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Instruction Manual

Fire Pump Controller

Model LX-2000

For Engine Driven Fire Pumps

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Instruction Manual
LX-2000 Fire Pump Controller

Introduction

Hubbell Fire Pump Controller, Model LX-2000, uses solid state electronic modules to automatically control the operation of diesel engines to drive centrifugal fire pumps. All Hubbell Fire Pump Controllers comply with the latest regulations of the NFPA 20 (National Fire Protection Association, Pamphlet 20). They are listed by Underwriters Laboratories, Underwriters Laboratories of Canada, and the Canadian Standards Association and are approved by Factory Mutual Laboratories.

Receiving, Handling, and Storage

1. Immediately upon receipt, carefully unpack and inspect the Controller for damage that may have occurred in shipment. If damage or rough handling is evident, file a damage claim with the transportation carrier.
2. Turn in keys to supervisory personnel. As per NFPA requirements, lock the Controller cabinet after installation and initial testing are complete.
3. If the Controller must be stored, cover it and place in a clean, dry location. Avoid unheated locations where condensation can result in damage to the insulation or corrosion of metal parts.

Installation

1. Consult the Controller nameplate to verify that the DC voltage and ground polarity matches the engine battery. Also verify that the Controller AC power requirement matches available AC power.
2. Locate the Controller as close to the engine as possible. The base for the Controller should be non-combustible and not subject to excessive vibration that may cause erratic operation of the pressure switch.
3. Level the Controller so that the pressure switch is level. Sight across the pressure switch cover screws.
4. Set the DC circuit breakers and the CONTROL SWITCH to the OFF position.

CAUTION: Before drilling and punching holes in the cabinet for wiring connections, cover the components inside the cabinet with a protective covering. Debris may cause shorts or prevent operation of components.

5. Punch holes in the top or the bottom of the cabinet for conduit.
6. Connect the water line to the INLET side of the solenoid valve located on the left side of the Controller. Connect a drain line to the DRAIN side of the valve. Connect the other end of the line

to a waste line or direct away from the Controller towards a floor drain. Valve body is 1/2″ NPT female. For further details, consult the latest edition of NFPA 20.

7. Make connections to the Relay Motherboard, TB1-1–12, to the like terminals in the engine junction box, 1–12. Connect the AC power between terminals TB1-14 and -13 with 10 AWG wire.
8. Connect the remote alarm contacts. Refer to the supplied Controller field connection diagram for terminal points.

Note

Refer to drawings in packet, in pocket mounted on inside of cabinet door, for applicable AC voltage and frequency, and for Engine and Alarm connections. Refer to the NFPA 70 (NEC) and Table 3-1 below for cable ratings. Secure conductors inside the cabinet so they can not make contact with the components.

Table 3-1 Connections from Controller to Engine

Controller Terminal Number **TB1**	Engine Junction Box Terminal Number	Minimum wire gauge ✳ # (AWG)
1	1	14
2	2	14
3	3	14
4	4	14
5	5	14
6	6	10
7	7	10
8	8	10
9	9	14
10	10	14
11	11	10
12	12	14

✳ These are minimum wire gauge sizes for a distance of less than 25 feet between engine and Controller. For distances over 25 feet, use 8 AWG for terminals 6, 7, 8, and 11.)

Table 3-2 Connections for standard remote signals

Signal	Controller Terminal Number **TB1-**
CONTROL SWITCH OFF/RESET or Manual Alarm	24—26 and 27— 29
Trouble Alarm	18—20 and 21—23
Engine Running Contacts (Louvers Open)	30—32, 33—35, and 36—38

Adjustments

1. Carefully remove the foam packing from the pressure switch between the mercury switch and the bourdon tube. Remove the installation instructions above the tube. Replace plastic cover.
2. Adjust the pressure switch set points on the right side of the switch to meet water system requirements. Set the upper pointer to the required STOP (HIGH) pressure setting. Set the lower pointer to the required START (LOW) pressure setting.

   The scale on the pressure switch is only for initial positioning of the pointers. During testing of the Controller, verify the pressure switch settings by referring to the system pressure gage. Readjust settings as necessary to obtain desired STOP and START settings. Refer to the instructions packed in the pressure switch and NFPA 20 for more information on adjusting the settings.
3. Adjust the Test Timer for the correct timing settings. Refer to Appendix A for instructions to set the timer.
4. Adjust the time delay on Controllers equipped with the optional sequence start relay, R15.
5. Verify that the pressure recorder has a battery installed. Adjust the pen and chart paper. Refer to Appendix B for information on the pressure recorder.

Functional Description

Electronic Control Unit

The Electronic Control Unit is an assembly consisting of two printed circuit boards, EM1 and EM2, that monitors specific input signals and provides outputs to energize or de-energize control relays. EM1 monitors the battery voltage and AC voltage in Controllers that start the engine upon AC power loss. The EM2 board has a timer and outputs for control. The EM1 board also has a power circuit to power both boards. Both the EM1 and EM2 provide active low output signals to energize the relays on the Relay Motherboard.

Note

The assigned names for relays and input and output signals of the Electronic Control Unit are typed in CAPITAL LETTERS. The assigned names of controls or light indication are typed in CAPITAL LETTERS using a sans serif font. Examples: 9R OVERSPEED relay, STOP push button.

Output signals

10R BATTERY 1 FAIL relay

This output goes low to energize relay 10R when the battery voltage from 12 V batteries falls to approximately 6 V or voltage from 24 V batteries falls to approximately 12 V.

11R BATTERY 2 FAIL relay

This output goes low to energize relay 11R when the battery voltage from 12 V batteries falls to approximately 6 V or voltage from 24 V batteries falls to approximately 12 V.

14R AC LOSS relay, optional

If enabled by a jumper on the EM1 board, a low from this output energizes relay 14R to indicate a loss of AC power. A built in time delay can be set from 5 to 100 seconds to prevent false alarms from momentary power outages. A jumper on the Relay Motherboard completes a path so that an AC loss start signal is routed to the AC FAIL input of the EM2 board to initiate an engine crank cycle.

Engine start inputs

Inputs from the items listed in this section cause the Electronic Control Unit to crank the engine.

REMOTE, optional

A momentary opening of REMOTE contacts energizes the 4R FUEL and WATER relay if there is no LOCKOUT input and the 9R OVERSPEED and the 2R FAIL TO START relays are not energized. Then the 5R/6R crank cycle begins. A sustained opening of the REMOTE input contacts inhibits the internal AUTO STOP signal, or the STOP input from the STOP switch closing, from de-energizing the 4R FUEL and WATER relay. The REMOTE input contacts have to close for the AUTO STOP function to work or for another input to start a crank cycle.

