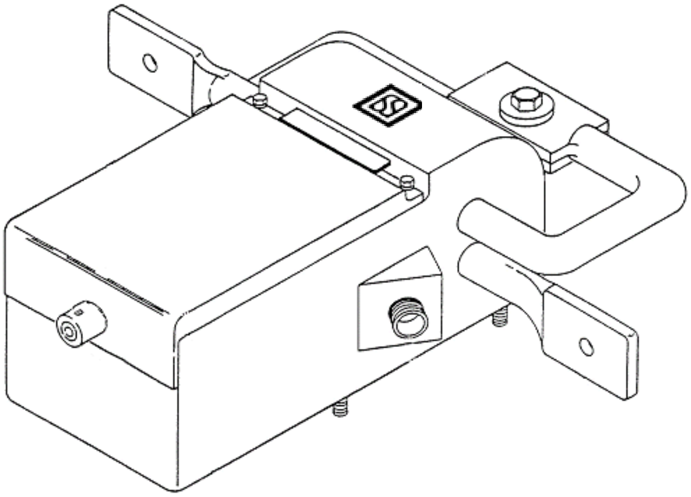
AnsaldoSTS
1000 Technology Drive, Pittsburgh, PA 15219
645 Russell Street, Batesburg, SC 29006

SM 9293

AF Track Circuit
Tuned Minibond

US&S Part No.
N451003-2008 (Group A)
N451003-2010 (Group B)



- ♦ Installation
- ♦ Maintenance
- ♦ Field Service

SM 9293, Rev. 4
January 2013

Proprietary Notice

Important Notice

ASTS USA constantly strives to improve our products and keep our customers apprised of changes in technology. Following the recommendations contained in the attached service manual will provide our customers with optimum operational reliability. The data contained herein purports solely to describe the product, and does not create any warranties.

Within the scope of the attached manual, it is impossible to take into account every eventuality that may arise with technical equipment in service. Please consult an ASTS USA local sales representative in the event of any irregularities with our product.

ASTS USA expressly disclaims liability resulting from any improper handling or use of our equipment, even if these instructions contain no specific indication in this respect. We strongly recommend that only approved ASTS USA spare parts are used as replacements.

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REVISION HISTORY

Rev.	Date	Nature of Revision
Original	June 2005	Initial Issue
Rev. 1	November 2005	Incorporated ECO 140102-1; added Section 1.5.4 - Environmental Specifications. Expanded spec on DC Propulsion Current in Section 1.5.2
Rev 2	June 2006	Incorporated ECO EE-2092; revised values for C7 capacitor for the -5211TR, 3900 Hz unit from .033 to .022 Mfd in Tables 4-5 and 5-6.
Rev 3	December 2011	Revised Section 1.5.2.. Added Figure 2-4.
Rev 4	January 2013	Added Section 2.3.2 added Note to Figure 2-5, Figure 2-6, Figure 2-7, Figure 2-8, and Figure 2-9.

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1. GENERAL INFORMATION

1.1. Introduction

This service manual provides the description, installation, and maintenance information for the Tuned Minibonds (Figure 1-1) used in an Automatic Train Control System. The minibond is a multifunction assembly used in cab signaling and train detection applications.

1.2. Description

The Tuned Minibond is a transformer consisting of a center tapped primary winding and three sets of secondary windings. The primary winding is connected rail-to-rail and serves two purposes – to balance the propulsion currents carried by the two rails, and to couple the AF train detection and cab signals to the rails. Each of the three secondary winding sets is tuned to a different resonant frequency – one set is tuned to the cab signaling frequency, the second set is tuned to the train detection transmitter frequency, and the third set is tuned to the train detection receiver frequency.

Normally the bond is applied as a track transmitter/receiver; it can also be used as a dual track receiver. However, the bond cannot be used as a dual transmitter, because the receiver circuit was not designed to be operated as a transmitter.

The train detection transmitter and receiver secondary winding sets are each capable of being tuned to one of the four available track frequencies (see nameplate Figure 1-2). This is accomplished by cutting the proper jumper (TL1 thorough TL8) on the minibond motherboard PCB (see Figure 5-3). The third secondary winding is tuned to the cab frequency (4550 Hz), and is not adjustable.

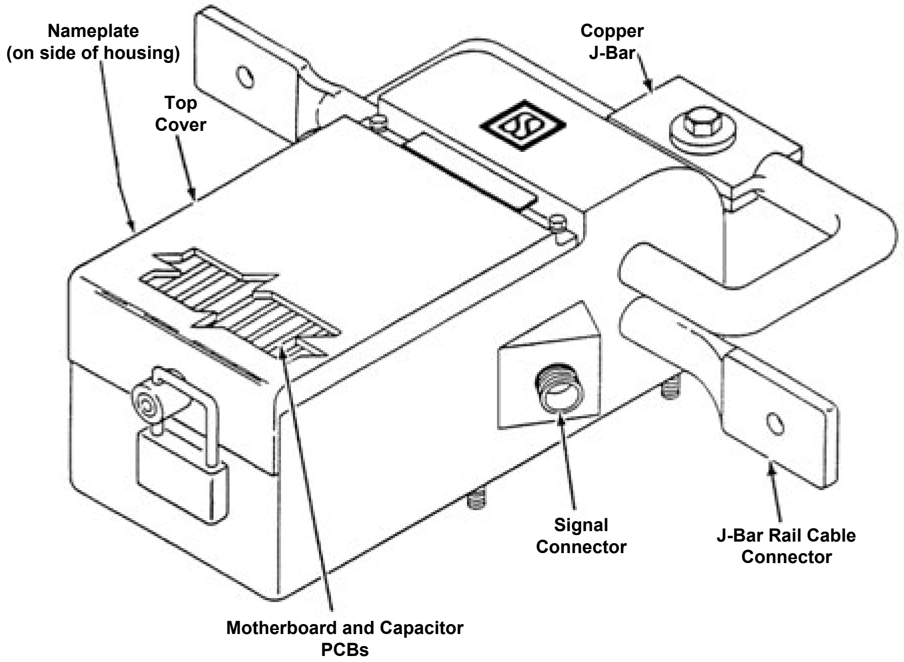


Figure 1-1. AF Tuned Minibond

Referring to Figure 3-5, each secondary winding set consists of two windings. One of these windings is isolated and capacitively-tuned to the appropriate resonant frequency. The other winding is connected in series with the equivalent windings from the other secondary winding sets and provides impedance matching to the AF electronics cardfile via a cable connector located on the side of the minibond.

The impedance of each tuned circuit peaks at its resonant frequency. As a result, the reflected impedance to the track or wayside at the resonant frequencies will be relatively high. Away from the resonant frequencies, the reflected impedance to the track or wayside will be low.

1.3. Abbreviations/Definitions

1.3.1. Abbreviations and Acronyms

AC	Alternating Current
AF	Audio Frequency
AWG	American Wire Gauge
CPM	Cycles Per Minute
CW	Continuous Wave
dB	Decibel
DC	Direct Current
LRU	Line Replaceable Unit
mA	Milliamp
msec	Millisecond

mV	Millivolt
PCB	Printed Circuit Board
p-p	Peak-to-Peak
rms	root-mean-square (method for expressing average AC voltage rating)
TBD	To Be Determined
US&S	Union Switch & Signal

1.3.2. Unit Symbols

A	Ampere
cm	centimeter
Hz	Hertz
in.	inch
kg	kilogram
lb	pound
oz	ounce
V	Volt
Ω	Ohm

1.3.3. Definitions

CAUTION	Caution statements indicate conditions that could cause damage to equipment.
Reference designator:	An abbreviation assigned to designate an electrical component. It generally consists of a capital letter and a number. Each letter designates a particular type of component. For example, "C1" identifies a capacitor and "R1" identifies a resistor.
Q	Quality factor of an inductor or capacitor. It is the ratio of a component's reactance (energy stored) to its effective series resistance (energy dissipated). For a tuned circuit, a figure of merit used in bandwidth calculations. Q is the ratio of reactive power to resistive power in a tuned circuit.
TBD:	To Be Determined: Component value determination procedure.
Vtc:	Voltage across Meter Scope (+) & Meter Scope (-) test points.
WARNING	Warning statements indicate conditions that could cause physical harm, serious injury, or loss of life.

1.4. Safety

Read and thoroughly understand this manual before attempting any of the procedures listed. Pay particular attention to the **WARNING** and **CAUTION** statements that appear throughout this manual. Always observe standard precautions familiar to trained electrical technicians. Always adhere to all safety regulations stipulated by the railroad.

1.5. Specifications

1.5.1. Physical

Dimensions:	21"W x 6 1/4"H x 12 3/16"D
Weight:	Approximately 65 pounds

1.5.2. Electrical

a. All Tuned Minibonds

Style:	AF Mini
Type:	DC Propulsion
DC Resistance:	0.00003 ±10% ohms, rail to rail at 20°C
Current Unbalance:	240 ampere turns DC through one turn of the propulsion winding, based on the operating characteristics of the AF track circuit system.

DC Propulsion Current:	3000 amps DC per rail, intermittent current rating of 6000 amps DC per rail for 1 minute, repeated at 10-minute intervals.

b. Tuned Minibond Impedances and Resonant Frequencies - Minibond N451003-2008 (see Table 1-1)

Table 1-1. Tuned Minibond Type, Function, Frequency – Group A Frequencies

Function	Freq. (Hz)	Test Voltage	Ohms ±10%
Group A Frequencies			
Cab 1 Transmitter	4550	1.000	1.050
Track Transmitter	2100	0.500	0.508
	2580	0.614	0.624
	3100	0.738	0.750
	3660	0.871	0.885
Track Receiver	2100	0.125	0.921
	2580	0.125	1.132
	3100	0.125	1.360
	3660	0.125	1.605

c. Tuned Minibond Impedances and Resonant frequencies – Minibond N451003-2010 (see Table 1-2).

Table 1-2. Tuned Minibond Type, Function, Frequency – Group B Frequencies

Function	Freq. (Hz)	Test Voltage	Ohms ± 10%
Group B Frequencies			
Cab Transmitter	4550	1.000	1.050
Track Transmitter	1900	0.450	0.460
	2820	0.671	0.681
	3370	0.802	0.813
	3900	0.929	0.941
Track Receiver	1900	0.125	0.720

Function	Freq. (Hz)	Test Voltage	Ohms ± 10%
	2820	0.125	1.510
	3370	0.125	1.376
	3900	0.125	1.592

1.5.3. Mechanical

The Tuned Minibond uses Moly-Permalloy toroidal cores to construct the coils. Each coil has two windings. The coils are bound together to form a coil assembly. Two J-shaped bars of 1-1/4" 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 top-back position of the bond. Provisions are provided in this cavity for mounting the motherboard and the capacitor PCBs. The motherboard contains the resistors used to adjust the impedance of the bond. The capacitor PCB contains capacitors used for tuning the board.

A steel cover with gasket is assembled over the mold cavity. It is fastened to the bond with three screws. The screw at the back of the bond is recessed inside a steel tube-like protrusion. A lock can be installed through this tube to block access to the screw. A metal catch at the front end of the bond limits travel of the front end of the cover.

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.

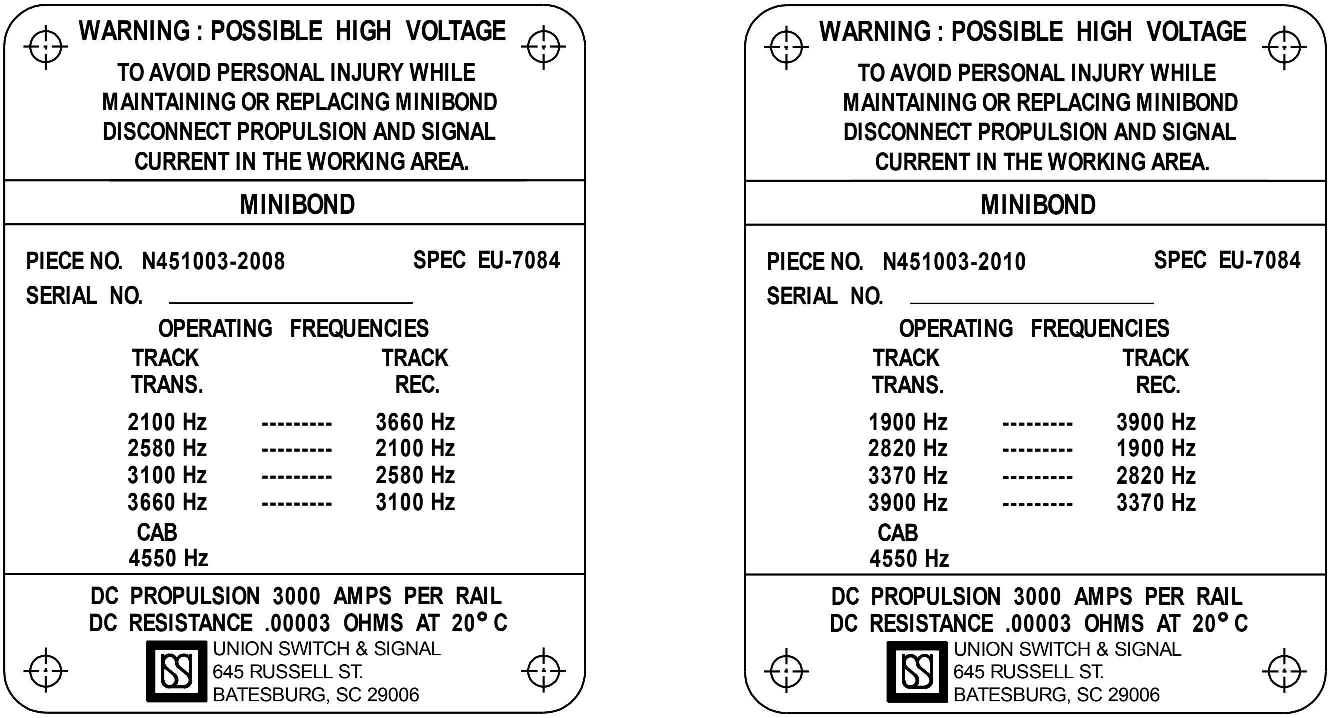
Four 1/2-13 x 1-3/8" long studs protrude from the bottom of the bond. These studs are welded to the mounting plate mentioned previously. These studs are used for mounting the bond during installation. Although these studs are sufficient for mounting the bond, two threaded inserts are available at the back of the bond to permit fastening down the back end, if desired.

1.5.4. Environmental

Operating Temperature Range	-40°C to +70°C
Humidity	0 to 95% non-condensing

1.6. Nameplate Data

Figure 1-2 illustrates a typical minibond nameplate. All applicable data is stamped on the nameplate for that specific bond.



WARNING : POSSIBLE HIGH VOLTAGE

TO AVOID PERSONAL INJURY WHILE
MAINTAINING OR REPLACING MINIBOND
DISCONNECT PROPULSION AND SIGNAL
CURRENT IN THE WORKING AREA.

MINIBOND

PIECE NO. N451003-2008 SPEC EU-7084
SERIAL NO. ____________________

OPERATING FREQUENCIES

TRACK TRANS.		TRACK REC.
2100 Hz	---------	3660 Hz
2580 Hz	---------	2100 Hz
3100 Hz	---------	2580 Hz
3660 Hz	---------	3100 Hz

CAB
4550 Hz

DC PROPULSION 3000 AMPS PER RAIL
DC RESISTANCE .00003 OHMS AT 20° C

UNION SWITCH & SIGNAL
645 RUSSELL ST.
BATESBURG, SC 29006

GROUP A FREQUENCIES

WARNING : POSSIBLE HIGH VOLTAGE

TO AVOID PERSONAL INJURY WHILE
MAINTAINING OR REPLACING MINIBOND
DISCONNECT PROPULSION AND SIGNAL
CURRENT IN THE WORKING AREA.

MINIBOND

PIECE NO. N451003-2010 SPEC EU-7084
SERIAL NO. ____________________

OPERATING FREQUENCIES

TRACK TRANS.		TRACK REC.
1900 Hz	---------	3900 Hz
2820 Hz	---------	1900 Hz
3370 Hz	---------	2820 Hz
3900 Hz	---------	3370 Hz

CAB
4550 Hz

DC PROPULSION 3000 AMPS PER RAIL
DC RESISTANCE .00003 OHMS AT 20° C

UNION SWITCH & SIGNAL
645 RUSSELL ST.
BATESBURG, SC 29006

GROUP B FREQUENCIES

Figure 1-2. Tuned Minibond Nameplate Data
(Drawing C45166220A)

2. INSTALLATION

2.1. General

Installation requirements for an impedance bond are controlled primarily by the physical specifications of user's trackage and associated signal hardware. The following remarks and drawings are intended only as a general guide to installation.

The installer should make whatever adjustments are necessary to insure that:

(a) The bonds, cables, and other pieces are well secured, with no possibility of being damaged by low hanging vehicle rigging, wheel flanges, etc.

(b) The section of track outfitted with the bonds maintains standards for tie spacing, ballast support, etc.

2.2. Track Layout Drawings

Figure 2-5 through Figure 2-9 provide information for the application of the tuned minibond to 115 lb. RE rail at sites employing the following:

a. Wood ties (typical mounting), Figure 2-5.

b. Concrete ties, 30" or 33" spacing (typical mounting), 30" shown, Figure 2-6.

c. Floating concrete slab and direct fixation (typical mounting), Figure 2-7.

d. Vaghuex concrete ties (typical mounting), Figure 2-8.

e. Minibond mounting pad, Figure 2-9.

Appropriate materials required for the installation, or replacement use, are listed in the applicable drawings.

2.3. Installation Procedures

It is necessary to set the minibond to the proper frequencies. This can be done in the field, but it would be better to pre-set the minibond prior to its installation. Set minibond frequency by cutting the appropriate buss wire (See Figure 5-3). New minibonds are supplied with all jumpers (TL2 - TL7) installed. This sets the track transmitter and track receiver to the same frequency (1900 or 2100 Hz). Before connecting the bond to the AF track circuit equipment, one jumper must be cut so that the transmitter and receiver are tuned to different frequencies. This is done to prevent the AF transmitter from energizing the receiver circuit inside the minibond. When using a bond as a single receiver at 1900 or 2100 Hz, the transmitter must be tuned to a different frequency by cutting TL2, TL3, or TL4."

The following paragraphs provide general information on installing minibonds:

WARNING

> To avoid personal injury while installing impedance bonds, be sure to disconnect propulsion and signal current in the working area.

2.3.1. Track Preparations

Using the appropriate installation drawing (see Figure 2-2 and Figure 2-3) 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. Use the application drawing to locate hold-down screw holes for the bond and other pieces.

2.3.2. Minibond Mounting

The minibond is secured to the mounting bracket with four 1/2 - 13 elastic stop nuts. When installing these nuts, torque them to 15 foot-pounds. Do not over tighten the nuts.

2.3.3. 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.

2.3.4. Cable Connections

See Figure 2-1 for connection applications. The minibond "J" bar has plated terminals. Propulsion cable lugs should also be plated or tinned.

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

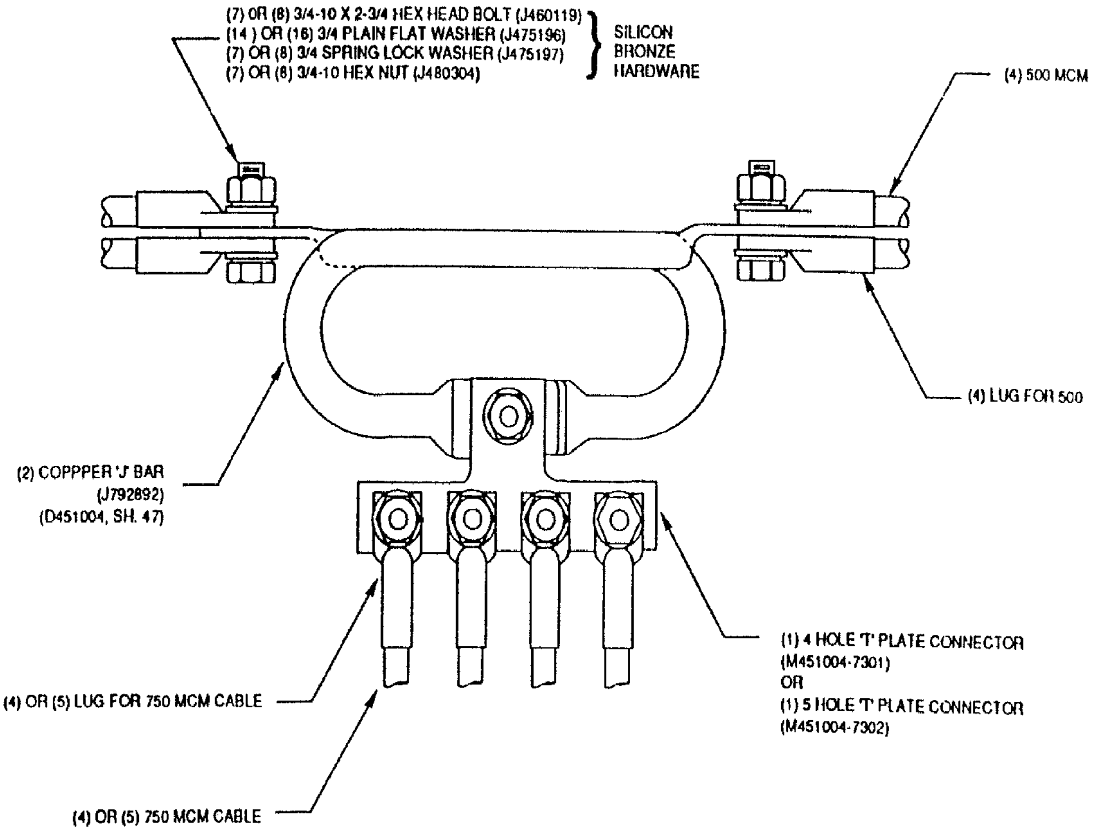
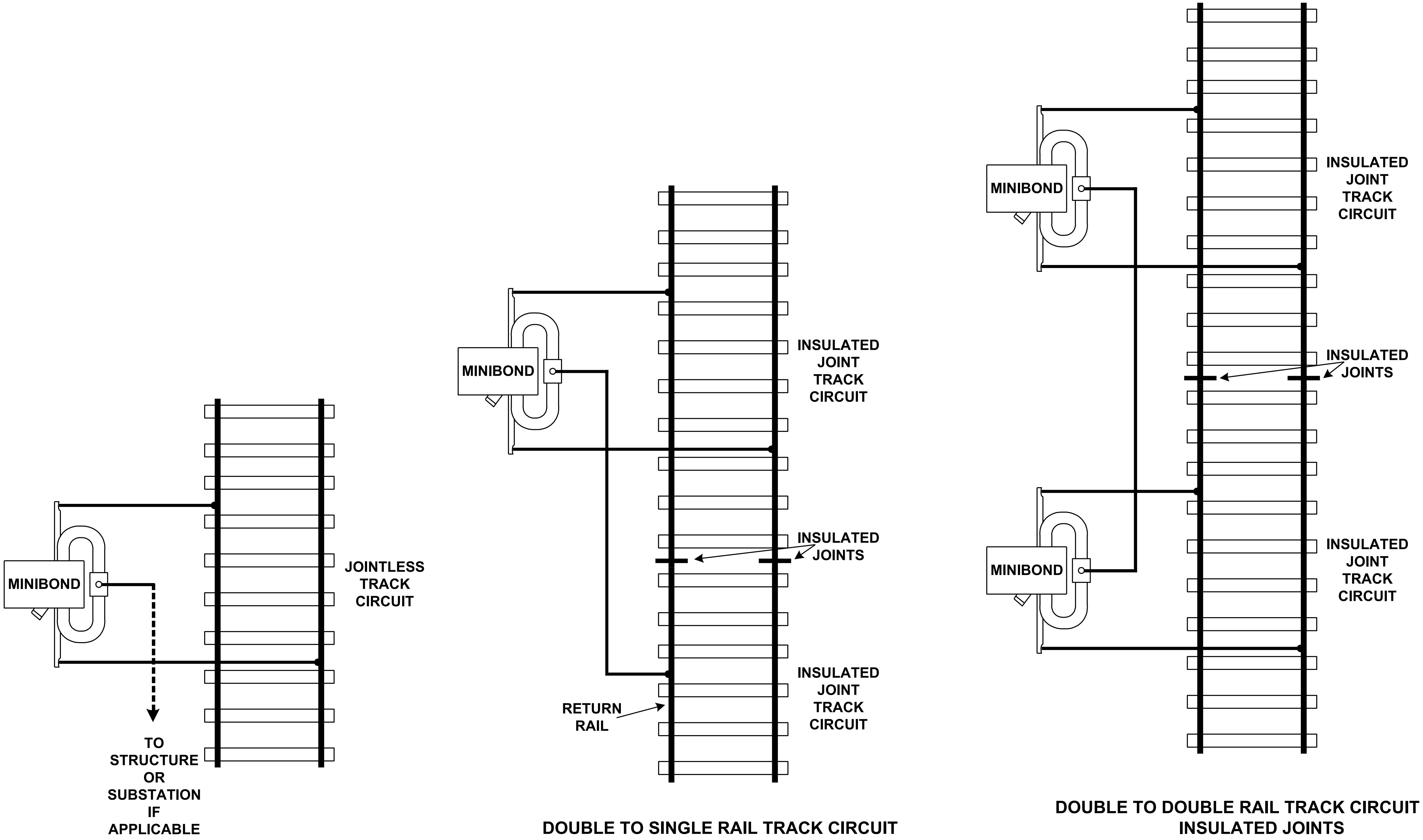


