

SKYVIEW-DIVR MKII OVERVIEW/SETUP GUIDE

SkyView-DIVR MKII Overview

SkyView-DIVR MKII provides operators with situational awareness of potential threat Unmanned Aircraft Systems (UAS) operations using passive, radio-frequency (RF) based detection techniques. SkyView-DIVR MKII is the 2nd generation of Verus Technology Group's SkyView fixed-site Counter UAS (CUAS) system, SkyView-DIVR. The system consists of the SkyView-DIVR MKII integrated split-design antenna array, the SkyView-DIVR MKII RF integrated processor, and power and RF cable assemblies. NOTE: The included power adapter is designed to support 110/220 AC. Custom power harnesses can be designed to support a variety of applications including vehicle and remote station configurations.

Capabilities

SkyView-DIVR MKII provides long-range detection, alerting, and tracking capabilities for many commercial Small Unmanned Aircraft Systems (sUAS), including advanced hobby-class UAS platforms and associated technologies. There are currently more than 20 different models and variants of UAS signatures supported by SkyView.

Types of Detections

SkyView-DIVR MKII systems provide varying levels of detection and tracking performance based on technology and environment. The 2 types of detections within the SkyView-DIVR MKII detection library are as follows:

Type 1: Directional Indicator / Non-Precision detection

For all UAS signatures supported by the SkyView detection library, SkyView-DIVR MKII provides fact-of, non-precision detection performance followed by 45-degree sector tracking.

SkyView-DIVR MKII will automatically scan for and alert operators of the detected signal with base level information including the detection type, platform/technology information, and detection characteristics such as power-level, platform/technology type, frequency/channel, and a 45-degree sector isolation tracking information (N, NE, E, SE, S, SW, W, NW).

Type 2: Precision Detection

For a sub-set of UAS signatures supported by the SkyView detection library, SkyView-DIVR MKII extracts precision telemetry from the UAS signal that yields details such as UAS location, UAS performance data, and detailed product information. Although SkyView may provide detailed platform information such as model numbers or serial numbers, SkyView will not provide any Personally Identifying Information (PII). If SkyView-DIVR MKII extracts precision information,

additional fields are displayed and recorded along with visual precision tracking via a near real-time map overlay.

Currently, precision detection/tracking functions are available for the following UAS technologies:

- Many DJI Lightbridge equipped devices with compatible firmware loaded on UAS (e.g., DJI Phantom 3, 4, Matrice, Inspire)
- DJI OcuSync equipped devices (e.g., Mavic, Mavic 2, new Matrice)
- DJI MavicAir (Enhanced WIFI)
- DigiXtend / Pixhawk Telemetry Links
- Some Futaba RCMA Telemetry Systems
- Some FrSky RCMA Telemetry Systems
- Legacy DJI WIFI Drones
- DJI WIFI Drones using Aeroscope (e.g., DJI Spark)
- Many PixHawk 433/915 Telemetry Systems (RFD, HolyBro, etc.)
- Yuneec Typhoon Series Multi-Rotors

NOTE: Although SkyView's precision tracking has been tested/verified at operationally relevant distances, precision tracking typically occurs at ranges less than the Type 1 Fact-of Detections for a given UAS signature.

Limitations

General Limitations

SkyView-DIVR MKII is a passive, radio-frequency (RF), library-based detection capability. The primary limitation for detection is that the UAS must have an RF transmitter and that RF signature must be present within SkyView's detection library. Only those RF signatures associated with a specific UAS technology that have been previously accounted for will be supported by the system in a given software release. SkyView's software-based detection library is continually improved with updates that are periodically provided to active customers. As new UAS platforms are added, software updates can be made to existing SkyView-DIVR MKII systems to provide the additional detection capabilities. The SkyView-DIVR MKII library was developed privately and in conjunction with mission partners to address either observed threats or those UAS platforms with the highest likelihood to present a threat. In addition to specific mission partner guidance, the general criteria that is used to develop the SkyView-DIVR MKII library evaluates UAS manufacturer's market leadership, the UAS platform's capabilities (operational range, payload, ISR features), and the general threat profile. As a result, the SkyView-DIVR MKII library does not provide detection capabilities for common toy-class multi-rotors such as those with a 3-8 minute battery life, extremely limited operating range, or have no payload capacity. Verus Technology Group has also not currently prioritized detection techniques for UAS technologies typically

employed by “blue” forces. For example, the library does not support UAS platforms such as the Indago Tactical series multi-rotors.

If a specific threat has presented itself and your community has interest in the UAS signature being added to SkyView’s library, please reach out to Verus Technology Group directly: info@verustechologygroup.com for consideration.

Precision Tracking Limitations

As described in the previous section, SkyView-DIVR MKII does not provide precision-level tracking for all sUAS signatures in the library. Some sUAS detections will only yield fact-of or directional indication tracking with a resolution of 45-degrees.

NOTE: SkyView-DIVR MKII does not record, store, or present any raw RF capture data. Additionally, SkyView-DIVR MKII does not record, store, or present any PII for UAS signatures in which precision tracking is available.

