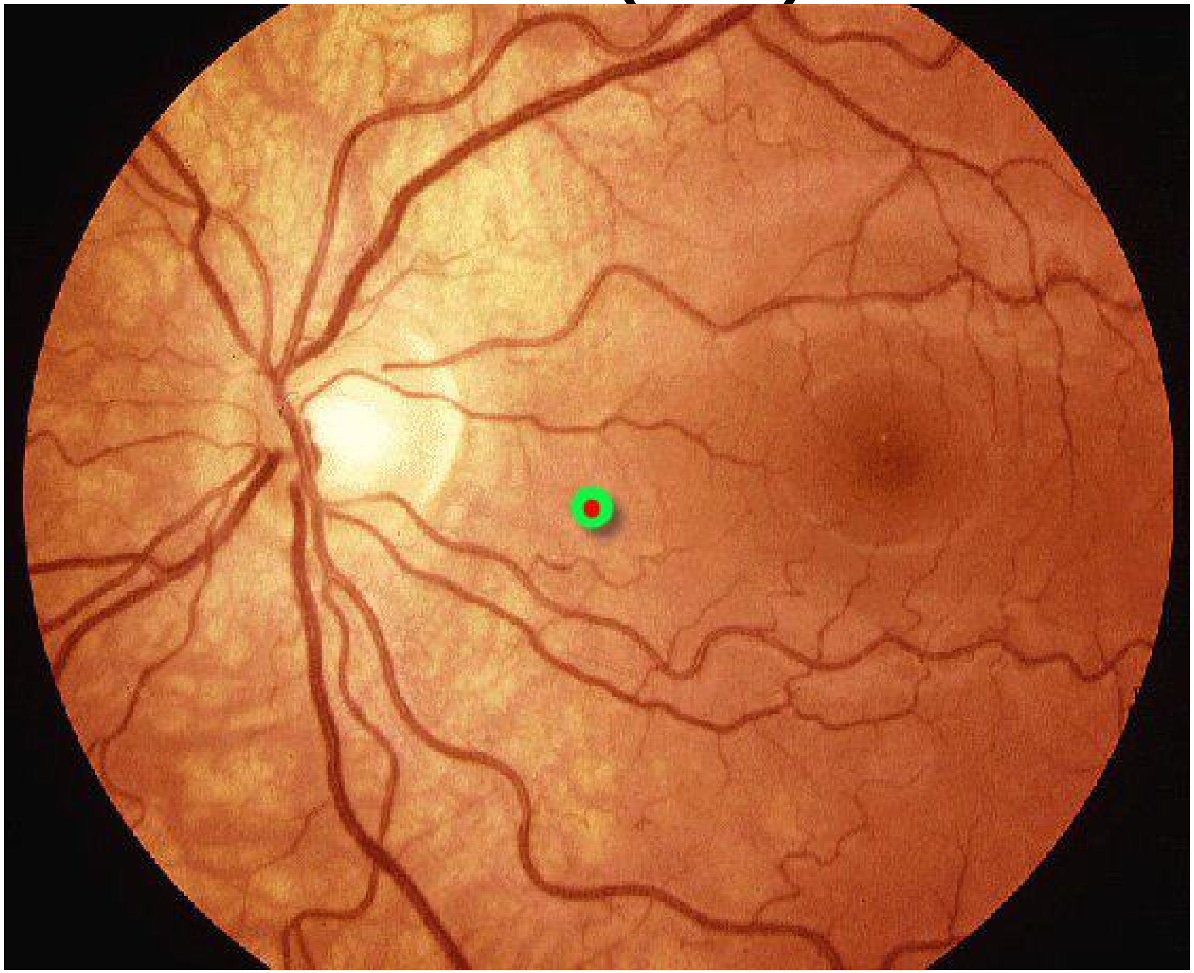
Not as easy as it sounds..

