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CSEL FREQUENCY CONVERTERS

COMPUTER SCIENCES CORPORATION
6565 Arlington Boulevard
Falls Church, Virginia 22046

February 1976

TECHNICAL REPORT AFAL-TR-75-146

Final Report for 1 March 1975 to 1 May 1975

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This final report was submitted by Computer Sciences Corporation, 6565 Arlington Blvd., Falls Church, Virginia 22046, under contract F33615-74-C-1186 job order 12271216, with Air Force Avionics Laboratory, Wright-Patterson AFB, Ohio. Wade T. Hunt AFAL/AAF-2 was the Laboratory Project Engineer.

This technical report has been reviewed and is approved for publication.

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2x10 to the minus 8th power

20. ABSTRACT (Continue on reverse side if necessary and identify by block number):

To evaluate various Air Force receivers and transmitters in a satellite communications application, it is necessary to convert their operating frequencies to frequencies within the capabilities of the K-Band Terminal Simulator portion of CSEL. This report describes four frequency converters provided for this purpose. Each includes a local oscillator with a stability of 2×10^{-8} per day so that the frequency drift should be negligible and, in addition, each converter uses dual conversion so that the output signal is

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not inverted when compared to the input signal. Two converters are provided which convert input signals of 700 MHz to 560 MHz and the remaining two convert 367.5 MHz to 700 MHz and 367.5 MHz to 560 MHz. Input and output levels can be as high as 0 dBm except for the 367.5 to 560 MHz converter, which will accept input signals as high as +30 dBm (1 watt).

PREFACE

The work reported herein was conducted at Computer Sciences Corporation, Falls Church, Virginia for the Hybrid Simulation Group, Air Force Avionics Laboratory, Air Force Wright Aeronautical Laboratories, Wright-Patterson AFB, Ohio, under contract F33615-74-C-1186. The contract was initiated under project 1227, Advanced Microwave Technology, Task 122712, Millimeter Wave Terminal, with Wade T. Hunt (AFAL/AAF-2) as project engineer.

Research under this contract was conducted from 12 May 1974 to 1 May 1975 and the report was submitted by the authors in June 1975.

The authors of the report are Mr. Douglas O. Alwine and Mr. Frederick J. Rose.

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SECTION I

INTRODUCTION

To accomplish its task of testing various receivers and transmitters in Air Force satellite communications applications, the Air Force Avionics Laboratory required four frequency converters to convert receiver of transmitter frequencies to those that can be accepted by the K-Band Terminal Simulator portion of CSEL. This report describes these four frequency converters.

The K-Band Terminal Simulator generates two signals that represent satellite users. Carrier modulation is accomplished at a frequency of 560 MHz. Doppler shift and fade are then applied to the signal prior to internal frequency conversion to the various output bands. If a modulated carrier of the user's choice is converted to 560 MHz, it can be used to replace the internally generated carrier. Doppler and fade can be applied to the external signal and it can be tuned to any of the normal K-Band Terminal Simulator output frequencies.

SECTION II

FREQUENCY CONVERTERS

1. INTRODUCTION

Frequency converter No. 1 is used to convert the 700-MHz output of a satellite signal processor to 560 MHz. The 560-MHz signal then enters the K-Band Terminal Simulator and replaces one of the existing accesses. Frequency converter No. 2 also converts the signal processor output to 560 MHz and contains a switch that can be used for switching between Frequency Converters Nos. 2 and 4. Frequency converter No. 3 converts a 367-MHz signal to 700 MHz and No. 4 accepts a 367-MHz output signal from a transmitter and converts it to 560 MHz.

All four converters are dual conversion, designed to have a 64-MHz bandwidth, and cause no spectrum inversion. All, except the 367 to 560 MHz unit, are designed for an input and output level of 0 dBm. The 367- to 560-MHz unit has an input that accepts signals as large as +30 dBm (1 watt) and has a maximum output level of 0 dBm.

All four frequency converters are mounted in the upper two panels of the hardware rack. One panel contains both of the 700 to 560 MHz units and the other panel contains the remaining two (3 and 4). Front panel photographs are provided in Figures 1 and 2. Photographs of the rear panels are provided in Figures 3 and 4.