⚠ Environmental Limitations

The SkyView-DIVR MKII processor is designed to support externally mounted configurations. However, the following considerations should be observed:

- ***The system has not been formally tested against any Military Standards (MIL-STD)***
- ***The system’s I/O ports are IP-rated when mated with their specified connectors.***
- ***The system is designed to operate in temperatures as high as 130-degrees F. Lab testing has been done as high as 140-degrees F, however, extended use in those temperatures may reduce system life.***
- ***A mounting plate has been provided with the system, however, custom mounting plates that leverage the existing enclosure’s mount points can be used. Any final configuration should adhere to the following guidelines:***
 - o ***The system should be mounted in an inverted orientation (connection panel pointed towards the ground). This further reduces moisture buildup and potential moisture ingress***
 - o ***The system should be mounted to ensure the heat-dissipating fins are exposure to ambient air flow.***

For additional information on recommended configuration guidance, please contact Verus Technology Group, Inc. (skyviewsupport@verustechologygroup.com)

System Packaging



Figure 1. SkyView-DIVR MKII System Packaging (Case 1: Processor/Antenna/Power/Tools, Case 2 RADOME, HW, RF Cabling)

A complete system is packed into 2 separate SKB transport cases (Figure 1). Case 1 contains the SkyView-DIVR MKII processor, power adapter, setup tools, and OMNI-directional antenna. Case 2 contains the SkyView-DIVR MKII antenna array components (2 pieces), antenna mounting hardware, RF cable assembly, and OMNI-directional antenna arm. Detailed descriptions of system components are provided in Table 1.

SkyView-DIVR System Component	Description
SkyView-DIVR RF MKII Processor with 110AC Power Cable	- Integrated rugged processor that provides radio-frequency detection and alerting of sUAS signatures. The integrated processor features rugged I/O ports, an LED power indicator, and network interface connectivity to provide remote monitoring or API data integration for multi-layered CUAS applications. The processor has 9 TNC RF cable connection points that are used to connect to the SkyView-DIVR integrated antenna array sensor (Sectors 1-8, and a single OMNI element).
SkyView-DIVR RF Cable Assembly	- A 32' bundle of 9 LMR240 labeled cable assemblies. One end of the bundle is designed to connect to the SkyView-DIVR MKII processor with 9 TNC connectors. The opposite end has 8 TNC connectors that connect to the SkyView-DIVR MKII RADOME antenna sensor and one extended OMNI cable with an N-Male connector that connects to the SkyView OMNI-directional antenna element.
SkyView-DIVR MKII OMNI-directional Antenna	- 18" OMNI directional, 2.4GHz/5.8GHz antenna used for initial detection/tracking logic. The OMNI antenna works in concert with the SkyView-DIVR MKII antenna array to provide multi-target detection and tracking of sUAS signatures.
SkyView-DIVR MKII Antenna Array	- Integrated Antenna Array (Split-RADOME) that provides SkyView-DIVR MKII's 45-degree sector isolation of sUAS signatures. The antenna assembly includes a mounting base designed to mount onto a 1 3/8" O.D. pipe. SkyView systems DO NOT ship with a mast as mast designs are highly dependent upon deployment configurations and end-user applications. The system does ship with HW that provides mounting options to BlueSky tactical masts as well.
SkyView-DIVR OMNI Antenna Arm and Hardware	- Arm extension that mounts to the SkyView-DIVR RADOME antenna array base. The arm provides a mounting point for the OMNI-directional antenna. The arm can be mounted to either side of the SkyView-DIVR antenna array base, based on application requirements. All hardware to mount the extension arm are included with the system.

Table 1. SkyView-DIVR MKII: System Components

Major System Components

SkyView-DIVR MKII Integrated RF Processor

The SkyView-DIVR MKII Integrated RF Processor is the core computational and radio-frequency (RF) processing component of the SkyView-DIVR MKII system. In conjunction with the SkyView-DIVR MKII antenna array, this component continuously monitors RF spectrum for sUAS signatures to provide long-range detection, alerting, and tracking functions. The main panel of the SkyView-DIVR MKII is depicted in Figure 2.

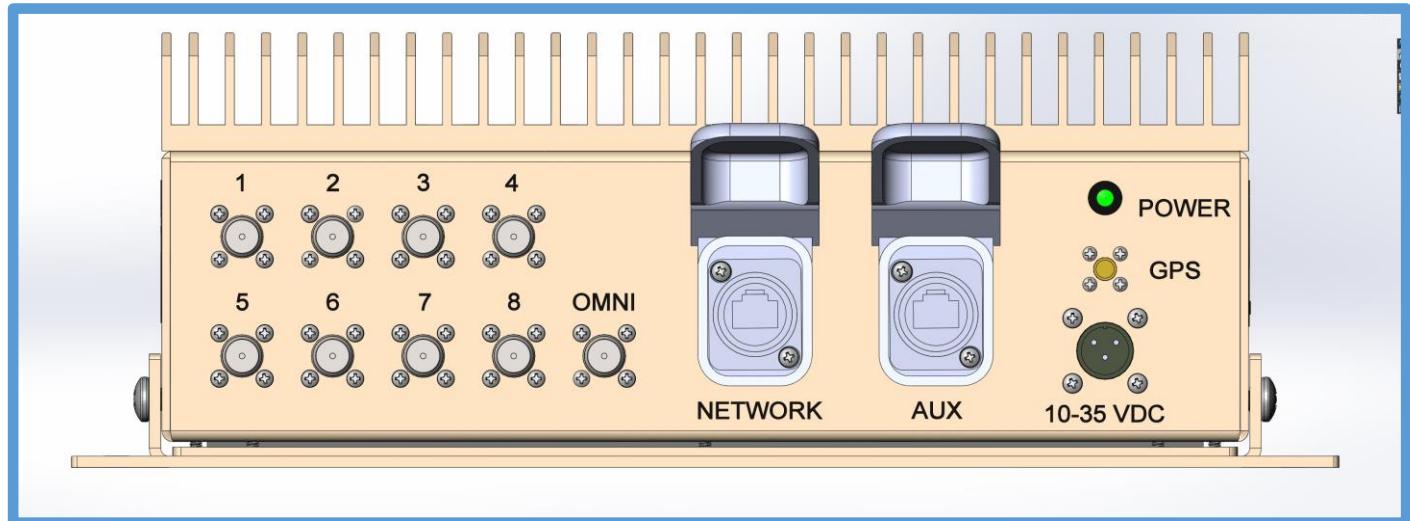


Figure 2. SkyView-DIVR MKII Integrated RF Processor (Front Panel / Front Panel Detail)