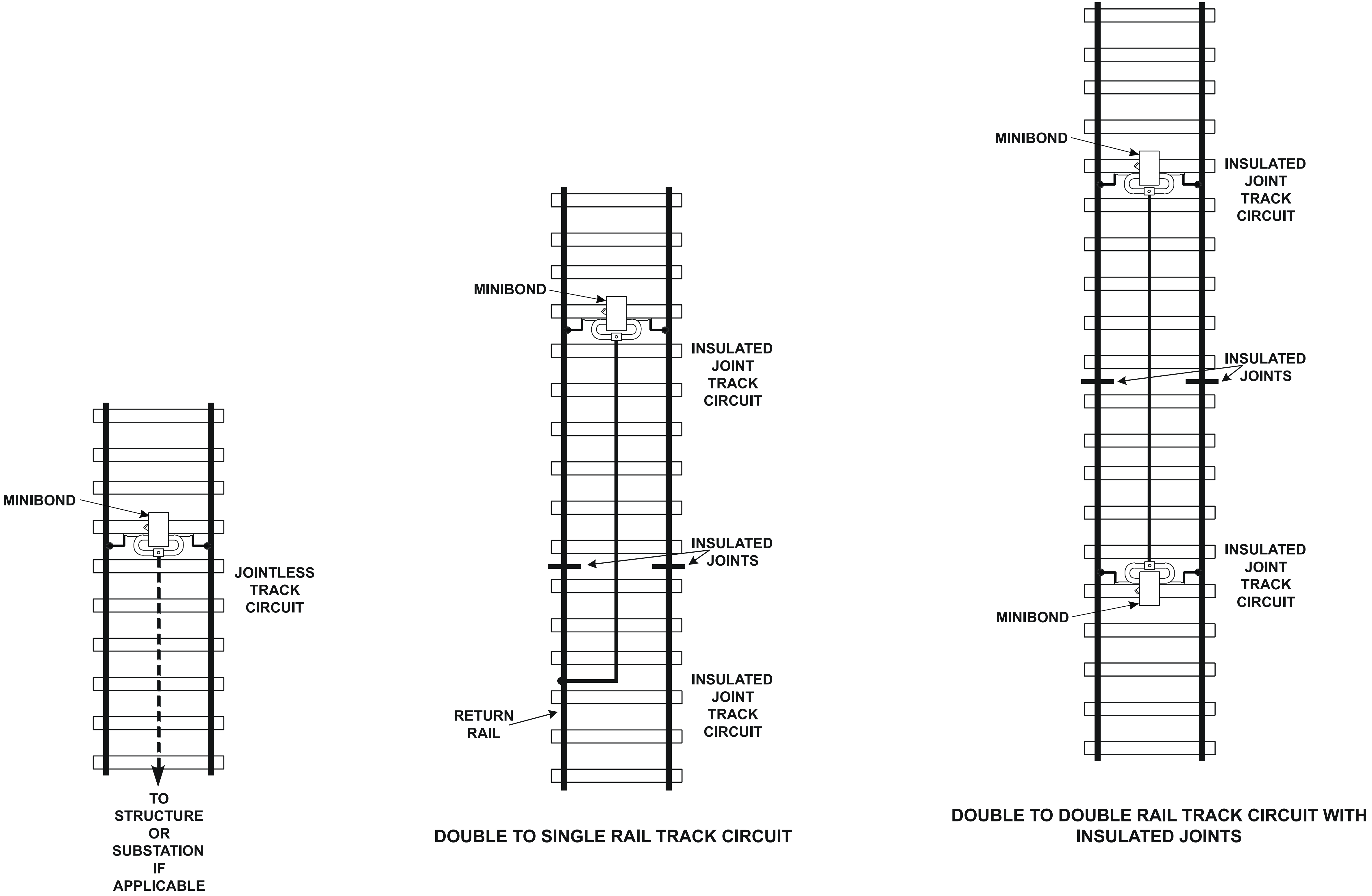
Figure 2-1. Application of Four or Five Hole "T" Plate Connector to "J" Bar



DOUBLE TO SINGLE RAIL TRACK CIRCUIT

DOUBLE TO DOUBLE RAIL TRACK CIRCUIT WITH INSULATED JOINTS

Figure 2-2. Typical Minibond Application (Mounted Outside Rails)



DOUBLE TO SINGLE RAIL TRACK CIRCUIT

DOUBLE TO DOUBLE RAIL TRACK CIRCUIT WITH INSULATED JOINTS

Figure 2-3. Typical Minibond Application (Mounted Inside Rails)

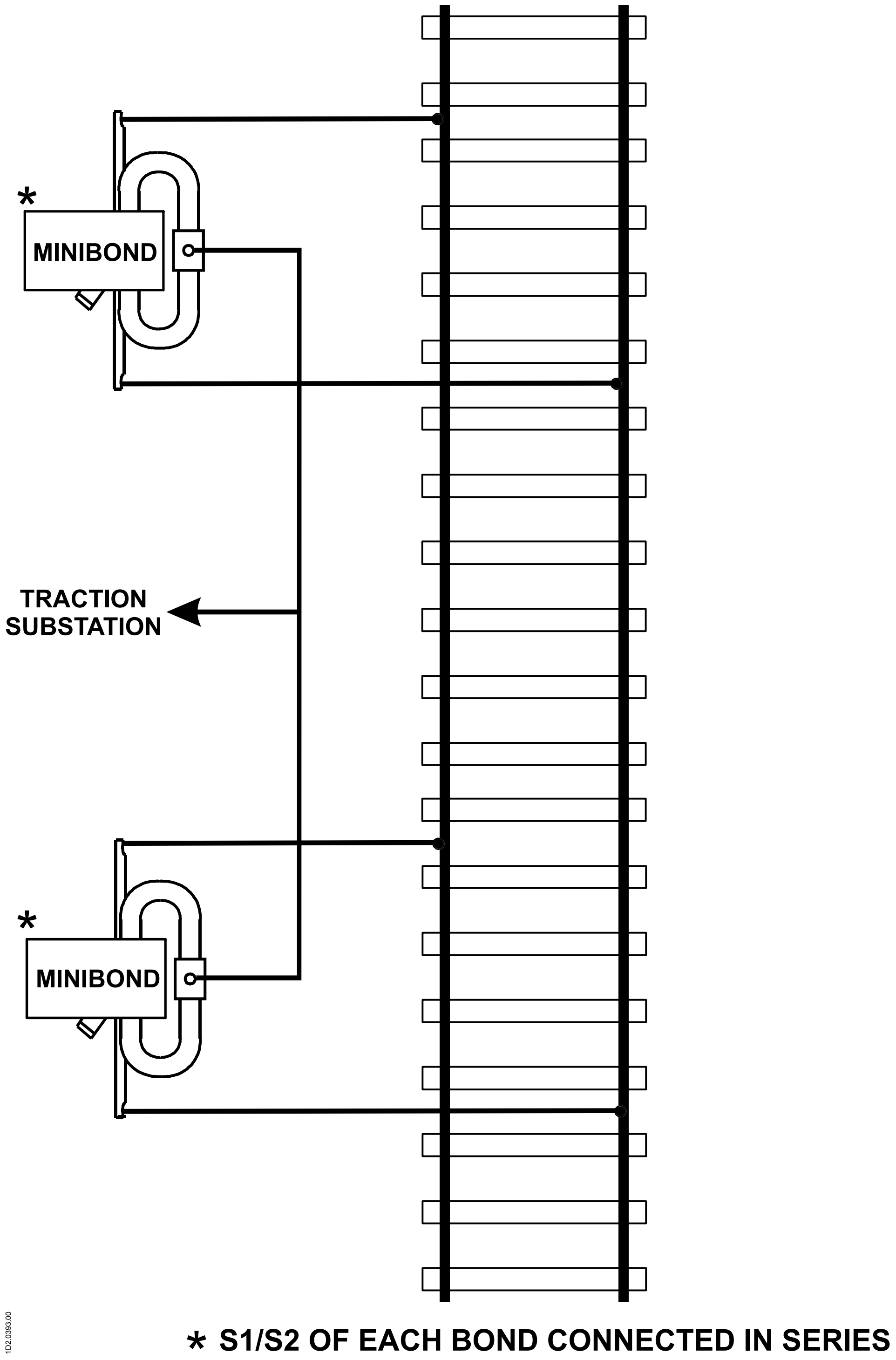
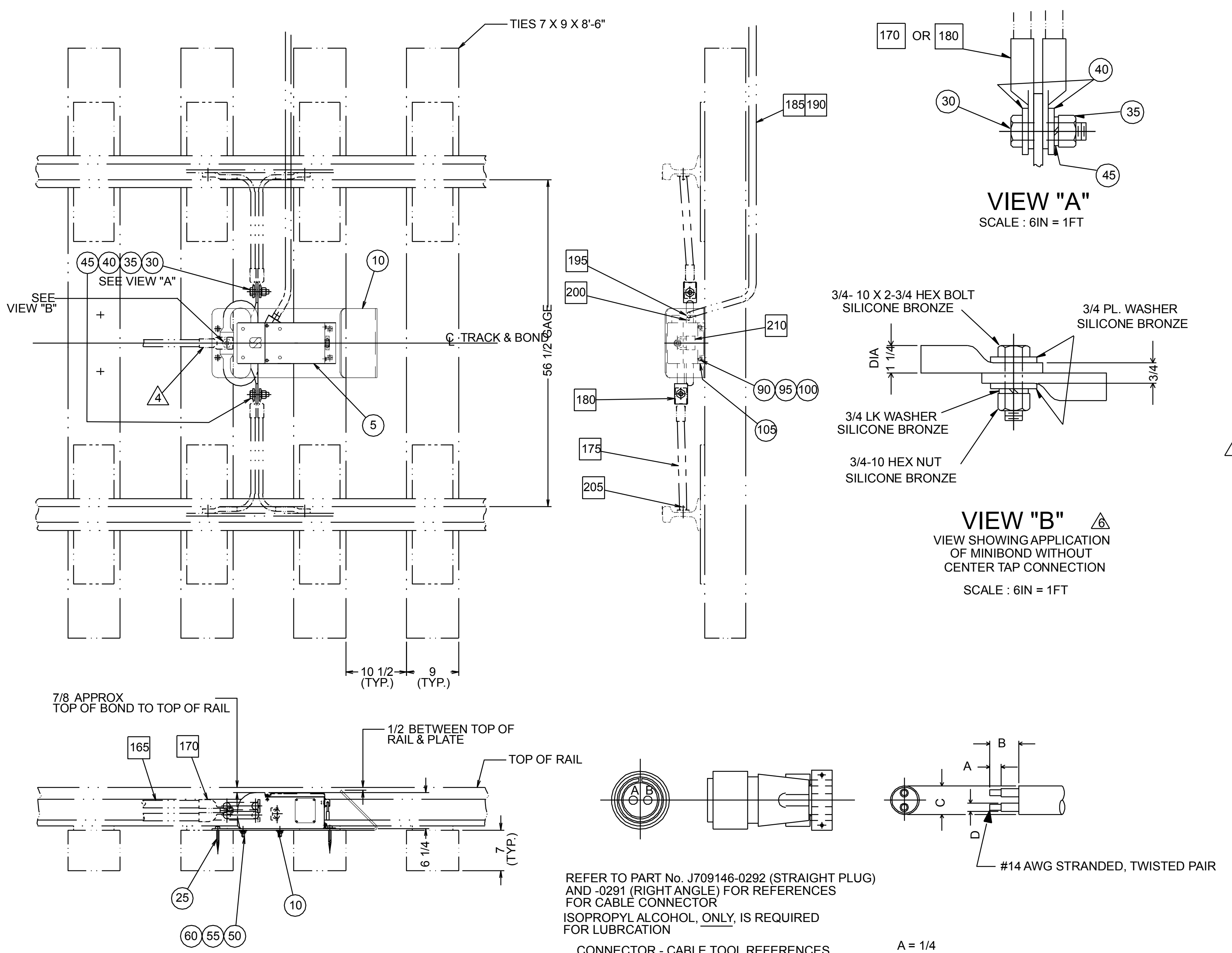


Figure 2-4. Double Bond Jointless AF track Circuit



VIEW "A"
SCALE : 6IN = 1FT

VIEW "B" △6
VIEW SHOWING APPLICATION OF MINIBOND WITHOUT CENTER TAP CONNECTION

SCALE : 6IN = 1FT

SHOWN						X	451486	GROUP	LAYOUT-TUNED MINIBOND	F	451486	28	
GR 2802		ITEM NUM	GROUP 2801			PART IDENTIFICATION			DESCRIPTION	DRAWING			
QTY	DEC		UM	QTY	DEC		NUMBER	SUFFIX		T	NUMBER	SHEET	SUB
- -		5	EA	1	.00		△3		MINIBOND-TUNED				
- -		10	EA	1	.00	M	379006	01	SKID PL/MTG BRKT,WOOD TIE	E	379	006	
- -		15	EA										
- -		20	EA										
- -		25	EA	4	.00	J	050324		SCREW, 1/2X4 LAG GALV				
- -		30	EA	2	.00	J	460119		BLT-3/4-10X2-3/4HXHD				
- -		35	EA	2	.00	J	480304		NUT-3/4-10 HEX				
- -		40	EA	4	.00	J	475196		WSHR-3/4" PL FLAT				
- -		45	EA	2	.00	J	475197		WSHR-3/4" SPR LK				
- -		50	EA	4	.00	J	047503		WASHER,1/2 STEEL PLATE				
- -		55	EA	4	.00	J	047783		WASHER,1/2 PL STL LOCK				
- -		60	EA	4	.00	J	048013		NUT,1/2-13UNC 2B HVY				
		65	EA										
		70	EA										
		75	EA										
		80	EA										
1	.00	85	EA	- -		X	451486	2801	LAYOUT, TUNED MINIBOND	F	451486	28	
2	.00	90	EA	- -		J	050013		1/4-20 5/8 HEX HD SCREW				
2	.00	95	EA	- -		J	047501		1/4 FLAT WASHER				
2	.00	100	EA	- -		J	047775		1/4 LOCK WASHER				
1	.00	105	EA	- -		M	451662	1802	ANGLE, BRACKET	F	451662	18	
		110	EA										
		115	EA										
		120	EA										
☐ THE FOLLOWING ITEMS, SUPPLIED BY INSTALLER, FOR REF ONLY													
		150	EA										
		155	EA										
		160	EA										
△8 {		165	EA						CABLE - 1000 MCM				
		170	EA						LUG				
		175	EA						CABLE - 500 MCM				
		180	EA						LUG				
		185	EA						CABLE - #14 AF				
		190	EA						CONDUIT				
		195	EA						CLAMP - CABLE				
△8		200	EA						CONN - PIN				
		205	EA						CONN - TERMINAL PIN				
		210	EA						PADLOCK (OPTIONAL)				

REFER TO PART No. J709146-0292 (STRAIGHT PLUG) AND -0291 (RIGHT ANGLE) FOR REFERENCES FOR CABLE CONNECTOR

ISOPROPYL ALCOHOL, ONLY, IS REQUIRED FOR LUBRCATION

CONNECTOR - CABLE TOOL REFERENCES	
CRIMP TOOL	J709146-0435
LOCATOR TOOL	J709146-0436
INSERTION TOOL	J709146-0437
EXTRACTION TOOL	J709146-0438
GUIDE PIN	J709146-0439
CONTACT, CRIMP #12 SOCKET	J709146-0434

A = 1/4
B = 5/8 APPROX.
C = .285 MIN. DIA. - .610 MAX. DIA.
D = .114 MIN. DIA. - .170 MAX. DIA.

MOUNTING NOTES

TORQUE THE FOUR ½ - 13 ELASTIC STOP NUTS (ITEM ⑥⓪) TO 15 FOOT - POUNDS. DO NOT OVER TIGHTEN.

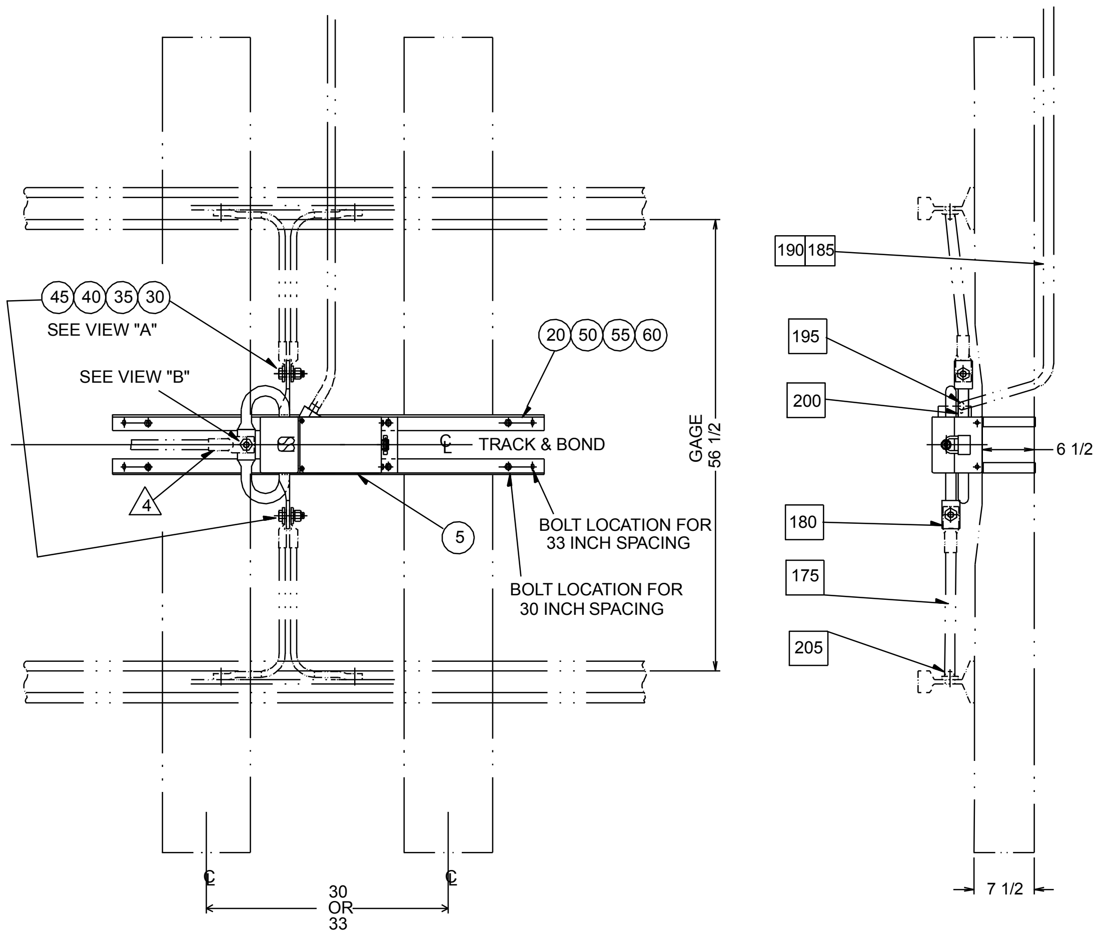
WAYSIDE CABLE APPLICATION NOTES

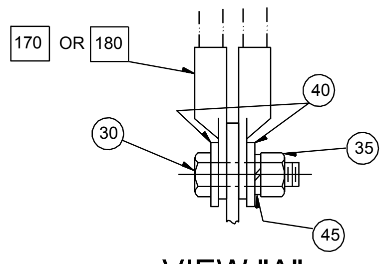
(CABLE FROM THE MINIBOND CONNECTOR TO NEARBY JUNCTION BOX)

NOTES: S. B. = SILICON BRONZE

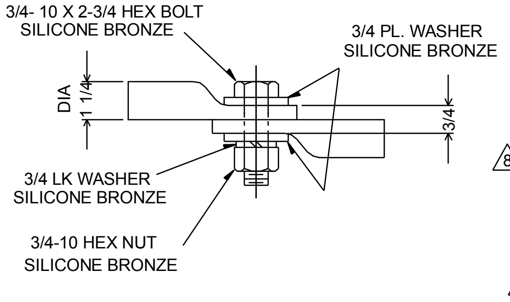
1. PARTS SHOWN IN FULL LINES TO BE FURNISHED BY US & S OR INSTALLER.
△2 115# RE RAIL WOOD TIES (TYPICAL MOUNTING).
△3 MINIBOND, (ITEM 5) TO BE ORDERED BY SYSTEMS ENG'R PER G. O. REQUIREMENTS. SEE DWG. F451003 SH.20 FOR PART NO'S.
△4 FOR 4 OR 5 CABLE CONNECTIONS SEE APPLICATION DWG. D451018-SH.28.
△5 (ITEMS 165 & 170) TO BE USED ONLY WHEN CENTER TAP IS REQUIRED.
△6 HARDWARE FOR THE MINIBOND CENTER TAP IS SUPPLIED WITH THE MINIBOND.
7. CABLES ANCHORED TO TIES PER INSTALLER DRAWINGS.
△8 REFERENCE FOR PLUG CONNECTOR, U.S.& S. PART NUMBERS
STRAIGHT J709146-0292
RIGHT ANGLE J709146-0291

Figure 2-5. Typical Minibond Mounting to Wood Ties





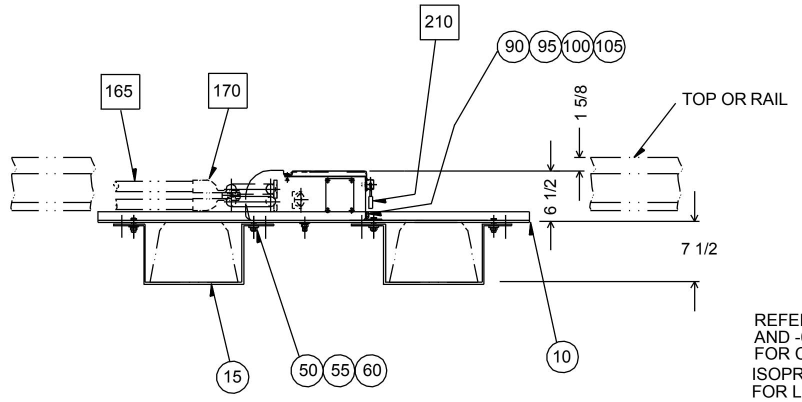
VIEW "A"
SCALE : 6IN = 1FT

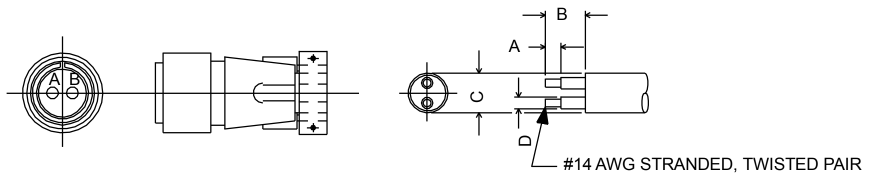


VIEW "B" △6
VIEW SHOWING APPLICATION
OF MINIBOND WITHOUT
CENTER TAP CONNECTION

SCALE : 6IN = 1FT

SHOWN						X	451486	GROUP	LAYOUT-TUNED MINIBOND	F	451486	29	
GR -2902		ITEM	GROUP 2901			PART IDENTIFICATION				DRAWING			
QTY	DEC	NUM	UM	QTY	DEC	T	NUMBER	SUFFIX	DESCRIPTION	T	NUMBER	SHEET	SUB
- -		5	EA	1	.00		△3		MINIBOND - TUNED	F	451003	20	
- -		10	EA	2	.00	M	451662	1803	BRACKET - MTG	F	451662	18	
- -		15	EA	4	.00	M	451662	1804	BRACKET - MTG	F	451662	18	
- -		20	EA	8	.00	J	050095		1/2-13 X 1-3/4 HEX STL				
- -		25	EA										
- -		30	EA	2	.00	J	460119		BLT-3/4-10X2-3/4HXHD				
- -		35	EA	2	.00	J	480304		NUT-3/4-10 HEX				
- -		40	EA	4	.00	J	475196		WSHR-3/4"PLFLAT				
- -		45	EA	2	.00	J	475197		WSHR-3/4" SPR LK				
- -		50	EA	16	.00	J	047503		WASHER,1/2 STEEL PLATE				
- -		55	EA	10	.00	J	047783		WASHER,1/2 PL STL LOCK				
- -		60	EA	16	.00	J	048013		NUT,1/2-13UNC 2B HVY				
		65	EA										
		70	EA										
		75	EA										
		80	EA										
1	.00	85	EA	- -		X	451486	2901	LAYOUT, TUNED MINIBOND	F	451486	29	
2	.00	90	EA	- -		J	050013		1/4-20 5/8 HEX HD SCREW				
2	.00	95	EA	- -		J	047501		1/4 FLAT WASHER				
2	.00	100	EA	- -		J	047775		1/4 LOCK WASHER				
1	.00	105	EA	- -		M	451662	1802	ANGLE, BRACKET	F	451662	18	
		110	EA										
		115	EA										
		120	EA										
☐		THE FOLLOWING ITEMS, SUPPLIED BY INSTALLER, FOR REF ONLY											
		150	EA										
		155	EA										
		160	EA										
		165	EA						CABLE - 1000 MCM				
		170	EA						LUG				
		175	EA						CABLE - 500 MCM				
		180	EA						LUG				
		185	EA						CABLE - #14 AF				
		190	EA						CONDUIT				
		195	EA						CLAMP - CABLE				
		200	EA						CONN - PIN				
		205	EA						CONN - TERMINAL PIN				
		210	EA						PADLOCK (OPTIONAL)				
		215	EA										
		220	EA										





NOTES:
S. B. = SILICON BRONZE

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

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

△3 MINIBOND, (ITEM 5) TO BE ORDERED BY SYSTEMS ENG'R PER G. O. REQUIREMENTS. SEE DWG. F451003 SH.20 FOR PART NO'S.

