

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

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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.

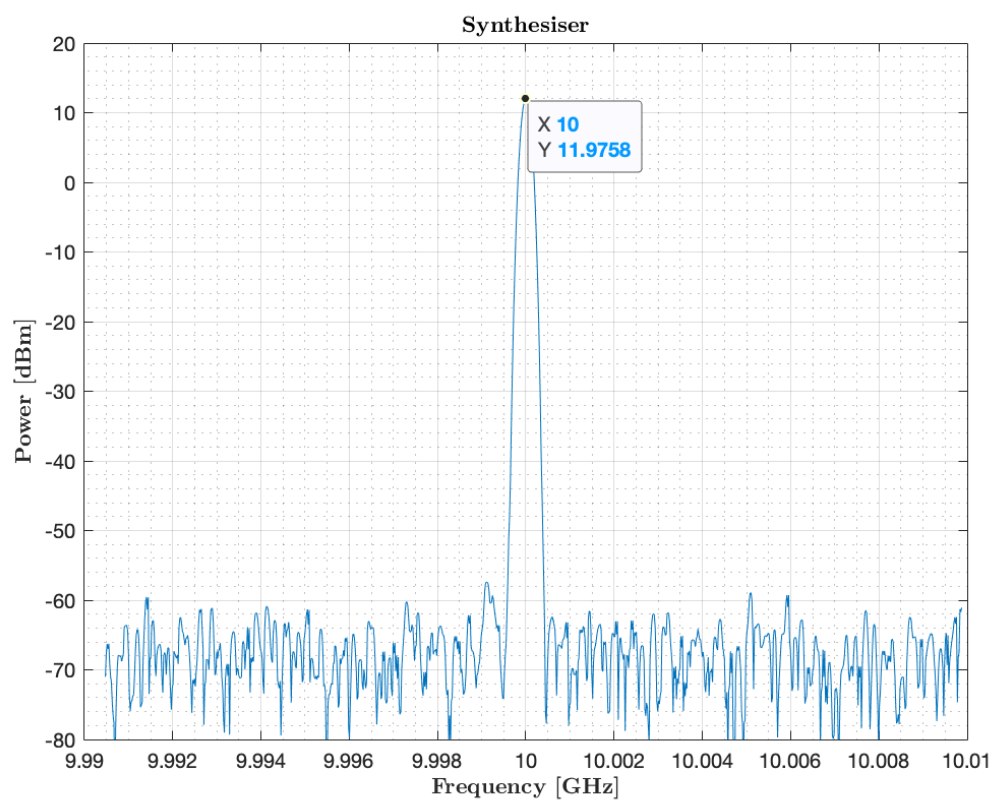


Figure 2.2: Output signal power of DLCRO.

