NAVSHIPS 0967-163-1010

UNCLASSIFIED

TECHNICAL MANUAL

for

VLF FREQUENCY COMPARATOR SYSTEM MODEL VLFC-1

(COMPARATOR - RECEIVER SET AN/URR-50(V))

THE TECHNICAL MATERIEL CORPORATION

MAMARONECK, N.Y. OTTAWA, CANADA

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IN-288

Issue Date: 15 OCT. 1966

NOTICE

THE TECHNICAL MATERIEL CORPORATION
COMMUNICATIONS ENGINEERS
700 FENIMORE ROAD MAMARONECK, N. Y.

Warranty

The Technical Materiel Corporation, hereinafter referred to as TMC, warrants the equipment (except electron tubes,* fuses, lamps, batteries and articles made of glass or other fragile or other expendable materials) purchased hereunder to be free from defect in materials and workmanship under normal use and service, when used for the purposes for which the same is designed, for a period of one year from the date of delivery F.O.B. factory. TMC further warrants that the equipment will perform in a manner equal to or better than published technical specifications as amended by any additions or corrections thereto accompanying the formal equipment offer.

TMC will replace or repair any such defective items, F.O.B. factory, which may fail within the stated warranty period, PROVIDED:

1. That any claim of defect under this warranty is made within sixty (60) days after discovery thereof and that inspection by TMC, if required, indicates the validity of such claim to TMC's satisfaction.
2. That the defect is not the result of damage incurred in shipment from or to the factory.
3. That the equipment has not been altered in any way either as to design or use whether by replacement parts not supplied or approved by TMC, or otherwise.
4. That any equipment or accessories furnished but not manufactured by TMC, or not of TMC design shall be subject only to such adjustments as TMC may obtain from the supplier thereof.

Electron tubes*furnished by TMC, but manufactured by others, bear only the warranty given by such other manufacturers. Electron tube warranty claims should be made directly to the manufacturer of such tubes.

TMC's obligation under this warranty is limited to the repair or replacement of defective parts with the exceptions noted above.

At TMC's option any defective part or equipment which fails within the warranty period shall be returned to TMC's factory for inspection, properly packed with shipping charges prepaid. No parts or equipment shall be returned to TMC, unless a return authorization is issued by TMC.

No warranties, express or implied, other than those specifically set forth herein shall be applicable to any equipment manufactured or furnished by TMC and the foregoing warranty shall constitute the Buyers sole right and remedy. In no event does TMC assume any liability for consequential damages, or for loss, damage or expense directly or indirectly arising from the use of TMC Products, or any inability to use them either separately or in combination with other equipment or materials or from any other cause.

*Electron tubes also include semi-conductor devices.

PROCEDURE FOR RETURN OF MATERIAL OR EQUIPMENT

Should it be necessary to return equipment or material for repair or replacement, whether within warranty or otherwise, a return authorization must be obtained from TMC prior to shipment. The request for return authorization should include the following information:

1. Model Number of Equipment.
2. Serial Number of Equipment.
3. TMC Part Number.
4. Nature of defect or cause of failure.
5. The contract or purchase order under which equipment was delivered.

PROCEDURE FOR ORDERING REPLACEMENT PARTS

When ordering replacement parts, the following information must be included in the order as applicable:

1. Quantity Required.
2. TMC Part Number.
3. Equipment in which used by TMC or Military Model Number.
4. Brief Description of the Item.
5. The *Crystal Frequency* if the order includes crystals.

PROCEDURE IN THE EVENT OF DAMAGE INCURRED IN SHIPMENT

TMC's Warranty specifically excludes damage incurred in shipment to or from the factory. In the event equipment is received in damaged condition, the carrier should be notified immediately. Claims for such damage should be filed with the carrier involved and not with TMC.

All correspondence pertaining to Warranty Claims, return, repair, or replacement and all material or equipment returned for repair or replacement, within Warranty or otherwise, should be addressed as follows:

THE TECHNICAL MATERIEL CORPORATION
Engineering Services Department
700 Fenimore Road
Mamaroneck, New York

The purpose of this addendum is to provide proper termination of the 1 MC output of Frequency Standard CSS-2.

Refer to figure 1 below. Connect common end of CA-864 to J-904 on CSS-2. Connect one end of CA-864 to P-904 of main cable harness, other end of CA-864 to a dummy load that is presently installed on rear of CSS-2.

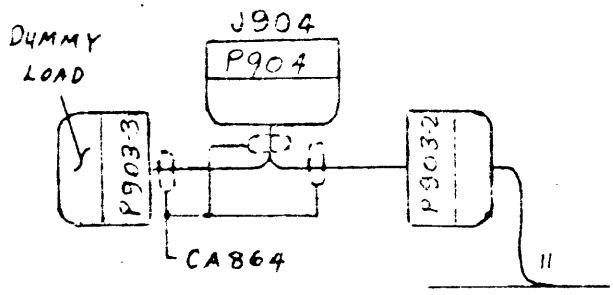

Figure 1

RECORD OF CORRECTIONS MADE

Change No.	Date of Change	Date Entered	Entered By

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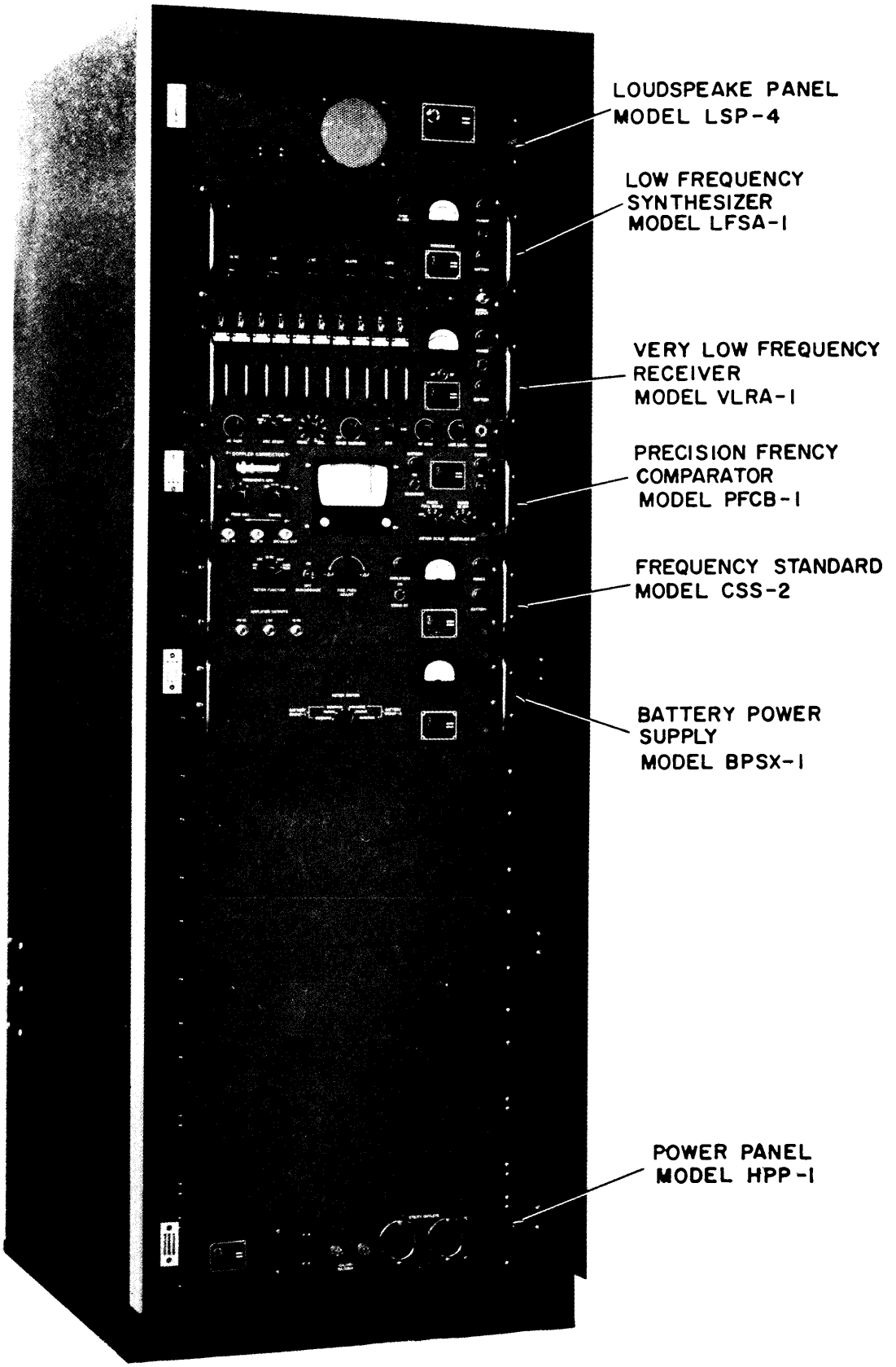

Figure 1-1. VLF Frequency Comparator System, Model VLFC-1

SECTION 1
GENERAL INFORMATION

1-1. PURPOSE AND DESCRIPTION.

a. PURPOSE. - The VLF Frequency Comparator System, Model VLFC-1 (figure 1-1) is a highly-stable frequency comparison system that is used to test the stability of station and/or equipment frequency standards. The overall frequency stability of stations transmitting in the VLF range of 10 to 100 Kc exceeds 1 part in 10^{11}. The VLFC system utilizes the ultra-stable transmissions of these VLF stations to maintain the stability of its internal 1-mc frequency standard. The internal frequency standard is then used as a reference signal to test the stability of external station and/or equipment frequency standards. Any variations occurring in the station and/or equipment standards are observed and recorded.

The stability of the internal frequency standard is practically the same as that of the VLF transmitting stations. The word "practically" is used due to two effects, namely the diurnal frequency shift of the transmitted signal at sunrise and sunset, and possible doppler effects from a mobile receiving site such as a ship moving to or from the transmitter. To defeat the former effect, measurements should not be taken when the diurnal frequency shift is present. The latter effect can be corrected by employing a doppler corrector which is optionally provided with the VLFC.

The VLFC also provides: ultra-stable output signals of 100-kc, 1-mc, and 10-mc, which can be distributed to a number of synthesized transmitters or receivers; an alarm indicates frequency drift beyond tolerance; and automatic switchover to battery operation if a-c power should fail.

b. DESCRIPTION. - The modular units constituting the rack-mounted VLFC system are briefly described in paragraphs (1) through (7) (refer to figure 1-2).

(1) LOUDSPEAKER PANEL, MODEL LSP-4. - Loudspeaker panel LSP houses a 4-inch permanent-magnet loudspeaker that monitors audio signals from Very Low Frequency Receiver VLRA.

(2) LOW FREQUENCY SYNTHESIZER, MODEL LFSA-1. - Low Frequency Synthesizer LFSA compares a 1-mc signal from Frequency Standard CSS with a TRF signal (with an upper frequency limit of 99.99-kc) from Very Low Frequency Receiver VLRA. Frequency differences between the two signals produce a d-c correction voltage. This correction volt-

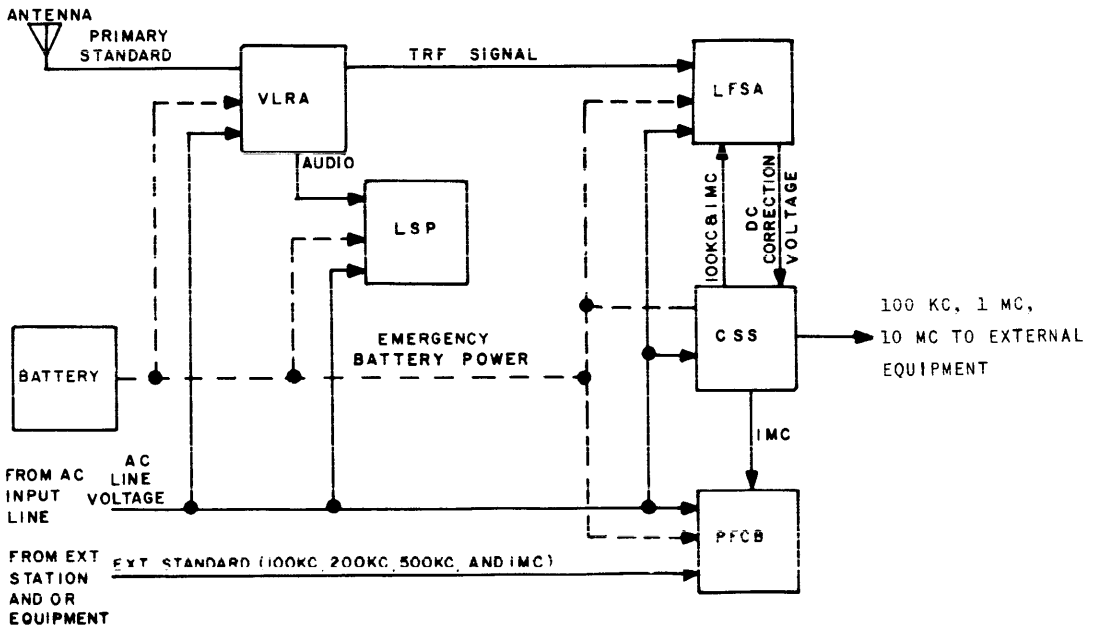

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Figure 1-2. Very Low Frequency Comparator System, Simplified Block Diagram

age maintains the 1-mc frequency standard to a stability equal to that of the TRF signal.

Front-panel switches permit the LFSA to be tuned to the frequency of the received TRF signal which is displayed on the front panel in one-inch high illuminated numerals. A front-panel meter indicates phase error; an alarm lamp indicates when the VLFC system is not synchronized. The LFSA power supply requires 115/230 volts, 50 to 60 cycles, a-c power for operation and provides positive and negative 12-volt d-c outputs. In the event of a-c power failure, provisions are made to switch over to battery power supplied by Battery Power Supply BPSX.

(3) VERY LOW FREQUENCY RECEIVER, MODEL VLRA-1. - Very Low Frequency Receiver VLRA is a superheterodyne receiver that accepts CW and beacon signals (the primary standard) within a range of 10 to 100-kc and with a presumed stability of 1 part in 10^{11}. Improved reception of frequencies below 40-kc is accomplished when low-pass filter FL1002 (mounted in RAK-43) is connected in series with the antenna. The VLRA supplies Low Frequency Synthesizer LFSA with a TRF signal that is a sample of the primary standard. Also, the VLRA provides Loudspeaker LSP with any audio intelligence that is detected in the primary standard.

The VLRA power supply requires 115/230 volts, 50 to 60 cycle, a-c power for operation and provides positive and negative 12-volt d-c outputs. In the event of a-c power failure, provisions are made to switch to battery power supplied by Battery Supply BPSX.