SkyView-DIVR MKII Antenna Array with OMNI-directional antenna

The SkyView-DIVR MKII integrated split-design antenna array and one (1) omni-directional antenna serve as single RF sensor to provide long range detection, identification, and tracking of SUAS signatures. The OMNI directional antenna provides an initial detection that is used to drive directional indication detection logic that leverages the 8 45-degree sector isolation array. This integrated design provides a minimum of 45-degree resolution tracking for most targets and precision tracking for many targets in a single sensor-node configuration which can be rapidly deployed into diverse operational environments. The fully assembled sensor array is illustrated in Figure 3.



Figure 3. SkyView-DIVR MKII Antenna Array with OMNI-directional Antenna (Mast is for illustration purposes only)

System Configuration Planning: Considerations for System Layout

The SkyView-DIVR MKII system supports a number of configuration layouts that will vary based on mission type. Although the system is designed for fixed-site applications, the components can easily accommodate mobile and/or expeditionary missions. Specific applications may require additional components to accommodate functions like multiple clients, long distance networks, ad-hoc mesh networking, and physical mounting options. Please contact Verus Technology Group (skyviewsupport@verustechnologygroup.com) for your specific application requirements for additional guidance

Considerations for Permanent, Fixed Site Applications

Antenna Mast

SkyView-DIVR MKII systems do not ship with an antenna mast. Each application will impose different requirements such as weight, method of securing the mast, the ability to accommodate other sensors, and environment/structural considerations. This is why SkyView-DIVR MKII systems do not ship with an antenna mast. The SkyView-DIVR MKII antenna array does provide an integrated mount that is designed for a 1 3/8-inch orbital diameter (1 3/8" OD) mast assembly. In addition, systems ship with adapters and hardware so that the antenna base can be mounted to BlueSky AL-1/AL-2 tactical masts that use a 2" OD system. Verus can assist with any questions regarding mast configurations for your specific application. The array's mounting sleeve provides eyelets for guy wires to secure the mounted antenna as well as an eyelet to accommodate a securing bolt or pin which is included with the system. This design provides maximum flexibility for operators to design, purchase, or modify a mast that can accommodate the specific requirements for the application.

Antenna Setup

As an RF detection system, maximum performance will be achieved if the following guidelines are observed when selecting a location and configuration of the SkyView-DIVR MKII antenna array.

- Utilize the included HW/brackets for mounting the antenna array and OMNI-directional antennas
- Minimize direct obstructions to the antenna array and OMNI-directional antennas to the maximum extent possible.
- Although the system will perform at a variety of mast heights, placing the array and antennas at the maximum achievable and safe height will maximize detection performance in most applications.
- Avoid placing the antenna array and OMNI directional antennas in the direct path of active RF emitters to include RADAR, ad-hoc / mech networking devices, point-to-point WIFI transmitters, or persistent EW/jammer systems.
- Utilize the included Guy-wire eyelets (4 total) on the base of the SkyView antenna mount to secure the antenna assembly.

Please reference the “Antenna and RF Cabling” section of this document for detailed instructions for antenna setup and cabling of the SkyView-DIVR MKII antenna.

RF Cabling

SkyView-DIVR MKII systems ship with 28' of LMR240 RF cabling that is used to connect the SkyView-DIVR MKII processor to the integrated antenna array and the OMNI-directional antenna. The system has been tested and validated to perform mission-relevant detection performance using the 28' included RF cabling assembly, however, it may be necessary to configure the system with an alternate RF cabling assembly. If the included cabling does not align with your requirements or the physical constraints of the installation site, please consult with Verus Technology Group (skyviewsupport@verustechologygroup.com) to determine alternatives. With appropriate planning, a deviation from the standard cable assembly should not materially impact mission performance of the system.

⚠ Environmental Protection: SkyView-DIVR MKII Processor

The SkyView-DIVR MKII RF processor is an integrated system that consists of sensitive electronics that are subject to failure if not properly protected from environmental conditions including moisture or excessive heat. **The processor IS designed to support outdoor/exposed operations provided that specified connectors and system orientation guidelines are strictly adhered to. Please adhere to the following specific guidelines when using the system in persistent outdoor/exposed applications**

