RESISTORS, VARIABLE

(FILM TYPE)

QUARTERLY PROGRESS REPORT #14

1 SEPTEMBER THROUGH 30 NOVEMBER 1961

CONTRACT NO. DA-36-039-SC-75981
ORDER NO. 43796-PP-58-81-81

Prepared for the U. S. Army Signal Agency

by

ENGINEERING AND RESEARCH DIVISION

INTERNATIONAL RESISTANCE COMPANY

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(FILM TYPE)

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1 SEPTEMBER THROUGH 30 NOVEMBER 1961

Contract No:	DA 36-039-SC-75981
Order No:	43796 PP-58-81-81
Applicable Specification:	MIL-R-94B (Modified)
Report Prepared at:	International Resistance Co. 401 North Broad Street Philadelphia 8, Penna.

Prepared By:

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Approved By:

Harry Casey
Project Leader

Sava I. Sherr
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ABSTRACT

Acceptable RV12 substrates have been received from American Lava.

Pre-pre-production tests and subsequent results obtained with unhoused elements show that moisture resistance can be improved with a thin film coating or a slight revision in termination material. Moisture failures appear to be greatly reduced by running the test without housings; indicating that moisture entrapment in the housings has been a major hindrance to good performance.

Manicuring of facilities continues as required.

An improved method of applying the silver shorting path for "C" tapers. which involves spraying through a mask in place of the silk screening method now used. has been developed.

BACKGROUND

The purpose of this contract is to develop, design, procure, install and manicure manufacturing facilities to produce variable film-type resistors capable of satisfying MIL-R 94B (as modified in accordance with Contract No. DA-36-039-SC-75981) whose major characteristics include 125°C ambient temperature, 100,000 cycle operation at ambient with rated load, and improved environmental stability.

In a Technical Action Request dated July 18 1959 IRC proposed changes in the applicable components specifications. Subsequently with one exception, the requested changes were approved. The exception involved rotational life characteristics and the possibility of future approval was made contingent upon the submission by IRC of further technical information. The most significant change involved noise level before and after rotation. This ENR level must (1) not exceed 1% of total resistance or 5 ohms (whichever is greater), (2) nor may it exceed 5% of total resistance or 25 ohms (whichever is greater), after 100 000 cycle operation, full rated load at 125°C or de-rated load at 150°C.

As a result of the signing of an operation agreement between IRC and Chicago Telephone Supply Service of Elkhart, Indiana, it was decided that IRC and CTS would submit a proposal to the USASSA allowing establishment of facilities at CTS.

The development program to date has been directed toward the establishment of a system (substrate, film and contact) which is capable of meeting the contract requirements. After considerable effort, this system has been incorporated into a potentiometer design.

Carbon alloy, metal, and glaze films have been tested on ceramic substrates using molded carbons, precious metals and carbongraphite wiper materials. While both metal film and resistive glaze elements showed some promise, the performance levels were not as high as those observed for carbon alloy.

After considerable difficulty experienced by Coors Porcelain Company in making substrates in the designed configuration, another vendor (American Lava) has tooled to produce 96% alumina substrates for both the RV11 and RV12 potentiometers. The surface finish requirement of these

substrates has been established at 15 microinches, and carbon alloy has been selected for deposition on the substrates. A single grade of carbon (Pure Carbon Co. E-27) will be used as the wiper on all resistance ranges from 100 ohms through 1,000,000 ohms.

The method of adjusting resistance tolerance as reported in Quarterly Report #7, on production elements is operational. The screening of a pattern of conductive material to produce nonlinear taper has been proved feasible.

Temperature coefficient curves indicate that for linear elements, 750 PPM can be maintained for resistance of 100,000 ohms and less. At 200,000 ohms, 750 PPM becomes marginal and 1500 PPM is exceeded for all values of 400,000 ohms and greater. Temperature coefficient on "C" tapered elements will correspond to those values observed on linear elements which are approximately double the resistance range of the tapered element.

An improved termination of VZA conductive paint with a VLS carbon ink overlay provides moisture resistance superior to that of VZA alone. However, moisture tests of housed elements have shown a high failure rate, indicating that the sealed housing has a deleterious effect.

