A72-9-1

MWDX-4 & Mini-MWDX-4 Series Phasing Units

Mark Connelly —= WA1ION DX Labs
30 William Road —= Billerica, MA 01866
11 OCT 1985

This article describes the construction and use of two similar series of antenna phasing units for reception enhancement. Previous models built here had incorporated two homemade transformers and several other components not readily available in retail electronics outlets. This new design eliminates such custom components in addition to offering, in most applications, improved performance over earlier designs.

These units allow the operator to phase-cancel a dominant (interference, or "pest") signal and thereby receive signals which were formerly covered by the QRM. The phasing scheme can produce a cardioid (unidirectional null) pattern, the null bearing of which is electrically steerable. Two antennae are required: these are typically two end-fed longwires of comparable length.

A two-wire phasing unit consists of two antenna-tuners with outputs that can be combined in both additive and subtractive modes by means of a switchable-phase (0 / 180 deg.) transformer in the output leg of one of the tuners.

Each tuner consists of input coupling (the S4 "Length Switch" and associated components), a parallel L-C tank circuit with a low/medium-impedance output "tap" on the inductance (done by means of an inductive voltage-divider in this case), and a tank-shunting pot which adjusts the Q and the output level of the tuner. Antennae having a predominantly capacitive component to their reactance may be tuned with S4 set to "Short" or "Normal"; antennae (typically longer wires) having a large inductive or resistive impedance component should be tuned with S4 set to "Long". The "Long" position shunts each wire input with a 100 ohm resistor, causing some signal attenuation. This is generally not a problem as longer wires that require the "Long" position usually provide more signal than needed anyway. Wires with R and/or L-dominated impedance could be coupled to the tanks inductively, but this would make the circuit more complicated than desired; the improvement in signal coupling would be of minor worth.

Before phasing (nulling) can begin, each tuner must first be adjusted independently for peak signal at the frequency of operation: this is done by setting the S2 Function Switch to the position corresponding to the single tuner being adjusted, the S1 Frequency Range (inductor) Switch to the appropriate range setting (per look-up table), the associated pot to its maximum Q/maximum level setting, and the tuner's variable capacitor to the position producing the strongest wanted-frequency signal.

Once the two tuner-output lines are in a peaked condition, the pot on the tuner yielding the stronger signal from the station to be nulled must be adjusted so that the "pest" station level is equal on both tuner output lines. Actual nulling may then commence.

The S2 Function Switch is set to the Null position: this combines the outputs of the two tuners. Whether this combination is additive or subtractive is determined by the S3 Null-Type switch which is wired to the secondary of the TA1 phase-reversing transformer card. The S3 position yielding greater "pest" signal reduction is the position to be used. Nulling requires phase-shifting of the signal on one of the tuner output lines. The tuner whose pot is set to the higher-Q position can be shifted more than the other tuner; therefore, the higher-Q tuner is chosen to be phase-shifted. The shifting is accomplished by offsetting the chosen tuner's variable capacitor from its initial (peaked) position. A significant null is usually attainable with this adjustment; further fine-tuning (as outlined by the operating procedures later in this article) is sometimes needed to get the maximum null obtainable. Formerly subdominant signals occasionally are reduced in absolute strength when the "pest" is nulled; however, the wanted-signal to "pest" ratio is almost always improved dramatically.

Reduction of wanted subdominant signals is generally minimal if there is a substantial difference in great-circle bearing between the wanted signal(s) and the signal being nulled. Use of Beverage-length aerials also reduces the likelihood of mutual cancellation. The angle (horizontal and/or vertical) between the two wires used is not overly critical: useful nulls have been obtained with parallel wires, wires at a right angle, wires in opposite directions, and wires separated by just about any other angle.

Parallel Beverages, one terminated and configured to favour a particular target area (e. g. Africa), and the other unterminated, are said to give particularly good results, especially when the locality chosen has salt water in the direction of desired DX and blockage (hills, mountains, lossy ground) towards "pest" domestic stations.

At this point, it is worth mentioning that the signal ("station") to be nulled can be a local noise source (e. g. light-dimmer, TV) rather than an actual signal from a communications transmitter. The benefits of such a system should be obvious to those involved in weak-signal reception on frequencies below 5 MHz - e. g. the 160-m. ham, the Trans-Atlantic broadcast-band DXer, the LOWFER band operator, and the tropical-bands shortwave buff.

Nulling by means of a phasing unit has certain similarities to obtaining a null by mechanically rotating a directive antenna such as a loop or a Yagi beam, despite the fact that the patterns of a two-wire phaser, a loop, and a Yagi are all different. The greatest similarity regards stability of a null. A null will always be more stable if there is stability in horizontal and vertical arrival angles of the signal to be nulled. High-angle skywave, by itself or mixed with groundwave, is notoriously difficult to keep nulled because of the rapid arrival-angle variations and the multiple paths usually involved. Low-angle skywave and pure groundwave can be nulled to a greater depth (with less need for re-adjustment of nulling controls) than that of short-skip.

MWDX-4 and Mini-MWDX-4 series

MWDX-4 series phasing units are housed in chassis measuring 7" x 5" x 3" (17.8 x 12.7 x 7.6 cm). Mini-MWDX-4 series phasing units are housed in chassis measuring 5" x 4" x 3" (12.7 x 10.2 x 7.6 cm).

The MWDX-4 series offers built-in amplification capability; the Mini-MWDX-4 series units are passive. Mini-MWDX-4 units are intended for urban-site applications: those for which use of a broadband-amplifier is not recommended because of the potential for overload. If gain is desired at high-signal-level sites, an external high-Q / high-dynamic-range TUNABLE output amplifier should be placed between the phasing unit's output and the receiver's input.

Both series of phasers offer two-wire phasing capability; in addition, loop vs. wire capability is offered on the MWDX-4 series. The loop to be used must have certain modifications (this is discussed later in this article).

Individual models are designated MWDX-4A, MWDX-4B, MWDX-4C, MWDX-4D, Mini-MWDX-4A, Mini-MWDX-4B, Mini-MWDX-4C, and Mini-MWDX-4D. The letter suffix refers to the frequency range. Figures 1A through 1F and 2 show the units' circuitry. Table 1 illustrates the relationship of letter suffixes, inductor values, frequency ranges, and S1 switch positions.

