SERVICE MANUAL 6349

Description, Installation and Maintenance

TUNED MINIBOND

Part Numbers

N451003-	1802	1803	1804	1805

June, 1985
ID0037F/DN0007F
A-3/88-25 2776-2

PRINTED IN USA

UNION SWITCH & SIGNAL
AMERICAN STANDARD INC./PITTSBURGH, PA. 15237

REVISION INDEX

Revised pages of this manual are listed below by page number and date of revision.

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SECTION I
GENERAL INFORMATION

1.1 INTRODUCTION

The Tuned Minibond is an extension of the basic audio frequency (AF) minibond with a center tapped primary and an inductively coupled secondary winding that is tuned to increase the impedance of the bond at desired frequencies.

1.2 DESCRIPTION

Like the basic AF Minibonds, the Tuned Minibonds have a center- tapped propulsion winding and permit coupling of ac signals between the secondary winding and the propulsion winding. The Tuned Minibond differs in the number of cores and secondary windings. The Tuned Minibond has three magnetic cores. Each core has two secondary windings. The propulsion winding is common to all three cores (see Figure 3-4).

The high turn secondary winding of each core is tuned to a particular frequency (depends on the part number of the bond). The low turn secondary windings are series connected. The group is connected to the high side of a coupling transformer. The wayside equipment would be connected to the low side of the transformer. The use of two secondaries per core allows the tuned windings to be isolated from each other.

Since each parallel resonant circuit has its own magnetic core, the bond impedance can be represented as the sum of the reflected impedances of the resonant circuits. This is true for both the propulsion winding termination and the wayside termination. The impedances can be complex. Section 3.2 (Design Concepts) discusses the above in more detail.

Each circuit is tuned to a different frequency called the resonant frequency. At the resonant frequency the impedance of the resonant circuit is high. The reflected impedance to the track or wayside will also be high. In summary, the bond's reflected impedance to the track or wayside terminals will be high near any one of the three resonant frequencies. Away from the resonant frequencies, the bond impedance will be low.

1.3 SPECIFICATIONS

1.3.1 Electrical

a. All Tuned Minibonds

Style:	AF Mini
Type:	DC Propulsion
DC Resistance:	0.00003 $\pm$ 10% ohms, rail to rail at 20°C
Current Unbalance:	250 amps dc through one turn of the propulsion winding, based on the operating characteristics of the AF-700 track circuit system.
DC Propulsion current:	3000 amps dc per rail (continuous)

b. Impedance and Resonant Frequencies

Part No. Suffix	Track Trans.		Cab Trans.		Track Rec.	
	Z±10%	Freq. ±5%	Z±10%	Freq. ±5%	Z±10%	Freq. ±5%
-1802	0.663	2590	1.15	4550	1.73	3870
-1803	0.760	2970	1.15	4550	1.58	3690
-1804	0.875	3690	1.15	4550	1.35	2590
-1805	0.868	3870	1.15	4550	1.55	2970

Some bonds are off-tuned at given frequencies to increase their dc unbalance current capacity. Values are based upon zero amps of dc unbalance current, at 20°C and at specified voltage levels. Impedance values will vary with variations of these parameters.

1.3.2 Mechanical

The Tuned Minibond utilizes moly-permalloy toroidal cores to construct three coils. Each coil has two windings. The three coils are bound together to form a coil assembly. The low turn windings of the coils are series connected. Two J-shaped bars of 1-1/4 inch copper are passed through the window of the coil assembly to form the two-turn track winding. The coil and core assembly, mounting plate, receptacle box connector, inserts, and screws are assembled into a mold. The mold is then filled with an epoxy compound and cured.

The mold forms a cavity at the back of the bond. There are four long studs inside the cavity. These studs are used to mount a circuit assembly. Each circuit assembly contains two boards. One board contains a coupling transformer and capacitors for tuning the bonds. The other board contains the resistors used to adjust the impedance of the bonds.

A sealing compound is applied to the back edges of the bond where the cover is assembled. The cover will make contact with a steel plate on the resistor printed circuit board. This provides a heat sink path for resistors located on the reverse side of the plate.

A two-pin connector protrudes from one side of the bond. This is where the connection to the wayside equipment is made. A nameplate is located on the opposite side.

Six 1/2-13 by 1-3/8 (approx.) inch studs protrude from the bottom of the bond. These studs are welded to the mounting plate mentioned earlier. These studs are used for mounting the bond during installation.

SECTION II
INSTALLATION

2.1 GENERAL

WARNING

TO AVOID PERSONAL INJURY WHILE INSTALLING IMPEDANCE BONDS, BE SURE TO DISCONNECT PROPULSION AND SIGNAL CURRENT IN THE WORKING AREA.

NOTE

Installation requirements for an impedance bond are controlled primarily by the physical specifications of the user's trackage and associated signal hardware. The following remarks and drawings are intended only as a general guide to installation. The customer should make whatever adjustments are necessary to insure (a) that the bonds, cables and other pieces are well secured, with no possibility of being damaged by low hanging vehicle rigging, wheel flanges, etc. and (b) the section of track outfitted with the bonds maintains standards for tie spacing, ballast support, etc.

2.1.1 Track Preparations

Using the appropriate installation drawing for the impedance bond, reposition and refashion the ties as needed to meet basic mounting requirements for the unit and any auxiliary pieces such as a protective ramp. Replace any deteriorated ties which may not hold attachment screw threads reliably. Where necessary, excavate ballast between the ties to insure that the bond will rest flush against the ties. Use the application drawing to locate hold-down screw holes for the bond and other pieces, with the object of installing the equipment on the center line between the rails.

2.1.2 Installation of Cables

Bond-to-bond cables are prepared according to the basic distance between bond units and special requirements such as crossbonding to other tracks. Propulsion cables should be prepared with length sufficient to take up rail running motion. Have the ties support the cable as much as possible and secure the cable to the tie so that only the outward end absorbs rail movements.

2.1.3 Cable Connections

A tin foil gasket (M06961) has been used between cable lugs and impedance bond terminals. This gasket improves conductivity by filling imperfections in the mating surfaces. The same result is achieved by tinning the terminals and lugs.

a. When a tinned or smooth surface lug is used with an impedance bond having tinned terminals, the tin foil gasket may be omitted.

b. A tin foil gasket shall be used between the mating surfaces of an impedance bond terminal and cast cable lug or where the mating surfaces are not smooth.

Corrosion at the bond terminal connections can be reduced by coating the connecting surfaces with a corrosion preventive type of oil or grease. A conductive type is recommended.

2.2 APPLICATION

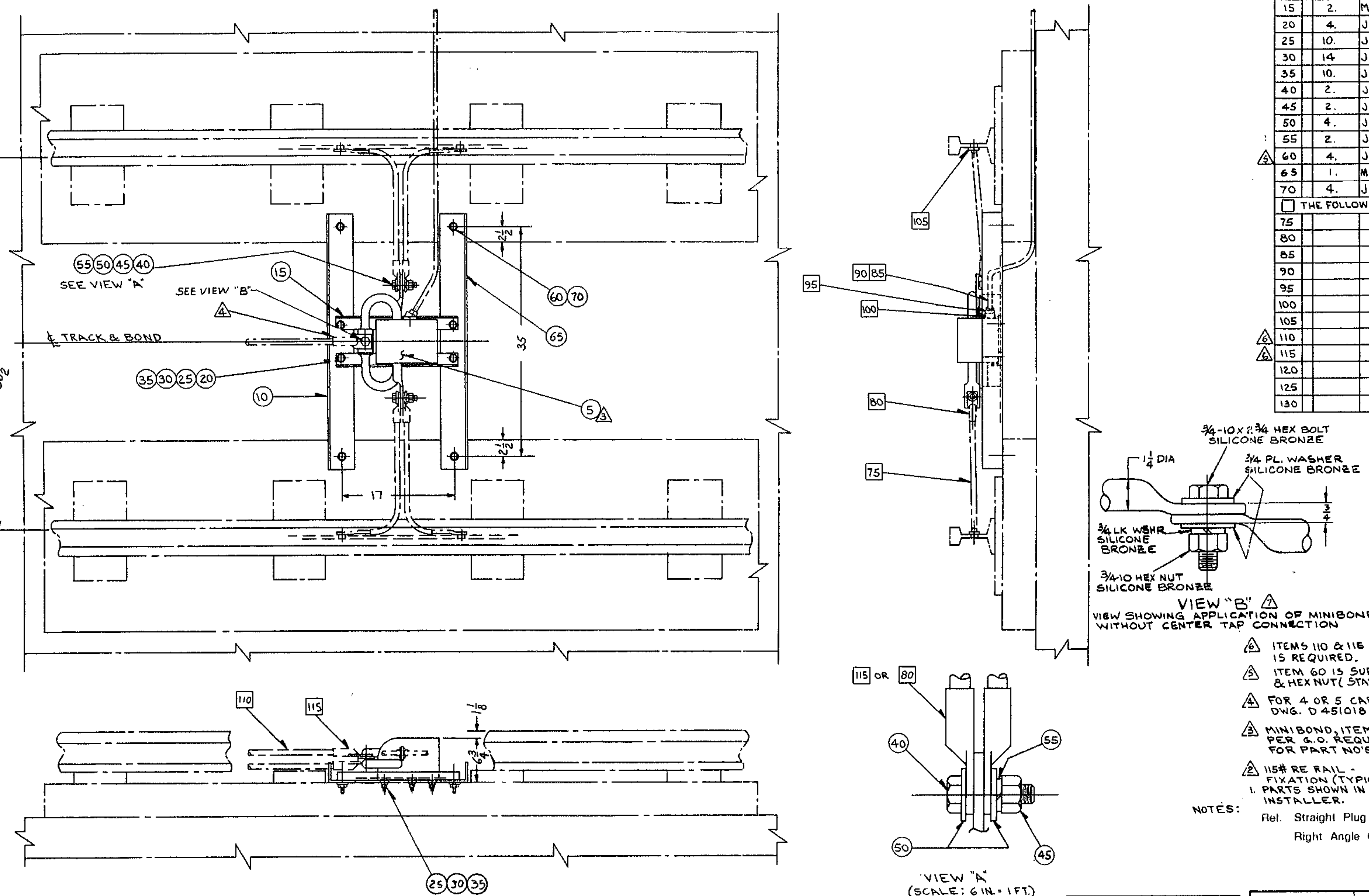
Figures 2-1 through 2-4 provide information for the application of the tuned minibond to 115 lb. RE rail at sites employing the following:

a. floating concrete slab and direct fixation (typical), Figure 2-1.

b. concrete ties, 30" or 33" spacing (typical), 30" shown, Figure 2-2.

c. wood ties (typical mounting), Figure 2-3.

d. Vagheux concrete ties (typical mounting), Figure 2-4.



				X	451486	SEE GROUP	LAYOUT-TUNED MINIBOND	D	451486	10	
ITEM NUMBER	GROUP-1001 U/M	QUANTITY UNITS	DEC.	PART IDENTIFICATION T	NUMBER	SUFFIX	DESCRIPTION	DRAWING T	NUMBER	SHEET	SUB
5		1.			(3)		MINIBOND-TUNED	C	451003	13	
10		1.		M	451004	6601	BRACKET-ANGLE MTG	D	451004	66	
15		2.		M	451004	6802	BRACKET-ANGLE MTG	D	451004	68	
20		4.		J	050095		SCR. ½-13 x 1¾ HEX. STL.				
25		10.		J	048013		NUT-½-13 HEX. STL. HVY. SF. CAD.PL.				
30		14		J	047503		WSHR-½ PL STL CAD.PL.				
35		10.		J	047783		WSHR-½ LK STL CAD.PL				
40		2.		J	460119		BLT-¾-10 X 2-¾ HX HD SB				
45		2.		J	480304		NUT-¾-10 HEX S.B.				
50		4.		J	475196		WSHR-¾ PL FLAT S.B.				
55		2.		J	475197		WSHR-¾ SPR LK S.B.				
(5) 60		4.		J	460120		ANCH. BLT. ½-13 x 3¾ SST				
65		1.		M	451004	6602	BRACKET, ANGLE MTG.	D	451004	66	
70		4.		J	475121	0115	WSHR-½ LK SST	V	475121	01	
☐ THE FOLLOWING ITEMS, SUPPLIED BY INSTALLER, ARE FOR REF. ONLY											
75							CABLE-500 MCM				
80							LUG				
85							CABLE-#14 AF				
90							CONDUIT				
95							CLAMP-CABLE				
100							CONN-PIN				
105							CONN-TERMINAL PIN				
(6) 110							CABLE-1000 MCM				
(6) 115							LUG				
120											
125											
130											

SB = SILICON BRONZE

NOTES:

8. CABLES ANCHORED TO TIES PER INSTALLER DRAWINGS.

(7) HARDWARE FOR THE MINIBOND CENTER TAP IS SUPPLIED WITH THE MINIBOND.

(6) ITEMS 110 & 115 TO BE USED ONLY WHEN CENTER TAP IS REQUIRED.

(5) ITEM 60 IS SUPPLIED WITH PLAIN WASHER & HEX NUT (STAINLESS STEEL).

(4) FOR 4 OR 5 CABLE CONNECTION SEE APPLICATION DWG. D451018-SH. 28, **FIGURE 2-5.**

(3) MINIBOND, ITEM 5, TO BE ORDERED BY SYSTEMS ENG'R. PER G.O. REQUIREMENTS. SEE DWG. C451003-SH. 13 FOR PART NO'S.

(2) 115# RE RAIL - FLOATING CONCRETE SLAB, & DIRECT FIXATION (TYPICAL MOUNTING).

1. PARTS SHOWN IN FULL LINES TO BE FURNISHED BY US&S OR INSTALLER.

Ref. Straight Plug Connector J709146-0292

Right Angle Connector J709146-0291

PART NUMBER	DESCRIPTION	MATERIAL/SPECIFICATION
X451486-1001	TUNED MINIBOND MOUNTING	(2)

DIMENSIONS ARE IN INCHES. SCALE 1½ IN. = 1 FT.

DR. JOHUNTER 7-1-82

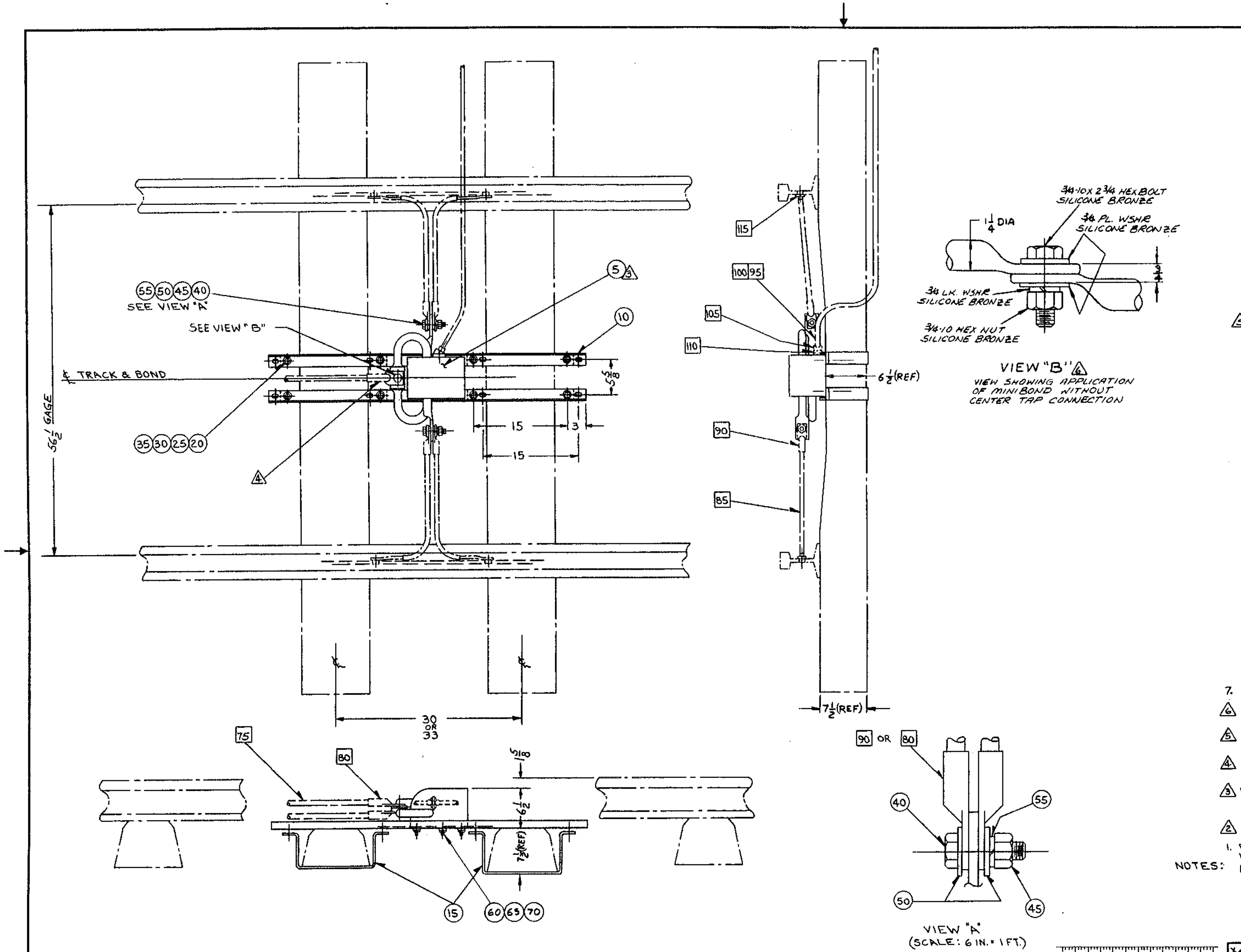
LAYOUT OF IMPEDANCE BOND WITH CONNECTION TO RAIL

UNION SWITCH & SIGNAL DIVISION
AMERICAN STANDARD INC.
SWISSVALE, PA 15218 U.S.A.

CODE IDENT NO. 61775 | SIZE D | 451486 | SHEET 10 | REV. 2

REVISIONS

Figure 2-1. Floating Concrete Slab and Direct Fixation



GROUP-1101 QUANTITY UNITS	ITEM NUMBER	T	PART IDENTIFICATION NUMBER	SUFFIX	DESCRIPTION	T	DRAWING NUMBER	SHEET	SUB
		X	451486	SEE GROUP	LAYOUT-TUNED MINIBOND	D	451486	11	
1.	5		△3		MINIBOND-TUNED	C	451003	13	
2.	10	M	451004	6801	BRACKET-ANGLE MTG	C	451004	68	
4.	15	M	451004	6501	BRACKET-MOUNTING	B	451004	65	
8.	20	J	050060		SCR, ⅜-16 x 2 HEX.STL. FIN. CAD. PL.				
8.	25	J	048009		NUT, ⅜-16 HEX.STL. HVY. SF. CAD. PL.				
16.	30	J	047502		WSHR-⅜ PL STL.CAD.PL.				
8.	35	J	047779		WSHR-⅜ LK STL CAD.PL.				
2.	40	J	460119		BLT-¾-10 X 2-¾ HX HD S.B.				
2.	45	J	480304		NUT-¾-10 HEX S.B.				
4.	50	J	475196		WSHR-¾ PL FLAT S.B.				
2.	55	J	475197		WSHR-¾ SPR LK S.B.				
6.	60	J	048013		NUT, ½-13 HEX.STL. HVY. SF. CAD. PL.				
6.	65	J	047503		WSHR-½ PL. STL.CAD.PL.				
6.	70	J	047783		WSHR-½ LK. STL.CAD.PL.				
THE FOLLOWING ITEMS, SUPPLIED BY INSTALLER, ARE FOR REF. ONLY									
△5	75				CABLE-1000 MCM				
△5	80				LUG				
	85				CABLE-500 MCM				
	90				LUG				
	95				CABLE-#14 AF				
	100				CONDUIT				
	105				CLAMP-CABLE				
	110				CONN-PIN				
	115				CONN-TERMINAL PIN				
	120								

S.B. = SILICON BRONZE

7. CABLES ANCHORED TO TIES PER INSTALLER DRAWINGS.

△6 HARDWARE FOR THE MINIBOND CENTER TAP IS SUPPLIED WITH THE MINIBOND.

