Combined coil geometry

Reference combined coil filament file: coils.m45_1231k10j2

Reference combined coil output file: coils.m45_1231k10j2.out

Coil geometry should be checked to assure that it is consistent with our conventions about currents and fields

Modular coil geometry

Ref. modular coil designation: m45_1231kj102

	M1	M2	M3
Length_m	7.351	7.13	6.537
NumberFilaments	400	400	400
Vmid	0.109	0.281	0.43
NumberCoils	6	6	6
NumWP	2	2	2
BundleHeight_mm	120	120	120
BundleWidth_mm	40	40	40
BundleArea_mm2	4800	4800	4800
BundleArea_m2	0.0048	0.0048	0.0048
EquivRadius_m	0.055279064	0.055279064	0.055279064
GroundWrap_mm	0.762	0.762	0.762
TurnInsulation_mm	0.762	0.762	0.762
InternalSeptum_mm	2.16	2.16	2.16
TurnsHigh	8	8	8
Turns	32	32	32
	0.768	0.768	0.768
ConductorLengthPerDP_m	118	114	105
ConductorHeight_mm	13.2855	13.2855	13.2855
ConductorWidth_mm	16.634	16.634	16.634
CornerRadius_mm	2	2	2
CornerArea_mm2	12.56637061	12.56637061	12.56637061
ConductorArea_mm2	208.4246364	208.4246364	208.4246364
FillFactor	0.75	0.75	0.75
Resistance correction for helical current path	3%	3%	3%
Length correction	1.5%	1.5%	1.5%
Area correction	-1.5%	-1.5%	-1.5%
CopperArea_mm2	154.008352	154.008352	154.008352
Tstart_K	85	85	85
Resistivity_ohm-m	2.36E-09	2.36E-09	2.36E-09
GeometricResistance_m-1	9.44E+06	9.16E+06	8.39E+06
InitialResistance_ohms	2.22E-02	2.16E-02	1.98E-02

TF coil geometry

TF surface geometry is specified by a surface (defined by [r,z] points) and a number of control parameters
Control parameters include the number of periods, coils per period, coil on v=0 plane (Y/N) etc.

Reference TF coil designation: ?

Reference TF coil input file: ?

	TF1	TF2	TF3	
Length_m	8.098			
NumberFilaments	100			
Vmid	0.083	0.25	0.417	
NumberCoils	6	6	6	18
TurnsHigh	3			
TurnsWide	4		*Must be a multiple of 2 for dou*	
Turns	12			
	0.288		Limiting current (MAT) per coil	
ConductorLengthPerDP_m	49			
EnvelopeHeight_mm	100			
EnvelopeWidth_mm	100			
BundleHeight_mm	87.096		**OK**	
BundleWidth_mm	99.906		**OK**	

BundleArea_mm2	8701.412976
BundleArea_m2	0.008701413
EquivRadius_m	0.074427761
GroundWrap_mm	0.762
TurnInsulation_mm	0.762
PancakeInsulation_mm	0.762
ConductorHeight_mm	27
ConductorWidth_mm	22.5
CornerRadius_mm	2.5
CornerArea_mm2	19.63495408
CoolingHoleDia_mm	13.5
CoolingArea_mm2	143.1388153
ConductorArea_mm2	444.7262306
FillFactor	1
CopperArea_mm2	444.7262306
Tstart_K	80
Resistivity_ohm-m	1.99E-09
GeometricResistance_m-1	3.93E+06
InitialResistance_ohms	7.82E-03
Required flexibility_T	0.3
Current per turn for flexibility_kA	10
Max current in reference scenario_kA	14

For use in ENERGIES code -

TF insulation worksheet	
75	V/mil
4000	V
2000	V
26.66666667	mils
30	mils
0.762	mm
6	coils
111.1111111	V
0.740740741	mils
30	mils
0.762	mm

Note:PF coils are asuumed to
Ground wrap around the whol
Turn-to-turn insulation around
A sheet of insulation between

TF conductor is Outokumpu

PF coil geometry

PF coil geometry is defined by coil centroids, builds, etc.

