TECHNICAL BRIEF

GenHawk™ Modulation Options

The **GenHawk (GH-60)** Vector Signal Generator is a compact, yet powerful handheld signal generator designed for professionals who require precise RF signals across a broad frequency range. Operating from 10 MHz to 6 GHz (with an upgrade option from 300 kHz to 6.5 GHz), it supports a wide array of analog and digital modulation techniques—from AM/FM and pulse modulation to advanced cellular standards like GSM, WCDMA, LTE, and 5G NR.

This Technical Brief provides an overview of what modulation options are available for GenHawk, the settings for those modulations, and who might find the capabilities useful.

Analog Modulation

Analog Modulation

AM, FM, PM

Ideal for: Aerospace, Defense, Broadcasting, Education, EMC Testing

Analog Modulation refers to the process of varying a continuous RF carrier signal in accordance with the amplitude (AM), frequency (FM), or phase (PM) of an analog signal. These are the most fundamental modulation techniques and remain relevant across a wide range of industries including aerospace, defense, broadcasting, EMC testing, and education. Engineers use analog modulation to simulate legacy communications systems, test receiver sensitivity or inject known signals for compliance and performance evaluation.

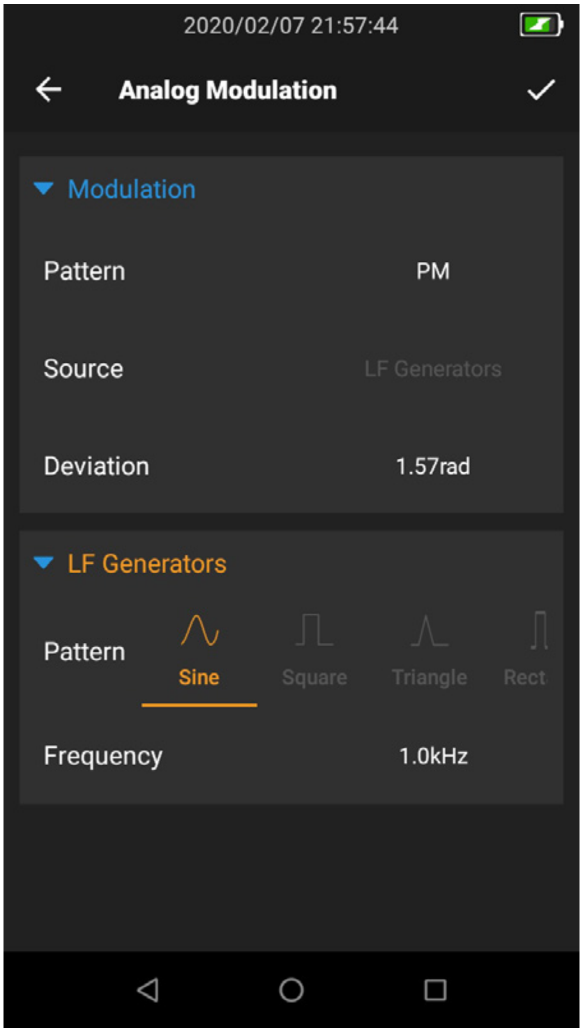
GenHawk's analog modulation option supports AM, FM, and PM, each having an adjustable deviation for the modulation. AM allows the depth of modulation to be set between 1 and 100%, FM allows the frequency deviation to be set between 0.1 and 10 kHz, and PM allows the phase deviation to be set between 0 and 2π radians.

Modulation Types

For each modulation type, you configure the modulation frequency through the Low Frequency Generator. The modulation frequency can be configured from 1 kHz–10 MHz as one of the following waveforms:

- **Sine wave**
- **Square wave**
- **Triangle wave**
- **Rectangle wave** (being a square wave with adjustable duty cycle from 1-100%)
- **Ramp Up**
- **Ramp Down**

Option MTX-S016



These controls reflect the most common real-world parameters engineers need to tweak when designing or testing analog RF systems. Offering this level of control ensures that users can replicate both ideal and degraded modulation conditions, which is critical when testing equipment behavior under various signal fidelity scenarios.

Custom Digital Modulation

ASK, PSK, FSK, and QAM

Ideal for: R&D, Compliance Testing, SDR Development

Digital Modulation encodes data onto a carrier signal through a range of digital schemes, such as PSK, FSK, or QAM. Digital modulation is used extensively for engineers developing or testing digital communication systems, including wireless protocols, software-defined radios, and embedded RF modules. It's especially valuable in R&D, compliance testing, and academic settings where users need to simulate or analyze specific modulation behaviors beyond standardized formats. GenHawk's custom digital modulation feature provides control over key parameters including the modulation types:

ASK (Amplitude Shift Keying)

ASK uses changes in signal amplitude to encode digital information.

PSK (Phase Shift Keying)

PSK Is a method of encoding digital information using phase variations. The PSK options included in this module allow you to select 2, 4, or 8 unique phases (symbols), some with EDGE (Enhanced Data Rates) options for GSM (Global System for Mobile Communications).

- **BPSK** (Binary Phase Shift Keying)
- **QPSK** (Quadrature Phase Shift Keying)
- **QPSK 45° Offset**
- **QPSK EDGE**
- **OPSQSK** (Offset Phase-Quadrature Shift Keying)
- **π/4-QPSK** (π/4 Shifted QPSK)
- **π/2-DBPSK** (π/2 shifted Differential BPSK)
- **π/4-DQPSK** (π/4 shifted Differential QPSK)
- **π/8-D8PSK** (π/8 shifted Differential 8PSK)
- **8PSK**
- **8PSK EDGE**

