Characterisation and Measurements of a 10 GHz Oscillator and a Frequency Doubler

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Table of Contents

List of Figures

List of Tables

1 Introduction

This report aims to gather information on the characterisation of a $10\,GHz$ oscillator and a frequency doubler.

The purpose of using these components is to obtain a $20\,GHz$ oscillator, as it has been requested, utilising components previously purchased by Yebes Observatory.

The components used in this report are as follows:

- **$10\,GHz$ Oscillator:** model DLCRO-005-10000-3-15, manufactured by MITEQ.
- **Frequency doubler:** model ADA-1020, manufactured by Marki Microwave.
- **Attenuators:** one of $5\,dB$ and another of $15\,dB$.

2 DLCRO

The main oscillator used is a Dual Loop Phase Locked Coaxial Resonator Oscillator (DLCRO), model DLCRO-005-10000-3-15P, manufactured by MITEQ.

This device has the following specifications:

- **External Reference Frequency**: $5\,MHz$.
- **Output Frequency**: $10\,GHz$.
- **Alarm**: $V_O = 0\,V$ if it is locked, otherwise $V_O = 5\,V$.
- **DC Supply**: $15\,V$.
- **RF Connectors**: SMA Female (Input & Output).

A picture of the device is shown in Figure 2.1, and the data sheet is provided in Appendix A.

Figure 2.1: DLCRO-005-10000-3-15P.

As indicated in Figure 2.1, a $5\,MHz$ signal is introduced into the DLCRO, which port is named 'REF INPUT'. This signal has been generated with an analogue signal generator and has a $3\,dBm$ amplitude. The 'RF OUTPUT' is shown in Figure 2.2. It represents the output signal obtained from the signal analyser highlighting the peak power. An output power of about $12\,dBm$ has been obtained at precisely $10\,GHz$. The DLCRO is locked since the alarm signal provides a low level and the output signal has no frequency shifting.

Figure 2.3 depicts the phase noise ($\mathcal{L}(f)$) of the DLCRO. Certain frequencies and their corresponding phase noise values are indicated in the legend.

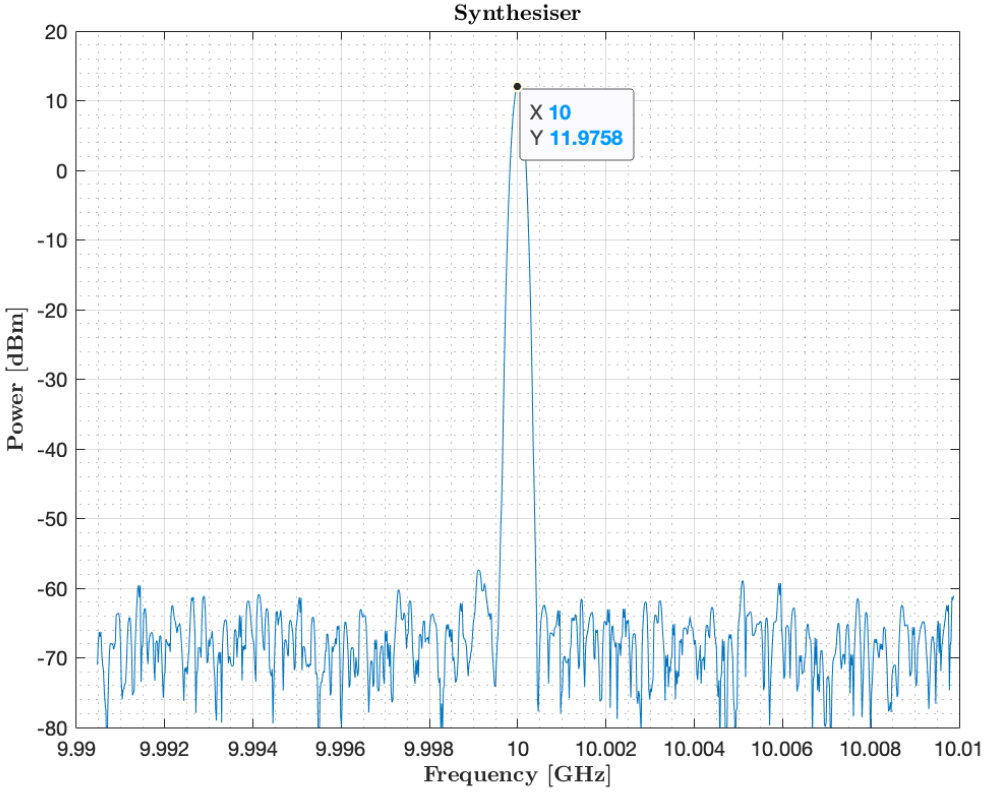


Figure 2.2: Output signal power of DLCRO.

