

RFID



High scalable system built on:

- Linux
- Apache
- MySQL
- PHP

This manual will show step by step how Radio-Frequency Identification can be useful in typical company.

COMPANY LOGO

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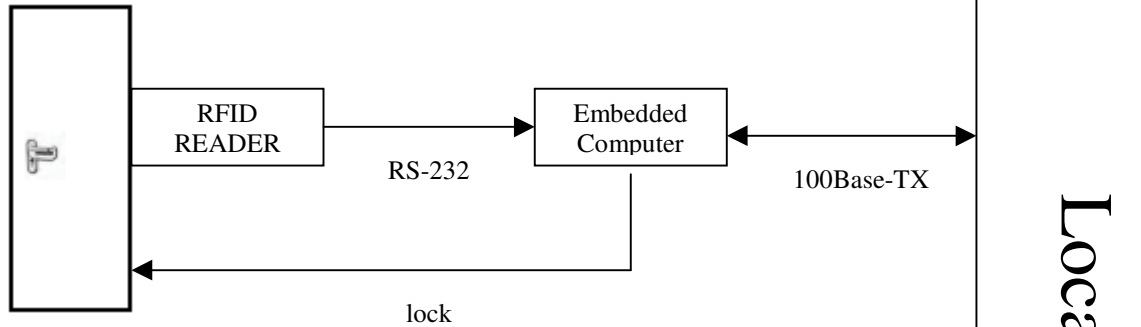
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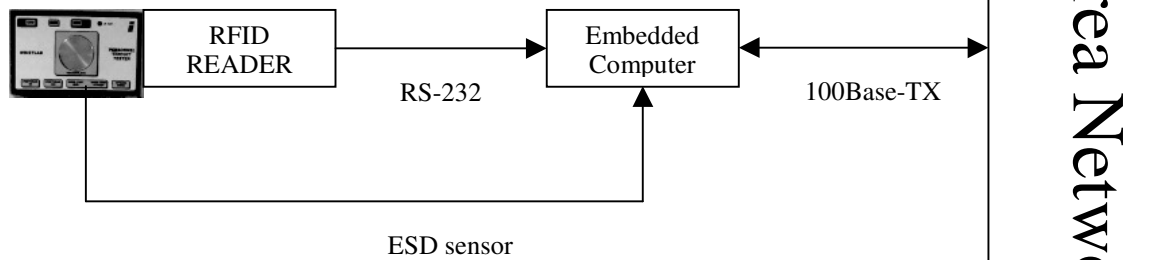
Sample implementation

Infrastructure overview for repair center

1. DOOR



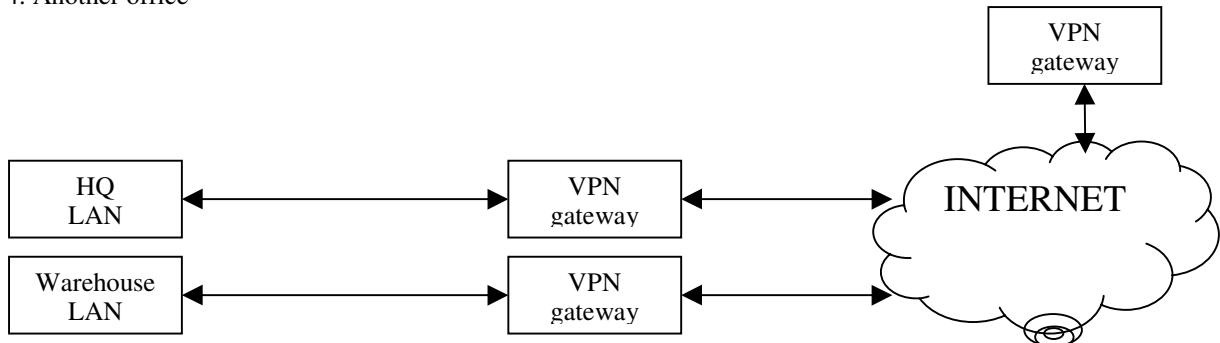
2. ESD checkpoint



3. HMI



4. Another office



Time and attendance system for employee

No matter how big or small company is, it needs to keep track of their crew. In the past paper time sheet or punch devices were used to track arrival and departure what was high vulnerable for error where employees register for other.

RFID is real solution to automate this process – readers are placed in critical places. This can be:

- main entry (Added security for employers)
- exit points of workstation
- zones like warehouse or social room like kitchen

Workers carry personal RFID identification system tag, which detects their location.

