

Oscillator Track: RF Oscillator Design

~ Toward Energy-Efficient and Low Phase Noise Signal Generation in Transceivers ~

Applicants: Students (both undergraduate and graduate tracks)

Preliminary review: No

1. Target specifications

(a) Center Frequency :

10 GHz $\pm$ 100 MHz ($\pm$ 1%)

(b) Output power :

Larger than 0 dBm (1mW)

(c) Harmonic content :

Smaller than -15 dBc for 2nd and 3rd harmonics (Figure 1)

(d) Power Consumption :

Lower than 100 mW total power consumption (max 25V)

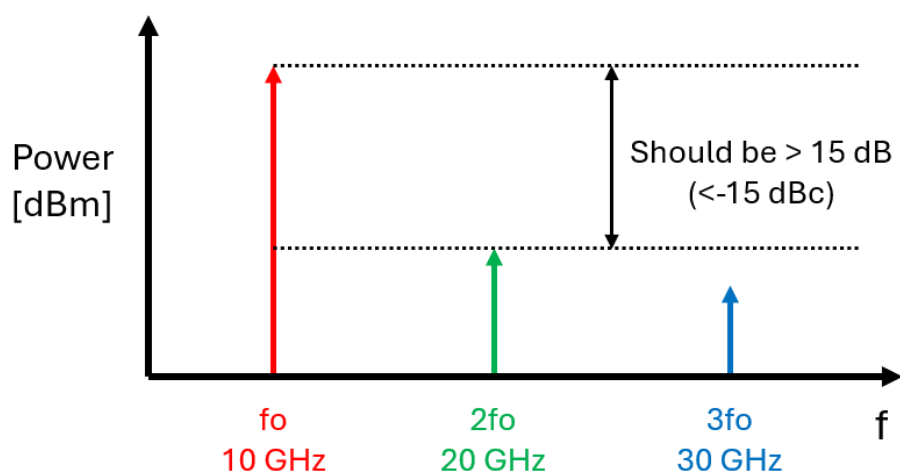


Figure 1. Target harmonic content power.

Selection rules

The winner will be determined by the circuit that achieves the maximum score based on the evaluation criteria below:

- Oscillation frequency (average of five measurements)
- Highest Efficiency
- Highest output power
- Lowest phase noise at 100 Hz, 1 kHz, 10 kHz, 100 kHz, 1 MHz (average 100)

Figure 2 displays the schematic of the measurement setup. A phase noise analyzer will be used to measure the oscillation frequency, output power, and phase noise. A short and low-loss 2.92mm coaxial cable (< 25 cm) will connect the designed oscillator to the phase noise analyzer. Insertion losses of the cable, coupler, and adapters will be deembedded for power analysis.

Each criterion will be scored independently. Oscillation frequency will be scored up to 7: First is 7, second is 5,

third is 3, and fourth is 1. Power consumption, output power, and phase noise at 100 Hz will be scored up to 5: First is 5, second is 3, third is 1. 1 kHz, 10 KHz, 100 KHz, and 1 MHz phase noise performances will be scored up to 3: First is 3, second is 2, third is 1.

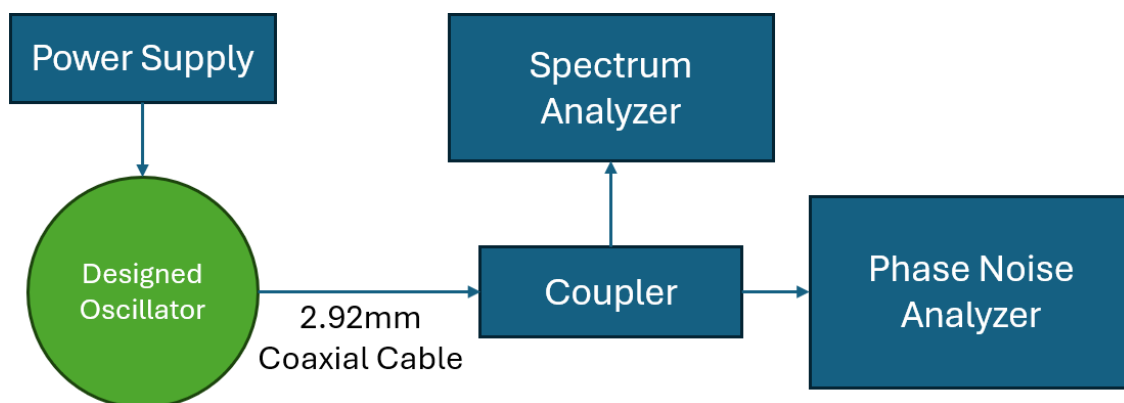


Figure 2. Measurement Setup.

