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MANUFACTURING METHODS AND TECHNOLOGY (MM AND T) MEASURE FOR FAB--ETC(U)

JUL 78 B B ADAMS, S W KESSLER, R E REED DAAB07-76-C-8120

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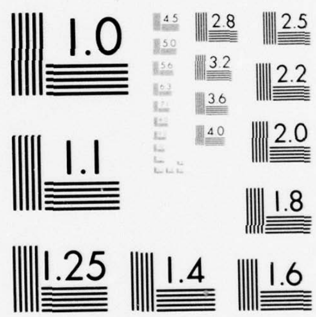

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

Eighth Quarterly Progress Report

MANUFACTURING METHODS AND TECHNOLOGY (MM&T) MEASURE FOR FABRICATION OF SILICON TRANSCALENT THYRISTOR

Period Covered:

1 July 1978 to 30 September 1978

Contract No. DAAB07-76-C-8120

Placed by:

U. S. Army Electronics Command
Production Division
Production Integration Branch
Fort Monmouth, New Jersey 07703

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DISCLAIMER STATEMENT

DISPOSITION INSTRUCTIONS

ACKNOWLEDGEMENT STATEMENT

This project has been accomplished as part of the U.S. Army (Manufacturing and Technology) Program, which has as its objective the timely establishment of manufacturing processes, techniques or equipment to insure the efficient production of current or future defense programs.

MANUFACTURING METHODS AND TECHNOLOGY (MM&T)
MEASURE FOR FABRICATION OF SILICON TRANSCALENT THYRISTOR

Eighth Quarterly Progress Report

Period Covered: 1 July 1978 to 30 September 1978

Object of Study: The objective of this manufacturing methods and technology measure is to establish the technology and capability to fabricate Silicon Transcalent Thyristors.

Contract No. DAAB07-76-C-8120

Prepared by:
B. B. Adams
S. W. Kessler
R. E. Reed
D. R. Trout

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
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16. DISTRIBUTION STATEMENT (of this Report)

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Thyristor	Power Switching Component	Transcalent Thyristor
High Current SCR	Power Conditioning Component	Production Engineering
Heat-Pipe Cooling	Solid State Device	Electrical Testing of SCR

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

This Eighth and Final Quarterly Report describes the conclusion of the MM&TE program for the Transcalent (Heat-Pipe cooled) thyristors. Production engineering measures for the device have been concluded. Test results on the 40 pilot production samples are listed.

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20. (Continued)

The present status includes the successful completion of the pilot production rate demonstration in accordance with the Preliminary Pilot Run Report as well as the completion of the fabrication of all of the pilot production devices and their shipment to the government.

Plans for the next Period include the completion of the documentation requirements which include the final monthly reports, this final quarterly report, the final technical report and the general report on Step II.

ABSTRACT

This Eighth Quarterly Technical Report on the MM&TE Contract DAAB07-76-C-8120 for Transcalent (Heat-Pipe cooled) SCR Thyristors describes the progress on device production for the 40 Pilot Run Samples. Also described are the problems encountered and the results achieved in the testing of the numerous characteristics, including the sampling of some design and environmental parameters as required by the contract.

Actual test results for the Pilot Run Samples are included to verify that the device design can be successfully reproduced to conform to the electrical, mechanical and thermal specification of SCS-477. Production rate data was prepared for the production rate demonstration and included in the Preliminary Pilot Run Report, issued separately.

The latest revision to the PERT Chart, prepared and submitted on 29 August 1977, continued to be applicable as the balance of the work program remained on schedule. All of the Pilot Run has been completed and the devices delivered to the government.

Plans for the next period include the completion of the documentation requirements for both Steps I and II.

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PURPOSE

The purpose of this production engineering contract was to establish the technology and capability to fabricate heat-pipe cooled semiconductor power devices, silicon Transcalent Thyristors, Type J15371. The subsequent pilot production of these devices was a part of the contract. This report covers the efforts performed by the contractor in the eighth quarterly period to perform the Pilot Run Sample Device production. Both the engineering and confirmatory samples were adequately characterized previously. Plans for future work are also presented and other pertinent information is further discussed to help assure that the purpose of the contract was accomplished.

