



# Excitation Control of a Synchronous Generator

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# Team Members

- ▶ Jacob D. Nelson
- ▶ Carlos E. Valdez
- ▶ Kerri McGinty
- ▶ Chien-Kai Wang

# Advisors

- ▶ Dr. Johnson
- ▶ Dr. Lee

# Clients

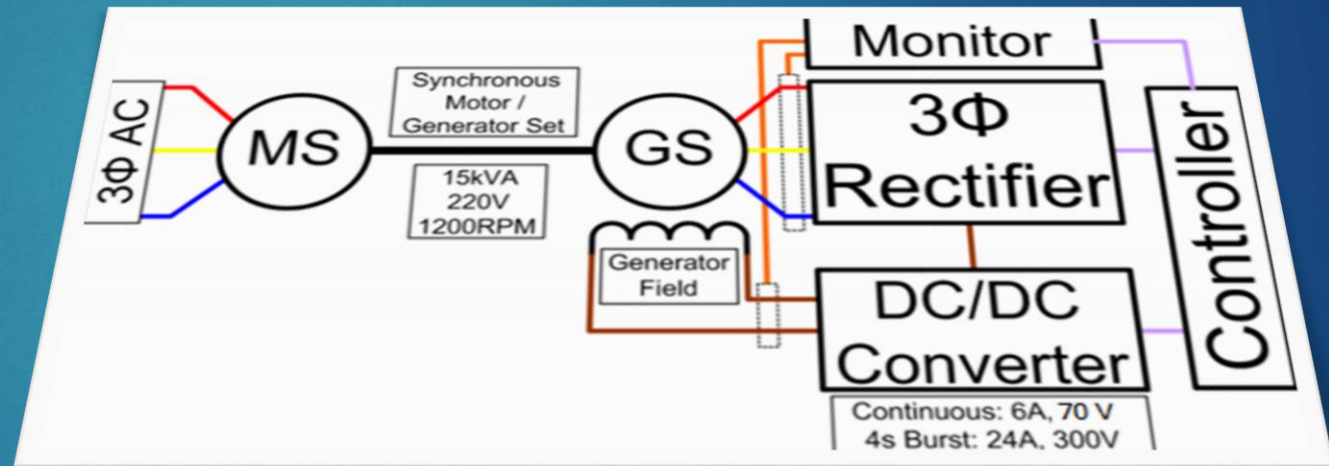
- ▶ Normann Fisher
- ▶ Fred Jessup

# Project Summary

# Project Details

## Goals

- Purchase
- Install
- Commission
- Verify



## What is an Exciter?

- Standalone operation regulates terminal voltage
- Parallel operation regulates the reactive power
- Limiters protect the generator

# Applications

- ▶ The exciter Will Be Used For:
  - ▶ Graduate Research, and fault testing
  - ▶ Simulations for upper division labs
  - ▶ Hardware use in Real Time Simulation

# Project Details

<b>Project Specifications</b>		
<b>Specific Requirement</b>	<b>Target</b>	<b>UNITROL-1020</b>
<b>Exciter Output</b>	Up to 6 Amps	Up to 20 Amps
<b>Short Term Overload</b>	Up to 24 Amps For Up to 3 Seconds	Up to 40 Amps For Up to 10 Seconds
<b>Voltage Regulation</b>	$\pm 0.1 \%$	$\pm 0.20 \%$
<b>Power System Stabilizer</b>	Included	Not Included in Initial Purchase
<b>Digital Model</b>	IEEE Standard Plus Limiters	Models Exciter and Limiters
<b>Physical Dimensions</b>	31.49" x 39.37" x 11.8"	6.69" x 11.89" x 6.69"



# Product Selection

Power and productivity  
for a better world™



## Key Advantages

- Max Input Voltage: 300V
- Voltage Regulation: 0.20%
- Analog I/O: 3 Inputs, 2 Outputs
- Size: 6.69" x 11.89" x 6.69"
- Cost: Discount Provided



## Key Disadvantages

- Voltage Regulation: 0.25%
- Analog I/O: 2 Inputs, 0 Outputs



## Key Disadvantages

- Max Input Voltage: 220V
- Size: 11.8" x 32.6" x 31.5"
- Cost: Out of Project Budget



