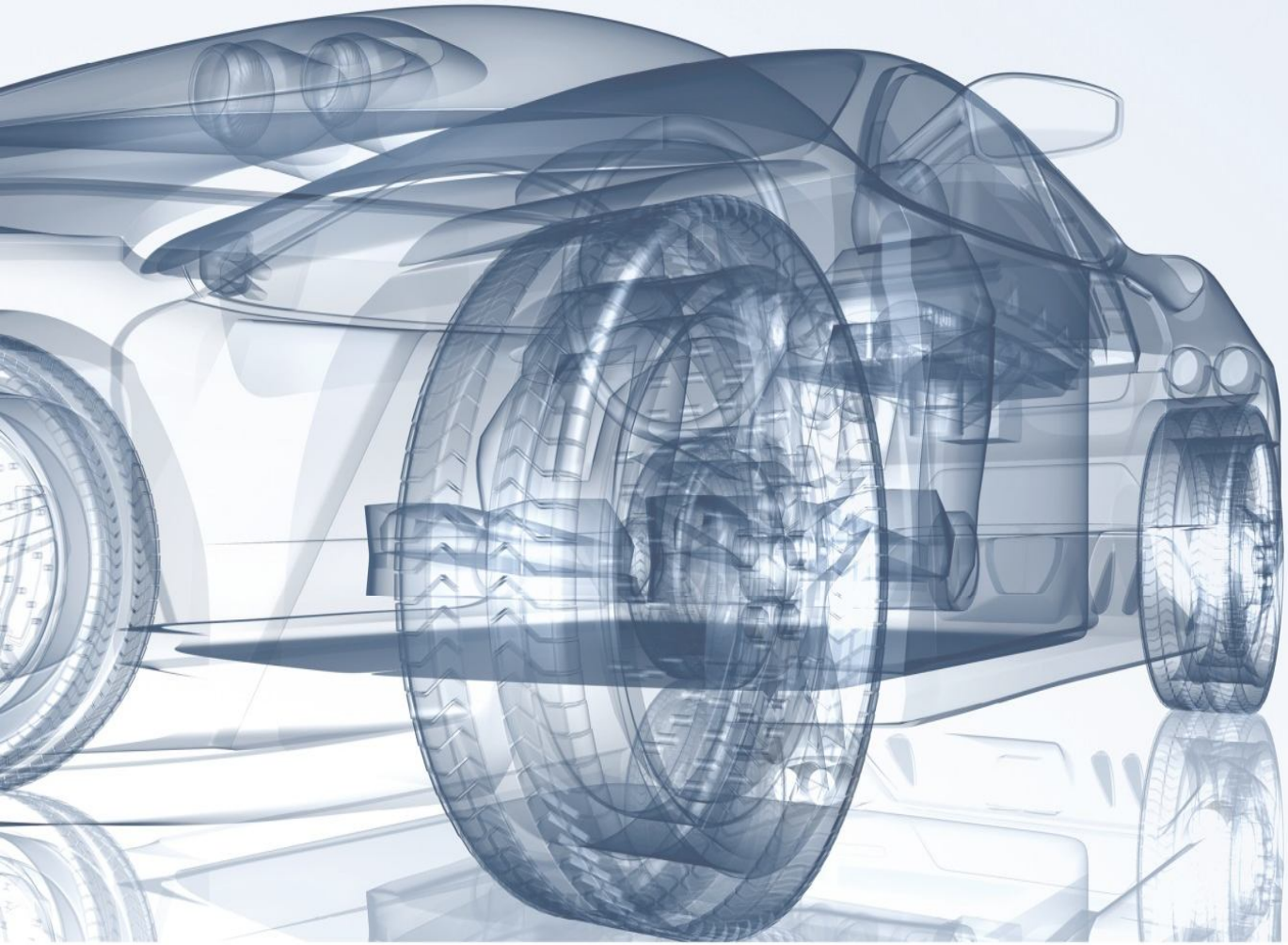
evs30



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A Study of Electric Vehicle Wireless Charging System Integration and Vehicle Alignment Optimization

2017. 10. 10

Hyundai Motor Company
Research & Development Division
Jaeyong Seong, Senior Research Engineer

