RFeye Arrays

Direction finding and geolocation systems

Key features

- ✓ AOA, augmented TDOA and POA
- ✓ Fast, sensitive, very high POI of all signal types
- ✓ Capture independent of signal polarization
- ✓ Antenna modules from 100 MHz to 18 GHz
- ✓ VHF frequency extender down to 20 MHz
- ✓ Easy integration with legacy and third party systems
- ✓ Rugged, IP65 rated, multiple power options
- ✓ Standalone or as part of a real-time network
- ✓ Ethernet and cellular connectivity
- ✓ Optical fibre interface option

Introduction

Wide area multi-mission direction finding and geolocation systems for spectrum-critical sites.

RFeye Arrays provide cost-effective high performance real-time signals monitoring, direction finding and geolocation for spectrum-critical areas. Sites include government test ranges, military training and proving grounds, army and naval bases, airports, sensitive borders and perimeters. Arrays are available in a range of sizes and antenna configurations for fixed or vehicle-based deployment with frequency range options from 20 MHz to 18 GHz. Twin receiver channels provide simultaneous monitoring, DF and geolocation capabilities.

Class-leading signal interception

The RFeye Array is a fully integrated multi-mission system for continuous 24/7 spectrum monitoring and surveillance for detecting and locating unauthorized, suspicious or interfering transmitters. It is designed to intercept signals, however transient, perform signals analysis and classification and quickly and reliably geolocate target transmitters, all in real-time or recorded for future analysis.

The RFeye Array uses a unique multi-layer approach that is more sophisticated and versatile than traditional direction finding. High performance spiral directional antenna modules are optimized for different frequency bands and arranged in multiple orientations. The Array is sensitive to the majority of incoming signal polarizations including all linear polarizations, allowing reliable detection of signals including those invisible to most DF systems that use only vertically polarized antennas.

Augmented geolocation techniques - "beyond direction finding"

The RFeye receiver commutates at very high speed around the antennas to make near-simultaneous measurements in multiple directions. It measures correlations and calculates actual positional probabilities using "augmented" Time Difference of Arrival (TDOA) and/or Power on Arrival (POA) techniques.

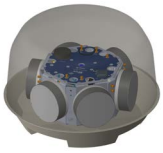
In addition, it gives an Angle of Arrival (AOA) bearing based on received power at each antenna. Measurements from these different techniques can be overlaid onto a wide variety of maps, satellite images and 2D / 3D GIS datasets, to give a unique positional display showing source geolocation probabilities. All signal types can be mapped, irrespective of signal power, bandwidth or frequency.

Modular and flexible deployments

Each RFeye Array is fully self-contained within a robust IP65 rated radome designed for hostile conditions. Close coupling of the RFeye Node and antenna modules reduces cable runs and cable losses and significantly improves performance at higher frequencies. Various directional antenna options are available from 100 MHz to 18 GHz and a frequency extender module is available for AOA on VHF signals down to 20 MHz. Arrays can be networked over large distances as part of a wider monitoring and TDOA network with other RFeye receivers.

RFeye Array configurations

RFeye Array 50



Single channel system configuration: AOA 500 MHz - 6 GHz, TDOA / background monitoring capability 10 MHz - 6 GHz with external omnidirectional antenna connection.

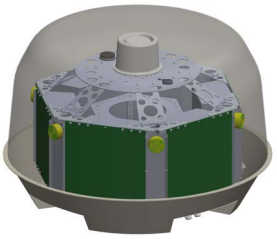
Frequency range	
AOA	500 MHz - 6 GHz
Monitoring and TDOA/POA	10 MHz - 6 GHz (with optional external antenna/s)
6 - 18 GHz (SHF) extender option	No
20 - 300 MHz (VHF) extender option	No

Number of channels	
Standard:	Single

Radome (optional)	
External diameter	0.65 m

Mechanical & environmental	
Power	10 - 56 VDC
Operating temperature	-28 to +55°C (-18 to 122°F)
Storage temperature	-40 to +70°C (-40 to 158°F)
Environmental protection	RFeye Node & electronics: IP67 System: IP65
Dimensions	Overall 0.65 m / 26" Ø, 0.275 m / 11" height
Weight	10 kg / 22 lbs

RFeye Array 200



Single channel system configuration (example): AOA 300 MHz - 18 GHz, TDOA / background monitoring 100 MHz - 18 GHz (to 10 MHz with externally mounted omnidirectional antenna). Base system plus SHF frequency extender.