- Not that it sounded that easy
- All biometric devices have a variance factor.
  - No two reads will ever be identical
  - There must certain amount of leeway allowed

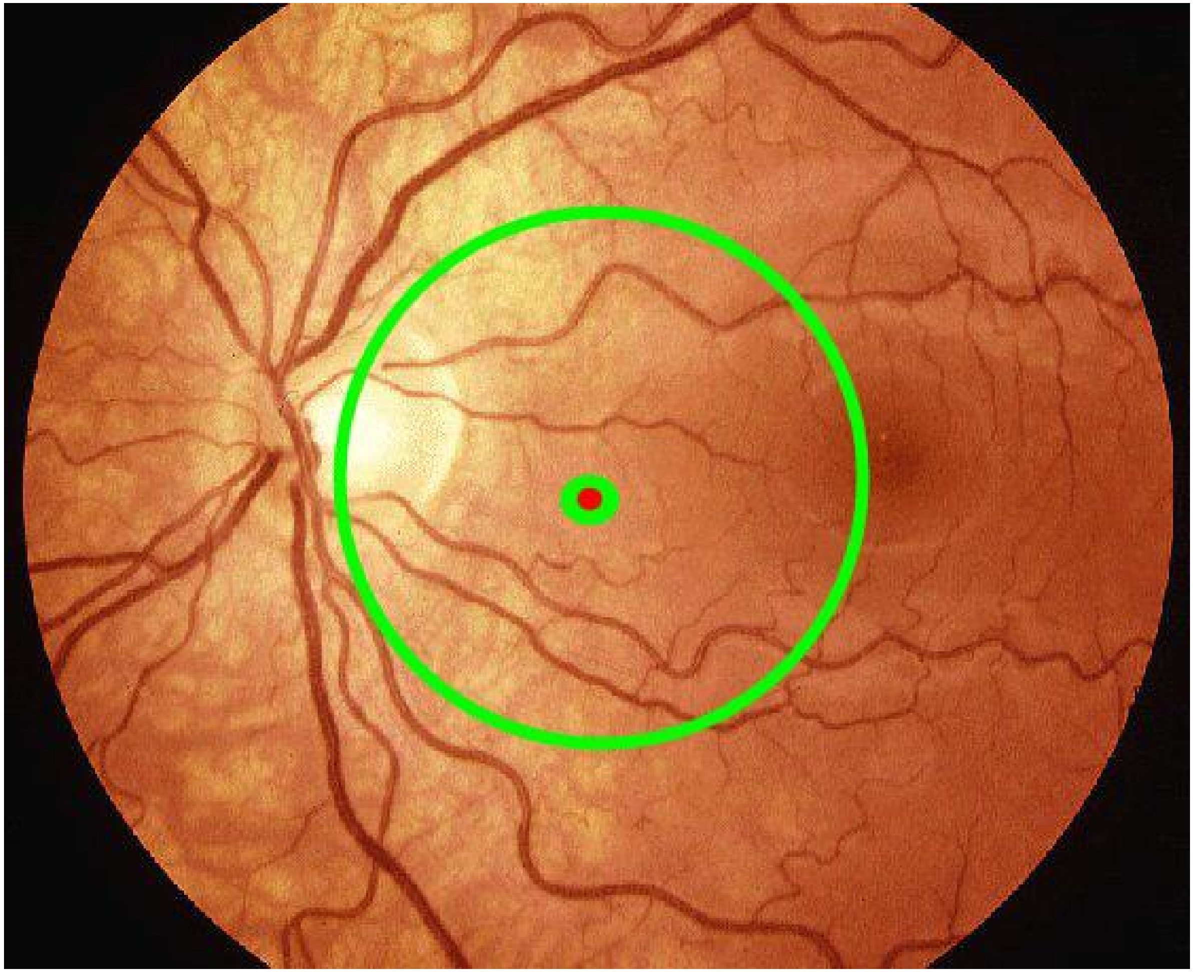
A retina (not mine!)



