

BRONCO

WITH SILICON CONTROLLED RECTIFIER (SCR) 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 GENERER 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 BRONCO 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 beneath 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 and labels against your order and specifications.

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

SECTION 3 INTRODUCTION

The Bronco SCR chargers represent a new level of sophistication in the microcontroller-based truck charger line utilizing Silicon Controlled Rectifier (SCR) technology for reliability and flexibility.

State of the art single chip microcontroller designs with flash memory provide highly integrated solutions including the foundation for future battery management systems. The charger control offers a wide range of functional options such as selectable outputs, selectable charge profiles including user defined profile, charge functions, automatic battery cell selection, real time clock, etc. All programming functions are user-friendly, timesaving and accessible from the front panel with password protection.

A normally open AC contactor is used to connect the AC power from the charger input to the main power transformer when charging the battery.

SECTION 4 CONTROL FEATURES

4.1 CONTROL FEATURES

- Advanced Silicon Controlled Rectifier (SCR) technology
- Multi-voltage charging capability
- Multi-Amp-Hour charging capability
- Fully controlled by microprocessor
- Multiple charge profiles designed for Flooded, Gel, VRLA batteries and user defined profile.
- Charge time of eight hours or less on a 100% discharged battery
- Temperature compensation
- Real-time clock built in
- Three start modes:
 - Auto start with five second delay
 - Selectable delayed start
 - Push to start
- Programmable automatic refresh frequency
- Interface jack ready for remote control and monitoring options
- Battery protection with override timers, incorrect battery sensing and negative slope termination
- Cool-down time display after charge complete
- Automatic shutdown for the following conditions:
 - 80% does not occur in 9 hours
 - Battery voltage per cell is too high or too low
 - Charging current is too high or too low
 - Battery cable is disconnected during charging
- Four-digit alphanumeric display indicating:
 - Charge current
 - Equalize in process
 - Clock time
 - Charge setup parameters
 - Charge data
 - Fault messages

- Four LED indicators indicating:
 - Charging
 - 80% charged
 - Charge complete
 - Fault shutdown
- Four push buttons for setup, display and control:
 - Review mode (before charging)
 - Selected charge profile
 - Selected start delay
 - Selected equalize frequency
 - Selected refresh charge frequency
 - Real-time clock
 - Setup mode (password protected)
 - Set desired charge profile and Amp-Hour (for non-BIT configuration)
 - Set desired start delay
 - Set desired equalize frequency
 - Set desired refresh charge frequency
 - Cool-down time display disabled/enabled selection
 - Real-time clock setup
 - Display mode (during charging)
 - Manual stop
 - Equalize select/deselect
 - Display archived charge data
 - Display current charge data
- Previous charge cycle data retention - 10 cycles of 7 parameters (Amp-Hour returned, total charge time, battery voltage prior to charge, battery voltage at the end of charge cycle, charge time until the gassing voltage is reached, output current at the beginning of charge and at the end of charge)
- Current charge data (Amp-Hour returned, total charge time, battery voltage prior to charge, battery voltage during charge, charge time until the gassing voltage is reached and output current at the beginning of charge)
- Watering control signal
- Manual and automatic equalization
- AC power failure recovery
- Random restart after AC failure
- Non-volatile memory for all settings
- Battery Identification Transmitter (BIT) compatible.

4.2 CHARGE PROFILES

Charge Profile No. 1 Flooded Profile (FLD)

The charger is in constant current mode (17A per 100Ahr) until the battery reaches the gassing voltage (2.37V). When the gassing voltage is reached the charger maintains the battery voltage and allows the charging current to slowly decrease until it reaches the finish current value (5A per 100Ahr). When the current drops to the finish rate current, the charger will stay in the constant current mode until one of the following conditions is reached:

- dv/dt , OR
- 6 hours from the gassing point.

Charge Profile No. 2 AGM Sealed Profile No.1 (AGM1)

The charger is in constant current mode (17A per 100Ahr) until the battery reaches the gassing voltage (2.40V per Cell). After the gassing voltage is reached the charger maintains the battery voltage and allows the charging current to slowly decrease until it reaches the finish rate current (3A per 100Ahr). When the current reaches the finish rate current value, the charger again returns to the constant current mode until one of the following conditions is reached:

- dv/dt , OR
- 3.5 hours from the gassing point

Charge Profile No. 3 GEL Sealed Profile No. 1 (GEL1)

This is a two-stage charge profile. The Green Charge LED will be illuminated throughout the charge cycle. The cycle starts with high rate, constant current (17A per 100 Ahr). The constant voltage phase begins after gassing point (2.33V per Cell) is detected. The 80% charged LED will illuminate during this phase.

During the constant voltage phase, the charger voltage limit is regulated to the gassing point level and the current is allowed to gradually drop. During this phase, the charger will shut off if:

- di/dt sensing, OR
- Negative slope is detected in charge current OR
- Six hours from gassing point

Charge Profile No. 4 Flooded Tubular/Cold Storage Profile (COLD)

This profile is for a Flooded Battery used in Cold Storage application, or a Flooded Tubular Battery. The charger is in constant current mode (17A per 100Ahr) until the battery reaches the gassing voltage (2.45V per Cell). When the gassing voltage is reached the charger maintains the battery voltage and allows the charging current to slowly decrease until it reaches the finish rate current value (5A per 100Ahr). When the current drops to the finish current, the charger will stay in the constant current mode until one of the following conditions is reached:

- dv/dt , OR
- 6 hours from the gassing point.

Charge Profile No. 5 AGM Sealed Profile No. 2 (AGM2)

The charger is in constant current mode (15A per 100Ahr) until the battery reaches the gassing voltage (2.37V per Cell). After the gassing voltage is reached the charger maintains the battery voltage and allows the charging current to slowly decrease until it reaches the finish current (3A per 100Ahr). When the current reaches the finish current value, the charger again returns to the constant current mode until one of the following conditions is reached:

- dv/dt , OR
- 3.5 hours from the gassing point

Charge Profile No. 6 GEL Sealed Profile No. 2 (GEL2)

The charger's microprocessor adjusts the output so that the charger is in constant current mode (16A per 100Ahr) until the battery reaches the gassing voltage (2.40V per Cell). After the gassing voltage is reached, the charger maintains this battery voltage and allows the charging current to slowly decrease until it reaches the finish current (1.5A per 100Ahr). When the current reaches the finish current value, the charger will maintain the constant current mode (1.5A per 100Ahr) for three hours.

Charge Profile No. 7 User Defined Profile (USER)

The charger is in constant current mode at a user defined current (10A to 17A per 100Ahr, in increments of 1A) until the battery reaches the user defined gassing voltage (2.29V to 2.45V per Cell, in increments of 40mV). When the gassing voltage is reached, the charger maintains the battery voltage and allows the charging current to slowly decrease until it reaches the user defined finish current (1A to 5A per 100Ahr, in increments of 1A). When the current drops to the finish rate current, the charger will stay in the constant current mode until one of the following conditions is reached:

- dv/dt , OR
- user defined finish rate time (6 hours from the gassing point)

4.3 FAULT MESSAGES

- Fault message - "*LOW VOLTAGE*" - 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 message - "*HIGH VOLTAGE*" - High volts per cell - Greater than 2.80 or 2.85 V/Cell (set with 80% point).
- Fault message - "*BATTERY DISCONNECTED*" - Battery was disconnected from charger during charge.
- Fault message - "*CHARGE DURATION EXCEEDED*" - Charge time exceeded - If the battery voltage does not reach a preset voltage in a preset time due to defective cell(s).
- Fault message - "*LOW CURRENT*" - Low charging current - Charging current less than approximately 3 amps.
- Fault message - "*HIGH CURRENT*" - The charger will shut down for abnormal current.
- Fault message - "*LOSS OF PHASE*" - The charger will shut down.
- Fault message - "*BIT ERROR*" - The charger failed to detect the BIT.