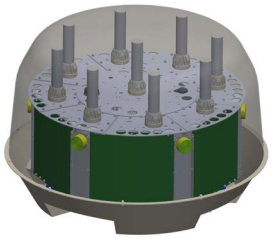
Frequency range	
AOA	300 MHz - 4 GHz
Monitoring and TDOA/POA	100 MHz - 6 GHz (optionally from 10 MHz)
6 - 18 GHz (SHF) extender option	Yes
20 - 300 MHz (VHF) extender option	No

Number of channels	
Standard:	Single

Radome	
External diameter	1.1m

Mechanical & environmental	
Power	10 - 56 VDC
Operating temperature	-28 to +50°C (-18 to 122°F)
Storage temperature	-40 to +70°C (-40 to 158°F)
Environmental protection	RFeye Node & electronics: IP67 System: IP65
Dimensions	Overall 1.1m / 43" Ø, 0.8 m / 31" height
Weight	70kg / 154 lbs

RFeye Array 300



Dual channel system configuration (example): AOA 20 MHz - 18 GHz, TDOA / background monitoring 10 MHz - 18 GHz (with externally mounted omnidirectional antenna/s). Base system plus VHF and SHF frequency extenders.

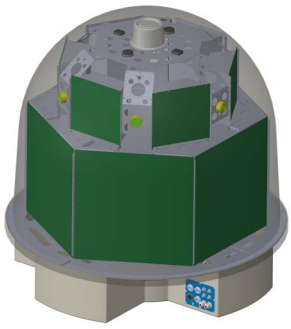
Frequency range	
AOA	300 MHz - 6 GHz
Monitoring and TDOA/POA	100 MHz - 6 GHz (optionally from 10 MHz)
6 - 18 GHz (SHF) extender option	Yes
20 - 300 MHz (VHF) extender option	Yes

Number of channels	
Standard:	Dual

Radome	
External diameter	1.1m

Mechanical & environmental	
Power	10 - 56 VDC
Operating temperature	-28 to +50°C (-18 to 122°F)
Storage temperature	-40 to +70°C (-40 to 158°F)
Environmental protection	RFeye Node & electronics: IP67 System: IP65
Dimensions	Overall 1.1m / 43" Ø, 0.8 m / 31" height
Weight	80kg / 176 lbs

RFeye Array 500



Dual channel system configuration (example): AOA 100 MHz - 18 GHz, TDOA / background monitoring 100 MHz - 18 GHz (to 10 MHz with externally mounted omnidirectional antenna). Base system plus SHF frequency extender.

Frequency range	
AOA	100 MHz - 6 GHz
Monitoring and TDOA/POA	100 MHz - 6 GHz (optionally from 10 MHz)
6 - 18 GHz (SHF) extender option	Yes
20 - 300 MHz (VHF) extender option	Yes

Number of channels	
Base system standard:	Dual

Radome	
External diameter	1.5m

Mechanical & environmental	
Power	10 - 56 VDC
Operating temperature	-28 to +50°C (-18 to 122°F)
Storage temperature	-40 to +70°C (-40 to 158°F)
Environmental protection	RFeye Node & electronics: IP67 System: IP65
Dimensions	Overall 1.66m / 65.4" Ø, 1.63m / 64.2" height
Weight	175kg / 385 lbs

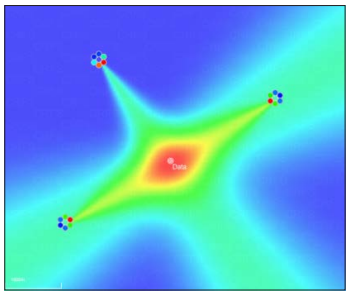
Guide to direction finding and geolocation

CRFS employs a unique multi-layer approach for high probability detection and geolocation of signals and transmitters of all types.

There are a number of well-established techniques for locating the source of a given signal. These include Angle of Arrival (AOA), Time Difference of Arrival (TDOA) and Power on Arrival (POA). Each technique has its advantages and disadvantages, with varying degrees of accuracy for successfully locating different signal types. CRFS's approach is to make simultaneous RFeye measurements using any two or all three of these geolocation techniques, as appropriate, overlaid onto a terrain map. This approach maximizes the probability of accurately locating a given transmitter, whatever the signal type.

Angle of Arrival

AOA direction finding provides a bearing to received signals by rapidly switching between directional antenna elements in an antenna array. AOA is effective with any RF transmission type as it responds directly to received RF power. Advantages from AOA include the excellent detection range resulting from directional antenna gain, and the ability to resolve multipath components to determine quality of signal bearings.



AOA: Three receiver points ensures geolocation to small area, even when target is collinear with two receivers

As the technique is measuring signal power, ability to obtain AOA results is limited only by the noise floor of the receiver. RFeye Arrays respond to most signal polarizations including all linear polarizations, overcoming the horizontal linear polarization blindness suffered by alternative direction finding systems. RFeye Arrays use single or multiple receiver channels split between tiered and banded antenna arrays to magnify the benefits from RFeye sweep speed and antenna switching speed for increased probability of signal intercept. AOA bearings from two or more Arrays are combined to provide geolocation to a single point. When augmented with TDOA geolocation results, AOA provides assured geolocation over the greatest possible range of target signal types.