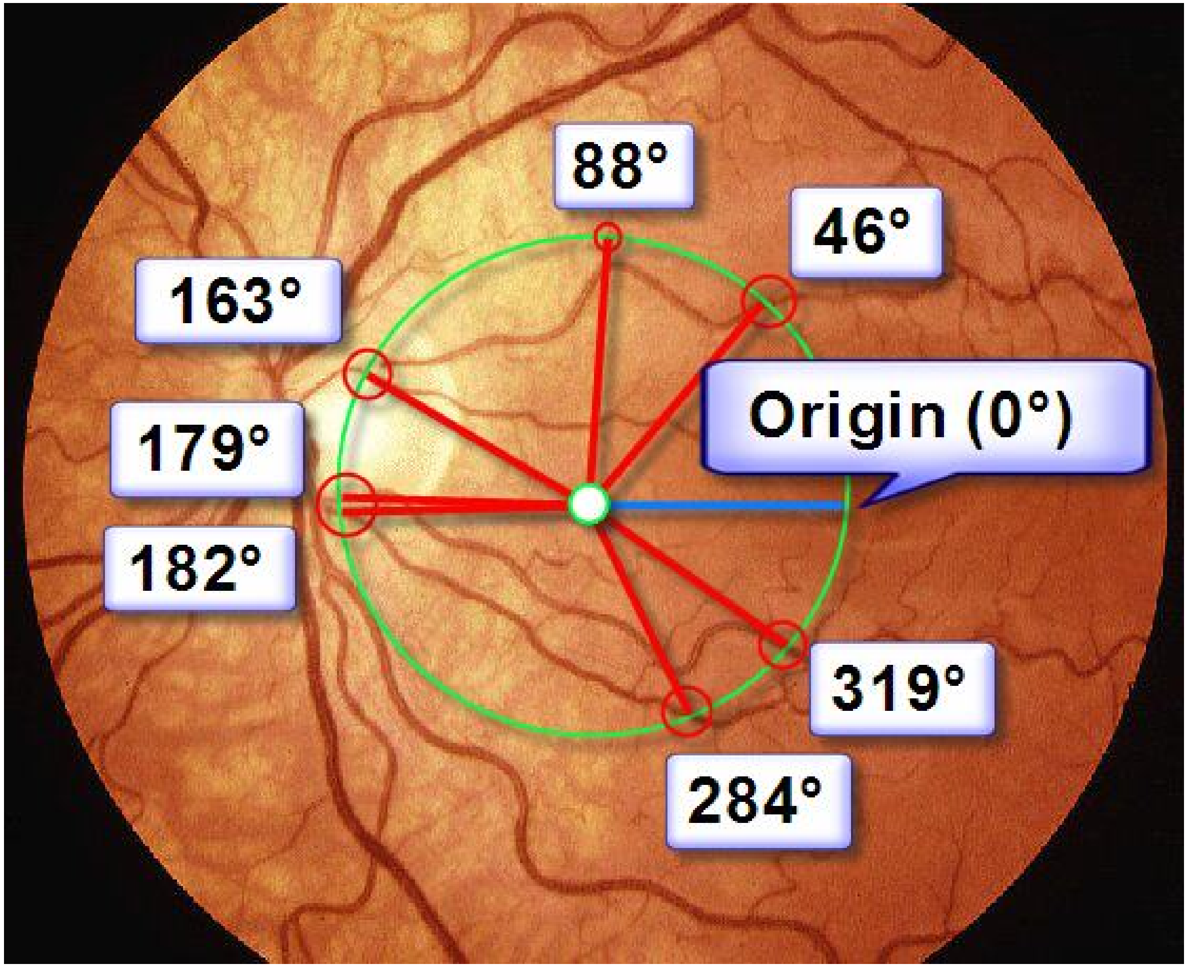
The user target alignment aligns the eye to the same position each time (sic)



When the scan button is pressed the reader scans a circle of the retina



Along the circle it spots the dark bits (Veins) and notes their location on the circle



Surprisingly enough…. The user credential is 360 bits long ☺

This changed with later models but it shows how the designers think.

Coolness factor:- High

- Alignment
  - Totally subjective
  - Almost like including a brain print
- Fudge factor
- ID generally ends up as a hash

Statistically speaking

- **False Acceptance Rate:**
  - Rate at which someone other than the actual person is falsely recognized.
- **False Rejection Rate:**
  - Rate at which the actual person is not recognized accurately.
- Also All of these technologies should be coupled with a user id!

Credential Revocation

Fingerprint / Hand revocation device

Credential Revocation

Retina / Iris revocation device

The Catch

You knew it was here somewhere…

Why backwards compatibility in the security industry is a

BAD THING™

Wiegand

- When Wiegand cards came out they were considered “The shit”
- Access control manufacturers all made sure that their systems could interface with wiegand enabled readers
- They still do……

- Every reader we saw today, from the super secure biometric retina scanner to as “crappy as it sounds” concealed barcode **uses the wiegand electrical and data protocols to communicate** to the access control system.

EEEK!

- “PLAIN TEXT”!
- Easily intercepted!!
- Easily replayed!!!
- Includes output from biometric readers!!!!
- Includes output from strong crypto contactless smart card readers!!!!!

