

Московский государственный технический университет
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**Обучение чтению литературы
на английском языке по специальности
«Радиоэлектронные системы и комплексы»**

Учебное пособие



Москва

ИЗДАТЕЛЬСТВО
МГТУ им. Н. Э. Баумана

2 0 1 4

УДК 802.8
ББК 81.2 Англ
С77

Издание доступно в электронном виде на портале *ebooks.bmstu.ru*
по адресу: <http://ebooks.bmstu.ru/catalog/238/book569.html>

Факультет «Лингвистика»
Кафедра «Английский язык для приборостроительных специальностей»

Рекомендовано
Учебно-методической комиссией Научно-учебного комплекса
«Фундаментальные науки» МГТУ им. Н.Э. Баумана

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С77 Обучение чтению литературы на английском языке по специальности «Радиоэлектронные системы и комплексы»: учебное пособие / И. В. Стасенко, И. Г. Сафарова, Ю. А. Кальгин. — Москва : Издательство МГТУ им. Н. Э. Баумана, 2014. — 35, [5] с.

ISBN 978-5-7038-4023-8

Данное учебное пособие предназначено для формирования у студентов умения продуктивно работать с оригинальной научной литературой на английском языке по своей специализации с целью извлечения наиболее значимой информации. Задания к текстам обеспечивают детальную проработку текстов и подводят обучающихся к составлению аннотаций и рефератов научных статей.

Для студентов, обучающихся по специальности «Радиоэлектронные системы и комплексы».

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ПРЕДИСЛОВИЕ

Основу данного учебного пособия составляют три урока, предназначенные для проработки студентами за один семестр. Каждый урок состоит из трех текстов (А, В, С), раскрывающих одну законченную тему.

В конце каждого текста в скобках указан его объем (количество знаков).

В первом уроке (Lesson 1) приведены общие сведения о радаре, его технические характеристики, представлена упрощенная схема радара с его основными функциональными составляющими (подсистемами). Разнообразные задания к тестам направлены как на извлечение информации о наиболее важных технических и функциональных деталях рассматриваемых систем и устройств, так и на понимание содержания текста.

Во втором уроке (Lesson 2) рассматриваются радиолокационные передатчики и радиолокационные антенны. В заключительном тексте приведен обзор многочисленных видов современных радаров с выделением их специфических характеристик и областей применения.

В текстах третьего урока (Lesson 3) подробно описываются основные функции радара, а именно: обнаружение объекта, определение расстояния до объекта, а также способы измерения скорости передвижения обнаруженного объекта и угловое наведение. Рассматривается вопрос наиболее эффективного использования диапазона рабочих частот.

В заключительной части пособия представлены тексты на русском языке, раскрывающие такую сторону научных достижений в радиолокации, как применение радиолокационных устройств в системах навигационного позиционирования GPS и ГЛОНАСС. Студенты должны изложить эту дополнительную информацию на английском языке в краткой форме в виде свободного высказывания.

Дополнительные тексты № 1 и № 2 предназначены для самостоятельного выполнения контрольного письменного перевода как основы для подготовки презентации. Текст № 2 пред-

ставляет собой оригинальную научную статью, к которой в качестве образца приложены аннотация и реферат на русском языке, оформленные в соответствии с рекомендациями ВИНТИ РФ и требованиями Международного стандарта ГОСТ 7.9—95.

Единая структура уроков позволяет реализовать и закрепить лексико-грамматические навыки студента, а также сформировать коммуникативные компетенции, предусмотренные программой УМКД «Английский язык».

Lesson 1

Memorize the following basic vocabulary and terminology to text 1A:

medium-range radar – РЛС средней дальности (среднего радиуса действия)

palm – палм (внесистемная единица длины)

precipitation – выпадение осадков

clear-air-turbulence – турбулентность при ясном небе

angular direction – угловое направление

rate of change of the range measurement – диапазон измерения ускорения

track – путь; зд. направление

Read text 1A and answer the questions after it.

Text 1A Radar in brief

Radar is an electromagnetic sensor for the detection and location of reflecting objects. Its operation can be summarized as follows:

- the radar radiates electromagnetic energy from an antenna to propagate in space;
- some of the radiated energy is intercepted by a reflecting object, usually called a target, located at a distance from the radar;
- the energy intercepted by the target is reradiated in many directions;
- some of the reradiated (echo) energy is returned to and received by the radar antenna;
- after amplification by a receiver and with the aid of proper signal processing, a decision is made at the output of the receiver as to whether or not a target echo signal is present. At that time, the target location and possibly other information about the target is acquired.

A common waveform radiated by a radar is a series of relatively narrow, rectangular-like pulses. An example of a waveform for a medium-range radar that detects aircraft might be described as a short pulse one millionth of a second in duration (one microsecond); the time between pulses might be one millisecond.

Some radars have to detect targets at ranges as short as the distance from behind home plate to the pitcher's mound in a baseball park (to measure the speed of a pitched ball), while other radars have to operate over distances as great as the distances to the nearest planets. Thus, a radar might be small enough to hold in the palm of one hand or large enough to occupy the space of many football fields.

Radar targets might be aircraft, ships, or missiles; but radar targets can also be people, birds, insects, precipitation, clear air turbulence, ionized media, land features (vegetation, mountains, roads, rivers, airfields, buildings, fences, and power-line poles), sea, ice, icebergs, buoys, underground features, meteors, aurora, spacecraft, and planets. In addition to measuring the range to a target as well as its angular direction, a radar can also find the relative velocity of a target either by determining the rate of change of the range measurement with time or by extracting the radial velocity from the Doppler frequency shift of the echo signal. If the location of a moving target is measured over a period of time, the track, or trajectory, of the target can be found from which the absolute velocity of the target and its direction of travel can be determined and a prediction can be made as to its future location. Properly designed radars can determine the size and shape of a target and might even be able to recognize one type or class of target from another.

(2 149)

Answer the following questions.

1. What is a radar? 2. How can its operation be summarized? 3. How can a common waveform (radiated by a radar) be described? 4. What is the range of a radar? 5. How can a radar influence on the size and shape of a target?

Task 1. Describe the operation of a radar.

Task 2. Speak about radar targets.

Task 3. Find some more information about radar.

Memorize the following basic vocabulary and terminology to text 1B:

duplexer – антенный переключатель

spatial filter to – фильтр пространственных частот

local oscillator – излучатель генератор

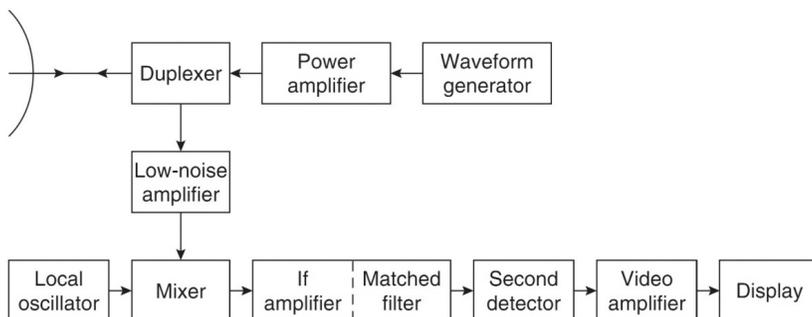
lownoise amplifier – усилитель с низким уровнем собственных шумов

Read and translate text 1B.

