

## Voltage Controlled Oscillator 12.2 – 13.8 GHz

Rev. V4

### Features

- Low Phase Noise
- Wide Tuning Range
- Divide-by-Two Output
- Integrated Buffer Amplifier
- Excellent Temperature Stability
- +5V Bias
- Lead-Free 5 mm 32-Lead PQFN Package
- Halogen-Free “Green” Mold Compound
- RoHS\* Compliant and 260°C Reflow Compatible

### Description

The MAOC-009270 is an InGaP HBT-based voltage controlled oscillator for frequency generation. No external matching components are required. This VCO is easily integrated into a phase lock loop using the divide-by-two output. The extremely low phase noise makes this part ideal for many radio applications including high capacity digital radios.

The MAOC-009270 primary applications are Point-to-Point Radio, Point-to-Multipoint Radio, Communications Systems, and Low Phase Noise applications.

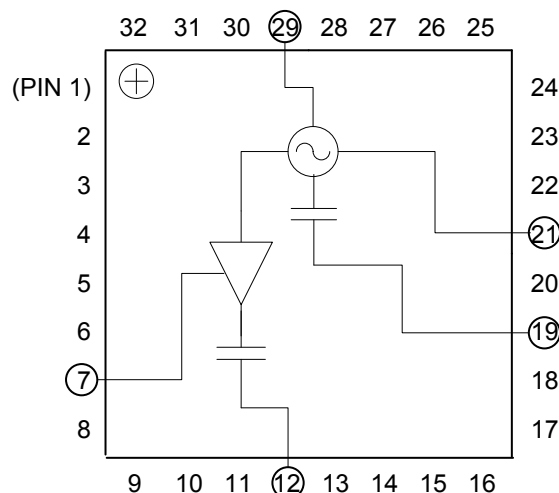
The 5 mm PQFN package has a lead-free finish that is RoHS compliant and compatible with a 260°C reflow temperature. The package also features low lead inductance and an excellent thermal path.

### Ordering Information<sup>1</sup>

| Part Number        | Package         |
|--------------------|-----------------|
| MAOC-009270-TR0500 | 500 piece reel  |
| MAOC-009270-TR1000 | 1000 piece reel |
| MAOC-009270-SMB003 | Sample Board    |

1. Reference Application Note M513 for reel size information.

### Block Diagram



### Pin Designations<sup>2</sup>

| Pin | Function            | Pin | Function          |
|-----|---------------------|-----|-------------------|
| 1   | N/C                 | 17  | N/C               |
| 2   | N/C                 | 18  | N/C               |
| 3   | N/C                 | 19  | RF                |
| 4   | N/C                 | 20  | N/C               |
| 5   | N/C                 | 21  | V <sub>CC</sub>   |
| 6   | N/C                 | 22  | N/C               |
| 7   | V <sub>BUFFER</sub> | 23  | N/C               |
| 8   | N/C                 | 24  | N/C               |
| 9   | N/C                 | 25  | N/C               |
| 10  | N/C                 | 26  | N/C               |
| 11  | N/C                 | 27  | N/C               |
| 12  | RF/2                | 28  | N/C               |
| 13  | N/C                 | 29  | V <sub>TUNE</sub> |
| 14  | N/C                 | 30  | N/C               |
| 15  | N/C                 | 31  | N/C               |
| 16  | N/C                 | 32  | N/C               |

2. The exposed pad centered on the package bottom must be connected to RF and DC ground. Connecting all N/C pins to RF/DC Ground in the layout is also recommended.

\* Restrictions on Hazardous Substances, European Union Directive 2002/95/EC.