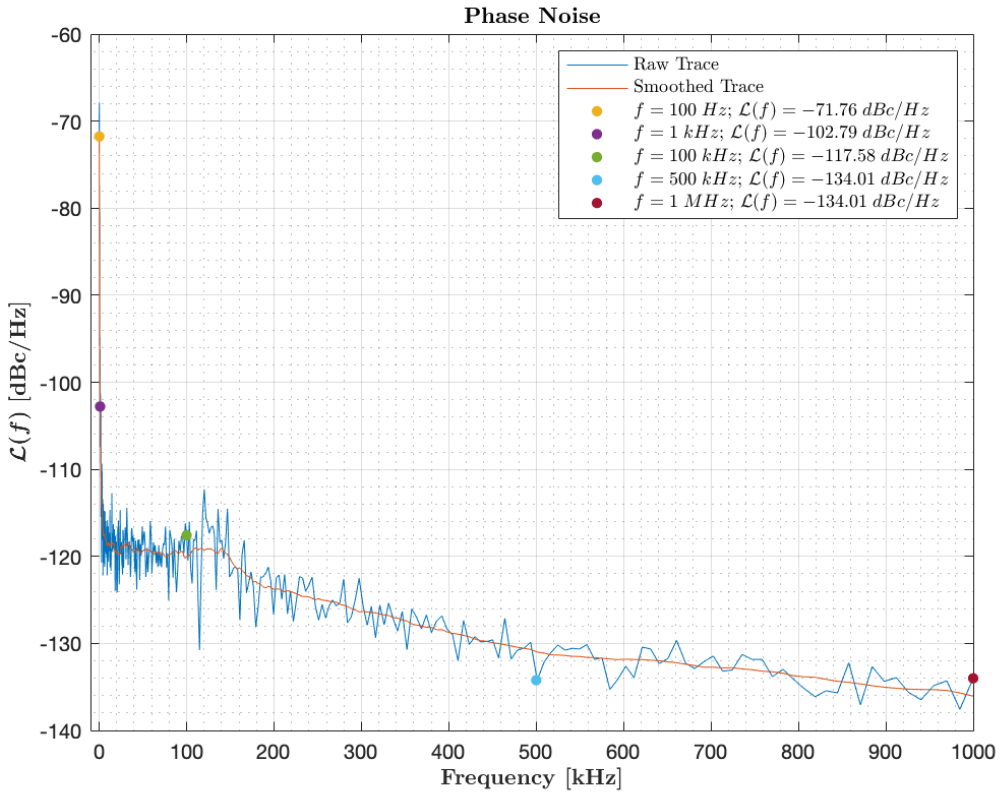


Figure 2.3: Phase noise of DLCRO-005-10000-3-15P.

3 Frequency Doubler

To shift the $10\,GHz$ frequency provided by the DLCRO to the desired $20\,GHz$, a frequency doubler has been employed. The ADA-1020 is a frequency doubler with amplification and a summary of its specifications is provided in Table 3.1.

Parameter	**Input (GHz)**	**Output [GHz]**	**Min**	**Typ**	**Max**
Input power [dBm]			$+5\,dBm$		$+10\,dBm$
Input frequency (f) [GHz]	$10-20$				
Output power [dBm]			$+15\,dBm$	$+20\,dBm$	
Output frequency ($2f$) [GHz]		$20-40$			
Bias Requirements [mA]					
$-5\,V$				$5\,mA$	$20\,mA$
$+5\,V$				$400\,mA$	$500\,mA$

Table 3.1: Summary of the ADA-1020 specifications

As required by the manufacturer 'It is required that the negative bias be applied before or concurrent with the positive bias'. Full specifications for the ADA-1020 can be found in its data sheet, provided in Appendix B. It is worth noting that the output connector is a $2.4\,mm$, rather than a $2.92\,mm$ connector.

4 Combination of the DLCRO and Frequency Doubler

Table 3.1 specifies that the input power must be limited to $+10\,dBm$ and as seen in Figure 2.2 the output from the DLCRO exceeds that level of power. Thus, an attenuator is needed. In this case, it has been introduced a $5\,dB$ attenuator between the DLCRO and the frequency doubler. A picture of the attenuator is presented in Figure 4.1.

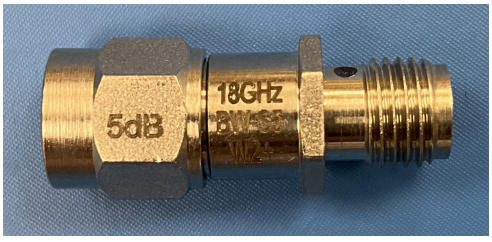


Figure 4.1: $5\,dB$ attenuator.

When using a frequency doubler with amplification, extra precautions are recommended for the signal analyser. An additional $15\,dB$ attenuator is used between the output of the frequency doubler and the measurement device.

Figure 4.2 shows the final interconnection between the two devices, with the $5\,dB$ attenuator placed between them.

Figure 4.3 shows the output resulting from the combination of both devices. This output has already been modified by the addition of the $15\,dB$ of attenuation mentioned earlier. The main peak of the output signal is centred at $20\,GHz$, with a power of about $11\,dBm$.

