



## Switched Reluctance (SR) Drive System Component Description

Section 06-03-03

Komatsu has made every effort to make this manual as accurate as possible based on the information available at the time of publication and printing. Continuous improvement and advancement of product design may cause changes to machines which may not have been included in this publication. Komatsu reserves the right to make changes and improvements at any time. To ensure the most current information, please contact your service center.

### Table of Contents

<b>Scope of This Publication</b> .....	<b>3</b>
<b>Safety</b> .....	<b>3</b>
Safety, Warnings and Cautions .....	3
<b>Motors/Generators</b> .....	<b>5</b>
Motors .....	5
Generators .....	6
Motor and Generator Rotors.....	6
Stator Coils .....	7
Motor Stator Coils/Connections.....	7
Generator Stator Coils/Connections.....	8
RPT (Rotor Position Transducer) .....	9
RTD'S (Resistance Temperature Detectors).....	9
<b>Kinetic Energy Storage System (KESS)</b> .....	<b>11</b>
<b>Braking Grids</b> .....	<b>15</b>
<b>Converter Assemblies</b> .....	<b>17</b>
<b>Cooling Pumps</b> .....	<b>19</b>

### List of Figures

Figure 1.	Motors & Generators .....	5
Figure 2.	Motor and generator rotors .....	6
Figure 3.	Stator coils.....	7
Figure 4.	Motor coil groups/connections (typical).....	7
Figure 5.	Generator coil groups/connections (typical).....	8
Figure 6.	RPT assembly .....	9
Figure 7.	RTD (Resistance Temperature Detector) .....	9
Figure 8.	Drive System Components with KESS .....	11
Figure 9.	Flywheel Motor .....	11
Figure 10.	SR Drive System .....	12
Figure 11.	SR Drive System – with KESS.....	12
Figure 12.	KESS Charging – High Throttle with Park Brake Released.....	13
Figure 13.	KESS during Propulsion.....	13
Figure 14.	KESS during Braking .....	14
Figure 15.	KESS Excess Energy during Braking .....	14
Figure 16.	Converter panel bus LED's .....	15
Figure 17.	Grid connection schematic.....	16
Figure 18.	Braking grid panel connections & warning labels .....	16

---

Figure 19.	Converter panel.....	17
Figure 20.	Converter panel exploded view.....	17
Figure 21.	Converter scalability.....	18
Figure 22.	IGBT cooling structure and pump .....	19
Figure 23.	Coolant reservoir fluid capacity .....	19

# Scope of This Publication

SR Drive System Component Description contains general component and safety information for SR drive components. Listed below are signal words, symbols and their meanings that may precede this information.

## Safety

This publication contains special instructions that pertain to safety, operation, maintenance, and repair of the machine. Listed below are the signal words and symbols that precede these instructions and their meanings:


### DANGER

- The danger label indicates a hazardous situation which, if not avoided, will result in death or serious injury.

### WARNING

- The warning label indicates a hazardous situation which, if not avoided, could result in death or serious injury.

### CAUTION

- The caution label, used with the safety alert symbol indicates a hazardous situation which, if not avoided, could result in minor or moderate injury (includes the safety alert symbol ).

### CAUTION

- The caution label (without safety alert symbol) is used to address practices not related to personal injury – only equipment damage.

### NOTICE

The NOTICE graphic is to indicate areas of importance to the reader that are not related to personal injury or machine damage.

## Safety, Warnings and Cautions

It is important that all personnel read and understand all CAUTIONS and WARNINGS before operating, or working on or near the machine.

### WARNING

#### ELECTRICAL SHOCK

- Risk of shock or injury by contact of the braking grids is possible. Do not open the door over the braking grids or touch anything on the grids when the engine is running or the converter panel bus LED's are glowing red in the electrical cabinet. Do not touch or enter these areas unless the

engine has been shut down and the bus discharge procedure has been followed. Failure to do so may result in shock or other injury.

# Motors/Generators



Figure 1. Motors & Generators

## Motors

The Komatsu SR Motor is a dual bearing, bi directional 4 quadrant motor. This means the motor is capable of running in both directions and operating in power mode or generator mode for retarding. The motor does not use any brushes and the only wear parts are the bearings. Depending on the model, the motor can be rated up to 4500 rpm and runs at varying speeds depending on the command and limits of the machine.

Some advantages of the SR motor are:

- No commutator maintenance – there are no brushes or brush rigging.
- Unit can run forward or backward as either a motor or a generator.
- Rotor is simply a stack of laminated steel plates.
- All coils are stationary.

## Generators

The Komatsu SR generator is a single bearing generator. It does not use any brushes. The endbell and bearing components on the generator are the same or similar to those used on the 4B, 7B, 9B and 6R AC generators for parts commonality. There were some small changes to allow mounting of the RPT assembly.

The generator turns at engine speeds and is capable of output power at all engine rpm.

As with all SR motors or generators the number of poles on the rotor is different from the number of poles on the stator.

## Motor and Generator Rotors

The rotor does not have any copper – it consists of laminations with poles mounted on a shaft and pressed and held together with plates at each end.