# Installation

# Generator Output Terminals

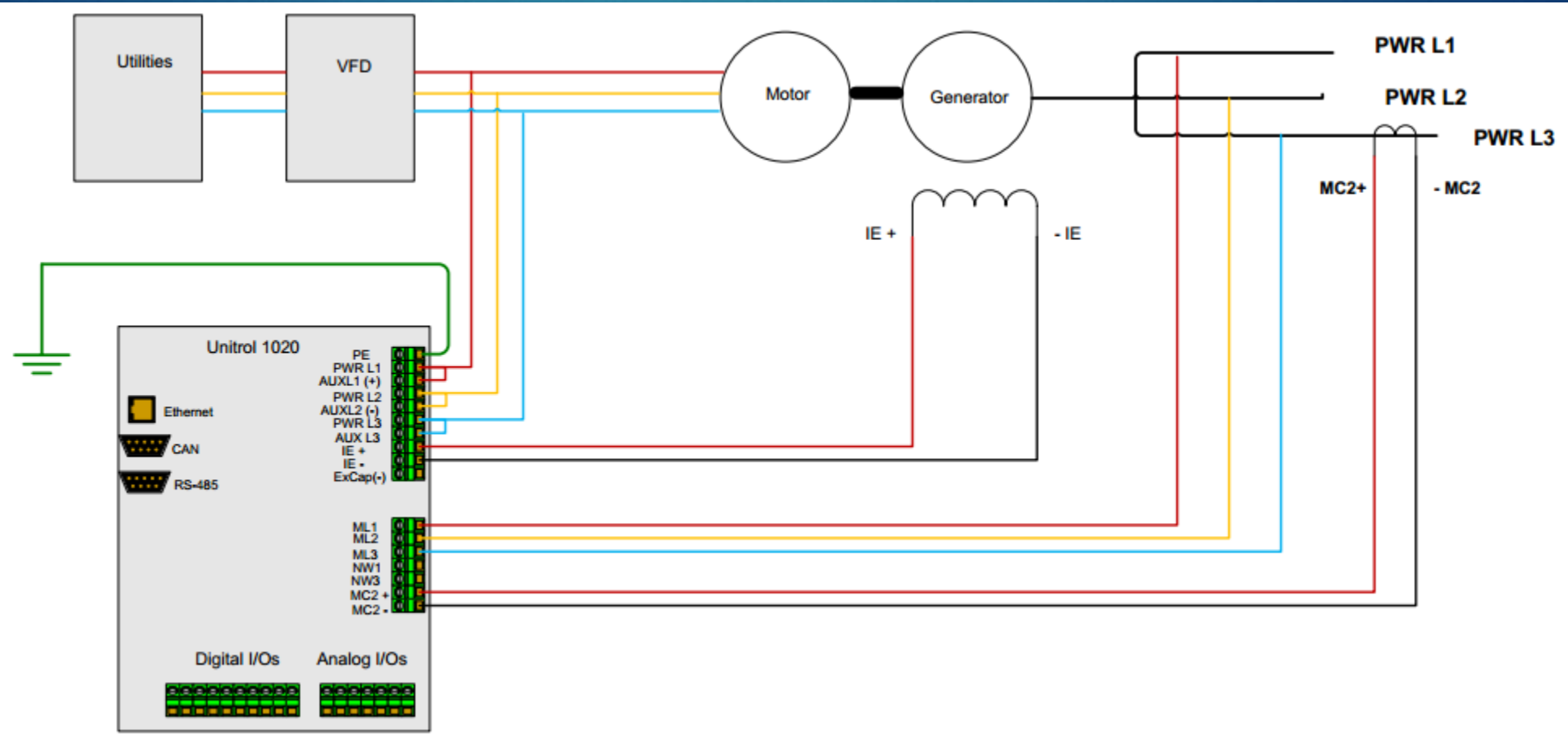
# Mounting



Unitrol-1020

Field Inputs

# Connections



# Commissioning

# Commissioning

## Exciter Settings:

### Setpoints

- ▶ Manual
- ▶ Automatic
- ▶ Power Factor

