

AD A032694



**FOURTH QUARTERLY PROGRESS REPORT
PRODUCTION ENGINEERING MEASURE (PEM)**

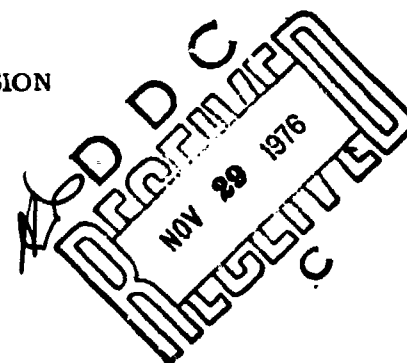
**MANUFACTURING METHODS AND TECHNIQUES
FOR PIEZOELECTRIC TRANSFORMERS**

CONTRACT DAAB07-76-C-0008

April 14, 1976 to July 14, 1976

**PLACED BY:
PRODUCTION DIVISION, PROCUREMENT AND
PRODUCTION DIRECTORATE, USAECOM
FORT MONMOUTH, NEW JERSEY**

**CONTRACTOR
HONEYWELL INC.
GOVERNMENT AND AERONAUTICAL PRODUCTS DIVISION
CERAMICS CENTER
GOLDEN VALLEY, MINNESOTA**



**DISTRIBUTION STATEMENT
UNCLASSIFIED: "Approval for public release; distribution unlimited"**

DISCLAIMER STATEMENT

"The findings in this report are not to be construed as official Department of the Army position unless so designated by other authorized documents."

DISPOSITION INSTRUCTIONS

"Destroy this report when it is no longer needed. Do not return it to the originator."

ACKNOWLEDGEMENT

"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 ensure the efficient production of current or future defense programs."

ADDITIONAL INFORMATION

PROJECT NO.	100-100000
DATE	10/1/77
BY	100-100000
REMARKS	100-100000

100-100000

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (WHEN DATA ENTERED)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Fourth Quarterly Progress Report	2. GOVT ACCESSION NUMBER	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (AND SUBTITLE) MANUFACTURING METHODS AND TECHNIQUES FOR PIEZOELECTRIC ENGINEERING MEASURE (PEM) Transformers.		5. TYPE OF REPORT/PERIOD COVERED Quarterly - April 14, 1976 to July 14, 1976
6. AUTHOR(S) William B. Harrison, L. Hiltner W. Kammerer		7. PERFORMING ORG. REPORT NUMBER 46585
8. PERFORMING ORGANIZATION NAME/ADDRESS (Honeywell Inc. Government and Aeronautical Products Division Ceramics Center Golden Valley, Minnesota 55422)		9. CONTRACT OR GRANT NUMBER(S) DAAB07-76-C-0008
10. CONTROLLING OFFICE NAME/ADDRESS Production Division, Procurement and Production Directorate, USAECOM, Fort Monmouth, New Jersey		11. PROGRAM ELEMENT PROJECT TASK AREA & WORK UNIT NUMBERS Project No. 2759525
12. REPORT DATE November 5, 1976		13. NUMBER OF PAGES 62
14. MONITORING AGENCY NAME/ADDRESS (IF DIFFERENT FROM CONT. OFF.) Quarterly progress rept. no. 4 14 Apr - 14 Jul 76		15. SECURITY CLASSIFICATION (OF THIS REPORT) Unclassified
16. DISTRIBUTION STATEMENT (OF THIS REPORT) Approval for public release; distribution unlimited. 12 58 p.		17. DECLASSIFICATION DOWNGRADING SCHEDULE 5 Nov 76
18. DISTRIBUTION STATEMENT (OF THE ABSTRACT ENTERED IN BLOCK 20, IF DIFFERENT FROM REPORT)		
19. SUPPLEMENTARY NOTES		
20. KEY WORDS (CONTINUE ON REVERSE SIDE IF NECESSARY AND IDENTIFY BY BLOCK NUMBER) Piezoelectric transformers Transformers Lead zirconate-lead titanate ceramics Night vision goggles Image intensifier tubes		
21. ABSTRACT (CONTINUE ON REVERSE SIDE IF NECESSARY AND IDENTIFY BY BLOCK NUMBER) The Fourth Quarterly Report for Contract DAAB07-76-C-0008 describes the progress and status of this program to establish a cost-effective production capability for 18mm and 25mm piezoelectric ceramic transformers. The construction and test results from engineering samples is reviewed. The life test station and results on the first and second engineering samples is also presented.		

HD-308 REV 11/74

SECURITY CLASSIFICATION OF THIS PAGE (WHEN DATA ENTERED)

--

SECURITY CLASSIFICATION OF THIS PAGE (WHEN DATA ENTERED)

FOURTH QUARTERLY REPORT

CONTRACT NO.

DAAB07-76-C-0008
Manufacturing Methods and Techniques
for Piezoelectric Transformers

PERIOD COVERED:

April 14, 1976 to July 14, 1976

PREPARED BY:

W. Harrison
L. Hiltner
W. Kammeyer

OBJECT OF STUDY:

The objective of this contract is to establish a production capability for 18mm and 25mm piezoelectric ceramic transformers with all required manufacturing methods, test procedures and production tooling for high production rates. These transformers are to be used in conjunction with a power supply for operating night vision image intensifier tubes.

DISTRIBUTION STATEMENT

UNCLASSIFIED: "Approval for public release, distribution unlimited"

ABSTRACT

The fourth Quarterly Report for Contract DAAB07-76-C-0008 describes the progress and status of this program to establish a cost-effective production capability for 18mm and 25mm piezoelectric ceramic transformers. The construction and test results from engineering samples are reviewed. The life test station and results on the first and second engineering samples are also presented.

PURPOSE

This Production Engineering Measure (PEM) contract covers all of the tooling, test methods, package designs, mounting techniques, interconnection techniques and other manufacturing methods and techniques required for eventual production of 18mm and 25mm piezoelectric transformers. These units are to be used with a power supply to improve the performance and reduce cost for image intensifier tubes used in various night vision devices.

TABLE OF CONTENTS

Section		Page
	PURPOSE	v
I	APPROACH	1
II	PROCESS REVIEW	2
	A. Raw Materials	2
	B. Completed Processes	2
	Manufacturing Procedure for 18mm and 25mm Packaged PETs	4
III	STATUS AND FUTURE WORK	8
	A. Task 1-6	8
	B. Task 7 - Polarization Tooling	8
	C. Task 8 - Test Console	8
	D. Task 9-13	8
	E. Task 14 - Test and Evaluation of First Engineering Samples	10
	F. Task 15 - Second Engineering Sample Build	10
	G. Task 16 - Test and Evaluation of Second Engineering Sample	10
	H. 18mm PET	25
	I. 25mm PET	26
IV	CONCLUSIONS	27
V	RECOMMENDATIONS	28
VI	REPORTS	29
VII	IDENTIFICATION OF PERSONNEL	30
APPENDIX A	PARTS AND DRAWINGS	A-1
APPENDIX B	DISTRIBUTION LIST	B-1

LIST OF ILLUSTRATIONS

Figure		Page
1	18mm and 25mm Packaged PET Flow Diagram	3
2	Program Status Against Schedule	9
3	Life Test Console	10
4	Circuit Diagram for PET Life Tester	11
5	18mm PETs Submitted as Second Engineering Samples	15
6	25mm PETs Submitted as Second Engineering Samples	15

LIST OF TABLES

Table		Page
I	18mm Piezoelectric Transformer Test Sequence (Second Engineering Sample)	16
II	25mm Piezoelectric Transformer Test Sequence (Second Engineering Sample)	17
III	Summary of 18mm Second Engineering Sample Test and Evaluation Results	18
IV	Summary of 25mm Second Engineering Sample Test and Evaluation Results	19
V	18mm Piezoelectric Transformer Summary of Test Results- Second Engineering Sample	20
VI	25mm Piezoelectric Transformer Summary of Test Results- Second Engineering Sample	22

SECTION I APPROACH

Our approach to both the 18mm and 25mm PET designs, its advantages and the analytical method used to determine performance of these transformers was discussed in the first quarterly report⁽¹⁾.

(1) First Quarterly Progress Report, Production Engineering Measures (PEM), Manufacturing Methods and Techniques for Piezoelectric Transformers, Contract Number DAAB07-76-C-0008, July 14, 1975 to October 14, 1975.

SECTION II PROCESS REVIEW

This section updates the status of each process step planned for manufacturing both the 18mm and 25mm PETs. Since there are only minor differences between the 18mm and 25mm process, one process outline will suffice. The new materials and special tooling that have been purchased, designed or built—and not discussed in previous quarterly reports—are discussed below.

A. RAW MATERIALS

The standard operating procedure for processing raw materials, calculating batch compositions and compounding each batch was fully described in the first quarterly report. (1)

B. COMPLETED PROCESSES

This section will describe or update those manufacturing procedures that have been completed thus far in the first four quarters of this program. Each operation given has been previously (2, 3) identified with a number, description and a list of the materials, tools, fixtures and procedures required to complete this operation. Only those operations that have been revised or not previously described are discussed. Figure 1 is an update of the process flow that identifies each operation. Appendix A contains a detailed parts list and drawings for the 18mm and 25mm PETs.

-
- (2) Second Quarterly Progress Report, Production Engineering Measure (PEM) Manufacturing Methods and Techniques for Piezoelectric Transformers, Contract Number DAAB07-76-C-0008, October 14, 1975 to January 14, 1976.
 - (3) Third Quarterly Progress Report, Production Engineering Measure (PEM) Manufacturing Methods and Techniques for Piezoelectric Transformers, Contract Number DAAB07-76-C-0008, January 14, 1976 to April 14, 1976.