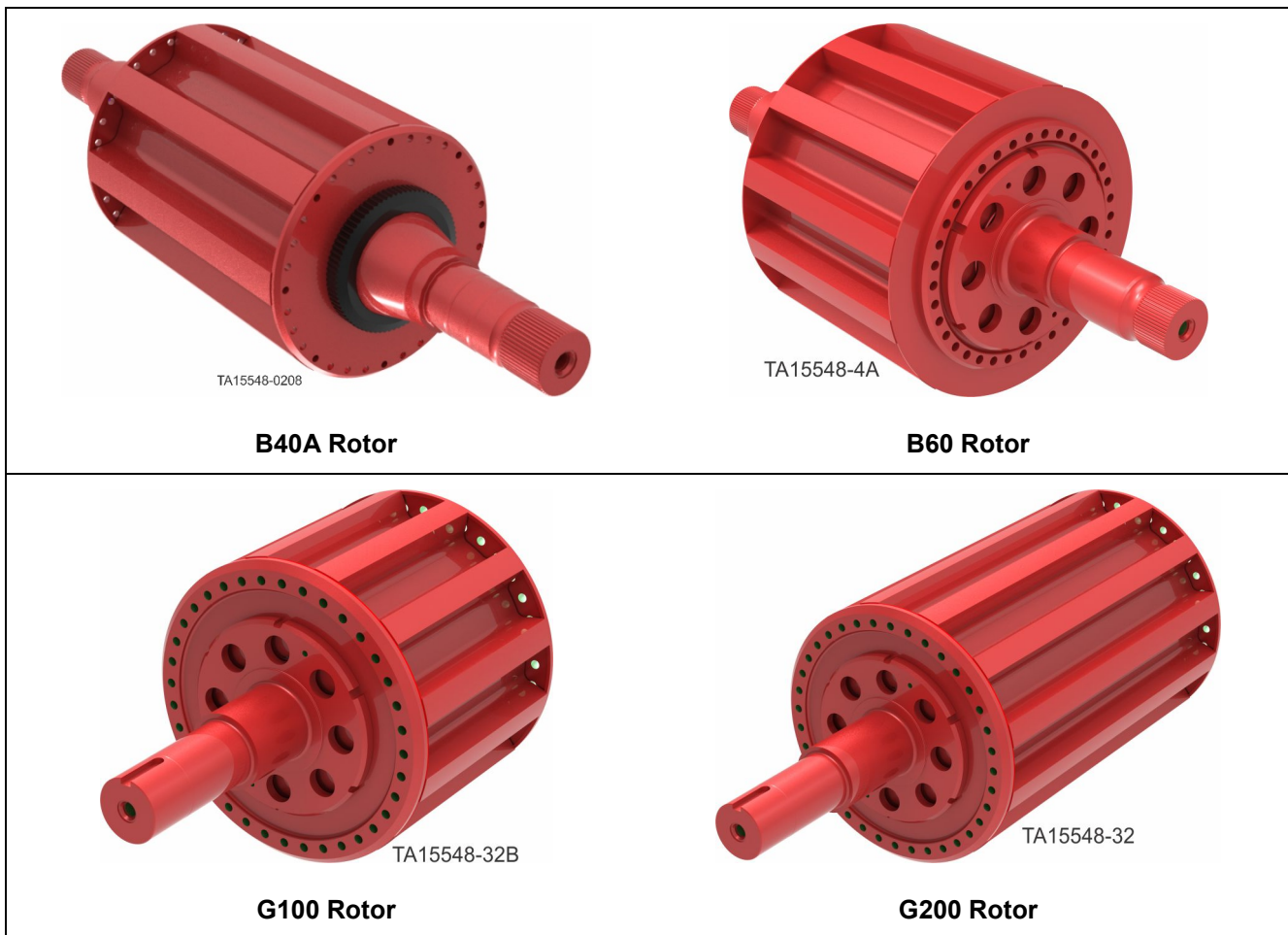


Figure 2. Motor and generator rotors

# Stator Coils

Each pole of the stator has a single multi-turn coil of copper wire. These coils are installed in a “green” state (no epoxy or varnish in the coil) and then the stator is processed in a VPI (Vacuum Pressure Impregnated) system to fully impregnate the coil and adhere the coil to the stator pole.

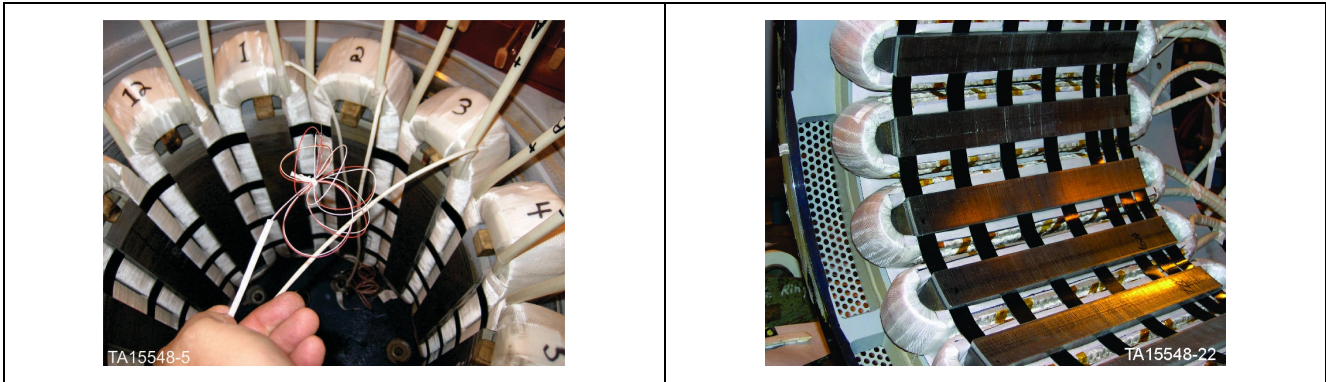


Figure 3. Stator coils

# Motor Stator Coils/Connections

The coils are joined in parallel in 3 groups. All of the coils in a group are energized at the same time.

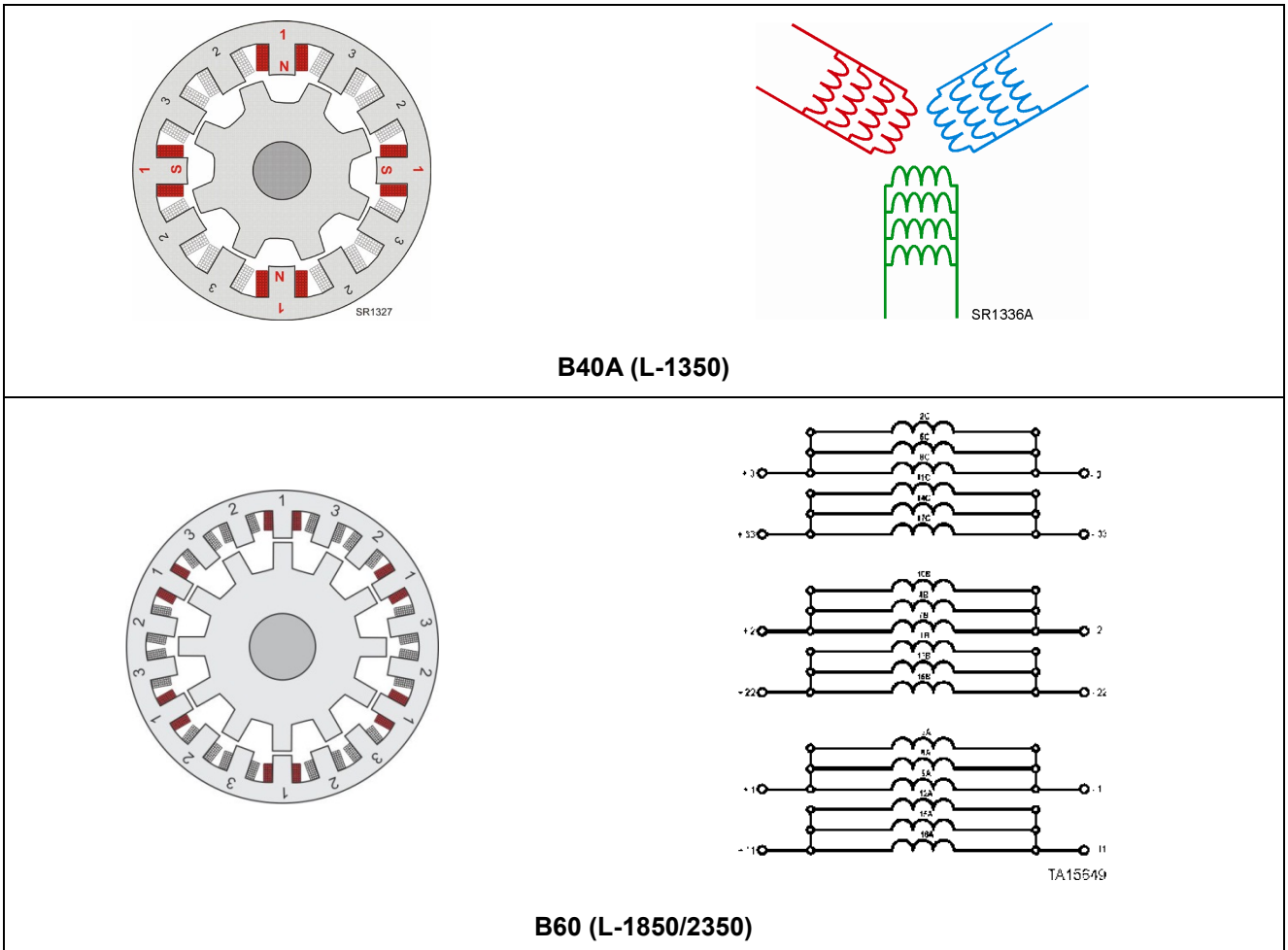


Figure 4. Motor coil groups/connections (typical)

# Generator Stator Coils/Connections

The coils are joined in parallel in 3 groups. All of the coils in a group are energized at the same time.