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**Electrical Specifications:**  $T_A = +25^\circ\text{C}$ ,  $V_{CC} = V_{\text{BUFFER}} = 5.0 \text{ V}^3$ ,  $Z_0 = 50 \Omega$

| Parameter                                                                                 | Test Conditions                                                                        | Units                 | Min.    | Typ.             | Max.             |
|-------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|-----------------------|---------|------------------|------------------|
| Output Power                                                                              | RF Port, 12.2 - 13.8 GHz<br>RF/2 Port, 6.1 - 6.9 GHz                                   | dBm                   | 3<br>-3 | 7<br>1           | —                |
| SSB Phase Noise<br>$V_{CC}=V_{\text{BUFFER}}=V_{\text{TUNE}}=5\text{V}$                   | RF Port, 10KHZ Offset<br>RF Port, 100KHZ Offset                                        | dBc/Hz                | —       | -78<br>-107      | —                |
| Harmonics/Subharmonics<br>$V_{CC}=V_{\text{BUFFER}}=V_{\text{TUNE}}=5\text{V}$            | RF Port, $\frac{1}{2} F_0$<br>RF Port, $2 F_0$                                         | dBc                   | —       | -18<br>-38       | —                |
| Pulling<br>(Sensitivity to Match)<br>$V_{CC}=V_{\text{BUFFER}}=V_{\text{TUNE}}=5\text{V}$ | RF Port, VSWR = 1.95:1 to 2.25:1                                                       | MHz pk-pk             | —       | 17.6             | —                |
| Pushing<br>(Sensitivity to Supply Voltage)                                                | RF Port, $V_{\text{TUNE}} = 5 \text{ V}$<br>RF/2 Port, $V_{\text{TUNE}} = 5 \text{ V}$ | MHz/V                 | —       | 14<br>7          | —                |
| Frequency Drift Rate<br>(Sensitivity to Temperature)                                      | RF Port, 12.2 - 13.8 GHz<br>RF/2 Port, 6.1 - 6.9 GHz                                   | MHz/ $^\circ\text{C}$ | —       | 1.2<br>0.6       | —                |
| Output Return Loss                                                                        | RF Port, 12.2 - 13.8 GHz<br>RF/2 Port, 6.1 - 6.9 GHz                                   | dB                    | —       | 3<br>6           | —                |
| Tuning Sensitivity @ RF Port                                                              | $V_{\text{TUNE}} = 5 \text{ V}$                                                        | GHz/V                 | —       | 0.22             | —                |
| Supply Current                                                                            | $I_{\text{TOTAL}} (I_{CC} + I_{\text{BUFFER}})$<br>$I_{CC}$<br>$I_{\text{BUFFER}}$     | mA                    | —       | 145<br>125<br>20 | 205<br>175<br>30 |
| Tune Voltage                                                                              | $V_{\text{TUNE}}$                                                                      | V                     | 1       | —                | 13               |
| Tuning Current Leakage                                                                    | $V_{\text{TUNE}} = 13 \text{ V}$                                                       | $\mu\text{A}$         | —       | 5                | 10               |

3. VCO can operate over the 4.75 V to 5.25 V supply voltage range.

### Absolute Maximum Ratings <sup>4,5,6</sup>

| Parameter                                              | Absolute Maximum                              |
|--------------------------------------------------------|-----------------------------------------------|
| Supply Voltage<br>( $V_{CC}$ & $V_{\text{BUFFER}}$ )   | +5.5 Vdc                                      |
| $V_{\text{TUNE}}$                                      | 0 to +15 Vdc                                  |
| Storage Temperature                                    | -55 $^\circ\text{C}$ to +150 $^\circ\text{C}$ |
| Operating Temperature                                  | -40 $^\circ\text{C}$ to +85 $^\circ\text{C}$  |
| Case Temperature ( $T_C$ )<br>(measured @ exposed pad) | +100 $^\circ\text{C}$                         |
| Junction Temperature <sup>7</sup>                      | +135 $^\circ\text{C}$                         |