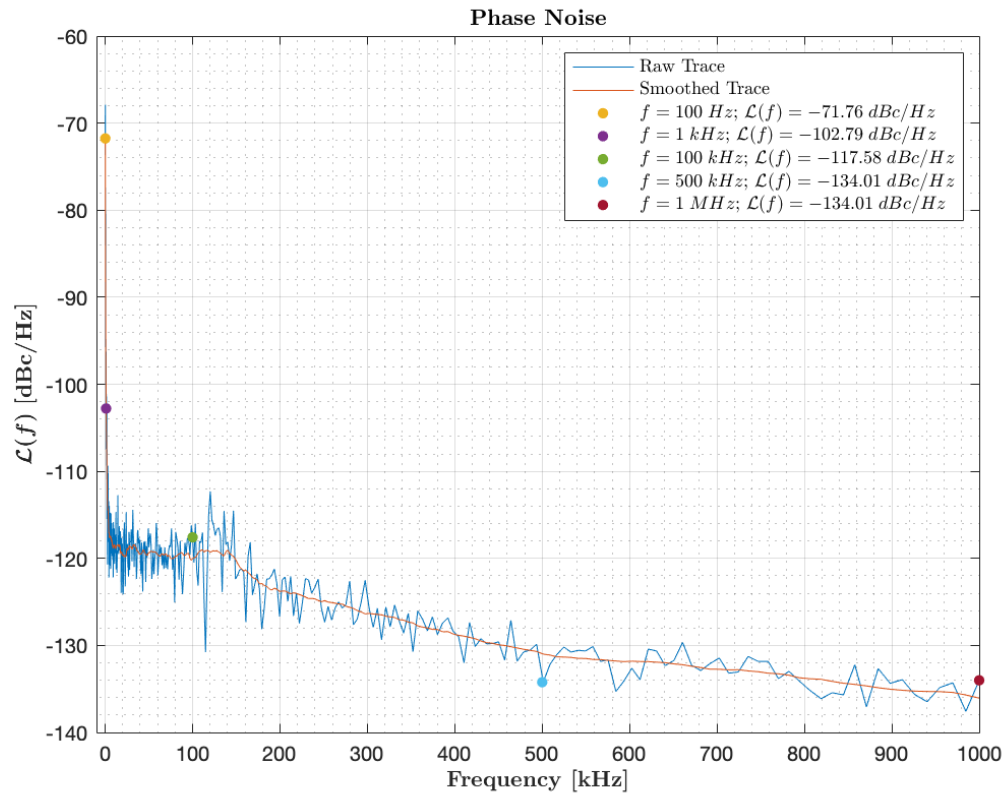


Figure 2.3: Phase noise of DLCRO-005-10000-3-15P.

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.

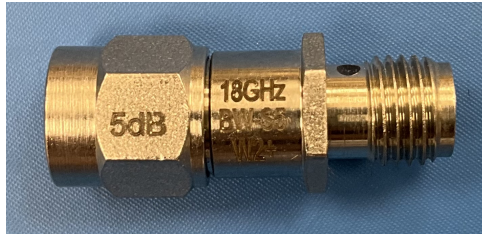


Figure 4.1: 5 dB attenuator.

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.

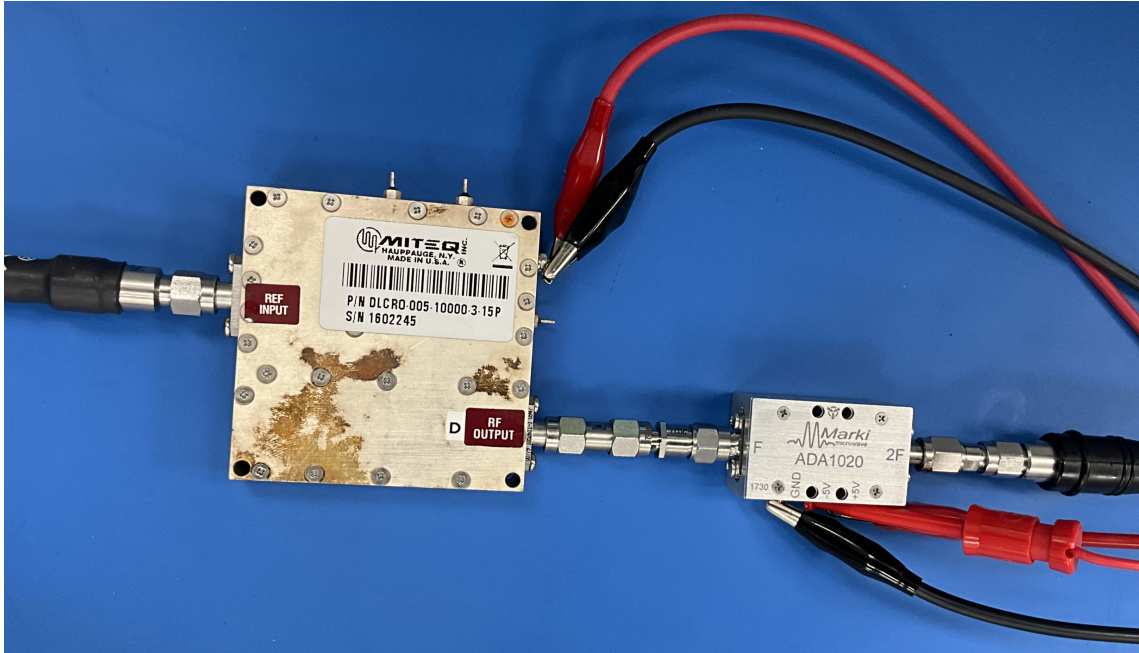


Figure 4.2: Combination of the DLCRO and the ADA-1020.

