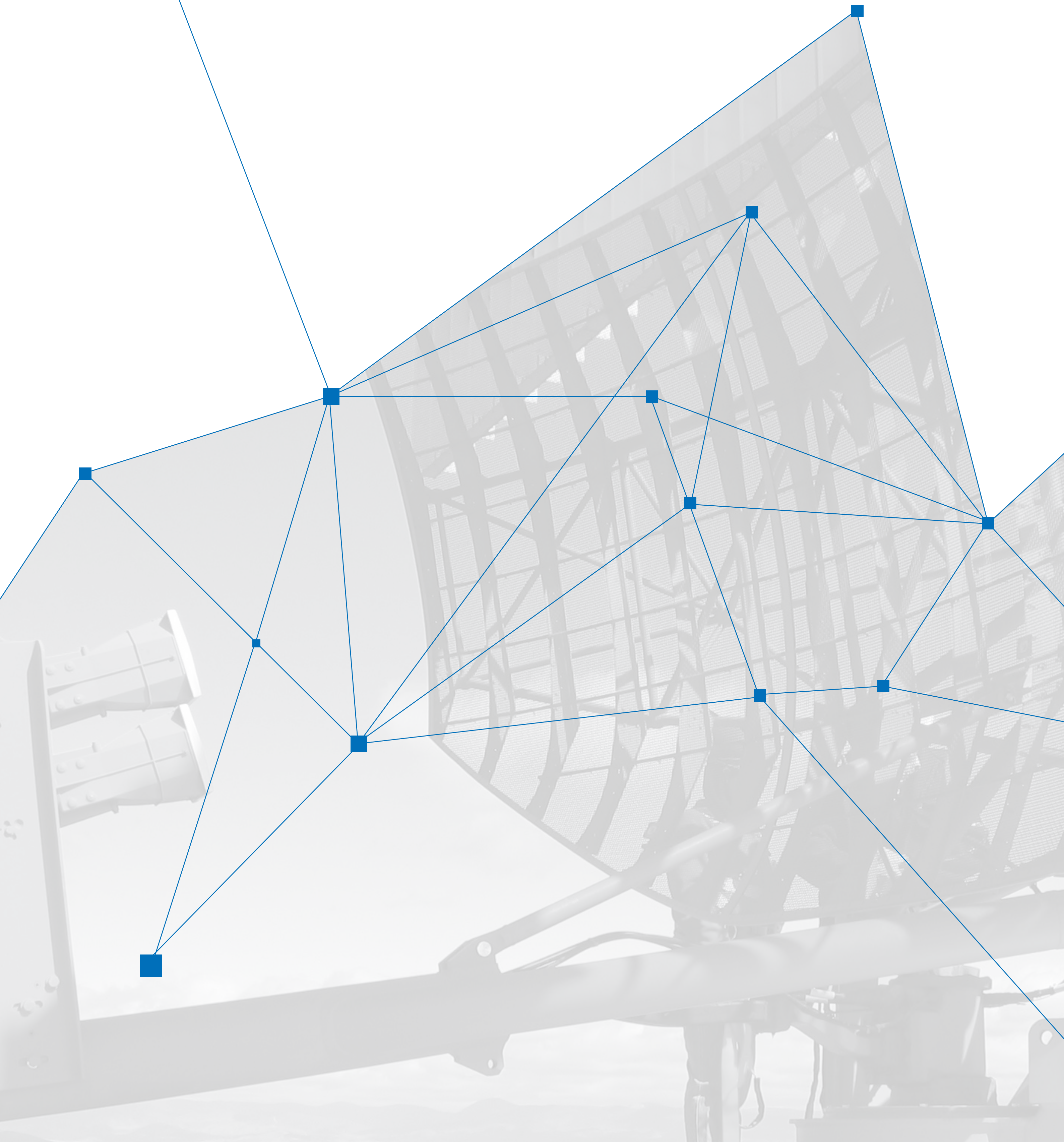
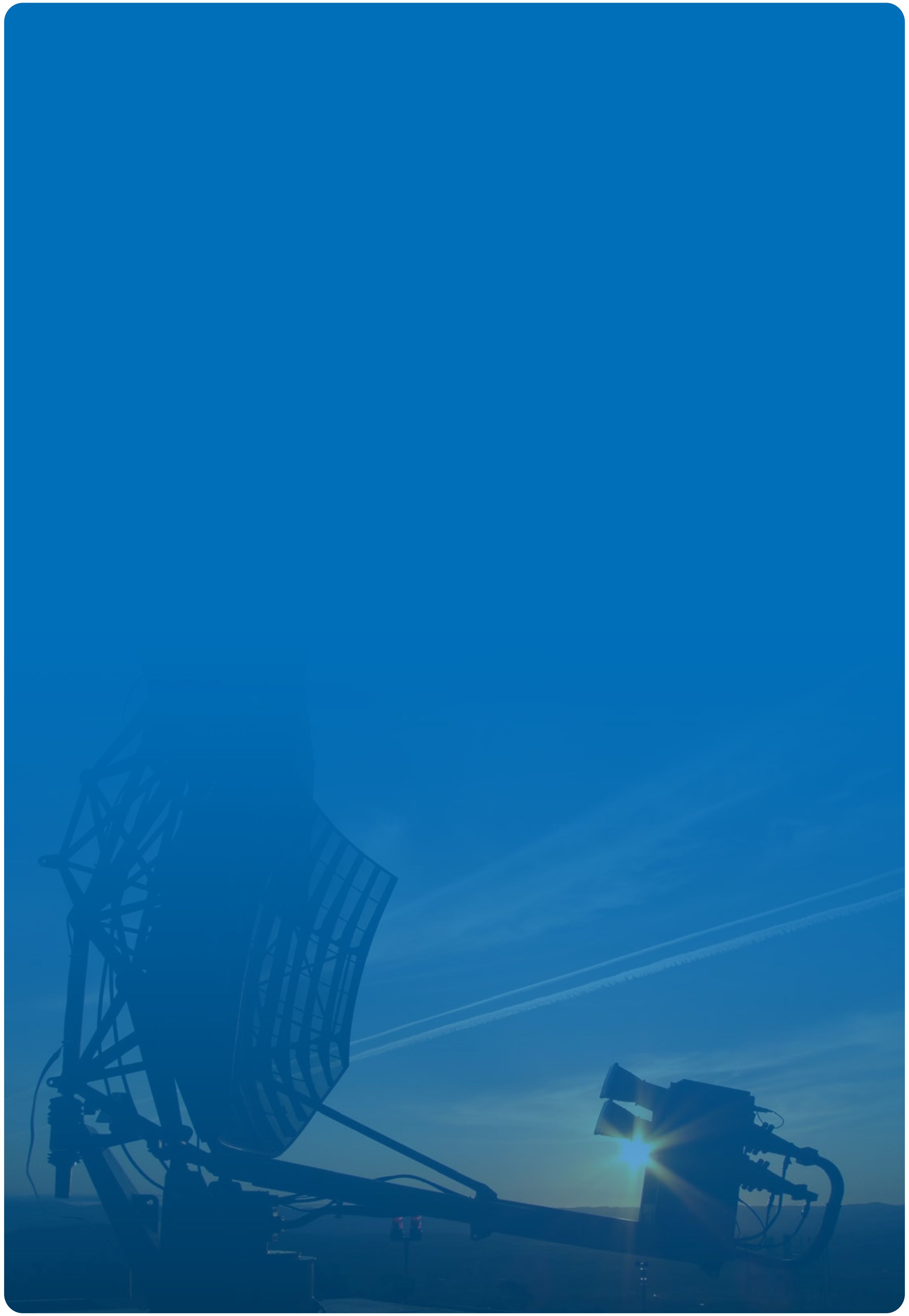
INTERSOFT ELECTRONICS

RASS® | Product Catalogue



RASS®



Radar Performance Evaluation

The Intersoft Electronics RASS portfolio includes a wide range of instruments, tools and services to assist radar technicians and engineers in the complete quality assessment of Communication, Surveillance and Navigation systems.This portfolio ranges from basic equipment for daily maintenance, to specialized tools for a complete picture of the entire radar chain, to real-time display and monitoring tools.

With RASS equipment, the engineer or maintenance technician can evaluate the performance of the radar at the highest level or in great detail in a preventive, corrective or continuous manner.
All of these tools have been developed independently of any manufacturer, resulting in a versatile portfolio of test equipment that provides objective analysis results.

The RASS Portfolio consists of 4 categories:

Test Equipment for radar system analysis

RASS test equipment is used for recurring maintenance activities as well as advanced fault isolation and hardware performance verification.

Software Tools for monitoring

Monitoring software tools provide analysis of opportunity traffic to verify key performance parameters under common air traffic situations.

Simulators for system performance testing

Intersoft Electronics offers a range of products to verify system performance in any operational scenario or environment. The Radar Environment Simulators (RES®) and Target Generators (RTG) can create a very realistic and repeatable environment for the radar and allow for on-site and off-site target injection as a flight test alternative.

Radar Analysis Services

Intersoft Electronics supports manufacturers, air navigation service providers, ministries of defense and other service providers during acceptance tests (FAT, SAT and Flight Trial), during periodic maintenance cycles or during time-critical events such as failures and troubleshooting.

CNS Services and Site Works

The RASS portfolio focuses on the performance evaluation of radar systems. However, the scope of Intersoft Services extends far beyond radar to include a wide range of Communication, Navigation and Surveillance (CNS) systems. These include ILS, DME, VOR, TACAN, PAPI, G-A-G and SatCom systems.

SkyRF® is the drone platform that provides radio frequency (RF) measurement services for performance analysis of CNS systems. SkyRF®'s dedicated on-board equipment and software platform are specifically designed to measure CNS performance in the field. Measuring and analyzing signals at altitude has never been easier, more accurate or more reliable. SkyRF® complements ground measurements and reduces the need for flight checks by up to 50%.

In addition to test and measurement services, Intersoft covers a wide range of design, installation, integration and maintenance activities for air traffic control systems, air navigation aids, meteorological systems and telecommunications. Our technicians and personnel are ATSEP certified to ensure expertise and flawless service delivery.

Radar technology and Service Life Extension Programs

Intersoft Electronics provides state-of-the-art technology for radar system integration, upgrade and service life extension.
The modular processor, receiver, transmitter and antenna subsystems provide a technology platform that allows for a flexible approach to civil and military radar projects, ranging from Airport Surveillance Radar (ASR-M®) to multi-beam long range systems.
The Next Generation System Platform (NGSP) and Non-Rotating Array (NORA) antenna systems are the key elements of the modular radar solutions from Intersoft Electronics. NGSP is the modular receiver-processor subsystem featuring state-of-the-art technologies that enable the system to deal with modern airspace challenges. NORA offers a revolutionary radar antenna design that significantly reduces maintenance costs thanks to the absence of rotating elements.

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2. Software Tools for monitoring

3. Simulators for system performance testing

4. Radar Analysis Services

1.

Test Equipment for radar system analysis

1.1 INTRODUCTION

The RASS system provides a complete solution for measuring the performance of your radar system on site: from the Rf signals at the antenna down to the serial radar data output.

Intersoft Electronics developed this system completely independently from any radar manufacturer in order to offer you an all-round radar analysis tool. The evaluation of the entire radar system will be completed quickly and with little interference to the controllers since the RASS system can be connected to signals which are already available and this under operational conditions.

After a few days training every radar operator or technician will be able to use the RASS tools and therefore measure and analyse all the necessary signals and data.
The scientific approach of the RASS system produces a top down analysis of all the elements in the radar chain, verifying the performance of each element separately in the operational environment of the radar.

RASS users comprise civil and military ATC organisations, radar and radome manufacturers, ANSP's and ADS-B ground station manufacturers.

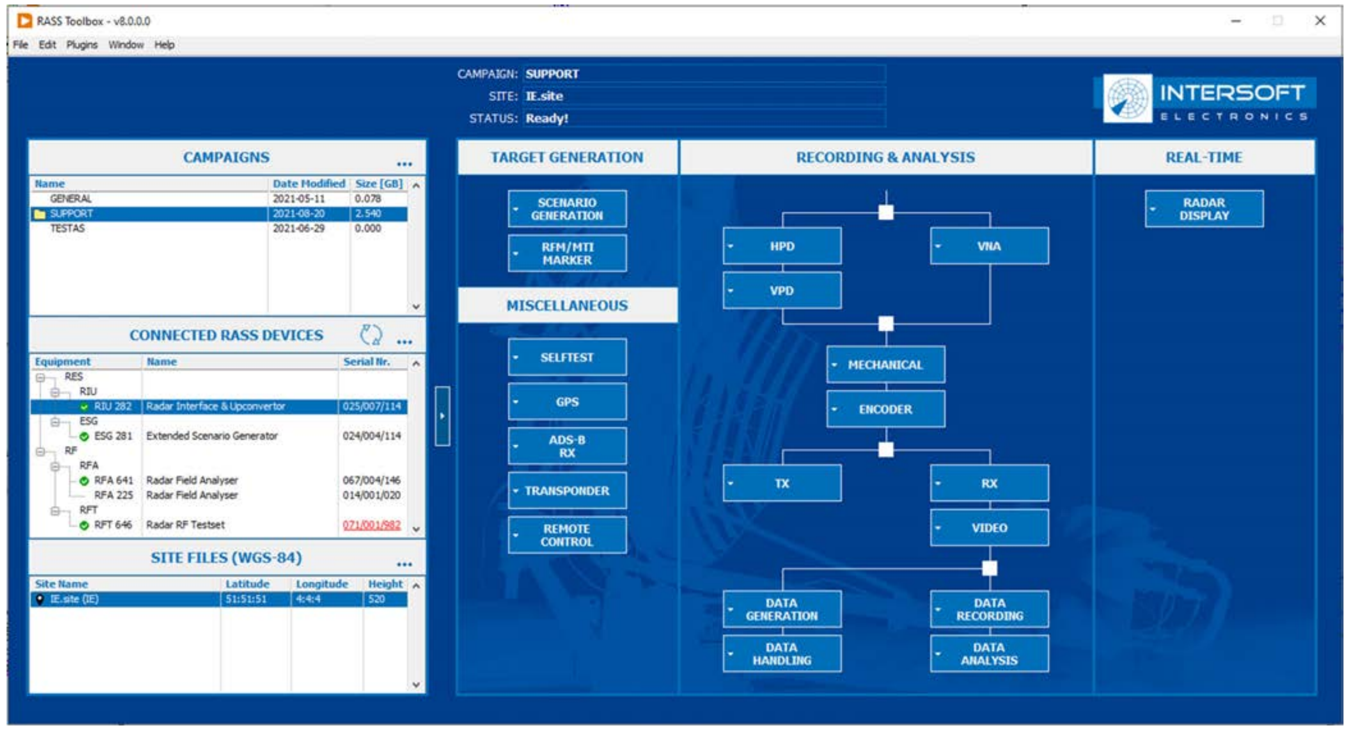
In short:

support for the recording and playback of all the important signals in the radar chain is provided.

The RASS software and hardware helps the radar engineer to get an accurate and total overview of the actual quality of every element of the Primary or Secondary Surveillance Radar (also Mode-S) for which (s)he is responsible.

1.1.2 The RASS® Toolbox

The software controlling the RASS equipment shares the same top-down conceptual idea. The "RASS Toolbox" consists of a number of functional menus accessible through buttons. Each of these controls a set of tools which corresponds to a specific element in the radar chain, starting from the antenna towards the data modems delivering plot and track data to ATC centers. A special set of tools qualify the plot and track data output and allow a detailed analysis of these data towards resolution and probability of detection parameters. GPS measurements can be used to verify the radar's accuracy.

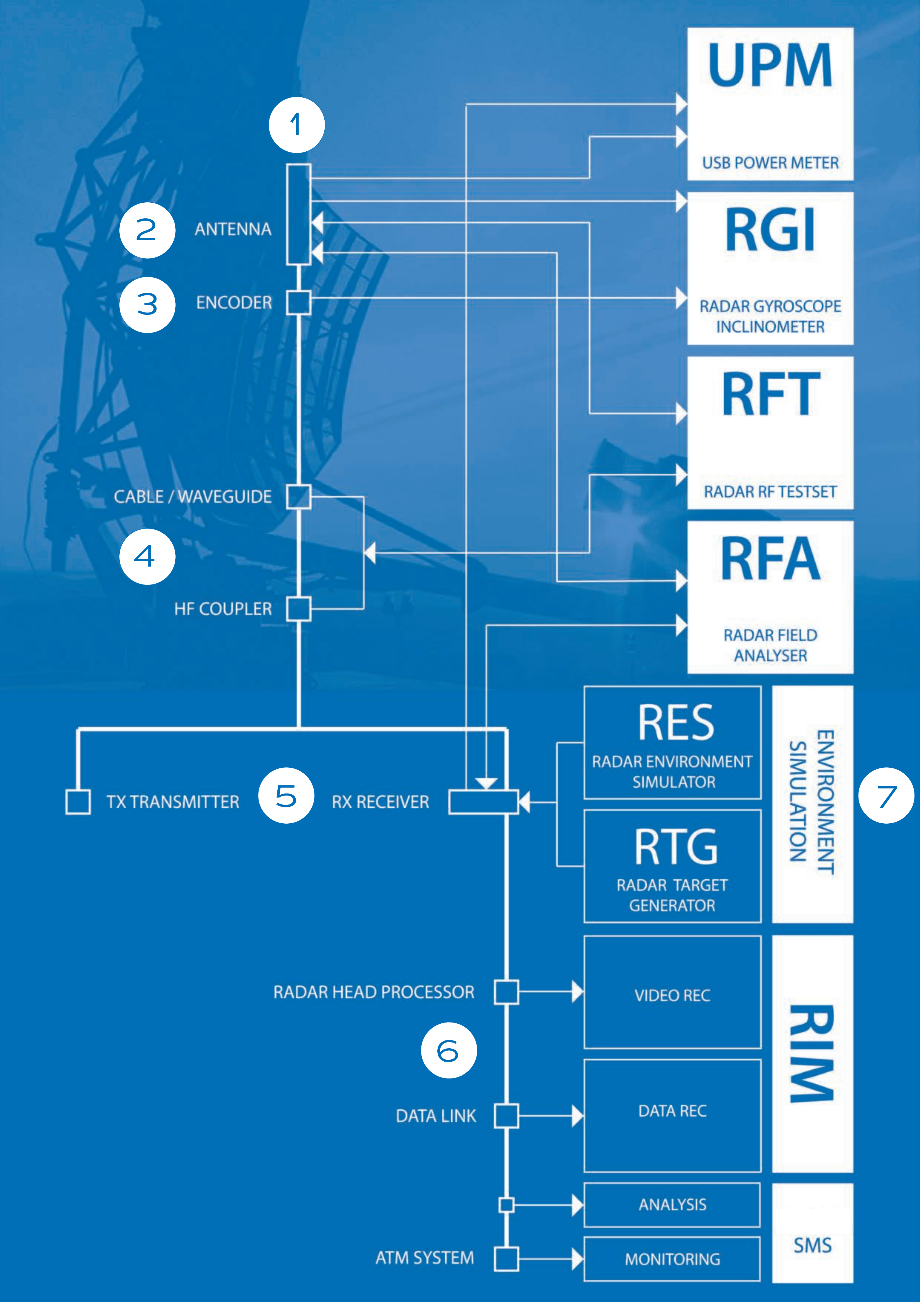


Principal Features:

- *Multiple use of programmable hardware using software virtual instruments*
- *Graphical user interface on a PC workstation*
- *Synoptical windows with push button operation*
- *Online Help functions on setup and use of the equipment*
- *Logging and retrieval of all measurements;*
- *Report printing.*

Some of the RASS functionalities:

- *(M) SSR/PSR HPD transmission pattern measurements*
- *Radar receiver measurements*
- *Vector Network Analysis and Pulse Vector Voltmeter function*
- *Recording of (M)SSR/PSR Downlink antenna diagrams*
- *Recording and analysis of Radar Video data*
- *Mechanical accuracy analysis*
- *Passive or active recording and playback of radar data*
- *Local plot and track analysis*
- *Rf target injection with full scenario control*
- *And many more…*



1.1.3 The top-down analysis

The top-down philosophy means that we always work our way down from the antenna chain in order to check the entire system. Each element of the total radar chain can be characterized by specific parameters.

1 **TRANSPONDER**

- Classification
- Monitoring
- Properties

2 **ANTENNA SYSTEM**

- Gain
- Tilt/Levelling
- Alignment
- Polarisation
- Reflections
- Rf properties

3 **ENCODER**

- Mechanical
- Turning Gear
- ACP/ARP Errors
- Stability
- Windload

4 **TRANSMISSION**

- Rf Cabling
- Waveguides
- Rotary Joint
- Coupler Losses
- Phase Matching
- VSWR
- Directionality

5 **RX / TX**

- Tx Power
- Pulse Shape
- PRF, Stagger
- Rx Sensitivity
- Rx Bandwith
- STC, Accuracy

6 **PROCESSOR**

- Accuracy
- Degarbling
- Load
- Delay
- Resolution
- Code Validation
- Probability of Detection

7 **ENVIRONMENT SIMULATION**

- PSR/SSR Targets
- Other interrogations
- FRUIT
- ACAS
- ADS-B
- Reflectors
- Weather
- Jammers
- Clutter

Measuring the antenna system

The first vital part of the radar chain is the antenna. Possible errors in this element can be characterised using the Radar Field Analyser, the RASS instrument to perform antenna and RF receiver measurements.

Notice that most antenna measurements are performed under operational conditions. They are intended for a regular checkup, often because the antenna is damaged or degraded due to the harsh environment.

1.2.1 General Introduction

The RFA641 is intended for on-site performance checks of (M)SSR ATC radars and primary radars in L and S band. For this purpose, the radar does not have to be taken out of its operational mode. The transmission pattern (power) of the LVA or Horn-feed antennas is continuously measured and plotted versus azimuth or time.

The complete RFA641 set-up fits in one carrying case. A log-periodic antenna with suitable frequency range and gain is delivered with the kit, along with all required accessories.

The RFA641 can perform the following measurements:

- *Uplink (transmission) antenna diagram: Pulse power = f(Azimuth)*
- *Generation of test pulses for downlink (reception) Antenna Diagram: Rx Pulse power = f(Azimuth)*
- *Receiver measurements: Rx sensitivity sweeps, Rx bandwidth sweeps and (sectorial) STC or DSTC sweeps*
- *Transmitter power, spectrum, pulse shape recording, timing, mode and stagger verification*
- *FRUIT generation for environment simulation*
- *ADS-B scenario generation*
- *Mode-S interrogation generator for transponder verification*
- *Transponder quality verification*
- *Target injection for non-pulse-compression primary radars*
- *Remote Field Monitor function for SSR (A/C).*

Using VCO and YIG filtering techniques, a frequency range from 900MHz up to 3.0GHz (optionally 3.5GHz) is covered both in the reception and transmission path. This allows the use of the same instrument on a wide variety of radars. The antenna diagram can be extracted for different radars at any time (e.g. multiple SSRs on one site) by means of the analysis software.

The Downlink (Rx) antenna diagram can be measured with the Radar Interface Module (RIM782) connected to the receiver of the radar and the RFA641 set-up in the field, producing test pulses at a selected frequency. This recording is slaved to the antenna rotation.

1.2.2 Key Features

- With its measurement frequency tunable in the 900...3000 MHz frequency range, the RFA641 supports both (M)SSR and PSR systems
- RF receiver for reception of RF interrogations with the purpose to measure the antenna diagram in transmission (uplink)
- RF Tx module for generation of test pulses for reception (downlink) pattern measurements and for receiver measurements (alignment, sensitivity, bandwidth, STC...)
- Data acquisition engine with DSP processing and USB2 interface for direct spooling of the captured pulse data to disk for later analysis. This enables a 'one button' semi-automated measurement approach
- Simple and easy set-up: connect the Radar Field Analyser to the measurement antenna, startup the host computer, take power from a car battery or a UPS and start measuring
- Highly portable and easily carried by one person

More technical information can be found in the RFA641 technical brochure.

1.2.3 Antenna Measurements

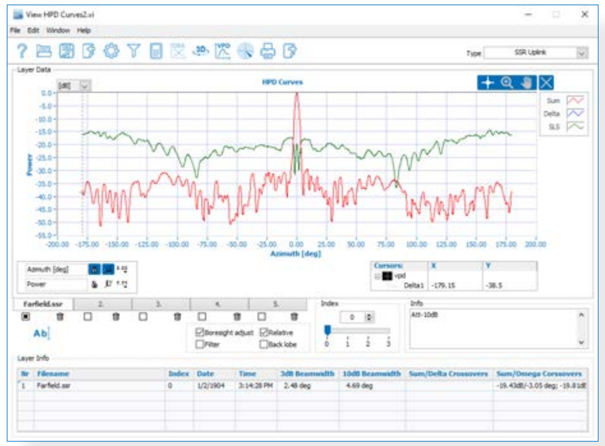
■ Uplink Horizontal Polar Diagrams

The uplink measurement will provide you with horizontal polar diagrams of any (M)SSR or PSR antenna in its operational environment, by recording the pulses of the radar.

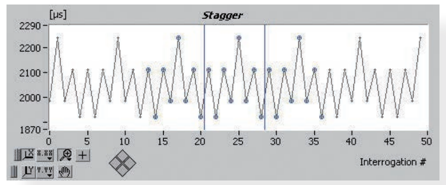
The pulses can be recorded in a condensed format (pulse mode) or in detail (scope mode). After the recording the HPD can be extracted from the data through fingerprinting (stagger), this extraction process is software controlled.

