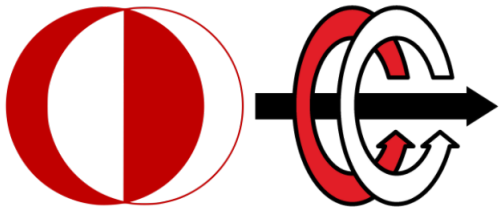

Middle East Technical University

Department of Electrical and Electronics Engineering

EE400 Summer Practice II
Report

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SP Beginning Date:
09.07.2018
SP End Date:
03.08.2018
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TÜRKSAT A.Ş.

EE400 SP Company Name:
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21/08/2018

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Contents

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 Kırıkkanat, 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 **AS**KERİ **EL**EKTRONİK **SAN**AYİ A.Ş.

2.2 Company Locations

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** Facilities .

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

Phone: +90 (312) 592 10 00

Fax: +90 (312) 354 13 02 / +90 (312) 354 26 69

2.2.1 Macunköy Facilities

Macunköy Facilities was established on an area of total 186.000 m2, 110.000 m2 of which is the closed area. **General Directorate**, **SST** Group, **UGES** Group and parts of **HBT** and **REHİS** Groups are at Aselsan Macunköy Facilities.

2.2.2 Other Facilities

- Akyurt Facilities (**MGEO** Group)
- Gölbaşı Facilities (**REHİS** Group)
- ODTÜ TEKNOKENT (SATGEB Building) (Part of **HBT** Group)
- ODTÜ TEKNOKENT (TİTANYUM Building) (Part of **HBT** Group)
- İstanbul Facilities (Part of **SST** Group)

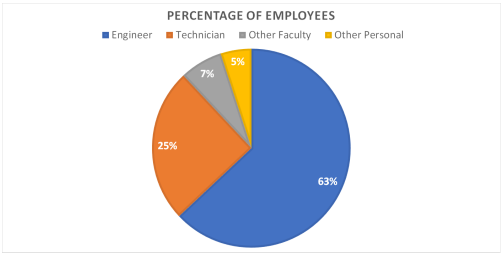
2.3 General Description of the Company

ASELSAN is a company of Turkish Armed Forces Foundation, established in 1975 after Cyprus Peace Operation 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.

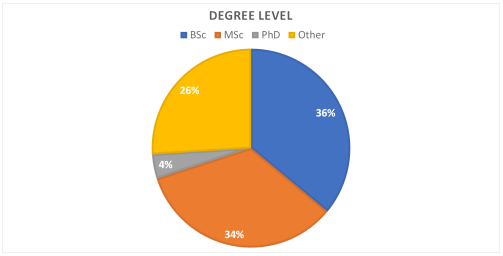
As one of the largest defence industry companies of Turkey, ASELSAN's product portfolio includes communication and information technologies, radar and electronic warfare, electro-optics, avionics, unmanned systems, land, naval and weapon systems, air defence and missile systems, command and control systems, transportation, security, traffic, automation and medical systems as can be seen from the *Figure 1*.

Figure 1: Business Fields of ASELSAN

In 2018, ASELSAN is listed as 55th biggest defense company worldwide in DefenseNews' Top 100 list[2]. And as of July 2018, ASELSAN has 5364 employees. 63% of them being engineer exact distribution of the employees can be seen at *Figure 2a*, while the academic distribution of the working engineers can be seen at *Figure 2b*.



(a) Distribution of the Employees



(b) Degree Levels of the Engineers

Figure 2: Statistics about ASELSAN Employees

2.4 The Organizational Chart of the Company

The organizational chart of ASELSAN can be seen in *Figure 3*.

