It's a Freakin' Beacon! by Expanded Spectrum Systems

The concept of placing a beacon on amateur radio frequencies is not new. However, many beacons presently in use are either completely home brew, or else they require some specialized skills or equipment to set up and to program. There are amateurs who would like to set up a beacon for experimental use, for hidden transmitter hunts, or to announce their participation in some radio event, but who lack the time, experience, skills, or equipment to do so. Until now! The Freakin' Beacon controller was intended from day one to be as straight forward and as general purpose as possible. This no nonsense approach made the Freakin' Beacon easy for us to design and easy for you to program and use. No special skills or equipment are required. Just connect the Freakin' Beacon to any PC with a terminal emulator, turn it on, and type in your message. The unique command set uses capital letters as instructions to the beacon, and lower case letters, numbers, and punctuation as "sent" characters. That's it! Just type in the character string, which is stored in non-volatile EEPROM inside the PIC microcontroller on the Freakin' Beacon, and you are ready to go. Then plug the Freakin' Beacon into the key jack of your beacon transmitter and let 'er rip.

How it works

The Freakin' Beacon is based on the Microchip PIC 16F628 microcontroller. The software for the Freakin' Beacon was written using the PicBasic Pro compiler from microEngineering Labs, Inc. A listing of the PicBasic Pro source code is available on the Expanded Spectrum Systems web site. The PIC 16F628 is a relatively new member of the PIC family, and it was selected for its low cost and high degree of integration. It is a pin compatible replacement for the popular 16F84, but it features lower cost and built-in brown-out reset, plus double the memory capacity for RAM, EEPROM, and flash program storage. There are even analog inputs, which are not being used for this project. The best way to program your own PIC 16F628 from scratch is with the PICSTART Plus Development Programmer from Microchip.

Connecting it to your transmitter

There are two functionally equivalent versions of the Freakin' Beacon. The FB1 is the compact version, designed to fit into tight spaces. Connections to the FB1 are via 100 mil spacing, 25 mil square post headers. The FB2 is the larger version, designed to make interfacing fast and easy. The FB2 uses PCB-mount connectors for the power, push-to-talk (PTT), key, and serial programming interfaces. The FB2 also includes a PCB-mount ON-OFF switch. With some transmitters, the only connection required is the key line. For others, it may be desirable to use the PTT line to activate the transmit mode and insert a short time delay before starting the message. The Freakin' Beacon provides 4 logic outputs at the P3 connector intended to select 1 of 4 output power levels from a specially equipped transmitter, but the outputs are available for general purpose use. A strip of approximately 18 socket contacts is provided with each FB1 and FB2 kit for interfacing with the headers. Break or snip off the desired number of contacts for each connection. Strip and tin the signal wires, and tack solder to the contact solder tails. If you have access to heatshrink sleeving and a heat gun, add heatshrink sleeving to the solder connections to make the connections more durable.

Loading your message

Loading your message into the Freakin' Beacon is super easy, and requires no special skills or equipment. If you own a Personal Computer (PC), you already have everything you need. There is no software to load. Just use the terminal emulator in your PC, such as HyperTerminal, to type in a single character string that contains a combination of control characters and message characters. See HyperTerminal setup instructions at the end of this document. Upper case letters are reserved for commands. Lower case letters, numbers, and punctuation are the "sent" characters, and are used to compose your message. The serial programming interface operates at 9600 baud.

Before attempting to program your own message, be sure your Freakin' Beacon is operational using the default message. Until you program your own message, the Freakin' Beacon will generate the following message: `PSDvvvSQSZ`

The translation is: Activate **P**TT, wait one **S**econd, speed **D** (21 WPM), send "**vvv**", wait one **S**econd, **Q**uit PTT, wait one **S**econd, **Z** end of message. See the following tables for the complete command and character set. Observe the red PTT LED and the green Key LED and listen to the message on any speaker connected to P2 (pins 3 and 4 for FB1, or pins 1 and 2 for FB2).

The default code speed is 21 WPM for any new messages. To program a message, install the Program- jumper on P1, between pins 2 and 3, and connect the serial port to your PC. Turn on the power to the FB1 or FB2 board. The Freakin' Beacon will send "y?" in CW, as heard from the speaker and displayed on D2, the green "Key" LED. The terminal emulator on the PC will *display the present message*, followed by "Change program? y/n". Type a lower case "y" within 10 seconds to enter your own message. If the character "y" is not typed within 10 seconds, the Freakin' Beacon will start sending its existing message. You can choose to leave the Program- jumper always in place to make message

programming more convenient, or you can choose to remove the jumper after programming to prevent accidental erasure of the message. Once you type the "y", the previous message is erased, and whatever you type until you reach the end of the 128 character EEPROM memory area or type a "Z" becomes the new message. There are no editing options, and no backspace. You must type the message correctly, or type it over! This message programming format was chosen to be easy to design and easy to learn to use. There are no frills, but you have lots of control over the operation of your Freakin' Beacon. The Freakin' Beacon even supports very slow speed CW (QRSS) for weak signal work! (Beacon6 and newer firmware. Dit/dah ratio remains at normal 1/3, even in QRSS mode.)

