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INTERIM DEVELOPMENT REPORT
SINGLE-SIDEBAND COMMUNICATIONS SYSTEM

For

UNITED STATES AIR FORCE

15 April 1957

Air Research and Development

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22 June 1955

This Report Covers the Period

15 January 1957 to 15 April 1957

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INTERIM DEVELOPMENT REPORT

SINGLE-SIDEBAND COMMUNICATIONS SYSTEM

PART I

1. PURPOSE

This project has been established for the purpose of planning, developing and demonstrating for Air Force use, a flexible single-sideband communications system which will provide reliable communications over long distances in ground-to-air, air-to-ground, and point-to-point service. This program has been divided into the following four phases:

a. PLANNING PHASE. - During this phase the basic equipment designs and system parameters were established. Detailed schedules for accomplishment of the work have been set up, and the necessary allocation of manpower and facilities made. Existing military equipment was studied to determine its applicability to the proposed system. Contact was made with possible subcontractors for certain portions of the work, and contracts were let where subcontracting appeared to be advantageous in implementing the system.

This phase is now complete.

b. DESIGN PHASE. - The second phase of engineering activity in connection with this program was the actual design and construction of equipment units to be used in the system. Such design and construction have gone forward on a parallel basis with simultaneous attention given to system engineering and installation problems. Because the program is being coordinated by a division of this company specifically devoted to system development, it was possible to secure completed submits and installation information concurrently.

For all practical purposes, this phase is now complete.

c. TEST PHASE. - It may be seen in the following report that the present activities for this project are centered largely in this phase. In addition to the testing of the subunits as they become available, complete systems tests are being conducted as time and available facilities permit. During the process of conducting these tests it becomes obvious that certain minor modifications to the equipment are necessary. Because of this, very close liaison is being maintained between the engineering and production facilities of this company.

This phase is now well under way.

d. INSTALLATION PHASE. - Inasmuch as this program includes not only the design, development, and manufacture of system components, but also the installation of two ground sites and in certain aircraft, it is important that all installation information be prepared and planned thoroughly. As noted above, installation information has been prepared concurrently with the execution of each phase of the program in order to insure that the Installation Phase can commence immediately upon completion of the Test Phase. At the conclusion of the installation period, the complete Air Force Single-Sideband Communications System will be ready for operational tests with ground-to-air, air-to-ground, and point-to-point communications.

2. GENERAL FACTUAL DATA

a. PATENTS. - For patents applicable to this program see the "First Quarterly Report," IDR-395-4, dated 15 December 1955.

b. REFERENCES.

(1) Rome Air Development Center Contract Specification, Exhibit RADC-1800, Single-Sideband Communications System (Requirements For)," Amendment No. 1, dated April 18, 1956; Engineering Change "A", dated 7 May 1956, and Exhibit RADC-1800A dated 30 January 1957.

(2) Collins Equipment Proposal, CEP-396, "Single-Sideband Communications System for United States Air Force," dated 10 June 1955, with addendum, CEP-396A, dated 18 June 1955.

(3) "Single-Sideband Communications System," Quarterly Reports, IDR-395-4, IDR-395-8, IDR-395-11, IDR-395-14, and IDR-395-17.

(4) Collins Equipment Proposal, CEP-563, "Technical Proposal for Single-Sideband Communications System," dated 24 April 1956.

(5) Collins Equipment Proposal, CEP-771, "Suggestions for Simplification of SSB Ground Stations," dated 19 February 1957.

(6) Collins Equipment Proposal, CEP-822, "Revised Proposal for Simplification of Birdcall Ground Stations," dated 1 April 1957.

3. DETAILED FACTUAL DATA

a. GENERAL SYSTEM DESCRIPTION. - The contract, as presently written, calls for two ground stations with diversity receivers, omnidirectional and steerable antennas, a single variable power transmitter, and remote control. The contract also includes installation of a number of airborne transceivers and delivery of a number of mobile radio systems suitable for aerial transport.

The basic system concepts for this contract were discussed generally in the Quarterly Report of 15 December 1955 and were covered specifically in the Quarterly Report dated 15 April 1956. However, there have been numerous trips and conferences during these reporting periods which have aided in clarifying the views of various groups within the Air Force regarding specific applications of the proposed system and equipments.

Before considering a detailed system description, it is appropriate to review some of the results and conclusions of these conferences as a background to the following discussion:

(1) On the 28th and 29th of January 1957, representatives of the contracting office visited this company in Cedar Rapids to observe the operation of the AN/ARC-58(XA-1) radio.

(2) A meeting was held at Rome Air Development Center on the 28th of February at which representatives of the contracting office and this company reviewed the time phase

of this contract and discussed the individual responsibilities of the contracting office and the contractor.

(3) Representatives of the contracting office visited this company on the 7th of March to review the equipment status for this program and also observe the operation of the AN/ARC-58(XA-1) radio.

(4) On March 7th and 8th a conference was held at Rome Air Development Center at which representatives of the Air Force and this company discussed the proposed modifications to the ground system portion of this program.

(5) Representatives of the contracting office visited Collins Radio Company, Dallas, Texas, on the 14th and 15th of March to review the progress of the equipment being developed at that location.

(6) On the 18th and 19th of March the contractor's Burbank, California, plant was visited by Air Force representatives for the purpose of reviewing the progress of the equipment being developed at that location for this program.

b. AIRBORNE EQUIPMENT RADIO SET AN/ARC-58(XA-1)

(1) SYSTEM. - Considerable testing has been done during this period. The results of these tests may be found in the portions of this report devoted to the individual modules. Final results of the tests will be presented when the tests are completed. A photo of the test setup for the thermal evaluation of the AN/ARC-58(XA-1) may be seen in figure 1.

(a) SYSTEM ANALYZERS. - Final nomenclature has been assigned by the Air Force as follows:

(1) RADIO TEST SET TS-1063(XA)/ARC-58. - Analyzer "A".

(2) RADIO TEST SET TS-1064(XA)/ARC-58. - Analyzer "B".

During this period this company received information that the diodes which were to be provided by the Texas Instrument Company for use in the power output stage of the

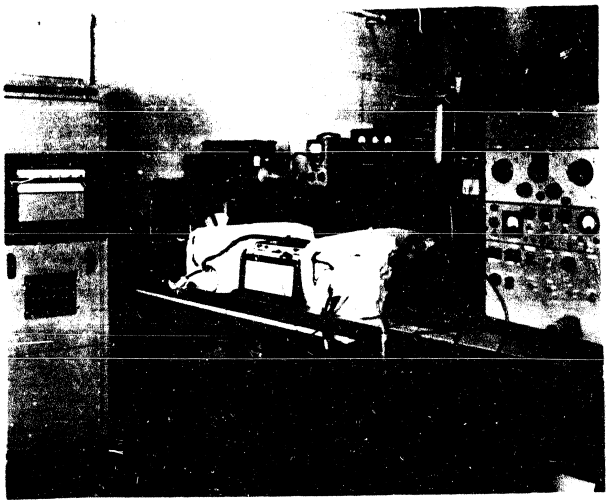


Figure 1. The AN/ARC-58(XA-1) System Test Setup

TS-1063 would not be available for approximately nine months. On the basis of the foregoing, some redesign is necessary, possibly resulting in a larger unit. An investigation is presently being conducted to determine which vacuum tube would perform most feasibly the function previously intended for the diodes.

(b) TEST BENCH HARNESS. - The items listed below shall comprise the requirements for the Test Bench Harness facilities to be provided under this contract and with the following exceptions, one of each item will be supplied: Either 9A, 9B, or 9C will be

supplied (for the initial quantity of six, two each will be supplied), three of Item 19 will be supplied, and two of Item 20 will be supplied.

Item	Name or Nomenclature	Description
1	HD-277(XA)/U	Fan, Vaneaxial
2	Mounting for R-761(XA)/ARC-58	To allow normal positioning of R-761, provide a cooling air couple including associated hose, provide complete access to both sides and front of R-761, rubber skid feet. 10" wide, 5" high, and 21" deep plus hose, 4 lb.
3	Mounting for T-605(XA)/ARC-58	To allow "on side" positioning of T-605, provide a cooling air couple including associated hose, provide total enclosure of T-605 with transparent sides including access holes for metering test points, or adjustment access and module extraction rubber skid feet. 8" wide, 12" high and 21" deep plus hose, 8 lb.
4	Mounting for C-1940(XA)/ARC-58	To allow "on side" positioning of C-1940, provide complete access to sides and front, rubber skid feet. 7" wide, 4" high and 13" deep, 3 lb.
5	Mounting for C-1939(XA)/ARC-58	To allow normal mounting of C-1939, this mounting then capable of being attached to other fixed support. 6" wide, 6" high and 7" deep, 2 lb.
6	Mounting for CU-523(XA)/ARC-58 or CU-XXX(CA)/ARC-58	To allow normal positioning of CU-523 or CU-XXX, without external case, by means of quick attachment hardware, providing access to all surfaces of CU-523, or CU-XXX, rubber skid feet. 9" wide, 12" high and 12" deep, 3 lb.
7	Junction Box with Pendant Cables	Junction box consisting of all necessary terminal tie points, power line breakers, metering test jacks and five pendant multiconductor cables and associated connectors. This junction box to provide the necessary terminal tiepoints to allow future addition of a single station intercommunications set similar to C-825/AIC-10, all necessary input power to be provided from external sources through a protective termination block. Side break out of cables and access of power termination block. 12" wide, 12" high and 4" deep, 20 lb. Average cable length 4 feet.

Item	Name or Nomenclature	Description
8	50 Ohm Dummy Load	A 1000 watt ambient air cooled 50-ohm dummy load with integral power level meter. 6" wide, 9" high and 23" deep, 30 lb.
9A	Dummy Antenna B-52	An artificial antenna approximating the characteristics of a B-52 tail cap antenna, used in conjunction with Item 8 and containing an antenna current meter and an integral cooling fan operating on 115 volt, 60 cycle power. 15" wide, 12" high and 10" deep, 15 lb.
9B	Dummy Antenna C-118	An artificial antenna approximating the characteristics of a C-118 tail cap antenna, used in conjunction with Item 8 and containing an antenna current meter and an integral cooling fan operating on 115 volt, 60 cycle power. 15" wide, 12" high and 10" deep, 15 lb.
9C	Dummy Antenna KC-97	An artificial antenna approximating the characteristics of a KC-97 tail cap antenna, used in conjunction with Item 8 and containing an antenna current meter and an integral cooling fan operating on 115 volt, 60 cycle power. 15" wide, 12" high and 10" deep, 15 lb.
10	Mounting for CV-531(XA)/ARC-58	A fixture to allow mounting of the CU-531 in an accessible manner on the input connector of Item 8 and provide the necessary metering test points to allow repair and adjustment. 6" wide, 4" high and 2" deep, 2 lb.
11	Module Patch Cable	15 pin Cannon D connector, cable one foot long, for usage with: AM-1523(XA)/URC, AM-1526(XA)/URC, AM-1527(XA)/URC, AM-1528(XA)/URC, and PP-1574(XA)/URC.
12	Module Patch Cable	37 pin Cannon D connectors, cable one foot long, for usage with: AM-1528(XA)/URC, and CV-465(XA)/URC.
13	Module Patch Cable	6 pin printed wiring connectors, cable one foot long, for usage with MX-2064(XA)/URC and MX-2065(XA)/URC.
14	Module Patch Cable	10 pin printed wiring connectors, cable one foot long, for usage with: AM-1529(XA)/URC, CV-466(XA)/URC, and CV-467(XA)/URC.

