Modeling 3-phase motor drive using GaNPower devices

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By
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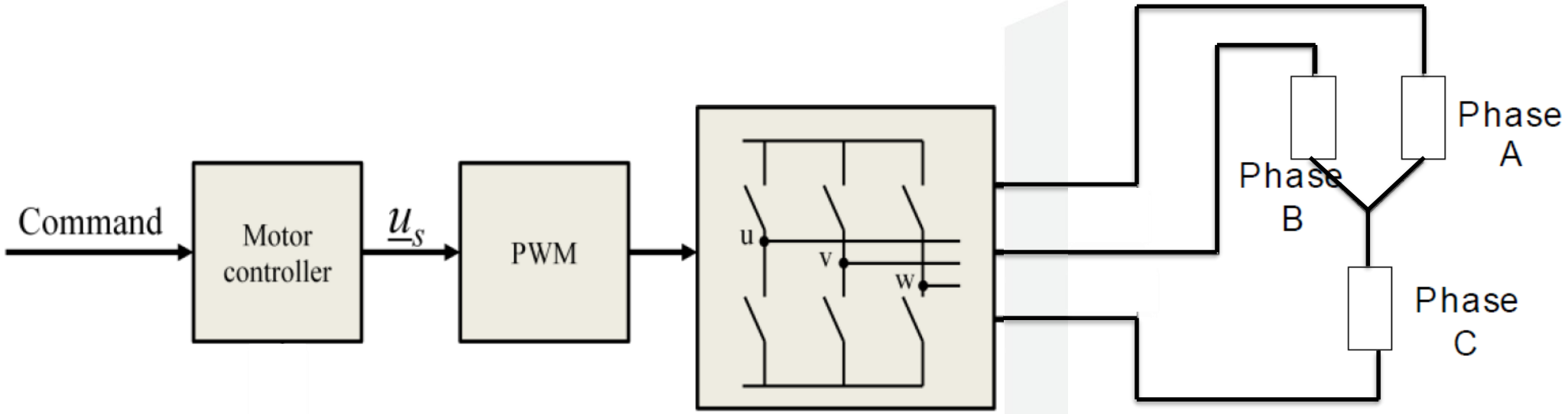
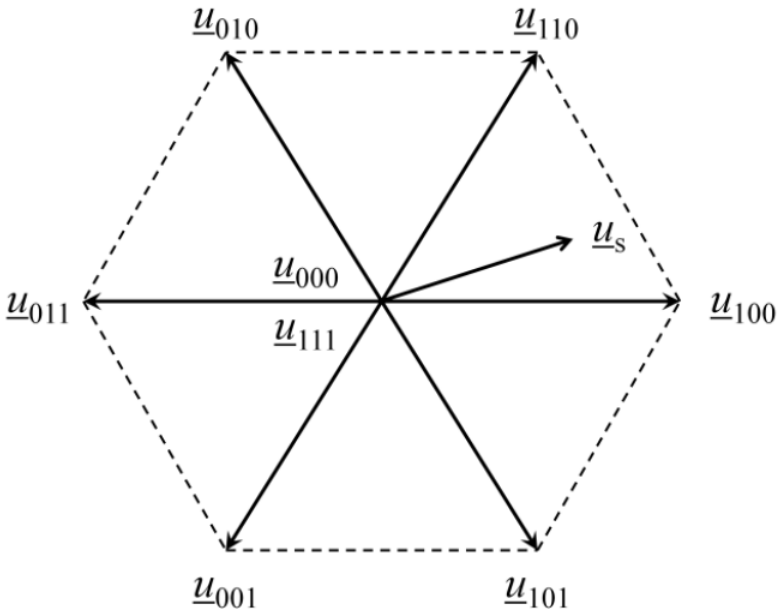
GaN power transistors for 3-phase motor drive

- Generation of PWM waveforms using space vector modulation
- Motor load model
- OVP-GaN
- Circuit model for 3-phase motor drive

Basic 3-phase motor configuration



Space vector modulation method



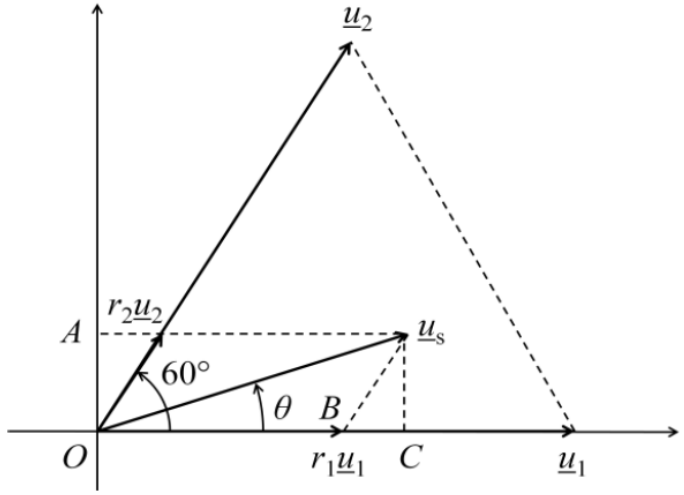
Voltage space vectors available using a three phase inverter

Six-step motor plotted on hex is the space vector configuration we work on.

