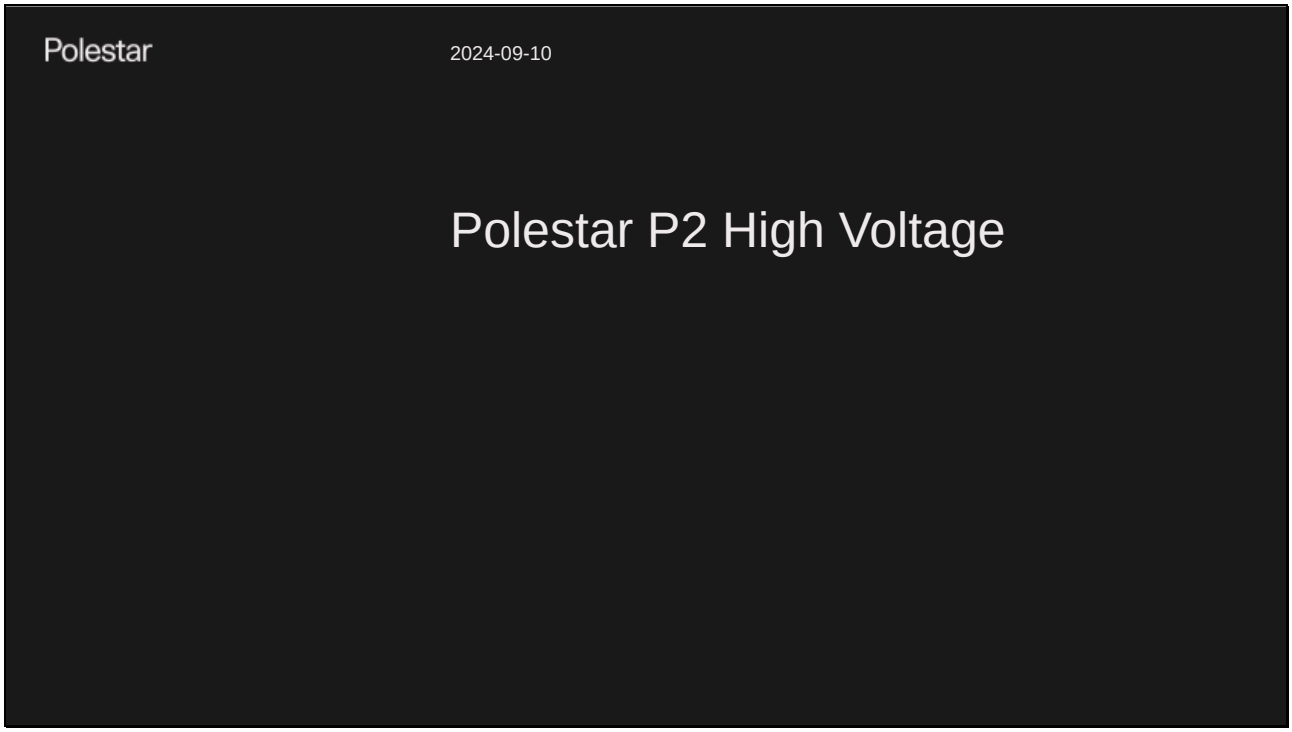
Slide 1



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Slide 11

SC0

High-Voltage System & Components

—

High Voltage Battery

Specifications

Voltage Range - 325V and 460V

Battery Modules - 27 connected in series

Two levels of battery cell modules within the battery.

Battery Temperature – Maintained by cooling plates

Battery Energy Control Module (BECM)

Located inside the HV Battery

Battery Disconnect Unit

Mounted on top of the HV Battery

Instructor Notes:

The voltage can vary between 325V and 460V

There are 27 battery modules connected in series

There are two levels of battery cell modules within the high voltage battery.

There are cooling plates designed to maintain cell module temperatures

The Battery Energy Control Module (BECM) is located inside the HV Battery

The Battery Disconnect Unit is mounted on top of the HV Battery

Slide 14

High-Voltage System & Components

High Voltage Battery

High Voltage Battery Cell Modules

Cell module use a 3p4s configuration
- 4 strings in series
- String includes 3 cells in parallel.

Nominal Cell voltage 3.68 V

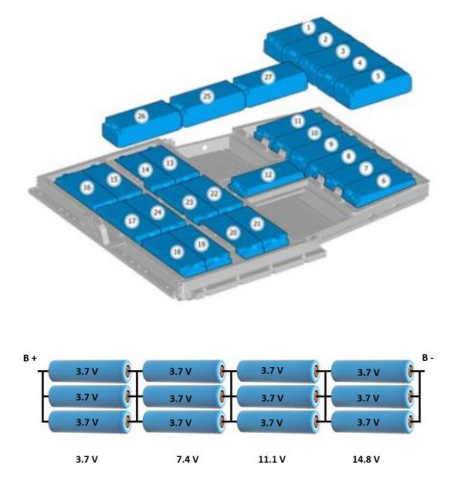
Each Cell Module 2.44 Ah

Total of 66 Ah

Stored 77.98 kWh, Usable 73.30 kWh

Weight: 1102 lbs.

Variant CK07



Instructor Notes:

Cell module use a 3p4s configuration, which means 4 strings connected in series where each string includes 3 cells connected in parallel.
Nominal Cell voltage 3.68 V
Each Cell Module produces approx. 2.44 Ah for total of 66 Ah
Stored Energy 77.98 kWh, Usable Energy 73.30 kWh
1102 lbs.
Variant CK07

Slide 18

SC0

High-Voltage System & Components

Battery Disconnect Unit (BDU)

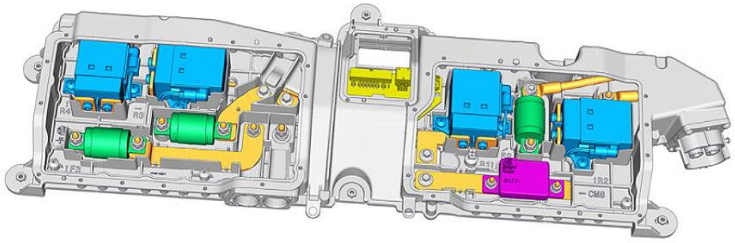
Specifications - Version 1

Connects the HV battery to other HV components:
- Electrical Vehicle Inlet (EVI)
- Inverter High voltage Front Axle (IHFA)
- Inverter ERAD Module (IEM)

Current Measuring Sensor (CMS)

Pre-charge contactor and resistor

HV fuses for the inverters and DC charging



Instructor Notes:

Connects the high voltage battery to other HV Load components:
- Electrical Vehicle Inlet (EVI)
- Inverter High voltage Front Axle (IHFA)
- Inverter ERAD Module (IEM)

Has built in Current Measuring Sensor (CMS) to measure the current of the HV battery

Slide 19

SC0

High-Voltage System & Components

Battery Disconnect Unit (BDU)

Specifications - Version 2

Connects the HV battery to other HV components:
- Electrical Vehicle Inlet (EVI)
- Inverter High voltage Front Axle (IHFA)
- Inverter ERAD Module (IEM)

Current Measuring Sensor (CMS)

Pre-charge contactor and resistor

Fast Breaker Fuse – 2500 Amp

Replaces the 3 HV Fuses

Instructor Notes:

Connects the high voltage battery to other HV Load components:
- Electrical Vehicle Inlet (EVI)
- Inverter High voltage Front Axle (IHFA)
- Inverter ERAD Module (IEM)

Has built in Current Measuring Sensor (CMS) to measure the current of the HV battery

