NASA CR-65988

FIRST QUARTERLY REPORT

(Phase C)

THIN-FILM PERSONAL COMMUNICATIONS AND TELEMETRY SYSTEM (TFPCTS)

Contract No. NAS 9-3924

MAR 1968
RECEIVED
NASA STI FACILITY
INPUT BRANCH

Submitted to

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
Houston, Texas

GPO PRICE $ _____

CFSTI PRICE(S) $ _____

Hard copy (HC) 3.00

Microfiche (MF) .65

ff 653 July 65

MELPAR, INC.
7700 Arlington Boulevard
Falls Church, Virginia 22046

LIBRARY COPY
AUG 1967
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

FACILITY FORM 602

N68-18780 (ACCESSION NUMBER)	(THRU)
15 (PAGES)	1 (CODE)
CR-65988 (NASA CR OR TMX OR AD NUMBER)	07 (CATEGORY)

NASA CR 65988

First Quarterly Report

Phase C

THIN-FILM PERSONAL COMMUNICATIONS AND TELEMETRY SYSTEM (TFPCTS)

For the period of March 24, 1967 to June 24, 1967

Contract No. NAS 9-3924

Submitted to

National Aeronautics and Space Administration
Manned Spacecraft Center
Houston, Texas 77058

July 1967

Melpar, Inc.
7700 Arlington Boulevard
Falls Church, Virginia 22046

TABLE OF CONTENTS

		Page
1.	INTRODUCTION	1
2.	TECHNICAL DISCUSSION	2
	2.1 Masking Controls	2
	2.2 Capacitor Plates	3
	2.3 Capacitor Dielectric	4
	2.4 RF Modules	5
	2.5 IF Modules	7
	2.6 Packaging	7
3.	PROJECT SCHEDULE AND OBJECTIVES	11
4.	PERSONNEL	12

LIST OF ILLUSTRATIONS

Figure		Page
1.	Assembled RF Amplifier a) Substrate b) Substrate With Shielding	6
2.	Preliminary Transceiver Package Design	8
3,	Receiver And Transmitter Subassemblies a) Receiver Package b) Transmitter Package	9

1. INTRODUCTION

This report for the first quarter of Phase C is submitted in compliance with Contract NAS 9-3924 between NASA-Houston and Melpar, Inc. The objective of the contract is to design and construct a thin-film personal communication and telemetry system. During Phase C, the objective is to package two transceivers using the modules developed in Phase B of the program. Four of the Phase B modules were not completed at the time of the Phase B final report. These modules are now being constructed and will be evaluated in the next report interval.

The evaluation process on the universal RF module has been very gratifying. A number of these modules have been fabricated and their performance has been excellent in regard to power gain and stability. The IF modules are the only critical modules which have not been fully evaluated. One IF substrate is partially assembled and appears to function properly.

A preliminary system package has been designed and the estimated volume of 10 cubic inches seems reasonable. All of the RF circuitry can be packaged in 4.5 cubic inches since each transmitter and receiver will be approximately 3/8" x 1" x 3". These dimensions include all of the shielding necessary to assure proper system operation.

The total program is approximately two months behind schedule due to mask and deposition problems as previously reported. The next two months of deposition and evaluation are critical to the schedule.

2. TECHNICAL DISCUSSION

There are a significant number of process controls necessary in the formation of reliable thin-film circuits. During the development of the transceiver circuits we encountered many problems which individually do not seem severe but when compounded they cause significant delays. The major problem areas and solutions are given in the following sections.

2.1 Masking Controls

Our normal procedure for a thin-film circuit requires the use of a 4" x 4" pallet which can hold sixteen 1" x 1" substrates. A set of metal masks (normally 6 or 7) must be mated such that each member of the set is aligned over the 16 square inches. By working at 10 to 1 enlargements and then photographically reducing, we have had no problem in obtaining ± 1 mil tolerance. However, in some original layouts, insufficient overlaps were allowed for capacitor dielectric and conductor interconnections to take care of the alignment, spread out during deposition and etching errors.