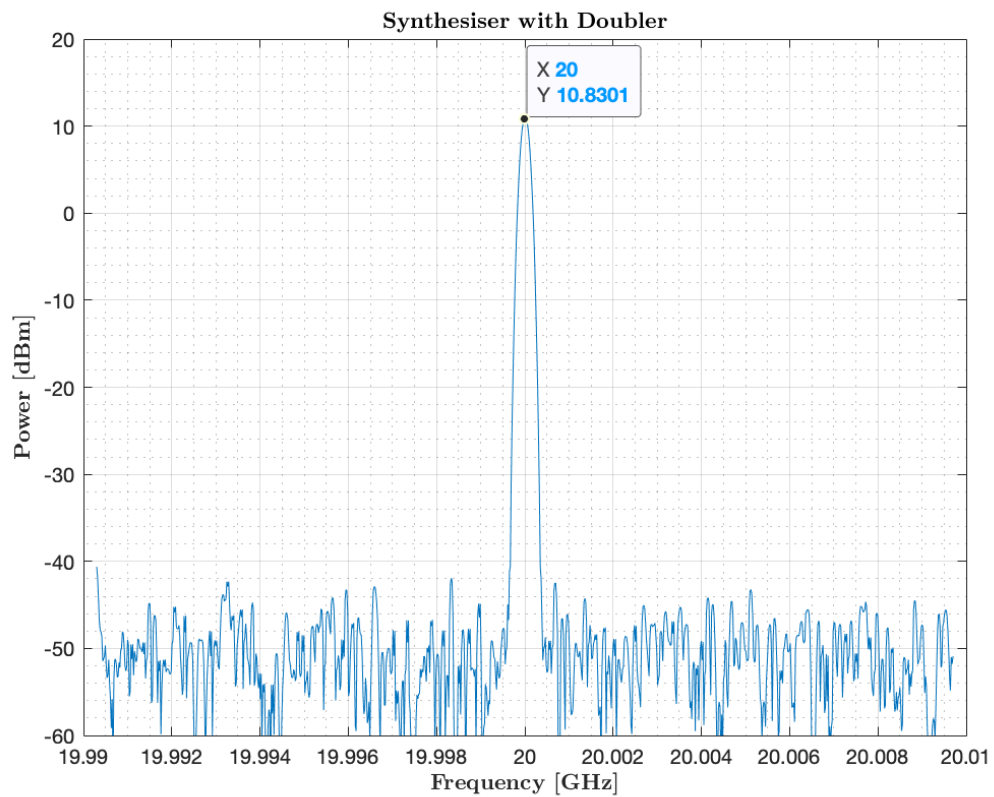


Figure 4.3: Output signal power of DLCRO combined with frequency doubler (ADA-1020).

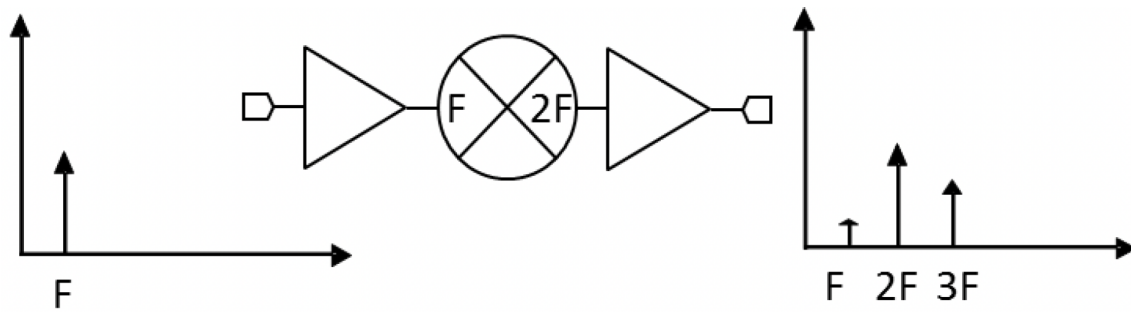


Figure 4.4: Schematic of the ADA-1020. Appendix B.

