

# MIDDLE EAST TECHNICAL UNIVERSITY

## DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

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### EE400 Summer Practice II Report

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# 1 Introduction

I performed my summer practice in ASELSAN A.Ş., one of leading defence industry companies in Turkey. my internship lasted 20 days and Pınar Kirikkanaç, an electronics engineer in ASELSAN was my supervisor and assisted me in my summer practice.

The summer practice started with an orientation program that briefly explains the company and how the works are handled. Following that, mandatory educations like occupational safety and health education is given to the interns by the company. After the educations, inters were sent to their assigned departments and division. I was similarly sent to HBT division to perform my summer practice.

In the first half of my internship, I was given time to observe, learn and participate the mechanical and electrical test conducted at our division. Mainly on ASELSAN 9661 Series Radios, I mostly observed and participated on the environmental tests of the equipments produced at the Communication & Information Technologies Vice Presidency, known as HBT. .

In the second part of my internship, I was given time to observe the work done behind the testing, in other words process design and management. In this part of my internship, I participated on documentation and research activities for the ULAK Base station of the ASELSAN. Since the work done at this stage can be mostly considered as classified information, I will mention the basics of what I have done in this part.

In this, report, I start with an introduction, that covers what was done in my summer practice. Then, I continued with a company description section in which the general description about ASELSAN is given. After that part, the work done in my summer practice is explained. Lastly, I finished the report with an conclusion part.

## 2 Description of the Company

In this chapter, I will introduce the company in five main parts:

### 2.1 Company Name

ASELSAN A.Ş. or **ASKERİ ELEKTRONİK SANAYİ A.Ş.**

### 2.2 Company Location

ASELSAN has six campuses in Turkey, one of them being in Istanbul, other campuses are located at Ankara. Throughout my summer practice, I spent my time at **Macunköy** Campus.

**Address:** **Macunköy Campus:** Mehmet Akif Ersoy Mahallesi 296. Cadde No: 16, 06370 Yenimahalle-Ankara, Türkiye

**Phone:** +90 (312) 592 10 00

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#### 2.2.1 Macunköy Facilities

Macunköy Facilities was established on an area of total 186.000 m<sup>2</sup>, 110.000 m<sup>2</sup> of which is the closed area. **General Directorate**, **SST** Group, **UGES** Group and parts of **HBT** and **REHİS** Groups are at Aselsan Macunköy Facilities.

## **2.3 General Description of the Company**

ASELSAN is a company of Turkish Armed Forces Foundation, established in 1975 in order to meet the communication needs of the Turkish Armed Forces by national means. Currently 74,20% of the shares are owned by the Foundation whereas the remaining 25,70% runs in İstanbul Borsa stock market.

ASELSAN is the largest defence electronics company of Turkey whose capability/product portfolio comprises communication and information technologies, radar and electronic warfare, electro-optics, avionics, unmanned systems, land, naval and weapon systems, air defence and missile systems, command and control systems, transportation, security, traffic, automation and medical systems. Today ASELSAN has become an indigenous products exporting company, investing in international markets through various cooperation models with local partners and listed as one of the top 100 defence companies of the world (Defense News Top 100).

ASELSAN, together with the technology emphasis in its vision, has targeted to be a company that maintains its sustainable growth by creating value in the global market; preferred due to its competitiveness, trusted as a strategic partner, and caring for the environment and people.

Together with the highly qualified engineering staff within more than 5000 employees, being the main driving factor of the company's success, ASELSAN allocates 6% of its annual income for self-financed research and development activities.

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## 2.4 The Organizational Chart of the Company

The organizational chart of ASELSAN can be seen in *Figure 1*.