Following picture shows sample screenshot of ERP application displaying presence records for office zone:
Allowed user like manager real-time insight into workforce daily availability

Okres (YYYYMM)		200908	Layout:	Presence	<input type="button" value="Submit"/>	<input type="button" value="Urlopy"/>	XLS .						
			1	2	3	4	5	6	7	8	9	10	
			Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	
A		01983845EC			9.8	10.1	10.6	10.3	8.8			10.1	
B		01982A5452			8.1	9.3	8.8	9.8	8.1			8.0	
K		0197E9ED42			8.5	8.6	8.7	4.6	8.4			8.8	
P		0198306086			8.4	8.4	8.4	8.5	8.4			8.5	
P	26	0197FD53B8			9.5	9.2	10.0	8.0	9.2			8.7	
R		0197E4E9AA			8.0	7.7	9.0	8.2	8.0			8.1	
Tomasz.Malewski	0923	01982257C6			11.9	11.6	11.6	10.5	11.8			10.2	
W		0197E7D183			U	U	U	U	U			9.1	
A		0197F423F2			11.0	9.5	9.7	11:36:00					
A		0197F97880			7.8	8.6	8.7	20090805 08:30:13					
C		0197FFF7B6			U	U	10.1	20090805 20:06:37					

RF02 / T1F

Because it's open source solution, application can be easy customized to fill any customer requirements with unlimited features ex. :

- reports by e-mail predefined events like tardiness and absenteeism (HR department)
- integrate with ocommunicator to set Away From Keyboard when human leave workstation (customer service or call center)
- turn on-off light/ machines to conserve energy (building automation).

How shown layout work:

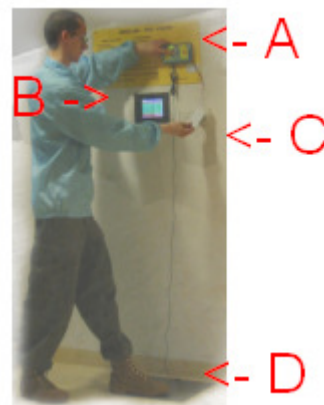
When tag wears by each worker is in range of any reader this event is recognized and sends over Local Area Network to Enterprise Resource Planning system to store in central SQL database. Because we use TCP/IP protocol Globally Integrated Enterprises can collect data from offices around the world into one HQ data center.

Checkpoint system.

Described in previous part passive tracking tags movement was basic example, next one will show more interactive solution. Sometimes when some task is done we need after that some kind of confirmation like signature on paper. RFID is solution to minimize series of most manual individual steps.

In repair center very important is ElectroStatic Discharge protection to avoid destroy electronic components by unwanted currents (ESD – more http://en.wikipedia.org/wiki/Electrostatic_discharge).

Workers wear antistatic foot-straps and clothes that help prevent static build up. During office hours each engineer should check own ESD protection by personnel circuit tester (on picture Wristlab from ITECO <http://www.iteco.it/en/wristlab.html>).



To pass foot-strap human has to touch with one hand point A and with foot sensor D – when resistance is acceptable it's confirmed by audible system. You can easy imagine that for bigger workshop X a few tests during day ... this process happened little randomly and nobody can be sure that it happened well. It's important process because person with incorrect ESD protection can destroy expensive electronic spare parts and harms warehouse budget.

Just simple integration ESD tester with RFID reader (C) and 6" HMI (B) to display some helpful data lets tracking this process on the fly to discover any skipped test and react manager immediately before any electronic component can be destroyed.

Following screenshot shows ERP application displaying done ESD test result for each worker. Marked with red colors indicate failed test which should focused local ESD supervisor attention.

[illegible]

In open-source solution You can easy adapt solution to own demands ex:

- (countdown period) when too long time elapsed from last test ERP can lock application with Pop-up “execute ESD test immediately”.

No matter it's ESD checkpoint or refueling system in transportation – this example just show interaction between RFID and some Input / Output device to make process more accurate.



HMI 6'' (on picture TPC-66 under Windows CE) communicate over TCP/IP with data center so can be placed anywhere on the green planet in unlimited qty and communicate by cables or Wireless network.

Possible implementation:

- display queue of orders coming from warehouse (supply chain management)



Real heart of RFID reader is shown on picture on right side - we attached two LED to simple indicate current reader mode if remote HMI fail:

Mode		Timeline	LED green (left)	LED red (top)	Description
Standby		*	Off	On	Reader is waiting for TAG
ESD Check					
Any TAG recognized		0	Blink every 1sec	On	Node every sec check sensor status to detect PASS form ESD Wristlab
	ESD Passed	0-10	On	Off	Back to standby
	ESD Failed	10	Off	On	If after 10sec no positive result detected (timeout)

Door lock / restricted area

Last implementation example is just door lock - to not use keys or numerical-keyboard to limit access for some area RFID is perfect solution for this problem, and most popular small range implementation for this technology. Human has just to approach card to reader to unlock doors and gain access in a second.



