C&D TECHNOLOGIES, INC.
Power Solutions

MOTIVE POWER DIVISION


# INSTALLATION AND OPERATING INSTRUCTIONS

# FerroCharge®

## INDUSTRIAL BATTERY CHARGERS

**PM990-1897-00, ISSUE 5**

## Issue History

| ISSUE | PAGE(S) | DESCRIPTION | APP'D / DATE |
|---|---|---|---|
| 1 | All | Original Release | 8/4/03 |
| 2 | 56 | Correct 575v 3 –ph primary connection | 4/16/04 |
| 3 | 53 to 60 | Remove optional ammeter and reference to TB3 watering | 2/15/05 |
| 4 | 5, 50-52 | Add models, add French safety instructions | 5/13/05 |
| 5 | 9,50-55, 59,62,65-82 | Add Models, Cabinet B, and three transformer diagrams, add TVS to diagrams, MC4 photos SEE ECN 15704 | MCM 9/20/06 |
| | | | |

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## Figures and Tables Content

## 1. IMPORTANT SAFETY INSTRUCTIONS

INSTRUCTIONS IMPORTANTES CONCERNANT LA SÉCURITIÉ

a. Read the instruction manual and all warning labels on the charger and battery before using the charger.
b. Familiarize yourself with the locations of hazardous voltages within the cabinet.
c. Danger: To prevent electric shock do not touch uninsulated live parts of the charger or battery. Danger: risque de chocs électriques. Ne pas toucher les parties non isolées du connecteur de sortie ou les bornes non isolées de l'accumulateur.
d. Shut off the charger before connecting or disconnecting the battery. Press the STOP key before disconnecting the battery.
e. The charger must be operated or serviced only by qualified personnel.
f. De-energize the ac input and disconnect the battery before servicing the charger.
g. Do not operate the charger outside its ratings as specified on the data nameplate.
h. FerroCharge chargers are intended for charging lead acid batteries only. Attention : utiliser pour charger uniquement les accumulateurs du type au plomb. D'autres types d'accumulateurs pourraient éclater et causer des blessures ou dommages.
i. Do not expose the charger to water or other liquids.
j. FerroCharge chargers are intended for indoor use only.
   CAUTION: DO NOT EXPOSE TO RAIN.
   ATTENTION: NE PAS EXPOSER À LA PLUIE.
k. Chargers are equipped from the factory with a tag describing the ac input Voltage. If the tag does not match the available ac line the input must be reconnected and the fuse values changed following the instructions in this manual.
   CAUTION – DISCONNECT SUPPLY BEFORE CHANGING FUSES.
   ATTENTION - COUPER L'ALIMENTATION AVANT DE REMPLACER LES FUSIBLES.
l. FerroCharge chargers are not intended for use in hazardous locations. Even if equipped with an explosion proof connector to match the battery, the charger must be located in a non-hazardous location.
m. Check for wear on the dc cables and connector. Replace cables that have cracked insulation. Replace connectors that overheat, are melted, or with pitted contacts.

# 2. RECEIVING AND INSTALLATION

## 2.1. Receiving

Inspect the charger for any shipping and handling damage as soon as it arrives. Describe any damage on the receiving slip and immediately notify the shipper. Verify the model and serial numbers printed on the packing list against the nameplate (Figure 2.1). If they disagree, contact your representative before proceeding with installation. Use caution when moving chargers. Use the proper moving equipment. Do not drop or otherwise abuse the charger.

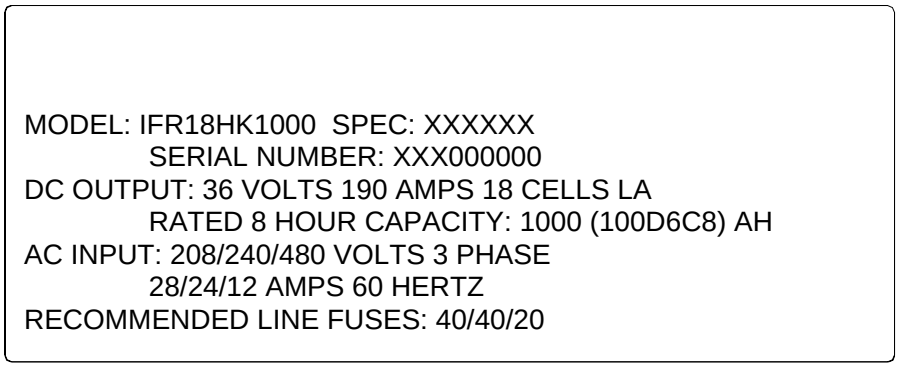



*FIGURE 2.1 NAMEPLATE*

## 2.2. Identification

A six-element model number identifies each charger. Each element describes a different charger performance characteristic. The model number of a **FerroCharge** charger describes its basic operating characteristics. A typical model number is:

| | | |
|---|---|---|
| IFR | - | Product Family |
| 12 | - | Number of (Lead-Acid) Cells in Battery to be charged |
| HK | - | AC Input Voltage Code, See Table 2.1 |
| 1000 | - | Ampere-Hour Rating for 8-Hour Charge |

| AC INPUT VOLTAGE CODES | | |
|---|---|---|
| **Code** | **Input (VAC) and Phase** | **Frequency (Hz)** |
| AC | 120/208/240, 1-Phase | 60 Hz |
| CE | 208/240/480, 1-Phase | 60 Hz |
| HK | 208/240/480, 3-Phase | 60 Hz |
| M | 575, 1-Phase | 60 Hz |
| K | 480, 3-phase | 60 Hz |
| L | 575, 3-Phase | 60 Hz |

*TABLE 2.1 AC INPUT VOLTAGE CODES*

## 2.3. Storage

Keep the charger in its original shipping container until it is ready to be installed. The unit can be safely stored in any clean, dry area where temperatures remain between 40°F and 120°F (5°C and 50°C).

## 2.4. Location

Battery charging produces heat and a potentially explosive mixture of odorless oxygen and hydrogen gases. Safe charging requires a clean, dry, well-ventilated area. For long battery life the room temperature should be between 60°F and 90°F (16°C and 32°C). Refer to the battery manufacturer's recommendations. The charger is rated to operate in ambient temperatures between 60°F and 104°F (16°C and 40°C). The charger may be operated for limited periods (up to 4 hours) at ambient temperatures between 104°F and 122°F (40°C to 50°C).

**FerroCharge** chargers are natural convection-cooled. Chargers require a MINIMUM of four inches of clearance between the floor, walls, chargers, and other obstructions for adequate air circulation. EXPLOSIVE, COMBUSTIBLE or FLAMMABLE MATERIALS SHOULD NOT BE PERMITTED IN THE CHARGING ROOM. NEVER MOUNT A CHARGER ON OR ABOVE COMBUSTIBLE MATERIALS. NE PAS INSTALLER SUR DES SURFACES COMBUSTIBLES OU AU-DESSUS DE TELLES SURFACES.

To prevent the accumulation of explosive concentrations of hydrogen and oxygen, the charging area should have sufficient ventilation to prevent formation of one percent, by volume, of hydrogen. It is important to note hydrogen is generated at different rates during various times in the charger cycle. Most of the gas forms during the last two to three hours of the charge when the average cell potential exceeds 2.37 volts. Every pint of water dissociated during recharge releases 23 cubic feet of hydrogen gas to the atmosphere. To calculate hydrogen formation, multiply the number of pints of water needed to correctly re-level cells after charging then multiply the number by 23. Thus, a lead-acid motive power battery that requires 1.5 pints of water to re-level, will produce 34.5 cubic (1.5 X 23) feet of hydrogen.

An approximation technique may be used to estimate hydrogen production from batteries charged by chargers equipped with CompuCharge and Ranger controls. It is estimated a total of 0.24 cubic feet of hydrogen gas will evolve from each cell per 100 ampere-hours of capacity. For example, an 18-cell battery rated at 720 ampere-hours:

Cells x Capacity x 0.24/100 = Cubic feet of hydrogen/charge cycle

18 x 720 x 0.24/100 = 31.1 Cubic feet of hydrogen/charge cycle

## 2.5. Mechanical installation

Chargers can be bolted to noncombustible floors or steel benches. Consult Figure 2.2 for charger cabinet dimensions. Wall mounting requires optional brackets, part number KBC05889A, quantity 2.

| Cabinet | Height | Width | Depth |
|---|---|---|---|
| A | 26.062 In | 21.75 In | 22.75 In |
| A | 662 mm | 552 mm | 578 mm |
| B | 26.062 In | 32 In | 22.75 In |
| B | 662 mm | 813 mm | 578 mm |

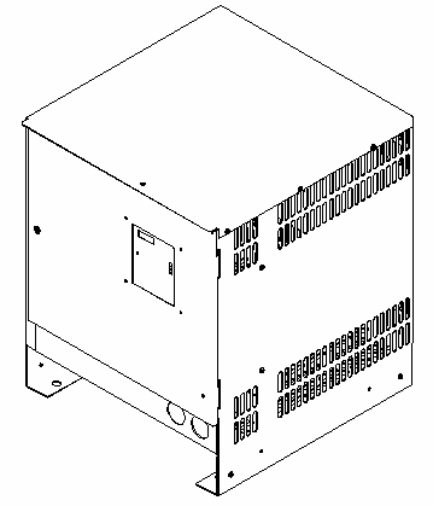


*FIGURE 2.2 CABINET DIMENSIONS*

## 2.6. Electrical connection

Each charger requires a fused safety disconnect switch or a circuit breaker. Use a line protection device rated for the recommended line fuse value shown on the charger nameplate (Figure 2.1). Electrical installations must be performed by a qualified electrician and satisfy all local, national and federal electrical codes. Proper grounding is required both for safety and to ensure optimum noise and transient immunity of the control board. Refer to the following sections for more specific information.

**CAUTION**
Electrical connections can work loose during shipping. Check all connections for tightness before connecting the charger to the AC supply voltage.

### 2.6.1. AC Input voltage and voltage changeover

The voltage circled on the input voltage rating label (Figure 2.3} must match the available line voltage. If the voltages are different, it will be necessary to change the AC line fuses, the control transformer fuse, and the connection terminals on both the ferroresonant power transformer and the control transformer. Consult the voltage changeover instruction label inside the cabinet door and the schematics or wiring diagrams at the back of this manual. BE SURE THE CHARGER IS DISCONNECTED FROM ITS AC POWER SUPPLY AND THE BATTERY BEFORE ATTEMPTING THIS MODIFICATION.

**CAUTION** – DISCONNECT SUPPLY BEFORE CHANGING FUSES.
**ATTENTION** - COUPER L'ALIMENTATION AVANT DE REMPLACER LES FUSIBLES.

NOTE: AC voltage changeover must be made at the terminals of both the ferroresonant power transformer and the control transformer.

Input voltage changeover CANNOT BE PERFORMED on chargers manufactured for 575 VAC only operation.

**CAUTION**

**DO NOT ATTEMPT TO RECONNECT VOLTAGE WITHOUT READING INSTRUCTIONS**

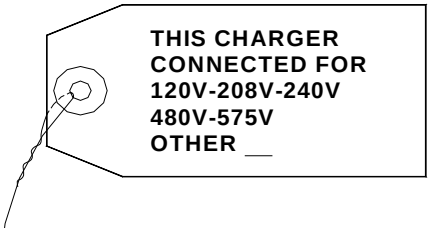



*FIGURE 2.3 AC VOLTAGE RATING LABEL (VOLTAGE CIRCLED)*

| CAUTION AC FUSE RATING<br>USE TYPES NOS, NLS, OR OTS ONLY | | | |
|---|---|---|---|
| 208V | 240V | 480V | 575V |
| 3 4 5 | 3 4 5 | 3 4 5 | 3 4 5 |
| 6 7 8 | 6 7 8 | 6 7 8 | 6 7 8 |
| 10 12 15 | 10 12 15 | 10 12 15 | 10 12 |
| 20 25 30 | 20 25 30 | 20 25 30 | 15 20 |
| 35 40 45 | 35 40 45 | 35 40 45 | 25 30 |
| 50 60 | 50 60 | 50 60 | 35 40 |

*FIGURE 2.4 AC FUSE RATING CHART. CIRCLES INDICATE THE PROPER FUSES FOR EACH VOLTAGE*.

### 2.6.2. AC input voltage cables

Customers or electrical contractors must furnish the AC connection. Cables should be sized for the recommended line fuse values shown on the charger nameplate. Allowable variations from nominal AC line voltages appear in Table 2.2. Route the AC conduit through the knockout provided in the charger cabinet. Connect the cables to the fuseblock terminals.

**CAUTION** – USE MINIMUM 75°C WIRING. USE COPPER CONDUCTORS.
**ATTENTION** - EMPLOYER DES FILS POUR AU MOINS 75 DEG C

*TABLE 2.2 ALLOWABLE AC INPUT RANGE*

| Nominal AC Voltage | AC Voltage Range |
|---|---|
| 120 | 106-127 |
| 208 | 184-220 |
| 240 | 212-254 |
| 480 | 424-508 |
| 575 | 508-600* |

*The charger will operate up to 632 VAC, but certain kinds of control and protective equipment have a maximum voltage limit of 600V. The manufacturer or power supplier or both should be consulted to assure proper application.

### 2.6.3. Grounding

The charger chassis must be grounded to the AC power source per the requirements of the National Electrical Code and applicable local codes. In order to assure dependable operation, it is imperative that the charger be provided a reliable earth ground. A solderless connector (lug) is provided on the floor of the cabinet near the AC fuseblock.

**WARNING** – THERE IS RISK OF ELECTRICAL SHOCK IF THE CHARGER IS NOT PROPERLY GROUNDED

### 2.6.4. DC cables and cable connectors

Each charger ships with a standard, eight-foot long cable that terminates with an appropriate connector. As an option, other lengths are available. If it is necessary to install longer cables, they must be properly sized to prevent overheating and ensure compliance with electrical codes.

When specifying replacement DC output connectors, it is important to remember single-phase chargers produce higher peak currents than similarly rated three-phase systems. The maximum DC current flowing from a single-phase charger is typically 1.3 times the ammeter reading. Higher capacity SB-350 connectors are recommended as retrofit equipment for all single-phase chargers rated at over 135 amperes.

DC CABLE LENGTHS FROM 15 TO 25 FEET SHOULD BE ONE CABLE SIZE LARGER THAN THE STANDARD CABLE. CABLE LENGTHS FROM 25 TO 35 FEET SHOULD BE TWO CABLE SIZES LARGER. DC CABLE LENGTHS SHOULD NOT EXCEED 35 FEET.

**CAUTION**
Be sure the charger positive terminal is connected to the charger connector terminal marked (+) and the negative terminal to the one marked (-).

## 2.7. Maintenance

Battery chargers work most efficiently and deliver better service life with good heat dissipation. Periodic cleaning with dry, low-pressure air will remove accumulated dust to assure good heat transfer to the surrounding air. At least twice a year, check input and output circuit connections and ground connections to make sure they are tight.

The DC cables and DC connector require periodic maintenance. Inspect the DC cables and DC connector to verify a sound, low-resistance connection, that there is no exposed metal, and that the connector is mechanically intact. Dirty or pitted contacts should be cleaned and lubricated or replaced following the manufacturer's recommendations. Cables should be replaced if the insulation is cut or cracked, or if the copper is exposed.

There are no other maintenance adjustments to the **FerroCharge** chargers.

**CAUTION: Disconnect charger from AC voltage supply before servicing or dismantling.**

# 3. SCOUT CONTROL

## 3.1. Description

The SCOUT CONTROL is a microprocessor-based controller that minimizes overcharging by continually monitoring battery voltage. Other STANDARD features include:

- Automatic start-helps prevent operator errors
- dV/dt termination
- Adjustable start delay
- Automatic equalization
- Safety features-checks for correct battery before charge begins
- Maximum charge time-helps prevent overheating
- Abort feature-when the control senses a problem, the red LED flashes twice every second

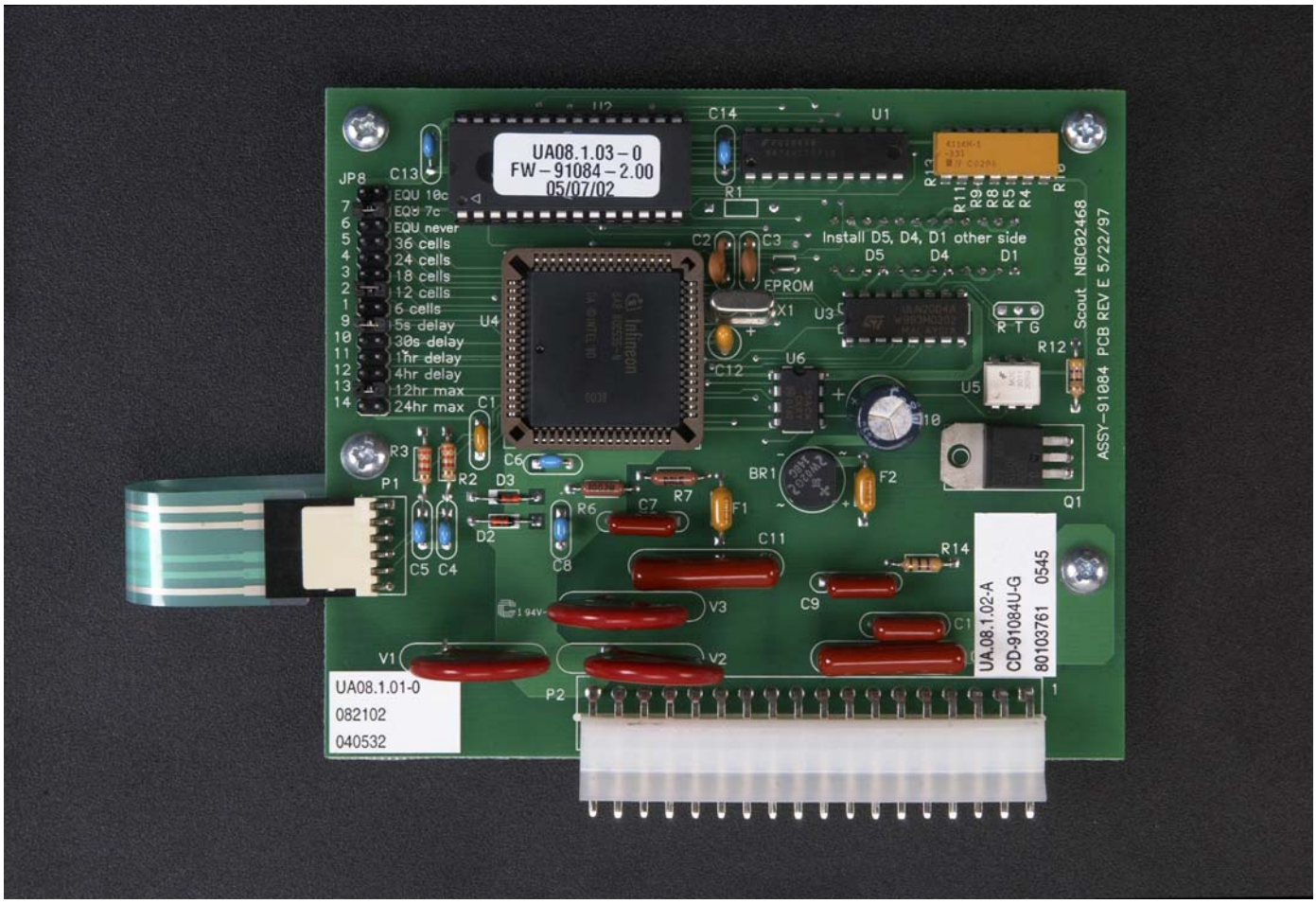



*FIGURE 3.1 SCOUT CONTROL BOARD*

## 3.2. Operation

### 3.2.1. Basic operation

SERIES chargers equipped with the SCOUT control have an LED display and keypad for operator interface. One LED indicates the charger is ready to operate, another LED indicates the battery is being charged and a third LED indicates when gassing voltage is reached. The Equal key activates the equalization charge mode and the Stop key allows the charger to be turned off during a charge.

Chargers equipped with the SCOUT control do not have start switches. Charging automatically begins five seconds after the operator connects the battery, unless the user specifies another delay (refer to Section 3.3.2).

When no battery is connected, the green LED will flash briefly every four seconds to indicate the charger is ready to begin charge. Once a battery is connected, the red LED will flash and glow steadily when the charge is in progress. When the battery is 80 percent charged, the yellow LED is lit, and the red LED will be extinguished. When the charge is complete, the green LED will glow.

If equalize is selected, the charge is extended by three hours. The red LED will flash when the battery is connected and during the charge. During equalization, the yellow LED will flash and will continue to do so throughout the equalize cycle. When the charge is complete, the green LED will flash.

If a battery with a number of cells that do not match the charger rating is connected, the charger will not start. Refer to Section 8, Troubleshooting.

If AC power is interrupted, charging will restart after a randomly timed start-up delay, not exceeding three minutes, thirty seconds. The random delay prevents a large inrush from the ac line if all chargers were to start at the same time.

In the event of an accidental battery disconnect, the system will shut down automatically, protecting charger components.

**WARNING**
If it is necessary to disconnect the battery during the charge, press the stop key before disconnecting the battery. FAILURE TO TAKE THIS PRECAUTION CAN CAUSE A SERIOUS ARC HAZARD AND A POTENTIALLY SERIOUS INJURY.

## 3.3. Basic settings

### 3.3.1. Setting the number of cells

The SCOUT control has jumpers to set the number of cells, 6, 12, 18, 24 or 36, to match the charger rating. The SCOUT is shipped from the factory matched to the charger. ADJUSTMENT OF THIS FEATURE IS NEEDED ONLY WHEN THE PRINTED CIRCUIT BOARD HAS BEEN REPLACED.

To change the number of cells:

1) Disconnect the ac power supply at the circuit breaker or fused safety-disconnect.
2) Open the instrument panel and locate the printed circuit board mounted directly behind it.
3) Locate the configuration jumpers as shown in Figure 3.2.
4) Move the jumpers to the desired number of cells, as shown in Figure 3.3.
5) Close the cabinet and reconnect the AC power supply.

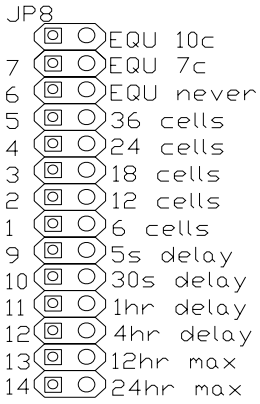



*FIGURE 3.2 SCOUT CONTROL BOARD JUMPERS*

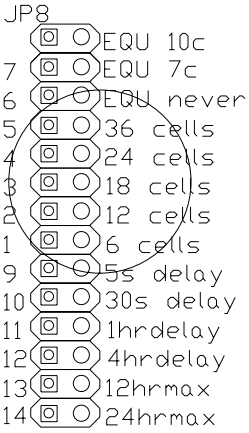



*FIGURE 3.3 JUMPERS FOR CHANGING CELLS*

### 3.3.2. Changing the five-second factory-set delay

The SCOUT control is shipped with a preset, five-second safety-delay. The delay can be changed to 30 seconds, one hour, or four hours.