### Limiters

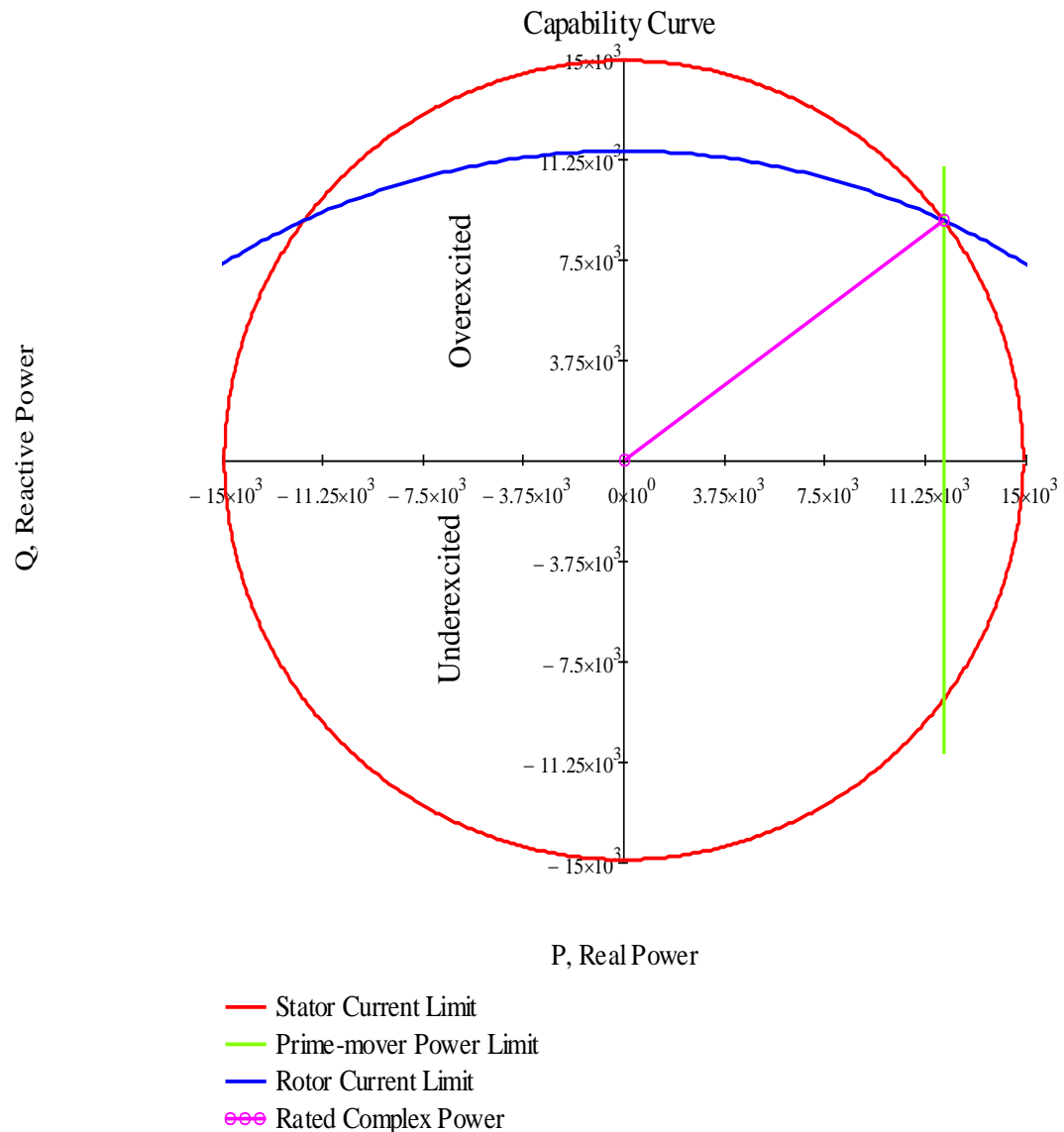
- ▶ Excitation current  
(Max, Min)
- ▶ Machine Voltage  
(Max, Min)

### Nominal Generator Data

- ▶ Excitation current
- ▶ Machine Voltage
- ▶ Machine Current
- ▶ Steady state reactance
- ▶ Frequency