- Use designated connectors for network I/O. The Neutrik NE8MC6-MO kit can be used to create custom network cables that are designed to securely mate with SkyView-DIVR MKII's Network Cable connector. This provides an IP-65 connection (Dust and Waterproof) in mated condition. A variety of electronics suppliers provide these connectors. In addition, a variety of pre-made cable lengths are available.
- Use designated connectors for system power. The Amphenol MS3106A10SL-3S MIL-DTL-5015 connector provides splash-proof performance for power connectivity.
- Mount the system in an inverted position (connection panel facing towards the ground). This mitigates any moisture build-up and pooling around connectors to prevent moisture ingress.
- Ensure that the heat-dissipating fins of the SkyView-DIVR MKII processor are free from direct obstructions so that ambient air can flow across the fins. Avoid operating the SkyView-DIVR MKII processor in a small, closed, unventilated enclosures or cases (e.g. a pelican case, wooden box, etc.). The rugged enclosure requires ambient air to dissipate heat from the core processing unit.
- For applications where the ambient temperature exceeds 130-degrees Fahrenheit (54 degrees Celsius), make use of climate-controlled enclosures. SkyView-DIVR MKII has been tested for continuous operations in excess of 130-degrees, however, performance and life will be degraded in applications where temperatures exceed the recommended limits.

SkyView-DIVR MKII RF Processor: Main Panel and Connections

The SkyView-DIVR MKII RF Processor main panel has a number of I/O ports and connectors to connect the system to the SkyView-DIVR MKII antenna array and OMNI antenna, a power source, and network device. Figures 5 provides an annotated illustration to assist in the setup and configuration of the system.

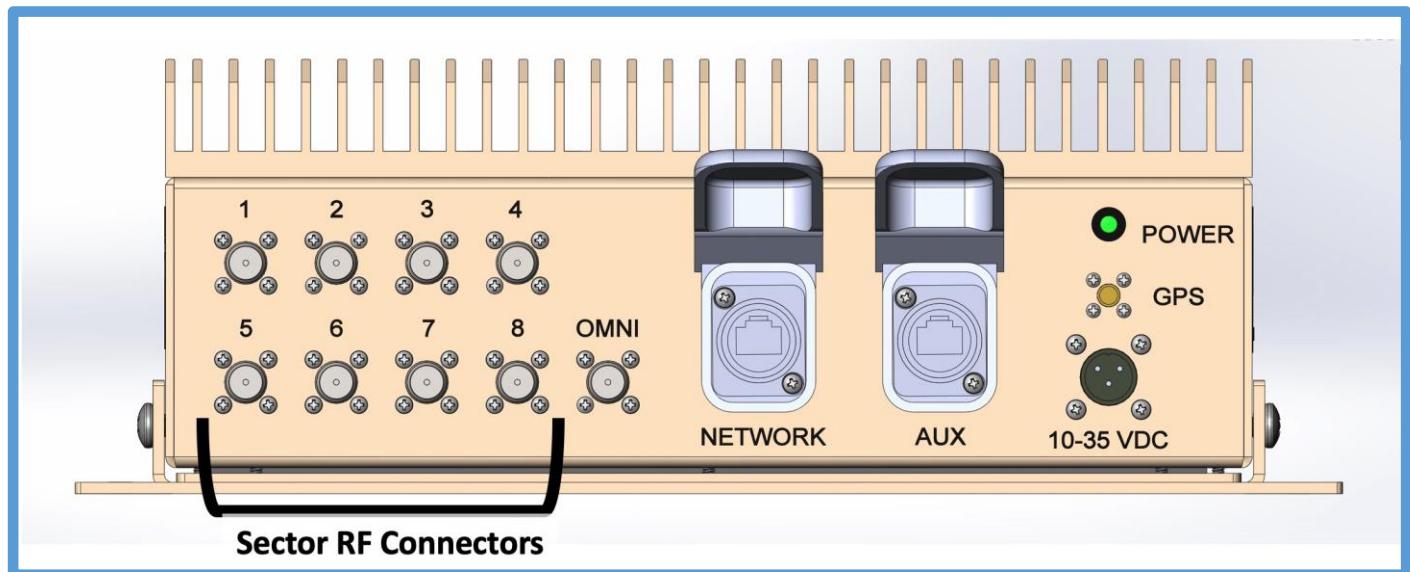


Figure 5. SkyView-DIVR MKII Panel Detail

SkyView-DIVR MKII's main panel (Figure 5) consists of the following connections and indicators (left to right):

- 8 Sector TNC RF connectors (Labeled 1-8): These connect to the respective connectors on the SkyView-DIVR MKII's antenna array (Labeled 1-8).
- 1 OMNI TNC RF connector (Labeled OMNI): This connects to the single OMNI-directional antenna element, typically mounted to the antenna array RADOME mounting base.
- 1 CAT5 Neutrik NE8MC6-MO connector (Labeled NETWORK): Connects to SkyView-DIVR MKII API client or web-based client network.
- 1 CAT5 Neutrik NE8MC6-MO connector (Labeled AUX): Connects to SkyView-DIVR MKII auxiliary network devices (e.g., ECM systems, Multi-Level Guard)
- 1 LED Power Indicator: Illuminates in GREEN when power is supplied to the SkyView-DIVR MKII processor
- 1 SMA GPS Connector: Connector for attaching any SMA-based GPS antenna
- 1 Amphenol DC Power Connector: 10-35VDC power input. NOTE: System power is activated upon supplying power to this connector (no on/off switch).

SkyView-DIVR MKII Antenna Array: Overview, Assembly and RF Cabling Guidance



Figure 6. Assembled SkyView-DIVR MKII Antenna: (8-sector RADOME, OMNI Arm, OMNI-Directional Antenna)

Figure 6 illustrates the major components of the SkyView-DIVR MKII antenna assembly which includes the 8-sector array and RADOME, mounting HW, OMNI-directional extension arm, and one (1) OMNI-directional dual-band antenna.

