



Service Manual

Controller

EC15N	A4EC1-10200-up
EC18N	A4EC1-20200-up
EC20N	A4EC2-10200-up
EC25N	A4EC2-20200-up
EC25EN	A4EC3-20200-up
EC25LN	A4EC3-30200-up
EC30N	A4EC3-40200-up

FOREWORD

This service manual is a guide to servicing of Cat® lift trucks. The instructions are grouped by systems to serve the convenience of your ready reference.

Long productive life of your lift trucks depends to a great extent on correct servicing — servicing consistent with what you will learn from this service manual. Read the respective sections of this manual carefully and familiarize yourself with all the components you will work on, before attempting to start a test, repair or rebuild job.

The descriptions, illustrations and specifications contained in this manual are of the trucks with the serial numbers in effect at the time it was approved for printing. Cat lift truck reserves the right to change specifications or design without notice and without incurring obligation.

Safety Related Signs

The following safety related signs are used in this service manual to emphasize important and critical instructions:



Indicates a specific potential hazard that could result in serious bodily injury or death.



Indicates a specific potential hazard that may result in bodily injury, or damage to, or destruction of, the machine.



Indicates a condition that can cause damage to, or shorten service life of, the machine.

SAFETY

 WARNING

The proper and safe lubrication and maintenance for this lift truck, recommended by Cat lift truck, are outlined in the **OPERATION & MAINTENANCE MANUAL** for these trucks.

Improper performance of lubrication or maintenance procedures is dangerous and could result in injury or death. Read and understand the **OPERATION & MAINTENANCE MANUAL** before performing any lubrication or maintenance.

The serviceman or mechanic may be unfamiliar with many of the systems on this truck. This makes it important to use caution when performing service work. A knowledge of the system and/or components is important before the removal or disassembly of any component.

Because of the size of some of the truck components, the serviceman or mechanic should check the weights noted in this Manual. Use proper lifting procedures when removing any components.

Following is a list of basic precautions that should always be observed.

1. Read and understand all warning plates and decals on the truck before operating, lubricating or repairing the product.
2. Always wear protective glasses and protective shoes when working around trucks. In particular, wear protective glasses when pounding on any part of the truck or its attachments with a hammer or sledge. Use welders gloves, hood/goggles, apron and other protective clothing appropriate to the welding job being performed. Do not wear loose-fitting or torn clothing. Remove all rings from fingers when working on machinery.
3. Do not work on any truck that is supported only by lift jacks or a hoist. Always use blocks or jack stands to support the truck before performing any disassembly.

 WARNING

Do not operate this truck unless you have read and understand the instructions in the **OPERATION & MAINTENANCE MANUAL**. Improper truck operation is dangerous and could result in injury or death.

4. Lower the forks or other implements to the ground before performing any work on the truck. If this cannot be done, make sure the forks or other implements are blocked correctly to prevent them from dropping unexpectedly.
5. Use steps and grab handles (if applicable) when mounting or dismounting a truck. Clean any mud or debris from steps, walkways or work platforms before using. Always face truck when using steps, ladders and walkways. When it is not possible to use the designed access system, provide ladders, scaffolds, or work platforms to perform safe repair operations.
6. To avoid back injury, use a hoist when lifting components which weigh 23 kg (50 lb.) or more. Make sure all chains, hooks, slings, etc., are in good condition and are of the correct capacity. Be sure hooks are positioned correctly. Lifting eyes are not to be side loaded during a lifting operation.
7. To avoid burns, be alert for hot parts on trucks which have just been stopped and hot fluids in lines, tubes and compartments.
8. Be careful when removing cover plates. Gradually back off the last two bolts or nuts located at opposite ends of the cover or device and pry cover loose to relieve any spring or other pressure, before removing the last two bolts or nuts completely.
9. Be careful when removing filler caps, breathers and plugs on the truck. Hold a rag over the cap or plug to prevent being sprayed or splashed by liquids under pressure. The danger is even greater if the truck has just been stopped because fluids can be hot.