# Commissioning

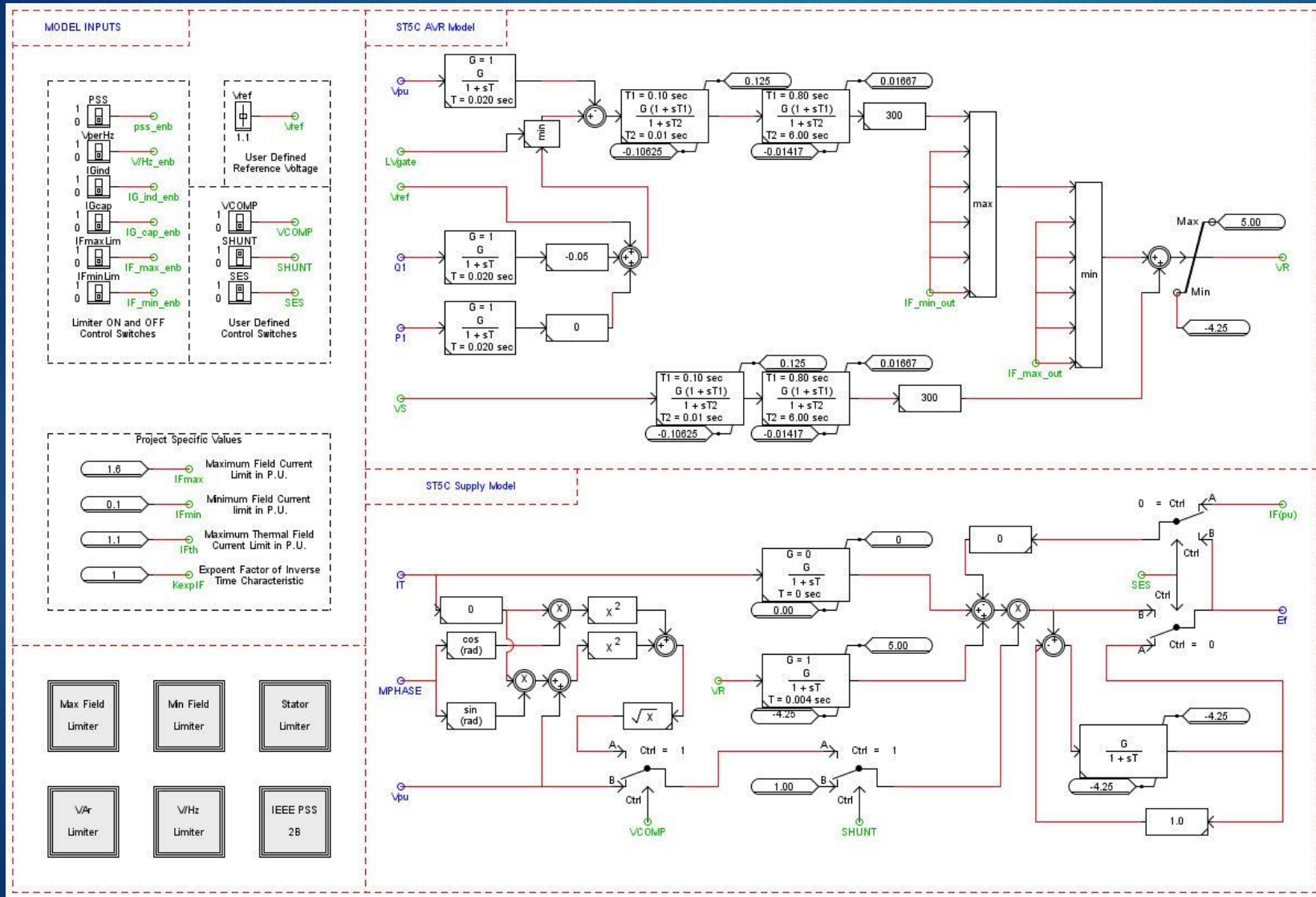
## Capability Curve



- ▶ Prime mover limits active power
- ▶ Over-excitation is set by the heating limit of the field
- ▶ Under-excitation is set by the heating limit of the armature

