

## Introduction of Products

### The Electric Excavators PC200LCE-11/PC210LCE-11

Masaho Yamaguchi

Norihiko Sato

Makoto Chiba

*The PC200LCE-11/PC210LCE-11, introduced as rental machines in the domestic and European markets since October 2023, are equipped with a large capacity lithium-ion battery. The goal of these excavators is to be able to operate throughout the day once fully charged.*

*This paper presents their electrical/hydraulic system.*

**Key Words:** Carbon neutrality, Electrification, Long operation hours, Lithium-ion battery, Quiet performance, Heat reduction

## 1. Introduction

Komatsu has been endeavoring to cut greenhouse gas, having a target of a 50% reduction (over FY2010) of CO<sub>2</sub> emission by 2030 and a challenging goal of reaching carbon neutrality in 2050.

We have cooperated with a battery manufacturer for these models since January 2021 and the models are equipped with the lithium-ion battery supplied by the manufacturer which has actual results with commercial vehicles. The models went through the verification test in customer's sites, and were exhibited in "bauma 2022" in October 2022 and "CONEXPO-CON/AGG 2023" in March 2023. Now they have been introduced to the market. We hope various customers with different operation conditions and power supply environment in the areas where the electrification market can possibly be formed will use these machines and appreciate their environmental performance and safety. We will accumulate customer voices and findings to build the electrification market.



Fig. 1 Appearance

**Table 1** Standard specifications

Quality goal			Developed model <b>PC210LCE-11</b>	Base model PC210LC-11
Machine mass	kg		24,400	22,450
Boom/arm length	mm		→	5,700/2,900
Bucket capacity (range)	m <sup>3</sup>		→	0.8 - 1.2
<b>Power source</b>	Rated output (motor, engine)	kW	→	123
<b>Battery</b>	Rated voltage	V	550 - 738	
	Capacity	kWh	450	
<b>Battery charger</b>	Charging standard	-	Combined Charging System Type2	
	Input voltage	V	3-phase, AC 400	
	Output	kW	50	
Major dimension	Track gauge (gauge)	mm	→	2,380
	Distance between tumbler centers	mm	→	3,655
	Tail swing radius	mm	→	3,020
Continuous operating hours	hour		5 - 10	14 and above
Dynamic noise	Operator's ear	dB(A)	→ (Actual measurement 63.2)	67.0
	Surroundings	dB(A)	→ (Actual measurement 92.9)	98.4
Environmental performance	Allowable ambient temperature	°C	→	-20-45
	High altitude adaptability	m	1,000	2,300

## 2. Aims of development

### (1) Environmental friendliness and economy

- The battery-powered machine realizing no emission to be gentle to working environment  
These models are battery-powered machines with no emission. They realize clean working environment and are gentle to workers and trees around them. They can be introduced in various working sites including indoor construction, plumbing, and construction in urban areas.

### (2) Comfortableness and safety

- A large-capacity lithium-ion battery securing operating hours  
The machines are equipped with the lithium-ion battery of 451 kWh which enables about 8 hours operation \*1 with its full charge. If the battery is fully charged using an accessory battery charger, the machine will operate for approximately 8 to 10 hours \*2.
  - The electric motor with high quiet performance reduces machine noise and exterior noise  
As the power source is a motor, noise from an engine is not produced. It contributes to easy communication between operators and other staff during operation to make the operation safe and accurate.
  - No machine vibration from an engine reducing operator's fatigue  
The machine has no engine, so the vibration to the operator is improved. Less stress and fatigue in the operation allow operators to work comfortably.
  - Reduced heat from the machine realizes comfortable working environment  
Having no engine as a heat source, the machine does not heat its surroundings. This allows comfortable operation.
- \*1: It depends on working condition and operating condition  
\*2: It depends on the power supply environment

### (3) Safety, reliability, and maintainability

- The battery components superior in safety and reliability are mounted  
We combined the battery manufacturer's lithium-ion battery with performance records in handling of high loads in various fields on the globe and in commercial vehicles and the components for the work equipment operation such as the hydraulic pumps, the controller, and the electric motor to harmonize with Komatsu's original coordination technique, which enabled the optimization of the entire machine control system and the development of the tough protective structure of the battery. The digging performance and the durability equivalent to those of an engine-driven hydraulic excavator is realized.