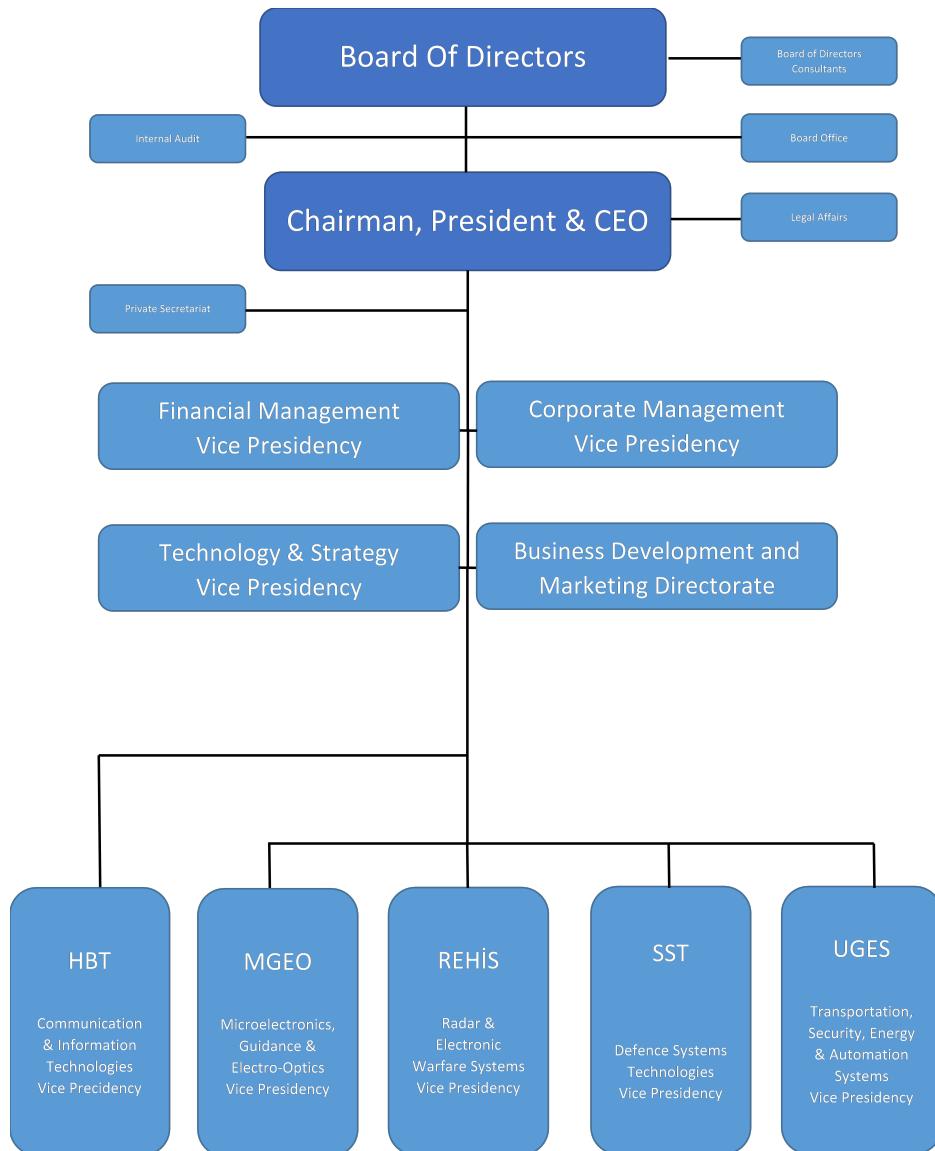


Figure 1: The Organizational Chart of ASELSAN

## 2.5 A Brief History of the Company

- **1978** : The first premises in Macunköy Facility were completed and the manufacturing operation started.
- **1980** : The first manpack and tank wireless radios were delivered to the Turkish Armed Forces.
- **1983** : The first export was realized.
- **1982-1985** : New products such as Field Telephones, Computer Controlled Central Systems and Laser Distance Measurement Appliances were included in the inventory.
- **1987** : ASELSAN was included in a common project attended by 4 NATO countries for the manufacturing of Stinger Missile and started the required investment for the thick film hybrid circuit production.
- **1988** : ASELSAN produced the first avionic appliance for the F-16 program.
- **1989** : The first technology transfer to Pakistan was realized. Wireless radio production was started with ASELSAN license in NTRC facilities in Pakistan.
- **1990** : On date 21.05.1990, the ASELSAN shares were offered to the public and as of date 01.08.1990, the shares were started to be traded in IMKB (İstanbul Stock Exchange)
- **1992** : The Radar systems were included in the ASELSAN product range.
- **1996** : The TASMUS agreement was executed.
- **1997** : ASELSAN 1919 Mobile Phone was launched to the market.
- **1998** : Thermal cameras, thermal weapon sight and thermal vision devices with target coordination addressing devices were submitted to the use of Turkish Armed Forces.
- **1999** : Agreements for Air Defence Early Warning and Command Control System, MILSIS Electronic Warfare and X-Band Satellite Communication System were executed.

- **2001** : ASELSAN took over 72% of the shares of ASELSAN MİKES A.Ş.
- **2002** : The equity capital of the company increased two and a half times compared to the previous year and reached the level of approximately one fourth of the aggregate resources.
- **2005** : HEWS, Helicopter Laser Warning Receiver system (LIAS) Project and Turkish Land Forces Avionic System Modernization Project was executed.
- **2007** : The construction of ASELSAN Integration Hall Building was completed and settlement activities were realized.
- **2007** : MILGEM war system supply project was executed.
- **2008** : ATAK agreement and Multi Band Digital Common Wireless Radio (ÇBSMT) Project were executed and ASELSAN delivered the first originally developed Air Defense Radar.
- **2009** : In 2009, four Research and Development Centrals were established, Leopard-1 Tank modernization was completed, MILGEM Warfare System 2nd Vessel Project, Ammunition Transfer system Project for Self-Propelled Howitzer (Fırtına- Storm) Ammunition vehicle and SAR / Reconnaissance System Supply Integration Project were executed.
- **2012** : Turkey's first national Air Defense System "Pedestal Mounted Stinger System" which has been designed and produced by ASELSAN, and whose delivery took nearly 23 years, last 5 pieces has been delivered to Turkish Armed Forces.
- **2013** : ASELSAN has continued its climb for the aim of being one of the top 50 defense companies, and ranked 74th according to annual sales.
- **2013** : ASELSAN was the company who has participated most at the 11th International Defence Industry Fair (IDEF 2013).