Agenda

I. Introduction

II. Integration

III. Results

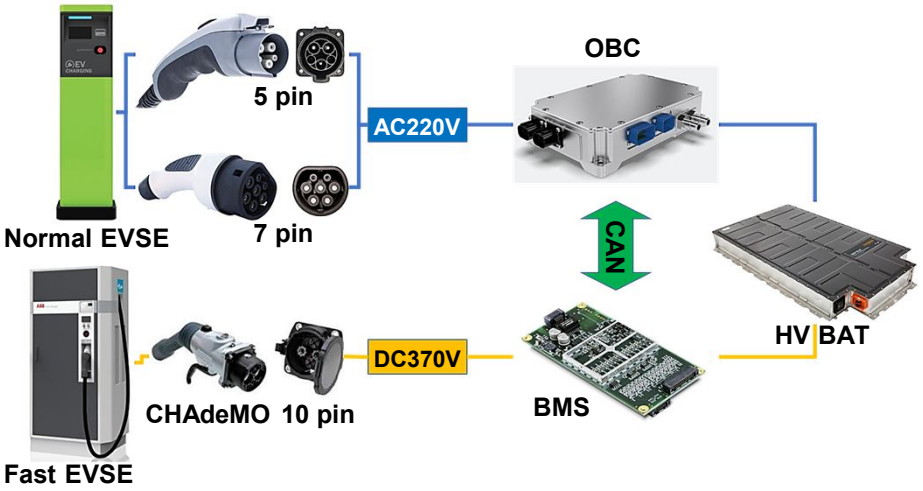
IV. Conclusion

I. Introduction

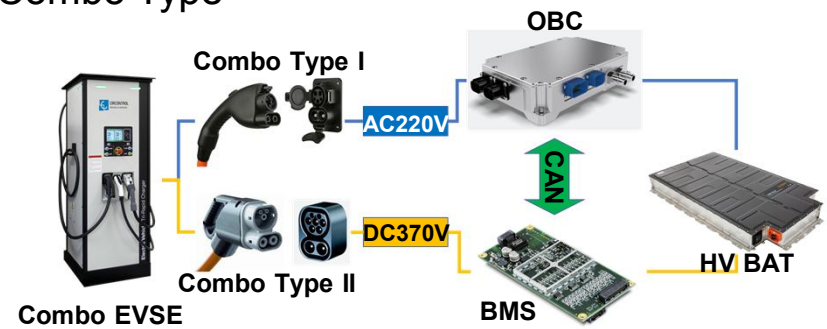
1. Electric Vehicle Charging System

Conductive Charging

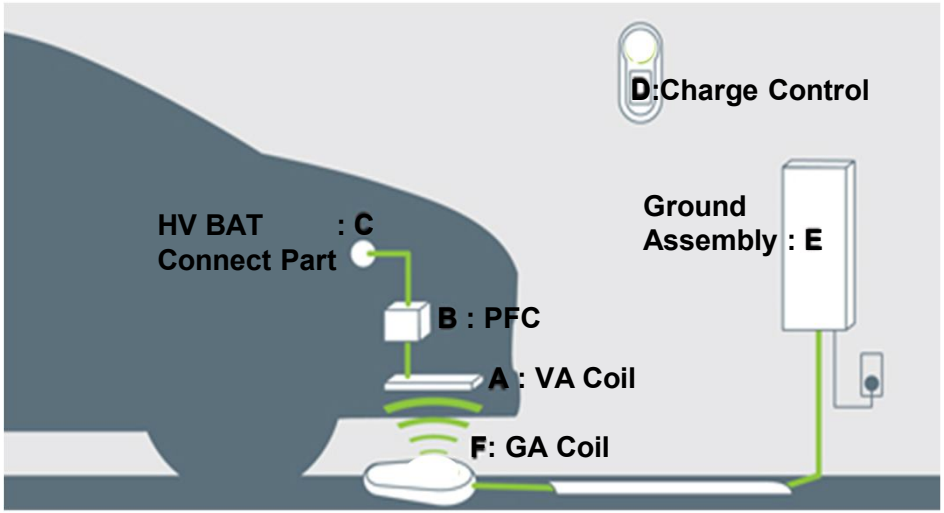
1) Normal / Fast separable Type

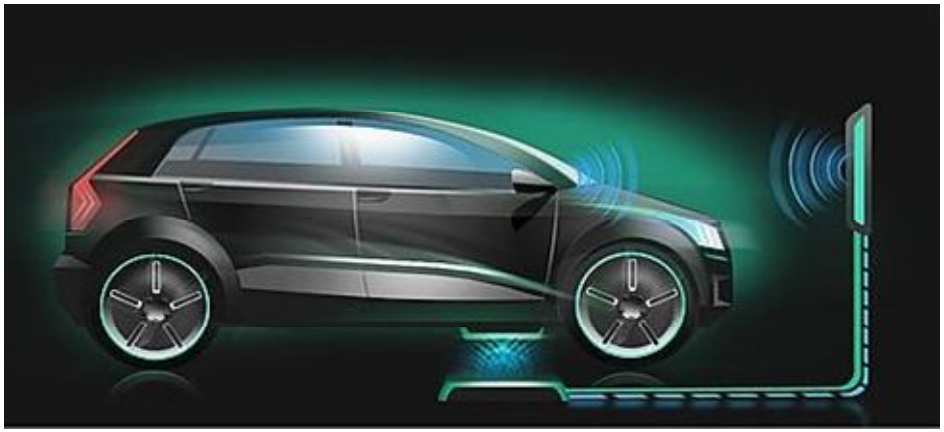


2) Combo Type



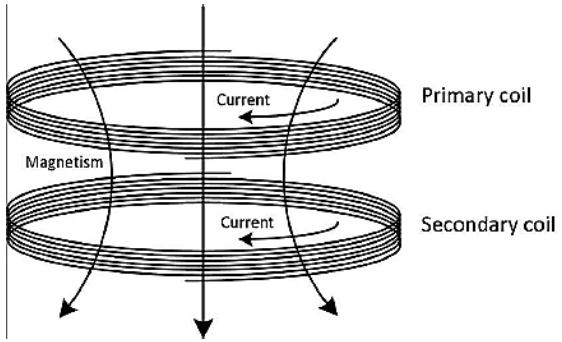
Wireless Charging

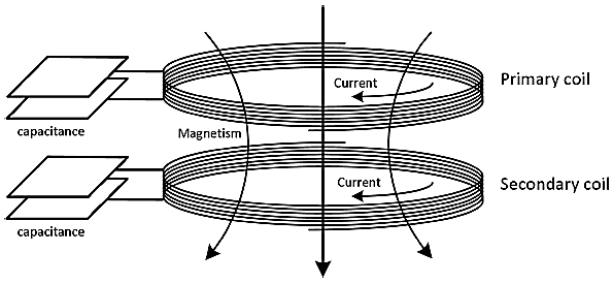


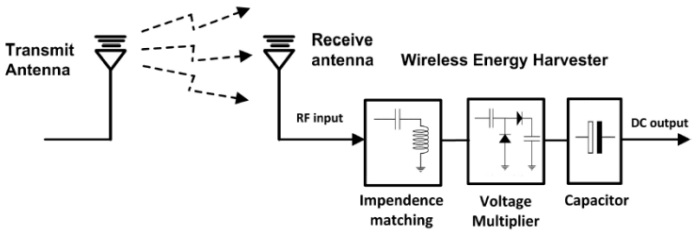


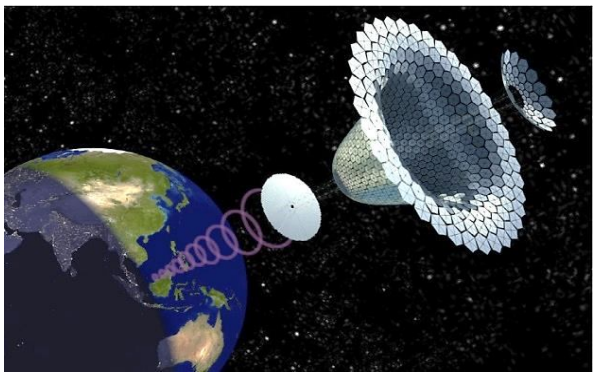
2. Wireless Charging Technologies

Inductive	Magnetic Resonance	Microwave
• Magnetic field induction • Charging distance : mm ~ cm • Ease of implementation • Applicable(ex. mobile devices)	• Two resonant coil oscillating magnetic field • Charging distance : cm ~ m • Loose alignment 1st & 2nd coils • High energy transfer(ex. EV)	• Utilizes diffused microwave as a medium to carry radiant energy • Charging distance : several tens of m • Powercaster or powerharvester • Due to the safety issue