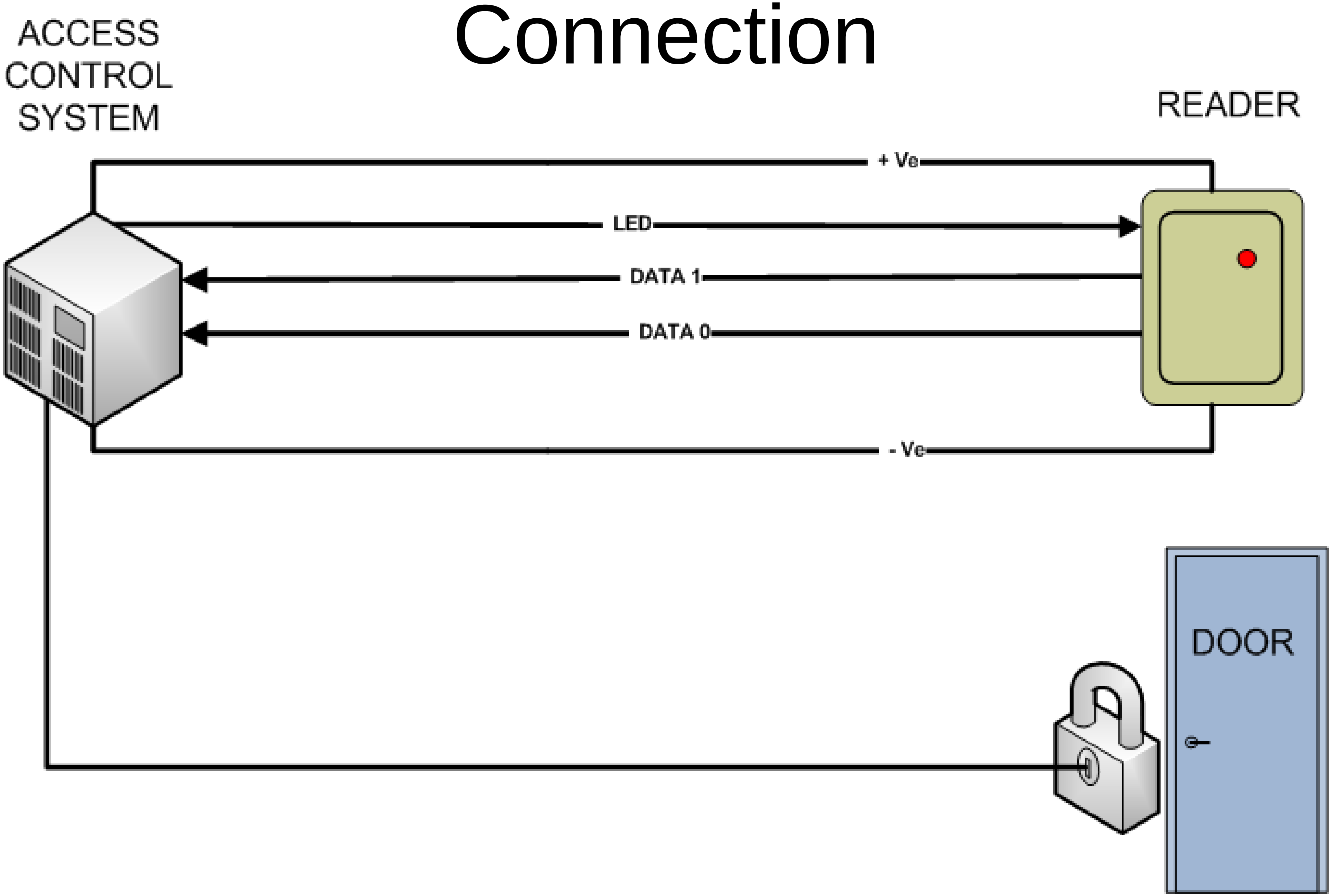
The Goal..

- Record wiegand id’s
- Replay wiegand id’s
- Small
- Easily installable
- Cheap (if poss)

Challenges..