A72-9-2

FIGURE 1A

(APPLIES TO MWDX-4 AND MINI-MWDX-4)

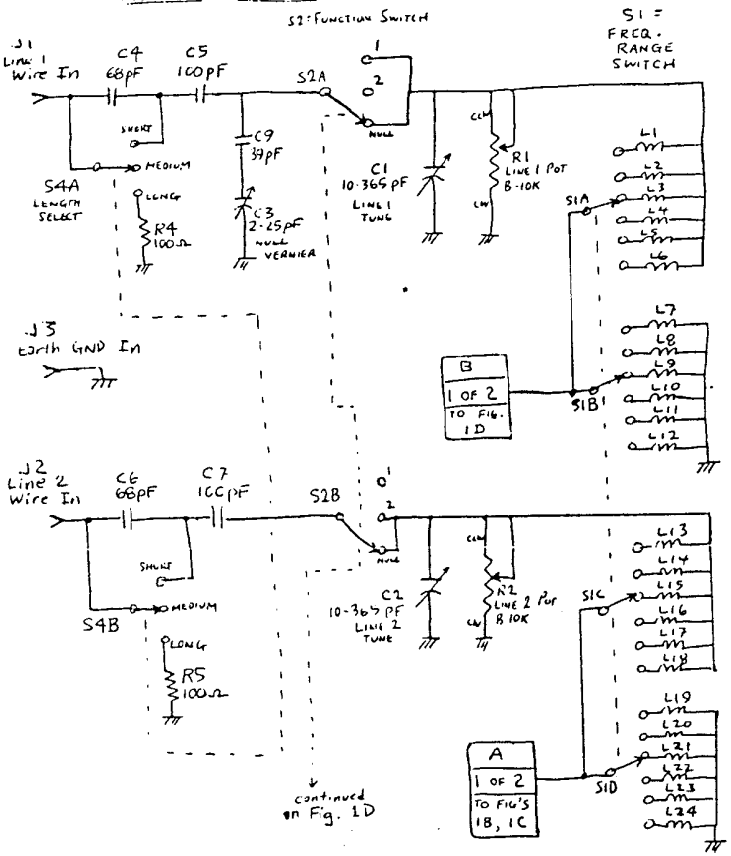


FIGURE 1B

(APPLIES TO MWDX-4 SERIES ONLY)

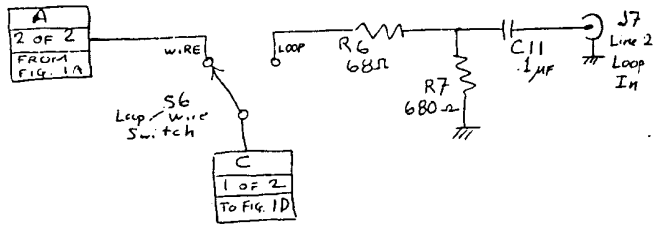


FIGURE 1C

(APPLIES TO MINI-MWDX-4)

FIGURE 1D

(APPLIES TO MWDX-4 AND MINI-MWDX-4)

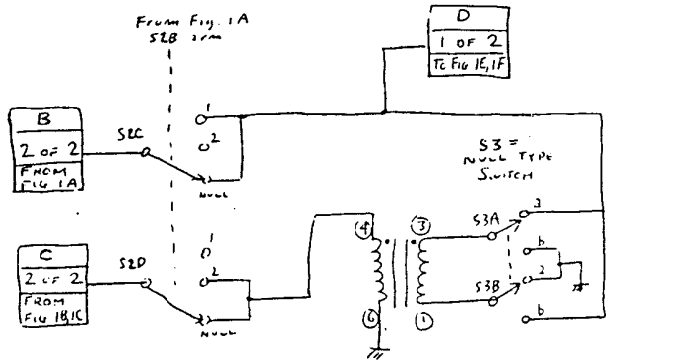
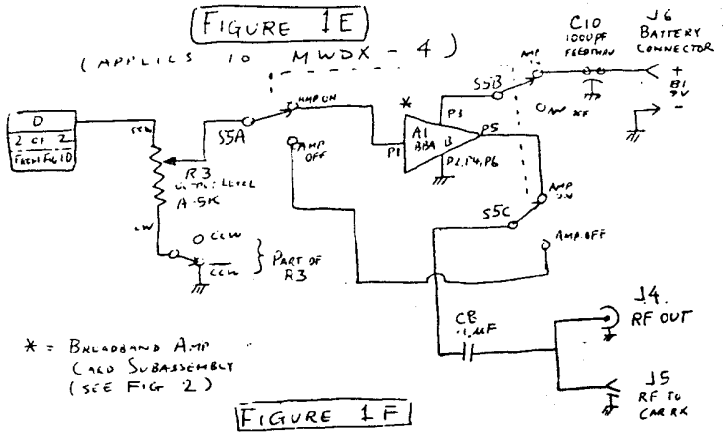


FIGURE 1E

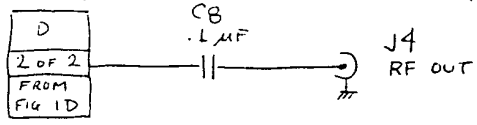
(APPLIES TO MWDX-4)



* = BROADBAND AMP (ASSEMBLY (SEE FIG 2)

FIGURE 1F

(APPLIES TO MINI-MWDX-4)



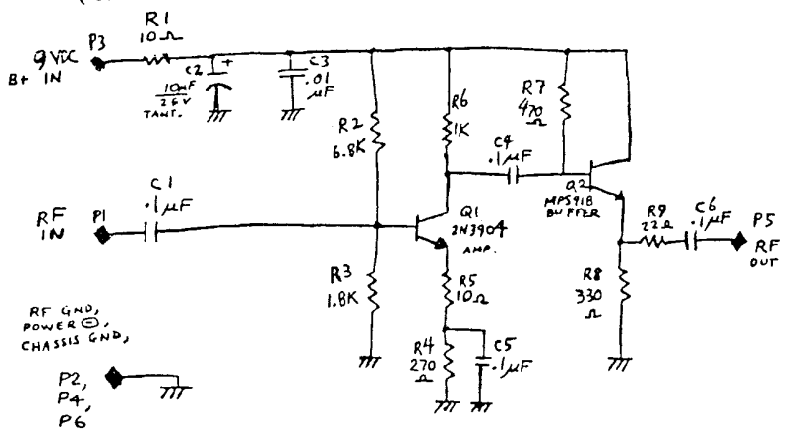
A72-9-3

FIGURE 2 (APPLIES TO MWDX-4)

BBA-B Broadband Amp. Card Schematic

REV: 20 JUL 1984

(SEE FIG. 6 FOR ASSEMBLY DRAWING)



COMPONENT DESIGNATIONS ON BBA-B CARD ARE SEPARATE ENTITIES FROM MAIN PHASING UNIT COMPONENT DESIGNATIONS.

