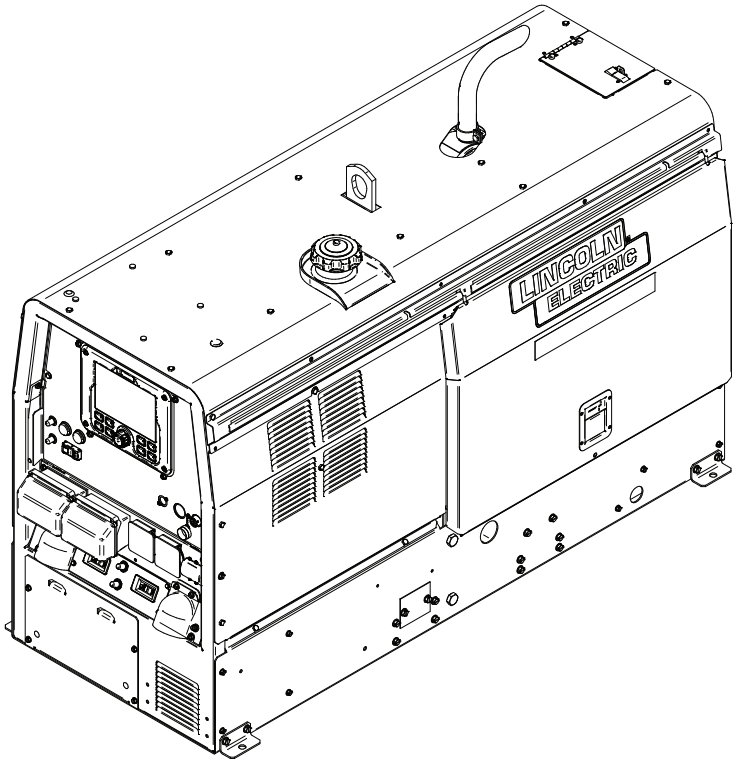
Service Manual

Frontier™ 400X/Frontier™ 400X Pipe



For use with machines having Code Numbers:

12716, 13202

GENUINE™ LINCOLN PARTS

Register your machine:
www.lincolnelectric.com/register

Authorized Service and Distributor Locator:
www.lincolnelectric.com/locator

Save for future reference

Date Purchased

Code: (ex: 10859)

Serial: (ex: U1060512345)

Need Help? Call 1.888.935.3877
to talk to a Service Representative

Hours of Operation:
8:00 AM to 6:00 PM (ET) Mon. thru Fri.

After hours?
Use "Ask the Experts" at lincolnelectric.com
A Lincoln Service Representative will contact you no later than the following business day.

For Service outside the USA:
Email: globalservice@lincolnelectric.com

SVM10605 | DRAFT date Jan-22

THE LINCOLN ELECTRIC COMPANY
22801 St. Clair Avenue • Cleveland, OH • 44117-1199 • U.S.A.
Phone: +1.216.481.8100 • www.lincolnelectric.com

THANK YOU FOR SELECTING A QUALITY PRODUCT BY LINCOLN ELECTRIC.

PLEASE EXAMINE CARTON AND EQUIPMENT FOR DAMAGE IMMEDIATELY

When this equipment is shipped, title passes to the purchaser upon receipt by the carrier. Consequently, claims for material damaged in shipment must be made by the purchaser against the transportation company at the time the shipment is received.

SAFETY DEPENDS ON YOU

Lincoln arc welding and cutting equipment is designed and built with safety in mind. However, your overall safety can be increased by proper installation ... and thoughtful operation on your part. **DO NOT INSTALL, OPERATE OR REPAIR THIS EQUIPMENT WITHOUT READING THIS MANUAL AND THE SAFETY PRECAUTIONS CONTAINED THROUGHOUT.** And, most importantly, think before you act and be careful.

⚠ WARNING

This statement appears where the information must be followed exactly to avoid serious personal injury or loss of life.

⚠ CAUTION

This statement appears where the information must be followed to avoid minor personal injury or damage to this equipment.

KEEP YOUR HEAD OUT OF THE FUMES.

DON'T get too close to the arc. Use corrective lenses if necessary to stay a reasonable distance away from the arc.

READ and obey the Safety Data Sheet (SDS) and the warning label that appears on all containers of welding materials.

USE ENOUGH VENTILATION or exhaust at the arc, or both, to keep the fumes and gases from your breathing zone and the general area.

IN A LARGE ROOM OR OUTDOORS, natural ventilation may be adequate if you keep your head out of the fumes (See below).

USE NATURAL DRAFTS or fans to keep the fumes away from your face.

If you develop unusual symptoms, see your supervisor. Perhaps the welding atmosphere and ventilation system should be checked.

WEAR CORRECT EYE, EAR & BODY PROTECTION

PROTECT your eyes and face with welding helmet properly fitted and with proper grade of filter plate (See ANSI Z49.1).

PROTECT your body from welding spatter and arc flash with protective clothing including woolen clothing, flame-proof apron and gloves, leather leggings, and high boots.

PROTECT others from splatter, flash, and glare with protective screens or barriers.

IN SOME AREAS, protection from noise may be appropriate.

BE SURE protective equipment is in good condition.

Also, wear safety glasses in work area **AT ALL TIMES.**

SPECIAL SITUATIONS

DO NOT WELD OR CUT containers or materials which previously had been in contact with hazardous substances unless they are properly cleaned. This is extremely dangerous.

DO NOT WELD OR CUT painted or plated parts unless special precautions with ventilation have been taken. They can release highly toxic fumes or gases.

Additional precautionary measures

PROTECT compressed gas cylinders from excessive heat, mechanical shocks, and arcs; fasten cylinders so they cannot fall.

BE SURE cylinders are never grounded or part of an electrical circuit.

REMOVE all potential fire hazards from welding area.

ALWAYS HAVE FIRE FIGHTING EQUIPMENT READY FOR IMMEDIATE USE AND KNOW HOW TO USE IT.

SECTION A: WARNINGS

CALIFORNIA PROPOSITION 65 WARNINGS

WARNING: Breathing diesel engine exhaust exposes you to chemicals known to the State of California to cause cancer and birth defects, or other reproductive harm.

