# The Oscillator Specification Sheet

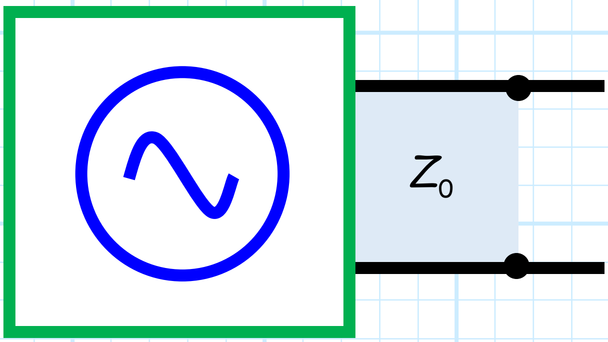



*Figure 1: The HMC-C200 Dielectric Resonator Oscillator (DRO) module covers 8.0 to 8.3 GHz.*

## Carrier Frequency

Microwave oscillators are generally specified in *MHz* or *GHz*.

Electronic oscillators have been made that work well into the **millimeter** wave region (e.g., 100 *GHz*), but we typically find that **increasing** the oscillating frequency means **decreased** oscillator performance (e.g., **lower power**, **less stability**) and increased oscillator **cost**!

Some oscillators are **tunable** (e.g. Voltage Controlled Oscillators), so the carrier frequency in **this case** is specified as a **bandwidth** (e.g., 2.3-3.9 *GHz*).

## Carrier Power

This is the **available power** of the source.

This value is generally specified in *dBm* for **low-power** oscillators, Watts for **high-power** oscillators.

**Typical** values for "small-signal" oscillators are **5 to 20 *dBm*** (hey, the same values as for **mixer LO** drive power—what a coincidence!).

## Accuracy

Specified in $\pm$**ppm** over the temperature range of the device (e.g., $-25^{\circ}$ C to $85^{\circ}$ C).

→This value is usually considered the **stability** of the oscillator!

## Harmonics and Spurs

Typically specified as the power of the **largest** spurious and/or harmonic signal, typically in terms *dBc*. For example:

*All spurious signal are less than -50 dBc*

This value depends on the quality **Q** of the resonator, as well as the amount of **filtering** provided between the oscillator and its output port.

## Phase Noise

Specified in **dBc** in a **one Hz bandwidth** at one or **more** specific frequencies **from the carrier**.

*e.g., -80 dBc in a 1Hz bandwidth at 1 kHz from the carrier frequency* $f_0$

**Every single word** in this specification is **required** in order to unambiguously specify phase noise!!!

The amount of phase noise exhibited by an oscillator depends on the **Q of the resonator**, the **carrier frequency** (higher frequencies generally exhibit worse phase noise), and the amount of **noise coupled** into the device through the power supply or tuning port.

## Noise Floor

This is the thermal noise (as opposed to phase noise) at the output of the oscillator. It is specified in terms of its **spectral power density**, assumed to be a **constant** value in mW/Hz, and generally specified as "*dBm, in a 1 Hz bandwidth*", or as "*dBm/Hz*" .

## DC power

Oscillators generally will **require** some specific **DC voltage**, and thus "pull" some amount of **DC current**.

The **product** of the two (DC volts and DC current) is of course the **DC power** $P_{DC}$ requirement of the oscillator.

## Efficiency

This coefficient expresses the **efficiency** at which the oscillator converts is DC power into microwave signal power (i.e., carrier power).

Efficiency $\eta$ is simply the **ratio** of the **available power** (in mW) of the oscillator (i.e., **carrier** power $P_C$ ) to the power (in mW) provided to the oscillator from the **DC power** supply (i.e., $P_{DC} = V_{DC} I_{DC}$ ):

$$\eta = \frac{P_C}{P_{DC}}$$

This coefficient varies from a **minimum of 0** (bad!) to a **maximum of 1.0** (good!).

## Frequency Pulling

Usually specified as the **maximum** frequency shift (in hertz or in ppm) from nominal frequency $\omega_0$, due to some worst-case load (expressed in VSWR, return loss, etc.). For example:

*Pulling is less than 0.1 MHz when driving a 2.5:1 VSWR load.*

This value again depends on the **Q of the resonator** and the **carrier frequency** (higher frequencies generally exhibit worse pulling). It likewise depends on the amount of **isolation** provided between the oscillator and its output port.

## Frequency Pushing

Expressed in units of *Hz/V* or *Hz/mV*, or sometimes as *ppm/V* or *ppm/mV* . Can be **either** a positive or a negative number.

This value depends on the **Q of the resonator**, the **carrier frequency** (higher frequencies generally exhibit worse pushing), and the amount of **internal voltage regulation** built into the oscillator.