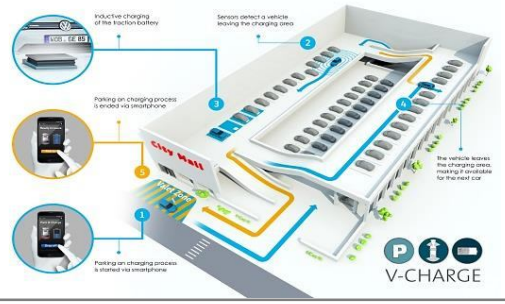




I. Introduction

3. EV WPT Trend

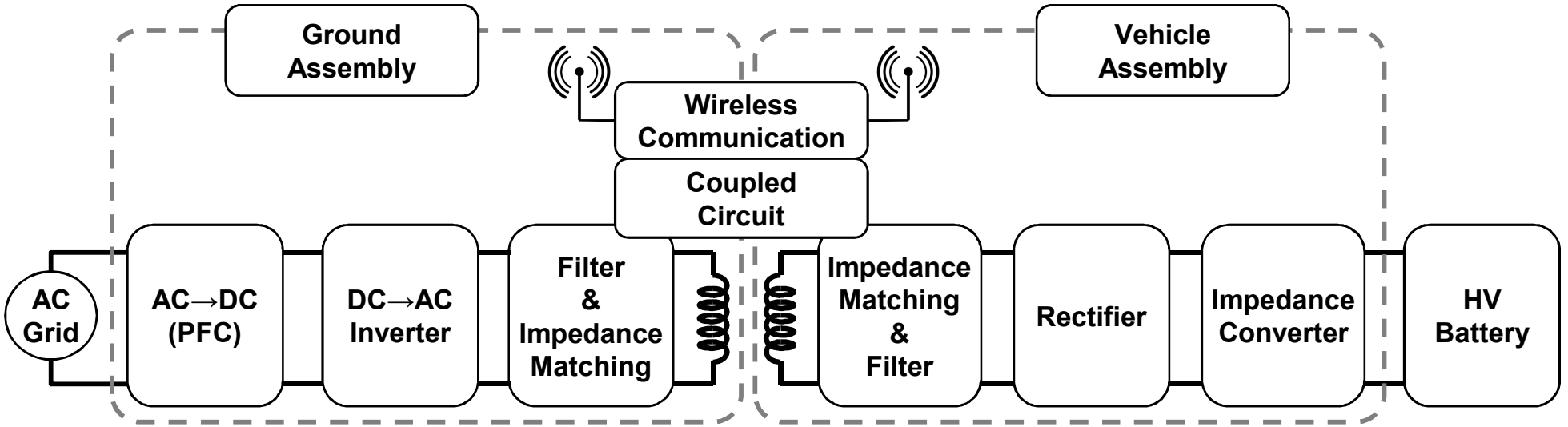
➢ Cooperation development of technology between vehicle OEM and charger supplier

	OEM / Supplier	Supplier	Manufacture
OEM & Supplier	• Demonstrated WPT for EV (’15 CES) • Contributions to ISO/IEC Standards. (ISO 19363 / IEC 61980) 	• Aftermarket products - Nissan Leaf 12MY / 13MY - GM Volt customers (’14.6) 	• Daimler S550 PHEV(’18) • BMW 530e PHEV(’18) • Toyota Prius PHEV (’17) 
Tech-nologies	**GA / VA coils**	**Alignment**	**Smart Charging**
• High Capacity WPT Coil:10kW↑ 	• Low power excitation, etc. 	• Optimal charging using V2G 	