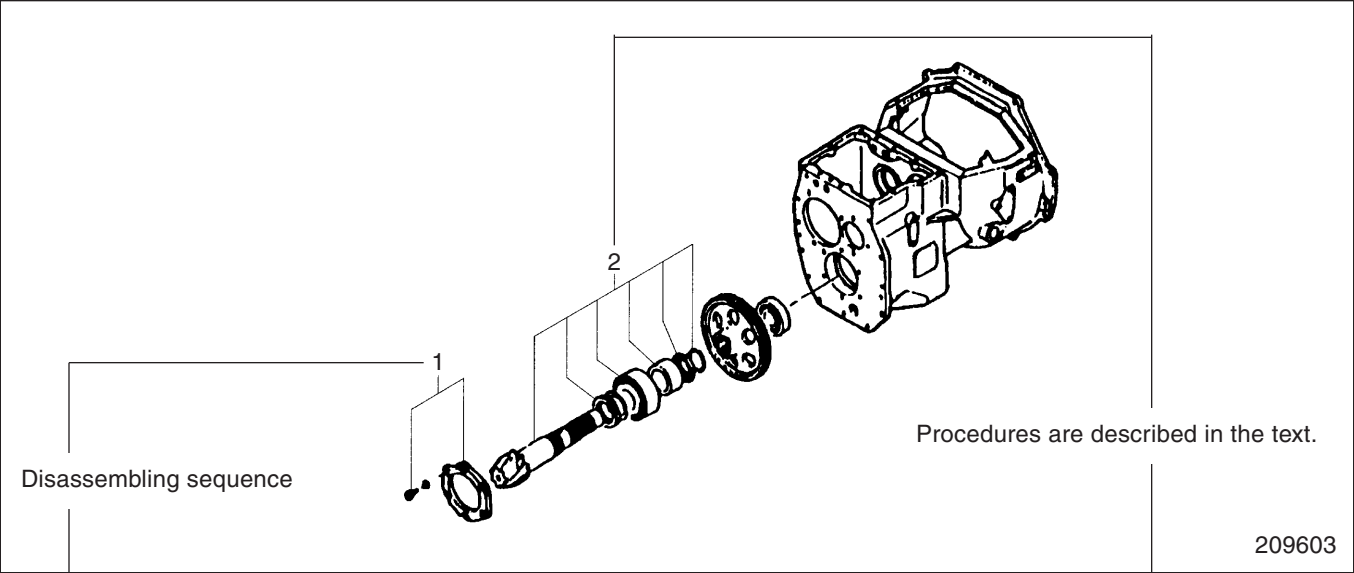
10. Always use tools that are in good condition and be sure you understand how to use them before performing any service work.
11. Reinstall all fasteners with same part number. Do not use a lesser quality fastener if replacements are necessary.
12. If possible, make all repairs with the truck parked on a level, hard surface. Block truck so it does not roll while working on or under truck.
13. Disconnect battery and discharge any capacitors (electric trucks) before starting to work on truck. Hang "Do not Operate" tag in the Operator's Compartment.
14. Repairs, which require welding, should be performed only with the benefit of the appropriate reference information and by personnel adequately trained and knowledgeable in welding procedures. Determine type of metal being welded and select correct welding procedure and electrodes, rods or wire to provide a weld metal strength equivalent at least to that of parent metal.
15. Do not damage wiring during removal operations. Reinstall the wiring so it is not damaged nor will it be damaged in operation by contacting sharp corners, or by rubbing against some object or hot surface. Place wiring away from oil pipe.
16. Be sure all protective devices including guards and shields are properly installed and functioning correctly before starting a repair. If a guard or shield must be removed to perform the repair work, use extra caution.
17. Always support the mast and carriage to keep carriage or attachments raised when maintenance or repair work is performed, which requires the mast in the raised position.
18. Loose or damaged fuel, lubricant and hydraulic lines, tubes and hoses can cause fires. Do not bend or strike high pressure lines or install ones which have been bent or damaged. Inspect lines, tubes and hoses carefully. Do not check for leaks with your hands. Pin hole (very small) leaks can result in a high velocity oil stream that will be invisible close to the hose. This oil can penetrate the skin and cause personal injury. Use cardboard or paper to locate pin hole leaks.
19. Tighten connections to the correct torque. Make sure that all heat shields, clamps and guards are installed correctly to avoid excessive heat, vibration or rubbing against other parts during operation. Shields that protect against oil spray onto hot exhaust components in event of a line, tube or seal failure, must be installed correctly.
20. Relieve all pressure in air, oil or water systems before any lines, fittings or related items are disconnected or removed. Always make sure all raised components are blocked correctly and be alert for possible pressure when disconnecting any device from a system that utilizes pressure.
21. Do not operate a truck if any rotating part is damaged or contacts any other part during operation. Any high speed rotating component that has been damaged or altered should be checked for balance before reusing.
22. When handling the parts containing asbestos, be careful not to inhale the asbestos. Doing so is hazardous to your health.