(4) PRECISION FREQUENCY COMPARATOR, MODEL PFCB-1. - Precision Frequency Comparator PFCB utilizes the ultra-stable 1-mc reference signal from Frequency Standard CSS to test external station and/or equipment frequency standards. The frequency error and stability of the external station and/or equipment standards are recorded and displayed on a chart recorder. A doppler corrector (optional unit) compensates for apparent frequency errors resulting from doppler shift. This unit is used only when the VLFC system is operated on a moving platform such as on board a ship. The PFCB power supply requires 115/230 volts, 50 to 60 cycles, a-c power for operation and provides positive and negative 12-volt d-c outputs. In the event of a-c power failure, provisions are made to switch to battery power supplied by Battery Power Supply BPSX.

(5) FREQUENCY STANDARD, MODEL CSS-2. - The CSS supplies stable 1-mc and 100-kc signals to Low Frequency Synthesizer LFSA. At the LFSA, the 1-mc standard signal is compared with a "primary standard" (CW or beacon signals received by Very Low Frequency Receiver VLRA). The resultant d-c correction voltage from the LFSA maintains the high stability of the 1-mc frequency standard of Frequency Standard CSS. The ultra-stable 1-mc signal from the CSS is then supplied to Precision Frequency Comparator PFCB as a reference signal where it is used to test the stability of external station and/or equipment frequency standards.

The CSS internal power supply requires 115/230 volts, 50 to 60 cycle a-c power for operation, and provides positive and negative 12-volt d-c outputs. In the event of a-c power failure, provisions are made to switch to battery power supplied by Battery Power Supply BPSX.

(6) BATTERY POWER SUPPLY, MODEL BPSX-1. - Battery Power Supply BPSX accepts the 24-volt battery packs required to operate the VLFC modular units in the event of a-c power failure. This action insures signal continuity during times of emergency. When normal a-c power is used, the batteries (optional) are on a "trickle" charge.

(7) POWER PANEL, MODEL HPP-1. - Power Panel HPP is an auxiliary panel containing two fused convenience outlets for use with external test equipment.

1-2. EQUIPMENT SUPPLIED.

Table 1-1 lists the equipment supplied with the VLFC.

TABLE 1-1. EQUIPMENT SUPPLIED

QTY.	OFFICIAL NOMENCLATURE NAME	DESIGNATION	OVERALL DIMENSIONS (IN) HEIGHT	WIDTH	DEPTH	WEIGHT (lbs.)
1	Loudspeaker Panel LSP-4	LS-452/U	5-1/4	19	2-1/2	2-1/2
1	Low Frequency Synthesizer LFSA	0-1276/UR		19		
1	Very Low Frequency Receiver VLRA	R-1333(P)/URR	7	19	17	30

TABLE 1-1. EQUIPMENT SUPPLIED (CONT)

QTY.	OFFICIAL NOMENCLATURE NAME	DESIGNATION	OVERALL DIMENSIONS (IN) HEIGHT	WIDTH	DEPTH	WEIGHT (lbs.)
1	Precision Frequency Comparator PFCB	CM-326/UR	5-1/4	19	15-5/8	
1	Frequency Standard CSS	0-1275/UR	5-1/4	19	14-1/2	16
1	Battery Power Supply BPSX	PP-4323/URQ	5-1/4	19	16	8-1/2
1	Power Panel HPP	SB-1866/FR	4-1/2	19	3-1/2	3
1	Rack RAK-43	CY-4463/URR, 50 (V)	69	24-5/8	30-3/8	
	Cable Assemblies:					
1	CA-906					
1	CA-907					
1	CA-908					

1-3. TECHNICAL SPECIFICATIONS.

Technical specifications of the VLFC system are as follows:

Frequency Range	10- to 100-kc plug-in, fixed-tuned r-f amplifiers selectable by front-panel control. Up to 10 plug-in modules can be inserted into the receiver.
Modes of Reception	Continuous Carrier and CW. FSK with appropriate converter.
Sensitivity	A 0.1-microvolt signal impressed across the input of the receiver will produce a minimum of 10-db signal + noise-to-noise ratio.
Receiver Input Impedance	50 ohms nominal.
Receiver r-f and i-f Bandwidth	100 cps.
RF Noise Cancellation	An RF noise cancelling circuit is incorporated in the individual RF tuning modules and is controlled on the front panel.
Receiver AGC	Amplified and delayed AGC provides no greater than 3-db change in output signal for 80-db change in input signal.
Type of Receiver Detection	Product detector. IF feed-through suppressed at least 60-db below designated signal.
Receiver Distortion	Total harmonic and inter-modulation distortion 1% or less at full power output.

1-3. TECHNICAL SPECIFICATIONS (CONT)

Audio Output	500-milliwatt, 4-ohm unbalanced output; one-milliwatt (0 dbm) balanced center tapped 600-ohm output.
Audio Response	Constant within $\pm$1.5 db from 100 to 2500 cps.
BFO	Adjustable 0 to 2.5 kilocycles from IF frequency.
Tuning	From 10-kcs to 99.999-kcs in 1-cycle increments. Displayed on front panel in 1-inch high illuminated numerals.
Reference Standard Correction	A d-c correction voltage derived from the phase difference between the received RF signal and the synthesizer output maintains internal reference standard to a stability equal to that of the received signal.
Reference Standard Adjustment	Multi-turn front-panel control with 3600-dial divisions provides total deviation of $\pm$1 part in 10^7 with resettable accuracy to 1 part in 10^9.

Test Input (Station and/or Equipment Standards):

Frequency	100, 200, 500, or 1000-kcs.
Level	.1 to 3 volts, peak-to-peak.

Maximum Error Display Time	10-seconds maximum time to display 1 part in 10^{11} error.
Error Readability	Minimum detectable error $\pm$1 part in 10^{11}.
Error Multiplication Factor	Adjustable error multiplication rate from 1 to 10,000 in five detented switch positions.
Environmental Condition	Designed to operate in any ambient temperature range from 0 to 50°C and any value of humidity up to 90%.
Weight: (with BPSX)	Approximately 110 lbs. (no batteries)
Dimensions (inches)	69 x 24-5/8 x 30-3/8.
Operating Power	105/115/125/210/230/250 vac, 50/60 cycles, single phase, 28 watts.
Battery Power BPSX-1	Battery packs (optional) may be provided in 4- or 8- hour plug-in units to operate the synthesizer, the receiver, the frequency comparator, and the frequency standard. Batteries are on trickle charge at all times under normal operating power.

Current Drain; Battery Group 1

Frequency Standard CSS	330 ma.

Current Drain; Battery Group 2

Low Frequency Synthesizer LFSA	400 ma.
Very Low Frequency Receiver VLRA	200 ma.
Precision Frequency Comparator PFCB	250 ma.

1-3. TECHNICAL SPECIFICATIONS (CONT)

*Doppler Correction Range	0-50 knots.
*Doppler Frequency Range	±100 cycles at 1 mc.
*Doppler Metering:	0 to 10 cps; or 0 to 100 cps.
*Doppler Outputs:	
Electronic	1 volt peak-to-peak available for use with digital counter.
Correction	1,000,000 to 1,000,200 cycles per second.

*Doppler Corrector is optionally provided with VLFC system.

SECTION 2
INSTALLATION

2-1. UNPACKING AND HANDLING.

The VLFC is shipped in three boxes as listed in table 2-1; box number and contents are stenciled on the outside of each box. Table 2-2 lists the gross weight and size of the shipping boxes. Inspect all boxes for possible damage when they arrive at the operating site. With respect to equipment damage for which the carrier is liable, the Technical Materiel Corporation will assist in describing methods of repair and the furnishing of replacement parts.

Figures 2-1 and 2-2 are typical illustrations of the method used to pack RAK-43 and the VLFC modules for shipment, respectively. Using figures 2-1 and 2-2 as a guide, unpack RAK-43 and the modular units in the reverse order of the indicated packing procedures; refer to table 1-1 for information regarding size and weight of RAK-43 and modular units.

Inspect the contents of each box for possible damage, and inspect the packing material for parts that may have been shipped as loose items. All cable assemblies used in the VLFC system are mounted in RAK-43 and taped in place.

2-2. POWER REQUIREMENTS.

All units of the VLFC system, except the Battery Power Supply, leave the factory wired for 115-volt, 50/60 cycle operation. Change may be made to 230-volt, 50/60 cycle operation by making minor wiring changes. Consult the installation section of the individual modular-unit manuals for the applicable wiring-change information.

CAUTION

If 230 volt, 50/60 cycle operation is used, all line fuses must be reduced to one half their rated current values to assure adequate circuit protection. Regulated and high voltage fuses remain the same with either line voltage.

Approximate power consumption of the VLFC ranges between 28 watts and 50 watts, depending upon the charge condition of batteries contained in Battery Power Supply BPSX. Power cabling of sufficient size to provide 10.5 amperes (approximately 1/2 ampere for the VLFC and 10 amperes for external test equipment connected to

TABLE 2-1. CONTAINER CONTENTS, VLFC SHIPMENT

BOX NO.	CONTENTS
1	Cabinet, Electrical Equipment, Model RAK-43, complete with Loudspeaker Panel, Model LSP-4, 1 each. Power Panel, Model HPP-1, Low Pass Filter, Model FX211, Line filter, Model FL1001, 1 each. Instruction Manuals, 2 each; loose items; and test data.
2	Frequency Standard, Model CSS, 1 each. Battery Power Supply, Model BPSX, 1 each. Precision Frequency Comparator, Model PFCB, 1 each.
3	Low Frequency Synthesizer, Model LFSA, 1 each. Very Low Frequency Receiver, Model VLRA, 1 each.

TABLE 2-2. CRATED WEIGHT, DIMENSIONS, AND VOLUME

BOX NO.	GROSS WEIGHT (LBS.)	OUTSIDE DIMENSIONS (IN.)			VOLUME (CU. FEET)
		LENGTH	WIDTH	HEIGHT	
1	608	75-1/4	36-3/8	33-1/2	50.0
2	215	32	23-7/8	30-3/4	13.0
3	210	36	26-3/4	34-3/4	19.4

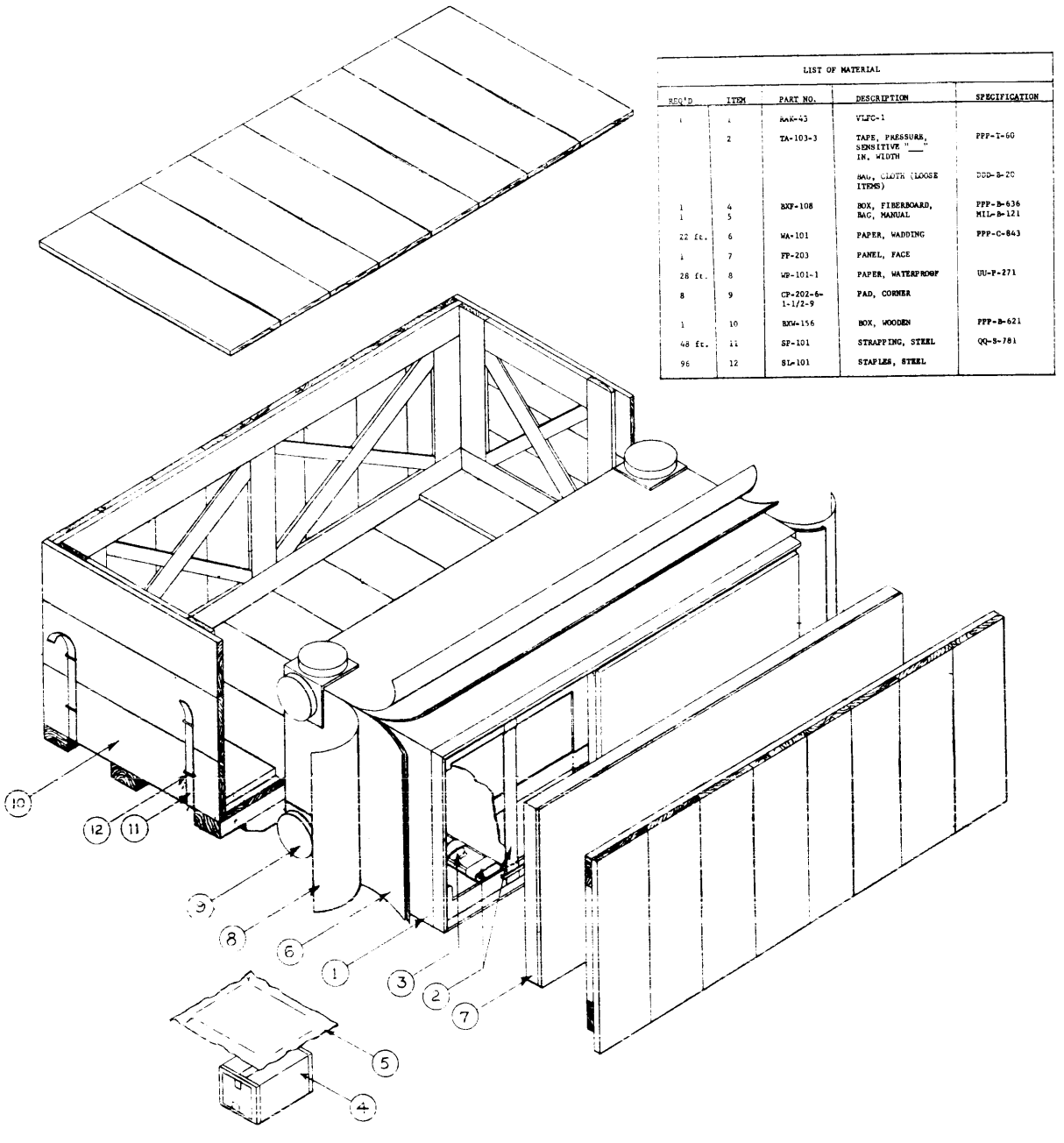
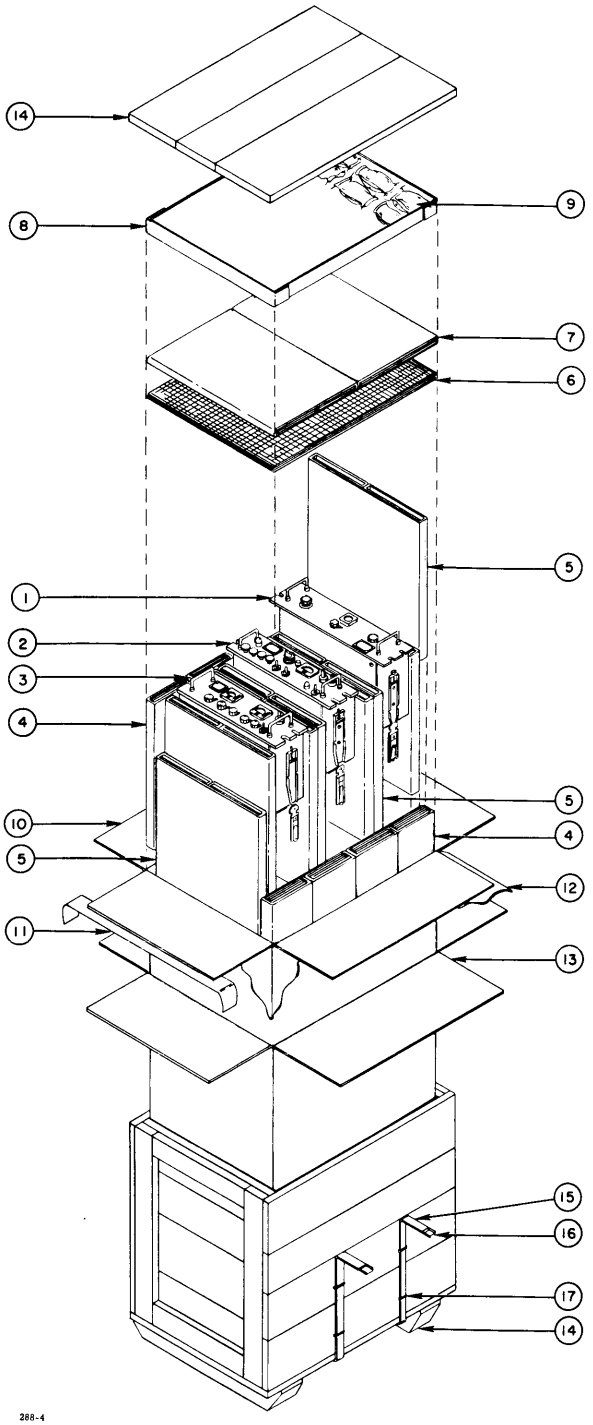