- Always start and operate the engine in a well-ventilated area.
- If in an exposed area, vent the exhaust to the outside.
- Do not modify or tamper with the exhaust system.
- Do not idle the engine except as necessary.

For more information go to www.P65 warnings.ca.gov/diesel

WARNING: This product, when used for welding or cutting, produces fumes or gases which contain chemicals known to the State of California to cause birth defects and, in some cases, cancer. (California Health & Safety Code § 25249.5 *et seq.)*

WARNING: Cancer and Reproductive Harm www.P65warnings.ca.gov

ARC WELDING CAN BE HAZARDOUS. PROTECT YOURSELF AND OTHERS FROM POSSIBLE SERIOUS INJURY OR DEATH. KEEP CHILDREN AWAY. PACEMAKER WEARERS SHOULD CONSULT WITH THEIR DOCTOR BEFORE OPERATING.

Read and understand the following safety highlights. For additional safety information, it is strongly recommended that you purchase a copy of "Safety in Welding & Cutting - ANSI Standard Z49.1" from the American Welding Society, P.O. Box 351040, Miami, Florida 33135 or CSA Standard W117.2. A Free copy of "Arc Welding Safety" booklet E205 is available from the Lincoln Electric Company, 22801 St. Clair Avenue, Cleveland, Ohio 44117-1199.

BE SURE THAT ALL INSTALLATION, OPERATION, MAINTENANCE AND REPAIR PROCEDURES ARE PERFORMED ONLY BY QUALIFIED INDIVIDUALS.

FOR ENGINE POWERED EQUIPMENT.

1.a. Turn the engine off before troubleshooting and maintenance work unless the maintenance work requires it to be running.

1.b. Operate engines in open, well-ventilated areas or vent the engine exhaust fumes outdoors.

1.c. Do not add the fuel near an open flame welding arc or when the engine is running. Stop the engine and allow it to cool before refueling to prevent spilled fuel from vaporizing on contact with hot engine parts and igniting. Do not spill fuel when filling tank. If fuel is spilled, wipe it up and do not start engine until fumes have been eliminated.

1.d. Keep all equipment safety guards, covers and devices in position and in good repair. Keep hands, hair, clothing and tools away from V-belts, gears, fans and all other moving parts when starting, operating or repairing equipment.

1.e. In some cases it may be necessary to remove safety guards to perform required maintenance. Remove guards only when necessary and replace them when the maintenance requiring their removal is complete. Always use the greatest care when working near moving parts.

1.f. Do not put your hands near the engine fan. Do not attempt to override the governor or idler by pushing on the throttle control rods while the engine is running.

1.g. To prevent accidentally starting gasoline engines while turning the engine or welding generator during maintenance work, disconnect the spark plug wires, distributor cap or magneto wire as appropriate.

1.h. To avoid scalding, do not remove the radiator pressure cap when the engine is hot.

1.i. Using a generator indoors CAN KILL YOU IN MINUTES.

1.j. Generator exhaust contains carbon monoxide. This is a poison you cannot see or smell.

1.k. NEVER use inside a home or garage, EVEN IF doors and windows are open.

1.l. Only use OUTSIDE and far away from windows, doors and vents.

1.m. Avoid other generator hazards. READ MANUAL BEFORE USE.

ELECTRIC AND MAGNETIC FIELDS MAY BE DANGEROUS

2.a. Electric current flowing through any conductor causes localized Electric and Magnetic Fields (EMF). Welding current creates EMF fields around welding cables and welding machines

2.b. EMF fields may interfere with some pacemakers, and welders having a pacemaker should consult their physician before welding.

2.c. Exposure to EMF fields in welding may have other health effects which are now not known.

2.d. All welders should use the following procedures in order to minimize exposure to EMF fields from the welding circuit:

2.d.1. Route the electrode and work cables together - Secure them with tape when possible.

2.d.2. Never coil the electrode lead around your body.

2.d.3. Do not place your body between the electrode and work cables. If the electrode cable is on your right side, the work cable should also be on your right side.

2.d.4. Connect the work cable to the workpiece as close as possible to the area being welded.

2.d.5. Do not work next to welding power source.

ELECTRIC SHOCK CAN KILL.

3.a. The electrode and work (or ground) circuits are electrically “hot” when the welder is on. Do not touch these “hot” parts with your bare skin or wet clothing. Wear dry, hole-free gloves to insulate hands.

3.b. Insulate yourself from work and ground using dry insulation. Make certain the insulation is large enough to cover your full area of physical contact with work and ground.

In addition to the normal safety precautions, if welding must be performed under electrically hazardous conditions (in damp locations or while wearing wet clothing; on metal structures such as floors, gratings or scaffolds; when in cramped positions such as sitting, kneeling or lying, if there is a high risk of unavoidable or accidental contact with the workpiece or ground) use the following equipment:

- Semiautomatic DC Constant Voltage (Wire) Welder.
- DC Manual (Stick) Welder.
- AC Welder with Reduced Voltage Control.

3.c. In semiautomatic or automatic wire welding, the electrode, electrode reel, welding head, nozzle or semiautomatic welding gun are also electrically “hot”.

3.d. Always be sure the work cable makes a good electrical connection with the metal being welded. The connection should be as close as possible to the area being welded.

3.e. Ground the work or metal to be welded to a good electrical (earth) ground.

3.f. Maintain the electrode holder, work clamp, welding cable and welding machine in good, safe operating condition. Replace damaged insulation.

3.g. Never dip the electrode in water for cooling.

3.h. Never simultaneously touch electrically “hot” parts of electrode holders connected to two welders because voltage between the two can be the total of the open circuit voltage of both welders.

3.i. When working above floor level, use a safety belt to protect yourself from a fall should you get a shock.

3.j. Also see Items 6.c. and 8.

ARC RAYS CAN BURN.

4.a. Use a shield with the proper filter and cover plates to protect your eyes from sparks and the rays of the arc when welding or observing open arc welding. Headshield and filter lens should conform to ANSI Z87. I standards.

4.b. Use suitable clothing made from durable flame-resistant material to protect your skin and that of your helpers from the arc rays.

