Vector Signal Generator

Model GH-60

Operation Manual

Instruction Book Part Number 920-GH-60 Rev. A

Safety Precautions

The following are general safety precautions that are not necessarily related to any specific part or procedure, and do not necessarily appear elsewhere in this publication. These precautions must be thoroughly understood and apply to all phases of operation and maintenance.

WARNING

Keep Away From Live Circuits

Operating Personnel must at all times observe general safety precautions. Do not replace components or make adjustments to the inside of the test equipment with the high voltage supply turned on. To avoid casualties, always remove power.

WARNING

Shock Hazard

Do not attempt to remove the RF transmission line while RF power is present.

WARNING

Do Not Service Or Adjust Alone

Under no circumstances should any person reach into an enclosure for the purpose of service or adjustment of equipment except in the presence of someone who is capable of rendering aid.

WARNING

Resuscitation

Personnel working with or near high voltages should be familiar with modern methods of resuscitation.

WARNING

Remove Power

Observe general safety precautions. Do not open the instrument with the power applied.

Safety Symbols

WARNING

Warnings call attention to a procedure, which if not correctly performed, could result in personal injury.

CAUTION

Cautions call attention to a procedure, which if not correctly performed, could result in damage to the instrument.

The caution symbol appears on the equipment indicating there is important information in the instruction manual regarding that particular area.

NOTE

Notes call attention to supplemental information.

Caution Statements

The following equipment cautions appear in the text whenever the equipment is in danger of damage, and are repeated here for emphasis.

CAUTION

Do not block airflow to fan or air vents.
Unit will overheat if the fan is not circulating air through the unit.

See page 9.

CAUTION

Replace battery pack with OEM part only, do not use any other battery.

See page 31.

Safety Statements

USAGE

ANY USE OF THIS INSTRUMENT IN A MANNER NOT SPECIFIED BY THE MANUFACTURER MAY IMPAIR THE INSTRUMENT'S SAFETY PROTECTION.

USO

EL USO DE ESTE INSTRUMENTO DE MANERA NO ESPECIFICADA POR EL FABRICANTE, PUEDE ANULAR LA PROTECCIÓN DE SEGURIDAD DEL INSTRUMENTO.

BENUTZUNG

WIRD DAS GERÄT AUF ANDERE WEISE VERWENDET ALS VOM HERSTELLER BESCHRIEBEN, KANN DIE GERÄTESICHERHEIT BEEINTRÄCHTIGT WERDEN.

UTILISATION

TOUTE UTILISATION DE CET INSTRUMENT QUI N'EST PAS EXPLICITEMENT PRÉVUE PAR LE FABRICANT PEUT ENDOMMAGER LE DISPOSITIF DE PROTECTION DE L'INSTRUMENT.

IMPIEGO

QUALORA QUESTO STRUMENTO VENISSE UTILIZZATO IN MODO DIVERSO DA COME SPECIFICATO DAL PRODUTTORE LA PROZIONE DI SICUREZZA POTREBBE VENIRNE COMPROMESSA.

SERVICE

SERVICING INSTRUCTIONS ARE FOR USE BY SERVICE - TRAINED PERSONNEL ONLY. TO AVOID DANGEROUS ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING UNLESS QUALIFIED TO DO SO.

SERVICIO

LAS INSTRUCCIONES DE SERVICIO SON PARA USO EXCLUSIVO DEL PERSONAL DE SERVICIO CAPACITADO. PARA EVITAR EL PELIGRO DE DESCARGAS ELÉCTRICAS, NO REALICE NINGÚN SERVICIO A MENOS QUE ESTÉ CAPACITADO PARA HACERIO.

WARTUNG

ANWEISUNGEN FÜR DIE WARTUNG DES GERÄTES GELTEN NUR FÜR GESCHULTES FACHPERSONAL. ZUR VERMEIDUNG GEFÄHRLICHE, ELEKTRISCHE SCHOCKS, SIND WARTUNGSARBEITEN AUSSCHLIEßLICH VON QUALIFIZIERTEM SERVICEPERSONAL DURCHZUFÜHREN.

ENTRENTIEN

L'EMPLOI DES INSTRUCTIONS D'ENTRETIEN DOIT ÊTRE RÉSERVÉ AU PERSONNEL FORMÉ AUX OPÉRATIONS D'ENTRETIEN. POUR PRÉVENIR UN CHOC ÉLECTRIQUE DANGEREUX, NE PAS EFFECTUER D'ENTRETIEN SI L'ON N'A PAS ÉTÉ QUALIFIÉ POUR CE FAIRE.

ASSISTENZA TECNICA

LE ISTRUZIONI RELATIVE ALL'ASSISTENZA SONO PREVISTE ESCLUSIVAMENTE PER IL PERSONALE OPPORTUNAMENTE ADDESTRATO. PER EVITARE PERICOLOSE SCOSSE ELETTRICHE NON EFFETTUARRE ALCUNA RIPARAZIONE A MENO CHE QUALIFICATI A FARLA.

About This Manual

This manual covers the operating and maintenance instructions for the following models:

GH-60

Changes to this Manual

We have made every effort to ensure this manual is accurate. If you discover any errors, or if you have suggestions for improving this manual, please send your comments to our Solon, Ohio factory. This manual may be periodically updated. When inquiring about updates to this manual refer to the part number and revision on the title page.

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Chapter 1 Introduction

GH-60 GenHawk Vector Signal Generator

The GH-60 GenHawk Handheld Signal Generator is a cutting-edge solution for professionals requiring reliable and precise RF signal generation and testing capabilities. As a state-of-the-art device, it combines advanced technology with user-centric design to address the growing demands of modern industries such as telecommunications, aerospace, defense, and electronic testing. This generator's compact and lightweight form factor makes it highly portable, enabling seamless use in both laboratory settings and field environments.

Engineered with versatility in mind, the GH-60 is packed with features to support a wide array of testing requirements, from basic frequency and amplitude adjustments to advanced signal modulation techniques. Whether it's testing mobile communication standards like GSM, LTE, and 5G NR, or generating custom waveforms and interference signals for specialized applications, the GH60 ensures unmatched flexibility and adaptability.

Moreover, the GH-60 empowers users to perform intricate testing and troubleshooting with unparalleled precision. Its comprehensive suite of modulation modes, including analog, digital, pulse, and noise generation, allows users to simulate real-world conditions and evaluate the performance and resilience of systems under test. The device's intuitive interface further enhances usability, enabling both novice and experienced users to harness its full potential with minimal learning curve.

Designed for professionals who demand high performance in diverse scenarios, the GH60 stands out as a robust and reliable tool that adapts to the ever-evolving landscape of RF technology. Whether in mission-critical defense applications, ensuring compliance with electromagnetic compatibility (EMC) standards, or fine-tuning the performance of advanced communication systems, the GH-60 delivers the precision, reliability, and convenience required for success.

RF Power Measurements

The GH-60 includes an application called Bird RF Meter, accessed from the device's home screen. This application can be used to perform RF power measurements when used in conjunction with Bird RF Power Sensors.

The power sensors compatible with the GH-60 include:

Device Type	***Model Number(s)***
Wideband Power Sensors (WPS)	5012, 5016, 5017, 5018, 5019, 7020
Terminating Power Sensors (TPS)	5015, 5015-EF
Directional Power Sensors (DPS)	4043, 5014
Statistical Power Sensor (STAT)	7022
Pulse Power Sensor	7023
Channel Power Monitor (CPM)	3141
Antenna and Cable Monitors (ACM)	ACMI Series
Broadcast Power Monitors (BPM)	BPME Series

Functions and Features

Key Features

- Frequency Range: 10 MHz to 6 GHz (upgradeable to 300 kHz to 6.5 GHz).
- Supported Modulation Types (See page 3 for details):
  - Analog: AM, FM, PM.
  - Pulse Modulation, LFM, Two-tone, and Multi-tone.
  - Digital Modulation: Includes ASK, PSK (BPSK, QPSK, QPSK 45° Offset, QPSK EDGE, AQPSK, OPQSK, π/4-QPSK, π/2-DBPSK, π/4-DQPSK, π/8-D8PSK, 8PSK, 8PSK EDGE), QAM (16QAM, 16QAM EDGE, 32QAM, 32QAM EDGE, 64QAM, 128QAM, 256QAM) and FSK (MSK, 2FSK, 4FSK, 8FSK).
  - AWGN (Additive White Gaussian Noise) and ARB (Arbitrary Waveform Generation).
  - Sweep Mode and Custom Modulation.
  - Mobile Signal Standards: GSM, EDGE, WCDMA, LTE (TDD/FDD), 5G NR, NB-IoT, and LoRa.
- Portability: Compact (197×93×61 mm), battery powered, weighing only 2.0 lbs (0.9 kg).

Example Applications

- Electromagnetic Compatibility (EMC) Testing
  - Ideal for large-scale equipment outside lab environments.
  - Tests electromagnetic and radio frequency interference resistance using AM/FM/Pulse signals.
- Field Interference Testing
  - Simulates interference using templates (e.g., wideband noise, frequency sweep interference).
  - Tests receiver sensitivity and troubleshooting interference in applications like antennas and national defense.
- Signal Monitoring Instrument Testing
  - Generates continuous wave (CW) and standard modulation signals.
  - Evaluates the performance of interference monitoring equipment.
- Distributed Antenna System (DAS) Testing
  - Generates sample mobile standard signals (LTE, 5G, etc.) and digital modulations for testing coverage.
  - Quickly deploy a test signal and evaluate coverage across a DAS with a reliable test signal.