Technical Hint:

Most readers are all-in-one case – assembled outdoor units are vulnerable to steal and vandalism what is expensive loss. In current implementation on outside side we expose only antenna which materials cost maybe 5 EUR. If thief steal again & again You can just place antenna under wall plaster. For LF RFID range between tag & reader is about 15cm , 5cm less of wall isn't bad but secure component from vandalism

RFID shoes / contactless

Most people say that RFID is contactless , but still implementation are old magnetic-card concept mind. To open door You have to get card from pocket, touch reader located on wall... when you carry in two hands some thing to pass this obstacle You still need one free hand .

Some shoe manufacture use already RFID tag in his products for distribution tracking. Why don't use it later as tag to tracking people ?

Doormat antenna is right answer. What ever you do/carry still legs are on the floor – this is right place for RFID antenna < it's my petition for RFID sector – please think about it. It works great for me Of course just pass-through gate can be used but is more expensive solution than antenna assembled into floor.

([RI-I02-114A](#) - Tag-it(TM) HF-I Standard Transponder Inlays Large Rectangle) .



Hardware

Door lock – backend platform

For my BSD licensed software You need any PC able to

- run LAMP (Linux / Apache / MySQL / PHP)
- has network card – NIC 10/100 or any LAN - WiFi
- COM ports RS-232 – to reader

I looked for some small industrial PC possible stick to wall nearly door and found UNO-2170 from Advantech .

- Input voltage 12-24v (safety low voltage + accu)
- 4 COM ports (able to drive 4 readers)
- RJ45 / RTL8139 (each Linux distro loves this NIC)
- LPT (as output for driving relay – door, lamp)
- CF socket (Compact Flash card are very cheap now, less heat/power than any hard disk drive). To deploy normally operating distro You need about 256MB compact flash card or more.
- Small /metal cover – to not fall with wall gibs.
- PCMCIA slot for WiFi card when LAN/RJ45 is dead or cut.



Some alternative solution can be ThinClients (HP) download O/S over PXE but if host server is dead each door are unlocked. Please remember about it from safety point of view in your implementation to build everything in „reversed” technology – **no power = no lock.**

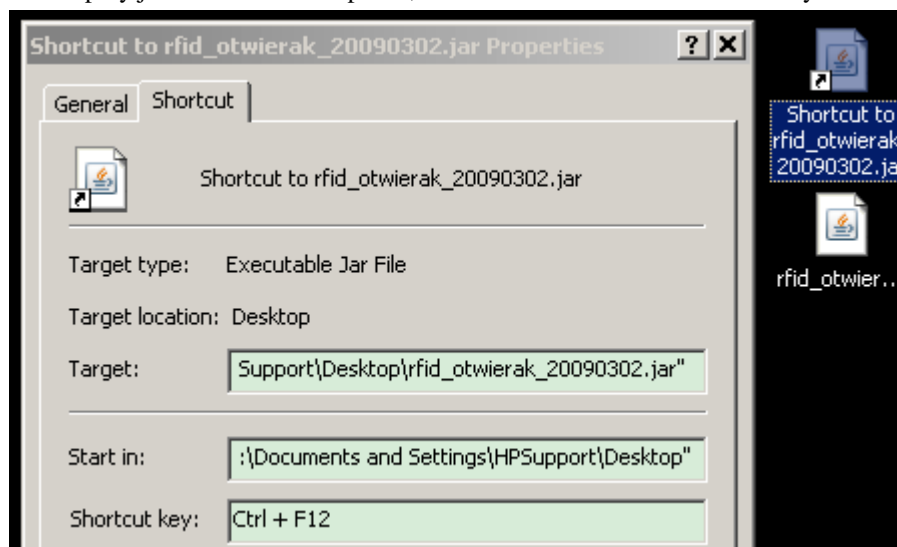
To avoid situation where during fire or Blue Screen Of Death nobody can leave locked zone. It will be really bad

Java trigger example / MS Windows bosskey

In some places like secretaryship person has to open remote door just after basic visual guest inspection – ex. postman, pizzaman . In typical application on desk is installed additional button and wires to unlock door. Today in each reception is computer so why not use it as RFID trigger to do this same without move hands from key-board.

This example shows simple application wrote in Java bind with hotkeys under Microsoft Windows operating system to call in background RFID system to open door for a few seconds.