4.c. Protect other nearby personnel with suitable, non-flammable screening and/or warn them not to watch the arc nor expose themselves to the arc rays or to hot spatter or metal.

FUMES AND GASES CAN BE DANGEROUS.

5.a. Welding may produce fumes and gases hazardous to health. Avoid breathing these fumes and gases. When welding, keep your head out of the fume. Use enough ventilation and/or exhaust at the arc to keep fumes and gases away from the breathing zone. **When welding hardfacing (see instructions on container or SDS) or on lead or cadmium plated steel and other metals or coatings which produce highly toxic fumes, keep exposure as low as possible and within applicable OSHA PEL and ACGIH TLV limits using local exhaust or mechanical ventilation unless exposure assessments indicate otherwise. In confined spaces or in some circumstances, outdoors, a respirator may also be required. Additional precautions are also required when welding on galvanized steel.**

5. b. The operation of welding fume control equipment is affected by various factors including proper use and positioning of the equipment, maintenance of the equipment and the specific welding procedure and application involved. Worker exposure level should be checked upon installation and periodically thereafter to be certain it is within applicable OSHA PEL and ACGIH TLV limits.

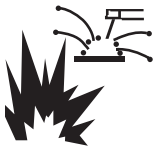
5.c. Do not weld in locations near chlorinated hydrocarbon vapors coming from degreasing, cleaning or spraying operations. The heat and rays of the arc can react with solvent vapors to form phosgene, a highly toxic gas, and other irritating products.

5.d. Shielding gases used for arc welding can displace air and cause injury or death. Always use enough ventilation, especially in confined areas, to insure breathing air is safe.

5.e. Read and understand the manufacturer’s instructions for this equipment and the consumables to be used, including the Safety Data Sheet (SDS) and follow your employer’s safety practices. SDS forms are available from your welding distributor or from the manufacturer.

5.f. Also see item 1.b.

WELDING AND CUTTING SPARKS CAN CAUSE FIRE OR EXPLOSION.



6.a. Remove fire hazards from the welding area. If this is not possible, cover them to prevent the welding sparks from starting a fire. Remember that welding sparks and hot materials from welding can easily go through small cracks and openings to adjacent areas. Avoid welding near hydraulic lines. Have a fire extinguisher readily available.

6.b. Where compressed gases are to be used at the job site, special precautions should be used to prevent hazardous situations. Refer to "Safety in Welding and Cutting" (ANSI Standard Z49.1) and the operating information for the equipment being used.

6.c. When not welding, make certain no part of the electrode circuit is touching the work or ground. Accidental contact can cause overheating and create a fire hazard.

6.d. Do not heat, cut or weld tanks, drums or containers until the proper steps have been taken to insure that such procedures will not cause flammable or toxic vapors from substances inside. They can cause an explosion even though they have been "cleaned". For information, purchase "Recommended Safe Practices for the Preparation for Welding and Cutting of Containers and Piping That Have Held Hazardous Substances", AWS F4.1 from the American Welding Society (see address above).

6.e. Vent hollow castings or containers before heating, cutting or welding. They may explode.

6.f. Sparks and spatter are thrown from the welding arc. Wear oil free protective garments such as leather gloves, heavy shirt, cuffless trousers, high shoes and a cap over your hair. Wear ear plugs when welding out of position or in confined places. Always wear safety glasses with side shields when in a welding area.

6.g. Connect the work cable to the work as close to the welding area as practical. Work cables connected to the building framework or other locations away from the welding area increase the possibility of the welding current passing through lifting chains, crane cables or other alternate circuits. This can create fire hazards or overheat lifting chains or cables until they fail.

6.h. Also see item 1.c.

6.I. Read and follow NFPA 51B "Standard for Fire Prevention During Welding, Cutting and Other Hot Work", available from NFPA, 1 Batterymarch Park, PO box 9101, Quincy, MA 022690-9101.

6.j. Do not use a welding power source for pipe thawing.

CYLINDER MAY EXPLODE IF DAMAGED.

7.a. Use only compressed gas cylinders containing the correct shielding gas for the process used and properly operating regulators designed for the gas and pressure used. All hoses, fittings, etc. should be suitable for the application and maintained in good condition.

7.b. Always keep cylinders in an upright position securely chained to an undercarriage or fixed support.

7.c. Cylinders should be located:

- Away from areas where they may be struck or subjected to physical damage.
- A safe distance from arc welding or cutting operations and any other source of heat, sparks, or flame.

7.d. Never allow the electrode, electrode holder or any other electrically "hot" parts to touch a cylinder.

7.e. Keep your head and face away from the cylinder valve outlet when opening the cylinder valve.

7.f. Valve protection caps should always be in place and hand tight except when the cylinder is in use or connected for use.

7.g. Read and follow the instructions on compressed gas cylinders, associated equipment, and CGA publication P-I, "Precautions for Safe Handling of Compressed Gases in Cylinders," available from the Compressed Gas Association, 14501 George Carter Way Chantilly, VA 20151.

FOR ELECTRICALLY POWERED EQUIPMENT.

8.a. Turn off input power using the disconnect switch at the fuse box before working on the equipment.

8.b. Install equipment in accordance with the U.S. National Electrical Code, all local codes and the manufacturer's recommendations.

8.c. Ground the equipment in accordance with the U.S. National Electrical Code and the manufacturer's recommendations.

Refer to http://www.lincolnelectric.com/safety for additional safety information.

CONTENT/DETAILS MAY BE CHANGED OR UPDATED WITHOUT NOTICE. FOR MOST CURRENT INSTRUCTION MANUALS, GO TO PARTS.LINCOLNELECTRIC.COM.

GRAPHIC SYMBOLS

The following graphics appear on the Frontier or in the manual.