4.4 LED INDICATORS

- GREEN - *CHARGING* - Charger is charging the battery.
- YELLOW - *80% CHARGED* - The battery voltage is greater than the preset gassing voltage.
- BLUE - *CHARGE COMPLETE*
 - Solid: The charge cycle has been terminated normally.
 - Blinking every 4 seconds during charging: The charger is set to Equalize at the end of the charge cycle.
 - Flashing, AND the CHARGING (GREEN) and 80% (YELLOW) LED's on solid: The charger is in the refresh mode.
 - Blinking alone: The charger is in Setup Mode.
- RED - *SHUTDOWN* - The unit has shut down for a fault.

4.5 DIGITAL ALPHANUMERIC READOUT

The readout displays the following information:

Start mode:

Battery capacity, number of battery cells and battery profile.

Charge mode and Archived data:

Charge current, equalize in process and archived charge data.

Idle mode:

Charge profile, battery capacity, number of battery cells, equalize frequency, refresh frequency, clock time and archived charge data.

Archived charge data:

Returned Amp-Hour, charge time, time in high rate, voltage per cell before charge, voltage per cell during charging or at the end of charge, output current at the beginning of charge and at the end of charge.

Shutdown mode:

Scrolled fault messages.

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 77°F (25°C), with occasional and brief periods of ambient temperature as high as 104°F (40°C). Combustible materials, open flames and smoking should not be permitted in or near the charging room.

WARNING

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

5.2 MOUNTING

The 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 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.

NOTE

The input connections are NOT phase sensitive.

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 near the fuse block. The AC input cable is to be connected to the proper AC INPUT terminals within the charger cabinet. The input connections are not phase sensitive.

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 a 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 BATTERY IDENTIFICATION TRANSMITTER WITH TEMPERATURE SENSOR (OPTIONAL)

1. Drill 7/64" (0.109") hole in the center of the positive post, at least 1/2" (0.500") deep.
2. Repeat step 1 for negative post.
3. Select one inter-cell connection bar in the center of the battery for mounting the thermal sensor. Drill 7/64" (0.109") hole in the center of the selected bar, at least 1/2" (0.500") deep.
4. Remove 2 nylon screws on BIT, holding the end cap in place, which will reveal 3 rotary switches (S1, S2, and S3). Referring to Table 5.2, set each rotary switch per battery's specification.

NOTE

THESE SETTINGS ARE VERY CRITICAL, AS THE INCORRECT SETTING COULD SEVERELY DAMAGE THE BATTERY.

5. Replace the end cap; do not over tighten the nylon screws.
6. Secure BIT device to inter-cell bar using 2 large cable ties. Route positive and negative cables from BIT to their respective posts on the battery. Running the wires underneath the inter-cell bars makes for a cleaner installation.
7. Run the thermal sensor to the inter-cell connection bar selected in step 3. With the potted side up, secure sensor to bar using the supplied screw (#6 x 3/4"). Do not over tighten.
8. Using the supplied metal screws (#6 x 1/2"), connect the POSITIVE lead from the BIT unit to the POSITIVE post on the battery. Then connect the NEGATIVE lead from the BIT to the NEGATIVE post on the battery.
9. Coat connections, cover each screw and terminal with grease to prevent corrosion.
10. Secure wires with supplied cable ties.

Table 5.2

S1	AMP-HOUR	S2	NO. OF CELLS	S3	PROFILE
0	425	0	6	0	FLD
1	475	1	6	1	AGM1
2	510	2	9	2	GEL1
3	540	3	12	3	COLD
4	600	4	18	4	AGM2
5	680	5	24	5	GEL2
6	750	6	36	6	USER
7	765	7	40	7	N/A
8	865	8	N/A	8	N/A
9	965	9	N/A	9	N/A
A	1050	A	N/A	A	N/A
B	1190	B	N/A	B	N/A
C	1450	C	N/A	C	N/A
D	N/A	D	N/A	D	N/A
E	N/A	E	N/A	E	N/A
F	N/A	F	N/A	F	N/A

SECTION 6 CHARGER OPERATING PROCEDURE

6.1 POWER UP

Once power has been applied to the charger, the readout on the front panel will display “CHARGER READY”. This indicates the charger is in the idle mode of operation, awaiting a battery connection. All charger setup parameters and charge data of the last 10 cycles can be reviewed using the readout and four push buttons below the readout. The factory-set parameters can be changed by using the readout, the four push buttons below the readout and the rotary switch S2. The setup mode is password protected. Refer to Section 8 for details. Lamp test may be performed at any time by pressing push buttons F2 and F3.

6.2 BEFORE CHARGING

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 and the amp-hour ratings of the battery to be charged **MUST** be within the range specified on the nameplate.

6.2.1 OPERATION *WITH* A BATTERY IDENTIFICATION TRANSMITTER (BIT)

If the charger is factory set to operate with a BIT and the BIT is installed on the battery, the charger will automatically turn on and self-adjust the output to match with the capacity, the number of cells and the charge profile programmed in the BIT. The charger also receives the battery temperature information before charge and compensates the gassing point accordingly.

If a BIT is not detected (the BIT fails to transmit the information to the charger or it is not installed on the battery), the charger will display fault code “BIT ERROR” then it will display flashing “CODE” prompting the user to enter the password to go to the setup mode. An audible alarm is activated and lasted until the user enters the setup mode. The user must enter the setup mode, use push button F3 to reprogram or review all charge parameters of each available cell count then press push buttons F1 and F2 simultaneously to start charging the battery. Refer to Section 8 for programming details.

The charge cycle will not begin if the number of cells programmed in the BIT is greater than the maximum number of cells specified on the charger nameplate or if the polarity of the battery cable is reversed. The output current of the charger will be limited to the maximum Amp-Hour rating if the Amp-Hour programmed in the BIT is greater than the maximum rating indicated in the charger nameplate.

6.2.2 OPERATION *WITHOUT* A BATTERY IDENTIFICATION TRANSMITTER

If the charger is not factory set to operate with a BIT and the number of cells of the battery is within the range specified on the nameplate, the charger will automatically detect the number of cells when the battery is plugged in and self-adjust the output to match with the preset parameters set in the setup mode.

The Amp-Hour and the charge profile are factory set to the minimum Amp-Hour (425AH) and the Flooded profile respectively. The user **must** change these settings for EACH number of cells prior to charging the battery for the first time. For example, the user is able to set the Amp-hour and the charge profile to 680AH/Flooded profile for 6 cell and 865AH/Sealed profile for 18 cell batteries.