$t_b = 2U(3^{-½})\sin(\alpha)$ where $U = |\underline{u}_s|$ (Modulation Index)

$t_a = U[\cos(\alpha) - (3^{-½})\sin(\alpha)]$ $\alpha = \angle \underline{u}_s$

a=> 1 b=>2



Approximation of an arbitrary voltage space vector using base vectors

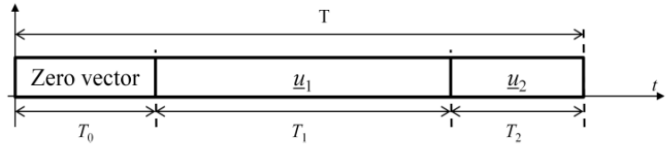
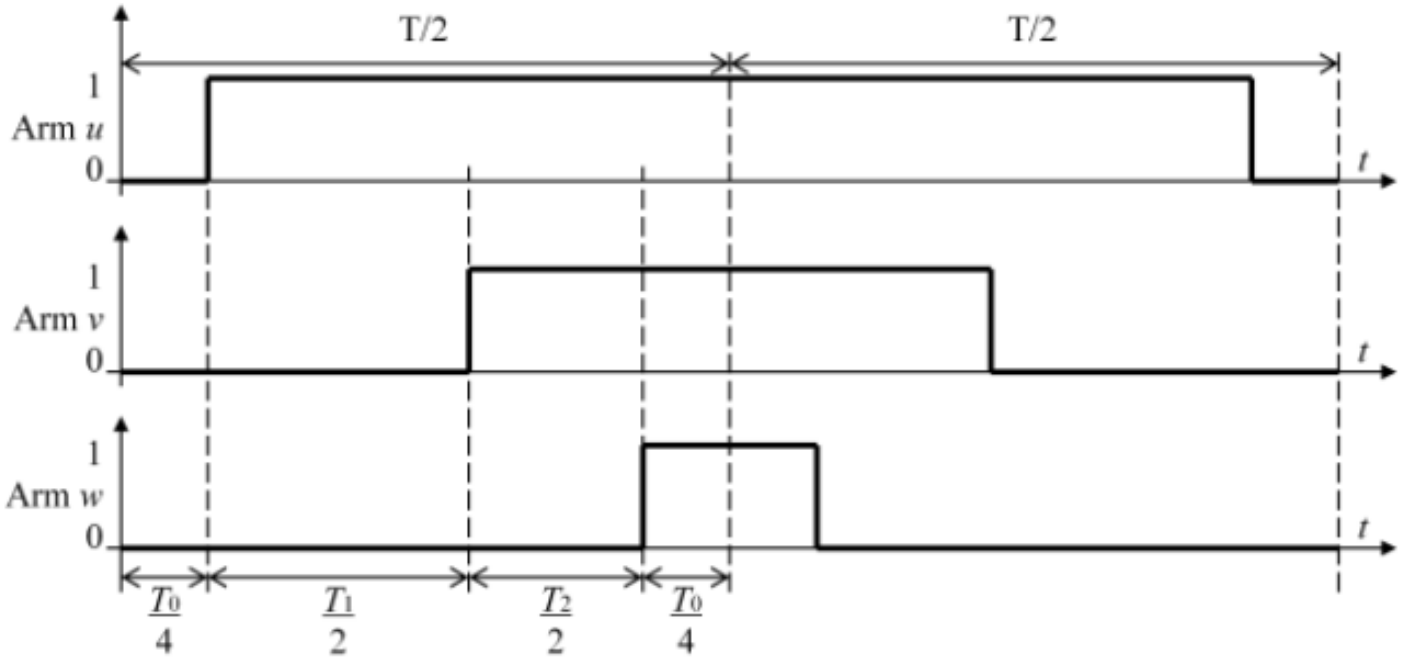