The manufacturer provides the schematic in Figure 4.4 to illustrate that the output signal has spurious frequencies at f and $3f$. Figure 4.5 details both spurious peaks, which are located at $9.98\,GHz$ and $30.02\,GHz$, with powers of $-17.48\,dBm$ and $-3.32\,dBm$, respectively.

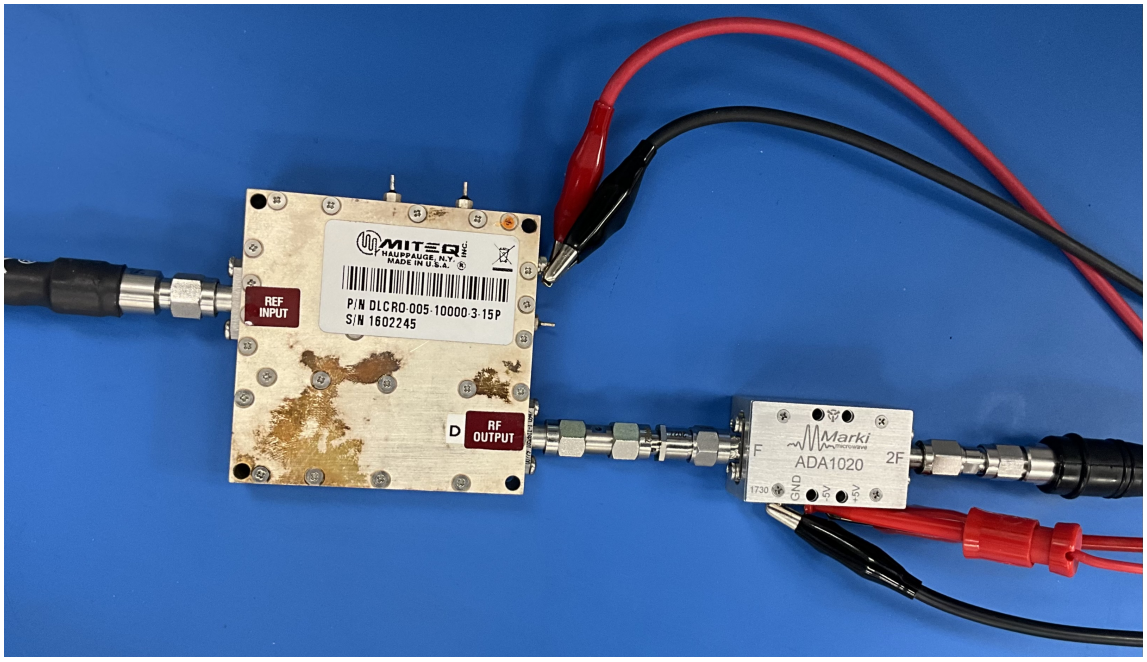


Figure 4.2: Combination of the DLCRO and the ADA-1020.

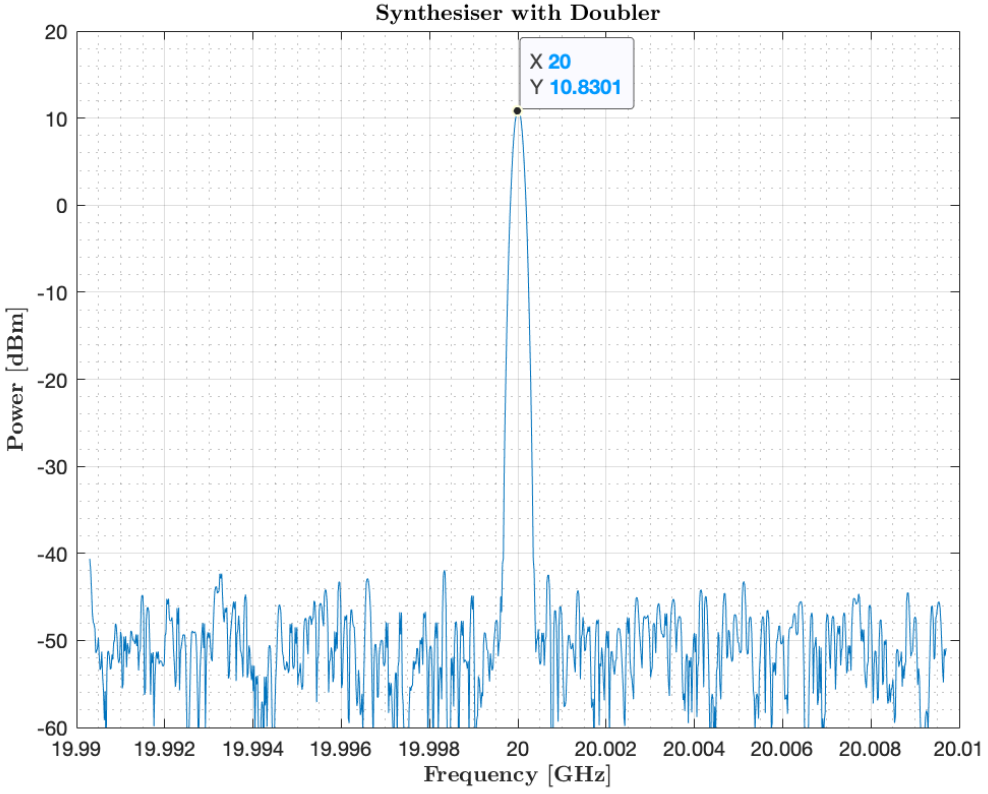


Figure 4.3: Output signal power of DLCRO combined with frequency doubler (ADA-1020).

