IPMSG의 발전 효율 비교 및 강성 해석

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HANYANG UNIVERSITY

MSG

김재현 – 고정자 코일 설계 및 강성 해석
김남현 – Rectifier 회로 및 SOC 효율
홍석현 – 회전자 설계 및 전자기 해석

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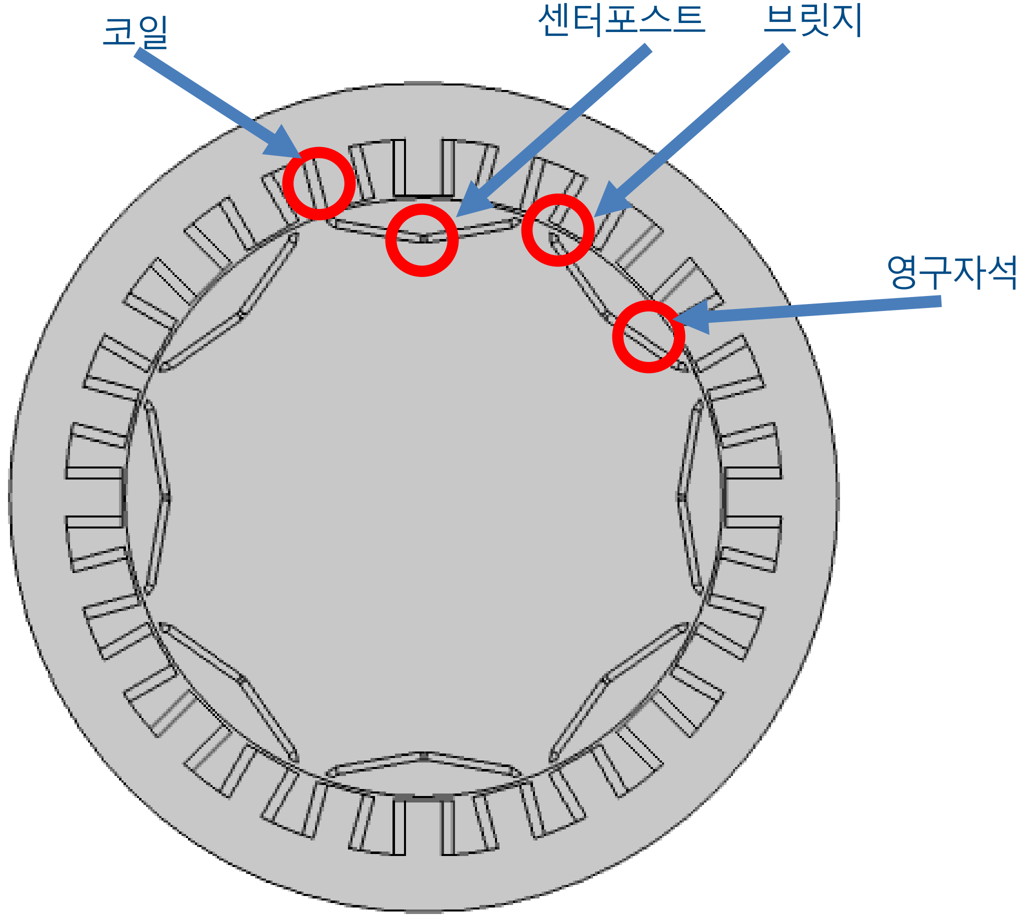
Modeling Procedure


코일
센터포스트
브릿지
영구자석

Modeling Procedure

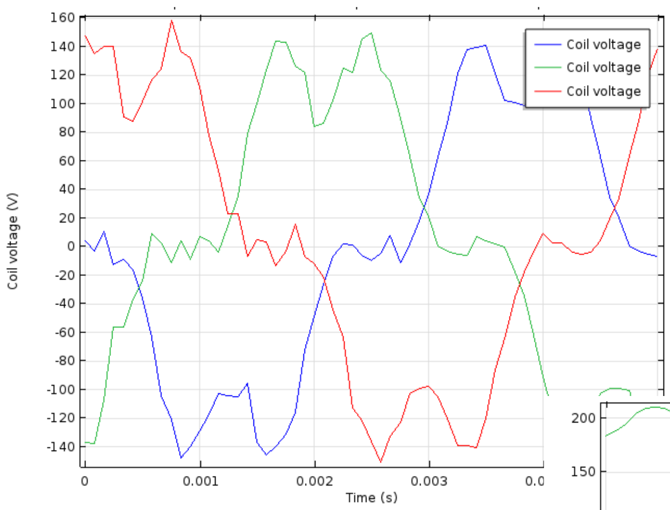
Modeling Parameters

구분	설계변수값	구분	설계변수값
로터 반지름	80[mm]	자석 비투자율	1.05
공극 길이	0.8[mm]	턴수	231
자석 길이	46[mm]	극수	8
자석 두께	5[mm]	센터포스트 길이	1[mm]
브릿지 길이	1.5[mm]	로터 두께	184[mm]

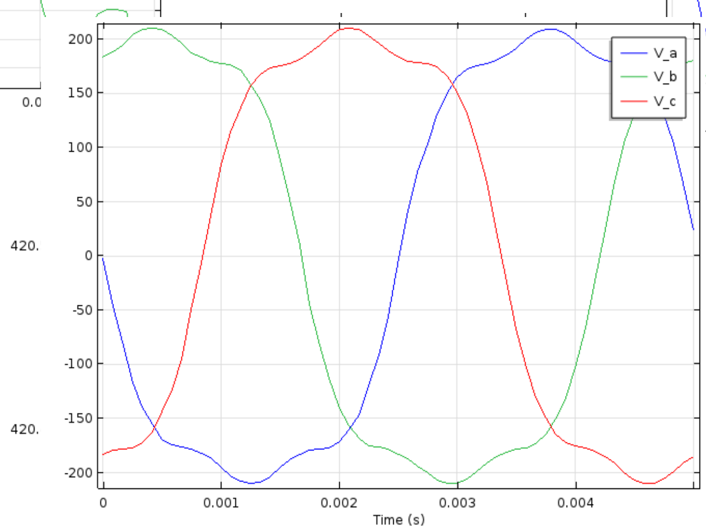
출처: 전기자동차 주행거리 확장용 매입형 영구자석 발전기 최적 설계 (서울대학교 대학원 전기·컴퓨터 공학부 임 동 국)

Modeling Procedure

Charging time Voltage Waveform



VER1



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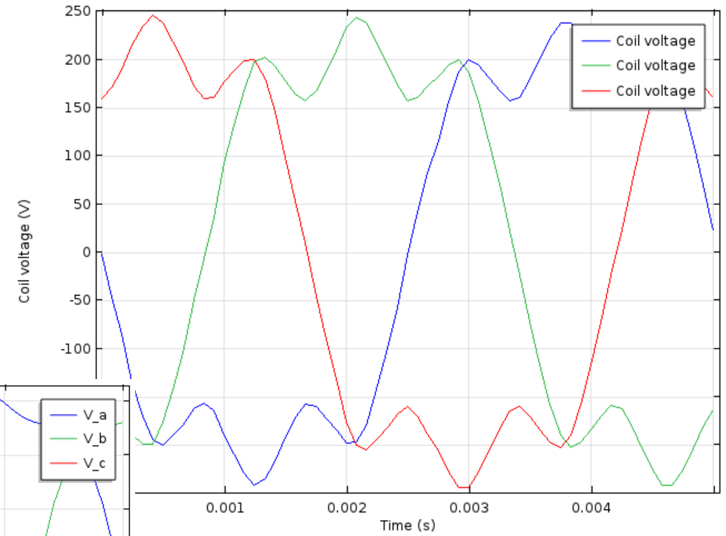
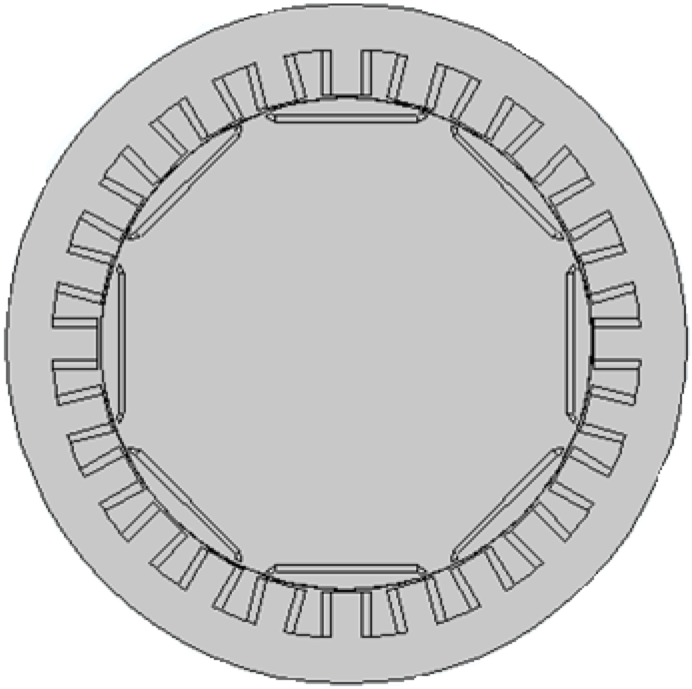


