

Team 311

Senior Design

FPGA Enhanced Digital Beam Steering Phased Array

Concept Generation

Given the generated Collective Concept List, Concept Classification, and Conceptual Function Application charts below, we were able to narrow down the high and medium fidelity concepts which are most applicable and realistic for our design.

3 High Fidelity Concepts:

1. Pre-built 4-Channel DDS (no PCB required)
2. FPGA and MCU based
3. Operation Frequency Band is 2.4 - 2.5 GHz

5 Medium Fidelity Concepts:

1. 7-segment Display and LCD Display
2. Handheld Size (can fit into shoe box)
3. Series Antenna Array
4. Pre-built DAC/DDS for signal generator
5. 120V 60Hz Power Supply

Collective Concept List (110 Total)

FPGA	MCU	Arduino	Raspberry Pi	MSP	OLED	Touch screen display	Smart Phone App	Head-mounted display	Development Boards I/O	Coax Cables
Development Board LCD	Monitor (PC)	LED array	7-segment	HDMI	USB-A	VGA	Ethernet	Bluetooth	Wi-Fi	USB-C
VHDL	Verilog	C	Python	C++	Java	C#	Linux	Javascript	Lab View	HDL
Development Board LCD	Monitor (PC)	LED array	7-segment	Quantum dot	OLED	Touch screen display	Smart Phone App	Head-mounted display	Micro-USB	Soldering
Buttons	Switches	Dials	Keyboard	Mouse	Command Line	Form Based	Menu Driven	Voice Control	Gesture Control	Touchscreen
Development Boards I/O	Coax Cables	HDMI	USB-A	VGA	Ethernet	Bluetooth	Wi-Fi	USB-C	Micro-USB	Soldering
Analog Waveform Generator	Pre-built DAC/DDS	Custom PCB with DDS	Analog Phase Shifter	Digital Phase Delay	Analog Beamformer	Time Delay	Distance between antennas	Pre-built Upconverter	Custom PCB with Upconverter chip	Analog Signal Amplifier
Transmitter	Receiver	Transceiver	Directional Antenna	Patch Antenna	Series	Matrix	Signal Amplifier	Fabricated Metal	Plastic	Carbon Fiber
40.66 - 40.7 MHz	902 - 928 MHz	2.4 – 2.5 GHz	5.725 – 5.875 GHz	24 - 24.250 GHz	ISM	Military	Aviation	Cellular	3D Printed	Easy Maintenance
Portable	Handheld	Semi portable	“Shoebbox” Sized	Permanent installation	Tabular size	120V 60Hz	DC Power Supply	Lithium-Ion Battery	12V Solar cell with battery	5V Battery

Concept Classifications

Options/ Subfunction	1	2	3	4	5	6	7	8	9	10	11
System Control	FPGA	MCU	Arduino	Raspberry Pi	MSP						
Development Language	VHDL	Verilog	C	Python	C++	Java	C#	Linux	Javascript	Lab View	HDL
Display	Development Board LCD	Monitor (PC)	LED array	7-segment	Quantum dot	OLED	Touch screen display	Smart Phone App	Head-mounted display		
User Interface	Buttons	Switches	Dials	Keyboard	Mouse	Command Line	Form Based	Menu Driven	Voice Control	Gesture Control	Touchscreen
Connectivity & Expansion	Development Boards I/O	Coax Cables	HDMI	USB-A	VGA	Ethernet	Bluetooth	Wi-Fi	USB-C	Micro-USB	Soldering
Power	120V 60Hz	DC Power Supply	Lithium-Ion Battery	12V Solar cell with battery	5V Battery	9V Battery	USB From Computer	Crank Generator	Wind Turbine	Wind Mill	Water mill
Signal Generation	Analog Waveform Generator	Pre-built DAC/D DS	Custom PCB with DDS								
Signal Phase Shift	Analog Phase Shifter	Digital Phase Delay	Analog Beamformer	Time Delay	Distance between antennas						
Up Conversion	Pre-built Upconvert	Custom PCB	Analog Signal	Signal Amplifier							