Text 1B Basic Parts of a Radar

Very elementary basic block diagram shows the subsystems usually found in a radar (See the figure). The transmitter, which is shown here as a power amplifier, generates a suitable waveform for the particular job the radar is to perform. It might have an average power as small as milliwatts or as large as megawatts. (The average power is a far better indication of the capability of a radar's performance than is its peak power.) Most radars use a short pulse waveform so that a single antenna can be used on a time-shared basis for both transmitting and receiving.

The function of the duplexer is to allow a single antenna to be used by protecting the sensitive receiver from burning out while the transmitter is on and by directing the received echo signal to the receiver rather than to the transmitter.



The antenna is the device that allows the transmitted energy to be propagated into space and then collects the echo energy on receive. It

is almost always a directive antenna, one that directs the radiated energy into a narrow beam to concentrate the power as well as to allow the determination of the direction to the target. An antenna that produces a narrow directive beam on transmit usually has a large area on receive to allow the collection of weak echo signals from the target. The antenna not only concentrates the energy on transmit and collects the echo energy on receive, but it also acts as a spatial filter to provide angle resolution and other capabilities.

The receiver amplifies the weak received signal to a level where its presence can be detected. Because noise is the ultimate limitation on the ability of a radar to make a reliable detection decision and extract information about the target, care is taken to insure that the receiver produces very little noise of its own. At the microwave frequencies, where most radars are found, the noise that affects radar performance is usually from the first stage of the receiver, shown here in the figure as a low-noise amplifier. (1 817)

Task 1. Give those radar technical characteristics that must be of interest for radar transmitter users.

Task 2. Find sentences which give the main idea of each paragraph and put them down.

Task 3. Write the plan of the text.

Task 4. Write a summary of the text in Russian according to your plan.

Memorize the following basic vocabulary and terminology to text 1C:

clutter – мешающие отраженные сигналы (помехи)

adversely affect – неблагоприятно воздействовать

saturate – насыщать

tolerated – допускать; tolerance – допуск

intermediate frequency – промежуточная частота

matched filter – согласованный фильтр

Doppler processing – доплеровская обработка данных

predetermined threshold – установленный заранее порог

excessive false alarms – избыточный ложный сигнал тревоги

locus of target locations – местоположение мишени

missile – реактивный снаряд
bandwidth – диапазон рабочих частот (ширина полосы частот)
degrade – искажать, ухудшать
IF – intermediate frequency – промежуточная частота (ПЧ)

Read text 1C with the dictionary.

Text 1C

Radar applications

For many radar applications where the limitation to detection is the unwanted radar echoes from the environment (called clutter), the receiver needs to have a large enough dynamic range so as to avoid having the clutter echoes adversely affect detection of wanted moving targets by causing the receiver to saturate. The dynamic range of a receiver, usually expressed in decibels, is defined as the ratio of the maximum to the minimum signal input power levels over which the receiver can operate with some specified performance. The maximum signal level might be set by the nonlinear effects of the receiver response that can be tolerated (for example, the signal power at which the receiver begins to saturate), and the minimum signal might be the minimum detectable signal. The signal processor, which is often in the IF portion of the receiver, might be described as being the part of the receiver that separates the desired signal from the undesired signals that can degrade the detection process. Signal processing includes the matched filter that maximizes the output signal-to-noise ratio. Signal processing also includes the Doppler processing that maximizes the signal-to-clutter ratio of a moving target when clutter is larger than receiver noise, and it separates one moving target from other moving targets or from clutter echoes. The detection decision is made at the output of the receiver, so a target is declared to be present when the receiver output exceeds a predetermined threshold. If the threshold is set too low, the receiver noise can cause excessive false alarms. If the threshold is set too high, detections of some targets might be missed that would otherwise have been detected. The criterion for determining the level of the decision threshold is to set the threshold so it produces an acceptable predetermined average rate of false alarms due to receiver noise.

After the detection decision is made, the track of a target can be determined, where a track is the locus of target locations measured over time. This is an example of data processing. The processed target detection information or its track might be displayed to an operator; or the detection information might be used to automatically guide a missile to a target; or the radar output might be further processed to provide other information about the nature of the target. The radar control insures that the various parts of a radar operate in a coordinated and cooperative manner, as, for example, providing timing signals to various parts of the radar as required.

The radar engineer has as resources time that allows good Doppler processing, bandwidth for good range resolution, space that allows a large antenna, and energy for long range performance and accurate measurements. External factors affecting radar performance include the target characteristics; external noise that might enter via the antenna; unwanted clutter echoes from land, sea, birds, or rain; interference from other electromagnetic radiators; and propagation effects due to the earth's surface and atmosphere. These factors are mentioned to emphasize that they can be highly important in the design and application of a radar. (2 685)

Task 1. Read text IC again and write headings to each paragraph.

Task 2. Find these words in the text. Write a short definition for each one.

magnetron	receiver	resolution
cavity	predetermined threshold	bandwidth
frequency	transmitter	saturation

Grammar exercise

Translate into Russian the following sentences paying attention to Gerund constructions and their syntactic functions.

1. We know the Great Russian scientist Konstantin Tsiolkovsky (1857–1935) to have developed fundamentals of rocket design. He also predicted future space flights more than a century ago.

2. It was not until April 1961 that the world learnt about the first orbital flight made by Soviet cosmonaut Yuri Gagarin.
3. It was not until March 1966 that the first docking of one space vehicle with another was carried out but failed.
4. It was not until 1968 that the first command service module landed on the Moon and sent views of lunar surface to the Earth.
5. It was not until May 1969 that the first lunar landing was made by American astronauts Armstrong and Aldrin who collected soil and rock samples. They were reported to have stayed on the Moon 21 h 36 min.
6. It was not until June 1963 that the first woman cosmonaut Valentina Tereshkova orbited the Earth.
7. It was not until the 16th century that the English discovered large deposits of pure graphite.
8. It was not until 1779 that Swedish chemist Carl Scheele realized that graphite is a variety of carbon.
9. It was not until the end of the 19th century that German geologist Gottlob Werner gave the newly discovered substance a more appropriate name – graphite.
10. It was not until the 1950s and 1960s that over-the-horizon radar systems were developed and used as a part of early warning systems.
11. The U.S. Department of Defence was developing the Global Positioning System in the 1970s. But it was not until 1978 that the first GPS satellite was launched.

