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SCANTER 1002 GSR Radar

Product Specification

Record of Changes

ECR/ECO	Description	Rev	Date
	Preliminary for costumers	A	2012-11-16
	Photo updated	A1	2012-12-07

Contents

1 Introduction

1.1 Purpose

This document serves as overall product specification for the SCANTER 1002 Radar System intended for Ground Surveillance (GSR) applications.

The SCANTER 1002 is a Ground Surveillance Radar that enables detection of moving targets by enhanced Doppler based processing. The design ensures detection and tracking of small objects including slow moving people under difficult weather conditions and provides an excellent discrimination of ground clutter.

1.2 Application

This document serves as reference in quotation and contract preparation. It describes the radar system configuration and includes detailed specifications for the system and related service features.

Within the basic configuration, a number of add-on features are available to fulfill the customer application. These are specifically mentioned where relevant.

Note that illustrations are for visualization only. Please refer to detailed drawings for specific details.

Terma aims to improve the product family continuously and consequently reserves the right to revise product characteristics without notice.

1.3 SCANTER 1002 at a glance

SCANTER 1002 is small and compact Radar System tailored for ground surveillance. It is a Ku-band, 2D, fully coherent pulse compression radar, based on Solid State transmitter technology with digital software defined functionality. Both the radar transmitter and receiver, the signal processing electronics, the embedded tracker and the antenna are enclosed inside a radome, giving an extremely compact and portable system. Figure 1-1 shows a complete radar unit.

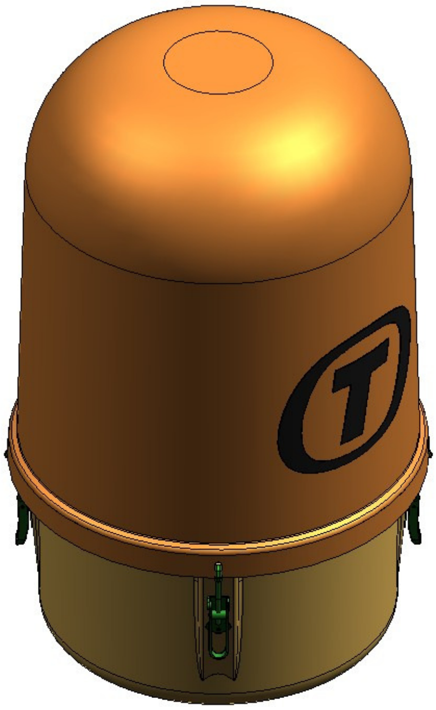


Figure 1-1 SCANTER 1002 Radar unit

The SCANTER 1002 meets the requirements for professional GSR, where detection of small and slow targets in bad weather conditions is required.

Terma's proven pulse compression technology, Frequency Diversity (FD) combined with the unique discrimination between stationary and slowly moving targets gives a truly high-end surveillance radar system.

SCANTER 1002 uses a Solid State Power Amplifier (SSPA) transmitter technology which ensures long service life and high availability.

A receiver with low noise and superior dynamic range provides high resolution and detailed radar pictures, in all weather conditions, with no need for operator intervention. Combined with the advanced moving target filtering software, the system is able to discriminate a walking or crawling man from the background clutter, even in rain.

An embedded tracker using Interacting Multiple Model technology is integrated into the radar unit to detect and track agile and small targets in severe weather conditions, and at the same time to use the tracker to detect large vessels. Information to track surface targets is obtained from a combination of normal and Doppler processed signals.

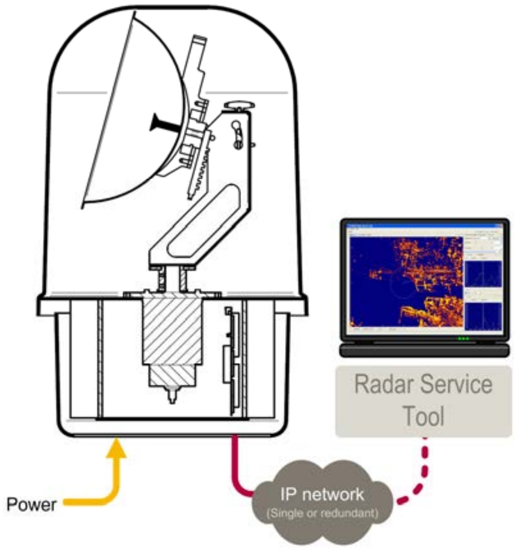


Figure 1-2 Simplified system components schematics

Communication interface to the Transceiver is established via a standard IP network (LAN or WAN), which provides network radar video, plots, tracks, control etc.

Service information is also obtained via the IP network.

The Radar Service Tool provides an easy interface for controlling the radar and gives detailed status and diagnostics information from the Built-in Test Equipment (BITE). It also provides access to powerful radar imaging and tracking information.

The radar unit is well suited as sensor components in the TERMA T.react CIP surveillance system designed for monitoring large or complex infrastructures.

2 GSR application

The SCANTER 1002 design and signal processing is optimized for detection and tracking of:

- Walking humans
- Crawling humans
- Bicycles
- Small vehicles
- Heavy vehicles
- Fast targets

SCANTER 1002 can survey an area of several square kilometers where it will detect any movement within its line of sight. It provides an ideal sensor for applications like:

- Protecting critical infrastructure like power plants, harbors and oil refineries
- Border surveillance
- Protection of military forces in the field
- Protection of refugee camps and military camps

Figure 2-1: Key application usages

3 Product characteristics

Main type features	2D fully coherent pulse compression radar Software defined radar - Fully digital Single channel time and frequency diversity 8 W SSPA. Up to 200:1 compression
Frequency band	17.1 GHz to 17.3 GHz
Frequency sub-bands	Software defined, up to 4 carriers
Number of profiles	16
Instrumented Range	Up to 12 Km (Profile dependent)
Minimum Detection Range - MDR	20 m (Measured from the antenna)
Range cell size	6 m
Target separation	Better than 24 m in range (6 m cell size)
BITE measurements	Fully integrated in all modules
Embedded tracker module	Default
SSPA RF peak / average / Equivalent power	8 W / 1.6 W / up to 1.6 kW (profile dependent)
Duty cycle	Up to 20%

3.1 Physical appearance

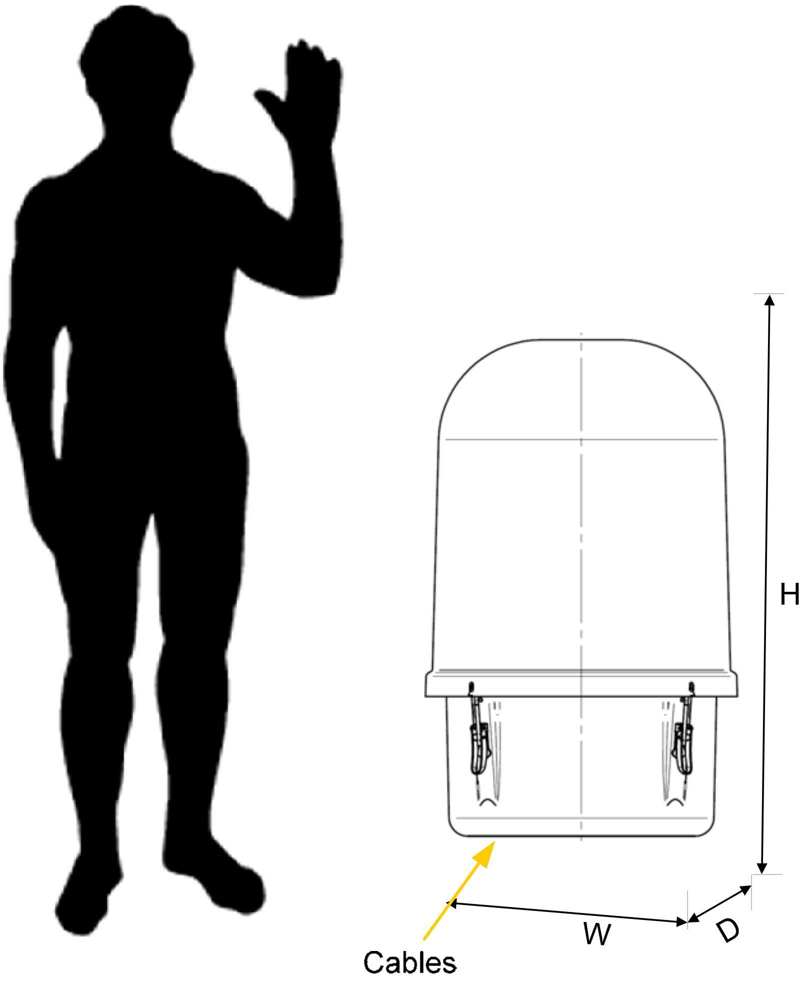


Figure 3-1: Transceiver dimensions

System	
Weight	~ 34 kg net.
	44 kg packed for transportation
h x w x d height x width x depth	770 x 500 x 500 mm installed
	~ 900 x 600 x 600 mm packed for transportation

Table 3-1: Mechanical dimensions

3.2 Performance

For a SCANTER 1002 system, the coverage is determined by a combination of antenna height, and environmental conditions. The following performance characteristics have been calculated for various target types with an antenna height of 5 m.

