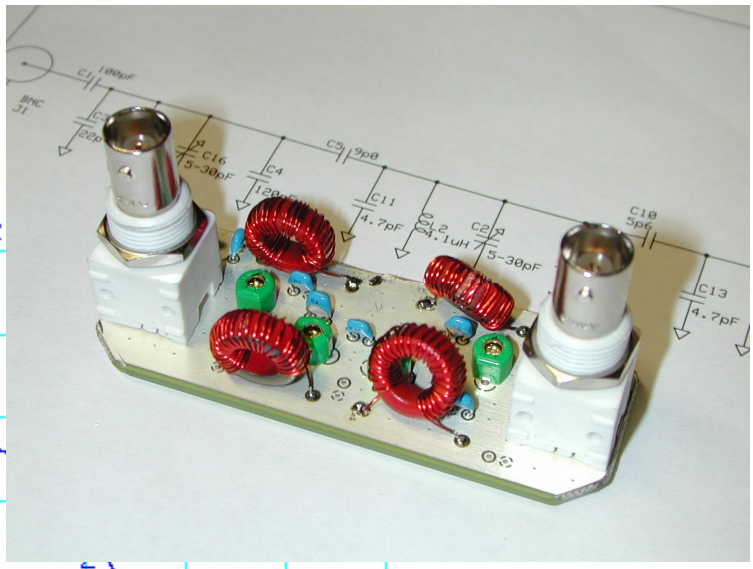
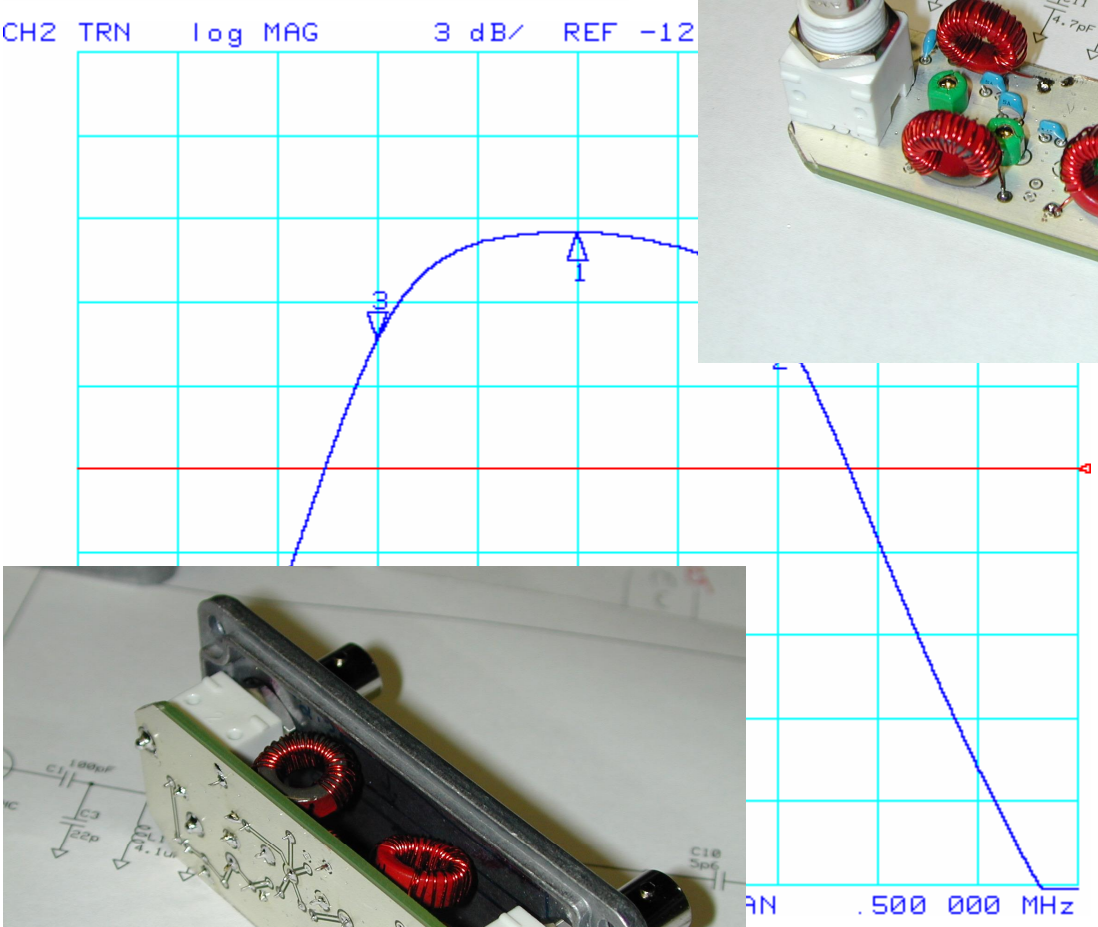
Model Z10010 4.915 MHz Bandpass Filter Z90/91 Dynamic Range Improvement with Elecraft K2 Transceiver

