

## Voltage Controlled Oscillator 11.0 – 11.82 GHz

Rev. V5

### Features

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

### Description

The MAOC-009872 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-009872 primary applications are Point-to-Point Radio, Point-to-Multipoint Radio, Communications Systems, and Low Phase Noise applications.

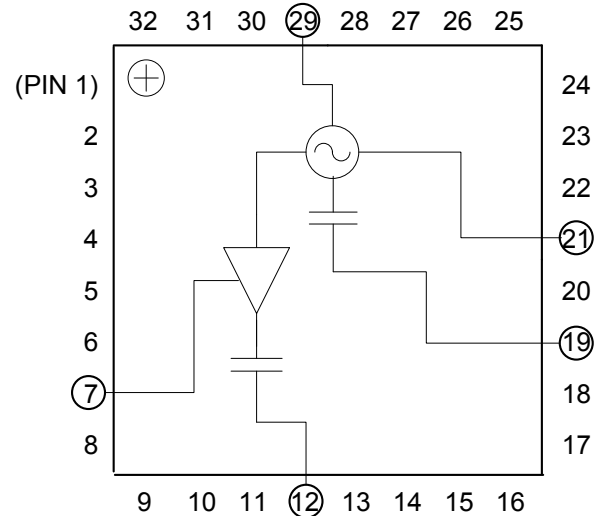
The 5 mm PQFN package has a lead-free finish that is RoHS compliant and compatible with a 260°C reflow temperature. The package also features low lead inductance and an excellent thermal path.

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

| Part Number        | Package         |
|--------------------|-----------------|
| MAOC-009872-TR0500 | 500 piece reel  |
| MAOC-009872-TR1000 | 1000 piece reel |
| MAOC-009872-001SMB | 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:  $T_A = +25^\circ\text{C}$ ,  $V_{CC} = V_{BUFFER} = 5\text{ V}^3$ ,  $Z_0 = 50\ \Omega$**

| Parameter   | Test Conditions  | Units                 | Min.        | Typ.             | Max.             |
|---|--|-----------------------|-------------|------------------|------------------|
| Output Power  | RF Port, 11.0 - 11.82 GHz<br>RF/2 Port, 5.5 - 5.91 GHz                 | dBm                   | 5<br>2      | 7<br>5           | —                |
| SSB Phase Noise   | RF Port, 10 kHz Offset<br>RF Port, 100 kHz Offset                      | dBc/Hz                | —           | -83<br>-112      | —<br>-108        |
| Harmonics/Subharmonics<br>$V_{CC}=V_{BUFFER}=V_{TUNE}=5\text{V}$            | RF Port, $\frac{1}{2} F_o$<br>RF/2 Port, $2F_o$                        | dBc                   | —           | -20<br>-9        | —                |
| Pulling<br>(Sensitivity to Match)<br>$V_{CC}=V_{BUFFER}=V_{TUNE}=5\text{V}$ | RF Port, VSWR = 1.95:1 to 2.25:1                                       | MHz pk-pk             | —           | 11.0             | —                |
| Pushing<br>(Sensitivity to Supply Voltage)                                  | RF Port, $V_{TUNE} = 5\text{ V}$<br>RF/2 Port, $V_{TUNE} = 5\text{ V}$ | MHz/V                 | —           | 5<br>2.5         | —                |
| Frequency Drift Rate<br>(Sensitivity to Temperature)                        | RF Port, 11.0 - 11.82 GHz<br>RF/2 Port, 5.5 - 5.91 GHz                 | MHz/ $^\circ\text{C}$ | —           | 0.8<br>0.5       | —                |
| Output Return Loss  | RF Port, 11.0 - 11.82 GHz<br>RF/2 Port, 5.5 - 5.91 GHz                 | dB                    | —           | 3<br>5           | —                |
| Tuning Sensitivity @ RF Port  | $V_{TUNE}=5\text{ V}$  | GHz/V                 | —           | 0.19             | —                |
| Supply Current  | $I_{TOTAL} (I_{CC} + I_{BUFFER})$<br>$I_{CC}$<br>$I_{BUFFER}$          | mA                    | —<br>—<br>— | 165<br>145<br>20 | 195<br>165<br>30 |
| Tune Voltage  | $V_{TUNE}$   | V                     | 2           | —                | 13               |
| Tuning Current Leakage  | $V_{TUNE}=13\text{ V}$   | $\mu\text{A}$         | —           | 5                | 10               |

