For use by the project lecturer	Approved		Revision required	

Feedback

To be completed by the student

PROJECT PROPOSAL 2019

Project no	DB1	Revision no	0

Title	Surname	Initials	Student no	Study leader (title, initials, surname)
Ms	**Undisclosed**	**CC**	14000000	Prof D Ball

Project title

Design of an antenna array

Language editor name	Language editor signature
DC Signal	
Student declaration I understand what plagiarism is and that I have to complete my project on my own.	**Study leader declaration** This is a clear and unambiguous description of what is required in this project
Student signature	Study leader signature

1. Project description

What is your project about? What does your system have to do? What is the problem to be solved?

With the progression of wireless networks in different applications such as communications, mobile application, appliances and the Internet of Things (IoT), the demand to have antennas operating within wireless frequency bands and the use thereof in base stations have increased. The solution to this ever increasing field is to make use of a wideband antenna. The wide impedance bandwidth will allow the antenna to operate over a wider range of applications. To increase the impedance bandwidth of microstrip antennas, the regularly used patch radiating element must be replaced with another planar radiating element to resolve the problem of only having narrow band capabilities. Another improvement can be done on the feed network used to power the array elements since this has a great effect on the operating bandwidth. The proposed feed network solution is a dual mode corporate feed network. This will result in a feed network that will ensure coherent phases between the elements in the dual polarized antenna array. To improve the control over the power direction, gain and impedance bandwidth the radiating element should be used in a 2x2 antenna array structure. The main objective will be to improve the wideband performance of the antenna arrays by implementing a dual mode corporate feed network.

2. Technical challenges in this project

Describe the technical challenges that are beyond those encountered up to the end of third year and in other final year modules.

2.1 Primary design challenges

The typical design challenges in regards with this project will include the design and simulation of various feed networks and the radiating elements. When designing the various feed networks and radiating elements each will have a different approach. A big challenge will also be to design a radiating element (not a patch element) that can be implemented in a 2x2 array pattern that will produce a wideband impedance response. Another challenge will be to feed the antenna array with a dual mode corporate feed network since the radiating element is not the generally used patch antenna.

2.2 Primary implementation challenges

The main implementation challenge will be to assemble the different designed components (feed network, matching network and radiating elements) accurately to form the final antenna array. Any slight deviation in the assembly of the designed components will affect the measured results of the gain, bandwidth, etc. Feeding the antenna, with the chosen dual mode corporate feed network, and ensuring the correct operation will be difficult if close attention is not paid in the assembly phase. The practical implementation of the dual mode feed will also be more complicated compared to the simulations. When testing the implemented antenna array, close attention should be paid to the objects in the surroundings since they will affect the antenna response.