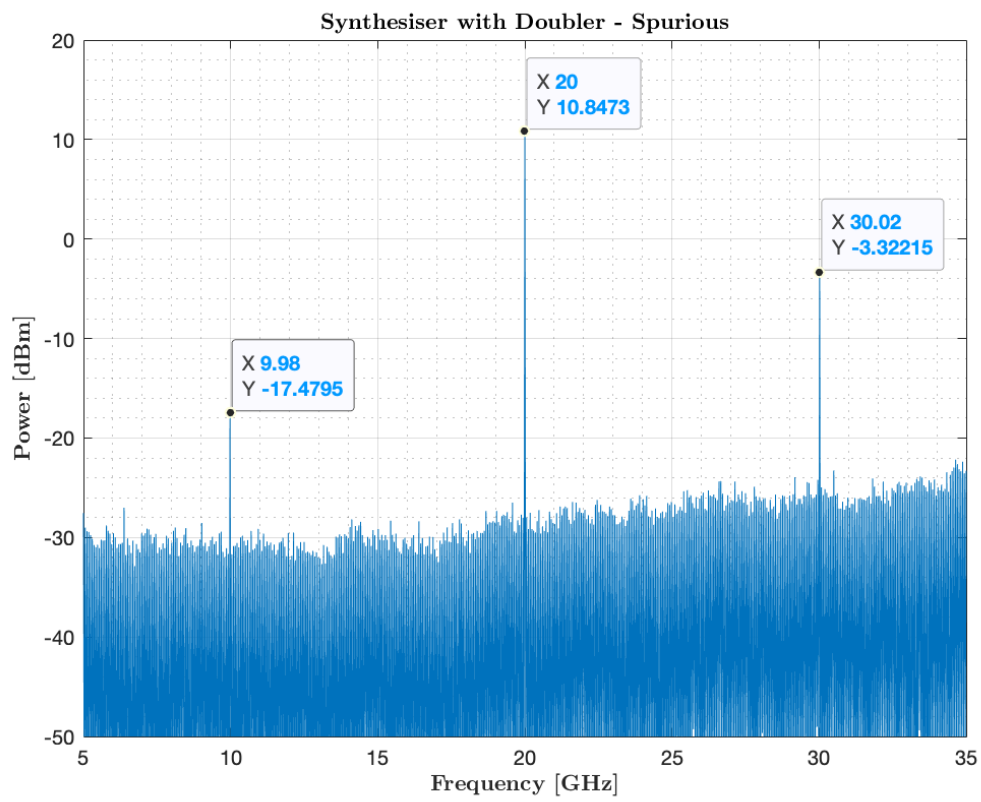


Figure 4.5: Output signal power of DLCRO combined with frequency doubler (ADA-1020). Spurious frequencies.

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

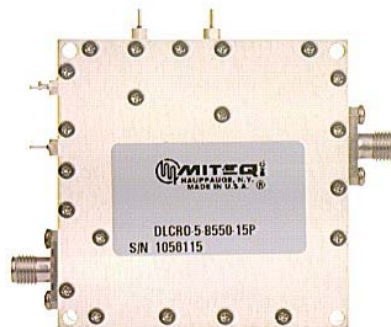
DUAL LOOP PHASE LOCKED COAXIAL RESONATOR OSCILLATOR