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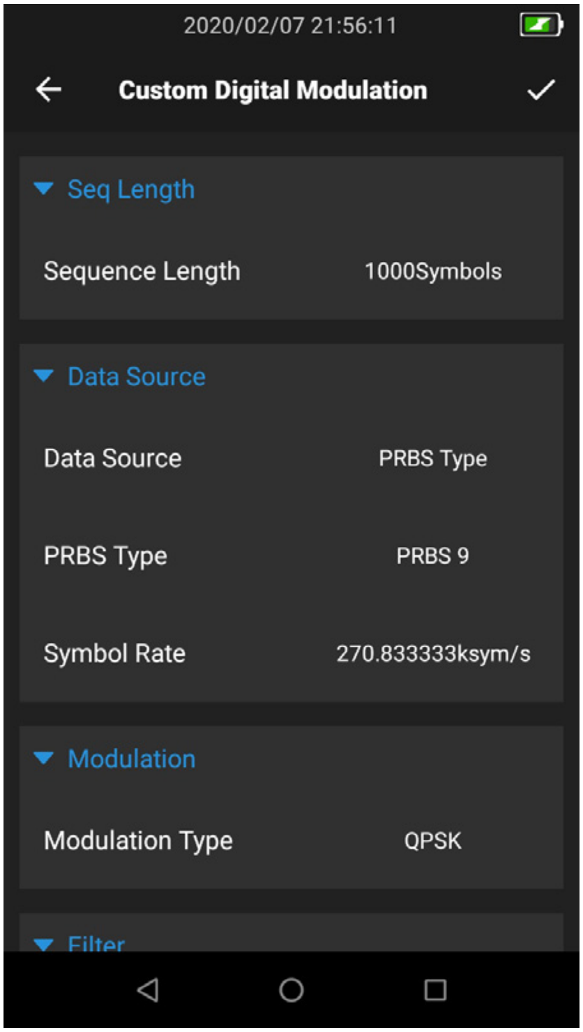


Custom Digital Modulation *(continued)*

ASK, PSK, FSK, and QAM

Ideal for: R&D, Compliance Testing, SDR Development

QAM (Quadrature Amplitude Modulation)

QAM is a method of digital modulation using two amplitude modulated signals in quadrature (90° out of phase from each other) called the In-phase (I) and Quadrature (Q) signals. The I and Q signals can be combined to 16, 32, 64, 128, or 256 unique symbols which are used to encode data on the signal.

- **16 QAM**
- **16 QAM EDGE**
- **32 QAM**
- **32 QAM EDGE**
- **64 QAM**
- **128 QAM**
- **256 QAM**

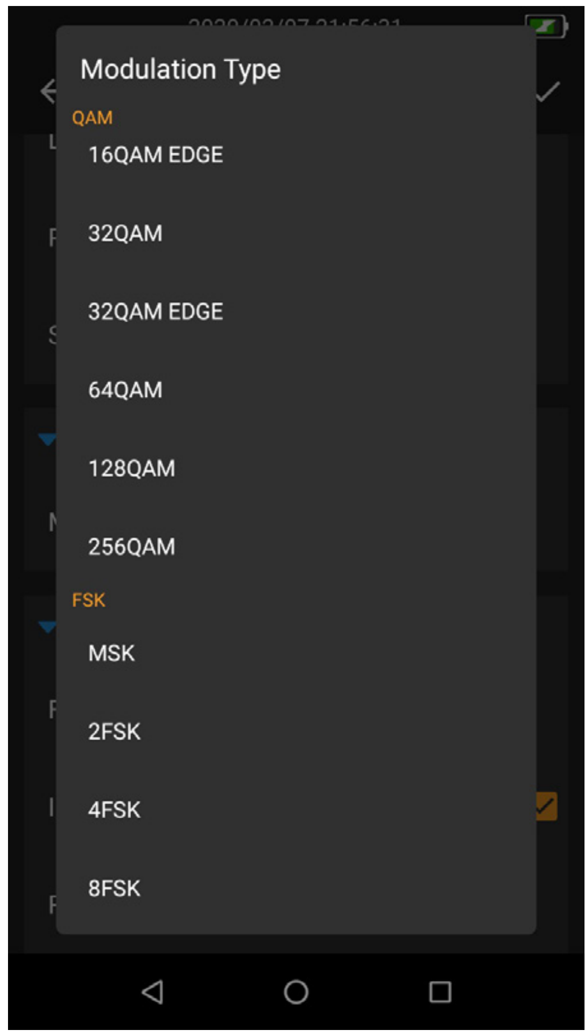
FSK (Frequency Shift Keying)

FSK encodes data through variation in frequency.

- **MSK (Minimum Shift Keying)**
- **2FSK**
- **4FSK**
- **8FSK**

The modulated signals can further be adjusted by setting the symbol rate (8–20,000 ksym/s). The data source can also be adjusted by either setting the bits to be all 0s, all 1s, or the user can select one of the seven PRSB (Pseudo-Random Binary Sequences) options. Filtering options include Root Cosine, Cosine, and Gaussian (for FSK), with adjustable settings like roll-off factor or B*T product.

Option MTX-S008



The Custom Digital Modulation module gives you the ability to generate a wide variety of digital signals that can be used to test devices' ability to process digitally modulated signals.

ARB

ARB (Custom Arbitrary Waveforms)

for specialized testing

Ideal for: Wireless Communication, Aerospace, Embedded RF

Arbitrary Waveform (ARB) modulation enables you to generate complex, user-defined signal patterns that go beyond standard modulation formats. It's a powerful tool for simulating real-world or proprietary signal environments in advanced R&D, system validation, and production testing. Engineers working in wireless communications, radar systems, and embedded RF development often use ARB to replicate specific traffic scenarios, stress-test receivers with custom interference patterns, or validate decoding logic under controlled conditions.

Custom Waveform Generation

GenHawk's ARB option allows you to generate custom waveforms, by uploading I/Q data as text, binary, or R&S .wv files; with various formatting options for each. The clock rate is adjustable between 1–250 MS/s.

ARB mode gives engineers the most precise command over waveform structure and timing—key for replicating specific modulation behaviors or edge-case signals with arbitrary complexity.

