

Industrial Battery Charger

Installation and Operation Manual

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SAFETY INSTRUCTIONS

WARNING

THIS EQUIPMENT CONTAINS LETHAL VOLTAGE LEVELS. INSTALLATION AND SERVICING MUST BE PERFORMED BY QUALIFIED PERSONNEL

IMPORTANT: SAVE THESE INSTRUCTIONS!

READ AND FOLLOW ALL INSTRUCTIONS BEFORE INSTALLING, OPERATING, OR SERVICING CHARGER. ANY DEVIATION CAN CAUSE SERIOUS AND PERMANENT DAMAGE. FAILURE TO FOLLOW THE INSTRUCTIONS VOIDS THE WARRANTY.

1. Install and ground the charger in accordance with the National Electric Code and your local electric code. Failure to properly ground the charger could result in a fatal electric shock.
2. To reduce the risk of fire, install chargers on a surface of non-combustible material, such as concrete, stone, brick or grounded metal.
3. This charger has been designed to only charge flooded, lead-acid batteries. It should not be used for charging other types of flooded batteries or sealed batteries.
4. Connect only batteries of the same number of cells and ampere-hour rating as listed on the charger nameplate. Damage to the battery could occur, particularly if the battery has fewer cells than the rating of the charger.
5. Do not touch uninsulated parts of the output connector or battery terminals. A possibility of serious electrical shock exists.
6. During charge, batteries produce hydrogen gas, which can explode if ignited. Never smoke, use an open flame, or create sparks in the vicinity of the battery. Ventilate well when the battery is in an enclosed space.
7. Do not connect or disconnect the battery plug while the charger is on. Doing so will cause arcing and burning of the connector resulting in charger damage or battery explosion.
8. Lead-acid batteries contain sulfuric acid, which is caustic and can cause chemical burns to the skin. Refer to the battery manufacturers instructions for safe handling of batteries. Use proper personnel protective equipment. Do not get in eyes, on skin, or on clothing. In cases of contact with eyes, flush immediately with clean water for 15 minutes. Seek medical attention immediately.
9. Do not operate the charger with the door open or with any panels removed. De-energize all AC and DC power connections before servicing the charger.
10. The charger is not for outdoor use. Do not expose the charger to water spray, rain or snow.
11. Do not operate the charger with damaged cables, including cables with exposed conductors or damaged connectors. Replace damaged cables before operation.
12. Do not operate the charger if it has been dropped, received a sharp blow, or otherwise damaged in any way. Call your service representative.

SECTION 1 - INSTALLATION

1.1. Receiving

Immediately upon receipt of the charger, check it against the shipping invoice to ensure the shipment is complete and undamaged.

Examine the outside of the packing for signs of rough handling before accepting the charger from the carrier.

If there is evidence of damage, the receipt should be signed, and both copies (carrier's and receiving copies) marked "Shipment Received Damaged". The carrier's representative should be called immediately and asked to make a "Carrier's Damage Report".

If concealed damage is later detected, the carrier should be called and requested to make a "Carrier's Inspection for Concealed Damage Report".

After inspection by the carrier, arrangements should be made with the charger representative to have the charger repaired before placing it in service.

When contacting your charger representative for assistance on a damage claim or shipment error, provide the Model, and Serial Number of the charger, and a full description of the damage or error.

It is good practice to move the charger to the installation site before uncrating. When using bars, hammers, etc. for uncrating, use care to avoid damage to the charger.

WARNING: To reduce the risk of fire, install the battery charger on a non-combustible surface such as concrete, stone, brick, or steel. DO NOT operate the charger on its shipping skid materials.

1.2. Location

For the best operating conditions and longest life, take care in selecting an installation site. Avoid locations exposed to high humidity, temperature extremes or dust. Moisture condensing on machine parts and electrical components can cause corrosion, which seriously affects operation, efficiency and life. All units are designed for floor mounting. Standard cases may be stack-mounted if required, up to 3 high. If so, optional stacking brackets are required and available. Consult factory.

Dust and dirt will also decrease heat radiation from heat-generating components, such as transformers and diodes. This will result in higher operating temperatures and shorter life. Adequate air circulation is needed at all times in order to ensure proper operation. Provide a minimum of 6 inches of free air space at the sides and rear of the charger. The front of the charger must remain unobstructed for serviceability.

1.3. Line Voltage Adjustments

All chargers are shipped with the AC line voltage jumper wires set for the AC voltage specified on the purchase order. Before connecting the charger to the AC service, it should be verified that the internal AC voltage connections match the available AC service voltage. If necessary change the AC voltage jumper wires shown in Figs. 1.3.1 through 1.3.3.

NOTE: For 50 Hz. Single or three phase fixed voltage chargers, there are no adjustments.

CAUTION: It will be necessary in most cases to change the AC fuses when the AC voltage jumpers are changed. Refer to the fuse chart on the inside door of the charger for the correct fuse rating.

NOTE: When a 120/208/240 AC input unit is set for 120VAC a fuse neutral (brass tube) is required in the Line 2 (neutral) fuse position.

Fig. 1.3.1.
A.C. Voltage Adjustments
1 Ø 60Hz. (120/208/240)
"A" Voltage Code

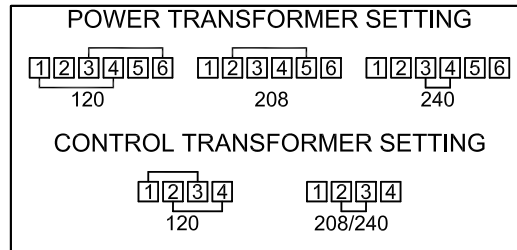


Fig. 1.3.2.
A.C. Voltage Adjustments
1Ø & 3Ø 60Hz. (208/240/480)
"B" Voltage Code

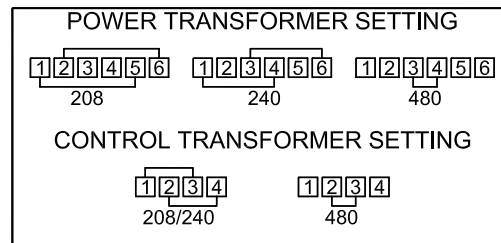
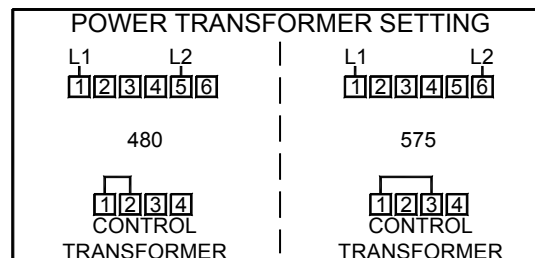


Fig.1.3.3.
A.C. Voltage Adjustments
3 Ø 60Hz. (480/575)
"K" Voltage Code



1.4. AC Service Requirements

Follow local code requirements if they are different than the instructions in this manual. After checking the transformer connections as described in Paragraph 1.3, refer to Table 1-1, to determine the correct ratings for the AC cable, AC fuses, and AC service disconnect switch for the line amperes as listed on the nameplate of the charger for the available AC voltage

| TABLE 1-1 | | |
|---------------|-------------------|----------------|
| Line Amperes | Disconnect Switch | Fuse Size Amps |
| 000.0 - 02.5 | 30A | 05 |
| 003.0 - 04.5 | 30A | 07 |
| 005.0 - 07.5 | 30A | 10 |
| 008.0 - 11.0 | 30A | 15 |
| 011.5 - 15.5 | 30A | 20 |
| 016.0 - 18.0 | 30A | 25 |
| 018.5 - 22.0 | 30A | 30 |
| 022.5 - 27.0 | 60A | 35 |
| 027.5 - 32.0 | 60A | 40 |
| 032.5 - 40.0 | 60A | 50 |
| 040.5 - 48.0 | 60A | 60 |
| 048.5 - 64.0 | 80A | 80 |
| 065.0 - 80.0 | 100A | 100 |
| 081.0 - 95.0 | 125A | 125 |
| 096.0 - 125.0 | 150A | 150 |

For voltages up to 240, use a 240 volt disconnect switch.

