

Author: Jacob Peters	Hapeman Electronics 761 N. Cottage Road Mercer, PA 16137	Locomotive Battery Conditioner Model HE96000 User Manual
Approved By: Bryan Hapeman		
For:		Date: 05/08/2019

Locomotive Battery Conditioner

Version 2

PN: HE96000

User Manual

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Purpose:

The purpose of this document is to explain the process required to safely use and maintain the Hapeman Electronics Locomotive Battery Conditioner.

Disclaimer: Hapeman Electronics is not responsible for injuries or damages resulting from the improper or untrained use of this device. Please abide by all safety recommendations, rules, and regulations regarding this product while it is in operation.

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WARNING:

Hazardous power present.

- 230VAC at 30A OR 480VAC at 20A supplies the cabinet
- 36VDC at 100A output from the charger

Any battery connected to the conditioner adds 36VDC at potentially lethal currents. If possible, disconnect all batteries before opening the door to the battery conditioner. Otherwise, power from connected batteries will be exposed within the battery conditioner EVEN WHEN THE MAIN POWER IS OFF.

Make sure to connect all battery leads to the inside of the cabinet before connecting them to the batteries.

All four battery returns are tied together on an internal bus. Take care when connecting batteries as to not accidentally create a short.

Do not operate when any of the sides of the resistive load are removed. It becomes hot during use and may cause potentially serious burns upon touch.

WARNING: Lead-acid batteries can emit dangerous fumes when being charged. It is recommended that these batteries be stored outside while charging.

Patch Notes for Version 1.3.1:

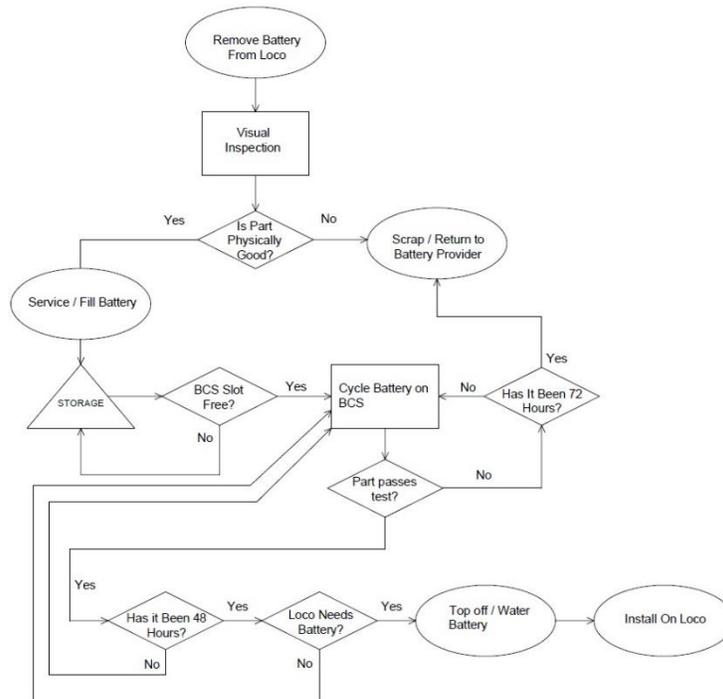
- Added a pre-charge state that turns on the pre-charge relay and lets a battery trickle charge for a set period of time. Only adds the pre-charge state if the battery is below a threshold voltage or if it fails to draw sufficient current during a normal charge sequence.
- Fixed the battery statuses to not change on update when there is a “NO BATTERY,” “PC LIMIT,” or “ADDING PC” condition until that battery is either restarted or removed.
- Added pre-charge current to display in the charger section of the main screen.
- Added the voltage divider selection during reset of calibration constants as well as in the admin settings.
- Added pre-charge record keeping to the charge history screens in battery analysis.
- Added legends to charge and load test history screens.
- Fixed the bug that used regular charge time for the desulfation steps.
- Added auto retry when a charge sequence quits early.
- Changed status wording from “NO BATTERY” to “NO/BAD BATT”
- Fixed bug that would cause the load test fuse error to happen when a bad battery is load tested.
- Added a screen to inform the user if a load test is being forced while another load test is running.
- Modified the battery slot color fills on the home screen.
 - a. Solid red – estop button pressed
 - b. Red gradient – No/Bad Battery or Pre-charge limit hit
- New editable system parameters with defaults.

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- 5K divider setting
- Pre-charge voltage threshold
- Pre-charge time length
- Charger off determination threshold
- Charger retry count limit
- Pre-charge retry count limit
- Minimum volts threshold for fuse error detection
- Charge current rolling average length
- Low current threshold for fuse error detection
- Minimum current for charging determination
- No Battery / Add PC timeout during charge

Process Overview:

The Hapeman Electronics battery conditioning system (BCS) is a great utility for recovering batteries that have pulled from a Locomotive due to failure. To get the best possible recovery rate from the BCS, the proper battery handling process must be followed. The recommended process for maximum recovery is outlined below.



Battery Processing Flow Chart

1. Remove the battery from the locomotive. If a battery not pulled from a locomotive is to be processed omit this step.
2. Inspect the battery for any obvious defects. If a battery looks like it has been damaged in anyway DO NOT hook it to the battery conditioner. Examples of damage include bent/broken

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connections, damaged fill caps, smashed / cracked casing, etc. Physically damaged batteries should be scrapped or returned to the manufacturer for service.

3. If the battery is physically good it must then be serviced using the manufacturer recommended service routine which typically consists of inspection, cleaning, and filling of the battery with water. Generally, batteries should be filled only to the point where the plates in all cells are covered.

Hapeman Electronics is not responsible for the process by which batteries are serviced prior to conditioning.

4. Place the battery in storage to await conditioning.
5. When a slot is free in the battery conditioner place the battery on the conditioner and begin cycling. Information on how to do this is presented in later sections of this document.
6. When a locomotive is ready to have a battery installed, select a battery attached to the battery conditioner that has passed its load test.
7. Top off the batteries with water before placing them on the locomotive.
8. If a battery has been connected to the conditioner for more than 72 hours and still has not passed load testing then it may be scrapped or returned to the manufacturer.

Assembly/Setup:

Upon arrival, the Hapeman Electronics Battery Conditioner will need to be partially assembled prior to use. This assembly consists of attaching the resistive load, punching a hole or holes for battery cables, attaching the battery cables, and hooking up cabinet power. It is recommended that any cable entries into the cabinet be equipped with grommets or liquid-tite style cable clamps in order to help protect against the weather.

Cabinet Placement:

1. Outdoor Placement: The cabinet may be permanently installed outside, however, it is recommended that it be placed under an awning or in some other style of partial cover/enclosure. This is specifically for added protection from harsher weather (heavy rain / snow) to greater increase the life of the unit.
2. Indoor Placement: The cabinet may also be placed indoors, however, the batteries being attached to it must be outdoors. This would require running the battery cables from the cabinet from the cabinet inside to the batteries outside.