1. Deploy jar file to local computer , create shortcut and bind shortcut key

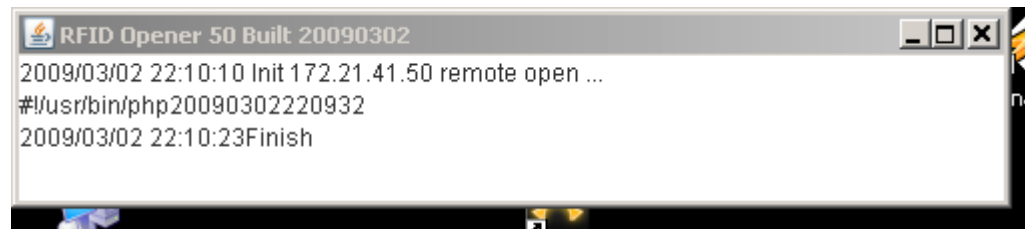


Every time when you push bosskey in taskbar following thread will begin:



After a few sec (5-8) background window will close self to not disturb user.

In any moment you can maximize window to check debug message if doors won't open:



If .jar file doesn't execute you need Runtime Environment J2RE:

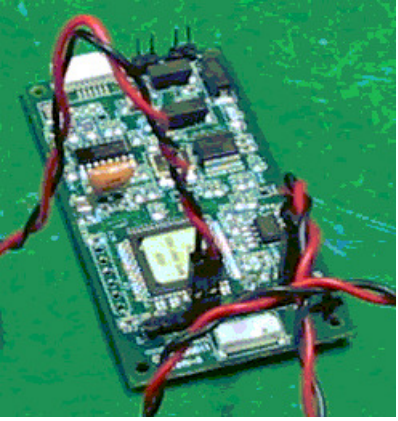
SUN <http://java.sun.com/j2se/1.4.2/download.html>

Readers

It's more important choice because depend by wanted technology You have to choose one. On the market you can find many products. Before you buy anything ask self:

- You are looking for ready to use device or want to build it by self (developing kit).
- How many time & money you can spent to born project.
- You are looking for flexible / development device or final product wash & go for implementation.

Below I describe some easy to purchase readers, if You know any good one please give me a sign.

	<p>Vendor: Texas Instrument http://www.ti.com/rfid/ Model: rf-mngr-mnmn (~ 50 EUR)</p> <p>Pros::</p> <ul style="list-style-type: none"> Dual Frequency Operation (LF / HF) Multi Protocol / Custom firmware - great for development GPIO http://en.wikipedia.org/wiki/GPIO Easy accessible on the market <p>Cons:</p> <ul style="list-style-type: none"> Phase-out – not supported by TI TTL 5v (requires converter TTL 5v to RS-232)
<p>CORE-12 RFID Reader Module</p>	<p>Vendor: http://www.rfidshop.com/</p> <p>Pros:</p> <ul style="list-style-type: none"> Wide range of ready to use products LF: Price from 15EUR (reader – require TTL conv) + 5 EUR (antenna) HF: Price from 50EUR (reader – RS-232)
	<p>Vendor: http://www.brooks-rfid.com/rfid-hardware.html</p> <p>Pros:</p> <ul style="list-style-type: none"> Wide range of ready to use products for industrial implementation.

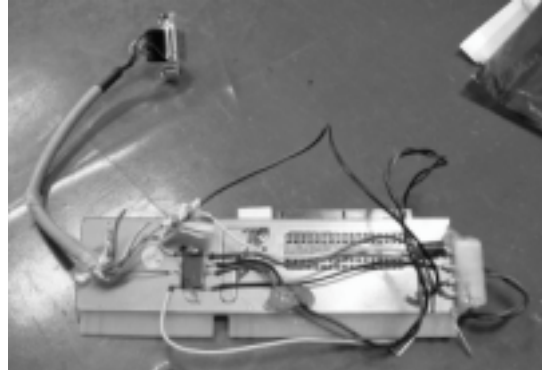
Hint:

Every time try to buy reader with “auto reader” as default operation mode after power on – it means that when You turn in it on it's ready to use as basic reader and send data over bus when TAG is recognized and don't required any additional commands. For basic implementation it saves many hours of writing source code.

Home Made RFID reader

If You have many free time You can try to build own reader as I did – for most RFID semiconductors vendors provide datasheet with sample electric application to make developers live easier.

If You will build it alone it can looks like ☹ -> It doesn't look professional but i decided to ISA bus because it exists on old cheap motherboards , if any unforeseen error/ short circuit just buy next one for a few bugs on ebay.



To build own reader You need to have RFID semiconductor. Unfortunately there is no many junkyard/eBay stuff to extract necessary parts, You will also have problem with reverse engineering if no any datasheet available.

