



Service Manual

Controller

E3000	A4EC1-10200-up
E3500	A4EC1-20200-up
EC4000	A4EC1-30200-up
E4000	A4EC2-10200-up
E5000	A4EC2-20200-up
EX4000	A4EC3-10200-up
EX5000	A4EC3-20200-up
E5500	A4EC3-30200-up
E6000	A4EC3-40200-up
E6500	A4EC4-10200-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.

WARNING

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.

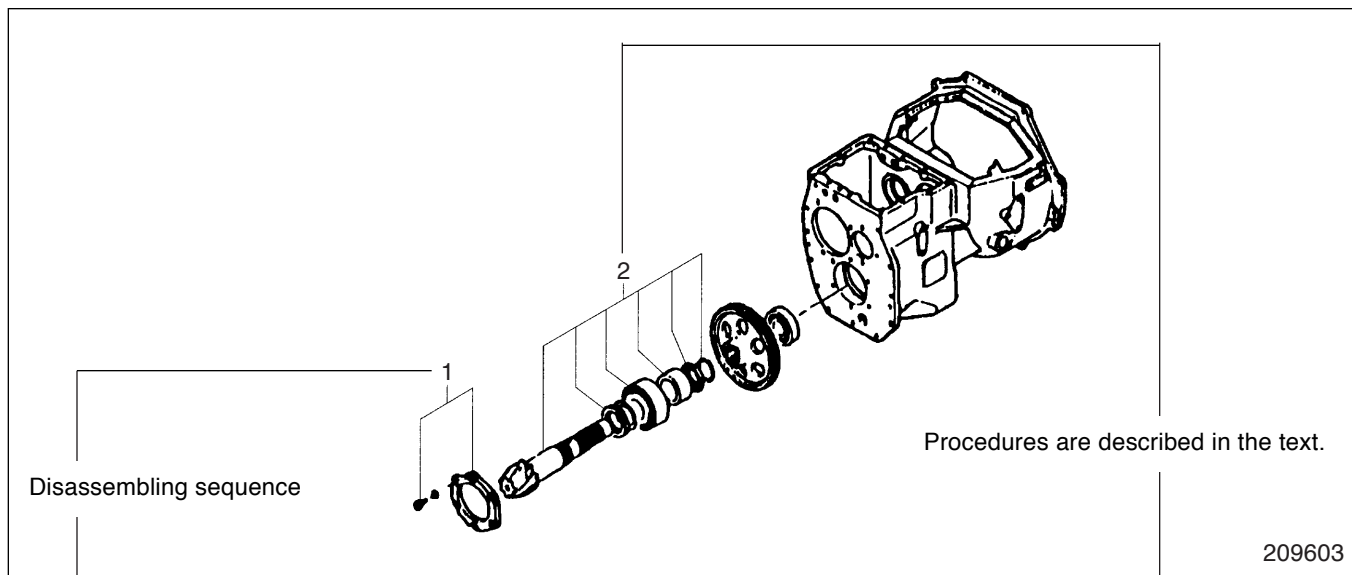
If the shop dust may contain asbestos, follow the precautions described below.

 - 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)

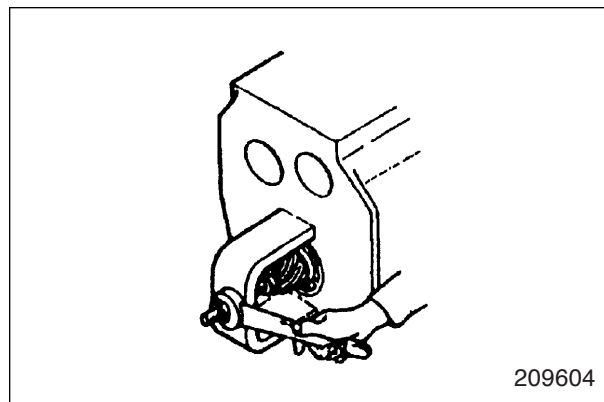


Sequence

- 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.

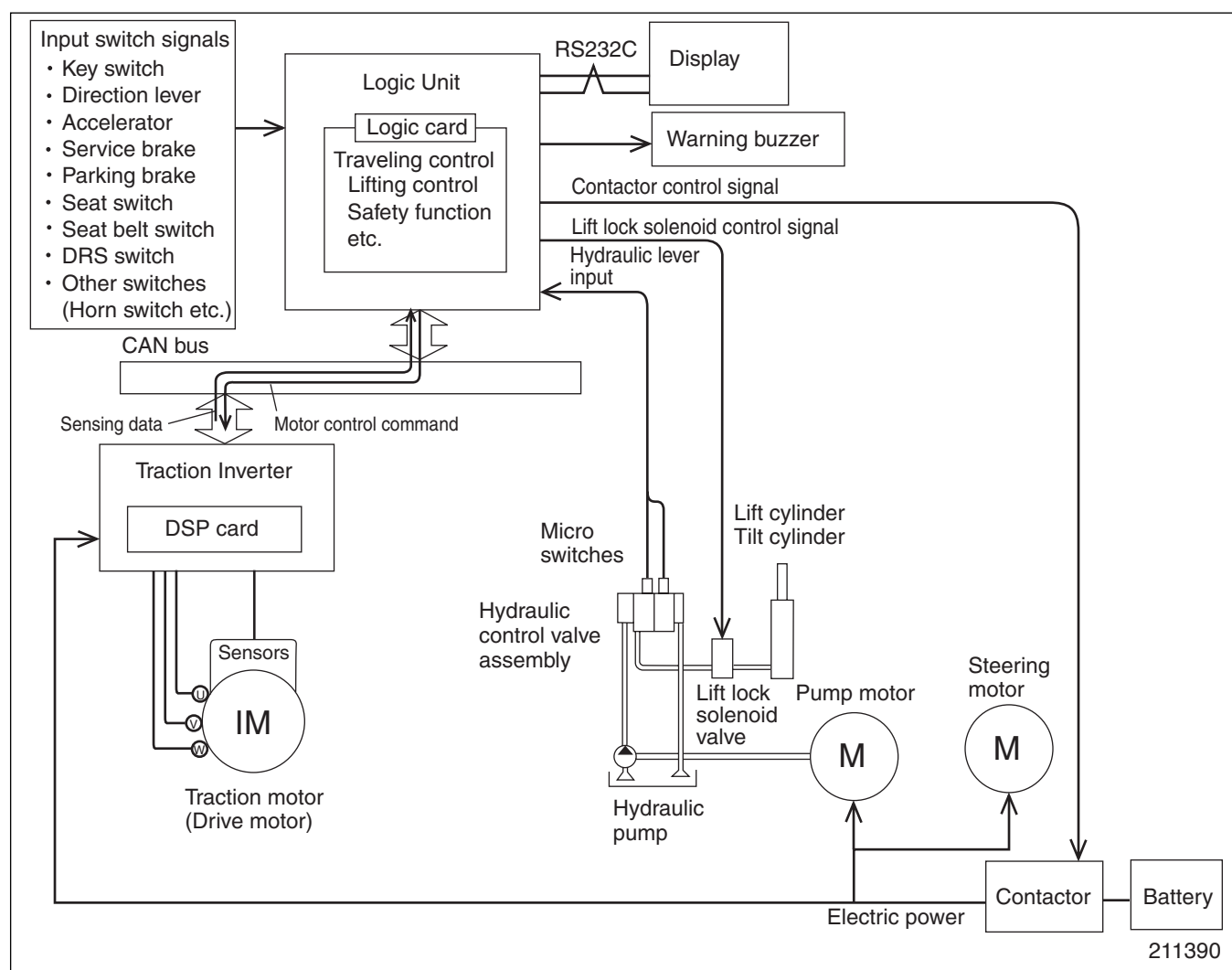
The logic unit and the inverter are linked together by the Controller Area Network (CAN) to communicate with each other. The logic unit sends the motor control command to the inverter and the inverter sends the sensing data to the logic unit.

The display unit indicates the truck conditions and setting data.

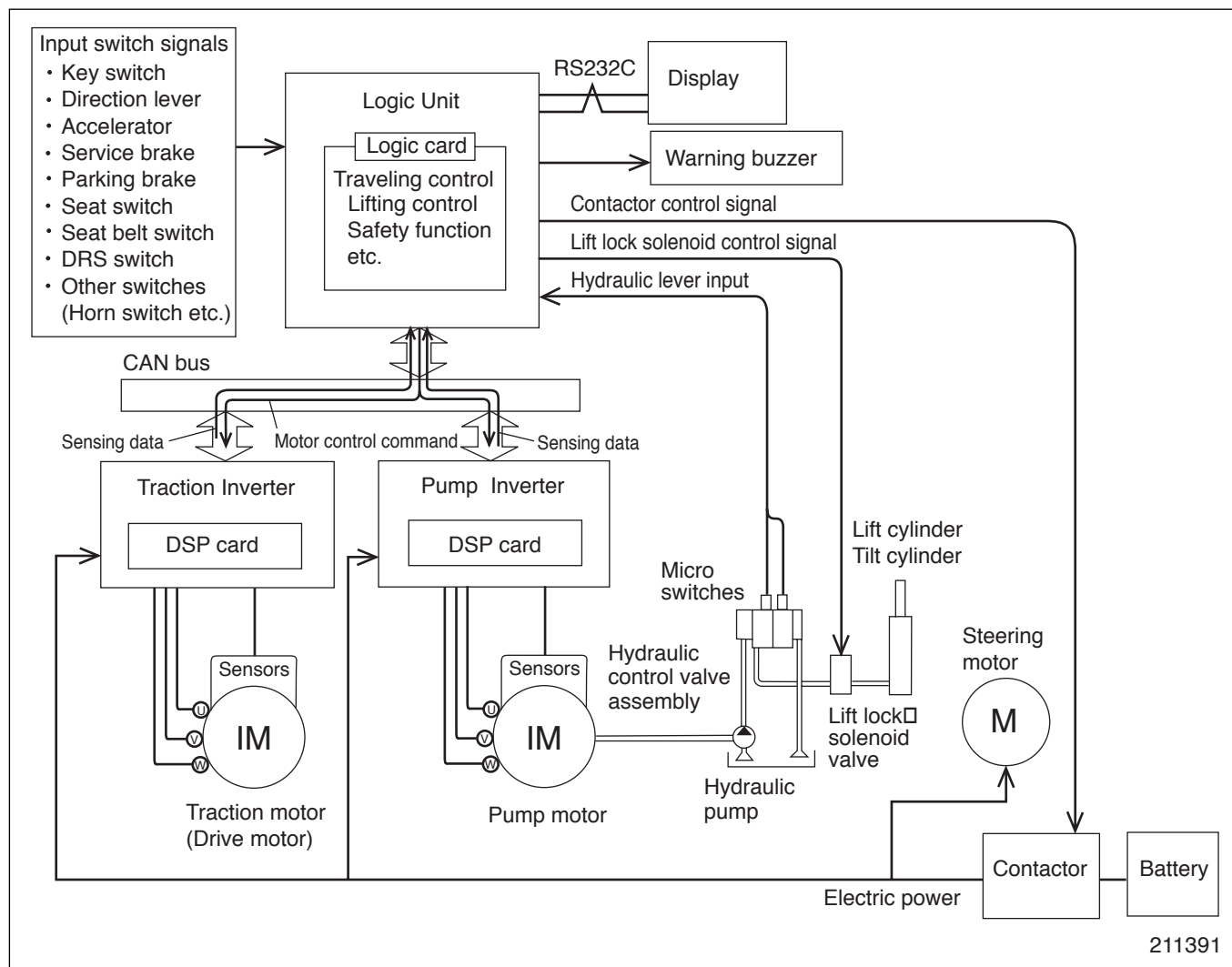
The logic unit communicates with the display unit through the serial communication protocol (RS232C).

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.

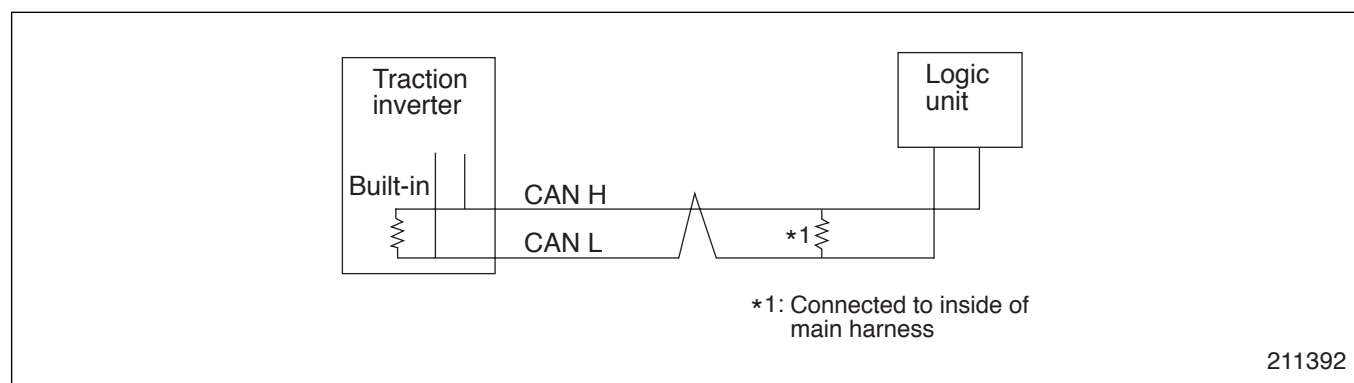
One of the terminal resistor is built into the traction inverter and another terminal resistor is connected to the inside of main harness (near the connector P3) in the Contactor Control Type.

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

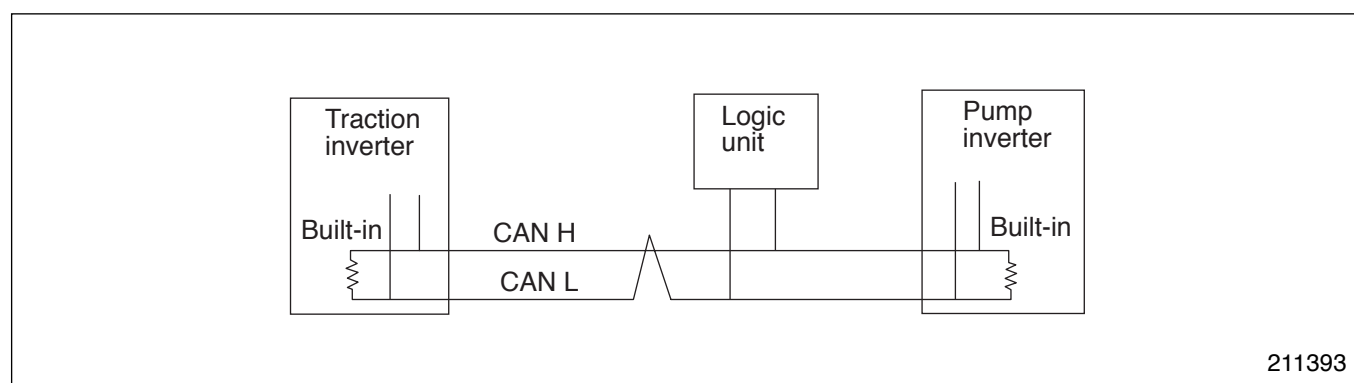
If the terminal resistors are not properly connected, the communication failure may occur between the logic unit and the inverters.

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

Network for Contactor Control Type



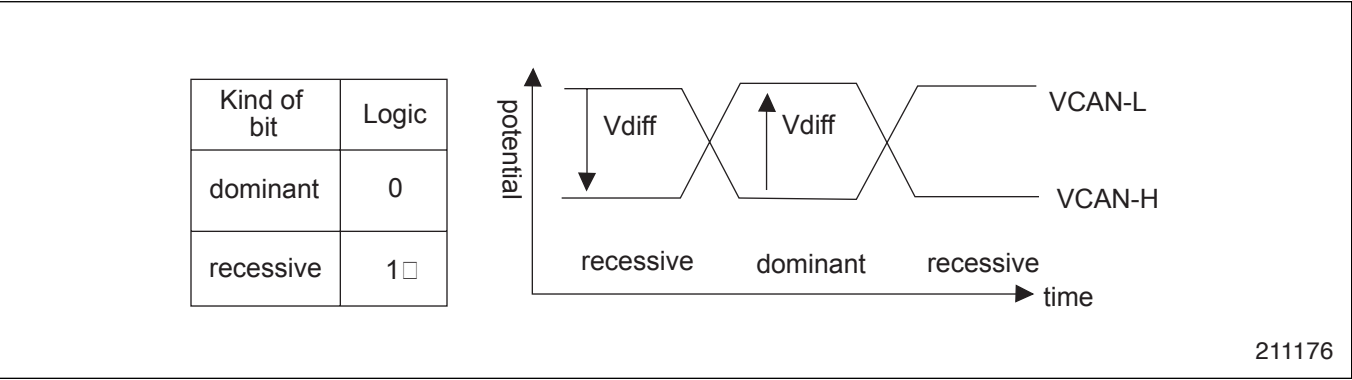
Network for Transistor Control Type



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.



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	Contacting Control Type, Transistor Control Type	#43
Mast type	Mast type	#44
Battery voltage adjust	Battery voltage adjustment	#46
Foot direction	Optional equipment	#47

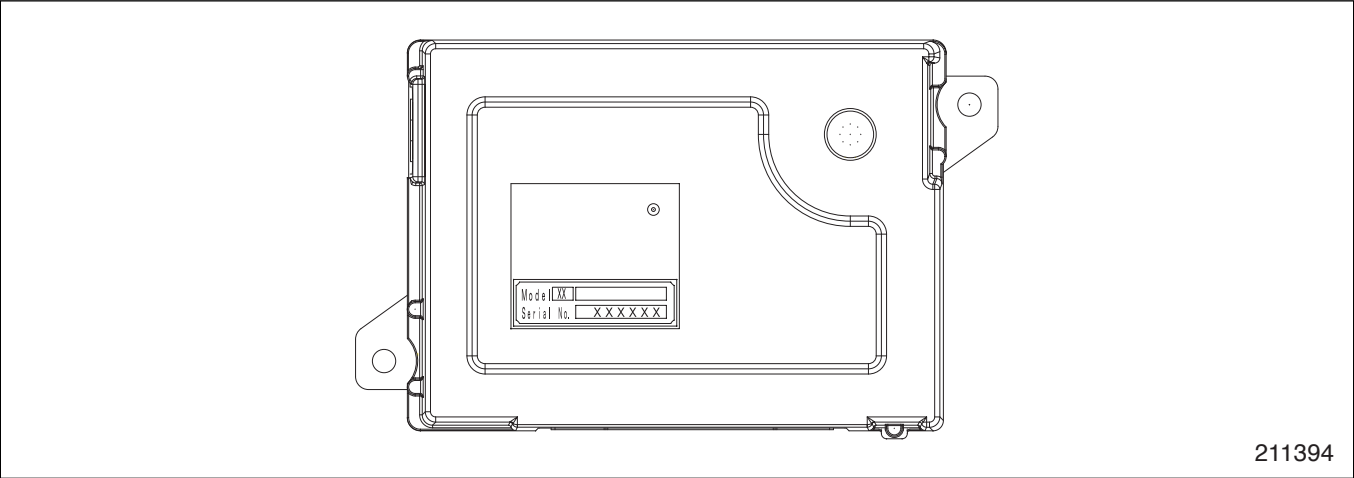
The current information is available to confirm and modify.

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

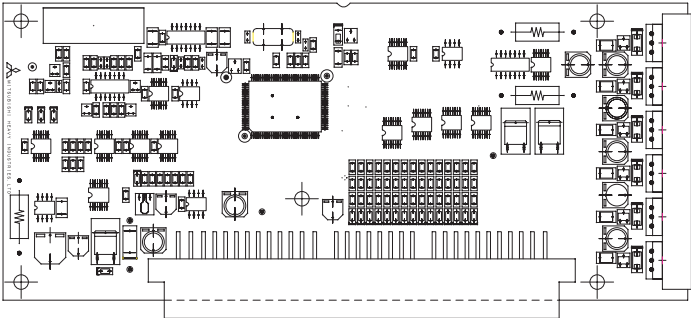
The model information and various features are set by the Setup Option (SUO).

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

Logic unit



Logic card



CN1

1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43	45	47	49	51	53	55	57	59	61	63
2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64

Logic card side CN1

25	23	21	19	17	15	13	11	9	7	5	3	1
26	24	22	20	18	16	14	12	10	8	6	4	2

Main harness side P3

41	39	37	35	33	31	29	27
42	40	38	36	34	32	30	28

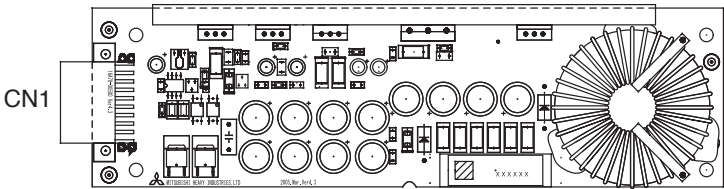
Main harness side P4

63	61	59	57	55	53	51	49	47	45	43
64	62	60	58	56	54	52	50	48	46	44

Main harness side P5

211395

Power supply card



CN1

1	3	5	7	9	11	13	15
2	4	6	8	10	12	14	16

Power supply card side CN1

15	13	11	9	7	5	3	1
16	14	12	10	8	6	4	2

Main harness side P8

211396

The Service Tool connector exists on main harness P18.

2. Inverter

The inverter is a motor drive controller that consists of Digital Signal Processor (DSP) card, Insulated Metal Substrate (IMS) module and their drive boards.

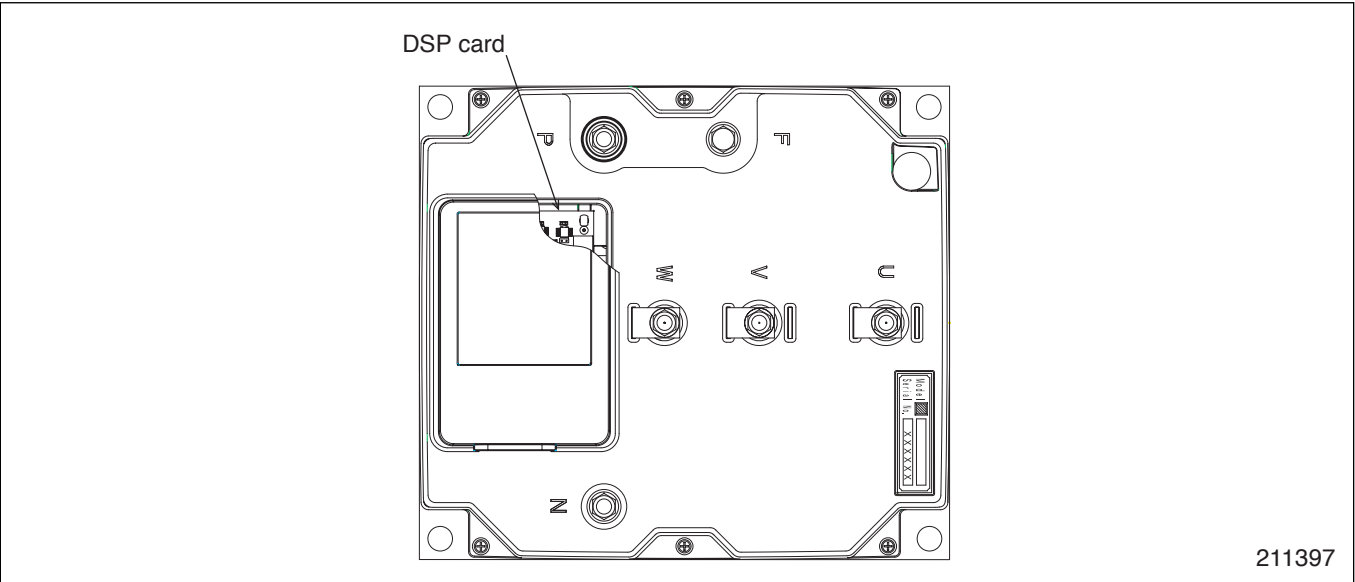
It drives the AC induction motors according to the motor control command from the logic unit. It also monitors malfunctions of motors and its own condition.

When a malfunction occurs, it stops the motors and informs to the logic unit.

The DSP card has the DSP chips that enables high-speed calculation and controls the AC induction motors.

The IMS module has plural MOS-FET modules and converts the battery DC current into AC current for supplying to the traction and pump motors. See also the “AC Motor System Basics” section on page 1-60.

Traction and pump inverters



Traction and pump inverter
DSP card

A detailed schematic of the DSP card, showing various electronic components like chips, capacitors, and connectors. A connector on the right is labeled 'CN2'.

1	3	5	7	9	11	13	15	17	19
2	4	6	8	10	12	14	16	18	20

Traction inverter card side CN2
Pump inverter card side CN2

19	17	15	13	11	9	7	5	3	1
20	18	16	14	12	10	8	6	4	2

Main harness side, Traction P1
Main harness side, Pump P2

211398

Controller Features

Traction Control Features

The line contactor closes in the following conditions when the key switch is turned on. This enables the inverter to control the traction motor.

Conditions for closing line contactor

All the following must be satisfied.

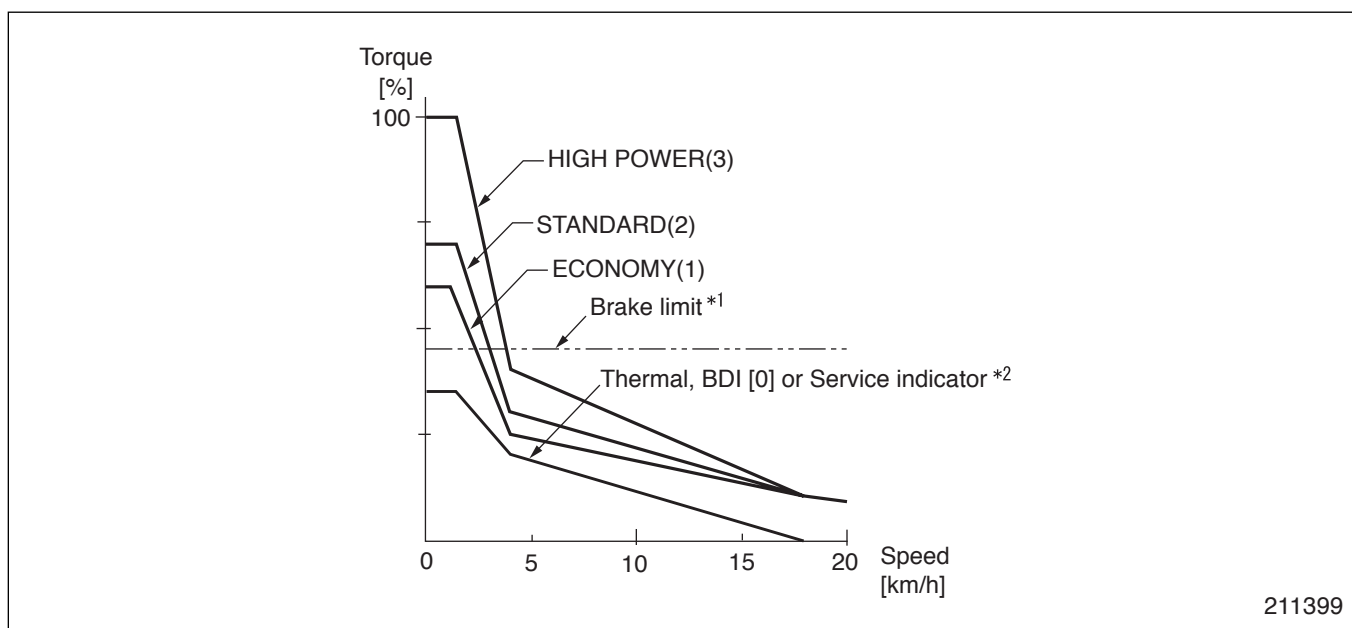
- The seat switch is turned on.
- The lifting operation is not performed (the hydraulic lever input does not occur).
- The traveling operation is not performed (the direction lever is placed to Neutral and the accelerator pedal is not pressed).
- Error related to the traveling and lifting operations does not occur.

1. Powering

(1) Normal traveling

Truck speed is controlled by the accelerator pedal depression. The speed is also controlled by the accelerator pedal depression when descending a grade and it is controlled only in the output torque range of the traction motor.

The controller supplies power to the traction motor according to the acceleration rate (set by SUO #8) and the torque characteristic (set by SUO #9) when the accelerator pedal is pressed. The controller returns power to the battery according to the deceleration rate and the torque characteristic that are set as fixed values when the truck is decelerated by releasing the accelerator pedal (regeneration function).



*1 Brake limit: Torque value resulting from reduction in current when the service brake or parking brake is applied.

*2 Thermal, BDI [0] or Service indicator: Curve of limited torque under a condition of overheating or battery voltage low or maintenance time over.

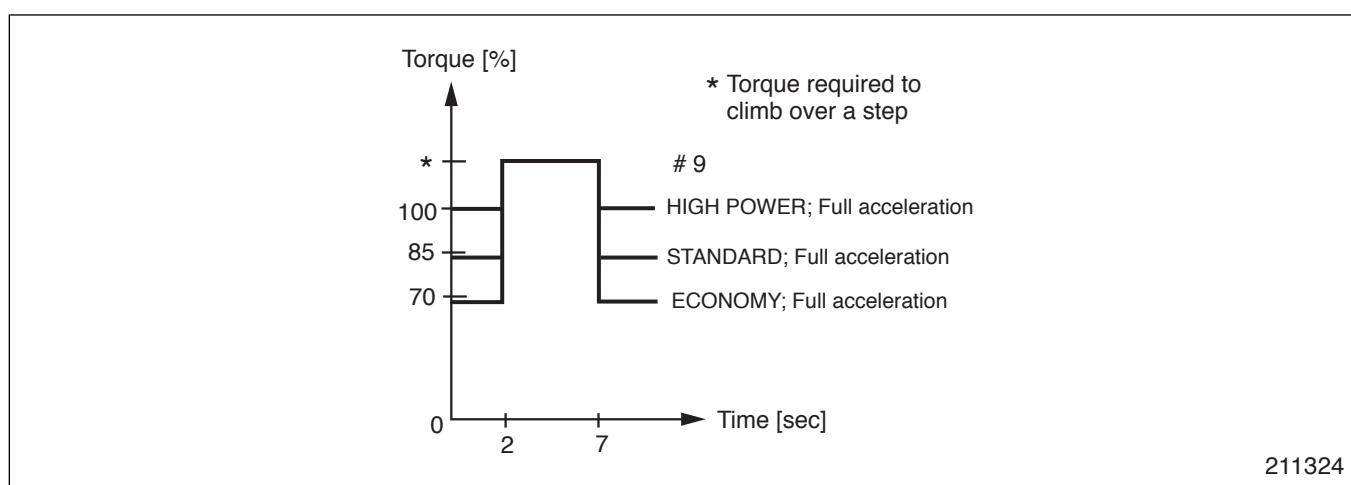
(2) Boost

When the truck traveling is blocked by a step, the boost function prevents stalling of the truck. Usually the motor maximum torque is set by SUO #9, but this function allows the truck to bypass a step regardless of the value setting of the motor maximum torque.

Fully depress the accelerator pedal for 2 seconds. The boost function increases the motor maximum torque for 5 seconds. If the pressure to the accelerator pedal is reduced or the direction lever is moved, the boost function will be canceled immediately.

If the service brake pedal is pressed or the parking brake is applied, before the boost function is activated or when the boost function is being activated, the following occurs.

- When the service brake pedal is pressed or the parking brake is applied, the boost function is not activated.
- If the service brake pedal is pressed or the parking brake is applied when the boost function is being activated, the boost function will be canceled immediately.



NOTICE: When the motor overheats, the boost will not work.

If the stall time setting is small, the motor protection function will be applied during prolonged slow speed traveling.

(3) Limitation of maximum travel speed

This function limits the maximum travel speed (set by SUO #7) of the truck.

The limitation that functions at all times and is used to keep the speed within the limits.

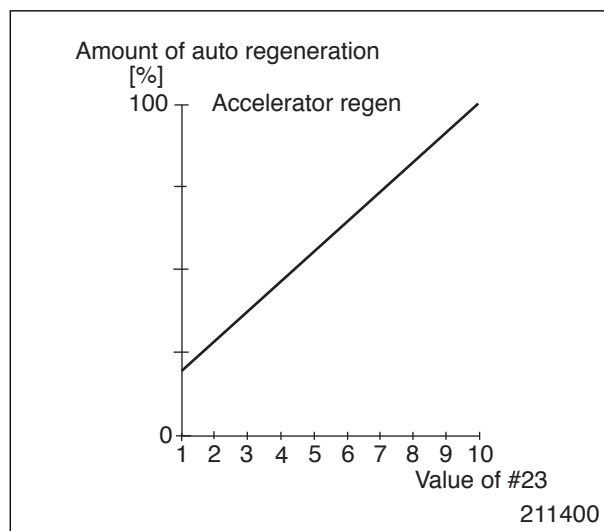
2. Regeneration

There are three types of regeneration control: the accelerator regeneration, lever regeneration and controlled roll-back.

(1) Accelerator regeneration (Auto regen)

The accelerator regeneration starts when the accelerator pedal is released with the direction lever shifted into the forward or reverse position during traveling.

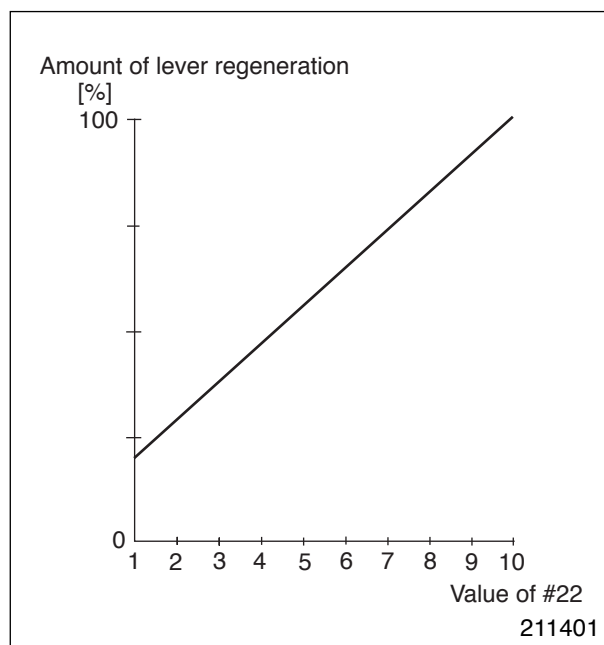
The amount of regeneration is determined by the accelerator regeneration characteristic (set by SUO #23).



(2) Lever regeneration

The lever regeneration starts when the direction lever is shifted into the position opposite to the truck traveling direction with the accelerator pedal depressed during traveling.

The amount of regeneration is determined by the lever regeneration characteristic (set by SUO #22).



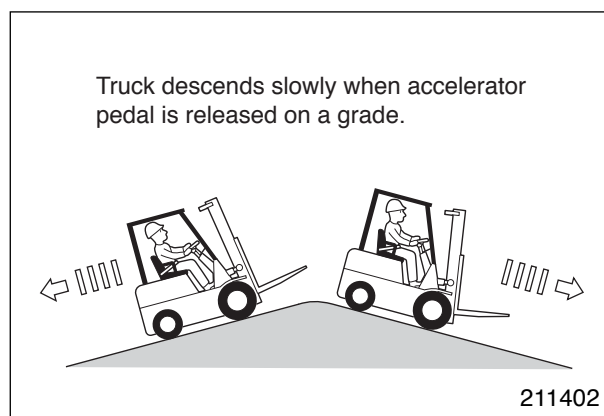
(3) Controlled roll-back

This function prevents hazardous descending of the truck on a grade.

The controlled roll-back is activated when the accelerator pedal is released on a grade with the direction lever shifted into the forward or reverse position.

The descending speed changes with the steepness of grade and the weight of load.

NOTICE: This is not a function to stop the truck when the accelerator pedal is released on a grade. This function is activated only in the output torque range of the traction motor.



Lifting Control Features

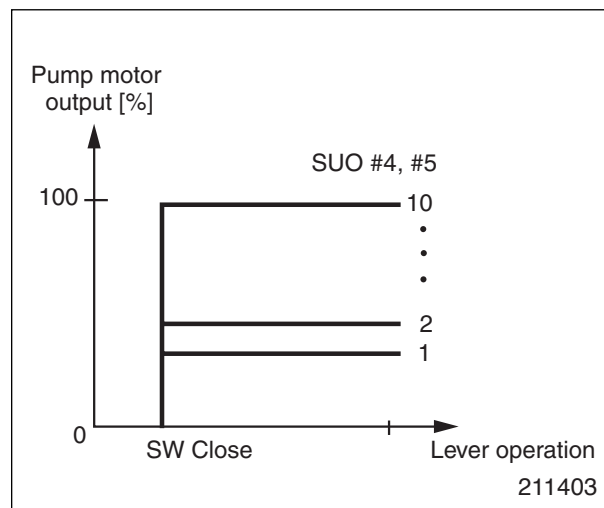
There are two types of lifting control system configuration as described on page 1-1: the Contactor Control Type and the Transistor Control Type.

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.

1. Contactor Control Type

The pump contactor closes and drives the DC pump motor when the hydraulic levers are operated with all the conditions for closing the line contactor (described in the traction control features) satisfied.

The lift work speed is controlled by not the controller but the hydraulic control valve when the hydraulic levers are operated.

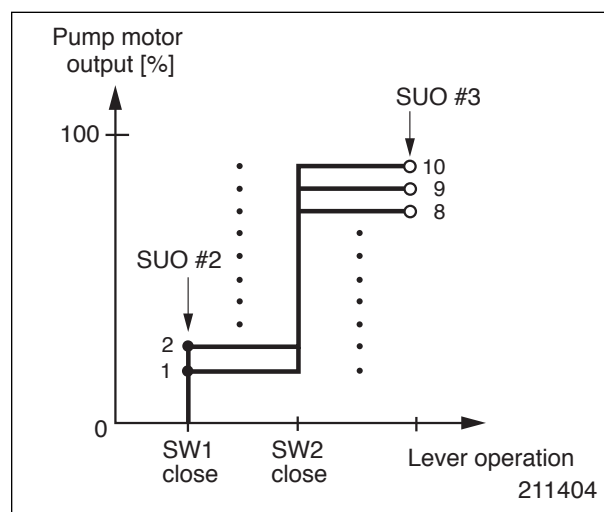


Pump motor output characteristics
(MC type, tilt and attachment 1, 2 operations)

2. Transistor Control Type

The controller drives the AC induction pump motor when the hydraulic levers are operated with all the conditions for closing the line contactor (described in the traction control features) satisfied.

When the hydraulic levers are operated simultaneously, priority is given in the following sequence: the tilt, attachment and lift-up.



Pump motor output characteristics
(MC type, lift-up operation)

Steering Control Features

The steering contactor closes and drives the steering motor when all the conditions for closing the line contactor (described in the traction control features) are satisfied. This enables the power steering operation.

After the steering contactor is closed, if the key switch is not turned off or if error related to the steering operation does not occur, the steering contactor will not be opened.

Diagnosis/Run/Setup (DRS) Modes

In addition to the normal operation mode for controlling the traveling and lifting operations, the controller has another two modes: the mode related to the truck failure and the mode for setting the truck parameter as shown in the table below.

Mode		Description
Diagnosis	Self diagnosis	Performs failure diagnosis of each equipment.
	Run time diagnosis	Displays and deletes fault data that were detected and stored in normal operation mode.
Run		Normal operation mode
Setup	Default data set	Sets default data of Group 1 & Group 2.
	Group 1 data set	Sets basic function.
	Group 2 data set	Sets detailed function.
	Group 3 data set	Sets model information.

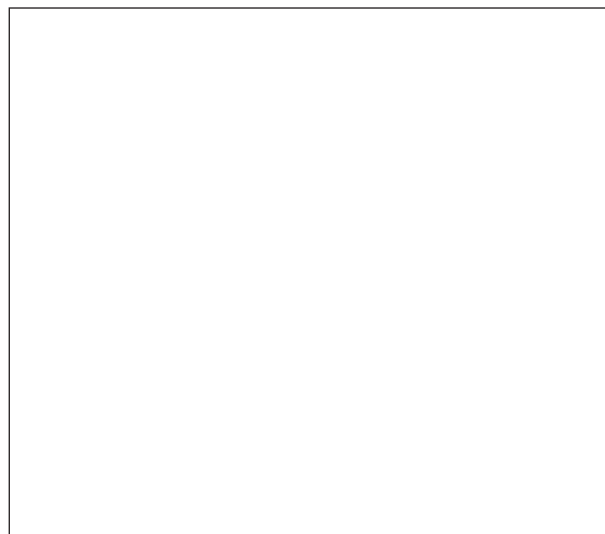
1. Mode setting with DRS switch

To enter each mode, turn off the key switch and set the DRS switch to the required position, then turn on the key switch.

NOTICE: If the DRS switch is set with the key switch turned on, the mode will not be changed.

To enter the Diagnosis and Setup modes, it is required to operate the seat switch, accelerator pedal, direction lever and hydraulic levers in addition to the DRS switch setting.

See “Setup Option” and “Diagnosis” for further details.



2. Mode setting on display unit (for setting SUO #1 of Setup Option Group 1)

The SUO #1 of the Setup Option data can be set (checked and changed) by pressing the buttons on the display unit in the RUN mode.

The setting procedures are as follows.

See “Setup Option” for details of SUO #1.

2.1 Turning on key switch in RUN mode

- (1) Turn off the key switch, then set the DRS switch to the RUN position.
- (2) Turn on the key switch.

The mode becomes RUN mode (The traveling and lifting operations can be performed). The display unit shows the clock, truck speed and BDI (Battery Discharge Indicator).

2.2 Setting SUO #1 (checking and changing data)

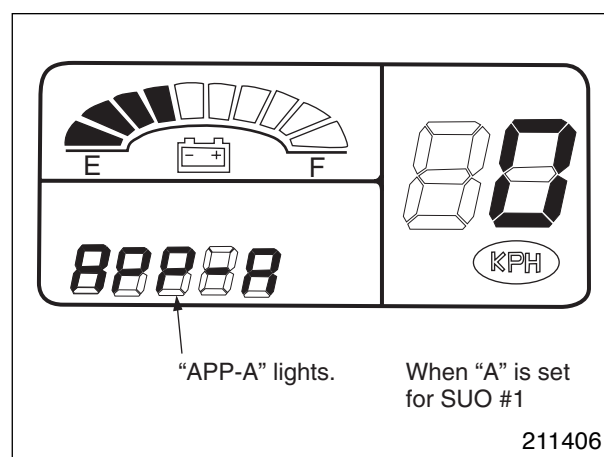
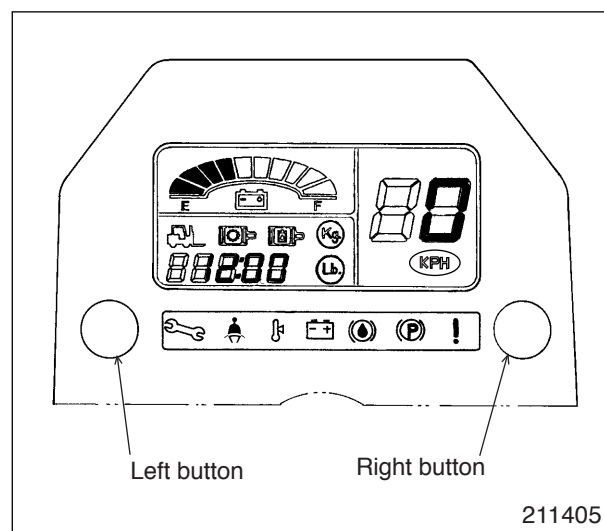
To check data, perform the following procedures.

- (1) Turn off all the operations (Turn off all the direction lever, accelerator pedal and hydraulic lever operations).
- (2) Press the right button on the display unit.

The mode changes to the data checking mode for SUO #1.

(Pressing the right button 4 seconds or more changes the mode to the data changing mode.)

- The clock indication of the display unit changes to the current data indication of SUO #1.
- The truck speed and BDI indications do not change.

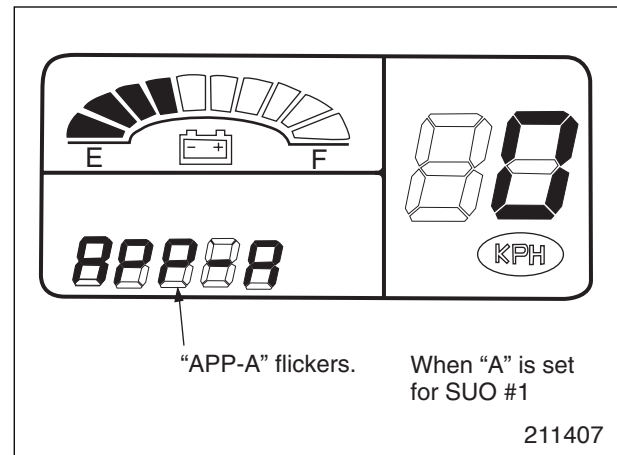


(3) When terminating the data checking mode for SUO #1, perform the following procedure.

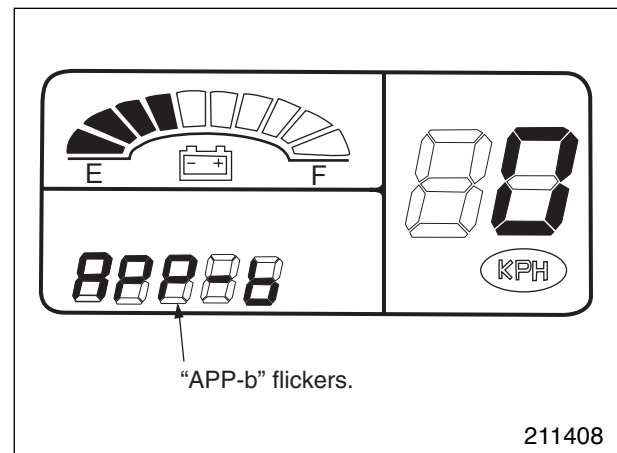
- Press the left button on the display unit.
The mode changes to RUN mode.
- Press the right button on the display unit.
The mode changes to RUN mode.
- Press the right button 4 seconds or more.
The mode changes to the data changing mode for SUO #1.

To change data, perform the following procedures.

- (1) Perform steps (1) and (2) of the data checking procedures to change the mode to the data checking mode.
- (2) Press the right button on the display unit 4 seconds or more. The mode changes to the data changing mode for SUO #1.
 - Current data of SUO #1 flickers. This enables to change the SUO #1 data.



- (3) Press the left button on the display unit to change the SUO #1 data.



(4) When terminating the data changing mode for SUO #1, perform the following procedure.

- Press the right button on the display unit.
The mode changes to RUN mode.

- NOTICE:
- If the direction lever, accelerator pedal or hydraulic lever is operated during SUO #1 setting, the SUO #1 setting will be canceled.
 - When the display unit shows the error code (except for “E” flickering and “L” flickering), SUO #1 setting can not be performed.
If the error code is displayed during SUO #1 setting, the SUO #1 setting will be canceled.

Safety Function

1. PDS (Presence Detection System)

(1) Preventing operator's absence

This function prevents the truck from traveling or lifting without the operator sitting on the seat.

For details, see the table below.

Item	Prevention result	
	When turning on power, operator is not on seat.	During normal operation, operator is not on seat.
Traveling	Stop Error code "E" flickers.	Deceleration and stop Error code "E" flickers.
Lifting	Stop Error code "L" flickers.	Stop Error code "L" flickers.
Line contactor	OPEN	OPEN after truck stops.
Steering	Stop (Steering contactor OPEN)	Operated

(2) Preventing lever and accelerator pedal operations

This function prevents the truck from traveling or lifting when turning on the key switch with the levers or accelerator pedal operated.

This also prevents the truck from traveling or lifting even if the line contactor closes when the operator is on the seat again after leaving the seat.

For details, see the table below.

Operated item	Prevention result	
	When turning on power	When operator is on seat again after leaving seat
Direction lever or accelerator pedal	Traveling, lifting and steering stop. Error code "E" lights.	Traveling and lifting stop. Error code "E" lights.
Lift lever	Traveling, lifting and steering stop. Error code "H1" lights.	Traveling and lifting stop. Error code "H1" lights.
Tilt lever	Traveling, lifting and steering stop. Error code "H2" lights.	Traveling and lifting stop. Error code "H2" lights.
Attachment 1 lever or attachment 2 lever	Traveling, lifting and steering stop. Error code "H3" lights.	Traveling and lifting stop. Error code "H3" lights.

(3) Preventing lift down

This function prevents the lift from lowering when the lift lever is operated with the key switch turned off.

The lift does not lower as the lift lock valve is closed when the key switch is turned off (when the control system is not controlled by the controller).

(4) Warning buzzer

- **Parking brake warning**

The buzzer sounds when the key switch is turned off or the operator leaves the operator's seat with the parking brake not applied.

- **Seat belt warning**

The buzzer sounds when the seat belt is not fastened with the operator on the operator's seat.

2. Stall timer

Traction Motor Stall Timer (Error code 16) error occurs to prevent the traction motor from overheating when the truck traveling is blocked for several seconds by a step though the accelerator pedal is fully depressed.

The time to shut down the truck can be set by SUO #20.

Other Features

1. BDI (Battery Discharge Indicator)

The BDI shows the remaining battery capacity of the current battery voltage with 11 levels from BDI 0 to BDI 10.

Set the BDI by SUO #40 and SUO #41 depending on the installed battery type and voltage.

If the previous indication is BDI 4 or less and the following indication is not BDI 7 or more when turning on the key switch, the BDI will show the previous indication.

When the battery voltage lowers, the following output power control is activated by the BDI function to protect the battery.

Control by BDI 1: Traveling is limited.

Control by BDI 0: Traveling and lifting are limited, and simultaneous operations of traveling and lifting are inhibited.

2. Service indicator

The maintenance time and the selection of output power control can be set by SUO #10.

The service indicator starts flickering 20 hours before the set maintenance time, and remains lit when the truck hour meter indication reaches the set time.

If the output power control is selected at SUO #10, the output power control will also be activated at the same time to limit the traveling and lifting operations.

3. Tire size

Tire diameter change resulting from tire wear can be compensated for by SUO #27.

This setting is used to adjust the truck speed indication when it differs from the actual speed by tire wear.

Setup Option

Outline

The logic unit is equipped with a type of memory module to hold recorded data even if the main power is

turned off.

The model information and various features are set during factory shipment.

The setup options are categorized from Group 1 to Group 3 according to the feature levels.

Setup group

Group	Description
Group 1	Basic function (#1 to #10)
Group 2	Detailed function (#20 to #27)
Group 3	Model information (#40 to #47)

The Group 1 and 2 are available to set the default value in a one-step operation and can be customized in accordance with applications. Since the Group 3 is for model information, it is required to be set to the same value as actual control system. It will not work properly if the model information is different.

When setting the setup option data for the first time after the assembly is completed or the logic card is replaced, be sure to set Group 3 data first, then the default data of Group 1 and 2, with the “service tool” in

each setup mode.