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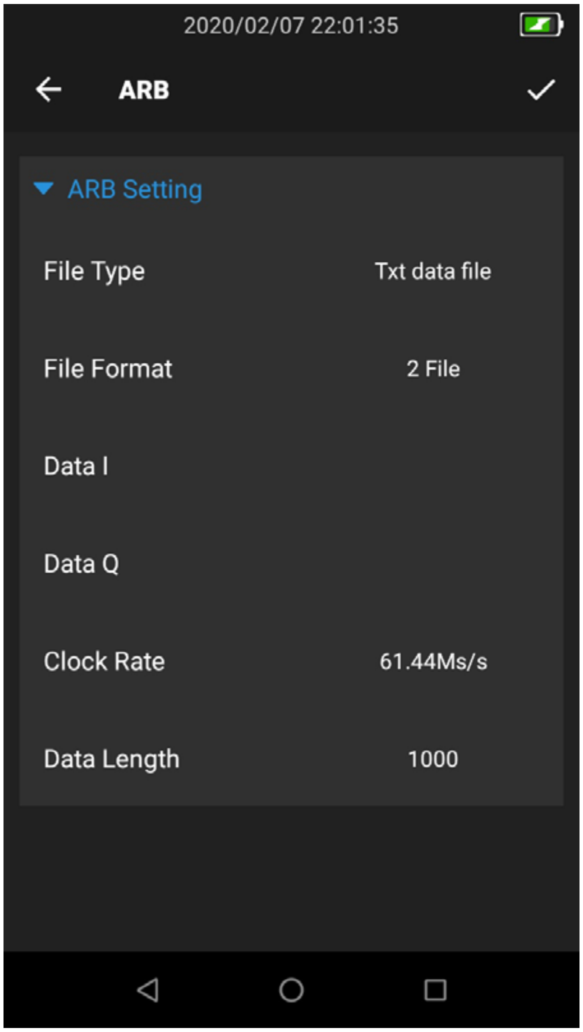


Linear Freq Modulation

Linear Frequency Modulation (LFM)

for response testing

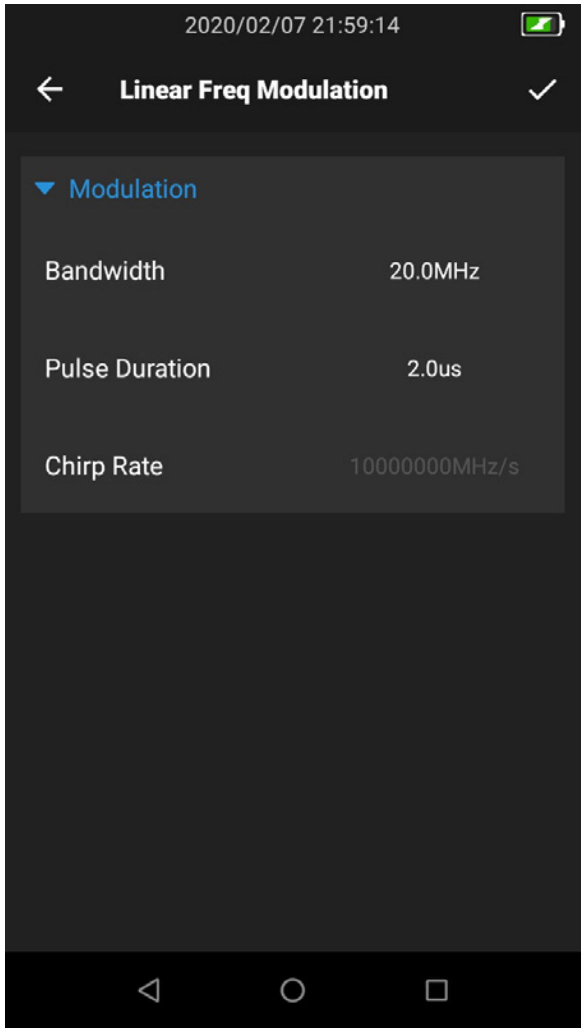
Ideal for: Radar, Electronic Warfare, Defense, Aerospace

Linear Frequency Modulation, often referred to as “chirp” modulation or LFM, involves sweeping the frequency of a signal linearly over time. It is commonly used in radar, electronic warfare, and communication systems that require high time-resolution or resilience to interference. Engineers use LFM to test how devices respond to dynamic frequency content—making it ideal for testing range detection, Doppler systems, or simulating frequency-agile threats in defense and aerospace applications.

Custom Time-Frequency Profiles

On the GenHawk, LFM is available through a dedicated modulation screen with settable bandwidth (1 Hz to 20 MHz) and pulse duration (1.25 to 10,000 µs). The GenHawk automatically calculates and displays the chirp rate based on those parameters. These controls are essential for tuning the time-frequency profile of the signal and ensuring it matches the application’s requirements—whether that’s narrowband chirps for fine resolution or wideband sweeps for broader system stress testing.

Option MTX-S016



Multi-Tone

for sideband testing

Ideal for: RF Design Validation, Production Test, Intermodulation Distortion

Multi-Tone Modulation generates a single or multiple pure tones at set spacings. It's often used for testing the linearity and intermodulation distortion (IMD) of RF components like amplifiers, filters, and receivers. Engineers in production test environments, wireless infrastructure development, and RF design validation often use multi-tone signals to expose non-linear behavior, especially when evaluating how a device handles dense spectral content or closely spaced signals in real-world deployments.

Tone Direction & Number Simulation

The GenHawk provides a multi-tone modulation mode where you can select the direction of the tones relative to the primary carrier frequency (Upper Sideband, Lower Sideband, or Multi Sideband) and configure the number of tones (even values from 2 to 100). The spacing between tones is set through the base frequency (0.1 Hz to 10 MHz). These parameters let engineers simulate passive intermodulation (PIM) scenarios or assess how a device responds to spectral congestion. By offering flexible tone count and spacing, the GenHawk allows you to fine-tune test conditions to match their specific RF environment or compliance standards—making it a valuable tool for uncovering issues that simple CW testing might miss.