Time Difference of Arrival

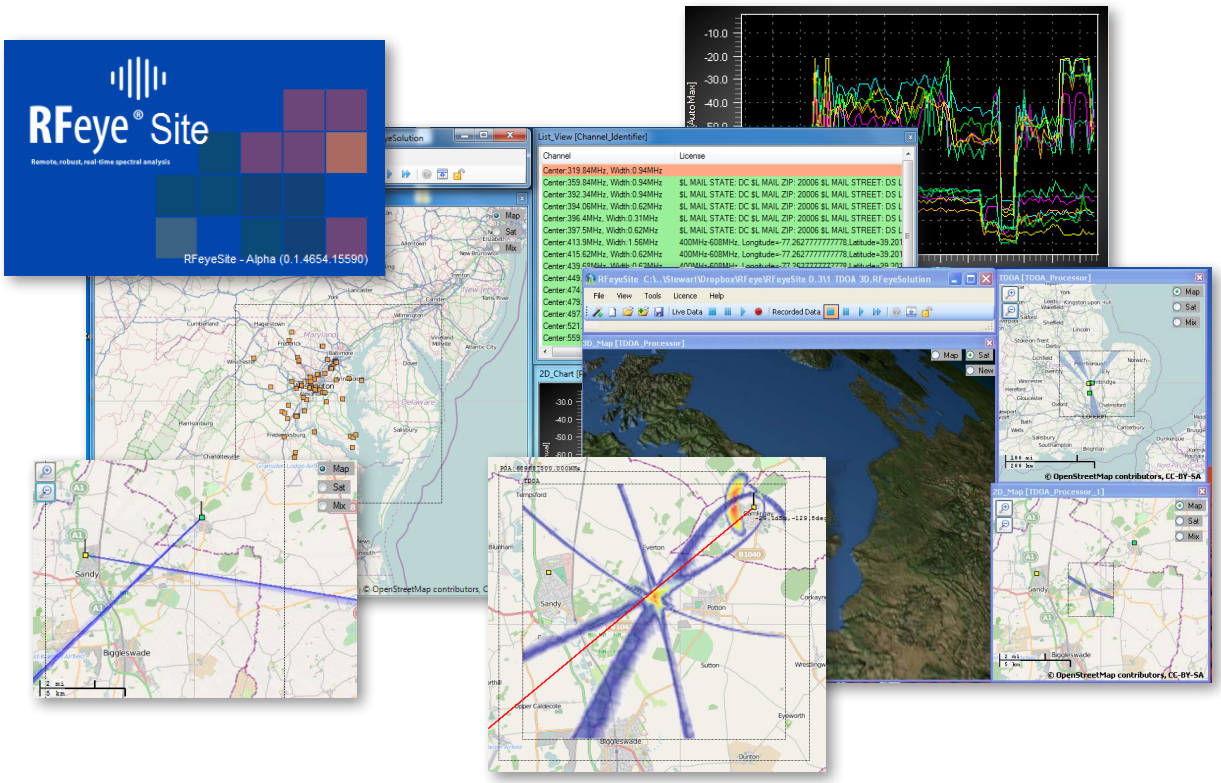
TDOA is a well-proven technique that uses synchronous time domain captures to determine the relative time of arrival of a signal at different receiver locations. The technique is optimal for geolocation over wide areas. Two monitoring receiver points will provide geolocation probability in two dimensions (i.e. approximately along a hyperbolic curve), whereas three or more monitoring receiver points will provide geolocation probability to a bounded area or point. TDOA works best for wider modulation bandwidths with better signal correlation properties and therefore localization to a more narrow area. A significant advantage of TDOA is that the processing gain of correlations allows successful geolocation of signals which are close to or even below the receiver noise floor. Timing synchronization is required between the receivers for TDOA. For wide area deployments, this is provided most practically by the RFeye on-board GPS receiver. Using RFeye Arrays, TDOA geolocation results are combined with AOA results to provide unrivalled geolocation performance.

Power on Arrival

POA is a simple geolocation technique that uses synchronous frequency domain captures to determine and compare the instantaneous relative power of a signal at different receiver locations. Given the rapid fall-off in received signal power over distance from a transmitter, the POA technique is optimal for relatively short-range geolocation such as in-building monitoring, where the amplitude comparison yields sufficient differences. POA requires three or more monitoring receiver points to provide geolocation probability to a point. Increasing the density of receiver points significantly improves the quality of the geolocation. POA is effective with any RF transmission type, from unmodulated carrier wave signals to narrow-band or short-burst pulsed transmissions, since the technique relies only on received RF power. POA requires timing synchronization between receivers. Although GPS synchronization is viable, it is typically not practical or secure for in-building applications. High performance wired timing synchronization systems such as RFeye SyncLinc™ are therefore used in-building.