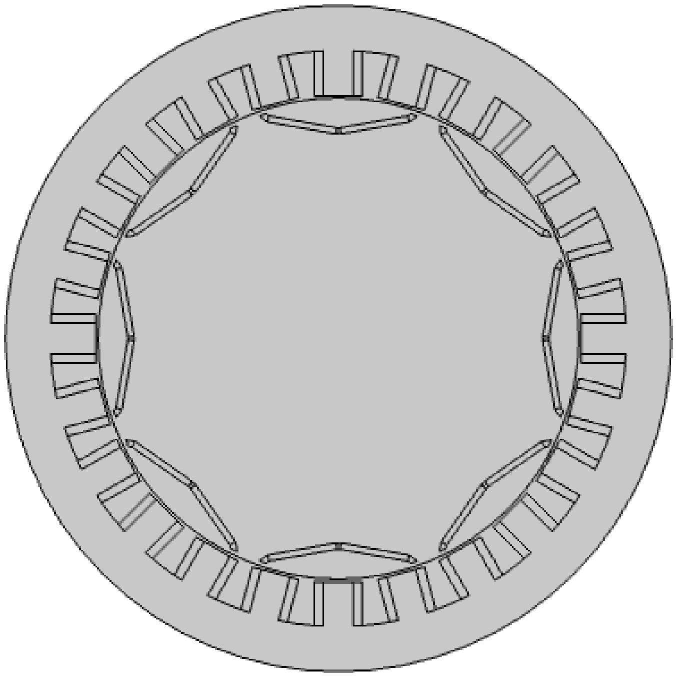
VER3

Modeling Procedure

I-Shape vs. V-Shape

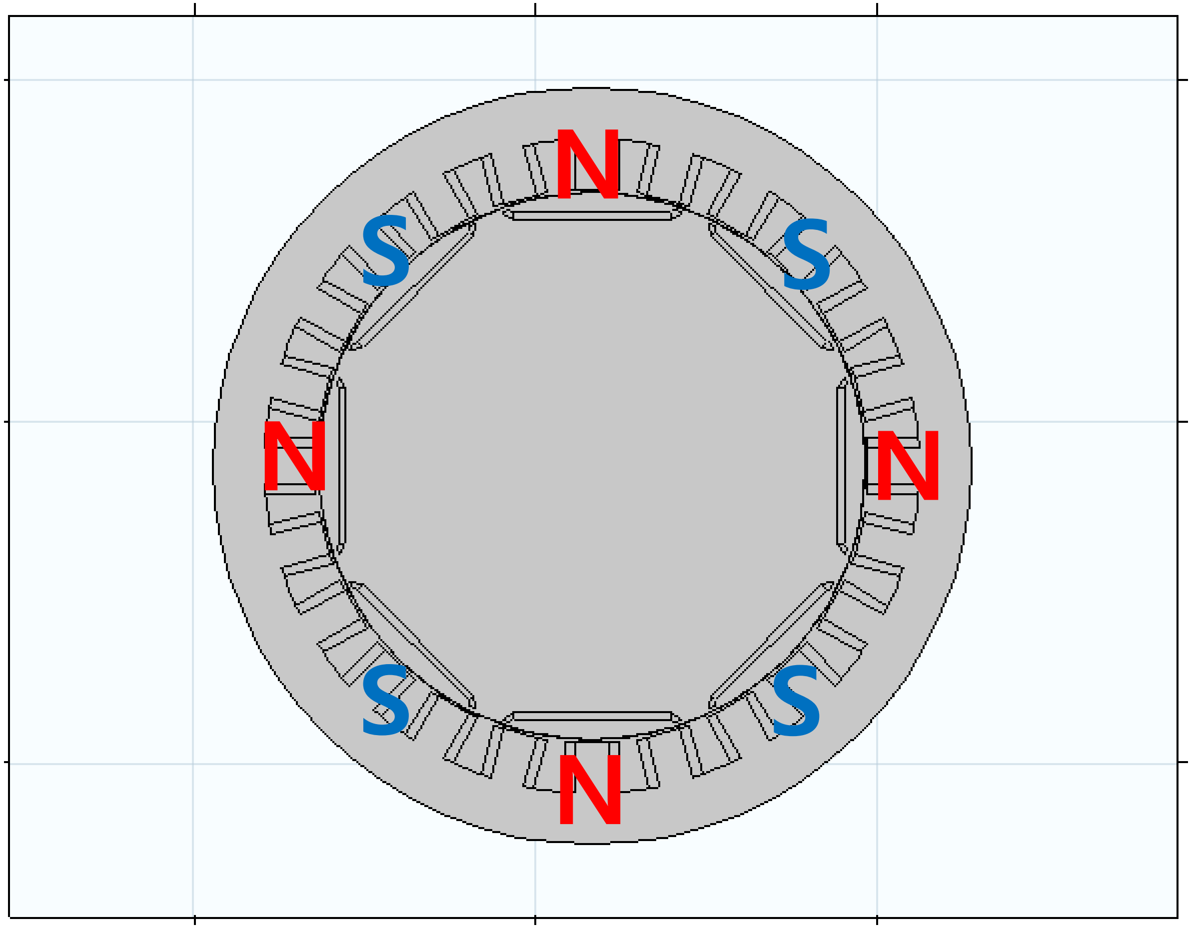
Geometry





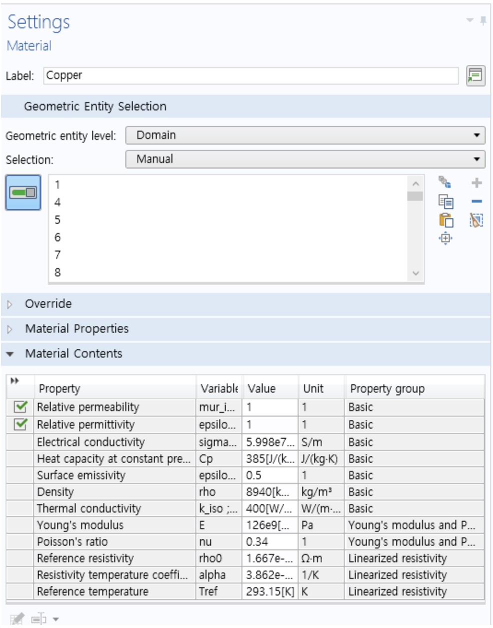
Modeling Procedure

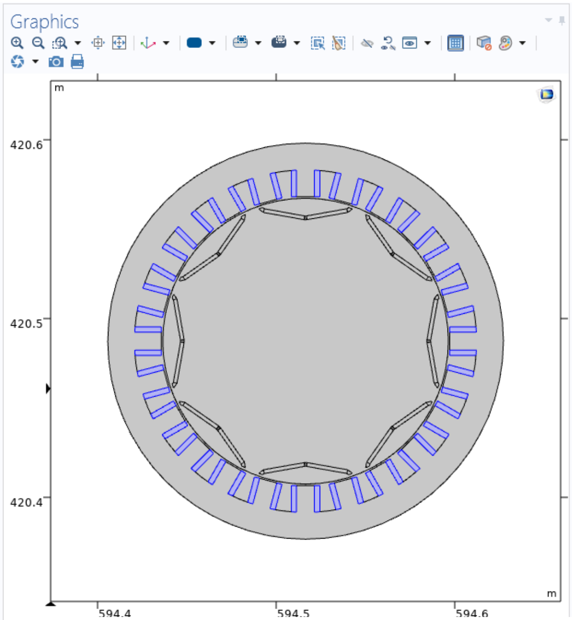
Magnet Modeling

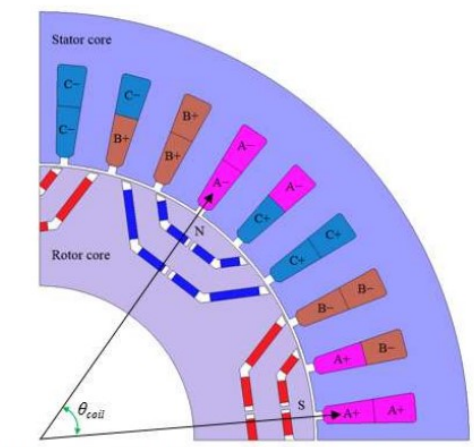


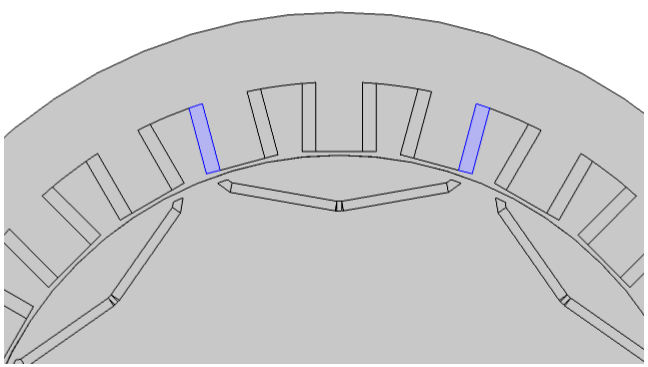
Modeling Procedure

Coil Modeling

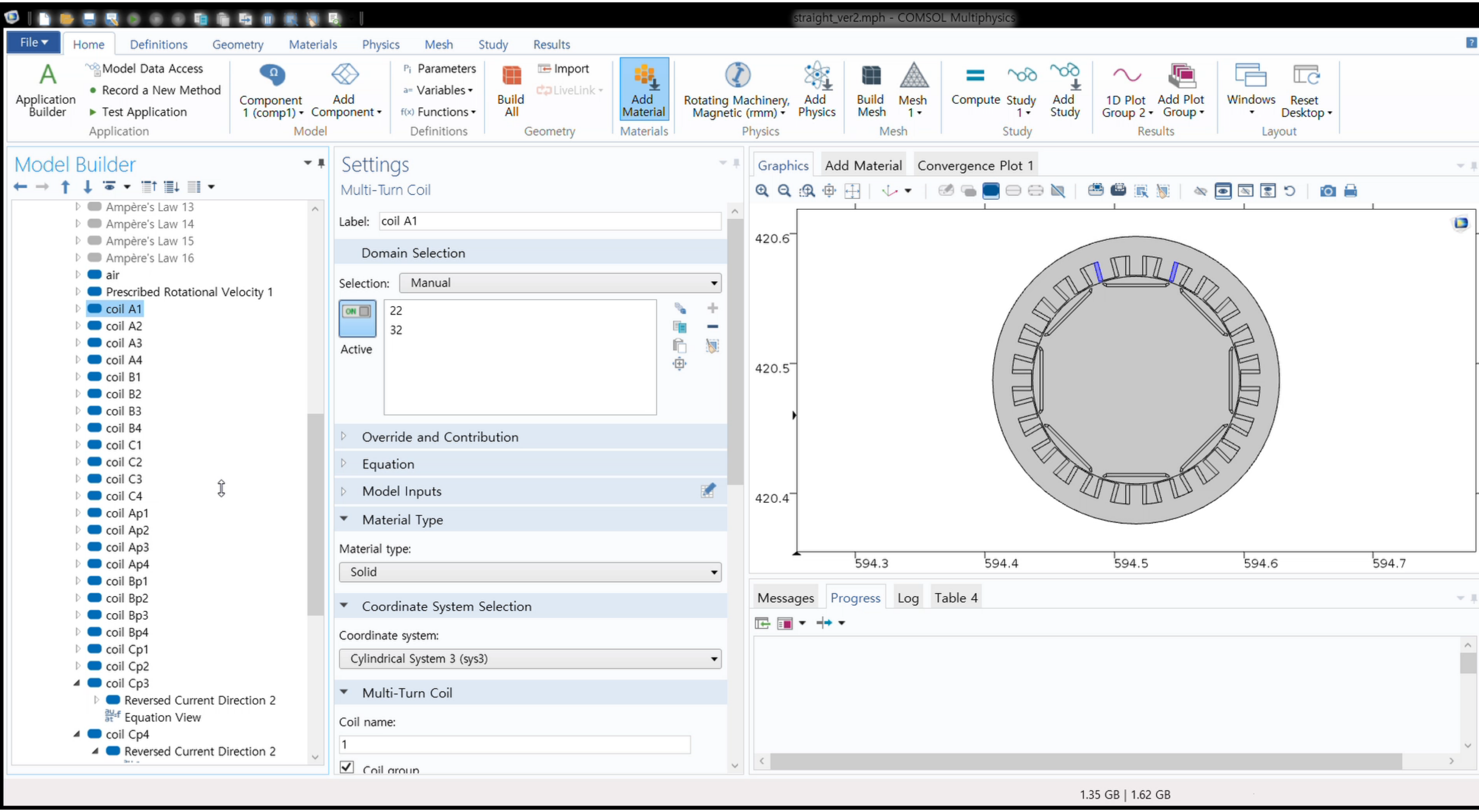








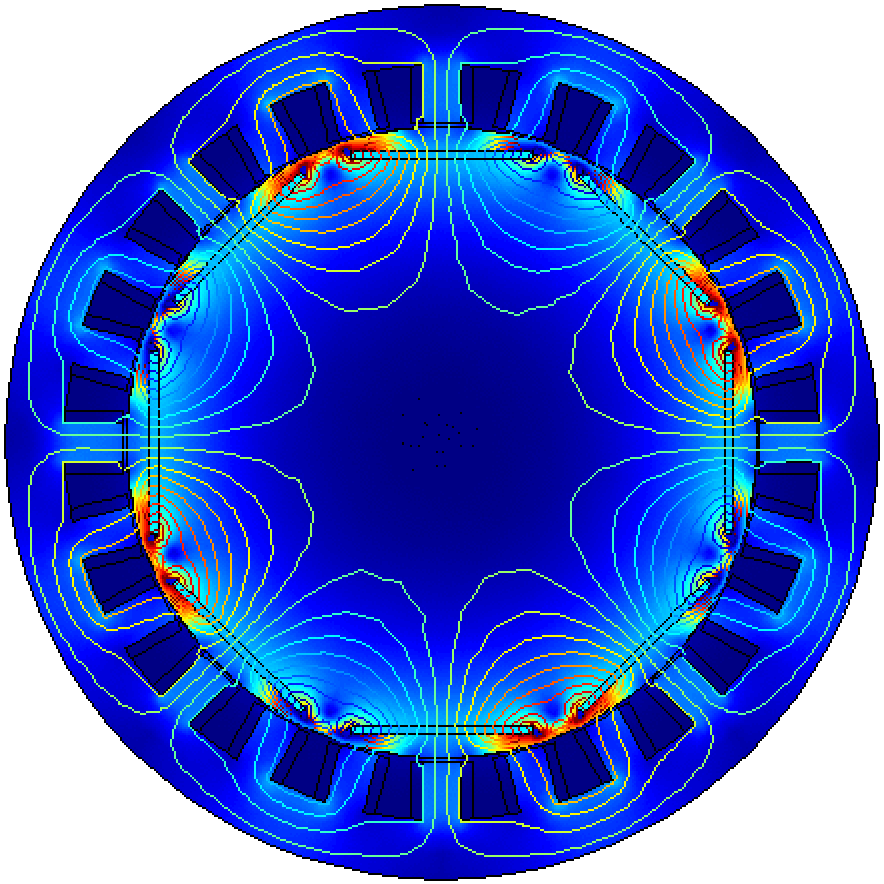