△5 ITEMS 75 & 80 TO BE USED ONLY WHEN CENTER TAP IS REQUIRED.

△4 FOR 4 OR 5 CABLE CONNECTIONS SEE APPLICATION DWG. D451018-SH. 28, **FIGURE 2-5.**

△3 MINIBOND, ITEM 5, TO BE ORDERED BY SYSTEMS ENG'R. PER G.O. REQUIREMENTS. SEE DWG. C451003-SH. 13 FOR PART NO'S.

△2 115# RE RAIL - CONCRETE TIES. (TYPICAL MOUNTING FOR 30 OR 33 INCH SPACING, 30 INCH SPACING SHOWN)

1. PARTS SHOWN IN FULL LINES TO BE FURNISHED BY US & S OR INSTALLER.

NOTES: Ref Straight Plug Connector J709146-0292

Right Angle Connector J709146-0291

REVISIONS: △6 1-30-84 FOR REF. ONLY IT. 95 WAS ¼ AF CABLE. ALL FOR REF ONLY ITEMS SHOWN DOT & DASH NOTE 7 ADDED (38091-4) TJS

PART NUMBER	DESCRIPTION	MATERIAL/SPECIFICATION
X45,486-1101	TUNED MINIBOND MOUNTING	△2

DIMENSIONS ARE IN INCHES. SCALE 1½ IN. = 1 FT. DR J.D. HUNTER 7-6-82. CHK 8-14-82. ENGR 6/3/83. DATE 6-3-83.

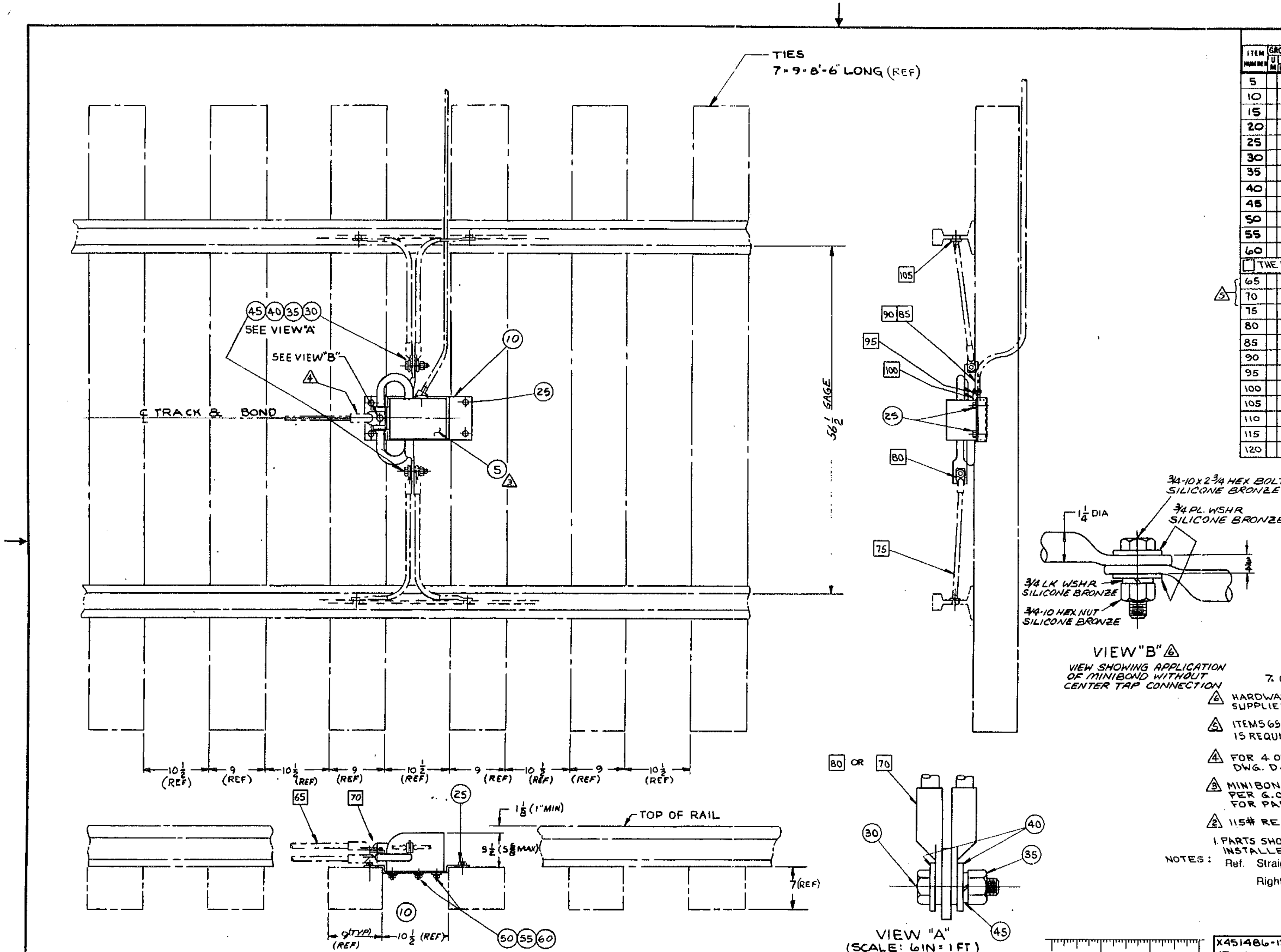
LAYOUT OF IMPEDANCE BOND WITH CONNECTION TO RAIL

UNION SWITCH & SIGNAL DIVISION
AMERICAN STANDARD INC.
SWISSVALE, PA 15218 U.S.A.

CODE IDENT NO. 61775 | SIZE D | 451486 | SHEET 11 | REV 1

D 451486-SH. 11 REV 1

Figure 2-2. Concrete Ties



			X	451486	SEE GROUP	LAYOUT-TUNED MINIBOND	D	451486	12	
ITEM NUMBER	GROUP - 1201 U/M	QUANTITY UNITS DEC.	PART IDENTIFICATION T	NUMBER	SUFFIX	DESCRIPTION	DRAWING T	NUMBER	SHEET	SUB
5		1.		△3		MINIBOND - TUNED	C	451003	13	
10		1.	M	451004	8801	BRACKET-MTG	C	451004	88	
15										
20										
25		4.	J	050324		SCR-½ X 4 LAG GALV				
30		2.	J	460119		BLT-¾-10 X 2-¾ HX HD S.B.				
35		2.	J	480304		NUT-¾-10 HEX S.B.				
40		4.	J	475196		WSHR-¾ PL FLAT S.B.				
45		2.	J	475197		WSHR-¾ SPR LK S.B				
50		6.	J	047503		WSHR,-½ PL. STL, CAD.PL.				
55		6.	J	047783		WSHR-½ LK STL. CAD.PL				
60		6.	J	048013		NUT-½-13 HEX STL. SF CAD.PL				
☐ THE FOLLOWING ITEMS, SUPPLIED BY INSTALLER, ARE FOR REF. ONLY										
65 △5						CABLE - 1000 MCM				
70 △5						LUG				
75						CABLE - 500 MCM				
80						LUG				
85						CABLE - #14 AF				
90						CONDUIT				
95						CLAMP - CABLE				
100						CONN - PIN				
105						CONN - TERMINAL PIN				
110										
115										
120										

S.B. = SILICON BRONZE

7. CABLES ANCHORED TO TIES PER INSTALLER DRAWINGS.

△6 HARDWARE FOR THE MINIBOND CENTER TAP IS SUPPLIED WITH THE MINIBOND.

△5 ITEMS 65 & 70 TO BE USED ONLY WHEN CENTER TAP IS REQUIRED.

△4 FOR 4 OR 5 CABLE CONNECTIONS SEE APPLICATION DWG. D451018-SH. 28, FIGURE 2-5.

△3 MINIBOND, ITEM 5, TO BE ORDERED BY SYSTEMS ENG'R PER G.O. REQUIRENTS. SEE DWG. C451003 -SH. 13 FOR PART NO'S.

△2 115# RE RAIL- WOOD TIES (TYPICAL MOUNTING)

1. PARTS SHOWN IN FULL LINES TO BE FURNISHED BY US & S OR INSTALLER.

NOTES:

Ref. Straight Plug Connector J709146-0292

Right Angle Connector J709146-0291

REVISIONS: 1-31-84 1 FOR REF. ONLY IT. 85 WAS 14 AF CABLE & ALL FOR REF ONLY ITS SHOWN DOT & DASH NOTE 7 ADDED. 138097-41 TJS FL084

REQ. 138095-1 DV/ 82423 0

X451486-1201	TUNED MINIBOND MOUNTING	△2
PART NUMBER	DESCRIPTION	MATERIAL/SPECIFICATION

DIMENSIONS ARE IN INCHES — SCALE 1½ IN = 1 FT
TOLERANCES ON FINISHED DIMENSIONS UNLESS OTHERWISE SPECIFIED — R.M.S. FINISH MAX 125 ✓ EXCEPT AS NOTED

BASIC DIMENSIONS	FRACTIONS	DECIMALS 2 PLACE	DECIMALS 3 PLACE
UP TO 6 INCHES	± 1/64	± .02	± .005
ABOVE 6 TO 24	± 1/32	± .03	± .010
ABOVE 24	± 1/16	± .06	± .015
ANGULAR DIMENSIONS	± 1/2° 0'		

DR SHUTT 7-16-82
CHK [signature] 8-16-82
DESIGN
IND DESIGN
ENGR [signature] 6/4/82
[signature] 6-3-83 DATE

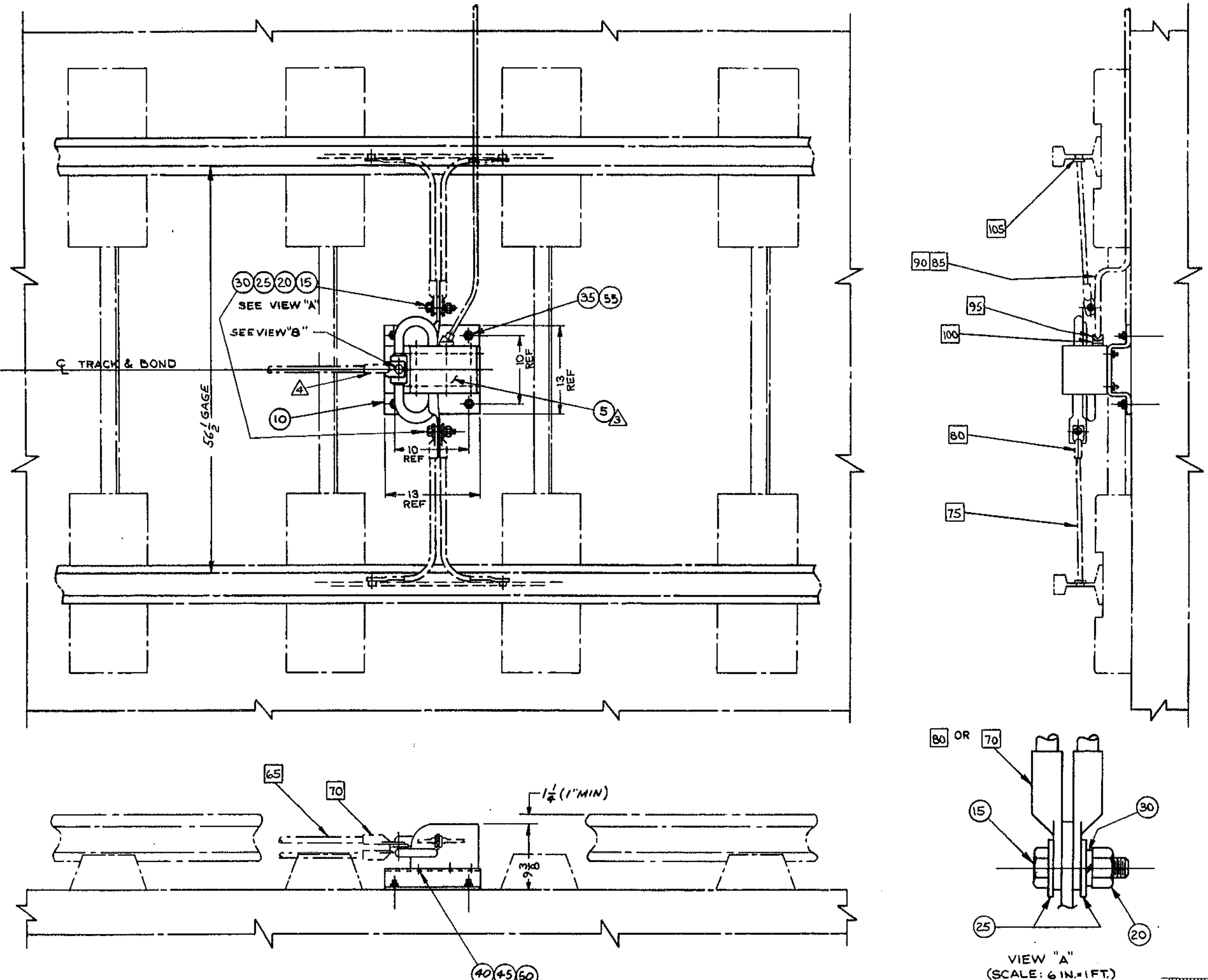
LAYOUT OF IMPEDANCE BOND WITH CONNECTION TO RAIL

GEN DWG./NEXT ASSY.

UNION SWITCH & SIGNAL DIVISION
AMERICAN STANDARD INC.
SWISSVALE, PA 15218 U.S.A.

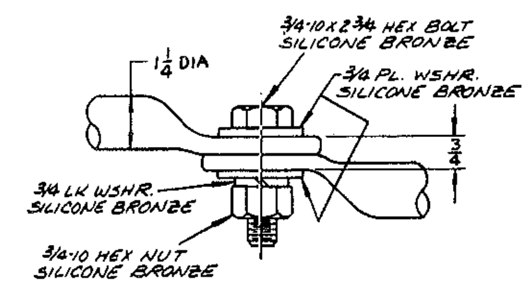
CODE IDENT. NO. 61775 | SIZE D | 451486 | SHEET 12 | CONT'D ON | REV 1

Figure 2-3. Wood Ties



ITEM NUMBER	U/M	QUANTITY UNITS	QUANTITY DEC.	T	PART IDENTIFICATION NUMBER	SUFFIX	DESCRIPTION	T	DRAWING NUMBER	SHEET	SHT
				X	451486	SEE GROUP	LAYOUT-TUNED MINIBOND	D	451486	13	
5		1.			⚠3		MINIBOND-TUNED	C	451003	13	
10		1.		M	451004	6302	BRACKET-MOUNTING	C	451004	63	
15		2.		J	460119		BLT-3/4-10 X 2-3/4 HX HD.S.B.				
20		2.		J	480304		NUT-3/4-10 HEX S.B.				
25		4.		J	475196		WSHR-3/4 PL FLAT S.B.				
30		2.		J	475197		WSHR-3/4 SPR LK S.B.				
⚠5 35		4.		J	460120		BLT-1/2-13×3¾ SST ANCHOR				
40		6.		J	048013		NUT, ½-13 HEX, STL. HVY. SF. CAD. PL.				
45		6.		J	047503		WSHR-1/2 PL. STL. CAD. PL.				
50		6.		J	047783		WSHR-1/2 LK. STL. CAD. PL				
55		4.		J	475121	0115	WSHR-1/2 LK SST	V	475121	01	
60											
☐ THE FOLLOWING ITEMS, SUPPLIED BY INSTALLER, ARE FOR REF. ONLY											
⚠6 65							CABLE-1000 MCM				
⚠6 70							LUG				
75							CABLE-500 MCM				
80							LUG				
85							CABLE-#14 AF				
90							CONDUIT				
95							CLAMP-CABLE				
100							CONN-PIN				
105							CONN-TERMINAL PIN				
110											

S.B. = SILICON BRONZE



VIEW "B" ⚠7

VIEW SHOWING APPLICATION OF MINIBOND WITHOUT CENTER TAP CONNECTION

NOTES:

8. CABLES ANCHORED TO TIES PER INSTALLER DRAWINGS.

⚠7 HARDWARE FOR THE MINIBOND CENTER TAP IS SUPPLIED WITH THE MINIBOND.

⚠6 ITEMS 65 & 70 TO BE USED ONLY WHEN CENTER TAP IS REQUIRED.

⚠5 ITEM 35 IS SUPPLIED WITH PLAIN WASHER & HEX NUT (STAINLESS STEEL)

⚠4 FOR 4 OR 5 CABLE CONNECTIONS SEE APPLICATION DWG. D 451018-SH. 28, **FIGURE 2-5**.

⚠3 MINIBOND, ITEM 5, TO BE ORDERED BY SYSTEMS ENG'R. PER G.O. REQUIREMENTS. SEE DWG. C451003-SH. 13 FOR PART NO'S.

⚠2 115# RE RAIL - VAGHEUX CONCRETE TIES. (TYPICAL MTG.)

1. PARTS SHOWN IN FULL LINES TO BE FURNISHED BY US & S. OR INSTALLER.

Ref. Straight Plug Connector J709146-0292

Right Angle Connector J709146-0291

PART NUMBER	DESCRIPTION	MATERIAL/SPECIFICATION
X-451468-1301	TUNED MINIBOND MOUNTING	⚠2

DIMENSIONS ARE IN INCHES — SCALE 1½ IN = 1 FT

DR. KEDZIERSKI 7-19-82 — CHK. 8-14-82 — ENGR 6/4/82

LAYOUT OF IMPEDANCE BOND WITH CONNECTION TO RAIL

UNION SWITCH & SIGNAL DIVISION
AMERICAN STANDARD INC.
SWISSVALE, PA 15218 U.S.A.

CODE IDENT NO.	SIZE		SHEET	REV.
61775	D	451486	13	1

REVISIONS: 1 — 1-31-84 — IT. 55 ADDED & ALL FOR REF. ONLY ITS. MADE DOT & DASH IT. 85 WAS #16 AF CABLE. NOTE 8 ADDED — 138097-41

D451486-SH. 13 REV. 1

Figure 2-4 Vagheux Concrete Ties

SECTION III
FUNCTIONAL DESCRIPTION

3.1 BASIC CONCEPTS

The Tuned Minibond design and application is an extension of the basic concept described below. The basic circuit configuration for an audio frequency (AF) minibond is represented by a primary winding with a center tap and a secondary winding inductively coupled to it (see Figure 3-1). The secondary winding may be tuned to increase the impedance of the bond at desired frequencies.