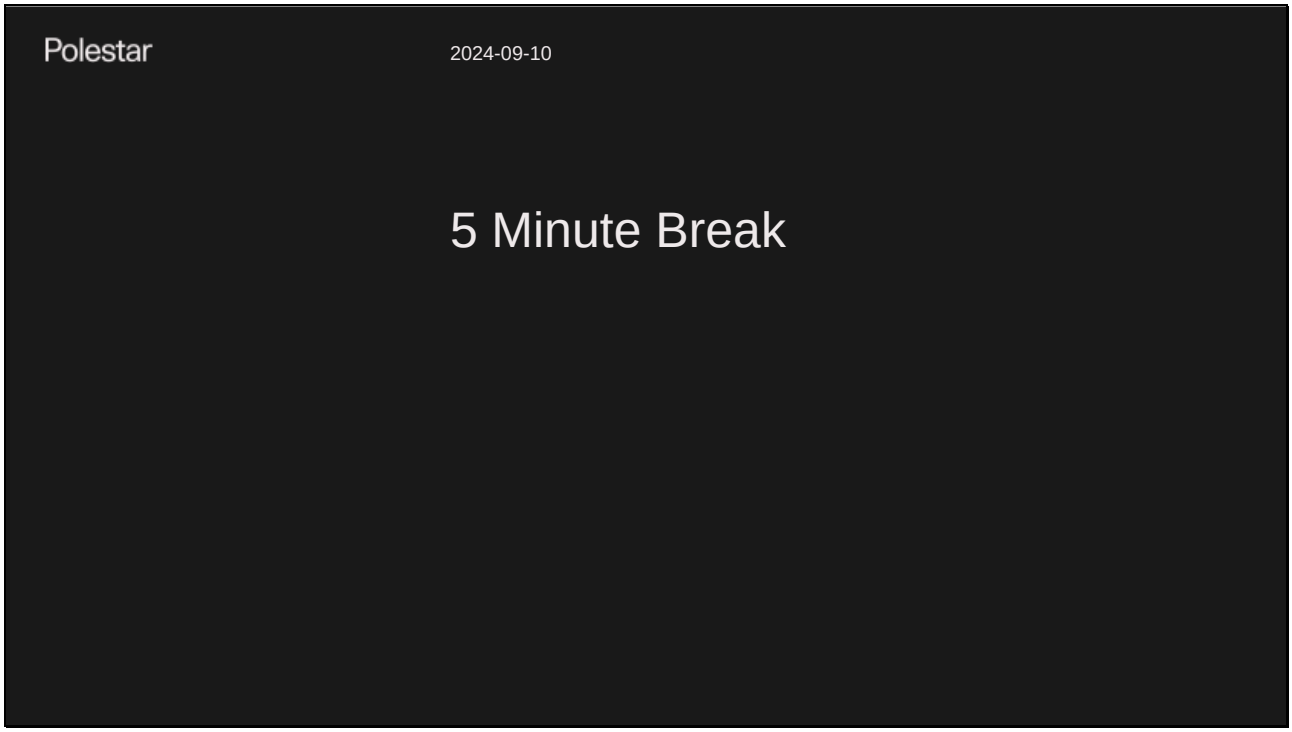
The BDU has a built-in Pre-charge contactor
and resistor

Contains the HV fuses for the inverters and DC charging

Slide 20

Stop Here Add PS3

Slide 21



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Slide 23

SC0

High-Voltage System & Components

—

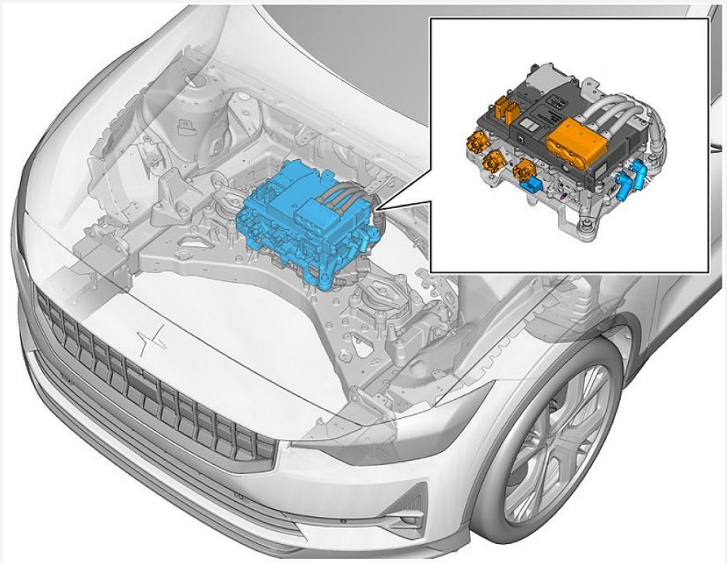
Inverter High Voltage Front Axle (IHFA)

Inverter that controls the EFAD

Converts HV DC to 3 phase AC

Converts HV DC to 12V DC

Provides voltage for the 12V battery



Instructor Notes:

- Inverter that controls the EFAD
- Converts HV DC to 3 phase AC
- Converts HV DC to 12V DC, then provides voltage for the 12V battery

Slide 24

SC0

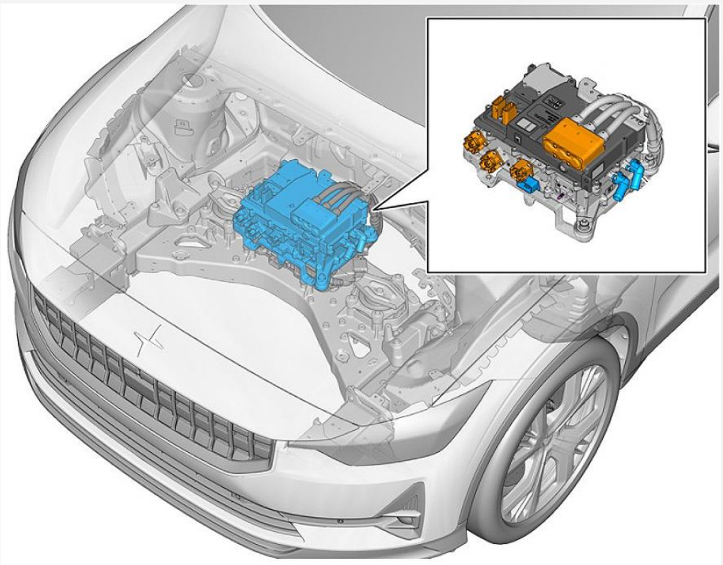
High-Voltage System & Components

—

Inverter High Voltage Front Axle (IHFA)

DC/DC active
- Convenience
- Active
- Driving (Ready)
- During charging of the HV battery

DC/DC also active
- 2-4 minutes after leaving “Convenience” mode
- external charging has been stopped
- acclimatization has been stopped



Instructor Notes:

- The DCDC is active in usage mode Convenience or higher, but also during charging of the HV battery
- The DCDC continues to be active for approximately 2 – 4 minutes after usage mode “Convenience” has been left, or external charging or acclimatization has been stopped

Slide 25

High-Voltage System & Components

—

Inverter High Voltage Front Axle (IHFA)

Connections

1 - 400 VDC connector, high voltage battery

2 - 400 VAC connector, Electric Front Axle Drive (EFAD)

3 - Coolant connection, outlet

4 - Coolant connection, inlet

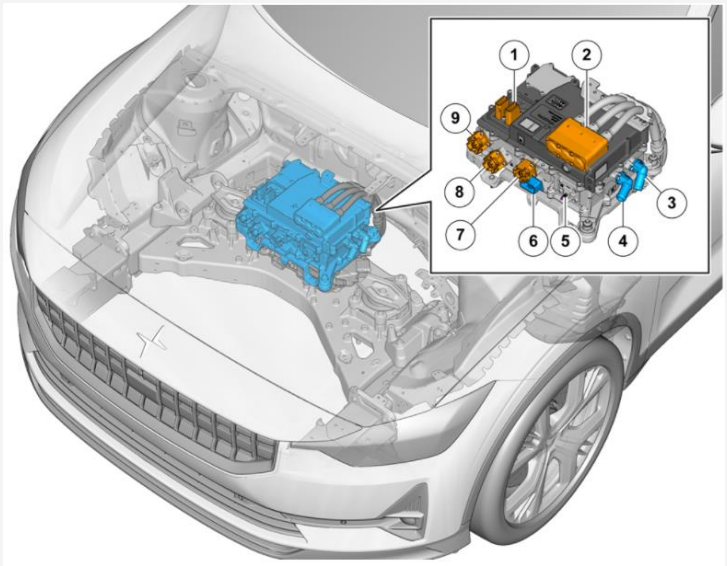
5 - 12 V connector

6 - Communication connector

7 - 400 VDC connector, Electric AC Compressor (ELAC)

8 - 400 VDC connector, ON Board Charger (OBC)

9 - 400 VDC connector, High Voltage coolant Heater A (HVHA)



Instructor Notes:

1 - 400 VDC connector, high voltage battery
2 - 400 VAC connector, Electric Front Axle Drive (EFAD)
3 - Coolant connection, outlet
4 - Coolant connection, inlet
5 - 12 V connector
6 - Communication connector
7 - 400 VDC connector, Electric AC Compressor (ELAC)
8 - 400 VDC connector, ON Board Charger (OBC)
9 - 400 VDC connector, High Voltage coolant Heater A (HVHA)

Internal Information - Polestar

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High-Voltage System & Components

—

Electric Front Axle Drive (EFAD)

Electric Rear Axle Drive (ERAD)

Main propulsion of the vehicle

Drive wheels via a planetary gearbox and drive shafts

No clutch

Permanent Magnetic Synchronous Motor

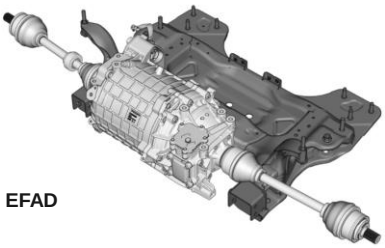
Three phase

Liquid cooled

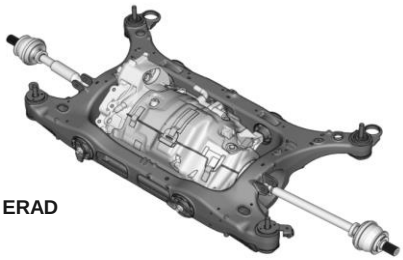
243 lb.-ft. (330 Nm) Torque

150 kW/204 hp (*each motor*)

300 kW/408 hp vehicle total



EFAD



ERAD

Instructor Notes:

EFAD and ERAD are the main propulsion of the vehicle
Each drive their respective wheels via a planetary gearbox and drive shafts (no clutch)
The electric motor is of a Permanent Magnetic Synchronous Motor (PMSM) type, with three phases.
Liquid cooled unit
If the temperature of the coolant exceeds 70°C (158°F), the power of the machine will be reduced in order to protect the stator windings.
243 lb.-ft. (330 Nm) Torque
300 kW/408 hp (150 kW/204 hp each motor)

Slide 29

High-Voltage System & Components

(EFAD)/(ERAD)

Main propulsion of the vehicle

Drive wheels via a planetary gearbox and drive shafts

No clutch

Permanent Magnetic Synchronous Motor

Three phase

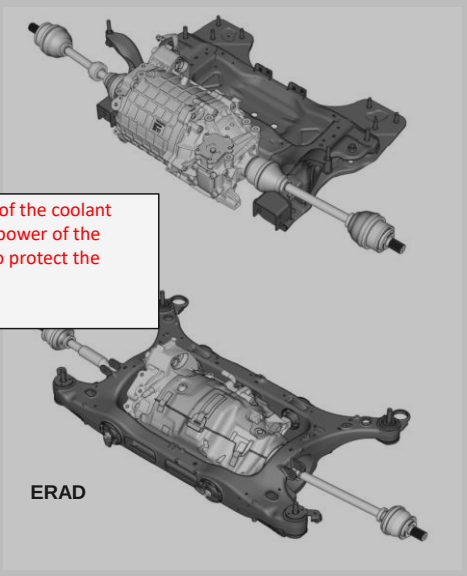
Liquid cooled

243 lb.-ft. (330 Nm) Torque

150 kW/204 hp (*each motor*)

300 kW/408 hp vehicle total

NOTE: If the temperature of the coolant exceeds 70°C (158°F), the power of the machine will be reduced to protect the stator windings.



ERAD

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EFAD and ERAD are the main propulsion of the vehicle
Each drive their respective wheels via a planetary gearbox and drive shafts (no clutch)
The electric motor is of a Permanent Magnetic Synchronous Motor (PMSM) type, with three phases.
Liquid cooled unit
If the temperature of the coolant exceeds 70°C (158°F), the power of the machine will be reduced in order to protect the stator windings.
243 lb.-ft. (330 Nm) Torque
300 kW/408 hp (150 kW/204 hp each motor)

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High-Voltage System & Components

—

Electric Vehicle Inlet (EVI)

EVI LED Colors

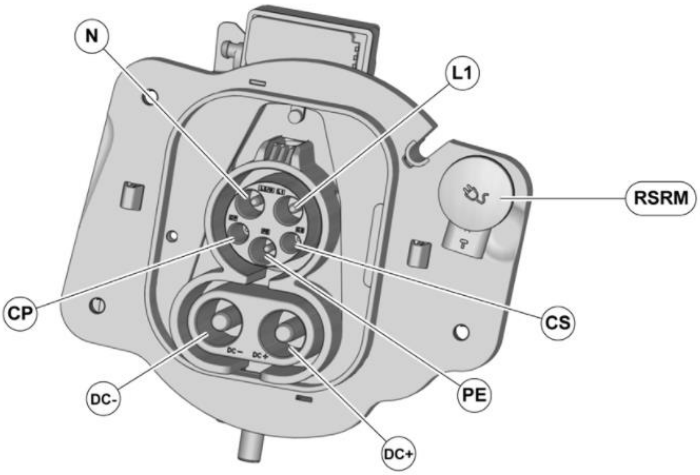
White constant - Guiding light

Yellow constant - Stand by

Yellow flashing - RSRM button pressed, authorizing

Green flashing - Charging ongoing
Slow flashing - close to fully charged
Green constant - Charging is completed
The green light goes off after a while
Red constant - OBC has detected a fault in the charging
No charging permitted
Red flashing - Authorization check failure.

Blue constant - A timer-based charging is activated
Polestar application.



Instructor Notes:

White constant - Guiding light
Yellow constant - Stand by. The charging cable is fitted into the EVI but charging has not started yet. The yellow light is shown for instance if the charging cable has been unlocked from the EVI.
Yellow flashing - The RSRM button is pressed and the authorisation check is ongoing.
Green flashing - Charging ongoing. Slow flashing indicates that battery is close to get fully charged.
Green constant - Charging is completed. The green light gets off after a while.
Red constant - OBC has detected a fault in the charging system and no charging is permitted.
Red flashing - Authorisation check failure.
Blue constant - A timer-based charging is activated in Polestar application.

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High-Voltage System & Components

—

One Pedal Drive (OPD)

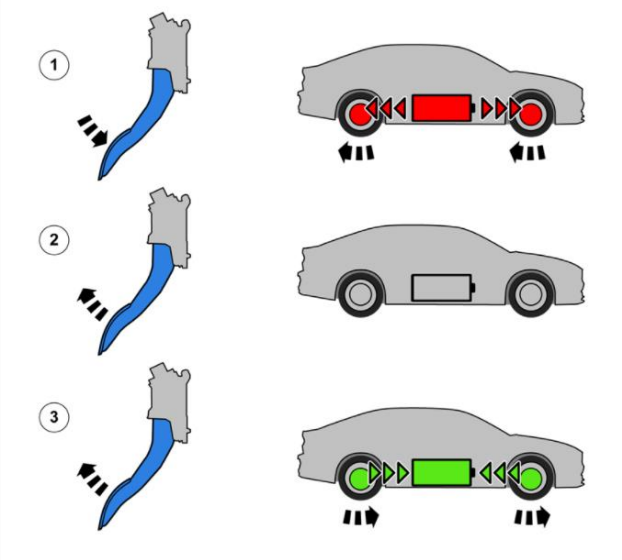
Simulates engine brake as with a conventional ICE

Enhances regenerative braking

3 modes:
- Off
- Low
- Standard

Creep function – can be turned off in the CCD

Brake light



Instructor Notes:

Simulates engine brake as with a conventional ICE
Enhances regenerative braking
There are 3 modes:
- Off
- Low
- Standard

OPD and braking – brakes used less. Clearing function to clean brake discs
OPD and regen braking – EFAD and ERAD used to slow vehicle. Brake blending (motors and brakes)
Creep function – can be turned off in the CCD
Brake light

