CIELO™ MOCKINGBIRD RF TEST SYSTEM

OWNER'S MANUAL | VERSION 1.0

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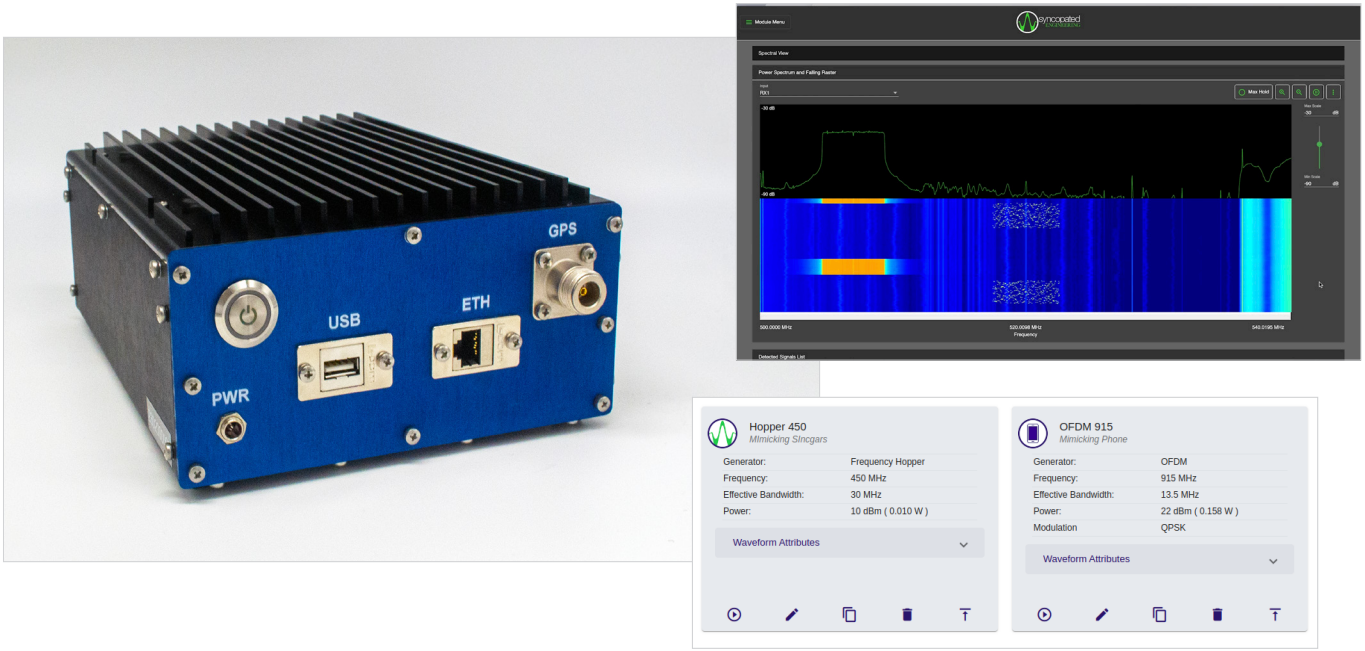
Mockingbird RF Test System

1. Product Overview

As a RF signal processing and test engineer, you need a RF test system that enables agile test-driven development at the pace of your development. Mockingbird provides RF signal generation, spectral analysis and signal capture in a compact, rugged, software defined RF test system that enables rapid testing and verification of RF systems in the lab and in the field. Verify wireless data links, signal detectors and demodulators, and complex spectral sensing algorithms throughout your development cycle from design prototypes to outdoor Over-the-Air (OTA) testing. The simple and intuitive web interface enables collaborative testing and remote monitoring applications, and Mockingbird integrates with the tools you use today like MATLAB and GNURadio



1.1. System Use Cases

The primary system uses cases include:

- RF Signal and Traffic Emulation
- RF Spectral Analysis and Monitoring
- RF Signal Capture