This contractual MM&TE program was used to establish the production techniques, to establish the quality control procedures and to verify a pilot production rate capability for the J15371 thyristor, conforming to the drawing attached to AMENDMENT 1 of SCS-477 as well as to the modifications No. P00001, P00002 and P00003 to the contract. Electrical, mechanical, thermal and environmental inspections were a part of the program as well as extensive documentation requirements, per DD 1423.

No high volume production facilities existed at the start of this contract for the Transcalent type of solid-state power device. However, facilitation was accomplished for the pilot rate requirement and higher volume production planning constitutes Step II of the contract. Thus, the time required to produce future large quantities of the J15371 will be reduced for either current military requirements or for future emergency requirements. Reduction of the reproductive costs for production quantities was also accomplished.

The J15371 thyristor is a 400 amperes RMS, 800 volts, forced air cooled solid-state power control device, lighter weight and smaller size than the conventional devices with their externally attached heat-sinks. Ruggedness and improved reliability resulted from these innovations. A blocking voltage capability of 800 volts minimum at 125° Celsius was successful as a requirement. Original R&D efforts were conducted successfully by RCA under Contract No. DAAK02-69-C-0609, for MERADCOM, Ft. Belvoir, VA. Potential applications include power conditioning, power switching, phase control, voltage variable power supply, motor speed control and other high power military equipments.

GLOSSARY

All abbreviations, symbols and terms used in this report are consistent with the Electronics Command Technical Requirements SCS-477, dated 5 December, 1974. This Technical Requirements document, in turn, references MIL-S-19500 for the abbreviations and symbols used therein except, as follows:

V_{GR} = Reverse Gate Voltage

I_{GR} = Reverse Gate Current

The format used for this report is that specified in the DD 1423, namely, ECIPPR No. 15, Appendix C, augmented by MIL-STD-847A. Sub-section numbering is based on Appendix C and the applicable test methods are those referenced in the following military standards:

MIL-STD-750B
MIL-Std-202E

Detail, individual item requirements shall be in accordance with MIL-S-19500.

NARRATIVE AND DATA

1. Device

a. Description of the Structure - Refer to pages 9-13 of the First Quarterly Report for a description of the Transcalent thyristor device, the applicable reports, and the applicable patents as well as the advantages of this heat-pipe cooled technical approach. Refer to Figure 1 in the Second Quarterly Report for the cross-section drawing of the J15371 with the external dimensions added.

b,c. Defining the Problem Areas and Work Performed to Resolve the Problem

(1) Conversion of Design for Production

The Transcalent Thyristor design achieved under R&D Contract No. DAAK02-69-C-0609 was described in the FTR, October, 1972. Subsequent refinements have been incorporated under Contract N62269-73-C-0635 and by RCA funded engineering projects. Additional engineering has been applied under this MM&TE program to convert the design to one more suitable for production, as described in prior Quarterly Reports covering the period 27 September 1976 to 30 June 1978 and below for the most recent quarterly period.

(a) Item No. 0001AC Pilot Run Phase

i. SCR Device Fabrication

The remaining Pilot Run samples were fabricated during this quarterly report period. All have passed the 100% basic electrical tests of Table I, Group A in SCS-477 as well as the sampling required for the Table II and III thermal and environmental tests. Refer to Section 5 of this report for a summary of the test results.

This group of Pilot Run devices was shipped in late September, 1978 to complete the contract requirement of 40 deliverable devices. Some of these devices were used to demonstrate the production rate, as required by Section F49 of Part II of the contract.

ii. Pilot Run Production Rate Demonstration

A Pilot Run production rate demonstration was performed on 10 and 11 July at the contractor's Lancaster, PA, location. The Preliminary Pilot Run Report for Fabrication of Silicon Transcalent Thyristor (30 May 1978) was used as a guide for the demonstration.

The aforementioned report described heat-pipe and thyristor device assembly in great detail. Dr. Russell Eaton, III of Ft. Belvoir, VA, witnessed each of the ten steps indicated on page 7 of the report, (Fig. 1 in this report), which shows the flow diagram for device assembly, and found the steps adequate for the production rate goal.

All production assembly steps except one, were performed at the required rate or better. The exception to the required production rate involved the exhaust processing. The six port exhaust facility used has been proven in previous processing of units. However, the six port facility can only produce 4.6 units in an eight hour shift. The capacity per port was 0.8 unit per eight hour day.