Signal Modulations Available for the GH-60

The GH-60 comes supplied with the capability to produce a basic carrier wave with settings for frequency and amplitude. A number of different signal modulations are available, each accessed using a license purchased separately:

Part Number	*Option Name*	*Description*
MTX-S001	GSM (2G)	Global System for Mobile Communications (GSM) uses GMSK modulation. GSM is used in 2G cellular networks for voice and low-speed data communication. See "GSM Modulation" on page 18.
MTX-S002	WCDMA (3G)	Wideband Code Division Multiple Access (WCDMA) uses QPSK modulation to transmit data over a wide bandwidth. WCDMA is employed in 3G mobile networks to support high-speed voice and data services. See "WCDMA Modulation" on page 19.
MTX-S003	TDD-LTE (4G)	Time-Division Duplex Long-Term Evolution (TDD-LTE) utilizes QPSK, 16-QAM, and 64-QAM to allow flexible uplink and downlink time sharing. TDD-LTE is used in mobile broadband networks with time-division techniques for uplink and downlink on the same frequency. See "EUTRA/LTE Modulation" on page 22.
MTX-S004	FDD-LTE (4G)	Frequency Division Duplex Long-Term Evolution (FDD-LTE) uses QPSK, 16-QAM, and 64-QAM modulation, where separate frequency bands are used for uplink and downlink. FDD-LTE is widely used in mobile broadband networks, especially in regions where spectrum is allocated for both uplink and downlink separately. "EUTRA/LTE Modulation" on page 22.
MTX-S005	NB-IoT	Narrow-Band Internet-of-Things (NB-IoT) uses QPSK modulation to provide low-power, wide-area communication for IoT devices. NB-IoT is used for low-bandwidth applications such as sensor networks, smart metering, and asset tracking in the IoT ecosystem. See "NB IoT Modulation" on page 26.
MTX-S006	Lo-Ra	Long Range (Lo-Ra) employs CSS modulation which spreads data over a wide frequency range for long-distance communication. LoRa is commonly used in LPWAN (Low Power Wide Area Networks) for long-range, low-power IoT applications. See "LoRa Modulation" on page 26.
MTX-S008	Custom Digital Modulation	Digital modulation encodes data into an analog carrier wave by varying the carrier's properties (amplitude, phase, or frequency) in discrete steps. Common methods include PSK, FSK, QAM, and OFDM. See "Custom Digital Modulation" on page 17**.**
MTX-S009	ARB	Arbitrary Waveform (ARB) modulation involves custom, programmable waveform generation where specific signals can be modulated for testing and simulation purposes. ARB simulates complex RF waveforms for testing communication equipment and systems. See "ARB Modulation" on page 27.
MTX-S010	Pulse Modulation	Pulse modulation involves converting the information signal into a series of pulses that vary in characteristics in accordance with the original signal. Pulse modulation is used in digital communication systems, audio signal processing, radar systems, and power control applications. See "Analog Modulation" on page 16.

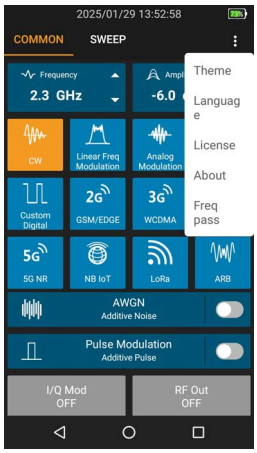
Part Number	Option Name	Description
MTX-S011	Analog Modulation	Analog modulation involves varying a continuous signal in accordance with the amplitude, frequency, or phase of the input analog signal. Analog modulation is used in systems where the signal needs to preserve its original analog characteristics. See "Analog Modulation" on page 16.
MTX-S012	Sweep Mode	Sweep Mode enables the device to automatically vary a specific parameter, typically frequency or amplitude, over a defined range and duration. This operation is performed continuously or stepwise, depending on the configuration, and is used to observe or measure how a system responds across a spectrum of input conditions. See "" on page 15.
MTX-S013	Multi-Tone	LSB and USB are forms of Single Sideband Modulation (SSB), where only one sideband (lower or upper) of the carrier signal is transmitted, reducing bandwidth and power consumption. Dual Sideband (DSB) is also supported. Multi-tone modulation involves transmitting two or more pure tones of different frequencies, typically used for testing amplifiers and radio equipment for passive inter-modulation (PIM). See "Multi-Tone Modulation" on page 17.
MTX-S014	5G NR	5G New Radio (NR) uses QPSK, 16-QAM, 64-QAM, 256-QAM, and OFDM for high throughput, low latency communications in diverse frequency bands. 5G NR supports high-speed data and low-latency services for applications like augmented reality, smart cities, and vehicles. See "5G NR Modulation" on page 25.
MTX-S016	LFM	Linear Frequency Modulation (LFM) involves varying the frequency of a signal linearly over time, commonly used in radar and communications for signal processing. LFM is used in radar systems, communication systems, and chirp radar for detection and range measurement. See "Linear Frequency Modulation" on page 16.
MTX-S018	AWGN	Active White Gaussian Noise (AWGN) is a noise model that adds random, Gaussian-distributed noise across all frequencies in the signal bandwidth. AWGN is used in simulations to model real-world noise in communication systems, helping to assess signal quality and robustness against interference. See "AWGN (Additive Noise)" on page 28.
MTX-S019	100 MHz Modulation Bandwidth	This license increases the GH-60's modulation bandwidth from 20 MHz to 100 MHz.
MTX-S020	300 kHz - 6.5 GHz Frequency Exmpansion	This license increases the GH-60's frequency range from 10 MHz - 6.0 GHz to 300 kHz - 6.5 GHz.

Activating Modulation Licenses

If you purchase one or more modulation licenses for the GH-60, you will receive a code to input on the device. Activating these codes can be done by following these steps:

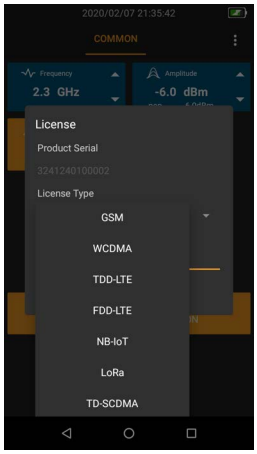
- From the main screen of the GenHawk app, select the three-dot menu button at the top right of the screen and select the License button

Figure 1 Selecting License from Main Screen



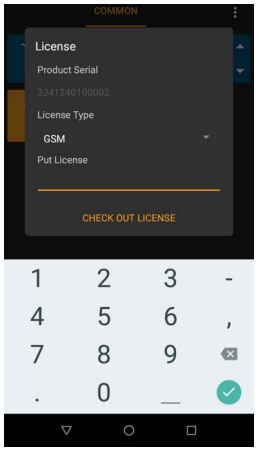
- Use the License Type drop-down menu to scroll for and select the license you're activating

Figure 2 Choosing a License



- Select the Put License text field and input the activation code

Figure 3 Entering License Code



- Select Check Out License to activate the code. Once complete, you should see the activated modulation button appear on the main screen.

Figure 4 GH-60 GenHawk Signal Generator

Items Supplied

Description	Part Number
Hard Carrying Case	7002A218-2
Soft Carrying Case	7002A219-1
AC Adapter (12 VDC)	SK05T-1200300Z
Touch Pen (stylus)	SK-TP-112
USB Adapter (USB-A (f) to USB-C (m)) USB Cable (USB-A (m) to USB-C (m))	SK-CONN-OTG-2
USB Drive	5A2745-1
Lithium Ion Battery	SK-BTY-7468

External Controls, Connectors, and Indicators

Item	Description
1	RF input connector, female N-type, 50 Ohms
2	Power Switch
3	Fan and air vent (vents located at top and bottom of unit)
4	USB-C connector **Note:** ***The GH-60 battery will not charge from the USB port. Use the supplied charger & adjacent charging port (item 5).***
5	Charging port, 9-12 VDC, 3.0 A
6	Charge indicator, illuminates when charger is connected, red indicates charging, green indicates full charge.
7	Display Screen, touch interaction, 5.5 inch, 1280 x 720.

Power Supply

Internal Battery

The GH-60 has an internal, rechargeable, lithium-ion battery pack that will operate the unit for 5 hours of continuous use. Recharging time, from a full discharge, is approximately 6 hours.

External AC Power Supply

The AC to DC Power Supply (12 VDC, 3.0 A) is capable of powering the device when the battery is discharged and will charge the battery in approximately 6 hours.

Unpacking and Inspection

1. Carefully inspect shipping container for signs of damage.
   - If the shipping container is damaged, do not unpack the unit. Immediately notify the shipping carrier and Bird Technologies.
   - If the shipping container is not damaged, unpack the unit. Save shipping materials for repackaging.
2. Inspect unit for visual signs of damage.

NOTE

If there is damage, immediately notify the shipping carrier and Bird Technologies.

Preparation for Use

Power Requirements

The GH-60's battery charger requires AC input power of 100-240 V, 1.5 A, 50-60 Hz. The unit may be operated while connected to the charger.

Charge the Battery

It is recommended that the batteries be charged before initial use.

1. Connect the battery charger to the GH-60.
2. Plug the battery charger into an AC outlet.

The GH-60 will operate for 5 hours on a fully charged battery. The battery's level of charge is indicated on the Signal Generator display, see "Charge Indicator" on page 11.

Power On

1. Power on the unit by pressing the power button for about three seconds.

CAUTION

Do not block airflow to fan or air vents.
Unit will overheat if the fan is not circulating air through the unit.

2. Verify the fan is operating after the unit is powered on.

Figure 5 GH-60 Power On

Power Off

Normal Power Off

1. Press and hold the power button for 4 seconds.
2. Tap the shutdown icon on the display.
3. Tap the confirmation icon on the display.