CLIFTON LABORATORIES





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Version 1.0 October 2006

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Z10010 4.915 MHz Bandpass Filter

1. Trademarks and Copyright

2. Warranty

This warranty is effective as of the date of first consumer purchase.

What is covered: During the ninety (90) days after date of purchase, Clifton Laboratories will correct any defects in the Z10010 due to defective parts or workmanship free of charge (post-paid). You must send the unit at your expense to Clifton Laboratories, but we will pay return shipping. Clifton Laboratories' warranty does not extend to defects caused by your incorrect assembly or use of unauthorized parts or materials or construction practices.

What is not covered: If the Z10010 is purchased as a kit, this warranty does not cover correction of assembly errors or misalignment; repair of damage caused by misuse, negligence, or builder modifications; or any performance malfunctions involving non-Clifton Laboratories accessory equipment. *The use of acid-core solder, water-soluble flux solder, or any corrosive or conductive flux or solvent will void this warranty in its entirety.* Whether purchased as an assembled unit or as a kit, also not covered is reimbursement for loss of use, inconvenience, customer assembly or alignment time, or cost of unauthorized service.

Limitation of incidental or consequential damages: This warranty does not extend to non-Clifton Laboratories equipment or components used in conjunction with our products. *Any such repair or replacement is the responsibility of the customer. Clifton Laboratories will not be liable for any special, indirect, incidental or consequential damages, including but not limited to any loss of business or profits.*

Under no circumstances is Clifton Laboratories liable for damage to your amateur radio equipment resulting from use of the Z10010, whether in accordance with the instructions in this Manual or otherwise.

3. Specifications

Center Frequency	4.915 MHz nominal	**Dimensions**	3.5" X 1.5" X 2" 89mm x 38mm x 51mm
Bandwidth (-3 dB)	200 KHz typical	**Connectors**	BNC-female (input and output)
Insertion Loss	3.5 to 4.5 dB typical	**Power Rating**	Receive Only
Impedance	50 ohms		

4. General Information

a. To provide improved dynamic range, some spectrum analyzers offer an optional "tracking pre-selector" input filter. The Z90/91[1] SpectraScreen digital Panadapter units from Clifton Laboratories will normally be used with one or two receivers