High-Voltage System & Components

—

High Voltage Wiring

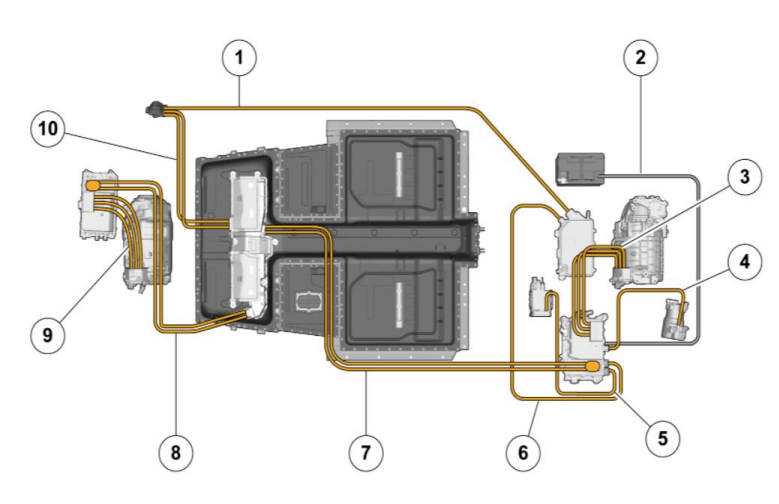
6.
OBC to Inverter IHFA, 400 V DC

7.
High voltage battery to IHFA, 400 V DC

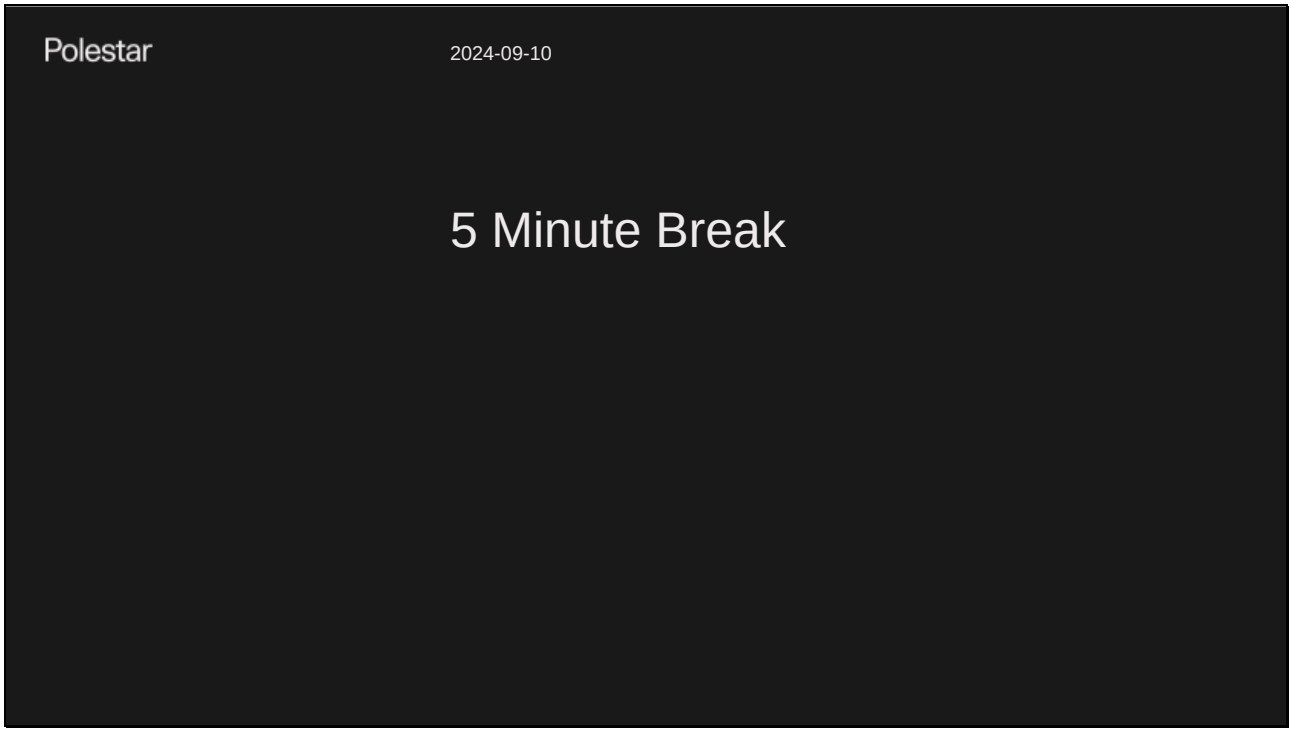
8.
High voltage battery to Inverter ERAD Module (IEM), 400 V DC

9.
IEM to Electric Rear Axle Drive (ERAD), 400 V AC

10.
Electrical Vehicle Inlet (EVI) to high voltage battery, 400 V DC



Slide 40



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Slide 41

Stop Here Add PS3

Slide 44

High-Voltage Cooling System

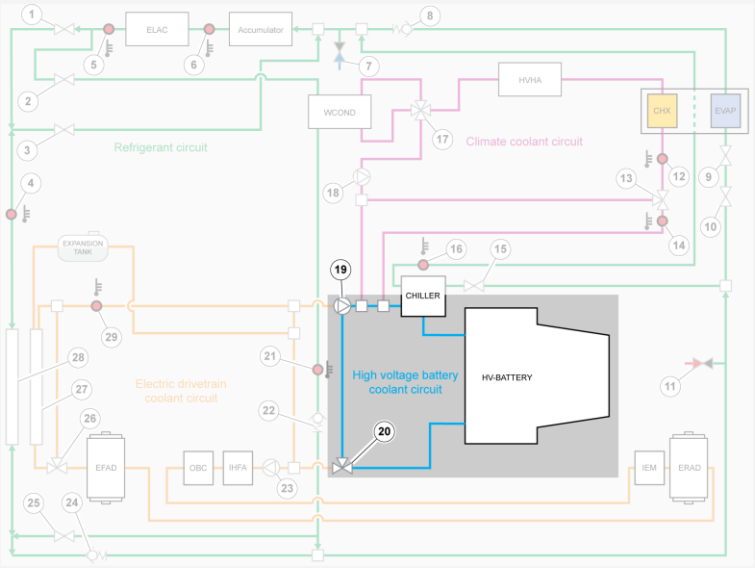
—

High-Voltage Battery Coolant Circuit

High-Voltage (HV) battery coolant circuit
Regulates the temperature of the battery modules.

(19) - 4/473 - Battery Coolant Pump Module, P1

(20) - 8/178 - High voltage battery cooling valve (V2)



Instructor Notes:

The high voltage battery coolant circuit regulates the temperature of the vehicle's high voltage battery, either by cooling or by heating.
When the battery operates with an even temperature, the lifetime increases.
If the temperature is such that there is no need of battery cooling or heating, the three circuits (High Voltage (HV) coolant circuit, Electric Drivetrain (ED) coolant circuit and the climate coolant circuit) are separated (no connection between the circuits).
If the temperature between the battery cells is uneven, the P2 will circulate coolant to even out the differences.

Internal Information - Polestar

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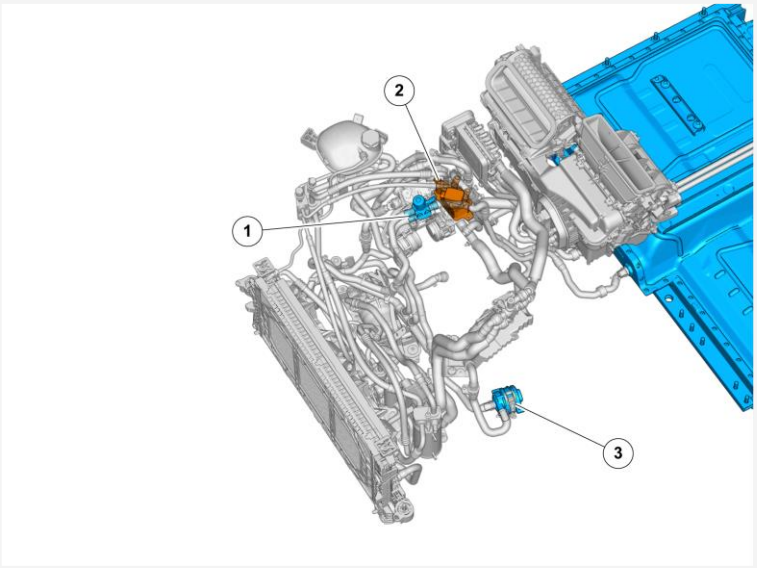
High-Voltage Cooling System
—
High-Voltage Battery Coolant Circuit

Components

(1) - 8/178 - High voltage battery cooling valve (V2)

(2) - Chiller

(3) - 4/473 - Battery Coolant Pump Module, P1



Instructor Notes:

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If the temperature between the battery cells is uneven, the P2 will circulate coolant to even out the differences.