1.2. Key Features

Table 1: Mockingbird Key Features and Benefits

Feature	Benefit

Waveform Toolkits	Direct emulation of specific signals, “radio personalities”, using configurable built-in waveform generators.
	• CW Test Signals: Tone, Two-Tone, Stepped Frequency, Sweep
	• Analog Modulation: AM, FM
	• Digital Modulation:
	  • FSK (MFSK, GFSK, MSK, GMSK)
	  • PSK (MPSK OQPSK, PI/4, QPSK, DPSK)
	  • QAM (QAM16, QAM64)
	• Frequency Hopper
	• OFDM

Arbitrary Waveform Generation	Import custom baseband I/Q waveforms from MATLAB and GNU Radio.
RF Scene Creation	Create realistic traffic patterns and mixtures of RF signals to create sophisticated RF scenes (i.e. emulated RF environments).
Spectrum Analyzer	Wideband dual-channel spectrum analyzer including power spectrum, and time-frequency falling raster with typical spectral analysis functions such as max hold, dual markers and peak search.
Spectrum Monitoring	Disjoint multi-band spectrum monitoring (e.g. 915 MHz ISM band and 2.4 GHz WiFi). Ability to create user configurable frequency scan lists.
Signal Capture	Capture narrowband and wideband signals up to 40 MHz BW, and 50 million complex baseband I/Q samples for detailed signal processing and analysis.
Wideband Dual-Channel Transceiver (50-6000 MHz RF range, 40 MHz IBW)	Wideband 2x2 MIMO Software Defined Radio: Dual transmit or receive channels. Rugged Low SWAP form factor: Enables OTA field testing as well as lab operation. GPS Enabled: Provides location information to field testing scenarios
Network Attached Software Defined Instrument	Ethernet attached device with simple and intuitive web interface. No software installation required. Configure for your network and start testing immediately. Create multiple system deployments, for more sophisticated testing scenarios or multi-user access. Supports remote operation.

2. Document Overview

This document provides guidance on how to configure and operate the system. Section 3 provides an overview of the Mockingbird RF test application. Section 4 describes how to launch the application, followed by Section 5 on how to configure the system. The remaining sections describe how to operate the system through the presentation of the system use cases.

3. How to Install the System

This section describes the system hardware installation and setup. The system does not require installation of software on an external computer. All software is provided within the system.

3.1. Unpack the System

The Mockingbird system includes the following components:

Table 2: System Components

Item	Description	Quantity
RF Test System	Ruggedized RF test system	1 (STANDARD)
AC Power Adapter	AC power adapter and power cord	1 (STANDARD)
GPS Antenna	*GPS Antenna [N-Type]*	*1 (OPTIONAL)*

3.2. System Setup

3.2.1. View and Configure Network Settings

The system interfaces are accessible from the two end plates. The power switch side is shown below with includes the primary interfaces to the host computer.

Figure 1: Mockingbird Power Side Interfaces

Table 3: System Interfaces

Interface	Description
GPS Antenna (GPS)	GPS Receive antenna port: (N-type connector, 50 ohm)
ETHERNET (ETH)	ETHERNET interface for system control and status
USB (USB)	USB interface (peripheral or device) used for factory reset
Power Switch	Apply System Power [ON / OFF]
Power Input	24 VDC input power

WARNING: System Power (PWR) Absolute Rating: 20-33VDC, 1.5A, 30W

WARNING: To avoid electric shock and damage to the equipment, only use the supplied AC power adapter and power cord.

The RF side of the system includes two RF transceiver ports.

