

## **BA1 Beacon Attenuator** by Expanded Spectrum Systems

Propagation beacons offer a simple means for assessing the state of a particular path on a particular frequency band. The problem is that if a low power beacon is not audible, one never knows whether it is the band or the beacon that is dead. To overcome this problem, the international beacons transmit their identification at 100 watts, followed by long dashes at 100 watts, 10 watts, 1 watt, and 100 milliwatts. This protocol for beacon operation allows the beacon to be heard much more reliably, but still allows the degree of propagation to be assessed as the signal drops off in 10 dB steps. Unfortunately, rigging up most beacon transmitters to deliver such a wide range of power levels with reasonable accuracy is just too complicated. The international beacons use a combination of open loop control and closed loop feedback into the ALC input of the TS-50 transceivers to establish the desired power steps. This technique requires careful alignment to function properly, and is not compatible with all transmitters. BA1 Beacon Attenuator to the rescue!

Designed to work with the Expanded Spectrum Systems (ESS) FB1 and FB2 Freakin' Beacon controller boards, the BA1 Beacon Attenuator provides a low loss through path (High Power), plus attenuation levels of 10 dB, 20 dB, and 30 dB. The BA1 is compatible with ALL transmitters, from DC to 148 MHz, up to 100 watts. With the BA1, any beacon transmitter can provide multiple power levels. The interface and commands to control the BA1 were built into the Freakin' Beacon controllers from day one, so if you already have an FB1 or FB2, setting up the BA1 is super easy! Not only that, the BA1 Beacon Attenuator provides accurate power steps with no adjustments, and there are no settings to drift with aging or temperature.

### **How it works**

The BA1 Beacon Attenuator uses resistive pi attenuators that are switched in and out using long life, low loss electromechanical relays. Using simple commands included in the Freakin' Beacon controller, the relays never switch hot, and are rated to switch over a million times. The BA1 is able to operate from HF through 2 meters because the attenuator sections are made up of low inductance resistors, and because the circuit board layout was designed to tune out the small inductance contributions of the resistors and the relays. The attenuator sections use progressively lower wattage resistors as the through power is reduced along the way from input to output. While the BA1 is not electrically directional, it must be connected in the proper direction for thermal dissipation reasons!

### **Setting it up**

There are two functionally equivalent versions of the Freakin' Beacon. The FB1 is the more 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 that are used to select 1 of 4 output power levels from the BA1 attenuator.

### **Composing your message**

Loading your BA1 control comments into the Freakin' Beacon is just like loading any other message, except that the four power control commands (H, M, L, X) are used. Be sure that the beacon is not transmitting at the point in the message where the power control command is executed. The best way to be sure is to insert a T command (Tenth of a second delay) after the last character transmitter and before the power control command. Then insert another T command after the power control command before initiating the following transmission.

The following character string will generate a message similar to the International Beacon Project messages:

```
HTn4ess/bTTKSUTMTKSUTLTKSUTXTKSUTHFFZ
```

## Freakin' Beacon Command Set

### *(BA1 commands in bold italics)*

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 = --..		

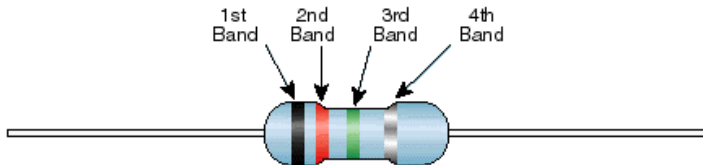
### Constructing a BA1 Beacon Attenuator kit

The BA1 uses a high quality, double sided, plated through hole circuit board. Part reference designation legends are etched into the top copper layer. Mostly through hole components are used, and the parts are not crowded together. The result is quick and easy assembly of the kit.

Assembling the BA1 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). 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 diodes, transistors, and polarized capacitors. Refer to the following figure for information on reading the resistor color codes. It is best to install the smaller components first. Save the larger components, such as the power resistors and the relays, for last so they do not get in the way. Handle the assembled board carefully to avoid damage.

