App Note for Component Selection

During this quarter 2, we had to design a FMCW radar system from ground up. My part consisted of component selection. To begin the component selection, you first need a diagram of the complete system so that you know what parts you need and what the power flow is. We decided to use the block diagram similar to quarter 1 lab because we knew that system worked, and we didn't know much about how components should flow in a radar system.

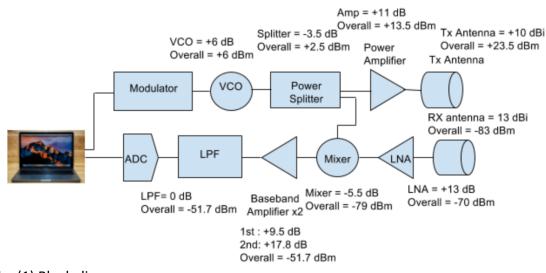


Fig. (1) Block diagram

The second step we needed to do was find the actual components online now. Our main websites we used were Digikey and Minicircuits. When trying to find the components online, it is very useful to use the filters they provide. For instance, if you want a component to work around a certain frequency, such as 2.4 GHz, you can choose that specification and the online website will show you all the components that match what you want. Our main goal was to find components that matched the 2.4 GHz range, so that's how our first round of components was chosen.

Vincent Saechao 912140715

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duct Index > <u>RF/IF and RFID</u> > <u>RF Mixers</u>	L				
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Manufacturer	Packaging	Series	Part Status	RF Type	Frequency
AKM Semiconductor Inc. Analog Devices Inc. Anaren Broadcom Limited 2EL DT, Integrated Device Technology Inc Intersil Linear Technology/Analog Devices M/A-Com Technology Solutions	- Bulk Cut Strip Cut Tape (CT) Digi-Reel® Tape & Reel (TR) Tray Tube	- D AD608 L AD6633 N AD6634 O	ctive iscontinued at Digi-Key ast Time Buy ot For New Designs bsolete reliminary	- AM, FM ASK, DECT, FSK Broadcast Radio, DAB CATV CATV, DBS, PHS, UHF, VHF CDMA, DCS, EDGE, GSM, UMTS, WCDMA CDMA, EDGE, GSM, UMTS, WCDMA CDMA, EDGE, GSM, UMTS, WCDMA	- OHZ ~ 10GHZ OHZ ~ 1GHZ OHZ ~ 2.4GHZ OHZ ~ 2.6GHZ OHZ ~ 500MHZ OHZ ~ 50HZ OHZ ~ 700MHZ OHZ ~ 70HZ
Stock Status Media Available In Stock Datasheet Normally Stocking Photo New Products EDA / CAD M	RoHS Comp Non-RoHS	oliant			

Fig. (2) Digikey component section applying filters

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	umber of Mixers	Gain	Noise Figure	Secondary Attributes	Current - Supply	Voltage - Supply	Package / Case
-2dB 1.6dB Integrated PLL and VCO 3mA 2V Module -1.9dB 1.7dB Mixer/Detector 3.5mA 2.3 V - 5.5 V Module, SMA Connectors -16B 2dB Quad MOSFET Array 3.7mA 2.5 V - 3.6 V SC-74A, SOT-753 -0.6dB 2.2dB RSSI Equipped 3.9mA 2.7 V - 3.3 V SOT-23-6 -0.5dB 2.4dB SMA Connectors 4.2mA 2.7 V - 3.5 V SOT-23-6 Thin, TSOT-23-6 -0.5dB 2.6dB Up Converter 4.8mA 2.7 V - 3.6 V 3-SMD, No Lead - 3.2dB Up/Down Converter 5mA 2.7 V - 5.25 V 6-SMD, Flat Leads		-7.7dB	-	-	-	-	-
-1.9dB 1.7dB Mixer/Detector 3.5mA 2.3 V ~ 5.5 V Module, SMA Connectors -1dB 2dB Quad MOSFET Array 3.7mA 2.5 V - 3.6 V SC-74A, SOT-753 -0.6dB 2.2dB RSSI Equipped 3.9mA 2.7 V - 3.3 V SOT-23-6 -0.5dB 2.4dB SMA Connectors 4.2mA 2.7 V ~ 3.5 V SOT-23-6 Thin, TSOT-23-6 -0.2dB 2.5dB Up Converter 4.8mA 2.7 V ~ 3.6 V 3-SMD, No Lead - 3.2dB Up/Down Converter 5mA 2.7 V ~ 5.25 V 6-SMD, Flat Leads	2	-3dB	1dB	Down Converter	2.4mA	1.8 V ~ 5.5 V	Die
-1dB 2dB Quad MOSFET Array 3.7mA 2.5 V ~ 3.6 V SC-74Å, SOT-753 -0.6dB 2.2dB RSS Equipped 3.9mA 2.7 V ~ 3.3 V SOT-23-6 -0.5dB 2.4dB SMA Connectors 4.2mA 2.7 V ~ 3.6 V SOT-23-6 Thin, TSOT-23-6 -0.2dB 2.5dB Up Converter 4.8mA 2.7 V ~ 3.6 V 3-SMD, No Lead -0.2dB 2.5dB Up/Down Converter 5mA 2.7 V ~ 5.25 V 6-SMD, Flat Leads		-2dB	1.6dB	Integrated PLL and VCO	3mA	2V	Module
-0.6dB 2.2dB RSSI Equipped 3.9mA 2.7 V ~ 3.3 V SOT-23-6 -0.5dB 2.4dB SMA Connectors 4.2mA 2.7 V ~ 3.5 V SOT-23-6 Thin, TSOT-23-6 -0.2dB 2.5dB Up Converter 4.8mA 2.7 V ~ 3.6 V 3-SMD, No Lead - 3.2dB Up/Down Converter 5mA 2.7 V ~ 5.25 V 6-SMD, Flat Leads		-1.9dB	1.7dB	Mixer/Detector	3.5mA	2.3 V ~ 5.5 V	Module, SMA Connectors
-0.5dB 2.4dB SMA Connectors 4.2mA 2.7 V ~ 3.5 V SOT-23-6 Thin, TSOT-23-6 -0.2dB 2.5dB Up Converter 4.8mA 2.7 V ~ 3.6 V 3-SMD, No Lead - 3.2dB Up/Down Converter 5mA 2.7 V ~ 5.25 V 6-SMD, Flat Leads		-1dB	2dB	Quad MOSFET Array	3.7mA	2.5 V ~ 3.6 V	SC-74A, SOT-753
-0.2dB 2.5dB Up Converter 4.8mA 2.7 V ~ 3.6 V 3-SMD, No Lead - 3.2dB Up/Down Converter 5mA 2.7 V ~ 5.25 V 6-SMD, Flat Leads		-0.6dB	2.2dB	RSSI Equipped	3.9mA		
- 3.2dB Up/Down Converter 5mA 2.7 V ~ 5.25 V 6-SMD, Flat Leads				SMA Connectors			
		-0.2dB					
Clear All Selections Apply Filters		(-	3.2dB	Up/Down Converter	5mA	2.7 V ~ 5.25 V	6-SMD, Flat Leads