Lesson 2

Memorize the following basic vocabulary and terminology to text 2A:

crossed-field tube – электронный СВЧ-прибор

crossed-field amplifier (CFA) – усилитель магнетронного типа

traveling wave tube (TWT) – лампа бегущей волны

linear beam tubes – электронно-лучевая трубка (лампа)

grid control vacuum tube – усилительный прибор

UHF (ultra high frequency) – ультравысокая частота

Read text 2A and answer questions after the text.

Text 2A Radar Transmitters

The radar transmitter must not only be able to generate the peak and average powers required to detect the desired targets at the maximum range, but also has to generate a signal with the proper waveform and the stability needed for the particular application. Transmitters may be oscillators or amplifiers, but the latter usually offer more advantages.

There have been many types of radar power sources used in radar. The magnetron power oscillator was at one time very popular, but it is seldom used except for civil marine radar. Because of the magnetron's relatively low average power (one or two kilowatts) and poor stability, other power sources are usually more appropriate for applications requiring long-range detection of small moving targets in the presence of large clutter echoes. The magnetron power oscillator is an example of what is called a crossed-field tube. There is also a related crossed-field amplifier (CFA) that has been used in some radars in the past, but it also suffers limitations for important radar applications, especially for those requiring detection of moving targets in clutter. The high-power klystron and the traveling wave tube (TWT) are examples of what are called linear beam tubes. At the high powers often employed

by radars, both tubes have suitably wide bandwidths as well as good stability as needed for Doppler processing, and both have been popular.

The solid-state amplifier, such as the transistor, has also been used in radar, especially in phased arrays. Although an individual transistor has relatively low power, each of the many radiating elements of an array antenna can utilize multiple transistors to achieve the high power needed for many radar applications. When solid-state transistor amplifiers are used, the radar designer has to be able to accommodate the high duty cycle at which these devices have to operate, the long pulses they must use that require pulse compression, and the multiple pulses of different widths to allow detection at short as well as long range. Thus the use of solid-state transmitters can have an effect on other parts of the radar system. At millimeter wavelengths very high power can be obtained with the gyrotron, either as an amplifier or as an oscillator. The grid-control vacuum tube was used to good advantage for a long time in UHF and lower frequency radars, but there has been less interest in the lower frequencies for radar.

Although not everyone might agree, some radar system engineers – if given a choice—would consider the klystron amplifier as the prime candidate for a high-power modern radar if the application were suitable for its use. (2 240)

Answer the following questions.

1. What is the aim of a radar transmitter? 2. What types of radar power sources are used in radar? 3. Describe a crossed-field tube as an example of the magnetron power oscillator? 4. In what cases a solid-state amplifier is used in radar? 5. What is a gyrotron?

Task 1. Describe different types of radar transmitters.

Task 2. Give full forms of the following abbreviation: RF, RRS, CRT, UHF, GPS, FET, NASA, ampl.

Task 3. Sum up the information about radar transmitters and formulate your own plan based on all texts above.

Read text 2B using a dictionary (time limit 25 min).

Text 2B

Radar Antennas

The antenna is what connects the radar to the outside world. It performs several purposes: concentrates the radiated energy on transmit; that is, it is directive and has a narrow beamwidth; collects the received echo energy from the target; provides a measurement of the angular direction to the target; provides spatial resolution to resolve (or separate) targets in angle; and allows the desired volume of space to be observed. The antenna can be a mechanically scanned parabolic reflector, a mechanically scanned planar phased array, or a mechanically scanned end-fire antenna. It can be an electronically scanned phased array using a single transmitter with either a corporate feed or a space-feed configuration to distribute the power to each antenna element or an electronically scanned phased array employing at each antenna element a small solid-state "miniature" radar (also called an active aperture phased array). Each type of antenna has its particular advantages and limitations. Generally, the larger the antenna the better, but there can be practical constraints that limit its size. (1 050)

Memorize the following basic vocabulary and terminology to text 2B:

- pulse radar – импульсная РЛС
- surveillance radar – обзорная РЛС
- moving target indication (MTI) – РЛС с селекцией движущихся целей
- tracking radar – сопровождающая РЛС
- Single Target Tracker (STT) – станция сопровождения цели
- imaging radar – РЛС с формированием изображения
- Synthetic Aperture Radar (SAR) – РЛС с синтезированной апертурой
- Inverse Synthetic Aperture Radar (ISAR) – РЛС с инверсной синтезированной апертурой
- Guidance Radar – РЛС наведения

Task 1. Read text 2C and fill in the following table describing each types of radar mentioned in the text.

Type of radar	Technical features	Main functions	Fields of application	Advantages	Disadvantages

Task 2. Prepare a presentation about some types of radars that are particularly interesting to you, prove their importance and advantages.

Text 2C

Types of radars

Although there is no single way to characterize a radar, here we do so by means of what might be the major feature that distinguishes one type of radar from another.

Pulse radar. This is a radar that radiates a repetitive series of almost-rectangular pulses. It might be called the canonical form of a radar, the one usually thought of as a radar when nothing else is said to define a radar.

High-resolution radar. High resolution can be obtained in the range, angle, or dop-pler velocity coordinates, but high resolution usually implies that the radar has high range resolution. Some high-resolution radars have range resolutions in terms of fractions of a meter, but it can be as small as a few centimeters.

Pulse compression radar. This is a radar that uses a long pulse with internal modulation (usually frequency or phase modulation) to obtain the energy of a long pulse with the resolution of a short pulse.

Continuous wave (CW) radar. This radar employs a continuous sine wave. It almost always uses the Doppler frequency shift for detecting moving targets or for measuring the relative velocity of a target.

FM-CW radar. This CW radar uses frequency modulation of the waveform to allow a range measurement.

Surveillance radar. Although a dictionary might not define surveillance this way, a surveillance radar is one that detects the presence of a target (such as an aircraft or a ship) and determines its location in range and angle. It can also observe the target over a period of time so as to obtain its track.

Moving target indication (MTI). This is a pulse radar that detects moving targets in clutter by using a low pulse repetition frequency (PRF) that usually has no range ambiguities. It does have ambiguities in the Doppler domain that result in so-called blind speeds.

Pulse Doppler radar. There are two types of pulse Doppler radars that employ either a high or medium PRF pulse radar. They both use the Doppler frequency shift to extract moving targets in clutter. A high PRF pulse Doppler radar has no ambiguities (blind speeds) in Doppler,

but it does have range ambiguities. A medium PRF pulse Doppler radar has ambiguities in both range and Doppler.

Tracking radar. This is a radar that provides the track, or trajectory, of a target. Tracking radars can be further delineated as STT, ADT, TWS, and phased array trackers as described below:

Single Target Tracker (STT). Tracks a single target at a data rate high enough to provide accurate tracking of a maneuvering target. A revisit time of 0.1 s (data rate of 10 measurements per second) might be "typical." It might employ the monopulse tracking method for accurate tracking information in the angle coordinate.

