ARMY TM 11-5895-833-34-3
NAVY NAVELEX 0967-LP-550-1070
AIR FORCE TO 31R5-2MSC46-12

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL

FOR
SYNTHESIZER,
ELECTRICAL FREQUENCY
0-1658/MSC-46(V)
(NSN 5895-00-127-4825)

This copy is a reprint which includes current pages from Changes 1 through 4.

DEPARTMENTS OF THE ARMY, THE NAVY, AND THE AIR FORCE

JULY 1977

The following are general safety precautions that are not related to any specific procedures and, therefore, do not appear elsewhere in this publication. These are recommended precautions that personnel must understand and apply during many phases of operation and maintenance.

WARNING

Operator and maintenance personnel should be familiar with the safety precautions before attempting installation or operation of the equipment covered in this manual. Failure to follow requirements and observe the safety precautions could result in injury or damage to the equipment.

WARNING

Do not operate the equipment without a suitable ground connection. Electrical defects in the unit, load-lines, or load equipment can cause DEATH by electrocution when contact is made with an ungrounded system.

WARNING

For the successful execution of methods of equipment destruction involving the use of demolition materials, all personnel should become familiar with the provisions of FM 5-25.

WARNING

HIGH VOLTAGE is used in this equipment. DEATH ON CONTACT may result if safety precautions are not observed.

WARNING

Performance of a field expedient repair may create a situation dangerous to equipment and personnel. The equipment so repaired should be taken out of service as soon as possible for replacement of the defective part.

WARNING

Under no circumstances should any personnel reach within an equipment inclosure for the purpose of servicing or adjusting the equipment without the immediate presence or assistance of another person capable of rendering aid.

WARNING

The cesium beam frequency standard C-field should not be adjusted, the phase lock opened, or time from the clock be changed without a directive from the U.S. Naval Observatory (NAVOBSY).

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Direct Support and General Support
Maintenance Manual
SYNTHESIZER, ELECTRICAL FREQUENCY
0-1658/MSC-46(V)
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FO-6②	FO-6②

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Direct Support and General Support
Maintenance Manual
SYNTHESIZER, ELECTRICAL FREQUENCY
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None	Figure FO-3

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Change
No. 2

DEPARTMENTS OF THE ARMY,
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Direct Support and General Support

Maintenance Manual

for

SYNTHESIZER, ELECTRICAL FREQUENCY

0-1658/MSC4(V)

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4-1 through 4-6	4-1 through 4-8
Figure FO-3	None
Figure FO-6[1]	Figure FO-6’

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  - 29-207(2)
  - 29-610 (2)

NG None

USAR: None

For explanation of abbreviations used, see AR 310-50.

Change No. 1 }

DEPARTMENTS OF THE ARMY,
THE NAVY, AND THE AIR FORCE
Washington, DC, 19 October 1979

Direct Support and General Support Maintenance Manual

for

SYNTHESIZER, ELECTRICAL FREQUENCY 0-1658/MSC-46(V)

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For explanation of abbreviations used, see AR 310-50.

Technical Manual
No. 11-5895-833-34-3
NAVELEX 0967-LP-550-1070
Technical Order
No. 31R5-2MSC46-12

DEPARTMENTS OF THE ARMY,
THE NAVY, AND THE AIR FORCE
Washington, DC, 26 July 1977

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL SYNTHESIZER, ELECTRICAL FREQUENCY 0-1658/MSC-46(V) (NSN 5895-00-127-4825)

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blanks Forms), or DA Form 2028-2 located in back of this manual direct to: Commander, US Army Communications-Electronics Command, ATTN: DRSEL-ME-MQ, Fort Monmouth, NJ 07703,

For Air Force, submit AFTO Form 22 (Technical Order System Publication Improvement Report and Reply) in accordance with paragraph 6-5, Section VI, T.O. 00-5-1. Forward direct to prime ALC/MST.

For Navy, mail comments to the Commander, Naval Electronics Systems Command, ATTN: ELEX 8122, Washington, DC 20360.

In either case, a reply will be furnished direct to you.

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CHAPTER 1

INTRODUCTION

Section I. GENERAL

1-1. Scope

a. This manual contains instructions for direct and general support maintenance of the Synthesizer, Electrical Frequency O-1658/MSC-46(V), hereafter referred to as the frequency synthesizer. The coverage includes functioning of equipment, troubleshooting data, removal and replacement procedures, repairs, alignment, and testing information. It also lists the tools, test equipment, and materials required for maintenance.

b. The following technical manuals, in addition to this manual, provide complete coverage of the Fre-quency Conversion Subsystem for the AN/TSC-54 Satellite Communications Terminal:

TM 11-5895-833-12	Operator's and Organizational Maintenance Manual Frequency Con-version Subsystem for Satellite Communication Terminal AN/TSC-54 NAVELEX 0967- LP- 550-1010/31R5- 2TSC54-91]
TM 11-5895-833-34-1	Direct Support and General Support Maintenance Manual - Frequency Conversion Subsystem for Satellite Communication Terminal AN/TSC-54 [NAVELEX 0967-LP-550-1030/31R5-2TSC54- 102]
TM 11-5895-833-34-2	Direct Support and General Support Maintenance Manual for Con-verter, Frequency, Electronic CV-3084/MSC-46(V), CV-3084 A/MSC-46(V)[NAVELEX 0967-LP-550-1050/31R5-2MSC46-2]
TM 11-5895-833-34-4	Direct Support and General Support Maintenance Manual Frequency Conversion Subsystem for Amplifier, Radio Frequency AM-6631/MSC-46 (V) [NAVELEX 0967-LP-550-1090/ 31R5-2MSC46-22]
TM 11-5895-833-34-5	Direct Support and General Support Maintenance Manual For Test Translator SM-F-753378 [NAVELEX 0967-LP-550-1110/ 31R5-2TSC54-112]
TM 11-5895-833-34-6	Direct Support and General Support Maintenance Manual for Equalizer, Group Delay CN-1425/MSC-46(V) [NAVELEX 0967-LP-550- 1130131R5-2MSC46-32]
TM 11-5895-833-34-7	Direct Support and General Support Maintenance Manual for (Con-verter, Frequency, Electronic CV-3085/MSC-46(V), CV-3085AIMSC-46(V) [NAVELEX 0967-LP-550-1150131R5-2MSC46-42]
TM 11-5895-833-34P-1	Direct Support, and General Support Maintenance Repair Parts and Special Tools Lists (Including Depot Maintenance Repair Parts and Special Tools) for Frequency Conversion Subsystem for Satellite Communications Terminal AN/TSC-54 [NAVELEX 0967-LP-550-1040131R5-2TSC54-104]
TM 11-5895-833-34P-2	Direct Support, and General Support Maintenance Repair Parts and Special Tools Lists (Including Depot Maintenance Repair Parts and Special Tools) for Converter, Frequency, Electronic CV-30841 MSC-46(V), CV-3084AIMSC-46(V) [NAVELEX 0967-LP-550-1060/31R5-2MSC46-4]
TM 11-5895-833-34P-3	Direct Support, and General Support Maintenance Repair Parts and Special Tools Lists (Including Depot Maintenance Repair Parts and Special Tools) for Synthesizer, Electrical Frequency O-1658/MSC-46(V) (NSN 5895-00-127-4825) [NAVELEX 0967-LP-550- 1080/31R5-2MSC46- 14]

TM 11-5895-833-34P4	Direct Support, and General Support Maintenance Repair Parts and Special Tools List (Including Depot Maintenance Repair Parts and Special Tools) for Amplifier, Radio Frequency AM-6631/MSC-46(V) (NSN 5820-00-155-8574) [NAVELEX 0967-LP-550-1100/31R5-2MSC46-24]
TM 11-5895-833-34P-5	Direct Support, and General Support Maintenance Repair Parts and Special Tools Lists (Including Depot Maintenance Repair Parts and Special Tools) for Test Translator [NAVELEX 0967-LP-550-1120/31R5-2TSC54-114]
TM 11895-833-34P-6	Direct Support, and General Support Maintenance Repair Parts and Special Tools List (Including Depot Maintenance Repair Parts and Special Tools) for Equalizer, Group Delay CN-1425/MSC-46(V) (NSN 5820-00-155-8572) [NAVELEX 0967-LP-550-1140/31R5-2MSC46-34]
TM 11-5895-833-34P-7	Direct Support, and General Support Maintenance Repair Parts and Special Tools List (Including Depot Maintenance Repair Parts and Special Tools) for Converter, Frequency, Electronic CV-3085/MSC-46(V); CV-3085A/MSC-46(V) [NAVELEX 0967-LP-550-1160/31R5-2MSC46-44]
TM 11-5895-3-20P	Organizational Maintenance Repair Parts and Special Tools List for Frequency Conversion Subsystem for Satellite Communications Terminal AN/TSC-54 [NAVELEX 0967-LP-550-1120/31R5-2TSC54-94]

1-2. Maintenance Forms, Records and Reports

a. Reports of Maintenance and Unsatisfactory Equipment. Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA Pam 738-750, as contained in Maintenance Management Update.

b. Report of Item Packaging Discrepancies. Fill out and forward SF 364 (Report of Discrepancy (ROD)) as prescribed in AR 735-11-2/DLAR 4140.55/SECNAVINST 4355.18/AFR 400-54/MC04430.3J.

c. Transportation Discrepancy Report (TDR) (SF 361). Fill out and forward Transportation Discrepancy Report (TDR) (SF 361) as prescribed in AR 55-38/NAVSUPINST 4610.33C/AFR 75-18/MCO P4610.19D/DLAR 4500.15.

1-2.1. Reporting Equipment Improvement Recommendations (EIR)

a. Army. If your equipment needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design or performance. Put it on an SF 368 (Product Quality Deficiency Report). Mail it to: Commander, US Army Communications-Electronics Command and Fort Monmouth, ATTN: AMSEL-PA-MA-D, Fort Monmouth, New Jersey 07703-5000. We'll send you a reply.

b. Air Force. Air Force personnel are encouraged to submit EIR's in accordance with AFR 900-4.

c. Navy. Navy personnel are encouraged to submit EIR's through their local Beneficial Suggestion Program.

1-3. Equipment Analysis

a. The frequency synthesizer provides a precision output frequency and a 10 MHz standard frequency for controlling local oscillators in either the up or down converter for purpose of dual conversion (See figure FO-1.) When used with the down converter the precise output frequency is variable between the range of 131 and 141 MHz accurate to 20 Hz. In up conversion, the precise output frequency is variable between 144 and 154 MHz with similar accuracy.

b. Stability and synchronization of the frequency synthesizer is maintained by an internal or external 5 MHz standard frequency The internal 5 MHz is generated by an oven stabilized crystal oscillator which retraces to within one part per hundred million of its previous frequency after 6 minutes of operation and maintains accuracy to 1 part per billion over a 24 hour period. When the frequency synthesizer is included as part of ANITSC-54 Satellite Communications Terminal, a cesium beam frequency standard provides the 5 MHz standard frequency. This 5 MHz standard frequency is distributed through Amplifier, Radio Frequency AM-6631/MSC-46(V).

c. In the down configuration, a receive frequency between 7.25 and 7.75 GHz is selected at the converter and applied to the frequency synthesizer as the remote frequency input command, a binary format code representing a frequency 700 MHz less than selected; that is, a frequency between 6.55 and 7.05 GHz. From the remote frequency input command code the frequency synthesizer generates a frequency 1/50th of the remote frequency. The output frequency of the frequency synthesizer controls an rf phase locked oscillator in the converter to tune to a frequency 700 MHz down from the received frequency. The received and tuned frequencies are mixed, thereby producing a 700 MHz 1st if. signal. In the process of dual conversion, the 700 MHz is lowered to a 2nd if. signal of 70 MHz by mixing the 700 MHz with a fixed 630 MHz output of an if oscillator phase locked to the 10 MHz standard output of the frequency synthesizer.

d. In the up configuration, a frequency is selected at the converter between 7 9 and 8.4 GHz (range of frequency to be transmitted) and applied to the frequency synthesizer as the remote frequency input command, a binary format code representing a frequency 700 MHz less than selected, that is, a frequency between 7.20 and 7.70GHz. From the remote frequency input command code, the frequency synthesizer generates a frequency 1/50th of that represented by the command code or a frequency in the range of 144 to 154 MHz. This frequency is applied to the converter for the second conversion to the transmit frequency.

e. For the first conversion operation, the 10 Hz standard frequency from the frequency synthesizer controls an oscillator to tune the 630 MHz phase locked to the 10 MHz. This frequency is mixed with the 70 MHz transmit signal at the converter producing the 700 MHz signal The precise output frequency from the frequency synthesizer controls an rf phase locked loop oscillator in the converter to generate a frequency that when mixed with the 700 MHz (added) produces the required 7.9 to 8.4 GHz transmit frequency completing the second conversion process.

Section II. DESCRIPTION AND DATA

1-4. Description
(Fig 1-1)

a. The frequency synthesizer is a completely solid-state device utilizing modular construction for maximum performance, reliability, and maintainability. The modules to be replaced at direct and general support are easily removable for maintenance purposes.

b. Modules comprising the frequency synthesizer are listed as follows:

Reference Designation	*Name*
A1	Front panel assembly
A2	10-MHz digit unit (DU) main VCO
A3	10-MHz digit unit (DU) main phase detector (PD)
A4	10-MHz digit unit (DU) if mixer
A5	10-MHz digit unit (DU) step loop VCO
A6	10-MHz digit unit (DU) step loop phase detector (PD)
A7	Input filter
A8	1-MHz digit unit (DU) step loop VCO
A9	1-MHz digit unit (DU) if mixer
A10	1- MHz digit unit (DU) main loop VCO
A11	Output amplifier
A12	Power supply
A15	Frequency standard
A16	Digit generator
A18	Motherboard
A19	Transformer assembl1
A20	Rear panel assembly
A21	1-5-10 MHz amplifier

1-5. Technical Characteristics

Electrical

Power requirement	115 Vac t 10% 47 to 420 Hz
Frequency range	130.00000 to 159.99998 MHz
Frequency increment	20 Hz
Output level	+6 dBm t 2 dB into 50 ohms
Additional frequency output	10 MHz t 1 Hz, 8 dBm t 2 dB
Time base output	I MHz :t I Hz
Standard output	5 MHz t 1 Hz
Source impedance	50 ohms
Remote frequency control	25 bit word in BCD (8-4-2-1) format equivalent to dialed frequency--700 MHz, where logic 0- 0 to 9 Vdc and logic 1- +2 to + 5 de (8-4, - and 2 bits of GHz digit not used)

Physical:

Overall dimensions	10 in wide 7 in high 21 5 in deep
Weight	52 pounds
Mounting	Standard 19 in rack

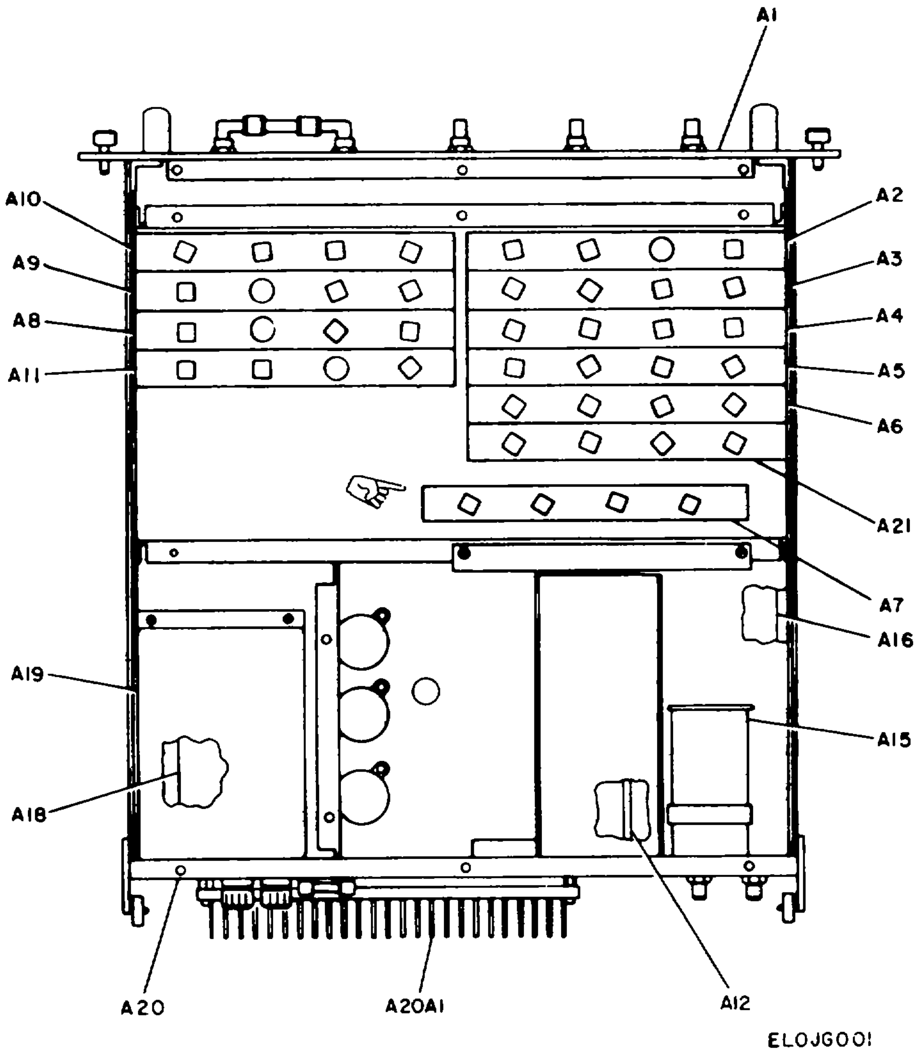


Figure 1-1. Frequency synthesizer component locations.

CHAPTER 2

FUNCTIONING OF EQUIPMENT

2-1. Introduction

a. This chapter provides a functional analysis of the frequency synthesizer The analysis is divided into an overall block diagram discussion, a general analysis of frequency synthesis, a functional block diagram discussion of each functional area described in the overall block and a detailed functional discussion of the major functional area of the frequency synthesizer

b. The overall block diagram discussion describes the various functional areas of the frequency synthesizer with reference to an overall block diagram.

c. The general analysis of the frequency synthesizer uses a hypothetical circuit to explain the method by which the frequency synthesizer generates a programmed frequency.

d. The functional block diagram discussion provides descriptions of each functional area illustrated on the overall block diagram with reference to individual block diagrams.

e. The detailed functional discussion describes operation of the frequency control section which is the major functional area of the frequency synthesizer The discussion references a functional block diagram The portion also includes instructions for calculating internal frequencies generated at all functional areas of the frequency synthesizer.

2-2. Overall Block Diagram Discussion (Fig 2-1)

a. The frequency synthesizer consists of six functional areas, namely; frequency control section (consisting of assemblies A2 thru A6, A8, A9, A10, and A16), input filter module A7, output amplifier All, 5 MHz frequency standard A15, 1-5-10 MHz amplifier A21, and power distribution (consisting of assemblies A12, A19, and A20A1) The frequency control section is the major area of the frequency synthesizer In this functional area the remote call frequency control com-mands are decoded and a frequency is synthesized, accordingly Primary standard frequencies of 5 and 10 MHz are supplied by the input filter A7 to the frequency control section to synchronize its operation Input filter module A7 derives the 5 and 10 MHz standard frequencies from an external frequency standard in-put at SYNTH IN connector J2 The frequency synthesizer's internal 5 MHz frequency standard A15 is used for test purposes and is coupled through a cable inter-connecting INT STD OUT connector J1 and SYNC IN connector J2.

b. In addition to controlling the frequency control section, the 5 MHz is applied to 1-5-10 MHz amplifier A21 which uses the 5 MHz to derive a 10 MHz, 5 MHz, and 1 MHz signal for external use.

c. Power distribution supplies all necessary internal power for operation of frequency synthesizer circuits.

d. The output amplifier All receives the frequency synthesized by the frequency control section and provides two final output signal levels. One output is channeled back to the converter and the other is used to sample the output of the frequency synthesizer.

e. The remote call frequency commanding the fre-quency control section originates at the transmit or receive frequency selector MHz thumbwheel switch of the up- or down converter This switch consists of seven individual sections corresponding to 1-KHz through 1-GHz decades With exception of the 1-GHz decades, each section provides a parallel 4-bit BCD code representing the remote call frequency in decimal numbers 1 through 9.

f. Table 2-1 provides the BCD remote call frequency code applied to the synthesizer for a corresponding transmit or receive frequency selector MHz thumb-wheel switch setting The 1-GHz decade of the switch supplies only 1-bit to denote two possible selections for this area of frequency A difference of 700 MHz exists between the frequency as dialed in on the switch and that supplied in BCD format; that is the remote call frequency This accommodates the frequency differen-tlal between the input to the converter and the local rf oscillator.

g. Frequencies that can be dialed In on the down converter are from 7 25 to 7 75 GHz with actual BCD remote call frequencies being 700 MHz less; that is from 6 55 to 7 05 GHz Up converter selections can be made from 7 9 to 8 4 GHz with actual BCD remote call frequencies also being 700 MHz less and are 7.2 to 7.7 GHz.

h. From the remote call frequency, having resolution to 1 KHz, the frequency synthesizer generates a frequency 1/50th of the remote call frequency with resolution to 20 Hz For example, if a frequency of 7 743219 is dialed, a BCD coded remove call frequency of 7 043219 is applied to the frequency synthesizer and the frequency synthesizer in turn generates a frequency of 140 86438 MHz The tens digit of the generated frequency (8) provides resolution in 20 Hz increments This digit is generated by the frequency synthesizer and is 1/50th of 7 043219 (equal to 140.86438).

