



Millennium - E



Owner's Manual



Welcome to the OLYMPIA Advantage

The OLYMPIA MILLENNIUM - E has been designed and built to deliver trouble free performance. Like all mechanical equipment however, trouble free operation is based on complete and ongoing maintenance procedures being adhered to in order to validate your Resurface Corp. warranty.

We have included a maintenance log form at the back of this manual to assist you in maintaining a permanent record of your maintenance program. Please copy this form to provide additional pages as needed.

The operational and maintenance procedures outline a step by step process that should be followed precisely. A variety of safety and performance- enhancing options are available and may be ordered on any model.

The illustrations and product information contained in this manual were current at the time of publication. In order to continue Resurface Corp. 's development of its ice resurfacing technology, Resurface Corp. reserves the right to change designs, models and specifications without notice and without liability for such changes.

The components in your OLYMPIA ice resurfacing machine are warranted against defects in material and workmanship by Resurface Corp., for two full years from the date of delivery.

For continued safe, economic operation and to validate the Resurface Corp. warranty, the balance of your OLYMPIA ice resurfacing machine should be strictly maintained under the guidelines outlined in this manual.

ALL WARRANTY REPAIRS MUST FIRST BE AUTHORIZED BY

RESURFACE CORP. OR AN AUTHORIZED DEALER

No warranty on this machine will be honoured by Resurface Corp. other than that stated above.



Millennium-E

Owner's Name:

Address:

.....

.....

Serial Numbers:

Ice Resurfacers:

Battery Charger:

Batteries.:

Water Cart.:

Controllers.:

FL FR

RL RR

Auger Vertical

Auger Horizontal

Hydraulic

Motors:

FL FR

RL RR

Auger Vertical

Auger Horizontal

Hydraulic

Gear Boxes:

FL FR

RL RR

Conditioner Size:

Options:

.....

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Dear User!

Before you put your OLYMPIA Ice Resurfacer into operation, please take the time to carefully read this operating manual.

Pay particular attention to the safety instructions given throughout the manual and to Chapter 1, Safety.

This is a prerequisite for...

- Safe handling and operation of the ice resurfacer,
- Trouble-free operation of the machine.

Always keep the operating manual in the vicinity of the ice resurfacer.

Note:

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1 SAFETY

1.1 Pictograms Used

Throughout the texts in this manual and in part, on the ice resurfacer itself, you will find, among other things, the following pictograms:



Imminent danger that can result in death, serious bodily injury, or major material damage.



Warning about dangerous electrical voltage.



Warning about hazardous movements that can result in hand injuries.



Warning about blades, sharp edges, and similar, that can result in cutting injuries.



Warning about potential explosion.



Application tips and other useful information.

1.2 Generally Applicable Safety Instructions

- Please study the operating manual with due attention before starting the first resurfacing operation. Always remember that you are responsible for an ice resurfacer that weighs several tons.
- The ice resurfacer has been built and designed in compliance with Canadian and international safety standards, so that it can be used without risk.
- To operate the ice resurfacer safely, you must follow the safety instructions.
- The OLYMPIA may only be operated when there are no people on the ice and no objects on the ice surface.
- Sound the horn when you drive through areas in which pedestrians may be present, where your view is restricted, and when you drive onto the ice surface or leave the ice surface again.
- No passengers are allowed on the ice resurfacer at any time.
- Operating conditions vary greatly and Resurface Corp. cannot predict them. Therefore, it is the User's responsibility to select the appropriate settings for operation of the OLYMPIA.
- Wherever necessary, safety circuits and safety devices are installed and are active. Therefore, no modifications and conversions may be undertaken on the ice resurfacer, nor must the safety circuits and devices be modified in any way, or rendered inoperable.



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- The OLYMPIA must be inspected at least once a day for visible signs of damage! Any changes, including changes in the operating behaviour must be reported to the responsible department or person immediately! The ice resurfacer must be switched off and secured immediately if necessary (e.g. push the emergency stop button and turn the key-operated switch to the off position and remove the key)!
- Do not perform any procedures that are not described in this manual!
- No liability will be accepted for any material damage or personal injury caused by failure to comply with the above directives, or failure to follow the instructions given in this operating manual. This also applies for damage caused as a result of improper or unauthorized use of the machine.

1.3 Proper Use

The OLYMPIA ice resurfacer has been manufactured exclusively for the resurfacing of ice surfaces. Do not use the OLYMPIA for any other purpose.

Only duly authorized and trained drivers may operate the OLYMPIA.

All information and instructions given in this documentation must be adhered to without fail.

1.4 Improper Use

The following are deemed to be improper use:

- Operation without the safety devices.
- Failure to comply with the on-site directive posted by the User.
- Driving on surfaces that have more than a 15 % incline (or 13.5°).
- Carrying of passengers.
- Operation without the duly trained driver.
- Operation in inadequate light conditions.
- Failure to comply with the instructions given in this documentation.

1.5 Organizational Measures

- The operating manual must be kept in a place where it is readily accessible to the operators and maintenance personnel!
- The personnel employed to work with and on the ice resurfacer must have read the operating manual before starting any work. This applies in particular for personnel who



only work occasionally on the machinery, e.g. for setup or maintenance purposes.

- Maintenance personnel must tie back long hair, and must not wear loose clothing or jewellery, including rings, when working on the machine. There is a risk of injury, e.g. by getting caught on or pulled into the machinery.
- The prescribed schedules, or those specified in the operating manual for periodic checks/inspections must be adhered to!
- Local safety standards must be adhered to as well as recommendations in this document.

1.6 Personnel Qualifications

- Every OLYMPIA has a variety of built-in safety functions. To prevent accidents from occurring, everyone that deals with the operation and maintenance of the machine must carefully read the instruction manuals provided by Resurface Corp. before they operate or service the OLYMPIA.
- Only the specially trained ice resurfacer operators may have access to the starter key and they must keep it under lock and key. The necessary training and instruction will be given by Resurface Corp. or one of their authorized distributors upon delivery of the machine.
- All operators must be trained by a qualified instructor.
- All safety instructions must be strictly followed when operating, maintaining and shutting down the ice resurfacer. Failure to adhere to the instructions can lead to accidents resulting in personal injury and material damage.
- The personnel are instructed both verbally and in writing, the emergency shut off switch must be switched off before disconnecting the battery connector (to avoid sparking). The emergency shut off switch must be switched on after connecting the battery charger.
- The driver is instructed both verbally and in writing, that he must wear the seatbelt if equipped at all times when operating OLYMPIA.

- Resurface Corp. recommends that the user holds regular training courses, in which special emphasis must be placed on the hazards and safety measures. The service personnel must be instructed about the specific hazards in association with the maintenance and repair of the ice resurfacer. This instruction must be repeated at regular intervals, at least once a year.
- The employees must wear protective gloves when doing maintenance and repair work. The hazards in association with the sharp components are pointed out in regularly held training courses. The hazard avoidance measures must be explained.
- The responsibilities of the personnel for operation, setup and maintenance of the ice resurfacer must be clearly defined. Make sure that only duly authorized personnel are allowed to work on and with the ice resurfacer!
- The maintenance personnel must be duly certified in accordance with the following charts.

Job \ Person	Instructed persons	Qualified technicians	Qualified electricians	Authorized Service personnel
Operation	X			
Troubleshooting			X	X
Mechanical fault rectification		X		X
Electrical fault rectification			X	X
Maintenance		X	X	X
Repair		X	X	X



1.7 Obligations of the User

The User must ensure that...

- The ice resurfacer is only used in the proper manner,
- The ice resurfacer is only operated when it is in perfect working order,
- The integrated safety devices are regularly maintained and checked for proper function,
- The operating manual is supplemented with all generally applicable, statutory and other binding accident prevention and environmental protection regulations, and that these are complied with!
- Personal protection gear/clothing is provided and is worn (e.g. protective gloves, warm clothing, safety helmet and, if necessary, ear muffs, steel toed safety boots, and also non-slip footwear (for walking on the ice surface).
- The operating manual is supplemented with facility-internal instructions, e.g. supervision and reporting duties to take account of facility-specific particulars, such as work organization, operational procedures, employed personnel, etc.
- It is checked, regularly, that the personnel are working in a safe and hazard-conscious manner and are adhering to the instructions given in the operating manual!

1.8 Operator's Workplace

Operation of the ice resurfacer is done solely from the driver's seat on the driver's platform.



Before doing any jobs of longer duration on moving parts, switch off the power and depressurise the systems at the vehicle and take suitable measures to prevent it from being switched back on again.

Turn the key switch to the OFF position and remove the key; switch off the emergency stop switch and pull the battery plug.

1.9 Safety Devices and Guards

Operator Presence switch at the driver's seat



There is an Operator Presence switch at the driver's seat on the OLYMPIA that must not be bypassed. When the driver leaves the seat, the ice resurfacer is stopped after a delay of 8 seconds, so that the OLYMPIA cannot be operated without the driver in the seat.



EMERGENCY STOP

The EMERGENCY shut off button can be used to shut down the whole ice resurfacer in an emergency. The EMERGENCY shut off button is located at the front left, in front of the steering wheel.

Switch-Off: Depress the knob on the switch to shut off the power (disconnect the circuit).

Switch-On: To switch the ice resurfacer back on again, pull out the knob until it locks into place. The normal switch-on procedure must then be executed from the beginning. (section 7.1.1)



Fig. 1.1: Emergency Shut off switch on the OLYMPIA



The Emergency Shut off switch turns off the whole ice resurfacer, except for the battery discharge indicator. The battery discharge indicator is mounted on the battery to save the stored data. When the battery connector is disconnected, the whole ice resurfacer is switched off too, with the exception of the battery discharge indicator.

Limitation: The (+) contact of the EMERGENCY STOP switch still carries the potential of the (+)Ub port of the battery!



Charging of the battery is also interrupted when the Emergency shut off switch is pressed. If the charger is not working, please first check whether the Emergency shut off switch has been pressed.



Caution!

Do not attempt to operate the ice resurfacer until the reason for the shut down has been discovered and corrected.

If the EMERGENCY STOP circuit is activated, all power to the OLYMPIA is switched off. The brake accumulator remains under pressure, but can be depressurised by simply pressing the brake pedal several times.



The removal of guards or safety devices or rendering them inoperable while the ice resurfacer is in operation is prohibited.

Guards and safety devices may only be removed or put out of operation for repair or maintenance purposes after the main switch has been turned off and measures taken to prevent it from being switched back on again, and after the ice resurfacer has been depressurised.

Tools are needed to open all covers and panels.



Horn Button

The horn button is located on the upper dash panel. The horn sounds as soon as you press this button.



Fig. 1.2: Horn button on the OLYMPIA

Warning Signals

- Warning lamp indicating that there is not enough water in the water tank
- Warning signal indicating that the battery is low (accumeter flashes)

1.10 Maintenance and Repair Regulations

In terms of this manual, maintenance work means all ...

- maintenance jobs that have to be done periodically on the OLYMPIA.
- lubrication.
- cleaning.
- setup and retooling, changing of components / sub-assemblies.
- Adjustments/setting of the electrical equipment, mechanical parts and hydraulic systems.
- Never open the control cabinet and/or any electrical components while power is being supplied to the machinery.
- The battery connector must be disconnected before doing any work on the ice resurfacer (including changing the blades). The proper way to do this is to check to make sure the snow dump tank is empty, then raise the tank to the fully open position, Remove the starter key and properly dismount the resurfacer, and install the snow dump safety supports. Disconnect the battery by separating the main power plug located directly in front of the operators platform under the snow dump tank. Carry the key on your person. Put up a notice on the ice resurfacer that says, DO NOT START.
- Before starting the work, cordon off the area in which the maintenance work is to be done with a red/white safety chain and put up notices that read MAINTENANCE WORK IN PROGRESS! UNAUTHORIZED ACCESS PROHIBITED. RISK OF INJURY.



After completing the maintenance jobs and before switching on the ice resurfacer, make sure that:

- There is nobody in the danger zone.
- There are no more tools or other parts in the vehicle.
- All safety devices/guards have been duly re-installed and are in proper working order.
- Adhere to the safety regulations that are specified in the descriptions of the individual maintenance jobs.

1.11 Waste Disposal

Hazardous waste must not be disposed of with general household waste. Each local community generally has drop-off locations for the proper disposal of hazardous waste.

The battery must be disposed of in the proper manner. Contact your battery supplier for proper disposal of your batteries. (refer to the regulations in your O.S.H.A. manual or Directive 91/157/EEC or to your local battery disposal regulations).



For more information, please contact your local waste disposal authorities.

1.12 Remaining Hazards



Risk of Injury!

The ice resurfacers operator must be in possession of all his mental and physical faculties to ensure that nobody gets run over (i.e. he must not have consumed alcohol, taken pills or other medication, or taken drugs).



Risk of Falling and Risk of Injury!

The carrying of passengers on the ice resurfacers is strictly prohibited, as they could fall off the machine and sustain injury.



Risk of Injury!

Before starting any maintenance job, make sure that you secure the snow dump tank with the safety supports to prevent it from dropping down, because there is a considerable hazard potential here.



Risk of Injury!

Always place blocks under the conditioner when performing maintenance work and blade changes.



Risk of Sustaining Cutting Injuries!

Always wear protective gloves when handling the blade. Because the blade is extremely sharp, for your own safety and to protect the sharp edge of the blade, always use the magnetic guard.



NEVER leave the OLYMPIA unattended when filling it with water, because hot water could leak out and injure someone.



Risk of Injury!

Make sure that there are no people or objects in the work and driving area.



Danger!

Do not spray the machine with a water hose to clean it, because this can lead to electrical faults.



Risk of Explosion!

Ensure proper ventilation during the charging process. Escaping hydrogen gas could lead to an explosion.



Risk of Short Circuiting!

The batteries must not come into contact with water. Never place anything on top of the batteries, otherwise short-circuiting could occur.



Risk of Injury!

If your ice resurfacer is parked on an incline, before releasing the handbrake turn the start key to the ON position. Make sure the gear selector is in neutral. Depress and release the accelerator pedal. Now you can depress the brake pedal, release the handbrake and the ice resurfacer will not move.

Failure to follow this procedure will result in the ice resurfacer rolling down the incline when the handbrake is released.



Risk of Injury!

Before switching on the OLYMPIA , it is necessary to make a complete circle check of the ice resurfacer.

Always use extreme caution when driving the OLYMPIA from the service area onto the ice surface (and vice-versa), as there could be people on the connecting routes.

The OLYMPIA may only be operated on the ice surface when it is completely clear of persons and debris.

The ice resurfacer operator must stop the ice resurfacer and secure it to prevent it from rolling away before leaving the seat on the ice resurfacer`s platform. This is done by setting the key-operated switch (starter switch) to the STOP position and applying the parking brake.

The driver`s seat has a timed operator presence switch that stops all movements eight seconds after the driver leaves the seat.

Caution:

In a hazardous situation, depress the emergency shut off switch immediately, if any other controls fail for any reason.



Risk of Getting Crushed!

There must not be any people in the vicinity of the OLYMPIA when the ice shavings are being unloaded.



Risk of Getting Crushed!

If other people enter the area during the unloading process, the ice resurfacer movements must be stopped and may only be resumed after these people have left the area again.



Risk of Falling!

Proceed with extreme caution when moving the ice resurfacer around or near the stationary snow dump area.



Risk of Getting Crushed!

When doing maintenance or repair work in the area under the snow dump tank, the safety supports must be secured, if the work is to be done with the tank open.



Risk of Injury!

When driving the OLYMPIA always proceed with caution.

When driving in areas with a restricted view or in narrow spaces, drive with a reduced speed.

When driving off-ice, the vehicle lighting must be switched on.

The OLYMPIA must not be driven on public roads, as it is not licensed for use on public roads and highways.



Risk of Getting Crushed!

There is an increased risk of accident when doing maintenance and repair work, because safety devices may have to be put out of action, while performing any diagnostics or repairs.

2 TECHNICAL DATA

2.1 Dimensions

With snow bin closed:

Width with 84 inch Conditioner	88" / 224cm
Width with 96 inch Conditioner	100" / 254cm
Length	162" / 411cm
Height	77" / 195cm

With snow bin open:

Length	228" / 579cm
Height	142" / 360cm

Blade width:

On 84 inch Conditioner	84" / 213cm
On 96 inch Conditioner	96" / 243cm
Turning radius	180" / 457cm

2.2 Weights

Net weight total (incl. 770 Ah batteries)	10,648 lbs / 4,830 kg
Front axle	3,792 lbs / 1,720 kg
Rear axle	6,944 lbs / 3,150 kg



Gross weight (incl. 770 Ah batteries and full water tanks) 12,853 lbs / 5,830 kg
 Front axle..... 4,828 lbs / 2,190 kg
 Rear axle 8,025 lbs / 3,640 kg

2.3 Noise Emission



Note: Ambient noise level 56 dB (A)

Readings taken on ice with dasher gates closed

Standing noise (hydraulic pump running only) 63 dB (A)
 Driving noise (with elevator turned off) 73 dB (A)
 Driving noise (with elevator turned on)..... 74 dB (A)
 At a distance of 25m away (with elevator turned off)..... 63 dB (A)
 At a distance of 50m away (with elevator turned on) 62 dB (A)

2.4 Filling Capacities

Capacity of snow bin 103 ft³ / 2.9 m³
 Capacity of wash water tank 45 Imp gal / 204 l
 Capacity of flood water tank 184.5 Imp gal / 838.8 l
 Hydraulic oil quantity 5 Imp gal / 22.75 l

2.5 Electrical System

Battery voltage 80 V
 Battery capacity up to 770 Ah
 Total power 17.4 kW

2.6 Brake Systems

Operating principle: Full disk brake at each wheel

Brake pads: asbestos-free

Application:

Main brake: Hydraulic

Parking brake: Mechanical

2.7 Hydraulic System

Hydraulic fluid: ATF 55 F-30589

Oil change interval: Approx. every 3 years

Oil filter: Exchangeable filter, 20 Micron

Oil cooling: Convection cooling at the oil tank

Oil temperature: Max: 80°C, normal: approx. 30°C

Hyd. Pump, Motor-driven: Tandem, gear pump

1 gpm / 4.55 lpm steering

6 gpm / 27.2 lpm auxillary

Emergency hand pump: Piston pump

0.15 in³ / 2.5 cm³/stroke

Steering: Load sensing hydraulic

2.8 Water System

Water Pumps:

Speed Related Water: Impeller pump

26.9 Imp gal/min (123 L/min) at 2,450 rpm

Tire wash pump: Impeller pump

8.7 Imp gal/min (40 L/min)



Wash water: Impeller pump
51.3 Imp gal/min (234 L/min) at 1,750 rpm

2.9 Tires

Tire size:

Tubeless: HANKOOK DYNAPRO M/T
LT225/75R16 10 ply
Tungsten tip studs
Aluminium alloy wheels

Tire pressure: Front: 85 psi / 5.8 bar
Back: 85 psi / 5.8 bar

2.10 Conditioner

2.10.1 Blades

Ice shaver blade: inlaid steel
Length: 84-96" / 213-244 cm
Width: 5" / 12.8cm
Cutting angle: 8,5 degrees
Blade grind angle: 27 degrees

2.10.2 Conveyor System

Auger:

Vertical: 8" / 20.3 cm
Horizontal: 12" / 30.5 cm

2.11 Materials Used

Stainless Steel:..... AISI 304L-316

Aluminium: 5052H32

Steel: Hot-dip galvanized
Electro zinc plating
Hard-chrome plating
painted

Plastics: Glass fibre-reinforced plastic
Polyamide
Polyurethane



3 ON-SITE CONDITIONS

3.1 Ground Conditions



Level, solid floor covering, preferably with spike-friendly overlay.

Maximum permitted incline: 15 %

3.2 Room Ventilation

In accordance with OSHA (North America), VDE (Europe) and local codes, the battery rooms should be designed such that natural ventilation is adequate (see OSHA 1926.441 or VDE 510).

3.3 Water Connections

- Ice making water on the left hand side of the ice resurfacer.
- Wash water on the right hand side of the ice resurfacer.
- The intake can be controlled with a solenoid valve. The solenoid valve is controlled by the ice resurfacer. Valve size is 1”.

3.4 Water Quality

- Clean water with low total grains of hardness.
- Ice making water temperature as hot as local codes will allow.
- Wash water: cold only.

3.5 Charger

Mains connection:

North America: 208, 480, 550, 600 volt, 3 phase fused disconnect.

Europe: Wall socket : 400 V/3~+N+PE 32 A 5-pol. CEE-Norm.

Charger cable:

15' (4.5m) long, battery connection plug is located under snow dump tank, directly in front of drivers platform.



It is possible to install longer cables from the charger.

3.6 Garage Temperature

Preferably above 15°C (59°F), never below 0°C (32°F)



Charging can take considerably longer at temperatures below 15° (59° F). Freezing of a partially discharged battery can damage the battery. The same applies for freezing of the water system.

3.7 Snow Dump Pit Threshold

A threshold at the snow dump pit must not be more than 23" (58.5cm)



4 DESIGN AND FUNCTION

4.1 Ice Resurfacer Design and Chassis



Fig. 4.1: Front view with open hood

- Item 1 EMERGENCY SHUT OFF switch
- Item 2 Steering wheel
- Item 3 Driver's seat
- Item 4 Ice making water fill station
- Item 5 Conditioner
- Item 6 Step for climbing up to the driver's seat
- Item 7 Board brush
- Item 8 Front bumper wheel
- Item 9 Snow bin
- Item 10 Front headlights
- Item 11 Snow bin hood



Fig. 4.2: Rear view of the OLYMPIA ICEBEAR

- Item 1 Handle for climbing up to the driver's seat
- Item 2 EMERGENCY SHUT OFF switch
- Item 3 Steering wheel
- Item 4 Top control panel
- Item 5 Manual Ice Making Water tap handle
- Item 6 Electrical control cabinet door
- Item 7 Tail lights
- Item 8 Drive motor for the horizontal auger
- Item 9 Automatic towel lift
- Item 10 Ice making water fill station
- Item 11 Spreader cloth
- Item 12 Conditioner bumper wheel
- Item 13 Reverse Light



The OLYMPIA is available in either mainly structural stainless steel, or structural black steel chassis design. This applies to the chassis, the conditioner, the snow dump tank, the frame of the snow tank cover, the steel structure of the driver's platform and all metal parts that, for technical reasons, should not be manufactured from any other material.

The electrical control cabinet is made of aluminium.

Self-supporting chassis

The chassis consists of 5/16" thick structural steel tube. It is supported on the front and rear axles. The front axle is designed as a floating axle. The rear axle is designed as part of the main chassis welded directly to the main frame rails. As well the battery holders, the driver's platform and the mountings for the conditioner, the brush and other parts are part of the chassis.

The control cabinet, the snow bin cover, all parts of the hydraulic system, power supply, water supply and panelling are bolted to the chassis.

The front axle

The front axle is of structural tube steel construction. It holds the front drive units (gear with motor), and the hydraulic steering components.

The drive units are supported in spindles attached via upper and lower king pins. They absorb all radial forces. The vertical forces are absorbed by a bearing ring. This extends the serviceable life of the bearing assembly.

Coupling of the front drives consists of two solid, adjustable steering links, which are connected to the gears via link fittings.

Steering is controlled by a hydraulic cylinder that is mounted between the steering links of the front wheels at the axle. In conjunction with a hydraulic orbit control and the hydraulic pump, this arrangement ensures smooth and low-maintenance steering.

Body Panels

All panels are made of glass fibre-reinforced plastic (GRP).

4.2 Snow Conveyor (Auger)

The horizontal auger in the conditioner transports the snow that has been scraped off the ice by the blade to the centre of the conditioner, where it is picked up by a vertical auger and is transported into the OLYMPIA'S snow dump tank. To switch on the horizontal and vertical augers, press the switch ELEVATOR ON on the dashboard.

Directional Control Switch for the elevator:

- This switch has three possible positions.
- Turning the switch to the left turns the elevator FORWARD (self- locking).
- The middle position is OFF.
- Turning the switch to the right turns the elevator REVERSE (turn and hold switch).

4.3 Hydraulic Components

A tandem hydraulic pump supplies the hydraulic system with oil. Control valves supply the ice resurfacers with oil for the operation of a series of control valves for movement control, and control of the flow of hydraulic fluid to the various components as needed. The hydraulic system must only be serviced by qualified personnel.



5 CONTROLS



Fig. 5.1: EMERGENCY Shut Off Switch

The ice resurfer is equipped with an EMERGENCY SHUT OFF SWITCH that is installed above the steering wheel, at the left.

To get power from the batteries to the ice resurfer, pull the red knob up.

To disconnect the batteries from the ice resurfer, depress the red knob.

5.2 Top Control Panel

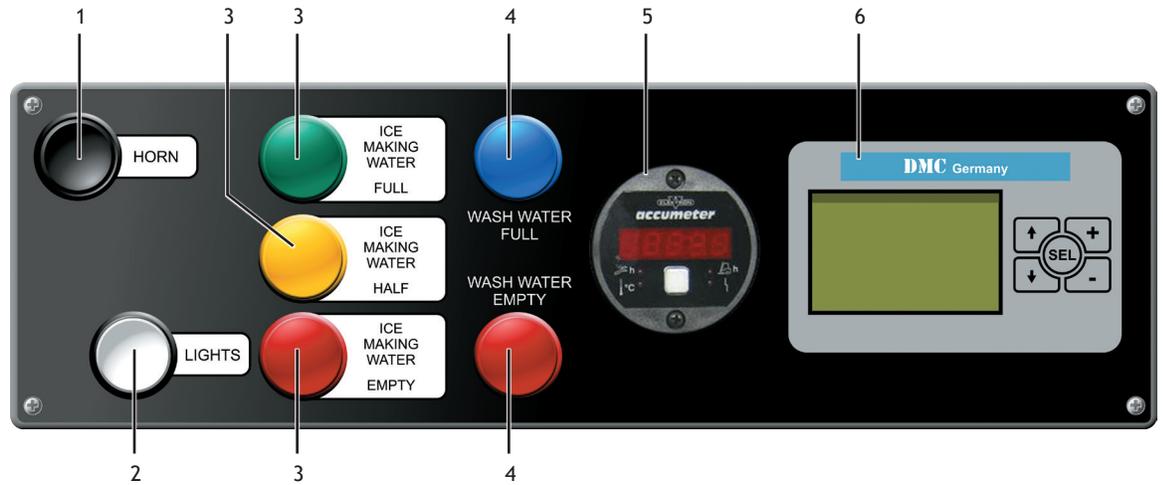


Fig. 5.2: Top control panel

Item 1

Horn Button

Press this button to sound the horn.



Item 2

Lights

This button turns the headlights and tail lights on and off.

Push and release to turn on, repeat to turn off.





Item 3

Ice Making Water Indicator



When the tank is full the green light will come on. If equipped, simultaneously the auto water fill valve will shut off the flow of water filling the tank. The yellow light will stay on until $\frac{1}{2}$ of the tank capacity is used. Again if equipped simultaneously the auto water fill valve will shut off the flow of water filling the resurfacer, if the $\frac{1}{2}$ full selection was used during the filling procedure. The red light will come on when the ice making water tank is empty. Simultaneously it will turn off the speed related water pump. When the red light first comes on there is approximately 100 litres of water in the tank.

Item 4

Wash Water Indicator



When the tank is full the blue light will come on. If equipped, simultaneously the auto water fill valve will shut off the flow of water filling the tank. The red light will come on when the wash water tank is empty. Simultaneously turning off the wash water pump and valve.

Item 5

Accumeter

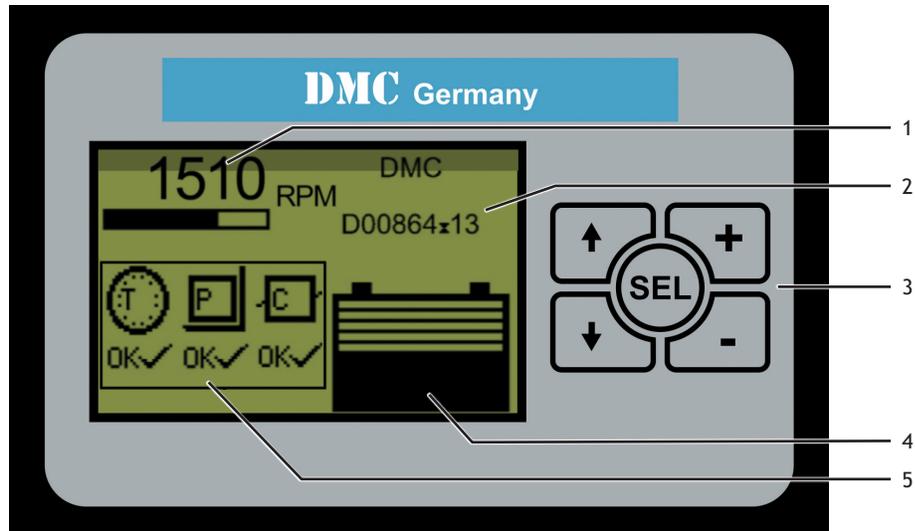


The accumeter is equipped with a digital LCD display. This will display the remaining capacity of the batteries. By pushing the white button it will change to operating hours. By pushing the white button a second time it will display hours until the next service is needed. A third push of the button will display operating temperature. A slashing red light in the right corner will indicate low electrolyte level.



For more information, please refer to the documentation provided by the manufacturer, Elektron.

Item 6 Dashboard Display



- Item 1 Display field for display of the speed.
- Item 2 Operating hours counter: can be activated using the display buttons.
- Item 3 Soft keys to set functions such as service intervals, operating hours counter and the customer information field.
- Item 4 Battery discharge status indicator
Indicates the discharge status of the battery.
- Item 5 Fault indicator
Indicates the status of the drive and pump controllers. If there is a fault, the relevant fault message appears instead of OK.



For more information, please refer to the documentation provided by the manufacturer, DMC.



5.3 Bottom Control Panel

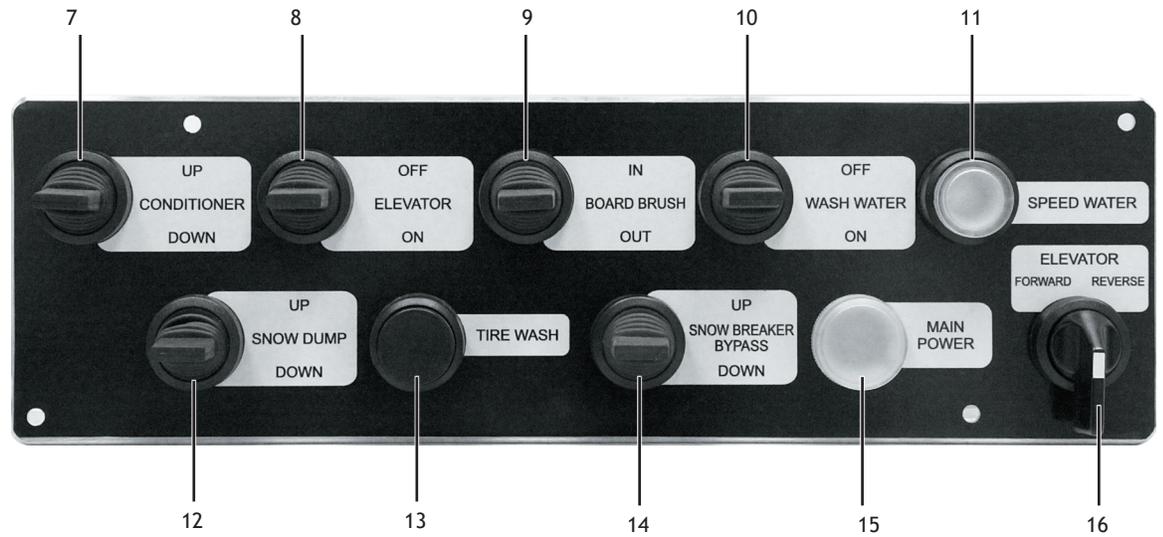


Fig. 5.3: Bottom control panel



The bottom control panel has been configured that the top row of switches is on ice and in a specific order to maintain the proper sequence of engagement. From Left to right.

Item 7

Conditioner Up/Down



Raises and lowers the conditioner

To raise the conditioner, push and hold the switch UP until the conditioner is in the full up position.

To lower the conditioner, push and hold the switch DOWN until the conditioner is in the full down position.

Item 8

Elevator Off/On



Turn both augers ON (horizontal and vertical auger), by pushing the switch down. Turn both augers OFF by lifting the switch to the off position.



If the ice resurfacers are switched off, with the ignition key or with the EMERGENCY SHUT OFF switch, the augers must be restarted again.



Item 9

Board Brush



Raises and lowers the board brush.

To lower the board brush push the switch down.

When the brush is lowered, it will automatically start to rotate.

To raise the board brush lift and hold the switch in the up position until the board brush is fully raised.

When the board brush is raised, it will automatically stop rotating.

Item 10

Wash Water On/Off



To turn the wash water system on push the switch down.

To turn the wash water off lift the switch up to the off position.

When switched on the water from the tank will flow for approximately 8 seconds before the wash water pump turns on. When switched off both the pump and the water flow stop at the same time.

Item 11

Speed Water



To turn on the speed related water system push the button in, the button will light up green indicating the pump and valve have been energized.

To turn off push the button again and the green light as well as the pump and valve will turn off.

Item 12

Snow Bin Up/Down



Opens and closes the snow dump tank.

To open the snow dump, lift and hold the switch up until the snow dump tank is fully open.

Before opening the snow dump tank make sure there is sufficient clearance as the snow dump tank will move forward and up.

To close the snow dump tank hold down the down switch until the snow dump tank is completely closed.

Before closing the snow dump tank make absolutely sure that there are no obstructions of any type that could get crushed between the tank and the chassis of the ice resurfacer.

It is recommended that if possible the snow dump tank should be left fully open after each ice cleaning operation, with the safety bars down and locked, so that any residual snow or water can drain from the tank.



Item 13

Tire Wash



Push the button in and hold to activate the tire washing system.

Let the button out to deactivate the tire washing system.



Item 14 Snowbreaker Override



Is a backup system which allows for the manual operation of the snowbreaker.

Pushing the switch down will move the snow breaker down.

Lifting the switch up will raise the snow breaker.

Item 15 Power On Light



When you turn the ignition key to the ON position the power on light will illuminate, indicating the ice resurfacer is turned on.

Turn the ignition key to the OFF position to switch off the ice resurfacer, the power light will turn off

Item 16 Elevator Forward/Reverse



Left switch position: Snow is transported from the conditioner into the snow bin by the horizontal and vertical augers

Centre position: Neither auger turns

Hold in right switch position: Both augers reverse

Item 17

Gear Shift Lever



Unless moving the ice resurfacers, always make sure the gear shift selector is in the neutral position. To move the ice resurfacers forward move the gear shift selector to the forward position. To reverse the ice resurfacers, move the gear shift selector to the reverse position.

F = Forwards

N = Neutral

R = Reverse



Always move the gearshift selector to the centre position (neutral position) before you leave the driver's platform.



If the lever is not in the neutral position when the ignition key is turned on, the drive control will be disabled until the gear shift selector is switched back to the centre position.



Make sure the ice resurfacers come to a complete stop before changing gears.

Item 18

Ignition Key



Turn the ignition key to the right or ON position to switch on the ice resurfacers and put it into operation.

Turn the ignition key to the left or OFF position to switch it off again.

The ice resurfacers can be switched off with the EMERGENCY SHUT OFF (Fig. 5.1) at any time.

When the ice resurfacers are switched off, all functions are shut down, except for the automatic water fill stations.



5.4 Ice Making Water Control Panel Optional



Fig. 5.4: Ice Making Water control panel

- Item 19 Indicator lamp for water tank level HALF FULL
- Item 20 Selector switch
- Item 21 Indicator lamp for water tank level FULL

This panel controls how much hot water can be put into the ice resurfacer.

The ice resurfacer is supplied with an electric water valve, to be mounted onto the water supply line in the building. Power for this valve is supplied from the ice resurfacer. Once mounted and wired.



The water hose down stream from the solenoid valve should not be too big in relation to the water pressure and pipe size, because a pressure difference of 0,5 bar (7 psi) is needed to close the solenoid valve.

The solenoid valve plug of the water supply pipe is connected at the Ice Making Water Control Panel and the water level for the water tank is set there. At the left of the selector switch there is a yellow indicator lamp (Fig. 5.4, Item 19) for half filling the water tank. At the right there is a green indicator lamp (Fig. 5.4, Item 21) for completely filling the water tank. To select the desired fill level, turn the selector switch (Fig. 5.4, Item 20) in the appropriate direction.

The filling process can be interrupted or stopped at any time by turning the selector switch to the centre position.



The control panel function can be used even when the ignition key is turned off, provided the battery connector is plugged in.

Connection of the Ice Making Water Line

First connect the water line to the water fill pipe on the side of the dash and then connect the solenoid valve to the supply socket on the panel. Turn the fill level selector switch to the desired setting (full or half-full). When the preselected water level is reached, the solenoid valve automatically turns off.



Always be sure to insert the fill hose into the ice resurfacer first.

Disconnection of the Ice Making Water Line

Proceed in the following order to disconnect the water hose from the ice resurfacer:

1. Turn the selector switch to the neutral position.
2. Pull the plug out of the socket.
3. Disconnect the hose from the ice resurfacer.



This procedure prevents the solenoid valve from opening before the water hose is connected to the ice resurfacer when the next fill takes place, thus preventing water from pouring out in an uncontrolled manner.



When the ½ or full mark is reached, the solenoid valve shuts off the supply of water.



When the solenoid valve is open, a pressure difference of at least 0.5 bar (7 psi) must prevail at the valve to ensure safe and speedy switching of the pilot-controlled solenoid. A smaller valve on a low-pressure supply pipe with a larger water hose therefore works better than a large valve in a small pipe at low pressure!

5.5 Wash Water Control Panel



Fig. 5.5: Wash Water control panel

Item 22 Selector switch (illuminated)

This panel controls how much cold water can be put into the ice resurfacer's wash water tank.

The ice resurfacer is supplied with an electric water valve, to be mounted onto the water supply line in the building. Power for this valve is supplied from the ice resurfacer. Once mounted and wired.



The water hose behind the solenoid valve should not be too big in relation to the water pressure and pipe size, because a pressure difference of 0,5 bar (7 psi) is needed to close the solenoid valve.

The solenoid valve of the cold water supply line is connected at the Wash Water panel. To switch the wash water supply ON or OFF, turn the switch (Fig. 5.5, Item 22) in the appropriate direction.



The filling procedure can be interrupted or stopped at any time by turning the selector switch to the OFF position.

The control panel function can be used even when the ignition key is turned off, provided the battery connector is plugged in.

Connection of the Wash Water Line

First connect the water line to the water-filling inlet and then connect the solenoid valve to the supply socket on the panel. When the water tank is full, the solenoid valve automatically turns off the water.



Always be sure to insert the fill hose into the ice resurfacers first.



Disconnection of the Wash Water Line

Proceed in the following order to disconnect the water hose from the ice resurfacer:

1. Turn the selector switch to the OFF position.
2. Pull the plug out of the socket.
3. Disconnect the hose from the ice resurface.



This procedure prevents the solenoid valve from opening before the water hose is connected to the machine when the next fill takes place, thus preventing water from pouring out in an uncontrolled manner.



When the solenoid valve is open, a pressure difference of at least 0.5 bar must prevail at the valve to ensure safe and speedy switching of the pilot-controlled solenoid. A smaller valve on a low-pressure supply pipe with a bigger cross-section therefore works better than a large valve in a small pipe at low pressure!

5.6 Foot Pedals and Parking Brake

Another three controls that you will work with a lot are located in the foot well area of the ice resurfacer:

Accelerator Pedal

The right foot pedal is the accelerator pedal and is used to control the driving speed of the machine.

Initially press the foot pedal just a little to switch on the hydraulic motor for the power steering. The more you press down on the pedal, the faster the OLYMPIA travels.



The accelerator pedal must not be pressed when you turn on the ice resurfacers, otherwise the controller will assume there is a fault and will not turn on.



Before pressing the accelerator pedal, it is essential that you first turn on the ignition with the key. And when ready select the direction in which you want to travel.

Brake Pedal

The left foot pedal is the main brake pedal. The foot brake acts simultaneously on all four drive wheels. ABS is not installed. The OLYMPIA braking system has a pressure accumulator, so that the brakes can be applied at least another two times after the hydraulic system has been switched off.

Parking Brake Lever

The parking brake lever (hand brake) is located at the right of the driver's seat. It acts on the two rear wheels. If movement of the ice resurfacers is started while the parking brake is applied, the controller switches to CREEP MODE (very low speed) to keep from damaging the wheel drive motors.



5.7 Controls for the Water

There must always be enough wash water available to be vacuumed up. The pump must not be allowed to run dry, because the impeller and shaft seal assembly is water-lubricated.

The wash water is sprayed directly out of the water tank onto the ice by a spray pipe on the back inside wall of the conditioner. When the wash water system is started, cold water is distributed in the conditioner over the whole width of the conditioner, creating slush. The squeegee then forces the slush into the cuts on the ice. Any excess water and debris is vacuumed back into the wash water tank.

5.7.1 Ice Making Water

The flow of flood water is controlled either by the speed-related pump, or by the ball valve at the base of the conditioner (Manual Water Valve). For the best resurfacing results, the ice making water should have a temperature NO HIGHER than local codes will allow. The hot water melts some of the surface of the ice, thus achieving the best possible bond with the existing ice. Hot water also holds less oxygen than cold water and therefore produces a denser, harder ice.

Harder ice does not get damaged as easily and therefore needs less depth of cut to achieve a smooth surface. Which in turn, results in minimal ice build-up.

This means less time spent on ice maintenance and less wear and tear on the resurfacing equipment.

Speed Related Water

The automatic flow of water depends primarily on the speed at which the ice resurfacer is being driven, and secondarily on the internal water valve setting. The lowest quantity of water flows when the ice resurfacer is at a standstill, the highest quantity when the ice resurfacer is driving at full speed. This automatic function reduces the flow of water in the curves to an adjustable minimum.

Manual Ice Making Water Flow

The manual water function allows water to be applied to the ice at a constant rate, regardless of the speed at which the ice resurfacer is travelling. It can also be used to supplement the speed related water.

5.8 Controls for the Hydraulic System

Switching the Hydraulic Pump Motor On and Off

There are two ways of switching on the hydraulic pump motor:

1. By pressing the accelerator pedal.
2. By pressing the appropriate function switch.

However, the ice resurfacer must be turned on at the ignition switch before the motor can be started up.

The hydraulic pump motor is switched off either by turning off the ignition switch, or automatically approx. 20 seconds after the accelerator pedal was last pressed, or as soon as you let go of a function switch.



6 START UP OF THE OLYMPIA MILLENNIUM - E

6.1 Charge the Batteries

Before you can start work with the OLYMPIA, you must charge the battery. A battery charger is supplied with the ice resurfacer for this purpose. This charger is designed to fully recharge a battery that has been drained as close to 0% on the accumulator as possible.

1. Raise the snow dump tank fully and install the safety support bars.
2. The battery charger will indicate connect battery.
3. Push down the EMERGENCY SHUT OFF switch.
4. Carefully disconnect the power supply coupling located directly in front of the operators platform above the rear wheel. Now plug the cable from charger into the power supply coupling.



Battery gassing does occur in the final stages of charging. Gassing emits dangerous hydrogen gas.

5. Pull up the EMERGENCY SHUT OFF switch.



The EMERGENCY SHUT OFF switch must be pulled up, otherwise charging will not take place.

6. In North America the charger will automatically start. For other countries it may be necessary to manually start the charger.



The battery charger switches off automatically when the battery is fully charged.

7. When recharging is complete, depress the EMERGENCY SHUT OFF switch, disconnect and store the charger cable from the ice resurfacer's power supply connection.



If the charging operation has to be interrupted for any reason, turn off the charger before disconnecting the charger plug.

8. Reconnect the OLYMPIA's internal power supply cables.

9. Pull the EMERGENCY SHUT OFF switch.



The batteries must not come into contact with water, as this could cause them to short out.



When working with acid batteries, avoid all contact of the acid with the skin or clothing.



Always wear proper safety clothing/equipment when working on or near batteries.



Always use only distilled water to fill batteries.



Check the electrolyte level in the batteries once a week immediately after recharging. Top it up, if necessary.



The battery water level is correct when all of the cell floats are visible. Periodically check the specific gravity with a hydrometer. In the log supplied, record water filling and specific gravity reading.



Watering The Batteries:

A battery watering cart is supplied with each ice resurfacer.

1. Connect the hose coupling to the respective battery trays.
2. Turn on the pump in the cart.
3. The batteries are automatically filled with distilled water until the float valve at the individual battery cells stop the filling process. The water flow indicator in the hose will stop spinning when the tray is full. This process must be repeated on both battery trays.



The optimal charging cycle for a maximum life expectancy of the battery is as follows:

1. Discharge until the battery is as close to 0% on the accumulator charge indicator as possible.
2. Recharge uninterrupted for 7-8 hours.
3. If at all possible do not attempt to charge the battery between resurfacings (opportunity charge).



Opportunity charging, although sometimes may be necessary should be avoided as it decreases the overall life of the battery.

6.2 Installation of the Squeegee

Mount the squeegee on the inside of the conditioner with the bolts and nuts provided. .

If not already trimmed, carefully trim the ends of the squeegee so that it fits tightly against the runners of the conditioner, as in the picture:



Squeegee Trimming

Snow that is pushed by the squeegee must stay within the area between the squeegee and the runners, and must not be pushed out from there, as this would cause ridges to be produced on the ice.

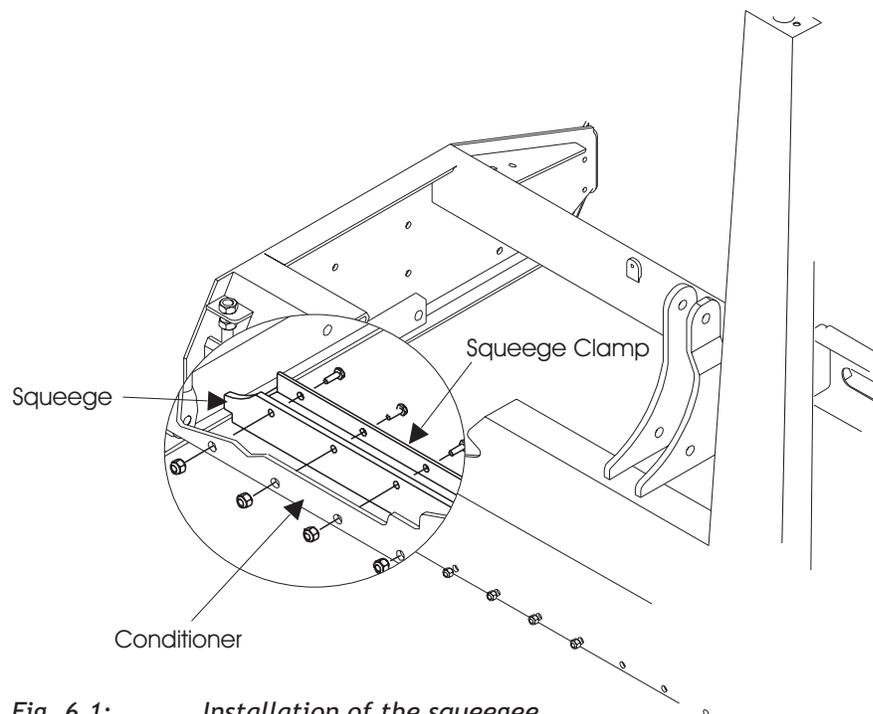


Fig. 6.1: Installation of the squeegee

- Item 1 Conditioner
- Item 2 Squeegee
- Item 3 Squeegee clamp bar



6.3 Blade Installation

1. Insert safety blocks under the conditioner before attempting to work under it.
2. Place the blade on small wood blocks(4) at the rear of the conditioner, remove it from the wood sheath and install the magnetic protector supplied with the tool kit.
3. Using the blade hook, lift and slide the blade underneath the conditioner and lift against the bladeholder until the attachment holes line up.
4. Tighten the blade hook thumb screws(2) so that the slide bracket(1) sits on top of the conditioner.

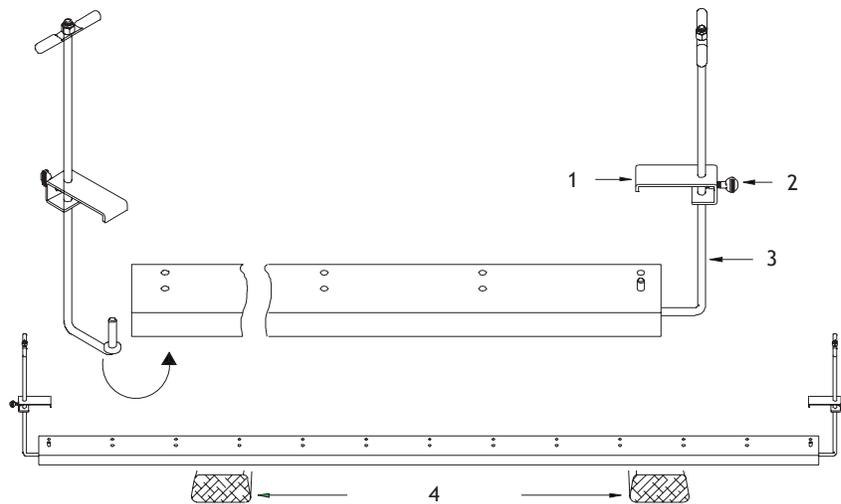
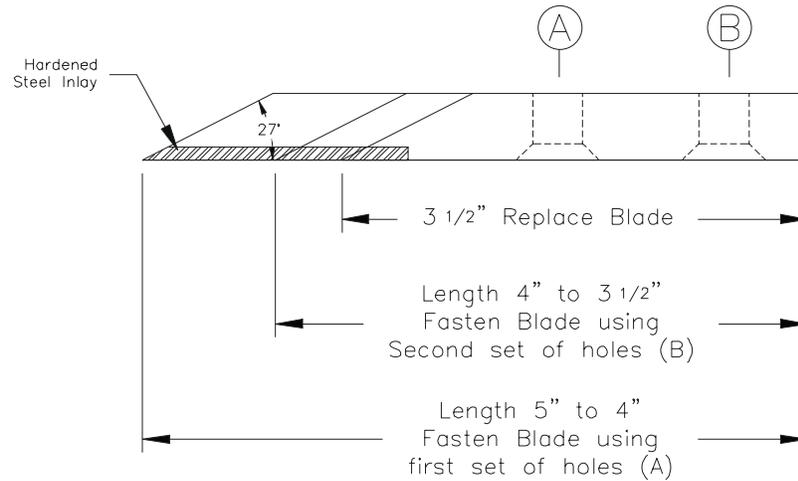


Fig. 6.2: Installing the blade

Item 1	Bracket
Item 2	Thumb screw
Item 3	Blade hook
Item 4	Wooden blocks



Install the blade bolts and finger tighten remembering to utilize the row of holes closest to the cutting edge. The second row of holes should be used when the blade has been ground down to 4 inch (approx. 10.16 cm) overall width.



The Order is Important



Following the diagrams below, begin to install the blade bolts. Finger tighten the bolts. DO NOT use lock washers as they will damage the blade holder.

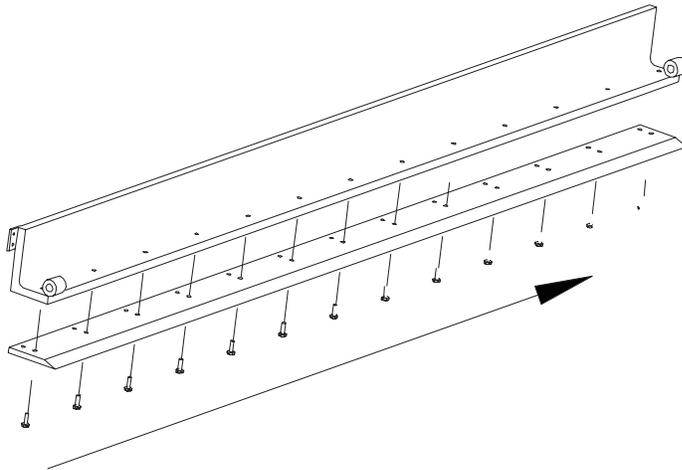


There are two ways of properly tightening the blade bolts:

Blade Bolt Sequence “A”

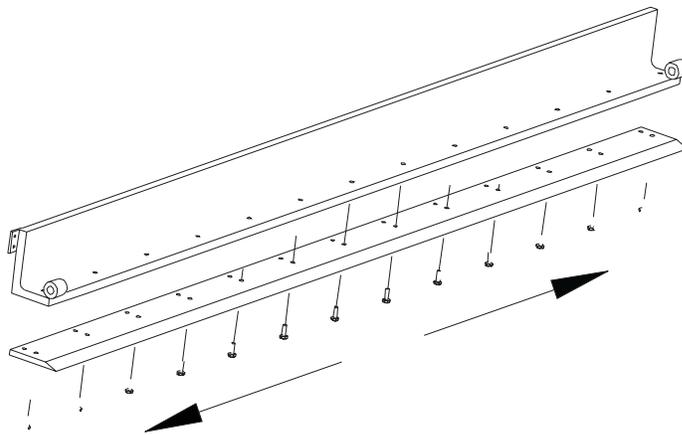
Sequence A - starting at one end of the blade, tighten the bolts consecutively across the blade to the opposite end.

Remove the blade hooks and insert the remaining two blade bolts and tighten.



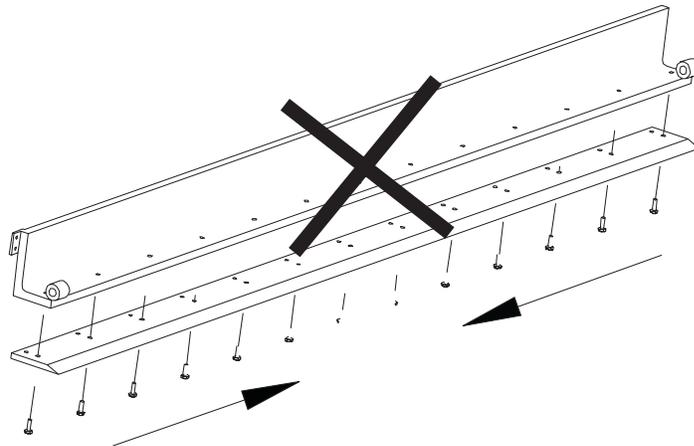
Blade Bolt Sequence “B”

Sequence B - starting in the middle tighten the bolts from the centre to one end then return to the centre and tighten the bolts to the other end in order. Remove the blade hooks and insert the remaining two blade bolts and tighten.

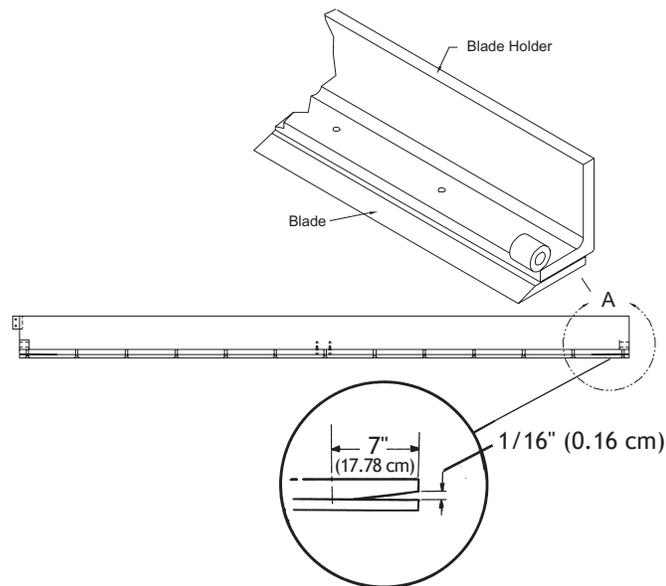


Wrong Sequence

Please note: Tightening the bolts in any other order, such as from the end to the middle or at random will result in a warped blade and uneven ice.



The blade holder is feathered by 1/16" (approx 1,6 mm) over the last 6" to 7" (15.2 to 17.78 cm) at each end. This prevents ridges from forming on the ice.

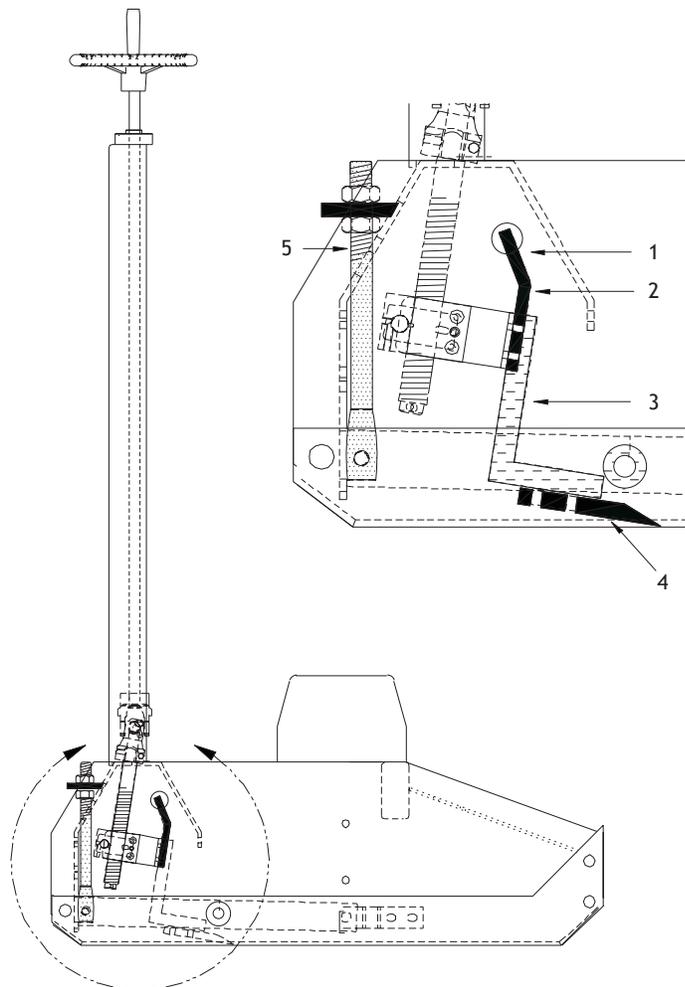


Removal of the blade is done in reverse order to that in which it was installed!



6.3.1 Blade Level Adjustment

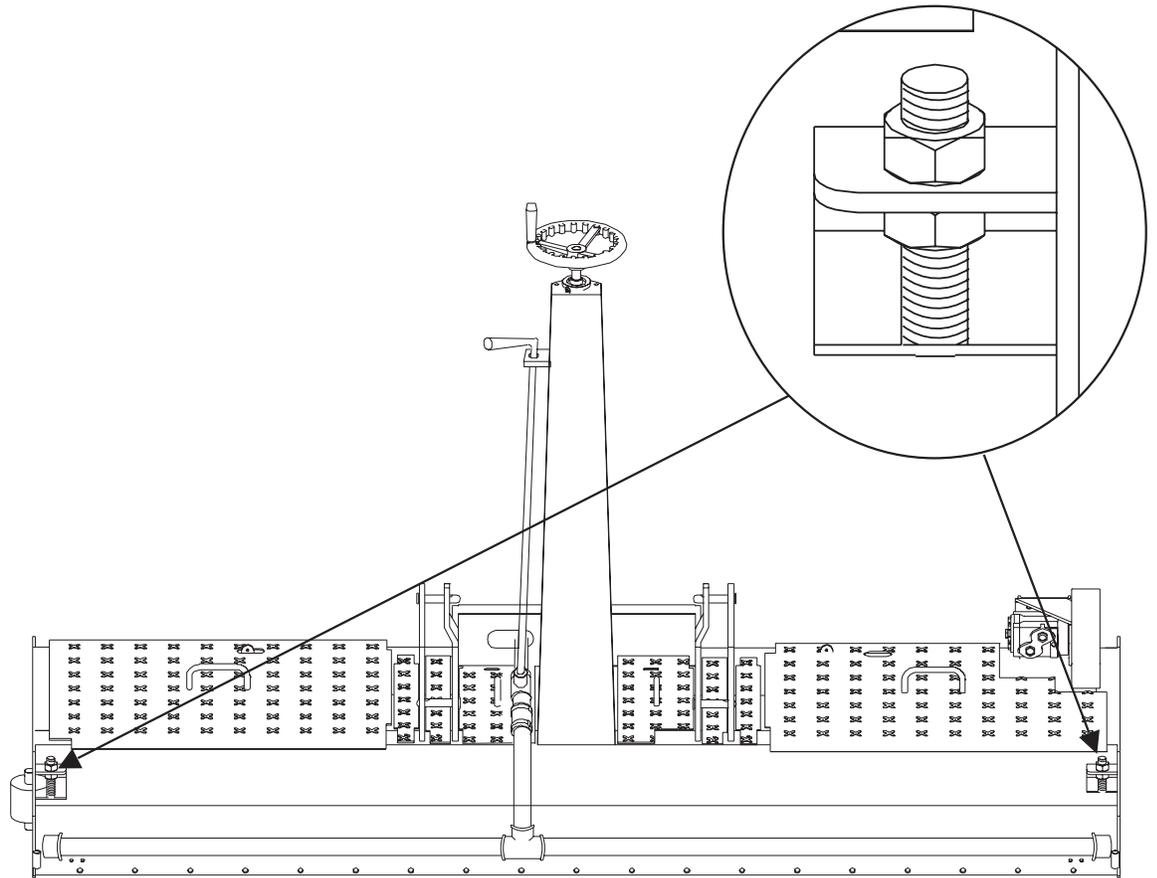
The next step is to adjust the angle of the blade. The blade adjustment crank, located on the tower to the right of the operator, raises and lowers the blade. The adjustment crank is turned until the indicator arm completely fills the sight hole at the side of the conditioner as shown below.



- | | |
|--------|----------------------|
| Item 1 | Sight hole |
| Item 2 | Indicator arm |
| Item 3 | Blade holder |
| Item 4 | Blade |
| Item 5 | Blade level adjuster |

Fig. 6.3: Blade height adjustment

If the sight hole is filled, but the blade is too low or high, go to the rear of the conditioner and using a 1 1/8" wrench, first loosen the top nut of the blade level adjusters located on each side of the rear of the conditioner shown below.



Then turn the nuts to raise or lower the blade into the proper position, which is exactly level with the bottom of the runner. Once the blade is at the proper level tighten the nuts on the blade level adjuster nuts.

When the ends of the blade are flush with the runners, the majority of the blade will extend 1/16" (1,6mm) below the runners, which is an excessive cut.

To check the level of the blade, slide a large coin along the runners of the conditioner, from back to front, until you feel it pass over the edge of the blade.



Safety Note: Be careful when doing the coin check. Make sure you are wearing gloves and that you move the coin from back to front as the blades are extremely sharp.



The sharp tip of the blade should be flush with the runners on both sides. If the blade is flush the coin will slide smoothly over the blade edge.

Blade/ Coin check

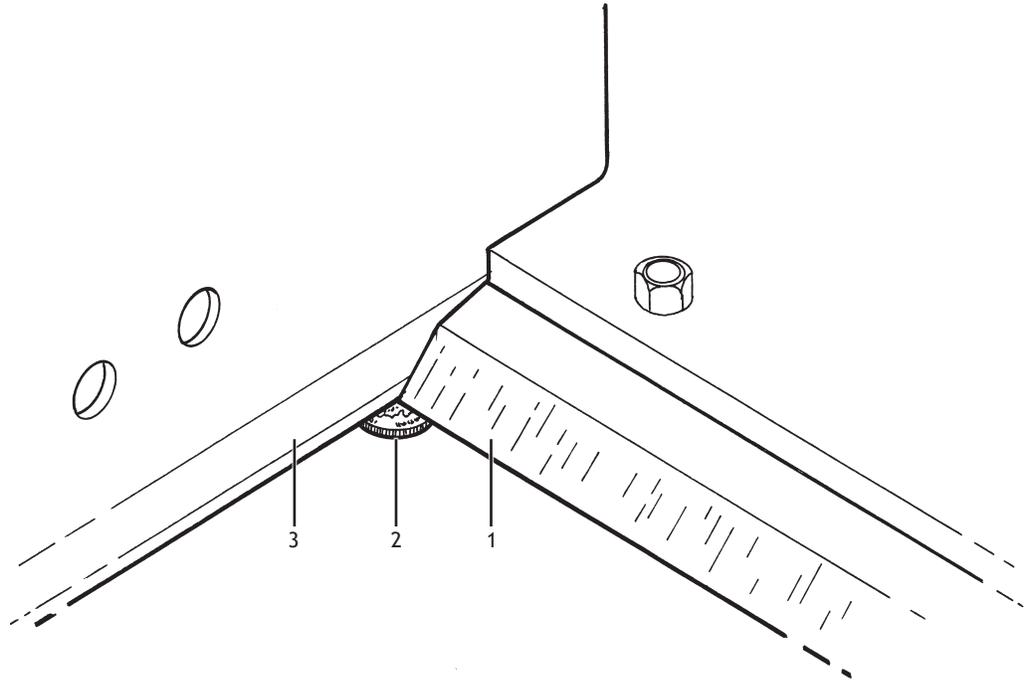


Fig. 6.4: Place a coin underneath

- | | |
|--------|--------|
| Item 1 | Blade |
| Item 2 | Coin |
| Item 3 | Runner |

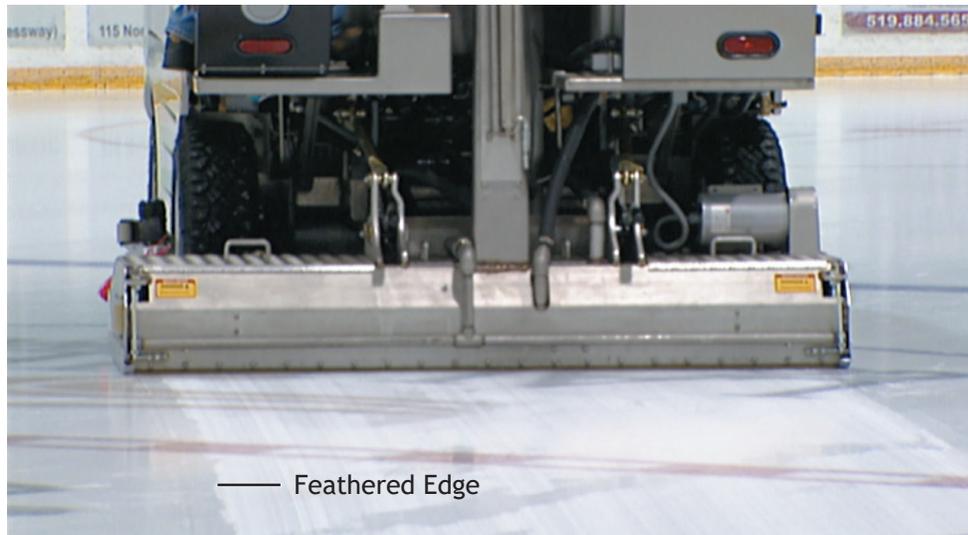
At this point go back to the blade adjustment crank and turn it counter clockwise 2 turns to raise the blade.