Notes:

- *Without using the BIT, the user can only select either 36 OR 40 cells. Refer to Section 7 for details*
- *The user setting of the Amp-Hour is limited to the maximum Amp-hour rating on the nameplate. Refer to Section 8 for programming details.*
- ***Two different Amp-Hour ratings cannot be programmed for the same cell count.***

The charge cycle will not begin if the number of cells of the battery are greater than the maximum number of cells specified on the nameplate or the polarity of the battery cable is reversed.

6.3 STARTING CHARGE

Depending on the preset starting mode, the charge cycle can be started in the following modes. Refer to Section 8 for programming details:

- Immediate start
- Delayed start in hours
- Automatic start at a preset time of day
- Manual start by pressing Start/Equalize button (F4)

Once the battery is connected to the charger, the display will go through the following steps:

- Display “READ” with all LEDs flashing for 30 seconds (if the charger is configured to operate with the BIT) or display “READ” for 3 seconds (if the charger is configured to operate with the BIT)
- Display the BIT programmed Amp-hour.
- Display the BIT programmed charge profile
- Display the BIT programmed number of cells of the battery under charge.
- Countdown from 9 to 0 with all the LED’s flashing.
- Energize the contactor connecting power to the charger
- Display the output current

6.4 CHARGING THE BATTERY

The green CHARGING LED will illuminate. The output current will increase slowly until it reaches the preset high rate current. The charger will control the output current and voltage as defined in the preset profiles. Refer to Section 4 for details in the preset profiles.

The charge cycle will complete automatically by the method determined by the charge profile, the readout will display cool-down time (default) or “CHARGE COMPLETE”. The display option is selected in the setup mode.

6.5 MANUAL TERMINATION

To manually terminate the charge, press the red STOP push button switch located on the front panel.

When the charge is terminated due to manual termination, the red SHUTDOWN LED will remain on until the battery is removed. The readout will display “STOP PB PRESSED”.

6.6 PROBLEM SHUTDOWN

Each of the PROBLEM SHUTDOWN terminations is indicated by a red SHUTDOWN LED and a fault message. The red SHUTDOWN LED will remain on and the fault message will scroll across the display until the battery is disconnected from the charger. Refer to Section 4 for details.

6.7 REFRESH CHARGE (Flooded Profile only)

If a battery remains connected to the charger for a preset time after the charge has been completed, the control will start a refresh charge cycle at the finish rate current. 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 LED and 80% CHARGED LED will illuminate and the charge COMPLETE LED will be blinking. Refer to Section 8 for details in setting up the refresh frequency.

6.8 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 left-most 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.

6.9 AUTO EQUALIZE

The automatic equalize can be activated in two ways:

- Equalize will be activated each time the number of preset cycles are reached. The remaining number of charge cycles until the next equalize cycle can be reviewed by pressing push button F4 prior to charge.
- The Equalize will be activated if a charge cycle is completed at any time during the weekend. Only one equalize cycle will be activated during the weekend.

When the Equalize function is requested, an “E” will appear in the left-most digit of the display. When the charger is actually in the Equalize mode the “E” will be flashing. Refer to Section 8 for details in setting up the Equalize frequency or the weekend equalize. Selecting the manual equalize cycle by pressing the manual equalize button F4 will not change the counter of the auto equalize or affect the weekend equalize setting.

6.10 WATERING FUNCTION

A watering signal is provided via the Auto Cell Select Board with a 24VAC watering valve connecting to the screw-type terminal block P5. The watering signal is on for 5 minutes at the end of every charge cycle. If equalize charge is selected, the watering occurs immediately after the equalize cycle.

SECTION 7 AUTO CELL SELECT

7.1 OPERATION WITH A BATTERY IDENTIFICATION TRANSMITTER

The Auto Cell Select (ACS) board receives the cell count information from the Main Control/Battery Identification Transmitter, generates the average voltage per cell and sends this back to the main control board.

7.2 OPERATION WITHOUT A BATTERY IDENTIFICATION TRANSMITTER

The “raw” open battery voltage prior to charge is detected in the Auto Cell Select (ACS) board. The ACS board determines the number of cells, generates the average voltage per cell and sends the information to the main control (MC) board before charging. If the number of cells exceeds the range specified in the nameplate, the charger will not turn on and the readout will display “HIGH VOLTAGE”.

If the controller cannot determine the correct number of cells due to the state of charge of the battery (fully charged or deep discharged), the control will test the battery until it can determine the correct number of cells. This process may take several minutes, the 80% LED will flash and the read-out will display “ADJUSTING”. If the battery is deep discharged the low volts override can be done by pressing both buttons F1 and F2 simultaneously during the “ADJUSTING” mode. The charger is forced to turn on for a period of 15 minutes. The charger may switch to regular charge cycle or return to the testing mode after that period.

If a 36 or 40 cell battery is to be used, the user must set DIP switch S2 on the ACS board. Refer to Section 8 for details.

SECTION 8 CHARGER CONTROL SETUP

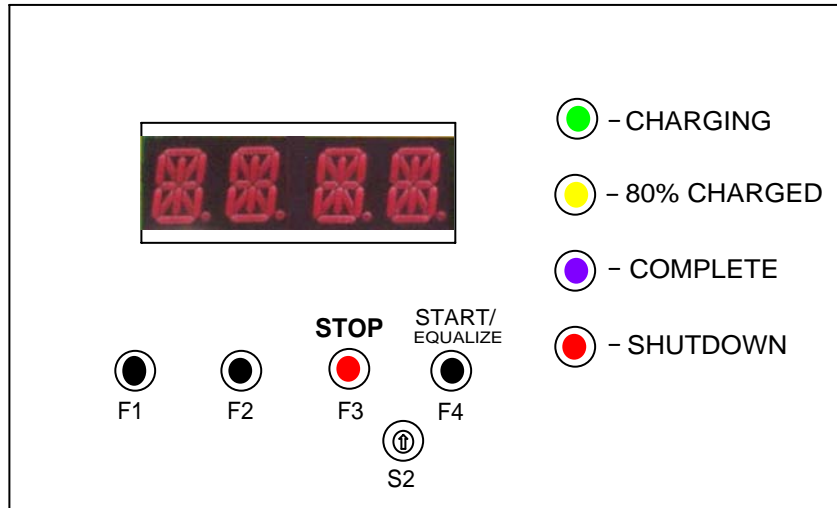


Figure 8.1 Front Panel Control

IMPORTANT:

THIS CHARGER, WITHOUT A BATTERY IDENTIFICATION TRANSMITTER, AUTOMATICALLY DETECTS THE NUMBER OF CELLS OF THE CONNECTED BATTERY AND OUTPUTS FACTORY PRESET AMP-HOUR AND CHARGE PROFILE. THE AMP-HOUR AND CHARGE PROFILE MUST BE RE-PROGRAMMED BEFORE CHARGING THE BATTERY FOR THE FIRST TIME. SEE THE FOLLOWING SECTION FOR DETAILS.

8.1 OVERVIEW

Setup Mode

This mode is accessible when the charger is powered and the battery is not connected or when the BIT is not detected. All factory-preset parameters such as Amp-hour Rating, Charge Profile, Start Delay, Equalize Charge, Refresh Frequency and Clock can be re-programmed by pressing the push buttons and rotating the front panel rotary switch.

NOTES

- Use the small, flat screwdriver (stored in door pocket) to rotate S2 to the desired display value.
- Press F1 and F2 simultaneously at anytime to exit the setup mode and return to "CHARGER READY."

