Variable Frequency Drive Model LDVFD_A Based on EPRI model from 2019



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Based on model from EPRI in 2019



Memorandum

March 18th, 2019

- TO: NERC LMTF
- FROM: Deepak Ramasubramanian, Parag Mitra, Anish Gaikwad, Electric Power Research Institute
- CC: Pouyan Pourbeik, PEACE-PLLC, WECC LMTF

SUBJECT: DRAFT MODEL SPECIFICATIONS FOR VARIABLE FREQUENCY DRIVE (VFD) INTERFACED MOTOR LOADS

Description of Model from EPRI



- EPRI performed lab tests on 6 variable frequency drives (VFDs) from 2 different manufacturers
- Voltage Sag
 - Dynamics of diodes and internal capacitor cause MW and Mvar to drop and then slowly rise back (like a washout action)
- Voltage Recovery
 - Dynamics of recharging the internal capacitor causes an inrush the MW and Mvar to rise and then slowly go down to steady state (again, like a washout)
 - Limiters are added to limit the magnitude of inrush

LDVFD_A Load Variable Frequency Drive Model

Load Characteristic LDVFD_A



See pseudo code in the DER_A machine model documentation for more information

<u>Vimult</u> always tracks the black line until following conditions are met. If the voltage stays below v1 for a duration greater than tv1, then it will now always follow the path of the red line when the voltage recovers. If the voltage stays below v0 for greater than tv0, then the output will always remain at zero.

<u>Vrfrac</u> determines the location of the red lines showing what factor returns after tripping. <u>Vmin</u> = track lowest value of voltage (state 1) <u>after the Tv1 timer has expired</u>

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Pink Highlights show some modifications from EPRI model



- Comments on getting a **Mbase** from the initial condition
- **Pfinit** parameter will be important when model used as a LoadComponent in Modular model
 - Pfinit would ONLY be used when model is a LoadComponent in modular



Example Simulations from EPRI Specification from 2019

- Example Parameters on the right
- Load = 86 MW, 1.5 Mvar
- Run 2 simulations
 - Voltage dip to 0.9 per unit for 2 seconds (120 cycle)
 - Undervoltage tripping doesn't start until 0.75 pu
 - Voltage dip to 0.4 per unit for 8 cycles
 - Undervoltage tripping occurs
- Following 2 slides show replication of EPRI simulations in PowerWorld Simulator



Example Simulation 0.9 pu dip for 120 cycles

• EPRI Test

PowerWorld LDVFD_A model



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Example Simulation 0.4 pu dip for 8 cycles



PowerWorld LDVFD_A model





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