Figure 4. Combination of vectors using time division

The three time durations are defined as

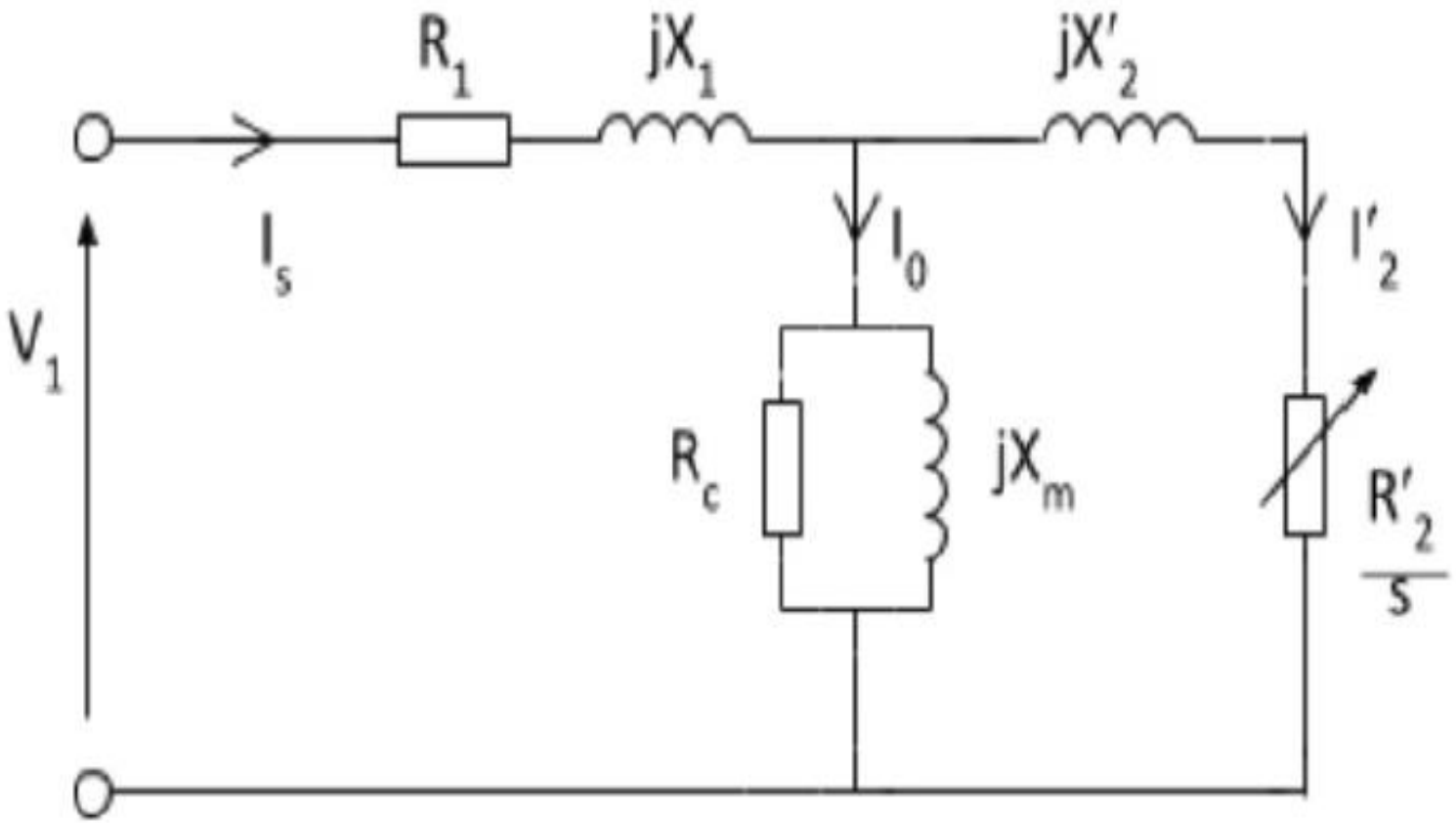
$$\begin{cases} T_0 = (1 - r_1 - r_2)T \\ T_1 = r_1 T \\ T_2 = r_2 T \end{cases},$$