Review Mode

This mode is accessible when the charger is powered and the battery is not connected. All preset parameters such as Start Option, Equalize Option, Refresh Option, Clock Time, Amp-Hour Rating, Charge Profile and Archived Charge Data may be reviewed by pressing the push buttons.

Operating Mode

This mode is accessible during charging. Push buttons are used to interrupt charge, select equalize cycle and review charge data.

8.2 SETUP MODE

8.2.1 SETUP PARAMETERS

Amp-Hour Rating Factory set: 425AH.

Nameplate (located on front door) indicates the allowable range.

Charge Profiles Factory set: Flooded Profile

- FLD (Flooded): I/E/I - 17A per 100AH / 2.37V per Cell / 5A per 100AH
- AGM1 (AGM Sealed #1): I/E/I - 17A per 100AH / 2.40V per Cell / 3A per 100AH
- GEL1 (GEL Sealed #1): I/E - 17A per 100AH / 2.33V per Cell
- COLD (Flooded Cold Storage): I/E/I - 17A per 100AH / 2.45V per Cell / 5A per 100AH
- AGM2 (AGM Sealed #2): I/E/I - 15A per 100AH / 2.37V per Cell / 3A per 100AH
- GEL2 (GEL Sealed #2): I/E/I - 16A per 100AH / 2.40V per Cell / 1.5A per 100AH
- USER (User Defined for Non-BIT version only):
 I/E/I - High Rate Current: 10 to 17A/100AH
 Gassing Voltage: 2.29, 2.33, 2.37, 2.41 and 2.45V/Cell
 Low Rate Current: 1 to 5A/100AH - Finish Rate Timer 6 hrs

Start Delay Factory set: No Delay Automatic Start

- D 0 No Delay – Automatic start
- D 1 to D 13 1 to 13 hour start delay
- MS Manual start – Press F4 to start
- 12:00 Time of day start delay

Automatic Equalize Factory set: No Equalize Selected

- E 0 No Equalize set
- E 1 to E 14 *Setup Mode*: Indicates how often Equalize cycle occurs (every 1-14 charge cycles)
Review Mode: Indicates number of charge cycles remaining until next Equalize
- WKN Equalize occurs if the charge cycle ends during Saturday or Sunday






Automatic Refresh Factory set: Refresh every 24 hours

- R 0 No Refresh cycle set
- R 6 to R 90 Refresh cycle occurs every 6, 12, 18, ..., 90 hours after charge complete


Cool-down Display Factory set: Display elapsed time after charge complete

- CD Y Display elapsed time after charge complete
- CD N Display "CHARGE COMPLETE" after charge complete





8.2.2 AMP-HOUR AND CHARGE PROFILE SETUP

STEPS	INPUTS	DISPLAY	DESCRIPTION
1	OF1 OF2 OF3 OF4	CHARGER READY	Charger is in Idle Mode without battery connected
2	OF1 OF2 ●F3 ●F4	CODE (flashing)	To enter Setup Mode, press F3 and F4 simultaneously during "CHARGER READY" OR Setup Mode will be prompted if the BIT is not detected
3	 S2	"1" then "2" then "3"	Enter 3 digit password using rotary switch S2. (1,2,3 for the 1st time - factory set password is 1,2,3)
4	OF1 OF2 OF3 OF4	SETUP	Setup Mode Entered - Blue LED flashing
5	OF1 OF2 ●F3 OF4	CL 6 or CL 12	Press F3 - Minimum Cell Count is displayed
6	OF1 OF2 ●F3 OF4	425	Press F3 - Previously set AH is displayed - factory set at 425AH
7	 S2	750	Change AH using S2 if necessary or go to the next step - 425,475,510,540,600,680,750,765,865,965,1050,1190,1450
8	OF1 OF2 ●F3 OF4	FLD	Press F3 - Previously set Charge Profile is displayed Factory set "Flooded"
9	 S2	AGM1	Change Charge Profile using S2, if necessary, or go to the next step - FLD, AGM1, GEL1, COLD, AGM2, GEL2, USER
10	●F1 OF2 OF3 OF4	CL 9	Press F1 to save and the next Cell Count will be displayed
11	OF1 OF2 ●F3 OF4	425	Repeat from Step 6 for EACH Cell Count
12	●F1 OF2 OF3 OF4	SETUP or USER	Press F1 to save - If User Profile is selected, you will be prompted for User Settings; otherwise go to step 21
13	OF1 OF2 OF3 OF4	17	Previously set User Hi Rate Current is displayed
14	 S2	15	Change High Rate Current using S2, if necessary, or go to the next step - 10, 11, ..., 17A
15	●F1 OF2 OF3 OF4	2.37	Press F1 to save - Previously set User Gassing Point is displayed
16	 S2	2.45	Change User Gassing Point using S2, if necessary, or go to the next step - 2.29, 2.33, 2.37, 2.41 and 2.45VPC
17	●F1 OF2 OF3 OF4	5	Press F1 to save - Previously set User Finish Rate Current is displayed
18	 S2	3	Change User Finish Rate Current using S2, if necessary, or go to the next step -1, 2, 3, 4, 5
19	●F1 OF2 OF3 OF4 ●F1 ●F2 OF3 OF4	SETUP CHARGER READY CHARGE CURRENT	Press F1 to save and return to Setup Mode - Continue another setup or press F1 & F2 simultaneously to exit Setup mode OR start charging if BIT is not detected

8.2.3 CLOCK SETUP MODE

STEPS	INPUTS	DISPLAY	DESCRIPTION
1	OF1 OF2 OF3 OF4	SETUP	If it is not in Setup Mode, press F3 and F4 during "CHARGER READY" then enter the password using S2 to enter the Setup Mode
2	OF1 ●F2 OF3 OF4	0:00	Press F2 - Previously set Time of Day is displayed
3	OF1 OF2 ●F3 OF4	1:00	Press and hold F3 to adjust Hour, if necessary
4	OF1 OF2 OF3 ●F4	0:01	Press and hold F4 to adjust Minute, if necessary
5	●F1 OF2 OF3 OF4	MON	Press F1 to save - Previously set Day of Week is displayed
6	 S2	TUE	Change Day of Week using S2, if necessary, or go to the next step
7	●F1 OF2 OF3 OF4 ●F1 ●F2 OF3 OF4	SETUP CHARGER READY	Press F1 to save and return to Setup Mode - Continue another setup or press F1 & F2 simultaneously to exit

8.2.4 START, EQUALIZE, REFRESH AND COOL-DOWN DISPLAY OPTIONS SETUP MODE

STEPS	INPUTS	DISPLAY	DESCRIPTION
1	OF1 OF2 OF3 OF4	SETUP	If it is not in Setup Mode, press F3 and F4 during "CHARGER READY Mode" then enter the password using S2 to enter the Setup Mode
2	OF1 OF2 OF3 ●F4	D 0	Press F4 - Previously set Start Delay option is displayed
3	 S2	D 2	Change Start Delay using S2, if necessary, or go to the next step - 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, MS, 0:00
4	●F1 OF2 OF3 OF4	E 0	Press F1 to save - Previously set Equalize Option is displayed
5	 S2	E 5	Change Equalize using S2, if necessary, or go to the next step - 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, WKN
6	●F1 OF2 OF3 OF4	R 0	Press F1 to save - Previously set Refresh Option is displayed
7	 S2	R 36	Change Refresh using S2, if necessary, or go to the next step - 0, 6, 12, 18, 24, 30, 36, 42, 48, 54, 60, 66, 72, 78, 84, 90 hours
8	●F1 OF2 OF3 OF4	CD Y	Press F1 to save - Previously set Cool-down Time Display Option is displayed
9	 S2	CD N	Change Cool-down Time Display Option using S2 if necessary or go to the next step - (0: Y - displayed, 1: N - not displayed)
10	●F1 OF2 OF3 OF4 ●F1 ●F2 OF3 OF4	SETUP CHARGER READY	Press F1 to save and return to Setup Mode - Continue another setup or press F1 & F2 simultaneously to exit