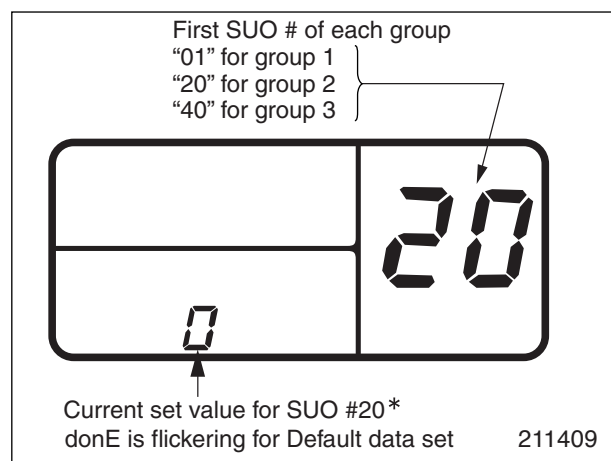
Summary list in each group is shown on page 1-34 to 1-37.

Operation Procedure

Turning on the key switch allows you to enter one of the modes in each setup group and show as the figure. You can not transfer to another mode unless the source power is turned off.

Entry to setup mode

Function	Description	DRS switch	Seat	Direction lever	Accel. pedal	Lift lever	Tilt lever	Attachment 1 lever
Default data set	Sets default data of Group 1 & Group 2.	S	Not sit	R	ON	OFF	OFF	OFF
Group 1 data	Checks and sets basic function (#1 to #10).	S	Not sit	N	OFF	OFF	OFF	OFF
Group 2 data	Checks and sets detailed function (#20 to #27).	S	Not sit	N	OFF	Pull	Pull back	OFF
Group 3 data	Checks and sets model information (#40 to #47).	S	Not sit	N	OFF	OFF	OFF	Pull back



First SUO # of Group 2 setup options (example)

*The current value is displayed. For the meaning of each number or symbol displayed, refer to the “Range” column of the relevant Setup Options table and Notes below the table.

Selecting SUO # and changing set value

The set value change procedure consists of selecting the desired SUO # using the DRS switch, changing the set value by moving the direction lever, and registering the new value.

- Cycle the DRS switch $S \rightarrow R \rightarrow S$. The set value displayed on the screen is registered. The SUO # on the screen then advances to the next SUO #. Changing the set value is now possible for the SUO #.

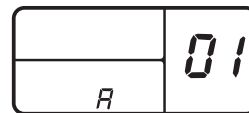
The first half of the DRS switch operation ($S \rightarrow R$) is for overwriting the previous value with the value on the screen (registering). When the value is registered, a set of three dotted lines appears on the screen as shown in the illustration on the right. The second half of the operation ($R \rightarrow S$) is for advancing the SUO #.

- Every time the DRS switch is cycled $S \rightarrow R \rightarrow S$, the SUO # increments. When advancing the SUO # without changing the set value, simply repeat by cycling the switch as many times as necessary. When the last SUO # is reached, "done" appears in the set value display area.
- Use the direction lever to change the set value. The value increases when the lever is cycled $N \rightarrow F \rightarrow N$; it decreases when the lever is cycled $N \rightarrow R \rightarrow N$. In either case, by increasing or decreasing direction, the value returns to the first or last value in the available value range.

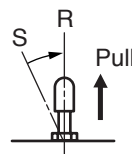
How to change set value

When changing setting of SUO #7 (Top Travel Speed Limit) from default 15 km/h to 13 km/h:

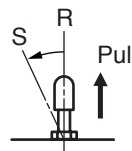
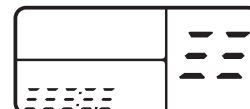
- Step 1. Since the SUO #7 belongs to Group 1 setup options, cause the first SUO # "01" of the group to appear on the screen using the operation procedure on page 1-19.



- Step 2. Move the DRS switch as follows to change the current setting for the SUO #7.



- (1) Move the DRS switch $S \rightarrow R$. The display changes as shown below. The set value (A) for the SUO #1 is overwritten simultaneously.



- (2) Move the DRS switch $R \rightarrow S$. The display shows the current setting for the next SUO #2.

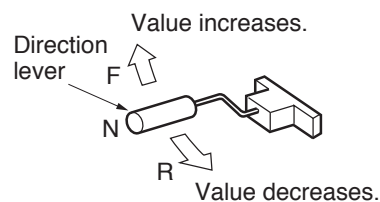


- (3) Cycle the DRS switch $S \rightarrow R \rightarrow S$ 4 times to cause the SUO #7 to appear on the screen.



Default value 15 for SUO #7

- Step 3. Change the set value from 15 to 13 by moving the direction lever $N \rightarrow R$ twice.



- Step 4. Register the new value by cycling the DRS switch $S \rightarrow R \rightarrow S$. The current value is overwritten with the new value. The screen shows the next SUO #8.

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Details of Setup Options

1. Setup Options (Group-1)

#1 Application Pre-Sets (Truck Operation Mode)

Truck mode can be selected from A to E, each with preset values for maximum vehicle speed, acceleration rate, power, automatic regeneration power, start lift speed, top lift speed and tilt speed.

These 7 settings are automatically set by changing the value of this setting.

Preset values for each setting are as follows. The setting range is A to E. (When #40 is set for “EE type” and #43 is set for “MC Contactor Control Type”: C only.)

For procedures for setting on the display unit, see page 1-13 in the “Controller Features.”

- **48V type mode setting**

							SUO#
Mode		A	b	C	d	E	1
Feature/ Application		STANDARD	HIGH POWER	ECONOMY	LONG DISTANCE	SHORT SHUTTLE	
Characteristic	Lift	Medium	Fast	Slow	Medium	Medium	
	Tilt	Medium	Medium	Medium	Medium	Medium	
	Vehicle speed	Medium	Fast	Slow	Fast	Fast	
	Acceleration	Medium	Fast	Medium	Medium	Fast	
	Power	Standard	Powerful	Economy	Powerful	Standard	
	Regeneration	Medium	High	Low	Medium	High	
Default value	Start Lift Speed	1	1	1	1	1	2
	Top Lift Speed	9	10	8	9	10	3
	Tilt Speed	7	7	7	7	7	4
	Max Vehicle Speed	15	18	12 or 14 ^{*1}	17	15	7
	Acceleration Rate	3	5	2	3	5	8
	Traveling Power	2	3	1	2	3	9
	Automatic Regeneration	7	7	7	7	7	23

^{*1}: When #41 is set for “48 volts” and #43 is set for “MC Contactor Control Type”, the mode C is 14 [km/h].
For setting other than above, the mode C is 12 [km/h].

You can modify these 7 settings afterwards individually. When settings are changed the indication (A to E) will be flickered to indicate that the settings are modified.

CONTROLLER

- 36V type mode setting**

							SUO#
Mode		A	b	C	d	E	1
Feature/ Application		STANDARD	HIGH POWER	ECONOMY	LONG DISTANCE	SHORT SHUTTLE	
Characteristic	Lift	Medium	Fast	Slow	Medium	Medium	
	Tilt	Medium	Medium	Medium	Medium	Medium	
	Vehicle speed	Medium	Fast	Slow	Fast	Fast	
	Acceleration	Medium	Fast	Medium	Medium	Fast	
	Power	Standard	Powerful	Economy	Powerful	Standard	
	Regeneration	Medium	High	Low	Medium	High	
Default value	Start Lift Speed	1	1	1	1	1	2
	Top Lift Speed	9	10	8	9	10	3
	Tilt Speed	7	7	7	7	7	4
	Max Vehicle Speed	15	18 or 17 ^{*1}	12 or 11 ^{*2}	17	15	7
	Acceleration Rate	3	5	2	3	5	8
	Traveling Power	2	3	1	2	3	9
	Automatic Regeneration	7	7	7	7	7	23

^{*1}: When #40 is set for “2.0 tons or more” and #41 is set for “36 volts”, the mode b is 17 [km/h].

For setting other than above, the mode b is 18 [km/h].

^{*2}: When #40 is set for “less than 2.0 tons”, #41 is set for “36 volts” and #43 is set for “MC Contactor Control Type”, the mode C is 11 [km/h].

For setting other than above, the mode C is 12 [km/h].

#2 Start Lift Speed

This setting affects pump speed when you start lifting operation.

MC spec: speed when lift switch 1 is turned on

Lift speed of the rise direction will become faster if the setting value is increased.

The setting range is 1 to 10 for all models.

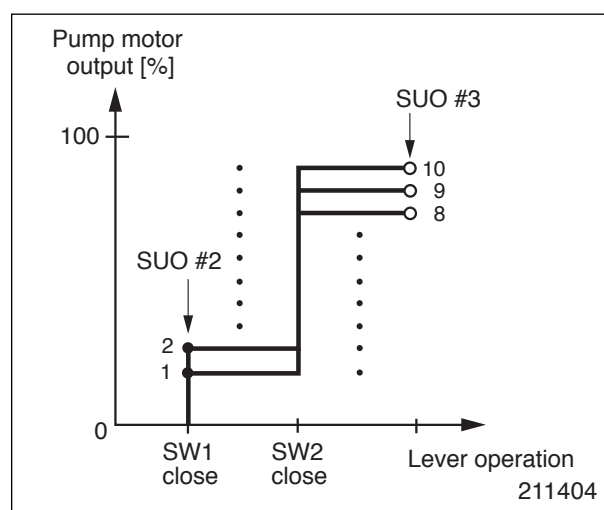
#3 Top Lift Speed

This setting affects pump speed when you pull the lift lever. If you set a smaller value than #2, then the #2 setting will be ignored.

MC spec: speed when lift switch 2 is turned on

Lifting speed will become faster if the value setting is increased.

The setting range is 1 to 10 for all models.



Pump motor output characteristics
(MC type, lift-up operation)

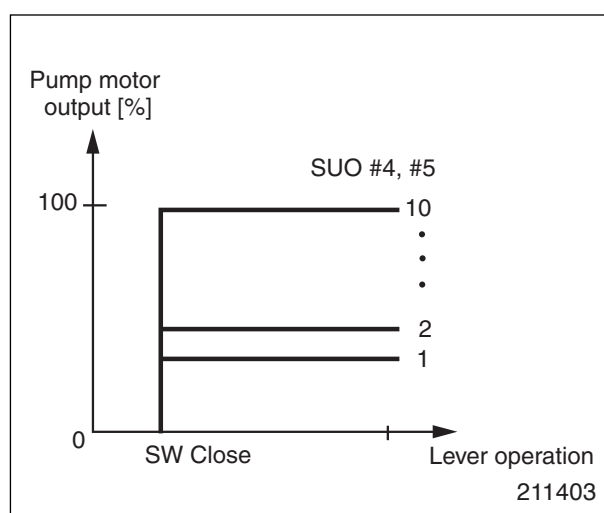
#4 Tilt Speed

This setting affects pump speed when you operate the tilt lever.

MC spec: speed when tilt switch is turned on

Tilt speed will be faster if the value setting is increased. The setting range is 1 to 10 for all models.

Tilt speed has priority over lifting speed, when the two levers are operated simultaneously.



Pump motor output characteristics
(MC type, tilt and attachment 1, 2 operations)

#5 Auxiliary 1 Speed

This setting affects pump speed when you operate the attachment 1 lever.

MC spec: speed when attachment 1 switch is turned on

Attachment 1 speed will become faster if the value setting is increased. The setting range is 1 to 10 for all models.

#6 Auxiliary 2 Speed

This setting is not used for all models.

Attachment 2 speed is the same as attachment 1 (#5).

#7 Top Travel Speed Limit

This setting affects maximum truck speed without load. Truck speed with load will be less than this setting. This setting affects top speed, and does not affect gradability or acceleration.

The setting range is 5 to 18 [km/h].

[When #40 is set for "2.0 tons or more (except for EE type)", #41 is set for "36 volts" and #43 is set for "MC Transistor Control Type": 5 to 17.]

[When #40 is set for "less than 2.0 tons (EE type)", #41 is set for "36 volts" and #43 is set for "MC Contactor Control Type": 5 to 11.]

[When #40 is set for "2.0 tons or more (EE type)", #41 is set for "36 volts" and #43 is set for "MC Contactor Control Type": 5 to 12.]

[When #41 is set for "48 volts (EE type)" and #43 is set for "MC Contactor Control Type": 5 to 14.]

#8 Acceleration Rate

This setting affects response time to calculate speed order from accelerator pedal position.

Acceleration of trucks becomes faster if the value setting is increased.

The setting range is 1 to 5.

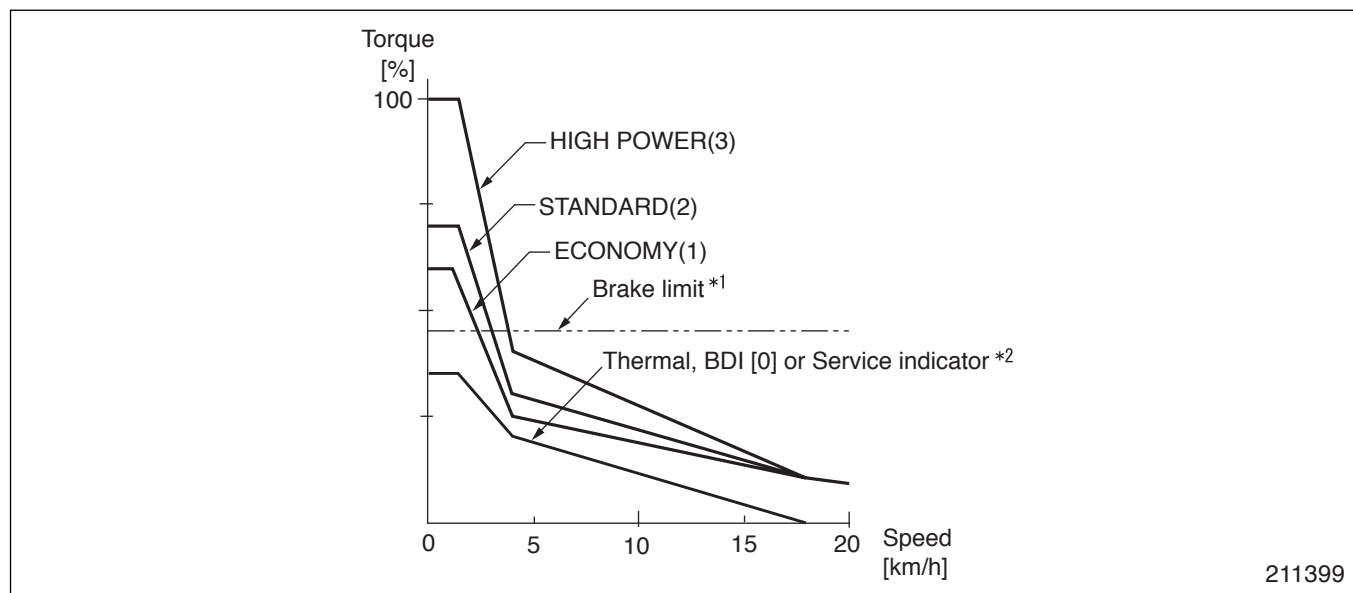
(When #40 is set for "EE type" and #43 is set for "MC Contactor Control Type": 1 to 2.)

#9 Traveling Power

This setting affects speed order which is calculated from accelerator pedal position.

The values are selected from three types : ECONOMY, STANDARD and HIGH POWER. (When #40 is set for “EE type” and #43 is set for “MC Contactor Control Type”: ECONOMY only.)

The figure is a torque characteristic at the time of Powering.



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*1 Brake limit : Torque value resulting from reduction in current when the service brake or parking brake is applied.

*2 Thermal, BDI [0] or Service indicator :
Curve of limited torque under a condition of overheating or battery voltage low or maintenance time over.

#10 Service Indicator

This setting sets the maintenance time. The time set here is added to the truck's hour meter and that value is stored in memory as the “maintenance time.”

When the truck's hour meter reaches maintenance time, the service reminder LED turns on.

It will flicker 20 hours before the time.

You can reduce the truck power when the LED flickers by setting the service indicator selection. You can also set the demo-mode, which shows the Service Indicator function in a short period of time.

The setting value is as follows.

Maintenance time [hour]	—	6 min (test)	100	150	In increments of 50	950	1000
Set data on display	Invalid	0					
	Only warning	0.1	100	150		950	1000
	Torque limit	=0.1	=100	=150		=950	=1000

The present hour meter time will be registered if the DRS switch is operated after the display of #10.

2. Setup Options (Group-2)

#11 Auxiliary Input for Lift and Drive Speed 1 (Harness pin No. -----)

This setting is not used for all models.

#12 Auxiliary Travel Speed Limit 1 (Harness pin No. -----)

This setting is not used for all models.

#13 Auxiliary Power Reduction 1 (Harness pin No. - -----)

This setting is not used for all models.

#14 Auxiliary Input for Lift and Drive Speed 2 (Harness pin No. -----)

This setting is not used for all models.

#15 Auxiliary Travel Speed Limit 2 (Harness pin No. -----)

This setting is not used for all models.

#16 Auxiliary Power Reduction 2 (Harness pin No. - -----)

This setting is not used for all models.

#17 Auxiliary Input for Lift and Drive Speed 3 (Harness pin No. -----)

This setting is not used for all models.

#18 Auxiliary Travel Speed Limit 3 (Harness pin No. -----)

This setting is not used for all models.

#19 Auxiliary Power Reduction 3 (Harness pin No. - -----)

This setting is not used for all models.

#20 Stall Timer

This setting shuts down the truck when the traction motor torque is very high (about 90% of maximum). This function is used to detect pulse sensor faults and to prevent the controller from overheating.

The setting range is 2 to 10 [second] for all models.

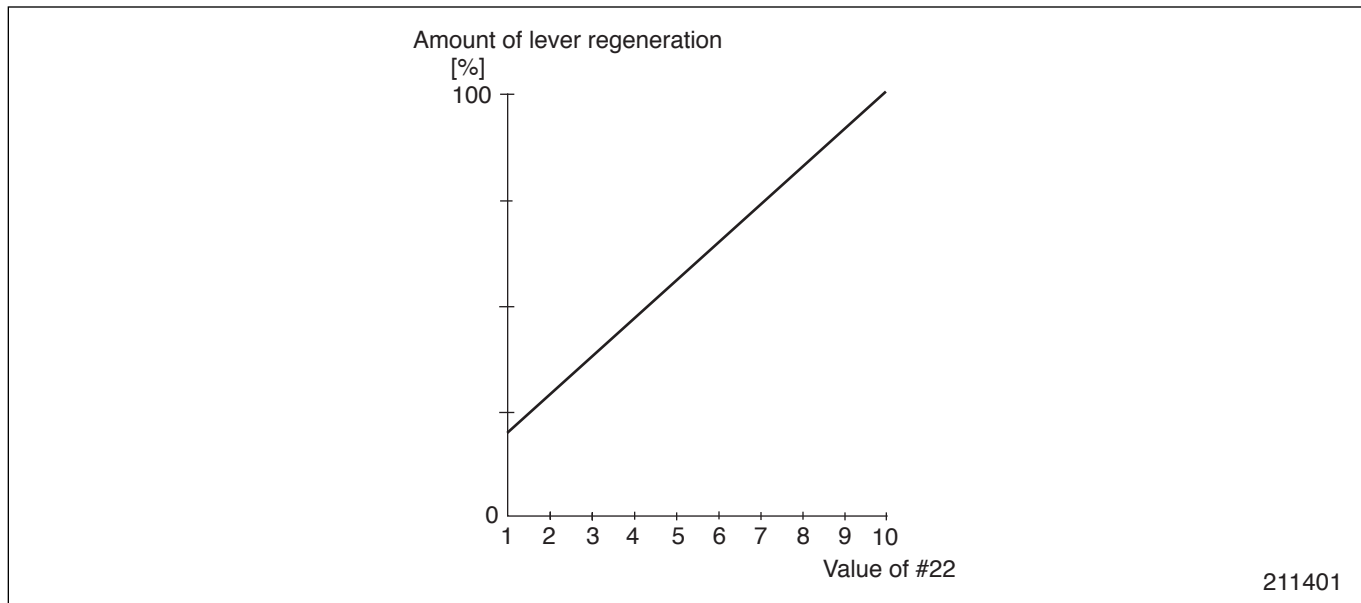
#21 Regen Function

This setting is not used for all models.

#22 Regen Adjustment for Lever Regen

This setting defines the “Lever regen” characteristic.

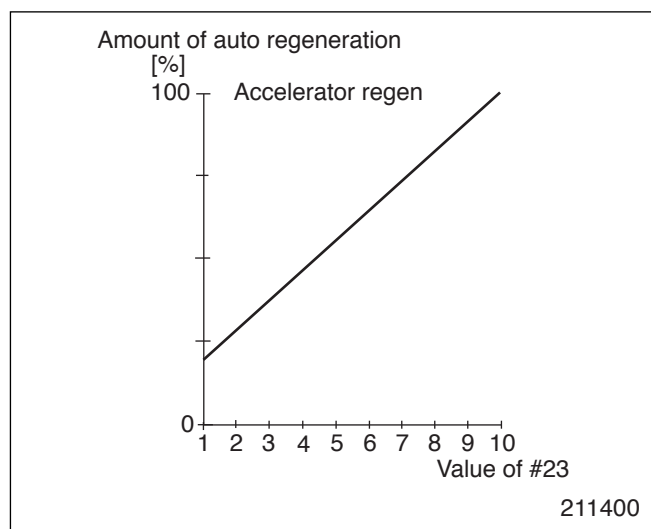
When the direction lever is shifted into the position opposite to the truck’s traveling direction, the “Lever regen” function is activated. The “Lever regen” characteristic is shown in this diagram. The setting range is 1 to 10 for all models.



Amount of deceleration when the accelerator pedal is released is determined by #23.

#23 Regen Adjustment for Auto Regen

This setting defines amount of deceleration when “Auto regen” is activated. The setting range is 1 to 10 for all models.



#26 Speed Alarm 1 (Harness pin No. -----)

This setting is not used for all models.

#27 Tire Size Adjustment

This setting is used to adjust the truck speed indicator.

1 digit equals 1 mm (0.04 in.) of wear in the diameter.
Default setting is 20.

When the tire diameter becomes 8 mm (0.31 in.) smaller than original, set 12 into this setting.

The setting range is 0 to 40 for all models. This allows fitting a bigger diameter wheel.

#30 Auxiliary Input for Travel Speed (Harness pin No. -----)

This setting is not used for all models.

#31 Auxiliary Maximum Travel Speed Setting (Harness pin No. -----)

This setting is not used for all models.

#32 Auxiliary Output Power Limit (Harness pin No. -----)

This setting is not used for all models.

#33 Auxiliary 3 Speed

This setting is not used for all models.

#34 Speed Alarm 2 (Harness pin No. -----)

This setting is not used for all models.

#35 Lowering Speed Adjust

This setting is not used for all models.

3. Setup Options (Group-3)

#40 Truck Type

This setting defines the type of truck.

The setting value is as follows.

Display value	Model		
	No setting		
15	E3000		
15EE	E3000EE		
18	E3500,	EC4000	
18EE	E3500EE,	EC4000EE	
20	E4000,	EX4000	
20EE	E4000EE,	EX4000EE	
25	E5000,	EX5000,	E5500
25EE	E5000EE,	EX5000EE,	E5500EE
30	E6000,	E6500	
30EE	E6000EE,	E6500EE	



CAUTION

If the truck type setting is incorrect, the truck may show unexpected movement.

#41 Battery Voltage

This setting defines the voltage of battery carried in the truck.

The setting value is 36 or 48 [v].

No setting shows “|| || || || ||.”

#42 Battery Type

This setting defines the type of battery carried in the truck.

The setting value is 0, 1 or 2.

0: Normal 1: Tubular 2: Reserve

This value selects Battery Discharge Indicator (BDI) table. The table is as follows.

Normal BDI

BDI#	36V	48V
0	– 34.4	– 45.9
1	34.5 – 34.8	46.0 – 46.4
2	34.9 – 35.2	46.5 – 46.9
3	35.3 – 35.6	47.0 – 47.4
4	35.7 – 36.0	47.5 – 47.9
5	36.1 – 36.4	48.0 – 48.4
6	36.5 – 36.7	48.5 – 48.9
7	36.8 – 37.0	49.0 – 49.8
8	37.1 – 37.3	49.4 – 49.7
9	37.4 – 37.6	49.8 – 50.1
10	37.7 –	50.2 –

Tubular BDI

BDI#	36V	48V
0	– 35.2	– 46.9
1	35.3 – 35.5	47.0 – 47.3
2	35.6 – 35.8	47.4 – 47.7
3	35.9 – 36.1	47.8 – 48.1
4	36.2 – 36.4	48.2 – 48.5
5	36.5 – 36.7	48.6 – 48.9
6	36.8 – 37.0	49.0 – 49.2
7	37.1 – 37.2	49.3 – 49.5
8	37.3 – 37.4	49.6 – 49.8
9	37.5 – 37.6	49.9 – 50.1
10	37.7 –	50.2 –

Reserve BDI

BDI#	36V	48V
0	–	–
1	–	–
2	–	–
3	–	–
4	–	–
5	–	–
6	–	–
7	–	–
8	–	–
9	–	–
10	–	–

#43 Hydraulic Control Selection

This setting defines the type of hydraulic control.

1: MC system (Transistor Control Type)

2: MC system (Contactor Control Type)

#44 Mast Type

This setting defines the type of the mast.

2-FF: 2-stage full-free 3-FF: 3-stage full-free

2-SP: 2-stage panorama

#45 Valve Section

This setting is not used for all models.

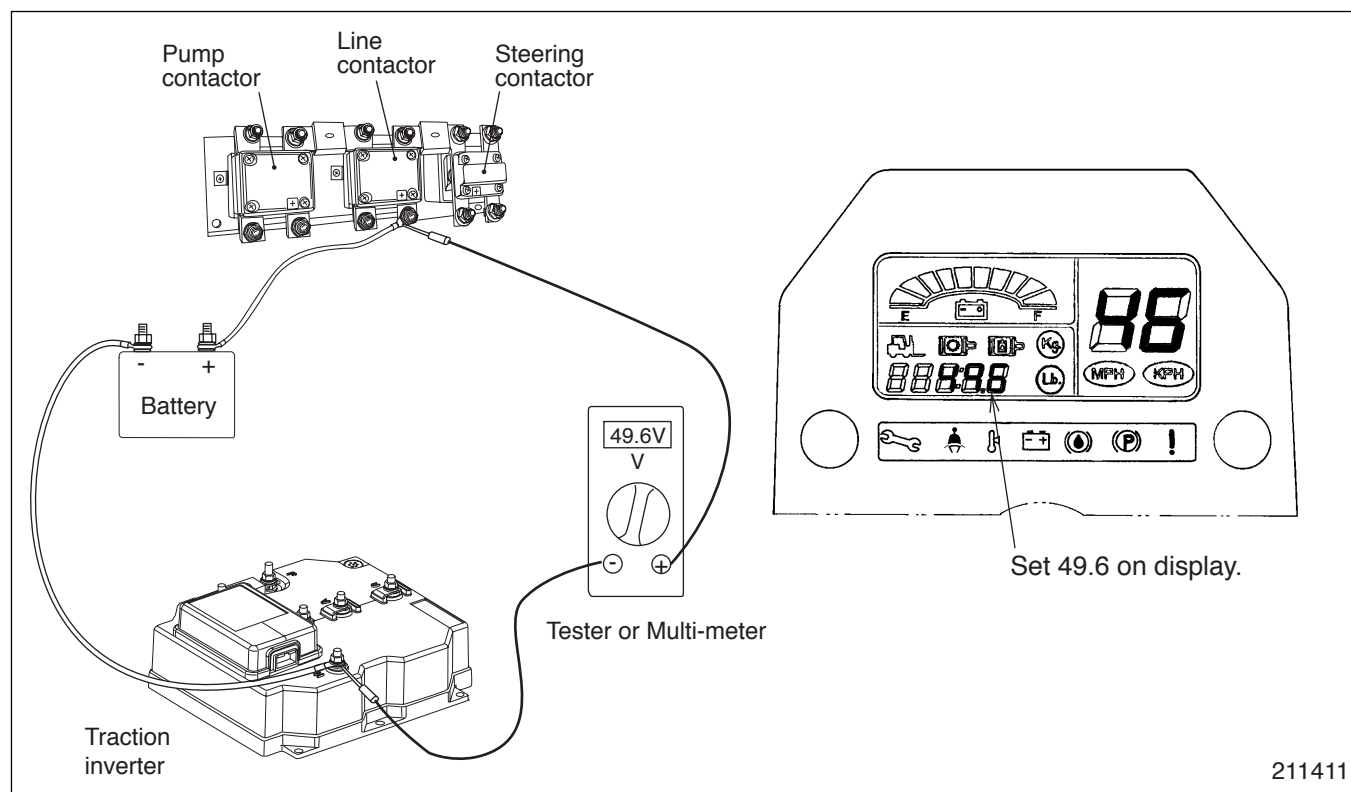
#46 Battery Voltage Adjust

This setting corrects the gap of the battery voltage which the controller recognizes, and actual battery voltage. The display shows battery voltage which the controller recognizes.

Measure actual battery voltage using a tester (or a multi-meter) and operate the direction lever to adjust the value.

Refer to the “Measurement of battery voltage” below.

Direction lever	Accelerator pedal	Value change [V]
N → F	—	+0.1
N → R	—	-0.1
F	Release → depress	+10
R	Release → depress	-10



Measurement of battery voltage

#47 Foot Direction

This setting defines the foot direction option.

1: Standard direction lever

2: Foot Directional Control (FoDiCo)

Setup Options (Group 1)

Option #	Title of Option	Description	Range	Default Value
#1	Application Pre-Sets (Truck Operation Mode)	The value setting of the following 7 items are registered beforehand. <u>Top travel speed</u> , <u>Acceleration rate</u> , <u>Traveling power</u> , <u>Regen adjustment</u> , <u>Start lift speed</u> , <u>Top lift speed</u> , <u>Tilt speed</u> . Refer to the explanation for details.	A, b, C, d, E (1), (4)	A (4)
#2	Start Lift Speed	Beginning lift speed Start lift speed cannot exceed top lift speed. (1: SLOW → 10: FAST)	1 to 10	1
#3	Top Lift Speed	Lift speed when operating the lever at maximum	1 to 10	9 (4)
#4	Tilt Speed	Speed setting for tilt	1 to 10	7
#5	Auxiliary 1 Speed	Speed setting for attachment 1	1 to 10	3
#6	Auxiliary 2 Speed	Not used	—	—
#7	Top Travel Speed Limit	Maximum travel speed	5 to 18 [km/h] or 5 to 17 [km/h] (3), (4)	15 (4)
#8	Acceleration Rate	Choice of acceleration rate (1: SLOW → 5: FAST)	1 to 5 (4)	3 (4)
#9	Traveling Power	Choice of powering characteristic (1: ECONOMY, 2: STANDARD, 3: HIGH POWER)	1, 2, 3 (4)	2 (4)
#10	Service Indicator	This function notifies service personnel that maintenance time is approaching or has passed. It means the lapsed time when setting up. Approached: !LED flicker (20 hour) Passed :!LED turn on and power reduction (selected) (2) Refer to the explanation for details.	0, 0.1, 100, 150, ...950, 1000, =0.1 (6 min.), =100, =150, ..=950, =1000 (In increments of 50 [hour]) “=”: power reduction 0: no action	0

- NOTICE:**
- (1) Before changing, when parameter data are different from the values of the selected mode, the truck mode indicator (A to E) flickers.
When the truck mode is changed, all parameter data is replaced by the set values of the selected mode.
 - (2) The data from the truck hour meter at set time is saved apart from the selected value. If the key switch is turned off without setting the DRS switch to R, the data at set time is maintained.
When the DRS switch is set to R, the data at set time is replaced by the current truck hour meter data.
 - (3) When #40 is set for “2.0 tons or more” and #41 is set for “36 volts”, the setting range is 5 to 17 [km/h].
For setting other than above, the setting range is 5 to 18 [km/h].

- (4) When #40 is set for “EE type” and #43 is set for “MC Contactor Control Type”, the setting range and default value of each Setup Option data are as follows.

Option #		Range	Default Value
#1		C only	C
#3		1 to 10	8
#7	(#40 “less than 2.0 tons” and #41 “36 volts”)	5 to 11	11
	(#40 “2.0 tons or more” and #41 “36 volts”)	5 to 12	12
	(#41 “48 volts”)	5 to 14	14
#8		1 to 2	2
#9		1 only	1

Setup Options (Group 2)

Option #	Title of Option	Description	Range	Default Value	Harness Pin No.
#11	Auxiliary Input for Lift and Drive Speed 1	Not used	—	—	—
#12	Auxiliary Travel Speed Limit 1	Not used	—	—	—
#13	Auxiliary Power Reduction 1	Not used	—	—	—
#14	Auxiliary Input for Lift and Drive Speed 2	Not used	—	—	—
#15	Auxiliary Travel Speed Limit 2	Not used	—	—	—
#16	Auxiliary Power Reduction 2	Not used	—	—	—
#17	Auxiliary Input for Lift and Drive Speed 3	Not used	—	—	—
#18	Auxiliary Travel Speed Limit 3	Not used	—	—	—
#19	Auxiliary Power Reduction 3	Not used	—	—	—
#20	Stall Timer	This option allows to shut down truck when the traction motor torque is too high.	2 to 10 [sec]	5	—

CONTROLLER

Option #	Title of Option	Description	Range	Default Value	Harness Pin No.
#21	Regen Function	Not used	–	–	–
#22	Regen Adjustment for Lever Regen	10 steps for regen power on lever regen	1 to 10	7	–
#23	Regen Adjustment for Auto Regen	10 steps for regen power on brake/accelerator regen	1 to 10	5	–
#26	Speed Alarm 1	Not used	–	–	–
#27	Tire Size Adjustment	Adjusts the amount of tire wear. It changes truck's speed recognition.	0 to 40 (Diameter -20 to +20 mm)	20 (±0 mm)	–
#30	Auxiliary Input for Travel Speed	Not used	–	–	–
#31	Auxiliary Maximum Travel Speed Setting	Not used	–	–	–
#32	Auxiliary Output Power Limit	Not used	–	–	–
#33	Auxiliary 3 Speed	Not used	–	–	–
#34	Speed Alarm 2	Not used	–	–	–
#35	Lowering Speed Adjust	Not used	–	–	–

Setup Options (Group 3)

Option #	Title of Option	Description	Range	Default Value
#40	Truck Type	This option is used to set the size and type of the truck. Refer to the explanation for details.	15 (E3000) to 30EE (E6000EE) 10 patterns	—
#41	Battery Voltage	This option is used to set the voltage of the battery.	36, 48 [V]	—
#42	Battery Type	This option is used to set the type of the battery. The electric discharge characteristic of a battery changes with battery type.	0: Normal BDI 1: Tubular BDI 2: Reserve BDI	—
#43	Hydraulic Control Selection	This option is used to set the type of the hydraulic control.	1: MC specification (Transistor Control Type) 2: MC specification (Contactor Control Type)	—
#44	Mast Type	This option is used to set the type of the mast.	2FF: 2-stage full-free 3FF: 3-stage full-free 2SP: 2-stage panorama	—
#45	Valve Section	Not used	—	—
#46	Battery Voltage Adjust	This setting corrects the gap of the battery voltage which the controller recognizes, and actual battery voltage. Measure actual battery voltage and operate the direction lever in order to adjust the value which is shown on the display to actual battery voltage. N→F: +0.1 F, Accel off→on: +10 N→R: -0.1 R, Accel off→on: -10 Refer to the explanation for operation. (4)	5.0 to 120.0 [V]	—
#47	Foot Direction	This option is used to enable the function for foot direction option.	1: Standard direction lever 2: Foot Directional Control (FoDiCo)	—

NOTICE: (1) The data of a group 3 has no default value, but it needs to set data by the actual truck type. If the value and the truck model aren't in agreement, the truck does not operate normally.

(2) When you set up for the first time, set up a group 3 first, and then set default data of group 1 and 2.

(3) If SUO data is not set, "I" is displayed.

(4) This value was adjusted at the time of LOGIC CARD inspection. Adjust the value, when the value shown on the display is different from actual battery voltage.

Diagnosis

Outline

The controller monitors status of various input/output equipment to allow diagnosis of truck's malfunction. There are two types of diagnosis: Run Time Diagnosis, diagnosis during normal operation, and Self Diagnosis, performing equipment check during maintenance.

Diagnosis

Diagnosis	Description
Self diagnosis	Checks function of each equipment.
Run time diagnosis	Diagnosis during normal operation

The logic unit is equipped with a type of memory module to hold recorded data even if the main power is turned off. The errors occurring during truck use are compared with the Run Time Diagnosis and recorded so as to be able to show.

Operation Procedure

To perform the Self Diagnosis or review the fault data stored by the Run Time Diagnosis, perform the following procedure.

Turning on the key switch allows to enter each diagnosis mode. You can not transfer to another mode unless the source power is turned off.

Entry to diagnosis mode

Function	DRS switch	Seat	Lift lever	Tilt lever
Self diagnosis	D	–	–	–
Run time diagnosis	D	Not sit	ON	ON

Self Diagnosis

Perform the Self Diagnosis using the following procedure.

1. Preparatory operations

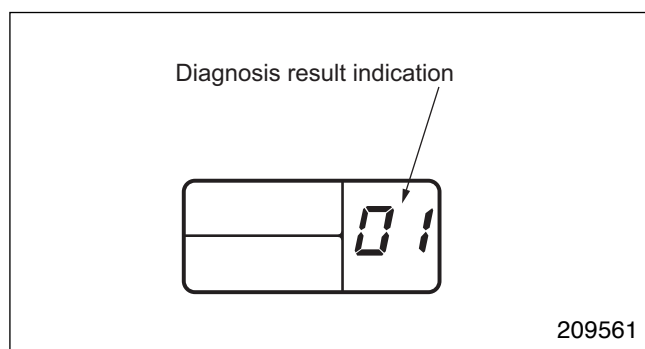
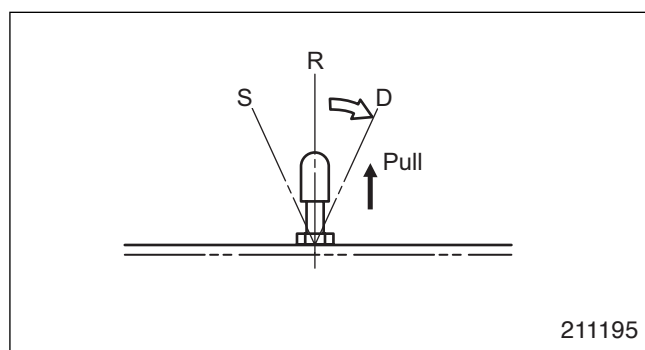
Perform the following procedures.

- (1) Place the parking brake lever in the locked position.
- (2) Turn OFF the key switch.
- (3) Disconnect the battery plug.
- (4) Discharge all inverters. See page 1-45.
- (5) Place the direction lever in the N position.
- (6) Place all the hydraulic levers in their OFF positions.
- (7) Set the DRS switch to the D (diagnosis) position.
- (8) Remove the traction fuse, pump fuse and steering fuse.
- (9) Connect the battery plug.

2. Diagnosis procedure

Perform the procedure using the Self-Diagnostics table in accordance with the following guide.

- (1) Start diagnosis with the Step 0 item in the table. Turn ON the key switch according to the instruction in the “Do this” box on the Step 0 line. If the item passes the check without any problem, the next step number “01” appears on the display. If the item involves any problem and fails in the check, “dd” is shown on the display. The display also shows “dd” when diagnosis is started without removing the fuse or when all the hydraulic levers are not placed in their OFF positions. In this case, diagnosis is prohibited from going even to the first step.
- (2) When the Step 0 item has passed the check, diagnosis may advance to the next Step 1 item (seat switch). Cycle the seat switch OFF→ON→OFF according to the instruction in the “Do this” box on the Step 1 line. If the item passes the check, the next step number “02” appears on the display. Do likewise for the succeeding items, following the instructions in the “Do this” column boxes. If the item of a step fails in the check, diagnosis does not advance automatically. In this case, diagnosis can be forcibly advanced to the next step by cycling the DRS switch D→R→D.



(3) When all the step items have been checked through, turn OFF the key switch and place the DRS switch in the R position. Do not forget to reinstall the traction fuse, pump fuse and steering fuse.

- Turn OFF the key switch to exit from the diagnosis mode.
- Repair all faults found immediately after diagnosis.

Diagnosis procedure requires moving the DRS switch to the D or R position. Follow the instructions in the diagnosis procedure guide above as well as those in the applicable boxes in the “Do this” column.

Fault Data Record of Run Time Diagnosis

When the fault is detected by the Run Time Diagnosis, the fault data will be stored in the memory of the logic card. The fault data includes the error code, the battery discharge indicator at the time of fault and the vehicle hourmeter reading at the time of fault. The stored data is maintained even if the key switch is turned off.

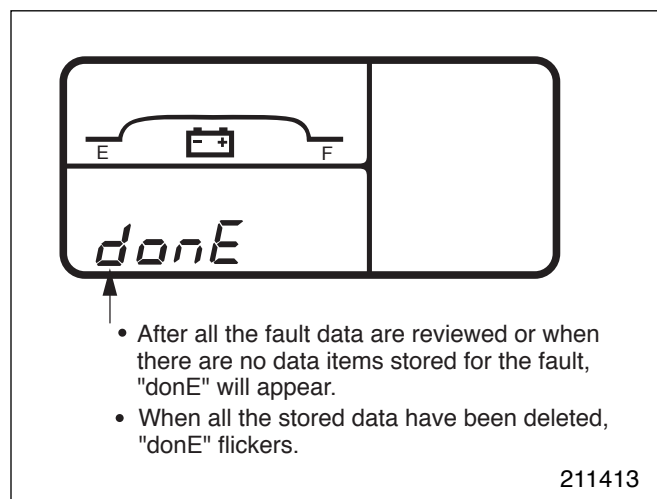
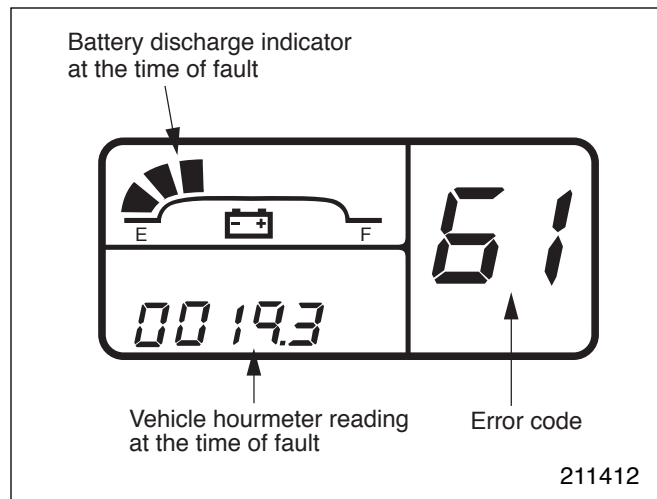
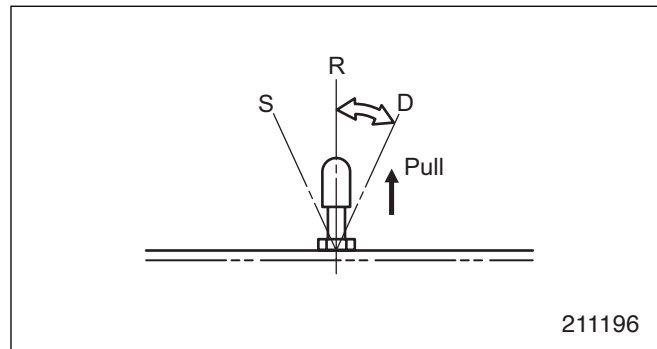
The maximum number of faults that can be stored in the memory is 32. When faults exceeding 32 occur, the oldest data will be erased to accommodate new data.

The data on the latest fault will appear on the display unit. After all the fault data are reviewed or when there are no data items stored for the fault, “donE” will appear.

Perform the following procedures to review the stored fault data.

- To review the data of the next older fault
Move the DRS switch from the D position to the R position and then back to the D position.
- To review the data of the latest fault again
With “donE” appeared on the display after all the fault data are reviewed, move the DRS switch from the D position to the R position and then back to the D position.
- To delete all the stored fault data
With “donE” appeared on the display after all the fault data are reviewed, move the DRS switch from the D position to the R position and then to the S position. When all the stored data have been deleted, “donE” flickers. Never turn off the key switch until “donE” flickers.

NOTICE: If the key switch is turned off before data deletion is completed, erroneous data will be displayed when reviewing the fault data. In this case, be sure to delete all the stored fault data by using the proper procedure again.



Self-Diagnostics (Hydraulic control: Transistor Control Type)

Step	Checking	Do this	Controller check this	Result	Display	Contactor operation
0	Power line voltage (Fuse check)	Turn on key switch.	Close line contactor and steering contactor, and check power line voltage.	Pass	01	Line contactor and steering contactor close and open.
				Fail	dd	
1	Seat switch	Release & press & release seat SW.	Input OFF → ON → OFF	Pass	02	
				Fail	01	
2	Direction switch	Cycle direction lever. N → R → N → F → N	Input changes as N → R → N → F → N	Pass	03	
				Fail	02	
3	Parking brake	Release & depress & release parking brake.	Input OFF → ON → OFF	Pass	04	
				Fail	03	
4	Service brake	Depress and release service brake.	Input OFF → ON → OFF	Pass	05	
				Fail	04	
5	Accelerator	Depress accelerator and release.		Pass	Number 0 to 15 flickers as accelerator is pressed.	
				Fail	-	
		DIAG → RUN		-	07	
7	Battery voltage	Automatic	Check battery voltage: (34V-51V)	Pass	08	
				Fail	07	
8	Lift switch	Pull and release lift lever.	Input OFF → ON (lift up) → OFF → ON (lift down) → OFF	Pass	09	
				Fail	08	
9	Tilt switch	Pull and release tilt lever.	Input OFF → ON → OFF	Pass	10	
				Fail	09	
10	Auxiliary 1 switch	Pull and release Aux. 1 lever.	Input OFF → ON → OFF	Pass	11	
				Fail	10	
11	Auxiliary 2 switch	Pull and release Aux. 2 lever.	Input OFF → ON → OFF	Pass	13	
				Fail	11	
13	Hydraulic speed check	Pull any lever and see display.		Pass	Flickering pump speed value	
				Fail	Other than above	
		RUN → DIAG → RUN		-	14	
14	Line contactor	RUN → DIAG	See line contactor close.	Pass	14	Contactor closes.
				Fail	14	Contactor does not close.
		DIAG → RUN	See line contactor open.	Pass	16	Contactor opens.
				Fail	16	Contactor does not open.
16	Steering contactor	RUN → DIAG	See steering contactor close.	Pass	16	Contactor closes.
				Fail	16	Contactor does not close.
		DIAG → RUN	See steering contactor open.	Pass	98	Contactor opens.
				Fail	98	Contactor does not open.
98	Controller software version	RUN → DIAG → RUN	See software version No. in hourmeter.	-	donE	

Self-Diagnostics (Hydraulic control: Contactor Control Type)

Step	Checking	Do this	Controller check this	Result	Display	Contactor operation
0	Power line voltage (Fuse check)	Turn on key switch.	Close line contactor, pump contactor and steering contactor, and check power line voltage.	Pass	01	Line contactor, pump contactor and steering contactor close and open.
				Fail	dd	
1	Seat switch	Release & press & release seat SW.	Input OFF → ON → OFF	Pass	02	
				Fail	01	
2	Direction switch	Cycle direction lever. N → R → N → F → N	Input changes as N → R → N → F → N	Pass	03	
				Fail	02	
3	Parking brake	Release & depress & release parking brake.	Input OFF → ON → OFF	Pass	04	
				Fail	03	
4	Service brake	Depress and release service brake.	Input OFF → ON → OFF	Pass	05	
				Fail	04	
5	Accelerator	Depress accelerator and release.		Pass	Number 0 to 15 flickers as accelerator is pressed.	
				Fail	-	
		DIAG → RUN		-	07	
7	Battery voltage	Automatic	Check battery voltage: (34V-51V)	Pass	08	
				Fail	07	
8	Lift switch	Pull and release lift lever.	Input OFF → ON (lift up) → OFF → ON (lift down) → OFF	Pass	09	
				Fail	08	
9	Tilt switch	Pull and release tilt lever.	Input OFF → ON → OFF	Pass	10	
				Fail	09	
10	Auxiliary 1 switch	Pull and release Aux. 1 lever.	Input OFF → ON → OFF	Pass	11	
				Fail	10	
11	Auxiliary 2 switch	Pull and release Aux. 2 lever.	Input OFF → ON → OFF	Pass	13	
				Fail	11	
13	Hydraulic speed check	Pull any lever and see display.		Pass	Flickering pump speed value	
				Fail	Other than above	
		RUN → DIAG → RUN		-	14	
14	Line contactor		See line contactor close.	Pass	14	Contactor closes.
		RUN → DIAG		Fail	14	Contactor does not close.
			See line contactor open.	Pass	15	Contactor opens.
		DIAG → RUN		Fail	15	Contactor does not open.
15	Pump contactor		See pump contactor close.	Pass	15	Contactor closes.
		RUN → DIAG		Fail	15	Contactor does not close.
			See pump contactor open.	Pass	16	Contactor opens.
		DIAG → RUN		Fail	16	Contactor does not open.
16	Steering contactor		See steering contactor close.	Pass	16	Contactor closes.
		RUN → DIAG		Fail	16	Contactor does not close.
			See steering contactor open.	Pass	98	Contactor opens.
		DIAG → RUN		Fail	98	Contactor does not open.
98	Controller software version	RUN → DIAG → RUN	See software version No. in hourmeter.	-	donE	

Run Time Diagnostics

Fault	How to detect	Display						Steering operation	Result	To return to normal	Memory
		LED									
		Error	Brake Oil	Parking Brake	Battery Low	Over Temp.	Seat Belt				
Traction Motor, Overheating	Thermistor (150°C, -25°C)				*		E0	○	Power reduction	Cool	*
Pump Motor, Overheating	Thermistor (150°C, -25°C) (Transistor Control type) Thermal SW ON (Contactor Control Type)				*		E2	○	Power reduction (Transistor Control Type) Operates 1 s only (Lift, Attachment) (Contactor Control Type)	Cool	*
Traction Inverter, Overheating	Thermistor (IMS 100°C, -25°C. Capacitor 110°C, -25°C)				*		E5	○	Power reduction	Cool	*
Pump Inverter, Overheating	Thermistor (Transistor Control Type) (IMS 100°C, -25°C. Capacitor 110°C, -25°C)				*		E7	○	Power reduction (Transistor Control Type)	Cool	*
	Thermistor (Contactor Control Type) (IMS 105°C, -25°C. Capacitor 115°C, -25°C)								Operates 1 s only (Lift, Attachment) (Contactor Control Type)		
Pump Motor BWI (Contactor Control Type)	Pump motor BWI SW ON	*					br	○	Operates 1 s only (Lift, Attachment)	Turn off key	*
Traction Motor Current Sensor Fault	Out of normal range	*					14	○	Line contactor Off(*) Steering contactor Hold	Turn off key	*
Traction Motor Over-current	More than 985 Arms (1.6 ms), 990 Arms (1 ms), 1018 Arms (a moment)	*					15	○	Line contactor Off Steering contactor Hold	Turn off key	*
Traction Motor Stall Timer	Measures time (set by SUO#20) while stalling.	*					16	○	Line contactor Off Steering contactor Hold	Turn off key	*
Pump Motor Current Sensor Fault (Transistor Control Type)	Out of normal range	*					34	○	Line contactor Off(*) Steering contactor Hold	Turn off key	*
Pump Motor Over-current (Transistor Control Type)	More than 985 Arms (1.6 ms), 990 Arms (1 ms), 1018 Arms (a moment)	*					35	○	Line contactor Off Steering contactor Hold	Turn off key	*
Line Contactor Fault	Checks voltage of power circuit.	*					40	○	Line contactor Off(*) Steering contactor Hold	Turn off key	*
Steering Contactor Fault	Checks voltage of power circuit.	*					41	×	Line contactor Off(*) Steering contactor Off(*)	Turn off key	*
Pump Contactor Fault (Contactor Control Type)	Checks voltage of power circuit.	*					42	○	Line contactor Off(*) Steering contactor Hold	Turn off key	*
Traction Motor Open	Traction motor open	*					45	○	Line contactor Off Steering contactor Hold	Turn off key	*
Pump Motor Open (Transistor Control Type)	Pump motor open	*					47	○	Line contactor Off Steering contactor Hold	Turn off key	*
Accelerator Sensor Fault	Accel SW ON: Below 0.3V Accel SW OFF: More than 1.41V Below 0.2V, More than 4.8V	*					51	○	Line contactor Off Steering contactor Hold	Turn off key	*
Traction Motor Pulse Input Fault	Out of normal range (5800 rpm)	*					52	○	Line contactor Off Steering contactor Hold	Turn off key	*
Pump Motor Pulse Input Fault (Transistor Control Type)	Out of normal range (4000 rpm, 2 s) With no rotation input during a current output (More than 240 Arms, 0 rpm, 1 s)	*					57	○	Line contactor Off Steering contactor Hold	Turn off key	*
Direction Lever or Accelerator, Faulty Setting	Lever/accel is not neutral at power-on and seat SW on.						E	×	Line contactor Off Steering contactor Off	Seat switch ON Direction lever is in neutral accel off	
	Seat SW is turned on after lever/accel is operated.							○	Slow down and Line contactor Off		
Seat Switch, Faulty Setting For Traction	Seat SW is off at power-on.						(E)	×	Line contactor Off Steering contactor Off	Seat switch ON Direction lever is in neutral accel off	
	Seat SW is off.							○	Slow down and Line contactor Off		
Lift Lever, Faulty Setting	Lever is not neutral at power-on and seat SW on.						H1	×	Line contactor Off Steering contactor Off	Seat switch ON Lever is in neutral	
	Seat SW is turned on after lever is operated.							○	Disables lever operation		
Tilt Lever, Faulty Setting	Lever is not neutral at power-on and seat SW on.						H2	×	Line contactor Off Steering contactor Off	Seat switch ON Lever is in neutral	
	Seat SW is turned on after lever is operated.							○	Disables lever operation		
Attachment 1 Lever, Faulty Setting	Lever is not neutral at power-on and seat SW on.						H3	×	Line contactor Off Steering contactor Off	Seat switch ON Lever is in neutral	
	Seat SW is turned on after lever is operated.							○	Disables lever operation		

Fault	How to detect	Display						Code	Steering operation	Result	To return to normal	Memory
		LED										
		Error	Brake Oil	Parking Brake	Battery Low	Over Temp.	Seat Belt					
Seat switch, Faulty Setting For Hydraulic	Seat SW is off at power-on.							(L)	×	Line contactor Off Steering contactor Off	Seat switch ON Lever is in neutral	
	Seat SW is off.								○	Disables lever operation		
Display Communication Fault	When serial communication is not going on	*						60	○	ERROR LED (!) flickers	Turn off key	*
	Display hour meter error									ERROR LED (!) lights		
Logic Card Initialize Failure	SUO Gr.#3 and default setting are not set. Inverter setting error	*						61	×	Line contactor Off Steering contactor Off	Turn off key	*
Logics Fault	Sum check of ROM Memory check of RAM Sum check of SUO data (EEPROM)	*						62	×	Line contactor Off Steering contactor Off	Turn off key	*
Traction Inverter Fault	Sum check of ROM Memory check of RAM Initial mode SW setting fault When CAN communication is not going on	*						63	×	Line contactor Off Steering contactor Off	Turn off key	*
Pump Inverter Fault	Sum check of ROM Memory check of RAM Initial mode SW setting fault When CAN communication is not going on	*						65	×	Line contactor Off Steering contactor Off	Turn off key	*
Contactor Coil Fault	Contactor coil current sensor Line contactor Pump contactor Steering contactor	*						72	×	Line contactor Off Steering contactor Off	Turn off key	*
Hydraulic Lock Solenoid Fault	Checks current of lift lock valve power circuit.	*						74	○	Disables lever operation	Turn off key	*
Electromagnetic Brake Solenoid Fault	Checks current of electromagnetic brake valve power circuit.	*						75	○	Line contactor Off Steering contactor Hold	Turn off key	*
Battery Voltage Too Low	Voltage class is not correct.	*						78	×	Line contactor Off Steering contactor Off	Turn off key	*
Battery Voltage Too High	Voltage class is not correct.	*						79	×	Line contactor Off Steering contactor Off	Turn off key	*
Battery Consumption Much	Much consumption with small capacity battery				*				○	Power reduction (economy table)	Charge battery	
Battery Consumption Too Much	Too much consumption with small capacity battery				*			(Lo)	×	Line contactor Off(*) Steering contactor Off(*)	Turn off key	
Brake Oil, Low Level	Level sensor (Contact)	*							○		Turn off key	

- NOTICE: (1) E0, E2, E5 and E7 don't appear on the display, but are stored in the memory.
- (2) E, (E), (L), H1-H3, and Lo appear on the display, but not stored in the memory. (E) means flickering.
- (3) "Line contactor off(*)" means that the contactor will open immediately when a fault is detected. "Line contactor off" means that the contactor will open when a current gets to 0.
- (4) Contactor "hold" means "no change." When the error occurs while the contactor is turned on, it keeps on.

