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PRODUCTION ENGINEERING MEASURES FOR TEMPERATURE COMPENSATED M_TC--ETC(U)
JUN 74 D L THOMANN DAAB05-72-C-5839
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PRODUCTION ENGINEERING MEASURES REPORT
DAAB05 - 72 - C - 5839

TEMPERATURE COMPENSATED MICROCIRCUIT CRYSTAL OSCILLATOR

SIXTH QUARTERLY PROGRESS REPORT

BY

Donald L. Thomann

1 JUNE 1973 TO 31 AUGUST 1973

ECOM

Production Division, Procurement and Production Directorate
USAECOM, Fort Monmouth, New Jersey 07703

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N O T I C E S

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PRODUCTION ENGINEERING MEASURES

FOR

TEMPERATURE COMPENSATED MICROCIRCUIT CRYSTAL OSCILLATOR

SIXTH QUARTERLY PROGRESS REPORT

Contract No. DAAB05-72-C-5839

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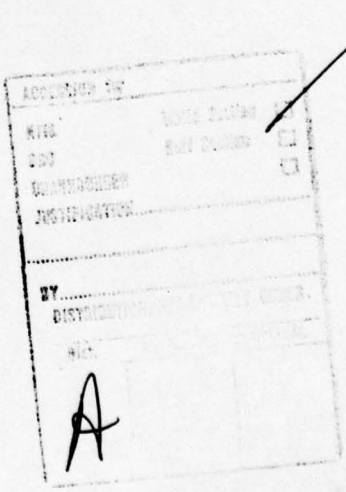
Prepared By

Donald L. Thomann

CTS KNIGHTS, INC.
SANDWICH, ILLINOIS

For

US Army Electronics Command
Fort Monmouth, New Jersey



ABSTRACT

A quantity of five MCTCXO engineering samples for each of the four contract frequencies were completed, tested for conformance to the specification, and submitted to ECOM for further evaluation.

The results of the test confirmed that the design is capable of meeting all the electrical requirements except power consumption. It is recommended that the specified power consumption be raised 20%.

A data package consisting of test data, drawings, a definitive specification per MIL-S-83490, and production layout was delivered with the engineering samples.

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PURPOSE

The purpose of the work performed during the Sixth quarter reporting period of 1 June 1973 to 31 August 1973 was to complete the assembly of five engineering samples of each of four frequencies and then to determine the degree of conformance of these units to Electronic Command Technical Requirements, SCS-357A, Amended by Special Note 6 of the contract.

DISCUSSION

The assembly of five MCTCXO engineering samples of each of the four contract frequencies was completed during this period. Testing was performed to demonstrate the degree of conformance of the design to the requirements of SCS-357A, amended by Special Note 6 of the contract.

ASSEMBLY

An exploded view of the final package design is shown in Figure 1. Final assembly was begun by mounting the crystal and lower substrate to the header. After functional check-out on the bench at room temperature, the MCTCXO's were placed in a fixture in a temperature test chamber. The required varactor voltage versus temperature at each of eight temperature points in the operating range was obtained for each unit. The required value of each component in the compensating network was then calculated from this data by means of a computer.

Each of the resistors on the compensation substrate were then abraded to value by means of a conventional "sand module" of the type used by resistor manufacturers. The one used was manufactured by S.S. White. The sand module was controlled by a commercially available "automatic stop resistance bridge". In operation, the desired resistance value is dialed into the bridge, the abrasive stream is started manually, and cermet resistor material is gradually removed. When the resistor being trimmed reaches the predetermined value, a comparator circuit within the bridge turns off the abrasive stream. A resistor tolerance better than 0.5% can be easily achieved in this way.

The network substrates were attached and temperature runs made to verify the units met specification. The units were then coldweld sealed in a dry nitrogen atmosphere maintained within glove box.

TEST RESULTS

Frequency vs. Supply Voltage. The unit with the greatest sensitivity to supply variation was S/N E10 with a deviation of 1.5×10^{-7}. The unit with the least sensitivity was S/N E18 with a deviation of less than 1×10^{-8}. The average of all units was 4.7×10^{-8} with a 5% supply change.