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

△5 (ITEMS 165 & 170) TO BE USED ONLY WHEN CENTER TAP IS REQUIRED.

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

7. CABLES ANCHORED TO TIES PER INSTALLER DRAWINGS.

△8 REFERENCE FOR PLUG CONNECTOR, U.S.& S. PART NUMBERS
STRAIGHT J709146-0292
RIGHT ANGLE J709146-0291

REFER TO PART No. J709146-0292 (STRAIGHT PLUG) AND -0291 (RIGHT ANGLE) FOR REFERENCES FOR CABLE CONNECTOR

ISOPROPYL ALCOHOL, ONLY, IS REQUIRED FOR LUBRCATION

A = 1/4
B = 5/8 APPROX.
C = .285 MIN. DIA. - .610 MAX. DIA.
D = .114 MIN. DIA. - .170 MAX. DIA.

CONNECTOR - CABLE TOOL REFERENCES

CRIMP TOOL	J709146-0435
LOCATOR TOOL	J709146-0436
INSERTION TOOL	J709146-0437
EXTRACTION TOOL	J709146-0438
GUIDE PIN	J709146-0439
CONTACT, CRIMP #12 SOCKET	J709146-0434

WAYSIDE CABLE APPLICATION NOTES

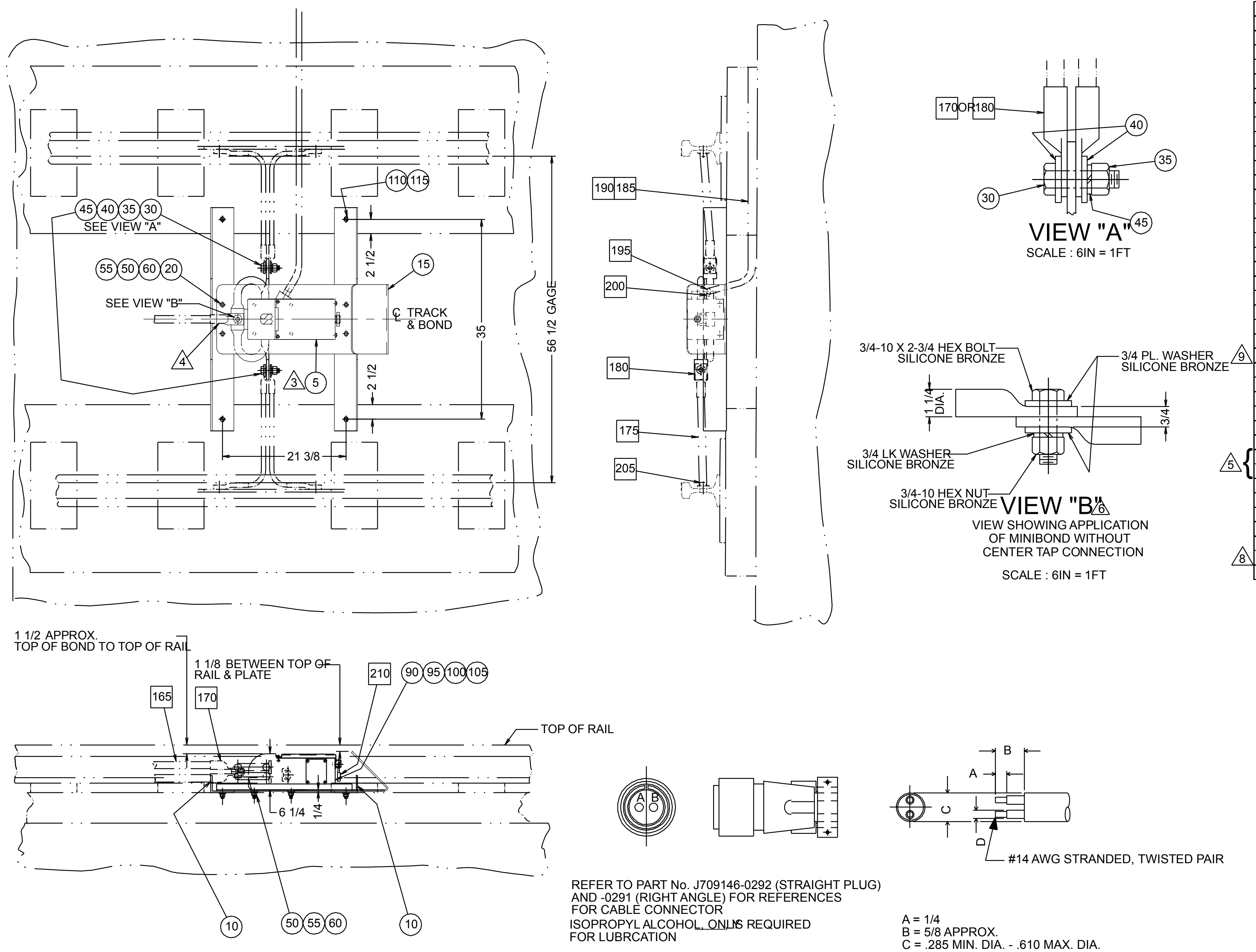
(CABLE FROM THE MINIBOND CONNECTOR TO NEARBY JUNCTION BOX)

MOUNTING NOTES

TORQUE THE FOUR ½ - 13 ELASTIC STOP NUTS (ITEM (60)) TO 15 FOOT - POUNDS. DO NOT OVER TIGHTEN.

1D2.0674.00

Figure 2-6. Typical Minibond Mounting to Concrete Ties



SHOWN						X	451486	GROUP	LAYOUT-TUNED MINIBOND	F	451486	30	
GR	-3002	ITEM	GROUP -3001			PART IDENTIFICATION				DRAWING			
QTY	DEC	NUM	UM	QTY	DEC	T	NUMBER	SUFFIX	DESCRIPTION	T	NUMBER	SHEET	SUB
-	-	5	EA	1	.00		△3		MINIBOND - TUNED				
-	-	10	EA	2	.00	M	451004	6601	BRACKET - MTG	D	451004	66	
-	-	15	EA	1	.00	M	379006	02	SKID PL/MTG BRKT,DIRECT FIX	E	379	06	
-	-	20	EA	4	.00	J	050095		1/2-13 X 1-3/4 HEX STL				
-	-	25	EA										
-	-	30	EA	2	.00	J	460119		BLT-3/4-10X2-3/4HXHD				
-	-	35	EA	2	.00	J	480304		NUT-3/4-10 HEX				
-	-	40	EA	4	.00	J	475196		WSHR-3/4" PL FLAT				
-	-	45	EA	2	.00	J	475197		WSHR-3/4" SPR LK				
-	-	50	EA	12	.00	J	047503		WASHER ,1/2 STEEL PLATE				
-	-	55	EA	8	.00	J	047783		WASHER,1/2 PL STL LOCK				
-	-	60	EA	8	.00	J	048013		NUT,1/2-13UNC 2B HVY				
		65	EA										
		70	EA										
		75	EA										
		80	EA										
1	.00	85	EA	-	-	X	451486	3001	LAYOUT, TUNED MINIBOND	F	451486	30	
2	.00	90	EA	-	-	J	050013		1/4-20 5/8 HEX HD SCREW				
2	.00	95	EA	-	-	J	047501		1/4 FLAT WASHER				
2	.00	100	EA	-	-	J	047775		1/4 LOCK WASHER				
1	.00	105	EA	-	-	M	451662	1802	ANGLE , BRACKET	F	451662	18	
△9 -	-	110	EA	4	.00	J	460120		BOLT ANKR 1/2-13X3-3/4				
-	-	115	EA	4	.00	J	475121	0115	WASHER 1/2 LK SST				
☐		THE FOLLOWING ITEMS, SUPPLIED BY INSTALLER, FOR REF ONLY											
		150	EA										
		155	EA										
		160	EA										
		165	EA						CABLE - 1000 MCM				
△5 {		170	EA						LUG				
		175	EA						CABLE - 500 MCM				
		180	EA						LUG				
		185	EA						CABLE - #14 AF				
		190	EA						CONDUIT				
		195	EA						CLAMP - CABLE				
		200	EA						CONN - PIN				
△8		205	EA						CONN - TERMINAL PIN				
		210	EA						PADLOCK (OPTIONAL)				

REFER TO PART No. J709146-0292 (STRAIGHT PLUG) AND -0291 (RIGHT ANGLE) FOR REFERENCES FOR CABLE CONNECTOR

ISOPROPYL ALCOHOL, ONLY IS REQUIRED FOR LUBRCATION

A = 1/4
B = 5/8 APPROX.
C = .285 MIN. DIA. - .610 MAX. DIA.
D = .114 MIN. DIA. - .170 MAX. DIA.

CONNECTOR - CABLE TOOL REFERENCES

CRIMP TOOL	J709146-0435
LOCATOR TOOL	J709146-0436
INSERTION TOOL	J709146-0437
EXTRACTION TOOL	J709146-0438
GUIDE PIN	J709146-0439
CONTACT, CRIMP #12 SOCKET	J709146-0434

MOUNTING NOTES

TORQUE THE FOUR ½ - 13 ELASTIC STOP NUTS (ITEM (60)) TO 15 FOOT - POUNDS. DO NOT OVER TIGHTEN.

WAYSIDE CABLE APPLICATION NOTES

(CABLE FROM THE MINIBOND CONNECTOR TO NEARBY JUNCTION BOX)

NOTES:

S. B. = SILICON BRONZE

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

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

△3 MINIBOND, (ITEM 5) TO BE ORDERED BY SYSTEMS ENG'R PER G. O. REQUIREMENTS. SEE DWG. F451003 SH.20 FOR PART NO'S.

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

△5 (ITEMS 165 & 170) TO BE USED ONLY WHEN CENTER TAP IS REQUIRED.

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

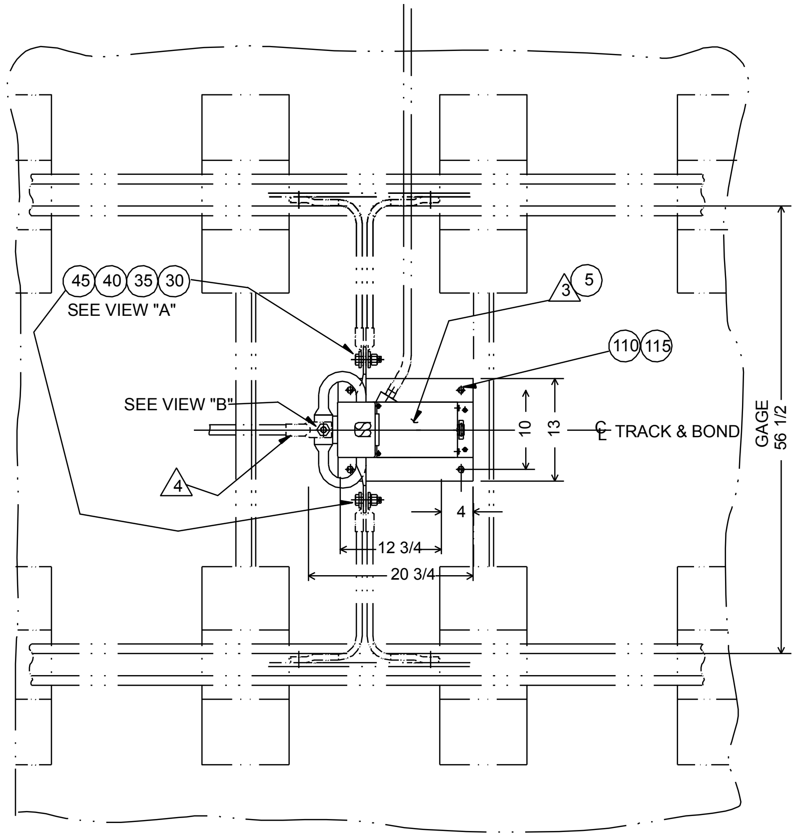
7. CABLES ANCHORED TO TIES PER INSTALLER DRAWINGS.

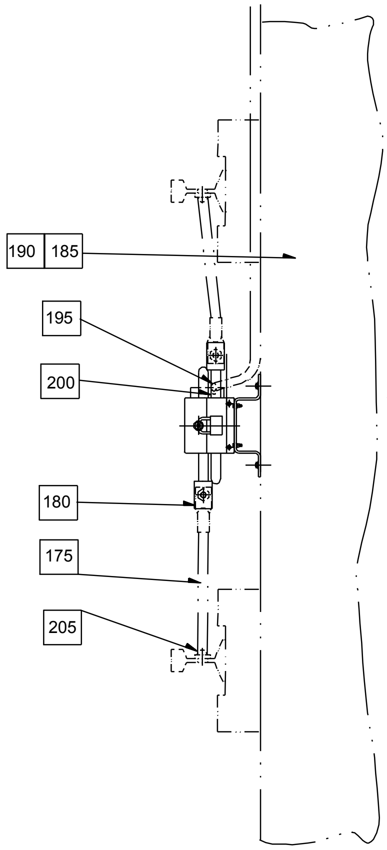
△8 REFERENCE FOR PLUG CONNECTOR, U.S.& S. PART NUMBERS
STRAIGHT J709146-0292
RIGHT ANGLE J709146-0291

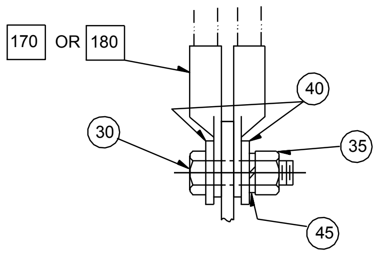
△9 ITEM 110 IS SUPPLIED WITH PLAIN WASHER & NUT (STAINLESS STEEL).

1D2.0675.00

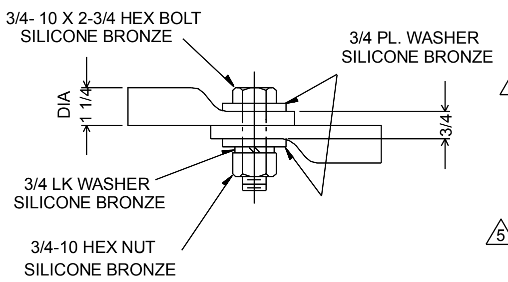
Figure 2-7. Typical Minibond Mounting to Floating Concrete Slab







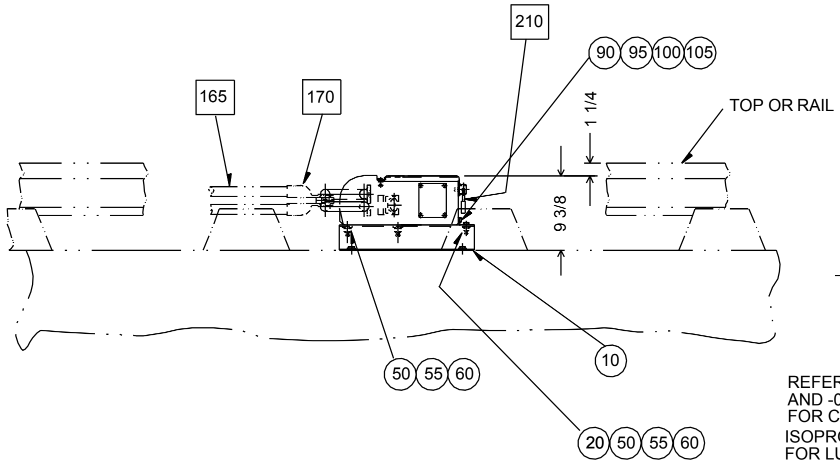
VIEW "A"
SCALE : 6IN = 1FT



VIEW "B" 6
VIEW SHOWING APPLICATION
OF MINIBOND WITHOUT
CENTER TAP CONNECTION

SCALE : 6IN = 1FT

	SHOWN						X	451486	GROUP	LAYOUT-TUNED MINIBOND	F	451486	31	
	GR	-3102	ITEM	GROUP -3101			PART IDENTIFICATION				DRAWING			
	QTY	DEC	NUM	UM	QTY	DEC	T	NUMBER	SUFFIX	DESCRIPTION	T	NUMBER	SHEET	SUB
	-	-	5	EA	1	.00		3		MINIBOND - TUNED	C	451003	13	
	-	-	10	EA	2	.00	M	451662	1806	BRACKET - MTG	F	451662	18	
	-	-	15	EA										
	-	-	20	EA	2	.00	J	050095		1/2-13 X 1-3/4 HEX STL				
	-	-	25	EA										
	-	-	30	EA	2	.00	J	460119		BLT-3/4-10X2-3/4HX HD				
	-	-	35	EA	2	.00	J	480304		NU T3/ 4-10 HEX				
	-	-	40	EA	4	.00	J	475196		WSHR-3/4"PLFLAT				
	-	-	45	EA	2	.00	J	475197		WSHR-3/4"SPR LK				
	-	-	50	EA	12	.00	J	047503		WASHER,1/2 STEEL PLATE				
	-	-	55	EA	6	.00	J	047783		WASHER,1/2 PL STL LOCK				
	-	-	60	EA	6	.00	J	048013		NUT,1/2-13UNC 2B HVY				
			65	EA										
			70	EA										
			75	EA										
			80	EA										
	1	.00	85	EA	-	-	X	451486	3103	LAYOUT, TUNED MINIBOND	F	451486	31	
	2	.00	90	EA	-	-	J	050013		1/4-20 5/8 HEX HD SCREW				
	2	.00	95	EA	-	-	J	047501		1/4 FLAT WASHER				
	2	.00	100	EA	-	-	J	047775		1/4 LOCK WASHER				
	1	.00	105	EA	-	-	M	451662	1802	ANGLE, BRACKET	F	451662	18	
10	-	-	110	EA	4	.00	J	460120		BOLT, ANKR 1/2-13X3-3/4				
	-	-	115	EA	4	.00	J	475121	0115	WASHER 1/2 LK SST				
			120	EA										
	☐		THE FOLLOWING ITEMS, SUPPLIED BY INSTALLER, FOR REF ONLY											
			150	EA										
			155	EA										
			160	EA										
5			165	EA						CABLE - 1000 MCM				
			170	EA						LUG				
			175	EA						CABLE - 500 MCM				
			180	EA						LUG				
			185	EA						CABLE - #14 AF				
			190	EA						CONDUIT				
			195	EA						CLAMP - CABLE				
9			200	EA						CONN - PIN				
			205	EA						CONN - TERMINAL PIN				
			210	EA						PADLOCK (OPTIONAL)				
			215	EA										
			220	EA										



NOTES:

S. B. = SILICON BRONZE

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

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

△3 MINIBOND, (ITEM 5) TO BE ORDERED BY SYSTEMS ENG'R PER G. O. REQUIREMENTS. SEE DWG. F451003 SH.20 FOR PART NO'S.

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

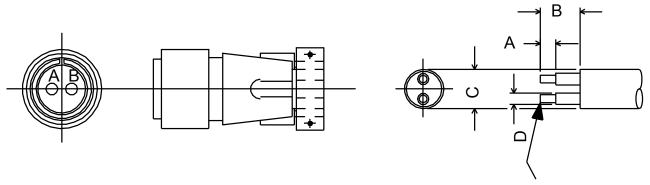
△5 (ITEMS 165 & 170) TO BE USED ONLY WHEN CENTER TAP IS REQUIRED.

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

7. CABLES ANCHORED TO TIES PER INSTALLER DRAWINGS.

△9 REFERENCE FOR PLUG CONNECTOR, U.S.& S. PART NUMBERS
STRAIGHT J709146-0292
RIGHT ANGLE J709146-0291

△10 ITEM 110 IS SUPPLIED WITH PLAIN WASHER & NUT (STAINLESS STEEL).



#14 AWG STRANDED, TWISTED PAIR

REFER TO PART No. J709146-0292 (STRAIGHT PLUG) AND -0291 (RIGHT ANGLE) FOR REFERENCES FOR CABLE CONNECTOR

ISOPROPYL ALCOHOL, ONLY, IS REQUIRED FOR LUBRCATION

CONNECTOR - CABLE TOOL REFERENCES

CRIMP TOOL	J709146-0435
LOCATOR TOOL	J709146-0436
INSERTION TOOL	J709146-0437
EXTRACTION TOOL	J709146-0438
GUIDE PIN	J709146-0439
CONTACT, CRIMP #12 SOCKET	J709146-0434

A = 1/4
B = 5/8 APPROX.
C = .285 MIN. DIA. - .610 MAX. DIA.
D = .114 MIN. DIA. - .170 MAX. DIA.

MOUNTING NOTES

TORQUE THE FOUR ½ - 13 ELASTIC STOP NUTS (ITEM (60)) TO 15 FOOT - POUNDS. DO NOT OVER TIGHTEN.

1D2.0676.00

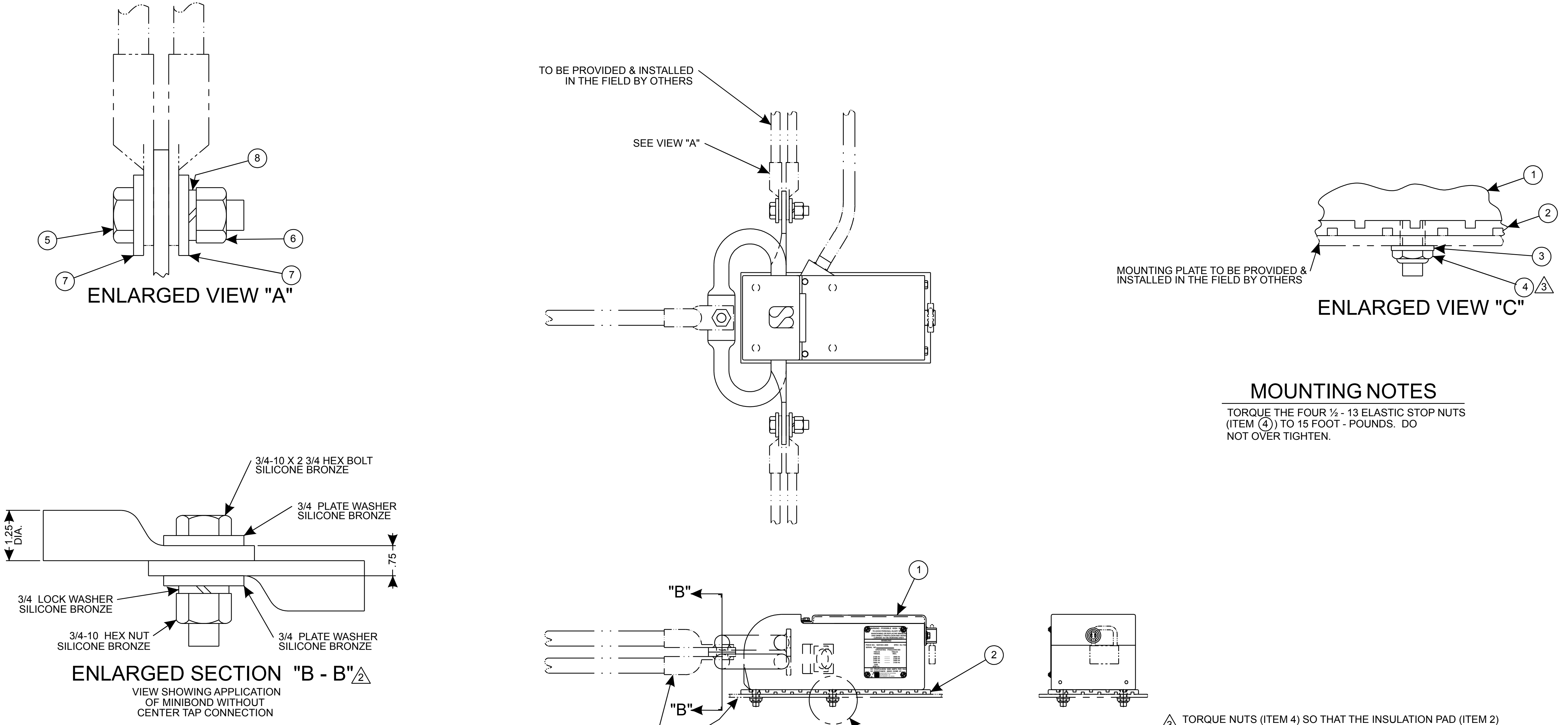
WAYSIDE CABLE APPLICATION NOTES

(CABLE FROM THE MINIBOND CONNECTOR TO NEARBY JUNCTION BOX)

Figure 2-8. Typical Minibond Mounting to Vagheux Concrete Slab

PART NUMBER	MINIBOND ①	PER GROUP	REMARKS
X37303001	N4510032008	1	WITH INSULATION PAD
X37303002	N4510032008	2	WITHOUT INSULATION PAD
X37303003	N4510032010	1	WITH INSULATION PAD
X37303004	N4510032010	2	WITHOUT INSULATION PAD

							X	373030	XX	KIT,MINIBOND	F	373	030	
ITEM	GROUP 2			GROUP 1			PART IDENTIFICATION				DRAWING			
NUM	UM	QTY	DEC	UM	QTY	DEC	T	NUMBER	SUFFIX	DESCRIPTION	T	NUMBER	SHEET	SUB
1	EA	1	.00	EA	1	.00	SEE TAB			MINIBOND,TUNED LR	F	451003	20	
2	EA	------		EA	1	.00	M	373029	01	INSULATION PAD,ELEVATED BOND	C	373	029	
3	EA	4	.00	EA	4	.00	J	475120	0116	WASHER,1/2 FLAT SST	V	475120	01	
4	EA	4	.00	EA	4	.00	J	048162	0010	NUT,1/2-13 ELAST STOP THIN SST				
5	EA	2	.00	EA	2	.00	J	460119		BOLT,3/4-10 X 2 3/4 HEX HD				
6	EA	2	.00	EA	2	.00	J	480304		NUT,3/4-10 HEX				
7	EA	4	.00	EA	4	.00	J	475196		WASHER,3/4 PL FLAT				
8	EA	2	.00	EA	2	.00	J	475197		WASHER,3/4 SPR LOCK				



MOUNTING NOTES

TORQUE THE FOUR ½ - 13 ELASTIC STOP NUTS (ITEM ④) TO 15 FOOT - POUNDS. DO NOT OVER TIGHTEN.