Before measurements, the organization committee will visually inspect the submitted circuits to ensure no commercial oscillator, battery, or super-capacitor is installed. Sealed casings are not allowed. If the circuit is placed in a package or enclosure, it should be suitable for visual inspection (removable cover, transparent box, etc.).

The students will connect their circuit(s) to the coaxial RF cables, which have 2.92 mm male connectors for the measurements. The implemented circuits should be structurally reliable enough to withstand mechanical forces, such as torque and cable tension. The competition committee accepts no responsibility for any physical damage that may occur during the competition. The designs meeting the technical design rules will be evaluated during the competition.

Each circuit will be given a maximum of 10 minutes to complete cable connections and prepare the circuit for the measurement (including tuning if necessary). The measurements will be done in a place open to all participants. A constant temperature condition cannot be guaranteed.

No tuning is allowed during the measurements while the circuit is connected to the phase noise analyzer. If there is enough time after measuring all of the participants' circuits, it may be possible to re-measure some circuits if time permits.

2. Design conditions

(1) Board shape and size:

The total area of the designs should not exceed 40 cm² (8 cm x 5 cm, 10 cm x 4 cm, etc.). Extension of connectors will not be considered (only PCB or case dimension). There is no restriction on board shape.

(2) Board material and passive components:

Any substrate materials and passive components (such as ceramic and multi-layer) are allowed for circuit design.

(3) Interface for output signal:

The connector should be a 50 Ω female type that is suitable for coaxial cables with 2.92 mm male connectors. 2.92 mm, 3.5 mm, and SMA connectors are compatible (mateable) with each other.



July 22, 2026

(4) Biasing:

There will be a 3-channel power supply for biasing and a tuning supply (if necessary) ready during the measurements at the competition day. Additional power supply, battery, or super-capacitor is not allowed. Participants should bring their biasing cables. Power supply will have standard 4 mm banana plugs.

(5) Number of circuits:

Each team can participate with a maximum of two circuits.

(6) Available components:

Only passive components (R, L, C) and unmatched transistors may be used. Any off-the-shelf oscillator IC and battery components are NOT allowed.

(7) Case:

Radio shielding case can be used. However, ensure that the judges can check the inside.

Therefore, the case should be ready for visual investigation.

(8) Integrated amplifier (optional):

An amplifier integrated into the design to increase the output power is allowed. It should be on the same circuit board as the oscillator. Additional biasing is not allowed. The oscillator and amplifier should share the same biasing source. Power consumption of the amplifier and oscillator will be used as the total power consumption score.

Example scoring:

Student	Oscillation Frequency [GHz]	Efficiency [%]	Output Power [dBm]	100 Hz [dBc]	1 KHz [dBc]	10 KHz [dBc]	100 kHz [dBc]	1 MHz [dBc]	Total
A	10.01 Score: 7	5.4 Score: 1	3.6 Score: 1	-50.6 Score: 3	-72 Score: 2	-85 Score: 2	-90	-105 Score: 3	19
B	10.06 Score: 3	7.1 Score: 3	5.0 Score: 3	-53.2 Score: 5	-76 Score: 3	-82 Score: 1	-91 Score: 1	-104 Score: 2	21
C	9.91 Score: 1	10.0 Score: 5	8.6 Score: 5	-46.0	-76 Score: 3	-86 Score: 3	-92 Score: 2	-103 Score: 1	20
D	9.95 Score: 5	2.2	1.2	-49.0 Score: 1	-70 Score: 1	-65	-93 Score: 3	-103 Score: 1	11

(All numbers are randomly selected. Do not use them as a reference!)