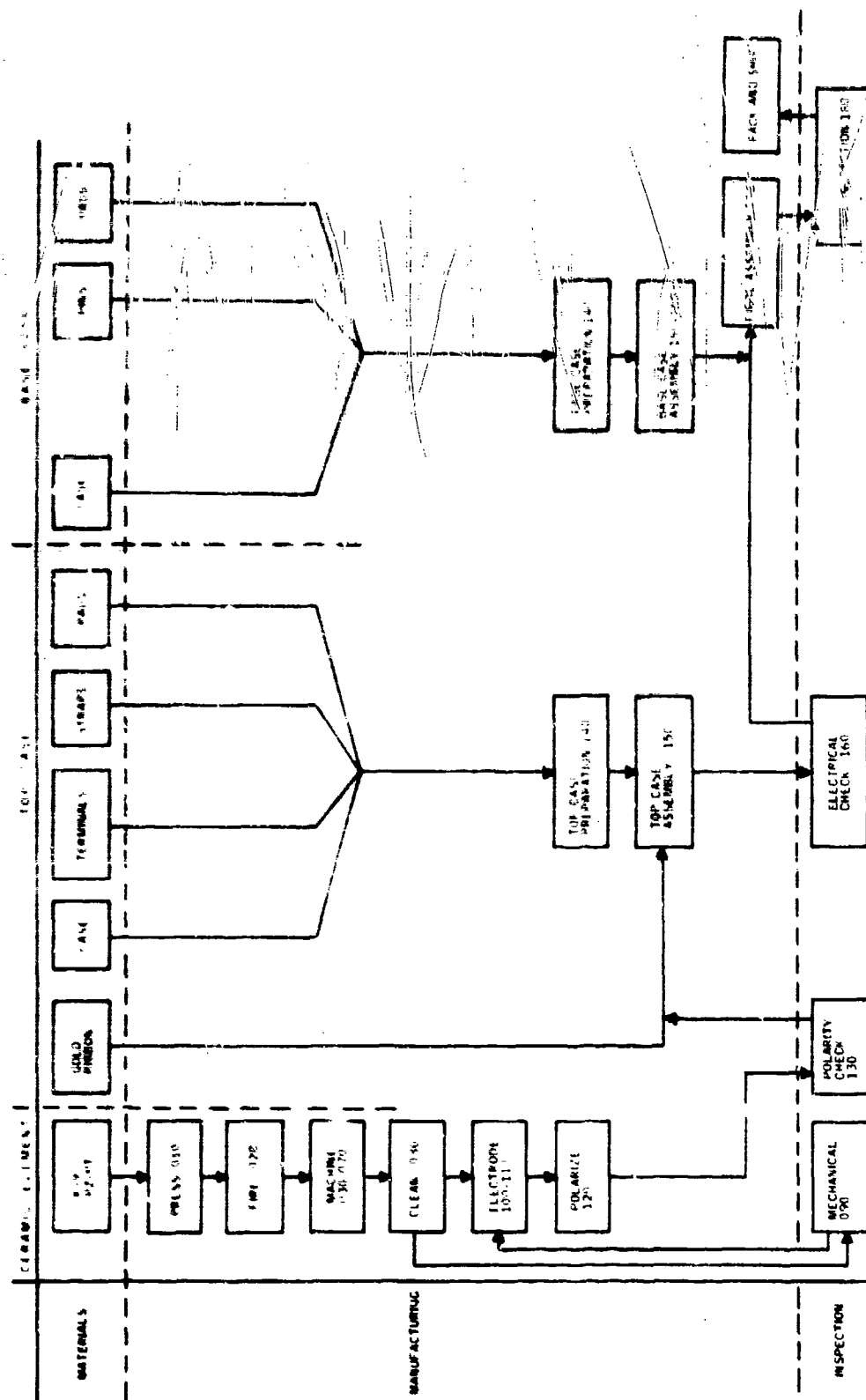


Figure 1. 18mm and 25mm Packaged PET Flow Diagram

Manufacturing Procedure for
18mm and 25mm Packaged PETs

- OP 010 Slug Processing (no change)
- OP 020 Hot Press Slugs (no change)
- OP 030 Blanchard Grind Slugs (top and bottom) (no change)
- OP 040 Core Drill Slugs (no change)
- OP 050 Hone I. D. of Slugs (add tolerance)
- B. 2 1.040 $\pm$ 0.001 inch I. D. for 18mm
1.700 $\pm$ 0.001 inch I. D. for 25mm
- OP 060 Grind O. D. of Slugs
- B. 3 Correct Diameter to 1.475
- OP 065 Slice 25mm Half Torroids (no change)
- OP 070 Mount and Slice Slugs (no change)
- OP 080 Clean Elements (no change)
- OP 090 Inspection of Unelectroded 18 and 25mm Elements (revised)
- Inspect sample for mechanical size per Dwg. No. 28100576 or
28100571 respectively.
- OP 100 Apply Silver Electrodes (no change)
- OP 110 Silver Fire (no change)
- OP 120 Polarization (no change)
- OP 130 Check Polarity (formerly OP 125)

(Deleted former OP 130 and made a part of OP 150)

OP 140 PET Package Preparation 18mm (revisions)

A1. Package Case Top - Dwg. 28100580

A2. Package Case Top - Dwg. 28100581

A3. Terminals - Dwg. 28100572

old A5. Deleted

new A5. 18mm Shorting Straps Top - Dwg. 38100579

new A6. 18mm Pins - Dwg. 28100570-002

new A7. Same as old A8

new A8. Same as old A9

C9. (to read) Ultrasonic clean package case base in freon

C10. Delete

C11. Delete

OP 140 PET Package Preparation 25mm (revisions)

A1. Package Case, Top - Dwg. 28100574

A2. Package Case, Base - Dwg. 28100575

A3. Terminals - Dwg. 28100572

A5. (to read) P_ Terminal Pin - Dwg. 28100570-003

A6. 25mm Shorting Straps, Top - Dwg. 28100573

A7. 25mm Pins - Dwg. 28100570-001

C9. (to read) Ultrasonic Clean package case base in freon

C10. Delete

C11. Delete

OP 150 Top Case Element Assembly (revised)

A. Materials

1. Conductive epoxy
2. Nonconductive epoxy
3. Solder
4. Gold Wire

B. Tools and Fixtures

1. Solder Iron
2. Curing Oven
3. Tweezers
4. Snips

C. Procedure

1. Solder gold wire to + terminal of first PET element, Dwg. 28100576 or 28100571.
2. Solder end of gold wire to each P_- , V_{12} and V_3 shorting strap and insert wire through 0.002 inch hole of top case, Dwg. 28100577 or 28100569, as in Dwg. 28100560 or 28100561.
3. Fold each wire into proper place (P_- , V_{12} and V_3) per 28100560 or 28100561 and attach with conductive epoxy.
4. Add non-conductive epoxy and next element.
5. Cure in oven.
6. Fold in place P_+ wires and attach with conductive epoxy per Dwg. 28100560 or 28100561. This completes 18mm assembly. For 25mm assembly add non-conductive epoxy and next element.
7. Cure in oven.
8. For 25mm repeat 3 through 7 as required to complete assembly Dwg. 28100561.

OP 160 Process Control Electrical Check (title change)

B2. (to read) From test console record resonant frequency, input voltage, input current and output voltages on data sheet and check against the room temperature requirements on Dwg. 28100560 or 2810561.

OP 170 Final Package Assembly (Revisions)

A2. (to read) solder iron

B1. (to read) Select a top case, Dwg. 28100577 or 28100567, and a base case (Dwg. 28100578 or 28100568); then align shorting pins from base case with holes in top case.

B2. Same as previous B-3.

B3. After all pins have been inserted in the package and it is fully closed, snip off excess pin length and solder to shorting strap.

B4. Same as previous B-7.

OP 180 Final Inspection (Revisions)

Inspect packaged 18 or 25mm piezoelectric transformers per Dwg. 28100560 or 28100561, respectively.

SECTION III STATUS AND FUTURE WORK

This section describes the status of work against the various tasks outlined in Figure 2 which were active during this fourth quarter of the program.

A. TASK 1-6

Work completed previously.

B. TASK 7 - POLARIZATION TOOLING

Work on the polarization tooling has been delayed until next quarter.

C. TASK 8 - TEST CONSOLE

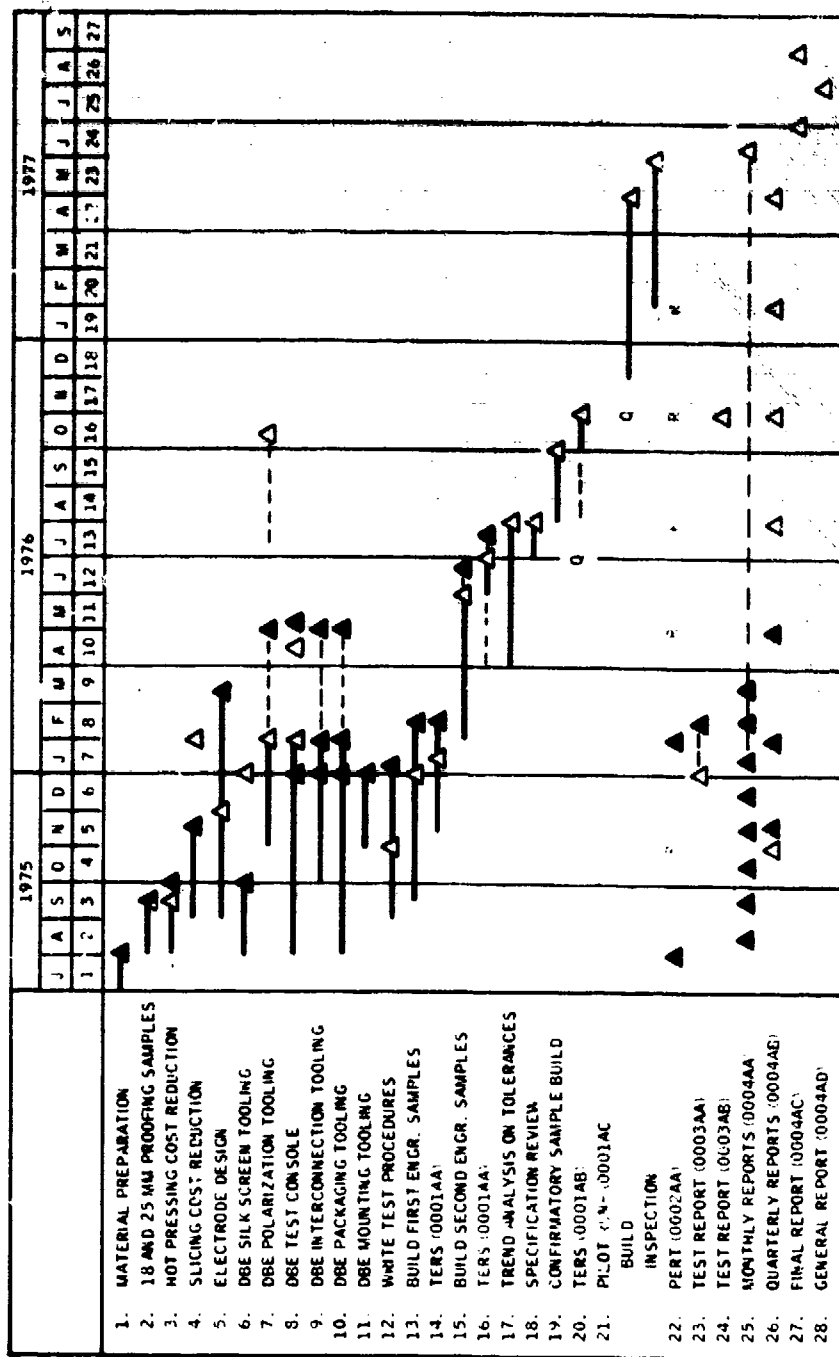
The first life test power supply was completed and put into service on May 14, 1976. Figure 3 is a photograph of the power supply, the 18mm test box and 25mm test box that can be used with each power supply. Figure 4 gives the circuit and chassis wiring diagram for the life test console.

Each console will drive up to six PETs at 125 percent of their rated input voltage and at the resonant frequency of each transformer. The tester continuously monitors the PET for shorts and abrupt changes in input current. The test console can also be used to monitor the performance of the PETs during vibration, humidity or other types of environmental testing.

A second console was also completed June 18, 1976 for use in testing the second engineering samples. This completes this task.

D. TASK 9-13

Completed previously.



DRE DESIGN BUILD AND EVALUATE
 TERS TEST AND EVALUATION REVIEW AND SUBMIT
 R REVISE QUARTERLY AS REQUIRED
 Q REQUEST FOR APPROVAL TO START
 Δ ORIGINAL OR REVISED COMPLETION DATES
 ▲ ACTUAL COMPLETION DATES

Figure 2. Program Status Against Schedule

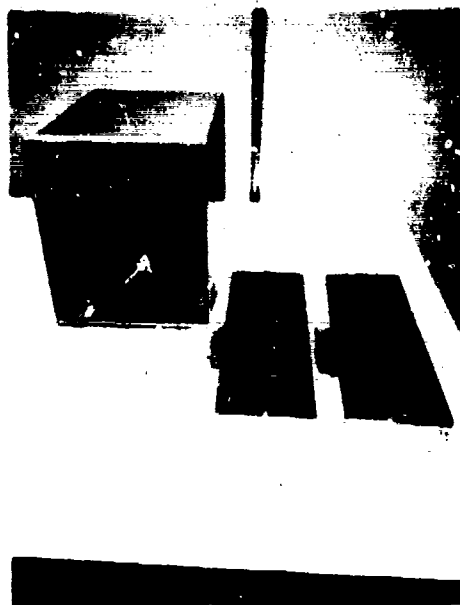


Figure 3. Life Test Console

E. TASK 14 - TEST AND EVALUATION OF FIRST ENGINEERING SAMPLES

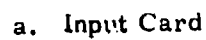
Life test on the three 18mm and three 25mm PETs has reached about 1250 hours without a failure. They will complete their 2000 hours of testing next quarter.