Resistive Load Setup (If necessary):

1. Using an assisted lifting mechanism (crane, fork truck) lift the resistive load by the supplied lifting lugs up to place it on the top of the main cabinet. It should seat so that the two cables exiting the top of the cabinet line up with two of the tabs on the resistive load.
2. Land the resistive load into place using the supplied hardware.
3. Remove the side of the resistive load closest to the connection tabs.
4. Land the load cables to the resistive load using the supplied hardware.
5. Reattach the side of the resistive load.

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Battery Cable Hole Location Possibilities:

1. On the right side of the cabinet about half-way up vertically centered between the row of contactors and the return bus. This would allow battery cables to be brought together right off of their landings and to continue out of the side of the cabinet.
2. On the right side of the cabinet near the bottom. There is room for all 8 cables to run down the center of the cabinet to the bottom and then out of the side. Be wary of the large load contactor when running your cables as to not interfere with its operation.
3. A hole may be punched in the bottom of the cabinet to allow the cables to go straight out of the bottom. This, however, would only be ideal in a situation where the cabinet is above a wire tray or trench.

Battery Cable Attachment:

WARNING: Do not attach cables to the battery conditioner that are already connected to a battery. Doing so is dangerous and may result in harm to the operator or the equipment.

1. Before attaching cables to the battery conditioner, label each in order to designate which battery it is going to and whether it is a positive or return connection.
2. Cables should be 4/0 AWG welding cable with lugs for landing them to the battery conditioner. Recommended lugs are CSWS-250-38-ILSC or equivalent.
3. For each of the 4 batteries, attach the cable to be used as positive to the open hole on the contactor. Connect the cable to be used as negative to the return bus.
4. Run all battery cables out of the cabinet using the whole punched previously to where the batteries are located. Be careful not to lay the cables over any hardware or contactors on the way out of the cabinet.

NOTE: It is recommended that each of the 4 batteries be placed a safe distance apart to reduce the likelihood of shorting out batteries by accidental movement or placement of cables.

230VAC Cabinet Power Hookup:

1. The cabinet takes 230VAC (single-phase) power at 30A.
2. Hook cabinet power from a facility source to the left side of the distribution block located about halfway up the back plane of the cabinet on the left hand side. This may require that a hole be punched in the cabinet for power entry.
3. It is recommended that the 230VAC source be fed from a nearby breaker or disconnect for easy maintenance. It is also recommended that this source be able to be locked out for safety reasons.

480VAC Three-Phase Cabinet Power Hookup:

1. The cabinet takes 480VAC (three-phase) power at 20A.

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2. Hook cabinet power from a facility source to the top of the fused disconnect on the right side of the cabinet. If the cabinet is outside, it is recommended that wire entry on the top of the disconnect be sealed to protect against the weather.
3. This disconnect is capable of being locked out for safety inside of the battery conditioner. If the disconnect itself needs to be worked on please lock out whatever facility power is sourcing it.

Power-Up Preparation:

1. Make sure that all connections are secure including battery cables and input power.
2. Close and lock cabinet door to ensure that it cannot be opened while powered.
3. Press in all 4 red STOP buttons on the door of the battery conditioner.
4. Ensure that all batteries and battery cables are in a safe state.
5. Apply power to the battery conditioner. The LCD screen on the door should turn on.

Battery Connection:

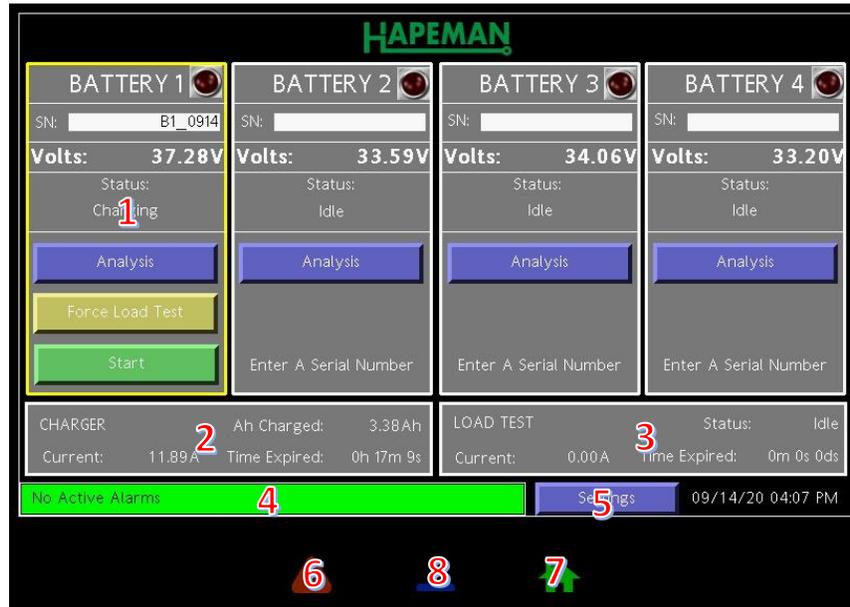
1. Make sure that the STOP button corresponding to the battery being connected is pressed in and locked.
2. Slide the supplied positive battery terminal cover onto the end of the positive cable. Orient it so that the slot in the cover is towards the battery terminal.
3. Connect the positive battery lead coming from the battery conditioner to the positive terminal on the battery.
4. Slide the terminal cover down the cable until it is over the battery terminal. The slot in the cover should fit snugly around the battery terminal.
5. Slide the supplied negative battery terminal cover onto the end of the negative battery cable. Orient it so that the slot in the cover is towards the battery terminal.
6. Connect the negative battery lead to the negative terminal on the battery and slide its terminal cover into place.
7. Use the supplied key to unlock and release the red STOP button corresponding to the battery connected.

Home Screen Navigation:

When the unit is first powered up the LCD screen will turn on and the user will be presented with the home screen. Below is a definition of each item on the screen. All items will be explained in detail further on in this document.

Note: If the screen is left to idle without user input for more than 5 minutes it will begin to scroll through various screens showing battery info and contact information. Press the "Home" button at any time to return to the home screen.

