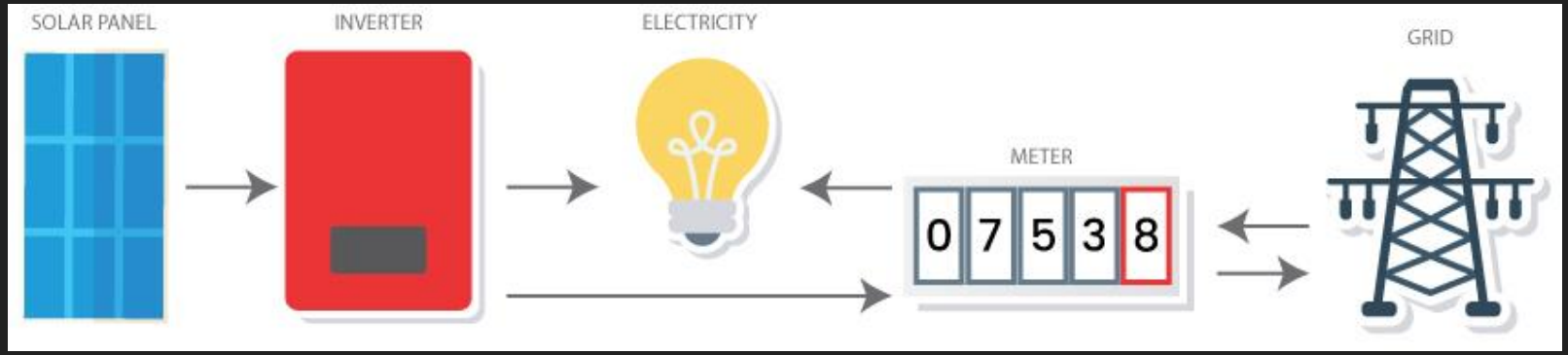
iPV++

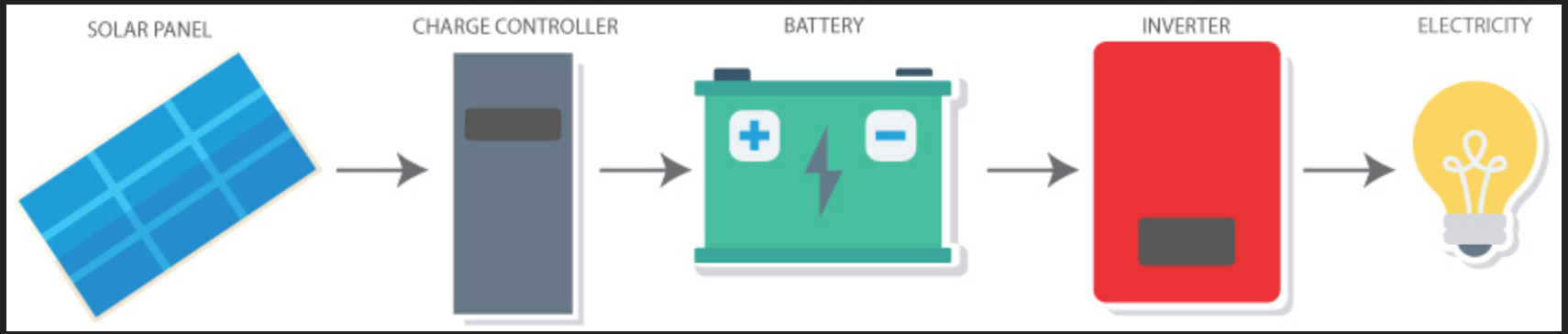
Group 17
Angelica Becker, Jeffrey Claudio, Emmanuel Ortiz

Motivation

- Clean energy source
- Increased want/need for renewable energy
- Reduce cost and complexity of installation and maintenance
- Optimize configuration
- Sponsored

Existing PV Systems





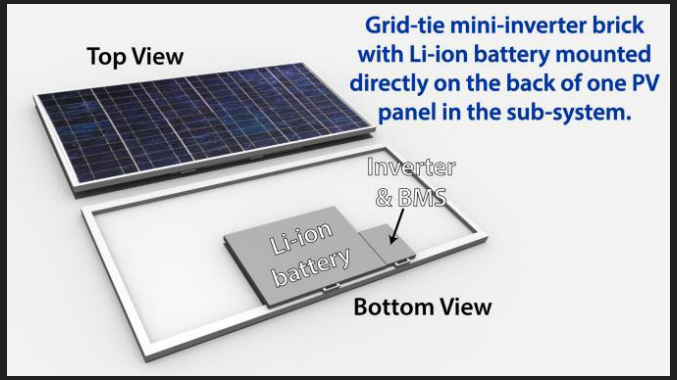
Goals and Objectives

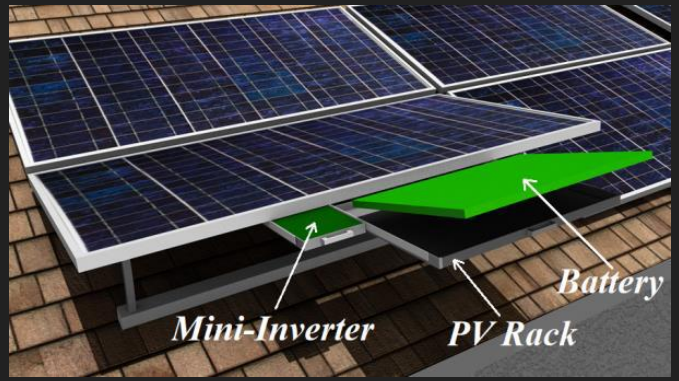
- Develop and design an advanced integrated and cost-effective PV system:
  - Design a unique architecture that integrates smart power electronics and local storage and battery management to harvest solar power
  - Present new innovative inverter with smart and dynamic control algorithm
  - ‘Plug-and-play’ easy replacement of battery and inverter to accelerator PV deployment and significantly reduce installation and maintenance costs

