

Thoroughbred

WITH CONTROLLED FERRO-RESONANT TECHNOLOGY

Installation and Operating Instructions



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SECTION 1 SAFETY INSTRUCTIONS

IMPORTANT SAFETY INSTRUCTIONS

1. SAVE THESE INSTRUCTIONS. THIS MANUAL CONTAINS IMPORTANT SAFETY AND OPERATING INSTRUCTIONS.
2. WORKING IN THE VICINITY OF A LEAD-ACID BATTERY IS DANGEROUS. BATTERIES GENERATE EXPLOSIVE GASSES DURING NORMAL BATTERY OPERATION. FOR THIS REASON IT IS OF THE UTMOST IMPORTANCE THAT EACH TIME BEFORE USING YOUR CHARGER, YOU READ AND FOLLOW THE INSTRUCTIONS PROVIDED EXACTLY.
3. TO REDUCE RISK OF BATTERY EXPLOSION, FOLLOW THESE INSTRUCTIONS AND THOSE ON THE BATTERY.
4. NEVER SMOKE OR ALLOW AN OPEN SPARK OR FLAME IN THE VICINITY OF THE BATTERY OR ENGINE.
5. USE CHARGER FOR CHARGING A LEAD-ACID BATTERY ONLY. IT IS NOT INTENDED TO SUPPLY POWER TO AN EXTRA LOW-VOLTAGE ELECTRICAL SYSTEM OR TO CHARGE DRY-CELL BATTERIES. CHARGING DRY-CELL BATTERIES MAY CAUSE THEM TO BURST AND CAUSE INJURY TO PERSONS AND DAMAGE TO PROPERTY.
6. NEVER CHARGE A FROZEN BATTERY.
7. DO NOT OPERATE IN A CLOSED-IN AREA OR RESTRICT VENTILATION IN ANY WAY.
8. DANGER: RISK OF ELECTRICAL SHOCK. DO NOT TOUCH UNINSULATED PORTION OF OUTPUT CONNECTOR OR UNINSULATED BATTERY TERMINAL.
9. CAUTION: DISCONNECT SUPPLY BEFORE CHANGING FUSE.

INSTRUCTIONS IMPORTANTES CONCERNANT LA SECURITE

1. CONSERVER CES INSTRUCTIONS. CE MANUEL CONTIENT DES INSTRUCTIONS IMPORTANTES CONCERNANT LA SECURITE ET LE FONCTIONNEMENT.
2. IL EST DANGEREUX DE TRAVAILLER A PROXIMITE D'UNE BATTERIE AU PLOMB. LES BATTERIES PRODUISENT DES GAS EXPLOSIFS EN SERVICE NORMAL. AUSSI EST-IL IMPORTANT DE TOUJOURS RELIRE LES INSTRUCTIONS AVANT D'UTILISER LE CHARGEUR ET DE LES SUIVRE A LA LETTRE.
3. POUR REDUIRE LE RISQUE D'EXPLOSION, LIRE CES INSTRUCTIONS ET CELLES QUI FIGURENT SUR LA BATTERIE.
4. NE JAMAIS FUMER PRES DE LA BATTERIE OU DU MOTEUR ET EVITER TOUTE ETINCELLE OU FLAMME NUE A PROXIMITE DE CES DERNIERS.
5. UTILISER LE CHARGEUR POUR CHARGER UNE BATTERIE AU PLOMB UNIQUEMENT. CE CHARGEUR N'EST PAS CONCU POUR ALIMENTER UN RESEAU ELECTRIQUE TRES BASSE TENSION NI POUR CHARGER DES PILES SECHES. LE FAIT D'UTILISER LE CHARGEUR POUR CHARGER DES PILES SECHES POURRAIT ENTRAINER L'ECLATEMENT DES PILES ET CAUSER DES BLESSURES OU DES COMMAGES.
6. NE JAMAIS CHARGER UNE BATTERIE GELEE.
7. NE PAS FAIRE FONCTIONNER LE CHARGEUR DANS UN ESPACE CLOS ET/OU NE PAS GENER LA VENTILATION.
8. DANGER: RISQUE DE CHOCS ELECTRIQUES. NE PAS TOUCHER LES PARTIES NON ISOLEES DU CONNECTEUR DE SORTIE OU LES BORNES NON ISOLEES DE L'ACCUMULATEUR.
9. ATTENTION: COUPER L'ALIMENTATION AVANT DE REMPLACER LES FUSIBLES.

SECTION 2 RECEIPT AND INSPECTION OF THE CHARGER

Upon receipt of the THOROUGHbred Rapid Charger, the information on the shipping carton should be checked against your order.

All chargers can be handled with a lift truck by inserting the forks under the bottom of the charger. Remove the carton and inspect the charger for damage. If there is any damage, save the carton for inspection and notify the carrier immediately. Check the nameplate & labels against your order & specifications.

Any discrepancies should be reported immediately to the nearest Applied Energy Solutions authorized representative.

SECTION 3 INTRODUCTION

The THOROUGHbred Rapid Charger is a full wave, silicon rectified controlled ferro-resonant charger. Charging current and voltage are controlled by the control circuit. This charger is designed to output high rate current charge of 40A/100AH for a pre-programmable period of time before switching to a lower high rate current.

A solid state, pre-programmed microprocessor:

- provides total control of output current and voltage throughout the charge cycle.
- terminates the charge cycle when the battery voltage reaches the gassing point to prevent the battery from gassing.
- provides an opportunity to automatically equalize the battery at a programmable time of the day and day of the week.
- monitors and controls the battery electrolyte temperature.

SECTION 4 CONTROL FEATURES

4.1 CONTROL FEATURES:

- Automatic five-second delayed start upon connection of a proper sized, good battery.
- Battery voltage sensing determines if there is a proper sized battery connected to the charger. This prevents charging if there is a bad battery connected, no battery connected, bad battery-to-charger connection or battery voltage and charger mismatch.
- Battery voltage and current are continuously monitored and controlled.
- Automatic DV/DT charge termination during finish rate.
- Negative battery slope termination to prevent overcharge/thermal runaway.
- Automatic 24-hour "REFRESH" charge adds a top off charge to a fully charged battery. The charger will start a "refresh" charge 24 hours after a normal charge complete has been reached, assuming that the battery was not disconnected during that time.
- Back-up timers prevent extended charging of a damaged battery. The first timer starts at the beginning of the charge cycle and runs for 5 hours. If the battery has not reached the gassing point the charger will shutdown. The second timer starts at the 80% point and runs for 6 hours. The charge cycle will terminate normally if the timer times out. If the charge cycle has not terminated after 6 hours, the charger will shut down.
- Automatic Shutdown Lock-out will not allow a charge to start after a manual stop or problem shutdown occurs. Automatic Shutdown Lockout is cleared by disconnecting the battery, then re-connecting it.

- Manual Start – The Equalize/Start switch when depressed prior to charging will turn on the charger at Rapid Charge High Rate (40A per 100AH) if the manual start function is set.
- Manual STOP switch - Will stop the charger from charging. The display will indicate “OFF” until the battery is disconnected. When pressed with no battery connected displays the delay start setting.
- Manual Equalize switch - The Equalize/start switch, when depressed during charge, will turn on and off the three hour additional equalizing charge. When the Equalize function is turned on, an “E” will be displayed in the leftmost digit of the display and the CHARGE COMPLETE LED will blink until the charger goes into the Equalize mode. An “E” in the display will flash during the actual Equalize charge cycle.
- Automatic Equalize – The equalize charge will be automatically set at a programmable time of the day and day of the week, adding three hours of finish rate charging at the end of the charge cycle. When the equalize charge is selected, an “E” will be displayed in the leftmost digit of the display and the CHARGE COMPLETE LED will blink until the charger goes into the equalize mode. An “E” in the display will flash during the actual equalize charge cycle.
- Real Time Clock – The real time clock - with calendar and daylight saving time features, provides signals to the main board to control the Full Charge Cycle disabled/enabled and Automatic Equalize functions.
- Full Cycle Charging - When the charger reaches the gassing point during the plant shutdown preset time frame, the charger will continue the regular charge cycle and terminate by DV/DT sensing.
- Automatic shutdown occurs for any of six failure conditions. The SHUTDOWN LED will flash.
- Start inhibit if the battery is fully charged
- Accurate Battery Temperature Monitoring - A temperature sensor that is inserted into the battery electrolyte of the battery’s center cell provides an accurate temperature of the battery electrolyte during charge. The charger control continuously monitors the temperature, modifies the charge current if the temperature reaches a preset limit, and shuts off the charger if the temperature reaches a higher preset limit