Warning or Caution


Instructions


Fumes and Gases


Explosion


Arc Rays


Moving Parts


Falling Equipment


Electric Shock

U0 Open Circuit Voltage

I2 Output Current

U2 Output Voltage

X Duty Cycle

U_r Reduced Open Circuit Voltage


Home


Remote

? Help


Back


Oil / Oil Pressure


Air Filter


Water Separator


Fuel Filter


Engine Coolant


Belt Drive


Battery


Hot Surface


Fire or Explosion


Battery Explosion


Battery Acid


Engine Temperature

\+ Positive Output

− Negative Output


SMAW Welding


FCAW-S Welding


GMAW / FCAW-G Welding


GTAW welding


Carbon Arc Gouging


APEX® System


Engine


Set-up


Hot Start


Arc Force

+/− Weld Terminal


Memory Setup


Frequency


Remote Accessory Type


Pinch


Protective Ground


Circuit Breaker

A Welding Amperage

V Welding Voltage


Wire Feeder

3 phase alternator

Direct Current

Auto Idle

High Idle

Fuel

CrossLinc

Phase

Welder Output

Voltage Output

Amperage Output

GRAPHIC SYMBOLS

The following graphics appear on the Frontier or in the manual.

 Stop

 Start

 Glow Plug

 Receptacle

 Electrode Type

 Diameter

 Material Thickness

 Productivity Metrics

 Arc Hours

 Auxiliary Hours

 Utilization Rate

 Standby Hours

 Fuel Savings

GENERAL DESCRIPTION

The Frontier® 400X is a diesel engine driven welding power source. The machine features DC multi-process welding plus 120/240 VAC single-phase and 240 VAC three-phase auxiliary power. The welding control system uses state of the art Chopper Technology® for superior welding performance. The machine utilizes a robust 7" graphical user interface display for simpled controls and advanced features.

The machine has been equipped with Crosslinc® Technology to provide weld cable communication for voltage control at the arc without the need for a control cable.

TECHNICAL SPECIFICATIONS

INPUT - DIESEL ENGINE	
Make /Model	**Description**
FRONTIER 400X (K3484-1, K3485-1) Perkins® 403F-15T EPA Tier 4 Final Compliant	3 Cylinder, 24.7 HP (18.4 kW) Turbocharged Water Cooled Diesel Engine
Speed (RPM)	**Displacement**
High Idle 1800 Low Idle 1440 Full Load 1800	91.0 cu. in. (1.5L) Bore / Stroke 3.30" x 3.50" 84mm x 90mm
Starting System	**Capacities**
12 VDC Battery and Starter	Fuel: 20 US gal. (75.7L) Oil: 6.40 US qts (6.0L) Radiator Coolant: 7.20 qts. (6.8L)
Battery Size	
BCI Group Size 34 650 Cold Crank Amps	

RATED WELDING OUTPUT @ 104°F(40°C)		
Duty Cycle	**Welding Output**	**Voltage**
100%	325 Amps (DC multi-purpose)	33 Volts
60%	400 Amps (DC multi-purpose)	26 Volts

OUTPUT @104°F (40°C) - WELDER AND GENERATOR	
WELDING MODE	**OUTPUT RANGE**
Stick (SMAW)	30-400 Amps
Flux-Cored Self-Shielded (FCAW-S)	10 to 45 Volts
MIG (GMAW)	10 to 45 Volts
Flux-Cored Gas-Shielded (FCAW-G)	10 to 45 Volts
Arc Gouging (CAC-A)	60-400 Amps
DC TIG (GTAW)	5-400 Amps
Pipe (SMAW)** **Only available on Frontier 400X Pipe model	30-400 Amps
Open Circuit Voltage 60 VDC Avg @1800 RPM 71 VDC Peak @1800 RPM	
Auxiliary Power(1) 120 V / 240 V, 60 Hz 10,000 Watts Continuous / 11,500 Watts Peak, Single Phase 11,000 Watts Continuous / 12,500 Watts Peak, Three Phase	

RECEPTACLES		
Receptacle	QTY	Circuit Breaker
120 VAC Duplex (5-20R) GFCI Protected	2	20 Amps
240 VAC Three Phase (15-50R)	1	50 Amps
120/240 VAC Single Phase (14-50R)	1	50 Amps

AGENCY APPROVALS & STANDARDS	
CONFORMITY MARK	CSA
INGRESS PROTECTION RATING	IP23
IEC STANDARD	60974-1

ENGINE DETAILS	
LUBRICATION	**EPA EMISSION**
Full Pressure with Full Flow Filter	Tier 4 Final Compliant
FUEL SYSTEM	**GOVERNOR**
Mechanical Fuel Pump, Auto Air Bleed System	Mechanical
Electric Shutoff Solenoid, Indirect Fuel Injector	Electric
AIR CLEANER	**ENGINE IDLER**
Single Element	Automatic Idler
MUFFLER	**ENGINE PROTECTION**
Low Noise Muffler with Rotating Exhaust Tube and Internal USFS Certified Spark Arrestor	Shutdown on low oil pressure & high engine coolant temperature
ENGINE WARRANTY:	2 Year - Complete (Parts and Labor) 3 Year - Major Components (Parts and Labor)

PHYSICAL DIMENSIONS	
Height(2)	35.94 in. (913 mm)
Width(3)	25.30 in. (643 mm)
Depth	60.00 in. (1524 mm)
Weight(4)	1035 lbs. (469 kg)

(1) Output rating in watts is equivalent to volt-amperes at unity power factor. Output voltage is within +/- 10% at all loads up to rated capacity. When welding, available auxiliary power will be reduced.

(2) Top of Enclosure. Add 7.9" (200 mm) for exhaust.

(3) Includes Door. Base is 24.0" (610 mm) wide.

(4) Approximate weight less fuel.

INSTALLATION

SAFETY PRECAUTIONS

⚠ WARNING

Do not attempt to use this equipment until you have thoroughly read all operating and maintenance manuals supplied with your machine. They include important safety precautions, detailed engine starting, operating and maintenance instructions and parts lists.

ELECTRIC SHOCK can kill.

- **Do not touch electrically live parts such as output terminals or internal wiring.**
- **Insulate yourself from the work and ground.**
- **Always wear dry insulating gloves.**

ENGINE EXHAUST can kill.

- **Use in open, well ventilated areas or vent exhaust outside**

MOVING PARTS can injure.

- **Do not operate with doors open or guards off.**
- **Stop engine before servicing.**
- **Keep away from moving parts**

Only qualified personnel should install, use or service this equipment.