Please Note: It is important that the blade holder and the blade surface be free of foreign material and lightly coated with oil to prevent rust.

Test drive the OLYMPIA doing a dry cut. If the blade is properly set up you will see a feathered edge on the ice surface on both sides of the conditioner. If the feathered edge on both sides of the conditioner is not an equal distance from the runners on both sides of the conditioner, stop, dismount, and adjust the driver's side , up or down, until the feathered edge is equal distance from the runners on both sides of the conditioner.

After the blade angle and level are set, any change in the cutting depth will alter the indicator arm position in the sight hole, but blade angle tolerances will accommodate such adjustment and further adjustment of the blade angle will not be necessary.



6.4 Horizontal and Vertical Augers

The horizontal auger in the conditioner carries the snow scraped off the ice by the blade into the centre of the conditioner where a vertical auger picks it up and transports it to the snow bin in the front of the OLYMPIA.

6.4.1 Horizontal Auger Adjustment

The horizontal auger should be approximately 1/8th" (3mm) above the bottom of the runners to maximize snow pick up while at the same time preventing any marking of the ice surface.



Auger Height Adjustment

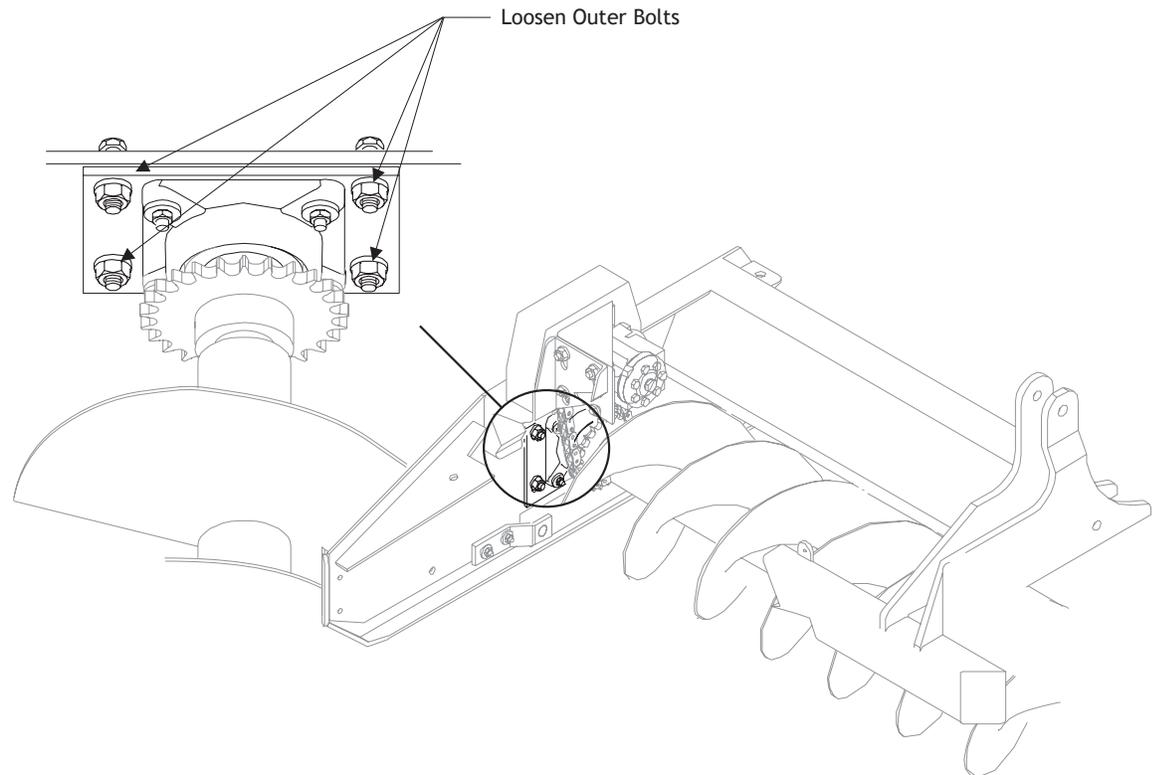
The horizontal auger is adjusted by loosening the four outer bolts on the bearing adjustment plate on each end of the auger and the four bolts for the auger motor mount. This can be checked by running a piece of string between the runners and observing the distance between the string and the auger.

Pry the auger to the proper position.

After the adjustment has been completed, re-tighten the four outer bolts on the bearing adjustment plate.

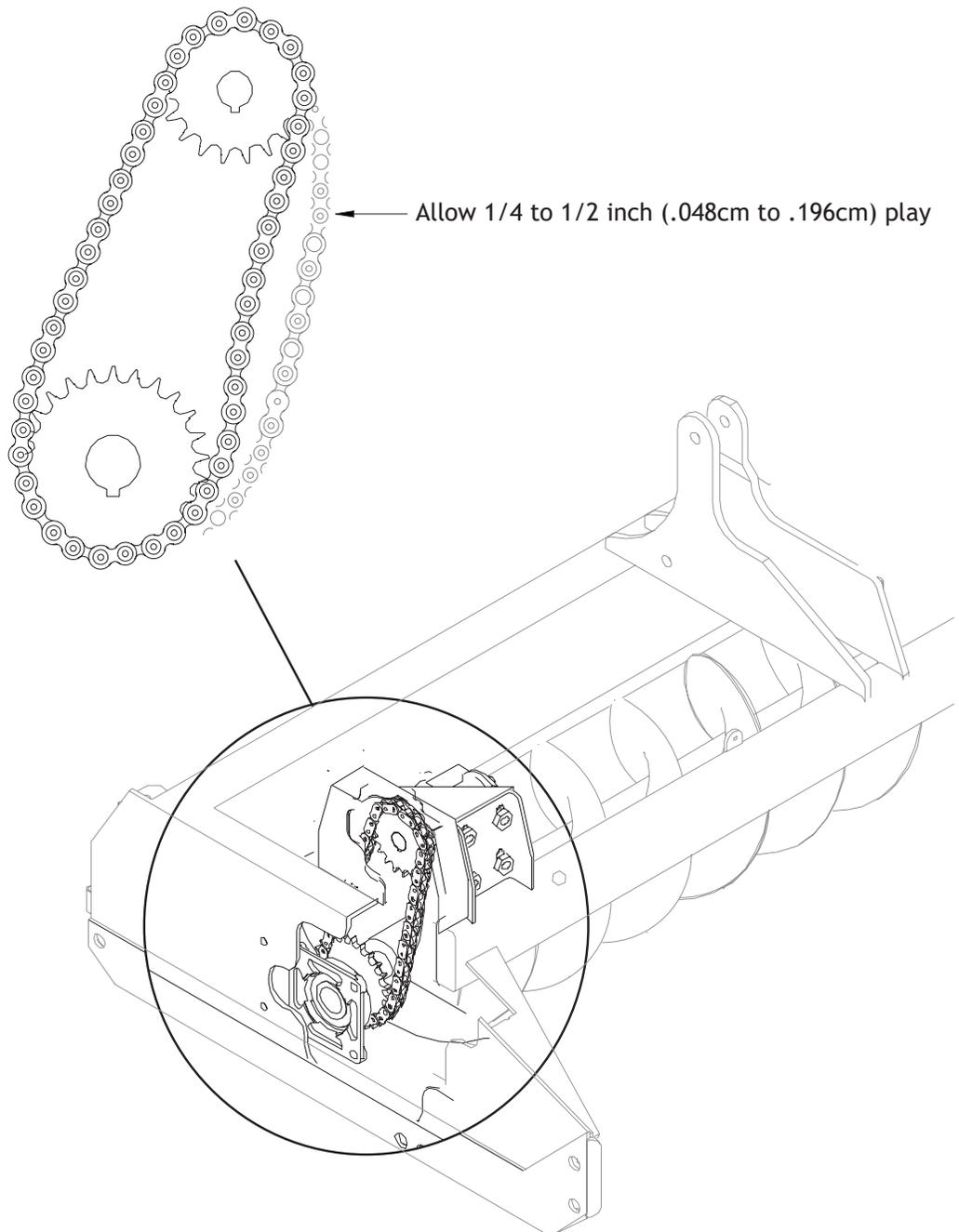
If the auger is set too low, diagonal lines may be found where the auger touches the ice.

If the auger is set too high, excessive amounts of snow will be left on the ice surface at the end of the resurfacing.



6.4.2 Auger Drive Chain Adjustment

The horizontal auger drive chain should be kept at a reasonable tension at all times. If too loose, the sprockets and chain will wear out prematurely. If too tight, the sprockets, chain and auger bearings will also wear out prematurely. To adjust the chain tension, loosen the motor mount plate bolts and adjust the motor mount until you get the proper tension.





Vertical Auger

There is only one adjustment to be made on the vertical auger, look into the inspection plate where the auger connects to the motor, the space between the coupling halves should be no more than 1/6th" (1.5mm).

Generally if the space is more than that it might be necessary to replace the bushing in the bottom of the vertical auger.

6.4.3 Down Pressure Check

Raise the blade to above the runners by turning the adjustment crank counter clockwise.

With the conditioner in the UP position, drive the OLYMPIA onto the ice surface.

Lower the conditioner to the ice surface by pushing and holding the CONDITIONER UP DOWN switch down until the lift arms are against the down pressure stops. Before operating the OLYMPIA, you should check to see if the runners are sitting level on the ice surface.

We recommend that you drive around the ice surface with the conditioner down for 2 or 3 laps to cool the runners.

To do this, the conditioner should be lowered so the runners are sitting on the ice surface and the conditioner lift arms are against the down pressure stops.

For proper traction and control the rear tires of the OLYMPIA should be in full contact with the ice surface, the entire width and 5" (12.7cm) of the circumference of the tire should be flat on the ice.

It is important to have the correct tire pressure 85 psi (5.8bar) in the tires prior to checking and adjusting the conditioner down pressure.

6.4.4 Down Pressure Adjustment

To adjust the down pressure, stop the OLYMPIA, place it in park and lower the conditioner until it is almost touching the ice surface.

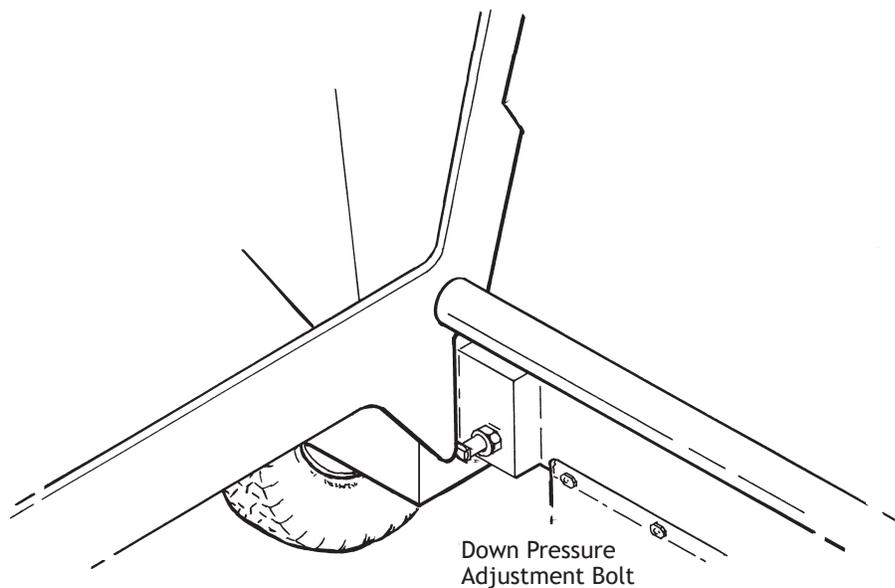
Properly dismount and turn the down pressure stop bolts in (clockwise) 5 full turns.

Remount the OLYMPIA, lower the conditioner until you have three tire lugs or 5" (12.7mm) of the tire touching the ice. Shut off the OLYMPIA, and dismount. Turn the down pressure stop bolts until they are tight against the down stops under the conditioner arms.

Now tighten the jam nuts.

Too much down pressure will lift the rear wheels off the ice resulting in a loss of control.

Too little down pressure will result in rippled ice and gouging in the corners.



Please Note: Every time you reset the down pressure you have to reset the top link adjustment.



6.4.5 Top Link Adjustment

Check to make sure the entire length of the runners are still on the ice surface.

Drive the OLYMPIA once around the rink.

When the top link is adjusted properly the rear tires should leave a full tread pattern on the ice.

Please Note: It is essential for proper operation that rear tire pressure be maintained at 85 psi (5.8 bar).

To test the top linkage, first loosen the lock nuts on both top links.

Now loosen both top links by turning them counter clockwise until there is no tension.

Remount the OLYMPIA and drive forward six feet (2 meters), stop, turn off the OLYMPIA and dismount.

Now simultaneously re-tighten the top links by turning them clockwise making sure to extend the top link to hand tight only.

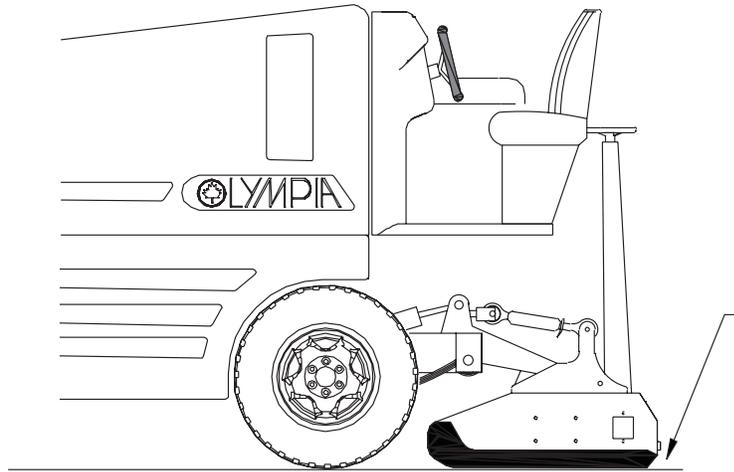
Secure the top links by tightening the lock nuts.

Check to make sure the front of the runners are still on the ice surface. When properly adjusted the runners will not leave any marks on the ice surface.

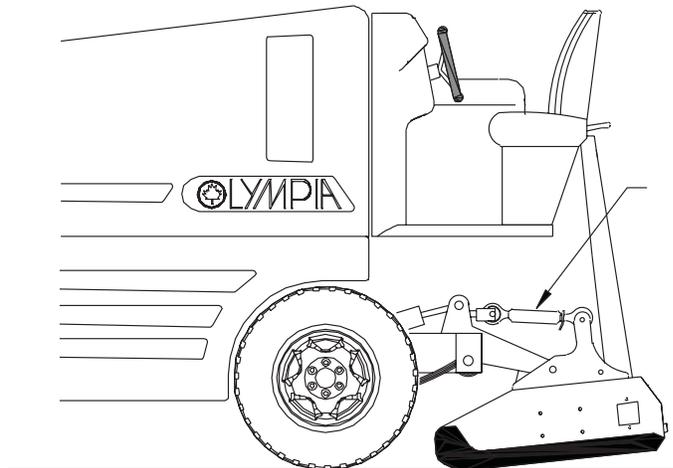


Please Note: It is essential that you adjust both top links at the same time, and in the same direction.

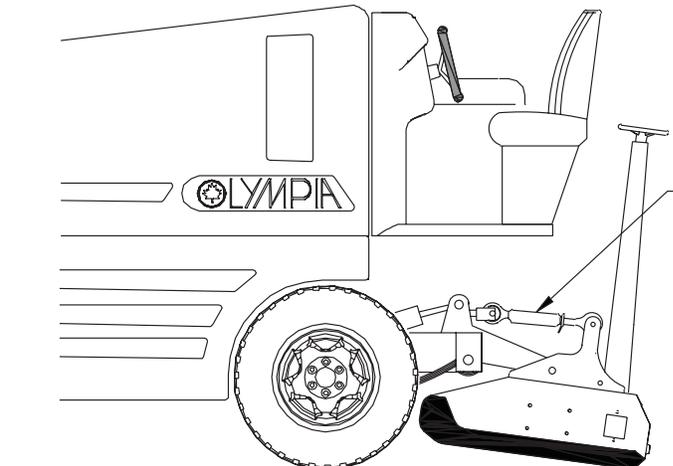
Proper Top Link Adjustment



Top Link too short



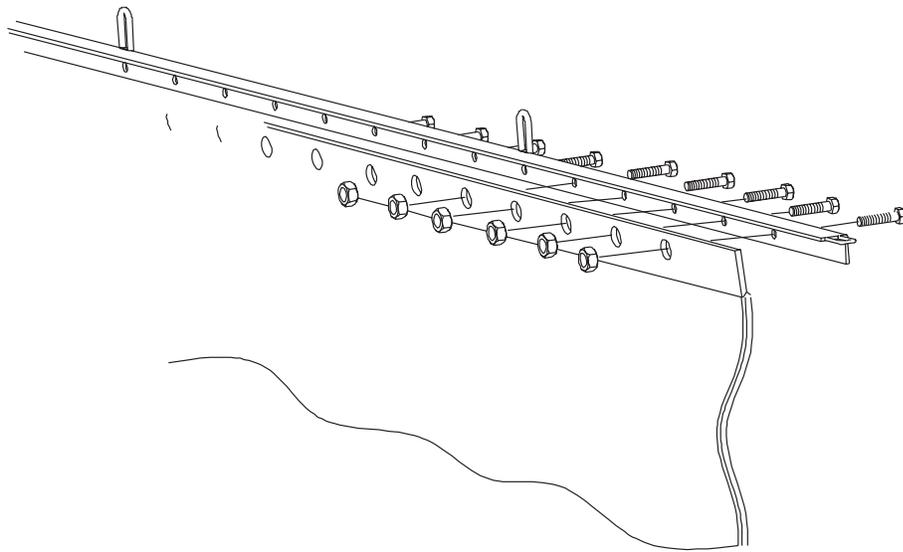
Top Link too long





6.5 Spreader Cloth Installation

1. Install the towel on the backside of the towel bar with the 3/8" hex head bolts and locknuts, making sure the nuts are on the towel side of the towel bar.
2. Place the towel bar assembly onto the towel lift guides.
3. Attach towel lift chains between the towel bar and towel lift arm.



6.6 Water Filling Procedure



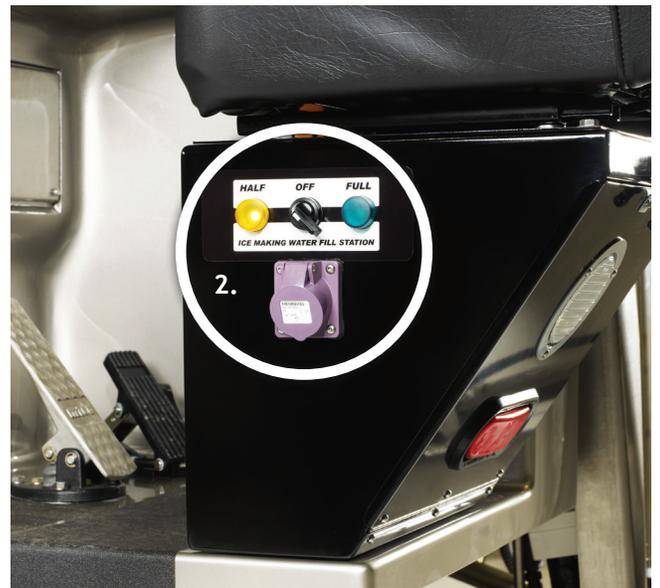
Always fill the ice making water tank with hot water, always fill the wash water tank with cold water.



Never leave the OLYMPIA unattended during the water filling procedure.

6.6.1 Ice Making Water Filling Procedure

1. To fill the ice making water tank, insert the hot water hose into the filling inlet (Item 1) on the left hand side of the OLYMPIA.
2. Plug the solenoid valve plug into the socket on the Ice making water fill station (Item 2).
3. Select whether you want to half-fill or completely fill the tank.
4. When the switch is turned, the water begins to flow until the previously selected water level is reached and the system shuts itself off automatically.
5. Return the switch to the OFF position, pull out the solenoid valve plug and remove the hose from the filling inlet.





6.6.2 Wash Water Filling Procedure

Always fill the wash water tank with cold water only.

1. Insert the cold water hose into the filling inlet (Item 1) on the right side of the ice resurfacer. Plug the solenoid valve plug into the socket on the Wash water fill station (Item 2) on the exterior right hand side of the OLYMPIA's control cabinet.
2. Turn the switch to the ON position, the water then begins to flow.
3. The filling procedure ends automatically when the tank is full.
4. Turn the switch to the OFF position, pull out the solenoid valve plug and remove the hose from the filling inlet.



6.7 Safety Circle Check

1. Do a smell check
2. Turn on the lights
3. Be sure battery charge is complete. Check to make sure battery charger is turned off.
4. Remove the ignition key.
5. Depress Emergency Shut Off switch.
6. Disconnect the battery cables and store.
7. Reconnect the internal power supply cables.
8. Make sure the front bumper wheel spins freely.
9. Check lug nuts and tire pressure and general condition of tire and studs on left front wheel.
10. At front of ice resurfacers check the body for damage
11. Look under ice resurfacers for any leaking fluids, debris and make sure no one is working under the ice resurfacers.
12. Check lug nuts and tire pressure and general condition of tire and studs on right front wheel.
13. Make sure both tank drains are closed.
14. Check lug nuts and tire pressure and general condition of tire and studs on right rear wheel.
15. Check the condition of the blade, in relationship to the runners. To avoid being cut by the blade, always start at the rear of the conditioner and slide your hand towards the front of the conditioner.
16. Check the runners for burrs that would leave scratches on the ice surface. Make sure you go the full length of the runner. The runner should have no nicks or scratches on it and the blade should be flush or slightly above the bottom of the runner.
17. Remove the conditioner cover on the right hand side and check that the horizontal auger turns freely in both directions.
18. Make sure there is no up, down or side to side movement.



19. Check the tension on the conditioner chain. There should be between a quarter and half- inch play (6,5-12,7mm).
20. Check the auger for up and down and side to side movement.
21. Check electrical connection for conditioner (horizontal auger) motor.
22. Check the blade holder pivot bolts to make sure they are tight. Replace the conditioner cover plate and install the locking pin. Go to the back of the ice resurfacer and flip up the towel.
23. Check the squeegee making sure it fits tightly from end to end and there are no nicks or cuts.
24. Examine the bottom side of the towel. Make sure it is clean, debris free and that the loops of the towel are in good condition.
25. Check the bottom of the runners again for burrs or nicks.
26. If your OLYMPIA is equipped with the optional edger on the conditioner, check the cutting tips for damage and make sure the plate is securely attached.
27. Check all the hydraulic hose connections on the edger and make sure there are no fluid leaks.
28. Check the electrical connections.
29. Check lug nuts and tire pressure and general condition of tire and studs on left rear wheel.
30. Check the board brush. Make sure that no debris is caught in the brush and that there is no free play.
31. Move the snow dump tank safety support bars to the stored position and lock in place.
32. Using a three point mount, step onto the ice resurfacer and sit down.
33. Turn the start key to the ON position.
34. Check the horn and the lights.
35. Make sure the conditioner is all the way up by pushing and holding the conditioner UP switch on the dash.

36. Test the elevator system. First, make sure the toggle switch is in the FORWARD position, then push the ON OFF switch for the elevator. While it is still running turn the toggle switch to the REVERSE position. The augers should come to a stop and then reverse direction. Then switch back to the forward position and shut off by lifting the ON OFF switch.
37. While the elevator is running check the snow breaker`s manual override by pushing the manual override switch down and then up to make sure the snow breaker cycles.
38. If the wash water tank is full turn on the wash water only long enough to make sure the wash water valve opens and you have an unobstructed water flow on both sides of the conditioner. Note (The augers must be turned on and the gear selector in the drive position to perform this check).
39. Check the board brush by pushing the board brush switch down, to lower the board brush and then up to raise the board brush.
40. Depress the brake pedal to check the brake lights.
41. Check the blade adjustment hand crank wheel. Make sure it turns freely.
42. Visually inspect snow breaker and cylinder to make sure all fasteners are tight.
43. Turn on the tire wash to make sure the pump works.
44. At least once a month lower the conditioner almost to the floor, insert the hand pump handle into the emergency hand pump located under the seat, push the switch under the seat to the HAND PUMP position and proceed to pump the conditioner up. After this is complete be sure to return the switch to the DRIVE position. Remove the hand pump handle and restow it.
45. Remove all hoses and cables from the ice resurfacer.
46. Complete the log book entry that you have performed the circle check.
47. You have now completed the safety check and are ready to proceed onto the ice surface and begin the resurfacing process. Make sure you use the horn when crossing any pedestrian areas.



7 WORKING WITH THE OLYMPIA MILLENNIUM-E

7.1 Driving

7.1.1 Starting

To start the OLYMPIA you must be seated in the driver`s seat. The red EMERGENCY SHUT OFF switch must be in the UP position. Turn the ignition key to the right and you will hear the switches turn on inside the electrical panel.

7.1.2 To move the ice resurfacer

Depress the accelerator pedal to start the hydraulic pump. Release the parking brake and select forward or reverse gear. Press down the accelerator pedal and carefully start driving. When you are on the ice surface, carefully check the distance to the boards.



In the event of electrical drive faults depress the EMERGENCY SHUT OFF switch on the dashboard. Wait for approximately 10 seconds and lift up the EMERGENCY SHUT OFF switch. This will reset all the electrical motor controllers. Restart the ice resurfacer. If a fault code persists a pictogram will appear showing the fault code on the lower left hand corner of the DMC gauge on the dashboard.

7.1.3 Brakes

To stop the OLYMPIA, take your foot off the accelerator pedal and carefully press the brake pedal.



Always apply the hand brake (parking brake), set the gear lever to neutral and turn the ignition switch to the off position before dismounting the OLYMPIA.

7.1.4 Shifting from Forward to Reverse

Always come to a complete stop before changing the direction of travel.

Never drive in reverse when the board brush is out.



When lowering the conditioner, make sure that the OLYMPIA continuously moves forwards!

7.2 Ice Resurfacing



Only lower the conditioner while the OLYMPIA is moving forward, otherwise it could sustain damage.



When working with the OLYMPIA, there must not be any other person on the ice.



Operation and start-up must only take place from the driver's seat!



Before driving onto the ice surface make sure pedestrian doors in the dasher boards are closed.



Before leaving the driver's seat, always turn off all functions!

7.2.1 Driving with the Board Brush

Normally the brush is used for the first lap around the boards at the beginning of each ice cleaning process.

This produces a clean, snow-free board area, right up to the edges. In connection with the edger and the automatic water function, the use of the brush reliably prevents a build-up of ice at the boards.



Drive with the brush in the same way as you would without the brush, but always travel in a clockwise direction around the boards.



Never drive backwards while the brush is extended. The brush can yield to the boards in the forward direction of travel, however, when driving in reverse, the brush could swing into an opening and catch the boards, causing severe damage.



Retract the board brush when approaching any ice level opening.

7.2.2 Water Application

Ice Making Water Procedure

1. Fill the tank with hot water through the fill pipe located on the driver`s side.

Note: A ½ full tank is more than sufficient for a single resurfacing.

2. Water flow can be turned on and off two ways.

A: Gravity flow regulates the flow of water by opening or closing the water tap mounted just in front of the blade adjustment hand wheel on the conditioner.

B: Turn on the speed related water on the bottom control panel. Ice making water will then be pumped out according to how fast or slow you are driving.



After each resurfacing it is recommended to drain any excess water left in the tank. This will reduce scale build up inside the ice making water tank.

Wash Water Procedure

The wash water system sprays water from both sides of the conditioner into the centre, in front of the squeegee, thus creating slush. Excess water and slush are then vacuumed up, taking with it any dirt and debris from the ice surface. In addition, any snow left behind by the blade is turned into slush by the wash water and is pushed into any cracks in the ice by the squeegee. The water is filtered and then returned to the wash water tank.



Always use cold water in the wash water system.

To turn on the wash water system during the resurfacing operation, depress the Wash Water switch. The water begins to flow. After 10 seconds, the wash water pump begins to vacuum up the water.

$\frac{3}{4}$ of the lap prior to completion of resurfacing, turn off the wash water, lift the Wash Water switch to the Off position. Both the water flow and the pump turn off at the same time.



By turning the wash water off $\frac{3}{4}$ of the lap before completion, any water trapped between the blade, squeegee and runners will be used up and this will prevent pooling of any water at the gate once the conditioner is raised.

The filter basket for the wash water is located in the top of the wash water tank, to the right of the driver and can be easily accessed.

Fill the water tanks with enough water to do a complete resurfacing job. Any water still remaining in the tanks at the end of the day should be drained completely, to prevent a build-up of scale.

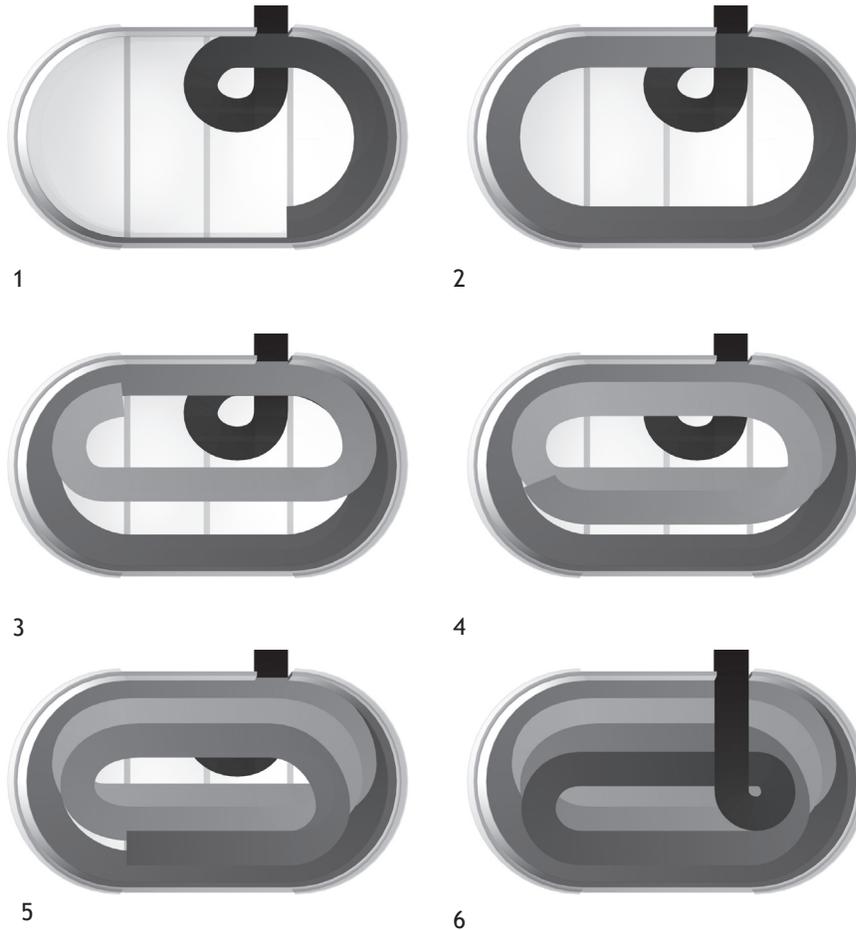
7.3 Resurfacing Procedure

Once you have taken on sufficient water, before driving onto the ice surface, turn on the tire wash to rinse the tires of any debris. Now carefully drive onto the ice surface and carry out the normal ice making procedure as follows:

- Lower the conditioner to the ice surface until the conditioner lift arms are against the down pressure stops.
- Engage both the vertical and the horizontal augers by pushing the top of the elevator on button.
- Turn on the ice making water with either the Speed Related Water button or the manually operated water valve.
- Turn on the Wash Water button.
- Now engage the board brush.
- Drive slowly ahead keeping the board brush close to the boards. (This will clean the snow on the kick plate and edges of the ice surface into the conditioner)
- Upon completion of a full circuit of the rink, retract the board brush and follow the pattern shown below.



Use extreme caution with the board brush when passing open gates as the board brush could swing into the opening, causing damage to both the boards and/ or the ice resurfacers.



- $\frac{3}{4}$ of a lap prior to completion of the resurfacing, turn off the wash water. Just prior to finishing the resurfacing, turn off the ice making water. Bring the OLYMPIA to a complete stop while the rear wheels are still on the ice surface.
- Turn off the horizontal and vertical augers.
- Lift the conditioner. Do not move the ice resurfacer until the conditioner is in the fully raised position.
- Proceed carefully to the snow dumping area. Prior to dumping check to ensure there is sufficient overhead clearance. Raise the snow dump tank button until it is completely opened.
- After dumping the snow lower the snow dump tank of after dismounting install the snow dump safety supports.

- Engage the parking brake and turn off the ice resurfacer.
- After stepping down from the ice resurfacer, be sure to remove cover plates and wash out the conditioner.



In order to maintain the recommended ice thickness of 1-1/4" (36mm), it is important that you cut the ice at a rate equal to the water you put down. Usually between 1/2 and 3/4 a bin of snow will equal the amount of water put down on an 8 to 10 minute resurfacing.



Proceed with extreme caution when driving up to the snow dumping area!



The snow dumping area should meet the following safety requirements:

- Red/white cordons at the left and right of the unloading area, with pictograms.
- Yellow/black threshold on the floor that is high enough to prevent the OLYMPIA from falling into the dump.
- Guard at the front of the snow dump to prevent people from falling in.

7.3.1 Cleaning the Ice Resurfacer after an Ice Resurfacing Operation

The conditioner should be rinsed out after each use. Do not hose down the whole ice resurfacer unnecessarily. The control cabinet, the hydraulic station, the battery panels and the driver's platform may only be cleaned with a damp cloth, never with a direct jet of water.



Keep the humidity in the storage area as low as possible!



8 CLEANING AND MAINTENANCE

8.1 Cleaning and Maintenance Safety Instructions



To perform the maintenance program, park the OLYMPIA with the conditioner in the fully UP position and shift the gear lever to the neutral position (N).

Fully raise the snow dump tank and install the safety support bars.

Turn off the ice resurfacer.



Before starting any maintenance jobs, remove the ignition key from the lock and keep it on your person. Put up a notice at the dashboard that says: **DO NOT SWITCH ON! WORK IN PROGRESS IN THE DANGER ZONE!**

Dismount using the three-point procedure.



When working on any of the other hydraulically operated components of the OLYMPIA, also secure them with safety bolts or props, so that a hazardous situation does not arise in the event of a component failure. Whenever working on the conditioner it is recommended that blocks be placed under it to prevent any possible injuries.



Maintenance and repair work must only be done by duly trained personnel. Specialists are needed for some jobs (e.g. electricians, hydraulics technicians, etc.).



Before doing such jobs, the whole ice resurfacer must be switched off. To do this, push down the Emergency shut off switch and disconnect the batteries from the resurfacer as shown in section 6.1. Put up a warning notice there that says: **DO NOT PLUG IN BATTERY CONNECTOR! WORK IN PROGRESS IN THE DANGER ZONE!**



Before starting the work, the OLYMPIA must also be secured with wheel chocks to prevent it from rolling away. The red/white plastic chains must be clearly visible at the sides of the machine. It is imperative that the wheel chocks are removed again before putting the OLYMPIA back into operation (the red/white plastic chains serve as a reminder).



Only after the OLYMPIA has been secured in the described manner may any isolating guards be removed (if necessary).



Only duly authorized personnel are permitted to be in the vicinity of the machine when maintenance and repair work is being performed.



If mechanically driven movements are necessary on the OLYMPIA in the course of maintenance and repair work, these may only be executed on the instruction of the facility supervisor, and at a safe, reduced speed.



Before starting the work, the employee responsible for doing the work must first ensure that this can be done without endangering people or facility equipment. Only after he has done so may he switch the power back on.



Mechanically driven ice resurfacer movements can only be started in jog mode during maintenance and repair work by holding the respective controls accordingly.



After completing the maintenance and repair jobs, the responsible employee must ensure that the isolating guards are remounted and that there are no people in the danger zone. After it has been ascertained that the ice resurfacer can be put back into operation without endangering people or facility equipment, the responsible employee can restore the power to the ice resurfacer by plugging the battery connector back in again. The people working on the ice resurfacer must be informed in advance.



In an emergency, press the EMERGENCY SHUT OFF switch. Before reengaging the ice resurfacer, make sure that this can be done without endangering people or facility equipment.



Employees must wear protective gloves when doing maintenance and repair work. The hazards associated with the sharp components should be pointed out in regular training courses.



Any failure of, or damage to the safety devices or guards must be reported to the facility supervisor without delay. He will then decide how to proceed.



8.2 Maintenance Checks

Failure to carry out the basic maintenance checks can lead to damage and downtime as well as possible personal injury.

8.2.1 Daily

- Carry out circle check as described in section 5.8.
- Recharge the battery (if necessary).
- Inspect all safety switches.
- If your ice resurfacer is equipped with an edger, inspect all the components.

8.2.2 Every Time the Blade is changed or Weekly



The procedure for changing the blade is described in Chapter 6.3.

- Re- grease the blade bolts.
- Lubricate the horizontal auger drive chain.
- Lightly oil bottom side of blade holder system.
- Grease blade holder pivots.
- Grease horizontal auger bearings.
- Grease conditioner lift arms.
- Grease conditioner mounting pins.



- Clean the entire ice resurfacer thoroughly with a damp cloth.
- Water the batteries using only distilled or RO. treated water.

Never spray an open jet of water into the ice resurfacer, as electrical components will be damaged.

8.2.3 After 5 Hours

- Check and torque the lug nuts to 140 (Nm) 103.25 ft·lb.

8.2.4 After 50 Hours

- Check all drive belts (vee-belts) and re- tension them, if necessary (Refer to Chapter 9.1).
- First oil change on the wheel drive gear boxes (using Dexron III).



8.2.5 Monthly

- Have the battery voltage measured and battery acid density checked by a battery specialist. Add distilled water, if necessary.
- Check whether the battery box is dry.
- Inspect the hydraulic system for any sign of leaks.
- Check the belt tension at all drive belts.
- Check the tire pressure (85 psi or 5.8 bar).
- Check that all lug nuts are tight (140 Nm).
- Check all traction drives for leaks.
- Check that the parking brake cable runs smoothly, re-lubricate it with penetrating oil, if necessary.
- Check the hydraulic oil level in the hydraulic tank.
- Check that the board guide roller runs smoothly.
- Check the surface of the blade holder in the conditioner and lightly oil it.
- Briefly test all functions.
- Check the tension of the conditioner drive chain, it should not have more than ½ inch (1,27 cm) of play.
- Spray lubricant onto the conditioner drive chain.

8.2.6 Annually or Before Storage

- Spray all metal surfaces of the conditioner with a thin coating of penetrating oil.
- Lubricate all lube points on the OLYMPIA to eliminate moisture.
- The horizontal and the vertical auger and all moving parts of the conditioner must be coated with a thin coating of penetrating oil.
- Open the drains.
- Remove the filter basket from the wash water tank. Using a wet vac, vacuum out any debris left in the tank.
- Remove the blade and properly store it.
- Oil the blade holder on the conditioner.
- Clean the ice resurfacer: Wash the OLYMPIA with luke- warm water and a mild soap. Make sure that you rinse off the soap with cold water before it dries and causes streaking on the surface of the OLYMPIA.



Never spray an open jet of water onto the ice resurfacer, as electrical components will be damaged.

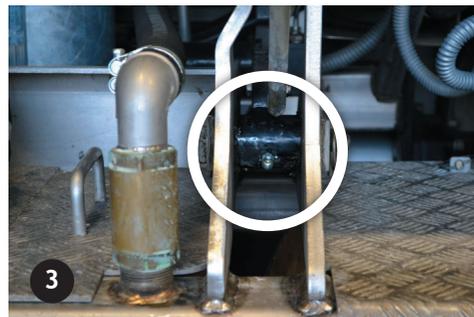
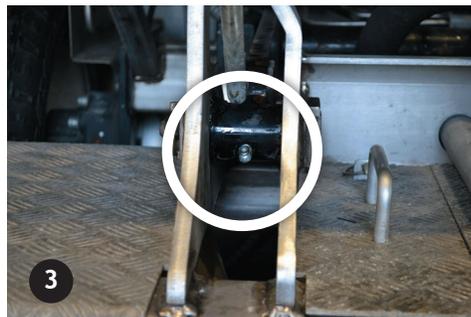
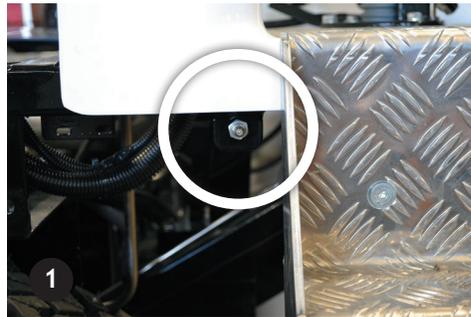
- Use a high- quality automotive wax to preserve the high- gloss finish of the OLYMPIA.
- Disconnect the battery charger and leave the batteries unplugged. If storing for more than one month charge the batteries each month.
- Have a qualified technician tighten all connections in the control cabinet.
- Check the brake lines for leaks and wear.
- Grease the entire ice resurfacer.
- Change hydraulic oil filter.

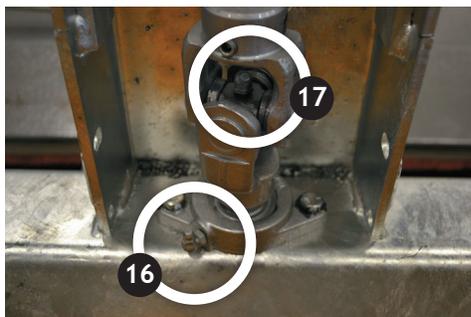
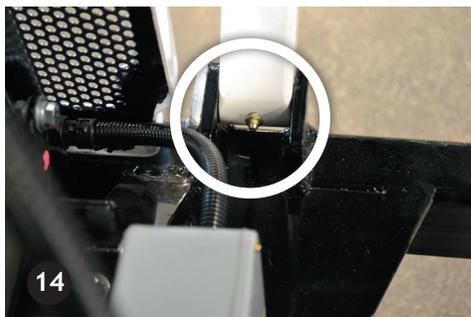
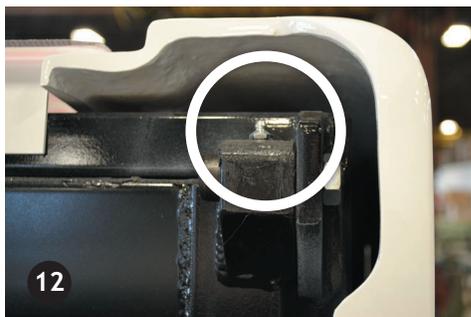
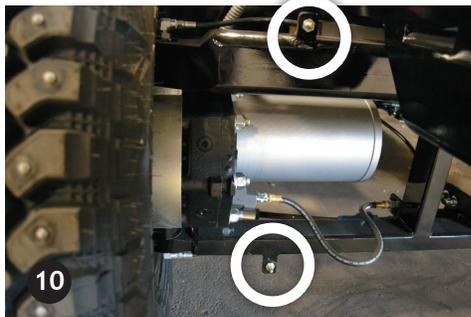
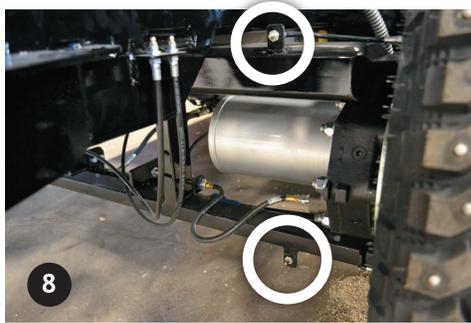


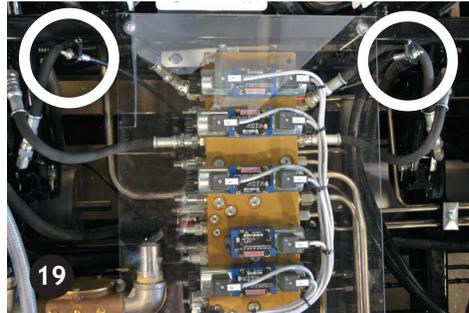
8.2.7 Lubrication to be Done Weekly and Before Long Term Storage



The lube points are shown on the separate lubrication chart in the appendix







Picture 1: Conditioner lift arm block left side

Picture 2: Conditioner lift arm block right side

Picture 3: Conditioner mount pins left and right sides

Picture 4: Board brush arm pivot and shaft

Picture 5: Blade holder pivot and horizontal auger bearing left side

Picture 6: Blade holder pivot and horizontal auger bearing right side

Picture 7: Blade adjustment screw,

Picture 8: Upper and lower king pin left side

Picture 9: Front axle center pivots

Picture 10: Upper and lower king pin right side

Picture 11: Snow dump tank cover pivot left side

Picture 12: Snow dump tank cover pivot right side

Picture 13: Snow dump tank pivot left side

Picture 14: Snow dump tank pivot right side

Picture 15: Upper bearing blade adjustment handle

Picture 16: Lower bearing blade adjustment wheel

Picture 17: Universal joint blade adjustment crank

Picture 18: Front bumper wheel

Picture 19: Parking brake linkage pivots on rear axle

8.2.8 Every 3 Years

- Change the wheel drive gear box oil (Dexron III)
- Change the hydraulic oil and filter

To put the OLYMPIA back into operation at the beginning of the season, perform the weekly maintenance procedure



9 SELF- HELP AND TROUBLESHOOTING

9.1 Squeegee Replacement

If the squeegee needs to be replaced, it should be mounted on the inside of the conditioner with hex head bolts (3/8" x 1-1/4") and locknuts. Install the squeegee such that the ends fit tightly against the sides of the conditioner.

Snow that is pushed by the squeegee is trapped between the squeegee and the runners and must not be able to escape to the outside, as it would form a ridge on the ice.

9.2 Towel Replacement

Inspect the towel and replace it if necessary. Attach the towel to the back of the towel holder with hex head bolts (3/8" x 1") and locknuts; make sure that the nuts are on the towel side of the towel holder.

9.3 Blade Replacement



Refer to Chapter 6.3, "Installation and Removal of the Blade".



10 APPENDIX

Hydraulic Drawings

Documentation provided by the company DMC (Controllers)

Documentation provided by the company Victron

Documentation provided by the company Siemens

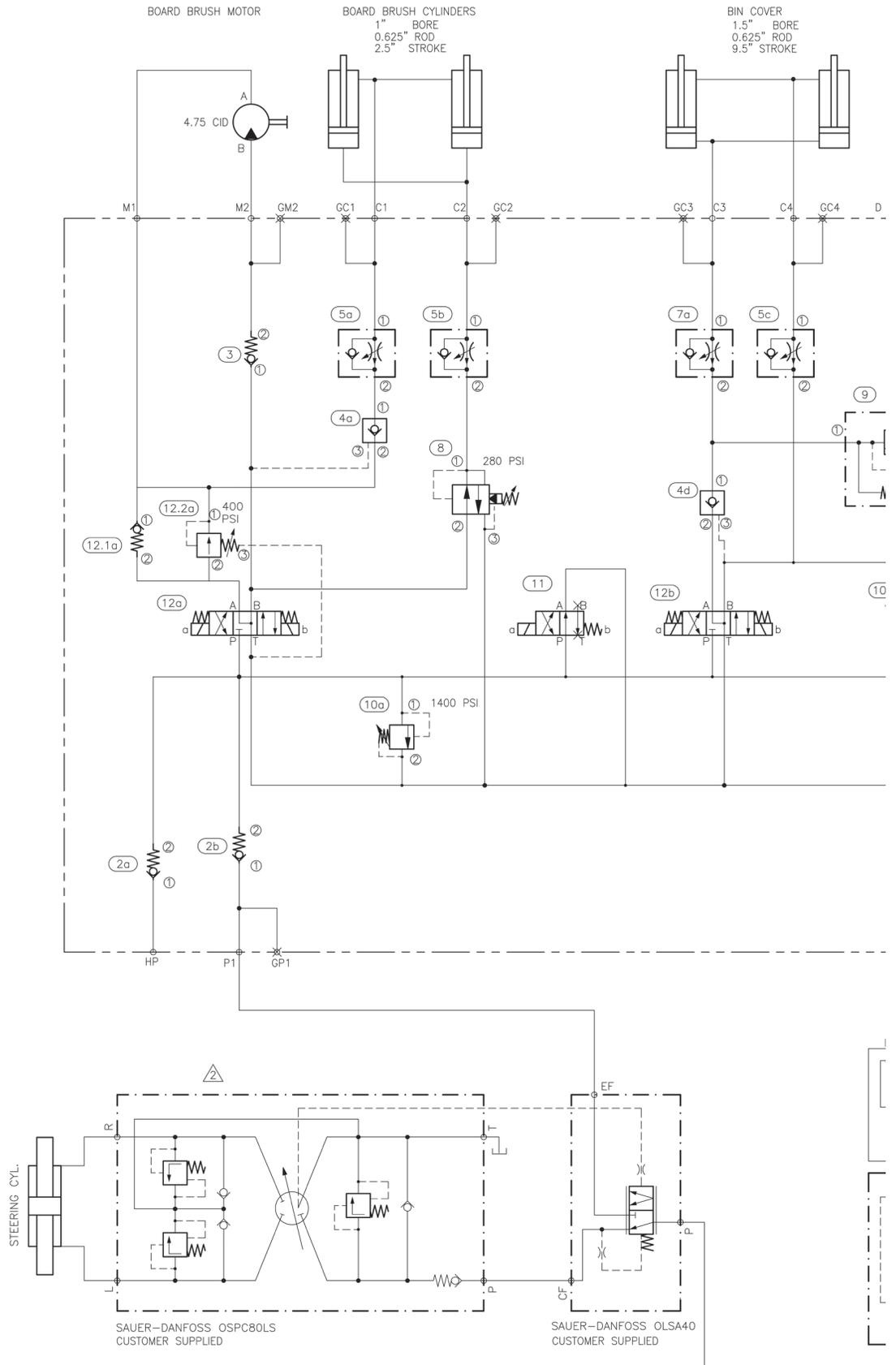
Documentation provided by the company Safe T Alert

Documentation provided by the company DMC (Converter)

Electric Drawings

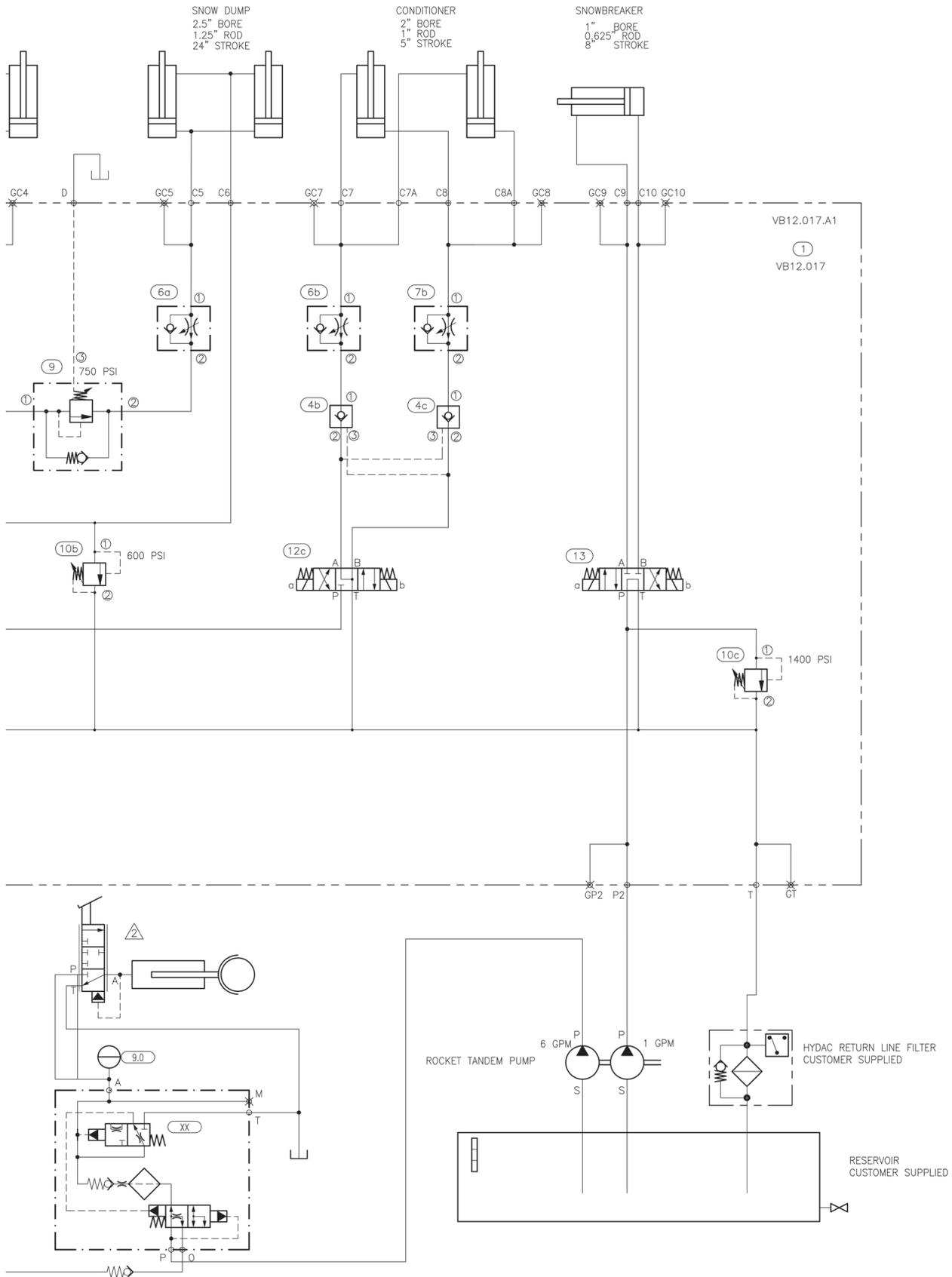
Grease Plan

Battery Information





Millennium-E





2/2-way Solenoid Valve with servo-diaphragm

- Universal version up to 232 PSI
- NBR, EPDM or FKM servo-diaphragms
- Waterhammer-free, low noise
- NC circuit function
- Brass and stainless steel body
- Threaded port or flange connections
- Approvals:     

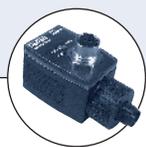
Type 5281 can be combined with...



Type 2508
Cable plug



Type 1078
Timer unit



Type 2511
ASI cable plug



Type 8600
Dosing control

Servo-assisted solenoid valve with servo-diaphragm for the control of liquid or gaseous media. A pressure difference of 2.9 PSI is required for a complete switchover.

Power consumption

Inrush AC [VA]	Hold (hot coil) AC [VA/W] DC [W]	
	AC [VA/W]	DC [W]
24	14/8	8

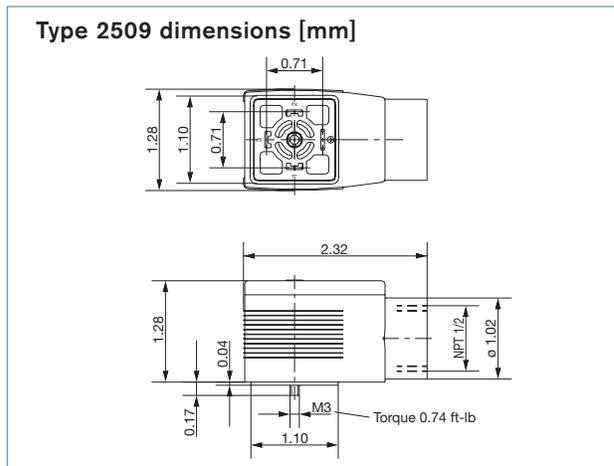
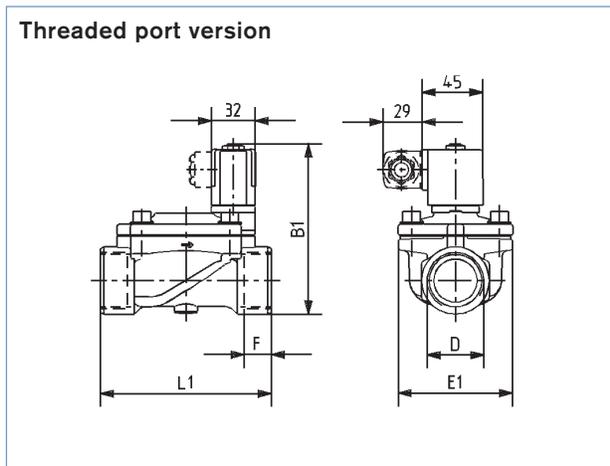
Technical data

Orifice	1/2" - 2" (DN 13 - 50 mm)
Body material	
Threaded port	Brass
Flange	Grey cast iron
Inner part valve	Stainless steel, brass
Seal material	NBR, EPDM, FKM
Media	
NBR	Neutral media, such as compressed air, water
EPDM	Oil and fat-free media
FKM	Hot air, oxygen, per-solutions
Media temperature	
NBR	14°F to 176°F (-10°C to +80°C)
EPDM	-40°F to 248°F (-40°C to +120°C)
FKM	14°F to 248°F (-10°C to +120°C)
Ambient temperature	Max. 131°F (+55°C)
Voltage tolerance	±10 %
Duty cycle	Continuous operation 100% ED
Electrical connection	Tag connector acc. to DIN 43650 Form A for cable plugs Type 2508 (see Accessories)
Protection class	IP 65 with cable plug
Installation	As required, preferably with actuator upright
Response times¹⁾	0.1 - 4 seconds (depending on orifice, pressure and viscosity)

1) Measured at valve outlet at 87 PSI and 68°F (+20°C).

Opening: pressure build-up 0 to 90%, Closing: pressure relief 100 to 10%

Dimensions [mm]



Threaded port						
DN	D	B1	B1*	E1	F	L1
13	NPT 1/2	100.0	120.0	40	14	65
20	NPT 3/4	107.5	127.5	60	16	100
25	NPT 1	116.0	136.0	70	18	115
32	NPT 1 1/4	126.5	146.5	85	20	126
40	NPT 1 1/2	135.5	155.5	85	22	126
50	NPT 2	157.2	177.2	115	24	164

B1* Version with manual override, available on request

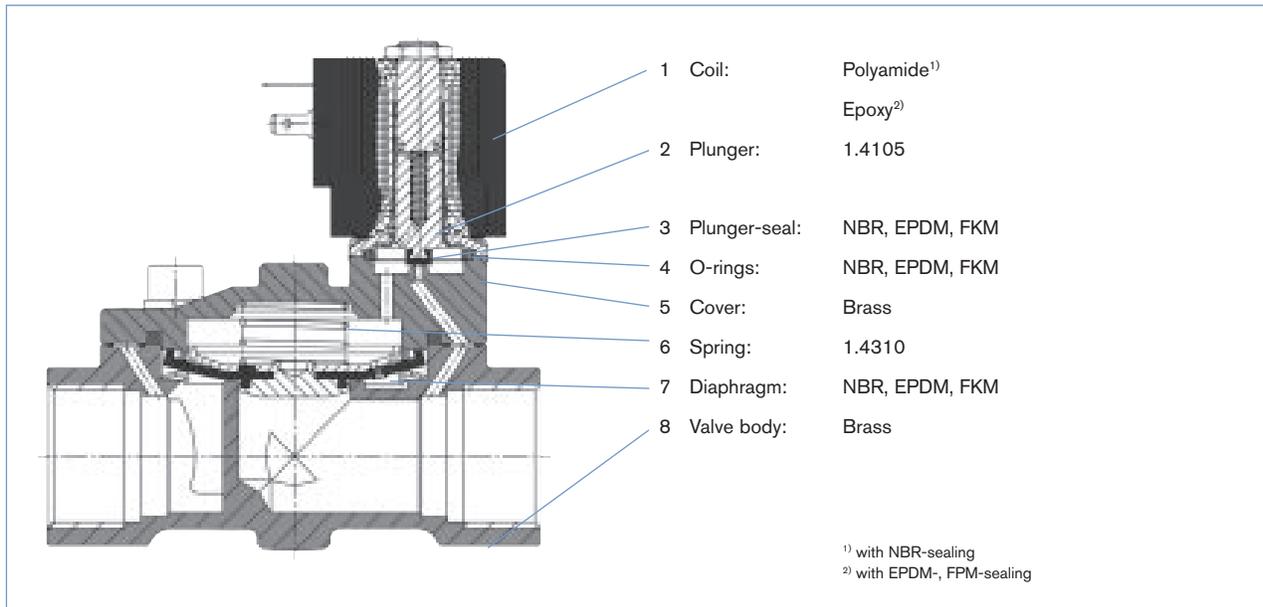
Ordering chart for valves (other versions on requests)

Circuit function A (Type 5281, normally closed), brass body, supplied with cable plug

Circuit function	Orifice [mm]	Port connection	C _v value water [GPM]	Pressure range [PSI]	Voltage/frequency [V/Hz]	Item no. UL listed / FM C1 Div1 / CSA / w/Type 2509 1/2 conduit connection	Item no. UL recognized w/Type 2508 DIN cable plug
A 2/2-way valve NC 	13	NPT 1/2	4.7	2.9 – 230	024/VDC	457 395	456 864
					024/60	457 396	456 865
					120/60	457 397	456 866
					240/60	457 398	456 867
	20	NPT 3/4	5.8	2.9 – 230	024/VDC	457 399	456 868
					024/60	457 400	456 869
					120/60	457 401	456 870
					240/60	457 402	456 871
	25	NPT 1	11.7	2.9 – 230	024/VDC	457 403	456 872
					024/60	457 404	456 873
					120/60	457 405	456 874
					240/60	457 406	456 875
	32	NPT 1 1/4	23.5	2.9 – 230	024/VDC	457 407	456 876
					024/60	457 408	456 877
					120/60	457 409	456 878
					240/60	457 410	456 879
	40	NPT 1 1/2	23.5	2.9 – 230	024/VDC	457 411	456 880
					024/60	457 412	456 881
					120/60	457 413	456 882
					240/60	457 414	456 883
	65	NPT 2	47.1	2.9 – 230	024/VDC	457 415	456 884
					024/60	457 416	456 885
					120/60	457 417	456 886
					240/60	457 418	456 887

Note: Versions with manual override available on request. FKM and EPDM seals are also available on request.

Materials



i Further versions on request

**Approvals**

UL/UR/CSA, ATEX-Ex, UL-fire protection, European gas approval

**Voltage**

110/50, other non-standard voltages

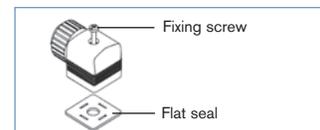
**Port connection**

NPT, Rc

Ordering chart for accessory

Cable plug Type 2508 according to DIN EN 175301-803 Form A

	Circuitry	Voltage / frequency	Item no.
	None (standard)	0 - 250 V AC/DC	008 376
	further versions see datasheet Type 2508		



The delivery of a cable plug includes the flat seal and the fixing screw. For other cable plug versions acc. to DIN EN 175301-803 Form A (previously DIN 43650), see separate datasheet Type 2508.

ELEKTRON ACCUMETER

Battery state of charge indicators



Precise and reliable indication of the charge of traction batteries (wet / gel / fleece)
- also for vehicles with regenerative brake

Adjustable discharge characteristic

Breaking contact as protection against exhaustive discharge

Leading OEMs use ACCUMETER



Made in Germany

ELEKTRON ACCUMETER EL-AC VII



EL-AC VII
Battery state of charge indicator
with integrated operating
hours meter and Bh button
(Indication of the count also at
disconnected battery)



EL-AC VII
Battery state of charge indicator
with integrated
operating hours meter



EL-AC VII
Battery state of charge indicator
without operating hours meter

TECHNICAL DATA

Operating voltages: 24V, 36V, 48V or 80V
(40V, 72V on request)

Suitable for: traction batteries (wet, gel and fleece)

Indication of discharge level: 8 red LEDs (per LED approx. 10%)

Characteristic: steplessly adjustable
(no-load voltage)

Measuring accuracy: typ. 2%

Break contact: at 20% residual capacity (adjustable)

Switching current: max. 3A

Switching voltage: max. 125VDC

Switching power: max. 90W

Resetting: after disconnecting the battery or
during charging process (2,35 V/cell
for at least 15 minutes)

LED control input: ON / OFF switching of the LED
indication (e. g. by key switch)

Operating temperature: -10 °C to +60 °C

Storage temperature: -25 °C to +60 °C

Relative humidity: max. 95%, without condensation

Protection class: connector IP21, front IP65

Electrical connection: central plug (6,3 mm Faston)

Housing: polycarbonate

Dimension drawing: see overleaf

Digital operating hours meter:

Display (LCD): 6 digits (99999,9h), with Bh-button
reading out also at disconnected
battery

Height of digits: 7,5 mm

Resolution: 0,1 h

Accuracy: +/- 0,1%

Start inputs: 1 x positive or 1 x negative
(depending on execution) 3 x positive*
3 x negative*
*no control input for LED display

Memory: EEPROM

Accessories:

Interface / software: for adjustment of the operating hours
meter per computer

Set adapter: for adjustment of the operating hours
meter w i t h o u t computer

You want to change to ELEKTRON ACCUMETER? Please contact us!

ELEKTRON ACCUMETER EL-AC III

TECHNICAL DATA

Operating voltages:	24V, 36V, 40V, 48V, 72V or 80V
Suitable for:	traction batteries (wet)
Indication of discharge level:	8 green LEDs (per LED approx. 10%)
Measuring accuracy:	typ. 2%
Warning / break contact:	at 30% / 20% residual capacity (fix)
Switching current:	max. 5A
Switching voltage:	max. 100VDC
Switching power:	max. 120W
Resetting:	after disconnecting the battery
Operating temperature:	-10 °C to +60 °C
Storage temperature:	-25 °C to +60 °C
Relative humidity:	max. 95%, without condensation
Protection class:	rear IP54, front IP65
Electrical connection:	connecting leads at the rear



EL-AC III
Battery state of charge indicator
Supplementary surface
mounting instrument

Dimensions: H = 30 mm
 W = 106 mm
 D = 82 mm

Housing: polycarbonate

ELEKTRON ACCUMETER EL-AC C3 and EL-AC C4

TECHNICAL DATA

Operating voltages	C3: 24V or 36V - 80V
Operating voltages	C4: 24V, 36V - 60V or 72V - 80V
Suitable for:	traction batteries with BICaT
Warning / break contact:	at 30% / 23% residual capacity (adjustable)
Switching current:	max. 3A
Switching voltage:	max. 125VDC
Switching power:	max. 90W
Operating temperature:	-10 °C to +60 °C
Storage temperature:	-25 °C to +80 °C
Relative humidity:	max. 95%, without condensation
Protection class:	connector IP21, front IP65
Electrical connection:	central plug (6,3 mm Faston)
Housing:	polycarbonate
Dimension drawing:	see overleaf
Vehicle identification:	programmable, automatic transfer to the BICaT
Data transfer	C3: via board supply (modulation)
Data transfer	C4: via separate data line
Accessories EL-AC C4:	programming interface



EL-AC C3 and EL-AC C4
Battery state of charge indicator
o n l y in combination with
battery controller BICaT

with multifunction display:

- Residual capacity
- Operating hours
- Service interval
- Battery temperature
- Faults

You need a special version e. g. for a cold store application? Please contact us!