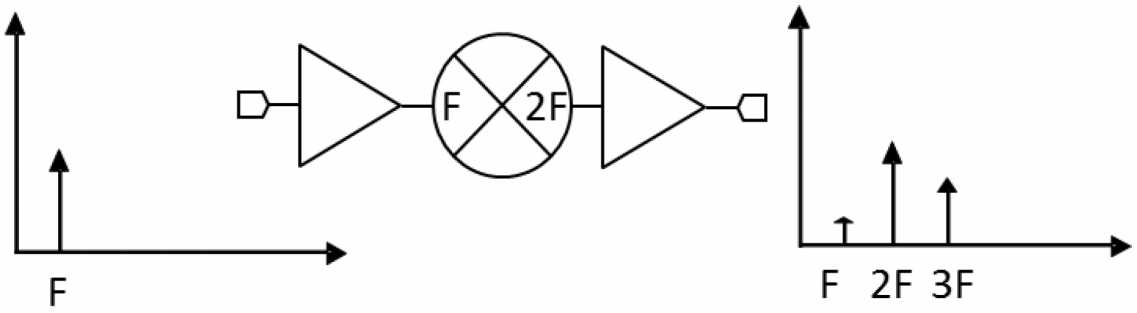


Figure 4.4: Schematic of the ADA-1020. Appendix B.

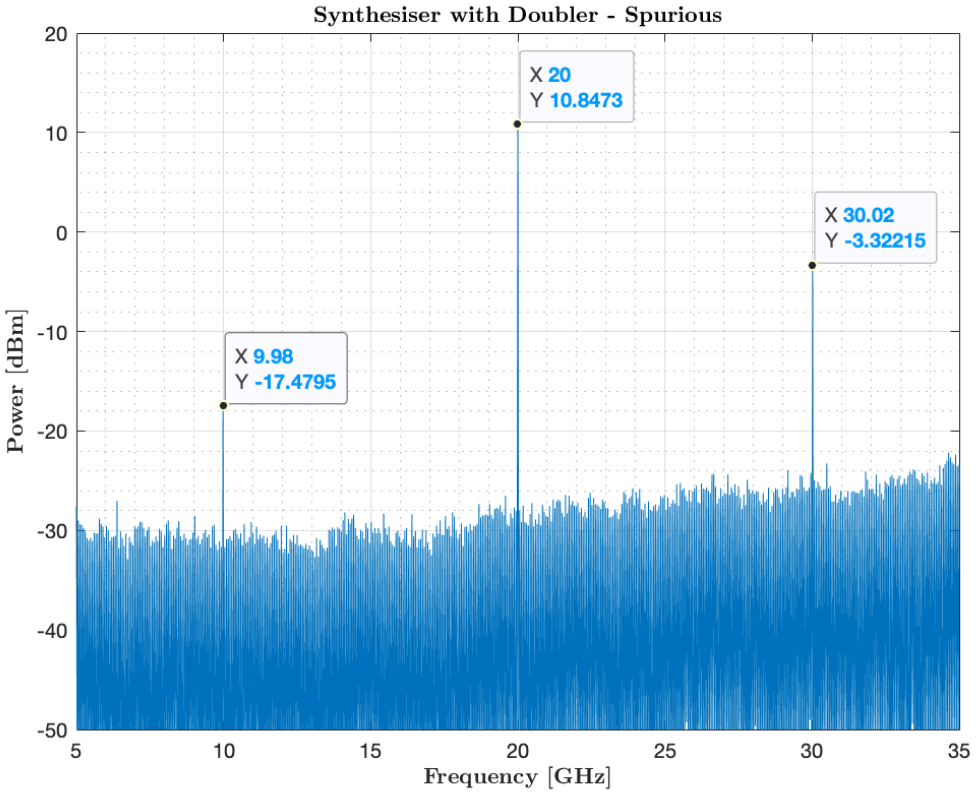


Figure 4.5: Output signal power of DLCRO combined with frequency doubler (ADA-1020). Spurious frequencies.