If the shop dust may contain asbestos, follow the precautions described below.

 - a. Do not use compressed air for cleaning.
 - b. Do not brush or apply grinder on asbestos containing materials.
 - c. To clean asbestos containing materials, wipe with moistened cloth or use a vacuum cleaner with particle filter.
 - d. If you have to handle the parts containing asbestos for a long time, be sure to do it in a well-ventilated area.
 - e. If the asbestos in the air cannot be removed, wear a mask.
 - f. Be sure to observe the working rules and regulations.
 - g. When disposing of materials with asbestos, be sure to observe the environmental protection regulations of your area.
 - h. Avoid working in the atmosphere where asbestos particles may be suspended.

HOW TO USE THIS MANUAL
(Removal, Installation, Assembly and Disassembly)

Disassembly diagram (example)

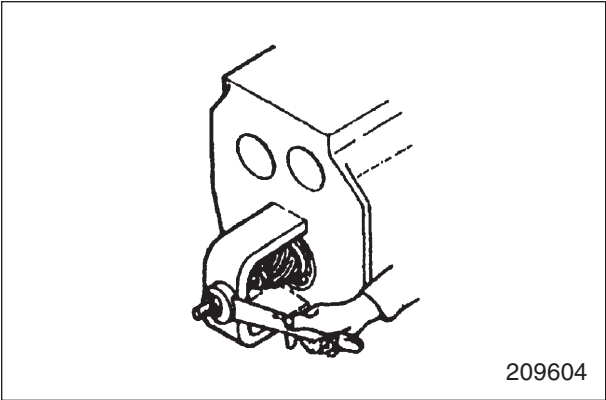


Sequence

- 1 Cover , Bolt, Washer (part name)
- 2 Snap ring (part name)

Suggestion for disassembling

- 1. Output shaft, Removing
Remove output shaft using a special tool.



Service Data

Gear Backlash	A	0.11 to 0.28 mm (0.0043 to 0.0110 in.)
	B	0.5 mm (0.020 in.)

A: Standard Value

B: Repair or Service Limit

Symbols or abbreviation

OP	Option
R1/4	Taper pipe thread (external) 1/4 inch (formerly PT1/4)
Rc1/8	Taper pipe thread (internal) 1/8 inch (formerly PT1/8)
G1/4A	Straight pipe thread (external) 1/4 inch (formerly PF1/4-A)
Rp1/8	Straight pipe thread (internal) 1/8 inch (formerly PS1/8)

Units

1. SI Units are used in this manual.
2. The following table shows the conversion of SI unit and customary unit.

Item	SI unit	Customary unit
Force	1 N	0.1020 kgf
	(1 lbf)	(0.4536 kgf)
Pressure	1 kPa	0.0102 kgf/cm ²
	(1 psi)	(0.0703 kgf/cm ²)
Torque	1 N·m	0.1020 kgf·m
	(1 lbf·ft)	(0.1383 kgf·m)

GROUP INDEX

GROUP INDEX	Items
CONTROLLER	Controller system, Controller features, Setup option, Diagnosis, Removal and installation, Basic check
TROUBLESHOOTING FOR CONTROL CIRCUITS	Faulty central vehicle monitor system, Faulty diagnosis indication, or Other abnormalities
MOTORS	Motor installation positions, Specifications, Structures, Tightening of high-power cable terminals, Procedures and suggestions for removal and installation, Procedures and suggestions for disassembly and reassembly

1**2****3**

CONTROLLER

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Controller System

System Configuration

The truck is controlled by the logic unit and the inverter.