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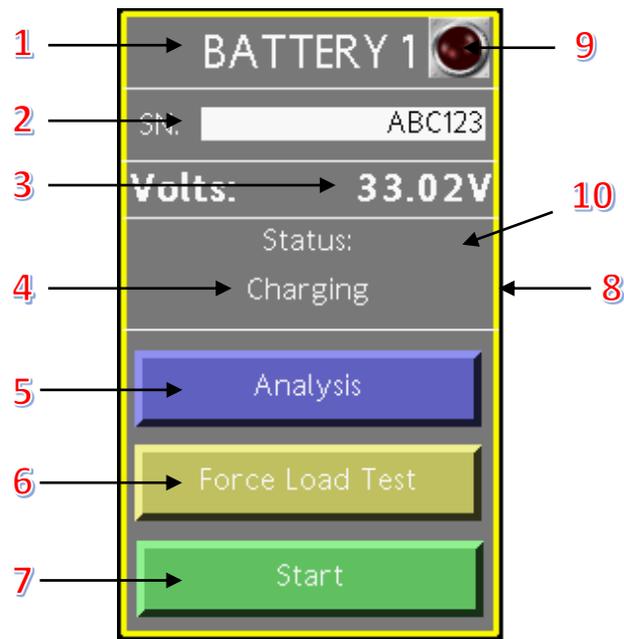


Main Screen Legend

1. Battery Control – Contains information about / control of the battery connected in that position. More info in “Battery Control” section
2. Charger information – Contains info about what the charger is doing, active during charging and desulfation tests, border blinks red when active
3. Load test information – Contains info about what the load tester is doing, active during load test and cooldown, border blinks red when active
4. Alarm indicator box – Displays the most recent active alarm
5. Button to navigate to the settings menu – more info in section “Settings Screen”
6. Button to navigate to the alarms and events page – more info in section “Alarms and Events Screen”
7. Button to navigate to the “Home” screen (referred to in this document as the “Home” button)
8. Button to navigate to the “Circuit Diagnostics” screen.

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Battery Control:



Battery Screen Legend

- Battery Number – The title of the box that shows which battery you are controlling / monitoring. It has the following illumination conditions:
 - White** – The battery has not been load tested on its current cycle
 - Red** – The battery has completed a load test and failed to meet spec
 - Green** – The battery has completed a load test and has passed
- Battery Serial Number – The serial number of the battery being conditioned. Entering a serial number is REQUIRED to start a new battery. If no serial number is present on the battery then use the following format:

MODYYYYMMDDX

MOD – Corresponds to the model number (Either 650 or 500)

YYYYMMDD – Corresponds to the date

X – Corresponds to the number of batteries that day with no serial number (the first would be '1', the second would be '2', etc.)
- Real-time voltage measurement on the battery
- Real-time status of the battery
- The “Analysis” button navigates to a page displaying recent data collected from this battery. More info in the “Analysis Screen” section.
- The “Force Load Test” button will allow the user to force a load test on the connected battery. It will be ignored if a load test is already underway on another battery or if the tester is in a cooldown state from recently performing a load test.
- The “Start” button activates the battery and loads a single charge and load test process into the process queue.

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8. The border around the battery controls has the following illumination conditions:
 - White** – The battery currently has no processes to run in the process queue
 - Yellow** – The battery currently has processes in the process queue or is actively running
9. The indicator light in the top right corner of the battery controls informs the user whether or not a battery is in pre-charge.
10. The background color of the battery controls will change color depending on the state of that battery.
 - Gray** – The battery currently has issues or is cycling
 - Red Gradient** – Either a NO / BAD BATTERY or PC LIMIT condition
 - Solid Red** – The estop button for this battery is pressed



Red gradient showing PC LIMIT (Left) and Solid red showing the estop was pressed (Right)

Activating A Battery and The Process Queue:

To start a battery, enter a serial number into the box corresponding to the location that the battery has hooked into. Once a serial number is entered the “Force Load Test” and “Start” buttons will appear. Press the “Start” button to begin cycling the battery. This will add a charge process and a load test process to the process queue for that battery. If a battery has a voltage lower than the pre-charge threshold then a pre-charge state will be added before the standard charge and load test. See “More on Pre-Charging” for more information.

The process queue is a list of tasks that are waiting to be performed by the battery conditioner. This queue is a first-in first-out system and tasks are performed in the order that they are received. For example, assuming all are above the pre-charge threshold, if we start battery 1, then battery 3, then battery 2 the following will be performed in order...

1. Battery 1 Charge
2. Battery 1 Load Test
3. Battery 3 Charge
4. Battery 3 Load Test
5. Battery 2 Charge

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6. Battery 2 Load test

The only exception to the order of this queue is if a load test is forced on a battery. See “Performing A Manual Load Test” for more information.

Note: Once a serial number is entered the serial number box is locked for quality purposes. The only way to start over and enter a new number is to hit that battery’s stop button and release it.

Single Battery Charging Cycle:

To help describe how the batteries cycle, the following are the specific states that a battery can be in.

Idle – The battery is connected but is not currently being cycled.

Charging – The battery is being charged normally with a 36VDC or greater signal at up to 100A. If the battery voltage is low (under 15-20 volts) the battery conditioner will perform a pre-charge on it to allow the charger to handle a battery with low charge.

Load Test/Cooldown – The battery is going through a load test to verify its integrity and allowing time for the load resistor to cool before continuing.

Desulfation – The battery is currently being charged with an additional high frequency pulse to help repair/improve it. *NOTE: The battery must be at a sufficient voltage to have the special desulfation signal activate. If the battery is not to a sufficient voltage it will simply charge normally.*

Pre-Charge – The battery is being trickle charged to attempt to raise sufficiently low voltage in order for the main charger to be able to do its job.

Good Battery – The battery is deemed to be in proper working order and will crank a locomotive if used immediately.

Bad Battery – The battery is deemed to be not in working order. This does not mean that the battery is defective, only that through a single cycle it did not pass the requirements set by the conditioner. Additional cycles may prove to remedy the battery, or the battery may in fact be defective.

The following is the process in which a battery is cycled the first time.

1. 3 hours* of **Pre-Charge** (if necessary).
2. 5 hours* of **Charging**.
3. **Load Test/Cooldown**. This test is the same that is done using Hapeman Electronics Battery Load Testers. It is comprised of a 5 second setting time, a 15 second load test and a 15 minute cooldown period. If the battery never dips below 26VDC while loading it will be considered a **Good Battery**. If it falls below 26VDC while loading it will be considered a **Bad Battery**.

WARNING: After a load test the resistive load on the top of the battery conditioner will be very HOT. Do not touch. Failure to do so may result in burns or other injury.

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After the first cycle the battery will have been deemed to be good or bad. For each cycle following the first, if a battery remains connected to the system it will perform a **Desulfation** cycle for 5 hours* and then ends its cycle. There are two reasons for this.

1. If the battery was deemed bad after its first cycle, the following desulfation cycles will hopefully improve or even repair the battery.
2. If the battery was deemed good after its first cycle, the following desulfation cycles will improve and /or maintain the battery while it sits connected to the conditioner.

Note: The battery conditioner will perform an additional load test after each desulfation cycle to check for improvement in the health of the battery. This can be turned off in the “Advanced Settings” screen if for some reason additional load tests are not wanted. *NOTE: If the battery is very low it may take multiple cycles to get the battery to pass the load test.*

*Charge and desulfation cycle duration is 5 hours by default. Pre-Charge duration is 3 hours by default. This may be changed using the button sequence found in “Changing The Charge/Desulfation Duration” under “Settings Screen.”