Item	Name or Nomenclature	Description
15	Module Patch Cable	10 pin printed wiring connectors, cable one foot long, for usage with: AM-1524(XA)/URC, AM-1529(XA)/URC, MD-286(XA)/URC, and SG-179(XA)/URC.
16	Module Subassembly Patch Cable	10 pin printed wiring connectors, cable one foot long, for usage with the following subassemblies of CV-465(XA)/URC: Ref. Intermediate Frequency Amplifier and Relay Amplifier.
17	Module Subassembly Patch Cable	10 pin printed wiring connectors, cable one foot long, for usage with the following subassemblies of CV-465(XA)/URC: Ref. Signal Intermediate Frequency Amplifier and Intermediate Frequency Mixers.
18	Module Patch Cable	12 pin printed wiring connectors, cable one foot long, for usage with: AM-1522(XA)/URC, AM-1525(XA)/URC and AM-1579(XA)/URC.
19	Coaxial Cable Assembly	RG-58C/U cable with UG-88C/U connectors, assembly length 4 feet.
20	Coaxial Cable Assembly	RG-58C/U cable with special connectors allowing mating to Standard HN fittings, assembly length 4 feet.
21	System Cable	Multiconductor cable with Bendix PB06E-18 32S connectors on each end, assembly length 4', for connecting C-1940 to CU-523.

(2) COUPLER, ANTENNA CU-523(XA)/ARC-58.

(a) GENERAL. - Perhaps the most serious problem encountered with this unit during this period was with high-voltage breakdown. However, the unit has performed satisfactorily in recent tests, the most recent being 9,000 volts at 20,000 feet simulated altitude. The success of this test was due to replacing the Kel-F block formerly used with a molded epoxy block with molded inserts, and the use of r-f feedthrough. The block discussed here is used to mount the capacitor. Teflon impregnated glass was used in place of phenolic for the gears as well as a few other parts in the vicinity of the high-voltage section.

It has been decided to use Kel-F for the tap roller for lack of a better material. However, should a material become available which would possess a coefficient of expansion surpassing Kel-F, the tap roller would be made out of the new material.

Rate generators have recently been added to the tap and coil servomotors in order to stabilize further the circuitry. Because the CU-523 will probably find its greatest application with wire antennas, more moderately rated components may be used and motor generators are available for this purpose.

An additional change has been made in the method used to feed the discriminator error to the amplifiers. The outputs of both discriminators are connected to both servo amplifiers as shown in figure 2.

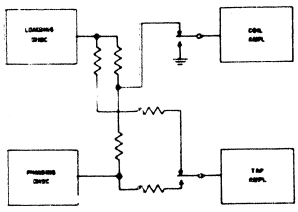


Figure 2. Revised Servo System of the CU-523(XA)/ARC-58

Since the above change was made in the servo system, it has been found that the coupler is able to find the tuning point if it is within the range of the basic tapped coil, regardless of where it starts. By this means, it is now possible to eliminate "prepositioning" by bands and "homing" is now accomplished at one position only. The Relay Assembly RE-284 is now greatly simplified as well as the variable vacuum capacitor operate circuits. If the coupler is able to tune without the capacitor, it will do so. If it cannot, either the coil will go to maximum or the tap will go to maximum. These limits, combined with the information that the other element is satisfied, serve to run the capacitor. As soon as tuning is possible within the range of the basic tapped coil, the elements back off from their limits and stop the capacitor, and the tuning cycle is completed.

It was found also during this period that higher efficiencies could be obtained generally by shunt-tuning when possible, so the variable capacitor is now "homed" at minimum and in shunt rather than at maximum and in series.

System tests are now being conducted with the entire ARC-58 radio. Environmental testing of the coupler as a system will be conducted during the next period and results of these tests should appear in the next quarterly report.

(b) DISCRIMINATOR CV-531(XA)/URC. - It was stated in the previous quarterly report that it might be necessary to repackage this unit in order to prevent a "sense" reversal at higher frequencies. Since that time, however, it has been discovered that this "sense" reversal could be prevented by altering slightly the dimensions of the phasing transformer. The present engineering models have been altered to include this revision.

Sensitivity and tracking measurements that have been taken have indicated that performance is generally adequate over the specified frequency and power range. However, in order to obtain the desired degree of performance, it was found necessary to match the phasing diodes. Tests at room temperature of one model has produced the following results:

Frequency	VSWR on the R-F Line When Both Discriminator Outputs are Zero
30 mc	1.170:1
26 mc	1.125:1
23 mc	1.095:1
17 mc	1.065:1
13 mc	1.047:1
9 mc	1.000:1
4 mc	1.065:1
3 mc	1.075:1
2 mc	1.103:1

Although not complete, the following environmental tests have been in progress and the results are as follows:

(1) Altitude: At 20,000 feet altitude, the voltage breakdown was found to exceed 1000 volts peak.

(2) Temperature: The unit was connected between a transmitter and a variable load and at each frequency, the variable load was tuned until the discriminator outputs were "zero". The VSWR on the transmitter line was then recorded. One set of data was taken at room temperature (+25°C), and another set was taken at +85°C. The maximum difference between any two readings taken at the same frequency was 5.71%.

Originally, the servo ground was connected to the chassis ground at one point in the discriminator. It was discovered, however, that this was causing some drift in the servo system. To alleviate this condition, the servo ground is now floating in the discriminator. It was necessary to make some slight alterations in the loading circuit to accomplish this. Also, the loading circuit has been changed to permit the use of a ratio detector-type circuit similar to that used in the phasing circuit. This has resulted in a reduction of the amount of modulation that appears at the output. Because the change involves only the d-c portion of the circuit, no significant change has been observed in the performance of the unit. This change is accomplished by replacing the present terminal board with an interchangeable printed circuit board.

It is planned to complete the environmental testing during the next period.

(3) CONTROL, ANTENNA COUPLER C-1949(XA)/ARC-58.

(a) MAIN CHASSIS. - There have been some changes in the wiring of this unit to accommodate the revisions of the RE-284. As was pointed out in the discussion of the CU-523, prepositioning to one of four bands is no longer necessary. Instead, one "home" position is now used for the entire frequency range.

A filter box has been added to the C-1940 and is presently undergoing tests with the ARC-58 system. Operationally, the C-1940 has performed very well in the system tests. However, a few difficulties were encountered.

The external wiring of the C-1940, the CU-523, and the ARC-58 has been reduced to a single cable between the CU-523 and the C-1940, and a single cable between the C-1940 and the ARC-58. Prior to this period, the single cable plug on the C-1940 went to both the CU-523 and the ARC-58. However, upon investigating the r-f pickup, excessive voltages were found on the leads between the C-1940 and the ARC-58. To eliminate this difficulty, two cable connectors are used on the front of the C-1940 to permit separate cables to the CU-523 and the ARC-58. Also, a keying relay has been added which grounds the receiver input when the unit is transmitting.

Work has been initiated to determine the requirements for a blower to cool the MX-2064 and MX-2065 Multicouplers. The air requirements appear to be very moderate and the only major problem will be the choice of a blower that is reliable, small, and of moderate air capacity. Great care is being given, however, to design an adequate air flow system which will permit continued use of the chassis already built. The design will not be compromised in order to use the chassis in the event they cannot be reworked to accommodate the cooling system.

(b) RELAY ASSEMBLY RE-284(XA)/URC. - This unit has undergone a major revision during this period which has reduced its complexity greatly. This revision, however, has not effected the general physical configuration or the number of fabricated parts required. Mainly, the changes brought about were to reduce the number of switch wafers from nine to five, the elimination of two d-c relays, and the simplification of the cable.

The previous problem of servo control relays has been solved adequately. A control is now available which permits the adjustment of the pull-in and drop-out voltage by the proper

selection of two resistors matched to the relay. By using this method of selecting resistors, a relay with pull-in and drop-out characteristic of 3-to-1 can be changed to almost 1-to-1. For this particular application, this feature is very desirable because it is simple, accurate, and requires very little time.

Because two d-c relays were eliminated, it was possible to take a d-c relay from the CU-523 and place it in the RE-284.

(c) ANTENNA CONTROL SUBASSEMBLIES MX-2064(XA)/URC AND MX-2065(XA)/URC. - These units are completed.

(4) TRANSMITTER, RADIO T-605(XA)/ARC-58.

(a) GENERAL. - Emphasis during the period covered by this report has been directed toward the electrical testing of engineering and pilot production models. Environmental tests and thermal evaluation has been started and coordination has been maintained with the production department on the assembly and testing of pilot line units. To date, three engineering models have been completed. Model no. 1 has been used in the ARC-58 system tests and model no. 2 has been prepared for thermal and environmental testing.

Vibration tests have been started and a photo of the T-605 on the Vibration Test table may be seen in figure 3.

(b) ENGINEERING MODELS. - As was pointed out above, model no. 1 has been operating in an ARC-58 system test for over two months and results have been very satisfactory. To date, no failures have occurred either with components or over-all performance. R-F interaction was noticed with the R-761 at low frequencies due to cable conduction. To solve this, the cable wire filtering was increased. These changes have been incorporated since into the T-605 design.

Engineering model no. 2 was electrically tested and used to obtain all of the troubleshooting data necessary for the instruction book. A low frequency parasitic oscillation

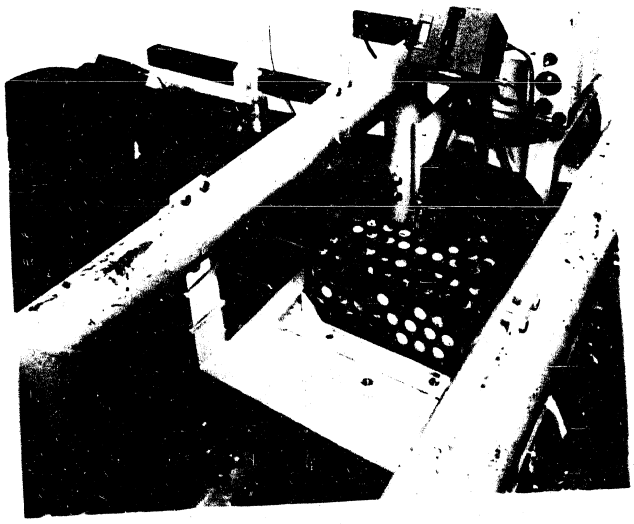


Figure 3. The T-605(XA)/ARC-58 on the Vibration Test Table

was found during the electrical testing. In order to suppress this oscillation it was necessary to add one resistor to the plate circuit of the driver stage. This model was prepared also for extensive thermal and altitude tests now in progress.

(c) PRODUCTION PILOT MODELS. - The production facilities of this company have completed several of the T-605 Radio Transmitters and testing of these units is now under way. Production model no. 1 was thoroughly tested by the engineering staff in order to facilitate the assembly drawing and cable drawing crosschecks. All discrepancies were immediately corrected and forwarded to pilot production.

Two additional T-605 test control panels were constructed by the engineering staff for use in the environmental test station, and for a standby test station. All of the test and special test equipment requirements were forwarded to the Production Test Department for appropriate action.