Gain ≈ 20 dB (dependent on Z_in, Z_out)

0.1 to 30 MHz

TABLE 1

Inductors to be used on S1 (Frequency Range Switch)

Unit Suffix:	A	B	C	D
Freq. Range, kHz (approx.):	140-300, 480-2000	100-600	440-2300	1500-10000
Inductor L #'s	<—— INDUCTANCES in uH ——>			
1, 13	4700	15000	560	47
2, 14	2200	6800	330	22
3, 15	390	3300	180	10
4, 16	180	1500	100	4.7
5, 17	82	680	56	2.2
6, 18	39	330	33	1.0
7, 19	1000	3300	120	10
8, 20	470	1500	68	4.7
9, 21	82	680	39	2.2
10, 22	39	330	22	1.0
11, 23	18	150	12	0.47
12, 24	8.2	68	6.8	0.22

All inductors are standard values of moulded miniature inductors available from Mouser Electronics (Santee, CA) and other vendors.

By the above table, it can be seen that a "MWDX-4D" phasing unit could be expected to operate from 1.5 to 10 MHz, thereby being of use on ham bands from 160 through 30 metres, tropical bands from 120 through 60 metres, and international broadcast bands from 49 through 31 metres.

The next section of this article concerns operating the MWDX-4 and Mini-MWDX-4 series of phasing units. Parts lists and hole-drilling tables may be found after the operating section. Information regarding the construction of the phasers is an appendix to this article.

Operating the MWDX-4 and Mini-MWDX-4 series Phasing Units

/* The techniques outlined below should first be practiced on groundwave signals during the daytime. This condition yields the steadiest nulls; therefore, it is the appropriate condition to allow a new phasing unit user the ability to gain familiarity with phasing procedures and the feel of the controls. Practice frequencies should have 2 groundwave stations, one about 25 dB stronger than the other. */

/* The "pest station" to be nulled need not be an actual broadcast signal. It can be a man-made noise source (such as a light-dimmer or TV sweep circuit) covering wanted signals. */

P1

Two-Wire Phasing with the MWDX-4 Phaser

1.0 Initial Set-up

1.1 Set S5 (Amp. switch) to "Off" initially. Connect 9 V battery to J6 battery clip.

1.2 Connect wire ant. #1 to J1.

1.3 Connect wire ant. #2 to J2. The two wires should be of similar length. For frequencies of 500 kHz or less, 30 m. / 100 ft. is the minimum suggested length of each wire; for frequencies above 500 kHz, 15 m. / 50 ft. is the minimum suggested length of each wire.

1.4 Connect output cable from J4 (or J5) to receiver.

1.5 Set S6 Line-2 Input (Loop/Wire) select switch to Wire.

1.6 Set S4 (Length Switch) to Medium, unless each wire is considered to be short (shorter than 50 m. / 164 ft. at freq. <= 500 kHz. or shorter than 25 m. / 82 ft. at freq. > 500 kHz.). If antenna wires are considered short, set S4 to Short.

1.7 Set R3 (Output Level Pot) to max. level / fully CCW setting (knob pointer at 8:00).

1.8 Connect earth-ground (or mains / cold-water-pipe ground) wire, if available, to J3.

2.0 Frequency-Range Switch (S1) Setting

2.1 If you have an MWDX-4A, set S1 according to the Table 2.

Table 2 MWDX-4A / Mini-MWDX-4A Frequency Range Chart

Operating Freq.(kHz)	S1 position	"Clock" pos. of knob pointer
140 to 180	1	9:30 (fully CCW)
180 to 300	2	10:30
450 to 620	3	11:30
620 to 850	4	12:30
850 to 1300	5	1:30
1300 to 2000	6	2:30 (fully CW)

A72-9-4

Different tables for other coil groups (e. g. B, C, D) should be prepared by the phasing unit user. This can be done by experimentation or can be computed roughly by the BASIC program:

```
10 PRINT "(to stop program, enter 0)"
20 INPUT "Inductance (uH) of SLA coil selected";L
30 IF L=0 THEN 100
40 O=330\GOSUB 70\PRINT"Minimum frequency = ";F;" kHz"
50 O=150\GOSUB 70\PRINT"Maximum frequency = ";F;" kHz"
60 PRINT\GO TO 10
70 F=159155/((L*C)^.5)
80 RETURN
100 END
```

3.0 Line 1 Tune

3.1 Set R1 fully CCW (pointer at 8:00 / max. level).

3.2 Set S2 (Function Switch) to Line 1 (11:00 / fully CCW) position.

3.3 Set C3 to half-meshed (9:00 on knob pointer) position.

3.4 Adjust C1 for maximum signal at operating frequency.

3.5 If a peak cannot be obtained, set the S4 Length Switch to its "next longest position" (medium if it had been on short; long if it had been on medium), then repeat step 3.4. A suitable peak should now be obtained.

4.0 Line 2 Tune

4.1 Set R2 fully CCW (pointer at 8:00 / max. level).

4.2 Set S2 to Line 2 (12:00 / centre) position.

4.3 Adjust C2 for maximum signal at operating frequency.

5.0 Level Comparison / Equalisation

5.1 Observe S-meter or audible signal level of station to be nulled as you set S2 to 1 and then to 2.

5.2 If the signal noted with S2 on 1 is stronger than that noted with S2 on 2, adjust R1 until the levels seen at both the 1 and the 2 positions of S2 are the same. If you adjusted R1, go to section 6.0.

5.3 If the signal noted with S2 on 2 is stronger than that noted with S2 on 1, adjust R2 until the levels seen at both the 1 and the 2 positions of S2 are the same.

6.0 Null-Type Switch (S3) Setting

6.1 Set Function Switch (S2) to Null position (pointer at 1:00 / fully CW).

6.2 Set Null-Type Switch (S3) to Null-a and then to Null-b while observing S-meter or audible signal level. Leave S3 on the position which yields the greater null of the unwanted "pest" station (i. e. leave S3 on the position with the weaker pest station signal / greater evidence of subdominant station(s)).