	er	with Upconv erter chip	Amplifier								
Antenna Array	Transmitt er	Receive r	Transcei ver	Directional Antenna	Patch Antenna	Series	Matrix				
Operation Frequency Band	40.66 - 40.7 MHz	902 - 928 MHz	2.4 – 2.5 GHz	5.725 – 5.875 GHz	24 - 24.250 GHz	ISM	Military	Aviation	Cellular		
Case	Fabricate d Metal	Plastic	Carbon Fiber	3D Printed	Easy Maintena nce	Non-use r servisabl e	Modular				
Size	Portable	Handhel d	Semi portable	“Shoebox” Sized	Permane nt installatio n	Tabular size					

Conceptual Function Application

User Interface	Display	Connectivity & Expansion	Power	Size	Architecture
graphical user interface	Liquid crystal display	Coax Cables	5V Battery	6.25cm	Waveform/Function Generator
graphical user interface	7-segment	HDMI	USB from Computer	12.5cm	RF Phase Shifter
graphical user interface	Liquid Emitting Diode	USB	Outlet	18.75cm	Beam Forming
graphical user interface	Quantum dot	VGA	Lithium Ion Battery	25cm	Beam steering
graphical user interface	Computer Monitor	Ethernet	Solar Cell	31.25cm	FPGA/MCU
command line	Liquid crystal display	Coax Cables	5V Battery	6.25cm	Waveform/Function Generator
command line	7-segment	HDMI	USB from Computer	12.5cm	RF Phase Shifter
command line	Liquid Emitting Diode	USB	Outlet	18.75cm	Beam Forming
command line	Quantum dot	VGA	Lithium Ion Battery	25cm	Beam steering
command line	Computer Monitor	Ethernet	Solar Cell	31.25cm	FPGA/MCU
menu driven	liquid crystal display	Coax Cables	5V Battery	6.25cm	Waveform/Function Generator

menu driven	7-segment	HDMI	USB from Computer	12.5cm	RF Phase Shifter
menu driven	Liquid Emitting Diode	USB	Outlet	18.75cm	Beam Forming
menu driven	Quantum dot	VGA	Lithium Ion Battery	25cm	Beam steering
menu driven	Computer Monitor	Ethernet	Solar Cell	31.25cm	FPGA/MCU
form based	liquid crystal display	Coax Cables	5V Battery	6.25cm	Waveform/Function Generator
form based	7-segment	HDMI	USB from Computer	12.5cm	RF Phase Shifter
form based	Liquid Emitting Diode	USB	Outlet	18.75cm	Beam Forming
form based	Quantum dot	VGA	Lithium Ion Battery	25cm	Beam steering
form based	Computer Monitor	Ethernet	Solar Cell	31.25cm	FPGA/MCU
Interactive user control	Touchscreen display	wireless	Lithium ion battery	20cm	Phase shift status
Frequency Classification	Frequency PSD graphs show on LCD	Booster pack extension	Booster connected to MCU	3cm	Frequency detection
Frequency measurement	Frequency value	Seven segment	Through	1cm	receiver

	displays on fpga seven segment display	display on DoC-1 board	fpga power source		
Phase measurement	Phase shift displays on fpga seven segment display	Seven segment display on DoC-1 board	Through fpga power source	1cm	receiver
Signal detection	Light up LED when signal is detected	LED on fpga	Through fpga power source	1cm	receiver
Phase range	Show phasor diagram on LCD	Booster pack extension	Booster connected to MCU	3cm	receiver
Voice Control steered beam	Display voice recognized phase value on LCD on MCU	Booster pack extension	Booster connected to MCU	3cm	transmitter
Voice Control signal range detection	Display voice recognized frequency range on LCD	Booster pack extension	Booster connected to MCU	3cm	Receiver, looks for signal within the given range