## 3 Orientation and Mandatory Education

### 3.1 Orientation

My summer practice at ASELSAN started with an orientation program. The program lasted about one day mainly focused on the company and the work done there. Chapter 2 mostly summaries what was covered in the orientation. After the orientation, we were given necessary mandatory educations in order to be allowed to work inside the ASELSAN facilities.

### 3.2 Mandatory Education

#### 3.2.1 Electrostatic Discharge (ESD) Education

Electrostatic discharge (ESD) is the sudden flow of electricity between two electrically charged objects caused by contact, an electrical short, or dielectric breakdown. A buildup of static electricity can be caused by tribocharging or by electrostatic induction. The ESD occurs when differently-charged objects are brought close together or when the dielectric between them breaks down, often creating a visible spark.

ESD can create spectacular electric sparks (lightning, with the accompanying sound of thunder, is a large-scale ESD event), but also less dramatic forms which may be neither seen nor heard, yet still be large enough to cause damage to sensitive electronic devices. Electric sparks require a field strength above approximately 40 kV/cm in air, as notably occurs in lightning strikes. Other forms of ESD include corona discharge from sharp electrodes and brush discharge from blunt electrodes.

ESD can cause harmful effects of importance in industry, including explosions in gas, fuel vapor and coal dust, as well as failure of solid state electronics components such as integrated circuits. These can suffer permanent damage when subjected to high voltages. Electronics manufacturers therefore establish electrostatic protective areas free of static, using measures to prevent charging, such as avoiding highly charging materials and measures to remove static such as grounding human workers, providing antistatic devices, and controlling humidity.

ESD simulators may be used to test electronic devices, for example with a human body model or a charged device model.

### **3.2.2 Occupational Safety and Health (OSH) Education**

Occupational safety and health (OSH), also commonly referred to as occupational health and safety (OHS), occupational health,[1] or workplace health and safety (WHS), is a multidisciplinary field concerned with the safety, health, and welfare of people at work. These terms also refer to the goals of this field,[2] so their use in the sense of this article was originally an abbreviation of occupational safety and health program/department etc.

The goals of occupational safety and health programs include to foster a safe and healthy work environment.[3] OSH may also protect co-workers, family members, employers, customers, and many others who might be affected by the workplace environment. In the United States, the term occupational health and safety is referred to as occupational health and occupational and non-occupational safety and includes safety for activities outside of work.[4]

In common-law jurisdictions, employers have a common law duty to take reasonable care of the safety of their employees.[5] Statute law may in addition impose other general duties, introduce specific duties, and create government bodies with powers to regulate workplace safety issues: details of this vary from jurisdiction to jurisdiction.

## **4 Work Done at SP Company**

### **4.1 Mechanical & Electrical Tests**

#### **4.1.1 Mechanical & Electrical Tests of ASELSAN 9661 Radio Family**

##### **4.1.1.1 9661 Radio Family**

The 9661 HF Radios are a new generation Software Defined Radio covering the HF 1.6-30MHz band. Software configurable architecture enables supporting various radio waveforms and EPM techniques. Beyond line of sight communication is made possible based on the latest HF technology via use of NATO STANAGs and Military Standards. The versatility of waveforms and modes enable communication even in the most hostile HF channel conditions. With the use of technologies such as Automatic Channel

Selection (ACS) and Automatic Link Establishment (ALE), ease of use is provided while reducing the need for well-trained and experienced operator.



Figure 2: The Organizational Chart of ASELSAN

The radio has embedded Built-In Digital Modem. Modem functionalities in the Software Defined HF Radio are implemented based on several NATO STANAGs and MIL-STD's. While voice and data can be transmitted over a preset fixed frequency, it is also possible to employ an Automatic Channel Selection mechanism which determines the usable frequency for communication. It is possible to communicate under intentional or unintentional interference by using frequency hopping mode of operation.

9661 HF Radio built-in modem (physical layer) includes Digital Data Waveforms, Automatic Link Establishment and Frequency Hopping. USB, LSB, ISB, AME, AM and CW modulations are supported through 9661 HF Software Defined Radio.