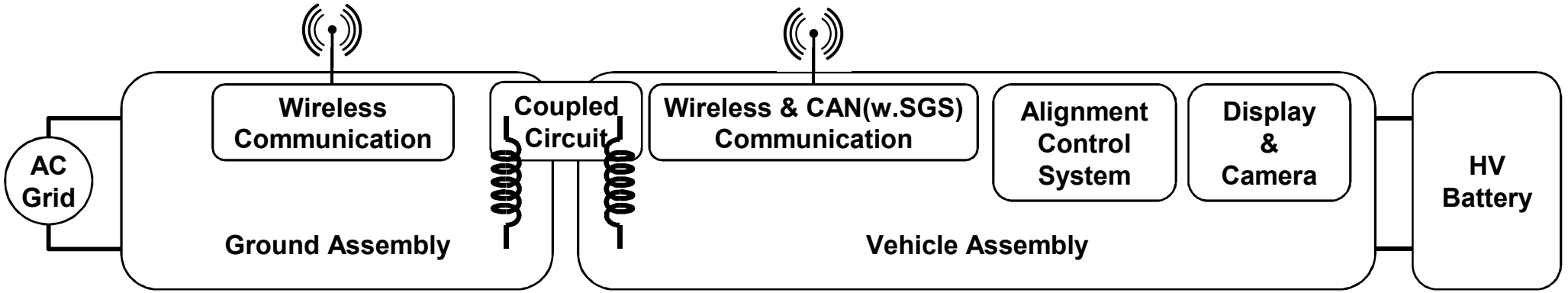
II. Integration

1. Block Diagram of WPT for xEV

- SAE J2954 TIR

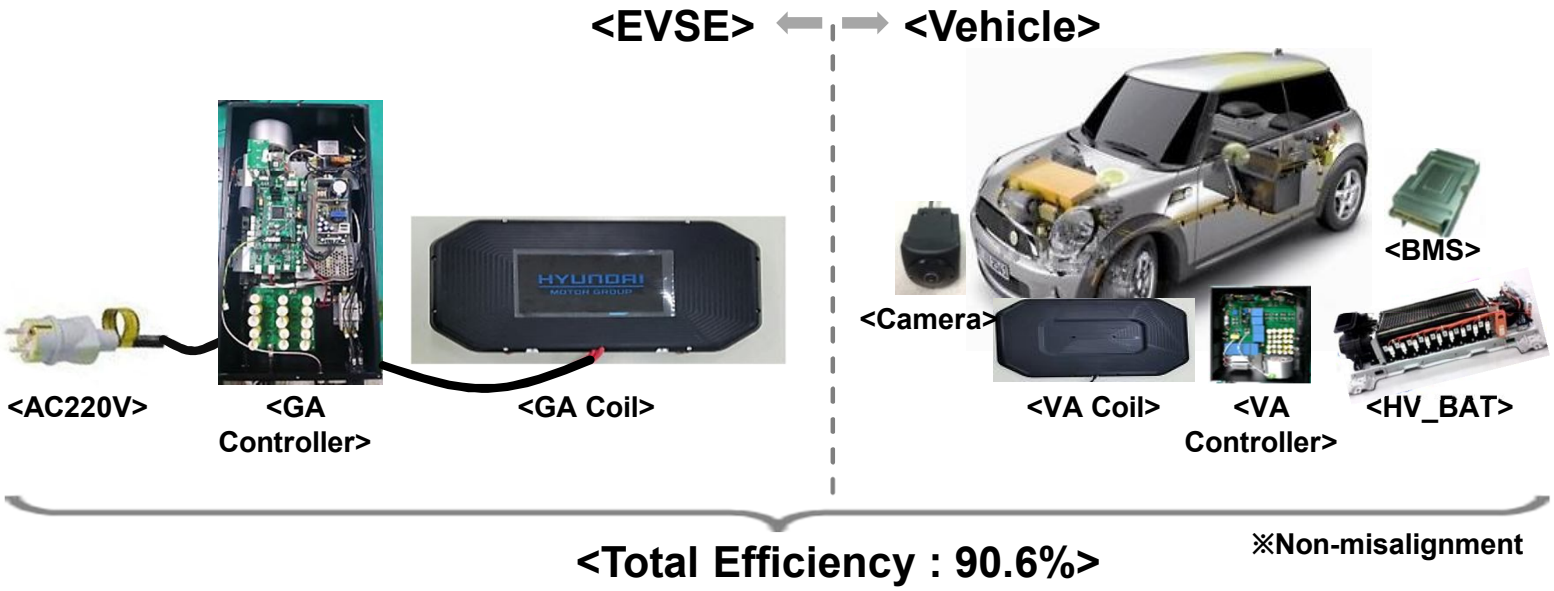


- Based on SOUL EV



II. Integration

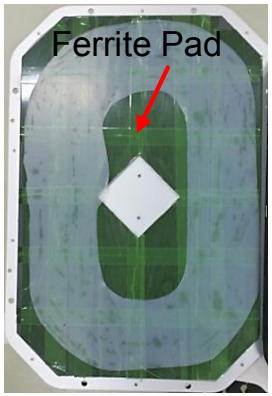
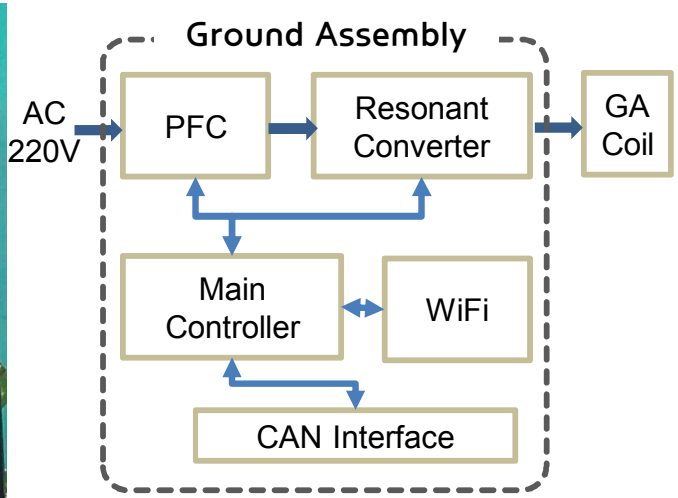
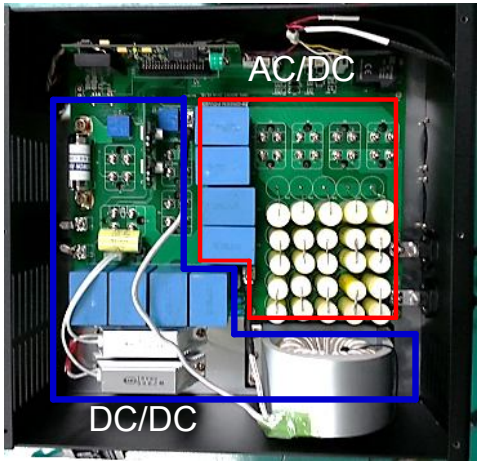
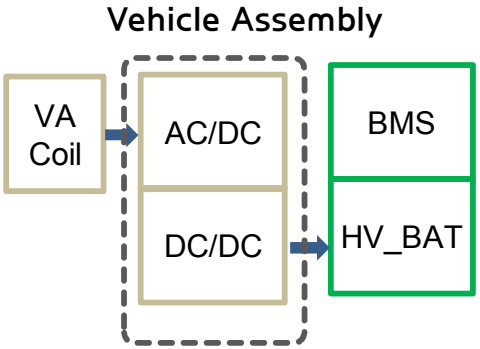
2. Implementation of Proto-type WPT in SOUL EV



	GA Coil size	VA Coil size	Z Height	Topology	Operation Freq.	Max. input Power	Efficiency
Proto-type	650x470x60 mm	250x250x20 mm	165 mm	Circular	85 kHz	3.7 kW	90.6 %
ref.SAE	675x590x60 mm	355x355x20 mm	140~210 mm (Z2 Class)	Circular	81.38 ~ 90kHz	0 ~ 3.7 kW	85 %↑

II. Integration

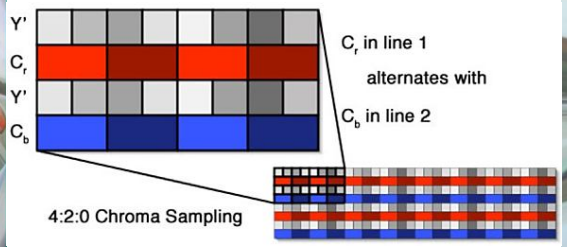
2. Implementation of Proto-type WPT in SOUL EV

	GA Coil	VA Coil
Coil Part	  	  
Power Part	 	 

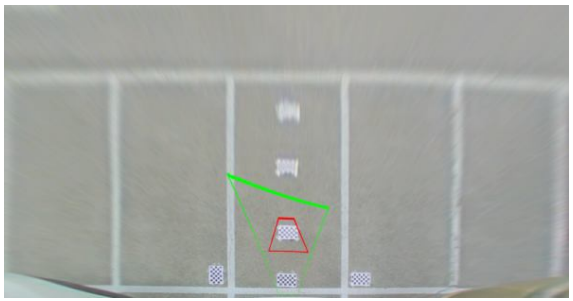
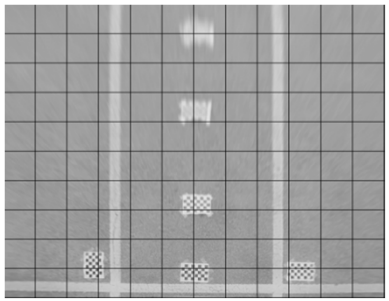
II. Integration

3. GA Coil Recognition & Position Alignment

- Video capture & correction

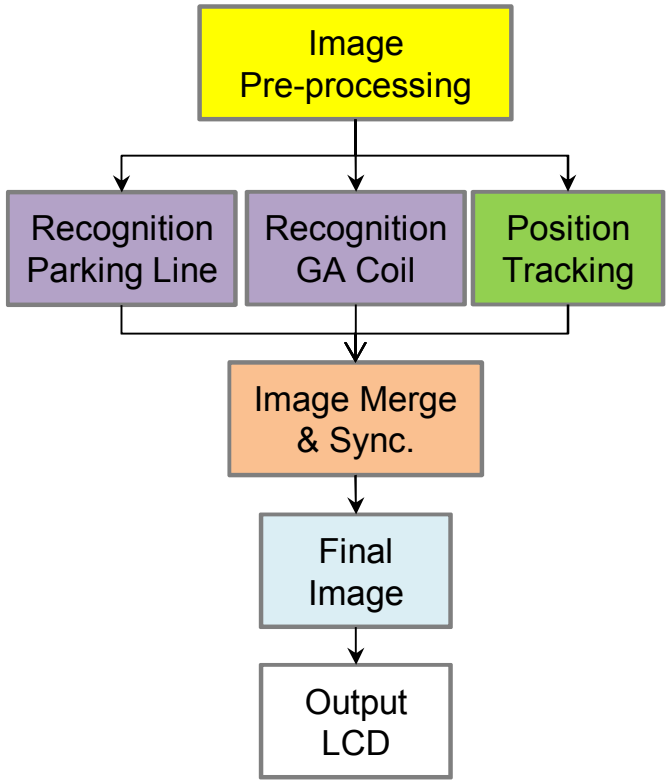
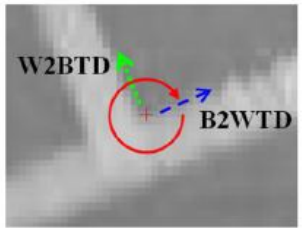
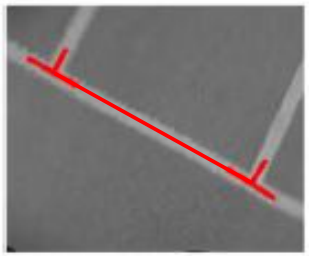
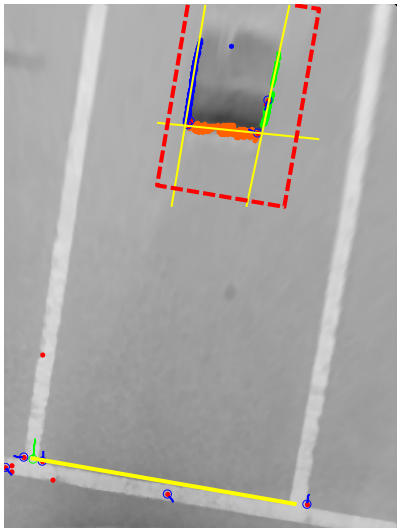
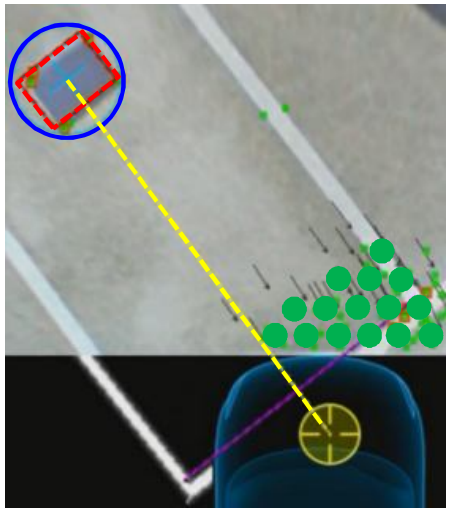
Algorithm	Result
Input Fr. Camera Input CAN Interface Video Capture	 Original image input through wide-angle camera  1280X720 YUV420SP  Distortion correction using lens distortion model