The center-tap divides the primary winding into two sections having an equal number of turns. Ideally the dc resistance of each section would be the same. The primary winding carries the propulsion current, hence it is constructed with heavy copper.

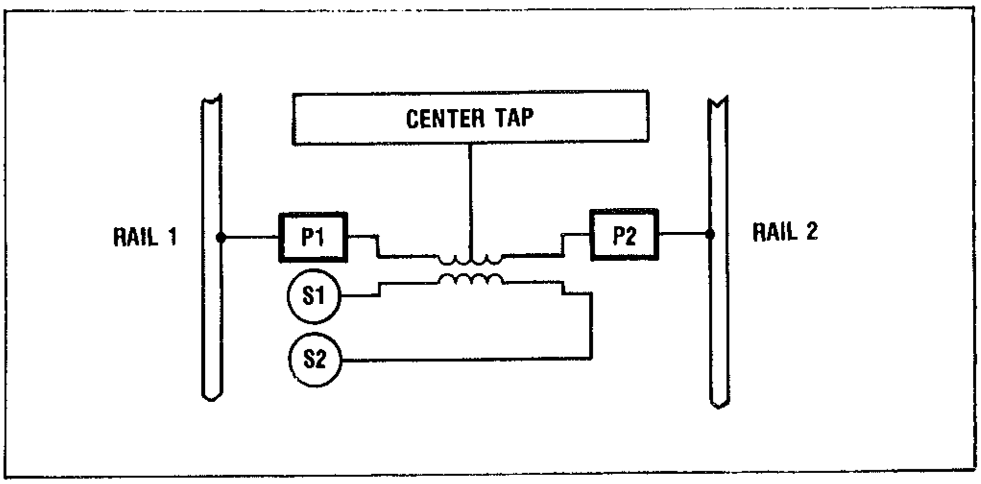


Figure 3-1. AF-Mini Impedance Bond - Basic Circuit

Typically, propulsion current can flow through the bond in four ways. Other variations exist.

1. Enters from both rails and exits at the center-tap, see Figure 3-2A.
2. Enters from the center-tap and exits at both rails, see Figure 3-2B.
3. Enters at one rail and exits at the other rail. Usually, the center-tap would not be used, see Figure 3-2C.
4. Enters at one rail and exits at the center-tap or vice-versa, see Figure 3-2D.

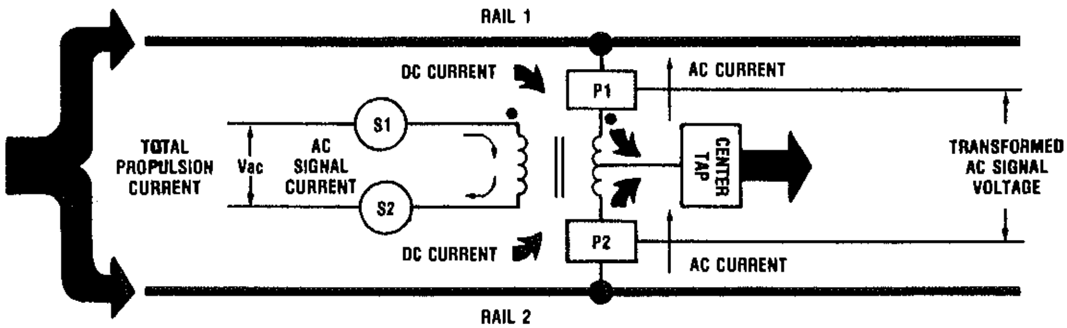


Figure 3-2A

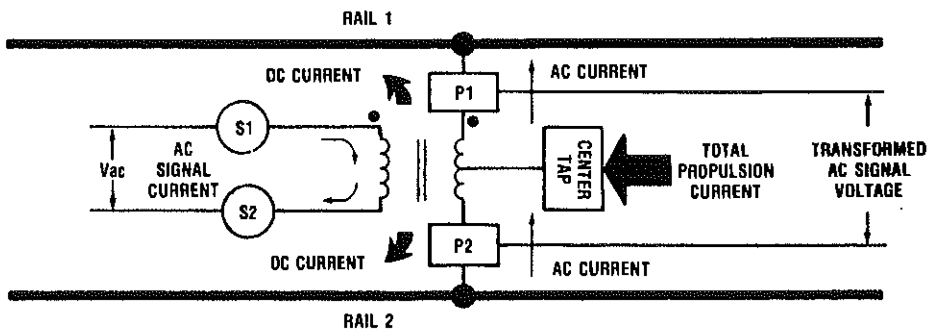


Figure 3-2B

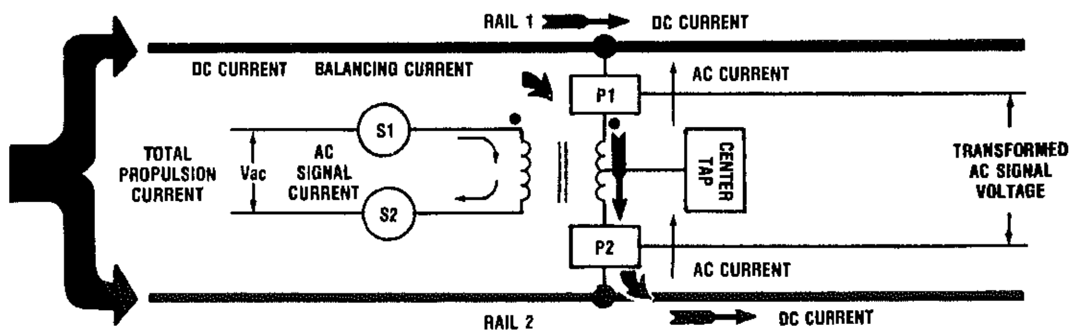


Figure 3-2C

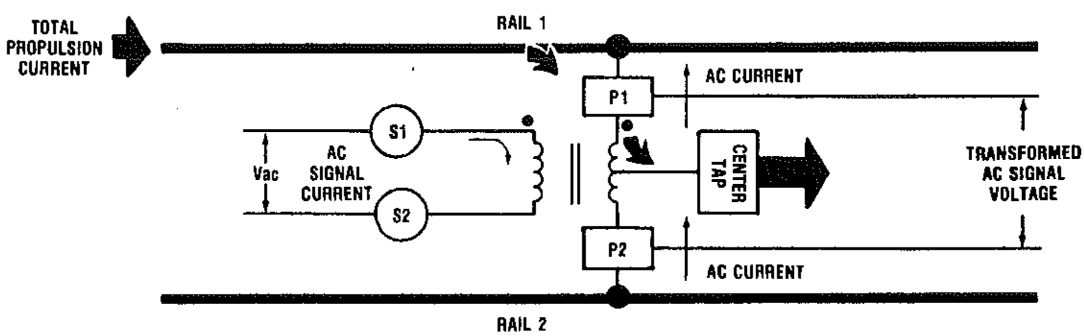


Figure 3-2D.

Figure 3-2. Typical Propulsion Current Flow

For cases 1 and 2, the total dc propulsion current flow is divided between the two halves of the primary winding. The current direction in one half will be opposite the current direction of the other half. The magnetic fluxes induced in the magnetic core of the bond will oppose each other and thus will tend to cancel each other. Equal currents (balanced) will cancel completely. An excessively large current unbalance will cause a loss in the ac signaling impedance.

The signaling current (ac) enters through one rail and exits through the other rail. It traverses the whole winding in one direction, hence no ac flux cancellation occurs. An ac signal is induced into the secondary winding. Similarly an ac signal can enter the secondary winding and induce a signal into the primary coil.

For case 3 the bond allows the propulsion currents to be re-distributed. In general, this tends to equalize the current in the rails. In this application, the bond does not benefit from cancellation of the dc current induced magnetic fluxes, hence the dc unbalance current capacity is reduced. The unbalance capacity becomes half of the established rating since current flows through both halves of the propulsion winding. In addition, the current capacity of the bond is also one-half of the established unbalance capacity.

Case 4 is similar to 3 except that the current flows through one turn instead of two. The bond will handle the established unbalance current rating.

A typical application of an audio frequency style minibond system is shown in Figure 3-3. The center tap on each bond is shown unconnected, however in certain applications the tap may be used for connections to other bonds on the same or adjacent tracks.

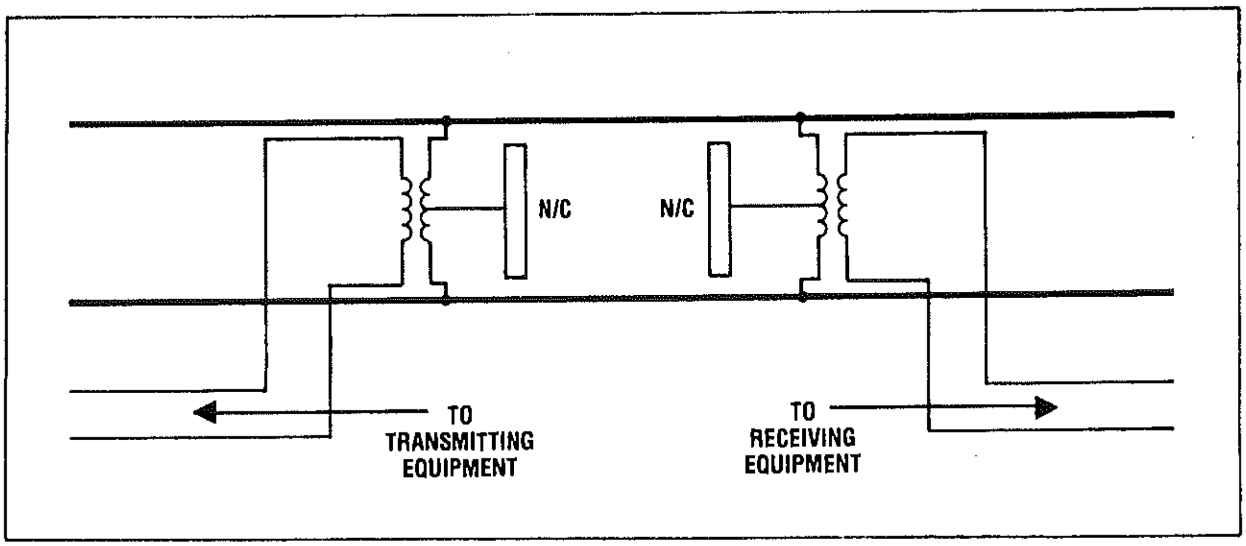


Figure 3-3. AF-Mini Impedance Bond - Circuit Application

3.2 DESIGN CONCEPTS

3.2.1 General

Figure 3-4 shows a general schematic of minibonds N451003-1802 through -1805. These bonds are tuned to three frequencies: cab transmitter, track transmitter and track receiver. The track winding is common to all the toroids. The high turn winding of each toroid is the inductor of a parallel resonant circuit. Each parallel resonant circuit inductor has a core that is independent of the other resonant circuits.

Figure 3-5 shows an equivalent circuit of Figure 3-4. The resonant circuits have been reflected to the low winding side of the toroidal coils.

3.2.2 Bond Impedance Across the Track Terminals

The inductance of the track winding is around one micro-henry. The reactance across the track terminals will be very low in the audio-frequency range. A value of 0.03 ohms would be typical at 5000 Hz. The impedance can be increased by tuning the winding. Tuning a secondary winding instead of the track winding allows use of smaller capacitors. High impedances require high circuit "Q's" and will only occur near the resonant frequency.

The minibonds have three parallel resonant circuits connected in series. The impedance across the track terminals will be the vector sum of the reflected impedances of each resonant circuit. The reflected impedances add (as in series instead of parallel) because induced voltages are proportional to the change in flux through its winding. The cores of all the resonant circuits pass through the track winding, hence the track winding sees a total flux equal to the sum of the individual core fluxes. Current passing through the track winding will cause a voltage drop across the terminals. The voltage will be transformed to the secondaries. The power imparted to each secondary will be determined by the ratio of the secondary reflected impedance to the total reflected impedance. The voltage impressed across each secondary will depend on:

a. the secondary reflected impedance.

b. the turn ratio between that secondary and the track winding.

When the impedances of all the resonant circuits are low, the impedance across the track terminals will be low. If the impedance of even one of the resonant circuits is high, then the impedance across the track winding will be high. An exception to this is when two or more high impedance resonant circuits develop a series resonance between them. In this case, the vector sum of the reflected impedances will be low.

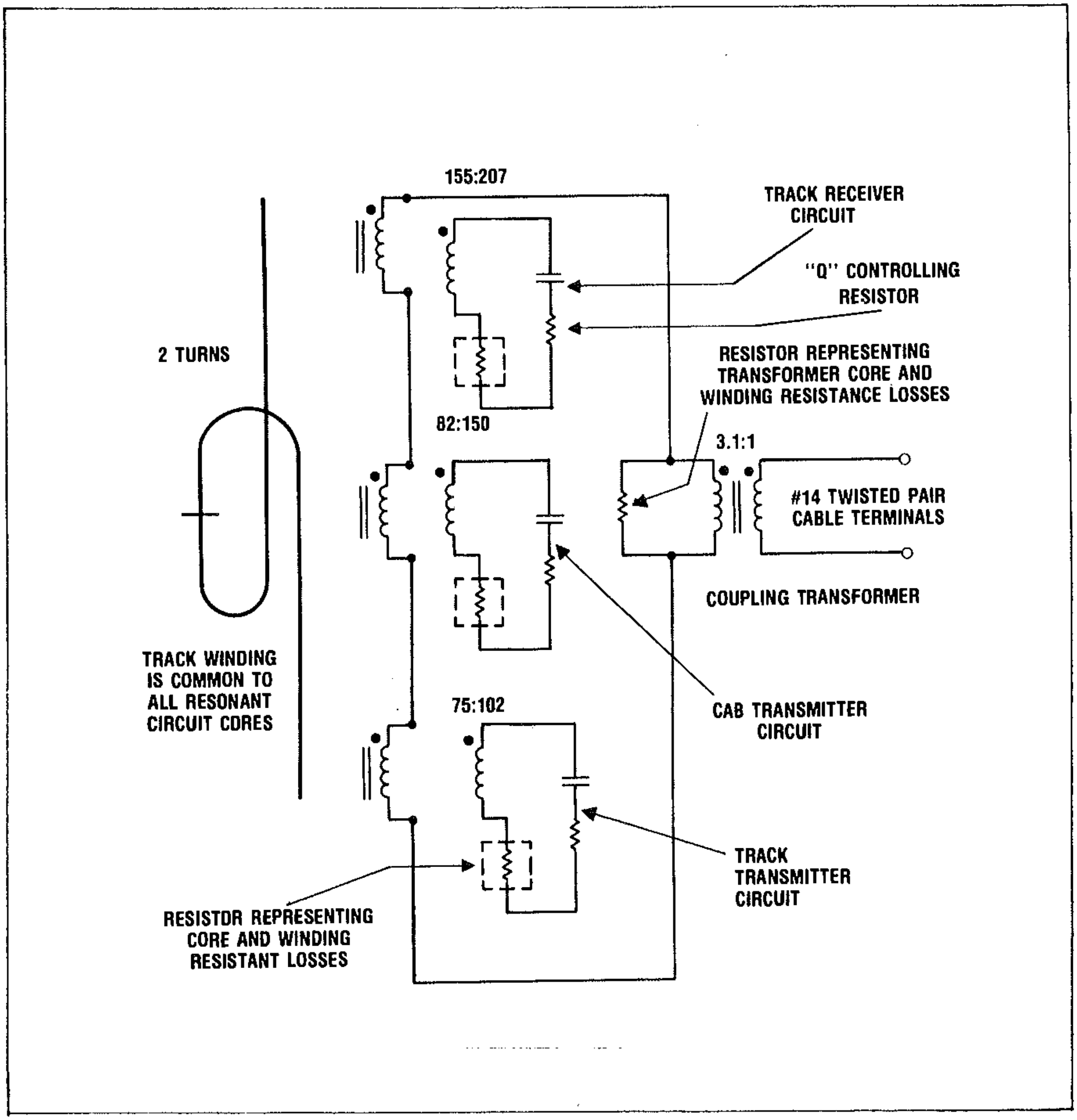


Figure 3-4. Minibond Schematic

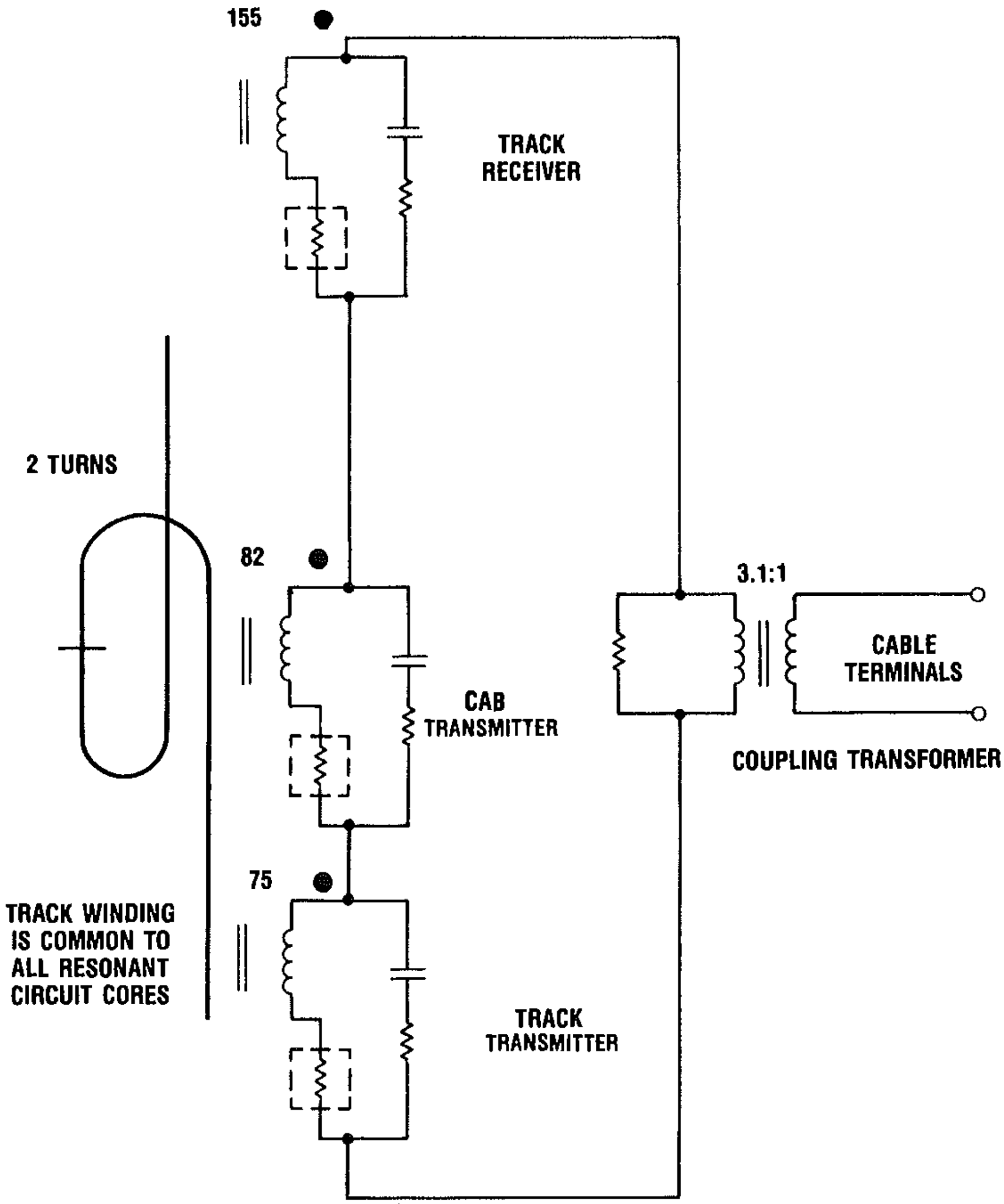


Figure 3-5. Equivalent Circuit of Figure 3-4

3.2.3 High "Q" Parallel Resonant Circuit

The following discussion assumes knowledge of parallel resonant circuit characteristics. Figure 3-6 illustrates the general characteristics of a parallel resonant circuit having a high circuit "Q". Figures 3-7 and 3-8 illustrate relative impedance characteristics of three high "Q" parallel resonant circuits having (1) different resonant frequencies and (2) non-overlapping bandwidths.