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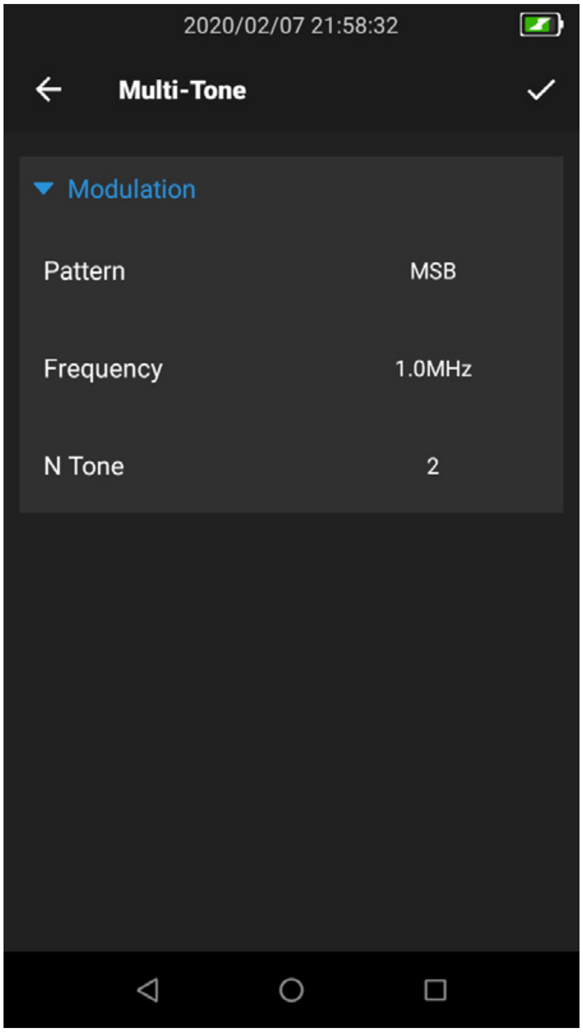
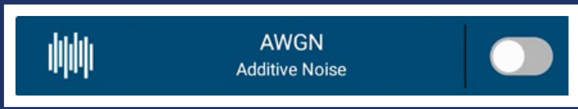




AWGN (Additive White Gaussian Noise)

to simulate real-world interference

Ideal for: Bit Error Rate Testing, Jamming Simulation, SNR Verification

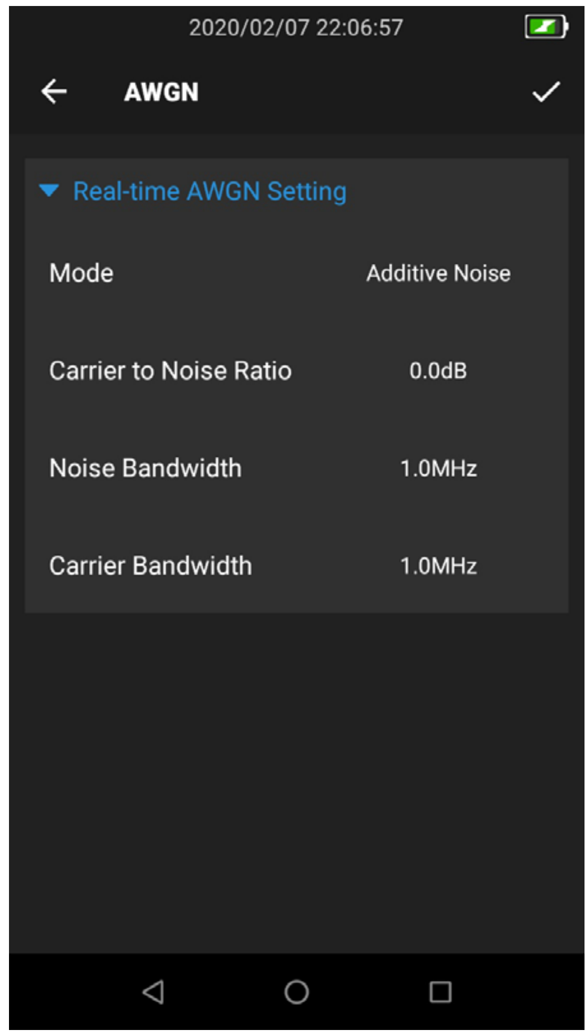
Additive White Gaussian Noise (AWGN) is a statistical noise model widely used to simulate real-world interference in RF systems. It represents a random signal with a constant power spectral density across all frequencies, making it ideal for testing how well receivers perform under noisy or degraded conditions. Engineers use AWGN in wireless communications, radar, and IoT development to evaluate bit error rates, signal-to-noise ratio (SNR) thresholds, and system robustness in the presence of unavoidable environmental noise or intentional jamming.

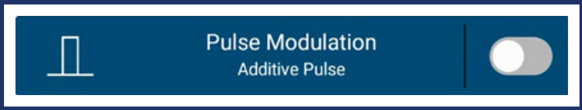
Add Noise for Modeling & Simulation

On the GenHawk, AWGN can be toggled on directly from the main screen, allowing users to quickly add noise to any signal being generated. Parameters such as noise power level and bandwidth are controllable, enabling fine control over how the noise interacts with the primary signal. These controls are essential for stress-testing systems in a controlled way, helping to model worst-case environments, validate performance under SNR-limited conditions, or replicate uncommon conditions.

By integrating AWGN into the signal chain without requiring external equipment, the GenHawk streamlines noise testing for both lab and field applications.