For a free line of sight and probability of detection 90%, the probabilities of detection for various weather situations are:

SCANTER 1002 Performance			
Target Type	**Detection Range**	**Detection Range**	**Detection Range**
	no precipitation	4 mm rain	16 mm rain
	[km]	**[km]**	**[km]**
Walking man[1]	3.7	3.2	2.5
Crawling man[2]	1	1	-
Small vehicle[3]	6.3	5.4	4.7
Large vehicle[4]	7.3	6.2	5.4
Fast target[5]	4.3	3.7	3.3
[1] Walking man (1 m2), heigth 1.5 m			
[2] Crawling man (0.5 m2) heigth 0.5 m			
[3] Small vehicle (5 m2) heigth 1.5 m			
[4] Large vehicle (10 m2) heigth 1.5 m			
[5] Fast moving target 1 (1 m2), heigth 1 m			

Table 3-2 SCANTER 1002 Performance

4 Technology, functions and features

Built on the flexible and powerful architecture and signal processing platform of the SCANTER 5000 and 6000 series, the new generation of GSR systems provide super compact and light radar systems optimized for detecting small and slowly moving targets.

SCANTER 1002 uses fully coherent, pulse compression technology to get superior resolution and radar image quality. The radar transmits chirps with frequency sweeps in different intervals, generated by a digital synthesizer. The chirps are up-converted to Ku-band frequencies and the output power is generated by a microwave SSPA.

In order to support frequency diversity, the receiver has four sub-bands, allowing the transmission and reception of different frequencies. The signals from the receiver channel is sampled in 12 bits at 200 MHz. This data stream is input to the processing chain, which uses Field Programmable Gate Arrays (FPGA) to perform the calculations and data reduction needed to provide radar images as input to the plot extraction and tracking.

All but the transmitter amplifier and receiver front-end, are purely digital. The system includes two integrated PC.s which perform system management and tracking respectively.

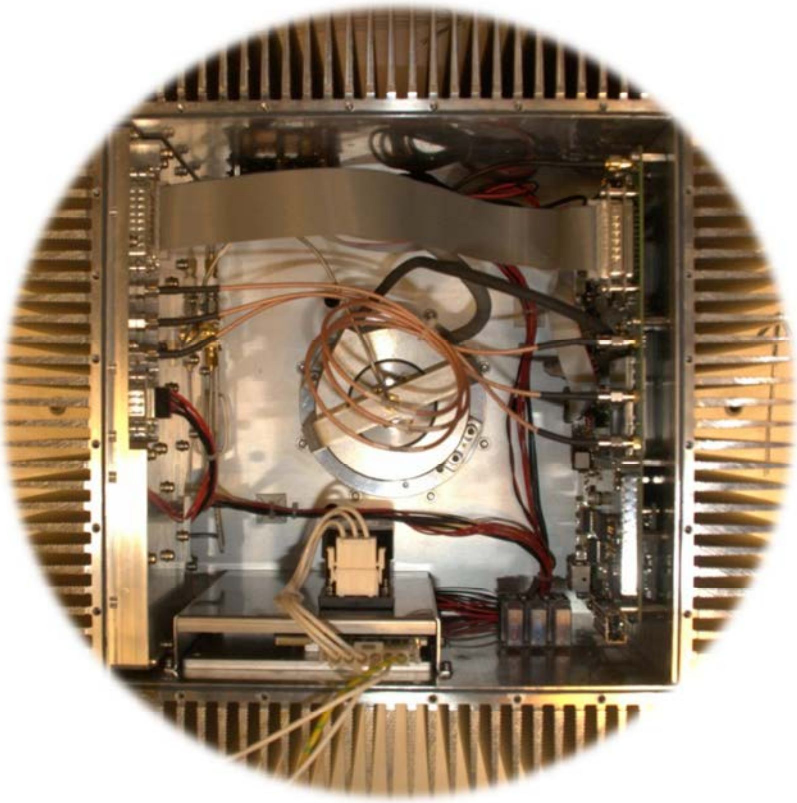


Figure 4-1: Bottom-up view of SCANTER 1002 Transceiver with the mounting plate removed. TR-module left, PC-module right and Antenna motor in the center.

The Transceiver contains a number of LRUs - Line Replaceable Units, as illustrated:

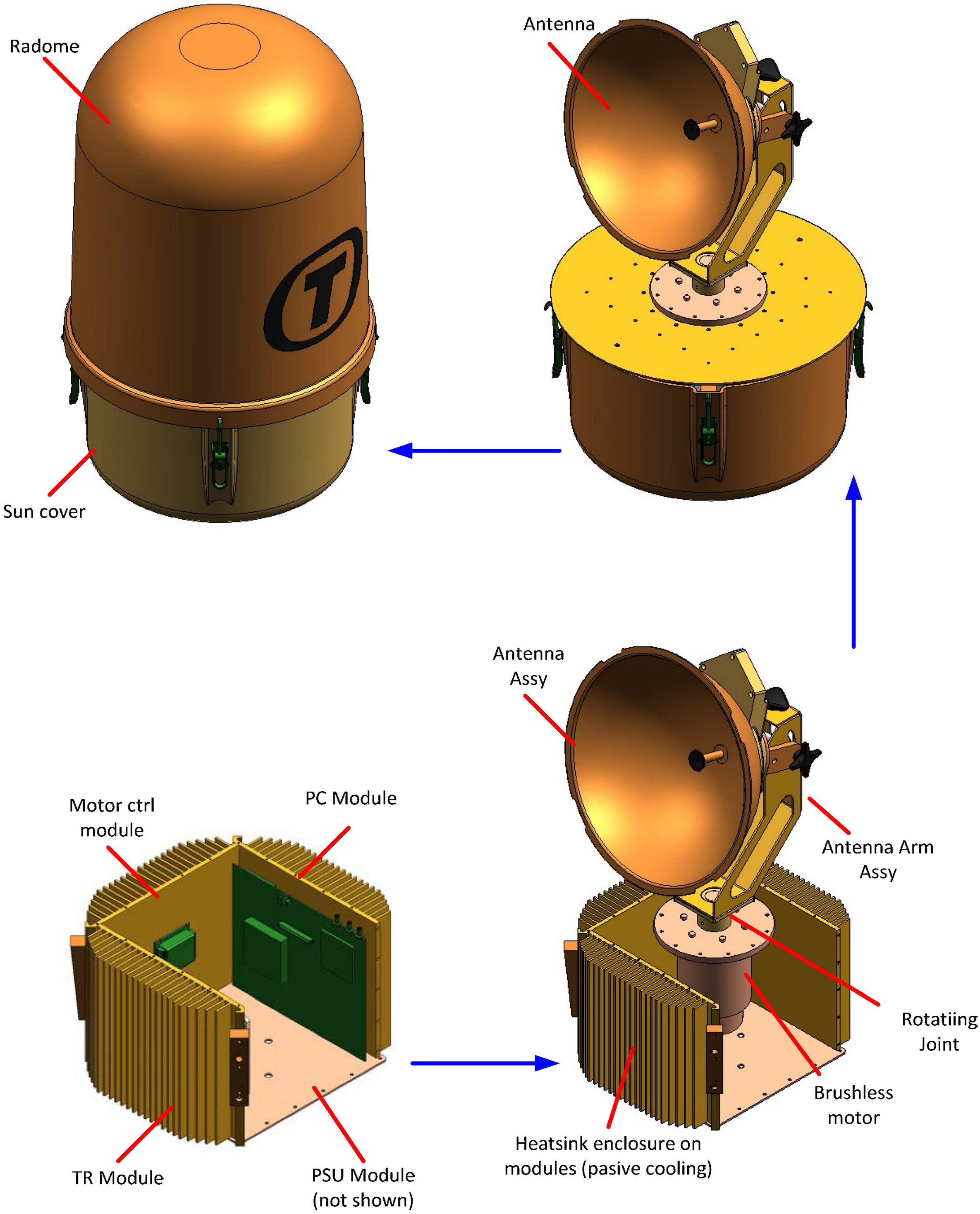


Figure 4-2: The interior of the SCANTER 1002 Transceiver

4.1 Functional description

The SCANTER 1002 radar system is an integrated unit containing both the radar transceiver, power supply, tracker PC and antenna with motor and encoder. The system is enclosed in a radome and sun cover, which provides environmental protection and passive cooling.