More on Pre-Charging:

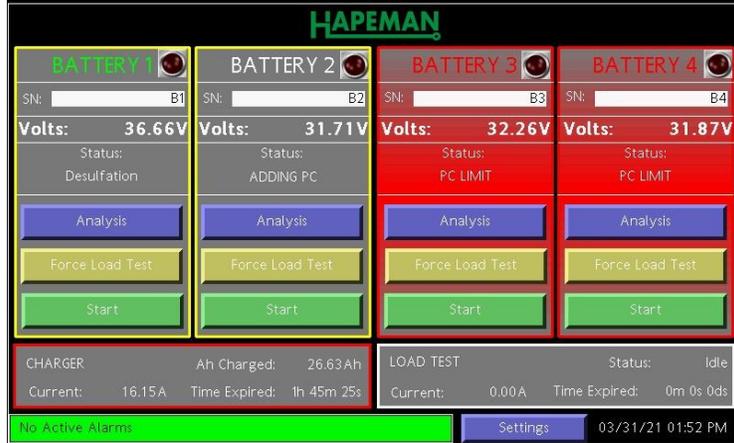
When a battery with a low voltage is connected to the system it is possible that the standard charger may not be able to start. This will often result in the loss of potentially recoverable batteries. To combat this issue, a Pre-Charge system is in place to trickle charge the batteries outside of the main charge cycle to help raise the battery voltage. Once the battery voltage is raised high enough the main charger can often perform its task of fully re-charging the battery.

Pre-Charge (or trickle charge) sequences are added in 3 specific scenarios as listed below:

1. When a has low voltage when it is connected to the unit a Pre-Charge step will be added before the “Charge” and “Load Test” steps when the start button is pressed.
2. If a battery has a high enough voltage to engage the main charger but fails to draw sufficient current, then the standard charge cycle will be aborted, and a Pre-Charge step will be added to help recover the battery enough that it can properly take a charge. This will result in a battery showing the status of “ADDING PC”.
3. If after an other sequence (Pre-Charge, Charge, Load Test, or Desulfation) the battery voltage is still low then an additional Pre-Charge sequence will be added.

Since pre-charging is used on batteries in sufficiently bad shape, a limit is placed on the number of pre-charge cycles that will be added before the system quits attempting to recover the battery. If a battery fails to be recovered, then it will be given the status of “PC LIMIT” and quit cycling. This battery will do nothing until it is either be restarted or removed.

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The main screen showing “PC LIMIT” and “ADDING PC”

Charger Retry:

There are several reasons why the main charger inside of the system might stop a charge cycle before the 5-hour* duration. Generally, this boils down to the charger believing that the system is finished charging due to a combination of sufficiently high voltage and low current draw. However, this can sometimes be pre-mature based on environmental factors or battery health factors that the charger itself cannot detect. For this reason, if the charge sequence quits early the system will attempt a total of 2 retries before moving on to the next battery. This will not reset the system charge sequence timer. For example, if battery 1 quits charging 1 hour into its 5-hour cycle, the system will stay in the battery 1 charging state and restart the charger up to 2 times. If charging continues it will continue from the 1-hour point to continue its cycle. If charging fails to restart, then the system will move on to the next process in the queue. The battery is not failed or flagged in any way because, as mentioned, this can happen if the battery is new, healthy, or fully charged. If a charger retry happens, a counter will display on the screen in the charger section.



Charger retry counter on the main screen

Performing A Manual Load Test:

Sometimes it may be necessary or advantageous to perform a load test on a connected battery without having to go through the standard charge cycle or wait for the other batteries to finish their cycles. This may be done by forcing a manual load test on the desired battery.

To perform a manual load test, press the “Force Load Test” button under the desired battery. A confirmation screen will display. Press “Yes” to continue.

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Performing a manual load test will interrupt any currently active cycles. The currently active cycle will be lost but all subsequent cycles will be restored once the manual load test is completed. For example, a manual load test is performed on battery 1 when battery 2 is currently charging and batteries 3 and 4 are waiting to charge. Battery 2 will stop charging immediately and battery 1 will load test. Upon the completion of the load test to battery 1, battery 3 will begin charging. The interrupted charge cycle on battery 2 will not resume.

Forced load tests will be ignored if another battery is already performing a load test or if the tester is in cooldown from recently running a load test. Once the tester has finished its cooldown cycle it will once again allow for a forced load test.

Removing A Battery:

Whether a battery is good or bad there will come a time when it will need to be disconnected from the battery conditioner. To disconnect the battery, simply do the following.

1. Press in the locking STOP button (physical button below the screen) of the battery that you wish to disconnect. Make sure that it is locked and does not release.
2. Remove the battery leads from the battery being careful not to touch any of the other batteries that are still connected to the system. **DO NOT open the cabinet and remove the battery cables from the battery conditioner.**
3. Inspect the battery fluid levels after removing the battery from the conditioner. Charging will evaporate battery fluid. Batteries left on the conditioner for long periods of time (> 72 hours) may require servicing. If a battery requires enough water, it is recommended that the battery be charged for 1 more cycle to ensure a good charge and fluid mixture.

Placing a Battery in Storage:

While it is not recommended that batteries be placed in storage after being pulled from the battery conditioner, it is sometimes necessary. If a battery / batteries must be stored after cycling the following steps should be followed to ensure the best possible results.

1. Make sure that the battery has cycled for at least 3 charge / load test cycles before removing from the conditioner.
2. Service the battery. If the battery requires more than a small amount of water, reattach it to the conditioner for one more cycle.
3. Place the battery in storage. It is not recommended that batteries be placed in storage for more than 2 weeks before use.
4. When removing a battery from storage, manually check the battery voltage before placing it on a locomotive. If the battery voltage is less than 33 volts, it may need additional conditioning before returning to the field.

Settings Screen:

The setting screen allows for the user to change various settings for the tester. Some of these settings require the use of a user name and password to access.

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Changing the Pre-Charge, Charge, or Desulfation Duration:

By default, the duration of each charge cycle and desulfation cycle are 5 hours to allow all batteries to cycle in a relatively timely manner. Pre-charge cycles are set to 3 hours by default. It is possible that longer times may be necessary for batteries incredibly low on charge. Shorter charge times may also be set but this may result in under-charging weaker batteries. In order to change them simply touch the box containing the desired duration time and enter a new value in minutes. Charge and desulfation times can be set from 5 min to 720 min (12 hours).

Time Display Format:

There are 3 different time display formats that can be selected for the BCS. This will only affect how the time is displayed on the screen of the BCS and not in the data that the it collects. The formatting changes how the unit displays hours, minutes, seconds, and deciseconds (tenths of a second). The measures of time always display in that order. The types of formatting are as follows:

- (H):(M):(S):(DS)
- (H)h (M)m (S)s (DS)ds
- (H),(M),(S),(DS)

Instructions – Tutorials:

From time to time an operator may need to recall some information on how to use the battery conditioner. By pressing this button, the operator can view the basic usage instructions for the unit. If an instruction requires more explanation the operator can select that instruction to go into more detail.

There is also a table of contents button which allows the operator to select from a list of topics rather than read through the step by step usage of the unit.

Resetting Default Values:

Warning: Only to be used in the event of a loss of calibration data or product malfunction. Contact Hapeman for advice before proceeding. Using this feature will replace all factory calibrated values.