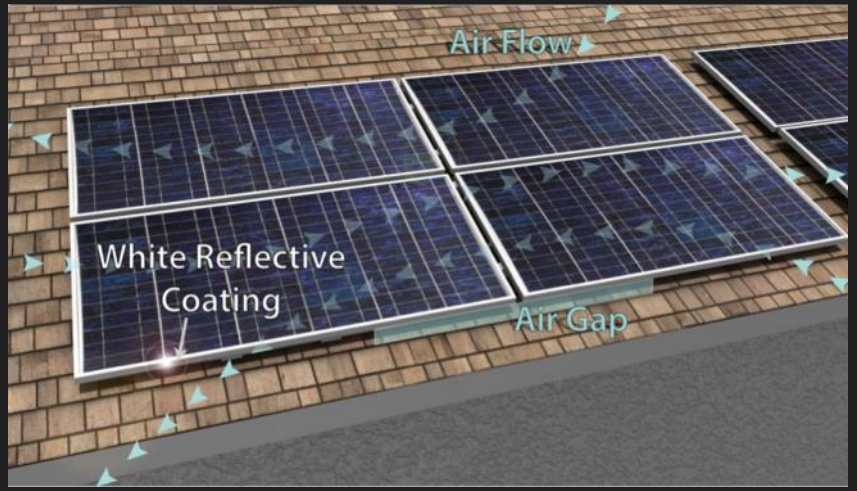
IPV++ Enclosure

- Electrical Team
  - DC/DC Converter
  - DC/AC Inverter

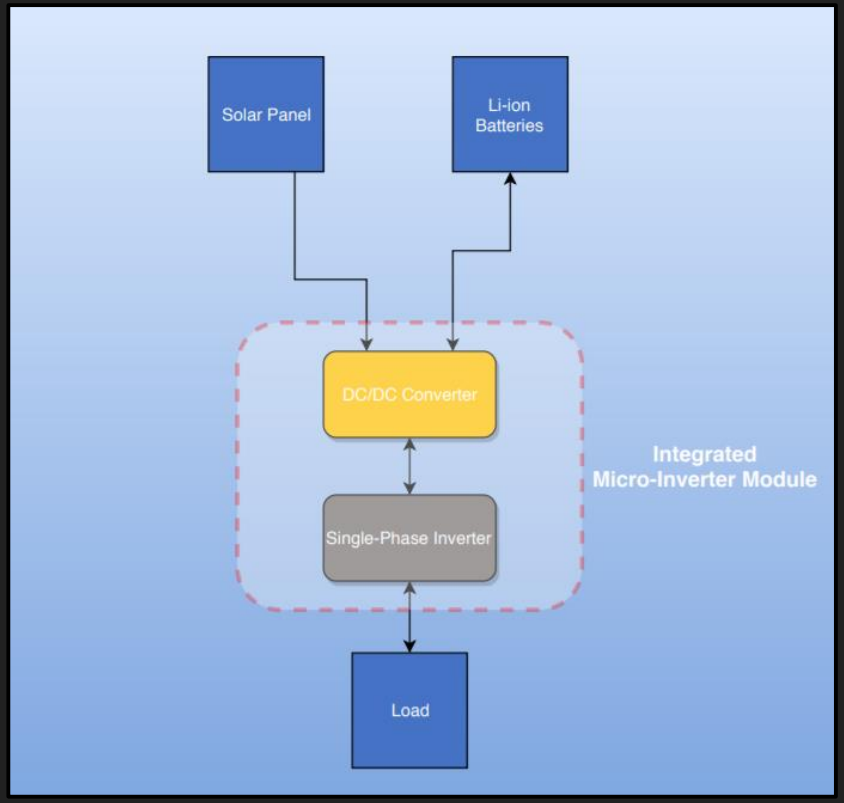
- Mechanical Team
  - PV Rack
  - Thermal Management and Packaging







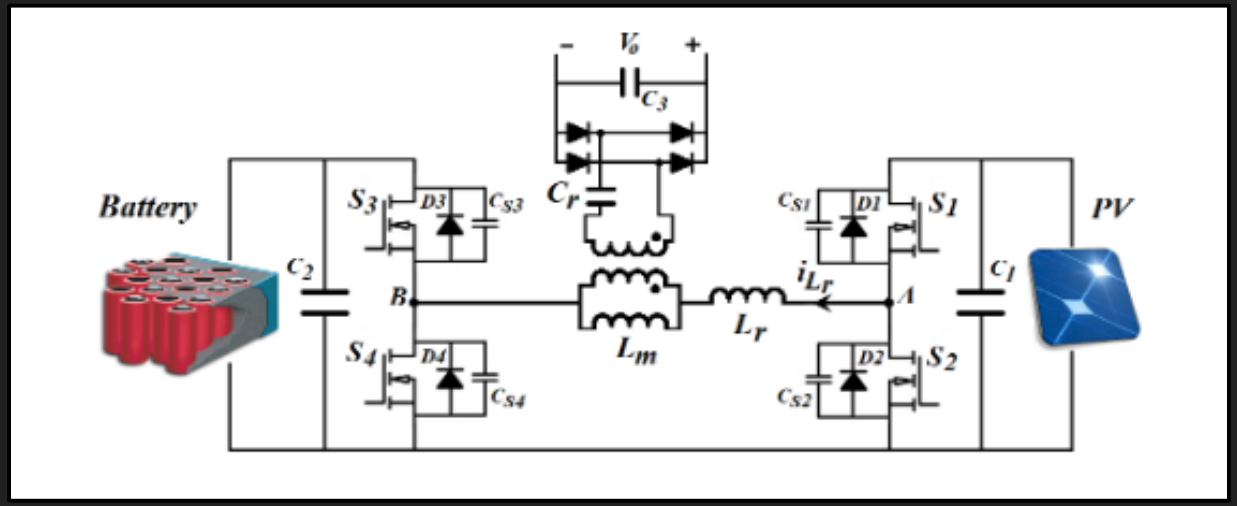
Specifications



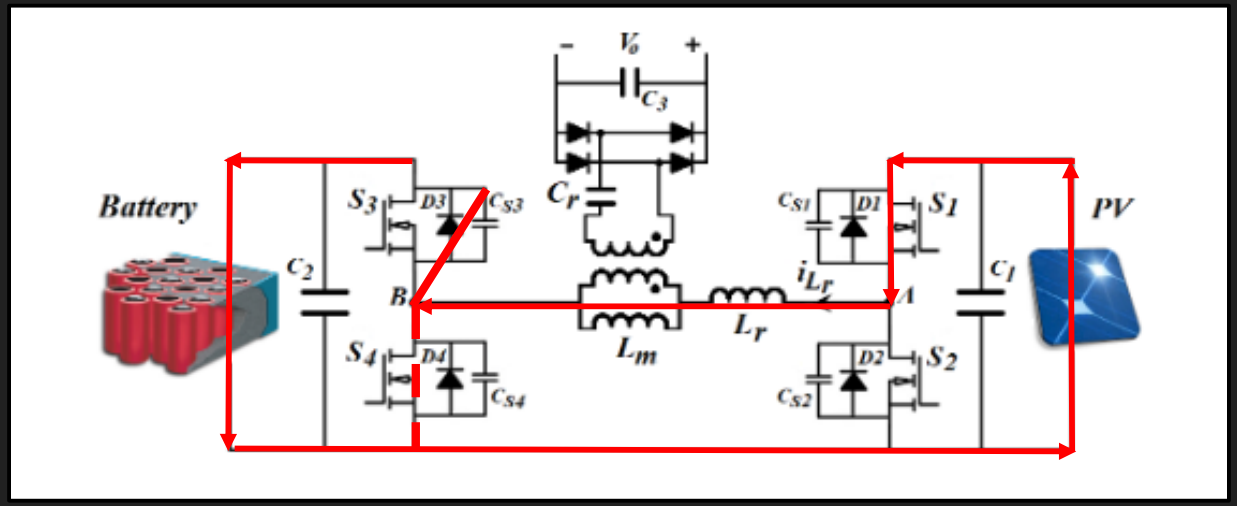
DC/DC Converter	• Dual Input • 400V Output • 500W Output
Single-Phase Inverter	• Input 400V • Output of 120V • Potential to be Grid-Tied
Microcontroller	• Programming DC/DC Controller and DC/AC Modules