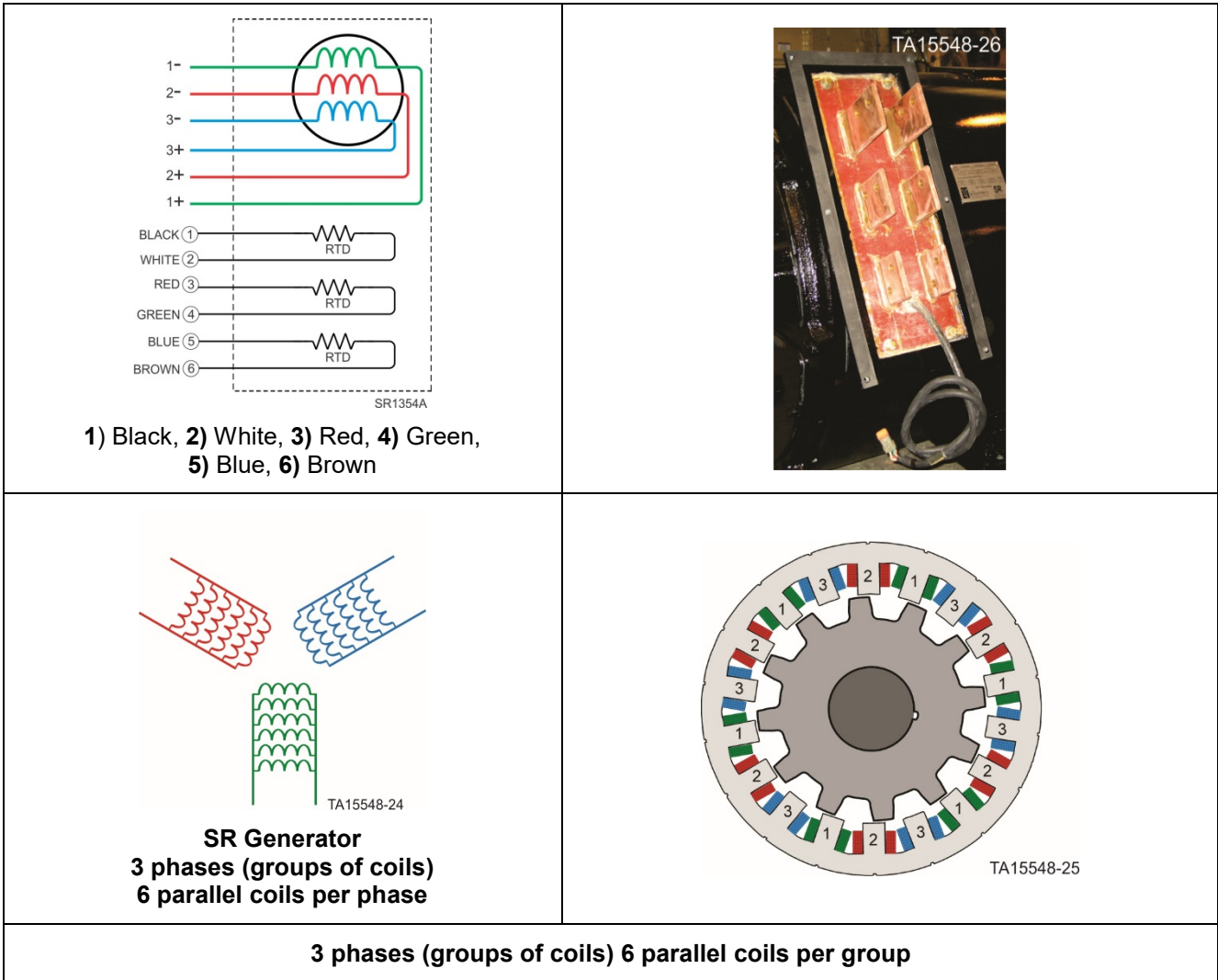


Figure 5. Generator coil groups/connections (typical)

## RPT (Rotor Position Transducer)

The position and speed of the motors and generator are determined by use of RPT (Rotor Position Transducer). The RPT's are mounter near the drive shaft on the generator and near the brake disk on the motors. The RPT looks at the position of the shutter tabs as they pass through the sensor. Only three of the 6 RPT's are used at any one time. The other 3 are spares.

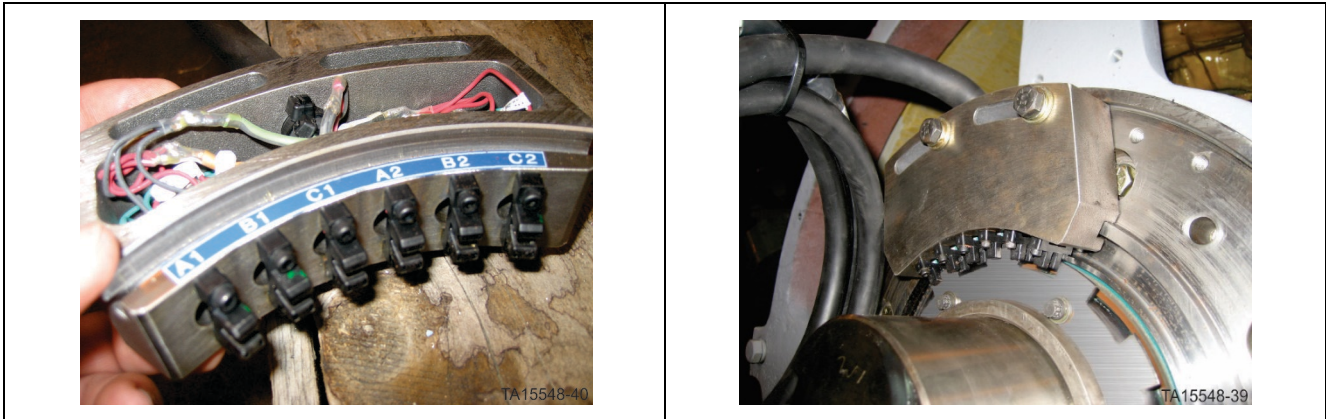


Figure 6. RPT assembly

## RTD'S (Resistance Temperature Detectors)

The temperature of the motor and generator are monitored by RTD devices. These are installed along with the coils during fabrication of the stator. The stator is then VPI'd (Vacuum Pressure Impregnated). These devices cannot be changed without changing the coil.