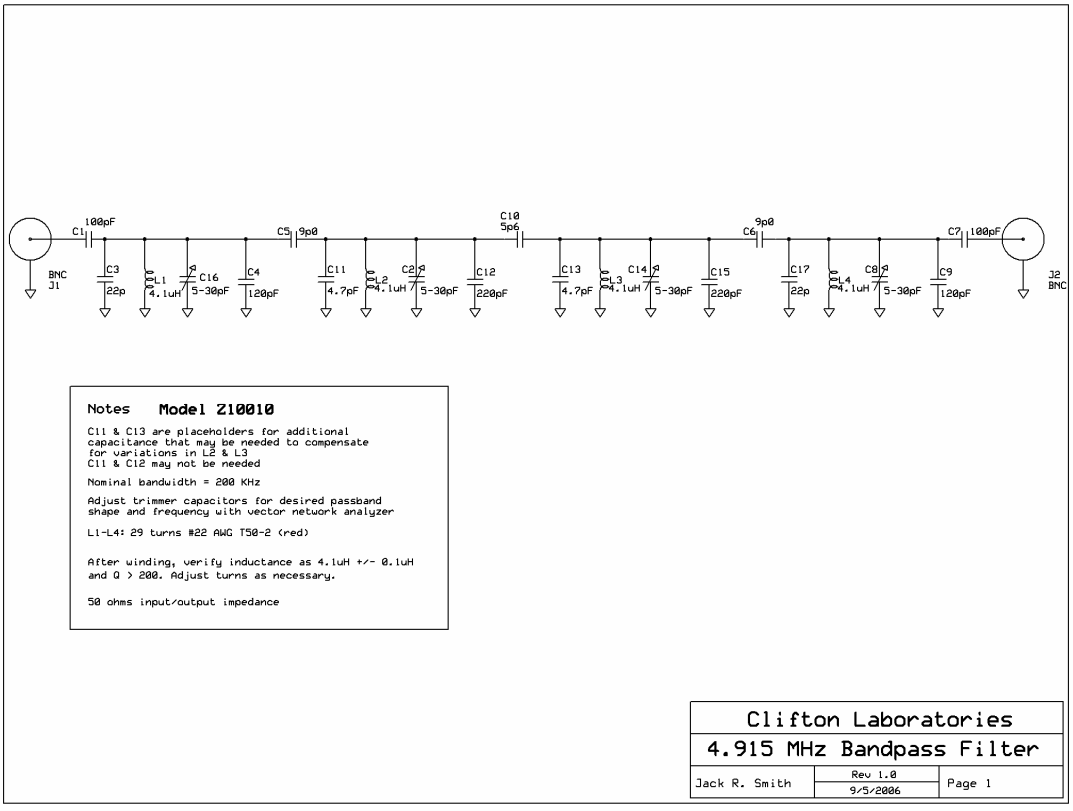
[1] *Unless otherwise stated, references to the Z90 also apply to the Z91 panadapter.*

with a fixed IF frequency, so it isn't necessary to provide a tracking pre-selector, but a pre-selector filter between the IF output and the Z90's input can significantly improve the Z90's ability to display weak amateur band signals by rejecting extremely strong out-of-band shortwave broadcast signals. Strong, out of-band shortwave broadcast signals can result in “baseband lifting” in the Z90, a phenomena whereby the entire display is shifted upward. This results from the out-of-band signals getting by the skirt selectivity of the Z90’s Gaussian crystal filters. The purpose of the Z10010 filter is to reduce the baseband lifting caused by strong out-of-band shortwave signals. Strong in-band signals will, of course, not be reduced by the Z10010 filter.

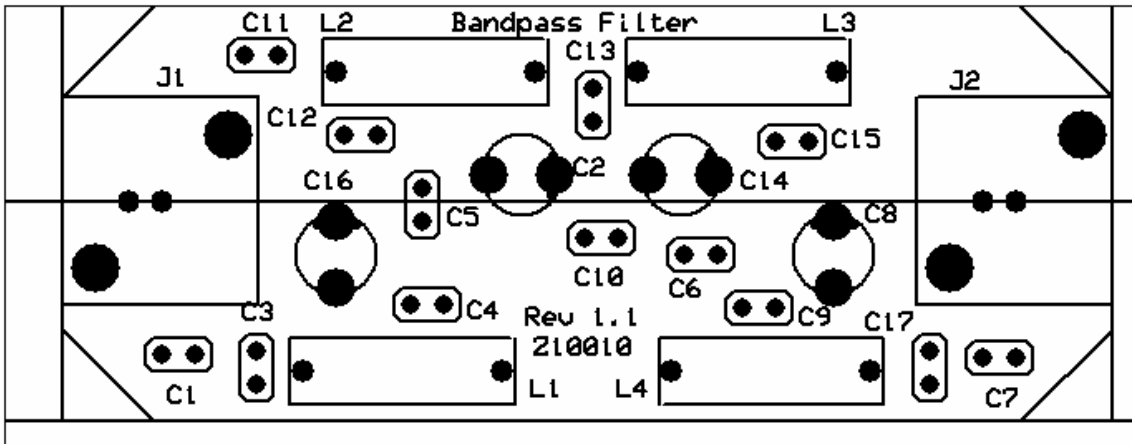
b. The intermediate frequency (IF) used in Elecraft’s K2 transceiver is nominally 4.915 MHz. The maximum recommended scan width for the Z90 is 200 KHz, so the Z10010 bandpass filter is designed for a center frequency of 4.915 MHz and a nominal 3dB bandwidth of approximately 200 KHz.

c. The filter design is a capacitive-coupled resonator, Butterworth design, matched to 50 ohms input/output via the series 100pF capacitors C1 and C7. Places are provided in the printed circuit board for additional capacitance at C11 and C13, should it be necessary, to compensate for variations in L2 and L3.

d. The following figure provides the Z10010’s schematic. The filter is symmetrical and either port may be used as an input or an output.

