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Phasing Unit Designs: Simple to Complex

Mark Connelly - WA1ION - 20 MAR 1990

The use of a phasing unit to null out a dominant station (allowing other stations to be heard) can often be of considerable benefit to the DXer. By using two wire antennae and such a unit, the DXer may enjoy effects comparable to those obtained by rotating a loop. Many DXers have used phasing with great success in the last 25 years or so. Situations where a loop cannot be used (e. g. when the operating position is inside a steel-frame building, mobile home, or vehicle) are those for which phasing is most highly recommended.

Numerous articles on the construction and use of phasing units have appeared in the medium-wave DX press. This article will draw references from these previous works:

Micro-MWDX-4A Loop-vs.-Wire Phaser (15 MAR 1989)
MWDX-4 and Mini-MWDX-4 series Phasing Units (11 OCT 1985)

These articles give parts lists, phaser operating techniques, and construction methods useful to the phasing unit builder / user. Copies of these articles may be obtained from the reprints services of NRC and IRCA.

The purpose of this article is not to go into a point-by-point description and construction plan for a specific type of unit, but to give some design outlines that, coupled with the other articles mentioned, will allow a DXer having little technical experience to get a simple unit up and running in short order. The first design to be presented represents the bare minimum in terms of component-count and design complexity for a 2-wire phasing unit that can be realistically expected to produce nulls of "pest" stations or electrical noises in an adequate number of situations to be worthwhile. Figure 1 shows the schematic of this basic medium-wave unit. Table 1 lists the principal parts required.

Table 1: Parts List for the Basic Phaser

Vendor codes [some of these represent updates]:

RS = Radio Shack / Many locations worldwide
MOU = Mouser Electronics / 11433 Woodside Ave. / Santee, CA 92071
MCL = Mini-Circuits Lab. / P. O. Box 350166 / Brooklyn, NY 11235-0003
RK = Radiokit / P. O. Box 973 / Pelham, NH 03076

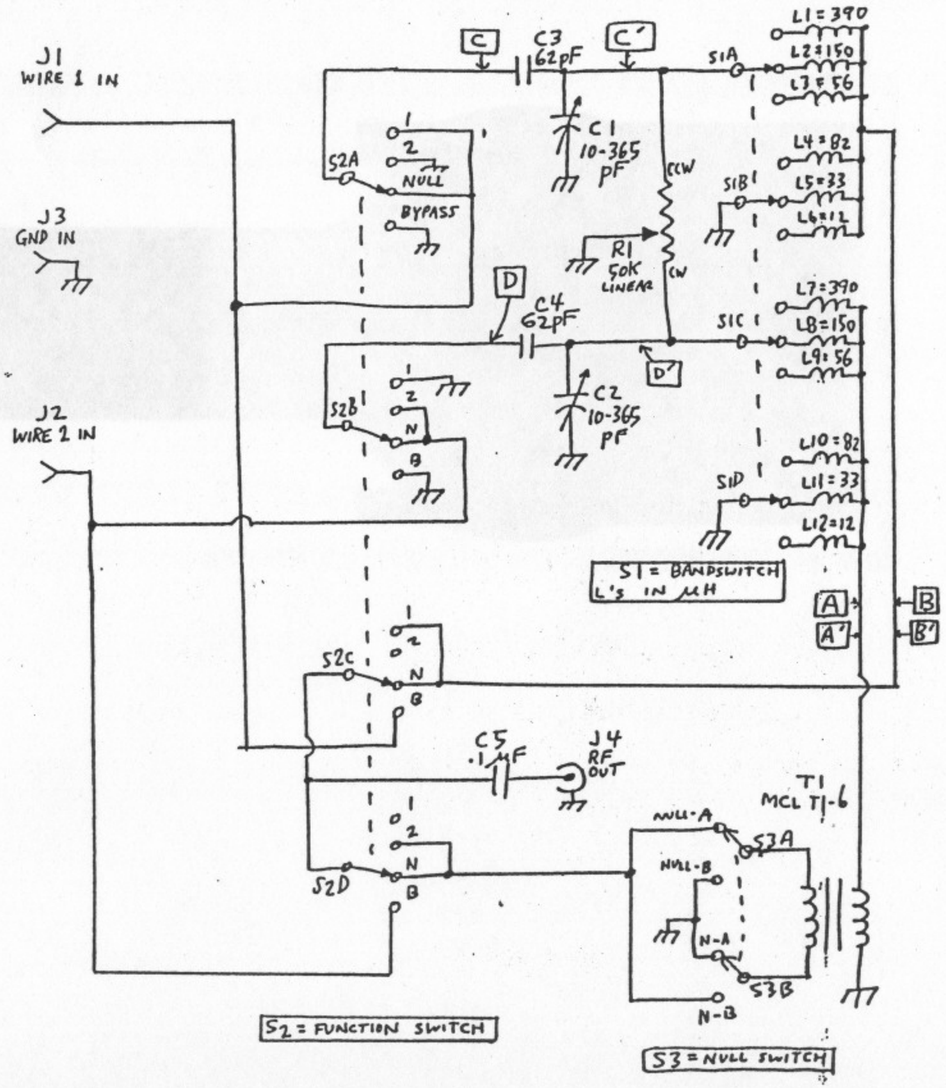
Item	Designator	Description/Value	Vendor	Vendor Stock #	QTY
1	-	chassis box	MOU	537-TF-779	1
2	(for C1,C2,R1,S1,S2)	knob	RS	274-415(or)274-416	5
3	T1	RF transformer(1:1)	MCL	T1-6	1
4	C1,C2	variable cap.,10-365pF	RK	BC-01	2
5	C3,C4	capacitor, 62 pF	MOU	21CB062	2
6	C5	capacitor, 0.1 uF	RS	272-109	1
7	J1,J2	red banana jack	RS	274-662	2
8	J4	BNC jack	RS	278-105	1
9	J3	black banana jack	RS	274-662	1
10	L1,L7	inductor, 390 uH	MOU	43LR394	2
11	L2,L8	inductor, 150 uH	MOU	43LR154	2
12	L3,L9	inductor, 56 uH	MOU	43LR565	2
13	L4,L10	inductor, 82 uH	MOU	43LR825	2
14	L5,L11	inductor, 33 uH	MOU	43LR335	2
15	L6,L12	inductor, 12 uH	MOU	43LR125	2
16	R1	pot., 50K, linear	MOU	31CT405	1
17	S1	switch/4pole/3pos.rotary	MOU	10YX043	1
18	S2	switch/6pole/4pos.rotary	MOU	10WR064	1
19	S3	switch,DPDT,on-on toggle	RS	275-663	1

