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MD-173

High Stability Coefficient Oscillator - I²C interface Oven Controlled Crystal Oscillator

The MD-173 is a Microsemi "Coefficient Oscillator" (CCXO) that contains a high-stability ovenized crystal oscillator and an I²C interface that communicates with temperature and current sensors, and an onboard EEPROM. The interface enables the customer to improve upon the already exceptional stability of the oscillator. Provided in a fully hermetic 28 x 38 mm package, the device is capable of aging rates of ≤ 0.06 ppb/day and uncorrected temperature stabilities of 0.4ppb from 0 to 70 °C. Use of the information provided in the I²C interface provides a cost effective means of further improving temperature stability.

Features

- Reflow process compatible
- Uncorrected temperature stability to 0.4 ppb
- Aging rate to 0.06 ppb/day
- Frequency range 5 to 20 MHz
- Standard frequencies: 5, 10, 12.8, 20 MHz
- I²C interface with frequency coefficients, temperature sensor, and current sensor

Applications

- LTE base stations
- Rubidium replacement
- Military communication equipment

Performance Specifications

Frequency Stabilities[1]
(Stabilities listed for ≤10 MHz. For stabilities > 10 MHz refer to page 6)

Parameter	Min	Typical	Max	Units	Condition
vs. Operating Temperature Range (referenced to +25°C) (uncorrected)	-0.4 -0.6 -0.8		+0.4 +0.6 +0.8	ppb ppb ppb	0 to +70°C -20 to +70°C -40 to +85°C
Initial Tolerance vs. Supply Voltage Change vs. Load Change vs. Aging / Day vs. Aging / Day vs. Aging/ Day vs. Aging / 1st Year vs. Aging / Year (following year) vs. Aging/ 10 years Hysteresis	-25 -0.5 -0.2 -1 -0.1 -0.06 -15 -10 -75 -0.2		+25 +0.5 +0.2 +1 +0.1 +0.06 +15 +10 +75 +0.2	ppb ppb ppb ppb ppb ppb ppb ppb ppb ppb	at time of shipment, nominal EFC V_s ±5% Load ±5% after 24 hours operation after 72 hours operation after 7 days operation after 72 hours operation after 72 hours operation maximum 4th order curve fit error over -40 to 85 10 °C/hour
Retrace[2]	-10		+10	ppb	
Warm-up Time			5	minutes	to ±10ppb of final frequency (1 hour reading) @ +25°C

Improved Frequency versus temperature F(T) performance obtained using on board temperature sensor (T) and frequency vs. temperature coefficients (A_n)stored in EEPROM, using formula:

$$F(T)=A_4T^4+A_3T^3+A_2T^2+A_1T+A_0$$

Performance Specifications

Supply Voltage (Vs)					
Parameter	Min	Typical	Max	Units	Condition
Supply Voltage (Vs)	4.75	5.0	5.25	VDC	Ordering code D
	11.4	12.0	12.6	VDC	Ordering code B , temp stability T and J only
Power Consumption			4.5	Watts	during warm-up, all temperatures
			1.8	Watts	steady state @ +25°C
		4		Watts	steady state @ -40°C
		1.0		Watt	steady state @ +85°C
RF Output					
Start Time		1	2	s	time required to achieve 90% of amplitude
Subharmonics			-30	dBc	frequencies ≥10 MHz
Signal [standard]	HCMOS				
Load		15		pF	
Signal Level (Vol)			0.5	VDC	with Vs=5.0V & 12V and 15pF Load
Signal Level (Voh)	3.5			VDC	with Vs=5.0V & 12V and 15pF Load
Duty Cycle	45		55	%	@ (Voh-Vol)/2
Signal	Sine Wave				
Load		50		Ω	
Output Power @ 5.0V,12 V	+5	+8	+11	dBm	
Harmonics			-40	dBc	
Frequency Tuning (EFC)					
Tuning range	±150		±350	ppb	16 bit DAC controlled through I2C interface (fixed frequency option available)
Linearity		10		%	
Tuning Slope	Positive				

Additional Parameters						
Parameter	Min	Typical	Max	Units	Condition	
Phase noise[3]			-95 -125 -135 -140 -145	dBc/Hz dBc/Hz dBc/Hz dBc/Hz dBc/Hz	1 Hz 10 Hz 100 Hz 1 kHz 10 kHz	@ 10MHz
Allan Deviation			5e-12 8e-12 1e-11 5e-11		1 s tau 10 s tau 100 s tau 1000 s tau	@ 10MHz
g-sensitivity		1		ppb/g		
Weight			30	g		