If a power surge or some other anomaly that causes the calibration constants to be erased, some portions of the unit will not work as intended. The most notable of this is that all the battery volts will read 0 Volts and there will be no current measured during either the charging cycles or the load test. If the calibration constants are lost, the system will inform the operator. Upon acknowledging this, the system will be reset to default automatically.

There may be other reasons to reset the system to its default settings. An example would be if an operator changed settings accidentally. Resetting the default values for the battery conditioner that will install generic calibration constants that will enable the unit to function within approximately 5% of the calibration originally performed on the unit assuming no major drift or damage. The procedure for resetting the default values is as follows:

1. Press the “Log In” button.
2. Log in using the user name “maint” and the password “hbcmaint”.

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3. Press the “Reset to Defaults” button.
4. A confirmation screen will warn that the calibration values will be overwritten and ask for the voltage divider setup in your system. Click “5K Mod” if your system is equipped with this modification, otherwise click “Not Modified” to continue. *This process cannot be reversed.*
5. Press the “Log Off” button.
6. Press the “Home” button to return to the main screen.

If you do not know whether your system is installed with the 5K modification, then please contact Hapeman for more information. It is also possible to check this using a handheld DMM. Simply select either option when resetting the default values and compare the voltage reading on the screen to the battery voltage you see with the DMM. The two readings should match within 5% or so assuming a properly functioning DMM. If there is an approximate 30% difference, then the wrong option was selected.

Advanced Settings and Re-entering Calibration Constants:

Warning: Editing of calibration constants only to be used in the event of a loss of calibration data or product malfunction. Contact Hapeman for advice before proceeding. Using this feature will replace factory calibrated values.

If calibration constants are lost, or for some other reason the unit is operating using the default constants, the original calibration constants may be re-entered into the unit. To do this the original constants will need to be available. They should be on the calibration report for the battery conditioner which can be provided by Hapeman given the serial number. The procedure for re-entering the calibration constants is as follows:

1. Press the “Log In” button.
2. Log in using the user name “maint” and the password “hbcmaint”.
3. Press the “Advanced Settings” Button.
4. A list of slopes and offsets will appear on the screen. Select each box that needs modified and enter the number that is on the calibration certificate provided by Hapeman. For more direct assistance on finding which values to use from the calibration certificate, contact Hapeman.
5. Once all desired values are entered, press the “Back” button at the bottom right of the window.
6. Press the “Log Off” button.
7. Press the “Home” button to return to the main screen.

There is also a list of “Other” settings in this page that can be used to tweak how the system handles certain aspects of charging and error handling. Below is a description of each setting and what it means.

- Jump Start Voltage – The voltage threshold below which the pre-charge system engages.
- Min Voltage Cnts – The raw analog input count threshold below which the system thinks the battery has an issue or is not there.
- Overload Threshold – The raw analog input count threshold above which the overload error is triggered on a given voltage input reading.

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- Perform load test after each desulfation? – This button enables or disables the addition of a load test after each desulfation.
- Max Cycle Count – The number of cycles a battery will perform automatically before stopping.
- Unlimited Cycle Count – Indicates if the Max Cycle Count is set to 0 which will allow unlimited cycles.
- Time to Maintenance Charge (Hours) – The time, in hours, until a maintenance charge cycle is performed on a battery that has hit the max cycle count.
- Load Current Low Limit – The current threshold below which the BCS assumes that the fuse is blown when performing a load test.
- Rolling Average Duration – The amount of time across which the rolling average is performed for the charge end-current reading.
- Ignore overload errors? – Enabling this button will allow the system to ignore all overload errors.
- Ignore contactor errors? – Enabling this button will allow the system to ignore all contactor errors.

There is a second page of settings that can be access by pressing the “Next” button. The second page contains the following settings.

- Pre-Charge Low Limit – The voltage threshold below which a pre-charge process is added for a battery
- Charger Timeout – The time the system waits after the main charger stops charging to attempt a retry
- Charge Retry Limit – The number of times the system will retry charging when a charge process is stopped early by the main charger
- Pre-Charge Cycle Limit – The maximum number of pre-charge cycles that the system will attempt on a battery before giving up
- Min Volts for Fuse Check – The voltage threshold for detecting if a battery is connected when checking for a blown fuse. If volts are below this threshold then fuse error is not thrown.
- Min Amps for Charger Done – The threshold for detecting if the main charger has quit charging the battery
- No Batt / Add PC Timeout – The timeout for the system detecting if the main charger is attempting to charge a battery. If there is a battery that is just not charging, a pre-charge cycle is added, otherwise there is no battery
- Using 5K Voltage Divider? – Enable if the system has the 5K mod
- Enable Jump Start? – This will allow the pre-charge circuit to connect to the battery while the main charger tries to start in attempt to jumpstart low voltage batteries. Not enabled by default.

While these settings are made available at the maintenance level access they are not intended to be used without direct instruction from Hapeman Electronics. If it appears that these settings need adjusted then please contact Hapeman Electronics before making any changes.

Process Queue:

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The process queue simply lists what the next 6 processes are in the sequence. It does not display the currently running process. This can be determined by looking at the home screen.

Change the Date and Time:

The date and time can be changed for the system to account for different time zones or daylight savings time. To do this simply press on the “Set Date and Time” button and enter the current date and time using military time. Once complete it should be changed in the bottom right hand corner of the screen where it is normally displayed.

Touch Screen Calibration:

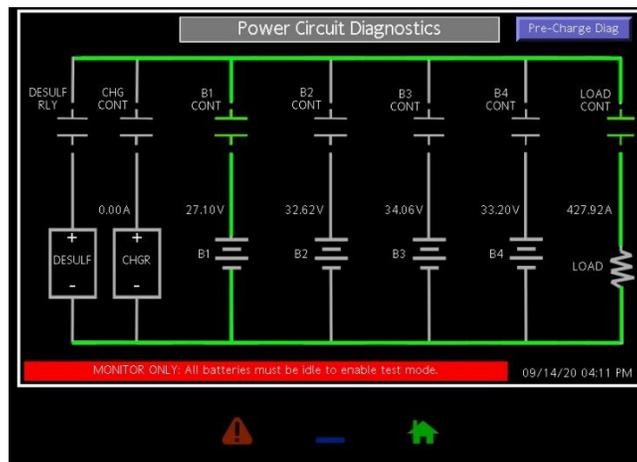
If the touch screen seems to be off, or is simply not responding to touch as expected, it may be calibrated. To do this press the “Touch Screen Calibration” button. Then touch each box as it lights up on the screen. Once complete press the “Home” button to return to the main screen.

Contact Info:

Pressing the “Contact Info” button displays a screen that simply shows the Hapeman Electronics’ contact info and battery conditioner firmware version.

Circuit Diagnostics Screen:

This screen can be accessed from the home screen by pressing the blue line between the “Home” and “Error” buttons at the bottom of the display panel. This screen is meant to show maintenance personnel how the main circuit is connected and the state of each element. The following features are available part of this screen.



