Phased Amplified Shortwires

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Most DXers are aware that a phasing unit is used to obtain nulls by combining the signals from one longwire aerial with those from another longwire, usually of similar length. As the phase relationship between the signals on each wire is adjusted, unwanted stations can be reduced in strength to yield subdominant stations of greater DX interest. Phasing, therefore, serves an overall purpose similar to that of looping.

A phasing unit works very well with Beverages (two wires of at least 1000'/305m) producing nulls even of high-angle skip difficult to handle with a loop. Nulls with a phased system may be unidirectional in some cases, providing the ability to cancel unwanted signals from the opposite direction as a desired station. Wires significantly shorter than 1000' can often be phased with fair results on short & medium skip signal rejection and with good to excellent nulls of groundwave & low-angle skip. When a good receiver is used, a pair of 100'/30.5 m wires can generally be phased to yield acceptable-strength DX catches after a dominant is nulled. Of course, the shorter wires require an input-tuning scheme different from that of the conventional phasing unit designed to tune Beverages only. My recent article, "Phasing Unit Design Modifications" (DX News 26 OCT '81 & DX Monitor 24 OCT '81), addresses this problem and puts forth the "flexible LC module" concept as a solution.

Having extended the usefulness of the phasing unit concept to the point that good performance with paired 100'/30.5 m longwires is possible, the next step is to achieve nulling with much shorter wires. Tests with the phasing unit indicate that strong locals may be nulled deeply with wires as short as 16'/5 m. It should be noted that, as the lead-in to the shack may be a quarter of the length of the two 16' shortwires, slight movements of the lead-ins or of any metallic objects near them can effect null stability. Wires can be peaked as a pre-requisite to nulling, if the flexible LC module concept is incorporated into the phasing unit.

As we get into phasing shorter wires, the ability to null is not the factor of limitation; rather, the low signal levels encountered with such short wires become the predominant problem. Typically, the 'pest stations' you are trying to null are themselves only 30 dB or so over the receiver noise floor when a pair of 16'/5 m shortwires are being used. A desired station 35 dB under the pest (5 dB under the noise) is still out of the picture, even if you can null the pest 50 dB. That desired station would have been an easy catch on phased wires of significantly greater length. So the problem here, quite simply, is system gain.

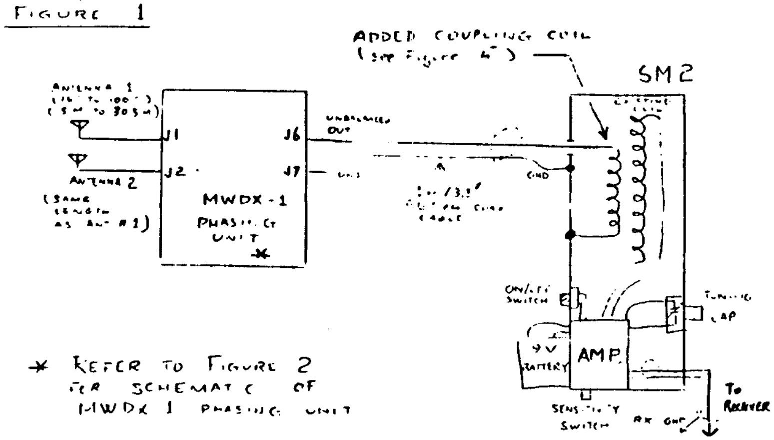
To make phased shortwires part of a truly viable DXing system, amplification is necessary. This amplification could be of a broad-banded nature, but a superior approach is the use of a tuned amplifier. The extra selectivity of a tuned amplifier acting upon the already-tuned phasing unit output gives good rejection of the spurious responses normally caused by receiver overloading.

The advantages of an amplified phased shortwire system to the DXer living in an apartment complex or in a trailer park should be obvious: in either situation a "stand-alone" indoor loop, shielded by steel from the outside, is a mediocre performer at best (pressed up against a window) and totally useless at its worst. In such living situations, outdoor space for wire aerials is severely limited: in an urban high-rise apartment building, a CB-type whip stuck out a window or on a balcony may be the only possible outdoor antenna. (Although 16'/5 m has been mentioned as a low limit on aerial length, two car radio whips could possibly be phased sufficiently to allow respectable domestic DXing above 900 kHz.)