Forced Power Off

1. Press and hold the power button for 15 seconds.
2. Tap the confirmation icon on the display.

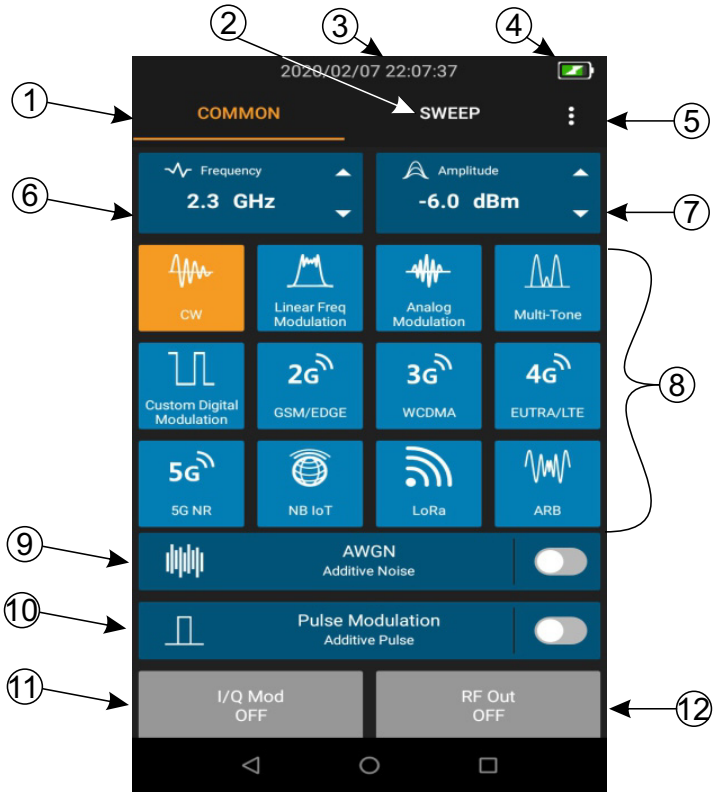
Chapter 3 User Interface

The GH-60 operates on the Android Operating System. The GenHawk app will automatically launch as soon as the unit is powered on. This section describes the elements of the User Interface, explains the methods used for Controls, and provides details about the GH-60's System Settings.

User Interface

The GH-60 user interface consists of a touch screen interface. The user taps the screen to access menus, change settings, generate signals, and save results.

Figure 6 User Interface Description



Item	Control	Description
1	Common Tab	The Common Tab displays the options for configuring the RF signal output.
2	Sweep Tab	The Sweep Tab opens the Sweep menu to configure and activate a sweep (requires license)
3	Date & Time	Shows the current date and time.
4	Charge Indicator	The charge indicator provides a visual indication of remaining battery charge. When the charger is connected the indicator contains a charging symbol to indicate the battery is charging.
5	System Menu	Menu provides access to Theme, Language, License input, and the About menu.
6	Frequency Control	The Frequency control is used to set the RF Out carrier frequency. The range for the setting is 10 MHz to 6 GHz. Default is 2.3 GHz.
7	Amplitude Control	Amplitude is the power of RF output CW, and the set table range is -130 dBm to +15 dBm.
8	Protocol	Select the desired modulation configuration (if purchased via license) to access the settings for that configuration
9	AWGN Noise	Additive White Gaussian Noise refers to the mixture of noises, including thermal noise and flicker noise, that is widely modeled as a Gaussian distribution with zero mean and varying variance. It is called "white" because it contains all frequencies and is commonly used to model disturbances in electrical devices.
10	I/Q Modulation	Used to enable/disable I/Q Baseband output.
11	RF Out	Used to enable/disable the RF output.

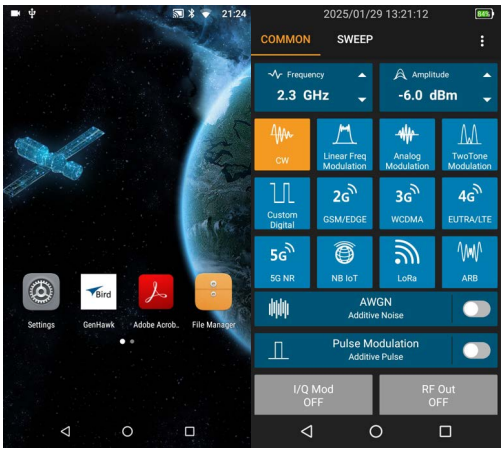
Chapter 4 Operation

The GH-60 is capable of generating signals under a multitude of customizable parameters, either with a standard carrier wave or with the available sweep mode. Signal output can be further modulated using formats acquired via licenses (See Chapter 5 - Signal Output Configuration). This chapter will provide a brief summary of generating a standard carrier wave signal, using the available Sweep mode (activated via license), and using the Bird RF power meter application.

Generating an RF Signal

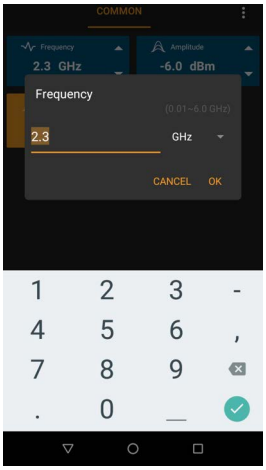
After turning on the GH-60, the main screen of the GenHawk app should appear. If not, open the app by selecting the GenHawk icon on the device's home screen:

Figure 7 GenHawk Device Home Screen and App Main Screen



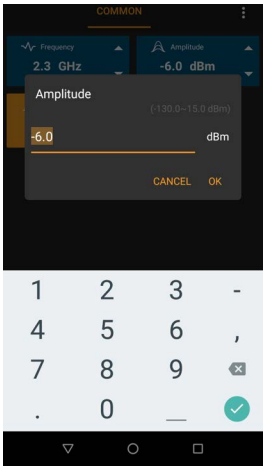
Select the Frequency value to input the desired signal frequency. This frequency serves as the carrier wave for any selected modulation.

Figure 8 Entering a Signal Frequency



Select the Amplitude value to input the desired signal amplitude (-130.0-15.0 dBm). The arrows next to Frequency and Amplitude may be used to step the values up or down. Press and hold on an arrow to set the step size.

Figure 9 Entering a Signal Amplitude



If In-Phase/Quadrature (I/Q) modulation is desired, select the I/Q Mod button at the bottom right to turn it on.

Figure 10 Turning I/Q Modulation On/Off

Finally, Select the RF Out button on the bottom right to begin signal generation. Ensure that appropriate receivers/ loads are in place before signal generation begins.

Figure 11 Turning RF Output On/Off

RF Power Measurement Using the Bird RF Meter Application

The Bird RF meter application can be installed onto the GH-60, either by downloading it from the Google Play store on the device or from www.birdrf.com/Products/Sensors/Software-Applications/Bird-RF-Meter-App/Bird-RF-Meter-App.aspx. Once installed, it can be opened using the app icon on the Home Screen 

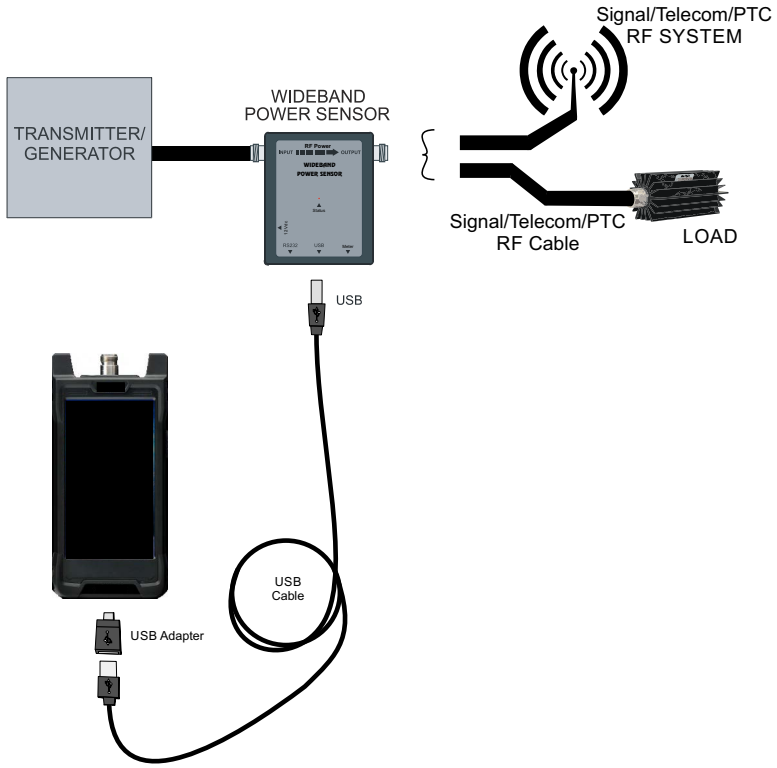
Sensor Connection

1. Connect USB cable to Bird Power Sensor.
2. Connect USB cable to USB Adapter.
3. Connect USB OTG Cable to FlightHawk-AV.

   Note: *Bird RF Meter App will automatically launch.*
4. Check the box to select Bird RF Meter as the default app. This setting allows the Bird RF Meter App to automatically connect to this sensor in the future.

   Note: *The Bird RF Meter will save all sensor settings (by serial number). Sensor settings will automatically load when the sensor is connected. Settings are saved in a Session File. Session Files are saved in the Session List.*
5. Tap OK.

The Power Sensor model number and serial number will be displayed on the Bird RF Meter device selection screen.



Chapter 5 Signal Output Configuration

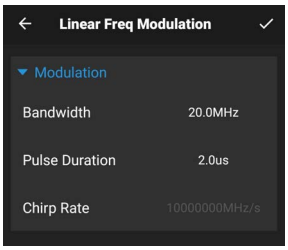
Description

If activated via the appropriate license(s), the GH-60 can be used to modulate the RF signal output under several different configurations, each with its own customizable settings:

Linear Frequency Modulation

LFM allows for the frequency of the RF signal to vary linearly over time. On the GH-60, this modulation can be customized by changing the Bandwidth (0.0000010-20.0 MHz) and Pulse Duration (1.25-10000.0 us).