I. PRODUCT ENGINEERING

A. Substrates

Deliveries of 1500 RV12 substrates have been received from American Lava. Dimensions are acceptable with the following deviations noted: 1) the .968 ± .005 outside diameter is undersized on most pieces, measuring .956 to .959; 2) the inner wall in the terminal slot area has been made thicker by addition of a radial contour, whereas, the drawing specifies two chords of the inside diameter. Deviation 1) has been accepted after checking with CTS to confirm that the substrate can be clinched in the clinching ring; 2) is a minor deviation having no effect on processing or assembling the element.

A small lot (27) of RV11 substrates were rejected, and returned to vendor, for high surface roughess. A sample of six pieces averaged 19.4 microinch RMS with a span of 18 to 22 microinch.

B. Testing

The pre-pre-production tests, representing the first data obtained with the carbon alloy elements assembled in housings, have been completed. Most of the data was reported in Quarterly Report #13. The completed data summaries are presented here (Tables II through V.). As previously noted, load life and rotational life changes were greater than the specified ±5% ΔR. Some of the larger load-life changes were attributed to substrate and termination defects. Process changes have been made to correct these conditions. Because one lot each of RV11 and RV12 units was found to have been improperly mounted on heat sinks during the load life test, the test was repeated (test lots No. 14200 and 14201 in Table IV) with potentiometers assembled at the same time as those previously tested. The resistance changes were again high. Disassembly of the units having the greatest changes showed that the terminations were thin and incomplete, as was noted before.

Another defect visible in the RV12 pots is an inadequate crimping of the clinching ring which prevents proper seating of the substrate against the ring. This decreases the heat conduction to the housing causing excessive film temperature. CTS will be advised of the situation so that corrections can be made before pre-production.

The major problem which showed up in pre-pre-production testing was poor performance in the moisture resistance test.

Data obtained in the last quarter (Quarterly Progress Report #13) indicated that a carbon ink overlay covering the VZA termination would improve moisture resistance. A lot of 12 RV11 potentiometers were assembled with the improved termination. All openings in the housing were sealed with epoxy; and in four assemblies, the opening between the shaft and bushing was also sealed. The latter operation prevents rotation of the shaft, but was used in this instance to determine whether or not an improved shaft seal is necessary. Half of the pots were submitted to the MIL-R-94B moisture resistance test at IRC; and half at CTS.

All of the units which had been sealed around the shaft, and 4 of the 8 other units, were "open" after 10 moisture cycles. (See Table I)

In an effort to improve moisture resistance of the element itself, 10 groups of unhoused elements were prepared and submitted to the moisture test. These groups used various protective coatings and termination modifications, as shown in Table VII. This table also summarizes the test results after 10 moisture cycles. Group numbers 4, 5, 8, 9, and 10 had no failures. There were no "opens" in any group, including group 6 which was terminated in the same manner as were the assembled pots of Table I. Moisture cycling of the unhoused elements is continuing in order to determine the best system.

It is apparent from the findings to date that the sealed housing is a detriment to good moisture resistance. In future assemblies, the housing will be left completely unsealed to allow entrapped moisture to escape.

II. PRE-PRODUCTION

Production of elements was stopped pending evaluation and solution of the moisture problem. Manufacture of pre-production elements will be started, using the revised termination and/or coating indicated by the tests in i B, above.

"C" taper shorting patterns have been successfully screened. Because of the fine resolution required in the RVII pattern, the consistency of the VZA is critical, and the screen must be cleaned frequently.

III. FACILITIES

A. Element

The element facility changes during the past quarter consisted of some minor manicuring of the equipment and the development of an improved technique for applying the taper shorting path.

The screening set-up for tapers was brought to the point where the taper pattern could be screened on the elements consistently. As pointed out above, the screening material viscosity is critical, however, the system is workable.

An alternative method of applying the same pattern was developed. It was demonstrated that a mask could be made by the photo-etch process which retained sharp definition. The silver was sprayed through this mask and the resulting pattern was acceptable. The operation is less critical than screening so this method will be tooled

A checking fixture for reading resistance at the mid rotation point of the elements was made

Also, an improved contactor of Paliney #7 Alloy was made to monitor the resistance of an element while adjusting it on the machine.

B. Housing

No changes to report.

CONCLUSIONS

1. Acceptable substrates can be produced for both the RV.. and RV12 sizes.

2. Moisture results obtained with unhoused elements are superior to data obtained with assembled, epoxy-sealed potentiometers.

