PROJECT ABSTRACT

DDS Signal Generator using AD9833 with Sweep Mode

A bench signal generator built on the AD9833 direct-digital-synthesis module: sine/square/triangle to 12.5 MHz, encoder-based UI, OLED readout, sweep mode and preset memory — delivered built-to-order with working prototype, firmware, wiring documentation, report, PPT and viva kit.

01. Title

DDS Signal Generator using AD9833 with Sweep Mode

02. Introduction / Background

Testing any analog circuit — a filter's cutoff, an amplifier's bandwidth — starts with injecting a known signal, which is why the function generator is a bench staple. Classical generators use RC or 555 oscillators whose frequency drifts with temperature and tunes coarsely. Direct digital synthesis takes the digital approach: a phase accumulator advances through a sine lookup table at a programmable rate and a DAC converts the samples to analog — the frequency is set by a digital tuning word against a stable crystal, accurate and adjustable in tiny steps. The AD9833 packages this engine in a cheap SPI module. This project wraps it in a complete instrument: Arduino control, rotary-encoder frequency entry, OLED display, waveform selection, automatic sweep mode and preset memory.

03. Problem Statement

Students use function generators as black boxes without understanding how stable, fine-stepped frequencies are actually produced. The project addresses this by building the instrument around a real DDS core, where the tuning-word math, the Nyquist limit and the sweep technique are all implemented in firmware the student writes and can explain — verified on an oscilloscope across the range.

04. Objectives

- Drive the AD9833 over SPI with firmware-computed 28-bit frequency tuning words.
- Generate sine, triangle and square waves from 0.1 Hz to 12.5 MHz (AD9833 datasheet range).
- Implement frequency sweep mode between configurable start/stop frequencies.
- Provide a rotary-encoder menu UI with OLED readout.

- Condition the output through an op-amp buffer/gain stage to a BNC connector.
- Store presets in EEPROM.
- Deliver a buyer-run verification procedure plus the complete student kit.

05. Proposed Methodology

The methodology has three stages. (1) DDS driver: firmware computes the tuning word from the desired frequency and reference clock, and writes frequency/control registers over SPI. (2) Instrument UI: a rotary-encoder menu sets frequency, waveform and sweep parameters shown on the OLED; presets persist in EEPROM. (3) Verification: the buyer checks the output on an oscilloscope/CRO across the range — waveform shape, frequency accuracy and sweep behavior — per the documented procedure, and uses sweep mode to find a test filter's cutoff.

06. System Architecture / Working

The chain is: Arduino -> SPI -> AD9833 (phase accumulator, sine table, 10-bit DAC, waveform modes) -> op-amp buffer/gain stage -> BNC output. The user interface chain is: rotary encoder with push-select -> menu firmware -> OLED display + EEPROM presets. In sweep mode the firmware steps the tuning word linearly between start and stop frequencies at the set rate while the OLED shows instantaneous frequency.

07. Hardware / Software Requirements

- Hardware: Arduino Uno/Nano, AD9833 DDS module, rotary encoder with push-button, I2C OLED display, op-amp output stage, BNC connector, enclosure.
- Software: Arduino IDE, C/C++ firmware (SPI driver, tuning-word math, menu UI, sweep engine, presets).
- Test: oscilloscope/CRO for the buyer's verification procedure.

08. Expected Outcomes

A working bench signal generator producing the three waveforms across the AD9833 range with crystal-referenced frequency setting, a usable sweep mode for response testing, and an instrument-grade encoder/OLED interface — verified by the buyer's own oscilloscope checks; plus firmware, wiring docs, report, PPT and viva Q&A.

09. Applications

Function generators serve filter/amplifier testing, sensor excitation, audio prototyping, education labs and RF-experiment signal sources. The DDS build teaches the synthesis principles inside modern commercial generators.

10. Future Scope

AM/FM modulation modes; arbitrary waveform via external DAC tables; USB/serial remote control (SCPI-style); dual-channel phase-locked outputs; and a frequency-counter input mode.