F. TASK 15 - SECOND ENGINEERING SAMPLE BUILD

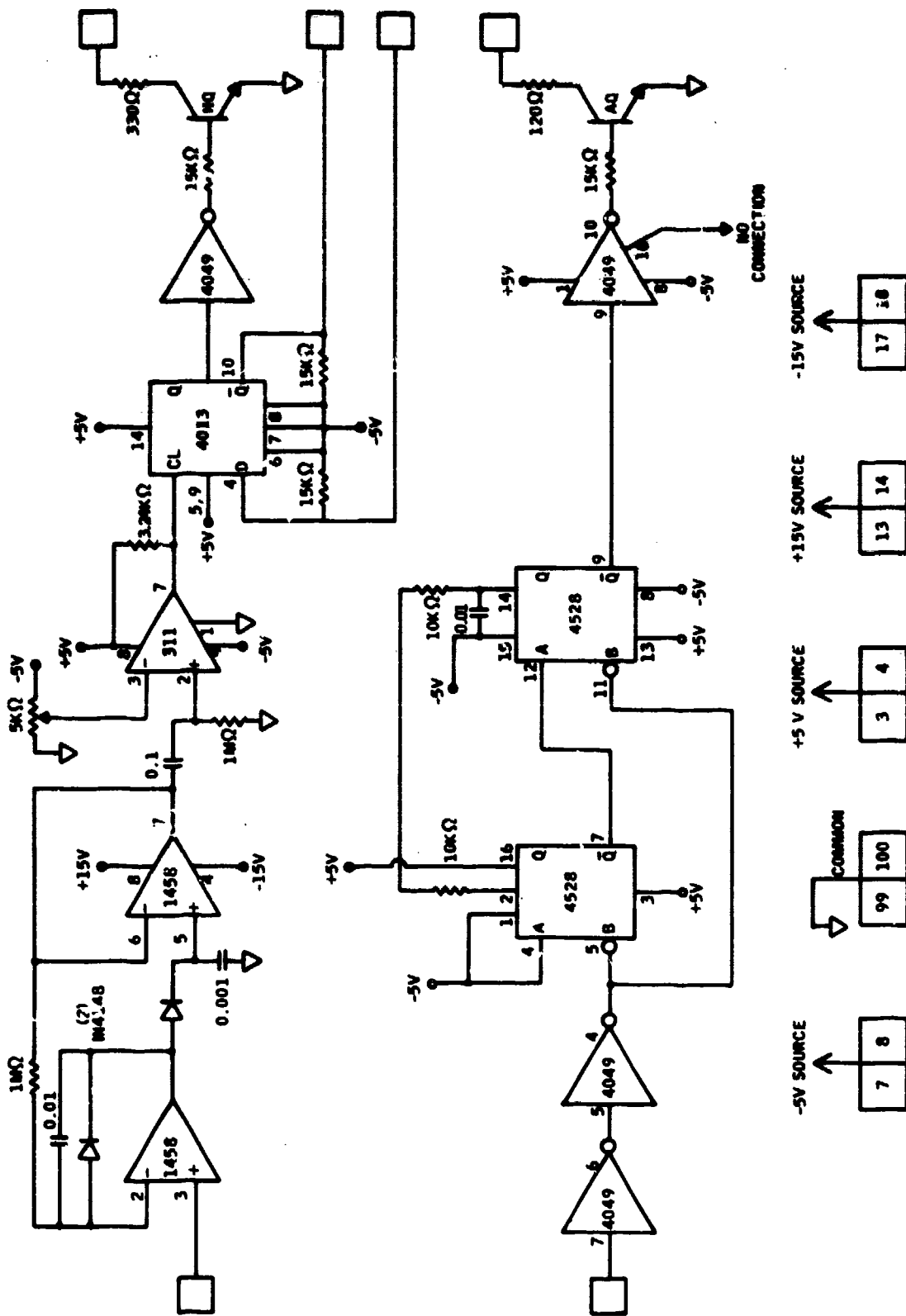
Twelve 18mm and 12 25mm PETs were built and submitted to inspection on June 11, 1976. Process changes have been noted in Section II. The most significant changes incorporated in this build are: (1) elimination of the 18mm package problem, (2) elimination of the base side shorting bar and interconnections associated with the base side in both PET designs, (3) bonding of ceramic elements and (4) introduction of soldered gold ribbon leads.

G. TASK 16 - TEST AND EVALUATION OF SECOND ENGINEERING SAMPLE

Figure 5 shows the 12 18mm PETs, and Figure 6, the 12 25mm PETs which were submitted as second engineering samples for test and evaluation. (The test sequence for the 18mm and 25mm PETs is indicated in Tables I and II, respectively.) The test results are summarized in Tables III and IV for the 18mm and 25mm PETs, respectively, while Table V



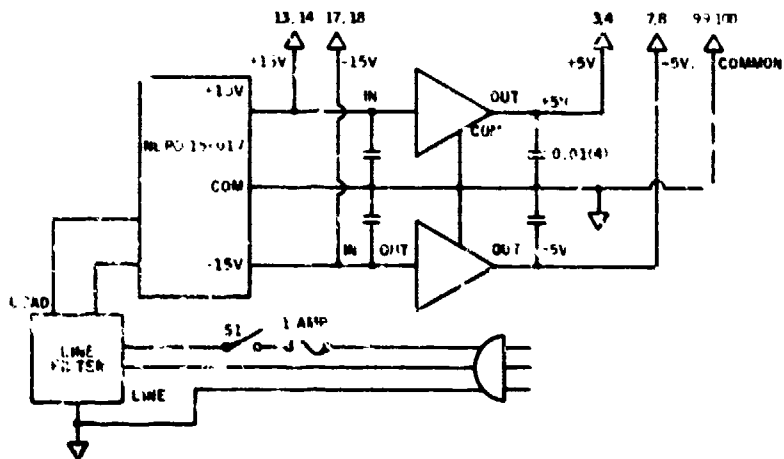
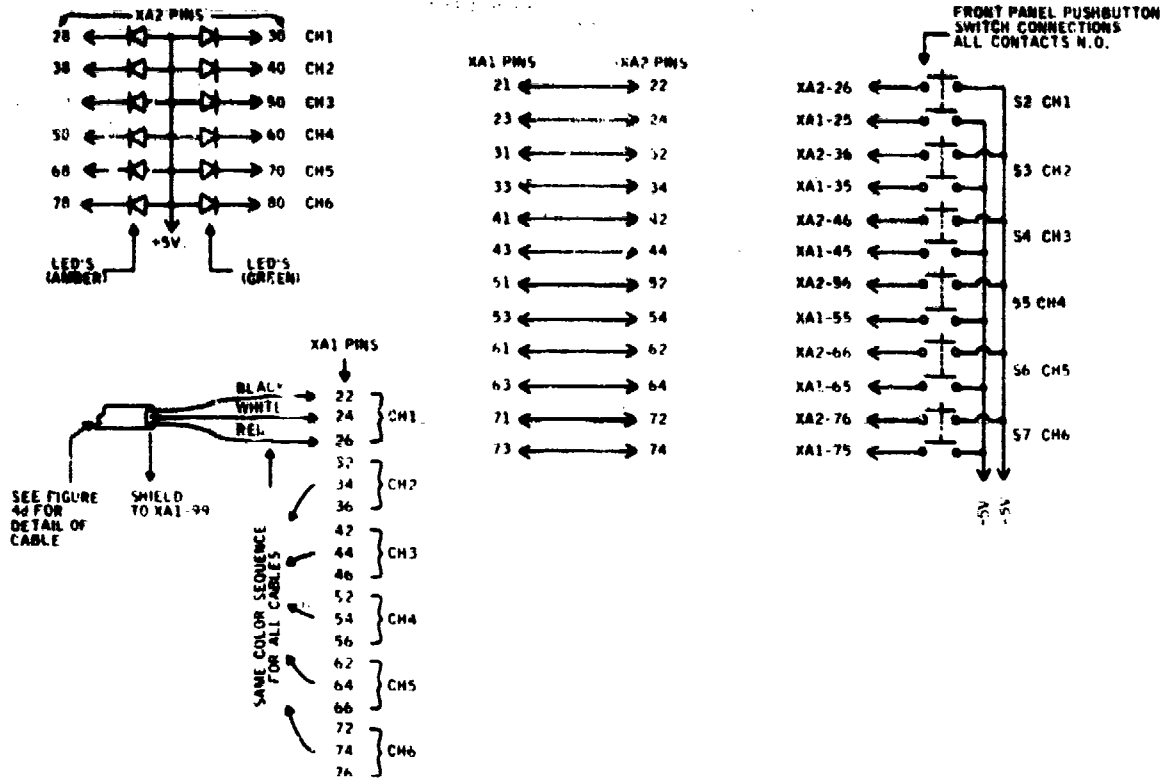
11



b. Output Card

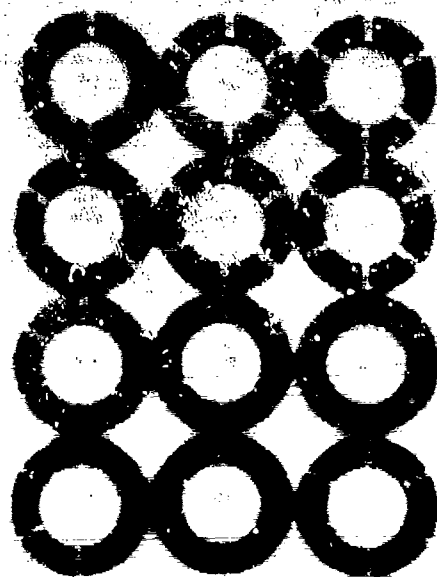
Figure 4. Circuit Diagram for PET Life Tester (Continued)

XA1 AND XA2 ARE 10C PIN CONNECTORS FOR
CARD'S A1 AND A2

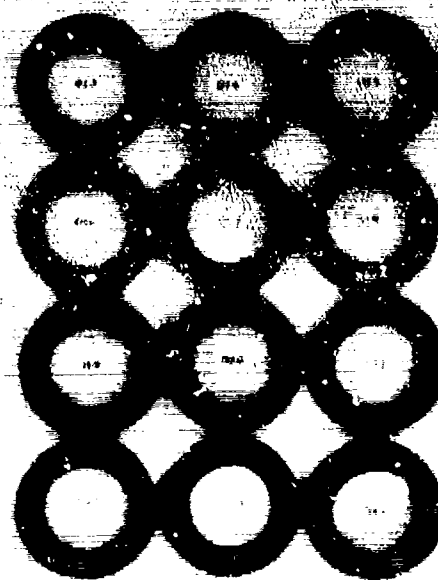


c. Chassis Connections

Figure 4. Circuit Diagram for PET Life Tester (Continued)