4.2 FAULT CODES

- Fault code “**Lo U**” - Low volts per cell - the battery voltage is less than 1.5 V/Cell. The charger will not be “locked off”. The charger will automatically start charging when the battery voltage is greater than 1.5 V/Cell.
- Fault code “**Hi U**”- High volts per cell - greater than 2.80 or 2.85 V/Cell (set with 80% point).
- Fault code “**disc**” - Battery disconnected from charger during charge.
- Fault code “**dur**” - Charge time exceeded - backup timer expired during “high rate” charge.
- Fault code “**Lo I**” - Low charging current - charging current less than approximately 3 Amps.
- Fault code “**Hi I**” during charging - The charger will shut down for abnormal current.
- Fault code “**Hi I**” within first 10 seconds after charge start - The incoming AC Voltage may have improper phase rotation. Have a qualified service person rotate the AC Input phasing to the charger.

4.3 LED INDICATORS

- CHARGING - charger is charging the battery.
- 80% CHARGED - the battery voltage is greater than the preset gassing voltage.
- CHARGE COMPLETE - the charge cycle has been terminated normally.- If flashing during charging, the charger is set to Equalize at the end of the charge cycle.- If flashing along with the CHARGING and 80% LED's on solid then the charger is in the Refresh mode.
- SHUTDOWN - the unit has shut down for a fault.

4.4 AMMETER/TIMER DISPLAY

The readout will display the following information:

- Charging current
- Fault codes
- Equalize mode
- Amp-Hour returned for this charge cycle
- Charge Time – the length of time the charger was charging.
- Volts per cell – the average battery cell voltage.

SECTION 5 INSTALLATION

5.1 PHYSICAL LOCATION:

Charging areas should be clean and dry. The temperature of the charging room should be between 32 °F (0 °C) and 104 °F (40 °C). Combustible materials, open flames and smoking should not be permitted near or in the charging area.

WARNING

A BATTERY ON CHARGE WILL EMIT EXPLOSIVE GAS.
VENTILATE THE CHARGING ROOM TO PREVENT GAS ACCUMULATION.

5.2 MOUNTING:

The THOROUGHbred charger cabinets must be mounted on a surface constructed from non-combustible material, such as stone, brick, concrete or metal. Mounting holes are provided in the frame for securing the charger.

5.3 INPUT POWER CONNECTION:

**THE THOROUGHbred RAPID CHARGERS ARE PHASE ROTATION SENSITIVE;
PLEASE ENSURE THAT CLOCKWISE PHASE ROTATION IS OBSERVED.**

The chargers are shipped from the factory connected for the input voltage specified on your purchase order. A "STOP/CAUTION" label, located inside the door, indicates the factory set input voltage.

WARNING

VERIFY THAT THE AC ELECTRICAL SERVICE IS DISCONNECTED AT THE SOURCE BEFORE ATTEMPTING TO CONNECT AC POWER TO THE CHARGER.

The AC input terminals are identified by a red-on-white AC INPUT label, located on the base near the fuse block. The AC input cable is to be connected to the proper AC INPUT terminals within the charger cabinet.

The fuse block's input terminals are rated for 14 AWG to 2 AWG wire. The recommended torque is listed on the fuse block itself.

A grounding wire (bare, green or green with yellow stripe) is to be connected from the Grounding Terminal within the charger cabinet to the service system ground. The Grounding Terminal is identified by a green-on-white Ground Terminal Label on the charger base. If a system ground is not available, the charger frame must be connected to a driven ground rod, in accordance with National and Local electrical codes. Proper application and tight terminal connections are important in avoiding future problems. The ground terminal is rated for 14 awg to 6 awg wire. The recommended torque setting is shown in Table 5.1

Table 5.1

| Wire Gauge | Recommended Torque Setting |
|-------------------|----------------------------|
| PANDUIT LAMA6-14Q | |
| 6 – 10 AWG | 40 in lbs |
| 12 – 14 AWG | 15 in lbs |
| T&B ADR6 | |
| 6 AWG | 35 in lbs |
| 8 – 14 AWG | 20 in lbs |

5.4 RECOMMENDED BATTERY PREPARATION FOR THOROUGHbred

Following are the recommended changes necessary to be incorporated on batteries to be used with Thoroughbred Rapid Chargers.

- Inter-cell connector straps are to be doubled or copper composition types used, that will yield a resistive drop of approximately 1/2 of the standard inter-cell connectors used for the particular battery rating.
- Battery leads are to be doubled; two leads for positive and two leads for negative.
- Leads are to be terminated in SBX style connectors with auxiliary contacts, one negative lead and one positive lead in each connector.
- For proper air circulation, sealing compound, if normally used to seal the tops of the battery cells in the tray, should not be used. No other special tray sizing or ventilation is required.

5.5 AUXILIARY WIRE HARNESS INSTALLATION

The auxiliary wire harness assembly (supplied) is installed in battery and battery cables to provide temperature sensing and battery disconnect cut-off. The assembly consists of:

- Temperature sensor
 - Wire jumper
 - Auxiliary wire harness
 - Cable ties
- Select a battery cell to install the sensor probe. A cell located in the center of the battery tray is recommended.
 - Drill a 7/16" diameter hole through the top of the jar.
 - Screw the sensor probe into the drilled hole. Make sure the probe tip is in contact with the electrolyte and has a minimum clearance of 0.25" from the tip of the sensor to the separator guard (See Figure. 5.1). The mounting depth can be adjusted from 1.5" to 2.4".
 - Insert the auxiliary leads with bare contacts completely through SBX connector, from cable end of connector. Slide red and black auxiliary terminal/housings together, with black on top, per Figures. 5.2 - 5.4. Assemble leads with contacts into housings.
 - Pull auxiliary lead back through SBX connector, ensuring black housing is toward top of connector (See Figure. 5.4). Either auxiliary wire harness may be connected to either of the two SBX connectors.
 - Insert retaining pins into SBX connector, from the bottom, as shown in Figure. 5.3. Ensure pins are flush with surface of connector. Repeat last three steps for other connector.
 - Select a proper location on the battery to secure cable harness to the battery using supplied cable ties.
 - Open the charger door; verify that the auxiliary wire harness is connected to the screw-type terminal on the control board as shown in Figure. 5.5.