### 3. Machine configuration

#### 3.1 Overview of system configuration

The battery-powered system consists of the lithium-ion battery, the electric motor/inverter for driving the main pump, the battery thermal management system, the DCDC converter for 24 V auxiliaries, and the in-house manufactured power distribution unit. In the system, the in-house manufactured distribution unit is the platform to allow discretion for the number of connections to outside manufactured electric components and the in-house produced logic is implemented in the in-house manufactured controller to utilize the functions of the outside manufactured electric components. (Fig. 2, 3, 4)

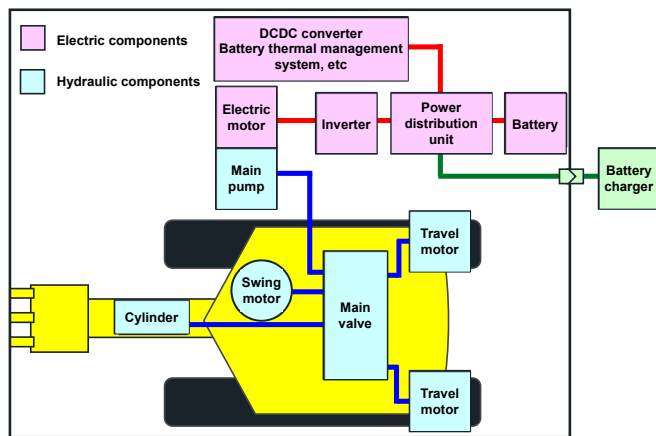


Fig. 2 Configuration of battery-powered system components

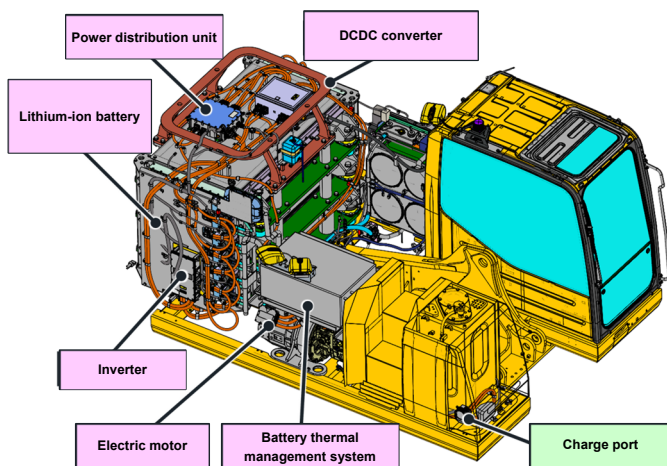


Fig. 3 Layout of electric components

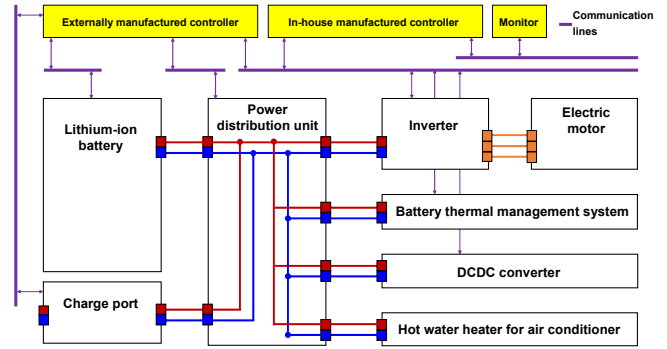


Fig. 4 Schematic diagram of high-voltage circuit

#### 3.2 Machine configuration components

##### 3.2.1 Battery

A lithium-ion battery pack with high energy density which has proven performance in safety and toughness with commercial vehicles is adopted.

Six battery packs are mounted on the machine to realize a large capacity of 451 kWh.

As a single battery pack has only vibration resistance for on-road, the battery frame with the vibration suppression mechanism using the damper mount is used to ensure the vibration resistance for off-road. (Fig. 5)

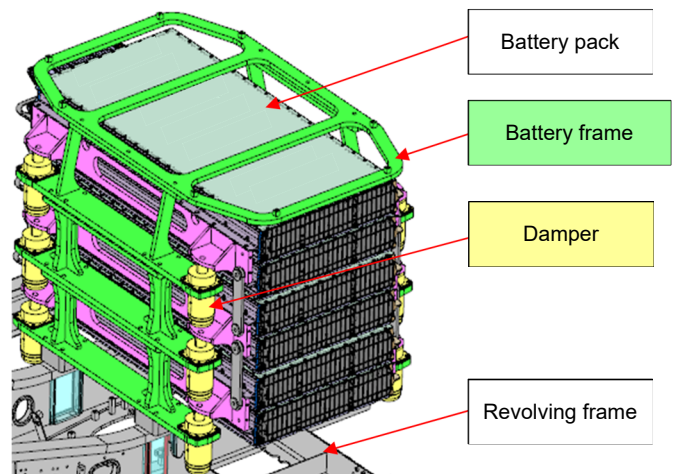


Fig. 5 Image of the lithium-ion battery pack on board

### 3.2.2 Battery thermal management system

The outside manufactured battery thermal management system that satisfies the battery temperature control performance requirements is adopted.

The water-coolant type is selected with the consideration of dustproof performance for construction machine operation sites.