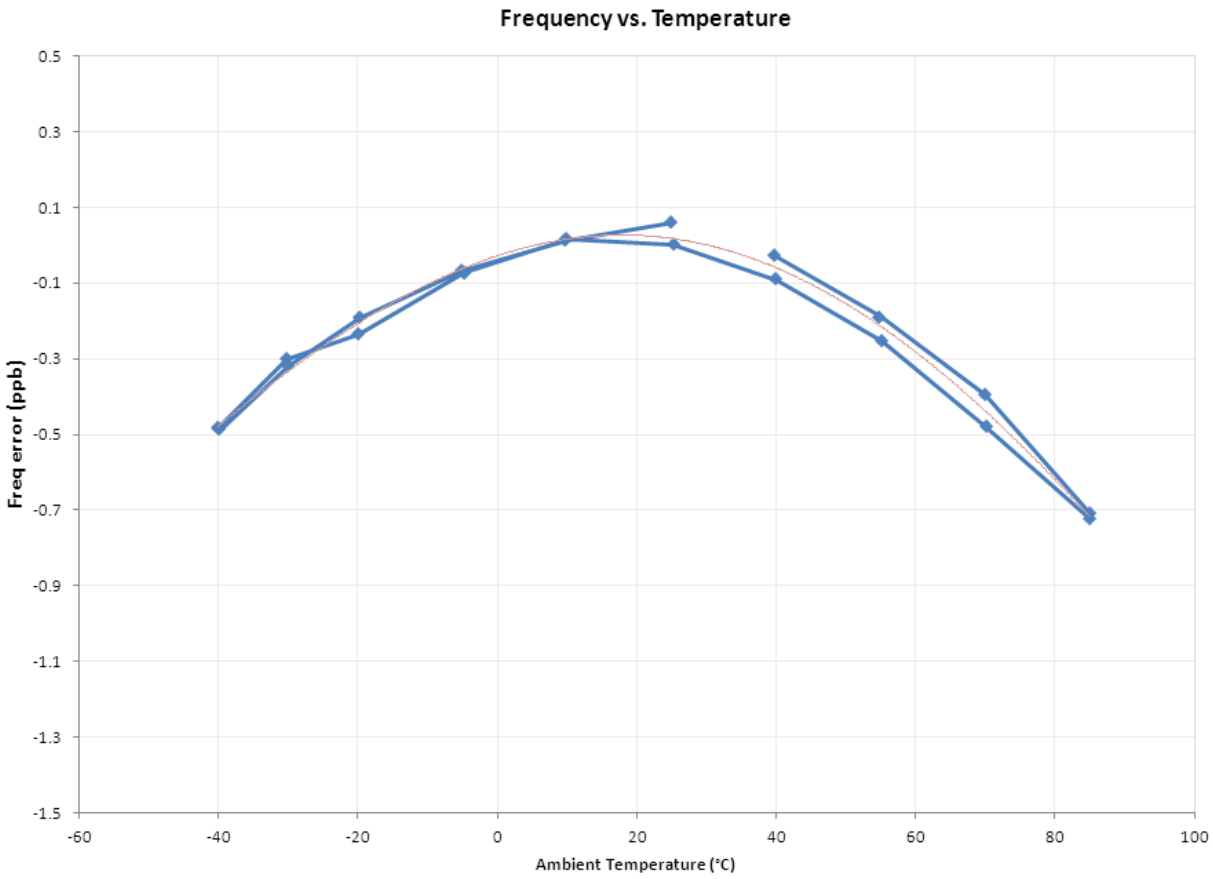
EEPROM (SCL, SDA) Pin 1, Pin 2						
Parameter	Min	Typical	Max	Units	Condition	
BUS voltage		3.3		V		
SCL Clock Frequency	0		100	kHz		
Communications	Reference I^2C Protocol				22.1 kOhm pull-up resistor used on SDA and SCL lines	
AC electrical characteristics					-40 to 85 °C for all parameters	

Devices and addresses
EEPROM - Atmel AT24C08C for EEPROM, address 1010100-1010111
Temperature Sensor - LM73 (set to 14 bit resolution), address 1001000
Current Sensor – MCP3021, address 1001101
DAC for EFC - TI DAC8571, address 1001100x
Reserved Addresses (used by factory)
1010100x
1010101x
1010110x
1010111x
1001000x
1001101x
0101001x
0101010x
0101000x
1001100x
1110111x
For full EEPROM Map please contact factory

Absolute Maximum Ratings					
			15.0	VDC	
Output load	25		50 open	pF Ohms	CMOS Sine
Operable temperature range	-55		+95	°C	Operable temperature range implies the device will continue to operate with no long-term damage to unit; however, it will not be specification compliant outside the operating temperature range.