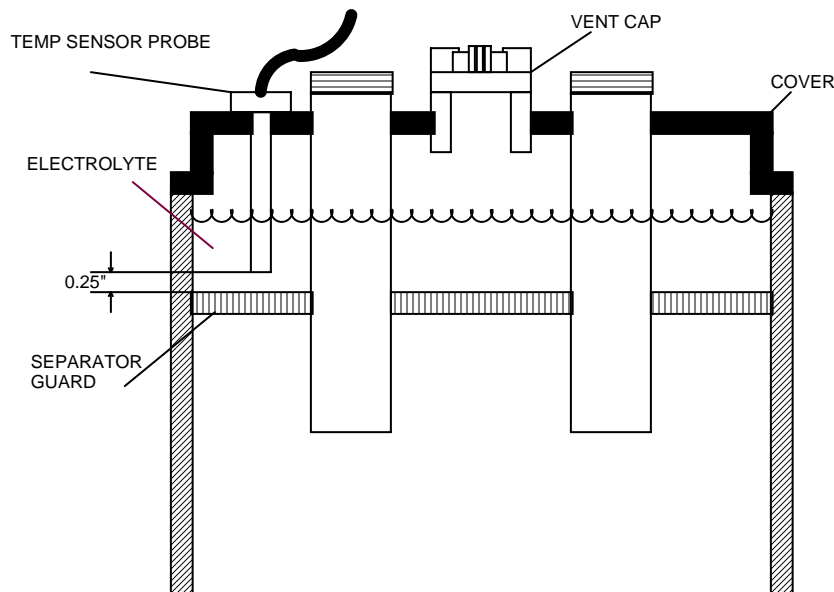


Fig. 5.1 Temperature Sensor Installation

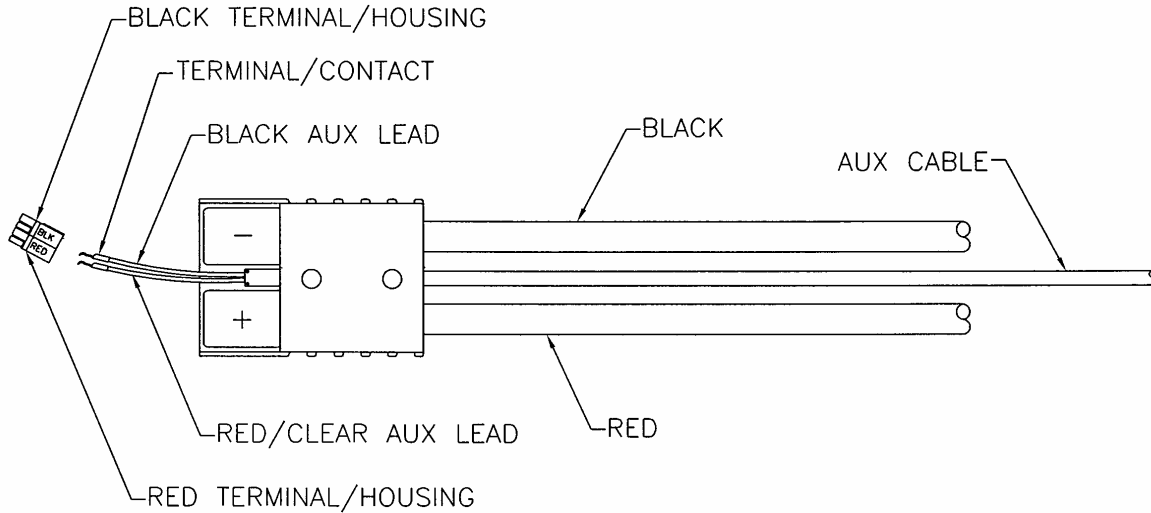


Fig. 5.2 Auxiliary Leads Drawn through SBX Connector for Insertion in Terminal/Housings

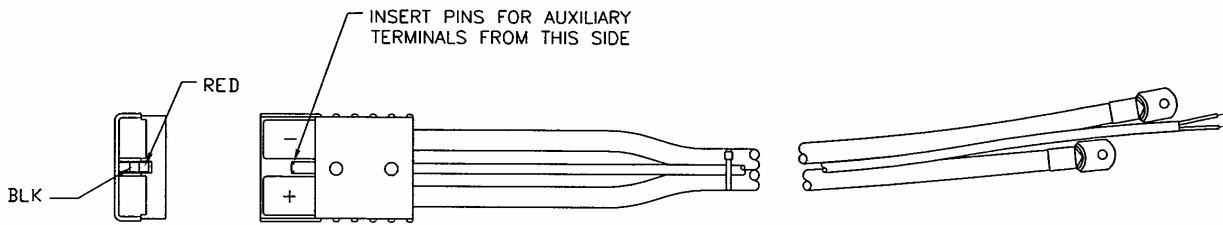


Fig. 5.3 Battery Cable with Auxiliary Contact Cable Harness

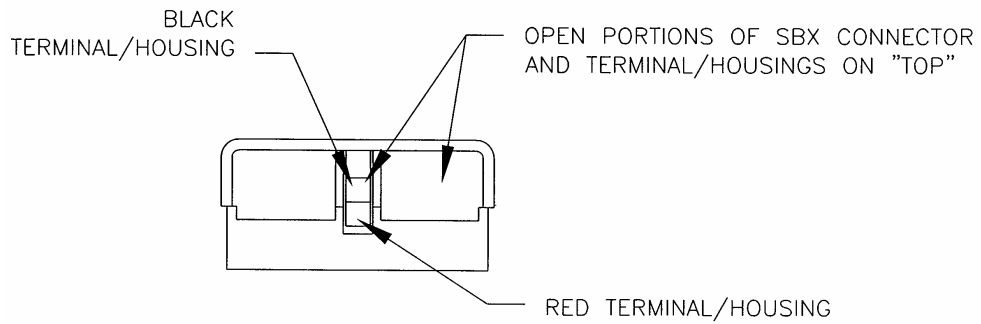


Fig. 5.4 Auxiliary Terminal/Housing Orientation

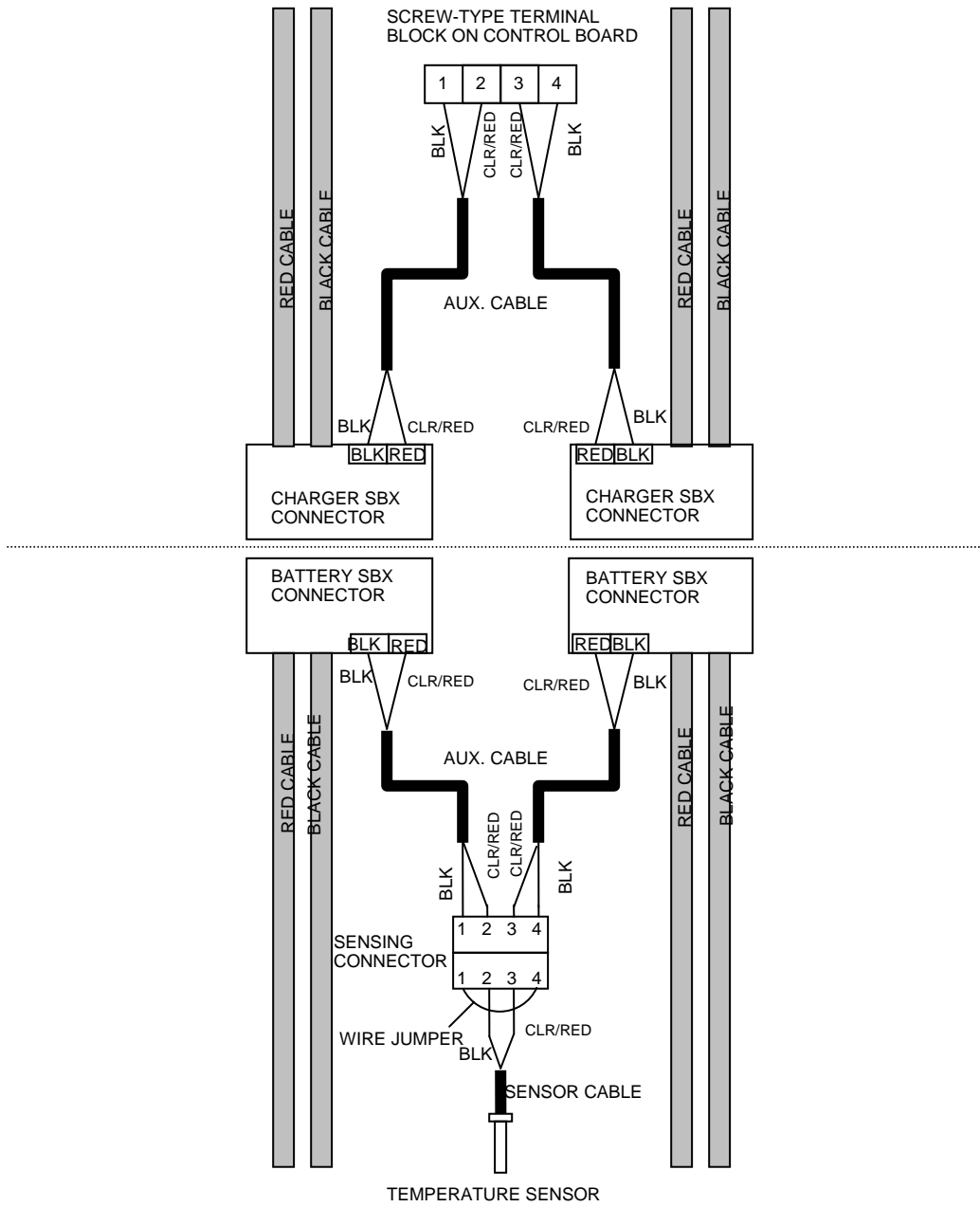


Fig. 5.5 Sensing Lead Installation Diagram

5.6 SETTING CHARGER DIP SWITCHES

The THOROUGHbred Rapid Chargers are equipped with switches that determine the charge profile settings. **Care must be used when changing the switch settings as incorrect settings can undercharge, overcharge or even damage the battery and/or charger.**