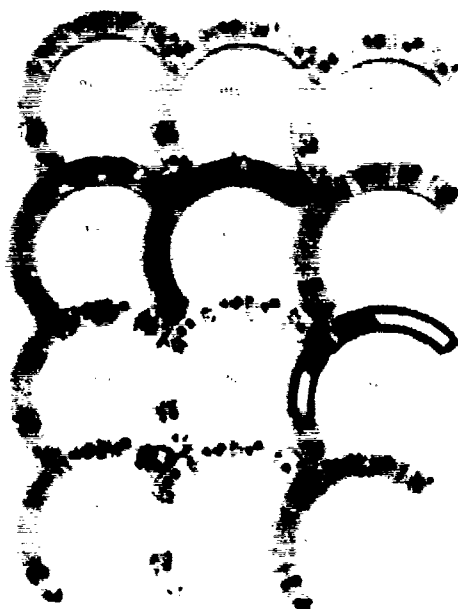


a. Top Side



b. Base Side

Figure 5. 18mm PETs Submitted as Second Engineering Samples



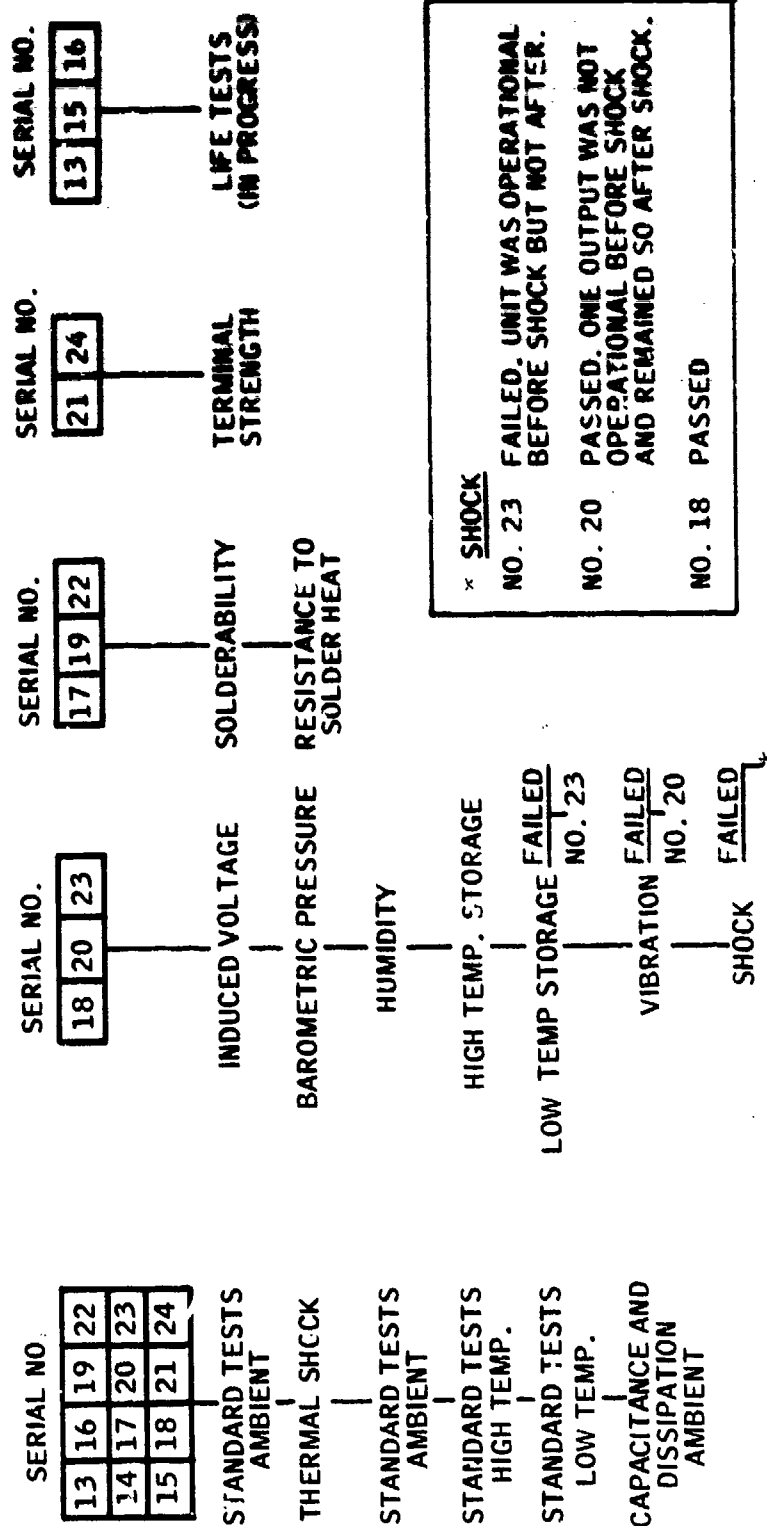
a. Top Side



b. Base Side

Figure 6. 25mm PETs Submitted as Second Engineering Samples

Table II. 25mm Piezoelectric Transformer Test Sequence (Second Engineering Sample)



× SHOCK

NO. 23 FAILED. UNIT WAS OPERATIONAL BEFORE SHOCK BUT NOT AFTER.

NO. 20 PASSED. ONE OUTPUT WAS NOT OPERATIONAL BEFORE SHOCK AND REMAINED SO AFTER SHOCK.

NO. 18 PASSED

Table III. Summary of 18mm Second Engineering Sample Test and Evaluation Results

SCS-480 Page No.	Specified Parameter	18mm Requirement	013	014	015	016	017	018	019	020	021	022	023	024
3.1	Item Definition (Geometry)													
3.2	Material	Doped 1% (Zr-100) ₂												
3.3	Physical Characteristics	5 gms (max)												
3.4	Resistance to Soldering Heat	280 C/30 sec												
3.5	Solderability													
3.6	Terminal Strength	min 1/2 lb									OK		OK	
3.7	Induced Voltage	150%			OK			OK		OK				
3.8	Room Temp. Input Voltage	5 Volts (pp)	4.77	4.63	4.37	4.73	4.11	4.47	4.39	3.47	4.36	4.02	4.78	4.31
3.8.1	Resonant Frequency	33.9 ± 0.2 kHz	39,724	32,791	31,883	29,669	31,766	31,875	38,917	32,479	31,553	31,685	39,335	30,992
3.8.2	Efficiency at Resonance	45% min	3.3	24.4	22.6	1.4	21.3	8.5	22.8	26.5	13.2	20.8		14.8
3.8.3	Voltage Step-up Ratio at V ₁₂ /V ₁ Resonance	170 ± 17	23/23	100/98	127/128	19/21	156/147	67/73	142/0	240/243	98/100	157/162	0/0	105/112
3.8.4	Input Capacitance/ Dissipation	14,000 pF ± 4% 1.75% max	28,09/ 1.01			26.83/ 1.03		26.47/ 1.41		24.84/ 0.60	26.98/ 1.60	26.44/ 1.02	25.44/ 0.82	22.78/ 1.08
3.8.5	Secondary Capacitance Dissipation Factor	7.6 pF ± 4% 4.6% max	10.8/ 2.2	8.3/ 0.8	14.0/ 1.0	12.3/ 1.2	13.4/ 1.0	12.2/ 0.7	10.9/ 2.2	11.3/ 0.6				
3.9	High Temp. 52°C ± 2°C Input Voltage	5 Volts (pp)	4.67	4.50	4.31	4.74	4.03	4.53	4.73	4.49	4.72	4.60		
3.9.1	Resonance Frequency	34.1 ± 0.2 kHz	38,669	32,988	31,837	38,586	31,070	32,020	38,682	33,025	38,684	30,704		
3.9.2	Efficiency at Resonance	50% min	0.3	24.6	21.6		21.7	10.7		32.8		24.7		
3.9.3	Voltage Step-up Ratio at V ₁₂ /V ₁ Resonance	170 ± 17	13/4	107/103	132/132	10/16	167/155	68/81		139/135		102/106		
3.10	Low Temp. - 54 ± 2°C Input Voltage	5 Volts (pp)	4.69	4.81	4.55	4.74	4.47	4.55	4.84	4.28	4.33	4.80		4.73
3.10.1	Resonance Frequency	33.3 ± 0.2 kHz	28,567	32,654	31,672	38,705	31,085	30,932	38,733	31,576	30,648	31,771		30,566
3.10.2	Efficiency at Resonance	25% min		15.5	17.9		14.4	4.0		15.4	7.4	18.7		9.6
3.10.3	Voltage Step-up Ratio at V ₁₂ /V ₁ Resonance	85 ± 8.5	10/22	98/54	93/98	14/10	96/88	43/47	83/0	114/114	62/50	63/62		52/54
3.11	Thermal Shock	No Damage	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
3.12	High Temp. Storage	71°C 2 hrs min			OK			OK		OK				
3.13	Low Temp. Storage	-65°C 2 hrs min			OK			OK		OK				
3.14	Humidity	95% RH at 52°C 6 hrs min			OK			OK		OK				
3.15	Mechanical Shock	per 4.5.13			Failed			OK		OK				
3.16	Mechanical Vibration	per 4.5.12			OK			OK		OK				
3.17	Reduced Barometric Press.	3.44 in. for 1 hr			OK			OK		OK				

* PKT unit crushed by mounting fixture.

Table IV. Summary of 25mm Second Engineering Sample Test and Evaluation Results

SCS-680 Page No.	Specified Parameter	18mm Requirement	013	014	015	016	017	018	019	020	021	022	023	024
3.1	Item Definition (Geometry)													
3.2	Material	Doped Pb(ZrTi)O ₃												
3.3	Physical Characteristics	5 gms (max)												
3.4	Resistance to Soldering Heat	280°C/30 sec					OK		OK			OK		
3.5	Solderability						OK		OK			OK		
3.6	Terminal Strength	min 1/2 lb									OK			OK
3.7	Induced Voltage	15%						OK		OK			OK	
3.8	Room Temp. Input Voltage	5 Volts (p-p)	4.50	4.49	4.46	4.46	4.56	4.58	4.68	4.58	4.67	4.63	4.54	4.65
3.8.1	Resonant Frequency	33.9 ± 0.2 kHz	30.475	30.058	30.541	30.275	29.611	30.534	30.622	30.644	30.383	29.986	30.157	30.350
3.8.2	Efficiency at Resonance	45% min	56.0	50.8	58.4	57.7	30.8	44.4	45.9	45.3	34.2	12.5	22.9	26.5
3.8.3	Voltage Step-up Ratio at V ₁₂ /V ₃ Resonance	170 ± 17	177/176	170/170	186/181	184/189	114/124	148/136	129/123	145/144	110/109	73/68	112/109	111/124
3.8.4	Input Capacitance/ Dissipation	14,000 pF ± 4% 1.75% max	31.22/ 0.50	33.83/ 0.67	30.83/ 0.69	32.04/ 0.80	32.34/ 1.00	32.09/ 0.77	21.64/ 0.62	34.82/ 0.47	22.77/ 0.63	32.39/ 0.61	70.55/ 0.87	30.86/ 0.70
3.8.5	Secondary Capacitance/ Dissipation Factor	7.6 pF ± 4% 4.6% max	14.2/ 0.82	6.6/ 0.84	10.4/ 0.88	18.9/ 0.90	14.4/ 0.87	8.8/ 0.88	13.7/ 0.73	13.7/ 0.78	13.7/ 1.19	16.5/ 0.84	10.1/ 0.78	10.5/ 0.46
3.9	High Temp. 52°C ± 2° Input Voltage	5 Volts (p-p)	4.42	4.49	4.40	4.39	4.52	4.45	4.61	4.44	4.61	4.69	4.54	4.44
3.9.1	Resonance Frequency	34.1 ± 0.2 kHz	30.709	30.282	30.716	30.503	29.510	30.721	30.801	30.804	30.439	30.074	30.289	30.321
3.9.2	Efficiency at Resonance	50% min	58.9	51.7	57.7	57.1	20.7	48.0	30.9	48.1	38.9	9.3	24.7	33.1
3.9.3	Voltage Step-up Ratio at V ₁₂ /V ₃ Resonance	170 ± 17	197/198	171/173	197/200	197/200	102/108	179/165	117/113	175/174	125/125	96/84	115/108	152/135
3.10	Low Temp. -54 ± 2°C Input Voltage	5 Volts (p-p)	4.58	4.54	4.55	4.54	4.60	4.57	4.74	4.55	4.73	4.68	4.60	4.54
3.10.1	Resonance Frequency	33.3 ± 0.2 kHz	29.418	29.128	29.359	29.201	28.845	28.464	29.814	29.621	29.311	28.295	29.473	29.324
3.10.2	Efficiency at Resonance	25% min	21.7	20.5	11.3	18.7	25.3	10.5	23.9	9.4	23.8	9.0	17.2	18.4
3.10.3	Voltage Step-up Ratio at V ₁₂ /V ₃ Resonance	85 ± 8.5	100/99	105/100	77/72	100/98	103/107	88/73	86/77	69/67	82/82	57/54	113/82	92/78
3.11	Thermal Shock	No Damage	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
3.12	High Temp. Storage	71°C - 2 hrs min						OK		OK			OK	
3.13	Low Temp. Storage	-65°C 2 hr min						OK		OK			OK	
3.14	Humidity	95% RH at 52°C 6 hrs min						OK		OK			OK	
3.15	Mechanical Shock	per 4.5.13						OK		OK			Failed	
3.16	Mechanical Vibration	per 4.5.12						OK		***Failed			OK	
3.17	Reduced Barometric Press.	3.44 in. for 1 hr						OK		OK			OK	

* V₃ open, V₁₂ OK

** PET crushed by mounting fixture

*** V₁₂ open, V₃ OK

Table V. 18mm Piezoelectric Transformer Summary of Test Results —
Second Engineering Sample