The following control measures were taken to eliminate this problem:

(1) Whenever possible, a 10 mil overlap is used in original artwork. (At 10 to 1 this is actually 100 mil.)

(2) A coordinateograph is used to make the original artwork instead of the 5 mil tape formally used.

(3) A new procedure has been developed to accurately locate the 16 substrate figures for a multiple circuit mask before the final photo reduction.

(4) A step etching technique is used to reduce etching errors. The pattern to be etched is photographically printed (with photo resist) on both sides of the metal foil. One side of the exposed foil is covered during the first etching step and the etching is allowed to progress to within 1/2 mil of breakthrough. The foil is then removed from the etch bath and the covering removed. The second etch is then allowed from both sides of the foil. The result is a much better control of dimensions.

(5) The etching is now accomplished within the thin-film facility which eliminates a problem of communication.

2.2 Capacitor Plates

A number of problems other than mechanical are concerned with the deposition of capacitors. For bonding purposes, it was found that aluminum over chromium forms a good surface and the chromium provides good adhesion to the glass. A single conductor pattern was made and both metals were deposited

sequentially. What was not known was that when this metallic combination is used as a capacitor plate, the capacitor gradually deteriorates. Depending on the polarity of voltage on such a capacitor one of the plates actually disintegrates. This is believed to be an electroplating action through small faults in the dielectric. When aluminum is used by itself, there is no problem with capacitor aging or with polarity sensitivity.

The solution to this problem was to make separate masks for aluminum and chromium depositions so that the combination can be used for bonding areas and aluminum only for capacitor plates.

Aluminum by itself can also cause problems in the formation of capacitors. The smoothness of the aluminum is effected by both the speed of deposition and the temperature of the substrates. By using a high speed deposition and a low temperature (less than 100° C) at the substrate, the resulting aluminum forms excellent capacitor plates.

2.3 Capacitor Dielectric

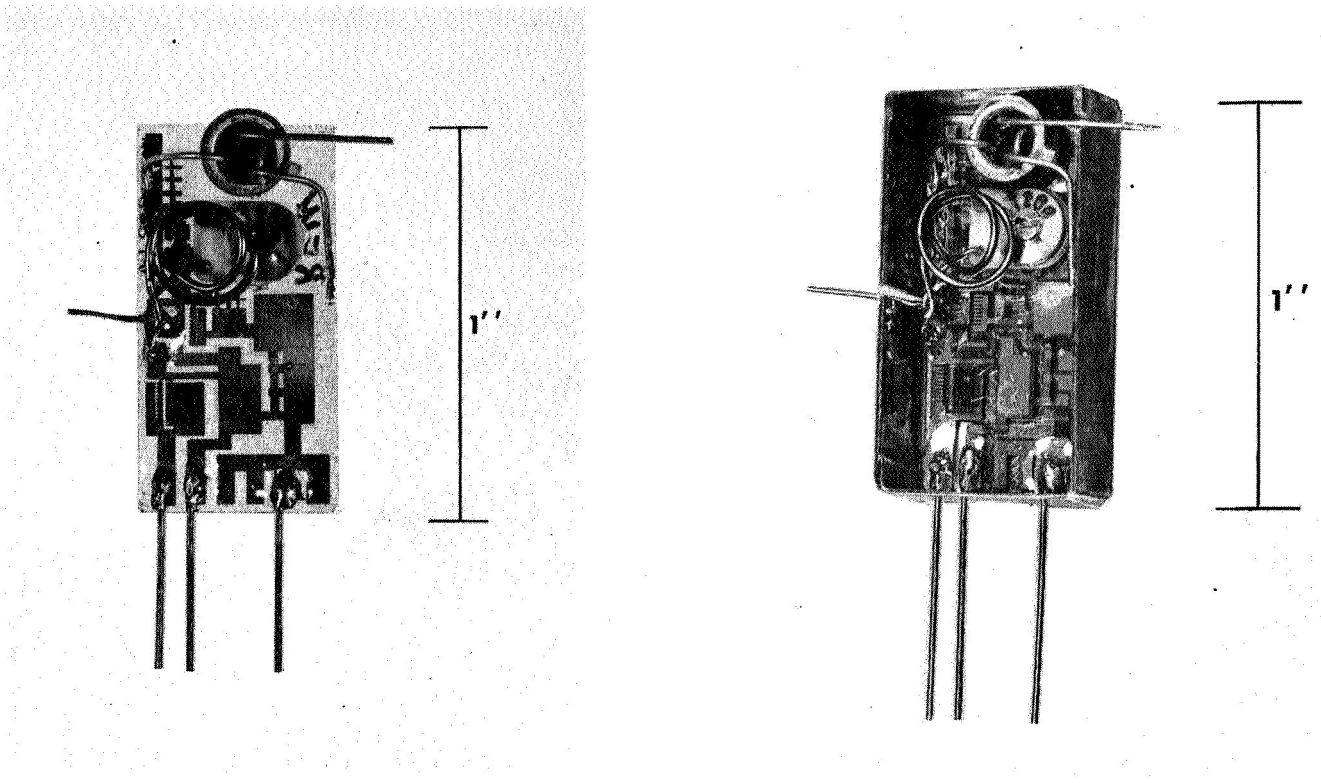
We have had considerable difficulty during the past few months in forming a good capacitor dielectric. The dielectric intended for use is a B_2O_3 (25%) - SiO_2 (75%) glass. The films have not been consistent; ranging from a