3. Definition and ease of application of the "C" taper pattern are improved by the use of a photo-etched mask and spray in place of the silk screening process.

PROGRAM FOR NEXT QUARTER

1. The moisture tests on unhoused elements will be continued to determine which termination and/or coating provides the most protection.

2. Pre-production of elements will be begun using the indicated new termination.

PERSONNEL

Engineering	Hours
J. Woods	136.0
M. Steidlitz	58.5
Mechanical, Chemical, Electrical Development	
F. Surowiec	21.0
E. Dietrich	15.0
E. Altorfer	2.0
W. Gold	20.0
Technicians	
B. Kelly	157.5
O. Leidic	66.5
A. Graft	40.0
G. Williams	40.0
D. Terry	136.5
E. Greenleaf	76.0
T. Arline	40.0
Test Section	124 7
Total IRC	933 7
Total CTS	44.0
TOTAL	977.7

APPEND X

TABLE I

Moisture resistance tests of 325KΩ RVII potentiometers (combined IRC and CTS results).

No. Units	(% ΔR (spec: ±5%) Max	Min.	Ave.	Fail	Remarks
8	+4.6	+0.81	+2.05 (ave. of 4)	4/8 (4 "open")	Units epoxy sealed on back of element and between case and bushing
4	ALL UNITS "OPEN"			4/4	Units sealed as above, plus epoxy seal around shaft.

Note: All units passed 500 V AC dielectric strength; 1/12 failed insulation resistance: 40 MΩ (spec. 100 MΩ minimum).

3-303-1

PREPARED BY	MK, JW
CHECKED BY	
APPROVED BY	

TITLE: *PRE-PREPRODUCTION TESTS – FILM POTE[NTIOMETERS]* 185KΩ

RESISTANCE & DATA NO.		TEMPERATURE COEFFICIENT PPM/°C −15°C	PPM/°C −55°C	PPM/°C +25°C	PPM/°C +105°C	PPM/°C +165°C (SPEC: 750PPM/°C)		LOAD LIFE 125° & 150°C (SPEC: ±3% ΔR ± 3%MAX) %ΔR 96 Hrs	%ΔR 192 Hrs	%ΔR 525 HRS	%ΔR 1005 HRS		VIB[RATION] %ΔR
FILM POT. (1 PC)	AV	−947	−872	−722	−704	−684		+0.34	+0.50	+0.77	+0.71		
RV-11	SPAN	−838	−774	−653	−629	−603		+0.32	+0.23	+1.06	+1.11	125°C	
185KΩ ½W		−998	−916	−788	−763	−746		+0.35	+0.60	+0.65	+0.46	FULL LOAD	
08227	FAIL	4/4	4/4	1/4	1/4	0/4		0/4	0/4	0/4	0/4		
FILM POT (1 PC)	AV	−844	−785	−665	−636	−612		±0.39	±0.44	±1.19	+0.57		
RV-11	SPAN	−730	−731	−613	−585	−555		+0.42	+0.52	+0.80	+1.40	150°C	
185KΩ ½W		[illegible]	−863	−755	−711	−697		−0.50	−0.58	−3.32	+0.07	40% LOAD	
08228	FAIL	4/4	2/4	1/4	0/4	0/4		0/4	0/4	0/4	0/4		
FILM POT (1 PC)	AV												±0.39
RV-11	SPAN												+0.6[illegible]
185KΩ ½W													−0.71
08229	FAIL												0/
FILM POT (1 PC)	AV												
RV-11	SPAN												
185KΩ ½W													
08230	FAIL												
	AV												
	SPAN												
	FAIL												
	AV												
	SPAN												
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	AV												
	SPAN												
	FAIL												