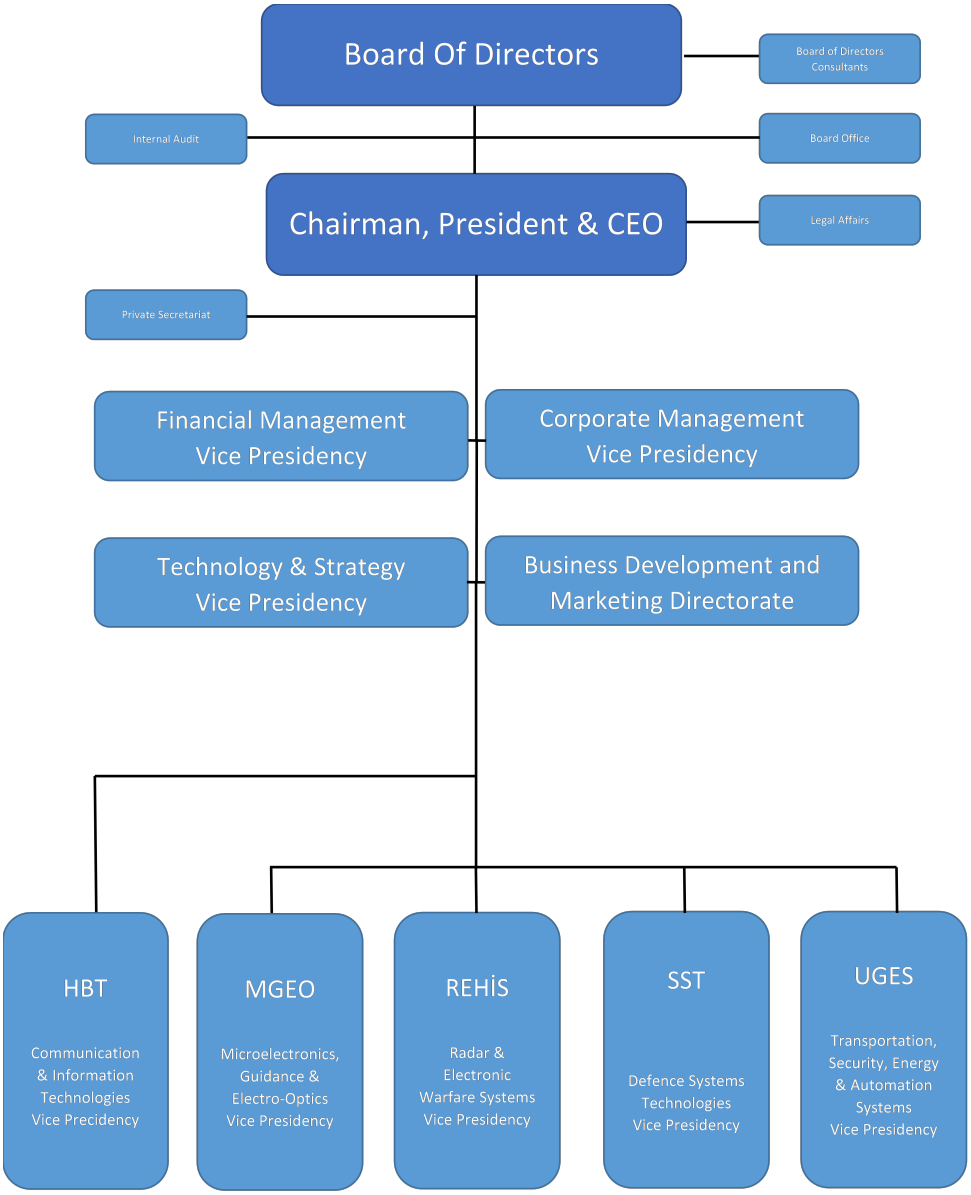


Figure 3: The Organizational Chart of ASELSAN

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 participiated 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 Educations

As required by the 4857/77 numbered law, all employers in the Republic of Turkey is obligated to train their employees in order to prevent the unnecessary work related accidents. In ASELSAN, we were given obligatory Occupational Safety and Health (OSH) Education and Electrostatic Discharge (ESD) Education to be able to work in the ASELSAN facilities safely.

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. **[2]**

A very casual example of electrostatic discharge can be given as lighting. However, not all ESD events are not as loudly or large-scale as lightnings. The less dramatic forms may be neither seen nor heard, but they can still be large enough to cause damage to sensitive electronic devices.

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. In order to prevent this unwanted side effects of ESD, companies such as ASELSAN prefers to train their workers not just for their health but also protect their product lines.

3.2.2 Occupational Safety and Health (OSH) Education

ASELSAN as a company in Turkey is required to satisfy the conditions determmined by the 6331 number Occupational Safety and Health (OSH) Education Law.

Occupational safety and health (OSH), also commonly referred to as occupational health and safety (OHS), 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, so their use in the sense of this article was originally an abbreviation of occupational safety and health program/department etc.[**3**]

Occupational safety and health programs aims to foster a safe and healthy work environment. OSH may also protect co-workers, family members, employers, customers, and many others who might be affected by the workplace environment.

Just in 2014, 221.336 worker had an work accident imn Turkey and 494 of them suffered from work related diseases. 1.626 workers died due to this accidents according to ÇSGB.[**4**] The importance of Occupational Safety and Health (OSH) Educations comes from the fact that these deaths can be prevented if the necessary precautions are taken.