Internal Information - Polestar

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High-Voltage Cooling System

Electric Drivetrain Coolant Circuit

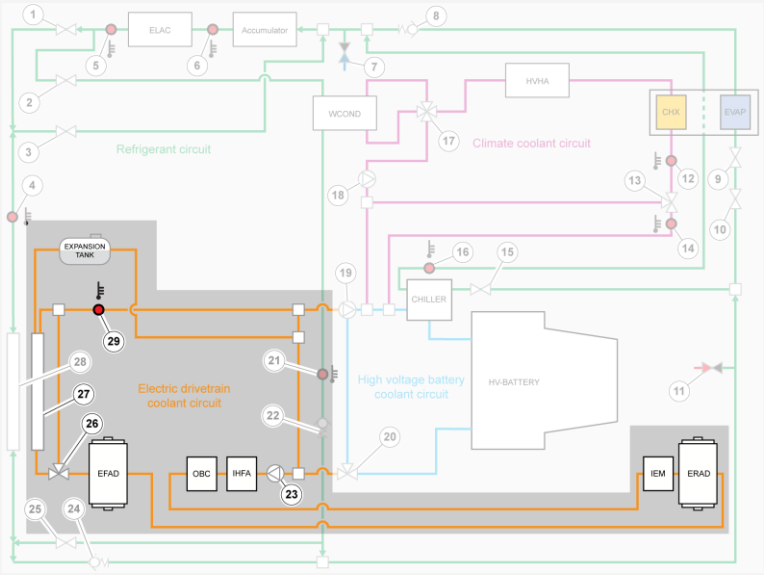
Electric drivetrain coolant circuit
Cools the high voltage components.

(23) - 4/475 - Coolant Pump for Electric Drivetrain (CPED), P2

(26) - 8/261 - Electric drivetrain coolant shut off valve (V1)

(27) - Radiator, electric drivetrain

(29) - 7/409 - Coolant temperature sensor (T1)



Instructor Notes:

The main function of the electric drivetrain coolant circuit is to regulate the temperature of the following components:

Electric Rear Axle Drive (ERAD)
Electric Front Axle Drive (EFAD)
Inverter Electrical rear axle drive Module (IEM)
Inverter High Voltage Front Axel (IHFA)
On Board Charger (OBC)

In order to avoid damage on these electrical components they need a controlled operating temperature.

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High-Voltage Cooling System

Electric Drivetrain Coolant Circuit

Components

1) - Radiator, electric drivetrain

(2) - 7/409 - Coolant temperature sensor (T1)

(3) - Expansion tank

(4) - 8/261 - Electric drivetrain coolant shut off valve (V1)

(5) - Inverter High voltage Front Axle (IHFA)

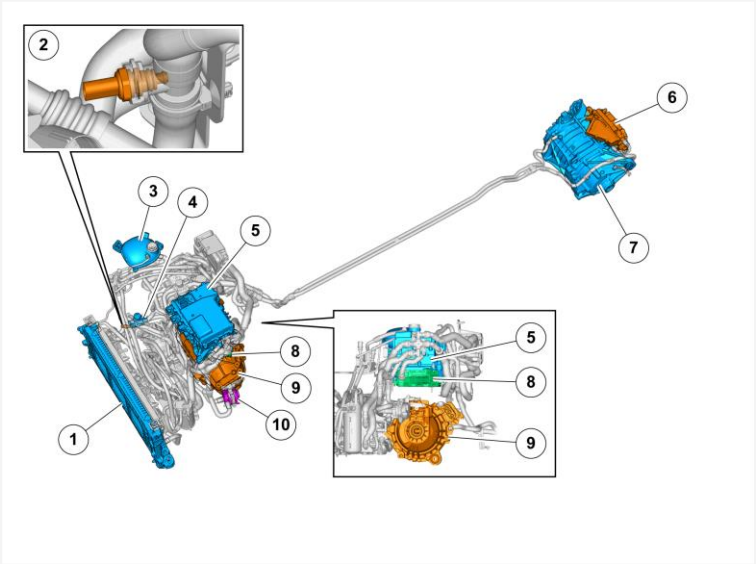
(6) - Inverter ERAD Module (IEM)

(7) - Electric Rear Axle Drive (ERAD)

(8) - On Board Charger (OBC)

(9) - Electric Front Axle Drive (EFAD)

(10) - 4/475 - Coolant Pump for Electric Drivetrain (CPED), P2



Instructor Notes:

The main function of the electric drivetrain coolant circuit is to regulate the temperature of the following components:

Electric Rear Axle Drive (ERAD)
Electric Front Axle Drive (EFAD)
Inverter Electrical rear axle drive Module (IEM)
Inverter High Voltage Front Axel (IHFA)
On Board Charger (OBC)

In order to avoid damage on these electrical components they need a controlled operating temperature.

Internal Information - Polestar

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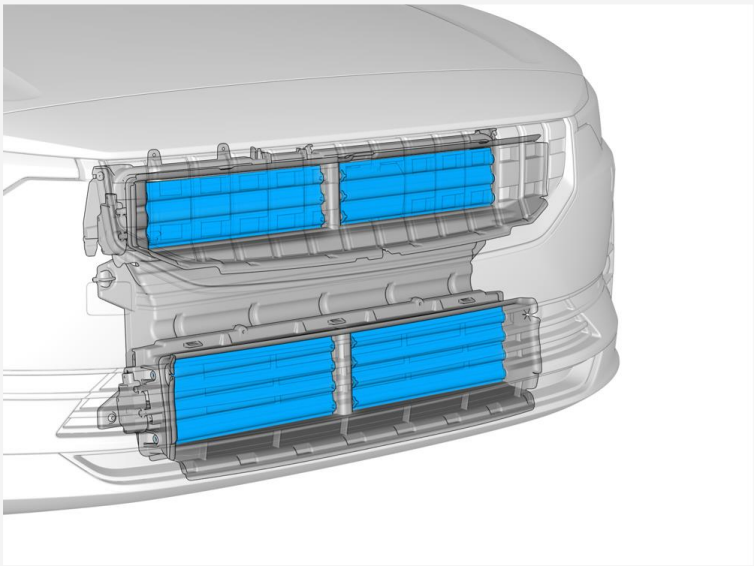
High-Voltage Cooling System
—
Active Shutters

The front of the vehicle is equipped with adjustable front covers consisting of two systems:
- grille shutter and
- spoiler shutter

The active shutters are controlled together with the cooling fan to allow for sufficient airflow over the radiators & AC condenser.

Default position - closed



Instructor Notes:

The front of the vehicle is equipped with adjustable front covers consisting of two systems; grille shutter and spoiler shutter. The active shutters are controlled together with the cooling fan to allow for sufficient airflow over the cooling pack (radiators, AC condenser).
The default position of the shutters is closed, but as soon as there is a need of airflow for either the power train or the AC system, the shutters will open. If the vehicle speed is low, the cooling fan will also start. The benefit of keeping the shutters closed is mainly to reduce the drag force acting on the vehicle at higher speeds, thus helping the vehicle achieving target speed at lower energy consumption. A secondary benefit is that closed shutters allows for faster heat up of both battery and cabin in cold climates.