The system configuration is classified into two types according to the lifting control system: the Contactor Control Type and the Transistor Control Type.

The Contactor Control Type controls the DC pump motor by the contactor. The Transistor Control Type controls the AC induction pump motor by the inverter.

The logic unit is the main part of the control system and controls the traveling, lifting and safety function systems. The logic unit is connected to the inverter, display unit and other control switches.

The inverter controls the AC induction traction (drive) motor and the AC induction pump motor.

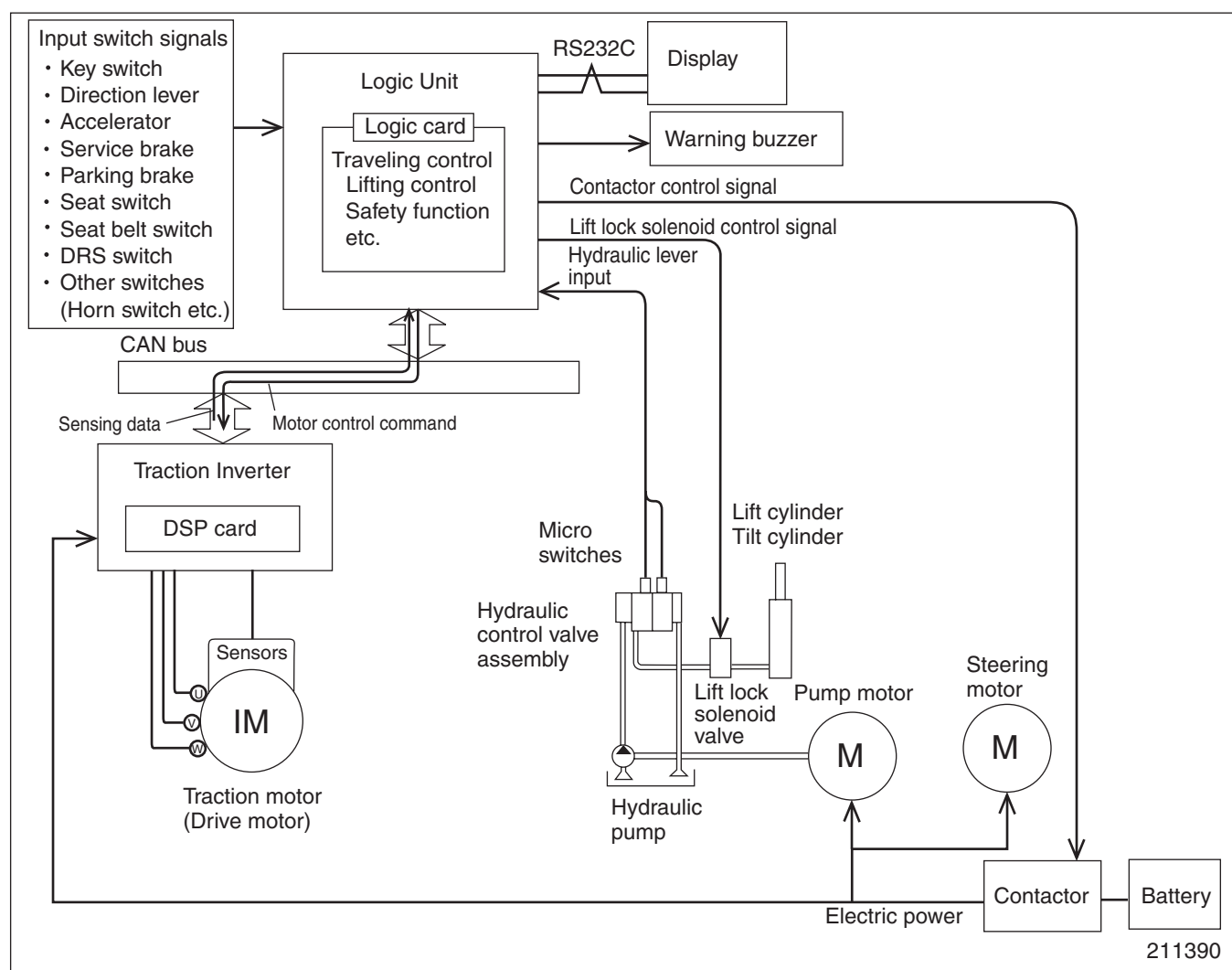
The logic unit and the inverter are linked together by the Controller Area Network (CAN) to communicate with each other. The logic unit sends the motor control command to the inverter and the inverter sends the sensing data to the logic unit.