The transceiver utilizes frequency modulation (chirping or frequency sweeping) and pulse compression to increase the range resolution as well as the S/N (signal-to-noise) ratio. This allows for transmission of long frequency modulated chirps with low peak power, but still gets a high range resolution and probability of detection.

The system uses Digital Frequency Synthesis to generate chirps within the four frequency bands which can be selected by the application. The signal is generated in the PCM module, which contains all digital electronics in the system and up-converted in two stages in the transmitter. The receiver will automatically tune to the transmitted frequency bands and pass the received signal to the PCM module which will sample the signal, demodulate it, perform pulse compression and after various filter functions will generate radar video used for plot extraction and tracking.

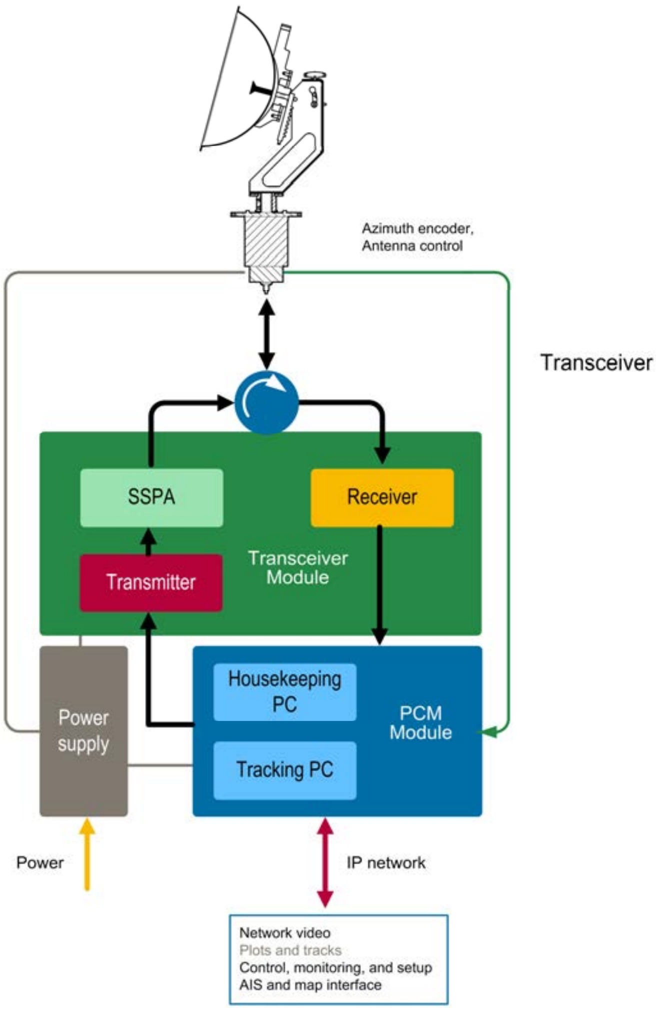


Figure 4-3: Transceiver block diagram

The receiver sensitivity is dynamically and automatically controlled in range, in azimuth and over time. Optimum S/N performance is ensured by low noise amplifiers.

In the SCANTER 1002 system the processing is done in the digital domain. The received radar echoes are down-converted in two mixer stages and sampled at 200 MHz in 12 bits. Then the signal is de modulated and pulse compression is performed.

Highly advanced proprietary processing techniques follow, providing normal radar video as well as Doppler processed radar video. The Doppler processed signal is passed through multiple MTI filter banks in order to separate slowly moving targets from the background of ground clutter. The Video is converted to logarithmic scale before making it available for plot extraction, tracking and image presentation.

The transceiver delivers IP network normal video as well as moving target video.

Embedded tracking is performed on an integrated plug-in PC module, making plots and tracks available on the IP network.

Integrated BITE functions perform continuous monitoring of the radar during startup and operation. This includes temperatures, voltages, signal activity, key performance parameters etc. The measured forward power are used for performance monitoring.

4.2 SSPA – Solid State Power Amplifier

The output state of the SCANTER 1002 transmitter is a Solid State Power Amplifier (SSPA). Based on state-of-the-art MMIC (Monolithic Microwave Integrated Circuit) GaAs amplifiers (HPA) these modules amplifies the signal to be transmitted and produces 8 W of Ku-band microwave power.

The Power sector mode feature allows the SSPA output power to be adjustable in azimuth sectors. This is achieved by sector wise attenuating the input signal into the SSPA from the transmitter.

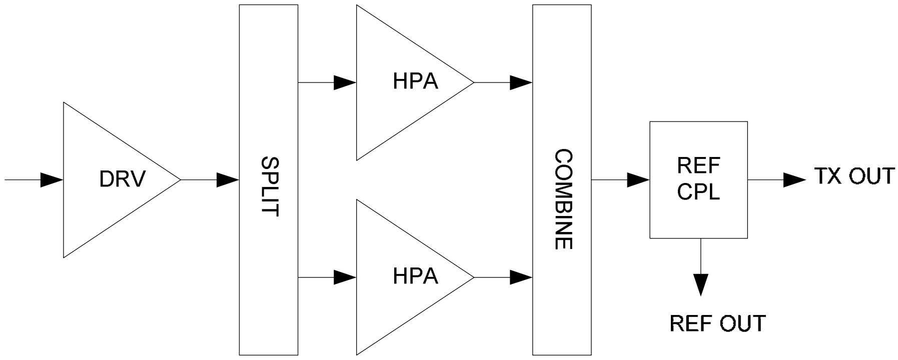


Figure 4-4 SSPA block diagram

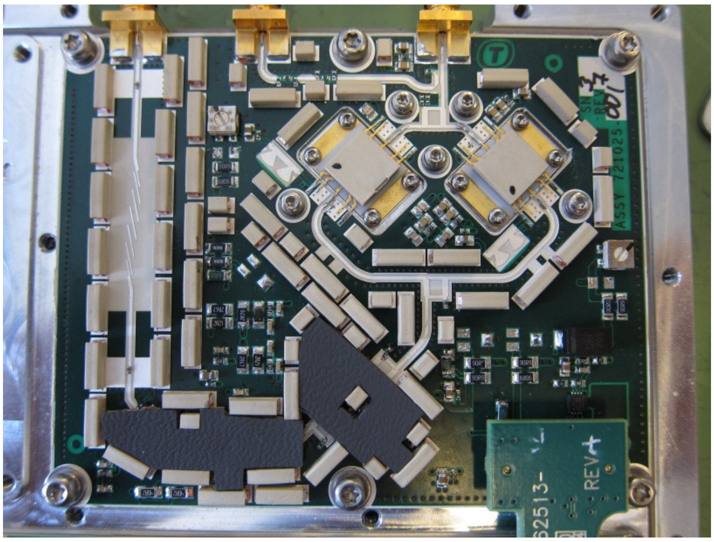


Figure 4-5 SSPA physical layout

4.3 Frequency Diversity

One of the most difficult challenges for a GSR radar system is to separate a small target from background clutter. In SCANTER 1002 this is achieved by a combination of transmission diversity and intelligent signal processing.

The effect of the Terma SCANTER frequency diversity is to reduce fluctuation of the echo from desirable targets, thereby enhancing targets relative to clutter. In combination with coherent pulse compression and interference filtering, the radar images becomes clear and well suited for tracking.

A prerequisite for the frequency diversity is the ability of the transmitter to change frequency instantaneously from chirp to chirp. The transmitter and receiver support four sub bands and can freely jump between these frequencies according to predefined profiles.

The advantage of using frequency diversity is that the noise and clutter will be different in the frequency bands, while the echo from the target remains constant. This means that the clutter can be cancelled by integrating echoes from different time intervals and different frequencies.