Use of symmetric pulse for better performance
With u111 inserted in pulse center

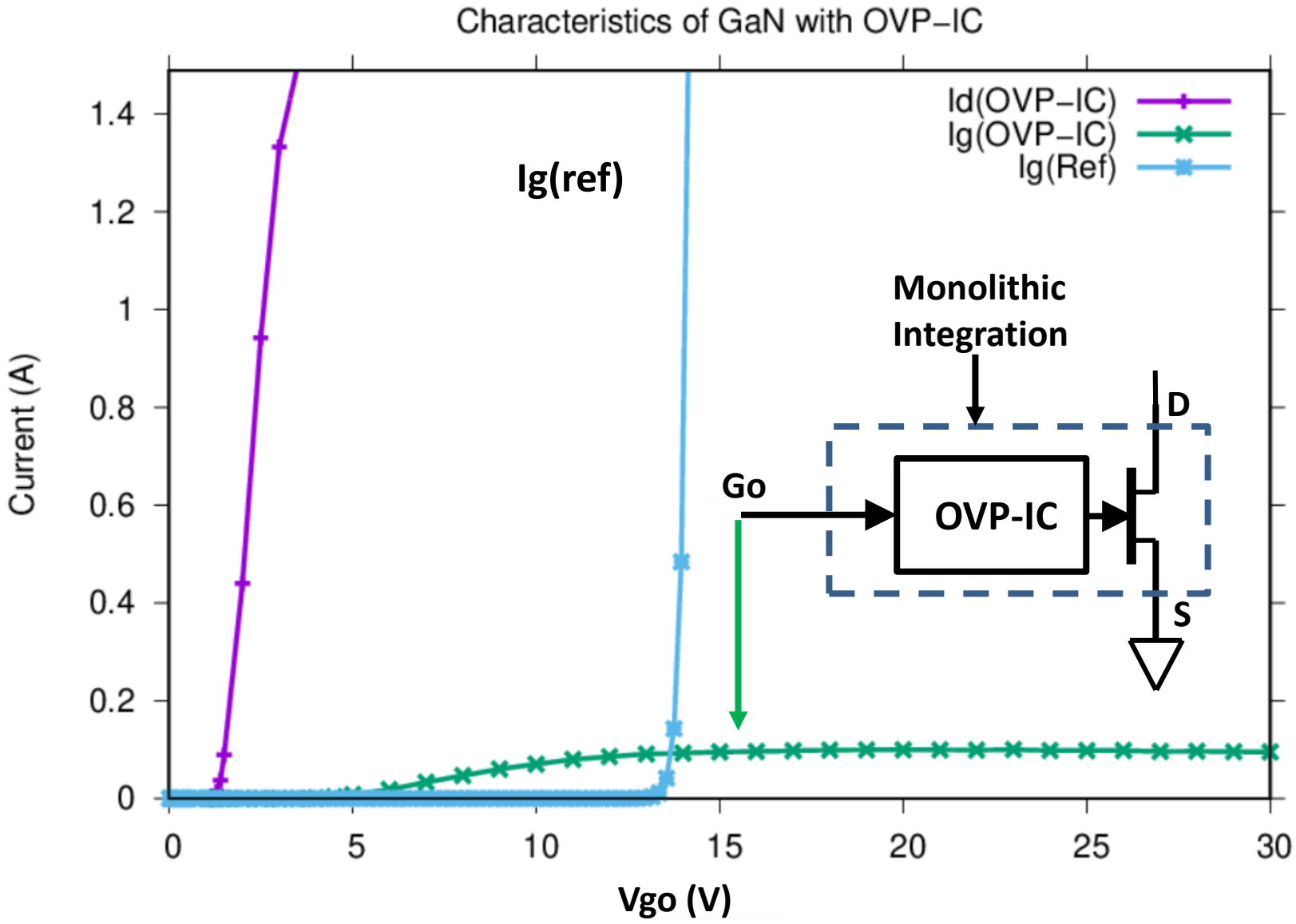


PWM switching sequence using both $\underline{u}_{000}$ and $\underline{u}_{111}$ as zero vectors

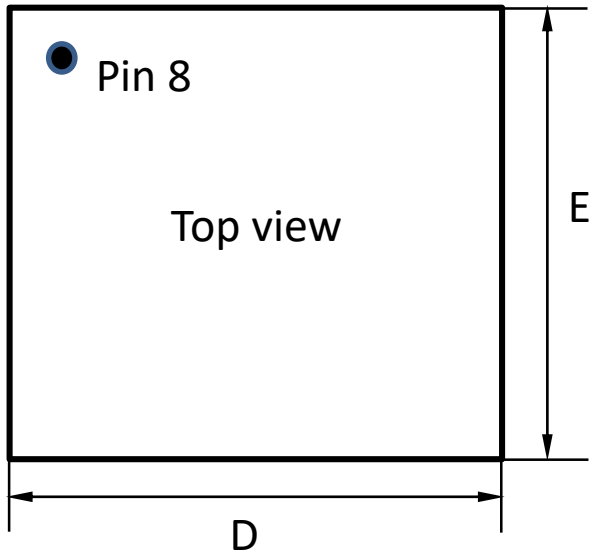
Induction motor equivalent circuit (single phase)