	S/N	Resonant Frequency (kHz)	Percent Efficiency	Step-up Ratio ₁₂	Step-up Ratio ₃	Input Capacitance (nF)	Input Dissipation (%)	Output ^{**} Capacitance (pF) ₁₂	Output ^{**} Dissipation (%) ₁₂	Output ^{**} Capacitance (pF) ₃	Output ^{**} Dissipation (%) ₃
Room Temperature Prior to Environment	013	30,730	4.3	47.2	26.5						
	014	32,736	17.1	145.6	144.6						
	015	32,001	20.7	143.6	140.4						
	016	31,600	4.5	32.0	25.6						
	017	32,183	20.0	138.4	134.8						
	018	32,202	9.3	64.8	53.6						
	019	32,260	18.4	151.2	102.8						
	020	32,379	19.0	160.4	100.0						
	021	30,961	-	20.6	16.0						
	022	32,174	10.0	141.6	148.0						
Post-Temp. Shock (Ambient)	023	32,688	-	12.8	20.4						
	024	31,410	10.3	72.8	82.8						
	013	29,724	-	21.6	31.2	28.00	1.01	18.56	2.12	10.10	2.30
	014	32,701	22.6	102.4	70.4	-	-	16.93	0.79	15.57	0.83
	015	31,863	19.5	110.8	112.0	-	-	21.67	0.00	22.31	1.09
	016	29,660	-	17.6	20.0	26.83	1.03	20.44	1.14	20.13	1.17
	017	31,766	17.5	128.4	120.8	-	-	20.33	0.89	22.55	1.07
	018	31,875	9.9	50.8	66.8	26.47	1.41	20.60	1.04	10.83	0.83
	019	32,017	-	130.4	2	-	-	18.78	2.08	21.07	2.25
	020	32,478	18.4	168.8	189.8	24.84	0.60	18.81	0.35	19.62	0.82
Post-Temp. Shock (High Temp.)	021	31,553	11.5	85.2	87.2	28.16	1.60	20.15	0.97	20.15	0.67
	022	31,863	16.7	136.0	130.4	26.44	1.02	20.05	0.80	16.50	0.70
	023	30,335	-	8.8	4.0	25.44	0.82	19.89	-	-	-
	024	30,972	12.7	90.4	96.4	27.78	1.08	15.24	0.86	14.45	0.8
	013	38,669	-	12.0	4.0						
	014	32,988	22.6	98.0	94.8						
	015	31,837	18.6	113.6	113.6						
	016	38,686	-	9.2	15.2						
	017	31,970	17.5	134.8	125.2						
	018	32,020	9.7	61.2	73.2						
Post-Temp. Shock (Low Temp.)	019	38,682	-	9.2	0.4						
	020	33,025	29.4	125.2	120.8						
	021	38,694	-	-	-						
	022	30,704	22.7	94.0	97.6						
	023	-	-	-	-						
	024	-	-	-	-						
	013	28,567	-	9.2	20.4						
	014	32,654	14.9	54.4	52.0						
	015	31,672	16.6	84.4	88.8						
	016	38,705	-	13.2	9.6						
	017	31,085	12.9	86.0	78.8						
Post-Temp. Shock (Low Temp.)	018	30,932	3.6	38.8	42.4						
	019	38,733	-	2.0	-						
	020	31,576	13.2	97.6	97.6						
	021	30,648	6.9	53.6	43.2						
	022	31,771	17.9	60.0	59.6						
	023	-	-	-	-						
	024	30,566	-	46.8	50.8						

* Values have not been corrected for lower input voltage levels.
** Values have not been corrected for about 8 pF stray capacitance.

Table V. 18mm Piezoelectric Transformer Summary of Test Results —
Second Engineering Sample (Concluded)

	N/N	Resonant Frequency (kHz)	Percent Efficiency	Step-up Ratio ₁₂	Step-up Ratio ₃	Input Capacitance (nF)	Input Dissipation (%)	Output Capacitance (pF) ₁₂	Output Dissipation (%) ₁₂	Output Capacitance (pF) ₃	Output Dissipation (%) ₃
Induced Voltage	015 018 020	OK OK OK	OK OK OK	OK OK OK	OK OK OK						
Euro-metric Pressure	015 018 020	32,440 32,340 32,520	27.0 8.6 18.4	90.8 48.8 171.5	86.8 52.0 175.2						
Post-Humidity	015 018 020	32,247 32,124 32,395	25.1 9.1 16.1	82.0 54.4 148.0	82.8 45.2 146.8						
Post-Temp. Storage (High)	015 018 020	32,581 32,195 32,631	9.8 17.6 27.6	93.2 73.4 170.4	94.8 81.8 170.0						
Post-Temp. Storage (Low)	015 018 020	31,891 31,327 31,996	4.1 12.0 20.4	56.8 47.2 96.0	55.2 36.0 92.8						
Post-Vibration	015 018 020	32,457 32,342 32,617	26.6 9.1 18.5	88.8 54.4 175.2	87.6 44.0 173.4						
Post-Shock	015 018 020	30,141 31,274 32,653	- 5.8 18.2	12.4 56.0 168.0	9.6 40.4 162.8						
Terminal Strength	021 023	OK OK	OK OK	OK OK	OK OK						
Solderability	013 016 019	OK OK OK	OK OK OK	OK OK OK	OK OK OK						
Life Tests	014 017 022	33,172 32,189 32,190	25.6 18.9 19.4	105.2 140.4 145.6	102.8 127.6 130.4	750 Hours 750 Hours 750 Hours					

Values have not been corrected for lower input voltage levels.
Values have not been corrected for about 8 pF stray capacitance.

Table VI. 25mm Piezoelectric Transformer Summary of Test Results —
Second Engineering Sample

	S/N	Resonant Frequency (kHz)	Percent Efficiency	Step-up Ratio ¹ ₁₂	Step-up Ratio ¹ ₁₃	Input Capacitance (nF)	Input Dissipation (%)	Output Capacitance ² (pF) ₁₂	Output Dissipation (%) ₁₂	Output Capacitance ² (pF) ₁₃	Output Dissipation (%) ₁₃
Room Temperature Prior to Environment	013	30,880	57.6	182.6	186.4						
	014	30,363	55.7	177.6	180.0						
	015	30,760	55.5	181.2	188.0						
	016	30,553	53.9	184.4	180.2						
	017	29,876	50.7	162.4	153.6						
	018	30,636	44.2	161.2	148.0						
	019	30,815	42.2	172.4	125.6						
	020	30,755	47.2	168.8	166.8						
	021	30,507	46.6	131.6	120.2						
	022	30,188	33.3	103.6	102.8						
	023	30,150	30.2	118.0	120.8						
	024	30,476	35.6	103.6	114.4						
Post-Temp. Shock (Ambient)	013	30,475	50.4	157.6	158.4	31.22	0.70	22.68	0.76	21.76	0.65
	014	30,058	49.8	152.8	152.8	32.63	0.67	18.34	0.68	18.70	0.70
	015	30,541	52.1	184.4	170.4	30.63	0.89	18.80	0.60	18.03	0.71
	016	30,275	51.5	164.4	168.4	32.04	0.80	27.60	0.80	26.00	0.79
	017	29,611	35.2	104.8	113.6	32.34	1.00	23.00	0.80	20.00	0.74
	018	30,554	40.7	135.5	124.4	32.09	0.77	10.71	0.47	10.00	0.70
	019	30,822	43.0	120.8	115.2	21.64	0.62	21.57	0.43	20.00	1.06
	020	30,644	41.5	132.8	137.0	34.62	0.67	22.60	0.66	20.63	0.69
	021	30,383	31.9	103.2	102.0	28.77	0.43	21.32	1.28	22.01	1.07
	022	29,996	11.5	66.0	63.2	32.39	0.61	25.43	0.79	23.64	0.88
	023	30,157	20.8	171.6	92.8	36.55	0.63	18.70	0.70	17.42	0.86
	024	30,350	34.0	43.2	115.2	30.86	0.70	18.61	0.53	18.34	0.38
Post-Temp. Shock (High Temp. Operation)	013	30,769	52.1	174.0	174.8						
	014	30,282	46.4	163.2	155.2						
	015	30,796	50.4	173.2	176.0						
	016	30,503	50.3	173.2	176.4						
	017	29,510	18.7	92.0	98.0						
	018	30,731	42.7	150.6	147.2						
	019	30,801	28.5	108.0	104.0						
	020	30,804	42.7	155.2	154.8						
	021	30,439	34.0	114.8	115.8						
	022	30,074	8.7	52.8	50.4						
	023	30,280	22.5	104.4	98.4						
	024	30,321	20.4	135.2	120.0						
Post-Temp. Shock (Low Temp. Operation)	013	29,418	19.1	91.2	90.8						
	014	29,128	18.7	93.2	90.8						
	015	29,359	10.3	70.0	65.6						
	016	29,201	17.0	90.4	87.2						
	017	28,845	23.3	94.4	78.0						
	018	29,464	5.6	62.0	66.4						
	019	29,814	22.7	81.2	72.8						
	020	29,621	8.52	62.4	61.2						
	021	29,311	22.3	77.6	77.2						
	022	28,205	4.4	53.2	50.8						
	023	29,473	15.8	82.8	75.2						
	024	29,724	15.1	64.8	72.0						

* Values have not been corrected for lower input voltage levels.
** Values have not been corrected for abo. 8 pf of stray capacitance.

Table VI. 25mm Piezoelectric Transformer Summary of Test Results —
Second Engineering Sample (Concluded)

	S/N	Resonant Frequency (kHz)	Percent Efficiency	Step-up Ratio ₁₂	Step-up Ratio ₁₃	Input Capacitance (nF)	Input Dissipation (%)	Output Capacitance ₁₂ (pF)	Output Dissipation ₁₂ (%)	Output Capacitance ₁₃ (pF)	Output Dissipation ₁₃ (%)
Induced Voltage	018 020 023	OK OK OK	OK OK OK	OK OK OK							
Barometric Pressure	018 020 023	30,807 30,781 30,985	48.4 48.2 29.0	146.8 164.8 122.8	181.2 168.0 118.4						
Humidity	018 020 023	30,504 30,586 30,546	41.1 42.8 24.4	142.4 143.4 68.0	129.2 142.0 69.6						
Post-Temp. Storage (High)	018 020 023	30,916 30,575 30,457	13.8 9.9 21.1	81.2 77.6 58.4	72.4 72.8 59.3						
Post-Temp. Storage (Low)	018 020 023	29,415 29,890 29,996	15.4 20.2 6.0	70.8 65.2 63.2	61.2 92.0 14.8						
Vibration	018 020 023	30,830 31,578 30,449	33.6 35.1 24.5	120.0 18.4 107.6	105.6 213.2 107.2						
Post-Shock	018 020 023	30,917 31,034 29,707	49.3 12.9 19.6	103.6 10.8 31.2	91.6 110.0 23.8						
Solderability	17 19 22	OK OK OK	OK OK OK	OK OK OK	OK OK OK						
Resist. to Solder Heat	17 19 22	Dipped too deep 30,657 32.0 100.8 100.4 No physical damage but unit was dropped on the floor prior to the test and it was no longer working at the time it was dipped into the solder.									
Terminal Strength	21 24	OK OK	OK OK	OK OK	OK OK						
Life Tests	13 15 18	In progress									

Values have not been corrected for lower input voltage levels.
Values have not been corrected for about 8 pF of stray capacitance.

and VI give the detail test data obtained. The results of the 18 and 25mm second engineering sample build are discussed for each SCS-480 requirement below:

1. **Physical Characteristics:** The weight of the revised 18mm and 25mm package PETs was 4.2 and 4.85 grams, respectively. The redesigned 18mm case performed quite satisfactorily and the warpage of the 25mm case was corrected by annealing. The wall thickness of the top and base 25mm cases was found to be oversize by 0.006 and 0.015 inch, which led to the assembled case being 0.010 inch oversize in outside thickness and undersize about 0.010 inch inside clearance. The injection mold die will be reworked to correct this problem. A package weight reduction of about 0.3 gram will be obtained and thus the 25mm PETs will weigh about 4.5 grams.
2. **Resistance to Soldering Heat:** As with the first engineering samples, when only the terminals were in contact with the solder, the packaged units survived the soldering heat resistance tests. One 25mm unit (No. 017) was dipped too far into the flux/solder bath and the face of the top case was partially melted.
3. **Solderability:** All units passed the solderability tests.
4. **Terminal Strength:** The terminals on two 18mm (021 and 023) and one 25mm (021) units were pulled to destruction. Typical pull strengths were 10 to 12 pounds. After several pounds of loading, the terminals remain tight and secure to the package.
5. **Induced Voltage:** No failure to the induced voltage test occurred.
6. **Thermal Shock:** All 12 25mm and seven of eight 18mm PET package units that were initially operational functioned after the specified thermal shock treatment. One 18mm unit (019), which functioned prior to thermal shock, contained only one output afterwards while another 18mm unit (021), which was unsatisfactory prior to thermal shock, produced outputs from both secondaries.
7. **High Temperature Storage:** All 18mm and 25mm PETs passed this test.
8. **Low Temperature Storage:** All 18mm and 25mm PETs passed this test.
9. **Humidity:** All 18mm and 25mm PETs passed the required humidity test.
10. **Mechanical Vibration:** All 18mm and 25mm PETs passed this test except one V_{12} output in a 25mm unit (020).