Reference PF coil designation ?

	PF1	PF2	PF3	PF4
Length_m	1.367	1.367	2.191	2.191
NumberFilaments	12	12	21	21
NumberCoils	2	2	2	2
Rpf	0.220	0.220	0.270	0.590
Zpf	0.225	0.675	1.240	1.580
Length_m	1.382300768	1.382300768	1.696460033	3.707079331
TurnsHigh	14	14	14	10
TurnsWide	4	4	8	10
Turns	56	56	112	100
ConductorLengthPerDP_m	38	38	61	44
	1.34	1.34	2.69	2.40
	1.10	1.34	0.49	0.42
	0.24	0.00	2.20	1.98
EnvelopeHeight_mm	410	410	430	230
EnvelopeWidth_mm	100	100	190	230
EnvelopeGap_mm	40	40	145	
BundleHeight_mm	**400.86**	**400.86**	**400.86**	**286.764**
BundleWidth_mm	**99.906**	**99.906**	**199.05**	**248.622**
BundleGap_mm	49	49	164	
BundleHeightMargin_mm	9.14	9.14	29.14	-56.764
BundleWidthMargin_mm	0.094	0.094	-9.05	-18.622
BundleArea_mm2	40048.31916	40048.31916	79791.183	71295.83921
BundleArea_m2	0.040048319	0.040048319	0.079791183	0.071295839
EquivRadius_m	0.159673266	0.159673266	0.22538111	0.213045396
GroundWrap_mm	0.762	0.762	0.762	0.762
TurnInsulation_mm	0.762	0.762	0.762	0.762
PancakeInsulation_mm	0.762	0.762	0.762	0.762
ConductorHeight_mm	27	**27**	**27**	**27**
ConductorWidth_mm	22.5	**22.5**	**22.5**	**22.5**
CornerRadius_mm	2.5	**2.5**	**2.5**	**2.5**
CornerArea_mm2	19.63495408	19.63495408	19.63495408	19.63495408
CoolingHoleDia_mm	13.5	**13.5**	**13.5**	**13.5**
CoolingArea_mm2	143.1388153	143.1388153	143.1388153	143.1388153
ConductorArea_mm2	444.7262306	444.7262306	444.7262306	444.7262306

FillFactor	1	1	1	1
CopperArea_mm2	444.7262306	444.7262306	444.7262306	444.7262306
Tstart_K	80	80	80	80
Resistivity_ohm-m	1.99E-09	1.99E-09	1.99E-09	1.99E-09
GeometricResistance_m-1	3.48E+05	3.48E+05	8.54E+05	1.67E+06
InitialResistance_ohms	6.92E-04	6.92E-04	1.70E-03	3.31E-03
1Vs_OH_MAT	2.295846678	2.802754657	1.026393447	0.866739386
1Vs_OH_A **(Ioh)**	40997	50049	9164	8667

PF1-6 conductor is Outokumpu 8431

Coil inductances

Coil inductances are calculated with ENERGIES code based on a single turn per coil, collapsed for like coils

ENERGIES inductance matrix

Coil_Name	M1	M2	M3
M1	2.95E-05	6.85E-06	3.48E-06
M2	6.85E-06	2.20E-05	6.60E-06
M3	3.48E-06	6.60E-06	2.42E-05
PF1	-2.94E-08	2.17E-08	8.13E-08
PF2	3.00E-09	-5.21E-09	4.41E-09
PF3	2.75E-08	-8.61E-09	-3.83E-08
PF4	6.86E-08	-2.43E-08	-1.41E-07
PF5	-4.94E-07	-2.73E-08	-4.47E-07
PF6	-8.61E-07	-5.04E-08	-7.47E-08
TF	3.78E-05	2.81E-05	2.22E-05
Plasma	-7.67E-07	-4.50E-07	-3.31E-07