Frequency vs. Load. The unit with the greatest sensitivity to load change was S/N E9 with a deviation of 1.8×10^{-7}. The unit with the least sensitivity was S/N E17 with a deviation of less than 1×10^{-8}. The average of all units was 4.1×10^{-8} with a 5 pf load change.

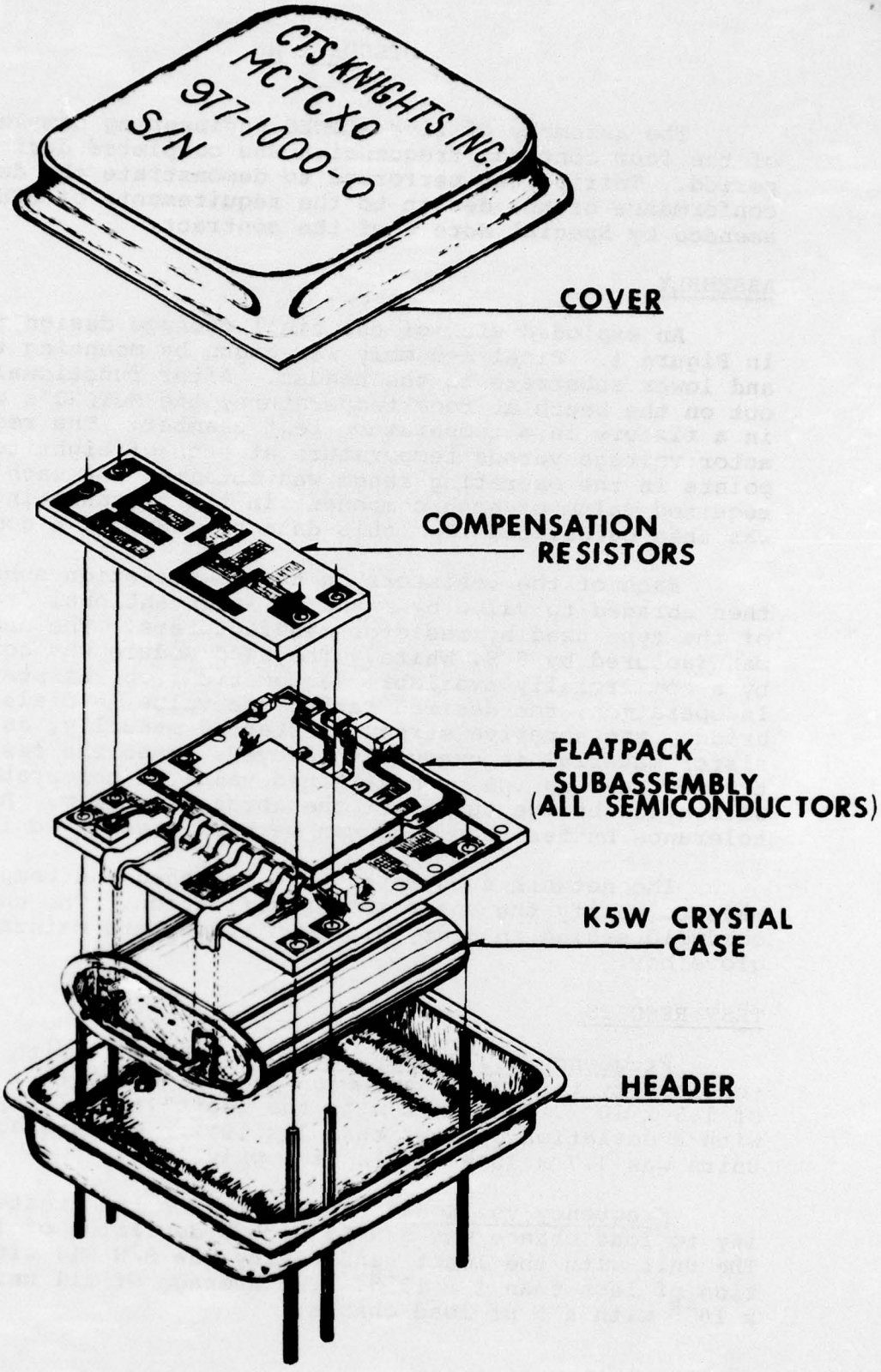
CTS KNIGHTS INC.
MCTCXO
977-1000-0
S/N
COVER
COMPENSATION
RESISTORS
FLATPACK
SUBASSEMBLY
(ALL SEMICONDUCTORS)
K5W CRYSTAL
CASE
HEADER