Figure 2-1. RAK-43, Typical Preparation for Shipment



LIST OF MATERIAL		
ITEM	DESCRIPTION	SPECIFICATION
1	MODULAR UNIT	
2	MODULAR UNIT	
3	MODULAR UNIT	
4	PAD, FIBERBOARD	PPP-B-636 TYPE I, CLASS I
5	CELL, FIBERBOARD	PPP-B-636 TYPE I, CLASS I
6	PAPER, TISSUE	UU-P-553
7	PAD, FIBERBOARD	PPP-B-636 TYPE I, CLASS I
8	TRAY, FIBERBOARD	PPP-B-636 TYPE I, CLASS I
9	DESICCANT	MIL-D-3464
10	BOX, FIBERBOARD	PPP-B-636 TYPE I, CLASS I
11	TAPE, PRESSURE SENSITIVE	PPP-T-60 TYPE III, CLASS I
12	BAG, BARRIER	MIL-B-131 CLASS I
13	BOX, FIBERBOARD	PPP-B-636 TYPE I, CLASS 2
14	BOX, WOOD	PPP-B-621 STYLE 2
15	STRAP	QQ-S-781
16	SEAL, STRAPPING	
17	STAPLE	FF-N-105

Figure 2-2. Modular Units, Typical Preparation for Shipment

utility outlets of Power Panel HPP-1) at 115 vac, single phase is adequate. For information concerning the connection of power cables, refer to paragraph 2-3.

2-3. INSTALLATION.

a. LOCATION OF RAK-43. - Before attempting to install the VLFC, ensure that adequate power (paragraph 2-2) is available at the selected site or location. After unpacking and inspecting cabinet RAK-43, place it in its operating location. It is advisable to do this while the modular units are not installed because the added weight will make movement more difficult. Refer to dimensional outline drawing figure 2-3 when choosing the operating location. Sufficient space to open front and rear cabinet doors is one of the prime considerations when choosing the operating location.

b. CABLING. - Figure 2-4 illustrates the cabling connections between the various modular units contained in the VLFC. After installing RAK-43, untape or unstrap all cable assemblies, NEGATOR B motors, and all other components attached to frame of rack.

c. CABLE ENTRY. - Cable entry for main power, is accomplished through openings with removable covers. These openings are located on both sides and at the bottom of the cabinet.

d. POWER CONNECTIONS. - Refer to paragraph 2-2 for information regarding power requirements, and proceed as follows:

(1) Remove cable access hole cover.

(2) Remove cover on input end of a-c line filter and connect three-wire input power cable. The hot leads are connected to the line studs. The ground lead is connected to the ground stud.

(3) Replace filter cover removed in step (2).

(4) Connect power cable to 115-volt, 60-cycle, single-phase source.

(5) Using Simpson Model 260 VOM or equivalent, measure voltage at convenience outlets on front panel of Power Panel HPP-1; reading should be 115 volts.

e. MODULAR UNIT. - Each compartment of the cabinet (RAK-43) is equipped with tracks that attach to slide mechanisms of the associated modular unit. To install any modular unit in its compartment refer to figure 1-1 and proceed as follows:

(1) Pull center section of associated compartment track out until it locks in an extended position.

(2) Position slide mechanisms of modular unit in tracks, and ease modular unit forward into rack until rearward release fingers or lock buttons engage hole in track.

CAUTION

Cables and electrical wiring should be carefully positioned to prevent snagging or catching as units slide in and out of equipment rack. Ensure that NEGATOR B motors used to retract the cable assemblies are functioning properly.

(3) Depress forward release fingers or lock buttons, and slide modular unit completely into compartment.

(4) Secure front panel of modular unit to rack with screws.

(5) Make necessary cable and electrical connections as shown in figure 2-4. After all connections have been made, ensure that cable clamps are properly secured.

f. ANTENNA. - Various types of antennas such as the loop, long wire, and vertical whip can be used with the VLFC. The antenna input when connected to the receiver should be 50-ohm unbalanced.

2-4. INSPECTION AND ADJUSTMENT.

a. GENERAL. - Although each modular unit of the VLFC has been aligned and thoroughly checked against the manufacturer's specifications prior to shipment, it is necessary to insure correct installation and proper operating condition of the VLFC by the following checkout procedures. These procedures must be performed after the equipment is installed and prior to releasing the equipment to operating personnel. If the results of any particular procedure are unsatisfactory, refer to the appropriate modular-unit manual for remedial information.

NOTE

When checking the complete VLFC system, the procedures should be performed in the sequence given.

b. PRELIMINARY OPERATIONS. - Refer to figure 3-1 and table 3-1 for location of controls and indicators; and switches at positions indicated below:

MODULAR UNIT	SWITCH OR CONTROL	POSITION
VLRA	POWER	On (upper)
	*BAT.	IN
	AF GAIN	Fully counter-clockwise
	AGC DECAY	MAN RF
	CHAN. SEL.	Selected receiver channel

MODULAR UNIT	SWITCH OR CONTROL	POSITION
	NOISE SILENCER	OFF
	BFO control	Mid-position
	RF GAIN	Fully clockwise
	LINE LEVEL	Mid-position
	AF-RF	RF
LFSA	POWER	On (upper)
	10 KC, 1 KC, 0.1 KC, 10 CPS, and 1 CPS	At selected frequency of VLRA receiver (observe nixie lamps for proper readouts.)
CSS	AMPLIFIERS	ON
	*BAT.	IN
	SYNCHRONIZE	OFF
	METER FUNCTION	24V
	FINE FREQ ADJUST	At initial setting supplied by TMC.
PFCB	ON-OFF	ON
	*BAT.	IN
	MULTIPLIER (m)	6
	METER SCALE	OFF
BPSX	METER SWITCH	BATTERY GROUP-1 CONDITION

* BAT switches are set at OUT only when Battery Power Supply BPSX is not supplied with batteries.

c. CHECKOUT PROCEDURES FOR VLFC SYSTEM. - Operating controls, indicators and jacks for the individual modular units are referenced with numerical callouts in figure 3-1. These callouts are included in the VLFC checkout procedures for location purposes (refer to table 3-1). To check out the VLFC system, proceed as follows:

NOTE

The following procedures assume that at least two batteries (one for each battery group) are supplied with the Battery Power Supply BPSX.

(1) Set VLFC controls and switches at positions indicated in paragraph 2-4b.

(2) On Very Low Frequency Receiver VLRA, Frequency Standard CSS, Precision Frequency Comparator PFCB and Low Frequency Synthesizer LFSA, observe that POWER lamps (14), (27), (20) and (9) are lit.

(3) On Frequency Standard CSS observe that function meter (28) indicates approximately 24 volts.

(4) On Battery Power Supply BPSX, observe that meter (32) indicates within BATTERY CONDITION area. Set METER SWITCH at BATTERY GROUP-2 CONDITION and observe that meter indicates within BATTERY CONDITION area. Then, set METER SWITCH at BATTERY GROUP-1 CHARGE and BATTERY GROUP-2 CHARGE. Meter should indicate between 0 and 0.1 amperes in both cases.

(5) Disconnect a-c line power from VLFC system.

(6) On Very Low Frequency Receiver VLRA, Frequency Standard CSS, Precision Frequency Comparator PFCB and Low Frequency Synthesizer LFSA, observe that POWER lamps (14), (27), (20) and (9) go off, and BATTERY lamps (17), (29), (21) and (11) should light.

(7) On Frequency Standard CSS, function meter should indicate approximately 24 volts. Set METER FUNCTION selector switch at OVEN TEMP.

(8) Reconnect a-c line power to VLFC system and observe that BATTERY lamps (11, 17, 21 and 29) go off, and that POWER lamps (9, 14, 20 and 27) light.

(9) On Very Low Frequency Receiver VLRA, perform the following:

NOTE

During system checkout the VLRA should be tuned to a strong VLF station with a known stability.

(a) Set AF/RF switch (16) at AF. Turn LINE LEVEL control (19) in clockwise then counterclockwise direction, observing corresponding changes on meter. Set AF/RF switch at RF.

(b) Adjust AF GAIN (48) control for comfortable audio level.

(c) Turn RF GAIN control (53) in clockwise and then counterclockwise direction, observing corresponding changes on meter (13). Set RF GAIN control at position where station is audible.

(d) Adjust BFO control (52) as required for desired tone.