To lengthen the factory-set delay:

1) Disconnect the battery and disconnect the ac power supply at the circuit breaker or fused disconnect.
2) Open the cabinet door. Remove the screws at the bottom of the instrument panel. Swing out the instrument panel.
3) Locate the bank of configuration jumpers on the control board as shown in Figure 3.2.
4) Move the jumpers to the desired time pattern: 30 seconds, one hour, or four hours. Refer to Figure 3.4.
5) Close all the panels and doors.
6) Reconnect the ac power supply.

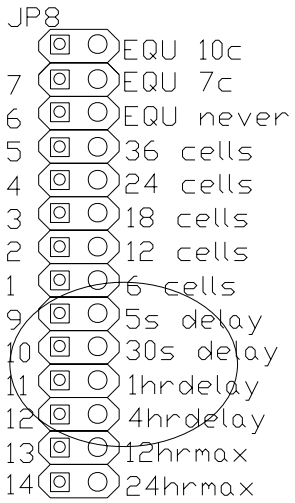



*FIGURE 3.4 JUMPERS FOR SETTING TURN ON DELAY*

### 3.3.3. Changing maximum charging time

The maximum charging time is factory-set at 12 hours. This feature should not need adjustment.

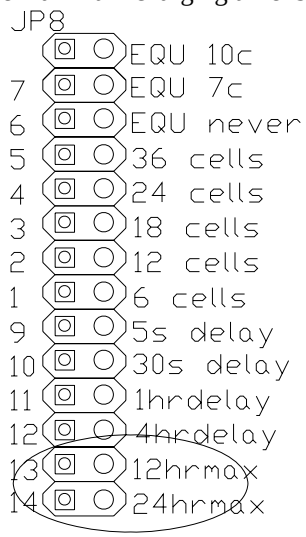



*FIGURE 3.5 JUMPERS FOR SETTING MAXIMUM CHARGING TIME*

### 3.3.4. Cold Storage Setting

The SCOUT control may be set to extend the charge by 30 minutes for cold storage or similar applications. A special combination of the override timer settings is used for this feature.

Place jumpers on both positions 13 and 14, 12hr max and 24hr max, to add 30 minutes of charging time with a 12-hour maximum charge time. Refer to Figure 3.5.

### 3.3.5. Manual equalizing

To initiate an equalization charge the operator connects the battery, waits for the red LED to flash or glow, and then presses the Equal key on the keypad. At the conclusion of an equalize charge the system automatically returns to the daily charge mode. The operator may initiate or terminate an equalize charge by pressing the Equal key while the charger is charging. If the charger is in the equalize part of the charge it will stop when the Equal key is pressed.

### 3.3.6. Automatic equalizing

The SCOUT control can be set to automatically equalize never, every seventh cycle, or every tenth cycle. To set the automatic equalization:

1) Disconnect the AC power supply at the circuit breaker or fused disconnect panel.
2) Open the cabinet door. Remove the screws at the bottom of the instrument panel. Swing out the instrument panel.
3) Locate the bank of configuration jumpers on the control board as shown in Figure 3.2.
4) Move the jumpers to the desired equalize cycle. The factory setting is 7 cycles. Refer to Figure 3.6.
5) Close all the panels and doors.
6) Reconnect the ac power supply.

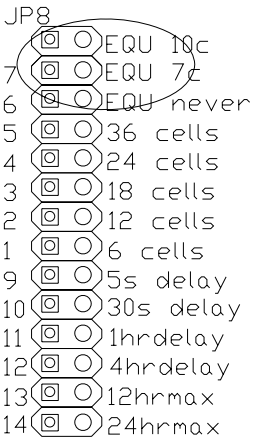



*FIGURE 3.6 JUMPERS FOR SETTING AUTOMATIC EQUALIZE*

# 4. COMPUCHARGE 3 CONTROL

## 4.1. Description

The COMPUCHARGE 3 CONTROL is a microprocessor-based controller that reduces the chance for overcharging by continually monitoring battery voltage and current. Other COMPUCHARGE 3 control features include:

- Automatic start-helps prevent operator errors
- dV/dt and dI/dt termination
- Turn-on time delay – Five seconds to seven hours, 45 minutes in 15 minute increments
- Automatic equalize – Never, every seven days, 1, 2, 3, 4, 5, 6, or 7 cycles
- Safety features-checks for correct battery before charge begins
- Maximum charge time-helps prevent overheating
- 4-digit, seven segment easy to read LED display
- Fully charged battery detector – won't start if detected
- Hot battery detector will terminate charge and resume after 8 hours cooling
- Automatic watering control output

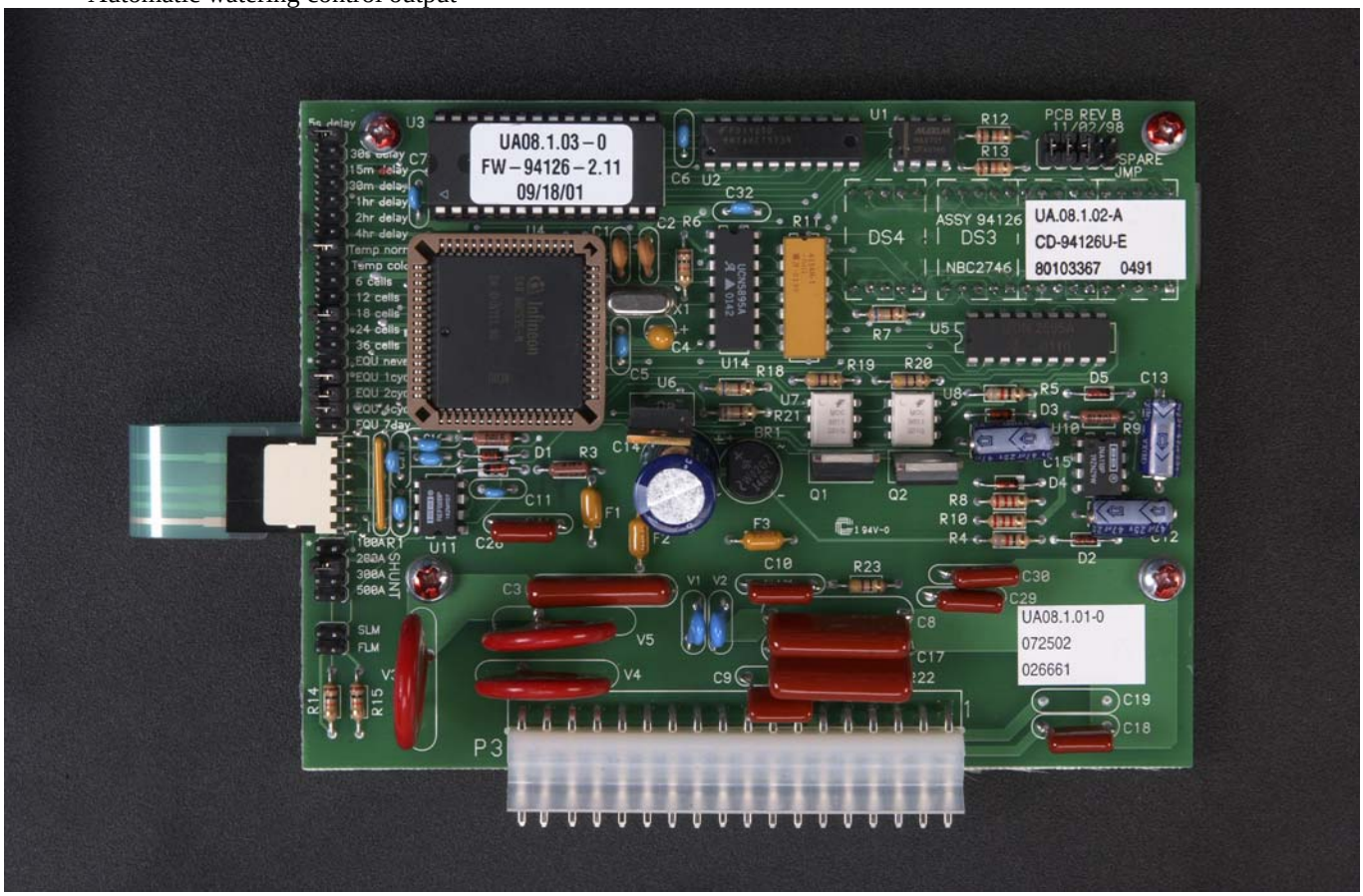



*FIGURE 4.1 COMPUCHARGE 3 CONTROL*

## 4.2. Operation

The operating panel of the COMPUCHARGE 3 control is a sealed membrane with a four character, ½ inch LED display, a Stop key, an Equal key, and a Scroll key.

The charging cycle is initiated when the battery is connected. The COMPUCHARGE 3 control checks for a battery of the proper voltage. If the match is correct, the display will show a count down until the charge starts. If a mismatch is detected, an error code ("bU E") will appear. (Refer to the troubleshooting section for more information.)

If an equalize charge is selected either automatically or by pressing the Equal key, a dot will appear on the display after the last character on the right. If automatic equalize is selected it will flash. If manual equalize is selected it will not flash. A manual equalize may be canceled by pressing the Equal key again.

After the user-selected start up delay the charge cycle begins. (For safety reasons the minimum delay is factory set at five seconds.) The charge current is displayed during the charge.

The COMPUCHARGE 3 control monitors the change in voltage and current to determine when the charge should be terminated. When the charge is greater than 80% completed, the last digit on the display will flash.

Pressing the Scroll key at any time during the charge cycle will display the battery voltage ("99.9U"). Pressing the Scroll key twice displays the Ampere-hours returned ("999r"). The display will return to the charging current after 60 seconds, or if the Scroll key is pressed a third time.

Charging continues until the battery is fully charged and the cell electrolyte is mixed. If the battery remains connected to the charger for three days, a refresh charge will be initiated automatically.

Cells nearing the end of their operating life or mistreated batteries may be unable to accept a complete charge. If the charge termination criteria have not been met after 12 hours, the charge cycle is stopped and an error message is displayed ("12hE").

When ac power is interrupted during a charge, charging will restart after a randomly timed startup delay not exceeding two minutes. The random delay prevents a large inrush from the ac line if a group of chargers were to start at the same time.

If a fully charged battery is inadvertently connected to the charger it will be detected and the charge terminated within three minutes.

A hot battery that goes into thermal runaway will be detected. The charger will stop for 8 hours, and then resume in the state where it left off. Typically thermal runaway only occurs as the battery approaches full charge.

## 4.3. Basic Settings

### 4.3.1. Setting the precharge delay

The precharge delay may be set to take advantage of lower utility rates. To change the precharge delay, follow these steps:

1) Disconnect the battery and disconnect the ac power supply at the circuit breaker or fused disconnect.
2) Open the cabinet door. Remove the screws at the bottom of the instrument panel. Swing out the instrument panel.
3) Locate the bank of configuration jumpers on the control board as shown in Figure 4.2.
4) Move the jumpers to the desired setting. When multiple jumpers are used the delay times are additive. For example, placing jumpers on 15 minutes, 2 hours, and 4 hours will set the delay to 6 hours and 15 minutes. Refer to Figure 4.2. Extra jumpers are located on the upper right hand corner of the board.
5) Close all the panels and doors.
6) Reconnect the ac power supply.

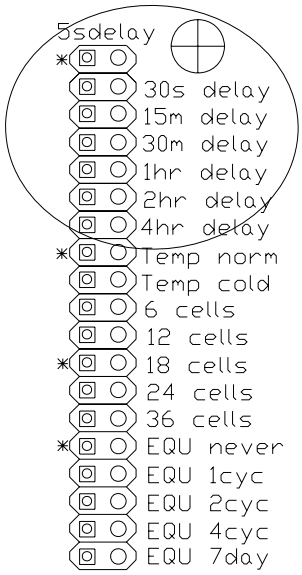



*FIGURE 4.2 JUMPERS FOR SETTING TURN ON DELAY*

### 4.3.2. Activating cold storage

Users with a cold storage application can set the COMPUCHARGE 3 control to adjust its charge termination. Battery starting temperatures of below 55°F are considered cold storage. To select this option, place jumpers on both the “temp norm” and “temp cold” pins (use two jumpers). Refer to figure 4.3.

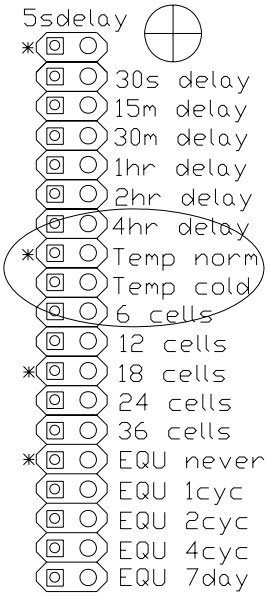



*FIGURE 4.3 JUMPERS FOR SETTING COLD STORAGE*

### 4.3.3. Setting the number of cells

The COMPUCHARGE 3 control is set up to match the charger. It has adjustments for a variable number of cells – 6, 9, 12, 15, 16, 18, 20, 24, 32, 36, and 40.

To change the number of cells:

1) Disconnect the battery and disconnect the ac power supply at the circuit breaker or fused disconnect.
2) Open the cabinet door. Remove the screws at the bottom of the instrument panel. Swing out the instrument panel.
3) Locate the bank of configuration jumpers on the control board as shown in Figure 4.4.
4) Move the jumpers to the desired number of cells. Refer to Figure 4.4. For 9, 15, 16, 20, 32, and 40 cells multiple jumpers are required as shown in the following table:

| Cells | Jumpers on |
|---|---|
| 9 | 6 and 12 cell |
| 15 | 12 and 18 cell |
| 16 | 6, 12, and 18 cell |
| 20 | 18 and 24 cell |
| 32 | 24 and 36 cell |
| 40 | 6 and 24 cell |

5) Close all the panels and doors.
6) Reconnect the ac power supply.

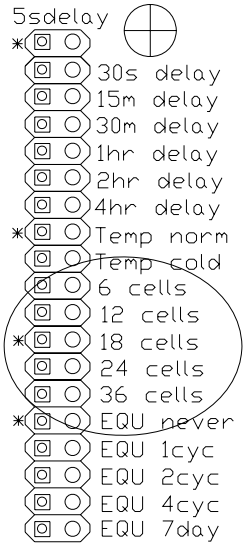



*FIGURE 4.4 JUMPERS FOR SETTING THE NUMBER OF CELLS*

### 4.3.4. Automatic equalizing

The COMPUCHARGE 3 control can be set to automatically equalize never, every 7 days, or every 1, 2, 3, 4, 5, 6, or 7 cycles.
To change the automatic equalize setting:

1) Disconnect the battery and disconnect the ac power supply at the circuit breaker or fused disconnect.
2) Open the cabinet door. Remove the screws at the bottom of the instrument panel. Swing out the instrument panel.
3) Locate the bank of configuration jumpers on the control board as shown in Figure 4.1 that start with "EQU".
4) Move the jumpers to the desired equalize setting. The factory setting is 7 days. Refer to Figure 4.5.
5) Close all the panels and doors.
6) Reconnect the ac power supply.

Note: The equalize cycles are designed for maximum flexibility, so multiple jumpers placed in the banks ending in "cyc" are additive. For example, a jumper on the pin marked "EQU 1 cyc" and a jumper on the pin marked "EQU 2 cyc" would result in an equalize charge every three cycles. A single jumper on the pin marked "EQU 1 cyc" results in equalize every cycle. "NEVER" takes precedence over all other jumpers. Spare jumpers are located on the control board.

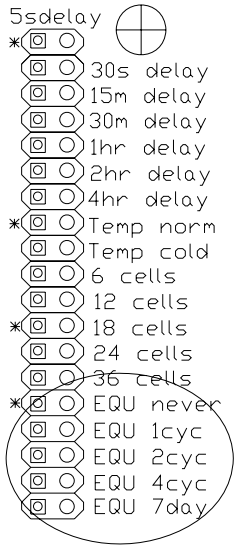



*FIGURE 4.5 JUMPERS FOR SETTING AUTOMATIC EQUALIZE*

### 4.3.5. Manual equalizing

To begin manual equalize, connect the battery and press the Equal key. Press the Equal key again to take the charger out of equalize.

### 4.3.6. Automatic watering

The COMPUCHARGE 3 control has a 24 VAC output to power a solenoid for automatic watering. One side of the solenoid connects to pin 5 of the control board and the other side of the solenoid connects to X4 on the control transformer (CXF). Refer to the schematics at the back of this manual.

The watering cycle lasts for 3 minutes at the end of charge. If equalize is set, the watering cycle precedes the equalize cycle. If the charger is equipped with a watering module, watering is automatic; there are no settings required.

Refer to the instructions supplied with the water module for installation and connections to the charger, and for connections to the water supply. Refer to the instructions supplied with the battery filling system for installation on the battery.

# 5. COMPUCHARGE 4

## 5.1. Description

The CompuCharge 4 is a microprocessor-based controller that reduces the chance for overcharging by continually monitoring battery voltage and current. The settings are menu driven and accessible from the front panel membrane switches. Other CompuCharge 4 features include:

- Automatic start-helps prevent operator errors
- dV/dt and dI/dt termination
- Turn-on time delay – 5, 10, 30, 60 seconds; 0.1, 0.2, 0.5, 1, 2, 5, 8, and 12 hours
- Manual or automatic equalize – None, 1 to 7 cycles, 7 days, or 14 days. Default is 7 cycles. Equalize duration of 1 to 6 hours, default is 3 hours. Equalize is indicated when the decimal point after the rightmost digit flashes.
- Checks for correct battery voltage before charge begins
- Maximum charge time of 12 hours helps prevent overheating.
- 4-digit, seven segment easy to read LED display for menu setup, current, Voltage, and accumulated Ampere-hours
- Gassing voltage set points of 2.37 or 2.40 Volts per cell
- Operating environment setting for normal or cold temperature
- Refresh charge mode settable for intervals of 3, 6, 8, 12, 15, 20, 24, 30, 40, 48, 60, or 72 hours. The default is 72 hours.
- 100 hour cooldown timer after end of charge helps to select the next battery to use
- Opportunity charging mode that Stops charge at gassing voltage. Settable hold time until full charge commences of 3, 6, 8, or 12 hours
- Fully charged battery detector – won't continue to charge if detected
- Hot battery detector will terminate charge and resume after 8 hours cooling
- Automatic watering control output
- All display segments light before start of charge to indicate proper operation

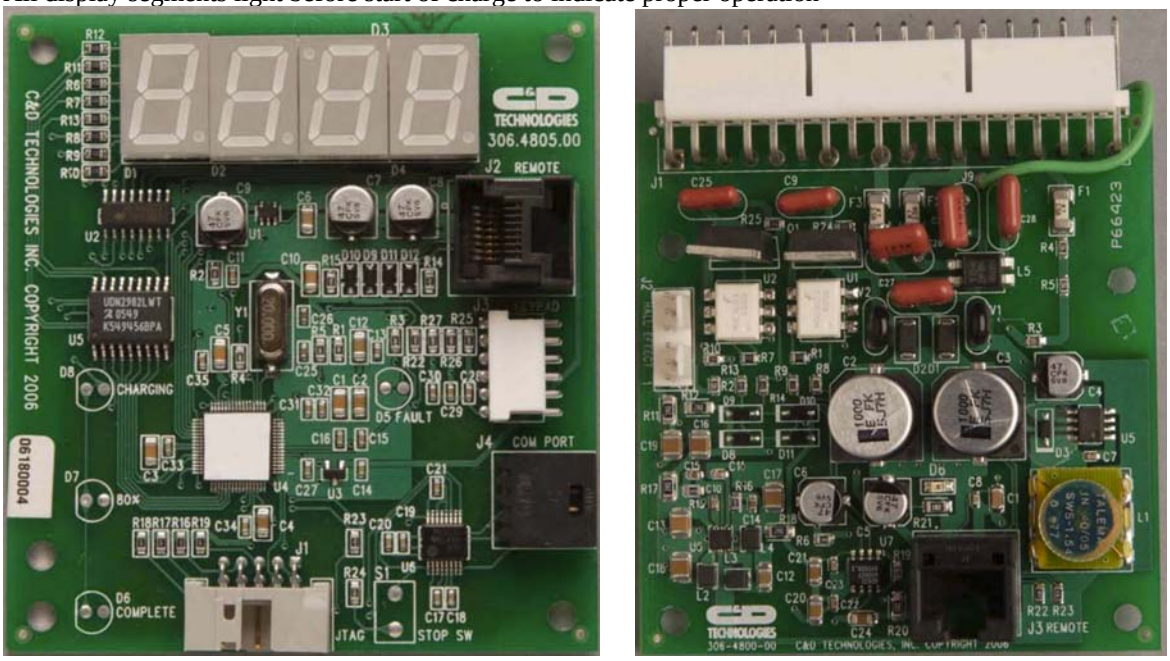



*FIGURE 5.1 COMPUCHARGE 4 CONTROL (L) AND INTERFACE (R) BOARDS*

## 5.2. Operation

The operating panel of the **CompuCharge 4** control is a sealed membrane with a four character, ½ inch 7-segment LED display. There are three membrane switches, Stop, Equalize, and Scroll (curved arrow) used to enter the setup menu and select the setup parameters or to display Volts or Ampere-hours accumulated during the charge cycle.

The 7-segment display shows the number of cells during the idle mode. The charging cycle is initiated when the battery is connected. The **CompuCharge 4** control checks for a battery of the proper voltage. If the match is correct, the display will show a count down until the charge starts. If a mismatch is detected, the display will show "**bV E**". (Refer to the troubleshooting section for more information.)

After the user-selected start up delay the charge cycle begins. (For safety reasons the minimum delay is factory set at five seconds.) The charge current is displayed during the charge.

The **CompuCharge 4** control monitors the change in voltage and current to determine when the charge should be terminated. When the charge is greater than 80% completed, the last digit on the display will flash.

Pressing the scroll key at any time during the charge cycle will display the battery Volts per cell ("**XX.XV**"). Pressing the key twice displays the Ampere-hours returned ("**999r**"). The display will return to the charging current after 60 seconds, or if the key is pressed a third time.

Charging continues until the battery is fully charged and the cell electrolyte is mixed. If the battery remains connected to the charger, a refresh charge will be initiated automatically after a selected interval.

**The CompuCharge 4** has an automatic equalize feature that extends the charge to mix the battery electrolyte and equalize the cell voltages. The decimal point to the right of the rightmost digit flashes to indicate the charger is in the equalize mode.

Cells nearing the end of their operating life or mistreated batteries may be unable to accept a complete charge. If the battery is not charged in 12 hours the charger will Stop and the display will show "**12hE**".

When ac power is interrupted during a charge, charging will restart after a randomly timed startup delay not exceeding two minutes. The random delay prevents a large inrush from the ac line if a group of chargers were to start at the same time. A battery that is mostly charged may show as fully charged after restarting.

If a fully charged battery is inadvertently connected to the charger it will be detected and the charge terminated within three minutes.

A hot battery that goes into thermal runaway will be detected. The charger will Stop for 8 hours, then resume in the state where it left off. Typically thermal runaway only occurs as the battery approaches full charge.

If the Stop key is pressed the display will show "**StPE**". The battery must be disconnected to clear the display.

## 5.3. Basic Settings

### 5.3.1. Setting the Precharge Delay

The precharge delay may be set to take advantage of lower utility rates. To change the precharge delay, follow these steps:

1) Press the Stop key and disconnect the battery to return to the idle mode.
2) Press and hold both the Equalize and Scroll keys for 5 seconds until the display goes to the setup menu. The first menu item is the delay.
3) Press the Equalize key until the desired setting of 5S (seconds), 10S, 30S, 60S; 0.1, 0.2H (hours), 0.5H, 1H, 2H, 5H, 8H, or 12H is reached
4) Press the Stop key to exit the menu or press the Scroll key to go to the next setting.