Table 1. AMPERE-HOUR RATING

| S2-1 | S2-2 | S2-3 | S2-4 | AMPERE-HOUR RATING (AH) | RAPID CHARGE CURRENT(A) |
|------|------|------|------|-------------------------|-------------------------|
| OFF | OFF | OFF | OFF | 425 | 170 |
| ON | OFF | OFF | OFF | 475 | 190 |
| OFF | ON | OFF | OFF | 510 | 204 |
| ON | ON | OFF | OFF | 540 | 216 |
| OFF | OFF | ON | OFF | 600 | 240 |
| ON | OFF | ON | OFF | 680 | 272 |
| OFF | ON | ON | OFF | 750 | 300 |
| ON | ON | ON | OFF | 750 | 300 |
| OFF | OFF | OFF | ON | 765 | 306 |
| ON | OFF | OFF | ON | 865 | 340 |
| OFF | ON | OFF | ON | 1065 | 386 |
| ON | ON | OFF | ON | 1065 | 386 |
| OFF | OFF | ON | ON | 1050 | 420 |
| ON | OFF | ON | ON | 1190 | 476 |
| OFF | ON | ON | ON | 1450 | 580 |
| ON | ON | ON | ON | 1750 | 700 |

Table 2. GASSING VOLTAGE SETTINGS

| S6-1 | S6-2 | F.R.CONST. VOLTS (V) | HI VOLTS ALARM (V) | BATTERY TEST VOLTAGE (V) | *** |
|------|------|----------------------|--------------------|--------------------------|-----|
| OFF | OFF | 2.42 | 2.80 | 2.010 | |
| ON | OFF | 2.40 | 2.80 | 2.010 | |
| OFF | ON | 2.50 | 2.80 | 2.25 | |
| ON | ON | 2.45 | 2.85 | 2.20 | |

Table 3. FAST CHARGE TIME @HIGH RATE CURRENT 40A/100AH

| S6-3 | S6-4 | FAST CHARGE TIME (minutes) | *** |
|------|------|----------------------------|-----|
| OFF | OFF | 100 | |
| ON | OFF | 60 | |
| OFF | ON | 45 | |
| ON | ON | 30 | |

Table 4. CHARGE START MODE

| S6-5 | CHARGE START MODE | *** |
|------|---|-----|
| OFF | PUSH THE START BUTTON TO START CHARGING | |
| ON | AUTOMATIC START | |

Table 5. CHARGE TERMINATION DURING FULL CHARGE DISABLED PERIOD

| S6-6 | S6-7 | CHARGE TERMINATION | *** |
|------|------|--------------------|-----|
| OFF | OFF | @ 85% RECHARGED | |
| ON | OFF | @ 84% RECHARGED | |
| OFF | ON | @ 82% RECHARGED | |
| ON | ON | @ 80% RECHARGED | |

*** Indicates Factory Setting

SECTION 6 CHARGER OPERATING PROCEDURE

6.1 PRELIMINARY SET-UP:

With all power removed from the charger, set the DIP switches S6 located on the back of the control board per Section 5.6 tables before attempting to charge a battery.

Once power has been applied to the charger, a "dash" will sequence across the display on the front panel. This indicates the charger is in the "IDLE MODE" of operation, awaiting a battery connection.

6.2 STARTING THE CHARGER:

Compare the number of cells and Amp-Hour capacity of the battery to be charged with the charger rating found on the charger nameplate. The number of cells in the battery to be charged **MUST** match the nameplate data. The Amp-Hour ratings should also match for timely charging of the battery. Once the battery to be charged has been determined to match the charger, the battery may be connected to the charger. The control will measure the average volts/cell of the connected battery. The battery open voltage must be above 1.5 volts/cell.

If the DIPswitch S6-5 is set OFF, the display will show "PUSH." When the START button is pressed, the charger display will show a countdown and the LED's will be flashing. If the DIPswitch S6-5 is set ON, the charger display will show a countdown and the LED's will be flashing. When the countdown reaches zero, the charger control will start the charging operation. The charger will start at fast charge high rate current (40A per 100AH).

If the battery is plugged into the charger and the open voltage before charge is greater than the battery test voltage (Section 5.6, Table 2), the charger will turn on to test the state of charge of the battery. The "80% charged" LED will blink during this testing process. If the battery is fully charged, the charger will shut off and display "FULL," otherwise it will continue at the normal high rate charge (20A/100AH). This test may require up to 30 seconds.

6.3 CHARGING THE BATTERY:

If the average volts/cell reading is less than 1.5 volts, the display shows "Lo U," the charge will not begin and the red SHUTDOWN LED will be flashing. If the battery voltage "floats" above 1.5V/Cell, the charger will automatically begin a normal charge cycle.

If the average volts/cell is greater than the High Volts limit, display shows "HI U" and the red SHUTDOWN LED will illuminate. Again, the charge will not begin.

Once the charge begins, the display will count down from 10 to 0 then show the output charging current in Amperes. The green CHARGING LED will illuminate. The cycle starts with high rate, constant current of 40A/100AH for a period of time set by switches S6-3 and S6-4 (Section 5.6, Table 3). The charge current then switches to 20A/100AH and remains at 20A/100AH until the *80% point* threshold is reached.

The *80% point* can be programmed at 2.37, 2.40, 2.42 or 2.45V/Cell by switches S6-1 and S6-2 (Section 5.6, Table 2). When the battery voltage reaches the *80% point*, the charger enters the constant voltage mode and the current gradually tapers off.

The battery voltage is regulated at the 80% point voltage level, and the current gradually tapers off.

When the battery reaches the *gassing point*, which is programmed by switches S6-6 and S6-7 (Section 5.6, Table 5):

- If the battery voltage reaches the gassing point during the full-charge-disabled period, the charger then shuts off and goes to Charge Complete mode in order to prevent the battery from gassing. A “dash” will sequence across the display and the COMPLETE LED will illuminate.
- If the battery voltage reaches the gassing point during the full-charge-enabled period, the charger will continue the regular cycle. Once the current drops to the finish rate current setting (5A per 100AH), the charge phase will change from constant voltage to constant current. The charge cycle will terminate by DV/DT sensing or override timer of 6 hours.

6.4 MANUAL TERMINATION

While charging, Manual Termination is accomplished by pressing the large red STOP push-button switch located on the front panel.

WARNING

To remove a charging battery from the charger, it is important to press the STOP push-button switch before disconnecting the battery from the charger. Failure to do this may damage the charger.

When the charge has been terminated due to MANUAL TERMINATION, the red SHUTDOWN LED will be on continuous until the battery is removed. The display will show “OFF.”

6.5 PROBLEM SHUTDOWN

Each PROBLEM SHUTDOWN termination is indicated by a flashing red SHUTDOWN LED and a FAULT code. The display indicator will remain on until the battery is disconnected from the charger.

6.6 REFRESH CHARGE

When a battery remains connected to the charger for 24 hours after the charge has been completed, the control will restart another charge cycle. The charge rate of the battery will be monitored with DV/DT termination occurring typically within 45 minutes. When the charger is in this REFRESH mode the charge current will be displayed, the CHARGING and 80% CHARGED LED's will illuminate and the CHARGE COMPLETE LED will be blinking.