Removal and Installation

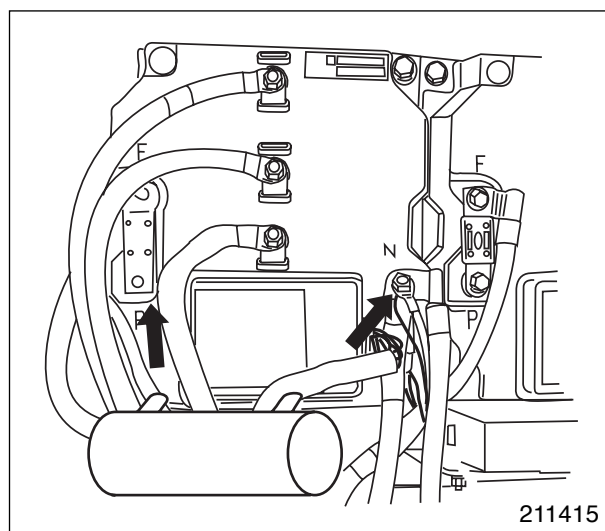
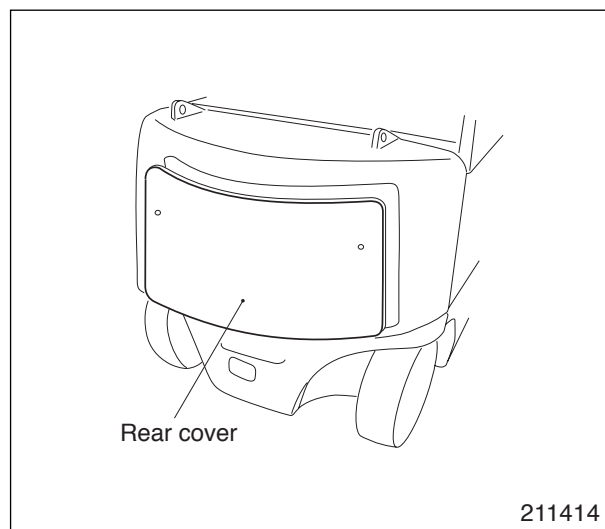
Inverter Discharging Procedure

Discharge electric charges stored in the inverters by using the following procedure.

1. Turn off the key switch.
2. Disconnect the battery plug.
3. Remove the rear cover.
4. Place a 150 Ω /25 W resistor between P and N terminals in the traction inverter to discharge electric charges stored in the inverter.
5. After touching the resistor to the P and N terminals for approx. five seconds, measure the voltage between the terminals with a multimeter and confirm a reading of 5 V or less.
6. Perform the same procedure for the pump inverter in order to discharge electric charges from all inverters.

Check whether the resistance between + and - of the battery plug on the truck side is 1 k Ω or more when connecting the battery plug for the first time after maintenance.

(Discharge electric charges completely before measuring. Longer measurement time reduces resistance value.)



Replacing Inverter

Removal

1. Raise the front wheels.
2. Perform step 1 to 5 in Inverter Discharging Procedure.

CAUTION

Ensure to discharge electric charges from all inverters.

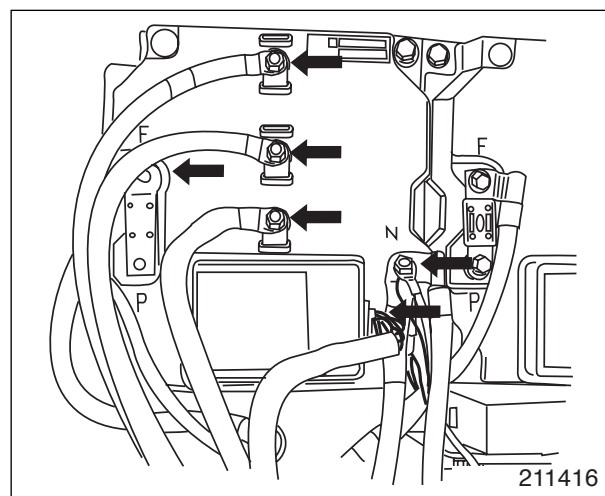
3. Disconnect all five power cables from F, N, U, V and W terminals.
4. Disconnect the connector.

CAUTION

When disconnecting the connector, hold the connector housing and plug, and unlock the connector.

Holding the case may cause damage to the inside card, while holding the cable may cause wire breakage.

5. Remove M10 bolts (four places) fixing the inverter, then remove the inverter.



Installation

1. Wipe off the dirt and thermal paste from the inverter mounting surface once, and also remove dirt from the mounting surface and the aluminum base plate of the inverter.
2. Apply thermal paste approx. 1 mm (0.04 in.) thick to the area where the aluminum base plate of the inverter comes into contact with the truck body.

CAUTION

Apply thin and even thermal paste since it works to release generated heat from the inverter to the truck body.

3. Fix the inverter with M10 bolts.
4. Connect the power cables to F, N, U, V and W terminals.

 CAUTION

Use the correct power cables and terminate marked cable ends to the correct terminals marked on the motor.

Cables terminated at the wrong terminals on the motor may cause the motor to rotate in the opposite direction when activated.

Tightening torque

M8 nut	$11.77 \pm 1.96 \text{ N}\cdot\text{m}$ ($1.20 \pm 0.20 \text{ kgf}\cdot\text{m}$) [$8.68 \pm 1.45 \text{ lbf}\cdot\text{ft}$]
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5. Connect the main harness connector to the inverter.

 CAUTION

Forcibly pressing the connector may cause damage to the DSP card. Hold the connector housing and press the connector, it may not be easy to lock.

NOTICE: It is recommended to check or replace the inverters every 10,000 hours of service operation.

Replacing DSP (Digital Signal Processor) Card

Removal

1. Perform step 1 to 5 in Inverter Discharging Procedure.

CAUTION

Make sure to discharge inverters before working on the electrical system.

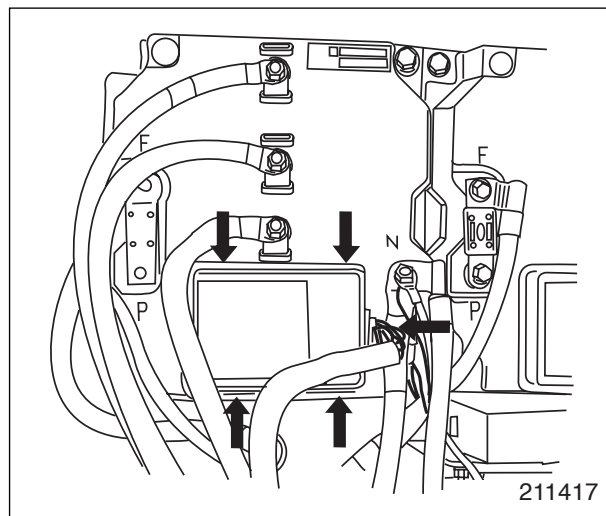
2. Disconnect the connector.

CAUTION

When disconnecting the connector, hold the connector housing and plug, and unlock the connector.

Holding the case may cause damage to the inside card, while holding the cable may cause wire breakage.

3. Push and lift up at the four corners of the card cover to remove the cover.



4. Unlock the connector that is connected to the flat cable.
Hold the both ends of the white part of the connector and pull it straight up.

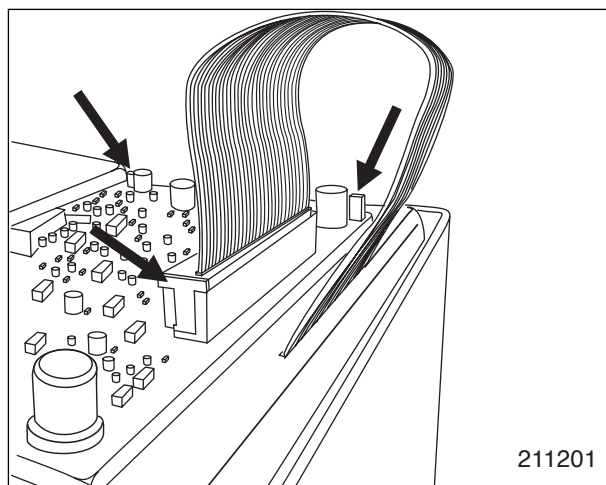
5. Pull the flat cable to disconnect it.

If it cannot be disconnected smoothly, raise the lock again to unlock.

6. Pinch the plastic spacers at the four corners of the DSP card with pliers to unlock and remove the card.

CAUTION

Be careful not to damage mounted parts with the pliers since the card has a number of fragile parts.



Installation

1. Align the four mounting holes of the new DSP card with the plastic spacer positions and press it into place.

CAUTION

Press at the card edges.

Make sure that the spacer lock works completely and the card cannot be removed.

2. Confirm that the flat cable connector is unlocked by raising the connector lock.
3. Insert the flat cable into the connector. Press down the connector lock.

CAUTION

Do not forcibly bend the flat cable. Insert its conductive surface in the direction shown in the illustration.

Also, confirm that the cable is not tilted.

4. Install the cover while pushing the flat cable toward the card side slightly.

CAUTION

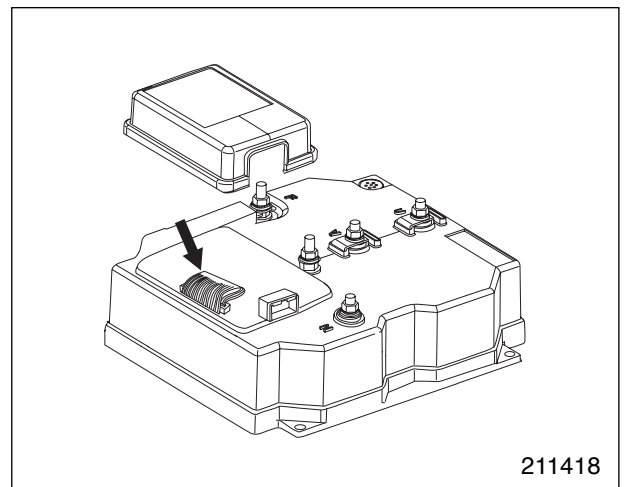
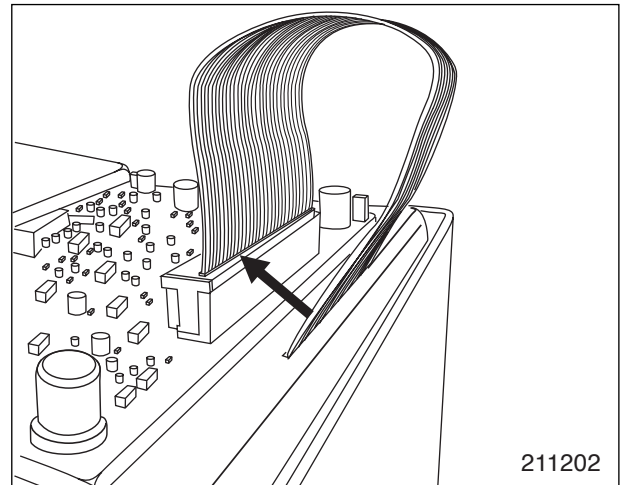
Do not push the flat cable by the inside of the inverter cover. Do not forcibly bend the flat cable.

Make sure that the cable will not be pinched underneath the cover. Confirm that the cover is completely locked.

5. Connect the main harness connector to the inverter.

CAUTION

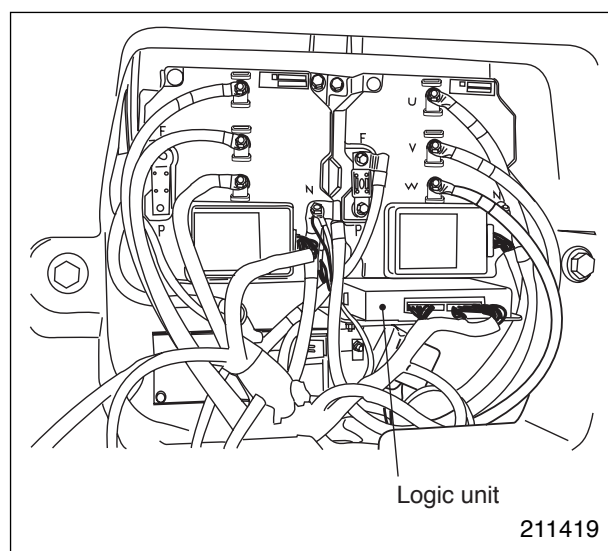
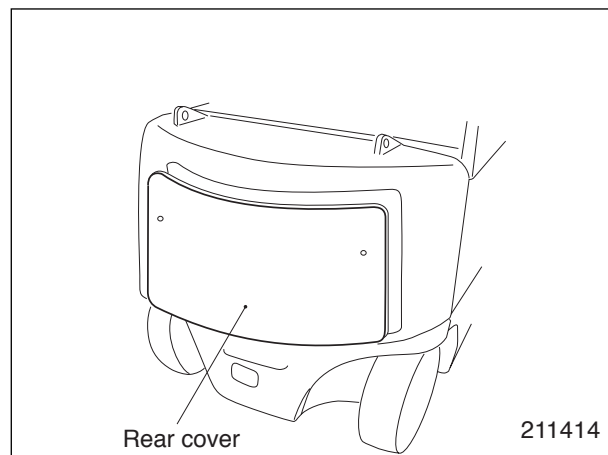
Forcibly pressing the connector may cause damage to the DSP card. Hold the connector housing and press the connector, it may not be easy to lock.



Replacing Logic Unit

Removal

1. Turn off the key switch.
2. Disconnect the battery plug.
3. Remove the rear cover.



4. Disconnect the connector (P3, 4, 5 complex) from the logic card and the connector (P8) from the power supply card.

CAUTION

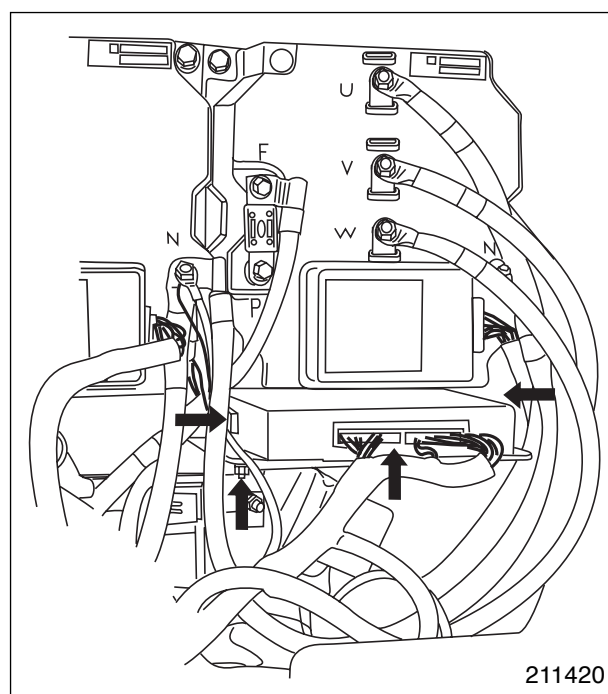
When disconnecting the connector, hold the connector housing and plug, and unlock the connector.

Holding the case may cause damage to the inside card, while holding the cable may cause wire breakage.

5. Remove M10 bolts (two places) and remove the logic unit.

Installation

Follow the removal sequence in reverse.



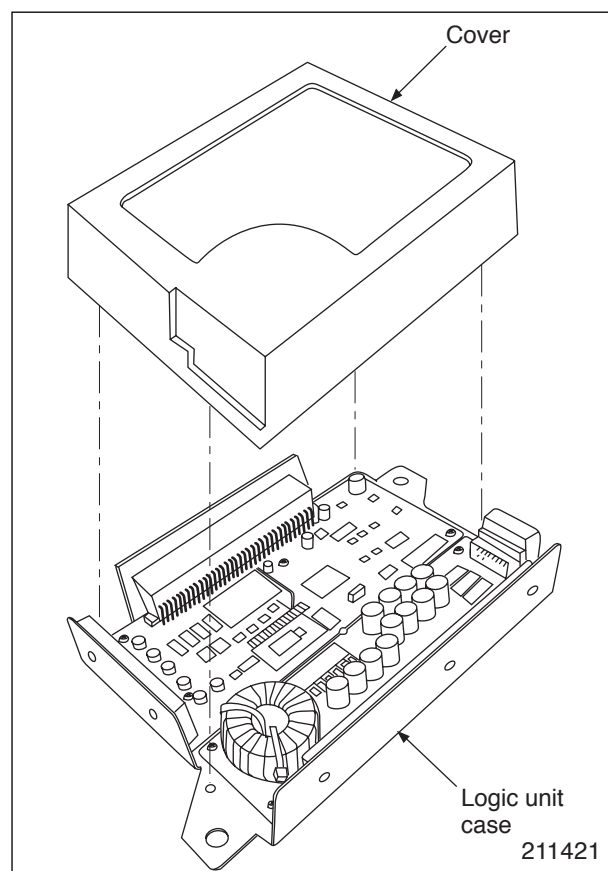
Replacing Logic Card

NOTICE: When replacing the logic card, it is recommended to replace the logic unit as an assembly.

When the cover is removed from the logic unit case, its tapped holes may be damaged. Replace the cover if the tapped holes of the cover are damaged.

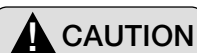
Removal

1. Perform step 1 to 5 in Replacing Logic Unit.
2. Remove M3 flat head screws (four places) from the bottom of the logic unit to remove the cover.
3. Remove M3 screws (seven places) fixing the logic card to the logic unit case to remove the logic card.
4. Remove the grommet from the logic card.

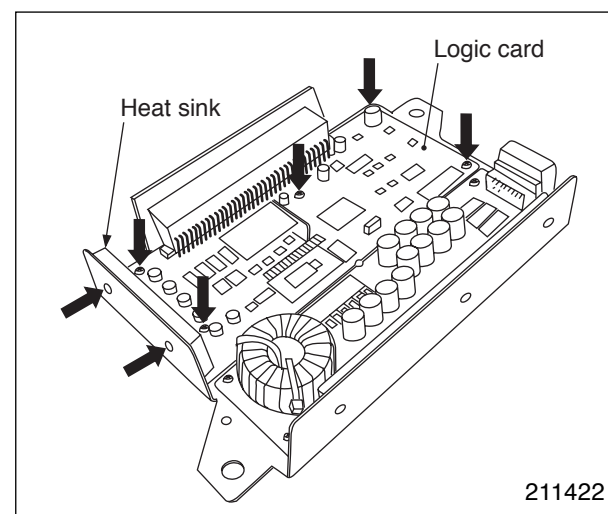


Installation

Follow the removal sequence in reverse.

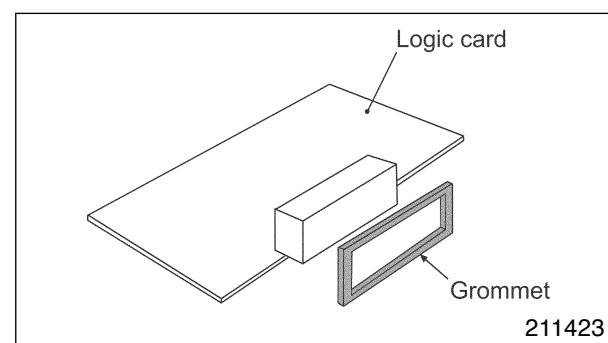


When installing the logic card onto the logic unit case, carefully tighten the logic card and heat sink fixing screws to the specified torque to avoid excessive stresses. Repair the heat sink first.



Tightening torque

M3 screw	$0.98 \pm 0.20 \text{ N}\cdot\text{m}$ $(0.10 \pm 0.02 \text{ kgf}\cdot\text{m})$ $[0.72 \pm 0.15 \text{ lbf}\cdot\text{ft}]$
M3 flat head screw	$0.30 \pm 0.10 \text{ N}\cdot\text{m}$ $(0.03 \pm 0.01 \text{ kgf}\cdot\text{m})$ $[0.22 \pm 0.074 \text{ lbf}\cdot\text{ft}]$



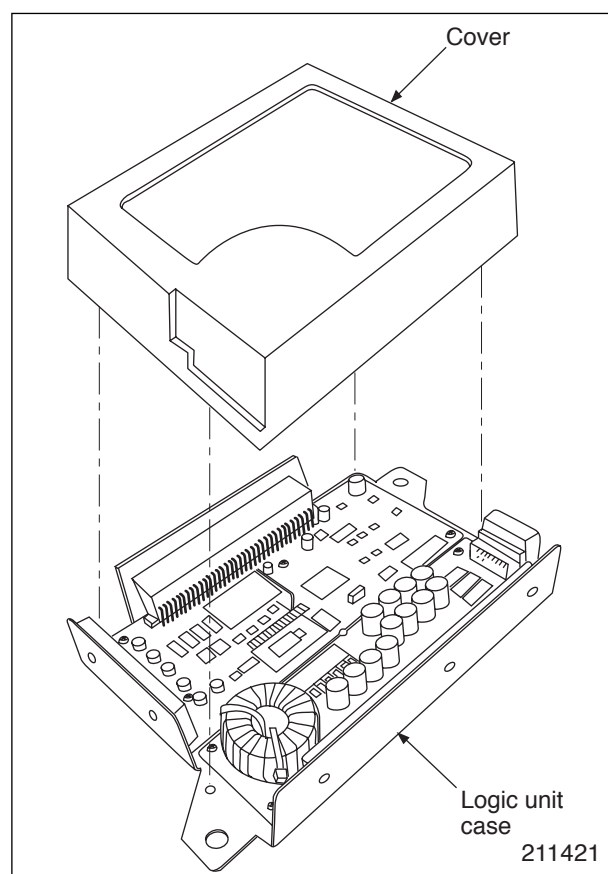
Replacing Power Supply Card

NOTICE: When replacing the power supply card, it is recommended to replace the logic unit as an assembly.

When the cover is removed from the logic unit case, its tapped holes may be damaged. Replace the cover if the tapped holes of the cover are damaged.

Removal

1. Perform step 1 to 5 in Replacing Logic Unit.
2. Remove M3 flat head screws (four places) from the bottom of the logic unit to remove the cover.
3. Remove M3 screws (seven places) fixing the power supply card to the logic unit case to remove the power supply card.
4. Remove the grommet from the power supply card.

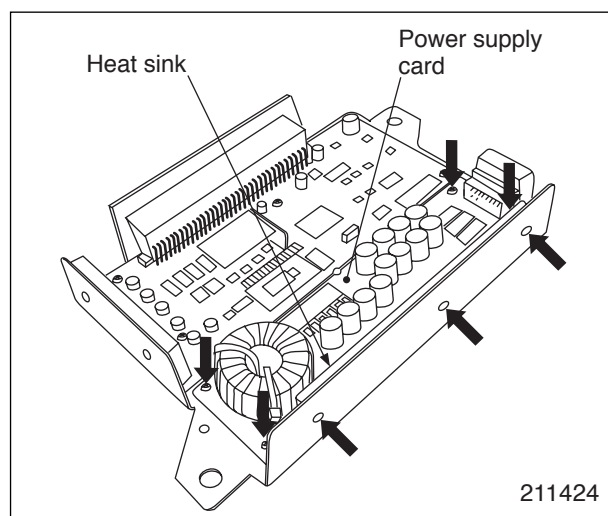


Installation

Follow the removal sequence in reverse.

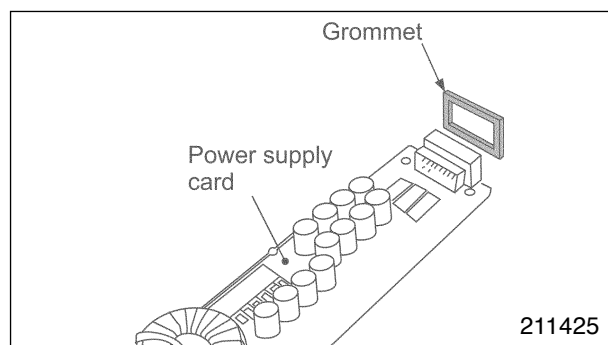
⚠ CAUTION

When installing the power supply card onto the logic unit case, carefully tighten the power supply card and heat sink fixing screws to the specified torque to avoid excessive stresses. Fix the heat sink first.



Tightening torque

M3 screw	$0.98 \pm 0.20 \text{ N}\cdot\text{m}$ $(0.10 \pm 0.02 \text{ kgf}\cdot\text{m})$ $[0.72 \pm 0.15 \text{ lbf}\cdot\text{ft}]$
M3 flat head screw	$0.30 \pm 0.10 \text{ N}\cdot\text{m}$ $(0.03 \pm 0.01 \text{ kgf}\cdot\text{m})$ $[0.22 \pm 0.074 \text{ lbf}\cdot\text{ft}]$



Basic Check

Always follow basic troubleshooting steps.

- Talk to the operator.
- Confirm his description of the problem with an operational check.
- Visually inspect cables, connectors, contactor tips, etc.
- Perform basic battery cables to frame resistance test. (at least 20 k ohm)
- Check battery condition.

Always check each option and write down the reading.

Testing Tools

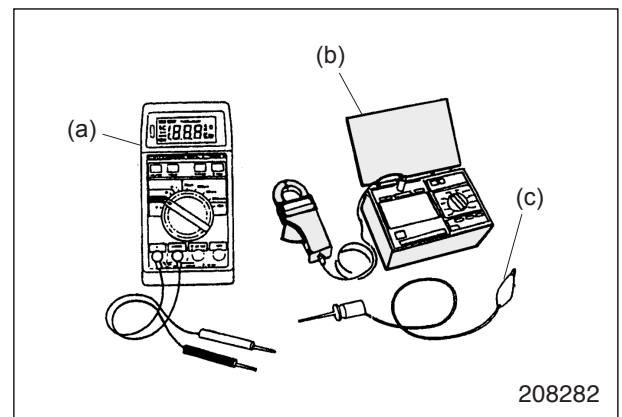
- (a) Circuit tester
- (b) Clamp meter
- (c) IC clip

NOTE

The illustrations show digital circuit testers. In these testers, the positive (+) terminal is applied with positive charge, and the negative (–) terminal with negative charge. It should be noted that the terminals must be connected inversely when using an analog meter tester.

! WARNING

Disconnect the battery plug before inspecting or adjusting the controller.



208282

Measurement of Card Voltage

 WARNING

To prevent accidental movement of the truck, place wood blocks under the truck to lift the front wheels off the ground. Do not close to the front wheels.

1. Tilt the mast fully backward. Place blocks under the mast, and tilt the mast forward.
2. Turn the key switch off.
3. Disconnect the battery plug. Remove the cover.
4. Reconnect the battery plug.
5. Turn the key switch on. Connect the negative terminal of the circuit tester to the V GND terminal of the card.
6. Set the circuit tester to the 100-VDC range.
7. Connect the positive terminal of the circuit tester to each pin of connectors.

NOTE

Be careful not to short-circuit pins. For the normal voltage value, refer to the card voltage chart on the following pages.

Logic card voltage chart

Card side connector No.: CN1 Main harness side connector No.: P3, P4 and P5

No.	Name	Stand-by voltage	Active voltage	Note
1	GND-L	0V	0V	
2	+15V-L	13.0V to 16.0V	13.0V to 16.0V	
3	GND-L	0V	0V	
4	+5V-L	5V	5V	
5	CANH	0 to 5V	0 to 5V	Between CANH and CANL Prohibition of [V] measurement with GND terminal
6	CANL	0 to 5V	0 to 5V	
7	BOOT	11.5V	0V	
8	FWE	11.5V	0V	
9	GND	0V	0V	
10	-			
11	-			
12	-			
13	-			
14	DISPLAY1-TxD	0 to 12V	0 to 12V	
15	-			
16	DISPLAY1-RxD	0 to 12V	0 to 12V	
17	GSE-TxD	-	-	
18	GSE-RxD	-	-	
19	POS VOLTAGE	Vbatt	Vbatt	
20	ACCEL ANGLE	0V	0 to 4.7V	Battery connector attached : Vbatt
21	-			
22	-			
23	GND	0V	0V	
24	+5V	5V	5V	
25	GND	0V	0V	
26	+5V	5V	5V	
27	-			
28	-			
29	-			
30	-			
31	DC PUMP MOTOR TH SW	11.5V	0V	
32	SEAT BELT SW	11.5V	0V	
33	SEAT SW	11.5V	0V	
34	PARK BRAKE SW	11.5V	0V	
35	SERVICE BRAKE SW	11.5V	0V	
36	REVERSE SW	11.5V	0V	
37	FORWARD SW	11.5V	0V	
38	BRAKE FLUID SW	11.5V	0V	
39	-			
40	DC PUMP MOTOR BWI1	11.5V	0V	
41	DC PUMP MOTOR BWI2	11.5V	0V	
42	ACCEL IDLE SW	11.5V	0V	
43	GND	0V	0V	
44	BUZZER	0V	0 to Vbatt	
45	DIAG SW	11.5V	0V	
46	SET SW	11.5V	0V	
47	-			
48	LIFT DOWN SW	11.5V	0V	
49	ATTACH1 SW	11.5V	0V	
50	TILT SW	11.5V	0V	
51	LIFT2 SW	11.5V	0V	
52	LIFT1 SW	11.5V	0V	
53	-			
54	PUMP CONTACTOR D1	0V	0 to Vbatt	
55	STEER CONTACTOR D1	0V	0 to Vbatt	
56	-			
57	LIFT LOCK +	0V	0 to Vbatt	
58	LIFT LOCK -	0V	0V	
59	LINE CONTACTOR CON	0V	0 to Vbatt	
60	HYDRAULIC CONTACTOR CON	0V	0 to Vbatt	
61	STEER CONTACTOR CON	0V	0 to Vbatt	
62	BRUSHLESS DC CONTROL CON	0V	0 to Vbatt	
63	CON VE	Vbatt	Vbatt	
64	ELECTRO MAG BRAKE SOL	0V	0 to Vbatt	

Vbatt: Battery voltage

CONTROLLER

Power supply card voltage chart

Card side connector No.: CN1 Main harness side connector No.: P8

No.	Name	Voltage	Note
1	+12V	12V	Fan
2	GND	0V	Fan
3	+15V-L	13.0V to 16.0V	DSP
4	+5V	8V	DSP
5	+15V-G	12V	DSP
6	GND	0V	DSP
7	+VE-L	Vbatt	
8	+VE-L	Vbatt	
9	+15V-L	13.0V to 16.0V	Logic
10	+5V	5V	Logic
11	GND	0V	Logic
12	GND	0V	Logic
13	V POW	Vbatt	Input
14	V POW	Vbatt	Input
15	V GND	0V	Input
16	V GND	0V	Input

DSP card voltage chart

Card side connector No.: CN2 Main harness side connector No.: P1 (traction) and P2 (pump)

No.	Name	Stand-by voltage	Active voltage	Note
1	MOTOR THERMAL +	0 to 5V	0 to 5V	
2	MOTOR THERMAL -	0 to 5V	0 to 5V	
3	CANH	0 to 5V	0 to 5V	Between CANH and CANL Prohibition of [V] measurement with GND terminal
4	CANL	0 to 5V	0 to 5V	
5	ROTARY SENSOR +15V	12V	12V	
6	ROTARY SENSOR A+	0 to 5V	0 to 5V	
7	ROTARY SENSOR B+	0 to 5V	0 to 5V	
8	MODE1	11.5V	0V	
9	MODE2	11.5V	0V	
10	BOOT	11.5V	0V	
11	GND	0V	0V	
12	TxD(GSE)	-	-	
13	RxD(GSE)	-	-	
14	CANR+	-	-	
15	CANR-	-	-	
16	+15V-G	12V	12V	
17	+15V-L	13.0V to 16.0V	13.0V to 16.0V	
18	+5V	8V	8V	
19	GND	0V	0V	
20	GND	0V	0V	

Checking Contactor Coil



Disconnect the battery plug and discharge the inverter before working on electrical system.

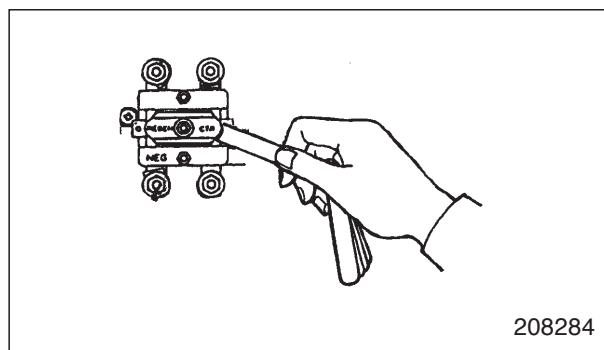
1. Disconnect the lead wire of coil.
2. Set the circuit tester to 200 ohm range.
3. Measure coil resistance.
The resistance must be 44 ohm at -30°C (-22°F) to 65 ohm at 80°C (176°F).
 - If the measured value deviates from the above range, replace the contactor assembly.
4. With the lead wire of contactor coil connected, set the circuit tester to 200-VDC range.
5. Connect the negative (–) terminal of the circuit tester to the negative-side coil terminal (small fasten terminal) and the positive (+) terminal of the circuit tester to the positive-side coil terminal (large fasten terminal).
6. Connect the battery, and operate the control device that activates the contactor.
7. The circuit tester should indicate about 24V after the contactor operates. When the contactor is found normal in the coil resistance test and if the measured voltage is not this value, replace the logic card.

Checking Contactor Tip

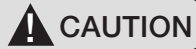
1. Visually inspect the contactor tips for melting, adhesion, heat seizure and pitting corrosion.
2. To check for interference, press the tips and release them.
3. Visually inspect the contactor assemblies. Make sure there are no foreign materials in the assemblies to interfere with contactor movement.
4. Measure the gap at each contactor tips using a thickness gauge.

[It must be 3 ± 0.5 mm (0.12 ± 0.02 in.)]

- If you find any troubles, replace or repair contactor.



Checking Inverter

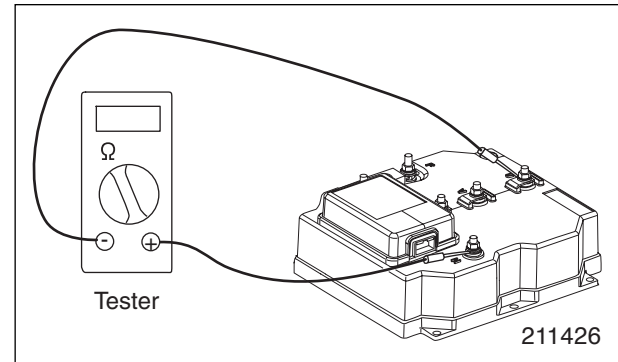
**CAUTION**

Disconnect the battery plug and discharge the inverter before working on electrical system.

1. Disconnect all five power cables from F, N, U, V and W terminals.
2. Check the resistance between terminals shown in the following table.

Positive probe	Negative probe	Resistance (ohm)
N	U	8k to 11k
	V	
	W	
U	P	
V		
W		

NOTICE: Short-circuit/disconnection of the inverter MOSFET can be confirmed by this check.
Other fault cannot be judged.

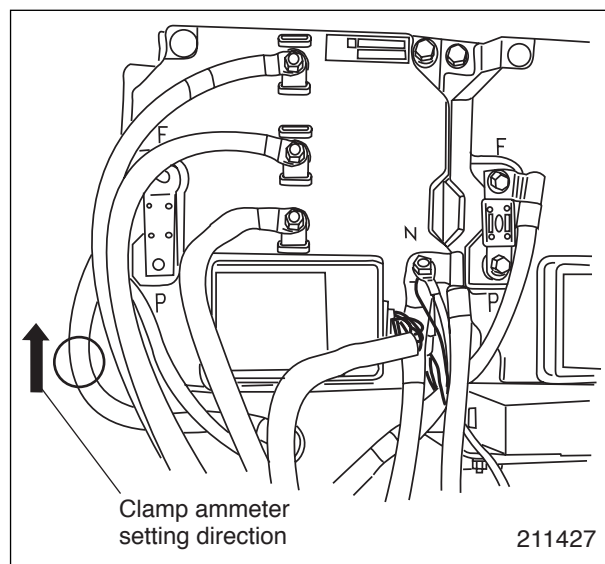


Regeneration Check

The AC motor uses a common circuit for circulating current in both loading and regeneration. This allows the following procedure to confirm regenerating.

1. Place the clamp ammeter onto the cable connected to the inverter's F terminal (use DC current range). This is positive direction as current flows from the battery to the inverter.
2. Run the truck forward. With the direction lever shifted in F position, release the accelerator pedal. Then perform a full-reverse operation.
3. The clamp ammeter should show a negative value. This value becomes the regeneration current.

Energy is generated when a motor is rotated with external force. The regeneration power is produced when this energy is larger than the one that is consumed with the controller and motor. This means that the regeneration current is not measured if the speed or load changes gradually.



AC Motor System Basics

1. Feature of AC motor

The AC motor model trucks covered by this manual use AC motors (three-phase induction motors) as the traction motor and pump motor. AC motors have the following advantages over DC motors:

- (1) AC motors are simple in construction. As they have no such friction parts as brushes and commutators, daily maintenance load is significantly reduced.
- (2) AC motors are compatible with high-speed operation.
- (3) An AC motor of a certain size produces higher power than a DC motor of the same size.

2. Speed control of induction motors

Speed control of DC motors depends on regulation of the field and armature current amounts, while that of AC motors basically depends on adjustment of the frequency of the alternating current power supply. The speed of an AC motor is determined by the frequency of the power supply AC current and the load on the motor. In addition, the voltage and current to the motor must be controlled properly such that the motor operates in its optimum characteristic range. (Fig. 1)

The frequency and voltage can be controlled in a variety of methods including the “vector control method” employed in the AC motor model trucks. This method provides highly responsive control according to ever changing truck-operating conditions through high-speed calculation on huge amount of data. The vector control calculation is performed by the inverter. (Fig. 2)

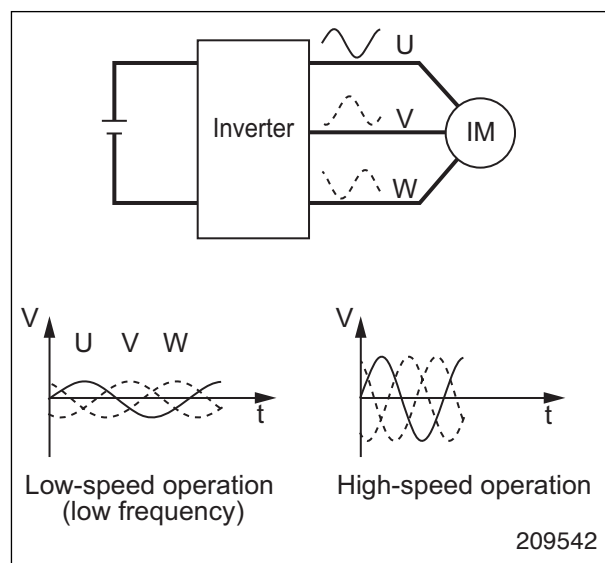


Fig. 1

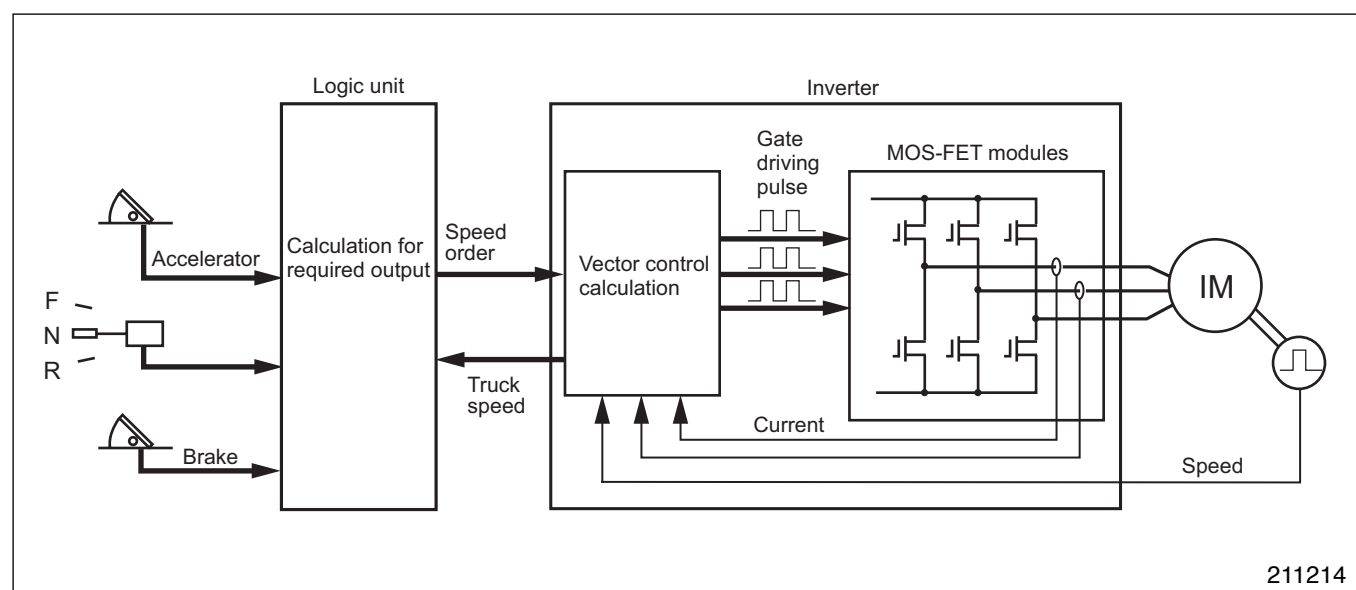


Fig. 2

3. Inverter

The truck battery delivers DC current, so the current must be converted into AC current to drive an AC motor. The device that converts direct current into alternating current is generally called “inverter.” The processes involved in creating AC current from DC current are described below.

(1) Changing DC voltage cyclically

If the switch in a circuit like a one shown in Fig. 3 is turned on for time T_1 and then turned off for time T_2 and this on-off operation is repeated many times, the average of the voltage applied to the load is determined by the ratio between T_1 and T_2 . Varying the ratio, therefore, results in varying voltage. The ratio between T_1 and T_2 is called “duty ratio.” By changing the duty ratio cyclically, it is possible to obtain cyclically changing DC voltage shown in Fig. 3.

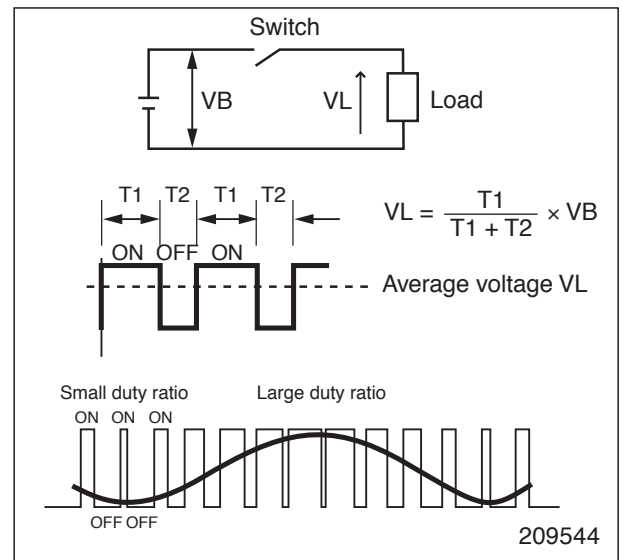


Fig. 3

(2) Converting DC power into AC power

Driving a three-phase AC motor using battery delivered power requires creating three phase outputs (U, V, W) of an identical waveform that differ in phase by 120° using a circuit with six switches S_1 to S_6 that are arranged as shown in Fig. 4. The outputs thus created forms a three-phase alternating current. Fig. 5 shows on-off condition of each switch (arm) and output voltage variation.