2. DESCRIPTION OF OPERATION

From Figure 5, both of the 700- to 560-MHz converters are essentially identical; the only difference is in switch A13. Two local oscillators A1 and A7, are provided, and each has its output split and used by both converters. The first conversion changes the input frequency of 700 to 1,790 MHz. The signal is then filtered and downconverted to 560 MHz. The 560 MHz signal is then filtered, amplified and filtered again. Each frequency conversion inverts the spectrum and, therefore, the two conversions result in a frequency-translation without inversion.

Figure 6 is a schematic diagram of the remaining two converters; 367.5 to 560 MHz and 367.5 to 700 MHz. Both converters share only the first local oscillator and A1 splits the first local oscillator signal for use by mixers A2 and A5. Both converters upconvert the incoming signal of 367.5 to 1260 MHz. Once the first conversion has been accomplished, A3 uses a 1,960-MHz signal to convert this frequency down to 700 MHz and A6 uses an 1,820-MHz signal to downconvert to 560 MHz. As with the first two converters, the signals are filtered and amplified.

All of the local oscillators are crystal-controlled and have a frequency stability of 2×10^{-8} per day. In each case the crystal oscillator is followed by a frequency multiplier that provides the required output frequency. The output line from each crystal oscillator includes a directional coupler. This coupler is connected to a rear panel connector so that a test point is available at which the output level and frequency of the local oscillators can be checked without removing the units from the rack.

The operation of these units is simple because they do not need to be tuned or adjusted. Power is applied by turning on the power supply located near the bottom of the rack. Input and output connectors are provided on both the front and rear panels.

3. TROUBLESHOOTING AND REPAIR

These units should need little maintenance. If trouble is encountered, the oscillators should be checked first. Rear panel connectors have been provided for this. If none of the oscillators operate properly, the 28-volt power supply in the bottom of the rack should be checked.

If the oscillators work properly but one or more converters malfunction, the unit will have to be removed from the rack, and a signal will be logically traced from input to output.

Figures 7 and 8 are photos of the interior of the assemblies to assist in locating parts shown on the schematic.