Freakin' Beacon Command Set

A = 5 WPM (QRSS60, 60 second dit)
B = 10 WPM (QRSS30, 30 second dit)
C = 15 WPM (QRSS10, 10 second dit)
D = 21 WPM (QRSS3, 3 second dit)
E = 52 WPM (QRSS1, 1 second dit)
F = Five seconds. Holds present state for five seconds. Useful when Keyed or Unkeyed.
G =
H = High power. (Default) (Sets P3 pin 1 high)
I = Inhibit QRSS mode.
J =
K = Key. Keys the transmitter.
L = Low power. (Sets P3 pin 3 high)
M = Medium power. (Sets P3 pin 2 high)
N = Null V command. (V ignored after N executes)
O = One minute. Holds present state for one minute. Useful when Keyed or Unkeyed.
P = PTT. Activates PTT.

Q = Quit PTT. Releases PTT.
R = QRSS mode. Speed will be per QRSS values A-E.
S = Second. Holds present state for one second. Useful when Keyed or Unkeyed.
T = Tenth second. Hold present state for one Tenth of a second. Useful when Keyed or Unkeyed.
U = Unkey. Unkeys the transmitter.
V = Very long delay. Holds present state for 10 minutes. Useful when Keyed or Unkeyed.
W = Wait. Wait if external trigger input is high.
X = eXtra low power. (Sets P3 pin 4 high)
Y =
Z = End of message.

Notes: Beacon6 command set. Code speeds and delay times are approximate. Always verify that performance meets your requirements before deployment.

Freakin' Beacon Character Set ("Sent" Characters)

```
a = .-            n = -.            1 = .----          . = .-.-.-
b = -...          o = ---           2 = ..---          , = --..--
c = -.-.          p = .--.          3 = ...--          ? = ..--..
d = -..           q = --.-          4 = ....-          <sp> = < >
e = .             r = .-.           5 = .....          / = -..-.
f = ..-.          s = ...           6 = -....          = = -...-
g = --.           t = -             7 = --...          & = .-...
h = ....          u = ..-           8 = ---..          * = ...-.-
i = ..            v = ...-          9 = ----.          ( = -.--.
j = .---          w = .--           0 = -----          + = .-.-.
k = -.-           x = -..-                             @ = .--.-
l = .-..          y = -.--
m = --            z = --..
```

Example messages:

An4essFZ
Speed **A** (5 WPM), sends "n4ess", waits **F**ive seconds, repeats.

PTCn4essSKFUQFZ
Activates **P**TT, waits one **T**enth of a second, speed **C** (15 WPM), sends "n4ess", waits one **S**econd, **K**eys the transmitter for **F**ive seconds, **U**nkeys the transmitter, **Q**uits PTT, waits **F**ive seconds, repeats.

Wn4essZ
Waits for trigger input (ground on P1, pin 1), sends "n4ess", repeats. Use this mode for a repeater ID, audio ID badge for club meetings, etc. The message is sent once, then the Freakin' Beacon waits for the next trigger input. The trigger input is level triggered, not edge triggered. The message will cycle continuously if the trigger input is held at ground potential.

VVVVVVVNn4essOZ
Waits for 60 minutes after power is applied, then sends "n4ess" every **O**ne minute. Useful for delayed startup of hidden transmitters.

Note: To verify message entry, cycle the power to the Freakin' Beacon with the programming jumper in place. The present message will be displayed on the serial terminal. (Beacon5 and newer firmware)

Constructing a Freakin' Beacon
The Freakin' Beacon uses a high quality, double sided, plated through hole, circuit board with solder mask and silk screened part legends. Only through hole components are used. The result is quick and easy assembly, with minimized risk of solder bridges and incorrect part locations.

Assembling the Freakin' Beacon is not difficult, but a few helpful hints are in order. If possible, use a temperature-controlled soldering iron with a small tip. Set the soldering iron between 600 and 700 degrees F. The soldering iron should have a 3-wire cord and a grounded tip to prevent damage to the active components due to electrostatic discharge (ESD). If a grounded soldering iron is not available, always remove U1 before soldering on the board. Use proper ESD techniques when handling the active devices and the assembled board. Use only rosin core solder, of course. It is also a good idea to keep a roll of braided solder wicking wire handy in case a part has to be removed. Please note the proper orientation of the integrated circuits (IC's), IC sockets, diodes, and polarized capacitors. The microcontroller, U1, installs in socket XU1. XU1 should be the first part installed, while the board will lie flat on the inverted socket. The microcontroller included in the kit is preprogrammed, but it should be the last part installed. Before or after installing potentiometer R1, the sidetone volume control, set the slider near mid-scale using an ohmmeter so that the morse code sidetone will be audible during initial check-out. Next, install the remaining parts, preferably in the order indicated on the parts list. For the FB2. be sure to keep the connectors, LED's, and switch flush with the board so that proper alignment with the front panel is maintained. Refer to the following figure for information on reading the resistor color codes.