The display unit indicates the truck conditions and setting data.

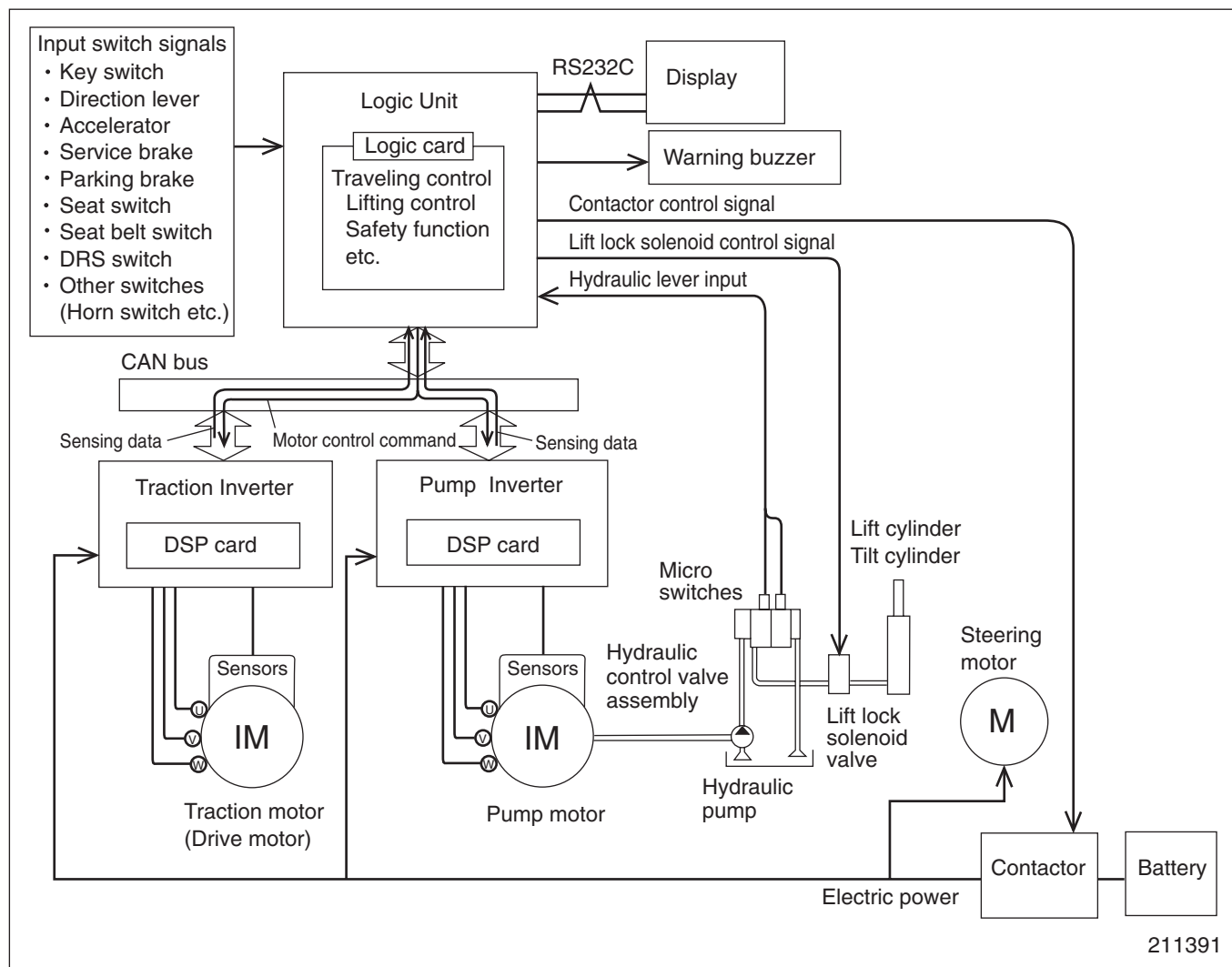
The logic unit communicates with the display unit through the serial communication protocol (RS232C).

