

## 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-009265 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-009265 primary applications are Point-to-Point Radio, Point-to-Multipoint Radio, Communications Systems, and Low Phase Noise applications.

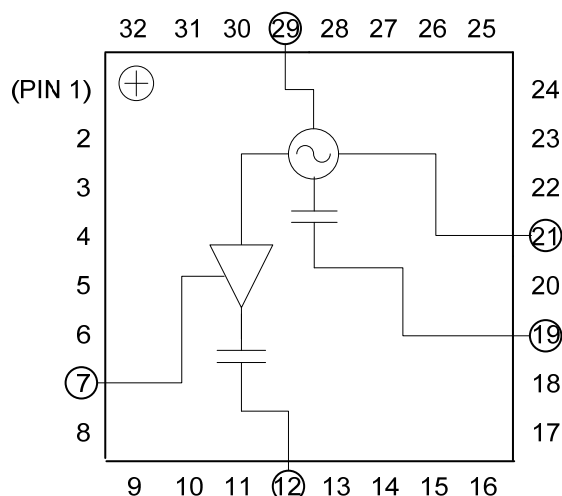
The 5 mm PQFN package has a lead-free finish that is RoHS compliant and compatible with a 260°C reflow temperature. The package also features low lead inductance and an excellent thermal path.

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

| Part Number        | Package         |
|--------------------|-----------------|
| MAOC-009265-TR0500 | 500 piece reel  |
| MAOC-009265-TR1000 | 1000 piece reel |
| MAOC-009265-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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## Voltage Controlled Oscillator

### 9.4 - 10.8 GHz

Rev. V2

**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, 9.4 - 10.8 GHz<br>RF/2 Port, 4.7 - 5.4 GHz                                    | dBm                   | 4<br>1 | 7<br>4           | —                |
| 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                | —      | -86<br>-113      | —                |
| 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                   | —      | -19<br>-27       | —                |
| 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             | —      | 8.2              | —                |
| 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                 | —      | 2<br>1           | —                |
| Frequency Drift Rate<br>(Sensitivity to Temperature)                                      | RF Port, 9.4 - 10.8 GHz<br>RF/2 Port, 4.7 - 5.4 GHz                                    | MHz/ $^\circ\text{C}$ | —      | 0.9<br>0.5       | —                |
| Output Return Loss                                                                        | RF Port, 9.4 - 10.8 GHz<br>RF/2 Port, 4.7 - 5.4 GHz                                    | dB                    | —      | 3<br>7           | —                |
| Tuning Sensitivity @ RF Port                                                              | $V_{\text{TUNE}} = 5 \text{ V}$                                                        | GHz/V                 | —      | 0.12             | —                |
| Supply Current                                                                            | $I_{\text{TOTAL}} (I_{CC} + I_{\text{BUFFER}})$<br>$I_{CC}$<br>$I_{\text{BUFFER}}$     | mA                    | —      | 175<br>155<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.
- M/A-COM Technology Solutions 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 $^\circ\text{C/W}$ .
  - For  $T_C = 25^\circ\text{C}$ ,  $T_J = 56^\circ\text{C}$  @ 5 V, 175 mA
  - For  $T_C = 85^\circ\text{C}$ ,  $T_J = 117^\circ\text{C}$  @ 5 V, 180 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

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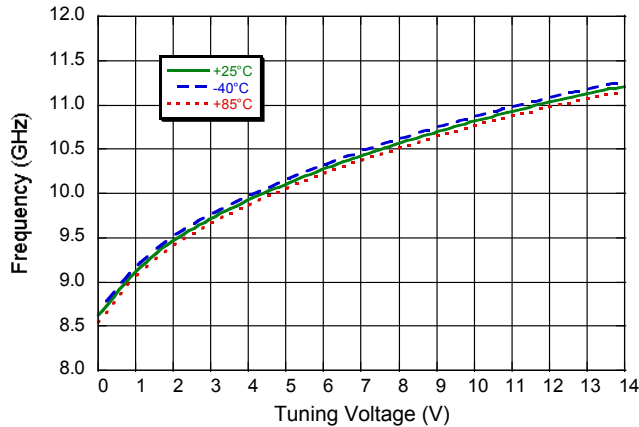
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## Voltage Controlled Oscillator 9.4 - 10.8 GHz