Miscellaneous: hardware (screws, nuts, washers, lugs, perfboard, etc.) - see MWDX-4 / Mini-MWDX-4A article (Fig's 4/5/5A & Tables 6/8 of that article) for rough estimates.

The hole list of the Mini-MWDX-4 can be used, with the following deletions: left side 1, 5, & 6; top side 12 & 13. In place of the 50K R1, two pots (R1 = 25K shunting C1, R2 = 25K shunting C2) could be used for a bit more flexibility. In that case, Mini-MWDX-4 top side holes 12 & 13 would be used.

FIGURE 1: BASIC PHASER

NOTE : LETTERS IN BLOCKS (E.G. [A]) ARE REFERENCE POINT DESIGNATORS USED IN THE ARTICLE.



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Enhancements

The builder may opt for any or all of the following custom improvements:

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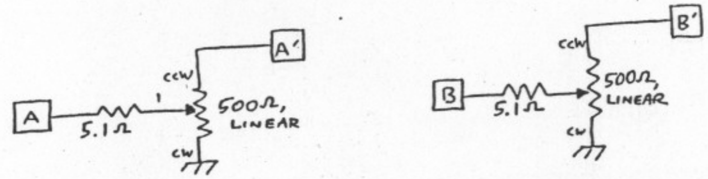
1 At the Figure 1 points labelled [A], [A'], [B], and [B'], break the connections and insert potentiometers and fixed resistors according to Figure 2.