ELEKTRON ACCUMETER EL-AC VII

This new digital flush instrument is mechanically and electrically compatible to the former versions ACCUMETER EL-AC IV and EL-AC V and additionally offers three important functions:

Consideration of energy recovery

Automatic reset

Adjustment of operating hours meter by laptop or PC

The ACCUMETER EL-AC VII is equipped with a digital operating hours meter (6 digits LED display). With the optional **Bh-button** we offer - contrary to many competitors - the possibility to read out the operation hours also at disconnected battery.

Function EL-AC VII

Microprocessor controlled electronic technology measures the no-load voltage of the battery and uses the discharge curve to determine the residual capacity with a high degree of accuracy.

Condition: alternation between on-load voltage / no-load voltage in short time intervals, typical operation for electric vehicles (e. g. fork lift trucks).

The 8 LED indicators move like a petrol tank level indicator from right to left. As soon as the battery has reached the reference voltage for approx. 80% discharge, the LED "Charge battery" lights up and the breaking contact is activated (e. g. for lift function or fast movement level).

Resetting and switching on again are achieved by disconnecting

the battery from the vehicle or by charging the battery in the vehicle (on board charger) after 2.35 V/cell have been reached.

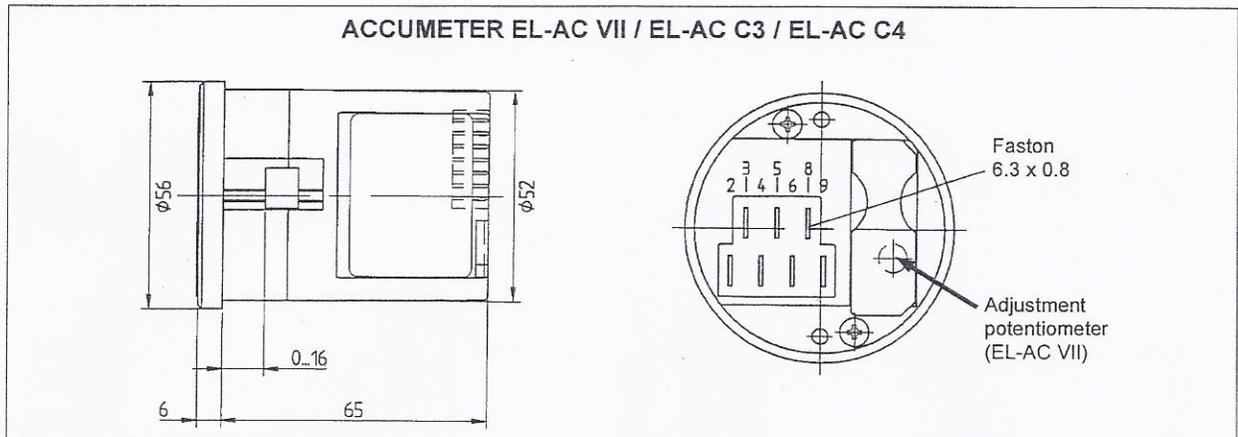
The breaking point is adjustable to adapt to different rates of battery discharge or types of battery (see table on the right).

The works adjustment „G“ is matched to an average load at single-shift operation for wet cells and is corresponding to a 80% discharge. Changing the works adjustment of the breaking voltage makes sense if the average discharge current permanently deviates from I_5 (I_5 = discharge current at 5-hours discharge). The breaking voltage should only be changed after longer observation of the operating conditions, the acid density and the voltage

response.

The setting range for sealed lead-acid batteries (gel batteries) should generally be coordinated with the battery manufacturer.

Reference letter (potentiometer)	Break point	
	earlier	later
S		
R		
Q		
P		
O		
N		
M		
L		
K		
J		
I		
H		
G		
F		
E		
D		
C		
B		
A		



10/2001 Subject to technical alterations



Installation Instructions

Back-up Alarm

General Information:

Congratulations! You have purchased a precision engineered, world-class back-up alarm. Back-up alarms are designed to provide a warning sound in hazardous environments associated with vehicles or mobile equipment. In order for this safety product to perform correctly it must be installed in conformance with the instructions provided in this guide. People's lives depend on the proper installation of this product and it is necessary for you to read, understand and follow these instructions. In addition, outlined below are some important safety instructions and precautions you should follow.

Failure to install this back-up alarm in accordance with manufacturer's recommendations for installation may result in property damage, serious injury, and/or death to those you are seeking to protect!!!

Selection and installation of an alarm should meet the requirements of ISO9533 (SAE J1446) "On-Machine Alarm Test & Evaluation Procedure for Construction & General Purpose Industrial Machinery", and all applicable codes. Operation of a vehicle in very noisy environments may require an alarm that is louder than indicated in ISO9533 (SAE J1446). Install an alarm that will be audible on the noisiest job site on which the vehicle will be used. Ground guidance should be provided to the driver when backing a vehicle in a job environment where the audibility of the alarm is in question.

Back-up alarms are intended for commercial use. Proper installation of a back-up alarm requires a good understanding of truck and heavy equipment electrical systems and procedures, along with proficiency in the installation and use of safety warning equipment.

Position the back-up alarm on the vehicle so it will operate properly under adverse conditions. The location must provide protection from impact and poor weather conditions while allowing unobstructed sound projection to the hazard area at the rear of the vehicle.

The back-up alarm system must be inspected each workday at the beginning of each shift to ensure that it is audible, operating properly, and securely attached to the vehicle. Inspect more often when: 1) The vehicle is operating in an adverse environment 2) The vehicle is operating in foul weather conditions 3) The operator has reason to believe the alarm has been damaged or is not working properly; and/or 4) Increased background noise interferes with the ability of workers to recognize when the alarm is sounding.

Note: Back-up alarms should be used for BACK-UP WARNING applications only. The back-up alarm sound is generally recognized as a warning for reversing vehicles/mobile equipment. Alarm products with different sound tones are available for non-reversing applications.

Installation Instructions & Sound Level:

This product is designed to concentrate its audible alarm in the target hazard area. NOTE: This product is a safety device. It must be connected to the vehicle's fused back-up lamp circuit or its own separate fused power point to assure its continued operation. For proper sound dispersion, it must be mounted

approximately 4 feet above ground level with the sound opening facing the target hazard area (see SELF ADJUSTING ALARMS below). The label on each alarm describes the sound output level in A-weighted decibels (dBA).

1. Select a mounting location at the rear of the vehicle that is protected from flying objects, debris, and foul weather conditions, while allowing unobstructed sound projection from the vehicle.
2. Using the alarm's housing as a template, mark location for the mounting holes. Drill holes at location marks.
3. Secure alarm on the vehicle.

4. This unit requires reliable power and ground connections for operation. Complete the wiring according to the wiring diagram shown in figure 1. Use 18-gauge wire (minimum) and observe correct polarity. **WARNING!** Anytime the Backup Alarm is in operation, continuity must be maintained between the positive voltage of the power source and the positive terminal (+) of the Backup Alarm as well as between the negative terminal (-) of the Backup Alarm and the common ground (the machine member to which all wire grounds are connected). During operation the voltage differential between the positive voltage of the power source and the positive terminal (+) of the Backup Alarm shall not exceed 150mV. During operation the voltage differential between the common ground and the negative terminal (-) of the Backup Alarm shall not exceed 150mV. Route wire in a protected manner in accordance with vehicle manufacturer recommendations. **NOTE:** The Back-up alarm is sensitive to polarity and will not operate when its power connections are reversed.

Important! DO NOT wire in parallel with a solenoid or relay coil. DO NOT spray any coating material, e.g. paint, undercoating, etc., over any part of the alarm. DO NOT install the alarm or its wiring in proximity to ignition wires. Failure to observe these conditions may have an adverse effect on the alarm's performance.

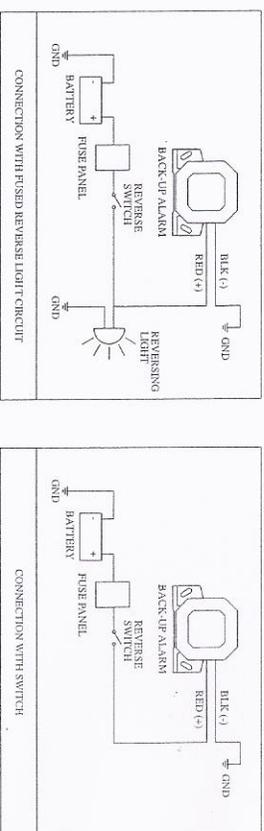


Figure 1

5. Test the alarm for proper operation. If alarm does not sound, review step 4. After confirming proper operation, affix the provided Warning Label to the dashboard of the vehicle in plain view of the operator. **Do not operate this vehicle if the back-up alarm is not functioning properly.**
6. Add requirement to "test back-up alarm system before operating vehicle" to the daily maintenance log and notify your supervisor or team leader that people operating this vehicle **MUST** confirm proper

alarm operation at the beginning of each work shift. Do not operate this vehicle if the back-up alarm is not functioning properly.

SELF ADJUSTING ALARMS have a self-adjusting feature which automatically changes their sound output level to be a minimum of five (5) dB(A) above the surrounding noise levels within a range of outputs. This sound output adjustment diminishes as surrounding noise levels approach the maximum output of the alarm. Note: SELF ADJUSTING ALARMS are designed to respond to ambient noise and must not be confined in internal compartments or enclosed spaces where localized noise may interfere with the self-adjusting volume mechanism.

Standard NON-ADJUSTABLE ALARMS have a fixed sound output level. Observe correct polarity.

Specifications:

A listing of product specifications is available upon request.

Vehicle Operations:

As the operator of a vehicle, you should always know when the alarm is sounding and when it is not sounding. Should the alarm become inoperative, discontinue vehicle operation and notify your supervisor or team leader. Operating a vehicle with an alarm that is not functioning properly could endanger the lives and/or property of those who depend on the alarm signal for safety.

Back-up alarm testing must be itemized on the daily maintenance log. An alarm on an operating vehicle must be tested prior to the vehicle's use at the beginning of each work shift. Check the daily maintenance log to confirm acceptable results of this testing before operating the vehicle/mobile equipment.

More frequent testing may be necessary if the vehicle is operating in adverse conditions.

- Ground guidance should be provided to the driver when backing a vehicle in a job environment where the audibility of the alarm is in question.

Maintenance:

Preventive maintenance procedures must specify an alarm safety system inspection. This check should include a thorough examination of the electrical connections and the sound opening. The alarm must be kept clear of dust, mud, or any other foreign material that may prevent the alarm from sounding properly. It is recommended that the alarm be cleaned regularly. Should inspection reveal an alarm that is not functioning properly, place a "Do Not Use" sign on the equipment and notify your supervisor or team leader.

Manufacturer Limited Warranty and Limitation of Liability:

Manufacturer warrants that on the date of purchase this product will conform to Manufacturer's specifications for this product (which are available from the Manufacturer upon request), and Manufacturer further warrants that this product is free from defects in materials and workmanship. This Limited Warranty extends for three to ten years, depend on model from the date of purchase. Other warranties may apply, call Manufacturer for details. Manufacturer will, at its discretion, replace or repair any product found by the Manufacturer to be defective and subject to this Limited Warranty.

DAMAGE TO PARTS OR PRODUCTS RESULTING FROM TAMPERING, ACCIDENT, ABUSE, MISUSE, NEGLIGENCE, UNAPPROVED MODIFICATIONS, FIRE, OR OTHER HAZARD; IMPROPER INSTALLATION OR OPERATION; OR NOT BEING MAINTAINED IN ACCORDANCE WITH THE MAINTENANCE PROCEDURES SET FORTH IN MANUFACTURER'S INSTALLATION AND

OPERATING INSTRUCTIONS VOIDS THIS LIMITED WARRANTY.

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This Limited Warranty defines specific legal rights. You may have other legal rights, which vary from state to state. Some states do not allow the exclusion or limitation of incidental or consequential damages.

2/2-way Solenoid Valve for gases and fluids



Type 0290 can be combined with...



Type 2508
Cable plug



Type 1078
Timer unit



Type 2511
ASI cable plug



Type 8600
Dosing control

- Universal valve with coupled diaphragm system
- Switches without differential pressure
- For gases and liquids
- Brass and stainless steel bodies
- Seal material NBR, EPDM and FKM
- Approvals:     

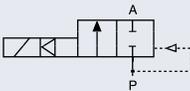
Pilot-controlled normally-closed valve with servo-diaphragm, forced valve lifting and coupled magnetic system. The valve switches without differential pressure from 0 bar with gases and liquids.

Power consumption		
Orifice	Inrush	Hold
[mm]	[W]	[W]
12	80	6
20 - 40	100	9
50	30	30

Technical data	
Orifice	7/16" - 2" (DN 12 - 50 mm)
Body material	Brass, stainless steel 1.4581
Internal parts of valve	See drawing on page 2
Seal material	NBR, FKM, EPDM
Media NBR FKM EPDM	Neutral media, compressed air, water, hydraulic oil Per-solutions, hot oils, oxygen Oil and fat-free media, e.g., hot water
Media temperature for NBR for FKM for EPDM	14°F to 176°F (-10°C to +80°C) 32°F to 248°F (0°C to +120°C) -22°F to 248°F (-30°C to +120°C)
Ambient temperature	Max. 131°F (+55°C)
Voltage tolerance	±10%
Duty cycle	100% continuous cycle
Electrical connection	Cable plug for Ø 7 mm cable (supplied as standard)
Protection class	IP 65 with cable plug
Installation	As required, preferably with actuator upright

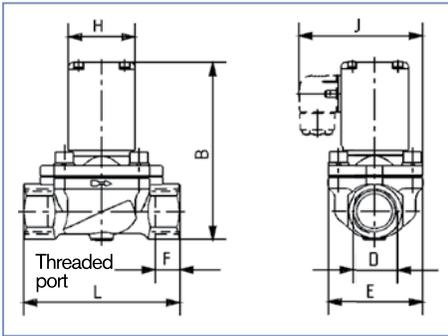
Solenoid valves

Ordering chart for valves (other versions on request) – all valves with cable plugs, brass bodies and various diaphragm materials

Circuit function	Orifice [mm]	Port connection [NPT]	Cv value water [GPM]	Pressure range [psij]	Body material	Voltage/ universal [AC/DC]	Approval ratings ²⁾	Order number
A 2/2-way valve NC 	12	NPT 1/2	3.3	0 – 232	Brass	24	UR	453 877 X
							UL	452 746 A
							-	452 239 E
						120	UL	453 058 D
						240	UL	452 745 H
	12	NPT 1/2	3.3	0 – 232	Stainless Steel	24	UR	454 216 Z
							UL	453 179 B
							-	452 241 G
						120	UL	452 819 U
						240	UL	453 180 Z
	20	NPT 3/4	5.8	0 – 232	Brass	24	UR	453 878 G
							UL	453 181 N
							-	450 639 R
						120	UL	453 182 P
						240	UL	450 836 X
						240	UR	455 291 W
	20	NPT 3/4	5.8	0 – 232	Stainless Steel	24	UR	454 412 N
							UL	453 184 R
							UR	453 792 S
							UL	452 747 B
						240	UL	450 748 W
						240	UL	456 119 S
	25	NPT 1	11.7	0 – 232	Brass	24	UL	452 862 X
							-	450 649 T
							UR	453 793 T
							UL	453 185 J
						240	UL	450 474 C
						240	UL	457 230 E
						-	450 824 T	
25	NPT 1	11.7	0 – 232	Stainless Steel	24	UL	453 187 L	
						-	452 253 C	
						UR	453 794 U	
						UL	453 188 V	
					240	UL	453 189 W	
32	NPT 1 1/4	18.0	0 – 174	Brass	24	-	455 624 T	
					120	-	453 641 A	
40	NPT 1 1/2	18.0	0 – 174	Brass	24	-	455 625 U	
					120	-	453 642 B	
					240	-	454 276 D	
50	NPT 2	44.0	0 – 174	Brass	120	-	453 643 C*	
					240	-	454 263 G*	

For 50 mm orifice and UC (universal current), the cable plug has an integrated single-phase bridge.

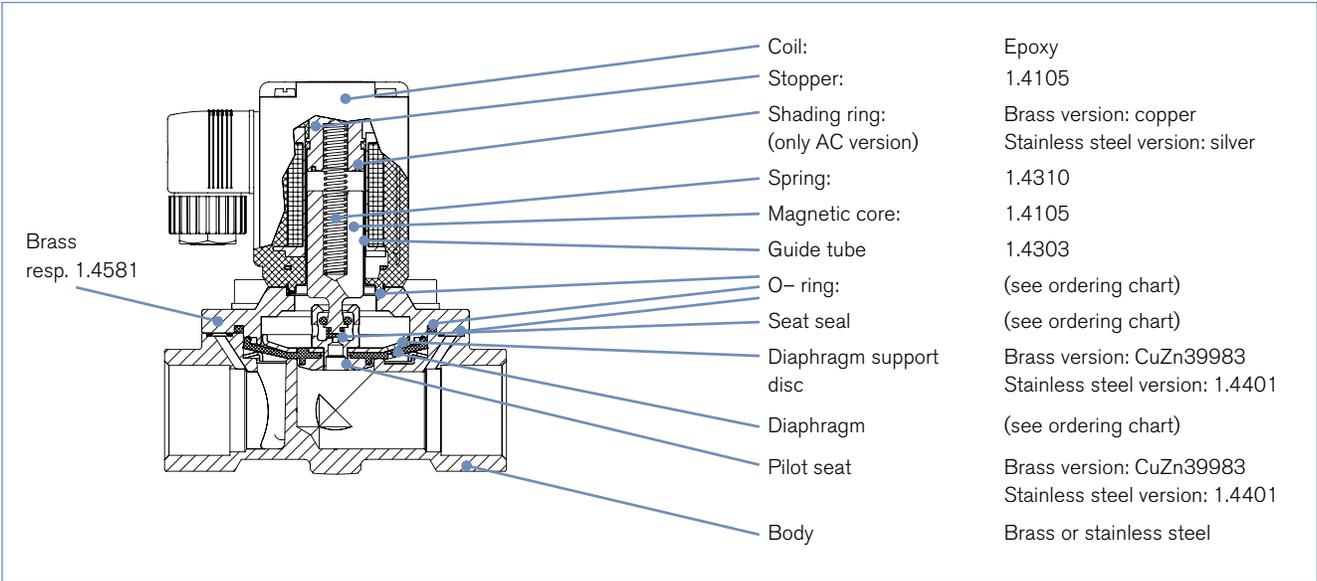
Dimensions [mm]



Dimensions [mm] according to DIN 2501

DN	D	B	E	F	H	J	L
12	NPT 1/2	95.5	40	14	40	73.0	74.5
20	NPT 3/4	122.0	60	16	49	86.5	100.0
25	NPT 1	131.0	70	18	49	91.5	115.0
32	NPT 1 1/4	145.0	85	20	49	99.0	126.0
40	NPT 1 1/2	154.0	85	22	49	99.0	126.0
50	NPT 2	211.0	115	24	72	126.0	164.0

Material



DTS 1000082395 EN Version: - Status: RL (released | freigegeben | validé) printed: 13.08.2008

EnForcer[™]
SCR

EnerSys[®]

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Model: ES3

***EnForcer[™] SCR Battery Charger
Service Manual***

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AC LINE VOLTAGE LETTER CODES

The following table describes the code letters to be used in new charger part numbers to indicate the AC line voltage(s) and AC line frequency at which the charger can be operated.

Code Letters	Voltages(s) (volts rms.)	Line Frequency (Hz)	Comments
B	208/240/480	60	Applicable to all charger families; single or three phase chargers.
D	220/380/440	50	Applicable to all charger families; single or three phase chargers.
J	480/550/600	60	Applicable to all charger families; single or three phase chargers.
T*	208	60	Use only for special designs; single or three phase chargers.
W*	240	60	Use only for special designs; single or three phase chargers.
X*	240/480	60	Use only for special designs; single or three phase chargers.
Y*	480	60	Use only for special designs; single or three phase chargers.
E	400	50	Use only for special designs. Contact the plant for further information.
S	Special Voltages	Unspecified	Use only for special designs. Contact the plant for further information.

*Replacement part numbers for chargers with such letter codes shall be referred to the charger's tables with code letter "B"

SPECIALTY CHARGER OPTIONS LIST

Suffix	Description
C6	6' of #10 AWG AC cord with 30 amp plug*
C10	10' of #10 AWG AC cord with 30 amp plug*
C12	12' of #10 AWG AC cord with 30 amp plug*
C8	8' of #10 AWG AC cord with 30 amp plug*
CF	10' of #8 AWG AC cord with 50 amp plug*
CF12	12' of #8 AWG AC cord with 50 amp plug*
CR	6' of #10 AWG AC cord with 30 amp Plug and 30 amp receptacle. *
D	Charger with AC Disconnect Switch
G	Outlet receptacle option, GFCI type
HD3	6' of #10 amp AC cord with 30 amp plug*
HD4	6' of #10 AWG AC cord with 30 amp plug and receptacle*
L10	10' of DC cable
L13	13' of DC cable
L15	15' of DC cable
L18	18' of DC cable
L20	20' of DC cable
L25	25' of DC cable
L30	30' of DC cable
LM	SCR charger with Load Management Control
NC	No DC cable
O	Special configuration of a standard EPROM **
P	Parallel DC cables, standard size.
PP	Charger Shipped on a Plastic Pallet
Q	Voltage conversion Quick Tap
S	Series DC cables
T	Block out timer switch
Z	Combination not listed

*When AC cord is installed at the factory only one input voltage is marked on the charger.

**Prior approval needed from Director of Engineering

IMPORTANT SAFETY INSTRUCTIONS

- 1) This manual contains important safety and operating instructions. Before using the battery charger, read all instructions, **cautions**, and **warnings** on the battery charger, the battery, and the product using the battery.
- 2) These chargers were designed to charge industrial batteries, flooded and sealed cell.
- 3) Read and understand all setup and operating instructions before using the battery charger to prevent damage to the battery and to the charger.
- 4) **Do not** touch non-insulated parts of the output connector or the battery terminals to prevent electrical shock.
- 5) During charge, batteries produce hydrogen gas that can explode if ignited. Never smoke, use an open flame, or create sparks in the vicinity of the battery. Ventilate well when the battery is in an enclosed space.
- 6) **Do not** connect or disconnect the battery plug while the charger is on. Doing so will cause arcing and burning of the connector resulting in charger damage or battery explosion.
- 7) Lead-acid batteries contain sulfuric acid that causes burns. **Do not** get in eyes, on skin, or on clothing. In cases of contact with eyes, flush immediately with clean water for 15 minutes. Seek medical attention immediately.
- 8) Only factory qualified personnel can service this equipment.
- 9) De-energize all AC and DC power connections before servicing the charger.
- 10) The charger is not for outdoor use.
- 11) Do not expose the charger to moisture. Operating conditions should be 0° to 104°F; 0 to 70% relative humidity.
- 12) Do not operate the charger if it has been dropped, received a sharp hit, or otherwise damaged in any way.
- 13) For continued protection and to reduce the risk of fire, install chargers on a floor of non-combustible material such as stone, brick, or grounded metal.

WARNING: The shipping pallet must be removed for proper and safe operation.

INSTRUCTIONS DE SÉCURITÉ IMPORTANTES

- 1) Ce manuel contient des informations et des consignes importantes pour l'emploi et l'utilisation du chargeur de batteries industrielles. Avant tout emploi, il est fortement conseillé de lire l'ensemble des instructions, recommandations, et avertissements concernant le chargeur et la batterie.
- 2) Ce chargeur a été conçu pour la charge des batteries industrielles type plomb-acide, les batteries étanches.
- 3) Lisez toutes les consignes d'installation et d'utilisation avant d'employer le chargeur de batterie pour empêcher des dommages à la batterie et/ou au chargeur.
- 4) **Ne pas être en contact avec** les pièces sous-tension non-isolées tels que la prise de charge ou des éléments de connexion de la batterie pour empêcher le choc électrique.
- 5) Pendant la charge, le dégagement d'hydrogène rend l'emploi de feu strictement interdit <<risque d'explosion>>. Ne jamais fumer, employer une flamme nue, ou créer les étincelles à proximité de la batterie. Ventiler suffisamment pour éviter toute condensation de gaz dans un espace restreint.
- 6) **Ne brancher ou débrancher la batterie que si le chargeur est à l'arrêt.** Faire ainsi risque d'endommager la prise de charge pouvant avoir pour conséquence des dommages du chargeur ou l'explosion de la batterie.
- 7) Les batteries d'acide au plomb contiennent l'acide sulfurique, qui cause des brûlures. Éviter le contact avec les yeux, la peau, ou sur l'habillement. Dans le cas de contact avec les yeux, il faut nettoyer immédiatement avec de l'eau propre pendant 15 minutes et consulter un médecin immédiatement.
- 8) Seul le personnel qualifié par l'usine peut entretenir cet équipement. Pour le service, veuillez contacter la société EnerSys ou l'un de ces représentant.
- 9) Avant toute intervention d'entretien ou de réparation il faut s'assurer que le chargeur est hors tension et la batterie est déconnectée.
- 10) Le chargeur **n'est** pas pour un usage extérieur.
- 11) Ne pas exposer le chargeur à l'humidité. Les conditions de fonctionnement devraient être -15° à 40°C; humidité relative de 0 à de 70%.
- 12) Ne pas mettre en fonctionnement le chargeur s'il a reçu un choc mécanique ou tout autre dommage de quelque façon.
- 13) Pour la protection permanente et pour réduire le risque du feu, installez les chargeurs sur un plancher ou un matériel non-combustible tel qu'un mur plein en béton, en brique, ou le acier.

INSTALLATION

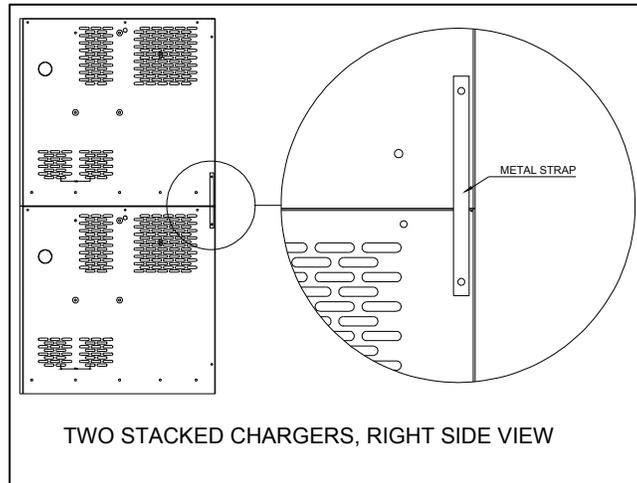
WARNING: The shipping pallet must be removed for proper and safe operation.

LOCATION

For maximum trouble-free service, choose a location that is free of excess moisture, dust, and corrosive fumes. Also, avoid locations where temperatures are high or where liquids will drip on the charger. Allow six (6) inches of clearance at rear and sides of the charger for air circulation. Do not obstruct the ventilating openings or the space under the charger.

STACKING MULTIPLE CHARGERS

These chargers can be stacked up to a maximum of 3 units high. Chargers are not designed to be stacked side by side due to ventilation requirements.



- 1) Position the first charger so that a minimum of 6 inches of space is between the charger and any wall, and 12 inches between the charger and any other equipment.
- 2) Place the second charger on top of the first. Align the bolt holes on each charger.
- 3) Fasten both charger cabinets together securely using 3/8" bolts and nuts.

NOTE: The two bolts toward the back of the charger may be omitted if an after market metal strap (about 8 inches) is used to secure both chargers. Remove existing 1/4" screws of the charger sides and attach strap with screws. Refer to picture.

Hardware kit #X225-99-0-2 can be ordered to attach two chargers.
- 4) Repeat steps 2 and 3 for the third charger.
- 5) Stacked chargers must be fastened to the wall using devices suitable for the wall construction and the bolt holes at the top of the highest charger.

NOTE: Ambient temperature at all levels cannot exceed 104°F/40°C.

ELECTRICAL CONNECTIONS

To prevent failure of the charger, be sure it is connected to the correct line voltage.

ON THREE PHASE UNITS

Connect all the chargers as follows:

Phase A to L1 (fuse block)

Phase B to L2 (fuse block)

Phase C to L3 (fuse block)

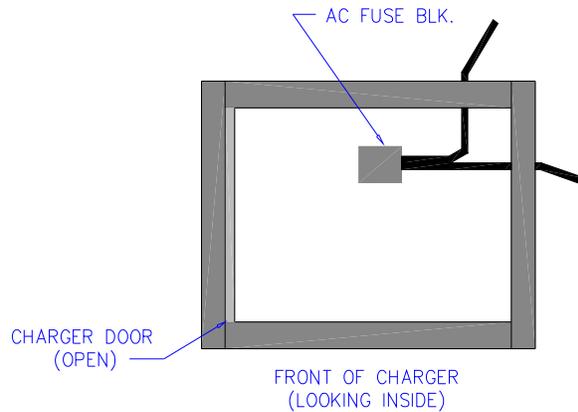
CONNECTING INPUT POWER

WARNING: Make sure the disconnect is in the OFF position and the battery is disconnected before connecting the input power to the terminals of the charger.

Connect the input power to the appropriate terminals, **including ground**. Follow your local electrical or National Electric Code in making these connections.

The figure that follows shows both the top and right side installation options for routing the incoming power.

IMPORTANT: When the AC Disconnect Switch is factory installed connect the input power to the Switch instead of the AC fuse block.



BRANCH CIRCUIT PROTECTION

The user must provide suitable branch circuit protection and a disconnect method from the AC power supply to the charger to allow for safe servicing. (Even if the charger has an optional factory installed Disconnect Switch)

PLUG POLARITY

The charging cable is connected to the DC output of the charger with the positive lead marked RED. The output polarity of the charger must be strictly observed when connecting to the battery (read warning above). Improper connection will open the DC fuse.

GROUNDING THE CHARGER

DANGER: FAILURE TO GROUND THE CHARGER COULD LEAD TO FATAL ELECTRIC SHOCK. Follow National Electric Code for ground wire sizing.

Connect a grounding conductor to the lug provided on the horizontal support panel. This lug is marked as shown:



THEORY OF OPERATION

INTRODUCTION

EnerSys™ EnForcer™ SCR Battery Chargers are three phase 50 or 60 Hz, and SCR/Diode Block-controlled. EnForcer™ SCR chargers use the control board known as “ES3”. See Replacement Parts Lists for complete part numbers.

SCR/Diode Blocks are used to control the output and yield tight regulation over the whole operating curve. Line variations of $\pm 10\%$ will have almost no effect on the operating curve.

All chargers are designed for convection cooling with no de-rating, up to an ambient temperature of 40°C, 104°F (if properly installed per the Installation and Operating Instructions manual).

All models have an Equalize cycle that can be started manually or automatically.

While charging, the information about the state of charge is provided through the control board LEDs and LCD display.

Batteries with cell size and amp hour ratings less than or equal to the charger nameplate values can be charged. Charging batteries that have higher cell size and amp-hour ratings above of the charger nameplate is strongly discouraged.

Refer to the schematic diagrams in the back of this manual as you read the following description.

The 3-phase SCR-controlled battery chargers are available with several operating voltage ranges and come in 50 or 60 Hz models. The voltage, current, and frequency ratings are specified on the nameplate located on the lower-left corner in the front of the charger. **It is important not to exceed any of these nameplate ratings.**

The charger power circuitry contains a transformer that provides full isolation from the primary source to the secondary.

In the transformer secondary there is a 3-phase bridge rectifier made up of 3 SCR/Diode Blocks that converts AC to DC for charging.

The AC voltage of the secondary is connected directly to the SCR/Diode Blocks.

For increased reliability there is a snubber assembly connected across each SCR/Diode Block to limit the gate firing noise and high voltage spikes. Each snubber assembly consists of an MOV (Metal Oxide Varistor), which is a device used to clamp positive or negative voltage spikes at a given level and a capacitor (used to limit DV/DT of the SCR) in parallel.

The magnitude of the secondary AC voltage can be measured across the inputs of the SCR/Diode Blocks, and the values are listed in the troubleshooting section of this manual.

Each primary input line is individually fused, and in some cases, the charger may have been provided an optional AC fused Disconnect Switch. This switch, when it is on, prevents the front door from opening. The secondary DC cable is fused on the negative lead.

Chargers rated at 36 cells and higher will have a different style fuse designed to operate with higher voltages. This will typically be a FWA style semiconductor fuse.

If the charger has been provided with optional parallel DC cables, each of the two negative leads will be individually fused with a size $\frac{1}{2}$ of the rating of a single-cabled charger of similar rating.

PRINTED CIRCUIT BOARDS

All charger functions, features, and controls are handled by one printed circuit board (PC Board) under microprocessor control. Because of its flexible design, this PC board model is capable of being used on an entire range of chargers.

If changes are required on a board that is already installed, then all adjustments, calibrations, and settings are made through the front panel using the pushbuttons and the display. The specific operation of all adjustments through the front panel is described in detail in later parts of this manual. The adjustments are permanently stored in on-board FLASH

memory. If AC power is lost during a charge cycle, the charge cycle will resume after a random delay when AC power is restored. This allows the charger to return to where it left off when power is restored. NOTE: There are no trimming potentiometers located in this charger.

Caution must be observed when handling or taking measurements on the PC board. The control common, or ground, is tied to the positive battery buss. This is especially important to consider when taking measurements on the board while it is operating.

CONTROL CIRCUITRY

The control circuitry measures current via the precision shunt located in the positive lead of the charger. DC Voltage is measured by means of a precision resistor circuit.

WARNING: Under no circumstance should the starting current be adjusted to higher than the charger's ampere-hour nameplate rating times 0.16, or overheating of the charger will occur.

The control circuitry has three phases of charge cycle. When set for SEALED it has four:

- 1) Constant-Current control at the start-current setting(.16 times battery AH rating).
- 2) Constant-Voltage control at the Gassing-Voltage (80%) point setting.
- 3) Constant current at finish rate.
- 4) Finish voltage will not exceed 2.53 VPC (SEALED configuration only).

These modes of operation are determined by the recharge characteristics described in the following sections.

The control circuitry is connected to three small windings off the main transformer through connector J1. The value of these AC voltages can be found in the troubleshooting section of this manual. These windings serve several purposes:

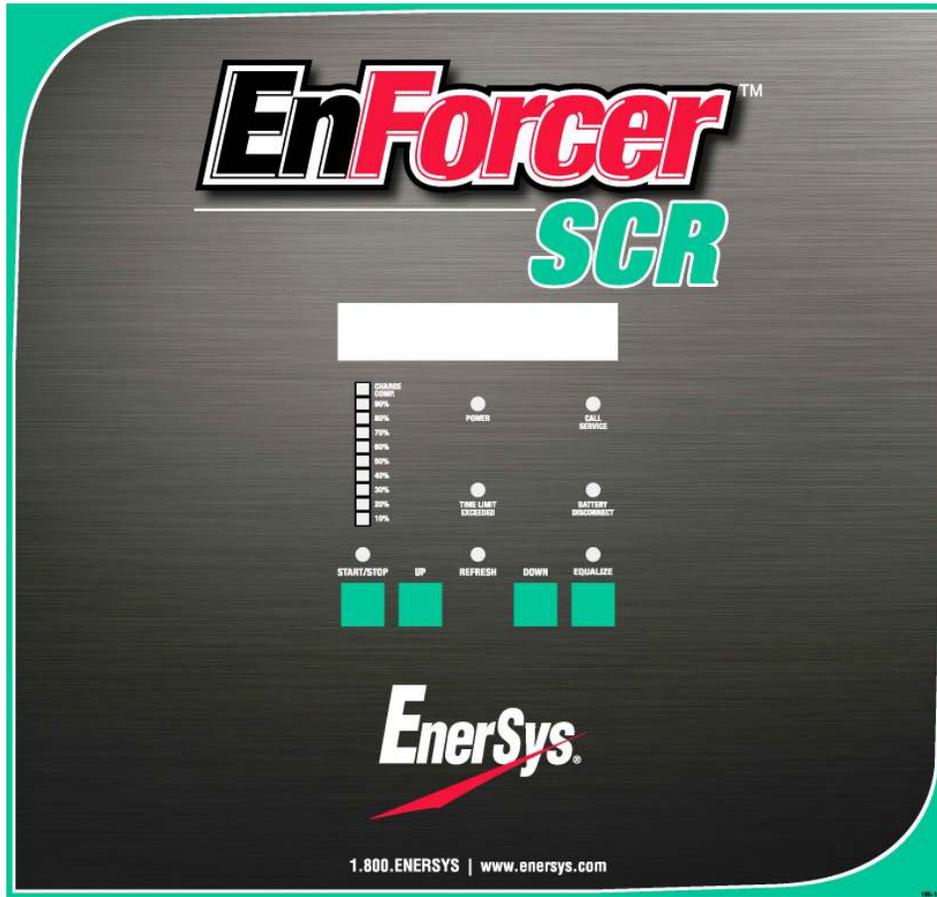
1. Provide the signals that enable the control circuitry to synchronize and determine the proper phase angle to gate on each SCR.
2. Provide power to the control board. The controller will give an AC fault if any of the three phases becomes low or distorted, or if any of the three AC fuses clear.

Each SCR is gated with a DC pulse. The red lead of the SCR is tied to control common, and the white gate lead is tied to the gate-firing circuit on the control circuitry. The control will automatically balance SCR currents to within 10% at the beginning of each charging cycle.

Refer to later sections of the manual for specific measurements and values that can be expected for normal charger operation.

EnForcer™ SCR Features

Front Panel



LED

POWER	Light on when control board powered
CALL SERVICE	Light on when serious fault occurs during charge cycle, usually requiring field assistance.
TIME LIMIT EXCEEDED	Light on when charger time fault occurs
BATTERY DISCONNECTED	Light on when battery disconnected during charge cycle before normal termination
START/STOP	Light on during charge cycle. Light is off when charger is stopped or charge cycle terminates
REFRESH	Light on during refresh cycle
EQUALIZE	Light flashes when an equalize cycle is pending. Light on during and after the actual equalize cycle. Light is reset when battery is disconnected from charger.
BAR GRAPH	Shows capacity returned to battery during charge cycle.

PUSHBUTTONS

START/STOP	Stops a charge in progress or restarts a charge that has been stopped. Can also force a charge cycle by pushing and holding for 5 seconds.
EQUALIZE	Will activate the equalize function at any time during the charge cycle. The equalize button is also used for programming the charger.
UP	Used to scroll through charge cycle data when charger is idle. Also used to scroll up through charger settings in programming mode.
DOWN	Used to scroll through charge cycle data when charger is idle. Also used to scroll down through charger settings in programming mode.

CHARGER FEATURES

GENERAL

The standard ES3 charger has a wide range of charging features for both flooded and sealed cell batteries. The ES3 is capable of charging various cell sizes and ampere-hour ratings as listed on the charger nameplate. Some of the basic features are described below.

DATA LOGGING

A new feature is the data logging of charge cycle parameters such as total charge time, amp hours returned, maximum charger voltage etc. Charge data is held in non-volatile memory for up to 1000 cycle incidents. After 1000 incidents, the charge counter rolls over.

CHARGE PROFILE OPTIONS

The ES3 is capable of charging sealed or flooded batteries under a variety of conditions. Multiple profiles, such as Flooded, Sealed, Opportunity and Automatic Guided Vehicle are only some of the charge profiles the ES3 is capable of delivering to the battery. Multiple termination and finish selections will provide the customer with the perfect charge to fit their battery needs.

LCD DISPLAY

A bright, 2X20 large character LCD display provides large and easy to read text messages and data throughout the charging cycles. Multiple settings let the user choose their preferred contrast and type of information they wish to display.

REAL TIME CLOCK/CALENDAR

The ES3 features a real time clock and calendar. The current time and date is displayed and the time/date information can be used for charge cycle control. A super capacitor enables the control board to retain the time and date information for up to one week during AC power outages.

AUTO CELL SIZING

The ES3 can charge any battery from 1 to 40 cells. Automatic cell sizing is limited to specific common cell sizes shown below. The range of battery cell sizes that an ES3 charger can automatically select is shown in the following table.

Charger Nameplate Rating	Automatic Battery Cell Select Range
40 cells	40,32,24,18,12,6
32 cells	32,24,18,12,6
24 cells	24,18,12,6
18 cells	18,12,6
12 cells	12,6

After detecting a battery, the ES3 will go into a two minute test charge phase, followed by a two minute rest period. The ES3 then automatically determines the battery cell size based on the voltage response of the test charge.

MULTIPLE BATTERY SELECT

A total of 3 completely different battery profile selections can be stored and quickly selected for the customer that has multiple battery cell sizes and amp-hours. Used in conjunction with auto cell sizing, the ES3 charger can automatically choose between batteries with different cell sizes, amp-hours and profiles. The default for the charger is to have this feature shut off so that only a single battery selection can be made.

AUTO START/DELAYED START

Auto Start enables the charger to start the charge cycle automatically after the battery is connected to the charger. A programmable delay can be programmed so that Auto Start will begin after a set time period. This delay can be set through the front panel display. Refer to **Delayed Start** in the **USER parameter** section. Auto start can be delayed anywhere from 0 up to 25 hours, in one minute intervals.

AUTO/MANUAL EQUALIZE CYCLE

An Equalize Cycle adds a predetermined amount of time to extend the battery's charge cycle. The ES3 charger is equipped with an auto equalize function referred to as **Equalize Count** in **USER parameters**. This is a configurable parameter; consult your service representative for more information. The factory default setting for the auto equalize cycle is 3 hours of charge time for every fifth charge cycle. A charge cycle consists of at least one hour of continuous charging of the battery by the charger. Every time the battery completes a charge cycle, the charge counter is incremented. When the charge counter reaches the programmed **Equalize Count** value, an equalize cycle will occur immediately after the battery completes its normal charge cycle. When an equalize charge cycle is pending, the **EQUALIZE** LED will flash. The equalize button can be pressed at any time during the normal charge cycle to stop the pending equalize cycle. Once the battery has completed a successful charge cycle, the **CHARGE COMPLETE** LED will light and the charger will immediately go into the equalize charge cycle. The **EQUALIZE** LED will then light steadily. Pressing the **EQUALIZE** button during the equalize charge cycle will have no effect on the charger. When **Equalize on Day** is chosen in the Service Parameters, the **Equalize Count** is automatically disabled.

The charger can also equalize a battery manually. Pressing the **EQUALIZE** button at any time during the charge cycle will activate the equalize function. Once pressed, the **EQUALIZE** LED will begin to flash indicating that an equalize cycle will occur once the battery has completed a successful charge cycle. The **EQUALIZE** button can again be pressed at any time during the normal charge cycle to stop the pending equalize cycle. The charge counter is reset every time the charger completes at least one (1) hour in Equalize charge.

NOTE: Since Equalize charging extends the recharge time; it is best to do this when additional cooling time is available (example: on a weekend). Consult your factory representative to determine Equalize intervals that meet your needs.

AC POWER FAIL

AC power may fail with a battery connected to the charger during a charge cycle. When AC power returns with the battery connected, the charge cycle will resume the battery charging after a random delay. The charger will also detect an AC fuse open when the charger is charging a battery. This will result in a stopping of the charge cycle and an AC fault message displayed.

REFRESH CYCLE

If a battery remains connected to the charger for a predetermined amount of time after a charge cycle has been completed, a refresh charge cycle will be given to the battery. The factory default setting for the Refresh Cycle is to refresh for 20 minutes every 24 hours. This is a configurable parameter; consult your service representative for more information.

COOL DOWN

When a battery completes a charge cycle without error, it ideally should cool down before being used. The **Cool Down** period after a successful charge cycle is an idle period that allows a battery to cool off before use. **Cool Down** is a configurable parameter that can be set through the front panel display, refer to **Cool Down** in section **User Parameter**. The factory default setting for the **Cool Down** is 1 hour.

PARALLEL CHARGING (OPTIONAL)

In parallel charging, batteries must have an equal number of cells and must match the charger nameplate's ratings. Amp-Hour rating of charger must be equal to the Amp-Hour of both batteries combined. Theoretically, charging current is

equally divided between both batteries provided that batteries % of discharge and ages are equal. Make sure both batteries are connected before charge cycle starts.

The charger must be set for parallel cable and have Auto Cell sizing disabled in the service settings. Contact your sales/service representative.

AC DISCONNECT (OPTIONAL)

When an AC disconnect is installed, access to the charger through the front door is denied unless the AC disconnect is switched off. When the AC disconnect is in the off position, power is only present at the disconnect switch input terminals. Make sure that main breaker is switched off before working on the charger.

AC INPUT CHANGE QUICK TAP™ (OPTIONAL)

Quick Tap™ is a feature to EnerSys chargers that allows the user to change AC input easily and quickly. See the heading VOLTAGE CONVERSION for more information.

ES3 Control Board

NORMAL OPERATION

1. **Idle Mode:** When AC input voltage is applied to the charger and no battery is connected, the **POWER** LED will be lit. Two alternating messages will appear on the front display:

**Connect
Battery #1**

Where Battery # is the selected battery settings 1-3.

**Tue. Dec. 11 2014
10:12:20**

The current date/time.

2. During Idle Mode, toggling the **UP** or **DOWN** pushbuttons will display the previous charge cycle parameters. Toggle the **UP** or **DOWN** to display the total charge time, Amp-hours delivered, highest voltage during the previous charge cycle, the number of charge cycles since the last equalize and the equalize count. Only the charge count and equalize count will be saved in non-volatile memory and can be recalled when AC power is restored after an outage. The other values will remain in volatile memory until the next charge cycle begins or if AC power is removed.

3. Plug the battery connector into the charger connector. The control board senses voltage. Once the battery is connected to the charger, the **START/STOP** LED will flash for approximately 5 seconds while the display shows this message:

**Start
Battery Charger
850 Amp Hours*
Flooded Profile***

* Note that the Amp Hour value and battery type will vary.

**Start in
3 Seconds
2 Seconds
1 Second**

Starting Charger

Charging will begin. The **START/STOP** LED will light steadily. The ES3 will now enter the **Auto Cell Sizing Test Charge** indicated by the displayed text message on the LCD and the 'bouncing ball' on the bar graph. After two minutes in the test phase, the charger will shut off and enter the **Auto Cell Selection** phase. The display will show the count down from two minutes. The ES3 will then choose the appropriate battery cell size based on the voltage response of the battery.

Start Charge
18 Cell 1000 AH

Cell size is chosen

Fllooded profile

Battery type displayed

The charge cycle starts and will reach steady state start current within a few seconds. The LED bar graph will indicate the percent charged status of the battery and the display will rotate through the following charge parameters.

Charger Current 46.3	(Charger output current)
Amp Hours Returned 268	(Amp-Hours returned to Battery)
Charge Time 3:12	(Total Charge Time)
Battery Volts/Cell 2.56	(Individual Cell Voltage)

These values are displayed in rotation for about 3 seconds each. The display settings can be changed so that one or all the above parameters will be displayed. The default setting is for all parameters to be displayed.

CAUTION: To prevent arcing and burning at the connector and possible battery explosion, press the START/STOP pushbutton first to stop the charge cycle before removing a battery that is currently on charge.

- When the battery reaches **Gassing Voltage**, the yellow **80%** LED will light and the charge current will begin to taper. The charge cycle enters constant voltage or E mode.
- After the current tapers to the finish-rate current, charging will continue until the battery voltage flattens or the time in taper equals 5 hours. If no Equalize charge is to be applied to the battery, the charger will stop and the display will show **Cool Down**. **Cool Down** is an idle time period that allows the battery to cool off before use. After a 1 hour Cool Down period (default), the display will show "**Done**".

6.

NOTE: If the battery is to receive an **Auto Equalize** charge, the charge cycle continues for 3 more hours at finish-rate current and then stops, displaying **Cool Down**.

- When the battery is fully charged the green **Charge Complete** LED will light, the **START/STOP** LED will extinguish and the charger will shut off. At this time the battery is at full capacity and ready for use.

If **Cool Down** is not selected, the display will read "**Done**" when the charge is complete.

If **Cool Down** is selected, at the end of charge the display will read:

Cool Down
In: 00:59

For the duration of the cool down period. After the cool down period has expired, the display will read “**Done/Battery Available**”.

8. When the battery is disconnected, only the **POWER** LED remains lit and the display will return to “**Connect Battery**” / **Time/ Date** alternately. The charge counter is incremented by one for the completed charge cycle.

USER PARAMETER CONFIGURATION

ENTER USER PARAMETERS

The charger's User parameters may only be configured while the charger is in idle mode with no battery connected. Press **Equalize** button and hold for approximately 5 seconds. The display will show: “**User Parameters**”. Release the **Equalize** button and the first User parameter: “**Set Clock/Calendar?**” is displayed.

ADJUSTING USER SETTINGS:

Toggle the **UP** or **DOWN** arrow keys to scroll through the available User Parameters. To view the contents of the variable displayed, toggle the Equalize button. The value of that setting will be displayed. To change the displayed value, toggle the **UP** or **DOWN** arrow keys to the desired value. If you press and hold the **UP** or **DOWN** pushbuttons for 3 seconds when adjusting the parameters, the options will scroll through at a rapid pace. Release the pushbutton to return to normal scrolling mode. Once the desired value is chosen for that parameter, toggle the **Equalize** button again to set it and to move on to the next parameter. In the case of setting the real time clock, toggle the **Equalize** button when “**Set Clock/Calendar?**” is displayed in order to enter the clock setting function. **Clock Minutes** is now displayed. Choose the **Clock Minutes** by toggling the Equalize button again. To change **Clock Minutes**, scroll with the **UP** or **DOWN** arrows. Press **Equalize** again to set the value. Scroll through the other real time clock value of hours, days etc. by toggling the **UP** or **DOWN** arrow keys and set in a similar fashion. Press the **Start/Stop** key to save and exit the real time clock function.

To exit and save from User Parameters at any time, press the **Start/Stop** button. For a list of available user parameters and their definitions, see the table below.

<i>Parameters</i>	<i>Description</i>	<i>Range</i>	<i>Default</i>
Battery Selection	Select Battery 1-3 When Battery Select is enabled in Service Parameters , choose between 1,2 or 3 completely different battery and charge profiles. NOTE: This parameter is displayed when Battery Select is enabled in Service Parameters.	1-3	1
Set Clock/Calendar	Minute, Hours, Date etc. Enter the set clock function to adjust the time/date. This should be set to match current Date/Time	various	none
Battery Cell Size	Battery Cell Size Select the battery cell size to be charged. This value can be less than or equal to the Charger nameplate cell size. Do not adjust unless order acknowledgement specifies a change.	1-Charger nameplate cell size	18
Battery Amp-Hours	Battery Amp Hour Select the battery amp hour value. This value can be less than or equal to the Charger nameplate amp hour value. Do not adjust unless order acknowledgement specifies a change.	10 – Charger nameplate amp hour	850

Contrast Adjust	Contrast Adjust Select the LCD contrast between characters and background. Do not adjust unless order acknowledgement specifies a change.	10-1100	100
Display Mode	Display mode The following selection determines the parameters that are displayed during the charge cycle. 3 = displays current, A-H returned, charge time and battery voltage 2 = displays current and voltage only 1 = displays current only 0 = displays voltage only Do not adjust unless order acknowledgement specifies a change.	0-3	3
Delayed Start	Delayed start Amount of time delay after a battery is connected to the charger, before charging proceeds. Increments in 1 minute intervals. Do not adjust unless order acknowledgement specifies a change.	0 min – 25 hr	.00
Cooldown Time	Cool Down Time Amount of time after a complete charge cycle that a battery needs to cool down before being utilized. Do not adjust unless order acknowledgement specifies a change.	0 hr – 12 hr	1.00 hr
Equalize Count	Equalize Counts Total amount of charge cycles that need to occur before an automatic equalize charge cycle will take place. Charge cycle must be 1 hour minimum duration. (0 indicates that no Equalize charge will occur) Do not adjust unless order acknowledgement specifies a change.	0(OFF) 1-20 charge cycles	5 charge cycles

SERVICE PARAMETERS

While in Idle Mode, hold down the **DOWN** and **EQUALIZE** buttons until the display reads **Service Parameters** (approximately 10 seconds).

Release the buttons and the display will read **Charger Cell Size, Range: 1- 40 Cells**.

Toggle the **UP** or **DOWN** arrow keys to scroll through the available Service parameters. To view the contents of the variable displayed, toggle the **EQUALIZE** button. The value of that setting will be displayed. To change the displayed value, toggle the **UP** or **DOWN** arrow keys to the desired value. If you press and hold the **UP** or **DOWN** pushbuttons for 3 seconds when adjusting the parameters, the options will scroll through at a rapid pace. Release the pushbutton to return to normal scrolling mode. Once the desired value is chosen for that parameter, toggle the **EQUALIZE** button again to set it and to move on to the next parameter. To save and exit from Service parameters at any time, press the **START/STOP** button.

The table below shows a list of the available Service parameters, their meanings, and allowed values. The table shows the Service parameters in the order that they appear.

Parameter	Description	Range	Default
Charger Cell Size	Charger Cell Size This is the maximum number of cells that the charger is designed to charge. This should be set to match the cell size rating on the charger nameplate.	1 - 40	18
Charger Amp-Hours	Charger Amp-Hours This is the maximum amp-hour rating of the charger. This should be set to match the amp-hour rating on the charger nameplate	10 – 2500	850

Time to Gassing	<p align="center">Time to Gassing Limit</p> <p>If the battery does not reach the gassing voltage within this time (in hours and minutes), the charger will shut off. Do not adjust unless order acknowledgement specifies a change.</p>	:01 – 12:00	6:00
Charge Time Limit	<p align="center">Charge Time Limit</p> <p>If the charge is not complete within this time (in hours and minutes), the charger will shut off and indicate fault. Do not adjust unless order acknowledgement specifies a change.</p>	:01 – 18:00	14:00
Refresh Time	<p align="center">Refresh Charge Time</p> <p>Length of refresh charge, in hours and minutes. Do not adjust unless order acknowledgement specifies a change.</p>	:00 – 1:00	:20
Refresh Interval	<p align="center">Refresh Interval</p> <p>Length of time between refresh charges, in hours and minutes. Do not adjust unless order acknowledgement specifies a change.</p>	2:00 – 99:00	24:00
Equalize Duration	<p align="center">Equalize Time</p> <p>Length of time to run in equalize, in hours and minutes. Do not adjust unless order acknowledgement specifies a change.</p>	:06 – 10:00	3:00
Gassing Voltage	<p align="center">Gassing Voltage</p> <p>Set point for gassing (80% point) voltage, in volts per cell. Do not adjust unless order acknowledgement specifies a change.</p>	1.00 – 3.00	2.370
-dvd(-voltage /time)	<p align="center">Negative dV/dt Voltage</p> <p>Set point for negative dV/dt voltage, in millivolts per cell. Used for hot battery or bad cell detection. Do not adjust unless order acknowledgement specifies a change.</p>	0 - 100	20
Up Battery Detect	<p align="center">Up Battery Time</p> <p>If battery reaches gassing voltage before this time, in minutes, has expired, the charger will stop and go to complete. Do not adjust unless order acknowledgement specifies a change.</p>	:00 - :10	:02
Cable Length	<p align="center">Cable Length</p> <p>Length of battery cables, in inches, installed on the charger – used in battery cable drop compensation calculations. This should be set to match the length of the cables installed on the charger.</p>	0 - 2400	120
Cable Type	<p align="center">Cable Type</p> <p>Size of battery cable: 1 = 4/0 cable 2 = 3/0 cable 3 = 2/0 cable 4 = 1/0 cable 5 = #2 cable This should be set to match the type of cable installed on the charger.</p>	1 - 5	4
Cable Configuration	<p align="center">Cable Configuration</p> <p>This parameter configures the controls to the configuration of the battery cables for the purposes of calculating the battery cable drop compensation: 0 = Cable drop compensation disabled. 1 = Standard cable 2 = Parallel cable This should be set to match the configuration of the cables installed on the charger.</p>	0 - 2	1
Termination Method	<p align="center">Termination Method</p> <p>Method used to finish charge: 1 = dV/dt 2 = time-voltage 3 = both dV/dt and time-voltage (whichever occurs first) 4 = proportional 5 = amp-hour</p>	1 – 5	2
Amp-Hours Removed	<p align="center">Amp Hours Removed</p> <p>If Amp-Hours Termination Method is chosen above. This parameter sets the Amp-hours removed. Do not adjust unless order acknowledgement specifies a change.</p>	10-2500	850
Extended dvd	<p align="center">Extended dV/dt</p> <p>Adds a specified time to the dV/dt termination method if dv/dt termination is</p>	0:00 – 4:00	0:00

	chosen above. Do not adjust unless order acknowledgement specifies a change.		
Delta Voltage- dv/dt	Delta Voltage- dv/dt The change in battery voltage over time limit that the charger monitors, in order to determine charge completion. Units are in mV/cell. High values correspond to a shorter charge cycle. Do not adjust unless order acknowledgement specifies a change.	0-50	10
Time after Gassing	Time after Gassing Voltage Time limit for time-voltage and Both termination modes (see above). Do not adjust unless order acknowledgement specifies a change.	0:00 – 10:00	5:00
Proportional Factor	Proportional Factor For proportional termination mode, this parameter specifies the percentage of start rate time to continue charging after reaching gassing voltage. Do not adjust unless order acknowledgement specifies a change.	0 – 100	40
Finish Current	Finish Current Setting for finish rate current in amps. This is automatically set to 4.5% of battery amp-hours when either battery amp-hours or charger amp-hours is set. If Sealed profile is chosen (VRLA), then this value is set to 2.5% of battery amp-hours. The maximum setting is 16% of charger nameplate amp-hours. Do not adjust unless order acknowledgement specifies a change.	3 – 200	38
Start Current	Start Current Setting for start rate current in amps. This is automatically set to 16% of battery amp-hours when either battery amp-hours or charger amp-hours is set. The maximum setting is 16% of charger nameplate amp-hours. Do not adjust unless order acknowledgement specifies a change.	3 – 400	136
Charge Profile	Charge Profile 1 = IEI (flooded) 2 = IEIE (sealed- VRLA) 3= AGV (Auto guided vehicle) 4= I (VVR) 5 = IE (Floating mode) 6= Opportunity This should be set to match the type of battery that the charger will be charging.	1 – 6	1
Sealed Finish Volts	Sealed Finish Volts For sealed (VRLA) charge profiles, the final voltage, in volts per cell. Do not adjust unless order acknowledgement specifies a change.	1.000 – 3.000	2.530
Sealed Finish Time	Sealed Finish Time For sealed (VRLA) charge profiles, the maximum time to stay in the final voltage stage. Do not adjust unless order acknowledgement specifies a change.	0:00 – 12:00	2:00
Equalize on Day 1	Equalize on Day 1 Equalize on a particular day of the week after charge cycle completes. Set from Sunday – Saturday or OFF. Used in conjunction with the real-time-clock. Will disable Equalize by Count in USER Parameters when ON. Do not adjust unless order acknowledgement specifies a change.	Sunday-Saturday or OFF	OFF
Equalize on Day 2	Equalize on Day 2 Second day equalize setting similar to above. Equalize on a particular day of the week after charge cycle completes. Set from Sunday – Saturday or OFF. Used in conjunction with the real-time-clock. Will disable Equalize by Count in User Parameters when ON. Do not adjust unless order acknowledgement specifies a change.	Sunday-Saturday or OFF	OFF
Block Out time Start	Block out Start Time Start time for charger block out period. Setting 00:00 is OFF. Do not adjust unless order acknowledgement specifies a change.	00:00(OFF) 00:01-23:59	00:00
Block Out time Stop	Block out Stop Time Stop time for charger block out period. Setting 00:00 is OFF. Do not adjust unless order acknowledgement specifies a change.	00:00(OFF) 00:01-23:59	00:00
Enable Forced Start	Enable Forced Start Enable/Disable the charger control forced start function. Do not adjust unless order acknowledgement specifies a change.	0(OFF) 1(ON)	1

Auto Cell Sizing	Auto Cell Enable Enable/Disable automatic cell sizing routine. Do not adjust unless order acknowledgement specifies a change.	0(NO) 1(YES)	1
Enable Battery Select	Enable Battery Select Enable/Disable automatic battery select routine. 0 = OFF 1 = ON Do not adjust unless order acknowledgement specifies a change.	0 – 1	0
Enable Random Delay	Random Delay Enable Enable/Disable random delay after AC power outage. 0 = NO 1 = YES Do not adjust unless order acknowledgement specifies a change.	0 – 1	1
Enable Clock Setting	Real Time Clock Setting Enable in User Parameters 0 = NO 1 = YES Do not adjust unless order acknowledgement specifies a change.	0-1	1
Enable Battery Cell	Enable Battery Cell Selection in User Parameters 0 = NO 1 = YES Do not adjust unless order acknowledgement specifies a change.	0-1	1
Enable Battery A-Hr	Enable Battery Amp-Hours in User Parameters 0 = NO 1 = YES Do not adjust unless order acknowledgement specifies a change.	0-1	1
Enable User Display	Enable Display Adjustment in User Parameters 0 = NO 1 = YES Do not adjust unless order acknowledgement specifies a change.	0-1	1
Enable Delay Start	Enable Delay Start in User Parameters 0 = NO 1 = YES Do not adjust unless order acknowledgement specifies a change.	0-1	1
Enable Cool Down	Enable Cooldown in User Parameters 0 = NO 1 = YES Do not adjust unless order acknowledgement specifies a change.	0-1	1
Enable Equalize Count	Enable Equalize Count in User Parameters 0 = NO 1 = YES Do not adjust unless order acknowledgement specifies a change.	0-1	1
Charger Counter	Charge Cycle Odometer Changeable Charger Cycle counter for short time testing. Do not adjust unless order acknowledgement specifies a change.	0-200	0
Total Charge Cycles	Total Charges Total Charge Cycle count of the number of charger cycles that terminated normally. This parameter is not adjustable.	0 – 64000	0

CHARGER FAULTS

The charger control circuitry constantly monitors for several fault conditions. If a fault should occur, the charge in progress is interrupted, and a fault message is displayed on the LCD. A list of the faults and their descriptions follow.

Displayed Fault	Description	Fault LED	Fault Clearing
No DC Current Check DC Fuse	Occurs when the DC fuse opens or no DC output current.	Call Service – Yes Bar Graph - Flashes	Can be reset by disconnecting the battery from charger. Replace fuse or trouble shoot.
Battery Disconnected While Charging!	Occurs when a charging battery is disconnected from the charger without first stopping the charge cycle.	Battery Disconnect - YES Bar Graph – Steady On	Can be reset by connecting a battery to the charger.
Time To Gassing Limit Exceeded	Occurs when the time limit to gassing voltage is exceeded.	Time Limit Exceeded - YES Bar Graph – Steady On	Can be reset by disconnecting the battery from the charger
Overall Charge Time Limit Exceeded	Occurs when the overall charge cycle time limit is exceeded	Time Limit Exceeded - YES Bar Graph – Steady On	Can be reset by disconnecting the battery from the charger
Time After Gassing Limit Exceeded	Occurs when the time limit after gassing is exceeded	Time Limit Exceeded - YES Bar Graph – Steady On	Can be reset by disconnecting the battery from the charger
Low Battery Voltage/ Check Battery	Occurs when the battery is first connected and the voltage is between 1.0 and 1.8 volts/cell*	Call Service – NO Bar Graph – Steady On	Can be reset if battery voltage is between 1.8 and 2.4 volts/cell
High Battery Voltage/ Check Battery	Occurs when the battery is first connected and the voltage is above 2.4 volts/cell.	Call Service – NO Bar Graph – Steady On	Can be reset if battery voltage is between 1.8 and 2.4 volts/cell
Battery Temperature/ Decreasing Voltage	Occurs when there is negative change in battery voltage	Call Service – NO Bar Graph – Steady On	Can be reset by disconnecting the battery from the charger
High Amp-Hours	Occurs when more than 150% of battery Amp-Hours are returned during the charge cycle	Call Service – NO Bar Graph – Steady On	Can be reset by disconnecting battery from the charger
AC Voltage Fault	Occurs when input AC voltage quality is poor or distorted. Note that this condition may be temporary. The charger will attempt to re-start after 3 minutes. If unsuccessful, will attempt a total of 4 times before a permanent fault condition occurs.	Call Service – NO, ON when fault is permanent. Bar Graph – Steady ON, Flashes when fault is permanent	Can be reset by Disconnecting and reconnecting battery to the charger. Disconnect AC power & check AC source.
AC fuse blown Or lost phase	Occurs when AC fuse is blown or a phase of AC power is interrupted when the charger is charging a battery. Note that this condition may be temporary. The charger will attempt to re-start after 3 minutes. If unsuccessful, will attempt a total of 4 times before a permanent fault condition occurs.	Call Service – NO Bar Graph – Steady ON, Flashes when fault is permanent	Can be reset by Disconnecting and reconnecting battery to the charger. Disconnect AC power & check AC source.

DEFAULT SETTINGS

To set the control board to the default control board settings, perform the following actions. Note that default values will not necessarily match the charger nameplate values. Entering **Service Parameters** and resetting selected parameters may be necessary.

1. Remove power to the control board.
2. Before applying power to the board, hold down the UP and DOWN pushbuttons.
3. Reapply power. Hold down the **UP** and **DOWN** pushbuttons, for approximately five seconds, until the display reads **Default Parameters**.
4. Release the **UP** and **DOWN** pushbuttons.
5. All battery profile settings will now be reset to the original default settings.

FIELD CALIBRATION

No field calibration is necessary. All control boards are factory calibrated. No pots or adjustments are available. Return all failed or defective boards to the factory.

RECHARGE CHARACTERISTICS

When a charge cycle begins, constant current is applied to the battery (start current mode). This constant current is called start rate current. When the gassing voltage point (80% charge voltage of 2.37 volts/cell) is reached, the charger stops applying constant current, and starts applying constant voltage (Constant Voltage mode).

GASSING VOLTAGE POINT NOT REACHED

If the gassing voltage point is not reached during the time allotted (which is factory set for 6 hrs), a time-to-gassing fault occurs resulting in charger shut down.

GASSING VOLTAGE POINT REACHED

When the gassing voltage point is reached within the time-to-gassing period, the charge cycle enters constant voltage or E mode. During constant voltage mode, the current tapers down to approximately 4.5 amps per 100 AH. At this point, the charger stops applying constant voltage and returns to applying constant current. This constant current is called finish rate current.

FINISH CURRENT MODE REACHED

If charger current drops below finish rate, the cycle will continue charging until termination time or a flattening of the battery voltage(dvdt) is achieved

EQUALIZE MODE

If this is an Equalize charge cycle, once the charger completes the normal cycle, it will enter Equalize mode where it will equalize all the cells in the battery. It is recommended that every fifth or sixth charge cycle be an equalize cycle (check with Service representative).

During Equalize mode the charger applies constant current at the same rate as the current in finish current mode. The Equalize mode adds 3 hours to a daily charge cycle.

REFRESH MODE

Refresh mode will be entered after the charge cycle has completed, if the battery is left connected to the charger for the period of time specified. The refresh wait period is factory set for 24 hours. A refresh charge assures that the battery is fully charged.