Fig. (3) Digikey component section applying filters

Once we found the components, the next step was to plug the components into ADI Sim. This would tell us if each component we chose is compatibles with each other. Each component needs enough power to run the next component. To get the numbers to fill into ADI sim, you have to read the datasheet provided for each component. Then, once all the components are in, you run the program. If it shows a red, that means the component you chose will not work for the system. Reasons for this could be because the voltage gain is too low, or the power gain is to low. It would be easy to tell because the specific box will be red. So, when it doesn't work, you have to go back to Digikey and find another component that fits what you want. It will be a lot of guessing and checking but once there is no red like the figures below, you will be set. ADI also tells you the output power of the whole system.

<u>F</u> ile <u>S</u> tage	Reference Da	ata Help																				
AHEAD OF WHAT'S PO	XES	•	•		\$]																¢
+		Stage 1	▶	Stage 2	•		Stage 3	•	Stag	e 4		Stage 5	•	Sta	ge 6		Stage 7	•	Stage 8	•	Stage	9
		Gain		-	}		-	-	-[-		-	-	-[-	-	}	-	}
Transi	nit	Gain Block	• 0	evice	-	Devic	e	-	Device		▼ De	vice	•	Device		_	Device	_	Device	-	Device	
Toggle T	x/Rx	Temp Part	• T	emp Part	-	PartN	umber	-	PartNumber		▼ Pa	tNumber	•	PartNumb	er	•	PartNumber	-	PartNumber	-	PartNumber	
Output Freq	(MHz)	2400		400																		
Zin	(Ohms)	50	5																			
Zout	(Ohms)	50	5	0																		
Power Gain	(dB)	11	1	D																		
Voltage Gain	(dB)	11	1	D																		
OIP3	(dBm)	44.6	1	00																		
OP1dB	(dBm)	22.5	9	0																		
Pout	(dBm)	13	2	3																		
Pout Backoff	(dB)	9.5	6	7																		
Peak Backoff	(dB)	9.5	6	7																		
Noise Figure	(dB)	0.9	0																			
Voltage	(V)	5	0																			
Current	(mA)	97	0																			
		<																				
		Input					Analys															
		Number							Power (rms)	23	dBm			e Figure	0.9	dB			OIP3	54.6	dBm	
			out Pov		dBm MHz				oltage (rms)	3.16	Vms				-152.1	dBm/ nV/rt		David 2	IIP3 dB) per tone))	33.6	dBm dBc	
		Analysis E PEP-to-R			dB			Output	Voltage (pp) OP1dB	8.92 32.5	Vpp dBm		Outp tput Nois	put NSD	5.6 -92.1	nV/rt dBr		rout-3	(B) per tone)) SFDR	-69.2 97.7	dBc	
		PEP-to-H P1dB Backof			dB				IP1dB	12.5	dBm		uput mole		115.1	dB			ACLR (est.)	-84	dB	
		Peak Backof			dB				Power Gain	21	dB			- All					Consumption	0.48	W	