Following measurements are included in the package:

- *Horizontal polar diagrams for RF pulse recording measurements from a distance of up to 40Km*
- *Scope measurement: view pulse to pulse interrogator transmissions*
- *Mode measurement: view succession of interrogation modes*
- *Stagger meter: measure timing info in multiple SSR environments*
- *Destagger & timing stability*
- *Cross Polarisation*
- *OTD (Out of Tolerance Detection) of important parameters such as: 3dB beam width, Crossovers, Punch-throughs (P1 > P2 outside the boresight region), 1st side lobe level, etc...These OTD parameters are checked against the EUROCONTROL standards for radar performance giving a detailed evaluation of the HPD diagram of your radar.*



Uplink antenna diagram



Stagger pattern

PSR Horizontal Polar Diagrams can be measured as well to verify some PSR specific parameters of the antenna:

- *Reflections*
- *RPM stability measurements.*

Typical errors which can be found in PSR HPD curves include radome influence on beamwidth and sidelobe anomalies.

Several measurement campaigns revealed lots of different erroneous antenna patterns. The most common errors are:

- *Punch-throughs*
- *Asymmetrical diagrams*
- *Side lobe level too high*
- *Back lobe punch-throughs*

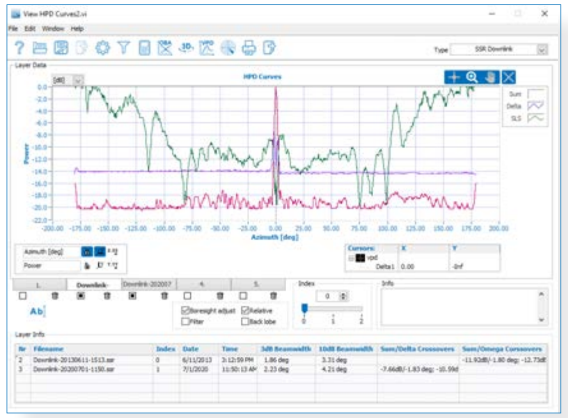
■ Downlink Horizontal Polar Diagrams

The Downlink measurement will provide you with Downlink Horizontal Polar Diagrams of any (M)SSR or PSR antenna. These diagrams are measured at 1090 Mhz.
The HPD Downlink configuration uses two sites for the measurements:
The complete Uplink setup is installed at a remote site, at maximum 2km from the radar station and will serve as a Rf source in the field. It will be configured to send test pulses to be captured by the Downlink equipment. The Radar Interface Module is connected to the radar video monitor ports and controlled from a second computer to record the radar video.

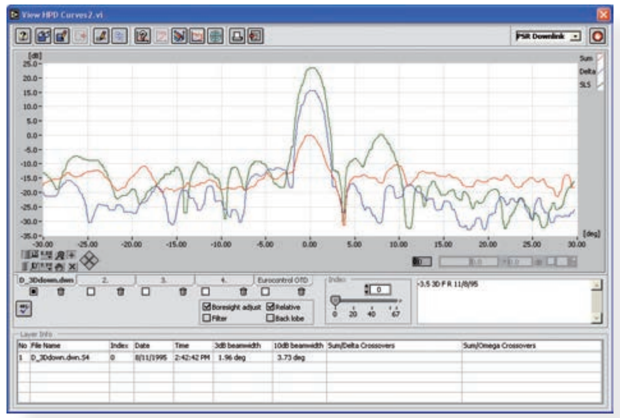
Following features are incorporated into the Downlink program:

- *Horizontal polar diagram measurement on 2 channels simultaneously (by software switching extended to 6)*
- *Error curve plotting (monopulse) log (SUM /DELTA)*
- *SSR receiver calibratio*
- *Monopulse operation*
- *Side Lobe blanking channel*
- *OTD calculation of important parameters such as:*
    - *Cross overs*
    - *3 dB beam width*
    - *1st side lobe level*
    - *back lobe level*

For 3D military radars the PSR should be placed in a collapsed and focussed beam mode. By collecting the HPD patterns at different elevation angles a 3D view of the antenna pattern can be built. 3D diagrams can be very useful to find sidelobes in the elevation pattern; these represent a real problem for the false alarm rate of modern 3D military radars.



SSR Downlink antenna diagram

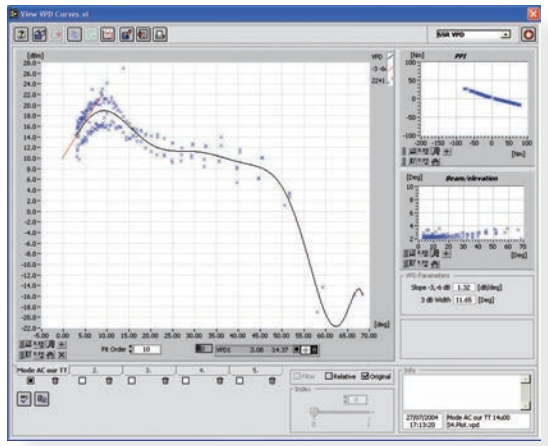


PSR Downlink antenna diagram

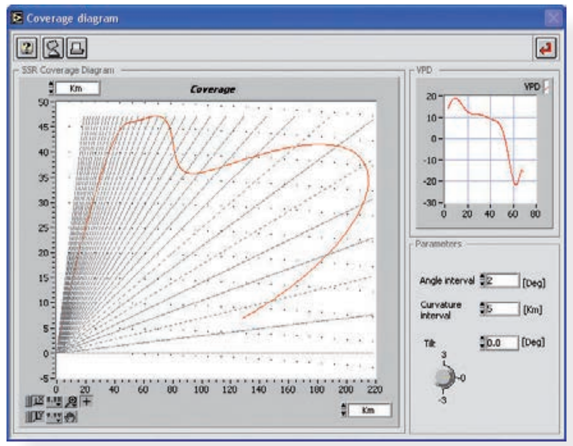
Vertical Polar Diagrams and Coverage Diagram

SSR vertical polar diagrams can be measured using replies coming from opportunity traffic. Special features for this package include:

- *OBA (= Off Boresight Angle, error curve) recording*
- *Vertical polar diagram measurement*
- *Antenna gain measurement*
- *Logging of "raw video data", synchronous responses, PPI view of selected transponder*
- *Coverage diagrams can be constructed from the VPD data*
- *Software simulation of changes in applied tilt, Tx power, antenna gain etc...*



Vertical Polar Diagram



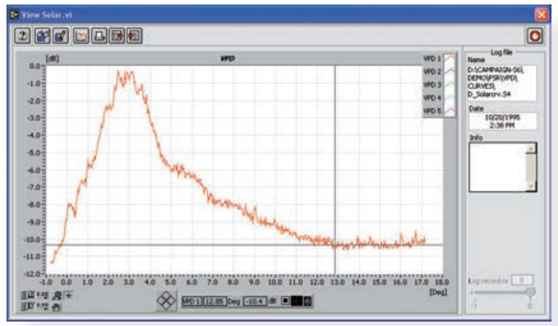
Coverage Diagram

The Solar software was developed for automatic measurement of primary Vertical Polar Diagrams on an operational PSR. The system samples the noise of the sun (sun-strobe) and stores the information together with its azimuth and elevation position. Post-analysis of the data calculates VPD and coverage diagrams from the logged "solar blips".

The software uses a standard RIM782 Downlink configuration for data acquisition and allows automatic tracking of the solar signal at sunset or sunrise.

Key benefits of this measurement method:

- *Absolute sensitivity check-up of complete radar system including antenna chain;*
- *Vertical Polar Diagram of PSR antenna;*
- *Coverage diagram of PSR;*
- *Software simulation of changes in applied tilt, Tx power, Target eff. cross section area, Antenna gain etc...*
- *Calculation of the electrical tilt of the antenna based on the solar data.*



VPD calculated from solar measurement (PSR)

1.2.4 (M)SSR/PSR Receiver Measurements

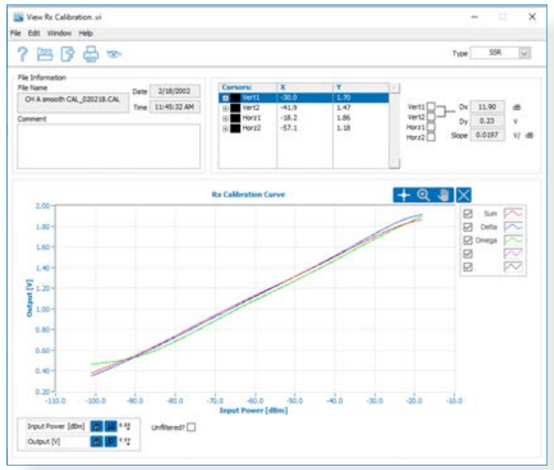
The Radar Field Analyser supports to measure the characteristics of the (M)SSR or PSR receiver channels, in order to investigate:

- *RF receiver dynamic range*
- *Noise level measurement (sensitivity)*
- *Receiver alignment (SUM, DELTA, SLS) for monopulse SSR systems*
- *Receiver bandwidth*
- *STC, GTC curves*
- *Sectorial STC, GTC.*

For these measurements the RFA641 injects RF power at the receiver input and measures the resulting output voltage at the log receiver video output.
The measurements are synchronous to the interrogation trigger, for instance to be able to set the test pulse at the end of the range, or to avoid STC, or in fact to be able to set the delay of the test pulse to measure the STC.

Receiver Calibration

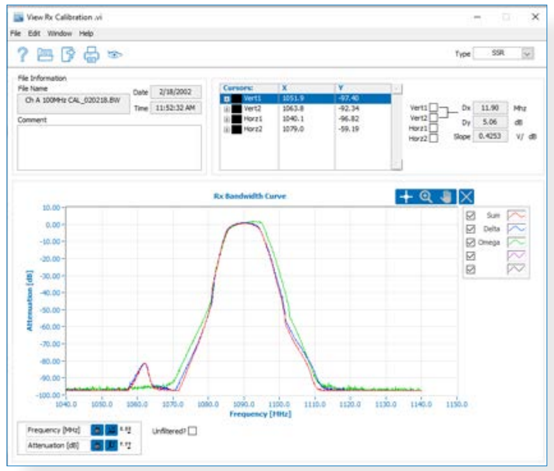
RF pulses generated at a selectable delay after the interrogation trigger and a selectable pulse width are injected in the radar receiver. The power level of the RF pulses is decreased from a selectable maximum (up to +10dBm) in order to measure the receiver range going from saturation level down to the receiver's noise floor. For (M)SSR radar the three monopulse channels can be measured separately and displayed in overlay to check for channel alignment. For these systems the SUM and DELTA channels should typically perfectly align while the SLS channel typically differs.



SSR Rx calibration curve

Bandwidth Calibration

A test pulse with fixed or varying amplitude is used as RF source. For this measurement the frequency of the test pulse is varied and the response voltage measured.



SSR Bandwidth calibration curve

Again the three monopulse channels can be checked suc-cessively and displayed in overlay to check the channels on alignment.

STC/DSTC Measurement

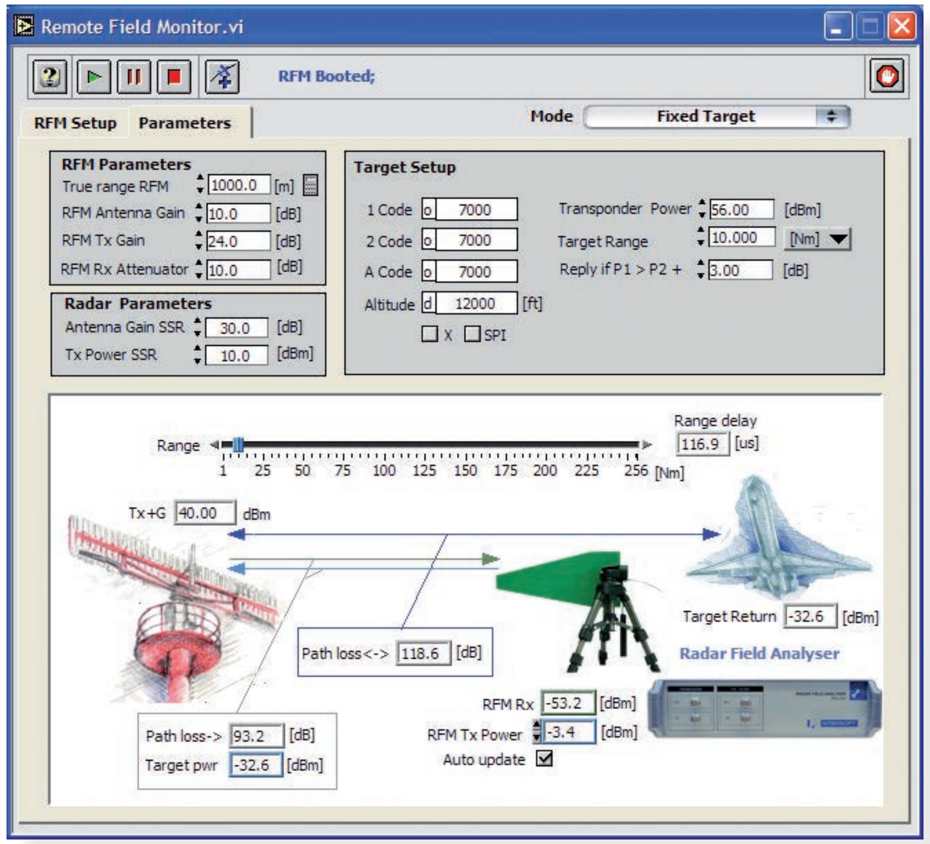
A test pulse with fixed amplitude is used as RF source. The test pulse's delay is varied from a selectable maximum to a selectable minimum while the pulse amplitude at the receiver output is measured.

Two possible methods can be used:

- *The STC measurement uses the analog video output of the receiver and measures the output pulse amplitude versus delay of the test pulse. The amplitude of the test pulse is kept constant.*
- *The DSTC measurement uses quantised video. For each delay the amplitude of the test pulse is increased from minimum power level up to the detection level. This is repeated for each delay.*

1.2.5 Remote Field Monitor Function

The Remote Field Monitor function of the RFA641 mimics the behaviour of an SSR (Mode 1, 2, 3, A, C) transponder. The tool has improved monitoring functions, programmable power and range, and the possibility to load and create scenarios. The SSR target can therefore be positioned at any range or follow a predefined range versus time trajectory.



Remote Field Monitor HMI (parameters and calculations)

1.2.6 Radar Field Analyser for X- band Radar Systems

The antenna is the first vital part of the radar chain. This is true for simple horn-feed reflector antennas and SSR LVA's at L-band frequencies, but becomes even more important when moving radars into the higher frequency regions. Especially to locate antenna problems in X-band radars, Intersoft Electronics extended its well proven "Radar Field Analyser" design, the de-facto standard RASS instrument to perform antenna and RF receiver measurements, into the X-band. The RFX474 (L-band and X-band usage) is intended for on-site performance checks of military hostile fire locating radars or precision approach radars on airports.

Typically, these radars should be set into a "maintenance-mode" such that they produce a constant rotating or "scanning" azimuthal pattern. This pattern (Power versus azimuth) can then be measured using the RFX474.

1.2.7. Product Specifications

INTERFACES	
Device Front	
RX, Tx, YIG-filter In/Out	4x BNC female, 50Ω
Device Back	
Analog (video)	BNC Ch1: video output from receiver log amplifier BNC Ch2: video input to acquisition system
Digital Input, Output	9pHD female connector, TTL
Azimuth	DB15pHD female connector, TTL
USB	for remote programming and high-speed data throughput. USB2; 480Mbit/s transfer rate compatible with USB1: 10Mbit/s transfer rate
TRANSMITTER	
Frequency Range	900MHz – 3.0GHz Oscillator Synthesizer stabilized; accuracy 100KHz
Optional:	Frequency range up to 3.5GHz
Max. Tx Power At Tx output port Optional:	 900MHz – 3.0GHz: > 10dBm and < 18dBm 3GHz – 3.5GHz: >5dBm and < 15dBm
Amplitude Pulse	900 to 1500MHz: 60dB
Modulation	1500MHz: 50dB
On/off Dynamic Range	> 70dB
Bi phase modulation	0 / 180° 5°
RFA Option A: Fruit Reply Code	 SSR pulse generator in compliance with Annex 10
Generator	Pulse duration Mode A/C 450ns 100ns Pulse duration Mode-S 500ns 50ns Pulse rise time < 100ns Pulse decay time < 200ns
RECEIVER	
Frequency Range	900MHz – 3.0GHz
Optional:	frequency range up to 3.5GHz
Sensitivity	-75dBm
YIG PRESELECTOR FILTER	
Centre Frequency	900MHz – 3.0GHz
Optional:	frequency range up to 3.5GHz
3 dB Bandwidth	25MHz 2MHz
POWER REQUIREMENTS	
Power supply	85-264VAC/47-63Hz or 120-370VDC Fused with 1.6A
MECHANICAL SPECIFICATIONS	
Dimensions WxHxD	600 x 220 x 460 mm (23.6" x 8.7" x 18.1")
Weight	14kg (31lbs), including accessories and PelicanTM case
Weight incl. packaging and accessories	21kg

Measuring the Rf Parts

A large part of the radar transmission/reception chain is formed by RF components: starting at the transmitter, a signal passes through a circulator; low loss cables convey it passing a rotary joint to the antenna.
In the LVA (Large Vertical Aperture) antennas of modern MSSR and 3D PSR radar RF signals are split and distributed along the different elements of the array antenna. Possible errors in all of these elements can be measured by the RF Testset. Special software allows pinpointing of the problematic areas in the antenna.

1.3.1 General Introduction

The RFT646 is a versatile dual-channel L-S band Rx measuring unit, capable of generating fixed or swept frequency RF test signals in the 900-3500 MHz range. Basically it consists of two phase controlled receivers with digital intermediate frequency measurement channels. Additionally two transmitter channels can provide arbitrary test pulses. A USB interface is used for real-time communication between the DSP controlling the RF-units and the user interface software running on the host computer. The functionality of the unit (as for all RASS equipment) can be determined by software.

The RFT646 VNA is developed for measuring the frequency characteristics of Rf single and dual ported devices. The unit can measure both amplitude and phase relation of a device under test connected between the input and output port. It also presents a time domain or system response curve. A time domain window can be used to single out the response of a specific element in a network. This feature is very valuable for fault finding in the radar Rf chain.

1.3.2.Key Features

- *Dual channel L-S band Rx system 900MHz-3500MHz*
- *General Vector Network Analysis (VNA): Measurement of VSWR, Reflective power, Forward and Reverse transmission*
- *Vector Network Analysis function for LVA near field antenna measurement to identify faulty antenna columns*
- *Far field antenna pattern simulation from measured LVA tapering table*
- *Dedicated VNA with scanning software for 3D PSR antenna*
- *Pulse Vector Volt meter*
- *IQ alignment measurement for PSR receivers*

More information can be found in the technical brochure of the RFT646.

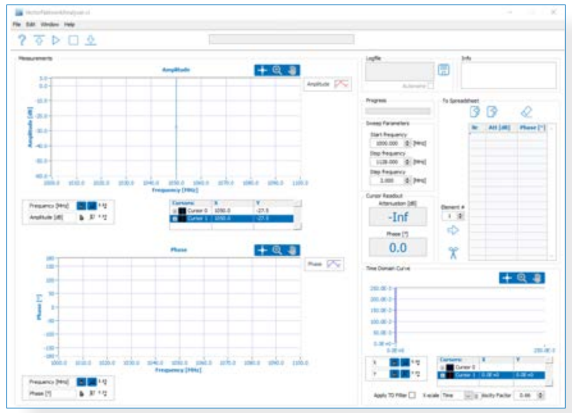
1.3.3.Vector Network Analysis (VNA)

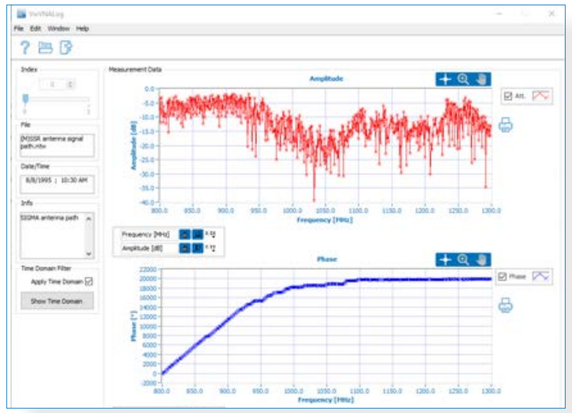
The VNA function allows the user to measure the characteristics of a transmission chain. With a simulation tool, the user can immediately view the effects on the antenna diagram when changing the tapering table of the antenna, i.e. when a column is going to be replaced.
In vector network analysis function, the Radar RF Testset transmitter is used to generate a frequency sweep with a selectable range (900 MHz ... 3500 MHz) and speed. A few external components (attenuators and a coupler) are sufficient to convert the RF Testset into a simple vector network analyser.

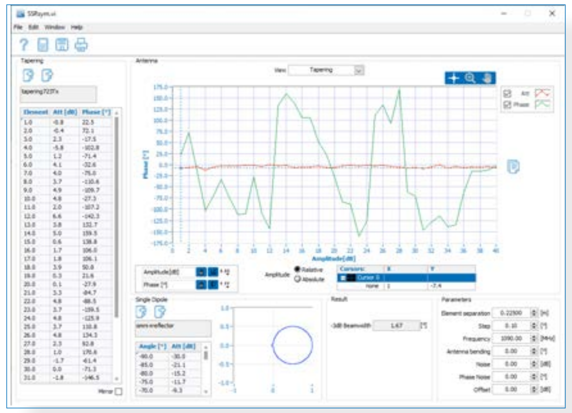
Most important functions:

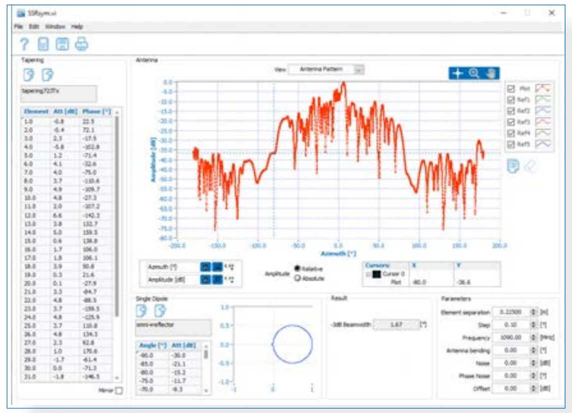
- *LVA column fault finding*
- *To measure the RF parts of the radar chain:*
    - *Rotary joint: leakage, reflections, loss*
    - *Low loss cables: VSWR, Loss, Cable damage*
    - *Monopulse cables: Phase alignment Splitters,*
    - *couplers, switches, etc...*

VNA measurements









The time domain settings of the VNA allow the different elements to be measured separately without physical disconnection.
Every peak value in the time domain response curve is a different reflection source at a readable distance. The software allows to focus on one element to measure the transfer characteristic of that element only.

Possible Measurements:

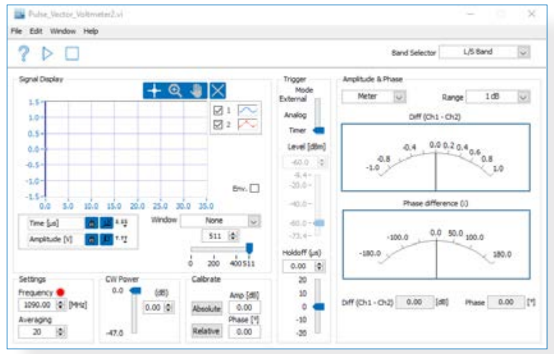
- *Rotary joint HF characteristics (leakage, reflections, loss)*
- *Low loss cable characteristics (VSWR, Loss, Cable damage)*
- *HF combiner (splitter/ circulator or switch) characteristics.*

Error Characterisation
Following errors can be found using these measurements:

- *Rotary joint HF-faults (SWR, reflections, impedance mismatch, etc...)*
- *Transmission cable faults (attenuation, reflections, impedance mismatch due to bending, etc...)*
- *HF combiner (attenuation, reflections, impedance mismatch, etc...) errors.*

1.3.4 Pulse Vector Voltmeter (PVV)

The Pulse Vector Voltmeter is intended to measure accurately the difference in amplitude and phase between two pulsed signals. The measurement can be performed on RF, on video or optionally on IF using an external IF downconverter module (DID647). Either the pulse itself or a digital trigger can be used to trigger sampling. A timer mode is available to allow sampling of CW signals if necessary. The tool allows compensating for cable lengths and attenuation by performing a 'relative' or 'absolute' reference measurement.
The time signal of both measurement channels can be viewed in the measurement window. The last 512 sample windows are available in memory for offline viewing.



PVV measurement

1.3.5 3D Antenna Scan

Vertical Antenna Diagram Analysis

■ General Introduction

The vertical antenna diagram can be derived from a near field measurement, given that the phase and amplitude relationship for every single horizontal row of the antenna is known. Therefore a specially designed pick-up dipole is used to sample these values in a vertical scan. This can be done for both transmission and reception beams, since in 3D phased array antennas the resulting uplink and downlink beams can be independent.

The measurement procedure is especially developed for 3D phased array antennas, like the military 3D air defense radars. The method has proven its efficiency on systems of the Martello family (S723 & S743) and the Lockheed Martin FPS 117 or 77.

The near field measurement has several applications:

- *Prediction of the antenna far field diagram*
- *Checking for defective or degraded transmitter performance*

The measurement can be done in a short time period (typical < 2 hours). So this tool is a very powerful resource for checking the antenna performance and performing maintenance activities in the most efficient way, certainly when keeping the complexity of these antenna systems in mind.