### 5.3.2. Setting the Automatic Equalizing Frequency

The **CompuCharge 4** can be set to automatically equalize none, every 1, 2, 3, 4, 5, 6, or 7 cycles, or every 7 or 14 days. The decimal point to the right of the rightmost digit flashes to indicate the charger is in the equalize mode.

To change the automatic equalize setting:

1) Press the Stop key and disconnect the battery to go to the idle mode.
2) Press and hold both the Equalize and Scroll keys for 5 seconds until the display goes to the setup menu. The second menu item is the delay.
3) Press the Scroll key until the display shows "**E no**", "**E** X**C**", or "**E**XX**d**".
4) Press the Equalize key until the desired setting of None, 1 to 7 cycles, 7 days, or 14 days is reached. Default is 7 cycles.
5) Press the Stop key to exit the menu or press the Scroll key to go to the next setting.

### 5.3.3. Setting the Equalize Charge Duration

To change the automatic equalize setting:

1) Press the Stop key and disconnect the battery to return to the idle mode.
2) Press and hold both the Equalize and Scroll keys for 5 seconds until the display goes to the setup menu. The third menu item is the equalize duration.
3) Press the Scroll key until the display shows "**Ed**X**h**".
4) Press the Equalize key until the desired setting of 1, 2, 3, 4, 5, or 6 hours is reached. Default is 3 hours.
5) Press the Stop key to exit the menu or press the Scroll key to go to the next setting.

### 5.3.4. Setting the Refresh Charge Interval

The **CompuCharge 4** can be set to perform a refresh charge if the battery remains connected for 3, 6, 8, 12, 15, 20, 24, 30, 40, 48, 60, 72, or 80 hours.

To change the refresh charge interval:

1) Press the Stop key and disconnect the battery to return to the idle mode.
2) Press and hold both the Equalize and Scroll keys for 5 seconds until the display goes to the setup menu. The fourth menu item is the refresh interval.
3) Press the Scroll key until the display shows "**r**XX**h**".
4) Press the Equalize key until the desired setting of 3, 6, 8, 12, 15, 20, 24, 30, 40, 48, 60, 72 or 80 hours. The default is 12 hours.
5) Press the Stop key to exit the menu or press the Scroll key to go to the next setting.

### 5.3.5. Setting the Number of Cells

The CompuCharge 4 must be set to match the rating of the charger in which it is installed.

To set the number of cells:

1) Press the Stop key and disconnect the battery to return to the idle mode.
2) Press and hold both the Equalize and Scroll keys for 5 seconds until the display goes to the setup menu. The fifth menu item is the number of cells.
3) Press the Scroll key until the display shows "**C** XX".
4) Press the Equalize key until the desired setting of 6, 9, 12, 15, 16, 18, 20, 24, 32, 36, or 40 is reached.
5) Press the Stop key to exit the menu or press the Scroll key to go to the next setting.

### 5.3.6. Setting the Shunt Size

The CompuCharge 4 must be set to match the rating of the charger in which it is installed.

To set the shunt size:

1) Press the Stop key and disconnect the battery to return to the idle mode.
2) Press and hold both the Equalize and Scroll keys for 5 seconds until the display goes to the setup menu. The sixth menu item is the shunt size.
3) Press the Scroll key until the display shows "**S** XXX".
4) Press the Equalize key until the desired setting of 100A, 200A, 300A, 500A, or 600A is reached.
5) Press the Stop key to exit the menu or press the Scroll key to go to the next setting.

### 5.3.7. Setting the Operating Temperature

The default setting is normal or "**Tnor**". Users with a cold storage application can set the **CompuCharge 4** control to adjust its charge termination. Battery starting temperatures of below 55°F are considered cold storage.

To set the operating temperature and extend the charge time:

1) Press the Stop key and disconnect the battery to return to the idle mode.
2) Press and hold both the Equalize and Scroll keys for 5 seconds until the display goes to the setup menu. The seventh menu item is the operating temperature.
3) Press the Scroll key until the display shows "**Tnor"** or **"Tcol**".
4) Press the Equalize key to select normal, Tnor, or cold, Tcol.
5) Press the Stop key to exit the menu or press the Scroll key to go to the next setting.

### 5.3.8. Setting the Gassing Voltage

The **CompuCharge 4** control may be set to detect a gassing point Voltage of 2.37 or 2.40 Volts per cell.

To set the gassing voltage detector:

1) Press the Stop key and disconnect the battery to return to the idle mode.
2) Press and hold both the Equalize and Scroll keys for 5 seconds until the display goes to the setup menu. The eighth menu item is the gassing voltage limit.
3) Press the Scroll key until the display shows "**G2.37"** or **"G2.40**".
4) Press the Equalize key to select 2.37 or 2.40.
5) Press the Stop key to exit the menu or press the Scroll key to go to the next setting.

### 5.3.9. Setting the Charge Profile

The **CompuCharge 4** control may be set for either a conventional or opportunity charging profile. In the opportunity charging mode the charger will Stop when the voltage reaches the gassing point. If the battery remains connected beyond a selected interval, a complete charge cycle will be performed.

To set the charge profile:

1) Press the Stop key and disconnect the battery to return to the idle mode.
2) Press and hold both the Equalize and Scroll keys for 5 seconds until the display goes to the setup menu. The ninth menu item is the charge profile mode
3) Press the Scroll key until the display shows "**PrCV"** or **"PrOP**".
4) Press the Equalize key to select conventional mode, "**PrCV"** or opportunity mode, **"PrOP**".
5) Press the Stop key to exit the menu or press the Scroll key to return to the beginning of the menu settings.

### 5.3.10. Setting the Hold Time for Opportunity Charging

In the opportunity charging mode the **CompuCharge 4** control may be set to wait for 3, 6, 8, or 12 hours after the charger Stops after reaching the gassing point to begin a full conventional charge cycle.

To set the hold time:

1) Press the Stop key and disconnect the battery to return to the idle mode.
2) Press and hold both the Equalize and Scroll keys for 5 seconds until the display goes to the setup menu. The ninth menu item is the charge profile mode
3) Press the Scroll key until the display shows "**PrCV"** or **"PrOP**".
4) Press the Equalize key to select the opportunity charging mode, **"PrOP**".
5) Press the Scroll key to display "**H**XX**h**", the hold time.
6) Press the Equalize key to select 3, 6, 8, or 12 hours.
7) Press the Stop key to exit the menu or press the Scroll key to go to the next setting.

### 5.3.11. Cooldown Timer at End of Charge

The **CompuCharge 4** control displays the hours and minutes, "**H.MMC**" or hours and tenths of hours, "**HH.HC**" since the charge ended up to 100 hours. This feature may be used to select the next battery to place back into use. The rate of change of the last two digits on the clock determines if they are seconds or minutes. After 100 hours the display will show "**COOL**".

### 5.3.12. Automatic watering

The **CompuCharge 4** control has a 24 VAC output to power a solenoid for automatic watering. One side of the solenoid connects to pin 5 of the control board and the other side of the solenoid connects to X4 on the control transformer (CXF). Refer to the schematics at the back of this manual.

The watering cycle lasts for 3 minutes at the end of charge. If equalize is set, the watering cycle precedes the equalize cycle. If the charger is equipped with a watering module, watering is automatic; there are no settings required.

Refer to the instructions supplied with the water module for installation and connections to the charger, and for connections to the water supply. Refer to the instructions supplied with the battery filling system for installation on the battery.

# 6. RANGER II CONTROL

## 6.1. Description

The RANGER II control uses a “plain-English,” menu-driven display program. When the charger is idle, the display shows the number of cells, the current date and the time.

Features of the RANGER II control include:

- **Bright, two-line vacuum fluorescent display**–visible in ambient light
- **“Plain English,” menu-driven display**–for fast set-up, preview and change of equalize, delayed start and other charge parameters
- **Delayed start**–turn-on time delay is selectable from five seconds to 12 hours in one second intervals and time of day start
- **Real-time 24-hour clock**–with automatic adjustment for daylight savings time.
- **Automatic or manual equalize**–automatic equalize selectable from one to 50 cycles or day of the week; manual equalize selectable from front panel
- **Automatic three-day refresh cycle**- if battery is connected for more than 72 hours, a brief boost charge is provided to maintain battery in fully charged condition
- **Automatic charge termination**– when voltages stabilize indicating full charge or if battery overheats
- **User programmable cool down step**
- **A variety of cell and shunt sizes**–selectable for six through 36-cell batteries and four shunt sizes
- **Output for optional automatic watering device**
- **Advanced features with compatible battery module:**
  - **Equalize by battery cycles**
  - **Watering by cycles**
- **Manual equalize and charger reports** can be accessed by pressing the Scroll key (curved arrow). Refer to sections 6.3.3 for specific information.

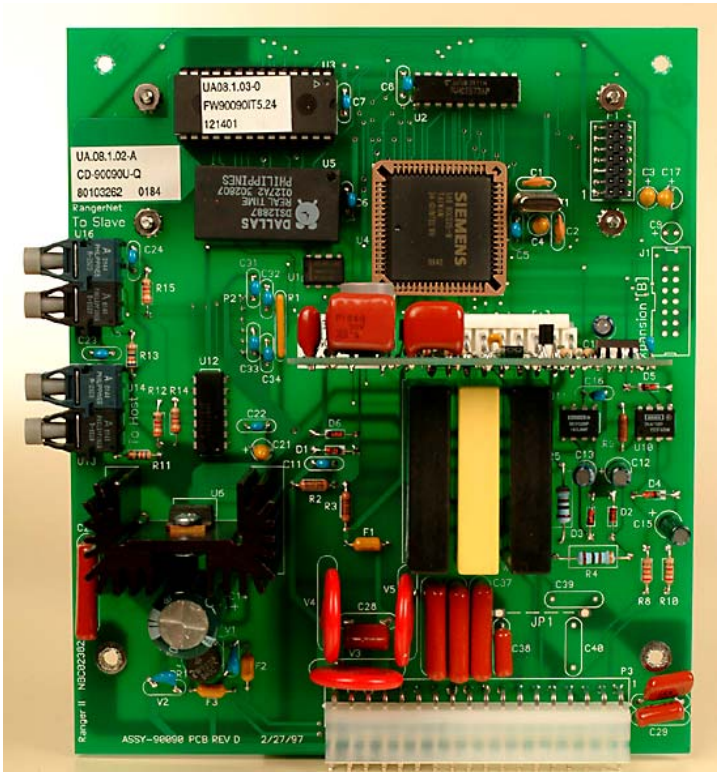



*FIGURE 6.1 RANGER II CONTROL WITH COMMUNICATIONS BOARD*

## 6.2. Basic Settings

Basic control settings such as number of cells, shunt size, delay before starting, etc. are set from the front panel using a "hidden" menu with restricted access. Before operating your charger, check to be sure these initial settings have not been changed. Should you need to change any of these settings, you may access them through the RANGER II control panel. The battery must be disconnected in order to enter the parameters menu.

To access this menu, press both Arrow keys at the same time when the seconds portion of the time display indicates :01 changing to :02.

The Scroll key is used to move from selection to selection, and the Arrow keys are used to enter information. Begin by using the Arrow key to select "parameters," then press the

Scroll key to view the first parameter. To return to the idle display, press the Stop key. All parameters are automatically saved and overwrite existing parameters.

**NOTE:** An internal, non-rechargeable lithium battery permits the RANGER II control to retain programmed operating parameters in memory even when the charger is disconnected from an AC line. This battery has an expected service life of more than 10 years, and, when required, should be replaced by C&D. In the event of battery malfunction, contact your local C&D representative.

### 6.2.1. Real-time or fixed increment starting

**IMPORTANT:** When using real-time starting or fixed increment delay starting, be sure to allow for at least eight hours of charging before the battery is used again.

Delayed starting lets you delay the time when the charge begins in order to take advantage of lower, off-peak after the preset start time has passed, the battery will still be charged after a short delay. This allows for unusual situations, such as extended-shift where the battery would not be available until after the preset time.

NOTE: When using real-time start, if you connect a battery within four hours after the preset time has passed, the battery will still be charged after a short delay.

Real-time or fixed delay starts can be selected from the programmable parameters menu.

Use the Arrow keys to select either "Start at real time" or "Fixed delay mode." If you have selected "Start at real time" press the scroll key and use the arrow keys to enter the start time in HH:MM. If you have selected "Start after delay," press the Scroll key, and use the Arrow keys to enter the delay in HH:MM:SS. **PP: Delay mode [↑↓]**

**PP: Delay [↑↓]**

### 6.2.2. Automatic equalizing

The RANGER II control can be set to automatically equalize every 1 to 50 cycles or to equalize all batteries charged on a particular day of the week.

Automatic equalize can be set through the programmable parameters (see Section 6.2). Use the scroll key until the display reads: **PP: Equlz mode [↑↓]**

Press the Arrow keys to select either the number of cycles, the day of the week, never, or always. Depending on your selection the following displays will appear:

**PP: Equlz cycl [↑↓]** or **PP: Equlz mode [↑↓]**

If you have selected never or always, the next menu will be: **PP: Water Mode [↑↓]**
To return to the idle display, press the **Stop** key or the **Scroll** key to continue entering parameters. When equalization is scheduled, **"C:(E)"** is displayed.

If you have selected number of cycles or day of the week, press the Scroll key and use the Arrow keys to enter the appropriate information. Equalizing cycles can be programmed for two to 50 cycles

**NOTE:** When a RANGER II charger programmed to equalize by cycles is connected to the optional compatible battery module it will equalize by battery cycles. Otherwise, it will equalize by charger cycles.

### 6.2.3. Automatic watering

Provisions for automatic watering have been made within the RANGER II control.

**NOTE:** If a charge mode other than conventional has been selected, these do not apply and the menus will not appear. It can be set to always, never, and if a communications board has been added for a compatible battery module, every 5 cycles or every 10 cycles.

To select automatic watering, scroll through the programmable parameters until the display shows:

**PP: Water mode [↑↓]**

Use the Arrow keys to select watering options.

**NOTE:** If the automatic watering parameter is set to every 5 cycles or every 10 cycles and a battery without a compatible battery module is connected, the RANGER II will always water the battery.

Once watering has been activated, it is important that it remain activated long enough to ensure all cells have been fully watered. In order to limit possible overflow due to damage or malfunction, the RANGER II only maintains water flow for a limited duration. This time is factory set at one minute, but can be adjusted.

To adjust automatic watering time, press the Scroll key until the display reads:

**PP: Set WTR tm [↑↓]**

Use the Arrow keys to set the length of the watering cycle. The watering cycle can last from 15 seconds to three minutes.

### 6.2.4. Setting cool time

After the charge is completed, the charger will pause for a preset period of time to allow the battery to cool. Select a time from one minute to eight hours.

**PP: Set cool time [↑↓]**

### 6.2.5. Monitoring water flow

To monitor the flow of water during a watering cycle, use the Arrow keys to select "enable."

**PP: Flow check [↑↓]**

When the flow check is enabled, the water flow is checked soon after the watering triac is turned on. If no flow is detected, the triac is turned off and a fault appears "**(- Flo)**". The flow is also checked at the end of the watering cycle, and if flow is still detected, the fault will appear "**(+ Flo)**". All flow faults appear after the postcharge display. Disconnecting the battery clears the fault.

### 6.2.6. Main power override

Under certain conditions, such as troubleshooting or recovery of an overdischarged battery, it is useful to be able to override the logic of the main control board and force the charger to turn on. Press the Arrow key to activate this feature. When activated, this feature energizes the main contactor and only checks for a connected battery. The contactor will be energized for a maximum of three minutes to preclude damage to a charger or battery caused by excessive charging with defective or mismatched equipment.

**PP: ctl MAIN [↑↓]**

### 6.2.7. Water control override

The water control override feature allows the watering output to be forced on for an indefinite period for troubleshooting.

It should not be left in the ON position for an extended period of time. Use the Arrow keys to turn it on and off.

**PP: CTL WATER [↑↓]**

If the charge mode is set for other than conventional, the CTL water display will be replaced by the following:

**P: CTL STAGE 2 [↑↓]**

Use the Arrow keys to turn the second stage ON or OFF for troubleshooting purposes. Watering mode functions, including flow check, are not available in non-conventional modes.

### 6.2.8. Setting the number of cells

The number of cells for the charger and the RANGER II control are designed to match. After entering the programming menu, as explained above, scroll through the selections until the above display appears. Use the Arrow keys to set the number of cells to match the charger nameplate rating. You may enter from six to 36 cells in 1-cell increments.

**PP: Set CELLS [↑↓]**

### 6.2.9. Selecting the shunt size

The RANGER II control is matched to its shunt size at the factory. There should be no need to change the shunt size unless a replacement control board is installed. Should you need to change the shunt size, refer to the parts lists on pages 50 & 51 (section 9). Use the Arrow keys to set the shunt at 100 mV to 100, 200, 300, or 500 amperes. Press the Scroll key to set the shunt size.

**PP: Set SHUNT [↑↓]**

### 6.2.10. Setting the rated output current

Set the rated current of the charger as it is indicated on the charger nameplate. Use the Arrow keys to enter rated current from 0 to 500 amperes in 5-ampere increments. Press the Scroll key to set rated output current.

**PP: Rated AMPS [↑↓]**

### 6.2.11. Setting the charge mode

Use the arrow keys to select ”conventional mode”. The **FerroCharge** charger can only charge conventional flooded batteries. The other settings are for battery types that are not compatible with this charger.

**PP: Charge Mode [↑↓]**

The ready screen will indicate the mode in use. If the charger is set for conventional mode it will display: **READY (STD): ## cells**

**Important: If the charger displays any mode other than (STD) the setting must be changed.**

If the charger is set for low maintenance battery mode it will display:
**READY (LM): ## cells**

If the charger is set for sealed battery mode it will display: **READY (VR): ## cells**

### 6.2.12. Setting the date

Set the current date by pressing the Arrow keys until the current date is displayed. The display is in MM/DD/YY format. Press the Scroll key to set the current date.

**PP: Set DATE [↑↓]**

### 6.2.13. Setting the correct time

The RANGER II charger has a 24-hour clock, which allows charger operation to begin at a preset time or at a fixed delay from time of connection. It also allows the charger to report the actual time, date and when the charge was begun and completed. The 24-hour clock is set when it leaves the factory; however it may need to be adjusted if you live in a different time zone than the factory. The correct time must be set before placing the charger in operation. Set the current time HH:MM:SS by pressing the Arrow keys until the current time is shown. Press the Scroll key to set the correct time.

**PP: Set TIME [↑↓]**

### 6.2.14. Setting the day of the week

By keeping track of weekdays, RANGER II can perform equalizing charges on the day most convenient for the user. For example, you can program the RANGER II so all Friday charges include an equalizing charge. Using the Arrow keys set the current day of the week. Press the Scroll key to set the day of the week.

**PP: Set DAY [↑↓]**

### 6.2.15. Activating daylight savings time

If the charger will be operated in an area using Daylight Savings Time, the automatic daylight savings time feature can be activated to automatically adjust the clock to daylight savings time and back to standard time on the proper days.

To activate this feature, press an Arrow key until “Auto daylight time” appears on the display. If you do not need daylight savings time, press an Arrow key until “Always STD time” appears on the display. To activate daylight savings time, press the Scroll key.

**PP: Set DST [↑↓]**

### 6.2.16. Activating and setting the address

If the Asset Management System (AMS) is in use, set the address for this charger. If the AMS is not in use set to net inactive.

**PP: Set NET [↑↓]**

### 6.2.17. Setting the baud rate

If the network is activated, set the baud rate per the instructions for the AMS.

**PP: Set Baud [↑↓]**

## 6.3. Operation

### 6.3.1. Manual starting

1. CONNECT THE CHARGER TO THE AC SUPPLY LINE. The digital display will show the number of cells for which the charger has been set as well as the charge mode selected and the time of day.

2. CONNECT THE BATTERY. The charge cycle will begin within five seconds, if no other delay time has been selected. The RANGER II control display will show the time remaining until the start of charge. If the battery is fully charged, the charger will move from charging to post-charge, or if manual equalize is selected, to equalize. When the charge begins, the display will show the elapsed time charging, voltage and current in amperes. When the battery is 80 percent charged, an "(80%)" will appear after the elapsed time display. If manual or automatic equalize is selected, an "(E)" will appear in the upper left hand corner. When voltage and current have stabilized "(EXT)" will appear after the elapsed time display. When equalization has begun, an "(EQU)" will appear on the display after the elapsed time. When the charge is complete, the RANGER II will show the ampere-hours and kilowatt-hours returned to the battery.

In the event of a charging problem or error, an error message will be displayed.
Refer to Section 8, Troubleshooting, for more information on error messages.

**NOTE:** This error message will clear if the battery is disconnected. This information and other charge parameters are also available during the charge and can be accessed by pressing the Scroll key twice.

### 6.3.2. Manual Stopping

To interrupt the charge before it is complete, press the Stop button.

**CAUTION:**
Always be sure charger is turned off—either manually or automatically—before disconnecting the battery from the charger. Otherwise, hazardous arcing will occur.

### 6.3.3. Manual equalizing

In the course of the normal charge/discharge cycle, a motive power battery develops inequalities of voltage and specific gravity among its cells. Equalizing batteries at regular intervals will restore cell equality, assuring rated performance. Activate manual equalizing by pressing the Scroll key anytime before or during a charge. The normal equalization program is overridden, and so this feature can be used to equalize a fully charged battery. To activate manual equalize, press an Arrow key. To deactivate manual equalize, press an Arrow key again. After 60 seconds, the display will return to the idle charger display.

**MNU: Manual EQU [↑↓]**

### 6.3.4. Operation after loss of AC power (warm start)

If the charger has been started manually, it will return to its previous operating mode as soon as power is restored and continue charging the battery until the charge cycle is completed. If the charger is set for real-time start and the power is discontinued and then restored before the selected start time, charger operation is unaffected. If the charger is set for real-time start and the power loss occurs 1) after start or 2) before start and extends into the preselected charge period, the charger will resume operation as soon as power is restored and continue the charging sequence until the charge cycle is completed. An exception to this would be if the power outage lasted into the next day (beyond 24:00, midnight), in

which case the charger would not restart until the preset hour that day. To reduce the possibility of tripping a breaker in multiple charger installations, the RANGER II control distributes charger starts randomly. The minimum delay time is 15 seconds and the maximum delay time is 3 minutes and 30 seconds.

### 6.3.5. Charge data retrieval

When a charge is completed, the RANGER II control can display the ampere-hours and kilowatt-hours required for the charge, followed by the word "complete." Pressing the Scroll key will enable the user to access information about starting time and date, open circuit battery voltage, starting and ending battery voltage, starting and ending battery current, ampere-hours and kilowatt-hours of charge, length of charge, ending time and date, and the number of non-equalized cycles. If the battery being charged has a compatible battery module installed and the charger is equipped for a compatible battery module communications, additional removed data will be available: ampere-hours moved on discharge and on charge temperatures. Press the Scroll key until the display reads:

**MNU: Charge rpt [↑↓]**

This data can be retrieved and shown on the display during or after the charge cycle. In the event of an error during the charge cycle, a "plain English" error message is displayed. Refer to Section 8, Troubleshooting.