FB1 users will have to construct a serial interface cable for connection to their PC for message loading. FB2 has the serial DB9 connector mounted directly on the PCB. Refer to the FB1 schematic page for pin-out information and a representative photograph of a completed cable. Use the provided DB9 connector, socket contact strip, and colored hook-up wire for the cable. Using side cutters, snip off a three (3) contact section of socket contacts. Strip and tin both ends of each wire before soldering to the connector contacts. If you have access to heatshrink sleeving and a heat gun, add heatshrink sleeving to the solder connections to make the cable more durable.

Standard EIA Color Code Table 4 Band: ±2%, ±5%, and ±10%
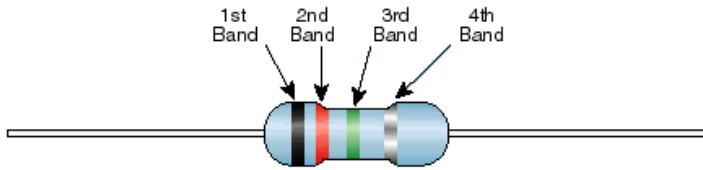
Color	1st Band (1st figure)	2nd Band (2nd figure)	3rd Band (multiplier)	4th Band (tolerance)
Black	0	0	10^0	
Brown	1	1	10^1	
Red	2	2	10^2	±2%
Orange	3	3	10^3	
Yellow	4	4	10^4	
Green	5	5	10^5	
Blue	6	6	10^6	
Violet	7	7	10^7	
Gray	8	8	10^8	
White	9	9	10^9	
Gold			10^{-1}	±5%
Silver			10^{-2}	±10%

Chart Provided By XICON
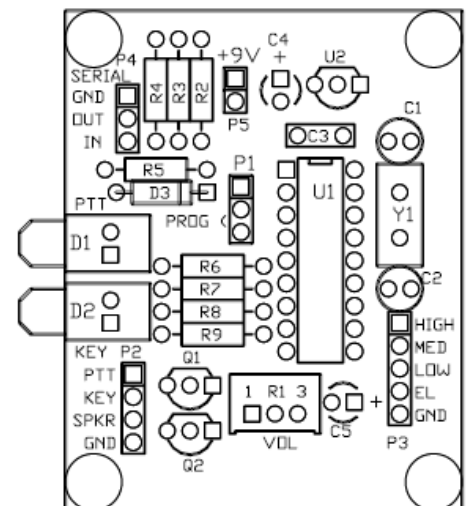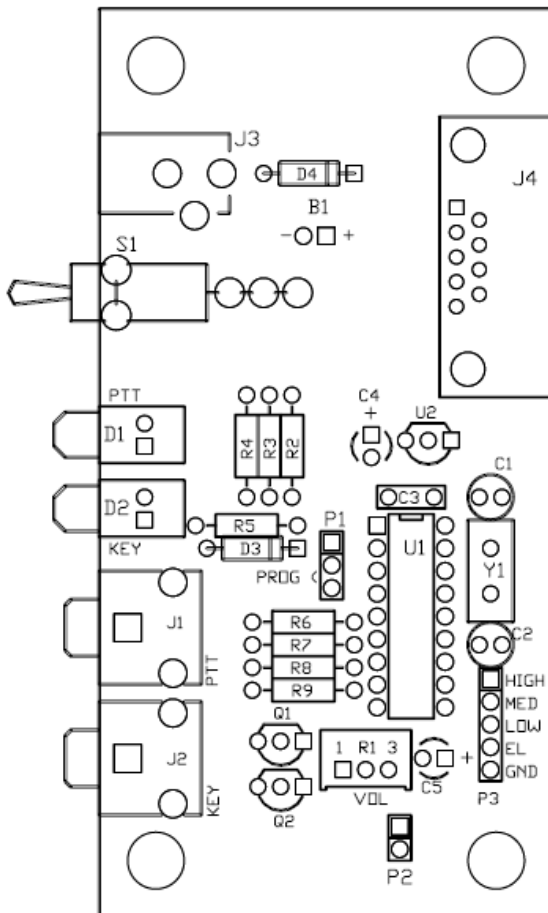
Freakin' Beacon parts placement: FB2 on the left, FB1 on the right.
(Notes: The stripe on C4 indicates the + lead. C3 is marked "104". J4 on the FB2 may include mounting hardware which should be removed and discarded. Use caution when connecting to pin headers as no polarization keying is employed. Match stripe on D3/D4 with stripe on PCB silkscreen.)

Initial Check Out

The quickest check out for the Freakin' Beacon is to perform the following steps.