Key Features

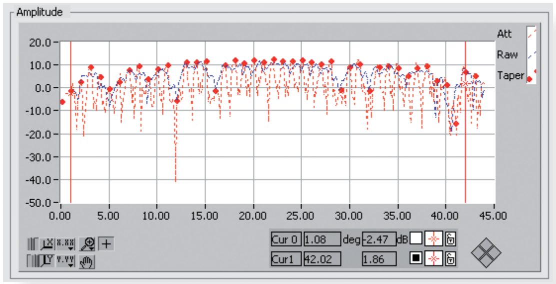
- Measures Near Field Tx and Rx path of 3D PSR array antennas
- Calculates Vertical antenna diagram from near field data
- Measures amplitude and phase
- Specific mechanical construction of kit simplifies measurement

The software allows the user to perform a deconvolution of the near field measurement with a reference diagram of a single transmitter. Because the pick-up dipole inside the surfboard has an omni diagram it is necessary to focus the energy measured on different positions. This way broken transmitters/rows can easily be identified.

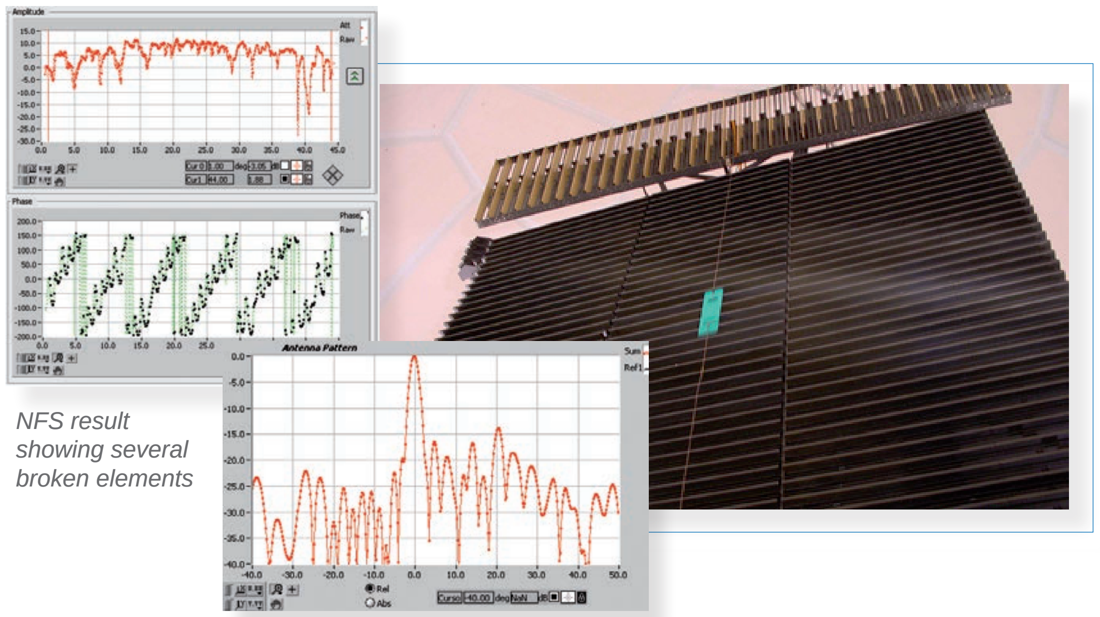
Near Field Scan Measurement

The planar array antenna is scanned and the near field is sampled in phase, amplitude and position using a scan board and a reference pickup dipole fitted with an encoder. At the connection points phase and amplitude are sampled in vector network analysis setup.

To measure the downlink diagram the surfboard injects a signal in the planar array antenna.
To measure the uplink diagram the radar sends a normal interrogation pulse into the array antenna, while the surfboard detects the signal.



NFS result after deconvolution identifying the broken elements



NFS result showing several broken elements

Measured antenna pattern

1.3.6 Product Specifications

INTERFACES	
Device Front	
RF Interface: Transmitter	2x BNC female, 50 Ω
RF Interface: Receiver	2x BNC female, 50Ω
Analogue Interface: Video Input	2x BNC, Ch1 & 2: video inputs to acquisition system
Device Back	
USB interface	for remote programming and high speed data throughput. USB2; 480Mbit/s transfer rate compatible with USB1 (and 3): 10Mbit/s transfer rate
Analogue Interface: Video Output	2x BNC, Ch1 & 2: video output from receiver
Digital Input/Output	9pHD female connector, TTL levelling
Azimuth	DB15pHD female connector, TTL levelling
TRANSMITTER	
Two identical programmable coherent transmitters, Rf-output CH1 and CH2	
Frequency Range	900 to 3500MHz programmable frequency Synthesizer stabilized, accuracy 100KHz
Frequency Step Size	125KHz
Max. Tx Power	900 to 3500MHz: <10dBm
Modulation Range	60dB
RECEIVER	
Frequency Range	900 to 3500 MHz
Linear Sensitivity	-20 … to -80dBm
Log Sensitivity	-10 … to -80dBm
POWER REQUIREMENTS	
Power Supply	85-264VAC/47-63Hz or 120-370VDC Fused with 1.6A
MECHANICAL SPECIFICATIONS	
Dimensions WxHxD	340 x 110 x 350 mm (13.4” x 4.3” x 13.8”)
Weight incl. packaging and accessories	16kg (35lbs)

Radar Video Recording

After a checkup of the antenna, the transmitter and the receiver, the signal processing should be checked. To do this, both the video input and the resulting processor data output need to be recorded. Additionally dedicated software allows emulating the plot extraction process and comparing with the radar output.

1.4.1. General Introduction

The radar processor produces several trigger and azimuth signals, and it receives the (up to three channel) video input from the receivers. This data will pass an intermediate video stage. The radar system will process this data and produce plot data, available as serial LAN messages.

Data at those two stages can be intercepted by the Radar Interface Module, which can be divided in two parallel running systems:

- *Video Recorder, which is intended for detailed recording of video level reply signals and digital trigger signals.*
- *Data Recorder that is capable of recording serial plot and track data, independent of the data format. It connects directly to the modem lines.*

This section will handle the Video Recorder section of the RIM782. The RIM782 can also record radar data using the RASS software.

The Radar Interface Module is able to record all types of PSR, SSR or Mode-S radar video signals. The RIM782 has 6 video signals (software selectable), 2 trigger signals and 2 rotation interfaces (ACP and ARP signals, both single-ended and differential). One can connect up to 6 video signals to the RIM782; through software 2 channels will be selected for recording. This allows connecting for instance both SSR channels or a combination of PSR/SSR video.

Special analysis tools create links between radar plot or track data and the recorded video. This allows you to recall any video on any "suspicious" plot or track messages, simply by clicking the correct link. For PSR radar evaluation, clutter recording analysis tools (PSR Viewer) operate from RIM782 recordings.

1.4.2 Key Features

- Direct digital recording to PC with time stamps
- Recording of (M)SSR/PSR Downlink Antenna diagrams
- PSR VPD Solar recording function
- Sectorial Video Recording for detailed reply recording
- Environment Recordings (FRUIT determination)
- Live monitoring of recordings
- Recording of SSR replies, Mode-S replies/interrogations and PSR returns
- Modify / add data to files, data manipulation on video levels
- On-screen playback of files for simulation & test purposes
- Embedded multi-level linking between radar data and video data
- Primary Clutter recording with clutter analysis software
- Can be used for RASS Displays (TMD3 and MRD3): requires RASS software

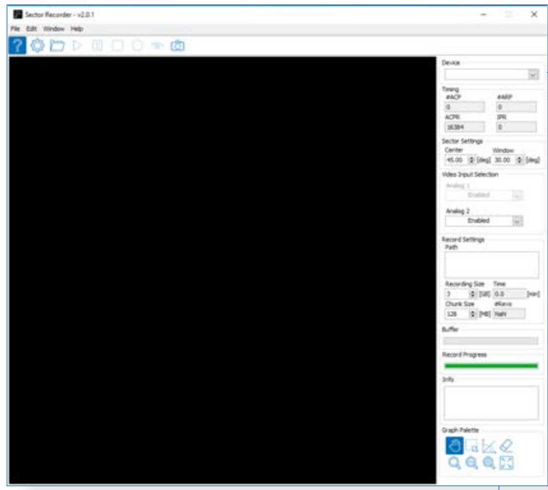
1.4.3 Sectorial Video Recording

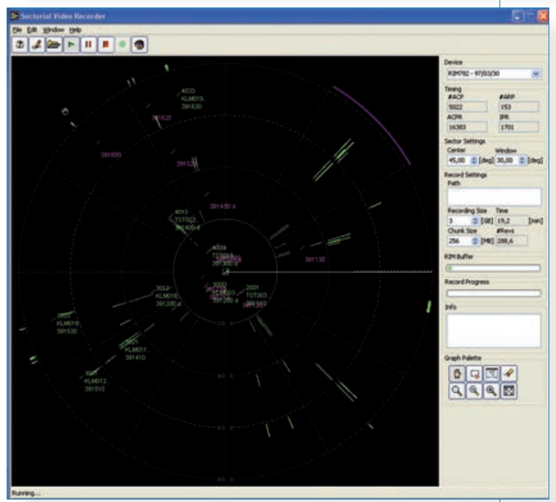
The Sectorial Video Recording tool introduces a new revolution in radar video recording. Previous recording tools had either the disadvantage of being limited in range/azimuth (Window-based Video Recording) or were difficult to set-up and limited to MSSR video pulses (Video Pulse Recording). The sectorial video recording combines the advantages of these two former tools into one single tool as it is designed to create highly detailed video recordings, unlimited in both range and azimuth.

The sectorial recording tool allows you to perform a window-based alike recording with an infinite range. The window width depends on the processing power of the PC. High-end desktops and laptops are able to record the full 360°. The Sectorial Video Recording tool is more flexible than the former pulse recording tool as the trigger can be set in the software, giving the user the opportunity to make a trial recording to verify the trigger setting.
Cursors can be used to investigate details of both time (replies) or azimuthal (OBA) captured information.

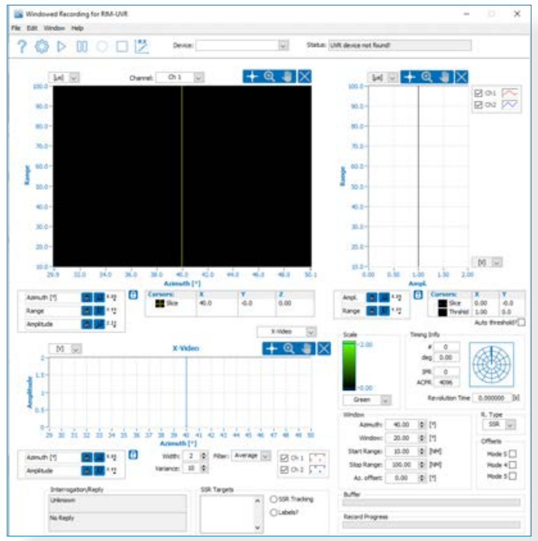
The video window displays the recorded video replies for each interrogation in the selected azimuth window. It uses intensity to show the signal amplitude and draws this vs. range in the Y-scale. By then drawing the recorded range window for the successive interrogation vs. azimuth, a visual representation of the complete reply block becomes available in the window.

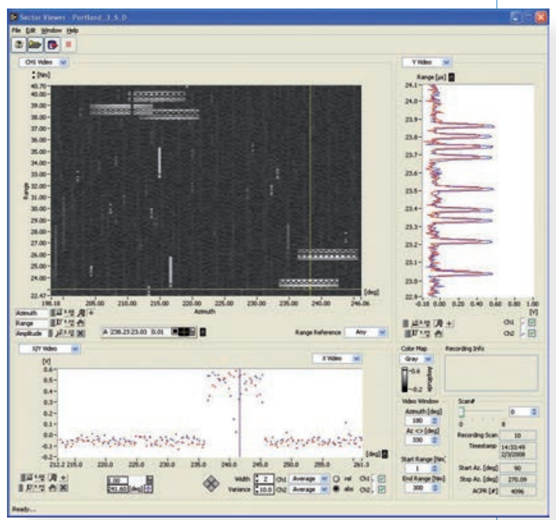
This allows an easy visual evaluation of the received replies, the azimuth extension can be determined, etc...





Sectorial Video Recording software





Sectorial Video Analysis software

(SRR example)

1.4.4 Multi-level Analysis Software

The multi-level analysis tools consist of off-line virtual software radar and allow visualisation of pulses, replies and plots at different levels. The output of the extraction process is a plot file, which can be compared with the plot output of the radar under test and allows multi-level analysis of the data. For each plot in the output data, the reconstructed video can be shown on the spot, showing the reason of appearance or disappearance of a plot.
The recorded video data can be loaded and processed using the pulse analysis program. If selected, the data will be displayed during the plot extraction process. For each part of the process, parameters are provided to control the extraction of data. Depending on the radar type (Mode AC, sliding window or monopulse, Mode-S) the settings shall be adapted.
When the processing is started, data is visualised in a range - azimuth graph, showing the video data in multiple levels (each type of information has its own icon and color). This allows an in depth analysis of the extraction process and of course of the recorded data.

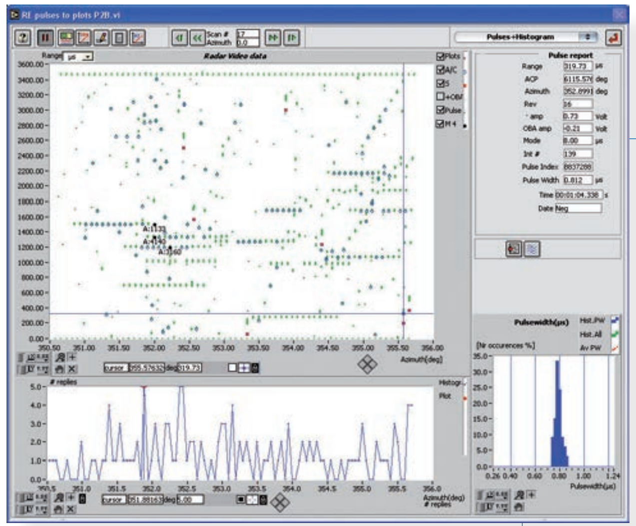
Following data is available in the video window:

- *Pulses: Raw recorded pulses. Each pulse is characterised by its pulse report, as can be viewed in the window.*
- *Replies: Extracted 1/2/A/C/S replies. The replies are extracted using framing extraction and OBA amplitude checking.*
- *Plots: Combination of a number of replies results into a plot.*

For each of the data levels, the software allows to query information.

Typically the plot extraction is performed by examining each sector in the recording step by step, verifying the detailed problems. After a complete examination of the video data and extraction process, a plot file can be generated.

This file type can then be viewed from the inventory program, which is intended to perform visualisation and analysis on recorded serial plot and track data.



Especially interesting for analysis is the linking of the inventory viewing and the multilevel analysis software. The extracted plot data from the video recording can be viewed simultaneously with the recorded plot and track data from the radar under test. For each plot in the inventory, it is possible to immediately query the video level signals in the multilevel analysis program and this way find out whether the radar should have been capable of producing a plot.

1.4.5 Product Specifications

GENERAL SPECIFICATIONS	
Operating Temperature Range	0…50°C
Storage Temperature Range	-20…+70°C
Relative Humidity:	10%…80%
Max. Operating Altitude:	3080m
Dimensions WxHxD (mm)	437x367x44 (case) ; 484x44 (Front)
Power supply RIM782	Input Voltage 90-264V; Input Frequency 47-63Hz; Power 22W

DATA RECORDING SPECIFICATIONS
The RIM782 has 2 serial communication channels for active and passive recording. They can handle transmission speeds up to 128 Kb/s. Two electrical standards are supported: RS232 (single ended) and RS422 (differential). The serial data is fed to the recorder using female DB15 connectors (alike X.21 connections) on the rear panel of the RIM782. The unit is supplied with 2 RS232 probe modules for connection of the DB15 connector to DB25 standard RS232 connector. A whole range of synchronous protocols is supported and other can be programmed upon request.

SUPPORTED PROTOCOLS	
The RIM782 can input the following passive protocols (up to 128 Kb/s):	U-HDLC: passive recording of HDLC based protocols, including LAP-B and X25.3 passive monitoring. (eg. ASTERIX, RDIF)
	SYNC 13: Passive recording of most bit protocols as implemented on US radars (CD1, CD2, ASR9, etc …)
	LINK 1: Passive recording of military LINK 1 protocol
	AIRCAT500 - EV760 - TVT 2 - EADS - RSRP - TPS 77 - RAT31
The RIM782 can output the following passive protocols:	U-HDLC – TVT 2 – AIRCAT500
The following protocols can be recorded and replayed bit-wise or converted in RASS at 9600 baud:	AUSTRO – BMIL – CD – ERICSSON 200/SRT – EUROCONTROL – FPS 117- HUGHES – RAT31S – SVE – TOSHIBA – TRS 22xx

TECHNICAL SPECIFICATIONS	
General Specifications:	2 ARP/ACP inputs: BNC connectors, single ended TTL and 2 ARP/ACP inputs: DB9 female connector, differential TTL.
	GPS interface for time stamping: dedicated interface to GPS450
	2 Trigger inputs: BNC connectors, TTL
Data Recording:	2 Synchronous serial data inputs/outputs: female DB15 connector, RS232/RS422 Driver/Receiver
	USB 2.0 data connection to processing pc

VIDEO RECORDER SPECIFICATIONS	
	4 Analog input channels :BNC connectors, Analog input voltage = [-2V .. +2V], 10kΩ
	I / Q analog input channels :BNC connectors, Analog input voltage = [-2V .. +2V], 10kΩ
	Sampling rate : 8MHz(2channels)/16MHz (1channel)
	Resolution digitized output : 12 bit + 11 digital inputs
	USB 2.0 video connection to processing PC

OPTIONAL ACCESSORIES	
GPS450	Weatherproof GPS receiver for UTC time stamping of messages

Recording Serial Links

The final stage of the radar chain is the data processor and the corresponding data transmission elements: data lines, modems, telephone or dedicated datalines. More and more these radar data are shared by multiple users distributed over a wide area. For efficient transportation of the data via private or public networks, high speed serial communication protocols are used.

EUROCONTROL selected LAPB/X25 transporting ASTERIX data for this purpose. Most recent radars installed in Europe adopted this standard. The IE Radar Data Recorders can be used to support these communication protocol layers. Of course a whole line of other standards is also supported.

1.5.1 General Introduction

The USB Data Recorder (UDR765) allows you to record 2 lines of serial radar data passively (spy-mode). We currently support unnumbered HDLC or LAPB connections and a wide range of radar data formats (such as ASTERIX, RDIF, Aircat, EUROCONTROL, CD ...). Tools are provided to analyse the recorded data for protocol errors or convert the data directly into a display format. The software also allows you to record data on a LAN, using TCP-IP or UDP-IP based protocols.

Since the UDR765 only allows to record passively, the connection itself is spied upon by the UDR765. If more than two channels are required, multiple UDR765s can be "stacked". The additional inputs azimuth and time make it a real radar evaluation tool. This allows for example evaluating the extraction delay.

The recordings made by the UDR765 can then be converted into a suitable data format for further evaluation: this can be a SASS-C compatible format or the RASS data format (.S4) or RASS input formats (.D6). Furthermore, since the full communication protocol is recorded together with the radar data, an analysis of the line quality and communication protocol syntax is possible. Every message is UTC-time stamped with µs resolution before it is stored on disk. For this purpose, the UDR765 should be installed along with the GPS450 receiver (optional item). Additionally, ACP/ARP of the recording is also stored, allowing specific radar data analysis.

1.5.2 Global Positioning System: GPS450

Measuring the accurate position and UTC time
The weatherproof, portable GPS receiver is automatically powered up after it is connected to the host computers serial port. Using a simple HMI the GPS450 data can be recorded and reviewed afterwards for analysis.

The GPS450 data can also be interpolated to be used as a reference source for data analysis (see RASS product catalogue for more information).

Another important function of this GPS450 is the absolute time stamping of radar data recorded by one of the radar data recording tools. By using the GPS450 each incoming radar message (ASTERIX) can be absolutely time stamped with an accuracy of 50µs. This allows the analysis of the processing delay of the radar. The time stamping is required for typical PTE analysis.

1.5.3 Recording and Converting Data

The RASS toolbox contains a number of functions to support the recording and conversion of serial data. Several types of data recordings are available.

The first type allows you to verify the data and clock lines of the serial connection. For this purpose data is recorded using the so called ‘event’ mode. Each transition on the data line or on the clock line is detected as an ‘event’ and recorded to disk. The purpose is to check for glitches on the line, and one can immediately find the active edge of the clock, to be used to sample the data.

The second type of recording is the so called bit recording. All bits are sampled at the active edge of the data clock. This type of recording is typical for specific protocols, such as 13bit CD, 9bit EUROCONTROL. This recording only consists of spying on one of the data lines of a connection, without taking part of the data transmission.

The third type of recording, the “Serial recording”, is the most common. In this case the data of the radar is transmitted using standard serial protocols, such as HDLC, LAPB or X25.3. Typically radars using ASTERIX or RDIF will use these transport protocols.

LAN recording is the last type of data recording. Two types of LAN recording tools are developed to record the data that is transported between radar and center or between 2 centers using IP based protocols (UDP-IP or TCP-IP). Active as well as passive UDP-IP or TCP-IP LAN recordings are possible. The following protocols are currently supported: ASTERIX, RDIF, DDE, EADS SIP-PEX, EADS PEX-ST. The recordings are performed using the build in Ethernet port of the computer running the tool.

After the recording has been performed, the data can be converted into a suitable data format for further evaluation (RASS-C Mayer-IOSS or the RASS data format). Conversion of data doesn’t need to be executed immediately.

The most important output of the convert process is the RASS plot file, which can be viewed and analysed in the Inventory program as part of the Local Plot and Track Analysis functions of the RASS toolbox.

The data conversion program can run in parallel with the recording function, in order to provide immediate viewing of the recorded data. This way the data can be verified visually while recording.

1.5.4 Local Plot and Track Analysis

The serial data will be used to represent data in specific graph types (polar, altitude, A/C code vs. time, Range vs. elevation, # plots/scan etc...). Each axis of the display can be modified, such that any available radar data field can be shown versus any other. The colour of the points (Z axis) can be modified according to a third selected data field.

Functions that are implemented are:

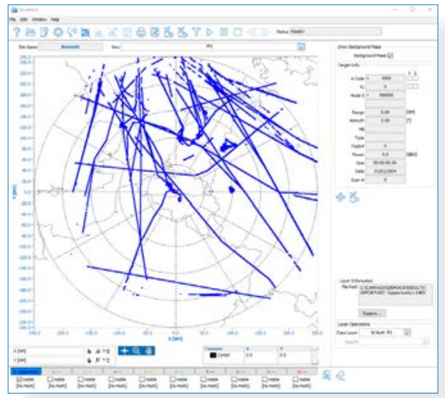
- *Inventory Tool: allows you to visualize data in different formats (PPI, vertical diagram, A or C code versus time, Range versus elevation...).*
- *LAPB/X.25/ASTERIX analyzer: for detailed investigation on the ASTERIX or RDIF protocols.*
- *Pd and Accuracy Tool: When a detailed reference data set (e.g. the RES28x scenario) is available, this tool can calculate all Pd numbers, accuracy figures, biases, etc... for the recorded data set.*
- *Data Link Analyser and Data Display: For Mode-S evaluation, a special set of tools is available, which allows you to analyse and display all interactions between Transponder, radar, ATC and GDLP.*
- *Cluster Analysis for Mode-S: testing and analysis of an integrated POEMS radar cluster in live environment and functioning in distributed mode.*

Inventory

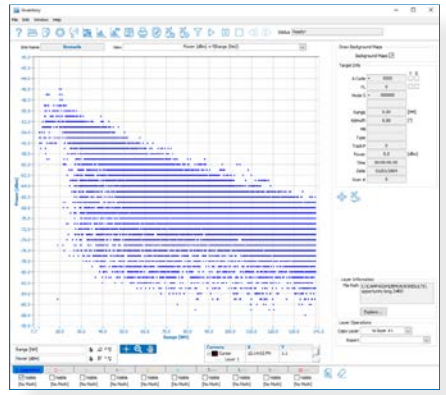
Key features:

- Multi layer presentation of data;
- User definable X, Y and Z scale data (any radar data field);
- Input filtering including logical combinations on data fields (AND, OR, NOT);
- Labelling functions;
- Real-time display layer for use with data recording and conversion program;
- Statistical analysis functions such as a histogram calculation;
- Direct linking to multi-level analysis software for visualising the video level of selected plots;
- Direct linking with the ASTERIX viewer software for direct viewing of the message data linked to a selected plot;
- “Third View” allows additional third axis to be shown as colour information;
- Display can have any size (small window to full screen).

The recorded plots and tracks can be filtered or selected for specific properties. Upon loading the RASS data, special filter conditions can be set. Specific A codes can be selected, range or azimuthal filters can be set. In fact, data can be filtered on the contents of each of the possible data fields. The multitude of viewing modes allows multiple analysis methods on the recorded data.



Inventory in PPI view



Inventory in Power vs. Range view

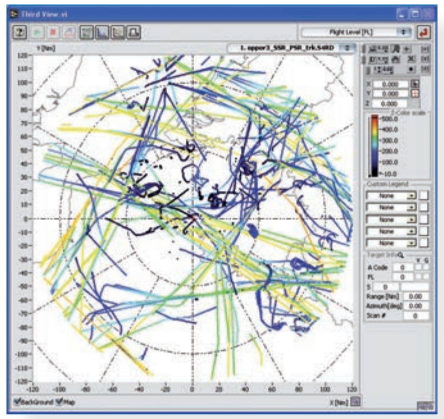
Three different types of layers are available. A layer has one of three possible basic configurations: Static, Dynamic and live.