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

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

| Parameter  | Absolute Maximum                              |
|--|---|
| Supply Voltage<br>( $V_{CC}$ & $V_{BUFFER}$ )          | +5.5 Vdc                                      |
| $V_{TUNE}$   | 0 to +15 Vdc                                  |
| Storage Temperature                                    | -55 $^\circ\text{C}$ to +150 $^\circ\text{C}$ |
| Operating Temperature <sup>6</sup>                     | -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  $\text{MTTF} > 1 \times 10^6$  hours.
- Junction Temperature ( $T_J$ ) =  $T_C + \Theta_{jc} * (V * I)$   
Typical thermal resistance ( $\Theta_{jc}$ ) = 35 $^\circ\text{C/W}$ .
  - For  $T_C = 25^\circ\text{C}$ ,  $T_J = 53.9^\circ\text{C}$  @ 5 V, 165 mA
  - For  $T_C = 85^\circ\text{C}$ ,  $T_J = 114.8^\circ\text{C}$  @ 5 V, 170 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 Class 1B devices.



**ESD Rating: 1B**

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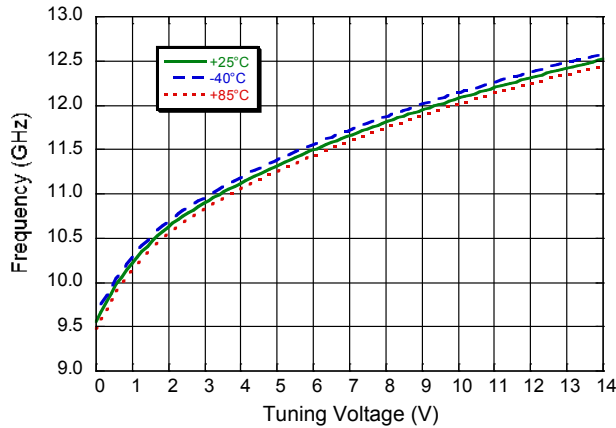
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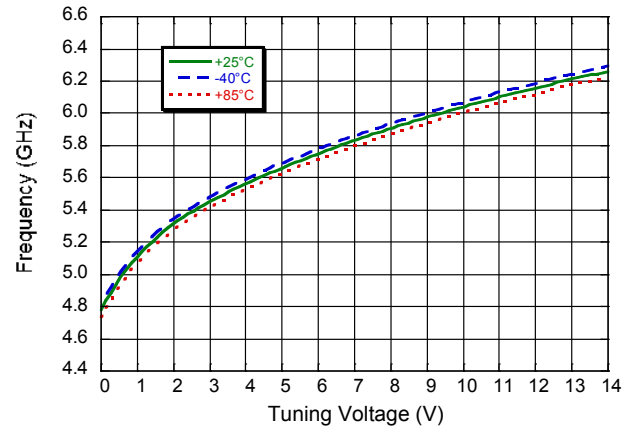
Rev. V5

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

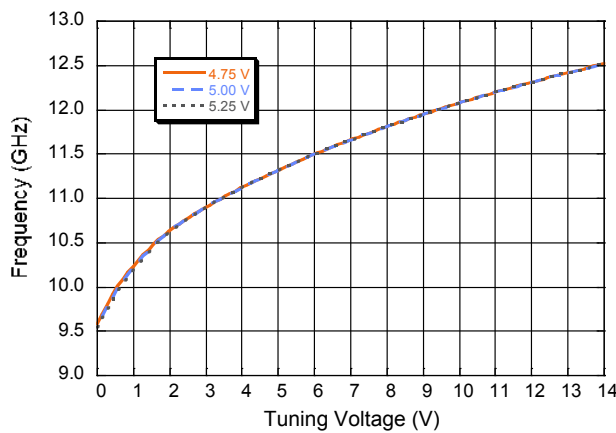
Output Frequency vs. Tuning Voltage - RF Port