The following section provides step-by-step instructions on how to leverage the antenna mounting HW, assemble the antenna components, and establish connections from the antenna elements to the SkyView-DIVR MKII RF processor.

Antenna Assembly

Each system includes a hardware antenna bag like that depicted in Figure 9 to secure one (1) OMNI-directional antenna arm. The following HW components are included:

- 11 x 3/8-16 Socket head bolts
- 11 x 3/8-16 Flat washers
- 11 x 13/8-16 Hex nylock nuts
- 2 x ¼-20 Phillips pan head screws
- 1 x ¼-20 Stainless hex nut
- 5 x Allen pan head screws
- 1 x OMNI Arm

Antenna Tool Kit:

- 9-piece SAE allen key set
- 6-piece SAE wrench set
- Multi-purpose screwdriver set
- Tool pouch

Referencing Figure 7, gently place both antenna radomes on a clean and level surface with their pole mounts facing up. Place the combining mount plate across the radome pole mounts with the antenna arm block between the sectors 1 and 8. Secure using eight (8) 3/8-16 socket head bolts, eight (8) 3/8-16 flat washers and eight (8) 3/8-16 hex nylock nuts. Secure using the included 7/16" wrench and 5/16" allen key.

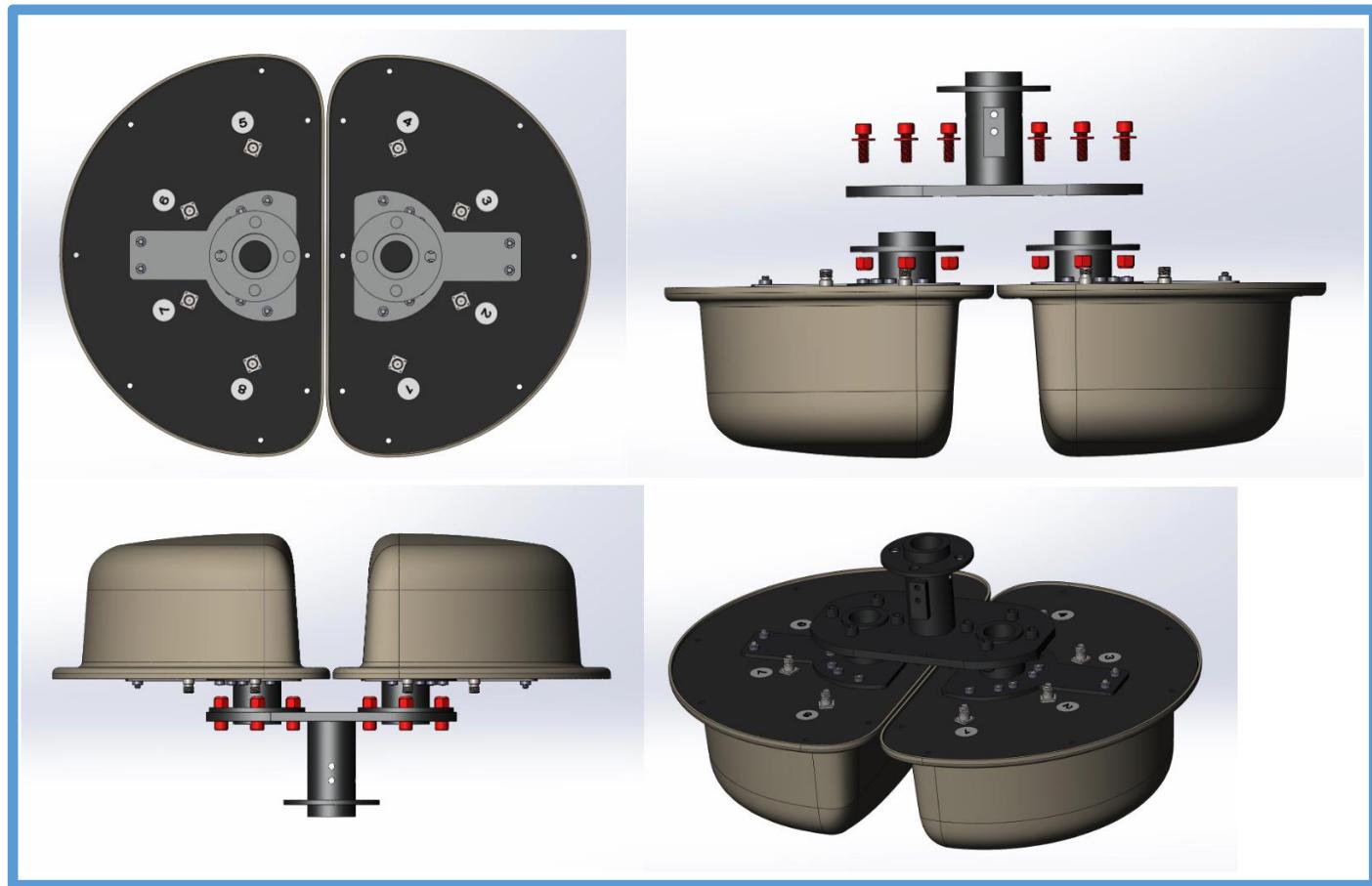


Figure 7. SkyView-DIVR MKII RADOME Assembly Guide

Referencing Figure 8, attach the Omni-antenna arm to the Delrin riser using three (3) 10-32 allen pan head screws using the included ¼" allen key.