For voltages greater than 240 to 600, use a 600 volt disconnect switch.

- Two conductors and ground wire required for single phase.
- Three conductors and ground wire required for three-phase

1.5. Connecting AC Service to the Charger

1.5.1 Single-Phase Models

Connect the AC service to the L1 and L2 terminals located at the end of the AC fuse block.

Note: If the charger has been ordered with an AC input door-mounted disconnect switch, the AC input wires will be connected to the L1 and L3 terminals at the top of the switch body.

1.5.2 Three-Phase Models

Connect the AC service to the L1, L2 and L3 terminals located at the end of the AC fuse block.

Note: If the charger has been ordered with an AC input door-mounted disconnect switch, the AC input wires will be connected to the L1, L2 and L3 terminals at the top of the switch body.

1.6 Grounding the Charger

The charger must be grounded to the AC system ground for personnel safety.

The green ground wire in the AC input wiring must be connected to the charger ground stud (identified by a green dot and ground symbol).

1.7 Battery Connector and Charging Cable

Verify that the connectors on both the battery and the charger are attached so that the positive output terminal of the charger is connected to the positive battery terminal.

**CAUTION: If the polarity is reversed, the DC fuse will blow.
If in doubt, check the polarity with a DC voltmeter.**

1.8 Charging Rate Adjustment

Note: Charging rate adjustments may be necessary to compensate for locations of extreme AC line variation or may be used to tailor the charger output for aging batteries.

The charging rate has been set at the factory; therefore, field adjustment should not be necessary.

If there appears to be a charging rate problem, refer to the troubleshooting chart, Section 4.

If it is necessary to either increase or decrease the charging rate, a rate adjustment terminal block is provided on the top rear of the transformer mounting bracket.

Change only one step at a time and observe the effect on the battery before making a second change.

The charging rate is increased by moving to the next higher tap setting in Table 1-2.

The charging rate is decreased by moving to the next lower tap setting.

No adjustments should be made without consulting the factory.

| TABLE 1-2 | | |
|-------------------------------|--------------------------|---------|
| CHARGING RATE ADJUSTMENTS | | |
| CONNECT RED JUMPER WIRE TO | CONNECT BLACK WIRE TO | OUTPUT |
| 9 | 12 | HIGHEST |
| 9 | 11 | |
| 9 | 10 | |
| 9 | 8 | NORMAL |
| 12 | 11 | |
| 12 | 10 | |
| 12 | 9 | LOWEST |

SECTION 2 - OPERATION

2.1. 046-164 Control



The charger utilizes a standard ferro-resonant transformer, which provides isolation from the AC service line and regulates the charging current. The transformer output is connected to a full-wave bridge of silicon diodes, which provides DC charging current to the battery.

The starting charge amps and length of time required for a charge vary depending on the charger model. See the data plate on the charger for information.

2.1.1. Feature Summary

- Charges flooded lead-acid batteries.
- Automatic start when battery is connected or manual start (if selected).
- Automatic stop when charge is finished.
- Fully charges partially discharged batteries without overcharging.
- Dead battery 'jump start' for overly-discharged batteries.
- Equalize charge by user request or automatic equalize every 7 charges (if selected).
- Automatic refresh charging every 12 hours (if selected).
- Automatic shut-down if battery starts to overheat.
- Automatically resumes charge after a power failure (if auto-start selected).
- Displays charging amps during the charge cycle.
- End voltage, end current, amp-hours returned, and run time can be displayed at the end of charge or after disconnecting the battery.
- Delayed start adjustable from 0 to 12 hours in 10 minute increments (if auto-start selected).
- Displays fault codes if a fault occurs during charging.
- Cool down timer that shows elapsed time after the charge is complete (if selected).

2.1.2. Description

The front panel has a 3 digit light-emitting-diode (LED) display which normally shows charging amps. This display also presents error messages if a fault occurs. A green 'Charging' indicator lights while the charger is charging. A yellow '80% Charged' indicator lights when the battery is 80% charged. A green 'Battery Ready' indicator lights when the charge is complete. A yellow 'Equalize' indicator lights when an equalize charge is selected. A red 'Fault' indicator lights if a fault occurs.

The front panel has power on, power off, equalize on, and equalize off buttons. A charge can be stopped by pressing 'POWER OFF' and resumed by pressing 'POWER ON'. While charging, an equalize charge can be requested by pressing 'EQUALIZE ON' and turned off by pressing 'EQUALIZE OFF'.

2.1.3. Operation

The control is used in ferro-resonant taper chargers to provide fully automatic battery charging. The control has a charging profile that handles standard flooded lead-acid batteries. The charging profile, or algorithm, uniquely monitors the output current and voltage to optimally charge the battery, based on battery manufacturer's recommendations.

The standard charging profile for flooded lead-acid batteries has 2 phases. During phase 1 the battery is charged at high current until the battery is 80% charged. Then phase 1 terminates and phase 2 begins. As the battery voltage rises during phase 2, charging current tapers down toward the finish rate current and the battery voltage starts to flatten out. Phase 2 ends and the charge is terminated when the battery voltage no longer changes. This termination method is called 'dv/dt-di/dt'.

The control offers several safeguards to protect the battery. If a wrong voltage battery is connected, the charger does not start and a Low-Battery-Voltage (F3) or High-Battery-Voltage (F4) fault message is

displayed. While charging, if the battery voltage exceeds a profile-specific cut-off value, the charge terminates with an End-On-Voltage warning message (EnU followed by the end voltage in v/c). If the battery starts to overheat, the charge terminates with a Battery Too Hot (F2) error message.

2.1.3.1. Normal Daily Charge

When no battery is connected, the 'Charging' indicator is off and the 3-digit display shows 0 amps. With the auto-start feature enabled, connecting a battery to the charger will cause it to begin a charge cycle. The charger will first perform a self-diagnostic test to verify the control is working properly. During this time a lamp test is performed causing all display segments and indicators to light. This allows the operator to observe any defective segments or indicators. When the self-diagnostic is complete, the charge starts if no delay is set, and the green 'Charging' indicator lights. The display shows the charging amps to indicate the charger is in phase 1 of the charge cycle. If auto start is disabled, the display shows 'OFF'. Press 'POWER ON' to manually start the charge.

When the battery is 80% charged, the yellow '80% Charged' indicator lights and the charger starts phase 2 of the charge cycle.

