(4) AD160

(5) 702100

Scale - 1

(6) PRODUCTION ENGINEERING MEASURE

VHF CRYSTAL UNITS CR(XM-36)/U

(15) CONTRACT ~~NO:~~ DA-36-039-SC-85971
ORDER NO: 6026-PP-61-81-81

(7) NA
(8) NA
(10) NA
(11) 30 Dec 62
(12) 14 p.
(13) NA
(14) NA
(16) NA
(17) NA
(18) NA
(19) NA
(20) U
(21) NA

(9) ~~SIXTH~~ QUARTERLY REPORT no. 6,
OCTOBER (1) ~~1962~~ TO DECEMBER (30) 1962

M. C.

PREPARED FOR
U.S. ARMY ELECTRONICS MATERIEL AGENCY
225 SOUTH 18TH. ST.
PHILADELPHIA, PENNA.

BY

PIEZO CRYSTAL COMPANY
CARLISLE, PENNA.

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PURPOSE

DEVELOP AND PRODUCE 500 UNITS ON FREQUENCIES 150 MC, 162 MC, 174 MC 188 MC AND 200 MC USING BOTH NATURAL AND CULTURED QUARTZ IN ACCORDANCE WITH SIGNAL CORPS TECHNICAL REQUIREMENT SCS-75 DATED 28 DECEMBER 1959.

Production Engineering Measure of VHF crystal units was contemplated

~~ABSTRACT~~

NINETY PERCENT OF THE UNITS SHOWED RESISTANCE PEAKS DURING TEMPERATURE TESTING. THIS WAS TRUE OF ALL OF THE 9TH OVERTONE CRYSTALS AT ALL THE FREQUENCIES 150 TO 200 MC. INVESTIGATION OF THESE RESISTANCE PEAKS INDICATED THAT VERY LOW DRIVE LEVELS WOULD ELIMINATE THEM, AND OPERATING CRYSTALS ON THE 7TH MODE REDUCED THE NUMBER OF REJECTS FOR RESISTANCE PEAKS TO 20% OR LESS. OTHER PLATING METALS WERE TRIED, SOME OF WHICH SHOW FAVORABLE RESULTS FOR RESISTANCE PEAKS DURING TEMPERATURE TEST. THESE METALS HAD OTHER UNFAVORABLE PROPERTIES FOR ~~OUR~~ PRESENT TECHNIQUES AND EQUIPMENT, THEY ALSO GAVE VERY POOR AGING PROPERTIES. ~~WHICH IS IMPORTANT IN THIS P.E.M. A REQUEST TO CHANGE THE DRIVE LEVEL WAS GRANTED AND THE PREPRODUCTION SAMPLES WILL BE PRODUCED.~~

NARRATIVE

AT THE END OF OUR LAST REPORT WE WERE EXPERIENCING RESISTANCE PEAKS THROUGH THE TEMPERATURE RANGE ON THE 9TH OVERTONE CRYSTALS. THE RESISTANCE PEAKS WERE REDUCED OR ELIMINATED ENTIRELY BY REDUCING THE DRIVE. THE SPECIFICATION CALLS FOR A 2 MILLIWATT DRIVE LEVEL WHICH FOR MOST PRACTICAL PURPOSES DOES NOT SEEM TO BE EXCESSIVE. HOWEVER, THE RESISTANCE PEAKS WHICH OCCURRED DURING TESTS ARE BEYOND THE 80 OHM MAXIMUM. WE TRIED SEVERAL WAYS OF FINISHING THE CRYSTALS IN ORDER TO ELIMINATE THE RESISTANCE PEAKS, NONE OF WHICH SOLVED THE PROBLEM. ON PAGES WE HAVE TEST CHARTS TO SHOW THESE RESISTANCE PEAKS UNDER VARYING CONDITIONS. ALUMINUM PLATING GAVE GOOD RESULTS WHERE RESISTANCE PEAKS WERE CONCERNED BUT MANY OTHER PROBLEMS CAME TO THE FOREFRONT WITH ALUMINUM PLATING. THE GREATEST PROBLEM WAS IN FINISHING TO FREQUENCY WITH ALUMINUM. WE WERE NOT TOOLED UP TO VAPOR FINISH SO OTHER METHODS OF FINISHING WERE TRIED. ETCHING THE ALUMINUM WITH CAUSTIC SOLUTIONS WAS EFFECTIVE, BUT THE RESISTANCE OF THE UNITS GOT HIGHER AND HIGHER AS WE ETCHED AWAY THE ALUMINUM SURFACES TO INCREASE THE FREQUENCY. OVERPLATING WAS TRIED, USING AN ALUMINUM SUBSTRATE WITH SILVER ON TOP SO THAT WE COULD ELECTROPLATE TO FREQUENCY.