Figure 1

Frequency Adjust Range. The total frequency adjust range of all units was 8 ppm or greater, however, six of the units had inadequate trim or none in the positive direction. This is a result of the compensation network having an offset error of 2 to 3 ppm. This was a process error and is not related to the design itself.

Input Power. The unit with the greatest input current as a percentage of specification was S/N E9 with 138%. The unit with the least input current was S/N E12 with 105% of specification. The average of all units was 117% of specification.

Output Voltage. The value of Logic "0" for all units was 0.2 volt. The Logic "1" for most units was 11.5 volts with the lowest going down to 11.0 volts and three going to 12.0 volts.

Frequency vs. Temperature. All units met the frequency vs. temperature requirement of ±2.5 ppm from -40°C to +80°C including any hysteresis resulting from running the test from hot to cold and then from cold to hot, as well as any skew in curve resulting from ± 3 ppm trim excursion. Typical curves obtained are shown in Figure 2.

Seal. Fifteen of the twenty units met the specified leak rate by a comfortable margin. Two units, S/N E1 and E16 were found to have leak rates of 1.2×10^{-8} atm cc/sec and 1.5 atm cc/sec respectively. Three other units, S/N E8, E9, and E15 were found to exceed the specified rate of 1×10^{-8} atm cc/sec, but were estimated to be less than 1×10^{-7} atm cc/sec. The design objective is considered to have been met.

Visual and Mechanical. The appearance of all units is acceptable. The dimensions of the units are .855 x .751 x .353. The product of these three dimensions results in a volume of .227 cubic inch. This is within the present design goal of 0.230 cubic inch.

If the volume of the MCTCXO is defined as being equal to the volume of water displaced when totally immersed, then a figure very close to 0.2 cubic inch, as orginally specified, is obtained.

A summary of the performance achieved compared to the performance objectives is shown as Table I.