At this point, the focus of this article turns to methods to implement the amplified phased shortwires concept. The amplification scheme used here is as simple as I could make it: the basic amplifying ingredient is the Worcester Electronics SM2 active ferrite loop modified in a very minor way. The SM2 thus modified can also be used as a simple shortwire tuner/booster. The modification to be made does not detract in any way from the performance of the SM2 as a "stand-alone" loop antenna.

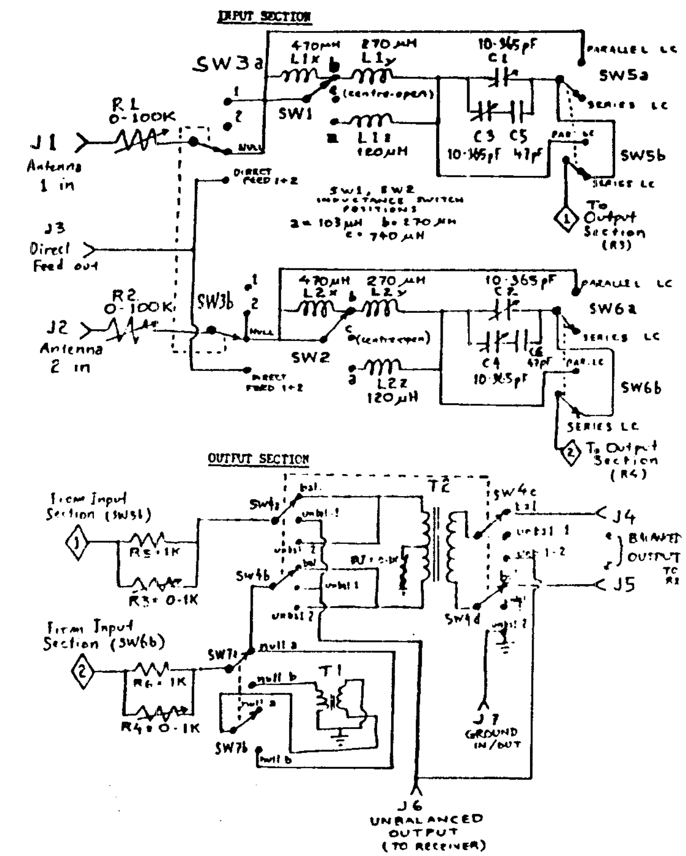
A block diagram of the amplified phased shortwire system is shown in Figure 1:

Figure 1



The phasing unit used, dubbed the MWDX-1, has features designed specifically with amplified phased shortwires in mind. This unit has the schematic shown in Figure 2.

Figure 2 : Schematic Diagram of "MWDX-1" Phasing Unit



Construction of this unit was detailed in my article "Phasing Unit Construction & Use" (DX News - 23 NOV 1981).

The phasing unit can pass its output (the desired station signal left after eliminating a pest by phasing 2 wires against each other) to the coupling coil on the SM2. The main coil of the SM2 receives this signal and passes it to the amplifier. If the phasing unit output had been connected directly to the receiver, a desired station's signal may have been in the noise after nulling the pest. By using the SM2 as an RF amp., a sufficient level of wanted-station signal may now be heard, even though very short wires are being phased. The necessary manipulations of the phasing unit controls & the SM2 controls must be done in a particular sequence: these methods will be outlined later in this article.

There is another possible phasing scheme: that of using the SM2's own pickup mixed with the output of the phasing unit. One longwire is acted on by the phasing unit to alter its phase relationship to the SM2's own signal. This method is similar to other loop versus longwire systems. The following articles on this subject should be consulted:

LSCA-1	R. F. Schatz	IRCA reprint A5, NRC reprint A20
LSCA-2	R. F. Schatz	" " A18, " " "
LSCA comments	G. P. Nelson	" " A6
Using 2 Antennae to Generate Asymmetrical Receiving Patterns	Mike Levintow	" " A12, NRC reprint A13
A Loop/Longwire Combo	Nick Hall-Patch	" " A32
Pattern Controlled Loops, parts I & II	G. P. Nelson	NRC reprint A6

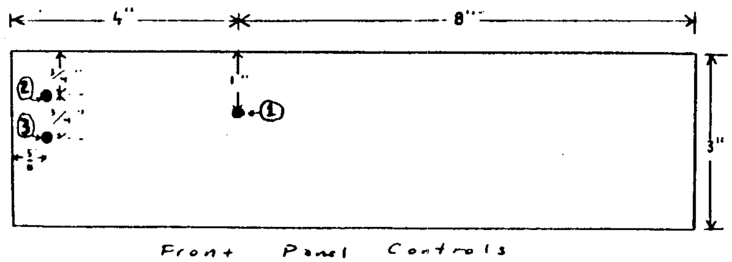
Modifying the SM2 loop for phasing unit amplification