Automatic detection and tracking (ADT). This is tracking performed by a surveillance radar. It can have a very large number of targets in track by using the measurements of target locations obtained over multiple scans of the antenna. Its data rate is not as high as the STT. Revisit times might range from one to 12 sec, depending on the application.

Track-while-scan (TWS). Usually a radar that provides surveillance over a narrow region of angle in one or two dimensions, so as to provide at a rapid update rate location information on all targets within a limited angular region of observation. It has been used in the past for ground-based radars that guide aircraft to a landing, in some types of weapon-control radars, and in some military airborne radars.

Phased array tracker. An electronically scanned phased array can (almost) "continuously" track more than one target at a high data rate. It can also simultaneously provide the lower data rate tracking of multiple targets similar to that performed by ADT.

Imaging radar. This radar produces a two-dimensional image of a target or a scene, such as a portion of the surface of the earth and what is on it. These radars usually are on moving platforms.

Sidelooking airborne radar (SLAR). This airborne sidelooking imaging radar provides high resolution in range and obtains suitable resolution in angle by using a narrow beamwidth antenna.

Synthetic aperture radar (SAR). SAR is a coherent* imaging radar on a moving vehicle that uses the phase information of the echo signal to obtain an image of a scene with high resolution in both range and cross-range. High range resolution is often obtained using pulse compression.

Inverse synthetic aperture radar (ISAR). ISAR is a coherent imaging radar that uses high resolution in range and the relative motion

of the target to obtain high resolution in the Doppler domain that allows resolution in the cross-range dimension to be obtained. It can be on a moving vehicle or it can be stationary.

Weapon control radar. This name is usually applied to a single-target tracker used for defending against air attack.

Guidance radar. This is usually a radar on a missile that allows the missile to "home in," or guide itself, to a target.

Weather (meteorological) observation. Such radars detect, recognize, and measure precipitation rate, wind speed and direction, and observe other weather effects important for meteorological purposes. These may be special radars or another function of surveillance radars.

Doppler weather radar. This is a weather observation radar that employs the doppler frequency shift caused by moving weather effects to determine the wind; the wind shear (when the wind blows in different directions), which can indicate a dangerous weather condition such as a tornado or a downburst of wind; as well as other meteorological effects.

Target recognition. In some cases, it might be important to recognize the type of target being observed by radar (e.g., an automobile rather than a bird), or to recognize the particular type of target (an automobile rather than a truck, or a starling rather than a sparrow), or to recognize one class of target from another (a cruise ship rather than a tanker). When used for military purposes, it is usually called a noncooperative target recognition (NCTR) radar, as compared to a cooperative recognition system such as IFF (identification friend or foe), which is not a radar. When target recognition involves some part of the natural environment, the radar is usually known as a remote sensing (of the environment) radar.

Multifunction radar. If each of the above radars were thought of as providing some radar function, then a multifunction radar is one designed to perform more than one such function—usually performing one function at a time on a time-shared basis.

There are many other ways to describe radars, including land, sea, airborne, space-borne, mobile, transportable, air-traffic control, military, ground-penetrating, ultra-wideband, over the horizon, instrumentation, laser (or lidar), by the frequency band at which they operate (UHF, L, S, and so on), by their application, and so forth. (5 700)

Grammar exercise

Make up impersonal sentences form incomplete phrases and verbs given below in points A and B.

Example:

The distance to the satellite....

calculate

The distance to the satellite was calculated.

A.

1. The 3D image-recognition algorithm...
2. The wide-band imaging system...
3. Some shortcomings of metal detection systems...
4. The signal transit time to both satellite...
5. The appearance of a wide range of products made of grapheme such as high-speed transistors...
6. Fundamental works of world-famous physicists...
7. New aspects of this phenomenon...
8. Some examples of remarkable grapheme qualities...
9. The importance of further research...
10. The importance of developing new computers technologies...
11. Advantages of millimeter-wave imagine techniques...
12. Previous research results in this field of science...
13. The appearance of quantum computer performing certain calculations more efficiently...

B.

verbs: confirm, consider, give, emphasize, devote, determine, calculate, predict, develop, estimate, list-enumerate, mention, specify, refer to.

Lesson 3

Memorize the following basic vocabulary and terminology to text 3A:

remote target – дистанционная цель
amplitude modulation – амплитудная модуляция
distinctive modulation – характерная модуляция
radar signal bandwidth – ширина спектра радарного сигнала
magnitude – величина, значение
air-surveillance radar – радиолокационный обзор
elevation – зд. вертикальный угол
discern – разглядеть

Read text 3A and answer questions after the text.

Text 3A Information Available from a Radar

Detection of targets is of little value unless some information about the target is obtained as well. Likewise, target information without target detection is meaningless.

Range. Probably the most distinguishing feature of a conventional radar is its ability to determine the range to a target by measuring the time it takes for the radar signal to propagate at the speed of light out to the target and back to the radar. No other sensor can measure the distance to a remote target at long range with the accuracy of radar (basically limited at long ranges by the accuracy of the knowledge of the velocity of propagation). At modest ranges, the precision can be a few centimeters. To measure range, some sort of *timing mark* must be introduced on the transmitted waveform. A timing mark can be a short pulse (an amplitude modulation of the signal), but it can also be a distinctive modulation of the frequency or phase. The accuracy of a range measurement depends on the radar signal bandwidth: the wider

the bandwidth, the greater the accuracy. Thus *bandwidth* is the basic measure of range accuracy.

Radial Velocity. The radial velocity of a target is obtained from the rate of change of range over a period of time. It can also be obtained from the measurement of the Doppler frequency shift. An accurate measurement of radial velocity requires time. Hence *time* is the basic parameter describing the quality of a radial velocity measurement. The speed of a moving target and its direction of travel can be obtained from its track, which can be found from the radar measurements of the target location over a period of time.

Angular Direction. One method for determining the direction to a target is by determining the angle where the magnitude of the echo signal from a scanning antenna is maximum. This usually requires an antenna with a narrow beamwidth (a high-gain antenna). An air-surveillance radar with a rotating antenna beam determines angle in this manner. The angle to a target in one angular dimension can also be determined by using two antenna beams, slightly displaced in angle, and comparing the echo amplitude received in each beam. Four beams are needed to obtain the angle measurement in both azimuth and elevation. The monopulse tracking radar is a good example. The accuracy of an angle measurement depends on the *electrical size of the antenna*; i.e., the size of the antenna given in wavelengths.

Size and Shape. If the radar has sufficient resolution capability in range or angle, it can provide a measurement of the target extent in the dimension of high resolution. Range is usually the coordinate where resolution is obtained. Resolution in cross range (given by the range multiplied by the antenna beamwidth) can be obtained with very narrow beamwidth antennas. However, the angular width of an antenna beam is limited, so the cross-range resolution obtained by this method is not as good as the range resolution. Very good resolution in the cross-range dimension can be obtained by employing the Doppler frequency domain, based on SAR (synthetic aperture radar) or ISAR (inverse synthetic aperture radar systems). There needs to be relative motion between the target and the radar in order to obtain the cross-range resolution by SAR or ISAR. With sufficient resolution in both range and cross-range, not only can the size be obtained in two orthogonal coordinates, but the target shape can sometimes be discerned. (2 900)

Answer the following questions.