The system configurations of the Contactor Control Type and the Transistor Control Type are as follows.

System Configuration for Contactor Control Type



System Configuration for Transistor Control Type



Controller Area Network (CAN)

Each controller is linked with the truck harness to form a network as follows.

The positions of terminal resistors (120 Ω) differ between the Contactor Control Type and the Transistor Control Type.

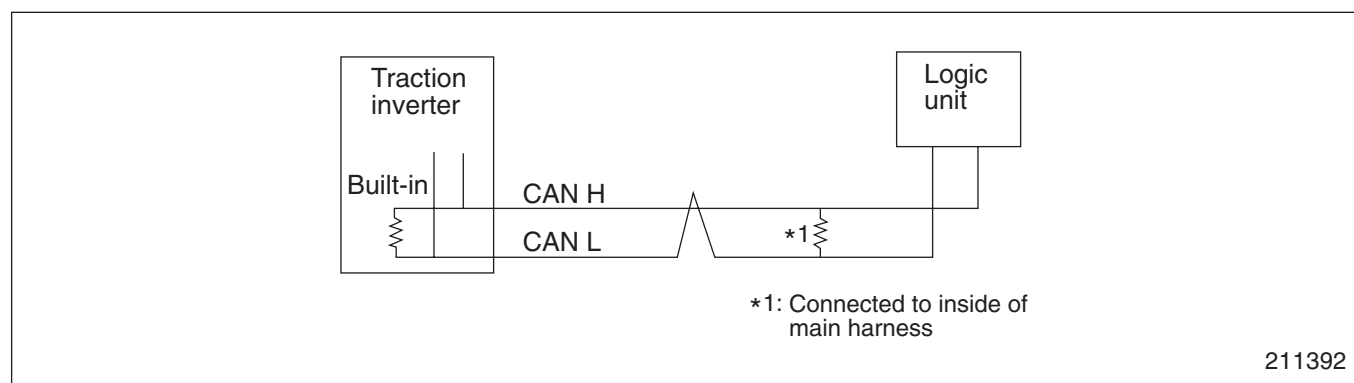
One of the terminal resistors is built into the traction inverter and another terminal resistor is connected to the inside of main harness (near the connector P3) in the Contactor Control Type.

In the Transistor Control Type, the terminal resistors are built into the traction inverter and the pump inverter.