The battery thermal management system ensures the vibration resistance on off-road by using the rubber mounting. (Fig. 6)

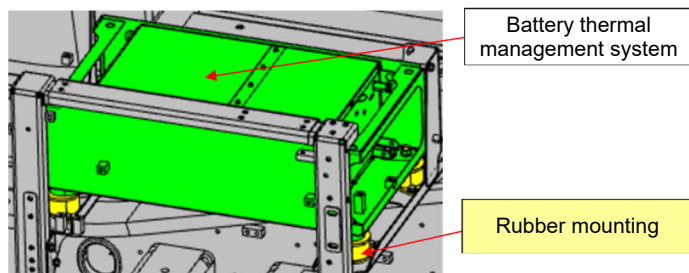


Fig. 6 Image of outside manufactured battery thermal management system on board

### 3.2.3 Electric motor, inverter

The outside manufactured electric motor (rated output 123 kW) and the inverter which realizes the performance equivalent to the conventional model motor are adopted.

The electric motor ensures the vibration resistance on off-road by using the rubber mounting (Fig. 7). The inverter ensures the vibration resistance on off-road as it is fixed on the battery frame with the vibration suppression using the damper mounting.

We have been reviewing the design of the components to adapt them to construction machines in cooperation with the manufacturers.

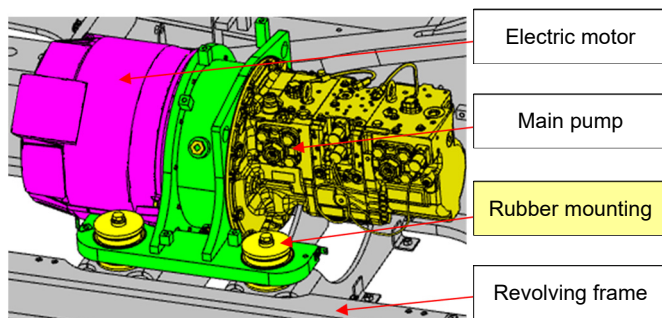


Fig. 7 Image of outside manufactured electric motor on board

### 3.2.4 Power distribution unit

The power distribution unit which distributes the power from the battery to each electric component has newly been developed. (Fig. 8)

The unit is manufactured in-house to ensure the mounting to construction machines and the environment resistance.

It also has freedom in connection to adapt to the standards of outside manufactured electrical components from various manufacturers and the safety function to respond to malfunctions of these electrical components.

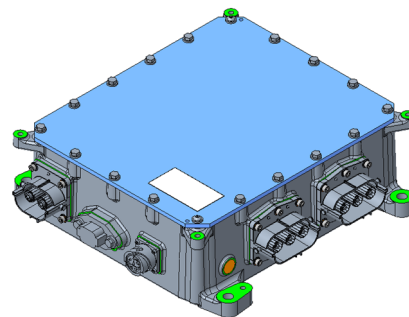


Fig. 8 Power distribution unit

## 4. Conclusion

We live in the era of global warming, and now global boiling, and come to realize that full achievement of the original goal of carbon neutrality has become essential. We proceeded with the development of these machines with an approach in which the persons concerned sort out the problems supposed to arise in the process of electrification through the introduction, and we take the ones which can be solved at the time and leave the ones which require major improvements to the next model to be developed, with emphasis on speed of development.

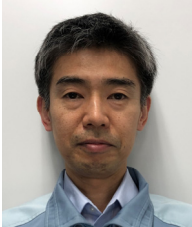
The realization of carbon neutrality is a very difficult problem and needs a long period of time. We will continue our endeavor to incorporate further quality improvement in the development of the next model, keeping the view of the speed, to present measures for realizing carbon neutrality.

## Introduction of the authors



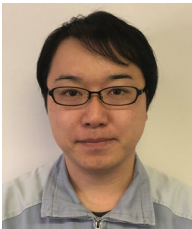
**Masaho Yamaguchi**

Joined Komatsu Ltd. in 1991.  
Vehicle Development Center 2,  
Development Division



**Norihiko Sato**

Joined Komatsu Ltd. in 1998.  
Electrification Development Center,  
Development Division



**Makoto Chiba**

Joined Komatsu Ltd. in 2010.  
Electrification Development Center,  
Development Division

## [A comment from the authors]

After three years from the conclusion of the collaboration contract with the battery manufacturer and then the start from zero, the machines are now in the process of the market introduction with a small scale. We, the development department, had made considerable efforts in the process but this attainment was possible with strong support from the departments of production, procurement, sales, service, and management.

These machines are the first models as middle-sized hydraulic excavators and we had some difficulties. The advices and support from the development departments of the preceding mini-excavator and the subsequent model greatly helped us.

Lastly, we would like to thank all the people concerned in this project.