1. What information is important for target detection? 2. How can range be measured? 3. How is the radial velocity obtained? 4. How can the angle to a target be determined? 5. What resolution capability is sufficient for size and shape?

Task 1. Find sentences which give the main idea of each paragraph.

Task 2. Remember Latin contractions such as e.g., i.e., et.al., viz, etc., vs.

Learn how to read them in Latin. Use them in your own examples.

Read text 3B and translate it into Russian.

Text 3B

The Importance of Bandwidth in Radar

Bandwidth basically represents information; hence, it is very important in many radar applications. There are two types of bandwidth encountered in radar. One is the signal bandwidth, which is the bandwidth determined by the signal pulse width or by any internal modulation of the signal. The other is tunable bandwidth. Generally, the signal bandwidth of a simple pulse of sine wave of duration τ is $1/\tau$. (Pulse compression waveforms can have much greater bandwidth than the reciprocal of their pulse width.) Large bandwidth is needed for resolving targets in range, for accurate measurement of range to a target, and for providing a limited capability to recognize one type of target from another. High range resolution also can be useful for reducing the degrading effects of what is known as glint in a tracking radar, for measuring the altitude of an aircraft based on the difference in time delay (range) between the two-way direct signal from radar to target and the two-way surface-scattered signal from radar to surface to target (also called multipath height finding), and in increasing the target-signal-to-clutter ratio. In military systems, high range resolution may be employed for counting the number of aircraft flying in close

formation and for recognizing and thwarting some types of deception countermeasures.

Tunable bandwidth offers the ability to change (tune) the radar signal frequency over a wide range of the available spectrum. This can be used for reducing mutual interference among radars that operate in the same frequency band, as well as in attempting to make hostile electronic countermeasures less effective. The higher the operating frequency the easier it is to obtain wide signal and wide tunable bandwidth.

A limitation on the availability of bandwidth in a radar is the control of the spectrum by government regulating agencies (in the United States, the Federal Communication Commission, and internationally, the International Telecommunications Union). After the success of radar in World War II, radar was allowed to operate over about one-third of the microwave spectrum. This spectrum space has been reduced considerably over the years with the advent of many commercial users of the spectrum in the age of "wireless" and other services requiring the electromagnetic spectrum. Thus, the radar engineer is increasingly experiencing smaller available spectrum space and bandwidth allocations that can be vital for the success of many radar applications. (2 130)

Task 1. *Propose and write your own plan of the text in logical consistency.*

Task 2. *Find some more data on bandwidth in radar applications to make this information more complete. Prepare and give a short presentation on the issue.*

Read text 3C with a dictionary.

Text 3C

The Doppler Shift in Radar

The importance of the Doppler frequency shift began to be appreciated for pulse radar shortly after World War II and became an increasingly important factor in many radar applications. Modern radar would be much less interesting or useful if the Doppler effect didn't exist. The Doppler frequency shift f_d can be written as

$$f_d = 2v_r/\lambda = (2v \cos \theta)/\lambda,$$

where $v_r = v \cos \theta$ is the relative velocity of the target (relative to the radar) in m/s, v is the absolute velocity of the target in m/s, λ is the radar wavelength in m, and θ is the angle between the target's direction and the radar beam. To an accuracy of about 3 percent, the Doppler frequency (Hz) is approximately equal to v_r (kt) divided by λ (m).

The Doppler frequency shift is widely used to separate moving targets from stationary clutter. Such radars are known as MTI (moving target indication), AMTI (airborne MTI), and pulse Doppler. All modern air-traffic control radars, all important military ground-based and airborne air-surveillance radars, and all military airborne fighter radars take advantage of the Doppler effect. Yet in WWII, none of these pulse radar applications used Doppler. The CW (continuous wave) radar also employs the Doppler effect for detecting moving targets, but CW radar for this purpose is not as popular as it once was. The HF OTH radar could not do its job of detecting moving targets in the presence of large clutter echoes from the earth's surface without the use of Doppler.

Another significant application of radar that depends on the Doppler shift is observation of the weather, as in the Nexrad radars of the U.S. National Weather Service.

Both the SAR and ISAR can be described in terms of their use of the Doppler frequency shift. The airborne Doppler navigator radar is also based on the Doppler shift. The use of Doppler in a radar generally places greater demands on the stability of the radar transmitter, and it increases the complexity of the signal processing; yet these requirements are willingly accepted in order to achieve the significant benefits offered by Doppler. It should also be mentioned that the Doppler shift is the key capability of a radar that can measure speed, as by its diligent use by traffic police for maintaining vehicle speed limits and in other velocity measuring applications.

Task 1. Use your background knowledge and give your comments on the formula in the text.

Task 2. Find sentences which give the main idea of each paragraph.

Task 3. Find the key-words to speak about the Doppler shift in radar.

Grammar exercise

Translate the following sentences into Russian paying attention to grammar constructions.

1. Though there are always enough satellites to provide a timing and location service, satellite availability is not always one hundred per cent.
2. Since GPS communicates via radio waves which travel at the speed of light, GPS is also a means of determining a user's position.
3. As GPS satellites are constantly moving, they have to be arranged in six orbital planes.
4. In case the ship is closer to one transmitter than to another, then receiving equipment on the ship can measure the time difference between the two signals.
5. Provided three transmitters are available, the ship can determine its position as one of two points of intersection of the hyperbolae.
6. Provided the ship has four transmitters, its position can be determined even more precisely.
7. If the ship crew wants to identify each transmitter uniquely and calculate the time difference, they should refer to Special Reference Book for further details on these points.
8. As ministry of Defense had the task to cover the entire globe with minimal positional errors, a military positioning system led to the rapidly evolutionising satellite-based system.
9. Since the US government also wanted such features as the ability to operate the receiving equipment on fast moving vehicles, such as aircrafts, all these requirements were met by placing the navigation transmitting stations in space.
10. The higher frequency carrier waves are employed, the smaller are positional errors.
11. As a satellite moves through its orbit, it will spend most of its time either moving away from or towards the user.

12. Provided we take into consideration the Doppler Effect, the frequency of the satellite carrier signal will appear slightly higher as the satellite moves towards the user and slightly lower as satellite recedes.
13. In case the satellite is exactly overhead, the carrier frequency will be absolutely correct.
14. Although the carrier frequencies are common to the GPS constellation, the code is different to each satellite.
15. Although spectrum techniques allow users to discern individual signals when many transmitters are using the same carrier frequency, this is like listening to someone talking in a crowded and noisy in room.
16. Since every specific code will repeat, the code itself does not convey any useful information other than to allow a user to receive information.
17. Though every code has high carrier frequencies and high chipping rates, the data stream from each satellite occurs at a very slow rate.
18. Since the user and satellites are located in different strength gravity fields (according to the Theory of Relativity) the satellite clocks will run faster than identical clocks located with the user.