Figure 3: The Organizational Chart of ASELSAN

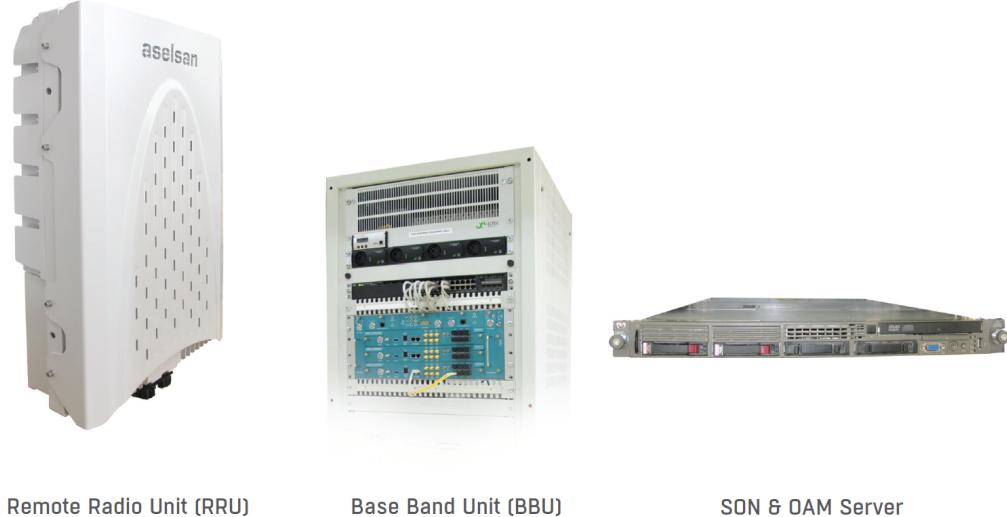
Digital voice coding/decoding is performed with MELPe vocoder and the data rate for digital voice can be 600, 1200 or 2400 bps. Digital voice communication over fixed frequency can be encrypted. Data communication over fixed frequency can be encrypted or clear. Frequency hopping is the Electronic Protection Measure (EPM) for transmission of digital voice and data.

9661 HF Radio family has three configurations for Manpack, Vehicle and Fixed Station usage. 20W can be used for Manpack and Vehicle configurations and 150 W can be used for Vehicle and Fixed Station configurations.

#### 4.1.2 Mechanical & Electrical Tests of ULAKE 4.5G Macrocell Base Station

##### 4.1.2.1 ULAKE 4.5G Macrocell Base Station

Based on Release 10 and Release 11 standards published by 3GPP, ULAKE Macrocell Base Station is designed to support both Release 12 and Release 13 standards with flexible architecture that is open to software development without any hardware changes and is designed to work on different frequency bands for use in Commercial or Public Safety networks.



Remote Radio Unit (RRU)

Base Band Unit (BBU)

SON & OAM Server

Figure 4: The Organizational Chart of ASELSAN

To enrich the product portfolio; the following studies are currently carried out:

Integration of LTE-A to Narrowband Communication Systems, LTE-Advanced Mobile Terminal Safety Software With the development of 4.5G Communication Systems, it is aimed to meet the need of fast, secure and continuous communication of both mobile operators and public institutions.

#### **4.1.3 Test Equipments**

##### **4.1.3.1 RF Attenuators**

RF attenuators are a universal building block within the RF design arena.

RF attenuators can be fixed, switched or even continuously variable.

Dependent upon their type, they can be designed using just resistors, they may need a switch, either mechanical or solid state, or they may use diodes to make them continuously variable over a given range.

What is an attenuator? As the name implies RF attenuators reduce the level of the signal, i.e. they attenuate the signal.



Figure 5: The Organizational Chart of ASELSAN

This attenuation may be required to protect a circuit stage from receiving a signal level that is too high. Also an attenuator may be used to provide an accurate impedance match as most fixed attenuators offer a well-defined impedance, or attenuators may be used in a variety of areas where signal levels need to be controlled.

There are many used for these RF attenuators and although these may not seem obvious initially when asking what is an attenuator, they are widely used in RF applications.

Types of RF attenuator Attenuators can be categorised in a number of ways according to their capabilities and the technologies they use.

**Fixed RF attenuator:** As the name implies fixed attenuators have a specific value and this cannot be changed. They may come in a variety of formats from small in-line items in a similar format to connector adaptors to those in small boxes with connectors on the ends to those incorporated within equipments. **Switched RF attenuators:** Switched RF attenuators are widely used in test systems where levels may need to be changed. They are often seen as small boxes with a number of switches, typically with switches for 1, 2, 4, 8, etc dB changes. Switched attenuators may also be found in items of test equipment to change the levels, for example of a signal generator output. **Variable RF attenuators:** variable RF attenuators are normally used in applications where it is necessary to continuously vary the level of

a signal. Typically they provide a continuous level change by varying an analogue voltage on the input control line. They are normally used where accuracy is not a prime requirement. There are a number of ways in which attenuators can be designed and made. The two main types are given below.

Resistor RF attenuators: Resistor attenuators are used to provide fixed levels of attenuation. Levels may be varied by switching in different attenuator sections to provide the levels that are required. PIN diode RF attenuators: PIN diode attenuators are normally used in attenuator designs where a continuously variable level is required. FET RF attenuators: FET attenuators are normally used in attenuator designs where a continuously variable level is required. Like a PIN diode attenuator, FET attenuators use an analogue control voltage to control the level of attenuation. These are only broad categories for RF attenuators - they can be categories in a variety of ways according to the application and the type of attenuator technology that is used.

RF attenuator schematic symbol It is often necessary to show the block symbol in a circuits schematic diagram for an attenuator without necessarily showing all the individual components.