6.7 MANUAL EQUALIZE

The Equalize button when pushed during charging will provide a timed three-hour charge extension after dv/dt termination has been reached. When the Equalize button is depressed an “E” will appear in the leftmost digit of the display. When the charger is actually in the Equalize mode the “E” will be flashing. Depressing the Equalize button a second time prior to the Equalize cycle will cancel the Equalize function.

6.8 AUTO EQUALIZE

The Equalize request signal is sent from the RTC at the specific time of day and day of week set in the RTC. When the Equalize function is requested, an “E” will appear in the leftmost digit of the display. When the charger is actually in the Equalize mode the “E” will be flashing. Depressing the Equalize button prior to the Equalize cycle will cancel the Equalize function.

6.9 DISPLAY MODE BUTTON

1. Press once to display the AMP-HRS returned this charge cycle.
2. Press twice to display the LENGTH OF CHARGE this cycle
3. Press three times to display the AVERAGE VOLTS PER CELL of the battery.

6.10 TEMPERATURE SENSING

The sensor provides the temperature information to the control module.

- When the electrolyte temperature reaches the factory preset temperature threshold (55°C), the temperature control is activated. The Fast Charge Current (40A/100AH) will be reduced to 20A/100AH. A character “H” will appear in the leftmost digit of the display and will remain for the rest of the charge cycle.
- When the electrolyte temperature reaches the factory preset temperature threshold (60°C):
 - If the charger is charging the battery, it will shut down. A character “H” will appear in the rightmost digit of the display and the red Fault LED will illuminate.
 - If the charger is in idle mode, it will not turn on when the battery is connected to the charger. A character “H” will appear in the rightmost digit of the display and the red Fault LED will illuminate.
- If the sensor fails or has a bad wiring connection, a character “F” will appear in the leftmost digit of the display. The charger will still function properly but the temperature control will not be active until the sensor assembly is replaced or repaired.

SECTION 7 AUTOMATIC EQUALIZE CHARGE

The automatic equalize charge is selected once a week by the real time clock. The following paragraph outlines this feature in detail.

7.1 EQUALIZE SELECT

- Auto Equalize is selected once a week at a specific time of day and day of week. Refer to Section 8.2 for the Equalize time setup.
- Auto Equalize can be disabled by setup.

7.2 EQUALIZE CANCELLATION

- Automatic equalize select cannot be canceled by pressing the Equalize button. To cancel equalize select, press the STOP button to interrupt charge, disconnect then reconnect the battery.
- Manual equalize select can be canceled by pressing the Equalize button again.

7.3 EQUALIZE ACTIVATION

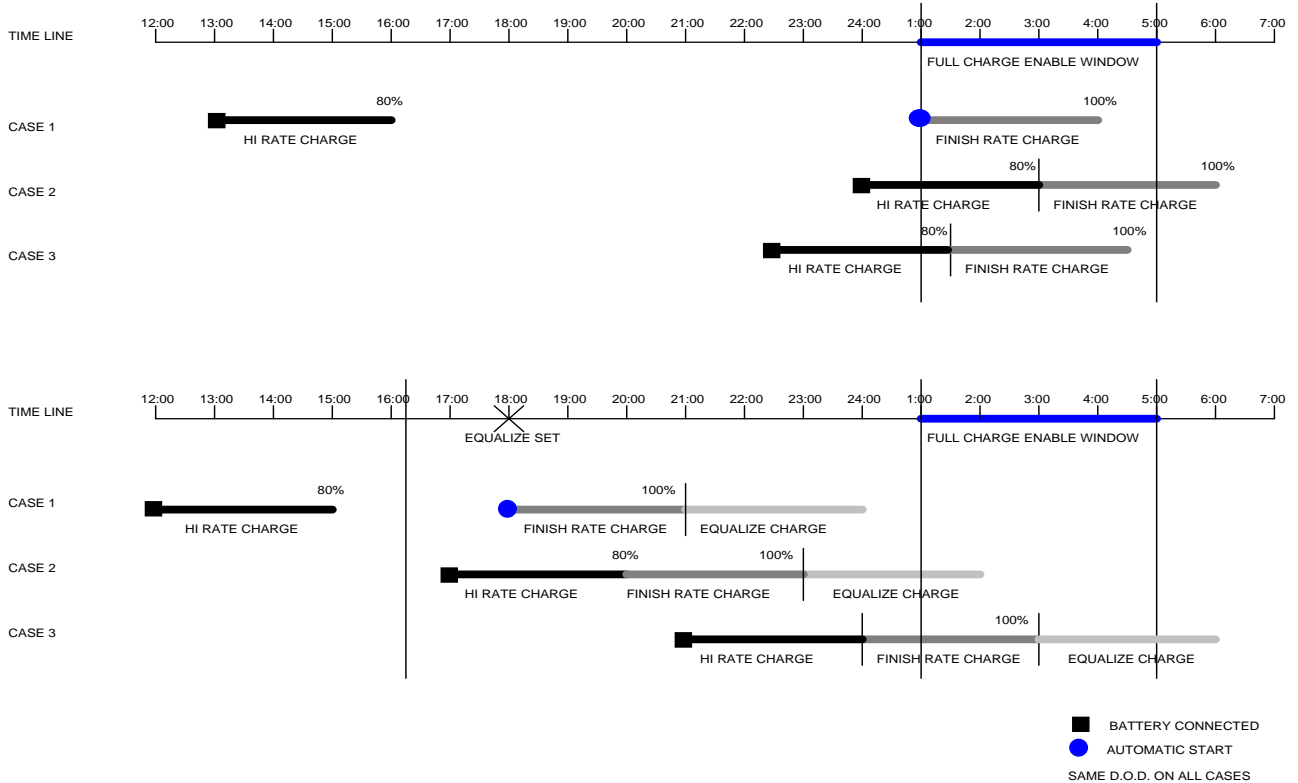
When the set time and set day are matched, equalize cycle can be activated at the following conditions:

- When the charge is in progress, the equalize cycle will start immediately after completing the 100% charge cycle.
- When the 100% charge cycle is already completed, the charger will automatically turn on to equalize charge the battery for 3 hours.
- When the 100% charge cycle is not complete because the battery voltage reached 80% before the full charge enable window was reached (1:00 to 5:00 is default setting of the full charge enable window), the charger will immediately resume to complete the 100% charge, then add three hours of equalize charge.
- When the battery is not connected, the Equalize Cycle will be accomplished the next time the battery is connected. The charger will remain on throughout the cycle until the Equalize cycle is complete and will not shut off at the gassing point.

7.4 FULL CHARGE TIME WINDOW

- When the battery voltage reaches 80% point within this window, the charge cycle will continue to fully charge the battery
- When the battery voltage reaches 80% point outside this window, the charger will shut off and resume when the ON time is reached.
- When the OFF time is reached, the charge will continue until the charge cycle is complete
- When the Equalize Time is set before the ON time of the full charge cycle, the charge cycle will resume, the charger will fully charge the battery then continue the 3 hour Equalize cycle.

7.5 AUTO EQUALIZE AND FULL CHARGE ENABLE EXAMPLES



SECTION 8 REAL TIME CLOCK (RTC)

8.1 INTRODUCTION:

The RTC is mounted inside the charger. It provides a time-of-day clock and calendar. A backup battery maintains data and operates the clock during power failure. The RTC also provides signals to the main control for:

- Seven-day control of full charge cycle disabled/enabled. The signal turn-on and turn-off time will be set separately.
- Automatic weekly Equalize charge cycle. A signal that simulates the pressing of the Equalize Select pushbutton will be sent to the main control at a programmable time of day and day of the week.