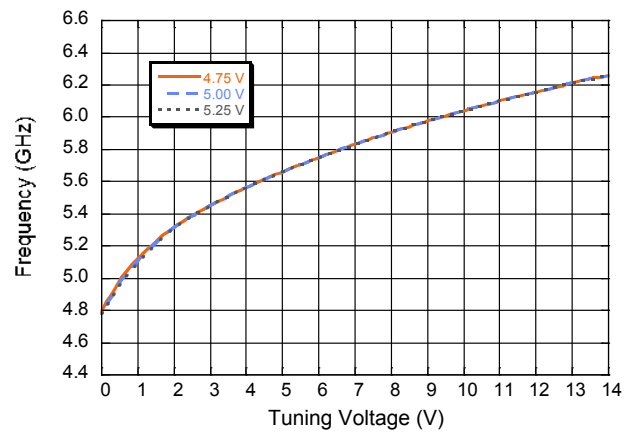
Output Frequency vs. Tuning Voltage - RF/2 Port



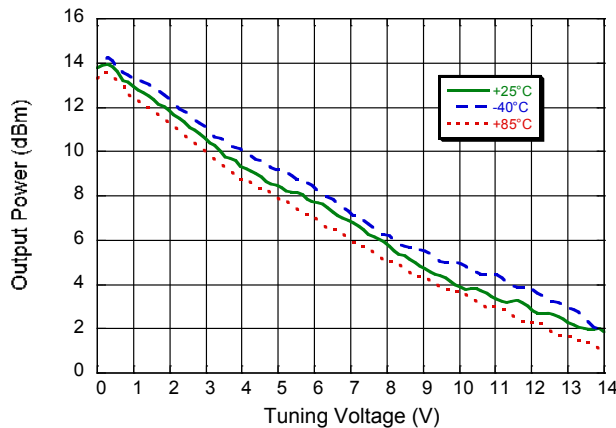
Output Frequency vs. Tuning / Supply Voltage - RF Port



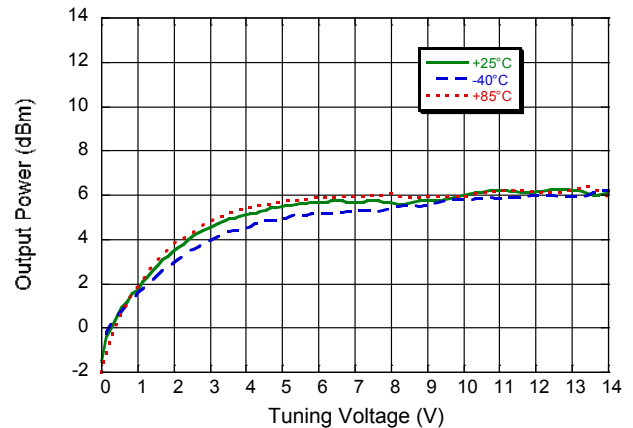
Output Frequency vs. Tuning / Supply Voltage - RF2 Port



