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Super-MWDX-5 Phasing Unit

Mark Connelly - WA1ION - 07 FEB 1993

The Super-MWDX-5 is a phasing unit with enhanced capabilities over the MWDX-5 described in my article of OCT 1991 (available as NRC / IRCA reprints). Added features include transformers for use as part of a noise-reducing antenna system, additional controls to give better nulling ability, and a jack for a "spare antenna" usable for broadband monitoring and quick parallel checks / scanning during DXpeditions. A metal box is used for superior shielding and mechanical ruggedness. A new hardware scheme was developed to "float" the tuning capacitors from chassis ground. This method should be of value to builders of balanced loops that also require a tuning capacitor isolated from chassis ground. The Super-MWDX-5 may be used for two-wire phasing or loop-vs.-wire phasing. In either case, nulls may be obtained that differ in directivity from those achievable with a standard loop; the result is potentially different DX from the loggings acquired with a loop alone. Nulling midwest "clears" to log Europeans at an East Coast US/Canada QTH is definitely a job better suited to phasing than looping. The MWDX-5 article gives useful background information on phasing as well as a list of other articles on the subject. The Super-MWDX-5 uses the BBA-C1 broadband amplifier which has good strong-signal handling performance; the BBA-B used on MWDX-4 style phasers could be substituted in rural areas for reduced battery drain.

Organization of article

Table 1: Super-MWDX-5 Controls and Input / Output Connectors

Controls

location	designation	operational description
left side	S3	Ground Mode switch
top	C1	Line 1 tuning capacitor
top	C2	Line 2 tuning capacitor
top	R1	Line 1 level pot
top	R2	Line 2 level pot
top	R3	Null vernier (Q-balance) pot
top	S1	Bandswitch
top	S2	Function switch
top	S4	Input Coupling (length) switch
top	S5	Output switch
top	S6	Wire / Loop switch (Line 2 input)

Input / Output Connectors

location	designation	operational description	connector type
left side	J1	Line 1 wire input	banana jack
left side	J2	Line 2 wire input	banana jack
left side	J3	earth ground input 1	banana jack
left side	J4	earth ground input 2	banana jack
left side	J8	Loop input	BNC jack
right side	J5	RF output	BNC jack
right side	J6	B+ in	phono jack
right side	J7	9V battery holder	Keystone 1290
right side	J9	spare antenna input	BNC jack

Table 2: S1 Bandswitch Settings Chart

Ranges are usually a bit greater than those shown. These ballpark values are for 50-m. / 164-ft. wires and the S4 coupling switch set to the "Normal" position. Other positions and wires may alter ranges somewhat.

The Super-MWDX-5 family of phasing units has frequency coverage characteristics as noted in the following table:

* MODEL: standard Super-MWDX-5 * (LWBC: 130-285; MW: 430-1800)

S1 Pos. #	S1 Knob Pointer "o'clock"	Min. Freq. kHz	Max. Freq. kHz	"Main" L ["Tap" L] Tank Inductor Values		
				L#	uH	Mouser Part #
1	9:30	130	180	L1,L13	4700	434-1120-473K
["	"	"	"	L7,L19	1000	43LR103]
2	10:30	180	285	L2,L14	2200	434-1120-223K
["	"	"	"	L8,L20	470	43LR474]
3	11:30	430	630	L3,L15	470	43LR474
["	"	"	"	L9,L21	100	43LR104]
4	12:30	630	880	L4,L16	220	43LR224
["	"	"	"	L10,L22	47	43LR475]
5	1:30	880	1260	L5,L17	100	43LR104
["	"	"	"	L11,L23	22	43LR225]
6	2:30	1260	1800	L6,L18	47	43LR475
["	"	"	"	L12,L24	10	43LR105]

* MODEL: Super-MWDX-5A * (LW & MW: 145-2700)

S1 Pos. #	S1 Knob Pointer "o'clock"	Min. Freq. kHz	Max. Freq. kHz	"Main" L ["Tap" L] Tank Inductor Values		
				L#	uH	Mouser Part #
1	9:30	145	230	L1,L13	3900	434-1120-393K
["	"	"	"	L7,L19	820	43LR824]
2	10:30	230	375	L2,L14	1500	434-1120-153K
["	"	"	"	L8,L20	330	43LR334]
3	11:30	375	620	L3,L15	560	43LR564
["	"	"	"	L9,L21	120	43LR124]
4	12:30	620	1050	L4,L16	220	43LR224
["	"	"	"	L10,L22	47	43LR475]
5	1:30	1050	1600	L5,L17	82	43LR825
["	"	"	"	L11,L23	18	43LR185]
6	2:30	1600	2700	L6,L18	33	43LR335
["	"	"	"	L12,L24	6.8	43LR686]

* MODEL: Super-MWDX-5B * (extended LW: 90-880)

S1 Pos. #	S1 Knob Pointer "o'clock"	Min. Freq. kHz	Max. Freq. kHz	"Main" L ["Tap" L] Tank Inductor Values		
				L#	uH	Mouser Part #
1	9:30	90	130	L1,L13	10000	434-1120-104K
["	"	"	"	L7,L19	2200	434-1120-223K]
2	10:30	130	180	L2,L14	4700	434-1120-473K
["	"	"	"	L8,L20	1000	43LR103]
3	11:30	180	285	L3,L15	2200	434-1120-223K
["	"	"	"	L9,L21	470	43LR474]
4	12:30	285	430	L4,L16	1000	43LR103
["	"	"	"	L10,L22	220	43LR224]
5	1:30	430	630	L5,L17	470	43LR474
["	"	"	"	L11,L23	100	43LR104]
6	2:30	630	880	L6,L18	220	43LR224
["	"	"	"	L12,L24	47	43LR475]

* MODEL: Super-MWDX-5C * (MW, tropical: 375-6500)

S1 Pos. #	S1 Knob Pointer "o'clock"	Min. Freq. kHz	Max. Freq. kHz	"Main" L ["Tap" L] Tank Inductor Values		
				L#	uH	Mouser Part #
1	9:30	375	620	L1,L13	560	43LR564
["	"	"	"	L7,L19	120	43LR124]
2	10:30	620	1050	L2,L14	220	43LR224
["	"	"	"	L8,L20	47	43LR475]
3	11:30	1050	1600	L3,L15	82	43LR825
["	"	"	"	L9,L21	18	43LR185]
4	12:30	1600	2700	L4,L16	33	43LR335
["	"	"	"	L10,L22	6.8	43LR686]
5	1:30	2700	4000	L5,L17	12	43LR125
["	"	"	"	L11,L23	2.7	43LR276]
6	2:30	4000	6500	L6,L18	4.7	43LR476
["	"	"	"	L12,L24	1	43LR106]

* MODEL: Super-MWDX-5D * (extended tropical, SWBC: 1260-12500)

S1 Pos. #	S1 Knob Pointer "o'clock"	Min. Freq. kHz	Max. Freq. kHz	"Main" L ["Tap" L] Tank Inductor Values		
				L#	uH	Mouser Part #
1	9:30	1260	1800	L1,L13	47	43LR475
["	"	"	"	L7,L19	10	43LR105]
2	10:30	1800	2800	L2,L14	22	43LR225
["	"	"	"	L8,L20	4.7	43LR476]
3	11:30	2800	4000	L3,L15	10	43LR105
["	"	"	"	L9,L21	2.2	43LR226]
4	12:30	4000	6500	L4,L16	4.7	43LR476
["	"	"	"	L10,L22	1	43LR106]
5	1:30	6500	8800	L5,L17	2.2	43LR226
["	"	"	"	L11,L23	0.47	43LR477]
6	2:30	8800	12500	L6,L18	1	43LR106
["	"	"	"	L12,L24	0.22	43LR227]

* MODEL: Super-MWDX-5E * (reduced coupling efficiency) (90-8800)

Note: For this configuration, S1 is a 2-pole, 12-position switch. The inductors on the S1A section (L1 through L12) are switched across the C1 stator to R1 arm path. The arm of R1 is tied to a 68 ohm resistor to GND rather than to an S1C "tap L" section. The inductors on the S1B section (L13 through L24) are switched across the C2 stator to S6 "Wire" path. The S6 "Wire" pin is tied to a 68 ohm resistor to GND rather than to an S1D "tap L" section. Output levels with Super-MWDX-5E are reduced from those achievable with models utilizing the S1C / S1D "tap L" architecture.