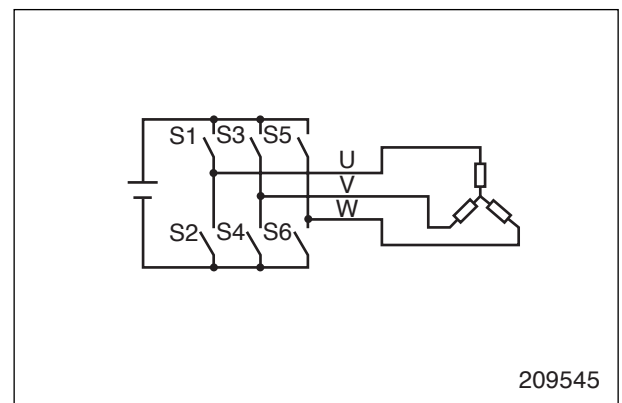


Fig. 4

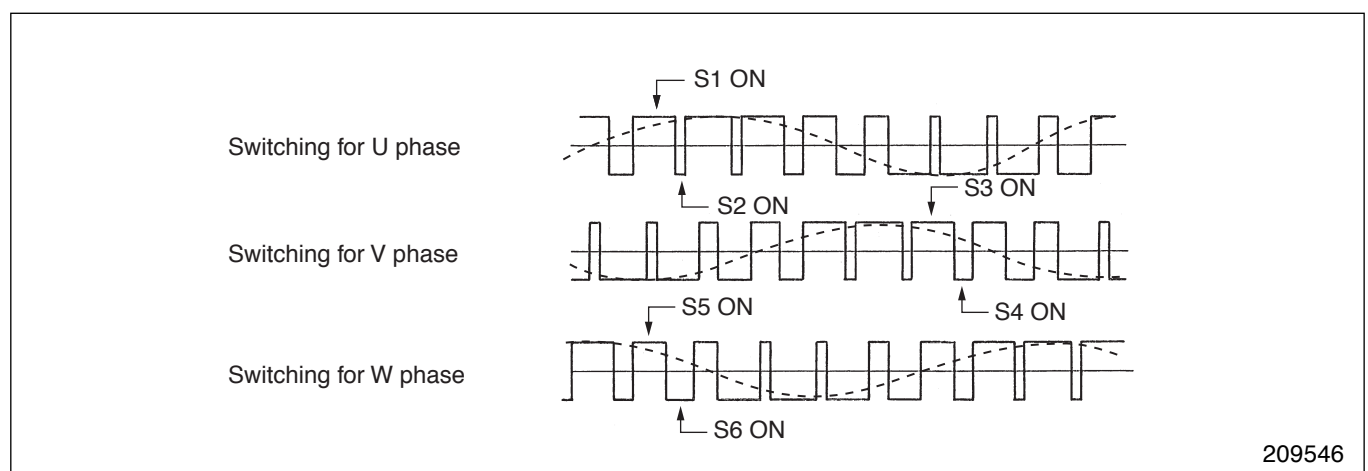


Fig. 5

TROUBLESHOOTING FOR CONTROL CIRCUITS

General Information	2 – 1
E0 Traction Motor, Overheating	2 – 3
E2 Pump Motor, Overheating (Transistor Control Type)	2 – 6
E2 Pump Motor, Overheating (Contactor Control Type)	2 – 9
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E7 Pump Inverter, Overheating	2 – 15
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Ⓔ Brake Oil, Low Level	2 – 18
br Pump Motor, Worn Brushes	2 – 20
(Contactor Control Type Only)	
14 Traction Motor Current Sensor Fault	2 – 22
15 Traction Motor, Over-current	2 – 24
16 Traction Motor, Stall Timer	2 – 27
34 Pump Motor Current Sensor Fault	2 – 29
(Transistor Control Type Only)	
35 Pump Motor Over-current (Transistor Control Type Only)	2 – 31
40 Line Contactor Fault	2 – 34
41 Steering Contactor Fault	2 – 37
42 Pump Contactor Fault (Contactor Control Type Only)	2 – 40
45 Traction Motor Open	2 – 42
47 Pump Motor Open (Transistor Control Type Only)	2 – 45
51 Accelerator Sensor Fault	2 – 48
52 Traction Motor Pulse Input Fault	2 – 51
57 Pump Motor Pulse Input Fault	2 – 54
(Transistor Control Type Only)	
60 Display Communication Fault	2 – 57
61 Logic Card Initialize Failure	2 – 59
62 Logics Fault	2 – 60
63 Traction Inverter Fault	2 – 61

65	Pump Inverter Fault (Transistor Control Type Only)	2 – 64
72	Contactor Coil Fault	2 – 67
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75	Electromagnetic Brake Solenoid Fault	2 – 72
78	Battery Voltage Too Low	2 – 74
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(L)	Seat Switch, Faulty Setting For Hydraulic	2 – 82
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H2	Tilt Lever, Faulty Setting	2 – 86
H3	Attachment 1 Lever, Faulty Setting	2 – 88
(Lo)	Battery Consumption Too Much	2 – 90
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	Electric System Diagram (Transistor Control Type, Standard) ..	2 – 95
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	Electric System Diagram (Contactor Control Type, Standard) ..	2 – 99
	Electric System Diagram (Contactor Control Type, Option)	2 – 101

General Information

Before replacing devices

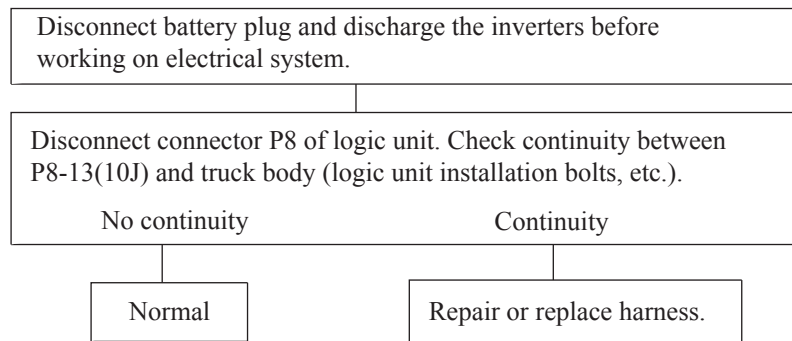
Do not replace devices casually even if replacement is required as a result of troubleshooting. Be sure to check the following items before replacing devices (logic unit, logic card, power supply card, inverters and inverter DSP cards).

- Loose battery connectors
- Abnormal wire harness connections
- Loose connectors
- Broken, bent or loose connector pins
- Dirty connectors

If connectors are dirty, remove the connector and clean connectors.

See “How to clean harness connectors and system components” on page 2-2.

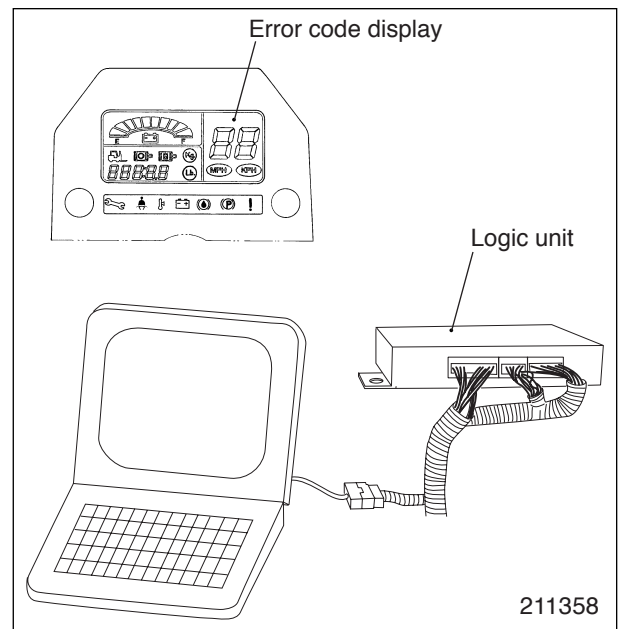
- Ensure that the main harness is not short-circuited to the truck body by using the following procedures.



If any of these items (above items) is a source of the trouble, the device will be damaged even if it is replaced with a new one. Be sure to check the above items and replace carefully.

Connection of the service tool

1. Turn off the truck power.
2. Remove the rear cover.
3. Find the connector to the service tool near the logic unit.
4. Remove the cover and connect the PC as shown.
5. Turn on the truck power.
6. Start the service tool software.



How to clean harness connectors and system components

1. Open-circuits are often caused by dirty harness connectors and components. Dust, together with greasy matter, forms grime which, in time, penetrates electrical connections, resulting in loose metal-to-metal contact or, for worse, electrical separation of surfaces in contact. For this reason, it is essential that the connectors and components be cleaned at each periodic inspection and at when servicing the truck. Instead of a commonly used solvent, use electronic parts cleaner (in the manner illustrated on the right).

Electronic parts cleaner	Three Bond 29D or Pow-R-Wash CZ*
--------------------------	----------------------------------

NOTE

The cleaner liquid is volatile. All you have to do is just give a strong spray to wash off grime.

No need to wipe off the sprayed liquid.

2. After checking the connector for continuity, wash it as shown. Then, uncouple the connector and spray contact surface activator onto contact surfaces.

Install and remove the connector several times to wet the surfaces thoroughly with the activator liquid.

After coupling up the connector, check to be sure that it is in locked state.

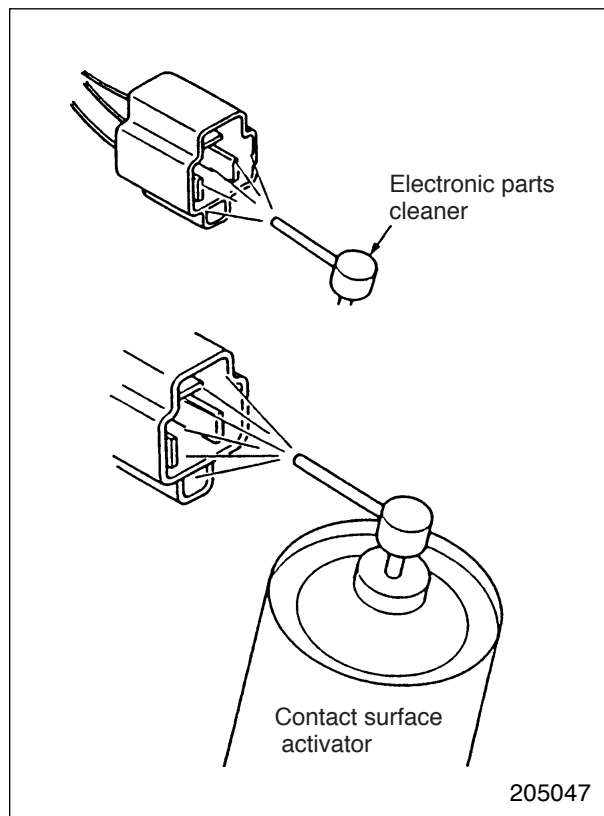
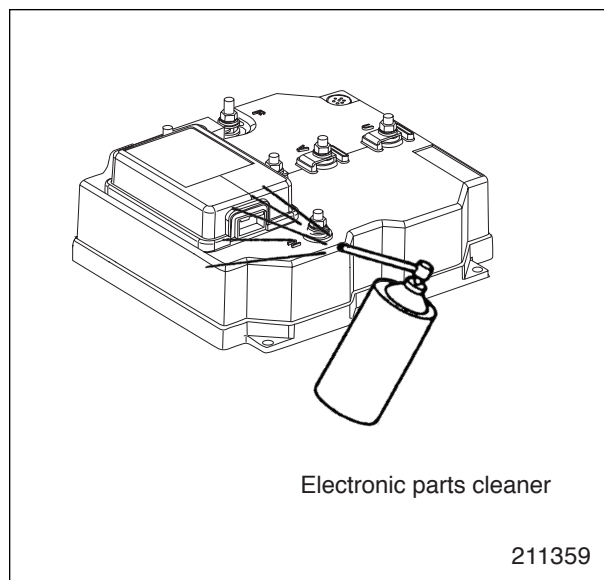
Contact surface activator	Three Bond 2501S (aerosol) or Nyogel 760G*
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NOTE

Do not spray too much liquid into the connector.

Cleaner liquid reacts differently with some resins (plastic materials).

*: Products contained in Terminal Maintenance Kit (SE000003)



Problem: Traction Motor, Overheating (E0)**(1) Situation**

Controller/motor overheat indicator ON. Poor pulling power and acceleration.
Normal pump motor and power steering operations. Service tool "Alarm status" and "E0" displayed.

(2) Possible cause

Overheating of traction motor, faulty traction motor or thermal sensor, faulty or open harness wiring,
faulty traction inverter DSP card, abnormal power supply of logic unit, brake or parking brake drag,
abnormality in front axle, faulty display unit.

(3) How the error code is triggered

Motor temperature is out of range of -25 °C to 150 °C (-13 °F to 302 °F).
It becomes normal when motor temperature is in range of -20 °C to 70 °C (-4 °F to 158 °F).

(4) Checks

Let truck cool for 15 minutes.

Overheat indicator ON

Overheat indicator OFF

(5) Traction motor becomes normal.

If problem recurs

(6) Disconnect battery plug. Disengage brake and parking brake, and check their drag.

No drag

Drag

(7) Adjust brake.

(8) Lift front wheels, and disengage parking brake.
Turn key switch to OFF, rotate front wheels.
Confirm there is no difference in rotation load between right and left wheels.

No difference

Difference

(9) Check if truck is operated on steep upgrade or to pull large cargo load.

Normal

(10) Perform inverter discharging work. See page 1-45.

(11) Replace traction motor.

See Chassis & Mast.

(12) Replace traction motor or front axle.
See Chassis & mast.

With service tool

Without service tool

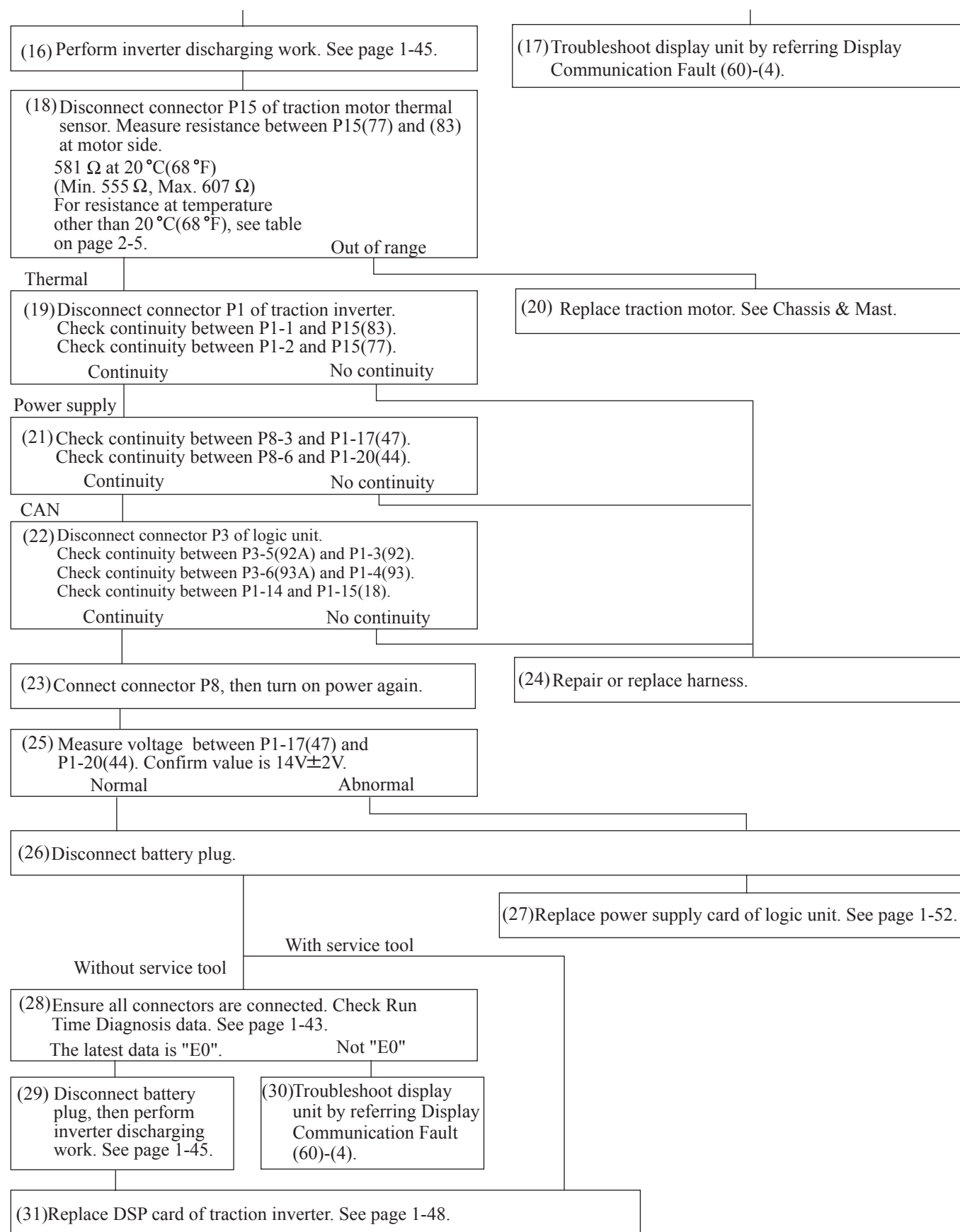
(13) Confirm temperature of traction motor with input/output monitor.

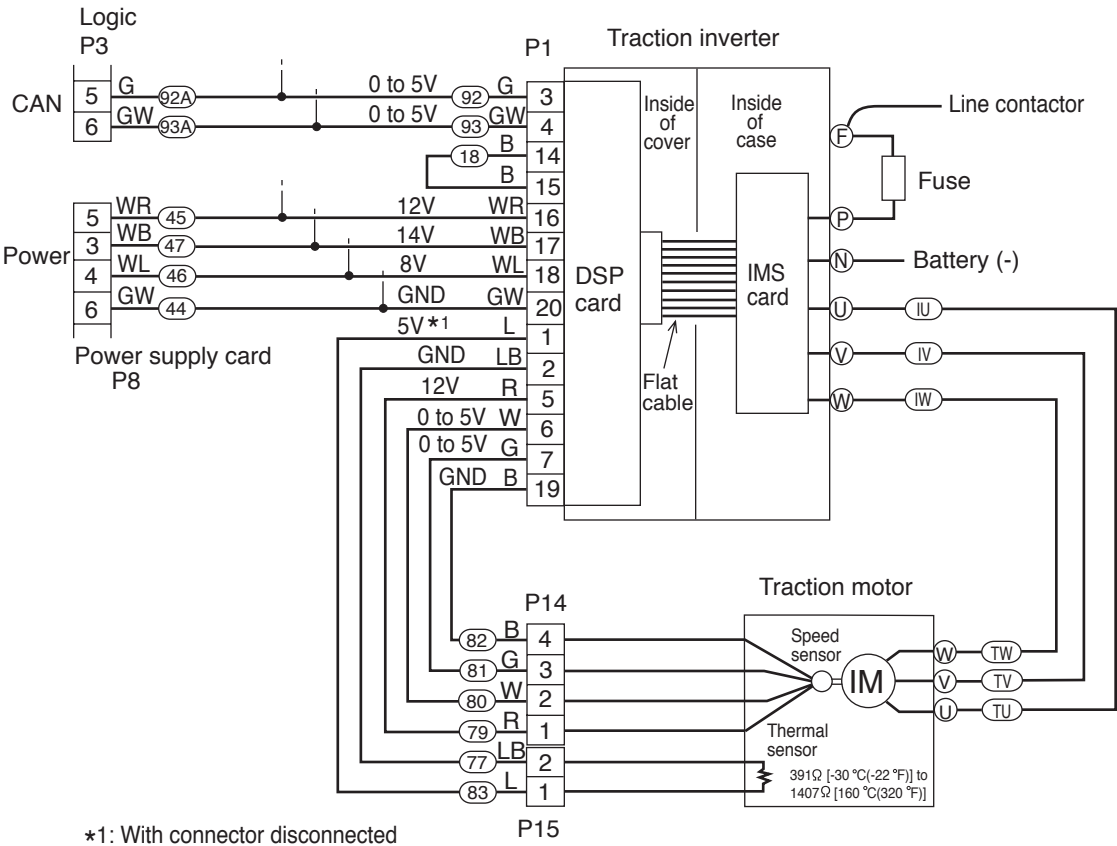
Less than -20 °C (-4 °F)
or more than 70 °C (158 °F)

-20 °C to 70 °C
(-4 °F to 158 °F)

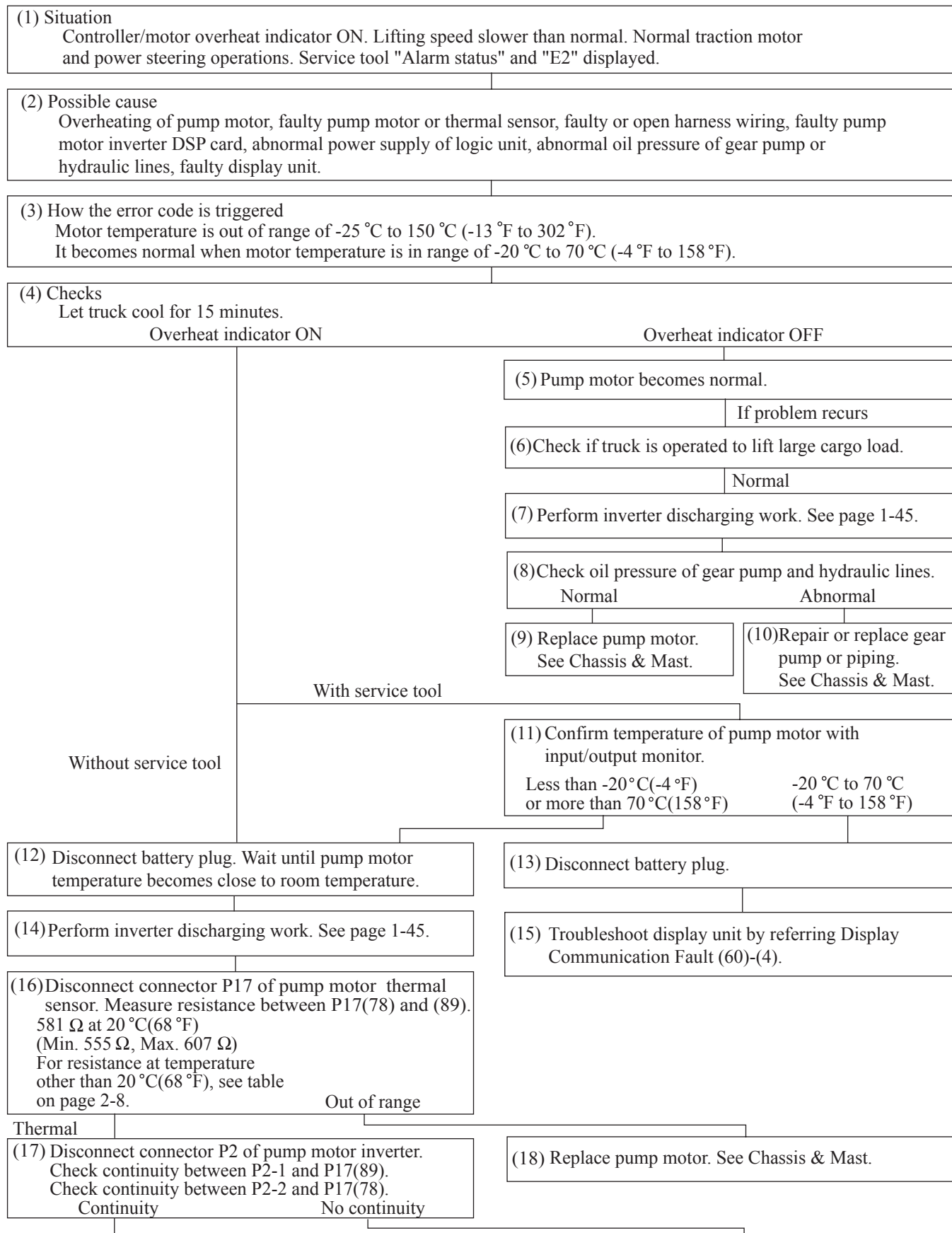
(14) Disconnect battery plug. Wait until traction motor temperature becomes close to room temperature.

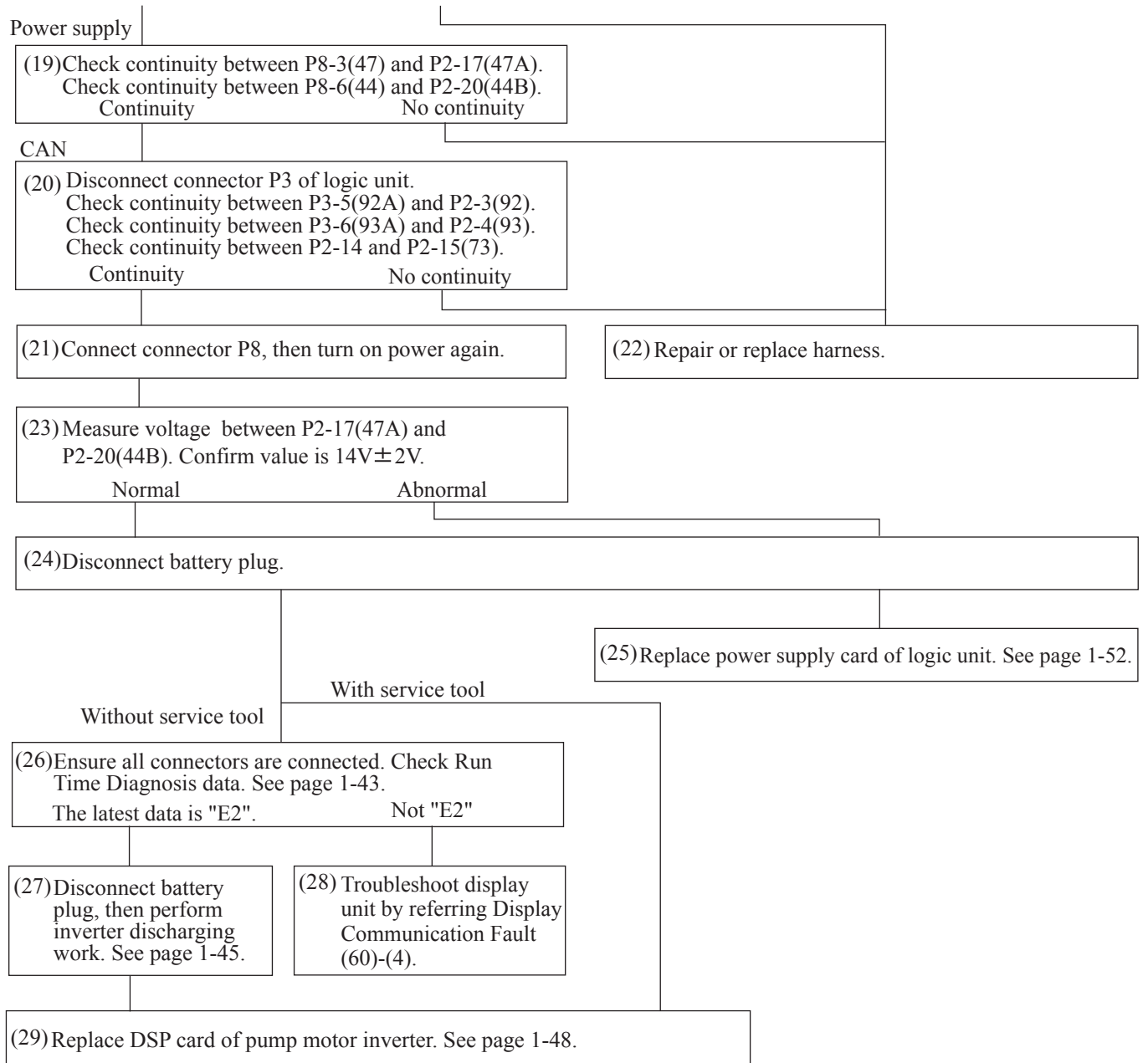
(15) Disconnect battery plug.

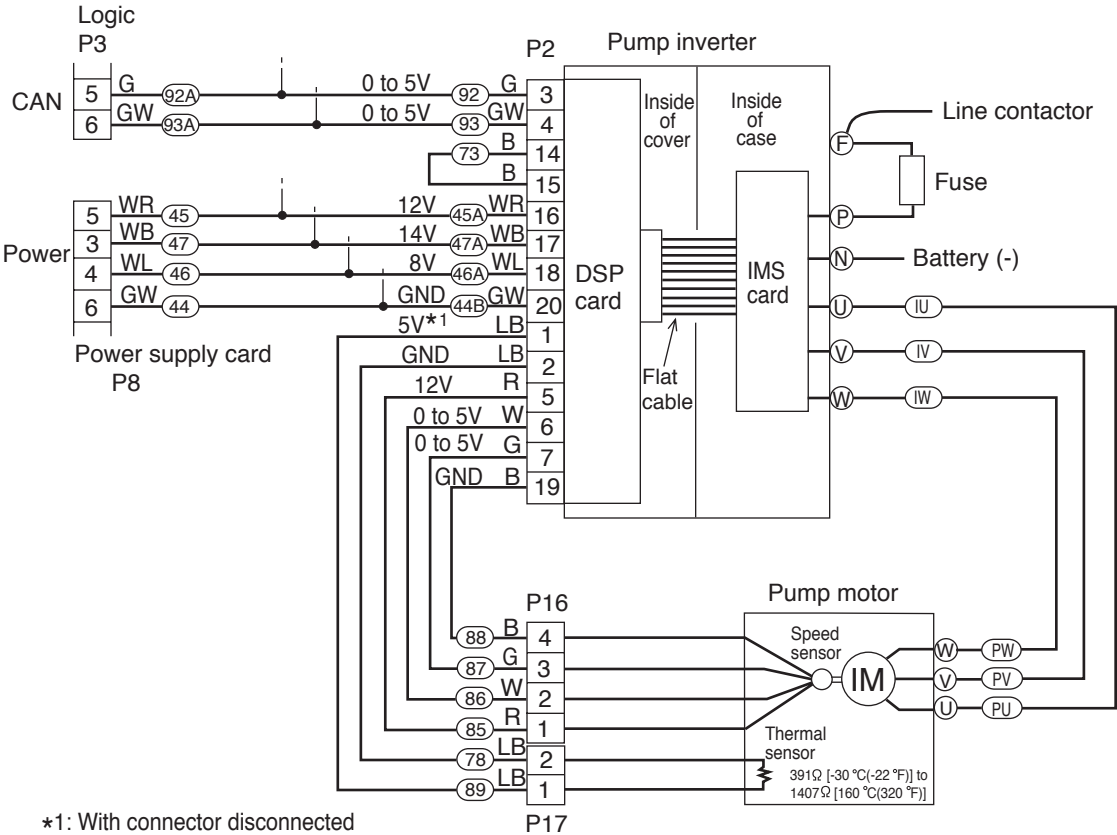




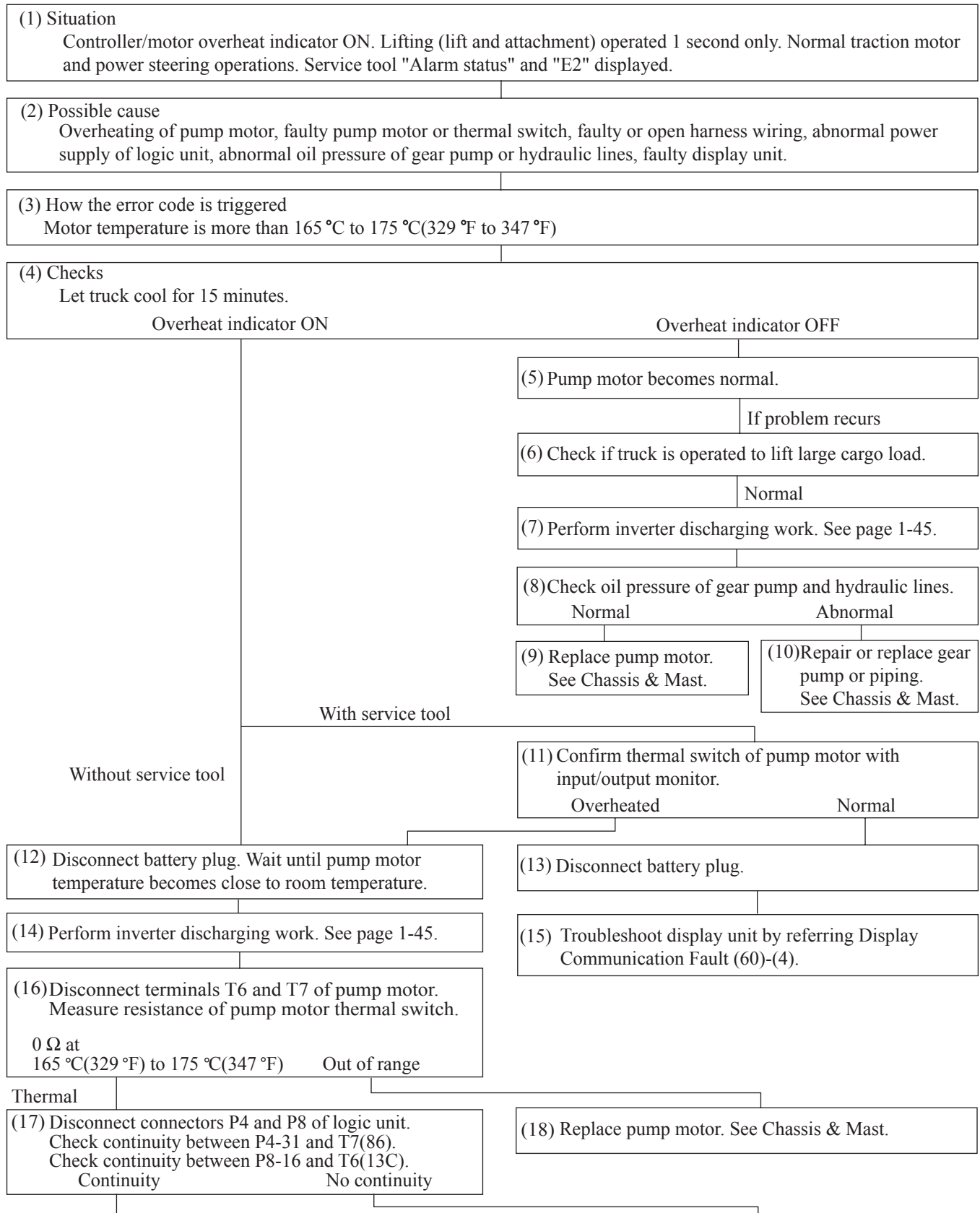
AMBIENT TEMPERATURE		RESISTANCE		
(°C)	(°F)	MIN.	TYP.	MAX.
-30	-22	362	391	419
-10	14	428	460	492
0	32	464	498	532
10	50	503	538	574
30	86	587	626	665
50	122	679	722	764
70	158	781	826	872
90	194	891	940	989
110	230	1007	1062	1117
130	266	1128	1194	1259
150	302	1256	1334	1412

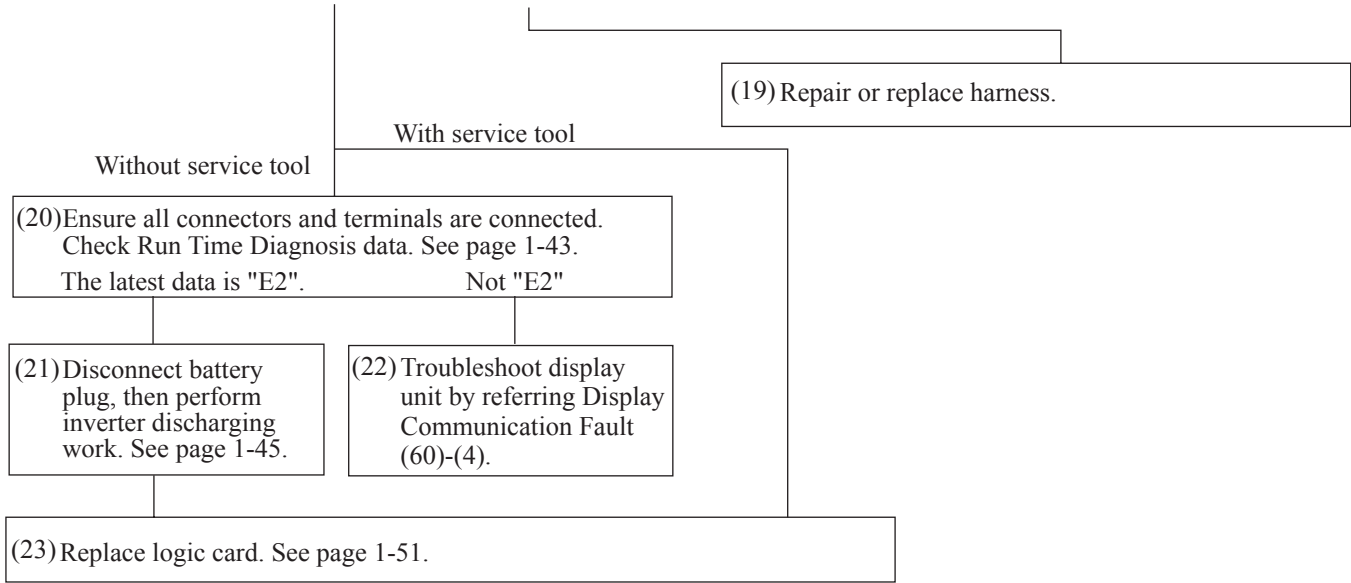
Problem: Pump Motor, Overheating (Transistor Control Type) (E2)

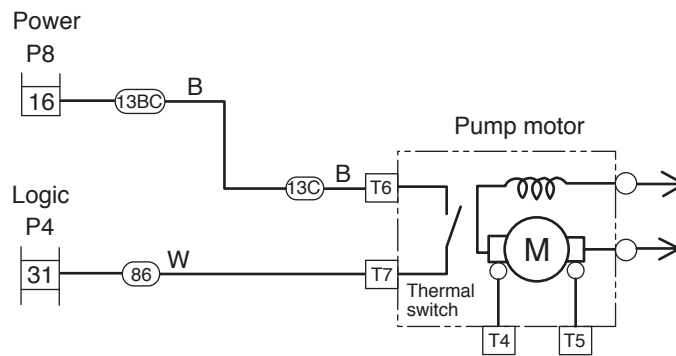




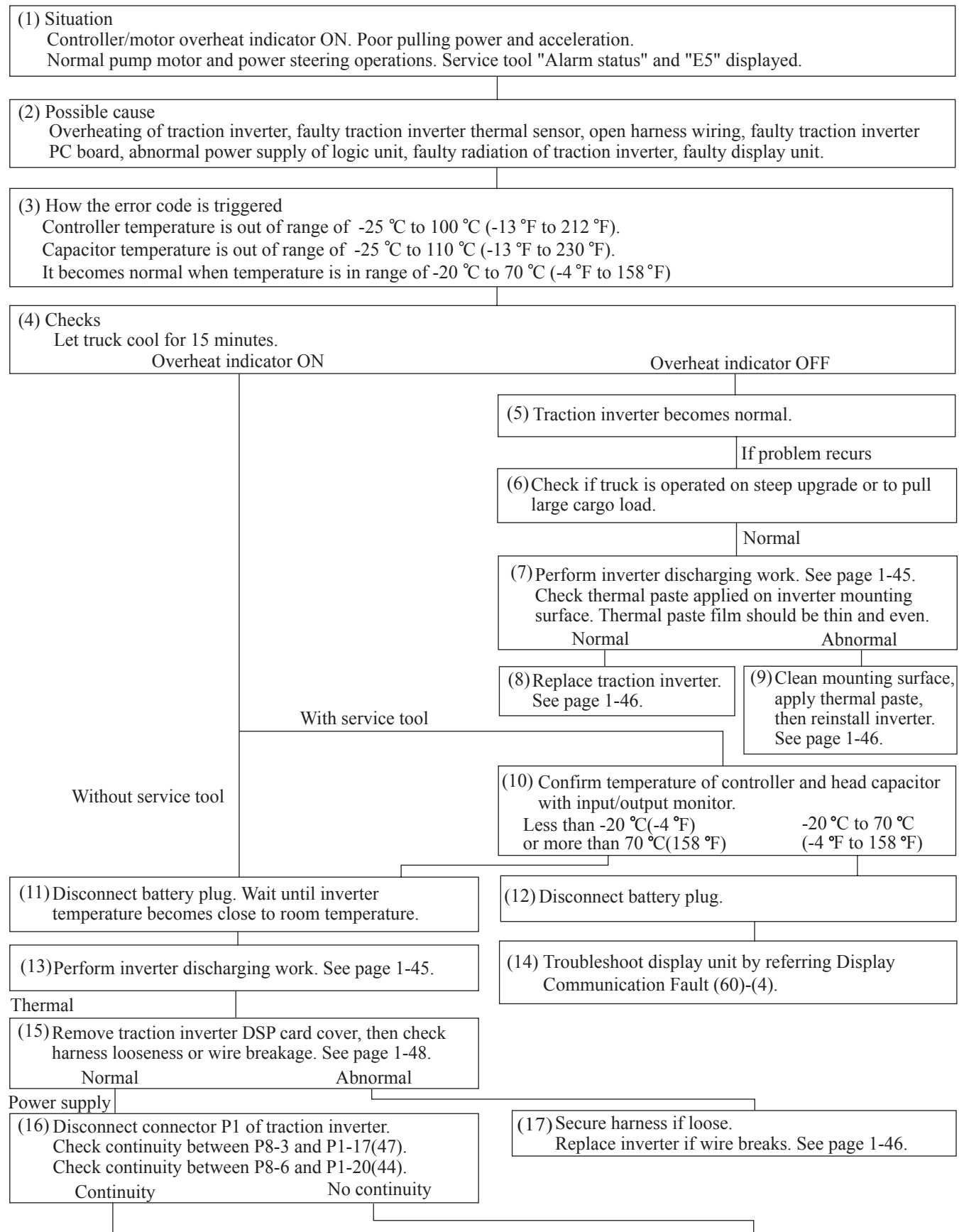
AMBIENT TEMPERATURE		RESISTANCE		
(°C)	(°F)	MIN.	TYP.	MAX.
-30	-22	362	391	419
-10	14	428	460	492
0	32	464	498	532
10	50	503	538	574
30	86	587	626	665
50	122	679	722	764
70	158	781	826	872
90	194	891	940	989
110	230	1007	1062	1117
130	266	1128	1194	1259
150	302	1256	1334	1412

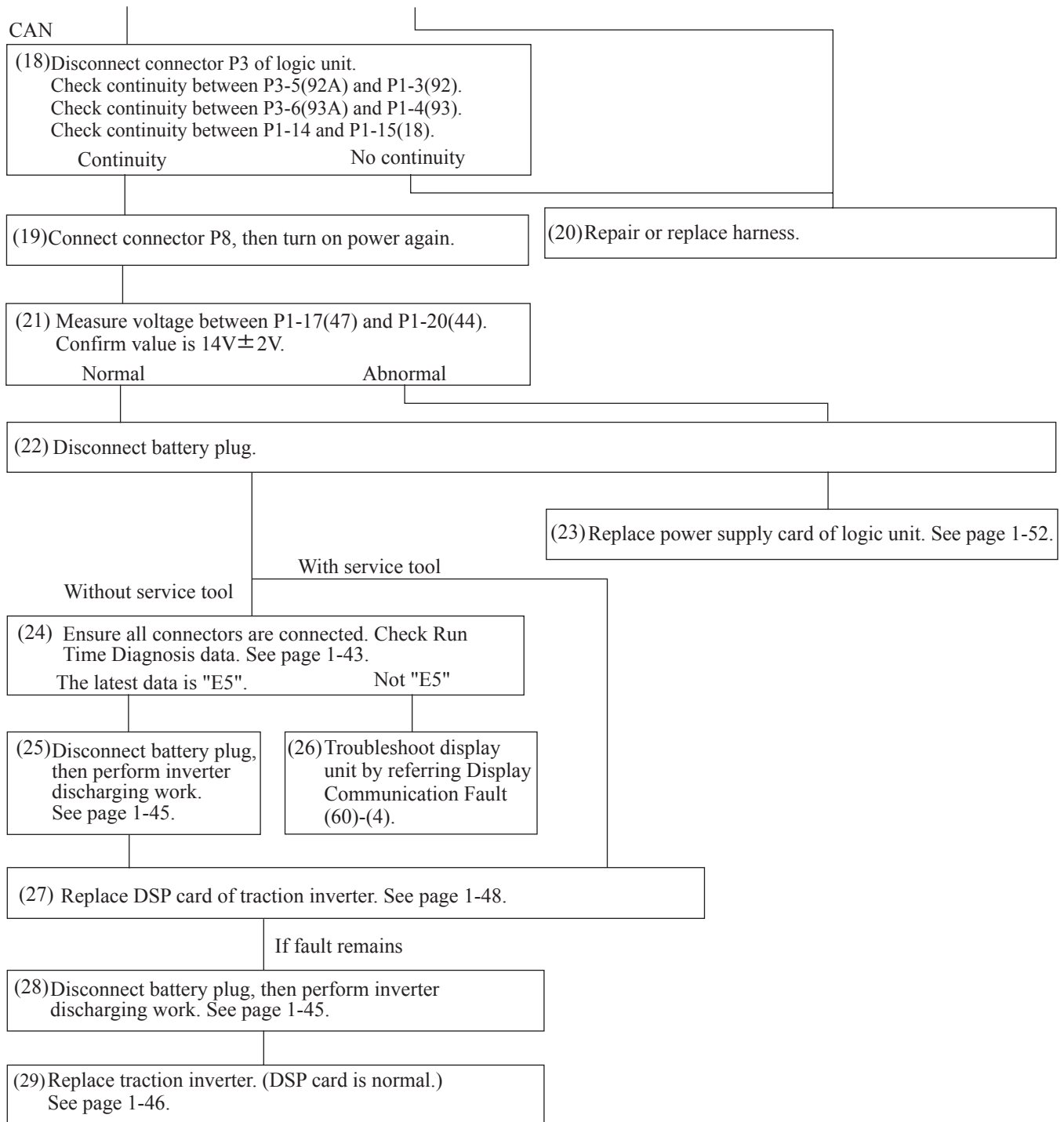
Problem: Pump Motor, Overheating (Contactor Control Type) (E2)

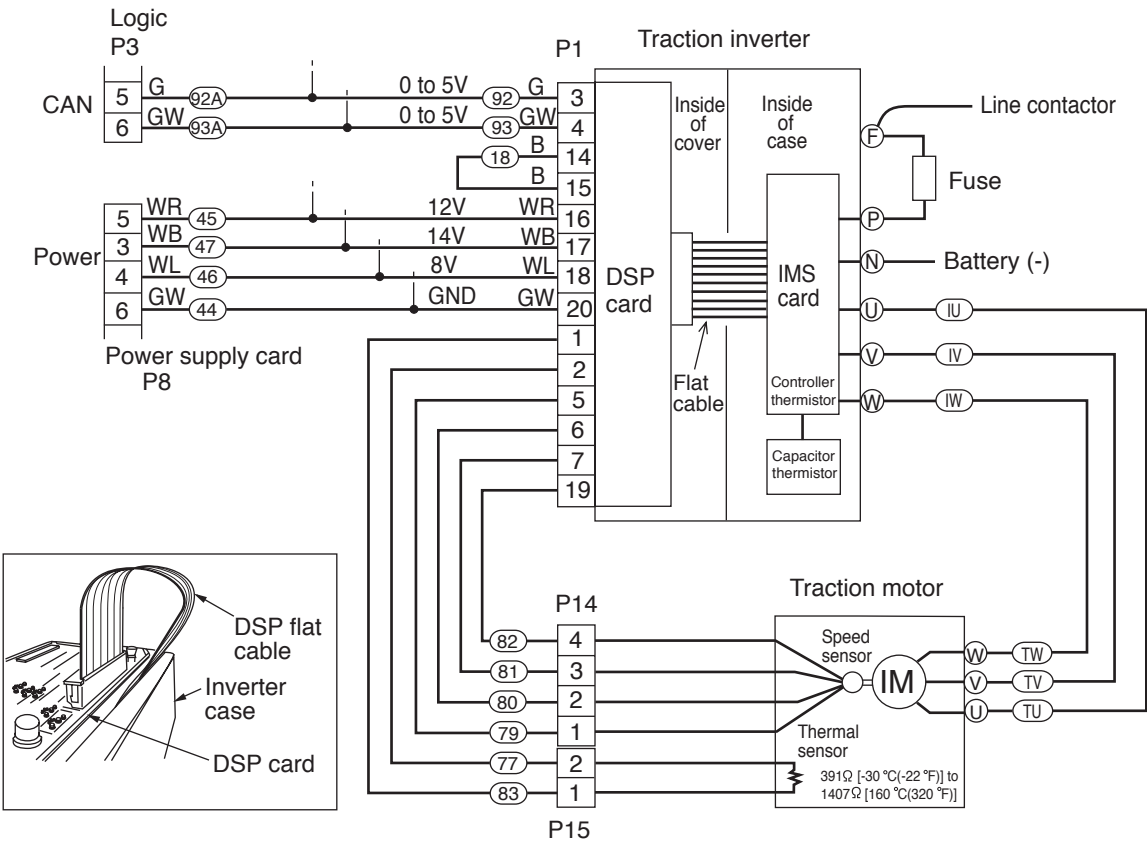




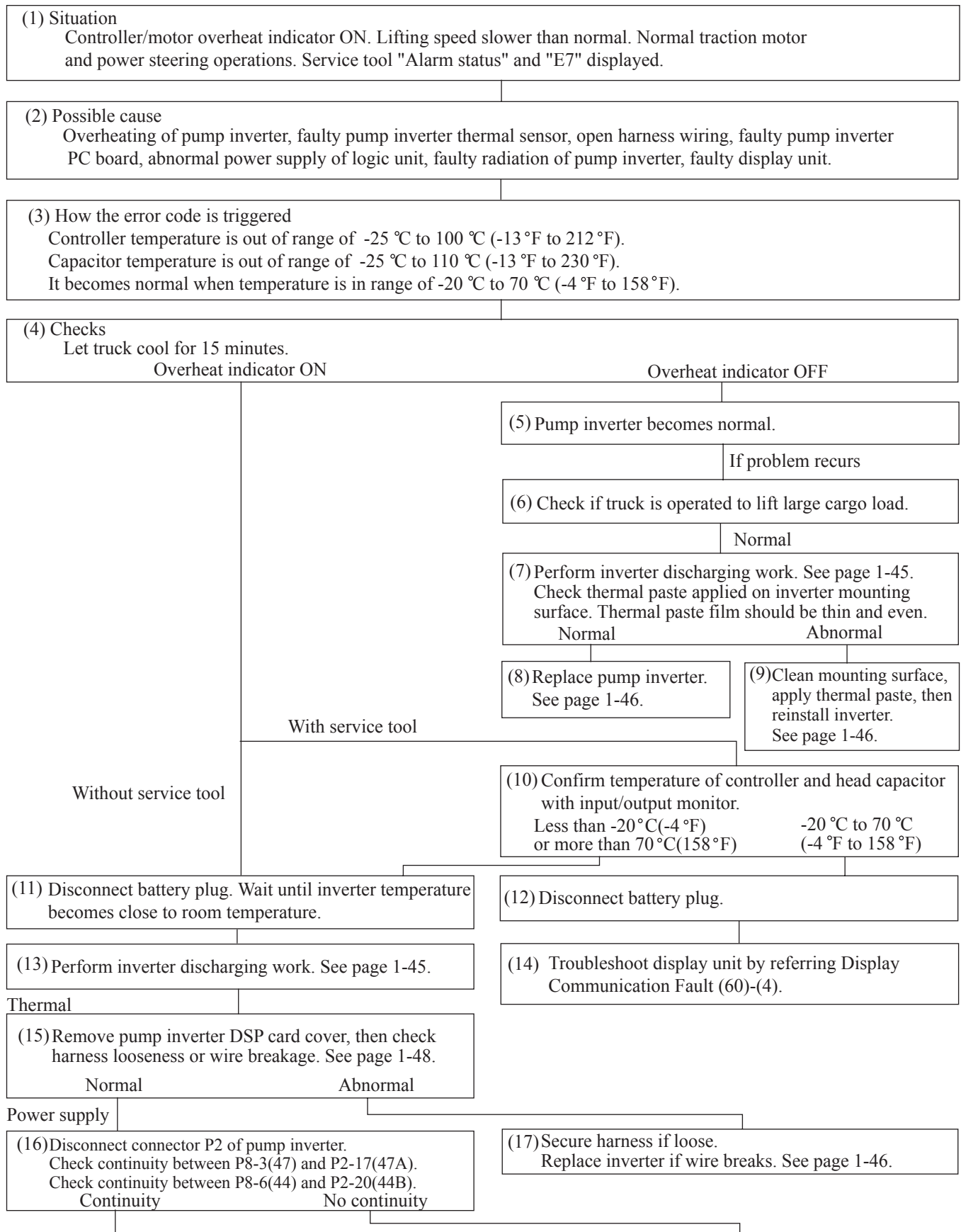
211362

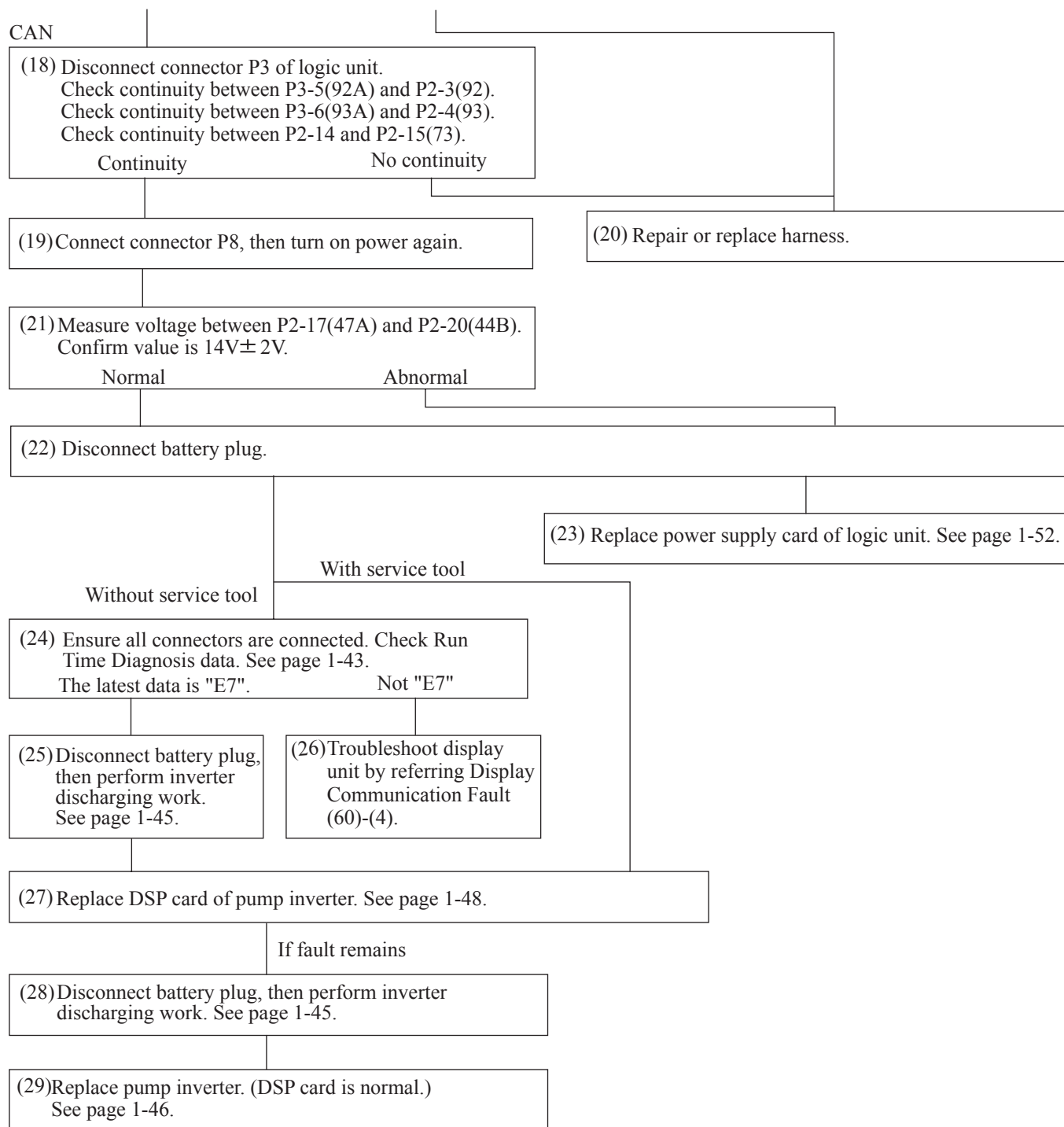
Problem: Traction Inverter, Overheating (E5)