# Digital Model

# Digital Model



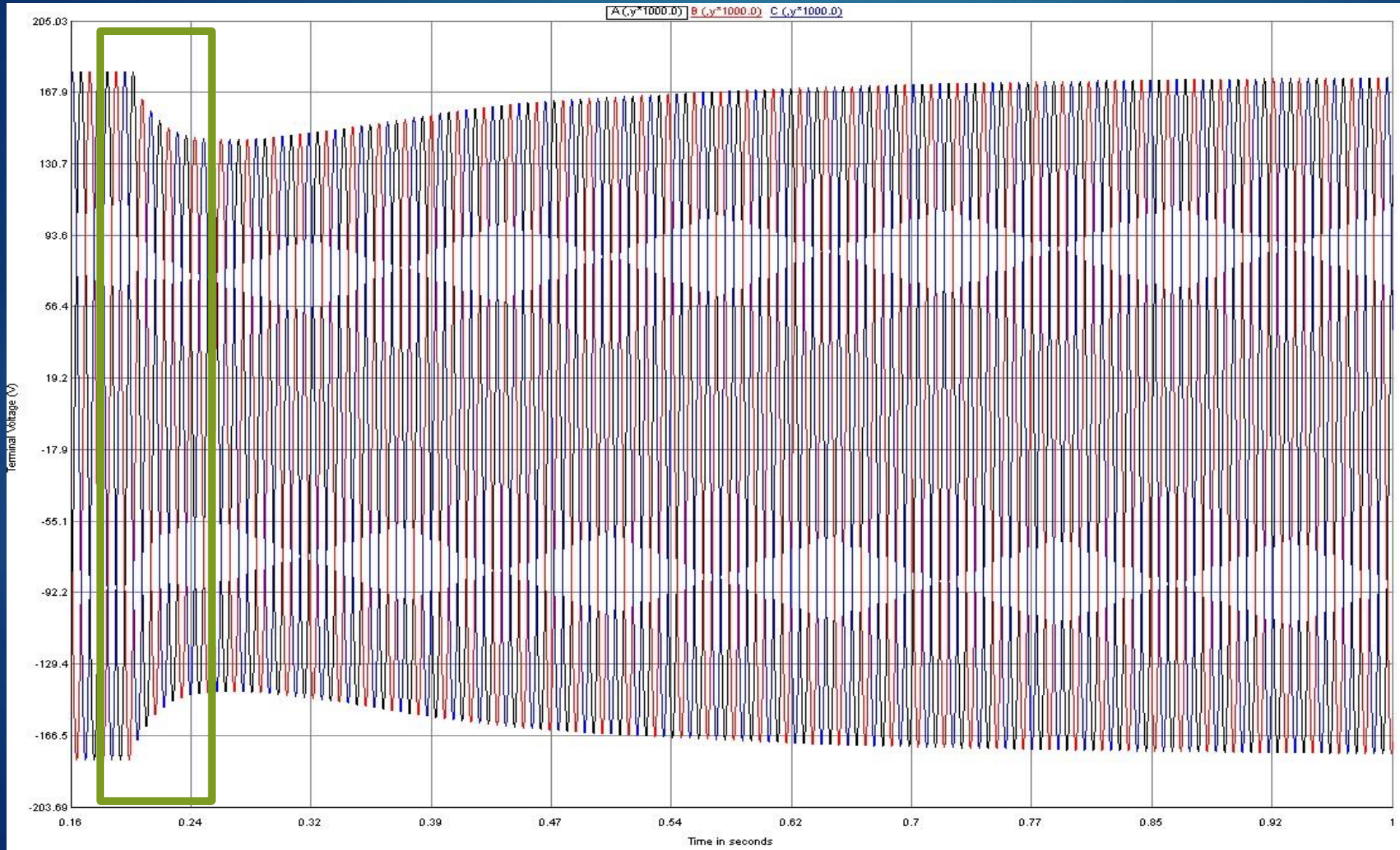
Models Not Shown:

- Field Limiters (min/max)
- Stator Limiters (min/max)
- V/Hz Limiters
- VAr Limiter

- Not all features are verified.
- Not all features are included with the physical exciter.