Option MTX-S018





Pulse Modulation

to simulate control signals

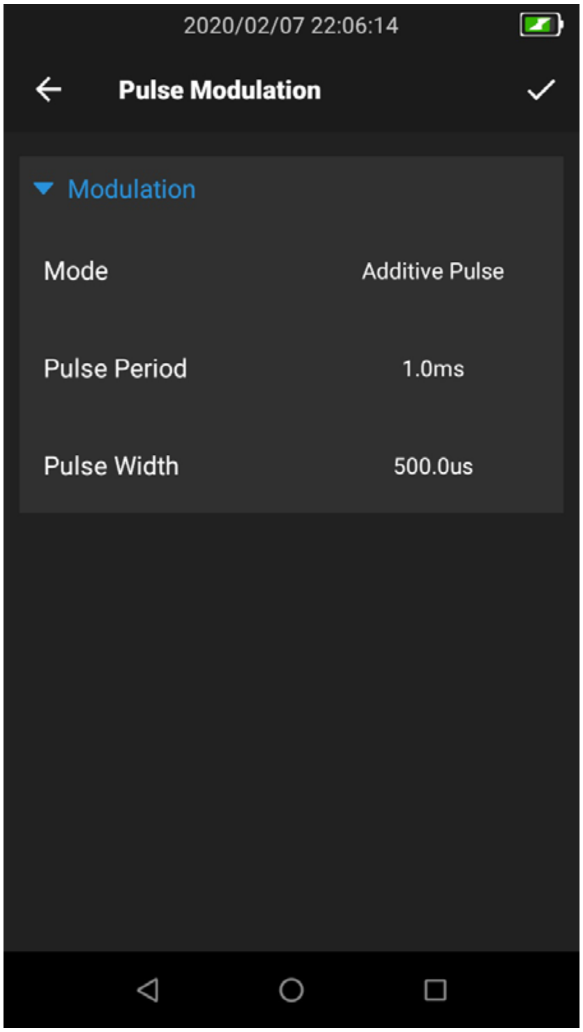
Ideal for: Radar, Telemetry, Digital Communications, Power Electronics

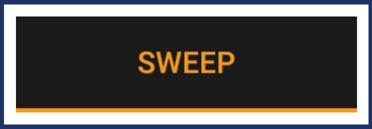
Pulse Modulation is a technique in which a carrier signal is switched on and off—or varied in pulse width, position, or amplitude—to convey information or simulate control signals. It is widely used in radar, telemetry, digital communication systems, and power electronics. Engineers use pulse modulation to replicate burst transmissions, measure time-domain response, or evaluate the performance of devices under pulsed RF conditions, especially in military, aerospace, and industrial applications.

Adjustable Pulse Parameters

GenHawk supports pulse modulation with adjustable pulse period (10 µs to 40 s), pulse width (10 ns to 20 s), and resolution (10 ns). These parameters give precise control over signal bursts, essential for simulating radar pings, gated transmitters, or duty-cycled systems. The ability to generate clean, well-defined pulses from a portable platform allows for effective field testing of sensitive receivers and time-gated systems.

Option MTX-S010





Sweep Mode

automatic frequency or amplitude sweeps

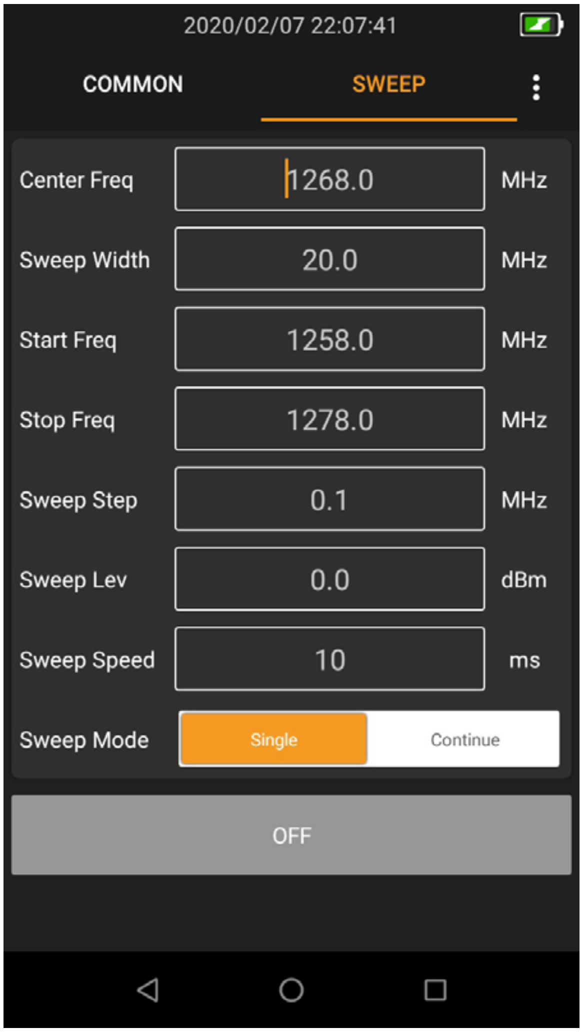
Ideal for: Filter, Antenna, or Amplifier Testing

Sweep Mode allows users to automatically vary frequency over a defined range and time interval. This functionality is commonly used in RF testing to characterize filters, antennas, amplifiers, and entire signal chains across a spectrum of input conditions. Engineers in design validation, production test, and field troubleshooting environments use sweep mode to identify frequency-dependent behaviors, resonances, or non-linearities that might otherwise go undetected with static signals.

Custom Configurations

GenHawk's sweep mode allows you to configure a sweep based on center frequency & width, or by start/stop frequencies. The sweep amplitude, step size, and speed can all be adjusted. These options give you the ability to bring easily customized, repeatable, broad-spectrum sweeps to your testing, all from a handheld interface.

Option MTX-S012



5G NR

for next-generation mobile

Ideal for: Mobile Infrastructure, IoT Design, Automotive

5G New Radio (NR) is the latest and current global standard for cellular wireless communication. It is designed to provide faster speeds, lower latency, and higher capacity in part through the use of OFDM for both uplink and downlink connections with optional enhancements like 256-QAM for higher data throughput. Engineers working in mobile infrastructure, IoT design, and in the automotive industry are all using 5G radios to tap into the benefits offered by this latest standard.