4 Work Done at SP Company

I have performed my summer practice in the Test & Process Design Department of the **HBT** Division. In this section, I will mainly explain what I have done in this department throughout my summer practice.

In my first days I was assigned to observe and participate the tests conducted at the Environmental Test Laboratory. The test conducted there was mainly on ASELSAN 9661 Series Radios as well as other radio handsets and base stations. I mainly observed the these tests and participated in them as much as I could. I also observed and took part in the test about ASELSAN'S base station named ULAK.

4.1 Tests on 9661 Radio Family

4.1.1 ASELSAN 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 4: ASELSAN 9661 Radio Series

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 5: ASELSAN 9661 Radio Series

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.

4.2 Tests on ULAK 4.5G Base Station

4.2.1 ULAK 4.5G Macrocell Base Station

Based on Release 10 and Release 11 standards published by 3GPP, ULAK 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.

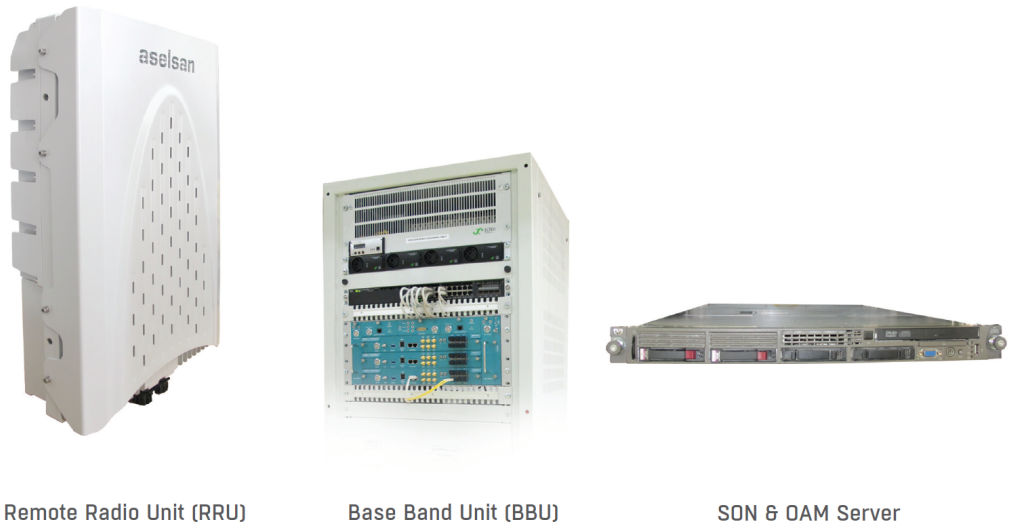


Figure 6: ULAK 4.5G Base Station

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.

4.3 Test Equipments

4.3.1 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.

As the name implies RF attenuators reduce the level of the signal, i.e. they attenuate the signal.

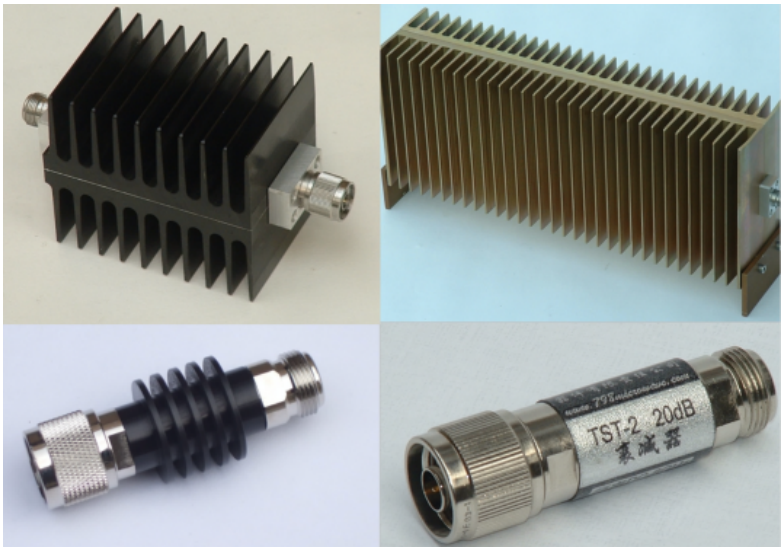


Figure 7: Some Attenuator Examples

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.