2-3. Frequency Synthesizer, General Analysis

This discussion is provided as an aid to understanding the basic methods by which the frequency synthesizer is able to generate discrete frequencies from programmed remote call BCD codes The discussion provides brief descriptions of fundamental circuit blocks which when used in certain configurations are able to create a variety of frequencies. These circuits are located in the frequency control section of the frequency synthesizer.

b. The frequency control section utilizes a number of controlled oscillators to generate particular frequencies These are called voltage controlled oscillators or VCO's Additionally, mixer circuits, phase detectors, and divider circuits process the VCO frequencies to construct the output frequency.

c. By using, as an example, a hypothetical circuit ar-rangement of these basic elements it can be shown how a frequency can be synthesized. In the frequency control section a very similar process Is used with greater repetition and added circuit elements but the example however serves to show the very important basic principles involved. Figure 2-2 illustrates an ar-rangement of VCO's, mixers, phase detectors, and divider circuits comprising these phase locked loops.

d. Each phase locked loop has the ability of generating an output frequency that is in phase with the input frequency. The added mixer and phase detector circuits enable the VCO's to be programmed to operate at a frequency apart from the input although in phase. The mixers used in the example as well as in the actual frequency synthesizer produce a difference at their output; that is they are subtractive mixers.

e. In the example, the phase locked loop circuits are connected in a series arrangement and are termed the main loops. The frequency to be synthesized in the ex-ample is 18.39 MHz. The first main loop is the 10 KHz digit section which synthesizes the 9 digit of the out-put frequency. A 1 0 MHz signal generated from a frequency standard is applied to one input of the phase detector. The second input to the phase detector is the differential results of mixing the output frequency of the VCO and the programmed frequency. In the 10 KHz digit loop, the mixer receives 18 MHz and the VCO is controlled to tune near the required output of 19 MHz. The 1 MHz differential of these frequencies is compared by the phase detector with the standard 1 MHz. If the frequency are in phase the VCO is con-trolled by the output of the phase detector to lock-in. If a difference of frequency or phase exists an error volt-age is generated by the phase detector to bring the VCO to the required output frequency phase locked with the input. Thus the output frequency of 19 0 MHz is established phase locked to the 1 0 MHz input The 9 m the 19.0 MHz is carried through the chain of phase lock loops as the 9 in the 18.39 MHz output.

f. The 19.0 MHz is divided by a factor of 10 to derive 1 9 MHz In the 100 KHz digit phase locked loop, the VCO is controlled to oscillate at or near the output frequency of 13.9 MHz. The output frequency is mixed with a programmed 12 MHz providing a differential of 1.9 MHz or a frequency near 1 9 MHz When the frequency of 1.9 MHz from the mixer is in phase with the 1 9 MHz from the preceeding stage, the phase detector locks m the VCO in phase with the in-put. Any differential of frequency or phase causes the phase detector to generate an error voltage to accomplish phase lock. 'The output of the 100 KHz digit sec--tion generates 13.9 MHz creating the 100 KHz digit and carrying with it the 10 KHz digit of the required output frequency of 18 39 MHz.

g. The final phase locked loop stage generates a fre-quency establishing the 1 MHz digit plus carrying the 100 KHz and 10 KHz digits The 13.9 MHz output from the 100 KHz digit section is divided by a factor of 10 to derive 1.39 MHz. The VCO is controlled to oscil-late near the output frequency. A programmed 17 MHz is mixed with the VCO output frequency to generate the differential of 1.39 MHz. The phase detector again controls the VCO to establish phase lock at 18.39 MHz.

h. The purpose of the phase lock arrangement is to enable the VCO to be initially controlled by the external control signal to operate near the required output The error voltage from the phase detectors bring the VCO to the exact required output in phase with the in-put as a result of programmed frequencies. In the frequencies synthesizer the programmed frequencies are generated by secondary phased locked loops termed step loops. In turn, the step loops are controlled by the remote call frequency BCD codes.

2-4. Functional Block Diagram Discus-sions

a. General. The following paragraphs provide block diagram discussions of the functional areas of the fre-quency synthesizer The major functional area of the frequency synthesizer is the frequency control section with the other areas providing secondary functions These secondary functional areas are briefly discussed.

b. Frequency Control Section. (Fig. FO-2.)

(1) The frequency control section consists of three functional areas; namely, 10 Hz - 100 KHz digits sec-tion on digit generator A16, 1 MHz digit section consisting of assemblies A8, A9, and A10, and 10 MHz

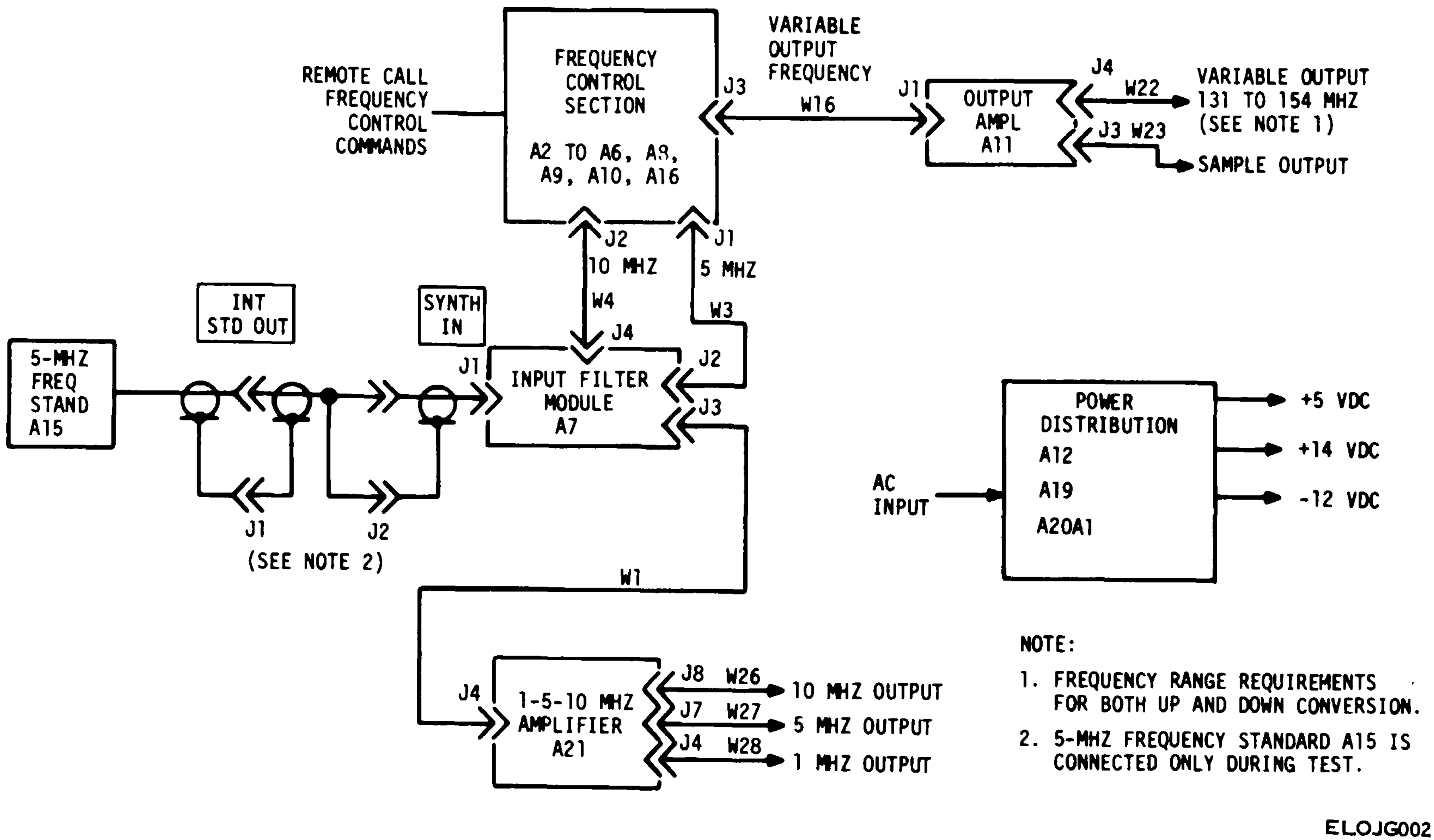


Figure 2-1. Frequency synthesizer overall block diagram

Table 2-1. Frequency Synthesizer Remote Call Frequency (BCD) Input

GHz Decade	Ganged Dial	100 KHz Decade	Remote Call GHz
Up			
1 2 4 8		1 2 4 8	
1 1 1 0	7 9	0 1 0 0	7 2
1 1 1 0	8 0	1 1 0 0	7 3
1 1 1 0	8 1	0 0 1 0	7 4
1 1 1 0	8 2	1 0 1 0	7 5
1 1 1 0	8 3	0 1 1 0	7 6
1 1 1 0	8 4	1 1 1 0	7 7
Down			
1 2 4 8		1 2 4 8	
0 1 1 0	7.2	1 0 1 0	6 5
0 1 1 0	7 3	0 1 1 0	6 6
0 1 1 0	7 4	1 1 1 0	6 7
0 1 1 0	7 5	0 0 0 1	6 8
0 1 1 0	7 6	1 0 0 1	6 9
1 1 1 0	7 7	0 0 0 0	7 0
Bit No: 1 '		2 3 4 5	

UP AND DOWN CONVERTERS

Dial	10 MHz Decade	Dial	1 MHz Decade	Dial	100 KHz Decade	Dial	10 KHz Decade	Dial	1 KHz Decade
	1 2 4 8		1 2 4 8		1 2 4 8		1 2 4 8		1 2 4 8
0	0 0 0 0	0	0 0 0 0	0	0 0 0 0	0	0 0 0 0	0	0 0 0 0
1	1 0 0 0	1	1 0 0 0	1	1 0 0 0	1	1 0 0 0	1	1 0 0 0
2	0 1 0 0	2	0 1 0 0	2	0 1 0 0	2	0 1 0 0	2	0 1 0 0
3	1 1 0 0	3	1 1 0 0	3	1 1 0 0	3	1 1 0 0	3	1 1 0 0
4	0 0 1 0	4	0 0 1 0	4	0 0 1 0	4	0 0 1 0	4	0 0 1 0
5	1 0 1 0	5	1 0 1 0	5	1 0 1 0	5	1 0 1 0	5	1 0 1 0
6	0 1 1 0	6	0 1 1 0	6	0 1 1 0	6	0 1 1 0	6	0 1 1 0
7	1 1 1 0	7	1 1 1 0	7	1 1 1 0	7	1 1 1 0	7	1 1 1 0
8	0 0 0 1	8	0 0 0 1	8	0 0 0 1	8	0 0 0 1	8	0 0 0 1
9	1 0 0 1	9	1 0 0 1	9	1 0 0 1	9	1 0 0 1	9	1 0 0 1
Bit No	6 7 8 9		10 11 12 13		14 15 16 17		18 19 20 21		22 23 24 25

* No Connection = Remote Call Frequency = Dialed Frequency -700 MHz

NOTE The 2,4,8 lines of the GHz section of the switch are wired together There are no connections from these bits to the frequency synthesizer.

digit section consisting of assemblies A2 through A6.

(2) Within the digit sections are main phase locked loops and step loops. Their functions are to synthesize respective digits of the output frequency Their basic functions are similar to the example shown in figure 2-2 and described in paragraph 2-3.

(3) In the discussion of the frequency control sec-tion reference to a digit m the remote call frequency and the internal frequencies of the frequency control section are with reference to the frequency represented in the column:

	100	10	1	100	10	1
GHz	MHz	M MH	MHz	KHz	KHz	KHz
7	6	2	7	3	2	9

100	10	1	100	10	1	100	10
MHz	MHz	MHz	KHz	KHz	KHz	Hz	Hz
1	5	2	5	4	6	5	8

(4) The 10 Hz - 100 KHz digits section provides the 100 KHz, 10 KHz, 1 KHz, 100 Hz and 10 Hz digits in the final output frequency. The 1 MHz digit and 10 MHz digit sections provide the 1 MHz and 10 MHz digits, respectively, with the 100 MHz digit always be-ing 1. Figure FO-2 illustrates the various internal frequencies generated at these functional areas with a specific programmed remote call frequency. The frequencies shown in parentheses are the frequencies generated when a remote call frequency of 7.627329 GHz is received. From this frequency an output fre-

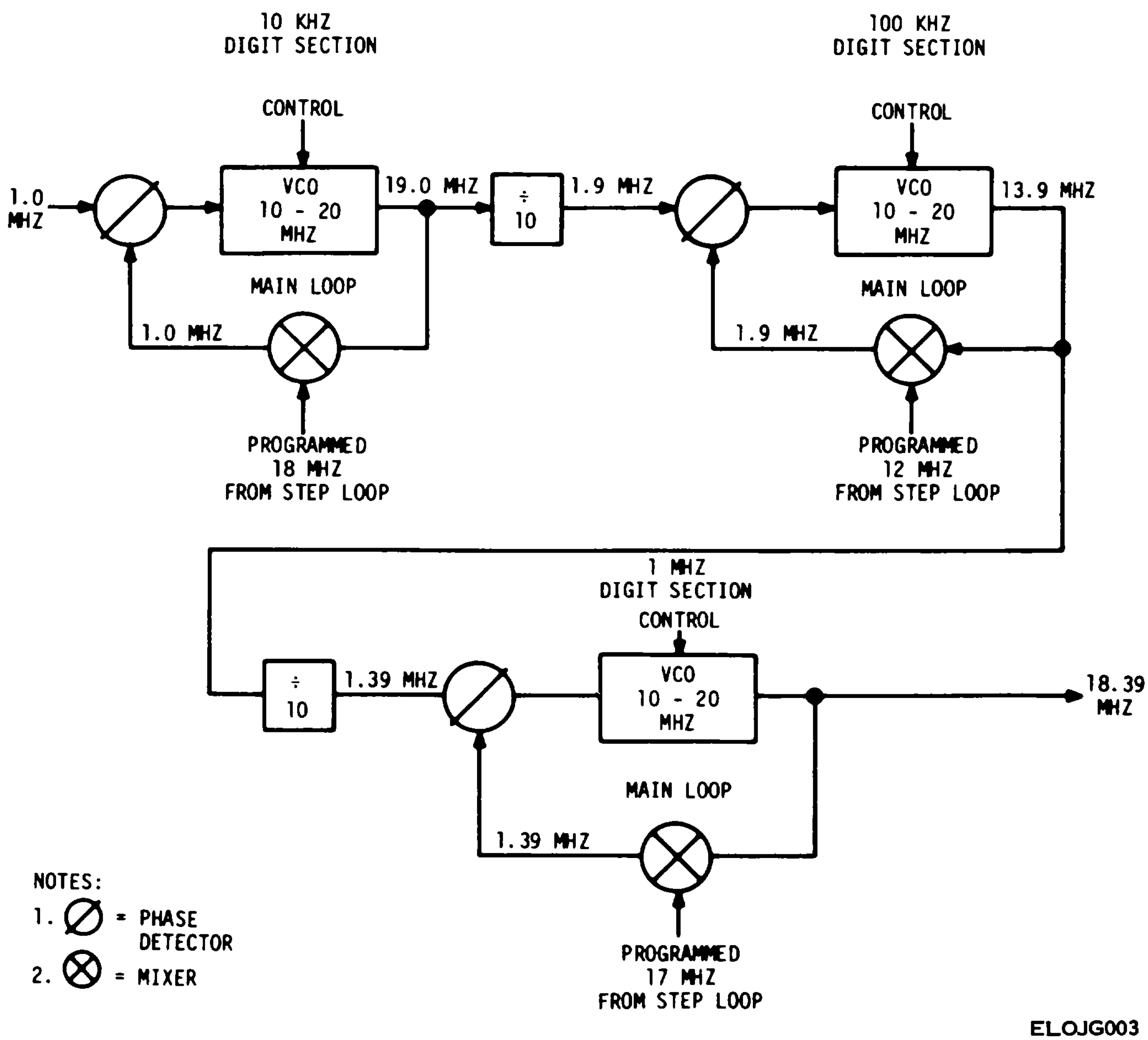


Figure 2-2. Hypothetical frequency synthesizer.

quency of 152.54658 MHz is generated, which is 1/50th of the remote call frequency.

(5) It is important to note at this point of the discussion that in order for a step loop to determine the resolution of frequency change, several digits of the remote call frequency must be taken into account The reason for this is that the frequency synthesized in the frequency control section is 1/50th of the remote call frequency and as the remote call frequency is changed by 1-KHz increments the output frequency changes with resolution of 20 Hz, developing a carry when the remote call frequency digit being changed reaches either 0 or 5. For example, the following list of frequencies shows how the 1 MHz, 100 KHz and 10 KHz digits of the output frequency would change as the re-mote call frequency is changed by 1 digit increments from 7.627329 to 7.650329 GHz.

Remote Call Frequency

GHz	100 MHz	10 MHz	1 MHz	100 KHz	10 KHz	1 KHz
7	6	2	7	3	2	9
7	6	2	8	3	2	9
7	6	2	9	3	2	9
7	6	3	0	3	2	9
7	6	3	1	3	2	9
7	6	3	2	3	2	9
7	6	3	3	3	2	9

Output Frequency

100 MHz	10 MHz	1 MHz	100 KHz	10 KHz	1 KHz	100 Hz	10 Hz
1	5	2	.5	4	6	5	8
1	5	2	5	6	6	5	8
1	5	2	5	8	6	5	8
1	5	2	6	0	6	5	8
1	5	2	6	2	6	5	8
1	5	2	6	4	6	5	8
1	5	2	6	6	6	5	8

Remote Call Frequency

GHz	100 MHz	10 MHz	1 MHz	100 KHz	10 KHz	1 KHz
7	6	3	4	3	2	9
7	6	3	5	3	2	9
7	6	3	6	3	2	9
7	6	3	7	3	2	9
7	6	3	8	3	2	9
7	6	3	9	3	2	9
7	6	4	0	3	2	9
7	6	4	1	3	2	9
7	6	4	2	3	2	9
7	6	4	3	3	2	9
7	6	4	4	3	2	9
7.	6	4	5	3	2	9
7	6	4	6	3	2	9
7	6	4	7	3	2	9
7	6	4	8	3	2	9
7	6	4	9	3	2	9
7	6	5	0	3	2	9

Output Frequency

100 MHz	10 MHz	1 MHz	100 KHz	10 KHz	1 KHz	100 Hz	10 Hz
1	5	2	6	8	6	5	8
1	5	2	7	0	6	5	8
1	5	2	7	2	6	5	8
1	5	2	7	4	6	5	8
1	5	2	7	6	6	5	8
1	5	2	7	8	6	5	8
1	5	2	8	0	6	5	8
1	5	2	8	2	6	5	8
1	5	2	8	4	6	5	8
1	5	2	8	6	6	5	8
1	5	2	8	8	6	5	8
1	5	2	9	0	6	5	8
1	5	2	9	2	6	5	8
1	5	2	9	4	6	5	8
1	5	2	9	6	6	5	8
1	5	2	9	8	6	5	8
1	5	3	0	0	6	5	8

(6) based on the example remote call frequency of 7.627329 GHz the following describes the operation of the frequency control section The 100 KHz, 10 KHz, and 1 KHz digits of the remote call frequency, 329, are applied to the 20 Hz -- 2 KHz resolution section The phase locked loop circuits of this section include scaling circuits which enable the VCO to generate a frequency between 800 KHz and 600 2 KHz which is proportional to the remote call frequency digits, that is 0 7342 MHz in our example. There are 199 8 divisions of 1 KHz between 800 KHz and 600 2 KHz This is 1/5th of the possible combinations of 100 KHz, 10 KHz, and 1 KHz digits of the remote call frequency, that is 999 Therefore 0 7342 MHz is derived by dividing 329 by 5 and subtracting the results 65 8 from 800 KHz This frequency represents the resolu-tion required for the 10 Hz, 100 Hz, and 1 KHz digits of the output in increments of 2.

(7) In the 20 KHz - 200 KHz resolution section, the step loop circuit is controlled by direct application of the remote call frequency BCD code for the 1 MHz digit and a BCD code from the code converter which is derived from the 100 MHz and 10 MHz digits of the remote call frequency. As shown in paragraph (5) above, the 10 MHz and 1 MHz remote call frequency digits have a direct relationship on generation of the 10 KHz and 100 KHz digits of the output of the frequency con-trol section. Also effecting the 100 KHz digit is the 100 MHz digit of the remote call frequency; that is, both the combination of 100 MHz and 10 MHz digits of the remote call frequency determine the weight of the 100 KHz digit in the frequency control section. Within the step loop circuit of the 20 KHz - 200 KHz resolution section a scale factor is generated between 54 and 103 resulting from these digits In turn, this scale factor determines the output frequency of the step loop VCO The VCO output frequency changes by 2 MHz for each incremental change of the scale factor In our example, the scale factor causes the VCO of the step loop to generate 16 2 MHz. This frequency is applied to the mixer along with the output frequency generated by the main phase lock loop VCO of the 20 KHz - 200 KHz section. To achieve phase lock for this.

area, the mixer must provide 0.7342 MHz which compares with the 0.7342 MHz from the preceding section. With an output of 16.2 MHz, the main phase locked loop VCO tunes to 15.4658 MHz. This frequency carries the 100 KHz, 10 KHz, 1 KHz, 100 Hz and 10 Hz digits of the required frequency control section output.