When a charge is finished, the charger automatically turns off. The green 'Charging' indicator and the '80% Charged' indicator both go out and the green 'Battery Ready' indicator lights. If cool down is enabled, the display shows elapsed time up to 24 hours in hh.m format where hh is hours, and m is the nearest 10 minute increment. If cool down is disabled or 24 hours has elapsed, the display shows 0 amps. If cool down is desired, contact your charger service person for control setup change.

2.1.3.2. Disconnecting the Battery

Warning: Risk of explosion. Do not disconnect the battery while the charger is running. Hydrogen gas produced by the battery during charging can be ignited by arcing that occurs when the battery cable is disconnected.

If the battery must be disconnected before the end of the charge cycle, the charger should be turned off first. Press 'POWER OFF', and verify the green 'Charging' indicator goes out. The 3-digit display will show 'OFF'. The battery may then be safely disconnected. If the green 'Battery Ready' indicator is lit, the battery may be disconnected at any time.

2.1.3.3. Equalize Charge

Over time batteries can develop inequalities in cell charge. This can lower the effective capacity of the battery and shorten life. An equalizing charge re-balances the charge in the battery cells. Perform an equalize charge if any of the following conditions exist:

1. On flooded batteries the specific gravity of any cell at the end of charge is 20 points less than the average of all the cells.
2. The on-charge voltage of any cell at the end of charge is 20 millivolts less than the average of all the cells.
3. The battery has been stored for 30 days.

The 046-0164 control can perform an equalize automatically every 7 charge cycles if auto equalize is enabled. Normal equalize consists of an additional 3 hour charge time at the end of a normal charge cycle. The 046-0164 control can also perform an equalize charge when requested manually. First connect the battery and allow the charge to start normally. Then press 'EQUALIZE ON'. The yellow 'Equalize' indicator will light. The charge time will be extended by 3 hours to allow the cells to equalize their charge.

The auto-equalize or manual equalize cycle can be cleared by pressing 'EQUALIZE OFF' while in the normal charge cycle. The yellow 'Equalize' indicator will turn off. The next auto equalize charge will occur after another 7 charge cycles if auto equalize is enabled.

If auto equalize is not desired, contact your charger service person for control setup change.

2.1.3.4. Delayed Start

The delayed-start feature allows the operator to delay starting the charge cycle. This might be desired to reduce peak energy surcharges if the charger were ready to start during a peak energy period. The delay time could be set to keep the charger from starting until after the peak period ends.

To view the delayed start setting, press 'EQUALIZE ON' while the charger is not charging and hold for 3 seconds. The display shows 'dLy' followed by the current delay time in hh.m format where hh is hours and m is the nearest 10 minute increment. To change the delay time, press 'POWER OFF'. The display shows 'hh._' where hh is the delay hours. Set the delay start hours using 'EQUALIZE OFF' and 'EQUALIZE ON' to scroll the value up or down. When the correct value is reached, press 'POWER OFF'. The display then shows '_mm' where mm is the delay minutes. Set the delay minutes using 'EQUALIZE OFF' and 'EQUALIZE ON' to scroll the value up or down. When the correct value is reached, press 'POWER OFF' to save the value. The display shows 'yES' to indicate the value was saved. To exit the delay start programming mode at any time, press 'POWER ON'. Any changes will automatically be saved and the display will show 'yES'.

While in the delay start programming mode, if no button is pressed for 10 seconds, the setting will automatically be saved and the display will return to the normal display of amps. The delay timer begins when a battery is connected. If a battery is already connected, it will be effective the next time a battery is connected. While waiting for the delayed start, the display shows 'dLy' and the hours and minutes remaining in hh.m format where hh is hours and m is the nearest 10 minute increment.

If the auto-start feature is disabled, the delayed start is automatically set to 0 and is disabled. The delayed start time cannot be set.

2.1.3.5. Auto-Refresh Charge

The control provides an auto-refresh charge every 12 hours as long as the battery remains connected to the charger. If AC power is lost during the 12 hour wait period, the control will resume from where it left off after power is restored. During the auto-refresh charge, the amp-hours and charge time will be added to the original charge. When the charger is in an auto-refresh charge and the battery is 80% charged, the 80% LED will blink to indicate a refresh charge.

If Auto Refresh is not desired, contact your charger service person for control setup change.

2.1.3.6. Viewing Charge Information

Additional charge information is available at the end of a charge cycle or after the battery is disconnected by pressing one of the four buttons. This information is retained after the battery is disconnected until the next battery is connected. After 10 seconds the display will return to the default display of amps. The following information can be viewed:

| BUTTON | DISPLAY | DESCRIPTION |
|---|-------------------|--|
| Power On | EnU #.## | Battery voltage at the end of charge in volts per cell (v/c). |
| Power Off | EnA ### | Charging current at the end of charge. |
| Equalize On | AHr ##_ ##_ | Accumulated amp-hours. The display will show the upper 2 digits (##_) followed by the lower 2 digits (_##_). |
| Equalize Off | tOC ##_. | Time on Charge. The time is displayed in hh.m format where hh is hours and m is the nearest 10 minute increment. |
| Power On and Power Off Simultaneously | UEr ### | Software version. ### indicates the version number. |

Note: The display does not have the ability to display the character 'V', so the character 'U' is used.

2.1.3.7. Fault Handling

If a fault occurs, the charge is terminated, the red fault indicator lights, and the display will show :

| DISPLAY | FAULT DESCRIPTION | POSSIBLE CAUSE |
|-------------------------|--|--|
| F0 ### | Battery voltage did not reach 2.0 V/C within 30 minutes. ### is the volts per cell at end of charge. | <ul style="list-style-type: none"> - Shorted Cell - Open diode - Low Charging amps - Low AC line voltage - Wrong size battery - Battery over-discharged |
| F1 ### | Battery did not reach gassing voltage within 8 hours (16 hours if set for 16 hour mode). ### is the volts per cell at end of charge. | <ul style="list-style-type: none"> - Shorted Cell - Open diode - Low Charging amps - Low AC line voltage - Wrong size battery - Battery over-discharged |
| F2 | Hot battery. Detected by battery voltage dropping after gassing. | <ul style="list-style-type: none"> - Battery is overheated |
| F3 ### | Low battery voltage, less than 1.6 V/C at start up. ### is the battery volts per cell. | <ul style="list-style-type: none"> - Wrong size battery - Battery over-discharged - S1 Dip switch setting incorrect |
| F4 ### | High battery voltage, more than 2.4 V/C at start up. ### is the battery volts per cell. | <ul style="list-style-type: none"> - Wrong size battery - Battery fully charged - S1 Dip switch setting incorrect |
| F5 | No charging current to the battery. | <ul style="list-style-type: none"> - Faulty AC line contactor - Open diode - Faulty resonant capacitor - Poor battery connections - Open cell - Faulty control board |
| F6 | Not Used | |
| F7 | Long charge, the charger ran longer than 6 hours from the gassing voltage. | <ul style="list-style-type: none"> - Open diode - Low Charging amps - Low AC line voltage - Wrong size battery - Battery over-discharged |
| F8 | Charger stayed on when control requested it to shut off. | <ul style="list-style-type: none"> - AC line contactor stuck on - Open shunt sense lead or loose connection - Faulty control board |
| F9 | Faulty keypad detected. One or more buttons are stuck on. | <ul style="list-style-type: none"> - Faulty keypad - Faulty control board |
| F10 | Charging current exceeds 110% of shunt setting. | <ul style="list-style-type: none"> - High charging amps - High AC line voltage - Incorrect shunt size - Open shunt sense lead or loose connection - Faulty control board |

Note: F3 and F4 will clear automatically if the battery voltage falls within acceptable limits. All faults except F8, F9 and F10 can be cleared by disconnecting the battery. For F8, F9, and F10 faults, correct the condition that caused the fault and disconnect the battery to clear the fault.