Figure 8. SkyView-DIVR MKII OMNI Antenna Arm Assembly Guide

Referencing Figure 9, attach the assembled Omni-antenna arm to the side of the combining mount plate between sectors 1 and 8 using two (2) ¼-20 Phillips pan head screws with the included screwdriver.

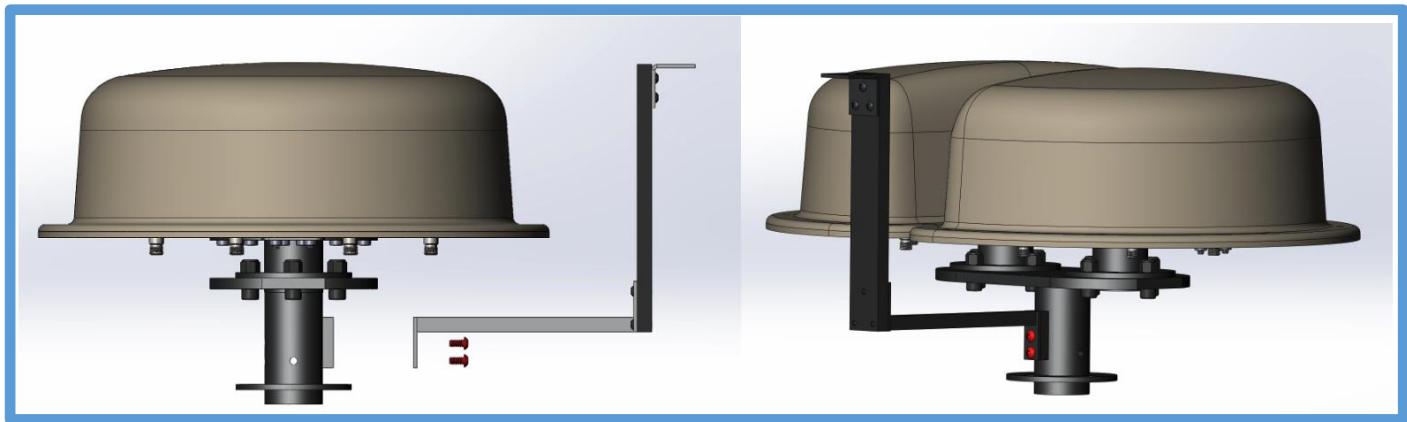


Figure 9. SkyView-DIVR MKII OMNI Antenna Arm Assembly Guide

Referencing Figure Attach the Omni-antenna arm support to the combining mount using two 10-32 allen pan head screws using the included $\frac{1}{4}$ " allen key.



Figure 10. SkyView-DIVR MKII OMNI Antenna Arm Attachment Guide

Figure 11 are exploded views of the antenna assembly for reference.

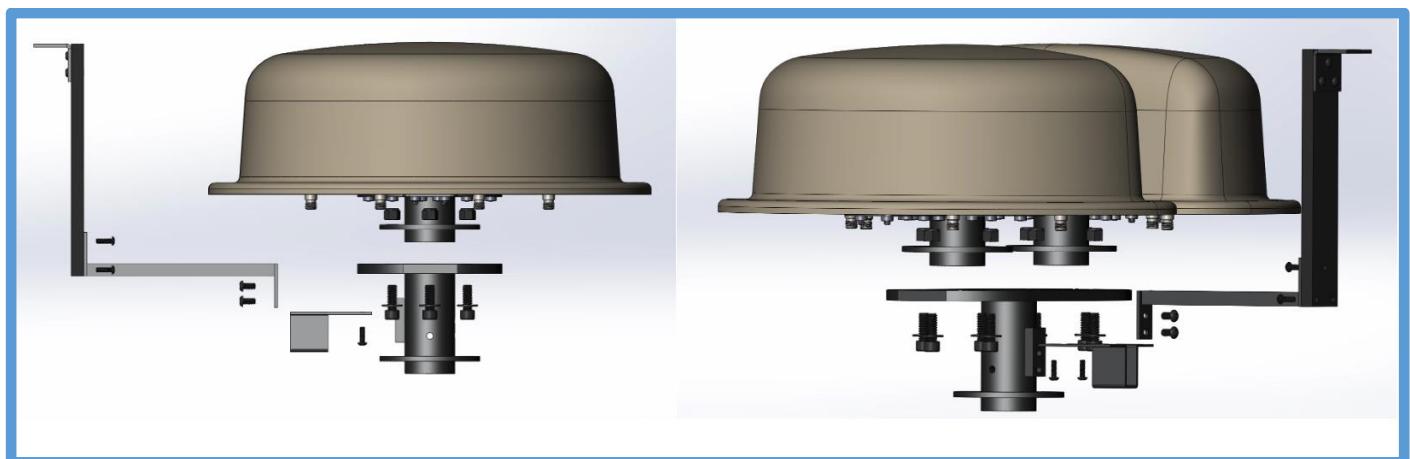


Figure 11. SkyView-DIVR MKII RADOME/OMNI Antenna (Exploded View)