Parts & tools required:

Parts	Tools
(1) 6-32 X ¼" metal screw	screwdriver (#6)
(1) #6 internal-tooth solder lug	longnose pliers
(1) 6-32 metal hexnut	soldering pencil
(1') #22 insulated hook-up wire	solder
(1) insulated banana jack with mounting hardware	drill with appropriate bits (see following modification procedure)
(1) non-insulated banana jack with mounting hardware	ohmmeter
(1) 1K pot (optional)	**Miscellaneous**
	glue or wax

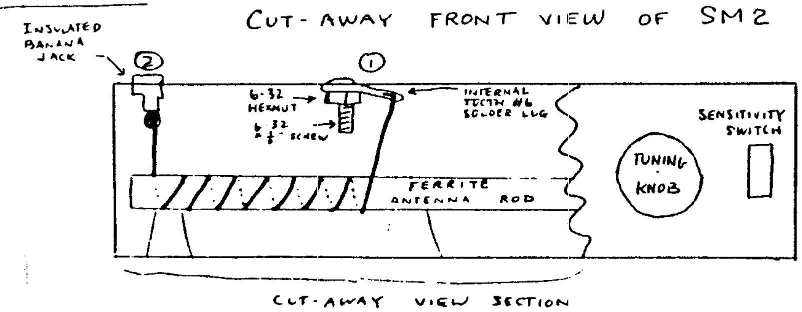
Observe Figure 3, the top view of the SM2 case.

Figure 3 TOP VIEW, SM2 CASE



Temporarily remove the battery from the SM2. At the point marked ①, drill a hole for 6-32 hardware by using a #28, 3.6 mm, or 9/64" bit.
Prepare a 1'/0.3 m length of #22 insulated hook-up wire. Strip ¼" of insulation from one end; solder that end to the eyelet of a #6 internal tooth solder lug.
Load a 6-32 X ¼" screw into the top of the SM2 at hole ①. Use longnose pliers to place the solder lug with attached wire over the screw inside the SM2. Then, place a 6-32 hexnut over the end of the screw inside the SM2. With the pliers, hold the nut in proper alignment while using a screwdriver to tighten the screw. Let the wire hang temporarily.
Drill holes ② & ③ with the appropriate bits for the banana jacks to be used (typically a letter-O, 8.0 mm, or 5/16 " bit). Mount an insulated banana jack at hole ②, using manufacturer-supplied hardware. Mount a non-insulated banana jack at hole ③. Verify with an ohmmeter that, at this step in assembly, the jack at ② measures open-circuit to the SM2 case and that the jack at ③ measures short-circuit (zero ohms) to the SM2 case.
Observe Figure 4, the cut-away front view of the SM2 case.

Figure 4 CUT-AWAY FRONT VIEW OF SM2



Wind 6 turns of wire, as shown, over the existing coil on the left 4" of the SM2 antenna rod (1 turn per ⅛"). Ensure the shortest possible lead length between the solder lug and the point 4" in on the rod where the interior end of the added coupling coil is located. Run the wire from the other end of the coupling coil (left end of the rod) to the insulated banana jack at hole ② ...

Cut off excess wire, strip the end, and solder it to the banana jack ② tab inside the SM2 case. Put a few drops of wax or Elmer's Glue on the added coupling coil to secure it. Blow all drill shavings, wire snippings, & solder droplets out of the SM2.
This completes SM2 modification. Re-install battery. Some may prefer to use a female BNC connector in lieu of the two banana jacks. A further refinement would be the addition of a 0 to 1K pot between the input jack & the left side of the coupling coil. Such a pot could be easily situated near the front left corner of the top side SM2 case. Ability to adjust the amount of signal to be coupled to the SM2 for amplification may prove advantageous in prevention of overloading in urban areas. In SM2 pickup versus single wire phasing (to be explained later), this pot may aid in fine-tuning of a null. As the (optional) pot changes the impedance imposed across the coupling coil, any time the pot is tweaked, the SM2 tuning capacitor must also be re-adjusted for peak signal.