There is a symbol that is widely adopted as the RF attenuator schematic symbol.

The circuit schematic symbol for a fixed RF attenuator used in reducing the level, typically of RF signals Fixed RF attenuator circuit symbol For some applications a variable attenuator may be required. There is a circuit symbol for this:

The circuit schematic symbol for a variable attenuator where the level of attenuation can be changed according to the requirements Variable RF attenuator circuit symbol RF attenuator specifications When designing, purchasing or using an RF attenuator it is necessary to be able to specify it to ensure that an attenuator with the correct performance is obtained. While some of the major specifications are detailed below, for some applications other parameters may need to be specified.

Attenuation: This is the primary specification for an RF attenuator. It is the ratio between the output and the input power levels and is typically quoted in decibels (dB). Attenuation accuracy : It is often necessary to know the accuracy of the level of the attenuation of the attenuator. Particularly in applications where equipment is being tested, the attenuation accuracy is likely to be important. In these cases a tolerance on the nominal level of attenuation will be given. Frequency response: The level of attenuation of

an attenuator will vary with frequency. This can result from the frequency dependence of the resistors or other components used in the RF attenuator, or where coupling between the input and output may exist as this will be frequency dependent. Some RF attenuators where the absolute level of attenuation is important may be provided with calibration charts measuring the absolute attenuation at different spot frequencies over a frequency band. Impedance : RF attenuators will be designed for use in systems with a given characteristic impedance. 50 ohms is the most common, although 75 ohms is also used, and it may be possible to obtain RF attenuators with other impedance values should the need arise. Power dissipation: In order to reduce the signal level, RF attenuators dissipate or absorb the unwanted power. For many small signal applications, power dissipation is not an issue, but for other applications where signal levels are higher, it is necessary to ensure that the RF attenuator will satisfactorily be able to handle the power levels anticipated. Power capabilities for RF attenuators may be quoted in Watts (or milliwatts) or as dBW - decibels relative one Watt (or dBm - decibels relative to a milliwatt); Mechanical details of the attenuator: The mechanical details may include aspects such as the size and weight. The connectors may be included in this area of the attenuator specification. Environmental details: Many applications for attenuators are for use within benign conditions such as a laboratory environment. Environmental conditions would not be an issue. However for some applications it is possible that an environmental is required to detail factors such as vibration, temperature, humidity and the like. RF attenuator applications RF attenuators are used in a wide variety of applications in RF circuits. They are a key building block used in many areas of RF design:

Reduce signal level: The basic concept behind an attenuator is to reduce the signal level. This can be required to control levels within a circuit to keep them within the required range. Improve impedance match: By its very nature an impedance matched RF attenuator will improve the impedance match. This can be very useful when driving RF mixers that are match sensitive and their performance will be degraded if a poor match is seen. Variable level control: RF attenuators can be used for level control on the output of items such as signal generators. It is far better to be able to generate an accurate fixed level from the basic generator and then used switch attenuators to reduce the signal to the required level. RF attenuators are used widely within RF circuits for a variety of reasons. Fortunately these attenuators are easy to design and using surface mount technology their

performance can be exceedingly good.

#### 4.1.3.2 Analyzers & Oscilloscopes

The analysis of RF and microwave signals in the frequency domain used to be the forte of the spectrum analyzer, but now it's become a choice between signal analyzers and digital oscilloscopes. How did this happen? What's the difference? How do we choose? Let's take a look.

Signal analyzers are really spectrum analyzers with digital signal processing (DSP) added to perform functions such as fast Fourier transforms (FFTs). Historically, digital oscilloscopes would not have been a good option for spectrum analysis because their bandwidths were too limited. Now digital scope bandwidths reach into the 100-GHz range. Combined with DSP, they have turned into very useful tools for frequency-domain analysis.

Both signal analyzers and digital oscilloscopes offer slightly different advantages. Therefore, a little study is needed in order to pick the best match for a given application.

The core of spectral analysis in both instruments is modern DSP, especially the use of the FFT to efficiently convert sampled time-domain data into a frequency-spectrum display. The FFT can output spectral data as real/imaginary, or amplitude/phase formats, retaining phase information for further modulation analysis. The physical differences in these instruments can be seen in their functional block diagrams (see figure).

##### Dissecting the Differences

The signal analyzer is really a modern version of the older swept spectrum analyzer. The input RF signal is downconverted to a lower intermediate frequency (IF). Instead of an analog, variable bandwidth filter used in a traditional RF spectrum analyzer, a digitizer converts the analog IF signal into a digital signal. Now DSP algorithms, including the FFT, can be applied.

One key difference separates the traditional swept spectrum analyzer from the newer signal analyzer: The signal analyzer can fix the local-oscillator (LO) frequency and perform a time signal capture and spectrum analysis at that fixed center frequency. The local oscillator determines the center frequency and the sampling clock, along with the related bandpass filter bandwidth, and determines the bandwidth—or span—of the spectrum display.