- Top view & recognition region

Algorithm	Result
Top View Transform Image Duplicate & Copy	 Perspective transform & Top view change  Image Duplicate & Copy(560X500 YUV420SP)

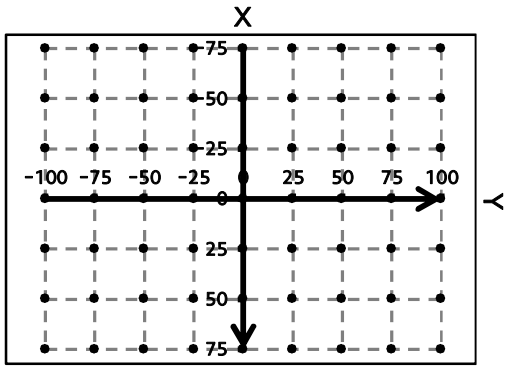
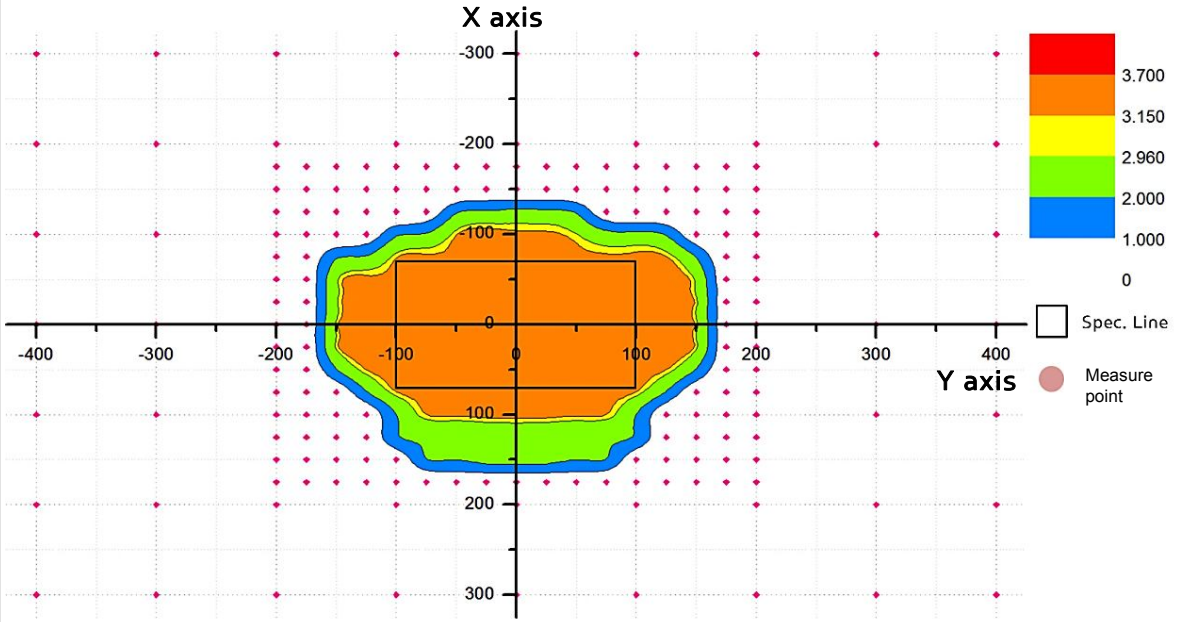
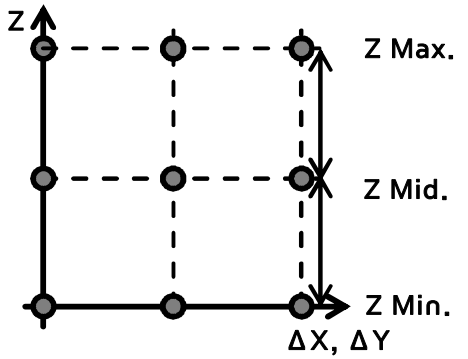
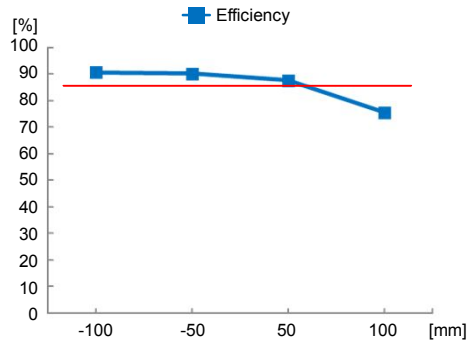
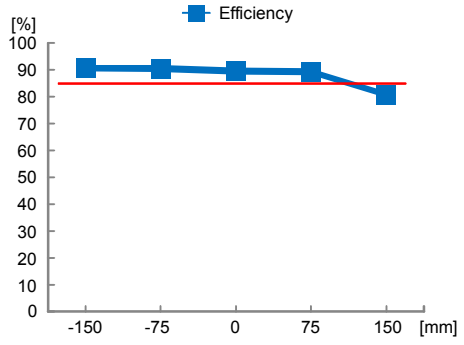
3. GA Coil Recognition & Position Alignment