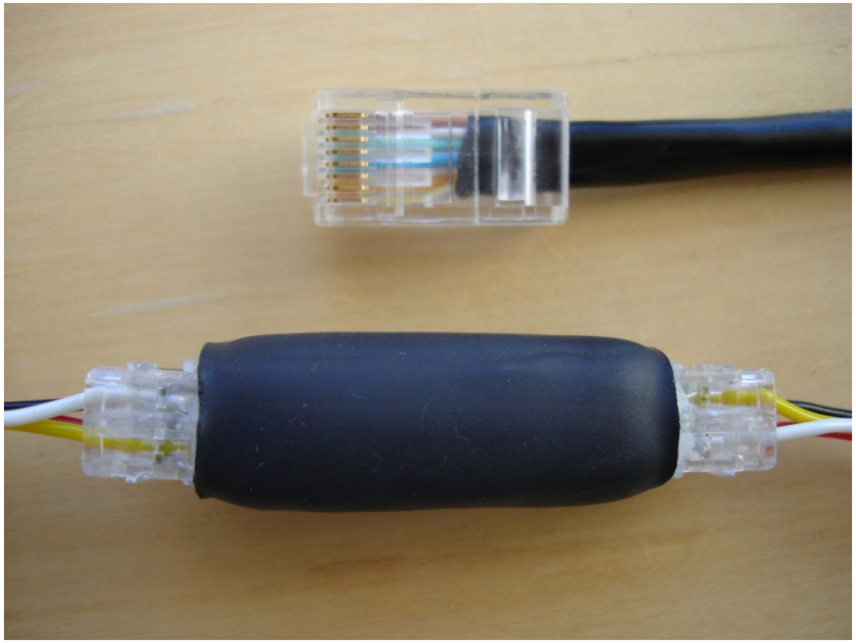
- Unit control (send replay command)
  - – Don’t really want wires hanging out
- Card validation (don’t record bad cards)
  - – Hmm
- Data Extraction (read out card id’s)
  - – Still don’t want wires hanging out