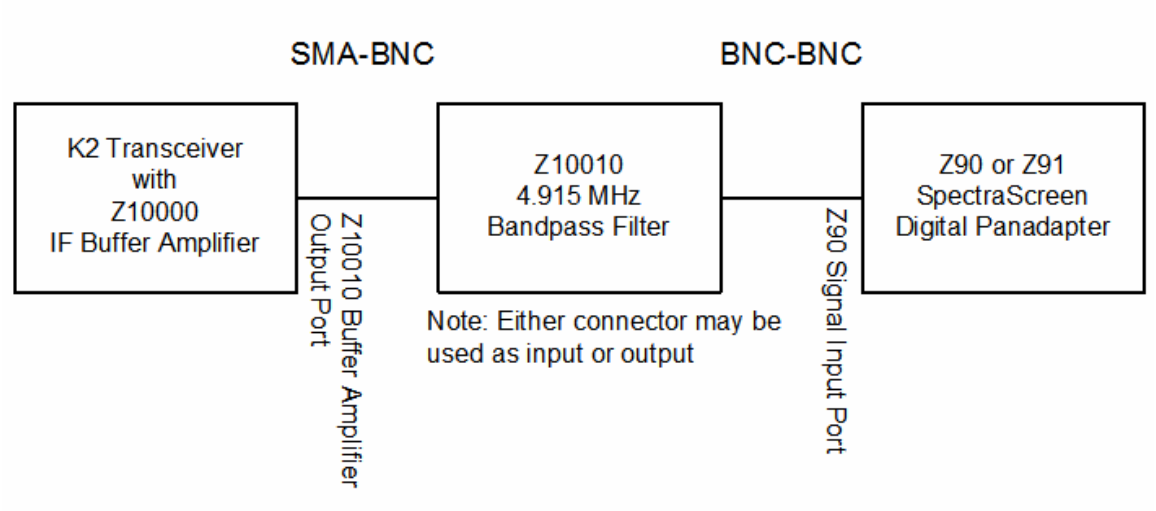


5. PCB Layout



6. Connection and Normal Operation

   a. In normal operation, the Z10010 is connected between the Z10000 buffer amplifier output and the Z90's signal input port, as illustrated below.



   b. The Z10010 requires no operator adjustment or intervention, once connected. The main change that you will notice after installation is that strong out-of-band shortwave broadcast stations will not result in baseband lifting to nearly the same extent as without the filter installed.

7. Troubleshooting

   a. The filter requires no adjustments and contains no active devices. If you believe the filter is not properly working, tune the K2 to a strong, stable signal and observe the signal's relative strength on the Z90 with the Z10010 filter connected and bypassed. With the Z10010 filter connected, the signal should decrease approximately 3.5 dB.

   b. A second test can be performed to observe the relative strength of the signal as you tune the K2. Set the Z90 for 200 KHz span and tune the K2 such that the test signal is at one edge of the Z90 display. Slowly tune the K2 so that the test signal moves to the other edge of the Z90 display. Note the signal's relative amplitude as you tune the K2. The maximum difference in signal amplitude between the center and both edges of the display should be approximately 3 dB. It may be

easier to observe this relatively small difference in amplitude shift if the Z90 is set to 2 dB/division.