(d) THERMAL AND ALTITUDE EVALUATION. - A thorough evaluation of the air distribution and internal temperatures of the T-605 has been started. These tests are being conducted at various air flows and altitudes (simulated) and include testing of the HD-277 blower unit. The test set up includes an R-761 normally used in conjunction with the T-605. Continuous voice modulation is fed to the R-761 by a tape recording in order that the test conditions are that of voice ssb operation without the benefit of a duty cycle. A tabulation of the results to date is shown as follows:

Component Location	Temperature Rise in °C per Air Volume Indicated					
	160 lb /hr T°C	144 lb /hr T°C	120 lb /hr T°C	100 lb /hr T°C	80 lb /hr T°C	60 lb /hr T°C
HV Trans - Front	10	11	12	16	18	25
Filament Trans.	11	12	13	16	19	26
Screen Trans.	8	9	9	13	15	21
28 V rectifier case	11	10	11	14	15	18
HV Trans - Rear	11	12	13	17	20	26
V1 6CL6 hot spot	68	71	80	94	105	125
V2 6CL6 hot spot	54	58	65	76	86	104
V104 4x250 Fil pin	39	42	45	52	58	69
V105 4x250 Fil pin	9	10	12	15	18	26
V106 4x250 Fil pin	55	57	61	69	75	87
Servo Amp rear - 4700 ohm 1 watt Res. by CR6	16	19	20	24	27	34
Servo Amp rear - Reactor	17	20	20	24	27	34
Servo Amp rear - R-18, 1K, 2 watt Res.	23	26	26	31	34	40
Servo Amp front - 4700 ohm res	13	16	16	20	21	28
Servo Amp front - reactor	12	14	15	19	20	27
Servo Amp front - R-18	21	24	25	29	30	37
Cover under PA tube exhaust	36	38	47	56	64	81
Center frame PA tube exhaust side	14	17	19	26	27	36
Center frame opp. PA tube exhaust	11	10	13	16	19	24

Component Location	Temperature Rise in °C per Air Volume Indicated					
	160 lb /hr T°C	144 lb /hr T°C	120 lb /hr T°C	100 lb /hr T°C	80 lb /hr T°C	60 lb /hr T°C
Wall front exhaust chamber	20	20	23	28	32	38
Servo Amp shelf, bottom opp side	13	13	16	20	22	27
Center frame opp PA inlet chamber	6	7	8	11	14	21
Center Frame opp Servo Amps	11	10	13	16	18	23
Shelf under HV Trans.	8	9	10	13	16	23
Inlet Air	31	30	30	30	30	31
PA coil - hot end air	1	2	2	3	3	6
PA Grid area air	11	12	13	16	19	24
PA coil - top - downstream - air	2	3	3	4	4	8
Exhaust air from HV Trans - bottom	9	10	11	13	15	19
Exhaust air from HV Trans - front	10	9	12	14	17	21
Exhaust air from HV Trans - rear	5	6	7	9	12	17
Exhaust air from HV Trans - stop	4	5	5	7	8	13
Chamber under Servo Amps - air	7	9	10	13	16	22
Inlet air to V104 4x250	8	9	10	14	17	24
Inlet air to V105 4x250	8	10	11	15	18	25
Inlet air to V106 4x250	11	13	15	19	23	32

Component Location	Temperature Rise in °C per Air Volume Indicated					
	160 lb /hr T°C	144 lb /hr T°C	120 lb /hr T°C	100 lb /hr T°C	80 lb /hr T°C	60 lb /hr T°C
V104 - 4x250 air exhaust - front	42	45	55	68	79	104
V104 - 4x250 air exhaust - rear	38	42	51	62	72	95
V105 - 4x250 air exhaust - front	38	42	50	63	73	98
V105 - 4x250 air exhaust - rear	49	55	64	82	92	121
V106 - 4x250 air exhaust - front	40	45	53	66	76	100
V106 - 4x250 air exhaust - rear	46	50	60	74	87	113
PA coil exhaust air - bottom	3	3	3	4	5	8
Servo Amp shelf bottom	14	14	17	21	23	27
Outside case - front left	10	9	12	14	16	20
Outside case - rear left	12	11	14	17	20	24
Outside case - rear right	9	7	10	13	15	19
Outside case - front right	9	7	10	12	14	18
Outside - case - clockwise from lower left corner	11	10	13	16	18	23
Outside - case - clockwise from lower left corner	15	14	18	23	27	33
Outside - case - clockwise from lower left corner	15	18	20	26	30	39
Outside - case - clockwise from lower left corner	15	15	19	23	26	32

Component Location	Temperature Rise in °C per Air Volume Indicated					
	160 lb /hr T°C	144 lb /hr T°C	120 lb /hr T°C	100 lb /hr T°C	80 lb /hr T°C	60 lb /hr T°C
Outside - case - clockwise from lower left corner	13	12	16	20	22	18
Outside - case - clockwise from lower left corner	11	9	12	15	18	22
Right outside case - top rear	9	8	11	14	15	19
Right outside case - lower rear	9	8	11	14	16	19
Right outside case - lower front	9	8	10	13	15	18
Bottom outside case - right rear	11	11	12	17	20	25
Bottom outside case - left rear (under PA tubes)	17	17	21	27	31	38
Bottom outside case - left center	14	14	18	13	26	33
Rear case - above exhaust	17	17		27	30	
Rear case - above inlet	11	10	13	17	19	24
Exhaust air	37	41	50	59	68	88

(e) CASE CY-2060(XA)/URC (Unpressurized). - Delivery has been started by the manufacturer. Tests conducted on the delivered units have proven the design to be adequate. Development on this unit may be considered to be complete.

(f) CASE CY-2059(XA)/URC (Pressurized). - The design of this unit is complete and production has been started.

(g) COOLER, AIR ELECTRONIC EQUIPMENT HD-266(XA)/URC. - Preliminary tests conducted on the prototype of this unit indicates the design to be satisfactory. Three

additional models are now nearly completed. Final test data will be given when the HD-266 is tested with the T-605 and the R-761 in a complete thermal evaluation.

(h) COOLER, AIR ELECTRONIC EQUIPMENT HD-277(XA)/URC. - Same as (g) above.

(i) PLANS FOR THE NEXT PERIOD. - Electrical tests will be completed on engineering model no. 3 along with the thermal and altitude evaluation of the T-605, HD-27[illegible] and the HD-266. Assistance will be provided to the production staff to aid in producing and testing the pilot line models. The environmental testing of the T-605 will be completed also.

(5) RECEIVER, RADIO R-761(XA)/ARC-58.

(a) GENERAL. - At the time of this report four engineering models have been completed and operated successfully. One of these engineering models has been subjected to a very thorough bench test. This test showed the system gain to be low along with excessive carrier leak. The input circuits of both the AM-1524 and the AM-1528 were revised with the combined effect of increasing the transmit gain approximately 16 db. The carrier leak was discovered to be caused by electrostatic coupling between the wires of the cable feeding the Balanced Modulator. A shield was installed between the two connectors of the MD-286 and the cabling was re-routed. Carrier leak now is limited to only that small amount of leak occurring within the MD-286 itself. Operational tests, including on-the-air reception with the receiver section, indicated the need for a manual r-f gain control. This control is now incorporated into the C-1939 Radio Control.

Considerable difficulty was experienced with the servo systems. The trouble was traced to the servo amplifiers. A parasitic oscillation was found to exist in the saturable reactors. Additionally, it was found to be impossible to use the same amplifier for both the AM-1528 motor (1 watt) and the CV-465 motor (5 watt). A new servo amplifier will be used for the one watt servomotor.

A thermal evaluation was started on the R-761. Tests at room temperature were completed and tests in the environmental chamber are now in progress. The results of this evaluation will be included in the next quarterly report.

Vibration tests have been started on the R-761 and a photo of the test setup may be seen in figure 4.

(b) AMPLIFIER-MIXER AM-1528(XA)/URC. - Four engineering models have been constructed and tested. Formal test procedures were followed in the alignment and

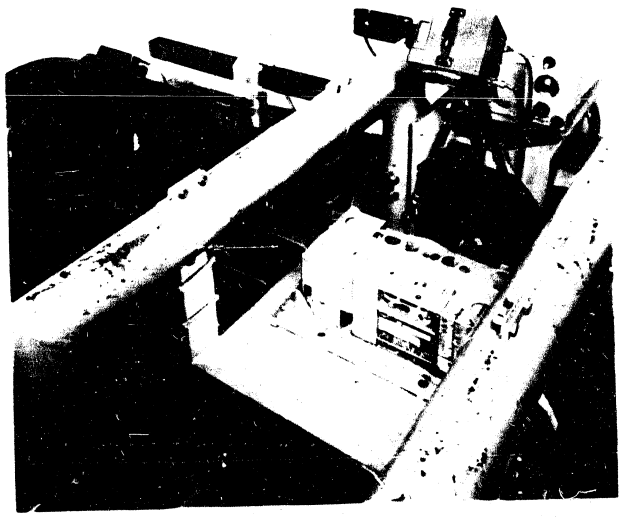


Figure 4. The R-761(XA)/ARC-58 on the Vibration Test Table

performance data was recorded. From this data the test limits were established for the production test requirements.

A thermal evaluation of this unit has been completed. A total of 34 thermocouples were attached to various components of the module, including one at the "hot spot" location on the bulb of each tube. A special technique was used to imbed the thermocouple in the glass. Temperature readings versus air flow were then recorded. It was concluded from the data that the module is capable of continuous operation in a 55°C ambient environment which is well within the margin of the components' temperature limits. In addition, the unit is able to withstand an air shutoff interval of four hours from a cold (23°C) start, and 40 minutes from a hot (55°C) start. It is also capable of passing the half hour environmental test at 71°C. In fact, it is marginally capable of continuous operation at this temperature.

(c) AMPLIFIER-DETECTORS AM-1523(XA)/URC, AM-1526(XA)/URC, AND AM-1527(XA)/URC. - All of the required engineering models of these units are now completed. Environmental testing is completed with satisfactory results. Tests of ten each production models of these units have given satisfactory results also. Final drawings are almost complete and should be released during the next period.

Unless some unprecedented trouble occurs with these units, they may be considered as being complete.

(d) MIXER-OSCILLATOR CV-465(XA)/URC.

(1) GENERAL. - All of the four engineering models were operated extensively during this period. In addition, environmental tests were run, including a six-day humidity test. This test was originally scheduled to run ten days, however, the failure of the rate generator section of the servomotor halted the test prematurely. Except for this component failure, operation was maintained throughout the test. Marginal performance was obtained

from the 100 kc spectrum generator owing to the fact that the tuning coils drifted with variations in temperature. This condition was corrected by decreasing the "on" time portion of the keying cycle which broadened the output spectrum to the extent that the frequency drift in the coils caused a negligible drop in the spectrum generator output. Difficulties with the spurious pickup at the Master Oscillator output at 3.5 mc was satisfactorily eliminated by using a doubly shielded coaxial cable in the output line. A spurious from the AM-1529 at 1035 kc was suppressed by the installation of a tuned circuit in the 2.4 mc input of the CV-465. It was found that by incorporating these changes the difficulties with incorrect locking were eliminated. Drift in the Frequency Discriminator has been reduced sufficiently by controlling the temperature of the Discriminator components and using matched transistors.

