In this file, the system model is developed for the purpose of

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multi-physics optimization of IMMD system for PEMD paper.

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Definitions

The system is composed of the following main parts:

- Drive power electronics
- Machine
- Heatsink

Design with GaN

```
m = 3;
Q = 48;
layer = 2;
n = 4;
p = 40;
Pout = 8e3;
Poutm = Pout/n;
Nrated = 540;
length = 0.15;
Din = 0.15;
Dout = 0.23;
effmotor = 0.9;

w = Q/(n*m);
ffund = Nrated*p/120;
kw = 0.933;

Bgapa = 0.6;
Bgap = Bgapa*pi/2;
fluxpp = 2*Din*length*Bgap/p;

zQ = 22;
Nph = zQ*w*layer/2;
```

```
E = 4.44*Nph*ffund*fluxpp*kw;
Vln = E*1.1;

Vdc = 540;
Vdcm = Vdc/2;

Vllrms = Vln*sqrt(3);
scale = sqrt(3)/(2*sqrt(2));
ma = Vllrms/(scale*Vdcm);

Pdrout = Poutm/effmotor;
pf = 0.9;
Sdrout = Pdrout/pf;
Iphase = Sdrout/(sqrt(3)*Vllrms);
```

Design ans Simulation with IGBT

```
Ts = 1e-6; % sec
% Modulation index
ma = 0.8;
% Switching frequency
fsw = 10e3; % Hz
% DC link voltage
Vdc = 400; % Volts
% Load
Ptotal = 8e3/0.9; % W
Pout = Ptotal; % W
pf = 0.9;
Sout = Pout/pf; % VA
fout = 50; % Hz
wout = 2*pi*fout; % rad/sec
Vll_rms = ma*Vdc*0.612; % Volts
Iline = Sout/(Vll_rms*sqrt(3)); % Amps
Zload = Vll_rms/(Iline*sqrt(3)); % Ohms
Rload = Zload*pf; % Ohms
Xload = sqrt(Zload^2-Rload^2); % Ohms
Lload = Xload/wout; % Henries

Rin = 10;
%Lin = 1e-3;
Vin = Vdc + Rin*(Ptotal/Vdc);
Cdc = 200e-6;

Iphase = Iline;
Idct = Ptotal/Vdc;
Idcc = (3/(2*sqrt(2)))*ma*Iphase*pf;
Irmss = Iphase*sqrt(2*ma*(sqrt(3)/(4*pi) + pf^2*(sqrt(3)/
pi-9*ma/16)));
Irms_perc = 100*Irmss/Idcc;

fsw = 10e3; % Hz
volt_ripple_perc = 1;
volt_ripple = volt_ripple_perc*Vdc/100;
Iapeak = Iphase*sqrt(2);
```

```
Cdc = ma*(Iapeak - Idcc)/(volt_ripple*fsw*2);
Cdcm = Cdc*1e6;
```

Capacitor selection

```
M = 0.8;
Iline = Iphase;
cosphi = 0.9;
module = 4;
efficiency = 0.98;

Icrms = module/2*Iphase*sqrt(2*M*(sqrt(3)/(4*pi) +...
    cosphi^2*(sqrt(3)/pi-9*M/16)));
Idc = module/2*(3/(2*sqrt(2)))*M*Iline*cosphi/efficiency;
Icrms_perc = 100*Icrms/Idc;

fsw = 40e3; % Hz
Cdc = 40e-6; % F
Iapeak = Iline*sqrt(2);
volt_ripple = M*(Iapeak - Idc/2)/(Cdc*fsw*sqrt(2))
volt_ripple_perc = volt_ripple/Vdc*100
```

```
volt_ripple =

    6.5364


volt_ripple_perc =

    1.6341
```

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