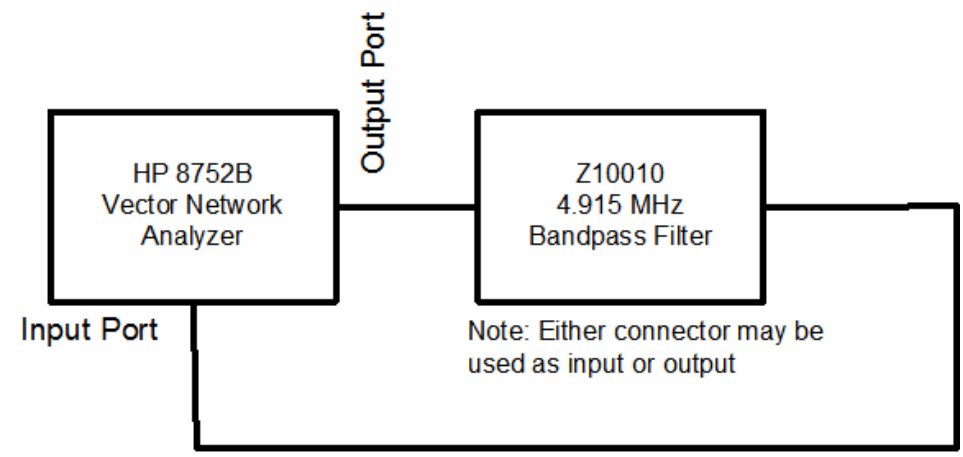
8. Alignment

   a. The only time the Z10010 should require realignment is if a component has been changed, or if the filter case has been opened and any of the components have been moved, particularly L1…L4.

   b. The Z10010 is aligned with a vector network analyzer in a test fixture that matches the enclosure, but with holes so that the four tuning adjustments may be reached. The filter's response when measured out of the enclosure will not match the response in the enclosure.

   c. Unless you have the appropriate test equipment, Clifton Laboratories does not recommend that you align the filter. The results are unlikely to be favorable.

   d. If it is necessary to realign the filter, the method used at Clifton Laboratories is shown below:



   e. If any parts are replaced, or for an initial tuning after construction, assemble the PCB to the special test fixture. If the test fixture is not available, a field expedient is to use the filter's normal enclosure:

      1. Remove the four screws from the filter enclosure, if not already removed.
      2. Remove the enclosure top from the filter PCB by removing the two retaining nuts and lock washers installed on the BNC connectors.
      3. Locate a small piece of flexible insulating material, such as a plastic bag or paper. Line the lower part of the filter enclosure with the insulating material and place the PCB into the enclosure, with the PCB resting against the insulating material at the bottom of the enclosure.

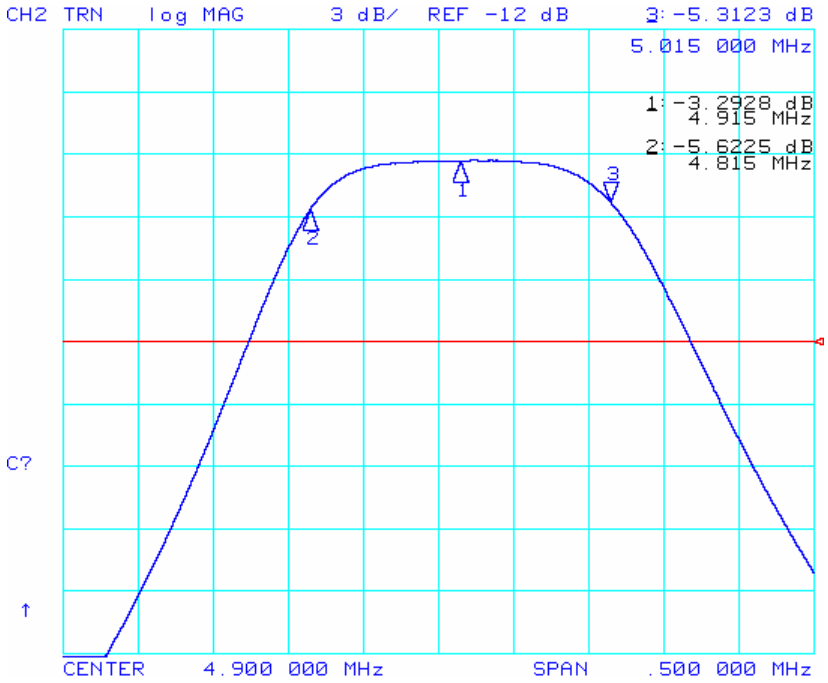
   f. Calibrate the network analyzer for a through transmission measurement, centered at 4.915 MHz and a span of 2 MHz. Set the network analyzer as follows:

      1. Span: 500 KHz
      2. Center frequency: 4915 KHz
      3. Vertical: 3 dB/division
      4. Vertical reference: Adjust to show filter peak in the top one-third of the display.