During Refresh mode, the charger applies constant current at finish rate. The time spent in Refresh mode is adjustable. Refresh Charging time is defaulted to 20 minutes.

CHECKING THE RECHARGE CHARACTERISTICS

You can check the battery voltage during start rate on a discharged battery. The battery voltage should gradually increase to 2.37 volts/cell (v/c) with the charging current at 16% of the charger nameplate rating. Example: If you are using a 550 AH charger, the charging current during start current mode will be 16% of 550, which is 88 amperes. The output voltage at the battery terminals can be checked during constant voltage mode. The battery voltage should be steady at 2.37 v/c \pm 1%, and the charge current should gradually decrease. The battery voltage can be checked during finish current mode. The battery voltage should measure at least 2.37 v/c at a constant current of 4.5% of the charger nameplate rating.

Termination Methods

There are five choices for termination methods. These termination methods apply mainly for flooded batteries with the IEI charge profile.

1. dvdt
2. Time-voltage
3. Both dvdt or time-voltage (whatever occurs first)
4. Proportional
5. amp-hour

dvdt

The dvdt termination algorithm looks for a flattening of the battery voltage after the charge cycle enters into finish rate. In particular, when the battery voltage does not increase greater than 10 mV/cell over a 30 minute period, the dvdt requirements are satisfied. The minimum time for dvdt termination is 50 minutes after gassing voltage is reached. Please note that the above values are default charger values and can be adjusted by modifying the service parameters **extended dvdt** and **delta voltage dvdt**.

Time-Voltage

A set time-after-gassing voltage period that charge cycle terminates. The default value in service parameters is 5 hours.

Both

Charge cycle completes when **either** time-voltage or dvdt termination methods, as described above, occurs.

Proportional

Charge cycle completes when the time after gassing reaches a set percentage of the start rate time before gassing. The default setting in service parameters is 40%. As an example, the charge cycle will terminate when the time after gassing is 40% of the start rate time.

Amp Hour

Charge cycle completes after set amount of amp-hours returned are reached. Note that an amp-hour return of greater than 150% of charger nameplate amp-hours will result in a high amp-hour fault.

Charge Profiles

There are six choices for charge profiles. These profiles have default time and level settings that are detailed below. The profile's settings can also be modified various ways in **Service Parameters** for custom applications to satisfy a customer's needs.

IEI (Flooded)

IEI is the standard flooded profile. The first stage of the charge cycle (the first I in IEI) is current mode at start rate current which is defaulted to 16% of the amp-hour rating. Start rate current is maintained as the battery voltage increases until gassing voltage is reached. Gassing voltage is set normally at the default rating of 2.37 volts/cell. Once gassing voltage is reached, the charger goes into the E mode where the charger voltage is held constant at gassing while the charge current tapers off. Once the charge current reaches the finish rate of 4.5% of the amp-hour rating (default), the charger enters the final I mode of the charge cycle. Charge termination will occur once the battery voltage flattens out in finish I mode (dvdt) or if the time period

after the gassing voltage is reached is 5 hours (time-voltage), whichever comes first. This result occurs if the charge termination is the default **"Both dvdt or time-voltage"** setting.

Defaults:

Start Rate Current	16% of Battery AH
Gassing Voltage	2.37 V/C
Termination Method	Both dvdt or Time Voltage
Time after gassing limit	5 Hours
Finish Rate	4.5% of Battery AH
Charge Time Limit	14 Hours

IEIE (Sealed)

IEIE profile is more commonly referred to as sealed or VRLA. This profile is similar to IEI except that the finish rate constant current is 2% of the amp-hour rating of the battery. Also, there is an added voltage mode (E) in the profile that will hold the battery voltage to 2.53volts/cell (default) until the charge cycle finishes. Dvdt termination does not apply in the sealed profile. Charge termination will occur when the time-after gassing reaches 4 hours if the battery voltage **does not** reach 2.53 volts/cell. If the battery voltage reaches 2.53 volts/cell before the 4 hour time limit, an added 2 hours in constant voltage E mode is added to the charge cycle.

Defaults:

Start Rate Current	16% of Battery AH
Gassing Voltage	2.37 V/C
Termination Method	Time Voltage
Time after gassing limit	4 Hours if under 2.53 V/C 2 Hours if 2.53 V/C reached
Finish Rate	2% of Battery AH
Charge Time Limit	14 Hours

AGV (Auto Guided Vehicle)

Automatic guided vehicle. AGV is an IE profile with a two hour time-after-gassing time limit. Charge cycle will terminate if the time-after gassing limit is reached **or** if the charge current drops below finish rate. If battery is disconnected from charger during the charge cycle, no **'Open Battery'** fault will result.

Defaults:

Start Rate Current	16% of Battery AH
Gassing Voltage	2.37 V/C
Termination Method	Time Voltage or Charge Current falls below Finish Rate
Time after gassing limit	2 Hours
Finish Rate	4.5% of Battery AH
Charge Time Limit	14 Hours

I (VVR)

Constant current mode throughout entire charge cycle. Charge current is limited to finish rate (default). Charge time limit defaults to 32 hours.

Defaults:

Start Rate Current	4.5% of Battery AH
Gassing Voltage	Does not apply
Termination Method	Does not apply
Time after gassing limit	Does not apply
Finish Rate	Does not apply
Charge Time Limit	32 Hours

IE (Floating)

Also known as floating mode. Constant start rate current until gassing voltage then constant voltage (E) mode. Gassing voltage default is 2.35 volts/cell. While in constant voltage mode, display indicates 'floating charge'. Note that there is no charge time limit in this profile. Charge cycle will continue indefinitely while battery is connected. Charge current may fall to zero with no **Open Battery** fault while charger is in floating (E) mode. Disconnecting the battery while in float mode will not result in a fault. However, disconnecting the battery while charging in start rate (I mode) or in equalize will cause an **Open Battery** fault. In case of a hot battery, charge current is limited to finish

rate in floating mode. If charge current rises above finish rate, charge cycle will terminate as **Charge Complete**.

Defaults:

Start Rate Current	16% of Battery AH
Gassing Voltage	2.35 V/C
Termination Method	Floating indefinitely
Time after gassing limit	Indefinite
Finish Rate	Floating (Does not apply)
Charge Time Limit	Indefinite

Opportunity

IE profile with a default of 10 hours time-after-gassing, settable up to 32 hours. Overall charge time limit default is 32 hours. When charge cycle is in constant voltage (E) mode, the charger is 'floating' and disconnecting the battery will not result in an **Open Battery** fault.

Defaults:

Start Rate Current	16% of Battery AH
Gassing Voltage	2.37 V/C
Termination Method	Time Voltage
Time after gassing limit	10 Hours
Finish Rate	Floating (Does not apply)
Charge Time Limit	32 Hours

Data Logging

While in Idle Mode or Done mode, hold down the **DOWN** and **UP** buttons (approximately 10 seconds) until the display reads **Data Logging Selections**.

Release the buttons and the display will read "**Number of Records:**".

Toggle the **EQUALIZE** button and the display will read **Display a Record?** The last record number will be shown at the bottom right of the display.

Toggle the **DOWN** arrow keys to scroll through the available records. To view the contents of the individual record, toggle the **EQUALIZE** button. The Log Date will be displayed. To view the log data, toggle the **UP** or **DOWN** buttons. The log time, charge parameters for that log can be read. To exit a particular log, press the **EQUALIZE** button. You can then continue to scroll through different Data Logs with the **UP** and **DOWN** buttons. Select a new log again by pressing the **EQUALIZE** button. In order to exit Data Logging at any time, press the **START/STOP** button.

The table below shows a list of the available Data Log parameters. The table shows the data in the order that it appears.

1. Log Date/Time	Date and time of log event
2. Log Store Code	1 = Daily charge Complete. 2 = Daily Charge Incomplete. 3 = Equalize Charge Complete. 4 = Equalize Charge Incomplete.
3. Total Charge Cycles	Total Charge cycles greater than 1 hour
4. Total Equ. Cycles	Total Equalize cycles greater than 1 hour
5. Total Charge Amp-Hours/1000	Total Amp- Hours the charger has put out in thousands of Amp-Hours.
6. Max. Charger Temperature *	Future option
7. Current Charger Temperature *	Future option
8. Minimum Charger Temperature *	Future option
9. Maximum Charger DC Volt	Max. DC volt for this particular charge cycle
10. Minimum Charger DC Volt	Min. DC volt for this particular charge cycle
11. BID Serial Number **	Future option
12. Battery Amp-Hour Rating	Battery Amp-hour setting from USER parameters
13. Battery Start Temperature *	Future option
14. Battery End Temperature *	Future option
15. Battery Cell Size	Battery Cell size from USER parameters
16. Equalize Count	Equalize count setting from USER Parameters
17. DC volts at Start	DC volts at beginning of charge cycle
18. DC volts at End	DC volts at end of charge cycle
19. Amp-Hours Returned	Amp hours returned for this particular charge cycle
20. DC Amps at Start	DC amps at beginning of charge cycle
21. DC Amps at End	DC amps at end of charge cycle
22. Pre 80% Charge Time	
23. Total Charge Time	
24. Charge Profile Used	Charge Profile 1-6 from Service Parameters.
25. Fault Code	1 = DC fuse, 2 = Open Battery, 3 = Time to gassing, 4 = Low Battery, 5 = Overall Time Limit, 6 = Hot Battery, 7 = High Battery Voltage, 8 = Time After Gassing, 9 = High Amp-Hours, 10 = AC power distortion, 11 = AC fuse or single phase

*Note that all the temperature features are future features.

** Note the BID serial Number is a future feature

A total of 1000 events can be logged before data logger rolls over and overwrites previous data.

CAUTION: To prevent arcing and burning at the connector or a possible battery explosion, press the START/STOP pushbutton first to stop the charge cycle before removing a battery that is currently on charge.

WATCHDOG CIRCUITS

There are two watchdog circuits on the Enforcer SCR control board – the Override Watchdog and the Reset Watchdog. Each has an associated orange LED, located on the bottom half of the right edge of the board. The LEDs can be readily observed by opening the door and looking at the board edge on. The status of the Override Watchdog is indicated by LED1 – the upper LED; the status of the Rest Watchdog is indicated by LED2 – the lower LED.

OPERATION OF RESET WATCHDOG AND OVERRIDE WATCHDOG

VERRIDE WATCHDOG

The Override Watchdog monitors the operation of the charge cycle and the Start/Stop pushbuttons and overrides the main microprocessor if a fault condition is detected. The SCRs are turned off and held off when an override occurs.

NORMAL OPERATION

LED1 flashes once a second to indicate that the microprocessor is operating correctly.

FAULT INDICATION

LED1 flashes at 6-8 times per second to indicate that a fault has been detected.

CONDITIONS THAT CAUSE FAULTS

Total charge time: If the charge time exceeds 19 hours (this includes successive refresh cycles), the Override Watchdog will operate.

Start / Stop button: If the Start/Stop button is pressed while the charger is charging and the main microcontroller does not shut off the output within ½ second, the Override Watchdog will operate.

Note that when the Override Watchdog operates, the main processor may still attempt to start a charge cycle. Since the SCRs are held off, a “DC fuse” error will eventually result. Continuous “DC fuse” faults are sometimes an indicator of an Override Watchdog operation.

FAULT RECOVERY

The only way to recover from any override watchdog fault is to cycle control board power.

Please note: If a battery has been connected to a charger for a long period after the charge cycle has completed, the successive refresh cycles may cause the 19 hour charge time limit to expire. The Override Watchdog will operate and prevent the main processor from starting a charge cycle. A “DC fuse” fault will result.

RESET WATCHDOG

The Reset Watchdog will reset the main processor in the event of a processor fail or lock-up.

NORMAL OPERATION

LED2 flashes every second for 2 minutes after control board power up. The Reset Watchdog is not enabled during this 2 minute start-up. After two minutes, LED2 stays on steady. The Reset Watchdog is now monitoring the main processor. For normal operation, LED2 will remain on steady.

FAULT INDICATION

If the main processor locks-up or does not operate as expected, the Reset Watchdog will reset the main processor after an 8 second delay. The control board will re-boot and resume normal operation. If a battery is connected to the charger, the control board will go into random delay before starting the charge cycle. LED2 will flash every 4 seconds indicating a Reset has occurred since the last control board power up.

SUBSEQUENT FAULT INDICATION

If the main processor locks-up again before the next control board power-down, LED2 will flash as shown below.

LED2 state	Main Processor
ON steady	No lock-ups or failures since last power-up.
Flash every 4 seconds	1 lock-up since last power-up.
Flash every 2 seconds	2 lock-ups since last power-up.
Flash every 1 second	3 lock-ups since last power-up.
Flash every ½ second	4 or more lock-ups since last power-up.

If the main processor locks-up more than four (4) times, LED2 will remain flashing every ½ second.

FAULT RECOVERY

The Reset Watchdog is reset by cycling power to the control board. After power-up, the Reset Watchdog will resume normal operation and will light steadily after the two minute time-out.

TESTING COMPONENTS

The following information applies to all charger types, unless otherwise noted.

TRANSFORMER

Please follow these steps before testing the Transformer:

- Disconnect the battery.
- Remove the charger cover.
- Connect the charger to AC power.

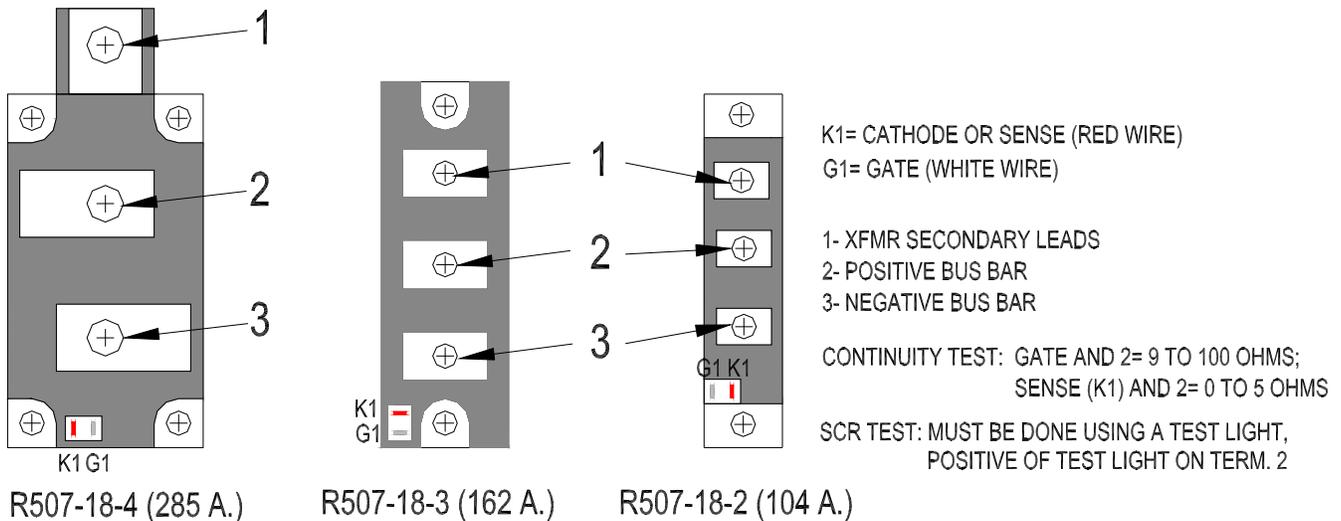
First Transformer Test

You will be testing the transformer's windings (with a good quality meter) to check the transformer's voltages. Your measurements should be within 10% of what is listed on the nameplate.

Second Transformer Test (120V Test)

Be sure to disconnect the transformer from SCR/Diode Block, PC board, and control transformer primary. You will need to have the transformer isolated for this test.

- 1) Use a line cord with a 3 to 5 amp slow-blow fuse in an in-line fuse holder.
- 2) Power each section separately. Power from TB #1 and #6, and jumper leads 3 and 4.
- 3) If a fuse has opened, there might be a winding problem in the transformer. Perform all other tests in this section before replacing the transformer.

SCR/DIODE BLOCK

WARNING: Faulty SCR/Diode Blocks may cause voltage to be present at the DC cables.

Physical Test

If you do not have a clamp-on meter to check for current in the 3 SCR/Diode Blocks, you can perform the following to locate a fault in the secondary phase:

- 1) Start the charger, and run it for 5 minutes with a battery connected.
- 2) Turn off the charger and disconnect the battery.
- 3) Within 1 minute, check the temperature of the SCR/Diode Blocks. If an SCR/Diode Block is cold, then it is defective.

WARNING: Heatsink and SCR/Diode Blocks may be very warm. Please exercise caution.

First SCR/Diode Block Test

Please follow these steps before testing the SCR/Diode Blocks:

Disconnect the battery.

Disconnect the AC power.

You will be testing the SCR/Diode Blocks to see whether there is continuity or forward leakage current (100K ohms or less).

- 1) Disconnect the gate leads from SCR/Diode Blocks:
- 2) Remove the transformer-input connection to the SCR/Diode Block (anode).
- 3) Using an ohmmeter, set to its 1k scale, check for continuity between each SCR/diode Block (anode) input connection and + bussbar. The ohmmeter should read infinity.
- 4) If continuity is shown, replace the SCR/diode Block.
- 5) If infinity (open) is measured in both directions, the SCR/Diode Block may be open. To prove the SCR/Diode Block functions properly, you need to go to the next test (Second SCR/Diode Block Test) to check the gating operation of the SCR/diode block.

Second SCR/Diode Block Test

Please follow these steps before testing the SCR/Diode Block:

Disconnect the battery.

Disconnect the AC power.

You can test a single SCR/Diode Block at a time. You will need a Flashlight tester or a Continuity tester with 2 AA batteries in it to do this.

Please follow these steps:

- 1) Disconnect the three phase input wires to each of the SCR/Diode Blocks.
- 2) Disconnect the nylon connector from the SCR/Diode Block (gate drive).

- 3) Connect the negative potential of your tester to the positive buss bar.
- 4) Connect the positive potential of your tester to the input connection of the SCR/Diode Block under test. Then by using a jumper wire touch the SCR/Diode Block gate pin (white lead connects there) to the SCR/Diode Block input connection. The tester will light.
NOTE: If your tester lights before connecting to the SCR/Diode Block input, then the SCR/Diode Block is defective. Test one SCR/Diode Block at a time to find the faulty one(s).
- 5) Disconnect the jumper wire to the SCR/Diode Block gate pin. The tester should remain lit.
- 6) The SCR/Diode Block is defective if the tester did not remain lit.

DIODE TEST

Please follow these steps before testing the diode:

- Disconnect the battery.
- Disconnect the AC power.

You will be testing the diode to see if it is shorted.

- 1) Disconnect the three phase input wires to the SCR/Diode Blocks.
- 2) Use an analog meter set to its X1 scale, or use a DVM set to its diode scale.
- 3) Connect the meter's negative lead to the input connection of the SCR/Diode Block.
- 4) Connect the meter's positive lead to the (-) buss bar.
- 5) If you are using an analog meter, it should read close to 0 ohms.
- 6) If you are using a DVM, it should read a .7V drop on the diode scale.
- 7) Reverse the wires on the meter.
- 8) The needle should not move on the analog scale (measurement of infinity). The DVM should not get a reading.
- 9) The SCR/Diode Block is shorted if the meter measures zero current for both directions (polarities).
- 10) The SCR/Diode Block is open if the meter reads infinity for both directions (polarities).

AC AND DC FUSES

Please follow these steps before testing the fuses:

- Disconnect the battery.
- Disconnect the AC power.

You will be testing each fuse to see whether there is continuity across it.

- 1) Using an ohmmeter, set to its X1 scale, test each fuse.
- 2) If a fuse tests as an open circuit (infinity), replace it.
- 3) If there is continuity across the fuse (less than 1 ohm), it is working properly.

PRINTED CIRCUIT BOARD FUSES AND VOLTAGES

Measure the voltages on the bottom terminals of the circuit board fuses with the charger AC power connected and the battery disconnected.

Measurement	Expected voltage (VAC)
F5-F8	10 ± 10%
F6-F8	10 ± 10%
F7-F8	10 ± 10%

Please note that these voltages are dependent on the line voltage.

PRINTED CIRCUIT BOARD

The printed circuit board is not field calibrated. No pots or jumpers are contained on the control board. In order to verify proper operation, insure that all **USER** and **SERVICE** parameters are set properly, especially the charger/battery cell size and amp hour ratings. Please follow these steps before testing the PC Board:

Set correct control board battery and charger cell size and amp hour ratings in **USER/SERVICE** parameters.

- 1) Connect appropriate size battery to charger. Battery terminal voltage should be at around 2 volts/cell.
- 2) Charger should detect battery and start a charge cycle. If charger does not respond, check wiring and ensure that DC battery voltage is being read at the control board..
- 3) Faulty control boards cannot be field modified. Replace faulty control boards and return to factory for evaluation.

SNUBBER ASSEMBLY

Please follow these steps before testing the snubber assembly:

- Disconnect the battery
- Disconnect the AC power.

The snubber assembly consists of a series resistor and a capacitor.

Before taking measurements on the Snubber assembly

- 1) Verify that the mounting wire is sound-properly screwed on and not broken.
- 2) Verify that the Snubber assembly is not burned, broken, or smoking.

To test the Snubber assembly

- 1) Disconnect a mounting wire and check for no continuity.
- 2) Replace if your meter reads less than 200K ohms.

REPLACING COMPONENTS

CAUTION: THERE ARE DANGEROUS VOLTAGES WITHIN THE BATTERY CHARGER CABINET. ONLY QUALIFIED PERSONNEL SHOULD ATTEMPT TO ADJUST OR SERVICE THIS BATTERY CHARGER.

INTRODUCTION

Return all replaced components to your service center.

The following sections explain how to replace each component. After replacing a component, be sure to:

- 1) Reconnect all leads exactly as they were removed.
- 2) Replace any heat-shrink tubing if any old tubing was removed.
- 3) Retighten all connections
- 4) Replace covers.

Preparation

Please follow these steps before removing or replacing any component:

- Disconnect the battery.
- Disconnect the AC power.

MAIN TRANSFORMER

Use the wiring diagrams in the back of this manual to help identify wires connected to the transformer.

Removal

To remove the transformer:

- 1) Remove the AC input wires from the 3 terminal input blocks.
- 2) Remove the transformer control voltage wires from the little glass fuse holder.
- 3) Remove the secondary leads from the SCR/Diode Blocks.
- 4) In the back compartment of the charger, remove the bolts (as many as 6) that hold the transformer to the charger frame.

WARNING: The transformer is heavy. Use appropriate equipment to lift it.

Replacement

To insert a transformer, follow these instructions:

- 1) Place the new transformer into the back of the charger, taking care of the transformer's pigtail.
- 2) Replace the bolts that secure the transformer to the charger frame.
- 3) Connect the AC input wires onto the 3 terminal input blocks. Do this by pre-bending the wires and trimming the double leads (wires #2 and #5) to the same length. The purpose for doing this is so that when you install the double leads into the terminal block, they both get properly secured when the screw is tightened down on them.
- 4) Be sure that all wires being connected to the terminal strip are bare. Make sure insulation is removed from the wires for good connections.
- 5) Avoid placing the A phase primary leads near the top panel's mounting hole.

WARNING: Be sure to install phase A, phase B, and phase C wires to their proper terminals in the front of the charger (A is on the left, C is on the right).
When installing primary leads into the terminal blocks, take special precaution in preparing the double-wire leads (wires #2 and #5) for insertion into the terminal blocks.

- 6) Connect the transformer's control voltage wires to the fuses.

WARNING: Be sure to install 7A, 7B, and 7C in proper order (A is on the left, C is on the right). If they are not connected properly, a phase control problem will occur.

- 7) Connect the secondary leads to the SCR/Diode Blocks. Again, be careful to connect phase A to phase A, phase B to phase B, etc.

SCR / DIODE BLOCK

Specifications for mounting SCR / Diode Blocks on Flat Aluminum Heat Sinks:

Surface

- 1) No scratches, gouges, or burrs allowed in the SCR / Diode block contact area.
- 2) No oil, dirt, paint, adhesive or other foreign substances are permitted in the contact area.
- 3) Apply a light coating of heat sink thermal compound to the flat side of the SCR / Diode Block.

Mounting Instructions

- 1) Tighten the nut with your fingers as far as possible. Then use the torque wrench. Do not exceed the torques shown in the following table.
- 2) Do not use any other wrench to tighten the nut.

SCR / Diode Block Size	SCR / Diode Block Mounting Torque (in/lb)		Buss Bar Mounting Torque (in/lb)	
	Bolt Size	Max	Bolt Size	Max
104 Amp	10-32 X 1.25	19.0	5mm	31
162 Amp	10-32 X 1.25	19.0	6mm	65
250 Amp	10-32 X 1.25	19.0	8mm	132
285 Amp	10-32 x 1.25	19.0	8mm	132

Removal

The SCR / Diode Blocks cannot be removed until the buss bars are removed first. These steps explain how to remove the heat sink.

- 1) Remove the DC cable leads.
- 2) Remove the DC control leads (red) from the PC board.
- 3) Unplug the SCR / Diode Blocks gate leads.
- 4) Remove the secondary transformer leads from the input of the SCR / Diode Block.
- 5) Unscrew the two buss bars from the SCR / Diode Blocks. Note on the units where the buss bar is directly attached to the jumper wire, leave the buss bar attached to the jumper wire and just move the buss bar away from the SCR / Diode Blocks.
- 6) Now you can remove the SCR / Diode Block from the heat sink.

Replacement

- 1) Remove old silicone-heatsink compound from the heatsink.
- 2) Apply silicone heatsink compound (i.e., thermalloy 249, Aavid 1001, etc.) to the SCR / Diode Block and fasten it to the heatsink. (Use the proper torque. See table above.)
- 3) Replace the heatsink into the charger case, being careful to slide it onto its holder.
- 4) Mount the two buss bars back to the SCR / Diode Blocks.
- 5) Connect the secondary transformer leads to the inputs of the SCR / Diode Blocks.
- 6) Reconnect the SCR / Diode Block gate leads.
- 7) Connect the DC control leads to the PC board.
- 8) Replace the DC cable leads.

Since you have removed the SCR / Diode Block gate leads from the harness, take special care in reconnecting the SCR / Diode Blocks firing lead connections making sure that:

- 1) Phase A is connected to phase A.
- 2) Phase B to phase B.
- 3) Phase C to phase C.

PRINTED CIRCUIT BOARD (PCB)

Removal

CAUTION: Use an anti-static wrist strap (i.e. EnerSys part number 174-2-1) when handling, removing and replacing circuit board assemblies.

Please follow these steps to remove a PC board. (Be sure your hands are clean before touching a PCB).

- 1) Turn the AC power OFF.
- 2) Unplug the battery.
- 3) Touch your finger to a ground to remove any static charge.
- 4) Unplug the connectors from the PCB.
- 5) Remove the 11/32" nuts from PEM studs that hold the PCB to charger door.

NOTE: Handle the PCB with care. Do NOT place it on top of the battery or other acid-contaminated surfaces.

- 6) Place the removed PCB into the anti-static bag (or foam) that the replacement board was in.

Replacement

Please follow these steps to install a PCB:

- 1) Using the 11/32" nuts that held the old PCB to the PEM studs, mount the replacement board on the door.
- 2) Tighten the 11/32" nuts slowly and gently. Tighten nuts only enough so that the tactile switches are just able to activate through the front decal. **Over tightening of the 11/32" nuts on the PCB will result in damage to the tactile pushbuttons.**
- 3) Attach the connectors to the replacement board. **Be careful to insert the connectors properly. The connectors should be inserted so that the raised portion of the socket slips under the raised portion of the plug on the PCB.**
- 4) Enter USER/SERVICE parameters. Set all USER/SERVICE parameters such as cell size, amp-hours etc. accordingly.
- 5) Turn AC power ON. Connect battery and insure proper charger operation.

VOLTAGE CONVERSION

These chargers are designed to operate from nominal line voltages as marked on the nameplate. The line voltage to which the charger is to be converted must be one of the voltages shown on the charger nameplate.

DANGER: POWER MUST BE DISCONNECTED BEFORE CHANGING AC INPUT CONNECTIONS.

AC INPUT CHANGE (STANDARD)

NOTE: Chargers with optional Quick Tap™ please refer to AC INPUT CHANGE WITH QUICK TAP™.

- 1) Change AC fuses to the value of the desired line voltage available for this charger. AC fuse values can be found on the decal inside the charge, or in charts contained in this manual.
- 2) Change provided jumpers, on the main transformer primary tap location, as shown on the decal inside the door of the charger, or on the following charts. Jumpers not being used are stored in the manual envelope, inside the charger.
- 3) Indicate the line voltage change on the decal inside the charger.

WIRE CONNECTION CHARTS (3 PHASE SCR CHARGERS)

MODEL B *	208 VOLT INPUT	240 VOLT INPUT	480 VOLT INPUT
WIRE MARKER	CONNECTION	CONNECTION	CONNECTION
D2	F1 TO A1	F1 TO A1	F1 TO A1
D7	F1 TO C5	F1 TO C6	F1 TO C6
D3	F2 TO A5	F2 TO A6	F2 TO A6
D3	F2 TO B1	F2 TO B1	F2 TO B1
D4	F3 TO B5	F3 TO B6	F3 TO B6
D4	F3 TO C1	F3 TO C1	V3 TO C1
A2	A1 TO A4	A1 TO A4	A3 TO A4
A2	A2 TO A5	A3 TO A6	B3 TO B4
A2	B1 TO B4	B1 TO B4	C3 TO C4
A2	B2 TO B5	B3 TO B6	A3 TO A4
A2	C1 TO C4	C1 TO C4	B3 TO B4
AS	C2 TO C5	C3 TO C6	C3 TO C4

*Replacement part numbers for chargers with letter codes T, W, X, or Y shall be referred to the charger's tables with code letter "B"

MODEL J	480 VOLT INPUT	550 VOLT INPUT	600 VOLT INPUT
WIRE MARKER	CONNECTION	CONNECTION	CONNECTION
D2	F1 TO A1	F1 TO A1	F1 TO A1
D7	F1 TO C5	F1 TO C6	F1 TO C6
D3	F2 TO A5	F2 TO A6	F2 TO A6
D3	F2 TO B1	F2 TO B1	F2 TO B1
D4	F3 TO B5	F3 TO B6	F3 TO B6
D4	F3 TO C1	F3 TO C1	F3 TO C1
A2	A2 TO A4*	A2 TO A4*	A3 TO A4*
A2	B2 TO B4*	B2 TO B4*	B3 TO B4*
A2	C2 TO C4*	C2 TO C4*	C3 TO C4*

*INDICATES TWO JUMPERS

WIRE CONNECTION CHARTS (3 PHASE SCR CHARGERS con't)

MODEL D	220 VOLT INPUT	380 VOLT INPUT	440 VOLT INPUT
WIRE MARKER	CONNECTION	CONNECTION	CONNECTION
D2	F1 TO A1	F1 TO A1	F1 TO A1
D7	F1 TO C6	F1 TO C5	F1 TO C6
D3	F2 TO A6	F2 TO A5	F2 TO A6
D3	F2 TO B1	F2 TO B1	F2 TO B1
D4	F3 TO B6	F3 TO B5	F3 TO B6
D4	F3 TO C1	F3 TO C1	F3 TO C1
A2	A1 TO A4	A2 TO A4	A3 TO A4
A2	A3 TO A6	B2 TO B4	B3 TO B4
A2	B1 TO B4	C2 TO C4	C3 TO C4
A2	B3 TO B6	A2 TO A4	A3 TO A4
A2	C1 TO C4	B2 TO B4	B3 TO B4
A2	C3 TO C6	C2 TO C4	C3 TO C4

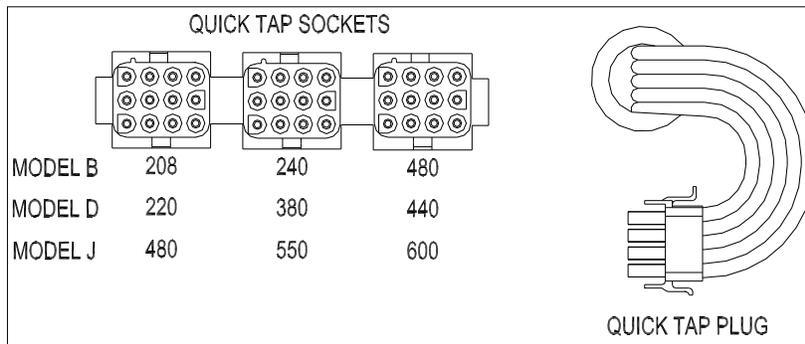
MODEL E	400 VOLT INPUT
WIRE MARKER	CONNECTION
D2	F1 TO A1
D7	F1 TO C6
D3	F2 TO A6
D3	F2 TO B1
D4	F3 TO B6
D4	F3 TO C1

AC INPUT CHANGE WITH QUICK TAP™

CAUTION: CONNECTOR IS KEYED AND PINS ARE FRAGILE.

- 1) Change AC fuses to the value of the desired line voltage available for this charger. AC fuse values can be found on the decal inside the charger, or in the charts contained in this manual.
- 2) Change Quick Tap™ plug to the desired line voltage as marked under the sockets.
- 3) Indicate the line voltage change on the decal inside the charger.

WIRING CONNECTION ILLUSTRATION



MAINTENANCE

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

ES3

REPLACEMENT PARTS

SCHEMATICS

REPLACEMENT PARTS

CAUTION: THERE ARE DANGEROUS VOLTAGES WITHIN THE BATTERY CHARGER CABINET. ONLY QUALIFIED PERSONNEL SHOULD ATTEMPT TO ADJUST OR SERVICE THIS BATTERY CHARGER.

PRINTED CIRCUIT BOARDS (CONTROL)	
X1060-09-ES3-1	STANDARD MODELS
X1060-09-ES3-2	41-80 CELL

DESCRIPTION	PART NUMBER
DOOR	X054-99-3-17
TOP PANEL	X052-99-3-12
BACK PANEL	X057-99-3-16
SIDE PANEL, LEFT	X057-99-0-5
SIDE PANEL, RIGHT (STANDARD OUTPUT HOLES)	X057-99-0-6
SIDE PANEL, RIGHT (OUTPUT HOLES FOR 4/0 CABLE)	X057-99-0-7
UPRIGHT	X052-99-0-6
DOOR LATCH	X044-1-32
RIVET FOR DOOR LATCH	164-8-6
TERMINAL BOARD, MAIN XFMR, LEFT	256-99-12
TERMINAL BOARD, MAIN XFMR, RIGHT	256-99-13
DC CABLE CLAMP (#2, 1/0, 2/0, & 3/0 CABLE)	356-5-15
DC CABLE CLAMP (4/0 CABLE)	356-5-16
FUSE REDUCER (<70A FUSE INTO 100A FUSE BLOCK)	X014-17-6
FUSE REDUCER (<40A FUSE INTO 60A FUSE BLOCK)	X014-17-5
GROUND LUG	X012-7-24
PC BOARD FUSE	X014-7-28

Base kits are required for base replacement. Each kit includes the base and cross-members for heat sink and transformer mounting. Determine the appropriate kit for your charger from the following chart:

DESCRIPTION	KIT PART NUMBER
11 INCH DISTANCE BETWEEN TRANSFORMER BRACKETS	X225-99-3-11
15 INCH DISTANCE BETWEEN TRANSFORMER BRACKETS AND ALSO FOR (3) HEAT SINK EXTRUSIONS	X225-99-3-15

SHUNT REPLACEMENT		
AMPERE HOURS	VALUE	PART NUMBER
0-680	150A	X117-99-2
681-1200	300	X117-99-1
1201 & UP	2 X 300	X117-99-1

DC FUSE REPLACEMENT		
AMPERE HOURS	VALUE	PART NUMBER
380	100	X014-11-2
450-680	150	X014-11-3
750-850	200	X014-11-9
950-1050	250	X014-11-16
1200	300	X014-11-17
1500	350	X014-11-13
1700	400	X014-11-14
2000	250 X 2	X014-11-16 (X 2)

MODEL NUMBERS WITH THE LETTER CODES T, W, X, & Y SHALL BE REFERRED TO THE TABLES WITH THE LETTER CODE "B".

MODEL NUMBER	TRANSFORMER PART NUMBER	SCR MODULE PART NUMBER
ES3-X (B MODELS)		
6-550B	X127-S06-680B	R507-18-2
6-680B	X127-S06-680B	R507-18-2
6-850B	X127-S06-850B	R507-18-2
12-550B	X127-S12-550B	R507-18-2
12-680B	X127-S12-680B	R507-18-2
12-750B	X127-S12-680B	R507-18-2
12-850B	X127-S12-850B	R507-18-2
12-950B	X127-S12-1050B	R507-18-3
12-1050B	X127-S12-1050B	R507-18-3
12-1200B	X127-S12-1200B	R507-18-3
12-1500B	X127-S12-1500B	R507-18-4
18-550B	X127-S18-550B	R507-18-2
18-680B	X127-S18-680B	R507-18-2
18-750B	X127-S18-680B	R507-18-2
18-850B	X127-S18-680B	R507-18-2
18-950B	X127-S18-1050B	R507-18-3
18-1050B	X127-S18-1050B	R507-18-3
18-1200B	X127-S18-1200B	R507-18-3
18-1500B	X127-S18-1500B	R507-18-4
18-1700B	X127-S18-1700B	R507-18-4
18-2000B	X127-S18-1700B	R507-18-4

MODEL NUMBERS WITH THE LETTER CODES T, W, X, & Y SHALL BE REFERRED TO THE TABLES WITH THE LETTER CODE "B".

MODEL NUMBER	TRANSFORMER PART NUMBER	SCR MODULE PART NUMBER
ES3-X (B MODELS)		
24-200B	X127-S24-200B	R507-18-2
24-680B	X127-S24-680B	R507-18-2
24-750B	X127-S24-680B	R507-18-2
24-850B	X127-S24-850B	R507-18-2
24-950B	X127-S24-1050B	R507-18-3
24-1050B	X127-S24-1050B	R507-18-3
30-1050BNC	X127-S40-1050B	R507-18-3
30-680BNC	X127-S40-680B	R507-18-2
36-450B	X127-S40-550B	R507-18-2
36-550B	X127-S40-550B	R507-18-2
36-850B	X127-S40-850B	R507-18-2
40-450B	X127-S40-550B	R507-18-2
40-550B	X127-S40-550B	R507-18-2
40-680B	X127-S40-680B	R507-18-2
40-850B	X127-S40-850B	R507-18-2

MODEL NUMBER	TRANSFORMER PART NUMBER	SCR MODULE PART NUMBER
ES3-X (D MODELS)		
12-550D	X127-S12-550D	R507-18-2
12-680D	X127-S12-680D	R507-18-2
12-850D	X127-S12-850D	R507-18-2
12-1050D	X127-S12-1050D	R507-18-3
18-550D	X127-S18-680D	R507-18-2
18-680D	X127-S18-680D	R507-18-2
18-750D	X127-S18-850D	R507-18-2
18-850D	X127-S18-850D	R507-18-2
18-950D	X127-S18-1050D	R507-18-3
18-1050D	X127-S18-1050D	R507-18-3
18-1200D	X127-S18-1200D	R507-18-3
18-1500D	X127-S18-1500D	R507-18-4
18-2000D	X127-S18-2000D	R507-18-4
24-550D	X127-S24-550D	R507-18-2
24-850D	X127-S24-850D	R507-18-2
24-1050D	X127-S24-1050D	R507-18-3
24-1200D	X127-S24-1200D	R507-18-3
24-1500D	X127-S24-1500D	R507-18-4
40-550D	X127-S40-550D	R507-18-2
40-600D	X127-S40-550D	R507-18-2

MODEL NUMBER	TRANSFORMER PART NUMBER	SCR MODULE PART NUMBER
ES3-X (J MODELS)		
12-550J	X127-S12-550J	R507-18-2
12-680J	X127-S12-680J	R507-18-2
12-750J	X127-S12-680J	R507-18-2
12-850J	X127-S12-680J	R507-18-2
12-950J	X127-S12-1050J	R507-18-3
12-1050J	X127-S12-1050J	R507-18-3
12-1200J	X127-S12-1200J	R507-18-3
18-550J	X127-S18-550J	R507-18-2
18-680J	X127-S18-680J	R507-18-2
18-750J	X127-S18-680J	R507-18-2
18-850J	X127-S18-850J	R507-18-2
18-950J	X127-1050J	R507-18-3
18-1500J	X127-S18-1500J	R507-18-4
18-1700J	X127-S18-1700J	R507-18-4
18-2000J	X127-S18-1700J	R507-18-4
24-550J	X127-S24-681J	R507-18-2
24-680J	X127-S24-681J	R507-18-2
24-750J	S24-850J	R507-18-2
24-850J	X127-S24-850J	R507-18-2
24-950J	X127-S24-1050J	R507-18-3
24-1050J	X127-S24-1050J	R507-18-3
24-1200J	X127-S24-1200J	R507-18-3
24-1500J	X127-S24-1500J	R507-18-4
24-1600J	X127-S24-1500J	R507-18-4
40-450J	X127-S40-550J	R507-18-2
40-550J	X127-S40-550J	R507-18-2
40-680J	X127-S40-680J	R507-18-2
40-850J	X127-S40-850J	R507-18-2

MODEL NUMBER	TRANSFORMER PART NUMBER	SCR MODULE PART NUMBER
ES3-X (E MODELS)		
12-850E	X127-S12-850E	R507-18-2
18-850EL13	X127-S18-850E	R507-18-2
24-550E	X127-S24-550E	R507-18-2
36-850E	X127-S36-850E	R507-18-2
40-550E	X127-S40-550E	R507-18-2
40-850E	X127-S40-850E	R507-18-2

REPLACEMENT AC FUSES

NOTE: Special charger models might not be listed in these tables. AC input is listed on the charger's nameplate. AC fuse values are listed on a decal inside the charger. The AC fuse part number would be: X014-99-X, where X = AC fuse value.

Replacement part numbers for chargers with letter codes T, W, X, and Y shall be referred to the charger's tables with code letter "B"

CHARGER MODEL	AC FUSES; MODEL B								
	208 VOLTS			240 VOLTS			480 VOLTS		
	I AC	VALUE	P/N	I AC	VALUE	P/N	I AC	VALUE	P/N
6-550	7	12	X014-99-12	6	10	X014-99-10	3	5	X014-99-5
6-680	8	12	X014-99-12	7	12	X014-99-12	4	7	X014-99-7
6-750	9	15	X014-99-15	8	12	X014-99-12	4	7	X014-99-7
6-850	10	15	X014-99-15	9	15	X014-99-15	5	8	X014-99-8
6-950	11	20	X014-99-20	10	15	X014-99-15	5	8	X014-99-8
6-1050	12	20	X014-99-20	11	20	X014-99-20	6	10	X014-99-10
12-550	13	20	X014-99-20	11	20	X014-99-20	6	10	X014-99-10
12-680	16	25	X014-99-25	14	25	X014-99-25	7	12	X014-99-12
12-750	17	30	X014-99-30	15	25	X014-99-25	8	12	X014-99-12
12-850	20	35	X014-99-35	17	30	X014-99-30	9	15	X014-99-15
12-950	22	35	X014-99-35	19	30	X014-99-30	10	15	X014-99-15
12-1050	24	40	X014-99-40	21	35	X014-99-35	11	20	X014-99-20
12-1200	28	45	X014-99-45	24	40	X014-99-40	12	20	X014-99-20
18-550	19	30	X014-99-30	17	30	X014-99-30	9	15	X014-99-15
18-680	24	40	X014-99-40	20	35	X014-99-35	10	15	X014-99-15
18-750	26	40	X014-99-40	22	35	X014-99-35	11	20	X014-99-20
18-850	29	45	X014-99-45	25	40	X014-99-40	13	20	X014-99-20
18-950	33	50	X014-99-50	28	45	X014-99-45	14	25	X014-99-25
18-1050	36	60	X014-99-60	31	50	X014-99-50	16	25	X014-99-25
18-1200	41	60	X014-99-60	36	60	X014-99-60	18	30	X014-99-30
18-1500	51	80	X014-99-80	44	70	X014-99-70	22	35	X014-99-35
18-1700	58	90	X014-99-90	50	80	X014-99-80	25	40	X014-99-40
18-2000	68	100	X014-99-100	59	90	X014-99-90	30	50	X014-99-50
24-550	25	40	X014-99-40	22	35	X014-99-35	11	20	X014-99-20
24-680	31	50	X014-99-50	27	45	X014-99-45	14	25	X014-99-25
24-750	34	50	X014-99-50	30	50	X014-99-50	15	25	X014-99-25
24-850	39	60	X014-99-60	34	50	X014-99-50	17	30	X014-99-30
24-950	43	70	X014-99-70	38	60	X014-99-60	19	30	X014-99-30
24-1050	48	70	X014-99-70	42	60	X014-99-60	21	35	X014-99-35
24-1200	55	80	X014-99-80	47	70	X014-99-70	24	40	X014-99-40
24-1500	68	100	X014-99-100	59	90	X014-99-90	30	50	X014-99-50
36-550	38	60	X014-99-60	33	50	X014-99-50	17	30	X014-99-30
36-680	47	70	X014-99-70	40	60	X014-99-60	20	35	X014-99-35
36-750	51	80	X014-99-80	44	70	X014-99-70	22	35	X014-99-35
36-850	58	90	X014-99-90	50	80	X014-99-80	25	40	X014-99-40
36-1050	72	100	X014-99-100	62	90	X014-99-90	31	50	X014-99-50
40-550	42	60	X014-99-60	36	60	X014-99-60	18	30	X014-99-30
40-680	52	80	X014-99-80	45	70	X014-99-70	23	40	X014-99-40
40-750	57	90	X014-99-90	49	70	X014-99-70	25	40	X014-99-40
40-850	64	100	X014-99-100	56	90	X014-99-90	28	45	X014-99-45
40-1050	N/A	N/A	N/A	69	100	X014-99-100	35	50	X014-99-50

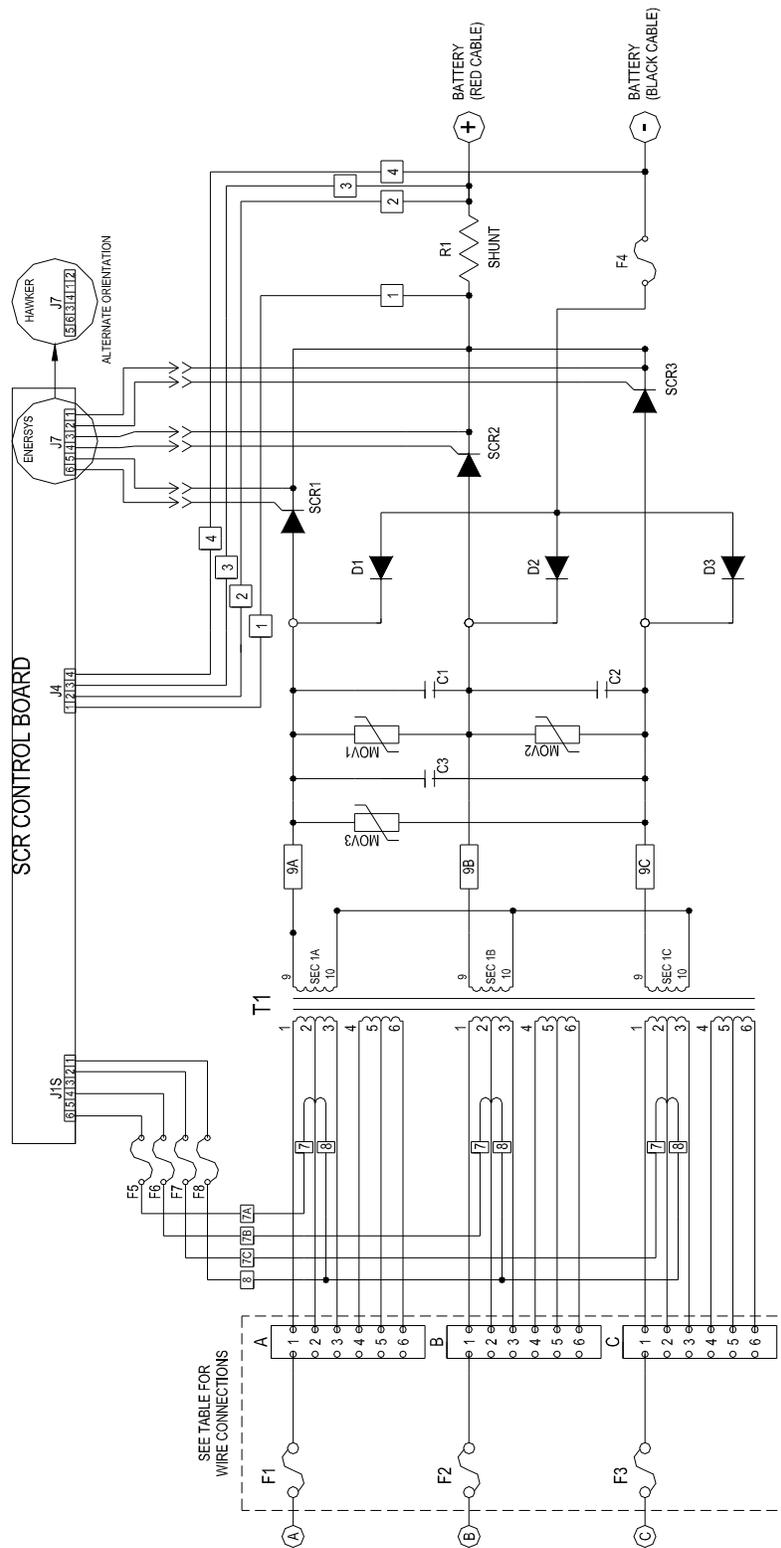
REPLACEMENT AC FUSES (con't)

CHARGER MODEL	AC FUSES: MODEL J								
	480 VOLTS			550 VOLTS			600 VOLTS		
	I AC	VALUE	P/N	I AC	VALUE	P/N	I AC	VALUE	P/N
6-550	3	5	X014-99-5	3	5	X014-99-5	3	5	X014-99-5
6-680	4	7	X014-99-7	3	5	X014-99-5	3	5	X014-99-5
6-750	4	7	X014-99-7	4	7	X014-99-7	3	5	X014-99-5
6-850	5	8	X014-99-8	4	7	X014-99-7	4	7	X014-99-7
6-950	5	8	X014-99-8	5	8	X014-99-8	4	7	X014-99-7
6-1000	5	8	X014-99-8	5	8	X014-99-8	4	7	X014-99-7
6-1050	6	10	X014-99-10	5	8	X014-99-8	5	8	X014-99-8
12-550	6	10	X014-99-10	5	8	X014-99-8	5	8	X014-99-8
12-680	7	12	X014-99-12	6	10	X014-99-10	6	10	X014-99-10
12-750	8	12	X014-99-12	7	12	X014-99-12	6	10	X014-99-10
12-850	9	15	X014-99-15	8	12	X014-99-12	7	12	X014-99-12
12-950	10	15	X014-99-15	9	15	X014-99-15	8	12	X014-99-12
12-1000	10	15	X014-99-15	9	15	X014-99-15	8	12	X014-99-12
12-1050	11	20	X014-99-20	9	15	X014-99-15	9	15	X014-99-15
12-1200	12	20	X014-99-20	11	20	X014-99-20	10	15	X014-99-15
18-550	9	15	X014-99-15	8	12	X014-99-12	7	12	X014-99-12
18-680	10	15	X014-99-15	9	15	X014-99-15	8	12	X014-99-12
18-750	11	20	X014-99-20	10	15	X014-99-15	9	15	X014-99-15
18-850	13	20	X014-99-20	11	20	X014-99-20	10	15	X014-99-15
18-950	14	25	X014-99-25	13	20	X014-99-20	12	20	X014-99-20
18-1000	15	25	X014-99-25	13	20	X014-99-20	12	20	X014-99-20
18-1050	16	25	X014-99-25	14	25	X014-99-25	13	20	X014-99-20
18-1200	18	30	X014-99-30	16	25	X014-99-25	15	25	X014-99-25
18-1500	22	40	X014-99-40	20	40	X014-99-40	18	35	X014-99-35
18-1600	24	40	X014-99-40	21	40	X014-99-40	19	35	X014-99-35
18-1700	25	40	X014-99-40	22	40	X014-99-40	20	35	X014-99-35
18-2000	30	50	X014-99-50	26	40	X014-99-40	24	40	X014-99-40
24-550	11	20	X014-99-20	10	15	X014-99-15	9	15	X014-99-15
24-680	14	25	X014-99-25	12	20	X014-99-20	11	20	X014-99-20
24-750	15	25	X014-99-25	13	20	X014-99-20	12	20	X014-99-20
24-850	17	30	X014-99-30	15	25	X014-99-25	14	25	X014-99-25
24-950	19	30	X014-99-30	17	30	X014-99-30	15	25	X014-99-25
24-1000	20	35	X014-99-35	18	30	X014-99-30	16	25	X014-99-25
24-1050	21	35	X014-99-35	18	30	X014-99-30	17	30	X014-99-30
24-1200	24	40	X014-99-40	21	35	X014-99-35	19	30	X014-99-30
24-1500	30	50	X014-99-50	26	40	X014-99-40	24	40	X014-99-40
36-450	14	25	X014-99-25	12	20	X014-99-20	11	20	X014-99-20
36-550	17	30	X014-99-30	15	25	X014-99-25	13	20	X014-99-20
36-680	20	35	X014-99-35	18	30	X014-99-30	16	25	X014-99-25
36-750	22	35	X014-99-35	20	35	X014-99-35	18	30	X014-99-30
36-850	25	40	X014-99-40	22	35	X014-99-35	20	35	X014-99-35
36-1000	30	50	X014-99-50	26	40	X014-99-40	24	40	X014-99-40
36-1050	31	50	X014-99-50	27	45	X014-99-45	25	40	X014-99-40
40-450	15	25	X014-99-25	13	20	X014-99-20	12	20	X014-99-20
40-550	18	30	X014-99-30	16	25	X014-99-25	15	25	X014-99-25
40-680	23	40	X014-99-40	20	35	X014-99-35	18	30	X014-99-30
40-750	25	40	X014-99-40	22	35	X014-99-35	20	35	X014-99-35
40-850	28	45	X014-99-45	25	40	X014-99-40	23	40	X014-99-40
40-1000	33	50	X014-99-50	29	45	X014-99-45	27	45	X014-99-45
40-1050	35	50	X014-99-50	30	50	X014-99-50	28	45	X014-99-45

REPLACEMENT AC FUSES (con't)

CHARGER MODEL	AC FUSES: MODEL D								
	220 VOLTS			380 VOLTS			440 VOLTS		
	I AC	VALUE	P/N	I AC	VALUE	P/N	I AC	VALUE	P/N
6-550	6	10	X014-99-10	4	7	X014-99-7	3	5	X014-99-5
6-680	8	12	X014-99-12	5	8	X014-99-8	4	7	X014-99-7
6-750	8	12	X014-99-12	5	8	X014-99-8	4	7	X014-99-7
6-850	10	15	X014-99-15	6	10	X014-99-10	5	8	X014-99-8
6-950	11	20	X014-99-20	6	10	X014-99-10	6	10	X014-99-10
6-1000	11	20	X014-99-20	7	12	X014-99-12	6	10	X014-99-10
6-1050	12	20	X014-99-20	7	12	X014-99-12	6	10	X14-99-10
12-550	12	20	X014-99-20	7	12	X014-99-12	6	10	X014-99-10
12-680	15	25	X014-99-25	9	15	X014-99-15	8	12	X014-99-12
12-750	16	25	X014-99-25	10	15	X014-99-15	8	12	X014-99-12
12-850	19	30	X014-99-30	11	20	X014-99-20	10	15	X014-99-15
12-950	21	35	X014-99-35	12	20	X014-99-20	11	20	X014-99-20
12-1000	22	35	X014-99-35	13	20	X014-99-20	11	20	X014-99-20
12-1050	23	40	X014-99-40	13	20	X014-99-20	12	20	X014-99-20
12-1200	26	40	X014-99-40	15	25	X014-99-25	13	20	X014-99-20
18-550	18	30	X014-99-30	11	20	X014-99-20	9	15	X014-99-15
18-680	22	35	X014-99-35	13	20	X014-99-20	11	20	X014-99-20
18-750	24	40	X014-99-40	14	25	X014-99-25	12	20	X014-99-20
18-850	28	45	X014-99-45	16	25	X014-99-25	14	25	X014-99-25
18-950	31	50	X014-99-50	18	30	X014-99-30	16	25	X014-99-25
18-1000	32	50	X014-99-50	19	30	X014-99-30	16	25	X014-99-25
18-1050	34	50	X014-99-50	20	35	X014-99-35	17	30	X014-99-30
18-1200	39	60	X014-99-60	23	40	X014-99-40	20	35	X014-99-35
18-1500	48	70	X014-99-70	28	45	X014-99-45	24	40	X014-99-40
18-1600	52	80	X014-99-80	30	50	X014-99-50	26	40	X014-99-40
18-1700	55	80	X014-99-80	32	50	X014-99-50	28	45	X014-99-45
18-2000	64	100	X014-99-100	38	60	X014-99-60	32	50	X014-99-50
24-550	24	40	X014-99-40	14	25	X014-99-25	12	20	X014-99-20
24-680	30	50	X014-99-50	17	30	X014-99-30	15	25	X014-99-25
24-750	32	50	X014-99-50	19	30	X014-99-30	16	25	X014-99-25
24-850	37	60	X014-99-60	21	35	X014-99-35	19	30	X014-99-30
24-950	41	60	X014-99-60	24	40	X014-99-40	21	35	X014-99-35
24-1000	43	70	X014-99-70	25	40	X014-99-40	22	35	X014-99-35
24-1050	45	70	X014-99-70	26	40	X014-99-40	23	40	X014-99-40
24-1200	52	80	X014-99-80	30	50	X014-99-50	26	40	X014-99-40
24-1500	64	100	X014-99-100	38	60	X014-99-60	32	50	X014-99-50
36-450	29	45	X014-99-45	17	30	X014-99-30	15	25	X014-99-25
36-550	36	60	X014-99-60	21	35	X014-99-35	18	30	X014-99-30
36-680	44	70	X014-99-70	26	40	X014-99-40	22	35	X014-99-35
36-750	48	70	X014-99-70	28	45	X014-99-45	24	40	X014-99-40
36-850	55	80	X014-99-80	32	50	X014-99-50	28	45	X014-99-45
36-1000	64	100	X014-99-100	38	60	X014-99-60	32	50	X014-99-50
36-1050	68	100	X014-99-100	39	60	X014-99-60	34	50	X014-99-50
40-450	32	50	X014-99-50	19	30	X014-99-30	16	25	X014-99-25
40-550	40	60	X014-99-60	23	40	X014-99-40	20	35	X014-99-35
40-680	49	70	X014-99-70	28	45	X014-99-45	25	40	X014-99-40
40-750	54	80	X014-99-80	31	50	X014-99-50	27	45	X014-99-45
40-850	61	90	X014-99-90	35	50	X014-99-50	31	50	X014-99-50
40-1000	72	100	X014-99-100	42	60	X014-99-60	36	60	X014-99-60
40-1050	75	100	X014-99-100	44	70	X014-99-70	38	60	X014-99-60

SCHEMATIC DIAGRAM, ES3

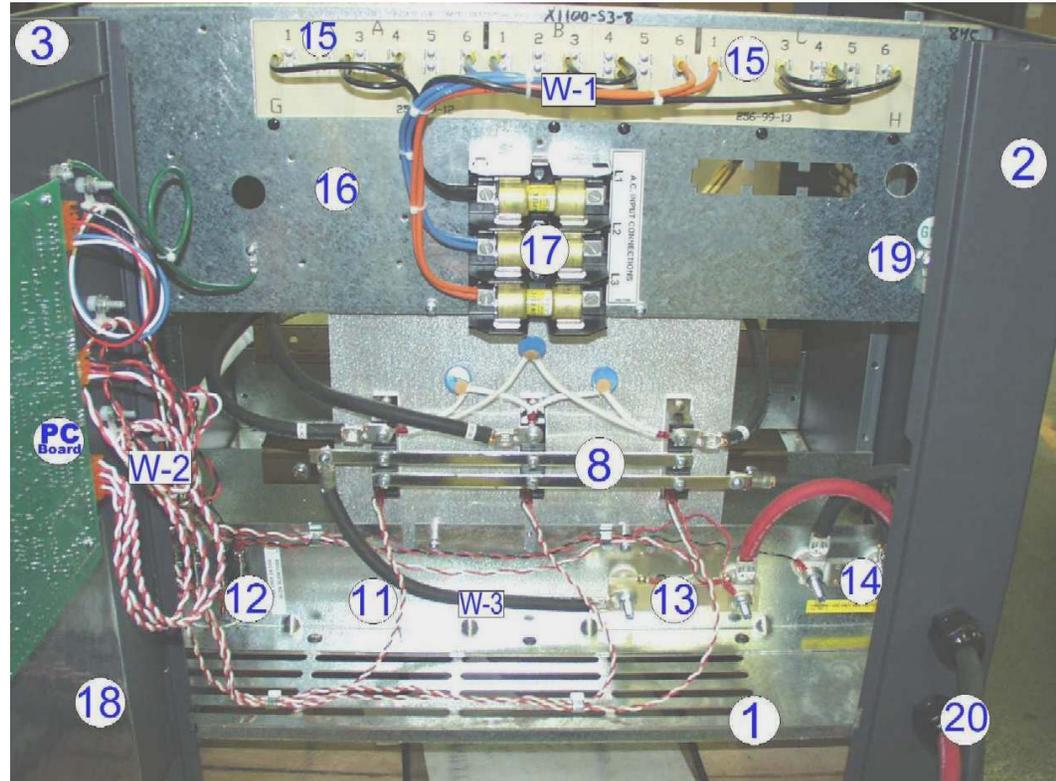


ES3

ASSEMBLY DRAWING

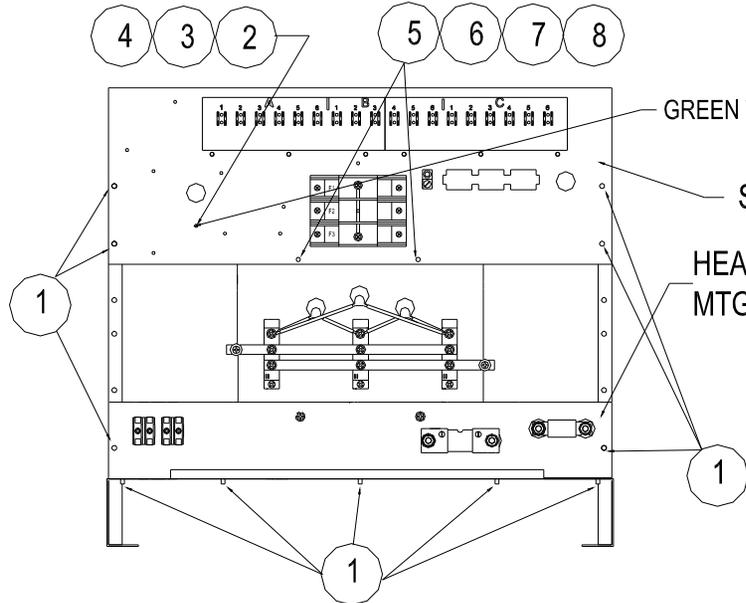
Note: The illustration below identifies the **location** of some important components in standard chargers. The component P/N may vary from charger to charger. (For a P/N, refer to the 'Replacement Parts' tables).