AC FAIL, optional

A sensed AC Power Loss from the EM1 board lasting longer than 5 to 100 seconds (set P1 on the EM1 board) sends a low signal to the AC FAIL input of the EM2 board. The EM2 board then energizes the 4R FUEL and WATER relay if there is no LOCKOUT input and the 9R OVERSPEED and the 2R FAIL TO START relays are not energized. Then the 5R/6R crank cycle begins. A sustained low on the AC FAIL input of the EM2 board inhibits the internal AUTO STOP signal and the STOP input from the STOP switch, from de-energizing the 4R FUEL and WATER relay. The AC FAIL input to the EM2 board must be high for the AUTO STOP function to work or for another input to start a crank cycle.

Pressure Switch

A momentary pressure switch contact closure due to a low pressure condition energizes the 4R FUEL and WATER relay if there is no LOCKOUT input and the 9R OVERSPEED and the 2R FAIL TO START relays have not energized. Then the 5R/6R crank cycle begins. A sustained closure of the pressure switch contacts inhibits the internal AUTO STOP signal, or the STOP input from the STOP

switch closing, from de-energizing the 4R FUEL and WATER relay. The pressure switch input contacts must be open for the AUTO STOP function to work or for another input to start a crank cycle.

TEST

Closure of the weekly Test Timer contacts or turning the CONTROL SWITCH to the TEST position energizes the 7R TEST START relay if the 4R FUEL and WATER, the 22R LOW OIL PRESSURE, and the 21R HIGH WATER TEMPERATURE, and the 1R TROUBLE relays have not energized. The energized 7R TEST START relay connects power to the water dump solenoid valve causing the water pressure to drop, initiating a pressure switch start. When the 4R FUEL and WATER relay energizes, the 7R TEST START relay de-energizes disconnecting power to the solenoid valve. When in the TEST mode, energizing of the 21R HIGH WATER TEMPERATURE or the 22R LOW OIL PRESSURE relays causes the 4R FUEL and WATER relay to de-energize, shutting down the engine. Also when in the test mode, the internal AUTO STOP signal and the STOP input from the STOP switch are inhibited.

MANUAL START

When the CONTROL SWITCH is in the MANUAL START position, power is supplied to the WATER FUEL SOLENOID output directly through the CONTROL SWITCH. Turning the MANUAL START switch initiates engine cranking. The 5R/6R crank cycle and all STOP functions are disabled. Alarm conditions are still monitored and displayed. If the engine is not running and the CONTROL SWITCH is left in the MANUAL START position for more than 15 minutes, the internal EVENT TIMER energizes the 2R FAIL TO START relay.

Engine stop inputs

Inputs from the items listed in this section cause the Electronic Control Unit to stop the engine.

OFF/RESET

When the CONTROL SWITCH is turned to this position, power is removed from the Electronic Control Unit disabling all functions. Turning the CONTROL SWITCH to any other position restores power and the Electronic Control Unit resets.

AUTO STOP, optional

The internal EVENT TIMER circuit has a three-position jumper (30 MIN, 15 MIN, and DISABLED) to select engine run time. When the TIMER expires, an AUTO STOP output de-energizes the 4R FUEL and WATER relay. An AUTO STOP output only occurs if there are no inputs to start the engine. The AUTO STOP feature is disabled when there is a TEST signal input.

LOCKOUT input, optional

This option is available only if the jurisdiction having authority allows the use of a lockout.

LOCKOUT inputs stop and inhibit the 5R/6R crank cycle and de-energizes the 4R FUEL and WATER relay, regardless of any other input. When there is no LOCKOUT input, the EM2 function is restored.

Note that when the CONTROL SWITCH is in the MANUAL START position, battery voltage energizes the engine fuel solenoid directly and the LOCKOUT input has no affect.

OVRSPD input

An OVRSPD (overspeed) input latches the 9R OVERSPEED relay and the 4R FUEL and WATER relay de-energizes regardless of any other input. Note that when the CONTROL SWITCH is in the MANUAL START position the battery voltage energizes the engine fuel solenoid directly and the OVRSPD input has no affect. When there is no OVRSPD input, the normal EM2 function is restored. Turn the CONTROL SWITCH to OFF/RESET and back to AUTO to reset the Controller.

STOP input

A STOP push button contact closure on this input de-energizes the 4R FUEL and WATER relay if there is no REMOTE input, AC power is available, and the pressure switch contacts are open. When the STOP push button contacts open, normal EM2 function is restored.

LOW O/P input in TEST mode

When the engine has been running for at least 15 seconds, a low on this input resets the FUEL and WATER signal and causes a LOW OIL PRESSURE output to energize the 22R LOW OIL PRESSURE relay. Turn the CONTROL SWITCH to OFF/RESET and back to AUTO to reset the Controller.

HIGH W/T input in TEST mode

A low on this input resets the FUEL and WATER signal and causes a HIGH WATER TEMPERATURE output to energize the 21R HIGH WATER TEMPERATURE relay. Turn the CONTROL SWITCH to OFF/RESET and back to AUTO to reset the Controller.

Output signals

5R CRANK 1 relay

This output goes low to energize the 5R relay, which connects Battery No. 1 to the engine starting circuit.

6R CRANK 2 relay

This output goes low to energize the 6R relay, which connects Battery No. 2 to the engine starting circuit.

4R FUEL and WATER SOLENOID relay

This output goes low to energize the 4R relay that enables the flow of fuel to the engine.

3R OIL PRESSURE TIME DELAY relay

This output goes low to energize relay 3R that connects the oil pressure switch to the 1R TROUBLE relay coil. Delaying this output, when the engine first starts running, allows the oil pressure to increase to normal operating pressure without sounding an alarm.

21R HIGH WATER TEMPERATURE relay

This output goes low to energize relay 21R to indicate high engine water temperature and prevent the 7R TEST relay from energizing. This output remains low until the CONTROL SWITCH is turn to the OFF/RESET position.

22R LOW OIL PRESSURE relay

This output goes low to energize relay 22R to indicate low oil pressure and prevent the 7R TEST relay from energizing. This output remains low until the CONTROL SWITCH is turn to the OFF/RESET position.

2R FAIL TO START relay

This output goes low to energize the 2R relay to sound an alarm if the engine does not start after completing the cranking cycle.

The 2R FAIL TO START relay energizes if one of the following conditions occurs: both batteries fail, the engine does not start by the end of the crank cycle, or the CONTROL SWITCH is set to the MANUAL START position and there is no ENG RUN input for 15 minutes.

Status LED's

The LED's listed below are on the EM2 board. They come on when the indicated condition is active.