     1. Connect a speaker to P2.

     2. Connect a DC source of 8 to 15 VDC for FB1 or 9 to 15 VDC for FB2. Observe polarity.

     3. Observe the factory programmed message on the LED's and from the speaker, "v v v" every 3 seconds.

Note: All "sent" characters activate the green Key LED and generate a sidetone while being sent. A steady Key generated using the Key command and a time delay will illuminate the Key LED and generate a sidetone.

Operating a Beacon

Before operating any beacon transmitter on amateur radio frequencies, consult the current FCC regulations, part 97.203, governing beacon stations. A portion of the regulation is provided below as an example of the information provided.

97.203 Beacon Stations

(a) Any amateur station licensed to a holder of a Technician, Technician Plus, General, Advanced or Amateur Extra Class operator license may be a beacon. A holder of a Technician, Technician Plus, General, Advanced or Amateur Extra Class operator license may be the control operator of a beacon, subject to the privileges of the class of operator license held.

(b) A beacon must not concurrently transmit on more than 1 channel in the same amateur service frequency band, from the same station location.

(c) The transmitter power of a beacon must not exceed 100 W.

(d) A beacon may be automatically controlled while it is transmitting on the 28.20-28.30 MHz, 50.06-50.08 MHz, 144.275-144.300 MHz, 222.05-222.06 MHz, or 432.300-432.400 MHz segments, or on the 33 cm and shorter wavelength bands.

(e) Before establishing an automatically controlled beacon in the National Radio Quiet Zone or before changing the transmitting frequency, transmitter power, antenna height or directivity, the station licensee must give written notification thereof to the Interference Office, National Radio Astronomy Observatory, P.O. Box 2, Green Bank, WV 24944.

End of Excerpt

Be considerate in selecting the frequency, timing, and power level for your Freakin' Beacon transmitter. Multiple beacons can share a single frequency if some quiet time is left between transmissions. Read and understand the FCC regulations regarding amateur radio beacon operation, as well as amateur agreements on where beacon transmitters should be located. Without special authorization from the FCC, beacon transmitters are only permitted in specific band segments at frequencies above 28 MHz. There is much information available on the internet, and in *The ARRL Operating Manual.*

Selecting a Transmitter

Select the lowest power transmitter that will serve your needs. Keep in mind the transmitter's duty cycle rating because your Freakin' Beacon will be transmitting its message continuously. Monitor both the transmitter and the power supply for signs of overheating before leaving them unattended. Insert more "dead time" using the **T**, **S**, **F,** and **O** delay commands if your transmitter shows signs of overheating. The Freakin' Beacon can key most modern transmitters directly with its open collector Key output. Contact ESS is you need assistance interfacing with the negative voltage present on an older grid-block keyed tube transmitter. If you are keying a transmitter in the semi-break-in mode, set the transmit-receive delay time to minimize wear and tear on the transmit-receive relay. A better method may be to use the PTT output to activate the relay, with user programmable delays inserted as necessary.

Transmitter Power Control Interface

The outputs of P3 are intended for selecting up to 4 power levels in conjunction with a transmitter equipped to respond to TTL logic levels, in order to increase the usefulness of radio propagation beacons. Creative Freakin' Beacon users can even emulate the operation of the International Beacon Project, where the beacon transmits long dashes at 100W, 10W, 1W, and 0.1W. Details of the International Beacon Project transmitter control circuits are available on their web site at http://www.ncdxf.org/beacon/index.html . A similar interface could be constructed and connected between the Freakin' Beacon and the ALC input of any HF transceiver. The H command (also the default state) sets the High output (P3, pin 1) to a TTL 1 and the other outputs to TTL 0 until another power command (M, L, or X) is executed or until the message repeats. Likewise, the M command sets the Med output (P3, pin 2) to a TTL 1 and the other outputs to TTL 0 until another power command (H, L, or X) is executed or until the message repeats. Commands L and X behave in the same manner as H and M, but activate the Low and EL outputs (P3, pins 3 and 4). P3, pin 5 is a ground return for the H, M, L, and X outputs. Of course, the P3 outputs can be used for any control function that can respond to TTL logic levels. For instance, for directional microwave beacons, the P3 outputs can be used to control relays to switch between multiple directional antennas. For users with dual-polarization antennas, the P3 outputs can be used to alternate between polarizations, with the appropriate comments included in the CW message.

Possible Applications

The Freakin' Beacon is a simple, convenient, and low cost platform with which to begin experimenting with radio propagation, both local and long range. QRP beacons are useful tools for VHF antenna testing or weak signal receiver testing. The Freakin' Beacon even supports very low speed CW (QRSS) modes that are useful for weak signal work, either terrestrial or moon bounce. Clubs may find the Freakin' Beacon to be just the ticket for transmitter hunts. The O, V, and N commands may be used to delay the startup and control the sequencing of hidden transmitters. The audio sidetone and PTT can be routed to an FM HT for keying and ID. Send us your applications and your suggestions for new products or improvements to this product. ESS is a small, user focused company dedicated to your enjoyment of amateur radio.