S1 Pos. #	S1 Knob Pointer "o'clock"	Min. Freq. kHz	Max. Freq. kHz	Tank Inductor Values		
				L#	uH	Mouser Part #
1	6:00	90	130	L1,L13	10000	434-1120-104K
2	7:00	130	180	L2,L14	4700	434-1120-473K
3	8:00	180	285	L3,L15	2200	434-1120-223K
4	9:00	285	430	L4,L16	1000	43LR103
5	10:00	430	630	L5,L17	470	43LR474
6	11:00	630	880	L6,L18	220	43LR224
7	12:00	880	1260	L7,L19	100	43LR104
8	1:00	1260	1800	L8,L20	47	43LR475
9	2:00	1800	2800	L9,L21	22	43LR225
10	3:00	2800	4000	L10,L22	10	43LR105
11	4:00	4000	6500	L11,L23	4.7	43LR476
12	5:00	6500	8800	L12,L24	2.2	43LR226

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Operating the Super-MWDX-5

Figures 1 through 3 are the schematics of the Super-MWDX-5. Please refer to them during the discussion of phasing procedure. Use wires at least 15m./50 ft. in length. There should be some angular or distance separation between the wires for optimum results in two-wire applications. See Tables 2 and 8 for physical positioning of switches.

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*** Super-MWDX-5 Two Wire Phasing Procedure ***

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1.0 Phasing Steps (2-wire)

(COMMENTS) The best method of nulling when the two antennas are delivering comparable signal levels (e. g. within 6 dB) differs from that to be used when there is a considerable strength difference (e. g. one of the Beverages or longwires is already throwing a partial null on the dominant; or, one of the wires is considerably longer than the other and, therefore, consistently provides more signal). Unlike previous phasers, the Super-MWDX-5 provides both Q-skewing (R3) and non-Q-skewing (R1, R2) level adjustment methods to handle a wide variety of nulling situations. Certain nulls may be achieved best by a blend of both methods; as operator experience with the unit increases, nulling judgment improves and getting to the desired DX becomes a considerably faster procedure. Nulling procedures sound complicated at first, but are quickly executed once learned. The user should practice during non-skip daylight conditions on "graveyard" and regional channels having discernable subdominants to get familiar with operation of the controls before attempting night-time nulls of unsteady signals. As with a loop, solid nulls of skip stations above 1 MHz in the 50 to 500 mile range are difficult because of the rapid changes in vertical (and sometimes horizontal) arrival angles inherent when dealing with high-angle skip. Such nulls are better when using phased Beverages than when using a loop or phased shorter wires.

1.1 ** INITIALIZATION OF SWITCHES **

Set frequency-range switch S1 to the correct range for the frequency of operation (see Table 2). Set S3 to Common (unless using an antenna system with noise-reduction transformers). Set Input Coupling switch S4 to Normal (or to a different position, depending on experimentation that leads to having determined the best position for a given antenna system). Set S5 Output switch to Phaser / Unamplified. Set S6 to Wire. S2 will be set subsequently.

1.2 ** INITIALIZATION OF POTENTIOMETERS **

Set level pots R1 (Line 1) and R2 (Line 2) to fully counterclockwise (minimum attenuation). R3 settings will be made subsequently.

1.3 ** CONNECTIONS **

Connect longwire #1 to J1 and connect longwire #2 to J2. coaxial cable is used (as in a noise-reduction transformers scheme), BNC or SO-239 to dual-banana-plugs adapters should be sed to connect Line 1 to J1 (center) / J3 (shield) and Line 2 o J2 (center) to J4 (shield). Otherwise, an available ground ay be connected to J3 and J4. Connect phaser's output (J5), via coaxial cable, to the input of the receiver to be used, or to a tunable preamp. between phaser and receiver. Connect a 9V battery to the J7 battery holder and plug P1 into J6, or connect the plug of an 8V to 16V DC power source to J6.

1.4 ** PEAK LINE 1 **

S2 on Line 1 / R3 at center) OR (S2 on Null-a / R3 fully CCW) Tune Line 1 by peaking desired-frequency signal strength with C1. At this time, leave C1 at its peaked-signal position.

NOTE THE SIGNAL STRENGTH (observe S-meter, if available, or note audible level).

[At this time, other positions of Input Coupling switch S4 may be tried to see if greater signal transfer is possible. Re-adjustment of C1, and possibly S1, may be needed to re-establish a peaked condition. In any event, the peak should have reasonable Q (be well defined) and C1 should not be set too close to fully CW or fully CCW. In most cases, S4 on Normal will provide good enough signal levels and reasonably sharp tuning not overly affected by differences in length between the two wires to be phased.]

1.5 ** PEAK LINE 2 **

(S2 on Line 2 / R3 at center) OR (S2 on Null-a / R3 fully CW) Tune Line 2 by peaking the desired-frequency signal strength with C2. At this time, leave C2 at its peaked-signal position.

NOTE THE SIGNAL STRENGTH (observe S-meter, if available, or note audible level).

1.6 ** DETERMINE POTENTIOMETER TO ADJUST **

If the dominant-station signal level noted when peaking Line 1 with C1 (step 1.4) is comparable (within 6 dB on meter, or not audibly different) to the strength noted when peaking Line 2 with C2 (step 1.5):

Adjust R3 to search for a null while trying the Null-a and Null-b positions of S2. If a distinct null is found, leave S2 and R3 at the best null-producing settings and proceed to step 1.7a. If a null is not found:

Switch S3 between Line 1 and Line 2 while adjusting R3 to make the observed signals equal on the S-meter (or not audibly different). R3 should, at this point, be close to its center position. Then, proceed to step 1.7a.

If the dominant-station signal level noted when peaking Line 1 with C1 (step 1.4) is noticeably greater than the strength noted when peaking Line 2 with C2 (step 1.5):

Set R3 to its center position. Adjust R1 to search for a null while trying the Null-a and Null-b positions of S2. If a distinct null is found, leave S2 and R1 at the best null-producing settings and proceed to step 1.7b. If a null is not found:

Switch S3 between Line 1 and Line 2 while adjusting R1 to make the observed signals equal on the S-meter (or not audibly different). Then, proceed to step 1.7b.

If the dominant-station signal level noted when peaking Line 1 with C1 (step 1.4) is noticeably lower than the strength noted when peaking Line 2 with C2 (step 1.5):

Set R3 to its center position. Adjust R2 to search for a null while trying the Null-a and Null-b positions of S2. If a distinct null is found, leave S2 and R2 at the best null-producing settings and proceed to step 1.7c. If a null is not found:

Switch S3 between Line 1 and Line 2 while adjusting R2 to make the observed signals equal on the S-meter (or not audibly different). Then, proceed to step 1.7c.