△3 TORQUE NUTS (ITEM 4) SO THAT THE INSULATION PAD (ITEM 2) DOES NOT COMPRESS MORE THAN 1.5MM (0.059 IN.)

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

1. PARTS SHOWN IN FULL LINES TO BE SUPPLIED BY U.S. & S. INC.

1D2.0677.00

Figure 2-9. Minibond Mounting Pad

3. 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 so it is constructed with heavy copper.

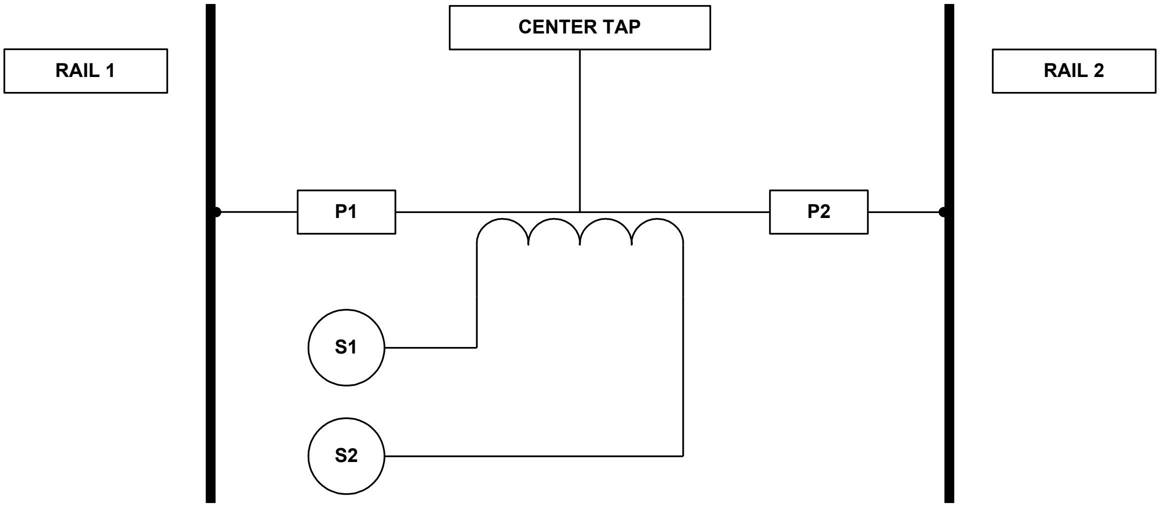


Figure 3-1. AF-Mini Impedance Bond - Basic Circuit

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

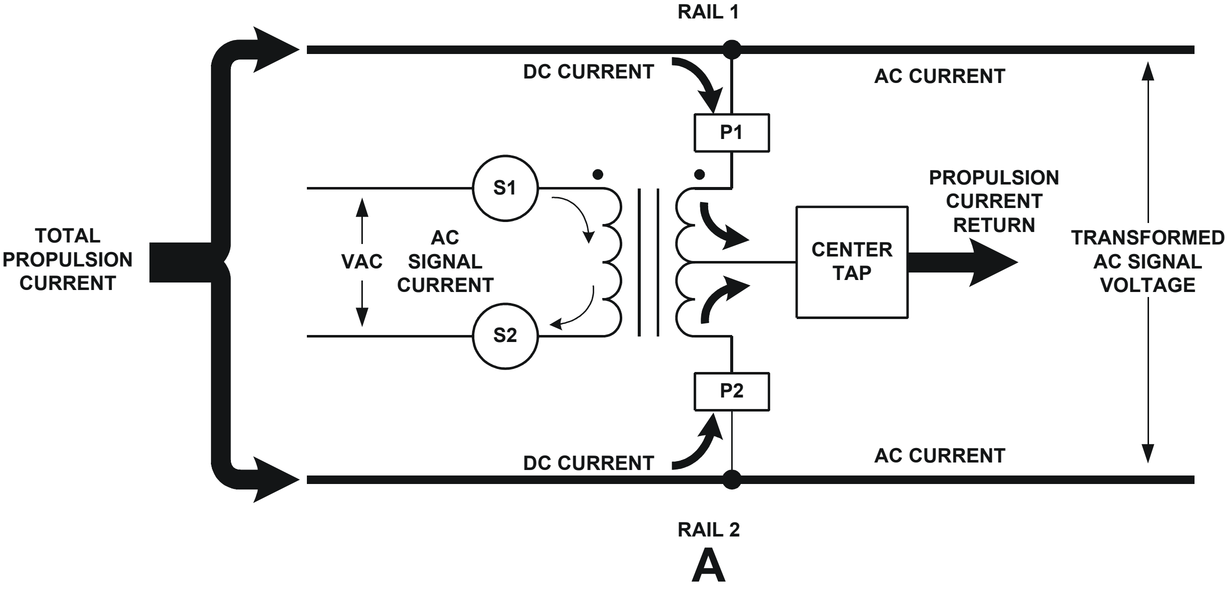
For cases "A" and "B", the total DC propulsion current flow is divided between the two halves of the primary winding. The current direction in one half will be opposite the current direction of the other half. The magnetic fluxes induced in the magnetic core of the bond will oppose each other and will therefore tend to cancel each other. Equal currents (balanced) will cancel completely. An excessively large current, if unbalanced, will cause a loss in the AC signaling impedance.

The signaling current (AC) enters through one rail and exits through the other rail. It transverses the whole winding in one direction, and no AC flux cancellation occurs as a result. 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 "C", 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, so 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 one-half of the established unbalance capacity.

Case "D" is similar to Case "C" except that the current flows through one turn instead of two. The bond will handle the established unbalanced current rating.

A typical application of an audio frequency style minibond system is shown in Figure 3-4. The center tap on each bond is shown unconnected, but in certain applications the tap may be used for connections to other bonds on the same or adjacent tracks.



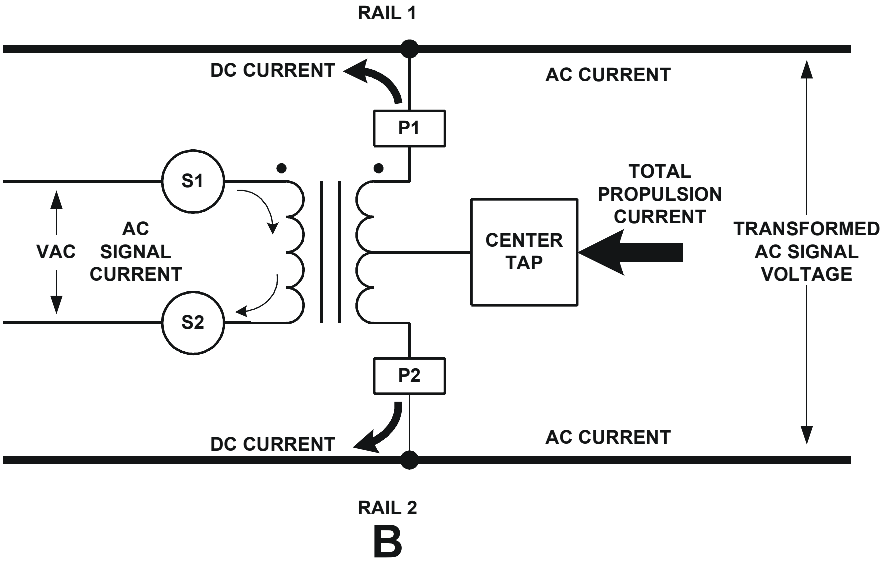


Figure 3-2. Typical Propulsion Current Flow (A and B)

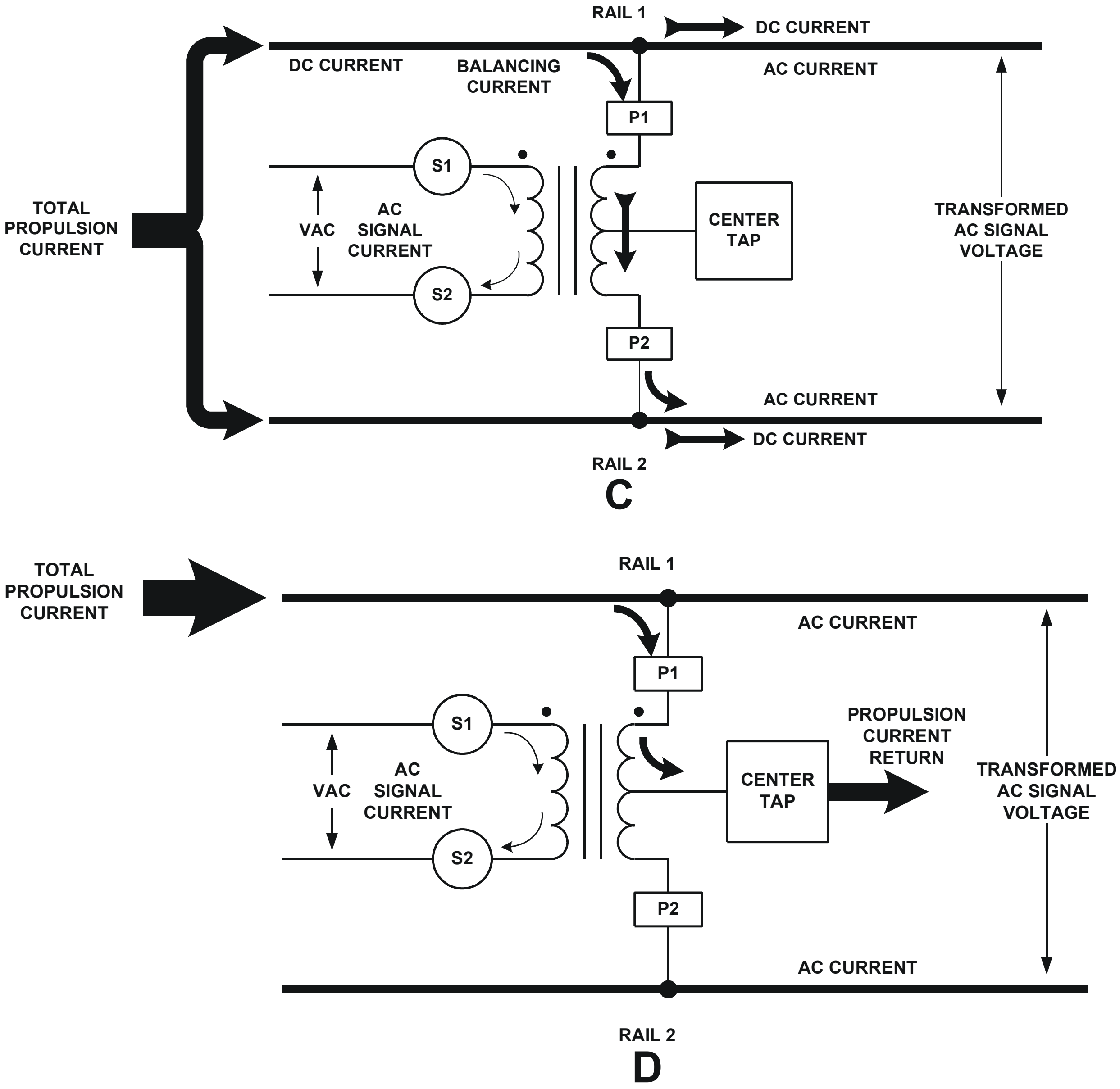


Figure 3-3. Typical Propulsion Current Flow (C and D)

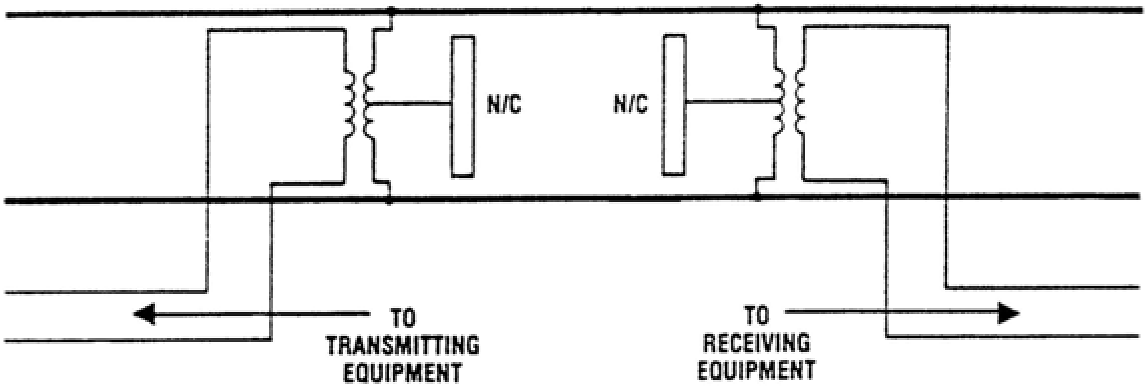


Figure 3-4. AF Minibond Circuit Application

3.2. Design Concepts

3.2.1. General

Figure 3-5 illustrates a general schematic of the minibond. The minibond is tuned to three frequencies: track receiver, track transmitter, and cab transmitter. 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. The track receiver and track transmitter minibonds are actually tuned to four frequencies. Only one frequency can be used for each at any given time.

Normally the bond is applied as a track transmitter/receiver; it can also be used as a dual track receiver. However, the bond cannot be used as a dual transmitter, because the receiver circuit was not designed to be operated as a transmitter.

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 minibond has 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, so 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 turns ratio between that secondary and the track winding.

When the impedance 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.

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”. Figure 3-7 and Figure 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.

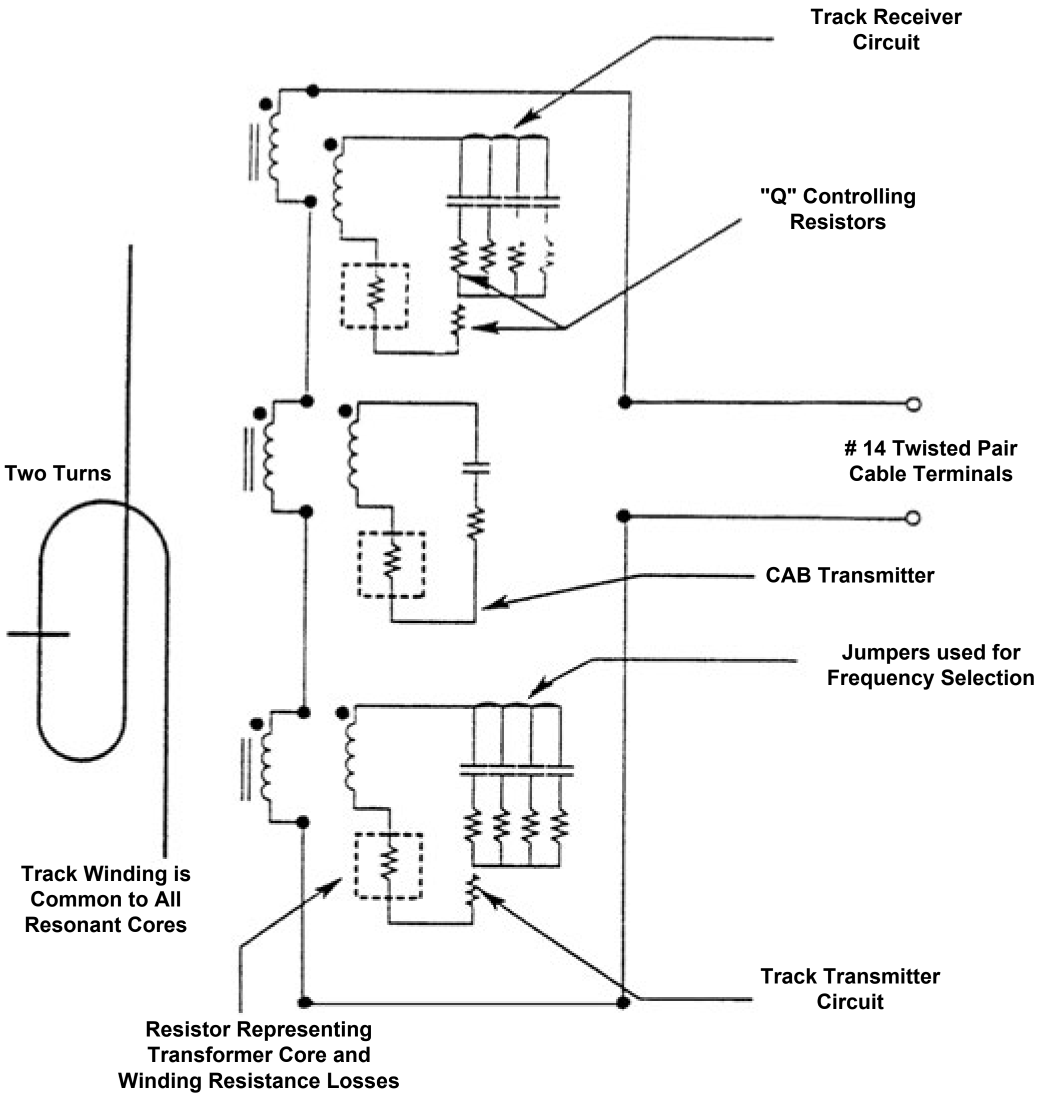
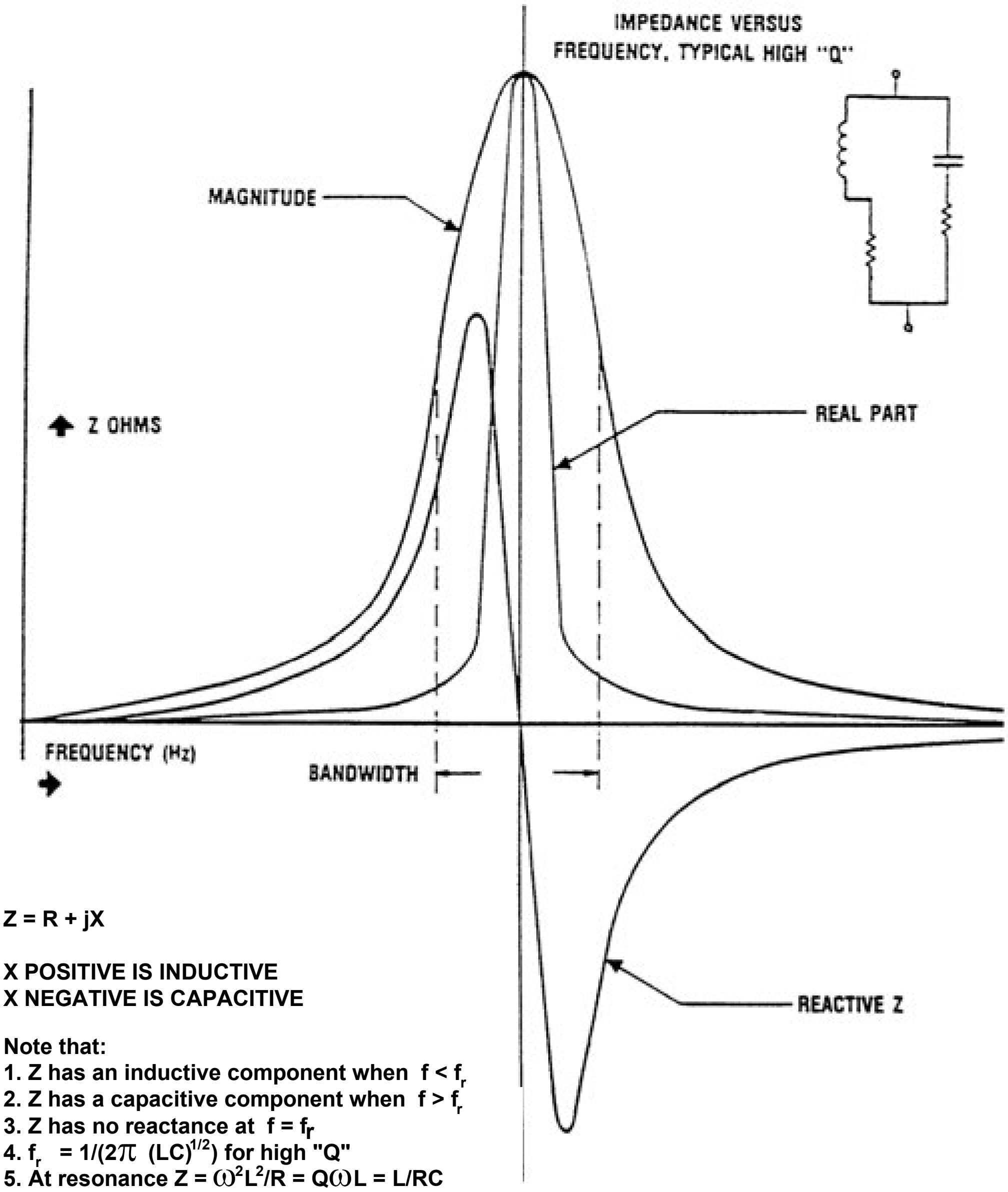


Figure 3-5. General Minibond Schematic



$Z = R + jX$

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 $Z = \omega^2 L^2/R = Q\omega L = L/RC$
6. When parallel resonance occurs, the loop current sees series resonance.
7. $\omega = 2\pi f$