HERE AGAIN WE RAN INTO HIGH RESISTANCE AND THE PLATING SOLUTIONS WEAKENED THE ADHERENCE OF THE METALS TO THE QUARTZ. OTHER METALS AND COMBINATIONS OF METALS WERE EXPLORED BUT IN ALL CASES WE STILL HAD RESISTANCE PEAKS OVER THE TEMPERATURE RANGE. AS A POINT OF INTEREST UNITS PLATED WITH COPPER BASEPLATE ELECTROPLATED TO FREQUENCY SHOWED LESS RESISTANCE PEAKS THAN ALL THE OTHER METALS TRIED WITH THE EXCEPTION OF THE ALUMINUM. PRELIMINARY AGING TESTS ON THE VARIOUS COMBINATIONS OF METALS INDICATED VERY POOR AGING CHARACTERISTICS, FAR FROM THE REQUIRED STABILITY. SINCE GOOD RESULTS WERE OBTAINED IN AGING USING THE SILVER BASE PLATE AND NICKEL ELECTROPLATE, AND POOR RESULTS WITH ANY OTHER METAL OR COMBINATION OF METALS IT MIGHT BE WISE TO COMPROMISE AND REDUCE THE 2 MILLIWATT DRIVE LEVEL IN ORDER TO REDUCE THE RESISTANCE PEAK REJECTS. TEST RUNS WERE MADE ON THE 7TH AND 9TH MODE CRYSTALS AT 2 MILLIWATTS TO CHECK THE RESISTANCE PEAKS OVER THE TEMPERATURE RANGE TO COMPARE THE DIFFERENCE IF ANY. A GROUP OF THE CRYSTALS AT 200 MC 9TH MODE AND 2 MILLIWATT DRIVE WERE TESTED OVER THE TEMPERATURE RANGE. ALL UNITS HAD RESISTANCE PEAKS OF OVER 80 OHMS. THE SAME UNITS TESTED AT 155.5 MC ON THE 7TH MODE AT 2 MILLIWATTS PASSED THE TEMPERATURE TEST WITH 1 RESISTANCE PEAK BUT IT WAS LESS THAN THE 80 OHM MAXIMUM.

ON PAGE 8 IS A CHART COMPARING THE RESISTANCE CURVES OF CRYSTALS ON THE 7TH & 9TH MODE OVER THE TEMPERATURE RANGE. A SECOND GROUP OF 155 MC 9TH OVERTONE CRYSTALS WAS TESTED OVER THE TEMPERATURE RANGE AT 2 MILLIWATTS AND ALL HAD RESISTANCE PEAKS OVER THE 80 OHM MAXIMUM. THIS SECOND GROUP WAS THEN TESTED AT 120.89 MC ON THE 7TH MODE AT 2 MILLIWATTS AND ALL PASSED THROUGH THE TEMPERATURE TEST WITH NO RESISTANCE PEAKS. APPARENTLY THE RESISTANCE PEAKS ARE MORE PREDOMINANT WITH THE HIGHER MODES THAN WITH HIGHER FREQUENCY. THE FINDINGS IN THESE TESTS WERE SUBMITTED TO COGNIZANT PERSONNEL AT FORT MONMOUTH NEW JERSEY, AND WE WERE ADVISED TO MAKE SOME FURTHER MEASUREMENTS ON 9TH OVERTONE CRYSTALS AT VARIOUS DRIVE LEVELS. THE FOLLOWING DATA WAS COLLECTED TO PRESENT THE PROBLEM TO THE U.S. ARMY ELECTRONICS MATERIEL SUPPORT AGENCY AND REQUEST TECHNICAL ACTION TO REDUCE THE DRIVE LEVEL REQUIREMENT.