7.0 Nulling

7.1 Adjust the capacitor on the line corresponding to whichever pot (R1 or R2) is still set at its initial fully-CCW setting. (C1 corresponds with R1, C2 with R2). If both pots are at fully CCW (no difference in line 1 & line 2 levels had been noted in section 5.0), start by adjusting C1.

[What you are adjusting-for is maximum null of the "pest" station: that is, establishment of the maximum ratio of wanted (previously-subdominant) signals to unwanted "pest" signal.]

7.2 Adjust the pot on the line opposite that of the capacitor you just tweaked (e. g. adjust R2 if you just tweaked C1) to deepen the null further. If the null depth is best with that pot fully CCW, leave it there and see if adjusting the other pot will deepen the null.

7.3 Make small successive adjustments of C1, C2, and whichever pot was used last in step 7.2 until maximum null depth has been obtained. Use C3 (Null Vernier), if necessary, to achieve the final amount of pest-cancellation attainable. Subdominant signal(s), if present, should now be audible with greatly diminished interference.

8.0 Amplification

8.1 If the desired signal(s) left after nulling the unwanted-dominant signal are too weak for adequate reception, perform the steps which follow in this section.

8.2 Set R3 to minimum output / fully CW (pointer at 4:00).

8.3 Set S5 (Amp. switch) to "On". Gradually bring R3 successively CCW, increasing RF output. Set R3 as far CCW as you can without introducing spurious mixing responses from stations not on the frequency of operation. In rural areas, full-gain amplifier operation (R3 at max. level setting) should be achievable without the introduction of "spurs": maximum realisable amplifier gain is approximately 20 dB.

8.4 Slight re-adjustments of the controls - (R1 or R2) and (C3) - may be needed to obtain the greatest null depth on the "pest" station.

****

Loop vs. Wire Phasing with the MWDX-4 Phaser

Follow two-wire procedure with following changes:

Before section 1.0:

```
/* Note: Loop to be used must have
   a) a Q-spoiling pot shunting the L-C tank (value = 18K or 25K,
      linear taper). This pot should be capable of being switched
      in or out by a toggle switch (to be referred to as the Q-switch).
   OR

   b) a tank-shunting Q-spoiling fixed resistor (18K or 15K) that can
      be switched in or out (by Q-switch); and a non-Q-spoiling level
      (amp. gain) pot.

   The pot used will be referenced as the Loop Pot.   */
```

Section 1.0 changes (steps replace those of same number) ...

1.3 Connect loop's output cable to J7. Initially set loop power switch to off.

1.5 Set S6 Line-2 Input (Loop/Wire) select switch to Loop.

(No changes to sections 2.0, 3.0)

Section 4.0 changes (steps replace those of same number) ...

4.1 Turn on loop power. Set loop's Q-switch to High-Q position. Set loop pot to max. level position.

4.3 Adjust loop tuning cap. for maximum signal at operating frequency; then set Q-switch to Low-Q.

Section 5.0 change (step replaces that of same number) ...

5.3 If the signal noted with S2 on 2 is stronger than that noted with S2 on 1, adjust the loop pot until the levels seen at both the 1 and the 2 positions of S2 are the same.

p10

(No changes to section 6.0) A-72-9-5

Section 7.0 changes (steps replace those of same number) ...

7.1 Adjust the capacitor on the line corresponding to whichever pot (R1 or the loop pot) is still set at its initial max. level setting. (C1 corresponds with R1, the loop tuning cap. with the loop pot). If both pots are at their max. level settings (no difference in line 1 & line 2 levels had been noted in section 5.0), start by adjusting C1.

[What you are adjusting-for is maximum null of the "pest" station: that is, establishment of the maximum ratio of wanted (previously-subdominant) signals to unwanted "pest" signal.]

7.2 Adjust the pot on the line opposite that of the capacitor you just tweaked (e. g. adjust the loop pot if you just tweaked C1) to deepen the null further. If the null depth is best with that pot at its initial setting (e. g. fully CCW for R1), leave it there and see if adjusting the other pot will deepen the null.

7.3 Make small successive adjustments of C1, the loop tuning cap., and whichever pot was used last in step 7.2 until maximum null depth has been obtained. Use C3 (Null Vernier) and slight physical re-positioning of the loop, if necessary, to achieve the final amount of pest-cancellation attainable. Subdominant signal(s), if present, should now be audible with greatly diminished interference.

Section 8.0 change (step replaces that of same number) ...

8.4 Slight re-adjustments of the controls - (R1 or the loop pot) and (C3) - may be needed to obtain the greatest null depth on the "pest" station.

****

Two-Wire Phasing with Mini-MWDX-4 series Phasing Units

Follow the MWDX-4 series Two-Wire Phasing procedure with the following changes:

Change all references to MWDX-4 to read Mini-MWDX-4.

Delete steps 1.1, 1.5, & 1.7.

Change step 1.4 to read as follows:

1.4 Connect output cable from J4 to receiver or to input of optional external amplifier (tuned or broadband) whose output feeds the receiver. If an external amplifier is used, set its function switch to "Off/Bypass" until section 8.0.

Section 8.0 header should read:

8.0 Amplification (optional)

Delete step 8.2.

Change step 8.3 to read as follows:

8.3 If you have an amplifier or active tuner in the line (up to now this has been in the "Off/Bypass" mode), set it up to amplify the phaser's output. Adjust active tuner controls, including regeneration if present, as if tuning a wire antenna. Adjust level control on amplifier or active tuner, if necessary, to prevent spurious responses, overloading, or oscillation.

Table 3 Hole List for MWDX-4 series phasing units

BOX USED = 7" X 5" X 3" (Mouser stock # 537-TF-782)

X = horizontal distance, in inches, from the vertical centreline (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.