Figure 3-6. Parallel Resonant Circuit

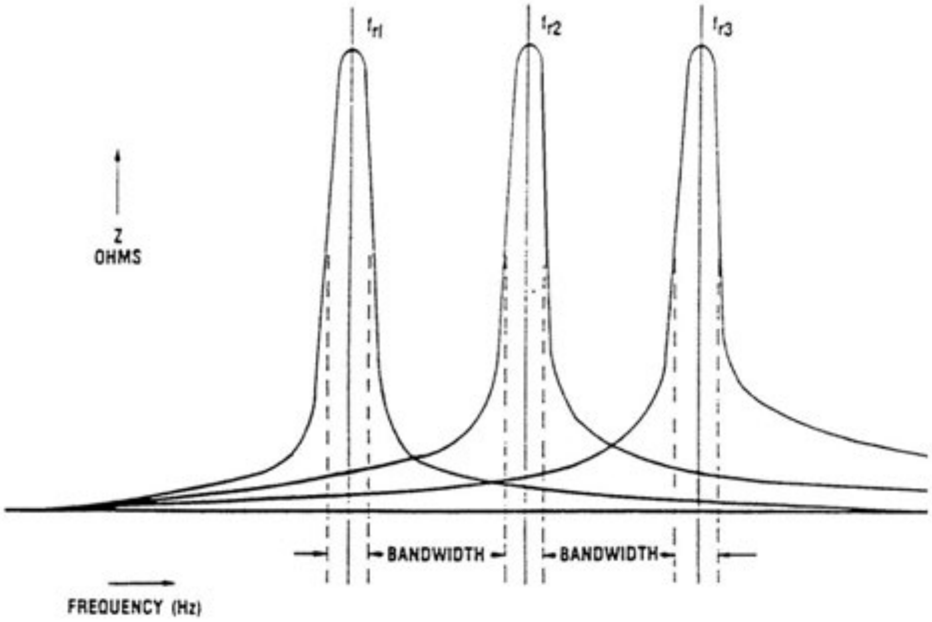


Figure 3-7. Impedance Versus Frequency

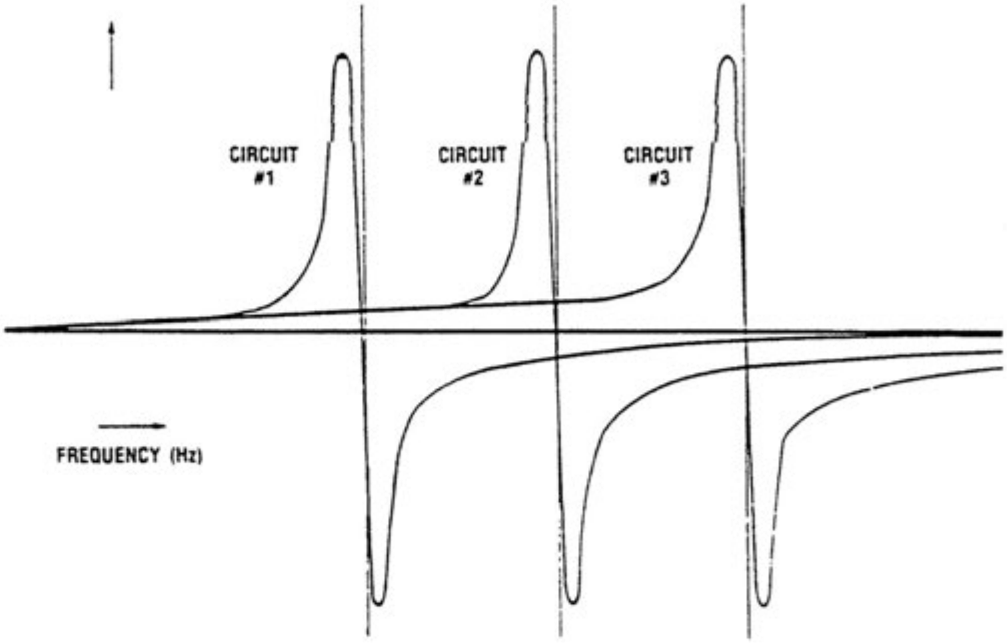


Figure 3-8. Reactive Impedance Versus Frequency

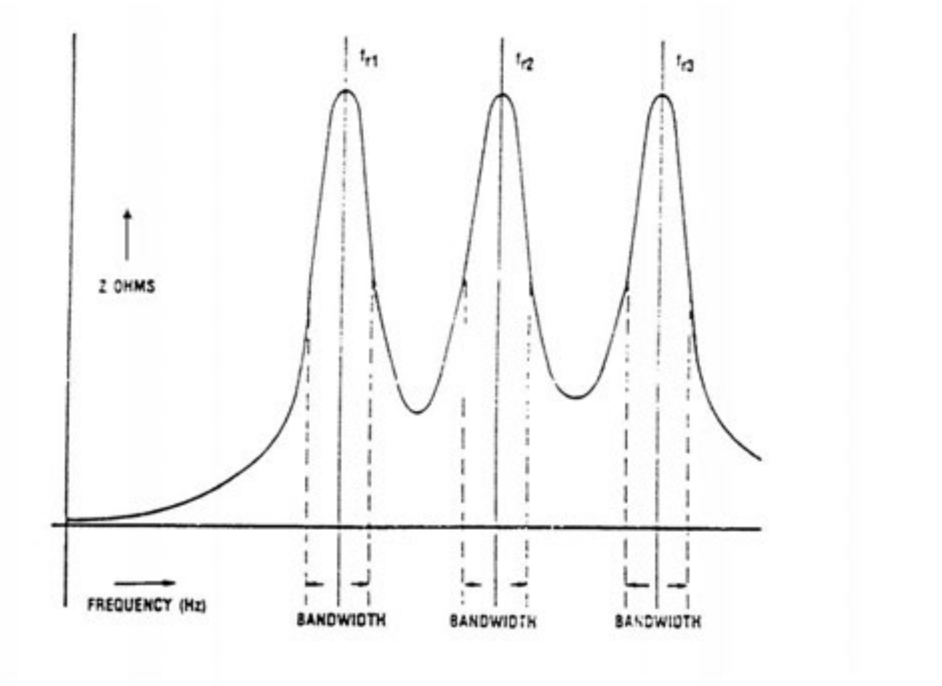


Figure 3-9. Impedance Versus Frequency; Three Circuits in Series

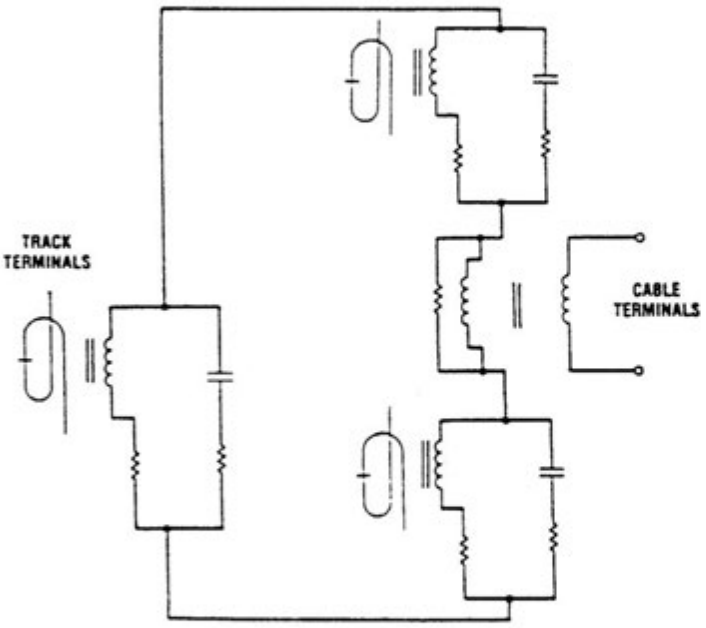


Figure 3-10. Circuit View from One Resonant Circuit

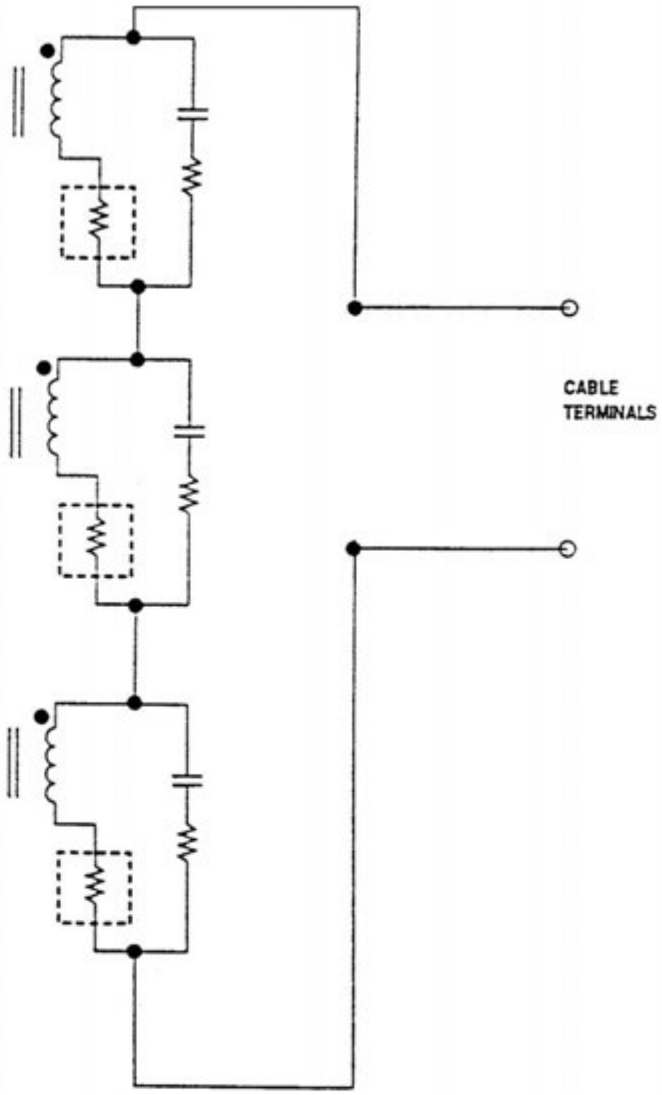


Figure 3-11. Impedance Reflected to Cable Terminal

4. MAINTENANCE

4.1. Field Maintenance and Inspection

WARNING

To avoid personal injury while maintaining or replacing impedance bonds, be sure to disconnect propulsion and signal current in the working area.

Field maintenance shall consist of periodic visual inspection of the bond for cracks in the housing, and bent, loosened, and corroded terminals. Corroded terminals may be cleaned with appropriate abrasive materials and cable lugs re-tightened. 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.

4.1.1. Minibond Operational Check

To check that the minibond is tuned correctly or that the proper minibond is installed for the track circuit under test, check the minibond as follows:

a. Disconnect the AF track circuit electronics from the minibond under test by opening the appropriate AF rack side straps.

b. Connect the audio oscillator to the field side of that line. Connect the oscilloscope and counter in parallel with the oscillator. (See Table 4-2 for recommended test equipment).

c. Sweep the audio oscillator from 1.7 KHz to 5.0 KHz while watching the scope. There will be three peaks. These peaks correspond to train detection transmit, train detection receive, and cab transmit.

d. Record the frequencies at which the peaks occur in the Data Sheet Figure 4-1. Compare these to the allowable frequency range shown in Table 4-1. If the minibond does not operate within the allowable frequency range, the minibond must be replaced and returned to the shop for repairs.

e. Remove the oscillator, oscilloscope, and counter, and reconnect the minibond by closing the appropriate AF rack side straps.

Table 4-1. Minibond Allowable Operating Range

Nominal Tuned Frequency	Lower limit (– 5%)	Upper Limit (+ 5%)
Group A (N451003-2008)		
F1 2100 Hz	1995 Hz	2205 Hz
F2 2580 Hz	2451 Hz	2709 Hz
F3 3100 Hz	2945 Hz	3255 Hz
F4 3660 Hz	3477 Hz	3843 Hz
Group B (N451003-2010)		
F5 1900 Hz	1805 Hz	1995 Hz
F6 2820 Hz	2679 Hz	2961 Hz
F7 3370 Hz	3202 Hz	3539 Hz
F8 3900 Hz	3705 Hz	4095 Hz
Cab 4550Hz	4322 Hz	4778 Hz

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 tuned minibond.

1. Sweeping the Frequency to Find Peaks

   Prior to performing any repair, it is suggested that the bond be swept through the audio range to determine probable faults and to isolate the problem to a specific area. 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, (refer to Section 4.1.1 for the procedure), for minibonds that have at least one jumper cut selecting the transmit and receive frequencies.

New minibonds will have only two peaks; one near 2100 Hz (suffix –2008) or 1900 Hz (suffix –2010) and the other near 4550 Hz, (refer to Section 4.2.7 for the procedure).

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

a) broken wire in the bond

b) loss of connection

c) track winding shorted

d) incorrect wiring

DC continuity tests can be used to check cases (a) and (b). A continuity test can also determine if the track winding is shorted (c) if the center-tap joint is insulated.

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) causes 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 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. Possible Causes for Resonant Impedance Loss Include:

   a) Increase in “Q” spoiling resistor
   b) Poor connections
   c) Shorted capacitor
   d) Open capacitor
   e) Shorted coil
   f) Open coil
   g) Broken wire
   h) Incorrect wiring

   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 one or more capacitors are shorted, case (c).

   For the remaining cases, measure the component values and compare them against what they should be (see Table 5-3 and Table 5-5).

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, Table 5-5. 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) can be replaced. Consult the parts list for replacement part numbers, Table 5-3. 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.

Location: ______________________________ Test No. ________________

______________________________ Revision: ________________

______________________________ Page ________ of ________

Minibond Track Stationing	Part Number	Minibond Peak Frequencies (Hz)						Comments
		F ___ IDEAL	Freq Meas	F ___ IDEAL	Freq Meas	F ___ IDEAL	Freq Meas	

MINIBOND FREQUENCY RANGES:

F1 – 2100 Hz (1995-2205) F2 – 2580 Hz (2451-2709) F3 – 3100 Hz (2945-3255) F4 – 3660 Hz (3477-3843)
F5 – 1900 Hz (1805-1995) F6 – 2820 Hz (2679-2961) F7 – 3370 Hz (3202-3539) F8 – 3900 Hz (3705-4095)
Cab Carrier – 4550 Hz (4322 – 4778)

Test Technician: ______________________________ Date: ____________

Inspector: ______________________________ Date: ____________

Figure 4-1. Minibond Data Sheet

4.2.2. Required Test Equipment

Table 4-2 lists the test equipment, or equivalent, required to perform the tuning and impedance adjustments.

Table 4-2. Recommended Test Equipment

Description	Manufacturer	Quantity
Synthesizer/Function Generator	Hewlett-Packard 3325B	1
Impedance Matching Transformer	US&S W-400, Part Number 451428-0103	1
Resistor, 1200 ohm, 160 W	Commercial	1
Resistor, 4 ohm, 120 W	Commercial	1
Capacitor, 0.1 Mfd	Commercial	1
Power Amplifier, Audio Freq., 150 watt	Commercial	1
Oscilloscope - Maximum capacitance of 100 picofarads, minimum impedance of 1 megohm		1
10X probe		1
Test resistors - 5 W min. 1% Tolerance	Commercial	.
0.25 ohm		1
0.30 ohm		2
0.35 ohm		1
0.50 ohm		2
0.75 ohm		2
Voltmeters, AC, true rms, maximum capacitance of 100 picofarads, minimum impedance of 1 megohm.		2
Various jumpers - #18 AWG or larger, approx. 6" long.		
Jumpers - #14 AWG or larger approx. 18" long. Ends shall be able to clamp to a 3/8" thickness		3
Impedance Bridge	Genrad Digibridge Model 1657	1
Hy-Pot Junior tester - 3000 volts rms, 60 Hz, 1 milliampere sensitivity		1
Decade Resistor Box - 0 - 2.0 ohms, 0.05 ohms increments, 5 amp rating, or equivalent set up.		1
Power Supply - 20 amps DC		1
Ammeter - 0 to 20 amps DC		1
Voltmeter - 0 to 0.001 vdc, 0.0001 volt resolution		1

4.2.3. Minibond Test

NOTE

The following tests are made on the minibond with all PCBs removed.

a. Connect the bond in the circuit shown in Figure 4-2.

NOTE

The leads to the voltmeter should be separated from the other testing leads and connected directly to P1 and P2.

b. Apply 20 amps DC to the bond and observe the voltage. The voltage shall be less than 0.0008 volts. Larger values indicate a resistive buildup (due to oxidation, corrosion, etc.) at the center tap joint at the rail connections. Clean the connection surfaces, and retest.

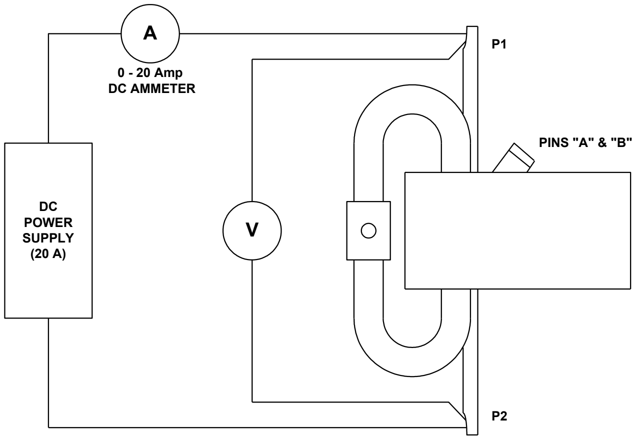


Figure 4-2. Minibond Test Circuit

c. Using the circuit of Figure 4-3, measure the series inductance (L) & (Q) values according to the tabulation shown in Table 4-3. Measurements are to be taken at 1000 Hz at a maximum voltage of 1 volt. The Dissipation Factor (DF) may be used instead of (Q).

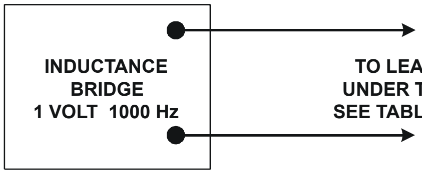


Figure 4-3. Connections for L & Q Values

Table 4-3. Minibond Sub-Assembly Inductance (mH)/Q Values

LEADS FROM BOND CAVITY OR CONNECTOR PINS								
PARAMETERS	**R1 - R2**		**T1 - T2**		**T3 - T4**		**A - B**	
	V*	T*	V*	T*	V*	T*	V*	T*
L (millihenries)	5.70	± .04	2.695	± .04	1.072	± .04	.900	± 9%
Q	75	Min.	22.2	Min.	22.2	Min.	12.0	Min.
DF	.013	Max.	.045	Max.	.045	Max.	.083	Max.

V* = Value, T* = Tolerance

Refer to the minibond schematic (Figure 4-4 and Figure 4-5) for connection references.

d. Breakdown Tests

A breakdown or leakage current in excess of one milliampere is cause for rejection of the part.

1. Connect jumpers to coils/leads to connect R2 to T3, T4 to T1, and T2 to Pin "A." Apply a 3000 volts, 60 Hz, one-minute breakdown test between Pin "A" and the primary winding.

2. Add a jumper between Pin "A" and primary terminal "P1". Apply a 3000 volts, 60 Hz, one-minute, breakdown test between primary terminal P2 and one of the 1/2 - 13 mounting bolts.

3. Remove the jumper connections used in steps "1" and "2". Apply a 3000 volts, 60 Hz, one-minute breakdown test between the leads R2 and T3. Repeat the test between the leads T4 and T1.

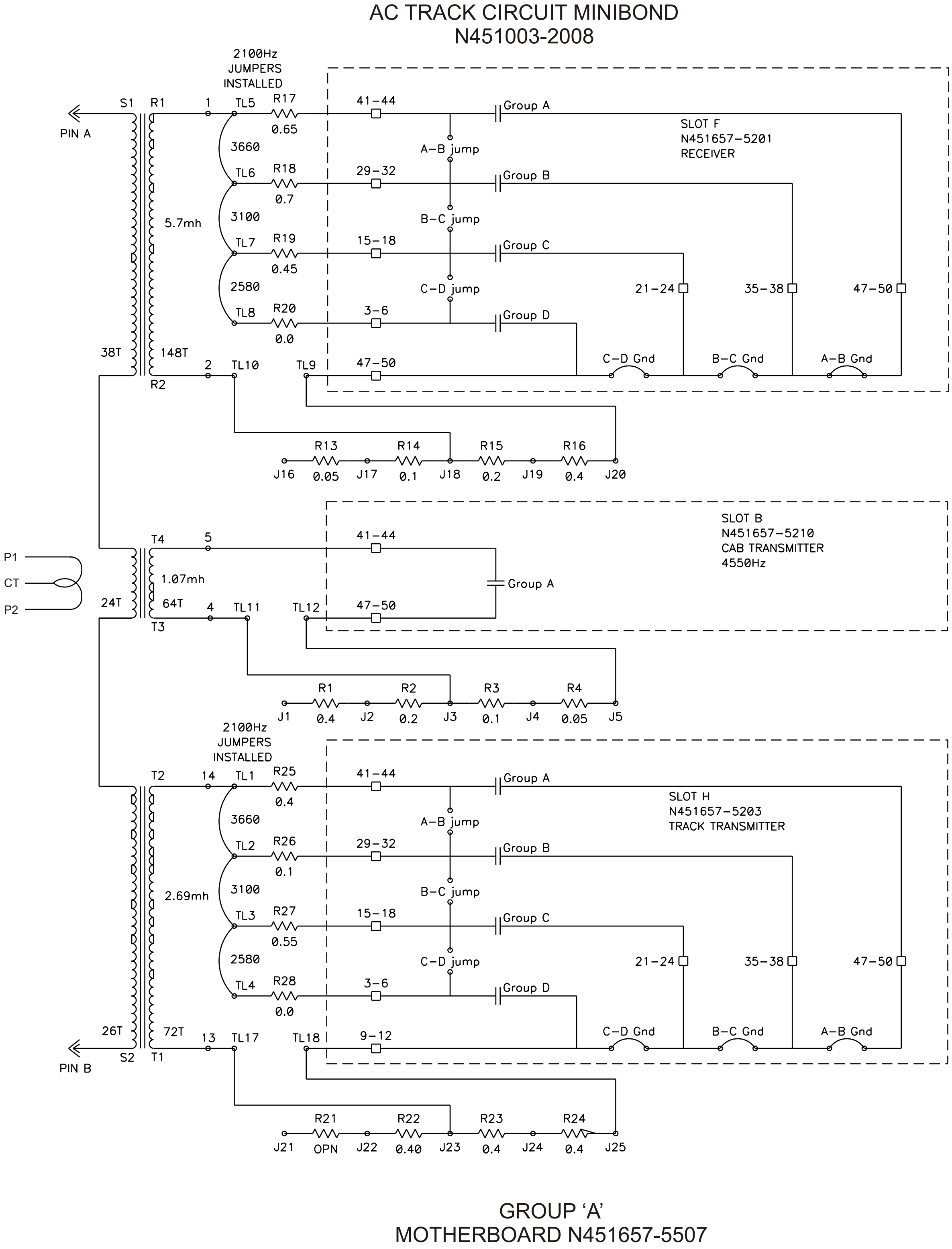


Figure 4-4. Minibond Schematic – Group A

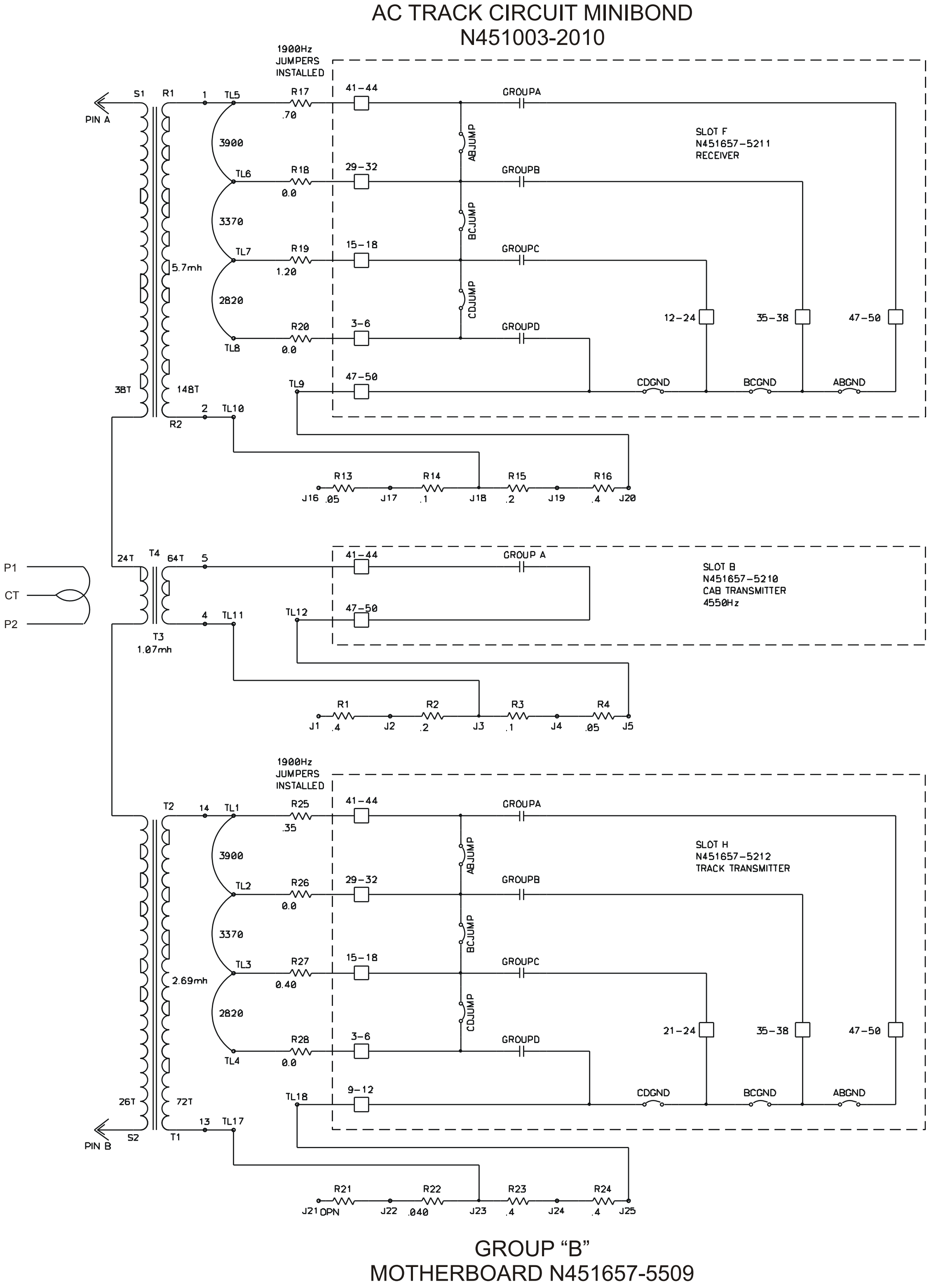


Figure 4-5. Minibond Schematic – Group B

4.2.4. Minibond Tuning

4.2.4.1. Generalized Tuning Concepts

a. Tuning a Parallel Resonant Circuit

The minibond is tuned by repeating a basic procedure. The basic procedure is to tune a parallel resonant circuit to the desired frequency by adding or removing capacitance. This is done by injecting the desired frequency into the circuit shown in Figure 4-6 and varying the capacitance until maximum V3 is obtained.