RF Cabling

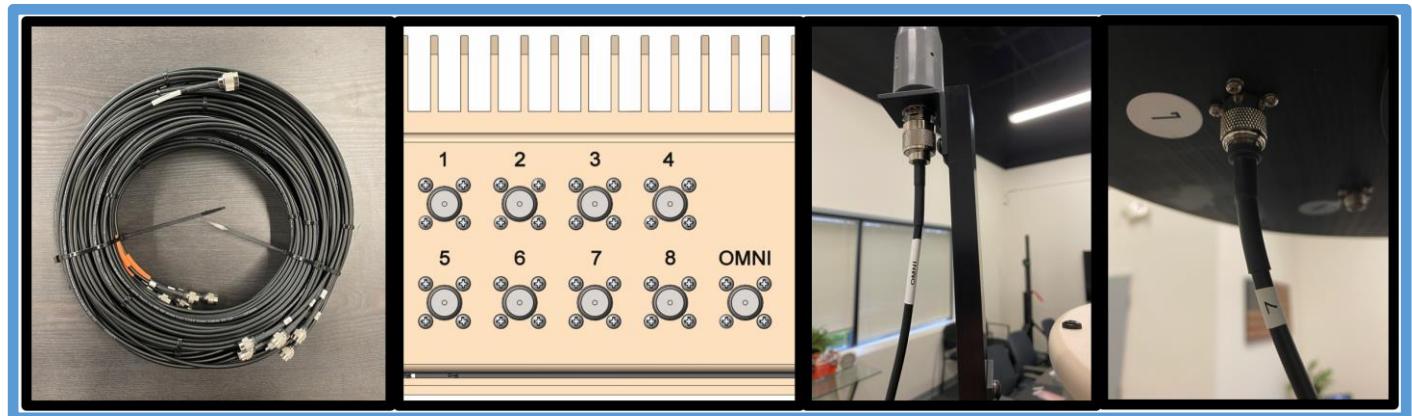


Figure 12. RF Cabling to SkyView-DIVR MKII Antennas

Using Figure 12 as a reference, locate the RF cable assembly and note one end has N-Male connector end labeled “OMNI” that is longer than the rest of the cable bundle. This is the end that will connect to the OMNI antenna and antenna array. The cable assembly contains eight sector cables and one “OMNI” cable. Each cable is labeled respectively on both ends to ensure proper connection. Connect the sector array cables labeled 1 through 8 to the corresponding connector on the underside of antenna array as illustrated. The longer cable labeled “OMNI” is connected to the base of the omnidirectional antenna arm as illustrated.

Now connect the RF cables to the RF connection panel of the SkyView-DIVR MKII RF processor based on the corresponding cable labels and the marked RF connectors as illustrated.

SkyView-DIVR MKII: Operations

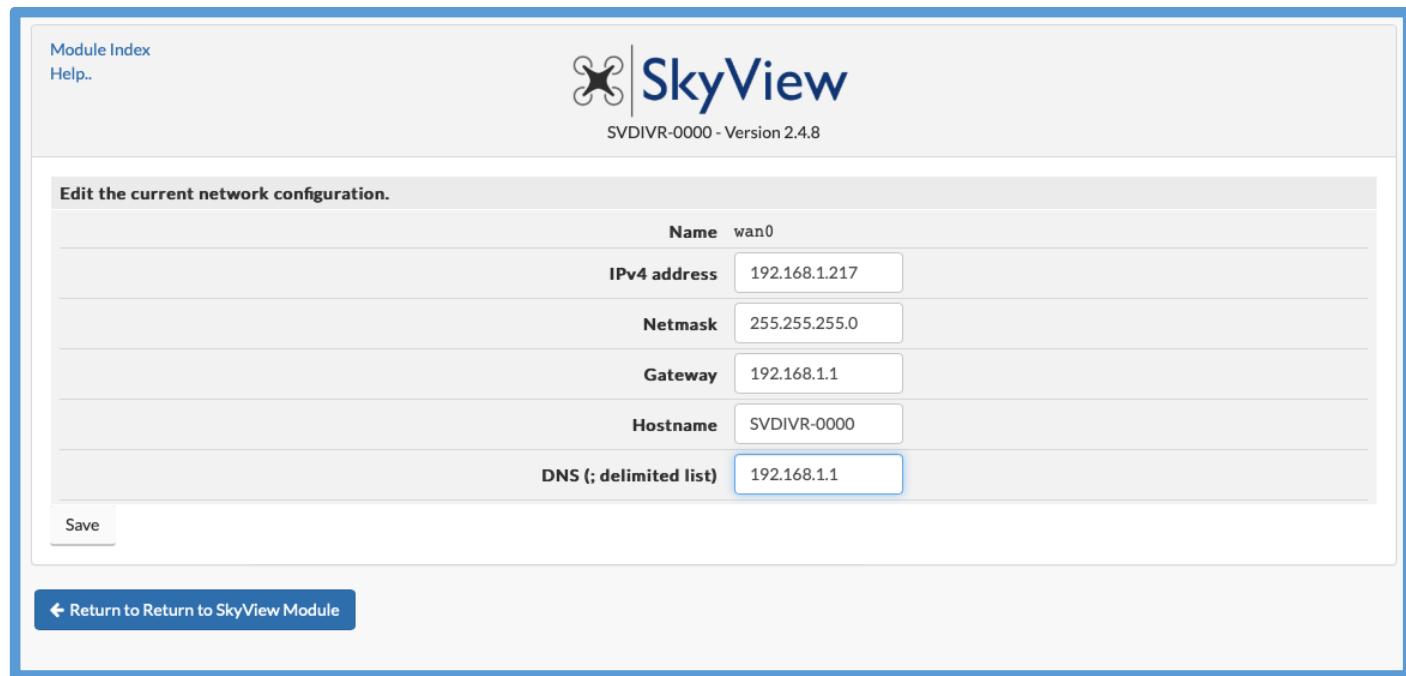
Powering the SkyView-DIVR MKII Processor

Once all connections have been made and secured to include power, network, RF cabling, the system is ready for operations. **CAUTION: Prior to powering up, please make sure to utilize the included power adapter or that any custom adapter has been correctly assembled and provides sufficient power to operate the SkyView-DIVR MKII processor.** The SkyView-DIVR MKII processor does not have a power switch, so the system will be powered on after power has been applied to the power supply. The system make take as much as 2 minutes to fully initialize on cold boot.