➢ Detection of parking space & GA coil

Algorithm	Result
	  •Parking space detection •Corner detection •Check the corner type
	 •Setting of GA coil recognition area •Corner detection of GA coil •Check the corner type of GA Coil •Shape detection of GA coil package
	 •Calculation of feature point change between video frames •Calculating the rotation center and rotation angle of a vehicle •Position calculation using rotation center and rotation angle

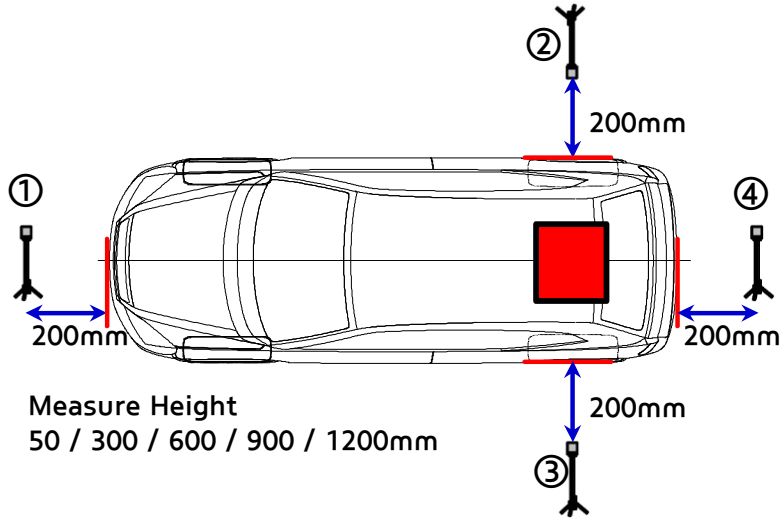
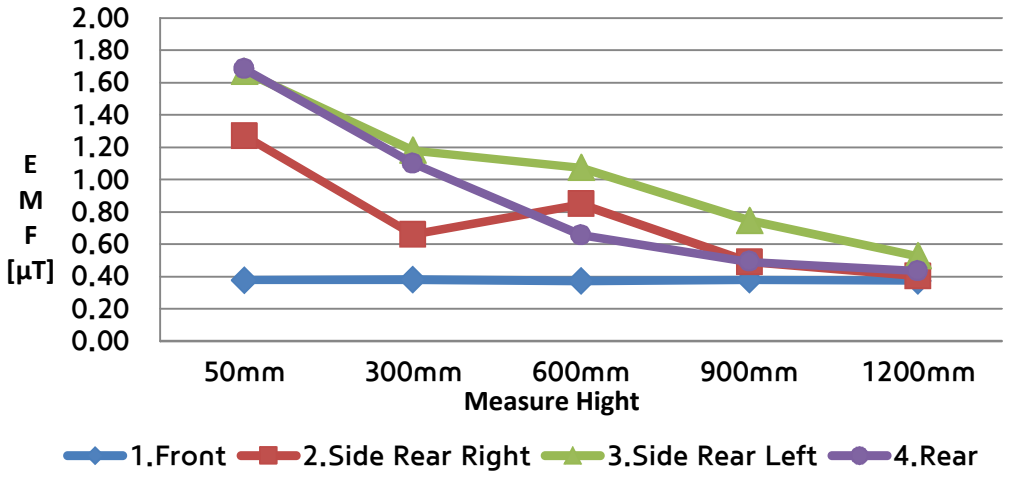
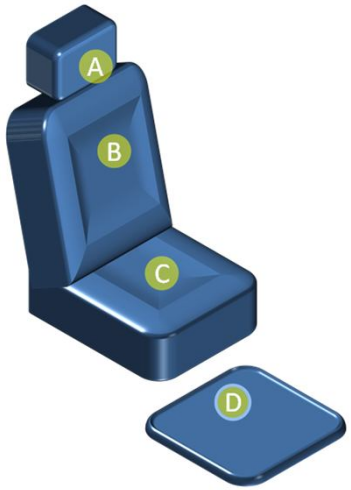
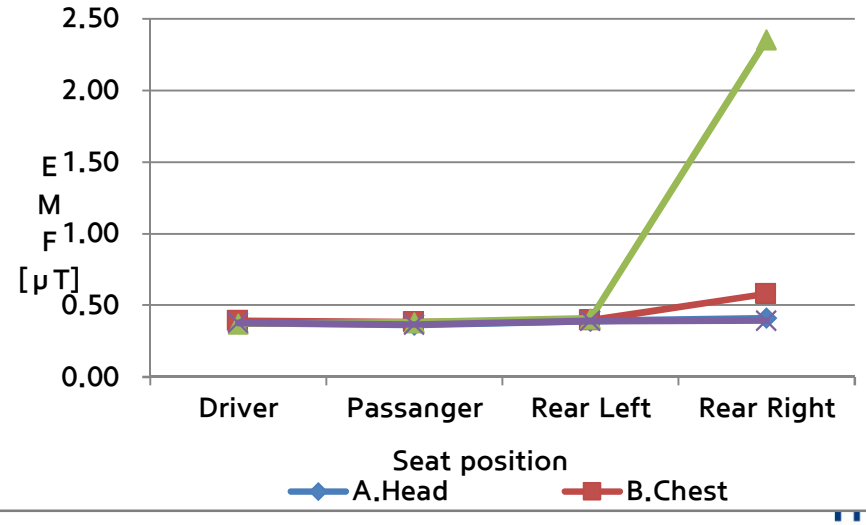
III. Results

1. Test Result of Efficiency and Positioning Tolerance

	Coordinate System	Spec.	Result
X axis Y axis		ΔX : ±75mm ΔY : ±100mm Effi. : 85%↑	
Z axis		Z1 :100~150mm Z2 :140~210mm Z3 :170~250mm Effi. : 85%↑	 Z = 160 / ±X axis  Z = 160 / ±Y axis