Refer to Figure 3-7. Note that the impedance at the resonant peaks is much greater than the impedances between the peaks. The impedance at a peak of one circuit is much larger than the sum of the magnitudes of the other circuit impedances.

Refer to Figure 3-8. Note that between the resonant peaks some curves are positive and some are negative. If these impedances were connected in series, they would tend to offset each other.

3.2.4 Series Connected High "Q" Parallel Resonant Circuits

Figure 3-9 illustrates the magnitude of the impedance for the three parallel resonant circuits of Figures 3-7 and 3-8 connected in series. Note that this curve appears similar to Figure 3-7. It is possible that the impedance peaks will occur at frequency values slightly different than those in Figure 3-7.

Between resonant peaks, the parallel resonant circuit contributes reactive impedance of opposite sign. At particular frequencies, series resonance will occur. Such resonance will occur once between peaks.

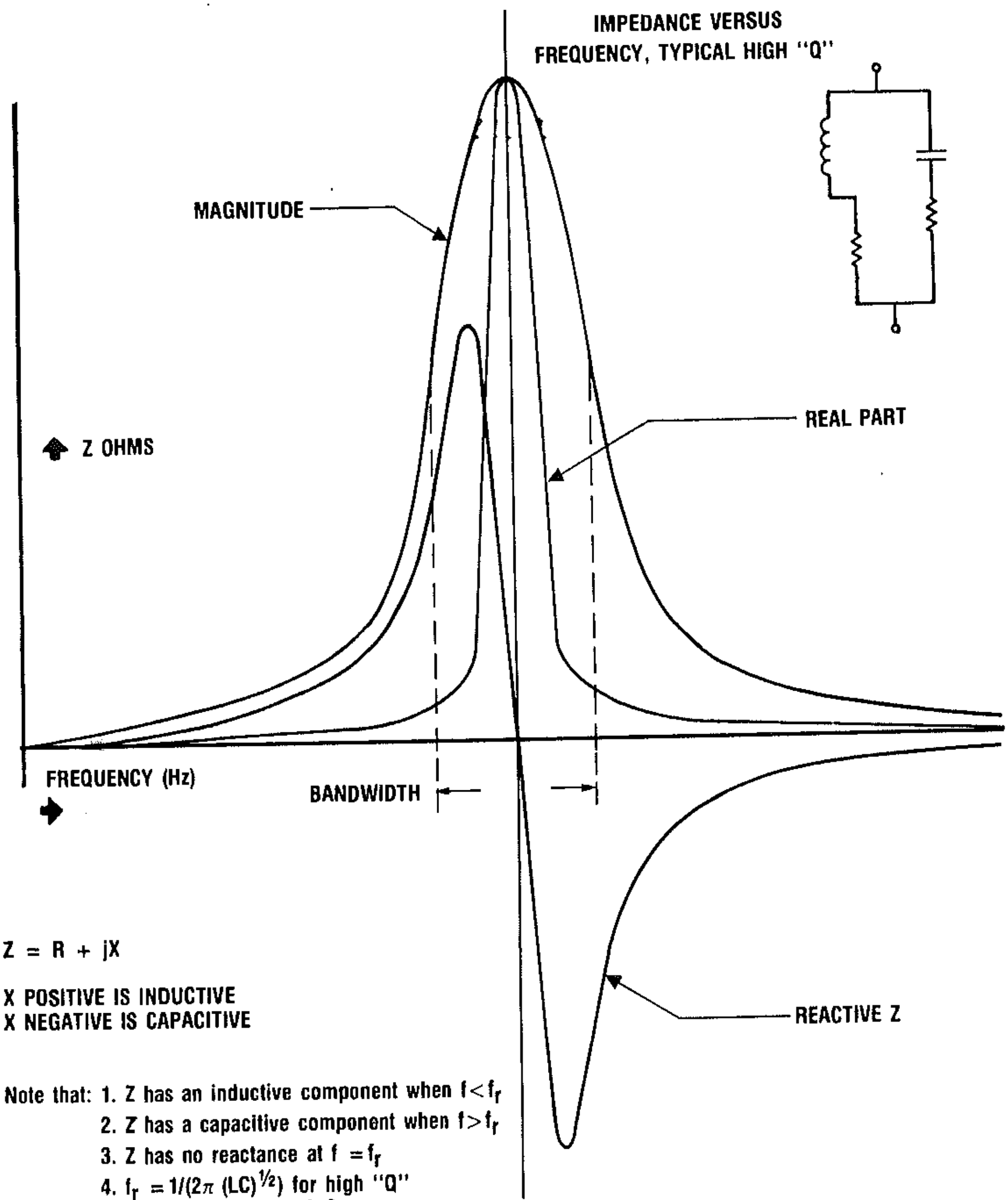
3.2.5 Minibond Impedance Versus Frequency Analysis

a. View from Track Terminals

Refer to Figure 3-5. The coupling transformer is connected in parallel to the series network of parallel resonant circuits. Signals from and to the wayside cable are coupled through this transformer. If this transformer impedance was sufficiently low, the impedance across the track terminals would also be low. Figure 3-10 shows the circuit viewed from one resonant circuit.

Note that if a series resonance occured in the right circuit branch, a low impedance would also be produced across the track terminals. A series resonance occurring near one of the parallel resonant frequencies is not acceptable. The design of the coupling transformer prevents such undesirable resonances from occurring.

The coupling transformer is designed to have a relatively large impedance, and will have little effect on tuning of the resonant circuit coils. Any shift that does occur is compensated for during factory test.



Z = R + jX

X POSITIVE IS INDUCTIVE
X NEGATIVE IS CAPACITIVE

Note that:
1. Z has an inductive component when $f < f_r$
2. Z has a capacitive component when $f > f_r$
3. Z has no reactance at $f = f_r$
4. $f_r = 1/(2\pi\,(LC)^{1/2})$ for high "Q"
5. at resonance $Z = w^2L^2/R = QwL = L/RC$
6. When parallel resonance occurs, the loop current sees series resonance.
7. $w = 2\pi f$

Figure 3-6. Parallel Resonant Circuit

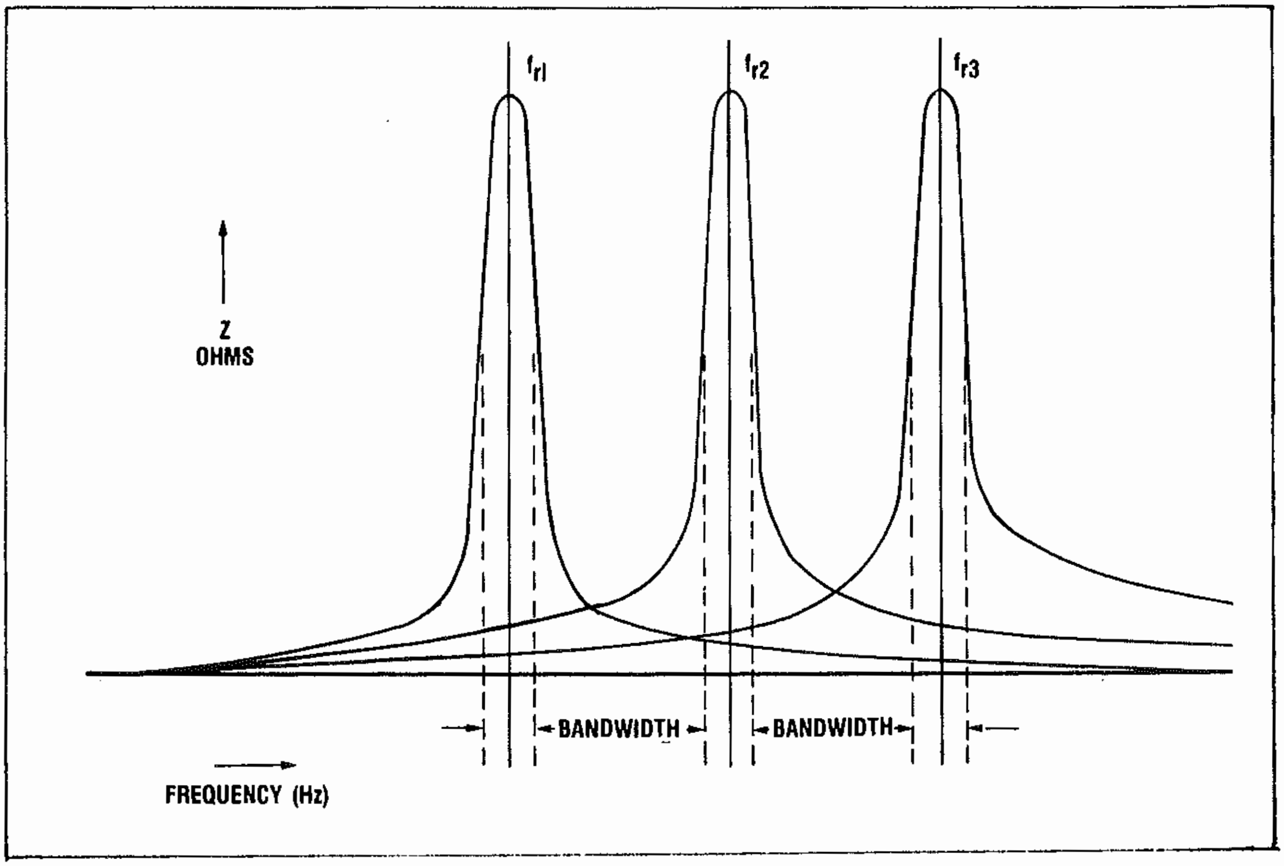


Figure 3-7. Impedance Versus Frequency

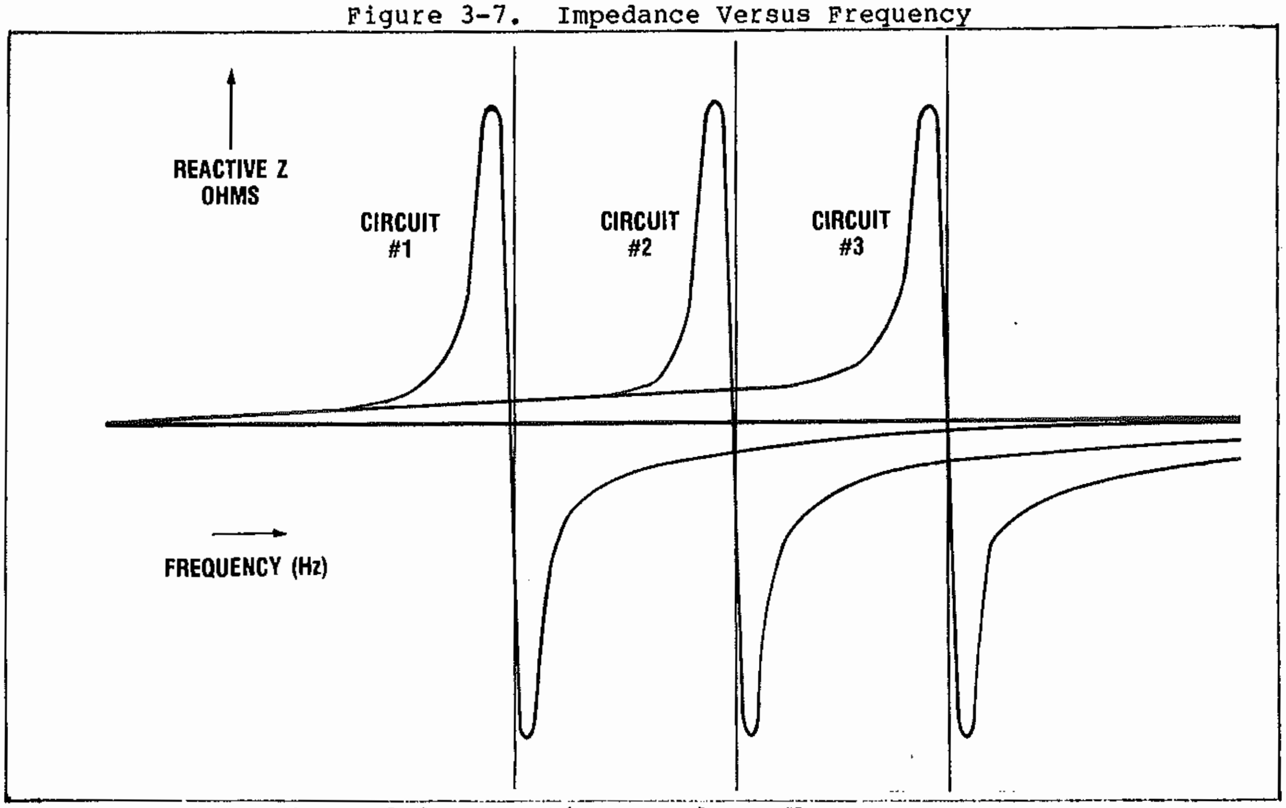


Figure 3-8. Reactive Impedance Versus Frequency

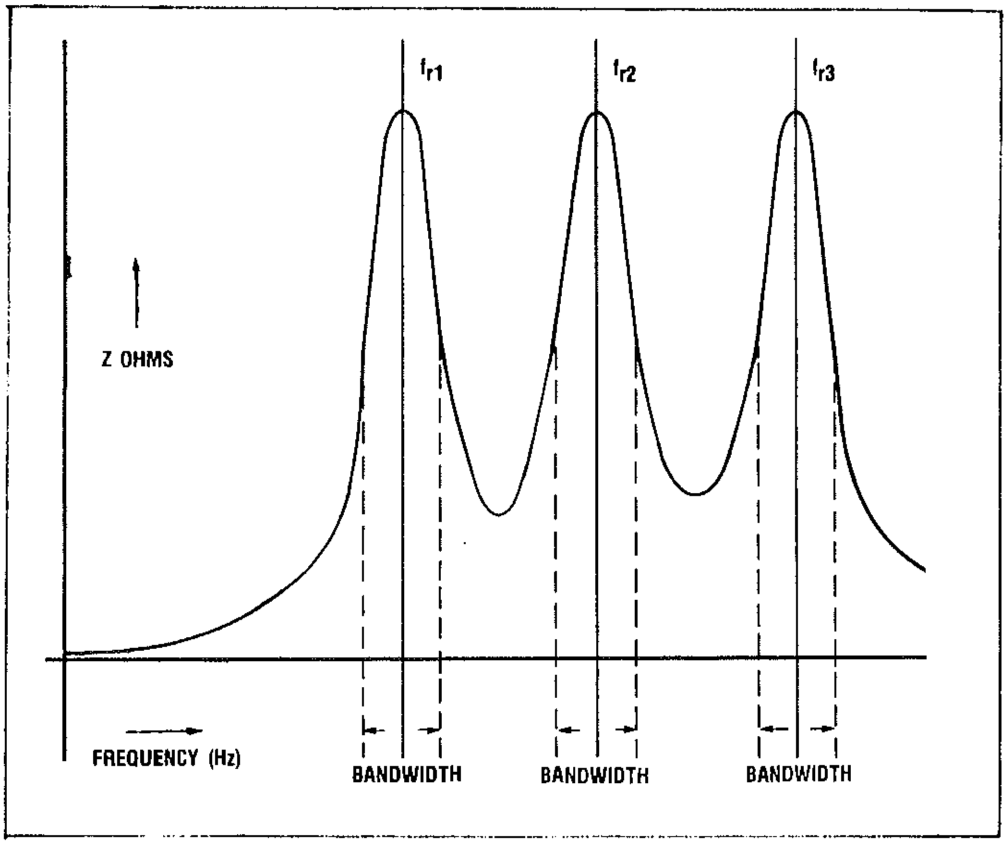


Figure 3-9. Impedance Versus Frequency
Three Circuits in Series

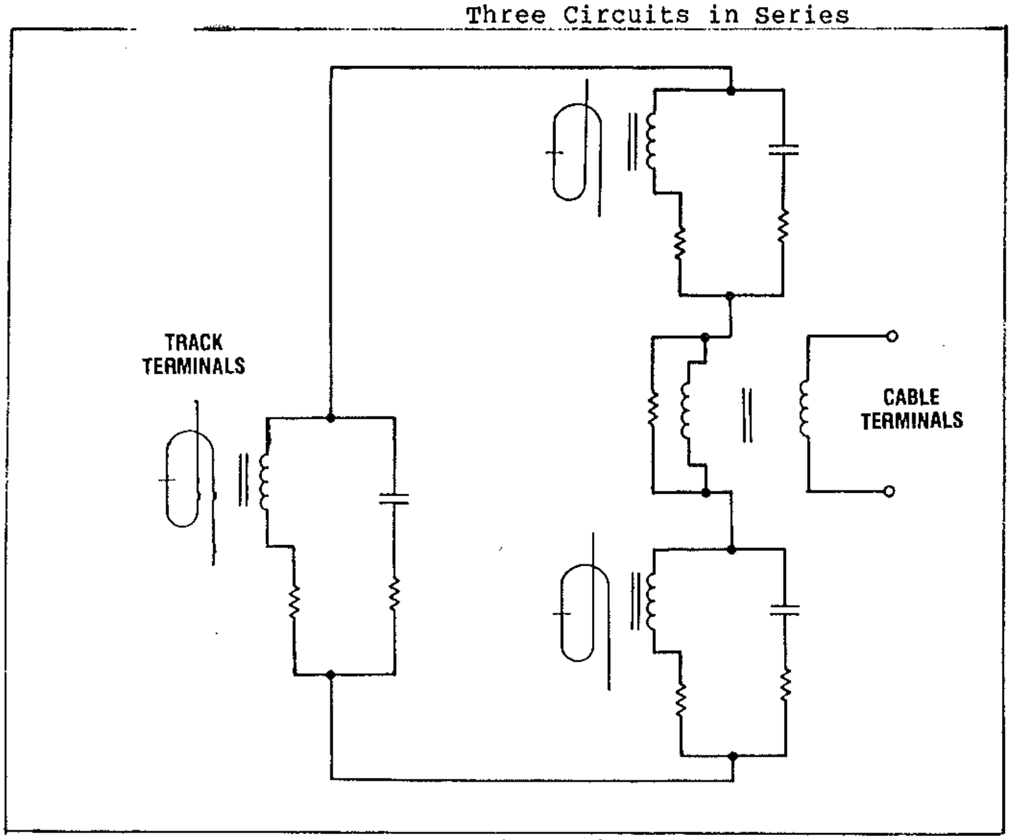


Figure 3-10
Circuit View From One Resonant Circuit

b. View from Wayside Terminals

Figure 3-11 shows the impedance bond reflected to the cable terminals. The resonant circuits will short the coupling transformer except when one or more circuits have a high impedance, or when the left branch exhibits a parallel resonance with the transformer. Again, the design of the coupling transformer prevents it from resonating in the frequency range of interest for AF signaling.

c. Compensation for Cable Capacitance

Minibonds are tuned with a 0.1 MFD capacitor across the wayside cable terminals. This is to account for the maximum capacitance expected from the #14 twisted pair cable. In the field, during initial track circuit adjustment, a capacitor will be added in parallel with the cable as required so that the total capacitance is 0.1 MFD.