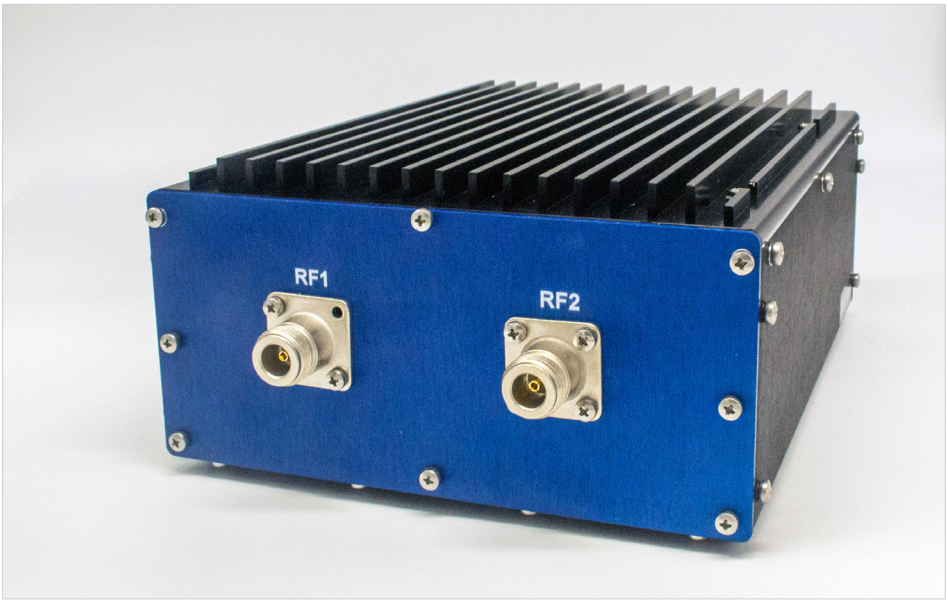


Figure 2: Mockingbird RF Side Interfaces

WARNING: RF Input (RF1, RF2): As a receiver, the DC voltage component and the maximum continuous power of the AC (RF) input signal component cannot exceed 5VDC and 24dBm.

3.2.2. How to Setup the System

To use the system, plug the AC power adapter into the system and the 120 VAC wall outlet, plug an Ethernet cable into the system and an operational Ethernet network connection, attach the GPS antenna if desired, and you are ready to use the system.

WARNING: System Power (PWR) Absolute Rating: 20-33VDC, 1.5A, 30W

WARNING: To avoid electric shock and damage to the equipment, only use the supplied AC power adapter and power cord.

4. How to Configure the System

4.1. Pre-Conditions

System is connected via an Ethernet network to the external controlling computer and powered on (see System Setup in the previous sections).

4.2. Network Configuration

To access the system web interface, you must first establish an IP network connection to the system via the Ethernet port. Then simply open a web browser and enter the IP address of the Mockingbird system. The default network configuration of the system is as follows:

Table 4: Factory Default Network Conifguration Parameters

IP Address	192.168.1.100
Netmask	255.255.0.0
Gateway	192.168.1.1

4.2.1. How to Establish an Initial Network Connection

Pre-Conditions:

- Mockingbird system is powered on and in the default factory configuration
- Mockingbird system is connected to an external controlling computer via an Ethernet cable

Procedure:

- Determine if the controlling computer has an IP route for the 192.168.1.0 local network
  - LINUX: Type `route` at the command prompt
  - MAC: Type `route` at the command prompt
  - WINDOWS: Type `route PRINT` at the command prompt
  - Verify IP address 192.168.1.0 is present in the displayed command response
- If IP address is present, network is configured. Proceed to verify network connection.
- If IP address is not present, add IP route for the 192.168.1.0 local network for your Ethernet device represented below as `<ethernet-device>`
  - LINUX: `sudo route -n add -host 192.168.1.100 dev <ethernet-device>`
  - MAC: `sudo route -n add -host 192.168.1.100 -iface <ethernet-device>`
  - Windows: `route add -host 192.168.1.100 if <ethernet-device>`
- Verify network connection:
  - Open a web browser (e.g. Chrome or Firefox) and enter default Mockingbird IP address: 192.168.1.1, which will result in the display of the Mockingbird User Interface.

4.2.2. How to Modify Network Connection

Pre-Conditions:

- Controlling computer is connected to the Mockingbird system and the user interface is open in web browser

Procedure:

- Select System Configuration from the Module Menu
- Edit the Network Configuration (e.g. add a new static IP address)
- Save the Network Configuration
- Enter the new IP address in the web browser on the controlling computer and verify user interface is displayed.