- Exceeding any one or combination of these limits may cause permanent damage to this device.
- MACOM does not recommend sustained operation near these survivability limits.
- Operating at nominal conditions with  $T_J \leq +135^\circ\text{C}$  will ensure MTBF >  $2.5 \times 10^6$  hours.
- Junction Temperature ( $T_J$ ) =  $T_C + \Theta_{jc} * (V * I)$   
Typical thermal resistance ( $\Theta_{jc}$ ) = 35 $^\circ\text{C/W}$ .  
a) For  $T_C = 25^\circ\text{C}$ ,  $T_J = 50^\circ\text{C}$  @ 5 V, 145 mA  
b) For  $T_C = 85^\circ\text{C}$ ,  $T_J = 111^\circ\text{C}$  @ 5 V, 150 mA

### Handling Procedures

Please observe the following precautions to avoid damage:

### Static Sensitivity

Gallium Arsenide Integrated Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these devices.



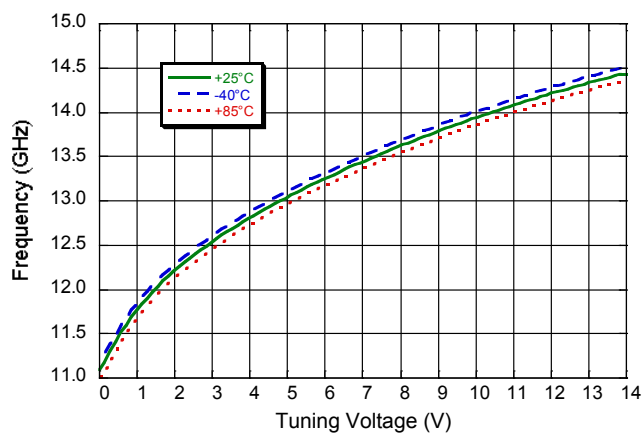
**ESD Rating: Class 1A**

## Voltage Controlled Oscillator 12.2 – 13.8 GHz

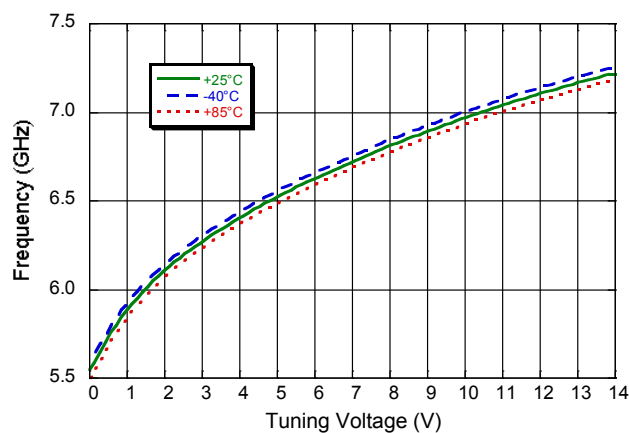
Rev. V4

Typical Performance Curves:  $V_{CC} = V_{BUFFER} = 5V$ ,  $T_A = +25^\circ C$  (unless otherwise indicated)

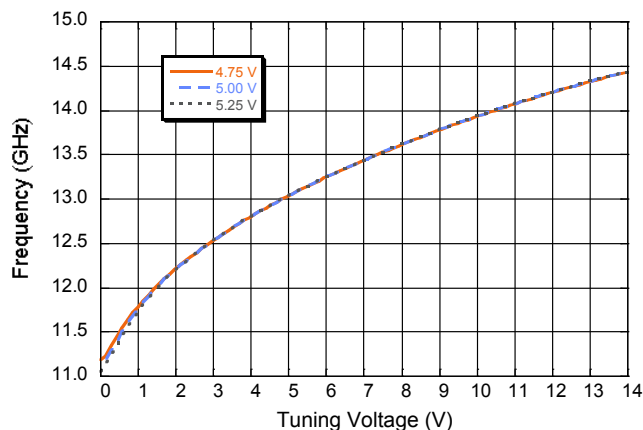
Output Frequency vs. Tuning Voltage - RF Port