1

TYPE RV11	DWG.NO.B	TABLE II
	DATE	6-21-61

5 — FILM POTENTIOMETER, RV11

K Ω

Storage 125° & 150°C %ΔR .5 HRS	%ΔR 1005 HRS		Vibration (spec. ± [illegible]% max) %ΔR [illegible] contact	Vibration %ΔR total R.	Solder (spec. ± 2%) %ΔR	Moisture Resistance Test %ΔR (spec. [illegible])	← Spec. → [illegible] elect.	Moisture Resistance Test MEG Ω 100 MΩ ins. res.	Rotation Test 30,000 cyc. @ 125°C Initial ENR, Ω (Spec: ≤ 1% R_T)	%ΔR (Spec: ±5% @ 100,000 cycles)	Final ENR, Ω (Spec: < 3% R_T)
.77	+0.71	125°C full load									
.06	+1.11										
.65	+0.46										
4	0/4										
.19	+0.57	150°C 40% load									
.80	+1.40										
.32	+0.07										
7	0/4										
			± 0.39	± 0.03		[illegible]	No	2.5·10[4]			
			+ 0.62	+ 0.22		[illegible]	[illegible]	6.8·10[4]			
			− 0.71	− 0.02		[illegible]	[illegible]	0.45·10[4]			
			0/8	0/8		2 *	/6	1/6			
					± 0.05				< 210	+25.5	< 350
					[illegible]				< 310	+38.0	< 700
					0.11				< 80	+17.2	< 400
					0/6				0/4	4/4 **	0/4

NOTES: * 2 MOISTURE FAILURES "OPEN". NOT INCLUDED IN AVE. OR SPAN.

** ROTATION FAILURES: CTS STATED THAT CENTER TERMINAL LUBRICATION WAS OMITTED.

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PREPARED BY BK, JW	TITLE PRE-PRE PRODUCTION TESTS	TYPE RV11 RV12	DWG. NO. B	TABLE III
CHECKED BY			DATE 9-18-61	
APPROVED BY				

RESISTANCE & DATA NO.		TEMPERATURE COEFFICIENT SPEC — RV11: 350 PPM TO 250K Ω, 1500 PPM TO 1 MΩ; RV12: 700 PPM TO 500K Ω, 1500 PPM TO 1 MΩ					LOAD LIFE SPEC: 3%				
		-15°C PPM	-55°C PPM	+105°C PPM	+125°C PPM	+65°C PPM	96 HRS	192 HRS	504 HRS	1008 HRS	TEMP & LOAD
RV12 2W 70KΩ 11120	AV	-362	-362	-315	-318	-304	+4.25	+3.99	+3.5	+20.6	
	SPAN	-380	-383	-335	-329	-321	+9.93	+9.44	+7.24	+58.74	150°C
		-353	-348	-290	-306	-282	+1.31	+1.11	+1.39	+1.35	0.8W
	FAIL	0/3	0/3	0/3	0/3	0/3	1/3	1/3	1/3	1/3	
RV11 1/2W 1 PC. 350KΩ 11296	AV	-1643	-1768	-1161	-1173	-1051	+1.69	+0.98	+2.39	+2.93	
	SPAN	-1750	-1888	-1290	-1253	-1106	+1.98	+1.21	+2.71	+3.68	150°C
		-1568	-1644	-1095	-1074	-956	+1.49	+0.72	+2.17	+2.46	0.2W
	FAIL	4/4	4/4	0/4	0/4	0/4	0/4	0/4	0/4	2/4	
RV11 - 1/2W 3 PC. 350KΩ 11121	AV	-1125	-1205	-851	-888	-902	+4.77	+4.0	+5.65	+14.82	
	SPAN	-1138	-1224	-880	-898	-936	+8.62	+7.36	+9.14	+24.21	150°C
		-1118	-1194	-828	-875	-864	+0.85	+0.63	+1.05	+5.45	0.2W
	FAIL	0/3	0/3	0/3	0/3	0/3	1/2	1/2	1/2	2/2	
RV12 2W 70KΩ 11118	AV	-349	-341	-344	-342	-349	+1.16	+4.10	+4.35	+5.65	
	SPAN	-365	-365	-368	-355	-372	+1.30	+5.91	+9.34	+12.48	125°C
		-283	-296	-325	-326	-326	+1.19	+1.34	+1.46	+1.08	FULL
	FAIL	0/3	0/3	0/3	0/3	1/3	1/3	1/3	1/3	1/3	
RV11 1/2W 1 PC. 350KΩ 11297	AV	-1646	-1728	-1135	-1151	-1035	+3.70	-4.95	+11.16	[illegible]	
	SPAN	-1803	-1904	-1230	-1213	-1158	+6.36	+10.74	+17.87	[illegible]	125°C
		-1562	-1556	-1035	-1064	-966	+0.42	+0.91	+4.45		FULL
	FAIL	4/4	4/4	0/4	0/4	0/4	2/4	2/4	1/2		
RV11 1/2W 2 PC. 350KΩ 11119	AV	-1131	-1176	-692	-688	-770	+2.86	+6.52	+6.76	+11.46	
	SPAN	-1178	-1224	-775	-734	-844	+4.99	+8.45	+8.42	+13.76	125°C
		-1085	-1129	-629	-635	-696	+0.45	+5.54	+6.11	+7.57	FULL
	FAIL	3/3	3/3	0/3	0/3	0/3	0/3	3/3	3①/3	3①/3	
RV12 2W 70KΩ 12901	AV						+3.40	+3.91	+8.25	[illegible]	
	SPAN						+5.57	+6.39	+11.52	Normal	125°C
							+1.10	+1.17	+2.94	3/5	FULL
	FAIL						1/6	2/6	2/4	1/	
RV11 1/2W 350KΩ 14100	AV						+3.55	+5.60	+8.86	+10.41	
	SPAN						+7.41	+11.19	+12.3	+27.21	125°C
							-0.17	-0.3	+3.33	+1.97	FULL
	FAIL						2/5	2/5	3/5	4/5	
RV12 2W 70KΩ 14201	AV						+2.85	+1.44	+5.64	+7.73	
	SPAN						+7.16	+4.60	+11.61	+17.22	125°C
							+0.18	+0.25	+0.25	+0.74	FULL
	FAIL						2/5	2/5	2/5	3/5	
	AV										
	SPAN					① ONE UNIT OPEN; NOT IN AVE.					
	FAIL	NOTE:									
	AV	1. FAILURE RATE FOR TC ON RV11, 250KΩ ASSUMES 1500 PPM SPEC.									
	SPAN										
	FAIL	2. UNITS OF #11297 & 12901 NOT PROPERLY MOUNTED ON HEAT SINK.									
	AV										
	SPAN										
	FAIL										