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Parts List: Freakin' Beacon FB1

| Quantity	Item/Designation	Label-Value	Attributes	Vendor	PN
1	1	PCB	2-layer, PTH, SS, SM		
2	C1, C2	22pF	CY200D100H31	Digi-Key	BC1005CT-ND
1	C3	.1uF 50V		Digi-Key	BC1101CT-ND
1	C4	1uF		Digi-Key	P2105-ND
1	C5	100uF 10V		Digi-Key	P5517-ND
1	D1	Red LED	PCB Mount, Chicago Miniature Lamp, 5300H5LC	Digi-Key	L20031-ND
1	D2	Green LED	PCB Mount, Chicago Miniature Lamp, 5300H5LC	Digi-Key	L20035-ND
1	D3	1N4148	Axial leads	Digi-Key	1N4148DICT-ND
2	P1, P4	Connector	Molex 22-28-4030	Digi-Key	WM6403-ND
1	P2	Connector	Molex 22-28-4040	Digi-Key	WM6404-ND
1	P3	Connector	Molex 22-28-4050	Digi-Key	WM6405-ND
1	P5	Connector	Molex 22-28-4020	Digi-Key	WM6402-ND
1	Jumper	Jumper	Amp 881545-2	Digi-Key	A26242-ND
2	Q1, Q2	PN2222A	TO-92	Digi-Key	PN2222A-ND
1	R1	2k var		Digi-Key	CT94W202-ND
3	R2, R3, R4	10k	.25W	Digi-Key	10KQBK-ND
1	R5	22k	.25W	Digi-Key	22kQBK-ND
4	R6, R7, R8, R9	1k	.25W	Digi-Key	1KQBK-ND
1	U1	PIC16F628	DIP18	Digi-Key	PIC16F628-04/P-ND
1	U2	78L05	TO-92	Digi-Key	NJM78L05A-ND
1	XU1	Socket, machined	DIP18	Digi-Key	A403AE-ND
1	Y1	Crystal, 4.00 MHz		Digi-Key	CTX006-ND
1 FT	Wire	Red hook-up wire (to DB9 pin 2)			
1 FT	Wire	Orange hook-up wire (to DB9 pin 3)			
1 FT	Wire	Green hook-up wire (to DB9 pin 5)			
1	DB9F	DB9F serial connector		Digi-Key	209F-ND
0.5	Socket Strip	Break-off socket strip, approx. 18 contacts.		Digi-Key	929974-01-36-ND

Parts List: Freakin' Beacon FB2

Quantity	Item/Designation	Label-Value	Attributes	Vendor	PN
1	1	PCB	2-layer, PTH, SS, SM		
2	C1, C2	22pF	CY200D100H31	Digi-Key	BC1005CT-ND
1	C3	.1uF 50V		Digi-Key	BC1101CT-ND
1	C4	1uF	(PCB label shows as C8)	Digi-Key	P2105-ND
1	C5	100uF 10V		Digi-Key	P5517-ND
1	D1	Red LED	PCB Mount, Chicago Miniature Lamp, 5300H5LC	Digi-Key	L20031-ND
1	D2	Green LED	PCB Mount, Chicago Miniature Lamp, 5300H5LC	Digi-Key	L20035-ND
2	D3, D4	1N4148	Axial leads	Digi-Key	1N4148DICT-ND
2	J1,J2	Stereo, .125", threaded, with nut	PCB Mount, CUI Stack, SJ-3543	Digi-Key	CP-3543-ND
1	J3	Power Jack, 2mm	PCB Mount, CUI Stack, PJ-102A	Digi-Key	CP-102A-ND
1	J4	DB-9 Connector	Amp '745781-2	Digi-Key	A23291-ND
1	P1	Connector	Molex 22-28-4030	Digi-Key	WM6403-ND
2	P2, XB1	Connector	Molex 22-28-4020	Digi-Key	WM6402-ND
1	P3	Connector	Molex 22-28-4050	Digi-Key	WM6405-ND
1	Jumper	Jumper	Amp 881545-2	Digi-Key	A26242-ND
2	Q1, Q2	PN2222A	TO-92	Digi-Key	PN2222A-ND
1	R1	2k var		Digi-Key	CT94W202-ND
3	R2, R3, R4	10k	.25W	Digi-Key	10KQBK-ND
1	R5	22k	.25W	Digi-Key	22kQBK-ND
4	R6, R7, R8, R9	1k	.25W	Digi-Key	1KQBK-ND
1	S1	SPDT, on-on	PCB Mount, C&K, 7101MD9AV2BE	Digi-Key	CKN1059-ND
1	U1	PIC16F628	DIP18	Digi-Key	PIC16F628-04/P-ND
1	U2	78L05	TO-92	Digi-Key	NJM78L05A-ND
1	XU1	Socket, machined	DIP18	Digi-Key	A403AE-ND
1	Y1	Crystal, 4.00 MHz		Digi-Key	CTX006-ND
0.5	Socket Strip	Break-off socket strip, approx. 18 contacts.		Digi-Key	929974-01-36-ND