## 6.4. Special features with a compatible battery module

A RANGER II charger connected with a compatible battery module will operate in the same manner as described in Sections 6.2 through 6.3, except for the enhancements noted below. While the charger is charging a battery with a compatible battery module connected, the RANGER II control checks the battery module to see that the last charge was full and the battery is discharged. It then calculates and displays the percent charged. If the battery module indicates the battery is already fully charged, the charge cycle is terminated within two minutes. The display will indicate the percent charge. The charger may enter a cooling cycle if the battery module indicates temperatures within a certain range; if it does so it is indicated on the display as **C:Cooling xx°F**, with the hours, minutes and seconds. When the battery temperature is less than 105°F, the RANGER II resumes the charge cycle and will enter the equalize mode, if necessary. After equalization or watering, the RANGER II checks the battery module again for temperature. It may enter the cooling stage again, indicating it on the display. Because the battery module keeps track of battery cycles, you can equalize and water by battery cycles, not charger cycles. If equalization is selected, the display will show "**C:E**." During equalization, the percent charge is displayed. You may specify equalizing parameters as indicated in Section 6.3. When a compatible battery module is connected to a RANGER II charger, the watering options are always, never, every five battery cycles or every 10 battery cycles.

**NOTE:** A battery module capable RANGER II control programmed for watering by battery cycles will always perform the watering cycle if connected to a battery without a battery module. Changing watering parameters is also described in Section 6.2.3.

### 6.4.1. Installing a compatible battery module communications board

The RANGER II control is designed to interface with a compatible battery module, enabling you to get data such as depth of discharge information, start and end of charge temperatures, minimum volts per cell, low volts per cell and more. In order for a RANGER II control to interface with a battery module, the charger must have a communications board installed.

The communications board is installed by inserting it into the RANGER II board at expansion slot A. Firmly seat the communications board onto the RANGER II board. (Be sure to disconnect both AC power and the battery during this procedure.)

### 6.4.2. Retrieving data from a compatible battery module

When entering the programmable parameters, a choice is given between the programmable parameters and the battery module menu. The battery module terminal menu is used to retrieve information from a compatible battery module

attached to a RANGER II control. If the RANGER II cannot communicate with the battery module, COMerr is displayed on the interface. If COMerr is displayed, contact your local C&D Technologies Manufacturing representative.

The following information is displayed; the Scroll key is used to move through the menu items.

| Menu display | Description |
|---|---|
| BT: Present T [C]<br>87 °F | The current temperature of the battery. |
| BT: Dischrg data [C]<br>2.37V 329AH 14.21 | Shows minimum volts per cell, ampere-hours removed and time in discharge. When this information is retrieved, the equivalent information in the charge summary report is replaced with this new data. |
| BT: Discharges [C]<br>1000 cycles | The number of discharge cycles from a compatible battery module. When this information is retrieved, the equivalent information in the charge summary report is replaced with this new data. |
| BT: Low VPC [C]<br>25 cycles 2.5% | The number of low volts per cell cycles and the percent of the total. |
| BT: Lo DOD cycls [C]<br>< 250, 30-70% 700 | The number of low depth of discharge cycles for 30% (indicated by "<") and 30 to 70% categories. |
| BT: Hi DOD cycls [C]<br>70-90% 45, > 5 | The number of high depth of discharge cycles for 70-90% and > 90% (indicated by ">"). |
| BT: SOC T cycls [C]<br>< 250, 500, > 250 | The number of cycles in each of three start of charge temperature categories: < 60°F (indicated by "<"), 60°F-100°F, and > 100°F (indicated by ">"). |
| BT: EOC T cycls [C]<br>< 250, 500, > 250 | The number of cycles in each of the three end of charge temperature categories: < 60°F (indicated by "<"), 60°F-100°F, and > 100°F (indicated by ">"). |
| BT: Power cycls [C]<br>2 | The number of times the power to the battery module has been cycled. |
| BT: Status [C]<br>SW Version 1.00 | The version of the compatible battery module software. |

### 6.5. Communications port

RANGER II controls are designed to be able to interface with a computerized asset management system (AMS). The unique fiber optic communications bus establishes a link with the AMS, enabling a user to have complete charging information on a fleet of **FerroCharge** chargers with RANGER II controls.

The network address should be set to inactive unless there is an AMS. This will hide the baud rate menu. For information on setup and using an AMS, see the AMS operating manual. For more information on the available asset management systems, ask your local C&D representative for a brochure.

# 7. CHARGER OPERATION

## 7.1. Recommended charging procedures

Chargers require little attention beyond periodic removal of dust buildup and inspection for loose connections. Refer to section 2.7, Maintenance. Proper charging procedures are important to prevent damage to chargers, batteries and operators.

Proper charging procedures require lead-acid batteries receive:

- Watering at the end of charge, as needed, to maintain proper electrolyte level and concentration;
- An equalizing charge approximately every seventh charge to correct voltage imbalances among cells;
- Periodic cleaning to remove corrosive spills;
- Freshening charges if batteries remain out of service for three or more days.

Operators should only connect batteries to chargers with matching voltage and sufficient power output. The charger must be OFF before batteries are connected or disconnected.

Motive power batteries are designed to be discharged daily but should not be discharged by more than 80 percent of their capacity during an 8-hour work shift. This allows sufficient time for them to charge and cool before they are returned to service and extends cycle life.

Charging shallow-discharged cells can also lessen battery life. Batteries discharged less than 20 percent should remain in service for another shift in light duty before being placed on the charger.

High resistance connections can reduce the charger's ability to properly charge the battery as well as reduce charging efficiency. Dirty or pitted contact surfaces on either the charger or battery connector should be cleaned and lubricated, or replaced with the identical part following the manufacturer's instructions and using the recommended tooling. Discolored contacts may also indicate loose crimps to the cable. Contacts should also be replaced if this is the case.

## 7.2. Operating characteristics

As a battery is placed on charge, there is an inrush of current to the battery. Charging increases battery voltage, and as the difference between the applied voltage and the battery voltage decreases, the flow of the charger current also decreases. During the final hours of the charge cycle, the charging rate is significantly reduced. Figure 7.1 shows typical ferroresonant charging characteristics.

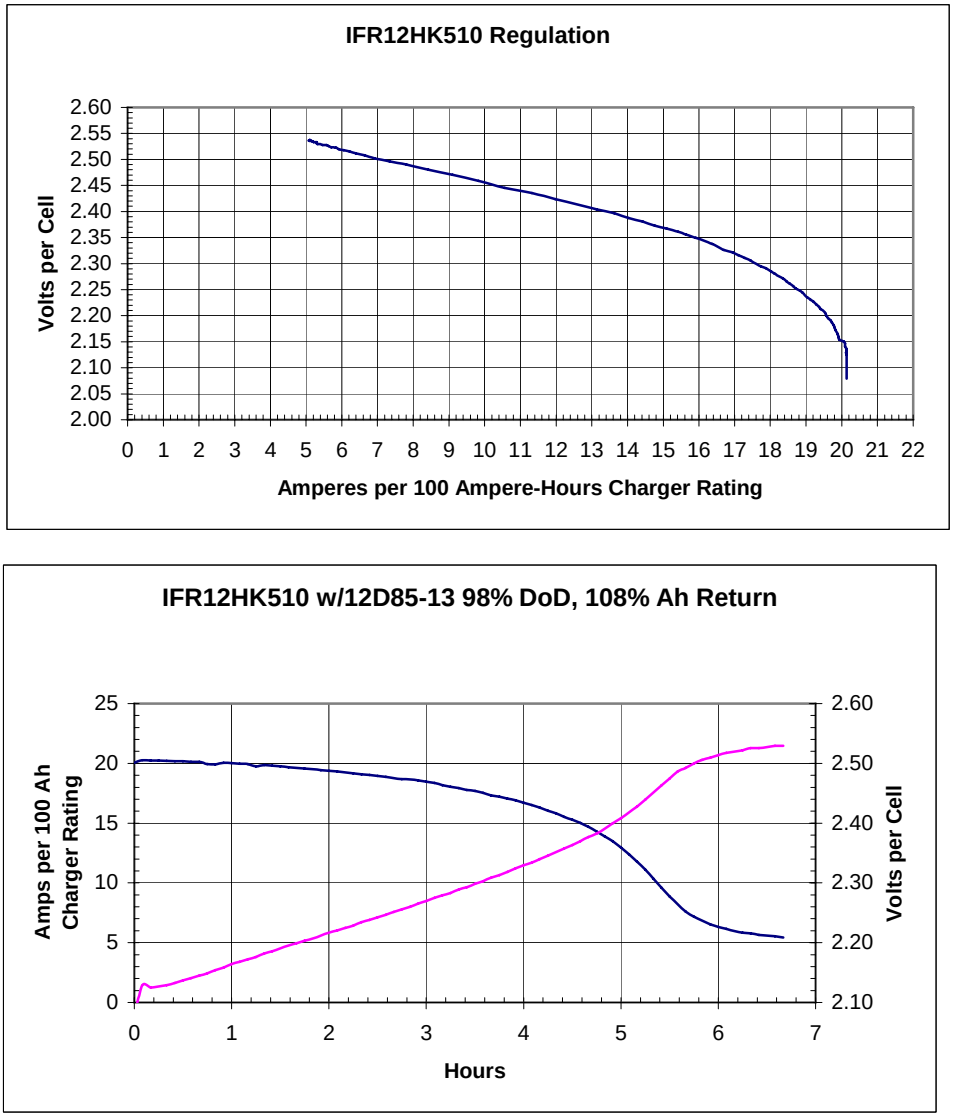



*FIGURE 7.1 TYPICAL FERRORESONANT CHARGER CURVES*

As with all electrical apparatus, **FerroCharge** operating economics are influenced by electric utility rates, the user's choice of single phase or three-phase power, and the electrical efficiency and power factor of the charger.

Electric utility rates are significantly lower during off-peak periods. However, to take advantage of these rates you may need a separate electric meter for the off-peak service connection. Your local utility representative can help you determine the type of off-peak program that best fits your application.

Efficiency is the measure of the useful energy the charger makes available to the cell, as measured at the charger output. It is calculated by the equation:

Percent efficiency = Output power (kW)/ Input power (kW) x 100

The power factor is the ratio of the true power (Watts) and the apparent power (Volts x Amps) a charger actually requires to operate. The equation for determining power factor is:

Power factor (PF) = True power/Apparent power = Watts AC/(Volts AC) x (Current AC)

# 8. TROUBLESHOOTING

## 8.1. General Troubleshooting Guidelines

1. Safety is a prime consideration.
   a. Think before acting; plan your actions and troubleshooting strategy
   b. Wear safety glasses
   c. Remove watches, rings, and jewelry before reaching into the cabinet
   d. After recording the way you find the charger, press the Stop key, disconnect the battery and disconnect the ac supply unless a test requires otherwise.
2. Keep a detailed record of the initial charger condition and the control board displays in case you need to request help later. By referring to the troubleshooting chart for the control board you can probably determine the problem from the display. Record the charger and battery model numbers and serial numbers. This information will be required when requesting service or warranty support.
3. Visually inspect the charger displays and condition such as burn marks, smells, etc.
4. Determine the symptoms.
5. Take measurements as required.
6. Diagnose the problem using the troubleshooting charts as a reference.
7. Make the repairs.

*TABLE 8.1 TEST INSTRUMENTS AND TOOLS FOR TROUBLESHOOTING*

| Troubleshooting Equipment |
|---|
| 0 to 200-mV scale VOM that reads up to 600 VAC and 250 VDC with minimum accuracy of 0.5 percent |
| Clamp-on ammeter |
| SB-175 or SB-350 shorting connector |
| Wrench set |
| Screwdriver set |
| Jumper cables with alligator clips |

Note: Diode replacement requires a supply of thermal joint compound and a torque wrench capable of achieving the values in Table 8.2.

## 8.2. Procedure

The following charts are designed to help a qualified technician diagnose and remedy malfunctions in the SCOUT, COMPUCHARGE, and RANGER II controls. In all cases, after recording the error message acknowledge the error message by pressing the Stop key.

The first two charts cover the control; troubleshooting instructions for the charger are presented in the third chart. Sections 8.3 through 8.4 provide information on testing and replacing components. Also refer to the wiring diagrams in Section 10.

**IMPORTANT:** Qualified personnel familiar with both local and national electrical codes must service this equipment.

**WARNING:** Line voltages are present within the battery charger cabinet. When performing the following troubleshooting procedures, be sure to observe all appropriate safety precautions. ALWAYS BE SURE THE CHARGER IS TURNED OFF BEFORE DISCONNECTING A BATTERY.

**SCOUT CONTROL TROUBLESHOOTING CHART**

| DISPLAY STATUS | CAUSE | ACTION |
|---|---|---|
| Yellow LED is lit and red LED is flashing rapidly | 1. The wrong size battery has been connected | a. Disconnect the battery and check that the number of cells in the battery matches the nameplate rating of the charger.<br>b. Disconnect the battery and check that the control board's jumper setting configuration for the number of cells matches the nameplate rating of the charger. If necessary, change the number of cells (see Section 3.3.1) by moving the jumpers and then restoring the power to the charger. |
| | 2. Battery is over-discharged | a. Press the Equal key to force the charger on. While the key is pressed, the charger will remain on. After battery voltage rises, release Equal key, disconnect and reconnect the battery. The charger should start automatically in the normal manner. |
| | 3. Battery has bad cells | a. Check the battery for defective cells. |
| Green LED is lit and red LED is flashing rapidly | 1. The maximum charging time has been exceeded | a. Disconnect the battery to reset the charger.<br>b. Check that the charger Ampere-hour rating matches the battery rating.<br>c. Check the charger for low dc output.<br>d. Check the battery for defective cells. |
| Both yellow and green LEDs are lit and red LED is flashing rapidly | 1. The Stop key has been pressed | a. Disconnect the battery. |
| All LEDs are lit constantly | 1. Watchdog timer has reset | a. Disconnect AC power from the charger, wait 30 seconds and reapply. If problem persists, call for service. |
| All LEDs flashing | 1. Low vpc early in the charge cycle due low charger output power. | a. Check AC line and AC fuses to all phases.<br>b. Check the charger for proper output voltage and current. |

**COMPUCHARGE CONTROL TROUBLESHOOTING CHART**

| ERROR CODE | DESCRIPTION | ACTION |
|---|---|---|
| bU E | 1. Battery voltage does not match the number of cells programmed (The wrong size battery has been connected.) | a. Disconnect the battery and check that the number of cells in the battery matches the nameplate rating of the charger.<br>b. Disconnect the battery and check that the control board's jumper setting configuration for the number of cells matches the nameplate rating of the charger. If necessary, change the number of cells (see Section 4.3.3) by moving the jumpers and then restoring the power to the charger. |
| | 2. Battery is over-discharged | a. Press the Equal key to force the charger on. While the key is pressed, the charger will remain on. After the battery voltage rises, release the Equal key, disconnect and reconnect the battery. The charger should start automatically in the normal manner. |
| | 3. Battery has bad cells | a. Check the battery for defective cells. |
| uS E -or -uT E | 1. The charger microprocessor needs to reset itself | a. Charger will reset after five seconds. It will begin from the Ready state. |
| bd E | 1. During charge, the battery was disconnected | a. Charger will reset itself after five seconds. It will begin from the Ready state. |
| hotE | 1. The battery temperature is too high | a. The charger will stop for 8 hours, then resume automatically. To clear the message, disconnect the battery. Let the battery cool down before using it. |
| StPE | 1. During the charge, user pressed the Stop key | a. To clear this message, disconnect the battery. |
| 12hE | 1. The battery has been on charge more than 12 hours | a. To clear this message, disconnect the battery.<br>b. Check that the charger Ampere-hour rating matches the battery rating.<br>c. Check the charger for low dc output.<br>d. Check the battery for defective cells. |

**RANGER II CONTROL TROUBLESHOOTING CHART**

| DISPLAY | CAUSE | ACTION |
|---|---|---|
| ABORT: discnect bat<br>Wrong battery size | 1. Battery not matched to charger (wrong number of cells) | a. Verify battery and charger match. |
| | 2. Battery has short-circuited cells or overdischarged | a. The charger can be "forced" on from this condition by holding the "up" arrow until the voltage reads an acceptable level. |
| | 3. Control board not matched to charger | a. Check and reset board settings to match charger output voltage. Verify other settings. |
| ABORT: discnect bat<br>Charge > 12 hrs | 1. Battery is too large for charger | a. Place battery on charger of proper size. |
| | 2. Control board failure | a. If problem is repeated, contact C&D |
| ABORT: discnect bat<br>Hot battery | 1. Hot battery | a. Allow several hours for cool-down before flt restarting charge. |
| ABORT: discnect PWR<br>OFF, but charging | 1. DC current continued to flow after contactor turned off | a. Check line contactor and replace if necessary. |
| ABORT: discnect bat<br>Operator STOP | 1. Charge terminated by operator | a. Resume charge if necessary. |
| ABORT: discnect bat<br>Zero current flt | 1. Operator disconnected battery | a. Reconnect battery and resume charge. |
| | 2. Charger problem | a. Refer to flowcharts on next page. |
| ABORT: press {Stop}<br>NVRAM is trashed | 1. Charger parameters lost | a. Remove and then restore AC power; re-enter parameters. If problem recurs, call your local C&D REPRESENTATIVE. |
| WDT RST:<br>Restarting | 1. Watchdog timer reset has occurred. The charger will automatically restart. | a. If problem recurs, call your local C&D REPRESENTATIVE. |
| ABORT: press [Stop]<br>Replace RTC (lobat) | 1. Real-time clock must be replaced | a. Call your local C&D REPRESENTATIVE. |
| ABORT: press [Stop]<br>State machine flt | 1. Control program found in an unknown state | a. Disconnect and reconnect charger. If problem persists, contact C&D. |

**POWERTRAIN AND OTHER CHARGER PROBLEM-TROUBLESHOOTING CHART**

| Problem | Possible Cause | Solution |
|---|---|---|
| Charger has no display | Loss of AC | Check AC supply fuses or breakers |
| | | Check AC fuses in charger |
| | | Check control fuse F3 (1-phase) or F4 (3-phase) |
| | | Check control transformer CXF |
| AC fuses or breaker blow | Charger ac input recently reconnected for a different voltage | Check that power transformer and control transformer primary connections were both changed correctly. Refer to schematics. |
| | | Check that ac fuses were changed for new line voltage |
| | Wrong fuse or breaker size | Check label in charger for internal fuses and recommended line fuses on nameplate for external fuses. |
| Charger will not start charging | Loss of AC | Check AC fuses or breakers |
| | | Check charger AC fuses |
| | Over-discharged battery | Check for correct number of cells. On Scout and CompuCharge controls press Equal key to force on the charger to raise battery voltage. |
| | Wrong battery or board set wrong | Check that battery matches cells on charger nameplate |
| | | Check that jumpers on control board are set to match cells on charger nameplate. |
| | Defective control transformer (CXF) | Check primary voltage and secondary voltages |
| | Defective Line contactor (LC) | Check for 24 Vac on coil |
| | Defective control board | Check for 24 Vac on line contactor coil |
| Charger has no DC output | Blown output fuse (DCF) | Check for reverse polarity battery. Were the charger or battery connectors replaced recently? |
| | | Shorted Diode |
| Charger does not stop | Defective control board | Press Stop. If charger keeps running, turn off ac. Restart ac. If charger starts immediately replace control board.<br>If charger goes to delay before starting the control board may have "hung up". Resetting the ac may correct the problem, but if the problem persists it may be necessary to replace the board. |

| | | |
|---|---|---|
| Low DC output, 3-phase charger | One of the power transformers is not working properly | Check ac fuses (F1-F3) |
| | | Check transformer input and output voltages. |
| | | Defective or disconnected resonant capacitor |
| | Diode is open in rectifier | Check diodes |
| | Loose connection in output wiring | Tighten all connections |
| Low DC output, 1-phase charger | Power transformer is not working properly | Defective or disconnected resonant capacitor |
| | | Check transformer input and output voltages |
| | Diode is open in rectifier | Check diodes |
| | Loose connection in output wiring | Tighten all connections |
| Override timer shuts down charger | Battery is over-discharged or has bad cells | Check battery |
| | Charger has low dc output | See chart entry for low output |
| Flashing lights on Scout control | Look at section 8.2 | Record display before calling for service support |
| Error code displayed on CompuCharge control | Look at section 8.2 | Record display before calling for service support |
| Utility power loss and restoration during the charge cycle | Both the Scout and CompuCharge controls will restart the charge after a random time delay. The Scout control delay is up to 3-1/2 minutes and the CompuCharge control delay is up to 2 minutes. | |

### 8.3. Component testing

Many problems can often be revealed by a visual inspection. In new chargers, look for connections that may have loosened during shipment. In previously operating systems, look for the whitish powder residue created by burning varnish, or a broken, melted or discolored wire.

When troubleshooting three-phase chargers, be sure to test both sets of components.

Always read and follow all warning labels and turn off the charger before touching, removing or installing components.

C&D supports **FerroCharge** chargers with prompt field service and overnight delivery of most components. If you do not know the name of your nearest representative contact:

C&D Technologies, Inc.
Integrated Power Systems,
Motive Power Division
65 Industrial Park Road, Dunlap, TN 37327
Customer Service, Voice: (800) 440-3504
Customer Service, Fax: (423) 949-3647
Field Service: (800) 299-3907
Web site – http://www.cdpowercom.com

| Device and Procedure | Device and Procedure |
|---|---|
| CAPACITORS: Before starting, be sure the capacitor is discharged. Before testing, disconnect both leads to isolate the capacitor from the charger circuit. Test capacitors with a calibrated ohmmeter. Different sizes of capacitors require different ohmmeter range settings. Begin with the highest setting. Be sure to reverse the leads for each check.<br>• A good capacitor deflects the ohmmeter needle toward zero then steadily rises toward infinite resistance.<br>• An open capacitor immediately shows Infinite resistance.<br>A short capacitor remains at zero resistance. | DIODES: Test diodes with the ohmmeter set at either the 1OX or 1OOX scale. Before testing, disconnect one lead to isolate the diode from the charger.<br>• A good diode shows low resistance when tested in one direction and high resistance when the ohmmeter probes are reversed.<br>• An open diode shows very high resistance in both directions.<br>• A shorted diode shows zero or low resistance in both directions. |
| CONTROL TRANSFORMER: Output should be between 22 and 26 VAC across the full secondary winding. | FUSES: Remove the fuse from the fuse holder and test it with an ohmmeter set to any scale.<br>• A good fuse shows zero resistance.<br>• An open or "blown" fuse shows infinite resistance. |

### 8.4. Replacing components

Ammeter shunts, capacitors, fuses, control boards, control transformers, line contactors, and power transformers can be user-replaced. Simply mate the leads of the replacement component with their appropriate connectors.

Printed circuit boards in the controls do not contain user-repairable parts. The entire printed circuit board must be replaced.

It is recommended that the entire rectifier be replaced rather than individual diodes. Users attempting diode replacement MUST observe the following procedure:

1) Disconnect the charger from the AC line and battery.
2) Remove the rectifier assembly.
3) Clamp the heat sink portion of the assembly in a vise.
4) Remove the faulty diode.
5) Coat the mating surfaces of the diode and the heat sink with a suitable thermal joint compound.
6) Place the diode on the heat sink and hand tighten the diode connection hardware.
7) Torque diode connections to values shown In Table 8.2.
8) Remove excess thermal joint compound.
9) Reinstall the assembly and reconnect leads.