Precise Uplink and Downlink Test Configuration

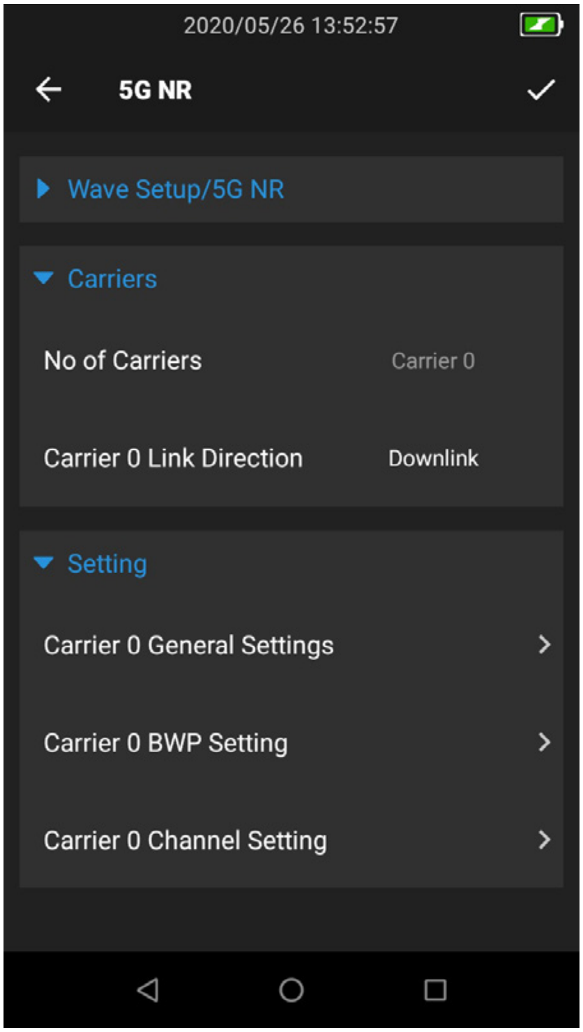
GenHawk can emulate both **uplink** and **downlink** 5G signals, each with more than 100 adjustable parameters for fine-grained control. For both directions you can configure general settings, spectrum control, and cell-specific parameters. Bandwidth Parts (BWPs) are editable, and on the downlink you can also tailor resource sets.

Downlink channel settings: SS/PBCH, DCI, DL-SCH, and CSI-RS

Uplink channel settings: UCI, UL-SCH, and SRS

This expanded flexibility lets you model virtually any 5G NR scenario, from simple link checks to complex cell performance tests.

Option MTX-S014



GSM/Edge

for 2G cellular

Ideal for: Smart Metering, Industrial Monitoring, Transportation Systems

GSM (Global System for Mobile Communications) is a 2G cellular standard that uses GMSK (Gaussian Minimum Shift Keying) modulation to transmit voice and low-speed data. Despite its age, GSM is still widely deployed in legacy networks and M2M (machine-to-machine) applications such as smart metering, industrial monitoring, and transportation systems. Engineers working in mobile infrastructure, device certification, or embedded cellular applications rely on GSM signal generation to validate connectivity, receiver sensitivity, and protocol compliance under controlled lab or field conditions.

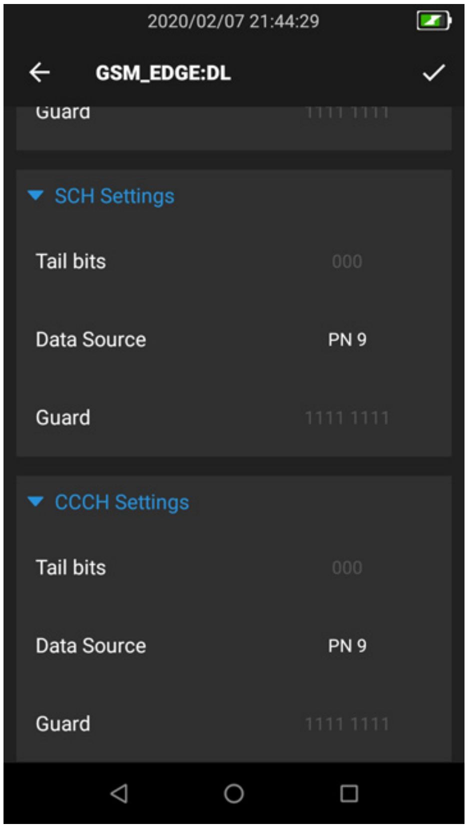
Channel Options

GenHawk supports GSM modulation for both uplink and downlink signal generation. You can configure parameters like Training Sequence Code (TSC), Base Station Identity Code (BSIC), and channel-specific data patterns (e.g., PN sequences) for the following channel options:

- **BCCH** (Broadcast Control Channel)
- **SCH** (Synchronization Channel)
- **CCCH** (Common Control Channel)
- **FACCH** (Fast Associated Control Channel)
- **SACCH** (Slow Associated Control Channel)
- **TCHFS** (Traffic Channel Full Rate Service)

These options give you the flexibility to create representative GSM frames needed for accurate testing of base stations, portable transceiver behavior, or system interoperability. The ability to control signal identity and structure allows robust, repeatable testing of your GSM equipment.

Option MTX-S001



3G WCDMA

WCDMA

for 3G cellular

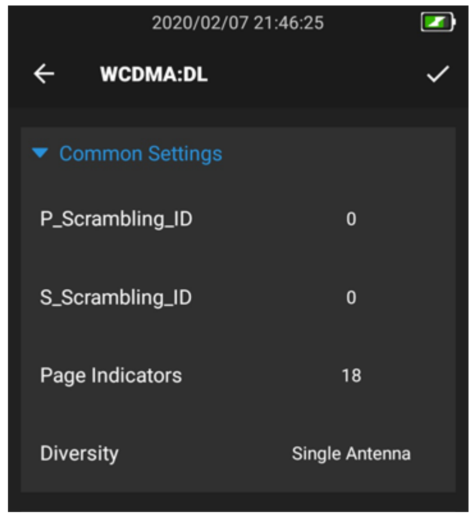
Ideal for: Mobile Infrastructure, Device Testing, Network Maintenance