Output Power vs. Tuning Voltage - RF Port



Output Power vs. Tuning Voltage - RF2 Port

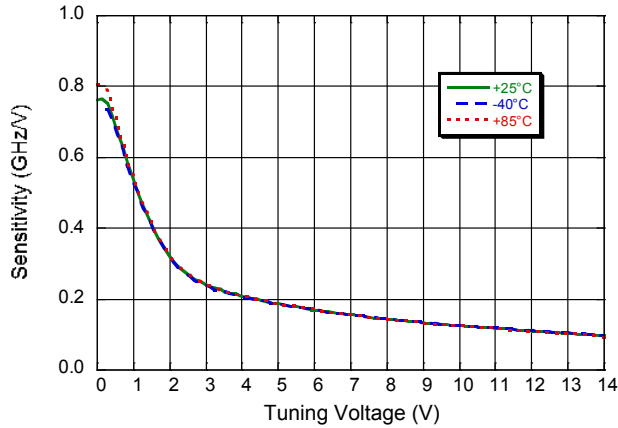


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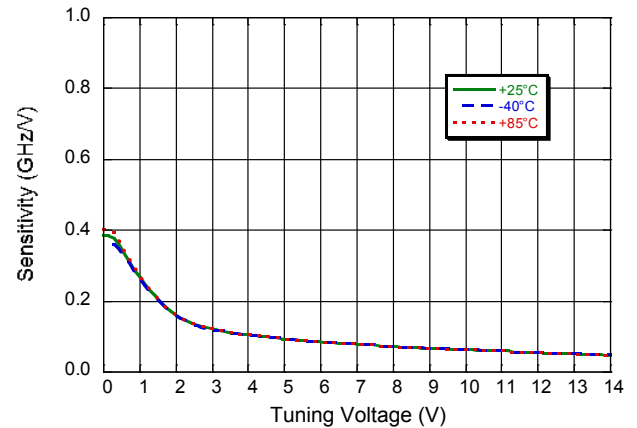
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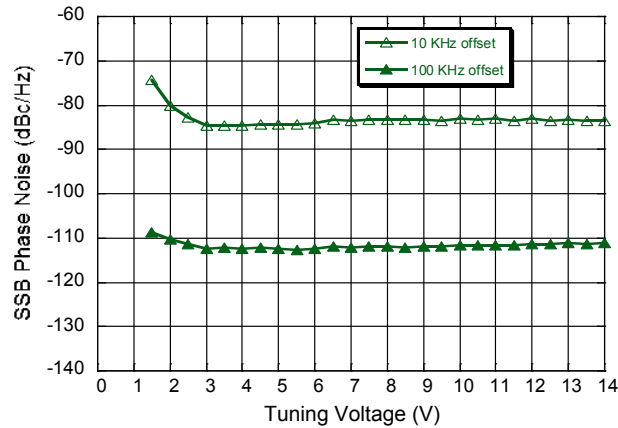
Frequency Sensitivity vs. Tuning Voltage - RF Port



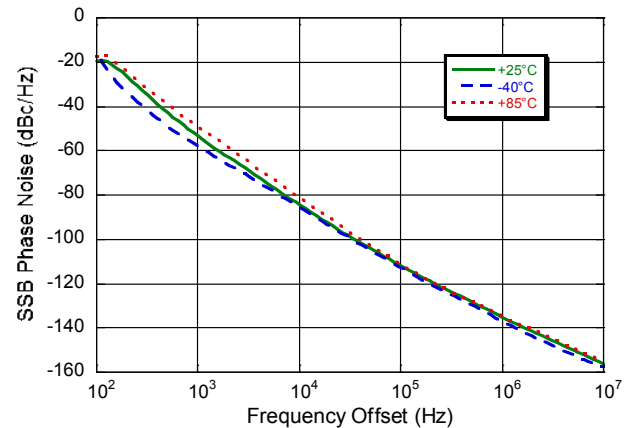
Frequency Sensitivity vs. Tuning Voltage - RF2 Port



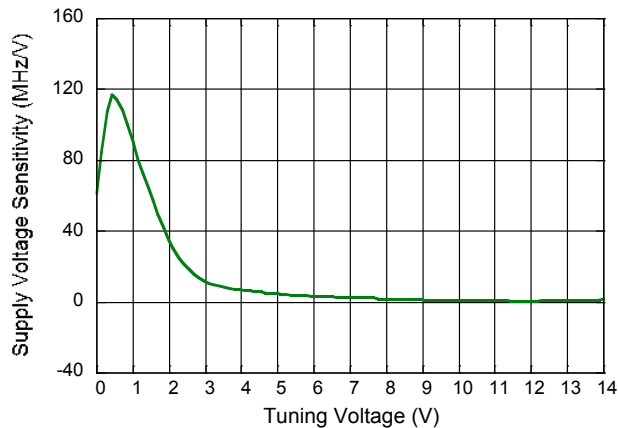
Single Side Band Phase Noise vs. Tuning Voltage  
RF Port



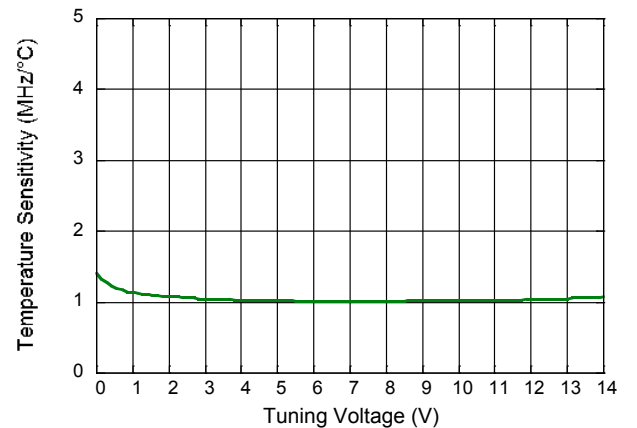
Single Side Band Phase Noise vs. Frequency Offset  
RF Port ( $V_{TUNE} = 5V$ )