The best way in my opinion is to use Texas Instruments Free samples program

<http://www.ti.com/sc/docs/sampfaq.htm>

It allow You absolutely free order necessary semiconductors (limited qty ~ 10pcs for each part number x 8) .

You need to create account in “My TI” – totally free.

Browse for Samples > RFID Systems > Readers > ex.

LF TMS3705A1DRG4

HF TRF7961

MAX232 if You build also own RS232 converter

Big advantage is that You receive TI support – datasheet / implementation samples.

Please be noted that free samples are sent from USA (FedEx) and You will have to pay duty if needed.

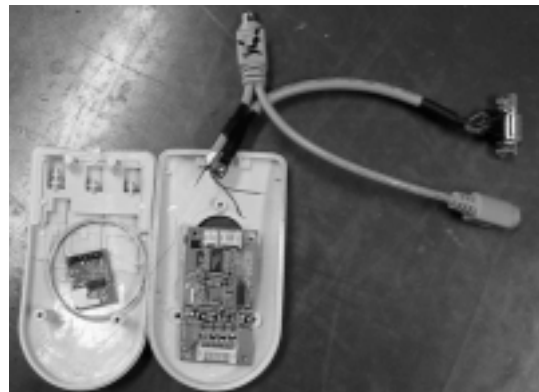
TI can also call to You after place order to ask more about Your project – it's good moment to increase qty if You really need more.

After many spend hours in soldering You will have desired RFID reader. In this case i used small panel computer covers + touchscreen controller to wall mount + blue LED inside. Cool demo.



With imagination You can hide everything in mouse cover, and ask surgeon to inject RFID implant into your hand ;) Seriously PC mouse on desk can be used to lock operating system when operator is away from keyboard.

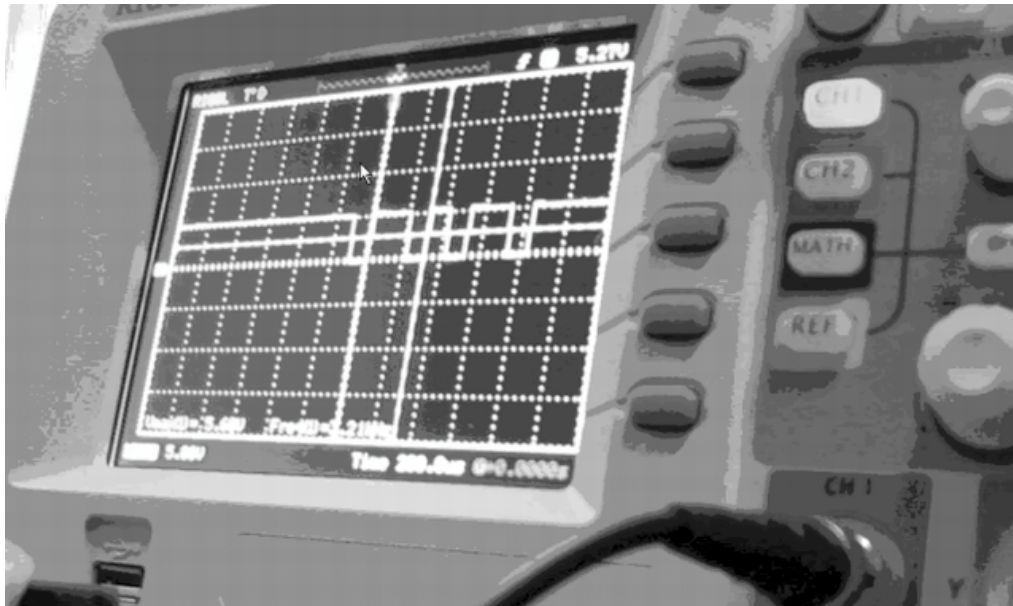
For outdoor environment i suggest to use old metal zoltrix modem, really cool and RS232 circuit converter already done.