hydroscopic quality (indicative of a high B_2O_3 percentage) to a voltage sensitive, high dissipation factor (indicative of SiO).

In analysing the results of a number of SiO depositions, the evaporation rate and total thickness of dielectric varied a factor of 2 to 1. Since the power applied was held constant it was assumed that the starting material was the variable. The mixing procedure and percentages were then investigated with no positive results. By selecting the raw SiO according to reflectivity and color it was found that the evaporation rate could be varied over the same 2 to 1 range. Successive evaporations showed that pure SiO evaporates at 300 A°/min and this test along with the reflectivity selection has given a workable process control. We have also found that evaporation of the entire starting material is more consistant than a power vs time control.

2.4 RF Modules

Four RF modules have been fabricated and evaluated. Figure 1(a) shows a substrate with attached leads and components. Figure 1(b) shows a shielded module. The modules have met all of the electrical design requirements except for one of the B+ by-pass capacitors. The inductance of the capacitor lead is larger than anticipated so that the area of the capacitor plates will have to be reduced to compensate. The mask has



(a) Substrate

(b) Substrate with Shielding

Figure 1. Assembled RF Amplifier

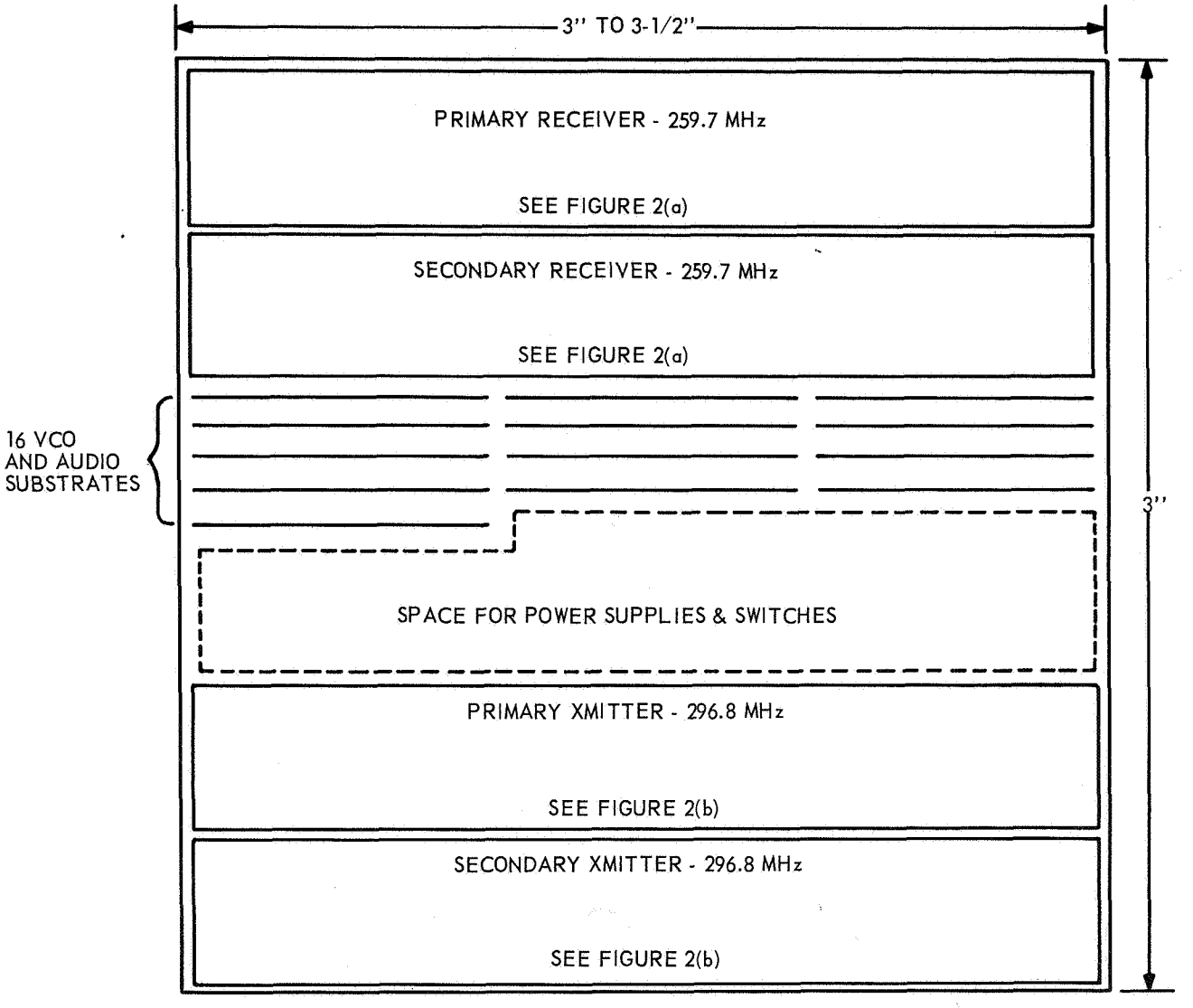
been modified for this purpose and a deposition run is in progress.

2.5 IF Modules

The first IF amplifier module to be evaluated has been partially fabricated. All of the transistors have been mounted and with a gain of 1500 the circuit is operating properly. This module is particularly significant since it contains 15 capacitors, 22 resistors, 14 transistors and 3 diodes on a single substrate. We have had no problem in fabricating this module and with the success in the RF module there are no major problems remaining in the module development program.

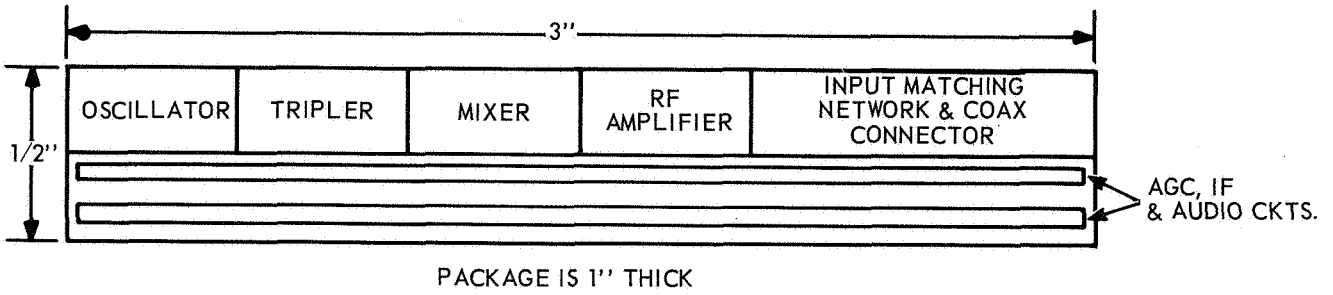
2.6 Packaging

A preliminary package design is shown in figure 2. The two receivers and two transmitters are individually packaged in shielded containers. Details of the internal construction for the RF portions are shown in figure 3. Construction of two transmitter containers has been completed so that a transmitter prototype can be fabricated within the next few weeks. The interconnections of modules will be accomplished on a printed circuit board that will also act as the bottom of the package. In a similar manner, the diplexers will be constructed on the sides or top of the package whichever proves more convenient.

