MWC Experiment 7

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Aim:

To perform GFSK using PlutoSDR and GNURadio

Theory:

PlutoSDR (ADALM-Pluto) is a **Software-Defined Radio (SDR)** platform developed by **Analog Devices**. It's designed primarily for learning, experimentation, and prototyping in the field of **wireless communications**, **signal processing**, and **RF systems**.

It connects to a computer via USB and allows users to **transmit and receive real-world RF signals** using software tools like **GNU Radio**, **MATLAB/Simulink**, or **PyADI-IIO (Python)**.

Key Features:

Feature	**Specification**
Frequency Range	325 MHz to 3.8 GHz (can be extended unofficially to ~70 MHz–6 GHz via firmware mod)
Bandwidth	Up to 20 MHz
ADC/DAC Resolution	12-bit

Feature	Specification
Transceiver IC	Analog Devices **AD9363** (a flexible RF agile transceiver)
Processor	Xilinx **Zynq Z-7010 SoC** (ARM Cortex-A9 + FPGA)
Interface	USB 2.0 (acts as both power and data link)
Tx/Rx Channels	1 Transmit, 1 Receive
Sampling Rate	Up to ~61.44 MSPS
Power Supply	USB powered (5 V)

PlutoSDR can **generate (transmit)** and **capture (receive)** radio signals in real time.
You can use software such as:

- **GNU Radio** – for flowgraph-based signal processing and modulation experiments.
- **MATLAB/Simulink** – for modeling and testing custom communication systems.
- **IIO Scope** – to visualize real-time signals.
- **Custom C/Python code** using libIIO libraries.

It behaves as a **bidirectional RF front-end**, meaning it can act as:

- A **signal source** (transmitter)
- A **signal analyzer** (receiver)
- Or both, for full **transceiver** operation.

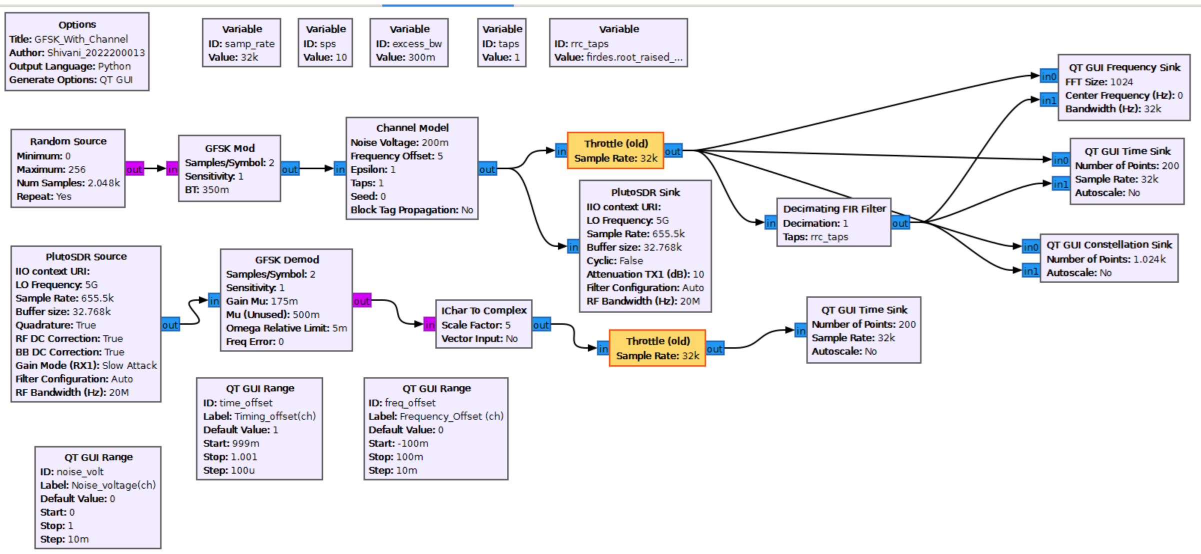
Advantages

- Affordable and compact SDR device.
- Easy to interface with open-source tools.
- Highly flexible and reconfigurable.
- Real-time RF experimentation possible.
- Large online community and documentation from Analog Devices.