- Static = Static inventory showing all plots selected from the input file.

- Dynamic = Dynamic inventory showing the recorded data vs. time. The start scan, # of history points, step size and refresh rate can be set.

- Live = Live input of data on a scan to scan base.

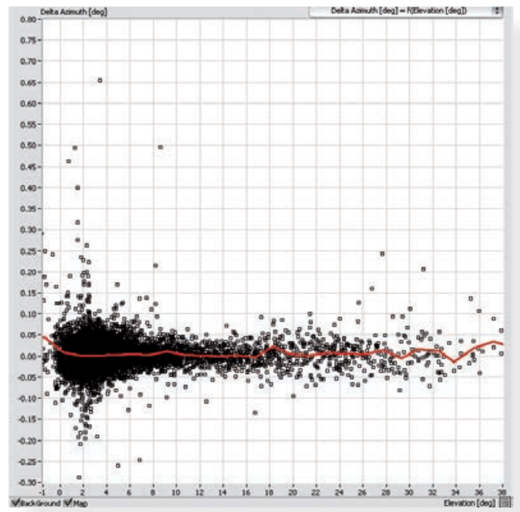
The Inventory display can also be used to represent a third axis (any radar data value) as a colour value. On top of this, each data point can have a specific point style, depending on user definable criteria, mostly a flag value. (E.g. All Garbled codes in round dots, all Invalid codes as crosses, etc.)



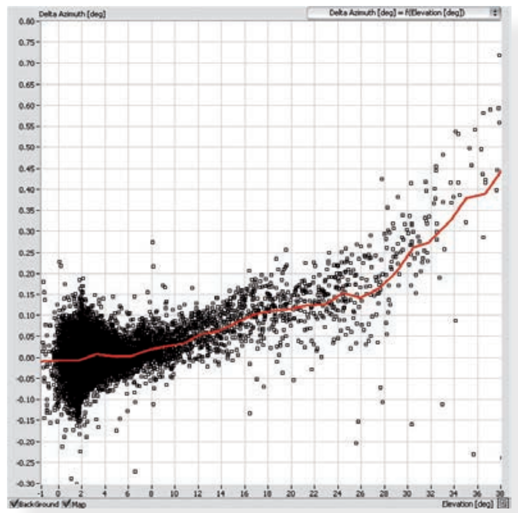
Inventory in third view mode
(in this example colour represents Flight Level)

An important feature for analysis is the histogram function, which allows a multitude of statistic calculations on any of the X, Y or Z data shown in the inventory. All data shown in the Inventory can also be exported into tab-separated text files for further analysis in e.g. spreadsheet style applications.

The following example demonstrates the value of the inventory tool by showing the results of a measurement of the beam widening of an LVA antenna: A large vertical aperture (LVA) antenna beam widening is known to increase the azimuth error with elevation. Typically the radars use a single OBA table for the measurement. MSSR radars do not suffer much from the effect because of the multiple interrogations and the azimuth averaging. However MODE-S radars are more affected by the phenomena because they determine position typically using a single reply, and a target is interrogated typically early in the beam, when the target is at the right side of the beam. This typically increases the azimuth bias at higher elevation angles. ADS-B data allowed measuring this parameter more accurate than ever before compared with a multi-radar measurement. In the following figures the azimuth error distribution vs. the elevation angle respectively for a MSSR and MODE-S radar are given. The MSSR radar doesn't have any azimuth bias increase vs. the elevation, the MODE-S radar has demonstrated the azimuth bias increase of about 0.45° for elevation angles greater than 10°.



The azimuth error vs. the elevation angle measured for MSSR radar (above) and for MODE-S radar (under); (black dots:measurements, red line: azimuth bias); ADS-B vs. radar measurement



LAPB/X25/ASTERIX Analyser

Key features:

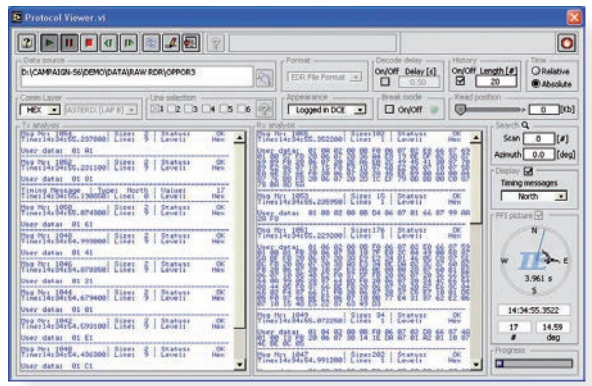
- Absolute UTC time stamping up to 50 µs, obtained from GPS clock using IE GPS450 Module

- Direct linking with the Inventory tool for immediate investigation of anomalous plots

- Visualising of 'disassembled' ASTERIX messages in readable format

The LAPB/X25/ASTERIX Analyser was especially developed to investigate the LAPB/X25 serial communication protocol which is used to transport ASTERIX data.
In the OSI model this represents the lowest three levels respectively for the serial communication (level 1), the LAPB (level 2), X25 (level 3) and the application layer (level 6) for the ASTERIX data. Furthermore radar timing signals (ACP/ARP) can be integrated in the analysis.

It is a most useful tool to verify the ASTERIX implementation on SAT of a new radar system. Since it is possible to perform the data recording with UTC time stamping, this process can also be verified.



Protocol viewer HMI

The LAPB/X25/ASTERIX Analyser is an off line analysis tool. It uses recordings made by the Serial recording tool, a LAN recording file or an IOSS (SASS-C) file as input. After file selection the input channel containing the data of interest must be selected. A number of functions are implemented to allow performing the visualisation and analysis in a convenient way. The disassembled messages as sent over Tx and Rx are shown next to each other together with the timing display, to allow easy analysis.

Pd and Accuracy tool

The Pd and Accuracy tool was developed to calculate a number of performance parameters using recorded data from a RES28x (Radar Environment Simulator) generated scenario.

The tool provides a theoretical indication of:

- *Probability of detection*

- *Code performance*

- *Mode-S and SSR accuracy in terms of declared range and azimuth on recorded SSR Mode-S and SSR based data on a limited and defined set of rules specified in the EC document stated above*

- *SSR performance analysis in resolution cases*

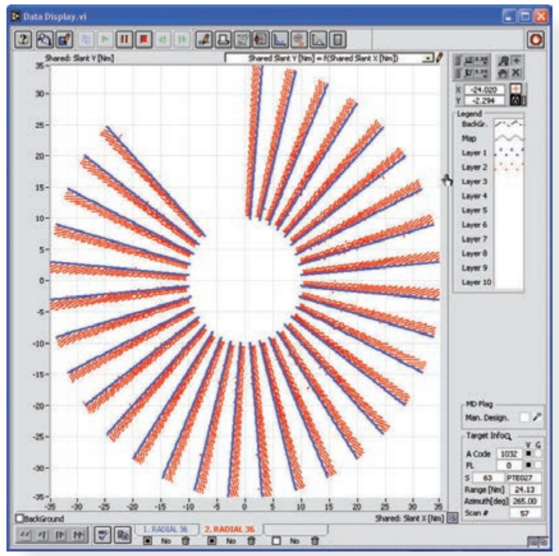
Data Link Analyser and Data Display

As part of the PTE developments, IE created a set of dedicated tools for Mode-S and Data link evaluation.
These tools calculate a whole set of parameters which can be used to asses the radar's performance in Mode-S and in more detailed data link cases.

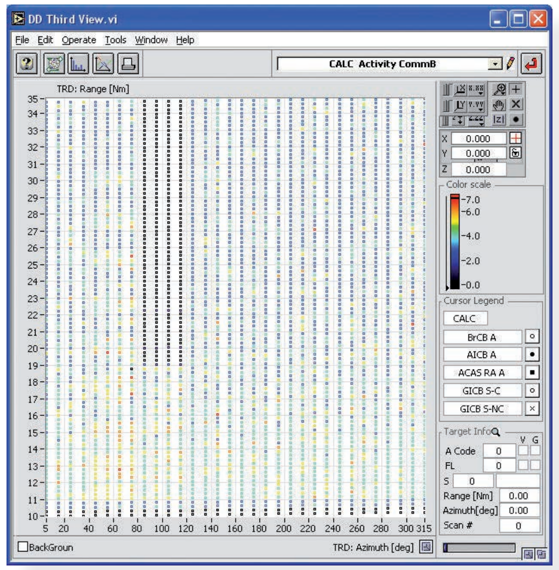
The "Data Display" tool has been derived from the "Inventory" tool, but is enhanced for use with a more elaborate data structure which incorporates for every plot the combination of reference position, radar data position (ASTERIX Cat48 data), all interrogations sent by the radar to that target and all replies sent by the target to the radar. Additionally, the structure also links all DLF-GDLP data (ASTERIX Cat18) to the same records.

The tool allows you to visualize in many different views a set of 440 different recorded and calculated parameter and data fields. Typically, the calculated values will be shown as color values or as Y values in the X-Y graph.

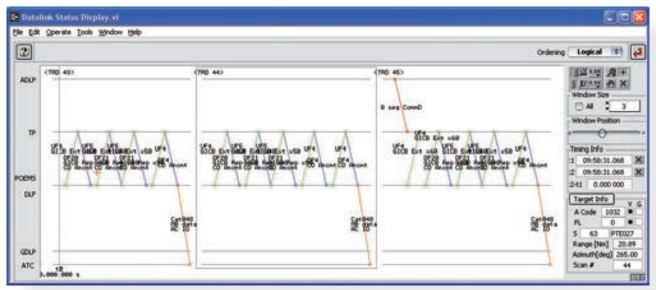
All data shown in the graphs can alternatively be shown in histogram representation. This allows calculations of statistical values.



Data Display software



Data Display software in third view mode



Datalink Status Display

■ Cluster Analysis for Mode-S

The PTE-P5 stage contains the development that enables the inter-operability testing and analysis of an integrated POEMS radar cluster in live environment and functioning in distributed mode.

This testing can not be seen as an automated process, but rather an intuitive and interactive process between specialist user and the cluster environment. The testing shall require huge amounts of data to be gathered at each node of the cluster under test. After data acquisition, the data can be processed and analysed.

The processed data can be analysed “manually”, by using extensive data visualisation tools, or automatically, by using calculation tools which asses the performance parameters of the cluster. The P5 tool will not be able to provide the user with one and unique performance figure. The complexity of the environment of a POEMS cluster is such that it requires a lot of specialist input to determine a final judgement on the cluster performance.

1.5.5 Product Specifications UDR765

GENERAL SPECIFICATIONS	
Temperature Range - Operating / Non operating	0...40°C/-30...+50°C
Relative Humidity	10%...80%
Max. Operating Altitude	3080m
Dimensions WxHxD (mm)	UDR765: 220x145x25
Power supply UDR765	USB 1.1. Self powered; max current drawn from PC: 500mA; allows connection of external supply when the PC is not able to deliver the full USB specification.

DATA RECORDING SPECIFICATIONS
The **UDR765** has two high-speed serial communication channels for passive recording. Each of the channels can be configured individually. They can handle transmission speeds up to 128 Kb/s. Two electrical standards are supported: RS232 (single ended) and RS422 (differential). The serial data is fed to the recorder using two DB15 connectors (alike X.21 connections). The unit is supplied with two RS232 probe modules for connection of the DB15 connector to a DB25 standard RS232 connector. A whole range of synchronous protocols is supported and other can be programmed upon request.

SUPPORTED PROTOCOLS	
The UDR765 can input the following passive protocols (up to 128 Kb/s):	U-HDLC: passive recording of HDLC based protocols, including LAP-B and X25.3 passive monitoring. (eg. ASTERIX, RDIF)
	SYNC 13: Passive recording of most bit protocols as implemented on US radars (CD1, CD2, ASR9, etc …)
	LINK 1: Passive recording of military LINK 1 protocol
	AIRCAT500 - EV760 - TVT 2 - EADS - RSRP - TPS 77 - RAT31
The UDR765 can output the following passive protocols:	U-HDLC – TVT 2 – AIRCAT500
The following protocols can be recorded and replayed bit-wise or converted in RASS at 9600 baud:	AUSTRO – BMIL – CD – ERICSSON 200/SRT – EUROCONTROL – FPS 117- HUGHES – RAT31S – SVE – TOSHIBA – TRS 22xx

TECHNICAL SPECIFICATIONS	
Digital interface	PPS: BNC connector, TTL GPS interface for timestamping: Dedicated interface to GPS450
6 Synchronous serial inputs/outputs:	RS 232/422 Driver/Receiver female DB15 connector
Connections	1 USB connector to computer

OPTIONAL ACCESSORIES	
GPS	GPS receiver for UTC time stamping of messages

1.6.1 General Introduction

Measuring the mechanical quality of antenna systems

The Radar Gyroscope-and-Inclinometer (RGI1193) and the Radar Timing Interface (RTI966) allow you to evaluate the mechanical and structural design of the antenna support and tower under wind-loads, temperature, etc. The RGI1193 basically has 2 co-related functions, measuring:

- *the quality of the encoder system*
- *the levelling of the platform*

The RGI1193 measures the angular velocity and planar angle of the antenna. For this purpose the device is mounted on the rotating part of the (SSR or PSR) antenna and the data is logged in the RGI1193's internal memory. Meanwhile the RTI966 will record the ACP/ARP timing signals of the encoder under test.The rotational information data combined with the encoder signal provide essential information on encoder accuracy and platform leveling. Note that deviation on the instantaneous azimuth (= encoder error) is measured, because biases (e.g. wind-load) are simultaneously recorded at encoder and antenna level. These two signals plus their difference are shown in the software.

Antenna start-up and stop are also recorded and provide information about the mechanical stiffness of the radar tower.

The analysis program allows the user to view the recorded gyro and ACP measurements on a scan by scan basis over multiple revolutions.

Gyro-Inclino Analysis software

1.6.2 Product Specifications RGI1193

INTERFACES	
USB connector (Data and charging) Charge LED Recording LED WiFi antenna (RP-SMA)	

TECHNICAL SPECIFICATIONS	
Gyro Module	
Max. Angular Rate	Configurable; ±60°/s; ±120°/s ±240°/s; ±720°/s
Resolution	16-bit
Self-calibrated using radars North and time reference	
Inclino Module	
Measuring range	±15°
Sensitivity	0.01°
WiFi	
Type	802.11bgn
Mode	Access Point
Output Power	17dBm
Recording	
Sample Rate	Configurable up to 1000Hz, default 200Hz
Time	10 hours (at 200Hz)

POWER REQUIREMENTS	
Battery Type	Li-ion
Capacity	2350mAh
Nominal Voltage	3.6V
Watt-hour rating	8Wh (acc. To UN38.3)
Weight	43g
Built in Safety Unit (over voltage, under voltage, current limit)	
System runtime – WiFi disabled	15 hours
System runtime – WiFi enabled	10 hours

ENVIRONMENTAL SPECIFICATIONS	
Charge Temperature	10° to 45°C (50° to 113°F)
Operating Temperature	-20° to 60°C (-4° to 140°F)
Storage Temperature	-40° to 85°C (-40° to 185°F)

MECHANICAL SPECIFICATIONS	
Dimensions WxHxD	150 x 120 x 80 mm
Weight device	1.0 kg
Weight incl. packaging and accessories	7.9 kg

1.6.3 Product Specifications RTI966

INTERFACES	
In/Out	DB9 male - Differential Timing input
In	DB15HD female - Single Ended Timing input
RB1/2	2x DB15HD female - Timing Signals and Power
GPS	DB9 female - GPS interface for timestamping
USB	USB2.0 B female (480Mbit/s high speed)

TECHNICAL SPECIFICATIONS
Differential Timing Input
RS422/RS232 4 inputs or 4 outputs or 2 in- and 2 outputs
Single Ended Timing Input
0...6 Volt, 2kΩ Selectable trigger level, 4 inputs

POWER REQUIREMENTS	
RASS Bus:RB1/2	
Timing signals	TTL, 2kΩ
Power in/out	200mA, 15V
Connects to power supply or other RASS device	

ENVIRONMENTAL SPECIFICATIONS	
Temperature Range - Operating / Non-operating	0° to 40 °C (32° to 104°F)

GENERAL SPECIFICATIONS	
Dimensions WxHxD	240x120x50mm
Weight	1.2kg

1.7.1. USB Power Meter: UPM772

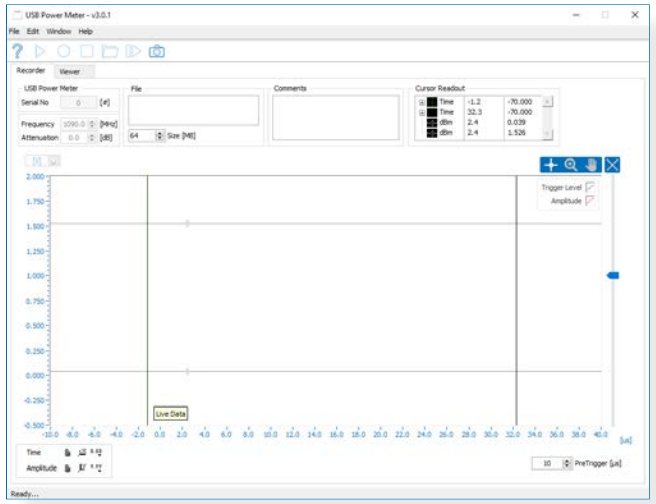
The USB Power Meter (UPM772) is a power meter designed for radar testing, both for on site (Tx and Tx driver) power measurements and for portable fieldwork. For the latter purpose the required receive antennas are included in the interface kit. The USB Power Meter can be used to take a snapshot of the antenna diagram of a radar system. The UPM772 records continuously through a USB interface. The recording will show the pulses (comparable to the “Scope” function of the Radar Field Analyser), showing the basic Tx and antenna parameters (pulse width, sidelobe levels,…).

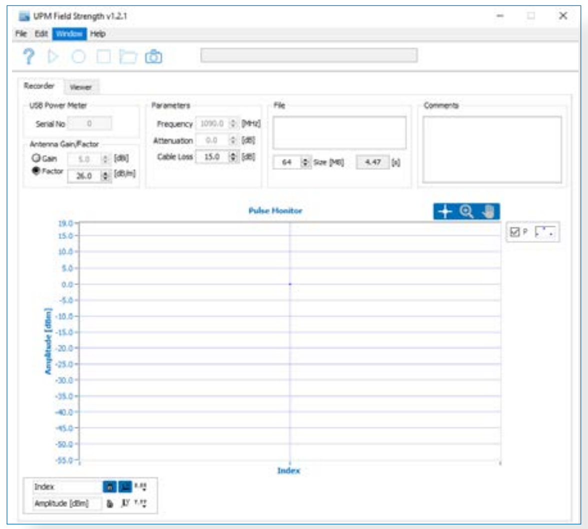
More technical information can be found in the UPM772 technical brochure.

Why Do You Need a UPM772?

The UPM772 offers the easiest method to read the fingerprint of the radar antenna from a remote, known location i.e. RFM. Keeping this in mind one can conclude that the UPM772 can be used as an easy, low-cost antenna measurement device in the following areas:

- ***Maintenance**: the antenna diagram can be measured and compared to a previous diagram for maintenance evaluation of the antenna.*
- ***Radome**: the antenna diagram will be measured before and after a radome installation. Comparing both results will show the influence of the radome.*
- ***Field Strength measurements**: the UPM772 can be used to measure the field strength in the environment of the radar. Therefore the influence between radar systems or towards people can be determined. The legislation for the field strength varies from country to country; therefore the tool will only give you the average electric field strength (V/m).*





Example of UPM Field Strength measurement

1.7.2 Product Specifications UPM772

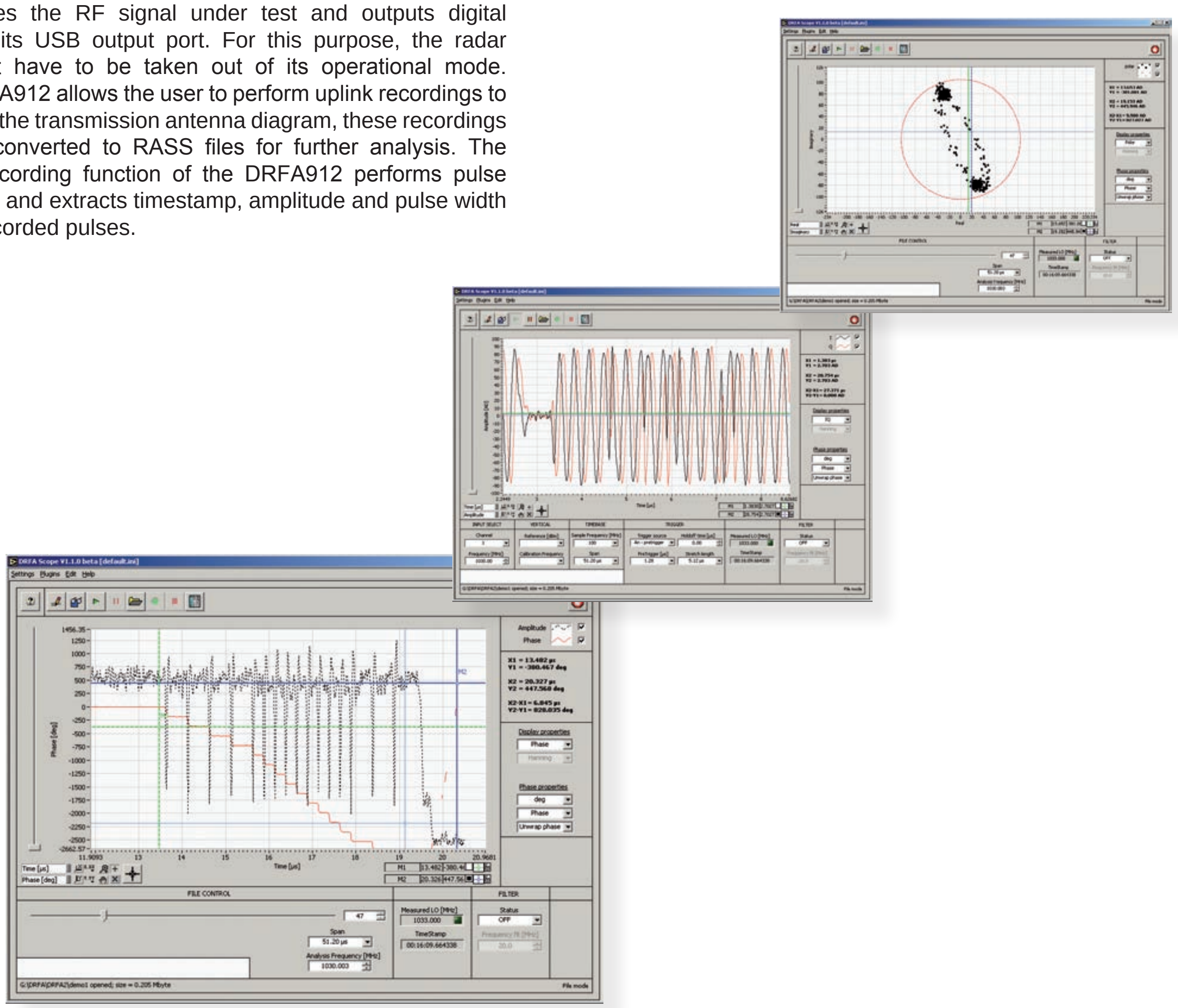
INTERFACES	
Rf in	SMA female
Video Out	BNC
USB	USB2.0
RF INPUT	
Frequency Range	10MHz to 10GHz
Input range	typically 0 to -60dBm
Maximum CW input power	+12dBm
Maximum peak input power	+30dBm (2µs)
Dynamic range	60dB for 10MHz to 6GHz
Application range	Ref. calibration file
VIDEO OUTPUT	
Output voltage	0 to 2V
Video Bandwidth	50MHz
Rise/Fall time	<20ns
Transfer function	Logarithmic
EXTRA SPECIFICATIONS	
8 bit ADC	
15MHz sample rate	
Maximum recording file size	2GB
POWER REQUIREMENTS	
Through USB2.0 interface	
ENVIRONMENTAL SPECIFICATIONS	
Temperature Range - Operating / Non-operating	-20° to +50°C (-4 to 122°F)
MECHANICAL SPECIFICATIONS	
Dimensions WxHxD	135 x 80 x 30 mm (5.3” x 3.1” x 1.2”)
Weight	0.2 kg (0.44 lbs)

1.7.3 Digital RF Analyser: DRFA912

The DRFA912 was developed to:

- *analyse the phase flips of a Mode-S interrogation. The Mode-S uplink interrogation format starts with 2 pulses, P1 and P2, which suppress Mode A/C transponders. The Mode-S interrogation data is contained in the P6 pulse and is DPSK (Differential Phase Shift Keying) modulated. In order to analyze these DPSK modulated data the device samples the I and Q signals resulting from down conversion of the Mode-S interrogation signal at a high rate. The signal is analyzed in software to calculate the phase modulation with respect to Annex 10: rise time,phase accuracy etc.*
- *analyse the chirp and modulation characteristics of a PSR. Military pulse-compression radar systems can also be tested.*

The DRFA912 operates on the entire L- and S-band region, it receives the RF signal under test and outputs digital data on its USB output port. For this purpose, the radar does not have to be taken out of its operational mode. The DRFA912 allows the user to perform uplink recordings to evaluate the transmission antenna diagram, these recordings can be converted to RASS files for further analysis. The uplink recording function of the DRFA912 performs pulse detection and extracts timestamp, amplitude and pulse width of the recorded pulses.