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

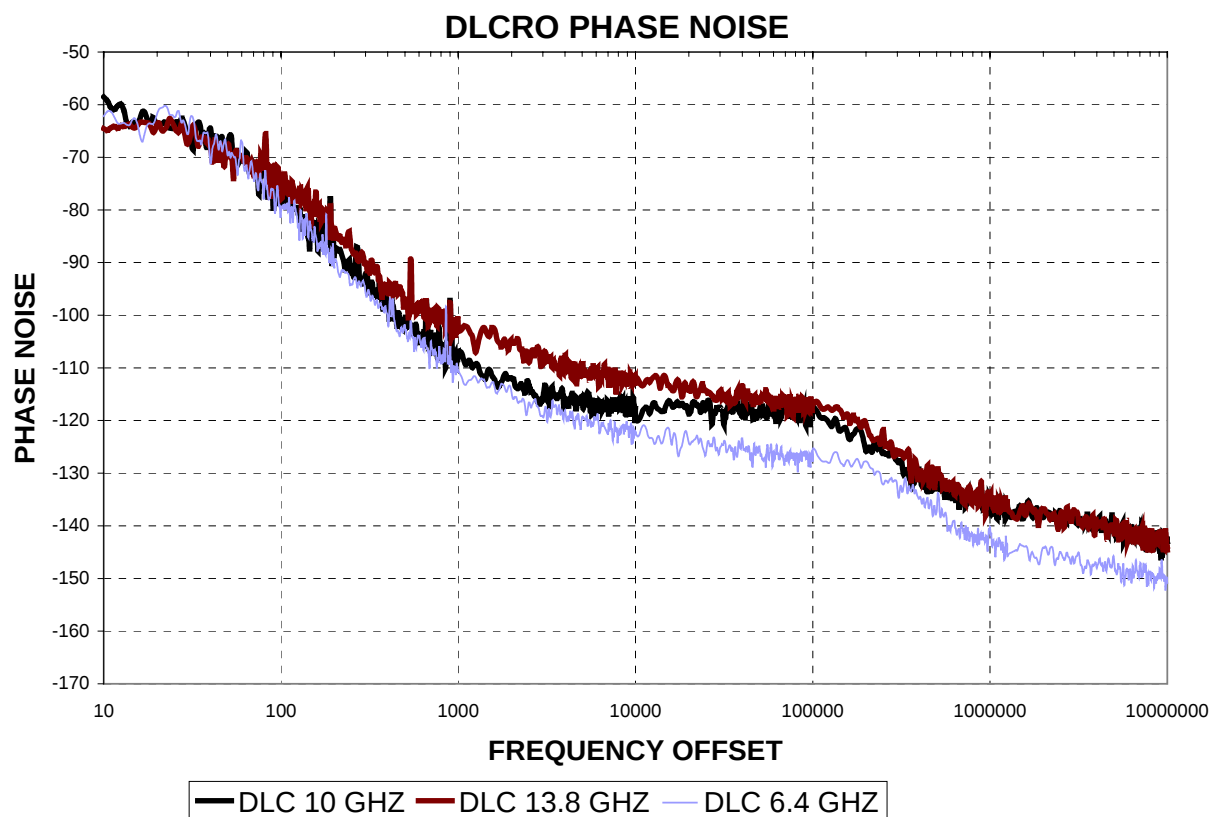
DLCRO- _____ - _____ - _____ - _____ P
External Reference Output Frequency ALARM D.C. Supply
Frequency (MHz) (MHz) (+volts)

Alarm options:

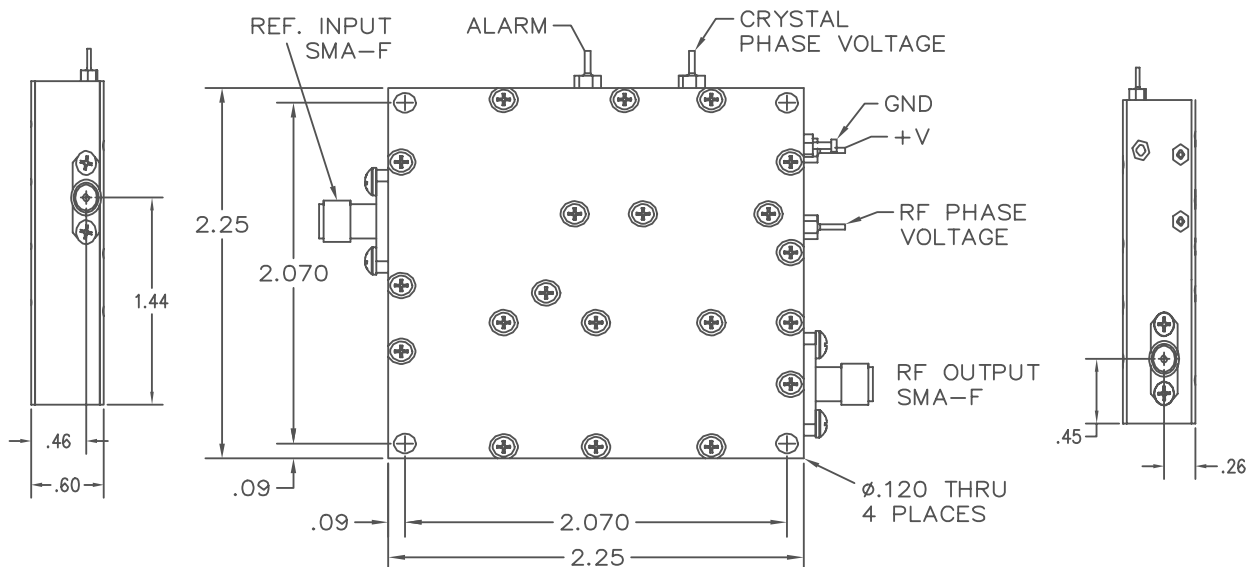
3. TTL: low in-lock, high out-of-lock
4. TTL: high in-lock, low out-of-lock



DUAL LOOP PHASE LOCKED COAXIAL RESONATOR OSCILLATOR



DLCRO OUTLINE DRAWING



Outline A:

DLCRO

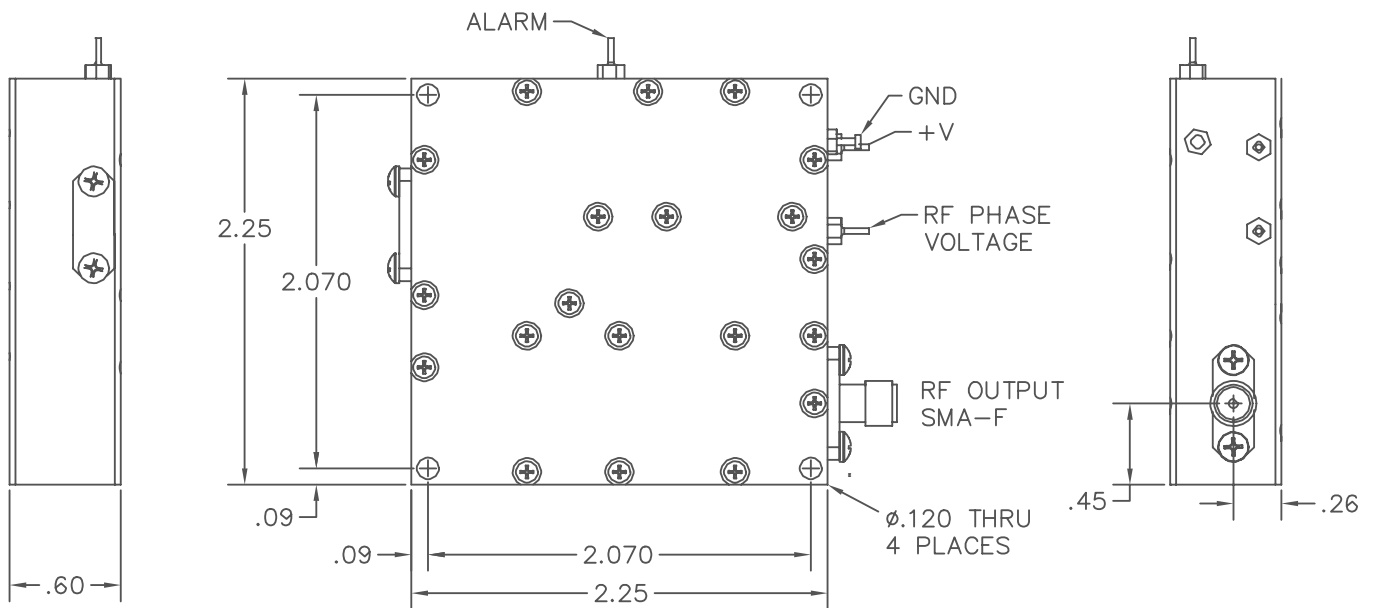


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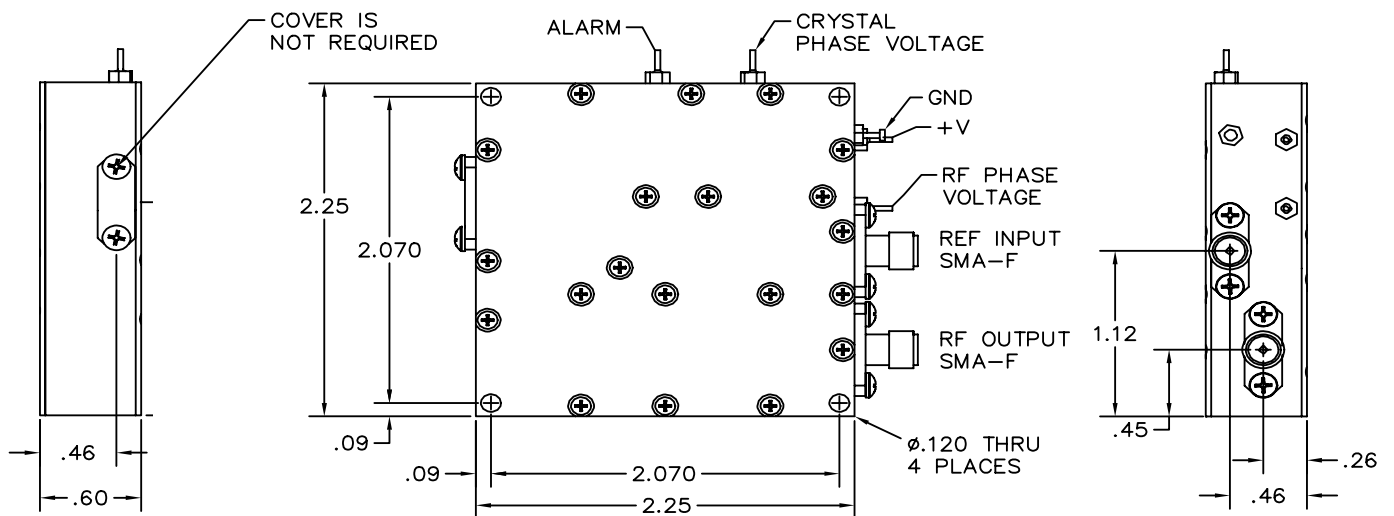
WN-177677B 8/21/2007

DUAL LOOP PHASE LOCKED COAXIAL RESONATOR OSCILLATOR

DLCRO OUTLINE DRAWING



DLCRO-1



Outline B:

DLCRO



B Data sheet: Frequency Doubler ADA-1020



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sales@fulai-elec.com
www.fulai-elec.com