DC/DC Converter

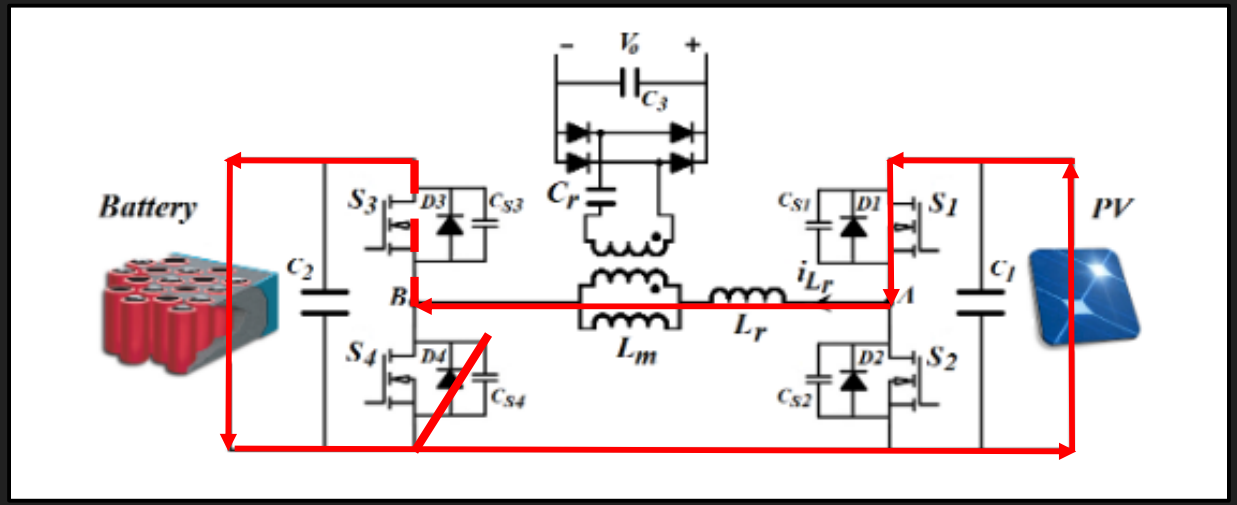
DC/DC Converter



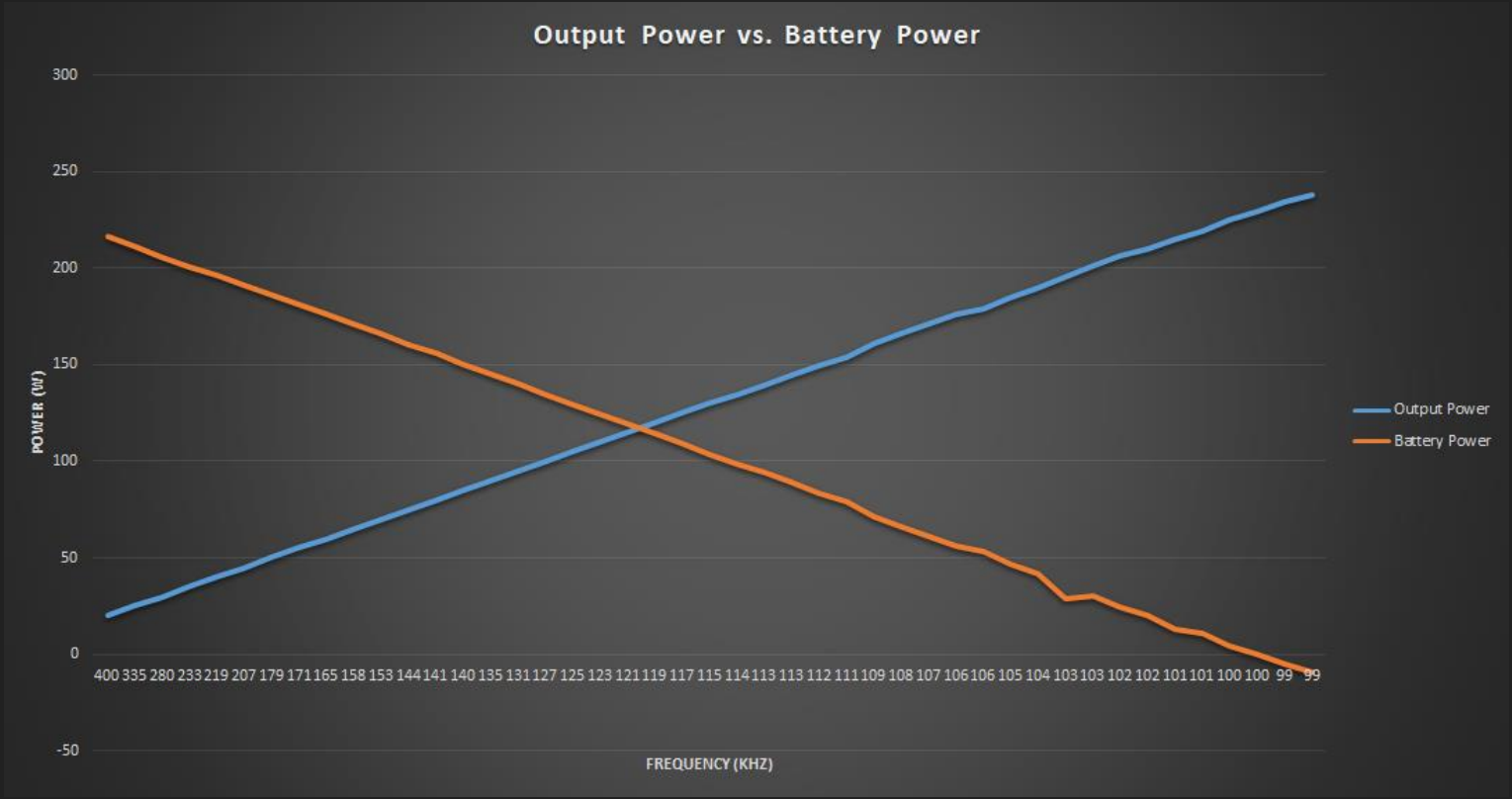
Charging Mode