*TABLE 8.2 DIODE CONNECTION TORQUE VALUES*

| DIODE CONNECTION TORQUE VALUES |
|---|
| 1/4" studs 25 +2/-2 in- lb. |
| 3/8" studs 112 +4/-3 in- lb. |
| 1/2" studs 137 +4/-4 in- lb. |
| 3/4" studs 260 +5/-3 in- lb. |

## 9. MODELS, RATINGS, AND PARTS LISTS

| Model | Input Voltage (V) | No. Of Phases | No. Of Xfmrs | Input Current (A) | Output Current (A) | Cells | Battery Ah Capacity for 8 h Charge, 100% DOD | Cabinet |
|---|---|---|---|---|---|---|---|---|
| IFR6CE450 | 208/240/480 | 1 | 1 | 8.5/7.5/4 | 85 | 6 | 450 | A |
| IFR6CE510 | 208/240/480 | 1 | 1 | 10.5/9/4.5 | 96 | 6 | 510 | A |
| IFR6CE600 | 208/240/480 | 1 | 1 | 14/12/6 | 108 | 6 | 600 | A |
| IFR6CE750 | 208/240/480 | 1 | 1 | 15/13.5/7 | 143 | 6 | 750 | A |
| IFR6CE875 | 208/240/480 | 1 | 1 | 16/14/7 | 158 | 6 | 875 | A |
| IFR6HK875 | 208/240/480 | 3 | 2 | 9.5/8/4 | 158 | 6 | 875 | A |
| IFR6HK1000 | 208/240/480 | 3 | 2 | 11.5/10/5 | 190 | 6 | 1000 | A |
| IFR6HK1200 | 208/240/480 | 3 | 2 | 16/14/7 | 228 | 6 | 1200 | A |
| | | | | | | | | |
| IFR12AC255 | 120/208/240 | 1 | 1 | 18/9/8 | 46 | 12 | 255 | A |
| IFR12CE255 | 208/240/480 | 1 | 1 | 9/8/4 | 46 | 12 | 255 | A |
| IFR12CE450 | 208/240/480 | 1 | 1 | 18/16/8 | 85 | 12 | 450 | A |
| IFR12CE510 | 208/240/480 | 1 | 1 | 20.5/18/9 | 96 | 12 | 510 | A |
| IFR12CE600 | 208/240/480 | 1 | 1 | 24/21/10.5 | 108 | 12 | 600 | A |
| IFR12CE750 | 208/240/480 | 1 | 1 | 30/26/13.5 | 135 | 12 | 750 | A |
| IFR12CE875 | 208/240/480 | 1 | 1 | 35/28/14 | 166 | 12 | 875 | A |
| IFR12HK510 | 208/240/480 | 3 | 2 | 10/9/4.5 | 96 | 12 | 510 | A |
| IFR12HK600 | 208/240/480 | 3 | 2 | 12/10.5/5.5 | 108 | 12 | 600 | A |
| IFR12HK750 | 208/240/480 | 3 | 2 | 15.5/13.5/7 | 135 | 12 | 750 | A |
| IFR12HK875 | 208/240/480 | 3 | 2 | 18/15.5/8 | 158 | 12 | 875 | A |
| IFR12HK1000 | 208/240/480 | 3 | 2 | 20/17/8.5 | 190 | 12 | 1000 | A |
| IFR12HK1200 | 208/240/480 | 3 | 2 | 23/20/10 | 228 | 12 | 1200 | A |
| | | | | | | | | |
| IFR18CE450 | 208/240/480 | 1 | 1 | 22/19/9.5 | 85 | 18 | 450 | A |
| IFR18CE510 | 208/240/480 | 1 | 1 | 25/22/11 | 96 | 18 | 510 | A |
| IFR18CE650 | 208/240/480 | 1 | 1 | 35.5/31.5/15.5 | 117 | 18 | 650 | A |
| IFR18CE750 | 208/240/480 | 1 | 1 | 41/36/18 | 135 | 18 | 750 | A |
| IFR18HK510 | 208/240/480 | 3 | 2 | 15/13.5/7 | 96 | 18 | 510 | A |
| IFR18HK650 | 208/240/480 | 3 | 2 | 20/17/8.5 | 117 | 18 | 650 | A |
| IFR18HK750 | 208/240/480 | 3 | 2 | 23/20/10 | 135 | 18 | 750 | A |
| IFR18HK875 | 208/240/480 | 3 | 2 | 26/23/11.5 | 158 | 18 | 875 | A |
| IFR18HK935 | 208/240/480 | 3 | 2 | 28.5/24.5/12 | 168 | 18 | 935 | A |
| IFR18HK1000 | 208/240/480 | 3 | 2 | 30.5/26.5/13.5 | 190 | 18 | 1000 | A |
| IFR18HK1100 | 208/240/480 | 3 | 2 | 32/28/14 | 198 | 18 | 1100 | A |
| IFR18HK1200 | 208/240/480 | 3 | 2 | 32/28/14 | 198 | 18 | 1200 | A |
| IFR18HK1250 | 208/240/480 | 3 | 3 | 36/32/16 | 238 | 18 | 1250 | B |
| IFR18HK1400 | 208/240/480 | 3 | 3 | 40/35/17.5 | 266 | 18 | 1400 | B |

| Model | Input Voltage (V) | No. Of Phases | No. Of Xfmrs | Input Current (A) | Output Current (A) | Cells | Battery Ah Capacity for 8 h Charge, 100% DOD | Cabinet |
|---|---|---|---|---|---|---|---|---|
| IFR24CE450 | 208/240/480 | 1 | 1 | 31/27/13.5 | 85 | 24 | 450 | A |
| IFR24CE510 | 208/240/480 | 1 | 1 | 38/33/17 | 96 | 24 | 510 | A |
| IFR24CE600 | 208/240/480 | 1 | 1 | 44/38/19 | 114 | 24 | 600 | A |
| IFR24CE680 | 240/480 | 1 | 1 | 46/23 | 129 | 24 | 680 | A |
| IFR24HK450 | 208/240/480 | 3 | 2 | 19.5/17/8.5 | 85 | 24 | 450 | A |
| IFR24HK510 | 208/240/480 | 3 | 2 | 23/20/10 | 96 | 24 | 510 | A |
| IFR24HK600 | 208/240/480 | 3 | 2 | 24/21/10.5 | 114 | 24 | 600 | A |
| IFR24HK680 | 208/240/480 | 3 | 2 | 27.5/24/12 | 129 | 24 | 680 | A |
| IFR24HK765 | 208/240/480 | 3 | 2 | 31/27/13.5 | 138 | 24 | 765 | A |
| IFR24HK850 | 208/240/480 | 3 | 2 | 35/30/15 | 153 | 24 | 850 | A |
| IFR24HK900 | 208/240/480 | 3 | 2 | 36/32/16 | 162 | 24 | 900 | A |
| IFR24HK1100 | 208/240/480 | 3 | 3 | 40/35/17.5 | 198 | 24 | 1100 | B |
| IFR24HK1250 | 208/240/480 | 3 | 3 | 48/42/21 | 228 | 24 | 1200 | B |
| IFR24K1360 | 480 | 3 | 3 | 23.5 | 258 | 24 | 1360 | B |
| | | | | | | | | |
| IFR36HK450 | 208/240/480 | 3 | 2 | 26.5/23/11.5 | 85 | 36 | 450 | A |
| IFR36HK510 | 208/240/480 | 3 | 3 | 31/27/13.5 | 96 | 36 | 510 | B |
| IFR36HK600 | 208/240/480 | 3 | 3 | 35/31/15.5 | 114 | 36 | 600 | B |
| IFR36HK680 | 208/240/480 | 3 | 3 | 39/34/17 | 129 | 36 | 680 | B |
| | | | | | | | | |
| IFR40HK510 | 208/240/480 | 3 | 3 | 35/30/15 | 96 | 40 | 510 | B |

| Model | Input Voltage (V) | No. of Phases | No. of Xfmrs | Input Current (A) | Output Current (A) | Cells | Battery Ah Capacity for 8 h Charge, 100% DOD | Cabinet |
|---|---|---|---|---|---|---|---|---|
| IFR6M450 | 575 | 1 | 1 | 4 | 85 | 6 | 450 | A |
| IFR6M510 | 575 | 1 | 1 | 4.5 | 96 | 6 | 510 | A |
| IFR6M600 | 575 | 1 | 1 | 6 | 108 | 6 | 600 | A |
| IFR6M750 | 575 | 1 | 1 | 6.5 | 143 | 6 | 750 | A |
| IFR6M875 | 575 | 1 | 1 | 7.5 | 166 | 6 | 875 | A |
| IFR6L875 | 575 | 3 | 2 | 3.5 | 166 | 6 | 875 | A |
| IFR6L1000 | 575 | 3 | 2 | 4 | 190 | 6 | 1000 | A |
| IFR6L1200 | 575 | 3 | 2 | 5.5 | 228 | 6 | 1200 | A |
| | | | | | | | | |
| IFR12M255 | 575 | 1 | 1 | 3.5 | 46 | 12 | 255 | A |
| IFR12M450 | 575 | 1 | 1 | 7 | 85 | 12 | 450 | A |
| IFR12M510 | 575 | 1 | 1 | 7.5 | 96 | 12 | 510 | A |
| IFR12M600 | 575 | 1 | 1 | 9 | 108 | 12 | 600 | A |
| IFR12M750 | 575 | 1 | 1 | 11 | 135 | 12 | 750 | A |
| IFR12M875 | 575 | 1 | 1 | 13 | 166 | 12 | 875 | A |
| IFR12L510 | 575 | 3 | 2 | 4 | 96 | 12 | 510 | A |
| IFR12L600 | 575 | 3 | 2 | 4.5 | 108 | 12 | 600 | A |
| IFR12L750 | 575 | 3 | 2 | 6 | 135 | 12 | 750 | A |
| IFR12L875 | 575 | 3 | 2 | 7 | 158 | 12 | 875 | A |
| IFR12L1000 | 575 | 3 | 2 | 7 | 190 | 12 | 1000 | A |
| IFR12L1200 | 575 | 3 | 2 | 8 | 228 | 12 | 1200 | A |
| | | | | | | | | |
| IFR18M450 | 575 | 1 | 1 | 8 | 85 | 18 | 450 | A |
| IFR18M510 | 575 | 1 | 1 | 9 | 96 | 18 | 510 | A |
| IFR18M650 | 575 | 1 | 1 | 13.5 | 117 | 18 | 650 | A |
| IFR18M750 | 575 | 1 | 1 | 15 | 135 | 18 | 750 | A |
| IFR18L510 | 575 | 3 | 2 | 5.5 | 96 | 18 | 510 | A |
| IFR18L650 | 575 | 3 | 2 | 7.5 | 117 | 18 | 650 | A |
| IFR18L750 | 575 | 3 | 2 | 8.5 | 135 | 18 | 750 | A |
| IFR18L875 | 575 | 3 | 2 | 9.5 | 158 | 18 | 875 | A |
| IFR18L935 | 575 | 3 | 2 | 10.5 | 168 | 18 | 935 | A |
| IFR18L1000 | 575 | 3 | 2 | 11 | 180 | 18 | 1000 | A |
| IFR18L1100 | 575 | 3 | 2 | 12 | 198 | 18 | 1100 | A |
| IFR18L1200 | 575 | 3 | 2 | 12 | 198 | 18 | 1200 | A |
| IFR18L1250 | 575 | 3 | 3 | 13 | 238 | 18 | 1250 | B |
| IFR18L1400 | 575 | 3 | 3 | 14.5 | 266 | 18 | 1400 | B |

| Model | Input Voltage (V) | No. of Phases | No. of Xfmrs | Input Current (A) | Output Current (A) | Cells | Battery Ah Capacity for 8 h Charge, 100% DOD | Cabinet |
|---|---|---|---|---|---|---|---|---|
| IFR24M450 | 575 | 1 | 1 | 11.5 | 85 | 24 | 450 | A |
| IFR24M510 | 575 | 1 | 1 | 14 | 96 | 24 | 510 | A |
| IFR24M600 | 575 | 1 | 1 | 15.5 | 114 | 24 | 600 | A |
| IFR24M680 | 575 | 1 | 1 | 19 | 129 | 24 | 680 | A |
| IFR24L450 | 575 | 3 | 2 | 7 | 85 | 24 | 450 | A |
| IFR24L510 | 575 | 3 | 2 | 8 | 96 | 24 | 510 | A |
| IFR24L600 | 575 | 3 | 2 | 9 | 114 | 24 | 600 | A |
| IFR24L680 | 575 | 3 | 2 | 10 | 129 | 24 | 680 | A |
| IFR24L765 | 575 | 3 | 2 | 11.5 | 138 | 24 | 765 | A |
| IFR24L850 | 575 | 3 | 2 | 12 | 153 | 24 | 850 | A |
| IFR24L900 | 575 | 3 | 2 | 13.5 | 162 | 24 | 900 | A |
| IFR24L1100 | 575 | 3 | 3 | 14.5 | 198 | 24 | 1100 | B |
| IFR24L1250 | 575 | 3 | 3 | 17.5 | 228 | 24 | 1200 | B |
| IFR24L1360 | 575 | 3 | 3 | 20 | 258 | 24 | 1360 | B |
| | | | | | | | | |
| IFR36L450 | 575 | 3 | 2 | 9.5 | 85 | 36 | 450 | A |
| IFR36L510 | 575 | 3 | 3 | 11.5 | 96 | 36 | 510 | B |
| IFR36L600 | 575 | 3 | 3 | 13 | 114 | 36 | 600 | B |
| IFR36L680 | 575 | 3 | 3 | 14 | 129 | 36 | 680 | B |
| | | | | | | | | |
| IFR40L510 | 575 | 3 | 3 | 12 | 96 | 40 | 510 | B |

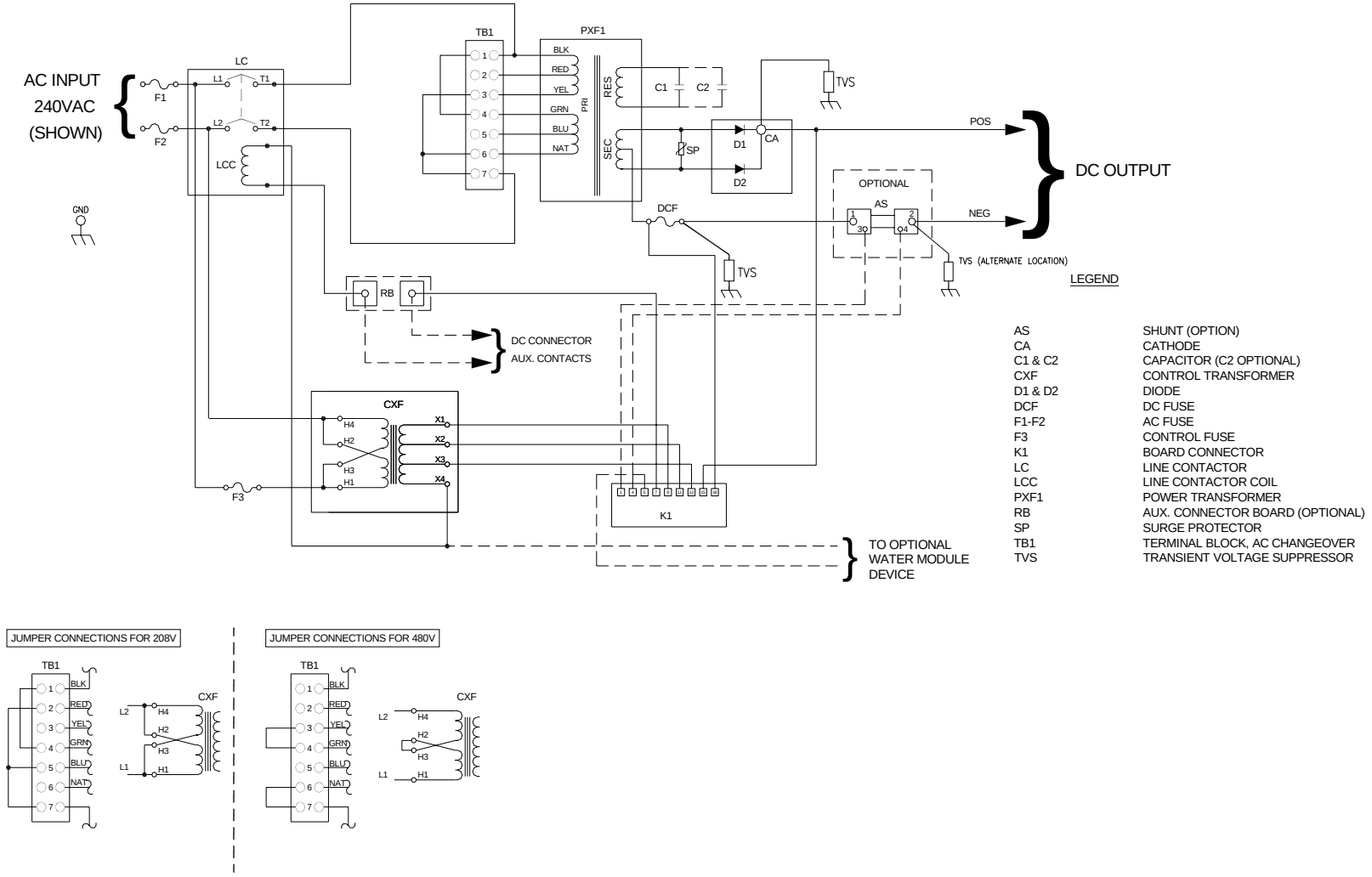
| Model | Input (AC) Fuse Rating – Amperes | | | | | Output (DC) Fuse Rating Amperes | Shunt Amperes |
|---|---|---|---|---|---|---|---|
| | 120 V | 208 V | 240 V | 480 V | 575 V * | | |
| IFR6CE450 | NA | 12 | 10 | 6 | 4 | 200 | 200 |
| IFR6CE510 | NA | 15 | 12 | 6 | 6 | 200 | 200 |
| IFR6CE600 | NA | 20 | 15 | 8 | 7 | 200 | 200 |
| IFR6CE750 | NA | 20 | 20 | 10 | 8 | 200 | 200 |
| IFR6CE875 | NA | 20 | 20 | 10 | 8 | 200 | 200 |
| IFR6HK875 | NA | 12 | 12 | 6 | 5 | 200 | 200 |
| IFR6HK1000 | NA | 15 | 15 | 7 | 6 | 325 | 300 |
| IFR6HK1200 | NA | 20 | 20 | 10 | 8 | 325 | 300 |
| | | | | | | | |
| IFR12AC255 | 20 | 12 | 12 | NA | NA | 100 | 100 |
| IFR12CE255 | NA | 12 | 10 | 6 | 5 | 100 | 100 |
| IFR12CE450 | NA | 25 | 20 | 10 | 10 | 200 | 200 |
| IFR12CE510 | NA | 30 | 25 | 12 | 10 | 200 | 200 |
| IFR12CE600 | NA | 30 | 30 | 15 | 12 | 200 | 200 |
| IFR12CE750 | NA | 40 | 35 | 20 | 15 | 200 | 200 |
| IFR12CE875 | NA | 40 | 35 | 20 | 15 | 200 | 200 |
| IFR12HK510 | NA | 15 | 12 | 6 | 6 | 200 | 200 |
| IFR12HK600 | NA | 15 | 15 | 8 | 6 | 200 | 200 |
| IFR12HK750 | NA | 20 | 10 | 10 | 8 | 200 | 200 |
| IFR12HK875 | NA | 25 | 20 | 10 | 10 | 200 | 200 |
| IFR12HK1000 | NA | 30 | 25 | 12 | 10 | 325 | 300 |
| IFR12HK1200 | NA | 30 | 30 | 15 | 12 | 325 | 300 |
| | | | | | | | |
| IFR18CE450 | NA | 30 | 25 | 12 | 10 | 200 | 200 |
| IFR18CE510 | NA | 35 | 30 | 15 | 12 | 200 | 200 |
| IFR18CE650 | NA | 45 | 40 | 20 | 20 | 200 | 200 |
| IFR18CE750 | NA | 60 | 50 | 25 | 20 | 200 | 200 |
| IFR18HK510 | NA | 20 | 20 | 10 | 8 | 200 | 200 |
| IFR18HK650 | NA | 25 | 25 | 12 | 10 | 200 | 200 |
| IFR18HK750 | NA | 30 | 25 | 15 | 12 | 200 | 200 |
| IFR18HK875 | NA | 35 | 30 | 15 | 12 | 200 | 200 |
| IFR18HK935 | NA | 40 | 35 | 15 | 15 | 325 | 300 |
| IFR18HK1000 | NA | 40 | 35 | 20 | 15 | 325 | 300 |
| IFR18HK1100 | NA | 45 | 40 | 20 | 15 | 325 | 300 |
| IFR18HK1200 | NA | 45 | 40 | 20 | 15 | 325 | 300 |
| IFR18HK1250 | NA | 50 | 45 | 20 | 20 | 325 | 300 |
| IFR18HK1400 | NA | 50 | 50 | 25 | 20 | 500 | 500 |

