Precision CMOS Clock Oscillator for HI-G Applications

Presented by
Fred Mirow
Chief Engineer
Micro Oscillator, Inc.

Co Author
Dick Mabry
AFRL/MNMF
Eglin AFB

WEB SITE: MICRO-OSCILLATOR.COM
**Title and Subtitle**  
Precision CMOS Clock Oscillator for HI-G Applications

**Author(s)**  
Mirow, Fred; Mabry, Dick

**Performing Organization Name(s) and Address(es)**  
Micro Oscillator, Inc.

**Sponsoring/Monitoring Agency Name(s) and Address(es)**  
NDIA (National Defense Industrial Association) 211 Wilson BLvd., Ste. 400 Arlington, VA 22201-3061

**Distribution/Availability Statement**  
Approved for public release, distribution unlimited

**Supplementary Notes**  

**Abstract**

**Subject Terms**

**Report Classification**  
unclassified

**Classification of Abstract**  
unclassified

**Number of Pages**  
23
Summary of Discussion

- MOI-1000 CLOCK OSCILLATOR
- COMPARISON OF OSCILLATOR TYPES
- SBIR AF98-220
- MOI-2000 CLOCK OSCILLATOR
- Proposed 32.7KHZ Oscillator
- Summary & Recap
MOI-1000 Clock Oscillator

- Smallest
- Fastest Turn On
- Most Rugged
- Lowest Power
OSCILLATOR CIRCUIT

CAP. 220PF

MICRO OSCILLATOR
MOI-1000

5.0V or 3.3V

OUTPUT
MOI-1000 SPECIFICATION

CMOS IC

SIZE 1.7 X .9 MM
FREQUENCY 16, 20, 24 MHz
FREQUENCY ACCURACY
(Temp. & Voltage, Etc.)
INDUSTRIAL TEMP 0.5%
MILITARY TEMP 1.0%
OPERATING POWER (5.0V) 25 mW
(3.3V) 10 mW
OUTPUT, SQUARE WAVE SYMMETRY 55/45%
SHOCK, OPERATIONAL > 80,000 G
PACKAGE SO-8, MSO-8 or Bare Die
MOI-1000 ACCELERATION TEST
(UNIT OPERATING)

50KHZ FILTERED

155 MM HOWITZER, CONCRETE WALL

PLOT CURTESY OF AFRL/MNMF
MOI-1000 ACCELERATION TEST
(UNIT OPERATING)

2KHZ & 10KHZ FILTERED

155 MM HOWITZER, CONCRETE WALL
PLOT CURTESY OF AFRL/MNMF
MOI-1000
CLOCK OSCILLATOR
SYSTEM BLOCK DIAGRAM
PROPAGATION DELAY TIME VARIATIONS

![Graph showing variations in delay with temperature and voltage.](image)
<table>
<thead>
<tr>
<th></th>
<th>Micro Oscillator</th>
<th>Crystal Clock</th>
<th>Ceramic Resonator</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Freq. Tol.</strong></td>
<td>MEDIUM</td>
<td>HIGH</td>
<td>MEDIUM</td>
</tr>
<tr>
<td><strong>Size (mm)</strong></td>
<td>0.9 x 1.7</td>
<td>5 x 7</td>
<td>2.8 x 6.5</td>
</tr>
<tr>
<td><strong>Hybrid</strong></td>
<td>YES</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td><strong>Ruggedness</strong></td>
<td>VERY HIGH</td>
<td>LOW</td>
<td>MEDIUM</td>
</tr>
</tbody>
</table>
MOI-1000 ADVANTAGES

1: COMPLETE CLOCK OSCILLATOR
2: SMALL SIZE, BARE DIE OR S0-8
3: NO START UP PROBLEMS
4: NO FREQUENCY JUMPING
5: 3.3 V OR 5.0 V AVAILABLE
6: +/- 0.5% TOLERANCE INDUSTRIAL
7: +/- 1.0% TOLERANCE MILITARY

MOI-1000 DISADVANTAGES

1: NOT AS ACCURATE AS CRYSTAL
EXISTING APPLICATIONS

PROGRAMMABLE PROJECTILE FUZE
CRITICAL REQUIREMENTS MET -
OPERATIONAL IN HIGH G ENVIRONMENT
FAST TURN ON TIME
BARE DIE FOR HYBRID PACKAGING
LOW OPERATING POWER