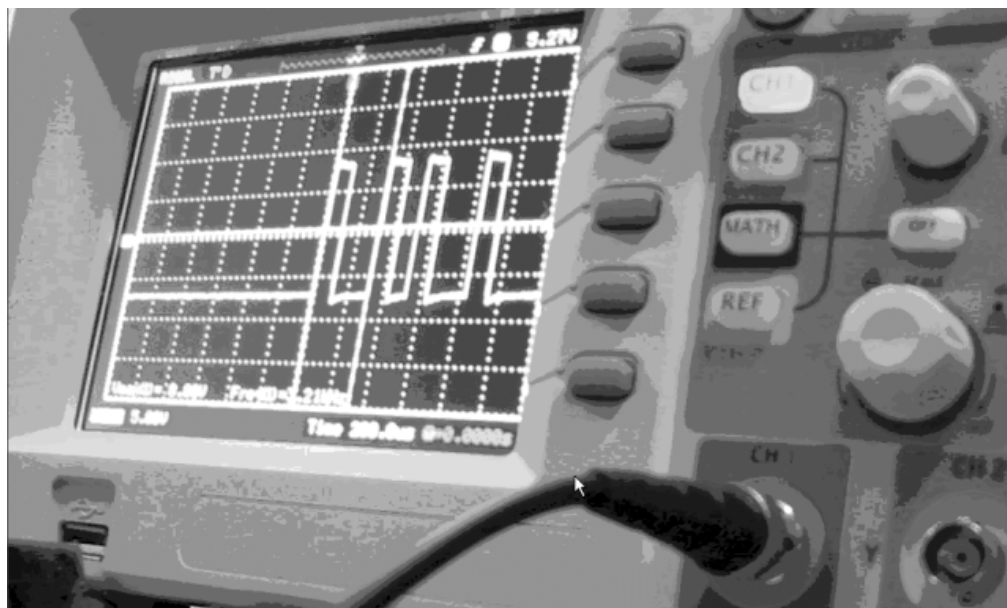
TTL to RS-232 converter (hint)

Most RFID semiconductors use TTL level (5V) to let it communicate over RS-232 You (12 V) need to build converter.

TTL 5 volts signal level:



RS-232 12 volts level signal:



Electric diagram / schematic :

In semiconductor datasheet (GD75232) on page 11 you have sample circuit

http://www.datasheetcatalog.com/datasheets_pdf/G/D/7/5/GD75232.shtml

The problem with this component is that requires voltages: 5V, 12V, -12V

Better solution is to use MAX-232 , page 7

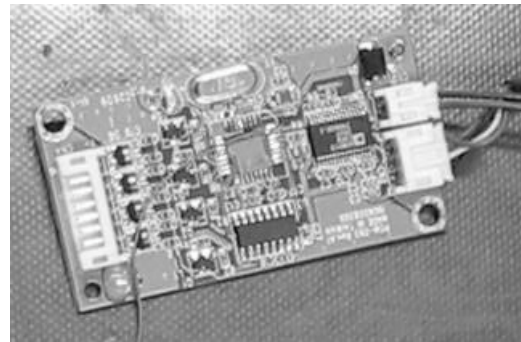
http://www.datasheetcatalog.com/datasheets_pdf/M/A/X/2/MAX232.shtml

This component operates on single 5V power supply, because contains internal inverter.

You can find this circuit in many RS-232 devices where is any TTL micro controller ex. Atmel family:

- mouse
- external modem
- handheld PDA

In home-made project i just use touchscreen sensor controller taken from junkyard, unsolder main CPU and join wires TTL TX/RX to TTL reader.



Source Code

```
2009-01-01 20:59      <DIR>      ..
2009-01-02 05:43    2'379  adv_rfid.php
2009-01-02 05:43      749  cl_easy_loop.php
2009-01-02 05:43      870  cl_easy_open.php
2009-01-02 05:43      564  easy_loop.php
2009-01-02 05:43    14'677  parashell
2009-01-02 05:43    14'415  pin
2009-01-02 05:43      416  rfid.log
2009-01-02 05:43      530  sv_sync.php
          9 File(s)    34'600 bytes
```

On market there is many RFID software:

- usually binary for Windows operating system
- closed source,
- payable,
- no API for data exchange with other nodes / cluster. Most one reader = one application.
- If any source code usually in C++

I worked on developing payable/closed source application – when i discovered RFID features and great impact for performance/security i decided to write again this same but under BSD license and share RFID way with the world. At this moment (2009/01/01) Open-sourced PHP class is very simply but i will slowly add more & more code to make it more useful.. The key of my project is to engage community to RFID & PHP (developers / hardware vendor) to build some common standard because RFID market is fresh and global collaboration allow offer more/faster/cheaper for ours end customer.

Newline problem

Please remember that PHP scripts to run under Linux shell have to be Linux newline friendly

<http://en.wikipedia.org/wiki/Newline>

If You edit php scripts under Windows each “enter”/newline is stored as CR+LF.

Linux newline is LF so it reports error ~ “^M” during execution.

There is many way to convert files :

Dos2unix http://linuxcommand.gds.tuwien.ac.at/man_pages/dos2unix1.html

But i prefer sed commands from Wiki:

```
sed -e 's/$\r/' inputfile > outputfile      # UNIX to DOS (adding CRs)
sed -e 's/\r$//' inputfile > outputfile      # DOS to UNIX (removing CRs)
```

adv_rfid.php

It's key PHP class using on both sides for client / server.