Use of the SM2 as a wire tuner/amplifier

The SM2 with the foregoing modifications has had its usefulness extended into several new realms. It will still work as a 'stand-alone' loop if there are no external connections to the input jack(s).
If a wire aerial is tied to the coupling coil input jack, the SM2 may be used to tune & amplify the signals on that wire. It is suggested that such peaking be done initially with the SM2 gain switch on its LOW position. Often, where there are potent locals, overloading (& resultant spurs) may occur in the HIGH gain switch position. Shortwave spurs of varying degrees of peskiness may also occur in the HIGH gain position. After peaking the SM2 tuning capacitor in the LOW gain mode, switch to HIGH gain. If the desired signal comes up without the addition of spurs, stay in HIGH gain. Tuning capacitor re-peaking should not be necessary. Having the ability to amplify & to tune a relatively short piece of wire outdoors is of great benefit to the urban apartment dweller: the 'stand-alone' loop inside a steel-frame building is of little use other than getting 40 dB over S9 dimmer & TV interference; the 20' shortwire hung out over the balcony does not produce enough signal on non-locals to be of much DX use. Tuning such a wire decreases the incidence of spurs; amplifying it makes the shortwire equivalent to a much longer aerial.

Using the SM2 to amplify the output of a phasing unit

In addition to direct boosting of low level signals from a shortwire, the modified SM2 loop may be used to amplify the low-level output of a phasing unit having as its two inputs wires much shorter than those commonly thought of as being "phaseable". Wires in the 16'/5 m to 100'/30.5 m length range can indeed be phased to produce nulls of unwanted stations. The peak-tuning of such wires by the phasing unit demands that the phasing unit to be used must have a flexible input LC module design like that of the MWDX-1 unit of Figure 2.
Furthermore, an easy method of disconnecting the aerials from the input of the phaser is necessary so that the SM2 can be peaked (in a condition of having the impedance of the phasing unit's output section across the coupling coil) without the influence of signals from the wire aerials. Using the "direct-feed-jack" antenna switch position on the MWDX-1 unit accomplishes this.
Actual tuning procedures will be detailed later in this article.
The connection from the unbalanced output & the ground of the phasing unit to the coupling coil input & chassis ground of the modified SM2 must be done with a short piece of coaxial cable, preferably lightweight, flexible RG174. If unshielded leads were used, feedback and other disagreeable phenomena could occur. Wire aerial leads should be kept at least 2'/61 cm from any part of the SM2 to minimise stray coupling which could decrease nulling efficiency. Flow charts of overall amplified phased shortwire operating methods follow:

("Shortwire"= a wire between 16' and 100')

NULLING SCHEME 1: SM2's own pickup versus one shortwire

Single shortwire is fed to the Antenna 2 input jack (J2) of the MWDX-1 phaser; RG174 coax (3.3'/1 m maximum length) transfers the phasing unit output to the added coupling coil on the SM2, as in Figure 1.

(a) Aim SM2 at desired station, if possible.
(b) Peak SM2 with shortwire disconnected from phasing circuitry (SW3 to direct-feed) but with the phasing unit output connected to the coupling coil.
(c) SW3 to Antenna 2. Peak #2 LC module on phaser.
(d) Offtune #2 cap. (C2) or #2 R (R2) to yield a null of the unwanted station.
(e) Null may be enhanced & finalised by slight re-positioning of SM2 loop.

It should be noted that if an SM2 is shielded from external signals (e. g. inside a metal-frame building or vehicle) or if its pickup consists of severe indoor-generated noise (e. g. dimmers, TVI), it can only be used as an amplifier, not an antenna. In that case, nulling scheme 1 should be abandoned in favour of nulling scheme 2.

NULLING SCHEME 2: SM2 amplifying two phased shortwires

One shortwire aerial to J1 of MWDX-1 phaser, other aerial to J2. RG174 coaxial lead from phasing unit output is routed to the SM2 coupling coil input, as in Figure 1.

(a) Peak SM2 with wires disconnected from phasing circuitry (SW3 to direct-feed-jack position) but with phasing unit output connected to the coupling coil on the SM2.
(b) SW3 to Antenna 1. Peak #1 LC module.
(c) SW3 to Antenna 2. Peak #2 LC module.
(d) SW3 to null; execute nulling procedure using tuning capacitors & pots on phaser.