1.7 ** CAPACITOR / POTENTIOMETER INTERACTIVE ADJUSTMENTS FOR NULL **

Perform procedure 1.7a, 1.7b, or 1.7c as determined by step 1.6.

1.7a (Prior adjustment: R3)

If R3 is at center position, or CCW from center: Set S2 to Null-a. Adjust C1 to improve the null. If the null isn't well-defined or C1 is near the CW or CCW end of its range: Set S2 to Null-b and re-adjust C1 for the null. Interactively adjust R3 and C1 to get the best available null with these controls.

If R3 is CW from center: Set S2 to Null-a. Adjust C2 to improve the null. If the null isn't well-defined or C2 is near the CW or CCW end of its range: Set S2 to Null-b and re-adjust C2 for the null. Interactively adjust R3 and C2 to get the best available null with these controls.

1.7b (Prior adjustment: R1 - e. g. R1 is not fully CCW)

Set S2 to Null-a. Adjust C2 to improve the null. If the null isn't well-defined or C2 is near the CW or CCW end of its range: Set S2 to Null-b and re-adjust C2 for the null. Interactively adjust R1 and C2 to get the best available null with these controls.

1.7c (Prior adjustment: R2 - e. g. R2 is not fully CCW)

Set S2 to Null-a. Adjust C1 to improve the null. If the null isn't well-defined or C1 is near the CW or CCW end of its range: Set S2 to Null-b and re-adjust C1 for the null. Interactively adjust R2 and C1 to get the best available null with these controls.

1.8 ** FINAL TOUCH UP TO GET MAXIMUM NULL **

Do the final null "touch-up" with an interactive adjustment of C1, C2, and R3.

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*** Super-MWDX-5 Loop vs. Wire Phasing Procedure ***

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2.0 Phasing Steps (Loop vs. Wire)

NOTES: The loop should be equipped with a Q-spoiling resistor of approximately 22K across its parallel-tuned LC tank. A 50K potentiometer (initially set to center) might be substituted; it can provide an added control over nulling if desired. The pot or fixed resistor should be easily removable (switch or clips) to facilitate stand-alone (high-Q) loop usage.

A loop used in a phasing application is usually oriented for best directivity toward desired DX signals, whether or not that position reduces the dominant. Sometimes orienting the loop for MAXIMUM dominant signal pick-up, or for dominant level equal to that from the wire, can actually help nulling.

2.1 ** INITIALIZATION OF SWITCHES **

Set frequency-range switch S1 to the correct range for the frequency of operation (see Table 2). Set S2 Function switch to Line 1; set S3 to Common (unless using an antenna system with noise-reduction transformers). Set Input Coupling switch S4 to Normal (or to a different position, depending on experimentation that leads to having determined the best position for the wire being used). Set S5 Output switch to Phaser / Unamplified, and set S6 to Loop.

2.2 ** INITIALIZATION OF POTENTIOMETERS **

Set level pots R1 (Line 1) and R2 (Line 2) to fully counterclockwise (minimum attenuation). Set Null Vernier (Q-Balance) pot R3 to center position.

2.3 ** CONNECTIONS **

Connect longwire #1 to J1 and connect the loop (coax.) to J8. If coaxial cable is used on Line 1, a BNC or SO-239 to dual-banana-plugs adapter should be used to connect to J1 (center) / J3 (shield). Earth ground may be connected to J4. Connect the phaser's output (J5), via coaxial cable, to the input of the receiver to be used, or to a tunable preamp. between phaser and receiver. Connect a 9V battery to the J7 battery holder and plug P1 into J6, or connect the plug of an 8V to 15V DC power source to J6. Connect the loop to its power source.

2.4 ** PEAK LINE 1 **

Tune Line 1 by peaking desired-frequency signal strength with C1. At this time, leave C1 at its peaked-signal position.

[At this time, other positions of Input Coupling switch S4 may be tried to see if greater signal transfer is possible. Re-adjustment of C1, and possibly S1, may be needed to re-establish a peaked condition. In any event, the peak should have reasonable Q (be well defined) and C1 should not be set too close to fully CW or fully CCW. In most cases, S4 on Normal will provide good enough signal levels and reasonably sharp tuning.]

2.5 ** PEAK LINE 2 **

Set S2 Function switch to Line 2. Tune Line 2 by peaking the desired-frequency signal strength with the loop's tuning capacitor. Leave this capacitor at its peaked-signal position.

2.6 ** DETERMINE LINE HAVING STRONGER DOMINANT-SIGNAL LEVEL **

Note the difference in the strength of the dominant signal to be nulled as you switch S2 between Line 1 and Line 2.

2.7 ** INITIATE NULL **

The potentiometer that will be adjusted initially will be that corresponding to the antenna line having the stronger peaked level (from step 2.6): adjust R1 if Line 1 is stronger; R2 if Line 2 is stronger. Set S2 to Null-a. Adjust the pot determined above (R1 or R2) to search for a null of the dominant. Try this again with S2 set to Null-b. Leave S2 on the position yielding the better-defined null.

If a well-defined null was not obtained; set the pot of the stronger line such that signal level of the dominant is the same when S2 is switched from Line 1 to Line 2. Set S2 to the position (Null-a or Null-b) having the lower level of dominant signal / greater evidence of subdominant signals.

Adjust the tuning capacitor (C1 or the loop tuning capacitor) of the line OPPOSITE of that whose pot was adjusted. Adjust this capacitor for best nulling of the dominant. If the null is not easily obtained or tends to occur at the end of the capacitor's adjustment range; set S2 to the other null position (e. g. Null-b if you had started on Null-a). In rare cases, better results may be obtained by re-peaking the capacitor (e. g. go back to S2 on Line 1 if C1 was just adjusted and re-adjust C1 for a peak), and then adjusting the capacitor of the SAME line as the pot that was offset from its fully-counterclockwise position. Again, this adjustment should be tried with S2 on Null-a and on Null-b to see which position results in the better null and in the adjusted tuning capacitor being closer to the center of its mechanical range at null.

2.8 ** COMPLETE THE NULL **

Once as much nulling as possible has been obtained by alternately adjusting the pot (R1 or R2) and tuning capacitor (the loop tuning capacitor or C1) determined by Step 2.7; do the final null "touch-up" with an interactive adjustment of C1, the loop tuning capacitor, and R3. Slight physical re-positioning of the loop may also help to finalize the null. If a 50K pot (initially set to center, ~25K) had been installed across the loop coil (instead of the approximately- 22K fixed resistor), it may also be touched up for null completion.

3.0 *** Output Amplification ***

3.1 If more gain is required after nulling, set S5 to Phaser / Amplified. Occasionally a slight touch-up of the pots and tuning capacitors might be required to get the best null. This generally occurs only with portable receivers that leak some pickup from their internal ferrite rod or whip antennas.