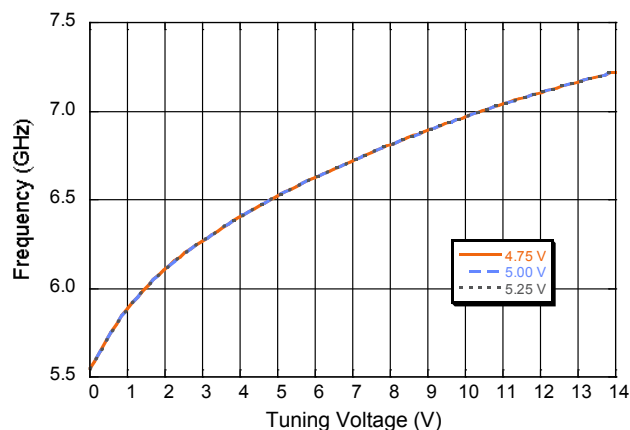
Output Frequency vs. Tuning Voltage - RF/2 Port



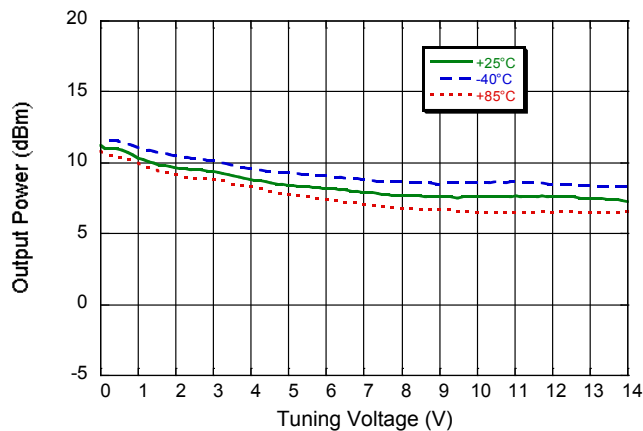
Output Frequency vs. Tuning / Supply Voltage - RF Port



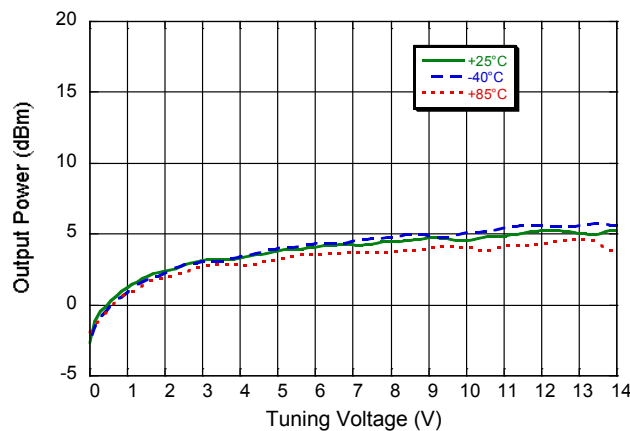
Output Frequency vs. Tuning / Supply Voltage - RF/2 Port