The DXer will find that preparing tables of SM2 tuning capacitor settings and of LC module peaking control positions for given length wires will expedite tuning. Typical tables follow:

SM2 Tuning Capacitor Settings, as Adjusted with 0 - 100 Vernier Knob

f, kHz. ↓ / Loading on Coupling Coil →	no load	phasing unit "unbal-1" position	phasing unit "unbal-2" position (no wires to phaser)	
550	96	96	(outside range)	0-100 SM2 knob settings
600	77	77	97	
650	65	65	83	
700	54	54	70	
750	47	47	60	
800	40	40	51	
900	29	29	39	
1000	22	22	30	
1100	16	16	23	
1200	12	12	18	
1300	8	8	13	
1400	5	5	9	
1500	2	2	6	
1600	0	0	4	

Peak-Yielding LC Module Control Positions (25' wire(s) to phasing unit)

f, kHz. ↓ / Control →	L switch (SW1 or SW2)	LC switch (SW5 or SW6)	C, main tune (C1 or C2) Dial	Approx. C, pF.
600	270 uH	series	7	200
700	"	"	10	85
850	"	"	16	15
1000	103 uH	"	10	85
1250	"	"	14	30
1500	270 uH	parallel	12	50

These tables are examples only. Variations in SM2's, phasing units, & wire aerials will produce differing results.

System Operation Details

Before thoroughly going into the two nulling modes (1. loop vs. wire, 2. two phased, amplified shortwires), a quick review of the phasing unit controls is in order. Refer to the MWDX-1 schematic, Figure 2. The antenna switch (SW3) selects the aerial to be fed to the phasing unit's tuning section. It can select Antenna 1 only, Antenna 2 only, both antennae (for 2-wire phasing), & neither antenna (wires are tied together and are fed to a separate jack: this is the direct-feed jack mode in which wires are disengaged from phasing circuitry to permit proper SM2 peaking). Antenna 1 signal is adjusted by R1, the main, or coarse, #1 pot) & by R3 (the fine-adjust, or trim, #1 pot). Similarly, Antenna 2 has R2 as its main level pot & R4 as its trim pot. Antenna 1 tuning controls include C1 (its main tuning capacitor), C3(its fine-tune capacitor or trim capacitor), SW1 (the Ant. #1 inductance-selection switch), and SW5 (the switch to select series or parallel L-C in the #1 LC module). Antenna 2 controls are C2 (main tuning cap.), C4 (fine-tune, or trim, capacitor), SW2 (Ant. #2 inductance switch), and SW6 (#2 LC switch, selecting series or parallel L-C in the #2 LC module). Each LC module has 6 "modes": 3 possible inductance switch positions (103, 270, or 740 uH) times 2 possible LC switch positions (series or parallel). Throughout the following operation runs, the subroutines "PEAK #1 LC", "PEAK #2 LC", "REPEAK #1 LC", and "REPEAK #2 LC" will be called up. These subroutines are broken down to their commands in the following lists:

PEAK #1 LC

SW3 to Antenna 1 - C3 to middle of tuning range.
Set R1, R3 to zero ohms
As you set up each of the following modes, run C1 through its range to obtain a peak in signal. Find the LC mode in which tuning C1 yields the strongest sharpest peak. Set up SW1 & SW5 for that mode and ensure that C1 is set for the desired signal peak.

PEAK #2 LC

SW3 to Antenna #2. C4 to middle range.
Set R2, R4 to zero ohms
As you set up each of the following modes, run C2 through its range to obtain a peak in sigal. Find the LC mode in which tuning C2 yields the best peak. Set up SW2 & SW6 for that mode; set C2 to peaked position.

PEAK #1 LC (continued)

#1 LC mode	SW1	SW5
1	103 uH	parallel
2	270 "	"
3	740 "	"
4	103 "	series
5	270 "	"
6	740 "	"

PEAK #2 LC (continued)

#2 LC mode	SW2	SW6
1	103 uH	parallel
2	270 "	"
3	740 "	"
4	103 "	series
5	270 "	"
6	740 "	"

As noted on the previous page, preparation of tables of L switch, LC switch, and tuning capacitor peaked settings for specific length wires will speed up the LC peaking process. Also, if you have already peaked one wire (e. g. Antenna 1), you can use the same L switch & LC switch positions for the second LC module if the second wire (e. g. Antenna 2) is of similar length to the first.

Subroutines REPEAK #1 LC, REPEAK #2 LC.