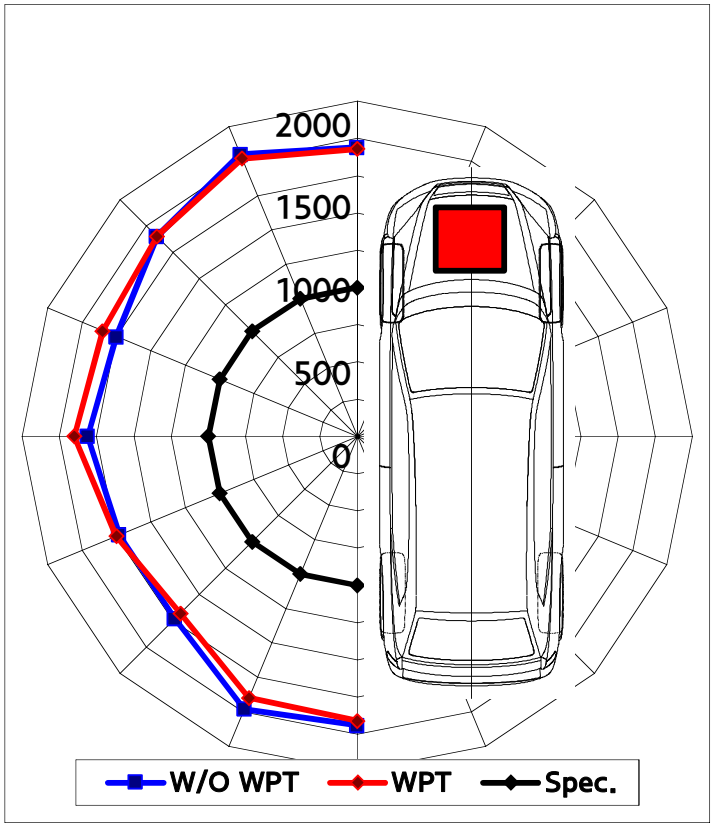
III. Results

2. Test Result of EMF

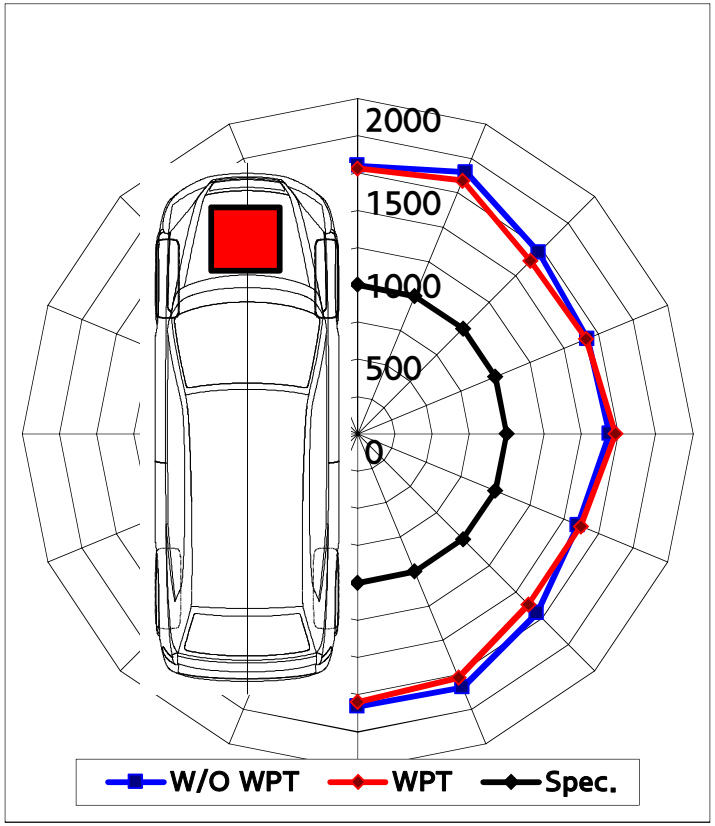
	Measure Point	EMF Result
Vehicle Outside		
Vehicle Inside		

