# Multiphase Drives for EV Applications

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## Project Statement

**Objectives:**

- Develop a six-phase inverter based on the requirements of the drive.
- Reduce the size of the DC-link bank of capacitors.

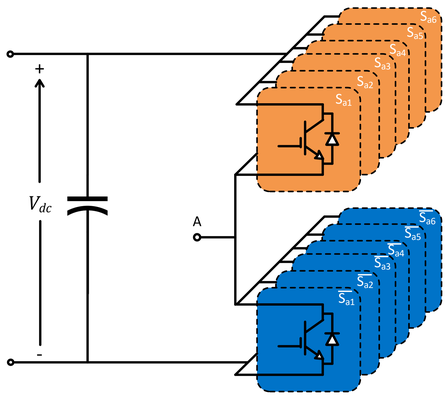
**Tasks:**

- Literature review on multiphase drives.
- Build up a scaled down prototype of six-phase inverter.
- Developing new control technique.
- Developing new switching technique for the capacitor sizing.

## Why Multiphase Drives

### Multiphase Drives Features:

1. Lower Power/Current Rating per Phase.
2. Fault-tolerance operation.
3. Torque density improvement.
4. Lower Dc-Link Current Ripples.




The figure shows a schematic of one phase-leg of the inverter used in Tesla Model S which has for the upper part 6 switches connected in parallel. The inverter comprises of 36 IGBT in total. The multiphase concept overcomes the problems associated with paralleling IGBT's.

## Modulation Techniques

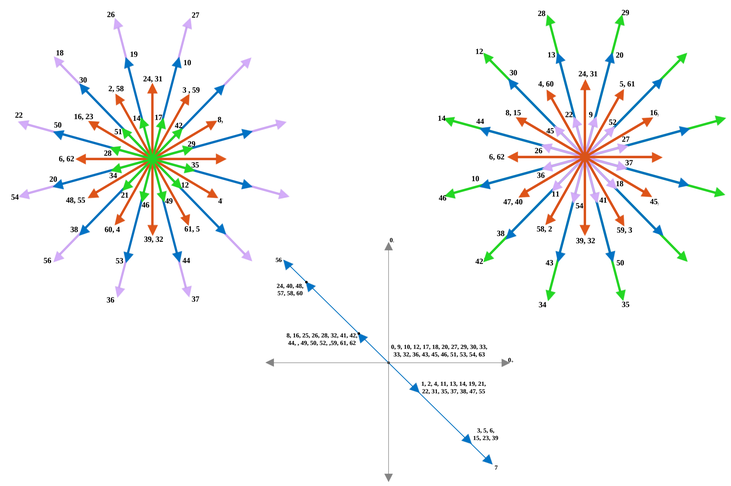
### 1. Space Vector Modulation (SVPWM) Based on Vector Space Decomposition (VSD):

Pros:

- Full control of voltage vectors in different subspaces
- Compensation of non-torque production harmonics.

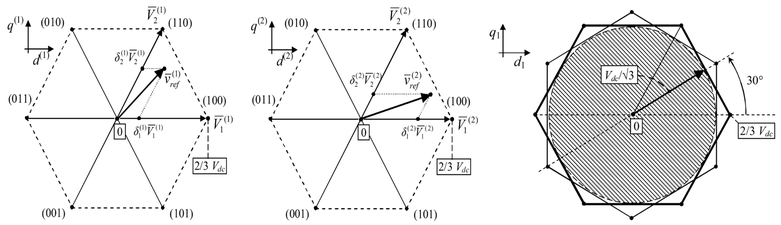
Cons:

- Requires high computational power.
- Requires additional controllers to compensate the effects of machine back EMF's.



### 2. SVPWM based on voltage classification method

Pros: Simple technique in implementation
Cons: Unable to eliminate the xy subspace harmonics.




Using two references

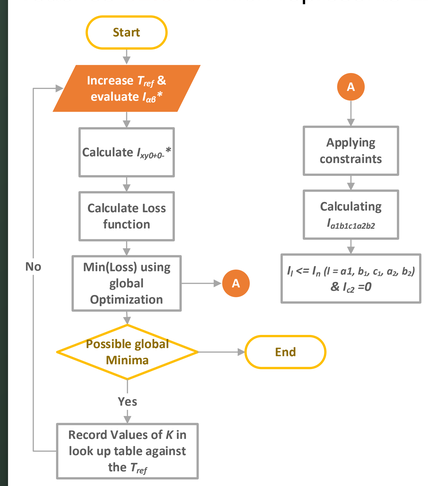
Using one reference

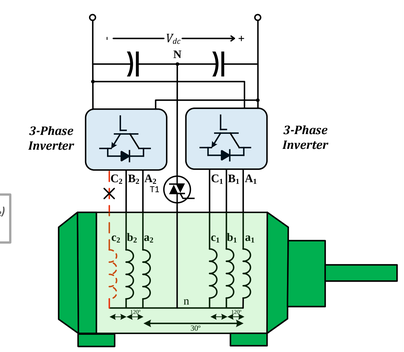
## Fault-Tolerance Capability

- Unlike Three-phase drives, Multiphase drives operates with high torque range under faulty conditions.
- Three-phase drives has 29% maximum output torque with output torque ripples under optimal current control.
- Six-phase Drives under one-phase loss can operate up till 69.5% under optimal current control with no torque ripples and minimum losses..

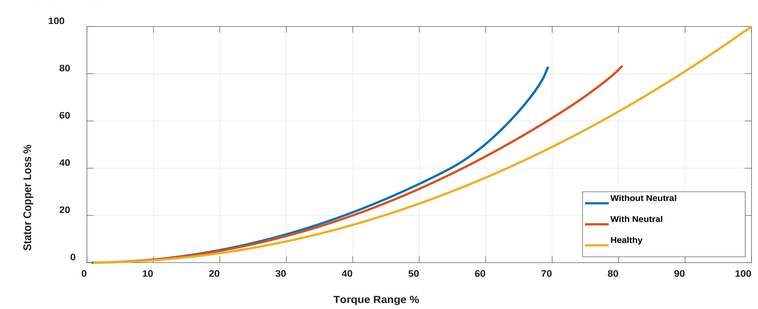
### Remedial Solution to increase the torque range under single-phase faults:

- The proposal is to provide a neutral connection to the dc-link midpoint and by applying global optimization the torque range reaches 81.6% which represents 11% increasement.




### Results:

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