Normal display:

Time of day and day of week
12:00:00 ** THU (example)

The following information will be displayed by pressing pushbutton PB1:

- Time of day, day of month, month, year, day of week (for setting)
12:00 22FEB01 TH (example)
- Full charge cycle enabled/disabled time for each day of the week

| | | |
|-----|------|-------|
| ON | SUN: | 00:00 |
| OFF | SUN: | 23:59 |
| ON | MON: | 01:00 |
| OFF | MON: | 05:00 |
| ON | TUE: | 01:00 |
| OFF | TUE: | 05:00 |
| ON | WED: | 01:00 |
| OFF | WED: | 05:00 |
| ON | THU: | 01:00 |
| OFF | THU: | 05:00 |
| ON | FRI: | 01:00 |
| OFF | FRI: | 05:00 |
| ON | SAT: | 00:00 |
| OFF | SAT: | 23:59 |
- Automatic weekly equalize cycle activation time
EQ 02:00 SAT

8.2 SETUP

The clock, calendar and full charge cycle enable time are factory preset. However, if necessary, adjustments can be made by following steps in this section.

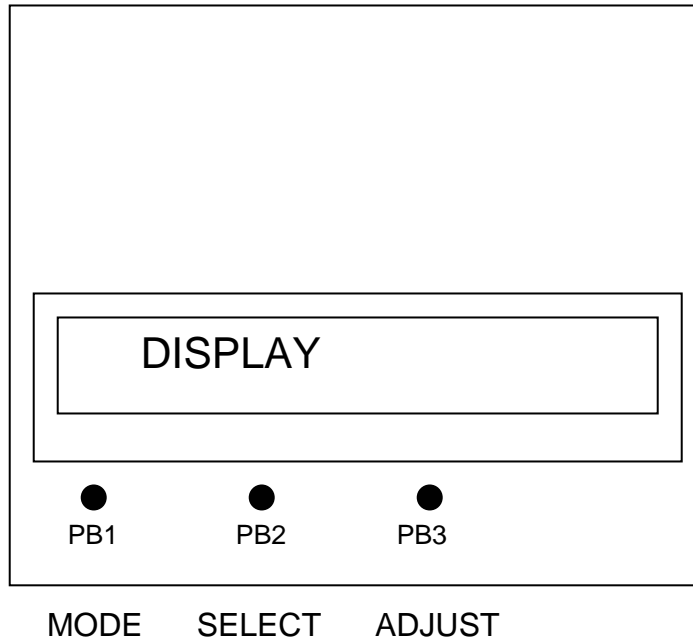


Fig. 8.1 RTC layout

8.2.1 Clock and Calendar setup

Note: The RTC is preprogrammed for automatic daylight savings time changeover. The calendar should be set correctly in order to have this function operate properly.

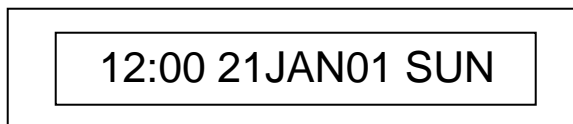


Fig. 8.2 Clock setting

- Step 1: Press pushbutton PB1.
- Step 2: The display is shown in Fig. 8.2 with "hour" flashing.
- Step 3: Press PB3 to change the setting.
- Step 4: Press PB2 to select "minute."
- Step 5: Press PB3 to change the setting.
- Step 6: Repeat step 4 until the clock and calendar are set.
- Step 7: Press PB1 to save the settings.
- Step 8: Press PB1 again to go to Full Charge Enabled/Disabled time settings.

8.2.2 Full Charge Enabled/Disabled time

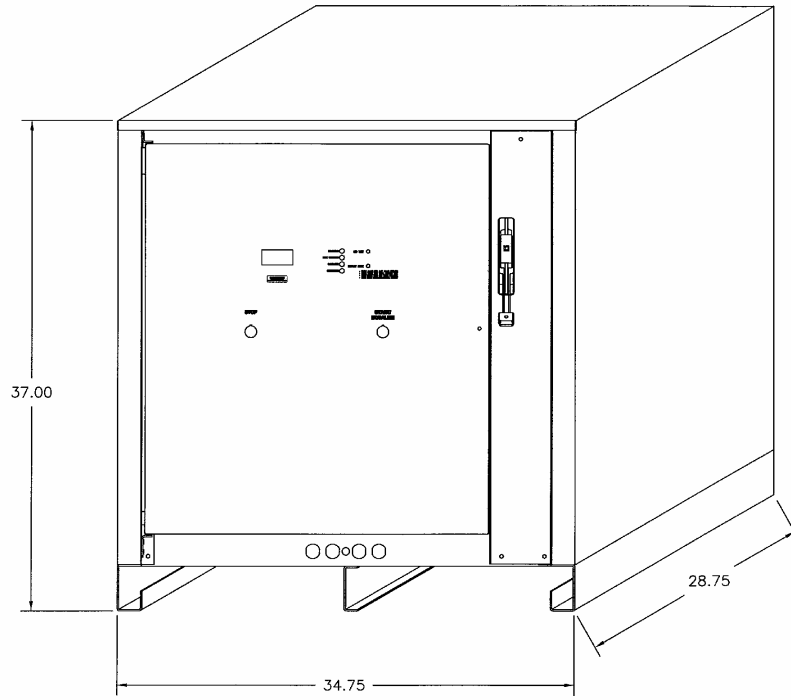
Note: - The following settings are factory preset. The default reset can be made at any time by pressing PB2 and PB3 during time display mode.

- Step 1: The display will show ON time for Sunday.
- Step 2: Press PB3 to change "hour."
- Step 3: Press PB2 to select "minute."
- Step 4: Press PB3 to change "minute."
- Step 5: Press PB1 to set OFF time for Sunday.
- Step 6: Repeat step 2 until OFF time for Saturday is set.
- Step 7: Press PB1 to proceed to the Equalize time setting.

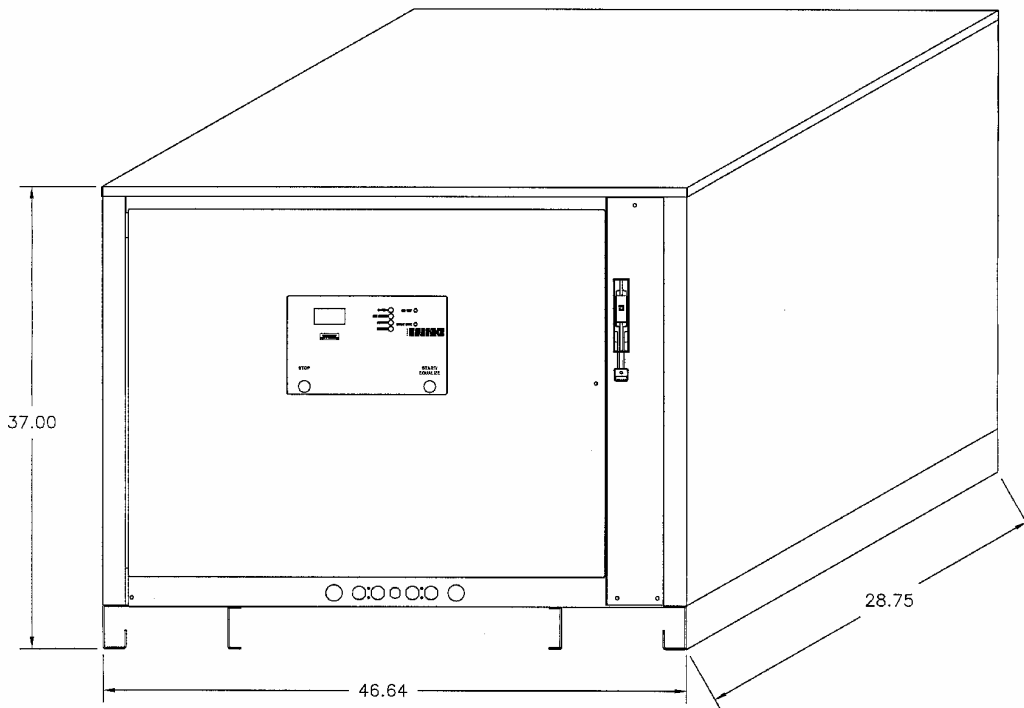
8.2.3 Automatic Weekly Equalize Cycle

- Step 1: The display will show EQ 02:00 SAT as default, with SAT flashing.
- Step 2: Press PB3 to change "day of week".
- Step 3: Press PB2 to select "hour."
- Step 4: Press PB3 to change "hour."
- Step 5: Press PB2 to select "minute."
- Step 6: Press PB3 to change "minute."
- Step 7: Press PB1 to save the settings and return to the time display mode.