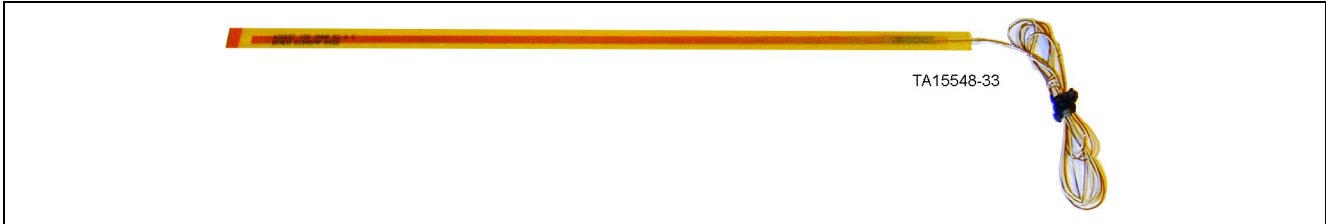
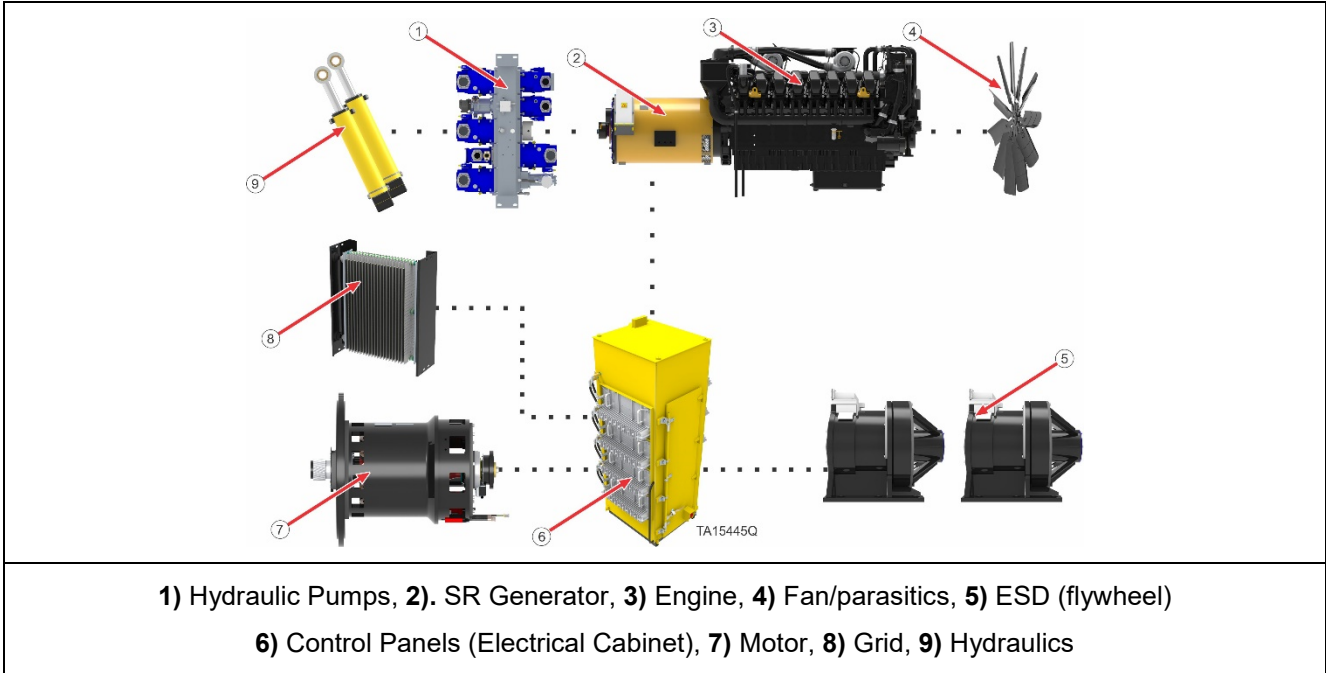


Figure 7. RTD (Resistance Temperature Detector)

This Page Intentionally Left Blank

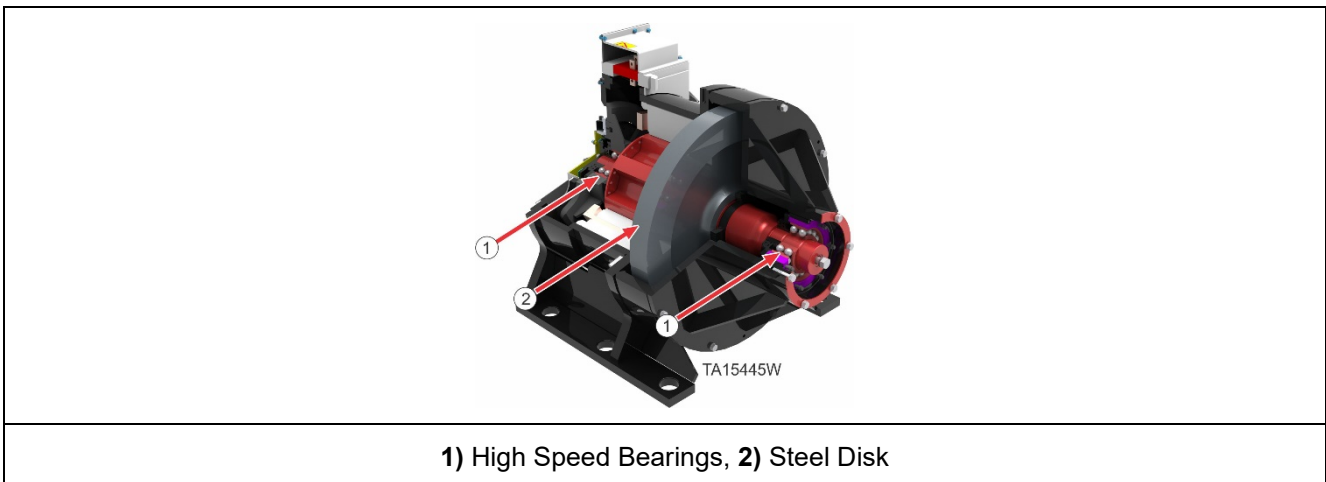
# Kinetic Energy Storage System (KESS)

The KESS is composed of one or more ESD's (Energy Storage Devices), converter panels, and fuses. KESS will allow storage of the energy captured during regenerative braking by the drive system for later use, increasing acceleration, speed, power, and a reduction of fuel consumption.



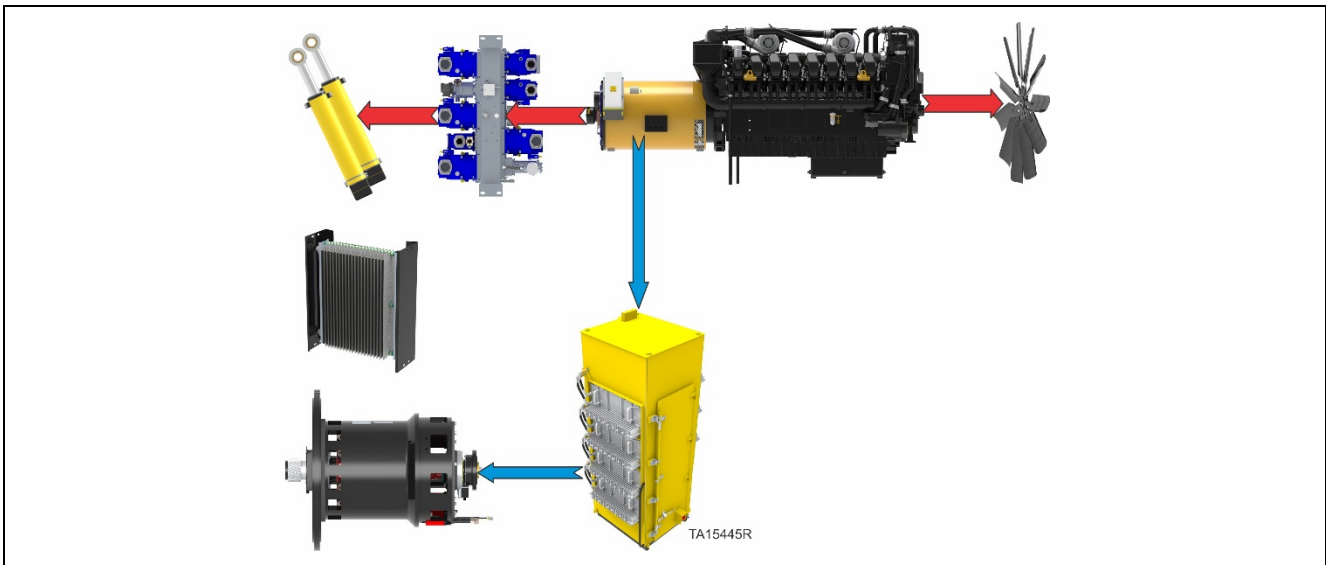
**Figure 8. Drive System Components with KESS**

The ESD's are created by adding high speed bearings and a simple internal steel disk to the shaft of an SR motor.