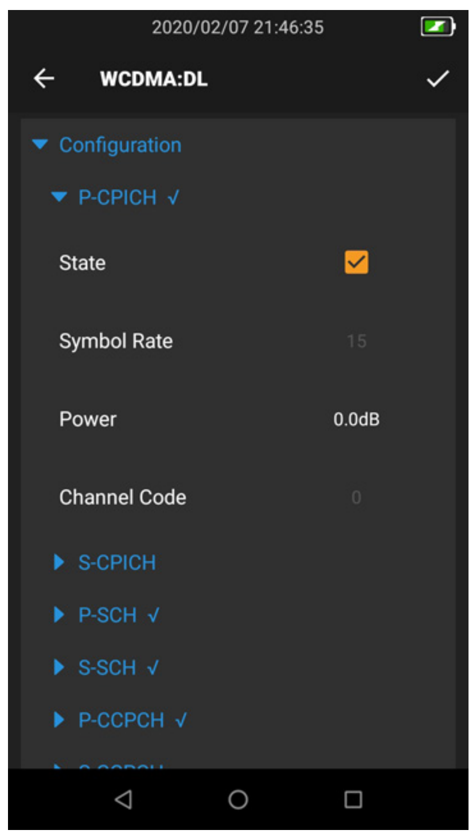
WCDMA (Wideband Code Division Multiple Access) is the core modulation scheme used in 3G mobile networks, supporting high-speed voice and data transmission over a wide bandwidth using QPSK. It remains relevant in many regions where 3G networks are still active or being repurposed for IoT and M2M applications. Engineers involved in mobile infrastructure development, device testing, or network maintenance often use WCDMA signal generation to validate receiver performance, conduct tests, or simulate real-world traffic scenarios for base stations and user equipment.

Uplink & Downlink Configurations

GenHawk enables WCDMA modulation for both uplink and downlink configurations. You can adjust key protocol parameters including scrambling codes, slot formats, power levels, and data sources across multiple logical channels like P-CPICH, P-SCH, S-CCPCH, and DPCH. With over 80 configurable options the interface also supports complex channel coding and interleaving options, allowing for highly customizable traffic models (see manual for details). These settings give you the ability to replicate realistic 3G network conditions or test edge-case scenarios in a repeatable and portable format. By offering fine-grained control over both signaling and payload configuration, GenHawk ensures engineers can simulate a broad range of WCDMA use cases with precision.

Option MTX-S002





EUTRA/LTE

for 4G TDD/FDD cellular

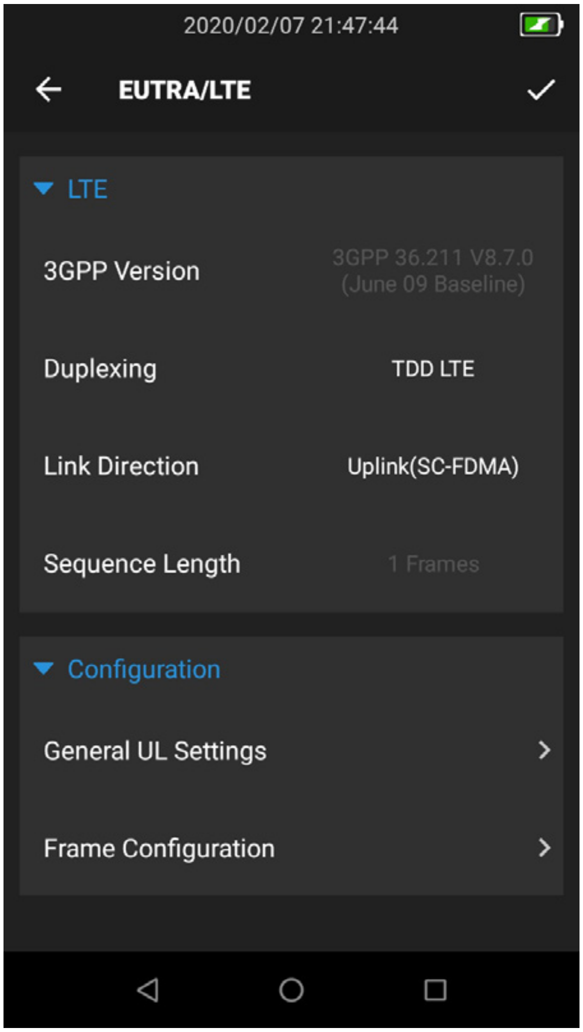
Ideal for: Mobile Infrastructure, Handset Development, Network Optimization, Compliance Testing

LTE (Long-Term Evolution) is a widely adopted 4G wireless communication standard used for high-speed data and voice services, in some parts of the world it is more commonly known as EUTRA. It employs OFDMA for downlink and SC-FDMA for uplink, supporting advanced features like adaptive modulation, and carrier aggregation. Engineers working in mobile infrastructure, handset development, network optimization, and compliance testing rely on LTE signal generation to validate performance under standardized channel models or simulate live network behavior in a controlled environment.

Custom Deployment Scenarios

GenHawk supports both FDD-LTE and TDD-LTE duplexing modes and allows configuration of uplink or downlink signal direction. You can select from a range of 3GPP-compliant test models (e.g., E-TM1.1 to E-TM3.3), define bandwidth (1.4 to 20 MHz), and configure key channel elements like PCFICH, PHICH, PDCCH, PDSCH, and PRACH. Parameters such as MCS, cell ID, cyclic prefix, and frame structure can be fine-tuned for each test case. These options give engineers and trained technicians the ability to replicate real-world LTE signaling and stress-test receiver performance, coverage, or throughput across a variety of deployment scenarios. GenHawk's portable design makes it easy to generate LTE signals on the bench or in the field without the complexity of full base station emulators.