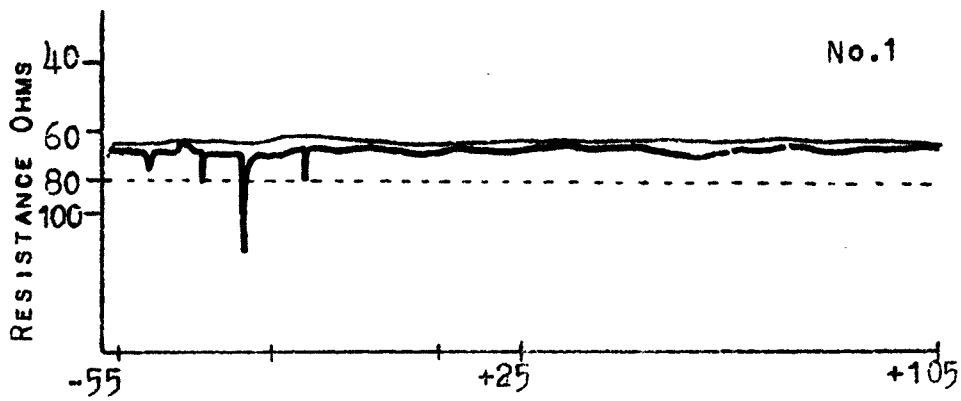
EFFECT OF DRIVE ON 9TH OVERTONE CRYSTALS

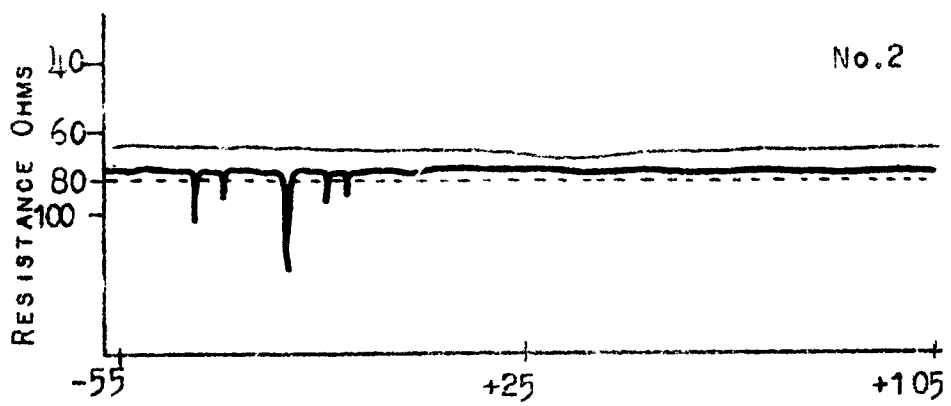
1. THE CONTRACTOR HAS EXPERIENCED DIFFICULTY WITH CRYSTAL TYPE CR-(XM-36)/U IN THE TEMPERATURE RUN. AT THE RATED DRIVE OF 2MW IN 80 OHMS, 90% OF THE UNITS EXCEED THE MAXIMUM RESISTANCE OF 80 OHMS, REJECTS DUE TO A SHARP SPIKE AT ABOUT -30°C.
2. RESISTANCE-TEMPERATURE GRAPHS AT 150 MC AND 200 MC WERE PRESENTED, THE SAME UNITS BEING RUN AT 2MW, 1MW, 0.5MW AND 0.25 MW. IT WAS SHOWN THAT THE LOWER THE DRIVE THE CLEANER THE TEMPERATURE RUN, ALL SPIKES HAVING DISAPPEARED AT 0.25MW.
3. FURTHER INVESTIGATION USING OTHER PLATING MATERIALS, AND DETERMINED THAT THOUGH THE EFFECT WAS PRESENT TO A LESSER DEGREE AT 2.0MW, THE DIFFICULTIES OF HANDLING THESE MATERIALS WERE SUCH THAT ENTIRELY NEW PROCESSES AND TECHNIQUES WOULD HAVE TO BE LEARNED AND DEVELOPED TO UTILIZE THESE OTHER MATERIALS.
4. THE CONTRACTOR ANALYZED CRYSTAL UNITS OF THE SAME TYPE AS REGULARLY MANUFACTURED AND REPORTED IN PARAGRAPH 2, ALL AT ROOM TEMPERATURE, AND AT ALL FIVE (5) OF THE CONTRACT FREQUENCIES, MEASURING FREQUENCY IN KILOCYCLES AND RESISTANCE IN OHMS, AS A FUNCTION OF DRIVE LEVEL. THESE DATA ARE PRESENTED IN TABLES I THROUGH V.