CAUTION: If F8 fault is showing, and the charger is providing current to the battery, remove AC power from the charger before disconnecting the battery.

F3 (Low Battery) Override

If battery voltage is below 1.6 volts per cell the charger will not start automatically. If this is due to an overly discharged battery of the correct voltage, the F3 fault can be manually overridden by pressing 'POWER ON' while the F3 Fault message (Low Battery) displays.

2.1.3.8. Display Summary

| 3 DIGIT DISPLAY | STATUS LED'S | DESCRIPTION | ACTION |
|----------------------------|--|---|---|
| 0 | None | Charger ready for battery | Connect Battery |
| 8.8.8. | All On | LED test. | None required. |
| bc | None | Battery connected. Checking battery voltage. | None required. |
| ### | 'Charging' (Equalize') | Charger on in phase 1. ### indicates charging amps. If 'Equalize' is lit, charger will equalize at the end of the charge cycle. | None required. Press 'Power Off' to terminate the charge. Press 'Equalize On' or 'Equalize Off' to select/de-select equalize for the current cycle. |
| ### | 'Charging' '80% Charged' (Equalize') | Charger on in phase 2. ### indicates charging amps. If 'Equalize' is lit, charger will equalize at the end of the charge cycle. | None required. Press 'Power Off' to terminate the charge. Press 'Equalize On' or 'Equalize Off' to select/de-select equalize for the current cycle. |
| ### | 'Charging' '80% Charged' blinking | Charger refreshing. ### indicates charging amps. | None required. Press 'Power Off' to terminate the charge. |
| dLy ##.# | None (Equalize') | Charger in a delayed start mode. ##.# indicates the time until the start of charge in hh.m format where hh is hours and m is the nearest 10 minute increment. | None required. Press 'Equalize On' or 'Equalize Off' to select/de-select equalize for the current cycle. |
| Coo ##.# | 'Battery Ready' | Charge complete. Battery cooling. ##.# indicates elapsed time from the end of charge in hh.m format where hh is hours and m is the nearest 10 minute increment. | None required. The battery may be disconnected at any time. |
| 0 | 'Battery Ready' | Charge Complete. | None required. The battery may be disconnected at any time. |
| EnU #.## | 'Battery Ready' | Charge Complete. Battery voltage reached 2.80 v/c. #.## indicates the voltage at the end of charge. | None required. The battery may be disconnected at any time. |
| Charge info | Any | Charger displaying charge information. | None required. See section 2.1.3.6. |
| Fault code | 'Fault' | A fault condition has occurred | See section 2.1.3.7. |

SECTION 2 – OPERATION (continued)

2.2. 046-0172 Control



The charger utilizes a standard ferro-resonant transformer, which provides isolation from the AC service line and regulates the charging current. The transformer output is connected to a full-wave bridge of silicon diodes, which provides DC charging current to the battery.

The starting charge amps and length of time required for a charge vary depending on the charger model. See the data plate on the charger for information.

2.2.1. Feature Summary

- Can be set to charge sealed or flooded battery types.
- Automatic start when battery is connected or manual start (if selected).
- Automatic stop when charge is finished.
- Fully charges partially discharged batteries without overcharging.
- Dead battery 'jump start' for overly-discharged batteries.
- Equalize charge by user request.
- Auto-refresh charging (if selected).
- Automatic shut-down if battery starts to overheat.
- Automatically resumes charge after a power failure during the charge cycle.
- Displays charging amps, battery volts/cell, full battery voltage, amp-hours returned, and run time.
- Delayed start adjustable from 1 minute to 24 hours.
- Delayed start until a certain time-of-day.
- Automatic equalize by number of charges.
- Automatic equalize by day-of-week.
- Fault codes with descriptive messages.
- Cool down timer adjustable from 1 minute to 24 hours.
- Periodic alert messages describing charger status.
- Compatible with the *I'mCool™* battery selection system.
- Watering valve control output for automatic watering.
- Compatible with the **Tobi® Battery Management System**.

2.2.2. Description

The 046-0172 has an 8 character display that has three sections: MODE, DATA, and UNITS. The MODE display shows a 2 character abbreviation that describes the status of the control. The DATA display is 4 characters and shows a value, such as amps or volts/cell. The UNITS display is 2 characters and shows the appropriate units for the value in the DATA display.

A 16-key pad allows the user to display volts/cell, amp-hours, run time, and other information.

The control is programmable to allow handling a wide variety of battery types and charging regimes. The control is factory set with the options needed based on information provided at the time of order. If the battery type or charging requirements have changed contact your sales representative for information on changing the control set-up.

The control has a messaging feature that can provide descriptive messages periodically to inform the user of its present status. For example, when no battery is present, the display periodically shows 'no bat' every 10 seconds. During the first phase of charge the display periodically shows 'CHG Ph1'. When the charge has ended and the battery is ready to be taken, the display periodically shows 'End bat rdy'. The messaging feature can be turned on or off. Contact your sales representative for more information.

2.2.3. Operation

The control is used in ferro-resonant taper chargers to provide fully automatic battery charging. The charging profile, or algorithm, uniquely monitors the output current and voltage to optimally charge the battery, based on battery manufacturer's recommendations.

The standard charging profile for flooded lead-acid batteries has 2 phases. During phase 1 the battery is charged at high current until the battery is 80% charged. Then phase 2 begins. As the battery voltage rises during phase 2, charging current tapers down toward the finish rate current and the battery voltage starts to flatten out. Phase 2 ends and the charge is terminated when the battery voltage no longer changes. This termination method is called 'dv/dt-di/dt'.

The control offers several safeguards to protect the battery. If a wrong voltage battery is connected, the charger does not start and a 'Low-Battery-Voltage' or 'High-Battery-Voltage' fault message is displayed. While charging, if the battery voltage exceeds a profile-specific cut-off value, the charge terminates with an 'End-On-Voltage' warning message. If the battery starts to overheat, the charge terminates with a 'Battery Too Hot' error message.

2.2.3.1. Normal Daily Charge

When no battery is connected, the display shows 'OK 0 A', and a 'no bat' message periodically if messaging is turned on. With the auto-start feature active, connecting a battery to the charger will cause it to begin a charge cycle. The charger will first perform a self-diagnostic test to verify the control is working properly. During this time a lamp test is performed causing all display segments to light. This allows the operator to observe any defective segments. Then the MODE portion of the display shows 'BC' for battery connected. When the self-diagnostic is complete, the charge starts and the MODE portion of the display shows 'HC' for high charge. The DATA display shows 'CHG Ph1' periodically (if messaging is active) along with the charging amps to indicate the charger is in phase 1 of the charge cycle. The UNITS portion of the display shows 'A' for amps. If equalize is active, the UNITS portion of the display shows 'AE' to indicate an equalizing charge is occurring.