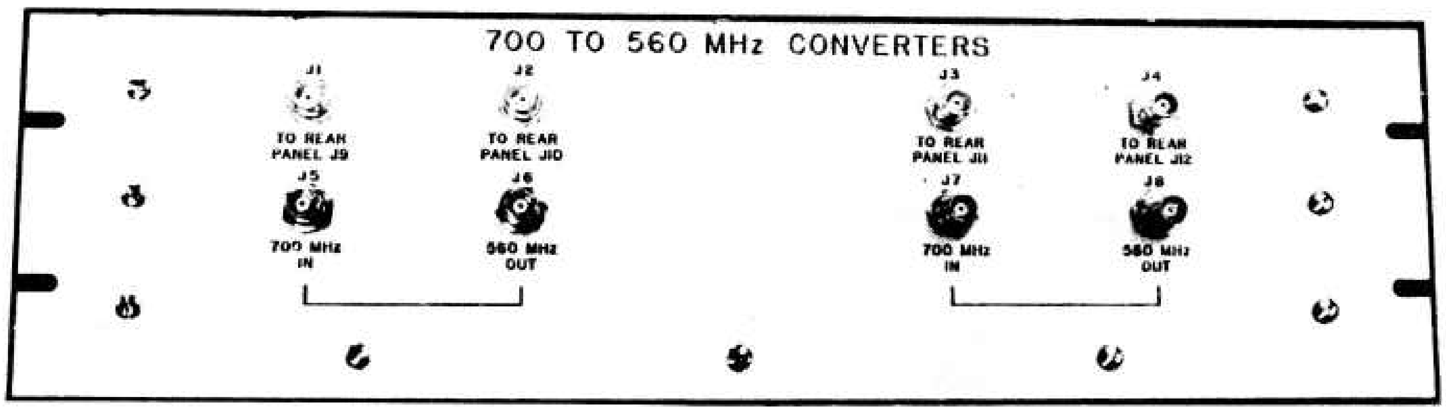

Figure 1. 700 to 560 MHz Converters, Front Panel

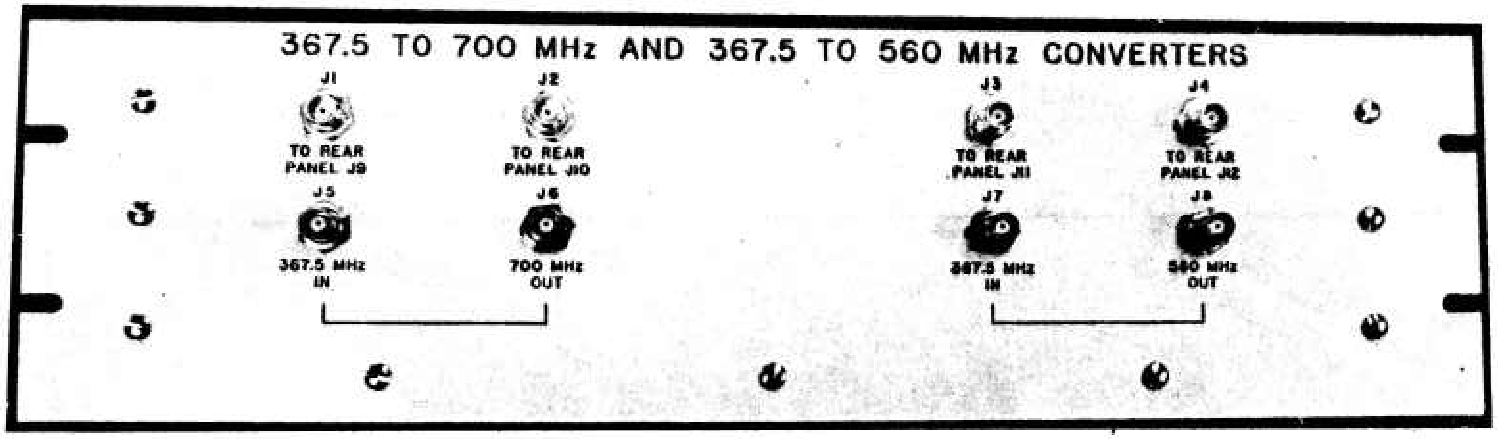

Figure 2. 367.5 to 700 MHz and 367.5 to 560 MHz Converters, Front Panel

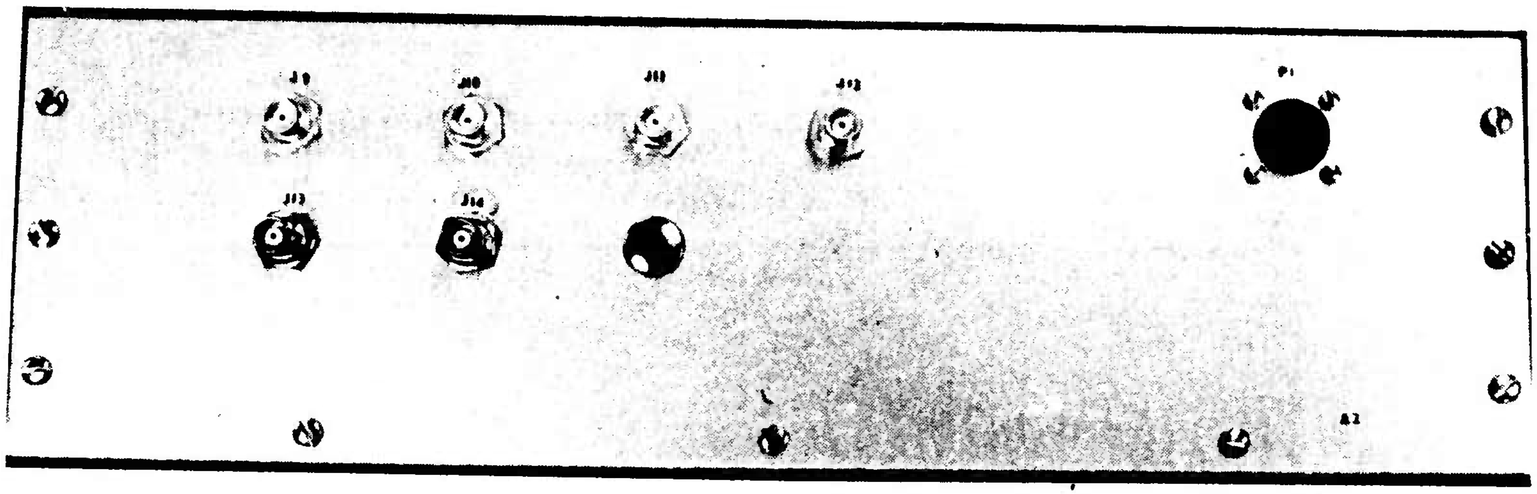

Figure 3. 700 to 560 MHz Converters, Rear Panel

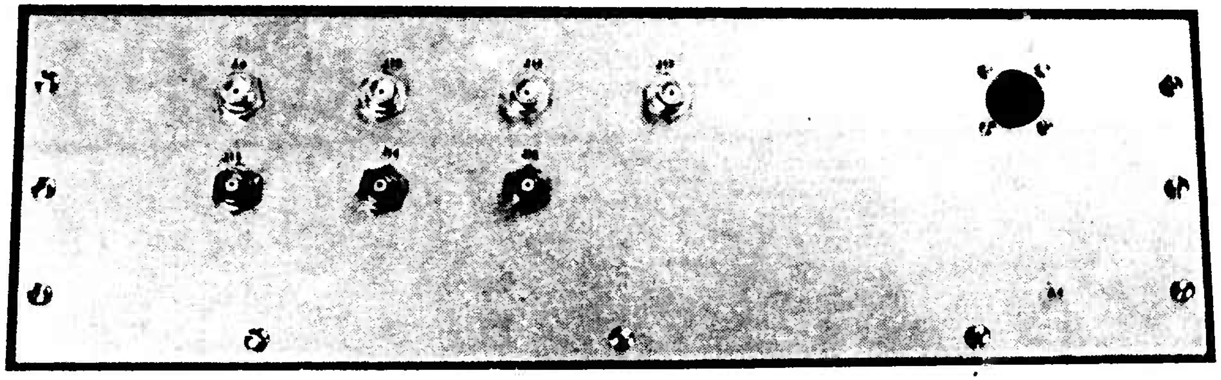

Figure 4. 367.5 to 560 MHz and 367.5 to 700 MHz Converters, Rear Panel