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PREPARED BY BK, JN	TITLE PRE-PREPRODUCTION TESTS	TYPE RV11 RV12	DWG.NO.B TABLE IV
CHECKED BY			DATE 9-18-61
APPROVED BY			

RESISTANCE & DATA NO.		VIBRATION 55CPS MAX		MOISTURE		
SPEC →		RV11- 1.5% RV12 ±.5%		± 5%		100 MΩ
		%ΔR TOTAL	%ΔR 50%	MOIST. TEST %ΔR	DIELECTRIC	INSUL. RES. MEG Ω
RV12 2W 70KΩ 11110	AV	±0.17	±0.18	±6.90		12.11x10²
	SPAN	+0.49	+0.42	+17.57		20x10²
		+0.06	+0.20	-0.66		1.47x10²
	FAIL	0/6	0/6	4①/6	0/6	0/6
RV11-1 PC ½W 250KΩ 11294	AV	±0.07	+0.86	ALL OPEN		
	SPAN	+0.25	+5.29			
		+0.06	-0.81			
	FAIL	0/8	1/8	8/6		
RV11-3PC ½W 250KΩ 11111	AV	+0.27	±0.57	+3.66		165.6x10²
	SPAN	+0.26	+0.59	+6.34		500x10²
		+0.15	-1.20	+0.98		4.5x10²
	FAIL	0/4	0/4	3②/4	0/4	0/4
	AV					
	SPAN					
	FAIL					
	AV					
	SPAN					
	FAIL					
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	FAIL					

① = NO. OPENS NOT INCL. IN AVE OR MAX.

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PREPARED BY BK, JW	TITLE PRE-PREPRODUCTION TESTS	TYPE RV11 RV12	DWG. NO. B	TABLE V
CHECKED BY			DATE	9-18-61
APPROVED BY				