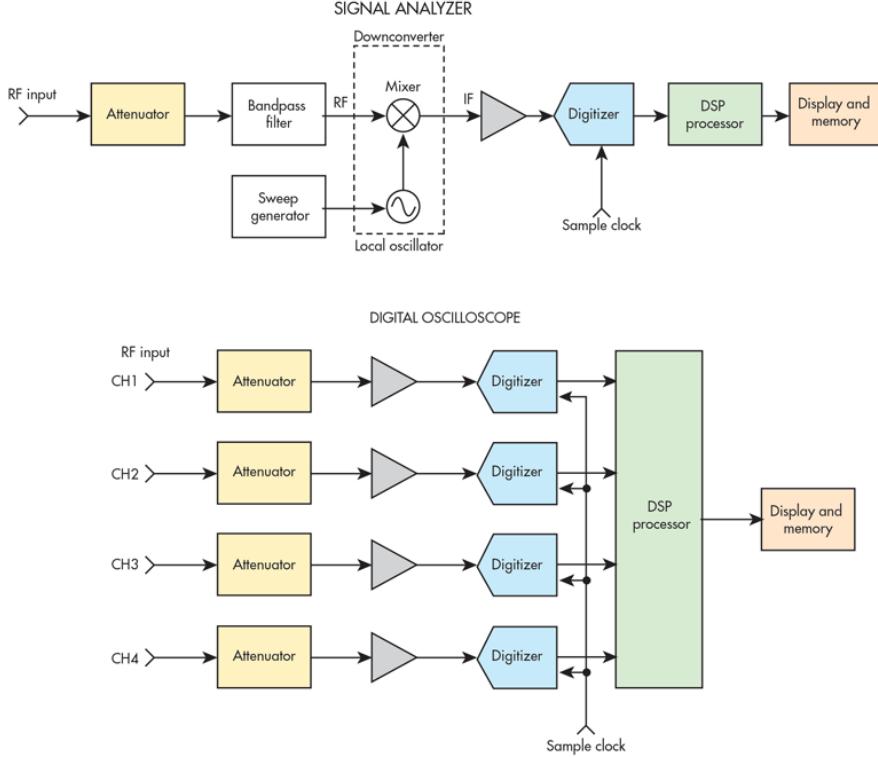


Figure 6: The Organizational Chart of ASELSAN

The signal analyzer is a spectrum analyzer that includes digital signal processing (DSP). The digital oscilloscope also has added DSP, and gains much higher bandwidths. Their differences in the context of frequency analysis derive from their front-end, signal-conversion approach.

In contrast to signal analyzers, the digital oscilloscope digitizes the RF signal directly. The resulting baseband spectrum is anchored at zero hertz (dc) and extends to the oscilloscope bandwidth, which is also related to its sample rate. As mentioned, oscilloscope bandwidth has greatly increased, up to 100 GHz.

Another obvious difference is that the digital oscilloscope can handle more than one channel. Digital oscilloscopes generally offer two, four, or eight channels, with synchronous triggering and sampling. This makes the digital oscilloscope a better choice for multiple-input, multiple-output (MIMO) applications.

A not-so-obvious difference is that the signal analyzer, because it down-

converts the signals to a lower intermediate frequency, can digitize with a higher-resolution analog-to-digital converter (ADC). Wide-bandwidth digital oscilloscopes most commonly use 8-bit ADCs. Some lower-bandwidth scopes offer 10 or 12 bits. Either way, it's a tradeoff between bandwidth and dynamic range. The signal analyzer, on other hand, usually offers 14- or 16-bit ADCs, which provides a much higher dynamic range.

The narrower analysis bandwidth of the signal analyzer also results in a lower noise floor. This makes the signal analyzer a better choice for hunting low-level signals over a wide range of frequencies.

When viewing time-domain signals, the wider bandwidth of the digital oscilloscope allows it to more accurately measure the signal transition times. A typical signal analyzer can render rise or fall times on the order of 20 ps, but a 100-GHz digital oscilloscope is able to extract transition times as low as 3.5 ps.

In summary, the digital oscilloscope offers wider-bandwidth analysis and multiple channels, compared to the higher dynamic range and lower noise floor of the signal analyzer. The signal analyzer typically has a bandwidth of a few hundred megahertz around the center frequency.

The measurement bandwidth will determine the cost of the instrument. At higher bandwidths ( $> 10$  GHz), the digital oscilloscope will be more expensive. However, at low-to-moderate bandwidths, it may be less costly than a signal analyzer. Also, for many applications, like radar, a high dynamic range may not be required, so keep that in mind, too.