A Data sheet: Oscillator DLCRO-005-10000-3-15P

DUAL LOOP PHASE LOCKED COAXIAL RESONATOR OSCILLATOR

DLCRO SERIES:

4 –15 GHz (MULTIPLIED)

FEATURES

- **High Performance in a small package**
- **Excellent spurious performance**
- **Excellent performance/cost ratio**
- **100% burn-in and temperature testing**
- **Three-year warranty**

The DLCRO Series phase-locked source offers excellent phase noise and spurious performance in a 2.25"Wx2.25"Lx.60"H housing. The dual loop configuration improves phase noise and spurious performance compared to a single loop design, and has the flexibility to allow output frequencies that are not direct multiples of the input. Available in fixed frequencies from 800 MHz to 15 GHz in fundamental or multiplied configurations. The DLC can operate with external reference of 1 to 200 MHz, and with 8 to 15 VDC supply input.

ELECTRICAL SPECIFICATIONS

Output frequency range……4 – 15 GHz
(>15 GHz, consult factory)
Output power……+13 dBm minimum
Output Harmonics……-50 dBc maximum
Output Spurious……-70 dBc maximum
Input frequency range……1 –200 MHz
Input impedance……50 ohms
Load VSWR……1.5:1
DC power requirements…….+8 to +15 volts @ 250 mA
(specify)
Phase noise……See graphs

ENVIRONMENTAL CONDITIONS

Temperature
Operating..... -10 to +60°C
Storage ..... -50 to +100°C
Humidity ..... 95% at 40°C noncondensing
Shock (survival) ..... 30 g's, 10 ms pulse
Vibration (survival) ..... 20 to 2000 Hz random to 4 g's rms
Weight..... 90 grams

Extended temperature available, contact factory.