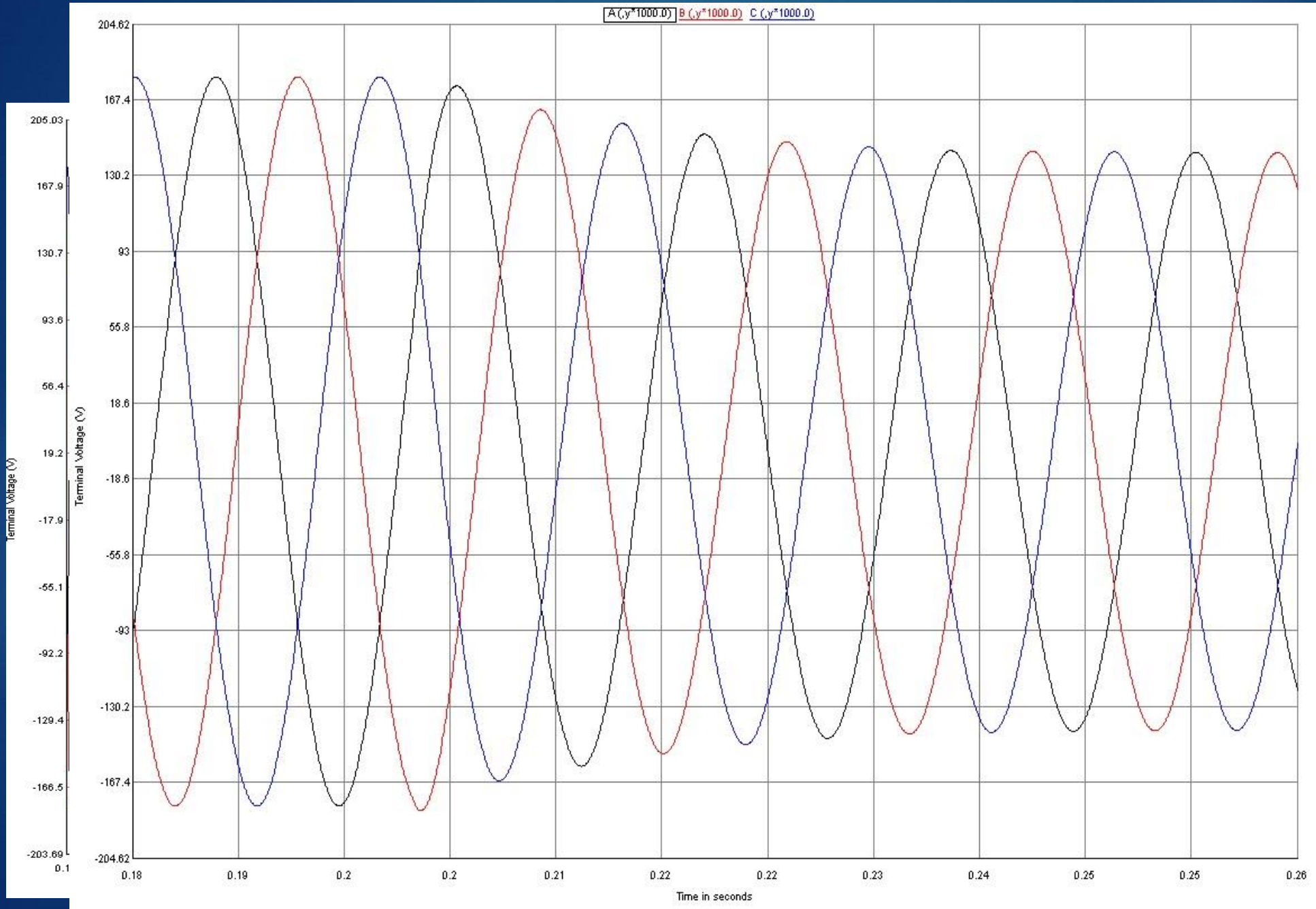


# Digital Model



At time 0.2 seconds  
the dynamic load was  
increased from:

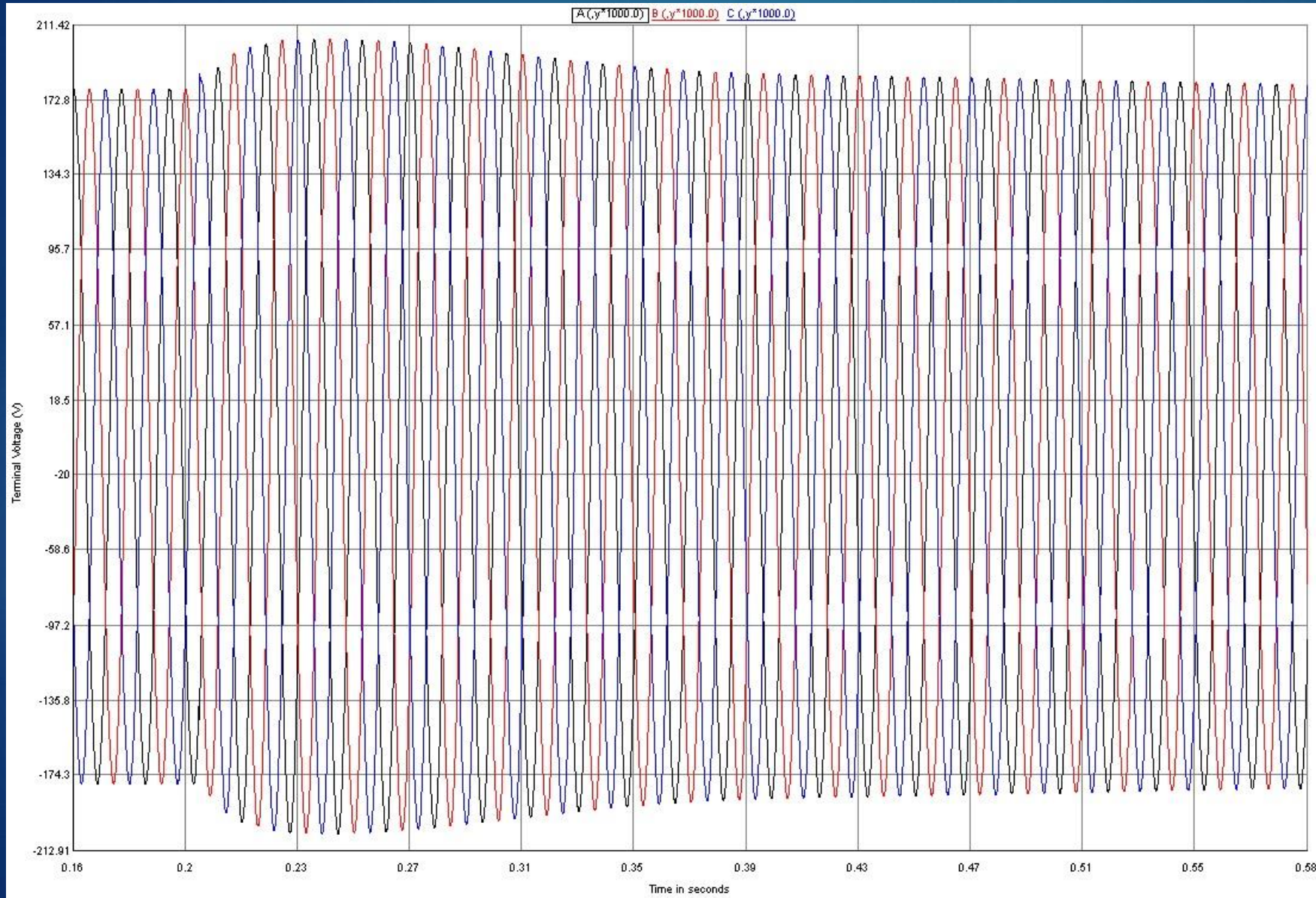
$P = 14.92 \text{ KW}$   
 $Q = 00.00 \text{ KVAr}$   
To  
 $P = 14.92 \text{ KW}$   
 $Q = 11.90 \text{ KVAr}$



At time 0.2 seconds  
the dynamic load was  
increased from:

- P = 14.92 KW
- Q = 00.00 KVAR
- To
- P = 14.92 KW
- Q = 11.90 KVAR

# Digital Model



At time 0.2 seconds the dynamic load was decreased from:

$$P = 14.92 \text{ KW}$$

$$Q = 11.90 \text{ KVAR}$$

To

$$P = 14.92 \text{ KW}$$

$$Q = 00.00 \text{ KVAR}$$

# Closing Points

# Special Thanks

Dr. Johnson

- Technical Advice

Michael West

- Machine Parameters

Greg Klemesrud

- Mounting

Stacy Rauch

- Purchase Order



Questions?