3.2.6 Conclusions and Comments

a. There will be one resonant frequency for each parallel resonant circuit. No additional parallel resonance will occur in the desired frequency range.

b. Factory tuning procedures compensate for the effects of one circuit upon another and for the 0.1 MFD capacitance expected in field application.

c. Factory testing procedures check each bond for proper tuning and impedance.

c. In theory, resonant frequencies at the cable terminals will be the same as those at the track terminals.

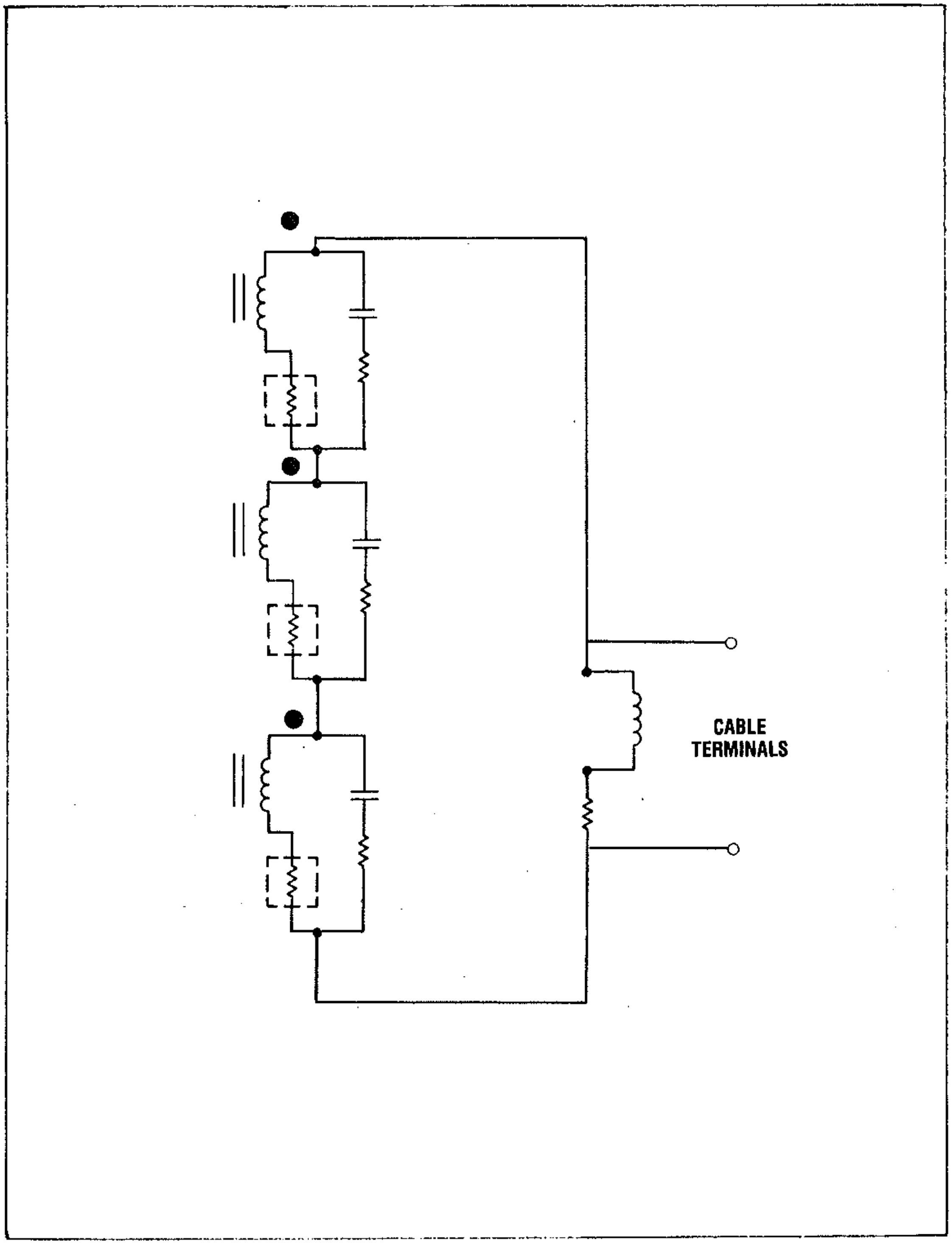


Figure 3-11
Impedance Reflected To Cable Terminals

SECTION IV
MAINTENANCE

4.1 FIELD INSPECTION AND MAINTENANCE

WARNING

TO AVOID PERSONAL INJURY WHILE MAINTAINING OR REPLACING IMPEDANCE BONDS, BE SURE TO DISCONNECT PROPULSION AND SIGNAL CURRENT IN THE WORKING AREA.

No disassembly or internal repairs shall be attempted on any impedance bond if trouble is suspected. A defective bond unit must be returned to the manufacturer as shipped. Field maintenance shall consist of periodic visual inspection of the bond for a cracked bond and bent, loosened and corroded terminals. Corroded terminals may be cleaned (with appropriate abrasive materials) and cable lugs retightened, however, in the event of case or terminal damage as specified above, the complete bond should be returned to the manufacturer.

All cables should be inspected for possible impact damage or fraying due to corrosion, and replaced if such problems are found. Also, tightness of various tie hold-down screws should be checked to make sure the bond is held securely to the ties.

4.2 SHOP MAINTENANCE

4.2.1 Troubleshooting

a. Types of Failures

1. Loss of impedance

   (a) Component failure
      1. Short
      2. Open

   (b) Broken wire

   (c) Bad or poor connection(s)

2. Impedance increase

3. Intermittent

b. Determining the Cause of Failure

Information is provided below to assist the user in troubleshooting and repair of the bond if the user so desires. However, return of the bond to the factory is recommended.

1. Sweeping the Frequency to Find Peaks

The best method to analyze bond failures is to test the bond in the circuits of Figure 4-1 or 4-2. A source voltage is applied and then the frequency is swept through the audio frequency range. Voltage peaks across the wayside terminals or the track terminals are noted. These peaks should occur at or near the tuning frequencies of the bonds. There should be three peaks.

The absence of all peaks indicates one or more of the following:

(a) shorted coupling transformer
(b) broken wire in the bond
(c) loss of connection
(d) track winding shorted
(e) open winding in the coupling transformer
(f) incorrect wiring

DC continuity tests can be used to check cases "b", "c", and "e". A continuity test can also determine if the track winding is shorted if the center-tap joint is insulated. For cases "b" and "e" the coupling transformer primary winding must be disconnected from bond leads S1 and S2.

Case "a" can be tested by bypassing the coupling transformer. If the peaks now appear, then the transformer was the problem.

The presence of one or more peaks indicates that the problem lies in the resonant circuits. The absence of a peak during a frequency sweep indicates which circuit(s) is (are) causing the problem.

2. Impedance Increase

Due to the nature of the design in the Tuned Minibonds, an increase in impedance can occur in two ways.

(a) The "Q" spoiling resistor(s) of the resonant circuit in question has decreased in value (i.e. shorted).

(b) Component failure of one resonant circuit shifts the tuning of that circuit to a resonant frequency near the resonant frequency of another circuit. This type of failure would cause an impedance loss at the original resonant frequency of the circuit shifted.

3. Resonant Circuit Impedance Loss

Some possible causes:

(a) Increase in "Q" spoiling resistor(s)
(b) poor connections
(c) shorted capacitor(s)
(d) open capacitor(s)
(e) shorted coil
(f) open coil
(g) broken wire
(h) incorrect wiring

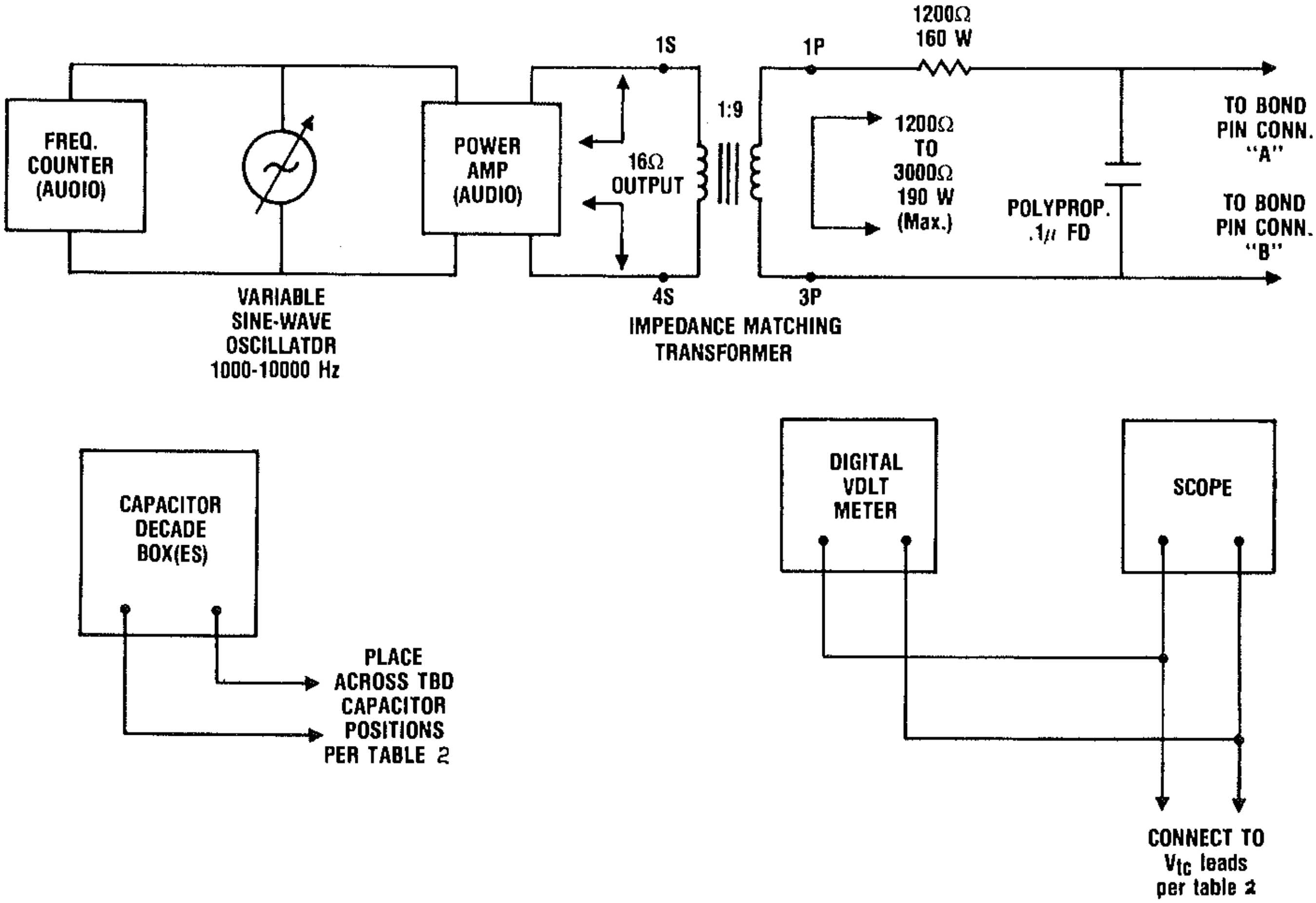


Figure 4-1 Tuning Circuit Test Set-Up

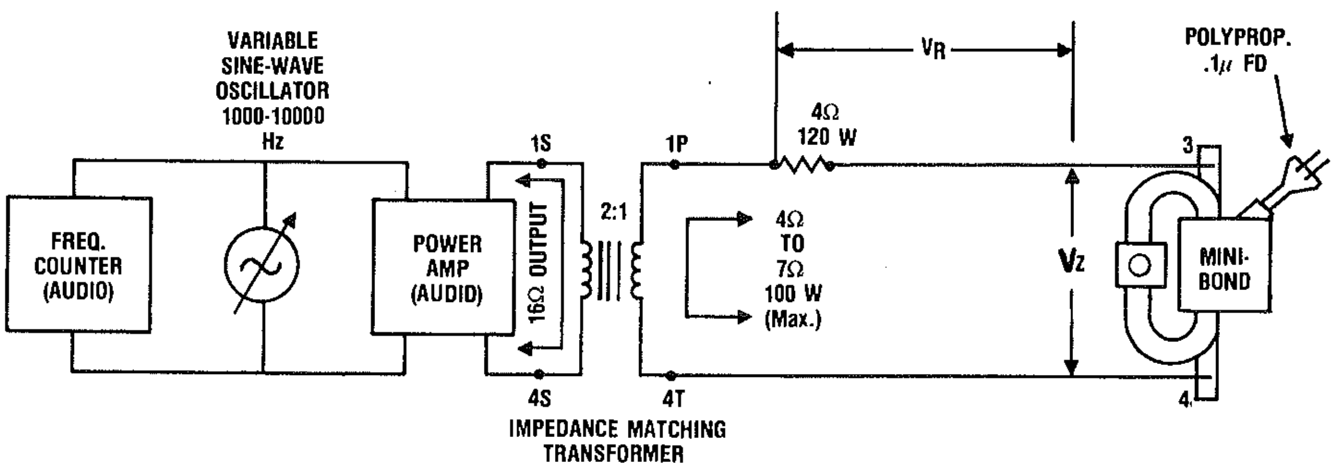


Figure 4-2 Impedance Measuring Test Set-Up

Note: Power amp output watts should exceed the combined wattage required to operate the transformer and test circuits of the bond. A high impedance transformer is recommended.

Disconnect the resonant circuit coil leads and make a continuity test across the coil leads. This checks for case "f".

If the coil is not open, then connect one of the coil leads and make a dc continuity test across the remaining coil lead and its connection point. The test should be applied until a stable reading is obtained, since circuit capacitors will draw current until they are charged. If continuity exists then capacitor(s) is (are) shorted (case "c").

For the remaining cases, measure the component values and compare them against what they should be as listed in Table 1.

c. Repair of the Determined Failure

1. Coil: The bond cannot be repaired unless the failure is due to a broken accessible lead.

2. Capacitors can be replaced. Consult the parts list for capacitor information. Replacement requires a tuning check and possibly an adjustment. The larger the capacitor value, the more likely an adjustment will be required.

3. Resistor(s): If a resistor fails, it is best to replace the whole resistor plate, since the resistors are difficult to access. Note the resistance values originally used or else impedance adjustments may be necessary.

4. Poor connections should be cleaned and/or tightened.

5. Broken wires should be replaced.

Table 1. Component Values

Bond Suffix	Resonant Circuit		Coil *		Approx. Capacitance	Resonant
	Type	Leads	Inductance (Millihenries)	Min. Q	($X\ 10^{-6}$ Farads)	Frequency (Hertz)
1802	TT	T3 & T4	5.33 ±0.15	35	0.70840	2590
	CAB	T1 & T2	5.80 ±0.15	11.1	0.21095	4550
	TR	R1 & R2	11.05 ±0.15	11.3	0.15425	3855
1803	TT	T3 & T4	5.33 ±0.15	35	0.53877	2970
	CAB	T1 & T2	5.80 ±0.15	11.1	0.21095	4550
	TR	R1 & R2	11.05 ±0.15	11.3	0.16936	3679
1804	TT	T3 & T4	5.33 ±0.15	35	0.35112	3679
	CAB	T1 & T2	5.80 ±0.15	11.1	0.21095	4550
	TR	R1 & R2	11.05 ±0.15	11.3	0.34173	2590
1805	TT	T3 & T4	5.33 ±0.15	35	0.31979	3855
	CAB	T1 & T2	5.80 ±0.15	11.1	0.21095	4550
	TR	R1 & R2	11.05 ±0.15	11.3	0.25988	2970

* Measured at 1 volt, 1000 Hz, at 20°C.

4.2.2 Tuning

a. <u>General Tuning Procedure</u>

1. Each bond has three frequencies:

   (a) The track transmitter frequency (TT)

   (b) The cab transmitter frequency (CAB)

   (c) The track receiver frequency (TR)

2. Bonds are to be tuned to each of the frequencies called for in the following order.

   1st-track transmitter frequency (TT) (varies)
   2nd-cab frequency = 4550 Hz (always)
   3rd-track receiver frequency (TR) (varies)

   The TT and TR frequencies are tabulated in Table 2.

3. The track transmitter and the track receiver frequencies are generally not tuned to the frequencies listed in the bond tabulation (operating frequencies). Bond tuning will use the frequencies tabulated in Table 2 (tuning frequencies).

4. Bonds are tuned by adding small values of capacitance. These capacitors are located on printed circuit board N451657-92XX. They are added to the circuit by soldering #18 buss wire to the appropriate turret lugs (see Figure 4-3 wiring schematic).

5. Bonds are adjusted for impedance in a similar fashion. This adjustment is made on printed circuit board N451657-91XX per Section 4.2.3 after the bond is tuned.

6. Both printed circuit boards are assembled into an assembly, N451662-11XX.

b. <u>Specific Tuning Procedure</u>

1. Read Section 4.2.2A (General Tuning Procedure) before tuning bonds.

2. Assemble circuit of Figure 4-1.

3. Adjust the frequency generator to the desired frequency.

4. Connect temporary jumpers to the resistor terminals (see Figure 4-3): R1R and R2, 0.25 ohms; T1R and T2, 1.5 ohms; T3R and T4, 2.0 ohms. However, if permanent jumpers are already in place these may be tried first.