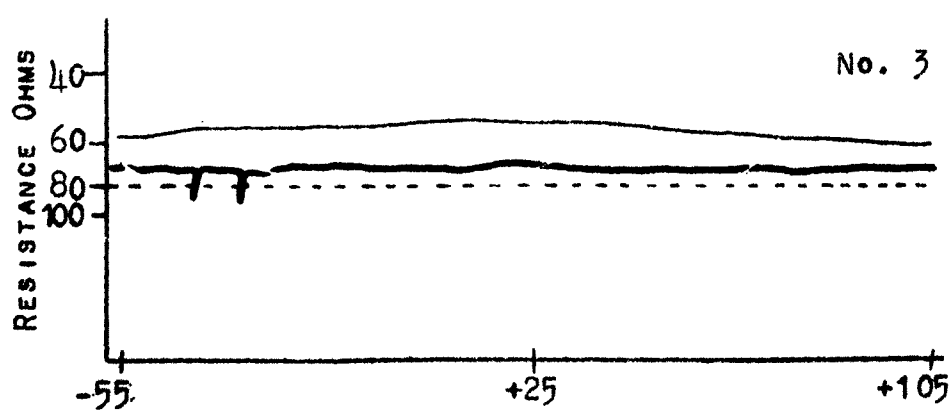
5. THERE IS NO SIGNIFICANT DIFFERENCE IN THE RESISTANCE OF THESE UNITS AS A FUNCTION OF DRIVE LEVEL BETWEEN 2MW AND 0.25MW WHEN OSCILLATED IN THE STANDARD CI METER TSM-15.