NEW FEATURES:

Besides the enhanced controllability of nulls mentioned in the above nulling procedures, Super-MWDX-5 affords two other critical improvements over its predecessors:

Compatibility with noise-reducing antenna systems

If Input Coupling switch S4 is set to the Noise-Reduction mode and Ground Mode switch S3 is set to the Float position, the phasing unit may be interfaced correctly with coaxial inputs from low noise antenna systems consisting of a wire antenna and a "field site" earth ground fed to the primary of a (field site) step-down transformer in the 4:1 to 12:1 range; either a Mini-Circuits T9-1-X65 or Nick Hall-Patch's homebrew version consisting of an Amidon FT50-43 core with 35 turns primary / 11 turns secondary will work well. The lower impedance output of this field-site transformer is paralleled with 270 to 330 ohms;

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one secondary lead goes to the shield of the coaxial cable going to the operator's "shack" and the other secondary lead goes to the center conductor of this coaxial cable through a small series resistor in the 5 to 12 ohm range. The resistors form a low-loss matching pad to reduce the degree of mismatch. Excessive mismatch can compromise the shielding effectiveness of the coaxial cable. One such low-noise set-up can be phased against a loop or, even better, against a second low-noise antenna system with different directional properties. In any event, the "shack end" of a Line 1 low-noise coaxial feed is connected to J1 (center) and J3 (shield) of the phasing unit; similarly, if such a coaxial feedline is to be used for Line 2, it should be connected to J2 (center) and J4 (shield).

For further discussion of noise-reduction schemes, the reader is advised to consult my articles "Another Look at Noise-Reducing Antenna Systems" (6 JUL 1992), "Bevmatcher" (15 JAN 1991), the Nick Hall-Patch / John Bryant article "Impedance Matching a Beverage Antenna to a Receiver" in Proceedings 1988, and the 1991 noise-reducing inverted-L articles by Dallas Lankford and Denzil Wraight. The reader should be advised that the noise being reduced is LOCAL electrical noise of the type caused by TV sweep oscillator harmonics, light dimmer buzz, and the like. These antenna systems cannot, singly, reduce static from lightning bolts. Such noise CAN be nulled by phasing two antennas if it is coming from far enough away as to approximate a point source not having great incoming-angle variation over time (it is then treated as a "dominant signal" as if it were a broadcast station interfering with desired DX).

"Spare antenna" input

DXpeditioning in Newfoundland and elsewhere has taught me the value of having a broadband antenna available with the flip of a switch without having to disconnect the phased set-up. This antenna is characteristically used for rapid bandscanning and searching for parallel frequencies. The beauty of having it go through the phasing unit is that you could have nulled out a noise or a "pest" station on medium-wave and be monitoring a rare African when the idea of checking a 60-meter parallel comes to mind. With one flip of Super-MWDX-5's Output Switch S5 to one of the spare antenna positions ("Spare / Unamplified" or "Spare / Amplified"), you are now on a third antenna, fed into J9. This could be a longwire, a Beverage, or even an untuned active whip such as the MFJ-1024. The 60-meter parallel is confirmed and then you can flip back to the phaser signal without upsetting the null whatsoever. In home set-ups, some DXers might like to feed a loop into J9 so they can switch back and forth between a two phased-wires-created-null and one created by the loop. Entirely different stations might be logged when the same dominant station has been nulled by the two different methods. It sounds weird, but it can happen. A few receivers such as the Drake R8 have their own antenna switches that let you pick one of two sources. But many don't. Sony ICF2010's and Realistic DX-440's are very popular for DXpeditions. Neither has such an antenna switch.

The added features make the Super-MWDX-5 a bit more complex than the standard MWDX-5 and much more complex than the Mini-MWDX-5. A well-equipped DX shack should have a very simple phaser such as Mini-MWDX-5 as well as a full-features version such as Super-MWDX-5. The simple unit will get nulls much of the time, but the more complex (and therefore, more flexible) unit can get more DX for the operator who has the patience to master its use.

Building the Super-MWDX-5 Phasing Unit

The documentation (schematics, assembly drawings, parts lists, hole lists, etc.) serves as the starting point. The following procedure should serve as an outline for the builder.

1. Gather all necessary parts (see parts lists to follow). Prepare work area with appropriate tools.
2. Drill out chassis box, in accordance with Table 3.
3. Assemble the A1 (BBA-C1) Broadband Amplifier Card subassembly, per Figures 4 & 5 and Table 5.
4. Mount the A1 (BBA-C1) circuit card at the hole locations noted in Table 3.
5. Install jacks, pots, and switches. Solder inductors onto S1 per Figure 2 and Table 2.
6. Install wiring and other components per Figures 1, 2, 3, 6, 7 and Tables 1-4, 6, 7, 8. Install knobs on C1, C2, R1, R2, R3, S1, S2, S4, and S5 per Tables 2, 4, and 8. Place labels near controls and jacks.
7. Follow Two-Wire Phasing Procedure or Loop-vs.-Wire Phasing Procedure steps given in this article.

Table 3: Super-MWDX-5 hole-drilling list

X = Horizontal distance, in inches, from the vertical centerline (VCL) on the side observed. Negative values of X are left of VCL, positive values of X are right of VCL.

Y = Vertical distance, in inches, from the bottom horizontal edge of the side observed.

D = Hole diameter in inches.

Hole loci are first marked on the box with a scriber and are then drilled with a .125" bit. Subsequently, as required, the holes are enlarged to the proper size by using progressively larger bits up to that corresponding to the final desired diameter.

Chassis Box = Mouser # 537-TF-782: 7" X 5" X 3"

LEFT SIDE

Hole #	Comp. Desig.	Description	X	Y	D
--	----	-------------------------	--.----	--.----	--.----
1	J1	Line 1 wire -red banana jack	-1.0625	0.5	0.3125
2	J3	GND1 In - black banana jack	-0.3125	0.5	0.3125
3	J4	GND2 In - black banana jack	0.3125	0.5	0.3125
4	J2	Line 2 wire -red banana jack	1.0625	0.5	0.3125
5	S3	Ground Mode switch - tab	-0.25	1.25	0.125
6	S3	Ground Mode switch - shaft	0.0	1.25	0.25
7	G1	grounding H/W - internal lug	0.75	1.25	0.125
8	J8	Loop in - BNC jack	1.875	1.125	0.375

TOP SIDE

Mounting holes on C1 & C2 must be tapped to 6-32 thread.

Hole #	Comp. Desig.	Description	X	Y	D
--	----	-------------------------	--.----	--.----	--.----
1	C1	Line 1 Tuning Cap.-Mtg.H/W 1	-2.963	3.875	0.25
2	C1	Line 1 Tuning Cap. - shaft	-2.5	3.625	0.5
3	C1	Line 1 Tuning Cap.-Mtg.H/W 2	-2.037	3.875	0.25
4	C1	Line 1 Tuning Cap.-Mtg.H/W 3	-2.5	3.0	0.144
5	C2	Line 2 Tuning Cap.-Mtg.H/W 1	-2.963	1.625	0.25
6	C2	Line 2 Tuning Cap. - shaft	-2.5	1.375	0.5
7	C2	Line 2 Tuning Cap.-Mtg.H/W 2	-2.037	1.625	0.25
8	C2	Line 2 Tuning Cap.-Mtg.H/W 3	-2.5	0.75	0.144
9	R1	Line 1 level pot - tab	-1.125	4.125	0.144
10	R1	Line 1 level pot - shaft	-0.8125	4.125	0.3125
11	S4	Input Coupling switch-shaft	-0.625	2.375	0.375
12	S4	Input Coupling switch - tab	-0.125	2.375	0.144
13	R2	Line 2 level pot - tab	-1.125	0.875	0.144
14	R2	Line 2 level pot - shaft	-0.8125	0.875	0.3125
15	S1	Bandswitch - tab	0.0	3.875	0.144
16	S1	Bandswitch - shaft	0.5	3.875	0.375
17	S2	Function switch - tab	0.0	1.125	0.144
18	S2	Function switch - shaft	0.5	1.125	0.375
19	S6	Wire/Loop switch - shaft	1.5	0.625	0.25
20	S6	Wire/Loop switch - tab	1.5	0.375	0.125
21	G2	grounding H/W - internal lug	1.875	2.375	0.125
22	G3	grounding H/W - internal lug	1.875	1.5	0.125
23	A1	Broadband Amp. Card-H/W 2	2.0	4.5	0.125
24	A1	Broadband Amp. Card-H/W 1	3.0	4.5	0.125
25	A1	Broadband Amp. Card-H/W 4	2.0	3.5	0.125
26	A1	Broadband Amp. Card-H/W 3	3.0	3.5	0.125
27	R3	Q-balance pot - shaft	2.8125	2.25	0.3125
28	R3	Q-balance pot - tab	3.125	2.25	0.144
29	S5	Output switch - shaft	2.625	0.875	0.375
30	S5	Output switch - tab	2.625	0.375	0.144

