

rtArts GNSS-SIM | Datasheet

TECHNICAL SPECIFICATION

Real-Time Multi-Channel Multi-Constellation GNSS RF Signal Simulator Platform

PRODUCT CATEGORY

GNSS RF Simulator

CONSTELLATION SET

GPS • GLONASS • GAL • BDS

RF ARCHITECTURE

Wideband Multi-Carrier

SIMULATION UPDATE

100 Hz Real-Time



4 Constellations

Full core integration for GPS L1 C/A, GLONASS L10F (FDMA), Galileo E1 (CBOC), and BeiDou B1C.



Wideband RF

Advanced digital RF synthesis enabling simultaneous multi-carrier transmission across L1/E1/G1/B1 navigation bands.



100 Hz Loop

Deterministic 100 Hz real-time simulation loop (10 ms epoch) guaranteeing continuous and stable RF carrier generation.



HWIL Optimized

Purpose-built for Hardware-in-the-Loop (HWIL) testing. Features an ultra-low latency UDP interface, 100 Hz deterministic kinematic updates, and robust physics extrapolation.

01 Product Overview

rtArts GNSS-SIM is an advanced, high-precision GNSS RF signal generator engineered for multi-constellation satellite navigation receiver testing, aerospace and defense avionics verification, and autonomous system validation. Built on a **4-constellation GNSS architecture**, the system provides real-time RF carrier synthesis across the primary navigation bands for **GPS L1 C/A, GLONASS L10F, Galileo E1, and BeiDou B1C**. Crucially, the core engine and processing pipeline are purpose-built for Hardware-in-the-Loop (HWIL) integration. This minimizes signal latency, eliminates jitter, and ensures mathematically robust real-time extrapolation under high-dynamic stress conditions.

INPUTS & CONTROL

RINEX 2/3 (GPS/GLO/GAL/BDS)

CSV Dynamic Trajectory

Real-Time HIL Stream (100 Hz)

Web UI / Remote API

MULTI-GNSS SIMULATION ENGINE

Real-Time Broadcast Propagator & RK4

Klobuchar, NeQuick-G & Saastamoinen

Attitude-Aware Antenna Masking & Attenuation

Real-Time Multi-Carrier Synthesis Pipeline

RF OUTPUT & STORAGE

Direct Coaxial RF Output

SMA Port (50 Ω)

Baseband Recording

High-Fidelity Complex I/Q

02 Supported GNSS Signals & Spectrum Allocation

BeiDou B1C (1575.42 MHz)

GPS L1 C/A • Galileo E1 OS (1575.42 MHz)

GLONASS L10F FDMA (1602.00 MHz)

CONSTELLATION	SIGNAL TYPE	CARRIER FREQUENCY	MODULATION / CHIP RATE	CODE STRUCTURE & LENGTH	NAVIGATION MESSAGE	ATMOSPHERIC ENGINE	SUPPORTED PRN / SLOT RANGE & ALLOCATION
GPS	L1 C/A	1575.42 MHz	BPSK(1) • 1.023 Mcps	1023-chip Gold code (PRN 1-32)	LNAV (50 bps)	Klobuchar + Saastamoinen	PRN 1-32 (Dynamic visibility tracking)
GLONASS	L10F FDMA	1602.00 MHz + k×562.5 kHz	BPSK(0.5) • 0.511 Mcps	511-chip m-sequence	GNAV (50 bps)	1/f ² Frequency Scaled + Saastamoinen	Slots 1-24
Galileo	E1 Open Service	1575.42 MHz	CBOC(6,1,1/11) • 1.023 Mcps	E1-B (Data) + E1-C (Pilot) (4092 chips/4ms)	I/NAV (250 sps)	JRC NeQuick-G + Saastamoinen	PRN 1-36 (Up to 12 active channels)
BeiDou	B1C	1575.42 MHz	QBOC(6,1,4/33) • 1.023 Mcps	10230-chip Weil code	B-CNAV1	BDGIM + Saastamoinen	PRN 1-63 (Dynamic visibility tracking)

03 RF Specifications & Multi-Constellation Operating Modes

Profile Name	Active Constellations	Carrier Center	Channel Plan
GPS Single-Constellation	GPS L1 C/A	1575.42 MHz	Dedicated L1 Channel Plan
GLONASS Single-Constellation	GLONASS L1OF	1602.00 MHz	Full FDMA Grid (k = -7...+6)
Galileo Single-Constellation	Galileo E1 OS	1575.42 MHz	CBOC Modulation Channel Plan
Multi-GNSS (GPS + GAL + GLO + BDS)	GPS + GAL + GLO + BDS	Wideband Span	Multi-Carrier Multiplexing
BeiDou Single-Constellation	BeiDou B1C	1575.42 MHz	QMBOC Channel Plan

04 Orbital Mechanics, Atmospheric & Environmental Models

Orbital Geometry & Relativistic Physics

- **Keplerian Orbit Computation:** Computes instantaneous satellite position and velocity vectors from broadcast ephemerides for GPS, Galileo, and BeiDou constellations.
- **Runge-Kutta Integrator:** Performs 4th-Order Runge-Kutta (RK4) numerical integration for GLONASS state vectors.
- **Time-of-Flight (TOF):** Utilizes an iterative convergence algorithm to accurately resolve the true light-time transmission delay.
- **Sagnac Correction:** Compensates for the geometric delay caused by Earth's rotation (Sagnac effect).
- **Satellite Clock Corrections:** Evaluates constellation-specific broadcast clock polynomials (bias, drift, drift rate) along with relativistic corrections.