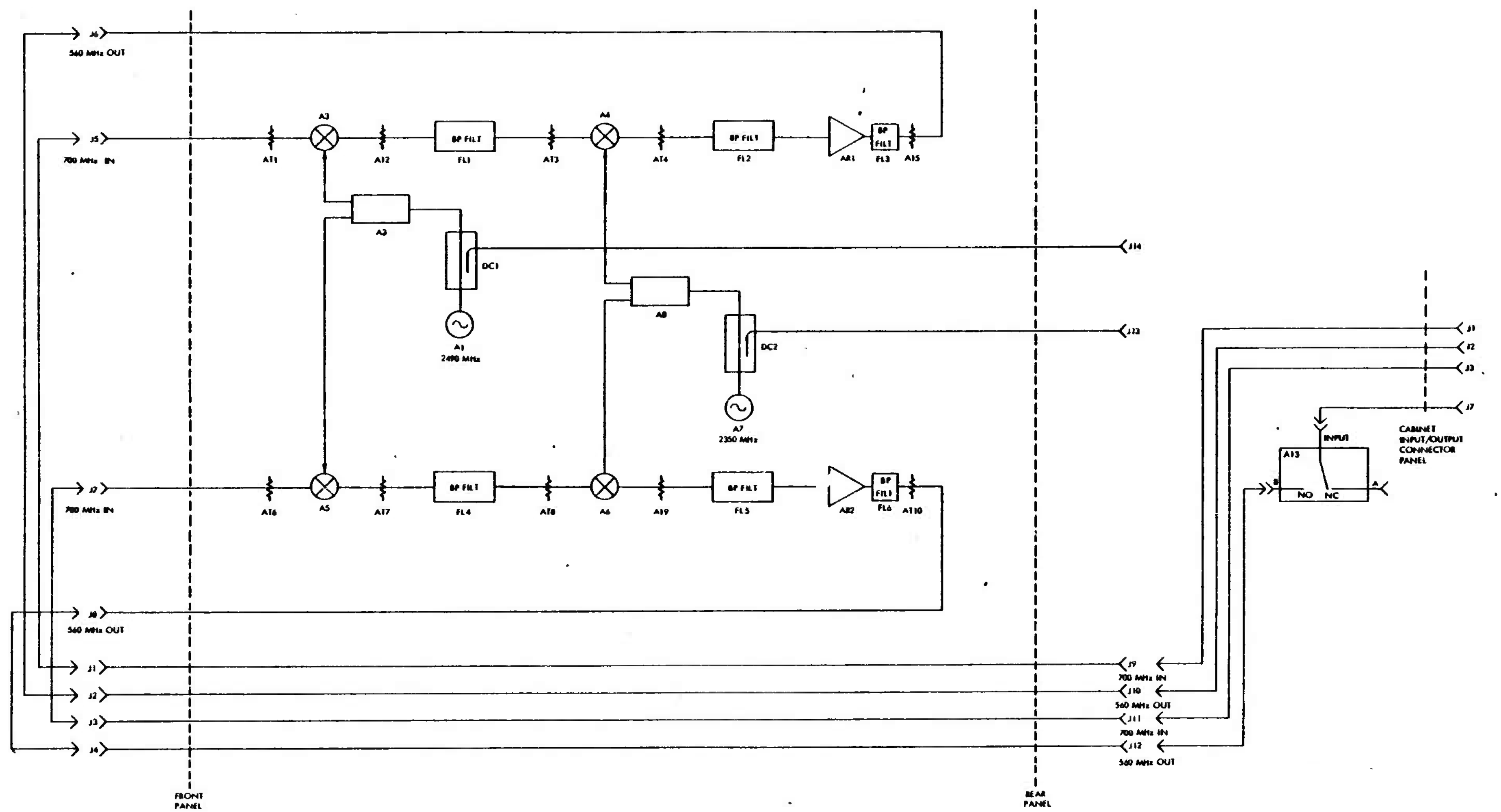

Figure 5. 700 to 560 MHz Converters, Schematic Diagram

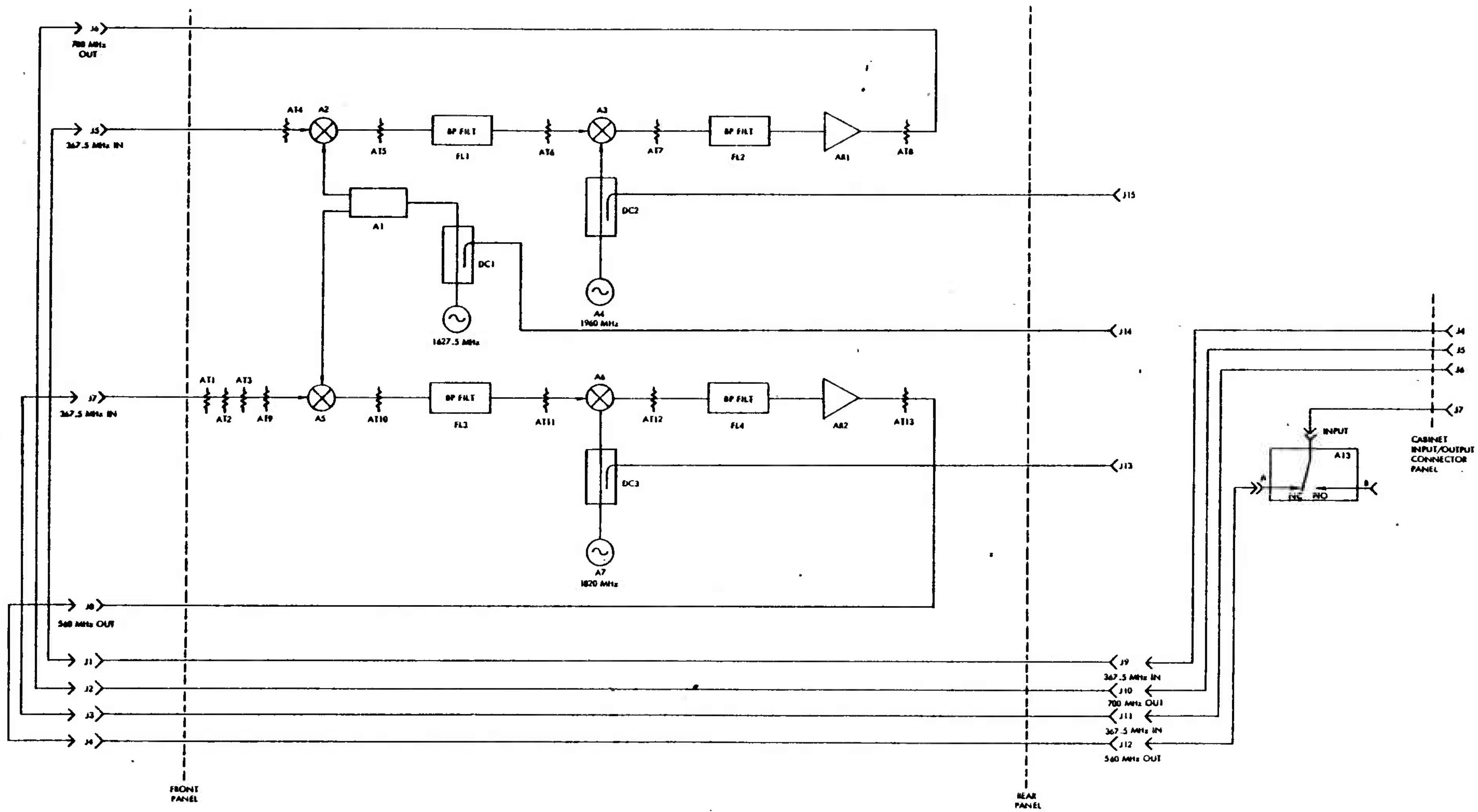

Figure 6. 367.5 to 560 MHz and 367.5 to 700 MHz Converters, Schematic Diagram

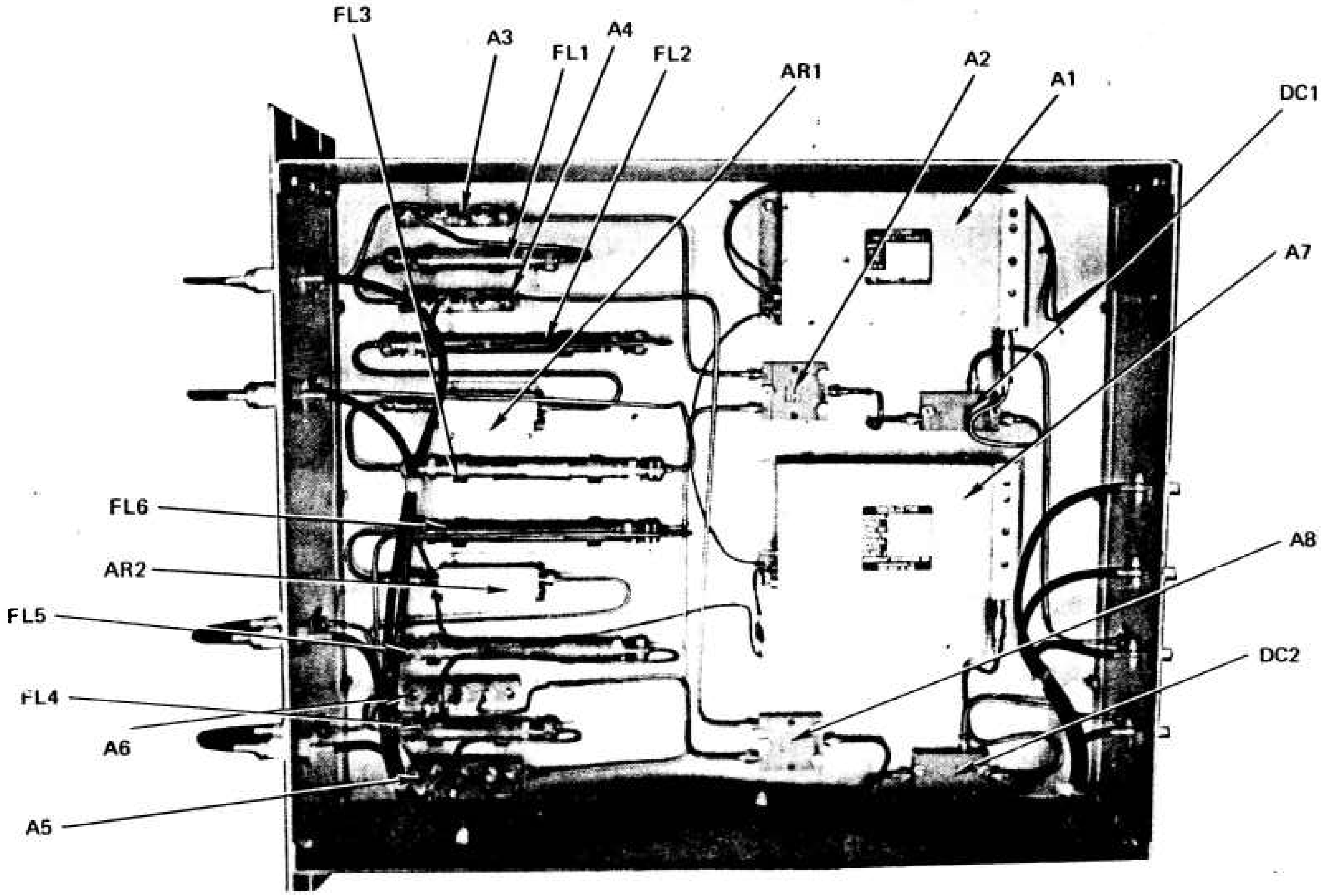

Figure 7. 700 to 560 MHz Converters, Top View

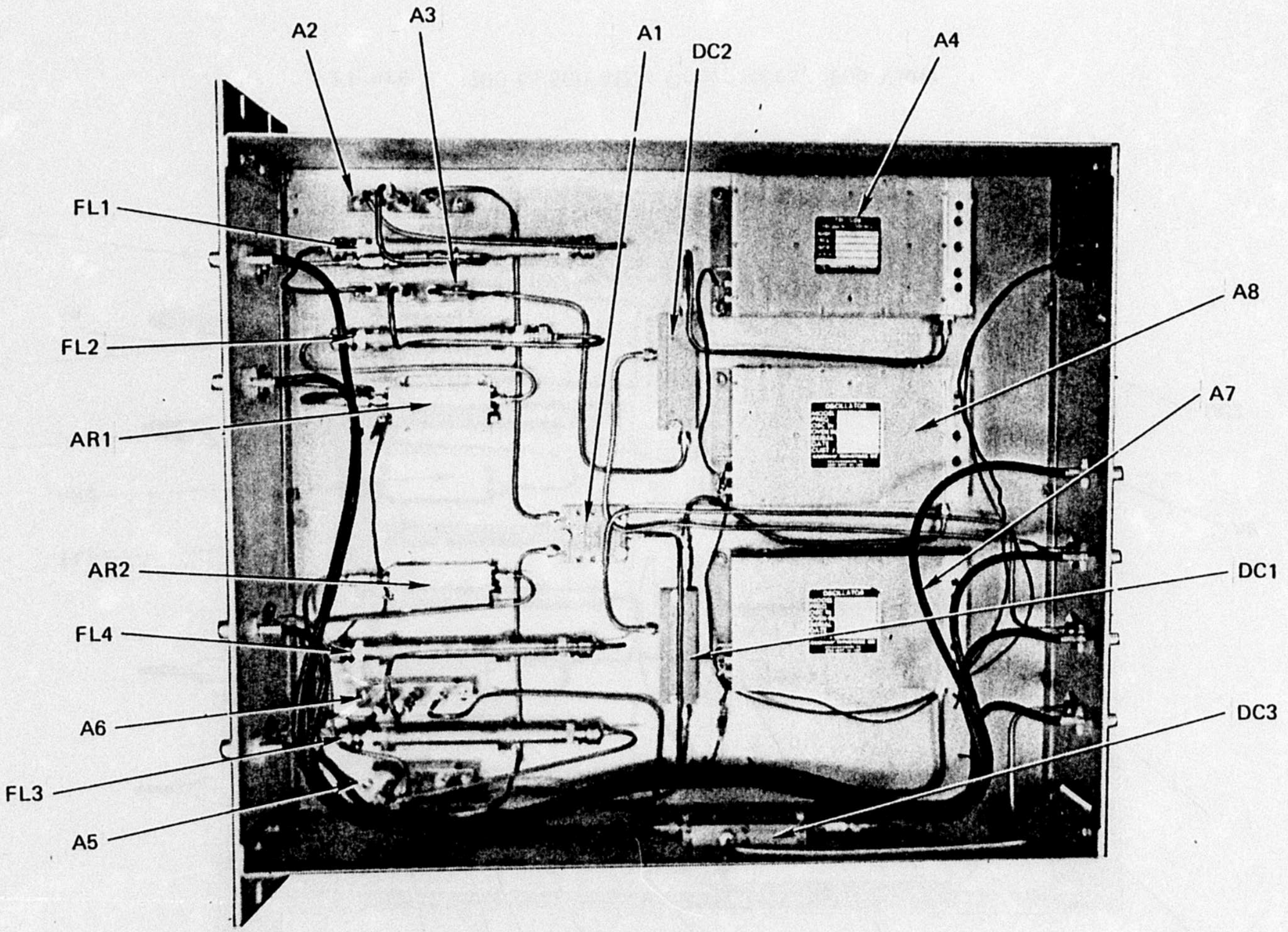