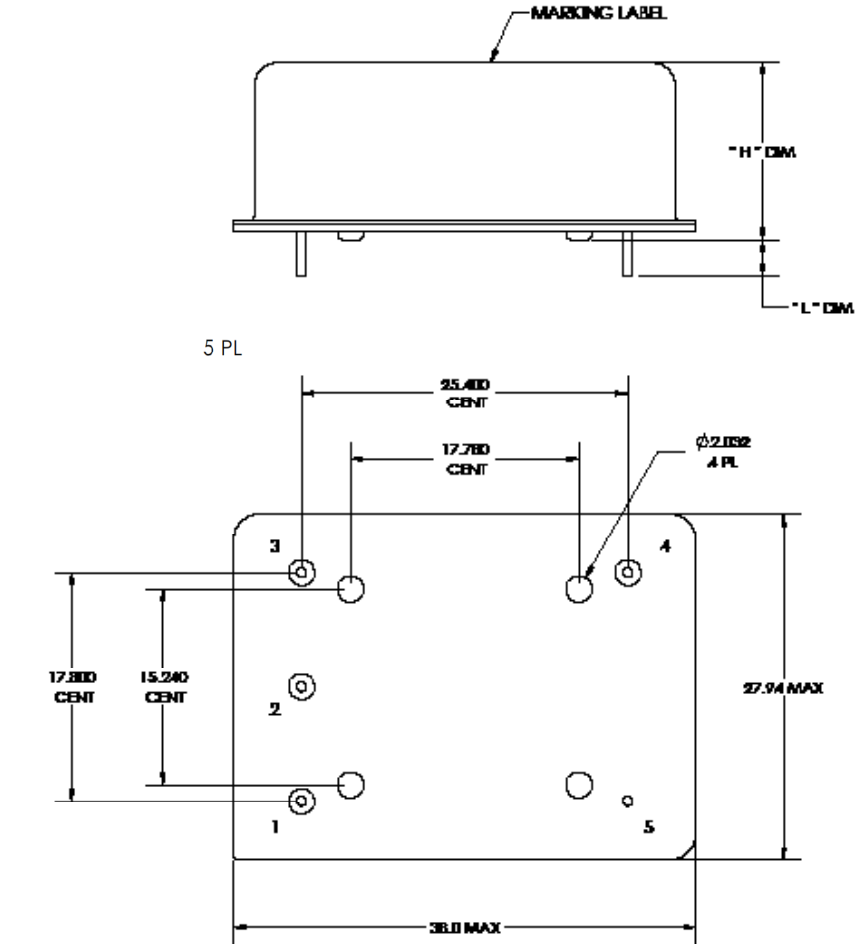
Environmental and Product Classification	
Shock (Endurance)	MIL-STD-202, Method 213, Condition J, 30g 11 ms
Sine Vibration (Endurance)	MIL-STD-202, Method 201 and 204, Condition A, except 5g to 500 Hz, 1 sweep each axis
Random Vibration (Endurance)	MIL-STD-202, Method 214, Condition I-D
Humidity	MIL-STD-202, Method 103, Condition B, 100% rh
Seal	MIL-STD-202, Method 112, Condition D, hermetic, washable
Altitude	MIL-STD-202, Method 105, sea level to space
Resistance to Soldering Heat	MIL-STD-202, Method 210, Condition A,B,C
Terminal Strength	MIL-STD-202, Method 211, Condition C (5 bends at 45°, 2 lbs)
Moisture Sensitive Level	1
RoHS	6 (fully compliant)

Storage Temperature Range	-55		+125	°C	



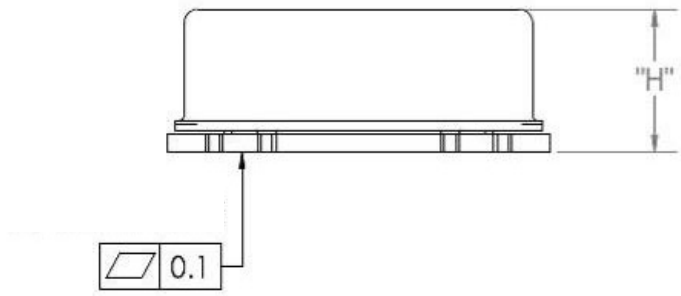
Frequency vs temperature plot -uncorrected
Blue line - measured data -
Red line - curve fit of data.