Figure 12 LFM Screen

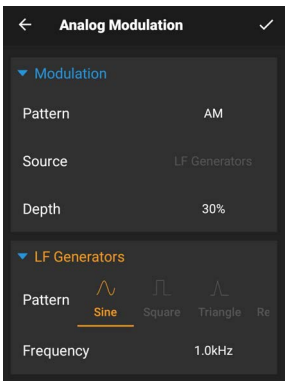


Once these settings are put in, the Chirp Rate will automatically update to fit the given parameters.

Analog Modulation

Analog modulation enables Amplitude, Phase, or Frequency properties of the carrier wave to be modulated. By selecting the Pattern button on screen, you can choose between AM, FM, and PM.

Figure 13 Analog Modulation Screen

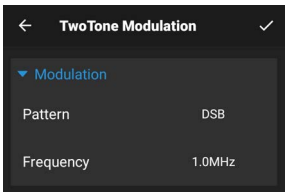


With AM, the depth can be set to 1.0 - 100.0%. With PM, deviation can be set to 0-2π radians. With FM, deviation can be set to 1.0-10000.0 kHz. Under LF (Low Frequency) Generators, the pattern of the modulation signal can be chosen (Sine, Square, Triangle, Rectangle, Ramp Up, and Ramp Down). Each of these allow the frequency of the modulation signal to be set between 0.1 and 10000.0 kHz (10 MHz), and the Rectangle can have a Pulse Duty Cycle between 1.0 and 100.0%.

Multi-Tone Modulation

Multi-Tone Modulation produces two carrier waves of similar frequencies to allow for the testing of system linearity. The patterns included are MSB, LSB, and USB.

Figure 14 Multi-Tone Modulation Screen

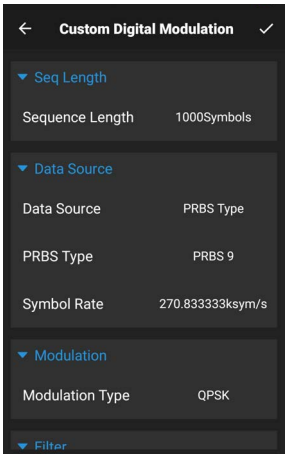


MSB, LSB, and USB can each have the frequency set to 0.00010-10.0 MHz, and can have the N Tone set to any even number between 2 and 100.

Custom Digital Modulation

Digital Modulation offers a multitude of different options to customize the desired profile for modulation. After opening the Custom Digital menu from the main screen, each of the settings can be customized as follows:

Figure 15 Custom Digital Modulation Screen

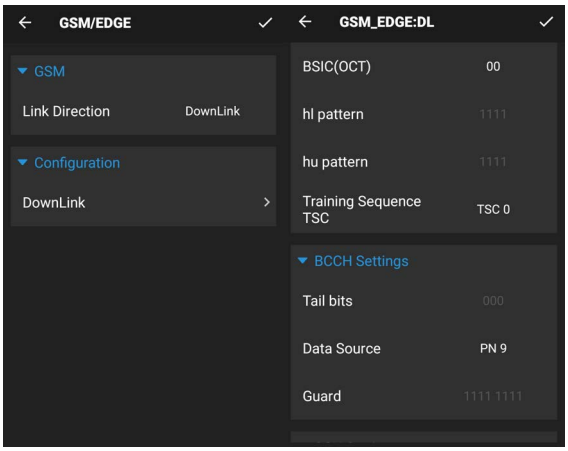


- Sequence Length
  - 1-10000 Symbols
- Data Source
  - Options for All 0, All 1, and Pseudo-Random Binary Sequence (PRSB) Type (includes PRSB 9, 11, 15, 16, 20, 21, and 23)
  - Symbol Rate (8.0-20000.0 ksym/s)
- Modulation Type
  - Includes: ASK, PSK (BPSK, QPSK, QPSK 45° Offset, QPSK EDGE, OPQSK, π/4-QPSK, π/2-DBPSK, π/4-DQPSK, π/8- D8PSK, 8PSK, 8PSK EDGE), QAM (16QAM, 16QAM EDGE, 32QAM, 32QAM EDGE, 64QAM, 128QAM, 256QAM) and FSK (MSK, 2FSK, 4FSK, 8FSK).
- Filter
  - Filter Type (Root Cosine, Cosine, Gauss(FSK) Gauss Linearized)
  - Impulse Length (1.0-128.0 or Auto)
  - (For Root Cosine and Cosine) Roll Off Factor (0.05-1.0)
  - (For Gauss(FSK)) B*T (0.15-2.5)

GSM Modulation

GSM/EDGE (2G) modulation can be performed as either Downlink or Uplink. After opening the GSM/EDGE menu, select Link Direction to make that direction's configuration menu appear. Then, Select either Uplink or Downlink from the Configuration menu to open the settings.

Figure 16 GSM Modulation Screens



The customizable parameters available include:

Downlink:

- BSIC (Base Station Identity Code) (00-77)
- Training Sequence TSC (TSC 0-7)
- BCCH Settings
  - Data Source (PN 9, 11, 15, 16, 20, 21, 23)
- SCH Settings
  - Data Source (PN 9, 11, 15, 16, 20, 21, 23)
- CCCH Settings
  - Data Source (PN 9, 11, 15, 16, 20, 21, 23)

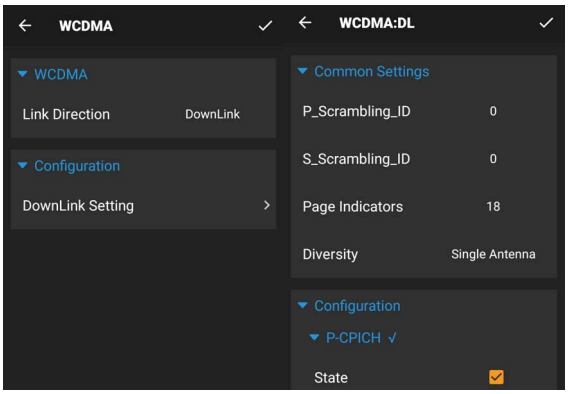
Uplink

- Training Sequence TSC (TSC 0-7)
- TCHFS Settings
  - Data Source (PN 9, 11, 15, 16, 20, 21, 23)
- FACCH Settings
  - Data Source (PN 9, 11, 15, 16, 20, 21, 23)
- SACCH Settings
  - Data Source (PN 9, 11, 15, 16, 20, 21, 23)

WCDMA Modulation

WCDMA (3G) modulation can be performed as either Downlink or Uplink. After opening the WCDMA menu, select Link Direction to make that direction's configuration menu appear. Then, Select either Uplink or Downlink Setting from the Configuration menu to open the settings.

Figure 17 WCDMA Modulation Screens



The customizable parameters available include:

Downlink:

Common Settings

- P_Scrambling_ID (0-511)
- S_Scrambling_ID (0-15)
- Page Indicators (18, 36, 72, 144)
- Diversity (Single Antenna, Antenna 1 of 2, Antenna 2 of 2)

Configuration

- P-CPICH
  - State (on, off) - a check mark will appear next to the parameter name while on
  - Power (-80.0-0.0 dB)
- S-CPICH
  - State (on, off) - a check mark will appear next to the parameter name while on
  - Power (-80.0-0.0 dB)
- P-SCH
  - State (on, off) - a check mark will appear next to the parameter name while on
  - Power (-80.0-0.0 dB)
- S-SCH
  - State (on, off) - a check mark will appear next to the parameter name while on
  - Power (-80.0-0.0 dB)
- P-CCPCH
  - State (on, off) - a check mark will appear next to the parameter name while on
  - Power (-80.0-0.0 dB)
  - Data Source (All 0, All 1, PN 9, 11, 15, 16, 20, 21, 23)
  - Channel Coding State (on, off)

- Interleaver 2 State (on, off)
- Transport Blocks Size (if Channel Coding State is on) (1-4096)
- Size of CRC (if Channel Coding State is on) (0, 8, 12, 16, 24)

- S-CCPCH
  - State (on, off) - a check mark will appear next to the parameter name while on
  - Power (-80.0-0.0 dB)
  - Slot Format (0-17)
  - Channel Code (0-255)
  - Data Source (All 0, All 1, PN 9, 11, 15, 16, 20, 21, 23)
  - TFCI (0-1023)
- PICH
  - State (on, off) - a check mark will appear next to the parameter name while on
  - Power (-80.0-0.0 dB)
  - Channel Code (0-255)
  - Data Source (All 0, All 1, PN 9, 11, 15, 16, 20, 21, 23)
- AICH
  - State (on, off) - a check mark will appear next to the parameter name while on
  - Power (-80.0-0.0 dB)
  - Channel Code (0-255)
- DPCH
  - State (on, off) - a check mark will appear next to the parameter name while on
  - Power (-80.0-0.0 dB)
  - Slot Format (0-16)
  - Channel Code (0-511)
  - Data Source (All 0, All 1, PN 9, 11, 15, 16, 20, 21, 23)
  - TFCI (0-1023)
  - TPC Source (All 0, All 1)
  - Interleaver 2 State (on, off)
  - Transport Blocks (1-24)
  - Transport Blocks Size (1-4096)
  - Size of CRC (0, 8, 12, 16, 24)
  - Error Protection (0, 1/2 Conv, 1/3 Conv, Turbo)

Uplink:

Common Settings

- Scrambling Code (1-16777215 bin)
- Mode (choice will update the settings screen with the relevant parameters)
  - DPCCH+DPDCH
  - PRACH Standard
  - PRACH Preamble Only

When mode selected is DPCCH+DPDCH:

- Scrambling Mode (Long Scrambling Code, Short Scrambling Code, Off)
- DPCCH Settings
  - Power (-80.0-0.0 dB)
  - Slot Format (0, 1, 2, 3, 4)

- TFCI (0-1023)
- TPC Source (All 0, All 1)
- FBI Source (All 0, All 1)

- DPDCH Settings
  - Power (-80.0-0.0 dB)
  - Overall Symbol Rate (15, 30, 60, 120, 240, 480, 960, 2*960, 3*960, 4*960, 5*960, 6*960 ksps)
  - DPCH Configuration
    - DTCH (DTCH1, DTCH2, DTCH3)
    - State (on, off)
    - Data Source (All 0, All 1, PN 9, 11, 15, 16, 20, 21, 23)
    - Transport Blocks (1-24)
    - Transport Blocks Size (1-4096)
    - Size of CRC (0, 8, 12, 16, 24)
    - Error Protection (0, 1/2 Conv, 1/3 Conv, Turbo)
    - Interleaver 2 State (on, off)
    - Rate Matching Attribute (1-1024)

When mode selected is PRACH Standard:

- Scrambling Mode (Long Scrambling Code, Off)
- PRACH Settings
  - Preamble Power (-80.0-0.0 dB)
  - Signature (0-15)
  - Preamble Repetition (1-10)
  - Data Power (-80.0-0.0 dB)
  - Control Power (-80.0-0.0 dB)
  - Message Length (1-2 Frames)
  - Slot Format (0, 1, 2, 3)
  - TFCI (0-1023)
  - Data Source (All 0, All 1, PN 9, 11, 15, 16, 20, 21, 23)
  - Coding State (on, off)
  - Coding Type (RACH RMC(TB size 168 bit), RACH RMC(TB size 360 bit))

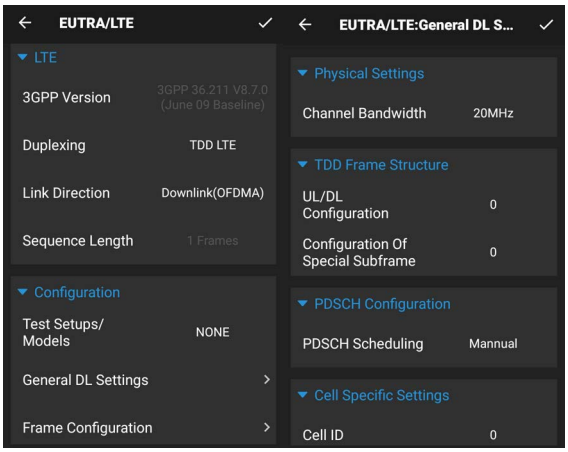
When mode selected is PRACH Preamble Only:

- Scrambling Mode (Long Scrambling Code, Off)
- PRACH Settings
  - Preamble Power (-80.0-0.0 dB)
  - Signature (0-15)
  - Preamble Repetition (1-10)

EUTRA/LTE Modulation

EUTRA/LTE (4G) modulation can be performed with either FDD LTE or TDD LTE duplexing and either Downlink (OFDMA) or Uplink (SC-FDMA) direction. After opening the LTE menu, select Link Direction to make that direction's configuration menu appear. Then, Select either Uplink or Downlink Setting from the Configuration menu to open the settings.

Figure 18 EUTRA/LTE Modulation Screens



The customizable parameters available include:

Downlink (OFDMA)

Configuration

- Test Setups/Models
  - NONE
  - E-TM1_1__1_4MHz
  - E-TM1_1__3MHz
  - E-TM1_1__5MHz
  - E-TM1_1__10MHz
  - E-TM1_1__15MHz
  - E-TM1_1__20MHz
  - E-TM1_2__1_4MHz
  - E-TM1_2__3MHz
  - E-TM1_2__5MHz
  - E-TM1_2__10MHz
  - E-TM1_2__15MHz
  - E-TM1_2__20MHz
  - E-TM2__1_4MHz
  - E-TM2__3MHz
  - E-TM2__5MHz
  - E-TM2__10MHz
  - E-TM2__15MHz
  - E-TM2__20MHz
  - E-TM3_1__1_4MHz
  - E-TM3_1__3MHz
  - E-TM3_1__5MHz

- E-TM3_1__10MHz
- E-TM3_1__15MHz
- E-TM3_1__20MHz
- E-TM3_2__1_4MHz
- E-TM3_2__3MHz
- E-TM3_2__5MHz
- E-TM3_2__10MHz
- E-TM3_2__15MHz
- E-TM3_2__20MHz
- E-TM3_3__1_4MHz
- E-TM3_3__3MHz
- E-TM3_3__5MHz
- E-TM3_3__10MHz
- E-TM3_3__15MHz
- E-TM3_3__20MHz

- General DL Settings
  - Physical Settings
    - Channel Bandwidth (1.4, 3, 5, 10, 15, 20 MHz)
  - TDD Frame Structure (If set to TDD LTE)
    - UL/DL Configuration (0, 1, 2, 3, 4, 5, 6)
    - Configuration of Special Subframe (0, 1, 2, 3, 4, 5, 6, 7, 8)
  - PDSCH Configuration
    - PDSCH Scheduling (Manual, Auto/DCI)
  - Cell Specific Settings
    - Cell ID (0-503)
    - Physical Cell ID Group (0-167)
    - Physical Cell ID Sector (0-2)
    - Cyclic Prefix (Normal, Extended)
    - PHICH During (Normal, Extended)
    - PHICH N_g (1/6, 1/2, 1, 2)
    - RA_RNTI (1-60)
- Frame Configuration
  - Configure PCFICH, PHICH, PDCCH
    - State (on, off)
    - PCFICH
      - ✓ Scrambling State (on, off)
      - ✓ Control region for PDCCH (1, 2, 3 OFDMA Sym.)
    - PHICH
      - ✓ User of Number (1, 2, 3, 4, 5, 6, 7, 8)
      - ✓ ACK/NACK Pattern (ACK, NACK)
    - PDCCH
      - ✓ DCI Format (Format 0, 1, 1A)
      - ✓ PDCCH Format (0-3)
  - PDSCH Manual
    - Enable PDSCH (on, off)
    - MCS (0-28)
    - Number of RBs (0-100)

Uplink (SC-FDMA)

Configuration

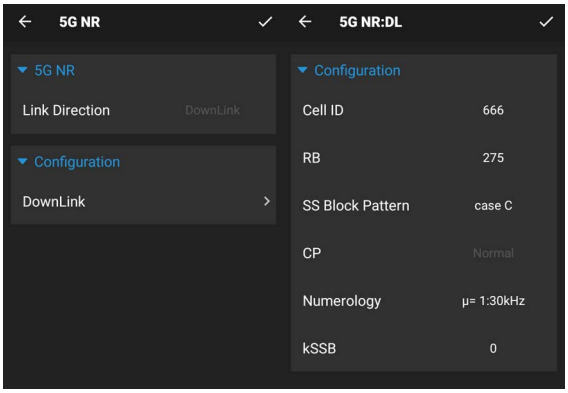
- General UL Settings
  - Channel bandwidth (1.4, 3, 5, 10, 15, 20 MHz)
  - Cell ID (0-503)
  - Physical Cell ID Group (0-167)
  - Physical Cell ID Sector (0-2)
  - Cyclic Prefix (Normal, Extended)
  - RNTI (1-65535)
  - Group Hopping (on, off)
  - Sequence Hopping (on, off)
  - Delta Sequence Shift for PUSCH (0-29)
  - n(1)_DMRS (0, 2, 3, 4, 6, 8, 9, 10)
  - Enable PRACH (on, off)
  - Restricted Set (High Speed Mode) (on, off)
  - PRACH Frequency Offset (0-94)
  - PRACH Configuration Index (0-47)
  - Zero Correlation Zone Configuration (0-15)
  - PRACH Logical Root Sequence Configuration (0-837)
  - PRACH Preamble sequences Configuration (0-63)
  - PRACH Time Offset (0, 624)
  - Frequency Hopping Module (inter-subframe, intra-subframe)
  - PUSCH Hopping Offset (0-98)
  - Number of Sub-bands (1-4)
  - Number of RBs Used for PUCCH (0-100)
  - Delta Shift (1-3)
  - N(1)_cs (0-7)
  - N(2)_RB (0-99)
  - SRS Configuration Paras (on, off)
  - SRS Cyclic Shift (0-7)
  - SRS Bandwidth Configuration C_SRS (0-7)
  - SRS Bandwidth B_SRS (0-3)
  - SRS Configuration Index I_SRS (0-16)
  - SRS Subframe Configuration (0-14)
  - SRS Transmission Comb k_TC (0, 1)
  - SRS Hopping Bandwidth (0-3)
  - SRS Freq Domain Position (nRRC) (0-23)
- Frame Configuration
  - Uplink Channel Selection (PUSCCH/PUSCH, PRACH)
  - Uplink Subframe No (0, 1, 2, 3, 4, 5, 6, 7, 8, 9)
  - Uplink Channel Type (If PUSCCH/PUSCH selected) (NULL, PUCCH, PUSCH)
  - Only SRS Channel (on, off)
  - PUCCH Format (Format 1, 1a, 1b, 2, 2a, 2b)
  - n(2)_PUCCH (0-12)
  - ACK/NACK Data Source (0000...00, 1111...11, 1010...10, 0101...01, PN9, PN15)
  - CQI Data Source (0000...00, 1111...11, 1010...10, 0101...01, PN9, PN15)
  - n(2)_DMRS (0, 2, 3, 4, 6, 8, 9, 10)

- Number of RBs for PUSCH (1-100)
- MCS (0-28)
- Frequency Hopping (on, off)
- Frequency Hopping Type (Type 1, 2)
- Information in Hopping Bits (0-2)
- RB Offset (0-90)

5G NR Modulation

5G NR modulation can currently only be performed in the Downlink direction. Downlink configurations can be customized as follows:

Figure 19 5G NR Modulation Screens

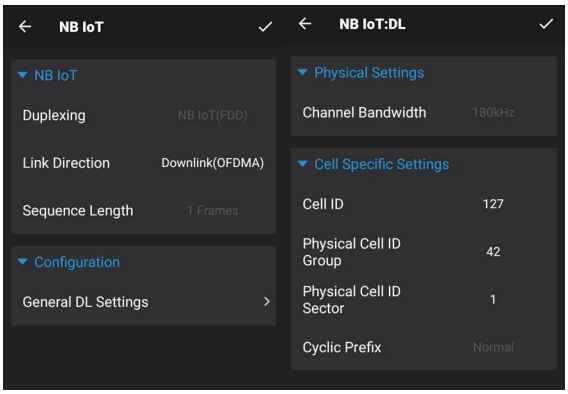


- Downlink Configuration
  - Cell ID (0-1007)
  - RB (20-275)
  - SS Block Pattern (case B, C)
  - Numerology (μ=0:15kHz, μ=1:30kHz)
  - kSSB (0-23)

NB IoT Modulation

NB IoT modulation can be performed in either Downlink (OFDMA) or Uplink (SC-FDMA) direction. After opening the NB IoT menu, select Link Direction to make that direction's configuration menu appear. Then, Select either General DL or UL Settings from the Configuration menu to open the settings.