(2) MASTER OSCILLATOR. - Attempts were made to use zener diodes and bias current in lieu of permanent magnets for the saturable reactor. Although the zener diode performs satisfactorily for control, it was found that a 3,000 cycle hysteresis frequency is produced when traversing the temperature range. Because this condition cannot be controlled, it can only be concluded that the zener diode is unusable in this application.

The MO has been operated in an altitude chamber up to 75,000 feet equivalent with a frequency shift of less than 500 cycles. This small shift in frequency is gratifying when considering that the slightest movement of shielding causes frequency change. No other variations were observed during the altitude tests.

Efforts have been made recently to install a thermal disabling switch in this unit which will act as a thermal time delay in order to prevent out-of-tolerance frequency production prior to warmup of the MO. Manufacturers have been in the process of making some modifications and have only recently been able to ship sample units for test. Efforts are presently being made to mount and test these sample units.

Results of tests for spurious with the oven energized from a 400 cycle supply and the B+ and filament from a 60 cycle supply may be seen in figure 5.

Several tests have been conducted during this period to determine the effect of stray magnetic fields upon the output spectrum (see figure 6). Measurements were made to duplicate the flux levels found in the CV-465. It was found that vibration also has caused a spectrum to be generated at the output (see figure 7).

The production facilities of this company have been given full information of the techniques of making variable pitched coils and have successfully provided several at the time of this report. Some difficulty was encountered in producing the lead screws. A special copper alloy had been specified and production had not been able to analyze the material received because of a tight schedule. When difficulty was discovered by a mass-spectograph analysis, some two dozen MO units had already been constructed. These units are presently being reworked.

The lead screw life tests are shown in figure 8 which demonstrates the rate of wear when the correct material is used.

All of the specifications for production, type test, and equipment have been reviewed during this period and revised where necessary. Final assembly drawings are being completed as soon as possible and liaison with production will continue as required in order that the engineering design will be followed as closely as possible.

(3) INTERPOLATION OSCILLATOR. - The problem of frequency drift caused by humidity has been reduced tenfold by sealing five trimmer adjustment holes with silicone grease and the remaining holes with epoxy. Drawings now have to be changed to include special instructions for calibrating before the sealing process.

The potting compound of epoxy - glass powder presently being used still appears to have the best temperature characteristics. At the present time, the toroidal coil

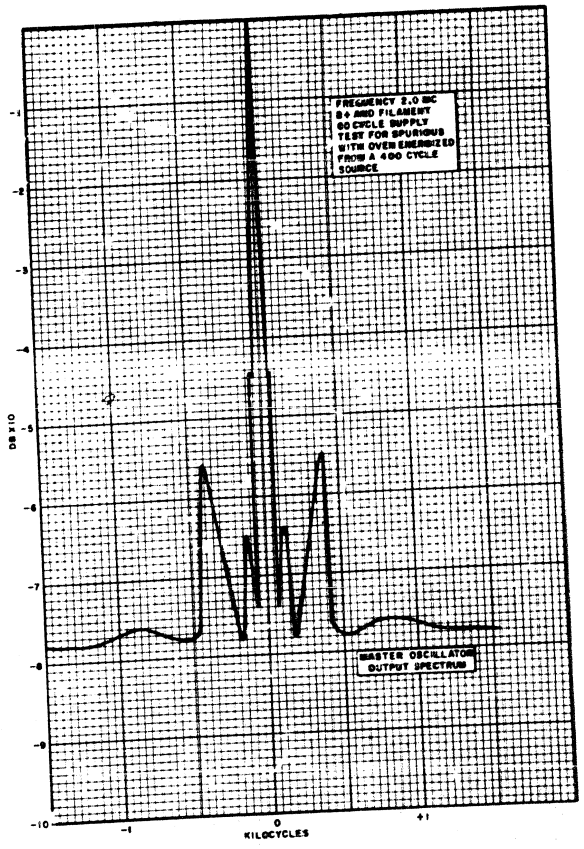


Figure 5. The CV-465 Master Oscillator Output Spectrum

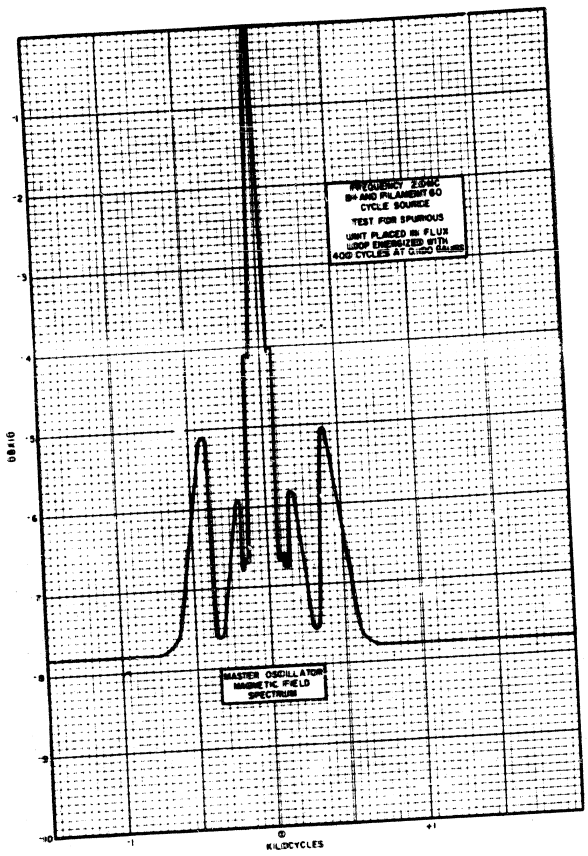


Figure 6. The CV-465 Master Oscillator Magnetic Field Spectrum

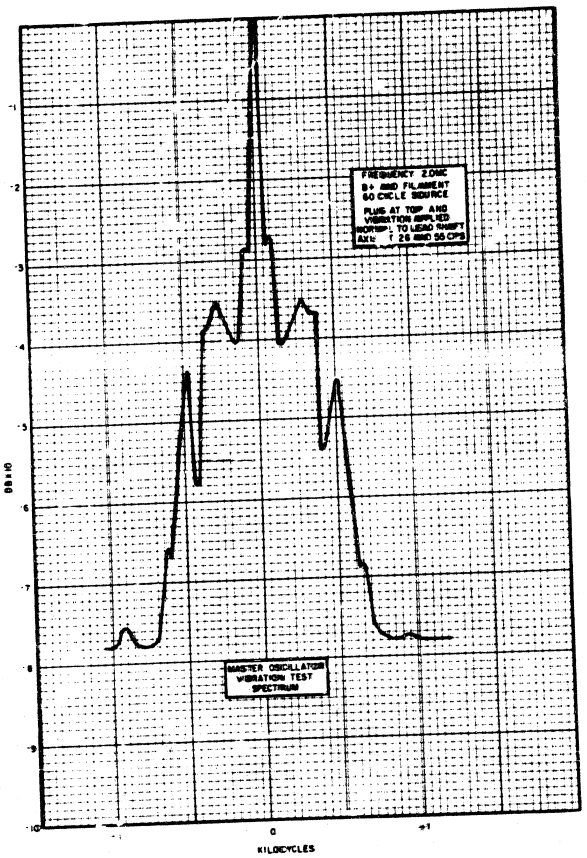


Figure 7. The CV-465 Master Oscillator Vibration Test Spectrum

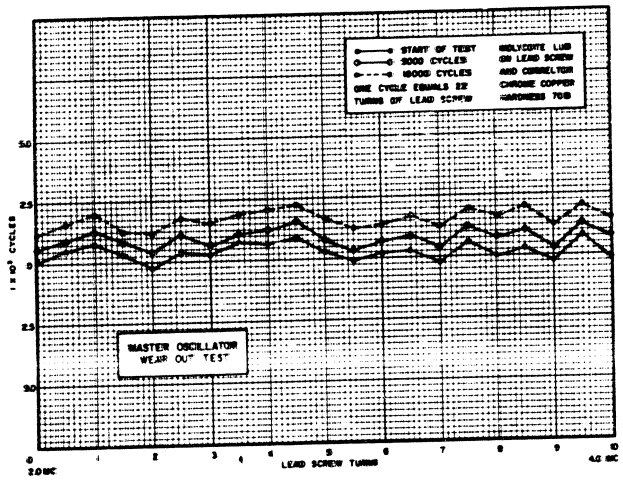


Figure 8. The CV-465 Master Oscillator Lead Screw Wearout Test

temperature coefficient is not sufficiently positive to reduce the spread of end-point frequencies at extreme temperatures. A suitable material for the toroidal cores is still being sought.

Considerable improvement of the temperature coefficient over the entire range of temperatures was obtained by additional curing of the potted assembly at +105°C, and by thermal cycling of the oscillator from -40°C to +80°C.

An altitude test to an equivalent altitude of 75,000 feet showed no significant effect on this unit.

Some difficulties were encountered in production with the potentiometers used for trimming the bridge resistance. The trouble was found to exist in the epoxy casting process whereby the epoxy would thin out slightly before gelation and would enter the trimming potentiometer thus causing a failure. A sealed trim-pot is being specified as a solution to the problem.

The equipment and production specifications have been corrected and a type test specification is presently being completed. Final assembly drawings will be prepared during the next quarter.

(e) BALANCED MODULATOR MD-286(XA)/URC. - Early in this reporting period a degradation in the carrier rejection of the engineering models was noticed. The checks that were made on all of the associated circuitry reduced the external carrier leak to a minimum. A shield was added to the main chassis between the printed circuit connectors which greatly increased the isolation between the input and output circuits. Also, slight modifications in the test jig served to improve this shielding.

Thorough measurements and analyses of the modulator circuitry have produced much conflicting data. Various minor modifications were required to improve the performance of various modules. In other words, differing means were required to accomplish the same end. Continued investigation revealed differences in the recovery time of the germanium diodes. Replacing these diodes with low resistance silicon type with negligible recovery time gave a marked improvement. Also, inductive, wirewound load resistors were found to give identical indications by setting up switching transients at diode cut-off time. Changing to silicon diodes and non-inductive load resistors did not necessitate any changes in the printed circuitry. There have been some changes started in the printed circuitry, however, to improve ground paths and to utilize the latest printed-circuit techniques.

(f) AMPLIFIER, ELECTRONIC CONTROL AM-1524(XA)/URC. - In the early part of this reporting period it was found that the gain of the VOX section of this unit was slightly low. By changing the loading on the input transformer for the TGC section of the module, the correct gain was obtained.

The assembly drawings have been completed and released. Testing of ten production models indicate satisfactory performance. Unless an unprecedented event occurs which requires further engineering effort, the design and development of this unit may be considered to be complete.

(g) POWER SUPPLY PP-1574(XA)/URC. - It was necessary to readjust slightly the voltage levels in the 28 v d-c and 130 v d-c supplies. These changes necessitated only the reduction and addition of resistance, respectively. These voltage corrections were necessary because the actual equipment load was slightly different than was originally estimated.

The assembly drawings for this unit have been completed and released. Also, the PP-1574 is performing satisfactorily in the ARC-58 system tests.

Testing of ten production PP-1574's have indicated satisfactory performance. The design and development, therefore, may now be considered completed.

(h) AMPLIFIER-OSCILLATOR AM-1529(XA)/URC. - In order to improve the reliability of this unit all of the mica capacitors have been changed to 130°C units. Also, the screen resistor of the crystal oscillator tube was made several times larger, thus decreasing the heat dissipation of both the resistor and the screen.