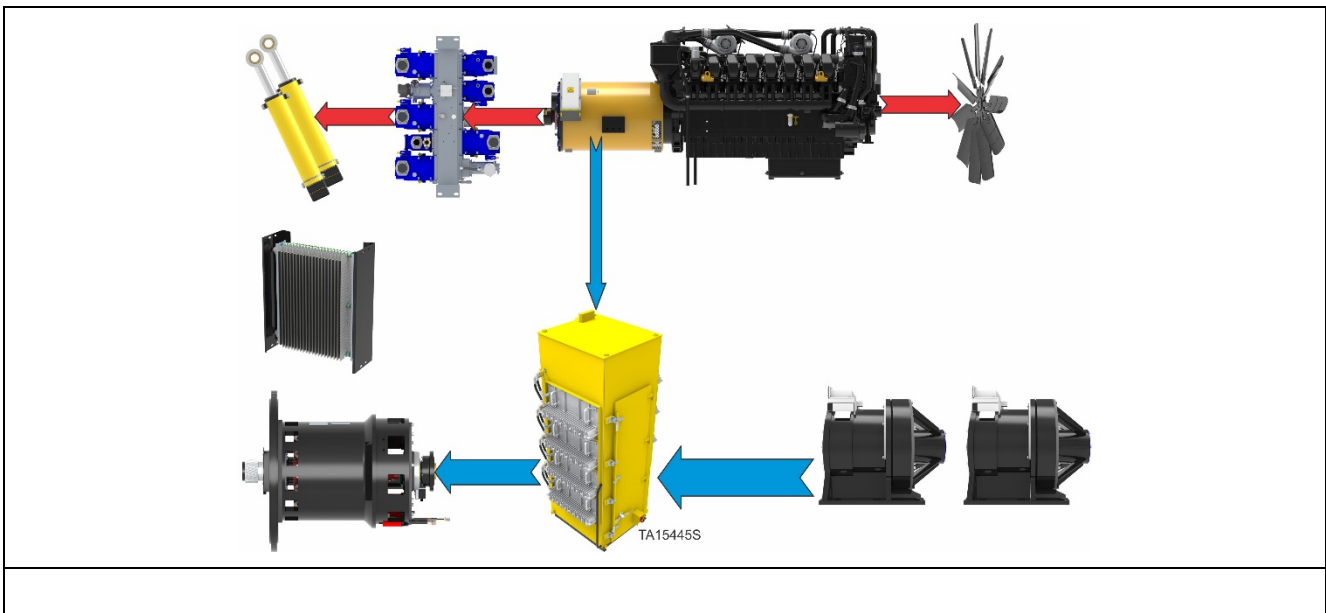
**Figure 9. Flywheel Motor**

With the current SR Drive system, the hydraulics (hoist, bucket, steering) and cooling fan/parasitics get priority while the drive system receives the remainder of the energy. This affects the ability of the machine to dig, hoist, and accelerate.



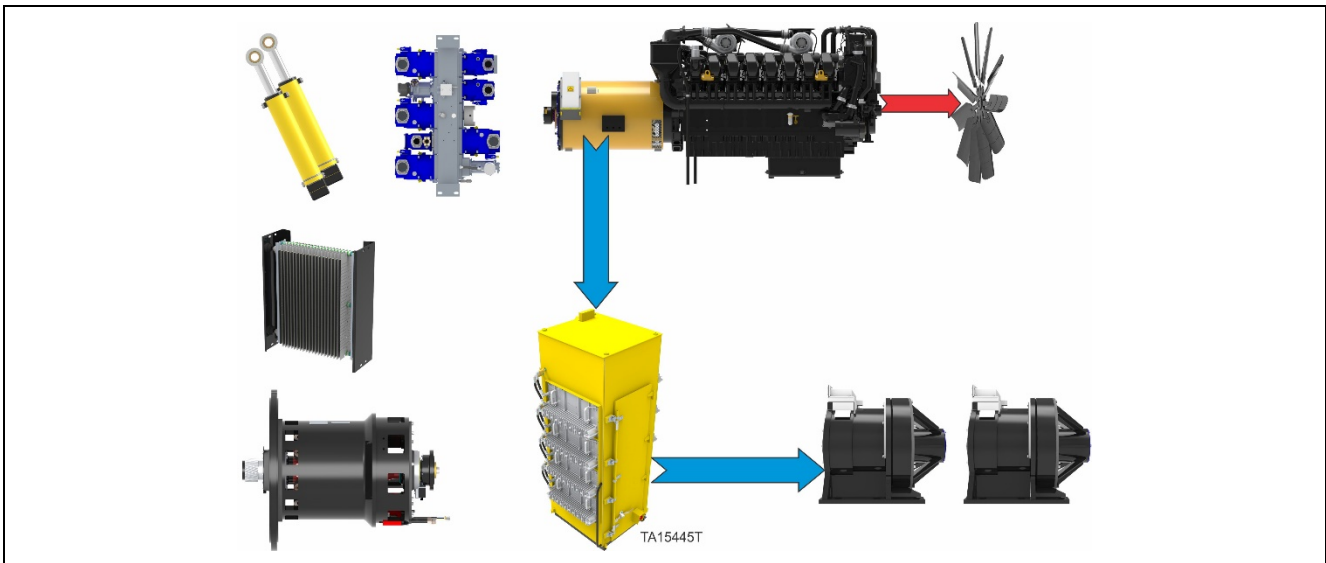
**Figure 10. SR Drive System**

In a SR Drive System with KESS, while the hydraulics and cooling fan/parasitics continue to get priority, the drive system gets a boost from the KESS flywheel motor(s). This gives the machine the ability to accelerate better when using hydraulics.



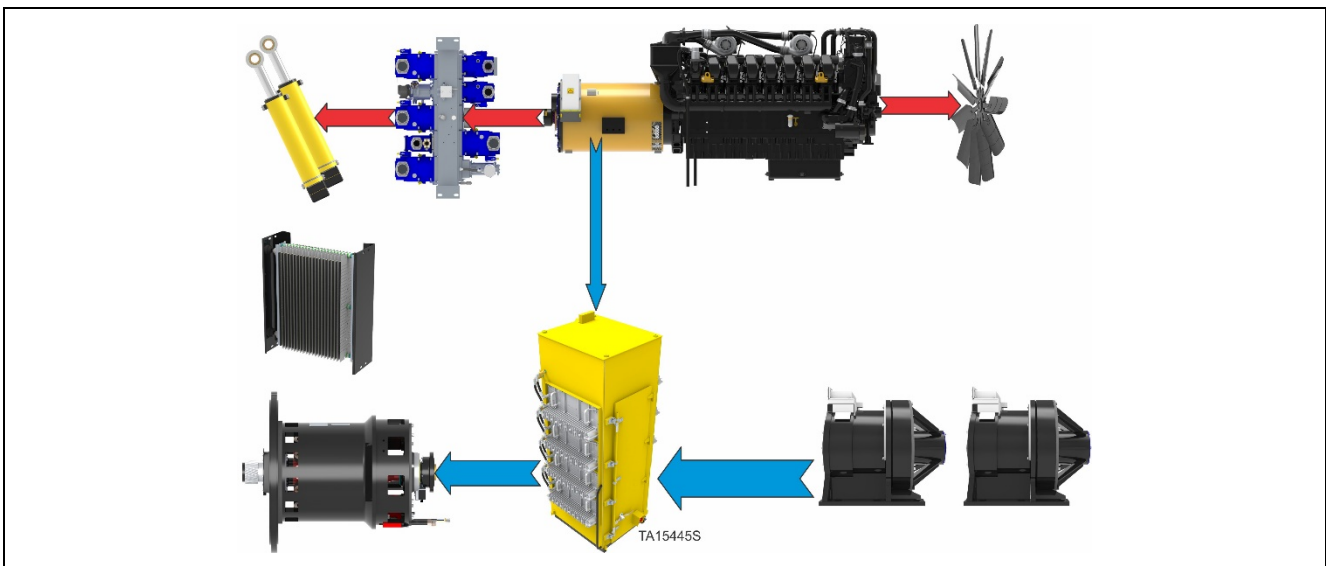
**Figure 11. SR Drive System – with KESS**

The KESS is initially charged when the engine is taken to high throttle and the park brake is released (energy is also provided to the fan/parasitics at this time).