## Modulation Analyzer

**Signal & Spectrum Analyzer** A signal analyzer is an instrument that measures the magnitude and phase of the input signal at a single frequency within the IF bandwidth of the instrument. It employs digital techniques to extract useful information that is carried by an electrical signal.[1] In common usage the term is related to both spectrum analyzers and vector signal analyzers. While spectrum analyzers measure the amplitude or magnitude of signals, a signal analyzer with appropriate software or programming can measure any aspect of the signal such as modulation. Today's high-frequency signal analyzers achieve good performance by optimizing both the analog front end and the digital back end.[2]

Theory of operation

**Modern Signal Analyzer Architecture** Modern signal analyzers use a superheterodyne receiver to downconvert a portion of the signal spectrum for analysis. As shown in the figure to the right, the signal is first converted to an intermediate frequency and then filtered in order to band-limit the signal and prevent aliasing. The downconversion can operate in a swept-tuned mode similar to a traditional spectrum analyzer, or in a fixed-tuned mode. In the fixed-tuned mode the range of frequencies downconverted does not change and the downconverter output is then digitized for further analysis. The digitizing process typically involves in-phase/quadrature (I/Q) or complex sampling so that all characteristics of the signal are preserved, as opposed to the magnitude-only processing of a spectrum analyzer. The sampling rate of the digitizing process may be varied in relation to the frequency span under consideration or (more typically) the signal may be digitally resampled.

**Typical usage** Signal analyzers can perform the operations of both spectrum analyzers and vector signal analyzers. A signal analyzer can be viewed as a measurement platform, with operations such as spectrum analysis (including phase noise, power, and distortion) and vector signal analysis (including demodulation or modulation quality analysis) performed as measurement applications. These measurement applications can be built into the analyzer platform as measurement firmware or installed as changeable application software.

A spectrum analyzer measures the magnitude of an input signal versus frequency within the full frequency range of the instrument. The primary use is to measure the power of the spectrum of known and unknown signals. The input signal that a spectrum analyzer measures is electrical; however, spectral compositions of other signals, such as acoustic pressure waves and optical light waves, can be considered through the use of an appropriate transducer. Optical spectrum analyzers also exist, which use direct optical techniques such as a monochromator to make measurements.

By analyzing the spectra of electrical signals, dominant frequency, power, distortion, harmonics, bandwidth, and other spectral components of a signal can be observed that are not easily detectable in time domain waveforms. These parameters are useful in the characterization of electronic devices, such as wireless transmitters.

The display of a spectrum analyzer has frequency on the horizontal axis and the amplitude displayed on the vertical axis. To the casual observer, a spectrum analyzer looks like an oscilloscope and, in fact, some lab instruments can function either as an oscilloscope or a spectrum analyzer.

Today, there are three basic types of analyzer: the swept-tuned spectrum analyzer, the vector signal analyzer, and the real-time spectrum analyzer.

**Power Reflection Meter** Directional power meters are used to measure power and reflection under operational conditions. Typical applications are in installation, maintenance and monitoring of transmitters, antennas and RF generators in industrial and medical fields.



Figure 7: The Organizational Chart of ASELSAN

### (UPV) Audio Analyzer

**Digital Phosphor Oscilloscope** The digital phosphor oscilloscope, DPO is another form of digital oscilloscope.

The DPO scope has a different architecture to that of the more traditional digital / digital storage types and this enables it to process signals more quickly.

To achieve this, the DPO adopts a parallel processing architecture rather than the more straightforward serial technology.

Digital phosphor scope basics Using parallel processing techniques and a dedicated processor, the DPO is able to capture transient events that occur

in digital systems more easily. These may include spurious pulses, glitches and transition errors. It also emulates the display attributes of an analogue oscilloscope, displaying the signal in three dimensions: time, amplitude and the distribution of amplitude over time, all in real time.

In terms of the digital phosphor oscilloscope architecture, the signal first enters an analogue vertical amplifier. This feeds into an analogue to digital converter in a similar fashion to a digital storage scope. However it is from this point that the architecture of a DPO differs from that of a DSO.

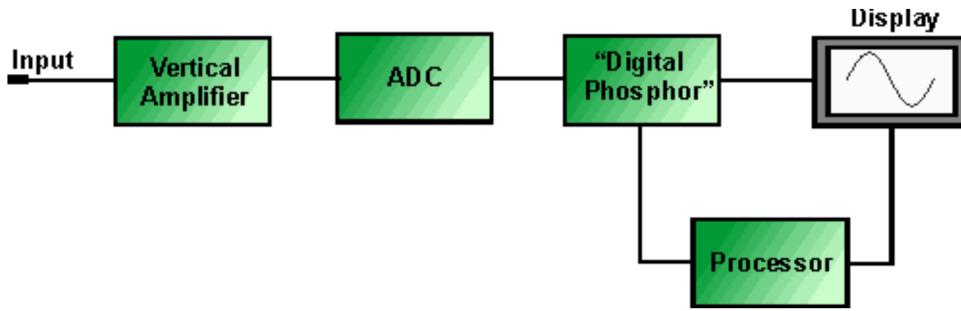


Figure 8: The Organizational Chart of ASELSAN

Basic block diagram for a digital phosphor oscilloscope showing how it gathers the vertical waveform and how samples are gathered and displayed. Digital phosphor oscilloscope, DPO, basic block diagram. For any oscilloscope there is a time delay between the end of one scan and when the trigger is ready to initiate the next one. During this period the scope does not see any activity that may occur on the signal line. For a DSO this time can be relatively long because the scope processes information serially and this can form a bottleneck. However the DPO uses a separate parallel processor and this enables it to capture and store waveforms despite the fact that the display may be acting much slower. By using the parallel processing the DPO is not limited by the speed of the display, signals may be captured independently of the activity of the display.