When the battery is 80% charged, the charger starts phase 2 of the charge cycle. The MODE portion of the display shows 'LC' for low charge. The DATA display shows 'CHG Ph2' (if messaging is active) along with the charging amps. The UNITS portion of the display shows 'A' for amps (or 'AE' if an equalize charge).

During the equalize portion of the charge cycle the DATA display shows 'EqL On' periodically (if messaging is active) along with the charging amps.

When a charge is finished, the charger automatically turns off. The MODE portion of the display shows 'EN' for end. The DATA display shows 'End bat rdy' if messaging is active. The UNITS portion of the display is blank. To view the end-current press the 'D.C. AMPS' key. To view the end-voltage, press the 'VOLTS CELL' key. Pressing the 'VOLTS CELL' key a second time will display the full voltage. To view the amp-hours returned to the battery, press the 'AH'S RT'ND' key. To view the charge time, press the 'RUN TIME' key. The battery may then be disconnected at any time.

Warning: Risk of explosion. Do not disconnect the battery while the charger is running. Hydrogen gas produced by the battery during charging can be ignited by arcing that occurs when the battery cable is disconnected.

If the battery must be disconnected before the end of the charge cycle, the charger should be turned off first. Press the 'ON/OFF' key. The MODE portion of the display will show 'OF' for OFF and the DATA portion of the display will show 'OFF'. The battery may then be safely disconnected.

2.2.3.2. Equalize Charge

Over time batteries can develop inequalities in cell charge. This can lower the effective capacity of the battery and shorten life. An equalizing charge re-balances the charge in the battery cells. Perform an equalize charge if any of the following conditions exist:

1. On flooded batteries the specific gravity of any cell at the end of charge is 20 points less than the average of all the cells.

2. The on-charge voltage of any cell at the end of charge is 20 millivolts less than the average of all the cells.
3. The battery has been stored for 30 days.

The control can perform an equalize automatically based on the number of charge cycles or on a specific day of the week. There are 3 types of equalize available, normal, pulse-1 and pulse-2. Normal equalize consists of an additional 3 hour charge time at the end of a normal charge cycle. Pulse-1 equalize consists of an additional 30 minute charge time at the end of a charge cycle plus a 6 minute maintenance charge every hour until the battery is removed. Pulse-2 equalize consists of a 2 minute maintenance charge every 30 minutes for 72 hours. For flooded lead acid batteries a normal equalize is generally used. For sealed lead-acid batteries, a normal equalize or one of the pulse equalize methods is used.

The control is set at the factory to perform a normal equalize every 7 charging cycles for flooded lead-acid batteries. For Champion sealed batteries, the normal equalize is set for every 20 charge cycles.

The control can also perform an equalize charge when requested manually. Press the 'EQUALIZE' key. The UNITS portion of the display will change from 'A' to 'AE' indicating an equalize charge will be performed on the current charge. If no battery is connected, the next charge time will be extended to allow the cells to equalize their charge.

The auto-equalize or manual equalize charge can be cleared by pressing the 'EQUALIZE' key again. The UNITS portion of the display will change from 'AE' to 'A' indicating a normal charge will be performed. The next auto equalize charge will occur after the programmed number of charge cycles.

If auto equalize is not desired, contact your sales representative for de-activating instructions.

2.2.3.3. Time of Day Start

The time-of-day start feature allows the operator to delay the start of charge until a particular time of day. This might be desired to reduce peak energy surcharges if the charger were ready to start during a peak energy period. The time-of-day start could be set to keep the charger from starting until after the peak period ends.

Press the 'SET FUNC.' key to enter the programming mode. The DATA display will show 'Set'. Press 'START TIME'. The MODE display will then show 'TS' for time-of-day start. The DATA display will show 'tod Str=' and the time of day in 24 hour format. The UNITS display will show 'HM' to indicate the time-of-day is expressed in hours and minutes. The parameter is changed by entering a new value using the numeric keys on the keypad. Data entry is from left to right. The digit being edited is highlighted. If more than four digits are entered, the left-most digits scroll off the left end of the DATA display. If an incorrect number is keyed in, press 0 four times to scroll the bad number off the display and continue entering the correct value. (Note that if no keys are pressed within about 8 seconds, the programming mode will time-out and the control will return to the normal 'OK 0 A' display.) After the time-of-day has been entered, press 'ENTER' to save it. The display will show 'OK yes OK' to confirm the new delay time was accepted. The control will then return to the normal 'OK 0 A' display. To de-activate time-of-day start, enter '99.99' for the start time. Note that entering '0.00' for the start time will cause the charger to start at midnight.

2.2.3.4. Setting Time of Day

In order to use the Time of Day Start feature, the current time of day must be set correctly.

Press the 'SET FUNC.' key to enter the programming mode. The DATA display will show 'Set'. Press 'CLOCK'. The MODE display will then show 'TD' for time-of-day. The DATA display will show 'tod=' and the time of day in 24 hour format. The UNITS display will show 'HM' to indicate the time-of-day is expressed in hours and minutes. The parameter is changed by entering a new value using the numeric keys on the keypad. Data entry is from left to right. The digit being edited is highlighted. If more than four digits are entered, the left-most digits scroll off the left end of the DATA display. If an incorrect number is keyed in, press 0 four times to scroll the bad number off the display and continue entering the correct value. (Note that if no keys are pressed within about 8 seconds, the programming mode will time-out and the control will return to the normal 'OK 0 A' display.) After the time-of-day has been entered, press 'ENTER' to save. The display will show 'OK yes OK' to confirm the new time was accepted. The control will then return to the normal 'OK 0 A' display.

2.2.3.5. Emergency Stop

To manually terminate the charge cycle, press 'ON/OFF'. The charge will immediately stop. The MODE display will then show 'OF' for 'off' and the DATA display will show 'OFF'. Pressing 'ON/OFF' while the DATA display shows 'OFF' causes the charge to resume.

2.2.3.6. Setting Battery Cool Down Time

A time period can be set to allow a battery to cool down after being charged. Press the 'SET FUNC' key to enter the programming mode. The DATA display will show 'Set'. Press 'COOL DOWN'. The MODE display will then show 'CT' for cool down time. The DATA display will show 'Cool dn For=' and the hours and minutes of cool down time currently set. The parameter is changed by entering a new value using the numeric keys on the keypad. Data entry is from left to right. The digit being edited is highlighted. If more than four digits are entered, the left-most digits scroll off the left end of the DATA display. If an incorrect number is keyed in, press 0 four times to scroll the bad number off the display and continue entering the correct value. (Note that if no keys are pressed within about 8 seconds, the programming mode will time-out and the control will return to the normal 'OK 0 A' display.) After the cool down time in hours and minutes has been entered, press 'ENTER' to save it. The display will show 'OK yes OK' to confirm the new delay time was accepted. The control will then return to the normal 'OK 0 A' display. To de-activate cool down time, enter '00.00' for the cool down time.