At the resonant frequency the parallel resonant circuit has the highest impedance (valid approximation for high Q circuit). The object of the tuning procedure is to adjust the resonant frequency (by varying the capacitance) until the resonant frequency equals the desired frequency. Once tuned, the capacitor(s) are permanently installed in the tuned circuit.

b. Multiple Resonant Frequencies

Additional resonant frequencies are obtained by adding more capacitance to the circuit of Figure 4-6. The additional capacitors are connected by jumpers. This is illustrated in Figure 4-7"A." An increase in circuit capacitance will decrease the resonant frequency.

Each of the capacitors illustrated in Figure 4-7"A," could represent a group of capacitors connected in parallel. This service manual will refer to such a group of capacitors as a capacitor bank. See Figure 4-7"B," which shows two banks labeled "1" and "2." The additional bank of capacitors lowers the resonant frequency.

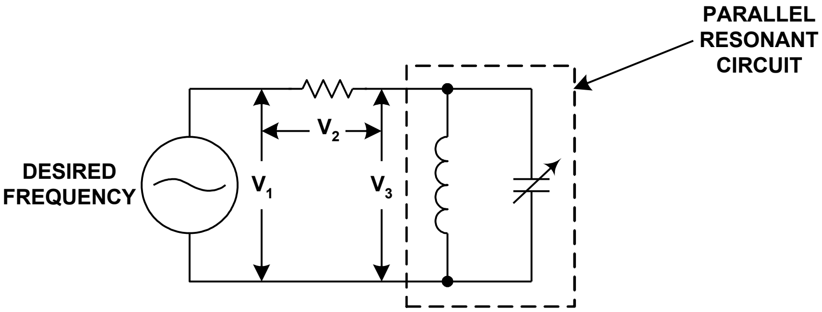


Figure 4-6. Basic Tuning Circuit

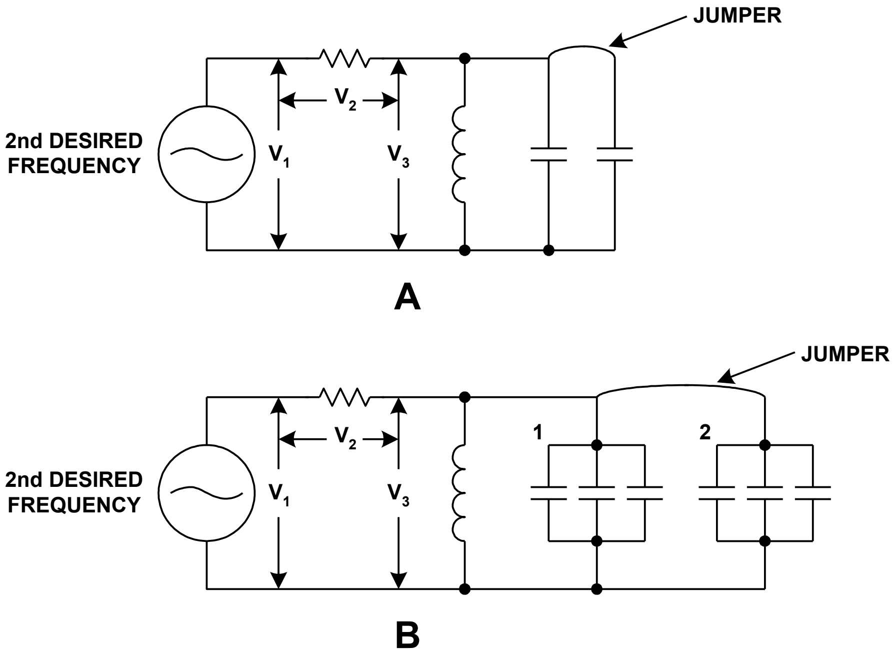


Figure 4-7. Multiple Resonant Frequencies

c. Multiple Parallel Resonant Circuits

Typically tuned minibonds contain more than one parallel resonant circuit. Figure 4-8 illustrates a minibond with three tuned circuits. Each capacitor illustrated represents a bank of capacitors.

Each additional bank of capacitors lowers the resonant frequency. Four capacitor banks allows a choice of four different frequencies. Only one frequency can be chosen at a time for each parallel resonant circuit. The customer makes the final frequency selection by disconnecting the appropriate jumper.

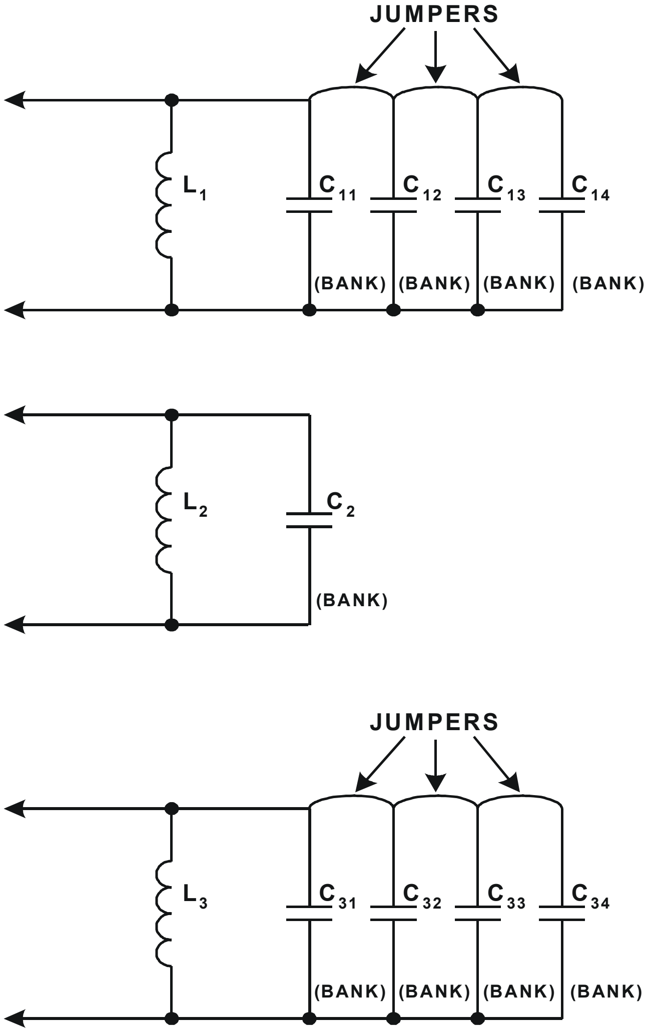
In practice, the capacitors illustrated in Figure 4-8 will consist of several capacitors connected in parallel and soldered in place on one or both sides of a printed circuit board. Figure 4-9"A" illustrates eight capacitor banks, with each bank containing four capacitors, two on the front side and two on the back side. Figure 4-9"B" illustrates four capacitor banks with seven capacitors per bank, no capacitors on the back side. Part numbers N451003–2008 and N451003-2010 contains two circuits with four banks per circuit. Single frequency circuits may also be present.

d. Coarse and Fine Tuning

Due to tolerances, the capacitance required for individual resonant circuits will vary from minibond to minibond. The printed circuit boards will contain one or two capacitors, which approximate the required capacitance (coarse tuning). These are permanently installed in the resonant circuit. The sum of their values should be less than or equal to the required capacitance.

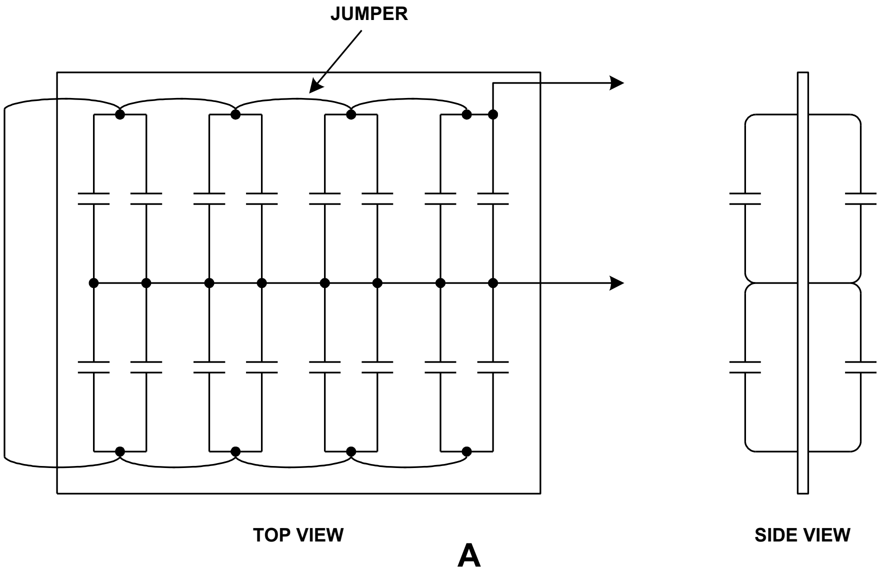
Additional smaller values are on the printed circuit boards, but they have only one end of each individual capacitor connected to the resonant circuit. The unconnected end can be jumpered into the resonant circuit as required to obtain resonance at the desired frequency value (fine tuning).

This specification will use capacitor decade boxes to determine the amount of capacitance required to fine tune the circuit. Appropriate values of capacitance can then be jumpered into the circuit.



NOTE:
Capacitor labels shown
are for example only.

Figure 4-8. Minibond with Three Tuned Circuits
(Two contain four capacitor banks each)



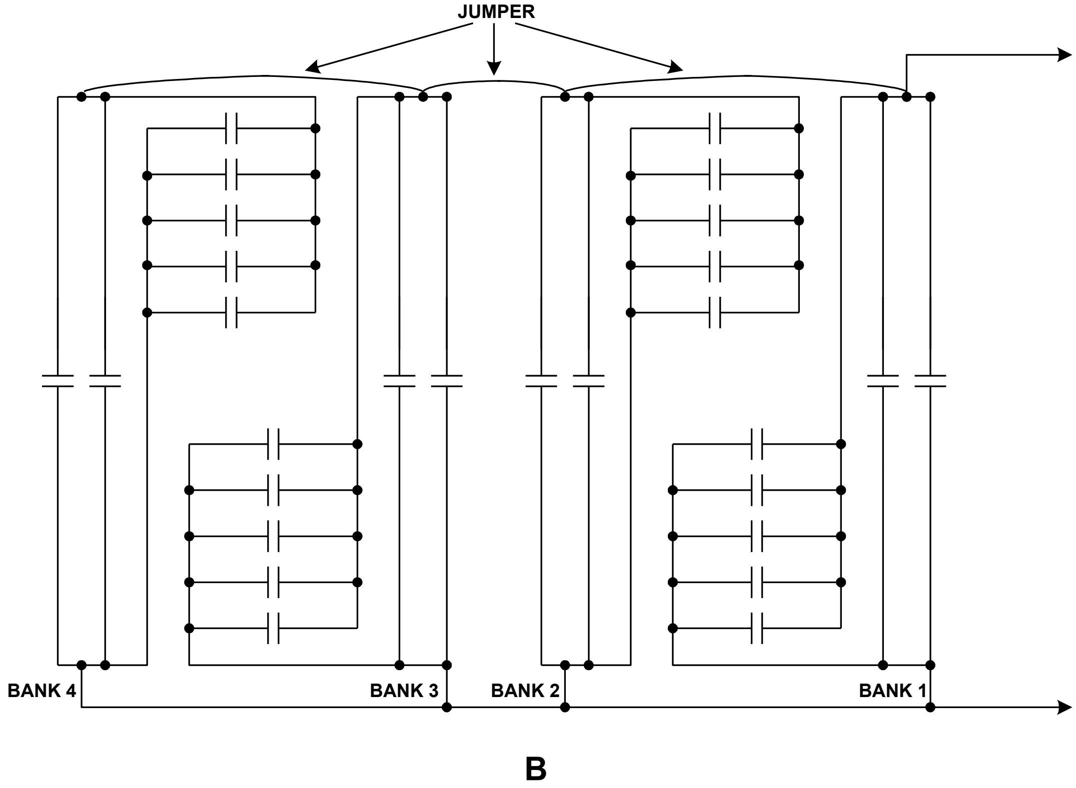


Figure 4-9. Connections of Capacitor Banks

4.2.4.2. General Information

a. Tuned minibonds are tuned to various frequencies. The number of tuned frequencies and the frequency values differ depending upon the tuned minibond part number. A resonant frequency or a group of resonant frequencies is associated with a particular track circuit function. These functions are:

1. Cab Transmitters: There is one frequency used. It is 4550 Hz, referred to as Cab.
2. Track (Train) Detection: (Track Transmitters and Track Receivers.) There are eight frequencies (divided into two groups) used in this function, Group A (2100, 2580, 3100, and 3660 Hz), and Group B (1900, 2820, 3370, and 3900 Hz).

A bond typically (but not always) is used to transmit one train detection frequency and receive another train detection frequency. This is accomplished by using two parallel resonant circuits. The two circuits are referred to as Track Transmitter (TT) and Track Receiver (TR) respectively. Each circuit is tuned to all four frequencies to facilitate frequency selection by removing a jumper wire. The tuning process starts with the highest frequency (3660 Hz for a Group A Minibond) because this frequency uses the lowest capacitance value. As the groups of capacitors are added together by means of jumper wires (TL2 - TL7) the tuned frequency is lowered to resonate at 3100, 2580, and 2100 Hz.

b. All test equipment connections are made to the motherboard per the applicable test wiring and tuning data Table 4-4. Minibonds are to be tuned to each frequency called for in the following order:

1st	Track Transmitter frequencies (TT), highest to lowest
2nd	Cab
3rd	Track Receiver frequencies (TR), highest to lowest

c. The capacitor boards and motherboard for a specific minibond part number are married to each other and to the minibond. If any printed circuit board is replaced, it must be replaced with one having the same part number. Tuning should be checked and verified for the particular function or functions.

d. Whenever a capacitor is replaced or repairs are made to a capacitor PCB (broken wire, solder connection, etc.), the tuning should be checked and verified for the particular function or functions.

4.2.4.3. Tuning Procedure

NOTE

Refer to Figure 4-10 for typical capacitor board circuit diagrams.

Make sure that Section 4.2.4.1 and 4.2.4.2 are read before proceeding with the following procedures.

a. Connect test equipment in accordance with the test circuit shown in Figure 4-11. The 0.1 Mfd test capacitor must be connected across connector terminals.

b. Refer to the appropriate test setup and tuning data table for the minibond being tuned, Table 4-4.

c. Refer to the applicable board suffix.

d. Verify that jumpers are installed across the turret lugs for the designated frequencies of the minibond. (See Motherboard layout, Figure 4-12)

NOTE

All jumpers above the designated frequency must be in place.

e. Preset track transmitter and track receiver functions (jumpers) per the tuning data Table 4-4. Set the frequency to the tabulated test frequency shown in the table.

f. Adjust the source voltage to obtain Vtc equal to 1/2 of the tabulated value of Vtc given in the table.

g. Verify proper frequency range as follows:

   1. Vary the frequency until a voltage peak is obtained.

   2. Adjust the source voltage to obtain Vtc equal to the tabulated Vtc given in Table 4-4.

   3. Repeat steps "1" and "2" above until voltage peak is obtained at tabulated value of Vtc.

   4. This frequency shall be within the tabulated tolerance given in the table. If not, continue with the following steps.

WARNING

Possible high voltage.
Use extreme care when working on the capacitor PCB.

h. Adjust the frequency generator to the desired frequency.

i. Adjust the source voltage to obtain Vtc = 1/2 of the tabulated Vtc listed in the wiring table.

j. Using clip leads clip in fine tuning capacitor values (on the PCB) until a voltage peak is found for Vtc (the scope or digital voltmeter reading).

k. Adjust the source voltage to obtain Vtc equal to the tabulated value of Vtc listed in the table.

l. Vary the capacitor value on the PCB by clipping fine tuning capacitors in and out until a voltage peak is found.

m. Turn the power down.

n. Repeat steps "k" through "m" until changing the fine tuning capacitors only decreases the voltage. Solder a #18 AWG jumper on PCB to connect capacitor(s) that were chosen in the previous steps. Remove clip leads from the circuit.

o. With Vtc set to the tabulated value, vary the frequency until a voltage peak is obtained. This frequency shall be within the tabulated tolerance listed in the wiring/tuning table. If necessary, repeat steps "k" through "n." If the frequency is too low, it will be necessary to remove capacitance from the circuit.

NOTE

Fine tuning capacitor values and their locations on the capacitor printed circuit boards are listed in the wiring table. An illustration of capacitor board N451657-52XX is shown in Figure 5-4.

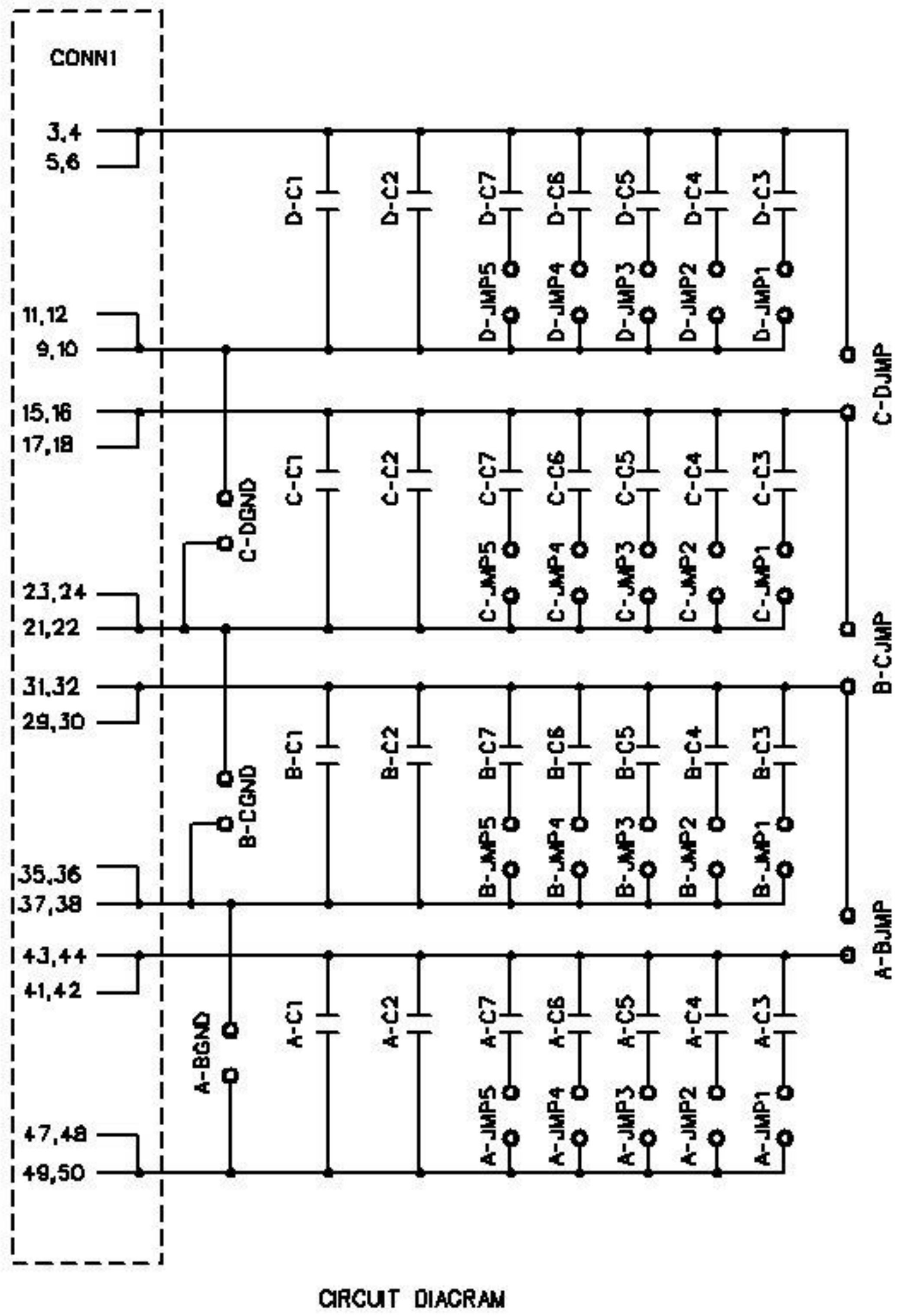


Figure 4-10. Capacitor PCB Circuit Diagram

Part No. N451003-2008
Wiring Table for Figure 4-11
and Tuning Data

Tuning Board N451657-52XX				Motherboard N451657-5507 Test Circuit Lead positions		*Track Rec.	*Track Trans.	Fine Tuning Capacitors (MFD) values located in positions slots						Temp. Test Resistor Ohms ±1%		Temp. Test Resistor Across	
Suffix No.	Freq. (Hz.)	Tol. ±	**Vtc volts	Meter / Scope (+)	(–)	Freq. (Hz.)	Freq. (Hz.)	BANK	C7	C6	C5	C4	C3				
5203 TT	3660	5	24.0	TL1	TL17	3100	3660	A	.033	.022	.010	.0068	.0033	R5	0.35	TL17	TL18
	3100	5	20.3	TL1	TL17	2580	3100	B	.015	.010	.0082	.0047	.0022	R5	0.35	TL17	TL18
	2580	5	16.9	TL1	TL17	2100	2580	C	.015	.010	.0082	.0047	.0022	R5	0.35	TL17	TL18
	2100	5	13.7	TL1	TL17	3660	2100	D	.033	.015	.0082	.0047	.0022	R5	0.35	TL17	TL18
5210 CAB	4550	5	32.0	TP1	TL12	2580	2580	A	.068	.033	.015	.0082	.0047	R2	0.30	TL12	TL11
5201 TR	3660	5	9.25	TL5	TL10	3660	2100	A	.015	.0082	.0047	.0022	----	R1	0.25	TL10	TL9
	3100	5	9.25	TL5	TL10	3100	3660	B	.0082	.0047	.0022	.0010	----	R1	0.25	TL10	TL9
	2580	5	9.25	TL5	TL10	2580	3100	C	.015	.010	.0047	.0022	----	R1	0.25	TL10	TL9
	2100	5	9.25	TL5	TL10	2100	2580	D	.015	.010	.0068	.0033	----	R1	0.25	TL10	TL9

* Note: These boards must be set to the proper frequency selection by using temporary jumpers across the appropriate turret lugs.
** Vtc = Voltage across Meter Scope (+) & Meter Scope (-) test points.