Modeling Procedure



Analysis

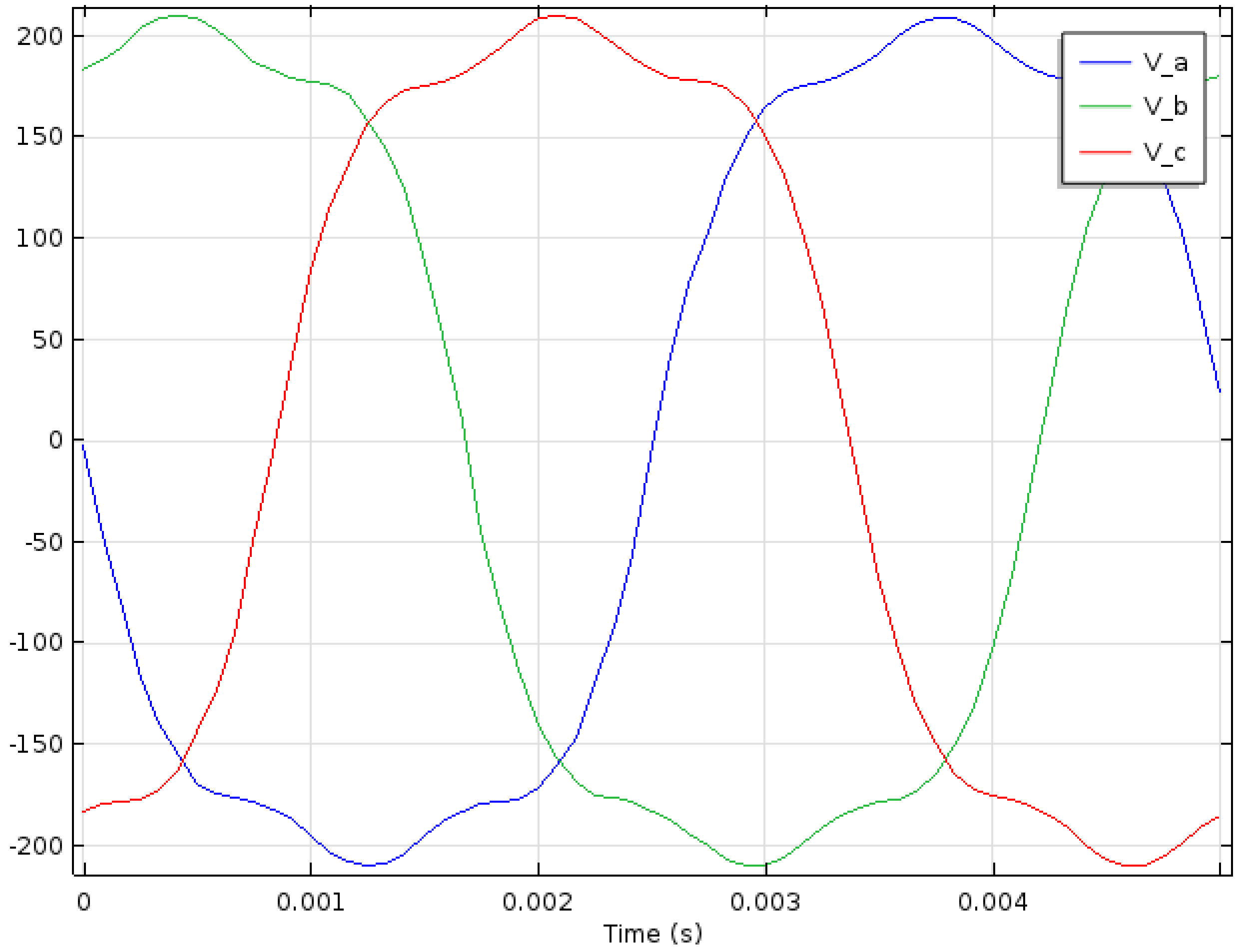
Analysis

I-Shaped IPM



Analysis

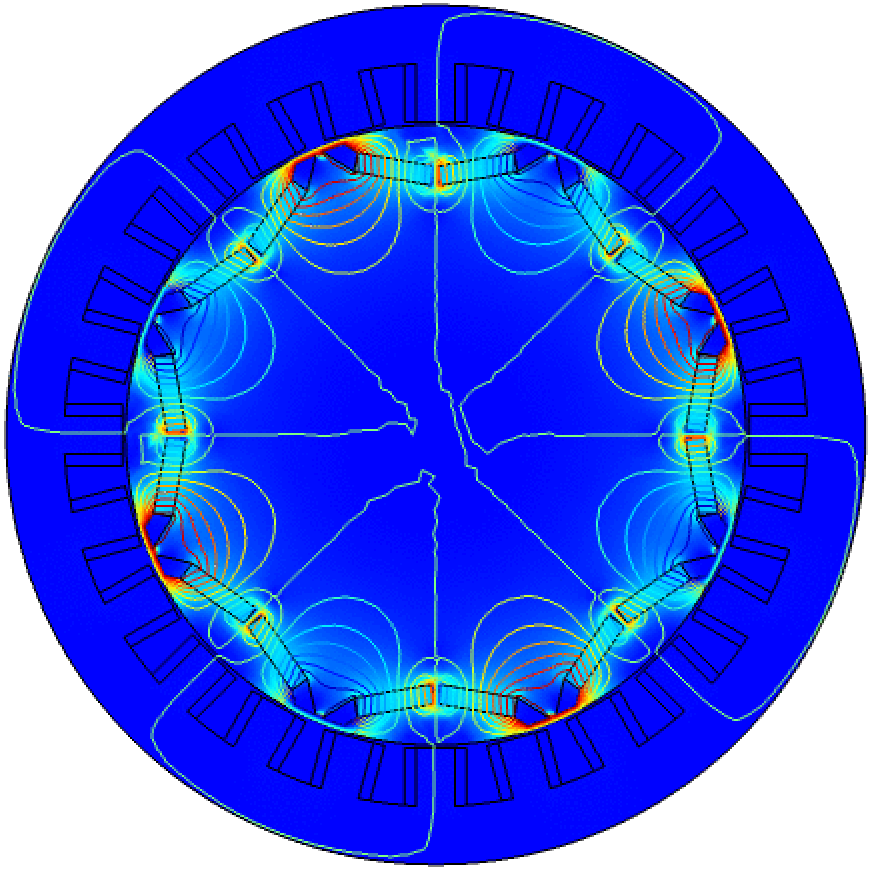
I-Shaped IPM Voltage Waveform



Analysis

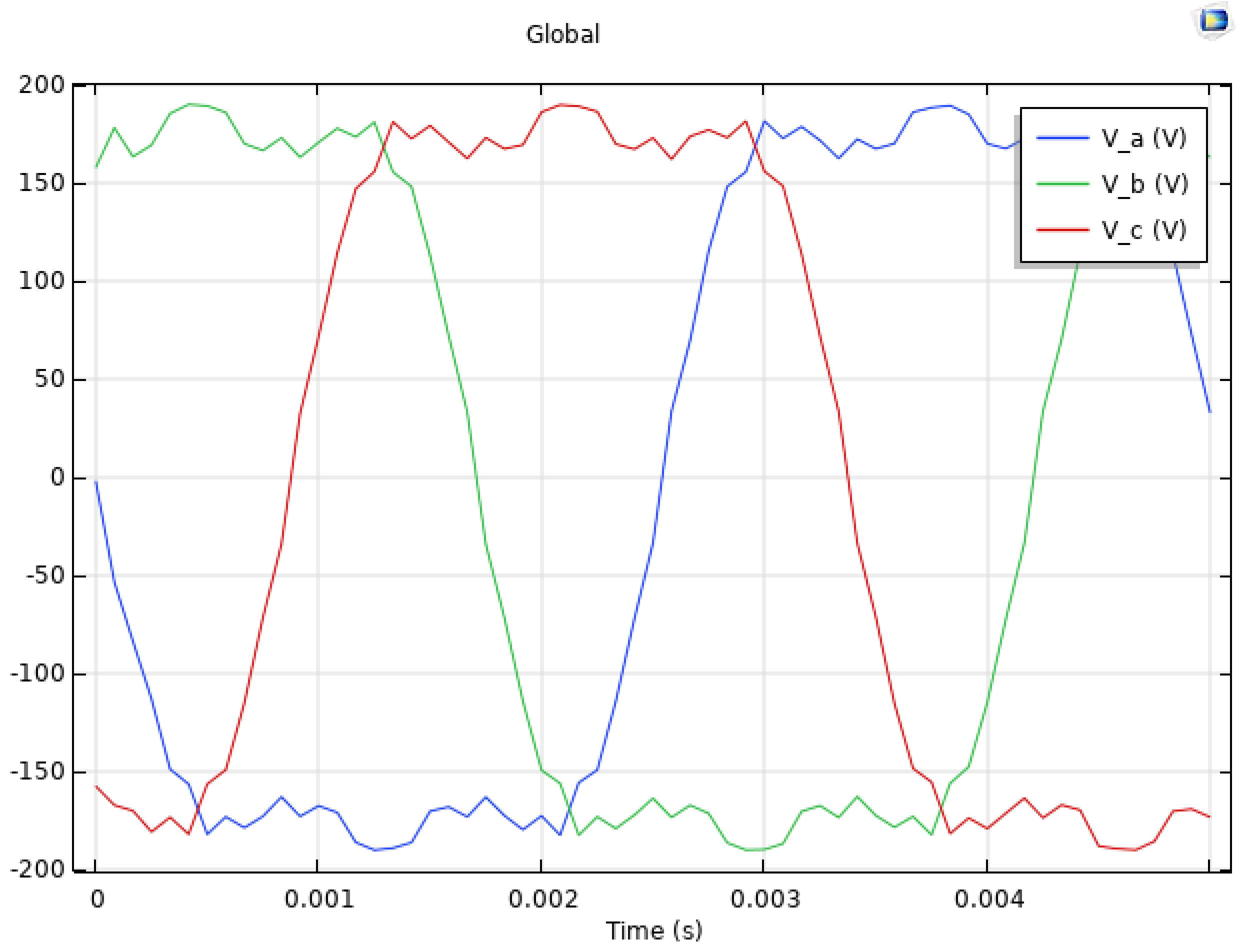
V-Shaped IPMSG

Magnetic Flux Density & Magnetic Vector Potential



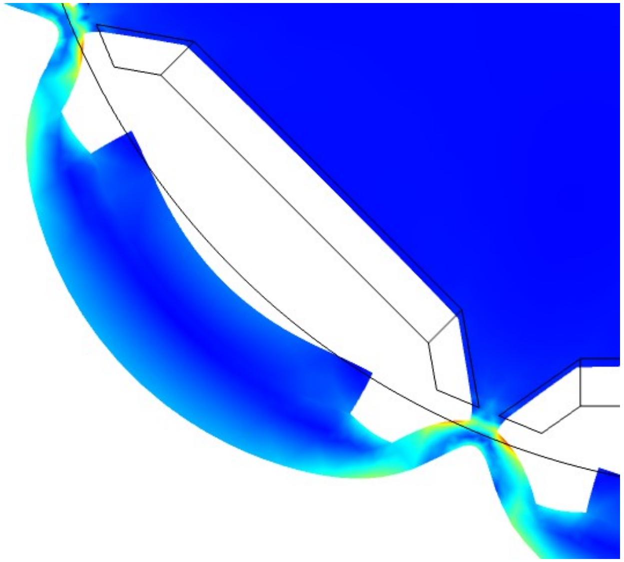
Analysis

V-Shaped IPM Voltage Waveform

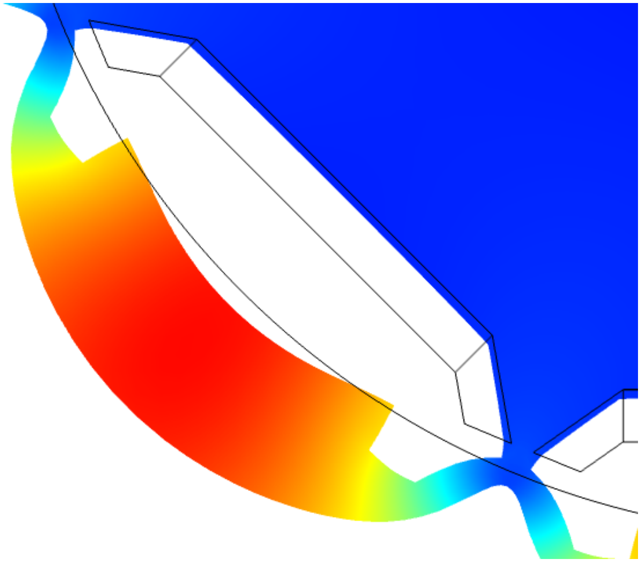


I-Shape
Maximum Stress & Maximum Displacement

