

Bat Machine

Ultrasonic Sensor and Servo
Control With a FPGA

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Project Delays

What Works

- Driver between ultrasonic sensor and peripheral
- Adjustable VGA radar according to echo signal (simulated)

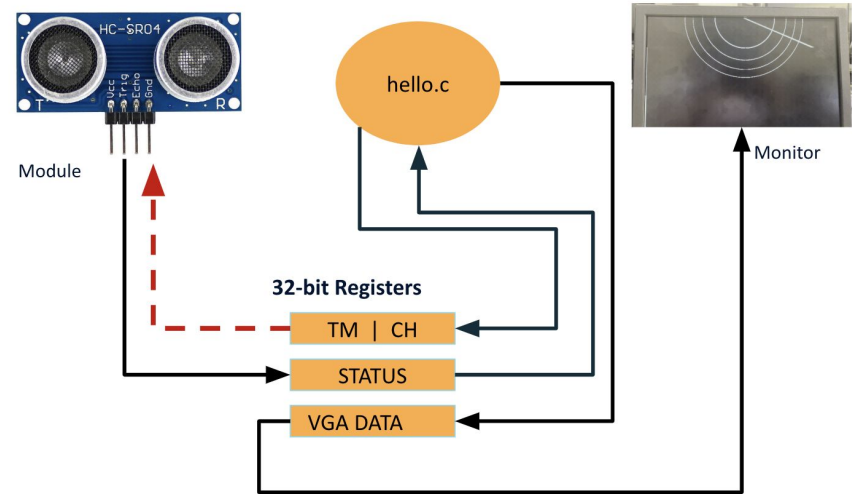


Project Delays

What Does Not Work

- Reading an echo signal from UltraSonic Sensor
- Controlling a servo motor with PWM