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.

4.3.2 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.

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.

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).

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.

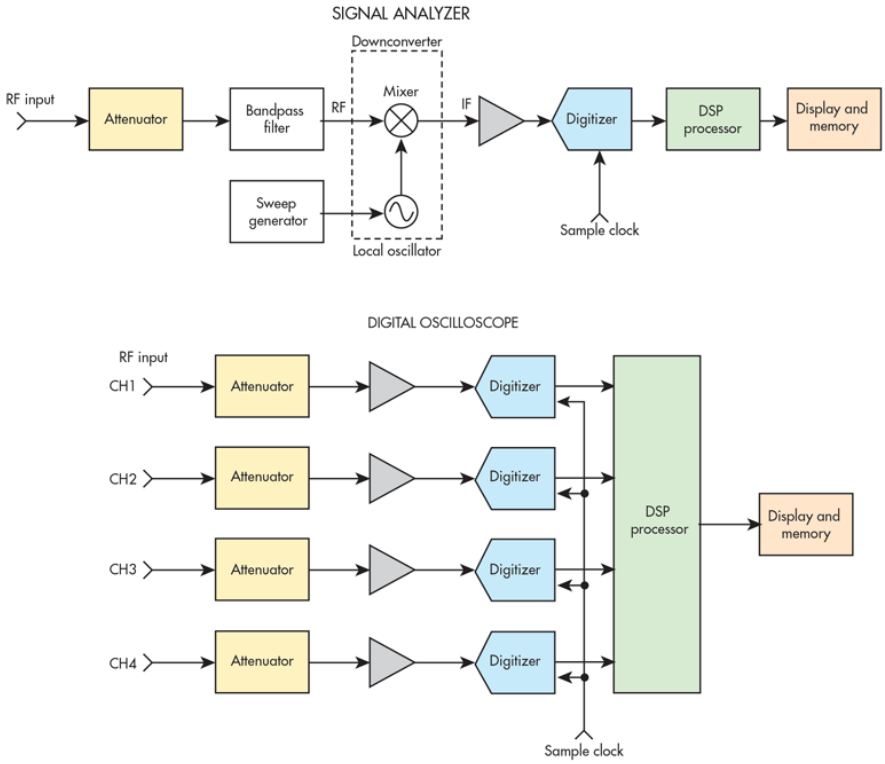


Figure 8: The Organizational Chart of ASELSAN

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.

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.

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]

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.

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.

(UPV) Audio Analyzer

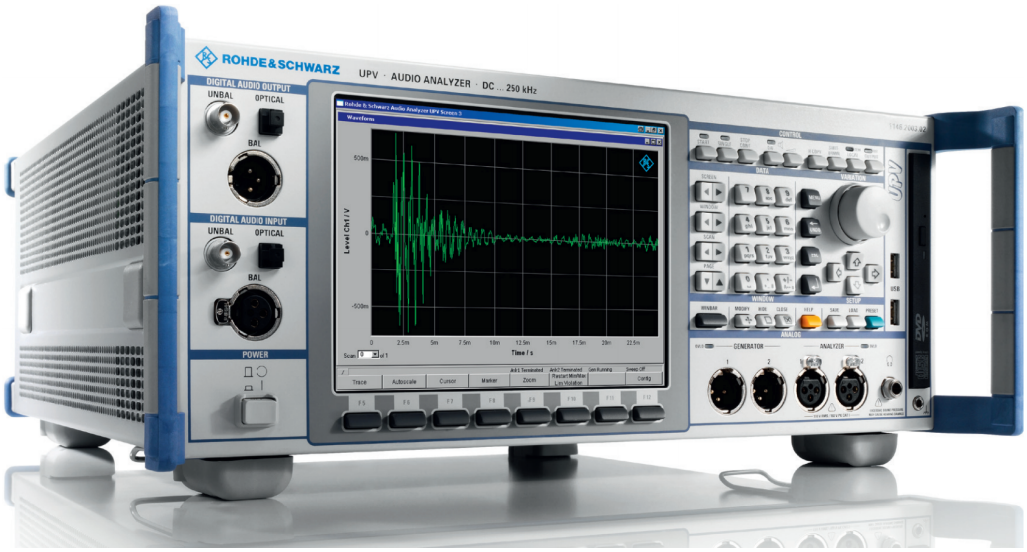


Figure 9: UPV) Audio Analyzer

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.