Connection

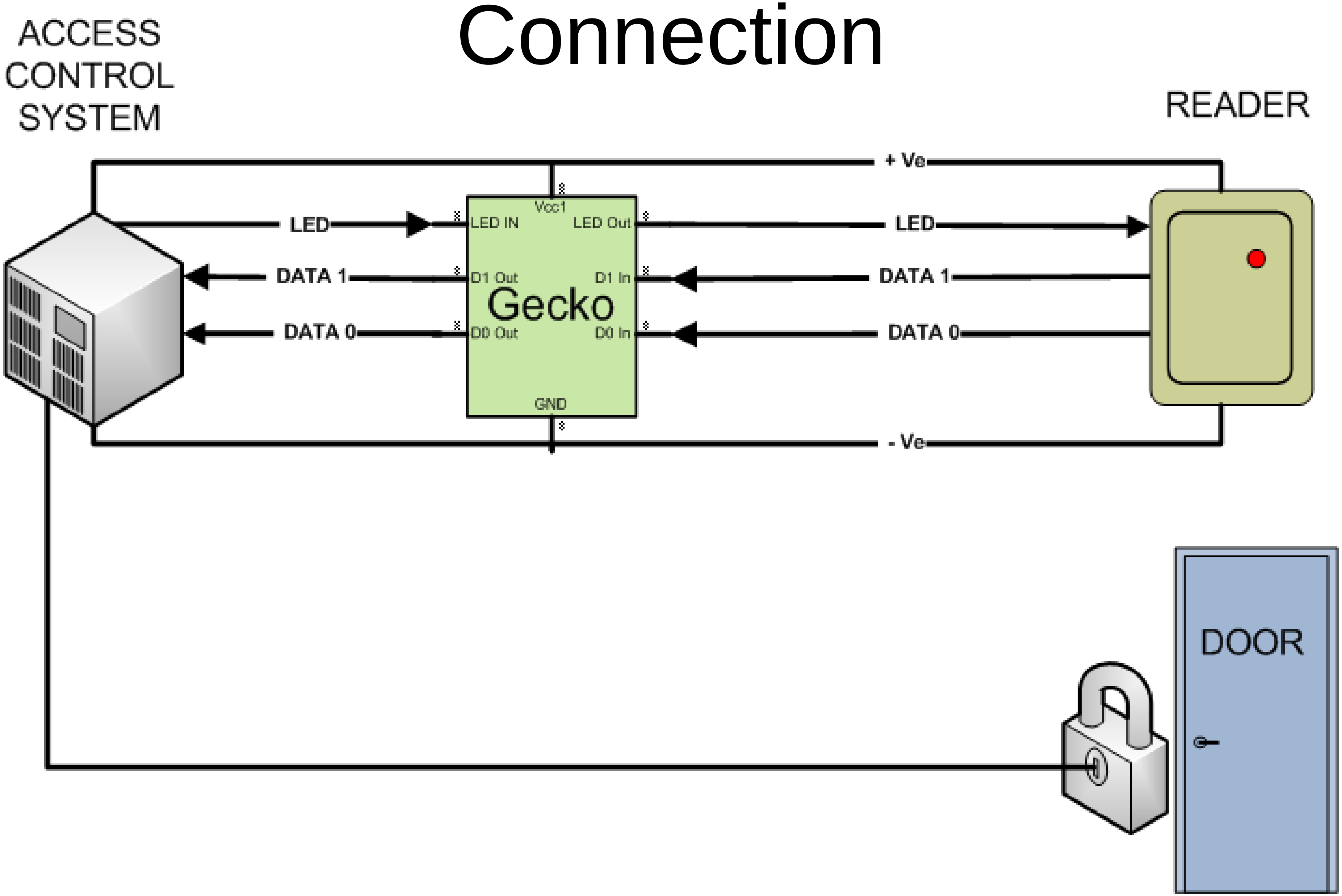


Say Hello to Gecko

- Uses “Command Cards” to control functions (Replay etc)
- Uses “Access Allowed” LED Control line to validate cards
- Uses “Access Allowed” LED to download data



Connection


ACCESS
CONTROL
SYSTEM
READER
+ Ve
Vcc1
LED
LED IN
LED Out
LED
DATA 1
D1 Out
D1 In
DATA 1
Gecko
DATA 0
D0 Out
D0 In
DATA 0
GND
- Ve
DOOR

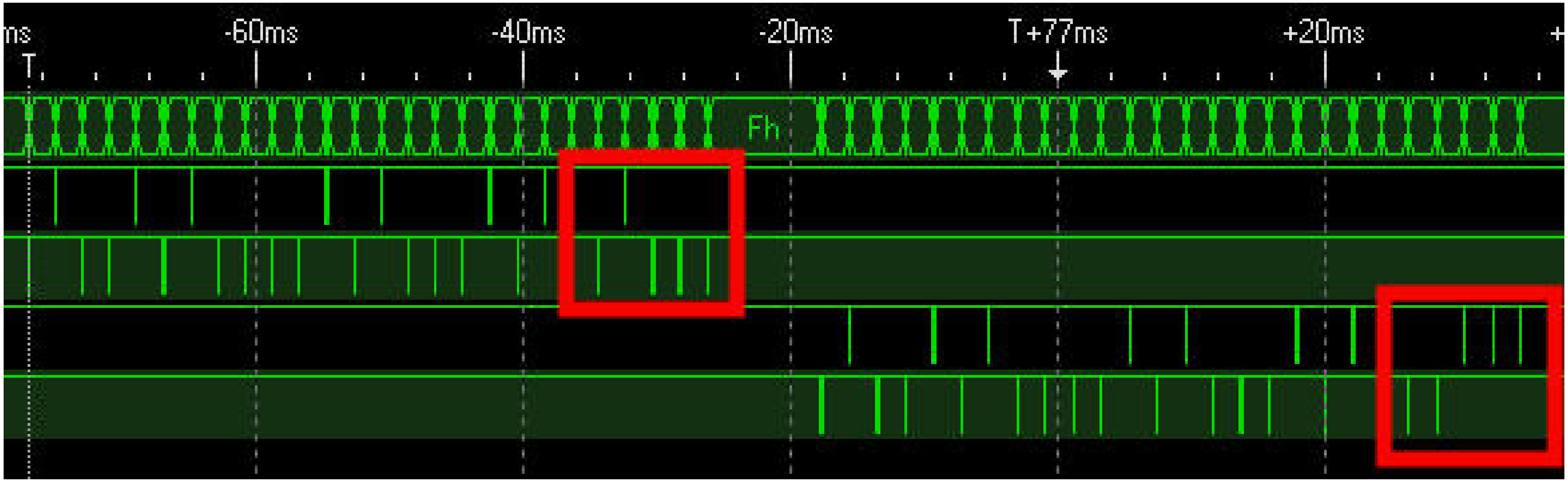
Demo

Standard Demo Disclaimer Applies:

This is a demo, so nothing will work.

However, if it does, I’m totally prepared to take all the credit for it!