* Models with M or L input voltage code only

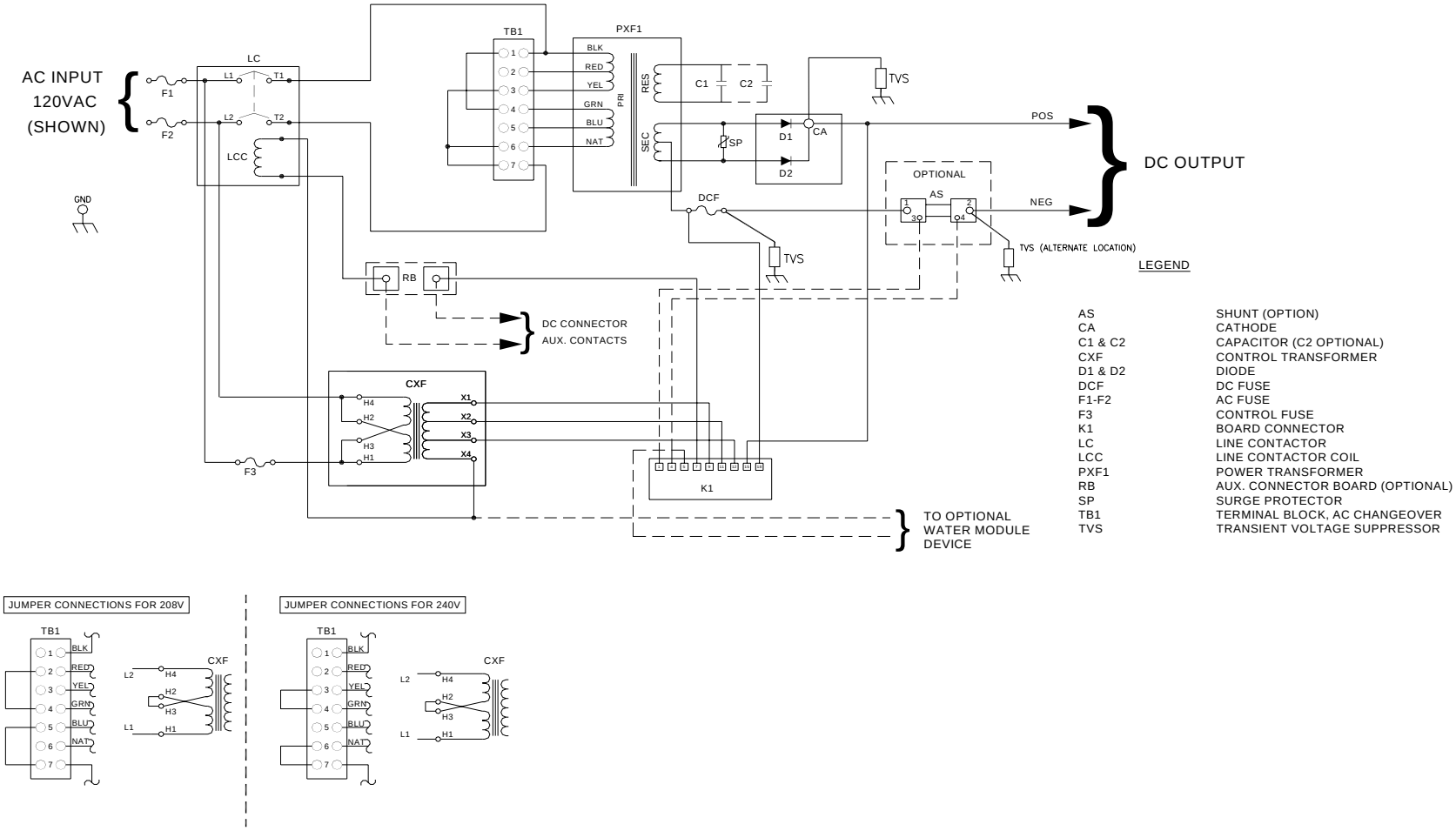
| Model | Input (AC) Fuse Rating – Amperes | | | | | Output (DC) Fuse Rating Amperes | Shunt Amperes |
|---|---|---|---|---|---|---|---|
| | 120 V | 208 V | 240 V | 480 V | 575 V * | | |
| IFR24CE450 | NA | 40 | 35 | 20 | 15 | 200 | 200 |
| IFR24CE510 | NA | 50 | 45 | 20 | 20 | 200 | 200 |
| IFR24CE600 | NA | 60 | 50 | 25 | 20 | 200 | 200 |
| IFR24CE680 | NA | NA | 60 | 30 | 25 | 200 | 200 |
| IFR24HK450 | NA | 25 | 25 | 12 | 10 | 200 | 200 |
| IFR24HK510 | NA | 30 | 30 | 15 | 12 | 200 | 200 |
| IFR24HK600 | NA | 30 | 30 | 15 | 12 | 200 | 200 |
| IFR24HK680 | NA | 35 | 30 | 15 | 15 | 200 | 200 |
| IFR24HK765 | NA | 40 | 35 | 20 | 15 | 200 | 200 |
| IFR24HK850 | NA | 45 | 40 | 20 | 15 | 200 | 200 |
| IFR24HK900 | NA | 50 | 45 | 20 | 20 | 325 | 300 |
| IFR24HK1100 | NA | 50 | 50 | 25 | 20 | 325 | 300 |
| IFR24HK1250 | NA | 60 | 60 | 30 | 25 | 325 | 300 |
| IFR24K1360 | NA | NA | NA | 30 | 25 | 500 | 500 |
| | | | | | | | |
| IFR36HK450 | NA | 35 | 30 | 15 | 12 | 200 | 200 |
| IFR36HK510 | NA | 40 | 40 | 20 | 15 | 200 | 200 |
| IFR36HK600 | NA | 50 | 40 | 20 | 20 | 200 | 200 |
| IFR36HK680 | NA | 50 | 50 | 25 | 20 | 200 | 200 |
| | | | | | | | |
| IFR40HK510 | NA | 50 | 40 | 20 | 15 | 200 | 200 |

* Models with M or L input voltage code only

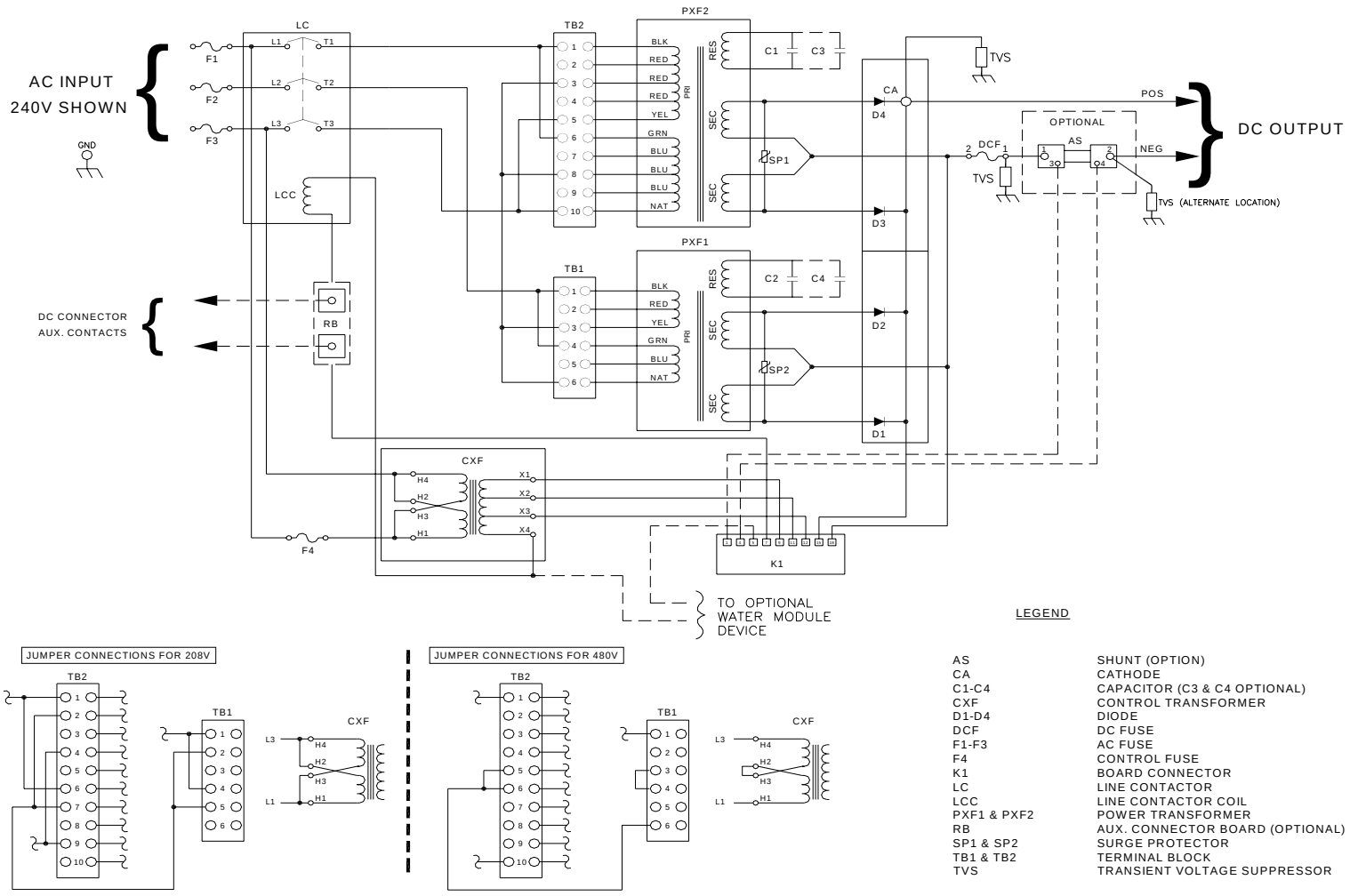
## 10. SCHEMATICS AND WIRING DIAGRAMS




**SCHEMATIC DIAGRAM – 208/240/480 VAC 1- PHASE**



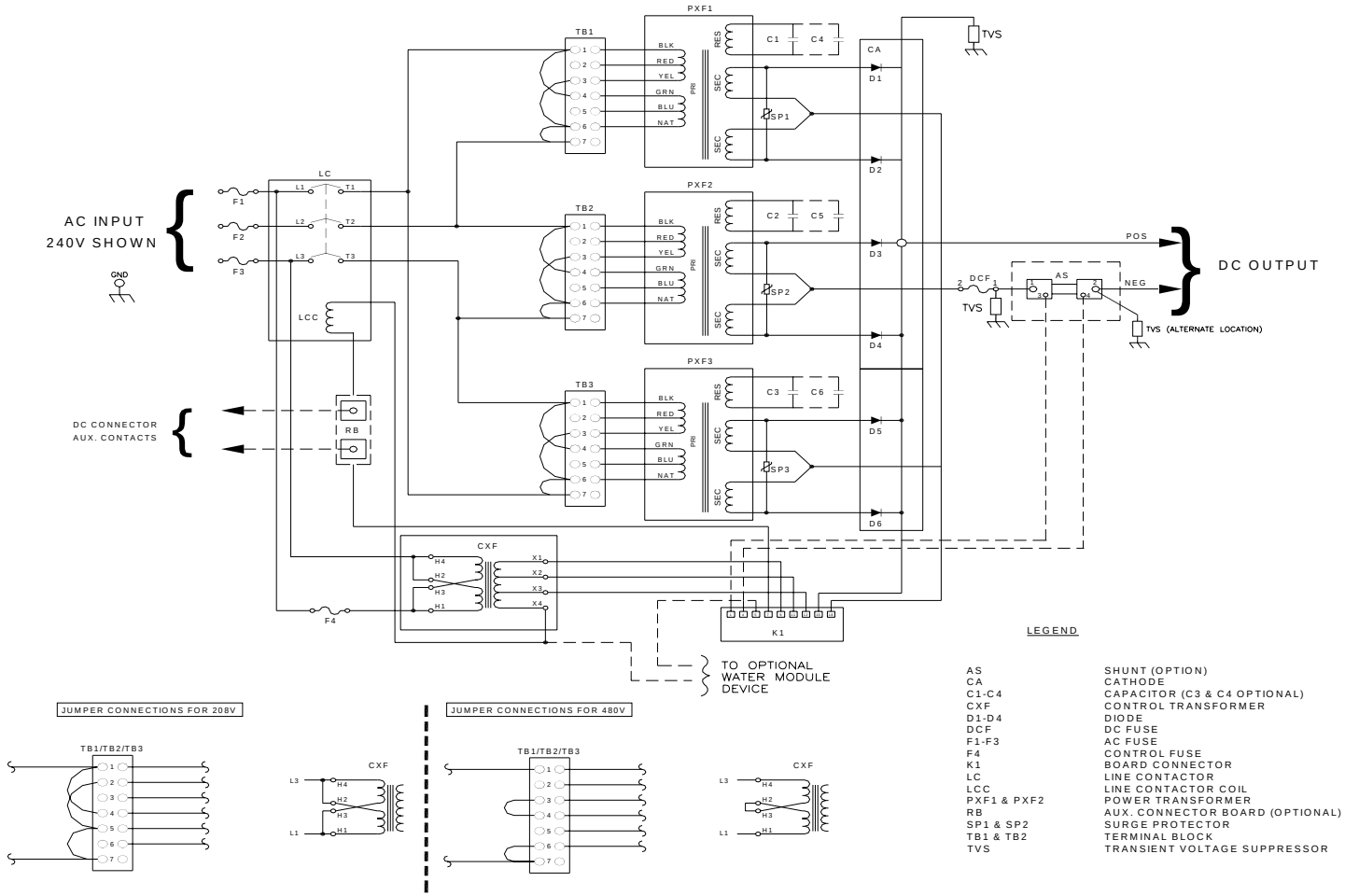

**SCHEMATIC DIAGRAM – 120/208/240 VAC 1- PHASE**



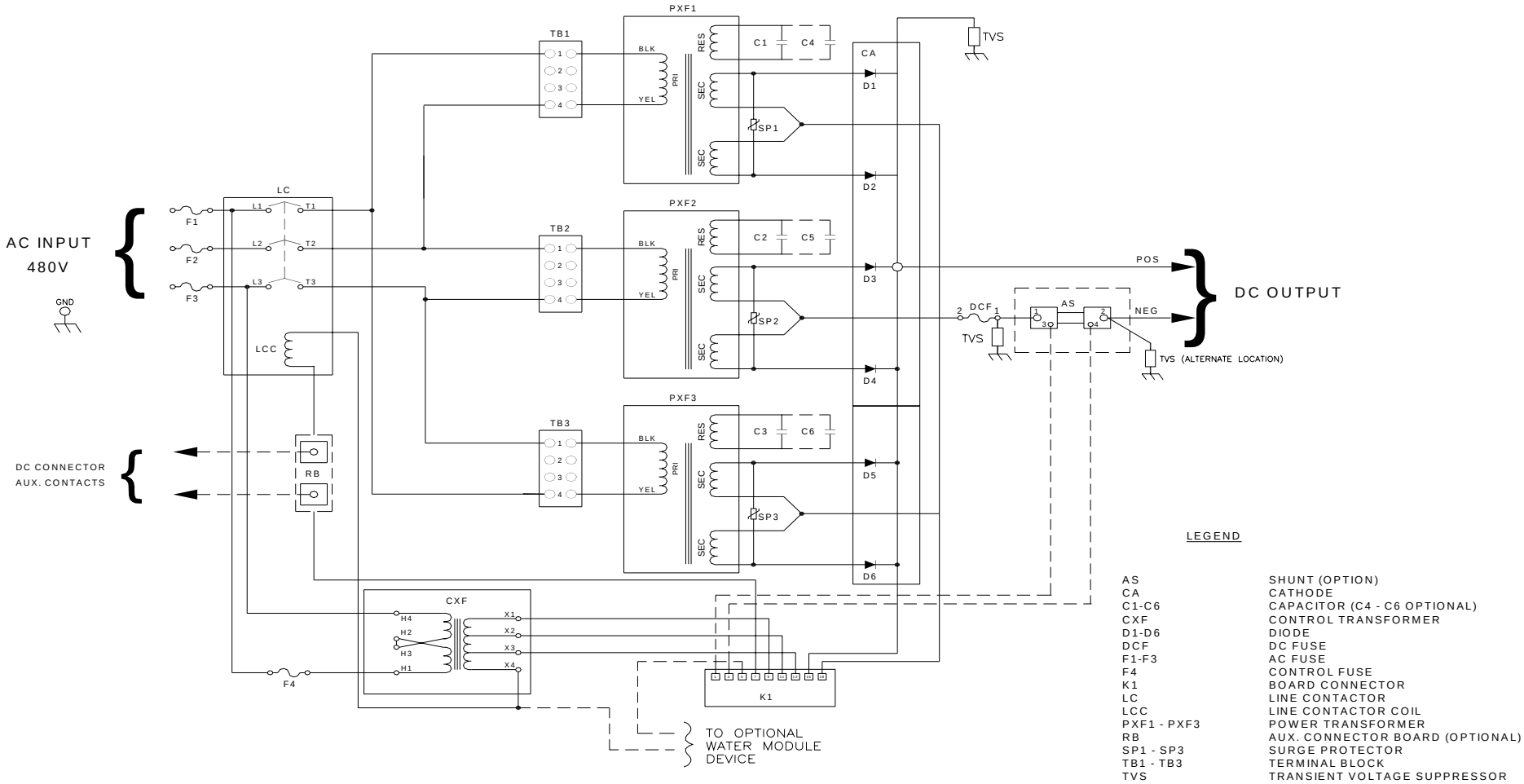

LEGEND

| | |
|---|---|
| AS | SHUNT (OPTION) |
| CA | CATHODE |
| C1-C4 | CAPACITOR (C3 & C4 OPTIONAL) |
| CXF | CONTROL TRANSFORMER |
| D1-D4 | DIODE |
| DCF | DC FUSE |
| F1-F3 | AC FUSE |
| F4 | CONTROL FUSE |
| K1 | BOARD CONNECTOR |
| LC | LINE CONTACTOR |
| LCC | LINE CONTACTOR COIL |
| PXF1 & PXF2 | POWER TRANSFORMER |
| RB | AUX. CONNECTOR BOARD (OPTIONAL) |
| SP1 & SP2 | SURGE PROTECTOR |
| TB1 & TB2 | TERMINAL BLOCK |
| TVS | TRANSIENT VOLTAGE SUPPRESSOR |

**SCHEMATIC DIAGRAM – 208/240/480 VAC 3-PHASE**



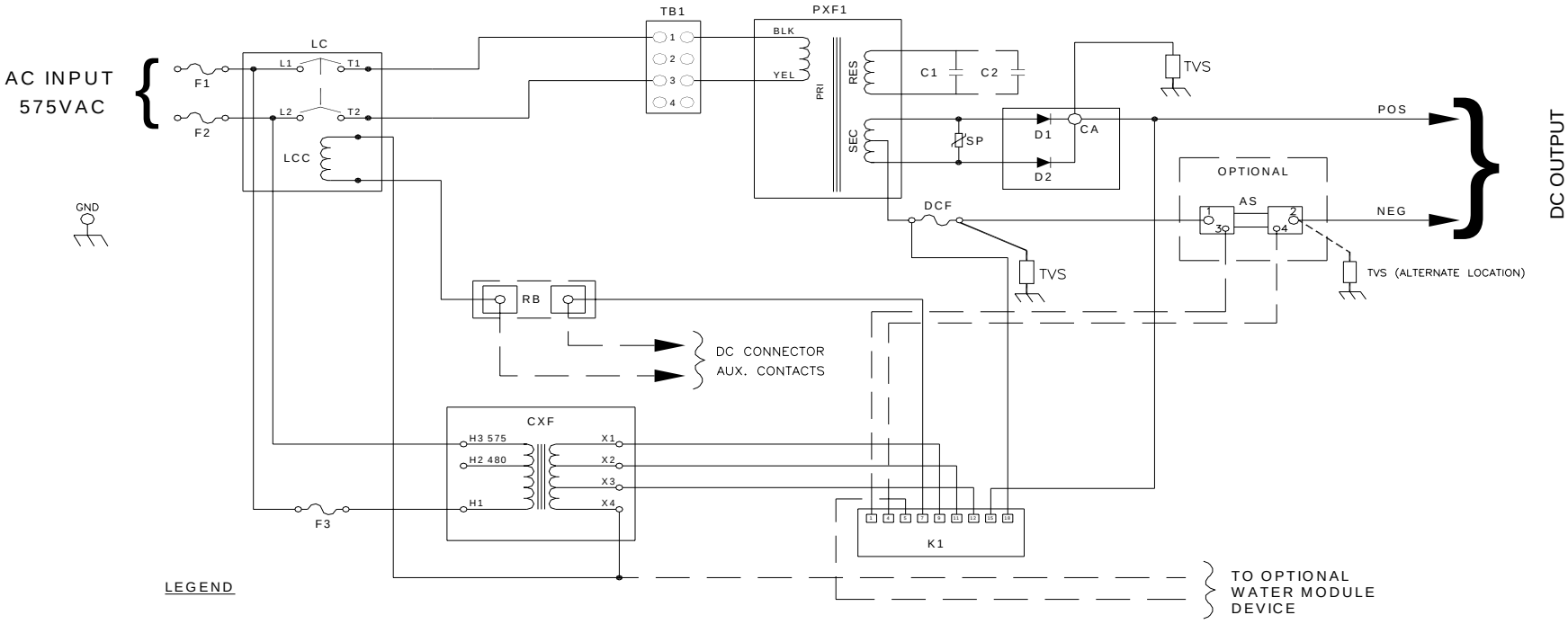

**SCHEMATIC DIAGRAM – 208/240/480 VAC 3-PHASE THREE TRANSFORMERS**




LEGEND

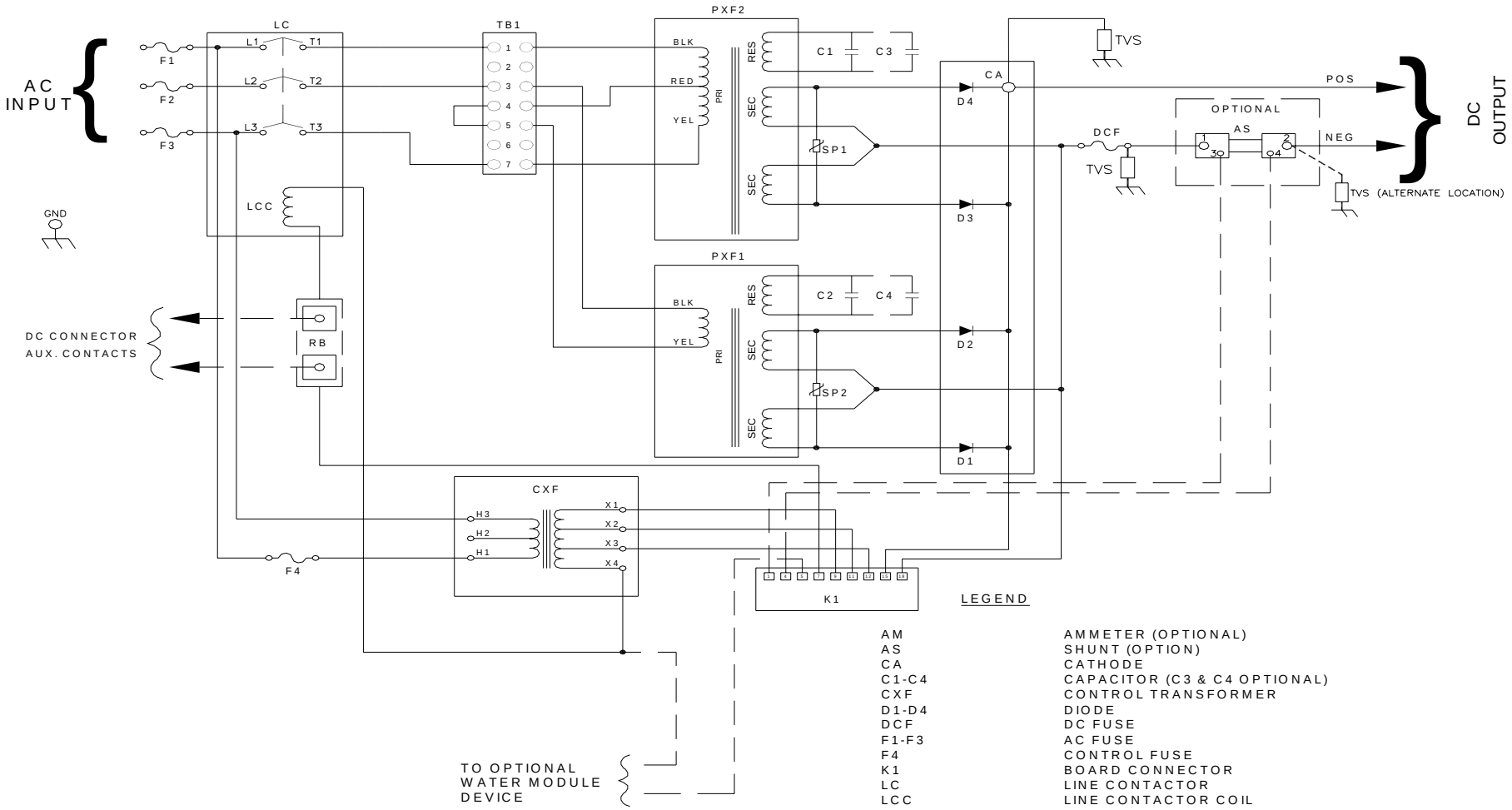
| | |
|---|---|
| AS | SHUNT (OPTION) |
| CA | CATHODE |
| C1-C6 | CAPACITOR (C4 - C6 OPTIONAL) |
| CXF | CONTROL TRANSFORMER |
| D1-D6 | DIODE |
| DCF | DC FUSE |
| F1-F3 | AC FUSE |
| F4 | CONTROL FUSE |
| K1 | BOARD CONNECTOR |
| LC | LINE CONTACTOR |
| LCC | LINE CONTACTOR COIL |
| PXF1 - PXF3 | POWER TRANSFORMER |
| RB | AUX. CONNECTOR BOARD (OPTIONAL) |
| SP1 - SP3 | SURGE PROTECTOR |
| TB1 - TB3 | TERMINAL BLOCK |
| TVS | TRANSIENT VOLTAGE SUPPRESSOR |