Mechanical Properties	Metric
Hardness, Brinell	146
Hardness, Rockwell A	49
Hardness, Rockwell B	79
Hardness, Vickers	150
Tensile Strength at Break	540 MPa
Tensile Strength, Yield	50.0 MPa @Strain 0.500 %
Modulus of Elasticity	200 GPa
Bulk Modulus	166 GPa
Poissons Ratio	0.291
Shear Modulus	77.5 GPa



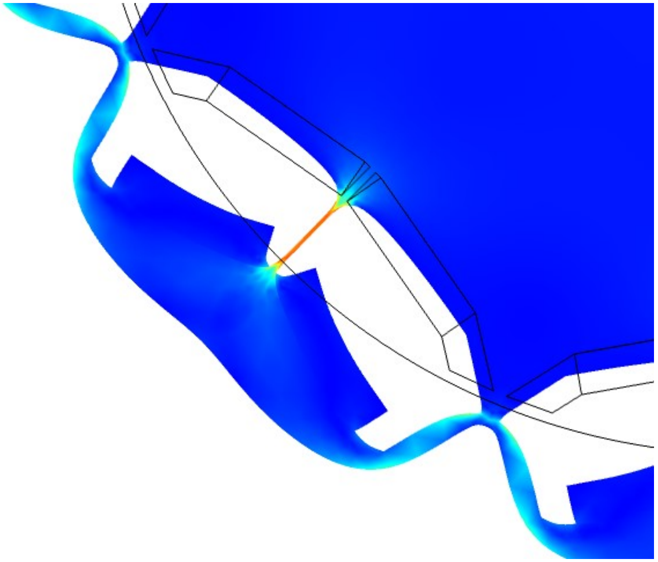
최대 응력(립) : 29[Mpa]



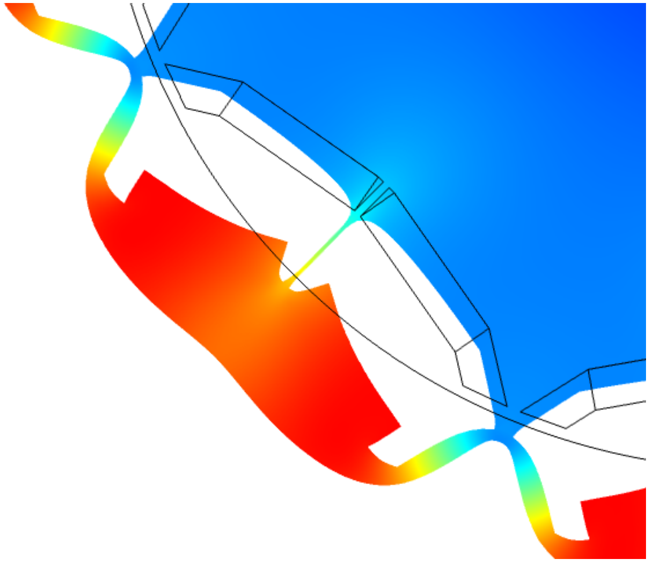
4.35[μm]

V-Shape
Maximum Stress & Maximum Displacement