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

¹It 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

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AMPLIFIER/DOUBLER/AMPLIFIER

Page 2

ADA-1020

Input 10.0 to 20.0 GHz
Output 20.0 to 40.0 GHz

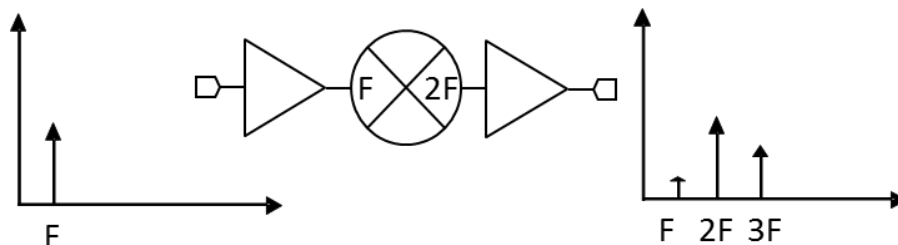
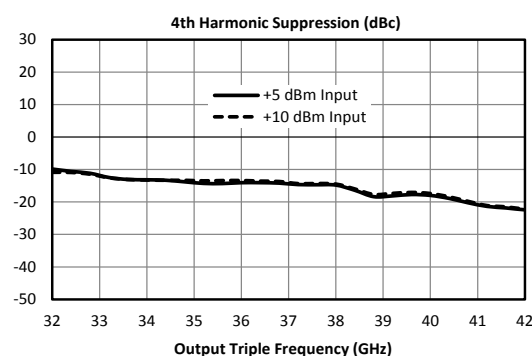
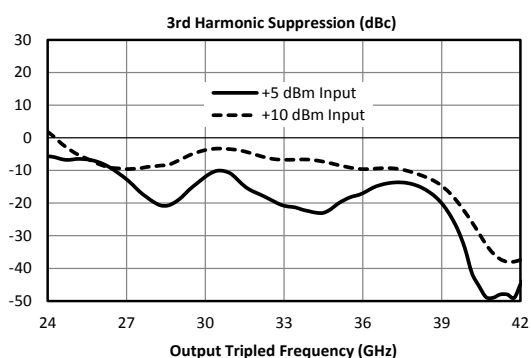
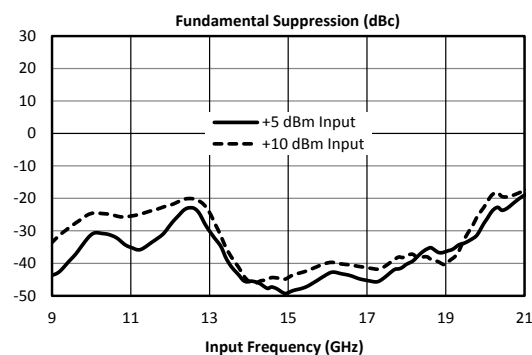
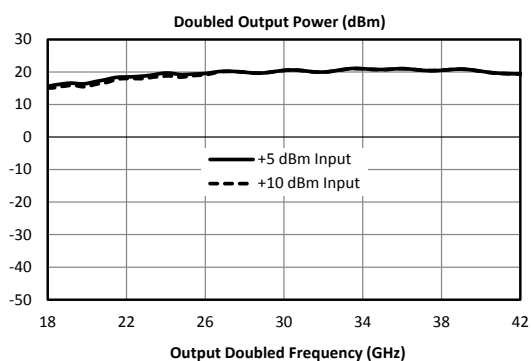


Figure 1. Schematic.

Typical Performance





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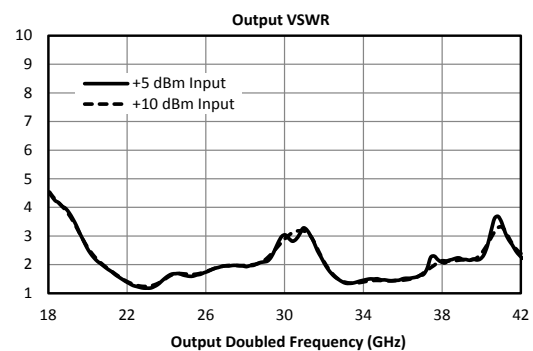
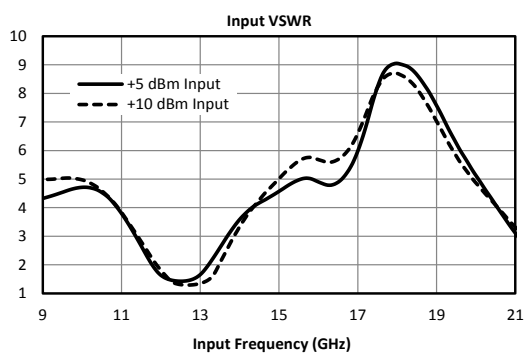
AMPLIFIER/DOUBLER/AMPLIFIER

Page 3

ADA-1020

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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