SYSTEM DIAGRAM



OVERVIEW

SOFTWARE

Calculate distance

HARDWARE

Status of Ultrasonic



OVERVIEW

SOFTWARE

Calculate distance



Radar Line Calculation

HARDWARE

Status of Ultrasonic

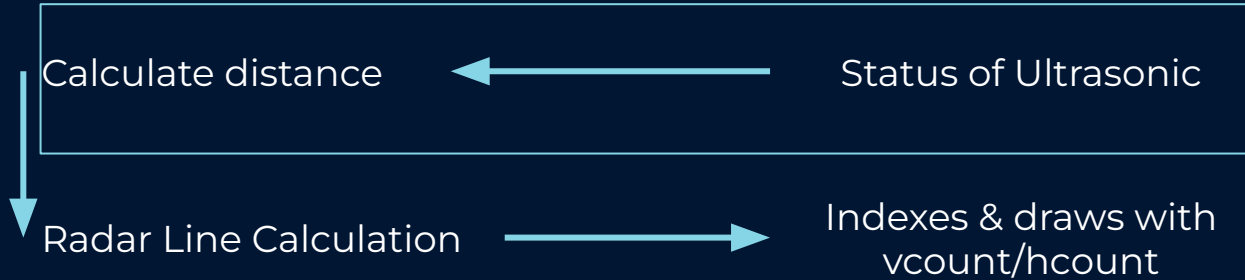
Indexes & draws with
vcount/hcount



OVERVIEW

SOFTWARE

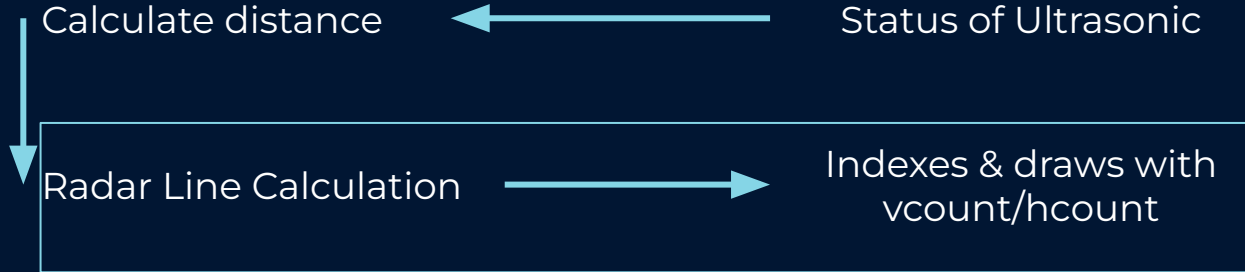
HARDWARE



OVERVIEW

SOFTWARE

HARDWARE



Platform Designer

System Contents Address Map Interconnect Requirements

System: soc_system Path: clk_0

Use	Connections	Name	Description	Export	Clock	Base	End
<input checked="" type="checkbox"/>		clk_0	Clock Source				
		clk_in	Clock Input	clk	exported		
		clk_in_reset	Reset Input	reset			
		clk	Clock Output	Double-click to	clk_0		
		clk_reset	Reset Output	Double-click to			
<input checked="" type="checkbox"/>		hps_0	Arria V/Cyclone V Hard Proce...				
		h2f_user1_clock	Clock Output	Double-click to	hps_0_h2...		
		h2f_mpu_events	Conduit	Double-click to			
		memory	Conduit	hps_ddr3			
		hps_io	Conduit	hps			
		h2f_reset	Reset Output	Double-click to			
		h2f_axi_clock	Clock Input	Double-click to	clk_0		
		h2f_axi_master	AXI Master	Double-click to	[h2f_axi_...		
		f2h_axi_clock	Clock Input	Double-click to	clk_0		
		f2h_axi_slave	AXI Slave	Double-click to	[f2h_axi_...		
	h2f_lw_axi_clock	Clock Input	Double-click to	clk_0			
	h2f_lw_axi_master	AXI Master	Double-click to	[h2f_lw_a...			
<input checked="" type="checkbox"/>	vga_ball_0	VGA ball					
	reset	Reset Input	Double-click to	[clock]			
	avalon_slave_0	Avalon Memory Mapped Slave	Double-click to	[clock]	0x0000_0000	0x0000_07ff	
	vga	Conduit	Double-click to	[clock]			
	clock	Clock Input	Double-click to	clk_0			
<input checked="" type="checkbox"/>	ultrasonic_sens...	ultrasonic_sensor					
	clock	Clock Input	Double-click to	clk_0			
	avalon_slave_0	Avalon Memory Mapped Slave	Double-click to	[clock]	0x0000_0000	0x0000_0003	
	reset	Reset Input	Double-click to	[clock]			
	sensor	Conduit	Double-click to	sensor			

