EM4100 (and beyond) RFID Tag Kit

This kit contains everything needed to build a low frequency EM4100 compatible RFID transponder tag based on a PIC microcontroller. All of the software and documentation can be found on github: https://github.com/kbembedded/DC21-darknet-RFID
Software (as of July 30th 2013) only supports an EM4100 standard; however, it is planned to implement EM4150/EM4450 read/write compatibility. The hardware is already in place to support both of these modes, as well as future fun shenanigans. The PIC12F683 in this kit is pre-programmed and will work out of the box. If there are any issues, please ask for help in the HHV or email support@kbembedded.com
You may notice an interesting theming of the PCB, as this device was intended for use in the DarkNet game running in the HHV over DC21, but, lack of write support basically killed any quest trees for RFID. But, go check out the game anyway. It will be a blast!

Label	Description
U1	PIC12F683
R1	100ohm
R2	33kOhm
D1, D2, D3, D4	Schottky Diode
D5	5.1V Zener Diode
D6	1N4148 Signal Diode
C1, C4	10nF Ceramic Capacitor
C2, C3	1nF Ceramic Capacitor
C5	100uF Electrolytic Capacitor
J1	6-pin Header (optional)
L1	162uH Inductor/antenna

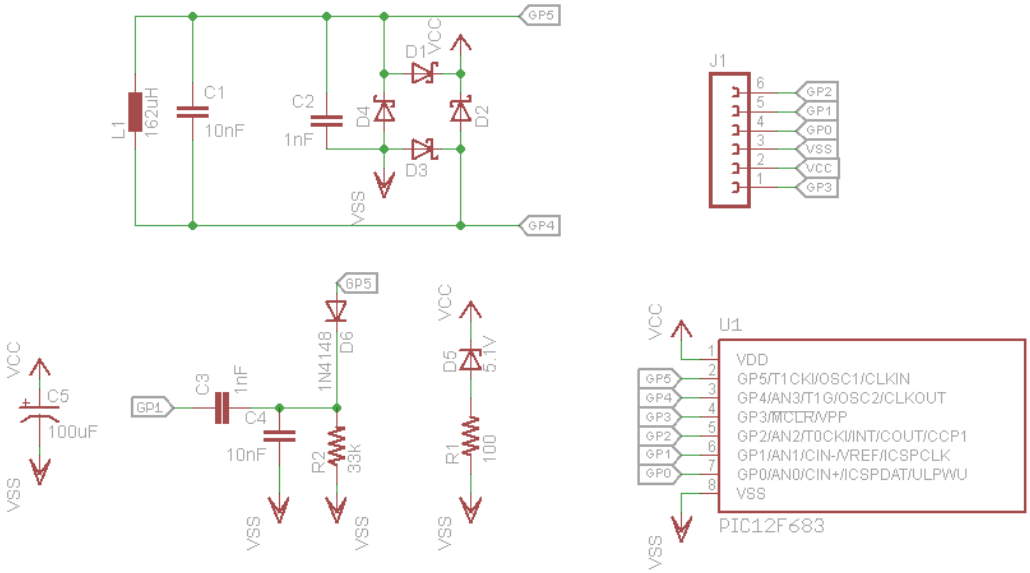
If there are any missing parts, talk to someone in the HHV, or email support@kbembedded.com and indicate the parts that are missing. Please also include a mailing address for sending replacement parts.

Notes about assembly:

U1, D1, D2, D3, D4, D5, D6, and C5 have a specific orientation
- U1 has a dimple to mark pin 1, line up with the "U1" name on the PCB
- D1-D6 match up stripe on the diode with stripe on the PCB
- C5 has a white stripe on the side, this is negative (cathode)
  - The stripe must be opposite the "+" symbol on the PCB!

D5 and D6 look very similar, take careful note of their differences
- D5 will have "5V1" stamped on the side of it

L1 is optional and is a PICkit2/3 programming header, not needed for basic function



Building L1:

In the kit is ~5m of 40ga wire wrapped around a thread bobbin; the start of the wire is wrapped around a hole and left hanging free. Part of the assembly fun is rolling your own antenna coil that needs to be tuned to 125kHz. The bobbin CANNOT be used as a core to wrap the antenna around, as it is too small. In order to ensure the highest energy transfer with most RFID readers, the loop radius should to be between 17.5mm and 30mm.

LC resonant frequency in Hz = (1/(2* π*sqrt(L*C))) Plugging in 162uH and 10nF gives a frequency of 125,107Hz. While this is not exact, it is close enough for us, since transponders and transceivers operate within 100kHz-150kHz

Now the fun part, calculating circular loop inductance:

$$L_{circle} \approx N^2 R \mu_0 \mu_r \left[\ln\left(\frac{8R}{a}\right) - 2 \right]$$

Where:
Lcircle is the desired inductance in Henrys
N is number of turns
R is radius of circle in meters
a is radius of wire in meters (40ga is .00003937m)
µr is relative permeability of the wire material (copper wire is 0.999994)
µ0 is permeability of free space, constant of 4π*10^-7

Get as close to 162uH as possible. Note that it is not required to use the 40ga wire included, you can get creative! The backside of this paper intentionally left blank to be used for calculations. :)

If you just want to get this damn thing built, search the internet for "Circular loop inductance calculators" or go bug someone in the HHV to help.