Full benefit from the frequency diversity is obtainable only if dynamic characteristics are adapted to actual weather and complex clutter situations.

The sensitivity is therefore matched to the actual clutter levels, providing optimum detection at all ranges and in all directions.

Due to the FD, improvement on target detection is in the order of 6 dB.

Furthermore, receivers and the processing chain have sufficient dynamic range and all components provide sufficient resolution to handle the variety of signals coming from small and large targets at all ranges. This contributes substantially to provision of crisp and clear radar images in all weather situations. Furthermore, high resolution improves discrimination of clutter from wanted targets and thereby allowing the processing to separate targets from clutter.

4.4 Full coherency

SCANTER 1002 is coherent utilizing amplitude and phase information during transmission and reception. A common, phase stable reference oscillator is used for transmission and reception. Coherency enables pulse compression and allows the receiver to compare the phases of the received echoes from chirp to chirp and thereby detect if targets are moving or not, utilizing the Doppler shift.

In order to detect moving targets, SCANTER 1002 also includes Doppler processing. This improves detection of targets moving radial (moving in range) and with a speed different from clutter.

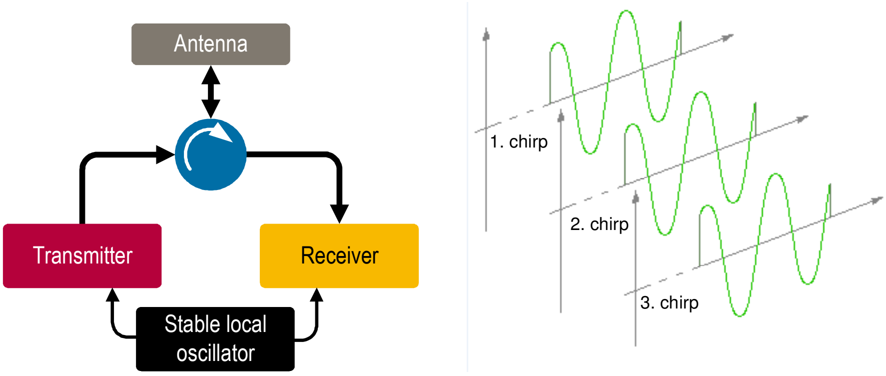
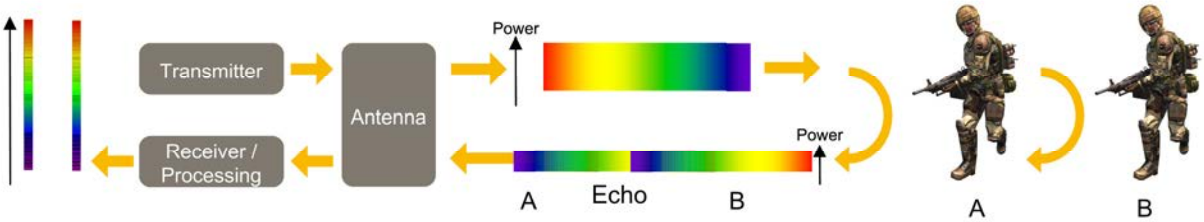


Figure 4-6: Coherency principle

4.5 Pulse compression

Because it is a compact solid state radar with low power consumption, SCANTER 1002 has a limited peak power. In order to illuminate the target with sufficient energy, it uses long pulses. Unless some clever processing is used, this would lead to a significant loss of range resolution. The transceiver utilizes frequency modulation (chirping or frequency sweeping) and pulse compression to increase the range resolution as well as the S/N ratio. This allows for transmission of long frequency modulated chirps with relative low peak power, and at the same time have sufficient average power and bandwidth.



When closely separated targets reflect these chirps, the frequency content of the echoes from different targets at a given time will be different as illustrated in Figure 4-7: Simplified

Figure 4-7: Simplified sketch of the pulse compression principle

sketch of the pulse compression principle

Pulse compression is achieved by transforming the received signal to the frequency domain, and cross correlating it with a conjugated and mirrored version of the transmitted signal or its modified replica.

By pulse compression, the S/N ratio is improved by the pulse compression gain or a factor, equivalent to the chirp length times the effective bandwidth of the transmitted chirps.

A special feature of the pulse compression technique is that the resulting radar sensitivity in noise is independent of the resolution bandwidth. The resulting signal to noise ratio is therefore proportional to the transmitted power divided by the overall receiver noise figure. In consequence, the bandwidth can be selected freely e.g. to minimize the clutter power, having in mind that too fine a resolution will introduce a range-straddling loss. In other words, the radar

Figure 4-8 Pulse compression processing

sensitivity is determined by the transmitted power (chirp or pulse length), as in normal pulse radar, but the resolution can be selected freely.

A drawback from the transmission of long chirps is an extended minimum range – the radar is blind during transmission. In order to compensate for this, the radar can use a mixture of short and long chirps. Because there is a short delay between transmission and reception of an echo from a target close to the antenna, short chirps are used for short ranges. However, since detecting small targets at long distance requires more energy, long chirps are used for medium and long distances. This is illustrated in Figure 4-9.

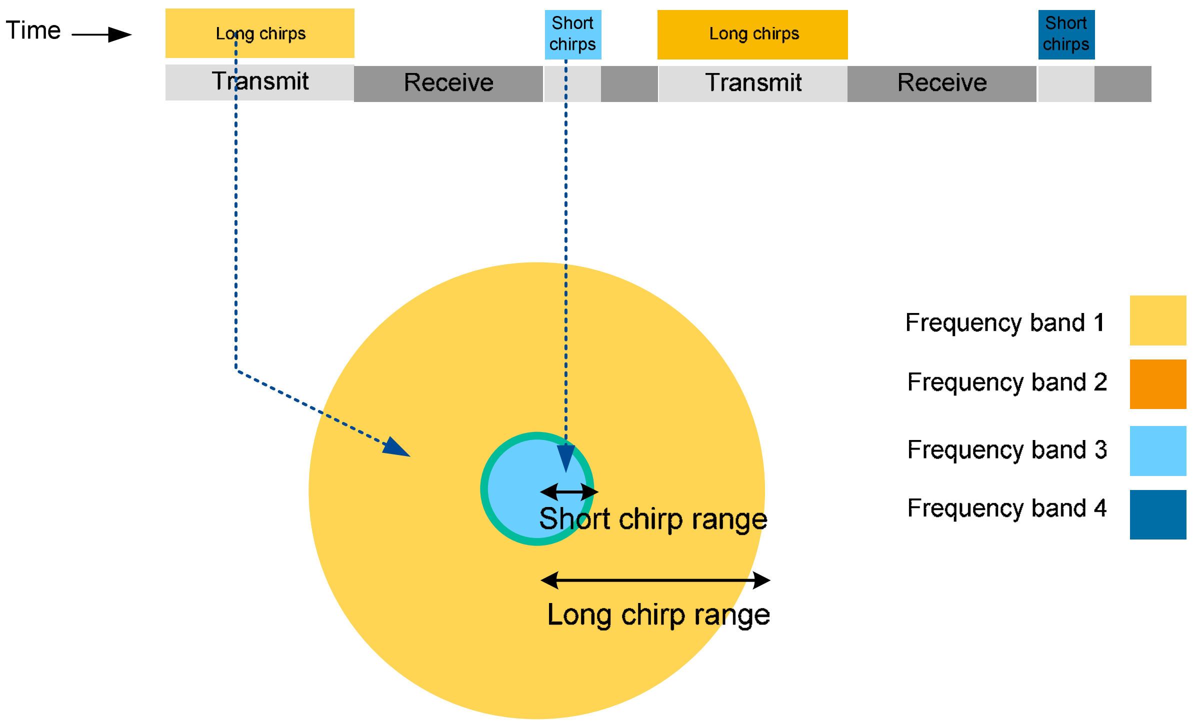


Figure 4-9 Principle sketch of transmission sequence

Up to 4 sub-frequency bands can be used and the sequence of pulse patterns is fully software defined and can be adapted to the actual situation and the chirp combination (Transmission sequence) is defined as part of individual profile set-ups.

By nature, pulse compression will create time side lobes in a radar image (**Error! Reference source not found.**). These are imperfections in range, where a target will appear with "artificial" targets before and/or after the actual target. similar effects can appear in azimuth and are called antenna side lobes.