Figure 20 NB IoT Modulation Screen



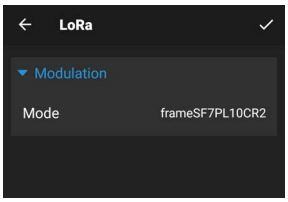
The customizable parameters available include:

- Downlink
  - Cell ID (0-503)
  - Physical Cell ID Group (0-167)
  - Physical Cell ID Sector (0-2)

LoRa Modulation

LoRa modulation can be performed in one of two modes: frameSF7PL10CR2 and frameSF8PL10CR2. After opening the LoRa menu, select the Mode to choose between the two.

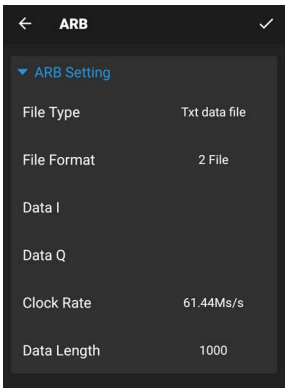
Figure 21 LoRa Modulation Screen



ARB Modulation

Arbitrary Waveform (ARB) modulation can be performed through the upload of custom parameters by adding the files to the GH-60 via download or USB transfer. After selecting ARB from the menu, file upload will be available from the settings menu.

Figure 22 ARB Modulation Screen



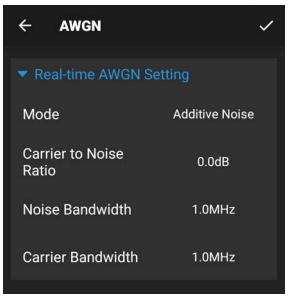
The customizable parameters available include:

- File Type (txt, binary, R&S .wv data file)
- File Format (2 file, 1 file I-Q, 1 file Q-I)
- Data I (2 File) (choose I file from storage)
- Data Q (2 File) (choose Q file from storage)
- Data (1 file I-Q & Q-I) (choose file from storage)
- Separator (1 file I-Q & Q-I) (comma, space, tab, semicolon)
- Endianness (binary file type) (little-endian, big-endian)
- Clock Rate (1.0-250.0 Ms/s)
- Data Length (1000-6144000)

AWGN (Additive Noise)

The GH-60 offers an optional AWGN additive noise generation that is turned on or off with the toggle switch on the main screen. Selecting the AWGN (Additive Noise) name itself opens up the settings menu, which offers several forms of customization:

Figure 23 AWGN (Additive Noise) Screen

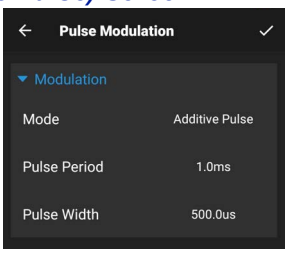


- Real-time AWGN Setting
  - Mode (Noise Only, Additive Noise)
  - Carrier to Noise Ratio (-30.0-40.0 dB)
  - Noise Bandwidth (0.1-100.0 MHz)
  - Carrier Bandwidth (0.1-100.0 MHz)

Pulse Modulation (Additive Pulse)

The GH-60 offers an optional additive pulse generation that is turned on or off with the toggle switch on the main screen. Selecting the Pulse Modulation (Additive Pulse) name itself opens up the settings menu, which offers several forms of customization:

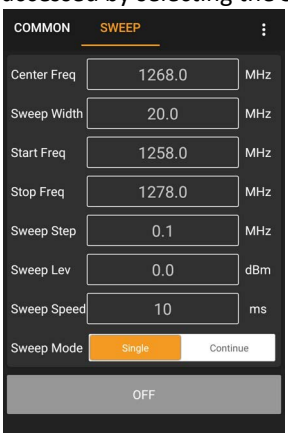
Figure 24 Pulse Modulation (Additive Pulse) Screen



- Modulation
  - Mode (Pulse Only, Additive Pulse)
  - Pulse Period (0.00050-40000.0 ms)
  - Pulse Width (0.1 us - Pulse Period)

Using Sweep Mode

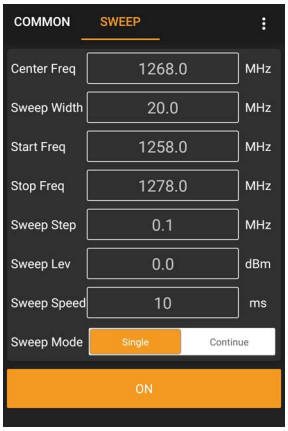
Sweep mode (if activated via license) can be accessed by selecting the SWEEP tab at the top of the main screen:



From here, multiple parameters can be customized for the sweep profile by selecting each and inputting a value:

- Center Frequency (Determines the center point of the sweep and automatically updates the Start and Stop Frequencies. Sweep will not begin if Start and Stop Frequencies exceed 10-6000 MHz range)
- Sweep Width (Determines the distance between that Stop and Start Frequencies, with the Center Frequency as the midpoint. Sweep will not begin if Start and Stop Frequencies exceed 10-6000 MHz range)
- Start Frequency (Adjusts automatically with center freq. and sweep width. Cannot be less than 10MHz)
- Stop Frequency (Adjusts automatically with center freq. and sweep width. Cannot be greater than 6000 MHz)
- Sweep Step (0.1 MHz-Sweep Width value)
- Sweep Level (-130-15 dBm)
- Sweep Speed (10-100 ms)
- Sweep Mode (Single, Continue)

After inputting the desired parameters, begin the sweep by pressing the on/off button at the bottom of the screen.



Cleaning

Care and cleanliness is a main factor in maintenance, clean the GH-60 with a soft cloth dampened with a mild detergent solution.

Troubleshooting

Problem	*Resolution*
Unit does not power on	Ensure battery is charged, plug in AC adapter
	Replace battery
Screen freezes or does not respond to touch inputs	Press and hold power button 15 seconds to turn off, then turn unit back on
GenHawk app does not open or function	Follow the procedure for Firmware Updates. See “Firmware Updates” on page 36.

Device Calibration

It is recommended that an instrument calibration be performed by a certified service provider at nominal one year intervals.

See "Customer Service" on page 36 , or go to birdrf.com.

Repair

Battery Replacement

Tools Required

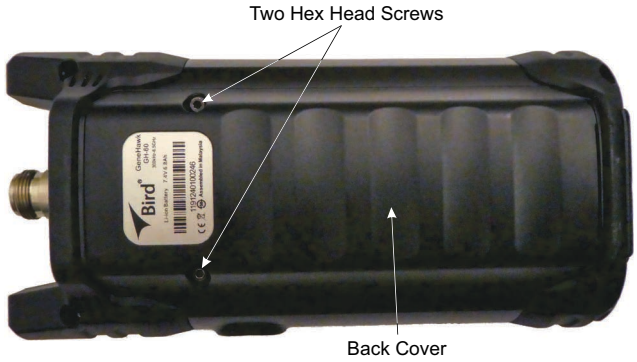
5/64 Hex driver

CAUTION

Replace battery pack with OEM part only, do not use any other battery.

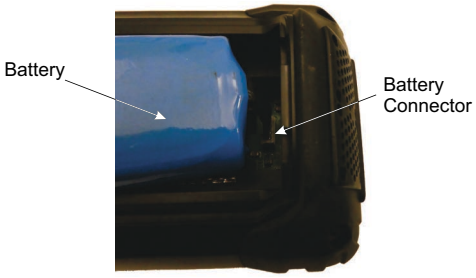
1. Power off the GH-60. See "Power Off" on page 9.
2. Disconnect AC Adapter cable, if connected.
3. Remove two hex screws securing the back cover. See Figure 25.

Figure 25 Back Cover Removal



4. Disconnect battery connector from chassis. See Figure 26.

Figure 26 Battery Connection



5. Install replacement battery.
6. Install two screws to secure the back cover. See Figure 25.
7. Charge the battery. See "Charge the Battery" on page 8.

File System

The GH-60 has an internal file system. Files may be transferred to and from the GH-60.

Transfer files

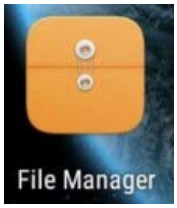
Files may be transfered to/from the GH-60 using a USB Drive or Bluetooth. For instructions on transfer via Bluetooth, see "Data Transfer via Bluetooth" on page 34.

Data Transfer via USB Drive

Files may be transfered to/from the GH-60 internal memory with the use of an external USB drive and the USB adapter (supplied).