Texts for rendering in English

Система Глобального Позиционирования (GPS) — это сеть из 24 спутников Navstar, летающих по орбите вокруг Земли на высоте 11000 миль (20200 км). Будучи изначально основанной Департаментом Обороны Соединенных Штатов (DOD) и при стоимости порядка \$13 млрд. долларов, GPS доступна бесплатно для всех пользователей, даже из других стран. Данные о позиционировании и времени, полученные от системы, используются в ряде прикладных задач, таких как воздушная, наземная и морская навигация, отслеживание положения автомобилей и кораблей, геодезия и картография, а также для мониторинга естественных ресурсов. С тех пор, как военные ограничения точности были частично сняты в марте 1996 года и полностью сняты в мае 2000 г., GPS может определить положение объекта размером с монету в любом месте на земной поверхности. Первый спутник GPS был запущен в 1978 г. Первые 10 спутников являлись отладочными спутниками, названными Блок I. С 1989 по 1993 год были запущены 23 рабочих спутника, названных Блок II. Запуск 24-го спутника в 1994 году завершил систему. Департамент Обороны держит 4 спутника в резерве для замены уничтоженных или вышедших из строя спутников. Спутники расположены таким образом, что сигнал от шести из них может быть принят практически в любое время и в любой точке земного шара. На сегодняшний момент существуют две спутниковые системы, отмеченные как нынешние и будущие, которые могут предоставлять услуги по определению местоположения.

1. **ГЛОНАСС.** ГЛОНАСС — это Российская спутниковая навигационная система. Во многих отношениях она похожа на GPS: полное «созвездие» состоит из 24 спутников; каждый спутник передает различные данные на двух несущих L-диапазонах; существует один навигационный сигнал, разрешенный для гражданского использования, и набор навигационных сигналов, зарезервированных исключительно для Российского военного применения; существует наземный сегмент, отслеживающий спутники и управляющий ими;

пользователи пассивно принимают сигналы системы, по которым могут ориентироваться в пространстве с точностью до нескольких десятков метров и даже выше. Однако, с точки зрения пользователя слишком легко предположить, что ГЛОНАСС — это то же самое, что GPS. Скорее, существуют несколько ключевых различий между двумя системами. Во многих отношениях ГЛОНАСС более элегантная и экономичная система, чем GPS. К сожалению, существует масса вопросов относительно контроля качества и гораздо более серьезные проблемы с финансированием. Система ГЛОНАСС была заявлена как полностью функциональная 18 января 1996 г. С тех пор было несколько ситуаций, когда функционировало полное созвездие из 24 спутников. В дополнение к выходу спутников из строя, 8 спутников отработали свой срок эксплуатации с того времени. Так что к концу 1997 г. только 15 спутников было доступно для навигации. Однако последние заявления Российских официальных лиц могут означать, что 6 лет пренебрежения ГЛОНАСС подошли к концу. Правительство взяло на себя серьезные финансовые обязательства по возврату системы к полному функционированию к 2006 г. Российские официальные лица также заявляют, что новое поколение спутников ГЛОНАСС (Глонасс-М) имеет более продолжительный срок работы, что должно сгладить нагрузку на систему. Они разработаны с расчетом на 7-летний срок службы, по сравнению с трехлетним сроком существующих спутников. Материализуются ли эти обещания — это второй вопрос. Но даже в сегодняшнем ослабленном состоянии ГЛОНАСС имеет потенциал как самостоятельной навигационной системы, так и дополнения к GPS.

2. **ГАЛИЛЕО.** Спутниковая радионавигационная система Галилео является инициативой Евросоюза и Европейского Космического Агентства. Проект предполагает плановое развертывание в 2006–2007 гг и введение в работу в 2008 г. с годовой стоимостью в 220 млн евро. Проект предполагает к 2008 г. запуск 30 спутников. Технология, положенная в основу «Галилео» более точна и надежна по сравнению с GPS или ГЛОНАСС. Это позволит критичным по безопасности системам — таким как системам управления воздушным движением, кораблями или автомобильной навигации — использовать данную технологию. Система также должна гарантировать покрытие недоступных ранее территорий, например, закрытых зданиями и приполярных областей. Стоимость проекта Галилео оценивают более чем в 3 млрд евро.

Supplementary texts

Task 1. *Read and translate the following text with a dictionary.*

Task 2. *Discuss GPS in power systems.*

Text 1

GPS in power systems

GPS (Global Positioning System) is a system for determining a user's position in space, as such it is widely used for navigation – it is also free of charge. Since GPS communicates via radio waves which travel at a known speed (the speed of light), GPS is also a means of determining a user's position in time.

GPS is now a fully operational service. It comprises three functional areas referred to as *segments*:

- Satellites (space segment)
- GPS receivers (user segment)
- Ground stations (control segment)

There are presently 24 satellites in the GPS constellation. Unlike satellites used for television broadcasting which always remain in the same position above the earth (geosynchronous), GPS satellites are constantly moving. GPS satellites are arranged in six orbital planes, take approximately 12 hours to orbit the earth and are located at a height of 10 898 nautical miles. From any position on the surface of the earth, there are always sufficient satellites in view to provide a timing and location service. Despite this, satellite availability is not always 100%; the system has been biased towards operation over the populated globe with the result that coverage suffers towards the poles (above 60°N and below 60°S).

GPS provides two services:

1. Precise *positioning service* (PPS) is available to restricted users only (mainly USA military). The accuracy of this service is 22 m horizontally and 27.7 m vertically for positioning in space, and 200 ns for positioning in time.

2. *Standard positioning service* (SPS) is available for civilian use and has an accuracy of 100 m horizontally 156 m vertically and 340 ns.

Satellite versus terrestrial positioning. It is useful to consider the reasons why a satellite positioning (navigation) system is preferable to a ground-based system, after all existing ground-based navigation systems are available and cost considerably less than anything involving satellites.

The ship receives a continuous carrier wave transmitted at the same frequency from two transmitters. If the ship is closer to the first transmitter than the second transmitter then receiving equipment on the ship can measure the time difference between the two signals.

Assuming that the signals travel at the speed of light, the ship is closer to transmitter 1. The locus of all such positions is a hyperbola; with a knowledge of the transmitter positions, the ship is able to fix its position on this locus. If three transmitters are available, the ship can determine its position as one of two points of intersection of the hyperbolae. With four transmitters, the ship can uniquely determine its position. This is the basis of the Omega navigating system. Of course there are many additional problems that must also be resolved such as how the ship can identify each transmitter uniquely and how the time difference τ can be calculated if it corresponds to more than one cycle of the carrier.