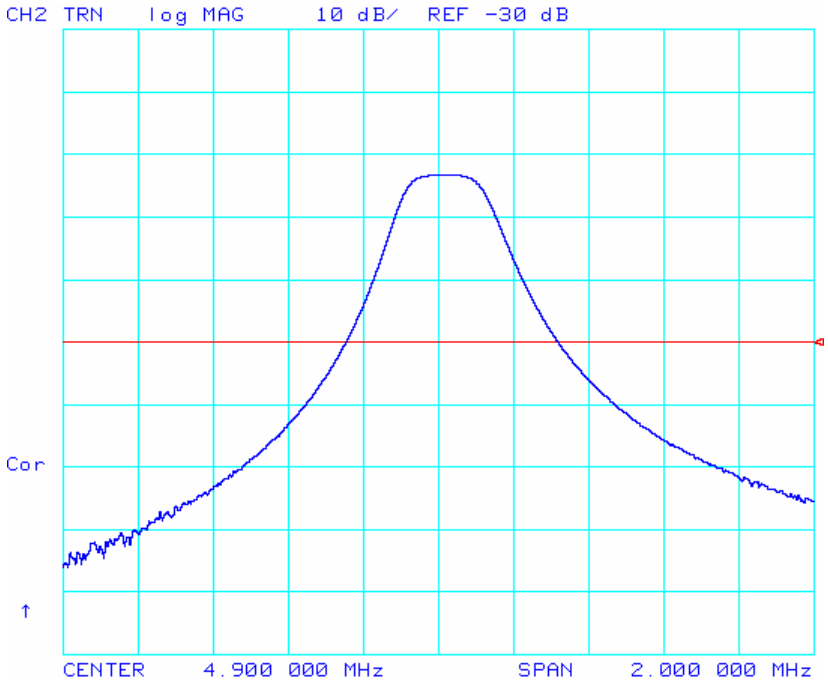
5. Set markers at 4915, 4815 and 5015 KHz, with the 4915 KHz marker being set as reference 0.

g. Using an insulated tuning tool, sequentially adjust the four tuning capacitors C16, C2, C14 and C8 to produce the desired response curve. The starting point is usually the two center node trimmers, C2 and C14. However, all tuning adjustments interact and a sequential adjustment method is essential. The filter should be tuned to balance the response curve's flatness against center frequency, insertion loss and bandwidth. Although the illustrations in this section represent a production version Z10010 filter, component tolerance may not permit all filters to have a flat-top response curve and still meet other performance specifications. The minimum 3 dB bandwidth is 170 KHz and maximum of 250 KHz. The difference in amplitude response between the upper and lower 100 KHz points should be approximately 1 dB or less. The insertion loss should be approximately 3.5 dB and not worse than 4.5 dB. The target response curve is shown below.

h.



i. After adjusting for passband, switch the VNA to 2 MHz span, 10 dB/division and check the filter flanks. A typical filter response is shown below.



j. It is normal for the filter to be non-symmetrical, with increased attenuation on the lower frequency side as that is inherent in a capacitive-top-coupled resonator design. Depending on component tolerance, a flat-topped response curve may not be achievable.

9. Parts List

ID	Value	Mfg	Mfg PN
C1, C7	100pF	Murata	RPE5C1H101J2P1A03
C4, C9	120pF	Murata	RPE5C1H121J2P1A03
C12, C15	220pF	Murata	RPE5C1H221J2P1A03
C3, C17	22p	Murata	RPE5C1H220J2P1Z03B
L1,L2,L3,L4	4.1uH	Clifton Labs	Z10010-002 29 turns Micrometals T50-2 (red) toroid core, verified for inductance and Q. Q minimum = 200, L = 4.1±0.15uH @7.9 MHz. Alternate: 30 turns Micrometal T50-6 (yellow) core.
C11, C13	TBD	Murata	Placeholder for auxiliary capacitance as might be needed for specific filter. Part value determined at time of alignment
C2, C8, C14, C16	5-30pF	Murata	TZ03R300E169B00
C10	5p6	Murata	RPE5C1H5R6C2P1B03
C5, C6	9p0	Murata	RPE5C1H9R0D2P1Z03
J1, J2	BNC	AMP/Tyco	5227222-3
Case		Hammond	1590A
BNC nut		AMP/Tyco	1-329631-2
BNC washer		AMP/Tyco	1-329632-2
Label		Clifton Labs	Z10010-003
PCB		Clifton Laboratories	Z10010-01