3. Functional analysis

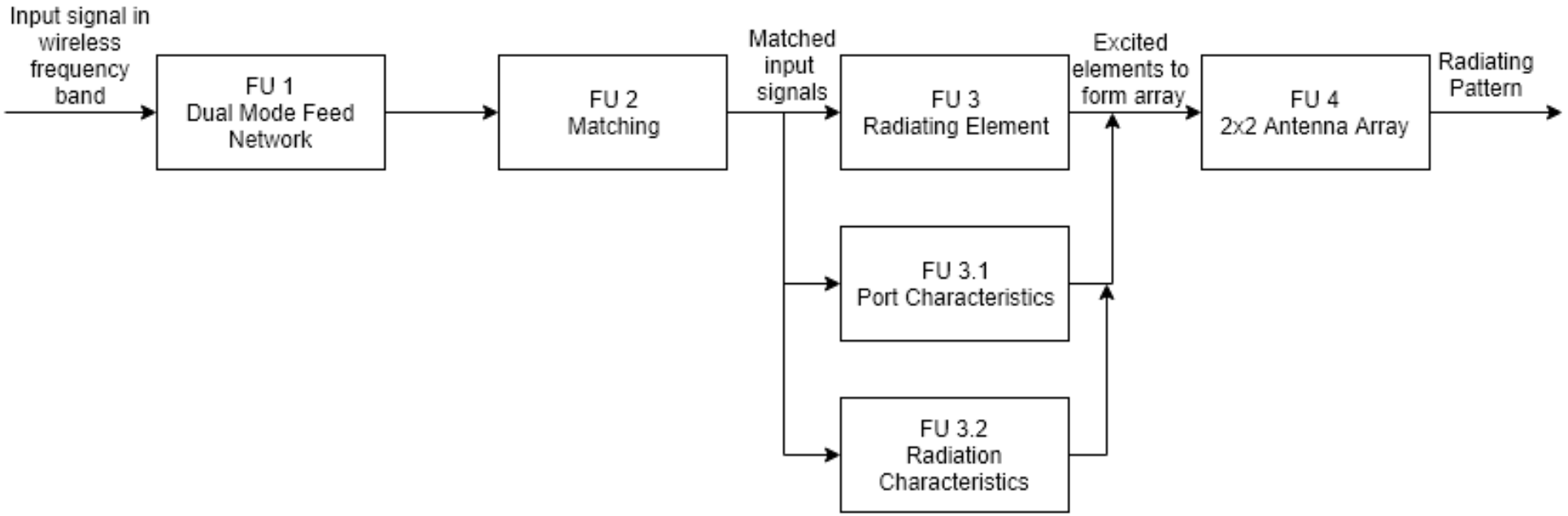
3.1 Functional description

Describe the design in terms of system functions as shown on the functional block diagram in section 3.2. This description should be in narrative format.

A wireless frequency band input signal will be applied to the feed network using a 50 Ω coaxial cable. The feed network (represented by FU 1) will consist out of a dual mode corporate feed network that will feed the input signal to the array elements (FU 3) within the array (FU 4). The feed network needs to be matched to the 50 Ω coaxial cable impedance to ensure correct operation and minimal reflection. A matching network (FU 2) is added to the feed network and should be designed accordingly. When FU 1 is not correctly matched the signal will not efficiently be fed to the radiating elements and will not deliver the desired results. The 2x2 antenna array referred to in FU 4 is fed by the feed network and the power is equally divided between the array elements in FU 3. The antenna array will consist of wideband radiating elements different from a patch element. FU 3 has sub-functional units indicated by FU 3.1 and FU 3.2 to focus the choice and design of FU 3 on port characteristics (FU 3.1) and Radiation Characteristics (FU 3.2). FU 3.1 includes the design characteristics and functionality of the impedance, bandwidth and VSWR. FU 3.2 includes the design and functional units of the gain and cross polarization. The combination of the radiating elements along with the port and radiation characteristics will result in the 2x2 array in FU4. The antenna array and the feed network should be in the form a planar antenna array. The array elements must also be matched to the feed network. Electromagnetic waves will be radiated from each array element. The radiation pattern will be obtained by observing the combined electromagnetic waves that are radiated from each array element. The combined antenna must have a main beam with a high gain and a wide impedance bandwidth in order to meet the requirements. These requirements will be included in the Port and Radiation characteristics. The specifications will be measured in the RF laboratory using a prototype antenna and will be compared to the simulated results.

figure resolution too low and text is too large. The functional block diagram is typical for this

3.2 Functional block diagram



4. System requirements and specifications

These are the core requirements of the system or product (the mission-critical requirements) summarised in table format .

	Requirement 1: fundamental functional and performance requirement	**Requirement 2**	**Requirement 3**
1. Core mission requirements of the system or product. Solution of the problem will be the most important requirement. Capture this in the set of requirements.	The planar antenna must obtain a high gain within the operating frequency.	The relative impedance bandwidth should be greater or equal to 5% in total.	The planar antenna array should be matched to the 50 Ω coaxial cable used for measurements in the RF laboratory.
2. What is the target specification (in measurable terms) to be met in order to achieve this requirement?	The peak gain within the frequency band should be at least 6 dBi.	The relative impedance bandwidth should be at least between 2.34 GHz to 2.46 GHz.	The peak VSWR should be less than or equal to 3.5:1.
3. Motivation: how will meeting this specification solve the problem?	The high gain is required in order to obtain the optimal operation of the antenna in the frequency range.	This specification is required to determine whether or not the antenna array is implemented as a wideband antenna as required.	The antenna feed network should be matched in order to obtain the best operation and to deliver the power from the feed network to the radiating elements.
4. How will you *demonstrate* at the examination that this requirement has been met?	To demonstrate that this specification is indeed met the simulations from FEKO/CST will be used as well as the results obtained from the RF laboratory measurement and be compared.	To demonstrate that this specification is indeed met the simulations from FEKO/CST will be used as well as the results obtained from the network analyzer and be compared.	Using both simulations and the measured results from the network analyzer the VSWR will be compared to demonstrate that the requirement is met.
5. What is the deliverable? What are the aspects that you will design and implement yourself to meet this requirement? If none, indicate clearly.	The gain of the antenna array will be designed to have a peak gain of 6 dBi.	The antenna array will be designed and implemented to obtain required 120 MHz impedance bandwidth.	The antenna array will be designed to be matched to the coaxial cable.
6. What are the aspects to be taken off the shelf to meet this requirement? If none, indicate clearly.	No aspect will be taken off the shelf. Only the simulation software will be a standard software.	No aspect will be taken off the shelf. Only the simulation software will be a standard software.	No aspect will be taken off the shelf. Only the simulation software will be a standard software.