11. **Mechanical Shock:** One 18mm and one 25mm PET unit failed to operate after the mechanical shock test; however, all six units were partially crushed during the mounting of the PETs in the test fixture. Rubber mounting pads will be added to the test fixture to prevent future damage.
12. **Barometric Pressure:** All 18mm and 25mm PET units passed the reduced barometric pressure test.
13. **Life Test:** Three 18mm (014, 017, 022) and three 25mm (013, 015, 016) PET units were selected and placed on life test June 7, 1976. These units reached 750 hours of testing without failure.
14. **Electrical Performance:** Eight of the 18mm PETs and 11 of the 25mm PETs produced significant output voltage.

H. 18mm PET

Three 18mm PETs were damaged during the final stages of closing the packages, while one unit was apparently damaged during bonding and insertion into the top case.

Seven of the eight operational 18mm PETs (S/N 014, 015, 017, 018, 020, 021 and 022) were of similar design, while S/N 024 contained the single primary single secondary type "M" electrode design discussed last quarter⁽³⁾. Only the standard electroded packages are discussed below.

The average resonant frequency of the 18mm units was 32.15 kHz with a range of 31.55 to 32.79 kHz, which is slightly higher than the first engineering samples. The input capacitance was 25.07 nF, which is lower than the 34.93 nF obtained with wide electroded first engineering samples. The secondary capacitance and dissipation of 12 pF and 0.9 percent were about the same as the previous set of PETs. The input dissipation of 1.0 percent was also about the same as previously.

The room temperature voltage step-up ratio was met by only two PETs, S/N 020 and 022, while S/N 017 contained one acceptable output and a second output only slightly below the minimum requirement of 153. The high temperature performance was normally equal to or slightly better than the room temperature; for instance, both outputs of S/N 017 were satisfactory. However, the output of S/N 020 and 022 decreased significantly. Poor contact of the PETs terminals to the test fixture probably explains the low output of S/N 015, 017 and 020. In fact, the drop in output at -54°C was not as great as had been anticipated.

The efficiency at resonance at all temperatures was less than desired. At room temperature and 52°C the best units were only 24 to 26 percent as opposed to the desired 45 percent, while at -54°C, 15 to 18 percent efficiency was obtained instead of the desired 25 percent minimum. Thus, at least a part of low output and efficiency of the first engineering samples was not a case problem, but a design/testing problem. Work is currently under way to determine (1) the reason for such low efficiencies, and (2) methods to correct this problem.

1. 25mm PET

The 25mm PETs had an average input capacitance of 32 nf as opposed to the 44 nf wider electrode, first engineering samples. Input dissipation was 0.8 percent, which was about the same as the first engineering samples. Resonant frequency of the second engineering samples averaged 30.5 kHz as opposed to 30.2 kHz for the previous samples.

The voltage step-up requirement at room temperature and 52°C was met by six of the 25mm PETs. S/N 013, 014, 015, 016, 018 and 020. At -54°C, S/N 015 and 018 were slightly below the minimum ratio for a total of 10 good units. The efficiency at resonance at room temperature and 52°C was greater than 50 percent and three others were about 45 percent. At -54°C, five units had an efficiency between 20 and 26 percent. At -54 and +52°C, temperatures, the resonant frequency was about 1.0 kHz lower and 0.2 kHz higher, respectively, than the PETs' room temperature value.

SECTION IV CONCLUSIONS

Both of the 18mm and 25mm package designs meet the physical and environmental requirements of this program and therefore no further changes need to be made in the packaging approach. The 25mm PETs appear to be meeting their electrical performance requirements, thus this item is ready for the confirmatory build phase. The low efficiency and marginal voltage step-up ratio indicate the need for further studies on the 18mm design.

SECTION V RECOMMENDATIONS

Additional 18mm units need to be built to determine how to improve their voltage step-up ratio and efficiency before the confirmatory build phase is started.

SECTION VI REPORTS

The third quarterly report on this program was approved and has been published and distributed during this report period. No other reports or publications have been made on this program.

SECTION VII IDENTIFICATION OF PERSONNEL

During the fourth quarter of this program, the following personnel worked the indicated hours in their area of responsibility. No new professional persons, whose backgrounds have not been given previously^(1, 2), were used.

Individual	Responsibility	Hours
W. B. Harrison	Program Manager	70
W. H. Kammeyer	Production Engineer, Ceramic Manufacture and PET Assembly	26
L. F. Hiltner	Quality Engineer	63
M. P. Murphy	Ceramic Technician Ceramic Manufacturing	261
M. R. Sandberg	Ceramic Technician Package Assembly	18
Miscellaneous	Production	22
R. Ripley	Insp. PET Testing	29
E. Jackman	Instrumentation Technician Life Test Circuits	17
P. Schansberg	Instrumentation Technician Life Test Circuits	90
R. Erickson	Drafting	31

*Backgrounds given in First and Second Quarterly Reports

APPENDIX A **PARTS AND DRAWINGS**

18mm Parts and Drawing List

Drawing No.	Drawing Title
28100560	Piezoelectric Transformer (18mm)
2810: 578	Case, Base
28100581	Case, Base Molding (18mm)
28100576	Element, Piezoelectric
28100577	Case, Top
28100579	Shorting Bar (18mm)
28100580	Case, Top Molding (18mm)
28100570-002	Pin
28100572	Terminal

25mm Parts and Drawing List

Drawing No.	Drawing Title
28100561	Piezoelectric Transformer (25mm)
28100568	Case, Base
28100575	Case, Base (Molded)
28100571	Element, Piezoelectric
28100569	Case, Top (25mm)
28100573	Shorting Bar (25mm)
28100574	Case, Top Molded (25mm)
28100570-001	Pin
28100570-003	Negative Terminal Pin
28100572	Terminal

ELECTRICAL REQUIREMENTS

When a 5 volt (p-p) sine wave input voltage to the PET is applied in parallel to the primary terminals (P₊ and P₋) and the ceramic is driven at its primary resonant frequency with the electrical load on each secondary terminal (V₁₂ and V₃) of 10 megohms and 10 pf, the package units shall meet the following electrical requirements.

Resonant Frequency:

22 ± 2°C 33.9 ± 0.2 kHz
 52 ± 2°C 34.1 ± 0.2 kHz
 -54 ± 2°C 33.3 ± 0.2 kHz

Step-up Voltage Ratio

22 ± 2°C 170 ± 10%
 52 ± 2°C 170 ± 10%
 -54 ± 2°C 85 ± 10%

Percent Efficiency

$$\frac{V_{12}^2 + V_3^2 \times 100}{(V_{in}) (I_{in}) (10 \times 10^6)}$$

22 ± 2°C 45% min.
 52 ± 2°C 50% min.
 -54 ± 2°C 25% min.

Capacitance and Dissipation Factor: The input and output capacitance shall be measured at a nominal voltage and drive of 1 volt and 1 kHz.

Input Capacitance at Room Temperature V₁₂ and V₃ 14,000 pf ± 4%
 Secondary Capacitance at Room Temperature 7.6 pf ± 4%
 Input Percent Dissipation at Room Temperature 1.75% max.
 Secondary Percent Dissipation at Room Temperature V₁₂ and V₃ 4.6% max.

The package PET unit must meet the requirements as described in SCS-480 for solderability, resistance to solder heat, terminal strength, induced voltage, thermal shock, high and low temperature storage, humidity, mechanical shock and vibration, reduced barometric pressure, life and workmanship.

Electrical Requirements

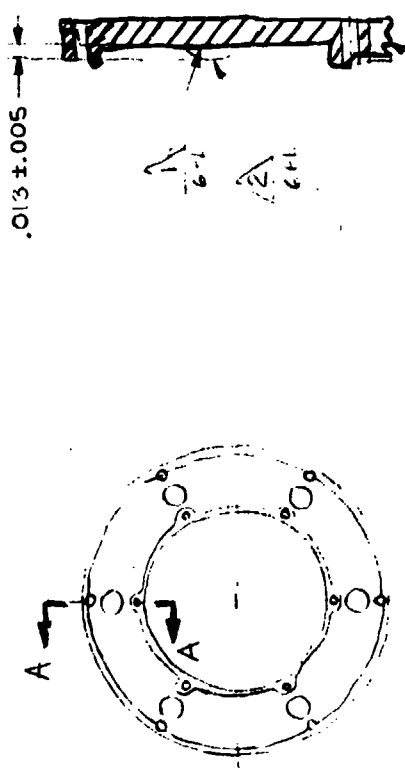
Size	Code Ident No.	Drawing No.
C	94580	28100560

Sheet 3 of 3

28100573

REVISIONS		
LTR	DESCRIPTION	DATE

PART NO.
28100573-001



CASE, BASE-28100581
SECTION A-A

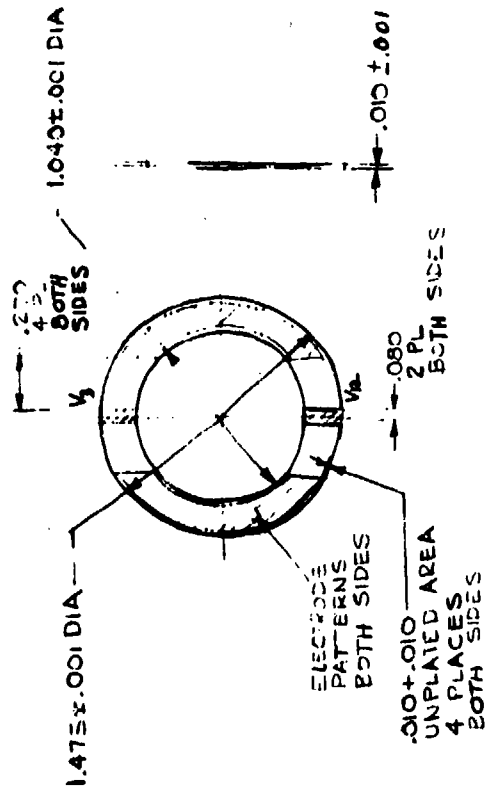
NOTES:
△-SILASTIC PRIMER
△-SILASTIC PAD

1		28100573		CASE, BASE-28100581		18 JUN 70	
TOLERANCES UNLESS NOTED OTHERWISE		DRAWN BY		HONEYWELL INC.		GOVERNMENT AND AERONAUTICAL PRODUCTS DIVISION	
CHECKED BY		DESIGNED BY		ENGINEER		HONEYWELL INC.	
MATERIAL		CONTRACT NO.		CASE, CASE		HONEYWELL INC.	
28100560 PZT T-200F		NEXT AMB		APPLICATION		USED ON	
FINISH-SEE NOTE		SIZE		CODE RIGHT NO		DRAWING NO.	
		B		94580		28100573	
		SCALE		SHEET		CONTROL	