Modifying the facility to a 14 port manifold would increase the capacity to eleven units in an eight hour day. The fourteen port system was not available during the pilot run demonstration, however, it is part of the contractor's future plans for high volume production.

A flow diagram for the RCA proprietary J15371 thyristor wafer metallizing, contouring and pretesting was shown in the Preliminary Pilot Run Report. The various steps involved were reviewed in conjunction with an industrial engineering station capacity study; station capacity data was obtained through an RCA funded time study and covered every aspect of the device fabrication. The time study was reviewed with Dr. Eaton, and proved to be a helpful reference during the demonstration.

Test procedures were also demonstrated. It was verified that the test station design and sequence were adequate to test at a rate of ten good thyristors in an eight hour day.

Figure 1

FLOW DIAGRAM FOR THE TRANSCALENT THYRISTOR ASSEMBLY

Anode Heat-Pipe

(1) Anode Body Sub-Ass'y.

(2) Anode Body Sub-Ass'y. (Wicked)

(3) Anode Body

Cathode Heat-Pipe

(1) Cathode Body Sub-Ass'y.

(2) Cathode Body Sub-Ass'y. (Wicked)

(3) Cathode Body

(4) Ceramic Insulator Ass'y.

(5) End Cap Ass'y.

(6) Anode Heat-Pipe Ass'y.

(6) Cathode Heat-Pipe Ass'y.

(7) Complete Anode Heat-Pipe Ass'y.

(7) Complete Cathode Heat-Pipe Ass'y.

(8) Thyristor Ass'y. Brazed

(9) Thyristor Ass'y. Welded

(10) Transcalent Thyristor Ass'y.

Test

Sufficient parts and sub-assemblies were not available within the scope of the contract to operate every work station at full capacity for an entire shift. Thus the rate verification was performed on a few representative sub-assemblies by the trained operators on the normal work schedule of the first and second shifts. The elapsed time measured for each individual process was then projected to a full eight hour day to verify the rate. Timing of the demonstration was accomplished in this manner in two days covering both shifts.

Brazing fixtures, tools and test equipment of proven design and proven reliability were used throughout the pilot run to produce the units. All purchased and machined parts were inspected to the pertinent drawings prior to utilization. Each manufactured sub-assembly was vacuum-leak checked on a 100% basis prior to its incorporation into a final unit.

The silicon Transcalent thyristor had been incorporated within the contractors' engineering standard, (specification control) system. This meant that part and sub-assembly configurations, as well as, manufacturing processes could be performed against the standards without deviations during the pilot production rate demonstration.

The pilot run demonstration performed for Dr. Eaton verified the contractor's ability through subsequent data presented, such as, engineering specifications and time study information, to produce the J15371 silicon Transcalent thyristor at a production level of ten net good units in an eight hour day.

iii. Yield Improvement

Information will be prepared and included in the Final Technical Report on the yield improvement accomplished during this MM&TE program.

(b) Item No. 0004AE General Report on Step II

This report for the production planning of the silicon Transcalent thyristor J15371 is being prepared. Draft copies will be submitted to the U.S. Army Mobility Equipment R&D Center for approval. This report will contain a production plan for 80 devices per eight hour day and describe the manpower as well as the facilities to be utilized in the future production of the silicon Transcalent thyristor. Diagrams, tables and time studied rates will be included, per the DD 1423 and the applicable references.

d. Conclusions

The hardware portion of the Pilot Run phase of the contract has been successfully completed by the shipment of the devices on schedule.

Preparations are underway for the completion of the data required, per DD 1423, in the next period.

e. Drawings

Drawings of the piece parts and sub-assemblies of the device were included in the first Quarterly Report with revisions to these engineering drawings subsequently included in the Second Quarterly Report. Subsequent revisions to the heat-pipe strain isolation were included in the Seventh Quarterly Report.

Refer to Table 2 for a cross-reference to the prior technical achievements reported under this contract.

2. Process, Equipment and Tooling

a. Purpose of Each Step

(1) Device Processing and Tooling

Figure 4, Engineering Drawing No. 3025577, in the First Quarterly Report, showed the flow of parts through the various assembly steps and a descriptive title was listed for each operation. Also shown were the sub-assembly drawings and fixture drawing numbers for each operation. In both the First and Second Quarterly Reports, the procedures for using the fixtures were included with a photograph of each fixture. This information continued to be used for the device fabrication and processing.