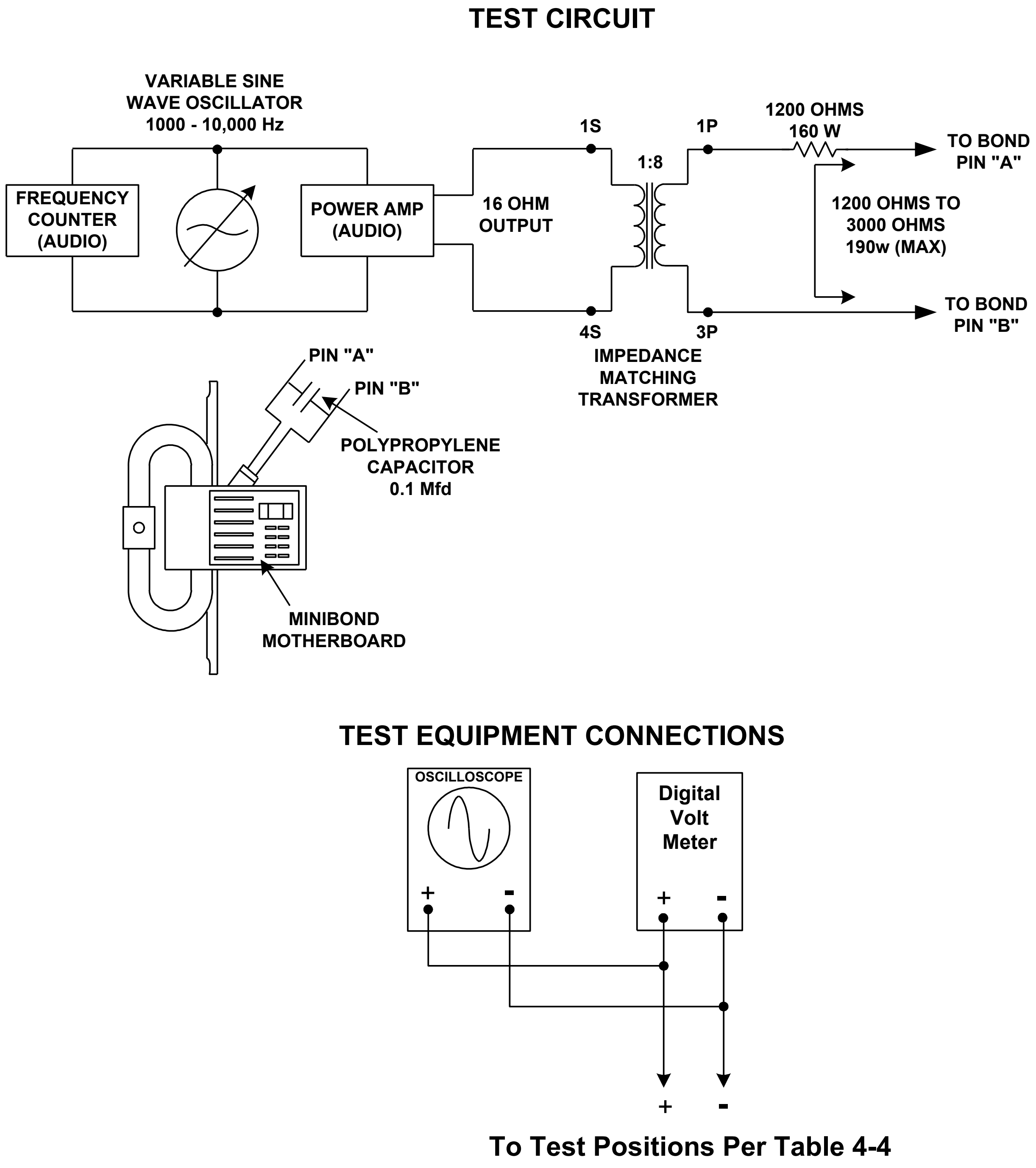
Table 4-4. Test Setup Wiring and Tuning Data

Part No. N451003-2010
Wiring Table for Figure 4-11
and Tuning Data

Tuning Board N451657-52XX				Motherboard N451657-5509 Test Circuit Lead positions		*Track Rec.	*Track Trans.	Fine Tuning Capacitors (MFD) values located in positions slots						Temp. Test Resistor Ohms ±1%		Temp. Test Resistor Across	
Suffix No.	Freq. (Hz.)	Tol. ±	**Vtc volts	Meter / Scope		Freq. (Hz.)	Freq. (Hz.)	BANK	C7	C6	C5	C4	C3				
				(+)	(–)												
5212 TT	3900	5	25.5	TL1	TL17	3370	3900	A	.033	.015	.0082	.0047	.0022	R5	0.35	TL17	TL18
	3370	5	22.0	TL1	TL17	2820	3370	B	- -	.015	.0082	.0047	.0022	R5	0.35	TL17	TL18
	2820	5	18.4	TL1	TL17	1900	2820	C	.015	.010	.0082	.0047	.0022	R5	0.35	TL17	TL18
	1900	5	12.4	TL1	TL17	3900	1900	D	.068	.022	.022	.01	.0082	R5	0.35	TL17	TL18
5210 CAB	4550	5	32.0	TP1	TL12	2820	2820	A	.068	.033	.015	.0082	.0047	R2	0.30	TL12	TL11
5211 TR	3900	5	9.25	TL5	TL10	3900	1900	A	.022	.0082	.0047	.0022	.0010	R1	0.25	TL10	TL9
	3370	5	9.25	TL5	TL10	3370	3900	B	.0068	.0033	.0015	.0010	----	R1	0.25	TL10	TL9
	2820	5	9.25	TL5	TL10	2820	3370	C	.033	.0082	.0047	.0022	.0010	R1	0.25	TL10	TL9
	1900	5	9.25	TL5	TL10	1900	2820	D	.033	.022	.01	.0082	.0068	R1	0.25	TL10	TL9

* Note: These boards must be set to the proper frequency selection by using temporary jumpers across the appropriate turret lugs.
** Vtc = Voltage across Meter Scope (+) & Meter Scope (-) test points.

Table 4-5. Test Setup Wiring and Tuning Data

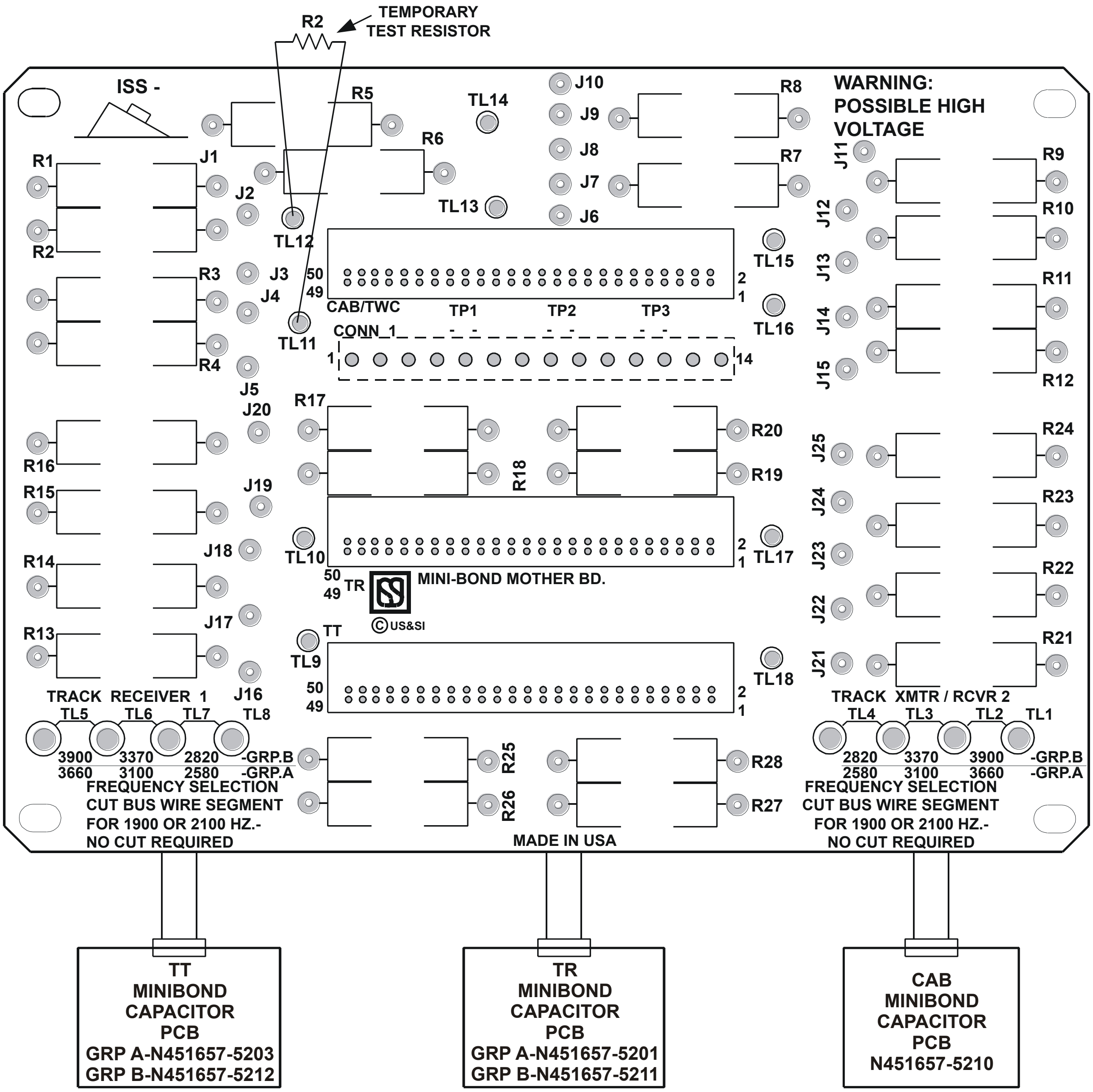


TEST CIRCUIT

TEST EQUIPMENT CONNECTIONS

To Test Positions Per Table 4-4

Figure 4-11. Tuning Circuit Test Set-Up



NOTE:
FREQUENCY SELECTION, CUT
BUSS WIRE SEGMENT.
FOR 2100 HZ. OR 1900 HZ
NO CUT REQUIRED

WARNING:
POSSIBLE HIGH VOLTAGE
REDUCE POWER BEFORE
HANDLING PCB
USE INSULATED TOOLS

Figure 4-12. Tuning Circuit Test Set-Up and Mother Board Layout

4.2.5. Impedance Adjustments

4.2.5.1. General Information

The impedance of the tuned minibond is adjusted by use of resistors located on the motherboard. Each function; TT, Cab, and TR has a group of resistors. The resistors in each group are connected in series to increase or decrease ohmic value. See Figure 4-13 for motherboard circuit diagram.

Whenever a resistor is replaced, or repairs (broken wire, solder joint, etc.) to the motherboard are made, the impedance value of the particular function or functions must be checked, and adjusted if required. To check the impedance, follow steps in Section 4.2.5.2 "a" through "g". If adjustment is required, refer to steps "a" through "d" and "g-l" through "g-10."

If all functions are to be tested, the test shall be done in the order given in the appropriate table. Track transmitter and receiver frequencies shall be done at the lowest frequency.

The 0.1 Mfd test capacitor must be connected across the connector terminals during adjustment.

4.2.5.2. Adjustment Procedure

NOTE

Before adjusting the minibond impedance, the minibond must be properly tuned (Refer to Section 4.2.4.3). Printed circuit boards are to be assembled in the bond.

a. Connect the test equipment in accordance with the test circuit shown in Figure 4-14. The 0.1 Mfd test capacitor must be placed across the connector terminals.

b. Refer to appropriate test setup wiring and impedance data table for the minibond being adjusted, Table 4-6.

c. Connect leads from test equipment to locations on motherboard as shown in appropriate table.

d. Verify that jumpers are installed across the turret lugs for the designated frequency of the minibond. This information is silk screened on the lower corners of the motherboard.

NOTE

All jumpers above the desired frequency must be in place.

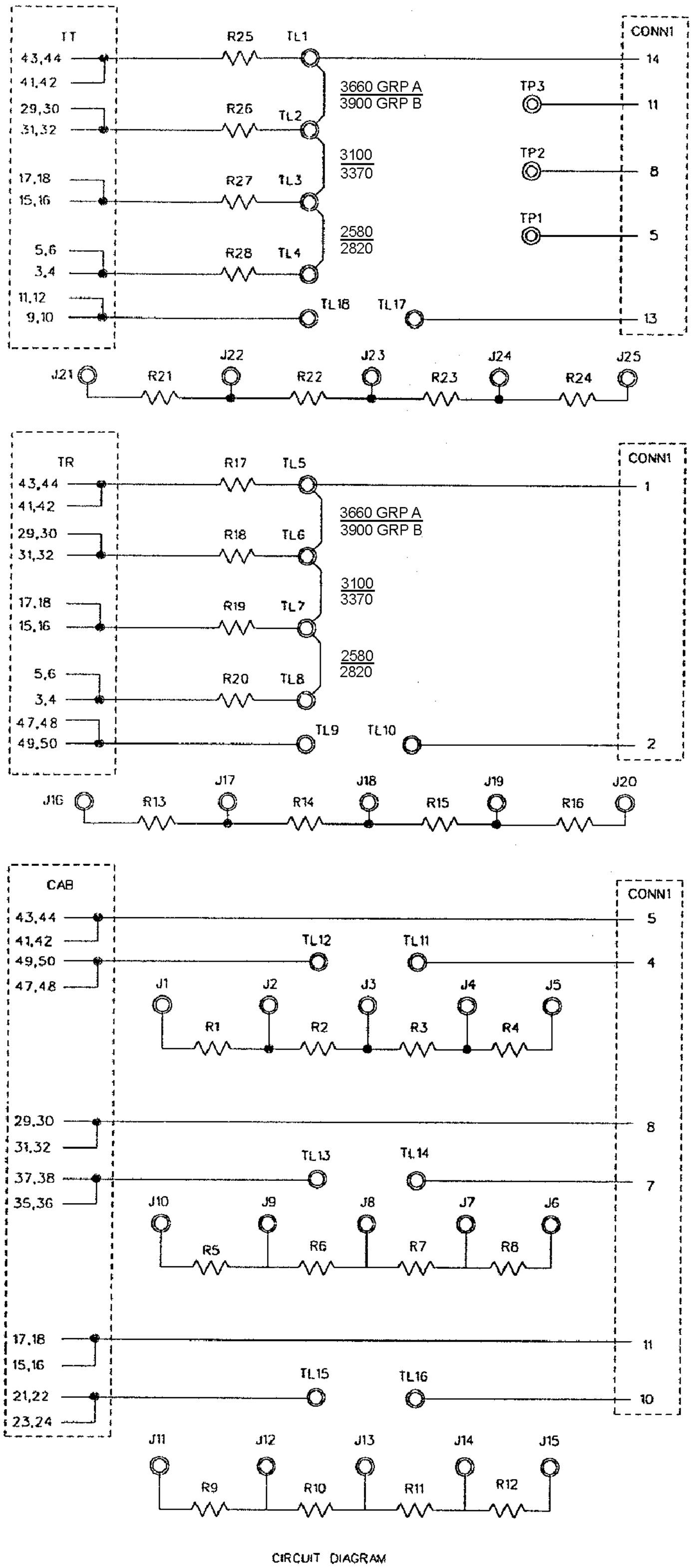


Figure 4-13. Motherboard Circuit Diagrams

e. Set the frequency to the tabulated test frequency shown in Table 4-6.

f. Adjust the source voltage to obtain Vr equal to the value of Vr shown in Table 4-6.

g. Measure the voltage Vz, and compare it against the tabulated value of Vz. If the measured value is within the proper range, the minibond impedance is correct. If the measured value is outside the range, proceed as follows:

   1. Remove jumpers connecting the resistors.
   2. Connect the decade resistance box to the motherboard terminals shown in the table for the function being adjusted. Set approximately to the test resistance value shown in Table 4-6.
   3. Set the frequency to the tabulated test frequency shown in Table 4-6.
   4. Adjust the source voltage to obtain Vr equal to the value of Vr shown in Table 4-6.
   5. Measure the voltage Vz, and compare it against the tabulated value of Vz. If the measured value of Vz is outside the permitted range, then vary the value of the decade box to bring it within the permitted range.
   6. Repeat steps "4" and "5" until the value of Vz is within the permitted range and Vr is within its permitted range. This indicates an acceptable impedance value.
   7. Note the value of resistance on the decade box. Remove the decade box from the circuit and place into the circuit that resistance value, or the closest value possible. This is done by installing buss wire from the turret lugs to the appropriate printed circuit board pads. The buss wire is soldered into place. It is permissible to short a resistor by installing and soldering buss wire between two pads. Buss wire is to be size #18 A.W.G.
   8. Verify that Vz is still within its permitted range by repeating steps "g4" and "g5."
   9. Record value of Vz, and value of resistance used to adjust circuit on a data sheet for future reference.
   10. If no further tests, remove and store all test equipment.

Part No. N451003-2008
Wiring Table for Figure 4-14
and Impedance Data

Function Being Adjusted	Test Conditions						Motherboard,N451657 -5507		Track*	Track*	Resistors, Adjusting (ohms) position R#, values (v)				Temp. Test Resistor Ohms ± 1%		Temp. Test Resistor Across	
	Freq. Freq. Tol. (Hz.) ±		Vr Value Tol. volts ±		Vz Value Tol volts ±		Test Circuit Lead Positions		Rec. Freq. (Hz.)	Trans. Freq. (Hz.)								
							Meter Scope (+)	Meter Scope (–)			R#,v	R#,v	R#,v	R#,v				
TT	2100	5	3.94	1%	0.50	5%	TL1	TL17	3660	2100	R21,TBD	R22,0.40	R23,0.40	R24,0.40	---		TL17	TL18
CAB 1	4550	5	3.81	1%	1.00	5%	TP1	TL12	2580	2580	R1,0.40	R2,0.20	R3,0.10	R4,0.05	R2	0.30	TL11	TL12
TR	2100	5	0.543	1%	0.125	5%	TL5	TL10	2100	2580	R13,0.05	R14,0.10	R15,0.20	R16,0.20	R1	0.25	TL9	TL10

* Note: These boards must be set to the proper frequency selection by using temporary jumpers across the appropriate turret lugs.

Table 4-6. Test Setup Wiring and Impedance Data

Part No. N451003-2010
Wiring Table for Figure 4-14
and Impedance Data

Function Being Adjusted	Test Conditions						Motherboard,N451657 -5509		Track*	Track*	Resistors, Adjusting (ohms) position R#, values (v)				Temp. Test Resistor Ohms ± 1%		Temp. Test Resistor Across	
	Freq. Freq. Tol. (Hz.) ±		Vr Value Tol. volts ±		Vz Value Tol volts ±		Test Circuit Lead Positions		Rec. Freq. (Hz.)	Trans. Freq. (Hz.)								
							Meter Scope (+)	Meter Scope (–)			R#,v	R#,v	R#,v	R#,v				
TT	1900	5	4.86	1%	0.50	5%	TL1	TL17	3900	1900	R21,TBD	R22,0.40	R23,0.40	R24,0.40	---		TL17	TL18
CAB 1	4550	5	3.81	1%	1.00	5%	TP1	TL12	2820	2820	R1,0.40	R2,0.20	R3,0.10	R4,0.05	R2	0.30	TL11	TL12
TR	1900	5	0.680	1%	0.125	5%	TL5	TL10	1900	2820	R13,0.05	R14,0.10	R15,0.20	R16,0.20	R1	0.25	TL9	TL10

* Note: These boards must be set to the proper frequency selection by using temporary jumpers across the appropriate turret lugs.

Table 4-7. Test Setup Wiring and Impedance Data

4.2.6. Final Assembly

a. Apply Red Glyptal to wire terminal connector screw heads (after tightening).

b. Motherboard and capacitor boards should be assembled as one unit prior to inserting the PCBs into the bond. Insert printed circuit boards into the bond.

c. Secure motherboard to bond with screws per drawing. If the motherboard bows, install #8 washers under the motherboard corners.

d. Apply Red Glyptal to screw heads at the corner.

e. Install cover.

4.2.7. Final Minibond Check

The minibond check shall be performed on the final assembled minibond to verify that it is operating properly.

a. Connect the minibond to the test circuit shown in Figure 4-14.

b. Initially set the frequency at 1700 ± 20 Hz.

c. Initially set Vr to 0.543 ± 5% volts.

d. Vary the frequency from 1700 Hz to 5000 Hz while looking for voltage peaks Vz (across minibond terminals). A peak should occur near the tuned frequency of each function listed in the appropriate Wiring and Impedance Data Table (Table 4-6), except that only one peak will occur for both track transmitter and receiver since they are tuned to the same frequency.

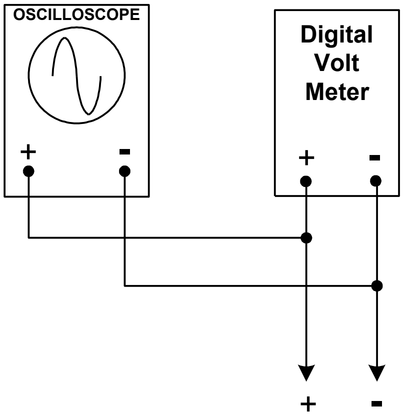
NOTE

Voltage peaks should occur at the frequencies listed in Table 4-8.

Table 4-8. Frequencies for Final Minibond Check

Minibond PCB No. 451003-	Final Check Function and Frequencies	
	Track Transmitter and Receiver ± 20Hz	Cab ± 50 Hz
- 2008	2095	4572
-2010	1895	4572

TEST EQUIPMENT CONNECTIONS



To Test Positions Per Table 4-6

TEST CIRCUIT

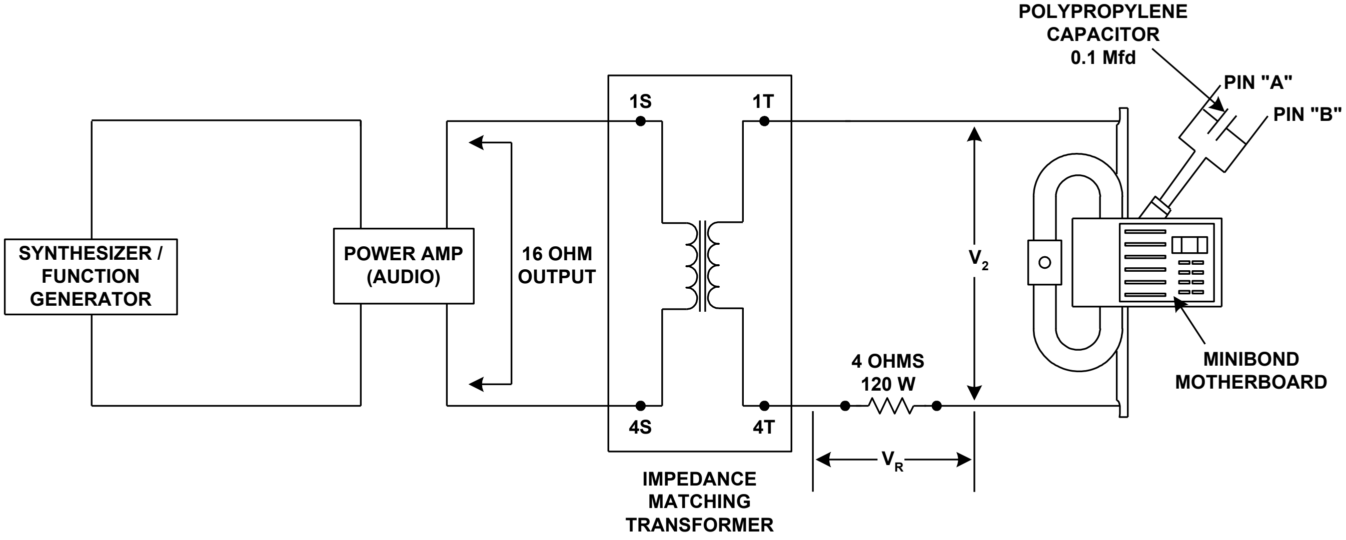


Figure 4-14. Impedance Measuring Test Set-Up

5. PARTS LIST

5.1. General Information

This section provides parts information for the tuned minibonds. Figure 5-1 tabulation lists the major sub assemblies, printed circuit boards, and miscellaneous hardware and parts. The tabulation for

lists all the component parts of the motherboard PCBs; the tabulation for Figure 5-4 lists all the component parts for the capacitor PCBs.

To use the parts list, identify the part by item number or reference. Refer to the tabulation for that item description and part number. When using the resistor and capacitor tabulations, refer to the column under the applicable printed circuit board part number.

Table 5-1. Parts List for Tuned Minibond Assembly (N451003-2008)
(See Figure 5-1)

Item Number	Description	Part Number
1	Minibond Subassembly*	N451662-1505
2	Motherboard PCB (See Fig. 5-2)	N451657-5507
3	Capacitor PCB, Tck. Rcvr. (See Fig. 5-3)	N451657-5201
4	Capacitor PCB, Tck. Xmitter (See Fig. 5-3)	N451657-5203
5	Capacitor PCB, Cab (See Fig. 5-3)	N451657-5210
6	Screw, Pan. Hd., SST, No. 8-32 x 7/16” (8 required)	J507295-0107
7	Washer, Plate, SST, No. 8 (8 required)	J475120-0109
8	Washer, Lock, SST, No. 8 (8 required)	J475121-0108
9	Cover, Gasketed	N451662-1604
10	Screw, Hex Hd, ¼ x 20 x ½” (3 required)	J500097-0108
11	Washer, Plate, SST, ¼” (3 required)	J475120-0112
12	Washer, Lock , SST, ¼” (3 required)	J475121-0111
13	Nameplate	M451662-2002
14	Spiral Wrap ½” O.D.	A774240
15	Jumper-25 Cond. (3 required)	J713767-0001
16	Base Cable Tie ADHS bk. (6 required)	J792669-0001
17	Tie-Cable Self Lock Tefzel (2 required)	J703372-0008
18	Tie-Cable Tefzel (6 required)	J703372-0009

Table 5-2. Parts List for Tuned Minibond Assembly (N451003-2010)
(See Figure 5-1)

Item Number	Description	Part Number
1	Minibond Subassembly*	N451662-1505
2	Motherboard PCB (See Fig. 5-2)	N451657-5509
3	Capacitor PCB, Tck. Rcvr. (See Fig. 5-3)	N451657-5211
4	Capacitor PCB, Tck. Xmitter (See Fig. 5-3)	N451657-5212
5	Capacitor PCB, Cab (See Fig. 5-3)	N451657-5210
6	Screw, Pan. Hd., SST, No. 8-32 x 7/16" (8 required)	J507295-0107
7	Washer, Plate, SST, No. 8 (8 required)	J475120-0109
8	Washer, Lock, SST, No. 8 (8 required)	J475121-0108
9	Cover, Gasketed	N451662-1604
10	Screw, Hex Hd, 1/4 x 20 x 1/2" (3 required)	J500097-0108
11	Washer, Plate, SST, 1/4" (3 required)	J475120-0112
12	Washer, Lock , SST, 1/4" (3 required)	J475121-0111
13	Nameplate	M451662-2004
14	Spiral Wrap 1/2" O.D.	A774240
15	Jumper-25 Cond. (3 required)	J713767-0001
16	Base Cable Tie ADHS bk. (6 required)	J792669-0001
17	Tie-Cable Self Lock Tefzel (2 required)	J703372-0008
18	Tie-Cable Tefzel (6 required)	J703372-0009

* This is an encapsulated subassembly and no attempt should be made to repair it.