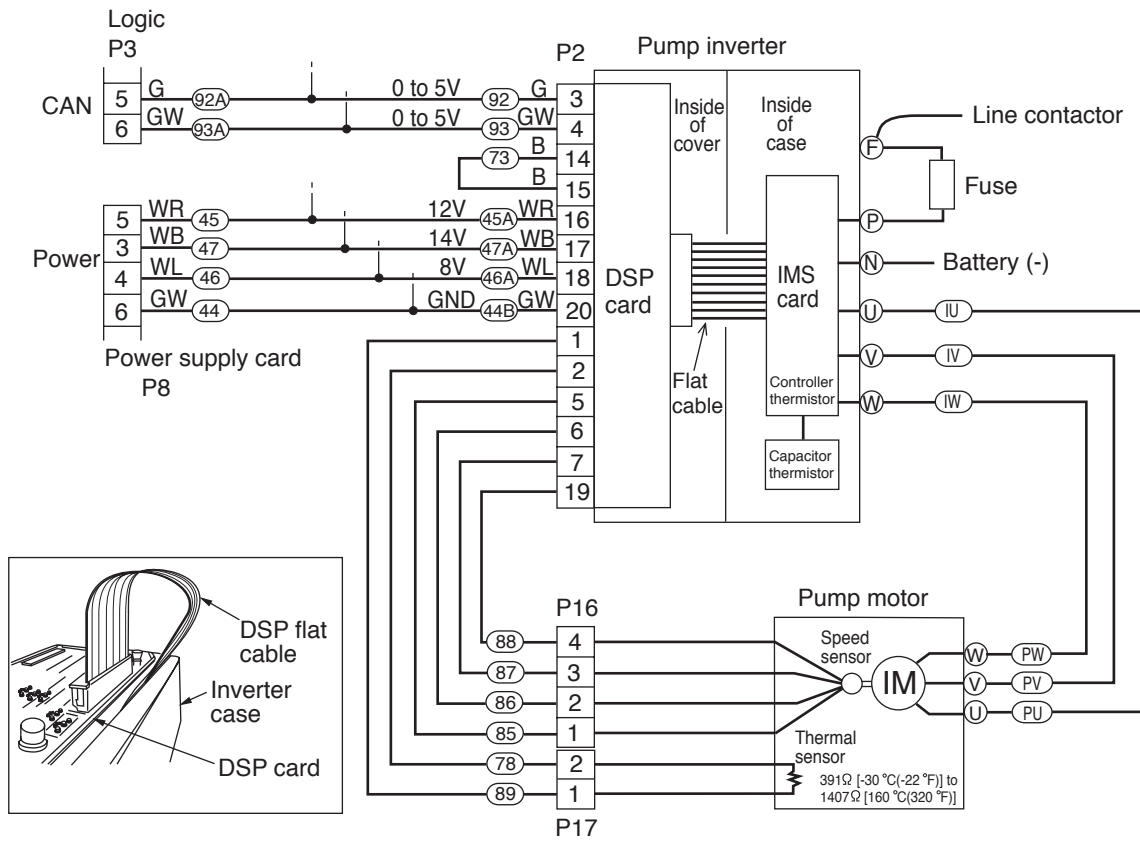




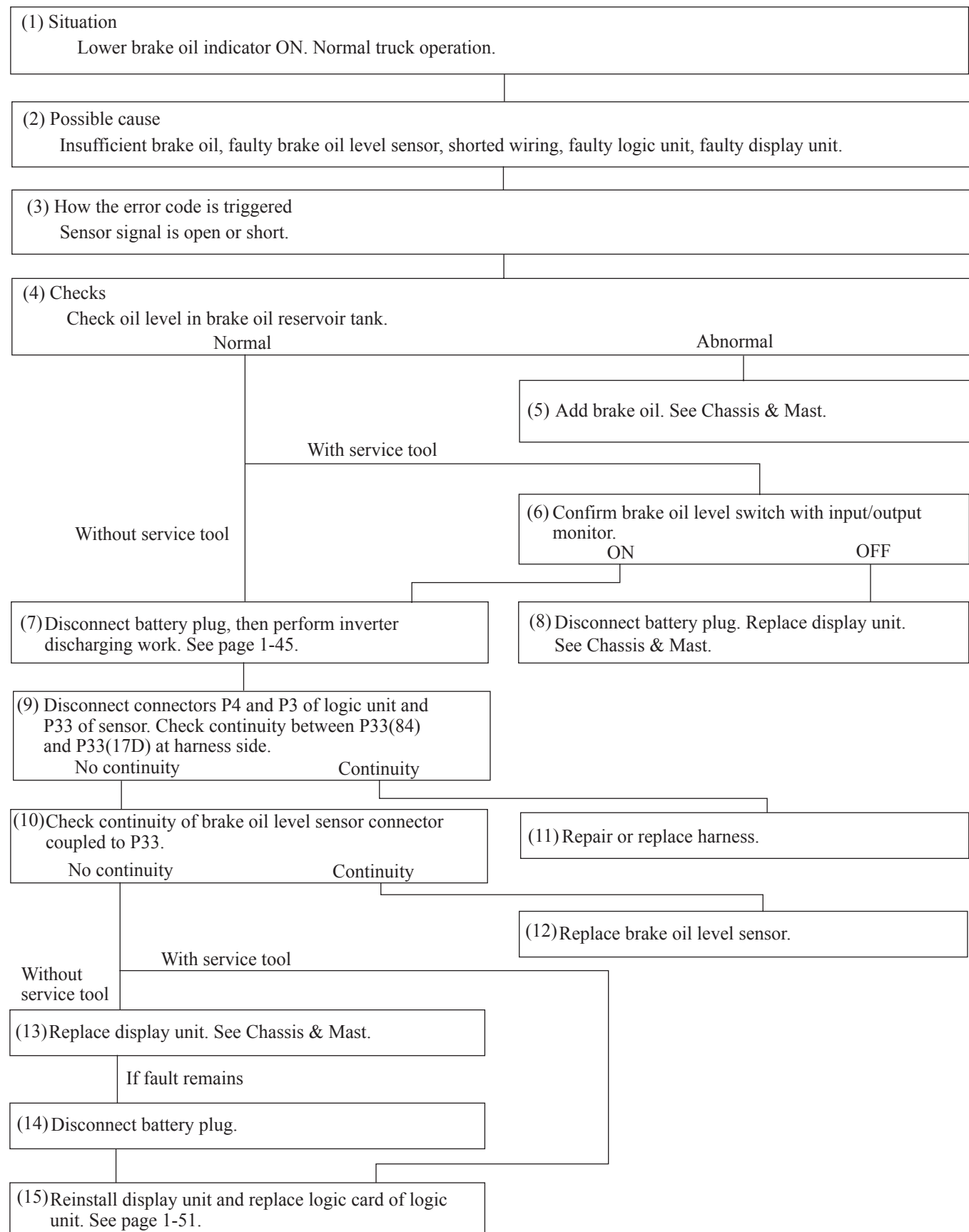
211363

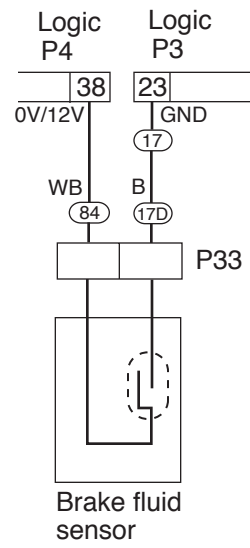
Problem: Pump Inverter, Overheating (Transistor Control Type Only) (E7)



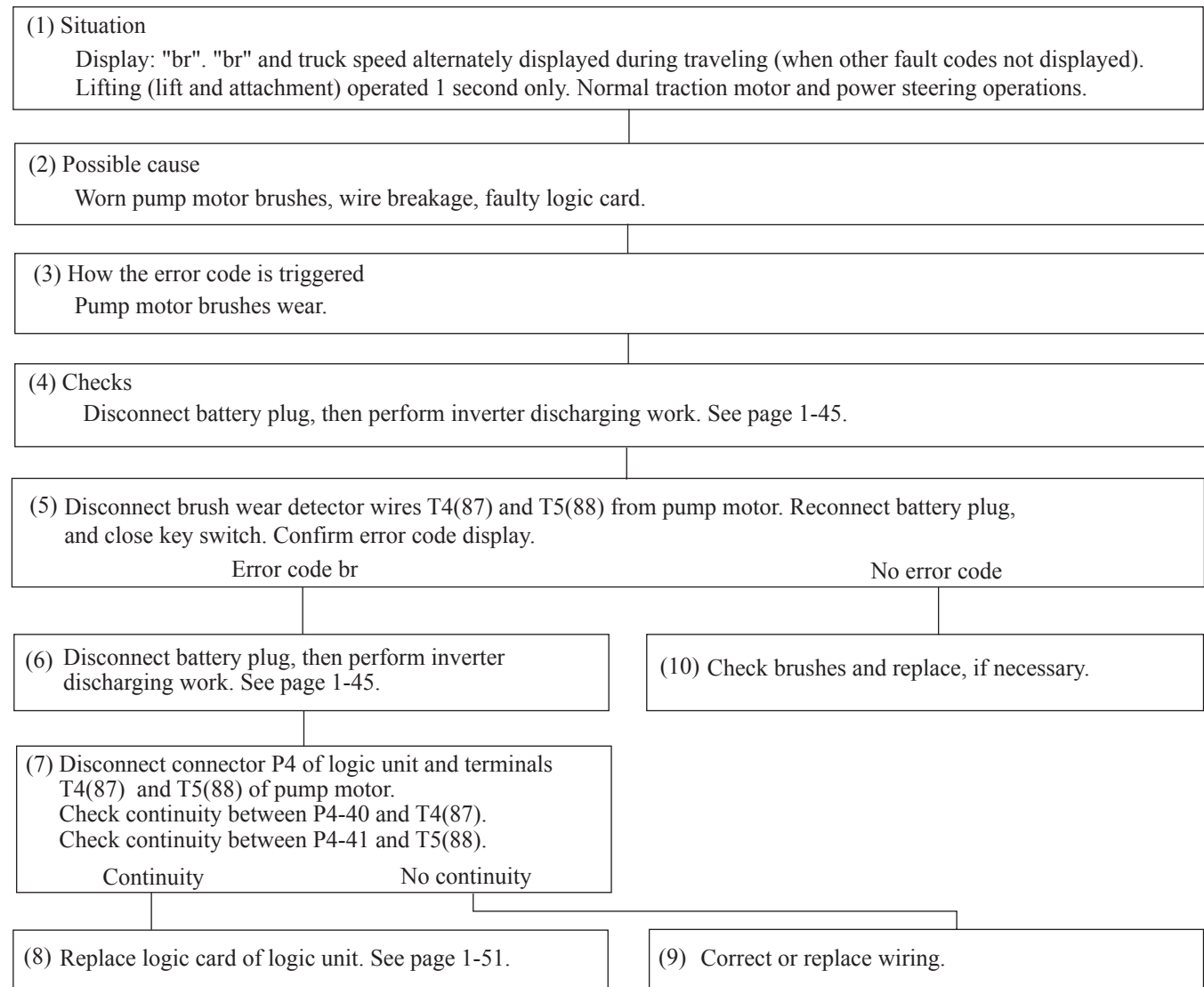


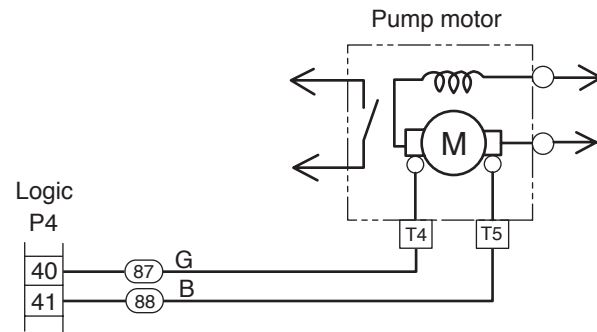
211364

Problem: Brake Oil, Low Level

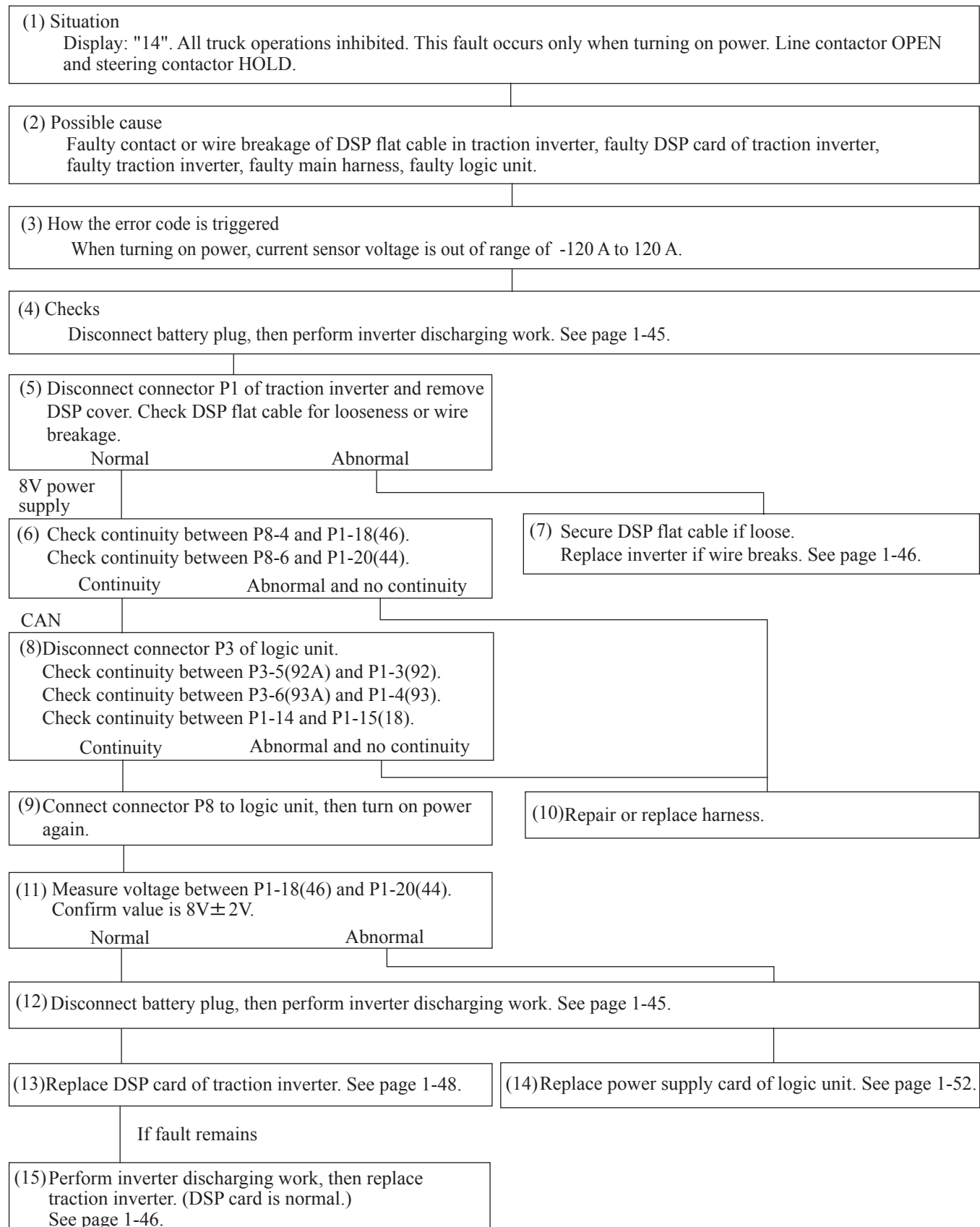


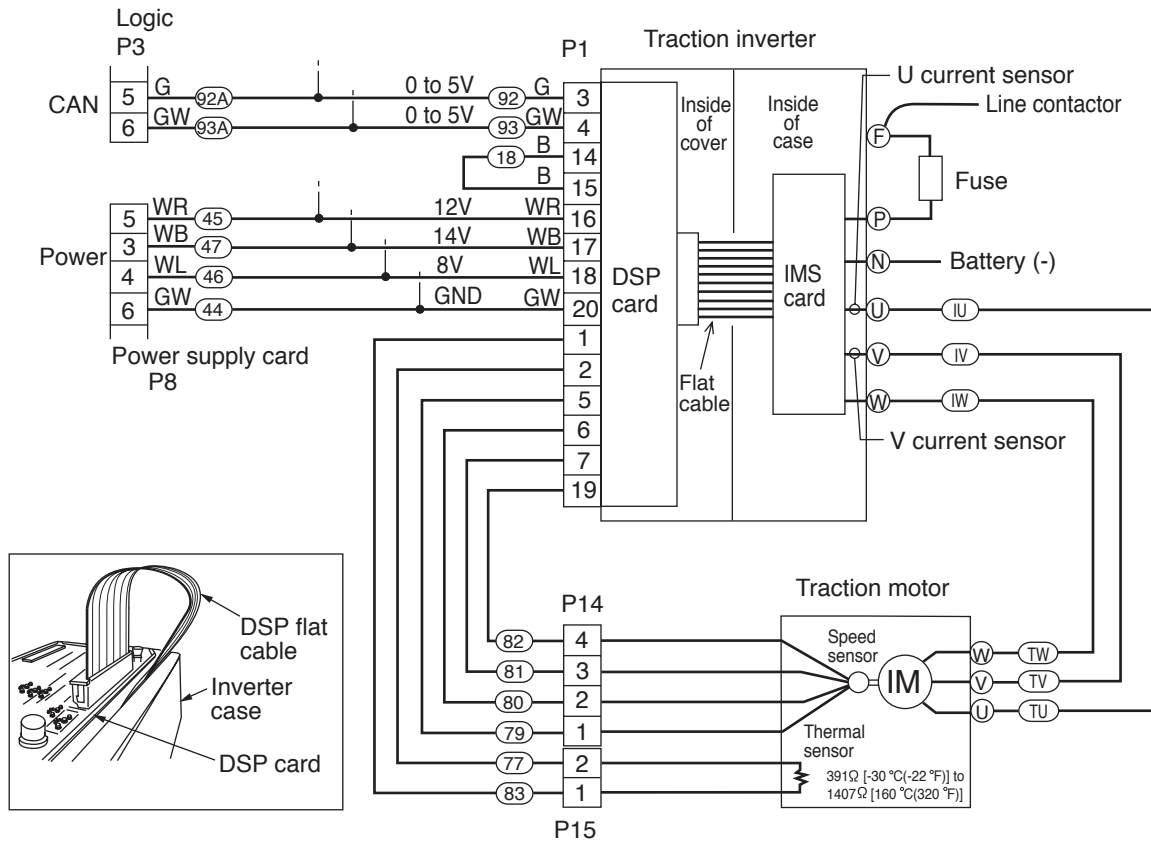
211365

Problem: Pump Motor, Worn Brushes (Contactor Control Type Only) (br)

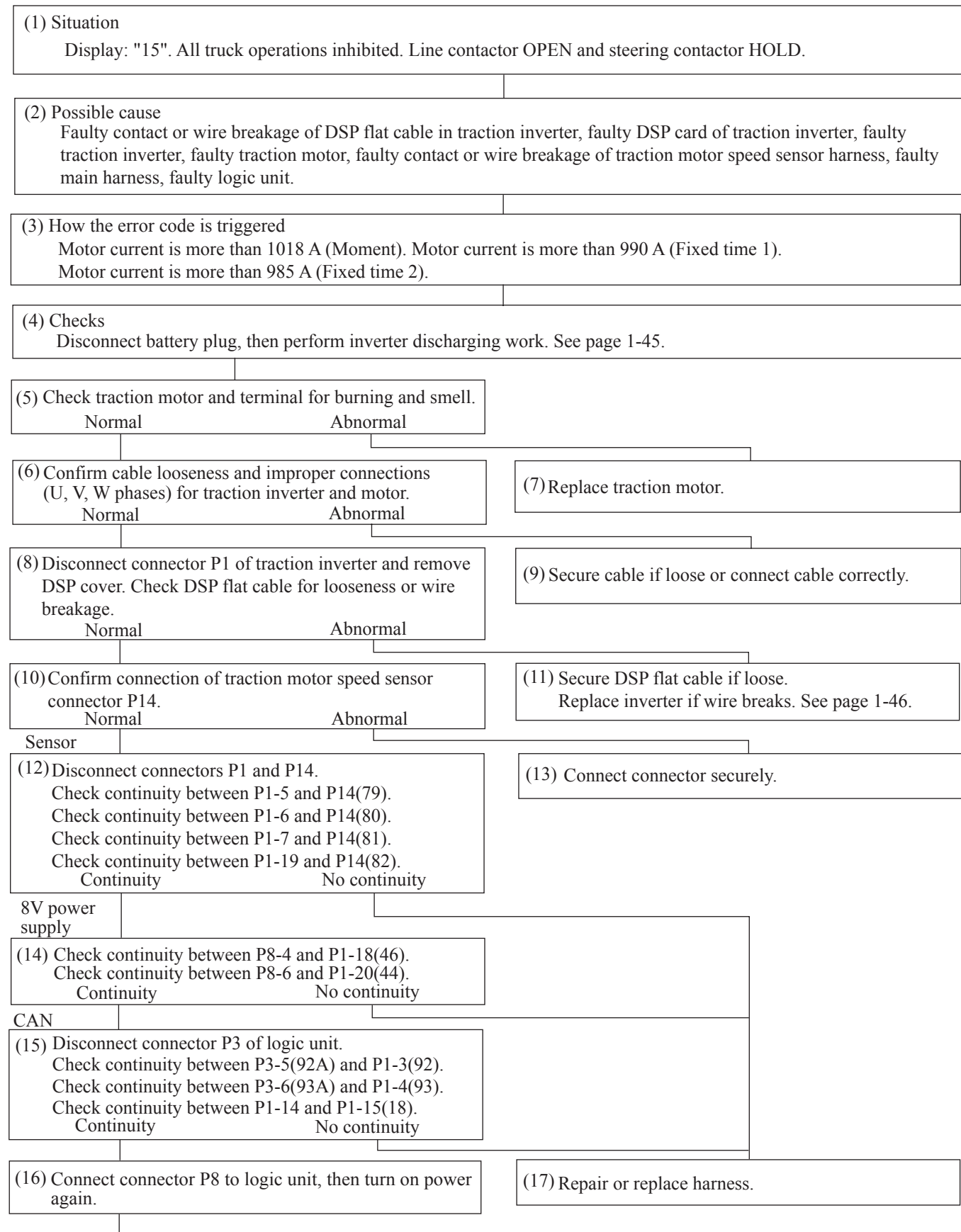


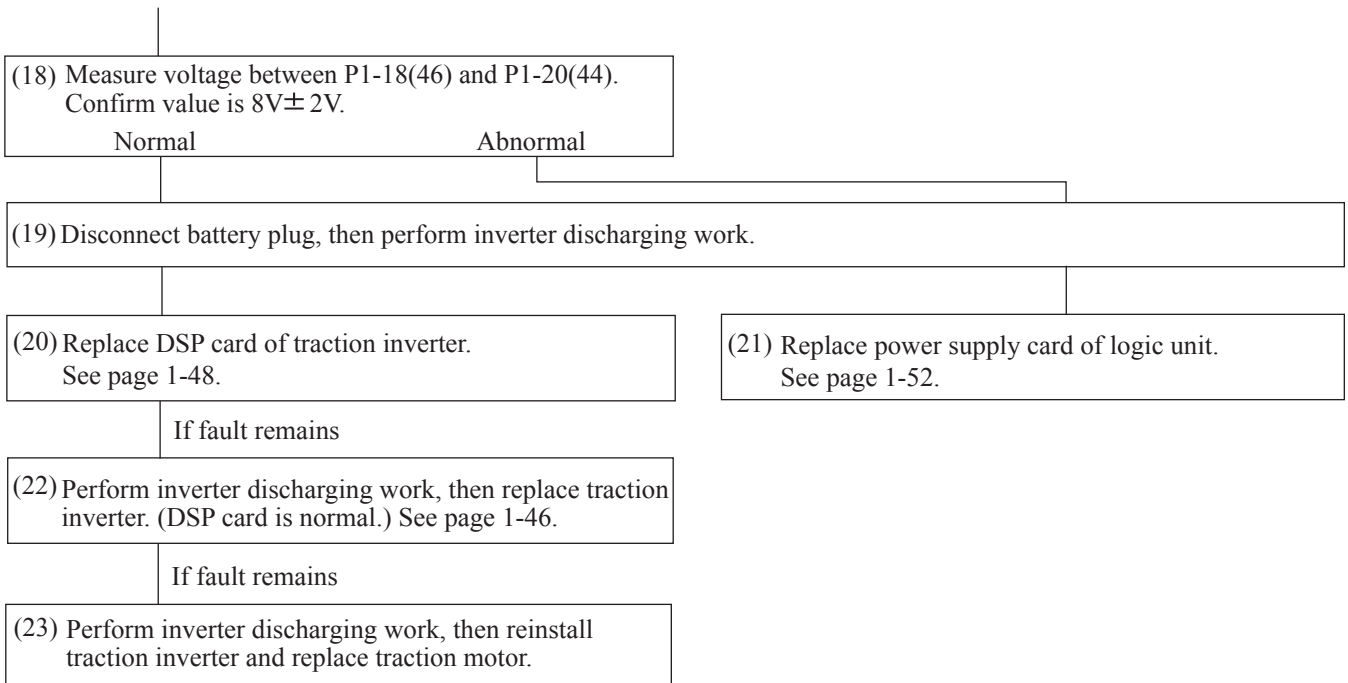
211366

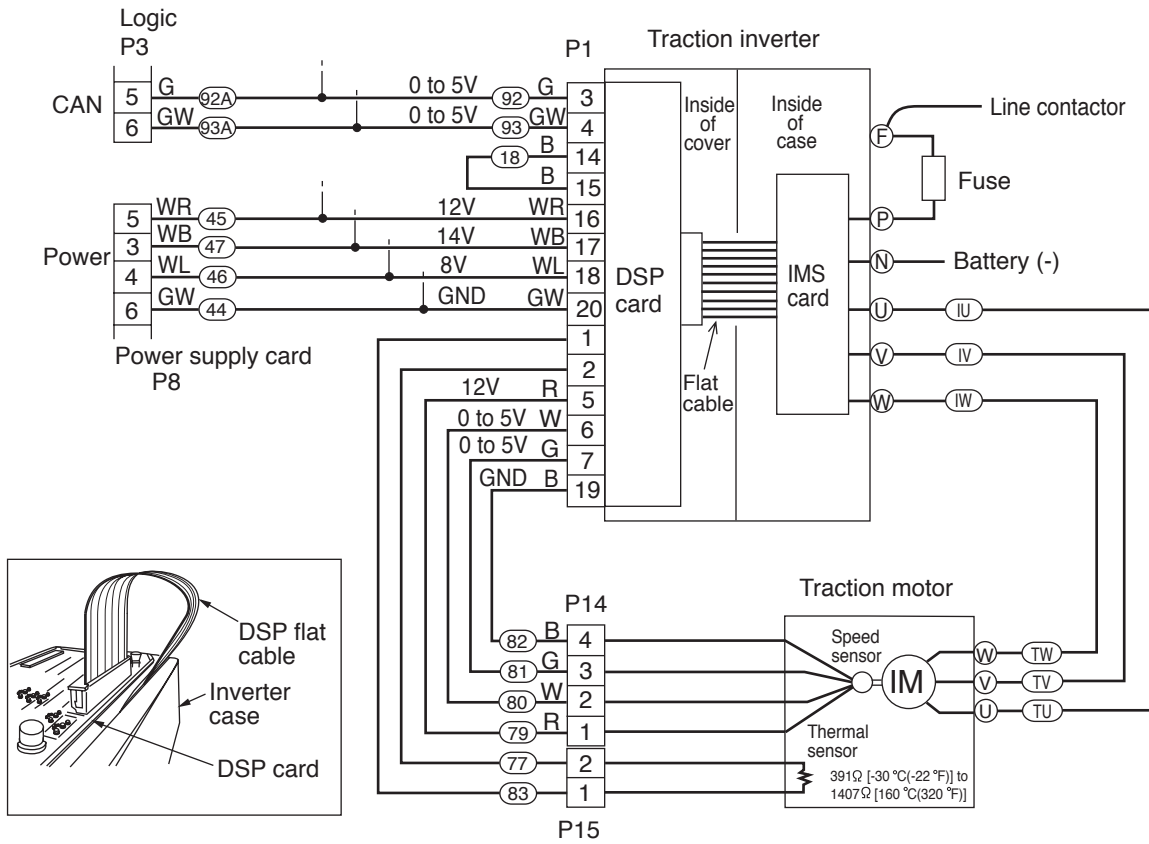
Problem: Traction Motor Current Sensor Fault (14)



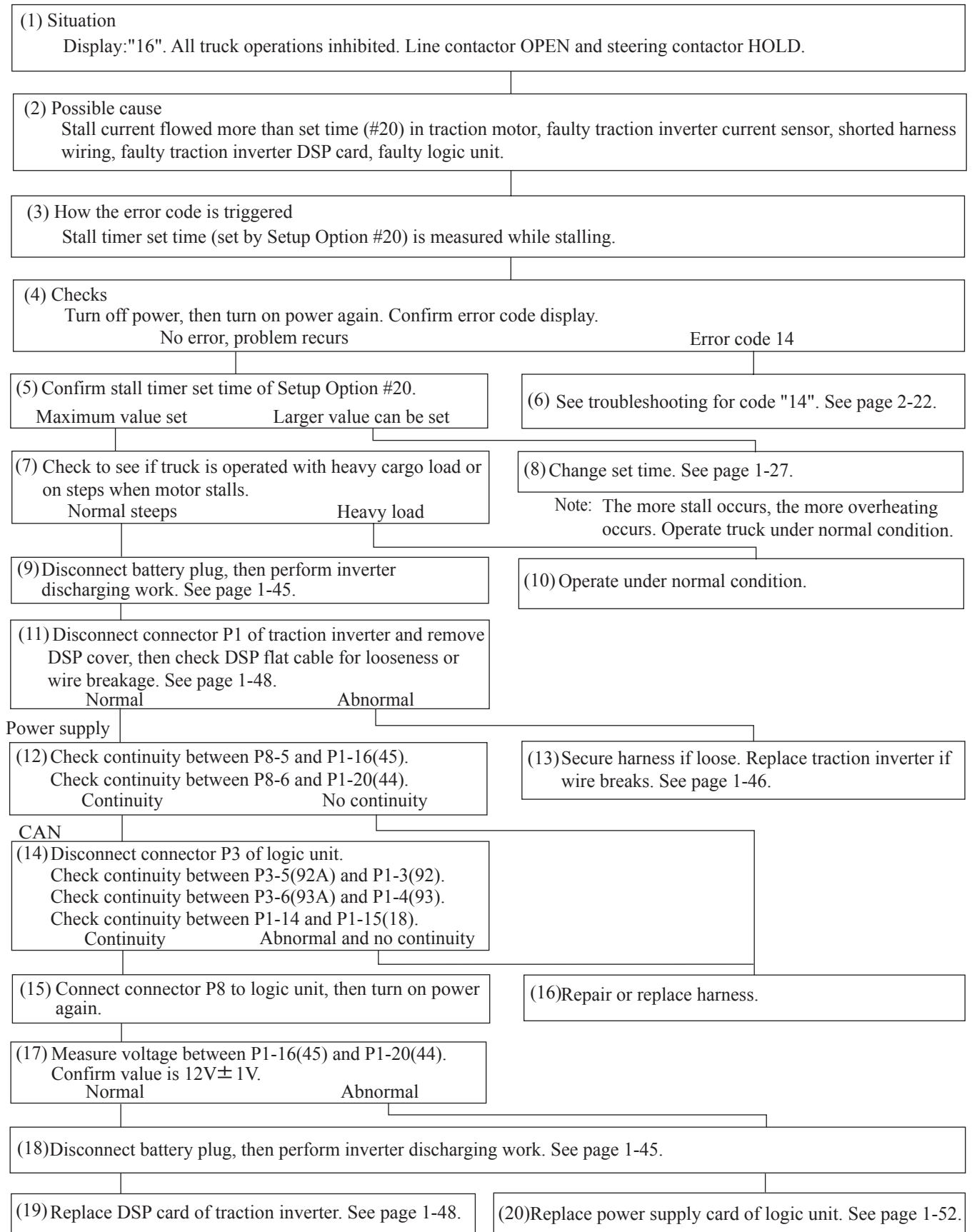
211367

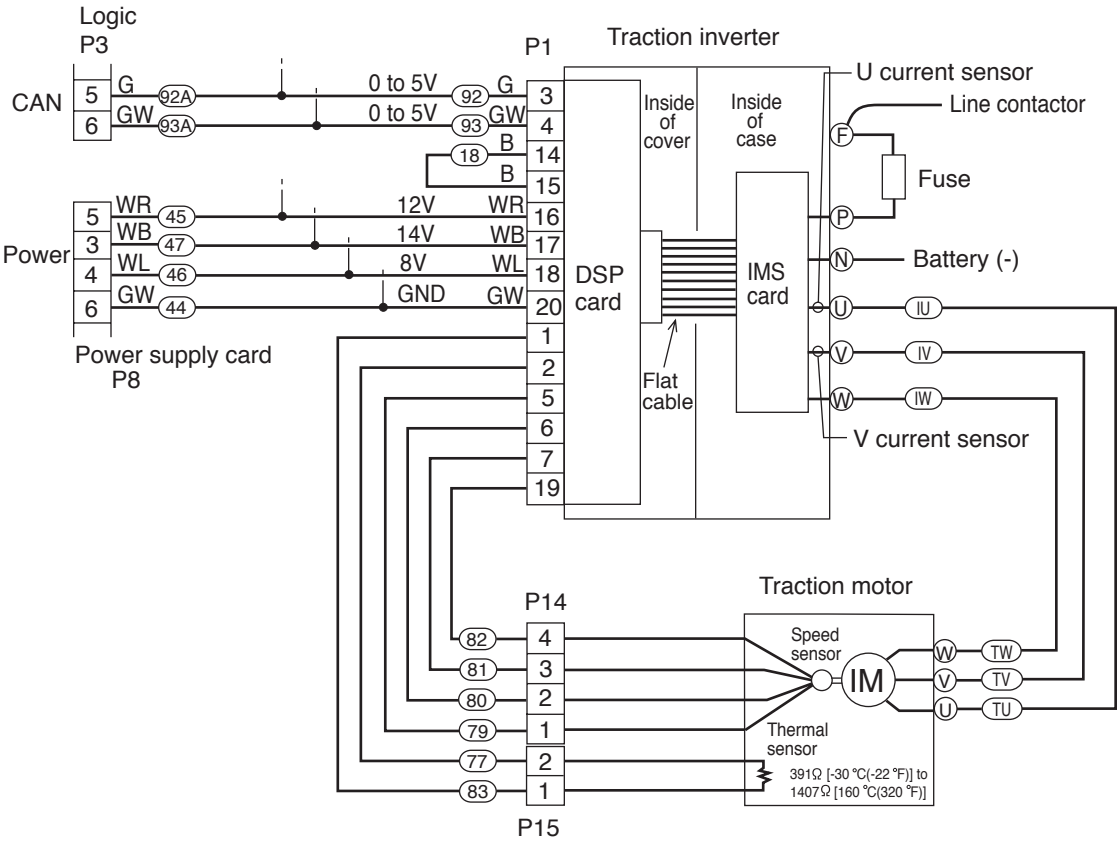
Problem: Traction Motor, Over-current (15)





211368

Problem: Traction Motor, Stall Timer (16)



211369

Problem: Pump Motor Current Sensor Fault (Transistor Control Type Only) (34)**(1) Situation**

Display: "34". All truck operations inhibited. This fault occurs only when turning on power.
Line contactor OPEN and steering contactor HOLD.

(2) Possible cause

Faulty contact or wire breakage of DSP flat cable in pump inverter, faulty DSP card of pump inverter,
faulty pump inverter, faulty main harness, faulty logic unit.

(3) How the error code is triggered

When turning on power, current sensor voltage is out of range of -120 A to 120 A.

(4) Checks

Disconnect battery plug, then perform inverter discharging work. See page 1-45.

(5) Disconnect connector P2 of pump inverter and remove DSP cover. Check DSP flat cable for looseness or wire breakage.

Normal

Abnormal

8V power supply

(6) Check continuity between P8-4(46) and P2-18(46A).
Check continuity between P8-6(44) and P2-20(44B).

Continuity

No continuity

(7) Secure DSP flat cable if loose.

Replace pump inverter if wire breaks. See page 1-46.

CAN

(8) Disconnect connector P3 of logic unit.
Check continuity between P3-5(92A) and P2-3(92).
Check continuity between P3-6(93A) and P2-4(93).
Check continuity between P2-14 and P2-15(73).

Continuity

No continuity

(9) Connect connector P8 to logic unit, then turn on power again.

(10) Repair or replace harness.

(11) Measure voltage between P2-18(46A) and P2-20(44B).
Confirm value is $8V \pm 2V$.

Normal

Abnormal

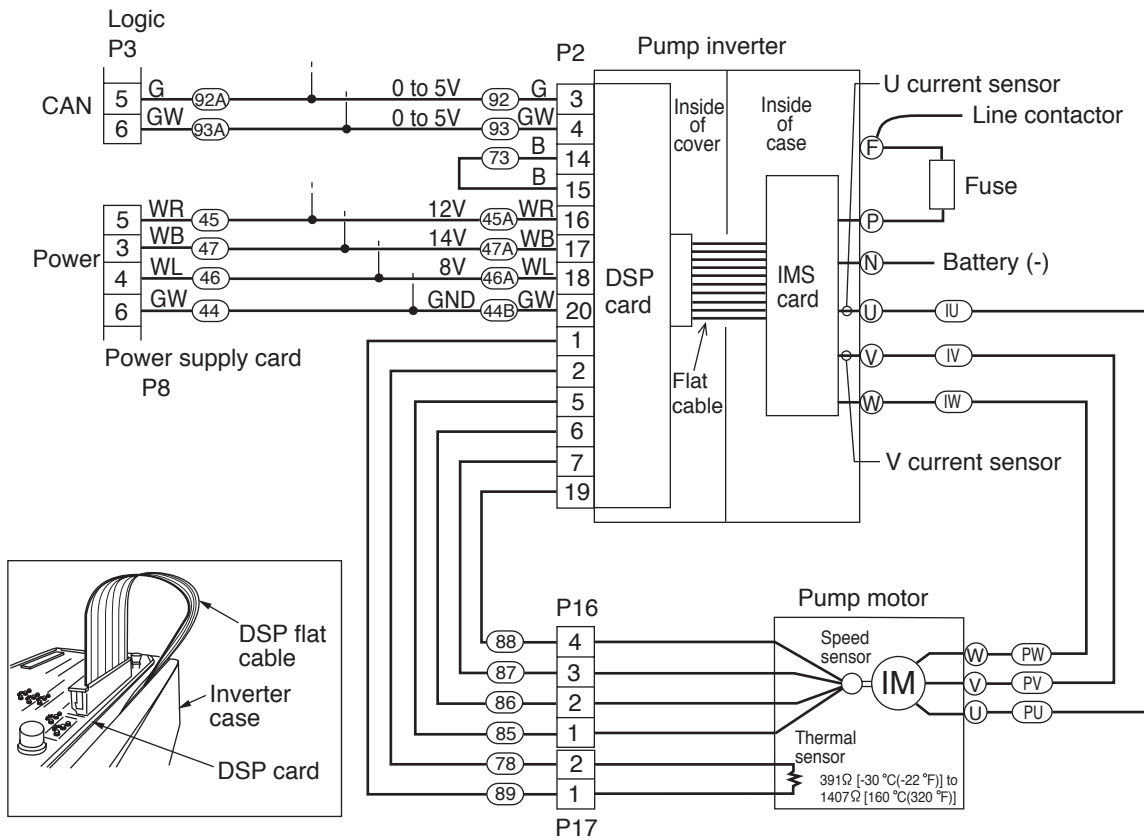
(12) Disconnect battery plug, then perform inverter discharging work. See page 1-45.

(13) Replace DSP card of pump inverter. See page 1-48.

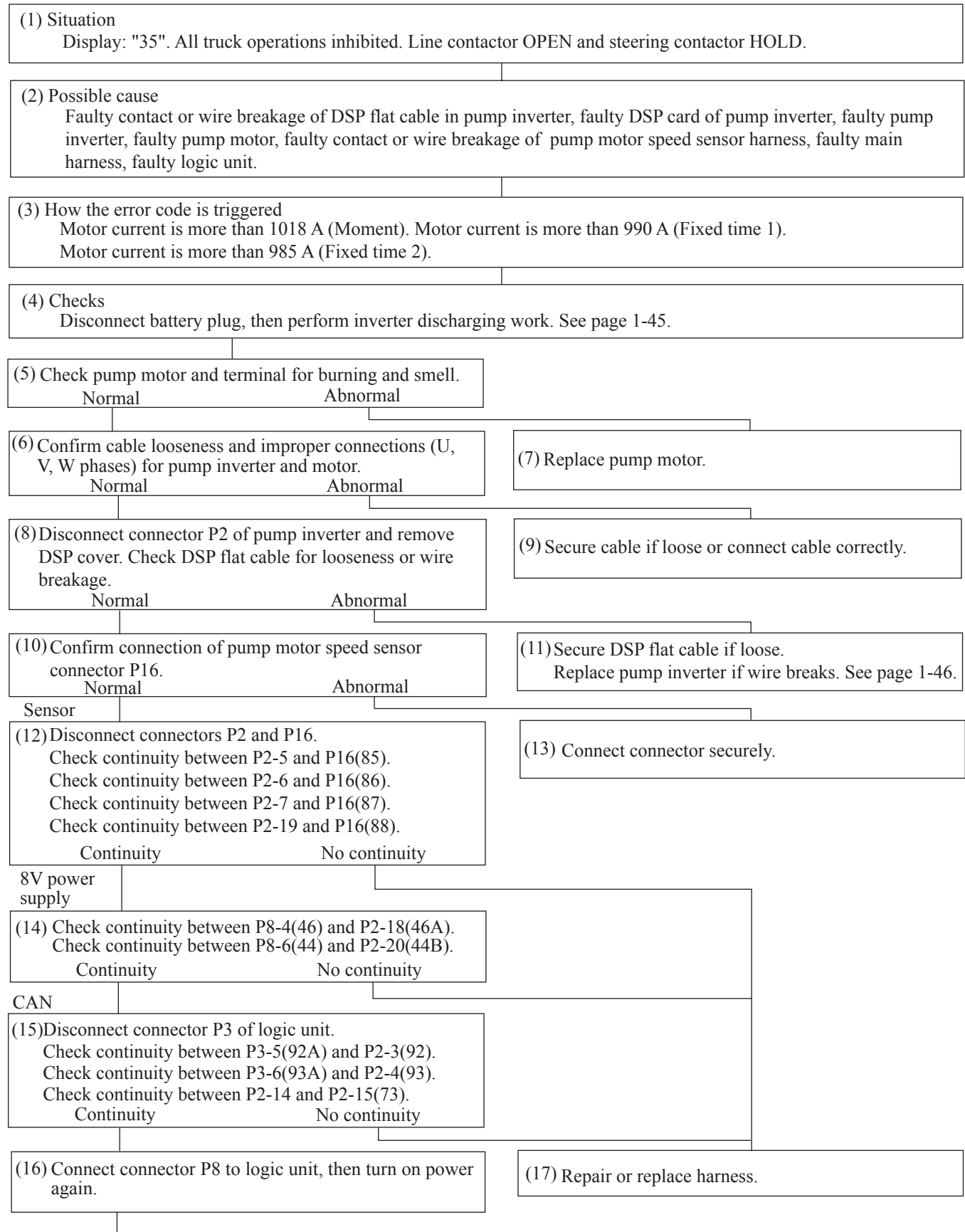
(14) Replace power supply card of logic unit. See page 1-52.

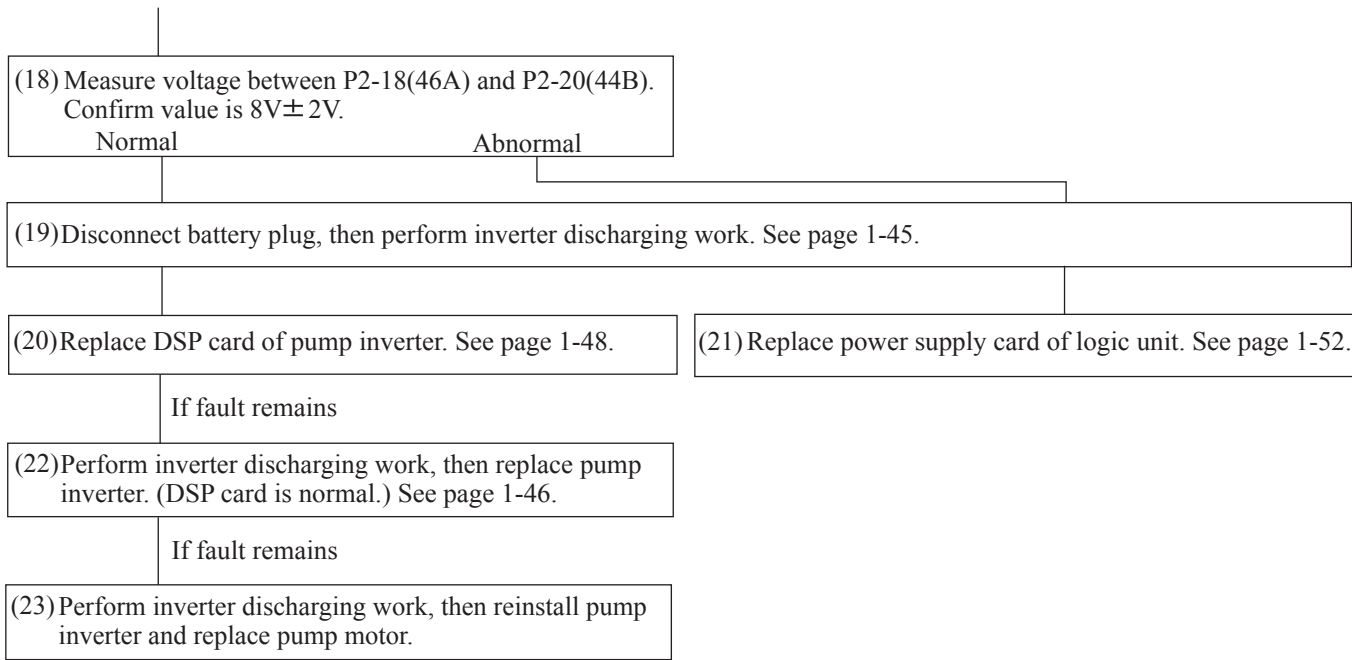
If fault remains

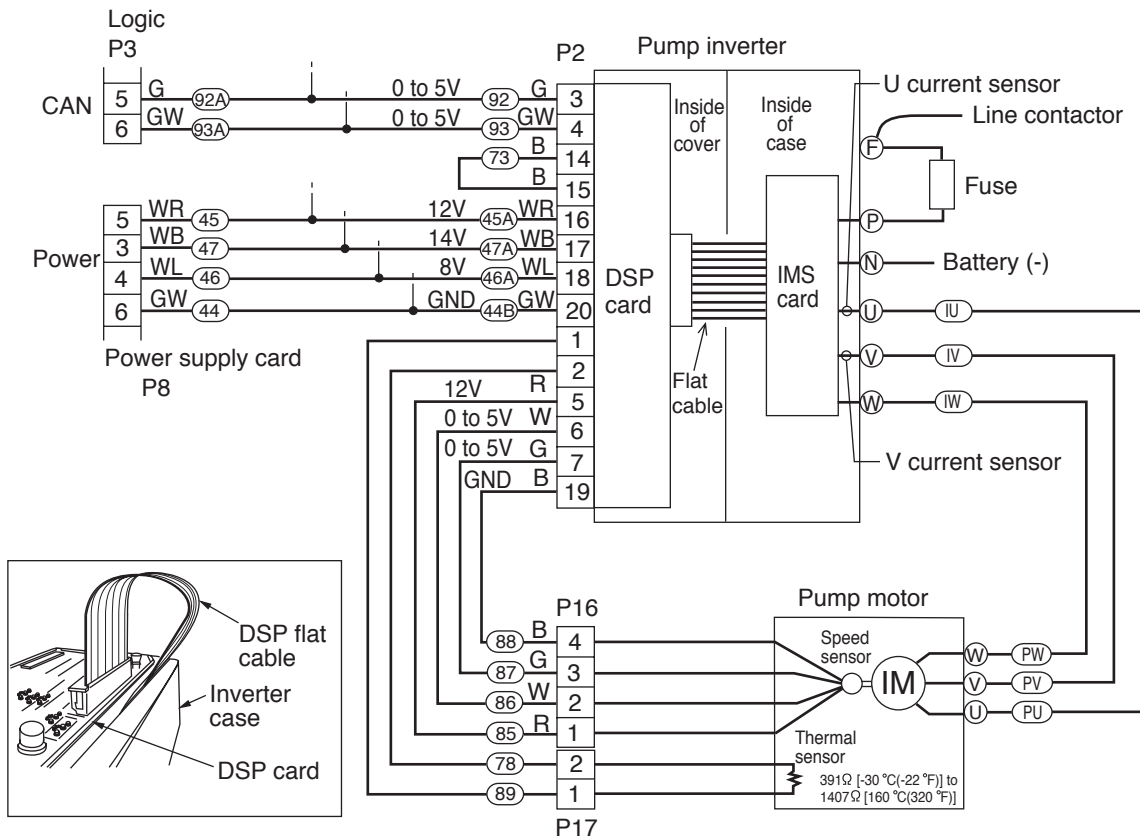
(15) Perform inverter discharging work, then replace pump inverter. (DSP card is normal.) See page 1-46.