(2) Electrical and Environmental Test Equipment

The flow chart of the electrical and environmental testing sequence was given in Figure 7, Drawing No. 3025578, of the First Report. The name of the test was given as well as the special conditions and the MIL-STD-750B method number. Long-time tests had the time interval indicated in the figure. This chart remained valid for the program.

b,c. Problem Areas and Work to Resolve Problems

(1) Device Processing and Tooling

Fabrication processes that were determined to limit the production quantities were improved for the Pilot Run by increasing the yields, by increasing the quantity per operation, by reducing the labor required, by improving the fixtures, and by a more complete documentation of the processes.

(a) Heat-Pipe Lapping Mechanization

The successful conclusion of the investigation into the machine lapping of the discs that form the evaporator ends of the heat-pipes was reported previously. Superior flatness and surface finishes were obtained on samples lapped at the machine vendor's plant. The procurement of this equipment has been initiated to eliminate a labor-intensive operation. Delivery is expected in the next period.

(2) Electrical Thermal and Environmental Test Equipment

(a) Test Equipment Calibration Schedules

Electrical test equipment calibration dates were listed in Table 4 of the Fourth Quarterly Report. The schedule established for the recalibration of these equipments on a regular basis was used to recalibrate each equipment in this report period. This call-out continues to occur automatically at four to six months intervals. The calibrations are carried out by the RCA Meter Laboratory Calibration and Standards Department.

Environmental test equipment calibrations in the RCA-Lancaster Environmental Laboratory are also performed at four to six months intervals. The calibration schedule was listed in Table 5 of the Fourth Quarterly Report.

d. Conclusion

The process, equipment and tooling designed, fabricated and used to fabricate and evaluate the engineering and confirmatory sample devices has also been used for fabricating the Pilot Run production. No process, equipment or tooling limitations were apparent during the pilot production phase.

e. Drawings and Photographs of Tooling and Equipment

Copies of the drawings of the special tools and fixtures were included in the First Quarterly Report along with Block Diagrams of the test equipment. Tools and fixtures that were revised were included in the Second Quarterly Report. Photographs of these items were included in both reports. These tools and fixtures were used for the Pilot Run.

Photographs of the electrical test equipment were included in the Third Quarterly Report with text references that described each equipment item. Testing procedures for the electrical test equipment were included in Appendix C of the Second Quarterly Report and in the Appendix of the Third Quarterly Report. These were used for the Pilot Run.

Refer to Table 2 for a cross-reference to the prior technical achievements reported under this contract.

3. Flow Chart of Manufacturing Process Yield

Manufacturing process yields were determined during the Pilot Run and will be reported in the Final Technical Report.

4. Equipment and Tooling Costs

This information will not be included since such a data requirement is generally not applicable to a Firm Fixed Price Contract on equipment and tooling that is purchased and furnished by the contractor for unrestricted use in fabricating the devices required by the contract or for other government end use. RCA has furnished the equipment and tooling used for this contract with the exception of some of the tools and fixtures. A list of the latter items will be included in the Final Technical Report.

5. Data and Analysis

a. Inspections

(1) Pilot Run Devices

The Pilot Run devices included in this report were inspected in accordance with paragraph 4.5, using the sampling plan included in this paragraph of the specification SCS-477. The requirements of paragraphs F.49 of the contract as well as 3.1.6 and 3.1.10 of ECIPPR No. 15 are also being observed. Specification modifications No. P00001, P00002 and P00003 have been included.

The evaluation testing of the initial candidates for the Pilot Run requirement began in April in accordance with the Test Plan submitted previously (SLIN No. 0005AA).

Testing of these devices was finalized in September. Detailed comments, analyses and discussions of those results will be listed in the final technical report (SLIN No. 0004AC).

The test results of forty devices tested for the Pilot Run are summarized in the attached Tables 1. The following codes are utilized in the tables.