(8) Following the generation of our example frequency, the 15.4658 MHz from the 20 KHz-200 KHz resolution section (output of digit generator A16) is applied to the 1-MHz digit section. Here the frequency is scaled down by a factor of 10 to derive 1.54658 MHz. The step loop in this section receives a 1, 2, 4, 8 code from the code converter which is a resultant of the BCD codes for both the 100 MHz and 10 HMz digits of the remote call frequency. The step loop in the 1 MHz digit section also contains a scaling circuit which determines the frequency generated by the step loop. The step loop VCO generates a frequency between 9 and 18 MHz in the increments of 1 MHz based on the combination of the 100 MHz and 10 MHz digits of the remote call frequency. In our example, this frequency is 11 MHz and is applied to one input of the mixer circuit. In order to achieve a phase locked condition, the main phase lock loop VCO must tune to 12.54658. This produces an output from the mixer of 1.54658 which compares with the 1,54658 as input to the main loop VCO. The 2 generated in the example frequency represents the 1 MHz digit. This frequency is applied the 10 MHz digit section, the last circuit in the frequency synthesis chain.

(9) The step loop in the 10 MHz digit section receives a 1, 2, 4, 8 binary code from the code converter which is derived from the 100 MHz and 10 MHz digit BCD code of the remote call frequency. In addition, a 1 bit representing GHz is applied to the main phase locked loop. This bit denotes selections of either 6 or 7 GHz of the remote call frequency. The step loop generates 120 to 140 MHz in 10 MHz increments. With 12.54650 MHz applied to the main phase locked loop, the mixer must provide this frequency to achieve phase lock. The step loop therefore generates 140 MHz and the VCO of the main phase locked loop tunes to 152.54650 MHz and is the final process for frequency synthesis.

c. Output Amplifier All. (See figure 2-3.) The output amplifier All consists of two wide-band amplifiers, a low-pass filter and a power splitter. The synthesized frequency from the frequency control section is amplified by the two cascaded wide-band amplifiers. Undesirable harmonic frequencies contained in the amplified frequency are filtered out by the low-pass filter (LPF) to a level of 30 dB down from the select frequency. The power splitter divides the output from the low-pass filter into two separate outputs each having a 50-ohm impedance. The variable output at VAR OUT connector J9 is adjusted at the wide band amplifier for a level of +6 dBm. When this level is correct, the output to SAMPLE OUT connector J5 is required -5 dBm.

d. 5 MHz Frequency Standard A15. (See figure 24.)

The 5 MHz frequency standard consists of crystal oscillator A15A1 and a control switch. The switch is activated by a ground signal and when activated places the oscillator in operation. When the ground is not applied, the line to the transistor switch is open and the oscillator switches to a standby condition. The 5 MHz frequency standard output is cabled between INT STD OUT connector J1 and SYNTH IN connected J2 applying the 5 MHz signal to the input filter module A7.

e. Input Filter Module A7. (See figure FO-3.) The input filter module A7 contains a phase lock loop circuit consisting of a voltage controlled oscillator (VCO), +2 frequency divider, phase detector, loop amplifier, buffer/amplifier and three additional amplifiers. The phase lock loop voltage controlled amplifier maintains an accurate 10 MHz frequency by being synchronized with the 5 MHz from either the external frequency standard or external source applied to SYNTH IN connector J2. This synchronization is maintained by dividing down the VCO 10 MHz to 5 MHz and detecting any phase difference between it and the reference. A phase difference causes the VCO to tune to eliminate this phase difference holding the VCO at phase lock. The 5 MHz at connector J2 is compatible with the TTL (transitor-transistor-logic) of the frequency control section. The 5 MHz applied through the buffer/amplifier is compatible with the 1-5-10 MHz amplifier AR1. The 10 MHz at the output of the VCO is coupled through an amplifier to connector J4 and applied to the frequency control section.

f. 1-5-10 MHz Amplifier A21. (See figure 2-5.) The 1-5-10 MHz amplifier A21 consists of a frequency doubler, three amplifier circuits, and a divide-by-five circuit. The 5 MHz cabled through the 5 MHz INPUT front panel connector from the input filter module is applied to the frequency dou-

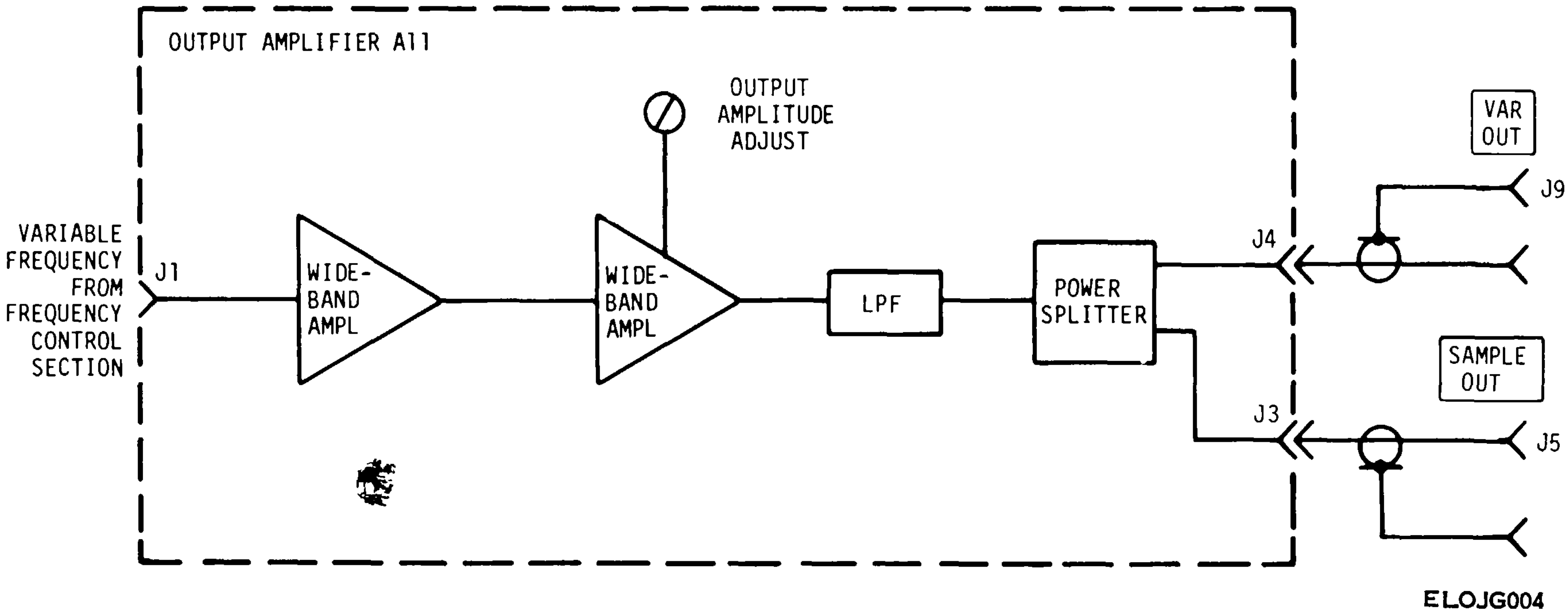


Figure 2-3. Output Amplifier All, Block Diagram

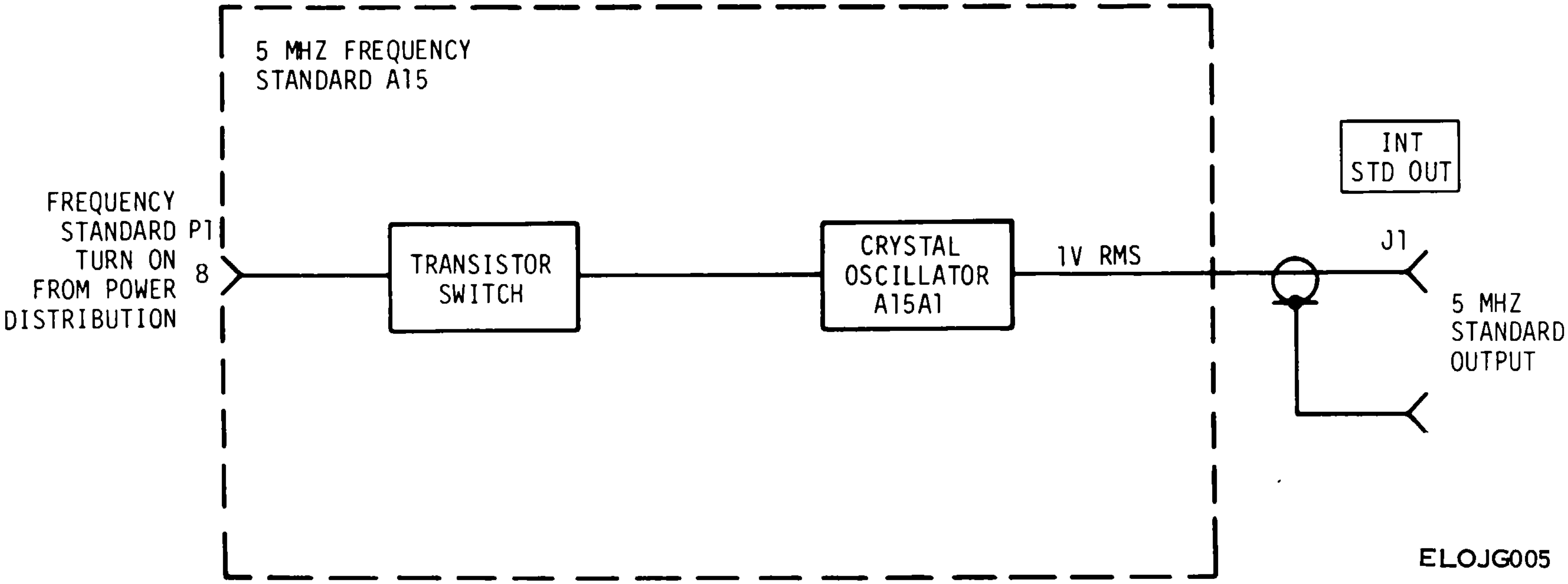


Figure 2-4. 5 MHz frequency standard A15, block diagram.

bier, buffer amplifier and the divide-by-five circuit. The frequency doubler multiplies the 5 MHz by a factor of two to derive 10 MHz. The 10 MHz signal is applied to the amplifier where the level of the signal is adjusted for an output of +8 dBm and furnishes an impedance of 50 ohms at 10 MHZ OUT connector j8 The 5 MHz applied to the buffer amplifier is adjusted for a 1 volt rms level at 5 MHZ OUT connector J7. The buffer amplifier provides a 50 ohm output impedance.

g. Power Distribution, (See FO-4.)

(1) Power distribution circuits consist of transformer assembly A19, motherboard A18, power supply A12, heatsink A20A1, METER FUNCTION switch, meter M1, power switch, and POWER indicator.

(2) The input primary power of 115 Vac +10%, 50 to 400 Hz is applied through an RFI filter and fuses F1 and F2 on transformer assembly A19 to transformer T1. The RFI filter eliminates any un-desirable radio frequency interference that is pres-ent. Fuse F1 and F2 protect circuits from excess current drain. Transformer T1 steps down the 115 Vac to three spearate reduced ac voltage These ac voltages are routed to motherboard A18 which provides full-wave rectification of the three ac voltages. The three dc output voltages of the motherboard A18 are applied to respective +5, -12, and +14 Vdc regulators on power supply A12 and heatsink A20A1.

(3) The +5 Vdc regulator always has power applied with connector J10 connected to primary power. The -12 and + 14 Vdc regulators are turned on by application of a ground from the POWER switch Also the ground provides a return for +14 Vdc applied to the POWER indicator causing it to light. The POWER switch also provides a ground to the frequency standard when set to OFF. This sets the frequency standard to a standby state.

(4) The +5, -12 and +14 regulated Vdc are applied to various circuits of the frequency synthesizer. In addition they are applied to the METER FUNCTION switch that can select any-one of the three voltages for monitoring on voltmeter M1.

2-5. Detailed Functional Discussion of Frequency Control Section (Fig. FO-5.)

The remote call frequency from the converter frequency selection switch is applied as a parallel 25-bit BCD word to the frequency control section through REMOTE FREQUENCY CONTROL connector P1 With the exception of the GHz decade, each switch decade numbers 0 through 9 are represented by a 4-bit BCD code in the 25-bit word. The HGz decade uses only 1 bit, as the selection of frequencies is either in the 6 or 7 HGz range The 25-bit word establishes the correct frequencies for the VCO's of the 10 HZ-100 KHz, 1 MHz, and 10 MHz digit sections for generating the synthesized frequency This synthesized frequency is 1/50th of the remote call frequency which is 700 MHz less than the dialed frequency.

a. Operations of the three functional areas of the frequency control section are synchronized by standard frequencies of 1 MHz and 10 MHz. An external 5 MHz from the cesium beam frequency standard or from the frequency synthesizer fre-quency standard are routed through SYNTH IN connector J2 to the input filter module A7. The input filter module A7 channels the 5 MHz to a divide-by-five circuit on 1 MHz step loop A8 to ob-tain the 1 MHz standard frequency and also multiplies the-5 MHz by a factor of two to derive the 10 MHz standard frequency. Further division of the 1 MHz standard is made within the digit generator A16 to obtain 200 KHz through a division of five and 8 KHz by dividing the 200 KHz by a factor of twenty-five.

b. The 4-bit BCD codes representing 100 KHz, 10 KHz, and 1 KHz digits of the remote call frequency are applied to N/1 divider A. The N/1 divider is then preset to an integer between 4000 and 3001 which provides a division of the output frequency of the VCO. This integer is actually 4000 minus the digits of 100 KHz, 10 KHz, and 1 KHz The output of the N/1 divider is compared with the 8 KHz standard frequency by the main loop phase detector of the 20 Hz-2 KHz section The ouput of the phase detector controls the VCO to tune until the VCO generates a frequency to the N/1 divider which enables the divider to produce an 8 KHz out-put. This 8 KHz when compared with the standard 8 KHz from the phase detector establishes the phase locked condition. When this occurs, the out-put frequency of the VCO is equal to the N/1 divider integer multiplied by 8 KHz; with a range be-tween 32.000 to 24.008 MHz. This frequency is reduced by a factor of 40 by a divide-by-forty circuit to obtain a frequency between ranges of 0 6002 and 0 8 MHz.

c. The 20 KHz-200 KHz resolution section consists of a main loop and a step loop. The step loop VCO frequency is determined by the N/1 divider B controlled by the 4-bit BCD code for the 1 MHz digit and a 4-bit binary code from the code converter which is a resultant of the 4-bit BCD code for the 10 MHz digit of the remote call frequency. The N/1 divider provides integers between 54 and 103. When the 10 MHz and 1 MHz digits are a number 49 or less the integer equals 54 plus the number. When the digits are 50 or greater, then the integer equals the number plus 4. The code converter determines when a carry is required; that is the number in the 10 MHz is 5 or greater. The phase detector of the step loop receives the output of the N/1 divider and the standard frequency of 200 KHz. The phase detector tunes the VCO until a frequency is produced by which the N/1 divider provides the 200 KHz match When this occurs the VCO frequency equals the integer of the N/1 divider times 0.2. The VCO frequency which is in the range between 10.8 and 20.6 MHz Is applied to one input of the mixer of the main loop of the 20 KHz-200 KHz resolution section. The mixer of this loop produces a subtractive frequency between the step loop VCO and the output of the main

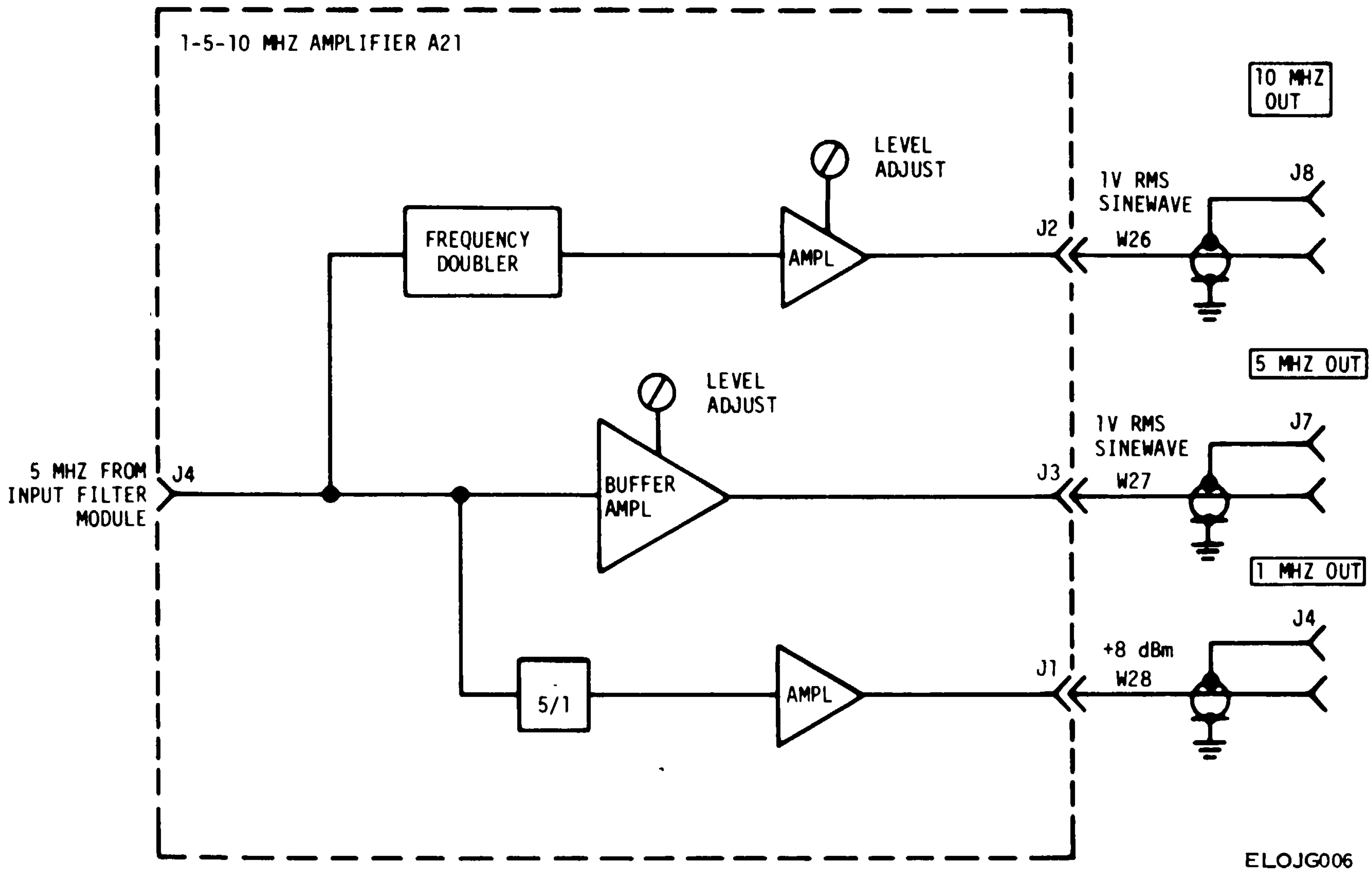


Figure 2-5. 1-5-10 MHz amplifier A21, block diagram.

loop VCO and applies this difference to a phase detector. The main loop VCO is phase locked when the mixer produces a differential equal to the compare in-put from the output of the 20 Hz - 2 KHz resolution section The VCO of the main loop tunes to a fre-quency between 10 and 19.9999 MHz to form the 100 KHz, 10 KHz, 1 KHz, 100 Hz and 10 Hz digits of the synthesized frequency.

d. The 1 MHz digit section consists of a main loop formed by 1 MHz DU main loop A10 and 1 MHz DU IF mixer A9, and a step loop formed by 1 MHz DU step loop A8. The VCO frequency of the step loop is deter-mined by the N/1 divider C which is controlled by a 4-bit code derived from the 100 MHz and 10 MHz digits of the remote call frequencies. The integer of the divider ranges from 9 to 18 for digits of 100 MHz and 10 MHz digits between 00 and 49 In equal units of 4 and repeats from 9 to 18 for 50 to 99; for example, 00 to 04 equals 9, 05 to 09, equals 10 etc., and when 50 is reached the integer is again 9 and continues to 18 The step loop VCO tunes to a frequency equal to the N/1 integer since the phase detector is comparing a 1 MHz standard frequency to a 1 MHz output of the Nil/ divider. The frequency from the VCO of the step loop is applied to one input of the main loop mixer on 1 MHz DU IF mixer A9. The input frequency to the main loop is reduced by a factor of 10 and applied to the phase detector of the main loop. A phase locked condition of the main loop is achieved when the VCO tunes to a frequency that when mixed with the VCO fre-quency of the step loop produces a differential equal to the frequency from the 10/1 divider. The VCO of the main loop is first presteered or tuned to a frequency in the range of the required output by the dc voltage from the digital/analog converter. The digital/analog converter receives the same 4-bit code as applied to the step loop. The frequency output of the 1 MHz DU main loop A10 synthesizes the 1 MHz digit and carries the previously synthesized digits for 100 KHz, 10 KHz, 1 KHz, 100 Hz, and 10 Hz. The actual frequency is be-tween 10 MHz and 19 99998 MHz.

e. The 10 MHz digit section consists of a main loop formed by 10 MHz DU main loop A3, 10 MHz DU main loop VCO A2, and 10 MHz DU IF mixer A4, and a step loop formed by 10 MHz DU step loop VCO A5 and 10 MHz DU step loop P. D. A6. The digital analog converter of the step loop is controlled by the GHz bit and a carry derived from the 100 MHz and 10 MHz digits of the remote call frequency The VCO can be presteered to oscillate at 120, 130 or 140 MHz The presteered frequency output from the VCO is com-pared with harmonic frequencies between 110 and 150 MHN generated by the spectrum generator on the 10 MHz DU step loop PD A6. The harmonics are even multiples of the 10 MHz standard frequency If the output from the VCO is near being in phase with a har-monic, the voltage output from the phase detector Is sufficient to phase lock without the assistance of the sweep control circuit and the VCO tunes and locks to 120, 130, or 140 Mhz If however, the VCO presteers to a frequency distant from a harmonic, then a differential voltage is generated by comparing the volt-age from the digital/analog converter with the output of the phase detector. This voltage increases the amplitude of the dc control voltage to the VCO at a polarity which slews the VCO toward phase lock When the fre-quency for phase lock is approached the output of the comparator goes to zero and the VCO tunes normally to a phase locked condition.

f. The 120, 130, or 140 MHz from the step loop portion of the 10 MHz digit section is applied to the mixer on 10 MHz DU IF mixer A4 of the main loop portion. The mixer provides a differential frequency between the VCO on 10 MHz DU main loop VCO A2 and the 120, 130, or 140 MHz from the step loop With the VCO of the main loop steered to a frequency near the required output, the differential is between 10 and 20 MHz. A low-pass filter (LPF) removes undesirable frequencies above 20 MHz and two amplifiers divide the 10 - 20 MHz signal into two identical signals of equal amplitude. The 10 MHz DU main PD A3 detects both frequency and phase differences between the 10 - 20 MHz from the mixer and the frequency from the 1 MHz digit section The frequency discriminator detects frequency difference and the phase detector provides phase difference detection. If the frequencies are the same but out of phase, a dc signal is developed through the adder to bring the VCO in phase lock. If the frequencies are different, the frequency discriminator detects this difference and provides the adder with a signal enabling it to produce a dc voltage to bring the VCO within frequency The adder circuit sums both variations to bring the VCO both to an m frequency and phased locked condition.

g. When the main loop is phase locked, the output frequency is the final synthesized frequency programmed from the remote call frequency This last 10 MHz digit section has synthesized the 10 MHz digit with the 100 MHz digit always providing unity, that is 100 MHz.

h. The output from the frequency control section is processed by the output amplifier All to provide a + 6 dBm signal at VAR OUT connector J9 matched to 50 ohms.