It was found necessary to change the shunt capacitance across the crystals in order to obtain more consistency in the correct oscillator frequencies.

Vibration tests have indicated that greater structural resistance to shock is needed in the mechanical filter. Filter designers offer hope for a solution very soon by using a modified coupling wire construction.

A reduction in the amount of 1035 kc spurious response will be obtained by increasing the screen resistance of the 455 amplifier tube. Selected values of a dropping resistor can then be used to compensate for variations in mechanical filter attenuation.

Ten production models of this unit have been received and tested. Several difficulties were encountered which are presently being corrected. Also, the changes in the drawings and specifications are being made in order to agree with these corrections. Final drawings are scheduled for completion during the next reporting period and additional work will be done with the production department in order to insure the units meet the design standards.

(i) AMPLIFIER, FREQUENCY MULTIPLIER AM-1579(XA)/URC (see figures 9 and 10). - All of the engineering models were completed during this period. Also, vibration, thermal evaluations, and various environmental tests were completed.

Figure 9. The Amplifier, Frequency Multiplier AM-1579(XA)/URC

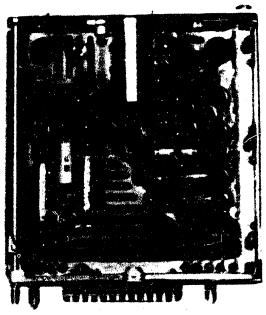


Figure 10. The Amplifier, Frequency Multiplier AM-1579(XA)/URC

It was discovered during the vibration tests that an excessive amplification factor existed at L1. The mounting was then changed by securing this component to the center plate through a mounting screw and a spacer. This change reduced the amplification factor by one-half. Results of the most recent test indicate it is now satisfactory.

The thermal evaluation was conducted using air flows of 50%, 75%, 100%, and 150% of the design standard (see figures 11 and 12). Results indicate that all components were sufficiently cooled except tubes V2 and V3. By changing circuitry of V2 heat dissipation was reduced by 70%, thus reducing its ambient temperature rise curve very near that of tube V1. It was not considered necessary to exert any effort to reduce the temperature of V3 because this tube operates only in the AM transmit condition. Also, during the thermal evaluation, this tube was operating at its maximum dissipation, namely zero agc voltage, which would not normally be the state of operation. For these reasons the reliability of the system will still be maintained without any additional changes in the circuitry.

A portion of the environmental testing program was completed. The unit was operated over the temperature range of -60°C to +85°C and results indicate that the equipment operates within the limits of the specification. The humidity and altitude tests will be conducted during the next reporting period.

Ten production models have been tested and all were found to meet the equipment specifications.

The final assembly drawings have been released to production. The production test requirements have been prepared and the type-test requirements are in process.

(j) FREQUENCY DIVIDER CV-866(XA)/URC. - Completed.

(k) FREQUENCY DIVIDER CV-867(XA)/URC. - Completed.

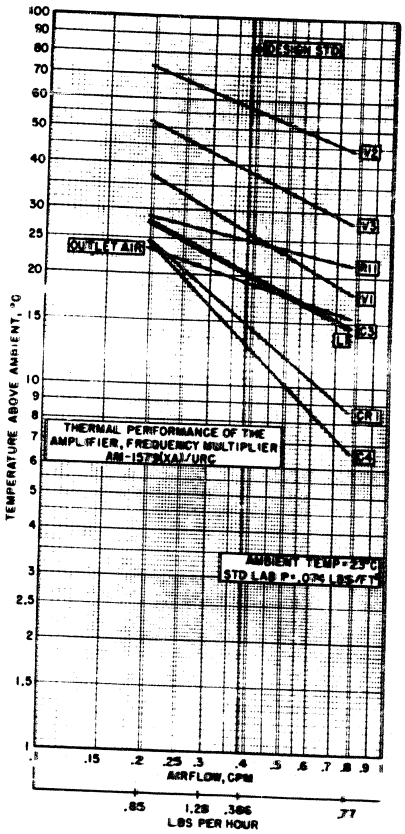


Figure 11. Thermal Performance of the Amplifier, Frequency Multiplier AM-1579(XA)/URC

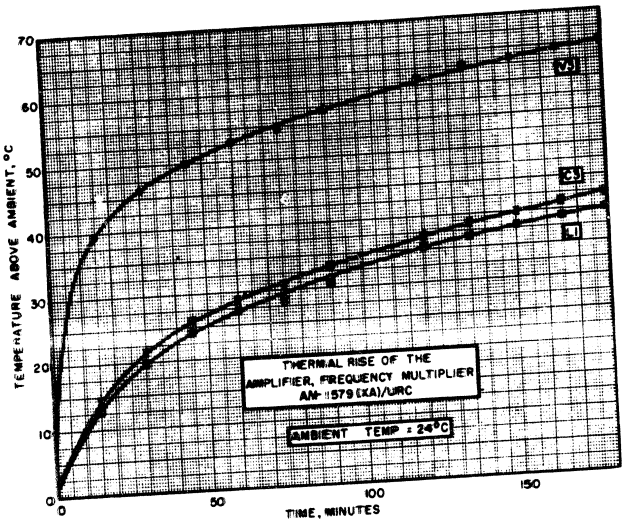


Figure 12. Thermal Rise of the Amplifier Frequency Multiplier AM-1579(XA)/URC

(l) FREQUENCY DIVIDER CV-466(XA-2)/URC (Transistorized). - The engineering design of this module has been completed and five engineering models have been built. Humidity tests have been started and vibration, temperature, and altitude tests are completed.

A loss in performance has been encountered because of deficiencies in transformer design. Transistor variations and measurement errors have made it extremely difficult to furnish the proper design requirements to the transformer manufacturers. Attempts were made to operate this unit at temperatures below the requirements of the specification. It was found that some transistors failed. No trouble was found to exist, however, within the limits of the specification.

(m) GENERATOR, REFERENCE SIGNAL SG-179(XA)/URC. - Completed.

(n) GENERATOR, REFERENCE SIGNAL SG-179(XA-2)/URC. - (See figures 13, 14 and 15). - The design and development of this transistorized signal generator was completed during this period. Six engineering models have been built and successfully type-tested.

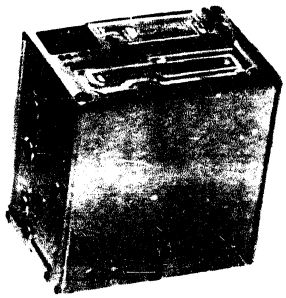


Figure 13. The Reference Signal Generator SG-179(XA-2)/URC

A mechanical redesign was initiated and completed in an effort to reduce the cost of fabricated parts, increase the ease of assembly, and reduce maintenance time. All of the fabricated drawings and purchased parts lists have been released.

Checks were made to insure that the transistorized model was interchangeable with the vacuum tube model. No difficulties were encountered and the units performed satisfactorily. A schematic of this unit may be seen in figure 16.

(o) AMPLIFIERS, ELECTRONIC CONTROL AM-1522(XA)/URC AND AM-1525(XA)/URC. - Satisfactory environmental testing has been completed on these units. All of the drawings have been brought up to date for MJO production.

Figure 14. The Reference Signal Generator SG-179(XA-2)/URC (Front)

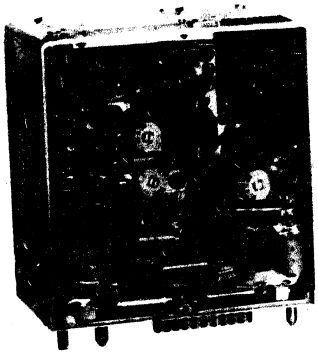
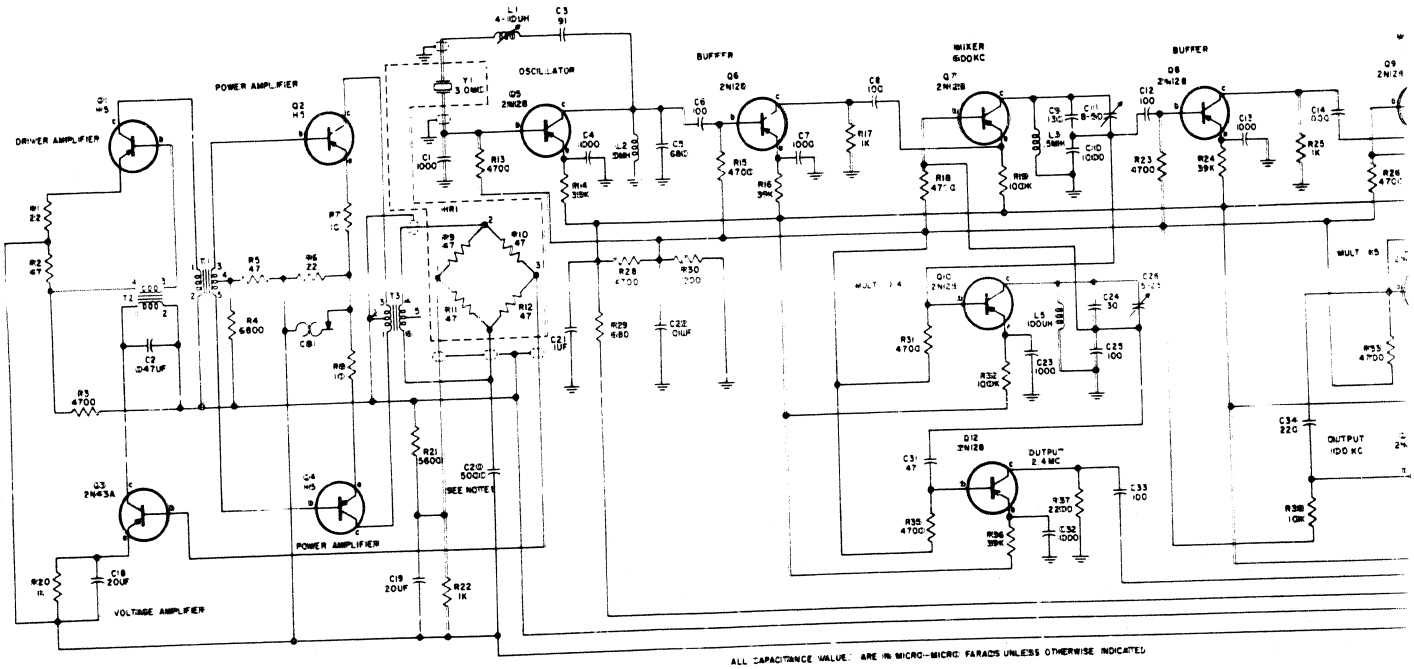


Figure 15. The Reference Signal Generator SG-179(XA-2)/URC (Rear)



