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## Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832

Email & Skype: info@chipsmall.com Web: www.chipsmall.com

Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China



## Frequency Doubler 16 - 24 GHz Output

Rev. V2

### Features

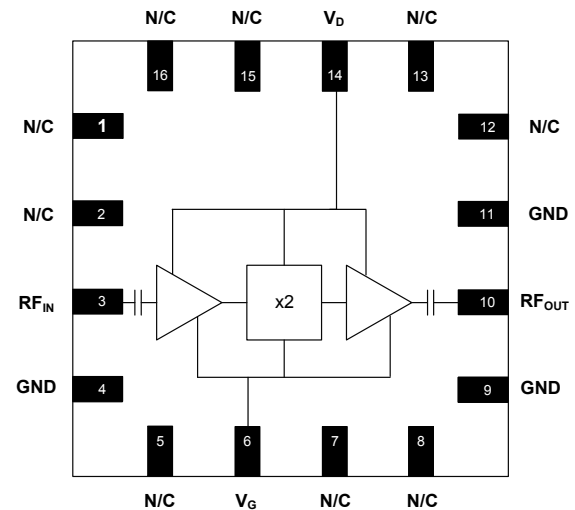
- 16 - 24 GHz Output Frequency Range
- 20 dBm Output Power
- High  $1x F_{IN}$  and  $3x F_{IN}$  Suppression
- High Dynamic Range
- Lead-Free 4 mm, 16-Lead QFN Package
- RoHS\* Compliant and 260°C Reflow Compatible

### Description

The MAFC-004403 is an active frequency doubler with an output frequency range of 16 - 24 GHz. The input power level ranges from 0 to 6 dBm, delivering a typical output power of 20 dBm. The device has excellent input and output return losses, and high  $1x F_{in}$  and  $3x F_{in}$  isolations.

The MAFC-004403 is ideally suited for use in LO chains in Point-to-Point radios for cellular backhaul applications. The 4mm QFN package is RoHS compliant and compatible with reflow temperatures to 260°C.

### Functional Block Diagram



### Pin Configuration<sup>1,2</sup>

| Pin No. | Function          | Description   |
|---------|-------------------|---------------|
| 1       | N/C               | No Connection |
| 2       | N/C               | No Connection |
| 3       | RF <sub>IN</sub>  | RF Input      |
| 4       | GND               | Ground        |
| 5       | N/C               | No Connection |
| 6       | V <sub>G</sub>    | Gate Voltage  |
| 7       | N/C               | No Connection |
| 8       | N/C               | No Connection |
| 9       | GND               | Ground        |
| 10      | RF <sub>OUT</sub> | RF Output     |
| 11      | GND               | Ground        |
| 12      | N/C               | No Connection |
| 13      | N/C               | No Connection |
| 14      | V <sub>D</sub>    | Drain Voltage |
| 15      | N/C               | No Connection |
| 16      | N/C               | No Connection |

\*Restrictions on Hazardous Substances,  
European Union Directive 2011/65/EU.

1. It is recommended that all No Connection pins (N/C) are connected to ground.
2. The exposed pad centered on the package bottom must be connected to RF and DC ground.

**Frequency Doubler**  
**16 - 24 GHz Output**

Rev. V2

**Electrical Specifications:  $V_D = +5\text{ V}$ ,  $V_G = -0.7\text{ V}$ ,  $P_{IN} = 0\text{ dBm}$ ,  $T_A = +25^\circ\text{C}$** 

| Parameter                  | Units | Min. | Typ. | Max. |
|----------------------------|-------|------|------|------|
| Frequency (Input)          | GHz   | 8    | —    | 12   |
| Frequency (Output)         | GHz   | 16   | —    | 24   |
| Output Power ( $P_{OUT}$ ) | dBm   | +18  | +20  | —    |
| $1x F_{IN}$ Leakage        | dBc   | —    | 30   | —    |
| $3x F_{IN}$ Leakage        | dBc   | —    | 20   | —    |
| $4x F_{IN}$ Leakage        | dBc   | —    | 20   | —    |
| Input Return Loss          | dB    | —    | 12   | —    |
| Output Return Loss         | dB    | —    | 12   | —    |
| Supply Current ( $I_D$ )   | mA    | 95   | 140  | 170  |

**Absolute Maximum Ratings**<sup>3,4,5</sup>

| Parameter                         | Absolute Maximum |
|-----------------------------------|------------------|
| Input Power                       | +8 dBm           |
| Drain Voltage                     | +7 V             |
| Gate Voltage                      | -1.5 V to 0 V    |
| Storage Temperature               | -55°C to +150°C  |
| Case Temperature                  | -40°C to +85°C   |
| Junction Temperature <sup>6</sup> | +160 °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  $T_J \leq 160^\circ\text{C}$  will ensure  $MTTF > 1 \times 10^6$  hours.
- Junction Temperature ( $T_J$ ) =  $T_C + \Theta_{jc} * ((V * I) - (P_{OUT} - P_{IN}))$   
 Typical thermal resistance ( $\Theta_{jc}$ ) = 93°C/W.
  - For  $T_C = 25^\circ\text{C}$ ,  
 $T_J = 81^\circ\text{C}$  @ 5 V, 130 mA,  $P_{IN} = +5\text{ dBm}$ ,  $P_{OUT} = 17\text{ dBm}$
  - For  $T_C = 85^\circ\text{C}$ ,  
 $T_J = 141^\circ\text{C}$  @ 5 V, 130 mA,  $P_{IN} = +5\text{ dBm}$ ,  $P_{OUT} = 17\text{ dBm}$

**Handling Procedures**

The following precautions should be observed 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 1A devices.