III. Results

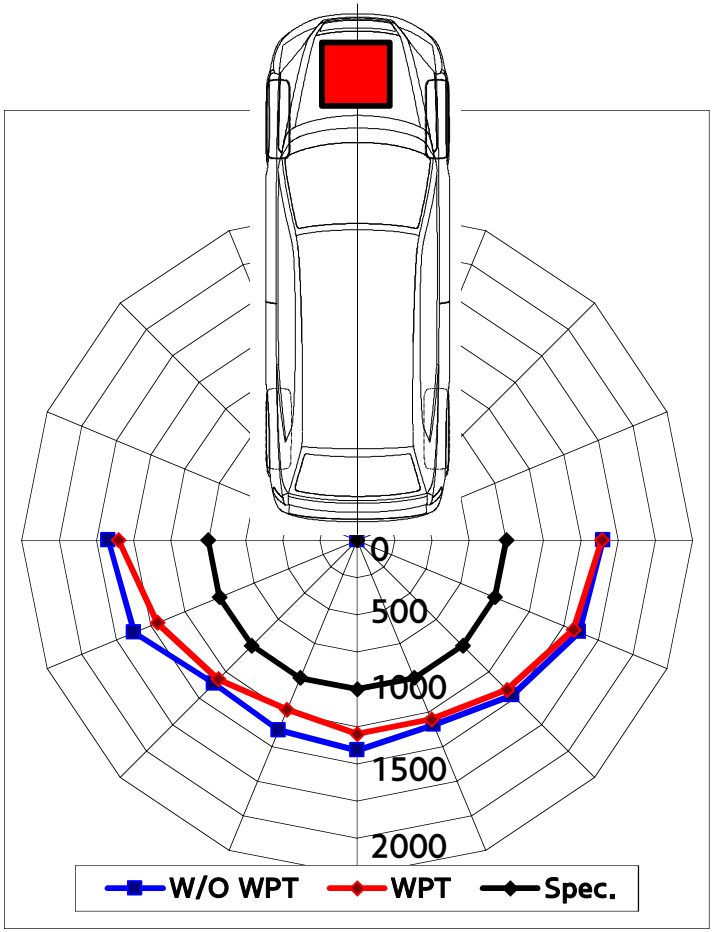
3. Test Result of Interference



<Driver Door>



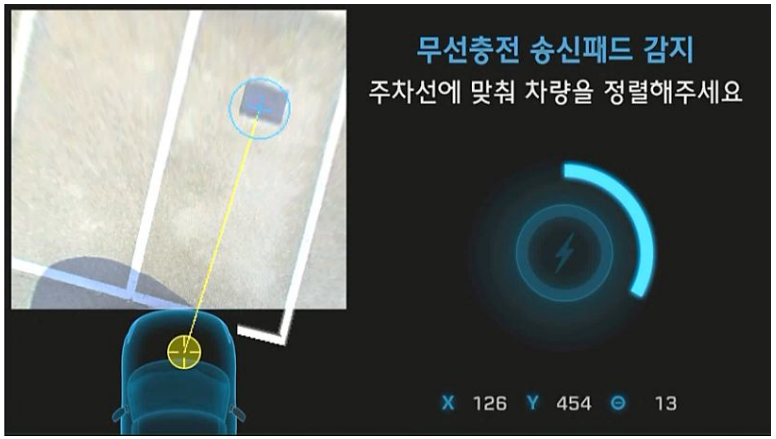
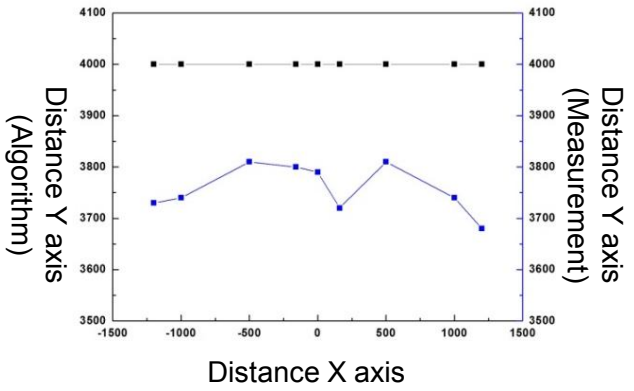
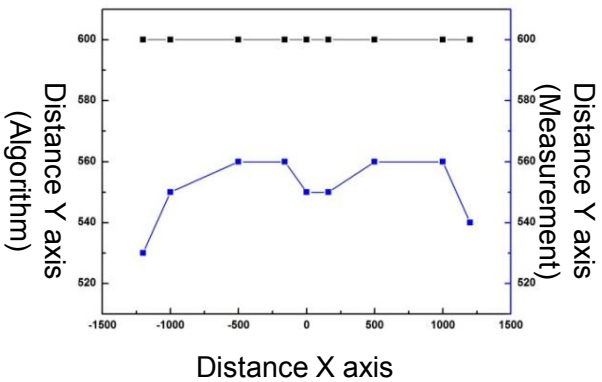
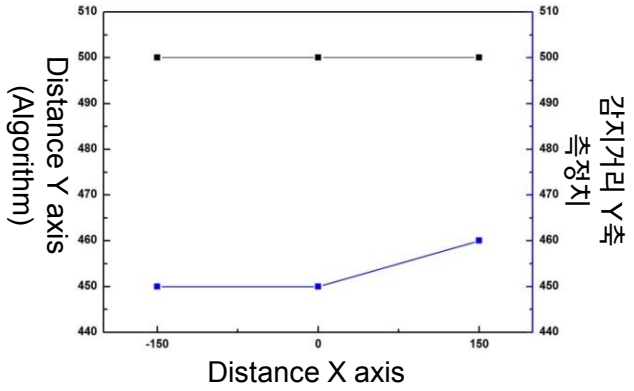
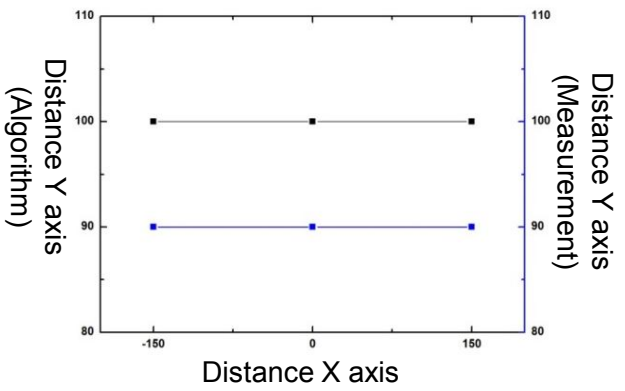
<Passenger Door>



<Tail Gate>

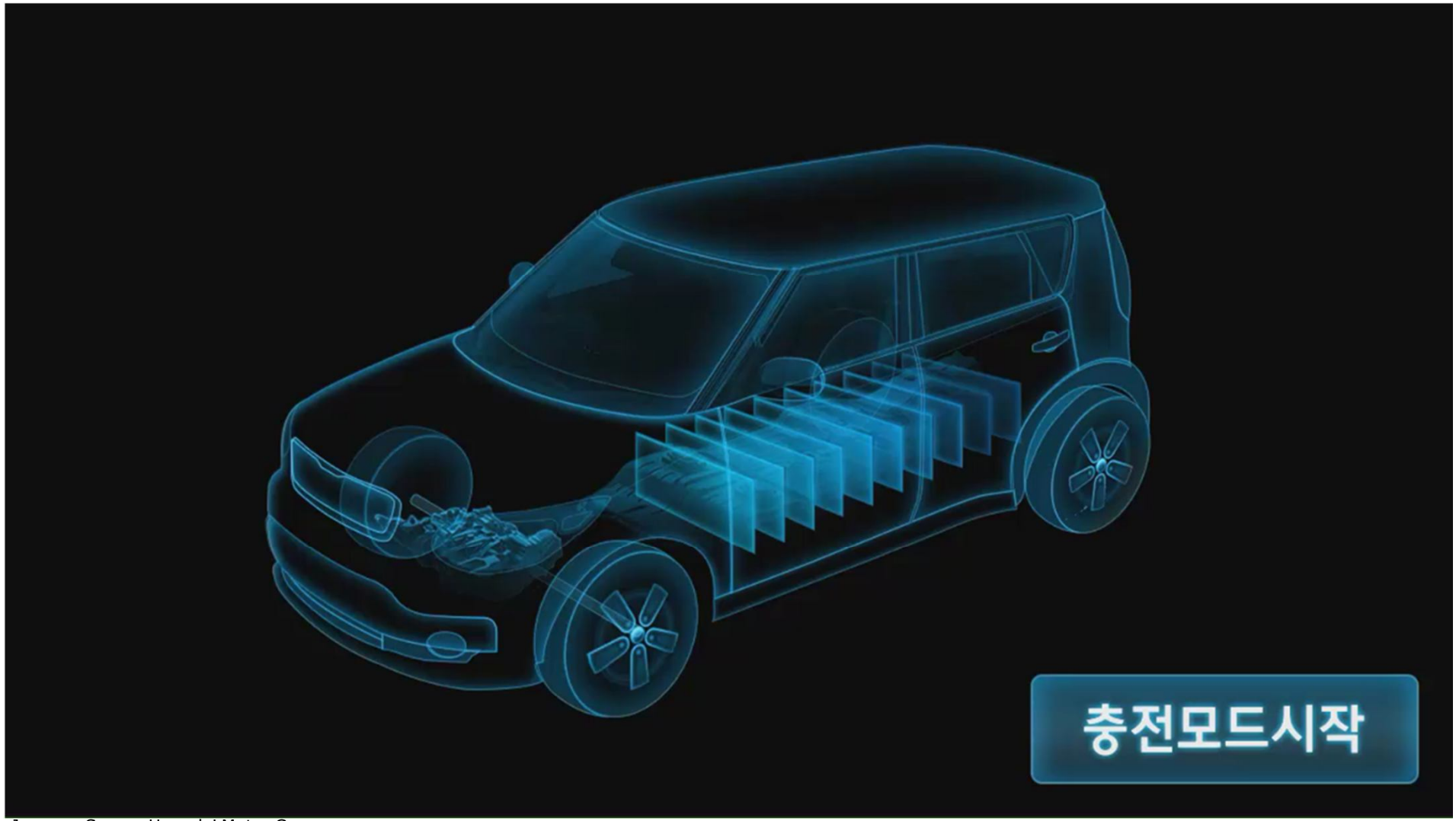
III. Results

3. Test Result of Primary Coil Recognition and Alignment

Experiment	Result
1st stage recognition of GA coil 	Avr. recognition 94%  Avr. recognition 92% 
2nd stage approach of GA coil 	Avr. recognition 91%  Avr. recognition 90% 

III. Results

4. Alignment Video



IV. Conclusion

➢ Integration 3.3kW wireless charging prototype in a Soul EV

: Input Source AC 220V, Charging Capacity 3.3kW, Charging Efficiency 90.6%

➢ Implementation of GA Coil Recognition & Position Alignment System

: Perspective & Top view transformation model

Parking space recognition & position tracking

➢ Ground Assembly Coil Detection

: The recognition rate of the actual vehicle evaluation result is more than 90%.

➢ Future Plan

: Development of wireless charging position alignment method using LF antenna

NEW THINKING.
NEW POSSIBILITIES.

Lifetime partner in automobiles and beyond