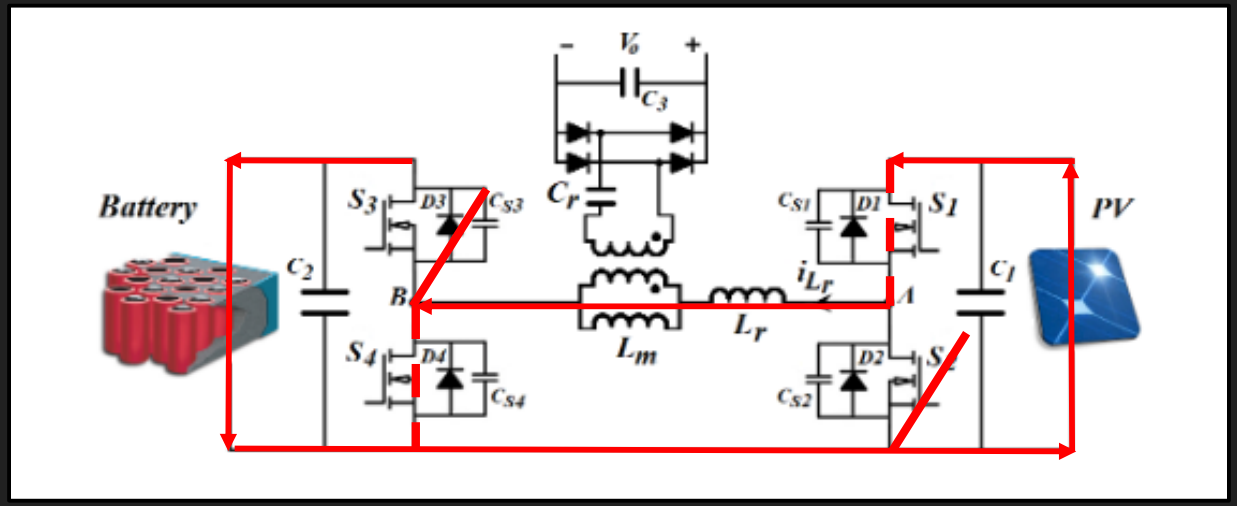
Charging Mode



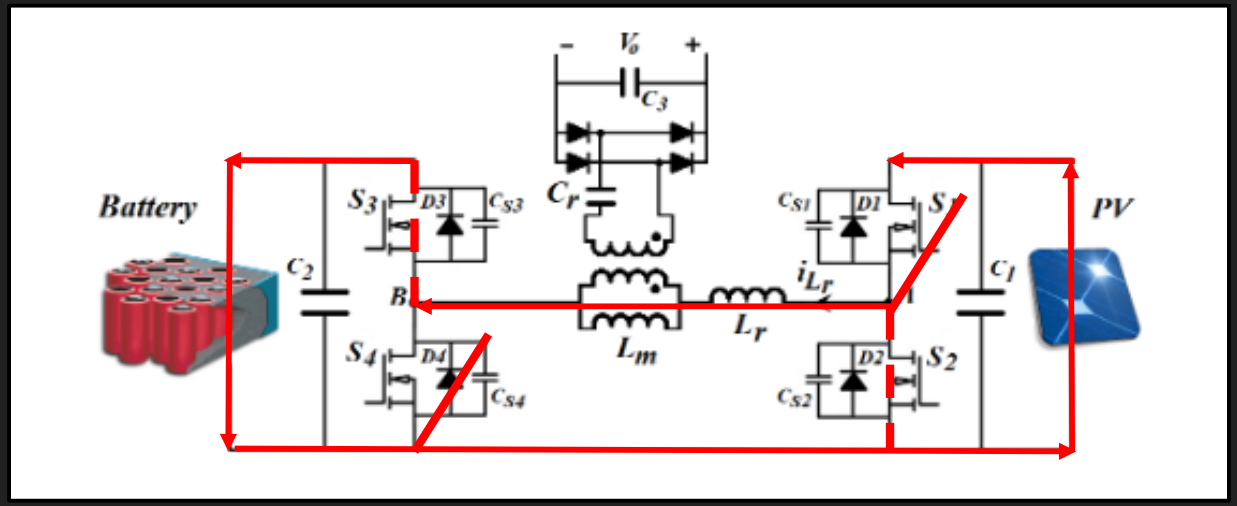
Frequency Manipulation (Constant DC Link)