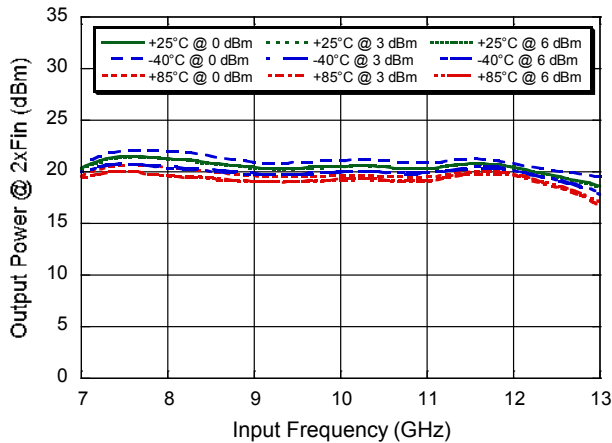


## Frequency Doubler 16 - 24 GHz Output

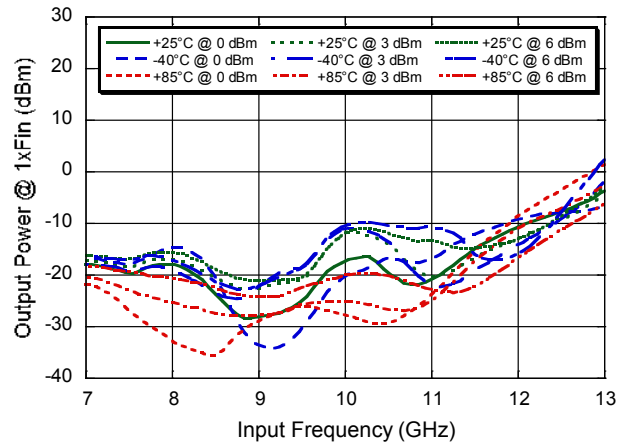
Rev. V2

Typical Performance Curves:  $V_D = +5\text{ V}$ ,  $V_G = -0.7\text{ V}$ ,  $Z_0 = 50\ \Omega$

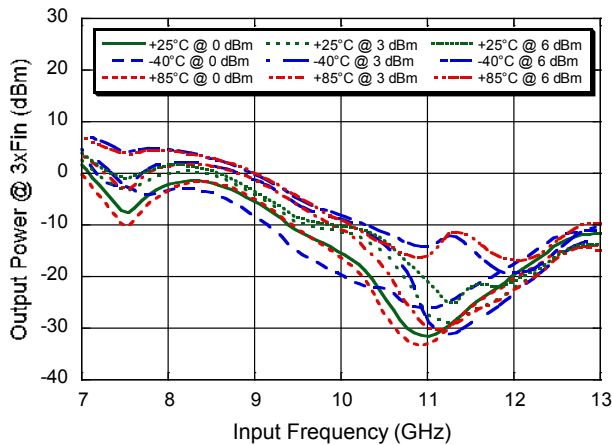
Output Power @  $2x F_{IN}$  vs. Temp.,  $P_{IN} = 0, 3, 6\text{ dBm}$



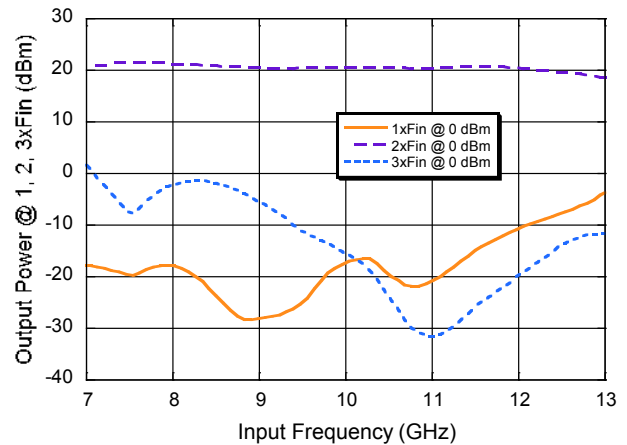
Output Power @  $1x F_{IN}$  vs. Temp.,  $P_{IN} = 0, 3, 6\text{ dBm}$