Figure 8. 367.5 to 560 MHz and 367.5 to 700 MHz Converters, Top View

APPENDIX A

PARTS LIST

UNIT NAME: 700 to 560 MHz Converter

DRWG NO: 3314-08-002

Item Symbol	Description
A1,	2490 MHz Oscillator, Greenray EY4-161-3
A2, A8	3dB PWR Splitter, Merrimac PDM-22-3.0G
A3, A4, A5, A6	Mixer, RELCOM MIG
A7	2350 MHz Oscillator, Greenray EYH-161-3
AT1, AT6	6 dB PAD, NARDA 4772-6
AT2, 3, 4, 5, 7, 8, 9, 10	3 dB PAD, NARDA 4772-3
AR1, AR2	Amplifier, Consisting Of The Following AVANTEK Parts Amplifier Stage UTO-1001 Amplifier Stage UTO-1002 Amplifier Stage UTO-1003 Mounting Board TB3 Case TC4
DC1, DC2	Directional Coupler, Merrimac C2M-20-3.0G
FL1, FL4	Filter, MU-DEL MBP-3-1790-70-50B
FL2, FL3, FL5, FL6	Filter, MU-DEL MBP-8-560-80-50B

APPENDIX B

PARTS LIST

UNIT NAME: 367.5 To 560 And 367.5 To 700 MHz Converters

DRWG NO. 3314-08-001

Item Symbol	Description
A1	3dB PWR Splitter, Merrimac PDM-22-1.5G
A2, A3, A5, A6	Mixer, RELCOM MIG
A4	1960 MHz Oscillator, Greenray EYH-161-1
A7	1820 MHz Oscillator, Greenray EYH-161-1
A8	1627.5 MHz Oscillator, Greenray EYH-161-3
AR1, AR2	Amplifier, Consisting Of The Following AVANTEK Parts Amplifier Stage UTO-1001 Amplifier Stage UTO-1002 Amplifier Stage UTO-1003 Mounting Board TB3 Case TC4
AT1, AT2, AT3	10 dB PAD, NARDA 4772-10
AT4, AT9	6 dB PAD, NARDA 4772-6
AT5, 6, 7, 8, 10, 11, 12, 13	3 dB PAD, NARDA 4772-3
DC1, DC2	Directional Coupler, Merrimac C2M-20-1.5G
FL1, FL3	Filter, MU-DEL MBP-8-1260-120-50B
FL2	Filter, MU-DEL MBP-6-700-70-50B
FL4	Filter, MU-DEL MBP-8-560-80-50B