Simple Network Connectivity

As a dedicated remote sensor, the SkyView-DIVR MKII system does not ship with a client computer system, however, the system provides a fully functional web-based interface that can be used to configure and monitor the system. A separate guide has been provided to describe the features and functions of the SkyView-DIVR MKII's web-based HMI.

For API clients, please observe the following information regarding default/factory configurations:



The screenshot shows a web-based configuration interface for the SkyView-DIVR MKII. At the top, there is a navigation bar with links for 'Module Index' and 'Help..'. The main header features the 'SkyView' logo and the text 'SVDIVR-0000 - Version 2.4.8'. Below the header, a sub-header reads 'Edit the current network configuration.' A table lists network settings for interface 'wan0':

Name	wan0
IPv4 address	192.168.1.217
Netmask	255.255.255.0
Gateway	192.168.1.1
Hostname	SVDIVR-0000
DNS (; delimited list)	192.168.1.1

At the bottom left of the form, there is a 'Save' button. At the very bottom of the page, there is a blue footer bar with a 'Return to SkyView Module' button.

Figure 13. Network Configuration Panel

To access SkyView's Web-Based HMI, using a modern web-browser and connect to:

<https://192.168.1.217:10000>

Credentials

User: admin

Password: password

SkyView-DIVR MKII GUI (Web Version 3.0)

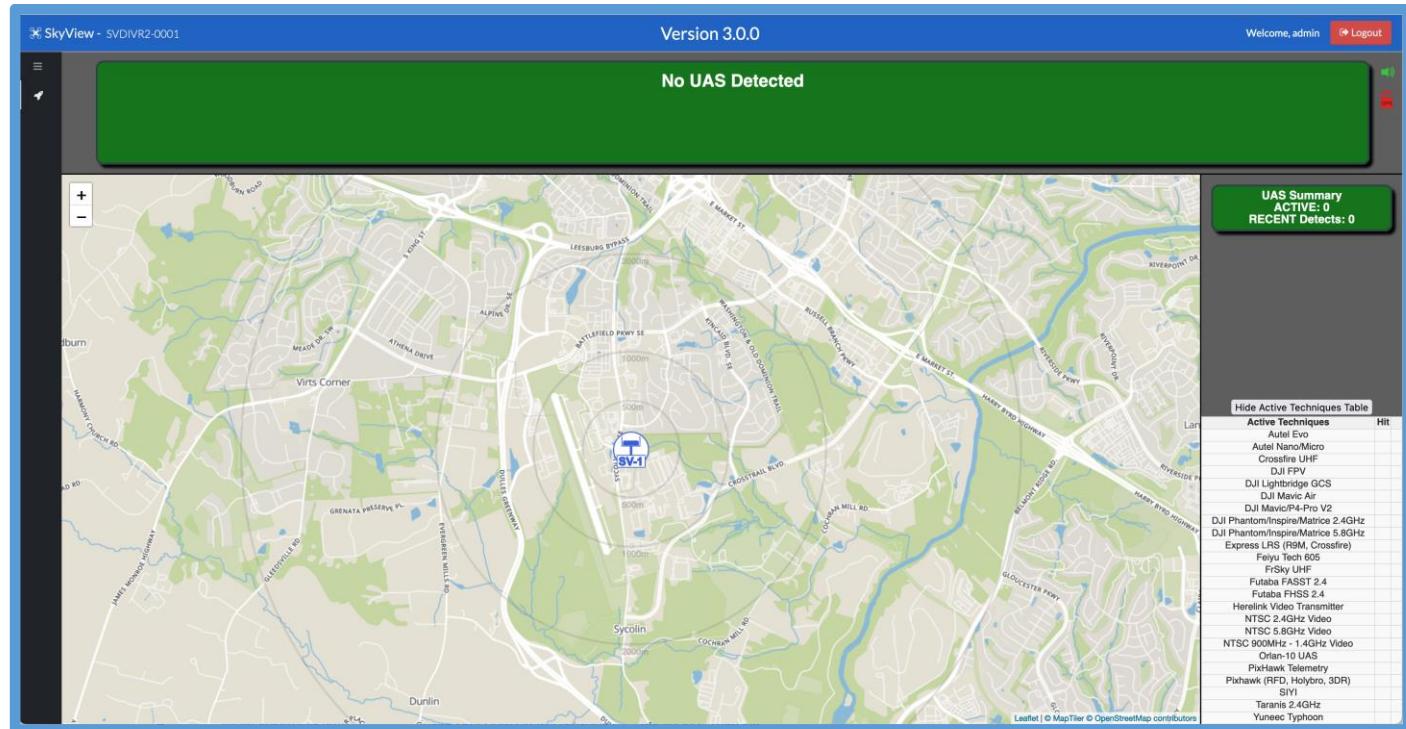


Figure 14. SkyView-DIVR MKII GUI: NO UAS Detected