2-6. Calculation of Frequencies Generated in Frequency Control Section

(Fig. FO-5)

a. The following paragraphs provide instructions for calculating frequencies generated at the major areas of the frequency control section based on the programmed remote call frequency To aid in the instructions, a sample dialed frequency is included.

b. Determine remote call frequency:

(1) Remote call frequency = Dialed frequency - 700 MHz

(2) *Example:*

Remote call frequency =

	100	10	1	100	10	1	
GHz	MHz	MHz	MHz	KHz	KHz	KHz	
8.	3	2	7	3	2	9	(Dialed) - 700

Remote call frequency = 7.627329

c. Calculate division factor of N/1 divider A: Range of divider is 4000 to 3001

(1) Subtract 100, 10, and 1 KHz digits of remote call frequency from 4000.

(2) *Example:*

4000-329 = 3671 (division factor)

d. Calculate output frequency of VCO (20 Hz - 2 KHz resolution). Range is from 24.008 to 32.00 MHz.

(1) Multiply N/1 divider A division factor (step c) by 8 KHz.

(2) *Example:*

3671 x 8 KHz = 29.368 MHz

e. Calculate output frequency of 20 Hz - 2 KHz resolution (4011 divider).

(1) Divide frequency output of VCO (20 Hz - 2 KHz resolution) by 40.

(2) *Example:*

$$\frac{29.368}{40} = 0.7342 \text{ MHz}$$

f. Calculate division factor of N/1 divider B: Range of divider is 54 to 103

(1) Add 10 MHz and 1 MHz digits of remote call frequency to 54 if they are 49 or below.

(2) Add 10 MHz and 1 MHz digits of remote call frequency to 4 if they are 50 or higher.

(3) *Example:*

10MHz 1MHz
V
54 + 27 = 81

g. Calculate output of step loop VCO (20 KHz - 200 KHz resolution). Range is from 10.8 to 20.6 MHz.

(1) Multiply N/1 divider B division factor (step f)

(2) *Example:*

81 x 0.2 MHz = 16.2 MHz

h. Calculate output frequency of 20 KHz - 200 KHz (output of main loop VCO). Range is from 10.00000 to 19.99998 MHz.

(1) Subtract output frequency of 20 Hz - 2 KHz resolution from step loop VCO (step g).

(2) *Example:*

16.2 MHz - 0.7342 MHz = 15.4658 MHz

a. Calculate output of 1 MHz digit section.

(1) Divide output of 20 KHz - 200 KHz resolution section (step *h)* by 10 to determine output of 10/1 divider. Example:

$$\frac{15.4658}{10} = 1.54658 \text{ MHz}$$

(2) Determine N/1 divider C. Using the 100 MHz and 10 MHz digits of the remote call frequency determine N using the following chart:

(2) Determine N/1 divider C Using the 100 MHz and 10 MHz digits of the remote call frequency determine N using the following chart

100 MHz Digit	10 MHz Digit	N
0	0	= 9
0	4	
0	5	= 10
0	9	
1	0	= 11
1	4	
1	5	= 12
1	9	
2	0	= 13
2	4	
2	5	= 14
2	9	
3	0	= 15
3	4	
3	5	= 16
3	9	
4	0	= 17
4	4	
4	5	= 18
4	9	
5	0	= 9
5	4	
6	0	= 11
6	4	
6	5	= 12
6	9	
7	0	= 13
7	4	
7	5	= 15
7	9	
8	0	= 15
8	4	
8	5	= 16
8	9	
9	0	= 17
9	4	
9	5	= 18
9	9	

Example:

100 MHz and 10 MHz digits = 62

62 is between 60 and 64 on chart

Therefore: N = 11

(3) Add output of 10/1 divider (step i (1)) to N/1 divider C (step i (2))

Example:

1.54658 + 11 = 12.54658 MHz

j. Calculate output of 10 MHz digit section (Output of Frequency Control Section).

(1) Determine output of 10 MHz digit section step loop VCO. Using the GHz and 100 MHz digits of remote call frequency determine the VCO output from

GHz Digit	100 MHz Digit	VCO Frequency
6	5	= 120 MHz
6	9	
7	0	= 130 MHz
7	4	
7	5	= 140 MHz
7	9	

Example

Remote call frequency GHz and 100 MHz digits = 76

7 6 is between 7.5 and 7 9 therefore VCO frequency = 140 MHz

(2) Add 10 MHz step loop VCO output (step *j* (1)) to output of 1 MHz digit section (i (3)).

Example

VCO output = 140 MHz

Output of 1 MHz digit section = 12.54658 MHz

140 MHz + 12 54658 MHz = 152.54658 MHz

Output of frequency control section based on remote call frequency of *7.627329* GHz is equal to *152.54658* MHz.

CHAPTER 3

DIRECT AND GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

Section I. GENERAL

3-1. Introduction

This chapter contains direct and general support maintenance procedures for the frequency synthesizer. Maintenance of the frequency synthesizer consists of troubleshooting, removal and replacement of defective modules and testing.

a. Troubleshooting procedures are provided in Section III. These procedures are used to isolate troubles to a defective module within a malfunctioning unit A troubleshooting flow chart is utilized to isolate the defective module.

b. The frequency synthesizer maintenance procedures are provided in Section IV. These procedures include instructions for removal and replacement of defective modules

c. The frequency synthesizer testing procedure is provided in Chapter 4. This procedure is used to check operation of the frequency synthesizer following repairs, replacement of defective modules, or whenever improper operation is suspected. The test procedure is also used to check operation of the frequency synthesizer after installation of a replacement subassembly.

NOTE

Careless replacement of parts often creates new troubles. Whenever a part has been replaced, make all necessary adjustments, and check the performance of the equipment to be sure that the original malfunction has been remedied and that no new trouble has developed in the equipment as a result of the repair.

3-2. Voltage and Resistance Measurements

Voltage and resistance measurements are an aid in determining circuit conditions and in evaluating clues in the course of troubleshooting.

a. Unless otherwise specified, take voltage measurements with the equipment operating and measure all voltages with respect to ground This equipment is transistorized, when measuring voltages, use tape or sleeving (spaghetti) to insulate the entire test prod, except for the extreme tip. A momentary short can destroy a transistor.

CAUTION

Before using any ohmmeter to test transistorized circuits, check the open circuit voltage across the ohmmeter test leads. *Do not* use the ohmmeter if the open circuit voltage exceeds 1.5 volts. *Do not* use the R x 1 range of any ohmmeter when testing low power transistors. The R x 1 range normally connects ohmmeter internal battery directly across the test leads, the comparatively high current may damage the transistor under test.

b. Make all resistance measurements with the cables disconnected. Observe the above caution when making resistance measurements on the printed circuit boards which contain transistors.

Section II. TOOLS AND EQUIPMENT

3-3. Tools

No special tools are required to perform maintenance on the frequency synthesizer. For standard shop tools required, refer to the maintenance allocation chart contained in TM 11-5895-833-12 (Operator's and Organizational Maintenance Manual, Frequency Conversion Subsystem for Satellite Communications Terminal AN/TSC-54).

3-4. Test Equipment and Materials Required

a. The test equipment and materials required for maintenance of the frequency synthesizer are listed in the appropriate paragraphs in which the maintenance procedures are given. The specified test equipment or suitable equivalents should be used to comply with the requirements of this chapter.

NOTE

Before using the test equipment, carefully read the operating instructions. For maximum accuracy in all measurements, use the range that will produce a meter reading as close to mid-scale as possible.

b. When using test equipment, place it on a firm support and position the test equipment so that its controls are , within easy reach.

WARNING

Do not allow an) test leads to drag across high-voltage circuits Severe burns or electrical shock to the user and damage to the equipment under tests may result.

Section III. TROUBLESHOOTING

3-5. General

a. This section provides procedures for isolating a malfunction in the frequency synthesizer to a defective module.

b. After the fault has been isolated, check associated coaxial cables for proper seating and possible defects prior to replacement of module.

3-6. Test Equipment

(1) Rf power meter (0 to 10 dBm at 131 to 154 MHz) with 50-ohm power detector.

(2) Frequency counter (0 2 MHz to 152 MHz: resolution to 1 Hz; 100 mV sensitivity').

(3) Frequency standard (1 MHz)

(4) Oscilloscope (10 MHz)

(5) Rms voltmeter (300 mv at 140 MHz)

(6) Multimeter (115 Vac, t 25 Vdc).

3-7. Preliminary Procedures

a. Remove frequency synthesizer top and bottom dust covers.

b. Set frequency synthesizer POWER switch to OFF.

c. Connect power cable to primary 115 Vac, 50 = 400 Hz power source and cable between INT STD OUT connector J1 and SYNTH IN connector J2.

d. Set POW'ER switch to ON.

3-8. Troubleshooting Procedures

a. Localize a malfunction in the frequency synthesizer by performing instructions in troubleshooting flow chart FO-6.

b. As a further aid to troubleshooting, refer to functional diagram figure FO-5 and table 2-1 providing remote call frequency) input codes. Also frequencies present within the frequency synthesizer can be calculated from procedures given in paragraphs 2-6.

c. Tables 3-1, 3-2, and 3-3 are referenced in the flowchart. Tables 3-1 and 3-2 list ac and de voltages to be measured in the power distribution functional area. Table 3-3 provides the command codes generated by the code converter on digit generator A16 from selected converter frequencies.

d. In table 3-3, the selection frequency column lists the possible digit combinations for both up and down converters that can be made on the GHz and 100 MHz decade switches. The adjacent remote call frequency column gives the actual remote call frequency digits for the GHz and 100 MHz decade as applied to the code converter, that is a frequency 700 MHz less than selected. Respective code converter input and output codes are given under appropriate column headings in binary format. To perform a check of the code converter as instructed in flow chart FO-6, place the converter frequency) selection switch through the possible combinations for GHz, 100 MHz and 10 MHz digits and observe that the code converter supplies required code at each selection.

e. In order to measure certain voltages and command codes, digit generator A16 must be placed in the service position. To accomplish this, perform the following procedures:

(1) Remove six screws and washers securing digit generator A16 to chassis.

(2) Lift digit generator A16 using plastic loop fastened to card and suing into upright, locked position.

NOTE

The frequency synthesizer should always be left in its normal configuration when checking for frequencies, keveks, etc. at the test ports. Therefor a tee connector should always be used when performing such troubleshooting.

WARNING

Voltages present in equipment can cause severe injury. Use extreme care when performing checks

f. As a further aid to localize a malfunction, figure 3-1 provides wiring and cabling information. The figure also shores the location of power supply assembly A19-12V and + 14 V adjustments.

SECTION IV. MAINTENANCE OF FREQUENCY SYNTHESIZER

3-9. Removal of Frequency Synthesizer Subassemblies

a. Before removal of any frequency component. remove line power from synthesizer.

b. If required, release frequency synthesizer assembly from cabinet turning four front panel captive screw s counter-clockwise (viewing front panel) until they are all disengaged.

c. Remove the hardware securing the dust covers to the top and bottom of the chassis, and remove dust covers.

CAUTION

The rf cables used in the frequency synthesizer are fragile. Use extreme caution when disconnecting these cables. Pull straight up when removing ribbon connectors or connector damage will result.

CAUTION

When unsoldering wires connected to feed-through capacitors, use heat sink clip at base of terminal.

3-10. Removal of Modules

a. Access to Modules A2 through A7 and A21. To gain access to modules A2 through A7 and A21, digit generator circuit board (fig. 3-1) must be placed in service position as follows:

(1) Remove six screws and lockwashers securing hinged digit generator circuit board to the synthesizer chassis.

(2) Remove two screws and lockwashers securing clamp plate to block at edge of A16, near center of chassis. Take care not to inadvertently remove hardware fastening the circuit board to the retaining bracket.

(3) Swing the digit generator circuit board outward from the synthesizer chassis to the upright service position. Check that retaining bracket is fully extended and locked.

(4) Unplug ribbon connector P8 from motherboard A18.

b. Removal of Modules A2 through A6, A8 through A11 and A21. (See figure 3-2) Modules A2 through A6, A8 through A11 and A21 are enclosed in metal containers and are similarly mounted. As a typical example, output amplifier All is removed as follows:

(1) Remove coaxial cable W22 (52) from connector J4.

(2) Remove coaxial cable W23 (51) from connector J3.

(3) Remove coaxial cable W16 (48) from connector J1.

(4) Unsolder wires from feed-through capacitor at bottom of module. Tag wires.

(5) Remove the securing hardware (61) from the bottom and side of the module while supporting the top of the module so it doesn't fall out of the chassis.

(6) Withdraw the module from the chassis.

c. Input Filter Module A7. (See figure 3-3).

(1) Remove three screws (4, 6 and 11) securing restraint bracket (5) to input filter module A7 and remove bracket with spacer attached.

(2) Disconnect the four coaxial connectors.

(3) Unsolder wires from feed-through capacitors at bottom of module. Tag wires.

(4) Remove two screws, lockwashers and flat washers (12) securing right-side resilient mount (2) to support bracket (1).

(5) Remove four screws, lockwashers, flat washers and nuts securing plate (7) to left side-wall of synthesizer chassis.

(6) Remove input filter module A7 with resilient mounts (2 and 10) and plate (7) attached.

(7) Remove two screws, lockwashers, and flat washers (3) securing right-side resilient mount (2) to input filter module A7 and remove resilient mount (2).

(8) Remove two screws (8) securing plate (7) to left-side resilient mount (10) and remove plate (7).

(9) Remove two screws, lockwashers and flat washers (9) securing left-side resilient mount (10) to input filter module A7, and remove resilient mount (10).

3-11. Removal of Digit Generator A16
(Fig. 3-2)

a. Remove the two coaxial connections from the top of the digit generator (72).

b. Unsolder the power wires from the chassis to the digit generator. Tag all wires.

c. Remove the securing hardware screws holding the digit generator to the chassis.

d. Swing up the digit generator on the hinge.

e. Unplug the ribbon connector from the motherboard.

f. Remove the retaining bracket (70) from the digit generator.

g. Remove the retaining ring from the retaining bar (70) that hinges the digit generator to the-chassis.

h. Slide retaining bar (70) aside until the digit generator is free.

3-12. Removal of Power Supply Assembly A12

Fig. 3-2.

a. Remove the two screws holding the sheet metal bracket over the power supply assembly printed circuit board. (37).

b. Slightly lift front of bracket, and disengage rear of bracket from the rear panel assembly (40).

c. Remove the sheet metal bracket to permit access to the printed circuit board.

d. With a general rocking motion, pull the printed circuit board out of the chassis connector.

Table 3-1. Connector A18-J13 Voltage

Pin	Volts AC
1	0
2	0
3	19.7 ± 15%
4	0
5	0
6	19.7 ± 15%
7	9.9 ± 15%
8	9.9 ± 15%
9	9.9 ± 15%
10	9.9 ± 15%

NOTE

Connector A18-J13 pins are accessed for voltage measurements on motherboard A18 as viewed from top of equipment. Refer to figure 3-1 for location and pin connections.

Table 3-2. Connectors A18-J10 and J11 Voltages

Pin	Volts DC
J10 Pin L	+25.2 ± 15%
J11 Pin 4	- 25.4 ± 15%
J11 Pin 9	+11.7 ± 15%

NOTE

To access connector J10 and J11 on motherboard A18 place generator A16 in service position to figure 3-1 for connector J10 and J11 location and pin connections.

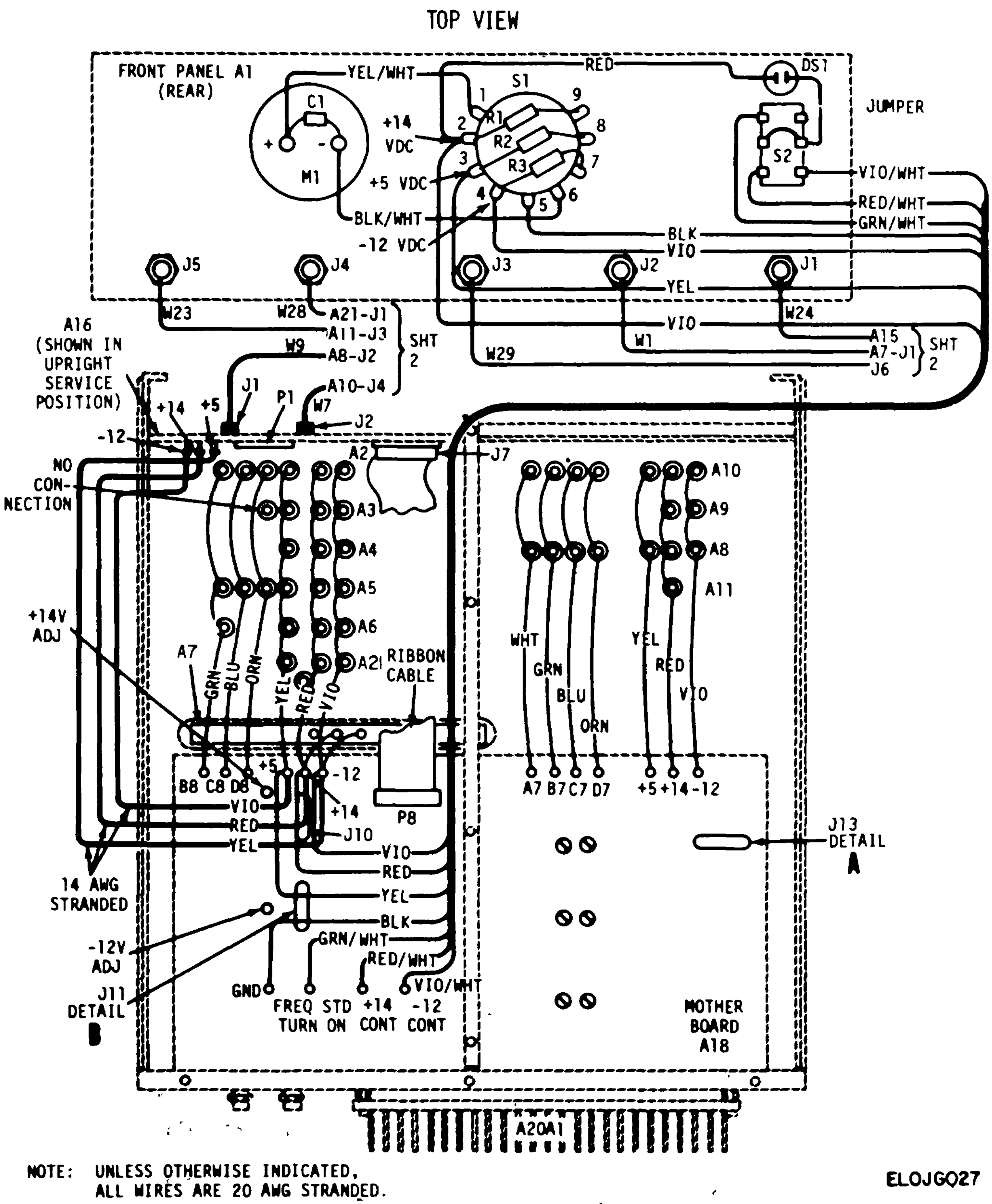
Table 3-3. Digit Generator Code Converter Output Vs. Remote Call Frequency