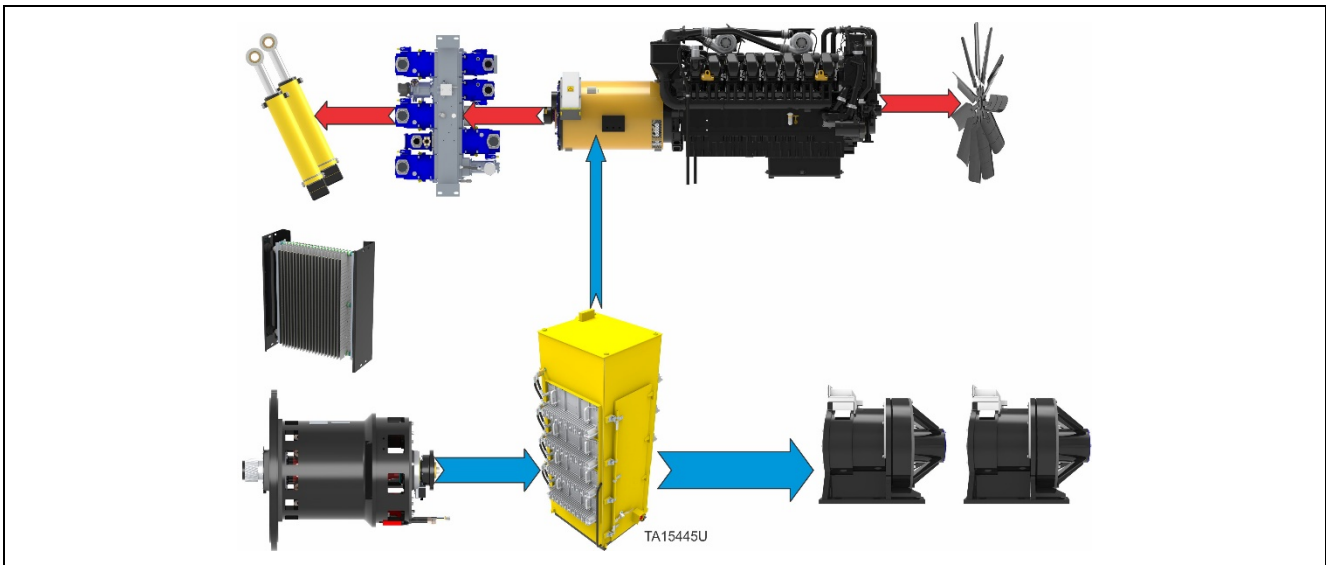
**Figure 12. KESS Charging – High Throttle with Park Brake Released**

During acceleration, stored energy is provided by the KESS and used to assist the engine in the propulsion of the machine.



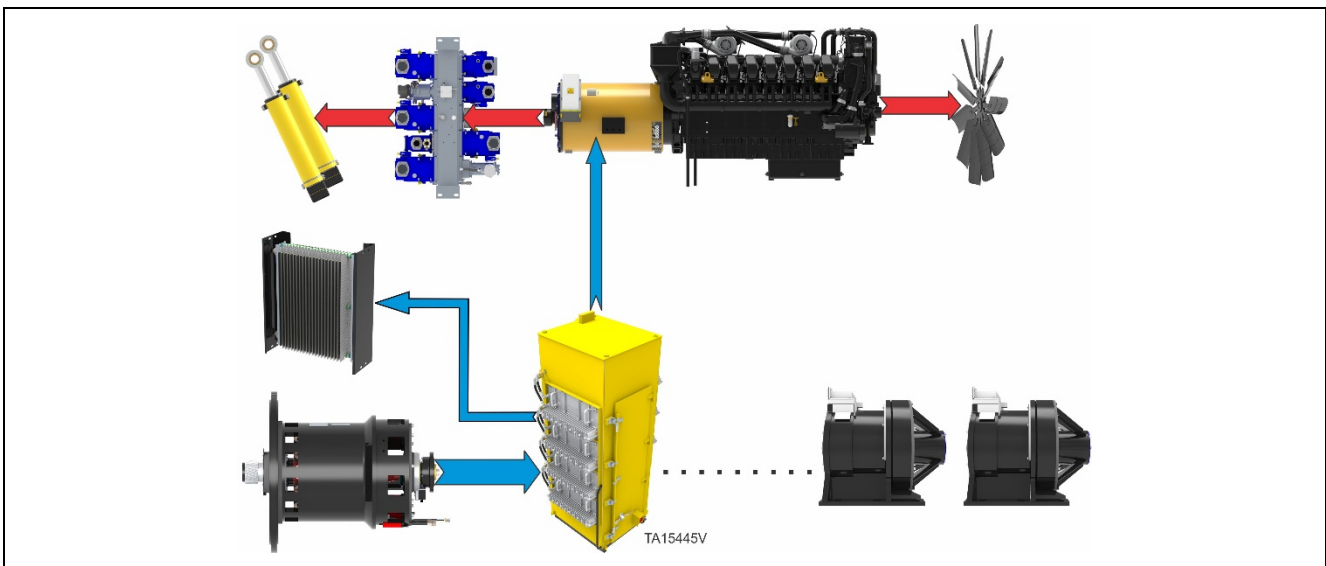
**Figure 13. KESS during Propulsion**

During braking, braking energy is routed to the generator and the KESS ESD flywheel unit(s). The engine will consume this braking energy until the engine is driven to zero fuel consumption. The KESS will increase in RPM until it reaches maximum RPM.



**Figure 14. KESS during Braking**

Once the engine is at zero fuel consumption and the KESS is full, any excess energy will be dissipated through the braking grids.



**Figure 15. KESS Excess Energy during Braking**

# Braking Grids

Braking grids, located at the rear of the machine, are designed to dissipate energy and provide electrical braking capability. These grids are connected to one side of the electrical bus. Whenever bus voltage is present, the grids always have voltage present.