Side lobes are unwanted, as they will limit the size of a small Radar Cross Section (RCS) target that can be detected next to a large RCS target. Traditionally this may be a severe limitation in pulse compression radars. However, SCANTER 1002 uses a proprietary approach that overcomes this problem. The result is that time side-lobes are strongly reduced, in the order of at least 50 dB.

4.6 Sub-clutter visibility with Doppler based processing

The SCANTER 1002 system is specifically tailored towards detecting small and slowly moving targets in a land environment. This constitutes quite a challenge because these targets are very easily masked by land clutter (trees, bushes etc.) and rain. This is clearly illustrated in Figure 4-10, which shows signal distributions for a walking or crawling man, compared to ground clutter and rain clutter.

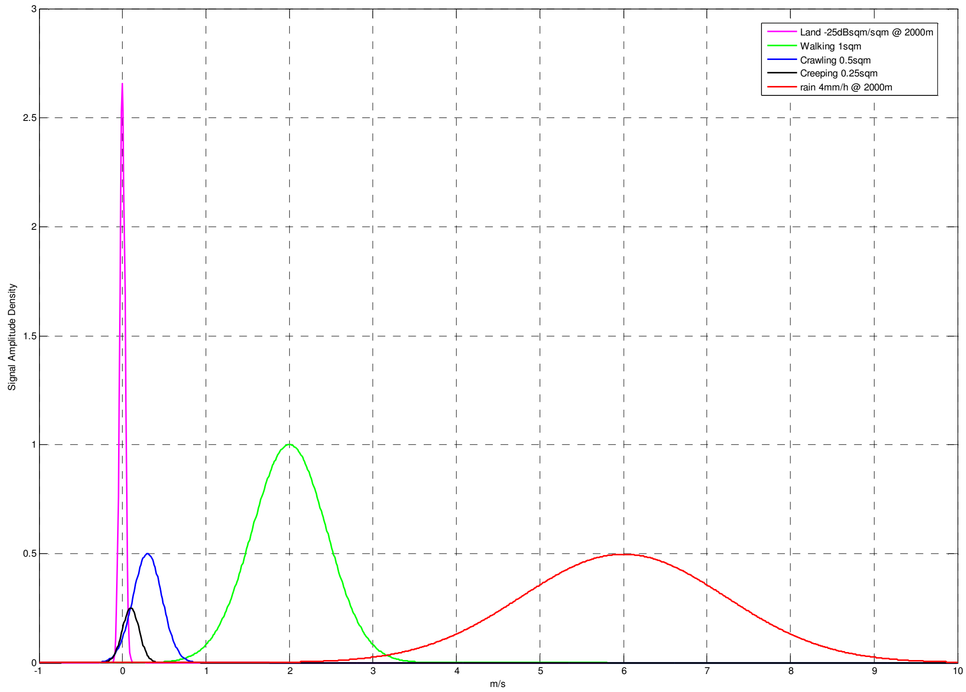


Figure 4-10 Signal distributions for a man compared to background clutter

4.7 Power Sector Transmission

In order to avoid interference from strong echoes from large stationary targets like buildings and mountains and to reduce the risk of interfering with other Ku-band systems, a power sector mode is available. This feature allows definition of up to 16 individual user-defined sectors where the transmitted power can be controlled. Each sector is defined as either:

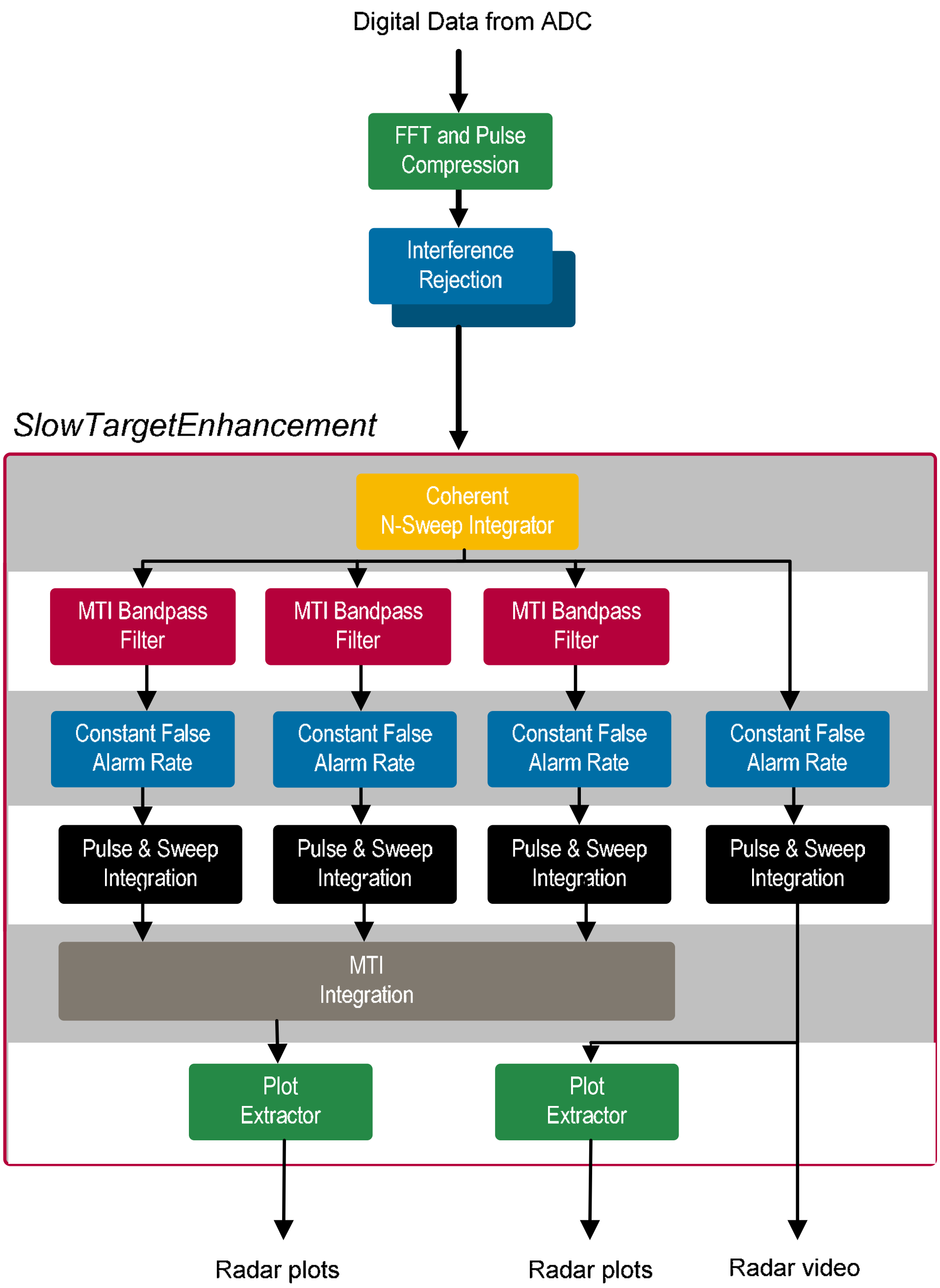
- Prohibit Sector
- Transmit Sector
- Reduced Power Sector

The sectors are aligned relative to north. The size of each sector may be chosen freely between 1° and 359°. Each sector may be given individual power attenuation in steps of 1 dB, down to approximately -30 dB. The system will perform an automatic sector wise power adaption to the specified level.

Prohibit sectors take precedence over transmit sectors.
For the transmit sectors the power may be attenuated, thus providing a mode with low probability of interception or interference.
A reduced power sector can also be used to handle short range areas in from of large buildings. A large building can act as a mirror where physical objects in front of the building will be seen as ghost echoes “inside” the building. Reduced power and thereby sensitivity can eliminate this.

4.8 Video Processing

After down conversion in the receiver the signal is sampled with 12 bit at very high speed, demodulated, pulse compressed and Doppler processed. Then the radar performs plot extraction before passing the radar plots together with the Doppler plots to the built-in tracker.



The processes include automatic adaptation to the environment. Smart channel combiner and interference filtering suppresses asynchronous interferences and second/multiple time around returns, as staggered transmission sequences are used.

The Doppler processing will simultaneously suppress stationary targets as well as moving clutter. The Doppler signal is compensated for the speed and propagation movement direction of clutter, which is automatically determined using Terma proprietary algorithms.

Adaptive parameter settings are used in the filters, in the Frequency Diversity combiners and in the integration processes to omit beam shape and other losses as well as to optimize sensitivity.