Atmospheric Delay & Antenna Masking

- **Ionospheric Models:** Supports GPS Klobuchar, GLONASS 1/f², Galileo JRC NeQuick-G, and BeiDou BDGIM models.
- **Tropospheric Refraction:** Implements the Saastamoinen standard atmosphere slant delay model (assuming 50% humidity).
- **Attitude-Aware Antenna Masking:** Dynamically evaluates line-of-sight based on the vehicle's 3D orientation. Features built-in geometrical profiles: Open Sky, Roof Top, Aircraft Top, and Body Mounted.
- **Elevation Cutoff:** Allows dynamic configuration of the elevation mask angle from 0° to 90° during runtime.

05 Operational Modes & Hardware-in-the-Loop (HIL)

Real-Time HIL Motion Ingestion

Ingests high-rate 50-100 Hz UDP binary telemetry streams to drive real-time 6-DOF dynamic trajectory simulations.

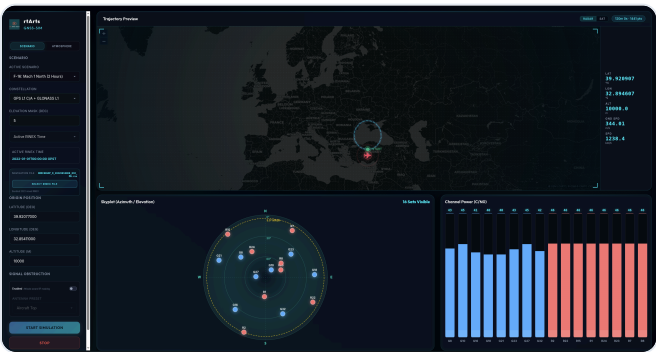
- ✓ **WGS-84 Datum Origin:** Automatically aligns the simulation to the initial geodetic origin.
- ✓ **Translational Kinematics:** Processes real-time 3D position, velocity, acceleration, and jerk vectors.
- ✓ **Attitude Dynamics:** Incorporates 3D vehicle orientation (heading, pitch, roll) and angular rates.
- ✓ **Synchronized Synthesis:** Continuously translates vehicle kinematics into instantaneous carrier Doppler shifts and pseudoranges.

System Network & Interface Map

Interface	Transport / Port	Function
Web Dashboard	HTTP :8888	HTML5 GUI
Remote API	JSON over TCP :9002	Line-delimited JSON interface for commands and telemetry
HIL Input	UDP :8080	Receives high-rate 6-DOF dynamic motion telemetry
RF Output	Coaxial SMA	Multi-channel RF carrier output (50 Ω)
Data File Export	File System	Raw baseband I/Q recordings

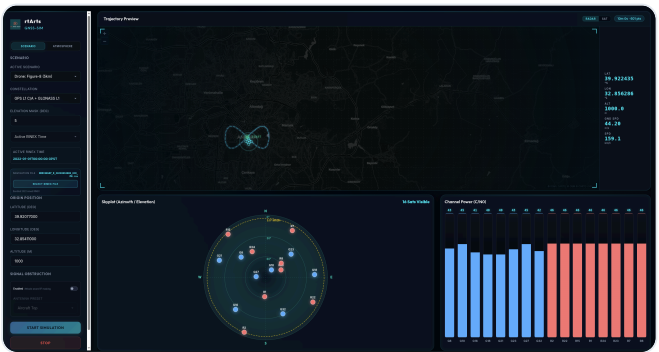
06 Control Interface & Real-Time Visualization

F-16 Mach 1 Supersonic Flight Scenario



Features a live dynamic flight trajectory preview, a multi-constellation polar skyplot (showing GPS and GLONASS SVs), and individual channel C/N0 power management bars.

Drone Lemniscate Flight Scenario



Demonstrates Lemniscate trajectory tracking over a regional map, accompanied by 6-DOF dynamic velocity and altitude telemetry, alongside synchronized multi-channel RF carrier synthesis.

System Operating Specifications

-  **Host Operating System:** Linux x86_64
-  **Compute Architecture:** Multi-core x86_64 processor
-  **System Memory:** 8 GB RAM minimum (16 GB recommended)
-  **RF Output Interface:** 50 Ω SMA Female
-  **Cabling & Attenuation:** Inline RF attenuation and DC block recommended for direct receiver connection