Power Diagnostics Screen

Schematic Diagram:

This shows the how each of the main power components of the BCS are connected. It contains symbols for the charger, desulfator, batteries, contactors, and load. It will also show live readings of the battery

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voltages, charge current, and load current. Battery icons will indicate with a red slash through them if no battery is connected to that slot.

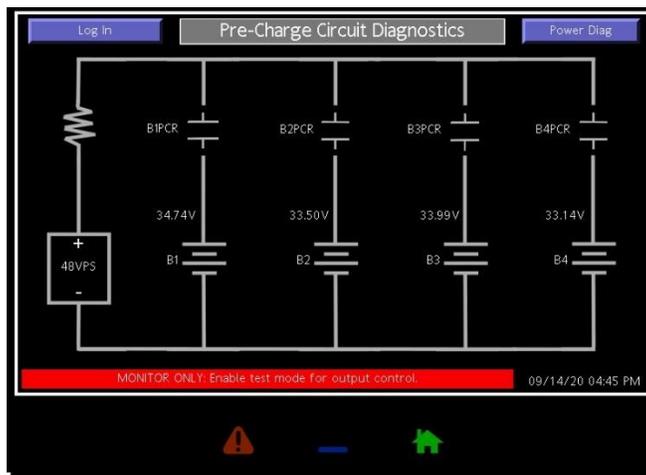
Circuit pathways are gray by default but will be highlighted green if activated. For example if battery one is in a charge step, the pathway from the charger to battery 1 through the contactors will be highlighted green with everything else remaining gray.

Contactors will be highlighted to show the state of the contactor. This can be useful when attempting to sort out contactor errors. The colors are as follows. Please note that the desulfation and pre-charge relays are not equipped with feedbacks and will only utilize the gray and green color.

- Gray – idle / not in use or the contactor is commanded to be open and the system has confirmed opening
- Blue – commanded to close but the system has not received the feedback confirming closure
- Green – commanded to close and the feedback confirms closure
- Red – commanded to open and the system has not received the feedback confirming opening

Pre-Charge Diag button:

Pressing this button will navigate to a similar screen that shows the pre-charge circuit instead of the power circuit. It operates the same as the power circuit screen.



Pre-Charge Diagnostics Screen.

Log In Button:

-Warning: Manual control of the system requires knowledge of the system components and how they interact. Failure to use this mode properly may result in damage to the system, batteries, facility, or harm to the operator. Please consult with Hapeman Electronics before attempting to manually control the unit.

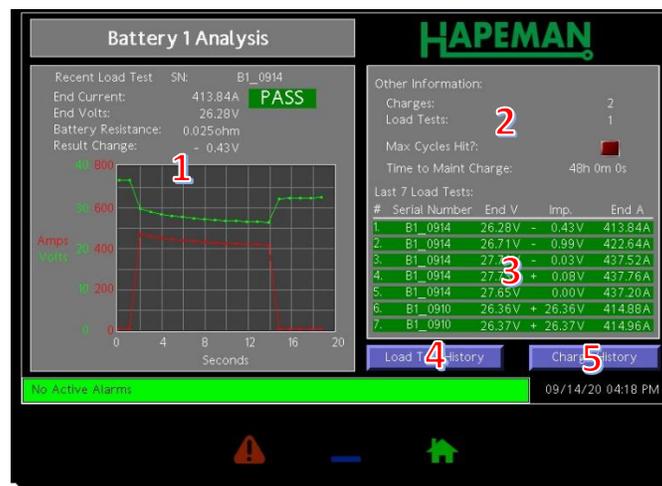
The diagnostic circuit on the screen can also be used to manually operate the battery conditioner contactors. To do this, a login must be performed to allow the system to be placed into “Test Mode.”

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Simply login using the maintenance level username and password provided above for resetting the system to defaults or accessing the advanced settings. Once logged in, pressing the “Test Mode ON/OFF” button will toggle test mode. With test mode active, pressing any of the contactor icons on the schematic will toggle the contactor / relay in question.

Analysis Screen:

On the main screen there is an “Analysis” button for each battery. Pressing this will show the Analysis screen for that battery. It shows the most recent load test data, the number of charges and load tests performed on the current battery, whether or not it has hit the max cycle count, and how long until a maintenance charge is performed on batteries that hit the max number of cycles.



Battery 1 Analysis Screen.

1. Most recent load test results – Information gathered during the most recent load test including a graph of the voltage and current during the load test and a pass / fail result.

Note: The pass / fail result will not update until the load test has completed, including cooldown. If the analysis screen is being watched during the load test and it looks like the battery should pass but is showing fail, wait until the cooldown is completed and the BCS has moved on to the next process before using this result.

2. Other information – information about the batteries not pertaining to load test results. All of this information is reset upon battery removal.
 - a. Charges – The number of charges performed on the currently connected battery.
 - b. Load Tests – The number of load tests performed on the currently connected battery.
 - c. Max Cycles Hit – Indicates if the maximum number of cycles for a given battery has been hit.
 - d. Time to Maint Charge – The time remaining until a maintenance charge is performed on the battery if it has hit the maximum number of cycles.
3. Last 7 Load Tests – This displays the load test history of that battery slot. It will contain all batteries load tested in that slot for the last 7 tests. Each line contains the serial number of the

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battery tested, the end voltage, the amount of voltage improvement since the last test (if applicable), and the end current. The line is also highlighted green if the battery passed the test and red if it failed.

4. The “Load Test History” button – This button navigates to the load test history screen. This screen shows the last 25 load tests performed on the slot. All data is displayed the same as in the “Last 7 Load Tests” section on the analysis page.
5. The “Charge History” button – This button navigates to the charge history screen. This screen displays information about the last 25 charge cycles performed on this slot. Each entry contains the serial number of the battery, the end charge current, the amount of Ah charged, and the amount of time the battery was charging.

The load test data shows that serial number of the most recently tested battery as well as whether it passed or failed the test. It also shows a graph of the volts and load amps of that battery throughout the duration of that load test and the final battery volts and amps at the end.

The real-time charger display shows the battery volts and charger amps over the last 10 hours.

Web Viewer Use:

Sometimes it is useful for administrators or even operators to be able to remotely view or operate the battery conditioner. If connected to the local network, the battery conditioner may be accessed remotely using any web browser. Simply plug an ethernet cable into the ethernet jack on the back of the LCD screen in the battery conditioner and connect it to the network. Once connected simply open any web browser and type in “192.168.1.45”. It will grant a few options.

1. View Data – Real time data from each battery.
2. View Logs – Records kept during the operation of the battery conditioner and includes charging data and load test data. These records may be saved in *.csv format by right-clicking the link and clicking “Save As”.
3. Remote View – Remote screen viewing and operation of the battery conditioner.
4. View or Pull all available recorded data off the unit (Right-click and save as) in *.csv format

Warning: Remote operation of the battery conditioner is not recommended. If remote operation is being used the operator must be certain that everything is hooked up properly, is in a safe state, and that no personnel are working on or around the battery conditioner or the batteries connected to it. Failure to do so may lead to severe injury.