RIGHT SIDE

Hole #	Comp. Desig.	Description	X	Y	D
--	----	-------------------------	--.----	--.----	--.----
1	J7	battery holder - H/W 1	-1.875	0.75	0.125
2	J7	battery holder - H/W 2	-1.0	0.75	0.125
3	J6	B+ input - phono jack	0.0	1.25	0.25
4	J5	RF out - BNC jack	0.0	0.5	0.375
5	J9	spare ant. in - BNC jack	1.25	1.25	0.375

Table 4: "upper level" parts list

NOTE: For bandswitch inductors, see Table 2.

*: Note follows parts list.

Vendor codes for this and subsequent parts lists:

AE = Antique Electronics /688 W. First St. /Tempe, AZ 85281 /Tel. 1-602-894-9503

DK = Digi-Key /P. O. Box 677 /Thief River Falls,MN 56701-0677 /Tel. 1-800-344-4539

MCL = Mini-Circuits Lab. / P. O. Box 350166 / Brooklyn, NY 11235-0003 /Tel. 1-718-934-4500

MOU = Mouser Electronics / 11433 Woodside Ave. / Santee, CA 92071 /Tel. 1-800-346-6873

RS = Radio Shack / Many locations worldwide

Item	Designator	Description/Value	Vendor	Vendor Stock #	QTY
====	====	==================	===	==============	===
1	-	chassis box	MOU	537-TF-782	1
2	A1	BBA-C1 amp. card		(refer to text)	1
3	(C1,2)	knob	MOU	45KN014	2
4	*	knob	RS	274-416	7
5	B1	9V alkaline battery	RS	23-553	1
6	C1,2	var. cap.,10-365pF	AE	CV-235	2
7	C3,4	capacitor, 33 pF	MOU	232-1000-033	2
8	C5,6	capacitor, 75 pF	MOU	232-1500-075	2
9	C7,8,9	capacitor, 0.1 uF	MOU	539-CK05104K	3
10	J1,2	red banana jack	RS	274-662	2
11	J3,4	black banana jack	RS	274-662	2
12	J5,8,9	BNC jack	RS	278-105	3
13	J6	phono jack	RS	274-346	1
14	J7 *	battery holder	MOU	534-1290	1
15	P1	phono plug	RS	274-339	1
16	R1,2	pot.,500 ohm,linear	MOU	31CT205	2
17	R3	pot., 50K, linear	MOU	31CT405	1
18	R4	resistor, 33 ohm	RS	271-007	1
19	R5,6	resistor, 68 ohm	RS	271-010	2
20	R7,8	resistor, 4.7 ohm	MOU	29SJ500-4.7	2
21	R9	resistor, 1 ohm	MOU	29SJ500-1.0	1
22	S1	switch/4pole/6pos.r	MOU	10WR046	1
23	S2,5	switch/3pole/4pos.r	MOU	10YX034	2
24	S3	switch,DPDT,onoffon	RS	275-620	1
25	S4	switch/6pole/4pos.r	MOU	10WR064	1
26	S6	switch,SPDT,on-on	MOU	10TC230	1
27	T1,2,3	RF transformer,1:1	MCL	T1-6-X65	3

Misc. items: hook-up wire, buss wire, solder,labels "AS REQUIRED"

*Item 4 note: for S1, S2, S4, S5, R1, R2, R3.

*Item 14 note: Keystone 1290 or equivalent.

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Table 5: (A1) BBA-C1 Broadband Amplifier card parts list

Item	Designator	Description/Value	Vendor	Vendor Stock #	QTY
1	BD	perfboard:1.4"X1.4"	RS	276-1396 (cut)	1
2	C1,2,5,6	capacitor, 0.1 uF	RS	272-109	4
3	C3	capacitor,10uF tant	MOU	581-10M35	1
4	C4	capacitor, 0.001 uF	RS	272-126	1
5	H1,2,3,4	screw, 4-40 X .25"	MOU	572-01880	4
6	H1,2,3,4	spacer, 4-40 X .5"	MOU	534-1450C	4
7	H1,2,3	split lockwasher,#4	MOU	572-00649	3
8	H4	solder lug, #4	MOU	534-7311	1
9	P1-8	flea-clip/.042 hole	MOU	574-T42-1/100	8
10	Q1	transistor, 2N3866	MOU	511-2N3866	1
11	R1,5,8	resistor, 4.7 ohm	MOU	29SJ500-4.7	3
12	R2	resistor, 33 ohm	RS	271-007	1
13	R3,6	resistor, 680 ohm	MOU	29SJ250-680	2
14	R4	resistor, 2.7K	MOU	29SJ250-2.7K	1
15	R7	resistor, 1 ohm	MOU	29SJ500-1.0	1
16	RFC1	inductor, 2200 uH	MOU	434-05-222J	1
17	U1	voltage reg., 7812	RS	276-1771	1
18	W	buss wire	RS	278-1341	~1'

Table 6: small hardware parts list, comprised of tables 6A - 6E

See Table 4 for vendor codes.

Note: Mounting hardware is supplied with the following components: J1 through J6, J8, J9, R1, R2, R3, S1 through S6.

*** Table 6A = A1 mounting hardware ***

Item	Designator	Description/Value	Vendor	Vendor Stock #	QTY
1	-	screw, 4-40 X.25"	MOU	572-01880	4
2	-	split lockwasher,#4	MOU	572-00649	4

*** Table 6B = C1 mounting hardware (see Figure 7) ***

[ ] designators refer to hole locations from Table 3. Item 3 note: 2 pieces at hole 1; 2 at hole 3; 1 at hole 4.

Item	Designator	Description/Value	Vendor	Vendor Stock #	QTY
1	[1],[3]	screw, 6-32 X.4375"	DK	H157	2
2	[1],[3]	rubber grommet	MOU	522-211	2
3	see note	fiber washer, #6	MOU	534-3201	5
4	[3]	solder lug, #6	MOU	534-7312	1
5	[1]	tooth lockwasher,#6	MOU	572-00675	1
6	[4]	nylonscrew,6-32X.5"	MOU	561-J632.5	1
7	[4]	hex nut, 6-32	MOU	572-00486	1
8	[4]	split lockwasher,#6	MOU	572-00650	1

*** Table 6C = C2 mounting hardware (see Figure 7) ***

[ ] designators refer to hole locations from Table 3. Item 3 note: 2 pieces at hole 5; 2 at hole 7; 1 at hole 8.