Signals are converted form linear to the logarithmic as part of the processing.

In order to separate moving targets from background, the radar uses a bank of very narrow Doppler filters in order to be able to detect slow targets.

4.9 Controlling and using the Radar

4.9.1 Remote control

Basically, the SCANTER 1002 is an “Install and forget” device in the sense that, once installed, it does not need any operator invention during normal operation.

However, all system parameters can be accessed and modified via the Radar Service Tool (RST) which also provides advanced status and diagnostic information. RST can be run on any PC connected to the IP network and it also provides radar video and track information.

4.9.2 Profiles

Profiles are predefined parameter-sets used by the software controlling the radar to set optimal Transceiver performance according to varying weather conditions or specific operational demands. Profiles are defined during system installation, but can be modified at any time from RST.

Up to 16 profiles may be installed, but typically the system will be using just one profile, unless specific profiles for changing weather conditions are required or in case of using the system for portable applications.

The profiles are selectable directly on the Transceiver, via the Radar Service Tool or per remote IP network.

4.9.3 BITE measurements and error handling

A BITE system is continuously monitoring performance parameters such as: Mains-on time, module status, forward power, internal voltages and temperatures, antenna rotation status etc.

All measurements and any errors are stored in a log for inspection and later reference.

The BITE log clearly describes the actual event or error and relates it to a specific module, i.e. no need for translation of code numbers.

At power up, the following diagnostic tests are performed:

- Module presence test
- Data Link test
- Memory test of all RAM circuits

If parameters exceed specifications warnings or error messages are automatically issued across the IP network interfaces.

4.10 Remote System Management and Diagnostics via Radar Service Tool

Each SCANTER 1002 radar sensor can be accessed for management and monitoring from a remote location through the Radar Service Tool running on a Laptop connected to the radar IP network.
The Radar Service Tool provides the following functionality:

- Situation Display with track overlay
- High-Level Control/BITE
- High-Level set-up and Service Tools
- Low-Level Parameter and BITE Access
- Documentation Library

4.10.1 Profile Setup

All parameters affecting the radar performance and processing can be saved in a named profile, which will provide a complete set of radar parameters. When the parameters have been defined the profile is saved with a profile name. The profiles are easily selected in a drop-down menu in the Radar Service Tool.

4.10.2 Status Monitoring

The Radar Service Tool provides status on radar functions and performance as well as detailed status of the system. All BITE information available about the modules are shown together with any status or error message issued by the module.

5 Embedded tracking

5.1 Characteristics

The purpose of the Embedded Tracker is to automatically identify moving objects in the radar image, assign to each object a unique identity and mark it with a symbol, determine the position, speed and course of the object and follow the track of the object by predicting its position from scan to scan and make this information available in the radar image.

The embedded tracker will detect and track any moving object. It gives the operator an overview of moving objects which the normal radar video alone cannot provide. The tracker combines the information from the different doppler filter channels with the scan to scan movements in the normal video to achieve separation of small moving targets from ground clutter.

5.2 Plot extraction

The basic purpose of the tracking process is to describe each real life target with a confirmed track with associated track parameters.

The first part of this process is the plot extraction. This involves the following steps:

- Radar echoes in the individual radar cells are selected for plot formation if the echo strength exceeds a certain video threshold.
- Radar echoes which are connected in range and azimuth are collected into a plot.
- Radar echoes have to span a minimum number of radar cells in order to become a plot.
- A plot is characterized by the position of its centre-of-gravity, the size in range and azimuth (the plot area), and the echo strengths.
- Plots are passed on to the tracking process.

5.3 Basic principles

Once the plots have been extracted, the tracker can start generating and maintaining track information. The basic principles of this process are shown in Figure 5-1:

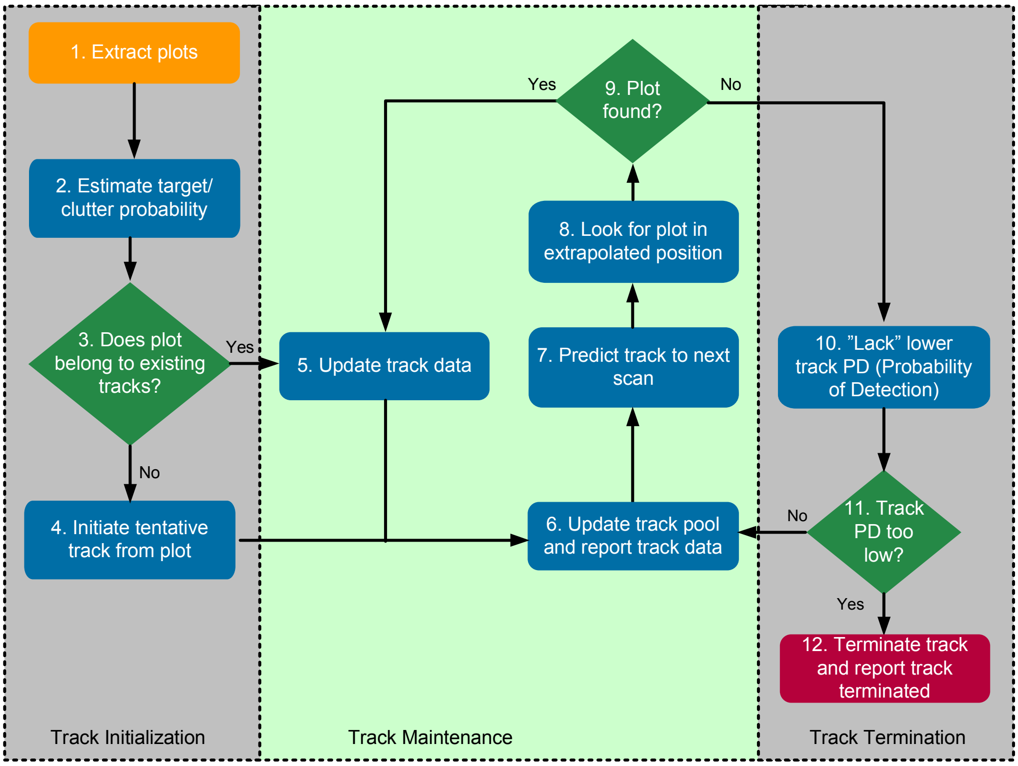


Figure 5-1 Tracking process

The generated tracks will pass through the following lifecycle process:

- When the tracker is switched on, all plots are treated as new tracks
- All new tracks start with a low "track score"
- From scan to scan, the tracker calculates the expected (extrapolated) position of each track object and expected clutter in this position
- For each new scan, the tracker looks for a plot in the expected locations. If a plot is found and its probability of belonging to the track is above a limit, it is associated with the track, the track score is updated and the track parameters are refined
- If no plot can be associated with a track in a particular scan it is treated as a "lack" and the track score is decreased
- When a track PD drops below a certain limit, the track is deleted
- If a new plot is detected in a scan and it cannot be associated with an existing track, a new track is initiated
- Newly formed track (with few associated plots) are treated as tentative tracks
- When the track PD rises above a certain limit, the track is confirmed and published

When making predictions for the extrapolated positions of the target, ET2 uses an Interacting Multiple Model:

- Several predictions are made, based on different hypotheses for the target movement: uniform motion, coordinated turn, etc.
- A weighted average is calculated from the different predictions and an elliptical search region is defined for the next scan
- The tracker looks for the next plot within the calculated search region
- The tracker creates an internal model for the target behavior and maintains this model by updating the probabilities throughout the track lifetime

