

Wideband Recording RF/DF Sensors



TeamSENTINELmini®

Transportable, network-ready ultra wideband recording HF, V/UHF, dual band and direction finding (DF) sensors

TeamSENTINELmini radio frequency collection, and DF-enabled, sensors are optimized for transportability. They provide simultaneous monitoring, analysis, and extended recording of time and frequency coherent, wideband RF spectrum, through Espy's teamSOIGNE® signal-mining GUIs.

Frequency band coverage of each sensor is determined by the RF Conditioner module selected. Options exist to support HF, HF/DF, V/UHF, and V/UHF-DF operations, as well as Dual-band operations (HF and V/UHF concurrently). All teamSENTINELmini sensors are Theater Net-Centric Geolocation (TNG) node compliant.

- 🔍 **Easily relocate sensors whenever and wherever mission requirements demand**
- 🔍 **Collect and record from 7-hours to 11.5-days of wideband RF/DF energy for retroactive signal processing, DF and analysis**
- 🔍 **Theater Network-Centric Geolocation (TNG) compliant time and frequency operations**
- 🔍 **Options for frequency coverage from as low as 10 kHz up to 6 GHz currently available**
- 🔍 **Recorded store bandwidths from 11 MHz to >1 GHz with support for multiple independently tunable store elements**

Sensor Modules The teamSENTINEL® family of wideband sensors are modular, flexible, and highly scalable, providing a very cost-effective platform that can be easily adapted to support a wide range of mission requirements. TeamSENTINEL subsystems are built using a combination of industry leading COTS solutions, and Espy developed hardware and software solutions.

RF Conditioner This module preconditions and channelizes the received wideband analog RF signal, applying bandpass filtering and attenuation as necessary, prior to digitization. HF, V/UHF, and Dual-band sensors are available in both DF, non-DF and TNG configurations. All RF Conditioner modules incorporate a GPS subsystem to provide built-in, TNG-compliant, system operations for most mission requirements (this subsystem can be

bypassed if an external GPS-disciplined reference is mandated).

Digital Receiver Modules TeamSENTINELmini sensors utilize a COTS 16-channel baseband receiver for HF applications, and a variety of COTS single, and multi-channel, digital receivers for the V/UHF bands. All receivers are GPS-disciplined, and time and frequency coherent, to provide TNG node-compliant time and frequency stability and accuracy.

TeamSENTINEL Acquisition Servers One or more teamSENTINEL servers provide the resources necessary to support the spectrum acquisition, recording, and signal processing of digital RF channels streamed from the integrated receivers. Additional servers can be added to increase the wideband store coverage, and/or recording capacity, of a sensor. Servers can be configured with either, lower-cost hard disk drives (HDDs), or high-performance, and higher capacity, solid state drives (SSDs). TeamSENTINELmini sensors utilize a Dell R440 1RU servers to minimize power, space and cooling requirements.

RF Distribution Modules Espy designs and builds a family of commutative DF sequencer modules, RF multicouplers, and RF band switches, to address the stringent operational and performance requirements of our wideband HF and V/UHF capabilities. One or more DF Sequencer modules can be configured to support a wide range of Espy and 3rd party DF antenna configurations. DF Sequencers are time coherent with receivers,

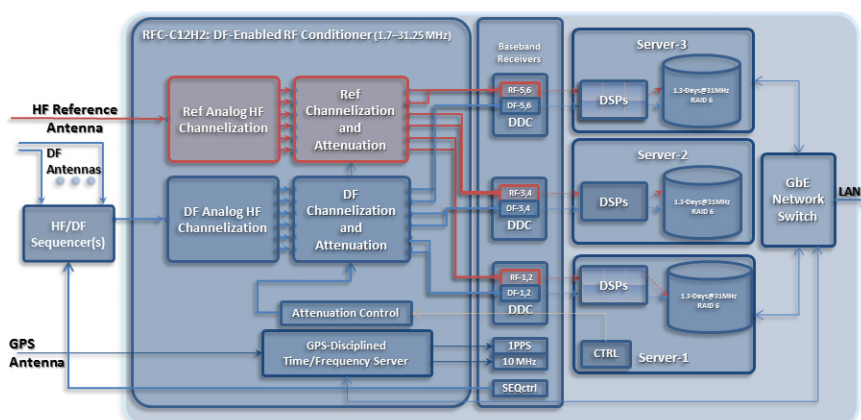
to guarantee maximum angle-of-arrival DF accuracy.



teamSENTINELmini Dual-Band, HF/DF-Ready Sensor

HF: 1.7-31.25 MHz, Store Bandwidth 29.4 MHz@11.5 Days
V/UHF 20-6,000 MHz Tunable, Bandwidth up to 176 MHz@2.3-Days