BAT1 FAIL	Battery No. 1 has failed	CRANK1	Cranking on Battery No. 1
BAT2 FAIL	Battery No. 2 has failed	CRANK2	Cranking on Battery No. 2
INIT START	Crank cycle initiated	W/F	Water/Fuel relay energized
LOCKOUT	Lockout in effect	ENG RUN	Engine is running
PRES SWT	Pressure is low; pressure switch contacts are closed.	CLOCK	AUTO STOP, OIL PRESSURE DELAY timer is running (blinks on/off approximately two times per second)
ENBL O/P	Oil pressure enable	HI W/T	Water temperature high
LOW O/P	Oil pressure low		

Battery Sense

The Battery Sense assembly incorporates two identical circuits to monitor the presence of both system batteries. If a battery is disconnected, a normally energized relay de-energizes. The relay contacts

transfer to signal a battery failure, a BATTERY FAILURE pilot light comes on, and the alarm sounds. Reconnecting the battery re-energizes the relay. Then the pilot light goes out and the alarm stops.

CONTROL SWITCH—OFF/RESET Position

The Controller is inoperative and the battery power is removed from all control circuits when the CONTROL SWITCH is in the OFF/RESET position. Turning the CONTROL SWITCH to this position resets the Controller after a failure to start, overspeed, and Battery No.1 or No.2 failure. CONTROL SWITCH contacts are provided for a remote alarm to indicate that the Controller is set to either the OFF/RESET or MANUAL START positions. The CONTROL SWITCH and the DC breakers should always be in the OFF position when servicing the engine or the Controller.

CONTROL SWITCH—MANUAL START Position

When the CONTROL SWITCH is in the MANUAL START position, Battery No. 1 (TB1-6) energizes the Fuel and Water solenoid (TB1-1) through circuit breaker CB1. Turning the MANUAL START switch to position 1 connects Battery No. 1 to TB1-9 to energize pilot contactor No. 1 to crank the engine. When the engine starts, release the switch to discontinue cranking. The engine speed switch closes to connect Battery No. 1 to TB1-2 energizing the 8R ENGINE RUN relay. The 20R contacts transfer to provide an engine running signal at TB1-30—32, -33—35, and -36—38 (louvers open).

In position 2, the engine starts in the same manner as described above with Battery No. 2 connected to energize pilot contactor No. 2.

To stop the engine turn the CONTROL SWITCH to the OFF/RESET position.

The oil pressure time delay and Controller alarm circuits are operational when the CONTROL SWITCH is in the MANUAL START position.

CONTROL SWITCH—AUTO Position

In this position, the AUTOMATIC MODE light is on to indicate that the Controller is in the standby mode to control fire pump operation. The following command signals start the engine in this mode:

- Pressure switch contacts close
- Weekly Test Start / Deluge (Solenoid) Valve Start
- Optional Remote start switch
- Optional AC Power Failure Start

Water Pressure Start

A decrease in water pressure below the preset level closes the pressure switch contacts to signal the Electronic Control Unit. The Electronic Control Unit energizes the 4R Fuel and Water Solenoid relay to transfer contacts (6,9) and applies battery voltage to the engine fuel solenoid connected to TB1-1. At the same time, the 5R CRANK 1 relay is energized by the Electronic Control Unit, and its contacts (4,7) transfer to apply battery voltage to the No. 1 Cranking Pilot Contactor connected to TB1-9. The Electronic Control Unit will keep the 5R relay energized for 15 seconds. When the engine starts, the

contacts of the engine speed switch connected to TB1-2 close and energize the 8R ENGINE RUN relay. The Electronic Control Unit senses the engine run signal and de-energizes the 5R relay to discontinue cranking. The 20R ENGINE RUN relay also energizes to provide the following relay contact output for remote indication or to open louvers: TB1-30, -31 closed; TB1-30, -32 open; TB1-33, -34 closed; TB1-33, -35 open; TB1-36, -37 closed; and TB1-36, -38 open.

If the engine does not start during the first 15 seconds, the Electronic Control Unit de-energizes the 5R relay for a 15-second rest interval. At the end of this rest interval, the Electronic Control Unit energizes the 6R CRANK relay, and its contacts (4,7) transfer to apply battery voltage to the No. 2 Cranking Pilot Contactor connected to TB1-10. The Electronic Control Unit keeps the 6R relay energized for 15 seconds followed by a second 15-second rest interval.

If the engine does not start, the above 5R/6R cycle repeats three times for a total of six cranking cycles and five rest periods. At the end of the last crank cycle, elapsed time approximately 165 seconds, the Electronic Control Unit inhibits further cranking by de-energizing relays 4R, 5R, and 6R, and energizes the 2R FAIL TO START relay. The 2R contacts (4,7) transfer to energize the FAIL TO START pilot light, and energize the 1R TROUBLE relay.

The Electronic Control Unit continually monitors the voltages of Battery No. 1 and Battery No. 2. Should the voltage of either battery drop below 50% of nominal during cranking, the Electronic Control Unit alters the cranking sequence to exclude the faulty battery and select the good battery for the remainder of the cranking sequence.

For example, if Battery No. 1 fails, the Electronic Control Unit does not energize the 5R relay and utilizes Battery No. 2 and the 6R relay for the remainder of the cranking sequence. The Electronic Control Unit also de-energizes the 10R BATTERY NO. 1 FAILURE relay, and its normally closed contacts (1,7) transfer to energize the 1R TROUBLE relay. The normally closed 10R relay contacts (2,8) transfer to energize the BATTERY NO. 1 FAILURE pilot light.

If Battery No. 2 fails, the Electronic Control Unit does not energize the 6R relay and utilizes Battery No. 1 and the 5R relay for the remainder of the cranking sequence. The Electronic Control Unit also de-energizes the 11R BATTERY NO. 2 FAILURE relay, and its normally closed contacts (1,7) transfer to energize the 1R TROUBLE relay. The normally closed 11R relay contacts (2,8) transfer to energize the BATTERY NO. 2 FAILURE pilot light.

The indications above described can also exist due to a tripped battery circuit breaker or missing battery. Reset the battery failure alarms by sequencing the CONTROL SWITCH to the OFF/RESET position.

Note

Anytime there is a failure that causes the 1R TROUBLE relay to energize, the contacts transfer to disconnect the 7R TEST START relay and sound the alarm. The 1R relay also provides the following contact outputs for remote indication: TB1-18, -19 closed; TB1-18, -20 open; TB1-21, -22 closed; and TB1-21, -23 open.

Battery Charger Failure

The Loss of Battery Charger relay contacts on the LX-750 Battery Charger panel transfer to indicate a loss of battery charging current when the engine is not running. The LOBC relay contacts connected

to the battery charger panel terminals (BC-TB2-1 and BC-TB2-2) activate the 1R TROUBLE relay and turn on the BATTERY CHARGER FAIL pilot light.