RFeye Site software

State-of-the-art desktop application for managing complex spectrtum operations using RFeye Arrays and Nodes.



RFeye Site software provide easy multi-mission control including 24/7 continuous spectrum monitoring, programmable masks and alarms, signal analysis and optional signal classification capability, and full geolocation mapping capability.

Each and every RFeye Array or Node in the network can be assigned tasks from a large configurable menu, ranging from requests for basic spectrum sweeps and occupancy measurements, to the detection and alerting of spectrum events, to advanced signal classification and real-time geolocation of sources of interest. Multiple users can simultaneously make multiple requests of or interact with all or any of the Nodes over wired or cellular networks, with relative priority levels assignable to user levels and missions.

Plug-in modules are available for RFeye Site to enable and control TDOA, AOA and POA geolocation. These support multiple simultaneous geolocations on multiple frequencies. Results are plotted on 2D or 3D maps and are displayed as probability heat map overlays. Multiple results can be overlaid onto the map for ease of visualization and analysis. The mapping tools include full zoom facility and ability to display many simultaneous maps. Shuttle Radar Topography Mission data overlay is available to aid geolocation analysis.

Product range

RFeye Array	Base / extender system	Description	Order code
RFeye Array 50	RFeye Array 50	Single channel system, AOA 500 MHz - 6 GHz, TDOA / background monitoring capability 10 MHz - 6 GHz (omnidirectional antenna not included) . Compact fixed or mobile system. Radome optional.	SYS-DFA0006
RFeye Array 200	RFeye Array 200	Single channel system, AOA 300 MHz - 4 GHz, TDOA / background monitoring capability 10 MHz - 6 GHz (omnidirectional antenna not included) . Compact fixed or mobile system, 1.1m radome or roofbox.	SYS-DFA0005
	RFeye Array 200	VHF Low frequency extender for RFeye Array 200, to 20 MHz. Extends AOA low end frequency range of RFeye Array 200 to cover VHF to 20 MHz. Ordered as addition to RFeye Array 200. Note: RFeye Array systems with integrated low frequency extender module require external omnidirectional antenna(s) for TDOA / background monitoring.	SYS-DFA0005-V
RFeye Array 300	RFeye Array 300	Base system: Dual channel system, AOA 300 MHz - 6 GHz, TDOA / background monitoring 100 MHz - 6 GHz. Includes omnidirectional antenna rated 100 MHz - 18 GHz, TDOA / background monitoring can be extended to 10 MHz with additional antenna fitted externally (not included). 1.1m radome, fixed or mobile system.	SYS-DFA0001
	RFeye Array 300-SHF	SHF Frequency extender for RFeye Array 300, to 18 GHz. Extends AOA and TDOA / background monitoring high end frequency range of RFeye Array 300 to cover SHF to 18 GHz. Ordered as addition to RFeye Array 300.	SYS-DFA0001-S
	RFeye Array 300-VHF	VHF Low frequency extender for RFeye Array 300, to 20 MHz. Extends AOA low end frequency range of RFeye Array 300 to cover VHF to 20 MHz. Ordered as addition to RFeye Array 300. Note: RFeye Array systems with integrated low frequency extender module require external omnidirectional antenna(s) for TDOA / background monitoring.	SYS-DFA0001-V
RFeye Array 500	RFeye Array 500	Base system: Dual channel system, AOA 100 MHz - 6 GHz, TDOA / background monitoring 100 MHz - 6 GHz. Includes omnidirectional antenna rated 100 MHz - 18 GHz, TDOA / background monitoring can be extended to 10 MHz with additional antenna fitted externally (not included). 1.5m radome, fixed system.	SYS-DFA0002
	RFeye Array 500-SHF	SHF Frequency extender for RFeye Array 500, to 18 GHz. Extends AOA and TDOA / background monitoring high end frequency range of RFeye Array 500 to cover SHF to 18 GHz. Ordered as addition to RFeye Array 500.	SYS-DFA0002-S
	RFeye Array 500-VHF	VHF Low frequency extender for RFeye Array 500, to 20 MHz. Extends AOA low end frequency range of RFeye Array 500 to cover VHF to 20 MHz. Ordered as addition to RFeye Array 500. Note: RFeye Array systems with integrated low frequency extender module require external omnidirectional antenna(s) for TDOA / background monitoring.	SYS-DFA0002-V

For more information

To find out more or discuss your specific application, please e-mail us at enquiries@crfs.com or call +44 (0) 1223 815 615. You can also find useful resources on our website at www.crfs.com.

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