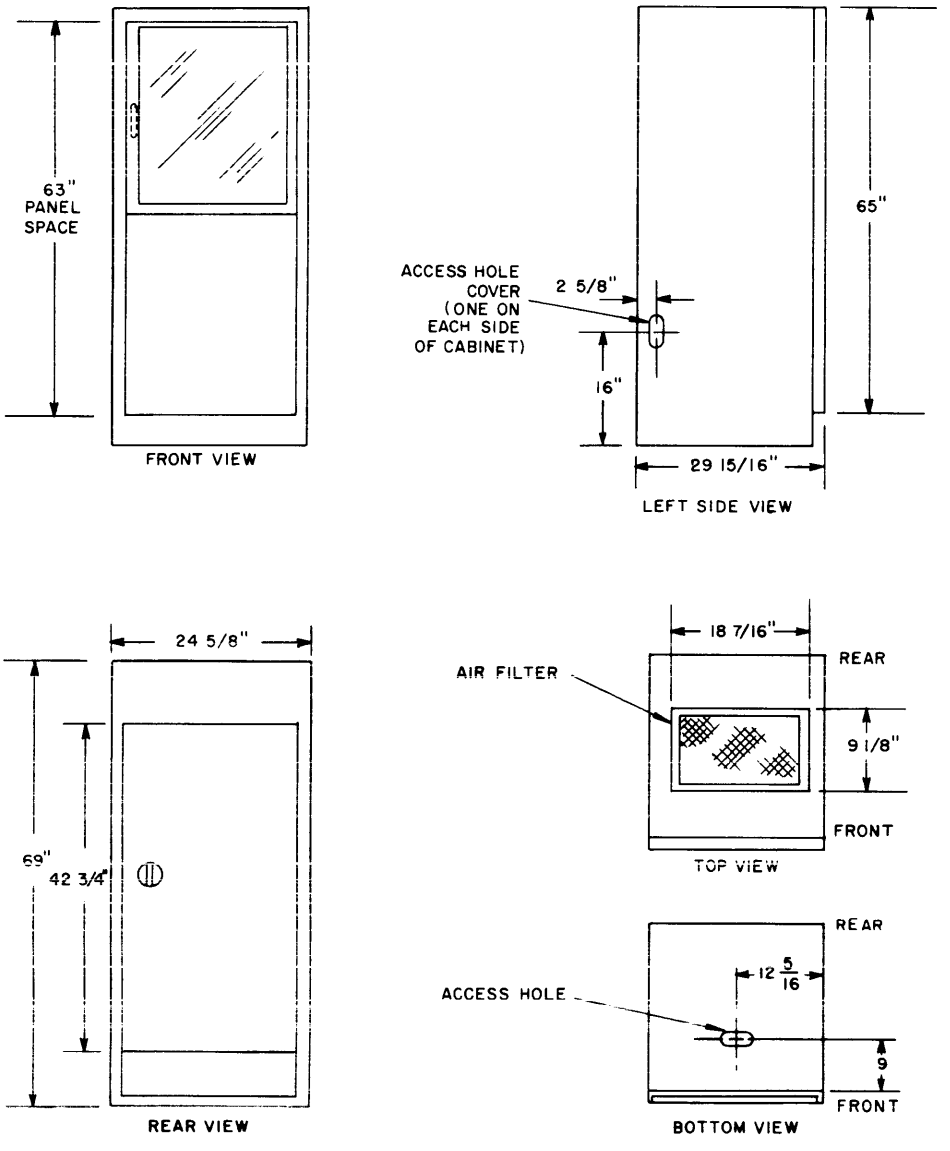


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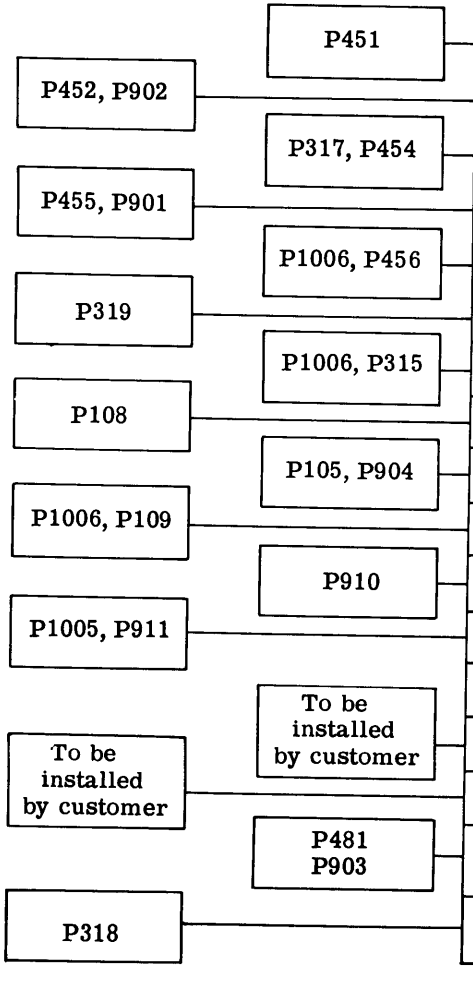
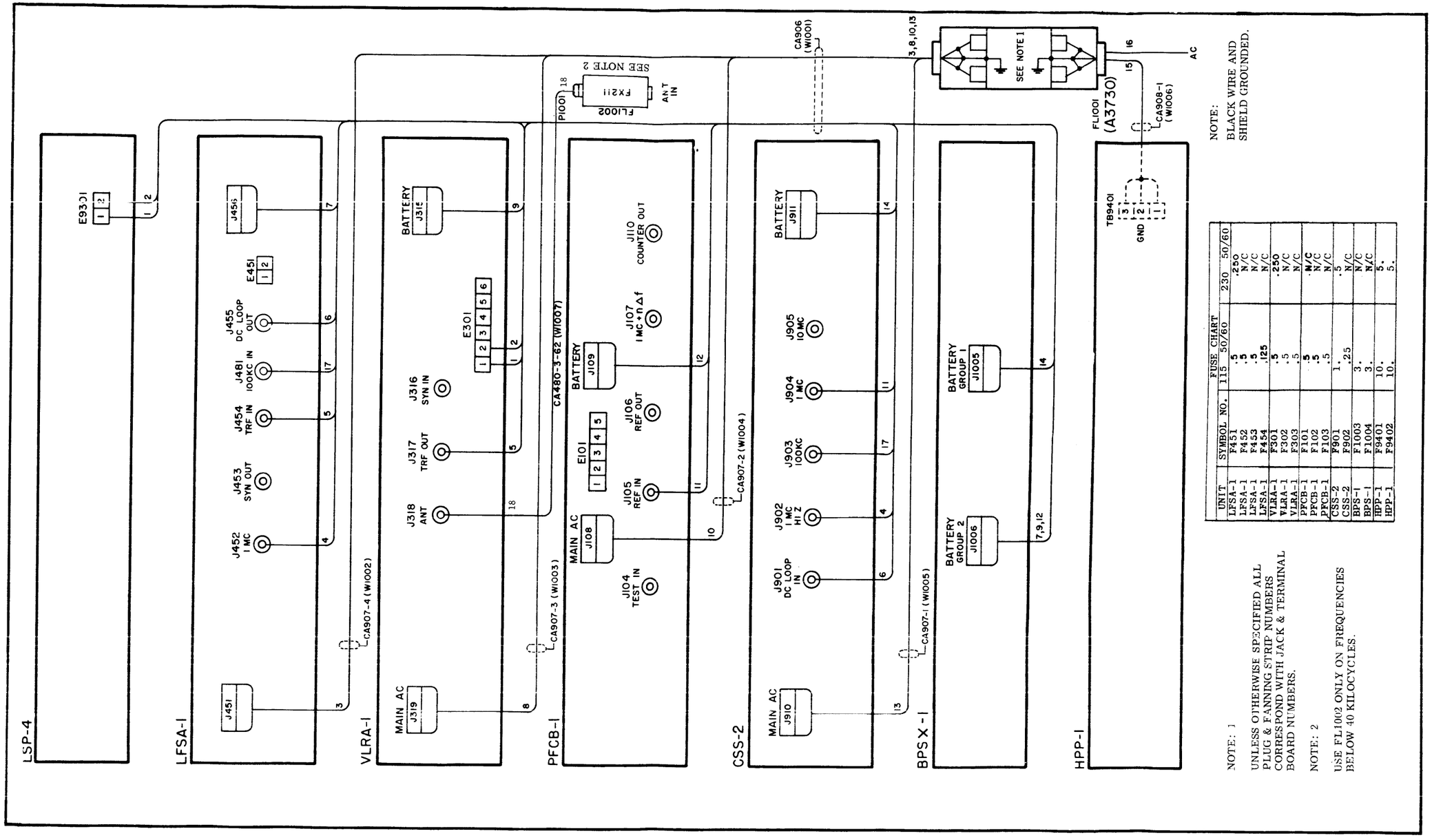
Figure 2-3. RAK-43, Dimensional Outline Drawing



CABLING INFORMATION			
ITEM	PART NUMBER	DESCRIPTION	SYMBOL
1	CA906	AUDIO INTERCONNECT	W1001
2	CA906	AUDIO INTERCONNECT	W1001
3	CA906, CA907-4	AC POWER INTERCONNECT	W1001, W1002
4	CA906	1 MC HI Z INTERCONNECT	W1001
5	CA906	TRF INTERCONNECT	W1001
6	CA906	DC CORRECTION VOLTAGE INTERCONNECT	W1001
7	CA906	DC BATTERY GROUP-2 INTERCONNECT	W1001
8	CA906, CA907-3	AC POWER INTERCONNECT	W1001, W1003
9	CA906	DC BATTERY GROUP-2 INTERCONNECT	W1001
10	CA906, CA907-2	AC POWER INTERCONNECT	W1001, W1004
11	CA906	1 MC INTERCONNECT	W1001
12	CA906	DC BATTERY GROUP-2 INTERCONNECT	W1001
13	CA906, CA907-1	AC POWER INTERCONNECT	W1001, W1005
14	CA906	BATTERY GROUP-1 INTERCONNECT	W1001
15	CA908-1	AC POWER INTERCONNECT	W1006
16		AC INPUT TO FI-104	
		ANTENNA INPUT	
17		100 KC INTERCONNECT	
18	CA480-3-62	RECEIVER-ANTENNA FILTER INTERCONNECT	W1007

Figure 2-4. Cabling Interconnection Diagram, VLFC System (Sheet 1 of 2)



UNIT	SYMBOL NO.	FUSE CHART 115	50/60	230	50/60
LFSA-1	F451	.5		.250	
LFSA-1	F452	.5		N/C	
LFSA-1	F453	.5		N/C	
LFSA-1	F454	.125		N/C	
VLRA-1	F301	.5		.250	
VLRA-1	F302	.5		N/C	
VLRA-1	F303	.5		N/C	
PFCB-1	F101	.5		N/C	
PFCB-1	F102	.5		N/C	
PFCB-1	F103	.5		N/C	
CSS-2	F901	1.		.5	
CSS-2	F902	.25		N/C	
BPS-1	F1003	3.		N/C	
BPS-1	F1004	3.		N/C	
HPP-1	F9401	10.		5.	
HPP-1	F9402	10.		5.	

NOTE: 1

UNLESS OTHERWISE SPECIFIED ALL PLUG & FANNING STRIP NUMBERS CORRESPOND WITH JACK & TERMINAL BOARD NUMBERS.

NOTE: 2

USE FL1002 ONLY ON FREQUENCIES BELOW 40 KILOCYCLES.

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Figure 2-4. Cabling Interconnection Diagram, VLFC System (Sheet 2 of 2)

(e) Set AGC DECAY switch (49) at best position suitable for speed of transmission.

(f) If necessary, adjust NOISE SILENCER control (51) to reduce noise present in received signal.

(g) Check remaining frequency channels by using CHAN SEL switch (50) and repeating steps (c) through (f). Then reset CHAN SEL switch for desired frequency.

(h) Connect headset with an impedance of 600 ohms to PHONE jack and listen for audio. Then, disconnect headset from PHONE jack.

(10) Allow Frequency Standard CSS to warm-up for 24-hour period.

(11) On Frequency Standard CSS, perform the following:

(a) Observe that meter (28) indicates within green area when METER FUNCTION selector switch (41) is set at OVEN TEMP.

(b) Set METER FUNCTION switch at 24V. Observe that meter indicates approximately 24 volts.

(c) Sequentially set METER FUNCTION selector switch at 100 KC, 1 MC, and 10 MC while observing meter; meter should indicate at least 1-volt rms for each switch position.

(d) Set METER FUNCTION switch at OVEN TEMP.

(12) To check Low Frequency Synthesizer LFSA, do the following:

(a) Observe that SYNCHRONIZE meter (8) pointer swings between two maximum limits in either yellow or red meter areas; SYNC ALARM lamp (7) should be lit.

(b) Using timing device such as a stopwatch, etc., take average reading of time it takes meter pointer to swing between two maximum limits; note reading.

(c) At Frequency Standard CSS, very slowly turn FINE FREQ ADJUST control (39) either clockwise or counterclockwise until average time it takes for meter pointer to swing between two maximum limits has increased.

(d) Continue to slowly turn FINE FREQ ADJUST control until maximum meter pointer swings are in GREEN meter area. At this point, SYNC ALARM lamp will go off.

(e) At CSS, set SYNCHRONIZE switch (40) ON. If maximum meter swings are outside GREEN area, repeat steps (c) and (d).

(13) On Precision Frequency Comparator PFCB, perform the following:

(a) Connect coaxial jumper between front-panel REF IN (43) and TEST IN (44) jacks.

(b) Set METER SCALE switch (26) at 5 and observe initial movement of recorder chart and pen. Pen markings as indicated on recorder chart should be centered at zero.

(c) Successively set MULTIPLIER (m) switch (25) at 7, 8, 9 and 10 PARTS IN 10^n and observe pen markings on recorder chart for zero indication at each switch position.

(d) Disconnect coaxial jumper connected between REF IN and TEST IN jacks. Set METER SCALE switch at OFF.

SECTION 3
OPERATOR'S SECTION

3-1. CONTROLS, JACKS, AND INDICATORS.

Before attempting to operate the VLFC, the operator should first familiarize himself with all controls and indicators. Controls, jacks, and indicators of the VLFC are listed in table 3-1 and illustrated in figure 3-1.

TABLE 3-1. CONTROLS, JACKS, AND INDICATORS

MODULAR UNIT	ITEM NUMBER	PANEL AND COMPONENT DESIGNATION	FUNCTION
Low Frequency Synthesizer LFSA	1	Luminous digital indicators, (no front-panel designation)	Indicate frequency of incoming TRF signal.
	2	10 KC switch S351	Tunes LFSA in 10-kc steps.
	3	1 KC switch S351	Tunes LFSA in 1-kc steps.
	4	.1 KC switch S351	Tunes LFSA in 100-cycle steps.
	5	10 CPS switch S351	Tunes LFSA in 10-cycle steps.
	6	1 CPS switch S351	Tunes LFSA in 1-cycle steps.
	7	SYNC ALARM lamp DS453	Lights when VLFC system is not synchronized.
	8	SYNCHRONIZE meter M451	Indicates phase difference between received r-f signal and synthesized LFSA signal.
	9	POWER lamp DS451	Indicates when a-c power is applied to power supply circuit.
	10	POWER switch S452	Connects a-c power to power supply circuit.
	11	BATTERY lamp DS452	Indicates when unit is powered by Battery Power Supply BPSX.
	12	SIGNAL OUTPUT jack J453	Permits monitoring of synthesizer signal applied to phase detector module.

TABLE 3-1. CONTROLS, JACKS, AND INDICATORS (CONT)

MODULAR UNIT	ITEM NUMBER	PANEL AND COMPONENT DESIGNATION	FUNCTION
Low Frequency Synthesizer LFSA (cont)	*	BAT. switch S451	A two-position switch. IN position connects battery power supply to LFSA circuits; automatic battery switching should be accomplished if a-c power fails. OUT position disconnects battery power supply from LFSA circuits.
Very Low Frequency Receiver VLRA	13	Meter M301	Operates in conjunction with AF/RF switch S3-4 (item 16). When S304 is set at AF, meter measures level of audio signal across 600-ohm line; when S304 is set at RF, meter measures strength of incoming r-f signal in db above 0.1 uv.
	14	POWER lamp DS301	Indicates when a-c power is applied to receiver power supply circuit.
	15	POWER switch S302	Connects a-c power to receiver power supply circuit.
	16	AF/RF switch S304	AF position connects line amplifier output signal to front-panel meter M301; RF (item 13) position connects agc signal to meter.
	17	BATTERY lamp DS302	Indicates when unit is powered by Battery Power Supply BPSX.
	18	PHONE jack J303	Permits headset monitoring of audio signal applied to Loudspeaker Panel LSP.
	19	LINE LEVEL potentiometer R309	Controls amplitude of audio signal applied to 600-ohm line.
	48	AF GAIN potentiometer R307	Controls amplitude of audio signal applied to 4-ohm speaker.
	49	AGC DECAY switch S303	A four-position rotary switch. MAN RF position permits RF GAIN control to control gain of r-f amplifier stages. FAST, MED, and SLOW positions permit agc circuit to control the gain; also, permits selection of time constants that change the decay time of the agc signal.
	50	CHAN SEL switch S301	Connects selected r-f module to receiver circuits.
	51	NOISE SILENCER potentiometer R301 R301	Controls amplitude of noise silencer signal required to remove impulse noise.
	52	BFO Variable Capacitor C304	Varies frequency of audio tone.

*Located on rear panel.

TABLE 3-1. CONTROLS, JACKS, AND INDICATORS (CONT)

MODULAR UNIT	ITEM NUMBER	PANEL AND COMPONENT DESIGNATION	FUNCTION
Very Low Frequency Receiver VLRA (cont)	53	RF GAIN potentiometer R302	Controls gain of r-f stages when AGC DECAY switch (item 49) is in MAN RF position.
	*	BAT. switch S305	A two-position switch. IN position connects 24-volt external battery to receiver circuits; automatic battery switching should be accomplished if a-c power fails. OUT position disconnects battery from receiver circuits.
Precision Frequency Comparator PFCB	20	POWER lamp DS101	Indicates when a-c power is applied to power supply circuit.
	21	BATTERY lamp DS102	Indicates when unit is powered by Battery Power Supply BPSX.
	22	POWER switch S101	ON position connects a-c power to power supply circuit. OFF position disconnects a-c power from power supply circuit.
	23	RECORDER switch S102	ON position connects a-c power to recorder motor. OFF position disconnects a-c power from recorder motor.
	24	Recorder	Monitors and permanently records error frequency of frequency standard under test.
	25	MULTIPLIER(m) switch S104	A five-position selector switch. Switch positions correspond to rate at which error frequency ($n\Delta f$) is multiplied.
	26	METER SCALE switch S103	A four-position switch. OFF position disconnects output module from the recorder. Remaining switch positions (1, 2, and 5) select full-scale readings of the recorder. For example, in position 5, the full scale reading is ± 5 parts. Therefore, with the suggested setting for MULTIPLIER(m) switch S104, (item 25) a full-scale deflection on either side of center indicates 5 parts in 10^6 difference between frequency standards.
	42	1 MC + $n\Delta f$	Permits monitoring of 1-mc + $n\Delta f$ frequency as selected by MULTIPLIER(m) switch S104 (item 25).
	43	REF IN jack J102	Permits monitoring the input frequency of reference frequency standard.
	44	TEST IN jack J101	Permits monitoring the input frequency of the frequency standard under test.
	*	BATTERY switch S104	A two-position switch. IN position connects 24-volt external battery to comparator

*Located on rear panel.