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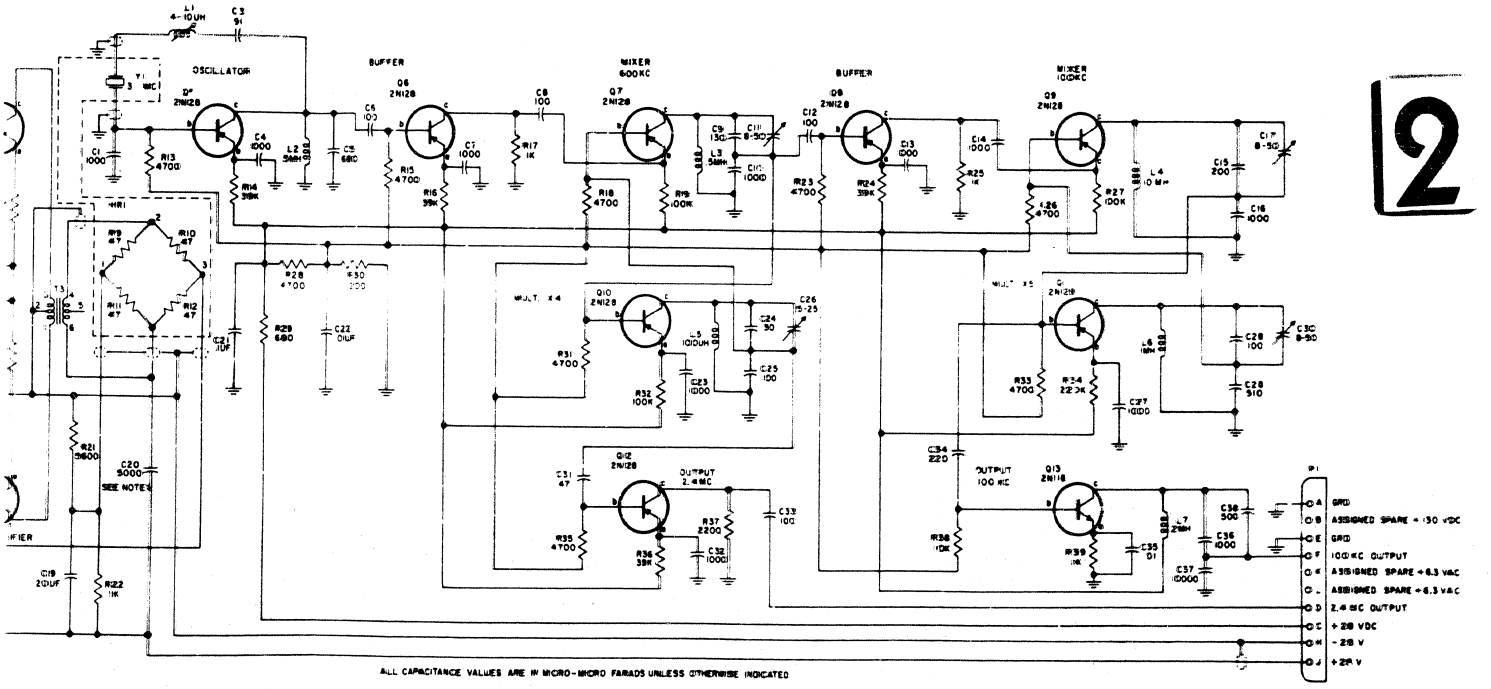

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Figure 16. Schematic of the SG-179(XA-2)/URC Reference Signal Generator

Difficulties were encountered during this period with variations of gain between high and low signal levels which required a minor modification. It is presently believed this unit is ready for release.

Liaison will be maintained between the engineering and production staffs of this company to assist in the production of these units to insure the final unit is in keeping with engineering design.

(6) CONTROL, RADIO C-1939(Xa)/ARC-58. - Tests have been completed on the C-1939 with the following results:

(a) It was determined that the flush-type boards are superior to the etched boards. Early failures were noted with the etched-type board.

(b) Coin silver, Phillney no. 7, and Baker Alloy no. 817 were found to be acceptable for use as contact material. Because of the limited test facilities, it was not possible to run a simultaneous comparison of these three materials. Current production requirements call for the use of coin silver on flush-type boards.

(c) The final engineering models are waiting for the delivery of the remainder of the rhodium plated switches. The balance of the order should be received before 1 May 1957.

(d) A duty cycle test has been completed on the "take control" coil. This coil was energized at 29 volts d-c for a period of two minutes after being stabilized at a temperature of +71°C for thirty minutes. Operation was satisfactory and the coil was not damaged.

(e) A test of the illumination of the C-1939 was completed and found to be in accordance with the specification.

(f) All of the assembly drawings have been completed and liaison is being maintained with the production facilities to assist the manufacturing of pilot line units.

Plans for the next period will include the assembly of the four remaining engineering models, completion of the environmental testing, and preparation of the type test procedure.

c. TRANSPORTABLE SINGLE-SIDEBAND COMMUNICATIONS SYSTEMS.

(1) GENERAL. - The transportable system, as specified by RADC-1800, requires that this company furnish suitably packaged ARC-58 components, a rotary frequency converter, and an antenna coupler-filter. This equipment is to be furnished to the using agency for installation in a helicop-hut.

The first of the ARC-58 components should become available during the next reporting period. At the present time, all but two of the various types of modules are being built by this company.

Investigation of the packaging problem has shown that the only modification necessary will be with the shock isolators. This, of course, is because of the different type of vibration the equipment will be subjected to in the mobile application as compared to installation in an airplane. The main difference is that the vibrations encountered in an aircraft installation are usually of rather high frequency. In a mobile application, vibrations normally encountered are low frequency shocks.

Design of the necessary cabling to integrate the ARC-58 components into the system has been completed and placed on order.

(2) ANTENNA COUPLER-FILTER. - Duplex operation from a single site with only 10% separation of frequencies between the transmitter and the receiver requires the use of an antenna coupler-filter. Essentially, this unit is a band-pass filter which is connected between the antenna and receiver in order to suppress undesired signals. The magnitude of the signal from the transmitter 10% removed from the receiver frequency is reduced to a sufficiently low level at the input of the receiver, so that operation with a desired signal is not impaired. The undesired signal may be as high as 500 volts. The coupler-filter receives its servo information from the receiver with which it is associated. The engineering model

of this unit is now 95% completed. It is presently intended to mount this unit at the base of the vertical receiving antenna. Because the antenna will be some distance from the hut, and exposed to the weather, consideration is presently being given to weather-proofing the coupler-filter device. Power and control problems are being investigated also.

(3) ROTA... FREQUENCY CONVERTER. - Because the equipment to be used in this system is designed for 400 cycle operation, a rotary converter is necessary to convert the 60 cycle primary power to 400 cycles. In selecting a rotary converter for this application it is obvious that weight and size are paramount in importance. Considering the above, the Georator Corporation has agreed to furnish the required converter in a very small and light package. Dimensions and weight are as follows

Length - 16 inches

Height - 12 inches

Width - 12 inches

Weight - 140 pounds.

The electrical requirements of the converter are that the device possess a capacity of 3 kva at 90% power factor. Output will be 115 volts to ground for each of the three phases with a tolerance of 5% for frequency and voltage. Because this device does not use brushes, there should not be any problem with electrical noise. This unit will be mounted mechanically with isolators.

(4) INSTALLATION. - The specification requires that this company furnish airborne components, the rotary frequency converter, plus other lesser items. The remainder of the discussion of the transportable equipment is based upon a study made to determine possible areas of expansion to the specification which would aid in fulfilling the tactical requirements. The equipment discussed is not required by the specification for this contract. However, this company feels that the possible application of the equipment merits some consideration. Also, it is understood that this company is not authorized to take any action toward expansion of the transportable system requirements until requested to do so by the contracting office.

(a) SWITCHBOARD. - This unit would provide either of two operators with the facilities necessary to control the MRC-65. This could be done by providing the necessary keys required to perform the desired functions. The facilities available would be: the selection of either simplex or duplex operation, phone patching, and monitoring.

(b) OPERATOR'S CONSOLE. - The proposed general configuration of this portion of the system appeared on pages 50 and 52 of the Fourth Quarterly Report for this project dated 15 October 56. It is believed that the storage and work area would be sufficient considering the intended use of the system.

(c) HEATING AND COOLING. - The requirements for heating and cooling would probably be for operation within the temperature range of -40°F to +130°F. The heating capacity would maintain an inside temperature of +65°F when the outside temperature was -40°F. When the outside temperature was +130°F, the air conditioner would be able to maintain an inside temperature of +75°F. The latter requirement presents one serious complication, however, in that the cooling capacity of a unit falls off very rapidly as the ambient temperature rises above 100°F. This cooling capacity could be expected to drop as much as 30 - 40% when the ambient temperature reached +130°F. Investigation of the load requirements and the efficiency of various standard units available on the commercial market has shown that to cool the hut properly would require a two-ton unit. The primary power required to operate a unit of this size would be approximately 3 kw. The weights of the various units investigated were all approximately the same, so weight would not become a determining factor in the selection of a unit. The noise level of an air conditioner of this size is not yet

known. When this information is available, it will be decided whether it would be feasible to mount the unit on the inside or the outside of the hut. In the event an air conditioner is mounted externally, provisions would be made to dismount the unit and tie it down inside the hut for transporting the system. Also, a system of duct work would be required.

(5) TYPE II TRANSPORTABLE COMMUNICATIONS SYSTEMS. - The proposed revision of RADC-1800 has outlined some additional transportable system requirements. There are four general configurations to provide SSB HF communications.

(a) TYPE A. - This would be a transmitter-receiver hut with the addition of government furnished VHF radio relay equipment.

(b) TYPE B. - This would be a transmitter-receiver hut with the addition of government furnished UHF equipment installed to provide air-to-ground communications.

(c) TYPE C. - This would be basically just a receiving station.

(d) TYPE D. - This would be basically just a transmitting station.

All of the above types would be equipped also with government furnished ancillary items such as multiplexing equipment. The HF equipment for these huts could be manually or automatically tuned. By using manually tuned equipment, the maintenance problems would be simplified because of the lack of servo systems. In addition, cost of the equipment would be reduced considerably from the cost of automatically tuned units. Preliminary consideration has been given to the arrangement and mounting of the equipment for the types described above.

Instruction manuals for the government furnished equipment have been requested. The information contained in these manuals is necessary before detailed requirements can be made.

(6) CONCLUSIONS.

(a) TYPE I SYSTEM. - The requirements outlined in RADC-1800 are being fulfilled. The various ARC-58 components should be available during the next reporting period. The rotary converter is scheduled for delivery during the period 3 July 57 to 3 August 57. Construction of the antenna coupler-filter will be started immediately.

(b) TYPE II SYSTEM. - These systems have been studied and could be furnished by the contractor. However, this company recommends that manually tuned equipment be given consideration for installation in these huts.

Upon finalization of the specification, every effort will be made to implement the necessary liaison between TAC and this company in order that the tactical requirements can be fulfilled.

d. GROUND SYSTEM.

(1) GENERAL. - The following discussion, although speculative in nature, and not within the scope of the contractual requirements for this project, is presented in this report because of its bearing on the over-all Birdcall program. Two Collins Engineering Proposals (CEP 771 and CEP 828) have been submitted to the contracting office at Rome Air Development Center for consideration and possible revisions of the contract. These proposals have been submitted because the contractor felt obliged to present to the user the most recent philosophies on the single-sideband communications program as applies to Project Birdcall. However, unless enthusiasm is indicated on the part of the Air Force with regard to these proposals, no further consideration will be given to these changes. In addition, projects as long in duration as Birdcall require that the over-all system be reviewed from time to time in order to ascertain that the philosophies applicable at the inception of the program are still compatible with the present state of affairs. Some of the various aspects which effect the conclusions of such a review are:

(a) Present cost of manpower and materials.

(b) Knowledge gained in the execution of the contract thus far.

(c) Knowledge gained in the research and development of other contracts.