VRD (VOLTAGE REDUCTION DEVICE)

The VRD reduces the OCV (Open Circuit Voltage) at the welding output terminals while not welding to less than 30 VDC when the resistance of the output circuit is above 200Ω (ohms).

The VRD requires that the welding cable connections be kept in good electrical condition because poor connections will contribute to poor starting. Having good electrical connections also limits the possibility of other safety issues such as heat-generated damage, burns and fires.

This machine has two VRD switches to allow VRD to be switched “ON” or “OFF” in CC modes, CV modes, or both. The machine is shipped with both VRD switches in the “OFF” position.

To utilize the CrossLinc feature on this product, the VRD needs to be switched “OFF” for the given output type.

To turn VRD “ON” or “OFF”:

- Turn the engine “OFF”
- Disconnect the negative battery cable
- Lower the front panel by removing 4 mounting screws (See Figure A.1)
- Place the VRD switches in the "ON" of "OFF" position (See Figure A.2).

  NOTE: Use the "CC" switch to enable/disable VRD in CC modes or the "CV" switch to enable/disable VRD in CV modes

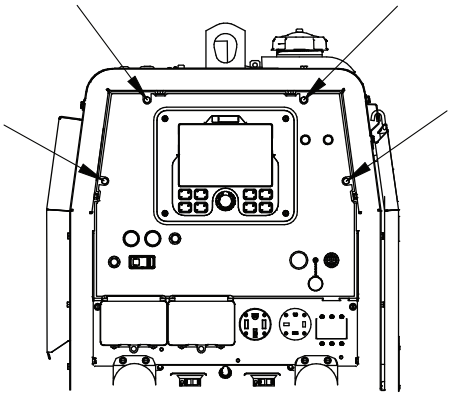


Figure A.1

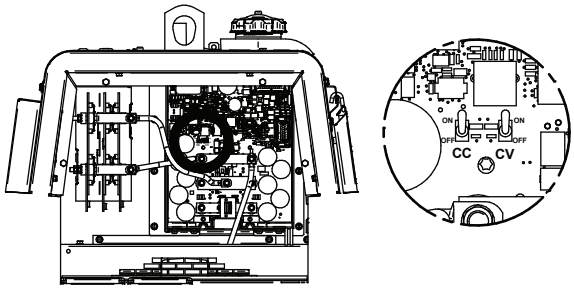


Figure A.2

Note: If VRD is ON, an indicator on the user interface will be active

LOCATION AND VENTILATION

The welder should be located to provide an unrestricted flow of clean, cool air to the cooling air inlets and to avoid restricting the cooling air outlets. Also, locate the welder so that the engine exhaust fumes are properly vented to an outside area.

⚠ WARNING

Air to cool the engine is drawn in the front and side and exhausted through radiator and case back. It is important that the intake and exhaust air is not restricted. Allow a minimum clearance of 1ft. (0.6m) from the case back and 16 in. (406mm) from either side of the base to a vertical surface. (Failure to resolve these guidelines may result in an overtemp condition resulting in engine shut down).

⚠ WARNING

DO NOT MOUNT OVER COMBUSTIBLE SURFACES

Where there is a combustible surface directly under stationary or fixed electrical equipment, that surface should be covered with a steel plate at least .06”(1.6mm) thick, which should extend not less than 5.90”(150mm) beyond the equipment on all sides.

STORING

1. Store the machine in a cool, dry place when it is not in use. Protect it from dust and dirt. Keep it where it can't be accidentally damaged from construction activities, moving vehicles, and other hazards.
2. Drain the engine oil and refill with fresh oil. Run the engine for about five minutes to circulate oil to all the parts. See the ENGINE OPERATION section manual for details on changing oil.
3. Remove the battery, recharge it, and adjust the electrolyte level. Store the battery in a dry, dark place.

STACKING

Frontier® 400X machines cannot be stacked.

ANGLE OF OPERATION

To achieve optimum engine performance the Frontier® 400X should be run in a level position. The maximum angle of continuous operation is 25° in all directions, 35° intermittent (less than 10 minutes continuous) in all directions. When operating the welder at an angle, provisions must be made for checking and maintaining the oil level at the normal (FULL) oil capacity. Also the effective fuel capacity will be slightly less than the speciÿed 20 gal. (75.7L).

LIFTING

The Frontier® 400X weighs approximately 1174 lbs. (533kg) with a full tank of fuel and 1035 lbs. (469kg) less fuel. A lift bale is mounted to the machine and should always be used when lifting the machine.

⚠ WARNING

FALLING EQUIPMENT can cause injury.

- **Lift only with equipment of adequate lifting capacity.**
- **Be sure machine is stable when lifting.**
- **Do not lift this machine using lift bale if it is equipped with a heavy accessory such as trailer or gas cylinder.**
- **Do not lift machine if lift bale is damaged.**
- **Do not operate machine while suspended from lift bale.**

HIGH ALTITUDE OPERATION

At higher altitudes, output derating may be necessary. For maximum rating, derate the welder output 2% for every 1000 ft. (305 m) above 5000 ft. (1524 m).

Contact a Perkins Service Representative for any engine adjustments that may be required.

HIGH TEMPERATURE OPERATION

At temperatures above 104°F (40°C), output voltage derating may be necessary. For maximum output current ratings, derate welder voltage rating 2 volts for every 21°F (10°C) above 104°F (40°C).

COLD WEATHER STARTING:

With a fully charged battery and OW-40 oil, the engine should start satisfactorily down to -5°F (-20C°). If the engine must be frequently started at or below 0°F (-18°C), it may be desirable to install cold-starting aides. For engines with common rail injection, the mixing of petroleum or kerosene and adding of extra low additives is not permissible. Fuels in accordance with ASTM S975 Grade 1D or DIN EN590-Arctic-Diesel may have no petroleum added. Allow the engine to warm up before applying a load or switching to high idle.

⚠ WARNING

Under no conditions should ether or other starting fluids be used with this engine!