REPEAK #1 LC

SW3 to Antenna 1
Set R1, R3 to zero ohms
C3 to middle of range
Leave SW1 & SW5 in their present positions.
Adjust C1 for peak signal

REPEAK #2 LC

SW3 to Antenna 2
Set R2, R4 to zero ohms
C4 to middle of range
Leave SW2 & SW6 in their present positions.
Adjust C2 for peak signal.

Output controls: SW7 selects "null mode" by switching a phase-reversing transformer (T1) into the Antenna 2 line or out of it. Most tuning is done with T1 in-line (null mode b). SW4 selects "unbal-1" (unbalanced operation without the balun), "unbal-2" (unbalanced operation with the balun), & "bal" (balanced output - not used in the Amplified Phased Shortwires system). R7 is the ground pot from the balun primary centre-tap: it is generally not used except in some fine null touching-up applications. Unless noted otherwise, it is to be set to zero ohms.

Step-by-Step Procedures

In the following procedures, note that the PEAK & REPEAK commands refer to the subroutines explained above. Note that a "DIP" in signal is a well-defined drop in the signal of the unwanted station at a control (pot or capacitor) setting not at the end of that control's range. In other words, the control may be adjusted clockwise and counterclockwise from the minimum signal position: in either case such adjustment increases signal level.

I. Loop versus Single Shortwire

Point loop to favour reception of desired (e. g. TA) station(s), if possible.
Using RG174 coaxial cable, connect outputs (J6 high, J7 low) to the SM2 coupling coil and case, in accordance with Figure 1.
Connect SM2 output to receiver input.
Connect shortwire aerial to J2 of phaser, the Antenna #2 input jack.
Set all potentiometers on the phasing unit to zero ohms.
Null switch (SW7) to null mode b (T1 in-line).
Antenna switch (SW3) to direct-feed-jack position (no aerials applied to LC modules).
SW4 to unbal-2
SM2 sensitivity switch on LOW
Turn SM2 on
Adjust the SM2 loop's tuning capacitor for maximum signal on the frequency of interest.
Subroutine "PEAK #2 LC" (SW3 to Antenna 2, etc.)
Off-tune C2 to obtain DIP, as defined earlier. Leave it at the dip-causing position. If dip does not occur with C2 off-tuning, set SW7 to null mode a & re-tweak C2 for a dip. Play R4, C4 to maximise null of pest. Moving the SM2 slightly may also help.
SM2 sensitivity to HIGH. If spurs occur, go back to LOW. If there are no significant spurious responses, leave the sensitivity switch on HIGH and retweak R4 & C4, if necessary, to finalise the null.

If a good null was not achievable, or if the wanted-station signal level is too low:
SM2 sensitivity switch to LOW.
SW7 to null mode b.
Subroutine: "REPEAK #2 LC"
Antenna switch (SW3) to direct-feed-jack position, disengaging shortwire from phaser.
SW4 to unbal-1.
Adjust SM2 tuning capacitor to obtain maximum signal on the frequency of interest.
SW3 to Antenna 2.
Off-tune C2 to obtain dip. Leave it at the dip-causing position. If dip is not found during off-tuning of C2, set SW7 to null mode a & re-adjust C2 to dip. Play R4 & C4 to maximise null of unwanted station. Slight movement of the SM2 may help in getting rid of that last vestige of pest station signal, hopefully yielding good DX.
SM2 sensitivity to HIGH. If no spurs arise, leave the sensitivity/gain switch HIGH & touch up R4 & C4, if necessary, to get best null of pest. Of course, if spurs crop up, set the SM2 sensitivity switch back to LOW.

In the very unlikely case that satisfactory nulls did not occur at any time during the above operations; several options are still open. These could include re-doing the foregoing procedure with a wire of different length and/or of different direction, starting with the loop oriented in a different direction, or proceeding to a two-wire phasing situation.

A question some might ask is "What is the advantage of the SM2-versus-shortwire set-up, in comparison to just turning the loop itself to get a null ?".

First of all, if you are at a site at which meaningful DX can only be heard with the loop pointed one way (such as in the case of a loop against a window inside a steel-frame building or house-trailer); phasing the wire against the loop will give you real nulling and directional reception capability.