PART NO.
28100560-3-001

REV	DESCRIPTION	DATE	APPROVED
1			

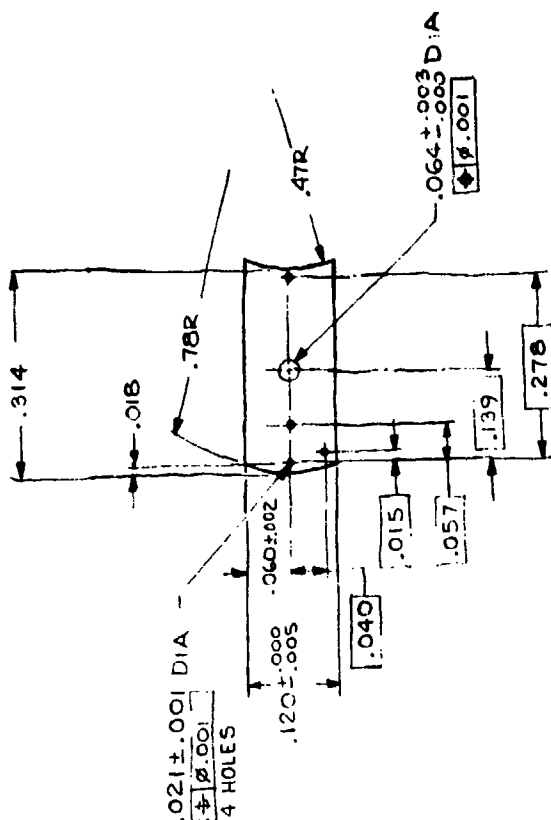


HONEYWELL INC.		GOVERNMENT AND AERONAUTICAL PRODUCTS	
ELEMENT, PIEZOELECTRIC (18 MM)		HONEYWELL INC. MILWAUKEE, WISCONSIN 53106	
SIZE	CODE	DRWG NO.	28100576
B	94580	SCALE	1:1
TOLERANCES UNLESS NOTED OTHERWISE		FINISH-SEE NOTE	
1. UNIFORMITY	1. UNIFORMITY		
2. UNIFORMITY	2. UNIFORMITY		
3. UNIFORMITY	3. UNIFORMITY		
4. UNIFORMITY	4. UNIFORMITY		
5. UNIFORMITY	5. UNIFORMITY		
6. UNIFORMITY	6. UNIFORMITY		
7. UNIFORMITY	7. UNIFORMITY		
8. UNIFORMITY	8. UNIFORMITY		
9. UNIFORMITY	9. UNIFORMITY		
10. UNIFORMITY	10. UNIFORMITY		
11. UNIFORMITY	11. UNIFORMITY		
12. UNIFORMITY	12. UNIFORMITY		
13. UNIFORMITY	13. UNIFORMITY		
14. UNIFORMITY	14. UNIFORMITY		
15. UNIFORMITY	15. UNIFORMITY		
16. UNIFORMITY	16. UNIFORMITY		
17. UNIFORMITY	17. UNIFORMITY		
18. UNIFORMITY	18. UNIFORMITY		
19. UNIFORMITY	19. UNIFORMITY		
20. UNIFORMITY	20. UNIFORMITY		
21. UNIFORMITY	21. UNIFORMITY		
22. UNIFORMITY	22. UNIFORMITY		
23. UNIFORMITY	23. UNIFORMITY		
24. UNIFORMITY	24. UNIFORMITY		
25. UNIFORMITY	25. UNIFORMITY		
26. UNIFORMITY	26. UNIFORMITY		
27. UNIFORMITY	27. UNIFORMITY		
28. UNIFORMITY	28. UNIFORMITY		
29. UNIFORMITY	29. UNIFORMITY		
30. UNIFORMITY	30. UNIFORMITY		
31. UNIFORMITY	31. UNIFORMITY		
32. UNIFORMITY	32. UNIFORMITY		
33. UNIFORMITY	33. UNIFORMITY		
34. UNIFORMITY	34. UNIFORMITY		
35. UNIFORMITY	35. UNIFORMITY		
36. UNIFORMITY	36. UNIFORMITY		
37. UNIFORMITY	37. UNIFORMITY		
38. UNIFORMITY	38. UNIFORMITY		
39. UNIFORMITY	39. UNIFORMITY		
40. UNIFORMITY	40. UNIFORMITY		
41. UNIFORMITY	41. UNIFORMITY		
42. UNIFORMITY	42. UNIFORMITY		
43. UNIFORMITY	43. UNIFORMITY		
44. UNIFORMITY	44. UNIFORMITY		
45. UNIFORMITY	45. UNIFORMITY		
46. UNIFORMITY	46. UNIFORMITY		
47. UNIFORMITY	47. UNIFORMITY		
48. UNIFORMITY	48. UNIFORMITY		
49. UNIFORMITY	49. UNIFORMITY		
50. UNIFORMITY	50. UNIFORMITY		
51. UNIFORMITY	51. UNIFORMITY		
52. UNIFORMITY	52. UNIFORMITY		
53. UNIFORMITY	53. UNIFORMITY		
54. UNIFORMITY	54. UNIFORMITY		
55. UNIFORMITY	55. UNIFORMITY		
56. UNIFORMITY	56. UNIFORMITY		
57. UNIFORMITY	57. UNIFORMITY		
58. UNIFORMITY	58. UNIFORMITY		
59. UNIFORMITY	59. UNIFORMITY		
60. UNIFORMITY	60. UNIFORMITY		
61. UNIFORMITY	61. UNIFORMITY		
62. UNIFORMITY	62. UNIFORMITY		
63. UNIFORMITY	63. UNIFORMITY		
64. UNIFORMITY	64. UNIFORMITY		
65. UNIFORMITY	65. UNIFORMITY		
66. UNIFORMITY	66. UNIFORMITY		
67. UNIFORMITY	67. UNIFORMITY		
68. UNIFORMITY	68. UNIFORMITY		
69. UNIFORMITY	69. UNIFORMITY		
70. UNIFORMITY	70. UNIFORMITY		
71. UNIFORMITY	71. UNIFORMITY		
72. UNIFORMITY	72. UNIFORMITY		
73. UNIFORMITY	73. UNIFORMITY		
74. UNIFORMITY	74. UNIFORMITY		
75. UNIFORMITY	75. UNIFORMITY		
76. UNIFORMITY	76. UNIFORMITY		
77. UNIFORMITY	77. UNIFORMITY		
78. UNIFORMITY	78. UNIFORMITY		
79. UNIFORMITY	79. UNIFORMITY		
80. UNIFORMITY	80. UNIFORMITY		
81. UNIFORMITY	81. UNIFORMITY		
82. UNIFORMITY	82. UNIFORMITY		
83. UNIFORMITY	83. UNIFORMITY		
84. UNIFORMITY	84. UNIFORMITY		
85. UNIFORMITY	85. UNIFORMITY		
86. UNIFORMITY	86. UNIFORMITY		
87. UNIFORMITY	87. UNIFORMITY		
88. UNIFORMITY	88. UNIFORMITY		
89. UNIFORMITY	89. UNIFORMITY		
90. UNIFORMITY	90. UNIFORMITY		
91. UNIFORMITY	91. UNIFORMITY		
92. UNIFORMITY	92. UNIFORMITY		
93. UNIFORMITY	93. UNIFORMITY		
94. UNIFORMITY	94. UNIFORMITY		
95. UNIFORMITY	95. UNIFORMITY		
96. UNIFORMITY	96. UNIFORMITY		
97. UNIFORMITY	97. UNIFORMITY		
98. UNIFORMITY	98. UNIFORMITY		
99. UNIFORMITY	99. UNIFORMITY		
100. UNIFORMITY	100. UNIFORMITY		

→

MEMORANDUM			
DATE	INITIALS	REVISION	DATE

PART NO.	2B130579-00.
----------	--------------



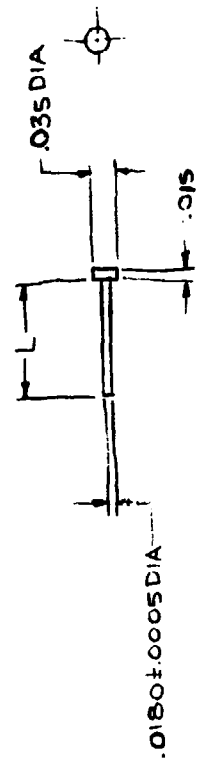
1- .0005 - 24K GOLD OVER
.001 COPPER

APPLICATION		FINISH-SEE NOTE		CONTRACT NO		DRAWINGS NO		CODE QONT NO		SIZE		B		84580		28100579		SHEET		CONTROL	
NEXT ASBY		24100579		92T TRANS		USED ON															

28100570

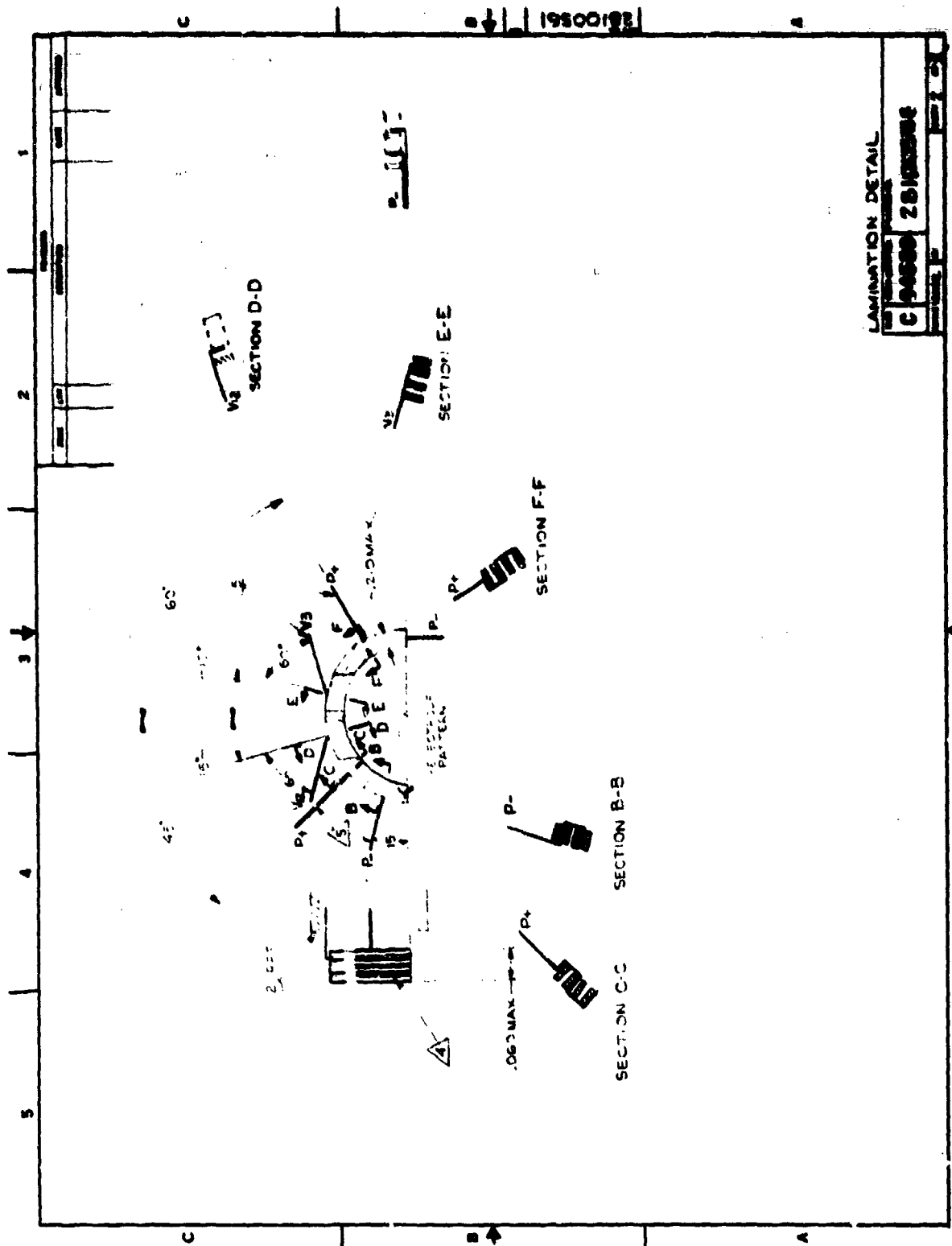
PART NO.	L	USED ON
28100570-001	.170	25 mm
-002	.120	18 mm
-003	.285	25 mm

REV	DESCRIPTION	DATE	APPROVED



1-.00005-24K GOLD OVER COPPER

DESIGNER		CHECKER		DATE		CONTRACT NO.	
HONEYWELL INC.		HONEYWELL INC.		28100570		28100570	
SIZE		CODE		NO.		DRAWING NO.	
B		94580		28100570		28100570	
SCALE		FINISH		SEE NOTE		USED ON	
APPLICATION		NEXT ASBY		USED ON		CONTROL	



ELECTRICAL REQUIREMENTS

When a 5 volt (p-p) sine wave input voltage to the PET is applied in parallel to the primary terminals (P_1 and P_2) and the ceramic is driven at its primary resonant frequency with an electrical load on each secondary terminal (V_{12} and V_3) of 10 megohms and 10 pf, the packaged units shall meet the following electrical requirements.

Resonant Frequency:

22 ± 2°C	33.9 ± 0.2 kHz
52 ± 2°C	34.1 ± 0.2 kHz
-54 ± 2°C	33.3 ± 0.2 kHz

Step-up Voltage Ratio V_{12} or V_3 output/input voltage

22 ± 2°C	170 ± 10%
52 ± 2°C	170 ± 10%
-54 ± 2°C	85 ± 10%

Percent Efficiency

$$\frac{V_{12}^2 + V_3^2 \times 100}{(V_{in})^2 (10 \times 10^6)}$$

22 ± 2°C	45 min.
52 ± 2°C	50 min.
-54 ± 2°C	25 min.