**SCHEMATIC DIAGRAM –480 VAC 3-PHASE THREE TRANSFORMERS**

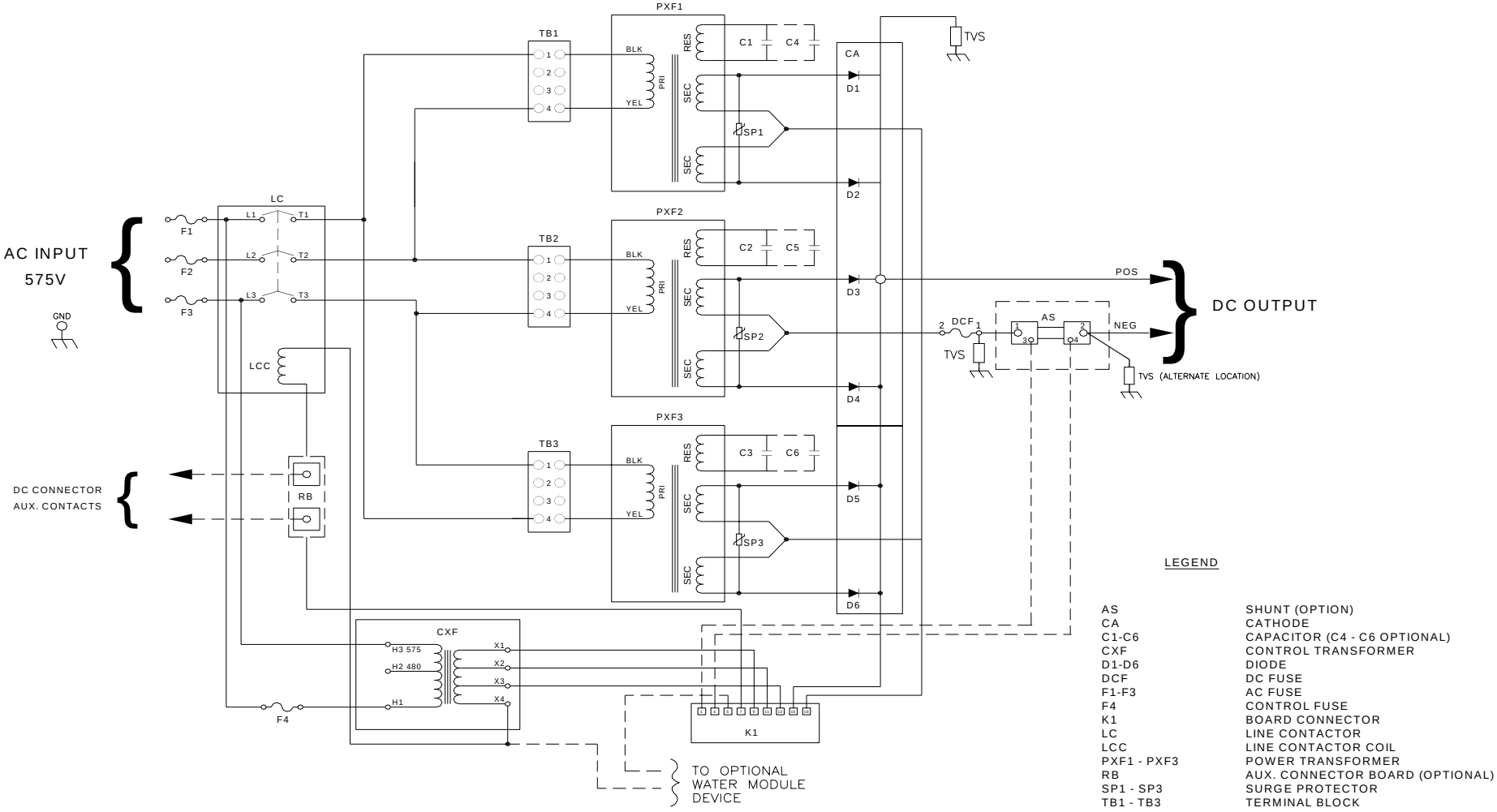



| | |
|---|---|
| AS | SHUNT (OPTION) |
| CA | CATHODE |
| C1 & C2 | CAPACITOR (C2 OPTIONAL) |
| CXF | CONTROL TRANSFORMER |
| D1 & D2 | DIODE |
| DCF | DC FUSE |
| F1-F2 | AC FUSE |
| F3 | CONTROL FUSE |
| K1 | BOARD CONNECTOR |
| LC | LINE CONNECTOR |
| LCC | LINE CONNECTOR COIL |
| PXF1 | POWER TRANSFORMER |
| RB | AUX. CONNECTOR BOARD (OPTIONAL) |
| SP | SURGE PROTECTOR |
| TB1 | TERMINAL BLOCK, AC CHANGEOVER |
| TVS | TRANSIENT VOLTAGE SUPPRESSOR |

**SCHEMATIC DIAGRAM – 575 VAC 1- PHASE**



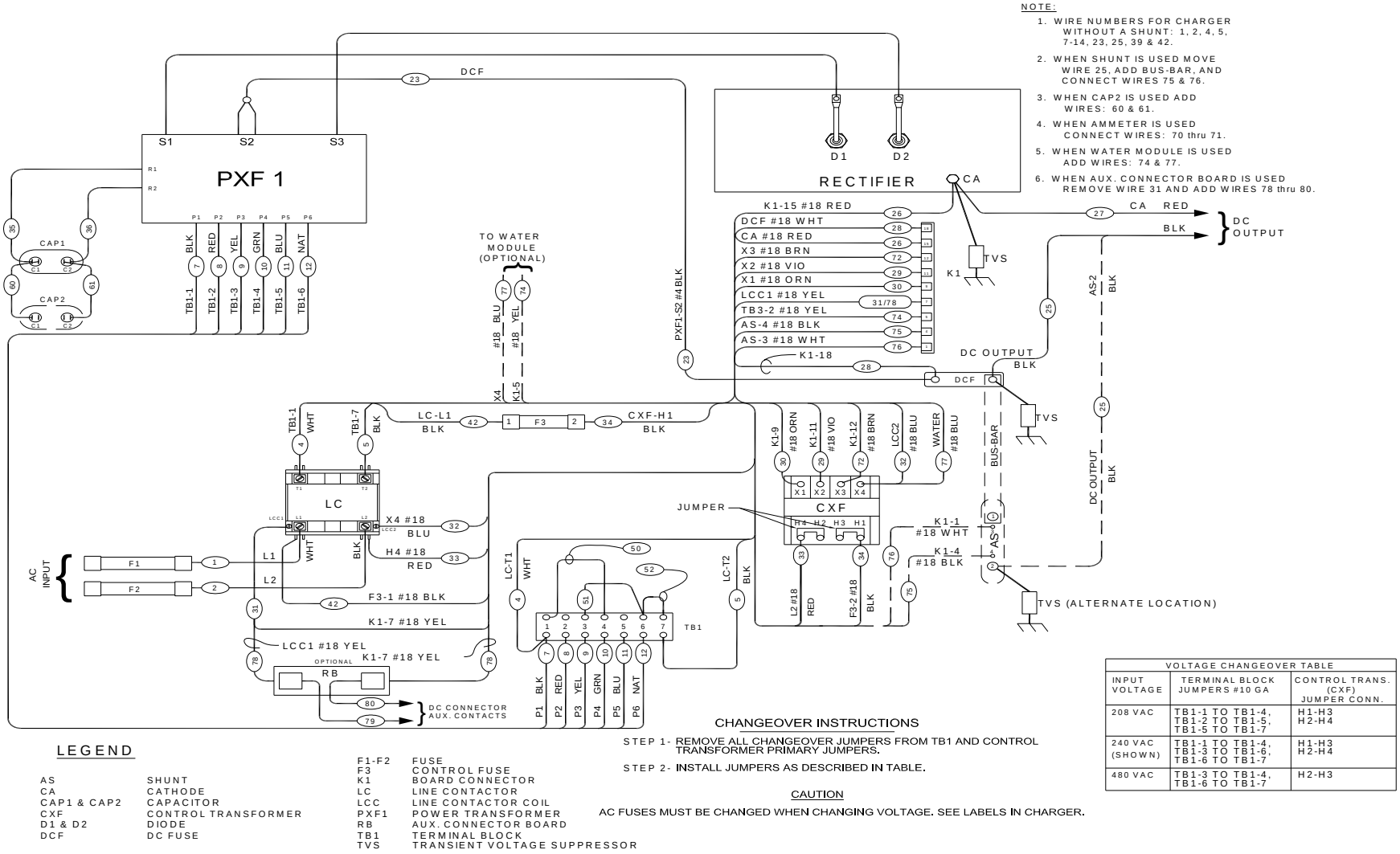

**SCHEMATIC DIAGRAM – 575 VAC 3- PHASE**




LEGEND

| | |
|---|---|
| AS | SHUNT (OPTION) |
| CA | CATHODE |
| C1-C6 | CAPACITOR (C4 - C6 OPTIONAL) |
| CXF | CONTROL TRANSFORMER |
| D1-D6 | DIODE |
| DCF | DC FUSE |
| F1-F3 | AC FUSE |
| F4 | CONTROL FUSE |
| K1 | BOARD CONNECTOR |
| LC | LINE CONTACTOR |
| LCC | LINE CONTACTOR COIL |
| PXF1 - PXF3 | POWER TRANSFORMER |
| RB | AUX. CONNECTOR BOARD (OPTIONAL) |
| SP1 - SP3 | SURGE PROTECTOR |
| TB1 - TB3 | TERMINAL BLOCK |
| TVS | TRANSIENT VOLTAGE SUPPRESSOR |

**SCHEMATIC DIAGRAM – 575 VAC 3- PHASE THREE TRANSFORMERS**




## LEGEND

| | |
|---|---|
| AS | SHUNT |
| CA | CATHODE |
| CAP1 & CAP2 | CAPACITOR |
| CXF | CONTROL TRANSFORMER |
| D1 & D2 | DIODE |
| DCF | DC FUSE |
| F1-F2 | FUSE |
| F3 | CONTROL FUSE |
| K1 | BOARD CONNECTOR |
| LC | LINE CONTACTOR |
| LCC | LINE CONTACTOR COIL |
| PXF1 | POWER TRANSFORMER |
| RB | AUX. CONNECTOR BOARD |
| TB1 | TERMINAL BLOCK |
| TVS | TRANSIENT VOLTAGE SUPPRESSOR |

## CHANGEOVER INSTRUCTIONS

STEP 1- REMOVE ALL CHANGEOVER JUMPERS FROM TB1 AND CONTROL TRANSFORMER PRIMARY JUMPERS.

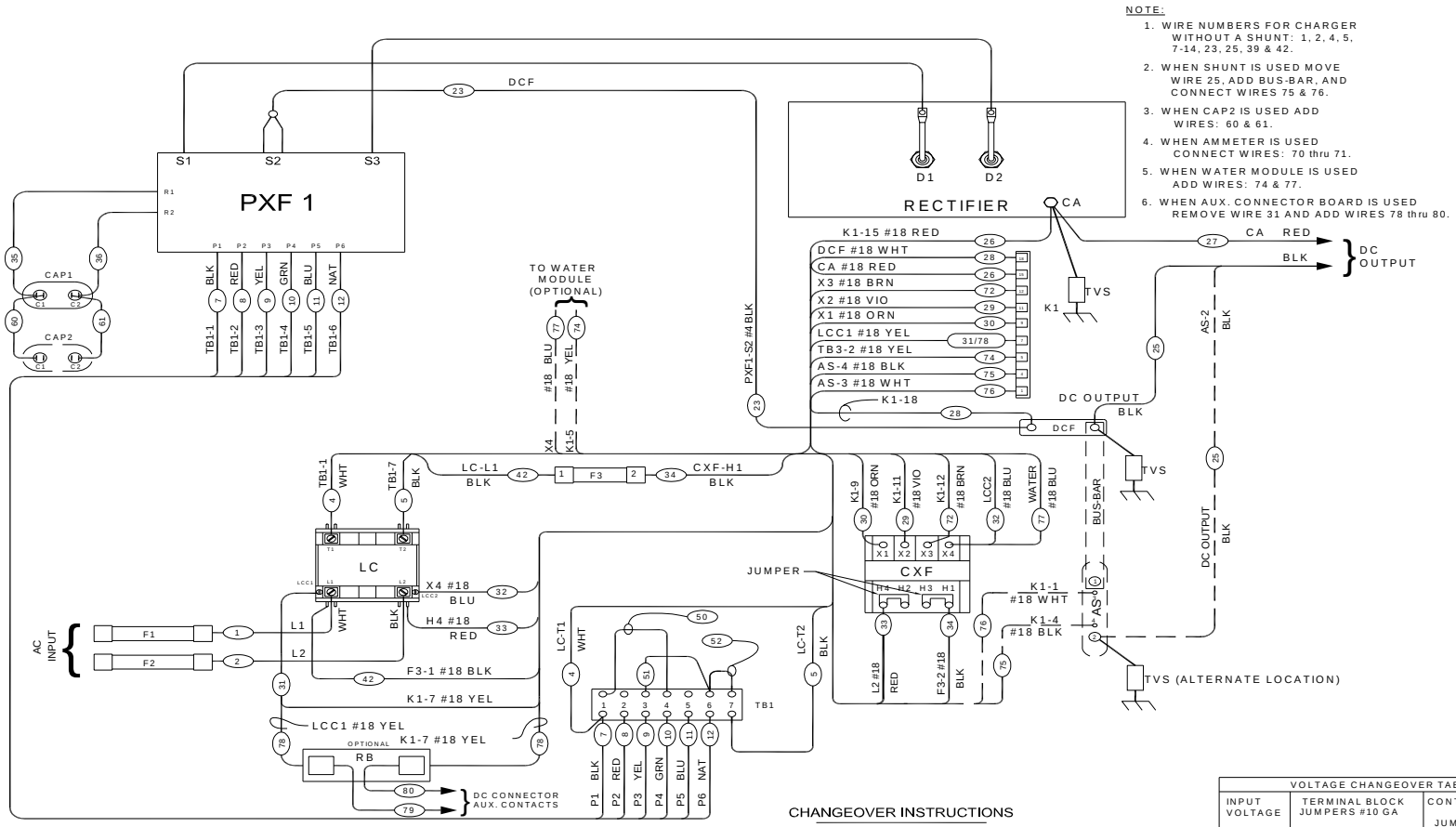
STEP 2- INSTALL JUMPERS AS DESCRIBED IN TABLE.

CAUTION

AC FUSES MUST BE CHANGED WHEN CHANGING VOLTAGE. SEE LABELS IN CHARGER.

| VOLTAGE CHANGEOVER TABLE | | |
|---|---|---|
| INPUT VOLTAGE | TERMINAL BLOCK JUMPERS #10 GA | CONTROL TRANS. (CXF) JUMPER CONN. |
| 208 VAC | TB1-1 TO TB1-4, TB1-2 TO TB1-5, TB1-5 TO TB1-7 | H1-H3 H2-H4 |
| 240 VAC (SHOWN) | TB1-1 TO TB1-4, TB1-3 TO TB1-6, TB1-6 TO TB1-7 | H1-H3 H2-H4 |
| 480 VAC | TB1-3 TO TB1-4, TB1-6 TO TB1-7 | H2-H3 |

**WIRING DIAGRAM - 1 PHASE - 208/240/480 VAC**




## LEGEND

| | |
|---|---|
| AS | SHUNT |
| CA | CATHODE |
| CAP1 & CAP2 | CAPACITOR |
| CXF | CONTROL TRANSFORMER |
| D1 & D2 | DIODE |
| DCF | DC FUSE |
| F1-F2 | FUSE |
| F3 | CONTROL FUSE |
| K1 | BOARD CONNECTOR |
| LC | LINE CONTACTOR |
| LCC | LINE CONTACTOR COIL |
| PXF1 | POWER TRANSFORMER |
| RB | AUX. CONNECTOR BOARD |
| TB1 | TERMINAL BLOCK |
| TVS | TRANSIENT VOLTAGE SUPPRESSOR |

## CHANGEOVER INSTRUCTIONS

STEP 1- REMOVE ALL CHANGEOVER JUMPERS FROM TB1 AND CONTROL TRANSFORMER PRIMARY JUMPERS.

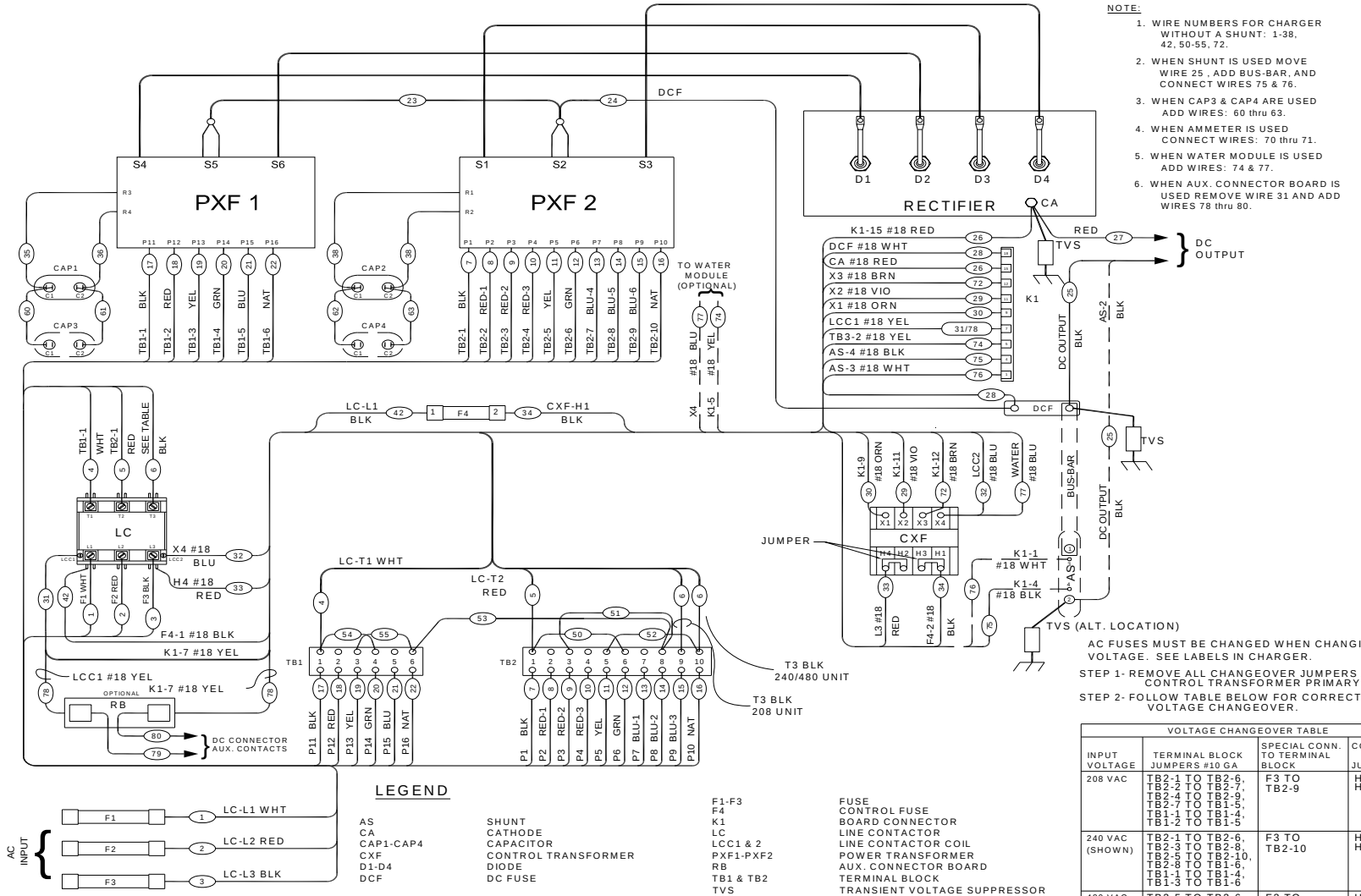
STEP 2- INSTALL JUMPERS AS DESCRIBED IN TABLE.

CAUTION

AC FUSES MUST BE CHANGED WHEN CHANGING VOLTAGE. SEE LABELS IN CHARGER.