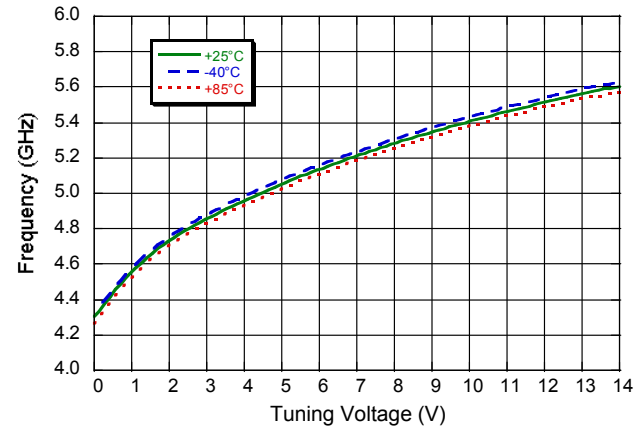
Rev. V2

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

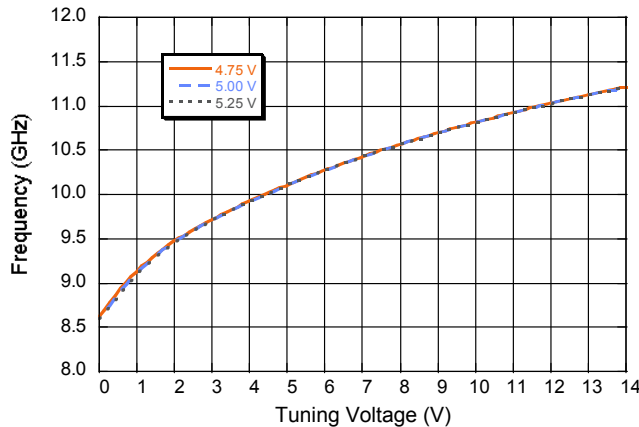
**Output Frequency vs. Tuning Voltage - RF Port**



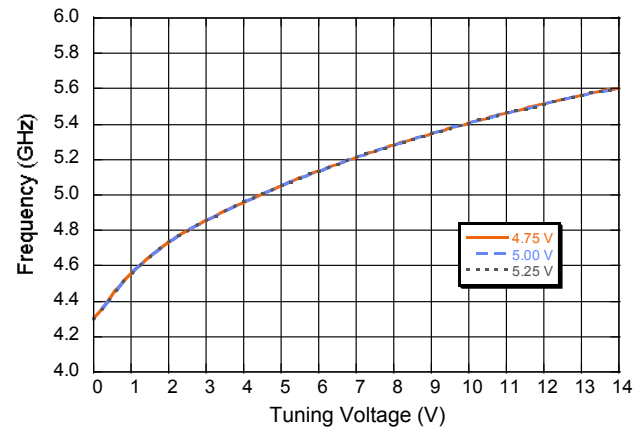
**Output Frequency vs. Tuning Voltage - RF/2 Port**



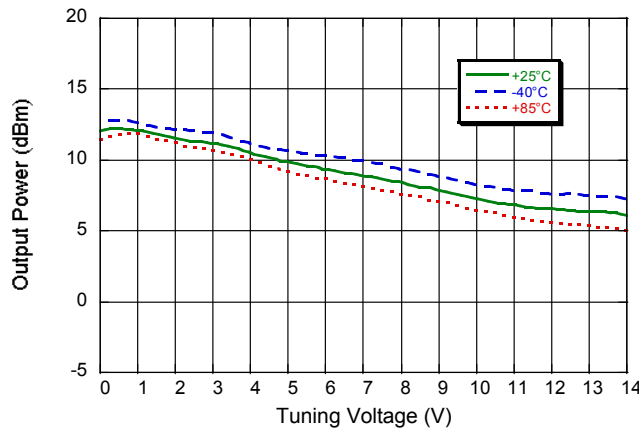
**Output Frequency vs. Tuning / Supply Voltage - RF Port**



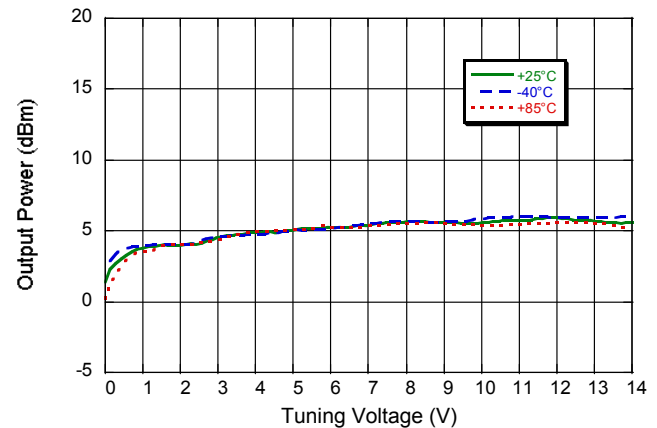
**Output Frequency vs. Tuning / Supply Voltage - RF/2 Port**