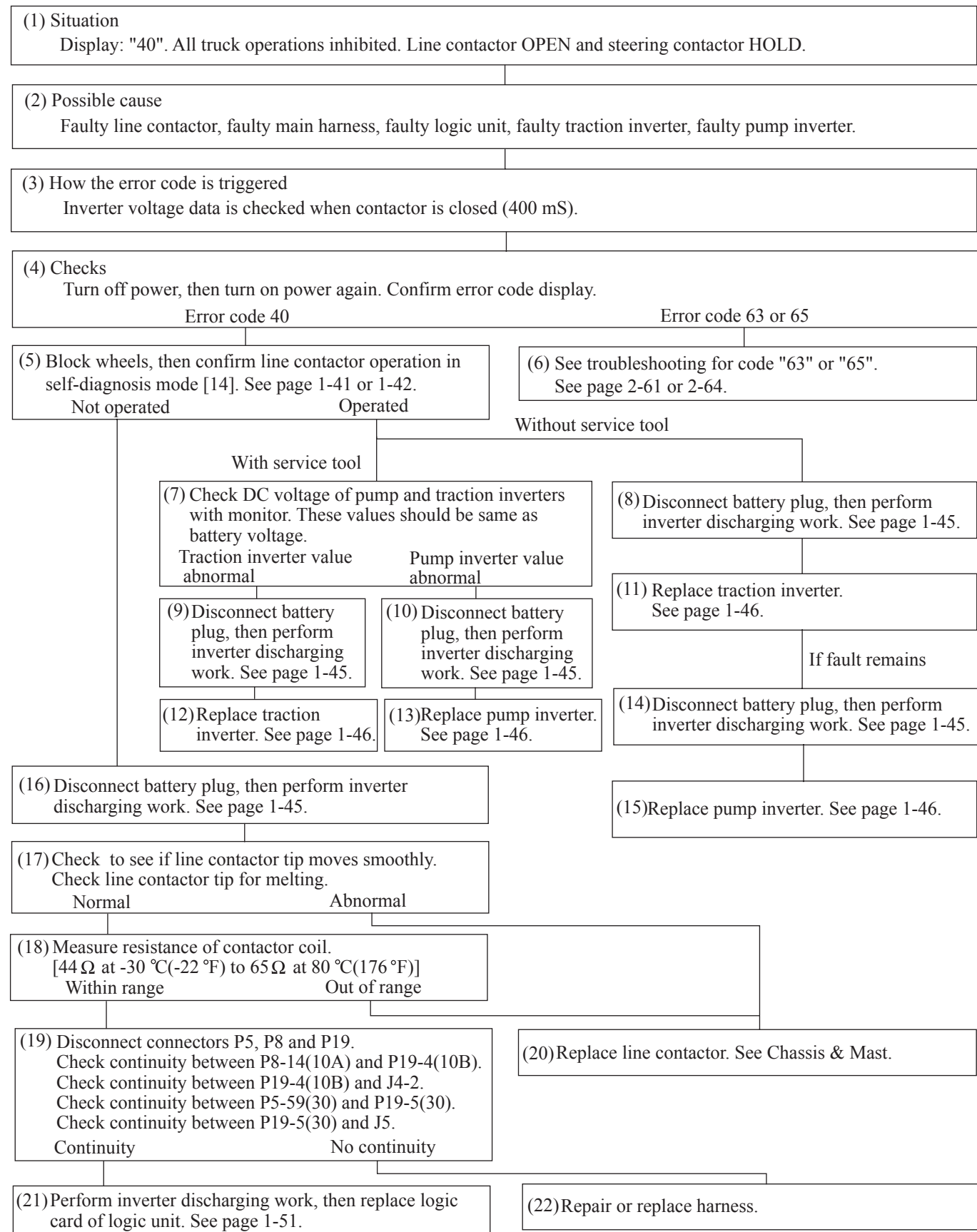
211370

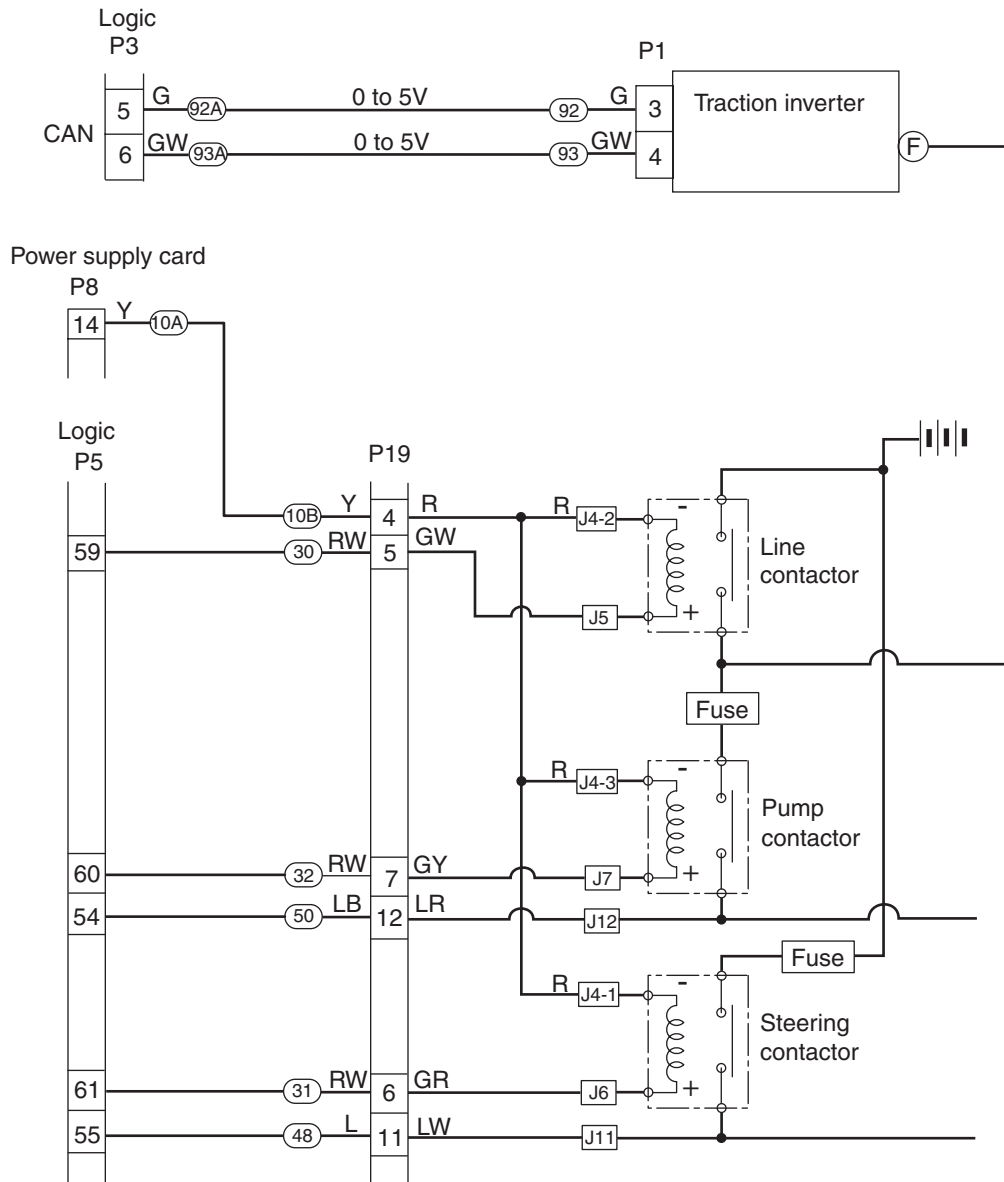
Problem: Pump Motor Over-current (Transistor Control Type Only) (35)





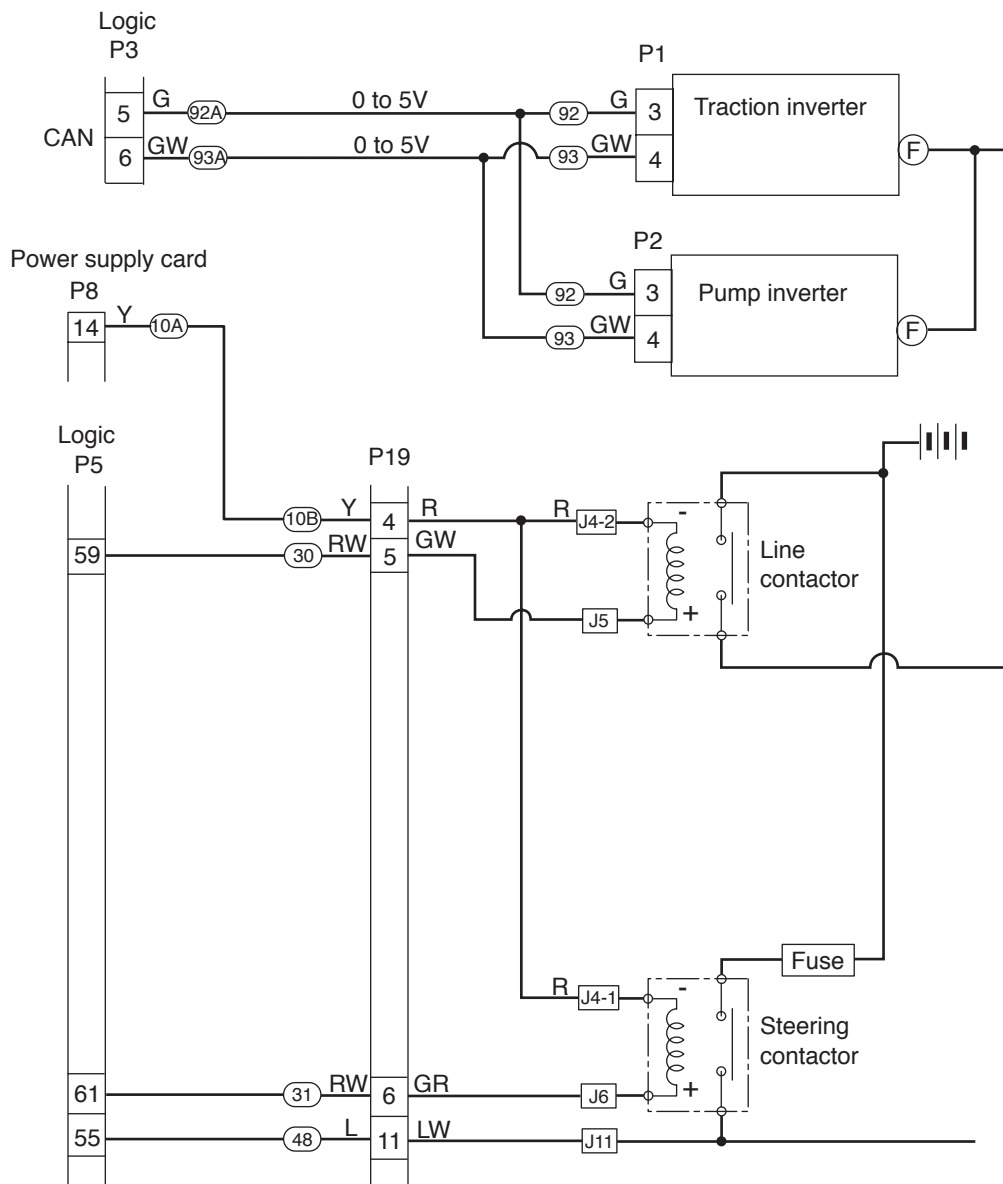
211371

Problem: Line Contactor Fault (40)



Contactor Control Type

211372



Transistor Control Type

211373

Problem: Steering Contactor Fault (41)**(1) Situation**

Display: "41". All truck operations inhibited. Line contactor OPEN and steering contactor OPEN.

(2) Possible cause

Faulty steering contactor, faulty main harness, faulty logic unit.

(3) How the error code is triggered

Inverter voltage data is checked when contactor is closed (600 mS).

Inverter voltage data is checked when contactor is opened (1400 mS).

(4) Checks

Block wheels, then confirm steering contactor operation in self-diagnosis mode [16]. See page 1-41 or 1-42.

Not operated

Operated

(5) Disconnect battery plug, then perform inverter discharging work. See page 1-45.**(6) Check to see if steering contactor tip moves smoothly.**

Check steering contactor tip for melting.

Normal

Abnormal

(7) Repair or replace harness.**(8) Measure resistance of contactor coil.**

[44 Ω at -30 °C(-22 °F) to 65 Ω at 80 °C(176 °F)]

Within range

Out of range

(9) Disconnect connectors P5, P8 and P19.

Check continuity between P8-14(10A) and P19-4(10B).

Check continuity between P19-4(10B) and J4-1.

Check continuity between P5-61(31) and P19-6(31).

Check continuity between P19-6(31) and J6.

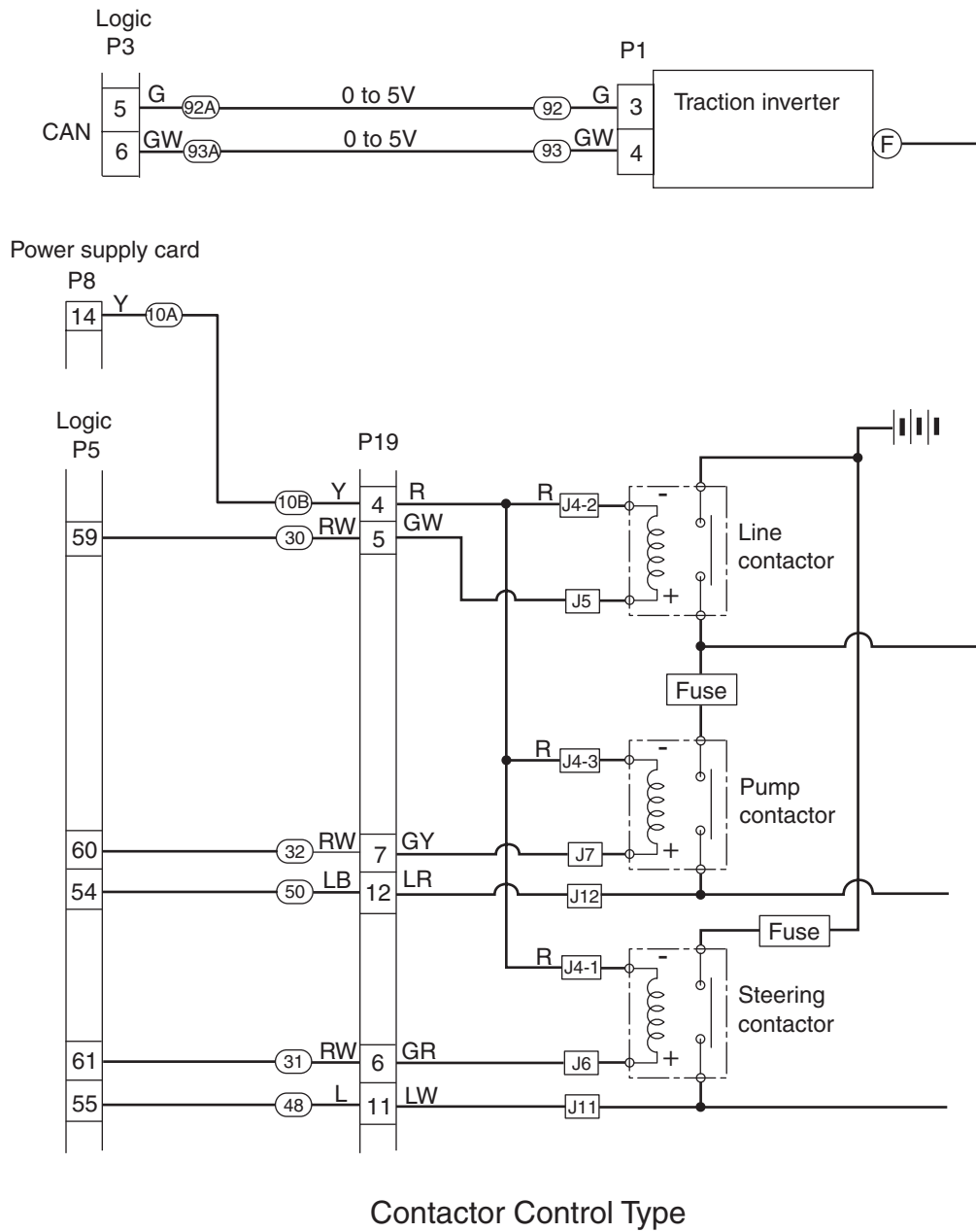
Check continuity between P5-55(48) and P19-11(48).

Check continuity between P19-11(48) and J11.

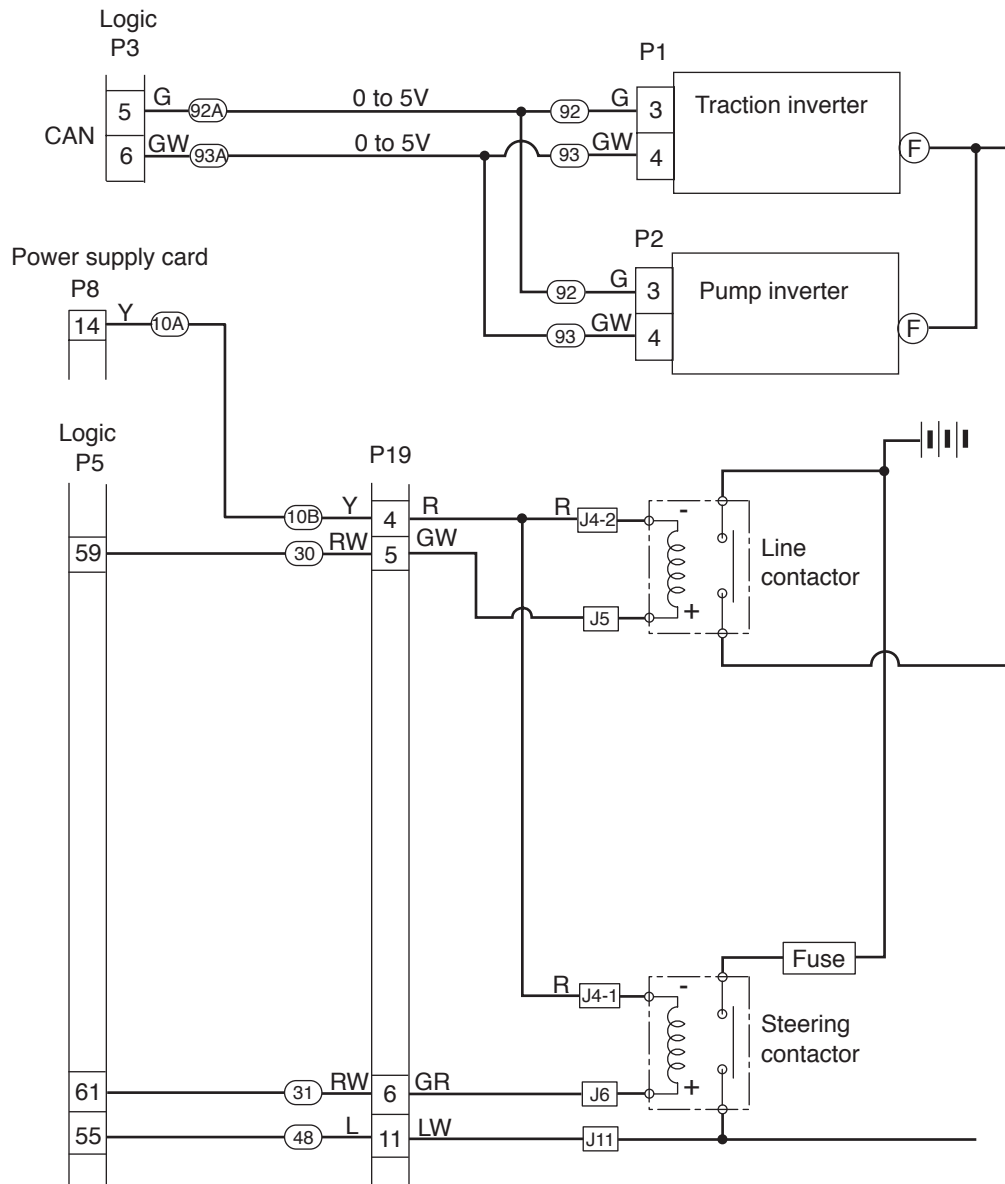
Continuity

No continuity

(10) Replace steering contactor. See Chassis & Mast.**(11) Perform inverter discharging work, then replace logic card of logic unit. See page 1-51.****(12) Repair or replace harness.**



211372



Transistor Control Type

211373

Problem: Pump Contactor Fault (Contactor Control Type Only) (42)**(1) Situation**

Display: "42". All truck operations inhibited. Line contactor OPEN, steering contactor HOLD and pump contactor OPEN.

(2) Possible cause

Faulty pump contactor, faulty main harness, faulty logic unit.

(3) How the error code is triggered

Inverter voltage data is checked when contactor is closed (600 mS).
Inverter voltage data is checked when contactor is opened (1400 mS).

(4) Checks

Block wheels, then confirm pump contactor operation in self-diagnosis mode[15]. See page 1-42.

Not operated

Operated

(5) Disconnect battery plug, then perform inverter discharging work. See page 1-45.

(6) Check to see if pump contactor tip moves smoothly.

Check pump contactor tip for melting.

Normal

Abnormal

(7) Repair or replace harness.

(8) Measure resistance of contactor coil.

[44 Ω at -30 °C(-22 °F) to 65 Ω at 80 °C(176 °F)]

Within range

Out of range

(9) Disconnect connectors P5, P8 and P19.

Check continuity between P8-14(10A) and P19-4(10B).

Check continuity between P19-4(10B) and J4-3.

Check continuity between P5-60(32) and P19-7(32).

Check continuity between P19-7(32) and J7.

Check continuity between P5-54(50) and P19-12(50).

Check continuity between P19-12(50) and J12.

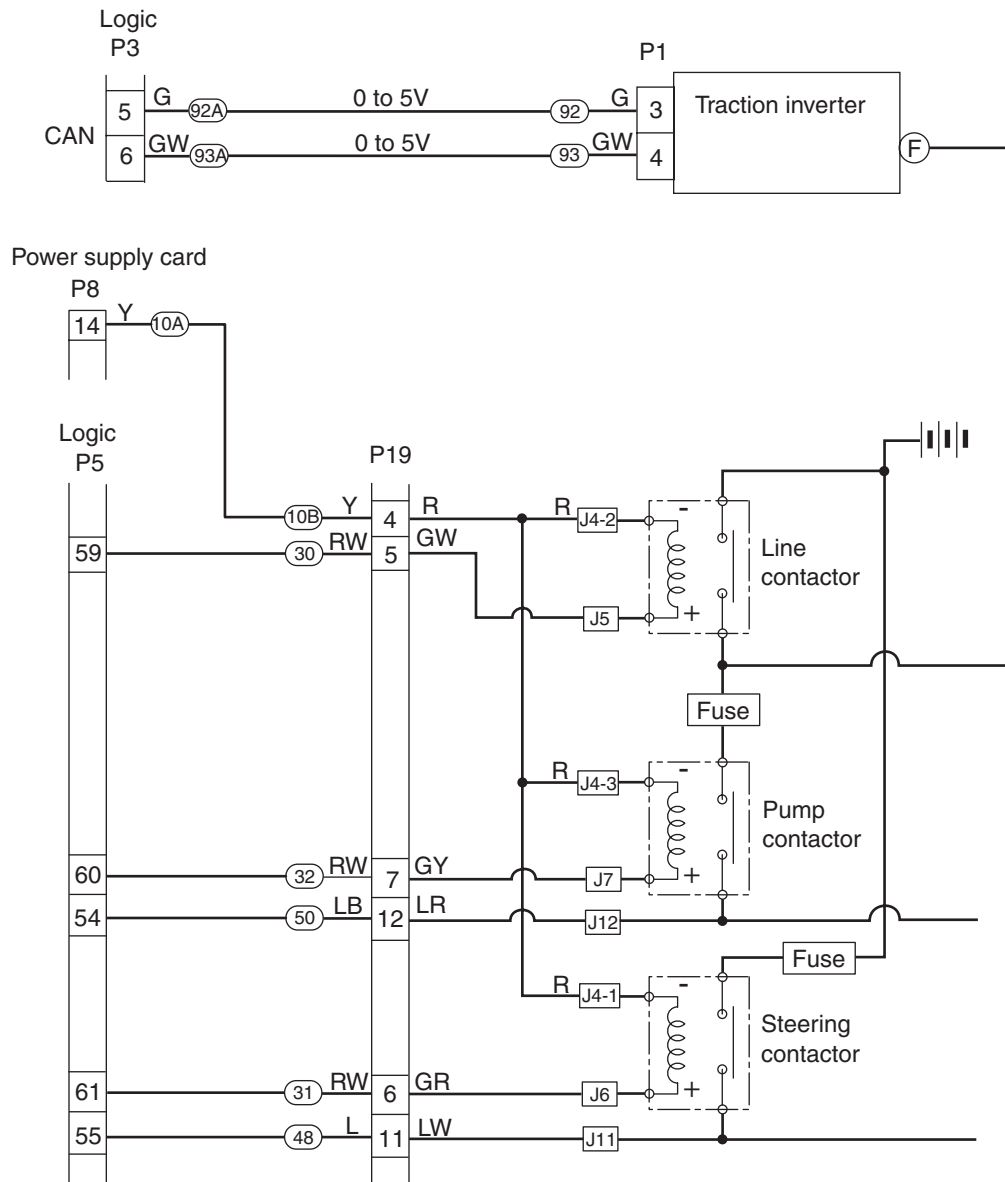
Continuity

No continuity

(10) Replace pump contactor. See Chassis & Mast.

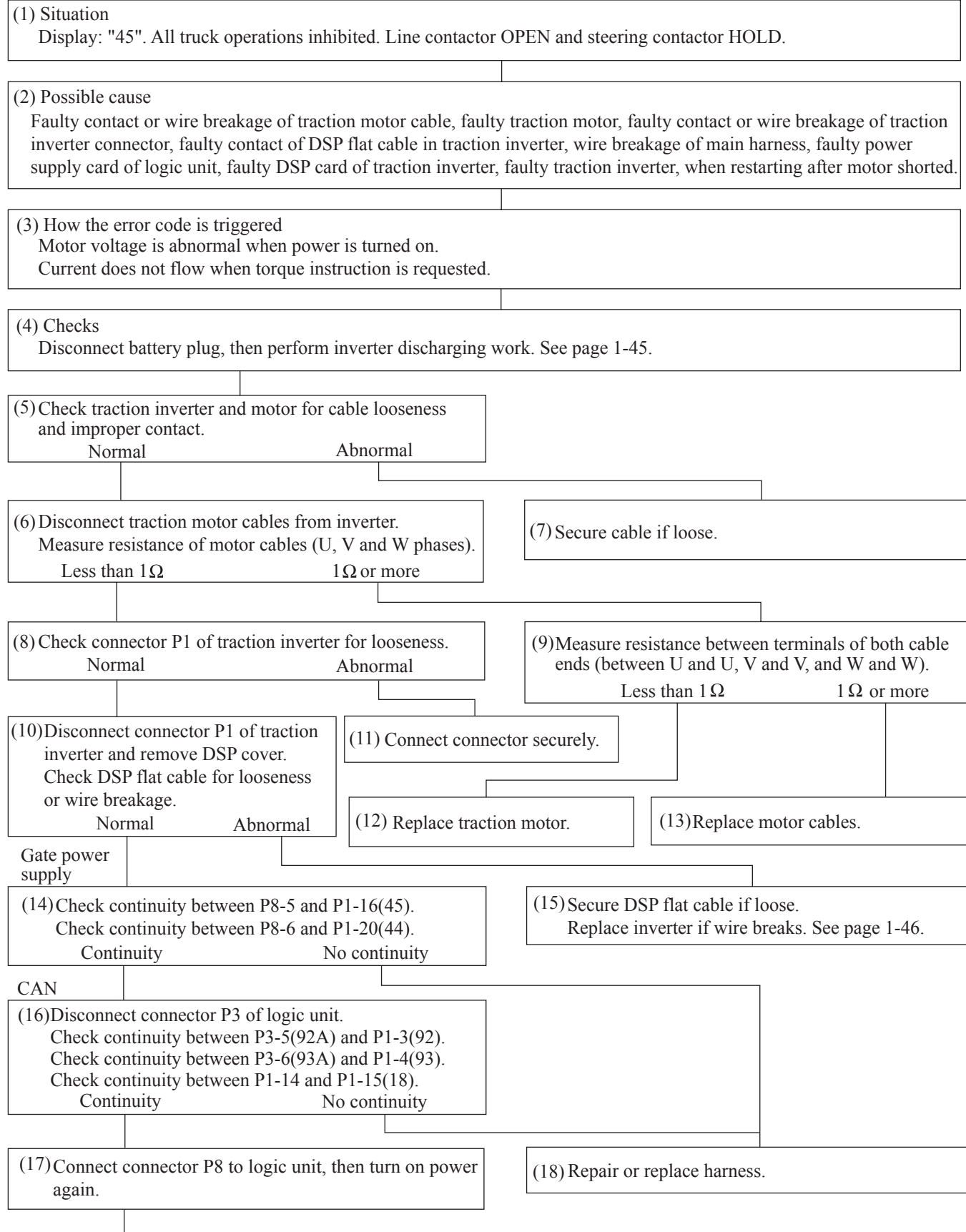
(11) Perform inverter discharging work, then replace logic card of logic unit. See page 1-51.

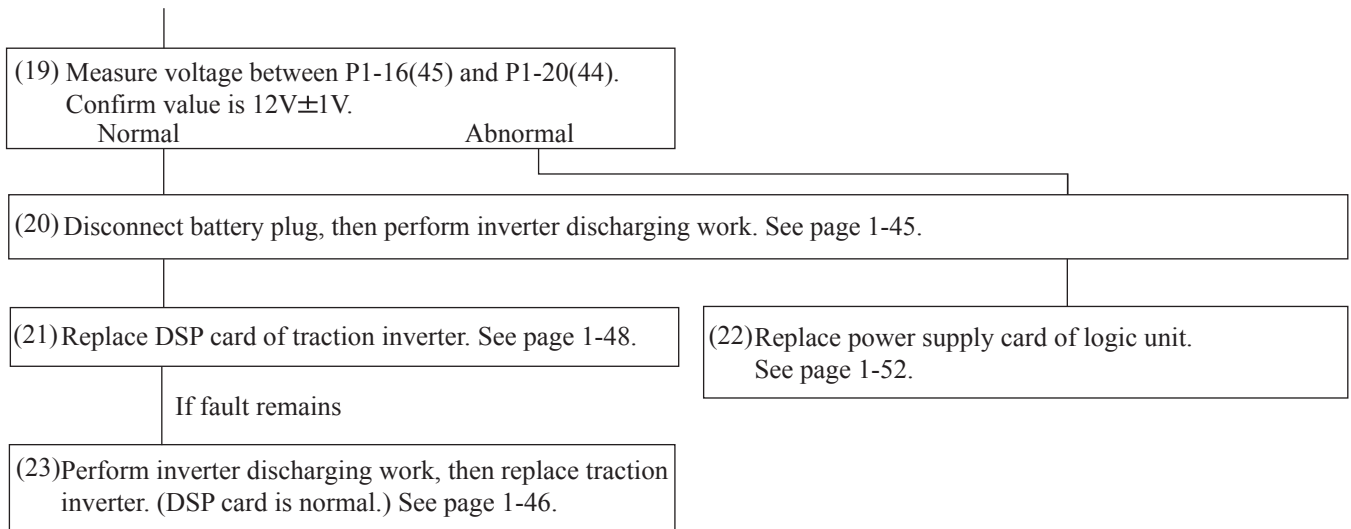
(12) Repair or replace harness.

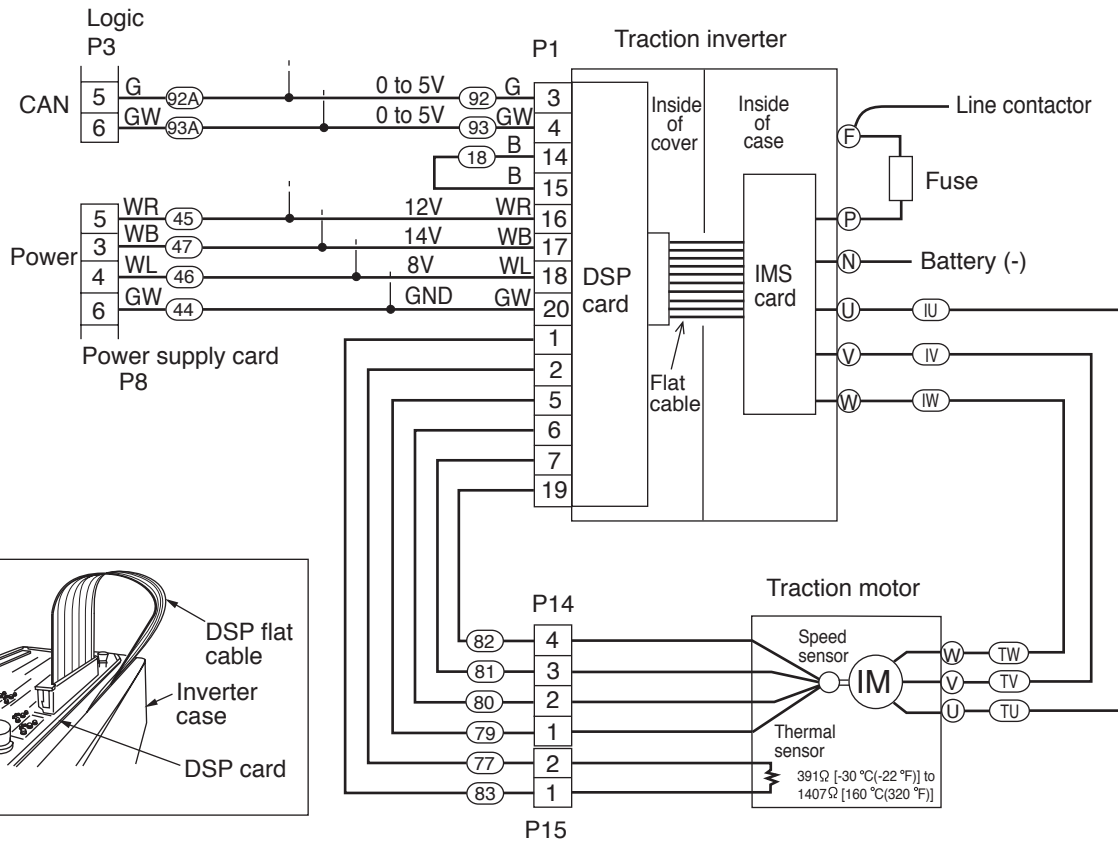


Contactor Control Type

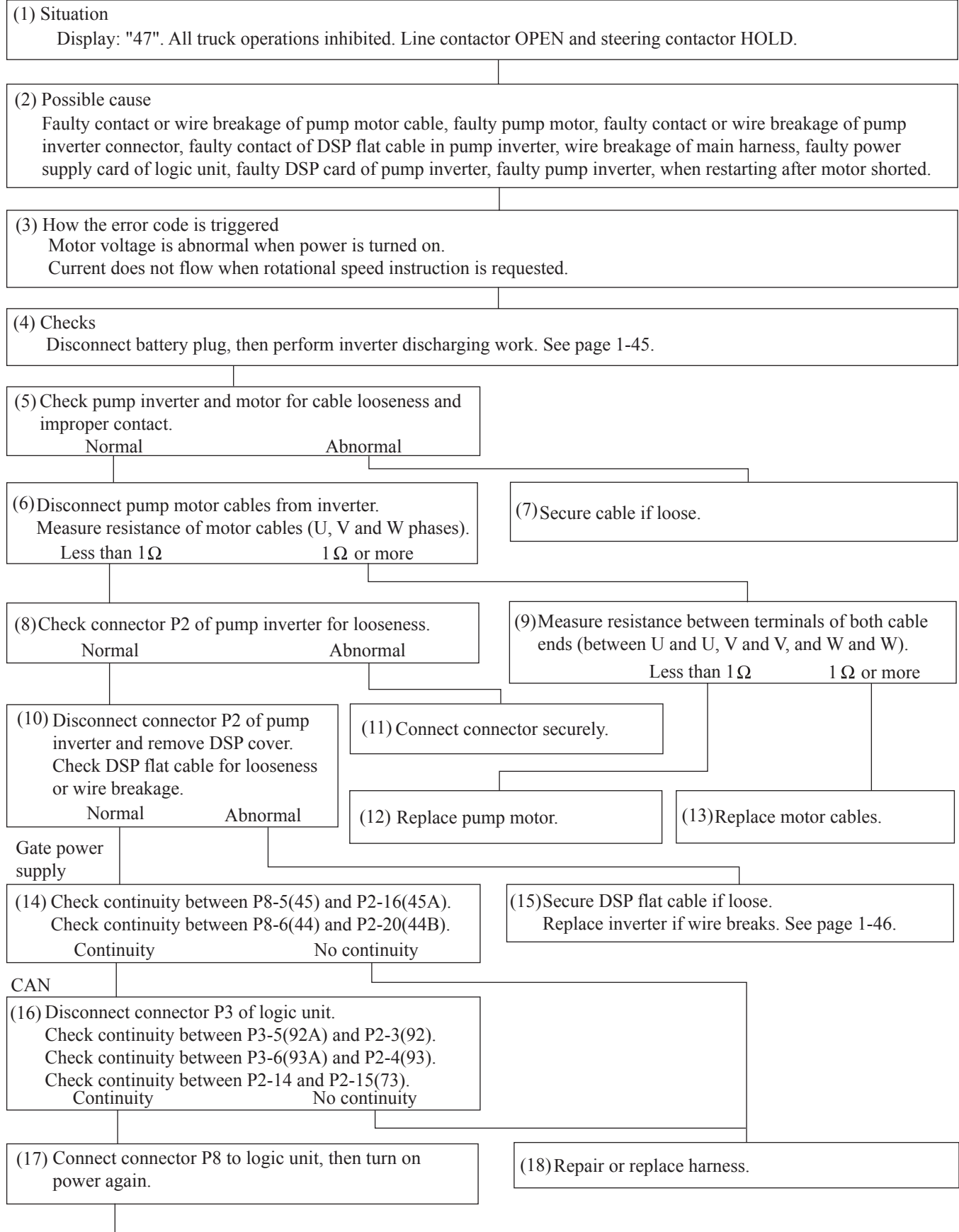
211372

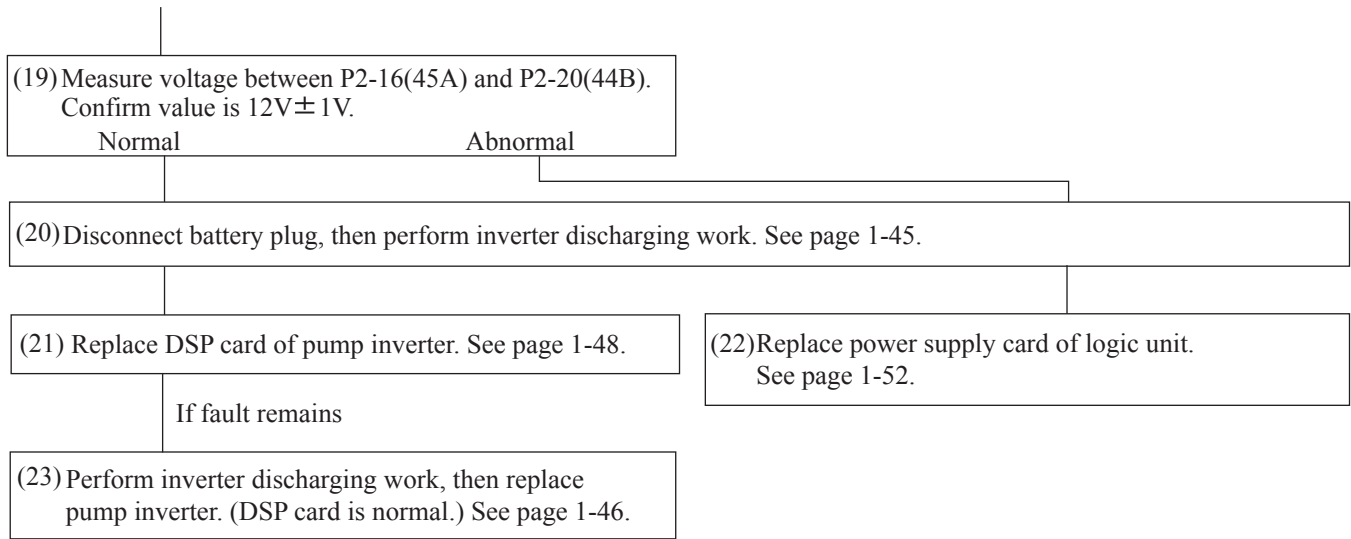
Problem: Traction Motor Open (45)

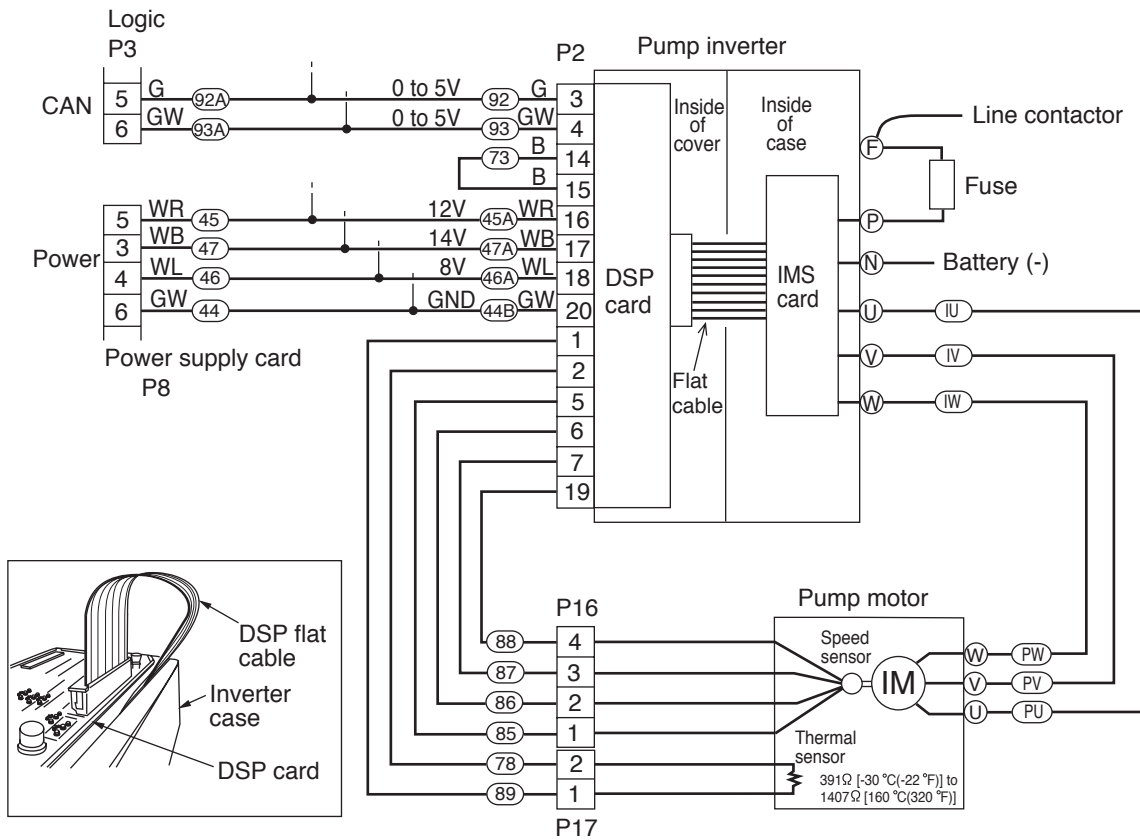




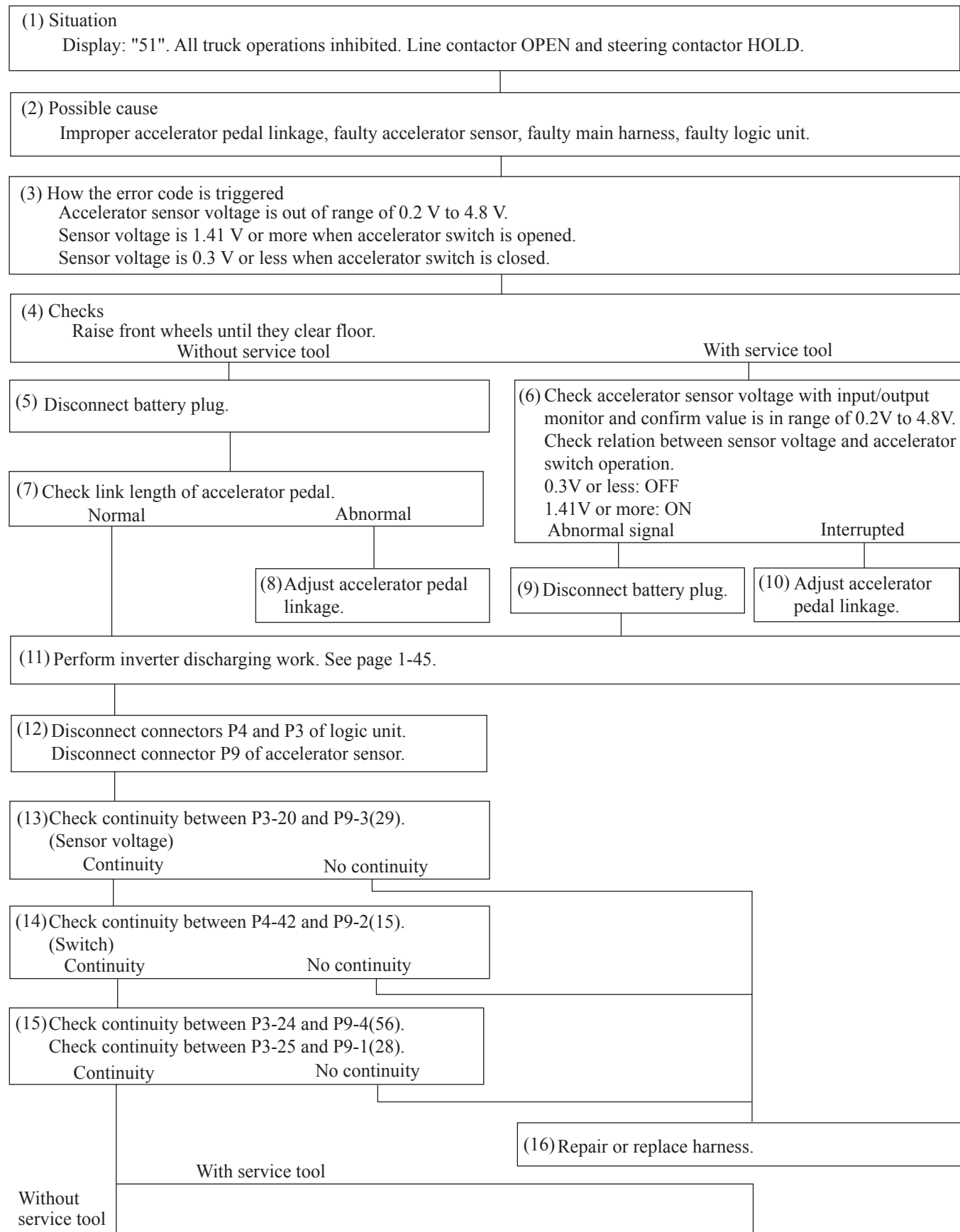
211374

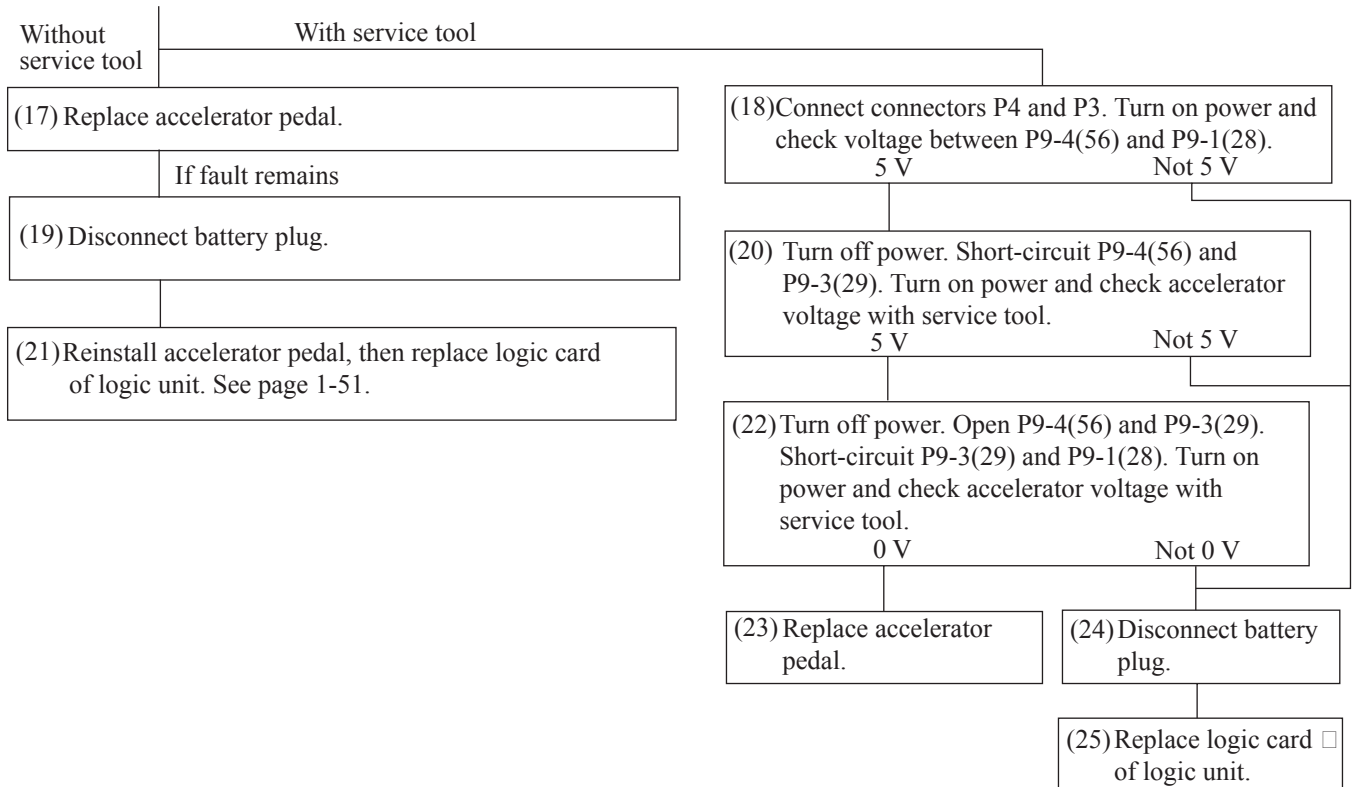
Problem: Pump Motor Open (Transistor Control Type Only) (47)

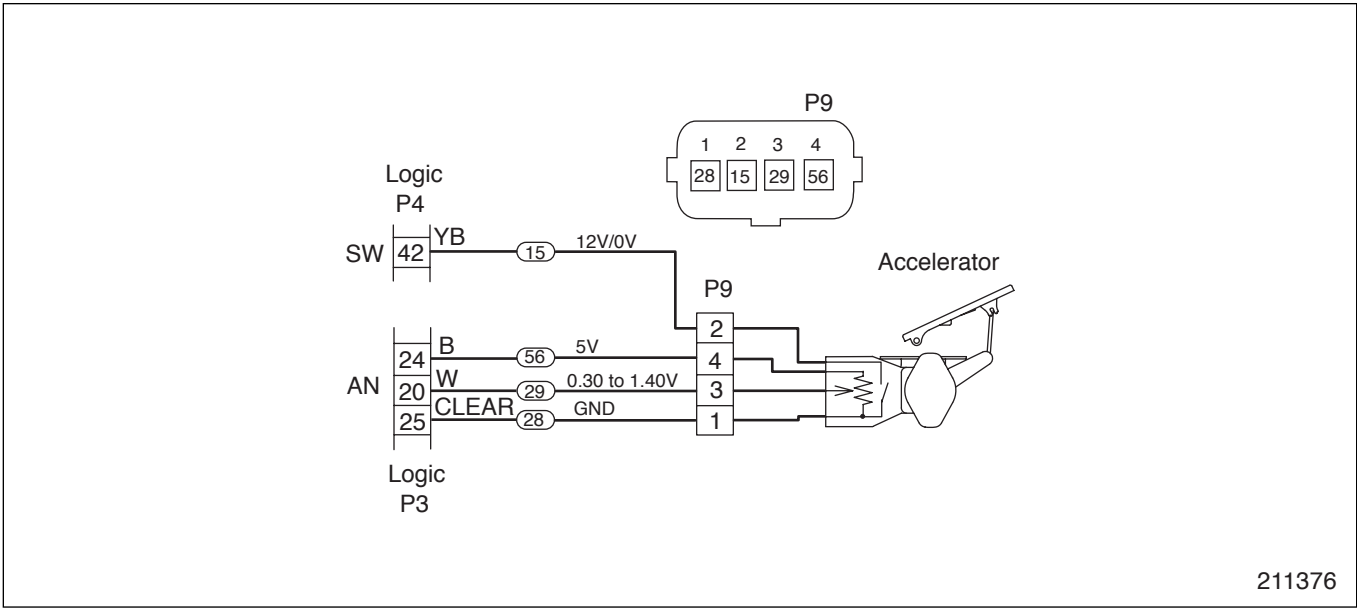




211375

Problem: Accelerator Sensor Fault (51)





Problem: Traction Motor Pulse Input Fault (52)**(1) Situation**

Display: "52". All truck operations inhibited. Line contactor OPEN and steering contactor HOLD.