	Selected Converter Frequency (GHz)	Remote Call Frequency (GHz)
Up	7.9	7.2
	8.0	7.3
	8.1	7.4
	8.2	7.5
	8.3	7.6
	8.4	7.7
Down	7.2	6.5
	7.3	6.6
	7.4	6.7
	7.5	6.8
	7.6	6.9
	7.7	7.0

Remote Call Frequency To Code Converter			Command Code Output of Code Converter on Digit Generator A16							
Digit	Decimal	Binary	A16 Terminals	10 MHz Code B8	10 MHz Code C8	10 MHz Code D8	1 MHz Code A7	1 MHz Code B7	1 MHz Code C7	1 MHz Code D7
			Code	4	2	1	8	4	2	1
GHz	6	1 bit			0					
	7				1					
100 MHz		BCD 8 4 2 1								
	0	0 0 0 0		1		0	0	0	0	
	1	0 0 0 1		1		0	0	0	1	
	2	0 0 1 0		1		0	0	1	0	
	3	0 0 1 1		1		0	0	1	1	
	4	0 1 0 0		1		0	1	0	0	
	5	0 1 0 1		1		1	0	0	0	
	6	0 1 1 0		1		1	0	0	1	
	7	0 1 1 1		1		1	0	1	0	
	8	1 0 0 0		1		1	0	1	1	
	9	1 0 0 1		1		1	1	0	0	
10 MHz	0	0 0 0 0								0
	1	0 0 0 1								0
	2	0 0 1 0								0
	3	0 0 1 1								0
	4	0 1 0 0								0
	5	0 1 0 1								1
	6	0 1 1 0								1
	7	0 1 1 1								1
	8	1 0 0 0								1
	9	1 0 0 1								1

Notes:

1. A16 terminals B8, C8, D8 are accessed by placing digit generator in service position.
2. Binary 0 = 0 to 0.9 V
   Binary 1 = +2 to +5 Vdc



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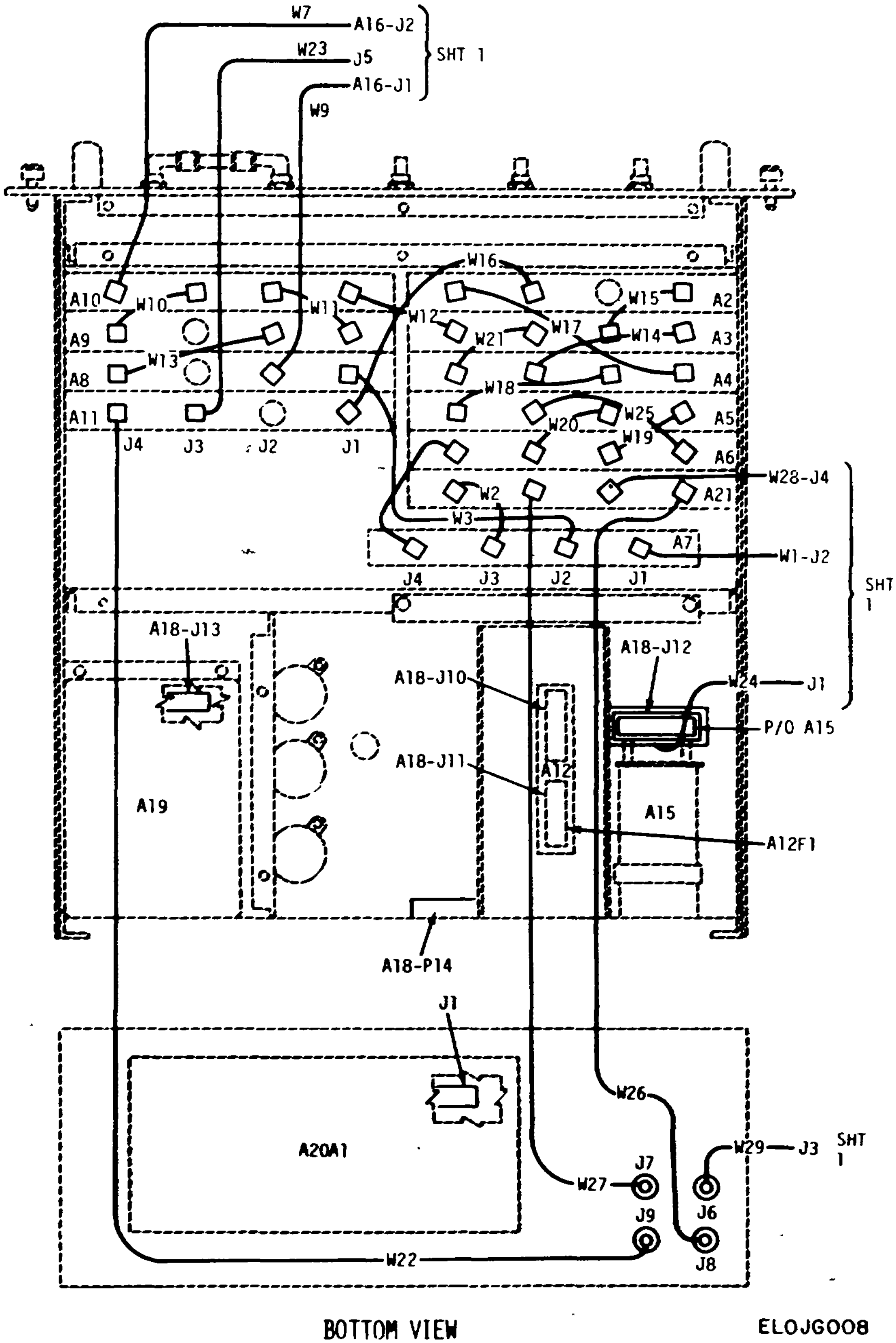
NOTE: UNLESS OTHERWISE INDICATRED,
ALL WIRES ARE 20 AWG STRANDED.

Figure 3-1. Wiring and cabling diagram (sheet 1 of 3).



BOTTOM VIEW

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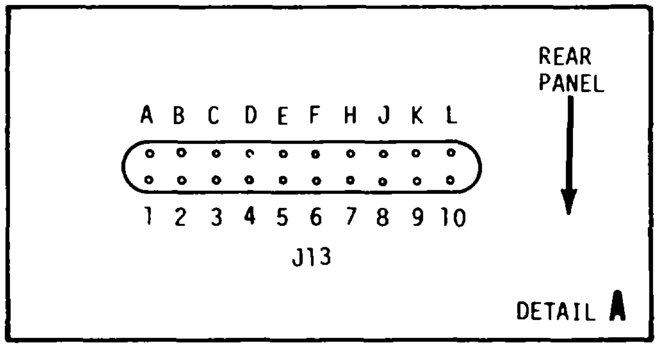
Figure 3-1. Wiring and cabling diagram (sheet 2 of 3).



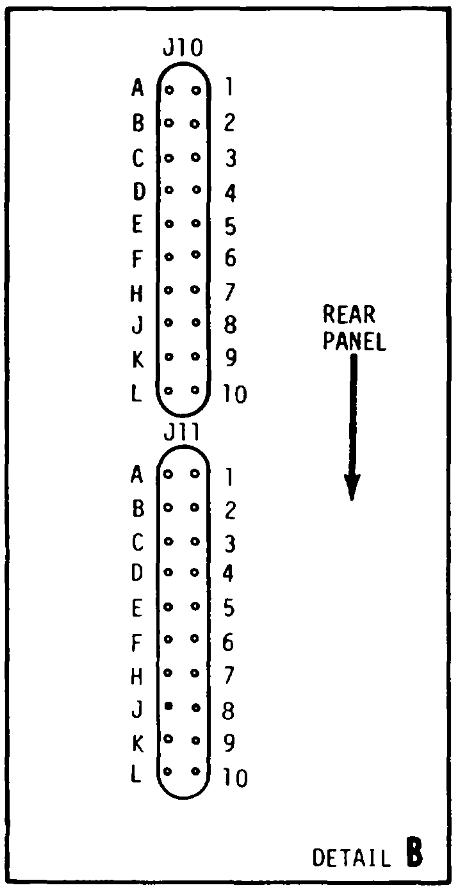


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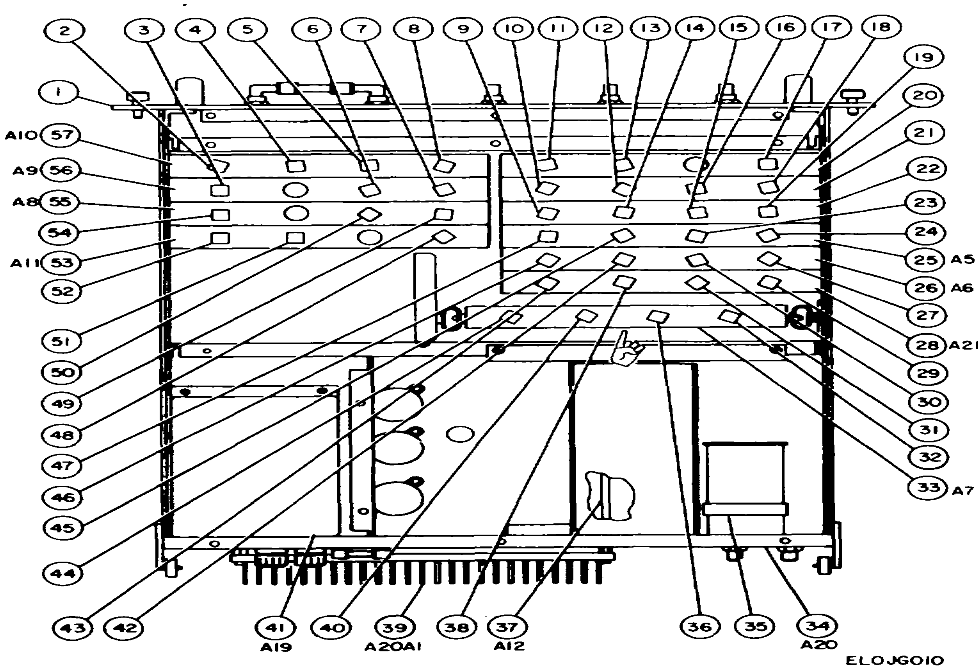
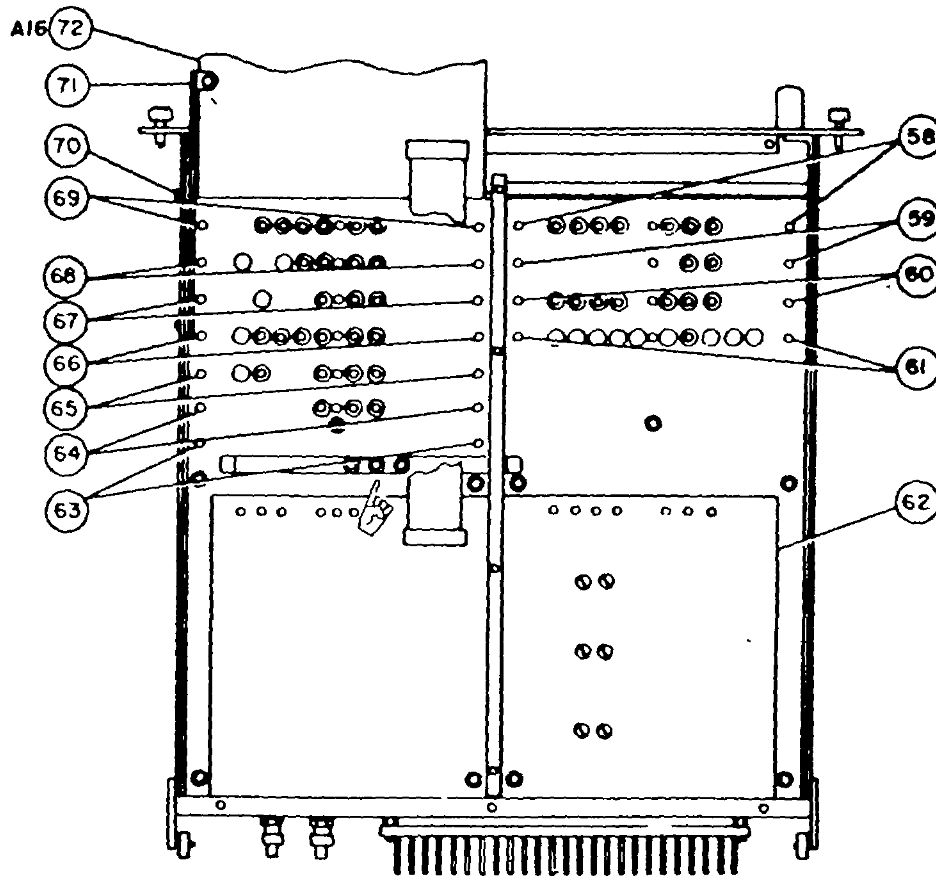
Figure 3-1.(3). Wiring and cabling diagram (sheet 3 of 3).



1 Front panel assembly A1
2 1-MHz DU main loop VCO A10 connector J4 (W7)
3 1-MHz DU if. mixer A9 connector J4 (W10)
4 1-MHz DU main loop VCO A10 connector J3 (W10)
5 1-MHz DU main loop VCO A10 connector J2 (W11)
6 1-MHz DU if. mixer A9 connector J2 (W13)
7 1-MHz DU if. mixer A9 connector J1 (W11)
8 1-MHz DU main loop VCO A10 connector J1 (W12)
9 10-MHz DU if mixer A4 connector J4 (W21)
10 10-MHz DU main PD A3 connector J4 (W12)
11 10-MHz DU main VCO A2 connector J4 (W17)
12 10-MHz DU main PD A3 connector J3 (W21)
13 10-MHz DU main VCO A2 connector J3 (W16)
14 10-MHz DU if mixer A4 connector J3 (W14)
15 10-MHz DU if. mixer A4 connector J2 (W18)
16 10-MHz DU main PD A3 connector J2 (W15)
17 10-MHz DU if mixer A2 connector J1 (W15)
18 10-MHz DU main PD A3 connector J1 (W14)
19 10-MHz DU main VCO A4 connector J1 (W17)
20 10-MHz DU main loop VCO A2
21 10-MHz DU main PD A3
22 10-MHz DU if mixer A4
23 10-MHz DU step loop VCO A5 connector J2 (W20)
24 10-MHz DU step loop VCO A5 connector J1 (W19)
25 10-MHz DU step loop VCO A5
26 10-MHz DU step loop PD A6
27 10-MHz DU step loop PD A6 connector J1 (W25)
28 1-5-10 MHz amplifier A21
29 1-5-10 MHz amplifier A21 connector J1 (W26)
30 10-MHz DU step loop PD A6 connector J2 (W19)
31 1-5-10 MHz amplifier A21 connector J2 (W28)
32 Input filter A7 connector J1 (W1)
33 Input filter A7
34 Rear panel assembly A20
35 Frequency standard A15
36 Input filter A7 connector J2 (W3)
37 Power supply assembly A12
38 1-5-10 MHz amplifier A21 connector J3 (W27)
39 Heatsink assembly A20A1
40 Input filter A7 connector J3 (W2)
41 Transformer assembly A19
42 10-MHz DU step loop PD A6 connector J3 (W20)
43 1-5-10 MHz amplifier A21 connector J4 (W2)
44 Input filter A7 connector J4 (W4)
45 10-MHz DU step loop VCO A5 connector J3 (W25)
46 10-MHz DU step loop PD A6 connector J4 (W4)
47 10-MHz DU step loop VCO A5 connector J4 (W18)
48 Output amplifier A11 connector J1 (W16)
49 1-MHz DU step loop A8 connector J1 (W3)
50 1-MHz DU step loop A8 connector J2 (W9)
51 Output amplifier A11 connector J3 (W23)
52 Output amplifier A11 connector J4 (W22)
53 Output amplifier A11
54 1-MHz DU step loop A8 connector J4 (W13)
55 1-MHz DU step loop VCO A8
56 1-MHz DU if mixer A9
57 1-MHz DU main loop VCO A10

1 Front panel assembly A1
2 1-MHz DU main loop VCO A10 connector J4 (W7)
3 1-MHz DU if. mixer A9 connector J4 (W10)
4 1-MHz DU main loop VCO A10 connector J3 (W10)
5 1-MHz DU main loop VCO A10 connector J2 (W11)
6 1-MHz DU if. mixer A9 connector J2 (W13)
7 1-MHz DU if. mixer A9 connector J1 (W11)
8 1-MHz DU main loop VCO A10 connector J1 (W12)
9 10-MHz DU if mixer A4 connector J4 (W21)
10 10-MHz DU main PD A3 connector J4 (W12)
11 10-MHz DU main VCO A2 connector J4 (W17)
12 10-MHz DU main PD A3 connector J3 (W21)
13 10-MHz DU main VCO A2 connector J3 (W16)
14 10-MHz DU if mixer A4 connector J3 (W14)
15 10-MHz DU if. mixer A4 connector J2 (W18)
16 10-MHz DU main PD A3 connector J2 (W15)
17 10-MHz DU if mixer A2 connector J1 (W15)
18 10-MHz DU main PD A3 connector J1 (W14)
19 10-MHz DU main VCO A4 connector J1 (W17)
20 10-MHz DU main loop VCO A2
21 10-MHz DU main PD A3
22 10-MHz DU if mixer A4
23 10-MHz DU step loop VCO A5 connector J2 (W20)
24 10-MHz DU step loop VCO A5 connector J1 (W19)
25 10-MHz DU step loop VCO A5
26 10-MHz DU step loop PD A6
27 10-MHz DU step loop PD A6 connector J1 (W25)
28 1-5-10 MHz amplifier A21
29 1-5-10 MHz amplifier A21 connector J1 (W26)
30 10-MHz DU step loop PD A6 connector J2 (W19)
31 1-5-10 MHz amplifier A21 connector J2 (W28)
32 Input filter A7 connector J1 (W1)
33 Input filter A7
34 Rear panel assembly A20
35 Frequency standard A15
36 Input filter A7 connector J2 (W3)
37 Power supply assembly A12
38 1-5-10 MHz amplifier A21 connector J3 (W27)
39 Heatsink assembly A20A1
40 Input filter A7 connector J3 (W2)
41 Transformer assembly A19
42 10-MHz DU step loop PD A6 connector J3 (W20)
43 1-5-10 MHz amplifier A21 connector J4 (W2)
44 Input filter A7 connector J4 (W4)
45 10-MHz DU step loop VCO A5 connector J3 (W25)
46 10-MHz DU step loop PD A6 connector J4 (W4)
47 10-MHz DU step loop VCO A5 connector J4 (W18)
48 Output amplifier A11 connector J1 (W16)
49 1-MHz DU step loop A8 connector J1 (W3)
50 1-MHz DU step loop A8 connector J2 (W9)
51 Output amplifier A11 connector J3 (W23)
52 Output amplifier A11 connector J4 (W22)
53 Output amplifier A11
54 1-MHz DU step loop A8 connector J4 (W13)
55 1-MHz DU step loop VCO A8
56 1-MHz DU if mixer A9
57 1-MHz DU main loop VCO A10

Figure 3-2.(1). Frequency synthesizer parts location diagram (sheet 1 of 2).



58 1-MHz DU main loop VCO A10 retaining hardware
59 1 MHz DU if mixer A9 retaining hardware
61 Output amplifier A11 retaining hardware
62 Motherboard A18
63 1-5-10 MHz amplifier A21 retaining hardware
64 10-MHz DU step loop PD A6 retaining hardware
65 10-MHz DU step loop VCO A5 retaining hardware
66 10 MHz DU if mixer A4 retaining hardware
67 10 MHz DU main PD A3 retaining hardware
68 10-MHz DU main VCO A2 retaining hardware
69 Digit generator A16 retaining bracket
70 Digit generator A16 retaining bracket
71 Retaining bracket
72 Digit generator A16

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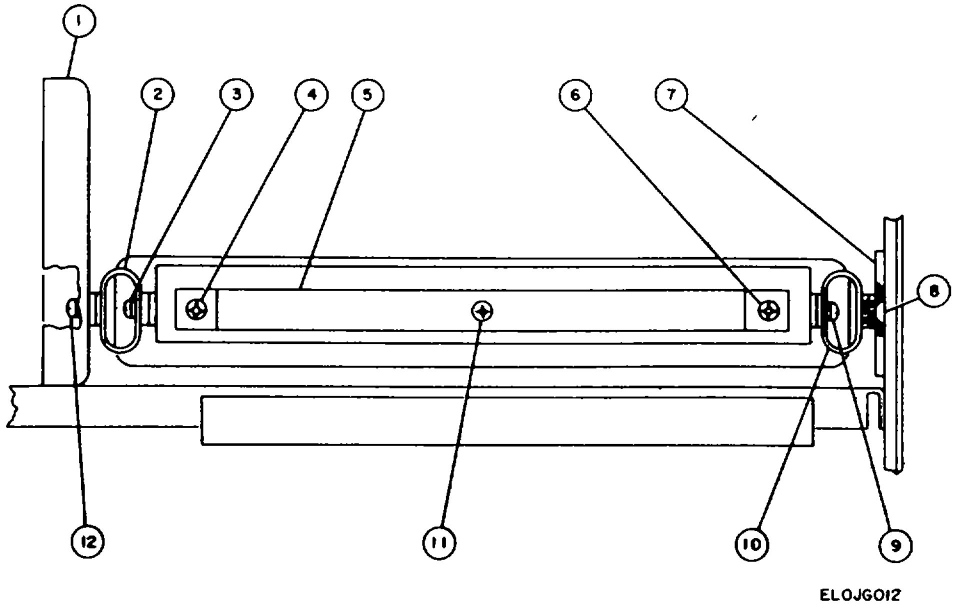


NOTE

Connector's associated cable numbers are shown in parenthesis.