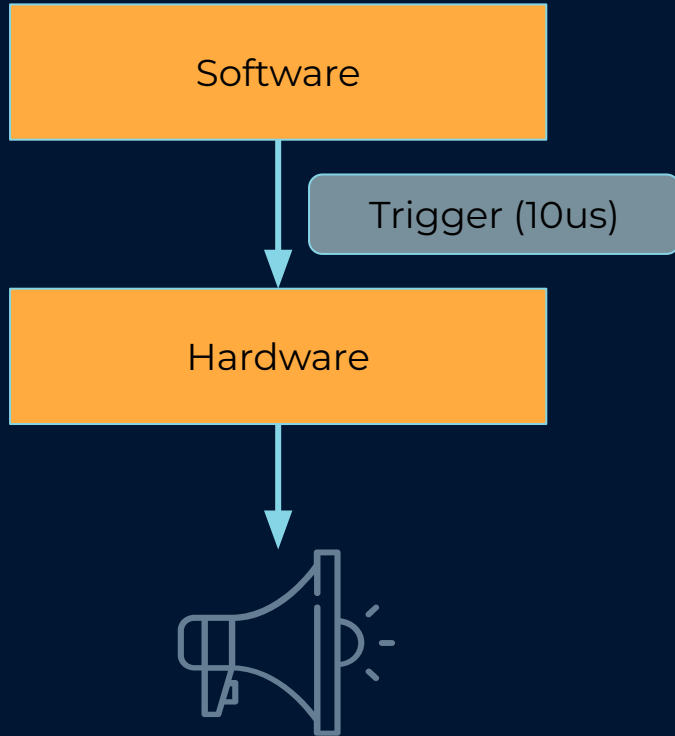
Platform Designer

System Contents Address Map Interconnect Requirements

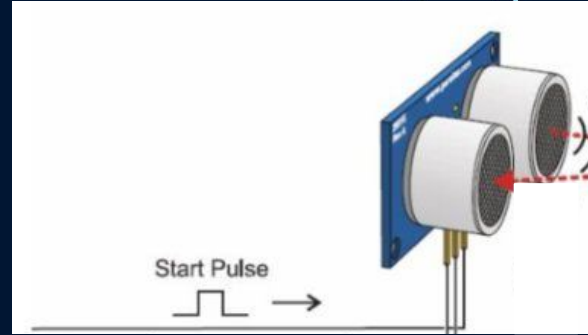
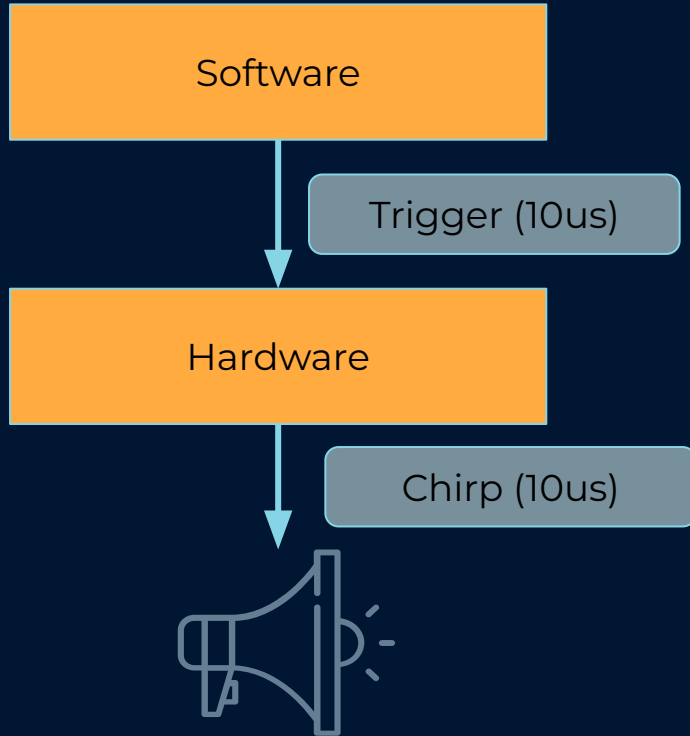
System: soc_system Path: clk_0

Use	Connections	Name	Description	Export	Clock	Base	End
<input checked="" type="checkbox"/>		clk_0	Clock Source				
		clk_in	Clock Input	clk	exported		
		clk_in_reset	Reset Input	reset			
		clk	Clock Output	Double-click to	clk_0		
		clk_reset	Reset Output	Double-click to			
<input checked="" type="checkbox"/>		hps_0	Arria V/Cyclone V Hard Proce...				
		h2f_user1_clock	Clock Output	Double-click to	hps_0_h2...		
		h2f_mpu_events	Conduit	Double-click to			
		memory	Conduit	hps_ddr3			
		hps_io	Conduit	hps			
		h2f_reset	Reset Output	Double-click to			
		h2f_axi_clock	Clock Input	Double-click to	clk_0		
		h2f_axi_master	AXI Master	Double-click to	[h2f_axi_...		
		f2h_axi_clock	Clock Input	Double-click to	clk_0		
		f2h_axi_slave	AXI Slave	Double-click to	[f2h_axi_...		
		h2f_lw_axi_clock	Clock Input	Double-click to	clk_0		
		h2f_lw_axi_master	AXI Master	Double-click to	[h2f_lw a...		
<input checked="" type="checkbox"/>		vga_ball_0	VGA ball				
		reset	Reset Input	Double-click to	[clock]		
		avalon_slave_0	Avalon Memory Mapped Slave	Double-click to	[clock]	0x0000_0000	0x0000_07ff
		vga	Conduit	Double-click to	[clock]		
		clock	Clock Input	Double-click to	clk_0		
<input checked="" type="checkbox"/>		ultrasonic_sens...	ultrasonic_sensor				
		clock	Clock Input	Double-click to	clk_0		
		avalon_slave_0	Avalon Memory Mapped Slave	Double-click to	[clock]	0x0000_0000	0x0000_0003
		reset	Reset Input	Double-click to	[clock]		
		sensor	Conduit	Double-click to	[clock]		