RESISTANCE & DATA NO.		SOLDER SPEC ± 2% %ΔR	ROTATION, FL @ 125°C 1% R_T ENR UNIT %R_T	5% R_T ENR UNIT %R_T	± 5% %ΔR
RV12 2W 70K Ω 2½ oz. 11106	AV	+0.10	0.34	1.19	+4.38
	SPAN	+0.52	0.51	2.56	+6.93
		0	0.27	0.54	+1.39
	FAIL	0 / 8	0 / 4	0 / 4	2 / 4
RV12 2W 70K Ω 1½ oz. 11107	AV	±0.05	1.16	3.16	+4.99
	SPAN	+0.06	3.2	3.90	+7.12
		0	0.2	2.64	+2.62
	FAIL	0 / 6	0 / 4	1 / 4	2 / 4
RV11 ½W 1 PC 350K Ω 1½ oz. 11109	AV	± 0.27	0.69	0.55	+4.75
	SPAN	+0.47	0.89	1.06	+6.07
		-0.18	0.49	0.16	+3.03
	FAIL	0 / 4	0 / 4	0 / 4	2 / 4
RV11 ½W 1 PC 350K Ω 2½ oz. 11295	AV	+0.23	0.64	1.0	+6.53
	SPAN	+0.32	0.91	2.31	+10.34
		+0.06	0.38	0.25	+3.43
	FAIL	0 / 8	0 / 4	0 / 4	3 / 4
RV11 ½W 3 PC 750K Ω 11108	AV	+0.26			
	SPAN	+0.91			
		+0.01			
	FAIL	0 / 8			
	AV				
	SPAN				
	FAIL				
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PREPARED BY BK, JW	TITLE PRE-PREPRODUCTION TESTS
CHECKED BY	
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RESISTANCE & DATA NO.		DC RESISTANCE				TORQUE	DIEL STRENGTH	ACCELERATION	SHOCK	HI FREQUENCY VIBRATION		LOW TEMP STORAGE & OPER	
SPEC		±5% NOM	±10% NOM	70K: 50 Ω 250K: 125 Ω 350K: 250 Ω		RV11: 5.5-6.0 RV12: 2.0-6.0		±3%	±2%	±2%	±10%	±2%	±3%
		R_T Ω	MIDPOINT % OF R_T	R_{MIN} LEFT Ω	R_{MIN} RT Ω	OZ IN		% ΔR	% ΔR	% ΔR TOTAL	% ΔR TRANSIENT	STOR % ΔR	OPER % ΔR
RV12 70K Ω	AV	73681	50.61	0.71	716	5.0	NO BREAKDOWN	+0.16	±0.04	±0.13	±0.79		
	SPAN	76410	58.7	1.47	1903	5.5		+0.20	+0.04	+0.02	+1.03		
		71300	45.74	0.41	46	4.5		+0.14	-0.11	-0.40	-1.11		
11114	FAIL	2/4	1/4	0/4	3/4	0/4	0/4	0/4	0/4	0/4	0/4		
RV11 1 PC 350K Ω	AV	353.92K	49.6	972.2	172.%	1.5	NO BREAKDOWN	+0.22	±0.10	+0.27	±0.39		
	SPAN	367.97K	56.7	4859.	863	1.7		+0.25	+0.06	+0.36	+.66		
		339.93K	47.6	.41	.38	1.3		+0.19	-0.29	0	-0.70		
11292	FAIL	1/5	0/5	1/5	1/5	0/5	0/5	0/5	0/5	0/5	0/5		
RV11 3 PC 250K Ω	AV	263.19K	53.1	20.39	2.52	1.3	NO BREAKDOWN	+0.24	+0.11	-0.13	±0.69		
	SPAN	272.12K	58.7	59.9	6.7	1.3		+0.26	+0.14	-0.04	+0.48		
		258.17K	47.0	.61	.31	1.2		+0.21	+0.08	-0.21	-0.42		
11115	FAIL	1/3	1/3	0/3	0/3	0/3	0/3	0/3	0/3	0/3	0/3		
RV12 70K Ω	AV	73599	50.5	3.07	169	3.9	NO BREAKDOWN					+0.15	+0.3
	SPAN	75370	51.61	11.55	486	4.5						+0.31	+0.9
		71900	48.49	0.25	29.6	3.0						+0.02	+0.2
11112	FAIL	1/4	0/4	0/4	3/4	0/4	0/4					0/4	0
RV11 1 PC 350K Ω	AV	348.71K	49.16	34.6	437.9	1.9	NO BREAKDOWN					±0.11	±0.
	SPAN	364.32K	52.3	137	2187	2.2						+0.15	+0.
		327.96K	44.1	.43	.46	1.6						-0.11	-0.
11293	FAIL	1/5	1/5	1/5	1/5	0/5	0/5					0/5	0
RV11 3 PC 250K Ω	AV	256.37K	49.5	401.5	3.11	1.3	NO BREAKDOWN					±0.06	±0.
	SPAN	266.44K	53.3	8334	47	1.5						+0.02	+0.
		243.30K	45	.34	.75	1.2						-0.11	-0.
11113	FAIL	1/3	0/3	2/3	0/3	0/3	0/3					0/3	0
RV12 70K Ω	AV	71770	51.91	0.49	108	4.44	NO BREAKDOWN						
	SPAN	72920	55.25	0.40	206	5.25							
		69000	48.42	0.33	11.4	3.25							
11116	FAIL	0/4	1/4	0/4	2/4	0/4	0/4						
RV11 1 PC 350K Ω	AV												
	SPAN												
11276	FAIL												
RV11 3 PC 250K Ω	AV	253.03K	51.9	.36	.55	1.5	NO BREAKDOWN						
	SPAN	269.54K	55.5	.60	.79	1.6							
		249.76K	49.3	.33	.37	1.4							
11117	FAIL	1/3	1/3	0/3	0/3	0/3	0/3						
	AV												
	SPAN												
	FAIL												
	AV												
	SPAN												
	FAIL												
	AV												
	SPAN												
	FAIL												