System requirements and specifications (continued)

	Requirement 4	Requirement 5	Requirement 6
1. Core mission requirements of the system or product. Solution of the problem will be the most important requirement. Capture this in the set of requirements.	The radiation pattern should be directional.		
2. What is the target specification (in measurable terms) to be met in order to achieve this requirement?	The cross polarization should be below at least -5 dB in the 3 dB main beam.		
3. Motivation: how will meeting this specification solve the problem?	A low cross polarization should be obtained since it is required that there must be little radiation in unwanted polarization.		
4. How will you *demonstrate* at the examination that this requirement has been met?	To demonstrate that this specification is indeed met the simulations from FEKO/CST will be used as well as the results obtained from the RF laboratory (Compact range) and will be compared.		
5. What is the deliverable? What are the aspects that you will design and implement yourself to meet this requirement? If none, indicate clearly.	The antenna array will be designed to obtain a low cross polarization.		
6. What are the aspects to be taken off the shelf to meet this requirement? If none, indicate clearly.	No aspect will be taken off the shelf. Only the simulation software will be a standard software.		

5. Field conditions

These are the core requirements of the system or product (the mission-critical requirements) summarised in table format .

	Field condition 1	Field condition 2	Field condition 3
Field condition requirement. In which field conditions does the system have to operate? Indicate the one, two or three most important field conditions.	The humidity in the RF laboratory must be kept within the required level according to the regulations of the accreditation.	The temperature in the RF laboratory must be kept at the required temperature according to the regulations of the accreditation.	
Field condition specification. What is the specification (in measurable terms) for this field condition?	To obtain electromagnetic measurement the humidity in the RF laboratory must be maintained between 30% and 60%.	To obtain electromagnetic measurements the temperature in the RF laboratory must be uphold at 23 ˚C with an allowable deviation of ±3 C.	

6. Student tasks

(1) The student should write in full sentences.
(2) Writing in the imperative voice is not allowed.

6.1 Design and implementation tasks

List your primary design and implementation tasks in bullet list format (5-10 bullets). These are *not* product requirements, but *your* tasks.

- Design different dual mode corporate feed networks and planar radiating elements along with the implementation thereof.
- Design a matching network for the different dual mode corporate feed networks and the antenna arrays to be able to simulate the designs correctly.
- Simulate various corporate feed networks and radiating elements and the combinations thereof using FEKO and/or CST.
- Design and determine which radiating element can be used in an array structure and which corresponding corporate feed network to use.
- Simulate and determine which combination of the feed network and radiating array elements obtain the optimal results.
- Simulate the final corporate fed planar antenna array using FEKO and/or CST and optimize the final design to ensure the requirements are obtained.
- Each component must be assembled and aligned with accuracy in order to obtain the desired planar antenna array prototype to be tested in the RF laboratory.
- Specific experimental results must be obtained using the antenna prototype in the RF laboratory. The results will then be compared to the simulations.

6.2 New knowledge to be acquired

Describe what the theoretical foundation to the project is, and which new knowledge you will acquire (beyond that covered in any other undergraduate modules).

- Additional research must be done to determine which substrate should be used for the antenna design and implementation.
- Wideband radiating elements must be investigated and researched to determine if an element can be used in an array structure.
- Various corporate feed networks and their respective impedance performances will need to be investigated and researched.
- Additional knowledge will need to be obtained in the understanding and usage of the simulation software, FEKO and CST.
- The required procedure to follow, in the RF laboratory (Compact range), when testing a prototype antenna will need to be investigated and researched.