Outline Drawing / Enclosure

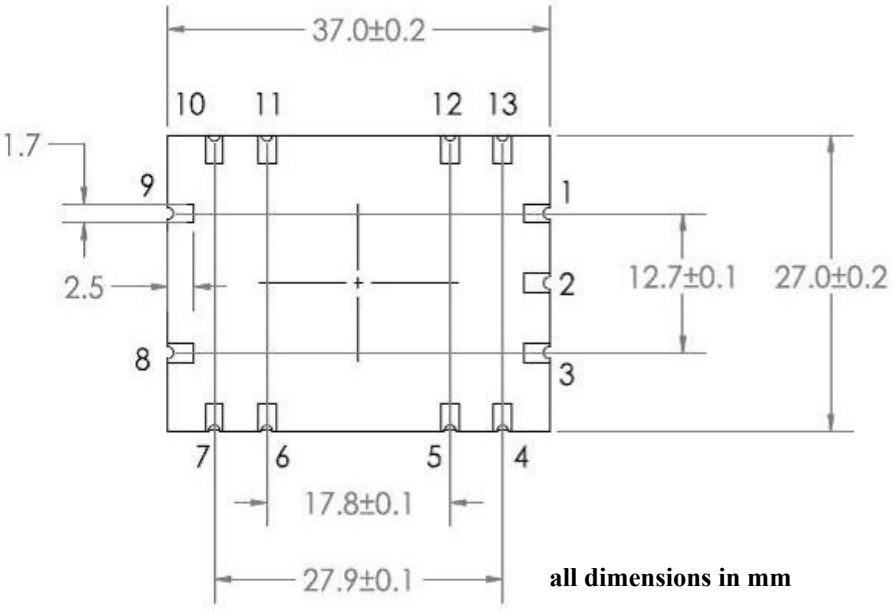


Through hole Package configuration A		
	Height "H"	Pin Length "L"
0	19 max	4.5 mm min

Pin Connections	
1	I²C Clock
2	I²C Data
3	Supply Voltage Input (Vs)
4	RF Output
5	Ground (Case)



Surface mount Package configuration B		
	Height "H"	Pin Length "L"
1	20.3 max	4.5 mm min



Pin Connections	
4,5,6,7, 11,12,13	No Connect
1	I²C Clock
2	I²C Data
3	Supply Voltage Input (Vs)
8	RF Output
9,10	Ground (Case)

all dimensions in mm

Ordering Information[4]

MD - 173 0 - D A E - 109 1 - 10M0000000

Product Family
MD: Module

Model
173

Package
0: package A - THT
1: package B - SMD

Supply Voltage
B: 12V
D: 5V

RF Output Code
A: HCMOS
E: Sinewave

Temperature Range
E: -40°C to +85°C
J: -20°C to +70°C
T: 0°C to +70°C

Stability Code
400: ± 0.4 ppb
600: ± 0.6 ppb
800: ± 0.8 ppb
109: ± 1.0 ppb
159: ± 1.5 ppb
209: ± 2.0 ppb

Frequency Control
0:Fixed frequency
1: ±150 to ±350 ppb

Frequency
5M00000000
10M0000000
12M8000000
20M0000000
(others available on request)

Stability code - Temperature and Frequency Options			
Frequency	0 to +70 °C	-20 to +70 °C	-40 to +85°C
5 to 10 MHz	400	600	800
> 10 MHz	109	159	209

Additional Ordering Options

Additional ordering options available include custom aging rates, custom temperature ranges, custom temperature stabilities, custom phase noise requirements, and improved g-sensitivity. These modifications require a custom dash number - please contact the factory for additional information.

Design Tools

Microsemi stocks the following items for small orders and prototype development:
MD-1730-DEE-8000-5M00000000
Microsemi stocks the following evaluation board for this product:
OCXO Evaluation Board
Application Notes:
Coefficient Oscillators

Notes:

1. Unless otherwise stated, all values are valid after warm-up time and refer to typical conditions for supply voltage, frequency control voltage, load, and temperature (25°C).
2. Retrace defined as f1-fo where fo is the reading after the unit has been on power for 24 hours, and f1 is the frequency after 24 hours off followed by 60 minutes on.
3. Phase noise degrades with increasing output frequency.
4. Not all options and codes available at all frequencies.

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