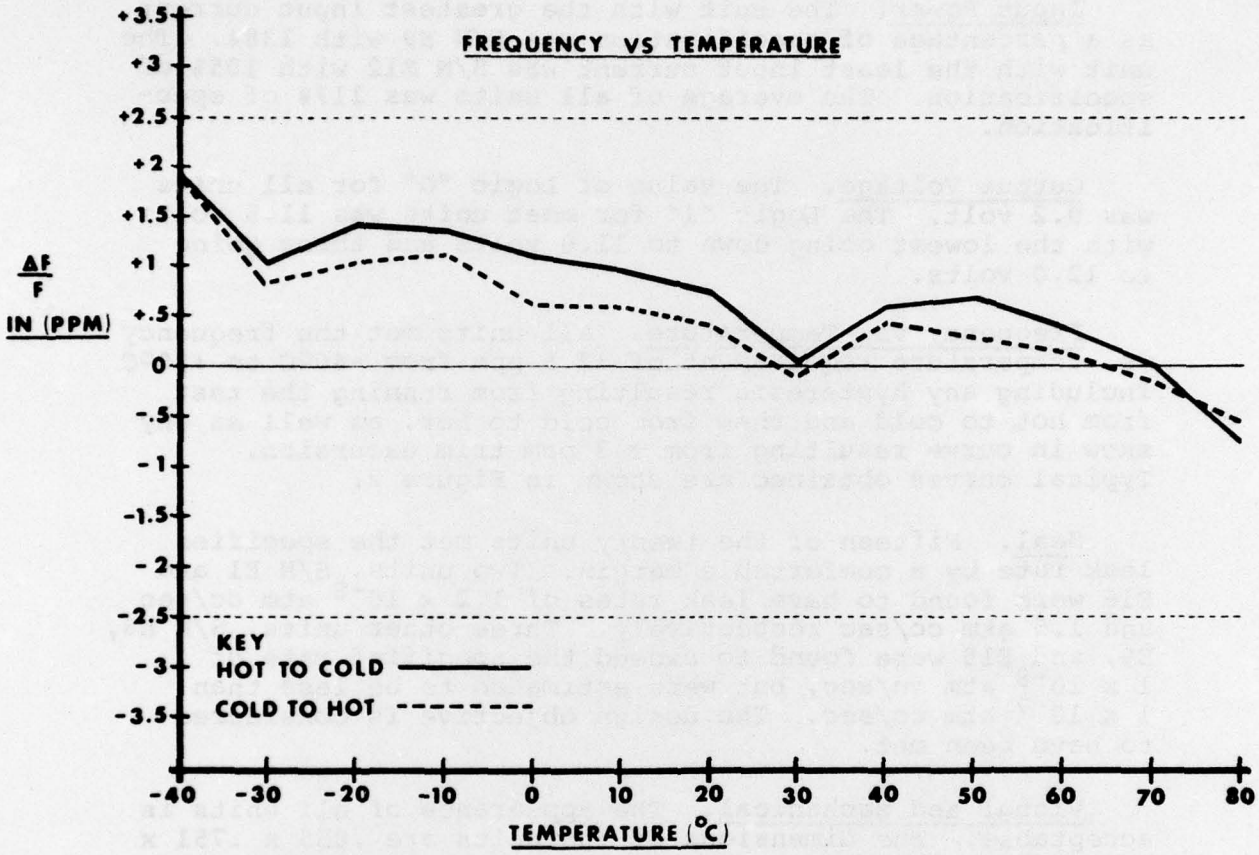
FREQUENCY VS TEMPERATURE
+3.5
+3
+2.5
+2
+1.5
+1
+.5
0
-.5
-1
-1.5
-2
-2.5
-3
-3.5
ΔF/F IN (PPM)
KEY
HOT TO COLD
COLD TO HOT
-40
-30
-20
-10
0
10
20
30
40
50
60
70
80
TEMPERATURE (°C)

FIGURE 2

TABLE I

		OBJECTIVE	ACHIEVED
FREQUENCY RANGE:		3 TO 10 MHz	3 TO 10 MHz
FREQUENCY STABILITY:		± 6 PPM OVERALL FOR 5 YEARS	TO BE DETERMINED
TEMPERATURE	(-40°C TO +80°C):	± 2.5 PPM	± 1 PPM
VOLTAGE	(± 5% CHANGE):	± 1 PPM	$\pm 1.5 \times 10^{-7}$
LOAD	(± 5 Pf CHANGE):	± 1 PPM	$\pm 1.8 \times 10^{-7}$
TIME	(2 WEEKS):	1×10^{-7}	TO BE DETERMINED
FREQUENCY ADJUST RANGE:		± 3 PPM	GREATER THAN ± 3 PPM
INPUT POWER (+ 12 VOLTS):			
$P_{MW} = 4.3$ F (MHz) + 4.8	3.00 MHz	17.7 MW	20.5 MW
	3.84 MHz	21.3 MW	21.6 MW
	5.00 MHz	26.3 MW	26.0 MW
	10.00 MHz	47.8 MW	50.4 MW
CASE VOLUME:		0.20 IN^3	0.23 IN^3
SEAL:		$1X\ 10^{-8}$ ATM CC/SEC	1×10^{-8} ATM CC/SEC
RELIABILITY:		1%/1000 HOURS 90% CONFIDENCE	TO BE DETERMINED

CONCLUSIONS

The testing performed on the MCTCXO engineering samples has demonstrated that the design meets or exceeds all the electrical requirements imposed except for power consumption. It is our opinion that the specified values of power consumption cannot be met on a practical basis at this time. It is recommended that the input current specification be increased by about 20%.

Although certain units were found to have insufficient trim in one direction, it was not related to the design. Rather, it was the result of a process error in determining compensation network values.

MANPOWER UTILIZATION REPORT

1 June 1973 to 31 August 1973

Contract No. DAAB05-72-C-5839

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14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
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Temperature Compensated Crystal Oscillator						
Crystal Oscillator						
C-MOS						