FIGURE 2: DUAL LEVEL POTS OPTION

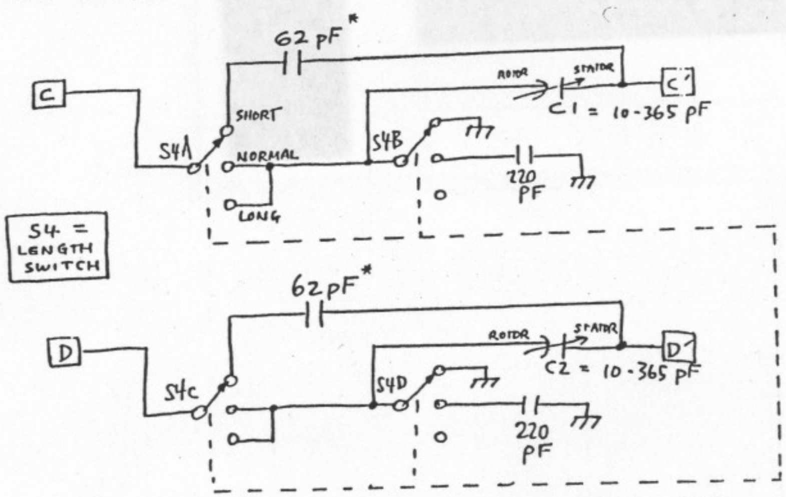


This will give more flexibility in setting up nulls. Note: these added pots control level without greatly influencing Q; therefore, they play a different rôle from that of R1 in Figure 1. They do not replace R1; rather, they supplement it.

2 Replace section [C] - [C'] and [D] - [D'] with the set-up of Figure 3.

FIGURE 3: LENGTH - SWITCH OPTION

REPLACE SECTIONS BETWEEN FIGURE 1 [C]-[C'] AND [D]-[D'] WITH THE FOLLOWING:



* = COULD INCREASE TO ≈ 120 PF FOR SHORTER WIRES

The added 4-pole, 3-position rotary switch is referred to as the "length switch". Its purpose is to allow efficient coupling of longer wire antennae (e. g. over 30-m.) than the Figure 1 scheme can. Signal-to-receiver-noise ratios can be improved in some circumstances. For even a bit more flexibility, use separate length-switches for Line 1 and for Line 2 (probably not a bad idea if vertical-vs.-Beverage phasing is to be done).

Note that the two tuning capacitors "float" from chassis ground in this design variation. This entails using a bit more mechanical ingenuity during the construction process. Use of a plastic, rather than a metal, chassis box could be helpful.

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3 Replace the 4-pole, 3-position bandswitch (S1) with a 4-pole, 6-position type [Figure 4A] or with a 2-pole, 12-position type [Figure 4B].

FIGURE 4A: 6 - BAND (LWBC, MW) SWITCH

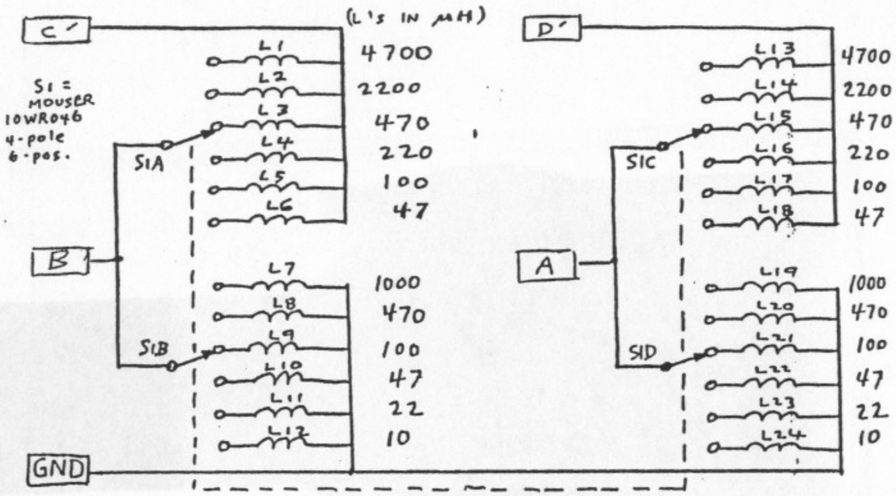
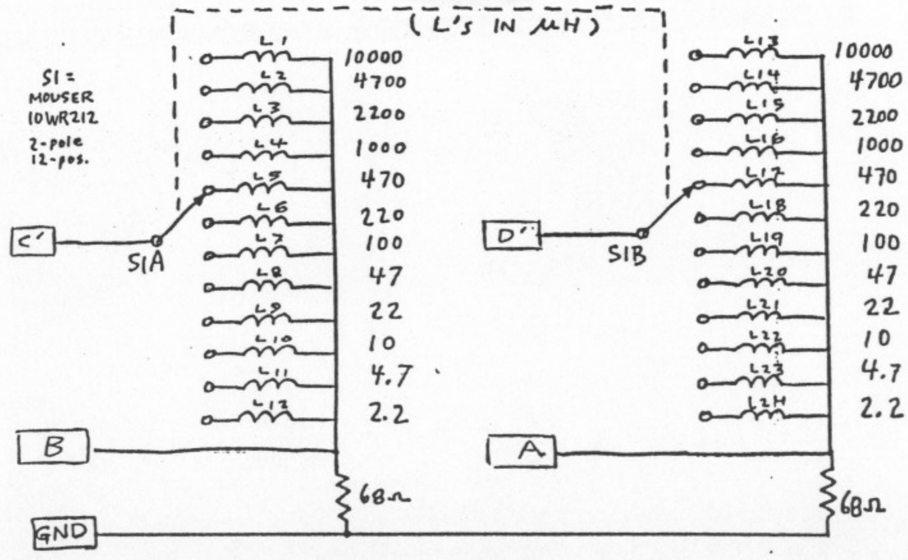