Low Oil Pressure

After the engine is running, the engine speed switch closes and energizes the 8R ENGINE RUN relay. The Electronic Control Unit initiates the 15-second time delay. After the delay, the 3R OIL PRESSURE TIME DELAY relay is energized, and its contacts (6,9) transfer to complete the alarm circuit from the oil pressure switch (TB1-4) to the 1R TROUBLE relay. If the engine oil pressure switch contacts open normally as oil pressure builds during the 15-second delay interval, the alarm does not sound when the 3R contacts close.

If the oil pressure switch contacts do not open, the 1R TROUBLE relay energizes through the 3R contacts. The 22R LOW OIL PRESSURE relay contacts (4,7) close to turn on the LOW OIL PRESSURE pilot light. Opening the oil pressure switch contacts de-energizes the 1R TROUBLE relay, but the LOW OIL PRESSURE pilot light remains on. Sequence the CONTROL SWITCH to the OFF/RESET position to reset the low oil pressure pilot light.

High Water Temperature

Closure of the water temperature switch, TB1-5, due to high engine water jacket temperature turns on the HIGH WATER TEMPERATURE pilot light and energizes the 1R TROUBLE relay. The 21R HIGH WATER TEMPERATURE relay contacts transfer so that the pilot light remains on and provide remote indication, TB1-42–44. Sequence the CONTROL SWITCH to the OFF/RESET position to reset the high water temperature alarm.

Note

Fire pump engines are not shutdown because of low oil pressure or high water temperature. The Controller only shuts down the engine due to low oil pressure or high water temperature when in the TEST mode.

Overspeed

Closure of the engine overspeed switch applies battery voltage to TB1-3 and energizes the 9R OVERSPEED relay. The 9R contacts (5,8) transfer to latch the 9R relay. The 9R relay contacts (4,7) close to turn on the ENGINE OVERSPEED pilot light and energize the 1R TROUBLE relay. The cause of an overspeed condition should be determined and corrective action taken before restarting the engine. Reset the engine as required and then reset the Controller by turning the CONTROL SWITCH to the OFF/RESET position.

Weekly Test

Closure of the weekly Test Timer contacts energizes the 7R TEST START relay and inputs a TEST signal to the Electronic Control Unit. The 7R TEST START contacts (6,9) close to energize the water dump solenoid valve. Opening this valve creates a pressure drop allowing the pressure switch contacts to close. Starting and control is identical to the water pressure start previously described. The normally closed 4R FUEL and WATER relay contacts (2,8) transfer when cranking begins to de-

energize the 7R TEST START relay which de-energizes the solenoid valve. The valve also de-energizes for any trouble signal by the transfer of 1R TROUBLE relay contacts (1,7).

Optional Remote Start

Opening external normally closed contacts, connected to TB1–17 and TB1-5 (battery ground), inputs a signal to the Electronic Control Unit. Starting and control is identical to that of a Water Pressure Start.

Optional AC Power Failure Start

The Electronic Control Unit detects a loss of AC power and energizes the 14R AC LOSS relay after a 5 to 100 second time delay. The energized 14R AC LOSS relay provides the following contact output: TB1-39, -40 closed; and TB1-39, -41 open. Starting and control is identical to the Water Pressure Start. The alarm resets after AC power is restored.

Control Switch—TEST Position

Turning the CONTROL SWITCH to the TEST position energizes the 7R TEST START relay. The TEST input enables the Electronic Control Unit and the 7R relay contacts (6,9) close to energize the solenoid valve. Opening this valve creates a pressure drop allowing the pressure switch contacts to close. Starting and control is identical to the water pressure start previously described. The normally closed 4R FUEL and WATER relay contacts (2,8) transfer when cranking begins to de-energize the solenoid valve. The valve also de-energizes for any trouble signal by the transfer of the 1R TROUBLE relay contacts (1,7). Turn the CONTROL SWITCH to the OFF/RESET position to reset the Controller before turning back to the AUTO position.

Note

When in Test mode, by turning the CONTROL SWITCH to the TEST position or by closure of the weekly Test Timer contacts, the AUTO STOP feature and STOP input from the STOP button does not shutdown the engine. The alarm circuits are operational when in the Test mode.

Stopping

The standard engine Controller is wired to manually stop the engine. If the CONTROL SWITCH is set for AUTO, turn the CONTROL SWITCH to OFF/RESET or press the STOP button, to shutdown the engine. The STOP button only stops the engine if no other starting signals are active. Closure of the STOP button contacts resets the Electronic Control Unit to de-energizes the 4R FUEL and WATER relay. The 4R contacts (4,7) open to de-energize the Fuel and Water Solenoid to shutdown the engine.

Engine Charging Circuits

When the engine is running, charging current is applied to TB1-7 of the Relay Motherboard. The 17R latching relay contacts (6,9 and 3,9) complete the charging circuit to either Battery No. 1 or Battery No. 2 depending upon which pilot contactor is energized. When pilot contactor No. 1 is energized, the latching coil of 17R is energized to connect Battery No. 1 to TB1-7. The 17R contacts (6,9) are held closed until the 17R relay is unlatched. When pilot contactor No. 2 is energized, the unlatching coil of

17R is energized transferring the contacts (3,9) to connect Battery No. 2 to TB1-7. These contacts are held closed until the 17R relay is latched again. Therefore, after the engine starts, the last pilot contactor energized determines the charging current path.

Options

Automatic Stop

The Controller automatically stops the engine after a selectable time delay of 15 or 30 minutes. Timing begins after all starting signals are activated. This feature of the Electronic Control Unit shuts down the engine by de-energizing the 4R FUEL and WATER relay. For Caterpillar engines, battery voltage applied to TB1-12 through the 51R TEST/AUTO RELAY contacts (4,7), energizes the Rack Shutdown Solenoid on the engine.

Sequential or Time Delay Start

When the pressure switch contacts close, the adjustable (0—30 seconds) solid state 15R SEQUENCE START relay begins timing. After the set delay interval, the 15R contacts (3,1) close to initiate engine starting. Starting and control is identical to the water pressure start previously described.

Lockout

This option is available only if the jurisdiction having authority allows the use of a lockout.

Closure of remote contacts connected to TB1-16 inputs a signal to the Electronic Control Unit. The input disables the Electronic Control Unit to prevent an automatic engine start.

Remote Pump House Trouble Indication

When a monitored pump house problem occurs, the external sensor contacts for that condition (TB2) close to energize a control relay for that condition. The control relay turns on a specific indicating pilot light and energizes the 18R PUMP HOUSE relay. The 18R PUMP HOUSE relay provides the following contact output: TB1-45, -46 closed; and TB1-45, -47 open. The 18R contacts (4,7) transfer to sound the audible alarm through the SILENCE ALARM switch. The SILENCE ALARM switch cuts off the alarm without turning off the indicator lights.