8.2.5 PASSWORD SETUP MODE

STEPS	INPUTS	DISPLAY	DESCRIPTION
1	OF1 OF2 OF3 OF4	SETUP	If it is not in Setup Mode, press F3 and F4 during "CHARGER READY" then enter the password using S2 to enter the Setup Mode
2	●F1 OF2 OF3 OF4	P123	Press and HOLD F1 for 3 seconds - Default or Preset password is displayed. Factory set password is 1,2,3
3	OF1 OF2 ●F3 ●F4	P255	Press F3 and F4 simultaneously to increment password.(0-255) Release both buttons at desired password
4	●F1 OF2 OF3 OF4 ●F1 ●F2 OF3 OF4	SETUP CHARGER READY	Press F1 to save and return to Setup Mode - Continue another setup or press F1 & F2 simultaneously to exit

8.2.6 ROTARY SWITCH S2 SETUP PARAMETERS

Rotary switch S2	Amp-Hour	Charge Profile	User Def. Start rate /100AH	User Def. Gass. Volts	User Def. Finish Rate /100AH	Start Delay	Equalize Cycle	Refresh Freq.	Cool-down
0	425	FLD	10	2.29	1	Disabled	Disabled	Disabled	Enabled
1	475	AGM1	11	2.33	2	1	1	6	Disabled
2	510	GEL1	12	2.37	3	2	2	12	-
3	540	COLD	13	2.41	4	3	3	18	-
4	600	AGM2	14	2.45	5	4	4	24	-
5	680	GEL2	15	-	-	5	5	30	-
6	750	P7	16	-	-	6	6	36	-
7	765	P8	17	-	-	7	7	42	-
8	865	P9	-	-	-	8	8	48	-
9	965	P10	-	-	-	9	9	54	-
10	1050	P11	-	-	-	10	10	60	-
11	1190	P12	-	-	-	11	11	66	-
12	1450	P13	-	-	-	12	12	72	-
13	1750	P14	-	-	-	13	13	78	-
14	-	P15	-	-	-	Manual	14	84	-
15	-	USER	-	-	-	Time of Day	Week-end	90	-

8.3 REVIEW MODE

STEPS	INPUTS	DISPLAY	DESCRIPTION
1	○F1 ○F2 ○F3 ○F4	CHARGER READY	Charger is in Idle Mode without battery connected
2	●F1 ○F2 ○F3 ○F4	LAST	Press F1 - Charge Data of the last cycle
3	●F1 ○F2 ○F3 ○F4	AH 1234	Press F1 - Returned Amp-Hour is displayed
4	●F1 ○F2 ○F3 ○F4	CT 5:40	Press F1 - Total Charge Time is displayed
5	●F1 ○F2 ○F3 ○F4	SV 2.13	Press F1 - Start of Charge Voltage is displayed
6	●F1 ○F2 ○F3 ○F4	FV 2.64	Press F1 - End of Charge Voltage is displayed
7	●F1 ○F2 ○F3 ○F4	HRT 2:05	Press F1 - Time in High Rate is displayed
8	●F1 ○F2 ○F3 ○F4	SC 127	Press F1 - Output Current at the beginning of charge is displayed
9	●F1 ○F2 ○F3 ○F4	FC 35	Press F1 - Output Current at the end of charge is displayed
10	○F1 ●F2 ○F3 ○F4	ARC1...ARC 9	Press F2 ANY TIME to select a Charge Cycle (1-9)
11	●F1 ○F2 ○F3 ○F4	AH 1234	Repeat Step 3 for charge data of the selected cycle
12	○F1 ○F2 ●F3 ○F4	CL 6	Press F3 ONCE - Amp-Hour, Charge Profile for each cell count will be sequentially displayed.
13	○F1 ○F2 ○F3 ●F4	D 0	Press F4 ONCE - Start Delay, Equalize Option, Refresh Option, Clock will be sequentially displayed.

8.4 OPERATING MODE

STEPS	INPUTS	DISPLAY	DESCRIPTION
1	○F1 ○F2 ○F3 ○F4	123	Charge is on - Output Current is displayed
2	●F1 ○F2 ○F3 ○F4	LAST	Charge Data of the last cycle
3	●F1 ○F2 ○F3 ○F4	AH 1234	Press F1 - Returned Amp-Hour is displayed
4	●F1 ○F2 ○F3 ○F4	CT 5:40	Press F1 - Total Charge Time is displayed
5	●F1 ○F2 ○F3 ○F4	SV 2.13	Press F1 - Start of Charge Voltage is displayed
6	●F1 ○F2 ○F3 ○F4	FV 2.64	Press F1 - End of Charge Voltage is displayed
7	●F1 ○F2 ○F3 ○F4	HRT 2:05	Press F1 - Time in High Rate is displayed
8	●F1 ○F2 ○F3 ○F4	SC 127	Press F1 - Output Current at the beginning of charge is displayed
9	●F1 ○F2 ○F3 ○F4	FC 35	Press F1 - Output Current at the end of charge is displayed
10	○F1 ●F2 ○F3 ○F4	ARC1	Press F2 ANY TIME to select a Charge Cycle (1-9)
11	●F1 ○F2 ○F3 ○F4	AH 1234	Repeat Step 3 for charge data of the selected cycle
12	○F1 ○F2 ●F3 ○F4	STOP PB PRESSED	Press F3 to interrupt the charge cycle
13	○F1 ○F2 ○F3 ●F4	E 123	Press F4 to manually select Equalize Cycle - Character "E" will appear on the 1st digit - Press F4 again to de-select

8.5 LAMP TEST

	○F1 ●F2 ●F3 ○F4	Press F3 & F4 simultaneously during "CHARGER READY" Mode. All segments of the display and all LED's illuminate
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SECTION 9 CHARGER CABINETS