ITEM #	DESCRIPTION
1	Cabinet, Base
2	Cabinet, Right side
3	Cabinet, Left side
4	Cabinet, Top/Back
5	Upright
6	Cross Member, Main Transformers
7	Main Transformer
8	Heat Sink Assembly
9	SCR diode/block
10	Buss bar
11	Cross Member, Heat Sink
12	PC Board Fuses
13	Shunt
14	DC Fuse
15	Terminal Board Primary, Main Transformer
15	Terminal Board Primary, Main Transformer
16	Panel, Sub-assembly
17	AC Block / Input Fuses
18	Door
19	Ground Lug
20	DC output cables and clamp
W-1	Wire Group, Primary Voltage
W-2	Wire Group, PC Board
W-3	Cable Connecting Heat Sink & Shunt



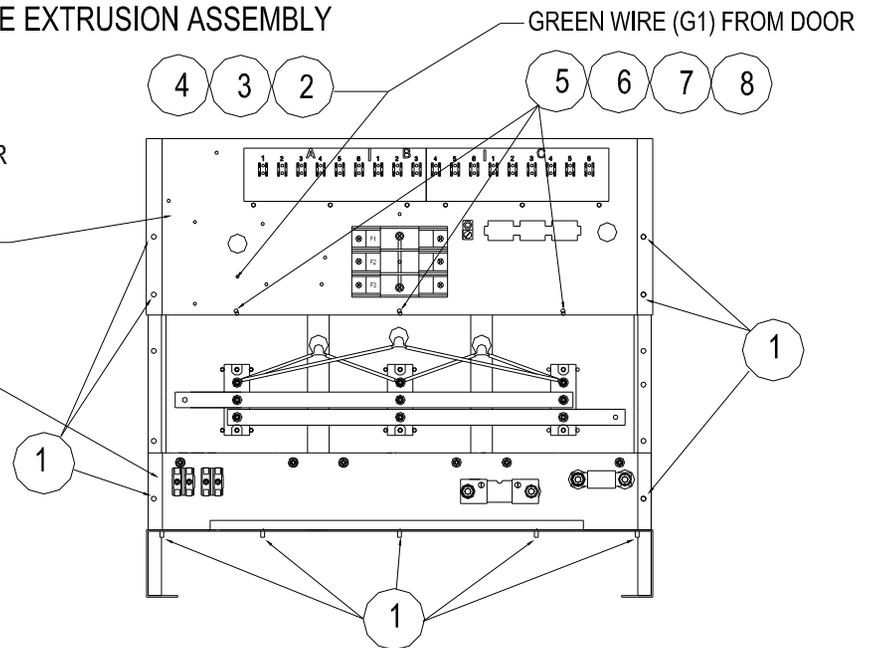
INTERIOR VIEWS:

SINGLE EXTRUSION ASSEMBLY



USED TO MOUNT HEAT SINK PANEL TO BASE

THREE EXTRUSION ASSEMBLY

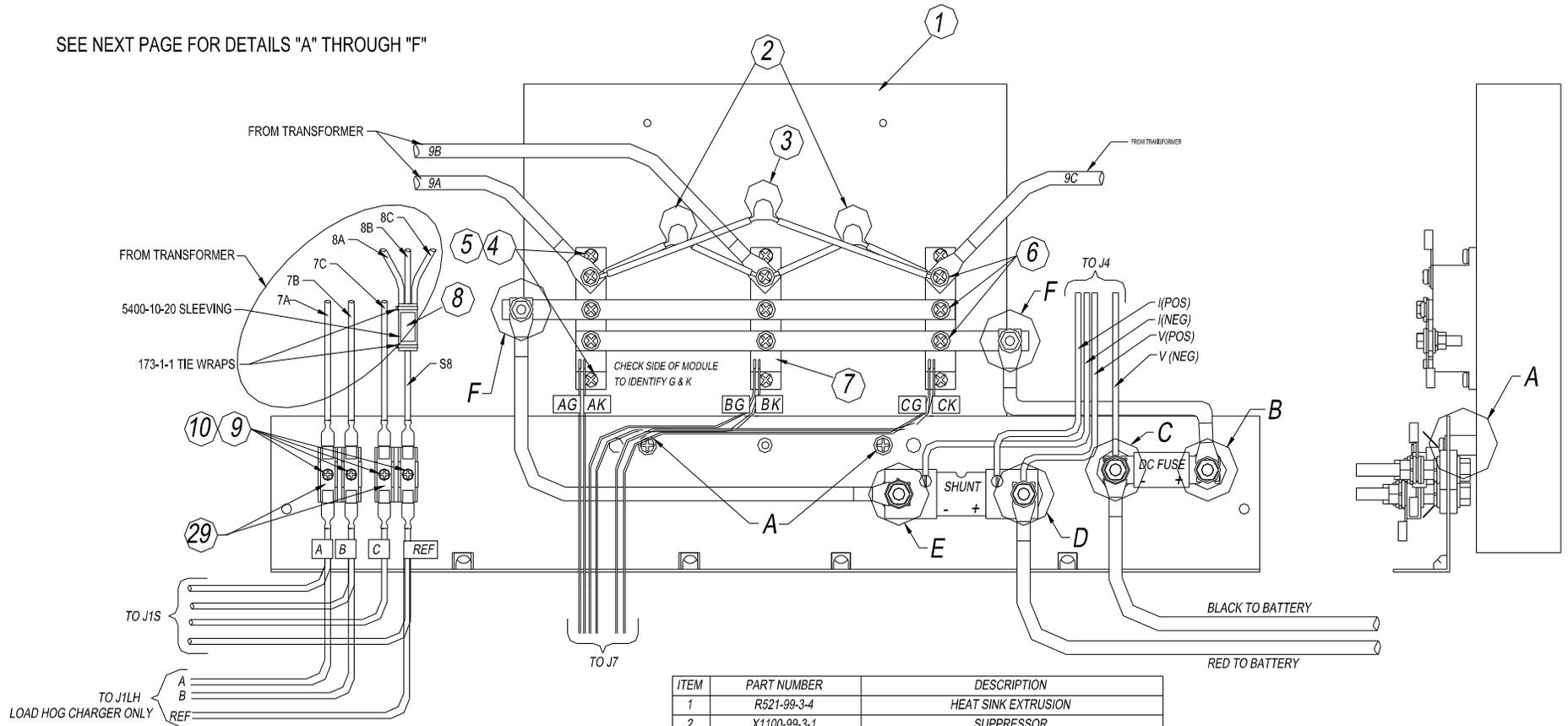


USED TO MOUNT HEAT SINK PANEL TO BASE

ITEM	P/N	DESCRIPTION
1	164-8-5	RIVET
2	074-3-18	#8 EXT. TOOTH LOCK WASHER
3	074-2-2	#8 LOCK WASHER
4	036-4-67	#8 SCREW
5	006-208-1	SPACER
6	074-7-17	#10 FLAT WASHER
7	074-2-3	#10 LOCK WASHER
8	036-99-1	#10 X 1.25 SCREW

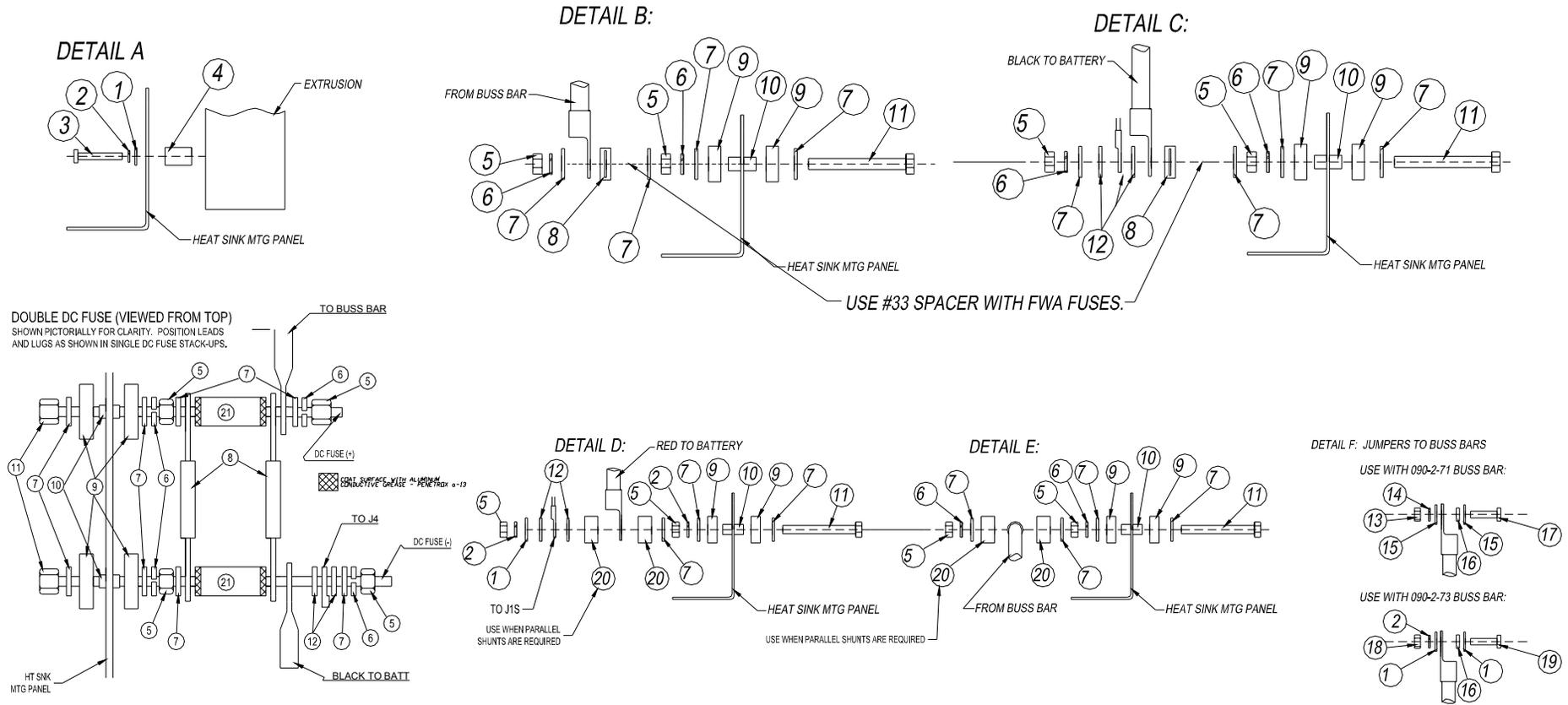
SINGLE EXTRUSION HEAT SINK ASSEMBLY

SEE NEXT PAGE FOR DETAILS "A" THROUGH "F"



ITEM	PART NUMBER	DESCRIPTION
1	R521-99-3-4	HEAT SINK EXTRUSION
2	X1100-99-3-1	SUPPRESSOR
3	X1100-99-3-2	SUPPRESSOR
4	074-2-3	#10 LOCK WASHER
5	101-41-7	#10 SCREW
6	PROVIDED	FLAT WASHER, LOCK WASHER, SCREW
7	SEE BOM	SCR MODULE
8	X012-5-80	BARREL LUG
9	074-2-1	#6 LOCK WASHER
10	036-4-59	#6 SCREW
11	074-7-17	#10 FLAT WASHER

SINGLE EXTRUSION HEAT SINK ASSEMBLY (HARDWARE STACK-UP DETAILS)

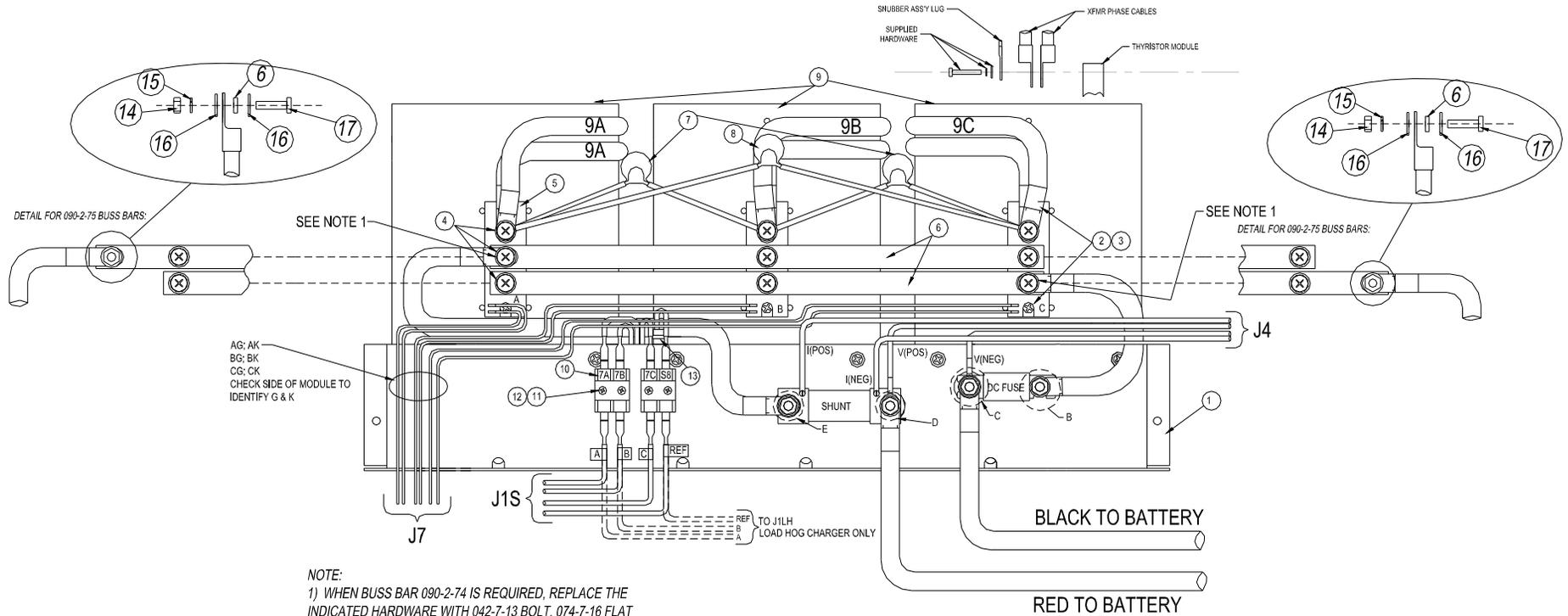


DOUBLE DC FUSE (VIEWED FROM TOP)
SHOWN PICTORALLY FOR CLARITY. POSITION LEADS
AND LUGS AS SHOWN IN SINGLE DC FUSE STACK-UPS.

ITEM	P/N	DESCRIPTION
1	074-7-17	#10 FLAT WASHER
2	074-2-3	#10 LOCK WASHER
3	036-99-1	#10 X 1.25 SCREW
4	006-208-1	SPACER
5	007-3-71	5/16 NUT
6	074-2-6	5/16 LOCK WASHER
7	074-7-16	5/16 FLAT WASHER
8	SEE BOM	DC FUSE
9	044-2-18	INSULATION WASHER
10	055-1-85	INSULATION BUSHING

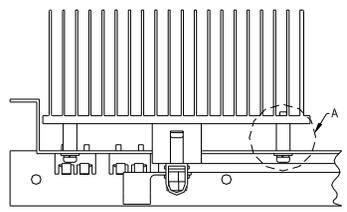
ITEM	P/N	DESCRIPTION
11	042-7-75	5/16-18 X 2.75 SCREW
12	074-4-6	5/16 FLAT WASHER, BRASS
13	007-3-51	1/4 NUT
14	074-2-5	1/4 LOCK WASHER
15	074-9-3	1/4 FLAT WASHER
16	SEE BOM	BUSS BAR
17	103-31-5	1/4 SCREW
18	007-3-41	#10 NUT
19	101-41-7	#10 SCREW
20	SEE BOM	SHUNT
21	006-207-1	ALUMINUM SPACER

THREE EXTRUSION HEAT SINK ASSEMBLY



AG: AK
 BG: BK
 CG: CK
 CHECK SIDE OF MODULE TO IDENTIFY G & K

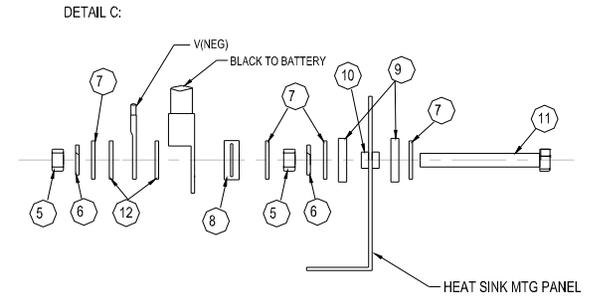
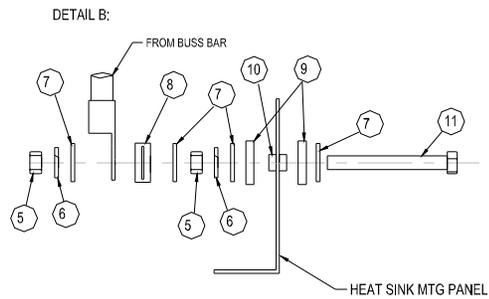
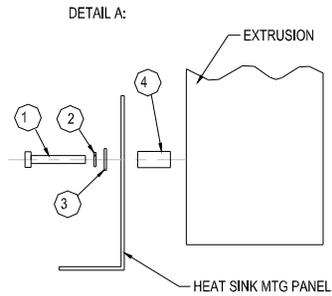
NOTE:
 1) WHEN BUSS BAR 090-2-74 IS REQUIRED, REPLACE THE INDICATED HARDWARE WITH 042-7-13 BOLT, 074-7-16 FLAT WASHER, AND 074-2-6 LOCK WASHER.



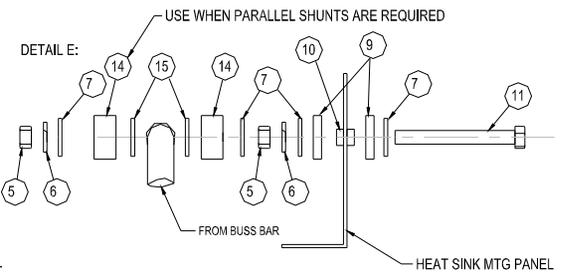
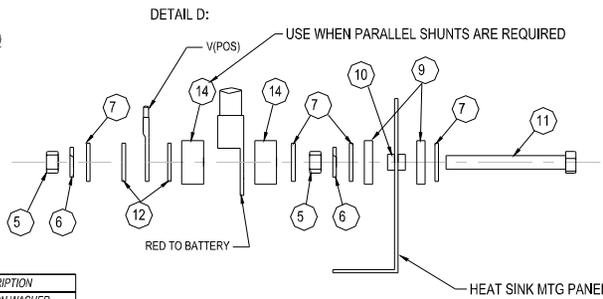
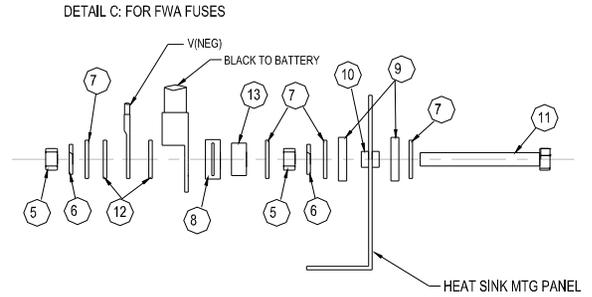
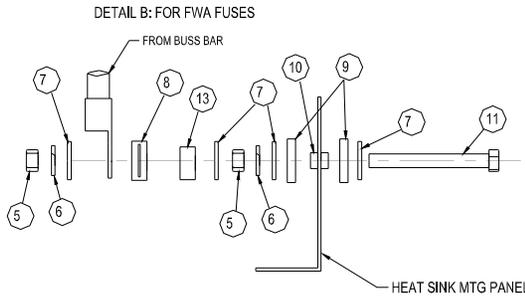
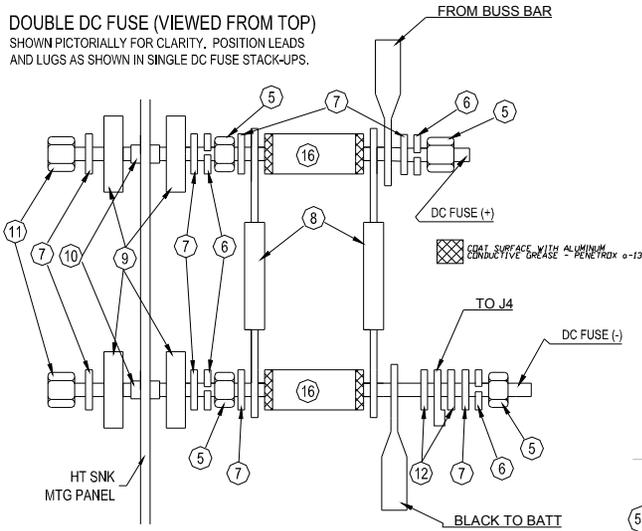
PARTIAL TOP VIEW

ITEM	P/N	DESCRIPTION
1	SEE BOM	HEAT SINK MTG PANEL
2	101-41-7	#10 X 3/4 SCREW
3	074-2-3	#10 LOCK WASHER
4	PROVIDED	FLAT WASHER, LOCK WASHER, SCREW
5	SEE BOM	BUSS BARS
6	SEE BOM	BUSS BARS
7	X1100-99-3-3	SUPPRESSOR
8	X1100-99-3-4	SUPPRESSOR
9	R521-99-3-5	HEAT SINK EXTRUSION
10	X015-48	FUSE BLOCK
11	036-4-59	#6 SCREW
12	074-2-1	#6 LOCK WASHER
13	X012-5-80	BARREL LUG
14	007-3-51	1/4" NUT
15	074-2-5	1/4" LOCK WASHER
16	074-9-3	1/4" FLAT WASHER
17	103-31-5	1/4" SCREW

THREE EXTRUSION HEAT SINK ASSEMBLY (HARDWARE STACK-UP DETAILS)



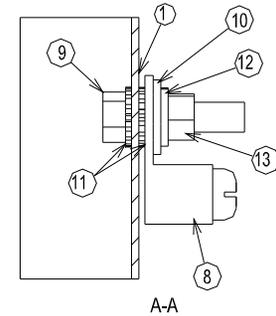
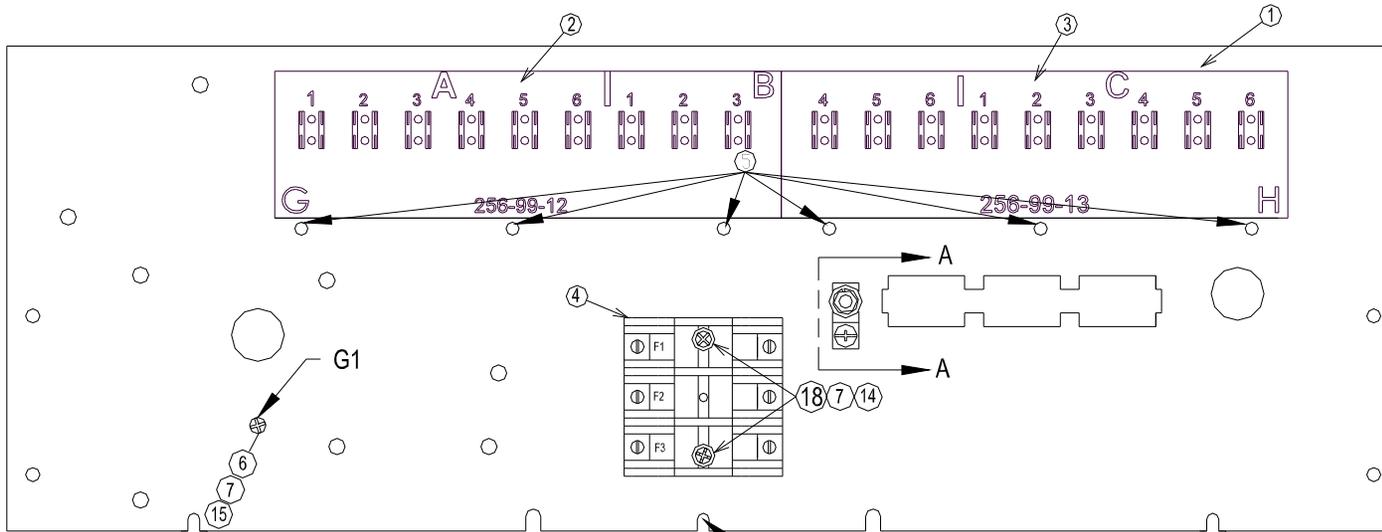
DOUBLE DC FUSE (VIEWED FROM TOP)
 SHOWN PICTORIALLY FOR CLARITY. POSITION LEADS
 AND LUGS AS SHOWN IN SINGLE DC FUSE STACK-UPS.



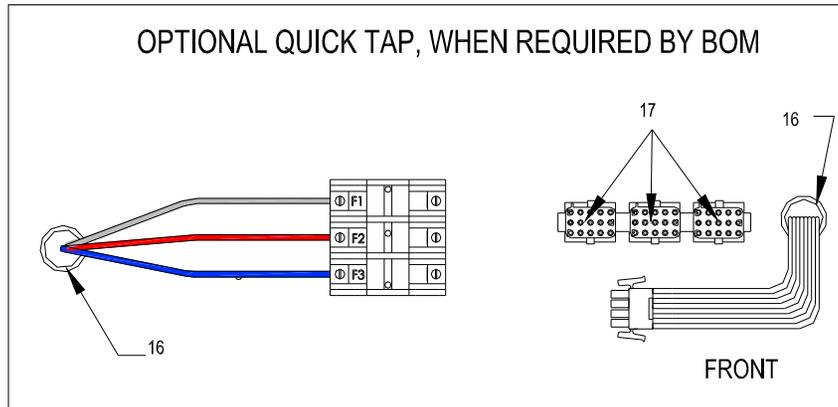
ITEM	P/N	DESCRIPTION
1	038-99-1	#10 X 1.25 SCREW
2	074-2-3	#10 LOCK WASHER
3	074-7-17	#10 FLAT WASHER
4	006-208-1	SPACER
5	007-3-71	5/16 NUT
6	074-2-6	5/16 LOCK WASHER
7	074-7-16	5/16 FLAT WASHER
8	SEE BOM	DC FUSE

ITEM	P/N	DESCRIPTION
9	044-2-18	INSULATION WASHING
10	055-1-85	INSULATION BUSHING
11	042-7-75	5/16-18 X 2.75 SCREW
12	074-4-6	5/16 FLAT WASHER, BRASS
13	006-207-2	SPACER
14	SEE BOM	SHUNT
15	074-6-3	5/16 FLAT WASHER, COPPER
16	006-207-1	ALUMINUM SPACER

SUB-ASSEMBLY PANEL ASSEMBLY



SEE NOTE 1



ITEM	PART NO.	DESCRIPTION
1	SEE BOM	3PH SUB-ASSY PANEL FOR SCR
2	SEE BOM	TERMINAL BOARD
3	SEE BOM	TERMINAL BOARD
4	SEE BOM	FUSE BLOCK
5	164-8-4	NYLON RIVET
6	036-4-67	SCREW, #8 X 1/2
7	074-2-2	#8 LOCK WASHER
8	X012-7-24	GROUND LUG
9	103-31-5	SCREW, 1/4-20 X 1, HEX HD
10	074-9-3	1/4 FLAT WASHER
11	074-3-10	1/4 LOCK WASHER, EXT. TOOTH
12	074-2-5	1/4 LOCK WASHER
13	007-3-51	1/4-20 NUT
14	074-7-9	#8 FLAT WASHER
15	074-3-18	STAR WASHER
16	055-5-71	SNAP BUSHING
17	SEE BOM	QUICK TAP SOCKETS
18	036-4-69	SCREW, #8 X 3/4

SUB-ASSEMBLY PANEL WIRING

MODEL B	LOOSE WIRE		
	MARKER #	COLOR	CONNECTION
	G1	GREEN	G1 TO DOOR

WIRE MARKER #	208 V CONNECTIONS	240 V CONNECTIONS	480 V CONNECTIONS
D2	F1 TO A1	F1 TO A1	F1 TO A1
D7	F1 TO C5	F1 TO C6	F1 TO C6
D3	F2 TO A5	F2 TO A6	F2 TO A6
D3	F2 TO B1	F2 TO B1	F2 TO B1
D4	F3 TO B5	F3 TO B6	F3 TO B6
D4	F3 TO C1	F3 TO C1	F3 TO C1
A2	A1 TO A4	A1 TO A4	A3 TO A4
A2	A2 TO A5	A3 TO A6	B3 TO B4
A2	B1 TO B4	B1 TO B4	C3 TO C4
A2	B2 TO B5	B3 TO B6	A3 TO A4
A2	C1 TO C4	C1 TO C4	B3 TO B4
A2	C2 TO C5	C3 TO C6	C3 TO C4

MODEL D	LOOSE WIRE		
	MARKER #	COLOR	CONNECTION
	G1	GREEN	G1 TO DOOR

WIRE MARKER #	220 V CONNECTIONS	380 V CONNECTIONS	440 V CONNECTIONS
D2	F1 TO A1	F1 TO A1	F1 TO A1
D7	F1 TO C6	F1 TO C5	F1 TO C6
D3	F2 TO A6	F2 TO A5	F2 TO A6
D3	F2 TO B1	F2 TO B1	F2 TO B1
D4	F3 TO B6	F3 TO B5	F3 TO B6
D4	F3 TO C1	F3 TO C1	F3 TO C1
A2	A1 TO A4	A2 TO A4	A3 TO A4
A2	A3 TO A6	B2 TO B4	B3 TO B4
A2	B1 TO B4	C2 TO C4	C3 TO C4
A2	B3 TO B6	A2 TO A4	A3 TO A4
A2	C1 TO C4	B2 TO B4	B3 TO B4
A2	C3 TO C6	C2 TO C4	C3 TO C4

SUB-ASSEMBLY PANEL WIRING (con't)

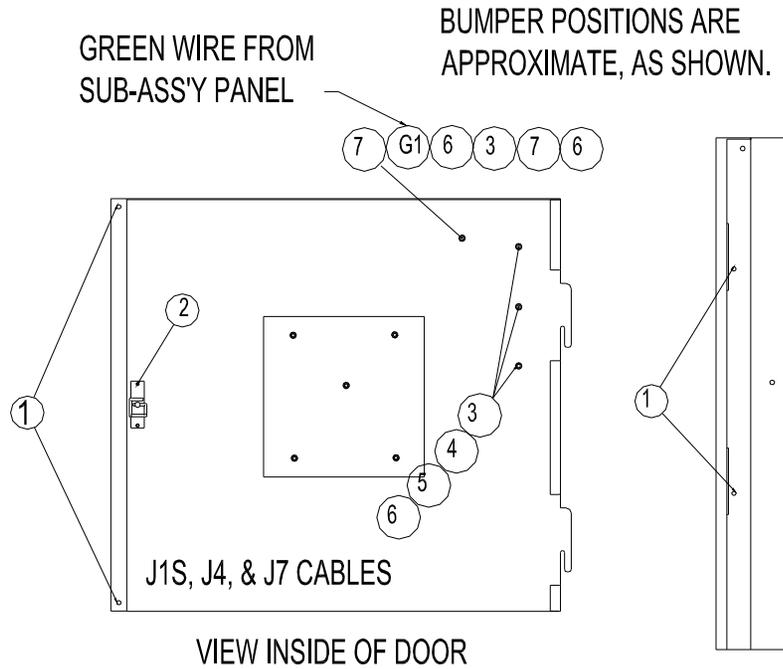
MODEL J	LOOSE WIRE		
	MARKER #	COLOR	CONNECTION
	G1	GREEN	G1 TO DOOR

WIRE MARKER #	208 V CONNECTIONS	240 V CONNECTIONS	480 V CONNECTIONS
D2	F1 TO A1	F1 TO A1	F1 TO A1
D7	F1 TO C5	F1 TO C6	F1 TO C6
D3	F2 TO A5	F2 TO A6	F2 TO A6
D3	F2 TO B1	F2 TO B1	F2 TO B1
D4	F3 TO B5	F3 TO B6	F3 TO B6
D4	F3 TO C1	F3 TO C1	F3 TO C1
A2	A2 to A4*	A2 TO A4*	A3 TO A4*
A2	B2 TO B4*	B2 TO B4*	B3 TO B4*
A2	C2 TO C4*	C2 TO C4*	C3 TO C4*

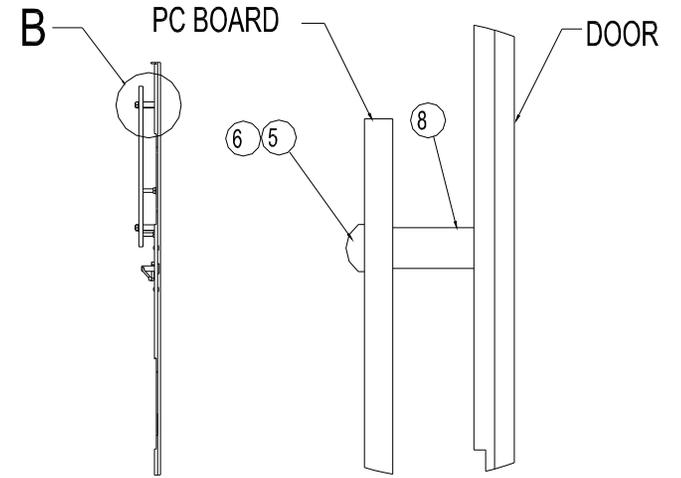
*INDICATES DOUBLE JUMPER

MODEL E	
400 V CONNECTIONS	
WIRE MARKER #	CONNECTIONS
D2	F1 TO A1
D7	F1 TO C6
D3	F2 TO A6
D3	F2 TO B1
D4	F3 TO B6
D4	F3 TO C1

DOOR ASSEMBLY



VIEW INSIDE OF LEFT SIDE
LOOKING TOWARDS FRONT
FROM BACK POSITION. NOTE
SLOTS FOR DOOR HINGES.

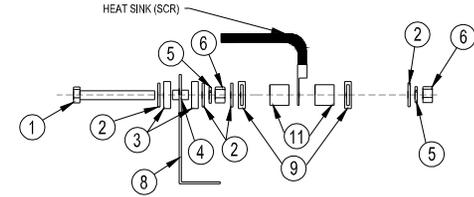
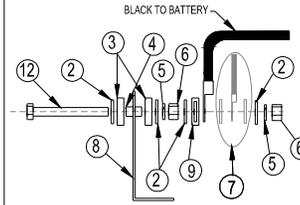
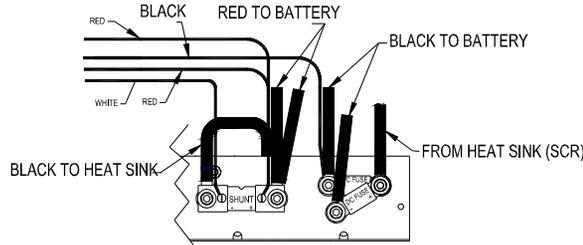


- B -

ITEM	P/N	DESCRIPTION
1	038-20-1	BUMPER
2	X044-1-32	LATCH
3	173-1-3	MTG HOLE CABLE TIE
4	074-7-9	#8 FLAT WASHER
5	074-2-2	#8 LOCK WASHER
6	007-3-21	#8 NUT
7	074-3-18	EXT TOOTH LOCK WASHER
8	006-207-.3	SPACER

PARALLEL CABLES (OPTIONAL)

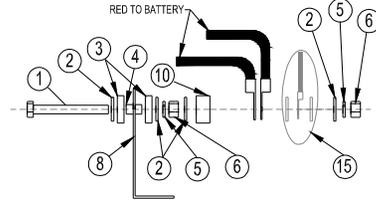
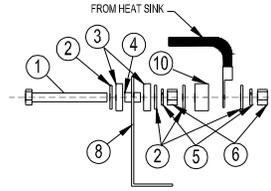
NOTE: DETERMINE NUMBER OF SHUNTS, FUSE TYPE, & CABLE SIZE FOR THE CHARGER. THEN, REFER TO THE APPROPRIATE ILLUSTRATION.



DC FUSE TYPE ANN, NEG (-) (TOP)

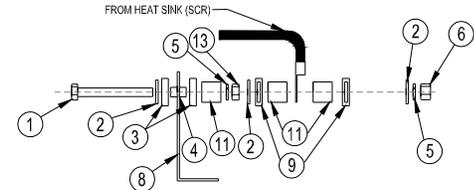
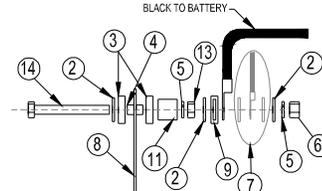
DC FUSE TYPE ANN, POS (+)

ANY SIZE PARALLEL CABLES



SINGLE SHUNT (NEG SIDE)

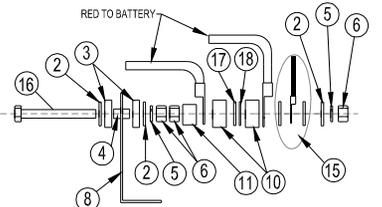
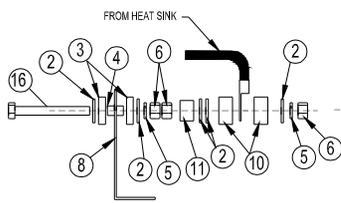
SINGLE SHUNT (POS SIDE)



DC FUSE TYPE FWA, NEG (-) (TOP)

DC FUSE TYPE FWA, POS (+)

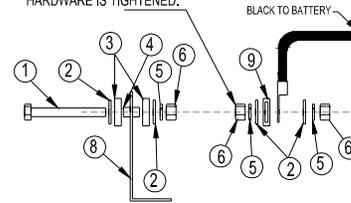
ANY SIZE PARALLEL CABLES



PARALLEL SHUNT (NEG SIDE)

PARALLEL SHUNT (POS SIDE)

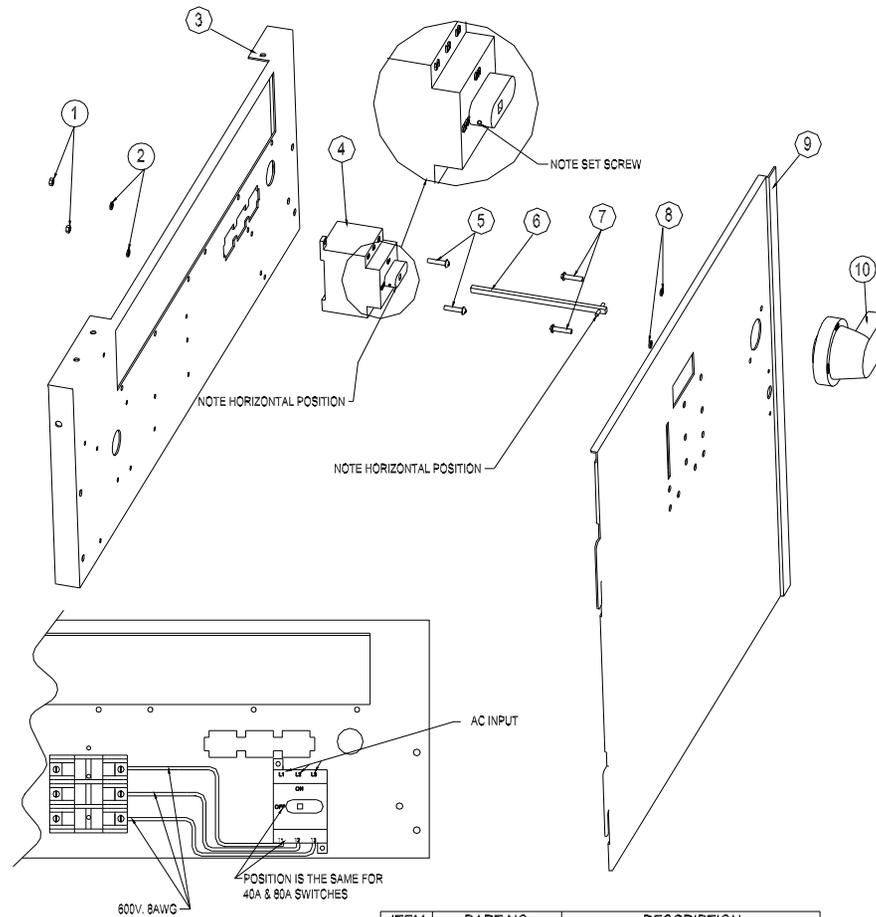
IMPORTANT NOTE:
THIS NUT MUST BE LOCATED SO THAT THE DC FUSE IS PARALLEL TO THE PANEL WHEN THE HARDWARE IS TIGHTENED.



DC FUSE (ANY TYPE), NEG (-) (BOTTOM)

ITEM	PART NUMBER	DESCRIPTION
1	042-7-75	5/16-18 X 2.75 HEX HD BOLT
2	074-7-16	5/16 FLAT WASHER, ZINC PL
3	044-2-18	INSULATION WASHER
4	055-1-85	INSULATION BUSHING
5	074-2-6	5/16 LOCK WASHER
6	007-3-71	5/16 HEX NUT, ZINC PL
7	074-4-6	BRASS WASHERS & BLACK LEAD
8	SEE BOM	HEATSINK MTG PANEL
9	SEE BOM	DC FUSE
10	SEE BOM	SHUNT
11	006-207-2	SPACER
12	042-7-42	BOLT, 5/16-18 X 1.75
13	007-3-73	5/16 JAM NUT, ZINC PL
14	042-7-52	BOLT, 5/16-18 X 2
15	074-4-6	BRASS WASHERS & RED LEAD
16	042-7-76	5/16-18 X 3.50 HEX HD BOLT
17	074-6-6	5/16" DIA. X 1/16" COPPER WASHER
18	074-6-3	5/16" DIA. X 1/32" COPPER WASHER

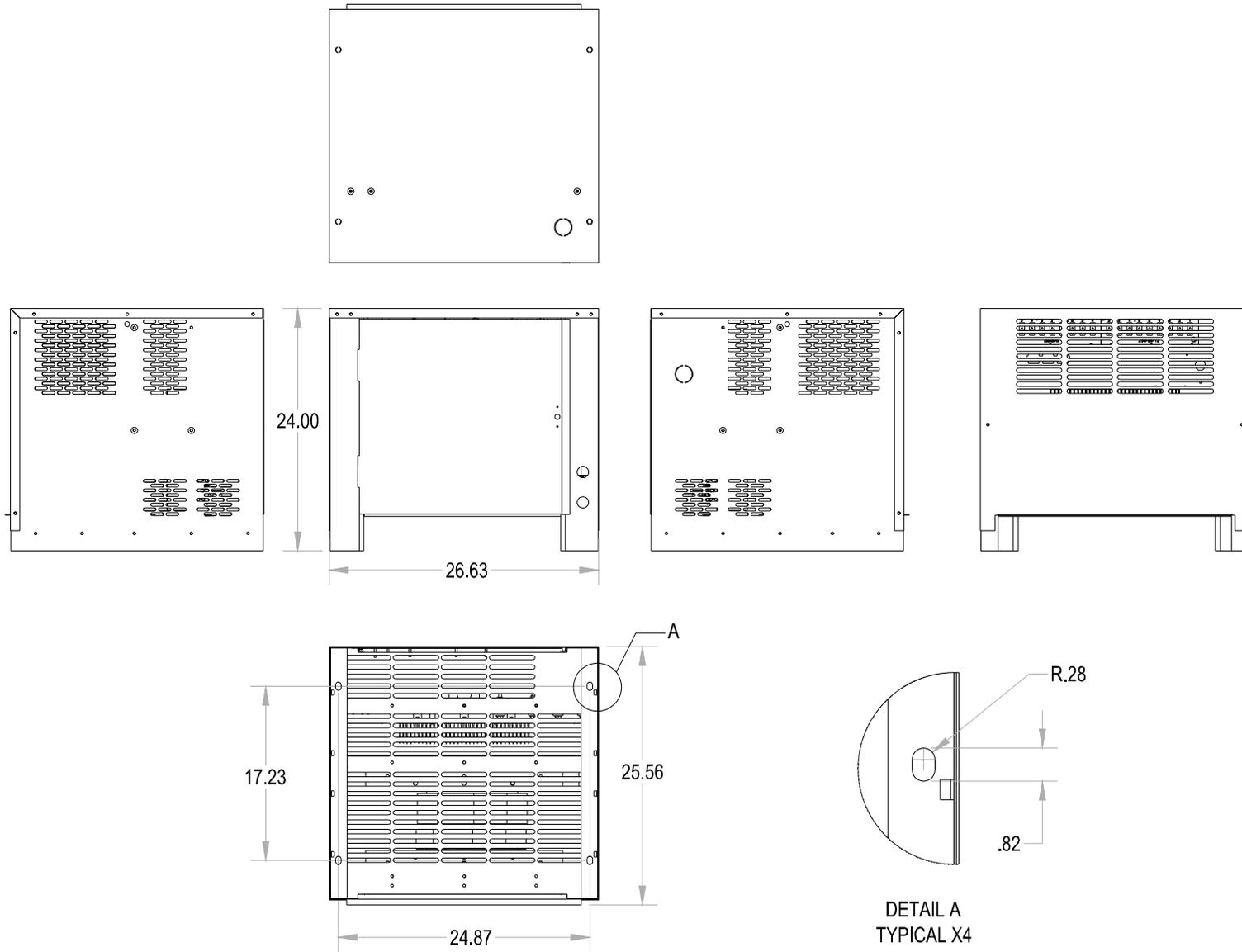
DISCONNECT SWITCH (OPTIONAL)



VIEW OF A 3PH. STANDARD CHARGER

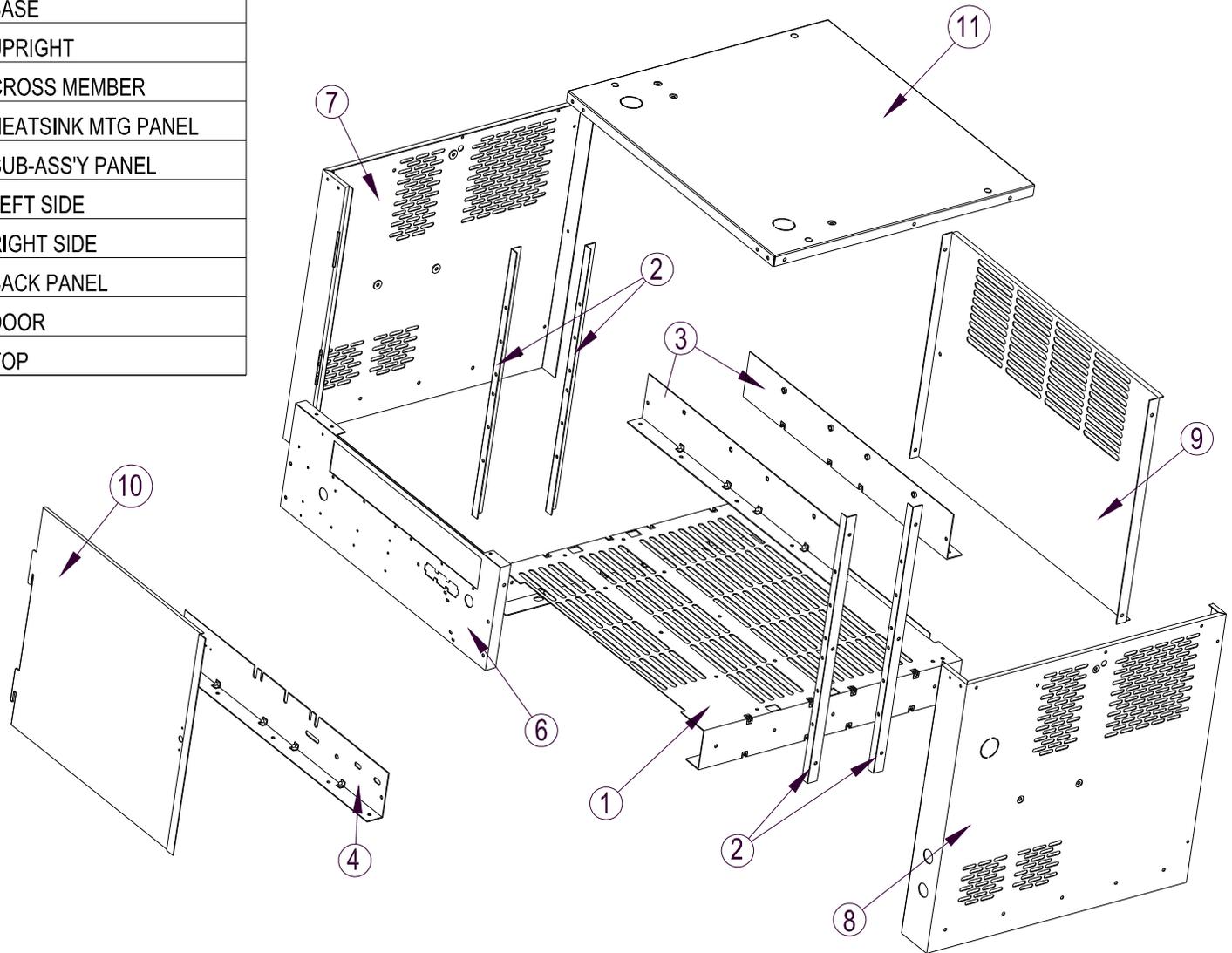
ITEM	PART NO.	DESCRIPTION
1	007-3-21	#8 NUT
2	074-2-2	#8 LOCK WASHER
3	SEE BOM	SUB-ASSY PANEL
4	X002-99-0-45	40A DISCONNECT SWITCH
	X002-99-0-51	80A DISCONNECT SWITCH
5	101-31-7	#8-32 X 3/4 SCREW
6	X002-99-0-47	ROD, CUT TO SIZE
7	PROVIDED	SCREW
8	PROVIDED	FLAT WASHERS
9	SEE BOM	DOOR FOR DISCONNECT SWITCH
10	X002-99-0-46	HANDLE

CABINET ASSEMBLY



CABINET ASSEMBLY, EXPLODED VIEW

ITEM NO.	PART NO.	DESCRIPTION
1	013-99-3-1	BASE
2	X052-99-0-6	UPRIGHT
3	SEE BOM	CROSS MEMBER
4	SEE BOM	HEATSINK MTG PANEL
6	SEE BOM	SUB-ASS'Y PANEL
7	X057-99-0-5	LEFT SIDE
8	X057-99-0-6	RIGHT SIDE
9	X057-99-3-16	BACK PANEL
10	X054-99-3-4	DOOR
11	X052-99-3-12	TOP



ES3

LARGE CABINET

REPLACEMENT PARTS

SCHEMATIC

REPLACEMENT PARTS / FUSE VALUES

CAUTION: THERE ARE DANGEROUS VOLTAGES WITHIN THE BATTERY CHARGER CABINET. ONLY QUALIFIED PERSONNEL SHOULD ATTEMPT TO ADJUST OR SERVICE THIS BATTERY CHARGER.

PRINTED CIRCUIT (CONTROL) BOARD

Charger Model Number	PCB Part Number	Charger Model Number	PCB Part Number
ES3-30-1700YNC	X1060-09-ES3-1	ES3-64-1250J	X1060-09-ES3-2

COMMON PARTS TO ALL MODELS

Description	Part Number
Door	X054-99-3-19
Top Panel	X057-99-3-23
Back Panel	X057-99-3-3
Left Side Panel	X057-99-3-13
Right Side Panel	X057-99-3-22
Base	013-99-3-3
Cross Member, Heat Sink Mtg.	X051-99-3-13
Cross Member, Xfmr Mtg, Front	X051-99-3-14
Cross Member, Xfmr Mtg, Back	X051-99-3-15
Upright Support	X052-99-0-6
Door Latch	X044-1-32
Door Latch Rivets	164-8-6

SHUNTS

Ampere Hours	Value	Part Number
0-680	150	X117-99-2
681-1200	300	X117-99-1
1201 & UP	300 X 2	X117-99-1

PARTS / FUSE VALUES FOR ES3-30-1700YNC

Description	Part Number
Transformer	X127-S30-1700Y
AC Fuses (70A)	X014-99-70
DC Fuse (400A)	X014-30-7
Shunt (300A)	X117-99-1

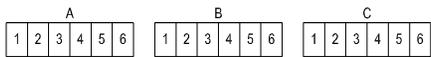
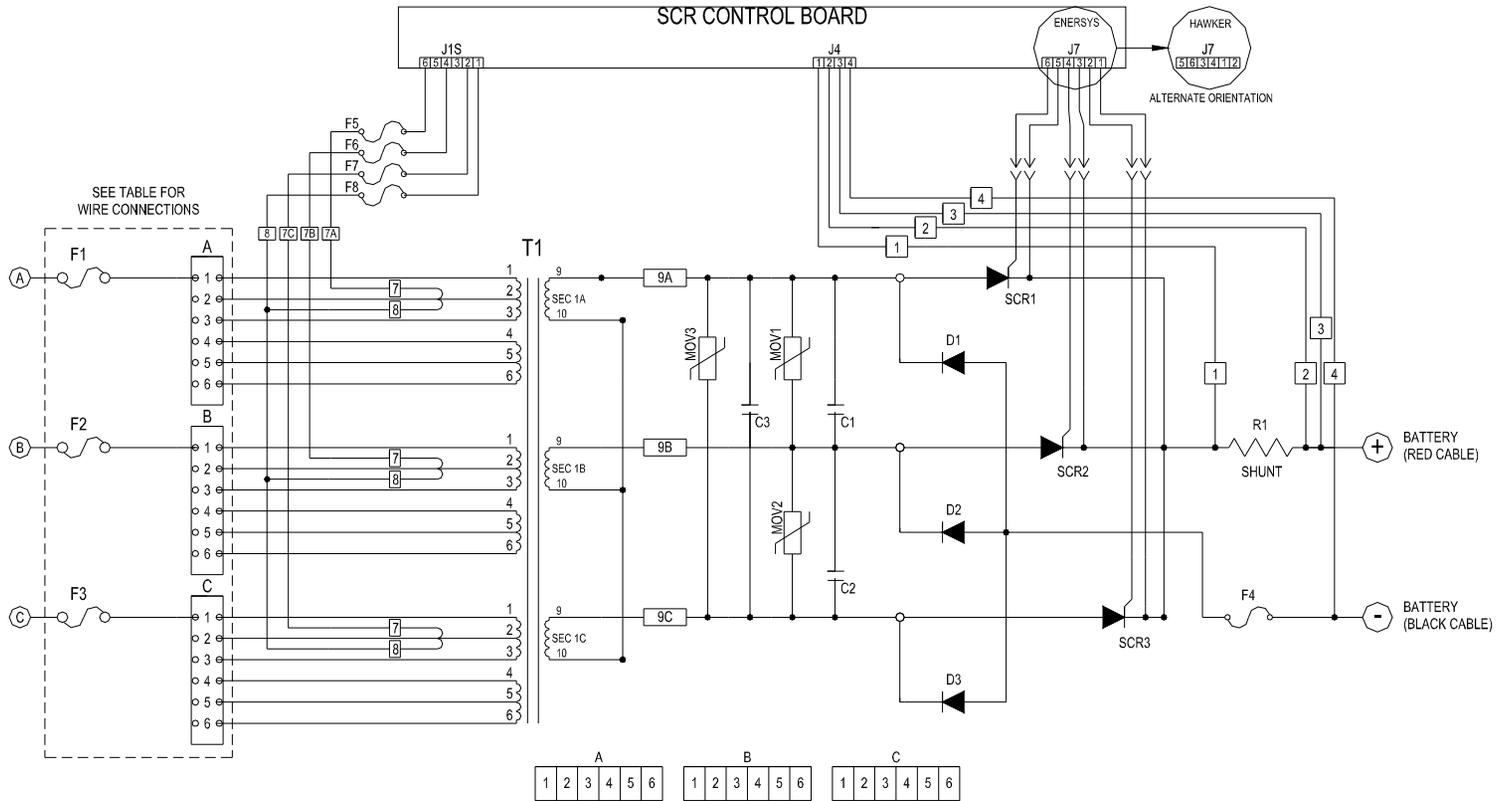
PARTS / FUSE VALUES FOR ES3-64-1250J

Description	Part Number
Transformer	X127-S64-1250J
AC Fuse, 480V Connection, 100A	X014-99-100
AC Fuse, 550/600V Connection, 90A	X014-99-90
DC Fuse (250A)	X014-30-4
Shunt (300A)	X117-99-1

AC INPUT AND FUSES

Special Models: **NOTE:** Special charger models might not be listed in these tables. However, AC input is listed on the charger nameplate. AC Fuse Values are listed on a decal inside the charger. The AC Fuse part number would be: **X014-99-X**, where X would equal the AC Fuse Value.

SCHEMATIC DIAGRAM



MODEL B		MODEL D		MODEL J			MODEL E		
208V	240V	480V	220V	380V	440V	480V	550V	600V	400V
F1 TO A1									
A1 TO A4	A1 TO A4	A3 TO A4	A1 TO A4	A2 TO A4	A3 TO A4	A2 TO A4	A2 TO A4	A3 TO A4	F1 TO C6
A2 TO A5	A3 TO A6	A3 TO A4	A3 TO A6	A2 TO A4	A3 TO A4	A2 TO A4	A2 TO A4	A3 TO A4	F2 TO A6
F2 TO A5	F2 TO A6	F2 TO A6	F2 TO A6	F2 TO A5	F2 TO A6	F2 TO A5	F2 TO A6	F2 TO A6	F2 TO B1
F2 TO B1	F3 TO B6								
B1 TO B4	B1 TO B4	B3 TO B4	B1 TO B4	B2 TO B4	B3 TO B4	B2 TO B4	B2 TO B4	B3 TO B4	F3 TO C1
B2 TO B5	B3 TO B6	B3 TO B4	B3 TO B6	B2 TO B4	B3 TO B4	B2 TO B4	B2 TO B4	B3 TO B4	
F3 TO B5	F3 TO B6	F3 TO B6	F3 TO B6	F3 TO B5	F3 TO B6	F3 TO B5	F3 TO B6	F3 TO B6	
F3 TO C1									
C1 TO C4	C1 TO C4	C3 TO C4	C1 TO C4	C2 TO C4	C3 TO C4	C2 TO C4	C2 TO C4	C3 TO C4	
C2 TO C5	C3 TO C6	C3 TO C4	C3 TO C6	C2 TO C4	C3 TO C4	C2 TO C4	C2 TO C4	C3 TO C4	
F1 TO C5	F1 TO C6	F1 TO C6	F1 TO C6	F1 TO C5	F1 TO C6	F1 TO C5	F1 TO C6	F1 TO C6	

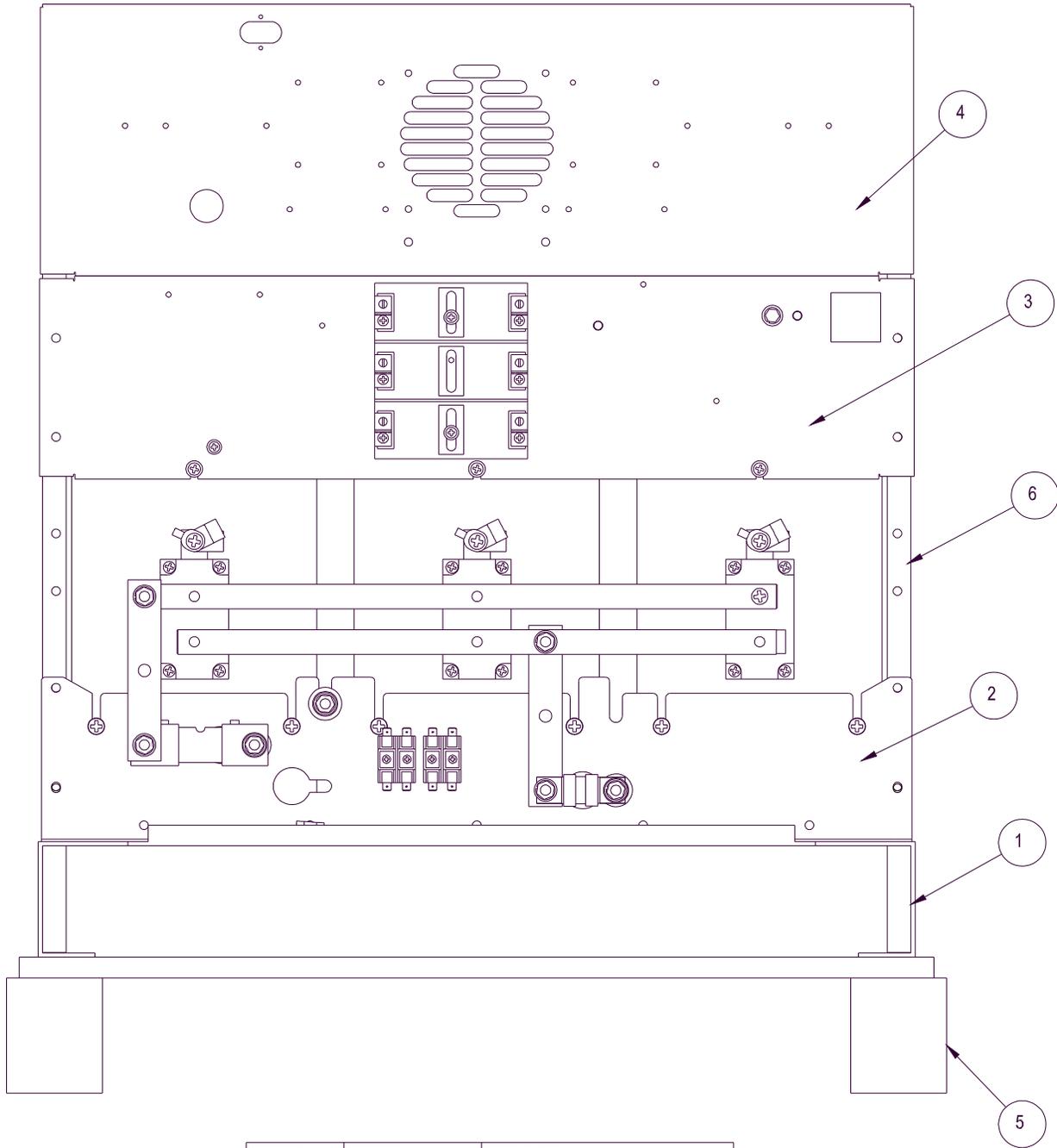
NOTE: CHARGER MODELS WITH LETTER CODES 'T', 'W', 'X', AND 'Y' SHALL BE REFERRED TO MODEL 'B' TABLE

ES3

LARGE CABINET

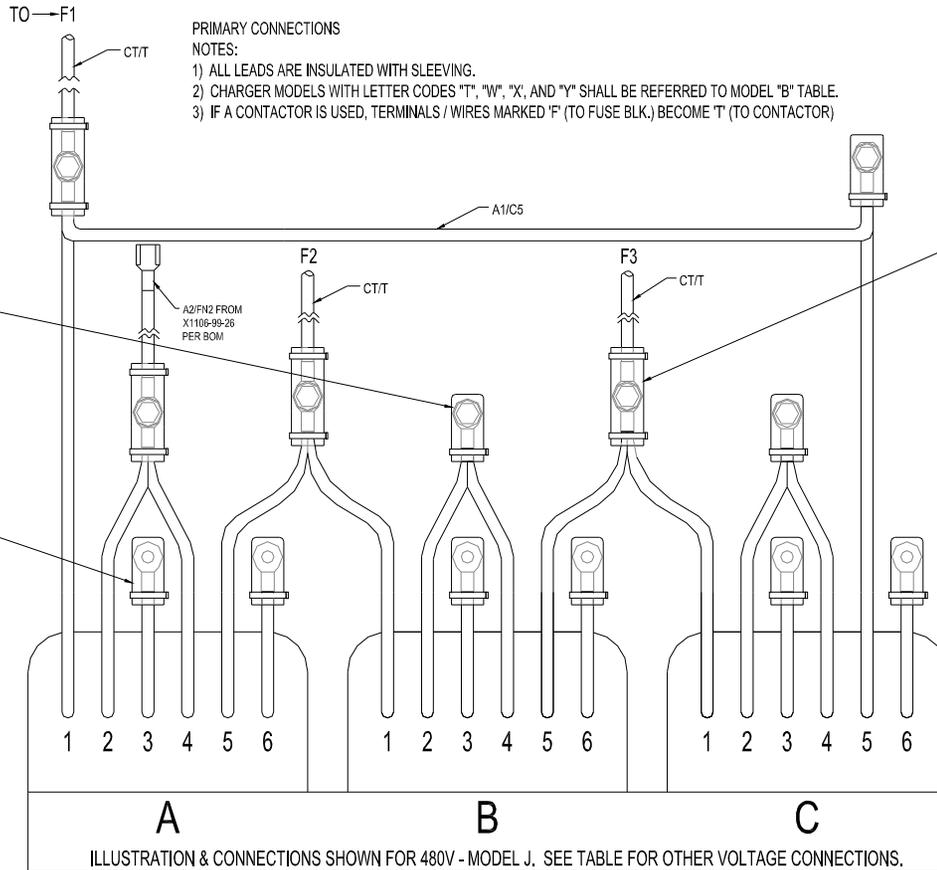
ASSEMBLY DRAWINGS

CHARGER INTERIOR VIEW



ITEM NO.	PART NO.	DESCRIPTION
1	013-99-3-3	BASE
2	REF DWG	HEAT SINK ASSEMBLY
3	REF DWG	FUSE BLOCK PANEL
4	X052-99-3-10	FAN MOUNTING PANEL
5	5600-99-0-8	PALLET
6	X052-99-0-6	UPRIGHT SUPPORT

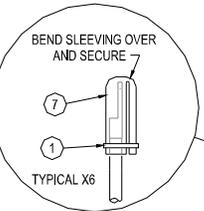
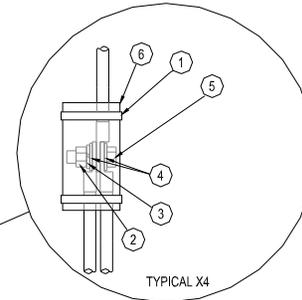
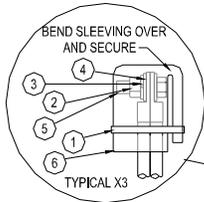
TRANSFORMER CONNECTIONS



PRIMARY CONNECTIONS

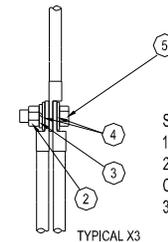
NOTES:

- 1) ALL LEADS ARE INSULATED WITH SLEEVING.
- 2) CHARGER MODELS WITH LETTER CODES "T", "W", "X", AND "Y" SHALL BE REFERRED TO MODEL "B" TABLE.
- 3) IF A CONTACTOR IS USED, TERMINALS / WIRES MARKED 'F' (TO FUSE BLK.) BECOME 'T' (TO CONTACTOR)



MODEL B			MODEL J		
208V	240V	480V	480V	550V	600V
F1 - A1					
*F1 - C5	*F1 - C6	*F1 - C6	*F1 - C5	*F1 - C6	*F1 - C6
F2 - A5	F2 - A6	F2 - A6	F2 - A5	F2 - A6	F2 - A6
F2 - B1					
F3 - B5	F3 - B6	F3 - B6	F3 - B5	F3 - B6	F3 - B6
F3 - C1					
A1 - A4	A1 - A4	A3 - A4	A2 - A4	A2 - A4	A3 - A4
A2 - A5	A3 - A6	B3 - B4	B2 - B4	B2 - B4	B3 - B4
B1 - B4	B1 - B4	C3 - C4	C2 - C4	C2 - C4	C3 - C4
B2 - B5	B3 - B6				
C1 - C4	C1 - C4				
C2 - C5	C3 - C6				

*USE 124-6B-20 (A1/C5) JUMPER.



SECONDARY CONNECTIONS:

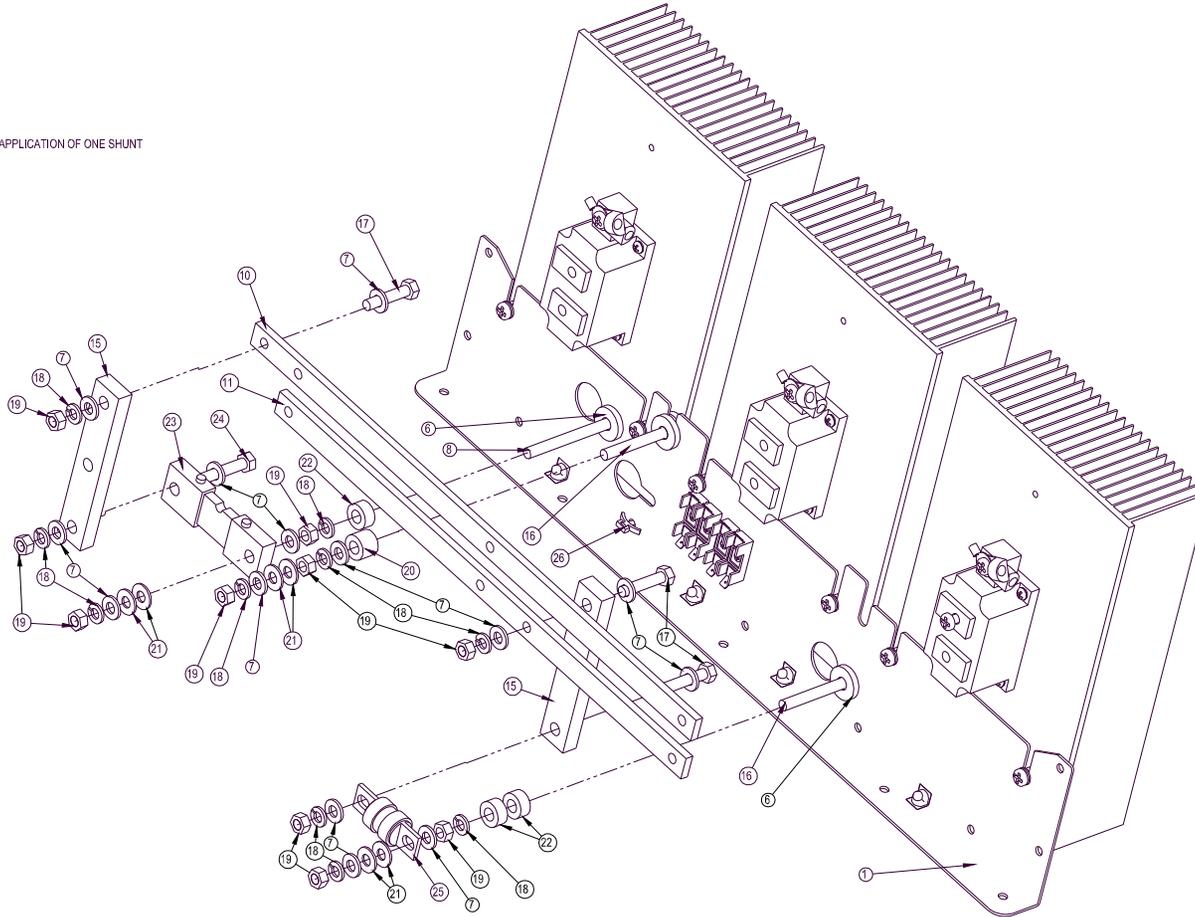
- 1) ATTACH 124-4/0W-32 CABLE TO XFMR #9 AS SHOWN, IF REQUIRED.
- 2) APPLY VINYL TRIM TO TOP EDGE OF XFMR BRACKETS, TO PROTECT CABLES.
- 3) ALL LEADS ARE INSULATED.