For properly working it need:

Parashell <http://parashell.sourceforge.net/>

This program drive LPT port output (ex. to drive relays connected to door). In shell it works like that:

```
./parashell 0x378 255
```

```
./parashell 0x378 0
```

```
./parashell (base address) (bits)
```

value 255 is for 8 wires (D0 D1 D2 D3 D4 D5 D6 D7) depend on Your implementation drive desired wires like byte does. http://www.cknow.com/tutorcom/term06_bitsbytes.htm

Pin

Together with parashell You get „pin” program works in this way:

```
./pin 0x378
```

It returns LPT status on input pins – ex. when crew push ESD checkpoint button and green (ok) led appears it send signal to LPT, than PHP run RFID reader and acquire user tag.

LPTc.c

For developing i'm using also this <http://www.jtz.eggs.pl/Html/mini/IO-Programming.pl-9.html>

```

/* example of port I/O
*
* This code does nothing useful, just a port write, a pause,
* and a port read. Compile with `gcc -O2 -o example example.c',
* and run as root with `./example'.
*/

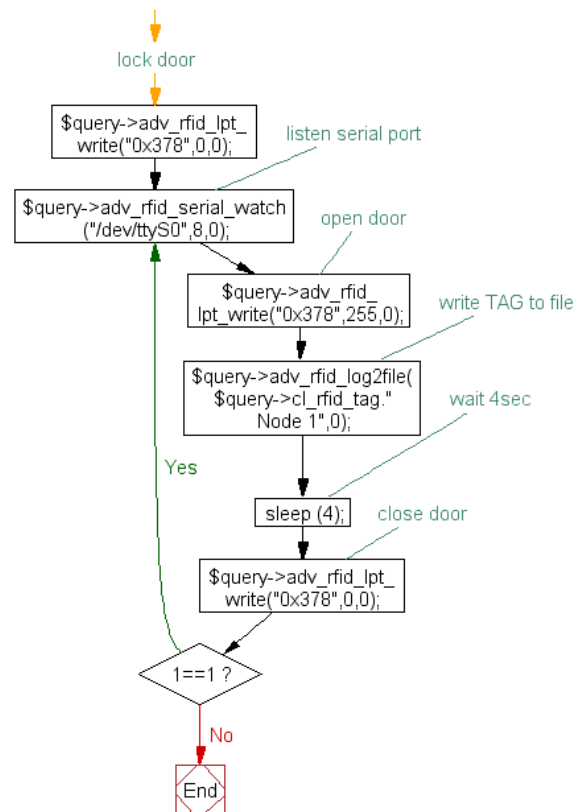
```

cl_easy_loop.php / usage example

It's simple example/loop how to use this class.

1. Set LPT IO 0x378 output to 0 value.
2. It listen /dev/ttyS0 (serial port COM1 in DOS calling) for 8 bytes
3. When any traffic on /dev/ttyS0 switch LPT IO 0x378 to 255 (ex. open door)
4. Write TAG ID , date to flat .txt file
5. Wait 4 sec
6. switch LPT IO 0x378 to 0 (ex. close door)
7. Loop begin again

1. `$query->adv_rfid_lpt_write("0x378",0,0);`
2. `$query->adv_rfid_serial_watch("/dev/ttyS0",8,0);`
3. `$query->adv_rfid_lpt_write("0x378",255,0);`
4. `$query->adv_rfid_log2file($query->cl_rfid_tag." Node 1",0);`
5. `sleep (4);`
6. `$query->adv_rfid_lpt_write("0x378",0,0);`



adv_rfid.php – functions description

adv_rfid_guestmac(\$debug)	Convert guest IP to mac Used during sync client<>server to allow server right identify node. When dynamic IP for machines MAC address is only one way. Remember that PHP need access to arping ex: // require root access or line in /etc/sudoers // ALL ALL=NOPASSWD: /bin/arping
adv_rfid_log2file(\$text,\$debug)	Write data to flat file Storage file is set self depend by date: ./log/rfid-200801.txt ./log/rfid-[Ym].txt each line contains date[YmdHis], client ip and &text. If Your client has HTTPD host can call this file and with „explode” copy
adv_rfid_sqlconnect(\$sql_host,\$sql_user,\$sql_password,\$sql_db,\$debug)	Estabilish connection to MySQL database
adv_rfid_lpt_write(\$base,\$value,\$debug)	Write to LPT port
adv_rfid_lpt_read(\$base,\$debug)	Read LPT port
adv_rfid_serial_watch(\$device,\$length,\$debug)	Read serial port Ex. /dev/ttyS0
function adv_rfid_beep(\$value,\$length,\$debug)	System beep ☺