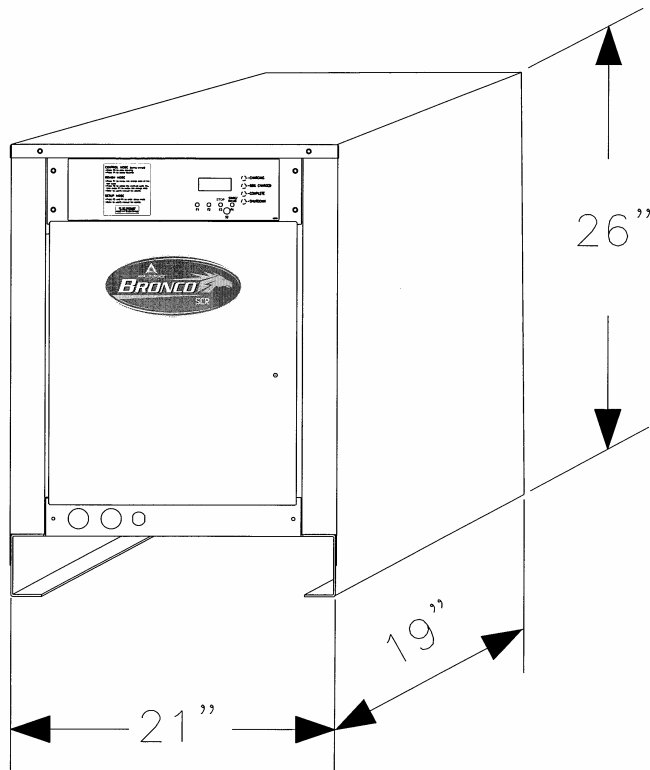


Fig. 9.1 CABINET "E"

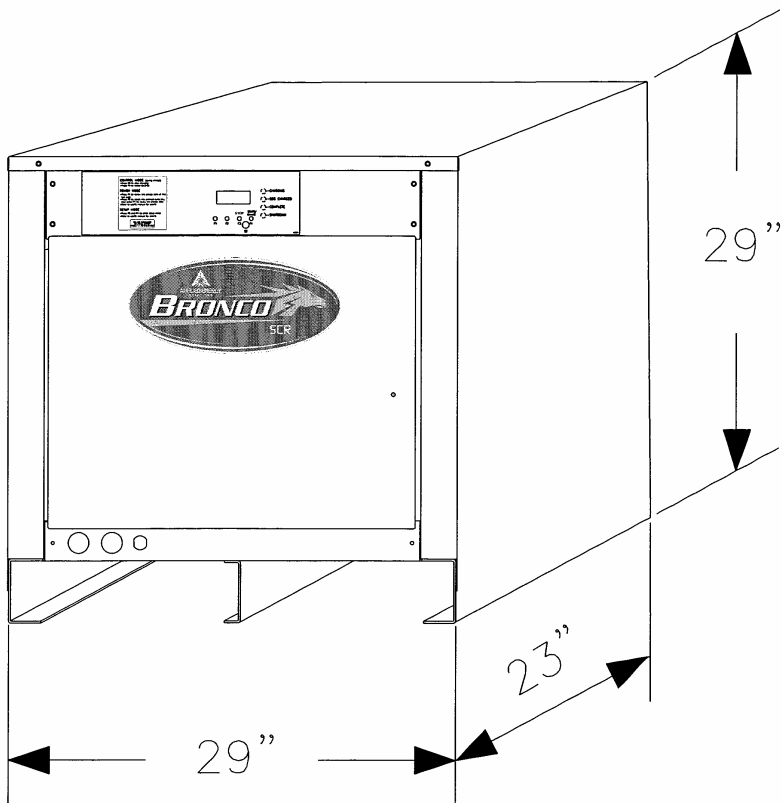


Fig. 9.2 CABINET "F"

SECTION 10 MAINTENANCE AND ADJUSTMENTS

10.1 MONTHLY PREVENTATIVE MAINTENANCE

WARNING

HIGH VOLTAGES EXIST WITHIN THE CHARGER, WHICH CAN CAUSE SEVERE INJURY OR DEATH. SERVICE SHOULD BE PERFORMED ONLY 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 slotted openings.
- 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 BRONCO chargers are designed to operate at 208/240/480/575 or 240/480/575 Volts 60 Hz electric services and factory set at the voltage specified in the purchase order. If the charger is to be operated on a different rated input voltage than the ordered value, follow the voltage changeover instructions described below.

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 with jumpers (one terminal block per phase, if three phase) and the Stop/Caution label (on the front door) describing the various voltage/jumper configurations (Refer to Figures 10.1, 10.2 or 10.3). The terminal block with jumpers is located on the main transformer.
- Change the jumpers in accordance with the Stop/Caution label 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 10.4)
- Change the voltage level on the Stop/Caution 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 rating of the new fuses.
 - Verify that the control transformer primary taps have been changed correctly.
 - Verify that the Stop/Caution label 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.

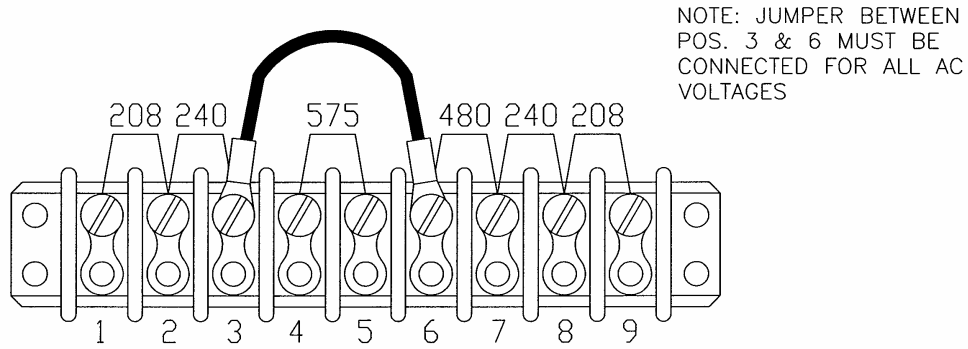


Figure 10.1 A.C. Input Voltage Selection (Single Phase)

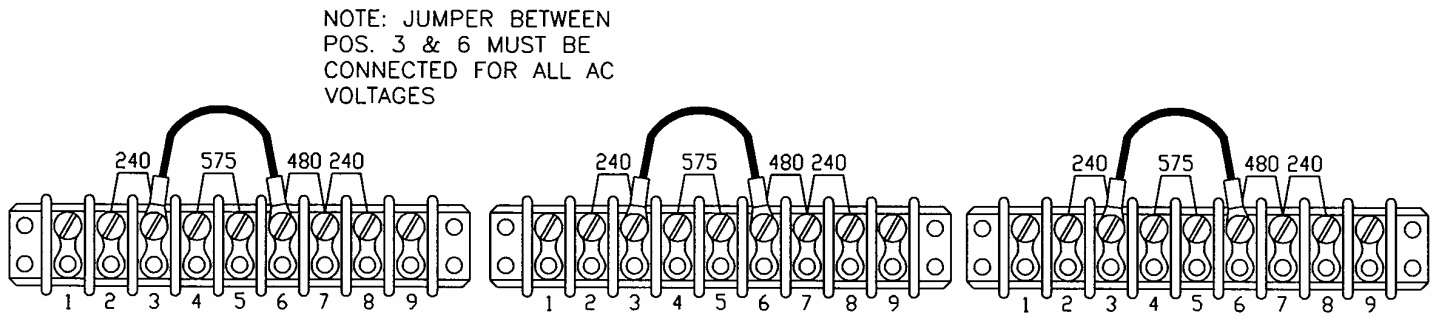


Figure 10.2 A.C. Input Voltage Selection (3 Phase without 208V)