Internal Information - Polestar

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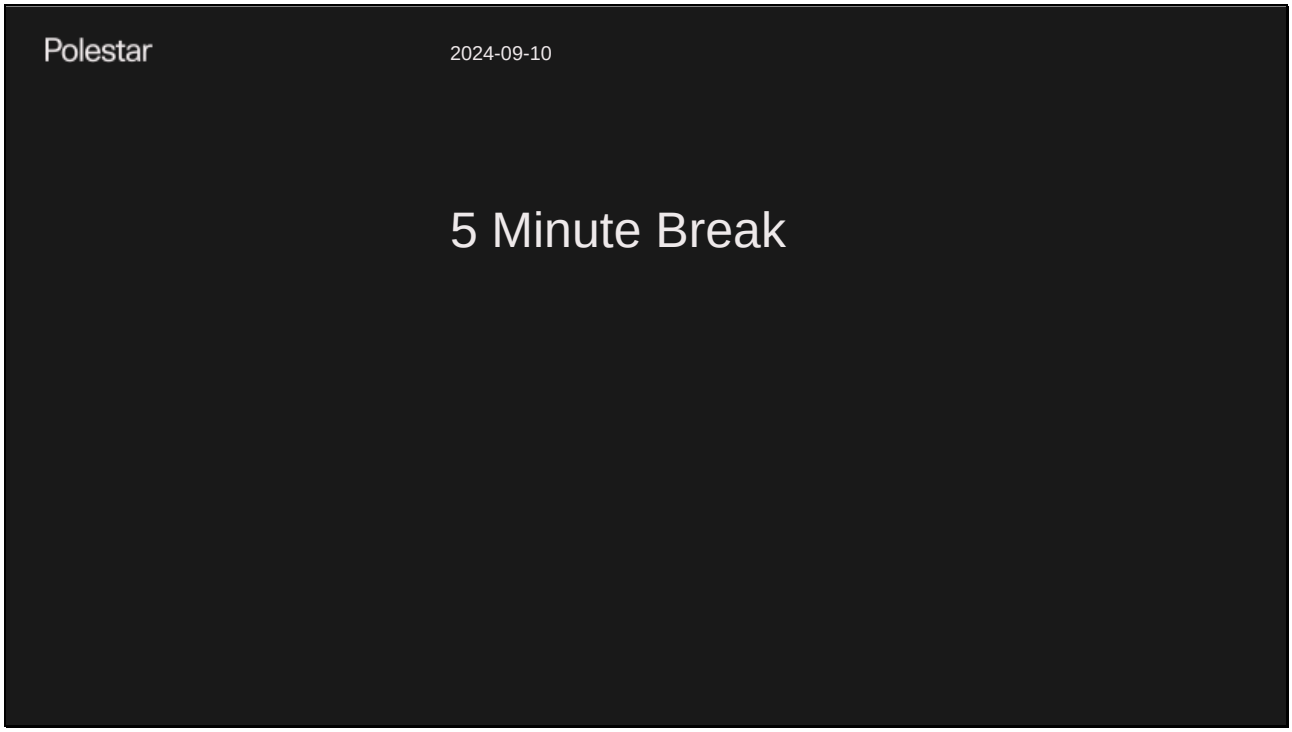

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Slide 61

MSD and Interlock Circuit

High Voltage Interlock Circuit (HVIL)

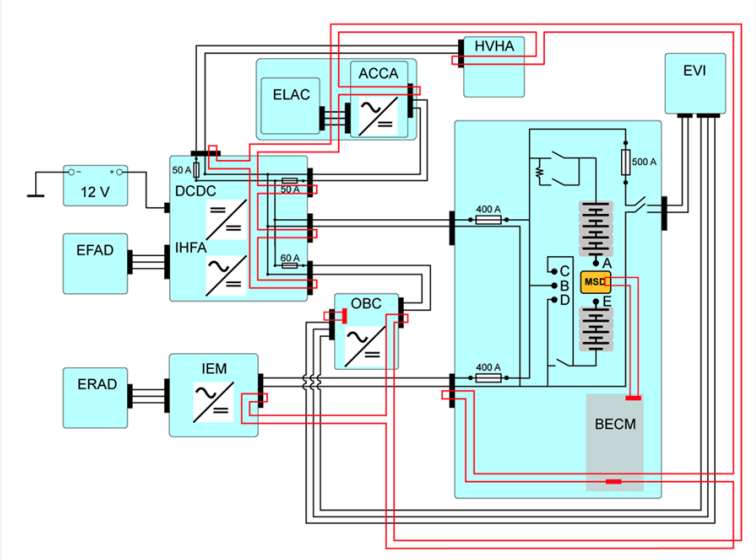
Interlock disconnects HV circuit

Interlock circuit is broken, BECM opens contactors.

HV circuit becomes de-energized.

Interlock circuit is a series circuit with HV components.

There are 2 HVIL circuits:
- HVIL1=MSD,
- HVIL2 HV DC Loads



Instructor Notes:

Interlock is a protection that disconnects the voltage from the high voltage circuit if any of its connectors is opened.

When an interlock circuit is broken, Battery Energy Control Module (BECM) opens the contactors so that the high voltage circuit becomes de-energized.

The interlock circuit is a series circuit with the HV components.

There are 2 HVIL circuits:
- HVIL1=MSD,
- HVIL2 HV DC Loads

Internal Information - Polestar

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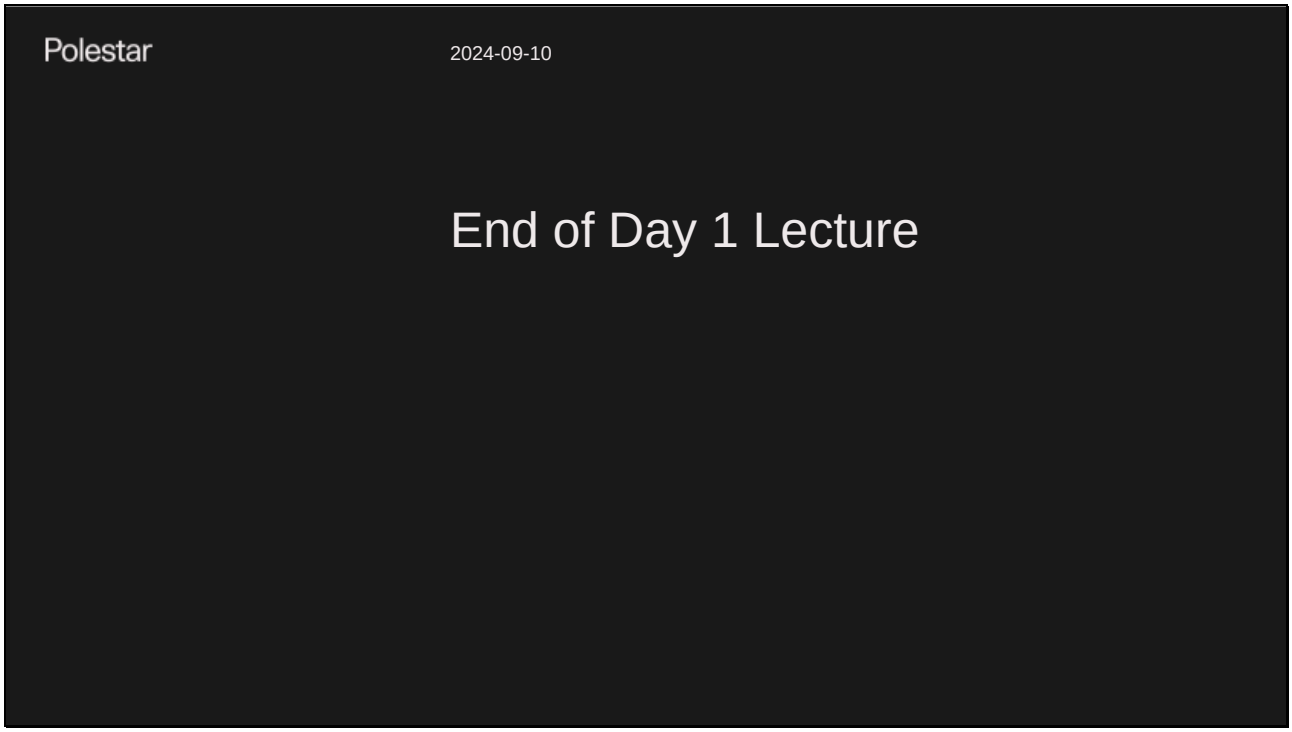