Code:
- P - Passed, including all of the final measurements required after each major test.
- IP - Test is in progress.
- F - Failed this test.
- A - Acceptance judged from another Pilot Run sample submitted to this test; per SCS-477, para. No. 4.5.

b. Discussion of Inspection Results

(1) Visual and Mechanical Inspections

Inspection of device No. F35 disclosed a hair-line crack in the high-voltage ceramic and the device, although operable, was considered to be rejected. However, this device passed all of Group A and a portion of the Group B inspections, including the surge test. This device failure along with the dv/dt failure of device No. F43 comprised the two allowed failures at Group A, Sub-Groups 1-4 inspection. Both are operable devices that failed only to meet one limit specified in SCS-477. Both passed several other tests required for the Pilot Run devices, as summarized in Table 1a, below. Both were shipped in fulfillment of the Pilot Run device requirements.

TABLE 1a

SUMMARY OF PILOT RUN DEVICES
PERFORMANCE vs. SPECIFICATIONS

Inspection	Device Serial No.													
Group A, Sub-Groups 1-4	F33	F35	F36	F39	F40	F41	F42	F43	F46	F49	F50	F51	F52	F54
Vis. & Mech.	P	F	P	P	P	P	P	P	P	P	P	P	P	P
i_{RBOM} @ 25°C	P	P	P	P	P	P	P	P	P	P	P	P	P	P
i_{FBOM} @ 25°C	P	P	P	P	P	P	P	P	P	P	P	P	P	P
I_H @ 25°C	P	P	P	P	P	P	P	P	P	P	P	P	P	P
i_{RBOM} @ 125°C	P	P	P	P	P	P	P	P	P	P	P	P	P	P
i_{FBOM} @ 125°C	P	P	P	P	P	P	P	P	P	P	P	P	P	P
V_{GT} @ 25°C	P	P	P	P	P	P	P	P	P	P	P	P	P	P
I_{GT} @ 25°C	P	P	P	P	P	P	P	P	P	P	P	P	P	P
V_{GT} @ 125°C	P	P	P	P	P	P	P	P	P	P	P	P	P	P
I_{GT} @ 125°C	P	P	P	P	P	P	P	P	P	P	P	P	P	P
dv/dt @ 125°C	P	P	P	P	P	P	P	F	P	P	P	P	P	P
t_{OFF} @ 25°C	P	P	P	P	P	P	P	P	P	P	P	P	P	P
V_{FM} @ T_C = 100°C	P	P	P	P	P	P	P	P	P	P	P	P	P	P

TABLE 1a (cont.)

SUMMARY OF PILOT RUN DEVICES
PERFORMANCE vs. SPECIFICATIONS

Inspection	Device Serial No.												
Group A Sub-Groups 1-4	F55	F56	F57	F58	F60	F65	F67	F68	F69	F71	F72	F75	F76
Vis. & Mech.	P	P	P	P	P	P	P	P	P	P	P	P	P
i_{RBOM} @ 25°C	P	P	P	P	P	P	P	P	P	P	P	P	P
i_{FBOM} @ 25°C	P	P	P	P	P	P	P	P	P	P	P	P	P
I_H @ 25°C	P	P	P	P	P	P	P	P	P	P	P	P	P
i_{RBOM} @ 125°C	P	P	P	P	P	P	P	P	P	P	P	P	P
i_{FBOM} @ 125°C	P	P	P	P	P	P	P	P	P	P	P	P	P
V_{GT} @ 25°C	P	P	P	P	P	P	P	P	P	P	P	P	P
I_{GT} @ 25°C	P	P	P	P	P	P	P	P	P	P	P	P	P
V_{GT} @ 125°C	P	P	P	P	P	P	P	P	P	P	P	P	P
I_{GT} @ 125°C	P	P	P	P	P	P	P	P	P	P	P	P	P
dv/dt @ 125°C	P	P	P	P	P	P	P	P	P	P	P	P	P
t_{OFF} @ 25°C	P	P	P	P	P	P	P	P	P	P	P	P	P
V_{FM} @ T_C = 100°C	P	P	P	P	P	P	P	P	P	P	P	P	P

TABLE 1a (cont.)