ITEM	P/N	DESCRIPTION
1	173-1-1	TIE WRAP
2	007-3-71	5/16 HEX NUT
3	074-2-6	5/16 LOCK WASHER
4	074-7-16	5/16 FLAT WASHER
5	103-51-5	5/16 X 1 HEX HD SCREW
6	5400-10-79	SLEEVING
7	5400-10-20	SLEEVING

ILLUSTRATION & CONNECTIONS SHOWN FOR 480V - MODEL J. SEE TABLE FOR OTHER VOLTAGE CONNECTIONS.

HEAT SINK ASSEMBLY

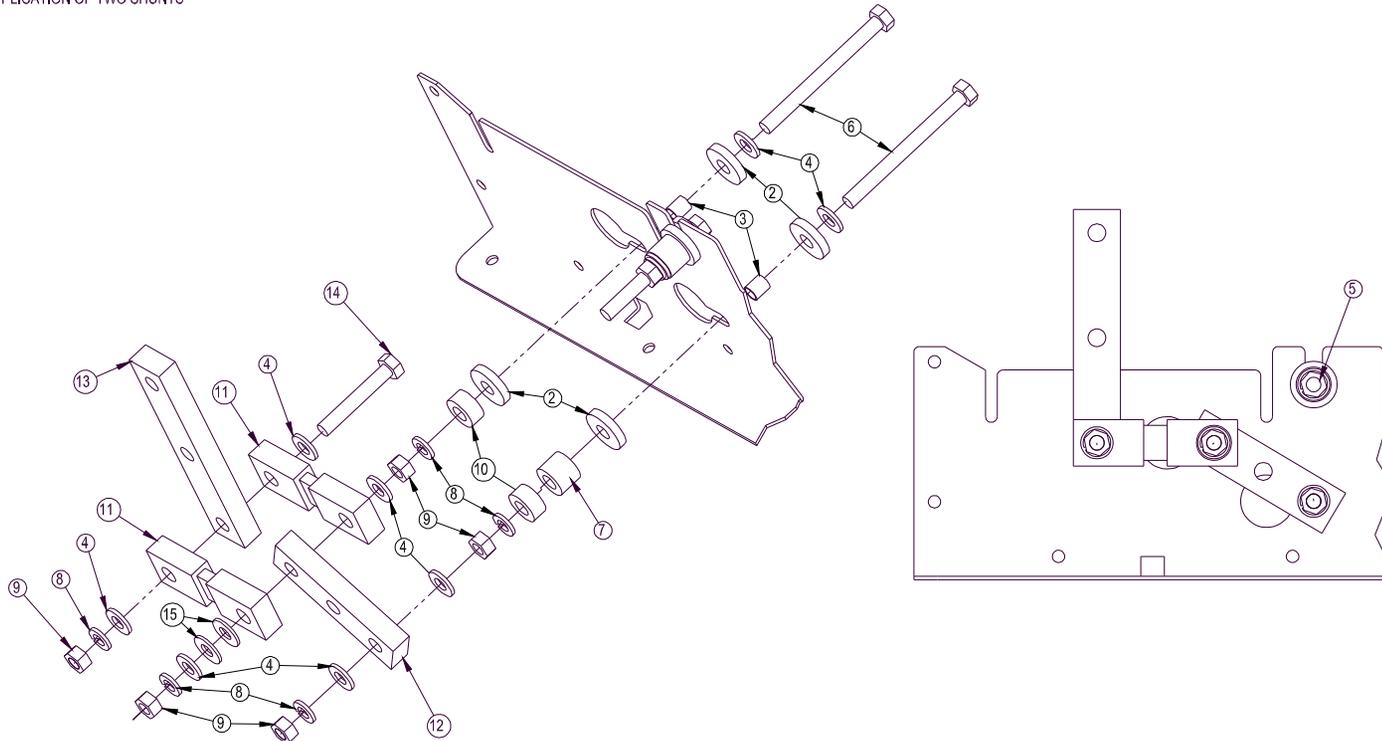
APPLICATION OF ONE SHUNT



ITEM NO.	PIN	DESCRIPTION	ITEM NO.	PIN	DESCRIPTION
1	X051-99-3-13	HEAT SINK MOUNTING PANEL	18	074-2-6	5/16 LOCK WASHER
6	044-2-18	WASHER, INSULATING	19	007-3-71	5/16 HEX NUT
7	074-7-16	5/16 FLAT WASHER	20	006-207-1	SPACER
8	042-7-76	BOLT, 5/16 X 3.5, HEX	21	074-4-6	5/16 FLAT WASHER, BRASS
10	090-2-88	BUSS BAR	22	006-207-2	SPACER
11	090-2-85	BUSS BAR	23	SEE BOM	SEE BOM
12	X015-46	FUSEBLOCK, 2 POLE, 1/4" DIA FUSE	24	042-7-42	BOLT, 5/16 X 1.75, HEX
13	074-2-1	#6 LOCK WASHER	25	FWA FUSE	SEE BOM
14	036-4-59	SCREW, 6-32 X 3/8, PAN HD	26	173-1-11	CABLE TIE, WINGED
15	090-2-83	BUSS BAR			
16	042-7-75	BOLT, 5/16-18 X 2.75, HEX HD			
17	042-7-32	BOLT, 5/16-18 X 1.5, HEX			

HEAT SINK ASSEMBLY (CON'T)

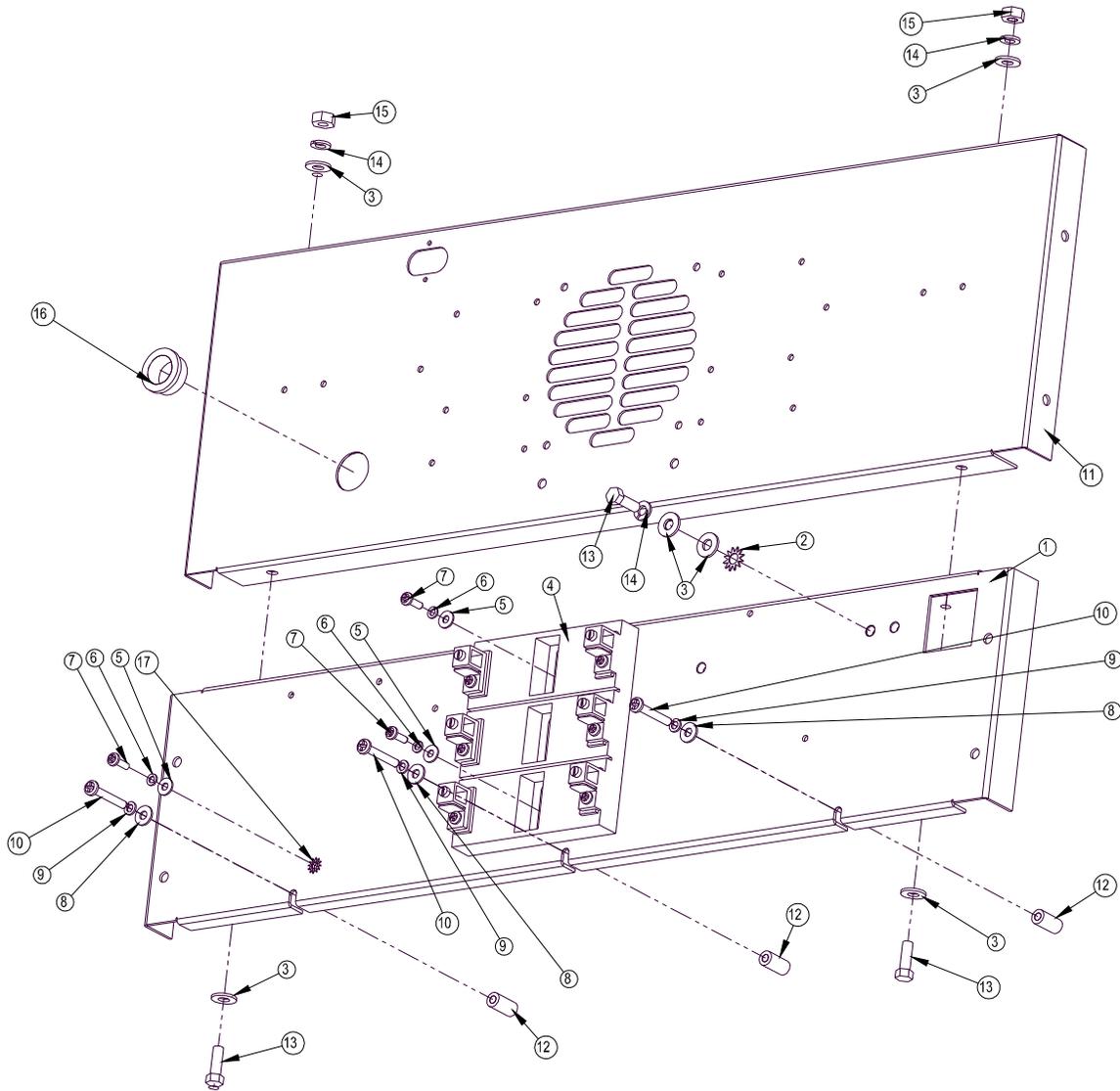
APPLICATION OF TWO SHUNTS



THIS TABLE APPLIES TO DOUBLE SHUNT VIEW ONLY

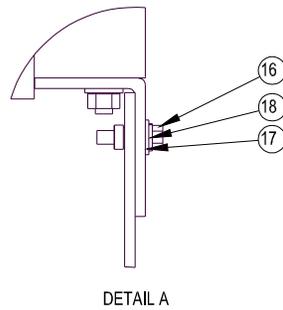
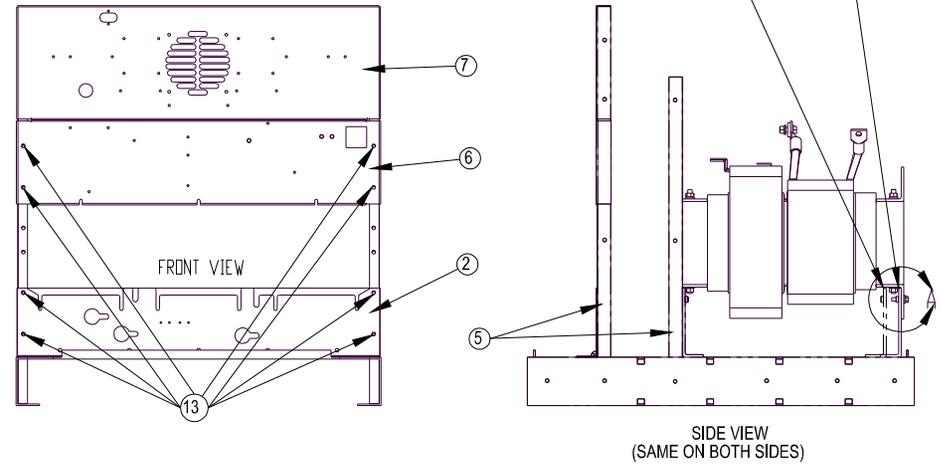
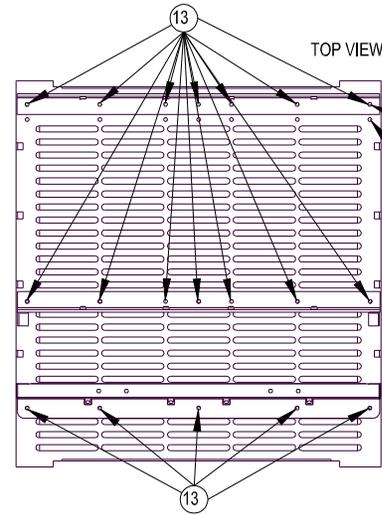
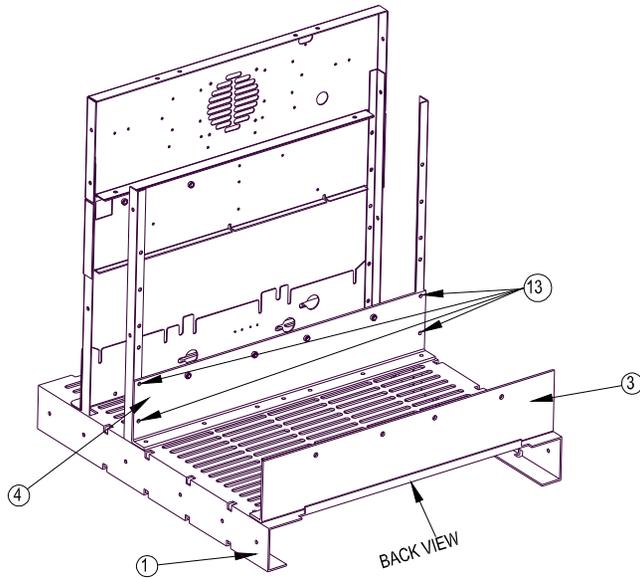
ITEM NO.	P/N	DESCRIPTION
2	044-2-18	WASHER, INSULATING
3	055-1-85	INSULATION BUSHING
4	074-7-16	5/16" FLAT WASHER
5	042-7-75	BOLT, 5/16-18 X 2.75, HEX HD
6	042-7-76	BOLT, 5/16-18 X 3.5, HEX HD
7	006-207-1	SPACER
8	074-2-6	5/16 LOCK WASHER
9	007-3-71	5/16 HEX NUT
10	006-207-2	SPACER
11	SHUNT	REFERENCE ORDER
12	090-2-84	BUSS BAR
13	090-2-83	BUSS BAR
14	042-7-52	BOLT, 5/16-18 X 2 HEX HD
15	074-4-6	5/16" FLAT WASHER, BRASS

SUB-ASSEMBLY PANELS



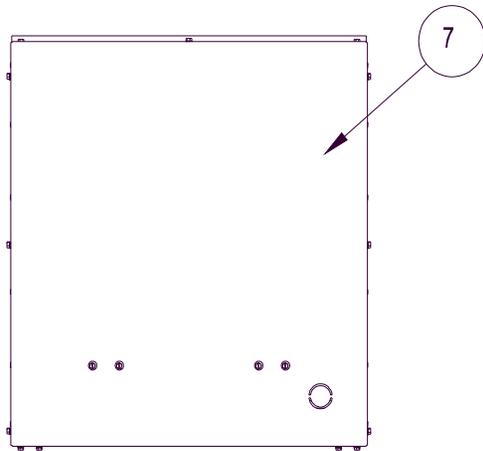
ITEM NO.	P/N	DESCRIPTION
1	X052-99-3-11	FUSE BLOCK PANEL
2	074-3-10	1/4" LOCK WASHER, EXT. TOOTH
3	074-9-3	1/4" FLAT WASHER
4	SEE TABLE	FUSE BLOCK, 100A, 3POLE, CLASS J
5	074-7-9	#8 FLAT WASHER
6	074-2-2	#8 LOCK WASHER
7	036-4-67	SCREW, #8-32 X 1/2
8	074-7-17	#10 FLAT WASHER
9	074-2-3	#10 LOCK WASHER
10	036-99-1	SCREW, #10-32 X 1.25
11	X052-99-3-10	FAN MOUNTING PANEL
12	006-208-1	SPACER
13	103-31-3	SCREW, HEX HD, 1/4-20 X 3/4
14	074-2-5	1/4" LOCK WASHER
15	007-3-51	1/4-20 NUT
16	055-5-71	GROMMET, NYLON, 1.00 OD
17	074-3-18	#8 LOCK WASHER, EXT. TOOTH

CABINET ASSEMBLY

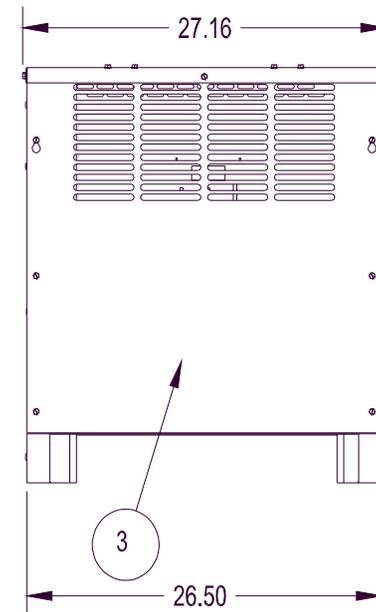
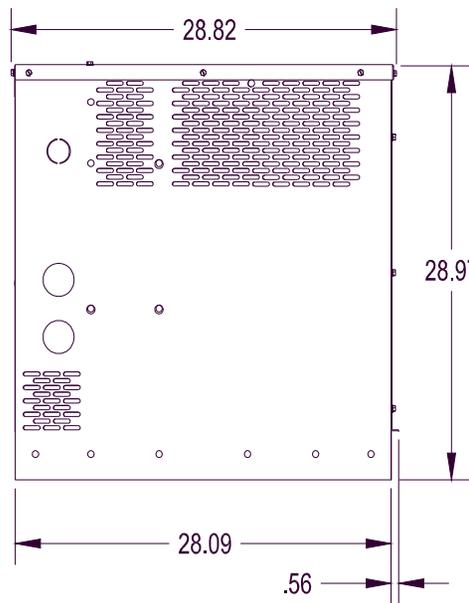
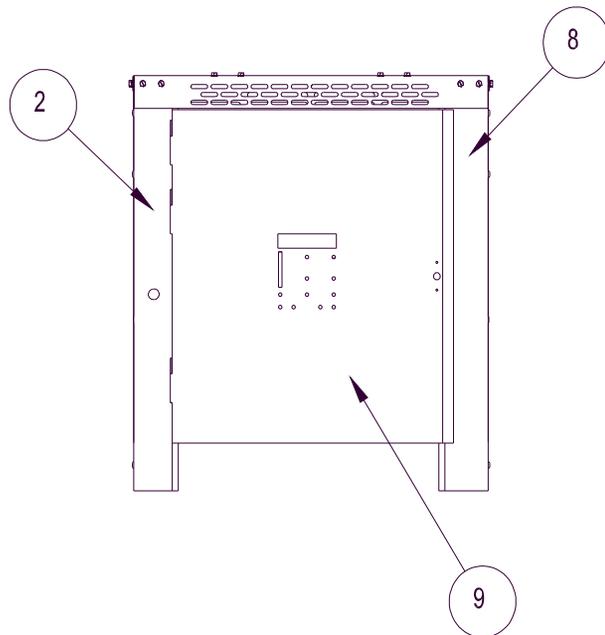


ITEM NO.	BASIC DESCRIPTION
1	BASE
2	HEAT SINK PANEL
3	XFMR CROSSMEMBER, BACK
4	XFMR CROSSMEMBER, FRONT
5	UPRIGHT
6	FUSE BLK PANEL
7	FAN MOUNTING PANEL
8	LEFT SIDE PANEL
9	RIGHT SIDE
10	BACK PANEL
11	DOOR, OVERSIZE
12	TOP PANEL
13	RIVET
14	1/4-20 SCREW W/ SERRATIONS
15	COVER PLUG, .535 X .602 SLOT
16	SCREW, HEX HD, 1/4-20 X 1.00
17	1/4" FLAT WASHER
18	1/4" LOCK WASHER

CABINET ASSEMBLY (CON'T)



ITEM NO.	PART NO.	DESCRIPTION
2	X057-99-3-13	LEFT SIDE PANEL
3	X057-99-3-3	BACK PANEL
7	X057-99-3-23	TOP PANEL
8	X057-99-3-22	RIGHT SIDE
9	X054-99-3-19	DOOR, OVERSIZE



I. PRODUCT IDENTIFICATION

Chemical Trade Name (as used on label): Lead-Acid Battery	Chemical Family/Classification: Electric Storage Battery
Manufacturer's Name/Address: EnerSys P.O. Box 14145 2366 Bernville Road Reading, PA 19612-4145	Telephone: For information and emergencies, contact EnerSys' Environmental, Health & Safety Dept. at 610-208-1996 24-Hour Emergency Response Contact: CHEMTREC DOMESTIC: 800-424-9300 CHEMTREC INTERNATIONAL: 703-527-3877

II. HAZARDOUS INGREDIENTS/IDENTIFY INFORMATION

Components	CAS Number	Approximate % by Wt. Or Vol.	Air Exposure Limits (ug/m ³)		
			OSHA	ACGIH	NIOSH
Inorganic Lead Compound:					
Lead	7439-92-1	60	50	150	100
* Antimony	7440-36-0	2	500	500	--
* Arsenic	7440-38-2	0.2	10	200	--
* Calcium	7440-70-2	0.2	--	--	--
* Tin	7440-31-5	0.2	2000	2000	--
Electrolyte (Sulfuric Acid)	7664-93-9	10-30	1000	1000	1000
Case Material:		5-10	N/A	N/A	N/A
Polypropylene	9003-07-0				
Polystyrene	9003-53-6				
Styrene Acrylonitrile	9003-54-7				
Acrylonitrile Butadiene Styrene	9003-56-9				
Styrene Butadiene	9003-55-8				
Polyvinylchloride	9002-86-2				
Polycarbonate, Hard Rubber, Polyethylene	--				
Other:					
Silicon Dioxide (Gel batteries only)	7631-86-9	20-40	N/A	N/A	N/A
Sheet Molding Compound (Glass reinforced polyester)	--		N/A	N/A	N/A

Inorganic lead and electrolyte (sulfuric acid) are the primary components of every battery manufactured by EnerSys. Other ingredients may be present dependent upon battery type. Contact your EnerSys representative for additional information.

III. PHYSICAL DATA

Electrolyte:			
Boiling Point:	203 - 240° F	Specific Gravity (H ₂ O = 1):	1.215 to 1.350
Melting Point:	N/A	Vapor Pressure (mm Hg):	10
Solubility in Water:	100%	Vapor Density (AIR = 1):	Greater than 1
Evaporation Rate: (Butyl Acetate = 1)	Less than 1	% Volatile by Weight:	N/A
Appearance and Odor:	Manufactured article; no apparent odor. Electrolyte is a clear liquid with a sharp, penetrating, pungent odor.		

IV. FIRE AND EXPLOSION HAZARD DATA

Flash Point: N/A	Flammable Limits: LEL = 4.1% (Hydrogen Gas)	UEL = 74.2%
Extinguishing Media: CO ₂ ; foam; dry chemical		

Special Fire Fighting Procedures:

If batteries are on charge, shut off power. Use positive pressure, self-contained breathing apparatus. Water applied to electrolyte generates heat and causes it to spatter. Wear acid-resistant clothing.

Unusual Fire and Explosion Hazards:

Highly flammable hydrogen gas is generated during charging and operation of batteries. To avoid risk of fire or explosion, keep sparks or other sources of ignition away from batteries. Do not allow metallic materials to simultaneously contact negative and positive terminals of cells and batteries. Follow manufacturer's instructions for installation and service.

V. REACTIVITY DATA

Stability: Stable
Conditions To Avoid: Prolonged overcharge; sources of ignition
Incompatibility: (Materials to avoid)
Sulfuric Acid: Contact with combustibles and organic materials may cause fire and explosion. Also reacts violently with strong reducing agents, metals, sulfur trioxide gas, strong oxidizers and water. Contact with metals may produce toxic sulfur dioxide fumes and may release flammable hydrogen gas.
Lead Compounds: Avoid contact with strong acids, bases, halides, halogenates, potassium nitrate, permanganate, peroxides, nascent hydrogen and reducing agents.

Hazardous Decomposition Products:

Sulfuric Acid: Sulfur trioxide, carbon monoxide, sulfuric acid mist, sulfur dioxide, and hydrogen.
Lead Compounds: High temperatures likely to produce toxic metal fumes, vapor, or dust; contact with strong acid or base or presence of nascent hydrogen may generate highly toxic arsine gas.

VI. HEALTH HAZARD DATA

Routes of Entry:

Sulfuric Acid: Harmful by all routes of entry.
Lead Compounds: Hazardous exposure can occur only when product is heated, oxidized or otherwise processed or damaged to create dust, vapor or fume.

Inhalation:

Sulfuric Acid: Breathing of sulfuric acid vapors or mists may cause severe respiratory irritation.
Lead Compounds: Inhalation of lead dust or fumes may cause irritation of upper respiratory tract and lungs.

Ingestion:

Sulfuric Acid: May cause severe irritation of mouth, throat, esophagus and stomach.
Lead Compounds: Acute ingestion may cause abdominal pain, nausea, vomiting, diarrhea and severe cramping. This may lead rapidly to systemic toxicity and must be treated by a physician.

Skin Contact:

Sulfuric Acid: Severe irritation, burns and ulceration.
Lead Compounds: Not absorbed through the skin.

Eye Contact:

Sulfuric Acid: Severe irritation, burns, cornea damage, and blindness.
Lead Components: May cause eye irritation.

Effects of Overexposure - Acute:

Sulfuric Acid: Severe skin irritation, damage to cornea, upper respiratory irritation.
Lead Compounds: Symptoms of toxicity include headache, fatigue, abdominal pain, loss of appetite, muscular aches and weakness, sleep disturbances and irritability.

Effects of Overexposure - Chronic:

Sulfuric Acid: Possible erosion of tooth enamel, inflammation of nose, throat and bronchial tubes.
Lead Compounds: Anemia; neuropathy, particularly of the motor nerves, with wrist drop; kidney damage; reproductive changes in males and females.

Carcinogenicity:

Sulfuric Acid: The International Agency for Research on Cancer (IARC) has classified "strong inorganic acid mist containing sulfuric acid" as a Category I carcinogen, a substance that is carcinogenic to humans. This classification does not apply to liquid forms of sulfuric acid or sulfuric acid solutions contained within a battery. Inorganic acid mist (sulfuric acid mist) is not generated under normal use of this product. Misuse of the product, such as overcharging, may result in the generation of sulfuric acid mist.
Lead Compounds: Lead is listed as a 2B carcinogen, likely in animals at extreme doses. Proof of carcinogenicity in humans is lacking at present.
Arsenic: Listed by National Toxicology Program (NTP), International Agency for Research on Cancer (IARC), OSHA and NIOSH as a carcinogen only after prolonged exposure at high levels.

Medical Conditions Generally Aggravated by Exposure:

Overexposure to sulfuric acid mist may cause lung damage and aggravate pulmonary conditions. Contact of sulfuric acid with skin may aggravate diseases such as eczema and contact dermatitis. Lead and its compounds can aggravate some forms of kidney, liver and neurologic diseases.

EMERGENCY AND FIRST AID PROCEDURES:

Inhalation:

Sulfuric Acid: Remove to fresh air immediately. If breathing is difficult, give oxygen.
Lead: Remove from exposure, gargle, wash nose and lips; consult physician.

Ingestion:

Sulfuric Acid: Give large quantities of water; do not induce vomiting; consult physician.
Lead: Consult physician immediately.

Skin:

Sulfuric Acid: Flush with large amounts of water for at least 15 minutes; remove contaminated clothing completely, including shoes.
Lead: Wash immediately with soap and water.

Eyes:

Sulfuric Acid and Lead: Flush immediately with large amounts of water for a least 15 minutes; consult physician.

Proposition 65:

Warning: Battery posts, terminals and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm. Batteries also contain other chemicals known to the State of California to cause cancer. Wash hands after handling.

VII. PRECAUTIONS FOR SAFE HANDLING AND USE

Spill or Leak Procedures:

Stop flow of material, contain/absorb small spills with dry sand, earth or vermiculite. Do not use combustible materials. If possible, carefully neutralize spilled electrolyte with soda ash, sodium bicarbonate, lime, etc. Wear acid-resistant clothing, boots, gloves, and face shield. Do not allow discharge of unneutralized acid to sewer.

Waste Disposal Methods:

Spent batteries: Send to secondary lead smelter for recycling. Place neutralized slurry into sealed containers and handle as applicable with state and federal regulations. Large water-diluted spills, after neutralization and testing, should be managed in accordance with approved local, state and federal requirements. Consult state environmental agency and/or federal EPA.

VII. PRECAUTIONS FOR SAFE HANDLING AND USE (Cont.)

Handling and Storage:

Store batteries in cool, dry, well-ventilated areas with impervious surfaces and adequate containment in the event of spills. Batteries should also be stored under roof for protection against adverse weather conditions. Separate from incompatible materials. Store and handle only in areas with adequate water supply and spill control. Avoid damage to containers. Keep away from fire, sparks and heat.

Precautionary Labeling:

POISON - CAUSES SEVERE BURNS

DANGER - CONTAINS SULFURIC ACID

VIII. CONTROL MEASURES

Engineering Controls:

Store and handle in well-ventilated area. If mechanical ventilation is used, components must be acid-resistant.

Work Practices:

Handle batteries cautiously to avoid spills. Make certain vent caps are on securely. Avoid contact with internal components. Wear protective clothing when filling or handling batteries.

Respiratory Protection:

None required under normal conditions. When concentrations of sulfuric acid mist are known to exceed the PEL, use NIOSH or MSHA-approved respiratory protection.

Protective Gloves:

Rubber or plastic acid-resistant gloves with elbow-length gauntlet.

Eye Protection:

Chemical goggles or face shield.

Other Protection:

Acid-resistant apron. Under severe exposure emergency conditions, wear acid-resistant clothing and boots.

Emergency Flushing:

In areas where sulfuric acid is handled in concentrations greater than 1%, emergency eyewash stations and showers should be provided, with unlimited water supply.

IX. OTHER REGULATORY INFORMATION

NFPA Hazard Rating for Sulfuric Acid:

Flammability (Red) = 0
Health (Blue) = 3

Reactivity (Yellow) = 2
Sulfuric acid is water-reactive if concentrated.

U.S. DOT:

The shipping information is as follows:

Proper Shipping Name: Batteries, wet, filled with acid
Hazardous Class: 8
UN Identification: UN2794

Packing Group: III
Label/Placard Required: Corrosive

Reference 49 CFR Packing Instructions 173.159

IATA:

The shipping information is as follows:

Proper Shipping Name: Batteries, wet, filled with acid
Hazardous Class: 8
UN Identification: UN2794

Packing Group: II
Label/Placard Required: Corrosive

Reference IATA packing instructions 870

IMDG:

The shipping information is as follows:

Proper Shipping Name: Batteries, wet, filled with acid
Hazardous Class: 8
UN Identification: UN2794

Packing Group: N/A
Label/Placard Required: Corrosive

Reference IMDG packing instructions P801

IX. OTHER REGULATORY INFORMATION (Cont.)

RCRA: Spent lead-acid batteries are not regulated as hazardous waste by the EPA when recycled, however state and international regulations may vary.

CERCLA (Superfund) and EPCRA:

- (a) Reportable Quantity (RQ) for spilled 100% sulfuric acid under CERCLA (Superfund) and EPCRA (Emergency Planning Community Right to Know Act) is 1,000 lbs. State and local reportable quantities for spilled sulfuric acid may vary.
- (b) Sulfuric acid is a listed "Extremely Hazardous Substance" under EPCRA, with a Threshold Planning Quantity (TPQ) of 1,000 lbs.
- (c) EPCRA Section 302 notification is required if 1,000 lbs. or more of sulfuric acid is present at one site. The quantity of sulfuric acid will vary by battery type. Contact your EnerSys representative for additional information.
- (d) EPCRA Section 312 Tier 2 reporting is required for batteries if sulfuric acid is present in quantities of 500 lbs. or more and/or if lead is present in quantities of 10,000 lbs. or more.
- (e) **Supplier Notification:** This product contains toxic chemicals, which may be reportable under EPCRA Section 313 Toxic Chemical Release Inventory (Form R) requirements.

If you are a manufacturing facility under SIC codes 20 through 39, the following information is provided to enable you to complete the required reports:

<u>Toxic Chemical</u>	<u>CAS Number</u>	<u>Approximate % by Wt.</u>
Lead	7439-92-1	60
Sulfuric Acid	7664-93-9	10 - 30
* Antimony	7440-36-0	2
* Arsenic	7440-38-2	0.2

If you distribute this product to other manufacturers in SIC Codes 20 through 39, this information must be provided with the first shipment of each calendar year.

The Section 313 supplier notification requirement does not apply to batteries, which are "consumer products".

* Not present in all battery types. Contact your EnerSys representative for additional information.

TSCA:

Ingredients in EnerSys' batteries are listed in the TSCA Registry as follows:

<u>Components</u>	<u>CAS Number</u>	<u>TSCA Status</u>
<u>Electrolyte:</u> Sulfuric Acid (H ₂ SO ₄)	7664-93-9	Listed
<u>Inorganic Lead Compound:</u>		
Lead (Pb)	7439-92-1	Listed
Lead Oxide (PbO)	1317-36-8	Listed
Lead Sulfate (PbSO ₄)	7446-14-2	Listed
Antimony (Sb)	7440-36-0	Listed
Arsenic (As)	7440-38-2	Listed
Calcium (Ca)	7440-70-2	Listed
Tin (Sn)	7440-31-5	Listed

CAA:

EnerSys supports preventative actions concerning ozone depletion in the atmosphere due to emissions of CFC's and other ozone depleting chemicals (ODC's), defined by the USEPA as Class I substances. Pursuant to Section 611 of the Clean Air Act Amendments (CAAA) of 1990, finalized on January 19, 1993, EnerSys established a policy to eliminate the use of Class I ODC's prior to the May 15, 1993 deadline.



Power/Full Solutions

Section 28.00

Instructions for Installation,
Operation and Maintenance of
Lead-Acid Batteries in
Motive Power Service

TUBULAR SINCE 1910

INSTRUCTIONS FOR INSTALLATION, OPERATION AND MAINTENANCE OF LEAD-ACID BATTERIES IN MOTIVE POWER SERVICE

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CLEANING	19
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STORAGE OF BATTERIES	21
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Hydrogen must be ventilated in order to avoid an explosion. When calculating assume all chargers in finish rate at same time.

The National Fire Protection Association (NFPA) allows up to 1% concentration. Make sure the ventilation system can remove the hydrogen before it reaches concentrations of 1% within the charging area.

5. The ventilation system must also be designed to provide removal of fumes and excess heat from the area directly above charging batteries. Inlet air ducts should be placed at shoulder height or lower so as to provide air movement across the charging room and across batteries. Failure to properly ventilate charging areas may result in employee complaints of heat and "battery odor" and may affect charger components.

b. Only personnel who have been trained in battery installation, charging and maintenance should be allowed to work on the battery. Read these instructions in their entirety before performing any work on or around batteries.

c. Keep the vent plugs firmly in place at all times except when adding water or taking hydrometer and temperature readings. Keep all factory installed insulators in place to prevent the exposure of live electrical parts.

d. Severe burns can be caused by the sulfuric acid contained in the batteries covered by these instructions:

1. SAFETY PRECAUTIONS

a. Explosion can result from the gases produced by a battery:

1. Do not smoke, use an open flame or create arcs or sparks in the vicinity of a battery.
2. Only charge a battery in a well-ventilated area with the cover of battery or compartment raised for maximum ventilation.
3. Do not charge the battery at a current greater than 5 amps per 100 amp-hours capacity at the end of charge.
4. Every battery gives off hydrogen and oxygen during recharge. Most of the gassing occurs after the 80% point has been reached. As the breakdown of water occurs, oxygen and hydrogen are produced. The concentration of the gasses is proportional to the current being delivered to the battery.

To calculate the hydrogen produced, use the following formula and ventilate the area as required.

Formula

$$.00027 \times (\text{finish rate}) \times (\text{number of cells}) = \text{cu. ft. of hydrogen produced per min.}$$

1. Batteries and sulfuric acid should be handled only by persons who have been instructed on the potential chemical hazards, in accordance with the OSHA 29 C.F.R. 1910. 1200, Hazard Communication Standard. Refer to EnerSys® Material Safety Data Sheet (MSDS) for lead-acid batteries.
2. In handling sulfuric acid, wear a face shield, plastic or rubber apron and gloves. Avoid spilling acid.
3. Do not get acid in eyes, on skin or on clothing. In case of contact, flush immediately and thoroughly with clean water for at least 15 minutes. Obtain medical attention when eyes are affected.
4. PRO Wash™ neutralizing and cleaning solution, or sodium bicarbonate solution (1 lb./1 gal.), will neutralize any accidentally spilled acid. Apply the PRO Wash solution until it turns yellow (sodium bicarbonate solution stops bubbling), then rinse with clean water. Do not allow any of this solution to enter the cells.
5. When diluting concentrated acid, always add acid to water, never vice versa. Pour slowly and stir constantly to avoid excessive heat or violent chemical reaction.

e. The battery is electrically alive at all times:

1. Keep the top of the battery clean and dry to prevent ground shorts and corrosion.
2. Do not lay metallic objects on the battery; insulate all tools used in working on the battery to prevent short circuits. Remove all jewelry before working on the battery.
3. Be especially careful when working on battery terminal connections. High voltage capable of electric shocks or burns may be present. Make sure all terminal connections are properly insulated for safety.

f. When lifting the battery, observe the following precautions:

1. Follow the instructions on handling loads covered in OSHA 29 C.F.R. 1910.1798(n).
2. Use a lifting device with two hooks which are electrically insulated from each other to prevent short circuits. Use a lifting beam that is completely insulated if possible, like an EnerSys PRO Series® Adjustable Lifting Beam.
3. When completely insulated lifting beams are not available, temporarily cover the exposed metal components of the cells with an insulating material (plywood, thick rubber, etc.) to reduce the risk of a short circuit from the chain or hooks.

2. SPILLS AND RECYCLING

a. Spills of sulfuric acid should be handled with consideration for the following:

1. Do not touch spilled materials without appropriate personal protective equipment (e.g. face shield, acid resistant gloves, etc.).
2. If possible, stop the flow of spilled acid with sand or other non-combustible absorbent. Neutralize with PRO Wash™ or other neutralizing agent.
3. Place spill residue into compatible containers. If spill occurs from a battery, waste should be tested for presence of hazardous constituents prior to disposal.
4. Do not allow the discharge of any electrolyte or acid into sanitary or storm sewers.
5. Spills which enter the environment (through sewers, waterways or soil) must be reported, as applicable, to city, state and/or federal environmental agencies as necessary.
6. Spills which occur during transportation of batteries should be reported to CHEMTREC (1-800-424-9300) - a 24-hour service for emergency assistance.

b. Handling and storage of new and used (spent) batteries:

1. Batteries and battery components should be handled only in accordance with the safety procedure outlined in Section 1.
2. All batteries, as well as other hazardous substances, should be stored under cover and on an impervious surface with adequate containment to prevent dispersion of containments to the environment.
3. Batteries and acids should be stored away from sewer and storm drains and from sources of heat.
4. Leaking or cracked batteries and cells must be contained to prevent further leakage.
5. Generally, there are no storage time restrictions for batteries or for spent lead-acid batteries which are destined for recycling. However, state regulations and local fire and health ordinances should be consulted for special restrictions on the storage of hazardous substances, including batteries and acid.
6. Sulfuric acid is listed as an extremely hazardous substance under the federal Emergency Planning and Community Right-to-Know Act (EPCRA). Notification and/or reporting to federal, state and local agencies may be required if the threshold planning quantity (TPQ) of sulfuric acid is exceeded, which is 1,000 pounds.

c. Recycling:

1. Spent lead-acid batteries which are destined for recycling are not regulated under federal hazardous waste regulations or by most state regulations. Contact your state environment agency for additional information.
2. Under federal land ban restrictions and individual state battery recycling laws, spent lead-acid batteries can be disposed of only by recycling/reclamation at permitted secondary lead smelters or other authorized recycling facilities. Spent batteries should be sent only to facilities which have obtained EPA or state hazardous waste permits for the storage of spent batteries prior to recycling. Call 1-800-EnerSys for EnerSys® Battery Recycling.
3. Acid which is removed from spent batteries may be regulated hazardous waste. Facilities which generate spent acid may be subject to state or federal regulations for large or small quantity generators applicable to labeling, manifesting, transporting and reporting.

3. INTRODUCTION

Whether it be in a warehouse, a manufacturing plant, in a mine or in airline ground support equipment, battery-propelled vehicles have an advantage over other means of transporting equipment. The vital power source of these vehicles is a storage battery. The purpose of this manual is to provide a better understanding of the characteristics, operation and care of this battery so that all of its advantages and economies may be realized.

4. FUNDAMENTALS

Battery: a device for converting chemical energy into electrical energy. All batteries are made up of individual compartments called *cells*, connected in series. Size, internal design and the materials used control the amount of energy available from each cell. A *lead-acid battery* is a number of cells filled with a mixture of sulfuric acid and water called electrolyte. The *electrolyte* covers vertical plates made of two types of lead. Chemical action between the *electrolyte* and the lead creates electrical energy.

Volt, V: the standard measure of electrical potential. A DC fork lift's running speed and lifting speed are determined by a battery's voltage. AC fork lifts typically draw a consistent level of power (Watts) from the battery, which means higher voltage batteries will require lower current draws to do the same work (Watts = Volts x Amperes). The advantage of higher battery voltages in AC lift trucks is lower ampere draws leading to extended run times. Since each cell in a lead-acid battery has approximately 2 volts, multiply the number of cells by 2 to determine the terminal (overall) voltage. Fork lifts are rated for a specific voltage battery.

Ampere, A: the standard measure of the amount of electric current. The amount or flow can be large (amperes) or small (milliamperes). Flashlight batteries are measured in milliamperes. Lift truck battery current is measured in amperes. While it is important to match battery size with the maximum amperage requirements of a fork lift truck, the most important factor to keep a truck running for an entire shift is the total capacity the battery has available, ie Ampere-hours.

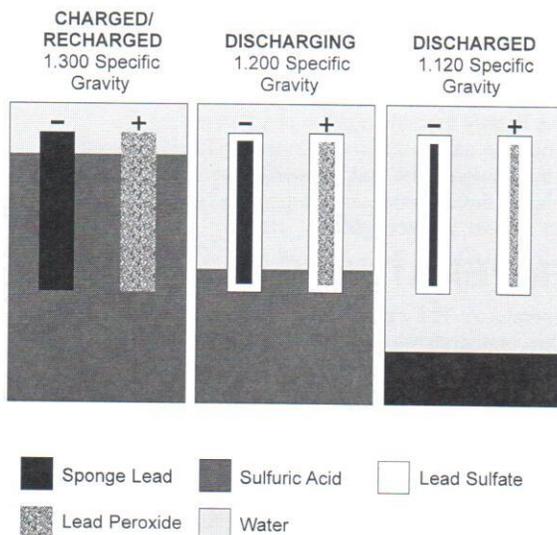
Ampere-hour, (Ah): the amount of current the battery can supply multiplied by the length of time the battery is discharged. The higher a battery's ampere-hour capacity, the longer a fork lift will run. The amp-hour capacity varies with the length of the discharge. American forklift battery manufacturers rate their battery at the 6 hour rate. For example, a hypothetical battery has a rating of 680 ampere-hours (Ah) at the 6 hour rate. By dividing 680 Ah by 6 hours, a discharge rate of 113 amperes is determined. This means if a fork lift's motor and attachments draw 113 amperes continuously, the battery will be completely drained of usable power in six hours. To maximize the life of your battery, it should not be discharged below 80% depth of discharge.

Watt, W: the standard measure of electrical power. Multiplying volts by amperes determines watts. Every 1,000 watts is a kilowatt (kW). The total capacity available from a battery can be determined by multiplying wattage by the length of the discharge. For example, if your fork lift needs 10 kW of continuous power for a 6-hour shift, you need a battery that provides 60-kilowatt hours (60 kWh) of energy.

Cycle: Every time a battery is charged and then discharged in use is one cycle. Battery life is usually measured in cycles. In a one shift per day operation, a battery designed for 1,200 to 1,500 80% discharge cycles should last 5 or 6 years. However, battery maintenance and charging procedures will either prolong or shorten battery life depending on how well recommended procedures are followed. EnerSys® will provide training aids and materials whenever requested. Also, when a battery's average voltage measures less than 2.08 volts (open circuit-after a full charge) times the total number of cells, the battery either needs repair or has reached the end of its life. To be sure the situation isn't the result of a maintenance problem, call your lift truck dealer or EnerSys representative.

Specific Gravity: As a battery is used, the sulfuric acid in the electrolyte changes into another chemical when it combines with the active material. As a result there is less and less power-generating sulfuric acid as the battery is discharged. When the battery is recharged, the sulfuric acid returns.

FIGURE 1



The hydrometer detects the chemical change by measuring the ratio of sulfuric acid to water. In addition, temperature also affects a battery's specific gravity. Temperatures above and below 77° F require correction of the hydrometer reading. EnerSys can provide a thermometer which shows how much to correct for the temperature at your location.

Gassing: Gassing occurs when the battery does not accept some or all of the charge current. This normally occurs during the last 20% of a charging cycle. The water in the electrolyte inside the battery breaks down into hydrogen and oxygen. When this happens, electrolyte will bubble and expand causing the battery to overflow if any cell was previously filled with too much water. Inexperienced maintenance personnel should never try to replace lost sulfuric acid. Under-watering is even worse than over-watering. The electrolyte level must be above the cell's separator protector during charging and use. Otherwise, part of the plates will be unused. The battery will then overheat and gas more violently. The exposed plates will eventually dry out and become permanently damaged. Scheduled maintenance must be performed if a battery is to work to its full rated capacity.

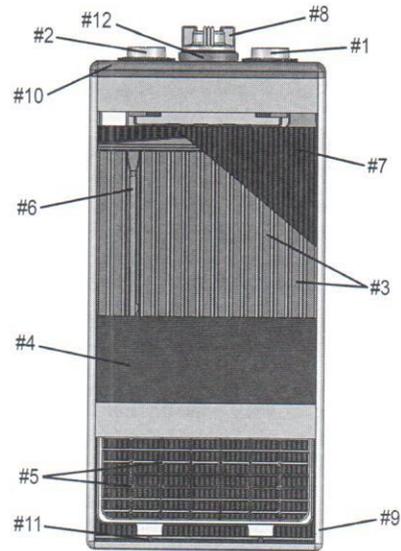
5. CONSTRUCTION

Fig. 2 illustrates the construction of a typical motive power cell of the tubular design.

Figure 2

Call-outs as follows:

1. Positive Post
2. Negative Post
3. Positive Plate
4. Negative Plate
5. Negative Grid
6. Positive Spine
7. Separator
8. Vent Cap
9. Jar
10. Cover
11. Bridge
12. Vent Well



6. INSPECTION OF THE BATTERY UPON RECEIPT

- a. Examine for physical damage or loss of electrolyte.
- b. Report actual or suspected damage to carrier.
- c. Give battery an equalizing charge. (See Section 14.)
- d. Check electrolyte levels IMMEDIATELY after charge and add water if needed.
- e. When adding water, the electrolyte height should be as specified in Section 18.

7. MOIST/DRY CHARGED BATTERIES

- a. Moist charged batteries are electrically live upon receipt, even before filling with electrolyte. Do NOT lay any metallic objects on the battery.
- b. Moist charged batteries or cells should be activated (unsealed, filled with electrolyte and charged) only when ready to be placed in service. Until ready for use, they must be stored in a cool, dry, low humidity location with the pressure relief valves/vent plugs tightly in place. Moist charged cells must be activated within 24 hours of the loosening/breaking of the seal of the pressure relief valves/vent plugs.

CAUTION: IF THE EXISTING VENT PLUG HAS A LABEL MARKED "DO NOT REMOVE", STOP ALL ACTIVITY AND CALL YOUR LOCAL ENERSYS REPRESENTATIVE.

- c. To prepare for use carefully remove the sealed PRV (pressure relief valve) using an approved tool or, if necessary, a wide-grip pliers, taking care not to damage the cell vent well exterior. THROW AWAY THE PRESSURE RELIEF VALVE/VENT PLUG. Fill all cells with electrolyte .015 sp. gr. lower than the nominal operating gravity.

d. Give the battery an equalizing charge, but keep resetting the charger to the equalize position until the specific gravities remain constant for a period of three hours. At no time should battery temperature be allowed to exceed 110°F (43°C).

e. At the completion of the charge, the specific gravities of all cells corrected to 77°F (25°C) should be as specified on the battery nameplate or shown in Table 3. If the specific gravity is higher, remove some electrolyte and replace with water; if lower, remove some electrolyte and replace with higher specific gravity electrolyte. Any specific gravity adjustments should be made with the charger on equalize in order to mix the electrolyte properly. Removed electrolyte must be disposed of in strict accordance with all environmental regulations.

f. Upon completion of the above steps, apply a standard vent cap to all cells.

8. INSTALLATION OF BATTERIES

a. The battery compartment in the vehicle should be ventilated and designed in a manner to keep out water, oil, dirt and other foreign matter. Drainage holes should be located in the floor of the battery compartment. Consult with your vehicle dealer if any questions arise.

b. When lifting the battery, use an EnerSys PRO Series® Adjustable Lifting Beam which exerts a vertical pull on the lifting tabs only.

c. The battery should be blocked, not wedged, to allow 1/8" minimum clearance on all sides for easy removal from the battery compartment. Excessive clearance will allow the battery to move inside the battery compartment which may cause damage.

d. During transit and storage, a battery may have lost some of its charge. Give it an equalizing charge before putting the battery in service. (See Section 14.)

e. If any connections on the battery itself are bolted together, make them clean and bright, using care not to remove the lead coating from any lead-plated copper parts. Coat the surfaces to be bolted together with No-Oxide grease. Torque all bolted connections to 120 in-lbs unless otherwise specified. Due to vibration, handling and heating during operation bolted connections loosen over time. Re-tighten them at least twice yearly using an appropriately set torque wrench.

f. No intermediate "taps" or connections should be made other than at the main terminal of the battery. Any lower voltage device should be supplied through a series resistor or from a separate source. Any such device connected to an intermediate point of a battery can void your warranty.

TAPPING THE BATTERY SHORTENS ITS LIFE BY UP TO THREE YEARS.

g. Storage - see Section 21.

9. FAST CHARGING AND OPPORTUNITY CHARGING

If a single battery is being used in a lift truck for multiple shifts or is partially recharged during breaks, lunches and other idle periods, it may be in a fast charge or opportunity charge mode of operation.

Opportunity charging can be used to keep the battery's state of charge above 30% depth of discharge during the daily discharge cycle thereby reducing or even eliminating the need to change out spent batteries in a heavy single shift or multi shift operation. Opportunity chargers need to limit battery gassing to one hour per 24 hour period (with the exception of the Equalization Charge). The total accumulated discharged ampere-hours should not exceed 120% of the batteries designed capacity rating per day. Discharge of more than 120% of the batteries designed capacity rating in a 24-hour period will shorten battery life. Charge rates during opportunity charging should not exceed 25 amps per 100 amp-hours of a battery's nameplate capacity. Under the opportunity charging procedures outlined in this paragraph, special opportunity battery warranties apply.

Fast charging is intended to extend a battery's run-time during a shift or day. A typical fast charging system will provide charge rates from 26 to 50 amps per 100 amp-hours of a battery's nameplate capacity. Fast charging requires special chargers that can monitor and manage battery temperatures during charge, limit battery gassing to no more than one hour per 24 period (with the exception of the Equalization Charge), assure a battery is recharged to at least 90% state of charge on a daily basis and automatically provide an Equalization Charge at least once per week. Also, a fast charge battery should be designed to accept higher charge current and to manage heat that may be created by higher charging rates. A fast charge system, including the battery and charger, should be designed to utilize no more than 160% of the battery's 6-hour capacity rating in a shift day. Under fast charging procedures outlined in this paragraph, special fast charging warranties apply.

If engaging in opportunity charging or fast charging, the battery must be returned to nameplate specific gravity at least once per week (Equalization Charge). However, a daily recharge to nameplate specific gravity is desirable.

10. OPERATION

a. Full charge specific gravity of a new battery will be specified on the nameplate located on the side of the battery tray. Full charge specific gravity will be affected by temperature, acid level and battery age. If acid is lost from overfilling, full charge specific gravity and capacity will be lowered.

b. Under normal conditions, only add water. **NEVER** add acid or other solutions to the cells.

c. Keep the plugs and receptacles in good condition. When disconnecting battery from the truck or charger, pull on the receptacle, **not the cable**. When disconnecting from a charger, assure that the charger is off first; otherwise, arcing will result. Arcing can cause battery explosion, damage to connector contacts and charger components.

11. TEMPERATURES

a. Low Temperatures. The capacity of a storage battery is reduced at low temperatures due to the increased viscosity and resistance of the electrolyte. An approximation of this reduction in capacity for batteries of these types is shown below.

TABLE 1

Internal Temperature of Cell (°F)	Percent Capacity
77	100
60	95
40	87
20	73

This, of course, refers to the actual temperature of the cell and not the ambient temperature. Thus a battery may be operated in quite low ambient temperatures for short periods without the actual battery temperature falling to a point where the capacity is seriously curtailed. For example, batteries used in cold storage plants or similar locations will deliver close to normal capacity if they are moved into warmer areas for charging and whenever not in actual use.

Low temperatures also increase the battery voltage on charge, resulting in lower charge currents and a longer recharge time. Undercharging could occur unless charger adjustments are made to compensate.

There is little danger of freezing of the battery electrolyte in temperate climates unless the battery is completely discharged. At the temperatures shown in the following table, the electrolyte will not freeze unless the specific gravity is lower than indicated.

TABLE 2

Battery Specific Gravity (Corrected to 77°F)	Freezes @ or Below Degrees F.
1.080	+20
1.130	+10
1.160	0
1.180	-10
1.200	-20
1.215	-30
1.225	-40

In sub-freezing temperatures, water should be added **just before charging is completed** to insure prompt mixing with the electrolyte. Otherwise it may freeze on the surface before mixing. No permanent harm results from low temperature operation as long as freezing is avoided.

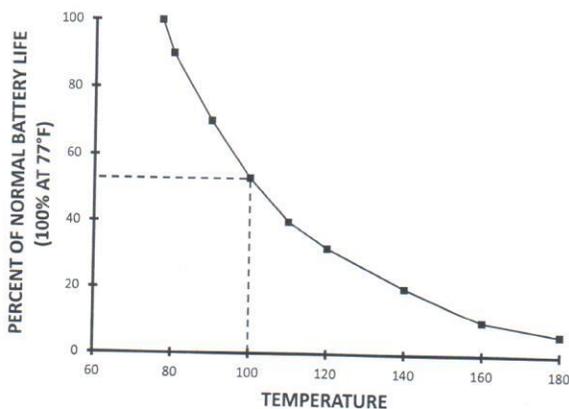
b. High temperatures have an adverse effect and all practical means should be employed to keep the battery temperature at normal values:

- Avoid overdischarging
- Charge in cool location
- Supply ample ventilation during charge by always opening battery compartment or battery cover and circulating air by fans if necessary
- Allow battery to cool down after charge before putting it back in service.

The effect of temperature on battery life on any lead acid truck battery is shown below.

AVERAGE LIFETIME BATTERY TEMPERATURE, °F

Figure 3 - Temperature vs. Battery Life Curve



EXAMPLE: If the average lifetime temperature of the battery is 100°F, it will result in a battery life of approximately 53% as compared to 100% at 77°F.

12. DISCHARGE CHARACTERISTICS

a. In general, a battery may be discharged without harm at any rate of current it will deliver, but the discharge should not be continued beyond the point where the cells approach exhaustion or where the voltage falls below a useful value. This point typically occurs at 80% depth of discharge.

b. Discharging at a constant current value, the initial voltage will depend on the rate of discharge and the normal characteristic of the cell. As the discharge continues, the cell voltage will slowly decrease during the first 70 to 80 percent of the total time period. It will then fall more rapidly, passing over the "knee" of the curve to the "final" voltage as full time and capacity are reached. This "knee" is more pronounced at low rates of discharge. Opportunity charging should not exceed 25 amps per 100 amp-hours of a battery's nameplate capacity. Under the opportunity charging procedures outlined in this paragraph, special opportunity battery warranties apply.

c. During discharge there is normally a rise in battery temperature, depending on the ambient temperature, on the rate of discharge and the type of battery assembly from the standpoint of heat dissipation. The higher the ampere discharge rate, the greater the temperature rise effect. During discharge, a battery's temperature will normally rise. The speed and magnitude of this temperature rise is dependent on the following conditions:

- ambient temperatures
- battery design and layout
- and battery discharge rate.

d. As mentioned, a battery should not be discharged beyond the point where the cells approach exhaustion. This is referred to as "overdischarging" and can have very harmful results, particularly if repeated for several days or cycles. Overdischarge can be avoided by using a properly calibrated lift interrupt device. When installed on the vehicle, the lift interrupt device gives a constant readout of battery condition and locks out the lift mechanisms as the battery approaches 80% depth of discharge.

TABLE 3
SPECIFIC GRAVITIES @ 77°F

Cell Type	Fully Charged	80% Discharge*	100% Discharge*
E-55L	1.315	1.170	1.130
E-75L	1.315	1.170	1.130
E-75	1.280	1.175	1.140
E-460	1.280	1.140	1.105
E-90	1.280	1.150	1.120
E-90D	1.280	1.155	1.125
E-100	1.315	1.150	1.110
E-100X	1.280	1.130	1.090
E-110	1.315	1.155	1.115
E-100D	1.280	1.115	1.125
E-125	1.280	1.150	1.120
E-125D	1.280	1.155	1.125
E-140	1.300	1.145	1.100
E-140X	1.280	1.140	1.105
E-155	1.315	1.155	1.115

*These values are for discharging at the 6 hr. rate, read immediately at the completion of the discharge and corrected to 77°F.

13. CHARGING EQUIPMENT

a. Battery charging should be accomplished with an electronically controlled charger that will regulate current and voltage. Refer to Table 4 Lead-Acid Battery Charging Specifications for proper charge rates, times and charge intervals.

b. When the discharged battery is placed on charge, the battery will draw a relatively high current which will be at or close to the maximum output of the charger. Within a few minutes, the current will adapt itself to the state of discharge of the battery, remaining high if the battery is considerably discharged or decreasing to a low rate if the battery is only partially discharged.

c. When charging any industrial battery, only use an approved charger that is capable of returning a discharged battery's specific gravity back to its nameplate rating within an 8 hour period. Several chargers offered by EnerSys® will accomplish this requirement. Some charger technologies, such as ferro-resonant, will not adequately charge an Ironclad tubular battery and will result in undercharging and short life. Please contact an EnerSys representative for more information.

d. Although a number of chargers meet the mentioned general requirements above, not all chargers are equal. Contact your local EnerSys representative for more details.

14. CHARGING CHARACTERISTICS

- a. To maximize life, charging should not result in excessive gassing during the initial stages of charge. In addition, the charging method should keep end-of-charge temperature below 125°F.
- b. Every effort should be made to ensure that the battery receives the proper amount of charge. Consistent under-charge and/or excessive over-charge will contribute to internal battery problems that will cause a loss of capacity and reduction of life.
 1. Sulfation - Residual sulfation remains in the plates if the battery is not fully charged to nameplate specific gravity or allowed to remain partially discharged for an extended period of time. This results in reduced performance and life. All motive power batteries must be returned to nameplate specific gravity at least once per week. However, more frequent recharges to nameplate specific gravity is desirable.
 2. Stratification - Caused by insufficient gassing at end of charge. Little or no mixing of electrolyte will create a higher concentration of electrolyte at the bottom of the cell compared to the top. This will eventually lead to sulfation of the bottom of the negative plate with subsequent fall off of performance and capacity.
- c. Overcharge
 1. Overcharge is uneconomical from a power standpoint and wastes electrical energy while running the risk of permanent damage to the battery.
 2. Excessive gassing, producing hydrogen and oxygen, not only increases the frequency of water additions to the battery but also increases an explosion hazard significantly over normal and safe charge conditions.
 3. It creates dangerously high battery temperature which significantly shortens normal battery life if repeated instances occur above 125°F. (See Figure 3 in Section 11.)

Higher temperatures tend to reduce the battery voltage on charge, permitting higher current flow from the charger and further raising the cell temperatures. Battery temperature at the end of charge should not exceed 125°F.

Should excessive battery temperature occur with some frequency, call your local EnerSys representative for assistance.

 4. When the battery reaches full charge, the charge should be stopped. No amount of overcharging can increase battery capacity.
- d. When charging batteries while they are in the vehicle, assure proper ventilation. Open the battery cover, if so equipped, as well as the battery compartment cover of the vehicle. Disregarding these recommendations can cause pockets of hydrogen to remain in the vehicle or battery, increasing the risk of explosions when the vehicle is put into use.

e. Extra effort to ensure proper charging is well spent because it will result in trouble-free battery performance, reduced maintenance and long battery life.

- f. Equalizing charge.
 1. Equalize charge is necessary to bring a battery to a state of full charge in order to avoid excess sulfation and unbalanced cells. Equalize charge must be done according to EnerSys specifications and excessive overcharge must be avoided.
 2. Equalize charge should be performed once weekly according to Table 4 Lead-Acid Battery Charging Specifications.
 3. Ensure battery temperature is 90°F or lower before initiating an equalize. Equalize should be scheduled at a time when water can be added at the end of equalize or as soon as possible thereafter.

15. MAINTENANCE AND RECORDS

- a. Specific records should be maintained for each battery in your fleet. These records will provide a means of identifying batteries which may need repair, adjustment, have a charger problem or which have reached the end of their useful life. Such records also help assure warranty protection. To assist your record keeping, EnerSys has developed Form 5847 (see sample on page 11 of this manual). You may copy Form 5847 to establish your own "Battery Log Book".
- b. Where more than several batteries are in use, each one should be identified with a permanent number assigned when received. That number should be plainly painted or stamped on the battery. If a large number of batteries are involved, including several sizes or types, various groups can be given prefixes or suffixes to identify size, voltage or shift.
- c. After each battery is received and equalized, record the corrected specific gravity of each cell. This serves as a reference for comparison with later readings.
- d. In a new application, the depth of discharge should be checked for several weeks to determine whether it is within a safe range. This is done by reading the specific gravity of a particular cell (or cells) at the beginning and end of the discharge. This daily discharge should not exceed 80% discharge (see Table 3). If the final corrected specific gravity is below 80%, there is a problem. Call your vehicle dealer or local EnerSys® representative. The "pilot cell(s)" used for such purposes should be changed at monthly intervals, as frequent hydrometer readings may noticeably reduce their specific gravity through inadvertent losses.
- e. While the record sheet can accommodate daily specific gravity readings for up to a month, EnerSys recommends quarterly specific gravity readings once the duty cycle and depth of discharge meet the criteria contained herein. When a gravity reading indicates an irregularity, then more frequent readings can be initiated. The final determination for frequency of hydrometer readings should depend on your past experience and advice from your local EnerSys representative.

TABLE 4 - Lead-Acid Battery Charging Specifications

Battery Type (charge type)	Flooded (8 HR charge)	VRLA – GEL (8 HR charge)	Flooded (Opportunity Charge)	Flooded (Fast Charge)
Start Charge Rate*	15%-20%	15%-20%	15%-25%	26%-50%
Finish Charge Rate*	4.5%-5.0%	1.0%-2.0%	4.5%-5.0%	5.0%
Charge Interval	Daily	Daily	Opportunity	Opportunity
Equalizing Charge Rate*	4.5%-5.0%	1.0%-2.0%	4.5%-5.0%	2.0-3.0%
Equalize Time on Charge	3 Hours	3 Hours	3-7 Hours	10 Hours
Equalize Interval	Weekly	Weekly	Weekly (minimum)	Weekly (minimum)

*Percentage of the battery's 6-hour nameplate ampere-hour capacity rating (ampere output)

16. TROUBLESHOOTING

The following conditions are usually indications of approaching trouble.

TABLE 5 - TROUBLESHOOTING CHART

CONDITION	CAUSE	SOLUTION*
Unequal or low specific gravities	<ul style="list-style-type: none"> a. Electrolyte spillage during watering b. Electrolyte flooding c. Insufficient charge d. Internal short 	<ul style="list-style-type: none"> a. Avoid overwatering, neutralize and clean. b. Water cells during end of charge. c. Extend charging time. d. Replace cell.
Excessive water requirement	<ul style="list-style-type: none"> a. Overcharging b. Jar leakage 	<ul style="list-style-type: none"> a. Select a properly sized charger. Check charging time and average battery temperature. b. Replace or repair cell.
Excessive cell temperatures	<ul style="list-style-type: none"> a. Overcharging b. Battery overworked c. Battery being charged more than once per day. d. Battery temperature too high at start of charge. e. Shorted cell(s) 	<ul style="list-style-type: none"> a. Check charger size and charging time. b. Reduce to one cycle/day or 300/year maximum. c. Reduce charging to once per day. d. Allow battery to cool down before starting charge. e. Replace defective cell(s).
Poor truck performance	<ul style="list-style-type: none"> a. Battery undersized b. Undercharged battery c. Discharge indicator malfunction d. Defective charging connector e. Excessive loss of electrolyte 	<ul style="list-style-type: none"> a. Install higher capacity battery. b. Extend charging time. c. Reset discharge indicator for 80%. d. Replace or repair cable and/or connector. e. Adjust gravities at state of full charge. Check for leakage.

17. DETERMINATION OF CAPACITY

a. A battery's capacity will, of course, decrease toward the end of its life. Assuming no specific cause of trouble, this will be a gradual decrease and ample warning of limiting capacity will be evidenced by the slowing of the truck toward the end of the day's work (DC motor) or shorten run times (AC motor).

b. A battery is usually considered to be at the end of its usefulness when its capacity decreases below 80% of normal rating. However, it can sometimes be transferred to a smaller job and thus give additional life and service.

c. Since the average motive power battery passes a "test" every day by performing to its regular work, it is seldom necessary to conduct a formal test of its capacity. Also, most users do not have the facilities to do this conventionally or accurately. If any such testing is desired, consult your EnerSys Representative regarding equipment and procedure.

d. An EnerSys Watering Gun is a convenient and accurate tool to aid in watering as it fills to a pre-selected height and automatically shuts off; however, care must be taken to adjust the watering gun so it will water cells to levels in accordance with Figure 4.

e. Another convenient way to ensure proper fill levels is the use of a single point watering (SPW) system. The PROSeries® SPW Systems are efficient methods of watering a battery. These reliable quality systems allow the operator to fill to the proper level each and every time.

f. Water should only be added to the battery when it is near the end of charge and gassing. As the electrolyte is at its maximum level during this time, it is a certainty that the level established by the addition of water will not be exceeded at any other time and overflow of the electrolyte (flooding) will never occur. When watering near or at the end of charge, sufficient water should be added to bring the level of the electrolyte between its upper limits. See Figure 4 for details.

18. WATERING

a. Use only approved water. That is 1) distilled water; or 2) de-mineralized water; or 3) local water that has been approved for use in batteries. Never add acid, commercial additives or other foreign material to the battery. Addition of acid, commercial additives or foreign material may void your warranty.

b. If there is some doubt as to whether the water being used is suitable for use in lead-acid storage batteries, an analysis should be obtained from a qualified laboratory; otherwise, distilled or deionized water should be used. Deionized water is available by using the EnerSys® PRO Clear Deionizer #94866.

c. Table 6 shows the maximum allowable impurities.