Output Power vs. Tuning Voltage - RF Port



Output Power vs. Tuning Voltage - RF/2 Port

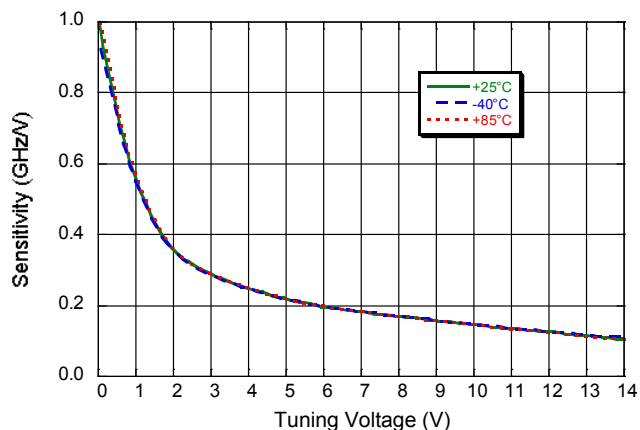


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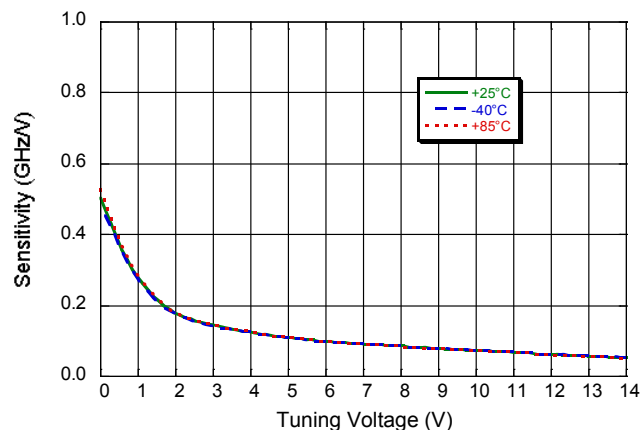
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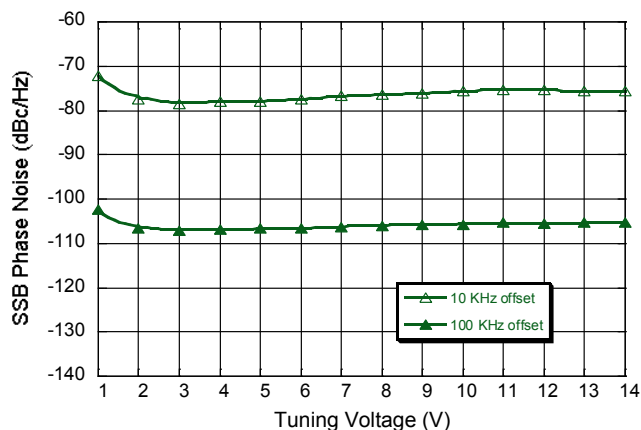
Frequency Sensitivity vs. Tuning Voltage - RF Port



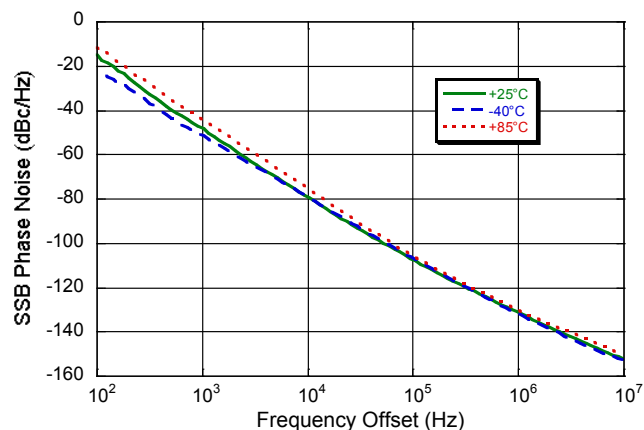
Frequency Sensitivity vs. Tuning Voltage - RF/2 Port



Single Side Band Phase Noise vs. Tuning Voltage  
RF Port



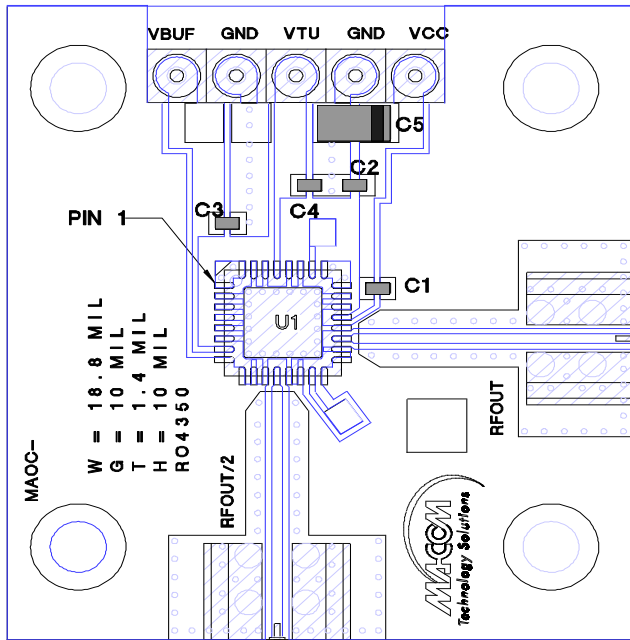
Single Side Band Phase Noise vs. Frequency Offset  
RF Port ( $V_{TUNE} = 5V$ )