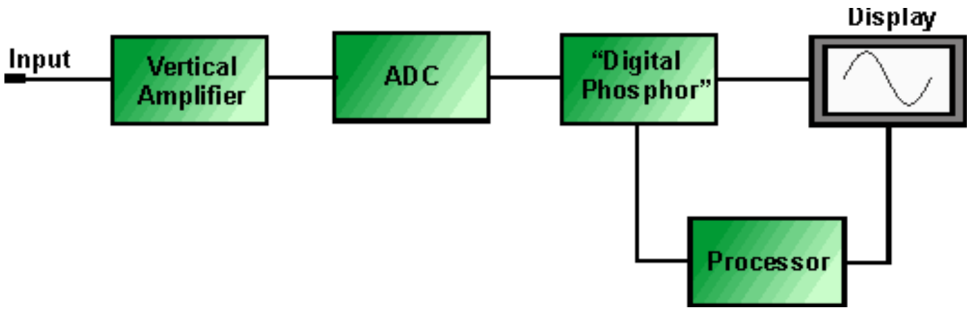


Figure 10: Working Principles of DPO

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.

4.3.3 Signal Generators

Analog Signal Generator

Vector Signal Generator

Synthesized Signal Generator

4.3.4 3920 Digital Radio Test Set

4.4 Test Stand

4.5 Outer Space Simulations & Tests using TVAC

4.5.1 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.

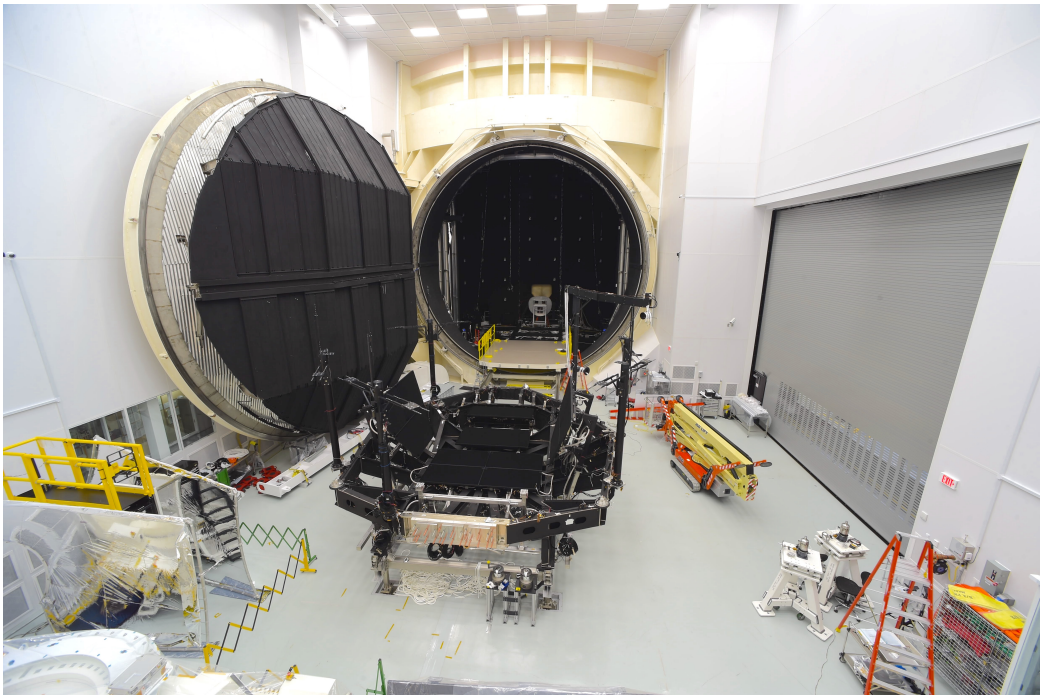


Figure 11: The Organizational Chart of ASELSAN

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.

4.6 Research on Components of ULAK 4.5G Base Station

4.6.1 Alternate Components

5 Conclusion

I completed my summer practice in ASELSAN A.Ş.(ASELSAN Electronics Industry and Ticaret A.Ş.) in supervision of Pınar Kırıkkanat, an electronics engineer in ASELSAN, in Yenimahalle/Ankara. It was quite experiential time for me. Throughout my summer practice, I learned many things about professional work life.

Firstly, I understodd the importance of mandatory educations like occupational safety and health education thanks to given educations by ASELSAN. After the educations, I was sent to my division, where I performed 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. .

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Finally, I recommend my summer practice company for other students who want to start their summer practice at ASELSAN.

6 References

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