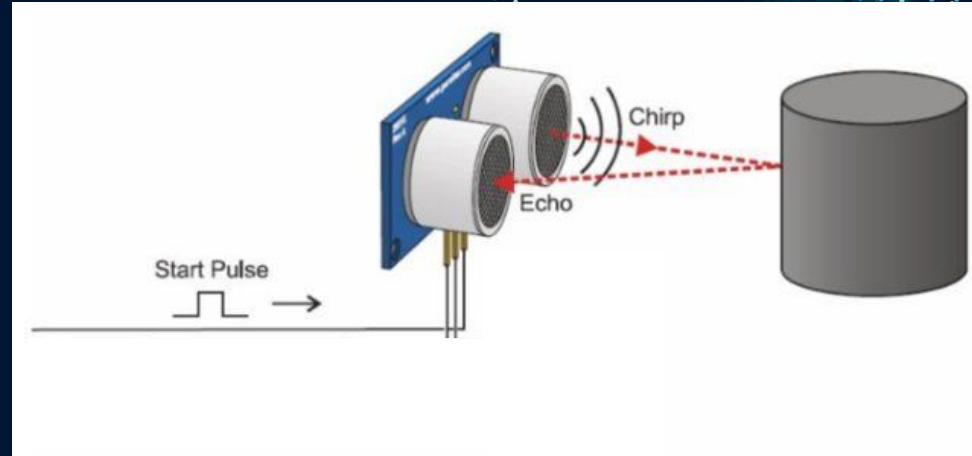
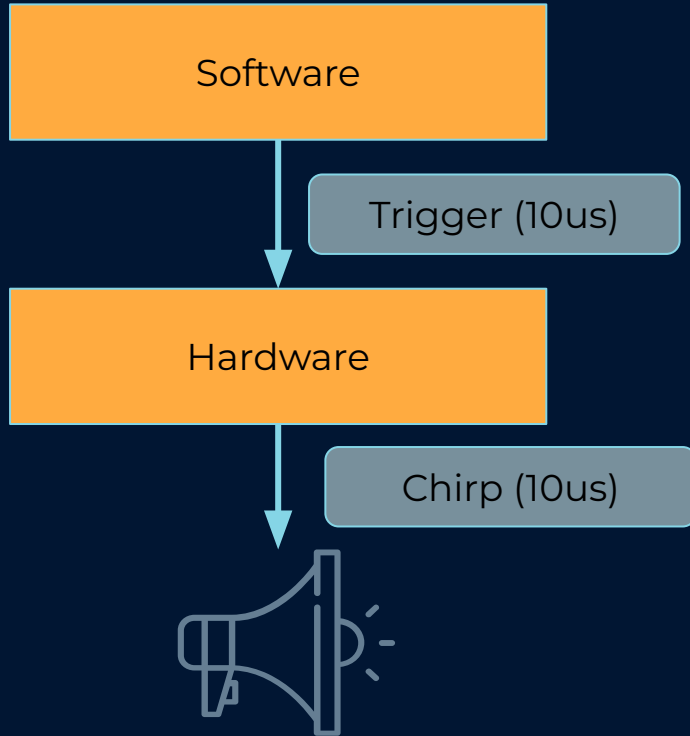
Ultrasonic Sensor Signals



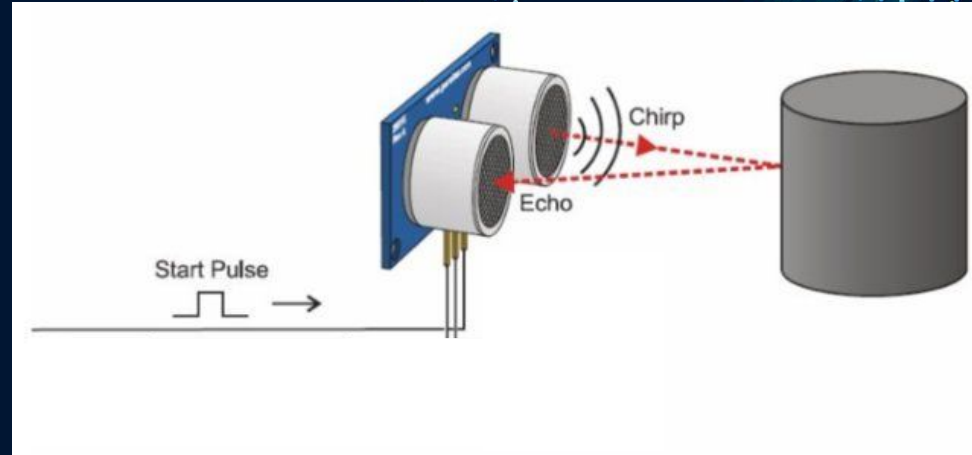
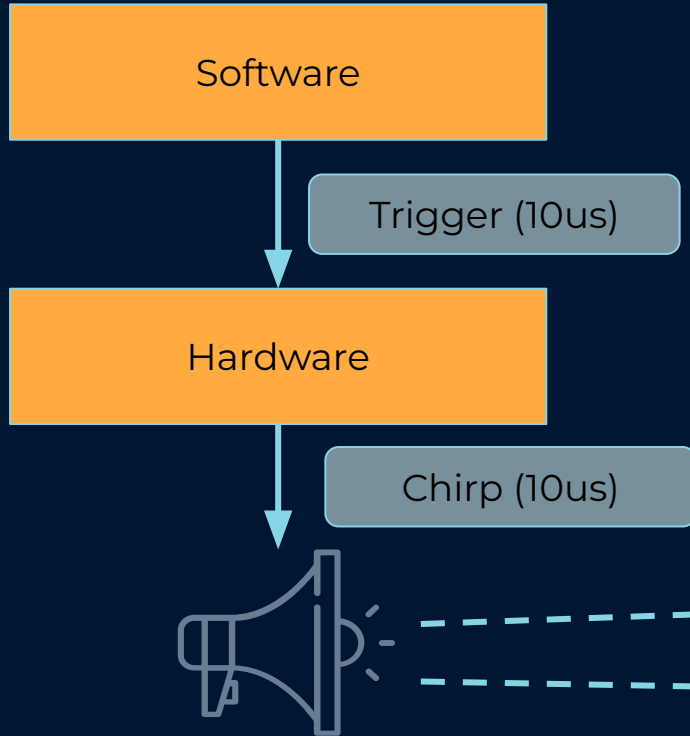
Ultrasonic Sensor Signals