Secondly, even if you are fortunate enough to be able get signals at any position of your SM2, the phased loop-vs.-wire configuration will allow nulls of stations at a 180° horizontal angle to the station of interest without killing the desired signal - this is generally beyond the capability of the loop in a stand-alone mode of operation. A Massachusetts DXer can now put a dent in New York stations (at a bearing of 240°) without nulling desired Mediterranean area stations on the opposite bearing (60°). Similarly, a southern US DXer can knock out Midwest stations to permit South American DX, a feat not normally achievable with the SM2. Phasing the wire against the loop can produce the cardioid (heart-shaped) pattern with its single-direction null, as opposed to the normal figure-8 pickup pattern of the loop.

II. Phased, Amplified Two-Shortwire System

Preliminary Set-Up

Connect one shortwire aerial to the Antenna 1 input (J1) of the phaser; another shortwire to the Antenna 2 input (J2).

Connect unbalanced output (J6 high, J7 ground), by using a 1 m./ 3.3' RG174U cable, to the coupling coil input jack & the ground jack installed on the SM2 (Figure1).

Position lead-ins from wire aerials so that they are at least 61 cm./2' from any part of the SM2 chassis.

Connect SM2 output to receiver input.

Operating Procedure

1. SW4 to unbal-2
2. Null switch (SW7) to null mode b (Π in-line)
3. Antenna switch (SW3) to direct-feed-jack (to disengage aerials from phasing circuit)
4. Turn SM2 power on.
5. SM2 sensitivity switch to LOW
6. Adjust SM2 tuning capacitor to obtain maximum signal at the frequency of interest.
7. Set all 5 phasing unit pots to zero ohms, if not done already.
8. Subroutine "PEAK #1 LC" (SW3 to Antenna 1, etc.)
9. SW3 to Antenna 2
10. Set #2 L switch (SW2) at the same inductance position as the SW1 position which was found to give peaking on the #1 antenna line.
11. Set #2 LC switch (SW6: series or parallel LC) to the same position as the SW5 position which was found to give proper peaking on the #1 antenna line.
12. Set C4 to middle of tuning range.
13. Adjust C2 for maximum signal . The peak signal should be within the moving range of C2, not fully clockwise or fully counterclockwise.
14. If C2 does not yield a proper peak within its moving range, do subroutine "PEAK #2 LC".
15. Repeatedly switch SW3 between Antenna 1 & Antenna 2; note which line produces the stronger <u>unwanted</u> station signal.
16. SW3 to null.
17. (a) Adjust the main pot on the line which had yielded the greater pest-station signal & look for a well-defined dip within the pot's moving range.
    (b) If such a dip (improving wanted-to-unwanted signal ratio) occurs, leave the pot at the dip-causing setting.
    (c) If there is no proper dip, return that pot to zero ohms.
18. Offtune the main tuning capacitor on that same line, again looking for a sharp dip (especially one that reduces pest level to a greater extent than it reduces other signals) within the capacitor's moving range.
19. If a dip occurs, leave that capacitor at the dip-yielding position, then fine-tune the 2 trim capacitors (C3, C4) & the 2 trim pots (R3, R4) to enhance the null. If there is no dip, go to step 23.
20. (a) SM2 sensitivity to HIGH.
    (b) If spurious signals occur, go back to LOW.
    (c) If there are no spurs, finely touch up R3, R4, C3, & C4, if necessary, to finalise the nulling process.(In this case, the sensitivity switch is left HIGH)
21. If the signal level of the wanted station(left after nulling the pest) seems too low, try doing steps (a) through (f) below, &, if necessary, do step 22.
    (a) SM2 sensitivity to LOW
    (b) SW4 to unbal-1
    (c) SW3 to direct-feed-jack
    (d) Adjust SM2 tuning capacitor for maximum composite (wanted + unwanted) signal.
    (e) SW3 to null
    (f) Play R3, R4, C3, C4 for a good null, if possible. If null occurs, set SM2 to HIGH sensitivity. Keep it there if there are no spurs, then re-tweak trim controls to finalise null. If spurs occur, set SM2 sensitivity switch to LOW.