Modified plasma inductances

Major radius	1.4	
Aspect ratio	4.4	
Minor radius	0.318181818	Based on aspect ratio
Elongation	1.8	
$l_i(3)$	0.5	
Poloidal beta	0	
Plasma inductance_H	2.67926E-06	
L/R during disruption_s	0.002	
R during disruption_ohms **(Rdisrupt)**	0.001339629	
L/R during rampdown_s	0.05	
R during rampdown_ohms **(Rramp)**	5.35852E-05	

Modified PF inductances

nmin 1

	PF1	PF2	PF3	PF4
	6.34658E-07	1.03524E-07	1.71126E-08	3.06566E-08
	1.03524E-07	5.47531E-07	6.67182E-08	5.90042E-08
	1.71126E-08	6.67182E-08	6.84818E-07	3.23117E-07
	3.06566E-08	5.90042E-08	3.23117E-07	2.72697E-06
	1.00736E-07	1.05149E-07	1.6481E-07	7.78652E-07
	1.17489E-07	1.13575E-07	1.54479E-07	6.71309E-07
Plasma	1.31281E-07	9.97582E-08	8.59614E-08	2.72045E-07

Modified single-turn inductance matrix

	Turns	M1	M2	M3
		32	32	32
M1	32	2.95E-05	6.85E-06	3.48E-06
M2	32	6.85E-06	2.20E-05	6.60E-06
M3	32	3.48E-06	6.60E-06	2.42E-05
PF1	56	-2.94E-08	2.17E-08	8.13E-08
PF2	56	3.00E-09	-5.21E-09	4.41E-09
PF3	112	2.75E-08	-8.61E-09	-3.83E-08
PF4	100	6.86E-08	-2.43E-08	-1.41E-07
PF5	24	-4.94E-07	-2.73E-08	-4.47E-07

PF6	8	-8.61E-07	-5.04E-08	-7.47E-08
TF	12	3.78E-05	2.81E-05	2.22E-05
Plasma	1	-7.67E-07	-4.50E-07	-3.31E-07

Modified multi-turn inductance matrix

Lcoils

M1	3.02E-02	7.01E-03	3.56E-03
M2	7.01E-03	2.25E-02	6.76E-03
M3	3.56E-03	6.76E-03	2.48E-02
PF1	-5.26E-05	3.90E-05	1.46E-04
PF2	5.37E-06	-9.34E-06	7.90E-06
PF3	9.86E-05	-3.09E-05	-1.37E-04
PF4	2.20E-04	-7.77E-05	-4.50E-04
PF5	-3.79E-04	-2.10E-05	-3.43E-04
PF6	-2.21E-04	-1.29E-05	-1.91E-05
TF	1.45E-02	1.08E-02	8.54E-03
Plasma	-2.45E-05	-1.44E-05	-1.06E-05

Ncircuit	11		
Tstart	85	85	85
Rgeometric	9.44E+06	9.16E+06	8.39E+06
Acoils	0.000154008	0.000154008	0.000154008
Initial Coil Resistance	2.22E-02	2.16E-02	1.98E-02

Calculated with readcur.f from combined coil filament file

Data supplied from WBS1

Winding packs (double pancakes) per coil

For use in ENERGIES code - models NumWP as a single coil
Ground wrap outside each winding pack (double pancake)

Double pancake construction assumed in each winding pack

Limiting current (MAT) per coil based on 24kA conductor current

Modular coil insulation worksheet

75	V/mil	
4000	V	PS terminal-to-terminal
2000	V	Assumes center ground
26.66666667	mils	Min ground wrap
30	mils	Assumed GW thickness
0.762	mm	
6	coils	
166.6666667	V	Max turn-to-turn
1.111111111	mils	Min turn-to-turn
30	mils	Assumed turn-to-turn thickness
0.762	mm	

Note:Double pancakes assumed in each winding pack
Ground wrap around each winding pack
Turn-to-turn insulation around each conductor