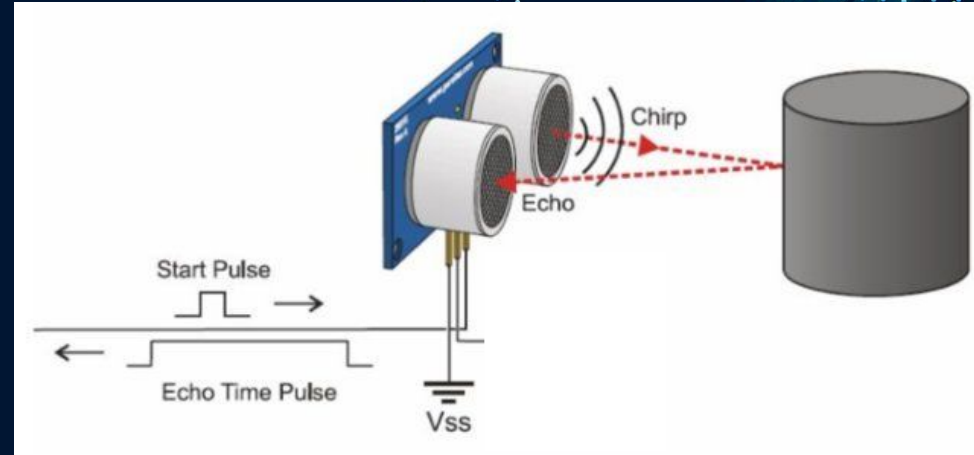
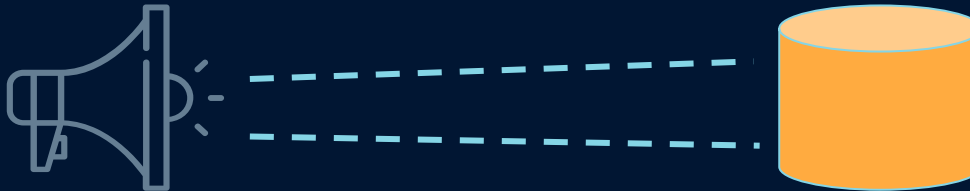
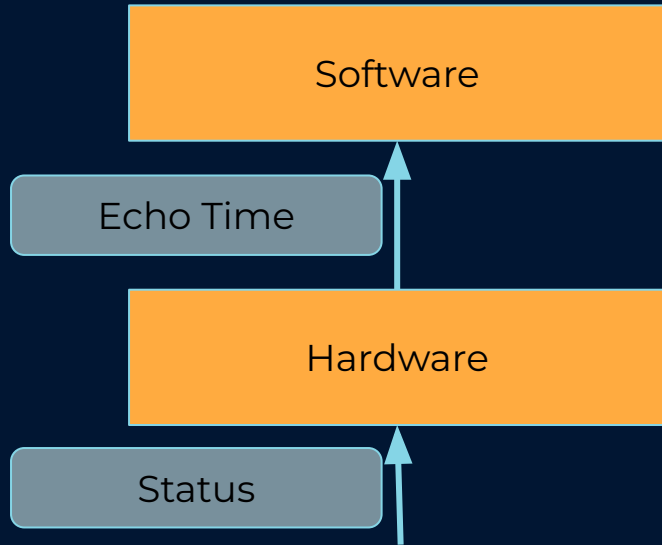
Ultrasonic Sensor Signals