SUMMARY OF PILOT RUN DEVICES
PERFORMANCE vs. SPECIFICATIONS

Inspection	Device Serial No.												
Group A, Sub-Groups 1-4	F79	F80	F82	F84	F85	F86	F87	F88	F91	F92	F95	F98	F100
Vis. & Mech.	P	P	P	P	P	P	P	P	P	P	P	P	P
i_{RBOM} @ $25^{o}C$	P	P	P	P	P	P	P	P	P	P	P	P	P
i_{RBOM} @ $25^{o}C$	P	P	P	P	P	P	P	P	P	P	P	P	P
I_H @ $25^{o}C$	P	P	P	P	P	P	P	P	P	P	P	P	P
i_{RBOM} @ $125^{o}C$	P	P	P	P	P	P	P	P	P	P	P	P	P
i_{FBOM} @ $125^{o}C$	P	P	P	P	P	P	P	P	P	P	P	P	P
V_{GT} @ $25^{o}C$	P	P	P	P	P	P	P	P	P	P	P	P	P
I_{GT} @ $25^{o}C$	P	P	P	P	P	P	P	P	P	P	P	P	P
V_{GT} @ $125^{o}C$	P	P	P	P	P	P	P	P	P	P	P	P	P
I_{GT} @ $125^{o}C$	P	P	P	P	P	P	P	P	P	P	P	P	P
dv/dt @ $125^{o}C$	P	P	P	P	P	P	P	P	P	P	P	P	P
t_{OFF} @ $25^{o}C$	P	P	P	P	P	P	P	P	P	P	P	P	P
V_{FM} @ $T_C = 100^{o}C$	P	P	P	P	P	P	P	P	P	P	P	P	P

TABLE 1b

SUMMARY OF PILOT RUN DEVICES
PERFORMANCE vs. SPECIFICATIONS

Inspection	Device Serial No.													
Group B, Sub-Groups 1-4	F33	F35	F36	F39	F40	F41	F42	F43	F46	F49	F50	F51	F52	F54
IF_M (Surge)	A	P	A	A	A	A	P		A	A	A	A	A	A
θ_{jc}, Initial	P	P	P	P	P	P	P	P	P	P	P	P	P	P
V_{GT} @ -25°C	P	P	P	P	P	P	P	P	P	P	P	P	P	P
I_{GT} @ -25°C	P	P	P	P	P	P	P	P	P	P	P	P	P	P
V_{FM} @ -25°C	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Thermal Shock	P	A	A	A	A	A	A	A	P	A	A	P	A	A
Moisture Resistance	P	A	A	A	A	A	A	A	P	A	A	A	A	A
Block. V. Life Test @ 125°C	A	A	P	A	A	A	P	A	A	A	A	P	A	A

TABLE 1b (cont.)
SUMMARY OF PILOT RUN DEVICES
PERFORMANCE vs. SPECIFICATIONS

Inspection	Device Serial No.												
Group B, Sub-Groups 1-4	F55	F56	F57	F58	F60	F65	F67	F68	F69	F71	F72	F75	F76
I_{FM} (Surge)	A	A	P	A	A	A	A	A	A	A	A	A	A
θ_{jc}, Initial	P	P	P	P	P	P	P	P	P	P	P	P	P
V_{GT} @ -25°C	P	P	P	P	P	P	P	P	P	P	P	P	P
I_{GT} @ -25°C	P	P	P	P	P	P	P	P	P	P	P	P	P
V_{FM} @ -25°C	P	P	P	P	P	P	P	P	P	P	P	P	P
Thermal Shock	A	A	A	A	A	A	A	A	A	A	A	A	A
Moisture Resistance	A	A	A	A	A	A	A	A	A	A	A	A	A
Block. V. Life Test @ 125°C	A	A	A	A	A	A	P	P	A	A	A	A	A

TABLE 1b (cont.)
SUMMARY OF PILOT RUN DEVICES
PERFORMANCE vs. SPECIFICATIONS

Inspection	Device Serial No.												
Group B Sub-Groups 1-4	F79	F80	F82	F84	F85	F86	F87	F88	F91	F92	F95	F98	F100
I_{FM} (Surge)	A	A	P	P	A	A	A	A	A	A	A	A	A
θ_{jc}, Initial	P	P	P	P	P	P	P	P	P	P	P	P	P
V_{GT} @ $-25^{o}C$	P	P	P	P	P	P	P	P	P	P	P	P	P
I_{G_T} @ $-25^{o}C$	P	P	P	P	P	P	P	P	P	P	P	P	P
V_{FM} @ $-25^{o}C$	P	P	P	P	P	P	P	F	P	F	P	P	P
Thermal Shock	P	P	A	A	A	A	A	A	A	A	A	A	A
Moisture Resistance	P	P	A	A	A	A	A	A	A	A	A	A	A
Block. V. Life Test @ $125^{o}C$	A	A	A	A	A	A	A	A	A	A	A	A	A