The SILENCE ALARM switch does not silence the Controller alarm due to any other sense indications—only the alarms in the pump house. Always switch the SILENCE ALARM switch back to NORMAL after correcting a pump house alarm problem. The audible alarm sounds again if the Switch is left in the SILENT position when the 18R PUMP HOUSE relay de-energizes.

Controller Testing

The following procedure provides a method for on-site testing of the Fire Pump Controller after installation. This procedure may also be used as part of a maintenance program to isolate problems when troubleshooting.

WARNING: Ensure that the CONTROL SWITCH is turned to the AUTO position after completing test(s).

Initial Conditions

- CONTROL SWITCH is set to OFF/RESET position
- Close circuit breakers CB1 and CB2

Check the Test Timer to make sure that the Timer contacts are not about to close. Closure of the Timer contacts during testing causes incorrect results.

Manual Start

a. Turn the CONTROL SWITCH to the MANUAL START position.

b. Turn the MANUAL START switch to the 1 or 2 position. Release as soon as the engine starts.

c. Turn the CONTROL SWITCH to the OFF/RESET position to stop the engine.

Automatic Engine Cranking in TEST

a. Disconnect the starter motor cable to prevent starting.

b. Turn the CONTROL SWITCH to the TEST position. The solenoid valve opens to discharge water, and the pressure switch contacts close to initiate cranking. When the engine starts to crank the valve closes to limit water spillage.

c. The Electronic Control Unit energizes 5R or 6R for 15 second intervals followed by 15 second rest periods with Battery No. 1 and then with Battery No. 2. After six cranking intervals, three per battery, cranking should cease, the FAILURE TO START pilot light comes on, the alarm sounds, and the remote 1R TROUBLE relay contacts transfer.

d. Turn the CONTROL SWITCH to the OFF/RESET position.

e. Reconnect the starter motor cable.

Automatic Pressure Start

a. Turn the CONTROL SWITCH to the AUTO position.

b. Open a drain valve in the water system to decrease system water pressure.

c. **Close** the drain valve when the engine begins to crank.

d. The engine should start and run until the STOP button is pressed, the CONTROL SWITCH is turned to the OFF/RESET position, or the optional Automatic Stop Timer, typically set for 15 or 30 minutes, stops the engine.

Weekly Test Timer Start

a. Turn the CONTROL SWITCH to the AUTO position.

b. Set and program the Test Timer. Refer to Appendix A for instructions on how to set and program the Timer.

c. The solenoid valve opens to decrease water pressure until the pressure switch contacts close to initiate cranking.

d. The engine should start and run for the programmed time.

e. Reprogram the Timer for desired weekly test run.

Battery Failure Test

a. Turn the CONTROL SWITCH to the AUTO position.

b. Open circuit breaker CB1.

c. BATTERY NO.1 FAILURE light should come on. The alarm sounds and the remote 1R TROUBLE relay contacts transfer.

d. Perform Automatic Pressure Start test.

e. Engine should crank from Battery No. 2 only.

f. Close CB1 and reset alarms by turning the CONTROL SWITCH from AUTO to OFF/RESET.

g. Repeat steps a. through f. for Battery No. 2 by opening CB2.

Low Oil Pressure Test

a. Turn the CONTROL SWITCH to the TEST position to start the engine.

b. Verify that the 3R OIL PRESSURE TD relay energizes after 15 seconds.

c. Momentarily connect TB1-4 to TB1-11 on the Relay Motherboard with a jumper.

d. Verify that the alarm sounds and the remote Trouble contacts transfer when the jumper is connected.

e. Verify that the LOW OIL PRESSURE pilot light comes on and remains on while the 4R Water and Fuel Solenoid relay de-energizes and the engine stops running.

f. Turn the CONTROL SWITCH to the OFF/RESET position to reset the Controller.

High Water Temperature Test

a. Turn the CONTROL SWITCH to the TEST position to start the engine.

b. Momentarily connect TB1-5 to TB1-11 on the Relay Motherboard with a jumper.

c. Verify that the alarm sounds and the remote Trouble contacts transfer when the jumper is connected.

d. Verify that the HIGH WATER TEMPERATURE pilot light comes on and remains on while the 4R Water and Fuel Solenoid relay de-energizes and the engine stops running.

e. Turn the CONTROL SWITCH to the OFF/RESET position to reset the Controller.

Overspeed Test

a. Turn the CONTROL SWITCH to the AUTO position.

b. Open a drain valve in the water system to decrease system water pressure.

c. **Close** the drain valve when the engine begins to crank.

d. Momentarily connect TB1-3 to TB1-11 with a jumper.

e. The engine should stop running. The OVERSPEED pilot light comes on, the alarm sounds, and the remote Trouble contacts transfer.

f. Reset the engine overspeed switch.

g. Turn the CONTROL SWITCH from AUTO to OFF/RESET to reset the Controller.

Optional Remote Test

a. Turn the CONTROL SWITCH to the AUTO position.

b. Open the remote start contacts.

c. Wait for engine to start and run.

d. Turn the CONTROL SWITCH to the OFF/RESET position to stop engine.

e. Close the remote start contacts.

Optional AC Power Failure Start

a. Turn the CONTROL SWITCH to the AUTO position.

b. Disconnect the AC power supply to the Controller.

c. After a time delay of 5 to 100 seconds (set on the EM1 board), the engine starts. The alarm sounds, AC POWER LOSS pilot light comes on, and both the remote 1R TROUBLE and 14R AC LOSS contacts transfer.

d. Reconnecting the AC power resets the alarms.

e. Turn the CONTROL SWITCH to the OFF/RESET position to stop the engine.

Troubleshooting

⚠ DANGER

Hazardous voltage
will shock, burn,
or cause death.
Do not touch
until ALL power
is disconnected.

WARNING: Disconnect AC power source to the Controller before servicing to prevent shock or accident hazard.

Before troubleshooting, perform the following checks:

a. visual inspection for physical damage.

b. ensure that all switches are in the normal operating position.

c. ensure that the engine controls are set for operation.

d. ensure that all wiring connections are secure.

e. always check Control panel wiring and relays before assuming the Electronic Control Unit is the cause of a fault.

f. review the information in the Electronic Control Unit section, beginning on page 6, for proper operation to help determine if the EM1 or EM2 board is faulty.

Note

Change the AA battery in the pressure recorder every six months to ensure the recorder is always operational.