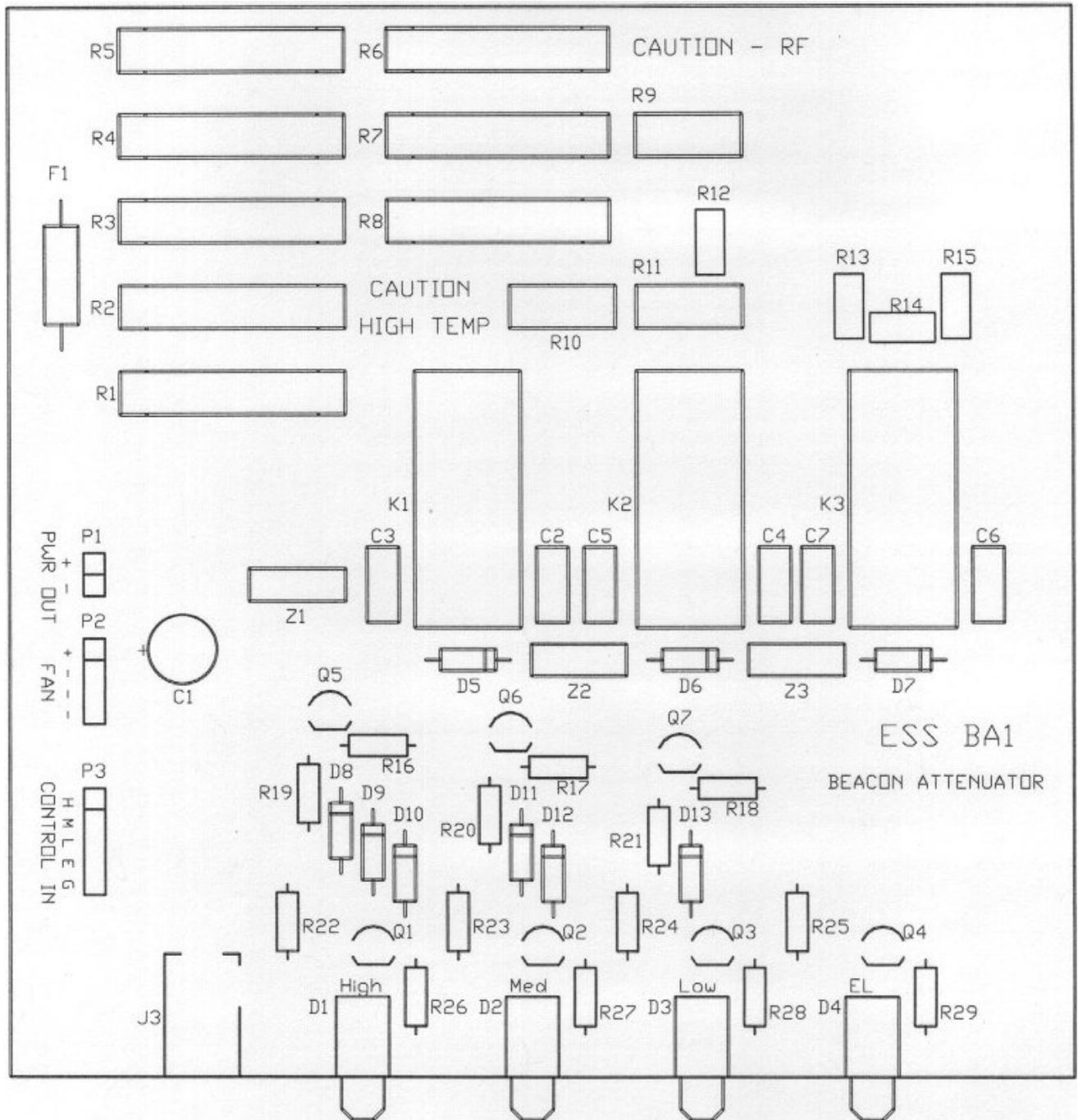
You will need to construct two interface cables that go between the BA1 and your FB1 or FB2. One cable provides DC power to the FB1 or FB2 from the BA1. The other cable provides power/attenuation control signals from the FB1 or FB2 to the BA1. Use the provided socket contact strip and colored hook-up wire for the cables. Using side cutters, snip off a pair of two (2) contact sections of socket contacts for the DC power cable. Next, cut off a pair of five (5) contact sections of socket contacts for the power/attenuation control cable. Use a black and a red wire for the DC power cable. 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. Use brown, red, orange, yellow, and green wires to make up the power/attenuation control cable. These colors represent pins 1 through 5 of the power/attenuation control connectors on the FB1 or FB2 and the BA1 using the standard resistor color code below.

**Standard EIA Color Code Table 4 Band: ±2%, ±5%, and ±10%**

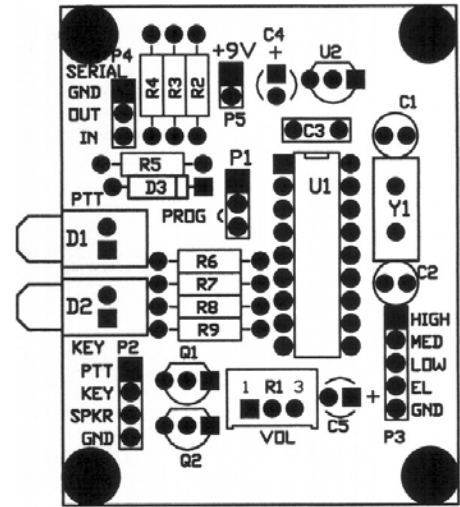
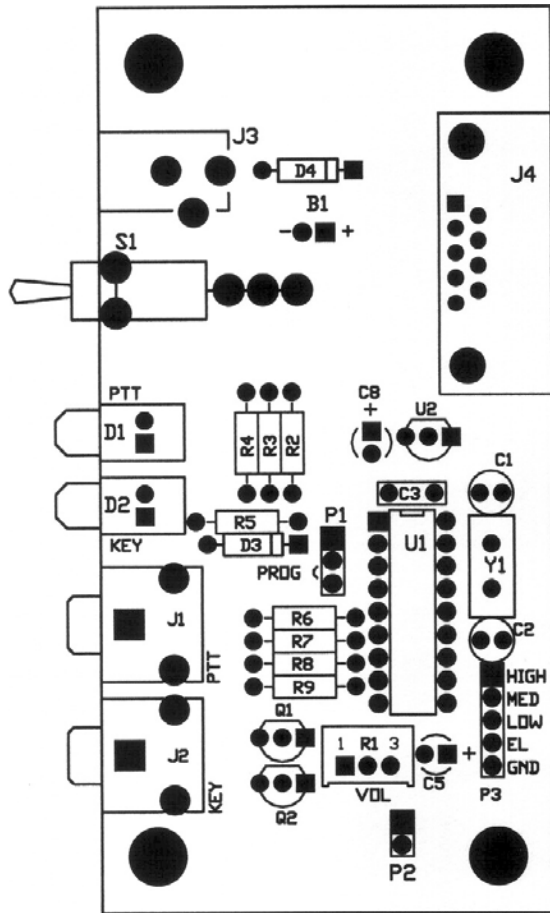