Calculated with readcur.f from combined coil filament file

Data supplied from WBS1

ıble pancake construction

l based on 24kA conductor current

models NumWP as a single coil

PS terminal-to-terminal
Assumes center ground
Min ground wrap
Assumed GW thickness

Max turn-to-turn
Min turn-to-turn
Assumed turn-to-turn and pancake insulation

be wound in vertical double pancakes
e coil
each conductor
each pancake (same thickness as turn-to-turn)

8431

PF5	PF6		
			Calculated with readcur.f from combined coil filament file
7.538	15.581		From filament file
75	153		
2	2		
			Data supplied from WBS1
2.130	2.700		
1.470	0.970		
13.3831847	16.96460033		Calculated analytically
6	4		
4	2		
24	8		
90	125		
0.58	0.19		Max MAT per coil based on 24kA
0.01	0.01		
0.57	0.18		MAT limits for NP
150	150		
100	60		
172.668	**115.62**		
99.906	**50.334**		
-22.668	34.38	-56.764	*Should be >0*
0.094	9.666	-18.622	*Should be >0*
17250.56921	5819.61708		
0.017250569	0.005819617		
0.104795293	0.060867753		For use in ENERGIES code - models NumWP as a single coil
0.762	0.762		
0.762	0.762		PF insulation worksheet
0.762	0.762		75 V/mil
27	**27**		4000 V PS terminal-to-terminal
22.5	**22.5**		2000 V Assumes center ground
2.5	**2.5**		26.66666667 mils Min ground wrap
19.63495408	19.63495408		30 mils Assumed GW thickness
13.5	**13.5**		0.762 mm
143.1388153	143.1388153		6 coils
444.7262306	444.7262306		333.3333333 V Max turn-to-turn

1	1	2.222222222	mils	Min turn-to-turn
444.7262306	444.7262306	30	mils	Assumed turn-to-turn and pancake insulation
80	80	0.762	mm	
1.99E-09	1.99E-09	Note:PF coils are asuumed to be wound in vertical double pancakes		
1.44E+06	6.10E+05	Ground wrap around the whole coil		
2.87E-03	1.21E-03	Turn-to-turn insulation around each conductor		
0.017547519	0.025476666	A sheet of insulation between each pancake (same thickness as turn-to-turn)		
731	3185			

PF1	PF2	PF3	PF4	PF5	PF6	TF	Plasma
-2.94E-08	3.00E-09	2.75E-08	6.86E-08	-4.94E-07	-8.61E-07	3.78E-05	-7.67E-07
2.17E-08	-5.21E-09	-8.61E-09	-2.43E-08	-2.73E-08	-5.04E-08	2.81E-05	-4.50E-07
8.13E-08	4.41E-09	-3.83E-08	-1.41E-07	-4.47E-07	-7.47E-08	2.22E-05	-3.31E-07
1.02E-06	8.54E-08	1.38E-08	3.22E-08	9.79E-08	1.12E-07	9.60E-21	1.21E-07
8.54E-08	9.51E-07	3.64E-08	5.95E-08	1.02E-07	1.09E-07	2.75E-19	9.84E-08
1.38E-08	3.64E-08	1.27E-06	4.58E-07	1.62E-07	1.49E-07	-2.04E-23	8.36E-08
3.22E-08	5.95E-08	4.58E-07	3.46E-06	6.76E-07	5.92E-07	-2.84E-22	2.81E-07
9.79E-08	1.02E-07	1.62E-07	6.76E-07	2.12E-05	9.73E-06	-1.41E-22	2.04E-06
1.12E-07	1.09E-07	1.49E-07	5.92E-07	9.73E-06	3.16E-05	2.14E-22	2.75E-06
9.60E-21	2.75E-19	-2.04E-23	-2.84E-22	-1.41E-22	2.14E-22	3.05E-04	-1.37E-07
1.21E-07	9.84E-08	8.36E-08	2.81E-07	2.04E-06	2.75E-06	-1.37E-07	6.46E-06