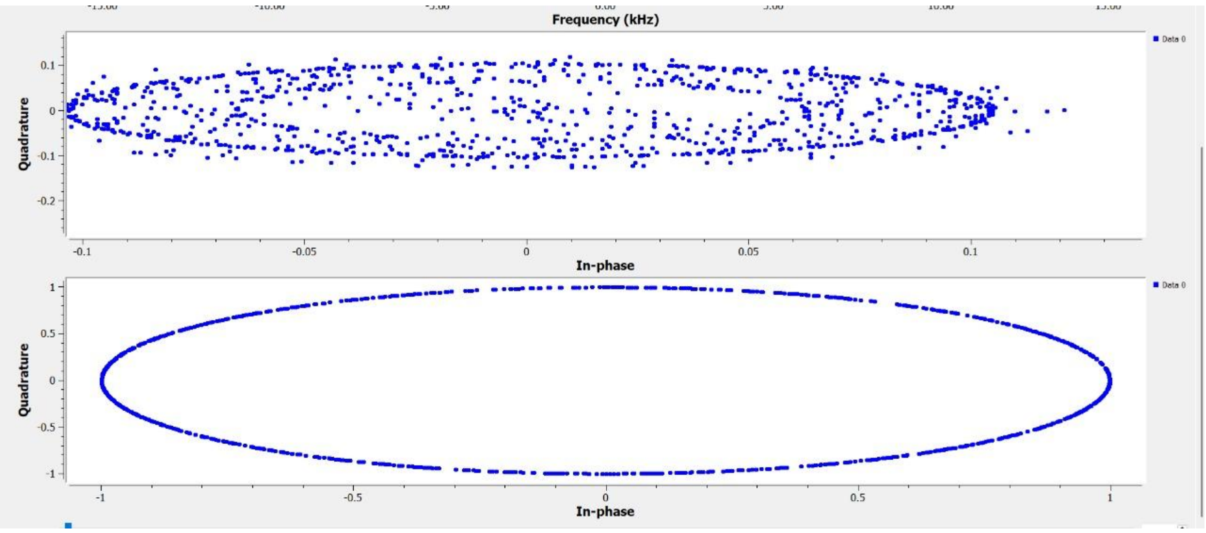
Limitations

- Only **1×1 MIMO** (one transmit, one receive channel).
- Limited bandwidth compared to high-end SDRs (e.g., USRP, BladeRF).
- USB 2.0 can be a bottleneck for high data rate applications.
- Output power is relatively low (not for long-range transmission).

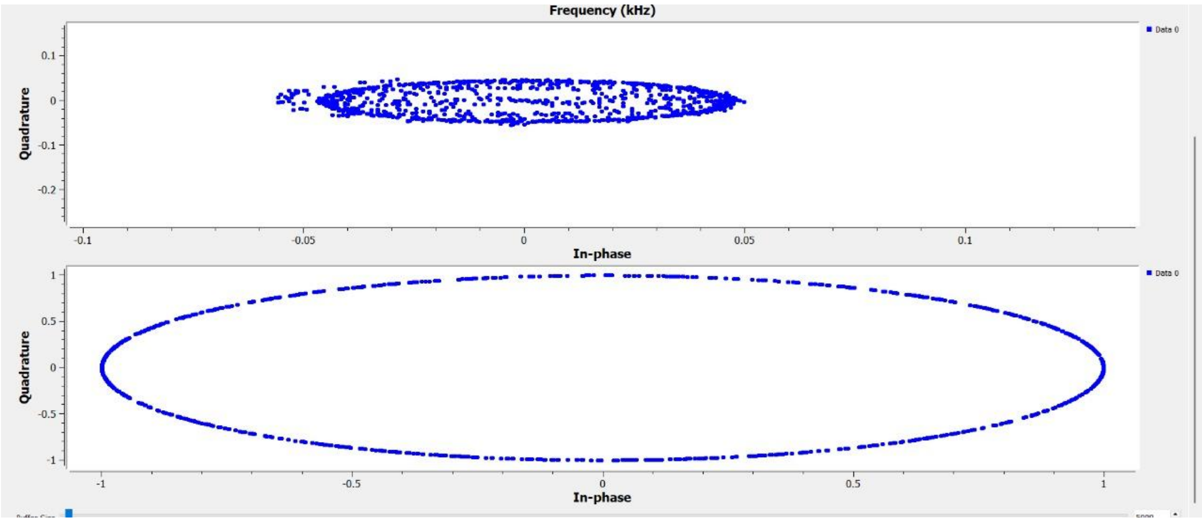
Simulations and Screenshots:



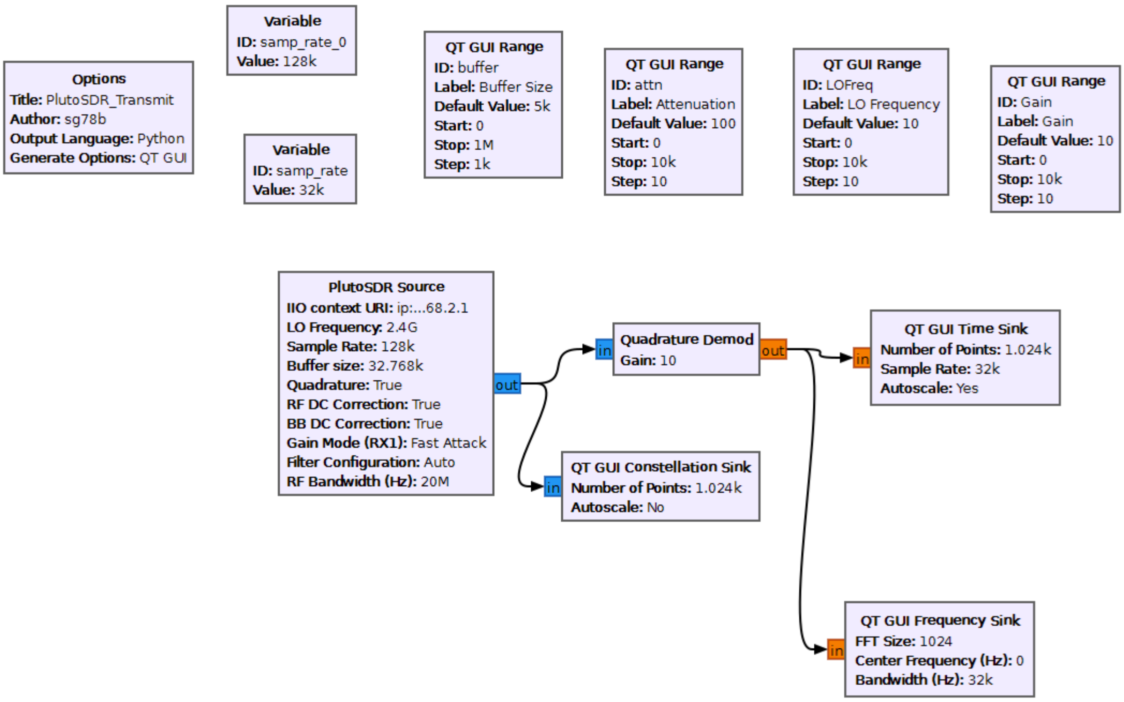
PlutoSDR Locally with the computer



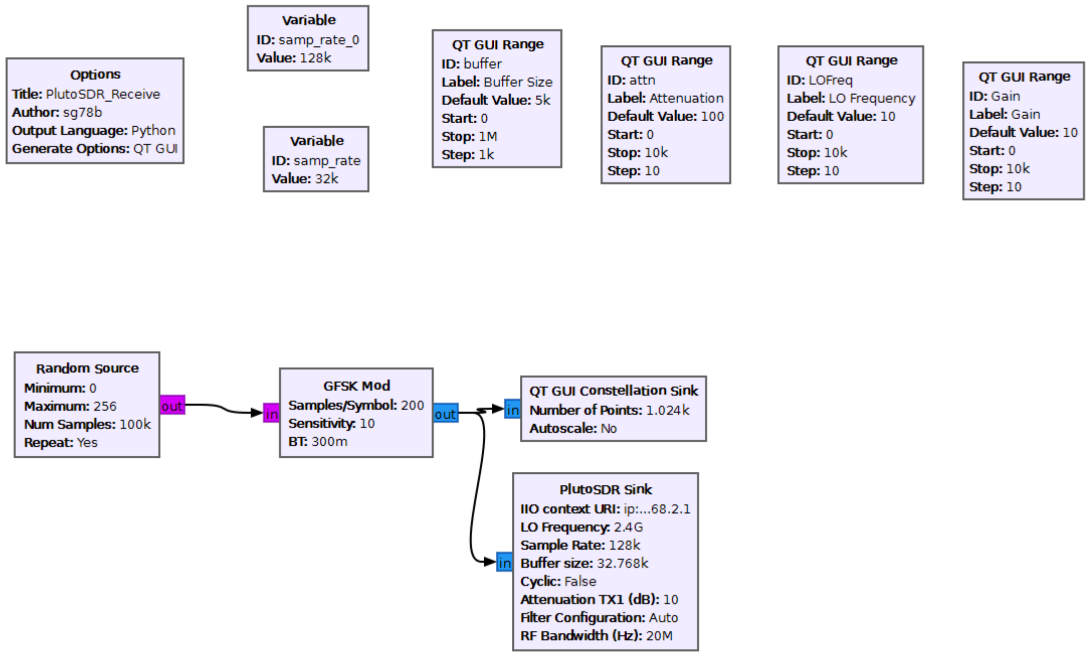
In air



When the device was blocked by hand



Transmitter



Receiver

Conclusion:

In this experiment, we used two PlutoSDRs — one configured as a **transmitter** and the other as a **receiver** — to analyze the behavior of **Gaussian Frequency Shift Keying (GFSK)** under varying channel conditions.

1. **Open-Air Transmission:**
   When both SDRs were in open air with a clear line of sight, the received signal strength was high and the demodulated bitstream closely matched the transmitted data. The constellation and spectrum remained clean, indicating minimal interference or multipath distortion.
   → **Conclusion:** GFSK performs reliably with high SNR in free-space conditions.

2. **Hand Obstruction (Human Attenuation):**
   When the transmitting antenna was partially blocked by a hand, noticeable attenuation occurred. The RSSI dropped, the received symbols exhibited frequency drift and phase distortion, and some bit errors were observed. This shows the impact of human tissue absorption (due to high water content) at RF frequencies.
   → **Conclusion:** Human body introduces significant attenuation and scattering, reducing link quality even over short distances.

3. **Indoor-to-Indoor (Lab Condition):**
   When both SDRs were placed inside the lab, reflections from metallic objects and walls created **multipath effects**, causing small frequency offsets and intersymbol interference. However, GFSK's constant envelope and narrowband nature helped maintain reasonable data integrity.

→ Conclusion: GFSK remains robust in multipath environments but is still affected by reflections and interference from lab equipment.

4. **Indoor-to-Outdoor Transmission:**
When one SDR was placed outside the lab (signal passing through a wall or door), the received power dropped significantly, and packet loss increased due to **material absorption and diffraction losses**.
→ Conclusion: Structural barriers (walls, doors) introduce severe attenuation; hence, GFSK over PlutoSDR has limited penetration through concrete or metallic boundaries.

The experiment demonstrates that **GFSK is a spectrally efficient and robust modulation technique for low-power and short-range wireless communication**, but **channel conditions — especially obstacles, human presence, and indoor reflections — significantly influence signal quality and reliability**. Practical deployments must therefore consider **antenna placement, frequency selection, and path loss** to maintain reliable performance.