Issues

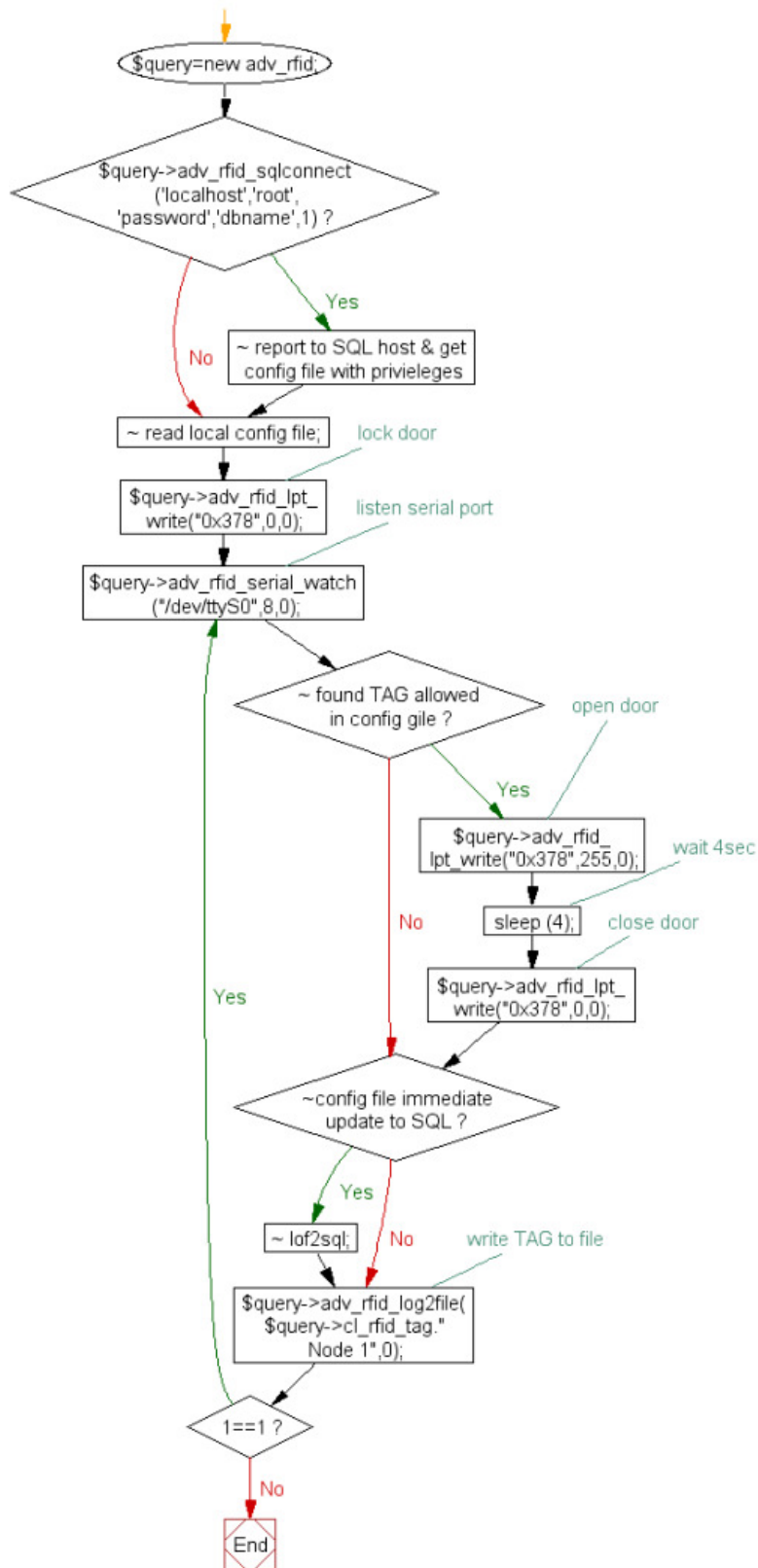
„is not within the allowed path”

php.ini open_basedir

display_errors = On

Appendix

Developing target of BSD project to provide this same functionality like commercial product does.



Glossary / links

RFID

<http://en.wikipedia.org/wiki/RFID>

PHP / Linux

<http://www.phpclasses.org/>

<http://johnath.com/beep/> Beep

<http://parashell.sourceforge.net/> LPT communication – parashell / pin

[http://en.wikipedia.org/wiki/Blue Ocean](http://en.wikipedia.org/wiki/Blue_Ocean) blue ocean strategy