Mechanical Properties	Metric
Hardness, Brinell	146
Hardness, Rockwell A	49
Hardness, Rockwell B	79
Hardness, Vickers	150
Tensile Strength at Break	540 MPa
Tensile Strength, Yield	50.0 MPa @Strain 0.500 %
Modulus of Elasticity	200 GPa
Bulk Modulus	166 GPa
Poissons Ratio	0.291
Shear Modulus	77.5 GPa



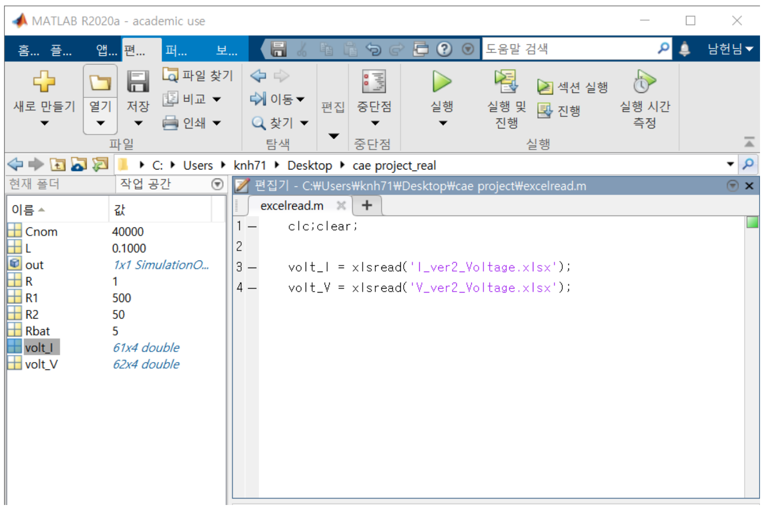
최대 응력(센터포스트) : 23.8[MPa]
응력(립) : 9[MPa]

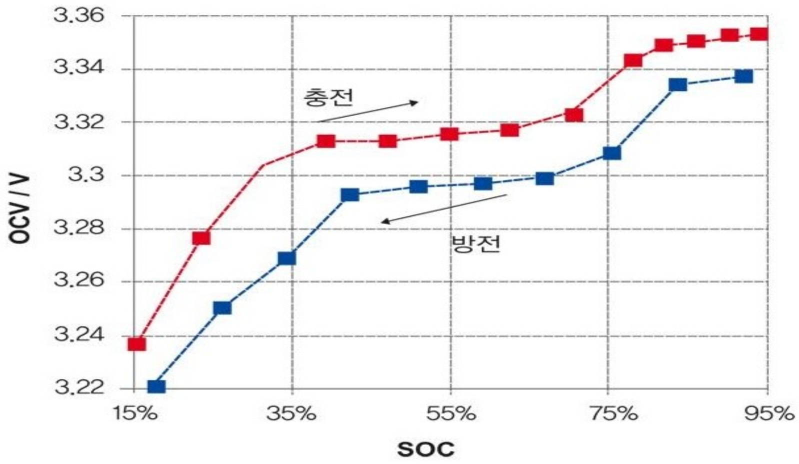


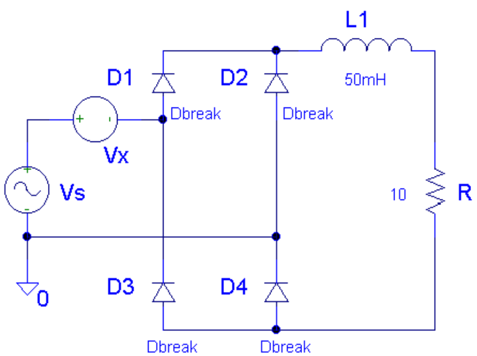
1.33[μm]