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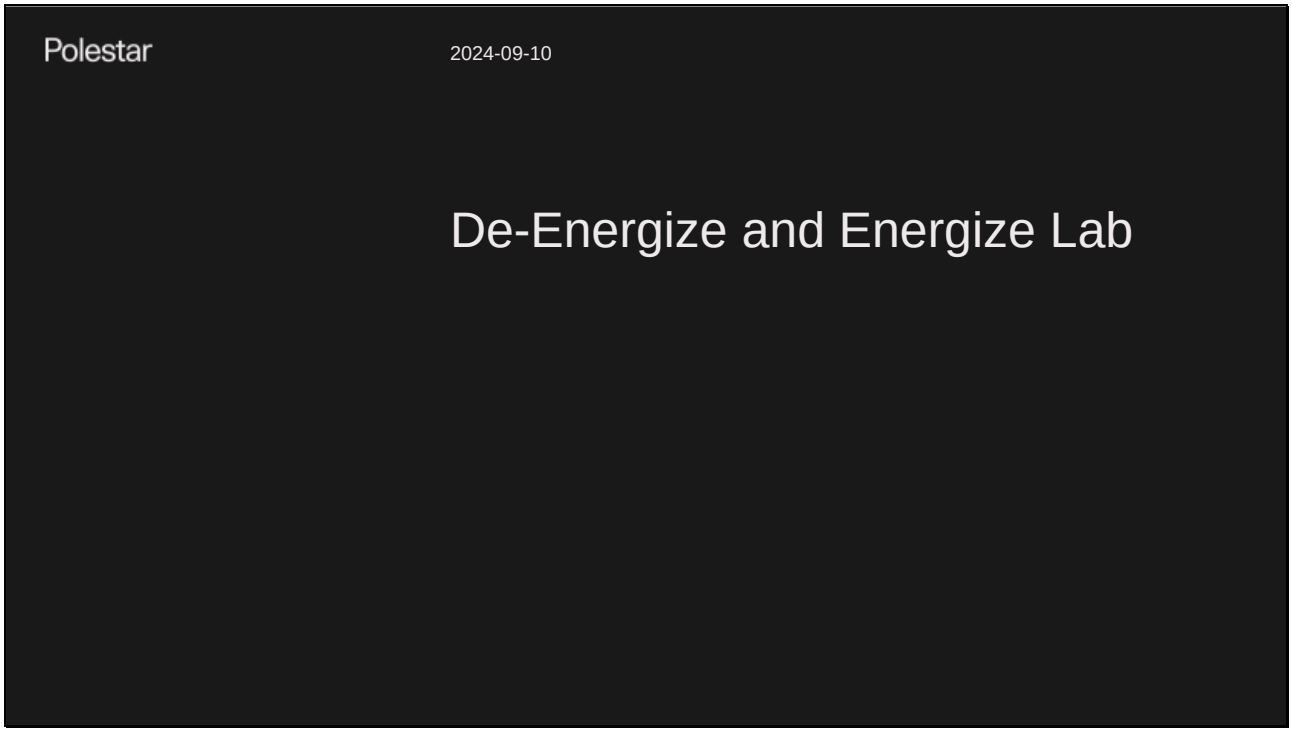
Slide 65



Stop Here Add PS3

Slide 72

High-Voltage Service Procedures

Vehicle De-Energize and Energization

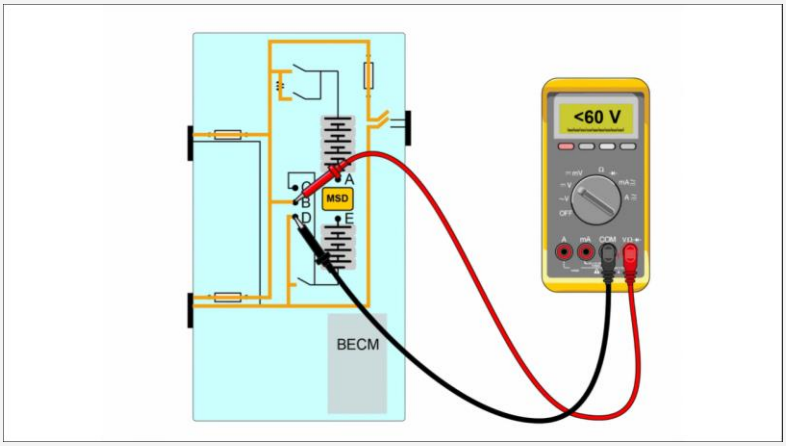
Isolation Testing Using MSD Tool

Measurement 1: (<60 Volts)

B (Negative) to D (Positive)

Test for High-Voltage or 12-volt supply to of from the vehicle

Example: External Charging



Instructor Notes:

Measurement 1: (<60 Volts)

B (Negative) to D (Positive)

Test for High-Voltage or 12-volt supply to of from the vehicle

Example: External Charging

Slide 73

High-Voltage Service Procedures

Vehicle De-Energize and Energization

Isolation Testing Using MSD Tool

Measurement 1: (<60 Volts)

B (Negative) to D (Positive)

Test for High-Voltage or 12-volt supply to of from the vehicle

Example: External Charging

Instructor Notes:

Measurement 1: (<60 Volts)

B (Negative) to D (Positive)

Test for High-Voltage or 12-volt supply to of from the vehicle

Example: External Charging

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High-Voltage Service Procedures

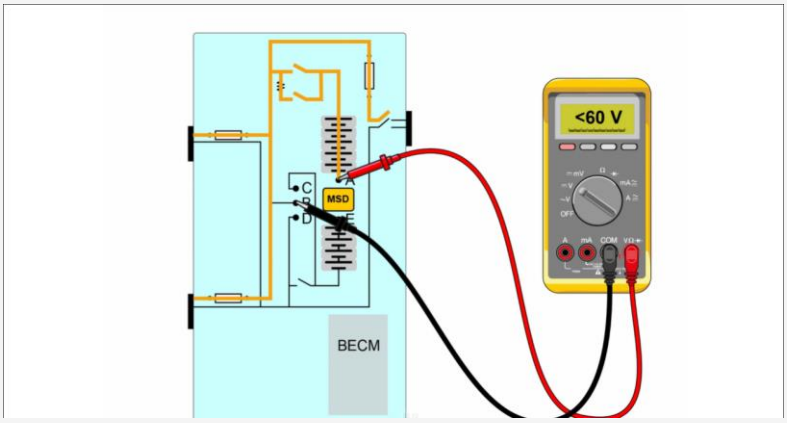
Vehicle De-Energize and Energization

Isolation Testing Using MSD Tool

Measurement 2: (<60 Volts)

A (Positive) to B (Negative)

Test for Positive Contactor Open



Instructor Notes:

Measurement 2: (<60 Volts)

A (Positive) to B (Negative)

Test for Positive Contactor Open

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High-Voltage Service Procedures

Vehicle De-Energize and Energization

MSD Cover Installation

Instructor Notes:

Removed during de-energization

Splits the circuit between modules 12 and 13

Creates an open circuit to breakdown the 400v in two sections 177v to 205v and 220v to 255v

Helps ensure no exposed dangerous voltage levels remain in the system

Internal Information - Polestar

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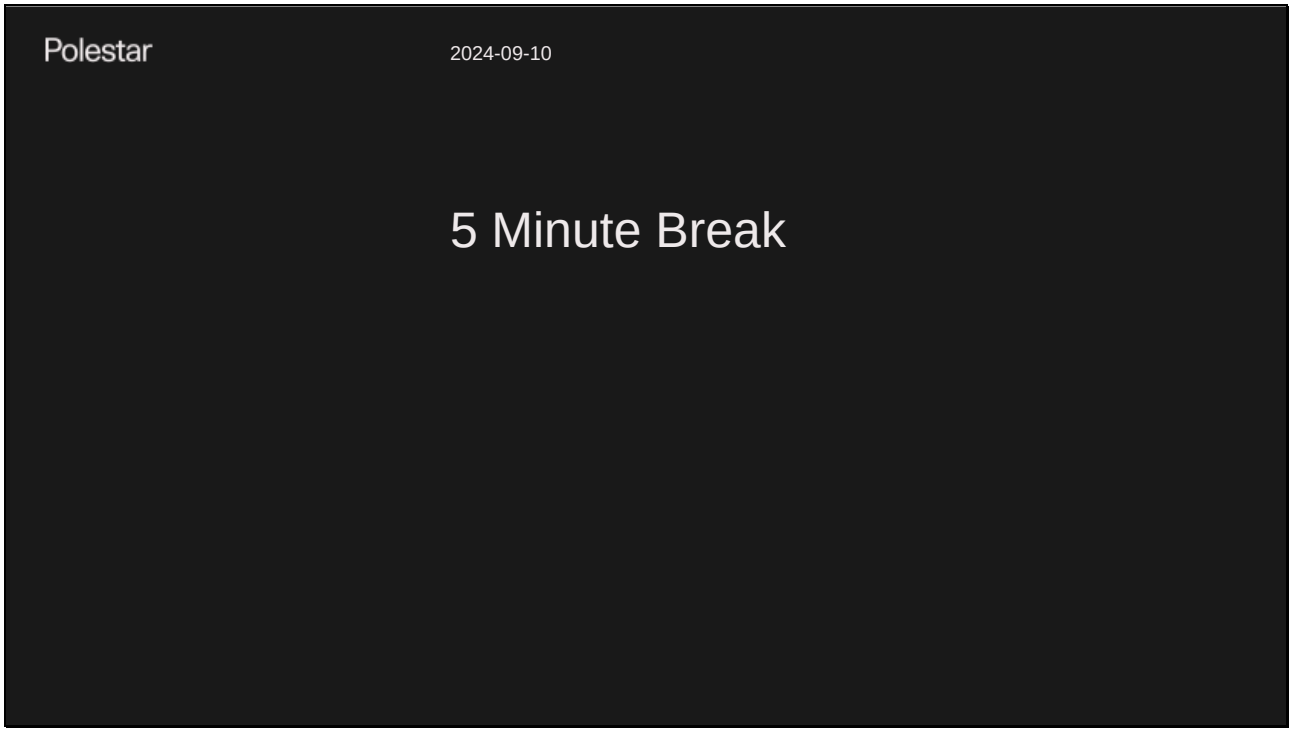