TABLE 3-1. CONTROLS, JACKS, AND INDICATORS (CONT)

MODULAR UNIT	ITEM NUMBER	PANEL AND COMPONENT DESIGNATION	FUNCTION
Precision Frequency Comparator PFCB (cont)			circuits; automatic battery switching should be accomplished if a-c power fails. OUT position disconnects battery from comparator circuits.
	**45	FREQ ADJ control C823	Variable capacitor that varies oscillator frequency from 1-mc to 200 cycles above 1-mc to adjust amount of correction.
	**46	RANGE switch S801	A three-position switch. OFF position disconnects Doppler Corrector from output circuit of PFCB. Other two-positions turn on Doppler Corrector and select frequency range of meter circuit.
	**47	FREQUENCY CPS meter M801	Indicates doppler correction frequency in cycles per second; the scale being selected by RANGE switch S801 (item 46).
Frequency Standard CSS	27	POWER lamp DS901	Indicates when a-c power is applied to power supply circuit.
	28	Function Meter M901 (no front-panel designation)	Monitors 100-kc, 1-mc, and 10-mc frequency outputs, 24-volt supply voltage, and oven temperature as selected by METER FUNCTION selector switch S901 (item 41).
	29	BATTERY lamp DS902	Indicates when unit is powered by Battery Power Supply BPSX.
	30	AMPLIFIERS lamp DS903	Indicates when B+ is applied to CSS circuits.
	31	AMPLIFIERS switch S903	ON position connects B+ power to CSS circuits; STANDBY position disconnects B+ power from CSS circuits.
	36	10 MC jack J908	Provides stable 10-mc signal at 1-volt across 50-ohm load.
	37	1 MC jack J907	Provides stable 1-mc signal at 1-volt across 50-ohm load.
	38	100 KC jack J906	Provides stable 100-kc signal at 1-volt across 50-ohm load.
	39	FINE FREQ. ADJUST control R952	10-turn vernier control used to calibrate 1-mc internal frequency standard. Each full turn produces 1/50 of a cycle change at 1-mc. Total deviation is ±1/10 cycle at 1-mc.
	40	SYNCHRONIZE switch S902	ON position connects d-c correction voltage from Low Frequency Synthesizer LFSA to 1-mc internal frequency standard; OFF

*Located on rear panel.
**If equipped with a Doppler Corrector.

TABLE 3-1. CONTROLS, JACKS, AND INDICATORS (CONT)

MODULAR UNIT	ITEM NUMBER	PANEL AND COMPONENT DESIGNATION	FUNCTION
Frequency Standard CSS (cont)			position disconnects correction voltage from 1-mc frequency standard.
	41	METER FUNCTION selector switch S901	A five-position (100 KC, 1 MC, 10 MC, 24 V, and OVEN TEMP) selector switch. Manually operated in conjunction with meter M901 to check output of 100-kc, 1-mc, or 10-mc circuits. It is also used to check 24-volt supply voltage and oven temperature.
	*	BAT. switch S904	A two-position switch. IN position connects 24-volt battery to CSS circuits; automatic battery switching should be accomplished if a-c power fails. OUT position disconnects battery from CSS circuits.
Battery Power Supply BPSX	32	Meter M1001	Monitors rate of charge, discharge, and operating condition of Battery Group-1, and Battery Group-2, as selected by METER SWITCH S1001 (item 35).
	35	METER SWITCH S1001	Six-position selector switch used in conjunction with meter M1001 (item 32) to monitor rate of charge, discharge, and operating condition, of Battery Group-1 and Battery Group-2.
Power Panel HPP	33	UTILITY OUTLET J9402	Permits connection to 115- or 230-volt a-c power.
	34	UTILITY OUTLET J9401	Same as item 33.

*Located on rear panel.

3-2. OPERATING PROCEDURES.

a. PRELIMINARY. - Before applying power to the VLFC, perform the following preliminary steps:

(1) Ensure that the system is installed in accordance with the instructions contained in Section 2; make certain that all external cables are properly connected.

(2) Ensure that modular-unit controls are set at positions given in table 3-2.

(3) If batteries are supplied, meter (32) on Battery Power Supply BPSX should indicate between limit lines of BATTERY CONDITION area.

NOTE

Numbers enclosed in parenthesis are callouts referenced to figure 3-1.

TABLE 3-2. PRELIMINARY CONTROL SETTINGS

MODULAR UNIT	CONTROL DESIGNATION	ITEM NO. (Figure 3-1)	POSITION
Low Frequency Synthesizer LFSA	10 KC	2	Any position
	1 KC	3	Any position

TABLE 3-2. PRELIMINARY CONTROL SETTINGS (CONT)

MODULAR UNIT	CONTROL DESIGNATION	ITEM NO. (Figure 3-1)	POSITION
Low Frequency Synthesizer LFSA (Cont)	.1 KC	4	Any position
	10 CPS	5	Any position
	1 CPS	6	Any position
	POWER	10	Off position (down)
	BAT.	*	OUT
Very Low Frequency Receiver VLRA	POWER	15	Off position (down)
	AF/RF	16	RF
	LINE LEVEL	19	Fully counterclockwise
	AF GAIN	48	Fully counterclockwise
	AGC DECAY	49	SLOW
	CHAN SEL	50	Select strongest channel in area
	NOISE SILENCER	51	OFF
	BFO	52	Mid-range
	RF GAIN	53	Mid-range
	BAT.	*	OUT
Precision Frequency Comparator PFCB	POWER	22	Off (down)
	MULTIPLIER (m)	25	6
	METER SCALE	26	OFF
	RECORDER	23	Off (down)
	RANGE	46	OFF
	FREQ ADJ	45	"0"
	BATTERY	*	OUT
Frequency Standard CSS	AMPLIFIERS	31	STANDBY
	FINE FREQ. ADJUST	39	Factory setting

*Located on rear panel.

TABLE 3-2. PRELIMINARY CONTROL SETTINGS (CONT)

MODULAR UNIT	CONTROL DESIGNATION	ITEM NO. (Figure 3-1)	POSITION
Frequency Standard CSS (cont)	SYNCHRONIZE	40	OFF
	METER FUNCTION	41	24 V
	BAT.	*	OUT
Battery Power Supply BPSX	METER SWITCH	35	BATTERY GROUP-1 CONDITION

*Located on rear panel.

b. STARTING. - To start the VLFC, proceed as follows:

(1) Connect power cord to a-c power source; refer to power requirements given in section 2.

(2) At Low Frequency Synthesizer LFSA, Very Low Frequency Receiver VLRA, and Precision Frequency Comparator PFCB, set POWER switches (10, 15, and 22, respectively) at ON.

(3) At Frequency Standard CSS, set AMPLIFIERS switch (31) at ON.

c. TESTING EXTERNAL STATION AND/OR EQUIPMENT STANDARDS. - Proceed as follows:

NOTE

Numbers enclosed in parenthesis are callouts referenced to figure 3-1.

(1) Start the VLFC as outlined in paragraph 3-2b.

NOTE

When performing step 2, the VLRA should be tuned to a strong VLF station with a known stability. If the receiving frequency is above 40-kc, the antenna must be removed from Low Pass Filter FL1002 and connected directly to Very Low Frequency Receiver VLRA.

(2) At Very Low Frequency Receiver VLRA, proceed as follows:

(a) Adjust AF GAIN control (48) for proper audio level.

(b) Adjust the BFO control (52) for pleasing audio tone.

(c) Set AGC DECAY switch (49) at position suitable for speed of transmission.

(d) If necessary, adjust NOISE SILENCER control (51) to remove impulse noise.

(3) At Low Frequency Synthesizer LFSA, proceed as follows:

(a) Adjust 10 KC, 1 KC, 0.1 KC, 10 CPS and 1 CPS switches (2, 3, 4, 5 and 6, respectively) until Nixie Indicators (1) read frequency of r-f signal. For example, for a frequency of 18.6 kilocycles, indicators should read 18.600.

NOTE

Before performing the following steps, permit the VLFC to warm up for a period of 24 hours. This allows the 1-mc standard oven in the Frequency Standard CSS to reach proper operating temperature.

NOTE

Frequency Standard CSS can be synchronized with the incoming TRF signal by either one of two methods. The standard method is given in step (4), (a). The alternate method given in step (4), (b) requires the use of a "master" standard with a stability equal to that of the TRF signal.

(4) To synchronize the CSS with the incoming TRF signal, proceed as follows:

(a) Standard Method:

1. Observe that pointer of SYNCHRONIZE meter (8) swings between two maximum limits in yellow or red meter areas; SYNC ALARM lamp (7) should be lit (indicating that the TRF signal and CSS are not synchronized).

2. Using a timing device such as a stopwatch, etc., take an average reading of time it takes meter pointer to swing between two maximum limits; note reading.

3. At the CSS, very slowly turn FINE FREQ. ADJUST control (39) either clockwise or counterclockwise until the average time it takes the meter pointer to swing between two maximum limits has increased.

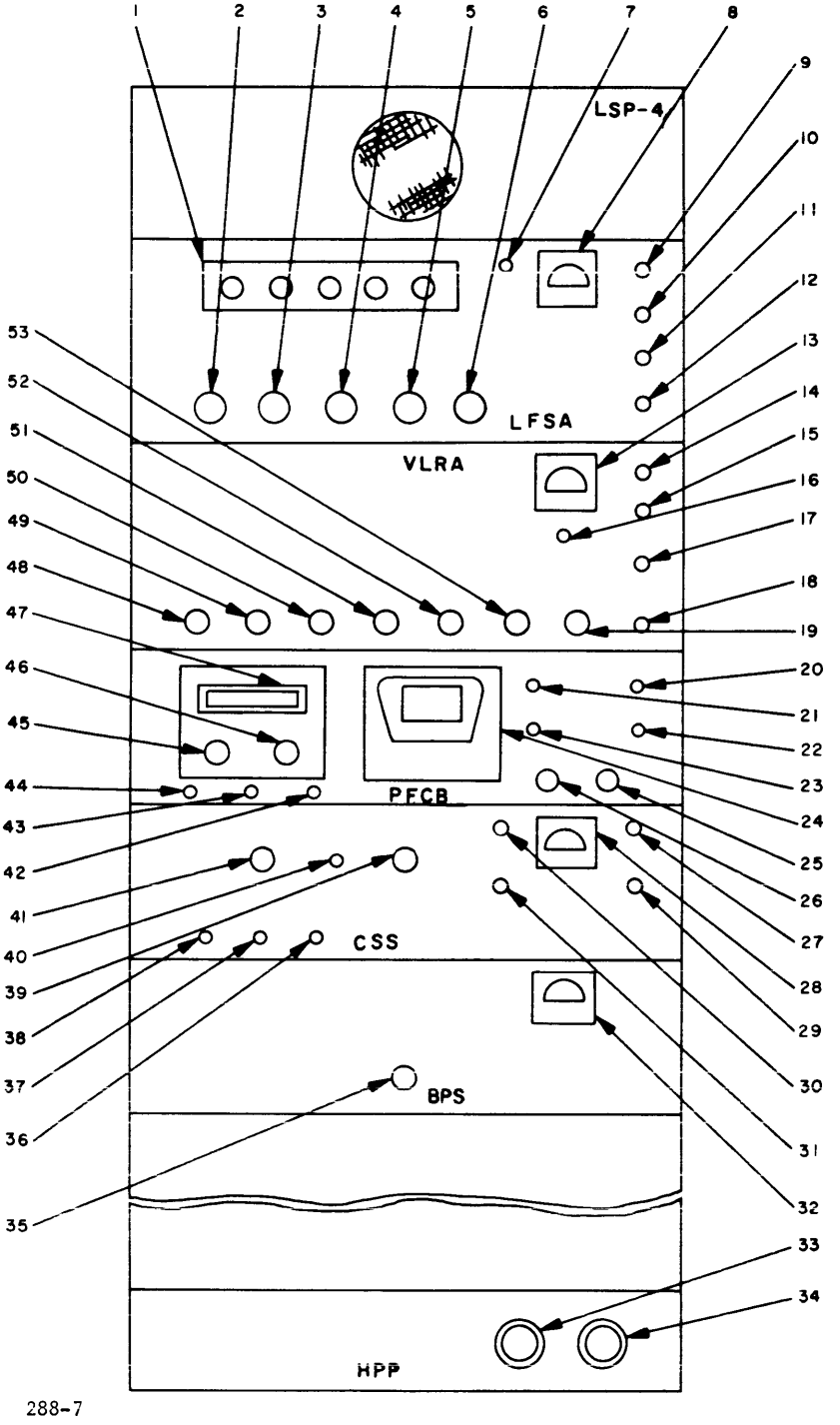

Figure 3-1. Controls and Indicators, VLFC

NOTE

The longer (in time) it takes the meter pointer to swing between its maximum limits, the closer the CSS is to synchronization with the TRF signal.

4. Continue to slowly turn the FINE FREQ. ADJUST control until the maximum meter pointer swings are limited to the green meter area. At this point the SYNC ALARM lamp should go off indicating that the CSS is synchronized with the incoming TRF signal.

5. At the CSS, set SYNCHRONIZE switch (40) at ON. If this causes the SYNC ALARM lamp of Low Frequency Synthesizer LFSA to light, then repeat steps 3. and 4.

(b) Alternate Method:

1. At the LFSA, observe that the SYNCHRONIZE meter (8) pointer swings between two maximum limits in either the yellow or red meter areas; the SYNC ALARM lamp (7) should be on indicating that the CSS is not synchronized with incoming TRF signal.

2. At the PFCB, connect the "master" standard to TEST IN jack (44). Set METER SCALE switch (26) at 5; set MULTIPLIER (m) switch (25) at 6; set the RECORDER switch (23) at ON. Readjust the METER SCALE and MULTIPLIER (m) switches for best recorder reading.

3. At the CSS, very slowly turn the FINE FREQ. ADJUST control (39) either clockwise or counterclockwise until the PFCB recorder indicates zero. At this point, the maximum SYNCHRONIZE meter (8) pointer swings should be limited to the green meter area; the SYNC ALARM lamp should be off indicating that the CSS is synchronized with incoming TRF signal.

4. At the CSS, set the SYNCHRONIZE switch (40) at ON. If this causes the SYNC ALARM lamp to light, then repeat step 3.

5. At the PFCB, reset the RECORDER switch (23) and the METER SCALE switch (26) at OFF; reset the MULTIPLIER (m) switch (25) at 6; remove the "master" standard from the TEST IN jack (44).

(5) If VLFC is operated at fixed station, proceed to step (a) below. If VLFC is operated on moving platform, such as on ship-board, proceed to step (b).

(a) For fixed station operation of Precision Frequency Comparator PFCB proceed as follows:

1. Connect a short cable from REF IN jack (43) to TEST IN jack (44).

2. Set METER SCALE switch (26) at 5; set MULTIPLIER (m) switch (25) at 6; set RECORDED switch (23) at ON. The recorder should operate and should indicate zero.