This prediction process is illustrated in Figure 5-2

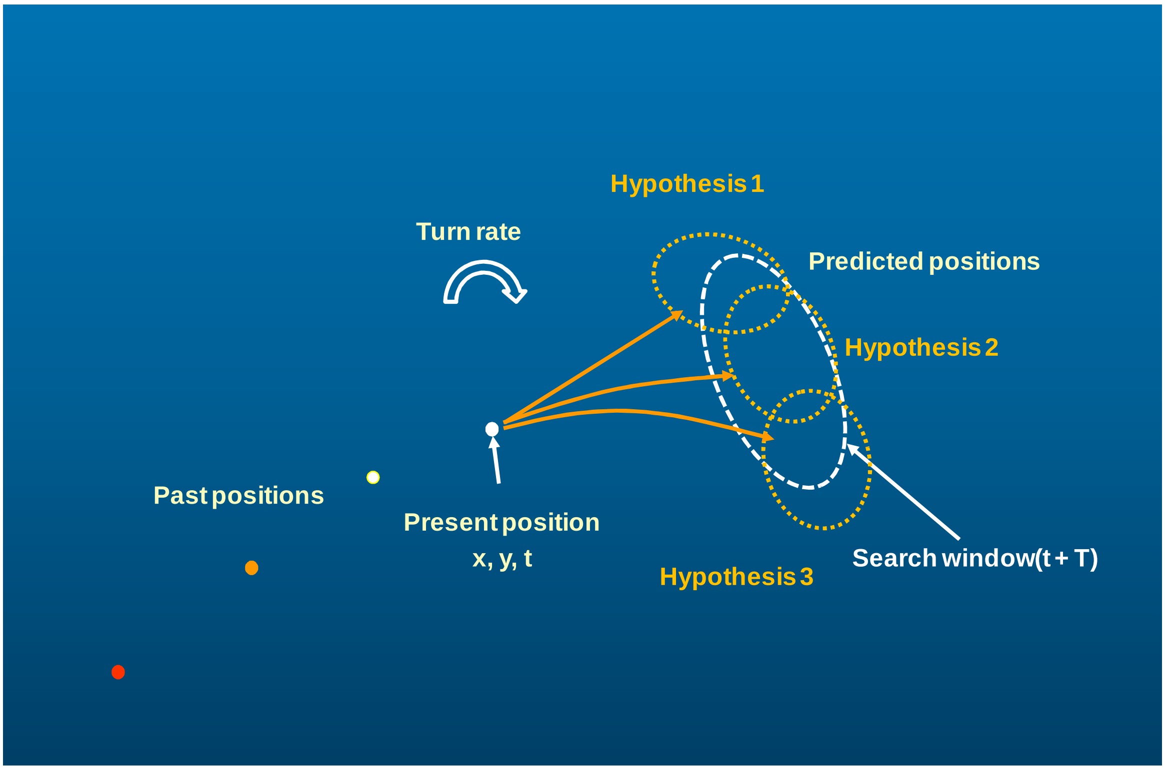


Figure 5-2 Track prediction

6 Terma Support, Maintenance and Availability

The Terma SCANTER radars are designed for un-interrupted service, tailored to individual applications and optimized for low life cycle cost. The systems are modular constructions with extended self test and built-in diagnostics. Using the remote access facilities of the Radar Service Tool it is usually possible immediately to identify a failing module.

Preventive and corrective maintenance is easily accessible and will ensure long term problem free operation.

6.1 Terma support

The Terma support covers the entire life cycle of the SCANTER products and Terma offer complete turn key solutions including delivery, installation, setting to work, fine tuning, training and maintenance.

Installation, setting to work, training and maintenance may alternatively be conducted by non-Terma personnel, but trained by Terma.

6.1.1 Setting-to-work Program

The considerable amount of experience and expertise gained at Terma over a number of years as both a prime and major subcontractor has resulted in a comprehensive and uniform approach to the setting-to-work Program, providing:

- Establishment of a permanent, dedicated project management office common to all SCANTER Radar projects, acting as the single point of contact and responsibility to each individual project.
- Clear, strong, and unambiguous lines of authority and responsibility for program managers across functional boundaries
- High management visibility into program progress, to permit rapid response in problem solving, resource allocation or other management actions.

The project team set-up for the SCANTER product supplies is a highly dedicated group of employees with several years of experience within the field of radar technology, electronics, software, and telecommunication matters. Furthermore, this project team has access to the complete range of Terma expertise.

6.1.2 Installation and set-to-work of equipment

The installation and set-to-work of equipment takes its beginning by proper planning, documentation, outlining of cable plans and establishment of an actual implementation plan. This enables easy installation the Radar Sensor and setting to work according to customer expectations.

6.1.3 Training

Terma offers training in order to ensure efficient utilization of the system and high maintainability at system and module level.

The training courses are conducted by experts (design engineer and/or technician) from Terma.

6.1.4 Maintenance

Radar Sensor systems are highly delicate instruments required to perform in accordance with well defined operational profiles.

Still, life cycle cost must be kept as low as possible. Therefore, the long term support of such systems must be based on highly efficient and skilled organizations though requiring minimum initial investments and low running costs.

Based on world wide experience from numerous installations Terma Radar Systems has designed a package of service solutions that will minimize investment costs, increase system performance and enhance operational lifetime.

Increased system reliability, shipping possibilities and possible remote access to BITE/Service tools in the radar have considerably reduced the need for an available spares and a “hot standby” service support organization.

6.1.5 Spare parts

The Terma SCANTER radars are often part of mission-critical solutions. This call for fast access to corrective maintenance and spare parts. The Terma support includes:

- Supply of spare part packages and consumables
- Exchange service for spare parts, where a defective LRU is replaced with a repaired or new unit from stock at a fixed price
- Repair service where a defective LRU is repaired at cost.

The Radar Sensor system consist of the following LRU's:

- TR module
- PC module
- PSU module
- Motor controller module
- Antenna Assy
- Antenna Arm Assy
- Motor
- Rotary Joint
- Radome & Sun cover

6.1.6 Maintenance contracts

Terma offer contracts for preventive and corrective maintenance, to individual customer requirements.

6.1.7 Total Service Concept

For customers that do not have a technical service organization, Terma can undertake the responsibility for total service of the radar sensor system including traveling to site as well as exchange of any defective modules including consumables (filters, fuses, etc.).

The total service concept includes system health check and preventive maintenance at regular intervals at our choice.

Terma maintains the necessary stock of spare modules.

6.2 Availability, reliability and maintainability

Table 6-1 summarizes the results from an availability, reliability and maintainability analysis performed for the SCANTER 1002 radar system.

The analysis is based on parts count and parts stress methods, combined with long-term experience and statistics obtained from previous SCANTER radar families.

The overall MTBF figures include any faults, whereas the critical MTBF allow for non-critical errors to be present, but repaired at a later stage, e.g. in connection with the next scheduled preventive maintenance visit.

Time for preventive maintenance and access time is allowed in the availability figure. Additional down time is allowed in redundant systems in order to minimize the need for on site spare parts.

The MTTR assumes experienced service technicians trained by Terma in maintenance of the SCANTER radars.

Availability, reliability and maintainability analysis		Board/unit count	MTBF, critical hours	MTTR, hours
Antenna:				0.3
	Antenna incl arm and motor	1	330,000	
Power supply:				1
	PSU	1	150,000	
Transceiver module:				1
	IF Module	1	220,000	
	RF Module	1	220,000	
	SSPA	1	170,000	0.5
Frontend:				
	Filter	1	560,000	0.3
	Cirkulator	1	330,000	1
	Limiter	1	330,000	0.2
	RoJo	1	170,000	1
PC Module:				
	PCM board	1	220,000	1
Motor Ctrl module:				
	Ctrl board	1	200,000	0.5
Transceiver unit, total incl. Antenna			**26,000**	
Availability, system with single transceiver unit			**99.95%**	
Figures are based on a parts count analysis, combined with experienced values for alike products.				
25°C Ambient temperature and 230 V mains supply assumed.				
- 2 hours of downtime/year is allowed for preventive maintenance in the availability calculation.				
- 0 hours of access time is allowed in the availability calculations.				

Table 6-1 SCANTER 1002 system availability

Scheduled maintenances will include visual inspection and cleaning of cooling fins and surface finish each 2-4th year depending on the environmental conditions. No wear parts or consumables are scheduled to be replaced within 7 years. Compliance to the scheduled maintenance will ensure at least 15 year operational life time of the Radar Sensor.

7 Safety

In order to protect the immediate surroundings from extended exposure to electromagnetic radiation, the safety system will prevent transmitting whenever the antenna is not rotating. This is achieved by not powering up the SSPA unless the antenna encoder signals are indicating that the antenna is rotating.

According to the ICNIRP guideline, the limit fo rhe incident power density level for the genereal public is 10 W/m2 in the frequency band from 1-300GHz and over any 6 minute period. The SCANTER 1002 radar operates within this frequency range. The corresponding level for occupational exposure is 50 W/m2.

Furthermore, the ICNIRP guidelines states that the peak power density shall not exceed the average power density by a factor of more than 1000. The peak power to average power ratio for SCANTER 1002 is 20 so the most important requirement is the average power.