2.2.3.7. Fault Handling

If a fault occurs, the charge is terminated, the MODE display shows 'ER', and the DATA display shows the fault code:

| DISPLAY | FAULT DESCRIPTION |
|----------------|---|
| F0 Sht CEL ### | Possible shorted cell or low charging amps. Battery voltage did not reach 2.0V/C (1.2V/C for Ni-Cad) within 30 minutes. ### is the volts per cell at end of charge. |
| F1 Sht CEL ### | Possible shorted cell or low charging amps. Battery did not reach gassing voltage during charge phase 1. ### is the volts per cell at end of charge. |
| F2 Hot bat | Hot battery. Detected by battery voltage dropping after gassing. |
| F3 Lo bat ### | Low battery voltage, less than 1.6V/C at start up. ### is the volts per cell when battery was connected. |
| F4 Hi bat ### | High battery voltage, more than 2.4V/C at start up. ### is the volts per cell when battery was connected. |
| F5 No Cur | No charging current to the battery. |
| F6 CHG Err | Charger current/voltage not what was set by control. N/A for standard ferro-resonant charger. |
| F7 Lng CHG | Long charge, the charger ran longer than the allotted time. |
| F8 CHG On | Charger stayed on when control requested it shut off. |
| F9 bad Pad | Faulty keypad detected. One or more keys is stuck on. |

2.2.3.8. F3 (Low Battery) Override

If battery voltage is below 1.6 volts per cell the charger will not start automatically. If this is due to an overly discharged battery of the correct voltage, the F3 fault can be manually overridden by pressing POWER ON while the F3 Fault message (Low Battery) displays.

2.2.4. Displaying Additional Charge Information

The user can view many different parameters associated with a charge. By pressing an appropriate key, information such as charger run time or amp-hours returned can be viewed. The display will time out after about 7 seconds and return to the default display which is usually amps.

2.2.4.1. Display Software Version

To display the software version number press '5'. The display will show 'UEr' followed by the software version number (e.g. 3.44).

2.2.4.2. Display Charging Current

In most applications charging current is normally displayed. However, on float utility chargers the battery voltage is generally the default display. If charging current is not already being displayed, press 'D.C. AMPS' to view. The DATA display shows charging current in amps. The UNITS display shows 'A' for amperes.

2.2.4.3. Display Volts Per Cell

To view volts per cell, press 'VOLTS CELL'. The DATA display shows the volts per cell and the UNITS display shows 'VC' for volts per cell. If the charge has finished and the battery is still connected, the end volts per cell is displayed. Repeatedly pressing the 'VOLT CELL' key will toggle between volts per cell and full battery voltage.

2.2.4.4. Display Full Battery Voltage

To view battery voltage, press 'VOLTS CELL' twice. The DATA display shows the full battery voltage and the UNITS display shows 'V' for volts. If the charge has finished, the end full battery voltage is displayed. Repeatedly pressing the 'VOLT CELL' key will toggle between volts per cell and full battery voltage.

2.2.4.5. Display Amp-Hours

To view amp-hours returned to the battery, press 'AH'S RT'ND'. The DATA display shows the amp-hours returned to the battery so far during the current charge. The UNITS display shows 'AH'.

2.2.4.6. Display Time-of-Day Start Time

To view the time-of-day start time, press 'START TIME'. The DATA display shows the time-of-day start time in hours and minutes, and the UNITS display shows 'HM' for hours and minutes format. The time-of-day is in 24-hour format. Thus a start time of 4:30PM would be displayed as '16.30'. If the time-of-day start is not active, the display shows '99.99'.

2.2.4.7. Display Charger Run Time

To view charger run time so far, press 'RUN TIME'. The DATA display shows the run time in hours and minutes and the UNITS display shows 'HM' for hours and minutes format.

2.2.4.8. Display Charger Identification Number

Chargers that are part of an *I'mCool™ Battery Selection System* or a *TOBi® Battery Management System* have a unique identifying number. To view this 'ID' number, press 'CHGR. ID'. The DATA display shows the charger ID number. If no number is set, the DATA display shows '9999'. UNITS display is blank.

2.2.4.9. Display Time of Day

To view the current time, press 'CLOCK'. The DATA display shows the time-of-day in 24-hour format. The UNITS display shows 'HM' for hours and minutes format.

2.2.4.10. Display Cool-Down Time

To view battery cool down time, press 'COOL DOWN'. The DATA display shows the cool down time setting in hours and minutes. The UNITS display will show 'HM' for hours and minutes format.

2.2.4.11. Display Percent Amp-Hours Returned

To view amp-hours returned as a percentage of the battery size press '% RET'N'. The DATA display shows the percentage of amp-hour capacity returned. The UNITS display will show '%' for percentage.

2.2.4.12. Display Trip Point

To view the cell voltage at which the battery is 80% charged, press 'TRIP POINT'. The DATA display will show the 80% voltage as volts per cell. The UNITS display shows 'VC' for volts per cell.

2.2.4.13. Perform Lamp Test

To check the display for out segments press 'LAMP TEST'. All segments in the display will light.

SECTION 3 - OPTIONAL FEATURES

3.1 Fusible Door-Interlock Switch (JIC Switch)

The door interlock switch assembly connects the AC service to the charger's input fuses for each AC line. The switch is mechanically latched by the door so that it must be in the OFF position before the door can be opened. Operation of the charger is identical to that of the standard model, except the charger cannot be energized if the door is open.

3.2 Remote Control

The remote control option makes it possible to operate the charger at a point within 15 feet of the charger. It includes a box equipped with the control option ordered, and either 15, 20, or 30 feet of jacketed control harness. Operation is identical to that of a standard charger except that the control is not mounted on the front of the charger.

3.3 Watering Valve

On chargers ordered with the 046-0072 control, an optional 24VAC watering solenoid can be ordered. The valve will activate at the end of the charge cycle. It works in conjunction with an automatic watering system that is supplied by others. Note: Watering valves have a one year part replacement warranty only.

3.4 Charger Stand

The charger stand is a metal frame that is designed to bolt the charger cabinet on top of it. It raises the cabinet up to the operator's level, rather than having the cabinet sitting on the floor.

SECTION 4 – TROUBLESHOOTING & GENERAL MAINTENANCE

Caution: There are lethal voltages exposed when the charger is energized with the door open. Always disconnect the AC service voltage to the charger before opening the door. The following chart lists the most probable cause of a malfunction.

SYMPTOMS AND POSSIBLE CAUSES

4.1. No charging current, the control has no display, contactor does not operate.

POSSIBLE CAUSE

- A. Blown AC fuse.
- B. No AC service voltage.
- C. Incorrect AC voltage.
- D. Control transformer output fuse blown.
- E. Defective control transformer.
- F. Defective control board.

4.2. No charging current, control has a display.

POSSIBLE CAUSE

- A. Blown DC fuse.
- B. Defective ammeter.
- C. Open battery cell.
- D. Defective diode.
- E. Defective capacitor.
- F. Shorted power transformer secondary.

4.3. AC fuse blows.

POSSIBLE CAUSE

- A. Incorrect fuse rating.
- B. Incorrect AC voltage.
- C. Fuse Block holding clips loose.
- D. Shorted transformer winding.

4.4. DC fuse blows.

POSSIBLE CAUSE

- A. Reversed battery connector.
- B. Incorrect fuse rating.
- C. Shorted diode.

4.5. Excessive water loss in battery.

POSSIBLE CAUSE

- A. Charging rate is too high. See Section 1.8.
- B. Charger amp-hour rating exceeds the battery amp-hour rating.
- C. Battery has defective cells.

4.6. Low specific gravity at the end of the charge cycle.

POSSIBLE CAUSE

- A. Battery was over-discharged.
- B. Charger amp-hour rating is less than the battery AH rating.
- C. Defective open diode.
- D. Charging rate is too low. See Section 1.8.
- E. Battery has defective cells.
- F. Battery has been over-watered.