3. Remove short cable connected between TEST IN jack (44) and REF IN jack (43).

4. Connect external station and/or equipment frequency standard to TEST IN jack (44). Readjust METER SCALE switch (26) and MULTIPLIER (m) switch (25) for best recorder readings. This reading represents frequency error of external frequency standard. Note reading for possible correction of external frequency standard.

5. At end of test, remove external station and/or equipment frequency standard; turn RECORDER switch to its off position.

(b) For mobile station operation of Precision Frequency Comparator PFCB, proceed as follows:

NOTE

Do not perform this procedure unless the doppler corrector has been supplied with the PFCB unit.

1. Connect short cable from REF IN jack (43) to TEST IN jack (44).

2. Set METER SCALE switch (26) at 1; set RECORDER SWITCH (23) at ON. The recorder should operate and should indicate zero.

3. Remove short cable connected between TEST IN jack (44) and REF IN jack (43).

4. Connect external station and/or equipment standard to TEST IN (44) jack. Readjust METER SCALE switch (26) and MULTIPLIER (m) switch (25) for best recorder reading. This represents frequency error of external frequency standard plus doppler error.

NOTE

The doppler corrector unit corrects for doppler error contained in the reference signal. To properly operate the doppler corrector, accurate information pertaining to ship's speed, course, and position relative to transmitting station must be obtained. These must be held constant during measuring period for valid results. For best results, the course measurement should be within approximately 1^{o} and speed should be approximately 1 knot.

5. Obtain position and course to determine angle θ when ship is traveling toward or away from transmitting station (see figure 3-2).

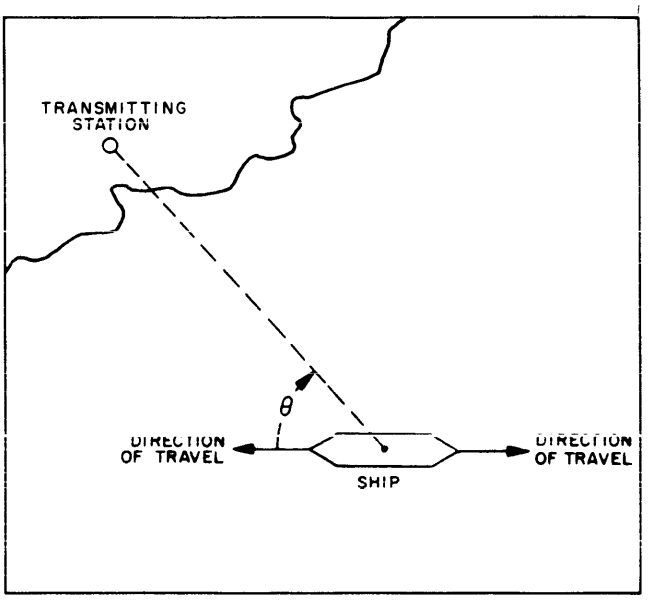

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Figure 3-2. Ship's Course and Position Relative To Transmitting Station

6. From a table of natural trigonometric functions obtain cosine of 0 and use in following formula:

$$\epsilon = .001715\ V \cos 0$$

ϵ = Doppler frequency error

V = Speed of ship in knots

0 = Angle between ship's course and bearing of station

7. Multiply doppler frequency error (ϵ) obtained in step (6) above by multiplication factor given in table 3-3 to obtain doppler correction frequency. Use multiplication factor corresponding to setting of MULTIPLIER (m) switch (25). Final computation must be less than 100 cycles. If computation is not less than 100 cycles, select next smaller multiplication factor and reduce setting of MULTIPLIER (m) switch (25) until final computation is less than 100 cycles.

TABLE 3-3. RANGE SELECTION

PARTS IN 10^m	MULTIPLICATION FACTOR
10^6	1
10^7	10
10^8	100
10^9	1000
10^{10}	10000

NOTE

The doppler corrector should be used only for short-term measurements. i. e. one-half hour or less when frequency error (ϵ) is low; one-quarter hour as error (ϵ) approaches 50 cycles per second. A rough sea or strong wind could easily push the recorder pen beyond 5 parts in 10^m, the limit of the PFCB's measuring ability.

8. Set RANGE switch (46) at appropriate range (0-10 or 0-100) in accordance with final computation in step 7 above.

9. Rotate FREQ ADJ control (45) as required (clockwise when traveling toward station and counterclockwise when traveling away from station) until FREQUENCY CPS meter (47) indicates frequency error calculated in step 7 above. Recorder pointer should move towards zero.

NOTE

For greater accuracy use a frequency counter to measure the doppler correction frequency. Connect the frequency counter to the COUNTER OUTPUT jack J110 located on the rear panel.

10. The difference reading represents the true error of the external frequency standard. Note reading for possible correction of external frequency standard.

11. At end of test, remove external station and/or equipment frequency standard and set RANGE switch (46) and RECORDER switch (23) at OFF.

d. STOPPING. - To stop the VLFC system, proceed as follows:

NOTE

Because the stability of the system will be affected by excessive starting and stopping, power should not be removed unless it is absolutely necessary.

(1) At rear panel of the Low Frequency Synthesizer LFSA, Very Low Frequency Receiver VLRA, Precision Frequency Comparator PFCB, and Frequency Standard CSS, ensure that BAT. or BATTERY switch is set at out.

(2) At Frequency Standard CSS, set AMPLIFIERS ON/STANDBY switch (31) at STANDBY.

(3) At Low Frequency Synthesizer LFSA, Very Low Frequency Receiver VLRA, and Precision Frequency Comparator PFCB, set POWER switches (10, 15, and 22 respectively) at OFF. POWER lamp (27) on Frequency Standard CSS should remain lit.

NOTE

The POWER lamp on Frequency Standard CSS will remain lit as long as the power cord is connected to the a-c power source. This allows the 1-megacycle standard oven

to maintain its proper c ɜrating temperature.

3-3. OPERATOR'S MAINTENANCE.

a. GENERAL. - The operator should observe that modular-unit controls, indicator lamps, and meters are in good condition and functioning properly (see figure 3-1 and table 3-1). Daily during operation, all electrical quantities measurable with built-in meters should be observed and compared with established standards for irregularity. Any noticeable irregularity is an indication of trouble.

b. REPLACEMENT OF FUSES. - Figure 3-3 shows the location of fuses for the various units of the VLFC system. Table 3-4 lists the fuses illustrated.

CAUTION

Do not replace a fuse with one of higher rating. If a fuse burns out immediately after replacement, do not replace it a second time until the trouble has been located and corrected.

TABLE 3-4. FUSE LOCATIONS AND FUNCTIONS

INDEX NUMBER (Figure 3-3)	PANEL DESIGNATION	FUSE RATING	CIRCUIT PROTECTED	SCHEMATIC SYMBOL
1	AC	1/2A/115V 1/4A/230V	LFSA 24-volt internal power supply.	F451
2	HV	1/8A	LFSA internal high-voltage supply.	F454
3	B-	1A	Minus 12-volt section of LFSA 24-volt internal power supply.	F453
4	B+	1A	Plus 12-volt section of LFSA 24-volt internal power supply.	F452
5	AC	1/2A/115V 1/4A/230V	VLRA 24-volt internal power supply.	F301
6	B-	1/2A	Minus 12-volt section of VLRA 24-volt internal power supply.	F302
7	B+	1/2A	Plus 12-volt section of VLRA 24-volt internal power supply.	F303
8	AC	1/2A/115V 1/4A/230V	PFCB 24-volt internal power supply.	F101
9	-12	1A	Minus 12-volt section of PFCB 24-volt internal power supply.	F102
10	+12	1A	Plus 12-volt section of PFCB 24-volt internal power supply.	F103
11	AC	1A/115V 1/2A/230V	CSS 24-volt internal power supply.	F901
12	B+	1/4A	Plus 12-volt section of CSS 24-volt internal power supply.	F903
13	F902	1A	Plus 12-volt section of CSS 24-volt internal power supply.	F902

TABLE 3-4. FUSE LOCATIONS AND FUNCTIONS (CONT)

INDEX NUMBER (Figure 3-3)	PANEL DESIGNATION	FUSE RATING	CIRCUIT PROTECTED	SCHEMATIC SYMBOL
14	FU1004 3A	3A	BT1003 and BT1004 in battery group 2 of BPSX unit.	F1004
15	FU1003 3A	3A	BT1001 and BT1002 in battery group 1 of BPSX unit and BT1002.	F1003
16	F1001 4A	4A	BT1001 and BT1002 in battery group 1 of BPSX unit.	F1001
17	F1002	4A	BT1003 and BT1004 in battery group 2 of BPSX unit.	F1002
18	F9402 10A/115V 5A/230V	10A/115V 5A/230V	A-C power source input to HPP unit.	F9402
19	F9401 10A/115V 5A/230V	10A/115V	A-C power source to HPP unit.	F9401

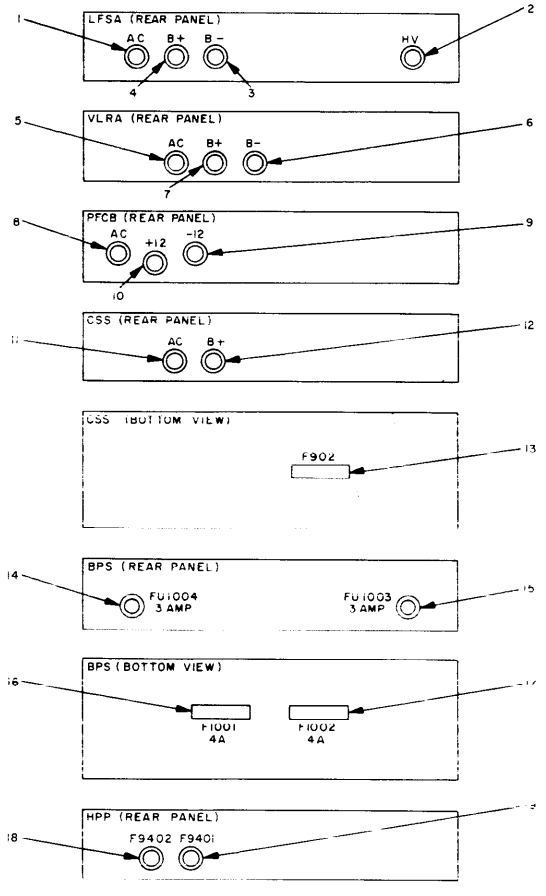

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Figure 3-3. Fuse Locations, VLFC

SECTION 4
PRINCIPLES OF OPERATION

4-1. OVERALL DESCRIPTION.

Refer to figure 4-1. The VLFC is a frequency comparison system that utilizes a highly stable VLF transmission (primary standard) to maintain its own internal frequency standard to the stability of the received VLF signal. The constantly corrected internal standard is then used to test the stability of external station and/or equipment standards.

The VLFC comprises Very Low Frequency Receiver VLRA, Low Frequency Synthesizer LFSA, Precision Frequency Comparator PFCB, Frequency Standard CSS, Battery Power Supply BPSX, Loudspeaker Panel LSP, and Power Panel HPP.

4-2. DETAILED BLOCK DIAGRAM DISCUSSION.

Incoming signals from a remote VLF station are applied either, directly (above 40-kcs) to Very Low Frequency Receiver VLRA or via Low Pass Filter FL1002 (below 40-kcs). Within the VLRA, the selected signal in the range of 10-100 kc undergoes 2 stages of r-f amplification and is then divided into two separate paths. One portion of the amplified 10-100 kc signal undergoes a 3rd stage of amplification and is applied to Low Frequency Synthesizer LFSA. The other portion of the 10-100 kc signal undergoes first conversion, and audio amplification. Audio signals from the VLRA are monitored by a 4-ohm speaker mounted on Loudspeaker Panel LSP.

Low Frequency Synthesizer LFSA receives a 10-to-99.999-kc TRF signal from the VLRA receiver, and 1-mc signal and 100-kilocycle signals from Frequency Standard CSS. The 100-kilocycle signal is processed by the spectrum generator module. The 1-mc signal from the CSS is processed by a 1-, 8-, and 10-megacycle generator module, a spectrum generator module, 5-plus-mixer modules, 4 divide-by-ten modules, five-spectrum filters, and a minus-mixer module; the output signal of these circuits, in the 10-to-99.999-kc range is applied to a phase detector circuit contained in Low Frequency Synthesizer LFSA. The 10-to-99.999-kc signal from the VLRA receiver is also applied to the LFSA phase detector. Any phase difference between the two signals applied to the LFSA phase detector circuit results in a d-c correction voltage which is used to correct the oscillator stage contained in Frequency Standard CSS.

The d-c correction voltage applied to Frequency Standard CSS is used to maintain its 1-mc internal frequency standard to a high stability. This ultra-stable 1-mc signal is applied to Precision Frequency Comparator PFCB where it is used as a reference signal. Frequency Standard CSS also provides output signals of 100 kilocycles, 1 megacycle, and 10 megacycles that are as stable as the 1-megacycle frequency standards. These signals are available at a level of 1 volt across a 50-ohm load at front-panel mounted jacks.

The ultra-stable reference signal from Frequency Standard CSS and an input signal from a station and/or equipment standard are processed by multipliers and a mixer circuit contained in Precision Frequency Comparator PFCB. The output of the PFCB mixer circuit is then applied to a comparison (output) module which develops a d-c comparison voltage. This comparison voltage is applied to a chart recorder that displays the frequency error of the station and/or equipment standard. The PFCB is designed to test 100-kc 200-kc, 500-kc and 1-mc frequency standards. A doppler corrector is optionally provided to correct for frequency errors (doppler effect) that may occur when the VLFC is used on a moving platform such as on board a ship.

The a-c operating power for all VLFC components with the exception of Power Panel HPP is filtered by Line Filter FL1001. This filter prevents spurious r-f signals from entering the VLFC circuits through the a-c power line. Power Panel, Model HPP is connected directly to the a-c power source. This panel contains two fused receptacles that provide a-c power connections for external test equipment.

Battery Power Supply BPSX has provision for two 24-volt battery groups that are used to power the VLFC system in the event of a-c power failure. Battery group 1 supplies 24-volts to Frequency Standard CSS; Battery group 2 supplies 24-volts to Very Low Frequency Receiver VLRA, Low Frequency Synthesizer LFSA, and Precision Frequency Comparator PFCB.