5. Adjust the source voltage to obtain 1/2 the tabulated Vtc for Vtc (Table 2) for the frequency concerned.

Table 2. Tuning Data

Minibond Pc. No. N451003-	Track Transmitter Tuning				Cab Transmitter Tuning				Track Receiver Tuning			
	Freq. ± 5 (Hz)	Vtc ± 3 (Volts)	Z ±10% (Ohms)	VR	Freq. ± 5 (Hz)	Vtc ± 1.5 (Volts)	Z ±10% (Ohms)	VR (Volts)	Freq. ± 5 (Hz)	Vtc ± .5 (Volts)	Z ±10% (Ohms)	VR (Volts)
1802	2590	153	0.663	18.10	4550	75.0	1.15	3.48	3855	10.0	2.25	0.1600
1803	2970	153	0.760	15.79	4550	75.0	1.15	3.48	3679	10.0	1.89	0.1905
1804	3679	153	0.890	13.48	4550	75.0	1.15	3.48	2590	10.0	1.35	0.2667
1805	3855	153	0.883	13.59	4550	75.0	1.15	3.48	2970	10.0	1.55	0.2323
Vtc Measured Across	PCB Capacitor Positions C1 through C8				PCB Capacitor Positions C9 & C10, C11 & C12, C13 & C14 C15 & C16, C17 & C18, C19 & C20 C21 & C22				PCB Capacitor Positions C23 through C30			

Table 3. Nameplate (Operating) Data

	Track Transmitter			Cab Transmitter			Track Receiver		
	Freq. ± 5 (Hz)	Vz ± 3 (Volts)	Z ±15% (Ohms)	Freq. ± 5 (Hz)	Vz ± .05 (Volts)	Z ±15% (Ohms)	Freq. ± 5 (Hz)	Vz ± .005 (Volts)	Z ±15% (Ohms)
1802	2590	3.00	0.663	4550	1.00	1.15	3870	0.090	1.73
1803	2970	3.00	0.760	4550	1.00	1.15	3690	0.090	1.58
1804	3690	3.00	0.875	4550	1.00	1.15	2590	0.090	1.35
1805	3870	3.00	0.868	4550	1.00	1.15	2970	0.090	1.55
NOTE Note: When Vtc = 153 volts Vz = 3.00 volts				NOTE When Vtc = 75.0 volts Vz = 1.00 volts			NOTE When Vtc = 10.0 volts Vz = .090 volts		

Vtc = Voltage across resonant
Freq. = Frequency (Hz = cyles/sec.)
Z = Impedance magnitude

Values are based upon 0 amps dc unbalance current at 20°C

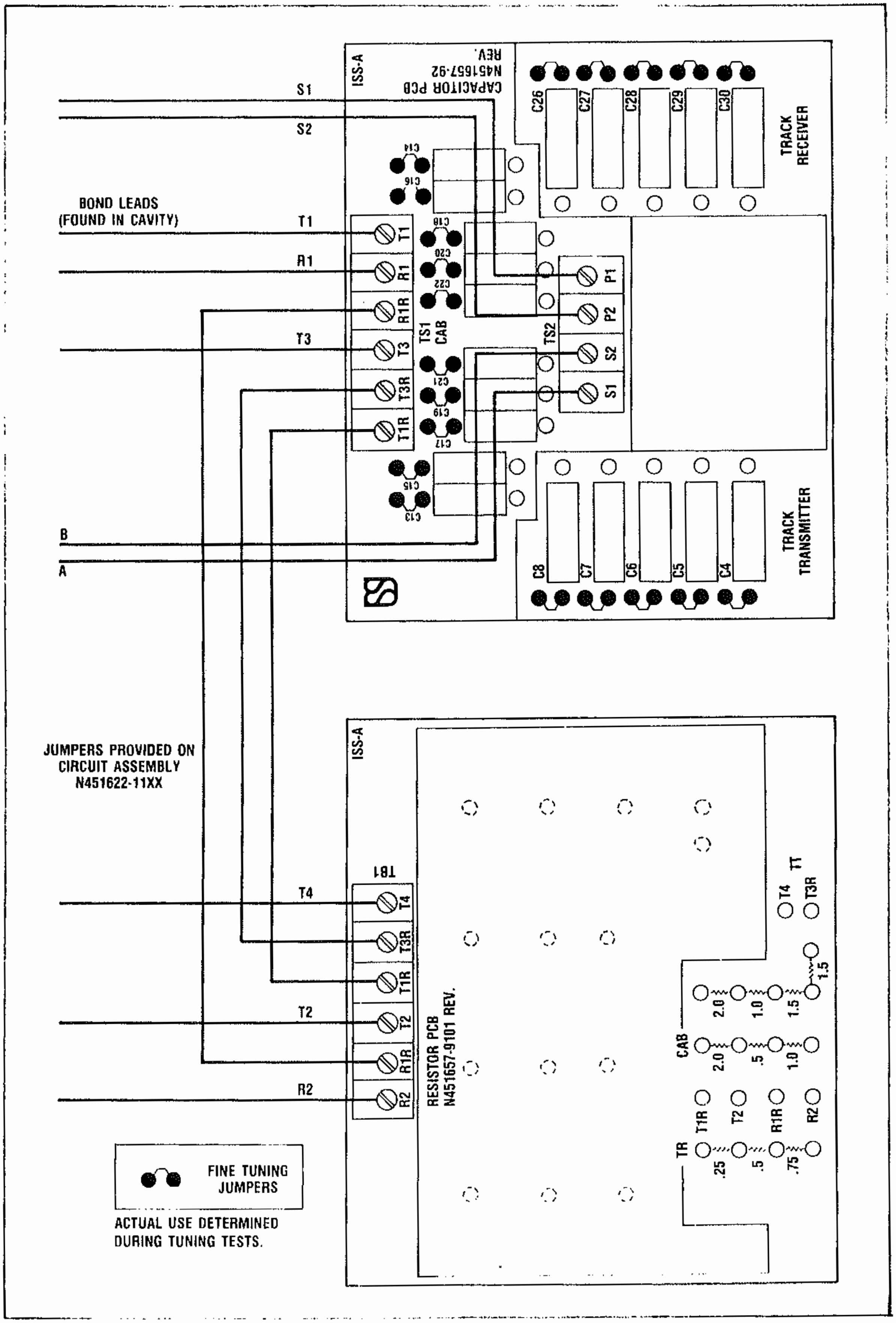


Figure 4-3. AF-700 Tuned Minibonds Wiring Schematic

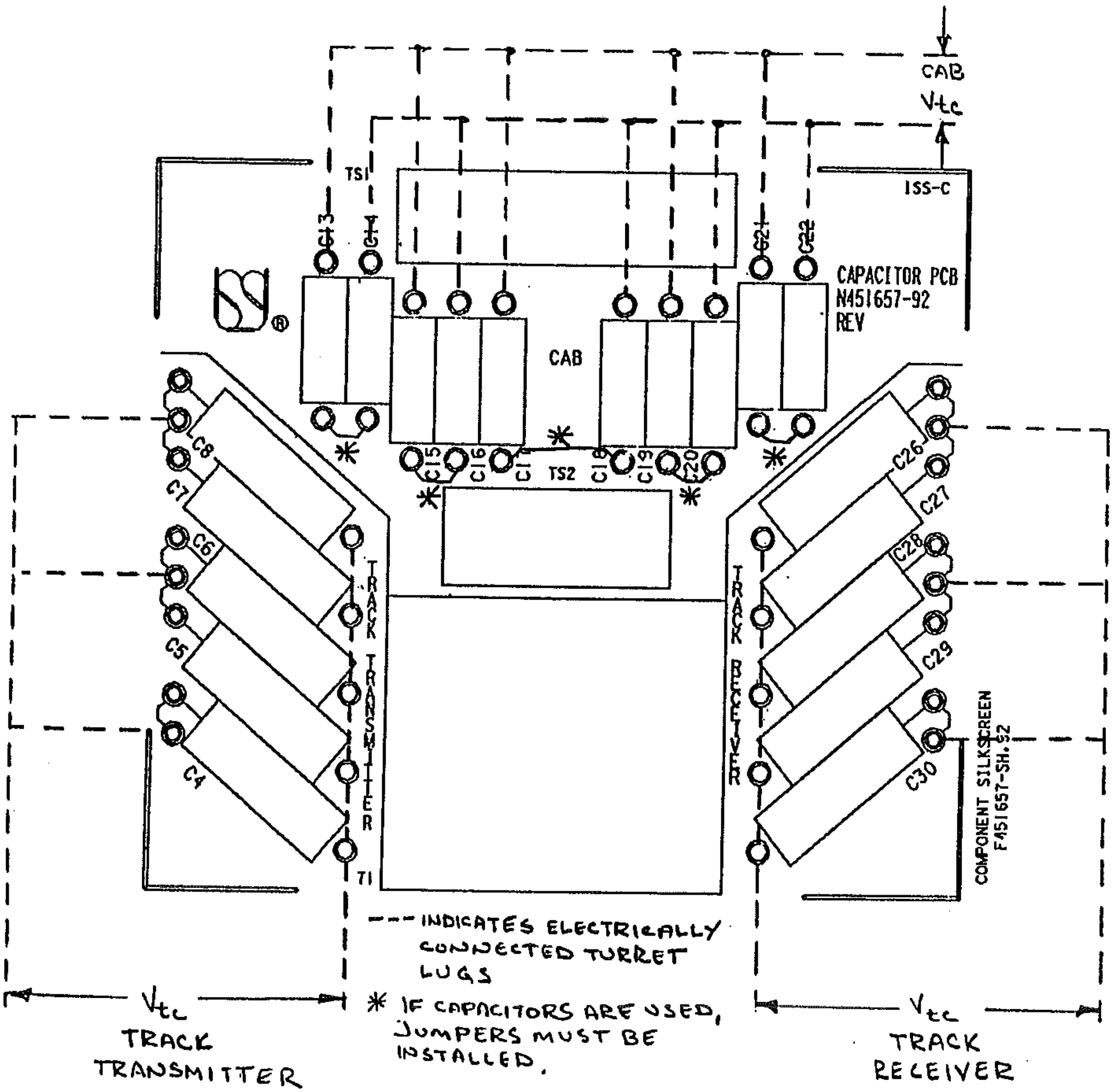


Figure 4-4. Capacitor PCB Tuning (Current Revision Layout)
Also see Figure 4-5

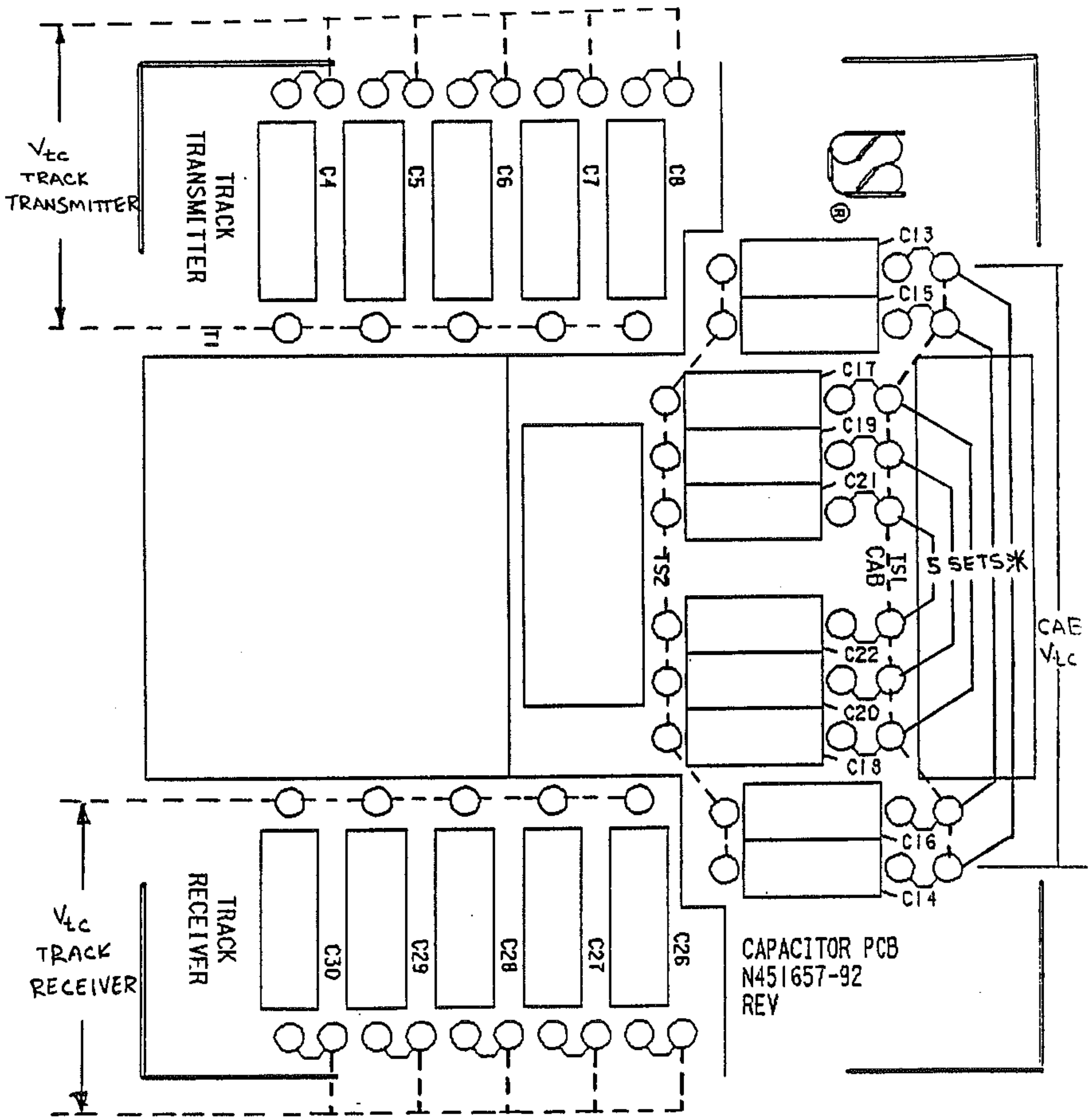


Figure 4-5. Capacitor Tuning (Earlier Revision Layout)
Also see Figure 4-4

--- Dashed line indicates electrically connected turret lugs.

* No jumper or both jumpers are to be used for each set.
Do not use only one jumper in a set.

6. Using temporary jumpers, add or remove capacitance until a voltage peak is found for Vtc in Figure 4-4 or 4-5 (the scope or digital voltmeter reading). Capacitor decade boxes are recommended for this.

WARNING

Circuit voltage may be high. Use insulated tools or turn the power down.

7. Adjust the source voltage to obtain the tabulated Vtc for Vtc.

8. Vary the jumpers, increase or decrease capacitor decade box value until a voltage peak is found.

WARNING

Circuit voltage may be high. Use insulated tools or turn the power down.

9. Turn the power down. Jumper capacitors into the circuit which approximate the value of the decade box. Tables 4 and 5 are provided as guides. Exception: for the cab transmitter frequency, two capacitors in series are required. The capacitor values will be twice the value of the decade box. Two jumper connections may be required to place PCB adjusting capacitors into the circuit. The effective capacitance equals one half of the value of one capacitor. The number of jumpers required depends upon which PCB revision the minibond is equipped with.

10. Repeat steps 6 through 8 until the voltage peak occurs at the tabulated Vtc.

11. With Vtc set to the tabulated value, vary the frequency until a voltage peak is obtained. This frequency shall be within the tabulated tolerance of Table 2.

12. Solder the appropriate capacitors into the circuit using #18 buss wire to make permanent jumper connections. Excess length is to be trimmed. After cooling, clean flux residue from the solder connections.

4.2.3 Impedance Adjustment

a. Adjusting Impedance

1. Assemble the circuit of Figure 4-2.

2. Measure and record the resistance of the 4 ohm (approx.) resistor (R of Figure 4-2).

3. Apply the track transmitter frequency to the circuit. Set Vtc to the value tabulated in Table 2.

4. Verify bond is correctly tuned.

Table 4. Adjusting Capacitor Values

Circuit	Capacitor Positions	Capacitor Values (MFD) for Board Pc. No. -1802	-1803	-1804	-1805
Track Transmitter Tuning	C4	.0033	.0022	.0010	.0010
	C5	.0068	.0047	.0022	.0022
	C6	.0100	.0082	.0047	.0047
	C7	.0220	.0150	.0082	.0082
	C8	.0330	.0330	.0150	.0150
Cab Transmitter Tuning	C13	.0022	.0022	.0022	.0022
	C14	.0022	.0022	.0022	.0022
	C15	.0047	.0047	.0047	.0047
	C16	.0047	.0047	.0047	.0047
(Effective capacitance equals 1/2 the capacitor values).	C17	.0082	.0082	.0082	.0082
	C18	.0082	.0082	.0082	.0082
	C19	.0100	.0100	.0100	.0100
	C20	.0100	.0100	.0100	.0100
	C21	.0150	.0150	.0150	.0150
	C22	.0150	.0150	.0150	.0150
Track Receiver Tuning	C26	.0068	.0068	.0150	.0100
	C27	.0033	.0033	.0068	.0068
	C28	.0015	.0015	.0033	.0033
	C29	.0010	.0010	.0022	.0022
	C30	.0005	.0005	.0010	.0010

Table 5 Capacitors/Part Numbers

Capacitance	Commodity No.
.00025	J709118
.0005	J700712
.001	J709145-0576
.0015	J709145-0577
.0022	J709145-0578
.0033	J709145-0579
.0047	J709145-0580
.0068	J709145-0581
.0082	J709145-0582
.0100	J709145-0583
.0150	J709145-0584
.0220	J709145-0585
.0330	J709145-0586
.0470	J709145-0587
.0680	J709145-0588
.0820	J709145-0589
.1000	J709145-0590
.1500	J709145-0591
.2200	J709145-0592
.3300	J709145-0593
.47	J709145-0597
.68	J709145-0598
.82	J709145-0608

5. Reference Figure 4-2. When desired impedance (Table 2 or 3) occurs, VR=(VZ) R/Z. Different values of VR (hence Z also) can be obtained by changing the jumper connections of the resistor(s) on printed circuit board N451657-9101, when VZ is held at the tabulated value.

6. Apply tabulated frequency to the circuit of Figure 4-2.

7. Apply tabulated VZ to bond terminals while holding VZ at the tabulated value. Vary jumpers until desired VR is obtained, (see Figure 4-3 and Table 6) per Table 2 or 3. Measure and record the values of R, VZ and VR. Calculate the impedance of the bond. Impedance = (VZ) (R)/(VR).

8. Replace temporary jumpers with #18 buss wire and solder the buss wire to the turret lugs. Exception: Use insulated wire for connections to T3R and T4.

9. Repeat steps 3 through 8 for the remaining frequencies (Cab Transmitter and Track Receiver).

NOTES

(a) A resistor decade box may be used to determine the amount of resistance required. The closest available resistor selection is then chosen.

A 5 amp rating is recommended for the decade box.

(b) An increase in value of the adjusting resistor will decrease the impedance of the bond.

4.2.4 Bond Assembly

a. <u>Final Assembly</u>

1. Apply Red Glyptal (A040171) to a corner of each terminal strip screw.

2. Assemble printed circuit board assembly into the bond. Apply Red Glyptal (A040171) to the nuts.

3. Clean edges of the bond cavity with a clean cloth. Apply RTV to the bond cavity edges and assemble covers.

4. Check impedances at the operating frequencies per Table 3 and Section 4.2.3, Step 7.

NOTE

The purpose of the Red Glyptal is to prevent loosening of the screws and nuts due to vibration. Any non-corrosive, non-conducting material that will perform this function may be used.