DRFA Scope software

1.7.4 Product Specifications DRFA912

INTERFACES-EXTERNAL CONNECTORS	
Video 1/2	2x MCX – Video input
Rf CH1/CH2/Out	SMA female
RB1/2	2x DB15HD female – Timing Signals and Power
GPS	DB9 female - GPS interface
USB	USB2.0 B female (480Mbit/s high speed)
INTERFACES-EXTERNAL CONNECTORS	
Sample frequency	4 / 8 / 16 / 32 / 64MHz
ADC resolution	14bit
Triggering	External / Analog / Ext – pre-trigger / Ext – delay / An – pre-trigger / An – delay
Video 1/2	
	-2V to +2V, 1.1kΩ
	3dB BW=32MHz
Rf CH1/CH2 inputs	
Impedance	50Ω
Frequency range	650 to 4000MHz
Demodulating	10.7MHz
VSWR	1.15<2GHz / 1.3<4.5GHz
Input power	-13dBm
Absolute maximum	+20dBm
Rf output	
Impedance	50Ω
Frequency range	650 to 4000MHz
Max. output power	<-5dBm
RASS Bus: RB1/2	
Timing signals	TTL, 2kΩ
Power in/out	400mA, 15V
	Connects to power supply or other RASS device
General Specifications	
Power supply	Through RASS Bus (via other RASS device) or directly via RB Power Supply
Dimensions WxHxD (mm)	125 x 48 x 245mm (4.9” x 1.9” x 9.6”)
Weight	1.1kg (2.4lbs)
Operating temperature	0° to +40°C (32° to 104°F)

1.7.5 3 Channel IF to Logarithmic Module: IFL520

Many applications in RASS require a logarithmic video signal with high dynamic range. Some newer PSR radars use Digital IF Processing, or simply do not have an external log-video available. If for RASS measurements or for some other purpose a log video signal is required and an IF signal is available, the 3 channel IF to Logarithmic module can help to solve this problem. The IFL520 converts any IF outputs of a SSR or PSR radar into Log video. The frequency of the input signal can vary between 10 and 500MHz. The input level can vary between +13dBm and -85dBm. The output is calibrated for 30, 60, and 90MHz; the calibration table is supplied with the IFL520 module and has a logarithmic transfer function.

Applications for the IFL520 include:

- *Sensitivity measurement of IF receivers*
- *Solar VPD measurements*
- *Bandwidth measurements of IF receivers*
- *Downlink HPD measurements of radar with Digital receivers*
- *Monitoring of IF signals in receiver path of radar*

1.7.6 Mode-S Decoder: MSD840

The Mode-S Decoder (MSD840) decodes SSR 3A/C, Mode-S (All Call, Roll Call) and IFF modes (1,2,4) interrogations on Rf input and provides the trigger signals to a video recording device (RIM782).

1.7.7 Didactical Test Interrogator: DTI529

RASS Training tool

The Intersoft Electronics Didactical Test Interrogator has been conceived as a light-weight instrument developed to simulate the basic signals of a surveillance radar. Except for the power aspect, the DTI529 will thus mimic the behavior of your surveillance radar. In order to improve the degree of realism and with the user comfort in mind, the structure of the instrument also resembles the normal radar systems configuration: an RF interrogator section and a video receiver module with monopulse output.

Originally the DTI529 was developed to support the training of the IE RASS tools. It allows the radar engineers to practice its main functionalities without the need to have a radar available. In the context of the RASS toolbox the DTI529 is mainly used to compare the different analysis methods. It thus becomes a functional reference tool offering a way to improve the reliability of the conclusions drawn from the test analyses.

Applications for the DTI529 include:

- Generation of simulated HPD diagram
- Generation of ACP-ARP rotation
- Generation of modulated Downlink diagram on 3 channels
- Real 3 channel monopulse receiver for receiver calibration measurements
- STC simulation for receiver measurements
- Simulation of 4 separate data streams for data recording training

2.

Software Tools for radar monitoring

In addition to the RASS hardware portfolio there is a collection of solutions that are used worldwide as reference analysis and evaluation tools. Civil and Military Air Navigation Service Providers (ANSP), flight calibration companies, radar manufacturers and engineers commonly use the real-time data collection, replaying, monitoring, displaying and analysis functionality:

- *RTQC Real Time Quality Control: RASS can run real time on a radar site or in an ATC Centre (ATCC) 24 hours a day*
- *Remote monitoring: RASS offers remote monitoring functions in large configurations*
- *Recording endless loop: RASS can make continuous recordings of radar*

The RASS RTQC tools are designed to operate in versatile surveillance Air Traffic Management (ATM) environments like Air Traffic Control Centers (ATCC) and at the radar site, providing flexibility, scalability and transparency.

The solutions are manufacturer and surveillance systems independent. It supports the users in their daily tasks and provides a high efficiency rate to solve unexpected system behavior and performance issues in difficult circumstances.

System engineers, technicians, maintenance personnel and validation officers responsible for testing, validation, certification, performance check and fault finding get a complete toolset that is applicable on all their sensor surveillance systems.

The RASS solutions consists of three subsections, containing different tools:

The **Data Handling Module**, **DHM** can execute different data handling functions. The DHM can input, output, record data and is able to convert the data stream to a number of specified formats. This data can then be used by displaying, monitoring and analysis solutions. The DHM offers complete scalability and redundancy and can be setup from RCMDE (Radar Message Conversion & Distribution Equipment) to large ATC Center RMCDE configurations. Therefore, often referred to as the backbone of the RASS.

Once the data is processed by the DHM, it can be viewed in the display solution **Multi Radar Display 3**, MRD3. The customer can monitor digital data, video data and weather data in combination with an advanced map editor. Visualization of the airspace with navaids, airroutes, airspace regions etc. will help you in monitoring, quality control and fault finding.

Finally, one can analyse the data with the Surveillance Sensor Performance Assessment Toolset -SSPAT. The **Radar Comparator Mono/Dual** (RCM/D) solutions can be used to assess sensor performance according the proper EUROCONTROL and ICAO standards.

- EUROCONTROL Standard Document for Radar Sensor Performance Analysis SUR.ET1.ST03.1000-STD-01-01
- EUROCONTROL Standard Document for European Mode S Station Functional Specifcation SUR/MODES/EMS/ SPE-01
- EUROCONTROL Standard Document for Radar Surveillance in En-route airspace and Major Terminal Areas SUR.NET. ET1. ST01.1000-STD-01-01
- EUROCONTROL Standard Document for ATM Surveillance System Performance
- ICAO ANNEX 10 (Recommendations)
- ICAO Document 8071 "Manual on the Performance Testing of ATC Radar Systems”
- ICAO Document 9684 “Manual of the SSR Systems”

The RC uses opportunity traffic data for the calculation of probability of detection (Pd), processing delay, false plot rate and codes probabilities and accuracy measurements (range, range gain, azimuth and timestamp random errors). Results are graphically presented in tables and on the displays supplied with cross-referencing functions, which is handy for further investigation and detecting radar problems and errors.

As opposed to other existing analysis tools, the SSPAT tools features an unique method for trajectory reconstruction and thus provides the radar community with a very efficient and easy-to-use tool for radar performance analysis using mono or dual radar data.

The Radar Comparator Mono/Dual use screening files generated by the **Coverage Map Calculator**, CMC. The CMC uses detailed geographic data gathered on several NASA space shuttle flights to accurately calculate the radar’s theoretical coverage.

In case RASS shows a failure or degradation of the radar, the user may decide to switch to the powerful RASS toolbox allowing in-depth investigation by a radar expert wanting to “zoom in” on the problem. The RASS equipment and toolbox can quickly lead to a diagnosis of the problem allowing swift repair.

The installation of a RASS system will not only improve the safety of your ATC environment significantly through the rapid pinpointing of possible failures or degradation, but will also augment the efficiency of maintenance personnel by providing them with a powerful fault-finding tool.

The RASS solutions can be combined and setup according to specific configuration, but still be completely radar-manufacturer independent, it can cope with different types of radars at the same time! Both features make that the RASS can operate in 2 different setups: RASS on the radar site and RASS in the ATCC.

RASS in the ATCC

In contrary with a sensor site installation, often a lot of scalability and redundancy is required in ATCC’s. RASS can for example be used as an independent source of recording, monitoring and analysis, used by operators or maintenance personnel.

Obviously, the main functionality in ATCC’s is the processing of data: continuous redundant data recording, protocol conversion, data replay etc. Data can be input (recording) and output (replay) over Ethernet or Serial lines by means of Intersoft Electronics’ Radar Data Convertor and Recorder RDCR992. Servers running these DHM’s are often referred to as Radar Message Conversion and Distribution Equipment or RMCDE. Via remote workstations, one can logon to different Data Handling Managers using the DHM Configuration Manager.

Consequently, all sources that the DHM’s input, can then be displayed on the Multi Radar Display. Since this display is independent of any radar data protocol, it can simultaneously display different protocols in overlay mode, together with weather data, digitized video and radar status messages. Upon the correct layer selection, one can also display data from different stages in the ATCC radar data processor. The sensor data can be forwarded to the SSPAT for analysis or transponders that are providing non-valid information; general detection problems or aircrafts with too low Pd or detailed analysis of the recorded data.

Finally, one can replay multiple data files synchronously on different DHM’s. The Data Replay module updates the timestamp to UTC time in real time. In this way, one can inject all recorded data again in the ATCC radar data processor for simulation, testing and faultfinding.

Of course, RASS offers an unlimited scalability and redundancy being an ATCC setup: from different distributed processors to SNMP support of hard- and software.

RASS on the radar site

On site the RASS system is also used to process data, monitor and analysis. But mostly, the data source is limited to 1 radar. Site-based setups are used by radar site maintenance engineers.
With respect to its functionality, the DHM on site can be used for similar purposes: record and playback the incoming radar data, convert to another protocol, split or merge of data streams etc.

A Radar Interface Module RIM782 can for example be controlled by the DHM to input video and serial data from the radar. Obviously, the DHM will not be distributed over many more processors as in ATCC’s.

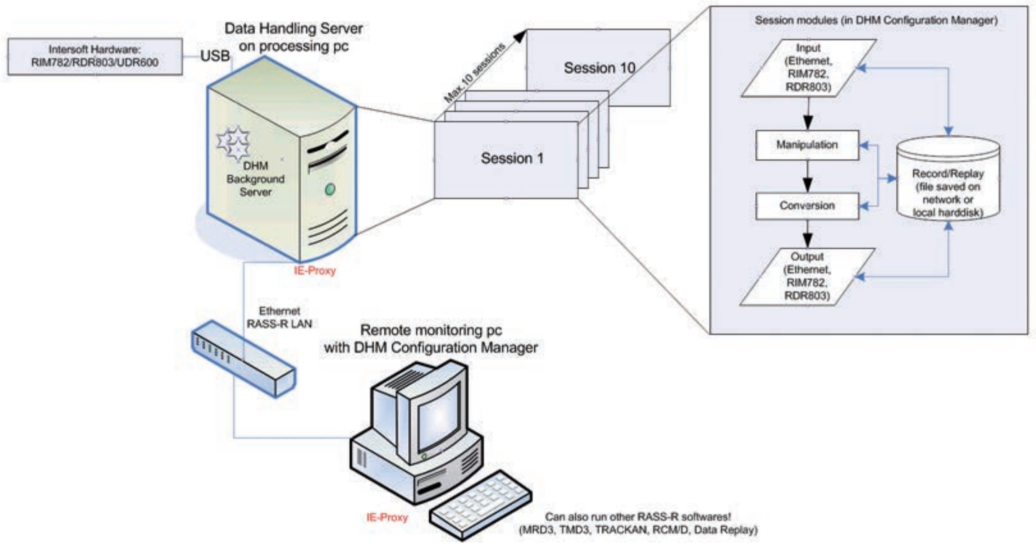
Though a RMCDE might be useful for example to convert a legacy radar data format to a newer protocol. (for example, an AIRCAT500 output to an ASTERIX data stream). But the RASS on site setup can be as easy as possible: on a portable computer, offering exactly the same functionalities as installed on server or desktop.
The sensor data can be forwarded to the SSPAT for analysis.

Every function of each RASS module is described more thoroughly in the next sections.

The RASS Data Handling Module (DHM) is a radar data input/output system.
On the one hand it can run as RMCDE, large scaled in an ATCC or smaller setup on the radar site. On the other hand, it can be the backbone for other RASS solutions by preprocessing data for displaying in the MRD3 and analysis in the SSPAT solutions. It can also be used in combination with the Data Replay tool to reinject timestamp corrected data.

The DHM consists of 2 main parts: the DHM Server and the DHM Configuration Manager HMI. Due to its unique design, both components offer complete scalability:

- *The DHM Background Server and DHM Configuration Manager can both run on the same systems or separately on two systems.*
- *Dependent on the required processor load, Hard Disk Configuration, network interface cards etc.; the DHM can run on a dedicated server, desktop or laptop.*
- *One or multiple DHM Servers can be combined in a network with one or multiple DHM Configuration Managers allowing remote connection and editing.*
- *SNMP-messages supporting Intersoft Electronics private MIB can be exchanged with any 3rd party SNMP-manager.*



A DHM setup consists of a DHM Background Server that runs multiple sessions in parallel and a DHM Configuration Manager running on a monitoring pc. The DHM Configuration Manager can login to the DHM Background Server to edit the DHM sessions

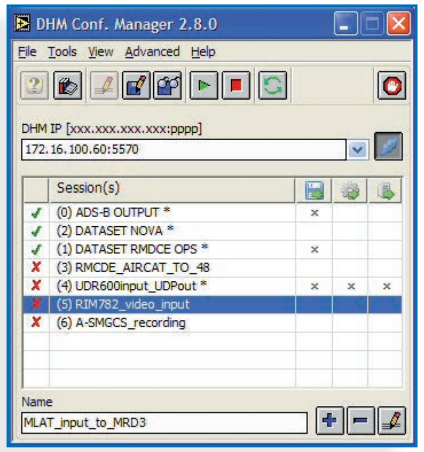
The DHM is compatible with the Eurocontrol ASTERIX and other legacy data protocols, its core functionality is:

- *Data recording and replay through various interfaces (for example Ethernet, serial port, FDDI)*
- *Manipulation of the data (changes in framing, for example a serial data input in U-HDLC and output in UDP)*
- *Real-time protocol conversion*
- *Real-time data correction (range, azimuth based on gyroscope eccentricity file, altitude, ...)*
- *Real-time filtering of data on all available data fields (for example filter on S-addresses, filter on presence of MB data)*
- *24 / 7 operability*
- *Real-time ADS-B video to plot extraction, output as ASTERIX Category 21 (Intersoft Electronics hardware required: UVR892 or RIM782 with optionally ARF800)*

The DHM HMI can connect to different DHM Servers using their IP addresses. A graphical design lets you configure the solution by dragging and dropping the consecutive processing steps inside the configuration manager. Different checks are made available to monitor the configuration.

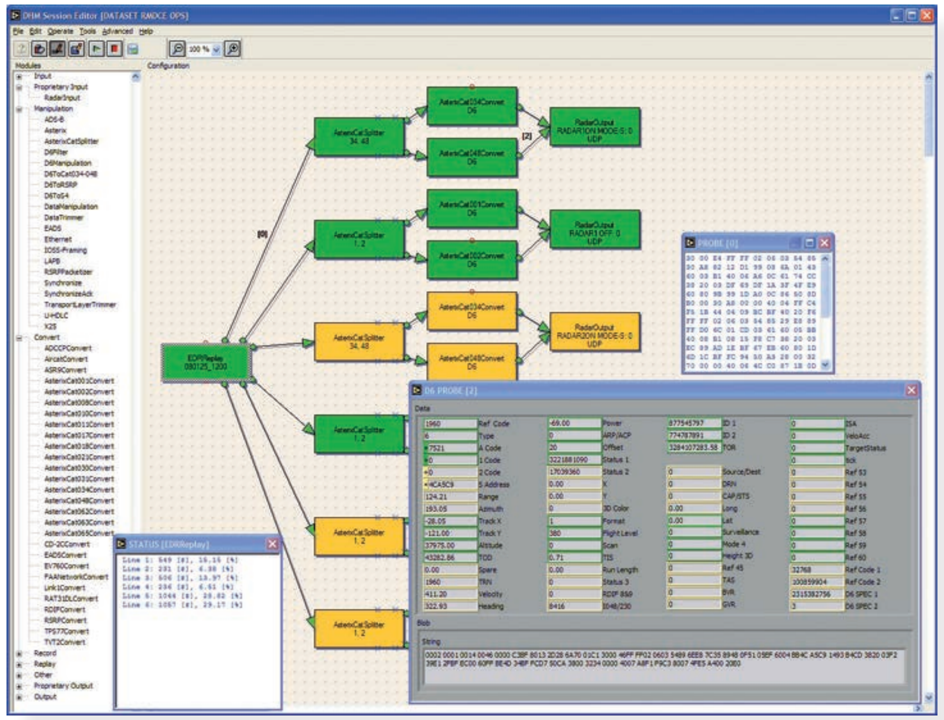
The user can for example process the data in different ways; merge different inputs to the same output; configure duplicate sessions for redundancy etc.

By its modular design, 3rd party protocols can easily be integrated and will become available as a new module in the DHM Session Editor.

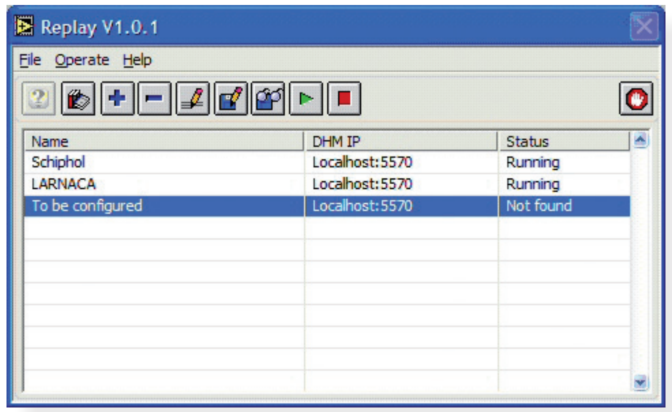


The DHM Configuration Manager is the user interface that controls, configures and monitors the DHM server configurations. The DHM configuration manager is a graphical layout design allowing the operator configure different modules (modules for input/convert/manipulation/record/replay/output) by simply clicking the modules and dragging arrows to connect them. Different types of probes make you inspect the different steps of radar data processing. The user can for example process the data in different ways; merge different inputs to the same output; configure duplicate sessions for redundancy etc.
By its modular design, 3rd party protocols can easily be integrated and will become available as a new module in the DHM Session Editor.

The DHM Configuration Manager displays the parallel running sessions on the DHM Server. All sessions perform other tasks (for example ADS-B OUTPUT or A-SMGCS recording)



The Session Editor displays the content of a session in a graphical way. Different probes allow inspecting the data paths.



The RASS Data Replay tool is used for re-injection of data with corrected timestamps, i.e. current UTC time. Suppose the following example: In the ATC-centre, sensor data is recorded by several RDCR992's. In order to re-inject it in the centre and let it pass through the multi radar tracker (MRT) the recorded data requires replacement of the original detection time with current UTC time stamp . This can be done by the Data Replay tool in combination with the DHM. The data to be replayed need to be processed first, after this step it can be replayed to any of the available DHM output sources for re-injection. (i.e. UDP output, serial output, output via UDR765 or RDCR992). One can then use the MRD3 to simultaneous view the original data versus the re-injected data using the UTC time as data label. The output of the MRT can then be recorded with DHM and analysed with SSPAT.

2.3 MULTI RADAR DISPLAY | MRD

The RASS Multi Radar Display 3 (MRD3) is a powerful multi radar display. Powerful because that it can display all types of radar data formats that are pre-processed by the DHM Server. Data can be displayed coming from one or multiple DHM Background Servers and originate from PSR/MSSR/Mode-S radars, ADS-B stations, MLT systems or multi radar trackers (for example ARTAS). Besides radar data, it is also able to display weather data, video data (by means of the RIM782 connected to a DHM) and status messages.

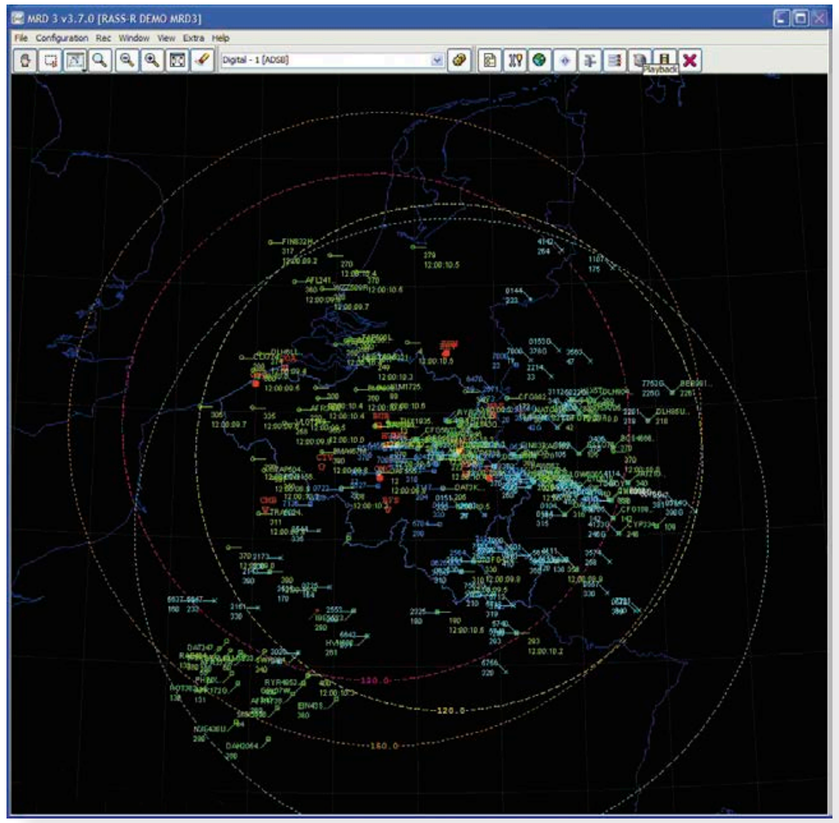
Since the system is radar manufacturer independent it can cope with different types of radar at the same time. This means that one system fits all, reducing the amount of equipment, training and experience needed. It is suitable to be installed in the radar shelter as well as in the ATCC.

Multi indicates that 6 sources of data can be displayed simultaneously, while even more sources can be configured!
One can choose to view each of the radars separately (individual PPI displays) or overlay multi radar mosaics, to view the data in real time or to record the data (in order to replay and analyse the recorded data afterwards).
The MRD3 system allows you to perform an on-the-spot real-time check-up of the radar's performance. It is equipped with a very user-friendly graphical HMI, reducing keyboard input to a strict minimum. It has the following main features:

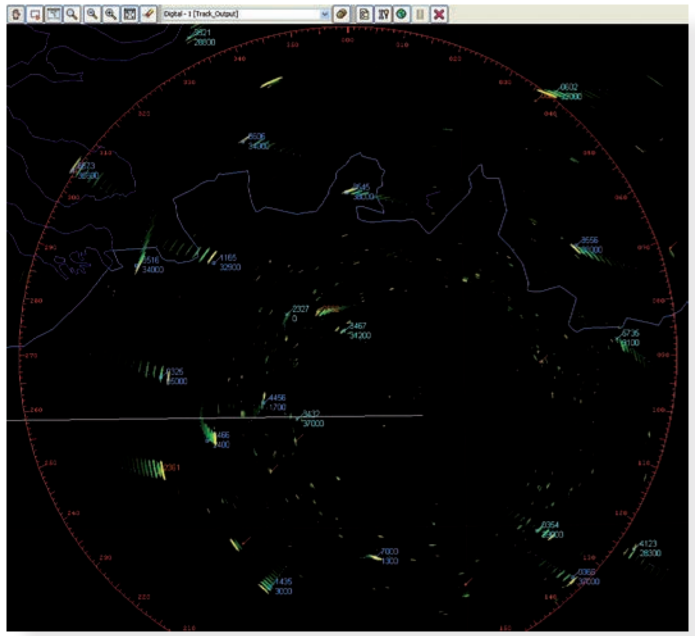
System Features:

- *Assign different labels to plots/tracks (for example call-sign, C-code and UTC time)*
- *Filter in altitude (FL) and filter on data content (for example on a particular S-address)*
- *Multiple Range Bearing Lines with Lon/Lat position*
- *On-line statistics of every data source (for example number of reports per scan)*
- *Advanced map editor supporting coastline maps, airports, runways, airways, navaids, waypoints, airspaces, cities, etc.*
- *Limited ATC controller features (call sign table with A-code to be filled in manually)*
- *Zoom, pan & centre functions*
- *QNH-correction*
- *Real time display of target message content (for example ASTERIX CAT048 in text format)*
- *Configurable target list with selection feedback*
- *Individual definable configurations for multiple users*
- *User friendly selection of radar data source*
- *Quick switching between radar data sources (6 out of N selection)*
- *Recording and playback of MRD3 data*
- *Floating dialogs with different transparency modes*
- *Full screen mode or normal window*

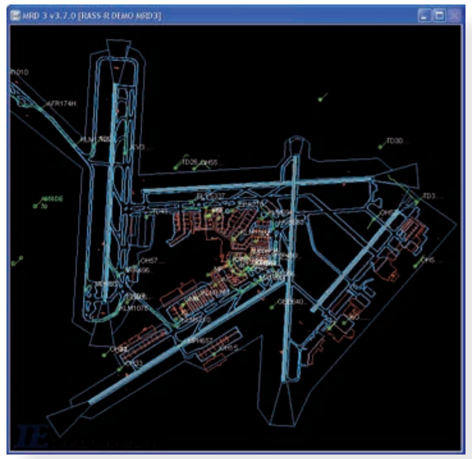
The MRD3 can be installed on a high-end desktop or portable pc with an advanced graphics card, to allow extreme high refresh rate of video and target position data.