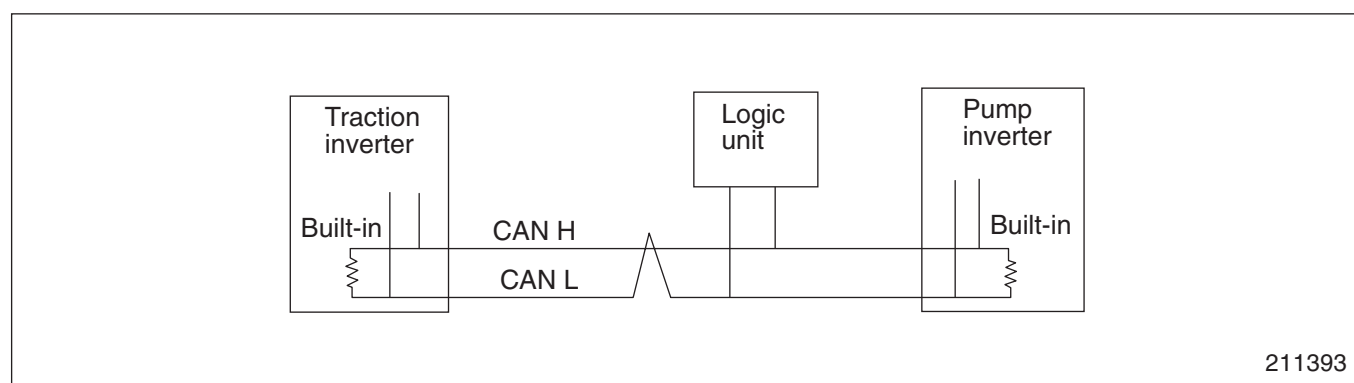
If the terminal resistors are not properly connected, the communication failure may occur between the logic unit and the inverters.

For details, see the “Traction Inverter Fault (63)” and “Pump Inverter Fault (65)” in “Troubleshooting for Control Circuits.”

Network for Contactor Control Type



Network for Transistor Control Type

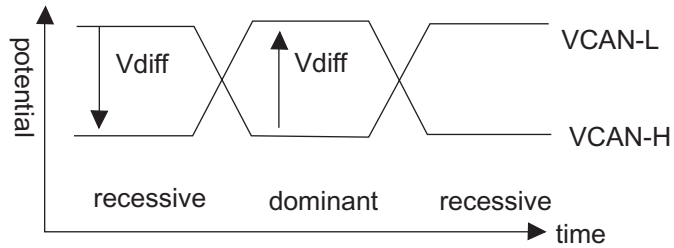


CONTROLLER

The data are expressed with electric potential difference in high- and low-level signals as follows.

They are transferred to each controller through the serial communication protocol.

Kind of bit	Logic
dominant	0
recessive	1



211176

Main specifications

Communication protocol	CANbus 2.0B passive	Non-Return to Zero method Broadcast communication protocol
Communication line	Dual 2-wire type serial communication	
Communication speed	500 kbps	
Data length	0 to 8 bytes	

Outline of Controller

1. Logic unit

The logic unit consists of the logic card and the power supply card.

The logic card has the CPU chips and controls all the jobs for the truck.

The logic unit calculates the traction motor control command through the input of the direction lever or accelerator pedal and sends the command to the traction inverter. It also monitors malfunctions of the traveling control system.

In the Transistor Control Type, the logic unit calculates the AC induction pump motor control command through the input of the hydraulic levers and sends the command to the pump inverter. It also monitors malfunctions of the lifting control system.

The logic unit communicates with the display unit through the RS232C. The truck speed and residual battery power are monitored and shown on the display unit. The seat belt and brake fluid level are also monitored and shown on the LED of the display unit.

The logic unit sets the model information and optional default data into internal memory. The information is secured even if the power supply for the logic unit is turned off. This information is set at the factory.

The following table shows the model information. The system will not work properly if the actual controller system is different from the model information.

Model information

Item	Description	SUO No.
Truck type	Model set	#40
Battery voltage	36 V, 48 V	#41
Battery type	Battery type	#42
Hydraulic control selection	Contact Control Type, Transistor Control Type	#43
Mast type	Mast type	#44
Battery voltage adjust	Battery voltage adjustment	#46
Foot direction	Optional equipment	#47

The current information is available to confirm and modify.

Refer to “Setup Option” on page 1-19 for details and setting procedures.

The model information and various features are set by the Setup Option (SUO).

The power supply card changes the battery voltage and supplies power to the logic card and the DSP card.

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