RESISTANCE CURVE ON 22.2 MC CRYSTAL AT 9TH & 7TH. MODE

LEGEND —— 7TH MODE —— 9TH MODE

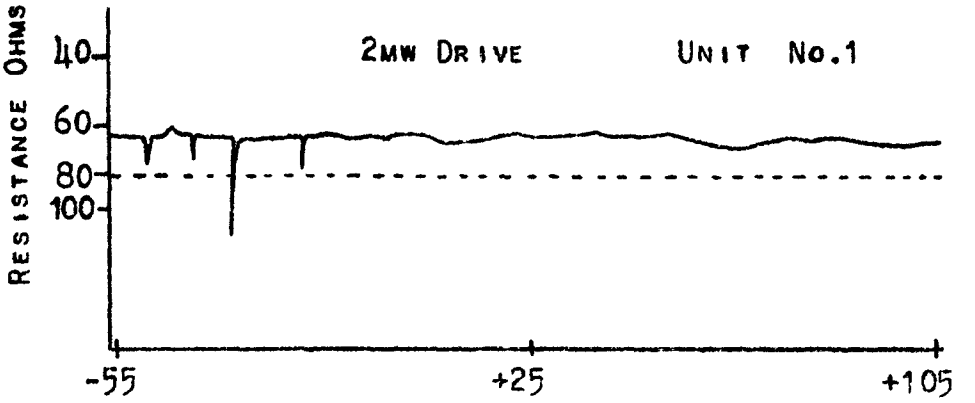




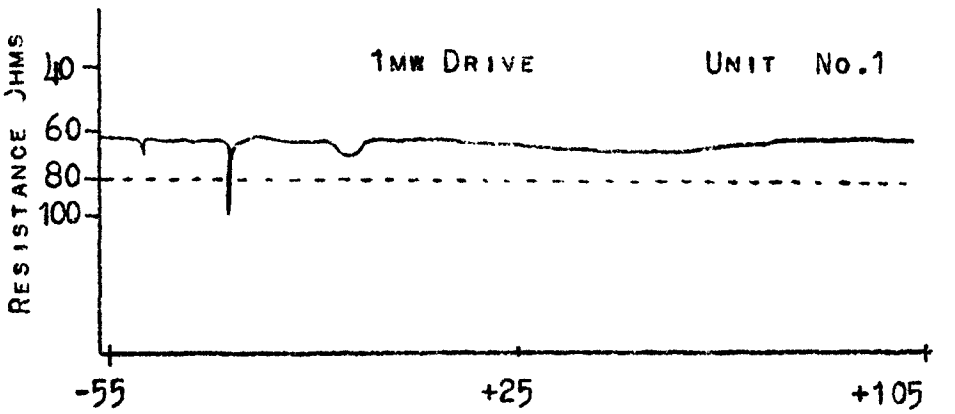


TEMPERATURE CENTIGRADE

200 MC 9TH MODE CRYSTAL
RESISTANCE GRAPH
TESTED AT VARIOUS DRIVE LEVELS

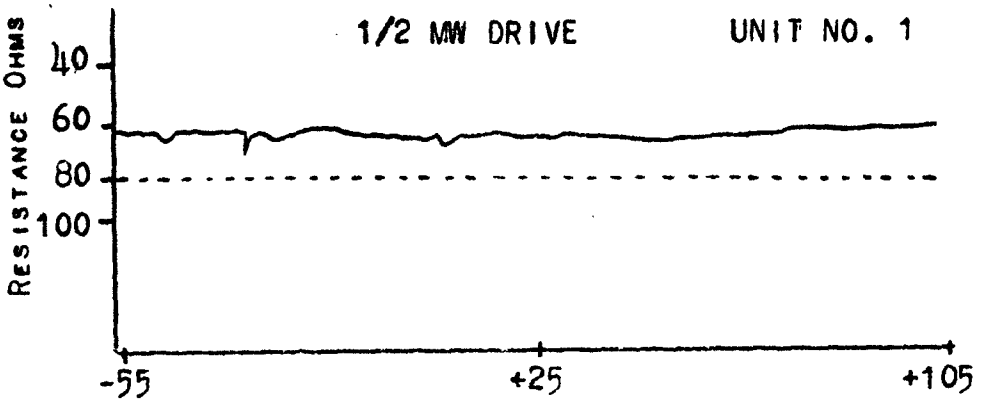


TEMPERATURE CENTIGRADE



TEMPERATURE CENTIGRADE

200 MC 9TH MODE CRYSTAL
RESISTANCE GRAPH



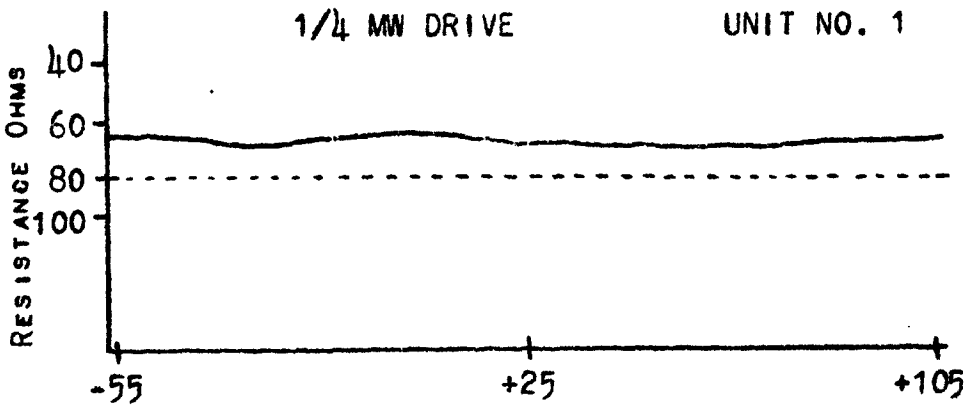


TABLE I 150.000 MC

XTAL. NO.	2.0 mw FREQ.	RES.	1.0 mw. FREQ.	RES.	0.5 mw FREQ.	RES.	0.25.mw FREQ.	RES.
6	149994.88	42	149994.83	42	149994.799	42	149994.78	42
10	149999.16	35	149999.09	35	149999.01	35	149998.97	35
12	150000.39	59	150000.21	60	150000.17	59	150000.15	59
13	150000.98	49	150000.91	49	150000.86	49	150000.82	49
21	150000.11	46	150000.16	46	150000.11	45	150000.10	45