TABLE 6 - WATER IMPURITY CHART

Requirements	Maximum Allowable Limits	
Total Solids*	350.0	
Fixed Solids*	200.0	Parts
Organic and Volatile*	150.0	
Iron	4.0	Per
Chloride	25.0	
Ammonium (NH ₄)	5.0	Million
Nitrates (NO ₂)	10.0	
Nitrates (NO ₃)	10.0	(ppm)
Manganese	0.07	
Calcium and Magnesium	40.0	

g. It is often inconvenient or impossible to be present at the end of charge to perform watering. In this case, it is recommended that the battery be watered as soon as possible after the termination of charging, as in this way levels will still be near the maximum and the danger of over- or under-watering is minimized. Fill to the lower limit in this case.

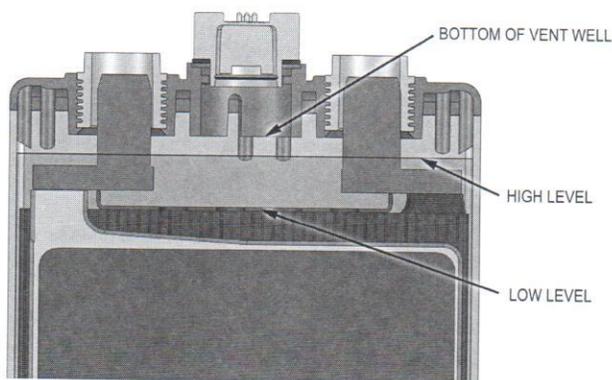
h. In motive power service, the **real** need to add water may vary from weekly to quarterly depending on application, battery temperature and battery design. To extend this interval to the maximum period possible, follow these steps:

1. Adjust watering gun to fill to maximum possible height.
2. Water while battery is on charge and gassing.
3. Do not add water until actual visual inspection shows top of separators/plates is visible.
4. A Battery Water Monitor is an excellent way to indicate when water is needed.
5. Once a repetitive routine is established, water your battery at that interval.

i. Should the battery start to use excessive water look for any of the following problems: charger not shutting off automatically, charging rate exceeds rate on battery nameplate, one cell shorted or weakened.

j. Caution - Avoid overfilling as it will cause overflow (flooding) of electrolyte resulting in loss of electrolyte, tray corrosion, ground paths and loss of capacity.

Figure 4 - Sketch showing permissible high and low limits of electrolyte level. High level marker indicates proper level immediately after charging. Low level marker indicates immediately after charging watering is required. The high level line is 1/4" below the bottom of the vent well.



19. CLEANING

WARNING - Do NOT use any type of oil, organic solvent, alcohol, detergent, strong acids, strong alkalis, petroleum-based solvent or ammonia solution to clean the jars or covers. These materials may cause permanent damage to the battery jar and cover and will void the warranty.

- a. Check the battery for cleanliness at regular intervals. When necessary, dust or other material which has accumulated should be removed by cleaning the battery. Make sure vent plugs are in place when cleaning or neutralizing a battery.
- b. Electrolyte spilled on the battery cell covers, trays or battery compartment never dries or evaporates. It causes paths to ground and corrodes any metal parts. For light cleaning, regular use of neutralizing cloth such as PRO Wipes™ #853638 may help remove these harmful deposits.

c. A periodic washing is recommended at least twice yearly. A clean battery is an indication of good maintenance and increases battery life. To both clean and neutralize your battery, use EnerSys PRO Wash™ Cleaner/Neutralizer # 94883. This spray-on pre-mixed cleaning solution changes color as it neutralizes electrolyte or acid. Use this cleaner or sodium bicarbonate and water (1.0 lb./1.0 gal.) any time you see electrolyte on top of the battery. If any corrosion exists on metal parts of the tray or compartment, repaint with acid-resistant paint after cleaning.

d. For large installations, a "washstand" should be provided with water hose and adequate drainage. It should include a container for the cleaner, brushes, etc.

e. Be sure to keep vent plugs in place and tight at all times to avoid loss of electrolyte due to gassing or spillage. The gas-escape holes in the vent plugs should be examined to see that they are not clogged with dirt. Wash all vent plugs yearly or as needed by immersing in a bucket of water and wiping clean.

20. ADJUSTING SPECIFIC GRAVITY

Acid or electrolyte should never be added to a cell without first making sure that charging will not restore the gravity to normal values. Therefore, a cell or a battery should first be fully charged and then given an equalize charge. See Section 14 f. The equalize charge should continue until there is no change in specific gravity for three consecutive hourly readings. Never make a gravity adjustment on a cell which does not gas freely on equalize charge.

If after the equalizing charge, the specific gravity (corrected for temperature) of any cells is lower than the normal gravity shown on the nameplate or in the instruction book, the specific gravity of the low cells should be adjusted to normal in the following manner:

- a. Put battery on charge again on equalize charge so the cells are gassing for thorough mixing. Make sure all cells begin gassing before starting a gravity adjustment.
- b. From the low reading cells, draw off electrolyte down to the splash cover. Replace slowly with electrolyte of 1.400 specific gravity. **NEVER USE ACID OF SPECIFIC GRAVITY HIGHER THAN 1.400.** When adding acid to the cells, pour it in slowly.
- c. Wait 20 minutes for the added electrolyte to become thoroughly mixed by the gassing charge and then read the specific gravities. If the specific gravity of any cell is still below minimum specification, repeat the process. Repeat as many times as necessary to restore specific gravity to within the nominal range. When the specific gravity of all cells has apparently been adjusted to within the specified limits, continue the equalize charge for an additional hour for thorough mixing of the electrolyte.
- d. If the corrected specific gravity of any cell is above the maximum specification, proceed as follows:

As the battery charges, withdraw a small amount of the electrolyte from the cell and replace with water, repeating at 20-minute intervals, if necessary, to within nominal specific gravity range.

On completion of the gravity adjustment, record the voltage of all cells while still on equalize charge and then stop the charge. Approximately 20 minutes after stopping the charge, record the specific gravity of all cells and the electrolyte temperature of at least two or three cells.

NOTE: Specific gravity changes with temperature. Normal values are at 77°F. This should be kept in mind when reading specific gravity and proper correction should be made to judge normal values. For each 3° above 77°F, ADD 0.001 to the measured specific gravity. For each 3° below 77°F, SUBTRACT 0.001.

21. STORAGE OF BATTERIES

- a. Batteries should be stored in a clean, dry and well-ventilated location away from radiators or heating ducts, etc. Do not store in direct sunlight.
- b. Before storing, it is necessary that the battery is fully charged and the electrolyte is at the proper level. Disconnect leads or cable connections to prevent possible added loss of charge during prolonged storage period. Do not remove electrolyte or dismantle the battery.
- c. If storage temperature is 80°F or higher, check specific gravity at least monthly. If 50°F or lower, check every two months. Whenever specific gravity falls to about 1.240 or below, give the battery an equalize charge as in Section 14 f.
- d. Fully charge, equalize and water the battery before returning to service from storage.

22. ACCESSORIES

Certain accessories and tools are desirable for routine work in the charging room. The following items are recommended for every charging room.

- a. EnerSys® PRO Alarm Hydrogen Detector™ #801550. This alarm will monitor the hydrogen emitted from batteries while gassing during charge and provide for ventilation and warning before explosive levels are reached (as the National Fire Protection Agency recommends). Call your local EnerSys representative for options and accessories.
- b. EnerSys Hydrometer #13142 (up to 1.300 SG). These devices accurately and quickly measure the concentration of acid in the electrolyte. Required to properly check full recharge, depth of discharge or freezing points as shown in Tables 2 and 3. Special floats available for different specific gravity scales.
- c. EnerSys Thermometer #88330. Quickly takes the internal temperatures of single cell. Assures that you have a method to check that charge temperatures have not exceeded 110°F (see section 11 a).
- d. EnerSys Watering Guns EZ Fill™ #50092755 or PRO Fill #92755. These tools allows manual pre-selection of internal watering height and when connected to a standard pressurized watering system automatically shuts off water flow. Flip Top Vent Cap #811112 makes watering a snap when used with watering guns.
- e. EnerSys PRO Wash™ Light #94883-4QT. This unique cleaner/neutralizer solution is a pre-mixed liquid in a spray bottle which neutralizes spilled electrolyte (acid) as it cleans and degreases your battery. In addition, the liquid turns from red to yellow giving a positive indication any corrosive acid has been neutralized. Four one quart bottles per package.
- f. EnerSys PRO Safety Kit #85879 provides all the personal protective equipment necessary to satisfy OSHA regulations.
- g. EnerSys PRO Clean Battery Maintenance Kit #85363 and PRO Wipes #85368. These products will help maintain a clean battery.
- h. EnerSys Emergency Spill Kits meet OSHA requirements 1910.178 (g)(2). Available in three convenient sizes: #853610 - 30 gallon, #853615 - 15 gallon, or #853620 - 6 gallon.

OTHER OPTIONAL ACCESSORIES

EnerSys also offers the following items that are useful in the operation of batteries:

- i. EnerSys PRO-Meter # 94870. This shirt pocket sized meter is versatile for 13 ranges in AC, DC and OHM readings. It has an audible continuity signal and is accurate to 0.75%. Ideal for the person who wants to do basic battery or charger troubleshooting.

j. EnerSys PROSeries® Battery Lifting Beam #PSBEAM-4PL. Adjusts to fit batteries from 21" to 42" long. Necessary in any shop where batteries are charged or where the user needs a safe method to lift the battery out of the vehicle.

k. EnerSys Portable Watering Cart #502056. Our portable watering cart is ideal for locations with no pressurized water or where a method is needed to quickly water batteries with distilled water. Cart comes complete with DC motor, battery, charger and 10 gallon tank.

NOTES



Ersatzteilliste Spare Parts list

GP 25

Gültig für: / Valid for:

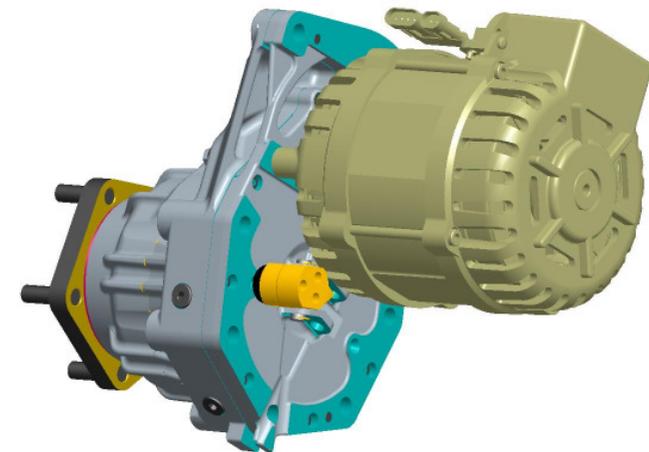
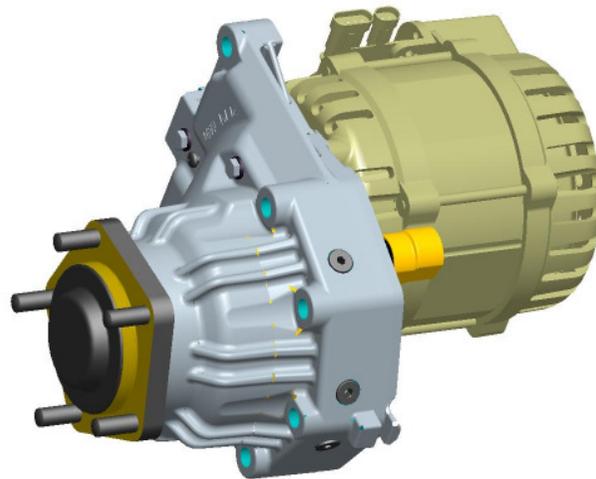
4699 825 013 / 4699 825 014 / 4699 825 016

4699 825 017 - 4699 825 022

4699 825 024 - 4699 825 033

4699 825 037 - 4699 825 039

4699 825 042 / 4699 825 048 / 4699 825 049



Ausgabe/Edition: 01.06.2010

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1. Contents list

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2. Vorwort

Die Ersatzteilliste ist nur gültig für die auf der Titelseite angegebenen Getriebetypen. Die Typenbezeichnung Ihres Getriebes können Sie dem Typenschild entnehmen. Verwenden Sie nur Original ZF Ersatzteile oder von ZF freigegebene Ersatzteile. Für Schäden, die durch die Verwendung von nicht Original ZF Ersatzteilen und Zubehör entstehen, übernehmen wir keine Haftung oder Gewährleistung.

Bei Bestellungen von Ersatzteilen bitte angeben:

- ⇒ Getriebetyp und Bauart
- ⇒ Getriebeausführung, Seriennummer und Identnummer
- ⇒ Pos. Nr., Benennung, Identnummer und Menge der benötigten Teile
- ⇒ gewünschte Versandart

Für die Lieferung der Ersatzteile gelten unsere allgemeinen Lieferbedingungen sowie die Kundendienstregelungen der ZF Gotha GmbH.

Bestellungen richten Sie bitte an:

ZF Gotha GmbH
Passauer Str. 1
D-99867 Gotha

Telefon: +49 (0)3621 311 4400
Telefax: +49 (0)3621 311 4419
E-Mail: Aftermarket.zfgotha@zf.com

2. Preface

This Spare Parts List is only valid for the type of transmission, as shown at the front page. You will find the transmission type on your transmission name plate. Use only original ZF spare parts or spare parts approved by ZF. We will not accept any liability or guarantee for damage resulting from the use of spare parts or accessories that did not originate from ZF.

When ordering spare parts, please state:

- ⇒ Transmission type
- ⇒ Transmission serial no and transmission ident no.
- ⇒ Item No., part name, part no. and quantity of parts required
- ⇒ Shipment desired

The supply of spare parts is subject to our General Terms of Delivery and the Service agreement of ZF Gotha GmbH.

Orders to:

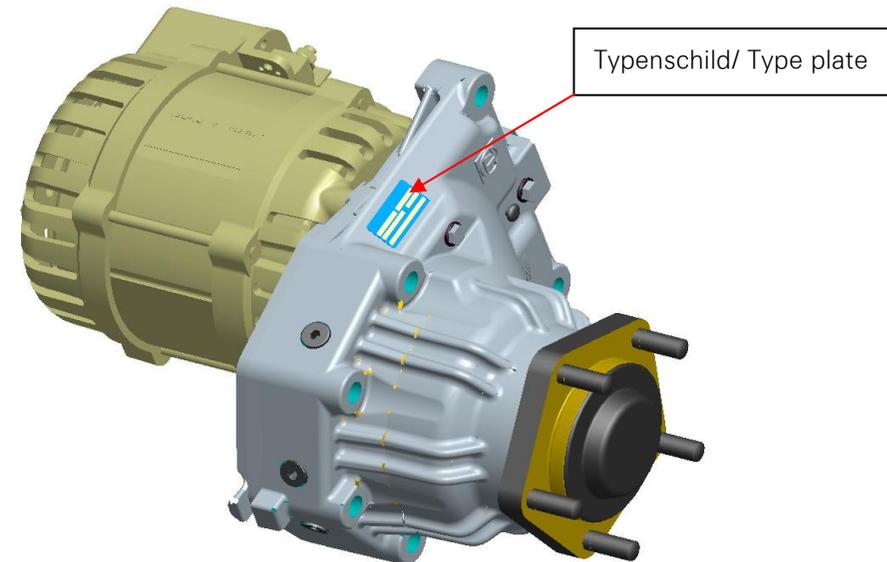
ZF Gotha GmbH
Passauer Str. 1
99867 Gotha
Germany

Phone: + 49 (0)3621 311 4400
Fax: + 49 (0)3621 311 4419
E-Mail: Aftermarket.zfgotha@zf.com

3. Identifizierung des Antriebssystems / MDU identification

Typenschild / Type plate

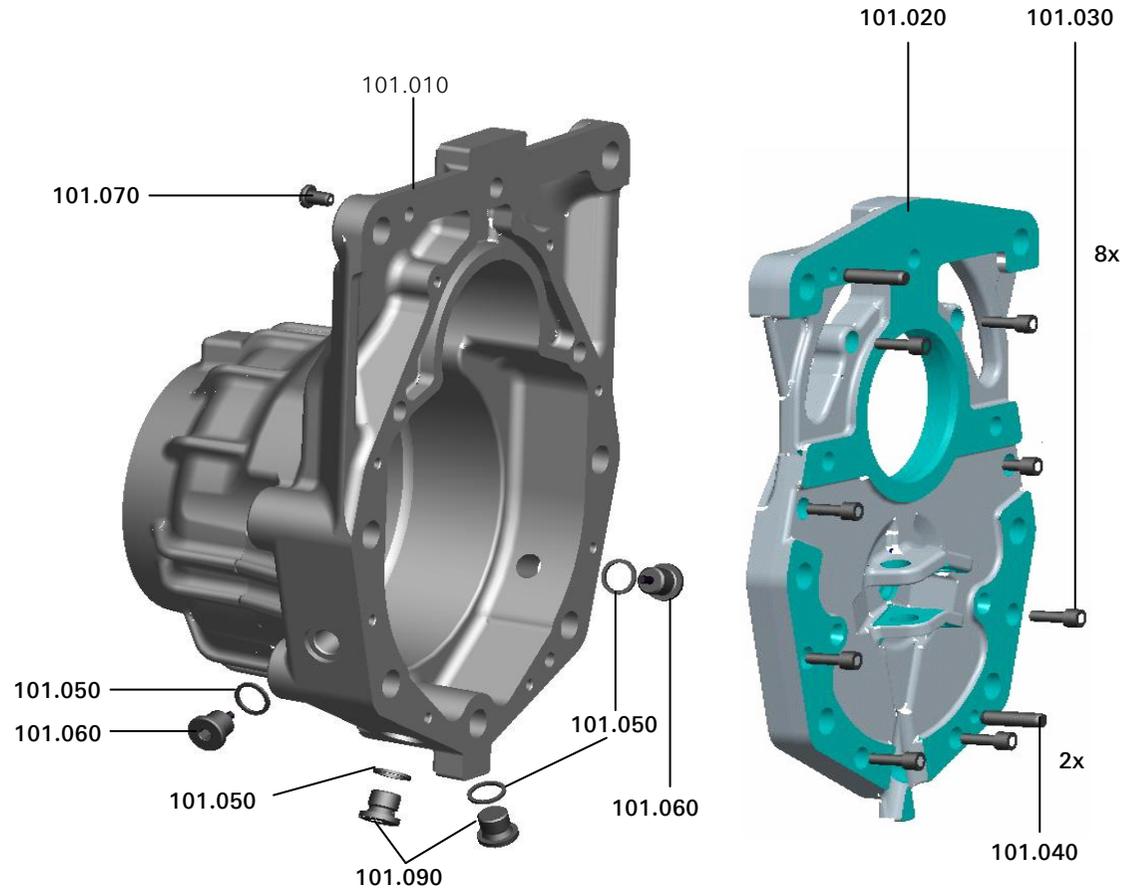
ZF GOTH A GMBH	
MADE IN GERMANY	
TYPE	SERIAL - NO.
1	2
3	4
PARTS LIST NO.	TOTAL RATIO
5	
CUSTOMER CODE - NO.	



Pos. Nr. / Item no	Bezeichnung	Description
1	Getriebetyp	Transmission type
2	Seriennummer	Serial number
3	Identnummer	Parts list number/ Transmission Id. No
4	Übersetzung	Ratio
5	Kundenidentnummer (optional)	Customer code number (optional)

4. Ersatzteile / Parts

4.1. Gehäuseteile / Housing parts

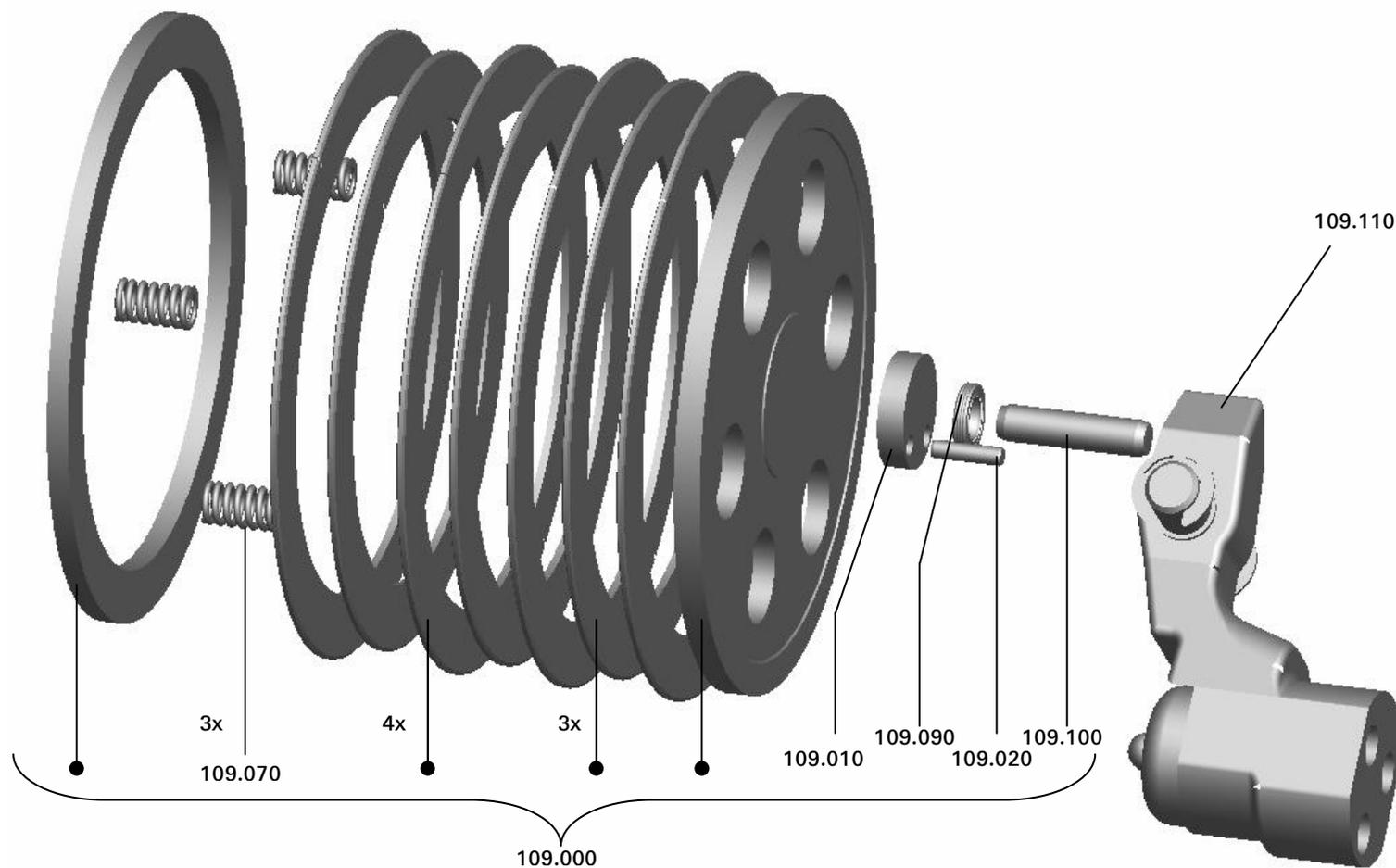


Die Abbildungen können von der tatsächlichen Getriebeausführung abweichen!
Illustrations may differ from actual design!



Gehäuseteile / Housing Parts				Benötigte Teilstückzahl / Required Number Of Pieces																									
Pos.Nr. / Pos. No.	Bezeichnung	Name	Bestellnummer / Order Number	4699 825 013	4699 825 014	4699 825 016	4699 825 017	4699 825 018	4699 825 019	4699 825 020	4699 825 021	4699 825 022	4699 825 024	4699 825 025	4699 825 026	4699 825 027	4699 825 028	4699 825 029	4699 825 030	4699 825 031	4699 825 032	4699 825 033	4699 825 037	4699 825 038	4699 825 039	4699 825 042	4699 825 048	4699 825 049	
101.010	Gehäuse	Housing	4699 301 145		1		1	1									1												
			4699 301 146	1		1			1	1	1	1	1	1	1	1	1		1	1	1	1		1	1		1	1	1
			4699 301 168																				1						
101.020	Gehäuse- deckel	Housing cover	4699 309 083																			1							
			4699 309 085	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1	1	1	1
101.030	Zylinder- schraube	Cylindrical screw	0636 101 411	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
101.040	Zylinderstift	Cylindrical pin	0631 302 212	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
101.050	Dichtring	Sealing ring	0634 801 038	2	4	2	4	4	2	2	2	2	2	2	2	2	4	2	2	2	2	2	2	2	2	4	2	2	2
101.060	Verschluss- schraube mit Magnet	Screw plug with magnet	0501 319 149	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
101.070	Entlüfter	Breather	0637 885 613	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
101.090	Verschluss- schraube	Screw plug	0636 302 013	0	2	0	2	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0

4.2. Bremsenteile / Brake system parts



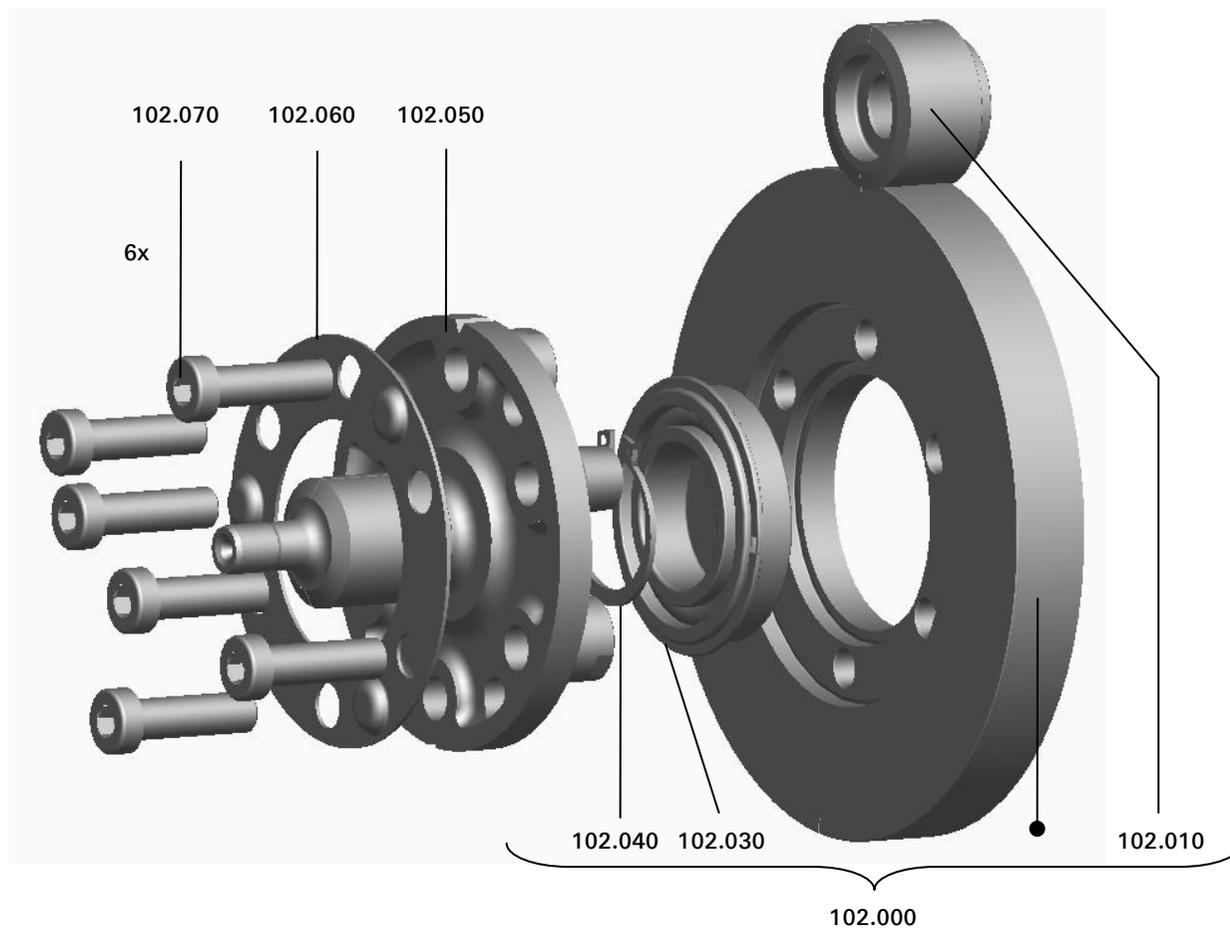
Die Abbildungen können von der tatsächlichen Getriebeausführung abweichen!
Illustrations may differ from actual design!

Bremsenteile / Brake System Parts				Benötigte Teilstückzahl / Required Number Of Pieces																								
Pos.Nr. / Pos. No.	Bezeichnung	Name	Bestellnummer / Order Number	4699 825 013	4699 825 014	4699 825 016	4699 825 017	4699 825 018	4699 825 019	4699 825 020	4699 825 021	4699 825 022	4699 825 024	4699 825 025	4699 825 026	4699 825 027	4699 825 028	4699 825 029	4699 825 030	4699 825 031	4699 825 032	4699 825 033	4699 825 037	4699 825 038	4699 825 039	4699 825 042	4699 825 048	4699 825 049
109.000	Kit Verschleißteile Bremse	Kit Brake wearing parts	4699 195 039	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Axiallager	Axial bearing		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Zylinderstift	Cylindrical pin		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Außenlamelle	Outer clutch disc		4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
	Innenlamelle	Inner clutch disc		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Druckscheibe	Pressure disc		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Druckscheibe (Set)	Pressure disc (set)		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Druckfeder	Pressure spring		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Dichtring	Sealing ring		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Druckstift (Set)	Pressure pin (set)		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1



Bremsenteile / Brake System Parts				Benötigte Teilstückzahl / Required Number Of Pieces																								
Pos.Nr. / Pos. No.	Bezeichnung	Name	Bestellnummer / Order Number	4699 825 013	4699 825 014	4699 825 016	4699 825 017	4699 825 018	4699 825 019	4699 825 020	4699 825 021	4699 825 022	4699 825 024	4699 825 025	4699 825 026	4699 825 027	4699 825 028	4699 825 029	4699 825 030	4699 825 031	4699 825 032	4699 825 033	4699 825 037	4699 825 038	4699 825 039	4699 825 042	4699 825 048	4699 825 049
109.010	Axiallager	Axial bearing	4699 309 054	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
109.020	Zylinderstift	Cylindrical pin	0631 313 003	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
109.070	Druckfeder	Pressure spring	0632 040 021	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
109.090	Dichtring	Sealing ring	0634 502 084	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
109.100	Druckstift (Set)	Pressure pin (set)	4699 209 004	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
109.110	Bremshebel	Brake lever	0501 319 755	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

4.3. Eintriebsteile / Input parts

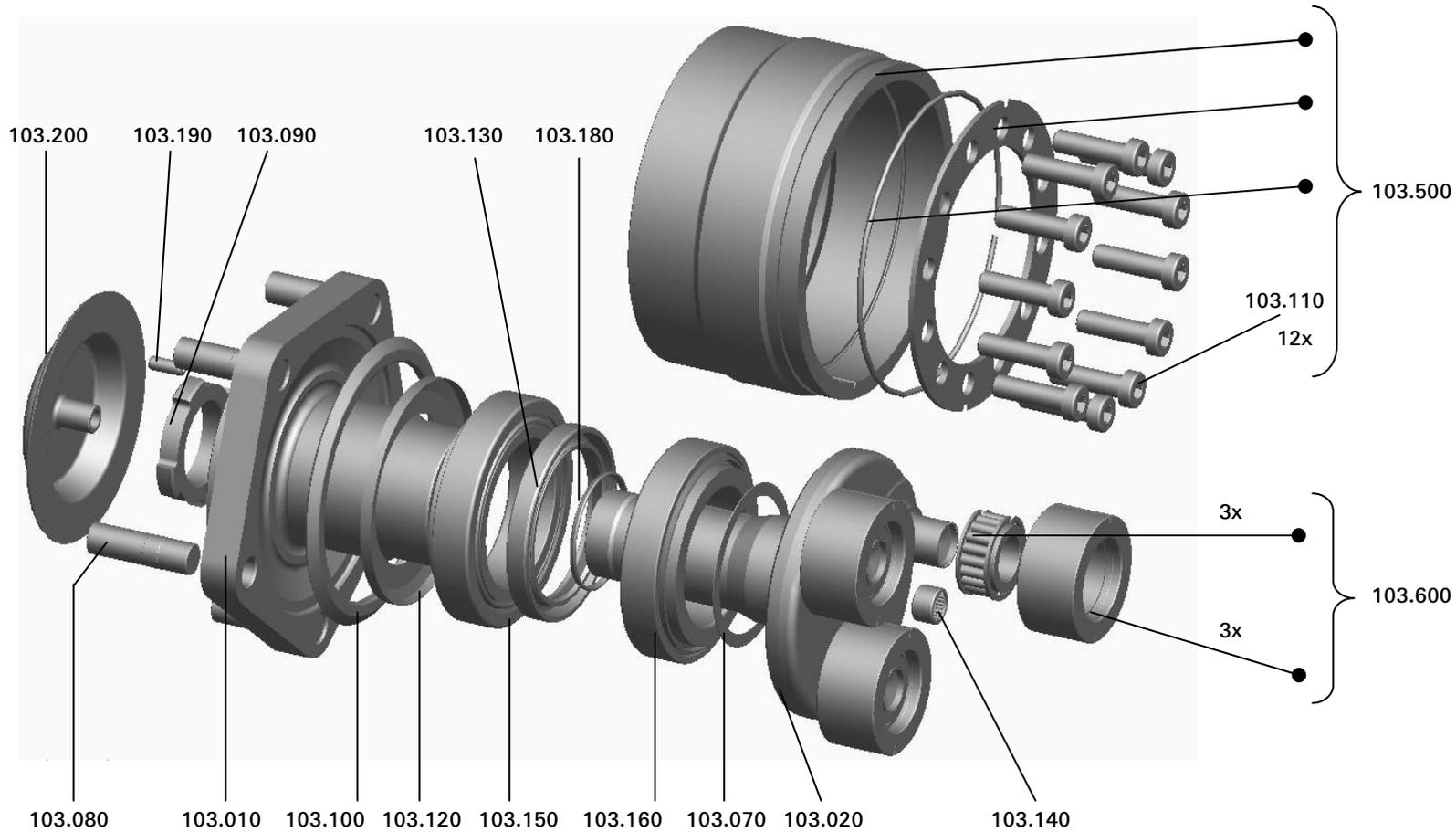


Die Abbildungen können von der tatsächlichen Getriebeausführung abweichen!
Illustrations may differ from actual design!



Eintriebssteile / Input Parts				Benötigte Teilstückzahl / Required Number Of Pieces																										
Pos.Nr. / Pos. No.	Bezeichnung	Name	Bestellnummer / Order Number	4699 825 013	4699 825 014	4699 825 016	4699 825 017	4699 825 018	4699 825 019	4699 825 020	4699 825 021	4699 825 022	4699 825 024	4699 825 025	4699 825 026	4699 825 027	4699 825 028	4699 825 029	4699 825 030	4699 825 031	4699 825 032	4699 825 033	4699 825 037	4699 825 038	4699 825 039	4699 825 042	4699 825 048	4699 825 049		
102.000	Kit Stirnrad	Kit Spur gear	4699 195 036	1					1											1					1		1			
			4699 195 037									1		1							1									
			4699 195 038			1	1	1			1		1		1	1	1	1					1	1	1		1		1	1
			4699 195 041		1															1										
	Stirnrad	Spur gear		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	Antriebsritzel	Input pinion		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	Kugellager	Ball bearing		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	Sicherungs- ring	Circlip		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
102.010	Antriebsritzel	Input pinion	4699 302 037	1					1											1					1		1			
			4699 302 053									1		1							1									
			4699 302 055			1	1	1			1		1		1	1	1	1					1	1	1		1		1	1
			4699 302 217		1															1										
102.030	Kugellager	Ball bearing	0635 331 100	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
102.040	Sicherungs- ring	Circlip	0630 501 028	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
102.050	Innenlamellen- träger	Inner disc carrier	4699 303 085	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
102.060	Halteblech	Fixing plate	4699 303 103	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
102.070	Torxschraube	Torx screw	0501 323 470	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6		

4.4. Abtriebsteile / Output parts



Die Abbildungen können von der tatsächlichen Getriebeausführung abweichen!
 Illustrations may differ from actual design!

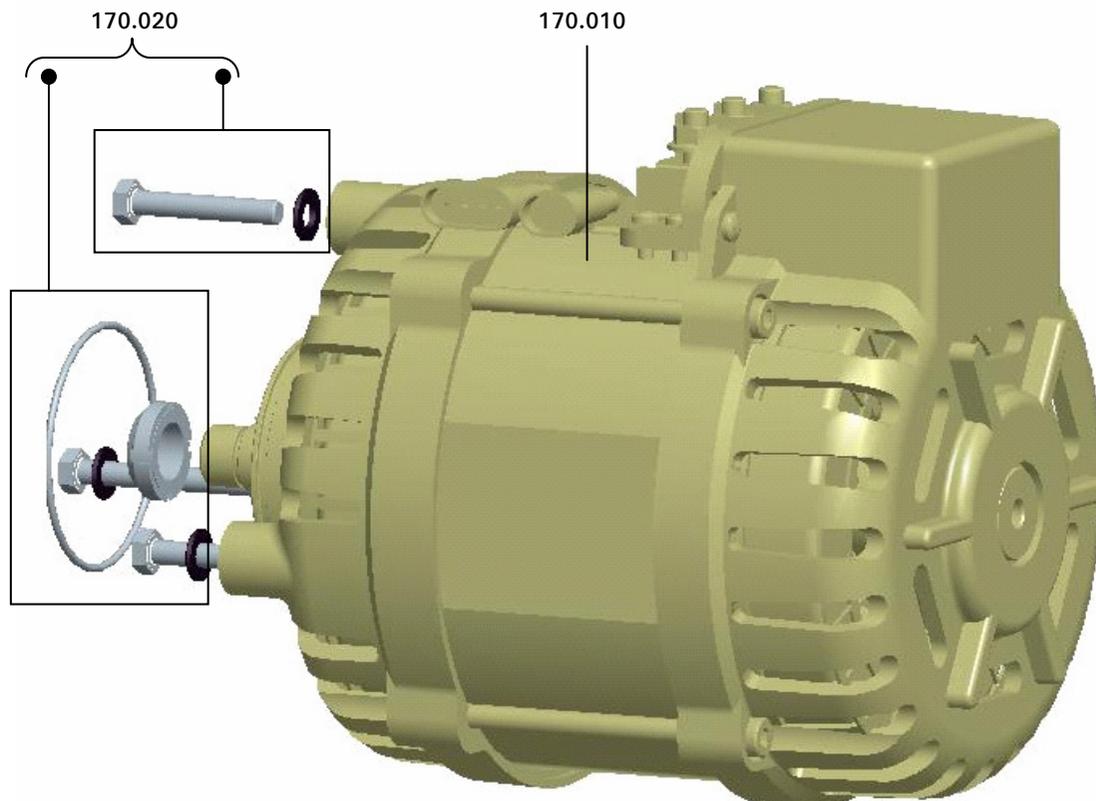


Abtriebsteile / Output Parts				Benötigte Teilstückzahl / Required Number Of Pieces																								
Pos.Nr. / Pos. No.	Bezeichnung	Name	Bestellnummer / Order Number	4699 825 013	4699 825 014	4699 825 016	4699 825 017	4699 825 018	4699 825 019	4699 825 020	4699 825 021	4699 825 022	4699 825 024	4699 825 025	4699 825 026	4699 825 027	4699 825 028	4699 825 029	4699 825 030	4699 825 031	4699 825 032	4699 825 033	4699 825 037	4699 825 038	4699 825 039	4699 825 042	4699 825 048	4699 825 049
103.500	Kit Hohlrads	Ring Gear Kit	4699 195 042	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Hohlrads	Internal gear		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Zahnscheibe	Lock washer		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Ring	Ring		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Torxschraube	Torx screw		12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
103.600	Kit Planetenradsatz	Planet gear set	4699 195 043	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Planetenrad	Planet gear		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Zylinderrollenlager	Cyl. roller bearing		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
103.010	Radwelle	Wheel shaft	4699 303 126	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
103.020	Planetenträger	Planet carrier	4699 303 127	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
103.070	Ausgleichscheibe	Shim	4697 202 004	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
103.080	Radbolzen	Wheel bolt	4699 300 110	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
103.090	Nutmutter	Slotted nut	4699 303 117	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1



Abtriebsteile / Output Parts				Benötigte Teilstückzahl / Required Number Of Pieces																									
Pos.Nr. / Pos. No.	Bezeichnung	Name	Bestellnummer / Order Number	4699 825 013	4699 825 014	4699 825 016	4699 825 017	4699 825 018	4699 825 019	4699 825 020	4699 825 021	4699 825 022	4699 825 024	4699 825 025	4699 825 026	4699 825 027	4699 825 028	4699 825 029	4699 825 030	4699 825 031	4699 825 032	4699 825 033	4699 825 037	4699 825 038	4699 825 039	4699 825 042	4699 825 048	4699 825 049	
103.100	Dichtring	Sealing ring	0501 323 422	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
103.110	Torxschraube	Torx-Screw	0501 323 470	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
103.120	Nilosring	NILOS ring	0501 325 596	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
103.130	Wellendicht- ring	Shaft seal	0634 301 781	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
103.140	Nadelhülse	Needle ring	0635 303 037	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
103.150	Kegelrollen- lager	Taper roller bearing	0750 117 615	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
103.160	Kegelrollen- lager	Taper roller bearing	0635 370 019	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
103.180	O-Ring	O-ring	0634 306 253	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
103.190	Zylinderstift	Cylindrical pin	0631 315 604	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
103.200	Schutzkappe	Protection cap	0501 325 098	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

4.5. Anbauteile / Attaching Parts



Die Abbildungen können von der tatsächlichen Getriebeausführung abweichen!
Illustrations may differ from actual design!



Anbauteile / Attaching Parts				Benötigte Teilstückzahl / Required Number Of Pieces																										
Pos.Nr. / Pos. No.	Bezeichnung	Name	Bestellnummer / Order Number	4699 825 013	4699 825 014	4699 825 016	4699 825 017	4699 825 018	4699 825 019	4699 825 020	4699 825 021	4699 825 022	4699 825 024	4699 825 025	4699 825 026	4699 825 027	4699 825 028	4699 825 029	4699 825 030	4699 825 031	4699 825 032	4699 825 033	4699 825 037	4699 825 038	4699 825 039	4699 825 042	4699 825 048	4699 825 049		
170.010	Motor	Motor	0501 213 927	1																		1					1			
			0501 319 869									1																		
			0501 007 341											1	1		1						1							
			0501 217 044															1									1			
			0501 214 992																1											
			0501 215 738																	1										
			0501 215 832																			1								
			0501 215 724																						1					
	Motoreinheit	Motor unit	0501 327 583																								1			
170.020	Montageteile	Assembly parts	4699 270 005	1							1	1	1		1	1	1			1	1	1	1		1	1	1			
			4699 270 018																1											

SELF-PRIMING PUMPS ELECTRO-MAGNETIC CLUTCH UNIT

FEATURES

Body:	Bronze
Impeller:	Nitrile
Shaft:	Stainless Steel
Seal:	Carbon-Ceramic, Face Type
Ports:	11860-Series, 1" NPT Internal 11870-Series, 1-1/4" NPT Internal
Bearings:	Shielded Ball Bearings
Weight:	11860-Series, 15 lb (6.8 kg) Approx. 11870-Series, 19-1/2 lb (8.9 kg) Approx.

Model	Clutch Volt/Belt	Cam	Impeller	Insert
11860-0005	12 / 2-A	Brass	Nitrile	Brass
11860-0045	12 / 1-B	Brass	Nitrile	Brass
11860-0006	24 / 2-A	Brass	Nitrile	Brass
11860-0046	24 / 1-B	Brass	Nitrile	Brass
11870-0005	12 / 2-A	Brass	Nitrile	Brass
11870-0045	12 / 1-B	Brass	Nitrile	Brass
11870-0006	24 / 2-A	Brass	Nitrile	Brass
11870-0046	24 / 1-B	Brass	Nitrile	Brass
11870-0007	32 / 2-A	Brass	Nitrile	Brass

APPLICATION

MARINE: Pumping bilges, Washdowns, Circulating water in bait tanks, Utility dock-side pump.

INDUSTRIAL: Circulating and transferring, Velocity-mixing, Pumping machine tool coolants, Return spill, Sump drainage, Chemicals, Pharmaceuticals, Soap, Liquors, Ink, Dyes, Alcohol, Various acids, Tanning Liquors, Glycerine, Brine, etc.

FARMING: Pumping water stock, Pumping water from shallow wells and cisterns.

PLUMBING AND HOME EMERGENCY USE: Pumping out flooded basements, Cesspools, Sumps, Water heaters and water closets, Drains and sinks, Draining fishponds and pools.

PUBLIC UTILITIES AND MUNICIPALITIES: Under the hood mounting on service trucks for draining meter boxes, manholes, excavations; For pollution control and watering for dust control.

INSTALLATION

Pump may be mounted in any position. Intake and discharge ports are determined by the direction of shaft rotation (refer to dimensional drawing). Before installing, energize clutch and turn pump shaft in direction of shaft rotation. Drive pump with two "A" size belts or one "B" size belt. Avoid dry-running by using Vacuum Switch Model 4732-0000 for automatic shutoff.



Models 11860, 11870-Series

WARNING

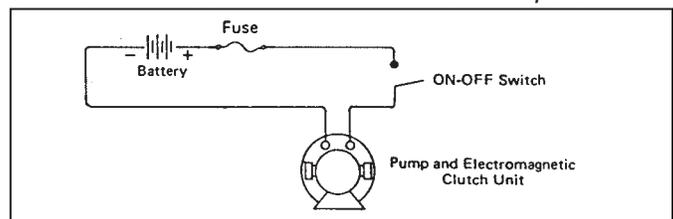


Injury hazard. Exposed pulleys and belts can cause injury. Install shield around pulleys and belts. Stay clear while machinery is operating.

WIRING

Connect wires as shown for manual on-off operation. Install appropriate size fuse (see Electrical Specification Chart) in positive lead as close to power source as possible. For complete wiring instruction, see diagram on last page.

Connect wires as shown for manual on-off operation.



ELECTRICAL SPECIFICATIONS

Voltage	Amp Draw	Fuse Size
12	4	7
24	2	4
32	1.5	2

OPERATION

Pump will self-prime at low or high speeds. Make sure that all connections are airtight. 12 Volt models are equipped with mechanical clutch engagement screws in case of electrical failure. To mechanically engage clutch, loosen locking nuts, tighten allen head screws and retighten locking nuts. Reverse procedure to disengage clutch. If the mechanical engagement feature is not desired, the screws may be removed. **DO NOT RUN PUMP DRY FOR MORE THAN 30 SECONDS. LACK OF WATER FLOW MAY DAMAGE IMPELLER.** To drain pump, loosen end cover screws. See Head Capacity Table for head pressures and flow. To avoid costly shutdowns, keep a Jabsco Service Kit on hand.

SERVICE INSTRUCTIONS

IMPELLER REPLACEMENT: Remove end cover gasket. Pull impeller out by grasping hub with pliers. With rotary motion in the direction the pump will be turning, push the impeller into the impeller bore. A light coating of grease in the impeller bore will protect the impeller during initial dry start up. Install gasket and end cover.

SHAFT SEAL REPLACEMENT, 11870-SERIES: Remove end cover, gasket and impeller, as outlined above. Loosen cam screw several turns. Give cam screw a couple of sharp raps with the handle of the screwdriver to loosen the cam from the impeller bore. Remove the cam screw and cam (clean sealant from cam and impeller bore). Remove wearplate with hooked wire. Remove marcel washer, seal assembly and seal seat assembly from seal bore with hooked wire, taking care not to scratch shaft or seal seat bore. Clean shaft surfaces behind splines and inspect for scratches or wear. Replace if necessary. Before installing new seal parts, clean any oil or grease from carbon and ceramic seal faces. Dip seal seat and gasket assembly in water and press into seal bore with boot first. Dip carbon seal assembly in water and install over shaft, carbon towards ceramic seal seat, until it bottoms firmly against ceramic seat. Slide marcel spring washer over shaft and against the rubber boot (washer) on carbon seal assembly. Replace wearplate, aligning notch with dowel pin in body. Apply sealant to top surface of cam and cam screw threads and install cam in impeller bore. Snug up but do not tighten cam screw. Replace impeller, gasket and end cover as outlined above. Tighten end cover screws. Tighten cam screw.

SHAFT SEAL REPLACEMENT, 11860-SERIES: Refer to major repair instructions.

FIELD COIL REPLACEMENT: Remove drive belts from pulley. Remove center bolt and washer from pulley (it may be necessary to remove end cover to hold impeller from turning, while removing center pulley bolt). Tap pulley with soft mallet to remove from shaft taper. Remove 3 bolts and washers holding field coil to adaptor (11870) or body (11860). Remove and replace field coil, tightening the 3 bolts securely. With drive key in place in shaft, replace pulley assembly. Secure to shaft, replace pulley assembly. Secure to shaft with center bolt and washer (again, it may be necessary to hold the impeller from turning to tighten center bolt). Replace drive belts. Do not over tighten belts. A deflection of 1/2" midway between pulleys is generally considered normal.

MAJOR REPAIR: Remove pump from installation for major repair. Disassembly: Remove end cover, gasket, impeller, cam and wearplate as outlined in shaft seal replacement, 11870-Series. Remove clutch as outlined in field coil replacement. Model 11870-Series: Use a punch to drive roll pins (key 17) in toward shaft approximately 3/8" (10mm). Remove clutch adaptor from body. Punch roll pin out of adaptor. Model 11860-Series does not have adaptor, clutch is secured directly to body. Remove bearing to body retaining ring. Support bearing end of body on arbor press platten. Press on impeller end of shaft to remove shaft and bearing assembly from body. Use screwdriver to pry inner bearing seal from body. Take care not to scratch or damage body bore.

11860-SERIES: Remove seal seat assembly from shaft. Support impeller end of body on arbor press platten and, using suitable tube, press seal out of seal bore towards impeller end.

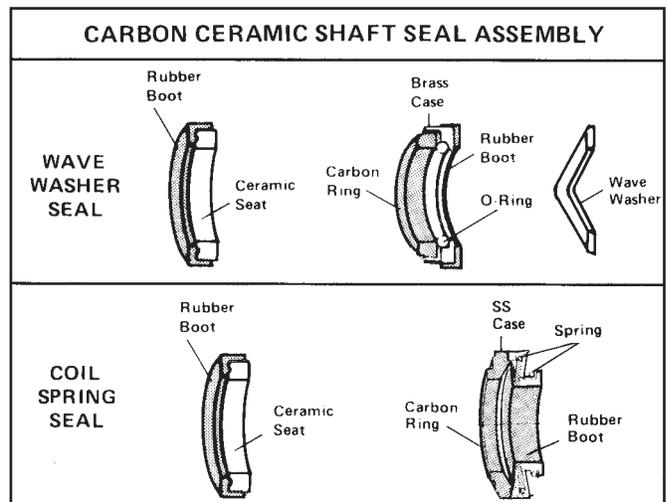
11870-SERIES: Remove slinger from drain area. Carbon portion of the seal assembly will be freed from shaft when shaft is removed from body. Press seal seat assembly from bearing bore end towards impeller bore. Remove bearing to shaft retaining ring. Support bearing and press on clutch drive end of shaft to remove shaft from bearing.

ASSEMBLY: Support inner race of bearing on arbor press platten. Oil shaft, insert drive end of shaft into bearing and press shaft through bearing until it bottoms firmly against shoulder. Install shaft to bearing until it bottoms firmly against shoulder. Install shaft to bearing retaining ring in groove of shaft. Support impeller bore end of pump on arbor press platten. Lubricate bearing seal with grease and press into bearing seal bore, flush with bearing bore shoulder, with lip facing away from bearing bore. For 11870-Series only: Insert slinger in drain slot, to be picked up by shaft during shaft/bearing assembly. Insert splined end

of shaft through bearing seal (and slinger on Model 11870-Series). Press on outer bearing race to assemble shaft/bearing assembly into body, bottoming bearing firmly against bearing bore shoulder. Install body to bearing retaining ring in groove in body with flat side against bearing. For 11870-Series only: Install clutch adaptor in bearing bore. If re-using adaptor previously disassembled from pump, line up dowel pin holes during assembly of adaptor to body. If installing new adaptor (which does not have pre-drilled dowel pin holes), insert into bearing bore until it bottoms and use dowel pin holes in body to pilot drill dowel pin holes through adaptor in two places, 180° apart. Clean any brass chips from bearing area. Press roll pins into body to secure adaptor. Attach field coil to adaptor (11870-Series) or body (11860-Series) with three round head bolts. Turn body over and support on field coil.

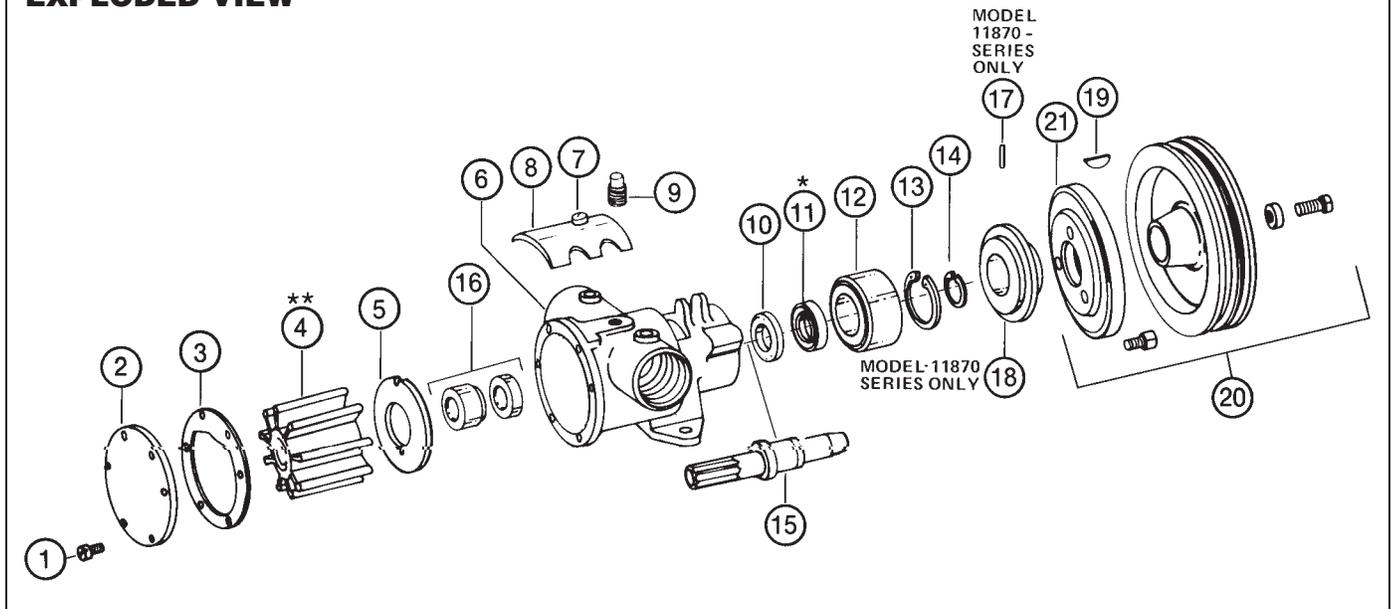
11860-SERIES: Dip seal seat assembly, consisting of ceramic seal seat and rubber washer, in water and push over shaft, with shiny side of ceramic facing impeller bore, until bottoms firmly against shaft shoulder. Press on outside edge of seal case with carbon seal face towards ceramic seat to install seal assembly in seal bore. Press flush with bottom of impeller bore.

11870-SERIES: Assemble rubber boot over ceramic seal seat so that shiny surface of seal seat is outwards. Dip assembly in water and insert into seal bore. Press firmly but carefully on seal seat until it bottoms against shoulder of seal bore. Check to see that the seal seat assembly remains in position and does not "pop" back out. A slight twisting motion while pressing will seat it firmly in position. In this pump, either a wave washer seal or coil spring carbon seal may be used. The wave washer is used only if the carbon portion of the seal does not have a coil spring attached.



Inspect shaft and seal seat bore to be sure sealing surfaces are free of nicks or scratches. Clean shaft surface behind splines to ensure proper O-ring seal on shaft. Apply light film of grease on shaft surface behind spline area. Slide carbon ring assembly, with carbon facing ceramic, over the shaft and firmly up against the ceramic seat. If carbon portion of seal does not have an integral coil type tensioning spring, slide wave washer over the shaft and against the rubber boot on metal case containing O-ring and carbon. Install wearplate in bottom of impeller bore, locating slot in outside edge of wearplate over dowel pin in body. Apply a small amount of sealant to surface of cam and cam screw threads and install cam in impeller bore. Edge of cam should be flush with flange face of body. With a rotary motion in the direction the pump will be turning, push the impeller into the impeller bore until it is firmly bottomed. Turn body over to install clutch pulley assembly. Press key into shaft. Position clutch/pulley assembly on shaft aligning key with slot in pulley hub. Secure with bolt and washer. To tighten bolt securely, it may be necessary to hold the impeller to prevent the shaft from turning. Turn pump assembly over. Dip gasket in water, position on pump flange face, install end cover and secure with end cover screws.

EXPLODED VIEW

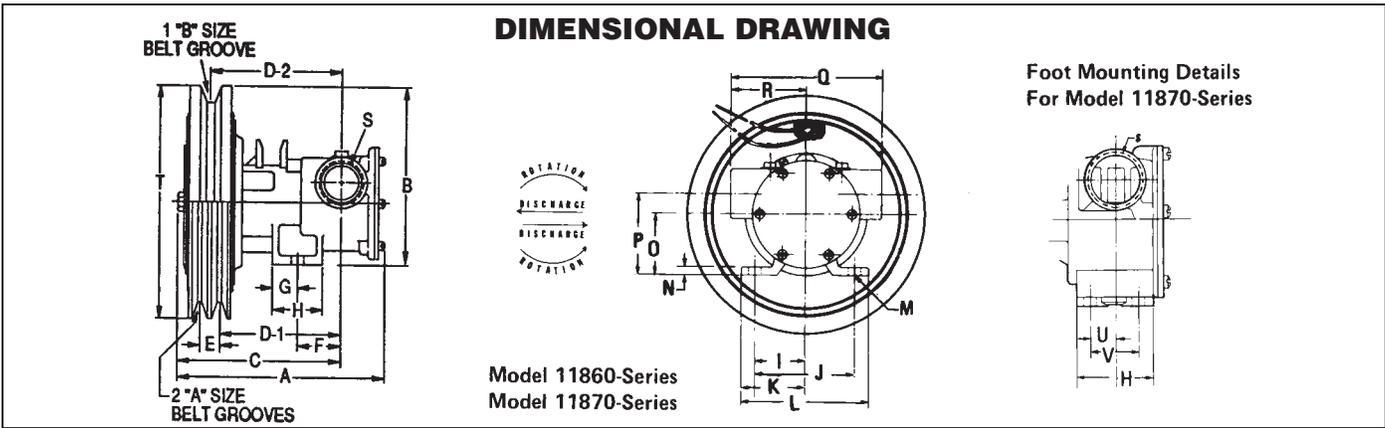


PARTS LIST

Key	Description		Qty. Req.	11860-Series Part No.	11870-Series Part No.
1	Screw End Cover	(3 Per Kit)	2	91003-0010	-
	Screw End Cover	(3 Per Kit)	2	-	91005-0040
2	End Cover		1	11831-0000	12062-0000
3	Gasket		1	890-0000	816-0000
4	Impeller Nitrile, Brass**		1	920-0003	836-0003
5	Wearplate		1	7868-0000	2574-0000
6	Body		1	11864-0000	18753-0585
7	Screw Cam	(3 Per Kit)	1	91004-0090	91005-0040
8	Cam, Brass		1	934-0000	834-0001
9	Pipe Plug		2	92650-0070	92650-0070
10	Slinger		1	3180-0000	3181-0000
11	Seal (Bearing)*		1	913-0000	817-0000
12	Ball Bearing (Pump)		1	92600-0540	92600-0040
13	Retaining Ring (Brg to Body)		1	18724-0000	18712-0000
14	Retaining Ring (Brg to Shaft)		1	18713-0000	18711-0000
15	Shaft		1	11867-0000	11877-0000
16	Seal (Shaft)		1	96080-0080	6407-0010
17	Roll Pin (Adaptor)		2	-	93100-0160
18	Adaptor		1	-	11876-0000
19	Key (Clutch Drive)		1	91401-0100	91401-0100
20	Clutch Assy. Complete	12 V - 2-A Grooves	1	92300-0030	92300-0030
		12 V - 1-B Groove		18753-0493	18753-0493
		24 V - 2-A Grooves		92300-0061	92300-0061
		24 V - 1-B Groove		18753-0494	18753-0494
		32 V - 2-A Grooves		-	92300-0050
21	Replacement Field Coil	12 V		98022-0500	98022-0500
		24 V		98022-2155	98022-2155
		32 V		98022-0510	98022-0510
	Service Kit Nitrile Impeller			90118-0003	90062-0003

* Use on pre 2002 models. Date code 01H or earlier.

**Special application model 11860-7001, use Impeller 17937-0001, Service Kit 90118-0001



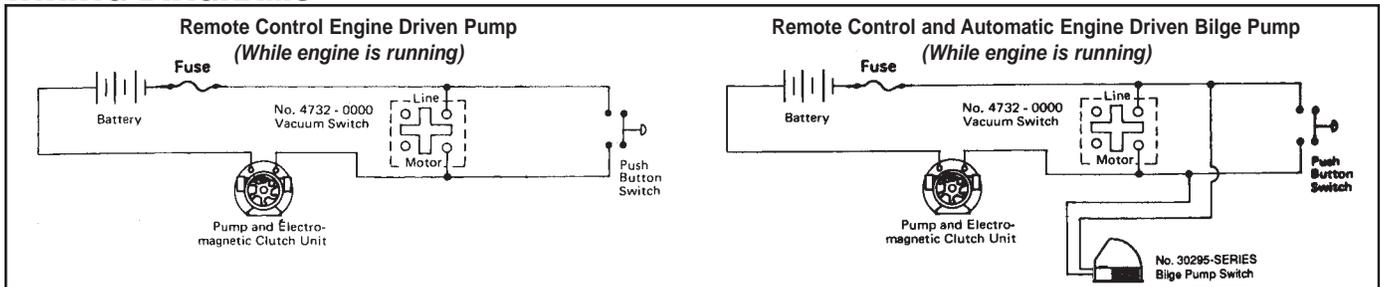
TABULATION OF DIMENSIONS (Inches and Millimeters)

Model	A	B	C	D-1	D-2	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
11860 Series	6-3/16 157	5-3/8 137	4-29/32 125	3-9/16 90	3-7/8 98	5/8 16	1-5/16 33	3/4 19	1-1/2 38	1-9/16 40	3-1/8 79	2 51	4 102	13/32 10	1/4 6	1-7/8 48	2-1/2 64	4-3/4 21	2-3/8 60	1" NPT	7 178	—	—
11870 Series	8-3/16 208	6-1/16 154	7-1/16 179	5-1/4 133	5-9/16 141	5/8 16	— 31	1-7/32 59	2-5/16 57	2-1/4 114	4-1/2 70	2-3/4 140	5-1/2 10	13/32 8	5/16 65	2-9/16 97	3-13/16 149	5-7/8 75	2-15/16 NPT	1-1/4" 178	7 21	3/16 21	1-1/2 38

CAPACITY TABLES

	Total Head				500 RPM			1160 RPM			1750 RPM			2450 RPM			3000 RPM		
	psi	kg per sq cm	feet of water	meters of water	GPM	LPM	HP	GPM	LPM	HP	GPM	LPM	HP	GPM	LPM	HP	GPM	LPM	HP
11860 Series	4.3	0.3	10	3.0	6.0	22.7	1/4	14.8	56.0	1/3	23.3	88.2	3/4	32.5	123.0	1	34.8	131.7	1-1/2
	8.7	0.6	20	6.1	5.5	20.8	1/4	14.1	53.4	1/2	22.3	84.4	3/4	31.8	120.4	1-1/2	34.2	129.5	1-1/2
	17.3	1.2	40	12.2	4.0	15.1	1/4	12.0	45.4	1/2	19.5	73.8	3/4	28.5	107.9	1-1/2	32.5	123.0	2
	26.0	1.8	60	18.3	—	—	—	8.8	33.3	3/4	15.0	56.8	1	23.5	89.0	1-1/2	29.8	112.8	2
	34.6	2.4	80	24.4	—	—	—	—	—	—	—	—	—	17.0	64.4	1-1/2	23.8	90.1	2
11870 Series	4.3	0.3	10	3.0	18.0	68.1	1/2	41.0	155.2	1	62.0	234.7	1-1/2	—	—	—	—	—	—
	8.7	0.6	20	6.1	17.0	64.4	1/2	40.0	151.4	1	60.0	227.1	1-1/2	—	—	—	—	—	—
	17.3	1.2	40	12.2	14.0	53.0	1/2	37.0	140.1	1-1/2	55.0	208.2	2	—	—	—	—	—	—
	26.0	1.8	60	18.3	—	—	—	30.0	113.6	1-1/2	50.0	189.3	2	—	—	—	—	—	—
	34.6	2.4	80	24.4	—	—	—	—	—	—	40.0	151.4	3	—	—	—	—	—	—

WIRING DIAGRAMS



REMOTE CONTROL: Install a pushbutton switch at one or more locations (multiple switches should be wired parallel). Depress pushbutton for 2 seconds. If there is water in bilge, pump will operate until dry, at which time vacuum switch will stop pump. If no water is in bilge, pump will stop when pushbutton is released.

AUTOMATIC BILGE PUMP: Install No. 30295-Series Automatic Bilge Pump Switch where it will energize clutch at maximum high water level in bilge. When water raises switch float, pump will start. Vacuum switch will maintain closed circuit until bilge is pumped dry. Pump will automatically stop, preventing impeller damage.

Jabsco



THE PRODUCTS DESCRIBED HEREIN ARE SUBJECT TO THE JABSCO ONE YEAR LIMITED WARRANTY, WHICH IS AVAILABLE FOR YOUR INSPECTION UPON REQUEST.