Figure 3-2.(2). Frequency synthesizer parts location diagram (sheet 2 of 2).

3-13. Removal of Frequency Standard A15 (Fig 3-2).

a. Remove the four screws holding the frequency standard (35) to the chassis (two in hold-don clamp), two in L-shaped bracket).

b. With a gentle rocking motion, lift the frequency standard away from the chassis to disengage the socket mounting board from the chassis connector.

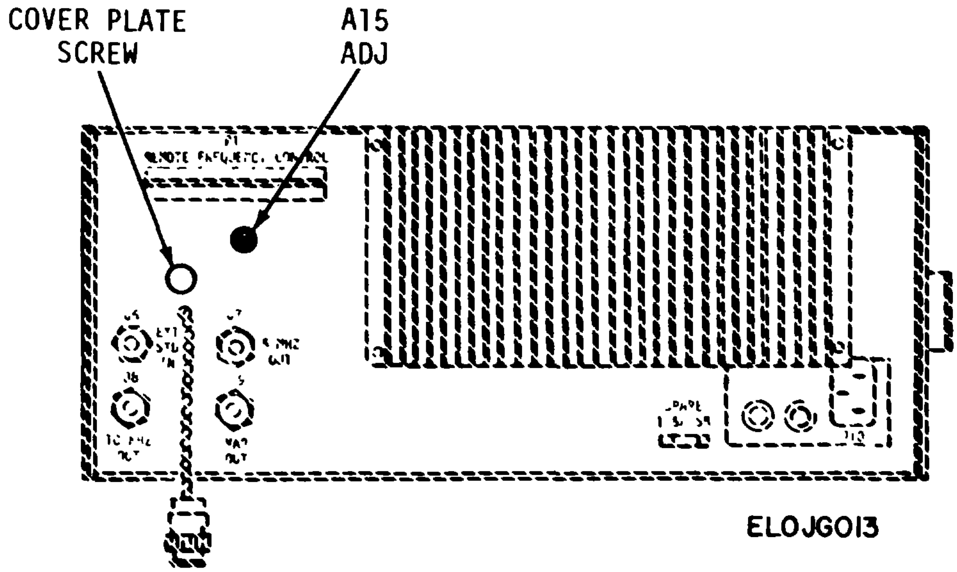
c. Disconnect the socket mounting board from the base of the frequency standard Use caution so as not to damage the rf cables In the area.

d. If it is necessary to remove the L-shaped mounting bracket from the frequency standard, remove the four nuts securing the bracket to the screw studs in the base of the frequency standard.

3-14. Removal of Transformer Assembly A19 (Fig 3-2).

a. Remove four Phillips head screws securing the heat-sink assembly to the rear panel assembly A20.

b. Remove two hex head screws securing the transformer assembly to the rear panel.



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1. Support bracket
2. Right-side resilient mount (including stiffener plates)
3. Right-side resilient mount retaining hardware (two screws, lockwashers, and flat washers)
4. Restraint bracket screw
5. Restraint bracket
6. Restraint bracket *screw*
7. Plate
8. Plate retaining hardware (four screws lockwashers, and flat washers)
9. Left-side resilient mount retaining hardware (two screws, lockwashers, and flat washers)
10. Left-side resilient mount
11. Spacer retaining screw
12. Right-side resilient mount retaining hardware (two screws, lockwashers, and flat washers)

Figure 3-3. Input filter module removed.

c. Remove two Phillips round head screws securing the transformer assembly to the side panel of the frequency synthesizer.

d. Remove two Phillips round head screws securing the transformer assembly to the frequency synthesizer chassis center plate.

e. Carefully loosen and disengage the transformer assembly printed circuit board connector from motherboard A18. Remove the transformer assembly with card retainer bracket from the frequency synthesizer chassis.

f. Remove four Phillips round head screws securing card retainer bracket to transformer assembly A19 and remove bracket.

NOTE

Card retainer bracket is to be used on new transformer assembly.

3-15. Removal of Motherboard A18

(Fig. 3-2.).

a. Remove power supply assembly A12. Refer to paragraph 3-12.

b. Remove frequency standard A15. Refer to paragraph 3-13.

c. Remove heat sink assembly from the rear panel of the frequency synthesizer.

d. Raise up digit generator A16 (paragraph 3-11) and unplug ribbon connector from the motherboard.

e. Remove bracket adjacent to digit generator by removing four Phillips round head screws.

f. Tag and unsolder all wires from motherboard A18.

g. Remove all hardware securing the motherboard A18 to the chassis and remove the motherboard.

3-16. Removal of Frequency Synthesizer

If it is necessary to remove the frequency synthesizer from the cabinet refer to TM 11-5895-833-34-1.

3-17. Power Supply A12 Adjustment

a. A digital voltmeter is used to accomplish adjustment of + 14 Vdc and -12 Vdc regulators of power supply A12.

b. Place digit generator A16 in service position with POWER switch set to OFF.

c. The + 14 Vdc and -12 Vdc adjustments are made through access holds of motherboard A18. (See fig. 3-1).

d. Connect digital voltmeter negative lead to -12 Vdc terminal on motherboard A18 and positive lead to ground.

e. Set POWER switch to ON and adjust -12V ADJ control (A19-R40) for -12 ±0.1 Vdc indication on digital voltmeter.

f. Connect digital voltmeter positive lead to + 14 Vdc terminal and negative lead to ground.

g. Adjust + 14V ADJ control (A19-R21) for +14 ±0.1 Vdc indication on digital voltmeter.

h. Disconnect digital voltmeter.

3-18. Frequency Standard A15 Adjustment

a. A frequency counter and 1 MHz frequency standard are used to accomplish adjustment of frequency standard A15.

b. Adjustment control for frequency standard A15 is accessed at the rear panel. (See fig. 3-3.)

c. Set POWER switch to OFF.

d. Connect frequency counter to VAR OUT connector J9 and synchronize counter to 1 MHz frequency standard.

e. Loosen access plate screw and push plate to uncover adjustment screw.

f. Set POWER switch to ON and wait for a period of 1 hour before proceeding.

g. Select a frequency of 8.3 GHz on up-converter or 7.7 GHz on down-converter.

h. Adjust frequency standard adjustment screw for an indication on frequency counter of 152.00000 MHz ±2 Hz if selection was made on up-converter or for 140.00000 MHz ±2 Hz if selection was made on down-converter.

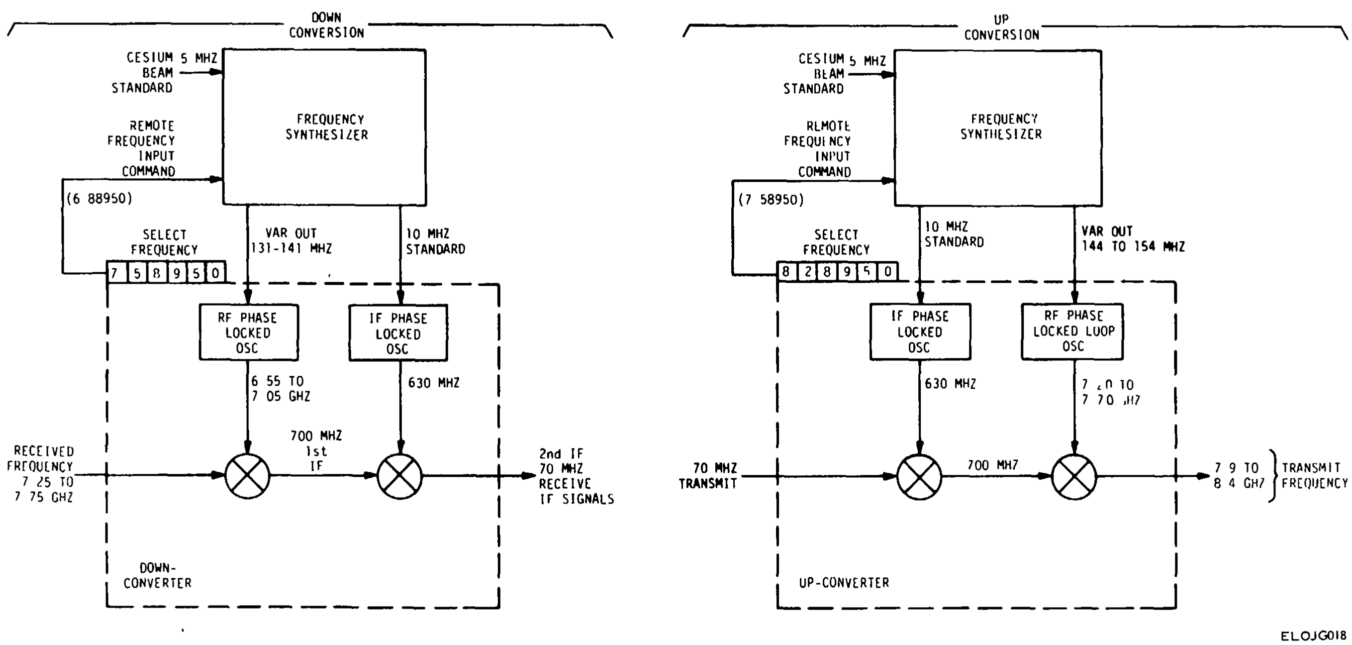


Figure 3-4. Frequency standard A15 adjustment.

CHAPTER 4

DIRECT AND GENERAL SUPPORT TESTING PROCEDURES

Section I. General

4-1. Introduction

a. The detailed testing procedures contained in this chapter present a comprehensive program to measure and determine the significant operating parameters of the frequency synthesizer. Each test represents a significant operating specification. In addition to utilization as an adjunct to troubleshooting and maintenance, these tests may be used as a checkout procedure, or a guide to rehabilitation of the frequency synthesizer.

b. All test procedures are performed with the frequency synthesizer under test installed in the frequency conversion subsystem. While the subsystem may be operating, the component under test (and its up- or down-converter) is always off-line. Before taking any component off-line to perform a test, record settings of the front panel controls and indicators to facilitate restoration of normal operating conditions after the test.

4-2. Test Equipment and Materials

a. Introductory test for each test procedure gives minimum specifications for general test equipment required in the performance of the particular procedure. Tests may be performed using any test equipment meeting these minimum specifications. Test equipment required for frequency synthesizer testing is listed in MAC.

b. Coaxial cable for general interconnections of test equipment is designated on test setup diagrams. Between-series connector adapters are given where their use is mandatory. Where use or selection of adapters may vary, depending on the particular external test equipment used, adapters are shown in the test setup diagrams.

c. To prevent introducing excessive dB losses, use the shortest available coaxial cable that will satisfy necessary test setup connections. The following cables are recommended for general interconnections of test set-ups.

Cable	*Connections*	*Length*	*Quantity*
RG-223( )/U	N male-BNC male	6 Ft	2
RG-223( )/U	N male-BNC male	3 Ft	1
RG-223( )/U	BNC male-BNC male	6 Ft	2
RG-223( )/U	BNC male-BNC male	4 Ft	2
RG-223( )/U	BNC male-BNC male	1 Ft	2

4-3. Frequency Synthesizer Physical Tests and Inspection

a. Test Equipment and Materials. Electric light fixtures MS-1292/PAQ is required.

b. Procedure. Perform physical Tests and inspection procedures described in table 4-1.

Table 4-1. Physical Tests and Inspections.

Step no.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	N/A	Controls may be in any position	*a.* Inspect all controls and mechanical assemblies for loose or missing screws and nuts.	*a.* Screws and nuts must be tight, none missing.
			b. Inspect POWER ON indicator lamp and status meter for cracked or broken glass.	*b.* Glass must not be cracked or broken.
			c. Inspect wires and cables for frayed or broken insulation.	*c.* Wires and cables must be free from frayed or broken insulation.

Table 4-1. Physical Tests and Inspections - (Cont'd)

Step no.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
			d. Inspect connectors for bent or broken pins, damaged insulation, or stripped threads.	*d.* Connector pins must be straight not broken. Insulation must be free from cracks, breaks, or signs of excessive wear. Threads must not be stripped.
			e. Inspect all finished surfaces for damaged paint, dirt, rust, corrosion, or bare metal.	*e.* Finished surfaces must be free from damaged paint, dirt, rust, or corrosion. Bare metal must not be evident.

4-4. Frequency Synthesizer Operational Power Test.

a. Test Equipment and Materials, None.

b. Test Connections and Conditions. The operational power test may be performed on an on-line frequency synthesizer operating from internal or external standard. The procedure is identical for testing any frequency synthesizer.

c. Procedure. Perform operational power test described in table 4-2.

Table 4-2. Frequency Synthesizer Operational Power Test.

Step no.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	N/A	POWER: ON	Observe POWER indicator lamp.	Lamp is lit.
2	N/A	Same as step 1.	*a.* Set METER FUNCTION switch to - 12 v. *b.* Set METER FUNCTION switch to + 14v. *c.* Set METER FUNCTION switch to + 5v.	*a.* Meter reads in green area. *b.* Meter reads in green area. *c.* Meter reads in green area. **NOTE** If meter readings are incorrect, refer to paragraph 3-17 and perform power supply A12 adjustment procedure.

4-5. Frequency Synthesizer Standard Output Test.

a. Test Equipment and Materials.

(1) Frequency counter (1 to 10 MHz; resolution to 1 MHz; 100-mV sensitivity).

(2) RF power meter (0 to 20 dBm at 1 to 10 MHz) with 50-ohm power detector.

(3) 6-dB attentuator (coaxial type, 1- to 10-Mhz range; 50 ohms).

(4) 1- MHz frequency-time standard.

b. Test Connections and Conditions The standard output test is performed with the frequency synthesizer under test off-line (disconnected from system cables) and operating on internal standard. The procedure is identical for testing any frequency synthesizer.

c. Internal Test Equipment Settings.

(1) Set all test equipment for 115-volt operation.

(2) Set frequency counter for fast recycle rate and external time base operations.

(3) Connect test equipment to ac power source. Turn on test equipment, and allow a 10-minute warm-up period.

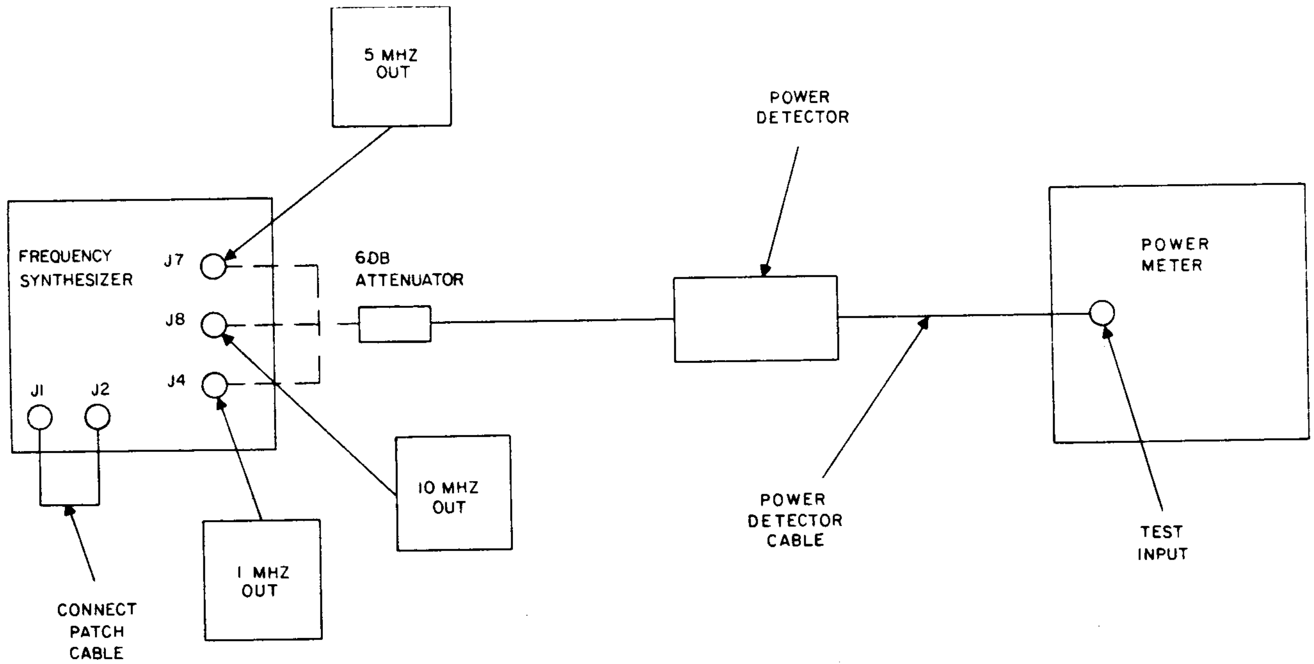
d. Procedure. Perform standard output test described in table 4-3.

Table 4-3. Frequency Synthesizer Standard Output Test.

Step no.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
1	*Frequency counter:* Power: On Resolution: 1MHz	POWER: ON	*a.* Connect frequency counter to J1 INT STD OUT.	*a.* Measured frequency should be 5MHZ ± 1MHz. Record measured frequency.
			b. Disconnect frequency counter and connect patch cable to frequency synthesizer front panel between J1 INT STD OUT and J2 SYNTH IN.	*b.* None.
			c. Connect 50-ohm termination at J3 EXT STD OUT and counter to J7 5 MHz OUT connector at rear panel.	*c.* Measured frequency is same as recorded in step *a.*
			d. Adjust internal frequency standard until frequency counter reads 3 counts off from present frequency and record frequency.	*d.* None.
			e. Connect frequency counter to J1 INT STD OUT.	*e.* Measured frequency recorded in step *d.*
2	Same as step 1	Same as step 1	*a.* Select a frequency 8.300GHz on up-converter or 7.700GHz on down-converter.	*a.* None.
			b. Disconnect frequency counter and connect patch cable to frequency synthesizer front panel between J1 INT STD OUT and J2 SYNTH IN.	*b.* None.
			c. Connect frequency counter to J5 SAMPLE OUT on front panel of synthesizer.	*c.* Measured frequency of 152.00000MHz ± 2Hz for up-converter or 140.00000MHz ± 2Hz for down-converter.
			d. If the above performance standard is not met, troubleshoot IAW FO-6.	*d.* None.

Table 4-3. Frequency Synthesizer Standard Output Test - (Cont'd).

Step no.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
3	*Power meter:* Power: On *Frequency Counter:* Power: On Resolution: 1Hz	POWER: ON	*a.* Connect test equipment as shown in figure 4-1 with test cable connected to J7 5MHz OUT on frequency synthesizer rear panel.	*a.* Measured power is + 13 dBm ± 2 dBm.
			b. Connect test equipment as shown in figure 4-2, with test cable connected to J7 5MHz OUT.	*b.* Measured frequency is 5 MHz ± 1Hz.
			c. Disconnect test cable from J7 and replace with 50-ohm pigtail termination. Reconnect frequency synthesizer to system.	*c.* None.
4	Same as step 3.	Same as step 3.	*a.* Connect test equipment as shown in figure 4-1, with test cable connected to J8 10 MHz OUT of frequency synthesizer rear panel.	*a.* Measured power is +8 dBm ± 2 dB.
			b. Connect test equipment as shown in figure 4-2, with test cable connected to J8 10 MHz OUT.	*b.* Measured frequency is 10 MHz ± 1 Hz.
			c. Disconnect test cable from J8.	*c.* None.
5	Same as step 3	Same as step 3.	*a.* Connect test equipment as shown in figure 4-1, with test cable connected to J4 1 MHz OUT on frequency synthesizer front panel.	*a.* Measured power is +13dBm ± 1dBm.
			b. Connect test equipment as shown in figure 4-2, with test cable connected to J4 1 MHz OUT.	*b.* Measured frequency is 1 MHz ± 1 MHz.
			c. Disconnect test equipment and reconnect 50-ohm termination to J4.	*c.* None.
6	N/A	N/A	Connect patch cable on frequency synthesizer front panel between J3 EXT STD OUT and J2 SYNTH IN. Connect 50-ohm termination to J1 INT STD OUT.	None.



NOTE:

UNLESS OTHERWISE INDICATED ALL
TEST CABLES ARE TYPE RG-223/U.