HARD TARGET FUZING
CRITICAL REQUIREMENTS MET -
OPERATIONAL IN HIGH G ENVIRONMENT
LOW OPERATING POWER
PURPOSES:

1) IMPROVE MOI-1000:

REDUCED OPERATING POWER
WIDER FREQUENCY RANGE

2) DEVELOP 32.7KHZ VERSION
# SBIR Timer Base System Specification

<table>
<thead>
<tr>
<th></th>
<th>SYSTEM 1</th>
<th>SYSTEM 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>5V +/-5%</td>
<td>3.3V +/-5%</td>
</tr>
<tr>
<td>Current</td>
<td>1 MA MAX</td>
<td>1 MA MAX</td>
</tr>
<tr>
<td>Freq. Tolerance</td>
<td>+/-1% absolute</td>
<td>+/-1% absolute</td>
</tr>
<tr>
<td>Freq. Range</td>
<td>14.0 TO 20.0 MHZ</td>
<td>3.5 TO 5.0 MHZ</td>
</tr>
<tr>
<td>Operating Temp.</td>
<td>-55 TO 125 °C</td>
<td>-55 TO 125 °C</td>
</tr>
<tr>
<td>Output Drive</td>
<td>2 HC CMOS</td>
<td>2 HC CMOS</td>
</tr>
</tbody>
</table>
MOI - 2000 CLOCK OSCILLATOR
SYSTEM BLOCK DIAGRAM

VR

REG

T

OSC
VOLTAGE

FB

A

F/2

F/2

SEL

S1

S2

F OUT

0 0  F

1 0  F/2

0 1  F/4
# Comparison of MOI-1000 to MOI-2000

<table>
<thead>
<tr>
<th></th>
<th>MOI-1000</th>
<th>MOI-2000</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Freq.</strong></td>
<td>14 to 24 MHz</td>
<td>4 to 20 MHz</td>
</tr>
<tr>
<td><strong>Current</strong></td>
<td>5 mA</td>
<td>1.6 mA</td>
</tr>
<tr>
<td>5.0 Volts</td>
<td>5 mA</td>
<td>1.6 mA</td>
</tr>
<tr>
<td>3.3 Volts</td>
<td>3 mA</td>
<td>1 mA</td>
</tr>
<tr>
<td><strong>Tol.</strong></td>
<td>+/-1%</td>
<td>+/-1%</td>
</tr>
<tr>
<td>Parameter</td>
<td>MOI-2000</td>
<td>Preproduction</td>
</tr>
<tr>
<td>--------------------</td>
<td>----------</td>
<td>---------------</td>
</tr>
<tr>
<td>Voltage</td>
<td>5</td>
<td>3.3</td>
</tr>
<tr>
<td>Current</td>
<td>2.2 Ma</td>
<td>1.4 Ma</td>
</tr>
<tr>
<td>Frequency</td>
<td>16 MHz</td>
<td>10 MHz</td>
</tr>
<tr>
<td>Freq. TOL.</td>
<td>± 1.0%</td>
<td>± 1%</td>
</tr>
<tr>
<td>Temp. Range</td>
<td>-55 - 125°C</td>
<td>± 1%</td>
</tr>
</tbody>
</table>
MOI-2000 OSCILLATOR OUTPUT
3.3V 12PF LOAD, 53/47% DUTY CYCLE
MOI-2000 OSCILLATOR OUTPUT
3.3V 12PF LOAD, 2 NSEC/DIV
MOI-2000 OSCILLATOR OUTPUT
DELAYED 3.3V 12PF LOAD
32.7 KHz TIME BASE SYSTEM
SBIR SPECIFICATION

Operating Voltage: 3.3v or 5V 5%
Operating Current: 0.2 ma max
Frequency Tol.: +/- 1%
Frequency: 32.7 KHz
Operating Temp.: -55 to 125 c
Package: S0-8
OSCILLATOR AVAILABILITY SCHEDULE

MOI-2000

5V  JULY 2001
3.3V  NOW

32.7KHz  JULY 2002
Summary & Recap

**MOI - 1000**
5 YEARS OF PROVEN PERFORMANCE IN HI-G APPLCIATIONS

**MOI - 2000**
SAME PROVEN TECHNOLOGY AS MOI-1000 AT A MUCH LOWER OPERATING POWER LEVEL