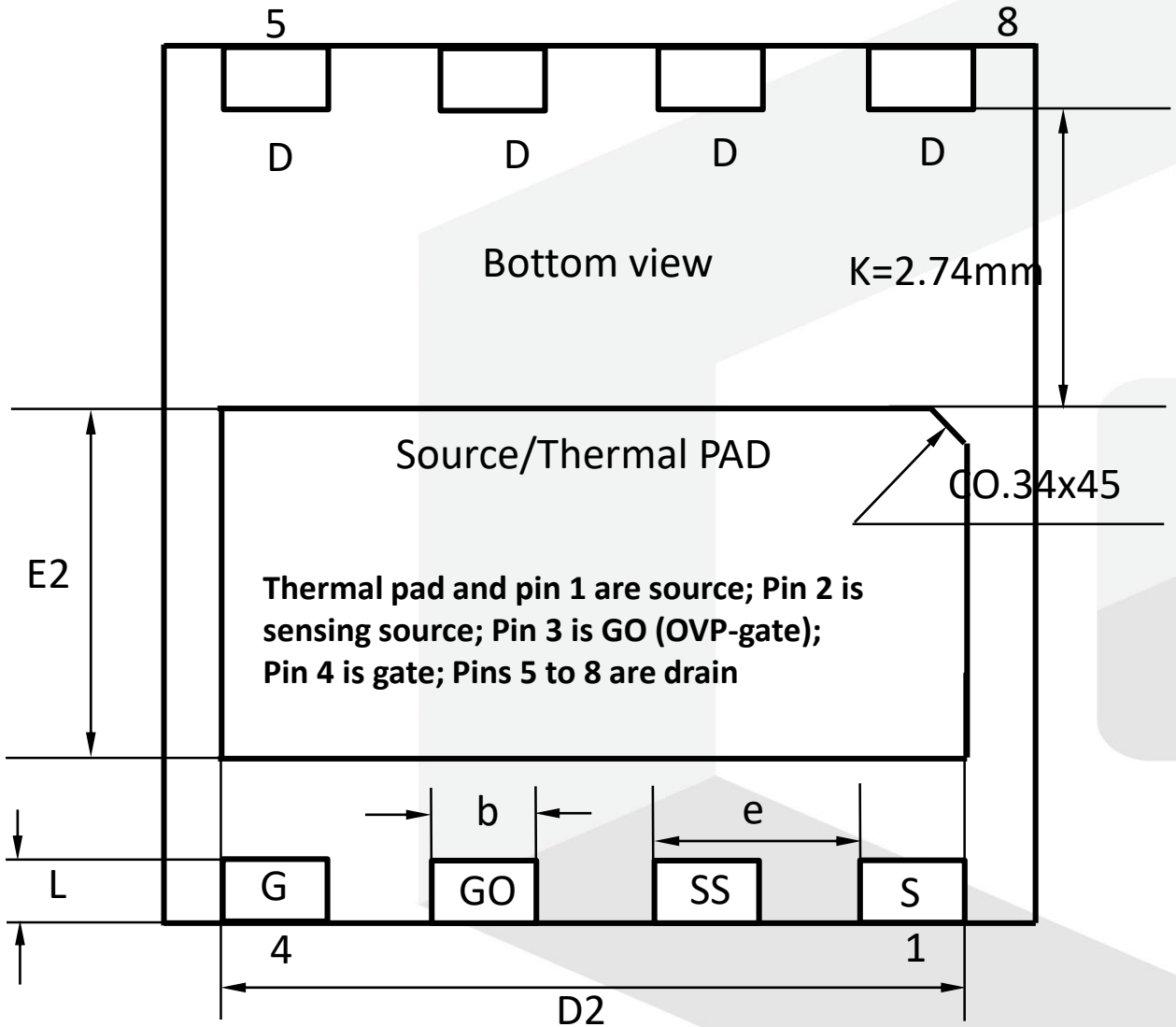


GaNPower New Product: GaN EHEMT with Integrated Over-Voltage Protection Circuit



DFN8x8-OVP. Suggested driving range G: 5-6V; GO: 5-15V, protection > 30V



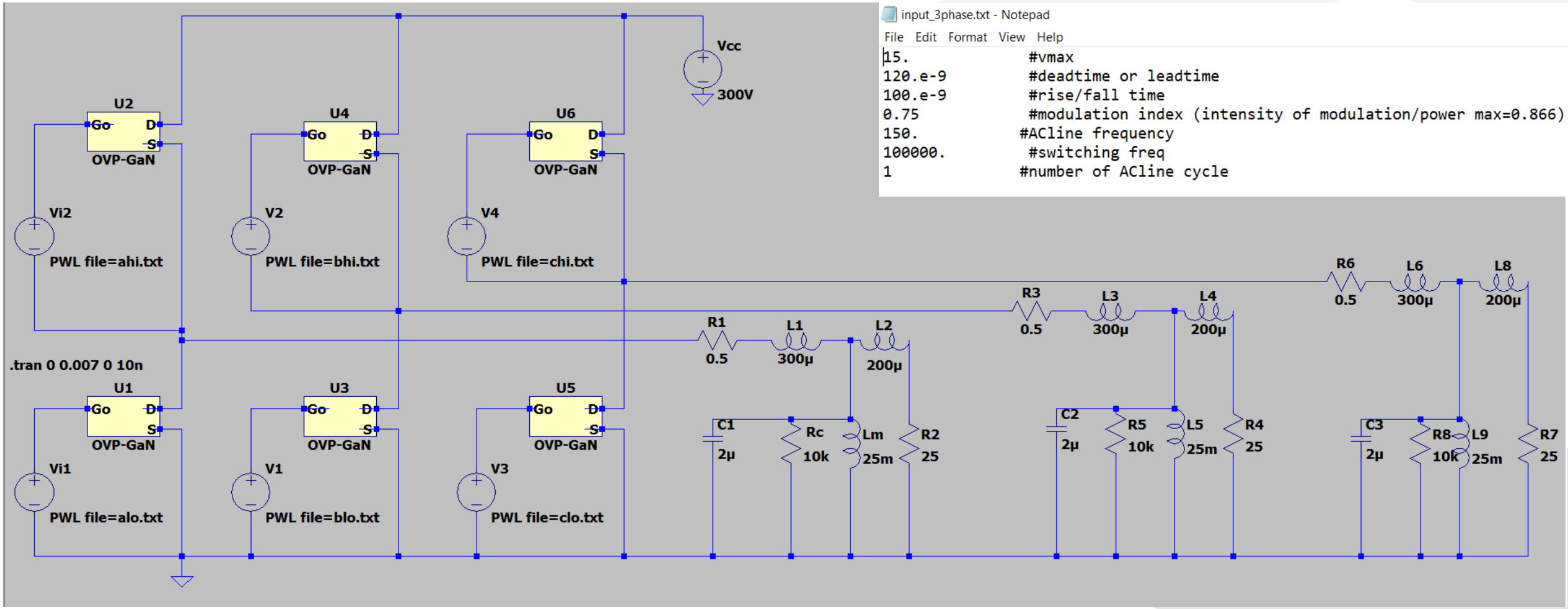


D=8; E=8; e=1.95; b=0.97; L=0.57; D2=6.82; E2=3.19

8LEAD DFN (8x8x0.75mm, Pitch 1.95mm)

IMPORTANT:Please connect the bottom thermal pad to the source electrode on PCB

A demo example of 3 phase motor driven by PWM generated by space vector modulation model. Waveforms stored in files alo.txt, ahi.txt, etc.