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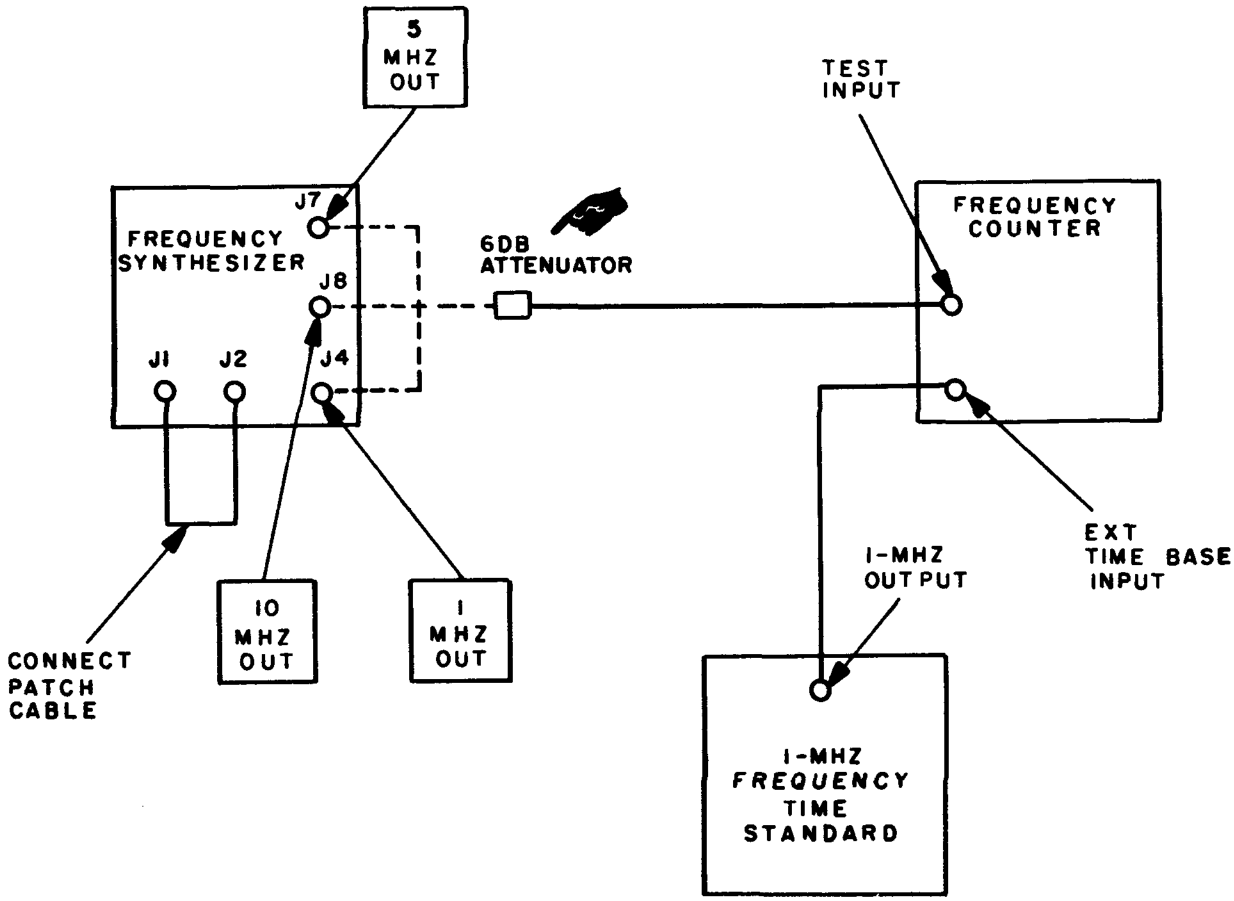
Figure 4-1. Frequency Synthesizer, Standard Outputs Test Setup No. 1.



NOTE:

UNLESS OTHERWISE INDICATED, ALL TEST
CABLES ARE TYPE RG-223/U

ELOJG015

Figure 4-2. Frequency Synthesizer, Standard Outputs Test Setup No. 2.

4-6. Frequency Synthesizer Synthesized Output Test.

a. Test Equipment and Materials.

(1) Frequency counter (131 to 154 MHz; resolution to 1 Hz; 100-mV sensitivity).

(2) RF power meter (0- to 10-dBm at 131 to 154 MHz) with 50-ohm power detector.

(3) Remote frequency controls (Comtech 4040003461 and 4040003462).

(4) 1-MHz frequency-time standard.

b. Test Connections and Conditions. The synthesized output test is performed with the frequency synthesizer under test off-line and operating on internal standard. Transfer to internal standard by connecting the patch cable on the frequency synthesizer front panel between J1 INT STD OUT and J2 SYNTH IN, and the 50-ohm termination to J3 EXT STD OUT. The procedure is identical for testing any frequency synthesizer.

c. Initial Test Equipment Settings.

(1) Set all test equipment for 115-volt operation.

(2) Set frequency counter for fast recycle rate on external time base operation.

(3) Connect test equipment to ac power source. Turn on test equipment, and allow a 10-minute warm-up period.

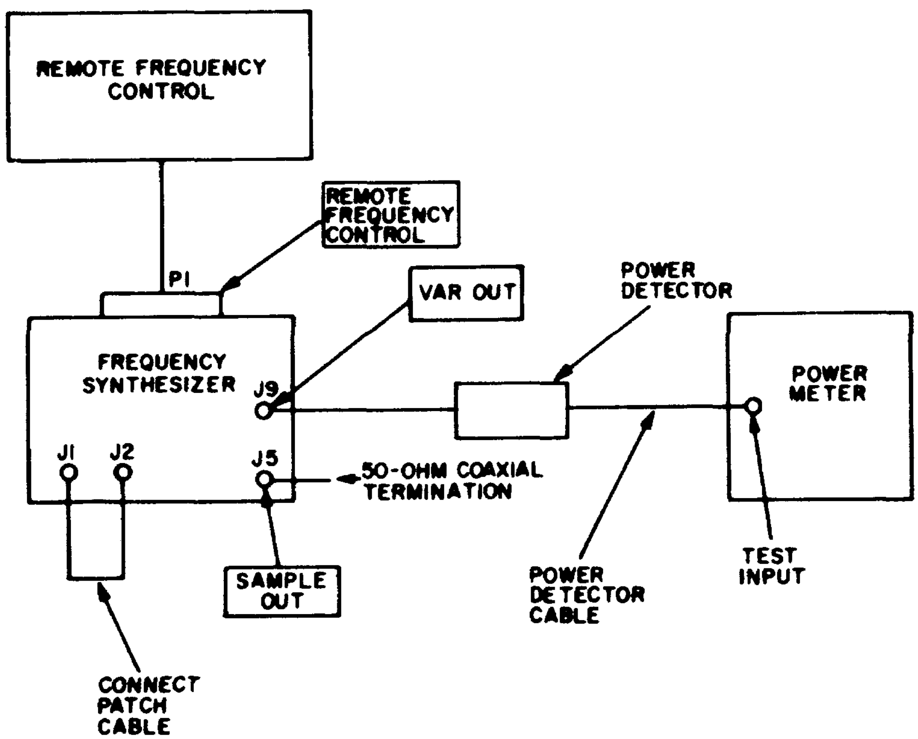
d. Procedure. Perform output test described in table 4-4.

Table 4-4. Frequency Synthesizer Output Test.

Step no.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
			NOTE To test frequency synthesizer when used with up-converter perform procedures in steps 1, 3, and 4. To test frequency synthesizer when used with down-converter perform procedures in steps 2, 3, and 4.	
1	*Power meter:* Power: On *Frequency counter:* Resolution: 1Hz.	POWER: ON	*a.* Connect test equipment as shown in figure 4-3, using remote frequency control TF-3461. *b.* Set dial up-converter to 8400.000 MHz *c.* Connect test equipment as shown in figure 4-4, using TF-3461 (still set at 8400.000 MHz). *d.* Set dial-up converter to each of the following frequencies: 7911.111 MHz 7922.222 MHz 8033.333 MHz 8144.444 MHz 8255.555 MHz	*a.* POWER indicator lamp is lit. *b.* Measured power is + 6 dBm ± 2 dB. *c.* Measured frequency at J9 is 154 MHz ± 1Hz. Measured power at J5 is -7 dBm ± 2 dB. *d.* Measured frequencies (+ 1 Hz) are: 1444222220 Hz 1444444440 Hz 1466666660 Hz 1488888880 Hz 1511111110 Hz
2	Same as step 1.	Same as step 1.	*a.* Connect test equipment as shown in figure 4-3, using remote frequency control TF-3462. *b.* Set dial-down converter to 7700.000 MHz. *c.* Set dial-down converter to 7250.000 MHz. *d.* Connect test equipment as shown in figure 4-4, using remote frequency control TF-3462 (still set at 7250.000 MHz).	*a.* POWER indicator lamp is lit. *b.* Measured power is +6 dBm ± 2dBm. *c.* Measured power is +6 dbm ± 2 dBm. *d.* Measured frequency at J9 is 131 MHz ± 1 Hz. Measured power at J5 is - 7 dBm ± 2 dB.

Table 4-4. Frequency Synthesizer Output Test (Cont'd).

Step no.	Control settings: Test equipment	Control settings: Equipment under test	Test procedure	Performance standard
			e. Set dial-down converter to 7700.000 MHz.	*e.* Measured frequency at J9 is 140 MHz ± 1 Hz. Measured power at J5 is - 7 dBm ± 2 dB.
			f. Set dial-down converter to each of the following frequencies: 7366.666 MHz 7477.777 MHz 7588.888 MHz 7699.999 MHz	*f.* Measured frequencies (± 1 Hz) are: 133333320 Hz 135555540 Hz 137777760 Hz 139999980 Hz
3	N/A	N/A	Disconnect test equipment; connect 50-ohm termination to J4. Reconnect frequency synthesizer to system.	None.
4	N/A	N/A	Connect patch cable on frequency synthesizer front panel between J3 EXT STD OUT and J2 SYNTH IN. Connect 50-ohm pigtail termination to J1 INT STD OUT.	None.



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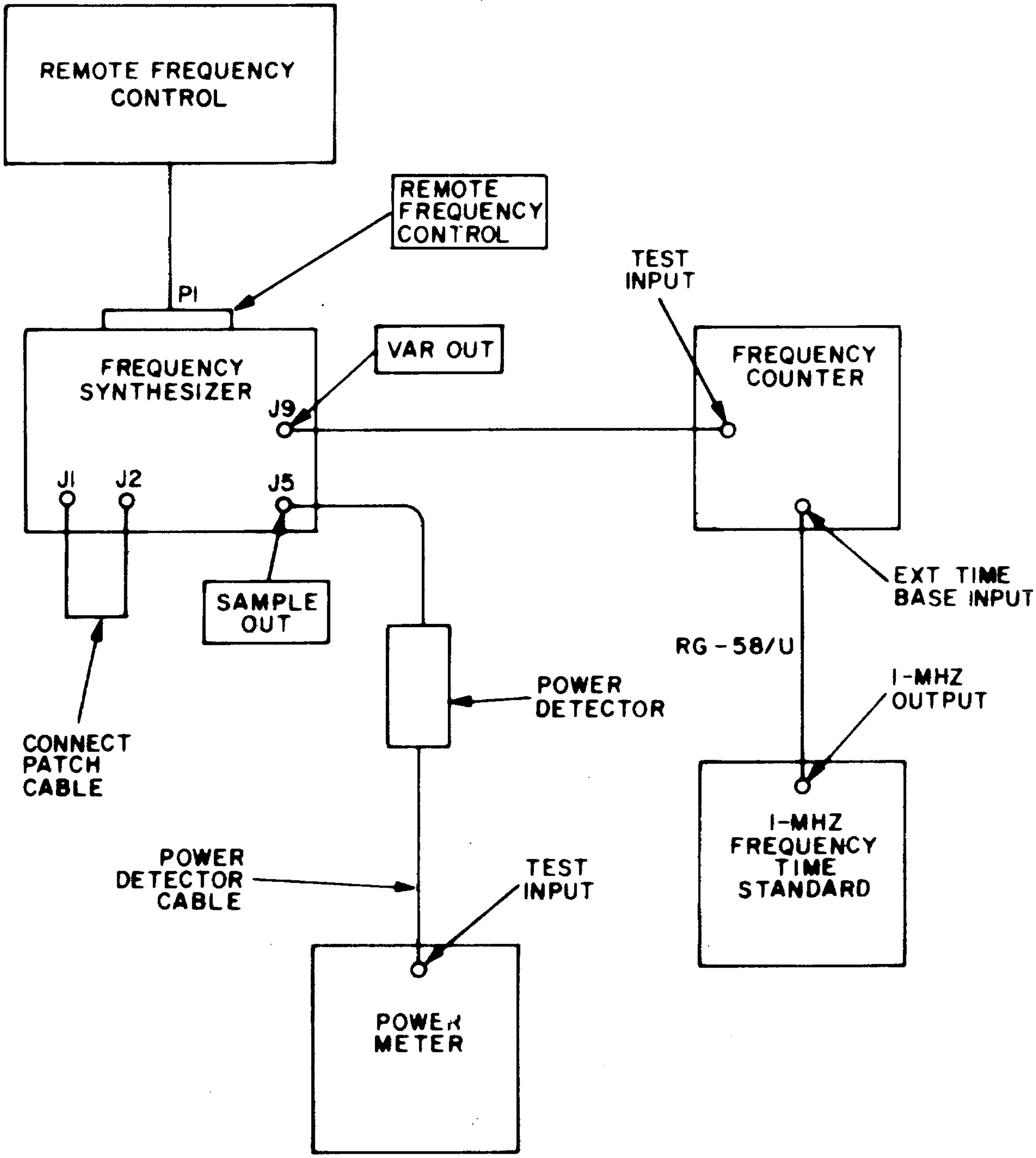
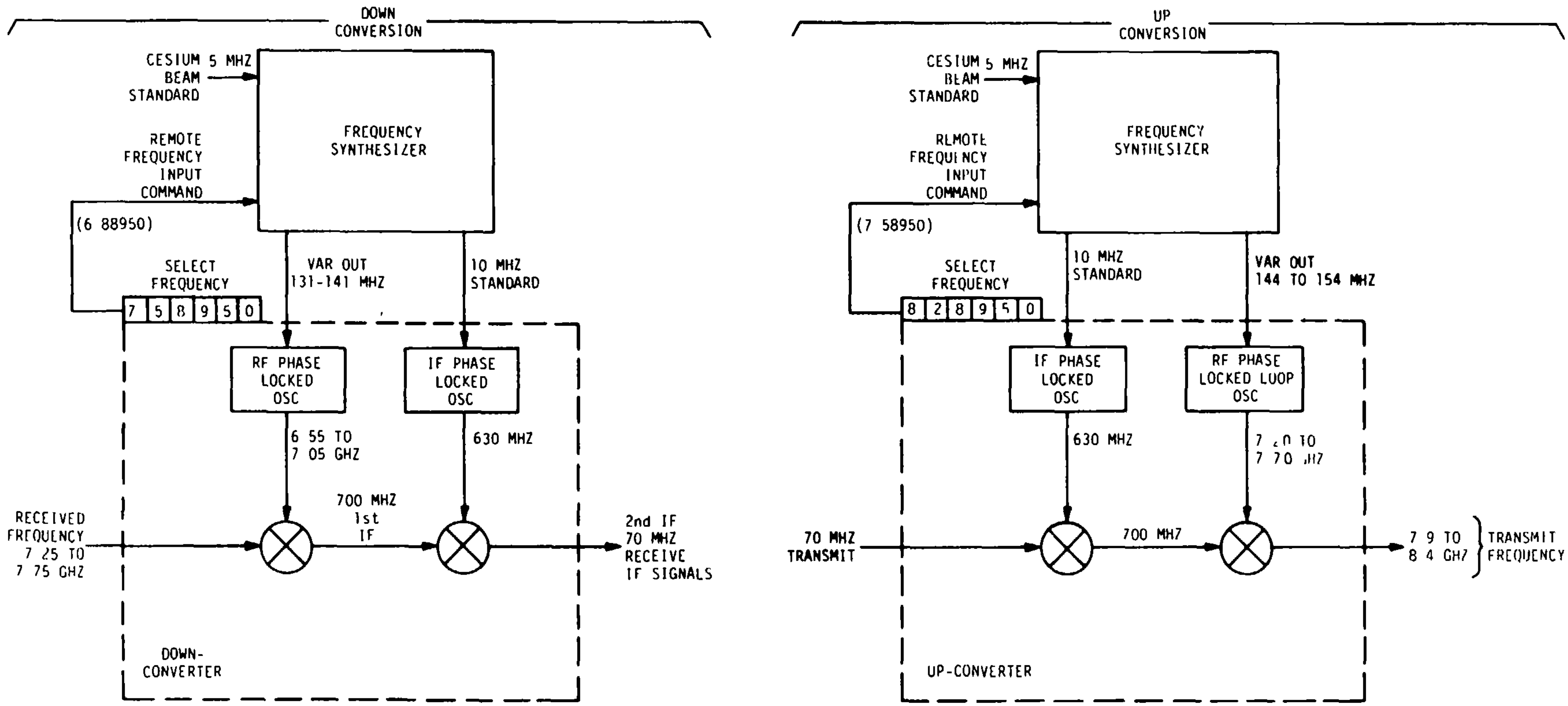
NOTE:
UNLESS OTHERWISE INDICATED, ALL TEST CABLES ARE TYPE RG-223/U.

Figure 4-3. Frequency synthesizer, synthesizer output test setup No.1.



NOTE:
UNLESS OTHERWISE INDICATED, ALL TEST CABLES ARE TYPE RG-223/U.

Figure 4-4. Frequency synthesizer, synthesized output test setup No.2.



ELOJG018

Figure FO-1. Frequency synthesizer in conversion loop.

APPENDIX A

REFERENCES

Number	*Title*
AR 380-5	Military Security
DA PAM 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (Types 7,8, and 9), Supply Bulletins and Lubrication Orders
DA PAM 310-7	US Army, Equipment and Index of Modification Work Orders
TM 11-5895-833-12	Operator's and Organizational Maintenance Manual Frequency Conversion Subsystem for Satellite Communication Terminal AN/TSC-54 *[*NAVELEX 0967-LP-550-1010/31R5-2TSC54-91*]*
TM 11-5895-833-34-1	Direct Support and General Support Maintenance Manual-Frequency Conversion Subsystem for Satellite Communication Terminal AN/TSC-54 *[*NAVELEX 0967-LP-550-1030/31R5-2TSC54-102*]*
TM 11-5895-833-34-2	Direct Support and General Support Maintenance Manual for Converter, Frequency, Electronic CV-3048/MSC-46(V); CV-3084A/MSC-46(V) *[*NAVELEX 0967-LP-550-1050/31R5-2MSC46-2*]*
TM 11-5895-833-34-4	Direct Support and General Support Maintenance Manual Amplifier, Radio Frequency AM-6631/MSC-46(V) *[*NAVELEX 0967-LP-550-1090/31R5-2MSC-22*]*
TM 11-5895-833-34-5	Direct Support and General Support Maintenance Manual Test Translator SM-F-753378 *[*NAVELEX 0967-LP-550-1110/31R5-2TSC54-112*]*
TM 11-5895-833-34-6	Direct Support and General Support Maintenance Manual Equalizer, Group Delay CN-1425/MSC-46(V) *[*NAVELEX 0967-LP550-1130/31R5-2MSC46-32*]*
TM 11-5895-833-34-7	Direct Support and General Support Maintenance Manual Converter, Frequency, Electronic CV-3085/MSC-46(V), CV-3085A/MSC-46(V) *[*NAVELEX 0967-LP-550-1150/31R5-2MSC46-42*]*
TM 11-5895-833-34P-1	Direct Support, and General Support Maintenance Repair Parts and Special Tools Lists (Including Depot Maintenance Repair Parts and Special Tools) for Frequency Conversion Subsystem for Satellite Communications Terminal AN/TSC-54 *[*NAVELEX 0967-LP-550-1040/31R5-2TSC54-104*]*
TM 11-5895-833-34P-2	Direct support, and General Support Maintenance Repair Parts and Special Tools Lists (Including Depot Maintenance repair Parts and Special Tools) for Converter, Frequency, Electronic CV-3084/MSC-46(V); *[*NAVELEX 0967-LP-550-1060/31R5-2MSC46-4*]*
TM 11-5895-833-34P-3	Direct Support and General Support Maintenance Repair Parts and Special Tools Lists (Including Depot Maintenance Repair Parts and Special Tools) for Synthesizer, Electrical Frequency O-1658/MSC-46(V) (NSN 5895-00-127-4825) *[*NAVELEX 0967-LP-550-1080/31R5-2MSC46-14*]*
TM 11-5895-833-34P-4	Direct Support and General Support Maintenance Repair Parts and Special Tools Lists (Including Depot Maintenance Repair Parts and Special Tools) for Amplifier, Radio Frequency AM-6631/MSC-46(V) (NSN 5820-00-155-8574) *[*NAVELEX 0967-LP-550-1100/31R5-2MSC46-24*]*

TM 11-5895-833-34P-5	Direct Support, and General Support Maintenance Repair Parts and Special Tools List (Including Depot Maintenance Repair Parts and Special Tools) for Test Translator [NAVELEX 0967-LP-550-1120/31R5-2TSC54-114]
TM 11-5895-833-34P-6	Direct Support, and General Support Maintenance Repair Parts and Special Tools List (Including Depot Maintenance Repair Parts and Special Tools) Equalizer, Group Delay CN-1425/MSC-46(V (NSN 5820-00-155-8572) /NAVELEX 0967-LP-550-1140/31R5-2MSC46-34]
TM 11-5895-833-34P-7	Direct Support, and General Support Maintenance Repair Parts and Special Tools Lists.(Including Depot Maintenance Repair Parts and Special Tools) for Converter, Frequency, Electronic CV-3085/ MSC-46(V); CV-3085A/MSC-46(V) [NAVELEX 0967-LP-550-1160/31R5-2MSC46-44]
TM 11-5895-833-20P	Organizational Maintenance Repair Parts and Special Tools List for Frequency Conversion Subsystem for Satellite Communications Terminal AN/TSC-54 [NAVELEX 0967-LP-550-1020/31R5-2TSC54-94

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Ft Huachuca (10)
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LBAD (14)
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SHAD (3)
Ft Gilem (10)
Sig FLDMS (1)

NG: None
USAR: None
For explanation of abbreviations used, see AR 310-50

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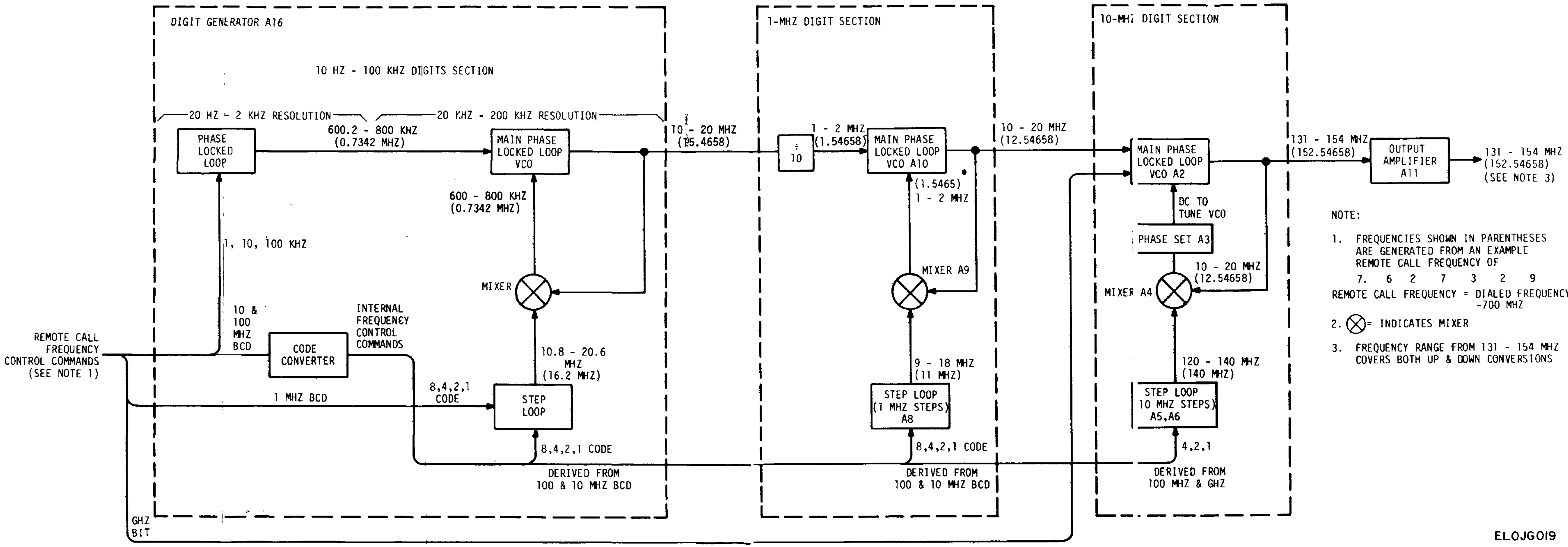


Figure FO-2. Frequency control section, black diagram.