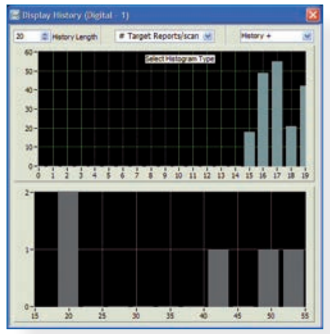
Multiple radar data sources can be displayed in overlay.



Video can be displayed in overlay with PSR/SSR targets. This example is after PSR video extraction with the Primary Radar Extractor PRE790 on a Thomson TA-10 ASR.



The advanced map editor makes it possible to display for example airports, allowing visualization of A-SMGCS or MLT data



Different types of statistic can be displayed in history or histogram view.

RADAR COMPARATOR MONO/DUAL

The Radar Comparator is an essential tool for radar performance analysis based on operational data from one or several sources (radars, ADS-B, MLAT, MRT, ...). It consists of 2 engines: the Radar Comparator Mono (RCM) for mono radar (source) analysis and the Radar Comparator Dual (RCD) for dual radar (source) analysis. To assess sensor performance according the proper EUROCONTROL and ICAO standards.

- EUROCONTROL Standard Document for Radar Sensor Performance Analysis SUR.ET1.ST03.1000-STD-01-01
- EUROCONTROL Standard Document for European Mode S Station Functional Specifcation SUR/MODES/EMS/ SPE-01
- EUROCONTROL Standard Document for Radar Surveillance in En-route airspace and Major Terminal Areas SUR.NET.ET1. ST01.1000-STD-01-01
- EUROCONTROL Standard Document for ATM Surveillance System Performance
- ICAO ANNEX 10 (Recommendations)
- ICAO Document 8071 "Manual on the Performance Testing of ATC Radar Systems"
- ICAO Document 9684 "Manual of the SSR Systems"

The RCM uses a single source opportunity traffic data for the calculation of probability of detection (Pd), processing delay, false plot rate and codes probabilities and accuracy measurements (range, azimuth and timestamp random errors). The RCD uses two sources of data for the calculation of the systematic (range, range gain, azimuth and time biases) and random (range and azimuth, X and Y, or Longitudinal and Transversal standard deviation) errors.

Results are graphically presented in tables and on the displays supplied with cross-referencing functions, which is handy for further investigation and detecting radar problems and errors. The processed data is exported for post-processing and trend finding using the RASS Inventory Tool. This combination has been proven to be a powerful method of analysis and troubleshooting during numerous radar testing campaigns.

The barometric height correction is applied using the atmospheric soundings data automatically retrieved by the Radar Comparator over the internet. It uses the high resolution screening angle files produced with the accurate digital terrain data (Coverage Map Calculator), and/or SMGET screening files. Since the screening angle profiles are calculated using the true MSL height, the height data (C-code) should be corrected using the atmospheric soundings data. This correction is very important both for mono-radar and dual-radar analysis, producing better accuracy on actual positions of AC and so the actual coverage of the traffic. The data can also be corrected for RF wave refraction, and radar ACP encoder eccentricity.

Dual radar analysis as opposed to the multi-radar analysis provides a number of benefits. Even if all known systematic errors (eccentricity, barometric, refraction etc.) are properly handled, in practice other unknown errors typically appear, as for example wrong sensor positional information, highly non-uniform barometric error distribution, etc. In such cases when the data are combined originated from a number of radars, such errors may significantly affect the results, consequently it is typically impossible to determine which radar is the true source of the error. Analyzing data with the RCD, one pair of radars after another, produces differentiated results; differences in the results point out to the specific problems. Thus the measurement environment becomes more controllable and the tool produces more consistent results. The general statistics on the results provides an estimate for the accuracy of the measurement.

The RCD uses two sources of the data at a time. It is proven that with two remote radars having a representative amount of common coverage opportunity traffic data an absolute measurement of the systematic and random errors of both sources is possible. Because of limited amount of the data (limited to two sources) the post-processing analysis of the data also becomes feasible for the user. As a result of such dual measurement the true trajectories are produced with the accuracy exceeding the positional accuracy of either of the sources. Using the RCD, radar vs. radar can be compared or radar vs. ADS-B. Using an ASD-B recording for the analysis is extremely beneficial, because of the high value of a part of ADS-B data. The true MSL height data, high update rate, uniform positional accuracy represent the unmatched advantage of ADS-B. The tool has been recently modified for radar vs. ADS-B analysis. ADS-B data being subject to the specific effects as the latency must be processed correctly to take into account and correct for these parameters. The standard transponder delay deviations ±0.25μs and ±0.5μs can also be measured and handled to result in unprecedented accuracy and consistency compared with radar to radar measurements.

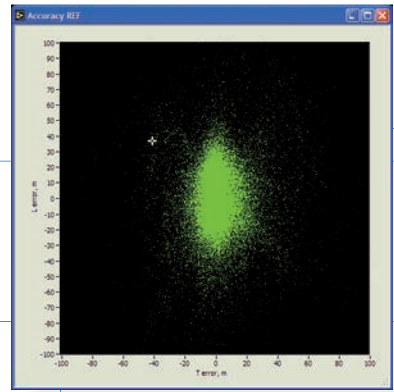
A number of new applications generated by comparing radar vs. ADS-B have been demonstrated, such as continuous 24-hour monitoring of radar alignment, precision measurement of the azimuth error due to the distortions caused by radomes and lightening rods, and of the azimuth bias increase for Mode-S radars due to the antenna beam widening, the dramatic potential of improvement of the elevation measurement accuracy by 3D radar. The side product of the radar vs. ADS-B evaluation is an efficient method of the ADS-B evaluation and monitoring.

Taking all above advanced features of the software into account, the Radar Comparator is the most efficient radar analysis software on the market and represents an easy-to-use tool for radar performance analysis using the traffic of opportunity.

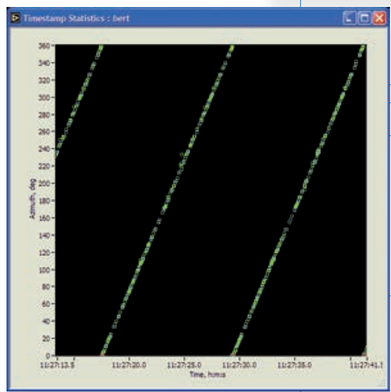
Processing methods and data types

- *Corrects input data for all known systematic errors: ACP-encoder eccentricity, barometric height error (automatically retrieving the data over the internet), range error due to the atmospheric refraction*
- *Sets the plot coverage bits according to the screening angles data calculated with the accurate high resolution digital terrain data (CMC) and the actual atmospheric conditions*
- *Stores the results in the database*
- *Exports data files for documenting and use with external analysis tools (for example RASS Inventory tool)*
- *The Radar Comparator uses RASS S4 files recorded by DHM*

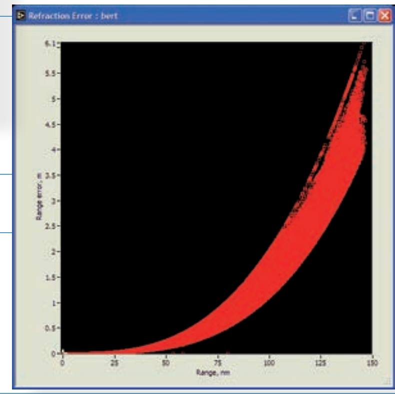
Practical Examples



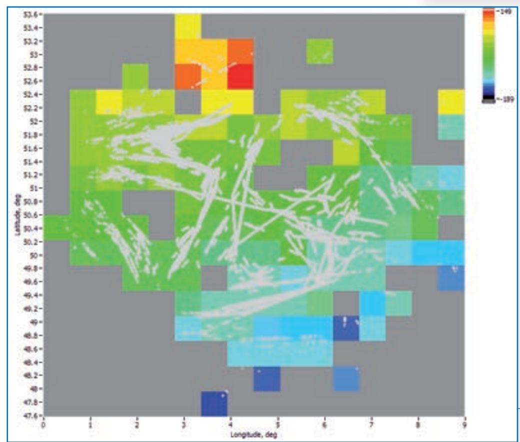
ADS-B random error (along vs. across trajectory)

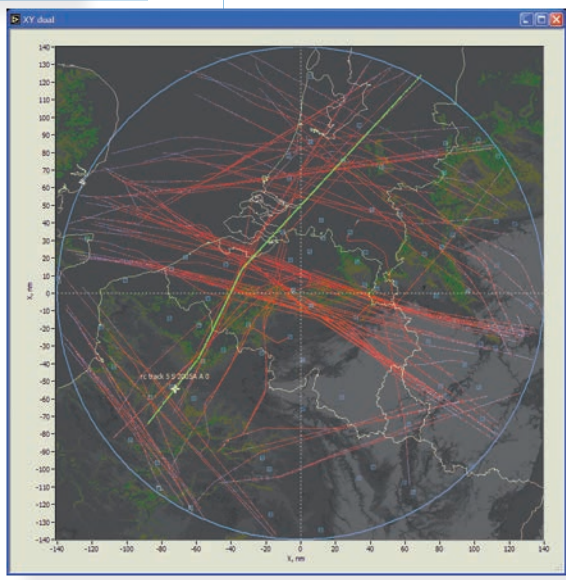


Timestamp error

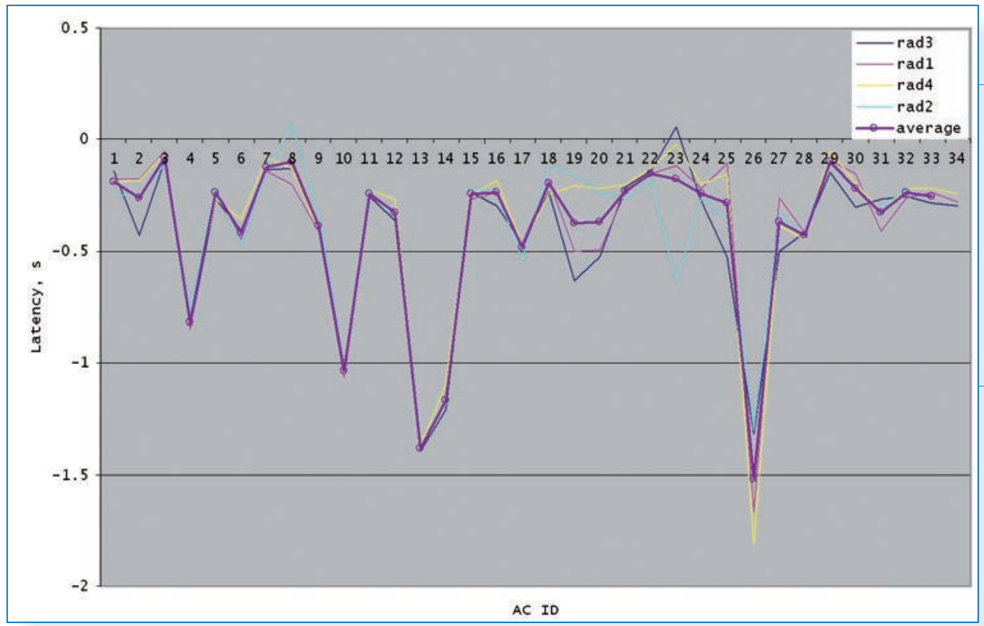


Example of small refraction error

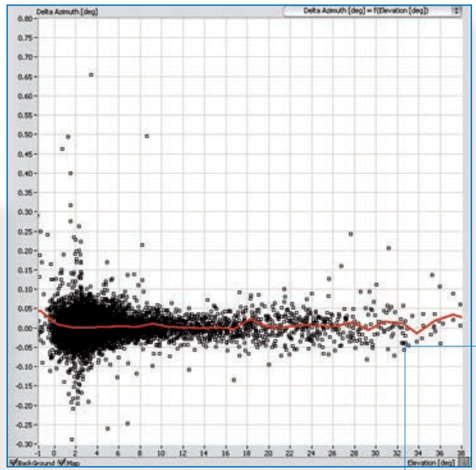




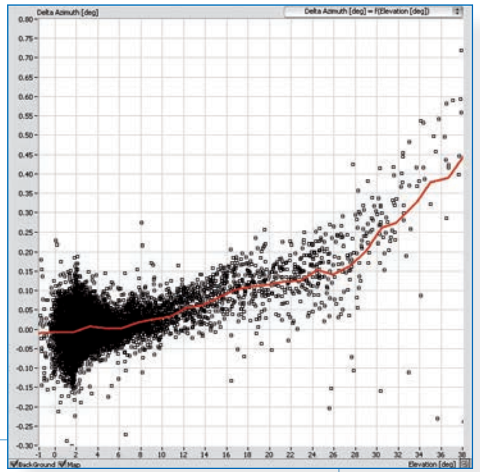
XY display showing results of radar vs. ADS-B analysis



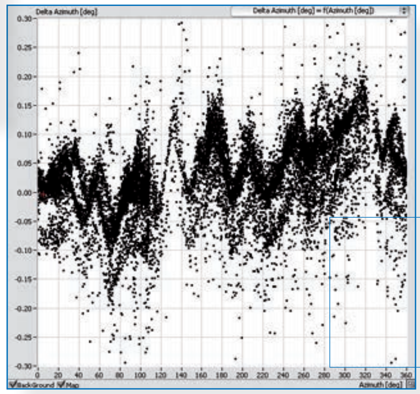
ADS-B latency measurement for four radars (Mode-S rad1, rad2 and MSSR rad3, rad4) compared in 4 separate measurement campaigns to the same ADS-B data set. The results represent the required corrections and not the errors.



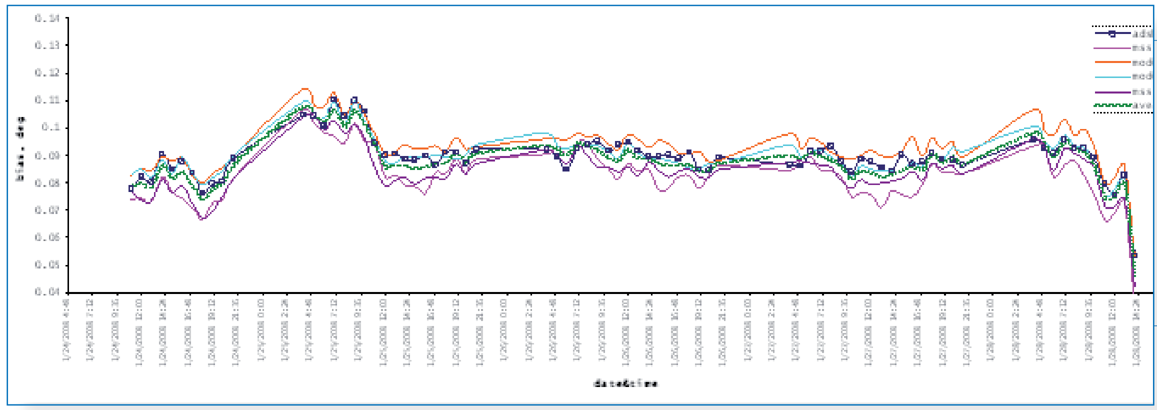
Azimuth error vs. elevation for MSSR radar measured using ADS-B data



Azimuth error vs. elevation for Mode-S radar (azimuth bias increases with elevation due to the beam widening) measured using ADS-B data



Azimuth errors caused by radome measured using ADS-B data



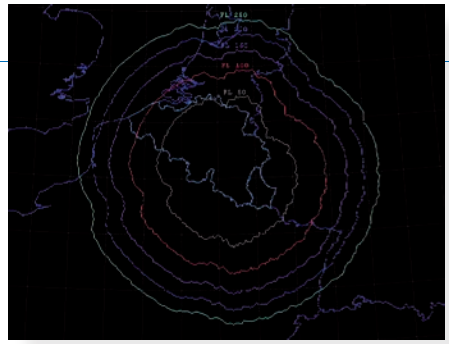
5-day continuous measurement of the azimuth bias of Mode-S radar vs. 2 MSSR, 2 Mode-S and ADS-B (measured each time separately using RCD)

2.5 COVERAGE MAP CALCULATOR | CMC

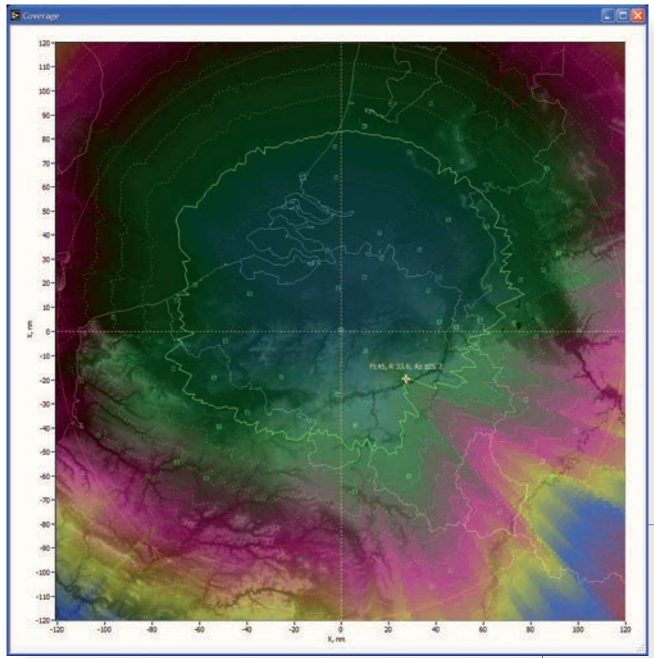
The RASS Coverage Map Calculator (CMC) uses accurate digital geographic data (SRTM-files) gathered on several NASA space shuttle missions to calculate radar theoretical and real coverage. Especially for mountainous regions this coverage volume prediction is essential. The tool produces high resolution coverage maps, and can set coverage bits in radar data structures. Other RASS tools as the RCM/D can then use these coverage bits for more accurate calculation of the radar performance.

Most radars produce target replies further than the line of sight due to the RF wave refraction in the atmosphere. The 4/3 of the Earth radius model is typically used to account for these atmospheric refraction effects. Target replies detected outside the coverage volume typically have larger position scattering and must be excluded from the radar accuracy (random errors) computation. The probability of detection also should be estimated taking into account the real coverage volume, and skipping the plots declared outside of coverage. The coverage volume is typically represented by the screening angles data, i.e. the minimum elevation angle vs. the range (or the central angle in the Geocentric Earth coordinate system) given for each azimuth between 0 and 360 degrees. CMC can generate high resolution screening angles data based on 1 to 3 arc seconds resolution digital terrain data available between 60th parallels of northern and southern latitude.

Display of the screening file in the MRD3 as equipotential FL Lines.



The CMC tool also produces relief files which can be displayed in the MRD3and RCM/D.



Display of relief and screening in RCM.

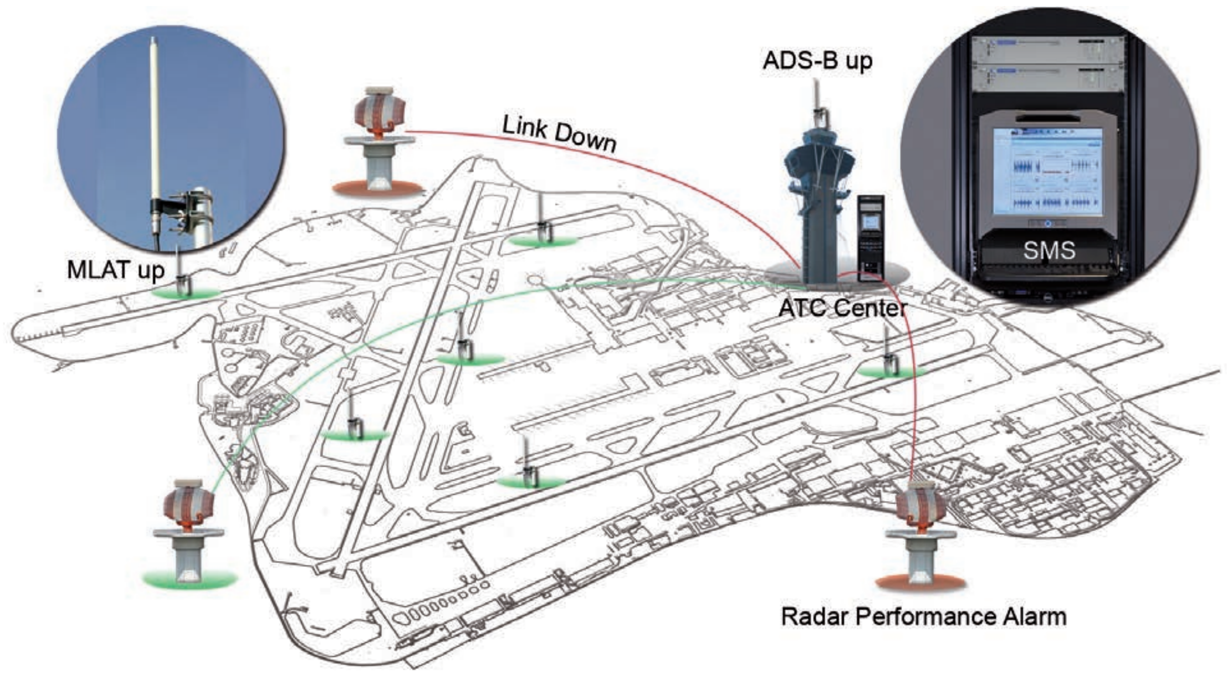
2.6 SURVEILLANCE MONITORING SYSTEM | SMS

Safety Assurance Through Continuous Sensor Monitoring | SMS

Intersoft Electronics' Surveillance Monitoring System (SMS), is a scalable surveillance monitoring system providing real-time analysis on one or multiple surveillance sensors. It has the capability to monitor PSR/SSR/Mode-S radars, ADS-B stations, MLAT systems, A-SMGCS data, ASDE-X data or system track data (for example ARTAS multi radar tracker).

In today's world, data from various sensors is fused in complex ATM systems often masking under-performing sensors. At ATM level, there is an increasing demand for early notification of sensor degradation in order to assure a Quality of Service (QoS) on the track output to the Controller Work Positions.

Civil and Military ANSPs often share sensor data in or between countries, based on contractual Service Level Agreements (SLA). Therefore, it is essential to know the quality of sensor data meets the contractual requirements.
The SMS monitors and reports the quality of this sensor data by standardizing measurement and analysis across multiple ATM platforms.



SMS FEATURES

- Early notification of sensor degradation
- Automated charts and alarm thresholds
- Advanced detailed analysis with RASS
- Audible and visual alarms
- Report scheduling
- Export capabilities

Surveillance Performance Model

Implementation of Intersoft's Surveillance Performance Model can provide added value to a customer through the integrated delivery, training and support of the SMS.

Fully operational systems are deployed in some of the busiest ATM systems in the world (e.g. Singapore, Australia, Indonesia, European ATM's) supporting ANSPs by providing this real-time sensor monitoring.

QUALITY OF SERVICE STANDARDS
Based on
EUROCONTROL, ICAO, Client Requirements

EVALUATE PERFORMANCE
Against
Quality of Service Standard with RASS

STANDARD OPERATING CONDITIONS
Capture the Baseline
against known performance

MONITOR PERFORMANCE
Real Time Monitoring with SMS

Assuring continuous monitoring of sensor quality

In real-time, the performance of each sensor is monitored. If it drops below predetermined threshold values, it generates visible and audible alarms and additionally email or text message alerts.

The solution is equipped with an in-depth capability to perform offline analysis and reporting on any of the recorded sensor data. Monitoring and Technical Displays provide a clear and concise visual depiction of all the available sensors and the key sensor statistics.

It greatly improves safety through the early provision of a warning of sensor degradation. Any potential coverage issues are readily identified by monitoring performance trends ensuring maintenance of the maximum Probability of Detection (Pd) for the delivered sensor, which in turn, reduces the likelihood of a Violation of Controlled Airspace (VCA). Intersoft Electronics' SMS is the most cost effective solution to ensure that all sensors remain operationally compliant against the ICAO and EUROCONTROL mandated standards.

SMS SYSTEM

Single Server Core

Firewall

All sensor data to the SMS passes a firewall which secures the connection between the SMS and the ATM environment .

Data Processing

The data Processing will record and process all the individual sensor data.

Processing features:

- Online Data Handling Module with a variety of integrated data handling tools and protocol conversion capabilities
- Data archiving of raw sensor data for more than 90 days with the ability to backup to external archive media
- Radar Comparator for REF/SUT sensor evaluation
- Statistics generation

RDCR992

Data Interfacing

All statistical results are saved in a database with various export capabilities.

features:

- Archiving of all statistical results for long term trend analysis
- Audible en visible alarms to web page interface and/or email alerts
- Automatic report generation
- Complete SMS monitoring with built-in SNMP-manager
- Built-in database backup&restore tools through web page interface
- Connection of all operator consoles for detailed online and offline analysis
- Exchange of SNMP messages to an External Fault Management System (EFMS)

SMS Architecture

SMS servers use a Linux operating environment. The monitoring station and technical display are Windows based desktops.