1. Connect the USB drive to the USB adapter, then connect the USB adapter to the USB-C port at the bottom of the unit.
2. Tap the Home button ○ on the GH-60 display.
3. Tap the File Manager icon on the unit's home screen.

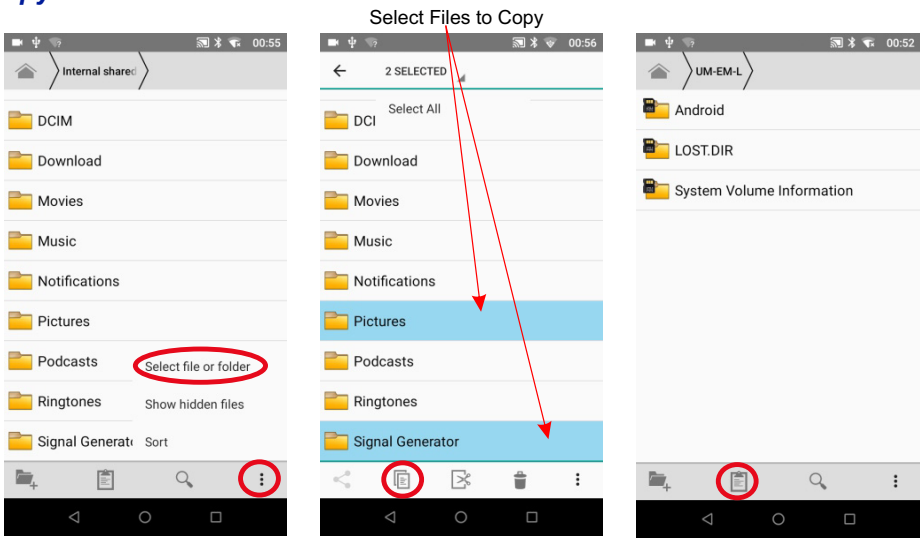
Figure 27 File Manager



4. Tap the location drop-down at the top of the File Manager window.
5. Tap Shared Storage.
6. Tap the folder containing the file(s) to be moved.
7. Perform one of the following:
    a. To copy a folder and all contents:
        i. Tap and hold the folder.
        ii. Tap the **Copy** icon. 
        iii. Navigate to where you would like to paste the folder.
        iv. Tap the **Paste** icon at the bottom of the page. 
    b. To copy one file:
        i. Tap and hold the file.
        ii. Tap the **Copy** icon at the bottom of the page.
        iii. Navigate to where you would like to paste the file.
        iv. Tap the **Paste** icon at the bottom of the page.
    c. To copy several files:
        i. Tap the kebab menu  .
        ii. Tap **Select file or folder**.
        iii. Select the files to copy. The selected files will be highlighted.
        iv. Tap the **Copy** icon at the bottom of the page.

v. Navigate to where you would like to paste the files.
vi. Select a folder at the destination.
vii. Tap the **Paste** icon at the bottom of the page.

Figure 28 Copy and Paste Files or Folders



8. Exit the File Manager.
9. Swipe down from the top of the screen to access the notification area.
10. Tap Eject.
11. You may now remove the USB Drive.

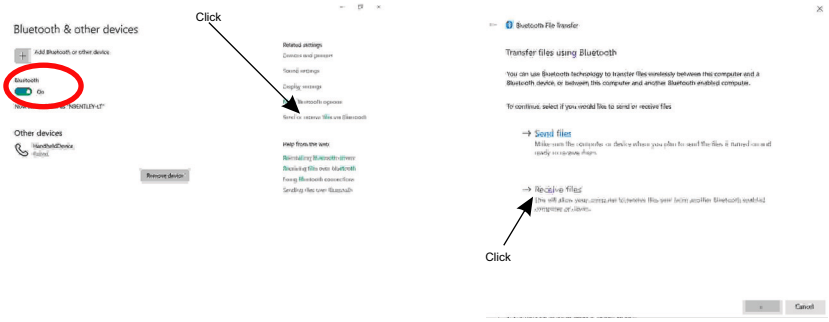
Data Transfer via Bluetooth

Files may be transfered to/from the GH-60 using the following steps. This procedure describes transferring files to a PC with Bluetooth enabled.

On the PC

1. Open Bluetooth settings. See Figure 29.
2. Turn on Bluetooth, if not already on.
3. Click on **Send or receive files via Bluetooth**.
4. Click the **Receive files** option in the dialog box.

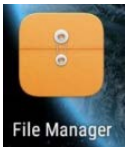
Figure 29 PC Settings



On the GH-60

5. Tap Home key on the GH-60 display.
6. Select Settings.
7. Turn on Bluetooth.
8. Tap Home key.
9. Tap the File Manager icon on the unit's home screen.

Figure 30 File Manager



10. Tap Shared Storage.
11. Tap the kebab menu ⋮.
12. Tap Select file or folder.
13. Select the files to copy. The selected files will be highlighted.
14. Tap the **Copy** icon.
15. Tap the **Share** icon.
16. Select the destination device from the devices listed.

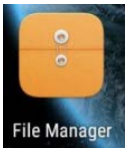
On the PC

17. Wait for file to transfer.
18. Save the file to a location on the PC.

Delete Files

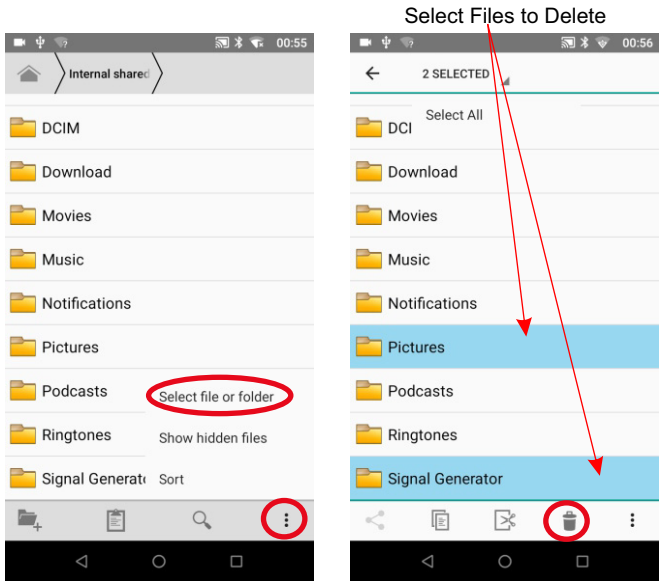
1. Press Home key on the GH-60 display.
2. Tap the File Manager icon on the unit's home screen.

Figure 31 File Manager



3. Tap the location drop-down at the top of the File Manager window.
4. Tap Internal Storage.
5. Navigate to the folder where the folders/files to be deleted are located.

Figure 32 Deleting Folders or Files



6. Tap the kebab menu  .
7. Tap Select file or folder.
8. Select the files/folders to delete. The selected files will be highlighted.
9. Tap the Delete icon at the bottom of the screen  .

Firmware Updates

Occasionally Bird may update the GH-60 software, updates may be downloaded when available from www.birdrf.com.

1. Go to www.birdrf.com/Products/Analyzers/Spectrum-Analyzers/.
2. Select GH-60.
3. Scroll down to the Downloads.
4. Click on the Firmware link.
5. Download the GH-60-Firmware-XXX.apk update file.
6. Connect the USB Drive to the PC.
7. Transfer the GH-60-Firmware-XXX.apk update file to the USB drive.
8. Remove the USB drive.
9. Connect the USB drive to the USB Adapter.
10. Connect the USB Adapter to the GH-60.
11. Turn on the GH-60.
12. Connect AC Adapter to the GH-60 or verify battery has sufficient charge.
13. Tap “File Manager” on the home screen.
14. Tap Storage at the top of the File Manager window.
15. Tap “USB storage”.
16. Tap GH-60-Firmware-XXX.apk.
17. Follow the Installation instructions on the unit.

Customer Service

Any maintenance or service procedure beyond the scope of those in this chapter should be referred to a qualified service center.

If the unit needs to be returned for any reason, request an Return Material Authorization (RMA) through the Bird Technologies website. All instruments returned must be shipped prepaid and to the attention of the RMA number.

Bird Service Center
30303 Aurora Road
Cleveland (Solon), Ohio 44139-2794
Fax: (440) 248-5426
E-mail: *bsc@birdrf.com*

For the location of the Sales Office nearest you, visit our Web site at:

http://www.birdrf.com

Chapter 7 Specifications

Signal Analysis Specifications

Frequency Range	10 MHz - 6.0 GHz (Upgradeable to 300 kHz - 6.5 GHz with MTX-S020)
Frequency Accuracy	+/- 0.5 ppm
Frequency Resolution	0.1 Hz
Output Settling Time	<1.5 ms (CW)
Power Range	-110 dBm to +10 dBm when f < 2 MHz -130 dBm to +15 dBm when f ≥ 2 MHz
Power Resolution	0.1 dB
Power Accuracy	+/- 0.75 dB@ ≥ -80 dBm +/- 1.5 dB -110 dBm to -80 dBm +/- 2.5 dB @ < -110 dBm
VSWR	<2.0 (typ.)
Max. Reverse Power	0.01 W
Harmonic CW, ≤ +10 dBm	≤ -22 dBc @ 300 kHz ≤ f < 2 MHz ≤ -30 dBc @ 2 MHz ≤ f ≤ 6.5 GHz
Nonharmonic CW, ≤ +10 dBm	≤ -25 dBc @ 300 kHz ≤ f < 10 MHz ≤ -35 dBc @ 10 MHZ ≤ f < 500 MHz ≤ -50 dBc @ 500 MHZ ≤ f ≤ 6.5 GHz
Phase Noise	≤ -119 dBc/Hz (typ.) @ 1 GHz ≤ -110 dBc/Hz (typ.) @ 3 GHz ≤ -104 dBc/Hz (typ) @ 6.5 GHz
Temperature Stability	+/- 1 ppm @ 0 - 50 deg. C
Error Vector Magnitude (EVM)	≤ 2% (typ.)
Wave Quality ρ	> 0.9999
Modulation Bandwidth	20 MHz (Upgradeable to 100 MHz with MTX-S019
Pulse Modulation (With MTX-S010)	Pulse Period: 10 us to 40 s Pulse Width: 100 ns to 40 s Width Resolution: 10 ns
Analog Modulation Types (Optional)	Analog Modulation: AM/FM/PM Multi-Tone: MSB/USB/LSB
Mobile Communication Standards (Optional)	GSM/WCDMA/TDD-LTE/FDD-LTE/NB-IoT/ LoRa/5GNR
Digital Modulation Types (with MTX-S008)	BPSK/QPSK/OQPSK/8PSK/MSK/FSK/ASK/ 16QAM/32QAM/64QAM/128QAM/ 256QAM
LTE Channels (with MTX-S003, MTX-S004)	PSS/SSS/CSRS/PBCH/PCFICH/PHICH/ PDCCH/PDSCH/PUSCH/PUCCH/PRACH/SRS