TOWING

Use a recommended trailer for use with this equipment for road, in-plant and yard towing by a vehicle(1). If the user adapts a non-Lincoln trailer, they must assume responsibility that the method of attachment and usage does not result in a safety hazard or damage the welding equipment. Some of the factors to be considered are as follows:

1. Design capacity of trailer vs. weight of Lincoln equipment and likely additional attachments.
2. Proper support of, and attachment to, the base of the welding equipment so there will be no undue stress to the framework.
3. Proper placement of the equipment on the trailer to ensure stability side to side and front to back when being moved and when standing by itself while being operated or serviced.
4. Typical conditions of use, i.e., travel speed; roughness of surface on which the trailer will be operated; environmental conditions; like maintenance.
5. Conformance with federal, state and local laws.(1)

(1) Consult applicable federal, state and local laws regarding specific requirements for use on public highways.

SERVICE TRUCK AND TRAILER INSTALLATION

The welder should be located to provide an unrestricted flow of clean, cool air to the cooling air inlets and to avoid heated air coming out of the welder recirculating back to the cooling air inlet. Also, locate the welder so that engine exhaust fumes are properly vented to an outside area.

⚠ WARNING

- **Improperly mounted concentrated loads may cause unstable vehicle handling and tires or other components to fail.**
- **Only transport this welding equipment on serviceable vehicles which are rated and designed for such loads.**
- **Distribute, balance and secure loads so vehicle is stable under conditions of use.**
- **Do not exceed maximum rated loads for components such as suspension, axles and tires.**
- **Mount equipment base to metal bed or frame of vehicle. Do not mount the welder using rubber mounts.**
- **Follow vehicle manufacturer's instructions.**
- **Do not install equipment where air flow is restricted. Equipment or the engine may overheat.**
- **Do not weld on the base. Welding on the base may cause fuel tank explosion or fire.**
- **Always ground the equipment frame to the vehicle frame to prevent electric shock and static electricity hazards.**
- **Do not place propane or shielding gas tanks near hot air or exhaust.**

PRE-OPERATION ENGINE SERVICE

READ the engine operating and maintenance instructions supplied with this machine.

⚠ WARNING

- **Stop engine and allow to cool before fueling.**
- **Do not smoke when fueling.**
- **Fill fuel tank at a moderate rate and do not overfill.**
- **Wipe up spilled fuel and allow fumes to clear before starting engine.**
- **Keep sparks and flame away from tank.**

OIL

The Frontier™ 400X is shipped with the engine crankcase filled with high quality SAE 10W-30 Oil that meets (API class CJ-4 or better) for diesel engines. Check the oil level before starting the engine. If it is not up to the full mark on the dip stick, add oil as required. The oil change interval is dependent on the quality of the oil and the operating environment. Refer to the Engine Operator's Manual for more details on specific oil recommendations, break-in information, and proper service and maintenance intervals.

FUEL

⚠ WARNING

USE ULTRA-LOW SULFUR DIESEL FUEL IN US AND CANADA

Fill the fuel tank with clean, fresh fuel. The capacity of the tank is 20 gal. (75.7L). When the fuel gauge reads empty the tank contains approximately 2 gal. (7.6L) of reserve fuel.

NOTE: A fuel shut off valve is located just before the pre-filter/sediment filter. Place the valve in the closed position when the welder is not used for extended periods of time.

ENGINE COOLING SYSTEM

⚠ WARNING

HOT COOLANT can burn skin.
Do not remove cap if radiator is hot.

The welder is shipped with the engine and radiator filled with a 50% mixture of ethylene glycol and water. See the MAINTENANCE section and the engine Operator's Manual for more information on coolant.

BATTERY CONNECTION

⚠ CAUTION

Use caution as the electrolyte is a strong acid that can burn skin and damage eyes.

The Frontier® 400X is shipped with the negative battery cable disconnected. Make certain that the RUN/STOP/IDLE switch is in the STOP position. Remove the four screws from the battery tray using a screwdriver or a 3/8"(10mm) socket. Attach the negative battery cable to the negative battery terminal and tighten using a 1/2"(13mm) socket or wrench.

NOTE: This machine is furnished with a wet charged battery; if unused for several months, the battery may require a booster charge. Be careful to charge the battery with the correct polarity. (See Battery in MAINTENANCE section)

⚠ WARNING

GASES FROM BATTERY can explode.

- **Keep sparks, flame and cigarettes away from battery.**

To prevent EXPLOSION when:

- **INSTALLING A NEW BATTERY — disconnect negative cable from old battery first and connect to new battery last.**
- **CONNECTING A BATTERY CHARGER — remove battery from welder by disconnecting negative cable first, then positive cable and battery clamp. When reinstalling, connect negative cable last. Keep well ventilated.**
- **USING A BOOSTER — connect positive lead to battery first then connect negative lead to negative battery lead at engine foot.**

BATTERY ACID can burn eyes and skin.

- **Wear gloves and eye protection and be careful when working near battery.**
- **Follow instructions printed on battery.**

IMPORTANT: To prevent ELECTRICAL DAMAGE WHEN:

a) Installing new batteries.

b) Using a booster.

Use correct polarity — **Negative Ground.**

EXHAUST OUTLET PIPE

Remove cap from muffler pipe protruding from roof.

Using the clamp provided secure the outlet pipe to the outlet tube with the pipe positioned such that it will direct the exhaust in the desired direction away from the air intake. Tighten using a wrench (See Figure A.3).

SPARK ARRESTOR

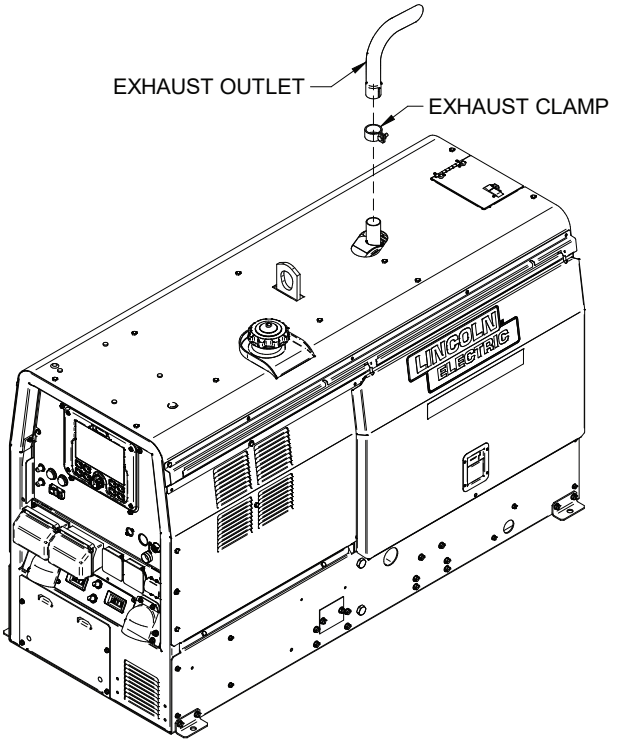
Some federal, state or local laws may require that gasoline or diesel engines be equipped with exhaust spark arrestors when they are operated in certain locations where unarrested sparks may present a fire hazard.