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TYPE RV11 RV12	DWG. NO. B	TABLE VI
	DATE 9-18-61	

FREQUENCY VIBRATION		-PW TEMP STORAGE & OPER.		TEMP CYCLE	SALT SPRAY
±1% R AL	±10% %ΔR TERMINAL	±2% STOR. %ΔR	±3% OPER. %ΔR	±3% %ΔR	
13	±0.79				
02	+1.03				
40	−1.11				
9	0				
27	±0.39				
30	+0.66				
	−0.70				
5	0				
13	±0.69				
04	+0.98				
21	−0.42				
3	0				
		+0.15	+0.37	+0.84	
		+0.31	+0.44	+1.14	
		+0.12	+0.25	−0.11	
		4	0 4	5 4	
		±0.11	±0.49	+0.84	
		+0.15	+0.35	+1.5	
		−0.11	−0.15	+0.4	
		0 5	0 5	0 5	
		±0.06	±0.39	+1.0	
		+0.02	+0.84	+1.0	
		−0.11	−0.21	+0.6	
		3	3	3	
					*
				1 ITEM 1.56	
				4	
					*
					5
					*
					2

* SALT SPRAY MECHANICALLY OPERATIVE; SOME CORROSION AT BUSHINGS & TERMINALS.

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TABLE VII

MOISTURE TESTS, UNHOUSED RVII ELEMENTS
10 Cycles

Group No.	Termination of Material and Configuration	Original Resistance Span	Protective Film	%ΔR Ave.	%ΔR Span	Failure Rate (>±5%)
1	VZA + VLS, STD. SPRAY	560K to 735K	DC200. 1000CS 50% TOLUOL	+4.91	+0.47 to +25.1	2/10
2	VZA + VLS. STD. SPRAY	600K to 700K	DC3	+6.45	+1.0 to +26.3	2/9
3	VZA + VLS, STD. SPRAY	590K to 670K	TEFLON. rubbed on	+2.3	+1.3 to +5.0	1/8
4	VZA + VLS. STD. SPRAY	570K to 680K	DC200. 0.65CS	+2.48	+1.8 to +4.2	0/9
5	VZA + VLS, STD. SPRAY	590K to 690K	DESICOTE	+2.07	+0.95 to +4.7	0/10
6	VZA + VLS. STD. SPRAY	535K to 635K	NONE	±3.27	-0.75 to +17.2	1/10
7	VZA only. curved hop off	315K to 575K	NONE	+3.8	+1.8 to +9.2	2/10
8	VZA + VLS (epoxy added) curved hop off	275K to 760K	NONE	+2.0	+0.31 to +3.3	0/10
9	VLS (epoxy added), STD. SPRAY	310K to 865K	NONE	±1.77	-0.6 to +3.1	0/10
10	VZA + 10K/□ ink (epoxy added) STD. SPRAY	300K to 820K	NONE	+1.92	+0.15 to +3.3	0/10