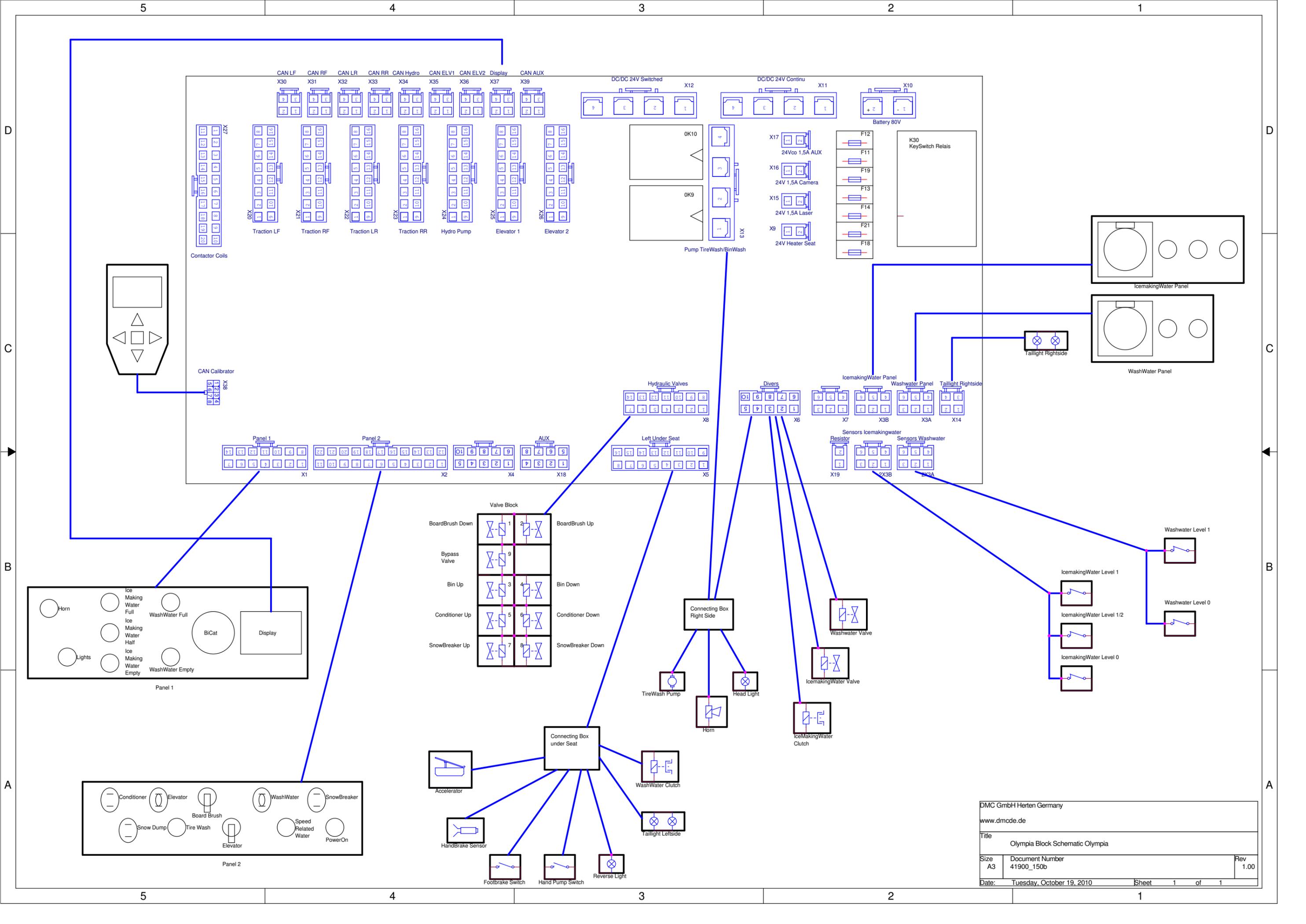
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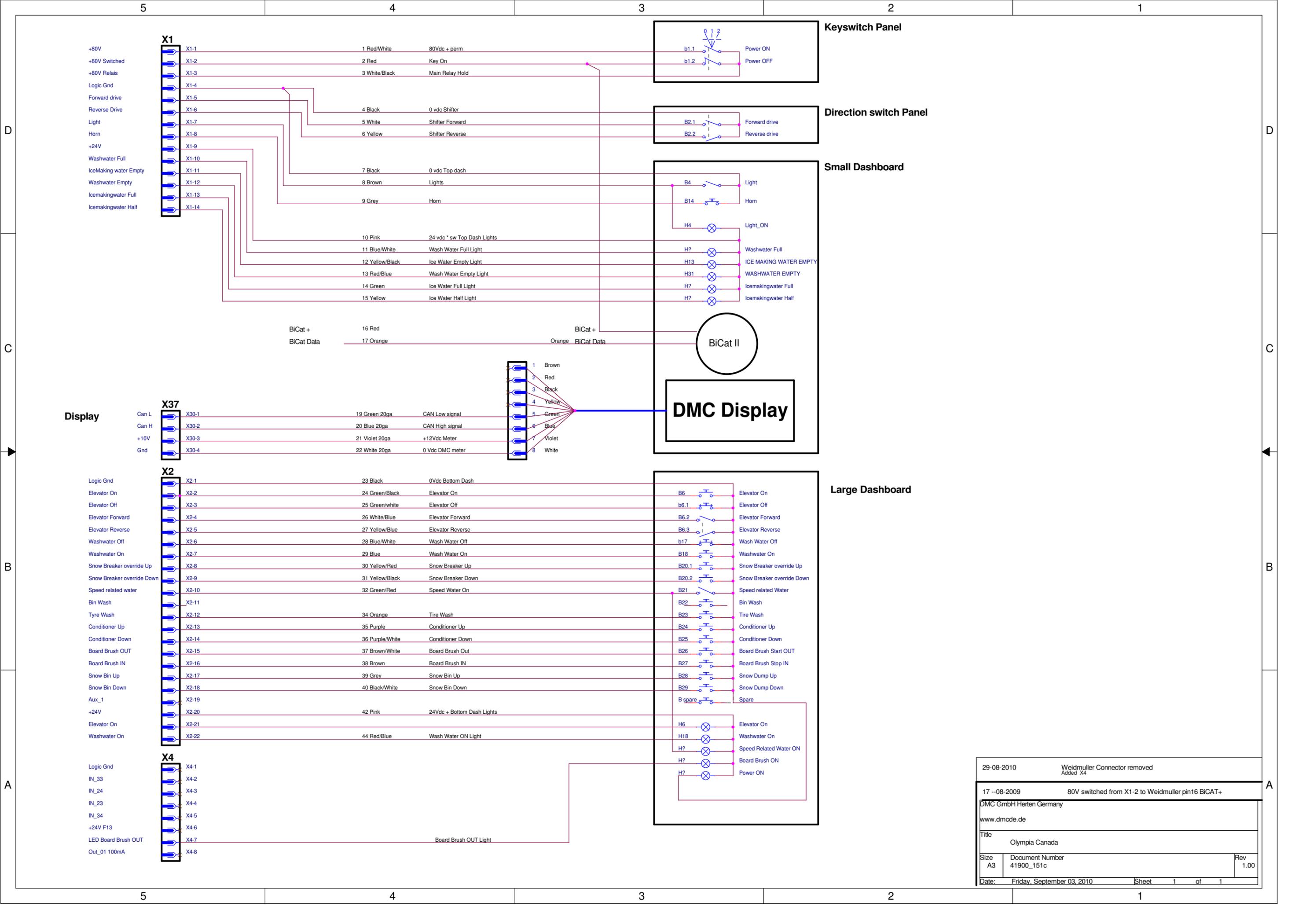
CANADA
Fluid Products Canada
55 Royal Road
Guelph, Ontario N1H 1T1
Tel: (519) 821.1900
Fax: (519) 821.2569

JAPAN
NHK Jabsco Company Ltd.
3-21-10, Shin-Yokohama
Kohoku-Ku, Yokohama, 222
Tel: 045.475.8906
Fax: 045.475.8908

GERMANY
Jabsco GmbH
Oststrasse 28
22840 Norderstedt
Tel: +49-40-53 43 73 -0
Fax: +49-40-53 53 73 -11

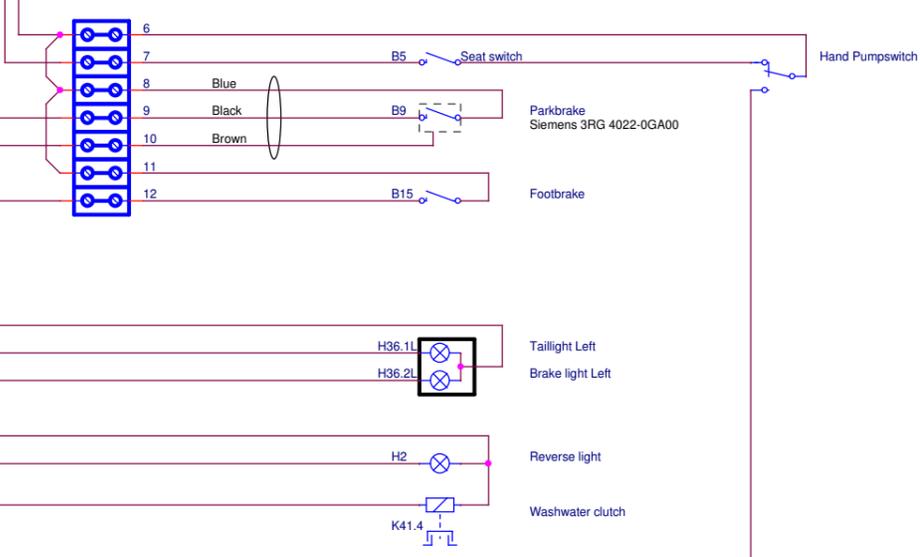
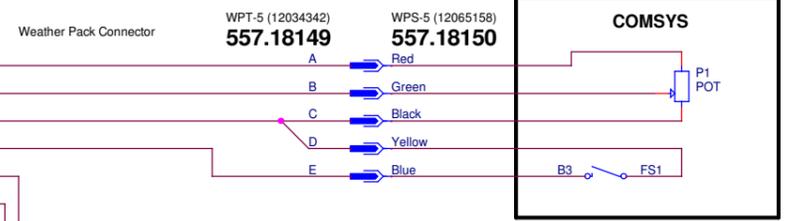
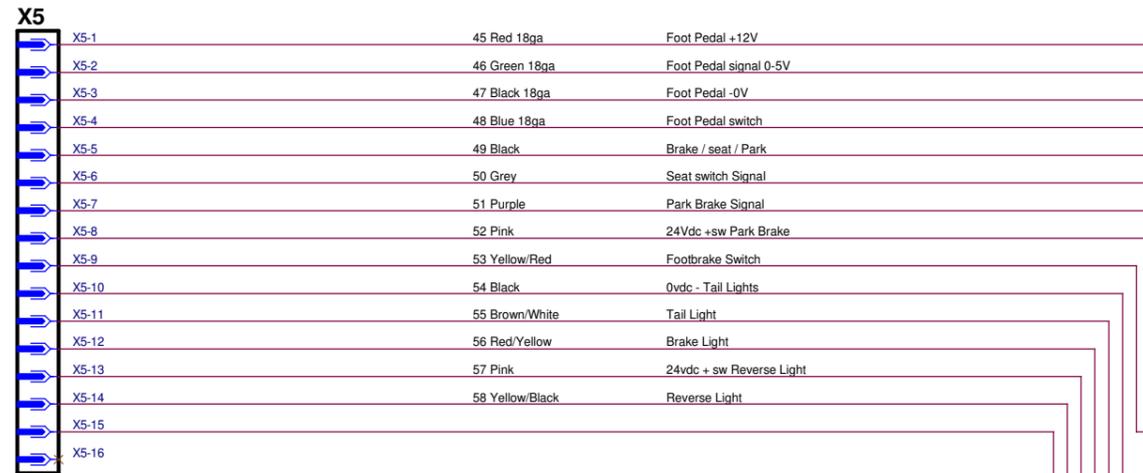


DMC GmbH Herten Germany		
www.dmcde.de		
Title Olympia Block Schematic Olympia		
Size A3	Document Number 41900_150b	Rev 1.00
Date: Tuesday, October 19, 2010	Sheet 1 of 1	



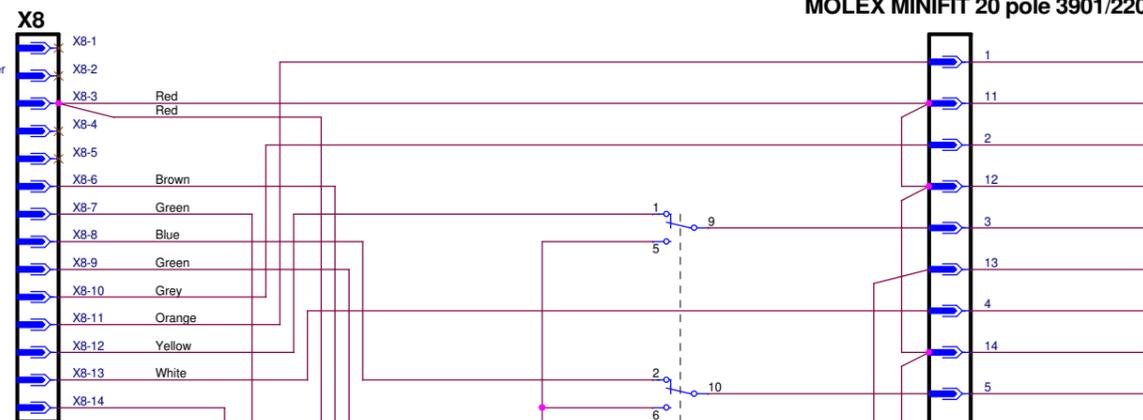
29-08-2010	Weidmuller Connector removed Added X4	
17 --08-2009	80V switched from X1-2 to Weidmuller pin16 BiCAT+	
DMC GmbH Herten Germany www.dmc.de		
Title Olympia Canada		
Size A3	Document Number 41900_151c	Rev 1.00
Date: Friday, September 03, 2010	Sheet 1	of 1

- +12V accelerator supply
- 0 - 5V Accelerator output
- Gnd Accelerator
- Accelerator switch
- Logic Gnd
- Seat switch
- Handbrake
- +24V
- Footbrake
- Power Gnd
- Taillight
- Brakelight
- Power +24V
- Reverse light
- Washwater clutch
- Spare

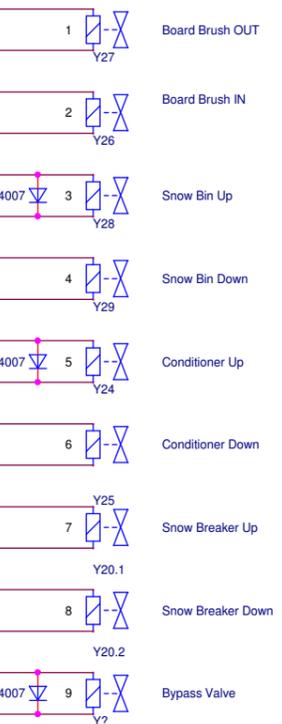


MOLEX MINIFIT 20 pole 3901/2201

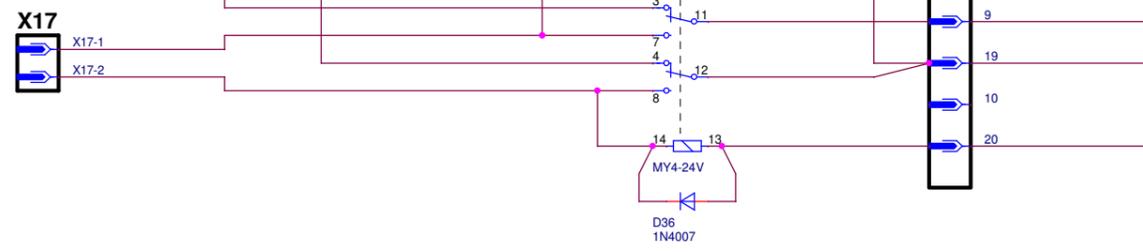
- Logic Gnd
- Hydraulic pressure Conditioner
- Power +24V
- Edger Up
- Edger Down
- Snow Breaker Up
- Snow Breaker Down
- Conditioner Up
- Conditioner Down
- Board Brush IN
- Board Brush OUT
- Snow Bin Up
- Snow Bin Down
- Bypass Valve



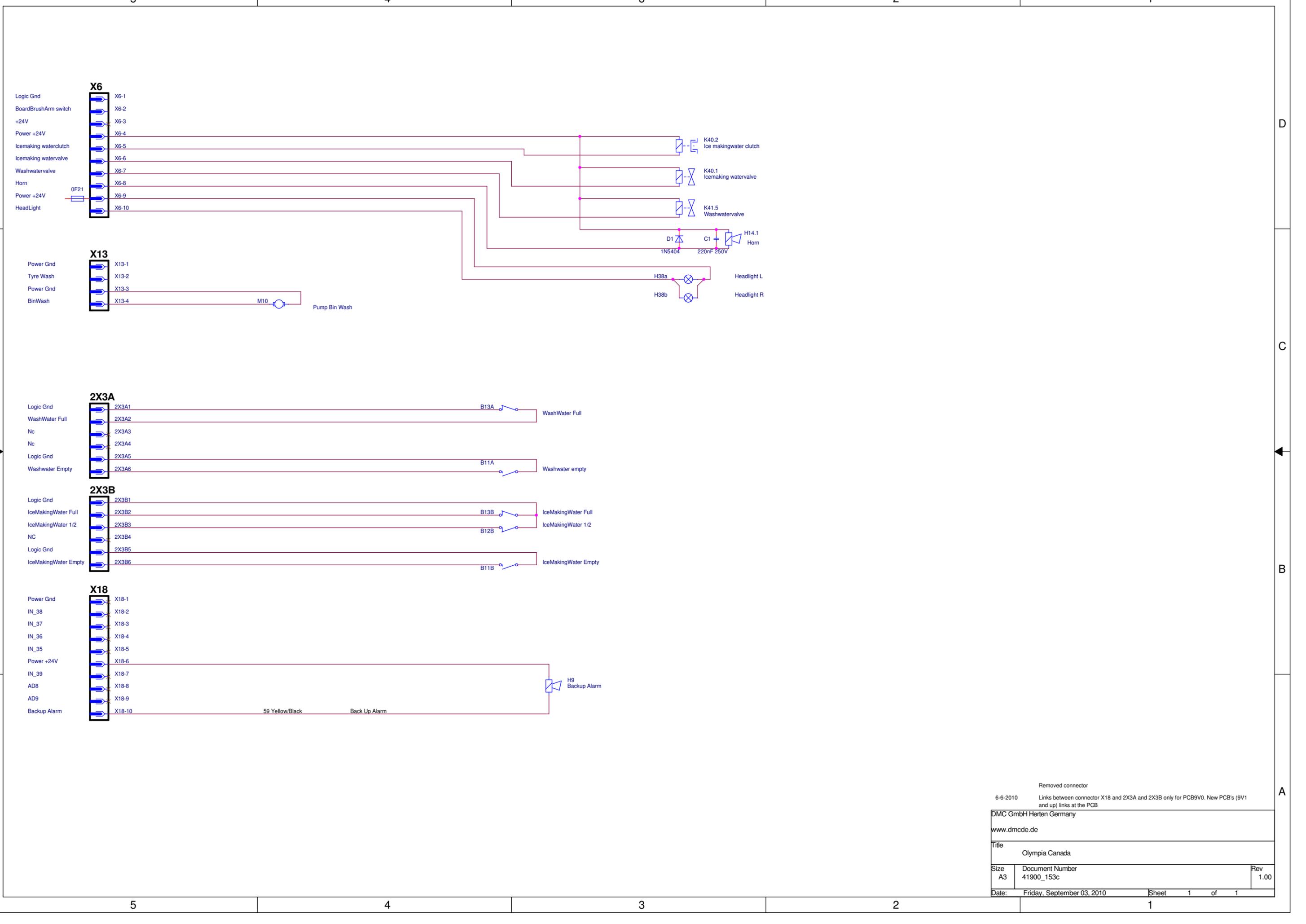
Hydraulic Valves



- Power Gnd
- +24V CO



29-08-2010	Weidmuller Connector removed Backup Alarm removed to page 41800_153 Washwater Clutch Placed
19-08-2009	Added Backup Alarm
DMC GmbH Herten Germany www.dmcde.de	
Title Olympia Canada	
Size A3	Document Number 41900_152c
Date: Friday, September 03, 2010	Rev 1.00
Sheet 1 of 1	



Removed connector
 6-6-2010 Links between connector X18 and 2X3A and 2X3B only for PCB9V0. New PCB's (9V1 and up) links at the PCB

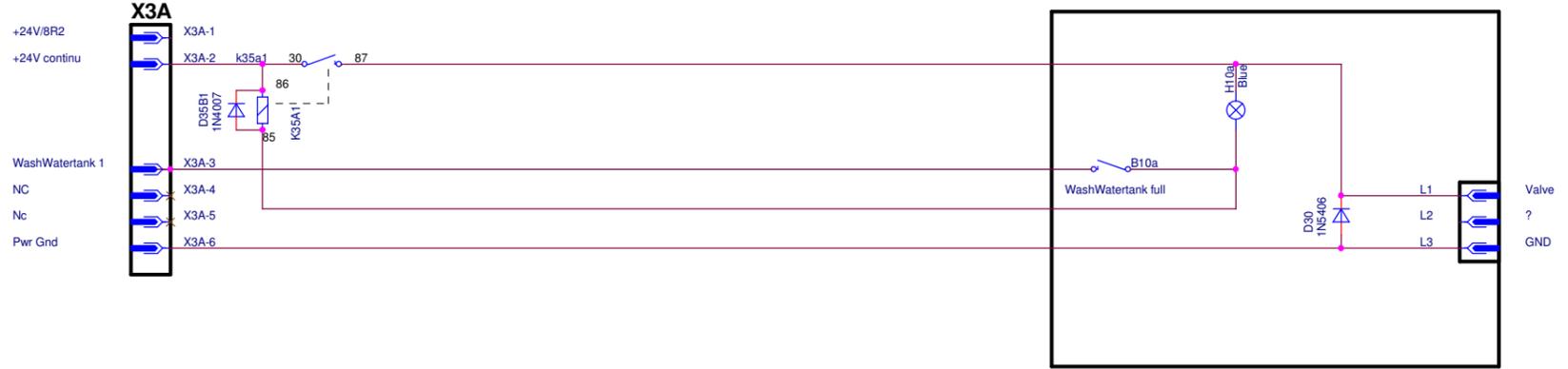
DMC GmbH Herfen Germany
 www.dmcde.de

Title
 Olympia Canada

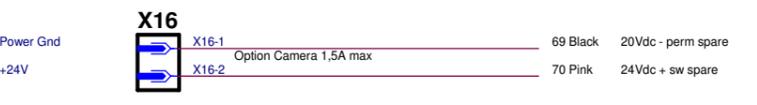
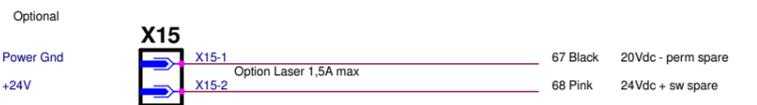
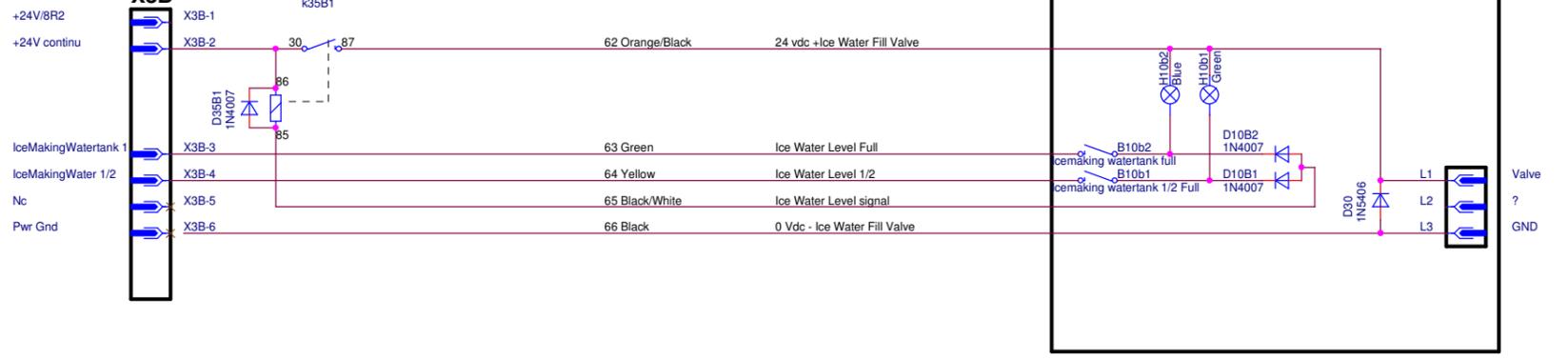
Size A3	Document Number 41900_153c	Rev 1.00
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Date: Friday, September 03, 2010 Sheet 1 of 1

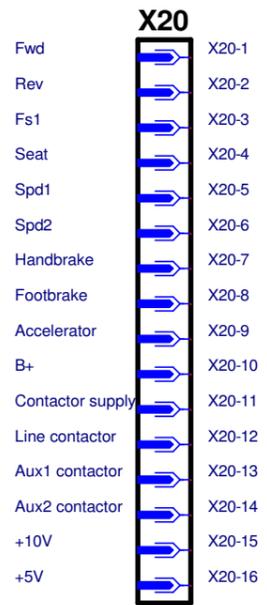
Panel 3A Small washwater panel



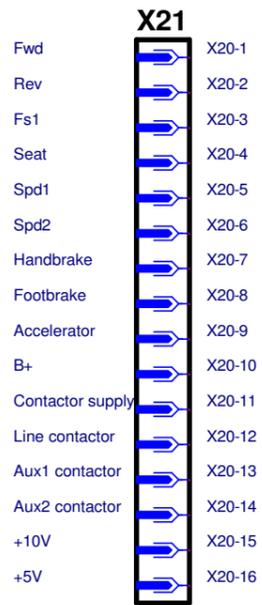
Panel 3B Icemaking Water Fill Station



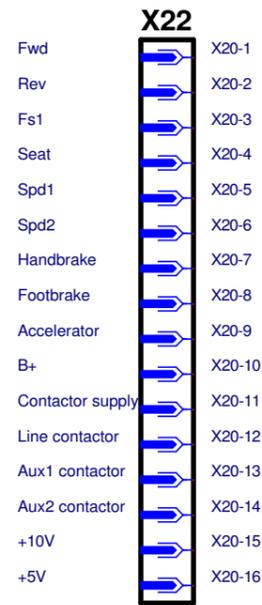
Traction Front Left



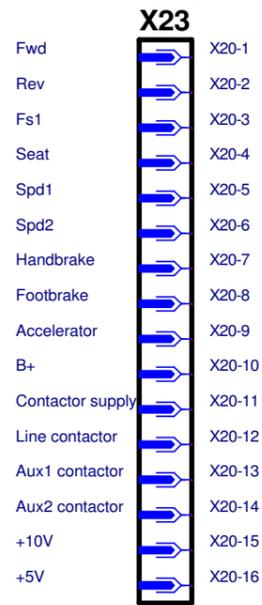
Traction Front Right



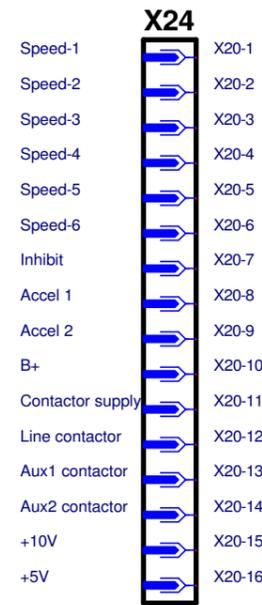
Traction Rear Left



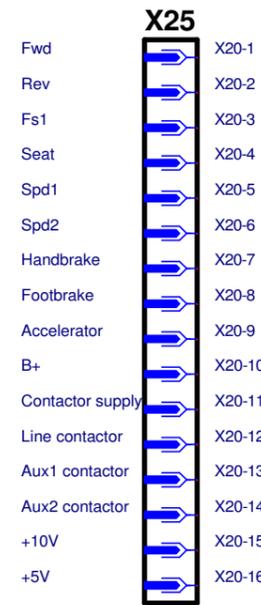
Traction Rear Right



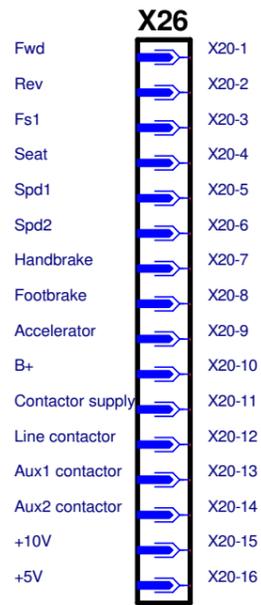
Hydraulic Pump



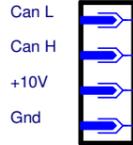
Elevator 1



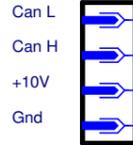
Elevator 2



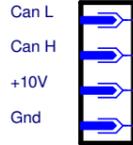
X30



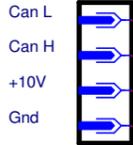
X31



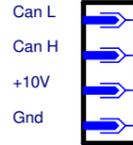
X32



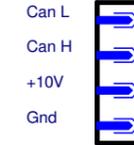
X33



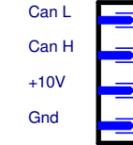
X34



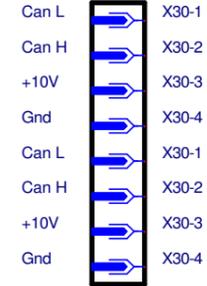
X35



X36



X38



X19



X10



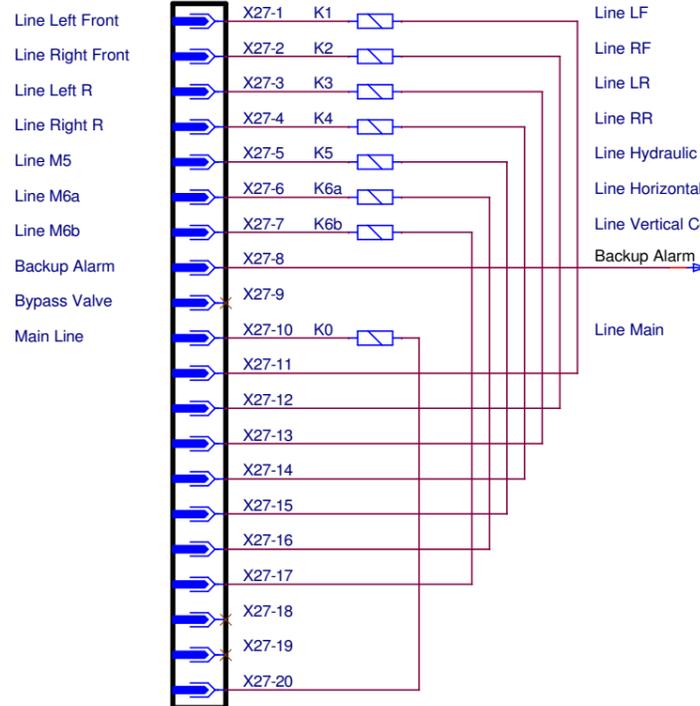
X11



X12



X27



Molex Minifit 2p

Link in Battery connector

10-10-2010 DCDC connection updated

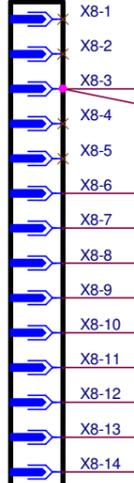
19-08-2009 Added backup Alarm

File	41900_156b Panel Connections Olympia	Rev	
Size	Document Number		
AI	41900_156b		1.00
Date	Tuesday, October 19, 2011	Sheet	1 of 1

MOLEX MICROFIT 14 pole

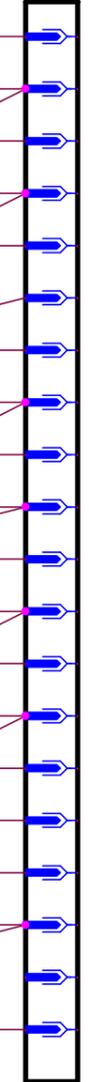
X8

- Logic Gnd
- Hydraulic pressure Conditioner
- Power +24V
- Edger Up
- Edger Down
- Snow Breaker Up
- Snow Breaker Down
- Conditioner Up
- Conditioner Down
- Board Brush IN
- Board Brush OUT
- Snow Bin Up
- Snow Bin Down
- Bypass Valve



- X8-1
- X8-2
- X8-3 Red
- X8-4 Red
- X8-5
- X8-6 Brown
- X8-7 Green
- X8-8 Blue
- X8-9 Green
- X8-10 Grey
- X8-11 Orange
- X8-12 Yellow
- X8-13 White
- X8-14

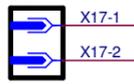
MOLEX MINIFIT 20 pole 3901/2201



- 1
- 11
- 2
- 12
- 3
- 13
- 4
- 14
- 5
- 15
- 6
- 16
- 7
- 17
- 8
- 18
- 9
- 19
- 10
- 20 Hand Pump switch

X17

- Power Gnd
- +24V CO



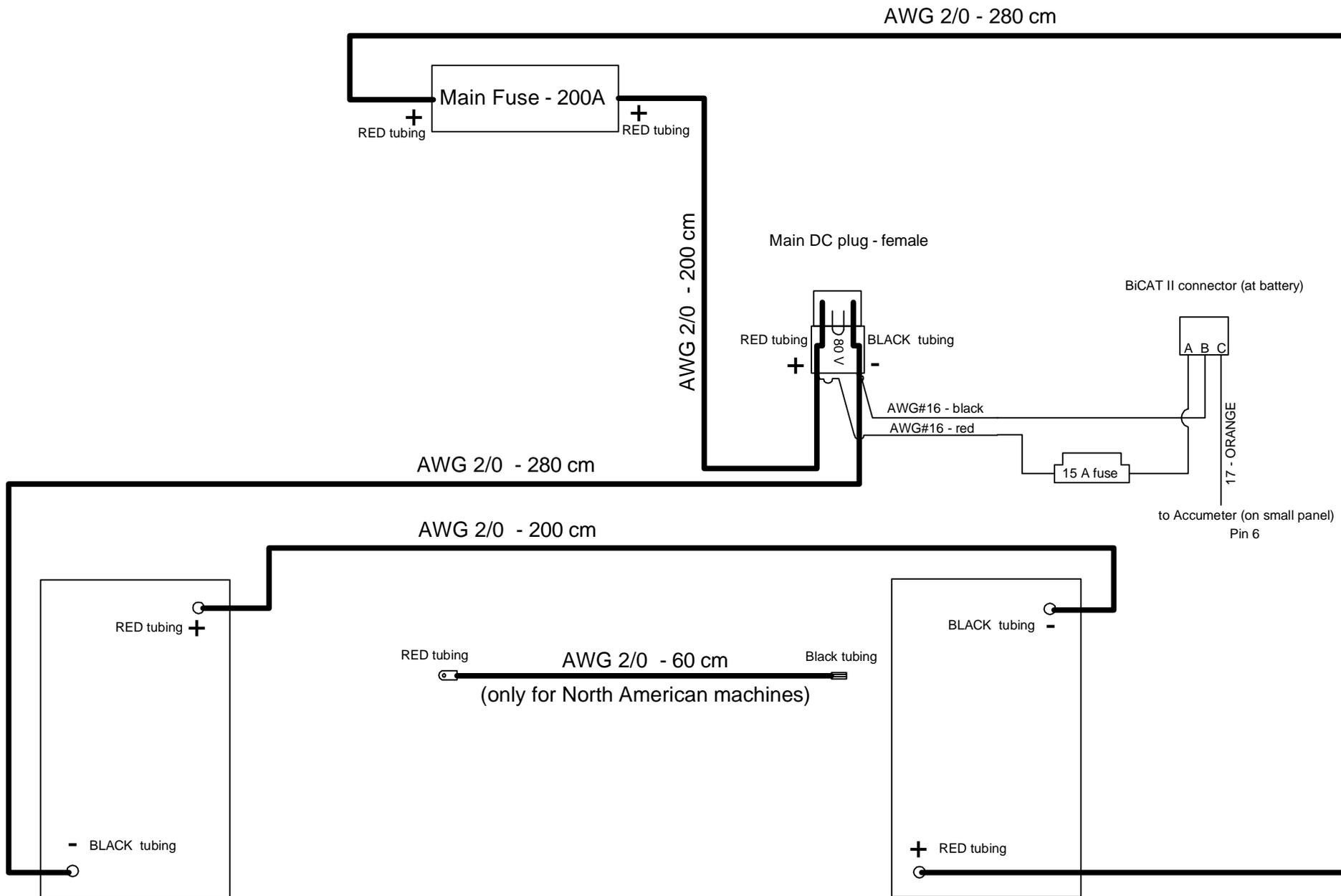
- X17-1
- X17-2

Omron MY4-24V

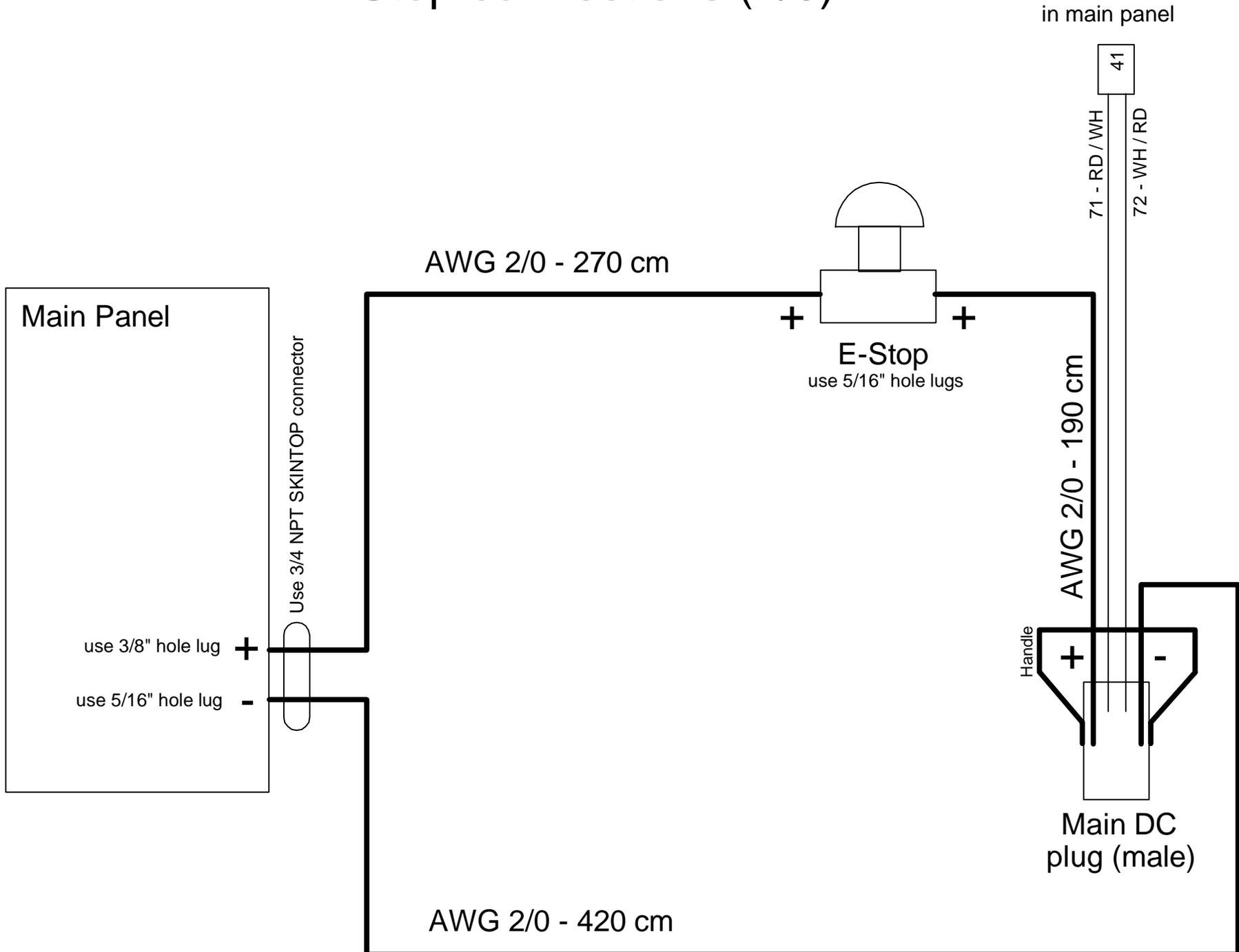
D36
1N4007

DMC GmbH Herten Germany		
www.dmcde.de		
Title Olympia Canada Panel Wiring Valves		
Size A3	Document Number 41900_157a	Rev 1.00
Date: Thursday, September 02, 2010	Sheet 1	of 1

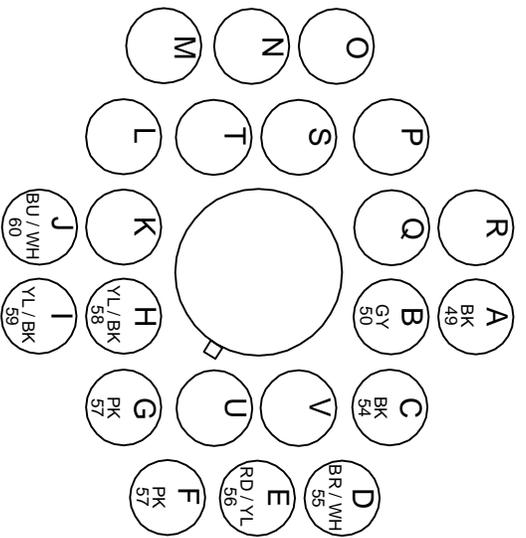
Battery connections (2/0)



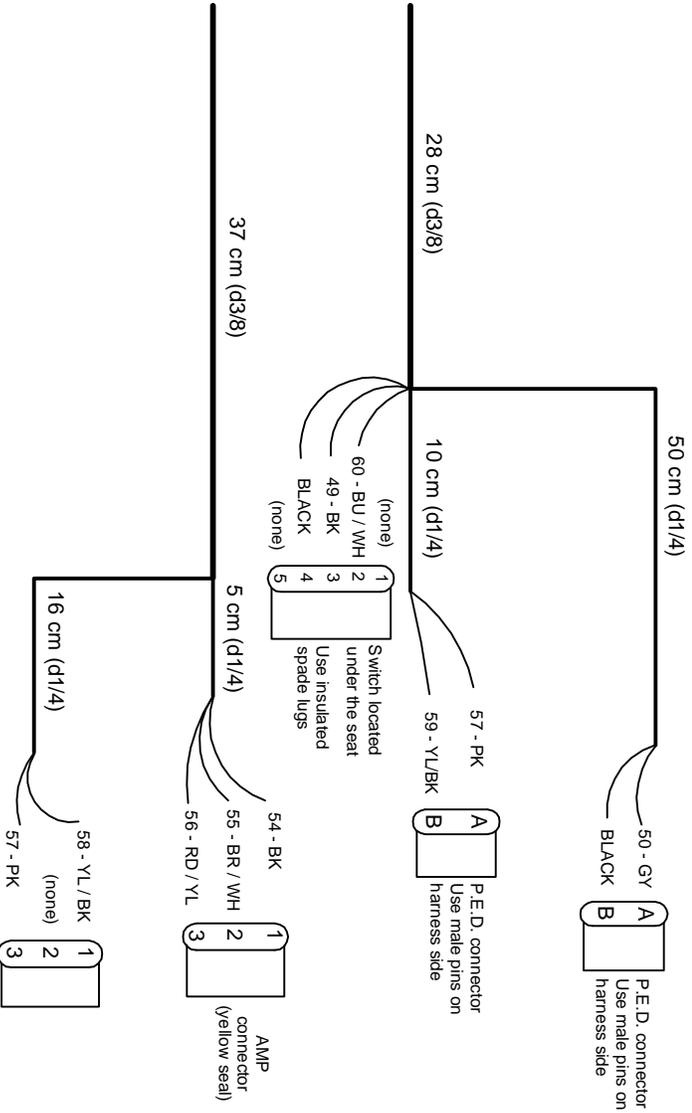
E-Stop connections (2/0)

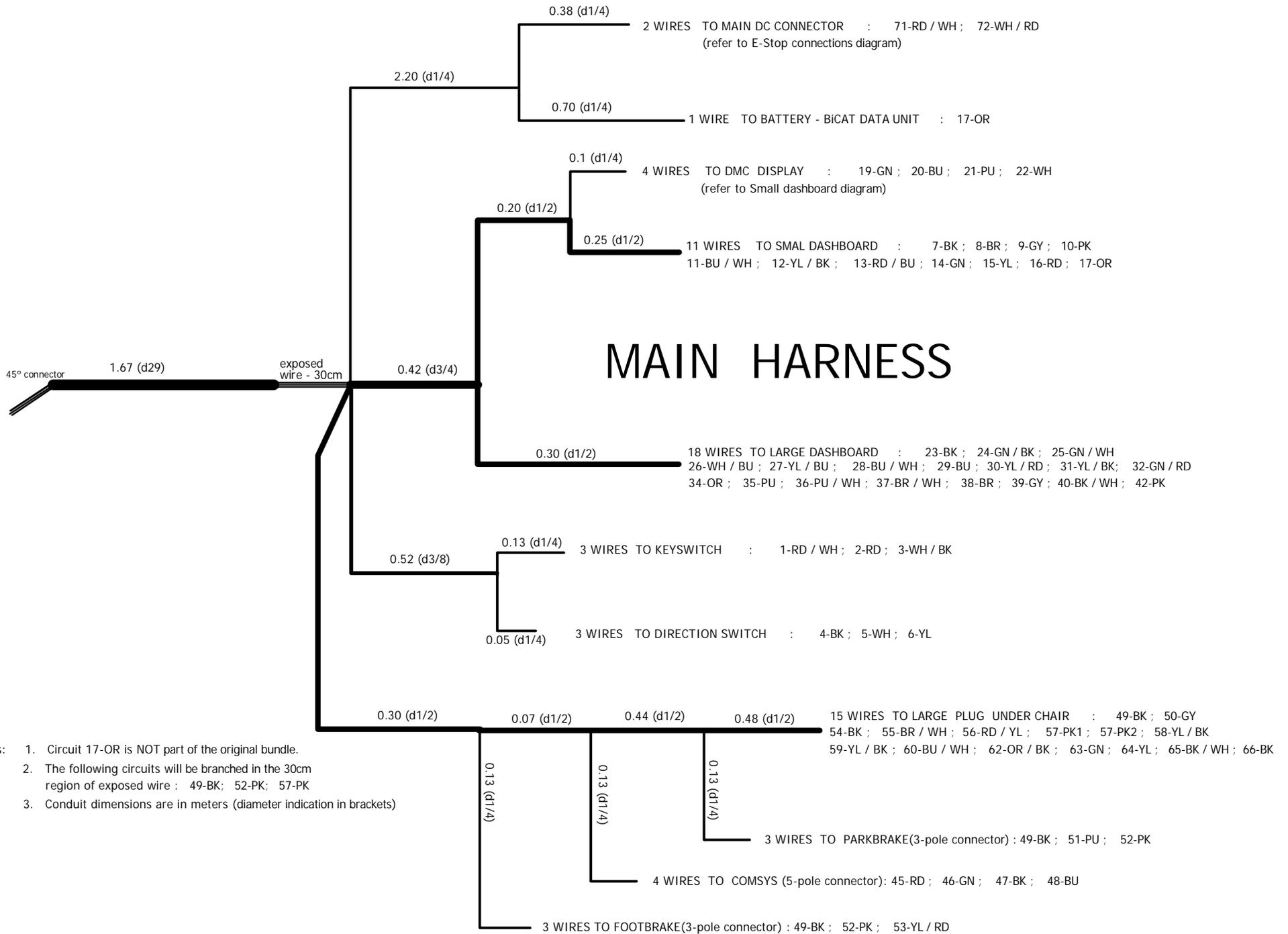


Large connector inside seat (Connects to Main Harness)



Large connector inside seat (Connects to Main Harness)

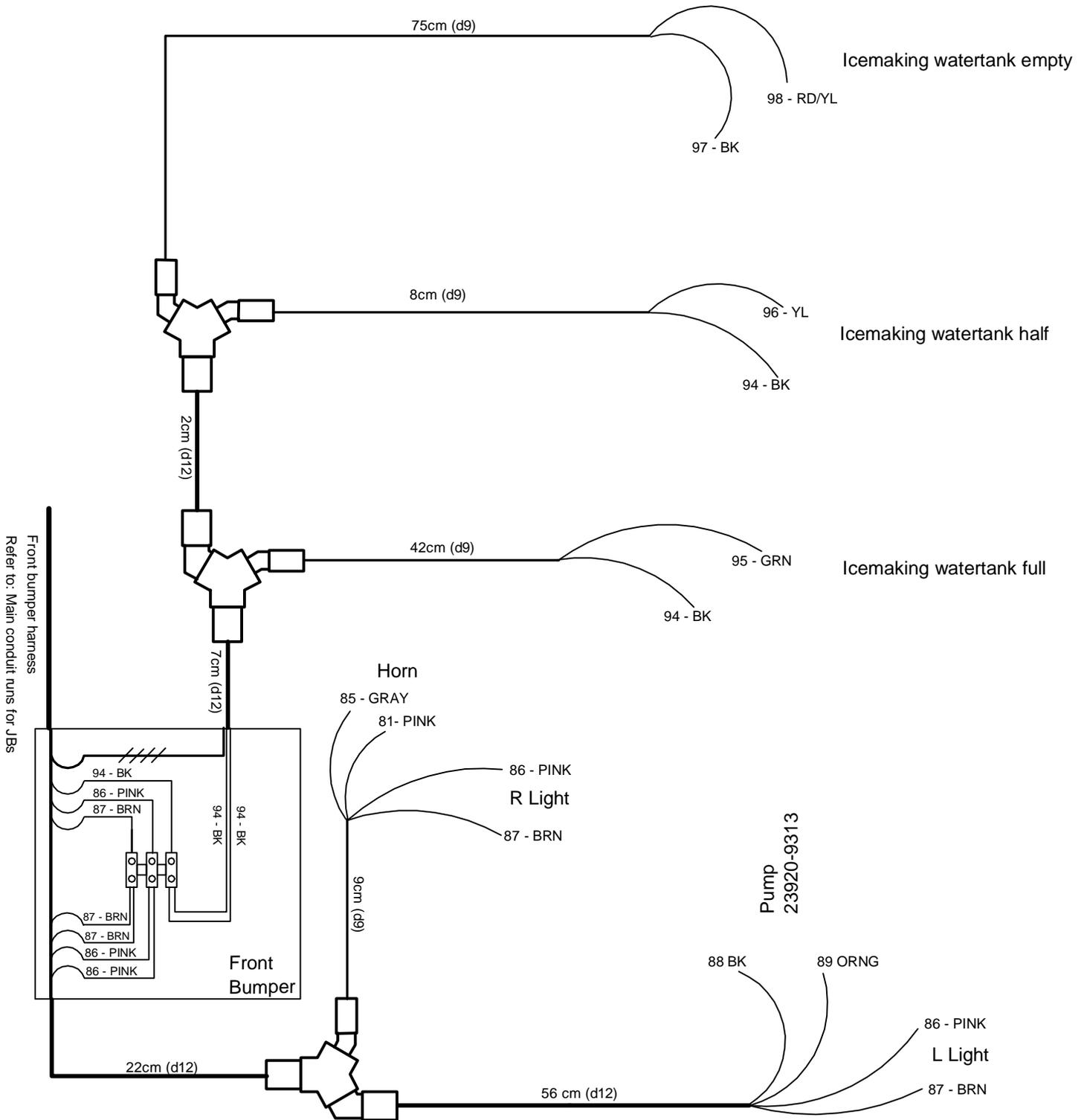




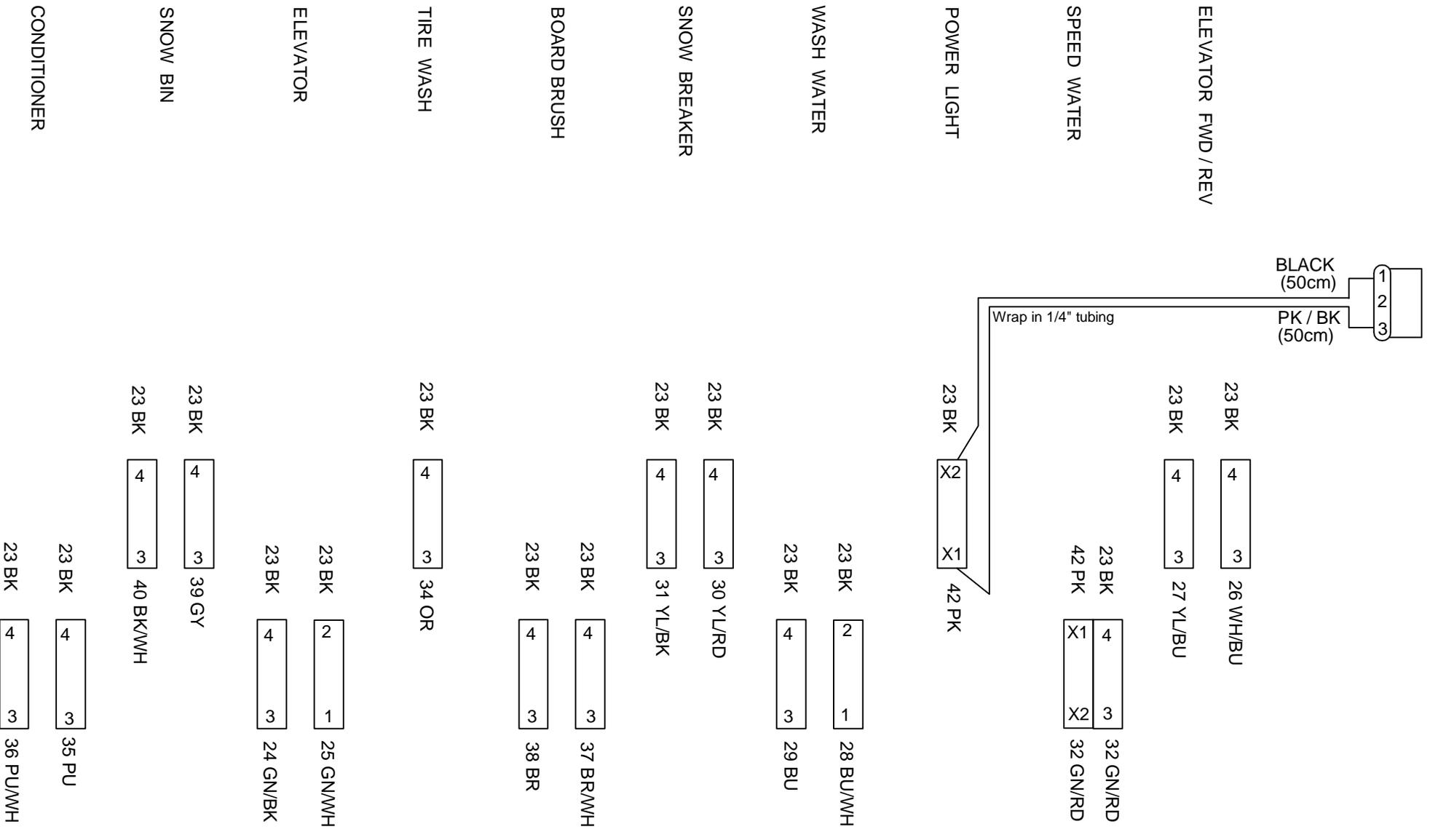
- Notes:
1. Circuit 17-OR is NOT part of the original bundle.
 2. The following circuits will be branched in the 30cm region of exposed wire : 49-BK ; 52-PK ; 57-PK
 3. Conduit dimensions are in meters (diameter indication in brackets)

Conduit runs from Front bumper JB

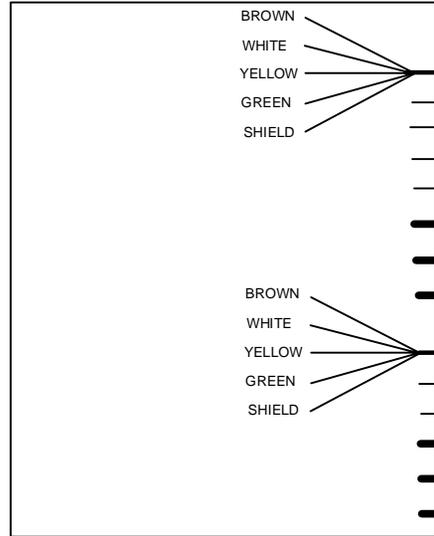
Use male pins on harness side where applicable



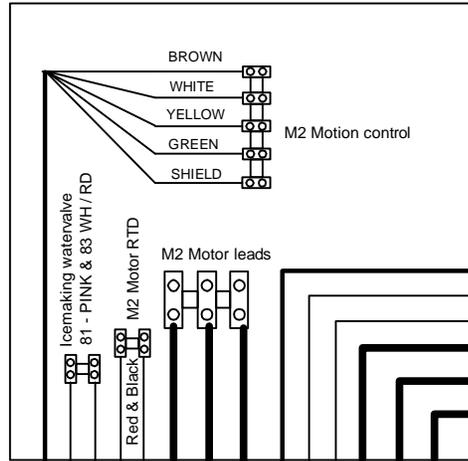
LARGE DASHBOARD



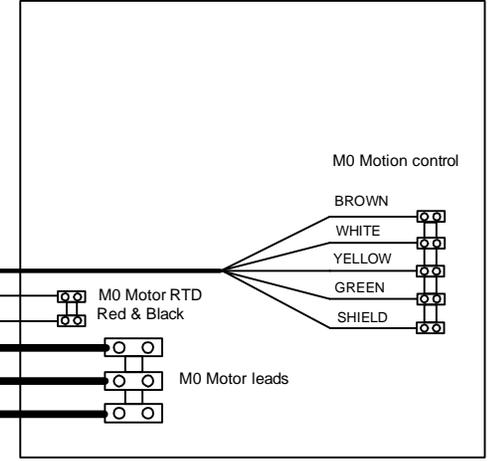
Main Panel



M2



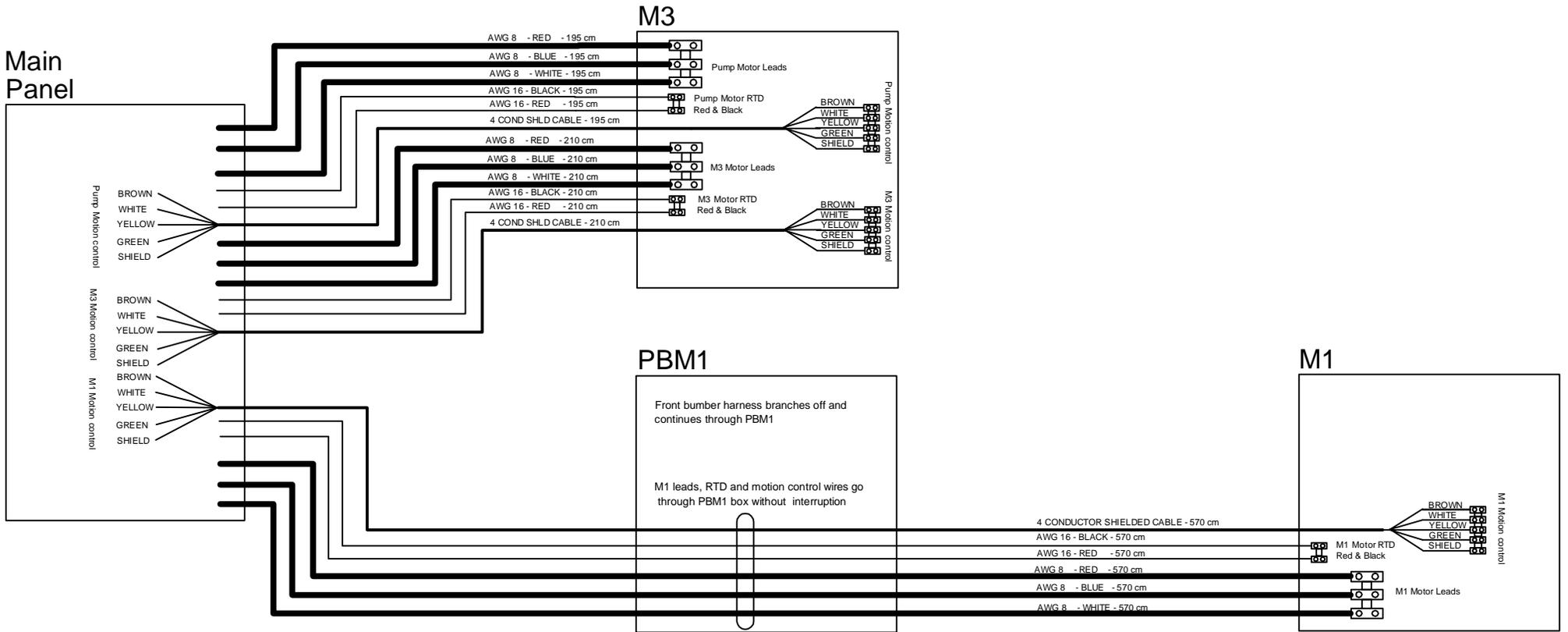
M0



M0 & M2 motor leads

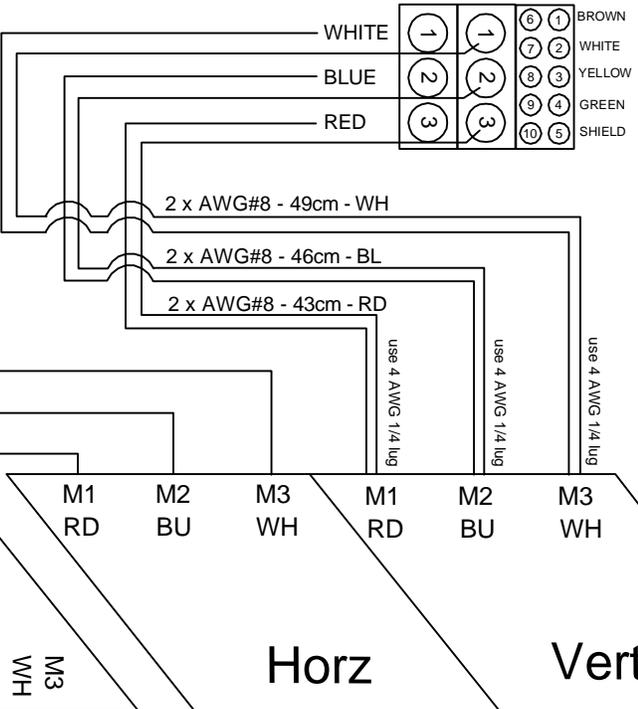


M1, M3 & Pump motor leads



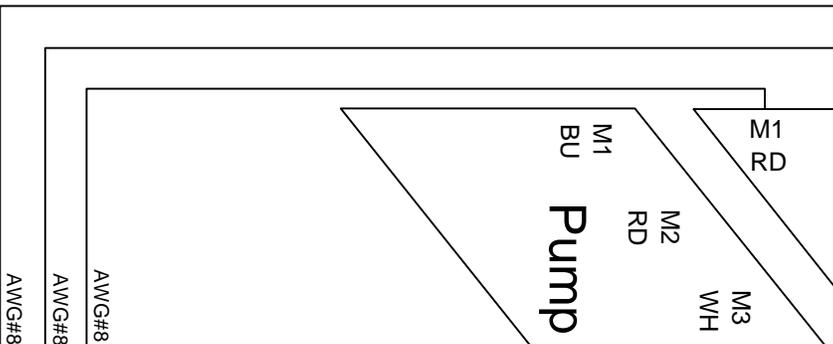
Side panel motor connector

4 Cond. cable shielded
use female connectors on panel side
58 cm



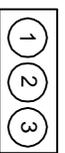
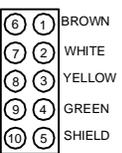
MOTOR CONNECTIONS

M1 RD	M2 BU	M3 WH	M1 BU	M2 RD	M3 WH
M-0			M-1		
M-2			M-3		
M3 WH	M2 BU	M1 RD	M3 WH	M2 RD	M1 BU

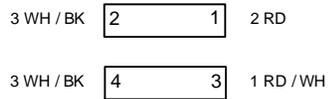


Bottom panel motor connector

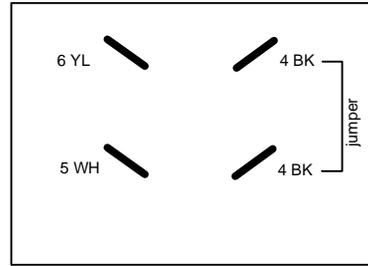
4 Cond. cable shielded
use female connectors on panel side
105 cm



Keyswitch

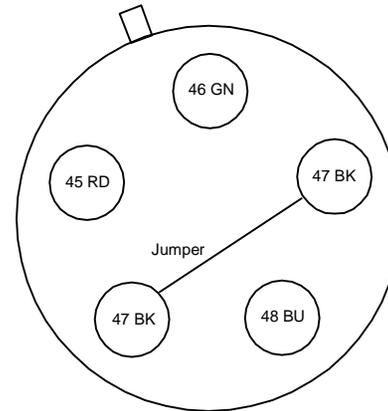


Direction switch



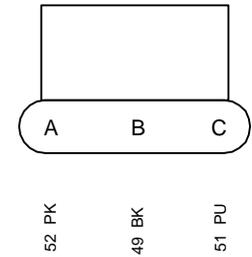
COMSYS

(Part of Main Harness - male pins)

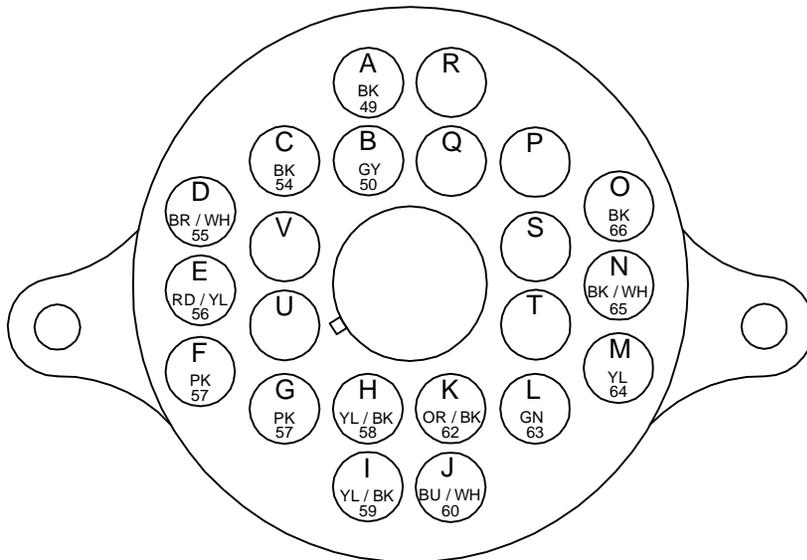


Parkbrake

(Part of Main Harness - male pins)

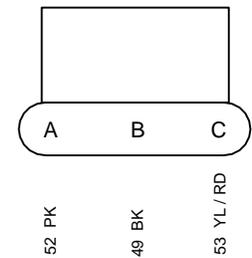


Large connector under seat (Part of Main Harness - gasketed side w. female pins)



Footbrake

(Part of Main Harness - male pins)



SMALL DASHBOARD