++

LEFT SIDE

Hole #	Comp. Desig.	Description	X	Y	D
1	C3	Null Vernier Cap. - shaft	-1.375	1.125	0.28
2	J1	Line 1 Wire Ant. ban.jack	-0.75	0.5	0.3125
3	J3	Earth GND In ban.jack	0.0	0.5	0.3125
4	J2	Line 2 Wire Ant. ban.jack	0.75	0.5	0.3125
5	S4	Length switch - tab	-0.25	1.125	0.113
6	S4	Length switch - shaft	0.0	1.125	0.25
7	C1	GND R/W - int.lug	0.625	1.125	0.113
8	J7	Loop In - BNC jack	1.375	1.125	0.375

++

TOP SIDE

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

Hole #	Comp. Desig.	Description	X	Y	D
1	C1	Line 1 Tune Cap. - R/W 1	-2.75	3.838	0.14
2	C1	Line 1 Tune Cap. - shaft	-2.5	3.375	0.5
3	C1	Line 1 Tune Cap. - R/W 2	-2.75	2.912	0.14
4	C2	Line 2 Tune Cap. - R/W 1	-2.75	2.088	0.14
5	C2	Line 2 Tune Cap. - shaft	-2.5	1.625	0.5
6	C2	Line 2 Tune Cap. - R/W 2	-2.75	1.162	0.14
7	R1	Line 1 Pot - tab	-1.125	3.75	0.14
8	R1	Line 1 Pot - shaft	-0.8125	3.75	0.3125
9	S3	Null type switch - tab	-1.0	2.5	0.113
10	S3	Null type switch - shaft	-0.75	2.5	0.25
11	G2	GND R/W - int.lug	-0.1875	2.5	0.113
12	R2	Line 2 Pot - tab	-1.125	1.25	0.14
13	R2	Line 2 Pot - shaft	-0.8125	1.25	0.3125
14	S1	Freq.Range switch - tab	0.0	3.5	0.14
15	S1	Freq.Range switch - shaft	0.5	3.5	0.375
16	S2	Function switch - tab	0.0	1.5	0.14
17	S2	Function switch - shaft	0.5	1.5	0.375
18	A1	BBA-B Amp.Card - R/W 2	2.0	4.5	0.113
19	A1	BBA-B Amp.Card - R/W 1	3.0	4.5	0.113
20	A1	BBA-B Amp.Card - R/W 4	2.0	3.5	0.113
21	A1	BBA-B Amp.Card - R/W 3	3.0	3.5	0.113
22	T1	Phase Reverser Card- R/W 1	1.875	2.4	0.113
23	T1	Phase Reverser Card- R/W 2	1.875	1.6	0.113
24	R3	Output Pot - shaft	2.875	2.0	0.3125
25	R3	Output Pot - tab	3.1875	2.0	0.14
26	S6	Wire/Loop switch - shaft	1.875	0.625	0.25
27	S6	Wire/Loop switch - tab	1.875	0.375	0.113
28	S5	Amp. On/Off switch - shaft	2.75	0.625	0.25
29	S5	Amp. On/Off switch - tab	2.75	0.375	0.113

++

RIGHT SIDE

Hole #	Comp. Desig.	Description	X	Y	D
1	J6	battery holder - R/W 1	-1.875	1.0	0.113
2	J6	battery holder - R/W 2	-1.0	1.0	0.113
3	C10	B+ in feedthrough cap.	0.0	1.1875	0.188
4	G3	GND R/W - ext.lug	0.75	1.1875	0.113
5	J4	RF out to RX - BNC jack	0.0	0.5	0.375
6	J5	RF to car RX - R/W 1	1.5	1.288	0.14
7	J5	RF to car RX - body	1.5	0.894	0.5
8	J5	RF to car RX - R/W 2	1.5	0.5	0.14

A72-9-6

Table 4 Hole List for Mini-MWDX-4 series phasing units

BOX USED = 5" X 4" X 3" (Mouser stock # 537-TF-779)

X, Y, D parameters are as defined in Table 3.

LEFT SIDE

Hole #	Comp. Desig.	Description	X	Y	D
1	C3	Null Vernier Cap. - shaft	-1.375	1.125	0.28
2	J1	Line 1 Wire Ant. ban.jack	-0.75	0.5	0.3125
3	J3	Earth GND In ban.jack	0.0	0.5	0.3125
4	J2	Line 2 Wire Ant. ban.jack	0.75	0.5	0.3125
5	S4	Length switch - tab	-0.25	1.125	0.113
6	S4	Length switch - shaft	0.0	1.125	0.25
7	G1	GND H/W - int.lug	0.625	1.125	0.113

TOP SIDE

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

Hole #	Comp. Desig.	Description	X	Y	D
1	C1	Line 1 Tune Cap. - H/W 1	-1.75	3.338	0.14
2	C1	Line 1 Tune Cap. - shaft	-1.5	2.875	0.5
3	C1	Line 1 Tune Cap. - H/W 2	-1.75	2.412	0.14
4	C2	Line 2 Tune Cap. - H/W 1	-1.75	1.588	0.14
5	C2	Line 2 Tune Cap. - shaft	-1.5	1.125	0.5
6	C2	Line 2 Tune Cap. - H/W 2	-1.75	0.662	0.14
7	R1	Line 1 Pot - tab	-0.125	3.25	0.14
8	R1	Line 1 Pot - shaft	0.1875	3.25	0.3125
9	S3	Null type switch - tab	0.0	2.0	0.113
10	S3	Null type switch - shaft	0.25	2.0	0.25
11	G2	GND H/W - int.lug	0.8125	2.0	0.113
12	R2	Line 2 Pot - tab	-0.125	1.0	0.14
13	R2	Line 2 Pot - shaft	0.1875	1.0	0.3125
14	S1	Freq.Range switch - tab	1.0	2.75	0.14
15	S1	Freq.Range switch - shaft	1.5	2.75	0.375
16	S2	Function switch - tab	1.0	1.0	0.14
17	S2	Function switch - shaft	1.5	1.0	0.375

RIGHT SIDE

Hole #	Comp. Desig.	Description	X	Y	D
1	TA1	Phase Rev. card - H/W 1	-0.875	1.3	0.113
2	TA1	Phase Rev. card - H/W 2	-0.875	0.5	0.113
3	J4	RF Out - BNC jack	0.0	0.5	0.375

Parts Lists for MWDX-4 and Mini-MWDX-4 phasing units

Table 5 = "upper level" of electrical & major mechanical components
Table 6 = TA1 phase-reversal transformer card subassembly components
Table 7 = A1 (BBA-B) broadband-amplifier subassembly components
Table 8 = small hardware

* = MWDX-4 only $ = Mini-MWDX-4 only

Vendor Abbreviations

DK = Digi-Key - P. O. Box 677 - Thief River Falls, MN 56701
MCL = Mini-Circuits Lab.- 2625 E. 14th St. - Brooklyn, NY 11235
MOU = Mouser Electronics- 11433 Woodside Ave.,- Santee, CA 92071
NEW = Newark Electronics- (many locations)
RS = Radio Shack - (many locations)