The muffler on the Frontier 400X has an internal USFS certiÿed Spark Arrestor.

AIR CLEANER SERVICE INDICATOR

Air cleaner service indicator provides a Go/No-Go visual indication of useful ÿlter service life. The indicator is located inside the service door.

FIGURE A.3



MACHINE GROUNDING

Because this portable engine driven welder creates its own power, it is not necessary to connect its frame to an earth ground, unless the machine is connected to premises wiring (home, shop, etc.).

To prevent dangerous electric shock, other equipment powered by this engine driven welder must:

a) be grounded to the frame of the welder using a grounded type plug, or

b) be double insulated.

When this welder is mounted on a truck or trailer, its frame must be securely connected to the metal frame of the vehicle. When this engine driven welder is connected to premises wiring such as that in a home or shop, its frame must be connected to the system earth ground. See further connection instructions in the section entitled STANDBY POWER CONNECTIONS as well as the article on grounding in the latest National Electrical Code and the local codes.

In general, if the machine is to be grounded, it should be connected with a #8 or larger copper wire to a solid earth ground such as a metal ground stake going into the ground for at least 10 ft. (3.1m) or to the metal framework of a building which has been effectively grounded. The National Electric Code lists a number of alternate means of grounding electrical equipment. A machine grounding stud marked with the symbol is ⏚ provided on the front of the welder.

AUXILIARY POWER RECEPTACLES

Start the engine and set the RUN/STOP/IDLE control switch to the "High Idle" position. Voltage is now correct at the receptacles for auxiliary power. This must be done before a tripped GFCI can be reset properly. See the MAINTENANCE section for more detailed information on testing and resetting the GFCI.

The auxiliary power of the Frontier® 400X consists of two 20 Amp 120 VAC (5-20R) duplex receptacles with GFCI protection, one 50 Amp 120/240 VAC single phase (14-50R) receptacle and one 50 Amp 240 VAC three phase (15-50R) receptacle.

The auxiliary power capacity is 10,000 watts continuous of 60 Hz, single phase power. The auxiliary power capacity rating in watts is equivalent to volt-amperes at unity power factor.

The 240 VAC output can be split to provide two separate 120 VAC outputs with a max permissible current of 50 amps per output to two separate 120 VAC branch circuits NOTE: These circuits are opposite polarities and cannot be paralleled. Output voltage is within ± 10% at all loads up to rated capacity.

The three phase auxiliary power capacity is 11,000 watts continuous at 60 Hz.

120 VAC DUPLEX RECEPTACLES AND GFCI

A GFCI protects the two 120 VAC auxiliary power receptacles.

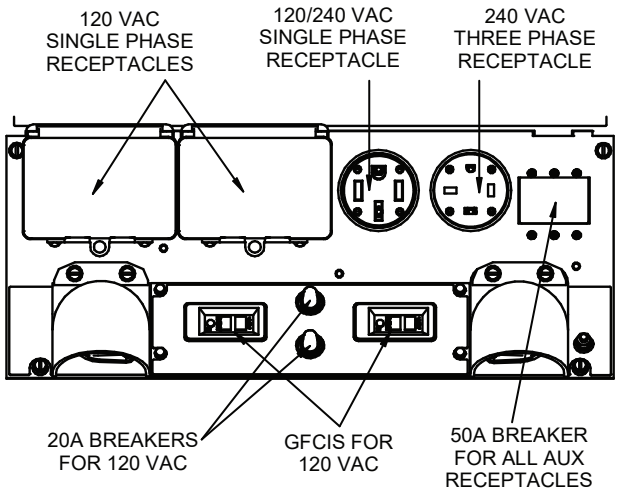
A GFCI (Ground Fault Circuit Interrupter) is a device to protect against electric shock should a piece of defective equipment connected to it develop a ground fault. If this situation should occur, the GFCI will trip, removing voltage from the output of the receptacle. If a GFCI is tripped see the MAINTENANCE section for detailed information on testing and resetting it. A GFCI should be properly tested before each use.

The 120 VAC auxiliary power receptacles should only be used with three wire grounded type plugs or approved double insulated tools with two wire plugs. The current rating of any plug used with the system must be at least equal to the current capacity of the associated receptacle.

CIRCUIT BREAKERS

All auxiliary power is protected by circuit breakers. The 120 VAC duplex receptacles have 20 amp circuit breakers for each receptacle. The 120/240V single phase and the 240V three phase receptacles have a 50 amp 3-pole circuit breaker that disconnects both hot leads and all three phases simultaneously. (See Figure A.4)

FIGURE A.4 - AUXILIARY POWER RECEPTACLES



ELECTRICAL DEVICE USE

This machine has been designed to support the power requirements of common jobsite tools and equipment. However, due to the nature of auxiliary power output, it is recommended for the operator to review the sensitivity and protections of any tools or equipment used with this machine to prevent any damage or failures.