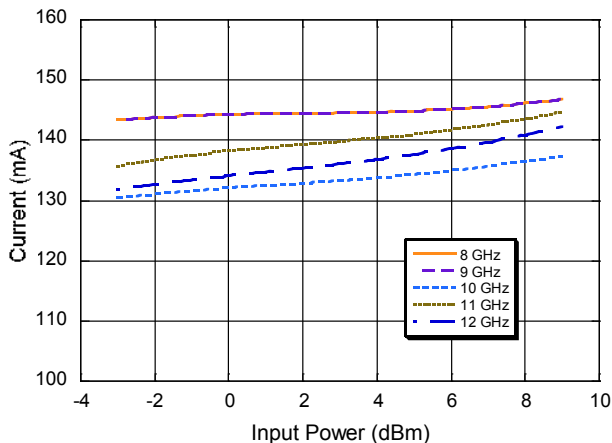
Output Power @  $3x F_{IN}$  vs. Temp.,  $P_{IN} = 0, 3, 6\text{ dBm}$



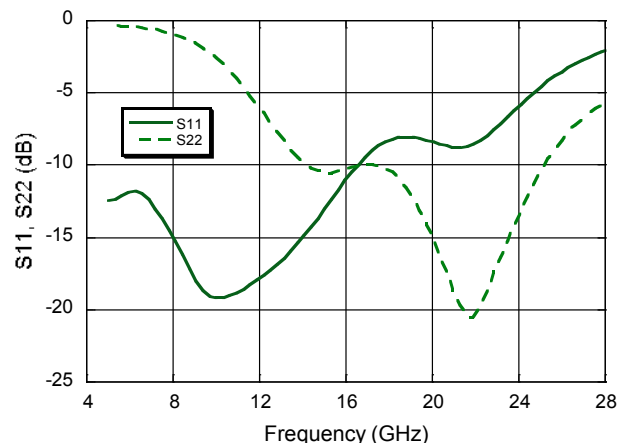
Output Power @  $1x F_{IN}$ ,  $2x F_{IN}$  &  $3x F_{IN}$ ,  $P_{IN} = 0\text{ dBm}$



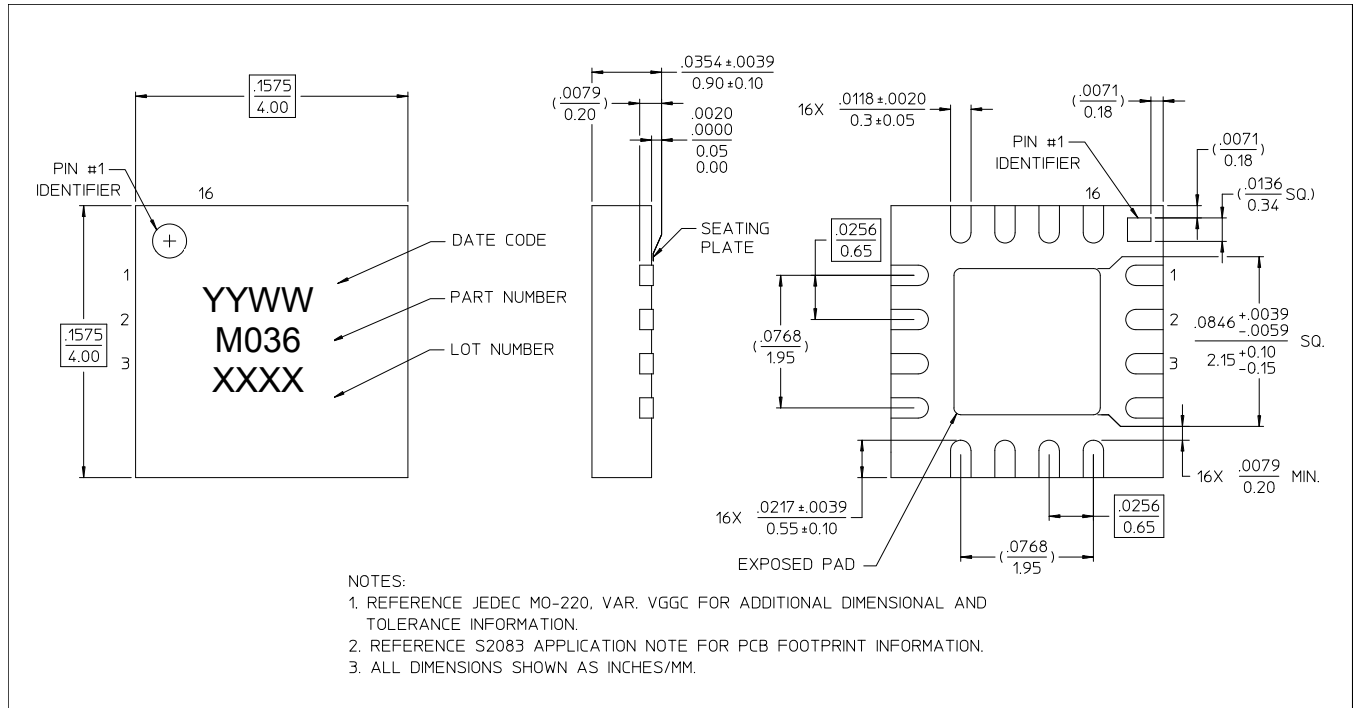
Supply Current



Return Loss



**Lead-Free 4 mm 16-Lead PQFN†**



† Reference Application Note S2083 for lead-free solder reflow recommendations.  
Meets JEDEC moisture sensitivity level 1 requirements.  
Plating is 100% matte tin plating over copper

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