Table 5 = "upper level" of electrical & major mechanical components

Component Designation	Description	Vendor	Stock #
BOX			
$ —	chassis box (5"X4"X3")	MOU	537-TF-779
* —	chassis box (7"X5"X3")	MOU	537-TF-782
SUBASSEMBLIES			
* A1	broadband amp. subass'y	[see Table 7]	
TA1	phase-reversing xfmr.card	[see Table 6]	
CONTROLS			
C1	10-365 pF var. capacitor	MOU	524-A1-227
C2	10-365 pF var. capacitor	MOU	524-A1-227
C3	2-25 pF var. capacitor	MOU	538-189-0569-1
R1	10K linear-taper pot	MOU	31CT401
R2	10K linear-taper pot	MOU	31CT401
* R3	5K audio-taper pot	MOU	31CB305
S1	4-pole, 6-pos. switch	MOU	10WA046
S2	4-pole, 3-pos. switch	MOU	10WA043
S3	DPDT on/on toggle switch	RS	275-663
S4	DPDT on/off/on toggle	RS	275-664
* S5	3PDT on/on toggle switch	RS	275-661
* S6	SPDT on/on toggle switch	RS	275-662
JACKS - CONNECTORS			
J1	banana jack (red)	RS	274-662
J2	banana jack (red)	RS	274-662
J3	banana jack (black)	RS	274-662
J4	BNC jack	RS	278-105
* J5	Motorola jack	MOU	16RJ107
* J6	battery holder (Keystone 1290)	MOU	534-1290
* J7	BNC jack	RS	278-105
ELECTRICAL COMPONENTS			
* B1	9V battery	RS	23-553
C4	68 pF mica capacitor	MOU	ME232-1500-068
C5	100 pF mica capacitor	MOU	ME232-1500-100
C6	68 pF mica capacitor	MOU	ME232-1500-068
C7	100 pF mica capacitor	MOU	ME232-1500-100
C8	.1 uF monolithic cap.	DK	P4525
C9	39 pF disc cap	MOU	21CB039
* C10	1000 pF feedthrough cap.	NEW	19F2861
* C11	.1 uF monolithic cap.	DK	P4525
L1 through L24		MOU	[see Table 1 & catalogue]
R4	100 ohm resistor	RS	271-812
R5	100 ohm resistor	RS	271-812
* R6	68 ohm resistor	RS	271-810
* R7	680 ohm resistor	RS	271-821
KNOBS			
—	knob for C1	RS	274-415 (pk 2)
—	knob for C2	RS	274-415 (pk 2)
—	knob for C3	RS	274-415 (pk 2)
—	knob for R1	MOU	45KN013
—	knob for R2	MOU	45KN013
* —	knob for R3	MOU	45KN013
—	knob for S1	MOU	45KN013
—	knob for S2	MOU	45KN013

A72-9-7

Table 6 - TA1 phase-reversal transformer card subassembly components

Designation(s)	Description	Vendor	Stock #	Qty.
BD	perfboard(0.6"x1.2")	RS	276-1396 (cut)	1
H1, H2	4-40 x .25 screw	DK	H142	2
H1, H2	4-40 x .5 spacer	MOU	565-2332	2
H1	#4 split lockwasher	MOU	572-00649	1
H2	#4 solder lug	MOU	565-1416-4	1
P1,P2,P3,P4	flea-clip .042"	MOU	574-TM2-1/100	4
T1	1:1 RF transformer	MCL	T1-6	1
W	bus wire	RS	278-1341 approx.	6"

Table 7 - A1 (BBA-B) broadband-amplifier subassembly components

Designation(s)	Description	Vendor	Stock #	Qty.
BD	perfboard(1.4"x1.4")	RS	276-1396 (cut)	1
C1; C4, C5, C6	.1 uF mono. cap.	DK	P4525	4
C2	10 uF/25V tant. cap.	DK	P2049	1
C3	.01 uF cer. disc cap.	RS	272-131	1
H1, H2, H3, H4	4-40 x .25 screw	DK	H142	4
H1, H2, H3, H4	4-40 x .5 spacer	MOU	565-2332	4
H1, H2, H3, H4	#4 split lockwasher	MOU	572-00649	3
H4	#4 solder lug	MOU	565-1416-4	1
P1, P2, P3, P4, P5, P6	flea-clip .042"	MOU	574-TM2-1/100	6
Q1	2N3904 NPN	DK	2N3904	1
Q2	MPS918 NPN	DK	MPS918	1
R1, R5	10 ohm res.	RS	271-1301	2
R2	6.8K res.	RS	271-1333	1
R3	1.8K res.	RS	271-1324	1
R4	270 ohm res.	RS	271-1314	1
R6	1K res.	RS	271-1321	1
R7	470 ohm res.	RS	271-1317	1
R8	330 ohm res.	RS	271-1315	1
R9	22 ohm res.	RS	271-005	1
W	bus wire	RS	278-1341 approx.	1'
Small hardware	[* = component only used on MWDX-4 series]			

NOTE: Mounting hardware is supplied with the following components: C3, J1, J2, J3, J4, * J7, R1, R2, * R3, S1, S2, S3, S4, * S5, * S6, knobs, and chassis box.

The builder should have a good stock (min. 20 pieces / item) of each type of hardware in Table 8.

Table 8 small hardware

Description	Vendor	Stock #
4-40X.25" screw	DK	H142
4-40 nut	DK	H216
#4 split lockwasher	MOU	572-00649
#4 solder lug	MOU	565-1416-4
6-32X.25" screw	DK	H154
6-32X.375" screw	DK	H156
6-32 nut	DK	H220
#6 split lockwasher	MOU	572-00650

MISC. - bus wire, hook-up (insulated) wire, coax. cable, twisted-pair wire, solder — "AS REQUIRED"

A P P E N D I X

Building the MWDX-4 and the Mini-MWDX-4 series of phasers

Most construction notes & documentation (other than the previous hole lists) apply to both series of units. If a note applies to only one series of unit, it will be identified as such.

Step-by-step instructions (à la Heathkit) are not included, as this is intended to be a project for people with at least a modicum of "homebrewing" experience.

The construction outline is as follows:

1. Preparation

   a) Ensure that work area is equipped with common electronics-industry assembly tools.

   b) Gather parts required (see parts lists, schematics).

   c) Make a copy of this article to keep at the workbench for possible marking-up / checking-off purposes.