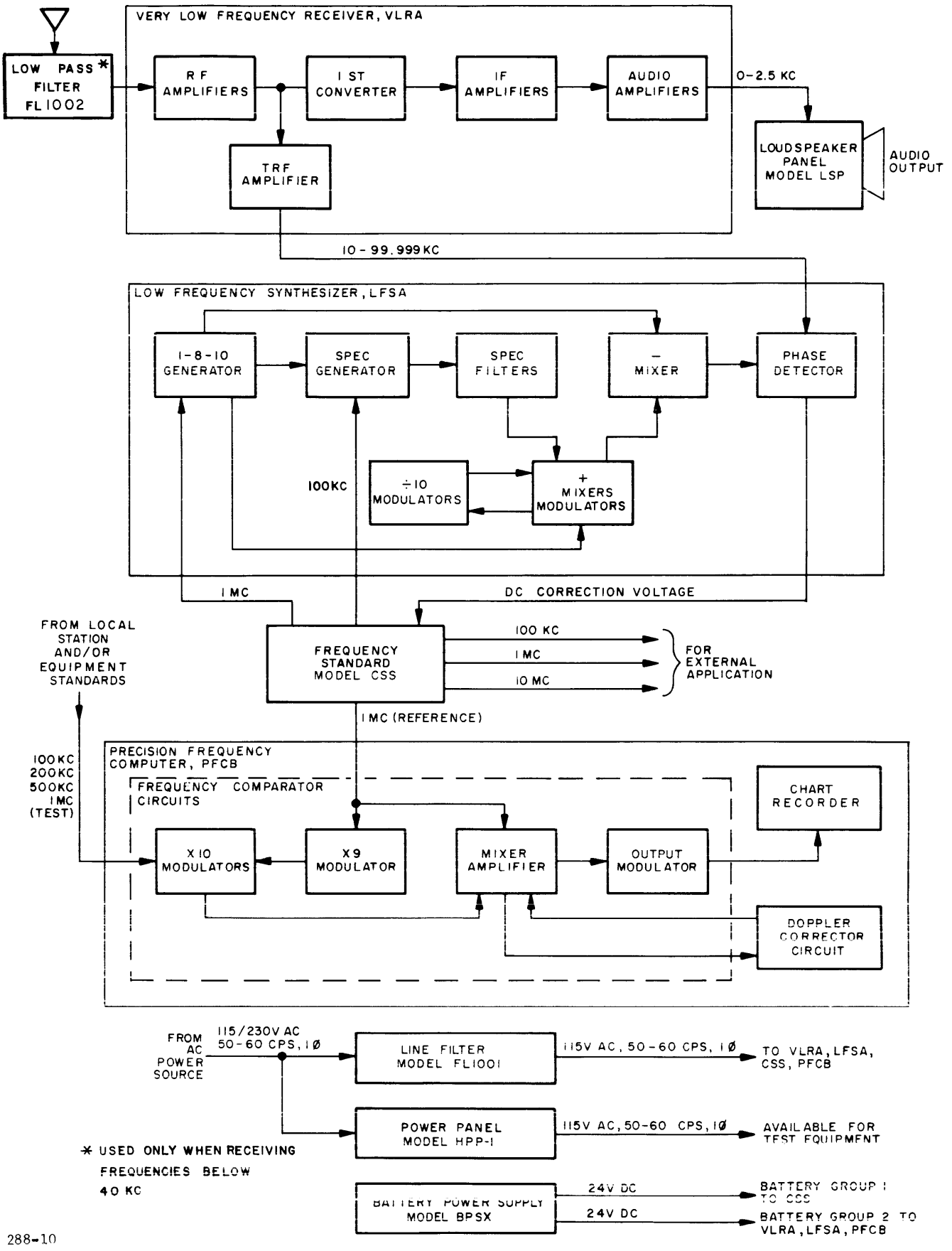


Figure 4-1. Functional Block Diagram, VLFC

SECTION 5
MAINTENANCE

5-1. GENERAL.

Separate manuals for subordinate equipments in the VLFC system are provided. For specific maintenance information on a particular equipment, refer to the corresponding equipment manual. Special tools and test equipment required for maintenance of the VLFC are listed in table 5-1.

TABLE 5-1. TOOLS AND TEST EQUIPMENT REQUIRED

ITEM	DESCRIPTION
1-mc Frequency Standard	TMC Model CSS
VLF Signal Generator	
VLF Antenna	
VOM	Simpson 260
Voltmeter (rms)	Ballantine
Dummy Load	

5-2. PREVENTIVE MAINTENANCE.

a. GENERAL. - The VLFC has been designed to provide long-term, trouble-free operation under continuous duty conditions. However, in order to prevent failure of the equipment due to corrosion, dust or other destructive elements, it is suggested that a schedule of preventive maintenance be set up and adhered to.

b. SCHEDULING. - At periodic intervals, the equipment should be removed from its mounting for cleaning and inspection. All accessible covers should be removed and the wiring and all components inspected for dirt, corrosion, charring, discoloring or grease. Remove dust with a soft brush or vacuum cleaner. Remove dirt or grease from other parts with any suitable cleaning solvent. Use of carbon tetrachloride should be avoided due to its highly toxic effects. Trichlorethylene or methylchloroform may be used, providing the necessary precautions are observed.

WARNING

When using toxic solvents, make certain that adequate ventilation exists. Avoid prolonged or repeated breathing of the vapor. Avoid prolonged or repeated contact with skin. Flammable solvents shall not be used on energized equipment or near any equipment from which a spark may be received. Smoking, "hot work", etc, is prohibited in the immediate area.

CAUTION

When using trichlorethylene, avoid contact with painted surfaces, due to its paint removing effects.

5-3. TROUBLESHOOTING.

Starting and operating procedures (section 3.) coupled with the system checkout procedure given in section 2 and block diagram figure 4-1, can be used as equipment performance checks. In most cases, front-panel meters and indicators will provide sufficient information to localize common troubles to a particular equipment. The initial point where VLFC controls and indicators do not function correctly will serve to indicate the faulty equipment. Once the trouble is localized, refer to the appropriate equipment manual for detailed information necessary to locate the repair or replace the faulty component.

5-4. ALIGNMENT.

a. GENERAL. - The following procedure covers overall system alignment. Separate procedures covering each individual equipment in the system are in the supporting equipment manuals.

b. PRELIMINARY SETTINGS. - Make the preliminary control settings indicated in table 5-2.

TABLE 5-2. PRELIMINARY SETTINGS

EQUIPMENT	SWITCH OR CONTROL	POSITION
VLRA	POWER BATTERY AF GAIN	ON (Upper) IN Fully Counterclockwise

TABLE 5-2. PRELIMINARY SETTINGS (CONT)

EQUIPMENT	SWITCH OR CONTROL	POSITION
VLRA (Cont)	AGC DECAY CHAN. SEL. NOISE SILENCER BFO Control RF GAIN LINE LEVEL AF-RF	MAN RF Selected Receiver Channel OFF Mid-position Mid-position Mid-position RF
LFSA	POWER *BAT 10 KC, 1 KC, .1 KC 10 CPS, and 1 CPS	On (Upper) OUT At selected frequency of VLRA receiver, (observe nixie lamps for proper readout).
CSS	AMPLIFIERS *BAT. SYNCHRONIZE METER FUNCTION FINE FREQ. ADJUST	STANDBY OUT OFF 24V At initial setting
PFCB	ON-OFF *BAT MULTIPLIER(m) METER SCALE	ON OUT 6 PARTS IN 10^m OFF
BPSX	METER SWITCH	BATTERY GROUP-1 CONDITION

*The battery switches are placed in the OUT position only when Battery Power Supply BPSX is not supplied with batteries.

c. PROCEDURE. - Steps (1) through (10) are performed during a 24-hour warm-up period. This is necessary to insure a stable 1-mc frequency output of Frequency Standard CSS.

(1) On Very Low Frequency Receiver VLRA, Frequency Standard CSS, Precision Frequency Comparator PFCB, and Low Frequency Synthesizer LFSA, observe that POWER lamps are lit.

(2) On Power Panel HPP, connect an a-c voltmeter to each utility outlet. The meter should indicate primary power voltage (115- or 230-vac as applicable).

(3) On Frequency Standard CSS, observe function meter; meter should indicate approximately 24 volts.

(4) When each battery group of the BPSX has been provided with at least one battery, observe that the meter indicates between 500- and 600-milliamperes. Set METER SWITCH at BATTERY GROUP-2 CONDITION and observe that the meter indicates between 500- and 600-milliamperes.

(5) Disconnect a-c line power from VLFC system.

(6) On Very Low Frequency Receiver VLRA, Frequency Standard CSS, Precision Frequency Comparator PFCB, and Low Frequency Synthesizer LFSA, observe that POWER lamps go off and BATTERY lamps light.

(7) On Frequency Standard CSS, function meter should indicate approximately 24 volts. Set METER FUNCTION selector switch at OVEN TEMP.

(8) Re-connect a-c line power to VLFC system and observe that the BATTERY lamps go out, and that the POWER lamps light.

(9) On Battery Power Supply BPSX, set METER SWITCH at BATTERY GROUP-1 CHARGE; meter should indicate between 0- and 100-milliamperes. Set METER SWITCH at BATTERY GROUP-2 CHARGE; meter should indicate between 0- and 100-milliamperes. Set METER SWITCH at BATTERY GROUP-1 CONDITION.

(10) On Very Low Frequency Receiver VLRA, perform the following:

NOTE

During system checkout, the VLRA receiver should be tuned to a strong VLF station that is transmitting at a known frequency stability of 1 part in 10^{11}.

(a) Turn RF GAIN control in clockwise and then counterclockwise direction, observing corresponding changes on meter. Set RF GAIN control at mid-position.

(b) Set AF/RF switch at AF. Turn LINE LEVEL control in clockwise then counterclockwise direction, observing corresponding changes on meter. Set RF GAIN control at mid-position and set AF/RF switch at RF.

(c) Adjust AF GAIN control for comfortable audio level.

(d) Adjust BFO control, as required for desired tone.

(e) Set AGC DECAY switch at best position suitable for speed of transmission.

(f) If necessary, adjust NOISE SILENCER control to reduce noise present in received signal, observe action on weak channel with an oscilloscope across 600-ohm line, and center tap on VLRA.

(g) Check remaining frequency channels by using CHAN. SEL switch, and repeating steps (c) through (f). Then reset CHAN. SEL switch to desired frequency.

(h) Connect headset with an impedance of 600 ohms to PHONE jack, and listen for audio. Then, disconnect headset from PHONE jack.

(11) Allow Frequency Standard CSS to warm up for a 24-hour period.

(12) On Frequency Standard CSS, perform the following:

(a) Observe that meter indicates within the green area.

(b) Set METER FUNCTION switch at 24V. Observe that meter indicates approximately 24 volts.

(c) Set AMPLIFIERS switch at ON. Sequentially set METER FUNCTION selector switch at 100 KC, 1 MC and 10 MC while observing function meter. Meter should indicate at least 1 volt (rms) for each switch position.

(d) Set METER FUNCTION switch at OVEN TEMP.

(13) On Low Frequency Synthesizer LFSA, observe SYNC ALARM lamp and SYNCHRONIZE meter for one of the following conditions:

(a) SYNC ALARM lamp is off and pointer on SYNCHRONIZE meter is centered within green area.

(b) SYNC ALARM lamp is lit and pointer of SYNCHRONIZE meter is in red area (left or right of green center area.)

(c) SYNC ALARM lamp is flickering on and off intermittently, and pointer on SYNCHRONIZE meter is in yellow area (left or right of center green area.)

NOTE

The direction of rotation for the FINE FREQ. ADJUST control (-f or +f is determined by which color area (right or left of green) the pointer on the Low Frequency Synthesizer SYNCHRONIZE meter lies. If the meter pointer is in the red-yellow area to the right, adjust FINE FREQ. ADJUST control clockwise; if the pointer is in the red-yellow or left of the green (center) area, adjust the FINE FREQ. ADJUST control in a counterclockwise direction

(14) Repeat step (13) and note above as many times as necessary until pointer on SYNCHRONIZE meter of Low Frequency Synthesizer LFSA centers in green area.

(15) On Frequency Standard CSS, set SYNCHRONIZE switch at ON. Observe SYNCHRONIZE meter. If meter is centered in green area, proceed to step (16). If not, repeat steps (13), (14), and note above.

(16) On Precision Frequency Comparator PFCB, perform the following:

(a) Connect coaxial jumper between front panel REF IN and TEST IN jacks.

(b) Set METER SCALE switch at OFF and observe initial movement of recorder chart and pen. The pen markings as indicated on recorder chart should be centered at zero. If not, remove snap-button cover centrally located at the bottom of recorder, and adjust screwdriver control on recorder for zero indication on recorder chart.

(c) Set MULTIPLIER(m) switch to 6 parts in 10^m and successively set METER SCALE switch at 5, 2 and 1, and observe markings on recorder chart for zero indication at each switch position. Remove top cover on PFCB and adjust R610 on card Z601 for zero if the chart recorder does not indicate zero.

(d) Set MULTIPLIER(m) switch on 7, 8, 9 and 10 parts in 10^m, and observe markings on recorder.

(e) Replace covers on recorder, and disconnect coaxial jumper connected between REF IN and TEST IN jacks.

(17) Connect the ultra-stable standard signal (1-mc, 600 millivolts or more) to the test input (J102) of the PFCB and observe, over a period of time, the drifts and variations on the various scale settings and the multiplier setting of the PFCB recorder.

NOTE

During the hours of sunrise and sunset, the rate of DIURNAL drift may exceed the tracking rate of VLFC system adjustment, and calibration should not be attempted at these times.

(18) Connect VLF generator to antenna input of VLRA and rms voltmeter to 600-ohm dummy load audio line, and check signal-to-noise ratios for 0.1 microvolt at 15 db using DL100-4 for noise reference.

(19) Check all channels for AGC dynamic range i.e., 80 db variation input should yield less than 3-db variation on line output (1-to-10,000 microvolts input).

(20) Set AGC DECAY switch to MAN RF and check sideband rejection of 60 db or greater, (**RF** Gain maximum).

(21) Check chart stability with the PFCB set to indicate parts in 10^9 for 24 hrs.

(22) Check chart stability with the PFCB set to indicate ± 2 parts in 10^{10} for five minutes.

(23) Check chart stability coincidence in 10 second intervals with the PFCB set to indicate parts in 10^8.

5-5. REPAIR.

a. GENERAL. - Repair encompasses those procedures necessary to repair and replace defective VLFC components. Repair procedures given in this section are confined to cable connectors and cable assemblies. Repair procedures for RAK-43 components or any equipment contained in the VLFC can be found in the appropriate modular unit-manual.

b. CABLE ASSEMBLY CA-906. - Cable assembly CA-906 is composed of single-wire coaxial and multi-wire special-purpose cables used for inter-connecting VLFC equipments (figure 2-4). Refer to the information provided in figure 5-1 and table 5-3 when repairing any of the CA-906 cables.