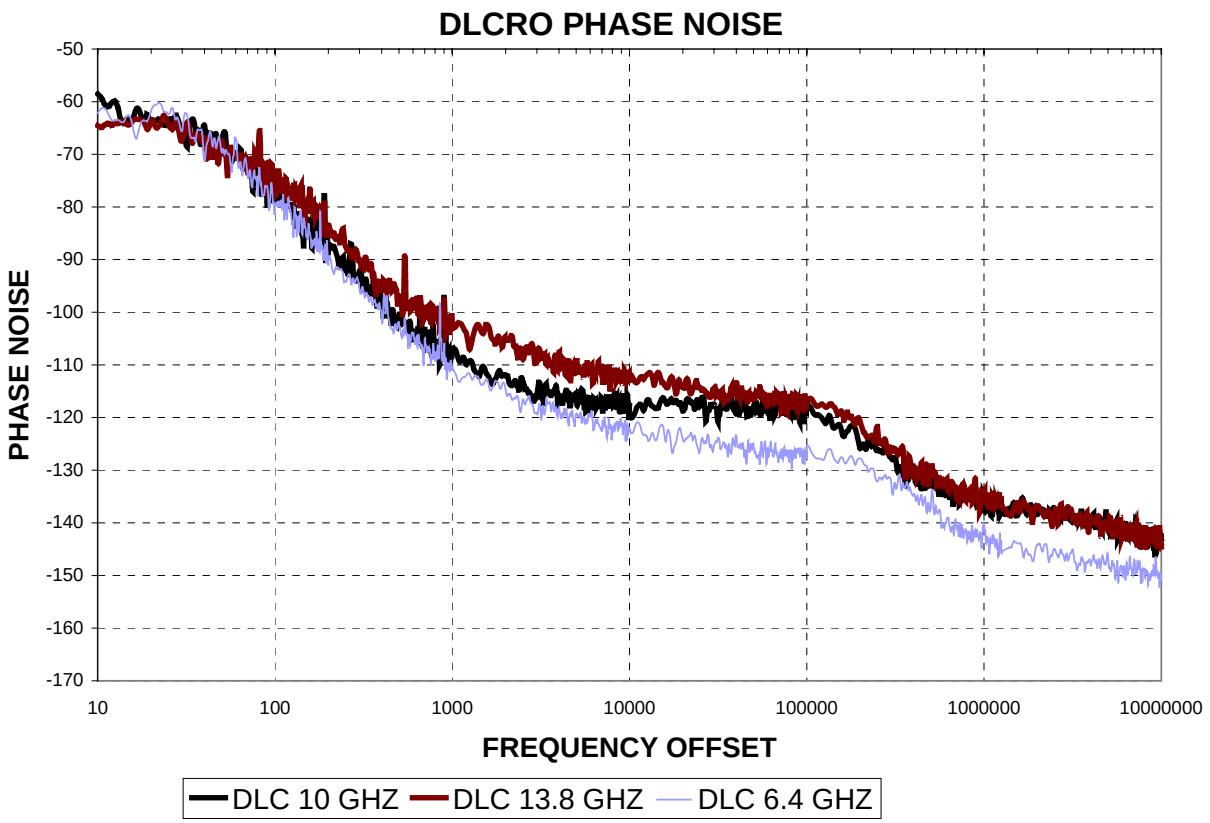
ORDERING INFORMATION

DLCRO- ___ ___ ___ - ___ ___ ___ ___ ___ - _____ - ___ ___ P

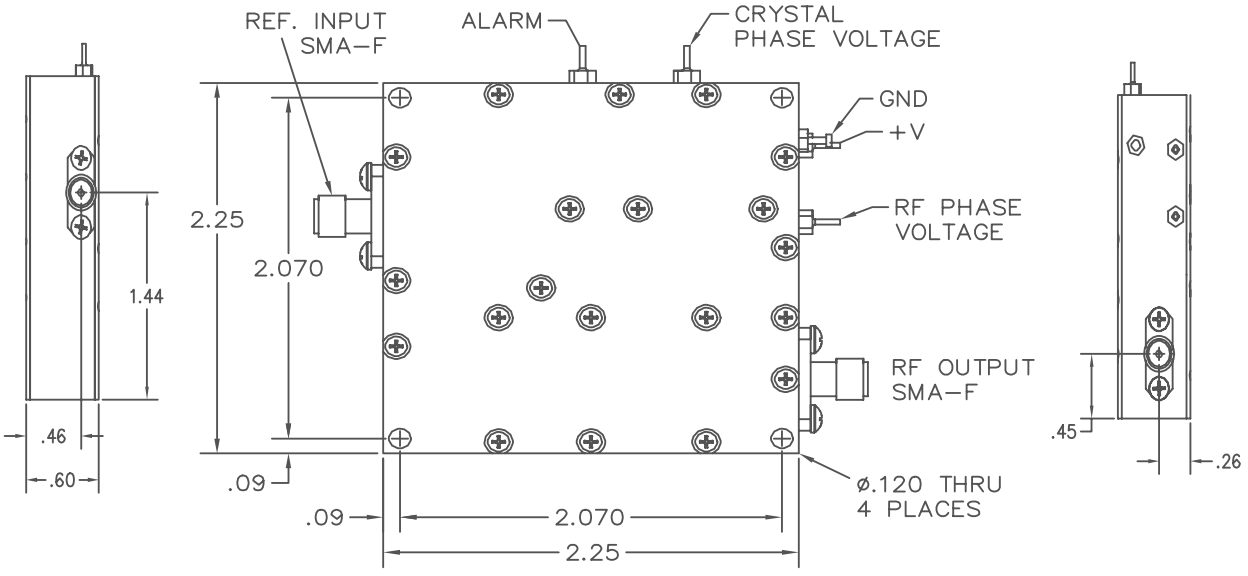
- ___ ___ ___: External Reference Frequency (MHz)
- ___ ___ ___ ___ ___: Output Frequency (MHz)
- _____: ALARM
- ___ ___: D.C. Supply (+volts)

Alarm options:
3. TTL: low in-lock, high out-of-lock
4. TTL: high in-lock, low out-of-lock

100 Davids Drive, Hauppauge, NY 11788 • TEL: (631) 439-9220 • FAX: (631) 436-7430 • www.miteq.com



DLCRO OUTLINE DRAWING



Outline A:

DLCRO

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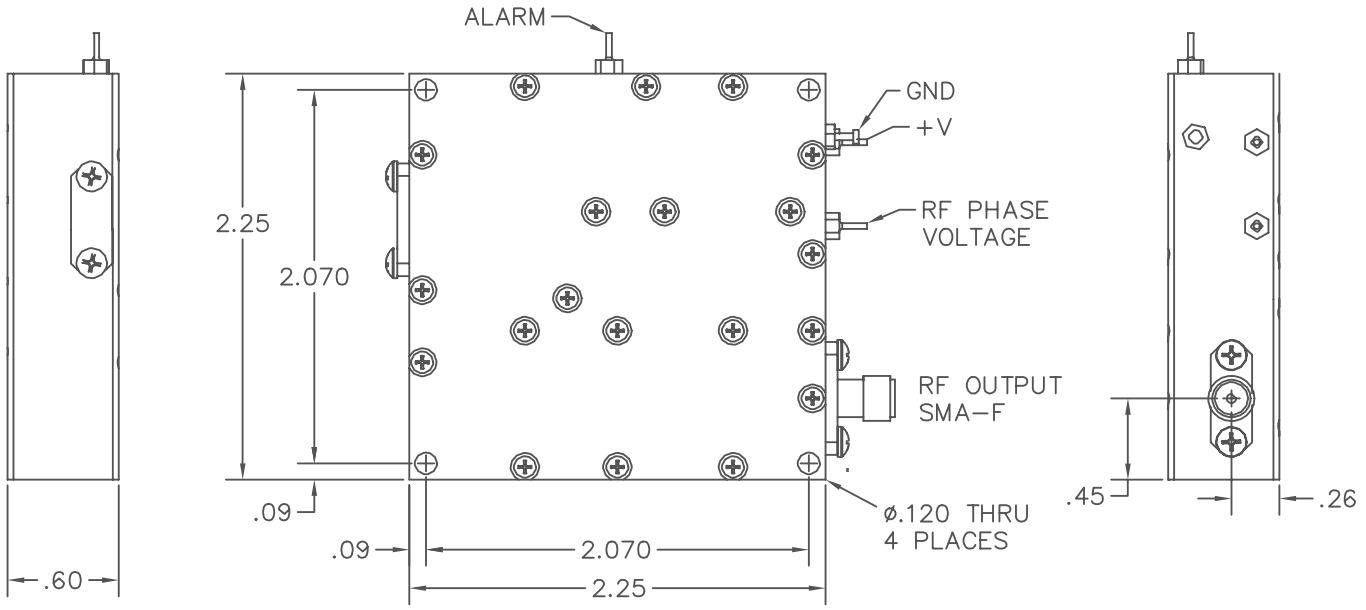
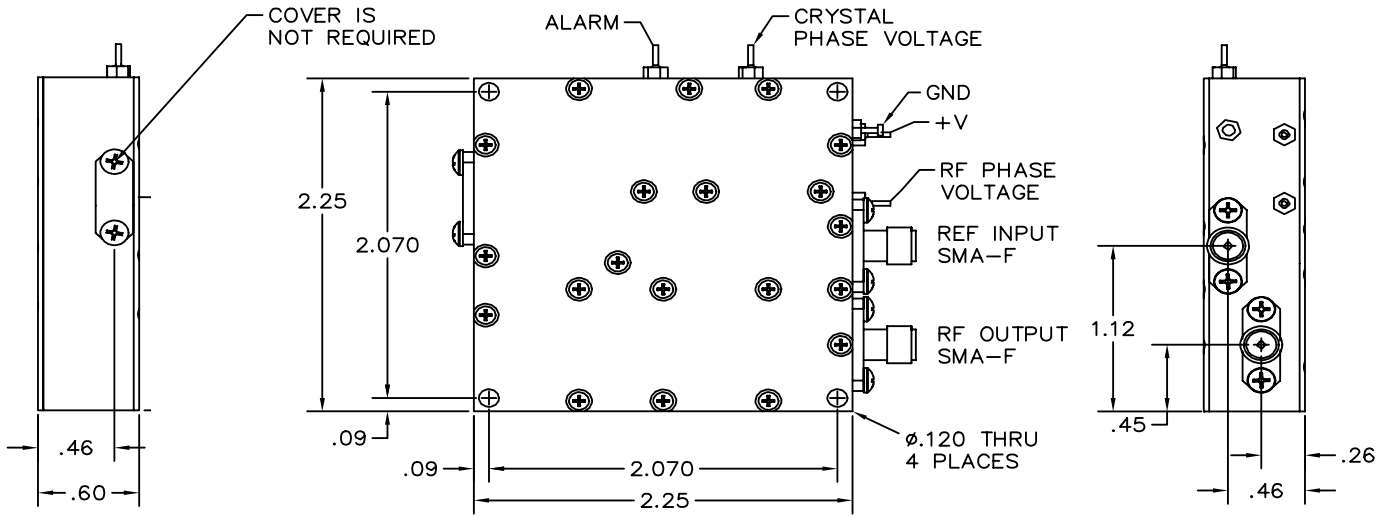
DUAL LOOP PHASE LOCKED COAXIAL RESONATOR OSCILLATOR

DLCRO OUTLI DLCRO OUTLINE DRAWING



DLCRO-I



Outline B:

DLCRO

MITEQ 100 Davids Drive, Hauppauge, NY 11788 • TEL: (631) 439-9220 • FAX: (631) 436-7430 • www.miteq.com

B Data sheet: Frequency Doubler ADA-1020

AMPLIFIER/DOUBLER/AMPLIFIER ADA-1020

Features

- Input 10.0 to 20.0 GHz
- Output 20.0 to 40.0 GHz
- +20 dBm Typical Output Power

Electrical Specifications - Specifications guaranteed from -30 to +70°C, measured in a 50-Ohm system.

Parameter	INPUT (GHz)	OUTPUT (GHz)	Min	Typ	Max
Input (dBm) F(in)	 10.0-20.0		 +5		 +10
Output Converted Power (dBm) 2F(out)		 20.0-40.0	 +15	 +20	
Suppressions (dBc) F(in) Fundamental 3F(out) Third Harmonic		 10.0-20.0 30.0-40.0		 See Plots	
Bias Requirements (mA) [1] +5 Volts DC -5 Volts DC				 400 5	 500 20

[1]It is required that the negative bias be applied before or concurrent with the positive bias. A heat sink is required.