Item	Designator	Description/Value	Vendor	Vendor Stock #	QTY
1	[5],[7]	screw, 6-32 X.4375"	DK	H157	2
2	[5],[7]	rubber grommet	MOU	522-211	2
3	see note	fiber washer, #6	MOU	534-3201	5
4	[7]	solder lug, #6	MOU	534-7312	1
5	[5]	tooth lockwasher,#6	MOU	572-00675	1
6	[8]	nylonscrew,6-32X.5"	MOU	561-J632.5	1
7	[8]	hex nut, 6-32	MOU	572-00486	1
8	[8]	split lockwasher,#6	MOU	572-00650	1

*** Table 6D = grounding hardware ***

Item	Designator	Description/Value	Vendor	Vendor Stock #	QTY
1	G1,G2,G3	screw, 4-40 X.375"	MOU	572-01881	3
2	G1,G2,G3	solder lug, #4	MOU	534-7311	3
3	G1,G2,G3	hex nut, 4-40	MOU	572-00484	3

*** Table 6E = hardware for battery holder J7 ***

Item	Designator	Description/Value	Vendor	Vendor Stock #	QTY
1	-	screw, 4-40 X.375"	MOU	572-01881	2
2	-	split lockwasher,#4	MOU	572-00649	2
3	-	hex nut, 4-40	MOU	572-00484	2

Table 7: wiring / component connections

Notes: I = insulated wire, approx. #22 AWG
B = bare solid (buss) wire
TP = twisted-pair (insulated)

Lengths are maximum typical required amount; in actual practice, use the shortest length possible to minimize stray coupling.

INSIDE BOX

wire #	From	To	Description
1	J1	S4A arm	3.5" I
[J1 connect directly to R5 side 1]			
2	R5 side 2	S3A "Terminated"	1.5" I
[J3 connect directly to T1 pin 1]			
[J4 connect directly to T2 pin 1]			
3	J2	S4D arm	4" I
[J2 connect directly to R6 side 1]			
4	J3	S3A arm	1" B
5	J4	S3B arm	2" I
6	S3B "Common"	S3A "Common"	0.5" B
7	S3A "Common"	G1 internal GND lug	1.5" B
8	S3A "Common"	R1 CW	4" I
9	G1 internal GND lug	T1 pin 6	2" I
10	G1 internal GND lug	T2 pin 6	2" I
11	R6 side 2	S3B "Terminated"	4" I
12	T1 pin 3	S4A "Noise Reduction"	3.5" I
13	T2 pin 3	S4D "Noise Reduction"	4" I
14	T1 pin 4	S4B "Noise Reduction"	4" I
15	T2 pin 4	S4E "Noise Reduction"	4" I
16	C1 rotor	S4B arm	3" I
17	C1 stator	S4C arm	2.5" I
18	C2 rotor	S4E arm	3" I
19	C2 stator	S4F arm	2" I
[R7 side 2 connect directly to S5A "Phaser/Amp."]			
20	R1 CCW	R7 side 1	6" I
21	R1 arm	jct. L1 through L12	2" I
22	R1 CW	S4B "Normal"	2.5" I
23	S4B "Normal"	S4B "Short"	0.5" B
24	S4E "Short"	S4E "Normal"	0.5" B
25	S4E "Short"	G3 internal GND lug	2.5" I
[C3 side 1 connect directly to S4A "Normal"]			
[C5 side 1 connect directly to S4A "Short"]			
26	S4C "Normal"	S4C "Short"	0.5" B
27	S4A "Short"	jct. C3side2/C5side2	1.5" I
28	S4A arm	S4B "Long"	1" B
[C4 side 1 connect directly to S4D "Normal"]			
[C6 side 1 connect directly to S4D "Short"]			
29	S4F "Normal"	S4F "Short"	0.5" B
30	S4F "Short"	jct. C4side2/C6side2	2.5" I
31	S2A "Line 2"	S4C arm	2" I
32	R3 arm	G2 internal GND lug	1.5" I
33	R3 CCW	S1B arm	4" I
34	R3 CW	S1A arm	2.5" I
35	S2A "Line 1"	S4F arm	2" I
36	S1A arm	S2A "Line 2"	4" I
37	S1B arm	S2A "Line 1"	4" I
38	S1C arm	S1D arm	1" I
39	S1D arm	G2 internal GND lug	3" I
40	S2A arm	S2C "Null-b"	0.5" B
41	S6 "Wire"	jct. L13 through L24	4" I
[C7 side 1 connect directly to J8]			
[C7 side 2 connect directly to R4 side 1]			
42	R4 side 2	S6 "Loop"	4" I
43	S6 arm	R2 arm	3" I
44	R2 CW	S4E "Short"	2.5" I
45	R2 CCW	T3 pin 1	4" I
[T3 pin 3 connect directly to G2 GND lug]			
46	S2B arm	T3 pin 4	2.5" I
47	S2C arm	T3 pin 6	2.5" I
48	S2B "Line 2"	G3 internal GND lug	1.5" B
49	S2B "Line 1"	S2A arm	1" I
50	S2B "Line 1"	S2B "Line 2"	0.5" B
51	S2B "Line 2"	S2B "Null-a"	0.5" B
52	S2C "Null-a"	S2C "Line 2"	0.5" B
53	S2C "Line 2"	S2B "Null-b"	1" I
54	S2B "Null-b"	R8 side 1	3" I
[R8 side 2 connect directly to S5A "Phaser/Amp."]			
55	S5A "Phaser/Amp."	S5C "Phaser/Unamp."	1.5" I
56	S5A "Phaser/Unamp."	S5A "Spare/Unamp."	0.5" B
57	S5A "Phaser/Unamp."	G3 internal GND lug	1.5" I
58	J9	S5A "Spare/Amp."	4" I
59	S5A "Spare/Amp."	S5C "Spare/Unamp."	2" I
60a	S5A arm	A1-P1	4" TP
60b	S5A "Phaser/Unamp."	A1-P2	4" TP
[R9 side 1 connect directly to J6 (center pin)]			
[R9 side 2 connect directly to C9 side 1]			
[C9 side 2 connect directly to J6 ground lug]			
61	S5B "Spare/Amp."	jct. R9side2/C9side1	2.5" I
62	S5B "Phaser/Amp."	S5B "Spare/Amp."	1" I
63	S5B arm	A1-P3	4" I
64a	S5C "Phaser/Amp."	A1-P5	4" TP
64b	S5A "Phaser/Unamp."	A1-P6	4" TP
65	S5C "Phaser/Amp."	S5C "Spare/Amp."	1" I
[J5 connect directly to C8 side 1]			
66	S5C arm	C8 side 2	2.5" I

OUTSIDE BOX

wire #	From	To	Description
67	J7 + terminal pin	P1 plug - center pin	2" I
68	J7 - terminal pin	P1 plug - shield pin	2" I
[P1 connects to J6 for battery operation]			

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Table 8: control orientation conventions

Ensure that components are mounted and wired in accordance with this table; align knob pointers to clock positions indicated. Orientations are as viewed from outside the chassis box assembly.