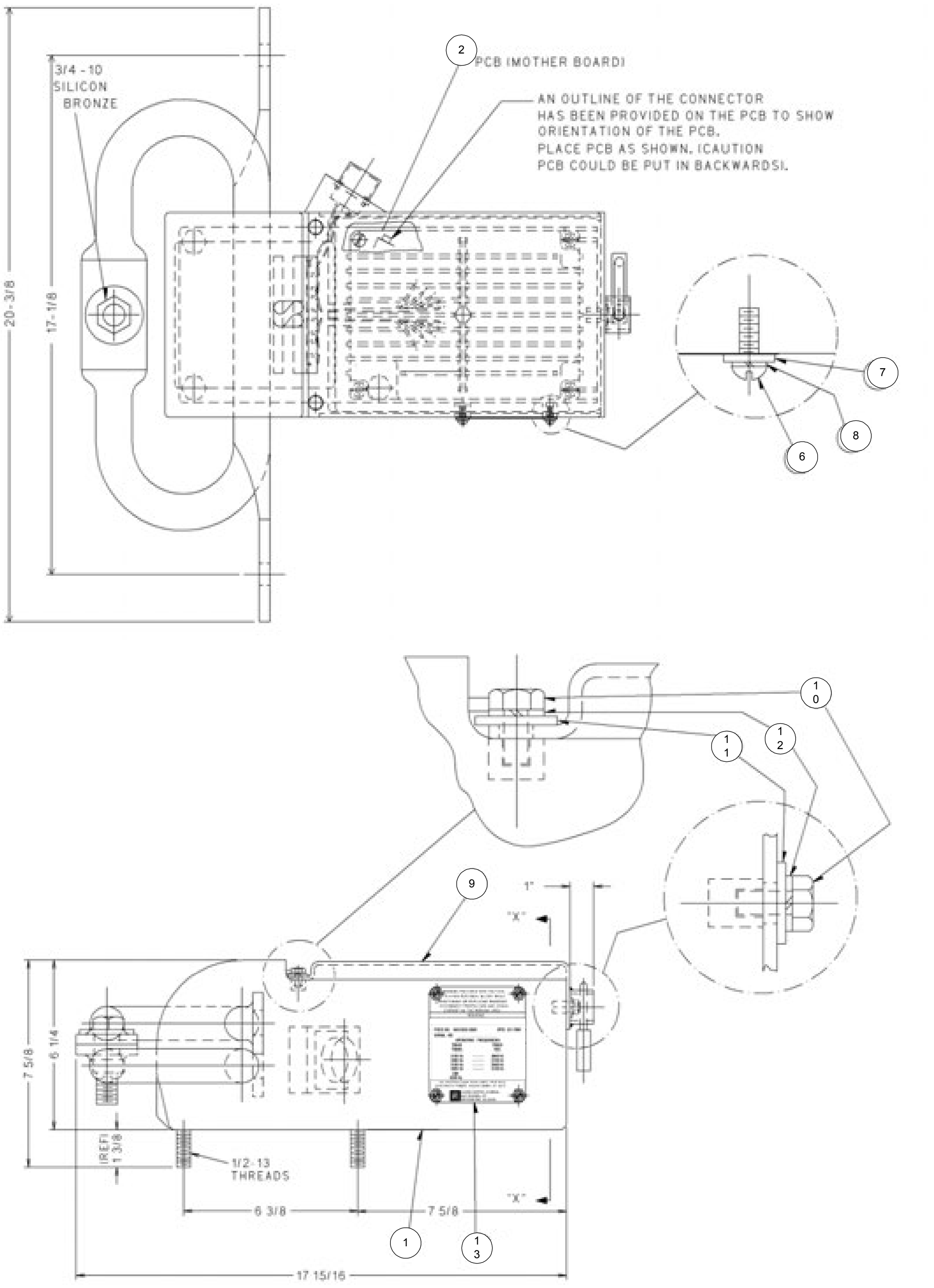


Figure 5-1. Part Location Diagram Tuned Minibond Assembly (Sheet 1 of 2)

WIRING TABLE PLUG CONNECTOR TERMINAL NUMBERS AND CORRESPONDING WIRE LEADS													
1	2	3	4	5	6	7	8	9	10	11	12	13	14
R1	R2	–	T3	T4	–	–	–	–	–	–	–	T1	T2

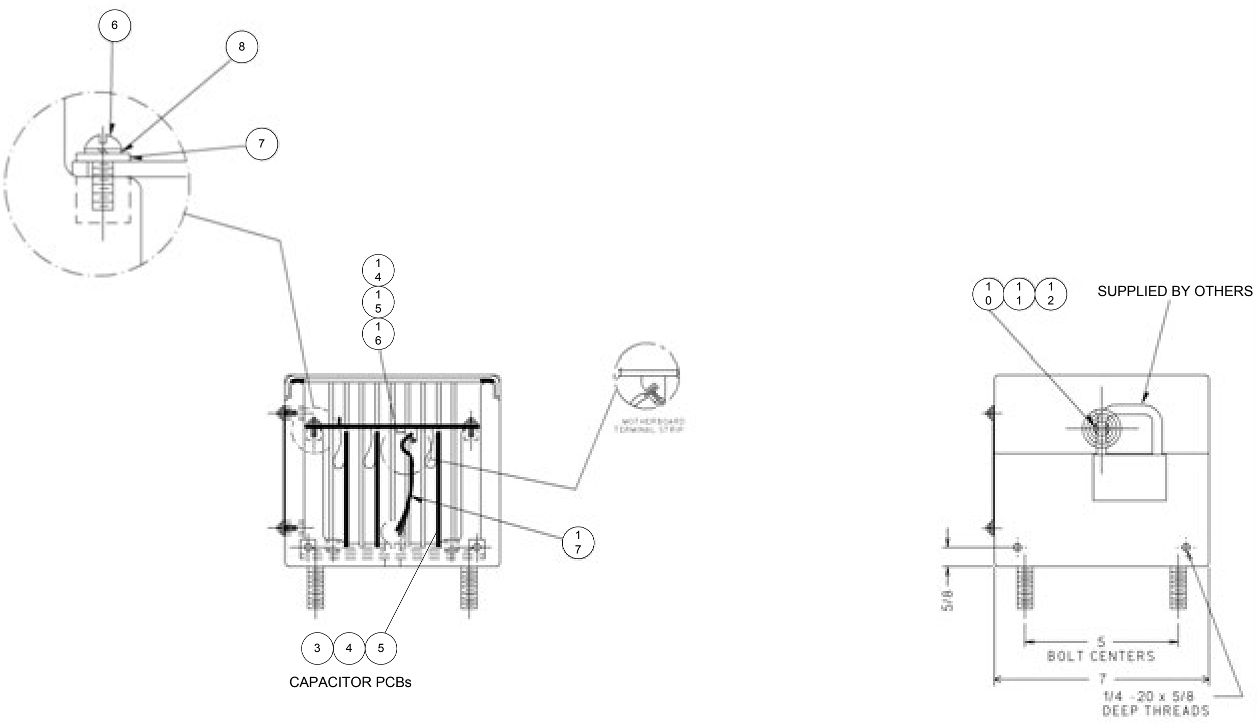
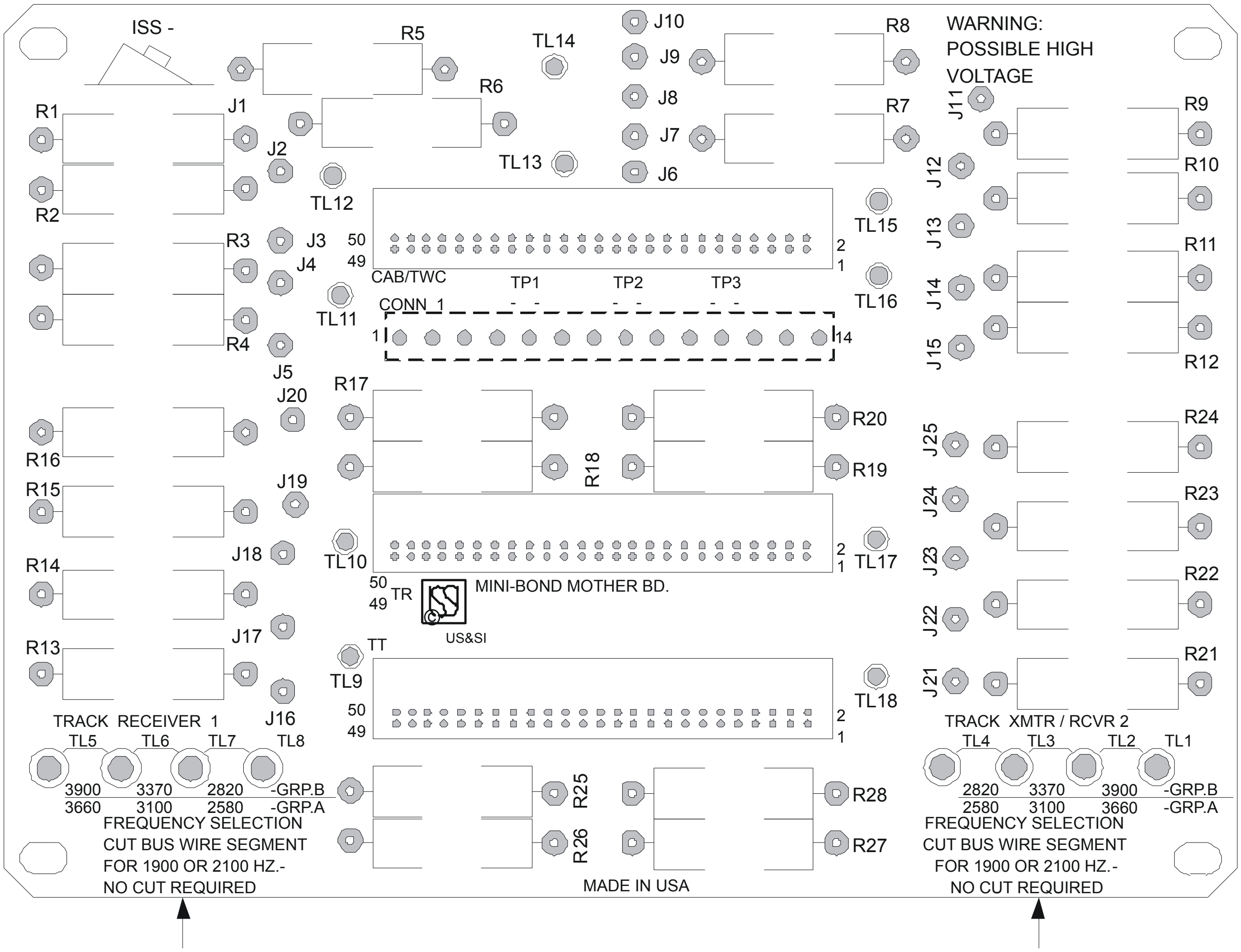


Figure 5-2. Part Location Diagram Tuned Minibond Assembly (Sheet 2 of 2)



TRACK RECEIVER
GROUP A

(F1) 2100 Hz. - NO CUT
(F2) 2580 Hz. - CUT TL7
(F3) 3100 Hz. - CUT TL6
(F4) 3660 Hz. - CUT TL5

GROUP B
(F5) 1900 Hz. - NO CUT
(F6) 2820 Hz. - CUT TL7
(F7) 3370 Hz. - CUT TL6
(F8) 3900 Hz. - CUT TL5

TRACK TRANSMITTER
GROUP A

(F1) 2100 Hz. - NO CUT
(F2) 2580 Hz. - CUT TL4
(F3) 3100 Hz. - CUT TL3
(F4) 3660 Hz. - CUT TL2

GROUP B
(F5) 1900 Hz. - NO CUT
(F6) 2820 Hz. - CUT TL4
(F7) 3370 Hz. - CUT TL3
(F8) 3900 Hz. - CUT TL2

Figure 5-3. Component Parts Layout, Motherboard Printed Circuit Board

Table 5-3. Parts List for Motherboard PCB (N451657-5507)
(See Figure 5-3)

Item Number	Description	Part Number
1	Motherboard PCB	N451657-5507
2	Terminal Strip-14 wire, Conn1 (1 required)	J709146-0860
3	Lug Turrent, TL1- TL12, TL17-TL18 (14 required)	J714138
4	Test Point, TP1, TP2 (2 required)	J713824
5	Resistor 0.1 ohm 5 watt R3, R14, R26 (3 required)	J735519-0701
6	Resistor 0.2 ohm 5 watt R2, R15 (2 required)	J735519-0702
7	Resistor .050 ohm 5 watt R4, R13 (2 required)	J735519-0713
8	Resistor .40 ohm 10 watt R1, R22-R25 (5 required)	J735519-0700
9	Resistor .55 ohm 5 watt R27 (1 required)	J735519-0707
10	Resistor .65 ohm 5 watt R17 (1 required)	J735519-0709
11	Resistor .70 ohm 5 watt R18 (1 required)	J735519-0710
12	Resistor .45 ohm 5 watt R19 (1 required)	J735519-0705
13	Resistor .40 ohm 5 watt R16 (1 required)	J735519-0704
14	W-18 Bare Tinned Cop R17-R20, R25-R28, TL17-TL18, TL11-TL12 (1.667 ft. required)	A043179

Table 5-4. Parts List for Motherboard PCB (N451657-5509)
(See Figure 5-3)

Item Number	Description	Part Number
1	Motherboard PCB	N451657-5509
2	Terminal Strip-14 wire, Conn1 (1 required)	J709146-0860
3	Lug Turrent, TL1- TL12, TL17-TL18 (14 required)	J714138
4	Test Point, TP1, TP2 (2 required)	J713824
5	Resistor 0.1 ohm 5 watt R3, R14 (2 required)	J735519-0701
6	Resistor 0.2 ohm 5 watt R2, R15 (2 required)	J735519-0702
7	Resistor .050 ohm 5 watt R4, R13 (2 required)	J735519-0713
8	Resistor .40 ohm 10 watt R1, R22-R24, R27 (5 required)	J735519-0700
9	Resistor .35 ohm 5 watt R25 (1 required)	J735519-0699
10	Resistor .70 ohm 5 watt R17 (1 required)	J735519-0710

Item Number	Description	Part Number
12	Resistor 1.20 ohm 5 watt R19 (1 required)	J735519-0714
13	Resistor .40 ohm 5 watt R16 (1 required)	J735519-0704
14	W-18 Bare Tinned Cop R17-R20, R25-R28, TL17-TL18, TL11-TL12 (1.667 ft. required)	A043179

Table 5-5. Parts List for Capacitor PCB
(See Figure 5-4)

Item Number	Description	Part Number
1	Capacitor PCB, Receiver	N451657-5201 -5211
	Capacitor PCB, Transmitter	N451657-5203 -5212
	Capacitor PCB, Cab	N451657-5210
2	Wire, copper, tinned, bare, AWG #18 (A-BGND, B-CGND, C-DGND)	A043179
3	Capacitors (Refer to Table 5-6)	
	NOTE All capacitor values are inmicrofarads; rated at 270 volts AC.	

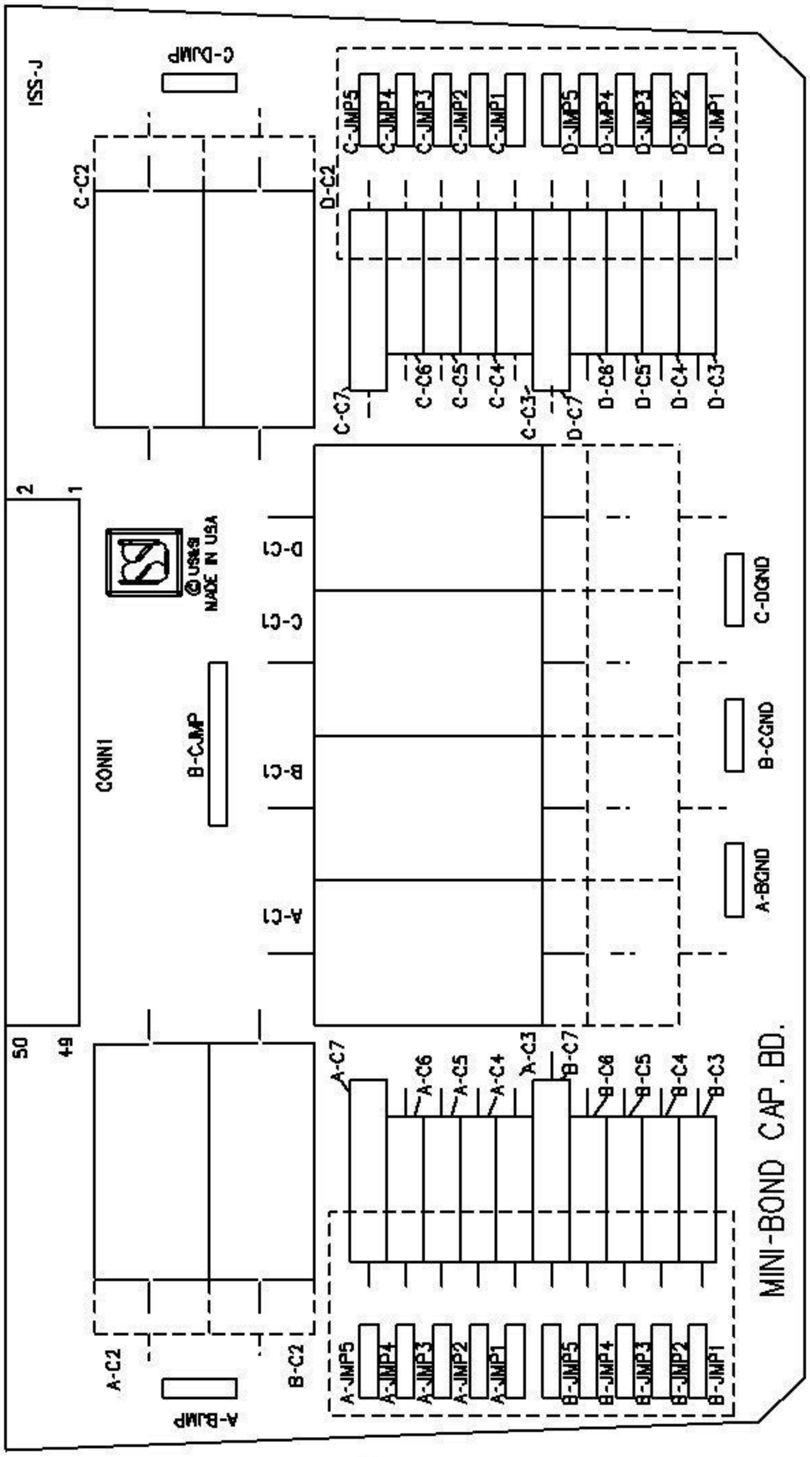


Figure 5-4. Component Parts Layout, Capacitor Printed Circuit Board

Table 5-6. Capacitor Tabulations

N451657 -5203	C1	C2	C3	C4	C5	C6	C7
A	J709145-0593 .33 Mfd	J709145-0593 .33 Mfd	J709145-0579 .0033 Mfd	J709145-0581 .0068 Mfd	J709145-0583 .01 Mfd	J709145-0585 .022 Mfd	J709145-0586 .033 Mfd
B	J709145-0591 .15 Mfd	J709145-0590 .1 Mfd	J709145-0578 .0022 Mfd	J709145-0580 .0047 Mfd	J709145-0582 .0082 Mfd	J709145-0583 .01 Mfd	J709145-0584 .015 Mfd
C	J709145-0593 .33 Mfd	J709145-0589 .082 Mfd	J709145-0578 .0022 Mfd	J709145-0580 .0047 Mfd	J709145-0582 .0082 Mfd	J709145-0583 .01 Mfd	J709145-0584 .015 Mfd
D	J709145-0598 .68 Mfd	---------	J709145-0578 .0022 Mfd	J709145-0580 .0047 Mfd	J709145-0582 .0082 Mfd	J709145-0584 .015 Mfd	J709145-0586 .033 Mfd

N451657 -5201	C1	C2	C3	C4	C5	C6	C7
A	J709145-0592 .22 Mfd	J709145-0589 .082 Mfd	J709145-0576 .001 Mfd	J709145-0578 .0022 Mfd	J709145-0580 .0047 Mfd	J709145-0582 .0082 Mfd	J709145-0584 .015 Mfd
B	J709145-0590 .1 Mfd	J709145-0585 .022 Mfd	---------	J709145-0576 .001 Mfd	J709145-0578 .0022 Mfd	J709145-0580 .0047 Mfd	J709145-0582 .0082 Mfd
C	J709145-0591 .15 Mfd	J709145-0586 .033 Mfd	---------	J709145-0578 .0022 Mfd	J709145-0580 .0047 Mfd	J709145-0583 .01 Mfd	J709145-0584 .015 Mfd
D	J709145-0592 .22 Mfd	J709145-0590 .1 Mfd	---------	J709145-0579 .0033 Mfd	J709145-0581 .0068 Mfd	J709145-0583 .01 Mfd	J709145-0584 .015 Mfd

N451657 --5210	C1	C2	C3	C4	C5	C6	C7
A	J709145-0607 1.0 Mfd	J709145-0587 .047 Mfd	J709145-0580 .0047 Mfd	J709145-0582 .0082 Mfd	J709145-0584 .015 Mfd	J709145-0586 .033 Mfd	J709145-0588 .068 Mfd
B							
C							
D							

N451657 –5211	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**
A	J709145-0591 .15 Mfd	J709145-0590 .1 Mfd	J709145-0576 .001 Mfd	J709145-0578 .0022 Mfd	J709145-0580 0047 Mfd	J709145-0582 .0082 Mfd	J709145-0585 .022 Mfd
B	J709145-0589 .082 Mfd	J709145-0583 .01 Mfd		J709145-0576 .001 Mfd	J709145-0577 .0015 Mfd	J7091450579 .0033 Mfd	J709145-0581 .0068 Mfd
C	J709145-0591 .15 Mfd	J709145-0583 .01 Mfd	J709145-0576 .001 Mfd	J709145-0578 .0022 Mfd	J709145-0580 0047 Mfd	J709145-0582 .0082 Mfd	J409145-0586 .033 Mfd
D	J709145-0597 .47 Mfd,	J709145-0592 .22 Mfd	J709145-0581 .0068 Mfd	J709145-0582 .0082 Mfd	J709145-0583 .01 Mfd	J709145-0585 .022 Mfd	J409145-0586 .033 Mfd

N451657 -5212	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**
A	J709145-0597 .47 Mfd	J709145-0590 .1Mfd	J709145-0578 .0022 Mfd	J70945-0580 .0047 Mfd	J706145-0582 .0082 Mfd	J709145-0584 .015 Mfd	J709145-0586 .033Mfd
B	J709145-0590 .1Mfd	J709145-0590 .1Mfd	J709145-0578 .0022 Mfd	J70945-0580 .0047 Mfd	J706145-0582 .0082 Mfd	J709145-0584 .015 Mfd	
C	J709145-0593 .33 Mfd		J709145-0578 .0022 Mfd	J70945-0580 .0047 Mfd	J706145-0582 .0082 Mfd	J709145-0583 .01 Mfd	J709145-0584 .015 Mfd
D	J709145-0598 .68 Mfd	J709145-0598 .68 Mfd	J709145-0582 .0082 Mfd	J709145-0583 .01 Mfd	J709145-0585 .022Mfd	J709145-0585 .022 Mfd	J709145-0588 .068 Mfd

6. TECHNICAL SUPPORT

6.1. RAIL Team and Technical Support

The Rapid Action Information Link Team (RAIL Team) is a group of experienced product and application engineers ready to assist you to resolve any technical issues concerning this product. Contact the RAIL Team in the United States at 1-800-652-7276 or by e-mail at railteam@ansaldo-sts.us.

End of Manual