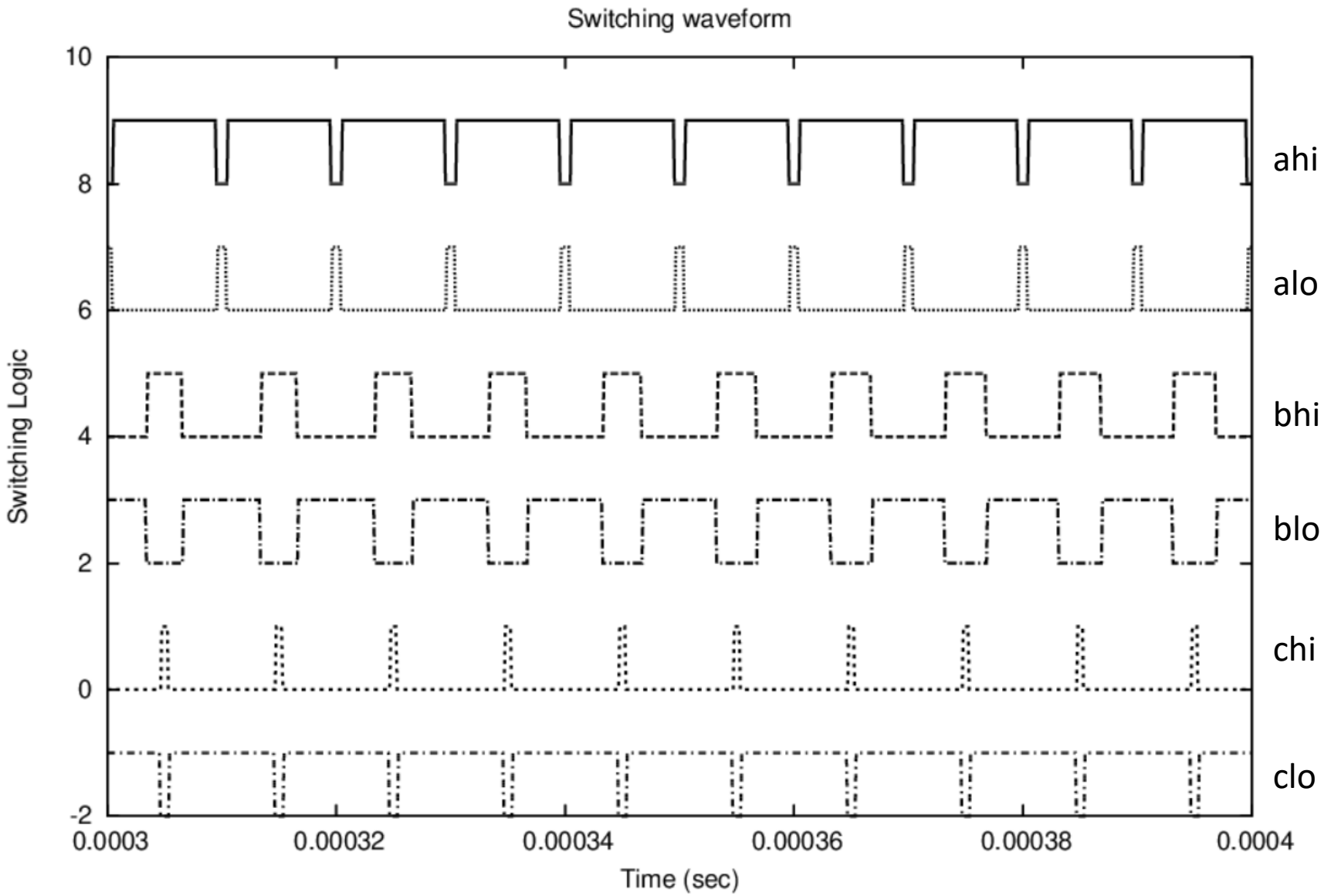


input_3phase.txt - Notepad

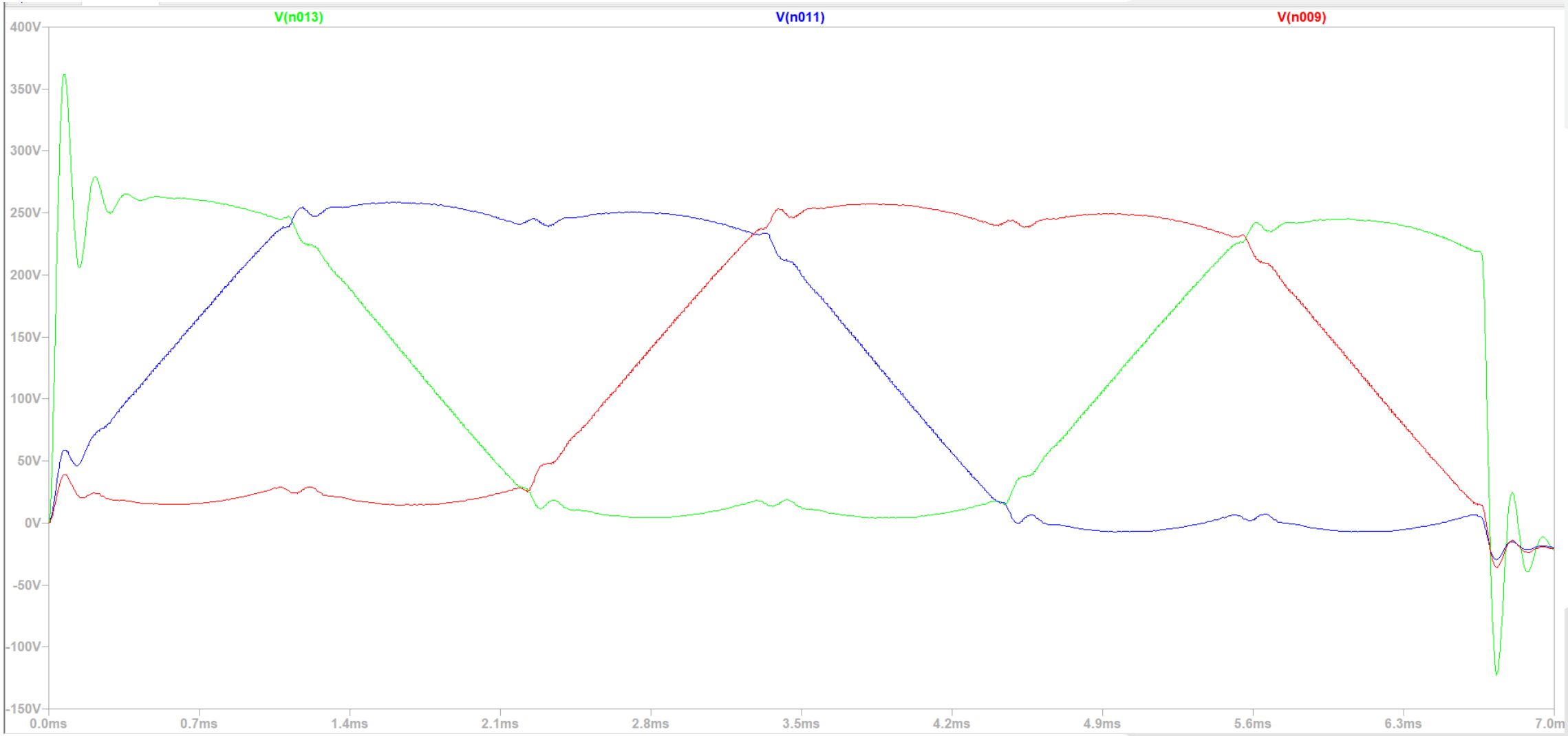
File Edit Format View Help

```
15.              #vmax
120.e-9          #deadtime or leadtime
100.e-9          #rise/fall time
0.75             #modulation index (intensity of modulation/power max=0.866)
150.            #ACline frequency
100000.          #switching freq
1               #number of ACline cycle
```