Table 1c
SUMMARY OF PILOT RUN DEVICES
PERFORMANCE vs. SPECIFICATIONS

Inspection	Device Serial No.												
Group C, Sub-Group 1-5	F33	F35	F36	F39	F40	F41	F42	F46	F49	F50	F51	F52	F54
Physical Dimen.	P	P	P	P	P	P	P	P	P	P	P	P	P
Shock	A	A	A	A	A	A	A	A	A	P	A	A	A
Vibration	A	A	A	A	A	A	A	A	A	P	A	A	A
Constant Accel.**	A	A	A	A	A	A	A	A	A	A	A	A	A
Barom. Press. Reduced	A	A	A	A	A	A	A	A	P	A	A	A	A
Salt Atmosphere	A	A	A	A	A	P	A	A	A	A	A	A	A
Thermal Fatigue	A	A	A	P	P	A	A	A	A	A	A	A	A
θ_{jc}, Final	P	A	P	P	P	P	P	P	P	P	P	P	P
Isothermal Charact.	P	P	P	P	P	P	P	P	P	P	P	P	P

**Information only test, per contract paragraph F3, item 7.

TABLE 1c (cont.)
SUMMARY OF PILOT RUN DEVICES
PERFORMANCE vs. SPECIFICATIONS

Inspection	Device Serial No.												
Group C, * Sub-Groups 1-5	F55	F56	F57	F58	F60	F65	F67	F68	F69	F71	F72	F75	F76
Physical Dimen.	P	P	P	P	P	P	P	P	P	P	P	P	P
Shock	P	A	A	A	A	P	P	A	A	A	A	A	A
Vibration	P	A	A	A	A	P	P	A	A	A	A	A	A
Constant Accel.**	A	A	A	A	A	A	A	A	A	A	A	A	A
Barom. Press. Reduced	A	A	A	P	A	A	A	A	A	A	A	A	A
Salt Atmosphere	A	P	A	P	P	A	A	A	A	A	A	A	A
Thermal Fatigue	A	A	A	A	P	A	A	P	A	A	A	A	A
θ_{jc}, Final	P	P	P	P	P	P	P	P	P	P	P	P	P
Isothermal Charact.	P	P	P	P	P	P	P	P	P	P	P	P	P

**Information only test, per contract paragraph F3, item 7.

TABLE 1c (cont.)

SUMMARY OF PILOT RUN DEVICES
PERFORMANCE vs. SPECIFICATIONS

Inspection	Device Serial No.												
Group C, Sub-Groups 1-5	F79	F80	F82	F84	F85	F86	F87	F88	F91	F92	F95	F98	F100
Physical Dimen.	P	P	P	P	P	P	P	P	P	P	P	P	P
Shock	A	A	A	A	A	A	A	A	A	A	A	A	A
Vibration	A	A	A	A	A	A	A	A	A	A	A	A	A
Constant Accel.**	A	A	A	A	A	A	A	A	A	A	A	A	A
Barom. Press. Reduced	P	P	A	A	A	A	A	A	A	A	A	A	A
Salt Atmosphere	A	A	A	A	A	A	A	A	A	A	A	A	A
Thermal Fatigue	A	A	A	A	A	A	A	A	A	A	A	A	A
θ_{jc}, Final	P	P	P	P	P	P	P	P	P	P	P	P	P
Isothermal Charact.	P	P	P	P	P	P	P	P	P	P	P	P	P

**Information only test, per contract paragraph F3, item 7.

c. Corrective Action

Previously reported corrective actions have proven successful in securing a reproducible thyristor device with consistently good electrical, thermal, mechanical and environmental characteristics. The results listed above for the pilot run are believed to verify this conclusion.

6. Specification

There are no further modifications proposed for the specification No. SCS-477. RCA has verified in the Pilot Run that the Transcalent thyristors fabricated during this phase of the contract meet all of the requirements of the specification.

7. Requirement for Pilot Run

The space, manpower, facilities, tooling, etc., required for the Pilot Run were listed in the Preliminary Pilot Run Report, dated 30 May 1978, and submitted separately as Contract Data Item No. 0004AE.