## ⚠ WARNING

**Risk of shock or injury by contact of the braking grids is possible. Do not open the door over the braking grids or touch anything on the grids when the engine is running or the converter panel bus LED's are glowing red in the electrical cabinet. Do not touch or enter these areas unless the engine has been shut down and the bus discharge procedure has been followed. Failure to do so may result in shock or other injury.**

**L-1350:** Each motor chopper has one grid (total 4), with each grid measuring 2.2 ohms.

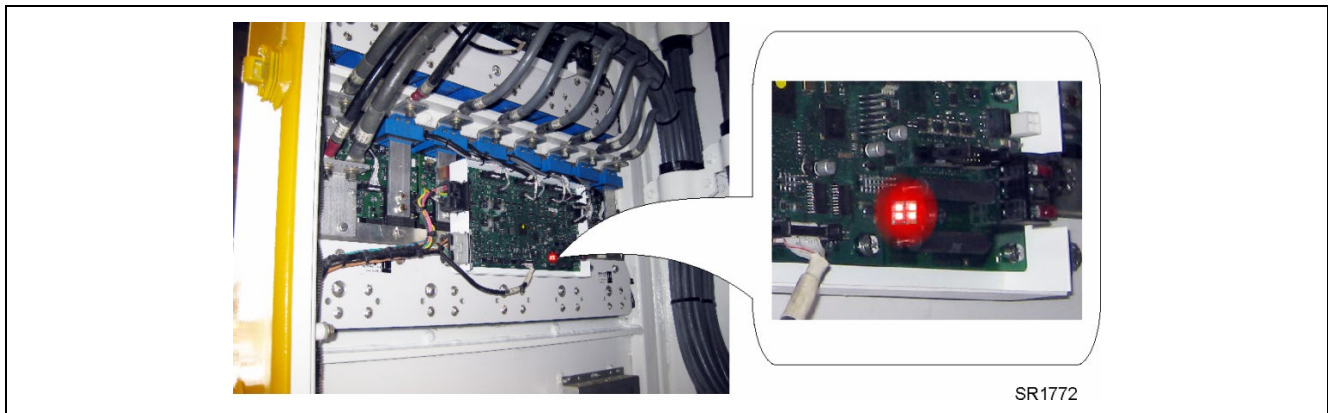
**L-1350:** Two grids on two generator converter panels (total 2), with each grid measuring 2.2 ohms.

**L-1850/2350:** Each motor chopper has two grids (total 8), with each grid measuring 2.2 ohms.

## NOTICE

All converters have built in chopper circuits; however, based on the loader model, not all converters have grids connected to them. In some cases, a generator converter will have a grid connected to it to assist in dissipating energy. Keep in mind the system uses a common bus to which all converters are connected. When bus energy needs to be dissipated across the grids, all choppers receive the command regardless if they are connected to a grid or not.

Machine Type	Total Converter Panels	Number of Grids
L1350	9	6
L1850, L2350	NA	8



**Figure 16. Converter panel bus LED's**

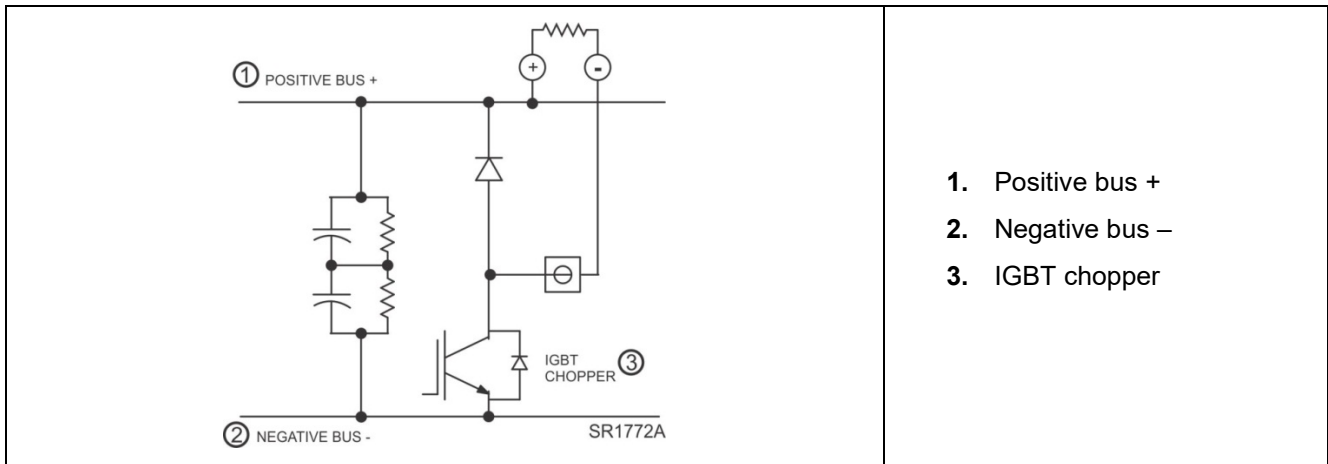


Figure 17. Grid connection schematic

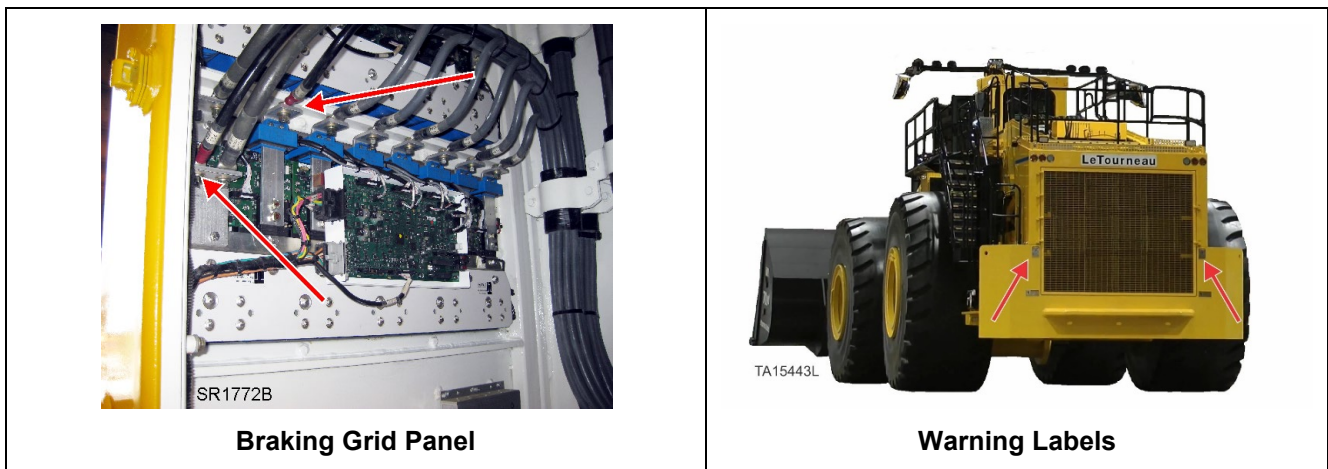


Figure 18. Braking grid panel connections & warning labels

**⚠ WARNING**



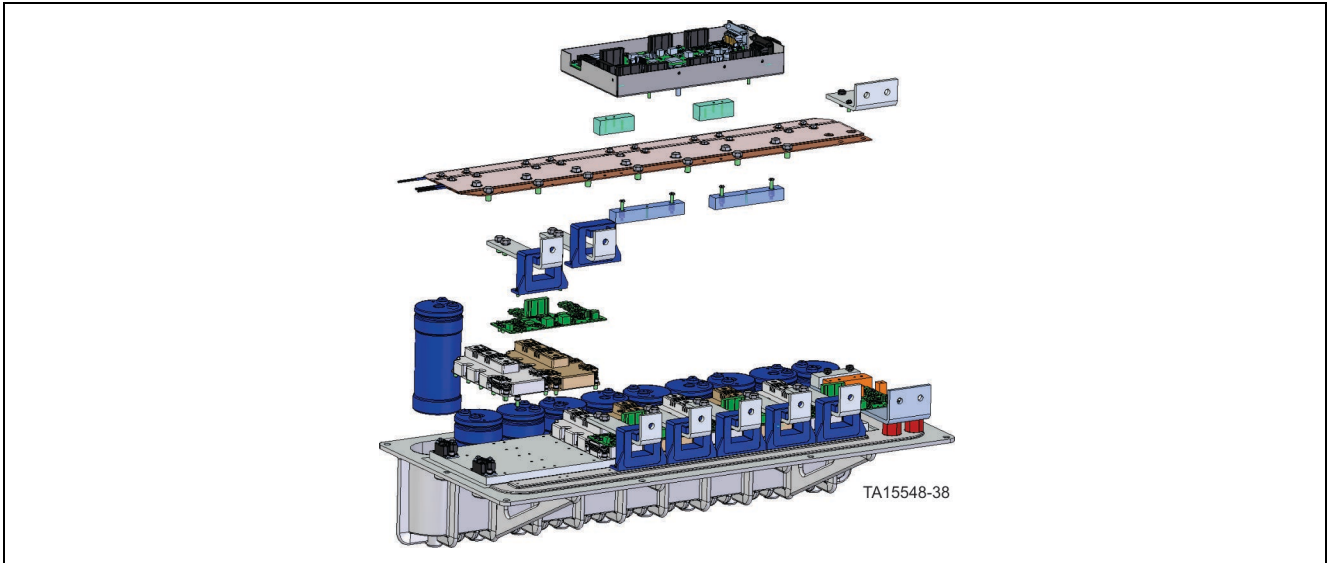
Risk of shock or injury by contact of the braking grids is possible. Do not open the door over the braking grids or touch anything on the grids when the engine is running or the converter panel bus LED's are glowing red in the electrical cabinet. Do not touch or enter these areas unless the engine has been shut down and the bus discharge procedure has been followed. Failure to do so may result in shock or other injury.