Freakin' Beacon FB1 Schematic

FB1 Serial Cable. See FB1 schematic for pin-outs.
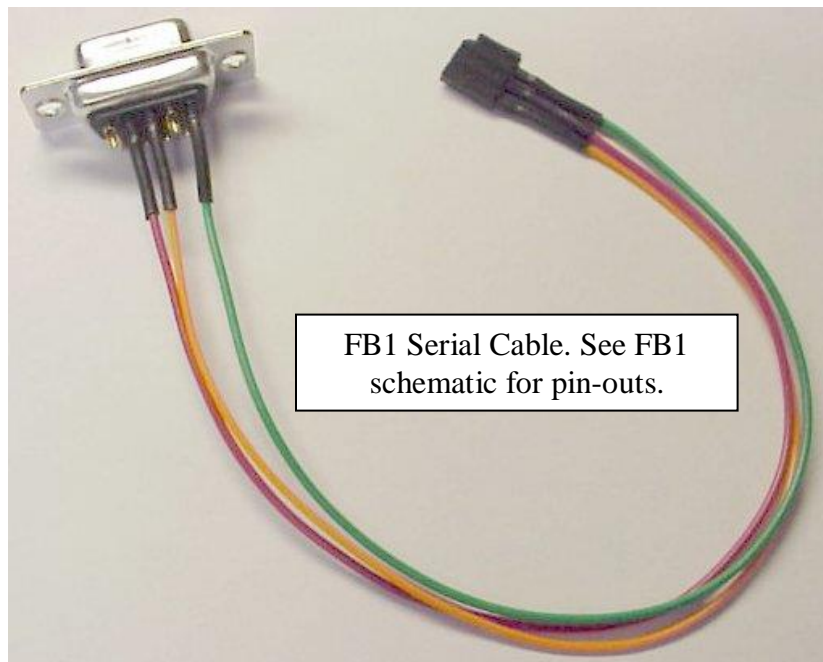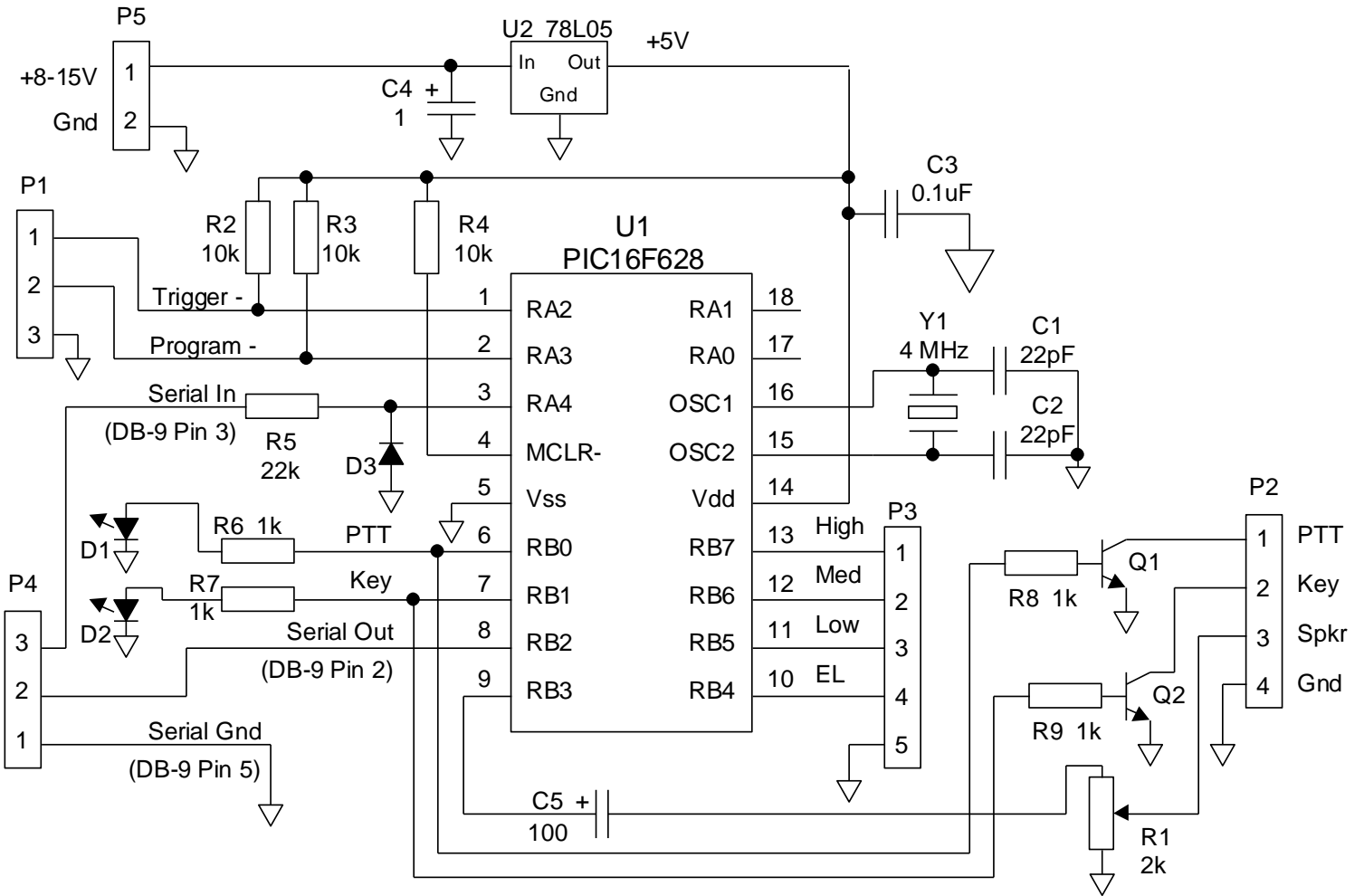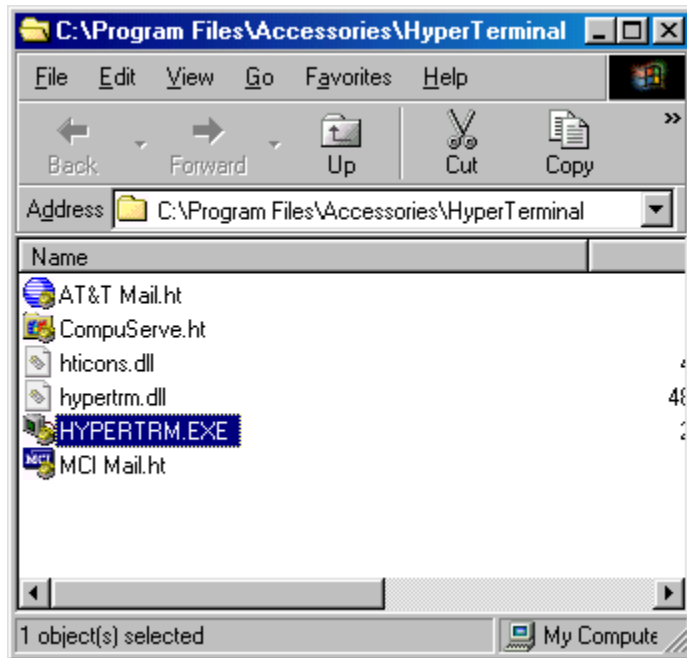