Ultrasonic Sensor Signals

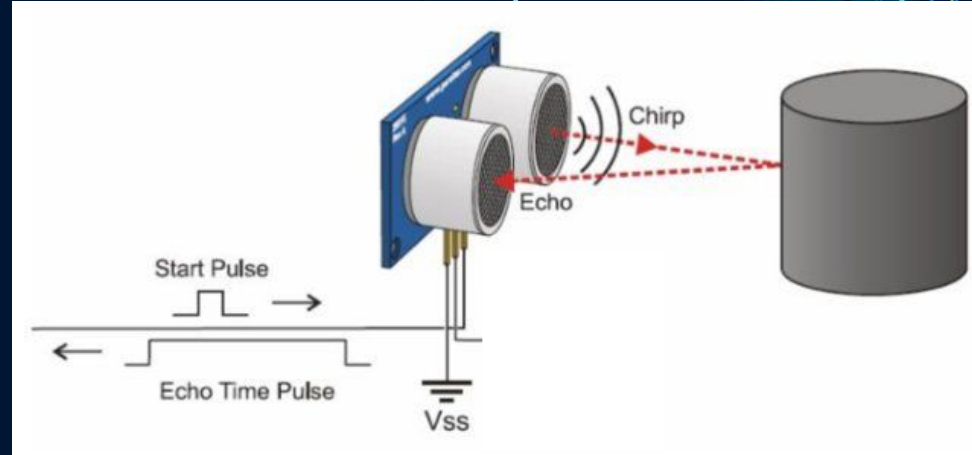
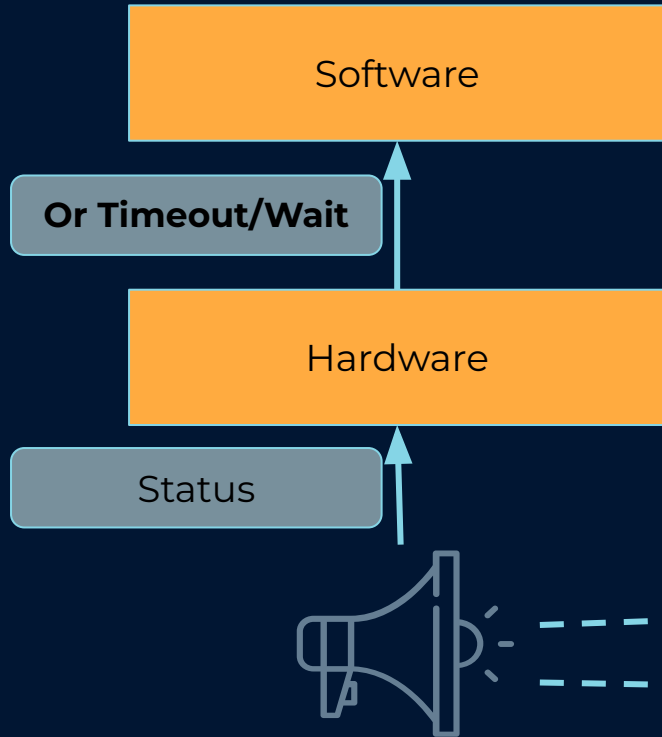


Ultrasonic Sensor Signals

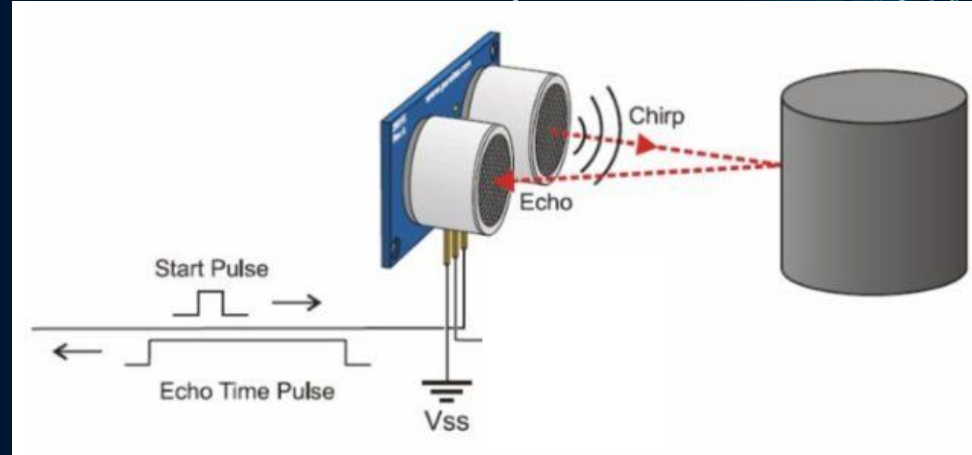
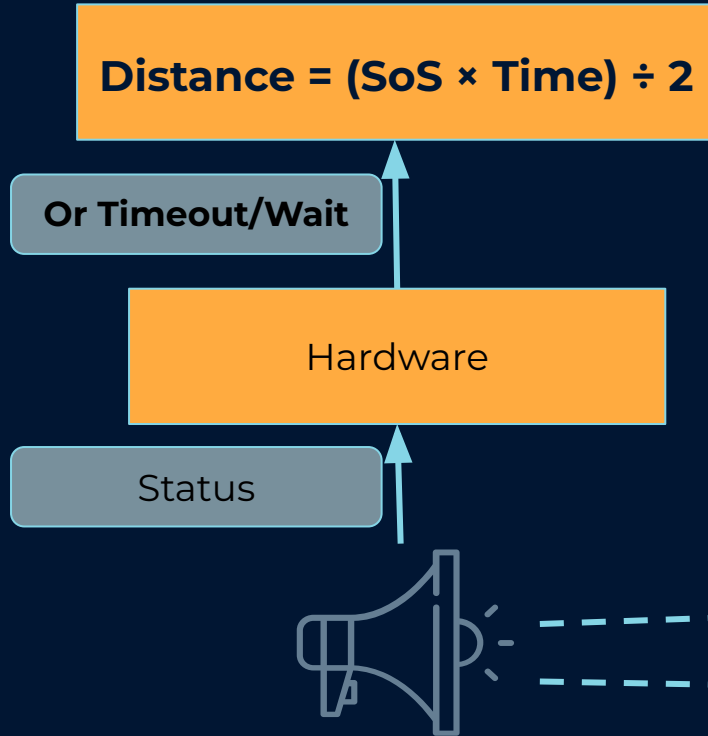