Worst case calculated distances, to comply with ICNIRP recommendations, with maximum available power fed to a non-rotating antenna in its horizontal position and including peak power considerations are shown in

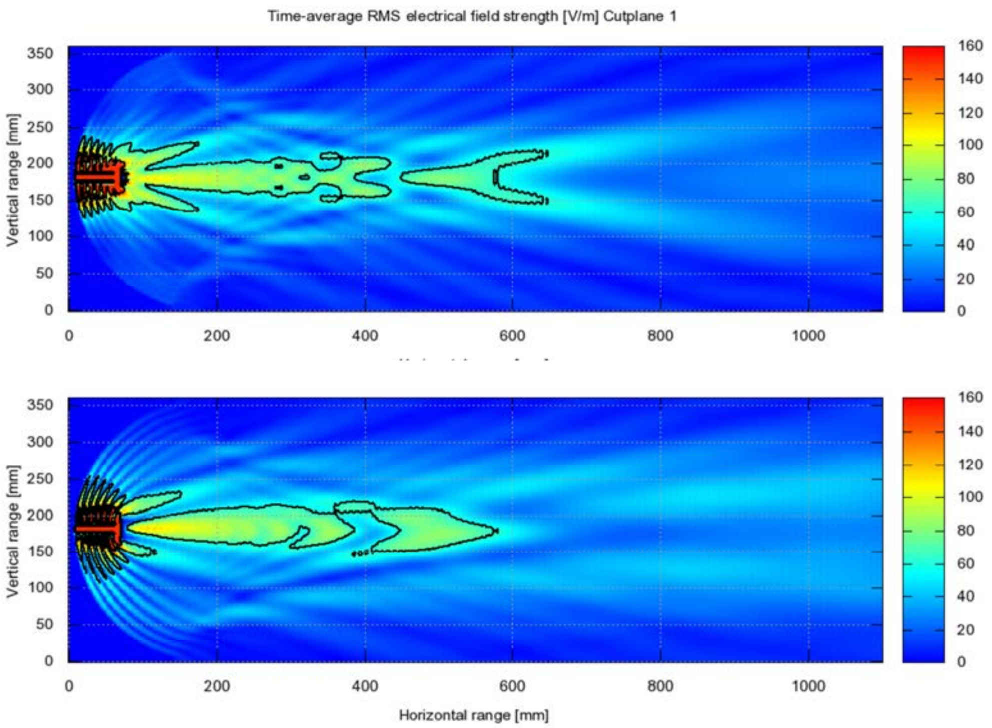


Figure 13 Electrical field strength in V/m for SCANTER 1002 in the horizontal plan (top) and vertical plan (bottom). Contour indicates 10 W/m2 (61.4 V/m). 50 W/m2 corresponds to 137 V/m.

The showed results are for a non-rotating antenna and this condition is avoided by the control system of the radar. When the antenna is rotation the average power level is 120 times lower (equivalent to 11 times lower electric field). Therefore, in normal operation, the hazard zone will be inside the cover of the radar and not accessible for any operator.

8 Interfaces

Power supply	
Mains input	1 x 100 - 230 VAC + Neutral 50 - 60 Hz. 120 - 150 watt
Communication	
Ethernet (1 pcs.)	IP Network video (Streaming) Control, monitoring and setup Plots, tracks and status output 10/100 Mbit/s BASE-T
Video output	
Network video	8 bit UDP/IP Network video

Table 8-1: External interface summary

9 Environment

Packed for transportation and storage environment requirements

Temperature	-40℃ to 70℃	IEC 60068-2-1 / 60068-2-2
Humidity	< 95% RH @ 45ºC	IEC 60068-2-3
IP protection class	Keep dry	
Bumps	15g, 16 ms, 1000 bumps	IEC 60068-2-29

Operational enviroment requirements

Temperature	-25 ℃ to 55 ℃ + 1120W/sqm sun radiation	IEC 60068-2-2 / 60721-2-4+A
Humidity	< 96% RH @ 45ºC	IEC 60068-2-38
Corrosivity category	C5-M (Severity (1))	EN ISO 12944
IP protection class	IP 54 (Dust and splashing water any direction)	IEC 60529
Shocks	25g, half sine, 6ms, 3 shocks	IEC 60068-2-27
EMC immunity	Immunity for industrial enviroments	IEC 61000-6-2
EMC emission	Emission standard for residential enviroments	IEC 61000-6-3
Radio spectrum	Unwanted emissions in the out-of-band domain	ITU-R SM.1541-2 Annex 8
	Unwanted emissions in the spurious domain	ITU-R SM.329-10
Acoustic noise	< 40 dB(A) @ 1 m	-

Table 9-1: Environmental requirements

10 Approvals, requirements and conformities

Designed and manufactured to conform to the following. Details can be supplied on request.

Approval / Conformity	Compliance	Reference / Remarks
CE	Certified	Machinery directive 2006/42/EC EMC directive 2004/108/EC Low Voltage Directive 2006/95/EC R&TTE Directive 1999/5/EC
RoHS	Designed to comply	Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment - RoHS - 2002/95/EC
IALA AISM	Designed to comply	International Association of Lighthouse Authorities IALA Recommendation V-128
INTERTEK ETL LISTED, UL, IECEE CB SCHEME	Certification in progress	Underwriters Laboratories / ETL Intertek SEMCO UL/ANSI 60950-1 2nd ed. CB report - IECEE
25	Designed to comply	China RoHS Environmentally safe for 25 years

Table 10-1 Standard compliance

11 Quality assurance certification

AQAP-2110

For more than 25 years, Terma A/S has been certified to the NATO Quality standard AQAP-1, later AQAP-110 and AQAP-150, and since 2006, Terma has been assessed and certified to AQAP-2110 by Bureau Veritas Certification.

ISO 9001

Since 2003, Terma has been assessed and certified to ISO 9001 by Bureau Veritas Certification.

Terma Quality Management System

Terma Quality Management System is an inherent part of the Terma Management System (TMS), which is an on-line process orientated information system on Terma’s intranet. TMS is formed as a front-end to the Quality Handbook and other business procedures for each business area giving an easy way to gain relevant information to the individual employee based on the actual job and stage in the process.

Other certifications

Contact Terma A/S for a complete list of various second party approvals and certificates.

12 Definitions

Term	Definition
ASCII	American Standard Code for Information Interchange
BITE	Built-in Test Equipment
CFAR	Constant False Alarm Rate
CMS	Combat Management Systems
CRP	Chirp repitition Frequency
EIA	Electronics Industries Alliance
EMC	Electromagnetic compatibility
EMCON	EMission CONtrol
ESD	Electro Static Discharge
FCC	Federal Communications Commission
FD	Frequency Diversity
I/O	Input/Output
IEC	International electrotechnical commission
IF	Intermediate Frequency
IP	Internet Protocol
ISO	International Organization for Standardization
ITU	International Telecommunication Union
kts	Knots
LAN	Local Area Network
LRU	Line Replacable Unit
LVDS	Low Voltage Differential Signalling
MDR	Minimum Detection Range
MDS	Minimum Detection Signal
MMIC	Monolithic Microwave Integrated Circuits
MTI	Moving Target Indicator
nmi	Nautical Miles
NTIA	National Telecommunications and Information Administration
PA	Power Amplifier
PC	Personal Computer
PRF	Pulse Repetition Frequency
PSLR	Peak Sidelobe Level Ratio
R&TTE	Radio and Telecommunications Terminal Equipment Directive
RCS	Radar Cross Section
RF	Radio Frequency
RH	Relative Humidity
RoHS	Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment
RPM	Rotations Per Minute
RS	Recommended Standard
Rx	Receive

RxTx	Transceiver
SFP	Small Form-factor Pluggable
SMR	Surface Movement Radar
SNR	Signal-to-Noise Ratio
SNTP	Simple Network Time Protocol
SOG	Speed Over ground
SSPA	Solid-State Power Amplifier
STC	Sensitivity Time Control
TCP/IP	Transmission Control Protocol / Internet Protocol
TD	Time Diversity
TIA	Telecommunications Industry Association
TMS	Terma Management System
Tx	Transmit
UDP/IP	User Datagram Protocol / Internet Protocol
UL	Underwriters Laboratories
USB	Universal Serial Bus
UV	Ultra Violet
VAC	Voltage Alternating Current
VDC	Voltage Direct Current
VMZ	Video Mask Zone
VSWR	Voltage Standing-Wave Ratio
VTS	Vessel Tracking Service
WAN	Wide Area Network

13 Appendix

SCANTER 1002 cross reference		

TBD