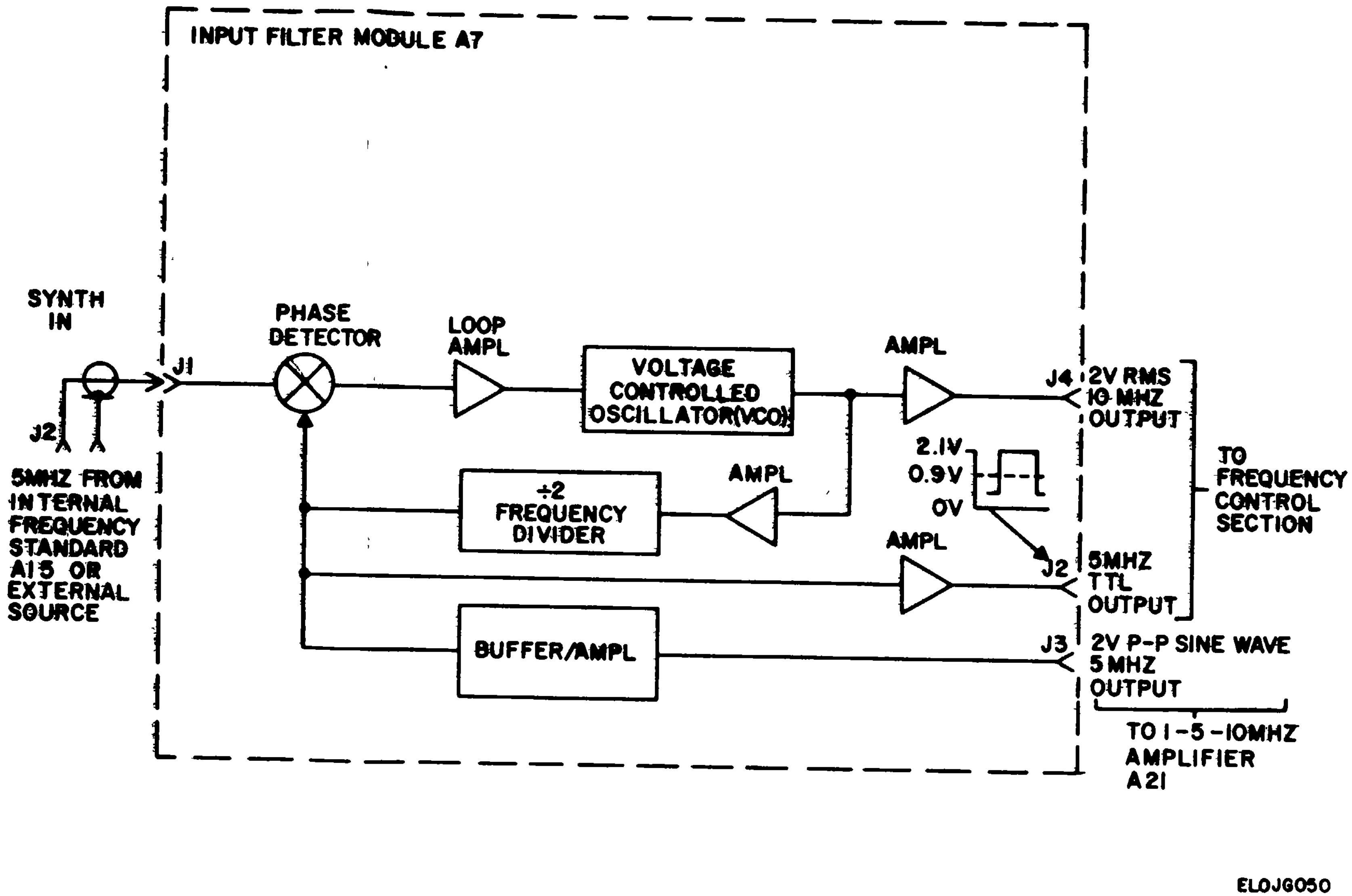


Figure FO-3. Input Filter Module A7, Block Diagram.

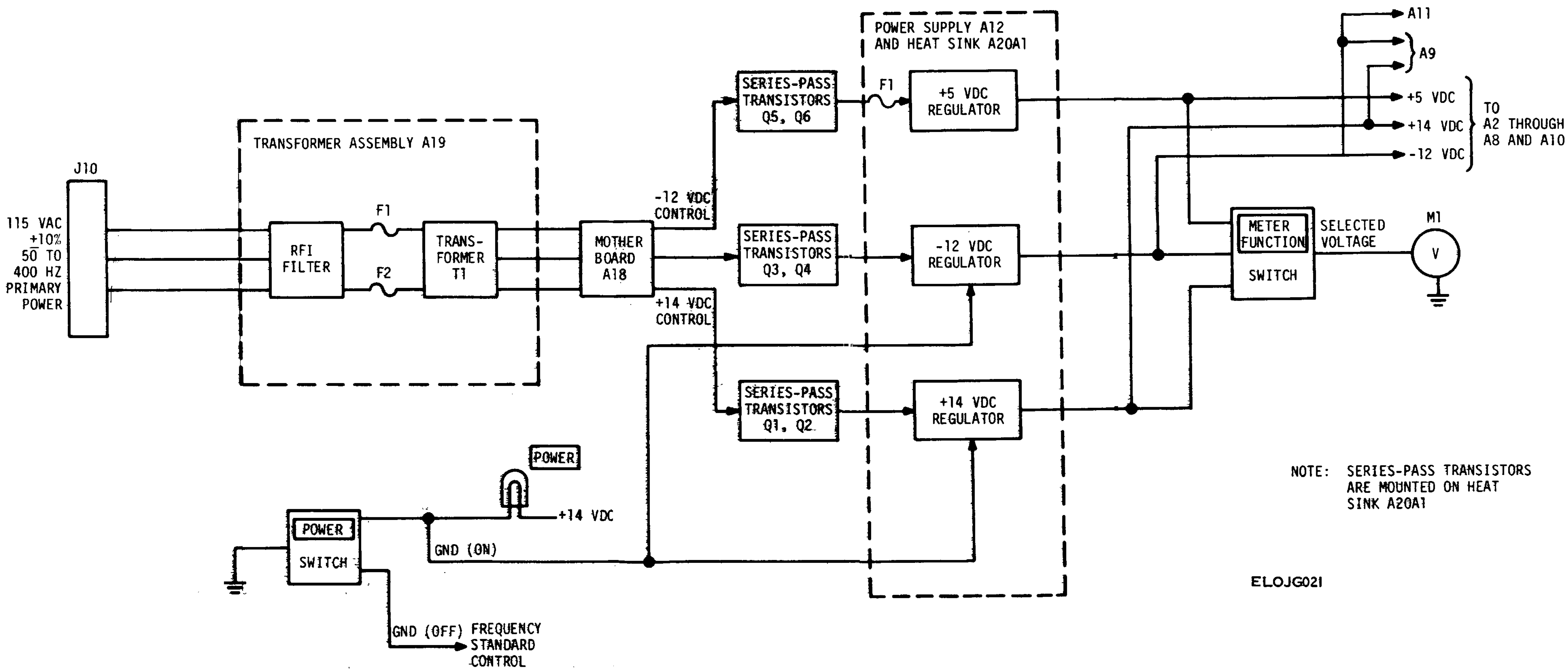
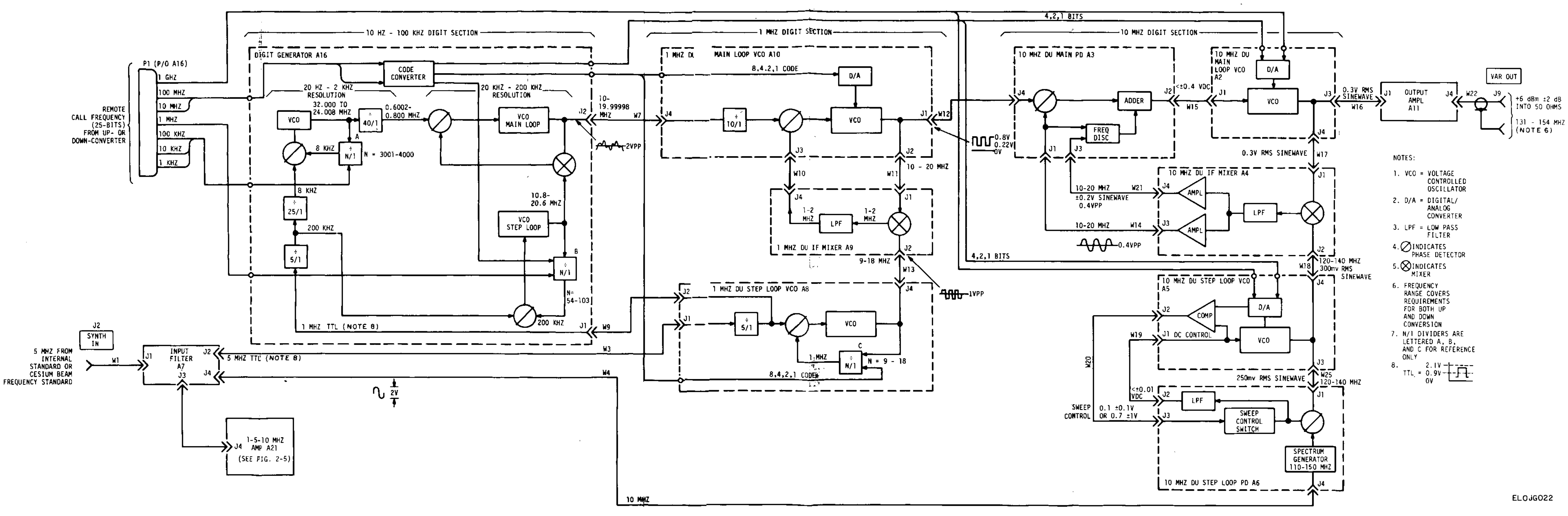


Figure FO-4. Power distribution, block diagram



■ *Figure FO-5. Frequency control section ,detailed block diagram.*

Change 4

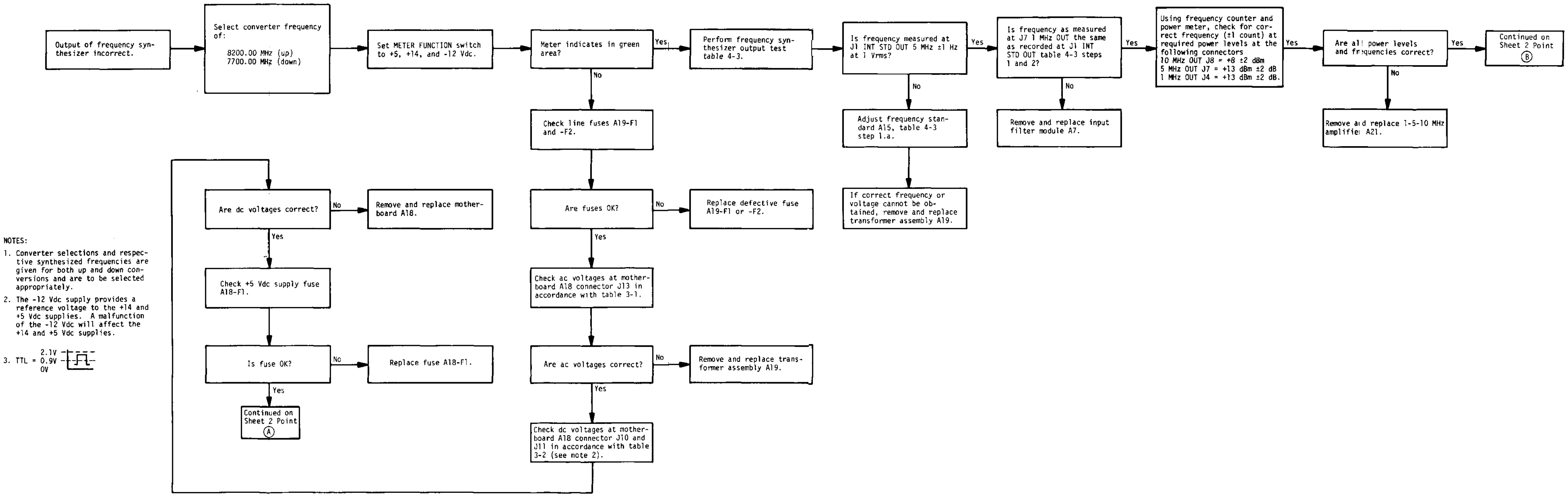


Figure FO-6. Frequency synthesizer troubleshooting flow diagram (sheet 1 of 3).

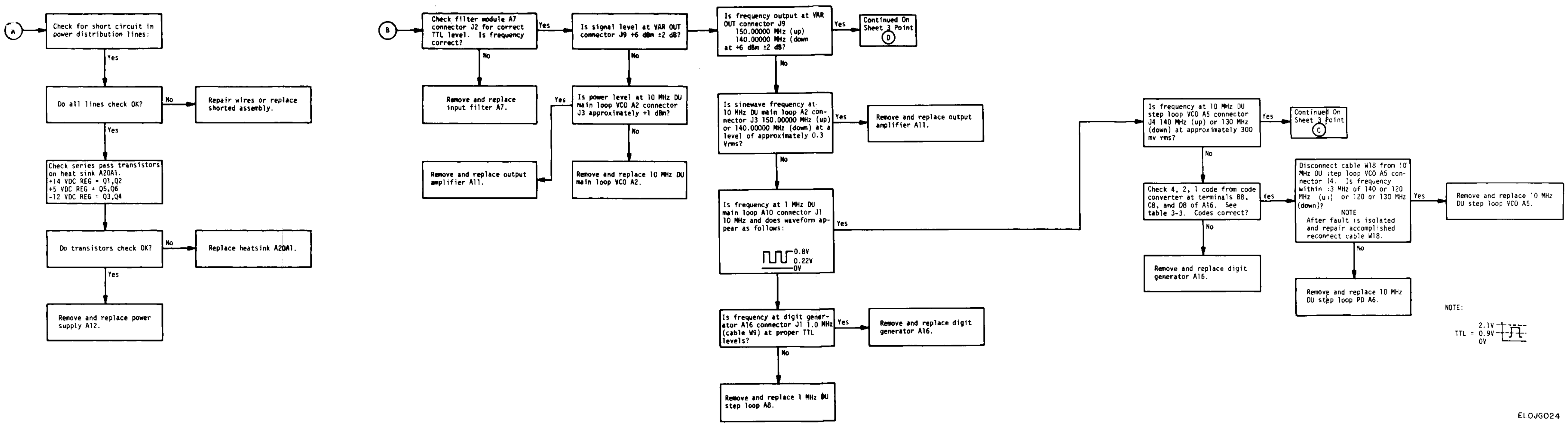


Figure FO-6.(2).Frequency synthesizer, troubleshooting flow diagram (sheet 2 of 3).

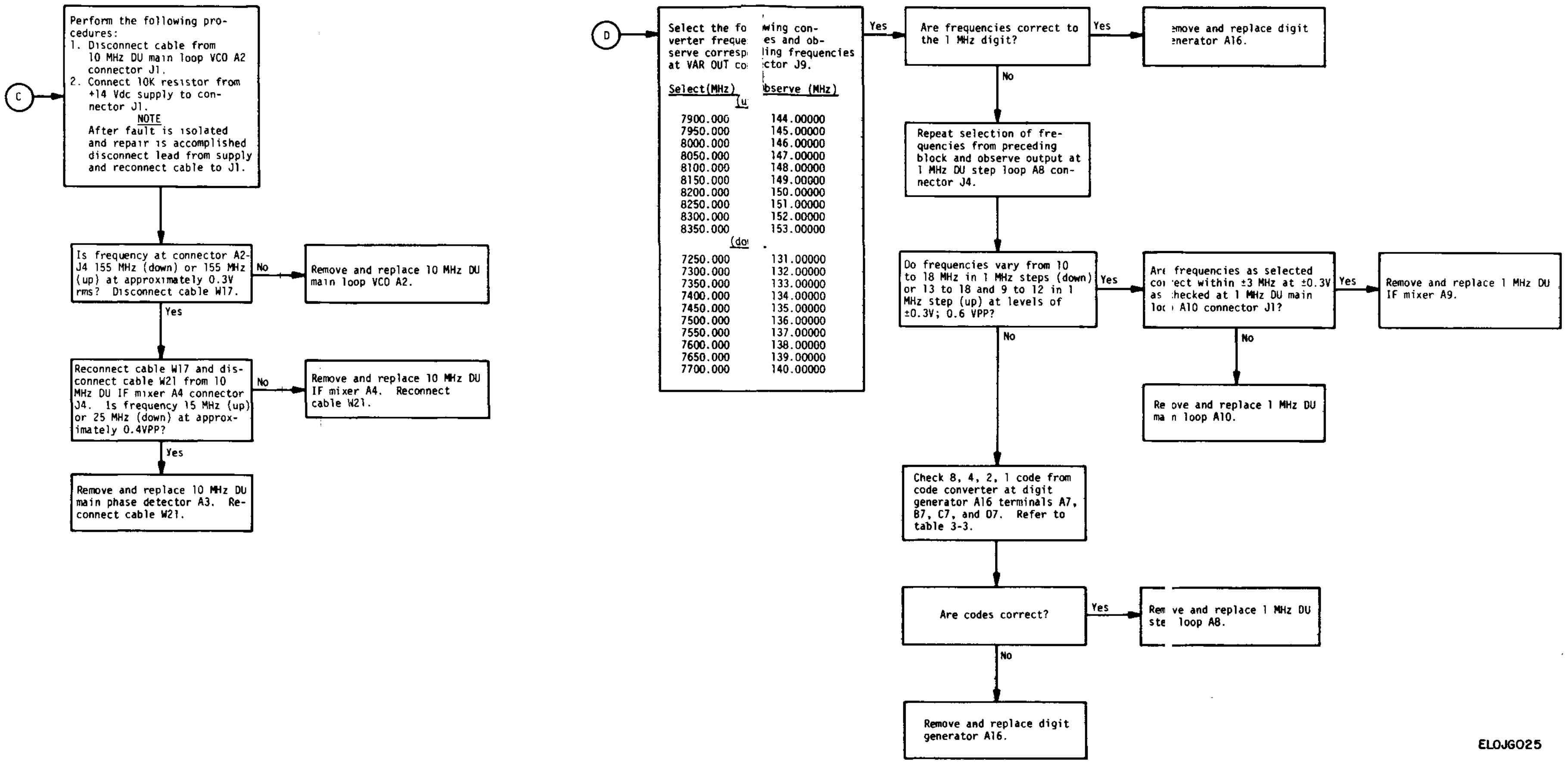


Figure FO-6. Frequency synthesizer, troubleshooting flow diagram (sheet 3 of 3)

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