Your protocol is not in the list?

Customized implementation of a new protocol is fairly easy since only a single convert module needs to be implemented!

SMS FORMATS

- ASTERIX CAT001
- ASTERIX CAT002
- ASTERIX CAT008
- ASTERIX CAT010
- ASTERIX CAT011
- ASTERIX CAT017
- ASTERIX CAT018
- ASTERIX CAT019
- ASTERIX CAT020
- ASTERIX CAT021
- ASTERIX CAT030
- ASTERIX CAT031
- ASTERIX CAT034
- ASTERIX CAT048
- ASTERIX CAT062
- ASTERIX CAT063
- ASTERIX CAT065
- CD1/2
- ASR9
- ADCCP
- AIRCAT500/PR800
- EV720/760
- TVT2
- EADS
- RSR
- TPS77
- RAT31
- ALENIA
- LINK 1

Monitoring Station

The Sensor Alert Monitoring Panel (SEAMP) is the main user interface of the SMS and is used for online analysis.

Capabilities:

- Web based SEAMP can be accessed by multiple operator consoles
- Dashboard with different charts, completely user configurable
- Sensor input, recording and analysis configuration
- Filtering options on data items and Coverage Assessment Volume (CAV)
- Alarm thresholds configuration set against aviation industry standards (ICAO/EUROCONTROL/ANSP)
- Report configuration and scheduling, various export formats (pdf/docx/csv/odt/ods)
- Built-in user accounts and logging reports of user activity
- Network monitoring with system health and latest status messages
- Statistics and alarms on data communication problems and data outages
- System control panel for system backups of data and configuration, database administration
- Editable help messages, built-in user manual
- Customer logo is visually displayed in SEAMP banner and reports

Performance Analysis Module

The Radar Comparator is the tool for mono and dual sensor performance analysis.
It uses a single source of opportunity traffic or two sources for the calculation of Biases and Accuracies (REF/SUT).
Implementation of filtering, coverage volume masks (for example airport building) and digital terrain elevation files/screening is possible.

A list of available statistics (but not limited to):

DATA COUNTERS

on all available fields in the raw sensor data, example:
Number of total messages, plots/tracks
Number of PSR/SSR/Mode-S only or combined targets
Number of North messages - sector messages
Number of special codes like 7500/7600/7700
Number of simulated targets RFM
Number of targets between flight levels
Number of CRC errors
Delay calculation

MONO SENSOR ANALYSIS STATISTICS

Number of chains after plot-to-track assocation
Code probabilities
- *Valid A/C-code*
- *Valid and Correct A/C-code*
- *Valid and Incorrect A/C-code*
- *Overall false A/C-codes ratio*
- *PSR/SSR probability of association*

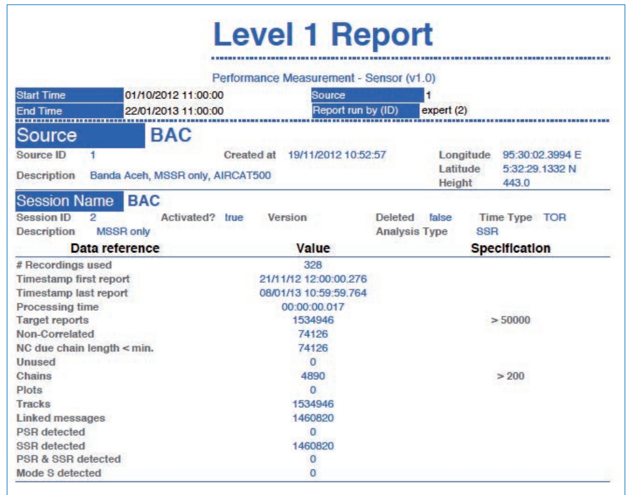
Probability of detection for PSR, SSR, Mode-S, ADS-B
Missed plots for PSR/SSR/Mode-S
False plot analysis for PSR
Multiple plot analysis – false SSR target reports
- *Multiple SSR target reports, categorized as multipath and reflections*
- *Sidelobe, backlobe and ringaround detections, split plots or non-classified plots*

Average gap size for SSR targets
PSR/SSR ratio of jumps
Positional accuracies in Range/Azimuth and X/Y
Resolution statistics
- *number of detections and misses of targets in resolution zones*
- *Pd's of targets in resolution zones*

DUAL SENSOR ANALYSIS STATISTICS

Range and azimuth accuracy
Range and azimuth bias
Range error at maximum range
Range and azimuth error RMS
Range gain
Relative time bias
Random ADS-B error (RMS) and accuracy across and along the track

SEAMP chart



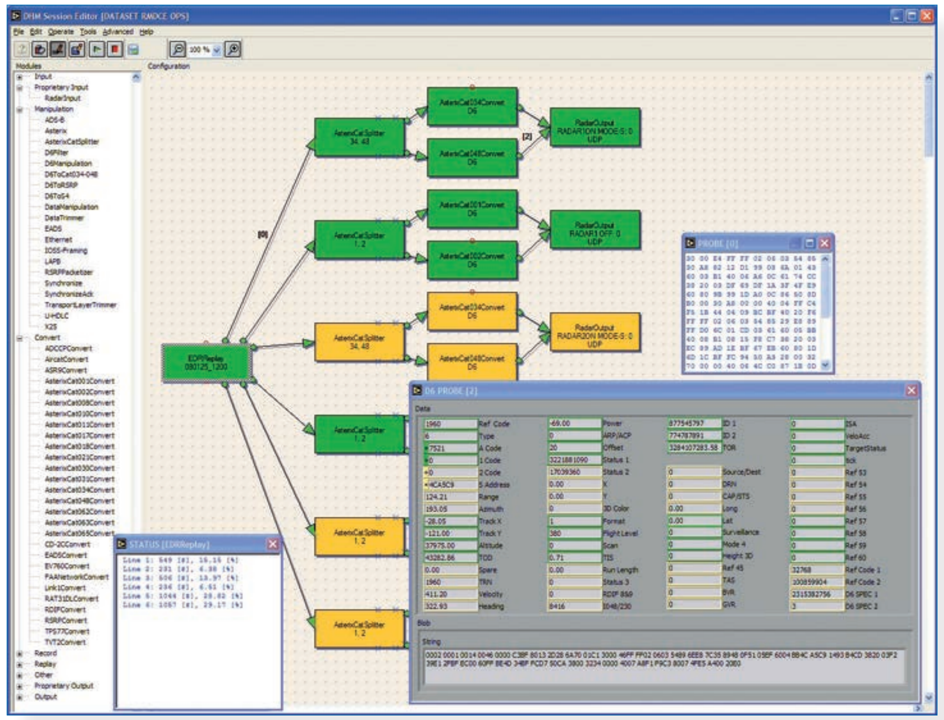
A Level 1 report gives a summary of mono and dual sensor analysis results for each sensor. Sent every 24 hours by email, it is a manager's instrument to follow up sensor performance and maintenance.

Technical Display

A Technical Display contains the following RASS modules

DHM Configuration Manager

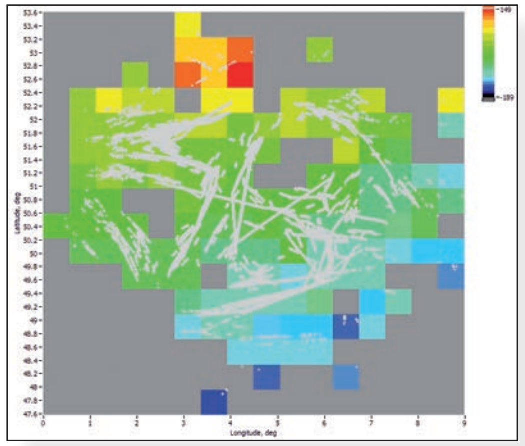
- Is used to input raw sensor data and can use all DHM modules to convert/manipulate/record/replay and display
- Replay of SMS recorded data and export to third party formats and applications (e.g. SASS-C)



DHM Configuration Manager

Multi Radar Display (MRD3)

- Multi sensor display to check input of all sensors to SMS
- Replay data to isolate problems reported by air traffic control for further investigation
- Legible history windows on data counters such as number of targets, number of sector messages, delay, etc.

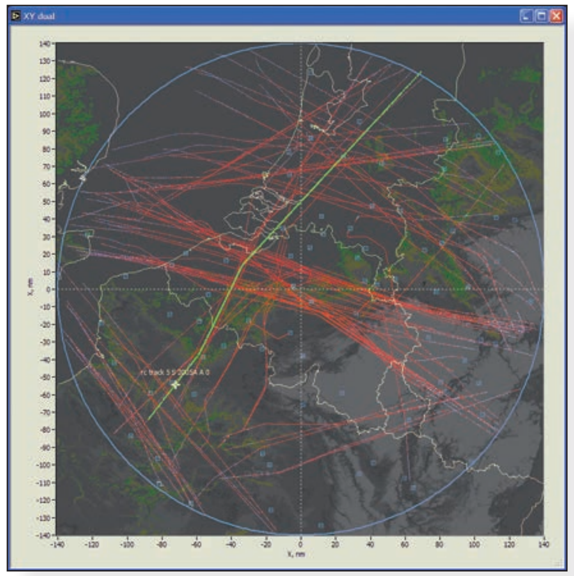


Radar Comparator

Multiple SSR plots?
Measure antenna pattern with DRFA912

Radar Comparator Mono/Dual

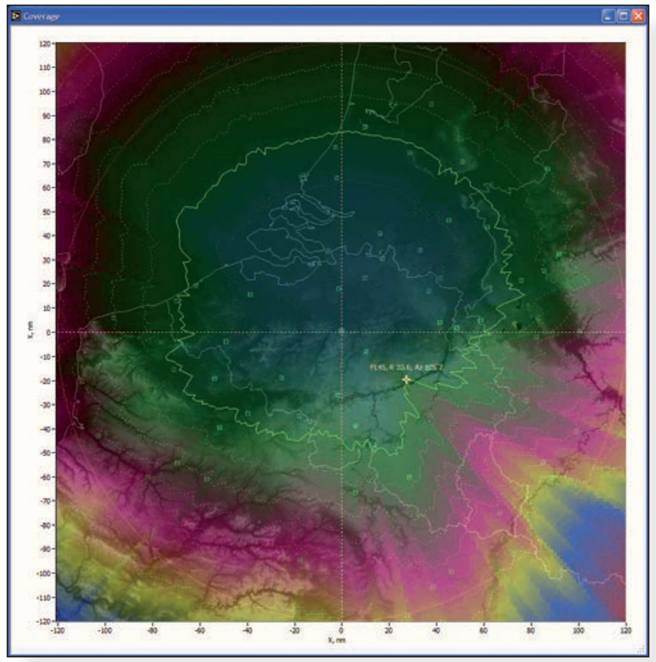
- To define parameters during set-to-work and upload them to SMS
- For various displays (X/Y, tabular display, coverage display, accuracy)
- To provide tabular data (track statistics, ADS-B statistics, false plot statistics...)



Radar Comparator

Coverage Map Calculator Module

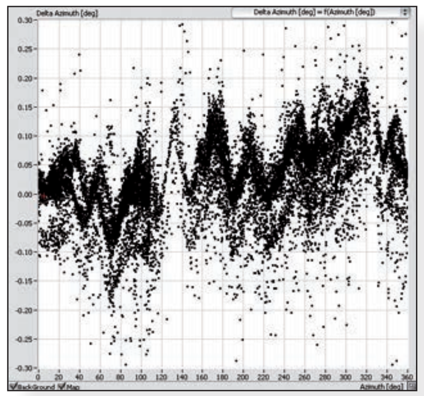
- Generation of sensor screening files (DTED) which can be used in the Radar Comparator Mono/Dual and MRD3
- Method to upload screening files to SMS



Coverage Map Calculator

Inventory tool

- display, SMS made recordings on any versus any scale with advanced histogram windows and 3D view
- overlay of multiple layers
- filter possibilities for example on flight check aircraft ID



Inventory Tool

Eccentricity problems?
Measure with gyroscope RGI596

Protocol viewer

- Textual view of raw sensor data

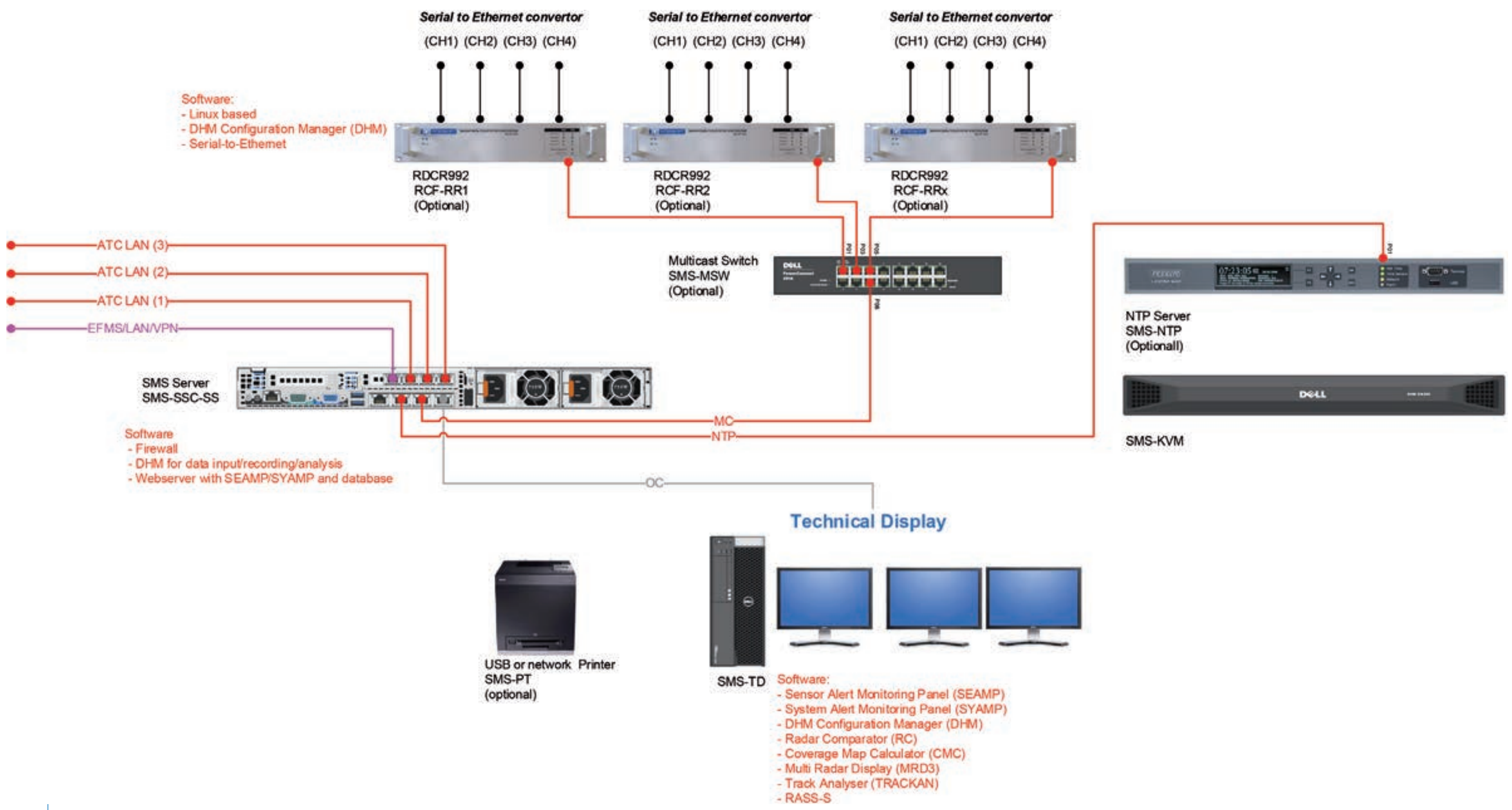
SMS HARDWARE

An SMS is delivered in a 19inch rack with the following systems from top-to-bottom:

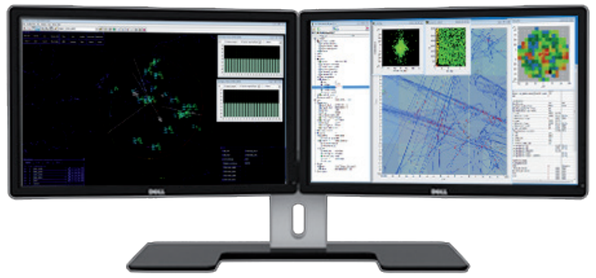
- Optionally a time server for correct UTC time-stamping of all units and sensor data
- Optionally a number of RDCR992's for serial-to-Ethernet convert
- KVM display and switch
- SMS server

together with the following operator consoles:

- Monitoring Station running a SEAMP web page
- Technical Maintenance Display running a full set of RASS software modules
- DHM, MRD3, RCM/D, CMC, Inventory Tool and Protocol Viewer
- Optionally a printer



Technical Display



Monitoring Station

The SMS is installed in a 19inch rack

3.

Simulators for system performance testing

The RTG (Radar Target Generator) synthetically generates primary radar returns based on user requirements, providing a high-fidelity simulation of real targets to enable the development and performance of precise test scenarios.

An RTG can be placed in the field (Remote Test Target) or connected to a radar for on-site target injection. In operation, the RTG detects and preserves a radar's transmit pulse, applies a highly precise fixed delay, and returns the pulse with the appropriate power, pulse-width, frequency, and Doppler shift.

For optimal operation, an accurate test system should allow constant and extensive monitoring. For this the RTG is equipped with several monitoring timestamping and recording functions.

The following versions are available:

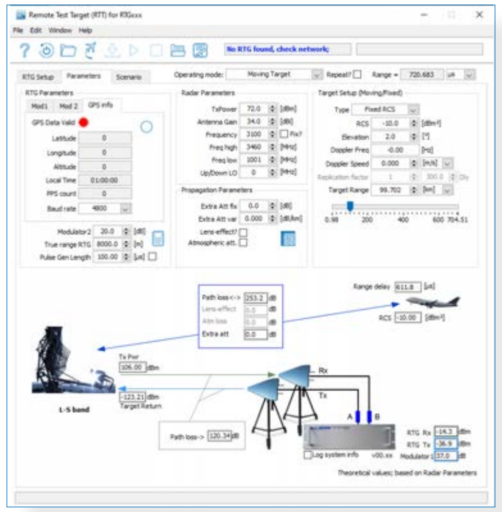
	Frequency band	Frequency range
RTG1002	L/S band	1001MHz to 3450MHz
RTG1062	C band	4200MHz to 6400MHz
RTG1063	X band	8.7GHz to 10.5GHz
RTG1085	UHF band	400MHz to 460MHz

The listed RTG versions all have the same look-and-feel and are used in a similar way.

RTG1002 Front panel

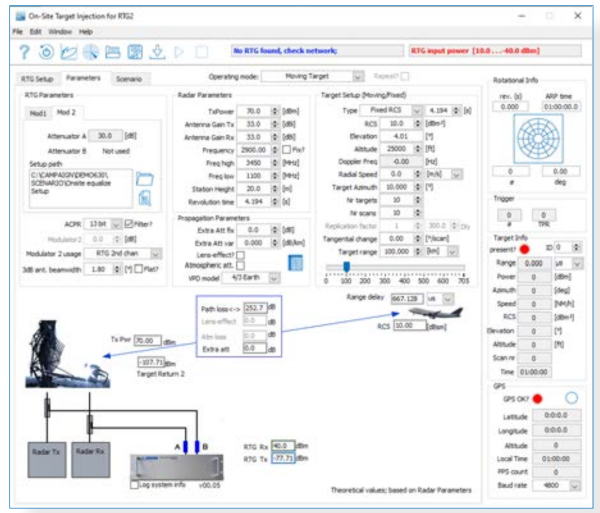
RTG1002 Rear panel

For Remote Test Target (RTT) usage the RTG is deployed in the field, typically connected to two log periodic antennas. The radar antenna system is tested in this way as well. The simulated target can be fixed or moving radially. The fixed target can appear as point clutter (no Doppler) or can have a simulated Doppler frequency.



Remote Test Target (RTT)

For on-site target injection the RTG is directly connected to the radar (an input for antenna synchronization (ACP/ARP) is available on the RTG). In this way, multiple targets can be generated in various directions on top of the existing radar environment and the current clutter situation. Targets can be programmed freely with any speed or RCS provided there is only one target generated per beam dwell. Targets can be replicated at different range cells and different azimuth sectors determined by a scenario generator. A 2nd RTG can be used to test the resolution of the radar (resolving a two-target overlap). The vertical antenna diagram can be loaded from a file for simulation. If the radar has two antennas on reception, like most of the ATC radars, these two beams can be simulated simultaneously.



On-site Target Injection

Product Highlights

- A correct Doppler is guaranteed on all frequencies, even in agile mode. This is advantageous on radar systems that resolve the Doppler ambiguity on different frequencies.
- The computer with associated application software is built in the 19-inch enclosure of the RTG. Interfacing is done with a network cable. The built-in computer has two network connectors and can easily be controlled over a remote desktop connection.
- Serial inputs enable UTC timestamping (NMEA protocol) from either a time server or from a GPS.
- The RTG can measure the frequency of the received pulses, which provides more accurate output power more because the output power is equalized vs frequency.
- An available correction table enables the user to enter the cable losses of the setup versus frequency.
- Output power can be modulated according to the received input power (adaptive beam modulation), even when the radar operates with frequency agility.

Software

The software HMI allows the input of all necessary parameters of the setup, such as the radar expected power, the type of target (Radar Cross section, fixed or swirling case), the attenuation values entered in the setup, etc. Some parameters, such as antenna gain or power of the transmitter, are used to calculate the probable target return in all cases.

The HMI allows the user to load a “scenario” containing several sequential target trajectories. These trajectories all consist of multiple parameters, such as RCS, position description, speed, and acceleration in time, which are evaluated to provide range and elevation information, as well as additional parameters, such as the “swirling factor”.

With a second tool the user can create such trajectories from scratch or calculate them based on missile characteristics. An RTG can generate a number of sequential trajectories, but will never generate more than one target at a time.