TABLE II 162.000 MC

XTAL. NO.	2.0 mw FREQ.	RES.	1.0 mw FREQ.	RES.	0.5 mw FREQ.	RES.	0.25 mw FREQ.	RES.
26	162000.56	52	162000.34	51	162000.42-	52	162000.34	52
33	161999.33	40	161999.16	40	161999.14	40	161999.11	40
37	162000.17	57	162000.07	57	161999.92	57	161999.82	57
40	162000.29	60	162000.19	61	162000.13	61	162000.07	61
43	162000.133	33	162000.07	37	161999.98	38	161999.96	38

TABLE III 174.000 MC

XTAL. NO.	2.0 mw FREQ.	RES.	1.0 mw FREQ.	RES.	0.5 mw FREQ.	RES.	0.25 mw FREQ.	RES.
51	173998.94	50	173998.92	51	173998.96	51	173998.87	51
52	173999.41	60	173999.35	61	173999.40	61	173999.21	61
53	173999.48	58	173999.29	58	173999.25	58	173999.19	58
54	173998.21	50	173998.18	50	173998.19	50	173998.10	50
55	173998.69	66	173998.60	67	173998.61	66	173998.55	66

TABLE IV 188.000 MC

XTAL. NO.	2.0 mw FREQ.	RES.	1.0 mw FREQ.	RES.	0.5 mw FREQ.	RES.	0.25 mw FREQ.	RES.
13	188000.69	46	188000.55	46	188000.45	46	188000.51	46
22	187998.351	51	187998.26	51	187998.21	51	187998.11	51
25	187997.35	56	187997.19	57	187997.25	57	187997.19	57
35	187998.30	60	187998.28	60	187998.29	61	187998.27	60
36	188000.46	40	188000.41	40	188000.49	40	188000.55	40

TABLE V 200.000 MC

XTAL. NO.	2.0 mw FREQ.	RES.	1.0 mw FREQ.	RES.	0.5 mw FREQ.	RES.	0.25 mw FREQ.	RES.
17	199998.85	43	199998.76	44	199998.62	44	199998.61	43
18	199999.85	50	199999.82	51	199999.68	51	199999.68	52
20	199999.96	55	199999.88	55	199999.75	55	199999.68	54
22	199997.95	61	199997.86	61	199997.68	61	199997.65	60
32	200002.75	46	200002.68	47	200002.59	47	200002.46	47

CONCLUSIONS

NINTH OVERTONE CRYSTALS IN THE FREQUENCY RANGE 150 MC TO 200 MC ARE VERY SENSITIVE TO TEMPERATURE CHANGES IF OPERATED AT DRIVE LEVELS OF 2 MILLIWATTS. SHARP RESISTANCE PEAKS OCCUR AT 2 TO 4 TEMPERATURE POINTS USUALLY IN THE RANGE OF -30°C TO 0°C. OPERATING THE CRYSTALS AT LOW DRIVES ELIMINATES THE RESISTANCE PEAKS AND DOES NOT INCREASE THEIR NORMAL RESISTANCE LEVELS.

PROGRAM FOR NEXT QUARTER

In order to prove the procedure developed during the time we were producing our samples, we will run a group of 100 units on each frequency.

Final data will be compiled to go with the pre-production samples for approval in the next few days.

PUBLICATIONS AND REPORTS

No publications or reports have been issued on this contract since the last report for the period ending September 30, 1962.

IDENTIFICATION OF PERSONNEL

THE FOLLOWING PERSONNEL HAVE EXPENDED TIME AS FOLLOWS ON THIS CONTRACT FOR THIS REPORTING PERIOD.

PERSON	TIME-HOURS
DEEMER BLOSER	75
DONALD NEIDIG	15
CAROLYN SPRAGLIN	25
KERMIT LACKEY	24
MANUFACTURING LABOR	700