Note: The web viewer may not be usable in networks with heightened security, firewalls, static IPs, etc. Contact the local IT department for information.

SD Card Data Collection:

There is an SD card installed into the side of the LCD screen that is used to store all collected data for the tester. To get the data off of the SD card remove it from the battery conditioner and put it into a computer with a compatible SD card slot. Using a file explorer, navigate to the SD card and pull off the desired data. It will be in *.csv format.

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Note: The SD card must be put back into the battery conditioner or data will no longer be recorded.

Updating the Firmware Using the SD Card:

It is possible to update the firmware on the BCS by using the equipped SD card. To do this simply place the SD card into a computer with a compatible SD card slot like you would to collect the data off it. Then, using the file explorer on the computer, copy the new firmware file to the root directory of the SD card. The new firmware file must be named "image.ci3" and can be obtained from Hapeman Electronics. Once the new firmware file is on the SD card, eject it from the computer and put it back into the BCS. If the BCS is still powered, cycle power and the firmware on the BCS will be updated with the new firmware on the SD card.

It is important to note that when the firmware is updated calibration information may be lost.

NOTE: It is recommended that upon downloading new firmware, a "Reset To Defaults" be performed before re-entering the calibration constants.

Critical Errors and Handling:

There are certain critical errors that will halt all operation of the BCS. Operation is halted because these errors could damage the BCS or even potentially harm the operator.

When one or more of these errors is detected, the BCS will halt all operation and display an alert screen showing the errors. It will also begin to beep and flash in order to get the operators attention. These errors can be reset from this screen. There is more on that below.

There are two types of critical errors that can be handled by the BCS. These are "Overload" errors and "Contactor" errors.

NOTE: If errors are reset and any stop button is pressed in, the system will continue to blink and beep. If this happens, release all stop buttons after resetting the error.

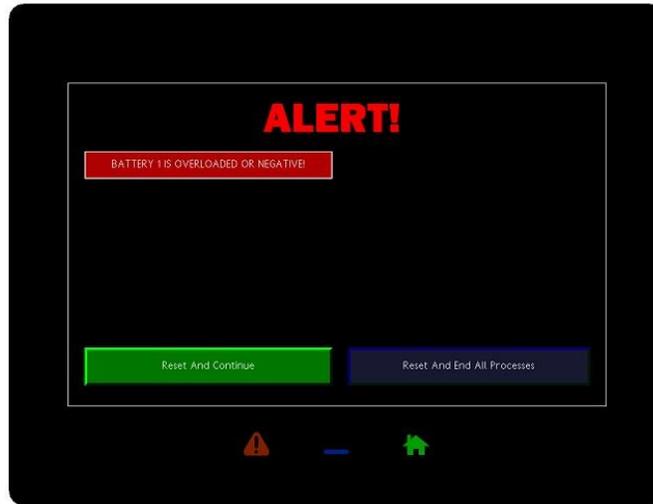
Overload Errors:

Overload errors are the result of a measurement device inside of the BCS unit being overloaded. This could mean any of the following things:

1. A battery has reached too high of a voltage.
2. A battery was hooked up in reverse and is negative.
3. A current measurement shunt is disconnected.
4. A current measurement shunt is hooked up in reverse and is negative.
5. A measurement channel on the controller has gone bad.

When one or more overload errors is active, the following screen will be displayed, informing the operator that there is an active error. Again, when this screen displays, all BCS operation is halted.

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Alert screen with a Battery 1 overload error.

There are two options on the screen for resetting the errors listed.

Reset and Continue – This will attempt to reset the error and then put the conditioner back in the state it was in before the error. This includes recovering the process list and restarting the process that was active at the time of fault.

Reset and End All Processes – This will attempt to reset the error and then put the conditioner into an idle state with the process list cleared but ready to run. The entered serial numbers for the attached batteries are saved.

When one of these buttons is pressed the screen will change showing a timer counting down while the system attempts to reset the errors. If the errors are reset the home screen will be displayed with either the batteries continuing their cycle or stopped and ready to cycle.



System is counting down while it attempts to reset errors.

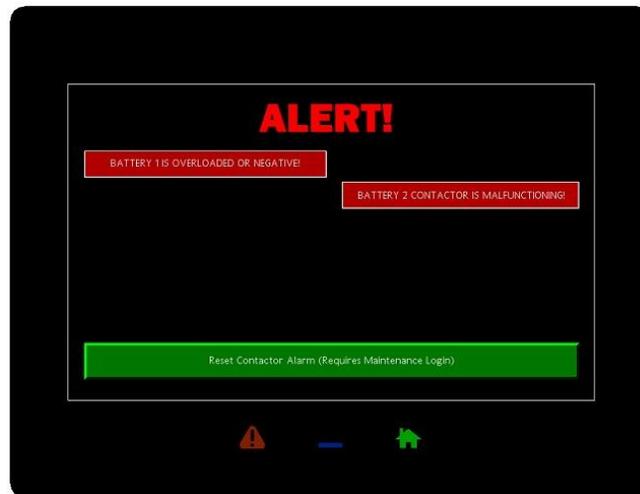
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Contactors Errors:

Contactors errors are the result of any contactor in the BCS being in an unknown or unexpected state. This could mean any of the following things:

1. Contactor is being commanded on but is not closing.
2. Contactor feedback is broken or disconnected.
3. Contactor is welded shut and won't open.

The screen that displays when a contactor error is listed is slightly different than that of an overload error. Contactor errors are especially dangerous to not only the BCS, but also the operators because the system cannot tell properly how the batteries / charger are connected. For this reason, there is only one option for resetting contactor errors and it requires a maintenance level login in order to clear them.

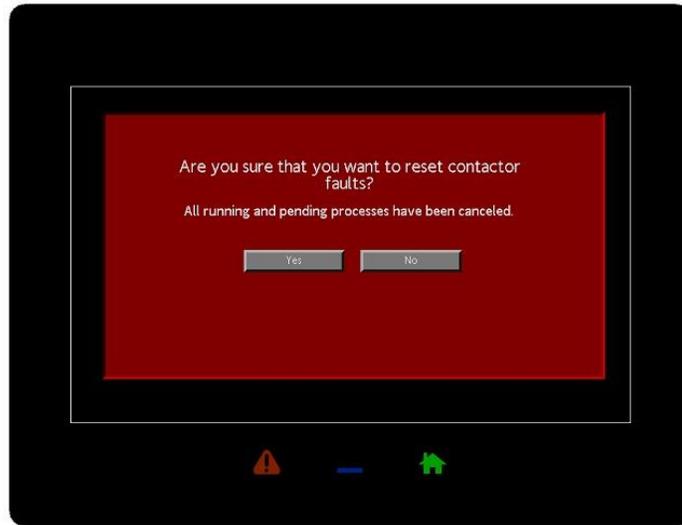


Alert screen with an active contactor error.