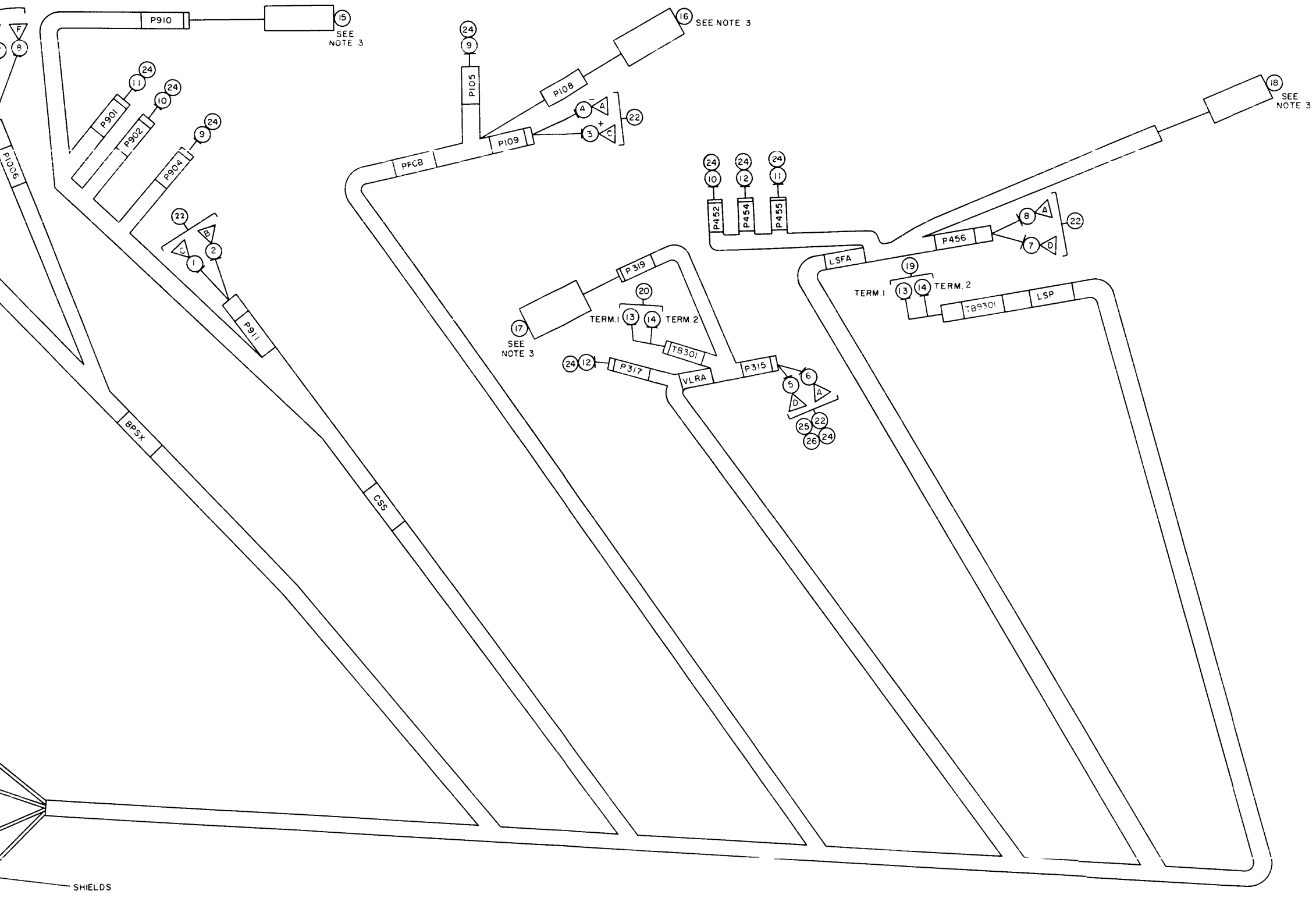
c. CABLE ASSEMBLIES CA-907 and CA-908-1. - Cable assemblies CA-907-1, 2, 3 and 4 and CA-908-1 (figure 5-2), are multi-wire, special-purpose cables used for interconnecting a-c power to VLFC modular units and to Power Panel HPP respectively (figure 2-4). Cable assemblies CA-907-1, 2, 3 and 4 are combined with the d-c power source and signal voltage wiring to form cable assembly CA-906 (see figure 5-1). Refer to the information provided in figure 5-2 and table 5-3 when repairing any of the CA-907 and CA-908 cable assemblies.

TABLE 5-3. VLFC INTERCONNECTION DATA

CABLE ASSEMBLY	UNIT	FROM CONNECTION	UNIT	TO CONNECTION	COLOR CODE OR CABLE TYPE
CA-906	BPSX	P1005-A	CSS	P911-C	Black
		P1005-B	CSS	P911-B	White/black
		P1006-A	PFCB	P109-C	Brown
		P1006-B	PFCB	P109-A	White/brown
		P1006-C	VLRA	P315-D	Red
		P1006-D	VLRA	P315-A	White/red
		P1006-E	LFSA	P456-D	Orange
		P1006-F	LFSA	P456-A	White/orange
	CSS	P901	LFSA	P455	Coaxial
		P902	LFSA	P452	Coaxial
		P904	PFCB	P105	Coaxial
	VLRA	P317	LFSA	P454	Coaxial
		TB301-1	LSP	TB9301-1	White
		TB301-2	LSP	TB9301-2	White/black
CA-906, CA-907	FL-1001 (Output side)	Threaded line stud at output side.	PFCB	P108-A	Red
			VLRA	P319-A	
			LFSA	P451-A	
			CSS	P910-A	
		Threaded ground stud at output side.	PFCB	P108-B	Black and shield
			VLRA	P319-B	
			LFSA	P451-B	
			CSS	P910-B	

TABLE 5-3. VLFC INTERCONNECTION DATA (CONT)

CABLE ASSEMBLY	UNIT	FROM CONNECTION	UNIT	TO CONNECTION	COLOR CODE OR CABLE TYPE
CA-906, CA-907 (cont)	FL-1001 (Output side) (cont)	Threaded line stud at output side.	PFCB VLRA LFSA CSS	P108-C P319-C P451-C P910-C	White
CA-908-1	FL-1001 (Input side)	Threaded line stud on input side.	HPP	TB9401-1	Red
		Threaded ground stud on input side.		TB9401-2	Black and shield
		Threaded line stud on input side.		TB9401-3	White



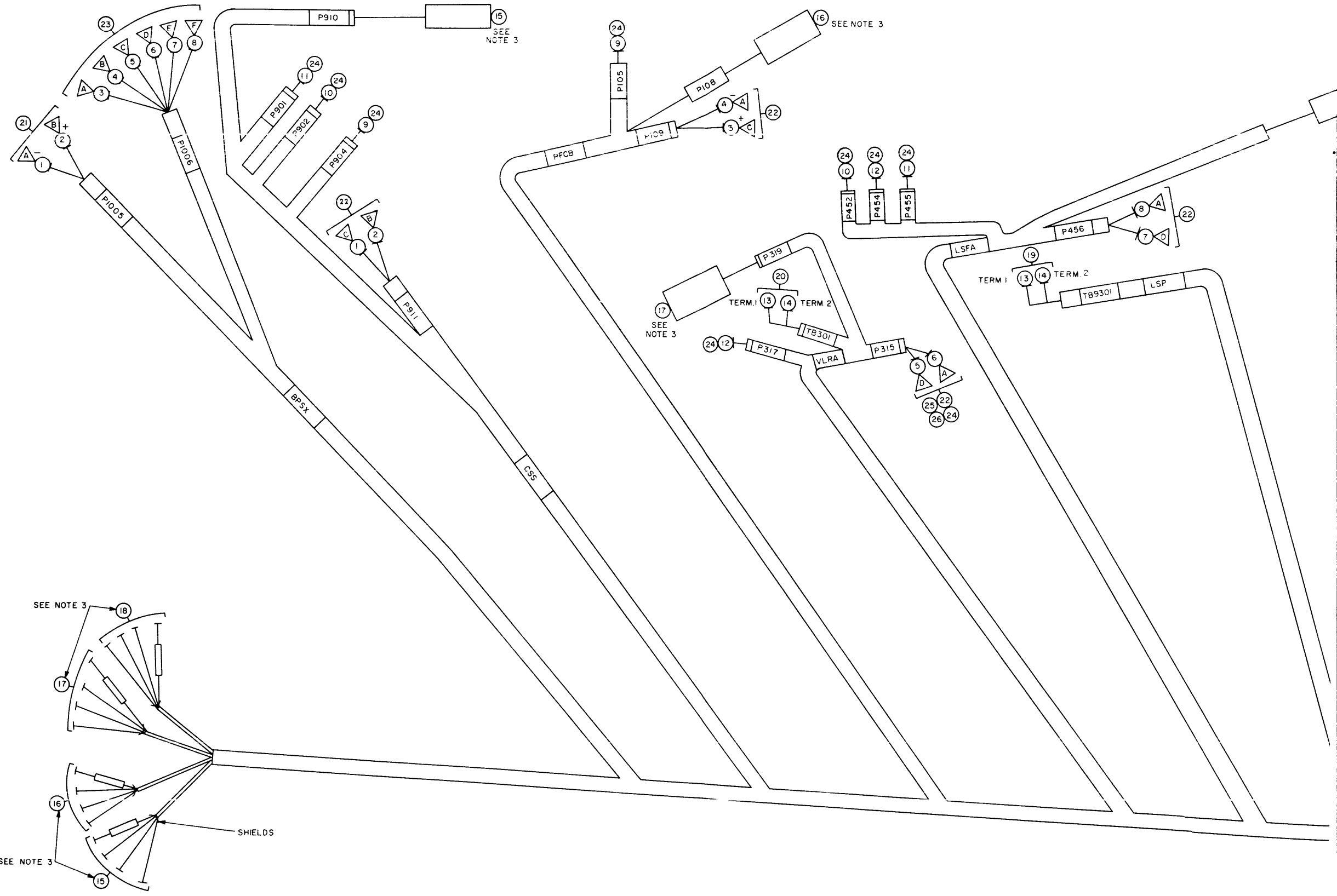
CA-906

ITEM	DESCRIPTION	COLOR
1	WIRE, ELEC, INS (16 AWG)	BLACK
2	WIRE, ELEC, INS (16 AWG)	WHT/BLK
3	WIRE, ELEC, INS (16 AWG)	BRN
4	WIRE, ELEC, INS (16 AWG)	WHT/ORN
5	WIRE, ELEC, INS (16 AWG)	RED
6	WIRE, ELEC, INS (16 AWG)	WHT/RED
7	WIRE, ELEC, INS (16 AWG)	ORN
8	WIRE, ELEC, INS (16 AWG)	WHT/ORN
9	CBL, RF (RG-174/U)	BLACK
10	CBL, RF (RG-174/U)	BLACK
11	CBL, RF (RG-174/U)	BLACK
12	CBL, RF (RG-174/U)	BLACK
13	WIRE, ELEC, INS (22 AWG)	WHT
14	WIRE, ELEC, INS (22 AWG)	WHT/BLK
15	CABLE ASSY, AC PWR (CA-907-1)	BLK/WHT/RED
16	CABLE ASSY, AC PWR (CA-907-2)	BLK/WHT/RED
17	CABLE ASSY, AC PWR (CA-907-3)	BLK/WHT/RED
18	CABLE ASSY, AC PWR (CA-907-4)	BLK/WHT/RED
19	TERM. BD-FNG	
20	TERM. BD-FNG	
21	CONN, PL, ML	
22	CONN, PL, FML	
23	CONN, PL, ML	
24	CONN, PL, RF, BNC (PL-244-1)	

NOTES:

1. ◯ DENOTES ITEM NUMBER.
2. △ DENOTES PLUG OR SOCKET TERMINAL CONNECTIONS.
3. SEE FIG 5-2 FOR DETAILS OF ITEMS (15), (16), (17) AND (18).

Figure 5-1. Cable Assembly CA-906



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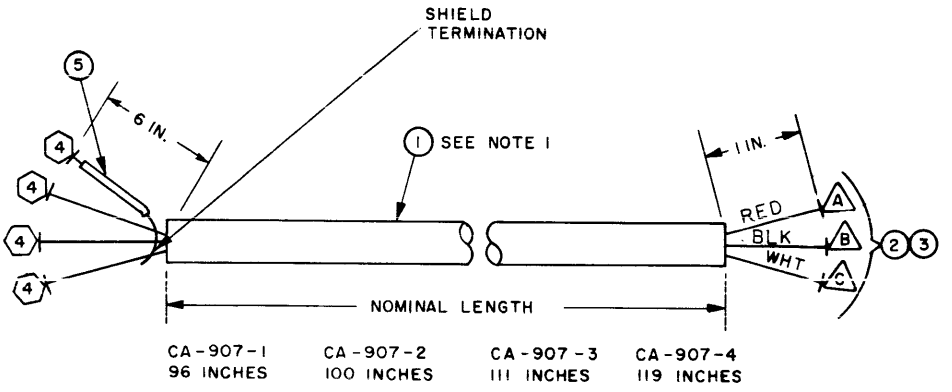

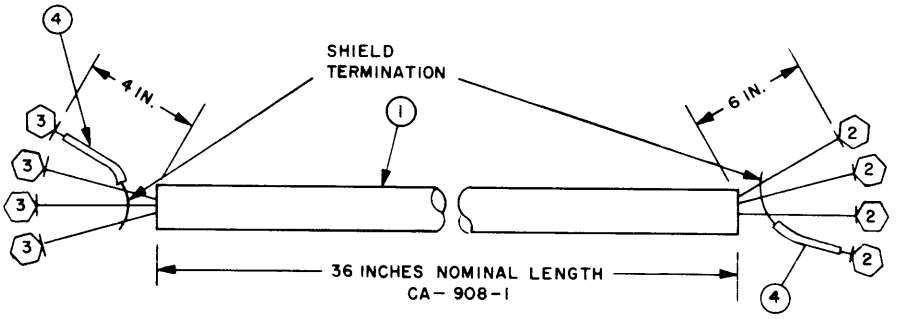

	CA 907 SERIES
ITEM	DESCRIPTION
1	CABLE, SPECIAL PURPOSE (WI-142-12)
2	CONNECTOR, PLUG, FEMALE
3	CLAMP
4	TERMINAL, SOLDERLESS (TE 159-34161)
5	SLEEVING, INSULATION

	CA 908 SERIES
ITEM	DESCRIPTION
1	CABLE, SPECIAL PURPOSE (WI-142-12)
2	TERMINAL SOLDERLESS (TE 159-34161)
3	TERMINAL SOLDERLESS (TE 159-34158)
4	SLEEVING, INSULATION

NOTES:

1. CABLE ASSEMBLIES CA-907-1, -2, -3, AND -4 ARE PART OF MAIN HARNESS CABLE ASSEMBLY CA-906, SEE FIGURE 2-4 AND 5-1
2. ○ DENOTES ITEM NUMBER
3. △ DENOTES PLUG OR SOCKET TERMINAL CONNECTIONS
4. ⬡ DENOTES EQUIPMENT TERMINAL CONNECTIONS AND ITEM NUMBER

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Figure 5-2. Cable Assemblies CA-907 and CA-908