Options MTX-S003(TDD) & MTX-S004(FDD)



NB IoT

NB-IoT

for low power IoT networks

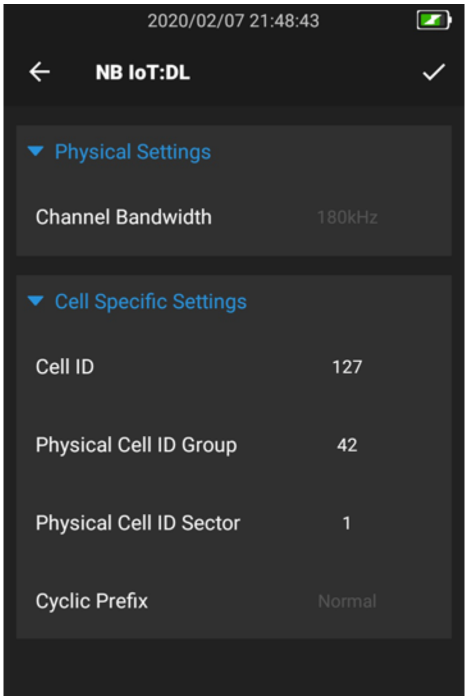
Ideal for: Smart Metering, Environmental Monitoring, Asset Tracking, Industrial Sensors

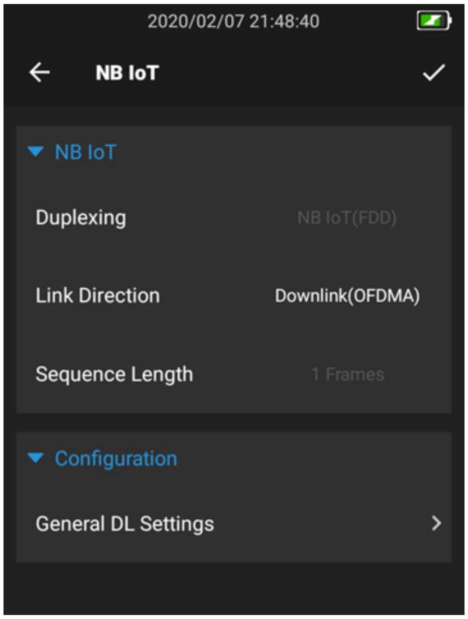
Narrowband Internet of Things (NB-IoT) is a low-power wide-area (LPWA) cellular technology designed specifically for connecting devices that transmit small amounts of data over long periods. It uses QPSK modulation within narrowband channels and is ideal for applications such as smart metering, environmental monitoring, asset tracking, and industrial sensors. Engineers working in IoT device development, carrier certification, and system integration rely on NB-IoT signal generation to test device performance, verify compliance with network requirements, and evaluate link reliability in challenging environments.

User-Selectable Parameter Configuration

GenHawk's NB-IoT modulation enables both uplink and downlink configurations with user-selectable parameters such as cell ID, physical cell ID group and sector, and duplexing mode (OFDMA for downlink, SC-FDMA for uplink). The interface allows you to set system-level parameters for narrowband behavior, enabling realistic simulation of low-bandwidth transmission scenarios. This level of control offered by GenHawk is critical for validating device functionality, especially when working with low-energy devices (that are therefore low-power transmitters) or embedded modules.

Option MTX-S005





LoRa

for long-range IoT

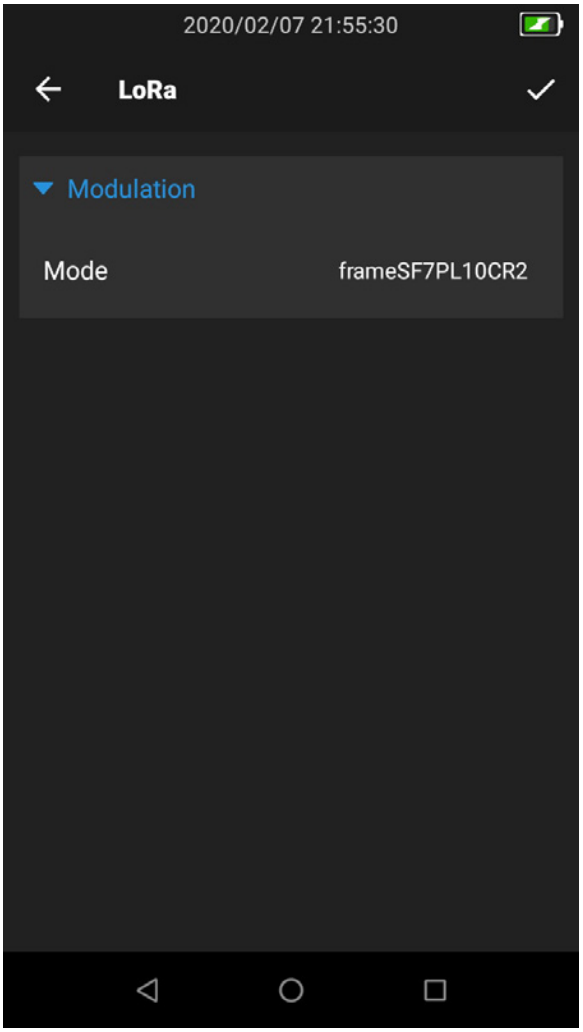
Ideal for: Smart Agriculture, Asset Tracking, Environmental Monitoring, Infrastructure Management

LoRa (Long Range) is a low-power wide-area modulation technique designed for long-distance, low-data-rate communication in IoT applications. It uses Chirp Spread Spectrum (CSS) modulation to maximize range and resistance to interference while keeping power consumption low. Commonly used in smart agriculture, asset tracking, environmental monitoring, and infrastructure management, LoRa is favored by engineers and system integrators deploying battery-powered sensors across wide geographic areas where traditional cellular or Wi-Fi connectivity is impractical.

Spreading Factor and Coding Rate Combinations

GenHawk enables LoRa signal generation through two selectable modulation profiles: frameSF7PL10CR2 and frameSF8PL10CR2. These options represent typical spreading factor and coding rate combinations used in deployed LoRa systems. You can easily choose between these modes via the touchscreen interface to evaluate system behavior under known operating conditions. This functionality allows for repeatable testing of LoRa gateways and endpoints, providing a valuable tool for validating coverage, sensitivity, and protocol integration.

Options MTX-S006



Field Ready. Lab Accurate.

The **GenHawk (GH-60)** Vector Signal Generator offers multiple modulation options, a lightweight form factor, and internal rechargeable battery allowing it to easily transition between field work and laboratory use. This flexibility makes it invaluable for tasks such as EMC testing, interference analysis, and distributed antenna system verification.The intuitive touchscreen interface and modular licensing scheme allow you to enable only the features you need, ensuring a streamlined workflow and simplified use for technicians. Whether performing routine diagnostics or handling complex signal simulations, GenHawk provides reliable performance, extensive customization, and convenient portability for modern RF measurement and testing challenges.

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