Table 6-1 Troubleshooting

Condition	Possible cause	Checks	Action
Engine does not crank with MANUAL START	Batteries	Voltmeters should read at least 12.5 or 25 VDC Check each battery in bank for correct voltage	Check electrolyte Test and recharge bad battery(s) Replace battery(s) with good battery(s)
	Battery circuits	CB1 and CB2 in ON position	Set breaker(s)
		Check battery and ground connections (TB1-6, -8, -9, -10, -11) Check battery voltage at TB1-6, -11 and TB1-8, -11 Check battery cables and connections	Clean and tighten connections as necessary
		Check engine starter cables and connections TB1-9, -10	Clean and tighten connections as necessary
Engine does not crank using MANUAL START - Battery No. 1	CB1, CONTROL SWITCH, or MANUAL START switch	Check battery voltage at TB1-9, -11 while holding MANUAL START switch	Refer to schematic Use volt/ohm meter to determine which component is faulty
Engine does not crank using MANUAL START - Battery No. 2	CB2, CONTROL SWITCH, or MANUAL START switch	Check battery voltage at TB1-10, -11 while holding MANUAL START button	Refer to schematic Use volt/ohm meter to determine which component is faulty
If voltage checks indicate batteries and circuits OK then the engine starter or the pilot (or starting) contactors are faulty. Also check relay 17R.			

Table 6-1 Troubleshooting (Continued)

Condition	Possible cause	Checks	Action
Engine cranks but does not start	Water and fuel solenoid circuits	Check battery voltage at TB1-1, -11	Clean and tighten connections
		Check relay 4R	Replace relay Replace EM2
	Water and fuel solenoid valves	Check solenoids Check fuel and water lines	Replace solenoid(s) or valve(s)
		Check engine, fuel, fuel filter	Complete necessary engine repairs
Engine continues to crank after starting CONTROL SWITCH set to AUTO or TEST	Relay or EM2 faulty	Check for voltage at TB1-2, -11	
		If no voltage, Check engine electrical circuits	Repair circuits
		If voltage OK, check 5R, 6R, 8R, circuits	Replace relay(s)
			Replace EM2
Engine does not crank in TEST or AUTO	Relay, or EM2 faulty		
Engine cranks with MANUAL START switch Water and fuel solenoids energized		21R or 22R not energized	Repair circuits
		Verify 5R / 6R and 7R energize	Replace relay(s)
			Replace EM2
Engine does not crank in AUTO when water pressure decreases	Pressure Switch faulty	Observe movement of mercury tube in Pressure Switch when pressure decreases	Replace Pressure Switch
Cranks with MANUAL START switch	Pressure Switch circuit faulty	Press P/S TEST button	If cranking cycle begins check wiring

Table 6-1 Troubleshooting (Continued)

Condition	Possible cause	Checks	Action
(continued)	CONTROL SWITCH, relay or EM2 faulty	Check 5R, 6R, CONTROL SWITCH, 12R, 15R (if used)	Replace relay(s) or CONTROL SWITCH Replace EM2
Engine stops without having to press STOP button or before run time is complete	Water and Fuel solenoid circuits and valves EM2 faulty	Check battery voltage at TB1-1, -11 Check relay 4R	Clean and tighten connections Replace relay Replace EM2
Engine does not start in TEST Starts after pressure drop	Relay or CONTROL SWITCH No AC power or solenoid drain valve faulty	Check 7R and 4R, Check CONTROL SWITCH Check for 120 VAC at TB1-13, -14 and CN19-1, -3 Check solenoid valve	Replace relay(s) or CONTROL SWITCH Trace for loss of AC power and reconnect Replace valve
Test Timer does not start engine CONTROL SWITCH in AUTO Engine starts in TEST	Faulty Timer	Check Timer program Check for 120 VAC at CN23	Set time, date, program test time Replace Timer
Alarm does not sound, Associated light not on	Bulb burnt out Relay faulty Alarm faulty EM2 faulty	Check associated bulb and relay Check alarm	Replace bulb Replace relay Replace alarm Replace EM2
No BATTERY FAILURE indication Engine cranks	Relay 10R or 11R EM1 faulty Battery Sense Assembly faulty	Check associated bulb and relay Check Battery Sense Assembly	Replace relay Replace EM1 Replace Battery Sense Assembly
No LOW OIL PRESSURE indication	Relay 3R or 22R Oil pressure switch	Connect a jumper across the oil pressure switch on the engine Start engine with MANUAL START switch Verify that engine starts and alarm sounds after 15 seconds	Replace 3R or 22R Replace oil pressure switch

Table 6-1 Troubleshooting (Continued)

Condition	Possible cause	Checks	Action
No HIGH ENGINE TEMP indication	Relay 1R or 21R Water temperature switch	Connect a jumper across the water temperature switch on the engine Start engine with MANUAL START switch Verify that engine starts and alarm sounds after 15 seconds	Replace 1R or 21R Replace water temperature switch
Engine overspeed does not stop engine	Overspeed switch	Verify that engine stops by connecting jumper to simulate overspeed (refer to engine electrical wiring)	Adjust or replace over-speed switch
No indication	Relay 9R	Check indication circuits	Replace 9R
Indication but engine does not stop under overspeed simulation	Relay 9R or EM2		Replace EM2
Cranking and rest periods greater than or less than 15 ±2 s			Replace EM2
Engine cranks less than six times	EM2 or relay faulty		
Engine continues to crank in AUTO position but does not start		Check 5R and 6R	Replace relay
Engine continues to crank in TEST position but not in AUTO	CONTROL SWITCH or relay faulty	Check relay 7R Check CONTROL SWITCH	Replace 7R Replace CONTROL SWITCH
Controller does not crank engine with good battery	Circuits	Check wiring	Replace EM1
	EM1 or EM2 faulty	Check status of LED's on EM2	Replace EM2
Engine cranking and indication OK			

Table 6-1 Troubleshooting (Continued)

Condition	Possible cause	Checks	Action
Engine does not crank with Remote Start Cranks when water pressure decreases	Remote switch faulty	Check switch and switch circuits	Repair circuits Replace switch
Engine does not start after AC power loss	Relay, EM1, or EM2 faulty Shunt on J4	Check relay 14R Ensure shunt is on pins 2 and 3 of J4	Replace 14R Replace EM1 Replace EM2
Engine does not stop with optional AUTO STOP	Relay or EM2 faulty	Check relay 4R	Replace 4R Replace EM2

Note

If the troubleshooting aids do not help in resolving a problem, the Relay Motherboard may be faulty. Consult the factory or a local Hubbell representative for further assistance.

Spare Parts

The following lists contain part numbers for identification and for ordering. Contact the local Hubbell representative to request additional information or parts.