(2) Possible cause

Faulty contact of traction inverter connector, faulty connection of traction motor connector and cable, faulty 12V input voltage of traction inverter, faulty contact or wire breakage of traction motor speed sensor harness, faulty DSP card of traction inverter, faulty traction motor speed sensor.

(3) How the error code is triggered

Motor rotation speed is more than 5800 rpm.

(4) Checks

Disconnect battery plug, then perform inverter discharging work. See page 1-45.

(5) Check to see if traction motor cables (U, V and W-phases) are connected to traction inverter properly.

Normal

Abnormal

(6) Check to see if connector P1 of traction inverter is fastened securely.

Normal

Abnormal

(7) Connect cables properly.

(8) Check to see if connector P14 of traction motor speed sensor is fastened securely.

Normal

Abnormal

(9) Fasten connector securely.

Sensor

(10) Disconnect connectors P1 and P14.

Check continuity between P1-5 and P14(79).

Check continuity between P1-6 and P14(80).

Check continuity between P1-7 and P14(81).

Check continuity between P1-19 and P14(82).

Continuity

No continuity

(11) Fasten connector securely.

Power
supply

(12) Check continuity between P8-3 and P1-17(47).

Check continuity between P8-6 and P1-20(44).

Continuity

No continuity

CAN

(13) Disconnect connector P3 of logic unit.

Check continuity between P3-5(92A) and P1-3(92).

Check continuity between P3-6(93A) and P1-4(93).

Check continuity between P1-14 and P1-15(18).

Continuity

No continuity

(14) Connect connector P8 to logic unit, then turn on power again.

(15) Repair or replace harness.

(16) Measure voltage between P1-17(47) and P1-20(44).
Confirm value is $14V \pm 2V$.
Normal Abnormal

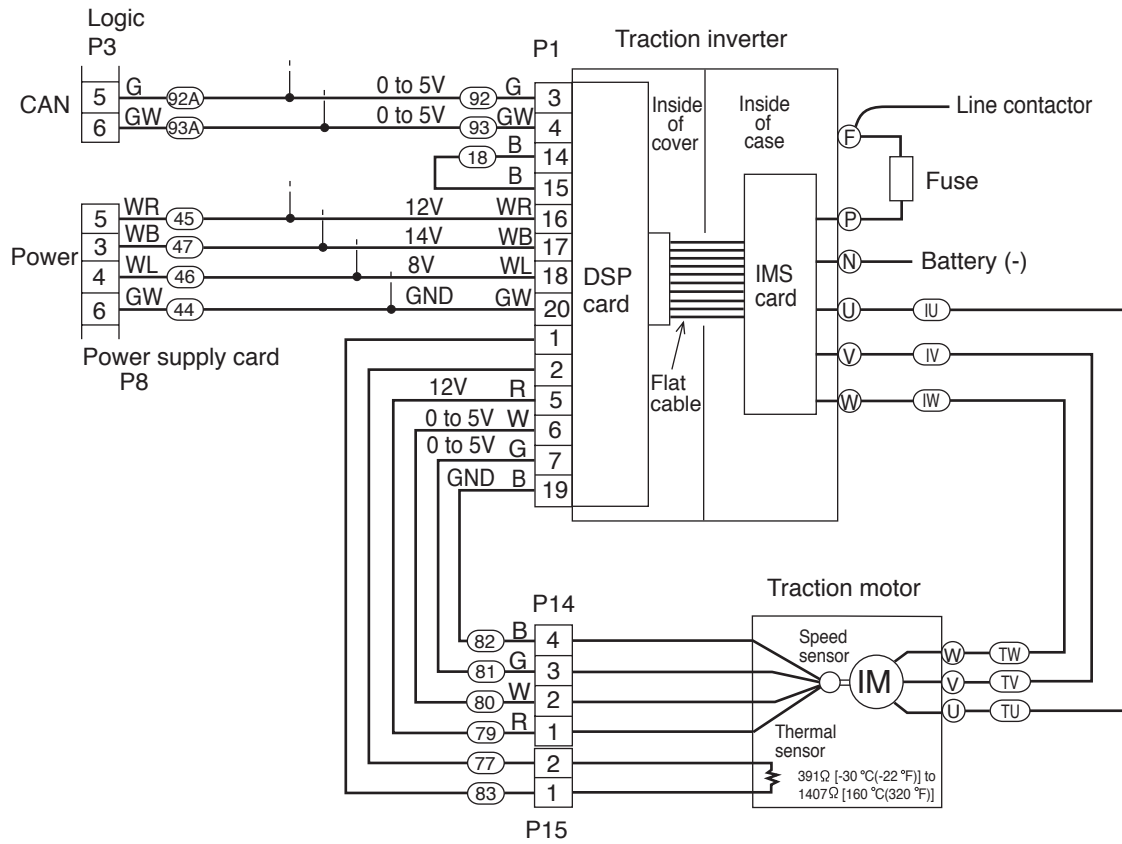
(17) Disconnect battery plug, then perform inverter discharging work. See page 1-45.

(18) Replace DSP card of traction inverter. See page 1-48.

(19) Replace power supply card of logic unit. See page 1-52.

If fault remains

(20) Perform inverter discharging work, then replace traction motor. (DSP card is normal.)



211377

Problem: Pump Motor Pulse Input Fault (Transistor Control Type Only) (57)**(1) Situation**

Display: "57". All truck operations inhibited. Line contactor OPEN and steering contactor HOLD.

(2) Possible cause

Faulty contact of pump inverter connector, faulty connection of pump motor connector and cable, faulty 12V input voltage of pump inverter, faulty contact or wire breakage of pump motor speed sensor harness, faulty DSP card of pump inverter, faulty pump motor speed sensor.

(3) How the error code is triggered

Motor rotation speed is more than 4000 rpm. Motor rotation speed is zero while current flows to motor.
Motor rotates in reverse.

(4) Checks

Disconnect battery plug, then perform inverter discharging work. See page 1-45.

(5) Check to see if pump motor cables (U, V and W-phases) are connected to pump inverter properly.

Normal

Abnormal

(6) Check to see if connector P2 of pump inverter is fastened securely.

Normal

Abnormal

(7) Connect cables properly.

(8) Check to see if connector P16 of pump motor speed sensor is fastened securely.

Normal

Abnormal

(9) Fasten connector securely.

Sensor

(10) Disconnect connectors P2 and P16.

Check continuity between P2-5 and P16(85).

Check continuity between P2-6 and P16(86).

Check continuity between P2-7 and P16(87).

Check continuity between P2-19 and P16(88).

Continuity

No continuity

(11) Fasten connector securely.

Power
supply

(12) Check continuity between P8-3(47) and P2-17(47A).

Check continuity between P8-6(44) and P2-20(44B).

Continuity

No continuity

CAN

(13) Disconnect connector P3 of logic unit.

Check continuity between P3-5(92A) and P2-3(92).

Check continuity between P3-6(93A) and P2-4(93).

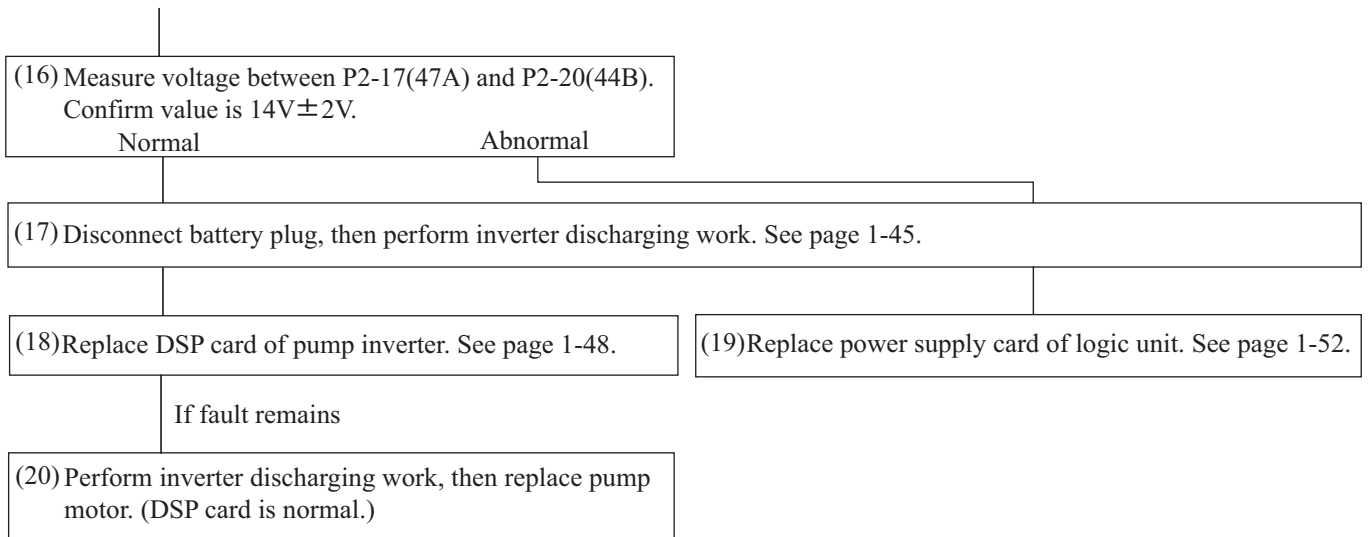
Check continuity between P2-14 and P2-15(73).

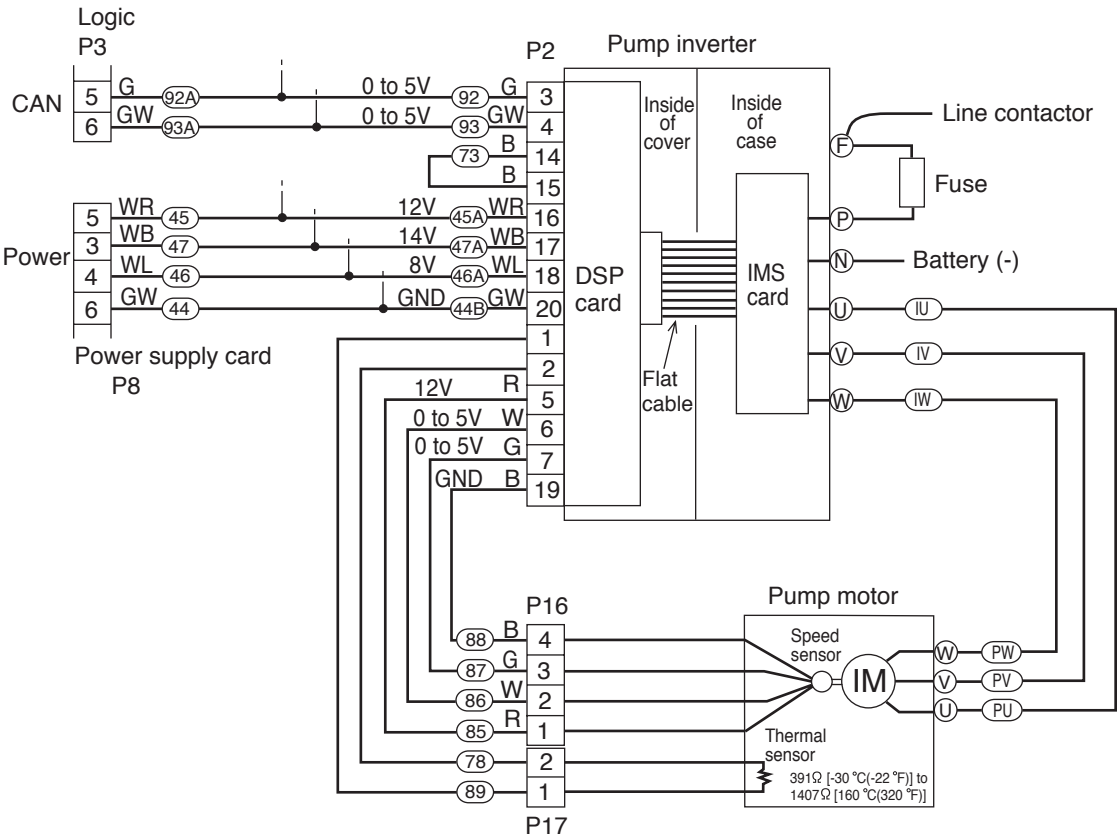
Continuity

No continuity

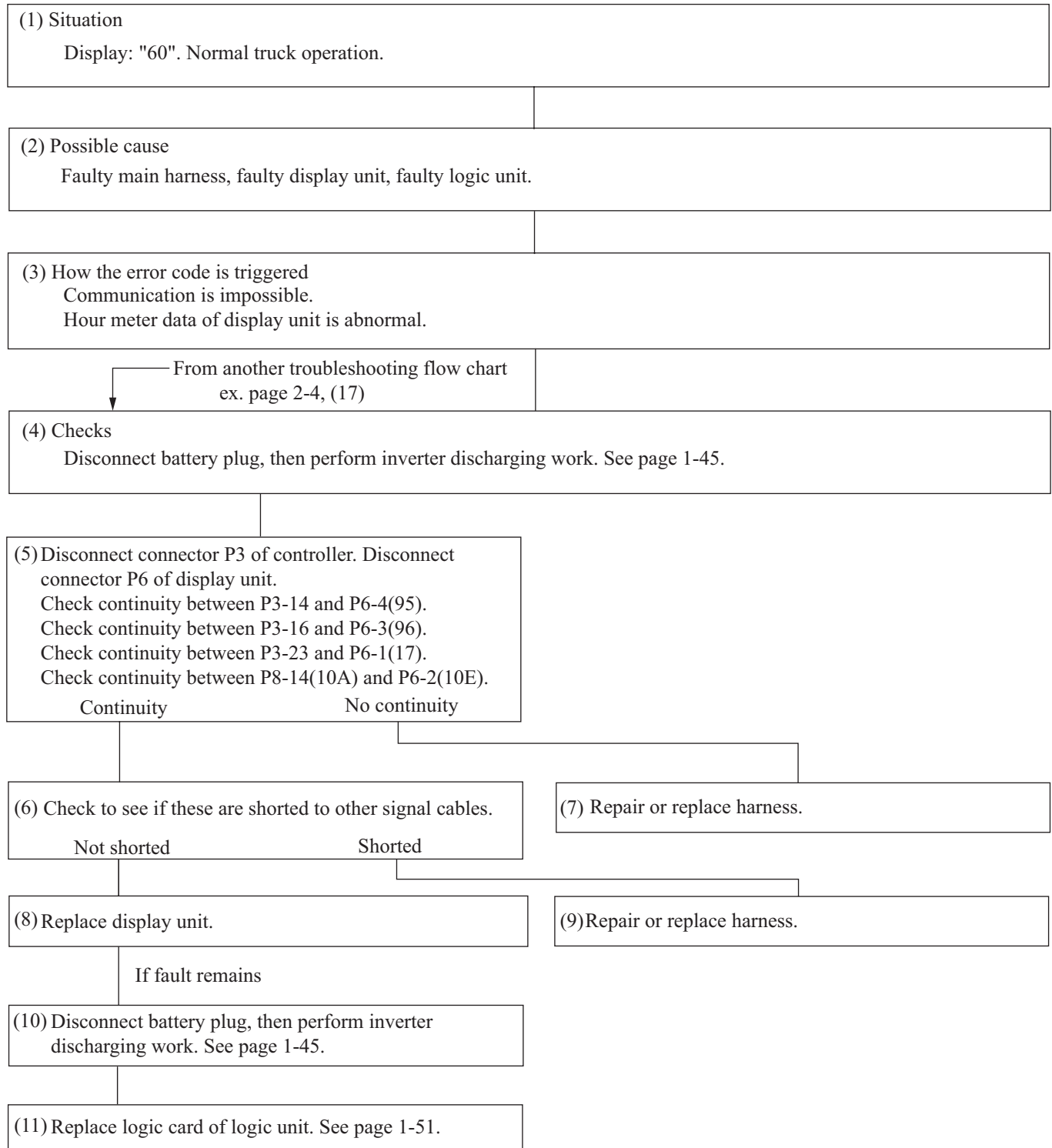
(14) Connect connector P8 to logic unit, then turn on power again.

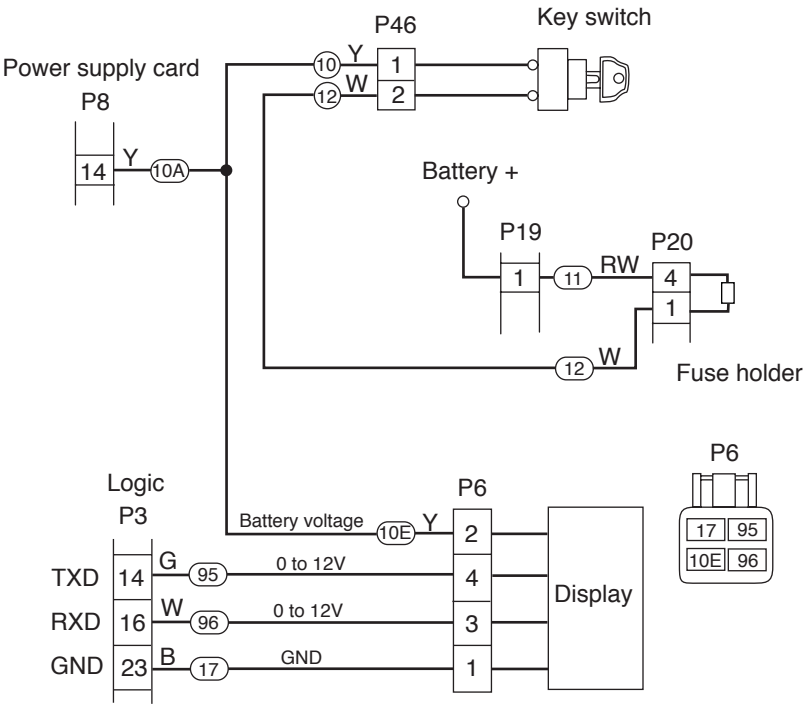
(15) Repair or replace harness.





211378

Problem: Display Communication Fault (60)



Problem: Logic Card Initialize Failure (61)**(1) Situation**

Display: "61". All truck operations inhibited. Line contactor OPEN and steering contactor OPEN.

(2) Possible cause

Setup Option Group 3 data not set, Setup Option Group 1 and 2 default data not set, faulty Setup Option data, faulty logic unit.

(3) How the error code is triggered

Setup Option data is in abnormal setting range.

(4) Checks

Turn off power, then turn on power in Setup Option Group 3 setting. See page 1-19.

(5) Set Setup Option Group 3 data. See page 1-31 to 1-33.

(6) Set Setup Option default data. See page 1-19.

(7) Turn on power in "RUN" mode. See page 1-19.

If fault remains

(8) With service tool, set Setup Option Group 3 data.

(9) With service tool, set Setup Option default data.

If fault remains

(10) Disconnect battery plug.

(11) Replace logic card of logic unit. See page 1-51.

(12) With service tool, set Setup Option Group 3 data.

(13) With service tool, set Setup Option default data.

Problem: Logics Fault (62)**(1) Situation**

Display: "62". All truck operations inhibited. Line contactor OPEN and steering contactor OPEN.

(2) Possible cause

Faulty EEPROM data, faulty logic unit.

(3) How the error code is triggered

ROM SUM value of logic card is different from check data. EEPROM SUM value of logic card is different from check data. RAM of logic card is faulty.

(4) Checks

Turn off power, then turn on power in Setup Option Group 3 setting. See page 1-19.

(5) Set Setup Option Group 3 data.**(6) Set Setup Option default data.****(7) Turn on power in "RUN" mode. See page 1-19.**

If fault remains "62"

Error code "61"

(8) Disconnect battery plug, then perform inverter discharging work. See page 1-45.**(9) See troubleshooting for code "61". See page 2-59.****(10) Replace logic card of logic unit. See page 1-51.****(11) With service tool, set Setup Option Group 3 data.
Set Setup Option default data.**

Problem: Traction Inverter Fault (63)**(1) Situation**

Display: "63". All truck operations inhibited. Line contactor OPEN and steering contactor OPEN.

(2) Possible cause

Faulty contact or wire breakage of DSP flat cable in traction inverter, faulty DSP card of traction inverter, faulty traction inverter, faulty main harness, faulty logic unit.

(3) How the error code is triggered

Traction inverter is connected as pump inverter (P1-9 is connected to GND).

ROM SUM value of traction inverter is different from check data.

RAM of traction inverter is faulty. Communication with traction inverter is impossible.

(4) Checks

Disconnect battery plug, then perform inverter discharging work. See page 1-45.

(5) Disconnect connector P1 of traction inverter and remove DSP cover. Check DSP flat cable for looseness or wire breakage.

Normal

Abnormal

8V power supply

(6) Check continuity between P8-4 and P1-18(46).

Check continuity between P8-6 and P1-20(44).

Continuity

No continuity

(7) Refasten flat cable or replace inverter. See page 1-46.

CAN

(8) Disconnect connector P3 of logic unit.

Check continuity between P3-5(92A) and P1-3(92).

Check continuity between P3-6(93A) and P1-4(93).

Check continuity between P1-14 and P1-15(18).

Continuity

No continuity

(9) Measure resistance of CAN with connectors P1 and P3 disconnected.

Resistance between P3-5(92A) and P3-6(93A)

$120\ \Omega \pm 5\%$

Other than $120\ \Omega \pm 5\%$

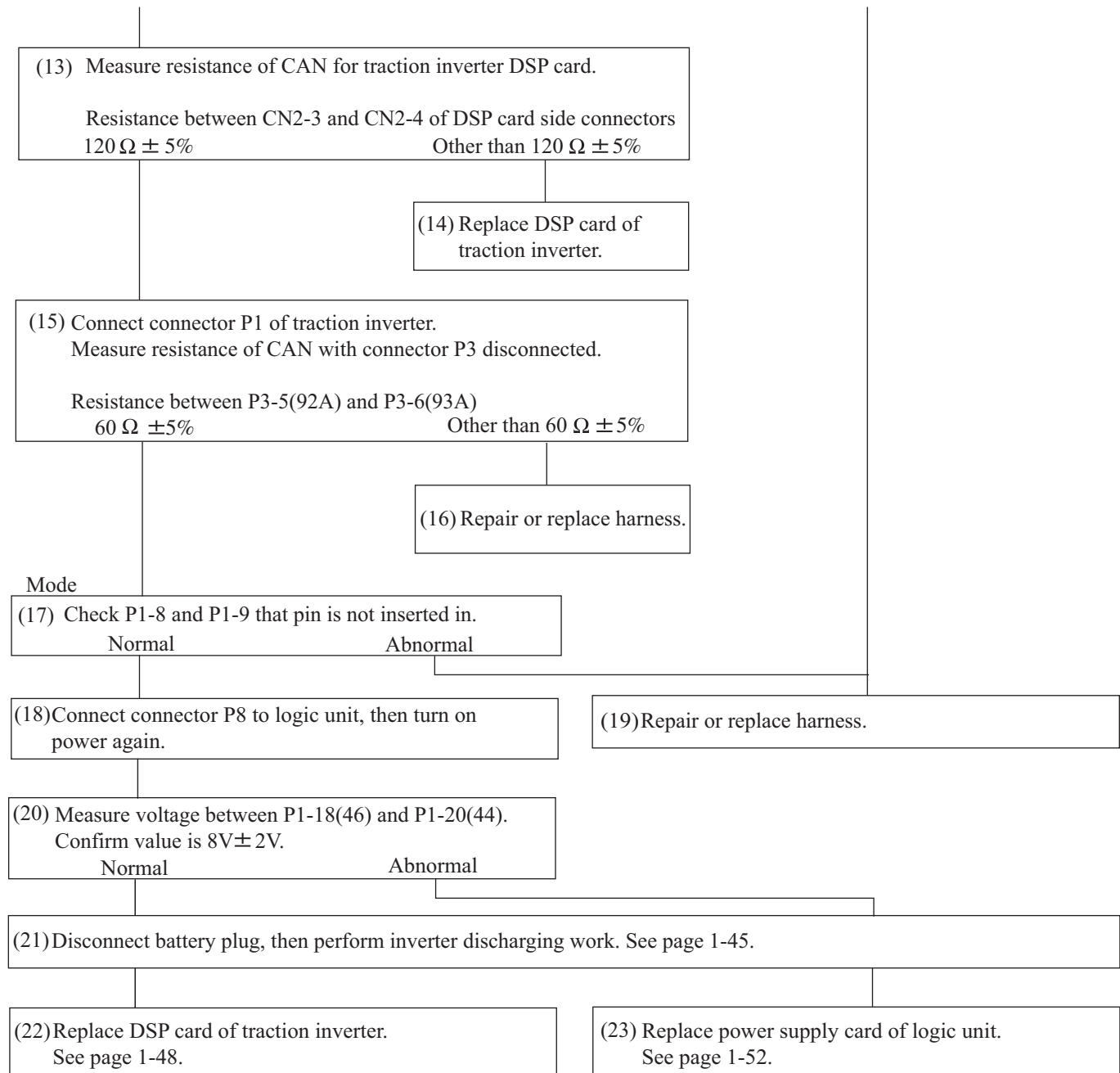
(10)

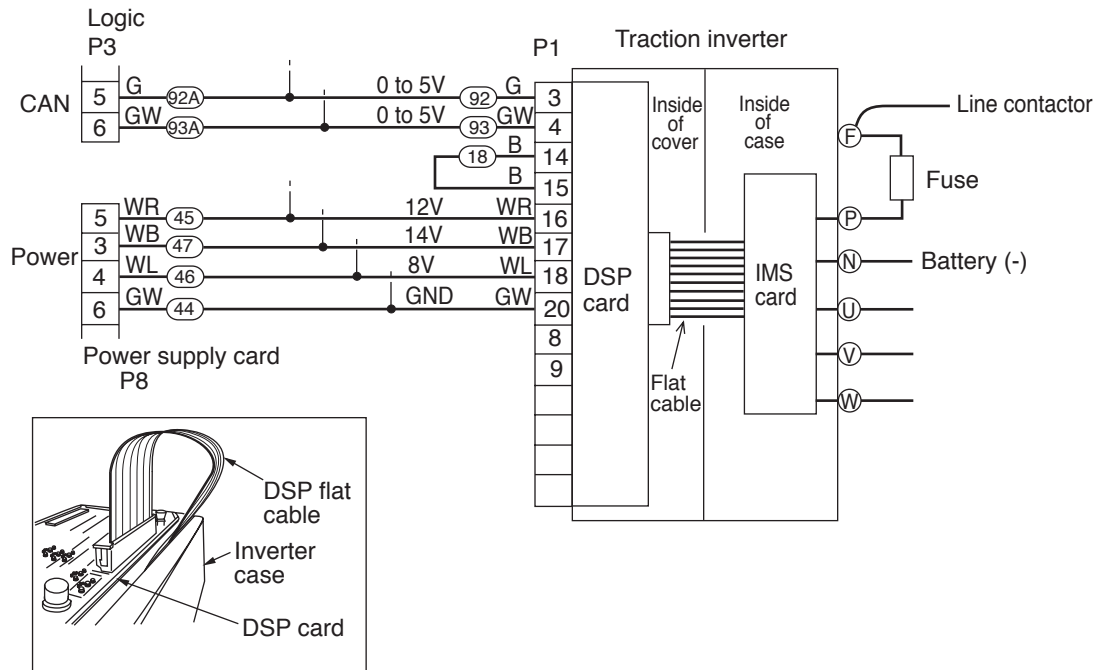
Transistor control

Contactor control

(11) Perform CAN check of Pump Inverter Fault (65).

(12) Repair or replace harness.
When repairing harness, repair resistor ($120\ \Omega$) on harness.





211380

Problem: Pump Inverter Fault (Transistor Control Type Only) (65)**(1) Situation**

Display: "65". All truck operations inhibited. Line contactor OPEN and steering contactor OPEN.

(2) Possible cause

Faulty contact or wire breakage of DSP flat cable in pump inverter, faulty DSP card of pump inverter, faulty pump inverter, faulty main harness, faulty logic unit.

(3) How the error code is triggered

Pump inverter is connected as traction inverter (P2-9 is opened).
ROM SUM value of pump inverter is different from check data.
RAM of pump inverter is faulty. Communication with pump inverter is impossible.

(4) Checks

Disconnect battery plug, then perform inverter discharging work. See page 1-45.

(5) Disconnect connector P2 of pump inverter and remove DSP cover. Check DSP flat cable for looseness or wire breakage.

Normal

Abnormal

8V power
supply

**(6) Check continuity between P8-4(46) and P2-18(46A).
Check continuity between P8-6(44) and P2-20(44B).**

Continuity

No continuity

(7) Refasten flat cable or replace inverter. See page 1-46.

CAN

(8) Disconnect connector P3 of logic unit.

Check continuity between P3-5(92A) and P2-3(92).
Check continuity between P3-6(93A) and P2-4(93).
Check continuity between P2-14 and P2-15(73).

Continuity

No continuity

(9) Measure resistance of CAN with connectors P2 and P3 disconnected.

Resistance between P3-5(92A) and P3-6(93A)

$120\ \Omega \pm 5\%$

Other than $120\ \Omega \pm 5\%$

(10) Perform CAN check of Traction
Inverter Fault (63).

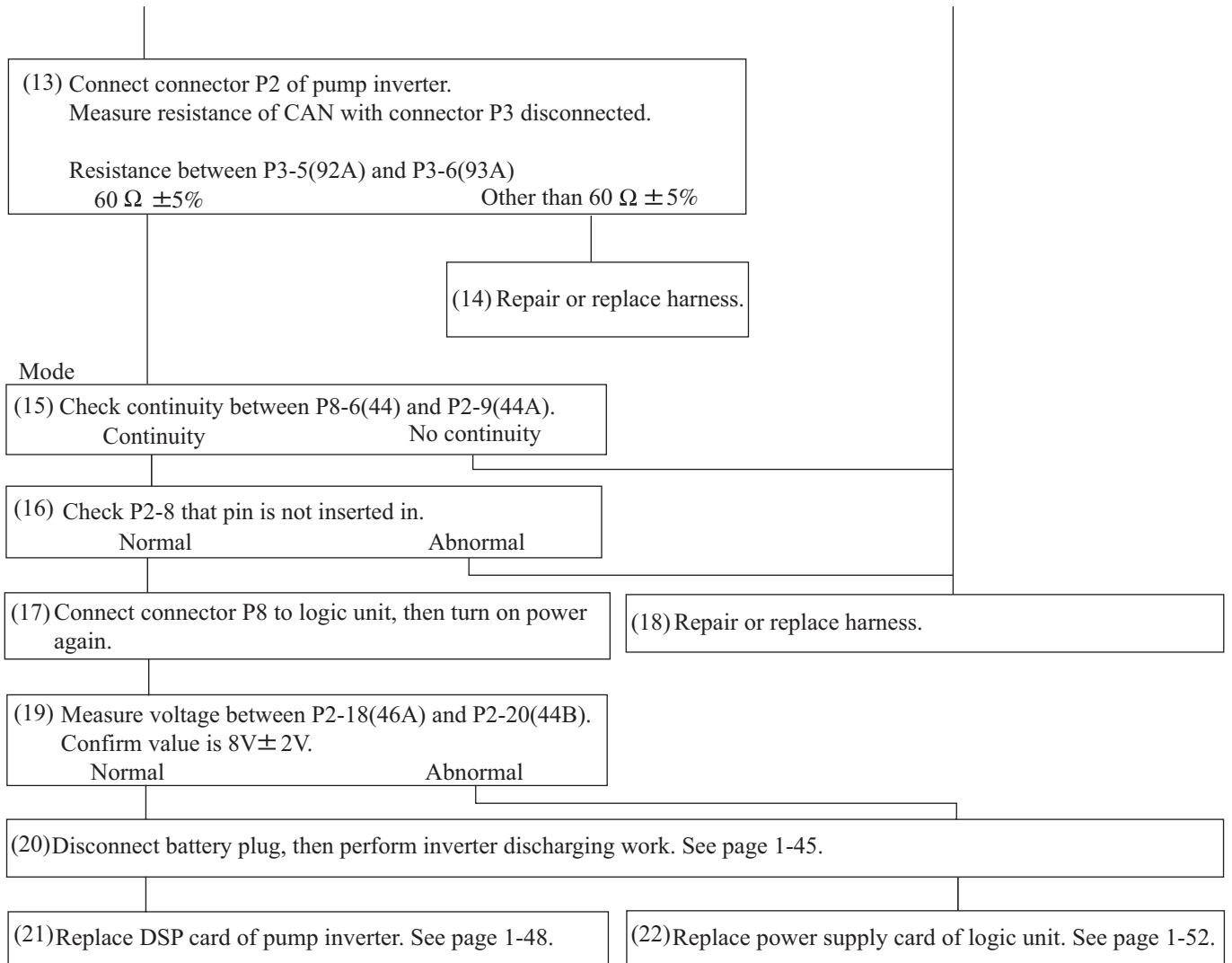
(11) Measure resistance of CAN for pump inverter DSP card.

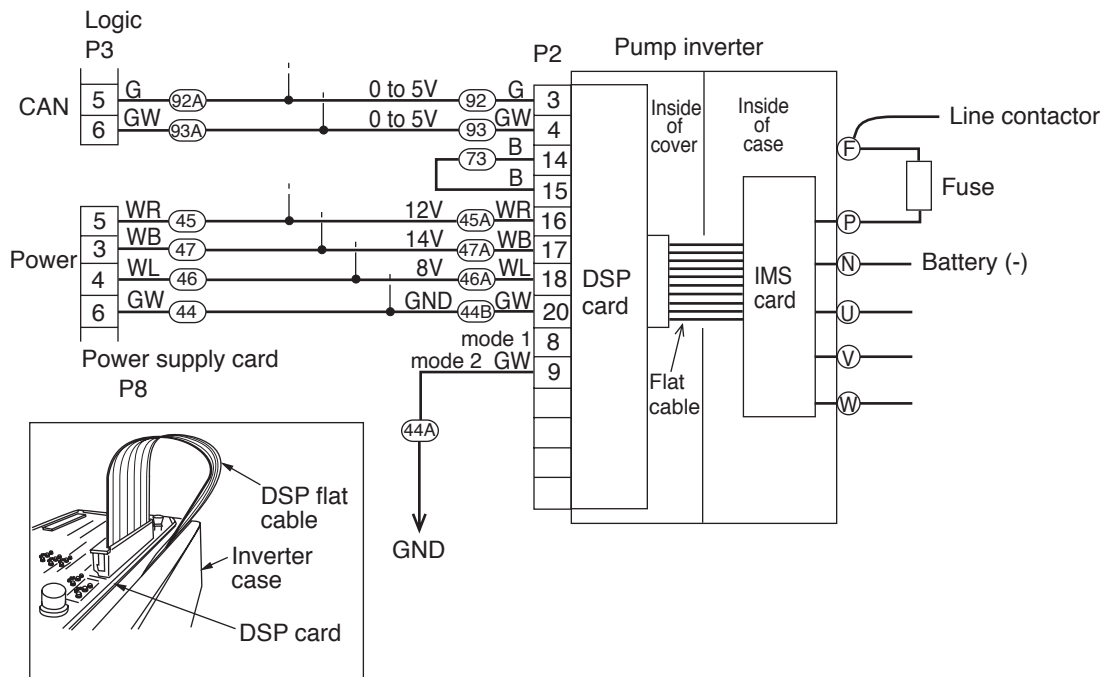
Resistance between CN2-3 and CN2-4 of DSP card side connectors

$120\ \Omega \pm 5\%$

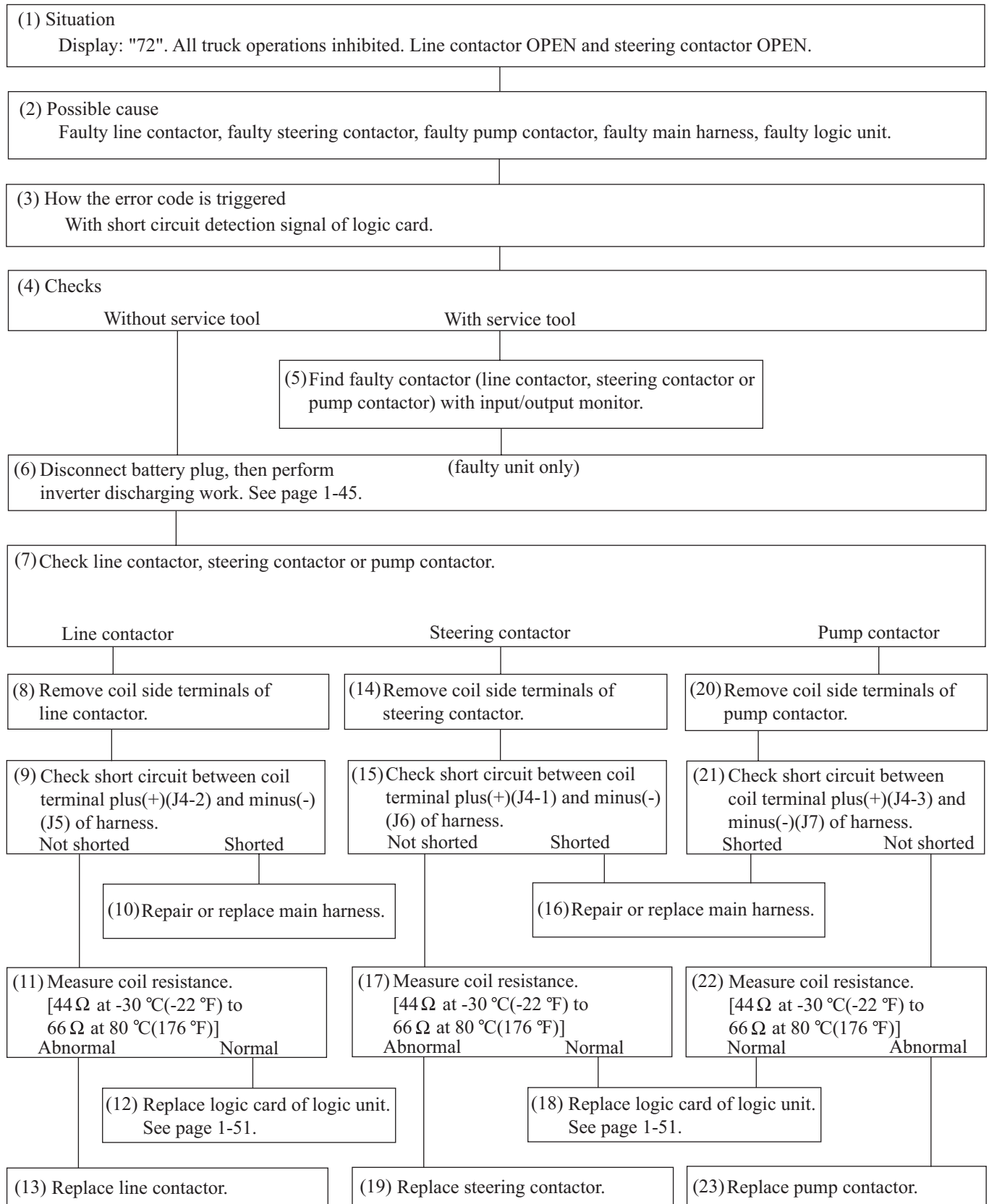
Other than $120\ \Omega \pm 5\%$

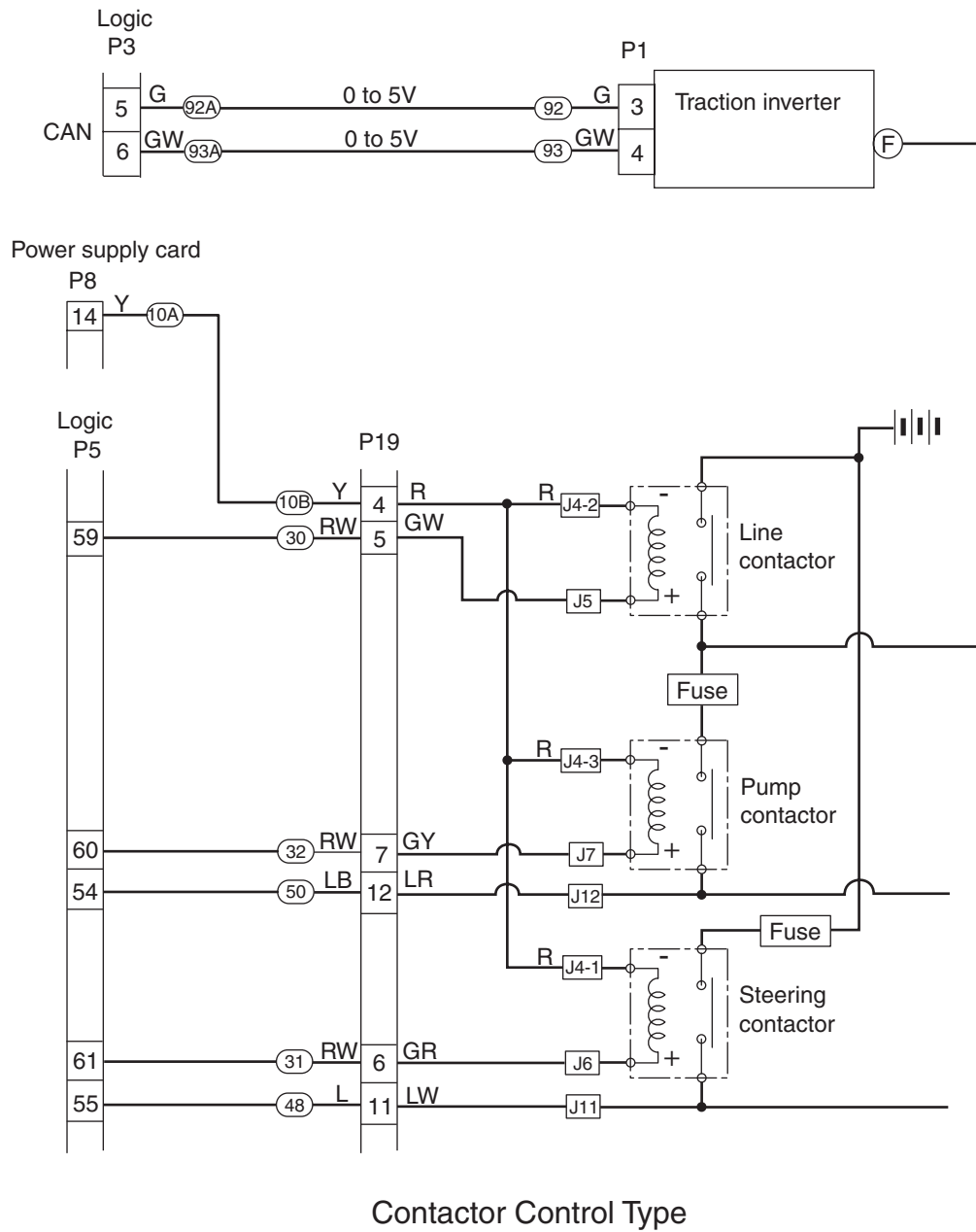
(12) Replace DSP card of pump
inverter.



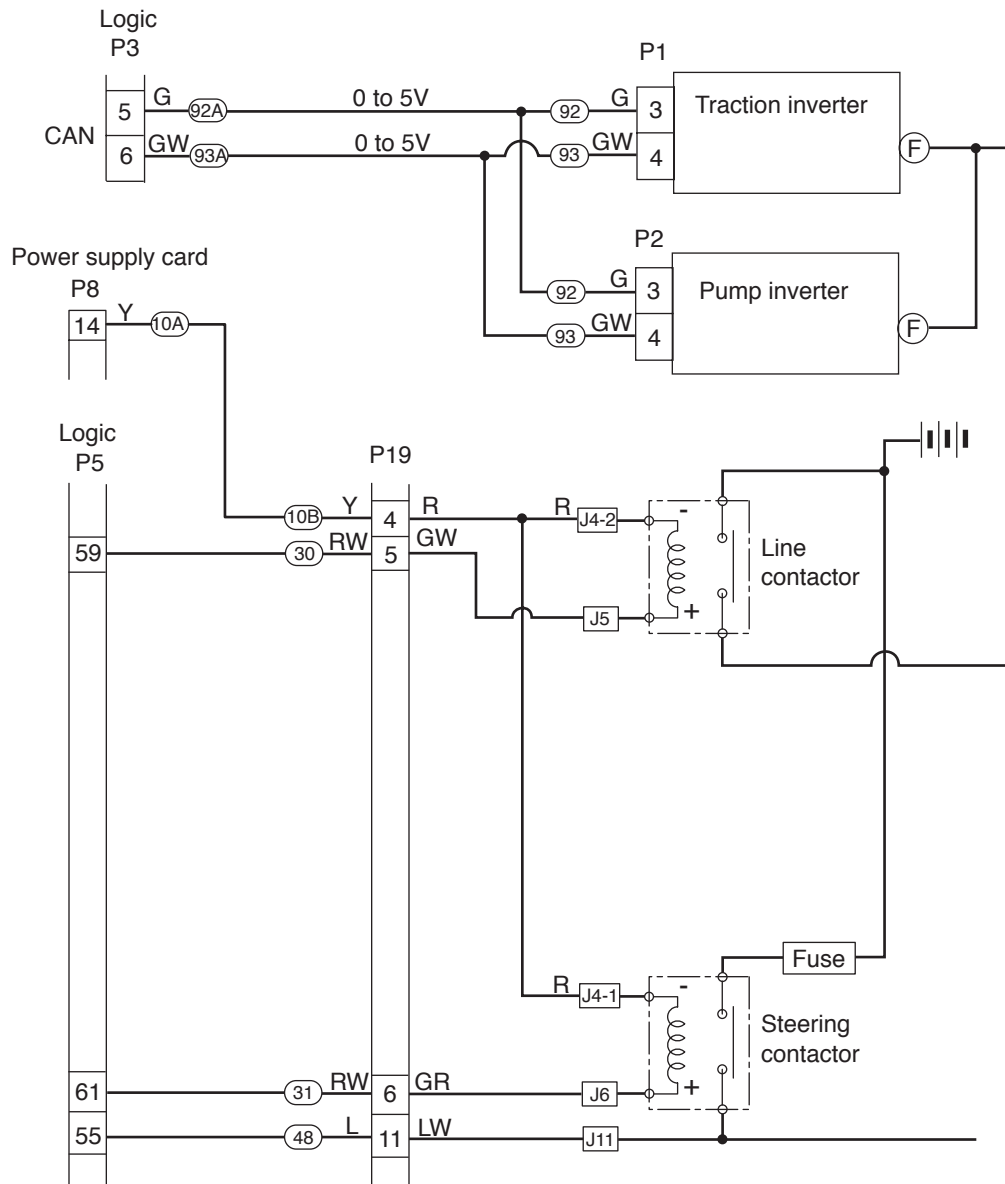


211381

Problem: Contactor Coil Fault (72)



211372

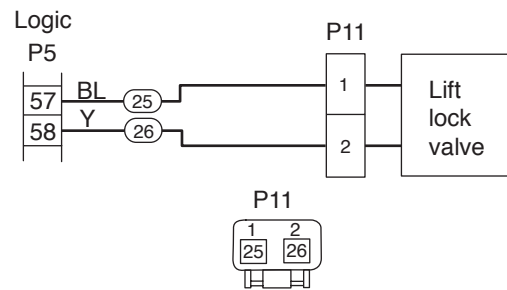


Transistor Control Type

211373

Problem: Hydraulic Lock Solenoid Fault (74)

(1) Situation Display: "74". Pump motor operation inhibited. Normal traction motor operation and power steering operation.	
(2) Possible cause Faulty lift lock valve, faulty main harness, faulty logic unit.	
(3) How the error code is triggered With short circuit detection signal of logic card.	
(4) Checks Disconnect battery plug, then perform inverter discharging work. See page 1-45.	
(5) Disconnect connector P5 of logic unit. Disconnect connector P11 of lift lock valve.	
(6) Check short circuit between P11-1(25) and P11-2(26).	
Shorted	Not shorted
(7) Repair or replace main harness.	(8) Check short circuit between lift lock valve side connectors. Measure coil resistance. [40.5 Ω at -30 °C(-22 °F) to 52 Ω at 80 °C(176 °F)] Normal Abnormal
(9) Replace logic card of logic unit. See page 1-51.	(10) Replace lift lock valve.