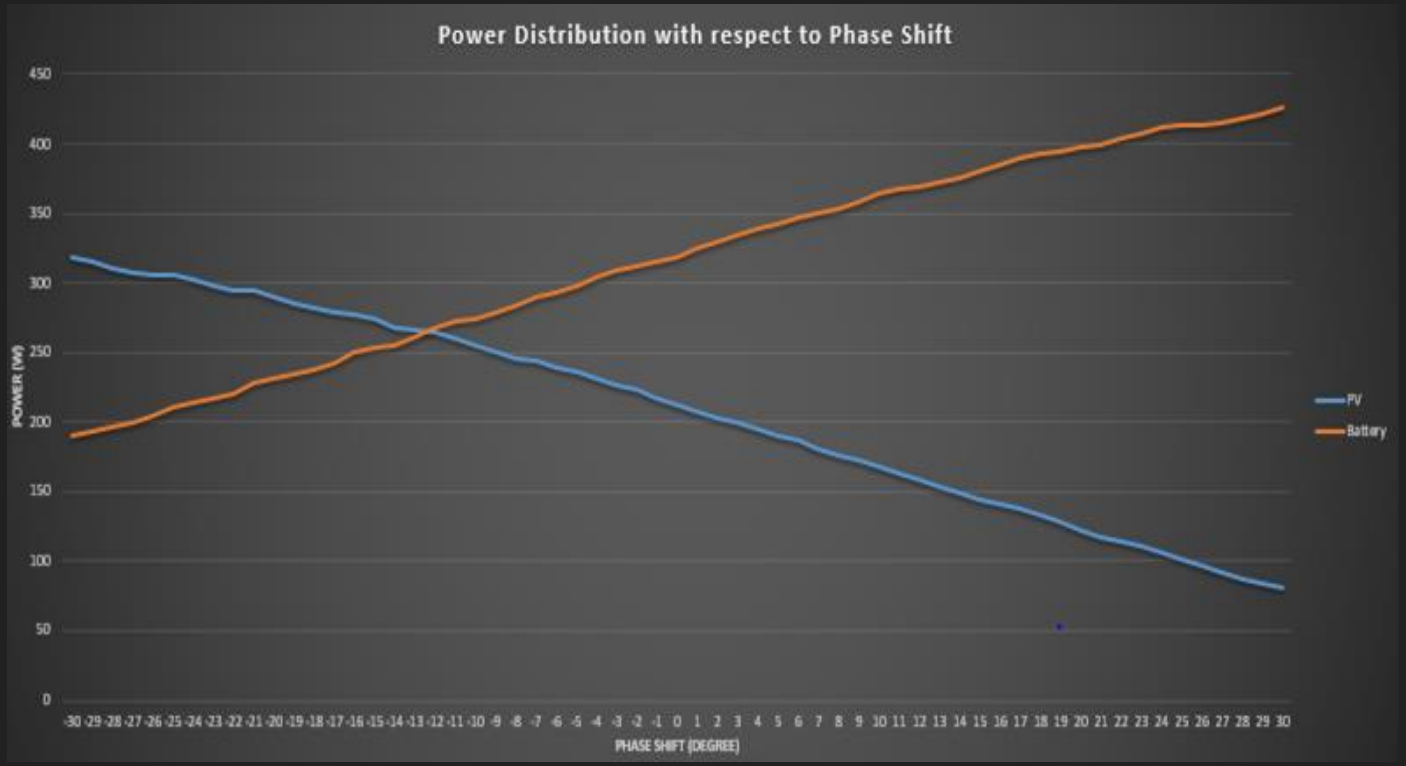
Maximum Power Mode



Maximum Power Mode



Phase Manipulation



DC/DC Converter Control

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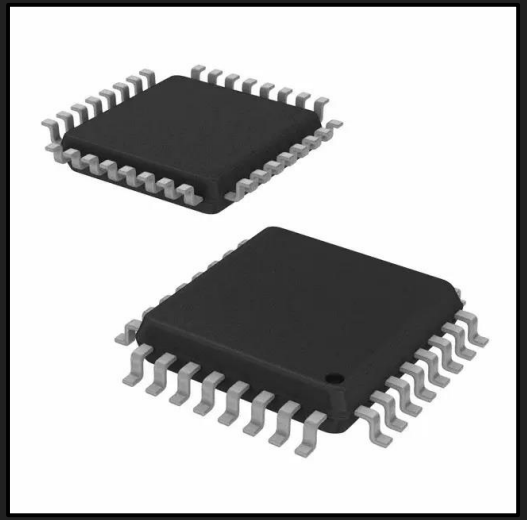
DC/DC Component Selection

DC/DC Microcontroller



Microcontroller	
STM32F334K8T7	
Price	$4.34
I/O Lines	10
Main Memory	64KB
Clock Speed	72MHz
PWM	20
Advanced Timer	4 Independent Channels

MOSFETs

DC/DC Switching

	FDB035N10A	IPB020N10N5ATMA1
Rds(on)	3 mOhm	2 mOhm
Qg	89 nC	168 nC
Vds	100 V	100 V
Price	$5.97	$7.33

DC/AC Inverter

Inverter Control

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Inverter Stage

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Inverter Stage

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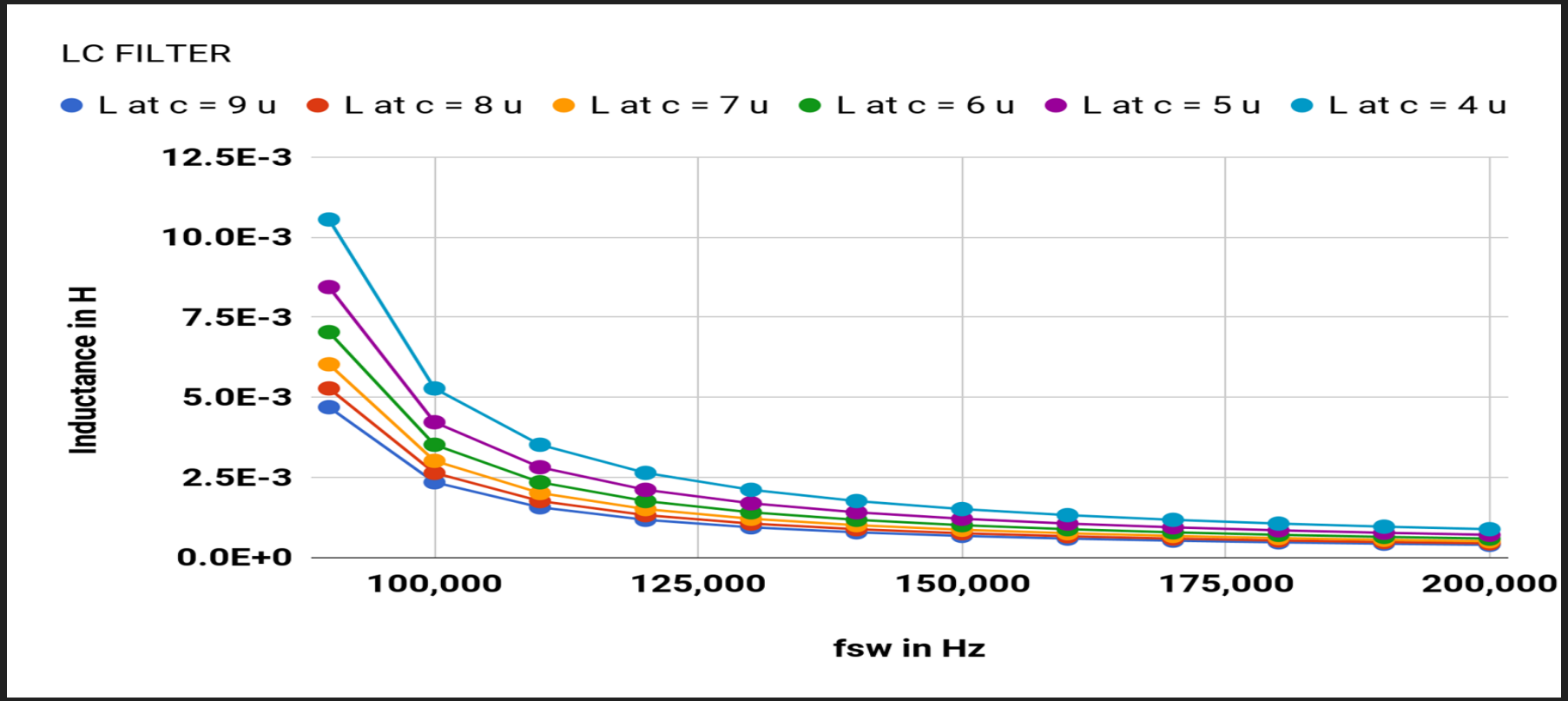
DC/AC Component Selection

DC/AC Inverter Microcontroller

Name	Atmel	DSPIC
Model	ATmega2560	dsPIC33FJ16GS504
Size	8-bit	16-bit
PWM	8	10
Price	$1.50	$4.70