(d) Consideration of recent developments and philosophies applicable to this program.

During the course of this reporting period a review of the over-all ground system was made with regard to the testing and operational requirements anticipated for the ground stations. Cost figures for ground station usage have been reviewed also with a particular view toward recommending certain modifications which would reduce the cost of the equipment without any undue sacrifice to the capability of the system. It is believed that a review should occur at this time because of several factors:

(a) The specification which governs this contract is presently being revised. It is felt that the final form of the revised specification should determine the activities of the program to its completion. Also, this specification should reflect the most advantageous features resulting from the current review. In this manner, the ultimate equipment supplied would have the dual capacity of being able to implement at the earliest possible date an improved world-wide communications facility through the integration of the equipment with existing stations, as well as to provide a complete test facility whereby the system parameters for future, ultimate capability networks could be evolved.

(b) Theory and model work of the antennas are completed.

(c) The effort and materials that have been expended up to this time of this contract would still be largely applicable, even though several factors might change as a result of the evaluation. Future effort, however, must be directed toward the specific equipment and requirements that will be stated in the final revision of the specification mentioned above.

(d) The recent implementation of a special point-to-point communications network for the Strategic Air Command has demonstrated several aspects whereby simplification of system requirements would actually increase the capability of the system.

Accordingly, this evaluation was completed during the period covered by this report. Some of the factors considered which received special attention are as follows:

(a) The ground stations, as required by the specifications as presently written, would have limited application because of the single transmitter supplied. The antennas available would represent a considerable investment, while providing only a single steerable beam for any one Collins Wullenweber structure.

(b) A complex three-site control and audio system is being developed for installations at two stations, each having only two sites--a control/receiver site and a transmitter site.

(c) The existing requirement for automatically tuning transmitter and receiver equipment pre-supposes access to a number of frequencies, any one of which would be usable at the stations. It is understood, however, that only a limited number of frequencies would be available to these stations, even during the test and evaluation phase.

Upon the completion of this evaluation, the contractor has concluded that the over-all system performance could be improved considerably by making certain revisions to the specifications for this program. Accordingly, two proposals have been prepared which outline the following suggested revisions:

(a) The antenna systems for both the transmitter and receiver sites would be identical except for the transmission lines and elimination of space diversity reception. The Collins Wullenweber steerable antennas would be replaced by billboard antenna assemblies. The omnidirectional antenna complement would consist of two discone antennas providing

frequency ranges of 3 mc to 8 mc and 8 mc to 24 mc respectively. Although the frequency range is reduced somewhat, the capability provided by the billboard configuration of six independent lobes increases the utility of the antenna system by a factor of six. A steerable, Collins Wullenweber receiving antenna would be supplied at the Rome Air Development Center site for side-by-side comparison of the performance of the two types of antennas.

(b) Manually-tuned radio equipment has been proposed for use as the primary equipment group for both stations. In order to evaluate the properties of automatically-tuned equipment, one each automatically-tuned exciter and diversity receiver would be supplied at the RADC site.

(c) Because the control and receiver sites are to be installed in the same building at both of the initial stations, it was proposed that the equipment take advantage of this fact and eliminate the circuitry which would be necessary to remote the control information to the receiver equipment from the control and operating positions. This would allow the operators to have direct access to the receiver functions, such as the r-f gain control and the signal strength meter. Further, it was proposed that these functions be brought directly to the operators' consoles.

(d) The above reductions in both cost and complexity would allow the active channel capability of the stations to be increased considerably without effecting appreciably the projected over-all station costs. The proposed increase would be effected as follows:

(1) In addition to the single automatically-tuned 45/12 kw transmitter, it was proposed to provide three manually-tuned 10-kw transmitters. Four fixed-tuned exciters would be supplied, with the necessary switching provided in order that the high-power transmitter could be selected remotely for operation with any of the four exciters. Consequently

by utilizing the various sides of the billboard or the discone antennas, four separate transmissions on different channels may take place simultaneously.

(2) At the receiver sites, sufficient receiving equipment would be supplied for operation up to eight channels. The inherent similarity between the transmission and reception functions of SSB makes a further increase in capability at nominal cost. This increase would be realized by supplying the additional components with four of the receivers acting as transceivers. These transceivers would provide a 500 watt transmitting facility at the receiver site for four frequencies. Here again, the increased antenna "channel capacity" would afford an efficient radiation system for flexible, simultaneous operation for as many as eight frequencies. Receiver pre-selector circuits would be provided in order that simultaneous, interference-free operation could be conducted on closely-spaced frequencies.

Greater details concerning the proposed modifications above may be found in Collins Engineering Proposals CEP-771 and CEP-828. It is the belief of the company that the adoption of the proposed modifications would permit a much more rapid implementation of an improved air-to-ground and point-to-point communications network when considering the compressed time scales for both installation and check-out of the modified stations. In addition, the ground stations provided would permit immediate operational usage, whereas the stations previously planned have limited operational value. However, the desirability of testing the concepts of automatically-tuned equipment, space diversity reception, and narrow-beam Collins Wullenweber antenna would be retained by the provision for sample quantities of this type of equipment at the RADC stations.

Recently, this company received copies of Exhibit RADC-1806A which revises and enlarges upon the previous specification for this contract. In addition to enumerating the requirements for the units already contracted for, this document lists several additional equipments to be included as additions in scope to the basic contract.

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2 OF 2

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Major additions to fixed station equipment include six additional low-powered transmitters and six receivers for installation in existing air-to-ground stations on the North Atlantic route. Also, another air/ground station complete except for steerable antennas has been added to the scope of the contract. It is the understanding of this contractor that the transmitting and receiving equipment will be installed in manned sites and that frequency changes at these sites will not be numerous. It has been suggested, therefore, that considerable monetary savings could be effected by the use of the manually-tuned equipment specified. It was proposed also that the 500-watt power amplifier proposed for use at the receiver site be considered for this application.

This company has been advised informally that the additional air-to-ground station specified is to be installed at Thule Air Force Base. The revised specification also requires that only the omnidirectional antenna system be supplied for this station and that all other system requirements be identical with those of the two initial stations.

An alternate plan has been proposed to meet the specialized requirements of the additional installation. Because of the extreme environmental conditions encountered at this base, it is felt that consideration should be given to concentrating the entire station at one site. The radio equipment proposed for installation at the combined site would be six manually-tuned transceivers and a single 45/12 kw power amplifier. The receive portions of the transceivers would be supplied with receiver pre-selector circuitry in order to permit simultaneous operation on closely-spaced channels with antennas in close proximity to one another. A switching arrangement would be provided which would allow the 45/12 kw power amplifier to be utilized with any of the emitter portions of the transceivers. The selection would be accomplished at the operations' consoles and the act of switching would initiate the automatic tuning of the power amplifier as required.

Two operator's consoles would be furnished, each of which would provide access to all of the radio equipment at the site as well as any land-lines required or ex-base circuits. The location of this site makes the factor of radio relay capability of prime importance and the operator's consoles would have ability to perform this function by means of simple key-switch operation.

This contractor has suggested that the antenna complement for the additional station be identical to that proposed for the modified transmitter site described previously. The hexagonal billboard antenna would permit the benefits of a steerable antenna and at the same time provide six electrically independent antennas for separate use. Two discone antennas would provide the omnidirectional capability for the station.

This company feels that the adoption of the proposed changes would result in an appreciably improved air-to-ground facility with very little change in the over-all station cost.

The contractor has received recently a request from the contracting office for an additional proposal concerning only the additional items listed in Bid Request No. - 81468. This proposal (CEP-839) is being prepared at this time and should be submitted soon.

Although several different methods for satisfying the ground station requirements for this project have been presented in CEP's 771 and 828, they have been purely speculative in nature and in no way have effected the efforts being expended to develop the ground station equipment as presently required.

(2) FREQUENCY SHIFT KEYER AND TTY EQUIPMENT.

(a) GENERAL. - The FSK equipment for this program is being developed at the contractor's Burbank, California, plant. The following information covers the development of the FSK equipment up to April 12, 1957.

(b) FREQUENCY SHIFT OSCILLATOR O-476(XA)/URC (see figures 17 and 18). - The electrical design of this unit is now completed. Six modules are being constructed and should be completed by May 15th. Environmental testing will be started at that time. The balanced output of this unit has been modified to permit a choice of 150-ohms or 600-ohms output impedance. The change of impedance can be made on a strapping basis within the mo' le.

The function of the O-476 is to convert the binary output of the AN/AGC-1 teletype-writer to two-tone audio frequency signals which are capable of operating the ARC-58 radio in FSK operation. The frequency of the output to indicate a "mark" is 2900 cps ±3 cps and to indicate a "space" 2700 cps ±3 cps. The voltage amplitude of these signals is 1 volt rms minimum to 2 volts rms maximum. The keying rate is 60 words per minute.

(c) KEYER - KY-217(XA)/URC (see figure 19). - The electrical design of this unit is currently being modified in that the current Loop Control for aircraft application is being omitted. Because of temperature requirements, the major complement of transistors is being changed from 2N158 germanium type to 970 silicon type.

The function of this unit is to convert low-level binary d-c information from the CV-330 into high level binary d-c suitable for operating the AN/AGC-1 teletypewriter. The

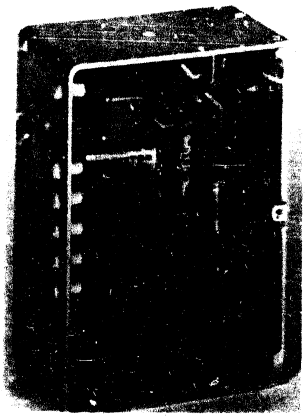

Figure 17. The Frequency Shift Oscillator O-476(XA)/URC (Front)

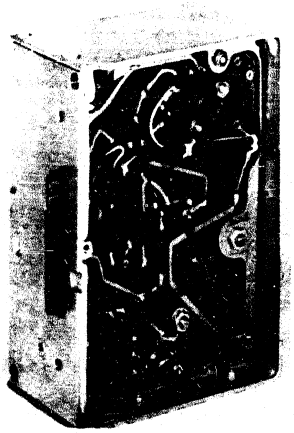

Figure 18. The Frequency Shift Oscillator O-476(XA)/URC (Rear)

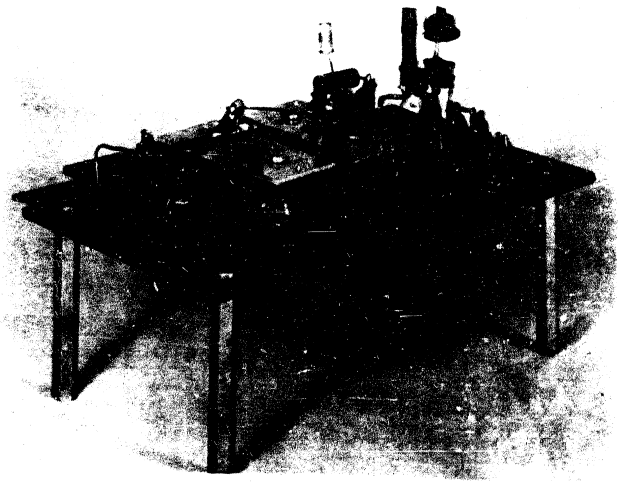

Figure 19. The Keyer KY-217(XA)/URC

voltage output for a "mark" is 60 volts d-c minimum to 90 volts d-c maximum and 0 volt d-c for a "space" when operating with the AGC-1. The signal output for 60 ma ground station operation is 120 volts d-c for a "mark" and 0 volt for a "space". Power requirements are 75 ma at +120 volts d-c.