Device Characteristics

Physical characteristics

Connectors RF Out USB Power interface	 N type, female, 50 Ω USB type C Slim Tip, DC 9 -12 V, 3 A
Power Supply	AC Input: 110-240 V, 1.5 A, 50-60Hz DC Output: 12V, 3A
Display	5.5 inch, 1280*720 p
Battery Type	Li-on
Battery Operating time	3.5 to 4 hours
Battery Charging time	6 hours
Operating Temperature	0° C to 50° C
Storage Temperature	-20° C to 70° C
Size	7.7 x 3.7 x 2.4 inches (197 x 93 x 61 mm)
Weight	2 lbs (0.9 kg)
Recommended Calibration Interval	1 year

Chapter 8 Glossary

5G NR — Fifth Generation New Radio, the global standard for a unified, more capable 5G wireless air interface.

ACK/NACK — Acknowledgment/Negative Acknowledgment, used in communication to confirm whether a data packet was received.

AC — Alternating Current.

AICH — Acquisition Indicator Channel, a physical channel used in WCDMA to transmit the acquisition indicator (AI).

AM — Amplitude Modulation, a method of encoding information in the amplitude of a carrier wave.

AQPSK — Alternate Quadrature Phase Shift Keying, a modulation technique.

ARQ — Automatic Repeat Request, an error control method in communication where a message is automatically re-sent if an acknowledgment is not received.

ASK — Amplitude Shift Keying, a form of modulation where the amplitude of the carrier signal is digitally varied according to the data signal.

BCCH — Broadcast Control Channel, used in the GSM standard to broadcast information about the base station in the downlink channel.

BPSK — Binary Phase Shift Keying, the most basic form of phase-shift keying with 2 phases being 180° out of phase.

BSIC — Base Station Identity Code, a unique identifier for base stations in GSM networks.

CCCH — Common Control Channel, used in the GSM standard to communicate basic control information.

CDMA — Code-Division Multiple Access, a channel access method based on spread spectrum usage where users are distinguished by different spreading codes. Compare to TDMA.

CRC — Cyclic Redundancy Check, an error-detecting code used in digital networks.

CW — Continuous Wave, a wave (or RF signal, in this manual) with constant amplitude, frequency, and phase.

CPICH — Common Pilot Channels, a set of two phase reference channel used in WCDMA being the Primary CPICH (P-CPICH) and Secondary (S-CPICH).

CQI — Channel Quality Indicator, used in LTE and 5G to communicate the quality of the downlink back to the base station.

DBPSK — Differential Binary Phase Shift Keying, a variation of BPSK where digital information is based on changes to the phase, rather than on the absolute state of the phase.

DPCCH — Dedicated Physical Control Channel, used in WCDMA uplink to carry control information like TPC, FBI, and TFCI.

DPCH — Dedicated Physical Channel, used in WCDMA downlink to carry data and physical layer control information.

DPDCH — Dedicated Physical Data Channel, used in WCDMA uplink to carry

DQPSK — Differential Quadrature Phase Shift Keying, the differential form of QPSK, see DBPSK.

DSB — Dual Sideband, a form of amplitude modulation with frequencies spaced equally above and below the carrier frequency.

DTCH — Dedicated Traffic Channel, a logical channel in WCDMA used to carry user-specific data.

DTMF — Dual-tone Multi-frequency, a modulation technique combining 2 frequencies, used in telecommunication for signal encoding push-button telephones.

EDGE — Enhanced Data rates for GSM Evolution, a 3G mobile data technology.

EUTRA/LTE — Evolved Universal Terrestrial Radio Access / Long-Term Evolution, a standard for high-speed wireless communication.

FACCH — Fast Associated Control Channel, used in GSM for transmitting control information during an active call.

FBI — Feedback Information, used in WCDMA uplink to support enhanced features of WCDMA.

FM — Frequency Modulation, a method of encoding information in the frequency of a carrier wave.

FSK — Frequency Shift Keying, a method of encoding digital information using frequency variations.

GSM — Global System for Mobile Communications, a standard for mobile phones.

GMSK — Gaussian Minimum-Shift Keying, a variant of minimum-shift keying notably used by the GSM standard where digital information to be transmitted first goes through a gaussian filter to reduce sideband power.

GNSS — Global Navigation Satellite System, any of several systems used for positioning, navigation, and timing.

LFM — Linear Frequency Modulation, a modulation technique consisting of a linear increase or decrease in frequency over time, a LFM signal is called a chirp.

LF — Low Frequency, a radio frequency range.

LoRa — Long Range, a low-power wide-area network (LPWAN) modulation technology.

LSB — Lower Sideband, the group of frequencies below the carrier signal.

MCS — Modulation Coding Scheme, an indexed value used to communicate the modulation depth (how many bits/symbol) and other signal parameters between the uplink and downlink.

NB IoT — Narrowband Internet of Things, a low-power wide-area network (LPWAN) modulation technology.

OFDMA — Orthogonal Frequency-Division Multiple Access, a method of multi-user simultaneous transmission in wireless networks.

OPQSK — Offset Phase-Quadrature Shift Keying, a variation of QPSK where I and Q changes are offset to prevent large amplitude changes in the modulated signal.

P-CCPCH — Primary Common Control Physical Channel, used in WCDMA for control information across an entire cell.

P-CPICH — Primary Common Pilot Channel, a phase reference channel for SCH, P-CCPCH, AICH, and PICH in WCDMA.

P-SCH — Primary Synchronization Channel, used in WCDMA to transmit a known synchronization code on all cells.

PCFICH — Physical Control Format Indicator Channel, used in LTE for carrying the Control Format Indicator (CFI).

PDCCH — Physical Downlink Control Channel, a channel in LTE for sending control information.

PDSCH — Physical Downlink Shared Channel, a channel in LTE used for data transmission.

PHICH — Physical Hybrid ARQ Indicator Channel, a downlink channel in LTE which carries the ACK/NACK.

PICH — Paging Indicator Channel, a channel used to carry the paging indicator in WCDMA.

PRK — Phase Reversal Keying, see BPSK.

PRACH — Physical Random Access Channel, used to initiate communication on the uplink.

PSCCH — Physical Synchronous Channel, used in LTE and 5G for synchronization.

PSK — Phase Shif Keying, a method of encoding digital information using phase variations.

PUCCH — Physical Uplink Control Channel, a channel in LTE used for control information.

PUSCH — Physical Uplink Shared Channel, a channel in LTE used for data transmission.

QAM — Quadrature Amplitude Modulation, 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.

QPSK — Quadrature Phase Shift Keying, a modulation technique that uses four orthogonal phases to encode data.

RA_RNTI — Random Access Radio Network Temporary Identifier, used in LTE for random access procedures.

RACH — Random Access Channel, used in wireless networks for devices to initiate communication.

RACH RMC — RACH Reference Measurement Channel, a specific configuration of a RACH request used in testing.

RNTI — Radio Network Temporary Identifier, a code used to distinguish users or channels in communication standards.

S-CCPCH — Secondary Common Control Physical Channel, used in WCDMA for control information.

S-SCH — Secondary Synchronization Channel, used in WCDMA to transmit frame synchronization codes and to identify the scrambling code group of the cell.

SC-FDMA — Single-Carrier Frequency-Division Multiple Access, used in LTE for uplink transmission because it is generally more error-resistant when used by lower power amplifiers.

SACCH — Slow Associated Control Channel, used in GSM to carry control information.

SCH — Synchronization Channel, used to identify a cell and synchronize communication. In WCDMA there is a Primary (P-SCH) and Secondary (S-SCH) channel.

SCI — System Control Information, used to manage system-level operations.

SRS — Sounding Reference Signal, used in LTE for uplink channel estimation.

TBS — Transport Block Size, related to data transmission size in LTE/5G.

TDMA — Time-Division Multiple Access, a channel access method where different users are assigned different, unique, time slots. Compare to CDMA.

TFCI — Transport Format Combination Indicator, used in WCDMA to inform the receiver of transport channel combinations.

TCHFS — Traffic Channel Full Rate Service, used in GSM networks to carry the full rate of information.

TPC — Transmit Power Control, used to manage the power level of transmissions in wireless systems.

UE — User Equipment, referring to the devices used by the end-user in mobile networks.

USB — Upper Sideband, the group of frequencies above the carrier signal.

V2X-LTE — Vehicle-to-Everything using LTE, a technology for communication between vehicles and their surroundings.

WCDMA — Wideband Code Division Multiple Access, a 3G mobile telecommunications technology based on the CDMA channel access method, implemented in the Universal Mobile Telecommunications System (UMTS) standard.