What is more important to understanding the advantages of satellite navigation systems is to consider the frequency of the carrier signal from the transmitters. There is a conflict of interests in the choice of frequency. These are summarised in the table.

It can be seen why navigational systems such as Omega use VLF carriers since they allow operation over large expanses of water, with a modest number of transmitting sites. Smaller coverage is available with medium frequency systems, such as Decca, with greater positional accuracy, typically 200 m, but many transmitters are required and local topology, i.e. non-direct line of sight between transmitter and receiver, can significantly degrade the location accuracy.

With these thoughts in mind, consider now the problem of providing a navigational system that has to cover the entire globe but with positional errors of less than 50 m. You will quickly come to the conclusion that such a system cannot be realised using a ground-based system. This was precisely the view that the US government came to when considering a military positioning system and led to the evolution of a satellite-based system. In addition the US government also wanted features such as the

ability to operate the receiving equipment on fast moving vehicles, such as aircraft, rather than just ships.

Summary of advantages and disadvantages of frequency choice

Frequency	Advantages	Disadvantages
Low	<ul style="list-style-type: none"> • long distance propagation possible via earth/ionosphere waveguide (VLF at approximately 10 kHz) • no multipath effects (no significant reflection of carrier signals) • few transmitters needed (very large transmitter spacing) • very large area coverage 	<ul style="list-style-type: none"> • long wavelength (16 km) • position error typically $\frac{1}{4}$ of wavelength 4 km (not very accurate)
Medium	<ul style="list-style-type: none"> • long-distance propagation possible to ionospheric reflections • fewer transmitters needed (large transmitter spacing) • large area coverage 	<ul style="list-style-type: none"> • ionospheric reflections can cause multipath receptions of signals • very difficult to achieve high positional accuracy with multipath effects
High	<ul style="list-style-type: none"> • wavelength very short, positional error very low 	<ul style="list-style-type: none"> • signals not reflected by atmosphere • many transmitters required (transmitter spacing is approximately line of sight) • small area coverage

All these requirements can be met by placing the navigation transmitting stations in space. All the transmitters have an unobstructed view of the earth's surface. Each satellite is at an altitude of nearly 11 000 nautical miles which gives direct line of sight coverage to 42 % of the earth's surface. Furthermore, the higher frequency carrier waves employed (between 1 and 2 GHz in GPS)

have a wavelength of 17...25 cm and so the positional error can be made small. Unlike Omega, GPS uses the time of arrival (TOA) difference technique to fix the receiver (the user) position. The main difference is that the satellites transmit their position to the user as well as a carrier signal.

Text 2

Mitigating the Threat of GPS Jamming

by Roger Watt (NovAtel White Paper – June 2012)

An Introduction to GPS Jamming. Originally developed in the 1970s by the U.S. Department of Defense, the global positioning system (GPS) was created so that military units would always know their exact location and the position of other units. GPS is widely credited with helping the U.S.-led coalition win the first Gulf War in 1991. During Operation Desert Storm, military vehicles relied on GPS to navigate without reference to roads or other fixed landmarks. This enabled a strategic battle of maneuver rather than a battle of encounter because soldiers could determine their own locations and target locations quickly and reliably. Then, the military could coordinate an attack based on a known target location rather than just searching on the ground for enemy forces.

GPS has become critical to nearly all military operations and weapons systems. By providing location and time information in all weather conditions, GPS signals are also used in a variety of civilian industries – from construction and surveying to telecommunications, oil and gas, and even agriculture. The system is maintained by the US government and is freely accessible to anyone with a GPS receiver. There are currently an estimated one billion GPS receivers worldwide with hundreds of applications.

GPS signals are transmitted on published radio frequencies from satellites that orbit 20,000 km above the Earth. The GPS transmit levels are only about 50 W at the satellite and weaken further as they approach Earth. This fundamental weakness makes the signals vulnerable to both accidental and deliberate interference. Jammers can prevent a tracking device from determining and reporting a vehicle's location and speed, rendering GPS inoperable. These devices are illegal but easy to obtain. In fact, detailed instructions for building jammers can be found online and simple models plug into a

12 volt car receptacle connector and can be purchased for as little as \$30 online.

A Growing Problem. As GPS jammers become more widely available, jamming occurs more frequently. For example, in late 2009, engineers at Newark airport in New Jersey noticed that GPS receivers used in a new navigation aid were suffering brief, daily breaks in reception. After two months of investigation, the Federal Aviation Administration (FAA) determined the cause was a nearby truck driver who had installed an inexpensive GPS jammer on his truck. His daily commute past the airport was causing the interference, which shows how easily unintended GPS jamming occurs.

Not all GPS jamming occurs innocently, however. The military's reliance on GPS for navigation makes the system a target for sabotage. Military land vehicles are especially vulnerable because almost all light armored vehicles and personnel carriers contain and rely on GPS for navigation. Deliberate jamming prevents proper vehicle navigation, both from the perspective of operation and from a command center's inability to coordinate troop location. A jammer overwhelms the weak GPS signal and prevents the determination of vehicle position and time.

This vulnerability is particularly acute for vehicles involved in targeting air and artillery strikes. If GPS jammers are deployed in an attack scenario, for example, an enemy could foreseeably block the location determination capabilities of an entire troop, rendering them invisible to the command control center. This prevents strategic troop deployment and protection in enemy territory. Jammers can also prevent military emergency vehicles from navigating to their required battlefield destinations.

It is disconcerting that a satellite navigation system that costs billions of dollars can be easily disrupted with an inexpensive, portable ground transmitter, yet it happens. Iraqi defense forces used jammers in the second Gulf War around Baghdad and in November 2007, Newsmax.com reported that China had produced vans equipped with jammers that could be deployed to deny GPS signals.

Defense officials in South Korea and other military organizations report that the North Koreans are capable of disrupting GPS receivers. Reports document signals emanating near the North Korean city of Kaesong that recently interfered with South Korean GPS military and civilian receivers. The jammers were repeatedly switched on for 10 minute periods for several hours over three days. Defense officials

in South Korea, Japan, and the United States have expressed concern about Pyongyang's suspected ability to disrupt GPS navigation.

Armed forces are increasingly aware that hostile jamming can severely impact navigation and timing capabilities. As early as 2005, a US Department of Defense paper presented a test perspective on GPS vulnerabilities and their potential impact on critical infrastructure. The paper stated that „over-reliance on GPS for critical applications could leave us vulnerable to future asymmetric attacks.”

Given the proven success and accuracy of GPS navigation and timing, reliance will not change, so a new solution is needed to protect the military from GPS jamming. America's Space-Based PNT Advisory Board has taken a similar stance, issuing a report in November 2010 that recommends several strategies be used to combat jamming, including a call to manufacturers to harden GPS receivers and create antennas that null interference.