Prior to any work being performed in this area, perform the following Bus Discharge Verification Procedure.

# Converter Assemblies



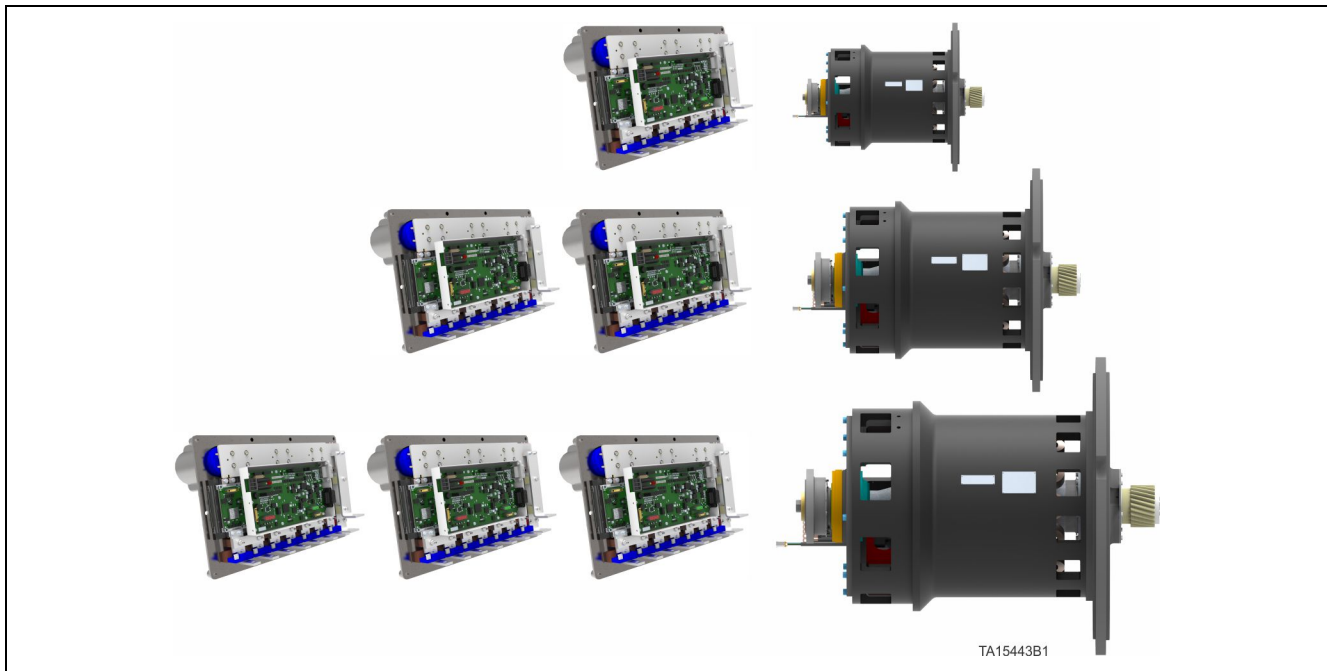
**Figure 19. Converter panel**



**Figure 20. Converter panel exploded view**

The converter assemblies are scalable and so are capable of having multiple assemblies per component. Referring to the chart below, the L-1350 has one converter assembly per motor while the L-1850 and L-2350 has two converter assemblies per motor. The Electrical Converter Cabinet will have up to 12 converter assemblies depending on the machine type. The generator converter assemblies will have 3 or 4 assemblies, depending on machine type. Refer to table below.

Machine Type	Wheel Motor Converter Panels	KESS Panels	Generator Panels	Total Panels
L-1350	4	2	3	9
L-1850, L-2350	8	NA	4	12

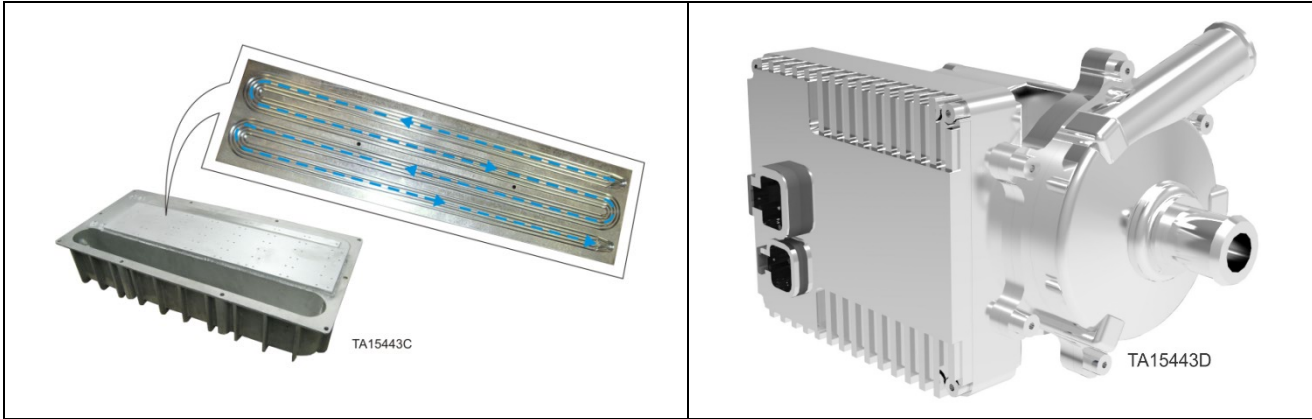


**Figure 21. Converter scalability**

The converter assemblies are comprised of a SR Control Board, Gate Driver Boards (phase and chopper), IGBT's, and DC bus capacitors with equalizing resistors. There are no field serviceable parts on these assemblies.

# Cooling Pumps

The IGBT modules are mounted to the panel and cooled by a dedicated liquid cooling system. CAN controlled pumps supply liquid flow based on the greatest converter temperature, and will run at full speed if the CAN data link is missing.



**Figure 22. IGBT cooling structure and pump**

The capacitors are convection cooled while the rest of the electrical converter cabinet components are air cooled by way of a 4” duct at the top of the cabinet and an exit screen at the bottom.

Model	Component	Capacity		Fluid
L1350	Drive Module(s) Coolant Reservoir	31 gallons	117 liters	Use engine manufacturer specifications.
L1850	Drive Module(s) Coolant Reservoir	40 gallons	151 liters	
L2350	Drive Module(s) Coolant Reservoir	41 gallons	155 liters	

**Figure 23. Coolant reservoir fluid capacity**

This Page Intentionally Left Blank