Although the name of the DPO may indicate that it relies on a chemical phosphor, this is not necessarily the case as more modern displays are used. However it possesses many of the aspects of a phosphor oscilloscope, displaying a more intense image the more often the waveform passes a certain point.

Each time a waveform is captured it is mapped into the DPO memory.

Each cell represents a screen location. The more times data is stored into a location, the greater the intensity attached to it. In this way intensity information builds up in cells where the waveform passes most often. The overall result is that the display reveals intensified waveform areas, in proportion to the frequency of occurrence of the signal at each point. This has the same appearance as those displayed on an analogue phosphor oscilloscope, and this gives rise to the name.

Effectively the processor within the DPO operates in parallel with the acquisition system for display management, measurement control, and overall instrument control. In this way its operation does not affect the acquisition speed of the overall scope.

The advantage of this approach is that it achieves a virtually 'real time' display that is able to capture transient events as well as the repetitive waveforms.

Additionally , only a DPO provides the Z (intensity) axis in real time, and this is a feature that is missing from conventional digital storage oscilloscopes.

#### **4.1.3.3 Signal Generators**

**Analog Signal Generator**

**Vector Signal Generator**

**Synthesized Signal Generator**

#### **4.1.3.4 3920 Digital Radio Test Set**

#### **4.1.4 Test Stand**

### **4.2 Outer Space Simulations & Tests using TVAC**

#### **4.2.1 Thermal Vacuum Chamber (TVAC)**

A vacuum chamber is a rigid enclosure from which air and other gases are removed by a vacuum pump. This results in a low-pressure environment within the chamber, commonly referred to as a vacuum. A vacuum environment allows researchers to conduct physical experiments or to test mechanical devices which must operate in outer space (for example) or for processes such as vacuum drying or vacuum coating. Chambers are typically made of metals which may or may not shield applied external magnetic fields depending on

wall thickness, frequency, resistivity, and permeability of the material used. Only some materials are suitable for vacuum use.

Chambers often have multiple ports, covered with vacuum flanges, to allow instruments or windows to be installed in the walls of the chamber. In low to medium-vacuum applications, these are sealed with elastomer o-rings. In higher vacuum applications, the flanges have knife edges machined onto them, which cut into a copper gasket when the flange is bolted on.



Figure 9: The Organizational Chart of ASELSAN

A type of vacuum chamber frequently used in the field of spacecraft engineering is a thermal vacuum chamber, which provides a thermal environment representing what a spacecraft would experience in space.

A thermal vacuum chamber is a vacuum chamber in which the radiative thermal environment is controlled.

Typically the thermal environment is achieved by passing liquids or fluids through thermal shrouds for cold temperatures or through the application of thermal lamps for high temperatures.

Thermal vacuum chambers are frequently used for testing spacecraft or

parts thereof under a simulated space environment.

### 4.3 Research on Components of ULAK 4.5G Macro-cell Base Station

#### 4.3.1 Alternate Components

1. –
2. –
3. –
4. –
5. –
6. –

Figure 10: —— ——

	—	—
1	—	—
2	—	—
3	—	—
4	—	—
5	—	—
6	—	—

Table 1: ——

1	
2	
3	—

1	
2	—

## 5 Conclusion

I completed my summer practice in ASELSAN A.Ş.(ASELSAN Electronics Industry and Ticaret A.Ş.) in Yenimahalle/Ankara. It was quite experiential time for me. Throughout my summer practice, I learned many things about professional work life. Firstly, I witnessed

I performed my summer practice in ASELSAN A.Ş., one of leading defence industry companies in Turkey. my internship lasted 20 days and Pınar Kırıkkanaç, an electronics engineer in ASELSAN was my supervisor and assisted me in my summer practice.

The summer practice started with an orientation program that briefly explains the company and how the works are handled. Following that, mandatory educations like occupational safety and health education is given to the interns by the company. After the educations, inters were sent to their assigned departments and division. I was similarly sent to HBT division to perform my summer practice.

In the first half of my internship, I was given time to observe, learn and participate the mechanical and electrical test conducted at our division. Mainly on ASELSAN 9661 Series Radios, I mostly observed and participated on the environmental tests of the equipments produced at the Communication & Information Technologies Vice Presidency, known as HBT. .

In the second part of my internship, I was given time to observe the work done behind the testing, in other words process design and management. In this part of my internship, I participated on documentation and research activities for the ULAK Base station of the ASELSAN. Since the work done at this stage can be mostly considered as classified information, I will mention the basics of what I have done in this part.

In this, report, I start with an introduction, that covers what was done in my summer practice. Then, I continued with a company description section in which the general description about ASELSAN is given. After that part, the work done in my summer practice is explained. Lastly, I finished the report with an conclusion part.

Finally, I recommend my summer practice company for other students.

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