4.7. Charger does not turn off when the control terminates the charge cycle.

POSSIBLE CAUSE

- A. Defective control.
- B. AC contactor has welded contacts.

4.8. General Maintenance

The charger requires a minimum of maintenance. Connections and terminals should be kept clean and tight. The charger should be periodically cleaned with an air hose to prevent any excessive dirt build up on components. Care should be taken not to bump or move any adjustments during cleaning. Make sure that both the AC lines and the battery are disconnected before cleaning. The frequency of this type of maintenance depends on the environment in which this unit is installed. If any cabinet sheet metal panels are removed for cleaning, be certain they are properly reinstalled upon completion.

SECTION 5 – REPLACEABLE PARTS

5.1 Ordering Information

The following information must be supplied when ordering a replacement part from your service agent in order to ensure that the correct part is supplied:

- A. Model or Spec. number of charger (Located on charger data plate)
- B. Serial number of charger (Located on charger data plate)
- C. Schematic reference symbol or part
- D. Description of part

5.2 Recommended Spares

The quantity of spares stocked should be increased as the number of chargers increases.

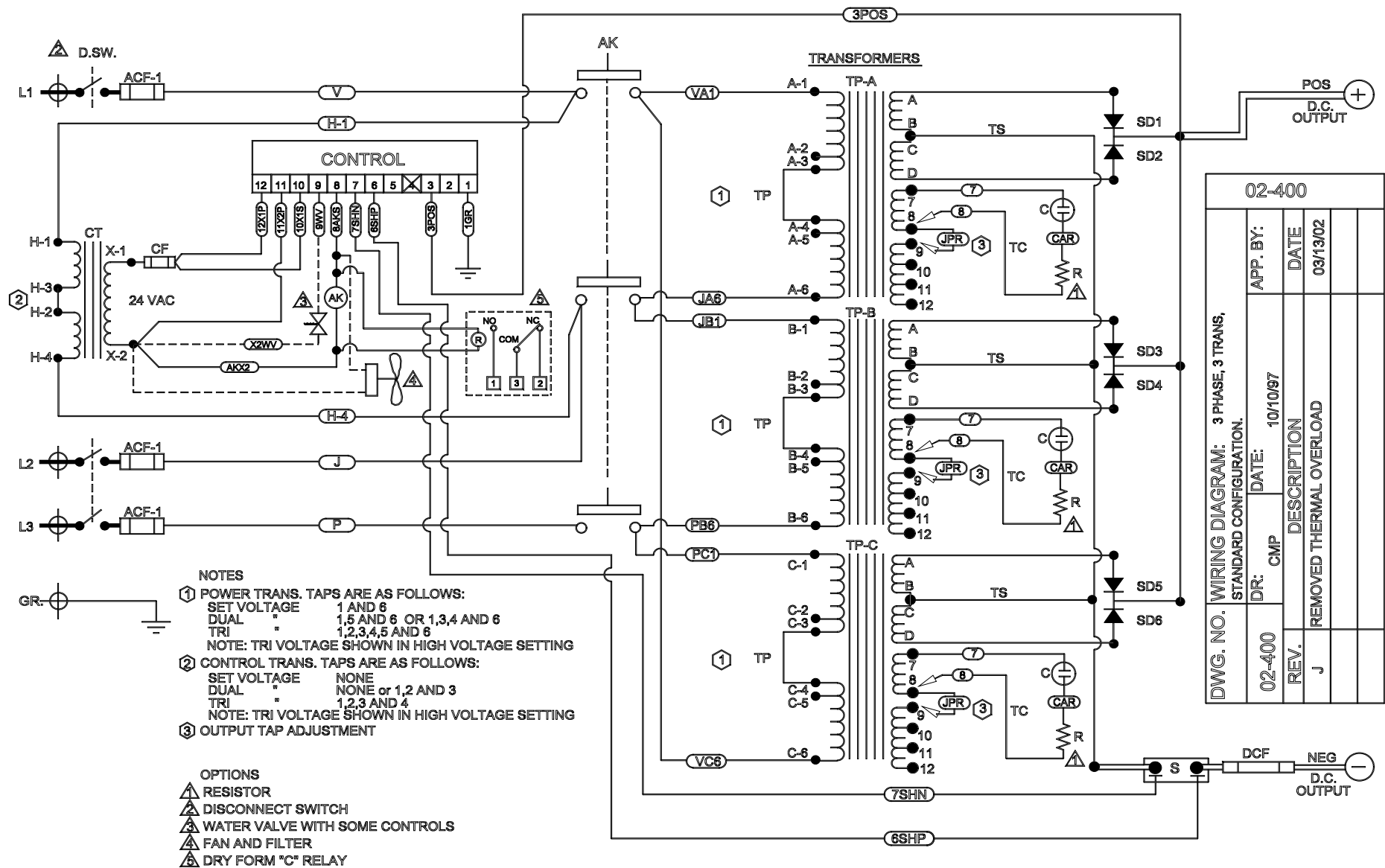
The following chart is the minimum quantity recommended per model for multiple charger installations:

| <u># OF CHARGERS</u> | <u># OF SPARE PARTS KITS</u> |
|----------------------|------------------------------|
| 1-3 | 1 |
| 4-10 | 2 |
| 11-25 | 3 |
| 26-50 | 4 |
| 51-100 | 5 |

| <u>SCHEMATIC REF</u> <u>SYMBOL</u> | <u>DESCRIPTION</u> | <u>QUAN. USED</u> | <u>QUANTITY RECOMMENDED</u> |
|---------------------------------------|----------------------|-------------------|-----------------------------|
| ACF | AC FUSE, 1 PH. | 2 | 4 |
| ACF | AC FUSE, 3 PH. | 3 | 6 |
| DCF | DC FUSE | 1 | 2 |
| CONTROL | CONTROL BOARD | 1 | 1 |
| AK | A.C. CONTACTOR | 1 | 1 |
| SD1,SD2 | SILICON DIODE, 1 PH. | 2 | 2 |
| SD1-SD6 | SILICON DIODE, 3 PH. | 6 | 3 |
| TP | TRANSFORMER, 1 PH. | 1 | 0 |
| TP | TRANSFORMER, 3 PH | 3 | 0 |
| C | CAPACITOR | VARIES | 1 |
| CT | CONTROL TRANSFORMER | 1 | 1 |