**Output Power vs. Tuning Voltage - RF Port**



**Output Power vs. Tuning Voltage - RF/2 Port**

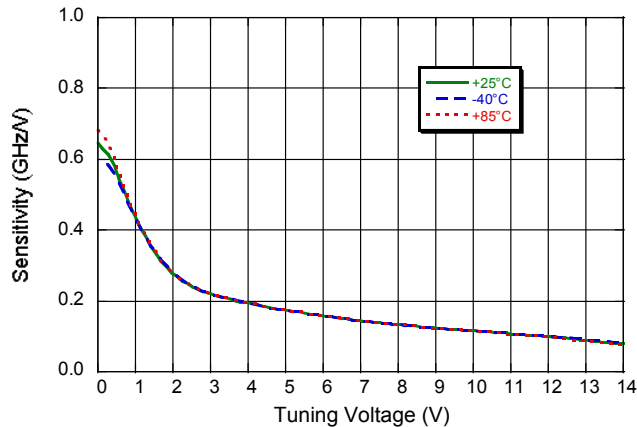


# Voltage Controlled Oscillator 9.4 - 10.8 GHz

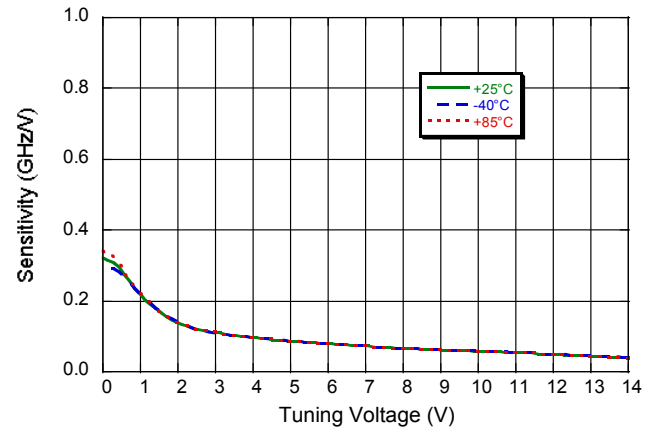
Rev. V2

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

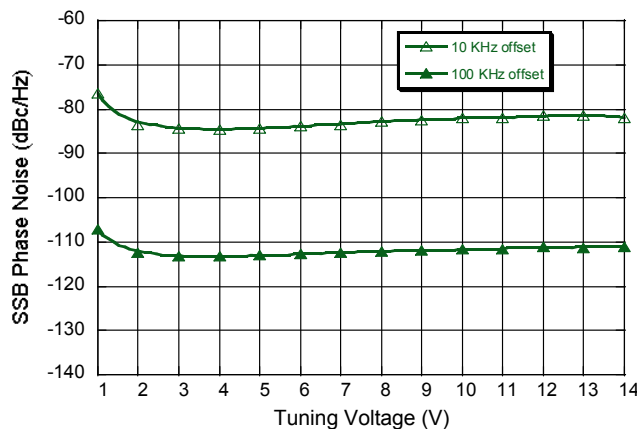
**Frequency Sensitivity vs. Tuning Voltage - RF Port**



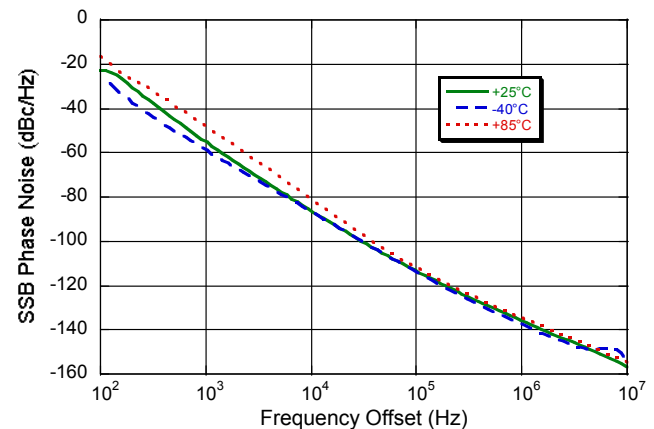
**Frequency Sensitivity vs. Tuning Voltage - RF/2 Port**