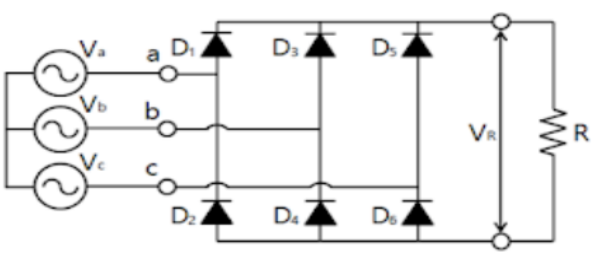
Analysis

I-shaped V-shaped Charging time compare









3상 전파 정류 회로

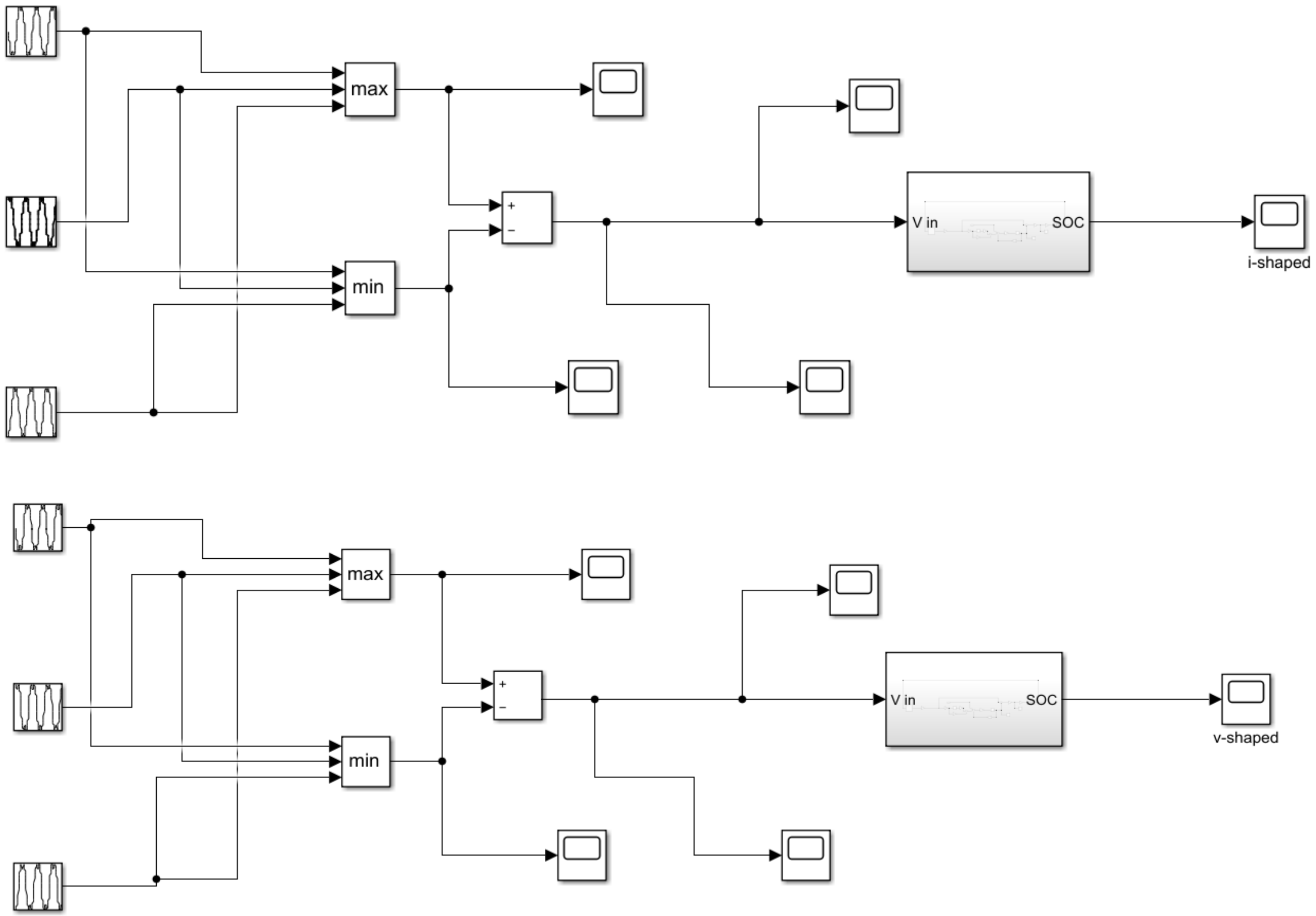
[도심형 배터리 팩 어셈블리]

항목	제원
셀 구성	90셀
정격 전압 (V)	324 (225~387)V
공칭 용량 (Ah)	120AH
에너지 (KWh)	39.2
중량 (kg)	325
냉각 시스템	수냉식

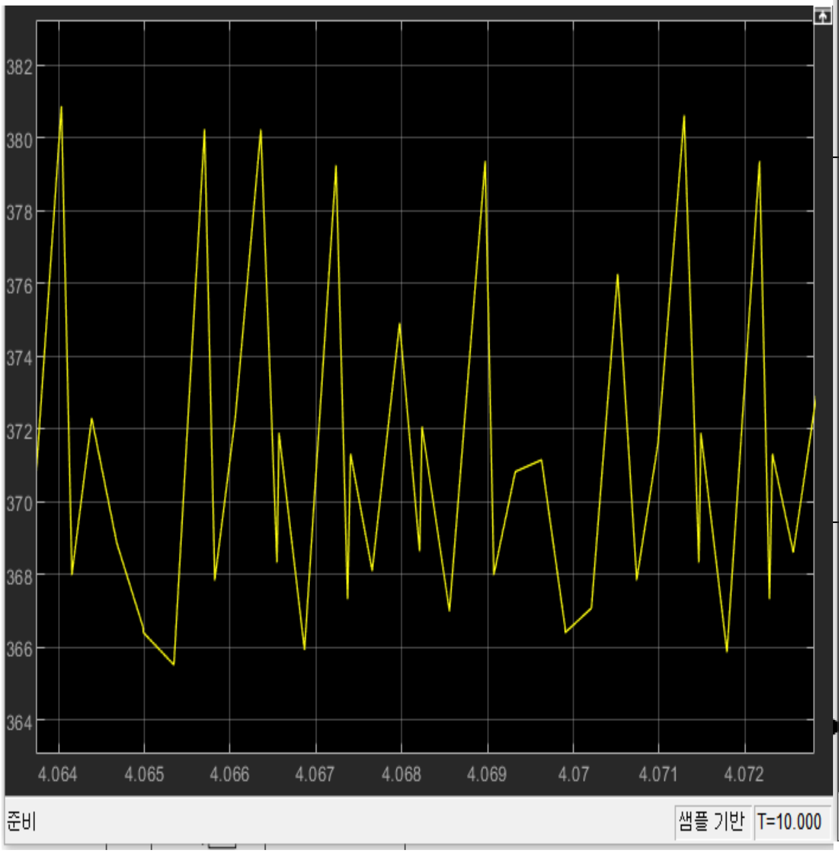
코나 EV 도심형 배터리 스펙(주행 가능 거리 복합 5.8Km/KWh)

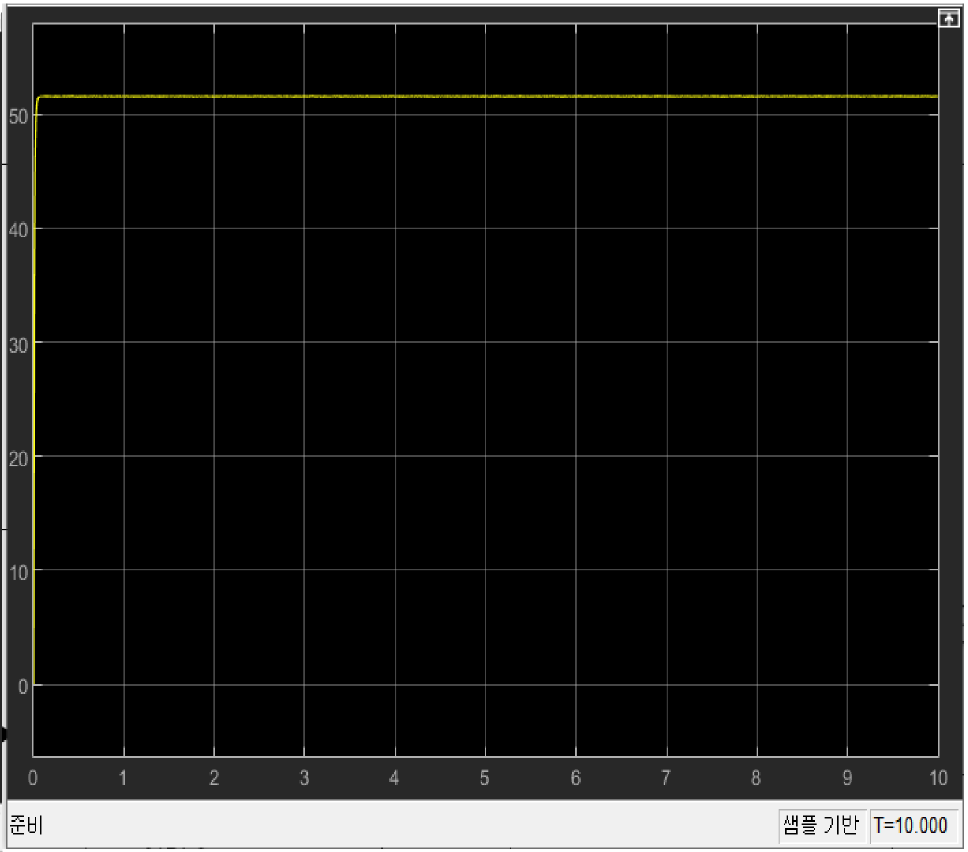
PERFORMANCE SPECIFICATIONS	
Nominal Voltage	12.8 volts
Rated Capacity	50.0 AH
Cycle Life (@DOD100%)	≤2000 cycles
Approximate Weight	14.33 lbs. (6.5kg)
Internal Resistance at 50% SOC	≤20.0 milliohms
Max Charge Current	50A
Max Discharge Current	50A
Pulse Discharge Current	150A withstand 3s
Discharge Cut-Off Voltage	10.0V
Protection/Communication	BMS and Bluetooth®
Operating Temperature Range Charge Discharge Recommended	 32°F (0°C) to 113°F (45°C) -4°F (-20°C) to 140°F (60°C) 59°F (15°C) to 95°F (35°C)
Case	Flame Retardant ABS Plastic UL94:V-0
Self-Discharge Rate Residual Capacity Reversible Capacity	 ≤3%/month; ≤15%/year ≤1.5%/month; ≤8%/year
Power Sonic Chargers	Contact us for information on a suitable charger