Spares	Symbol	Description	Part No.	
			12 V	24 V
2	1R	Trouble Relay	402021520 or 31658103*	402022220 or 31658104*
	2R	Fail To Start Relay		
	3R	Oil Pressure Time Delay Relay		
	4R	Fuel and Water Solenoid Relay		
	5R	Crank 1 Relay		
	6R	Crank 2 Relay		
	7R	Test Start Relay		
	8R	Engine Run Relay		
	9R	Overspeed Relay		
	10R	Battery No. 1 Failure Relay		
	11R	Battery No. 2 Failure Relay		
	14R	AC Power Loss Relay, optional		
	18R	Pump House Alarm Relay, optional		
	21R	High Water Temperature Relay		
	22R	Low Oil Pressure Relay		
1	15R	Sequence Start Relay, optional	402023620	402023820
1	17R	Engine Charge Circuit Relay	31658076	402022420
1	EM1	Electronic Module	49204101	49204102
1	EM2	Electronic Module	49205101	
		Relay Motherboard w/ relays	49267-101	49267-102
			49267-103*	49267-104*

* Relays with gold flash contacts.

Spares	Symbol	Description	Part No.	
			12 V	24 V
		LX-750 Battery Charger Negative ground Positive ground	 49175101 49175102	 49175201 49175202
	HORN	Alarm	402059420	
	PS	Pressure Switch (0–300 psi)	57501023	
		Pressure Recorder	57501013	
2	PL1 to PL15	Lens, green Lens, red	402066720 402067520	
2		Mini Lamp Socket	402066520	
10		Pilot Lamp (bulb)	402021820	402022520
	CS	Control Switch	57508017	
		Rectifier, Control Switch	47283026	
1	Test Timer	Test Timer (50 or 60 Hz)	31658139	
2	CB	Circuit Breaker	57504540	
	SV	Drain Valve Solenoid	57493001	
		Manual Start switch	80321311	
		Stop push button	402161520	
	SAS	Silence Alarm Switch, optional	402024620	
		Space Heater, optional	402025620	
		Heater Switch, optional	302006920	
		Control Transformer, optional	Consult factory	

Notes

Consult the factory for other optional parts such as stainless steel pressure recorders or pressure switches.

For foreign applications, double the number of recommended spares.

Specify the Serial Number of the Controller when ordering parts.

Refer to Bulletin 1000 for information on one-year parts and labor warranty.

Appendix A Electronic Test Timer

Set the time

1) Press the **Res.** (reset) button to clear the memory
2) Press and hold the 🕒 (time/run mode) button while setting the time
   a) Press the **h** button to set the hours
   b) Press the **m** button to set the minutes
   c) Repeatedly press the **Day** button to select the day of the week (1—7, Monday–Sunday)
3) When set correctly, the colon between the hours and minutes flashes
4) To reset for daylight savings time
   a) Press the **±1h** button one time in the spring to advance the time one hour
   b) Press **±1h** one time in the fall to set the time back one hour

Notes

The time and the day of the week must be set before programming the Timer.
The Timer has sufficient back up power to maintain the time and program settings for up to four days.

Programming

1) To set the Timer to start the engine once a week and run for thirty minutes, Friday at 9:00 a.m.
   a) Press the **Prog.** (program) button to display the day of the week and time setting for the program
   b) Press the  (ON/OFF) button once to display the ON (open circle) symbol
   c) Press **h** to set the hours until 09 AM is displayed
   d) Press **m** to set the minutes until 00 is displayed
   e) Press **Day** eight times to select 5 (Friday) as the day of the week to run
      (Press the button four times to select Monday or up to 10 times to select Sunday.)
   f) Press **Prog.** button
   g) Press  twice to display the OFF (open circle with dot) symbol
   h) Repeat steps c), d), and e) to set 9:30 a.m., Friday
   i) Press **Prog.** button
   j) Press the 🕒 (time/run mode) button
2) To review the programming
   a) Press **Prog.** once to see the engine start time

b) Press **Prog.** a second time to see the engine stop time.

c) Press **Prog.** a third time to see the number of additional start and stop times can be input **Fr18**

3) To manually override the Timer press the  button

a) Pressing  once transfers the Timer contacts—output ON (starts the engine) Automatic control resumes after the next programmed event—temporary override

b) Press  twice consecutively turns the output ON—permanent override

c) Press  three times consecutively to turn the output OFF—permanent override

d) Press  until the 🕒 symbol appears to end the override—return to run mode

4) To delete a program

a) Press **Prog.** to display the program to delete

b) Press **m** until the display is blank

c) Press **h** until the display is blank

d) Press 🕒 to return to run mode

Appendix B Pressure Recorder

Set up

Before using, verify that an “AA” battery and chart paper are installed. Set the time using a coin or screwdriver to turn the chart hub clockwise to the time index clip. The index clip is on the right side of the chart. Remove the pen tip cover. The recorder is now ready to be pressurized.

Pen replacement

The pen should last for one year of service. Slide the used pen cartridge off the pen arm. Slide on new cartridge and remove tip cover.

Battery replacement

The battery should be replaced every six months. The battery compartment is in the lower right section of the dial plate. Record the date of replacement.

Pen setting

Periodically check the pressure indicated by the pen with the system water pressure gage. If necessary, adjust the pen with the adjusting screw in the upper left corner of the dial plate. The recorder accuracy is 2% of scale.

Appendix C LX-750 Battery Charger

Introduction

The Hubbell LX-750 series of Automatic Battery Chargers consist of battery chargers, a LOBC (Loss of Battery Charger) module, and a timer mounted on a panel. The terminal connections for 120 VAC power input, batteries, and Charger Failure output are located along the bottom of the panel. Underwriters Laboratory and Factory Mutual approve the LX-750 for use in the Hubbell LX-2000 Diesel Fire Pump Controller cabinets. The four models are 12 and 24 VDC with negative or positive ground.

49175-101	12 VDC, 10 A, negative ground
49175-102	12 VDC, 10 A, positive ground
49175-201	24 VDC, 10 A, negative ground
49175-202	24 VDC, 10 A, positive ground

The LX-750 maintains the charge of 12 V (24 V) lead acid batteries used to start fire pump diesel engines. To maximize battery life, the batteries are charged in a three-step charging cycle. Charger control circuitry checks for high operating temperature and correct battery voltage. Fuse protection and isolating transformers protect the charger circuitry and the batteries. The LED arrays indicate battery status and charging current.