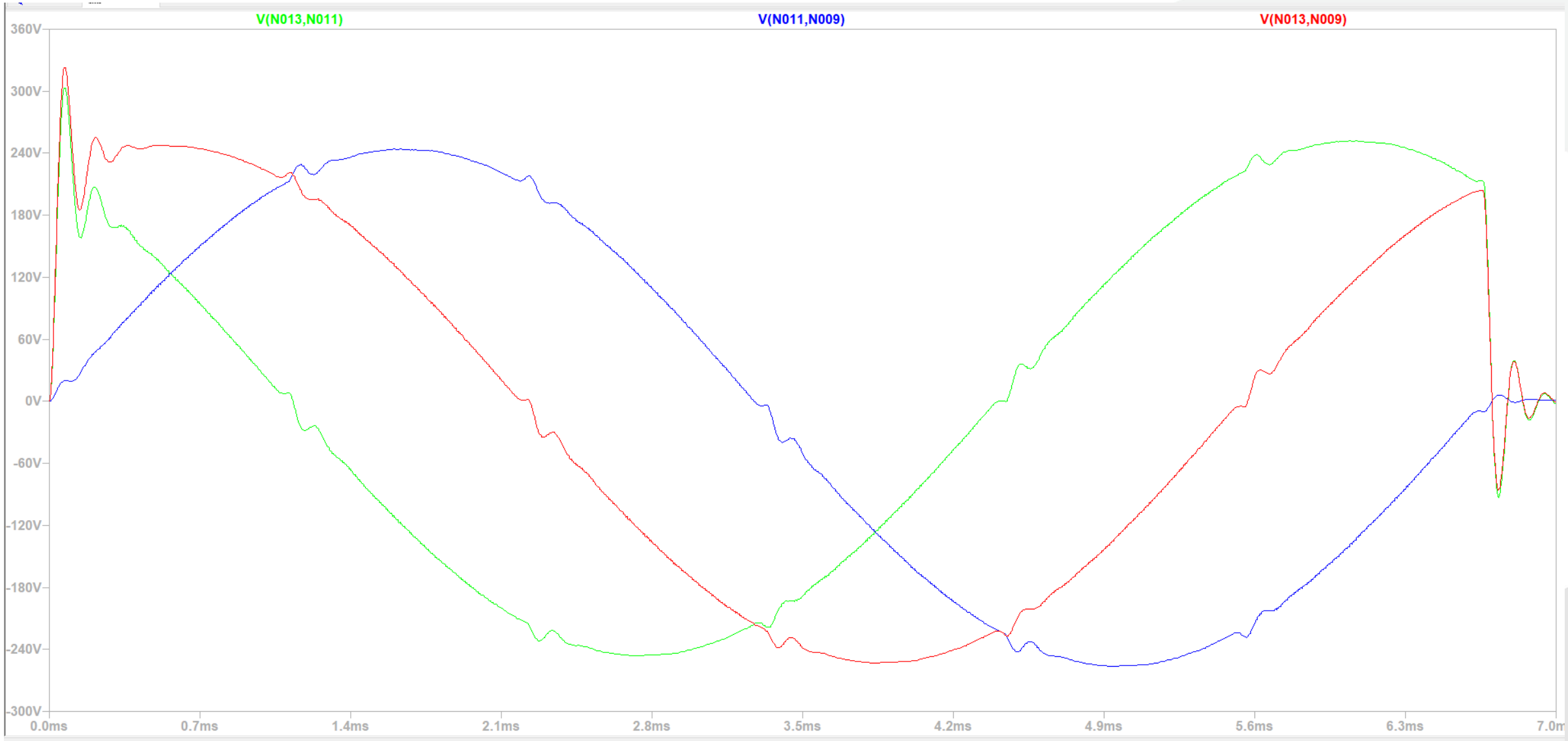
Normalized waveform for all six transistors



Single phase output voltage for one AC-line period



Line-to-line output voltage for a single AC-line period



Conclusions

- A 3-phase motor circuit model has been set up to demonstrate the use of over-voltage protection GaN (OVP-GaN) from GaNPower.
- Space vector modulation method has been used to generate the proper PWM 15V waveform to drive the OVP-GaN.
- Good sine wave line-to-line output has been achieved on the simulated motor load equivalent circuit.
- Feasible to use OVP-GaN for motor drive and other inverter applications.

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Integrity

Technology Innovation

Fast Growing

GaNPOWER

THANKS FOR YOUR PATIENCE AND SUPPORT

衷心感謝您的耐心與支持