21. <u>Comment</u>: The user will eventually know if going to unbal-1 is necessary. This is primarily a consideration if the balun is lossy and/or if very short wires are used. Wanted-signal level in unbal-2 is more apt to be low below 900 kHz. Initial peaking of LC modules is best done with SW4 on unbal-2 as input-to-output isolation is better than in unbal -1. After switching to unbal -1 after PEAK (or REPEAK) #1 LC & #2 LC in unbal-2; the SM2 capacitor must be re-adjusted to allow for the difference in coupling coil loading between unbal-1 & 2. Nulling may then be attempted in the unbal-1 mode.
22. If a good null was not obtained in step 21 (f), do steps (a) through (f) below:
    (a) re-iterate steps 1, 3, 5, 6, & 7.
    (b) Subroutine "RE PEAK #1 LC"
    (c) Subroutine "RE PEAK #2 LC"
    (d) SW4 to unbal-1 / SW3 to direct feed jack / Adjust SM2 tuning capacitor for peak signal.
    (e) Re-iterate steps 15 through 20.
    (f) If no dip can be obtained, go to step 23.
23. If, during the above procedure, good dipping/nulling of unwanted signals did not occur (very unlikely), set SW7 to null a & re-iterate steps 1, 3-22 above.

Most stations should be nulled successfully with the above procedure. If you <u>almost</u> have a perfect null, moving the SM2 or the aerial lead-ins a bit may provide that last small amount of phase shift required to obtain a truly deep null.

If 3 wires, each separated from the others by a horizontal angle of 120°, are available, lower angle stations from most directions should be nullable: with 3 wires you have 3 choices of paired combinations (e. g. 50° & 170°, 50° & 290°, 170° & 290°).

High-angle skip, of course, is difficult to suppress (because of rapid short-term arrival-angle variation) with any system except, perhaps, phased Beverages over poor ground (sand dunes, rocks) or large phased verticals on good ground (salt marsh).

Application Notes: Motel Room DXing on a Trip

The problem is partially one of the building acting as a shield, reducing signals received with the SM2 driving a receiver (SM2 indoors, as stand-alone loop). Most of the problem, however, is the man-made electromagnetic interference, or noise, from light-dimmers & TV sets in the motel. Such EMI may cover all but the strongest local stations.

It is found that a 20' wire hung out the window still gets an appreciable level of motel-generated garbage, although a few more stations are heard with it than on the indoor loop. Still, serious LA & TA DX is out of the question.

<u>Solution</u>: Phase the outdoor shortwire against a "trash antenna", a wire of similar length run around the inside of the room. The level pot on the trash-antenna line can reduce the noise level on that line to the same amplitude as that picked up on the outdoor shortwire. When, by means of phase-reversal, the attenuated trash-antenna noise signal is subtracted from the noise present on the outdoor wire, nearly complete cancellation of noise should result at the frequency of interest. As the indoor "trash" antenna is not receiving broadcast signals at anywhere near the level received by the outdoor wire, there is little chance that a broadcast signal could be cancelled out. The DXer should realise that phasing, in this application, is used only to null noise, not stations. If two external wires were used, phasing out stations would probably just yield the man-made noise. Also, with two outside wires, nulling the noise could also knock out wanted stations. The "trash antenna" concept seems to be the best solution in cases where man-made (indoor) noise is the most severe limitation on DXing. For the northeast US DXer with a specific interest, such as Caribbean DX, a motel room facing target stations (e. g. southeast) should be chosen. The inherent end-fire pattern of the shortwire run out the window would then be favourable for the DXer's intended target area. Even if a motel's electrical system is bristling with RF noise, decent DX should be possible, using the "indoor trash antenna phased against favourably directed external shortwire" concept. Of course, if the motel room window faces out to an ocean beach in the direction of desired DX, all the better.

Further Experimentation

The "trash antenna" concept just discussed is just one specialised case of a general rule in shortwire phasing: you should use <u>one aerial directed to strongly favour a desired target area</u> and a <u>second aerial sited to give the greatest unwanted signal to wanted signal</u> ratio. This is at odds with the common practice of Beverage phasing, in which parallel wires are used.

The aerial with the greatest unwanted signal (pest) to desired station (DX) ratio can be <u>scaled</u> by the 0 - 100K phasing unit input pot and then <u>subtracted</u> by phase cancellation from the wanted-station wire's signal with the result of <u>great cancellation of the pest with insignificant cancellation of desired DX</u>.

Some phased amplified shortwire aerial combinations for experimentation follow: (2-wire phasing) (Bearings in degrees east of north) (For MA/RI/NH/ME rx. QTH)

	DX aerial	Pest aerial	Expected result
1.	10 m. long/ 5 m. high, 50°	10 m. long, on gnd., 270°	Null midwest, get TA's
2.	" " " / " " ", 170°	" " " " ", 270°	Null midwest, get Caribbean
3.	10 m. vertical wire	" " " " ", 270°	Null high-angle domestics, [illegible]