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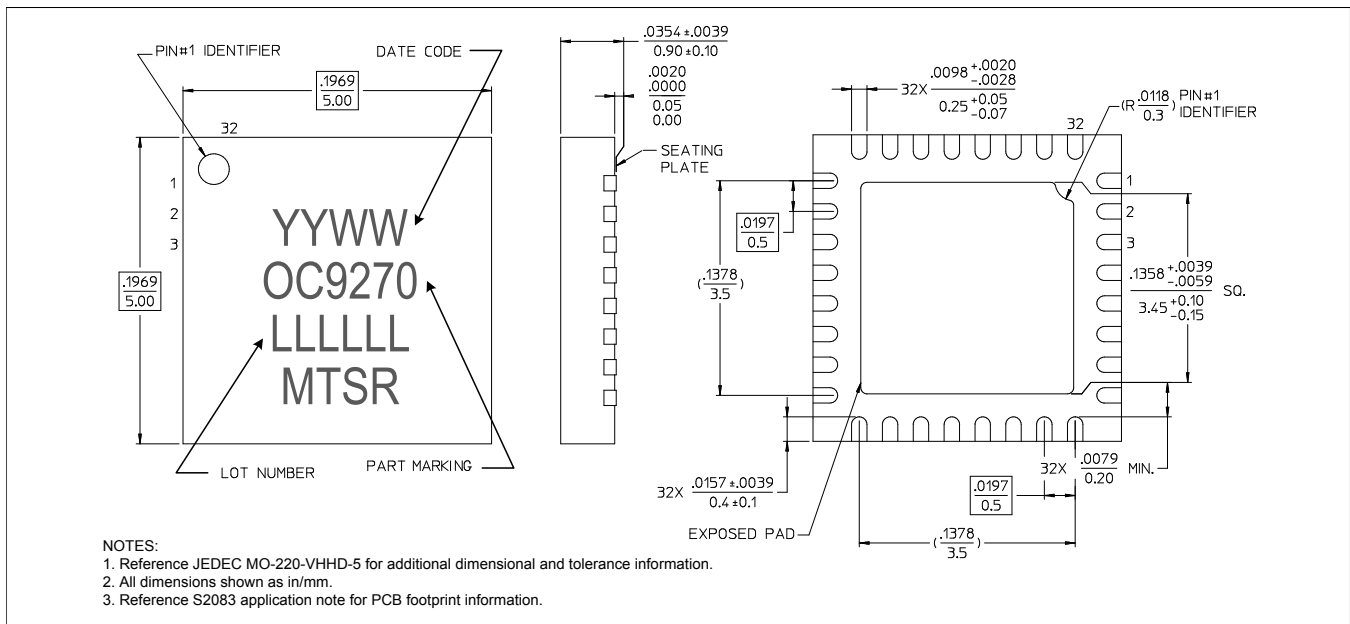
### Sample Board



### Parts List

| Component  | Value               | Case Size |
|------------|---------------------|-----------|
| C1         | 100 pF              | 0402      |
| C2, C3, C4 | 0.1 $\mu$ F         | 0402      |
| C5         | 10 $\mu$ F Tantalum | 1206      |

### Lead-Free 5 mm 32-Lead PQFN<sup>†</sup>



<sup>†</sup> Reference Application Note S2083 for lead-free solder reflow recommendations.  
Meets JEDEC moisture sensitivity level 3 requirements.  
Plating is 100% matte tin over copper.

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