211382

Problem: Electromagnetic Brake Solenoid Fault (75)**(1) Situation**

Display: "75". All truck operations inhibited. Line contactor OPEN and steering contactor HOLD.

(2) Possible cause

Faulty electromagnetic brake valve, faulty main harness, faulty logic unit.

(3) How the error code is triggered

With short circuit detection signal of logic card.

(4) Checks

Disconnect battery plug, then perform inverter discharging work. See page 1-45.

(5) Disconnect connector P5 of logic unit. Disconnect connector P24 of electromagnetic brake.

(6) Check short circuit between P24-1(10G) and P24-2(5).

Not shorted

Shorted

(7) Check short circuit between electromagnetic brake side connectors. Measure coil resistance.
[Approximately 22.1 Ω]

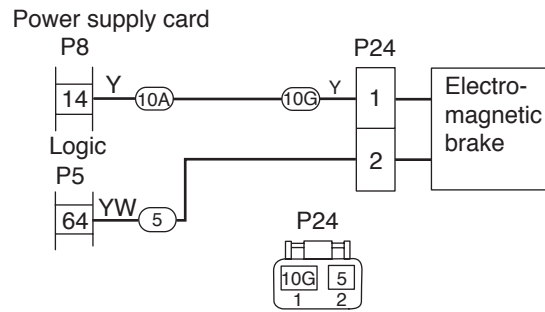
Shorted

Not shorted

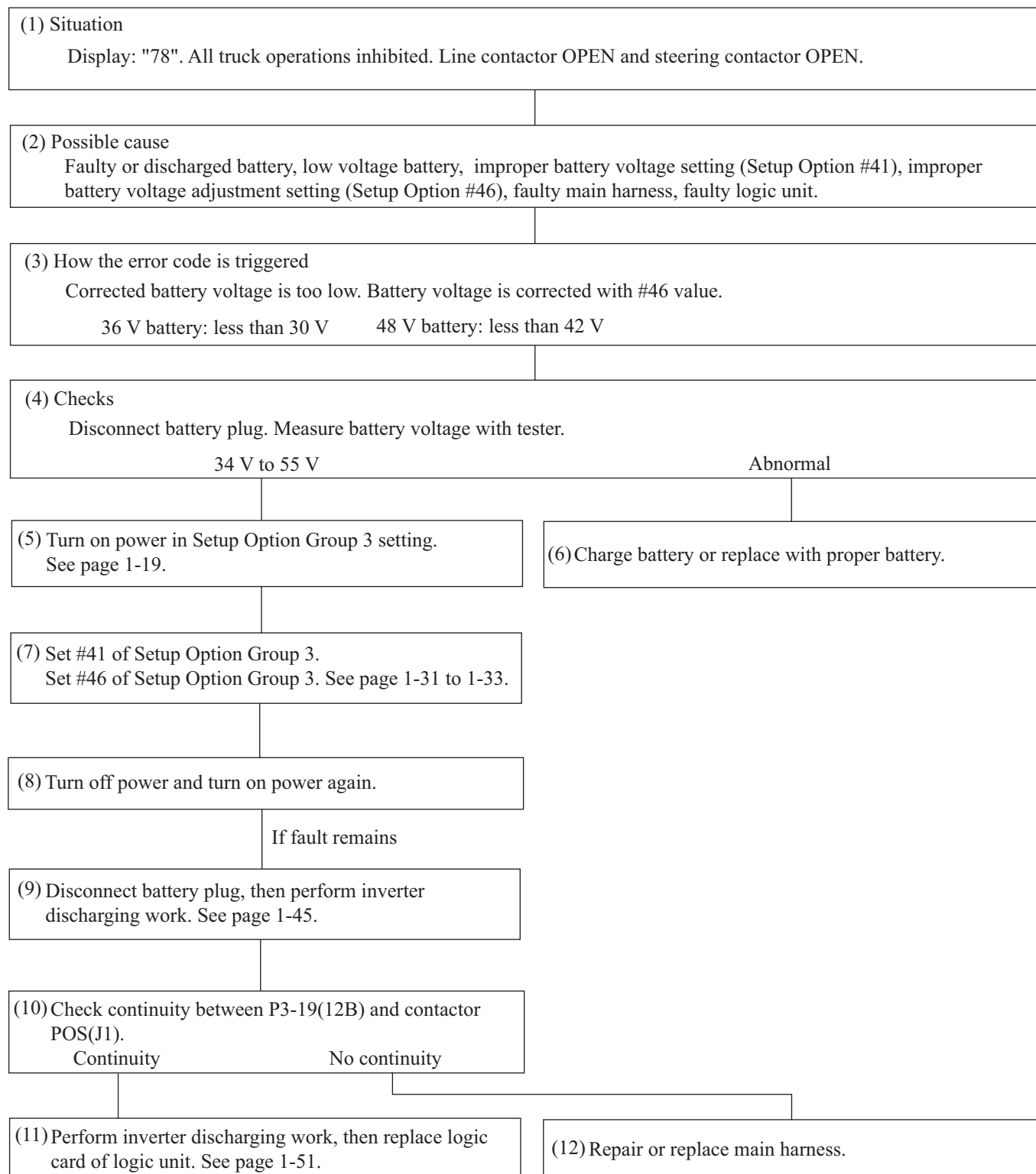
(8) Repair or replace main harness.

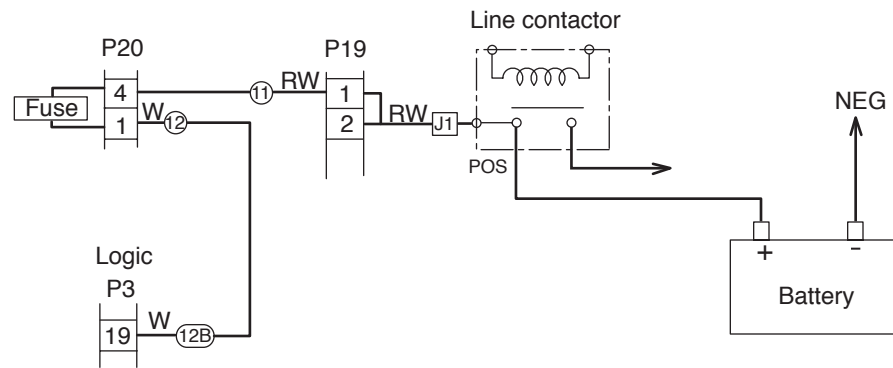
(9) Replace electromagnetic brake.

(10) Replace logic card of logic unit. See page 1-51.



211383

Problem: Battery Voltage Too Low (78)



211384

Problem: Battery Voltage Too High (79)**(1) Situation**

Display: "79". All truck operations inhibited. Line contactor OPEN and steering contactor OPEN.

(2) Possible cause

Faulty or highly charged battery, high voltage battery, improper battery voltage setting (Setup Option #41), improper battery voltage adjustment setting (Setup Option #46), faulty logic unit.

(3) How the error code is triggered

Corrected battery voltage is too high. Battery voltage is corrected with #46 value.

36 V battery: more than 42 V

48 V battery: more than 60 V

(4) Checks

Disconnect battery plug. Measure battery voltage with tester.

34V to 55 V

Abnormal

(5) Turn on power in Setup Option Group 3 setting.
See page 1-19.

(6) Replace with proper battery.

(7) Set #41 of Setup Option Group 3.
Set #46 of Setup Option Group 3. See page 1-31 to 1-33.

(8) Turn off power and turn on power again.

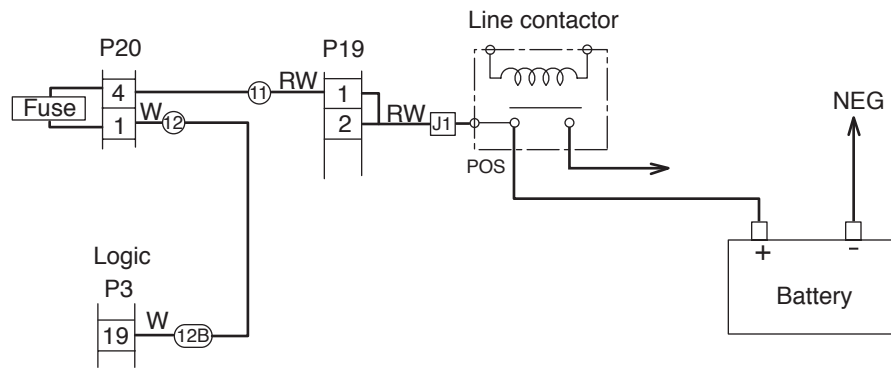
If fault remains

(9) Disconnect battery plug, then perform inverter
discharging work. See page 1-45.

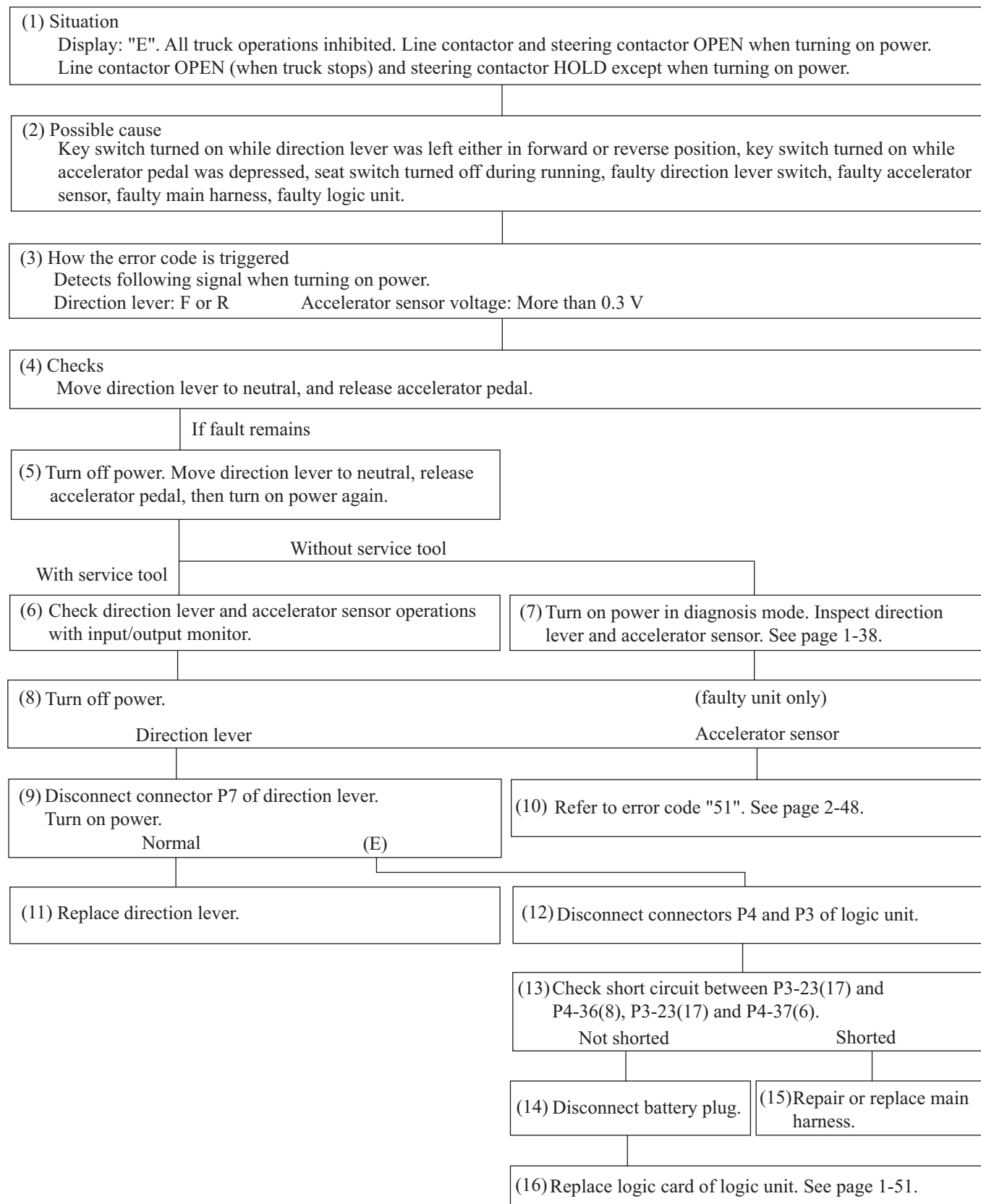
(10) Check continuity between P3-19(12B) and contactor
POS(J1).
Continuity No continuity

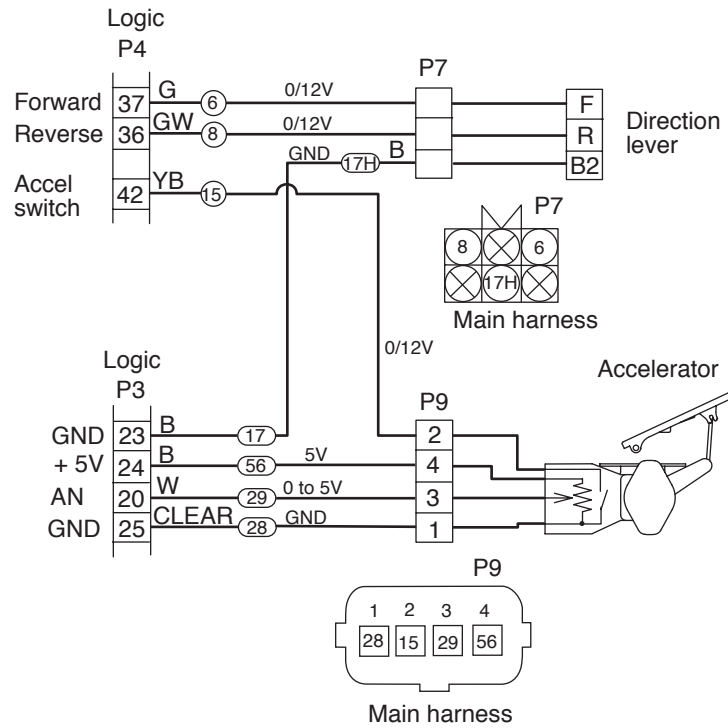
(11) Perform inverter discharging work, then replace logic
card of logic unit. See page 1-51.

(12) Repair or replace main harness.

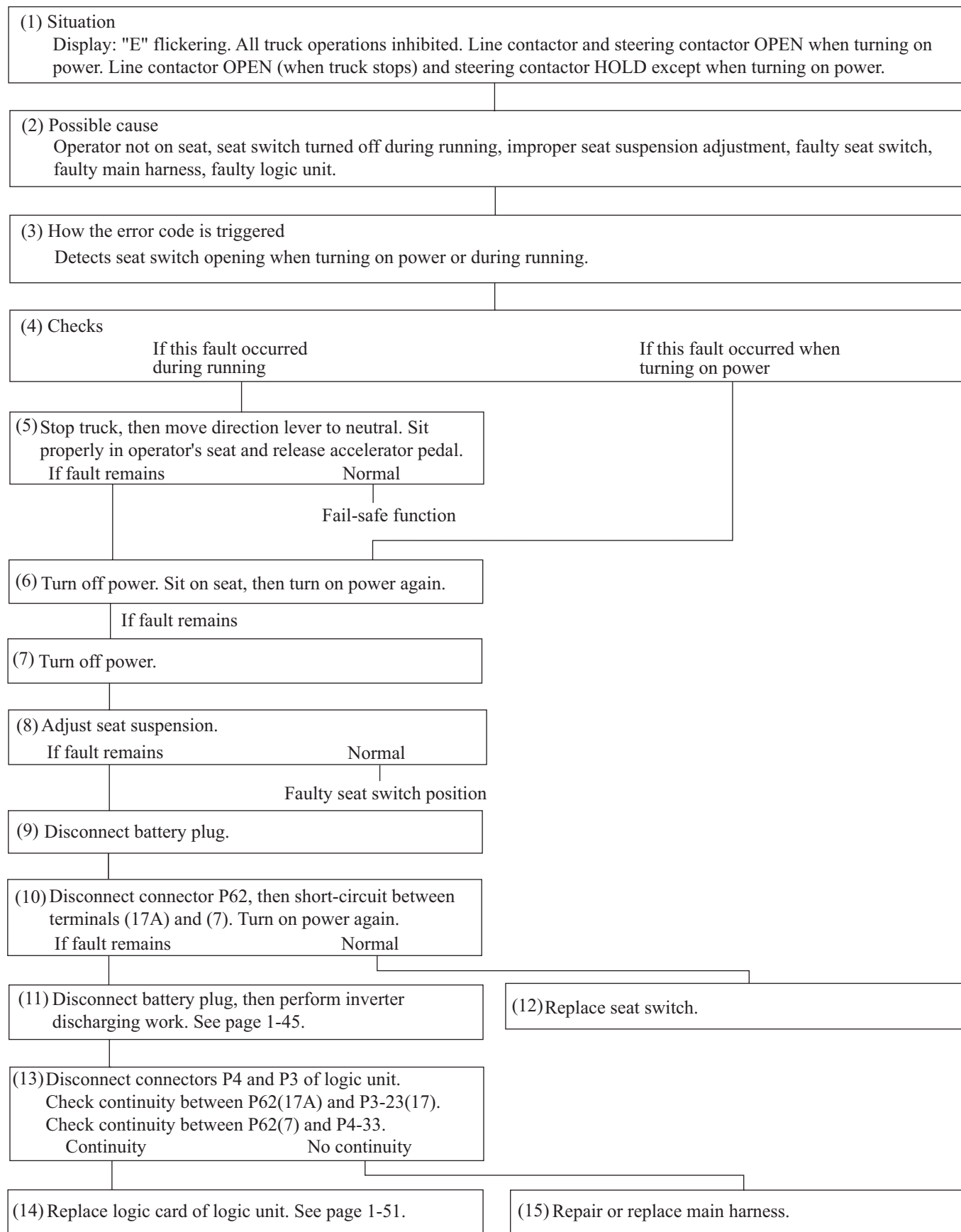


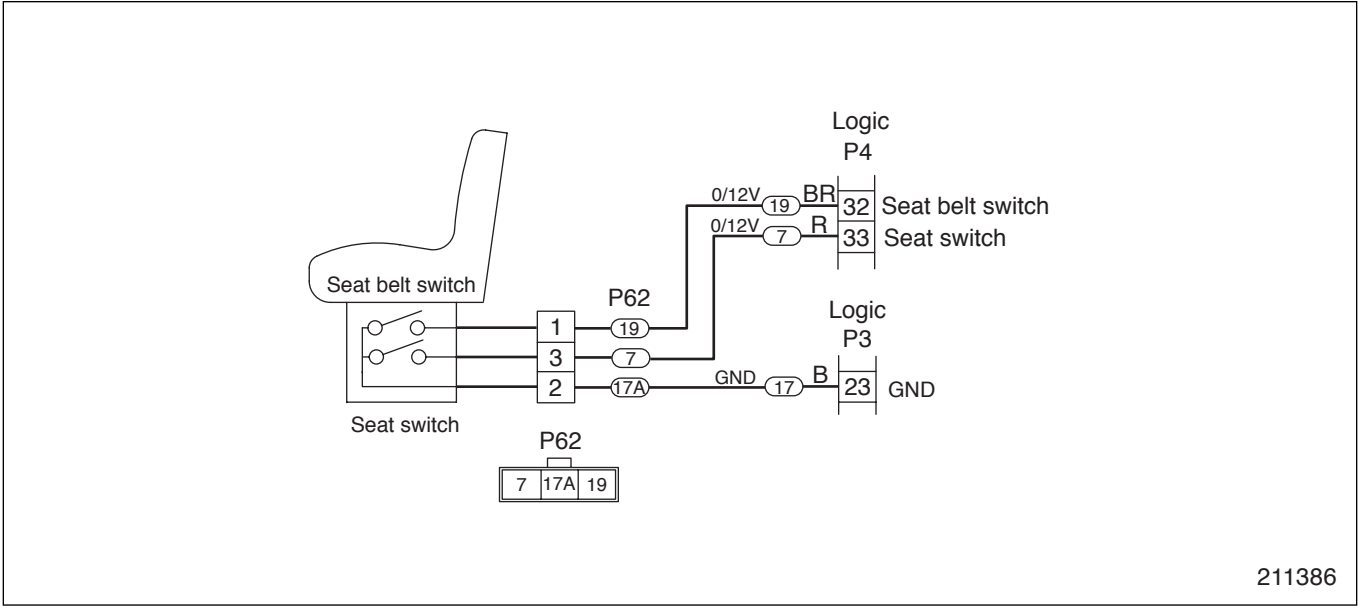
211384

Problem: Direction Lever or Accelerator, Faulty Setting (E)



211385

Problem: Seat Switch, Faulty Setting For Traction ((E))



Problem: Seat Switch, Faulty Setting For Hydraulic ((L))**(1) Situation**

Display: "L" flickering. All truck operations inhibited. Line contactor and steering contactor OPEN when turning on power. Line contactor OPEN (when truck stops) and steering contactor HOLD except when turning on power.

(2) Possible cause

Operator not on seat, seat switch turned off during pump motor operation, improper seat suspension adjustment, faulty seat switch, faulty main harness, faulty logic unit.

(3) How the error code is triggered

Detects seat switch opening when turning on power or during pump operation.

(4) Checks

If this fault occurred during
pump motor operation

If this fault occurred when
turning on power

(5) Sit on seat, then stop pump motor operation.

If fault remains

Normal

Fail-safe function

(6) Turn off power. Sit on seat, then turn on power again.

If fault remains

(7) Turn off power.**(8) Adjust seat suspension.**

If fault remains

Normal

Faulty seat switch position

(9) Disconnect battery plug.**(10) Disconnect connector P62, then short-circuit between terminals (17A) and (7). Turn on power again.**

If fault remains

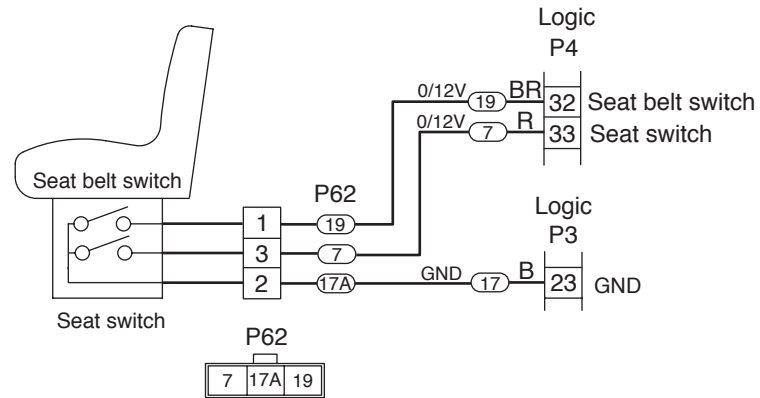
Normal

(11) Disconnect battery plug, then perform inverter discharging work. See page 1-45.**(12) Replace seat switch.****(13) Disconnect connectors P4 and P3 of logic unit. Check continuity between P62(17A) and P3-23(17). Check continuity between P62(7) and P4-33.**

Continuity

No continuity

(14) Replace logic card of logic unit. See page 1-51.**(15) Repair or replace main harness.**



211386

Problem: Lift Lever, Faulty Setting (H1)**(1) Situation**

Display: "H1" flickering. All truck operations inhibited. Line contactor and steering contactor OPEN when turning on power. Line contactor OPEN (when truck stops) and steering contactor HOLD except when turning on power.

(2) Possible cause

Key switch turned on while operating lift lever, faulty lift switches 1 and 2, faulty lift down switch, faulty main harness, faulty logic unit.

(3) How the error code is triggered

Detects lift microswitch 1 or 2, or lift down microswitch when turning on power.

(4) Checks

If this fault occurred during
pump motor operation

If this fault occurred when
turning on power

(5) Sit on seat, then stop pump motor operation.

If fault remains

Normal

Fail-safe function

(6) Turn off power. Sit on seat, then turn on power again without lift operation.

If fault remains

(7) Turn off power.**(8) Disconnect connector P13 of microswitch. Sit on seat, then turn on power again.**

If fault remains

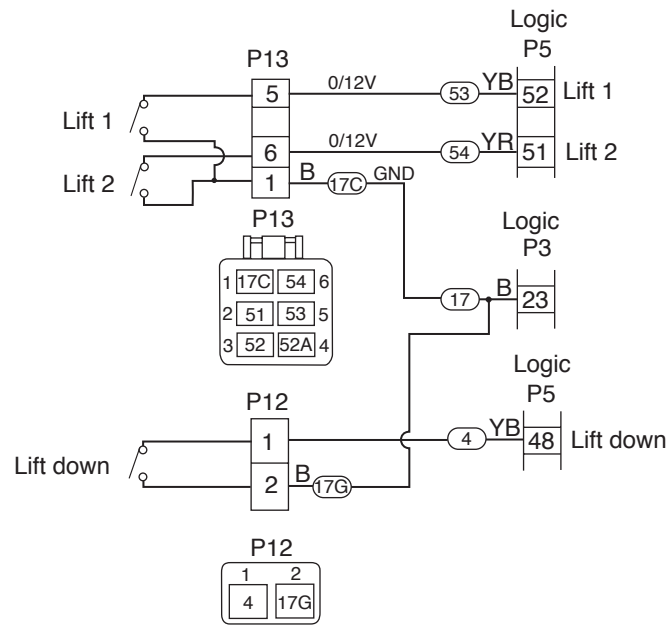
Normal

(9) Disconnect battery plug, then perform inverter discharging work. See page 1-45.**(10) Replace lift switch 1 or 2.****(11) Check continuity between P5-52 and P13-5(53).
Check continuity between P5-51 and P13-6(54).
Check continuity between P5-48 and P12-1(4).
Check short circuit between P13-5(53) and P13-1(17C).
Check short circuit between P13-6(54) and P13-1(17C).
Check short circuit between P12-1(4) and P12-2(17G).**

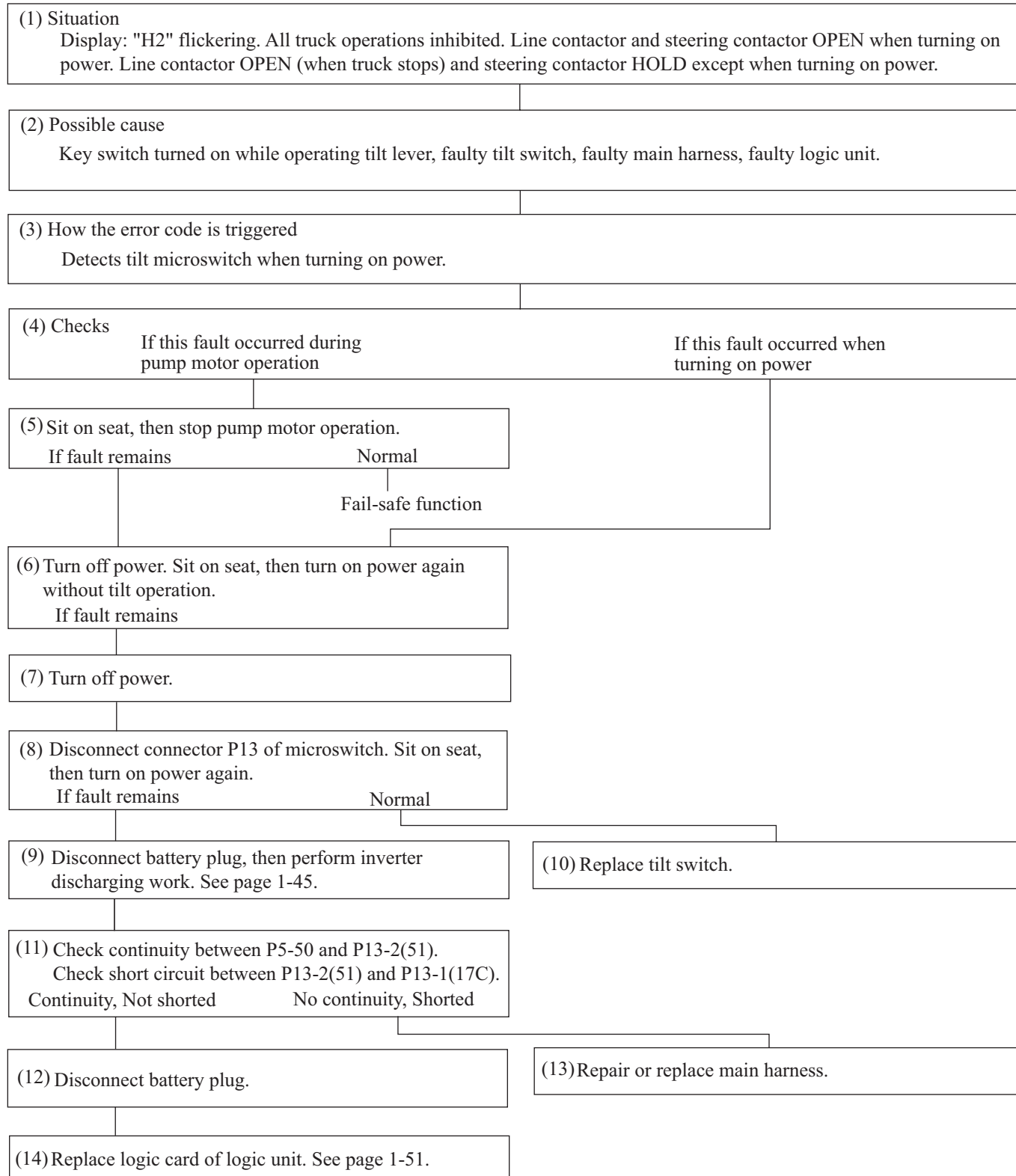
Continuity, Not shorted

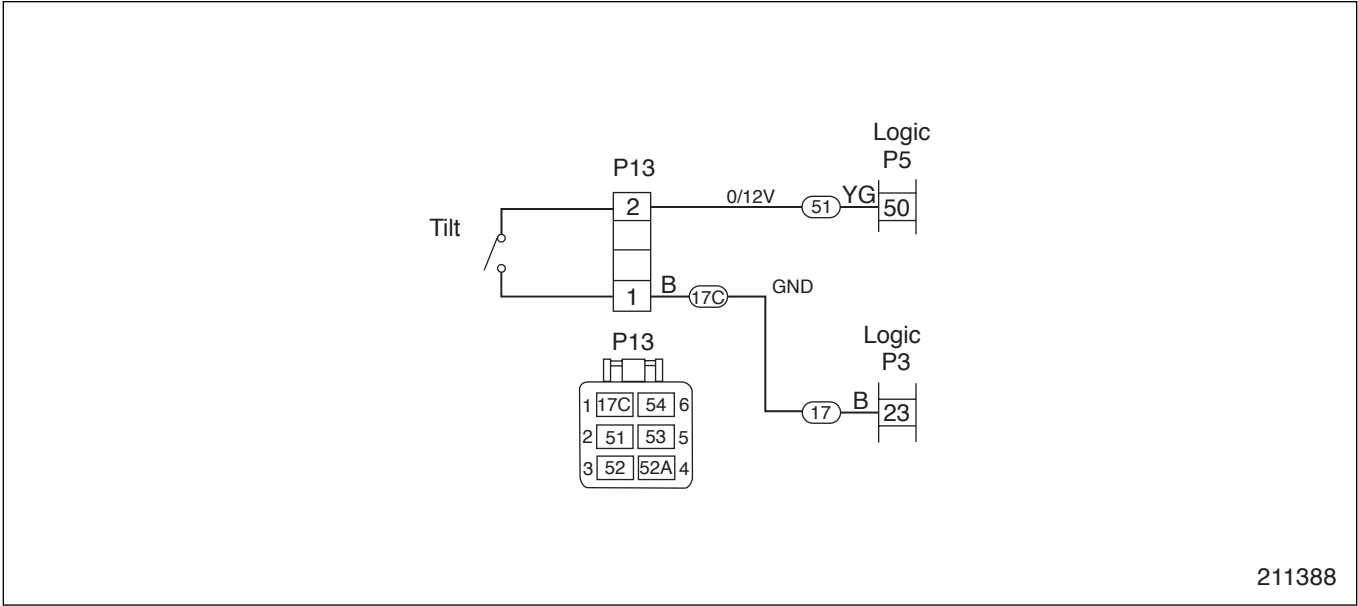
No continuity, Shorted

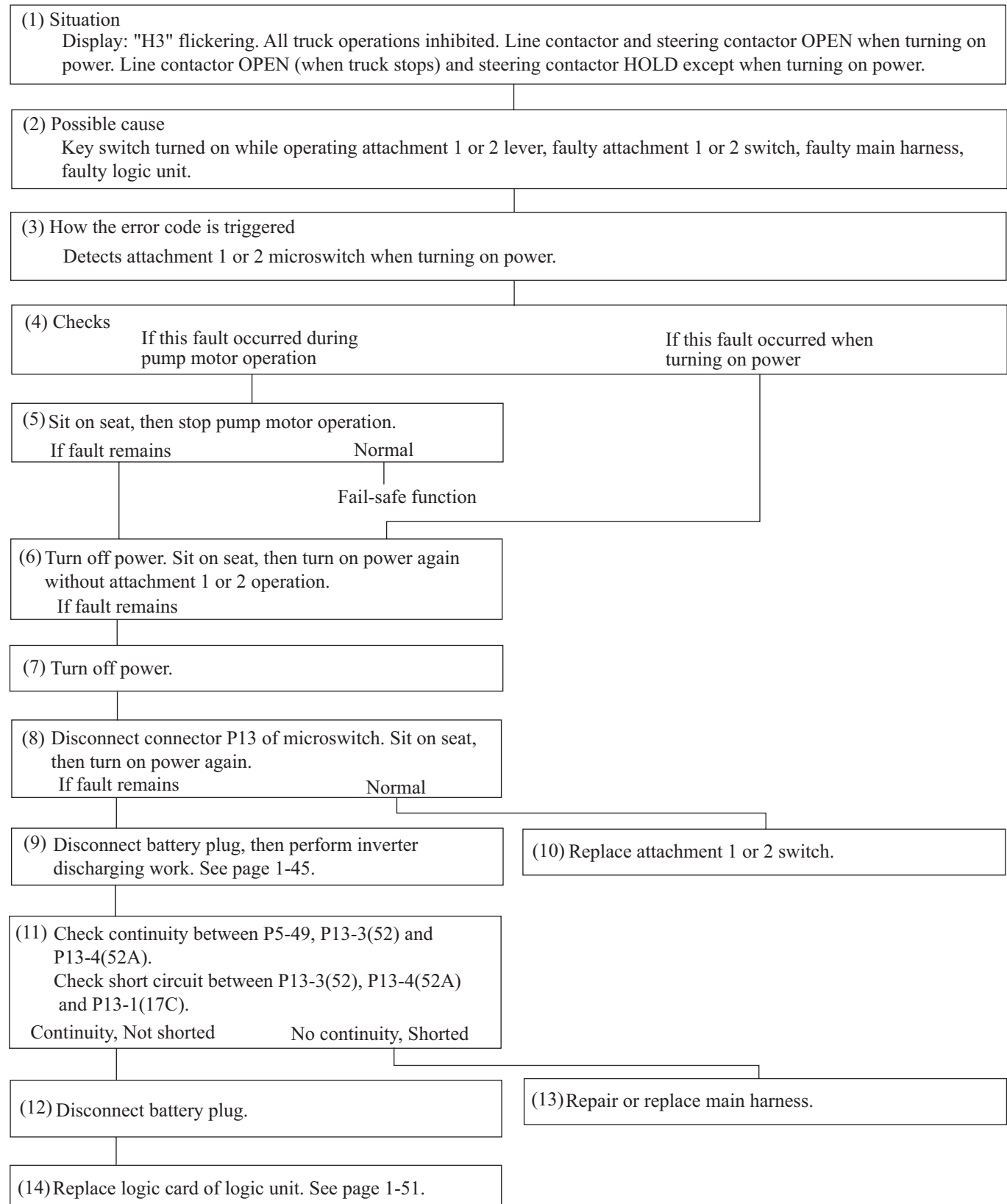
(12) Disconnect battery plug.**(13) Repair or replace main harness.****(14) Replace logic card of logic unit. See page 1-51.**

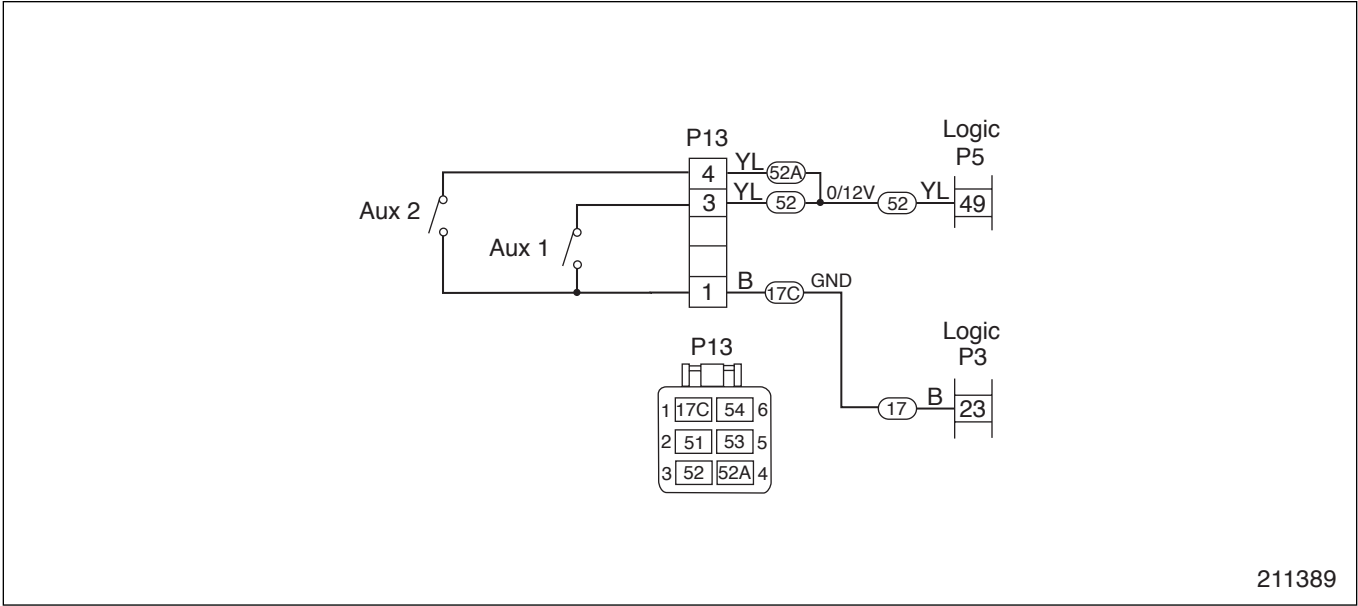


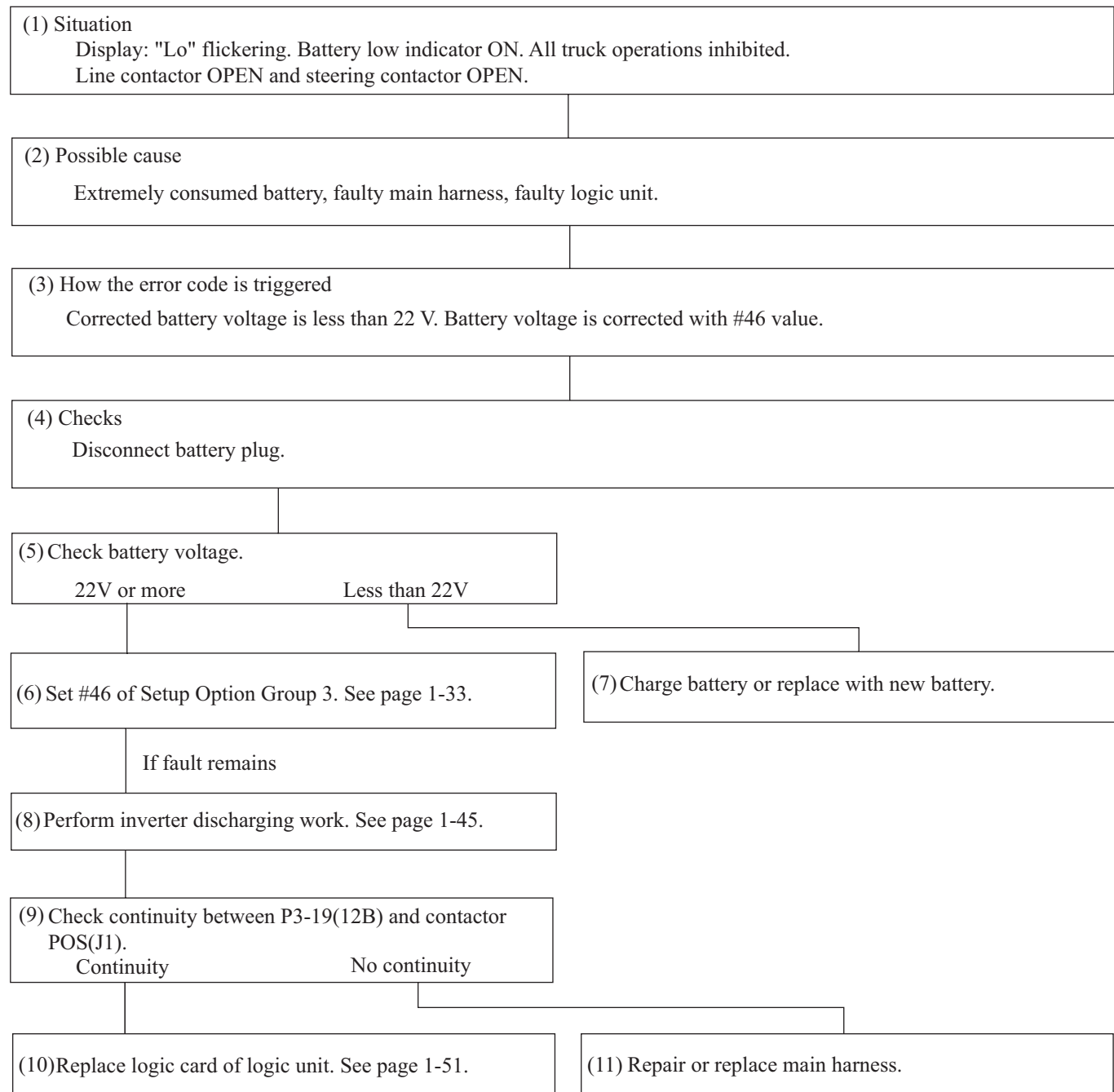
211387

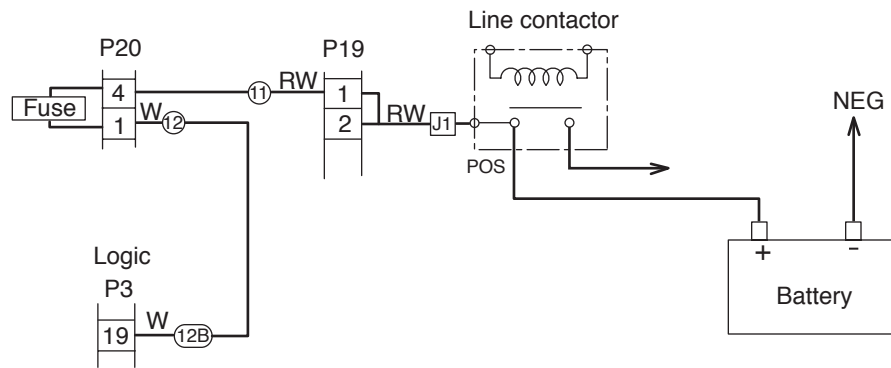
Problem: Tilt Lever, Faulty Setting (H2)



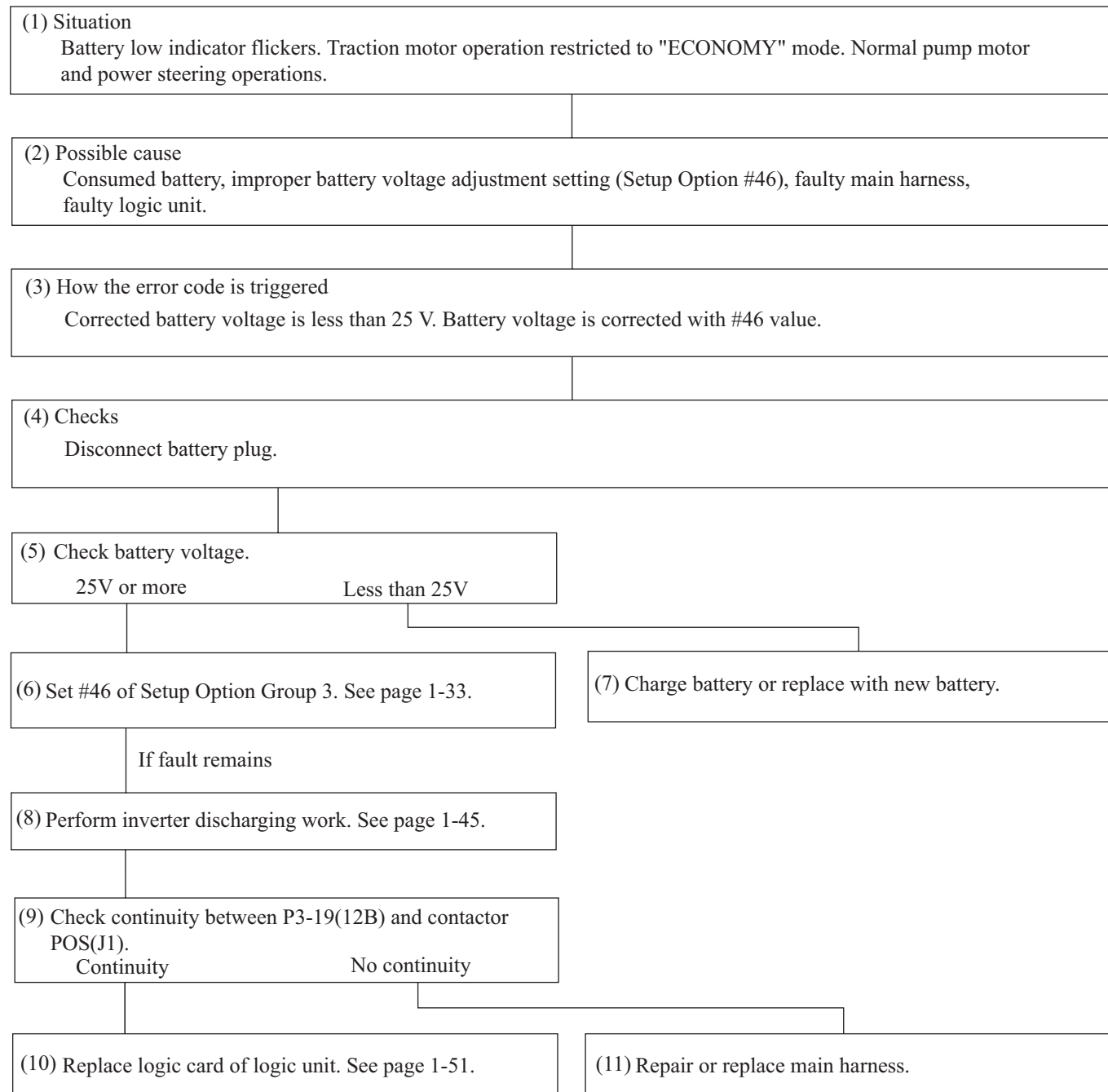
Problem: Attachment 1 Lever, Faulty Setting (H3)

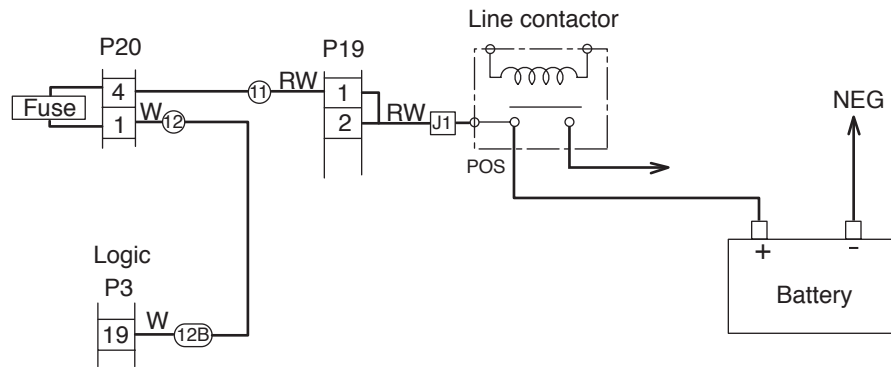


Problem: Battery Consumption Too Much ((Lo))



211384

Problem: Battery Consumption Much



211384



Insert copy of oversized schematic

99759-8C100

Electric System Diagram (Transistor Control Type, Standard)

Electric System Diagram (Transistor Control Type, Option)

Electric System Diagram (Contactor Control Type, Standard)

Electric System Diagram (Contactor Control Type, Option)

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