SECTION 9 CHARGER CABINETS



CABINET "C"



CABINET "D"

SECTION 10 MONTHLY PREVENTATIVE MAINTENANCE

10.1 MONTHLY PREVENTATIVE MAINTENANCE

WARNING

HIGH VOLTAGES EXIST WITHIN THE CHARGER WHICH CAN CAUSE SEVERE INJURY OR DEATH. SERVICE SHOULD ONLY BE PERFORMED BY QUALIFIED SERVICE PERSONNEL. IMPROPER SERVICING MAY DAMAGE THE CHARGER.

- If a battery is being charged, terminate the charge by pressing the STOP button.
- Disconnect the battery from the charger.
- Remove AC power from the charger.
- Using compressed air, remove any dust from the inner cabinet walls and internal components of the charger.
- Wipe the exterior of the cabinet and clear any obstructions from the ventilation louvers.
- Make sure that all bolted or screwed electrical connections are tight.
- Make sure that the insulation on all cables and wires are in good condition. Replace if necessary.

10.2 CHARGER ADJUSTMENTS

10.2.1 CHANGING THE AC INPUT LINE VOLTAGE:

The THOROUGHbred chargers are designed to operate at different voltage levels. The chargers can be ordered for 240/480/575 volts or 480/575/600 volts 60 Hz electric services.

If the charger is to be operated on a different rated input voltage than the ordered value, follow the voltage changeover instructions described below (Refer to Figures 10.1.1 or 10.1.2).

10.2.2 VOLTAGE CHANGEOVER INSTRUCTIONS:

- Manually terminate the charging battery by pressing the STOP button and disconnect battery from charger.
- Remove AC power from the charger.
- Locate the Terminal Block(s) with Jumpers (one Terminal Block per phase) and the label describing the various voltage/jumper configurations. (Refer to Figures 10.1.1 or 10.1.2). The Terminal Block(s) with Jumpers are located on the Ferro-resonant Transformer.
- Change the jumpers in accordance with the Jumper label, located within the charger cabinet, for the voltage input configuration desired.
- Locate the AC fuses and fuse label. Change the fuses to the appropriate value as indicated by the circled values on the fuse label.
- Locate the Control transformer. Change the primary input connection in accordance with the voltage printed on the transformer. (Refer to Figure 10.2)
- Change the voltage level on the STOP label to the new voltage level.

- CHECKLIST:
 - Verify that the Terminal Block(s) with Jumpers are configured correctly. Make sure that all the Terminal Blocks with Jumpers have been changed properly.
 - Verify the installation of properly rated fuses.
 - Verify that the Control Transformer primary taps have been changed correctly.
 - Verify that the STOP label, located inside the door, has been corrected to the new input voltage level that the charger is set for.
- Close and secure the cabinet.
- Connect the AC power to the charger.

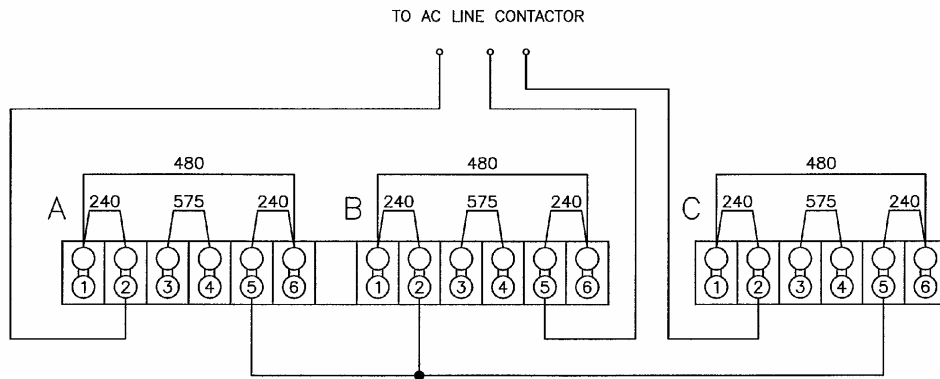


FIGURE 10.1.1 A.C. VOLTAGE SELECTOR BLOCKS (240/480/575V)

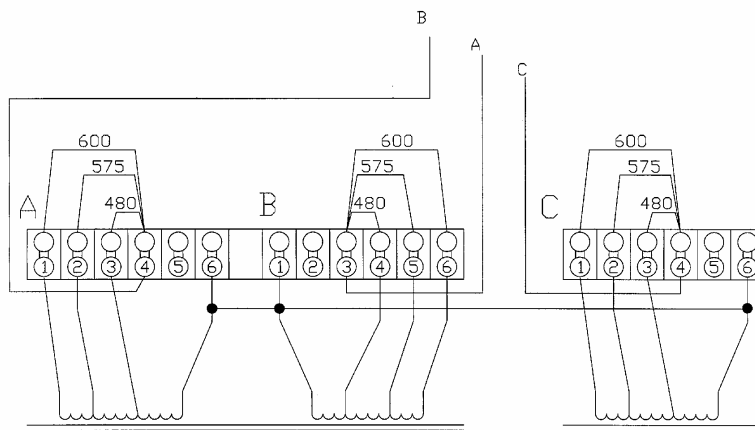


FIGURE 10.1.2 A.C. VOLTAGE SELECTOR BLOCKS (480/575/600V)

NOTE: INPUT VOLTAGE SETTING FOR CONTROL TRANSFORMER
(LEADS FROM AC INPUT MUST BE EXACT) TO AC LINE CONTACTOR

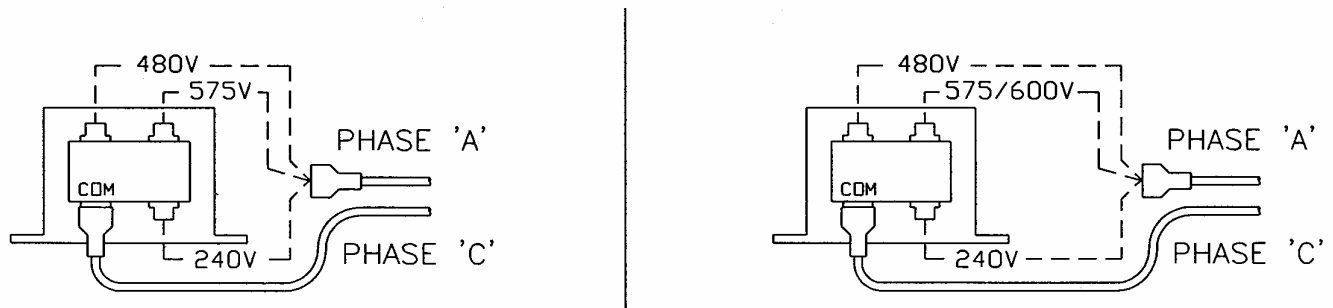


FIGURE 10.2

A.C. VOLTAGE SELECTION ON PRIMARY SIDE OF CONTROL TRANSFORMER

WARNING

HIGH VOLTAGES EXIST WITHIN THE CHARGER WHICH CAN CAUSE SEVERE INJURY OR DEATH. SERVICE SHOULD ONLY BE PERFORMED BY QUALIFIED SERVICE PERSONNEL. IMPROPER SERVICING MAY DAMAGE THE CHARGER.

SECTION 11 TROUBLESHOOTING GUIDE

SYMPTOM 1 POWER IS APPLIED BUT THE DISPLAY IS NOT ON

- Make sure the input line from the AC power outlet is connected at the AC fuse block properly. Verify the AC voltage at the fuse block.
- Locate the control transformer. Verify the voltage at the primary of the transformer. If there is no voltage, check the wiring between the control transformer and the contactor.
- Verify the secondary voltage of the control transformer across terminals 5 and 7. The voltage should be approximately 18-20 Volts RMS. If there is no voltage, the transformer is defective and should be replaced. If the secondary voltage is extremely high or low, verify that the AC voltage is connected to the proper primary inputs of the control transformer. (Refer to SECTION 10.2.2)
- Locate the Main Control Board and the Cell Select Board. Verify the proper connection of the boards and cables.