Pushing - RF Port



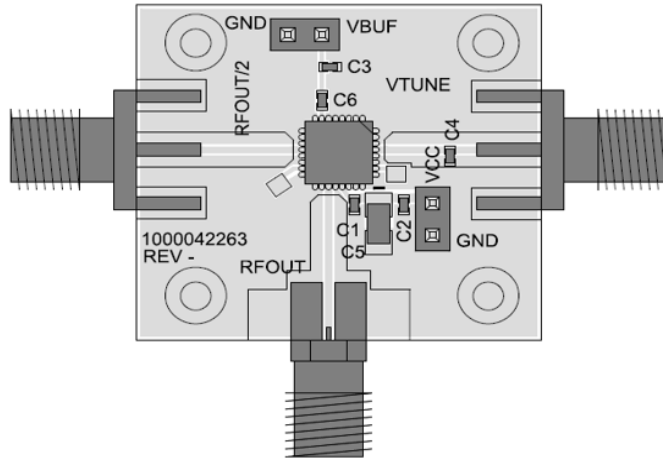
Temperature Drift - RF Port



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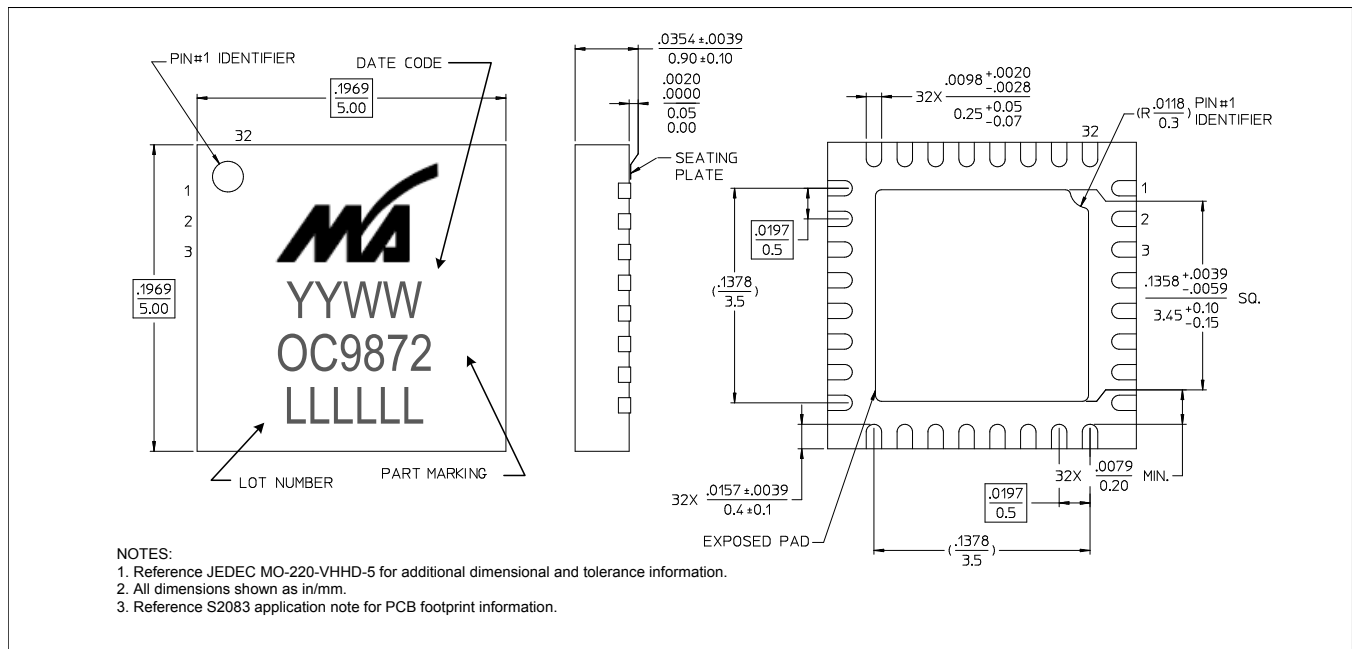
### Sample Board



### Parts List

| Component  | Value               | Case Size |
|------------|---------------------|-----------|
| C1         | 100 pF              | 0402      |
| C2, C3, C4 | 0.1 $\mu$ F         | 0402      |
| C5         | 10 $\mu$ F Tantalum | 1206      |
| C6         | 0 $\Omega$          | 0402      |

### 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.

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