Side	Control	Orientation Conventions
top	C1	CCW = minimum C = 9:00; CW = maximum C = 3:00
top	C2	CCW = minimum C = 9:00; CW = maximum C = 3:00
top	R1	CCW = maximum level (no attenuation) = 7:00 CW = minimum level (maximum attenuation) = 5:00
top	R2	CCW = maximum level (no attenuation) = 7:00 CW = minimum level (maximum attenuation) = 5:00
top	R3	CCW = maximum level/Q Line 1 (min. Line 2)= 7:00 CW = maximum level/Q Line 2 (min. Line 1)= 5:00
top	S1	[see Table 2]
top	S2	Line 1 = 10:30; Line 2 = 11:30; Null-a = 12:30; Null-b = 1:30
left	S3	common = left; float = center; terminated = right
top	S4	long = 10:30; normal = 11:30; short = 12:30; noise-reduction = 1:30
top	S5	phaser + amp. = 10:30; phaser = 11:30; spare antenna = 12:30; spare antenna + amp.= 1:30
top	S6	wire = up; loop = down

FIGURE 1: SUPER-MWDX-5 (INPUT SECTION)

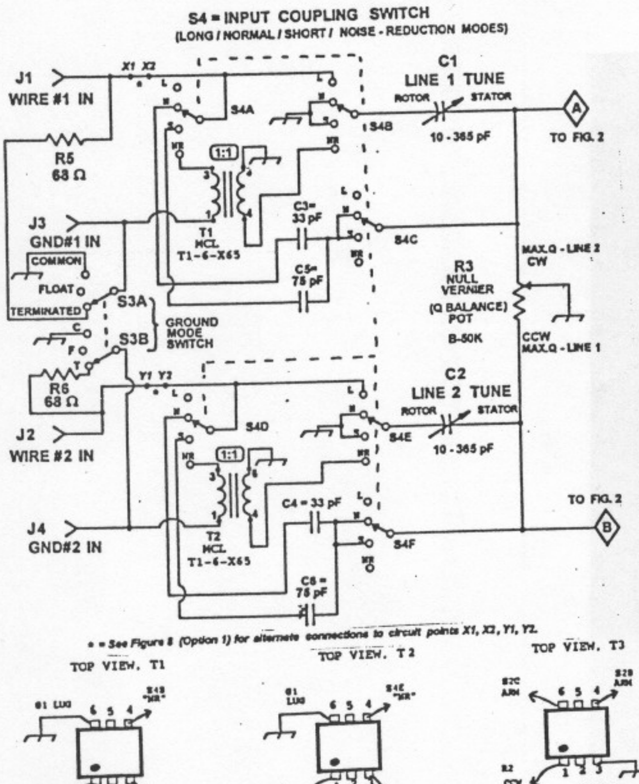

FIGURE 2: SUPER-MWDX-5 (COMBINING SECTION / BANDSWITCH)

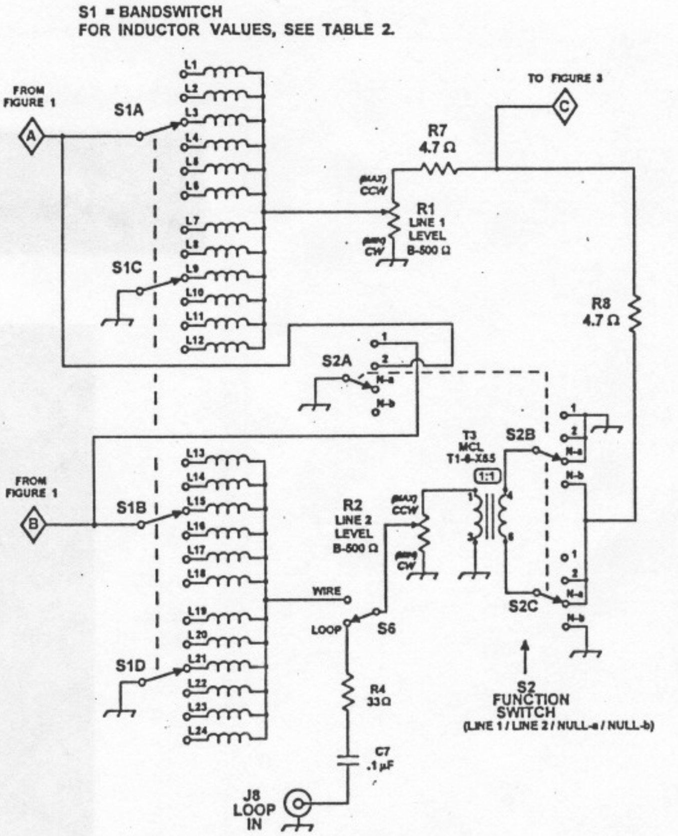

FIGURE 4: BBA-C1 IMPROVED BROADBAND AMPLIFIER CARD - SCHEMATIC
(A1 OF SUPER-MWDX-5 PHASING UNIT) *WALTON DX Labs - 17 MAR 1992*

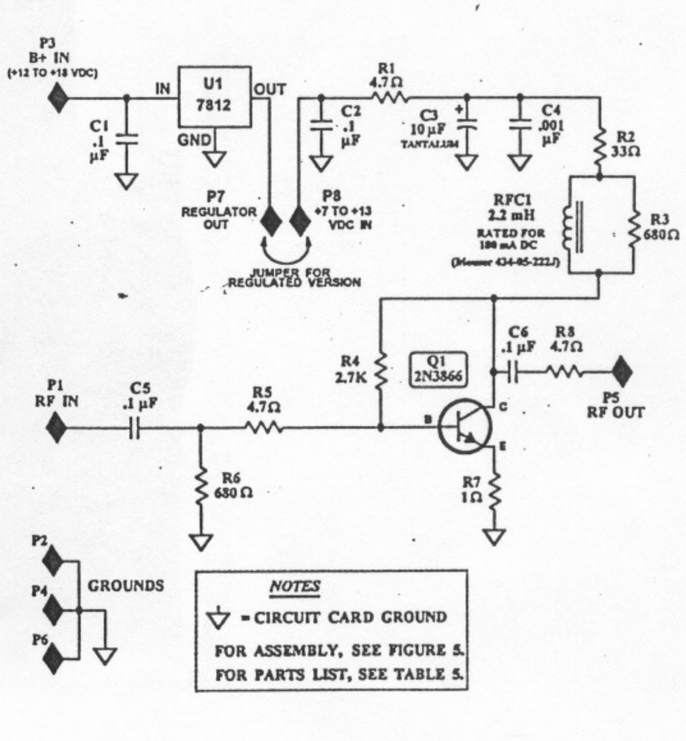

FIGURE 3: SUPER-MWDX-5 (OUTPUT SECTION)

(S5 = OUTPUT SWITCH: PHASER AMPLIFIED / PHASER UNAMPLIFIED / SPARE ANT. UNAMPLIFIED / SPARE ANT. AMPLIFIED)