temperature_celsius

Ultrasonic Sensor Signals



Ultrasonic Sensor Signals



Defining the line

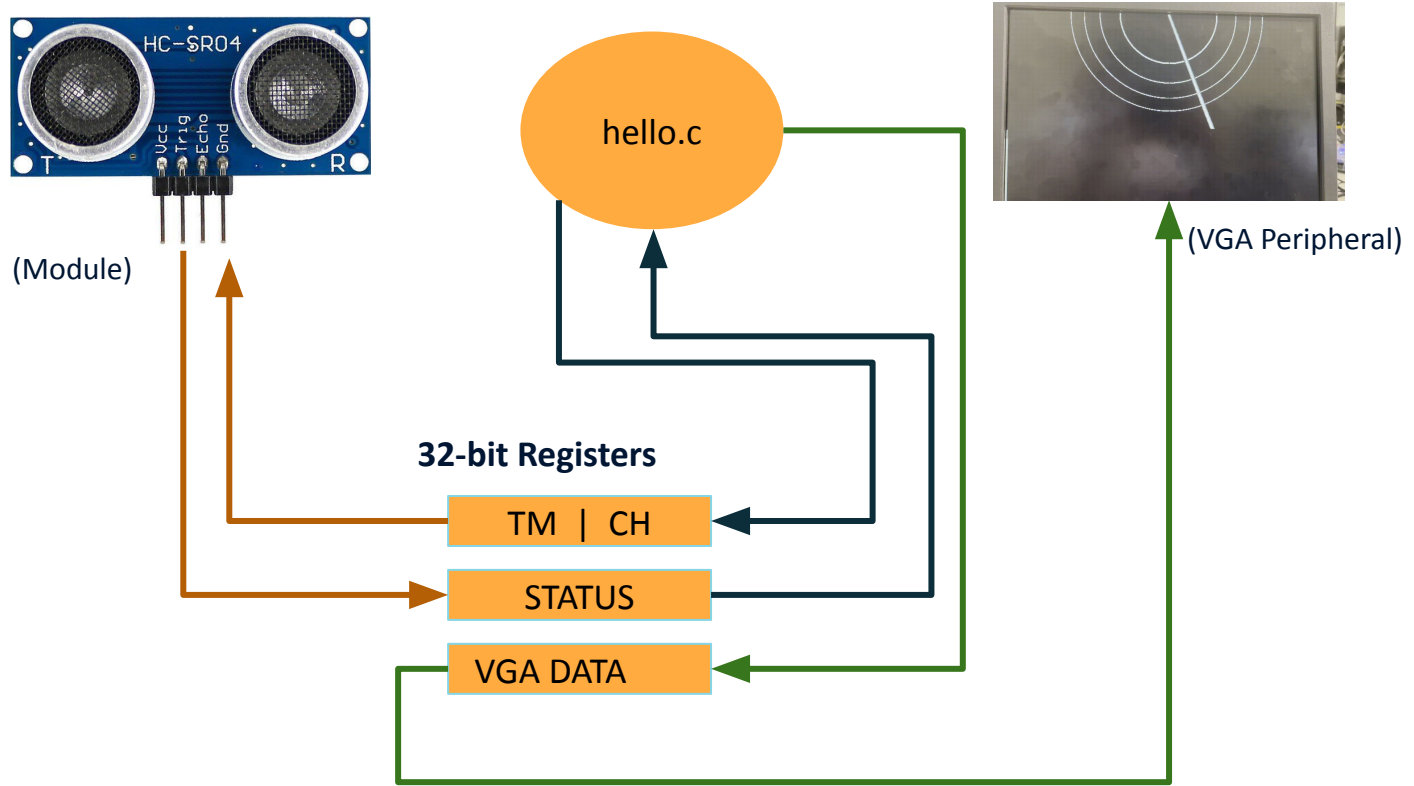
Given theta, define a line with horizontal ranges indexable by vcount.