Analysis

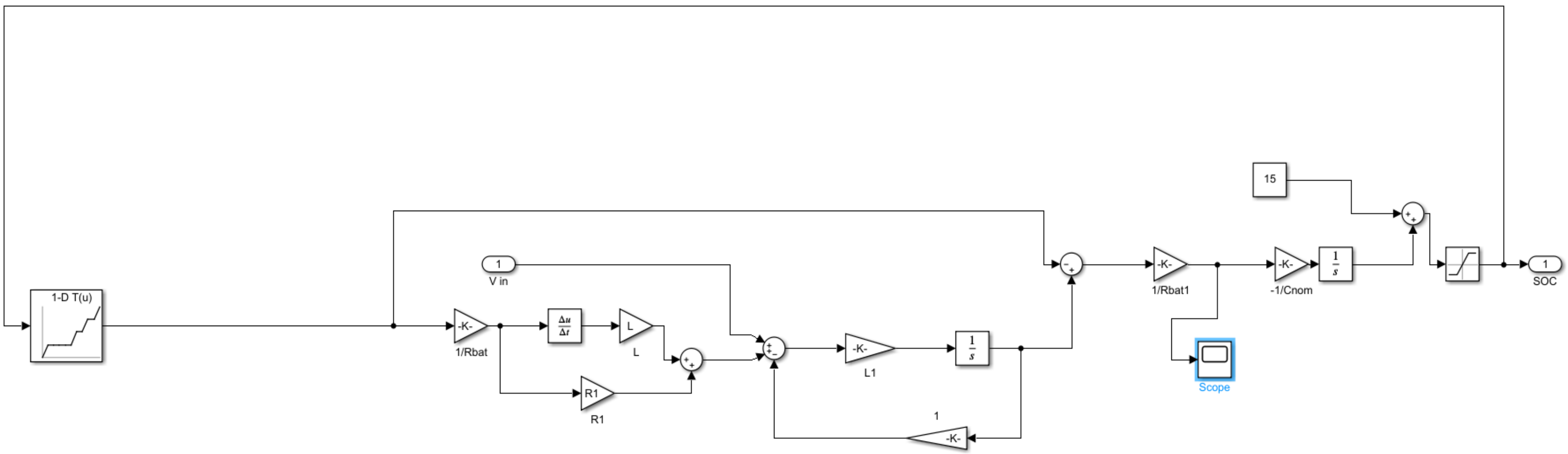


Analysis

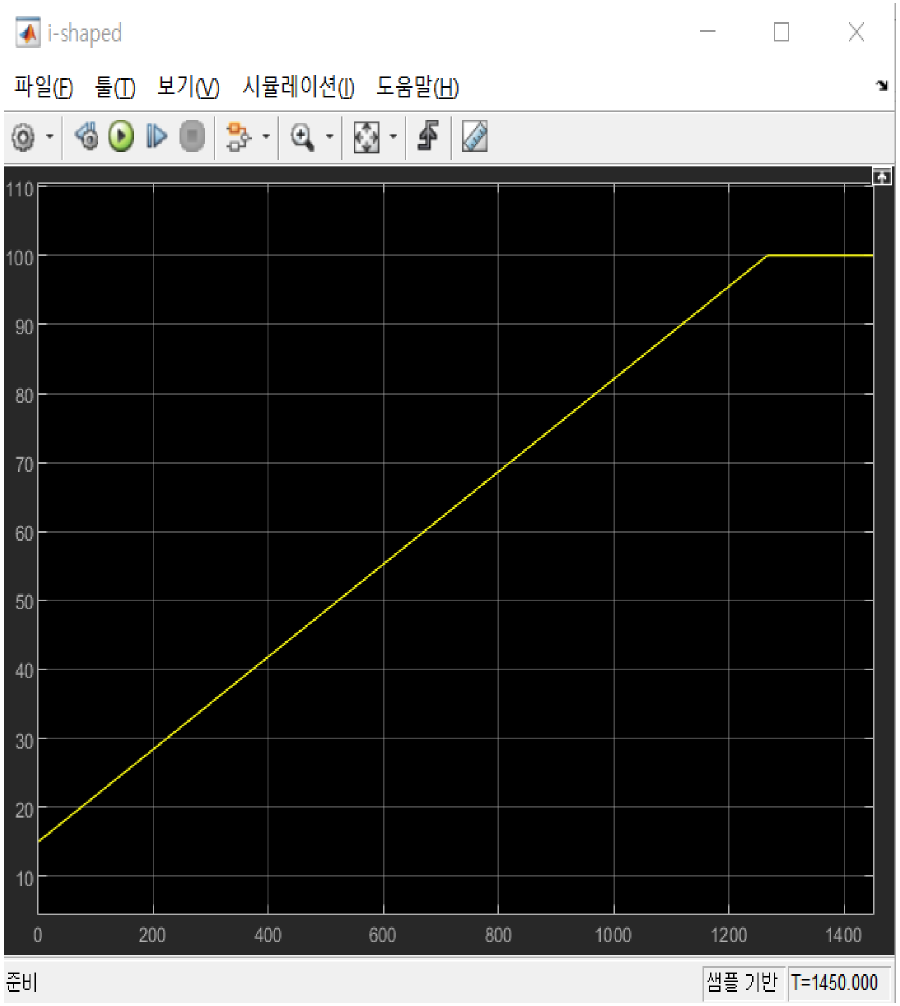

382
380
378
376
374
372
370
368
366
364
4.064
4.065
4.066
4.067
4.068
4.069
4.07
4.071
4.072
준비
샘플 기반
T=10.000