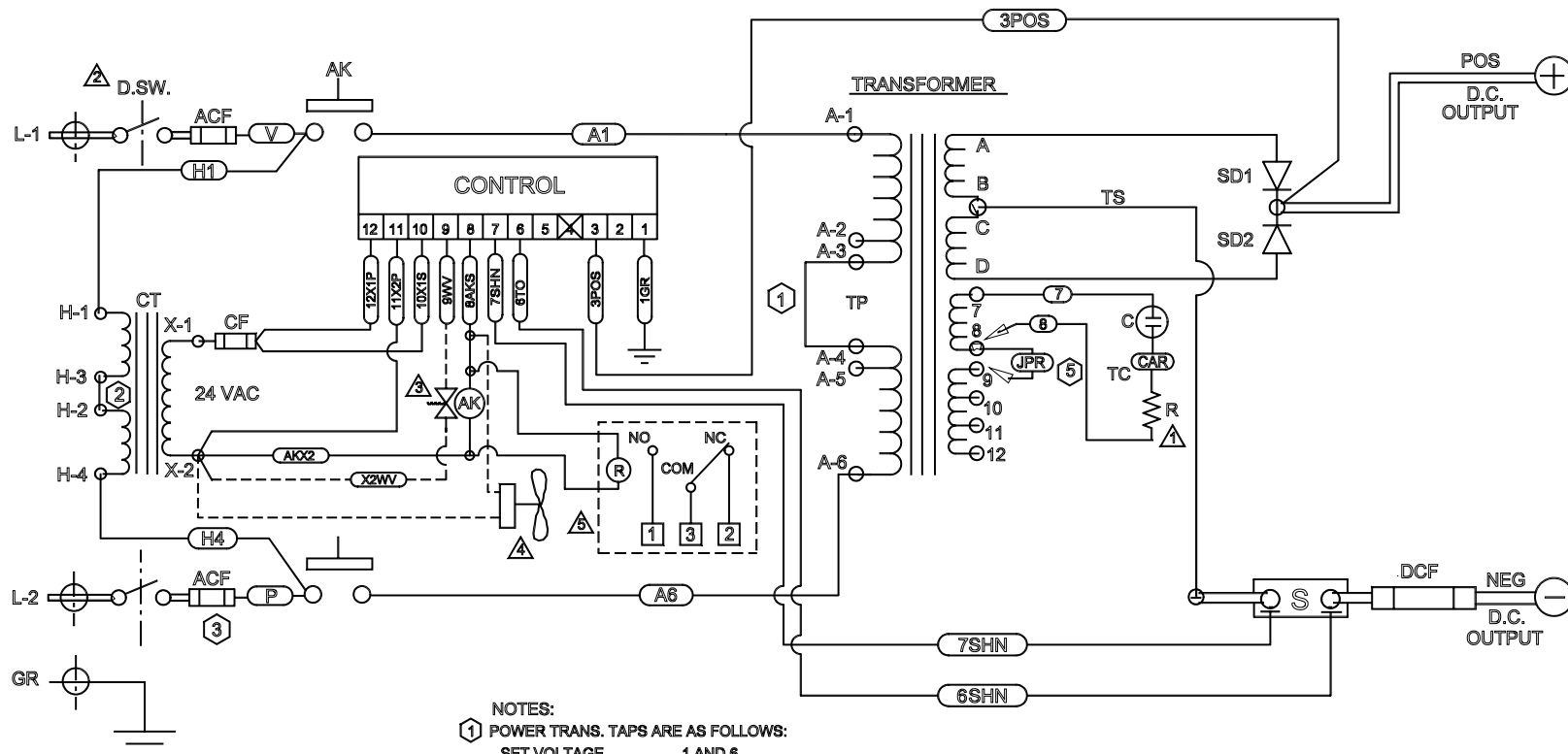
5.3 Spare Parts List

| <u>Part Number</u> | <u>Description</u> |
|------------------------------------|----------------------|
| <u>Condensers</u> | |
| 008-0002 | 2 MFD 440 Volt |
| 008-0004 | 4 MFD 440 Volt |
| 008-0006 | 6 MFD 440 Volt |
| 008-0008 | 8 MFD 440 Volt |
| 008-0010 | 10 MFD 440 Volt |
| 008-0012 | 12.5 MFD 440 Volt |
| 008-0015 | 15 MFD 440 Volt |
| 008-0017 | 17.5 MFD 440 Volt |
| 008-0020 | 20 MFD 440 Volt |
| 008-0030 | 30 MFD 440 Volt |
| 008-0040 | 40 MFD 440 Volt |
| <u>Resistors</u> | |
| 037-0017 | 1.25 Ohm 100 Watt |
| 037-0018 | 1.25 Ohm 200 Watt |
| 037-0015 | 2.50 Ohm 100 Watt |
| 037-0010 | 2.50 Ohm 200 Watt |
| <u>Diodes</u> | |
| 024-001 | 70 A 600 Volt |
| 024-003 | 150 A 600 Volt |
| <u>Contactors</u> | |
| 009-0020 | 30 Amp 3 Pole |
| 009-0021 | 30 Amp 2 Pole |
| 009-0049 | 60 Amp 3 Pole |
| <u>Controls</u> | |
| 046-0164 | 4 Button control |
| 046-0172 | 16 Button control |
| <u>Control Transformers</u> | |
| 003-1210 | 240/480P, 24S, 50 VA |
| 003-1211 | 120/240P, 24S, 50 VA |
| 003-1213 | 480/600P, 24S, 50 VA |
| <u>DC Fuses</u> | |
| 011-0243 | 80 Amp, 130 Volt |
| 011-0044 | 100 Amp, 130 Volt |
| 011-0045 | 150 Amp, 130 Volt |
| 011-0046 | 200 Amp, 130 Volt |
| 011-0047 | 250 Amp, 130 Volt |
| 011-0048 | 300 Amp, 130 Volt |
| 011-0049 | 400 Amp, 130 Volt |



| DWG. NO. WIRING DIAGRAM: 3 PHASE, 3 TRANS, STANDARD CONFIGURATION. | | | | |
|--|------|-----|-------------|--------------------------|
| 02-400 | DR: | CMP | DATE: | 10/10/97 |
| | REV. | J | DESCRIPTION | REMOVED THERMAL OVERLOAD |
| APP. BY: 03/13/02 | | | | |

Three Phase Charger Schematic # 02-400



OPTIONS:

- ① RESISTOR
- ② DISCONNECT SWITCH
- ③ WATER VALVE WITH SOME CONTROLS
- ④ FAN AND FILTER
- ⑤ DRY FORM "C" RELAY - OPTIONAL

- NOTES:
- ① POWER TRANS. TAPS ARE AS FOLLOWS:
 SET VOLTAGE 1 AND 6
 DUAL 1,5 AND 6
 TRI 1,2,3,4,5 AND 6
 NOTE: TRI VOLTAGE SHOWN IN HIGH VOLTAGE SETTING
 - ② CONTROL TRANS. TAPS ARE AS FOLLOWS:
 SET VOLTAGE NONE
 DUAL NONE OR 1,2 AND 3
 TRI 1,2,3 AND 4
 NOTE: TRI VOLTAGE SHOWN IN HIGH VOLTAGE SETTING
 - ③ FOR 120V OPERATION, INSTALL A DUMMY FUSE IN LINE 2. CONNECT THE NEUTRAL INPUT LEAD TO LINE 2.
 - ④ TRANSFORMER THERMAL OVERLOAD
 - ⑤ OUTPUT TAP ADJUSTMENT

| | | | | | | |
|----------|--------------------------|---|----------------|-----------|--------|---------|
| DWG. NO. | | WIRING DIAGRAM: 1 PHASE, 1 TRANS STANDARD CONFIGURATION. | | | 02-416 | |
| 02-416 | | DR: CMP | DATE: 10/15/97 | APPVD BY: | | |
| REV | DESCRIPTION | | | | | DATE |
| 1 | REMOVED THERMAL OVERLOAD | | | | | 3/13/02 |
| | | | | | | |
| | | | | | | |

Single Phase Charger Schematic # 02-416