Calculate horizontal distance:

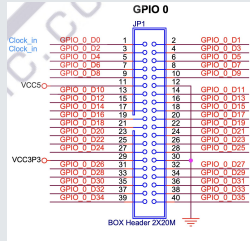
$$X_{\text{high/low}} = \cos(\Theta) * (\text{skipped x distance}) +/- \Delta$$

```
int x0 = SCREEN_WIDTH/2 + (int)(cosf(theta * (float)M_PI / 180.0f) * vx) - (2 + AngleDistanceFrom90);  
int x1 = SCREEN_WIDTH/2 + (int)(cosf(theta * (float)M_PI / 180.0f) * vx) + (2 + AngleDistanceFrom90);
```

SYSTEM DIAGRAM



ULTRASONIC SENSOR + MODULE



If CHIRP:

- TRIGGER 10 microseconds
- Wait for ECHO; STATUS = 0.

TIMEOUT | CHIRP

If ECHO:

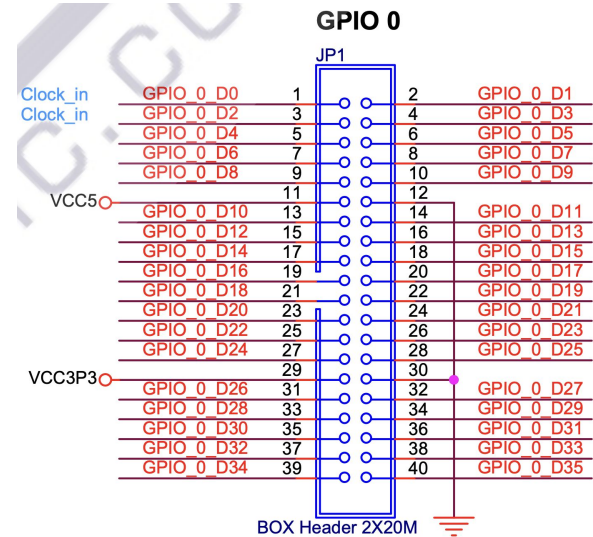
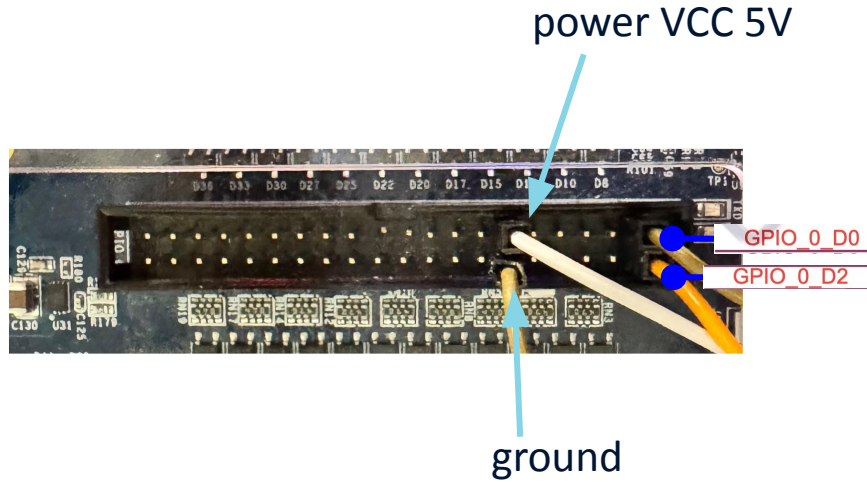
- Count echo; STATUS = 0.
- STATUS = Final Count.


STATUS

If echo takes too long:

- STATUS = Timeout.

ULTRASONIC SENSOR + MODULE





```
Writing config: timeout=0xffff, chirp=0, cfg=0xffff0000
Echo status @ 132° = 0xe0688c92, chirp = 0
Writing config: timeout=0xffff, chirp=0, cfg=0xffff0000
Echo status @ 131° = 0xe0688c92. chirp = 0
```

```
Writing config: timeout=0xffff, chirp=0, cfg=0xffff0000
Echo status @ 120° = 0xe0abcc74, chirp = 0
Writing config: timeout=0xffff, chirp=0, cfg=0xffff0000
Echo status @ 119° = 0xe0abcc74. chirp = 0
```