Fig. (4) ADI Sim for transmitter

ADISimRF - n																			- [
<u>F</u> ile <u>S</u> tage	Reference Da	ita Help																		
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+		Stage 1	Stage 2	-	Stage 3	•	Stage	4 -	S	tage 5		St	age 6		Stage	7	Stage	3 🌗	Stage	9
					\otimes)				Gain	~	-	LPF		-	}	-	}	-	}
Recei	ve		Device	Ŧ	Mixer (Rx)	-	Gain Block	•	 Gain B 	lock	-	LPF		•	Device	-	Device	-	Device	
Toggle T	x/Rx		PartNumber		Temp Part	-	Temp Part		 Temp 	Part	•	Temp P	art	•	PartNumber	-	PartNumber	-	PartNumber	
Input Freq	(MHz)	2400			2400		0		0			0								
Zin	(Ohms)	50			50		50		50			50								
Zout	(Ohms)	50		5	50		50		50			50								
Power Gain	(dB)	13		•	5.5		9.5		17.8			0								
Voltage Gain	(dB)	13		•	5.5		9.5		17.8			0								
IIP3	(dBm)	15		2	22.7		35		17.1			100								
IP1dB	(dBm)	22		1	17		14.5		24			108								
Pin	(dBm)	-56.7		-	43.7		-49.2		-39.7			-21.9								
Pin Backoff	(dB)	78.7		6	60.7		63.7		63.7			129.9								
Peak Backoff	(dB)	78.7		e	60.7		63.7		63.7			129.9								
Noise Figure	(dB)	2.3		1	12		0.9		0.8			0								
Voltage	(V)	5		5	5		5		5			0								
Current	(mA)	110		1	41		200		90			0								
		<																		
		Input			Analy	sis														
		Number of S				Output I	Power (rms)	-21.92	dBm		Nois	e Figure		dB			OIP3	34.32	dBm	
		Input F		dBm			oltage (rms)		mVrms			put NSD		dBm/			IIP3	-0.5	dBm	
		Analysis Band PEP-to-RMS		MHz dB		Output	Voltage (pp)	50.64	mVpp dBm	-		put NSD	38.7	nV/rti dBm		1D3 ((Pin-	3dB) per tone)	-118.5	dBc dB	
		PEP-to-RMS P1dB Backoff Wa		dB			OP1dB IP1dB	34.75 1	dBm dBm	0	utput Noi:	se Floor SNR	-75.2 53.3	dBm dB			SFDR ACLR (est.)	72.9 -53	dB	
		Pidb Backoff Wa	-	dB			Power Gain	34.8	dB	In	out Rx Se		-110	dBm		Pw	Consumption	-55	W	
		Min S/N for D		dB			oltage Gain	34.8	dB								2210011000	.		

Fig. (5) ADI Sim for Receiver

Compon ent	Model Number	URL
LNA (1)	HMC 639ST89E	https://www.digikey.com/product-detail/en/analog-devices- inc/HMC639ST89E/1127-3004-ND/5359984
VCO	ROS- 2490+	https://www.minicircuits.com/WebStore/dashboard.html?model= ROS-2490%2B
Mixer	Sim- 63LH+	https://www.minicircuits.com/WebStore/dashboard.html?model=SIM- 63LH%2B
LPF	MAX291E SA+	https://www.digikey.com/product-detail/en/maxim- integrated/MAX291ESA/MAX291ESA-ND/1513302
Amplifier (Rx) #1	PGA-103	https://www.minicircuits.com/WebStore/dashboard.html?model=PGA- 103%2B
Amplifier (Tx)	PGA-103	https://www.minicircuits.com/WebStore/dashboard.html?model=PGA- 103%2B
Amplifer (Rx) #2	MMG2024 1H	https://www.mouser.com/productdetail/nxp- freescale/mmg20241ht1?qs=sGAEpiMZZMvIz5n0fllKWCPT5hyshv% 2FsuQS0BdS5sXs%3D
Antenna	Yagi	http://www.wa5vjb.com/pcb-pdfs/Yagi2400.pdf or http://www.wa5vjb.com/products2.html
Splitter	BP2U+	https://www.minicircuits.com/WebStore/dashboard.html?model=BP2U %2B

Table (6) Component List

This is a list of our components we purchased. It will be very convenient to put all the parts in one list and links to where they can be purchased. You yourself will not have to order the components. But you will have to make a list like this and include the quantity you want. Then send it to the TA's and they will order for you. I recommend ordering three to four of each component if you can afford it in your budget because sometimes your first PCB design might not work, and you would want to restart another one. Also, the components are very small, so they are very easy to lose so ordering a few extra may be very beneficial. I also recommend starting your component list early and placing the order in early because they do take a while to come in. This concludes the component selection app note.