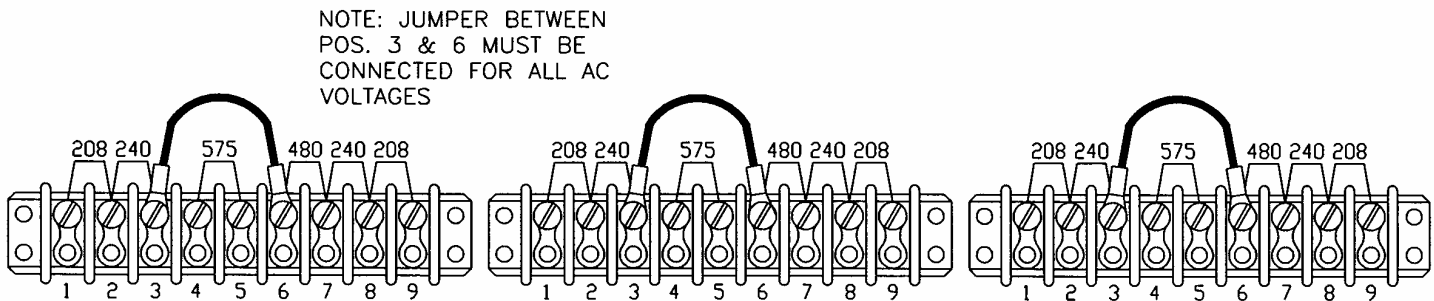


Figure 10.3 A.C. Input Voltage Selection (3 Phase with 208V)

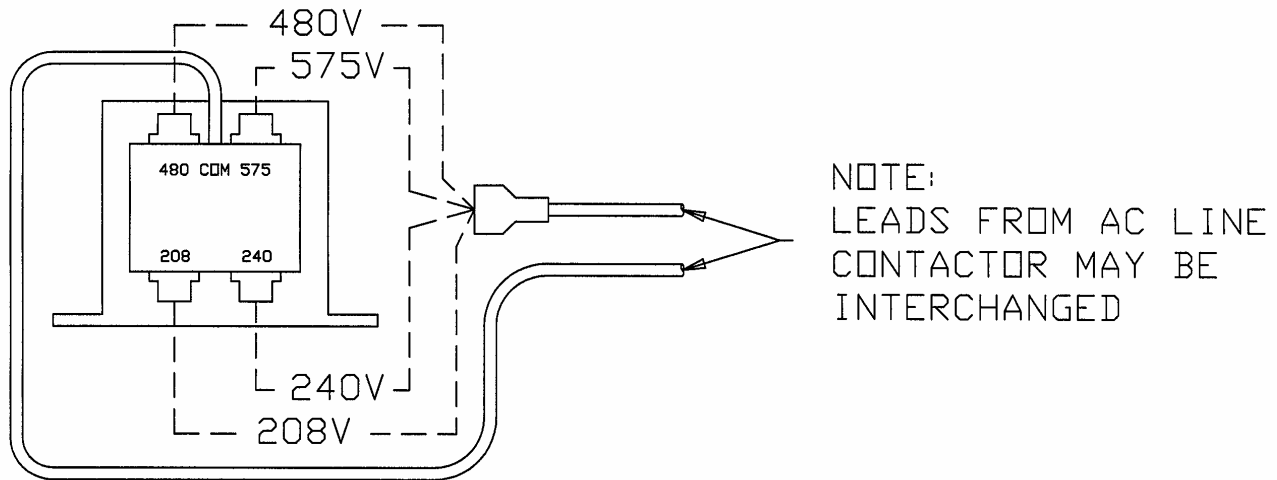


Figure 10.4 A.C. Voltage Selection of Control Transformer

WARNING

HIGH VOLTAGES EXIST WITHIN THE CHARGER, WHICH CAN CAUSE SEVERE INJURY OR DEATH. SERVICE SHOULD BE PERFORMED ONLY 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

- Check for blown AC fuses
- 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)
- Locate the Main Control (MC) Board and the Auto Cell Select (ACS) Board. Verify the proper connection of the boards and cables.

SYMPTOM 2 DISPLAY IS ON BUT CHARGER WILL NOT START

- If "CHARGER READY" is still displayed when the battery is plugged in, check the battery connections and the output fuse for open fuse.

SYMPTOM 3 DISPLAY COUNTS DOWN BUT CHARGER SHUTS DOWN IMMEDIATELY

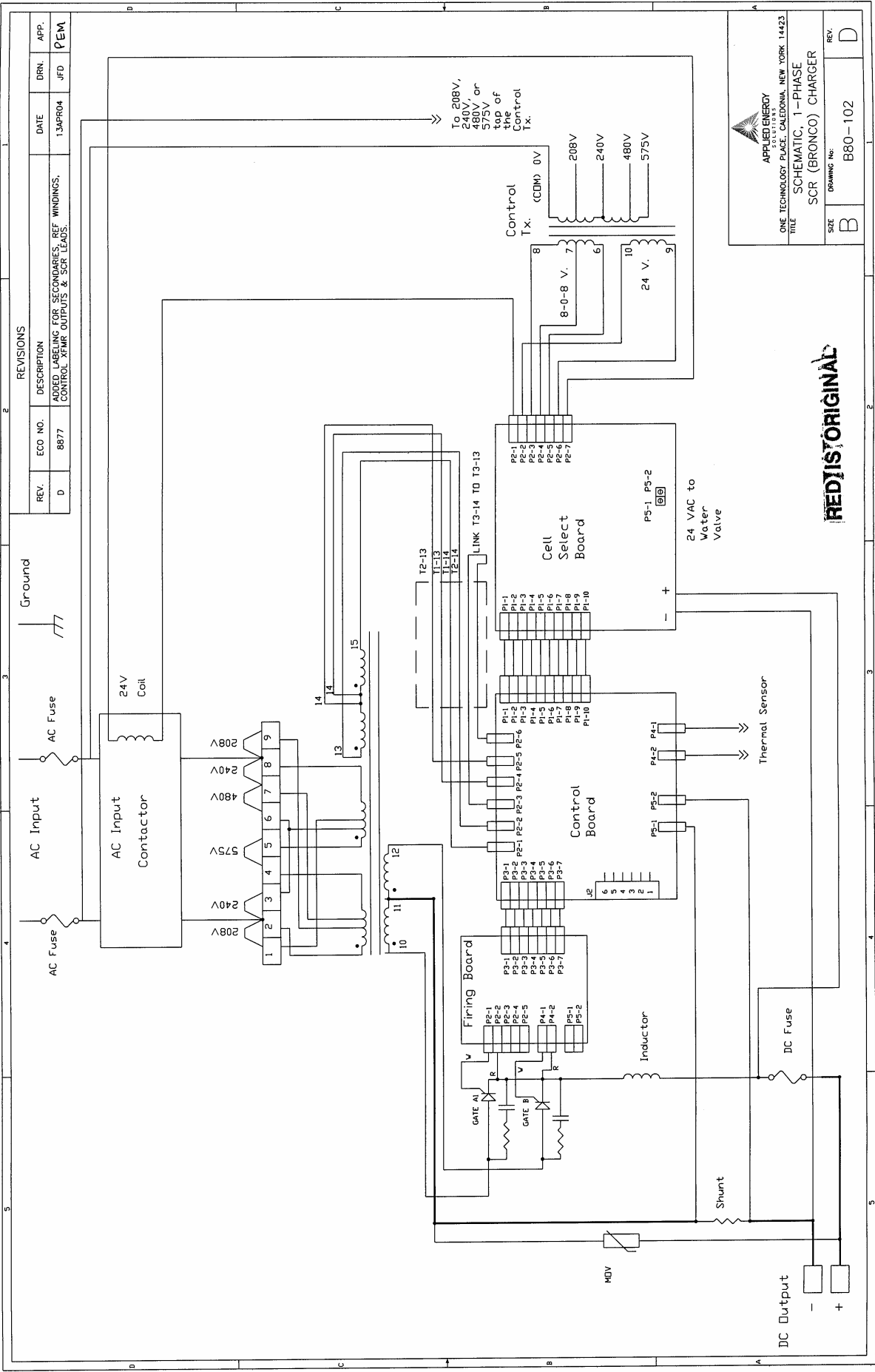
- If the charger shuts off immediately after countdown, check the readout for the fault message. Refer to Section 4.