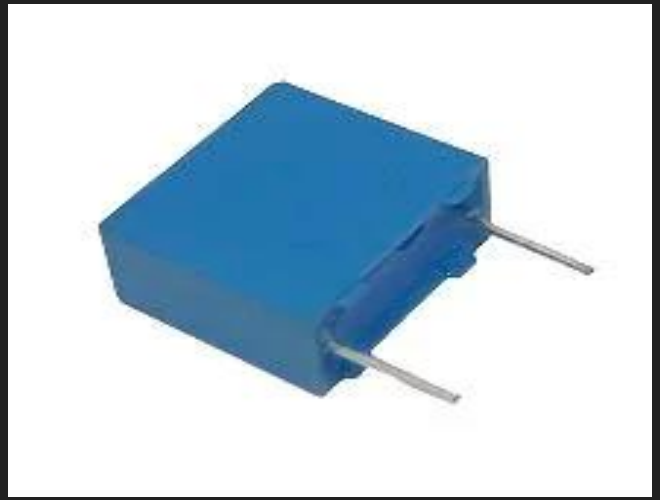
LC Filter

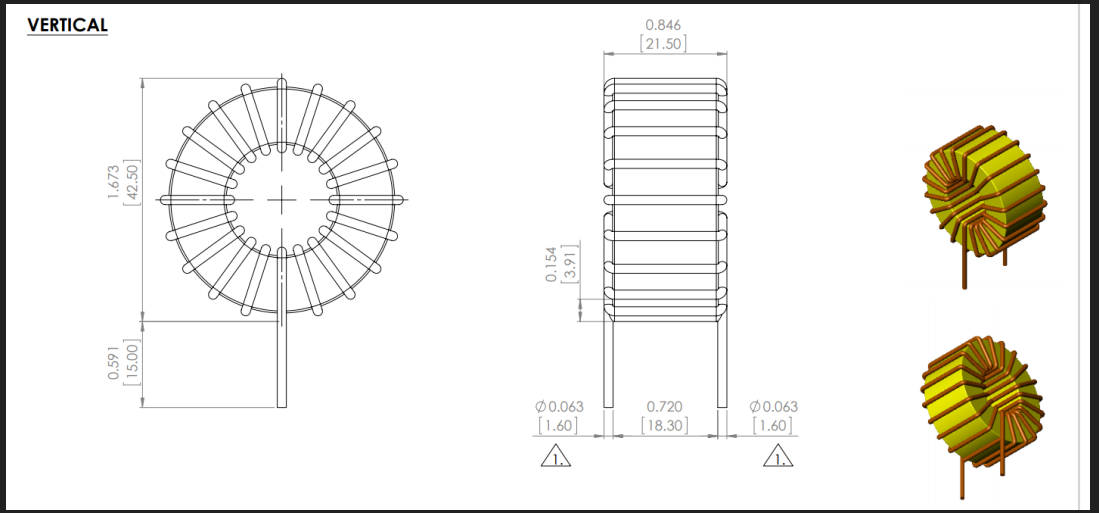

LC FILTER
L at c = 9 u
L at c = 8 u
L at c = 7 u
L at c = 6 u
L at c = 5 u
L at c = 4 u
12.5E-3
10.0E-3
7.5E-3
5.0E-3
2.5E-3
0.0E+0
Inductance in H
100,000
125,000
150,000
175,000
200,000
fsw in Hz

LC Filter

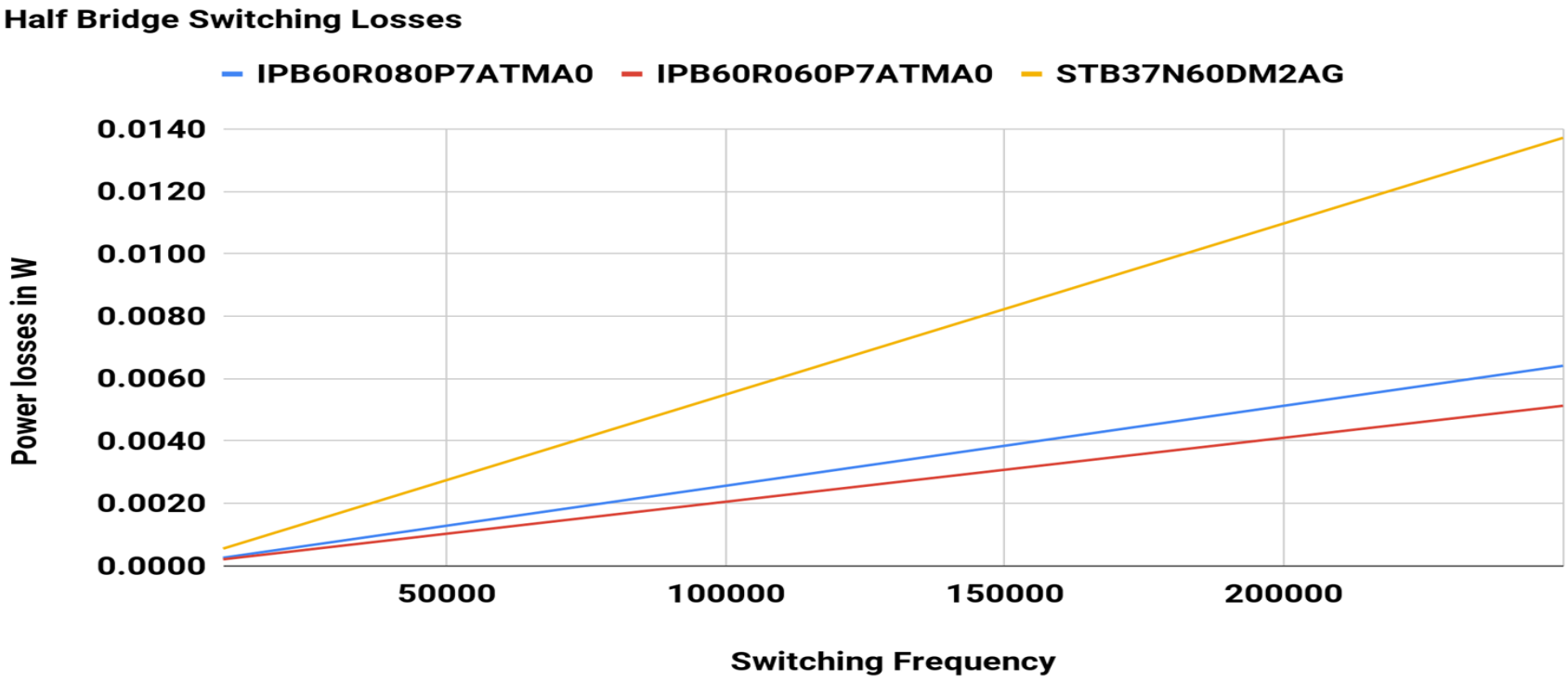
Components value at Switching Frequency 150,000 Hz

Component	Value	Part Number	Price
Capacitor	6 uF	B32754C3605K000	$4.46
Inductor	470 uH	ATCA-08-471M-V	$9.20