2. Chassis-Drilling

   a) Ensure that hole list is adjusted (if necessary) if you have substituted components different from those on the parts lists.

   b) Use an accurate draftsman's steel ruler and a scriber / awl to draw 1"-spaced X & Y coordinate grid lines on the top, the left side, and the right side of the chassis box to be used. Coordinate conventions are defined in the hole lists.

   c) Mark each hole locus with scriber. Dig the scriber into the metal enough that a small drill bit (e. g. .113") will not slip.

   d) Drill each hole initially with a small drill bit: e. g. .113".

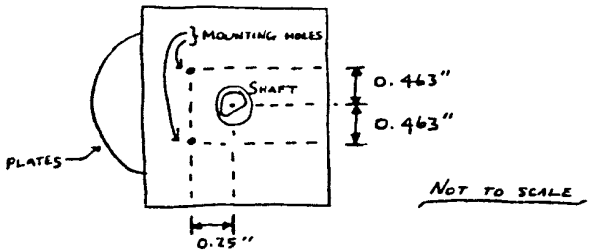
   e) Drill all holes with proper-size bit, per hole list. Holes to be larger than .25" should probably be drilled with a .25" bit as an interim measure to prevent slippage of larger bits.

3. Component Preparation

   a) Variable Capacitors C1 & C2: Use a 6-32 tapper to tap (put threads in) the mounting holes identified by Figure 3.

Figure 3

TOP (SHAFT-END) VIEW OF VARIABLE CAPACITORS SHOWING MOUNTING HOLES TO BE TAPPED



   b) TA1 subassembly: Assemble T1 transformer & hardware onto 0.6" x 1.2" vectorboard as shown in Figures 4, 5A, and 5B.

   c) S1 Frequency-Range Switch: Assemble inductors L1 through L24 (per schematic and Table 1) onto S1. Switch Position 1 (lowest frequency range) is fully counterclockwise (CCW) if switch is observed from the shaft side. Keep lead lengths as short as possible; try to minimize volume occupied by S1 and its inductors.

   d) [MWDX-4 series only] BBA-B Broadband Amplifier Card subassembly: Assemble the BBA-B Amp. Card (refer to following Figure 6 and previous Figure 2 and Table 7). An International Crystal Manufacturing BAX-1 amplifier may be substituted for the BBA-B; however, the BBA-B has somewhat better dynamic range and better performance into low-impedance outputs than the BAX-1 has. BBA-B hardware assemblies H/W 1, 2, & 3 are the same as that depicted by Figure 5A; assembly H/W 4 is the same as that depicted by Figure 5B. The same H/W assemblies may be employed if an I. C. M. BAX-1 amplifier card is to be installed instead.

A72-9-8

Figure 4

(H/W 1 is shown in Figure 5A; H/W 2 is shown in Figure 5B.)

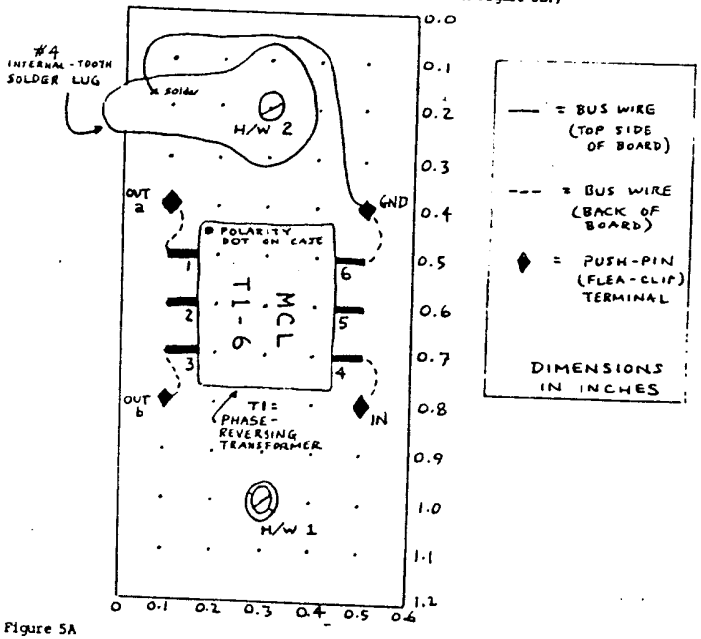


Figure 5A

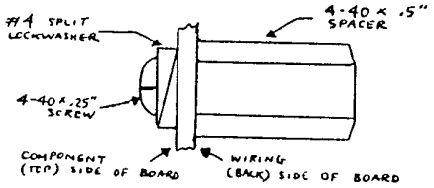
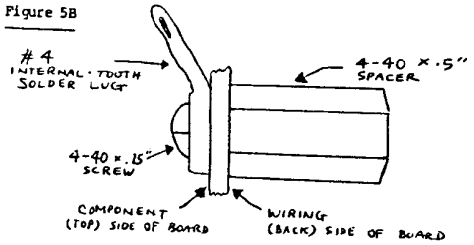
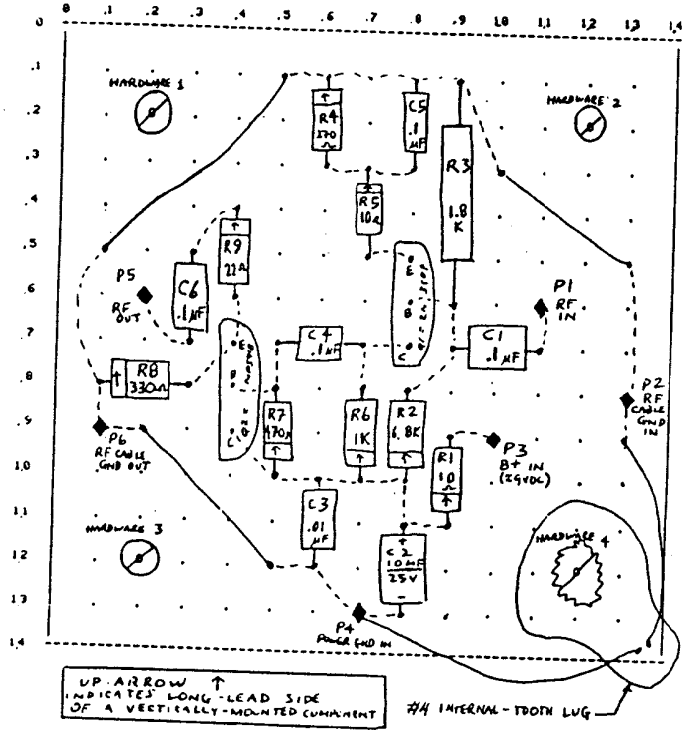


Figure 5B



P18

FIGURE 6 MWDX-4 PHASING UNIT: A1 SUBASSEMBLY
BBA-B BROADBAND AMPLIFIER CARD "ROADMAP"
WAIZON DX LABS : REV= 20 JUL 1984



VECTORBOARD / PERFBOARD USED IS 1.4" x 1.4"

FOR SCHEMATIC, SEE FIGURE 2.
FOR PARTS LIST, SEE TABLE 7.