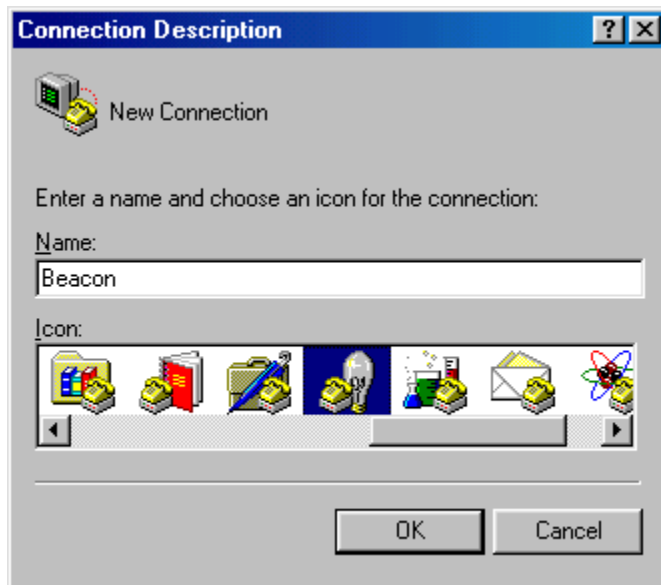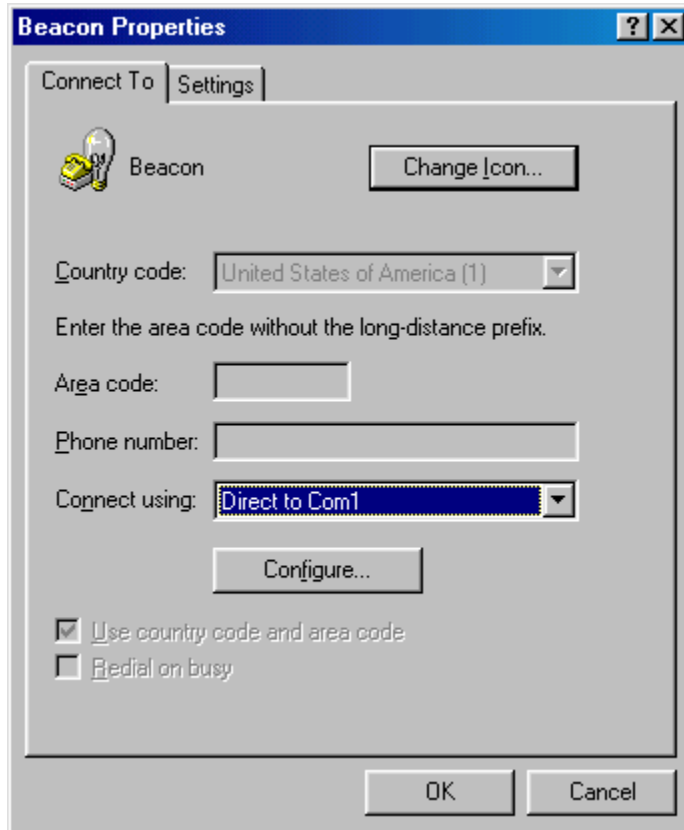# Freakin' Beacon FB2 Schematic
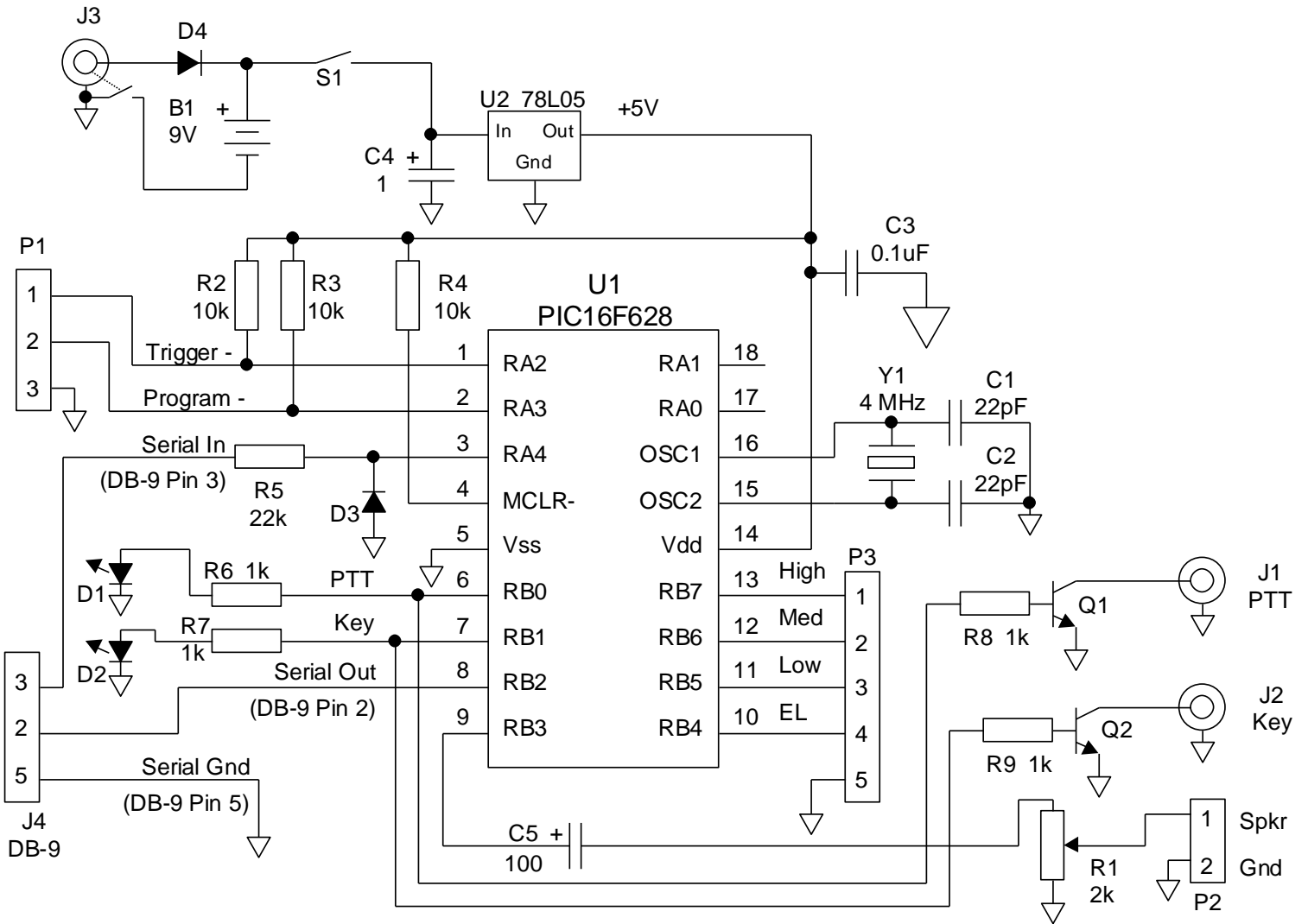
HyperTerminal Setup:

Start HyperTerminal.

Enter a name for the new connection, and pick an icon.

File\Properties.

Configure: 9600b, 8 bits, No parity, 1 stop bit, no flow control.