Replay in progress…



Development V1

- Proof of concept
- Basic feature set:-
  - Record
  - Replay
  - Disable
  - Enable

Version 2

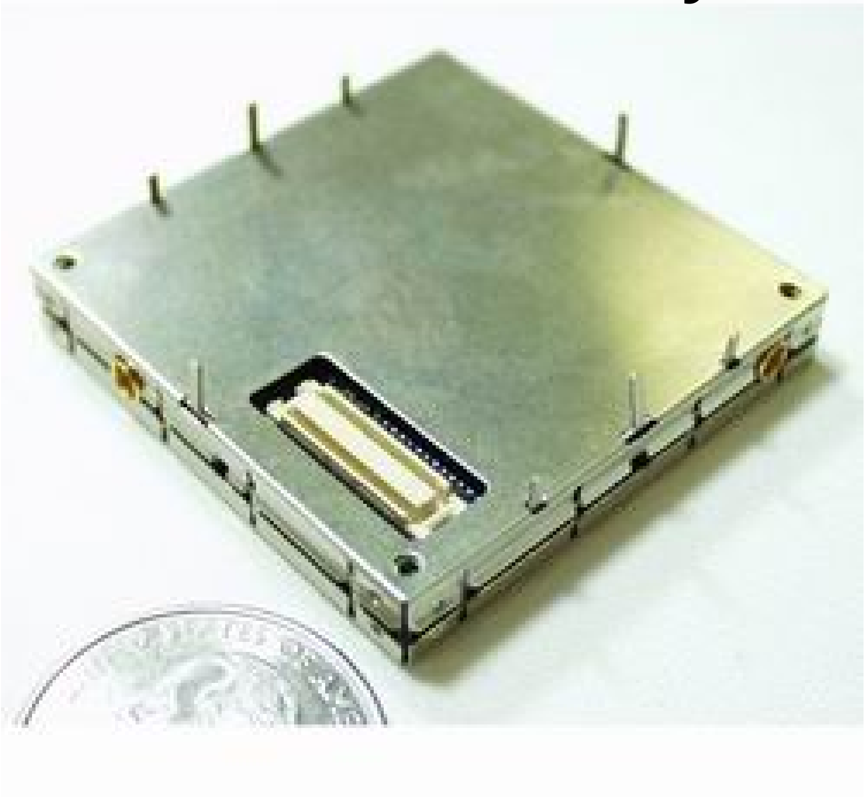
- Store multiple ids to eeprom/flash
- Check validity of card by monitoring reader led line
- Download data via reader led ☺
- Load data via command cards

Version 3

- All the functionality of V2, but with a bluetooth control interface.
- Ideal for biometric devices

Version 4

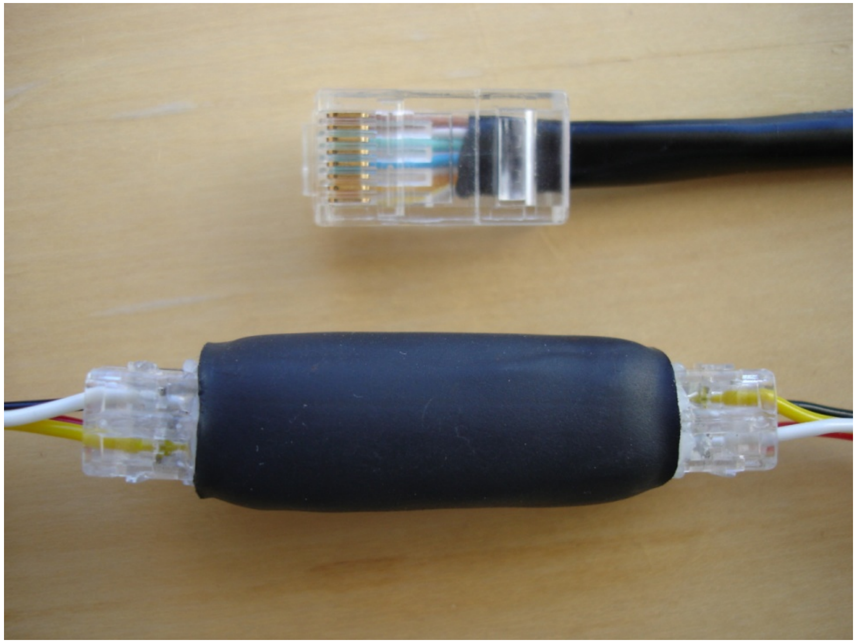
- All the functionality of V3, but with a GSM interface.
- Monitor access to the facility remotely



Props

- **Videoman**: made the demo plexiglass mounting
- **MajorMalfunction**: kept me sane during the pcb design

Q & A



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BlackHat DC 2008