Part Number Options

Please specify package style by adding to model number.	
Package Style(s)	**Example**
CM, CMM, CMV, CMMV	ADA-1020 CM

215 Vineyard Court, Morgan Hill, CA 95037 | Ph: 408.778.4200 | Fax: 408.778.4300 | info@markimicrowave.com

AMPLIFIER/DOUBLER/AMPLIFIER

ADA-1020

Input 10.0 to 20.0 GHz
Output 20.0 to 40.0 GHz

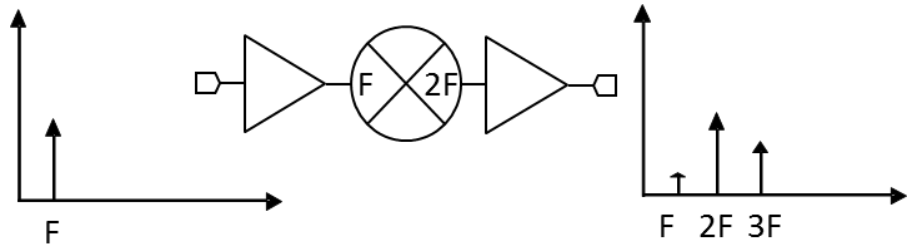
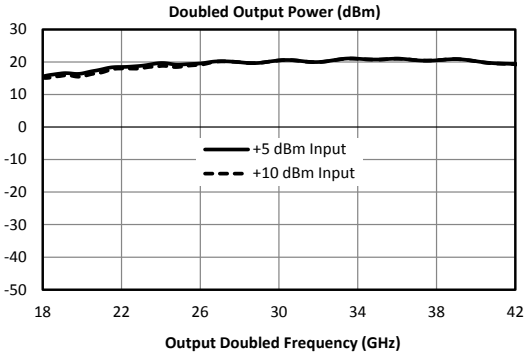
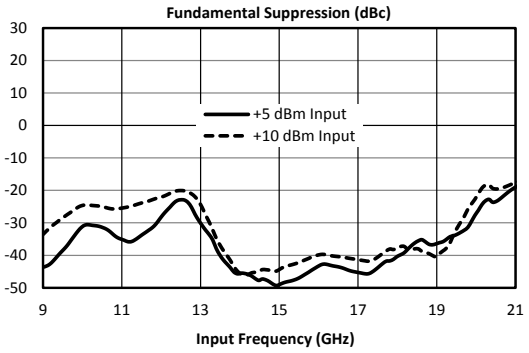
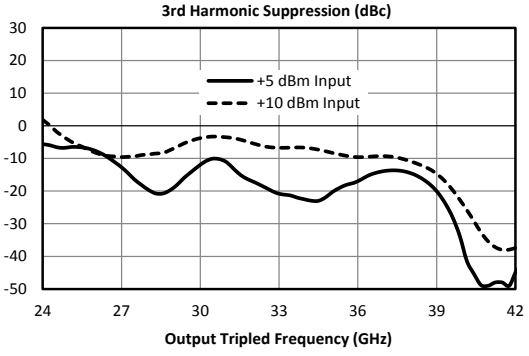


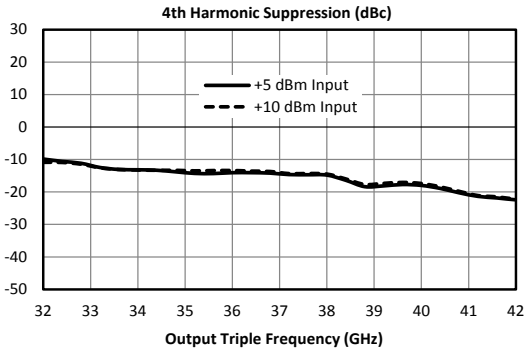
Figure 1. Schematic.

Typical Performance



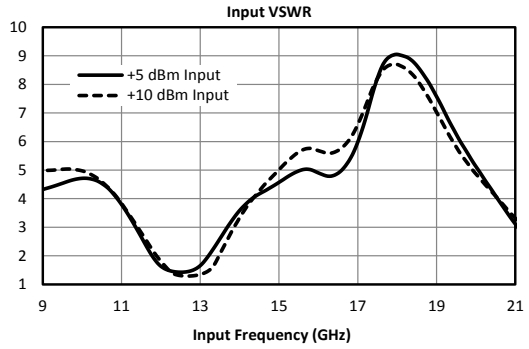


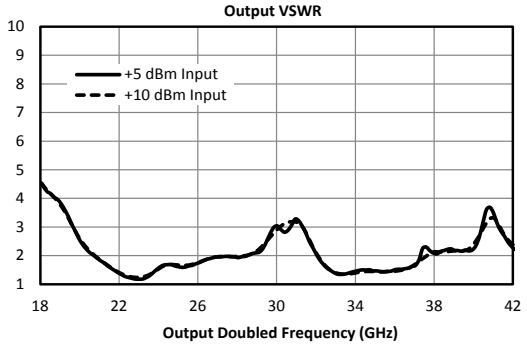




Input 10.0 to 20.0 GHz
Output 20.0 to 40.0 GHz

Typical Performance (cont)





DATA SHEET NOTES:

1. Maximum input power without damage is +16 dBm at +70°C.
2. A heat sink is required for sustained operation.
3. Specifications are subject to change without notice. Contact Marki Microwave for the most recent specifications and data sheets.

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