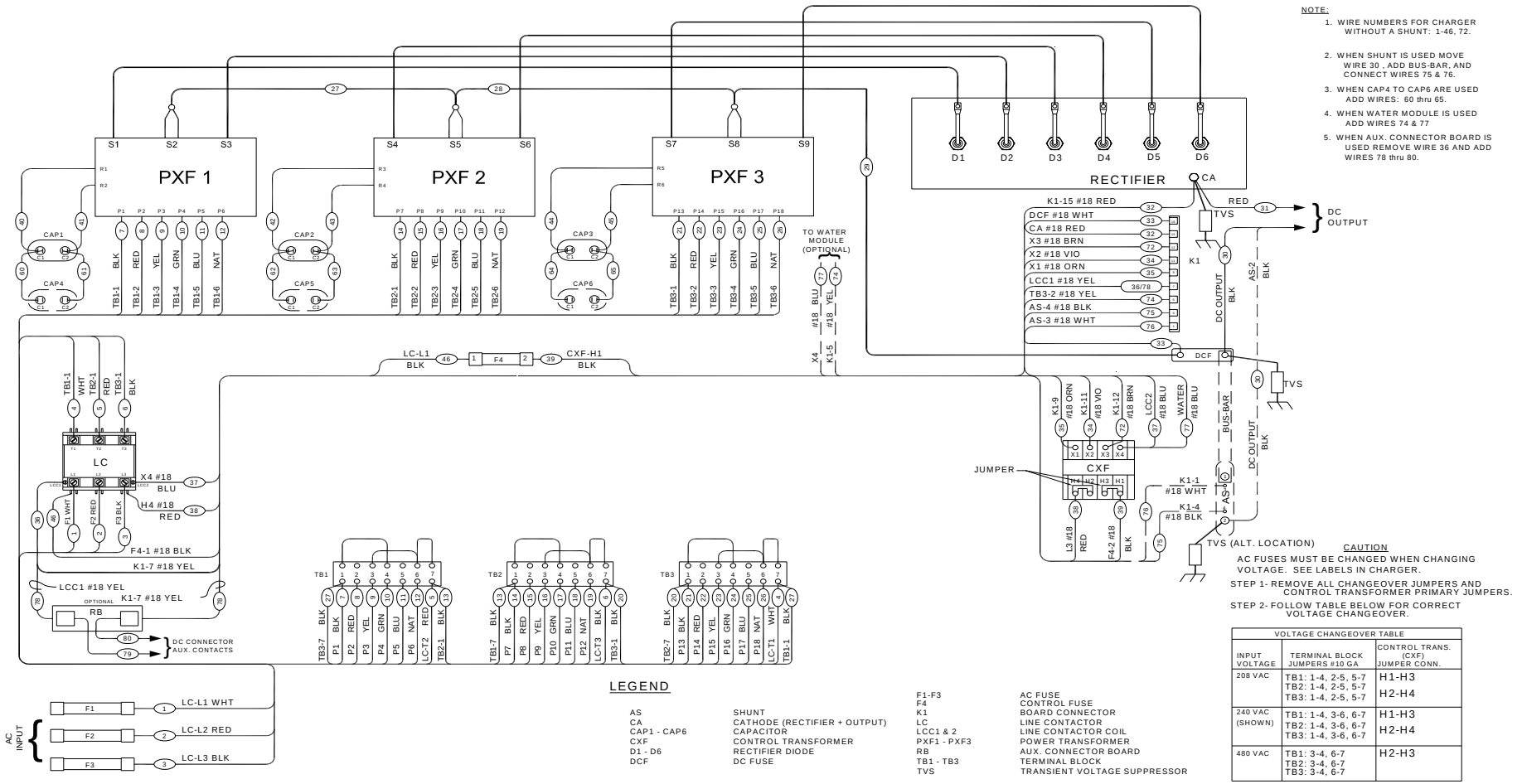
| VOLTAGE CHANGEOVER TABLE | | |
|---|---|---|
| INPUT VOLTAGE | TERMINAL BLOCK JUMPERS #10 GA | CONTROL TRANS. (CXF) JUMPER CONN. |
| 120 VAC (SHOWN) | TB1-1 TO TB1-4,<br>TB1-3 TO TB1-6,<br>TB1-6 TO TB1-7 | H1-H3<br>H2-H4 |
| 208 VAC | TB1-2 TO TB1-4,<br>TB1-5 TO TB1-7 | H2-H3 |
| 240 VAC | TB1-3 TO TB1-4,<br>TB1-6 TO TB1-7 | H2-H3 |

**WIRING DIAGRAM - 1 PHASE - 120/208/240 VAC**

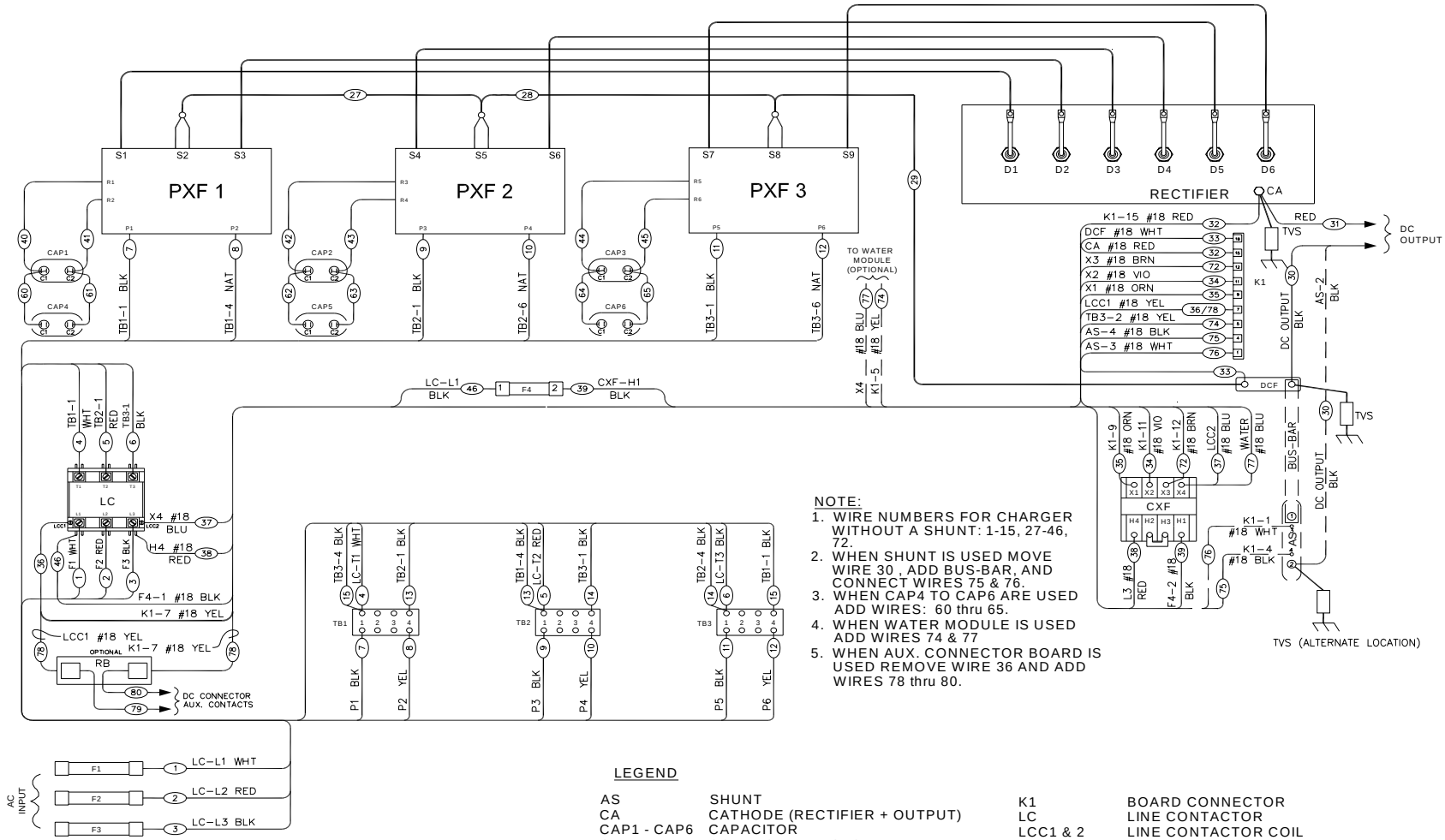



| VOLTAGE CHANGEOVER TABLE | | | |
|---|---|---|---|
| INPUT VOLTAGE | TERMINAL BLOCK JUMPERS #10 GA | SPECIAL CONN. TO TERMINAL BLOCK | CONTROL TRANS. (CXF) JUMPER CONN. |
| 208 VAC | TB2-1 TO TB2-6,<br>TB2-2 TO TB2-7,<br>TB2-4 TO TB2-9,<br>TB2-7 TO TB1-5,<br>TB1-1 TO TB1-4,<br>TB1-2 TO TB1-5 | F3 TO TB2-9 | H1-H3<br>H2-H4 |
| 240 VAC (SHOWN) | TB2-1 TO TB2-6,<br>TB2-3 TO TB2-8,<br>TB2-5 TO TB2-10,<br>TB2-8 TO TB1-6,<br>TB1-1 TO TB1-4,<br>TB1-3 TO TB1-6 | F3 TO TB2-10 | H1-H3<br>H2-H4 |
| 480 VAC | TB2-5 TO TB2-6,<br>TB2-6 TO TB1-6,<br>TB1-3 TO TB1-4 | F3 TO TB2-10 | H2-H3 |

**WIRING DIAGRAM - 3 PHASE - 208/240/480 VAC**



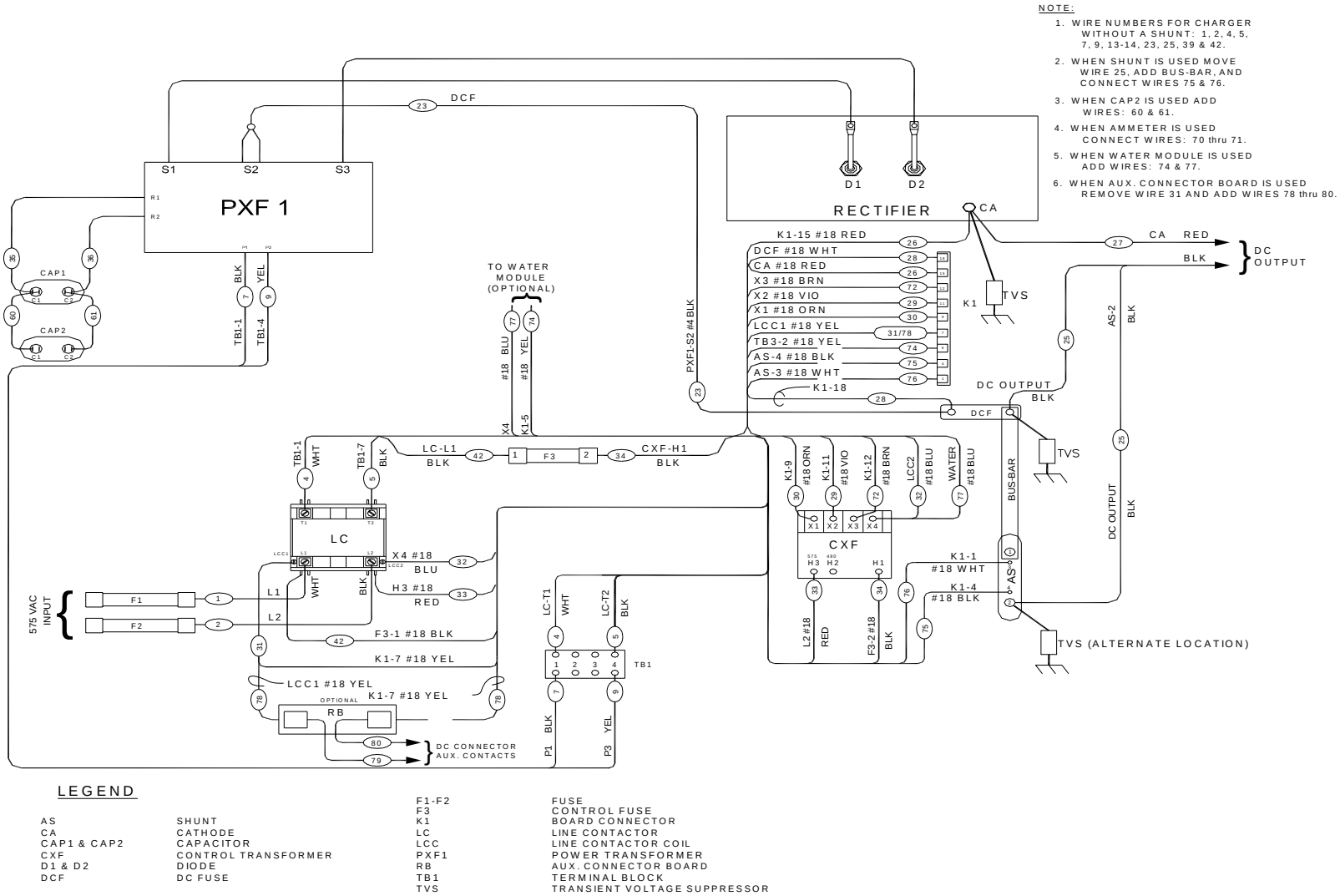

**WIRING DIAGRAM - 3 PHASE - THREE TRANSFORMERS - 208/240/480 VAC**




LEGEND

| | | | |
|---|---|---|---|
| AS | SHUNT | K1 | BOARD CONNECTOR |
| CA | CATHODE (RECTIFIER + OUTPUT) | LC | LINE CONTACTOR |
| CAP1 - CAP6 | CAPACITOR | LCC1 & 2 | LINE CONTACTOR COIL |
| CXF | CONTROL TRANSFORMER | PXF1 - PXF3 | POWER TRANSFORMER |
| D1 - D6 | RECTIFIER DIODE | RB | AUX. CONNECTOR BOARD |
| DCF | DC FUSE | TB1 - TB3 | TERMINAL BLOCK |
| F1-F3 | AC FUSE | TVS | TRANSIENT VOLTAGE SUPPRESSOR |
| F4 | CONTROL FUSE | | |

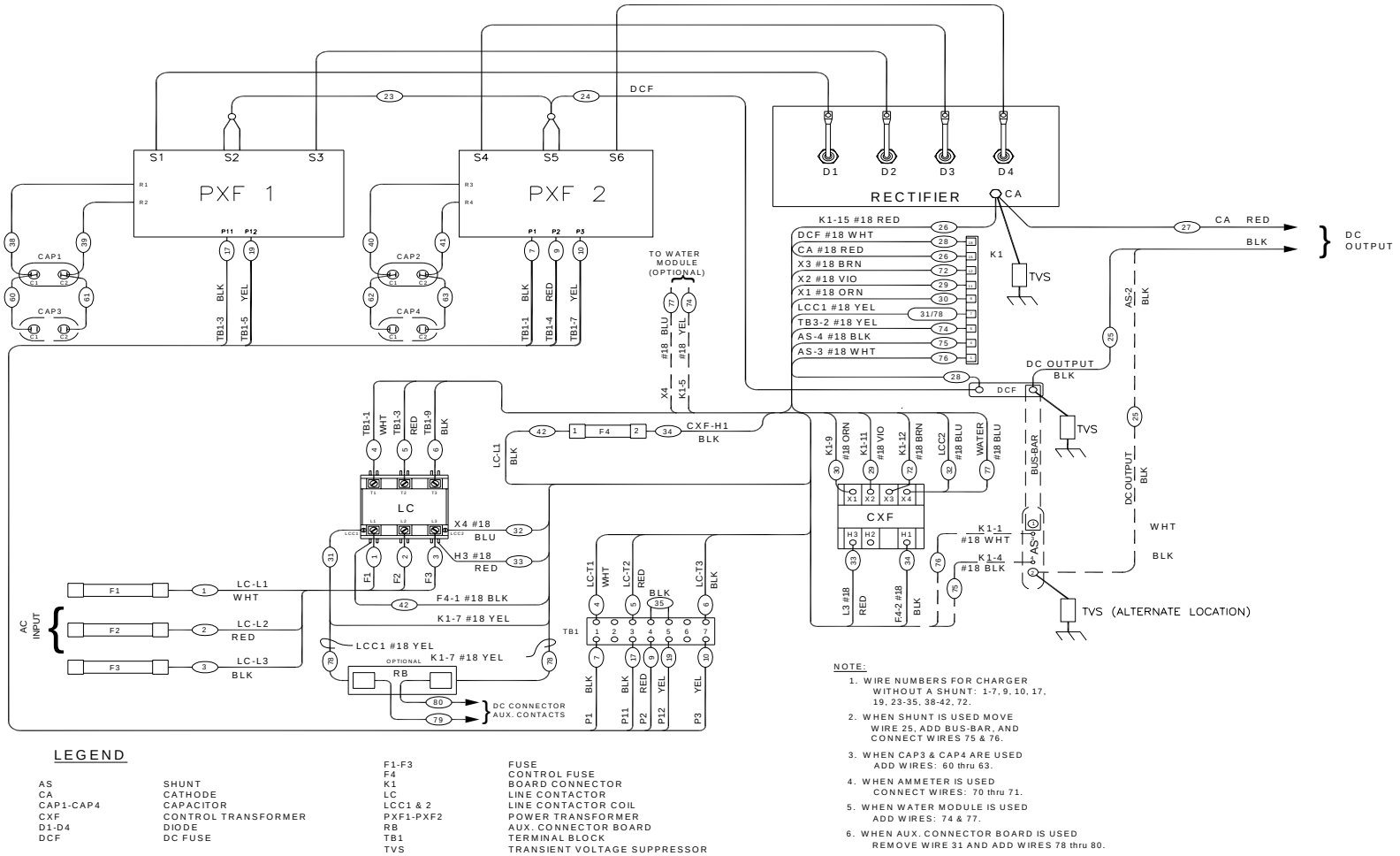
**WIRING DIAGRAM - 3 PHASE - THREE TRANSFORMERS - 480 VAC**




LEGEND

| | | | |
|---|---|---|---|
| AS | SHUNT | F1-F2 | FUSE |
| CA | CATHODE | F3 | CONTROL FUSE |
| CAP1 & CAP2 | CAPACITOR | K1 | BOARD CONNECTOR |
| CXF | CONTROL TRANSFORMER | LC | LINE CONTACTOR |
| D1 & D2 | DIODE | LCC | LINE CONTACTOR COIL |
| DCF | DC FUSE | PXF1 | POWER TRANSFORMER |
| | | RB | AUX. CONNECTOR BOARD |
| | | TB1 | TERMINAL BLOCK |
| | | TVS | TRANSIENT VOLTAGE SUPPRESSOR |

**WIRING DIAGRAM - 1 PHASE - 575 VAC**



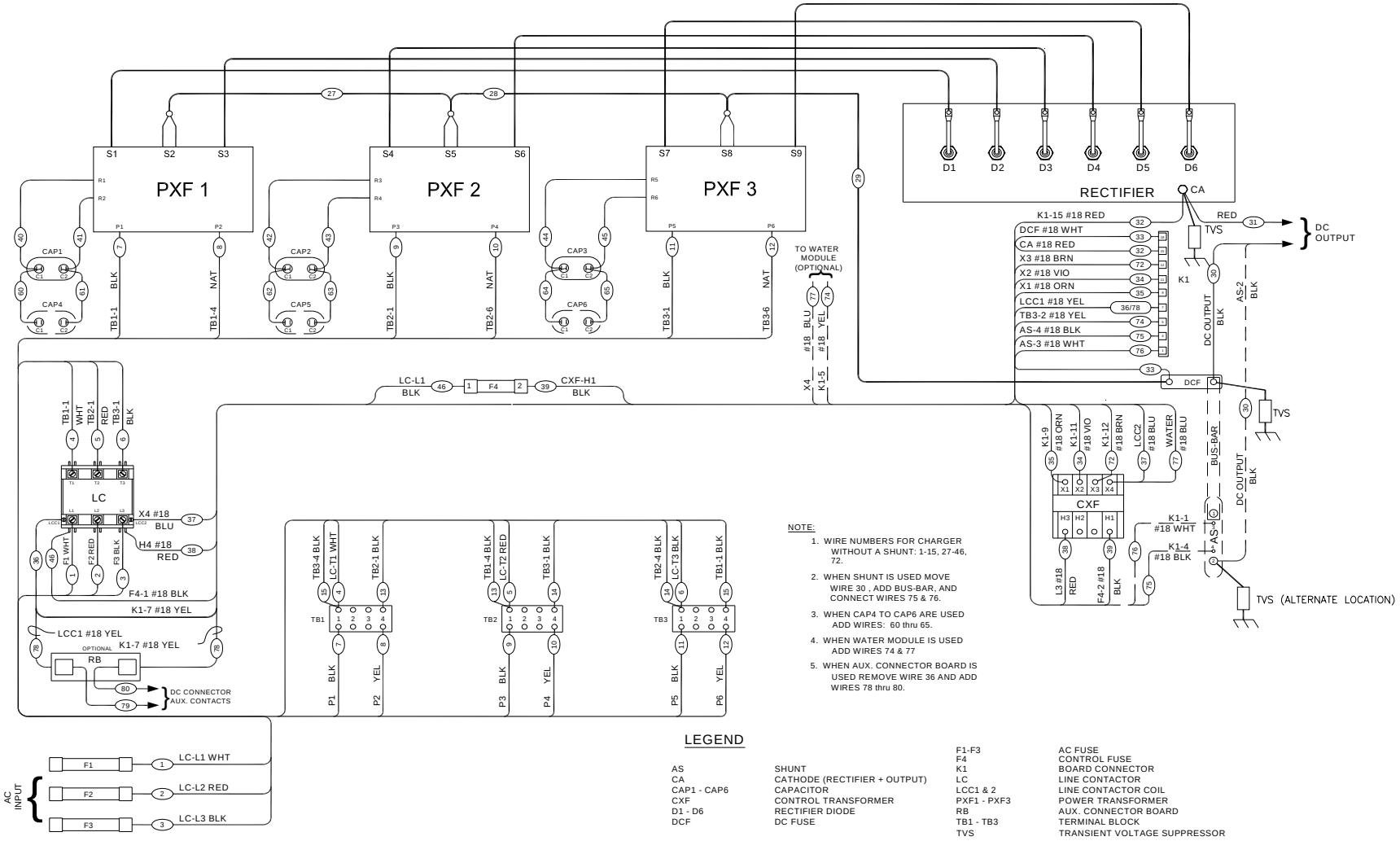

NOTE:

1. WIRE NUMBERS FOR CHARGER WITHOUT A SHUNT: 1-7, 9, 10, 17, 19, 23-35, 38-42, 72.
2. WHEN SHUNT IS USED MOVE WIRE 25, ADD BUS-BAR, AND CONNECT WIRES 75 & 76.
3. WHEN CAP3 & CAP4 ARE USED ADD WIRES: 60 thru 63.
4. WHEN AMMETER IS USED CONNECT WIRES: 70 thru 71.
5. WHEN WATER MODULE IS USED ADD WIRES: 74 & 77.
6. WHEN AUX. CONNECTOR BOARD IS USED REMOVE WIRE 31 AND ADD WIRES 78 thru 80.

LEGEND

| | | | |
|---|---|---|---|
| AS | SHUNT | F1-F3 | FUSE |
| CA | CATHODE | F4 | CONTROL FUSE |
| CAP1-CAP4 | CAPACITOR | K1 | BOARD CONNECTOR |
| CXF | CONTROL TRANSFORMER | LC | LINE CONTACTOR |
| D1-D4 | DIODE | LCC1 & 2 | LINE CONTACTOR COIL |
| DCF | DC FUSE | PXF1-PXF2 | POWER TRANSFORMER |
| | | RB | AUX. CONNECTOR BOARD |
| | | TB1 | TERMINAL BLOCK |
| | | TVS | TRANSIENT VOLTAGE SUPPRESSOR |

**WIRING DIAGRAM - 3 PHASE - 575 VAC**




NOTE:

1. WIRE NUMBERS FOR CHARGER WITHOUT A SHUNT: 1-15, 27-46, 72.
2. WHEN SHUNT IS USED MOVE WIRE 30 , ADD BUS-BAR, AND CONNECT WIRES 75 & 76.
3. WHEN CAP4 TO CAP6 ARE USED ADD WIRES: 60 thru 65.
4. WHEN WATER MODULE IS USED ADD WIRES 74 & 77
5. WHEN AUX. CONNECTOR BOARD IS USED REMOVE WIRE 36 AND ADD WIRES 78 thru 80.

LEGEND

| | | | |
|---|---|---|---|
| AS | SHUNT | F1-F3 | AC FUSE |
| CA | CATHODE (RECTIFIER + OUTPUT) | F4 | CONTROL FUSE |
| CAP1 - CAP6 | CAPACITOR | K1 | BOARD CONNECTOR |
| CXF | CONTROL TRANSFORMER | LC | LINE CONTACTOR |
| D1 - D6 | RECTIFIER DIODE | LCC1 & 2 | LINE CONTACTOR COIL |
| DCF | DC FUSE | PXF1 - PXF3 | POWER TRANSFORMER |
| | | RB | AUX. CONNECTOR BOARD |
| | | TB1 - TB3 | TERMINAL BLOCK |
| | | TVS | TRANSIENT VOLTAGE SUPPRESSOR |

**WIRING DIAGRAM - 3 PHASE - THREE TRANSFORMERS - 575 VAC**