**Single Side Band Phase Noise vs. Tuning Voltage  
RF Port**



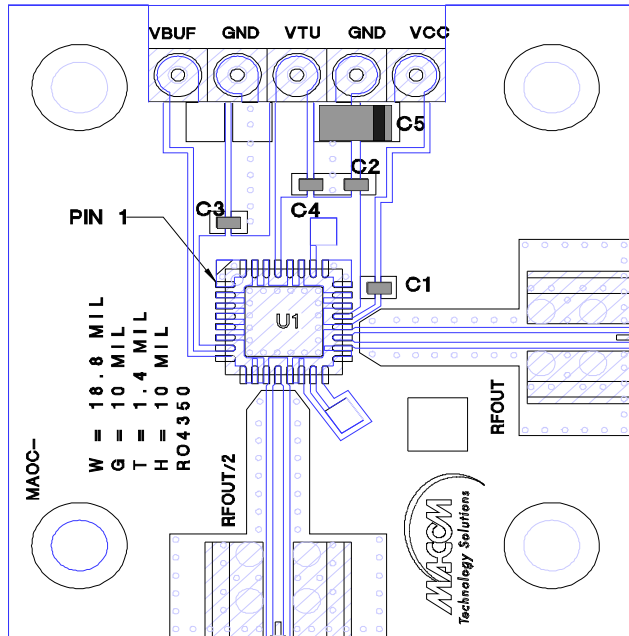
**Single Side Band Phase Noise vs. Frequency Offset  
RF Port ( $V_{TUNE} = 5V$ )**



## Voltage Controlled Oscillator 9.4 - 10.8 GHz

Rev. V2

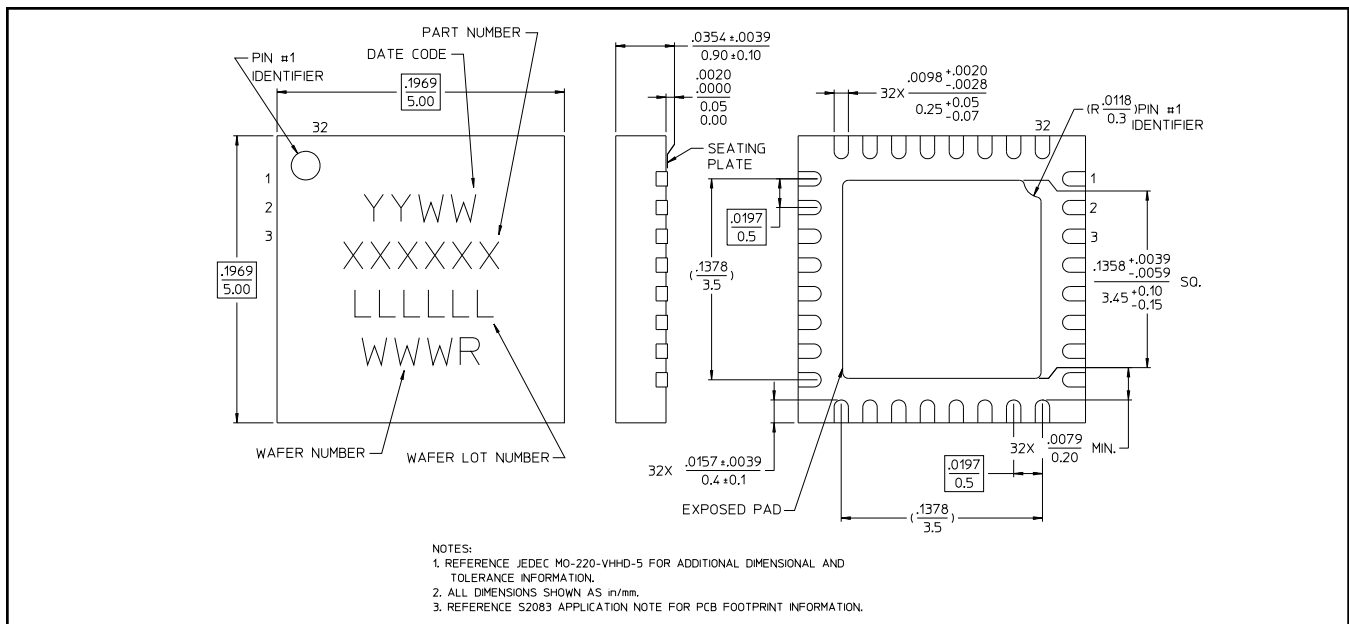
### Sample Board



### 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 1 requirements.  
Plating is 100% matte tin over copper.