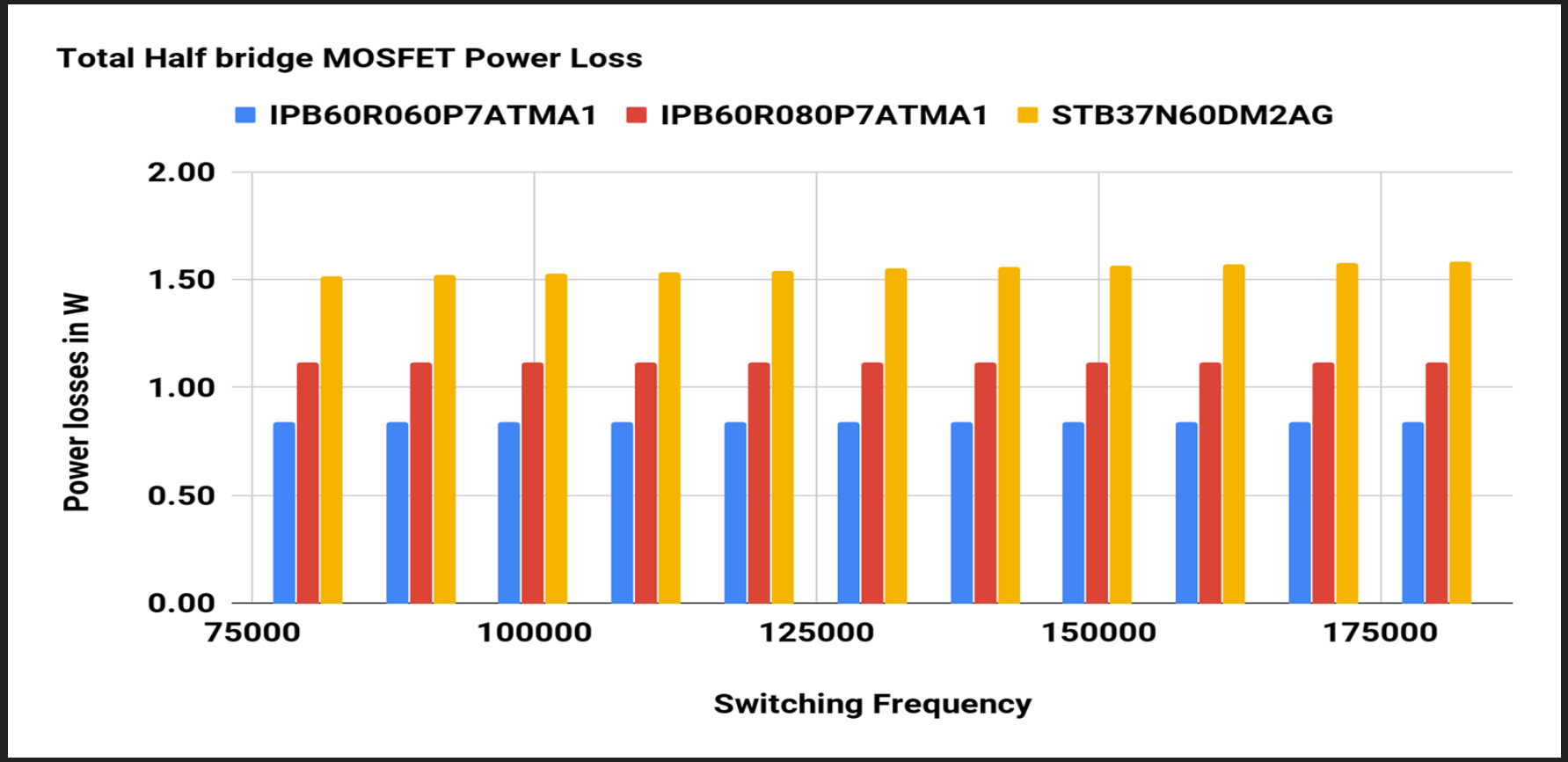




Power MOSFET



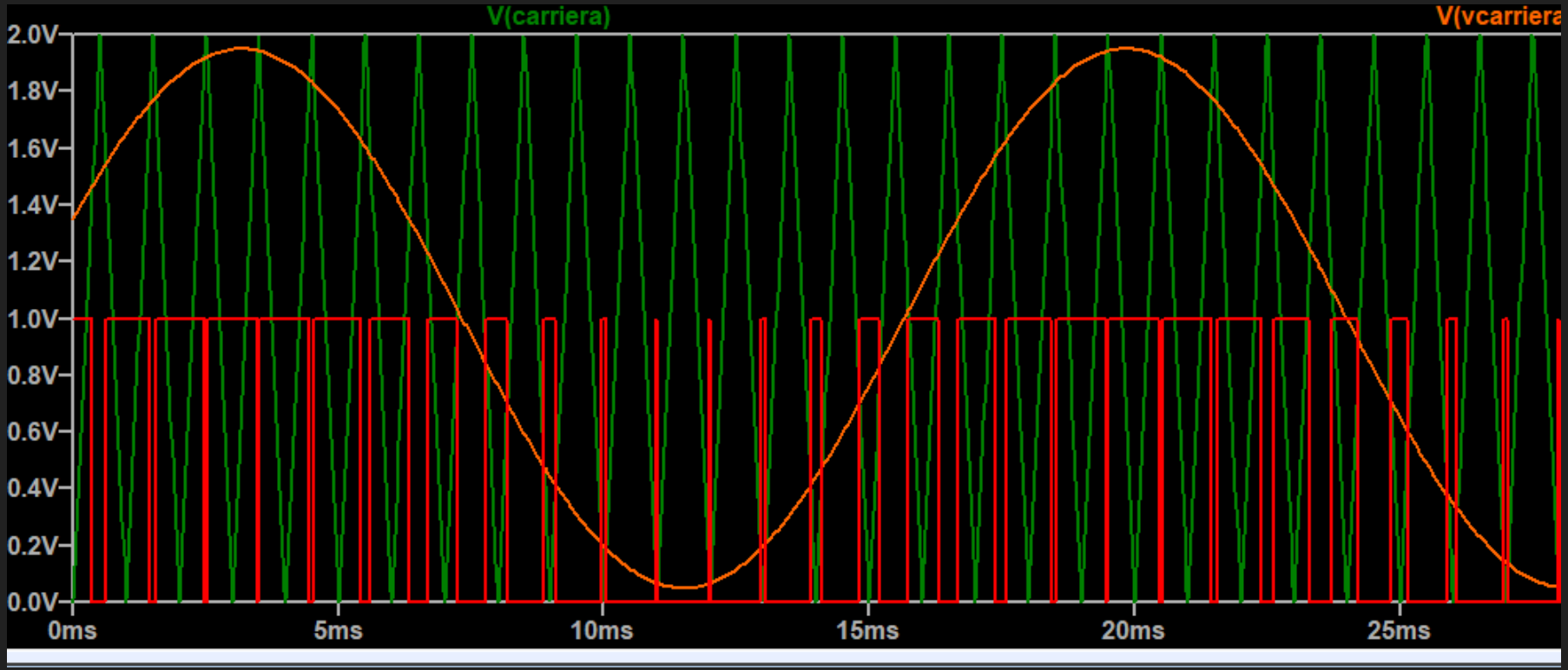
MOSFET Power Loss



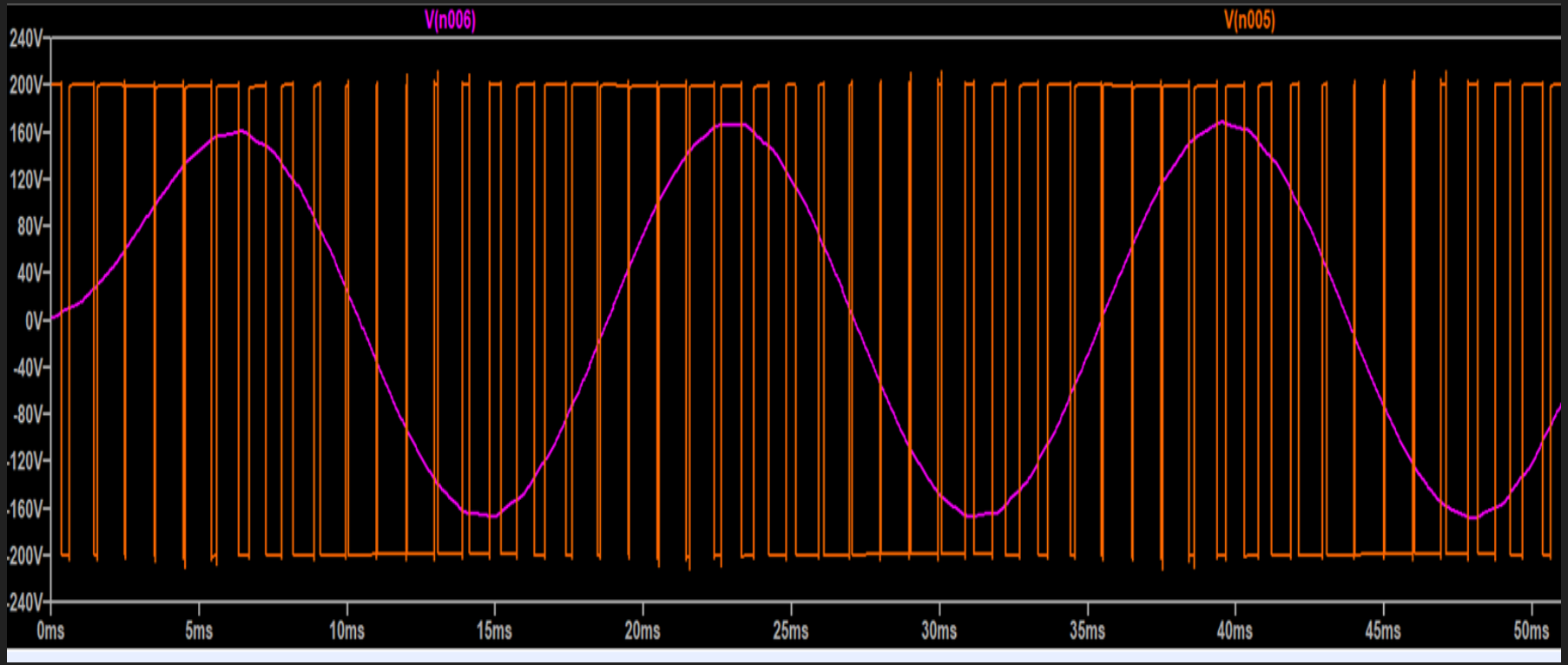
Power MOSFET

IPB60R080P7ATMA1	
Rds(on)	80 mOhm
Qg	51 nC
Vds	650 V
T(on)	15 ns
T(off)	70 ns
Price	$6.39

Sinusoidal Pulse Width Modulation



Output Before and After LC Filter



Issues

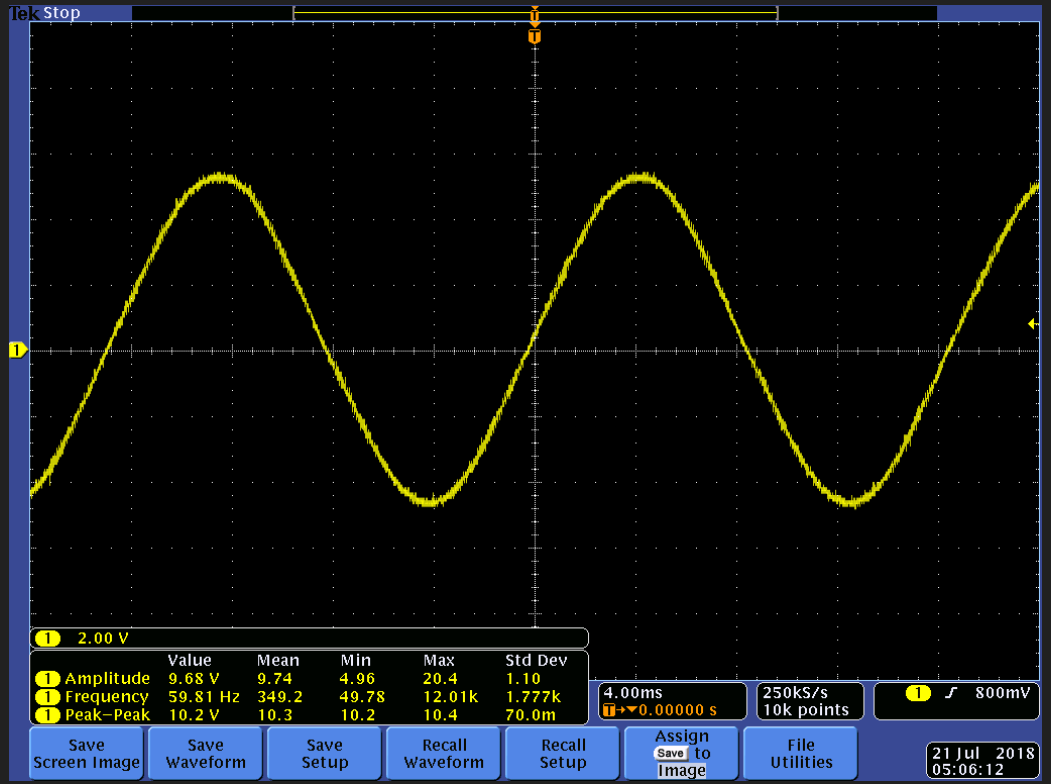
- Communication/Expectations
- Funding
- Parts Shortage
- Simulation
- Programming

Changes to Design

- Uni-Directional
- External Resonator added to DC/DC Converter Stage
- Revision B: DC/AC Inverter for a more efficient design
- Microcontroller change in DC/AC Inverter

Changes to Design

Arduino Mega
• 256 KB Flash Memory • 15 PWM Channels • Open Source Code



Administrative

Budget

Part	Price
DC/DC Converter	$174.75
DC/AC Inverter	$224.57
PCBs	$56.00
	Total : $455.33

Work Distribution

	Jeffrey	Angelica	Emmanuel
DC/DC Converter	P		S
DC/AC Inverter		P	P
PCB Design	P	S	P
Programming	S	P	

Questions?