Specifications

☐ General Specifications for the 4 RTG versions

INTERFACES	
RTG Interfaces	
ETHERNET	Ethernet connection to control the RTG1002 hardware.
GPS	DB9 connector, NMEA protocol, Meinberg compatible • UTC Time stamp ARP during on site target injection • UTC Time stamp target range (±100ms interval)
SERIAL	Engineering interface for development only
RASS (2)	RASS-bus: interface for encoder signals, trigger out and Gate output
Embedded PC Interfaces	
Network (2)	Local embedded PC network connection
DVI	Digital Video Interface, display output
USB2.0 (2)	USB connection for keyboard and mouse
POWER REQUIREMENTS	
Power supply	85-264VAC/47-63Hz or 120-370VDC Fused with 1.6A
MECHANICAL SPECIFICATIONS	
Dimensions WxHxD	435x128x363(mm), 19” enclosure
Weight incl packaging and accessories	30kg ; RTG packed in black pelicase, incl. accessories, display, keyboard and mouse

☐ Specifications RTG1002

RTG1002 CONNECTORS	
Rf Input Rx	+10dBm to -35dBm 1001MHz to 3450MHz Accuracy <1dB
Rf Input Monitor	Output for monitor purposes = Rx input - 8dB
Digital Delay Out	Delayed signal, unequalized
Modulator 2 In	Maximum input level +10dBm, +30dBm no damage
Modulator 2 Out	Equalized output vs freq. maximum output level 0dBm
Rf Output Tx	Equalized output vs freq. maximum output level 0dBm
Generator Out	Output of white noise generator, -10 dBm maximum integrated output power
TARGET SPECIFICATIONS	
Range	Min. 36m, max. 701km (435 miles)
Range resolution	21.4mm (0.84 in), sampling at 7GHz
Range accuracy	Bias 0.1m linearity 0.5ppm
Output power	Min -100dBm, max 0dBm
Max speed	8190m/s (18320 mph)
Doppler and speed resolution	0.25m/s (0.55 mph)
Dynamic range out	100dB
Output Amplitude resolution	0.5dB
Output Amplitude accuracy	1dB for power between 0 dBm and -80dBm
Amplitude Ripple	Measured with 1MHz RBW 95 percentile < 0.20 dB average 0.1 dB

Specifications RTGC1062

RTGC1062 CONNECTORS	
Rf Input Rx	+5dBm to -35dBm 4200MHz to 6400MHz Accuracy <1dB
Rf Input Monitor	Output for monitor purposes = Rx input - (3→6)dB
Digital Delay Out	Delayed signal, unequalized
Modulator 2 In	Maximum input level +10dBm, +30dBm no damage
Modulator 2 Out	Equalized output vs freq. maximum output level 0dBm
Rf Output Tx	Equalized output vs freq. maximum output level 0dBm
Generator Out	Output of white noise generator, -10 dBm maximum integrated output power
Modulator 2 used as Attenuator	Min < -80dB, Max Power out 0dBm (±1,85dB accuracy)

TARGET SPECIFICATIONS	
Range	Min. 36m, max. 701km (435 miles)
Range resolution	21.4mm (0.84 in), sampling at 7GHz
Range accuracy	Bias 0,1m linearity 0,5ppm
Output power	Min -90dBm, max 0dBm
Max speed	8190m/s (18320 mph)
Doppler and speed resolution	0.25m/s (0.55 mph)
Dynamic range out	Min 90dB
Amplitude resolution	0.5dB
Output Amplitude accuracy	1dB for power between 0 dBm and -80dBm
Amplitude ripple	Measured with 1MHz RBW 95 percentile < 0.30 dB average 0.10 dB

Specifications RTGX1063

RTGX1063 CONNECTORS	
Rf Input Rx	+5dBm to -35dBm 8.5GHz to 10.5GHz Accuracy <1dB
Rf Input Monitor	Output for monitor purposes = Rx input +2dB
Digital Delay Out	Delayed signal, unequalized
Modulator 2 In	Maximum input level -10dBm, +30dBm no damage
Modulator 2 Out	Equalized output vs freq. maximum output level 0dBm
Rf Output Tx	Equalized output vs freq. maximum output level 0dBm
Generator Out	Output of white noise generator, minimum -10 dBm integrated output power

TARGET SPECIFICATIONS	
Range	Min. 36m, max. 701km (435 miles)
Range resolution	21.4mm (0.84 in), sampling at 7GHz
Max speed	8190m/s (18320 mph)
Doppler and speed resolution	0.25m/s (0.55 mph)
Dynamic range out	90dB min
Amplitude resolution	0.5dB (±1dB accuracy)
Output Amplitude resolution	1dB for power between 0dBm and -80dBm
Amplitude ripple	Measured with 1MHz RBW 95 percentile < 0.36 dB average 0,11 dB

Specifications RTGU1085

RTGU1085 CONNECTORS	
Rf Input Rx	+10dBm to -40dBm 400MHz to 460MHz Accuracy <1dB
Rf Input Monitor	Output for monitor purposes = Rx input -8dB
Digital Delay Out	Delayed signal, unequalized
Modulator 2 In	Maximum input level +10dBm, +30dBm no damage
Modulator 2 Out	Equalized output vs freq. maximum output level 0dBm
Rf Output Tx	Equalized output vs freq. maximum output level 0dBm
Generator Out	Output of white noise generator, -10 dBm maximum integrated output power

TARGET SPECIFICATIONS	
Range	Min. 500m, max. 5600km (3479 miles) for the UHF version with extended range
Range resolution	171mm (6.7 in)
Output power	Min -100dBm, max 0dBm
Max speed	8190m/s (18320 mph)
Doppler and speed resolution	0.25m/s (0.55 mph)
Dynamic range out	100dB
Amplitude resolution	0.5dB
Output Amplitude accuracy	1dB for power between 0 dBm and -80dBm
Amplitude ripple	0.6dB (worst case frequency)

RF Target Injection for MSSR and Mode-S

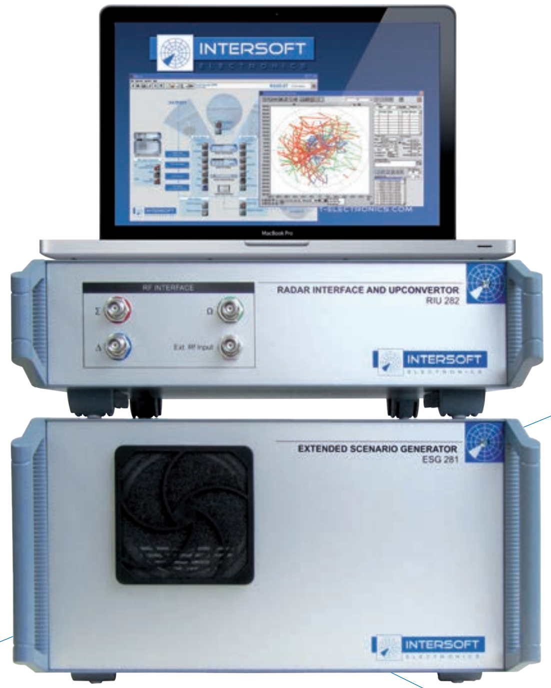
IE's Radar Environment Simulator (RES) simulates a secondary radar's physical environment, producing up to 2048 SSR or Mode-S targets, reflectors, and LVA antenna behaviors on an RF level. Based on user requirements, the RES creates, outputs, and injects all required RF signals that would occur in operational situations into a radar's antenna connectors. The RES generates accurate responses to a radar's interrogations, precisely replicating the interactions that would occur with operational transponders.

The RES provides a significant advantage over using real traffic by providing the radar with "perfect" signals from a known (laboratory) source, delivering a precisely defined transponder behavior and environment. Environmental factors, such as malfunctioning transponders, reflections, transponder occupancy are eliminated. Additionally, RES can input erratic signals, such as jammer frequencies, into a scenario if desired.

Used in conjunction with other RASS tools, the RES can present a known reference environment to the radar and the radar output data can be compared to the input scenario. The RASS portfolio enables radar data recording, video signal recording, and (Mode-S) interrogation recording, plus a wide range of analysis tools. These tools enable a user to visually compare the input data (input scenario) against the output data (recorded ASTERIX, CD- 2, etc.) and calculate performance parameters from the data. They also produce for the user statistical result data on measured radar accuracy, biases, measured Pd, reflection elimination, false plot rate, etc.
In addition to producing environment simulation via RF injection, the RES can provide simulation at the radar data level. Scenarios created by IE's RES software can be generated as a serial data stream under U-HDLC, LAPB or X25.3 (using RASS hardware), or on LAN (UDP or TCP-IP). Currently, RES can generate ASTERIX Cat 001/002, Cat 34/48, Cat021, Cat 62 (tracker) or RDIF data. This feature can be used to test radar communication lines and radar tracking systems or provide users with a general-purpose radar data source. Scenarios can be generated for one or multiple radars.

The RES also integrates with IE's PSR target generator RTG10xx, allowing combined SSR-PSR testing, using the same scenarios. Timing signals are therefore easily coupled using the standardized RASS interfaces.

ADS-B squitter generation is also supported by the RES, allowing a user to test ADS-B receivers separately or integrated in the radar. RES will generate test scenarios complying with D0 260 standards for testing ADS-B-ES1090.



Why do you need a RES® system?

RES® is the industry standard test equipment for radar acceptance and development!

RES® has been widely adopted by three major groups of users:

- **Radar or ADS-B sensor developers**

  It is the only available tool that allows a user to simulate full Mode-S data link for up to 2048 targets. RES provides the same service in Mode 1, 2, 3/A, C, Mode 4, Mode 5 (with RSE option), ADS-B-ES1090 and TIS-B. It was designed in close cooperation with EUROCONTROL and provides full test capabilities for the EMS and U.S Department of Defense AIMS requirements for Second Surveillance Radar.

- **Radar acceptance engineers**

  RES provides the ultimate test instrument to perform installation and factory acceptance of SSR or Mode-S radars. The RES software enables the user to create scenario's very quickly by using implemented models allowing to test a radar's most challenging performance specifications, such as: load capacity testing, Mode S performance, Mode 1 and 2 performance, resolution behavior, accuracy, probability of reply, performance when using low PRF, high rotation speed, etc. When used jointly with the RTG10xx device or the Data Replay tool, PSR-SSR merging can also be tested.

- **Maintenance engineers**

  Modern (Mode-S) SSR radars are incredibly complex, requiring a vast number of parameters to be tested. When a radar's settings or environment are modified, or if a radar's firmware is upgraded by the manufacturer, maintenance personnel require a method to determine the new performance of the radar and compare it to the "previous" condition. RES is perfectly suited for this type of regression testing. Several predefined scenarios can be injected in the radar before and after modifications, allowing performance to be compared. The same principle can be used to compare radar channels for similar behavior and parameter setting.


RIU282 Front Panel


RIU282 Rear Panel


ESG281 Front Panel


ESG281 Rear Panel

Product Specifications

GENERAL	
Max nr of targets	2048/scan, including reflections
Nr of target generation channels	4
Max nr of overlapping targets (garbling simulation)	4 (in case no interference from FRUIT, ADS-B or jamming is present)
FRUIT generation	Up to 22000 FRUIT/sec
Programmable frequency targets	1087-1093 MHz
Accuracy azimuth	Azimuth < 22 mdeg; Range < 10m
Target power output	+5…-60dBm at RES output -25…-90dBm at radar input (using a 30dB coupling chain)
Full simulation of horizontal and vertical Mono-pulse SSR antenna diagram	
Path loss simulation	
RES operates in master or slaved mode to radar rotation;	12, 14 or 16 bit ACP In and Output; Differential ACP/ARP provided (using RTI-966)
TARGET TYPES	
Transponders programmable for Modes 1, 2, 3/A, C, Mode 4 and 5 (optional), Inter Mode and full Mode S	Supports DF 4, 5, 11, 20 and 24 Roll Call replies for all targets
Supports Lockout, stochastic acquisition, data link protocols	Transponder Power and MTL Programmable
Mode S level 1 through 5 supported; II or SI code Interrogations.	ICAO Annex 10 compliant Transponders logic and RF signals, Previous versions can be emulated (am69, 71, 73, …)
Data link Comm A, AICB, Broadcast Comm B, Resolution Advisories and EHS support for Mode-S	Up to 32 BDs registers/target (programmable contents)
DF17, 18 and 19 ADSB ES1090 & TIS-B reply generation	PSR target by integration with RTG10xx
SCENARIO	
Simulation of straight flights, turns, accelerations, climbs/descends, static targets, accelerated turns, etc	Uplink events programmable through DLF (ASTERIX Cat018) on LAN or serial interface
Simulation of simple reflection environment	Automatic generation of load models and other example scenarios
Correct Mode C (and DF5/21) Altitude codes according to scenario	Simulation of multiple radar (on RF or ASTERIX)
Programmable S address, 1, 2, 3/A codes per target	Simulation of moving radar platform, with NAV data output generation
In flight code changes, Emergency codes, SPI, Military emergency …	Simulation of ADS-B or TIS-B targets, with up to 12 overlapping interfering (FRUIT) replies.
Programmable downlink datalink activities (Broadcast Comm-B, AICB, ACAS RA, CommD)	Simulation of PSR targets (Replay functionality, RTG10xx input)
RECORDING	
Using UTC timestamping (only serial link EDR)	Recording of rotation data
Recording of Interrogation schedule (timing, type, power)	Recording of radar data by EDR-679, UDR765 (serial) or LAN (UDP-IP / TCP-IP)

ANALYSIS	
Analysis of Accuracy, Resolution behaviour, Pd, Sensitivity	Analysis of interrogation schedules
Analysis of Mode S data link behaviour	Automatic comparison
Visualisation of Scenario and radar data overlayed	
POWER REQUIREMENTS	
Power Supply	85-264VAC/47-63Hz or 120-370VDC Fused with 1.6A
INTERFACES	
RF Interface: Σ, Δ, Ω	3x BNC, 3 channel RF injection (FRUIT, external signal generators) connectors
External RF Input	BNC, input of 1090MHz external signal to be measured (self-test)
Radar Interface and Upconvertor Back	
SCSI I/O	Interface for data throughput between RIU and ESG
ESG Digital I/O	Serial bus, Mode-S data output and interrogation mode output interface
Σ, Δ, Ω	3xSMA, 3 channel RF interface to radar using couplers
ACP/ARP	DB15pHD female connector, Master output of encoder simulation
RVI	DB15pHD female connector, Mode-S data information and slaved ACP/ARP, Trigger signals for Video recording
IF Signals: VL, VR	2x SMA, IF input signal interface from ESG
EXT. CLK	SMA, Master clock output to ESG
Video In	BNC, Analog input for sampling Rx video (max. 5V)
Video Out	BNC, Log receiver monitor video output
Extended Scenario Generator Back	
SCSI I/O	Interface for data throughput between RIU and ESG
USB Interface	for remote programming and high-speed data throughput. USB2; 480Mbit/s transfer rate compatible with USB1 / 3 : 10Mbit/s transfer rate
Digital I/O	Serial bus, Mode-S data output and interrogation mode output interface
IF Signals: VL, VR	2x SMA, IF output signal interface to RIU
EXT. CLK	SMA, Clock input
MECHANICAL SPECIFICATIONS	
Dimensions WxHxD	ESG281: 340 x 180 x 460 mm RIU282: 340 x 90 x 460 mm
Weight device	34.5kg (76lbs) (RIU+ESG)
Weight incl. packaging and accessories	46kg (101lbs) in 2 PelicanTM cases
COMPLIANCE	
ICAO Annex 10, 4th and 5th Edition	EUROCONTROL EMS 3.11
STANAG 4193 Edition 2 & Edition 3	DoD 260 A, B
DoD AIMS 3-1000 A, B	

4.

Radar Analysis Services

Sensor Performance Evaluations

Intersoft Electronics® (IE) has highly skilled, experienced and trained engineers. They are provisioned in the use of RASS and other radar evaluation techniques independent from the radar manufacturer.
IE engineers can support manufacturers, Air Navigation Service Providers, Ministry Of Defense and other service providers during acceptance testing (FAT, SAT and Flight Trial),during normal verification period as scheduled maintenance cycles or during time critical event as failure and fault finding.
The support of IE engineers and their expertise will reduce the risk of redo expensive acceptance test, due to improper radar optimization or perturbed video/data recording.

The performance evaluation of a radar sensor is structured to provide investigation and analysis to three distinct levels dependent on client requirements:

Level 1 | RASS Data Analysis and Monitoring

- Continuous and Real time or 6 monthly monitoring of key parameters and performance trends
- Early detection of system degradation before system failure occurs, leading to better preventive maintenance and higher system availability
- After sensor baseline performance has been established
- RASS COTS analysis tool EUROCONTROL and ICAO compliant

Level 2 | RASS Sensor Baseline Analysis

- Detailed periodically technical analysis of all individual subsystems
- Identify the reasons for possible performance degradation over time
- Definition of sensor coverage and operational performance capabilities
- Assessment against established standards and requirements
- Test efficacy of the radar sensor's optimisation
- RASS COTS hardware and software components

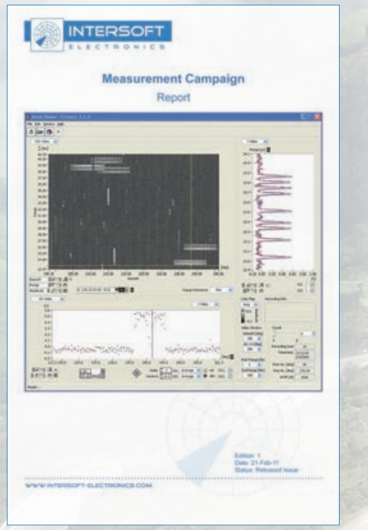
Level 3 | Commissioning or Specialised Measurements

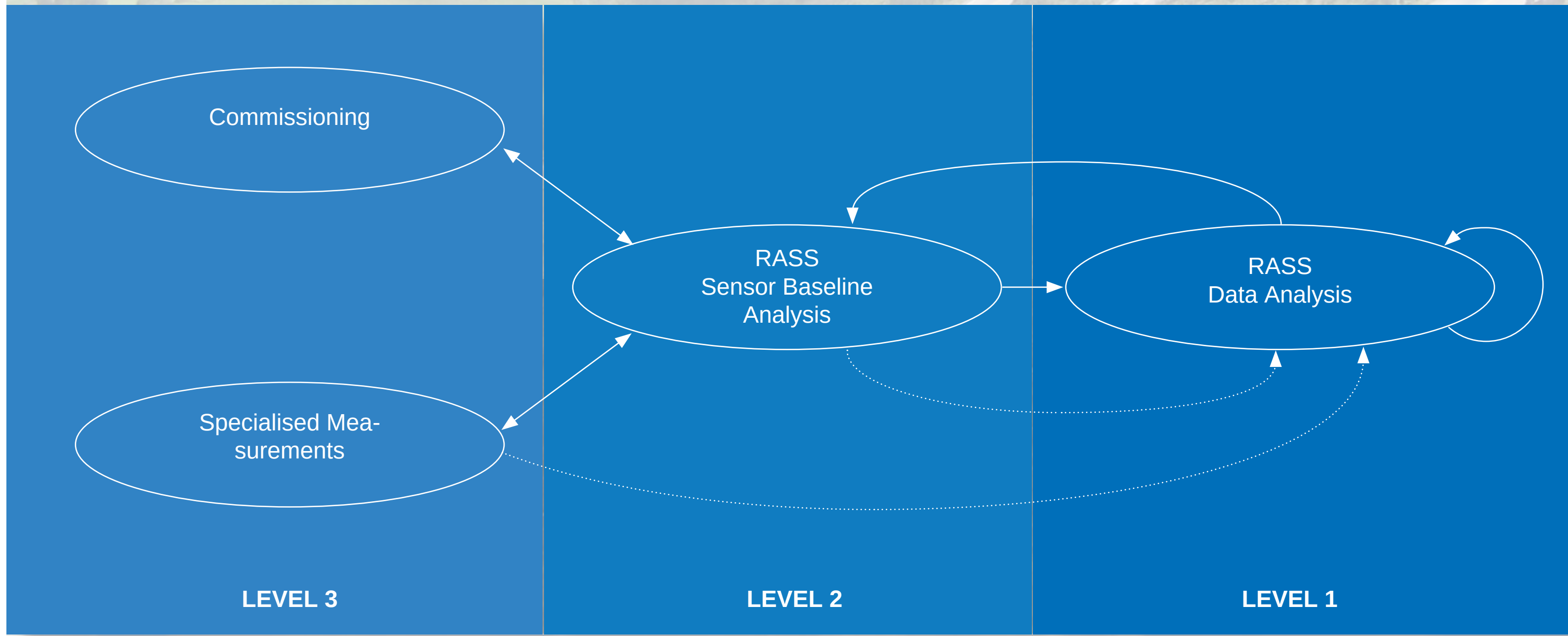
- Typical Factory or Site Acceptance Testing (FAT/SAT)
- Assess a radar system at a deeper Level
- Assess the readiness of a radar sensor for Flight Check Analysis
- Specialised COTS equipments such as Radar Target Generator (RTG1002) and Radar Environment Simulator (RES®28x).

RES®28x

What does an IE Sensor Performance Analysis comprise?

- IE engineer goes on site to perform a Level 1/2/3 campaign
- IE engineer takes all necessary hardware tools with him
- After analysis of the measurements, IE delivers a detailed report containing an Executive Summary of the radar's performance, details of the analysis and recommendations.





Typically, Level 3 measurements are performed during FAT/SAT in the scope of radar sensor commissioning. After that, a Level 2 RASS Sensor Baseline Analysis is performed, preliminary to a Level 1 RASS Data Analysis. Level 1 analyses are typically repeated every 6 months in order to monitor performance trends. Level 2 analyses are repeated periodically in agreement with the client or when system degradation is observed during 6 monthly level 1 analysis. Level 3 specialised measurements are performed when level 2 Sensor Baseline Analysis reveals dedicated performance issues. After level 2 and/or level 3 testing, Level 1 Data Analysis is always performed.

Deliverables

- The deliverables provided to the client at the conclusion of the sensor performance analysis are:
- Test schedule as agreed
- Report containing details on the analysis and recommendations

Complete evaluation directory, including data collected, pictures and documents

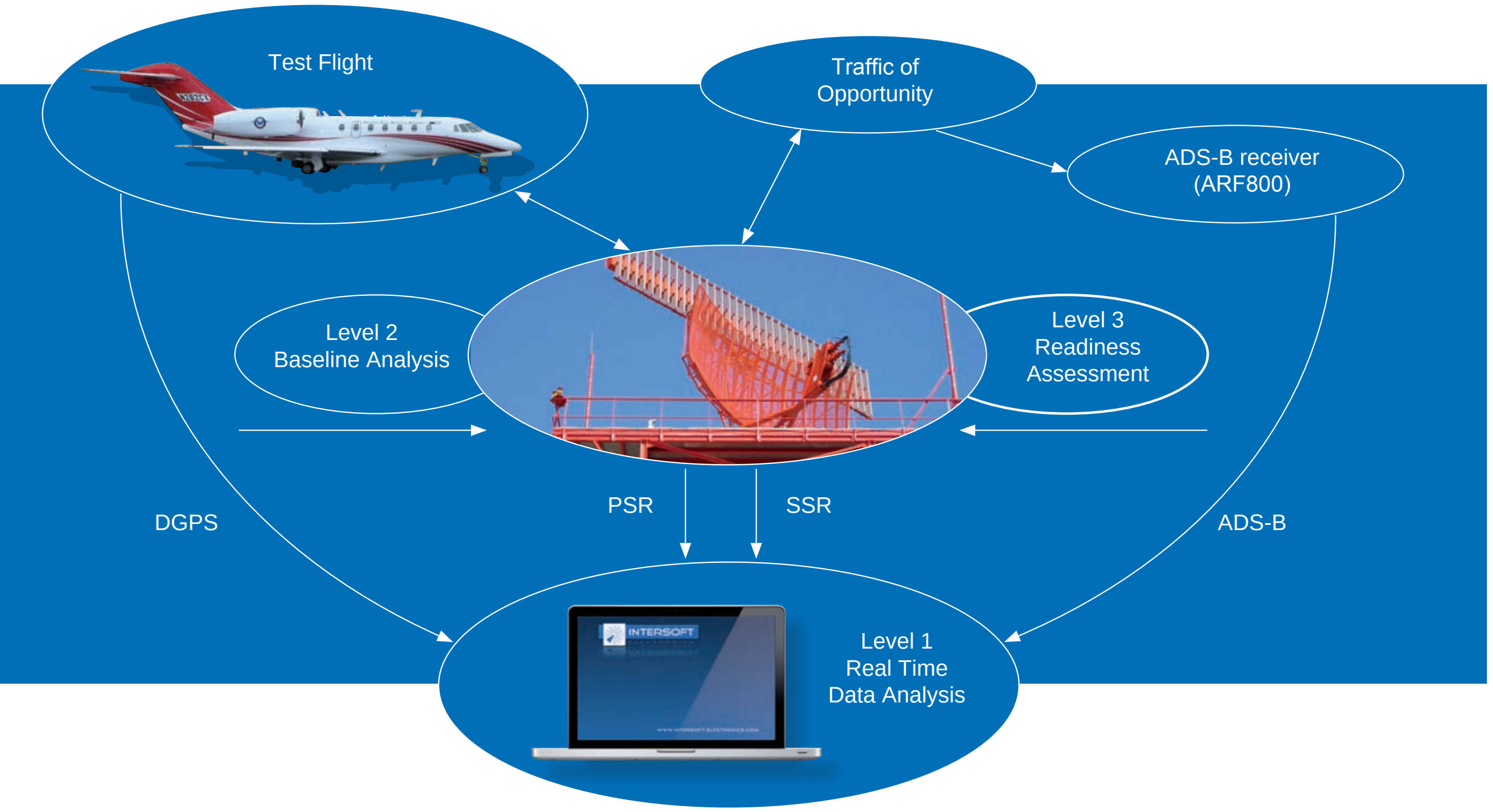
Flight Check Analysis

When performing flight check analyses, people often face lack of control over their measurements due to the restrictions of their ground based equipment. Flight checkers do not always have easy acces to real time radar sensor monitoring tools at control centres. They rely on the information they get from an airborne reference GPS Measurement Unit (GMU) after the measurements are completed.

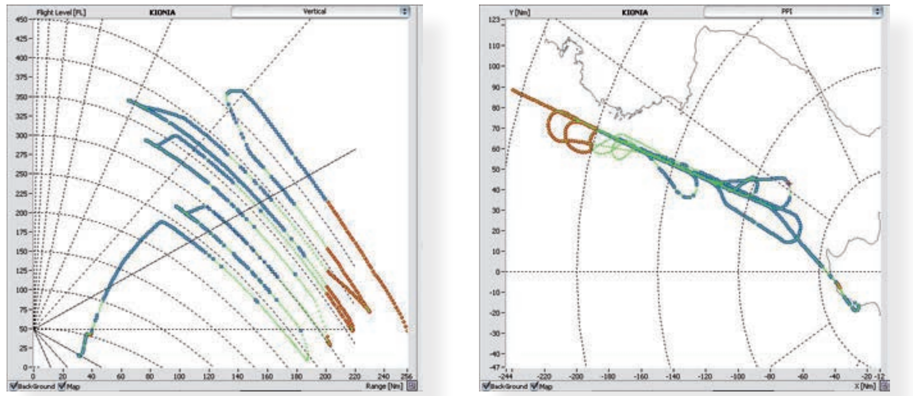
A radar sensor may not be ready for flight check analysis, it may need to be tuned first before taking of for expensive test flights.

IE offers solutions for the flight checker and his client in the form of

- Assessing the readiness of a radar sensor for Flight Check Analysis using Level 3 Specialised Measurement (RTG1002/RES®28x)
- Tuning the radar sensor before Flight Check Analysis if necessary, using Level 2 Baseline Analysis tools
- Providing Level 1 Real Time Data Analysis tools



During Flight Check Analysis, simultaneous recordings of PSR/SSR data are made at the radar head using IE's Level 1 RASS Data Analysis tools. These tools allow real time displaying and analysis of the recordings. Simultaneously, ADS-B recordings are made for Traffic Of Opportunity (TOO) analysis. For this purpose, IE offers the COTS ADS-B system. Finally, the DGPS data from the flight checker are added for Level 1 RASS Data Analysis.
With DGPS as a very precise reference for the test flight and ADS-B as a reference for PSR/SSR replies from the TOO, the radar sensor performance can be evaluated with a high accuracy using IE's Level 1 Data Analysis tools.



Vertical and PPI views from a testflight trajectory: DGPS reference trajectory data is in green and PSR detections are in blue. Red parts of the trajectory are out of coverage.

Advantages

- The advantages of IE's Flight Check Analysis solutions are versatile:
- Compact and light weight portable equipment
- Less time on site required thanks to real time availability of data from radar under test and reference data
- Minimal impact on operational service
- Assessment can be conducted on different types of radar systems regardless of manufacturer
- Fast analysis of the radar system
- Capabilities for corrections, modifications and finetuning of degraded radar quality
- Delivery of detailed report

Together we make the sky safer

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