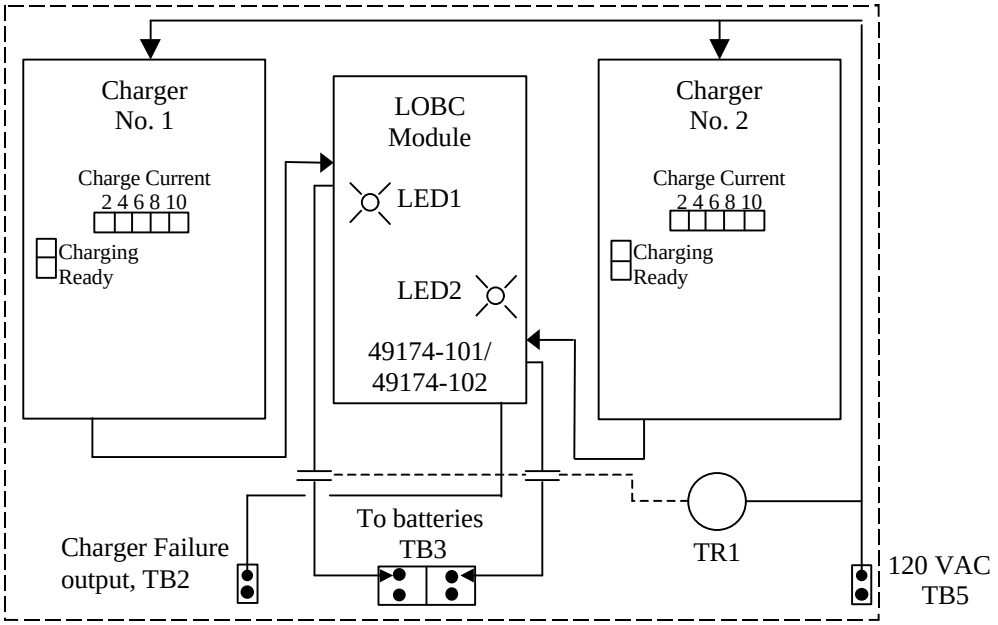

Figure C-1
Block diagram
of LX-750

The LOBC module monitors the charging current and voltage of both chargers. A Charger Failure relay de-energizes (contacts close) if a fault occurs. The two green LED's indicate that the chargers are supplying current output.

The delay timer, TR1, ensures that the chargers are connected to AC power before the batteries are connected.

Specifications

Charger	12 VDC, 10 A max.
Voltage output	
Charging	14.8 VDC
Float	13.9 VDC
Battery Capacity	25 to 200 Ah
LED Indication	
READY, green	On indicates float condition
CHARGING, yellow	On indicates charge in progress
CHARGE CURRENT, green	Charging current greater than or equal to current indicated
LOBC #1 and #2, green	On indicates charging greater than 50 mA, Off indicates not charging or charging less than 16 mA
Power supply	90 to 130 VAC
Operating temperature	32° F to 95° F (0° C to 35° C)
Charger Failure relay	120 VAC/30 VDC, Form C contacts
Timer	Make on-delay, set for 10 seconds at factory
Approvals	Underwriters Laboratories, Factory Mutual for Diesel Fire Pumps Meets NEMA, NFPA 20, and UL1236 standards

Installation

The battery and AC power connections are made inside the LX-2000 cabinet. The terminals, TB1, are located at the bottom of the Relay Motherboard.

Operation—12 V (24 V) Chargers

Applying AC power starts the make on-delay timer relay, TR1, set for 10 seconds. This allows the charger functions to start before contacts close to connect the batteries.

The first step of the charging cycle charges the batteries at 10 A until the battery voltage reaches 14.8 V (29.6 V). This corresponds to approximately 75% of the final charge of the battery. During the second step, the charging voltage remains constant at 14.8 V (29.6) while the charging current tapers down to approximately 1 A (1.5 A). (When the amperage drops below 2 A the Charging and LOBC LED's remain on.) The cycle continues to the third step if the amperage goes below 1 A (1.5 A) or the batteries have been charging for 5 hours (6 hours) in the second step. At this point, the batteries are

fully charged. The third step or float charge maintains the charge at 13.5 V (27 V) until the cycle starts again.

The chargers begin the three-step charging cycle…

- when AC power is cut off for 30 to 60 seconds
- 21 days after the last charging cycle
- when the battery voltage drops below 12.5 V (25.0 V) for more than 15 minutes

Any time the battery voltage drops below 10 V (20 V) or the internal temperature of the charger reaches 158° F (70° C) the charger stops the charging cycle. Charging resumes when these conditions are at safe levels.

The LOBC Charger Failure relay energizes for normal charging of the batteries. The relay de-energizes upon loss of AC power or charger failure.

Troubleshooting

WARNING: Lead acid batteries generate explosive gases during normal operation.

Precautions: Do not work alone.
Wear eye protection and protective clothing.
Have soap and water available in case of skin contact with acid.
If acid enters eye, immediately flush eyes with cold running water for ten minutes and get medical attention.

If problems develop, check all connections and clean the battery terminal connections. Use the LED indicators on the chargers and the LOBC as an aid to determine the cause of any potential problems. Return faulty chargers to the factory.

CAUTION: Always disconnect the AC power source before disconnecting the batteries when performing maintenance.

Troubleshooting Chart

Symptom	Possible cause	Solution
All charger LED's off, cabinet CHARGER FAILURE pilot light on	1) No AC power 2) Charger AC fuse blown	1) Check for 120 VAC at TB5-2 and –3 2) Hubbell recommends that the charger be returned for repair
Charge Current LED's scroll,* cabinet CHARGER FAILURE pilot light on	1) Battery connections reversed, 2) Charger DC fuse blown	1) Check battery connections 2) Hubbell recommends that the charger be returned for repair

* The charger LED's scroll in order as follows: Charge Current LED's 10 A to 2 A, Charging, Ready.

Troubleshooting Chart (Continued)

Symptom	Possible cause	Solution
Charging LED blinking, LOBC LED's off	Battery voltage high due to Engine charging circuit supplying charging voltage above control charger value.	Troubleshoot engine charging circuit
10 A Charge Current LED flashing	Charger stopped charging due to high temperature	Allow charger time to cool Improve ventilation in area
Ready LED does not come on, Batteries do not charge fully	1) Battery capacity too high 2) Excessive load on batteries 3) Short to ground 4) Battery terminals corroded 5) Battery has faulty cell	1) Check battery rating, must be less than 200 Ah 2) Verify load is normal 3) Clear the short 4) Clean battery terminals 5) Check battery/Replace

Spare Parts and Drawing References

Contact the local Hubbell representative to request additional information, parts, or drawings.

Spare Parts

Description	Part No.	Description	Part No.
Battery Charger 12 V	49175-031	Loss Of Battery Charger Board, 12 V	49174-101
Relay Timer, On-Delay	31658-111	Loss Of Battery Charger Board, 24 V	49174-102

Drawings

Drawing No.	Title	Drawing No.	Title
49175-100	12 Volt Battery Charger System Assembly	49174-501	Schematic Loss Of Battery Charger Board
49175-200	24 Volt Battery Charger System Assembly	49175-501	Schematic Diagram for Battery Charger Panel