Table 6. Impedance Adjusting Resistor Selections

Track Transmitter Terminals T3R, T4 Ohms, Resistors		Cab Transmitter Terminals T1K, T2 Ohms, Resistors		Track Receiver Terminals R1R, R2 Ohms, Resistors	
0.0	Short TR	0.0	Short CAB	0.0	Short TT
.25	.25	.5	.5	1.0	1.0
.50	.50	1.0	1.0	1.5	1.5L
.75	.25 & .50	1.5	1.0 & .5	2.0	2.0
1.00	.75 & .25, Short .5	2.0	2.0	2.5	1.0 & 1.5L
1.25	.75 & .5	2.5	2.0 & .5	3.0	1.5L & 1.5R
1.50	.75 & .5 & .25	3.0	2.0, Short .5, 1.0	3.5	2.0, Short 1.0, 1.5L
		3.5	2.0 & .5 & 1.0	4.0	1.0 & 1.5L & 1.5R
				4.5	2.0 & 1.0 & 1.5L
				5.0	2.0, Short 1.0, 1.5L, 1.5R
				6.0	2.0 & 1.0 & 1.5L & 1.5R

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Appendix A

PARTS LIST

TUNED MINIBOND

Part Numbers

N451003-	1802	1803	1804	1805

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A-3/88-25 2776-2
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UNION SWITCH & SIGNAL
AMERICAN STANDARD INC./PITTSBURGH, PA. 15237

APPENDIX A
PARTS LIST

A1.1 TUNED MINIBOND (Complete). See Figure A-1.

Cab -4550; TT-2590; TR-3870	N451003-1802
Cab -4550; TT-2970; TR-3690	N451003-1803
Cab -4550; TT-3690; TR-2590	N451003-1804
Cab -4550; TT-3870; TR-2970	N451003-1805

Item	Description	Part No.
200	Minibond Sub-Assembly (Basic)	N451003-1801
205	Circuit Assembly (Used on -1802)	N451662-1101
	Circuit Assembly (Used on -1803)	N451662-1102
	Circuit Assembly (Used on -1804)	N451662-1103
	Circuit Assembly (Used on -1805)	N451662-1104
210	Washer, 1/4", Stl. Plate	J047501
215	Washer, 1/4", Stl. Lock	J047775
220	Nut, 1/4-20	J048002
225	Name Plate	M451607-6601
230	Washer, #10, Stl. Lock	J047733
235	Screw, 10-32 x 5/16	J052562
240	Cover	M451004-7101
245	Screw, 1/4-20 x 1/2, Hex	J050012
	R.T.V.	A041652
	Red Glyptal	A040171

A1.1.1 Minibond Sub-Assembly (Basic) N451003-1801 (See Figure A-1)

Item	Description	Part No.
* 5	Coil and Core Assembly	N451662-0901
* 10	"J" Bar	N451004-4701
* 15	Mounting Plate	R451004-7002
* 20	Epoxy	A041844
* 45	Duct Sealer	A041498
* 50	Insert	M451005-0104
* 55	Receptacle Connector	J709146-0252
* 60	Screw, 6 x 1/2 Rd. Hd.	J525164
* 65	Terminal, Pre-Insul.	J730039
* 70	Screw, 1/4 x 20 x 3	J525340
* 75	Insulating Bushing	M438881
* 85	Insert	M451005-0105
90	Lead	M438746-006
95	Wire Marker	J079714
100	Bolt, 3/4 x 10-3/4, Hex Hd., Silicon Bronze	J460119
105	Washer, 3/4", Pl. Flat, Silicon Bronze	J475196
110	Washer, 3/4", Spr. Lock, Silicon Bronze	J475197
115	Nut, 3/4-10, Hex, Silicon Bronze	J480304
120	Spacer, 1/2 x 1/4 x 1/2	J725920-0009
125	Washer, 1/4", Stl. Plate	J047501
130	Washer, 1/4", Stl. Lock	J047775
135	Nut, 1/4-20	J048002

* Encapsulated material, impossible or very difficult to replace, shown for reference.

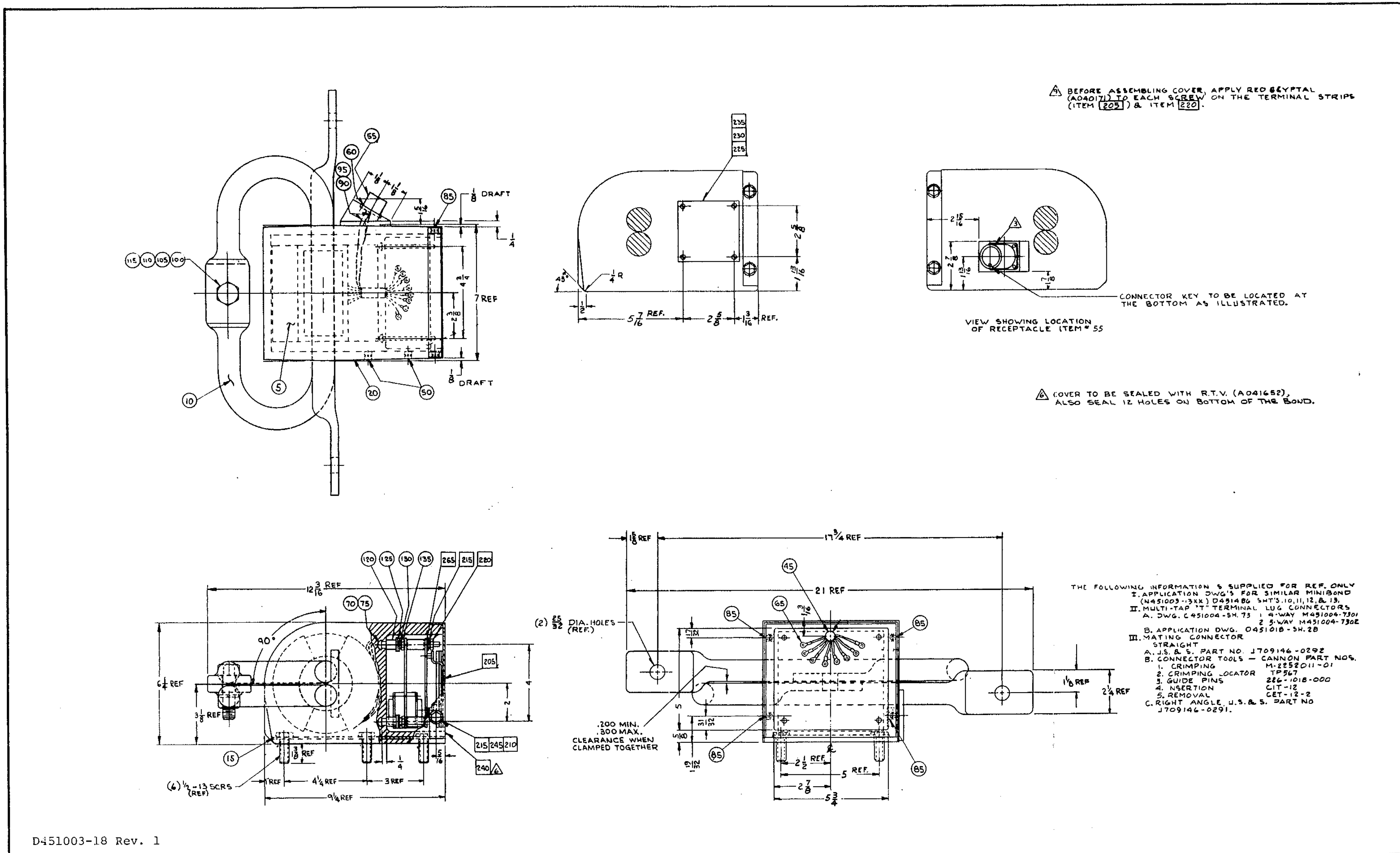
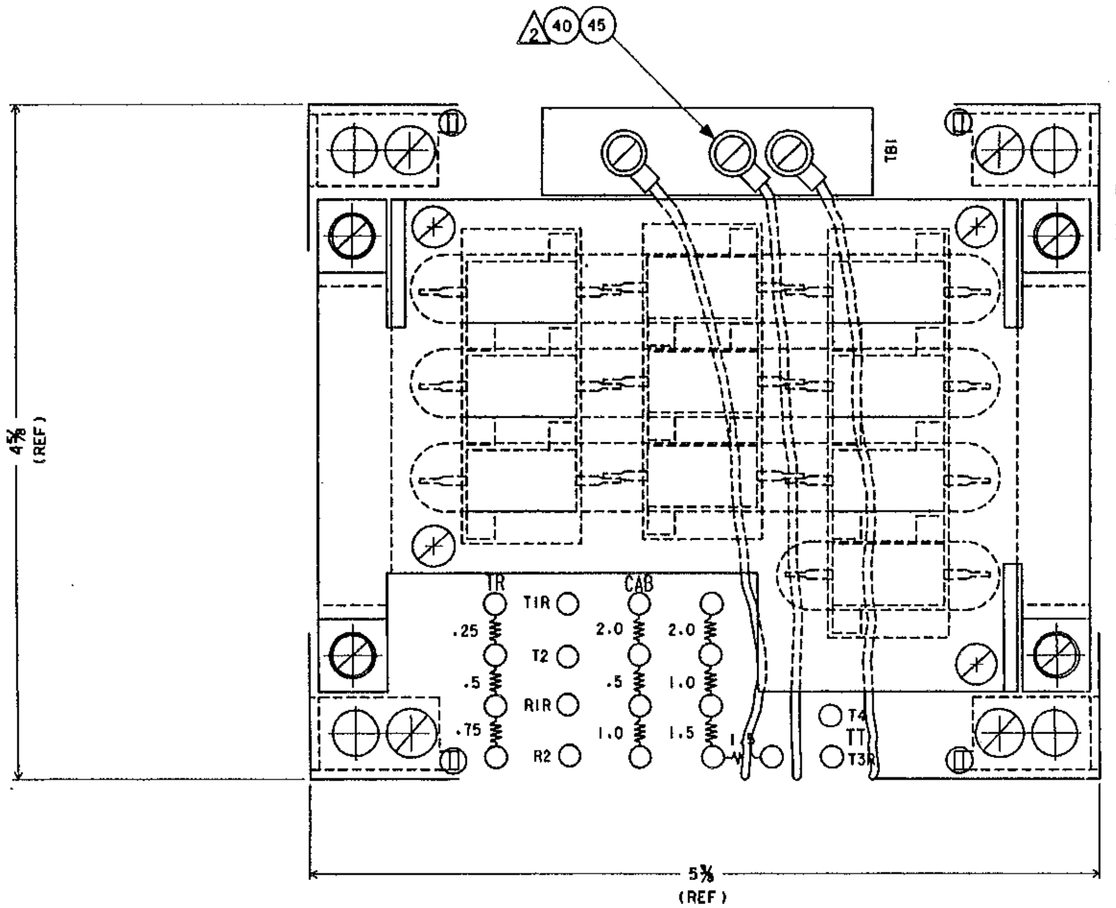


Figure A-1. Tuned Minibond Assembly

A1.1.2 Circuit Assembly (See Figure A-2)

N451662-1101 (Used on N451003-1802)
N451662-1102 (Used on N451003-1803)
N451662-1103 (Used on N451003-1804)
N451662-1104 (Used on N451003-1805)

Item	Description	Part No.
5	Capacitor PCB (Used on -1101)	N451657-9202
	Capacitor PCB (Used on -1102)	N451657-9203
	Capacitor PCB (Used on -1103)	N451657-9204
	Capacitor PCB (Used on -1104)	N451657-9205
10	Resistor PCB	N451657-9101
15	Spacer Bracket	M451662-0102
20	Screw, 8-32 x 7/16 Fl. Hd.	J521081
25	Washer, #8, Lock	J047681
30	Nut, 8-32, Hex, Stl.	J048166
35	Washer, #8 Pl. Flat, Stl.	J047745
40	Wire, Teflon, #18	A045010-0001
45	Terminal, Pre-Insul.	J730039

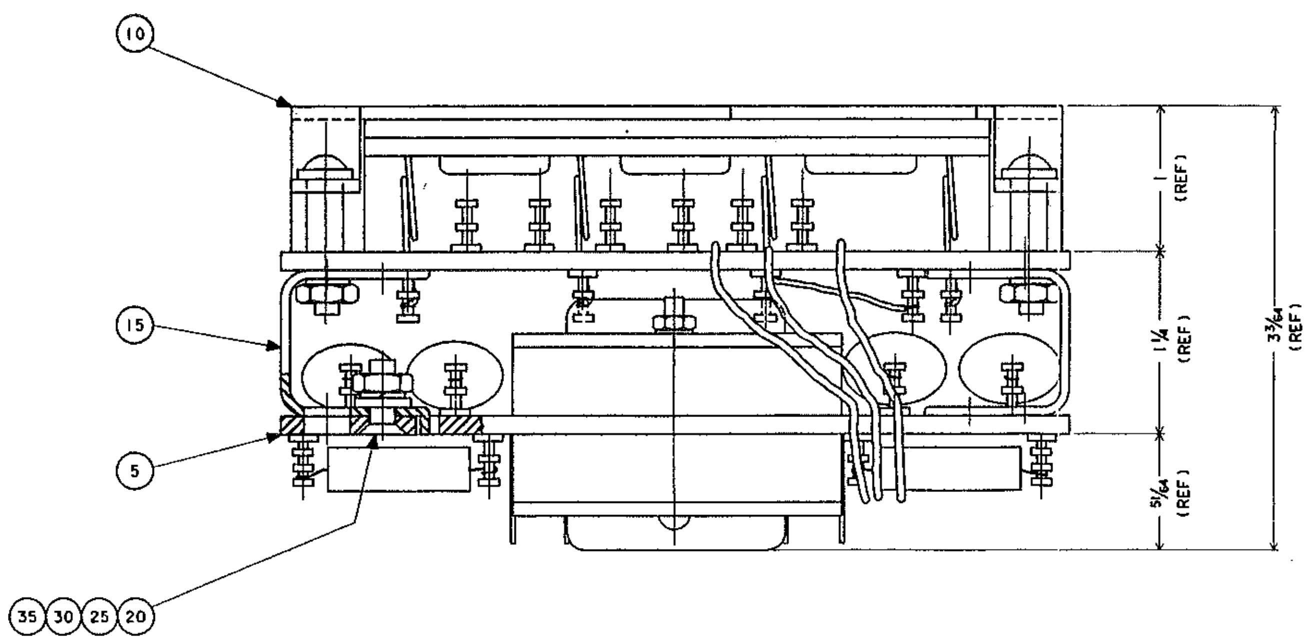


1 NOTE ORIENTATION OF CAPACITOR PCB & RESISTOR PCB PRIOR TO ASSEMBLY

2 CRIMP TERMINALS (IT.40) ON EACH END OF A 1 FT. PIECE OF WIRE (IT.45) AND INSTALL BY MATCHING TERMINALS T1R, T3R, & R1R.

4 WHEN ROUTING WIRES FROM TERMINAL STRIP ON RESISTOR PCB TO TERMINAL STRIP ON CAPACITOR PCB, INSERT WIRES INTO RESTRAINT SLOTS ON THE EDGE OF EACH PCB AS SHOWN

COMPONENT SIDE OF RESISTOR PCB



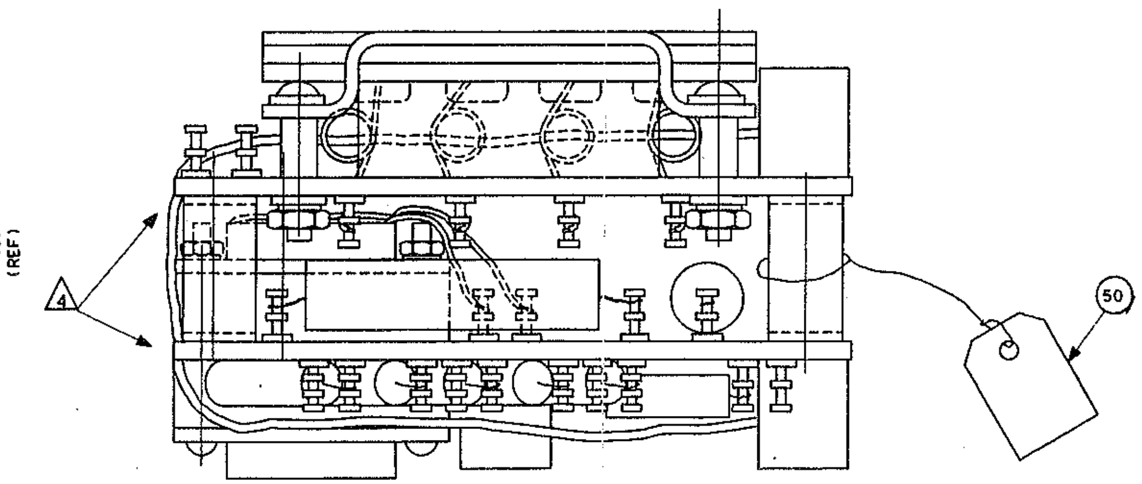


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Figure A-2. Circuit Assembly

A1.1.2.1 Capacitor PCB (See Figure A-3)

+ N451657-9202 (Used on -1101)
+ N451657-9203 (Used on -1102)
+ N451657-9204 (Used on -1103)
+ N451657-9205 (Used on -1104)

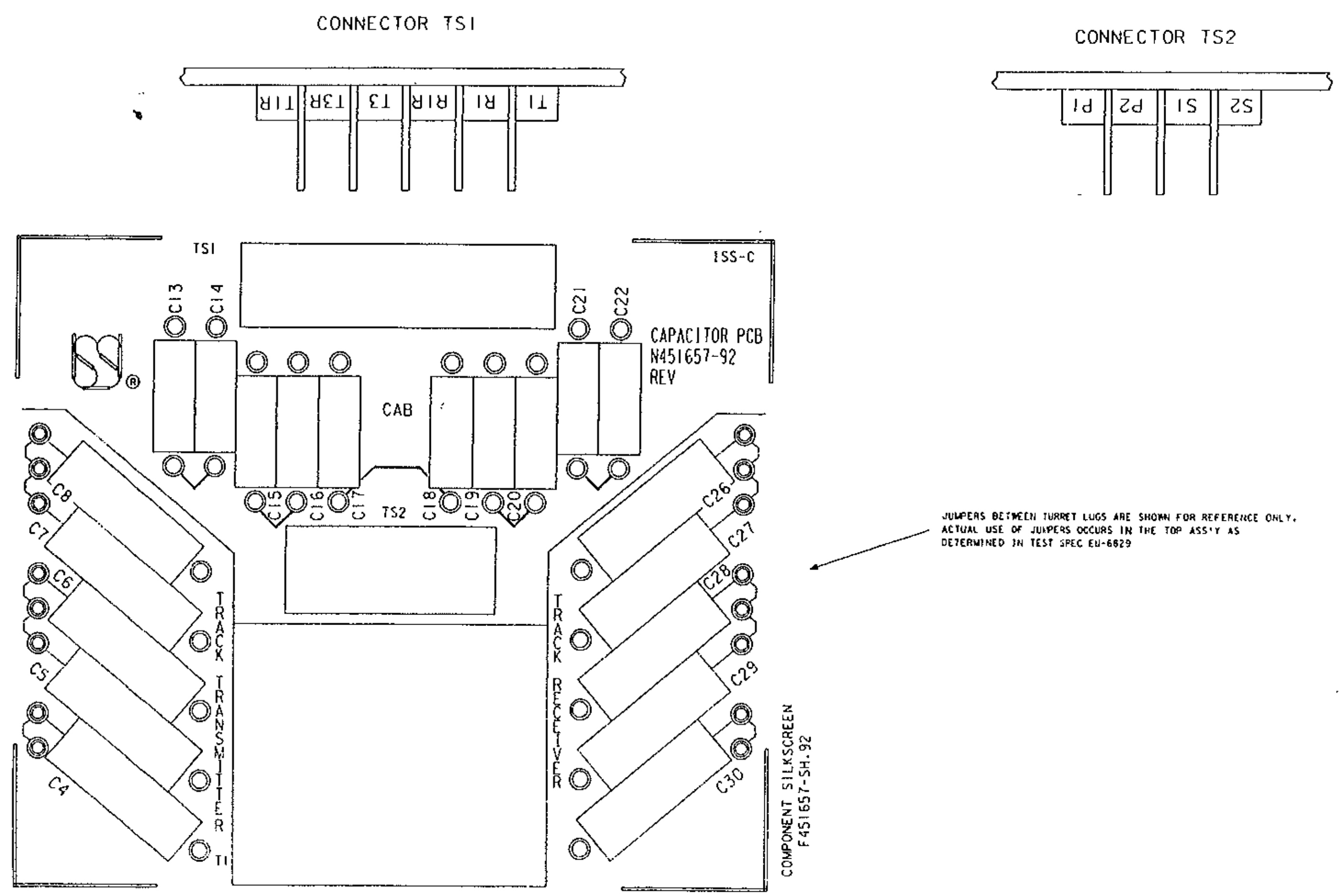
Item		Description	Part No.
* 5		Epoxy Sheet, 1/8"	A772106
* 10		Laminations	J792656
* 15		Coil	N451637-1101
20		Screw, 4-40 x 1-1/2, Rd. Hd.	J525093
25	T1	Washer, #4	J047765
30		Nut, 4-40, Hex	J480006
35		End Plate	M451611-1101
40		Turret Lug	J714090
45		TS1, Terminal Block (6 Way)	J752715-0013
50		TS2, Terminal Block (4 Way)	J752715-0012
55		Wire, #18, Bare Tinned Copper	A043179
		For part number of capacitors C1 through C30, see tabulation on Figure A-3.	