Color	1st Band (1st figure)	2nd Band (2nd figure)	3rd Band (multiplier)	4th Band (tolerance)
Black	0	0	$10^0$	
Brown	1	1	$10^1$	
Red	2	2	$10^2$	±2%
Orange	3	3	$10^3$	
Yellow	4	4	$10^4$	
Green	5	5	$10^5$	
Blue	6	6	$10^6$	
Violet	7	7	$10^7$	
Gray	8	8	$10^8$	
White	9	9	$10^9$	
Gold			$10^{-1}$	±5%
Silver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

Chart Provided By 



Beacon Attenuator BA1 Parts Placement



Freakin' Beacon parts placement: FB2 on the left, FB1 on the right. Note locations of the power and control connectors. On the FB2, the power connector is labeled B1. On FB1, the power connector is labeled P5 (9V). On both the FB1 and the FB2, the control connector is labeled P3. The square pad indicates pin 1.

#### 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 if 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 used 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. With the BA1 Beacon Attenuator, Freakin' Beacon users can now 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 are available at <http://www.ncdxf.org/beacon/index.html>. Best of all, the BA1 is compatible with any HF, 6m, or 2m transmitter. 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. The BA1 responds to the 4 control lines and provides attenuation values of 0, 10, 20, or 30 dB.

#### **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.

#### **Contacting Expanded Spectrum Systems**

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## Parts List: Beacon Attenuator BA1

Quantity	Item/Designation	Label-Value	Attributes	Vendor	PN
1	1	PCB	2-layer, PTH, SS, SM	Axon Circuit	
1	C1	220uF 25V		Digi-Key	P5153-ND
6	C2-C7	.01uF 50V		Digi-Key	BC1095CT-ND
4	D1-D4	Red LED	PCB Mount, Chicago Miniature Lamp, 5300H5LC	Digi-Key	L20031-ND
9	D5-D13	1N4148	Axial leads	Digi-Key	1N4148DICT-ND
1	F1	Thermal Fuse	135 Deg C	Digi-Key	P10924-ND
1	Fan	12 VDC	User provided		
2	J1,J2	RF In/Out	User provided		
1	J3	Power Jack, 2mm	PCB Mount, CUI Stack, PJ-102A	Digi-Key	CP-102A-ND
3	K1-K3	DPDT Relay 12VDC	Aromat JW2SN-DC12V	Digi-Key	255-1117-ND
1	P1	Connector	Molex 22-28-4020	Digi-Key	WM6402-ND
1	P2	Fan Connector	Molex 22-28-4040	Digi-Key	WM6404-ND
1	P3	Connector	Molex 22-28-4050	Digi-Key	WM6405-ND
7	Q1-Q7	PN2222A	TO-92	Digi-Key	PN2222A-ND
5	R1-R5	510	10W	Digi-Key	TA810PW510RJ-ND
3	R6-R8	200	10W	Digi-Key	TA810PW200RJ-ND
2	R9,R10	100	5W	Digi-Key	TA205PA100RJ-ND
1	R11	82	5W	Digi-Key	TA205PA82R0J-ND
3	R12, R13, R15	100	0.5W	Digi-Key	P100WCT-ND
1	R14	68	0.5W	Digi-Key	P68WCT-ND
3	R16-R18	2.2k	.25W	Digi-Key	2.2KQBK-ND
7	R19-R25	10k	.25W	Digi-Key	10KQBK-ND
4	R26-R29	1k	.25W	Digi-Key	1.0KQBK-ND
1 FT	W1	Wire, Black	#28 to #24 AWG	Practical	
1 FT	W1	Wire, Brown	#28 to #24 AWG	Practical	
2 FT	W1	Wire, Red	#28 to #24 AWG	Practical	
1 FT	W2	Wire, Orange	#28 to #24 AWG	Practical	
1 FT	W3	Wire, Yellow	#28 to #24 AWG	Practical	
1 FT	W3	Wire, Green	#28 to #24 AWG	Practical	
1	Socket Strip	Approx 18 Pins		Digi-Key	929974-01-36-ND
3	Z1-Z3	Ferrite Bead	#24 AWG bus wire	-	-

# Schematic: Beacon Attenuator BA1