FIGURE 4B: 12 - BAND (140-7000 KHZ) SWITCH



The Figure 4B set-up gives more frequency coverage than that of Figure 4A, but achievable output levels are somewhat less.

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4 Add a switch (or two switches) to go from wire operation to external loop operation on one (or both) of the lines feeding the summation point. See the MWDX-4 / Mini-MWDX-4 article for such a set-up (Figure 1B of that article).

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5 Smoother / more precise tuning may be obtained through the use of vernier reduction-drive knobs (e. g. Mouser part number 45KN100) on the two tuning capacitors. The Micro-MWDX-4A article gives a detailed description of how this can be done. Note that extra holes and hardware, and more panel space, will be required. The mechanical layout should be worked out thoroughly before drill meets metal. For an even better set-up, put vernier knobs on any level-balancing and Q-adjusting pots as well.

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6 An amplifier could be included in the phasing unit box (as was done with MWDX-4), or in a separate unit between the phaser output and the receiver input. An amplifier input level adjustment pot or stepped attenuator should be provided unless the amplifier module has AGC and/or an unusually high dynamic range figure. My current methodology is to put a small-signal, non-power-hungry 20-dB-gain broadband amplifier inside of the phasing unit box (see MWDX-4) for rural-locale or shorter-than-normal-wire operation, and to use a more "muscular" (power-gobbling) amplifier, usually of high-Q tuned design, in an external box when off-channel signal levels are too high for the built-in amplifier. One could theoretically build a high-Q tuned (e. g. regenerative) amplifier into the phasing unit box, but this would increase the number of control knobs on the phasing box to the confusion-inducing level. Reduction of DXer operating efficiency would be the inevitable result.

"Active phasing"

Gain could be put between the high-impedance point of each of the two tank circuits (C1 & C2 stators) and the summation point, rather than after the summation. This would mandate the use of two high-impedance-in / low-impedance-out amp. cards (typically referred to as "front-end" or "active probe" cards). Doing this would eliminate the need for the inductive-divider set-up in the S1 bandswitch. This active-phasing concept is probably the only viable means of phasing two very short antennae (e. g. car whips). The 62 pF input coupling capacitors should be increased to over 200 pF for car whip tuning. Active phasing has been tinkered with at WA1ION DX Labs, but inter-modulation distortion / crossmodulation / overloading problems have been found to be a serious limitation with typical JFET (2N4416 / MPF102) high-Z input amplifiers. VMOS FET designs and amplifiers built around "buffers" such as the National Semiconductors LH0033 and the Burr-Brown 3553 look more promising in this regard. The crunchproof front-ends, of course, get rather warm and consume much more power than a 9-volt transistor radio battery could ever deliver.

Conclusion

A very simple phasing unit design, as shown in Figure 1, can be used effectively to null out unwanted signals and allow new DX to be heard. The construction of this Basic Phaser is within the capabilities of many DXers.

With a bit more investment in time and materials, phasing units of greater complexity can be assembled. The specific enhancements chosen will tailor the unit to perform better in the ways most important to the end user (e. g. greater frequency coverage, greater sensitivity, better nulls).

DXers are always encouraged to report any research results from phasing unit experimentation. The most meaningful results, in the final analysis, are the new stations put into the logbook.