PF5	PF6
1.00736E-07	1.17489E-07
1.05149E-07	1.13575E-07
1.6481E-07	1.54479E-07
7.78652E-07	6.71309E-07
2.13762E-05	9.96587E-06
9.96587E-06	3.43625E-05
1.83615E-06	2.46341E-06

PF1	PF2	PF3	PF4	PF5	PF6	TF	Plasma
56	56	112	100	24	8	12	1
-2.94E-08	3.00E-09	2.75E-08	6.86E-08	-4.94E-07	-8.61E-07	3.78E-05	-7.67E-07
2.17E-08	-5.21E-09	-8.61E-09	-2.43E-08	-2.73E-08	-5.04E-08	2.81E-05	-4.50E-07
8.13E-08	4.41E-09	-3.83E-08	-1.41E-07	-4.47E-07	-7.47E-08	2.22E-05	-3.31E-07
6.35E-07	1.04E-07	1.71E-08	3.07E-08	1.01E-07	1.17E-07	9.60E-21	1.31E-07
1.04E-07	5.48E-07	6.67E-08	5.90E-08	1.05E-07	1.14E-07	2.75E-19	9.98E-08
1.71E-08	6.67E-08	6.85E-07	3.23E-07	1.65E-07	1.54E-07	-2.04E-23	8.60E-08
3.07E-08	5.90E-08	3.23E-07	2.73E-06	7.79E-07	6.71E-07	-2.84E-22	2.72E-07
1.01E-07	1.05E-07	1.65E-07	7.79E-07	2.14E-05	9.97E-06	-1.41E-22	1.84E-06

1.17E-07	1.14E-07	1.54E-07	6.71E-07	9.97E-06	3.44E-05	2.14E-22	2.46E-06
9.60E-21	2.75E-19	-2.04E-23	-2.84E-22	-1.41E-22	2.14E-22	3.05E-04	-1.37E-07
1.31E-07	9.98E-08	8.60E-08	2.72E-07	1.84E-06	2.46E-06	-1.37E-07	2.68E-06

-5.26E-05	5.37E-06	9.86E-05	2.20E-04	-3.79E-04	-2.21E-04	1.45E-02	-2.45E-05
3.90E-05	-9.34E-06	-3.09E-05	-7.77E-05	-2.10E-05	-1.29E-05	1.08E-02	-1.44E-05
1.46E-04	7.90E-06	-1.37E-04	-4.50E-04	-3.43E-04	-1.91E-05	8.54E-03	-1.06E-05
1.99E-03	3.25E-04	1.07E-04	1.72E-04	1.35E-04	5.26E-05	6.45E-18	7.35E-06
3.25E-04	1.72E-03	4.18E-04	3.30E-04	1.41E-04	5.09E-05	1.85E-16	5.59E-06
1.07E-04	4.18E-04	8.59E-03	3.62E-03	4.43E-04	1.38E-04	-2.74E-20	9.63E-06
1.72E-04	3.30E-04	3.62E-03	2.73E-02	1.87E-03	5.37E-04	-3.41E-19	2.72E-05
1.35E-04	1.41E-04	4.43E-04	1.87E-03	1.23E-02	1.91E-03	-4.06E-20	4.41E-05
5.26E-05	5.09E-05	1.38E-04	5.37E-04	1.91E-03	2.20E-03	2.06E-20	1.97E-05
6.45E-18	1.85E-16	-2.74E-20	-3.41E-19	-4.06E-20	2.06E-20	4.39E-02	-1.64E-06
7.35E-06	5.59E-06	9.63E-06	2.72E-05	4.41E-05	1.97E-05	-1.64E-06	2.68E-06

80	80	80	80	80	80	80	0
3.48E+05	3.48E+05	8.54E+05	1.67E+06	1.44E+06	6.10E+05	3.93E+06	0
0.000444726	0.000444726	0.000444726	0.000444726	0.000444726	0.000444726	0.000444726	0
6.92E-04	6.92E-04	1.70E-03	3.31E-03	2.87E-03	1.21E-03	7.82E-03	0