SYMPTOM 2 DISPLAY IS ON BUT CHARGER WILL NOT START

- If the “sequenced dash” remains displayed when the battery is plugged in, check the battery connections and the output fuse for open fuse.
- If the charger starts immediately without displaying “PUSH,” then shuts off after 30 seconds ~ 2 minutes and displays “FULL,” the battery is fully charged.

SYMPTOM 3 *DISPLAY COUNTS DOWN BUT CHARGER SHUTS DOWN IMMEDIATELY*

- If “Hi I” is displayed within first 10 seconds after power-up, check the phase sequence.
- If “Hi I” is displayed after 10 seconds, check all wiring connections, referring to SECTION 12 SCHEMATICS.

The following checks should be performed to resolve this problem:

- Is the cable harness connected properly between the main control board, the adaptor board and the inductor boards (IB1 and IB2)?

For two transformer circuits in the left (T1 & T2):

- Is “COMMON” of the control transformer T5 connected to phase 3 of the contactor?
- Is the other terminal of the control transformer T5 connected to phase 1 of the contactor?
- Is terminal T1 of the contactor K1 connected to terminal A2 of the main transformer T1 (transformer with 12 position terminal block)?
- Is terminal T2 of the contactor K1 connected to terminal B5 of the main transformer T1 (transformer with 12 position terminal block)?
- Is terminal T3 of the contactor K1 connected to terminal C2 of the second transformer T2 (transformer with 6 position terminal block)?
- Are terminals A5, B2 and C5 connected together?
- Are the cables from capacitor winding 7 of the main transformer T1 and from terminal M3 of the inductor board IB1 connected to the same side of the resonant capacitor?
- Is the cable from capacitor winding 8 of the main transformer T1 connected to the power resistor mounted near the capacitor?
- Are the cables from the other side of the power resistor and from terminal M4 of the control assembly connected to the same side of the capacitor?
- Are the cables from capacitor winding 7 of the second transformer T2 and from terminal M1 of the inductor board IB1 connected to the same side of the resonant capacitor?
- Is the cable from capacitor winding 8 of the second transformer T2 connected to the power resistor mounted near the capacitor?
- Are the cables from the other side of the power resistor and from terminal M2 of the control assembly connected to the same side of the capacitor?

For two transformer circuits in the left (T3 & T4):

- Is “COMMON” of the control transformer T6 connected to phase 3 of the contactor?
- Is the other terminal of the control transformer T6 connected to phase 1 of the contactor?
- Is terminal T1 of the contactor K2 connected to terminal A2 of the main transformer T4 (transformer with 12 position terminal block)?
- Is terminal T2 of the contactor K2 connected to terminal B5 of the main transformer T4 (transformer with 12 position terminal block)?
- Is terminal T3 of the contactor K2 connected to terminal C2 of the second transformer T3 (transformer with 6 position terminal block)?
- Are terminals A5, B2 and C5 connected together?
- Are the cables from capacitor winding 7 of the main transformer T4 and from terminal M3 of the inductor board IB2 connected to the same side of the resonant capacitor?

- Is the cable from capacitor winding 8 of the main transformer T4 connected to the power resistor mounted near the capacitor?
- Are the cables from the other side of the power resistor and from terminal M4 of the control assembly connected to the same side of the capacitor?
- Are the cables from capacitor winding 7 of the second transformer T3 and from terminal M1 of the inductor board IB2 connected to the same side of the resonant capacitor?
- Is the cable from capacitor winding 8 of the second transformer T3 connected to the power resistor mounted near the capacitor?
- Are the cables from the other side of the power resistor and from terminal M2 of the control assembly connected to the same side of the capacitor?

SYMPTOM 4 CHARGE TERMINATES EARLY

- Fault code "**Lo U**" - Low volts per cell - the average battery voltage is less than 1.5 V/Cell. Check for bad cells.
- Fault code "**Hi U**" - High volts per cell - the average battery voltage is greater than the high voltage limit. The battery may be fully charged before connecting to the charger.
- Fault code "**disc**" - Battery is disconnected from charger during charge.
- Fault code "**dur**" - Charge time exceeded - the battery voltage did not reach the gassing point within 10 hours. Check for bad cells or deep discharge condition.
- Fault code "**Lo I**" - Low charging current - no charging current detected or charging current is too low. Check the DC fuse for open fuse.
- Display "**OFF**" - Charge cycle is terminated by pressing the STOP button.

SECTION 12 SCHEMATIC

See following page

CHARGER WARRANTY

APPLIED ENERGY SOLUTIONS warrants that each new and unused battery charger manufactured and supplied with good workmanship is free from any known mechanical defect, provided that (A) the product is installed and operated in accordance with the accepted industrial standards and in accordance with the printed instructions furnished by APPLIED ENERGY SOLUTIONS, (B) the product is used under normal conditions for which designed, (C) the product is not used in a corrosive, abnormally dusty or high humidity moisture condensing environment, and (D) the product is not subjected to misuse or negligence, and the product receives proper care, protection and maintenance under supervision of competent personnel.

Warranty Terms and Conditions

APPLIED ENERGY SOLUTIONS Thoroughbred Industrial Battery Chargers are warranted for 10 Years⁽¹⁾, which begins on the date of shipment from APPLIED ENERGY SOLUTIONS.

NOTES: ⁽¹⁾Warranty covers parts and labor,

AC fuses and DC fuses are not warranted unless they are found to be defective prior to use.

NON-TRANSFERABLE WARRANTY. This warranty is extended by APPLIED ENERGY SOLUTIONS only to the original user (purchaser) of new equipment from APPLIED ENERGY SOLUTIONS or one of its authorized agents. The product purchased under this agreement shall be used exclusively by the buyer. There shall be no third party beneficiary of this warranty.

REPAIR LIMITATIONS. APPLIED ENERGY SOLUTIONS has the right to site inspection and judgment of the claimed defects in any product covered by this warranty. APPLIED ENERGY SOLUTIONS' liability is limited to the repair of any defects found to exist by APPLIED ENERGY SOLUTIONS or at APPLIED ENERGY SOLUTIONS' option, the replacement of the defective product.

APPLIED ENERGY SOLUTIONS and its authorized agents shall not be liable for direct or indirect damages in excess of such repair or replacement. In no event shall the purchaser be entitled to recover for contingent expenses from, but not limited to, telephone calls, telegrams, travel expenses, lodging, duties and taxes, labor, rental or replacement equipment, loss of business or profit or other commercial losses.

CONTINUED USE OF DEFECTIVE PRODUCTS. The continued use of an APPLIED ENERGY SOLUTIONS Industrial Battery Charger that is known to be defective VOIDS ALL WARRANTIES.

REPAIR OF MODIFIED EQUIPMENT. Except as authorized in writing the warranty specified does not cover any equipment that has been repaired by any party other than APPLIED ENERGY SOLUTIONS or its authorized agents. Except as authorized in writing the warranty specified does not cover any equipment that has been modified, mechanically or electrically by any party other than APPLIED ENERGY SOLUTIONS.

WARRANTY EXPENSE LIMITATIONS. APPLIED ENERGY SOLUTIONS will limit the warranty expense of all chargers to be paid at a maximum of the original purchase price of the charger.

The provisions of this warranty shall not apply to product in use outside of the continental USA.

Except as stated above, all other warranties and conditions, either expressed or implied, including implied warranties of merchantability and fitness for a particular purpose, are excluded and buyer assumes all risk and liability resulting from the use of the goods. APPLIED ENERGY SOLUTIONS neither assumes or authorizes any persons to assume for APPLIED ENERGY SOLUTIONS any other liability in connection with the sale or use of the goods sold and there are no oral agreements or warranties collateral to or affecting this written warranty.

When installing, servicing or operating these products, safe practices should be used by skilled and qualified technical persons.