50
40
30
20
10
0
0
1
2
3
4
5
6
7
8
9
10
준비
샘플 기반
T=10.000

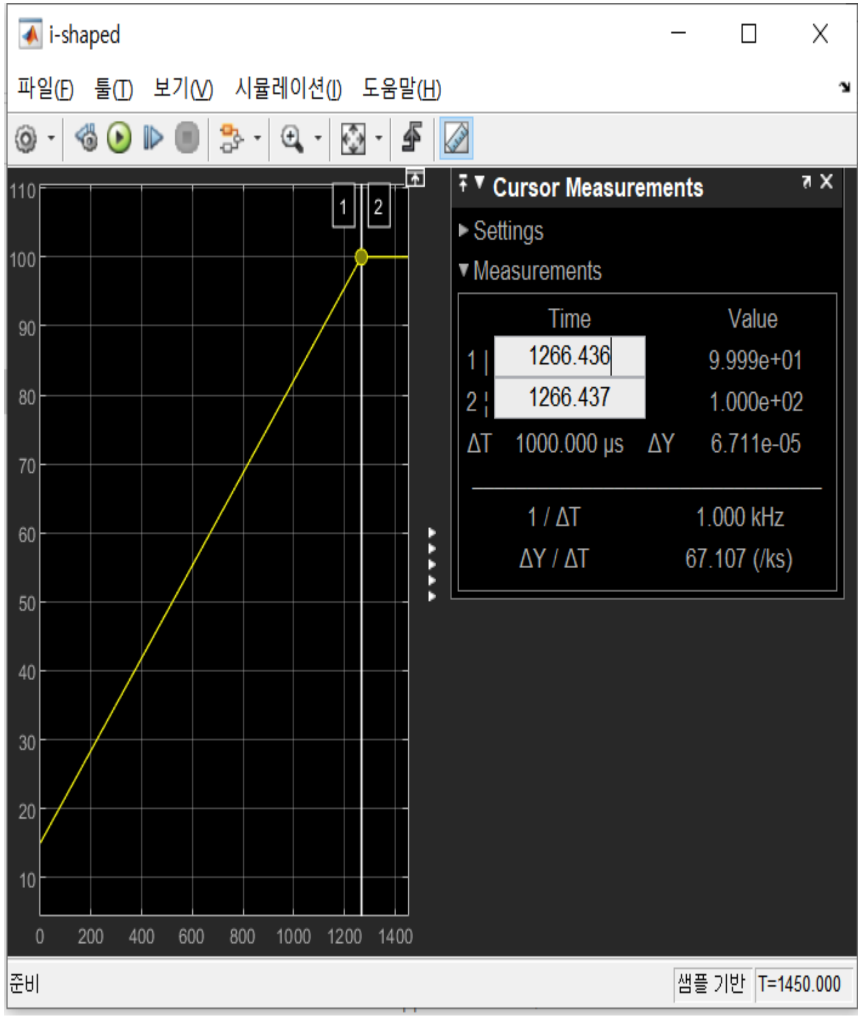
Analysis


1-D T(u)
1
V in
-K-
1/Rbat
Δu/Δt
L
L
R1
R1
-K-
L1
1/s
1
-K-
-K-
1/Rbat1
-K-
-1/Cnom
1/s
15
Scope
1
SOC

Analysis

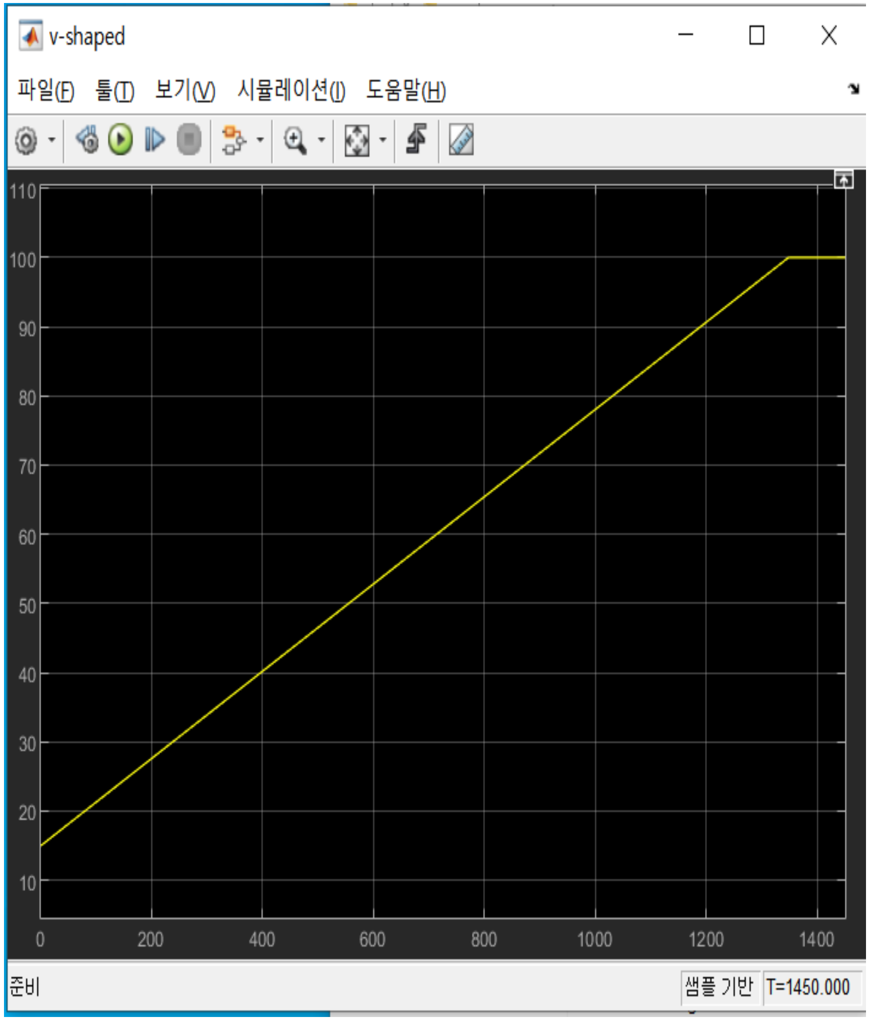

i-shaped
파일(F) 툴(T) 보기(V) 시뮬레이션(I) 도움말(H)
110
100
90
80
70
60
50
40
30
20
10
0
200
400
600
800
1000
1200
1400
준비
샘플 기반
T=1450.000

Analysis

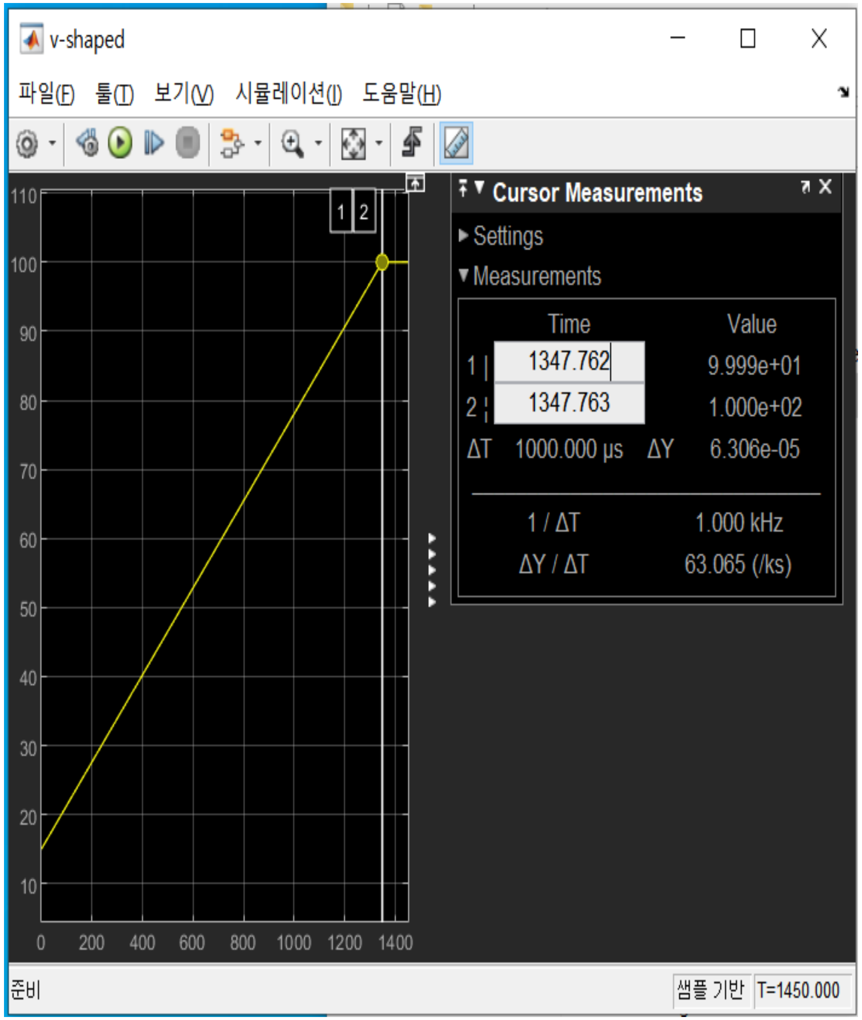


I –shape는
약 1266초
21분 소요!

Analysis


v-shaped
파일(F) 툴(T) 보기(V) 시뮬레이션(I) 도움말(H)
110
100
90
80
70
60
50
40
30
20
10
0
200
400
600
800
1000
1200
1400
준비
샘플 기반
T=1450.000

Analysis



V –shape는
약 1347초
22분 소요!

Conclusion

- V-Shape 센터포스트는 누설 자속을 발생, 기구적인 측면에서는 원심력으로 인한 자석의 비산을 막아 IPMSG가 안정적으로 구동
- 전자기적으로는 I-Shape가 우세하지만 응력 조건에서 V-Shape이 유리
- V-Shape의 립 부분을 더 얇게 할 수 있다. 따라서 더 많은 구조적 이점을 취할 수 있음

• 참고문헌

3-D K-means clustering method considering internal chemical state variation of self-dischareg of Li-ion battery
-Dongho Han* , Sanguk Kwon* , Seungwoo Kim* , Cheolwoo Lim**, Jonghoon Kim* Chungnam National University* , KAIST Satellite Technology Research Center
출처: 전기자동차 주행거리 확장용 매입형 영구자석 발전기 최적 설계 (서울대학교 대학원 전기·컴퓨터 공학부 임 동 국)
도시철도차량 견인용 IPMSM의 구조 특성에 따른 회전자 형상 설계에관한 연구 –정거철,, 박찬배, 오세영
, 이 주

Q & A

Thank you!