SYMPTOM 4 CHARGE TERMINATES EARLY

- Fault message “LOW VOLTAGE” - Low volts per cell - The average battery voltage is less than 1.5 V/Cell. Check for bad cells.
- Fault message “HIGH VOLTAGE” - 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 message “BATTERY DISCONNECTED” - Battery is disconnected from charger during charge.
- Fault message “CHARGE DURATION EXCEEDED” - Charge time exceeded – The battery voltage did not reach the gassing point within 9 hours. Check for bad cells or deep discharge condition.
- Fault message “LOW CURRENT” - Low charging current - No charging current detected or charging current is too low. Check the DC fuse for open fuse.
- Fault message - “*HIGH CURRENT*” - High charging current - The charging current is abnormally high. Check all wiring connections going to the control boards.
- Fault message “LOSS OF PHASE” - Input phase missing - Check the input fuse of phase 2 (phase B).
- Display “STOP PB PRESSED” - Charge cycle is terminated by pressing the STOP button.


SECTION 12 SCHEMATICS

See following pages

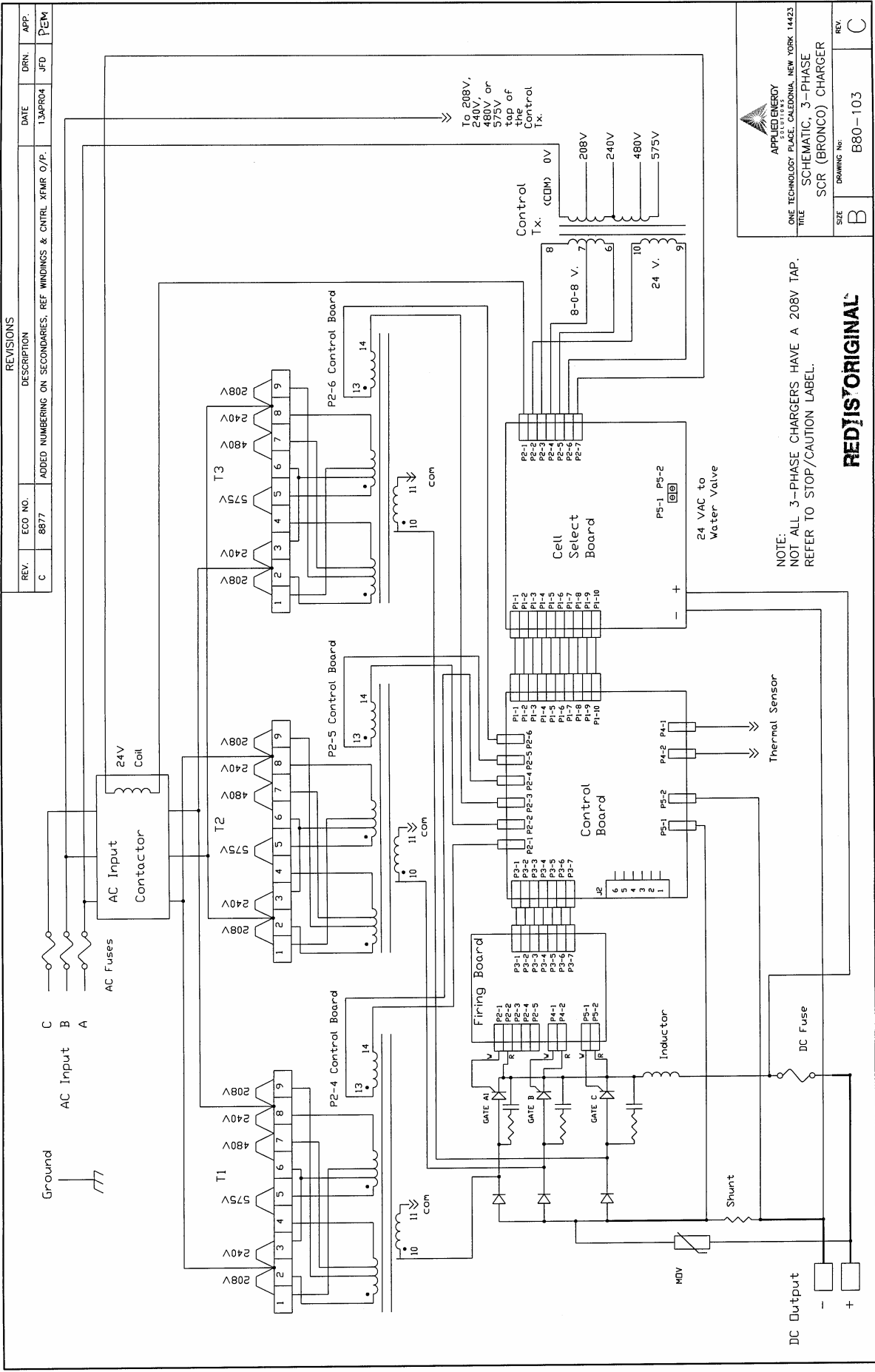


REV.	ECO NO.	DESCRIPTION	DATE	DRN.	APP.
D	8877	ADDED LABELING FOR SECONDARIES, REF WINDINGS, CONTROL XFMR OUTPUTS & SCR LEADS.	13APR04	JFD	PEM

REVISIONS



APPLIED ENERGY SOLUTIONS
 ONE TECHNOLOGY PLACE, CALEDONIA, NEW YORK 14423
 TITLE: SCHEMATIC, 1-PHASE
 SCR (BRONCO) CHARGER
 SIZE: B DRAWING No: B80-102
 REV: D

REDI'S ORIGINAL



REV. ECO NO.		DESCRIPTION		DATE	DRN.	APP.
C	8877	ADDED NUMBERING ON SECONDARIES. REF WINDINGS & CNTRL. XFMR D/P.		1/3/1980	JFD	PEM

REVISIONS		DATE	DRN.	APP.
C	8877	1/3/1980	JFD	PEM


APPLIED ENERGY SOLUTIONS
 ONE TECHNOLOGY PLACE, CALEDONIA, NEW YORK 14423
TITLE SCHEMATIC, 3-PHASE SCR (BRONCO) CHARGER
SIZE B **DRAWING No.** B80-103 **REV.** C

NOTE:
 NOT ALL 3-PHASE CHARGERS HAVE A 208V TAP.
 REFER TO STOP/CAUTION LABEL.

RED IS ORIGINAL

To 208V,
 240V, or
 480V or
 575V
 tap of
 the
 Control
 Tx.

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 BRONCO Industrial Battery Chargers are warranted for 5 Years⁽¹⁾ (10 years on power transformers, diodes and SCRs), 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.