(d) FREQUENCY SHIFT CONVERTER CV-530(XA)/URC (see figures 20 and 21). - The electrical design of this unit is now completed. Construction of six modules is scheduled to be completed by June 1st, at which time the environmental tests will be started. The input circuit has been modified to offer either a 600 ohm or 1000 ohm impedance. The choice of impedances can be made on a strapping basis within the module.

The CV-530 converts the nonsynchronous two-tone audio FSK signals from the ARC-58 radio into a binary d-c voltage suitable for operating the KY-217 keyer. The amplitude of the signal input voltage is 1.5 volts rms minimum and 6.0 volts rms maximum. The dynamic range of the limiter is 0.010 to 10.0 volts rms. The voltage of the signal output for a "mark" is +1.0 volt d-c and -10.0 volts d-c for a "space". The loss of an input signal produces a steady "mark" output. This feature is optional, however, and can be eliminated by changing a strapping arrangement within the module.

(e) POWER SUPPLY PP-1664(XA)/URC (see figure 22). - This 400 cycle power supply is being redesigned to include a 120 volt, 60 ma supply for teletypewriters other than the Kleinschmidt AGC-1.

The PP-1664 converts 115 volts at 400 cycles to d-c power for all of the subunits of the Converter-Oscillator. Voltage and power outputs are -25 volts d-c at 20 ma, +15 volts d-c at 13 ma, and -120 volts d-c at 75 ma.

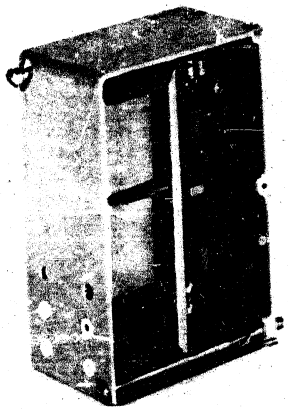

Figure 20. The Converter CV-530(XA)/URC (Front)

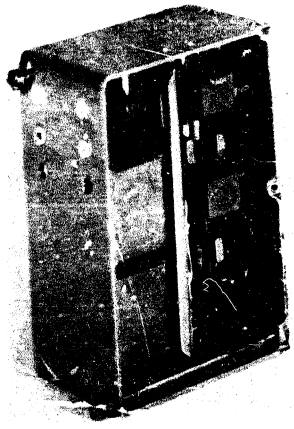

Figure 21. The Converter CV-530(XA)/URC (Rear)

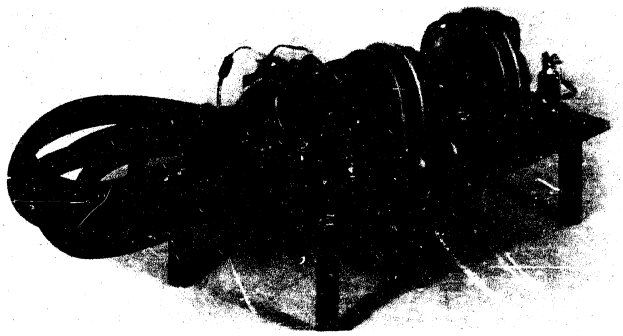

Figure 22. The Power Supply PP-1664(XA)/URC (400 Cycle)

(f) POWER SUPPLY (60 cycle) (see figure 23). - Final military nomenclature has not been assigned to this unit. Electrical design and breadboard tests are completed and the unit has been released to the mechanical staff for layout and assembly. This full wave rectifier produces 25 volts at 30 ma and 15 volts at 10 ma.

(g) CONTROL LOOP CURRENT. - The military nomenclature has not been assigned to this unit. It consists mainly of 2500-ohm 25-watt potentiometers, series jacks, and a loop current meter. Electrical design is completed and the mechanical layout is presently in progress.

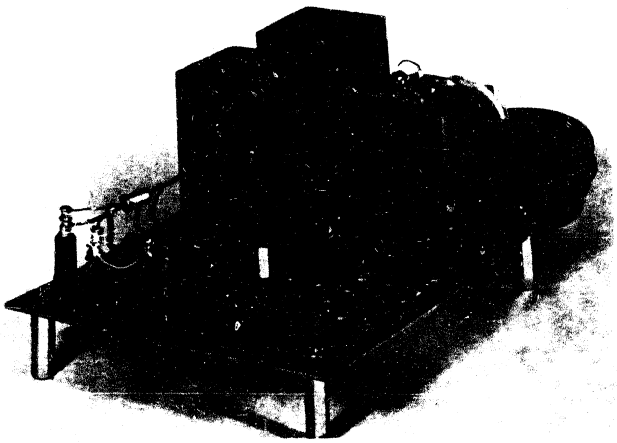

Figure 23. The FSK 60-Cycle Power Supply

(3) GROUND STATION EXCITERS AND AMPLIFIERS.

(a) GROUND STATION EXCITER 310F - 1. - The status of the modules to be used in this unit may be seen in the section of this report devoted to the ARC - 58. Development for the 310 F - 1 is scheduled for completion in June 57 and construction should be completed in August 57.

(b) THE 45 12KW TRANSMITTER 205J-1. - During the period covered by this report tests were conducted to determine the adequacy of air supply and cooling to critical components within the R-F cabinet. As a result of these tests, changes of a relatively minor nature were made to more equitably distribute the air. These changes also resulted in lowering the load on the blower motor, so that it operates at a satisfactorily safe margin below rating.

A new control module for supervising the operation of the transmitter during the automatic tuning cycle has been designed and tested. The new design was found to be necessary in order to incorporate a gain limiting circuit to prevent excessive plate dissipation in the power amplifier stage, and excessive input signal to the driver stage during the tuning cycle.

A new design of shorting contact for the power amplifier tuning coil was designed and operating tests proved it to be an improvement over the earlier type. An improved roller contact was also designed for use in the power amplifier loading coil.

The major part of the work during this period consisted of the construction of two final models of the R-F units. At the present time, the first of these units has been connected to one of the previously assembled power supplies and operation tests have been started. Initial tests have consisted of a complete wiring check, operation test of the control system, and mechanical adjustments and preliminary tests of the servomechanisms.

The second R-F unit is nearing completion of the assembly work. It is estimated that wiring checks can be started about the end of April.

(4) GROUND STATION RECEIVER 50E-1D. - The status of the modules to be used in this unit may be seen in the section of this report devoted to the ARC-58. Development of the 50E-1D is scheduled for completion in August 57 and construction should be completed in September 57.

(5) MISCELLANEOUS EQUIPMENT.

(a) DIVERSITY SELECTOR. - This unit is complete.

(b) LIMITER AMPLIFIER (see figures 24, 25, and 26). - Three additional engineering models were built and tested during the period covered by this report. Each of these units has shown a characteristic equivalent to that listed in the Fifth Quarterly Report of this project. Of the four engineering models available, two are being used in the parent equipment, one is being used for a production model, and one is being used for environmental tests.

A 60 cycle hum component was found in one of these units and it was determined that it was caused by flux leakage from the power transformer to the audio input transformer. Because the level of this hum was only 38 db below the level of the two volt output, it was necessary to specify that shielding be used on the input transformer. Tests conducted after the shielding was added showed the hum to be 52 db or more below the output level.

Some environmental testing has been completed with very satisfactory results. Shock tests were conducted using the plane of the unit which would be best for determining any weaknesses in the mechanical structure. No deficiencies were found. The unit was operative at 10,000 and 40,000 feet simulated altitude with no detectable deficiencies. Also, at 80°C in the heat chamber, no discernible effect in either output or waveform was noted, and no components were damaged. The humidity and vibration tests are scheduled to be started during the next period.

The production test requirements have been written and the equipment specification has been revised. The production drawings are nearly completed with two final assemblies to

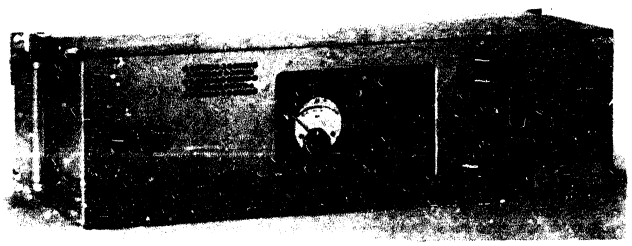

Figure 24. The Limiter Amplifier (Cover On, Front)

Figure 25. The Limiter Amplifier (Cover Off, Front)

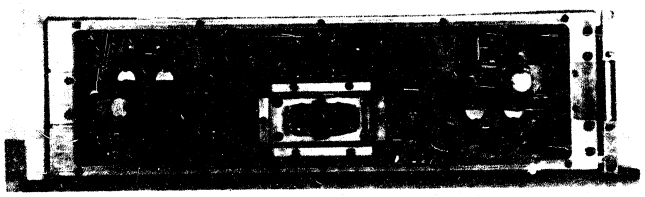

Figure 26. The Limiter Amplifier (Cover Off, Rear)

be completed during the next period. It may be necessary to modify slightly the two units being used with the parent equipment in order to make the units more compatible.

Assembly of the production models is scheduled for the next reporting period. Liaison will be maintained with the production facilities in order to insure the units will be in keeping with the design performance.

(6) GROUND ANTENNA SYSTEM.

A study was made during this period of the report submitted by Mr. Ashton. It appears at this time that some mechanical redesign is necessary to meet the anticipated environmental conditions. That redesign will be approached with the intent to improve the structural quality of the antenna system while stressing the economy. Definite facts and figures are not available at the writing of this report. However, the next Quarterly Report will contain the detailed information regarding the necessary changes.

E. CONCLUSIONS AND SUMMARY.

The foregoing report has presented the chronological events in the progress of the equipment being developed under this contract. Perhaps the most outstanding feature of the progress reported herein is the number of modules that have been tested, completed, and are now being produced for the parent unit.

Various meetings and conferences were held during the period covered by this report with representatives of the Contracting Office to aid in clarifying some of the requirements of the user and the obligations of the contractor.

The performance of the modules exposed to the stringent requirements of the environmental specifications has required slight modifications in some cases. None of these, however, were anything but minor in nature and were easily corrected. Results of the tests conducted to date have indicated that the final units will be reliable under all conditions and perform well within the limits of the specifications.

PART II

PROGRAM FOR THE NEXT INTERVAL

The next period will be devoted to the continuation and completion in some areas, of the development and testing of the equipment for this program. Major emphasis will be placed on completing the design and development of the ground station.

Considering the state of development of the airborne equipment, and the revised specifications as set forth in RADC-1800A, more effort can now be concentrated on the ground equipment for this program. Now that the required equipment for this portion of the contract is firm, progress should be positive and rapid.

Considerable site preparation is scheduled for the ground stations during the next period, especially for the Ava and West Stockbridge Hill sites. Completion of the substructure installation for the omnidirectional antennas is scheduled for July. Site preparation for the steerable antennas is also scheduled for completion in July. Construction of the 45 12 KW transmitter should be completed in June.

Although the present status of many units now comes under the direct supervision of the production facilities of this company, engineering personnel will continue to follow closely the production of these items in an attempt to facilitate further improvements to insure that the equipment, when delivered, will be the most reliable and best performing possible.