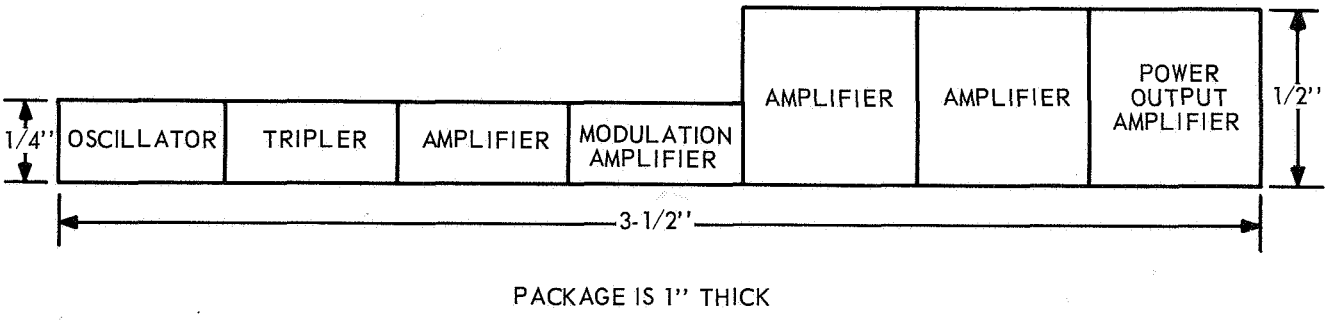


NOTES:
1. PACKAGE IS APPROX 1 INCH THICK
2. BOTTOM IS A PRINTED CIRCUIT INTERCONNECTION BOARD
3. TOP IS A PRINTED CIRCUIT DIPLEXER

Figure 2. Preliminary Transceiver Package Design



(a) RECEIVER PACKAGE (TOP VIEW)



(b) TRANSMITTER PACKAGE (SIDE VIEW)

Figure 3. Receiver and Transmitter Subassemblies

The 16 VCO and audio substrates are shown in the center of the package. Center to center spacing for these modules can be less than 0.1 inch. The remaining space is available for power supply componets, manual switches and the coax switch.

Figure 3(a), Receiver Package, indicates the relative position of the individual receiver modules. This package contains a complete receiver from RF input to audio output on six thin-film substrates. Total volume is 1.5 cubic inches. Some additional shielding may be required between the IF amplifiers. This can be included by depositing a conductive coating on the unused side of the substrate or by insertion of a metallic plate.

A trans~~ceiver~~mitter package is shown in figure 3(b). The increased height in the last three stages is needed to accommodate large transistor cases. When inserted in the system package the two Xmitters will be interleaved so that the larger section fits against the smaller section. The total height is then 3/4"; the total volume of a Xmitter is 1.3 cubic inches.

3. PROJECT SCHEDULE AND OBJECTIVES

We are now in a position to deliver an RF module and an IF module. These two have been evaluated and require packaging only. The second IF and an VOX module still remain to be evaluated. Four audio frequency amplifiers have been assembled and are stored for use in the final deliverable transceivers. If the deposition processing remains under control during the next two months (no problems are anticipated), we will be able to meet the original delivery schedule of 24 March 1968. At present we are two months behind schedule but during the fabrication stage we can use a larger staff to increase the module output rate.

During the next quarter, priority will be given to completion of the module delivery and to fabrication of RF portions of the final package.

The percentage of thin film components remains unchanged at approximately 75%.

4. PERSONNEL

Listed below are the key personnel involved with this program.

Project Leader	J. C. Mould
Senior Engineers	B. J. Weiner
	F. J. Hemmer
	H. L. Wilson
Engineers	S. Muzidal
	J. Guiliani