The Solution—GPS Anti-Jamming Technology. NovAtel Inc. and QinetiQ Ltd. have partnered to create a solution for military land and security applications encountering GPS jamming. High performance GAJT (GPS Anti-Jam Technology) is a single unit, GPS interference mitigation antenna that fits any land vehicle. GAJT uses a concept similar to that of noise-cancelling headphones, canceling jamming signals and allowing GPS receivers to acquire and track the satellite signals needed to calculate an accurate position.

Designed as a compact standalone system (just under 290 mm in diameter), GAJT provides anti-jam performance that is comparable to much larger, multi-component CRPA systems, but at a significantly lower cost. The rugged, exterior-mounted. GAJT integrates easily into new platforms and, most importantly, is compatible with existing GPS receivers and vehicle navigation systems.

How GAJT Works. GAJT mitigates interference by creating «nulls», or deliberate blind spots, in antenna gain patterns in the jammer's direction to allow satellite signals to reach the receiver. GAJT generates antenna «nulls», or deliberate blind spots, to mitigate the jammer and allow GPS signals to reach the receiver.

GAJT uses NovAtel's seven-element, small footprint Pinwheel™ antenna to receive GPS signals in the L1 and L2 bands. These frequencies are down- converted to intermediate frequency for high-speed, battlefield performance algorithms. The algorithm optimizes the power and phasing of the seven independent signals to create a single,

high quality output signal that mitigates jamming sources in up to six directions. Then, the output is up-converted to the original GPS frequencies. The clean output signal is delivered through a standard antenna connector via a coaxial cable to any standard new or legacy GPS receiver through the external antenna input port. GAJT accommodates wide bandwidth, ensuring future compatibility with the 24 MHz M-Code GPS signal. GAJT is also capable of creating multiple nulls to protect against several jamming sources.

The Benefits of GAJT Without GPS anti-jam technology, a simple one watt jammer can overpower GPS signals over a large area, denying a position solution from the victim receiver. GAJT improves the GPS jamming immunity of the connected receiver, significantly decreasing the jammers' reach and ensuring that positioning capabilities are retained during combat, training, or other vehicle-based missions. The GAJT system suppresses GPS jamming, which ensures that positioning and timing capabilities are retained during combat or training. This promotes situational awareness, protecting soldier's lives, and improving strategic battlefield performance.

Compact Size, Easy to Integrate GAJT is less than 290 mm in diameter and the antenna elements on NovAtel's CRPA are set at GPS near quarter-wavelength separation. This makes it easy to retrofit GAJT on to vehicles as it simply replaces the old antenna and minimal vehicle alterations are needed. Operator training is not necessary because the original GPS unit remains in place. GAJT is externally mounted, requiring no additional electronics inside the vehicle – only power and a single RF cable. As a single unit, GAJT provides an all-in-one solution unlike other anti-jam systems that typically feature more than one component. This minimizes vehicle downtime and makes it easier to integrate or retrofit existing and legacy fleets with the new GAJT antenna. GAJT can also be used for GPS timing applications on fixed or moving platforms.

Conclusion. GPS technology has revolutionized modern warfare. GPS jammers, now available for sale on the Internet, are increasingly used to degrade and block the satellite signals required to determine position. GPS jamming is, unfortunately, a growing problem that must be addressed, especially as it begins to affect ground troops. NovAtel and QinetiQ have combined their world-leading research and manufacturing capabilities to develop GAJT (GPS Anti-Jam Technology) – a compact, cost-effective system that is essential to

maintain GPS signal acquisition for land vehicle navigation and network timing applications. GAJT delivers anti-jam performance comparable to that of much larger, multi-component CRPA systems used by military organizations, but at a significantly smaller size and lower cost.

References

1. Final Report to Congress: Conduct of the Persian Gulf War, National Defense University, April 1992. <http://www.ndu.edu/library/ebooks/cpgw.pdf>.

2. National PNT Advisory Board Comments on Jamming the Global Positioning Systems – A National Security Threat: Recent Events and Potential Cures, November 2010.

Task 1. Read the following examples of an abstract and summary to supplementary text 2 given above.

Task 2. Analyze these examples of text compression and transformation.

Task 3. Render the compressed texts in English.

Аннотация (образец)

[Защита от помех подавления GPS сигнала]
Mitigating the Threat of GPS Jamming. Roger Watt.
«NovAtel White Paper», 2012, V, 16-21 (англ.)

Рассматривается важность гражданского и военного использования GPS сигналов для определения положения объектов с привязкой ко времени. Обсуждается легкость внесения помех к приему GPS сигнала и актуальность проблемы для военных. Описывается новая высоконадежная система подавления помех GPS сигналам.

Реферат (образец)

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Используемые для разнообразных стратегических и тактических военных операций и гражданских целей GPS сигналы предоставляют

информацию о времени, расположении и перемещении объектов. GPS сигналы достаточно слабы и могут подвергаться случайным и преднамеренным помехам. Легкая доступность устройства подавления GPS сигналов на рынке электроники сделало проблему подавления помех GPS сигналам более актуальной. Примеры умышленного и неумышленного подавления GPS сигнала ставят под угрозу определение положения войск, передачи координат и выполнение аварийно-спасательной техникой боевой задачи. Компания NovAtel Inc совместно с QinetiQ Ltd разработали высококачественную технологию защиты от подавления GPS сигналов и создали экономичное и надёжное средство для наземного военного транспортного средства (НВТС). Антенну менее 290 мм в диаметре устанавливают на внешнюю сторону кузова любого НВТС. Устройство способно свести к нулю активные преднамеренные помехи и позволяет GPS приемникам получать и отслеживать сигналы спутника для обеспечения точного позиционирования НВТС на поле боя. Более дешевая, высоконадёжная, малогабаритная и независимая антенна сравнима с находящейся на вооружении многих военных частей многоэлементной, крупногабаритной антенной с управляемой диаграммой направленности на приёме. Антенну успешно интегрируют в новые базовые системы и совмещают с существующими GPS приемниками и системами навигации НВТС. Новая антенна гарантирует высокую помехозащищенность в ходе военных действий или проведения учений и обеспечивает надёжное определение местоположения, привязку по времени и повышает эффективность проведения военных действий.

(Novatel, Calgary, Канада) Ил. 3. Библ. 2 Ю. Кальгин
02.09.2013 *подпись*

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Учебное издание

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Обучение чтению литературы
на английском языке по специальности
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В оформлении использованы шрифты
Студии Артемия Лебедева

Оригинал-макет подготовлен
в Издательстве МГТУ им. Н.Э. Баумана.

Подписано в печать 08.10.2014. Формат 60×84/16.
Усл. печ. л. 2,3. Тираж 350 экз. Изд. № 32. Заказ

Издательство МГТУ им. Н.Э. Баумана.
105005, Москва, 2-я Бауманская ул., д. 5, стр. 1.
press@bmstu.ru
www.baumanpress.ru

Отпечатано в типографии МГТУ им. Н.Э. Баумана.
105005, Москва, 2-я Бауманская ул., д. 5, стр. 1.
baumanprint@gmail.com