TeamSENTINELmini RFC-C12H2: Single-band, 29.4 MHz DF-enabled



Example: teamSENTINELmini HF/DF Sensor Architecture

| SPECIFICATION | HF | V/UHF |
|--|-------------|------------|
| MAX Channel Sample Rate | 5.6 Msps | 51.2 Msps |
| MAX Channel Recorded Bandwidth | 4.9 MHz | 88 MHz |
| MAX Number of Channels/Tuners | 12 | >16 |
| MAX Sensor Acquisition Bandwidth | 29.4 MHz | >1,000 MHz |
| Sensor Receive Freq Range ² (MHz) | 1.7 – 31.25 | 20 – 6000 |
| Base Sensor Recording Capacity | 21.75 Hours | 7 Hours |
| Max Sensor Recording Capacity | 11.5 Days | 2.3 Days |
| DDR ¹ Narrowband Extract Storage | >220 GB | >220 GB |
| Max DDR Extract Duration | Hours+ | Hours+ |
| Max DDR Extraction Sample Rate | 5.6 Msps | 51.2 Msps |
| Typical SFDR (single tone) | >98 dB | >75 dB |
| Typical Sensitivity | -115 dB | -100 dB |
| Typical DF Accuracy ³ | 2° RMS | 2° RMS |

¹Digital Drop Receiver ²Frequency coverage depends on sensor configuration

³DF-enabled sensor required



Worldwide Correlation and Collaboration

Interoperability Multiple teamSENTINEL-family sensors, as well as multiple teamSOIGNE client workstations, can be distributed around the world to allow remote data sharing and system control. A single client workstation can monitor and control multiple front-end sensors using teamVIEW®. Likewise, a single sensor can interface with multiple clients and/or sensors. Remote monitoring and control capabilities, along with Espy's field-proven reliability, mean that front-end teamSENTINEL sensors can be effectively operated and maintained, even when located thousands of miles from an operations center.

Retroactive Signal Prosecution Retroactive, ("post facto", "after action" or "look back") signal processing refers to the ability of teamSENTINEL sensors to perform energy prosecution (digital drop record (DDR) file extraction, energy detection, baud detection and transmitter geolocation) from signals recorded in the past. Since teamSENTINEL DF-enabled sensors record all the data in the wideband stare necessary to compute a DF, and not just detected energy bursts, any signal visible to the systems analyst (SA) in the spectrum can be tasked for geolocation, regardless of how far in the past it was recorded.

Collaborative Exploitation of the RF Spectrum Espy's family of teamSENTINEL sensors are designed to operate as an interconnected team. Multiple sensors can be networked together to create a fabric of geographically dispersed sensor sites, connected to a distributed community of SAs and subject matter experts (SME). From a single GUI, Espy's teamVIEW capability provides SAs with access to the wideband spectrum collected from multiple teamSENTINEL sensors. Any front-end sensor in the SAs teamVIEW can be selected as the primary spectrum, and used to extract, and/or geolocate energy received at that sensor. Every SA action is recorded to an SQL database, and immediately distributed to other SAs and SMEs currently connected to the common sensor network.

High-Performance Signal Processing

Energy Extraction Digital drop receiver (DDR) files can be manually or automatically extracted with a wide range of signal bandwidths and sample rates [2, 4, 8, 10, 20, 80, 160 or 640 KHz or the entire channel, 5.6 Msps]. Each ARM can support hundreds of random-access DDR extractions per minute through automated tasking interfaces, all while the system is recording.

Energy Prosecution Because of its high sample rate wideband recording capability, teamSENTINEL is especially well suited for the collection of fast frequency sweeping, and frequency agile signals. Visual detection and analysis of a wide variety of modulation types is made easy through teamSOIGNE's signal mining tools. Entire wideband channels can be extracted for specialized post-processing, and months of sensor prosecution IQ and metadata results can be stored in an industry-standard SQL database.

Transmitter Geolocation TNG and DF-enabled teamSENTINEL sensors allow retroactive direction finding and geolocation of any energy selected from the recorded delay buffer. Individual sensors configured with DF antenna arrays can generate lines of bearing (LOBs). DF and TNG enabled sensors can produce angle of arrival DF fixes and/or TNG fixes when networked together. Both Commutative and N-channel DF solutions are available. Geolocation results are displayed interactively on a OpenStreetMap® enabled 3-dimensional globe which is linked to the primary spectrum display and related signal metadata.

RF-Conditioner module options

| RF-CONDITIONER MODULES | HF | V/UHF | DF | TNG | FREQUENCY RANGE (MHZ) | NO. TUNER CHANNELS | CHANNEL BW (MHZ) | MAX BW (MHZ) |
|------------------------|----|-------|----|-----|-----------------------|--------------------|------------------|--------------|
| RFC-C6H2 | ✓ | | ✓ | ✓ | 1.7-31.25 | 12 | 4.9 | 29.4 |
| RFC-D2U2 | | ✓ | | ✓ | 20-6,000 | 8 | 11, 22, 44 | 352 |
| RFC-D4U4 | | ✓ | | ✓ | 20-6,000 | 16 | 11, 22, 44 | 704 |
| RFC-D2U2-DF | | ✓ | ✓ | ✓ | 20-6,000 | 4 | 11, 22, 44 | 176 |
| RFC-DC4U4-DF | | ✓ | ✓ | ✓ | 20-6,000 | 8 | 11, 22, 44 | 352 |
| RFC-C6H2-D2U2 | ✓ | | ✓ | ✓ | 1.7-31.25 | 12 | 4.9 | 29.4 |
| | | ✓ | | ✓ | 20-6,000 | 8 | 11, 22, 44 | 176 |



All teamSENTINELmini sensors and teamSOIGNE signals analysis workstations are sold with a 5-year Return-to-Factory limited warranty, and a 5-year of Software Update Service subscription.

"es|py (e spi', i-) vt. -| pied', -| py'ing to catch sight of; make out; discover; detect; find"

- Merriam-Webster

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