GAIN ≈ 20 dB, 0.1 TO 30 MHz

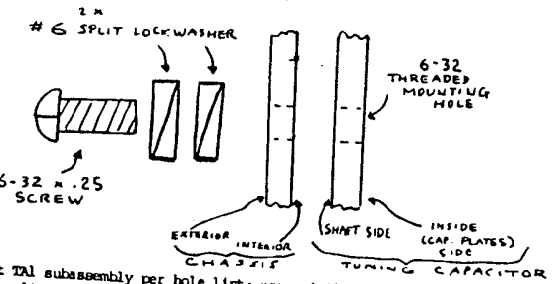
BBA-B CARD COMPONENT DESIGNATIONS ARE A SEPARATE ENTITY FROM THE DESIGNATIONS OF MAIN-ASSEMBLY COMPONENTS.

A72-9-9 p17

4. Component Mounting

a) Mount C1 and C2 per hole list and Figure 7.

Figure 7 Exploded view, C1 & C2 mounting H/W (2 locations per capacitor)



b) Mount TA1 subassembly per hole list; use a 4-40 x .25 screw with a #4 split-lockwasher (flat of screw head against lockwasher; lockwasher against exterior surface of box). (2 mounting locations)

c) [MWDX-4 series only] Mount A1 (BBA-B or BAX-1) card subassembly in the same manner used to mount the TA1 card. (4 locations)

d) Install grounding hardware assemblies (see Figures 8A & 8B) at loci called out on hole list.

Figure 8A

GND H/W - Int. Lug

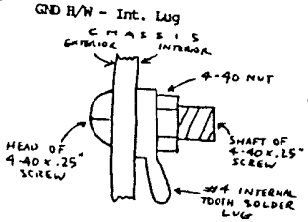
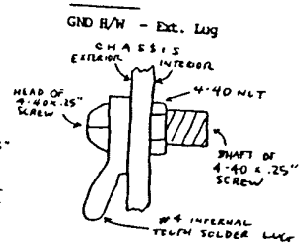


Figure 8B

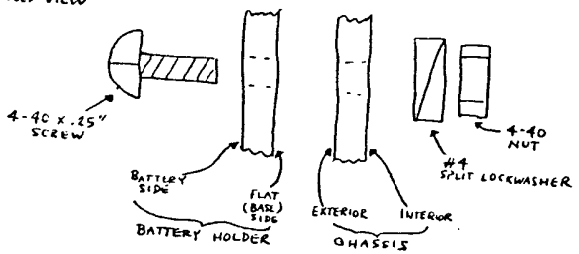
GND H/W - Ext. Lug



e) [MWDX-4 series only] Install Keystone 1299 battery holder (J6) per hole list. Use the two mounting holes at the end of the battery holder opposite that of the terminals. Use hardware depicted by Figure 9 at each mounting hole.

Figure 9

EXPLODED VIEW

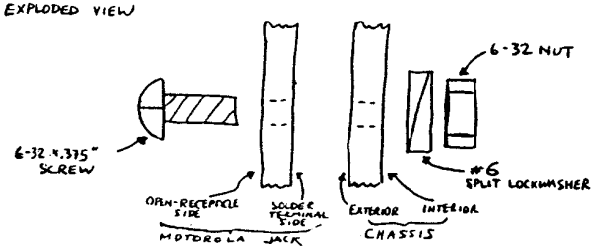


p20

f) [MWDX-4 only] Mount Motorola jack (J5) in accordance with Figure 10 and hole list (2 mounting locations).

Figure 10

EXPLODED VIEW



g) Assemble all other components (refer to hole list, schematic, and parts list) with the mounting hardware supplied with these jacks, pots, switches, etc.

h) Install knobs (as indicated by parts list) on all appropriate controls. Pointer orientation should conform to Table 6.

Table 6 Control Orientation Conventions

* = MWDX-4 series only

	S4	short = left / medium = centre / long = right
	C3	fully open (Cmin) = 12:00 / fully meshed (Cmax) = 6:00
	C1	fully open (Cmin) = 12:00 / fully meshed (Cmax) = 6:00
	C2	fully open (Cmin) = 12:00 / fully meshed (Cmax) = 6:00
	R1	max.level = fully CCW = 8:00/ min.level = fully CW = 4:00
	R2	max.level = fully CCW = 8:00/ min.level = fully CW = 4:00
	R3	max.level = fully CCW = 8:00/ min.level = fully CW = 4:00
	S3	Null a = left / Null b = right
	S1	range 1 = fully CCW = 9:30 / range 6 = fully CW = 2:30
	S2	Line 1 = 11:00 / Line 2 = 12:00 / Null = 1:00
*	S6	wire = up / loop = down
*	S5	Amp. On = up / Amp. Off = down

5. Circuit Connection (Wiring)
Use the schematic to make wiring connections within the unit. Lead lengths should be kept as short and as close to the chassis as practicable. "Hook-up" wire (approx. #20 A.W.G., insulated) is to be used with the following exceptions:

a) [Both series of units] Install 3.5" twisted pair:
Cond. 1: From S3A arm - To TA1 Out-b pin
Cond. 2: From S3B arm - To TA1 Out-a pin

b) [MWDX-4 series only] Install 4" RG-174 coax (or other shielded cable):
Cond. 1 (hot): From S5C "On" pin - To P5 of A1 card
Cond. 2 (GND): From TA1 GND lug - To P6 of A1 card

c) [MWDX-4 series only] Install 4" RG-174 coax (or other shielded cable):
Cond. 1 (hot): From S5A "On" pin - To P1 of A1 card
Cond. 2 (GND): From TA1 GND lug - To P2 of A1 card

6. Final Touches: Affix suitable labels to controls. Check all wiring. Blow any solder and wire scraps out of unit; clean flux from solder joints with alcohol or another suitable solvent.

\# END #