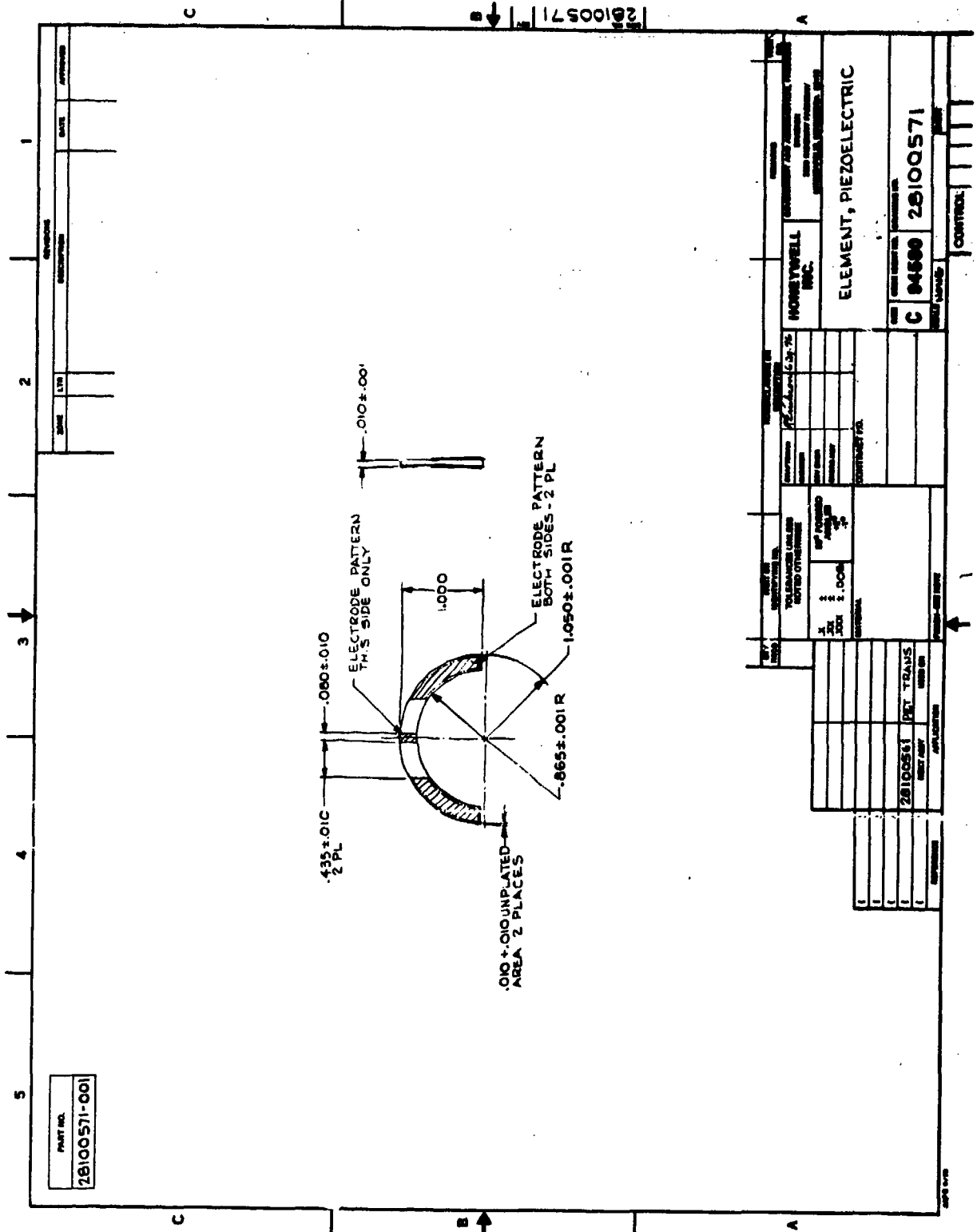
Capacitance and Dissipation Factor: The input and output capacitance shall be measured at a nominal voltage and drive of 1 volt and 1 kHz.

Input Capacitance at Room Temperature	V_{12} and V_3	14,000 pf ± 4%
Secondary Capacitance at Room Temperature		7.6 pf ± 4%
Input Percent Dissipation at Room Temperature		1.75% max.
Secondary Percent Dissipation at Room Temperature	V_{12} and V_3	4.6% max.

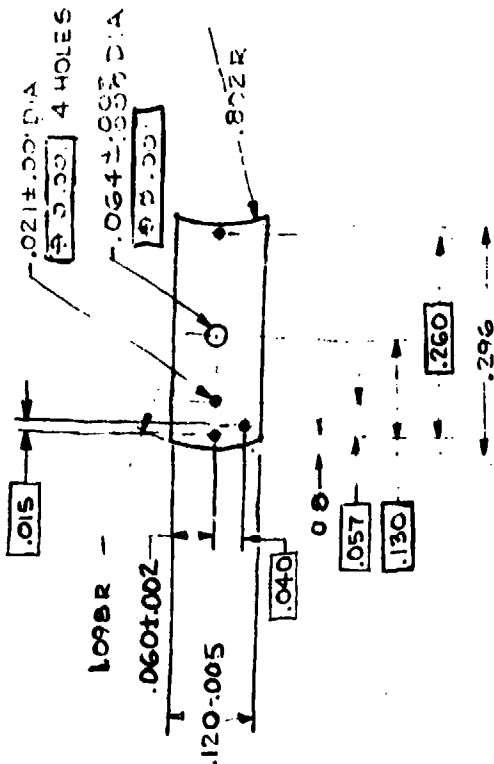
The package PET unit must meet the requirements as described in SCS-480 for solderability, resistance to solder heat, terminal strength, induced voltage, thermal shock, high and low temperature storage, humidity, mechanical shock and vibration, reduced barometric pressure, life and workmanship.

Electrical Requirements

Size	Code Ident No.	Drawing No.
C	94580	28100561
Sheet 3 of 3		



PART NO.	28100573-001
----------	--------------



1-.00005-24K GOLD OVER
.001 COPPER

[illegible]

APPENDIX B DISTRIBUTION LIST

	Copies
Commander US Army Electronics Command ATTN: AMSEL-TL-BD (Dr. E. Schlam) Fort Monmouth, NJ 07703	1
Commander US Army Electronics Command ATTN: AMSEL-TL-BD (Mr. M. E. Crost) Fort Monmouth, NJ 07703	1
US Army Advanced Ballistic Missile Defense Agency ATTN: Mr. William O. Davies Director, Optics Development Division PO Box 1500 Huntsville, AL 38507	1
Commander US Army Electronics Command Night Vision Laboratory Systems Development Area ATTN: Mr. P. T. Deepel Fort Belvoir, VA 22060	1
Commander Frankford Arsenal ATTN: Mr. J. L. Helfrich, SARFA-DDS Philadelphia, PA 19137	1
Commander US Army Research Office Chief of Electronics Branch Engineering Science Division ATTN: Dr. Horst Wittmann Box CM, Duke Station, Duke University Durham, NC 27706	1
Naval Research Laboratory ATTN: Dr. D. Barbe, Code 5214 4555 Overlook Avenue, S. W. Washington, D. C. 20375	1
Commander US Army Electronics Command ATTN: DRSEL-TL-MD (Mr. Samuel DiVita) Fort Monmouth, NJ 07703	1
Commander, RADC ATTN: ISCE/Mr. M. Kesselman Griffiss AFB, NY 13440	1

	Copies
Lincoln Laboratory, MIT ATTN: Dr. Frank L. McNamara PO Box 73 Lexington, MA 02173	1
The Institute for Defense Analysis Science and Technology Division ATTN: Dr. Alvin D. Schnitzler 400 Army - Navy Drive Arlington, VA 22202	1
NASA Headquarters ATTN: Dr. Bernard Rubin, Code RES Washington, D. C. 20546	1
Director, National Security Agency ATTN: Mr. Paul S. Szczepanek, R-4 Fort George G. Mead, MD 20755	1
Director Night Vision Laboratory, USAECOM ATTN: AMSEL-NV-SD (Mr. Howard Kessler) Fort Belvoir, VA 22060	2 plus balance of undistributed copies
Director ATTN: AMSEL-RD-EV (Mr. Soo Young Shin) Fort Belvoir, VA 22060	1
Commander US Army Electronics Command ATTN: AMSEL-PP-I-PI-1 (Mr. Edward Mason) Fort Monmouth, NJ 07703	3
Commander US Army Production Equipment Agency ATTN: AMXPE-MT (Mr. C. E. McBurney) Rock Island, IL 61201	1
Commander US Army Electronics Command ATTN: AMSEL-RD-ET-2 Fort Monmouth, NJ 07703	1
The Institute for Defense Analysis Science and Technology Division ATTN: Mr. Lucien M. Biberman 400 Army - Navy Drive Arlington, VA 22202	1
Naval Electronics Systems Command ATTN: Mr. R. Wade ELEX-0151431 Washington, D. C. 20360	1
Defense Electronics Supply Center Directorate of Engrg. & Standardization DESC-ECS/N. A. Mauck 1507 Wilmington Pike Dayton, OH 45401	1

	Copies
Air Force Materials Laboratory Electronics Branch ATTN: Mrs. E. Tarrants Wright Patterson AFB, OH 45433	1
Commander Naval Electronics Laboratory Center Library San Diego, CA	1
ITT, Electron Tube Division ATTN: Mr. A. Hoover PO Box 7065 Roanoke, VA 24019	1
NI-TEC Night Technology Corporation ATTN: Mr. Ferd Fender 7426 Linder Avenue Skokie, IL 60076	1
RCA Main Plant, Electronics Components Division ATTN: Mr. Richard Mangen New Holland Avenue Lancaster, PA 17604	1
Varo, Incorporated 2203 Walnut Street Garland, TX 75040 ATTN: D. Lipke	2
Galileo Electro Optics Corporation Galileo Park Sturbridge, MA 01518 ATTN: J. Zaghi	2
Defense Documentation Center ATTN: DDC-IRS Cameron Station (Bldg. 5) Alexandria, VA 22314	12
Director, Electro-Optical Device Laboratory Bell Telephone Laboratories, Incorporated ATTN: Dr. Eugene I. Gordon Murray Hill, NJ 07974	1
Westinghouse Advanced Technology Laboratory ATTN: Dr. James A. Hall 3525 PO Box 1521 Baltimore, Maryland 21203	1
Advisory Group on Electron Devices ATTN: Working Group on Special Devices 201 Varick Street New York, NY 10014	2

	Copies
Xerox Corporation Palo Alto Research Center ATTN: Dr. Benjamin Kazan 3180 Porter Drive Palo Alto, CA 93404	1
General Electric Company Corporate Research & Development ATTN: Dr. Rowland W. Redington PO Box 8 Schenectady, NY 12301	1
RCA Electronic Components ATTN: Dr. Ralph E. Simon New Holland Pike Lancaster, PA 17603	1
Stanford University ATTN: Dr. William E. Spicer Department of Electrical Engineering Stanford, CT 93405	1
Massachusetts Institute of Technology ATTN: Dr. Robert Rediker Bldg. 13-3050 Cambridge, MA 02139	1
Litton Industries 960 Industrial Road San Carlos, CA 94070 ATTN: B. Bedford	1
Channel Products Incorporated 16722 Park Circle Drive, West Chargin Falls, OH ATTN: Mr. D. Berlincount	1
Erie Technological Products of Canada, Ltd 5 Fraser Avenue Trenton Ontario, Canada ATTN: P. Ransom	1
Venus Scientific 399 Smith Street Farmingdale, NY 11735 ATTN: F. Galluppi	1
Vernitron Piezoelectric Division 232 Fobes Road Bedford, OH 44146 Attn: G. Howatt	1
L&K Industries 3579 Merrick Road Seaford, Long Island, NY 11783	1

Gulton Industries
Piezo Products Division
Box 4300
Fullerton, CA 92634
ATTN: D. Herzfeld

Copies

1

K&M Electronics
59 Interstate Drive
West Springfield, MA 01089

1