Stop Here Add PS3

Slide 83

Stop Here Add PS3

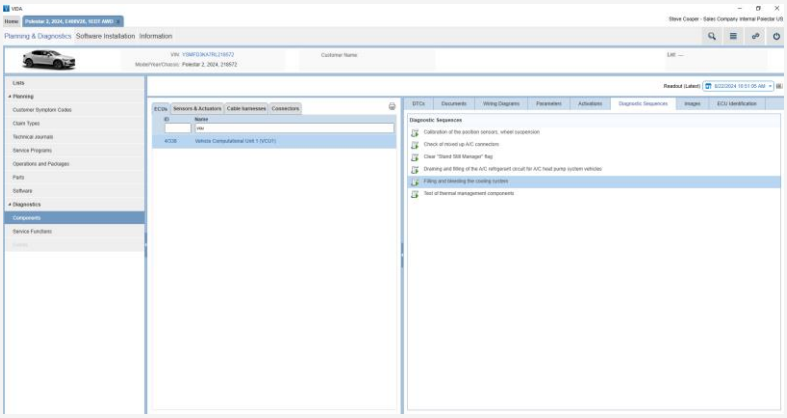
Slide 84

High-Voltage Service Procedures

Cooling System Bleeding & Pressure Test

Fill the cooling system with Volvo Original Coolant.

Perform bleeding according to VIDA:
- Planning and Diagnostics
- Diagnostics
- Components
- ECUs
- Vehicle Computational Unit 1 (VCU1)
- Diagnostic Sequences
- Filling and bleeding the cooling systems



Instructor Notes:

Fill the cooling system with Volvo Original Coolant.

Perform bleeding according to: Planning and Diagnostics / Diagnostics / Components / ECUs / Vehicle Computational Unit 1 (VCU1) / Diagnostic Sequences / Filling of the coolant systems

Make sure that fluid level is to the MAX mark.
Post-fill the cooling system if necessary.
Install the Special tool.
Make sure that the system pressure is within specification.
Ensure not to undercut the time specified in the image.
Check the cooling system for leaks.

Remove the Special Tool.

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High-Voltage Service Procedures

Cooling System Bleeding & Pressure Test

Make sure that fluid level is to the MAX mark.

Post-fill the cooling system if necessary.

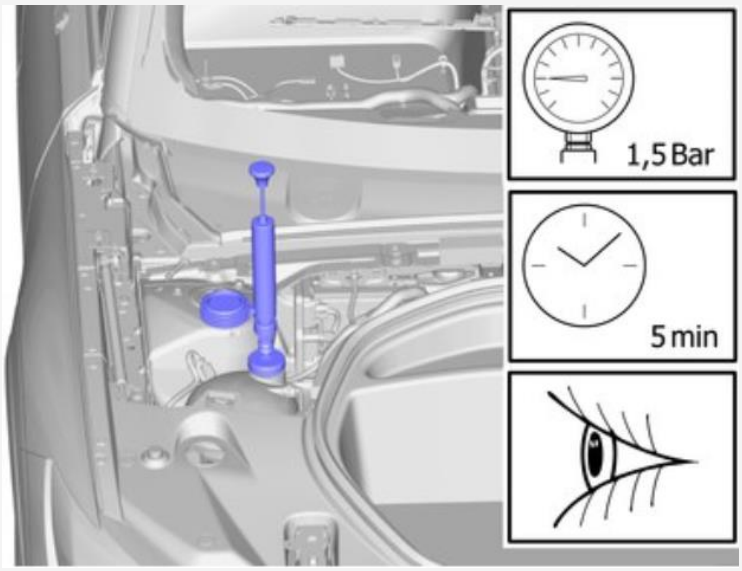
Install the Special tool.

Make sure that the system pressure is within specification.

Ensure not to undercut the time specified in the image.

Check the cooling system for leaks.

Remove the Special Tool.



Instructor Notes:

Fill the cooling system with Volvo Original Coolant.

Perform bleeding according to: Planning and Diagnostics / Diagnostics / Components / ECUs / Vehicle Computational Unit 1 (VCU1) / Diagnostic Sequences / Filling of the coolant systems

Make sure that fluid level is to the MAX mark.
Post-fill the cooling system if necessary.
Install the Special tool.
Make sure that the system pressure is within specification.
Ensure not to undercut the time specified in the image.
Check the cooling system for leaks.

Remove the Special Tool.

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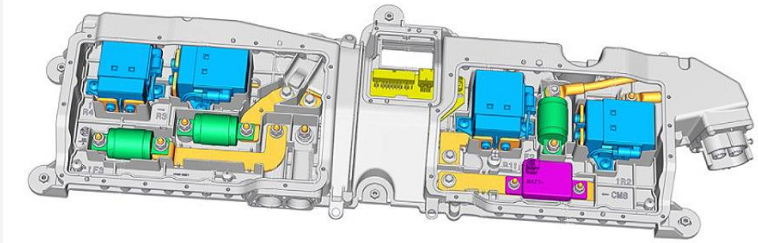
High-Voltage Service Procedures

BDU Service

Fuse - DC Charging

Perform service according to VIDA:

- Planning and Diagnostics
- Diagnostics
- Components
- Sensors & Actuators
- Fuse
- Fuse, DC Charging
- Documents
- Removal, Replacement and Installation
- Fuse BDU



Instructor Notes:

DC charging Fuse - 15
IHFA Fuse - 14
IEM Fuse - 7

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High-Voltage Service Procedures

BDU Service

Current Measurement Unit (CMU) *CMS*

Perform service according to VIDA:

- Planning and Diagnostics
- Diagnostics
- Components
- Sensors & Actuators
- Current Measurement Unit
- Documents
- Removal, Replacement and Installation
- Current Measurement Unit (9)

Instructor Notes:

CMS - 9

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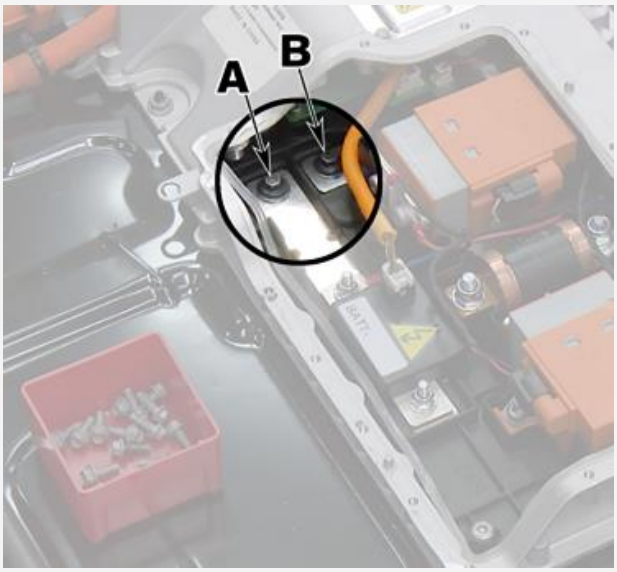
High-Voltage Service Procedures

BDU Bus Bar Isolation Test

BDU Bus Bar Isolation Test

After the MSD is removed, and prior to removing the BDU, you must check the BDU Bus Bar Terminals

A(-) to B(+) = 0V
A(-) to battery Case = 0V
B(+) to battery case = 0V



Instructor Notes:

After the MSD is removed, and prior to removing the BDU, you must check the BDU Bus Bar Terminals

- A(-) to B(+) = 0V
- A(-) to battery Case = 0V
- B(+) to battery case = 0V