Note: Once the IP address is changed, you will need to enter the new IP address to connect to the system. Therefore, write down the new IP address and save in a secure place in order to re-connect to the system. The system can always be reconfigured to the default factory settings, which allows connection via the default IP address (see section on How to Establish an Initial Network Connection), but this also deletes any stored user data (see section on How to Factory Reset)

5. How to Verify the System

5.1. To verify the network connection system:

- Open a web browser (e.g. Chrome or Firefox) and enter the Mockingbird IP address
- Verify the Mockingbird User Interface is displayed.

5.2. To verify the transmitter:

To verify the transmitter, you can transmit a tone from Mockingbird and observe on an external spectrum analyzer.

Note: Please see the User Guide for detailed instructions on system operation and usage.

WARNING: To avoid damage to the spectrum analyzer, ensure spectrum analyzer input power is below the maximum rating of spectrum analyzer by reducing Mockingbird transmit power and using an external attenuator.

- Connect Mockingbird RF port to an external spectrum analyzer input RF port.
- From the Mockingbird Interface: Select Waveform Library
- From the Mockingbird interface: Create a tone waveform.
- From the Mockingbird Interface: Transmit the waveform.
- Verify transmitted signal with a spectrum analyzer.

5.3. To verify the receiver:

To verify the receiver, you can transmit a tone from an external signal generator and receive with Mockingbird and verify via Mockingbird spectral analysis function.

Note: Please see the User Guide for detailed instructions on system operation and usage.

WARNING: To avoid damage to Mockingbird, ensure the signal generator output power is below the maximum rating of Mockingbird receiver input power (24 dBm)

- Connect the external signal generator RF output to the Mockingbird RF port and configure the external signal generator to transmit a tone.
- From the Mockingbird Interface: Select Radio Control and tune the radio via the Manual Tune section so that the input signal is within the receiver bandwidth.
- From the Mockingbird interface: Select Spectrum View and verify received signal spectrum

6. How to Maintain the System

There are no direct maintenance activities required of the system, other than charging the battery.

6.1. How to Install System Software Updates

Note: Please see the User Guide for detailed instructions on system operation and usage.

Once you have received a new software/firmware update file, you can update the system with the following procedure:

- Select System Control, then Firmware Upgrade.
- Select Upgrade Firmware and follow the steps.

7. How to Troubleshoot the System

Table 5: Troubleshoot System

Symptom	Corrective Action
User Interface does not display	Verify network settings (see section on network configuration)
System does not transmit	Verify Transmit enabled under *System Control/Transmitter Settings*
System spectrum display is blank	Verify Receive is enabled, and the radio receive has been configured via manually tuning or select a frequency scan.

8. How to Reset the System to the Factory Default Configuration

The system can be reset to the factory default state in order to re-establish a network connection using the default IP address. The factory reset does not alter the installed Mockingbird software, only the system configuration parameters.

Performing a factory reset will result in the following actions:

- The network settings will revert to the factory default static IP address
- Removal of all stored user-defined system configurations including waveforms, traffic patterns, schedules, and frequency scan list.
- Removal of all stored user-defined mission profiles.
- Removal of all installed license upgrades resulting in only the default product licenses.

The procedure defined below performs a factory reset operation via USB TTY:

- Connect a USB A-A cable from the Test PC to Mockingbird's USB port.
- Ensure that you have permission to the TTY:

```
ls -l /dev/ttyACM0 # show the TTY's owner and group (e.g. dialout)

groups # show the user's group membership, should include dialout
```

- Open a terminal emulator to the UUT, e.g.:

```
tio /dev/ttyACM0
```

- On the terminal, enter the following command (in bold) and expect the following output:

```
recovery-shell> factory-reset
Performing factory reset
  Shutting down com_control
  Waiting for com_control to shutdown... 15
  Waiting for com_control to shutdown... 14
  Shutdown com_control
  Deleting user configuration
  Deleting OpenVPN configuration
  Deleting SSH keys
  Restoring default network settings
  Securing system
  Syncing
  Done
You may now power down the system
recovery-shell>
```

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