8. Total Cost for Pilot Run

Cost data will become available when the Pilot Run is completed. The total cost of the Pilot run phase through this quarterly period is almost $55,000.00 for the materials, labor and overhead costs, but prior to the addition of any general and administrative expenses or fees. Over six percent of the total represents the material costs.

These expenditures, although not quite complete, are less than the estimated costs for the Pilot Run phase because of the additional preparatory work performed in the prior phases as well as the utilization of some parts and materials purchased previously for the total contract scope.

9. Program Review

The PERT Chart revision submitted 29 August 1977 remains in effect with the Pilot Run delivery made on schedule in late September, 1978. The final program data is expected to be submitted also on schedule.

CONCLUSIONS

Effort expended in the eighth contract quarter was successful in finishing the Pilot Run Samples. Verification on the Confirmatory Samples that the design had met all of the specifications added assurance that the Pilot Run phase would also be successful. Time studies have been used to verify the required production rate capability exists on the work stations. Where required, increases in capacity were made at the few limiting work stations, to bring them up to the required pilot production rate. RCA is thus confident in having met the full MM&TE specification requirements for the Pilot Run devices. Both improved wafers and improved packages were fabricated for these devices.

The program has proceeded in accordance with the latest revised PERT Chart, dated 29 August 1977. All of the Pilot Run devices have been completed and shipped, to date.

PROGRAM FOR THE NEXT PERIOD

1. Issue the final monthly reports,
2. Submit the draft copies of this Eighth Quarterly Report for government approval,
3. Prepare and submit the draft copies of the General Report on Step II for government approval, and
4. Prepare and submit the draft copies of the Final Technical Report for government approval.

IDENTIFICATION OF PERSONNEL

The professional and skilled technical personnel who are actually working on the MM&TE project during the first eight quarters of the contract have varied backgrounds, as listed in the biographical resumes included in the previous Quarterly Reports. However, additional resumes are included in this report since added personnel were assigned to the project in the eighth quarter.

In addition to the major responsibilities, above, numerous supporting personnel including managers, secretaries, purchasing agents, environmental technicians, machinists, electricians, experimental tube builders, etc., have contributed to the progress made in the first twenty-four months of the contract.

Patrick M. Bransby - Electronics Technician, Electrical and Mechanical

Mr. Bransby graduated from Columbia High School and Willow Street Vocational Technical School in 1978 where he majored in Electronics. He joined the Transcalent Development group in August of the same year.

The subjects taken at Willow Street during his two years of study included Basic Electric Theory, Vacuum Tube Theory, Solid State Circuits, Practical Amplifier Circuits and courses on the operation of oscilloscopes, power supplies, meters and other laboratory equipment.

Since he joined the Transcalent group in August, Mr. Bransby has acquired additional skills, such as the evaluation of solid state MM&T devices through DV/DT, thermal impedance, on-state voltage and many other tests.

At the present time, he is continuing his theoretical education through RCA's Engineering Technology Program. He will be assigned to the inspection phase of the proposed Transcalent contract.

Wendy L. Krown - Publications' Technician

Miss Krown graduated from Manheim Twp. H.S. and Susquehanna University in 1974 and 1978, respectively. She earned a B.A. degree in English and a B.A. degree in Theater. She has recently joined the Transcalent Engineering group as the Publications' Technician with responsibilities for editing and writing the numerous reports required by this and other government contracts.

Applicable subjects taken in the schools, above, included Organic and Inorganic Chemistry, General Physics, Advanced Biology, and Advanced English courses. Her studies also included courses in Expository Writing, Creative Writing, many and varied literature courses, and Interpersonal Communications, as well as Broadcasting, where she qualified for the FCC Third Class Operator's License. She furthered her science background by electing additional courses in Biology and Geology as well as technical mathematics courses.

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The following pages include the distribution list supplied by the contracting officer with the approval letter for the First Quarterly Report as well as the additions authorized subsequently.

That list was utilized also for the distribution of the Second, Third, Fourth and Fifth Quarterly Reports. One deletion was made for the Sixth and Seventh Quarterly Reports. Additional revisions were made for the Eighth Quarterly Report, however, no new corrections were made for this Final Technical Report.

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