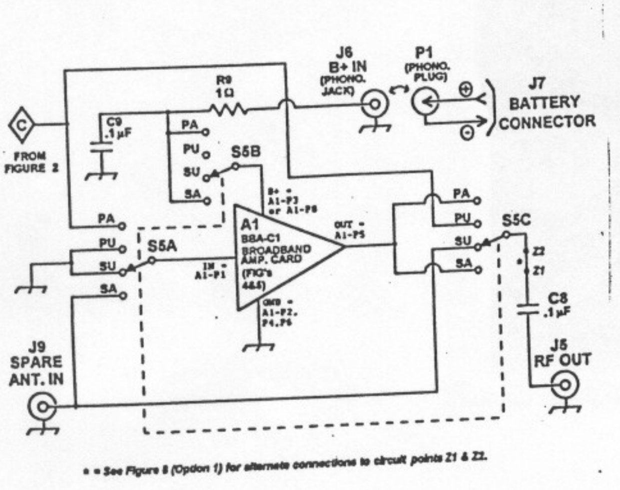

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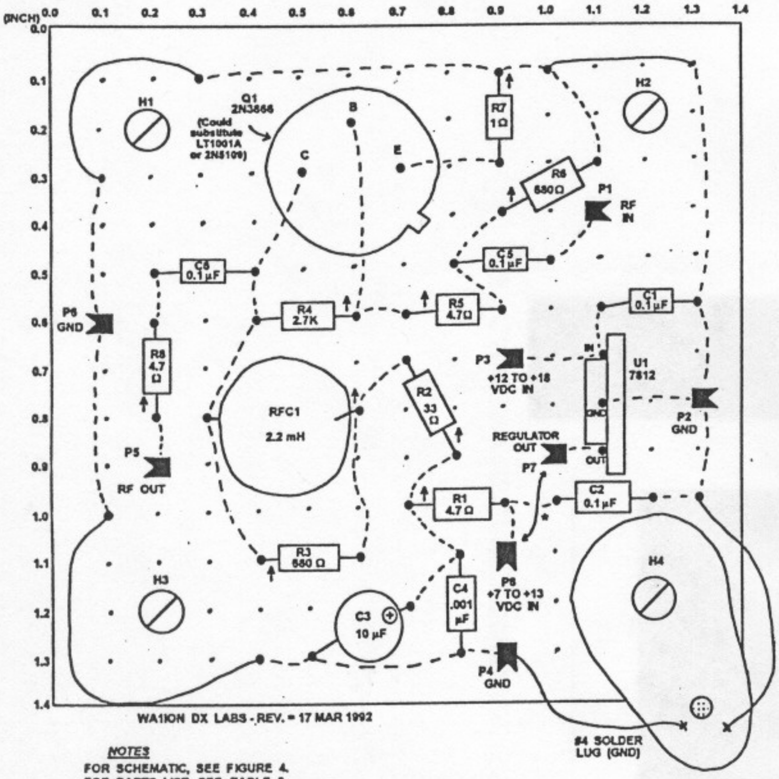
FIGURE 5: BBA-C1 IMPROVED BROADBAND AMPLIFIER CARD - ASSEMBLY



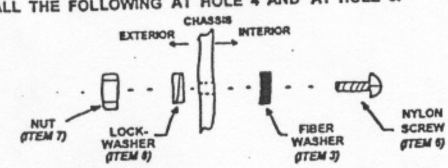
NOTES

FOR SCHEMATIC, SEE FIGURE 4.
FOR PARTS LIST, SEE TABLE 5.
↑ = LONG-LEAD SIDE OF VERTICALLY-MOUNTED COMPONENT.
— = BUSS-WIRE ON COMPONENT SIDE OF BOARD.
- - - = BUSS-WIRE ON SOLDER SIDE OF BOARD.
= "FLEA CLIP" TERMINAL PIN. OPEN SIDE
* = JUMPER INSTALLED (P7 TO P8) FOR REGULATED OPERATION.

FIGURE 7: C1, C2 MOUNTING DETAILS

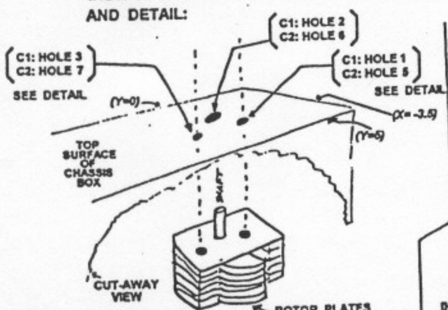
ITEM NUMBERS ARE ACCORDING TO TABLES 6B & 6C.
HOLE NUMBERS ARE ACCORDING TO TABLE 3.

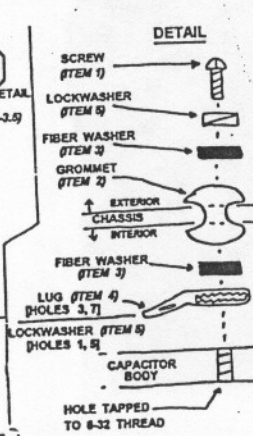
INSTALL THE FOLLOWING AT HOLE 4 AND AT HOLE 8.



CUT THE NYLON SCREW TO BE FLUSH WITH THE NUT.
AFTER ASSEMBLY.

INSTALL C1 AND C2 ACCORDING TO THE FOLLOWING PICTORIAL AND DETAIL:





After mounting C1 & C2, install knob (Table 4, Item 3) on each capacitor shaft. If shaft length is insufficient, the knob may be installed by using a non-conductive shaft extender such as H. H. Smith / NTT part numbers 130, 140, or 161. These are available from Newark Electronics, Gerber Electronics, and others.

FIGURE 6: SUPER-MWDX-5 SWITCH DETAILS

(SKETCH OF INTERIOR VIEW OF COMPONENTS, BOTTOM COVER REMOVED)
NOTE: POSITIONS, SIZES APPROXIMATE — NOT TO SCALE
RIGHT, LEFT SIDE CONNECTORS / CONTROLS NOT SHOWN

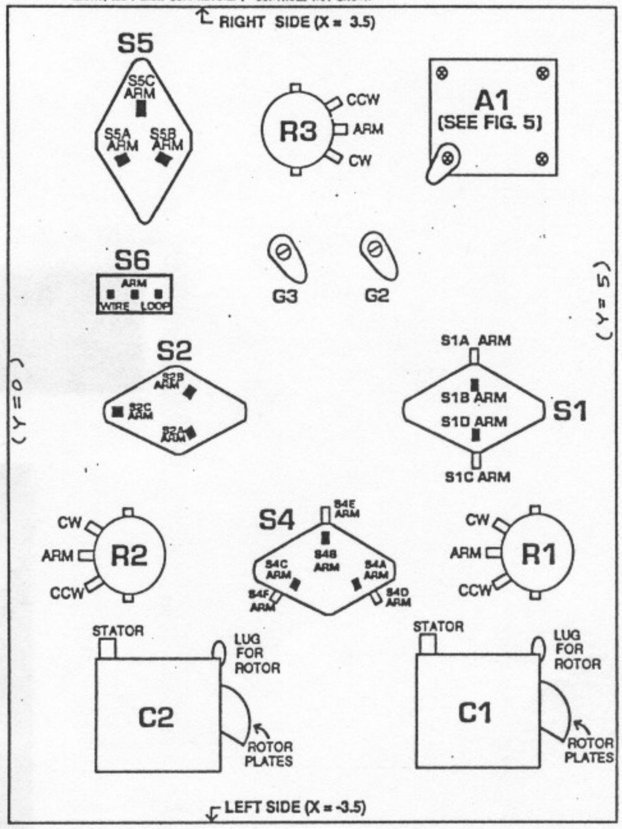
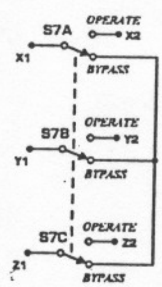


FIGURE 8: OPTIONS FOR THE SUPER-MWDX-5

Option 1 Operate / Bypass Switch

Install 3-pole, double-throw toggle switch (Mouser 10TC280) at holes drilled at: shaft = (X=0.75, Y=2.375, D=0.25); tab = (X=0.75, Y=2.625, D=0.144). X1, X2, Y1, Y2 are circuit points in Figure 1; Z1 & Z2 are from Figure 3. Wires connecting X1 to X2, Y1 to Y2, and Z1 to Z2 are re-routed, as shown below:



Option 2 Use of BUF-A Buffer Amplifier (see RTL-2 Remotely-Tuned Loop article) in place of BBA-C1. BUF-B of RTL-2 could be used instead of BUF-A. Buffer-type amplifiers may offer lower current drain.