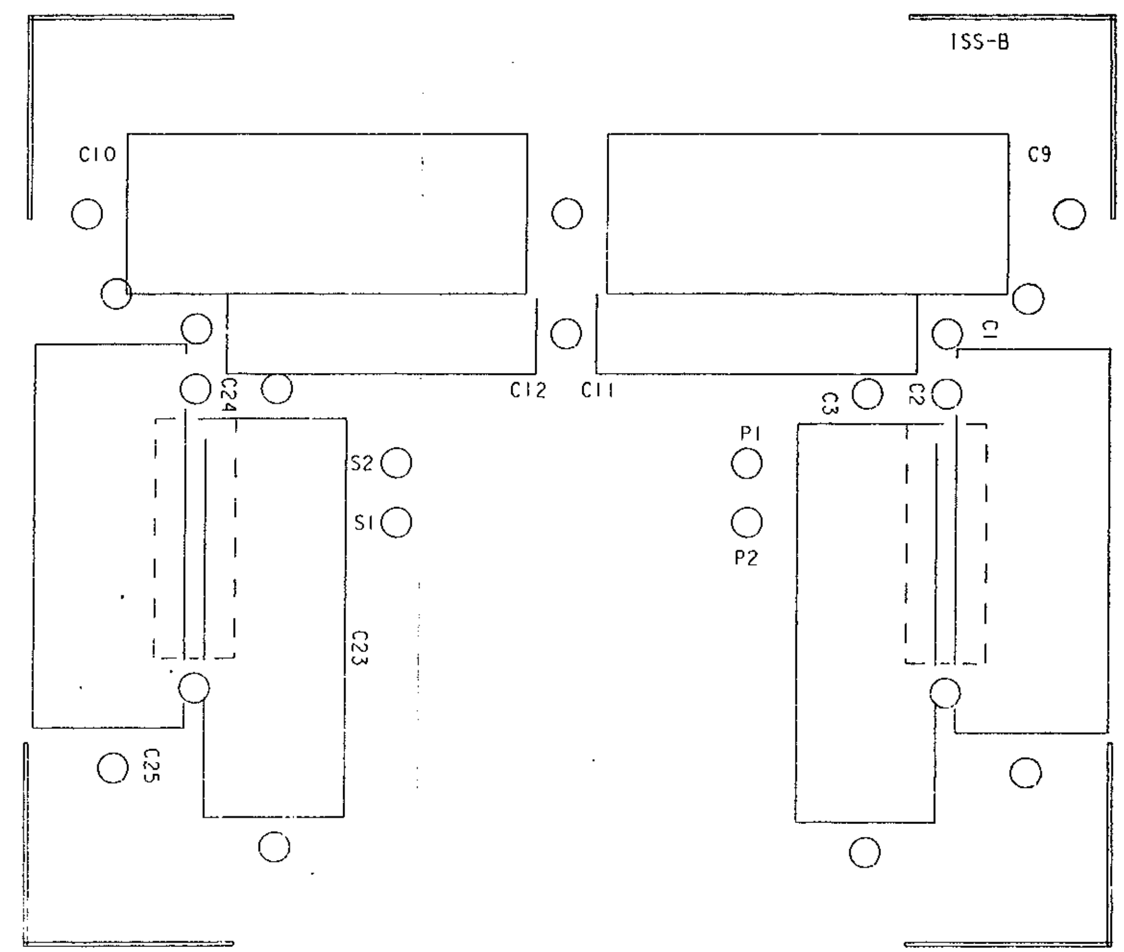
+ Excluding capacitors, all items are part of the basic board N451657-9201

* Replacement and repair will usually require disassembly. This can be time-consuming. Replacement of the complete board should be considered.

SUFFIX USING BASIC BOARD -9201	OPERATING FREQUENCIES (HZ) (FOR REFERENCE ONLY)			TRACK TRANSMITTER (TT)																CAB TRANSMITTER (CAB)													
				CAPACITOR C1		CAPACITOR C2		CAPACITOR C3		CAPACITOR C4		CAPACITOR C5		CAPACITOR C6		CAPACITOR C7		CAPACITOR C8		CAPACITOR C9		CAPACITOR C10		CAPACITOR C11		CAPACITOR C12		CAPACITOR C13		CAPACITOR C14		CAPACITOR C15	
	TT	TR	CAB	PC. NO.	MFD.	PC. NO.	MFD.	PC. NO.	MFD.	PC. NO.	MFD.	PC. NO.	MFD.	PC. NO.	MFD.	PC. NO.	MFD.	PC. NO.	MFD.	PC. NO.	MFD.	PC. NO.	MFD.	PC. NO.	MFD.	PC. NO.	MFD.	PC. NO.	MFD.	PC. NO.	MFD.	PC. NO.	MFD.
-9202	2590	3870	4550	J709145-0593	.33	———		J709145-0593	.33	J709145-0579	.0033	J709145-0581	.0068	J709145-0583	.01	J709145-0585	.022	J709145-0586	.033	J709145-0593	.33	J709145-0593	.33	J709145-0580	.068	J709145-0588	.068	J709145-0578	.0022	J709145-0578	.0022	J709145-0580	.0047
-9203	2970	3690	4550	J709145-0592	.22	J709145-0588	.068	J709145-0592	.22	J709145-0578	.0022	J709145-0580	.0047	J709145-0582	.0082	J709145-0584	.015	J709145-0586	.033	J709145-0593	.33	J709145-0593	.33	J709145-0580	.068	J709145-0588	.068	J709145-0578	.0022	J709145-0578	.0022	J709145-0580	.0047
-9204	3690	2590	4550	J709145-0593	.33	———		———		J709145-0576	.001	J709145-0578	.0022	J709145-0580	.0047	J709145-0582	.0082	J709145-0584	.015	J709145-0593	.33	J709145-0593	.33	J709145-058[illegible]	.068	J709145-0588	.068	J709145-0578	.0022	J709145-0578	.0022	J709145-0580	.0047
-9205	3870	2970	4550	J709145-0591	.15	———		J709145-0591	.15	J709145-0576	.001	J709145-0578	.0022	J709145-0580	.0047	J709145-0582	.0082	J709145-0584	.015	J709145-0593	.33	J709145-0593	.33	J709145-058[illegible]	.068	J709145-0588	.068	J709145-0578	.0022	J709145-0578	.0022	J709145-0580	.0047

SUFFIX USING BASIC BOARD -9201	OPERATING FREQUENCIES (HZ) (FOR REFERENCE ONLY)			CAB TRANSMITTER														TRACK RECEIVER (TR)															
				CAPACITOR C16		CAPACITOR C17		CAPACITOR C18		CAPACITOR C19		CAPACITOR C20		CAPACITOR C21		CAPACITOR C22		CAPACITOR C23		CAPACITOR C24		CAPACITOR C25		CAPACITOR C26		CAPACITOR C27		CAPACITOR C28		CAPACITOR C29		CAPACITOR C30	
	TT	TR	CAB	PC. NO.	MFD.	PC. NO.	MFD.	PC. NO.	MFD.	PC. NO.	MFD.	PC. NO.	MFD.	PC. NO.	MFD.	PC. NO.	MFD.	PC. NO.	MFD.	PC. NO.	MFD.	PC. NO.	MFD.	PC. NO.	MFD.	PC. NO.	MFD.	PC. NO.	MFD.	PC. NO.	MFD.	PC. NO.	MFD.
-9202	2590	3870	4550	J709145-0580	.0047	J709145-0582	.0082	J709145-0582	.0082	J709145-0583	.01	J709145-0583	.01	J709145-0584	.015	J709145-0584	.015	J709145-0590	.1	———		J709145-0628	.04067	J709145-058[illegible]	.0068	J709145-0579	.0033	J709145-0577	.0015	J709145-0576	.001	J700712	.0005
-9203	2970	3690	4550	J709145-0580	.0047	J709145-0582	.0082	J709145-0582	.0082	J709145-0583	.01	J709145-0583	.01	J709145-0584	.015	J709145-0584	.015	J709145-0591	.15	———		J709145-0581	.0068	J709145-0581	.0068	J709145-0579	.0033	J709145-0577	.0015	J709145-0576	.001	J700712	.0005
-9204	3690	2590	4550	J709145-0500	.0047	J709145-0582	.0082	J709145-0582	.0082	J709145-0583	.01	J709145-0583	.01	J709145-0584	.015	J709145-0584	.015	J709145-0592	.22	———		J709145-0590	.1	J709145-0581	.015	J709145-0581	.0068	J709145-0579	.0033	J709145-0578	.0022	J709145-0576	.001
-9205	3870	2970	4550	J709145-0580	.0047	J709145-0582	.0082	J709145-0582	.0082	J709145-0583	.01	J709145-0583	.01	J709145-0584	.015	J709145-0584	.015	J709145-0592	.22	———		J709145-0585	.022	J709145-0503	.01	J709145-0581	.0068	J709145-0579	.0033	J709145-0578	.0022	J709145-0576	.001





F451657-92, 92A, 92E

Figure A-3. Capacitor PCB

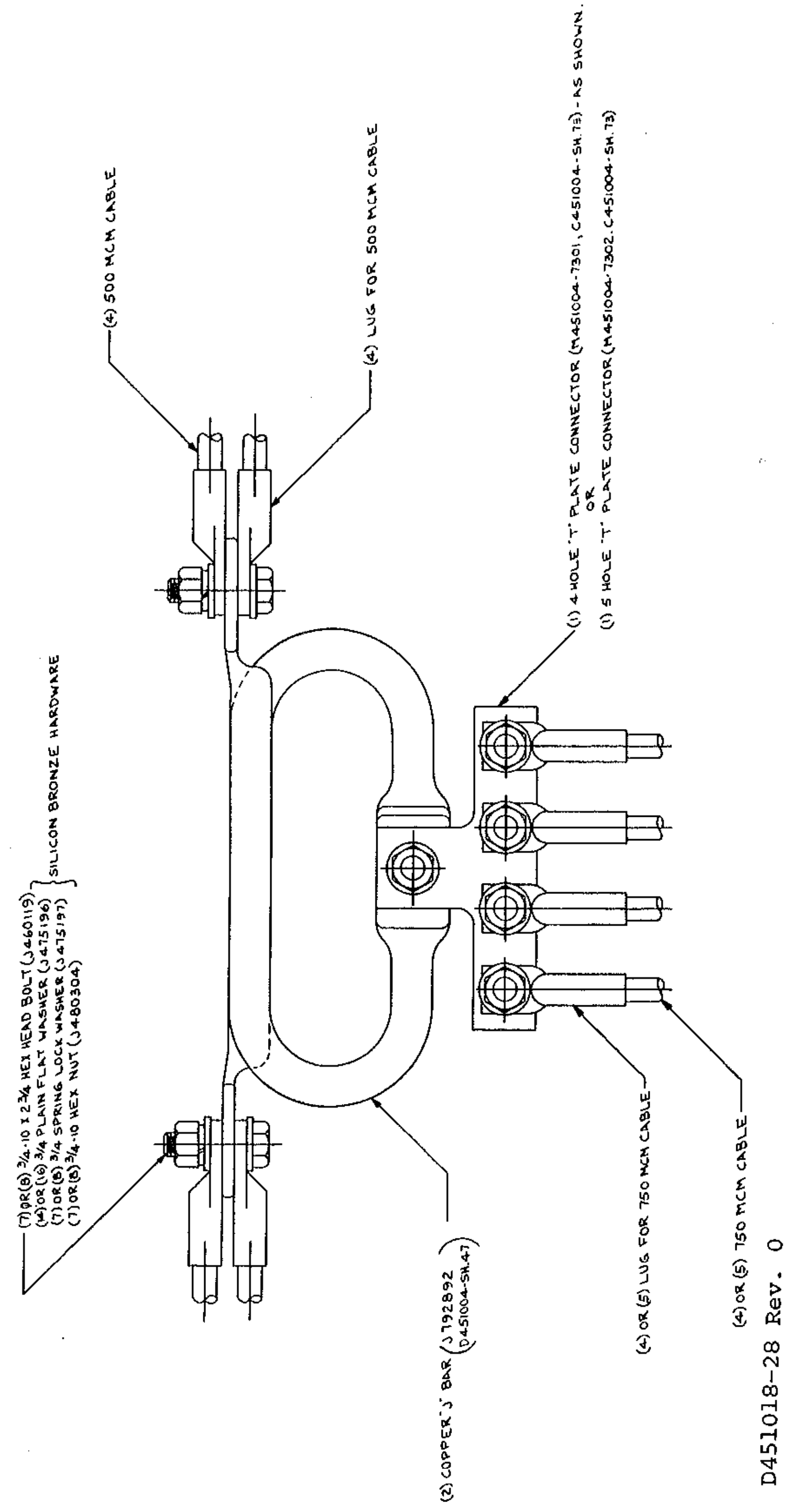


Figure 2-5

Application of 4 or 5 Hole "T" Plate Connector

A1.1.2.2 Resistor PCB - N451657-9101 (See Figure A-4)

Item	Description	Part No.
10	Terminal Strip	J725715
15	Terminal Lug	J714090
25	Rubber Pad	M451662-0401
30	Resistor Plate Assembly	N451662-0301
35	Spacer	J725920-0008
40	Screw, 8-32 x 1, Rd. Hd.	J052604
45	Washer, #8, Flat	J047745
50	Washer, #8, Lock	J047681
55	Nut, #8, Hex	J048166
60	Rubber Adhesive	J041531
65	Wire, #18, Teflon, Black	A045010-0001

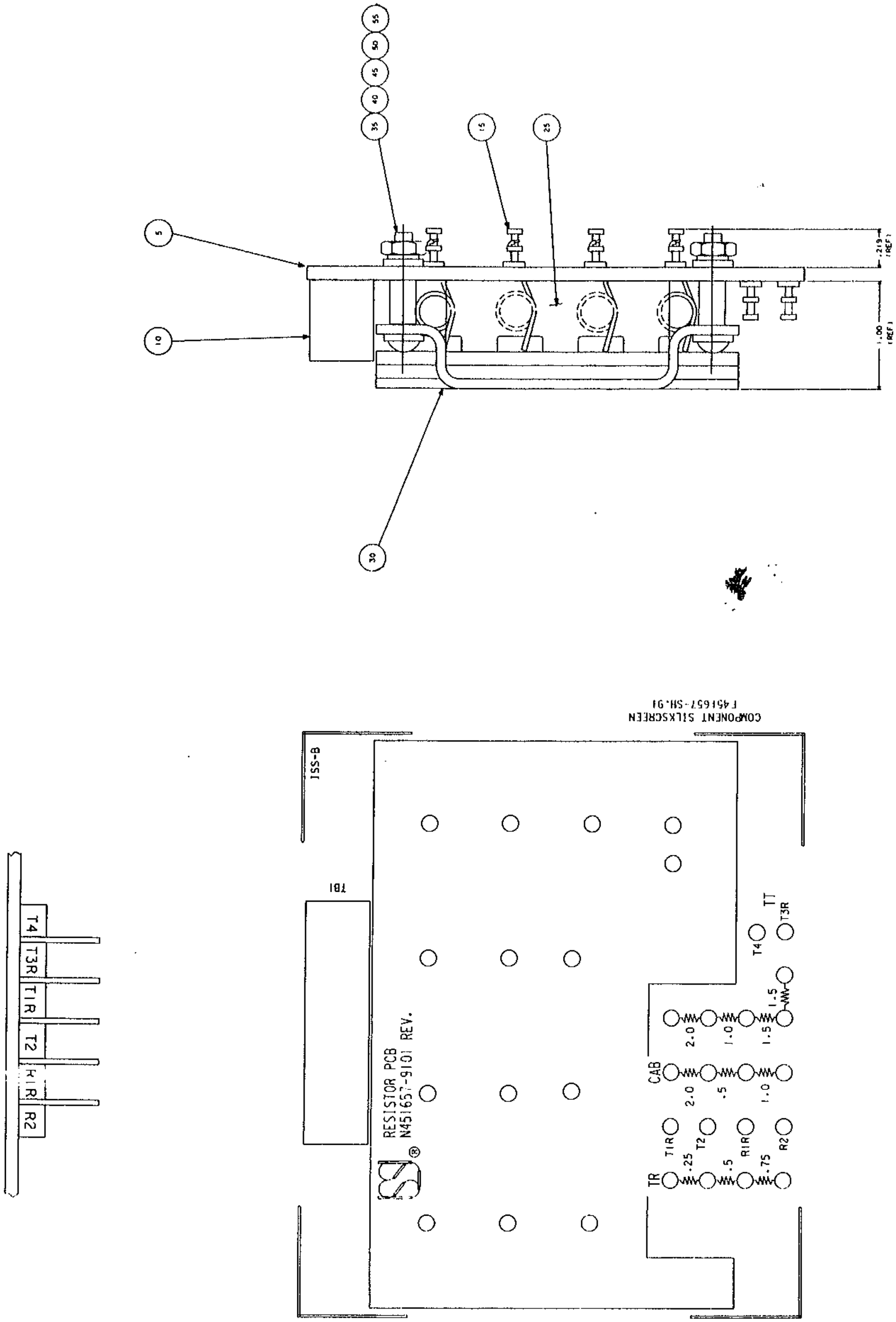


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Figure A-4. Resistor PCB