*Warning: Before even attempting to reset any contactor alarm, a properly trained maintenance technician must look over the cabinet to verify that contactors are in proper working order. This may require powering down / disconnecting all batteries in order to check the contactors for welding or other damage. **DO NOT touch or attempt to fix any contactor when batteries are still attached to the system. This could result in severe personal injury.***

Once all errors are resolved and the reset button is pressed, login and a new screen will appear verifying that the system is ready to reset. Press “Yes” to reset the faults.

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Contactor reset verification.

NOTE: If BCS power is cycled while being assessed or fixed by maintenance, it will automatically try to reset these errors upon power up and may not require manual reset.

Operation While in Error State:

Sometimes it may be necessary to operate the unit while it is in an error state to determine the cause of the error. To do this, press the blue line on the panel below the screen between the “Home” and “Alarms” buttons. A login will be prompted. Use the same maintenance level username and password as found elsewhere in this document. The user will be taken to a warning screen which will inform the user of the dangers of using the BCS in this way. Once acknowledged the system will navigate to the home screen which will appear normal except for the “Active Errors” button in the upper right-hand corner. The battery conditioner may be used as normal. When it is time to reset the errors simply press the “Active Errors” button on the home page to return to the active errors screen. Reset the errors from here as normal.

Checking / Adjusting the Charger Settings (480VAC Unit Only):

WARNING: This should only be performed by a trained person and only after discussing symptoms and issues with Hapeman Electronics.

This procedure must be performed inside of the cabinet with the power on. DO NOT touch anything in the cabinet other than the charger front panel controls. There will be live 480VAC facility supply in this cabinet. If there are batteries connected to the conditioner there will also be live battery voltage in the cabinet.

The charger used in the battery conditioner has a few settings that are programmed from the factory to allow it to handle locomotive batteries. Below is how to change the settings in the charger so that they

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are correct. If simply checking the charger settings, simply follow the steps below without performing the actual changes.

Before opening the cabinet, make sure that all estop buttons are pressed in halting all active charge and load test procedures.

Login to Level 2 User Mode:

1. Enter the charger menu by pressing "OK."
2. Using the arrow keys, navigate down to "Log In" and press "OK."
3. Enter the access code "3562" using the left and right arrow to select the digit and the up and down arrow to change it. Press "OK" to continue.

Changing the Charger Parameters:

1. Press "OK" to enter the menu.
2. Login to level 2 user mode as shown above.
3. Navigate to "Service" and press "OK."
4. Navigate to the bottom of the list and select "Advanced". Press "OK."
5. Navigate to the second page by using the right arrow.
6. Select "Curve Param" and press "OK" to edit. Change to "ON" using the arrow keys and press "OK" again to set it.
7. Press "ESC" to return to the service menu.
8. Select "Charging Param" and press "OK".
9. The values should be set as follows. Values are changed by selecting a parameter, pressing "OK" to edit using the arrow keys, and pressing "OK" again to set it.

Curve	43.OPXX-01
Capacity(Ah)	650
Cells	16

10. Navigate to the second page of "Charging Param" with the right arrow button.
11. Select "Curve Param" and press "OK."
12. The values should be set as follows:

I1U1_Uset	2.40 VPC
I1U1_Iset	016.3 %Cap
I1U1_Tmin	00:00 hh:mm
I2U2_Uset	2.60 VPC
I2U2_Iset	005.0 %Cap
I2U2_Tmin	00:01 hh:mm

13. Press "Esc" until returning to the main screen. This screen should say "CONNCT BATTERY."

Setting the Equalize Interval:

1. Press "OK" to enter the menu.

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2. Login to level 2 user mode as shown above.
3. Navigate to **“Service”** and press **“OK.”**
4. Select **“Equalize”** and press **“OK.”**
5. The values should be set as follows. Values are changed by selecting a parameter, pressing **“OK”** to edit using the arrow keys, and pressing **“OK”** again to set it.

Function	Cyclic
Status	Enabled
Interval	0

6. Press **“Esc”** until returning to the main screen. This screen should say **“CONNCT BATTERY.”**

Parts List:

Description	Part Number	QTY Per Unit
HMI / System Controller	HE96001	1
Charger	HE96002	1
Load Contactor	HE96003	1
Battery / Charger Contactor	HE96004	5
Load Shunt	HE96005	1
Charger Shunt	HE96006	1
Fuse	HE96007	1
Control Transformer	HE96008	1
24VDC Power Supply	HE96009	2
48VDC Power Supply	HE96010	1
Pre-Charge Contactors	HE96011	4
Control Relays	HE96012	7
Grid Resistor	HE96013	1
Locking Stop Buttons	HE96014	4
Pre-Charge Resistor	HE96015	1

Legacy Patch Notes - V1.3:

1. Maximum Number Of Cycles – allows the user to enter a maximum number of charge cycles for a battery left on the BCS. Once that limit is hit the BCS will no longer add cycles and will display **“Max Cycles Hit”** for the battery status. A value of **“0”** in the cycle count will allow unlimited cycles.
2. Automatically reset to default values if the calibration numbers are lost. This always happens in the case of a new firmware update.
3. Estop buttons no longer display as system errors. They simply change the color of the box for the associated battery on the screen. This eliminates the issue where the screen will continue to flash after an actual error if any of the buttons are pressed in.
4. No longer deletes the serial number of the battery when there is a **“No Battery”** condition.
5. Fixed the total load test counter to include forcing load tests.

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6. Display the load test history in the analysis screen for each battery. This allows the operator to see the results of the last 7 load tests including serial number, end voltage, battery voltage improvement, and end current. Clicking the “Load Test History” button shows a full 25 entry history.
7. Added new power and pre-charge circuit diagnostics screens. Each screen shows a graphical representation of the respective circuit. This allows the operator to monitor graphically how the circuit is connecting the batteries to the system at any given time. Contacts change color if they are enabled. Batteries are detected by voltage and if a battery is not hooked up then an indicator is placed over the battery. When test mode is enabled, all contactor and relay icons may be pressed to actuate them.
8. Created a manually generated file to store a master list of all load tests performed which includes the date/time, serial number, battery number, voltage, current, and pass / fail determination.
9. Created a manually generated file to store an overall history of the processes run on the BCS. Each entry includes data/time, serial number, battery number, and process. Processes include Charge, Load Test, and Desulfation. Unknown states are stored as “BAD”.
10. Basic Instructions / Tutorial Pages that can be used as operator reference on how to run the BCS.
11. Maintenance Charge Restart – If a battery has hit the maximum number of cycles, it will automatically add a desulfation step for that battery if it has remained on the BCS for so long.
12. Make the unit usable in an error state with a maintenance level login.
13. Variable data entry for the check fuse error current level.
14. Battery Improvement Calculation to see how much the battery load test results have improved over multiple cycles.
15. Display charge history information in the battery analysis screens for each battery. Pressing the “Charge History” button shows the last 25 charge cycles and displays the serial number, ending charge current, total Ah charged, and charge duration.
16. Added user adjustable time formatting. Allows charge and load test times to be displayed in 3 new formats.