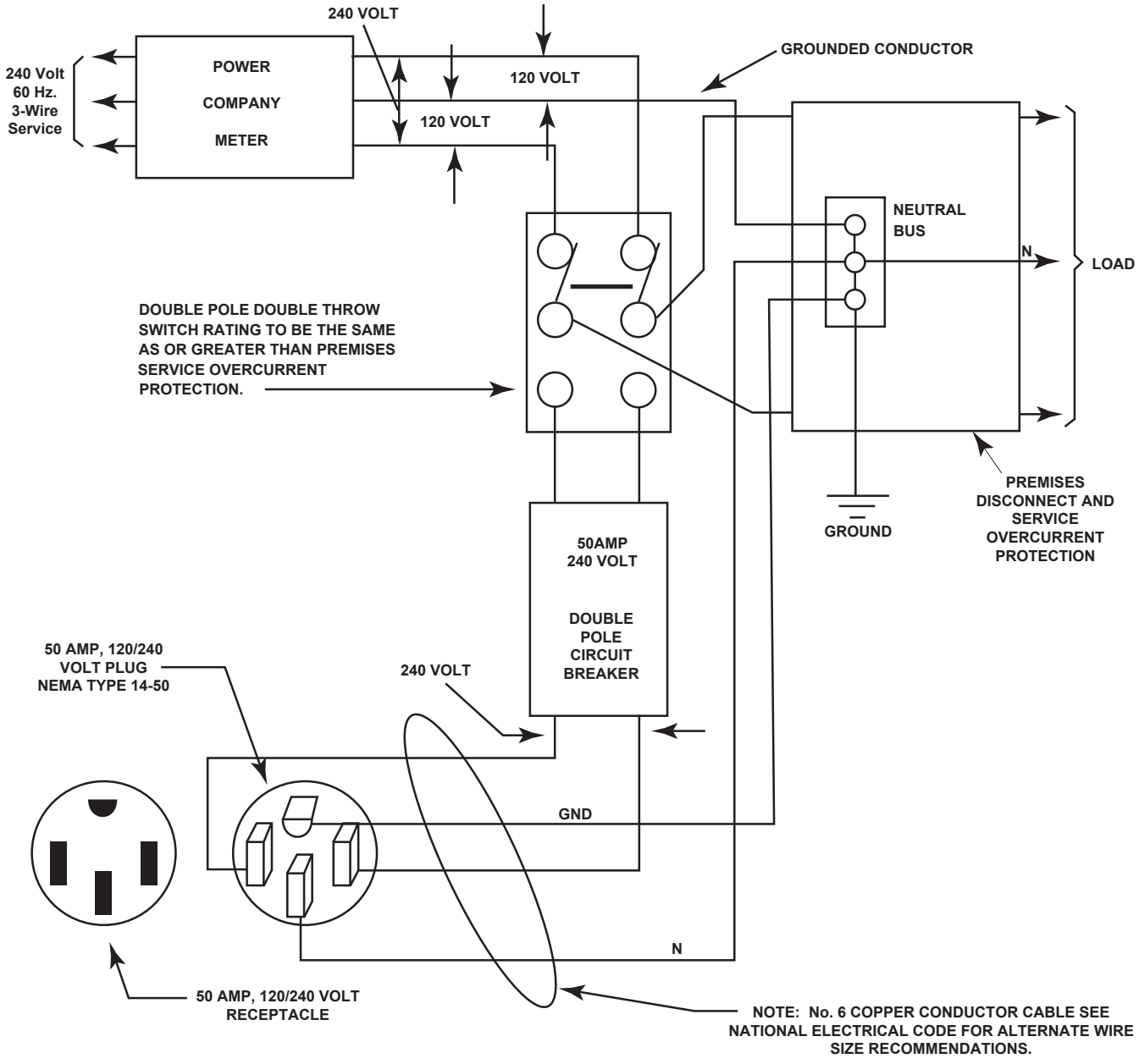
STANDBY POWER CONNECTIONS

The Frontier® 400X is suitable for temporary, standby or emergency power using the engine manufacturer's recommended maintenance schedule.

The Frontier® 400X can be permanently installed as a standby power unit for 240 VAC, 3 wire, 50 amp service. Connections must be made by a licensed electrician who can determine how the 120/240 VAC power can be adapted to the particular installation and comply with all applicable electrical codes. Refer to the connection diagram shown in Figure A.5.

1. Install the double-pole, double-throw switch between the power company meter and the premises disconnect. Switch rating must be the same or greater than the customer's premises disconnect and service over current protection.
2. Take necessary steps to assure load is limited to the capacity of the Frontier® 400X by installing a 50 amp, 240 VAC double pole circuit breaker. Maximum rated load for each leg of the 240 VAC auxiliary is 50 amps. Loading above the rated output will reduce output voltage below the allowable -10% of rated voltage which may damage appliances or other motor-driven equipment and may result in overheating of the engine and / or alternate windings.
3. Install a 50 amp 120/240 VAC plug (NEMA Type 14-50P) to the double-pole circuit breaker using No. 6, 4 conductor cable of the desired length.
4. Plug this cable into the 50 Amp 120/240 Volt receptacle on the Frontier® 400X case front.

FIGURE A.5 Connection of the Frontier® 400X to Premises Wiring



WELDING OUTPUT CABLES

With the engine off, connect to the terminals provided. These connections should be checked periodically and tightened if necessary.

Listed in Table A.1 are copper cable sizes recommended for the rated current and duty cycle. Lengths stipulated are the distance from the welder to work and back to the welder again. Cable sizes are increased for greater lengths primarily for the purpose of minimizing cable voltage drop.

TABLE A.1

OUTPUT CABLE GUIDELINES						
Amperes	Percent Duty Cycle	CABLE SIZES FOR COMBINED LENGTHS OF ELECTRODE AND WORK CABLES [RUBBER COVERED COPPER - RATED 167°F (75°C)]**				
		0 to 50 Ft.	50 to 100 Ft.	100 to 150 Ft.	150 to 200 Ft.	200 to 250 Ft.
200	60	2	2	2	1	1/0
200	100	2	2	2	1	1/0
250	30	3	3	2	1	1/0
250	40	2	2	1	1	1/0
250	60	1	1	1	1	1/0
250	100	1	1	1	1	1/0
300	60	1	1	1	1/0	2/0
300	100	2/0	2/0	2/0	2/0	3/0
350	40	1/0	1/0	2/0	2/0	3/0
400	60	2/0	2/0	2/0	3/0	4/0
400	100	3/0	3/0	3/0	3/0	4/0

** Tabled values are for operation at ambient temperatures of 104°F (40°C) and below. Applications above 104°F (40°C) may require cables larger than recommended, or cables rated higher than 167°F (75°C).

CABLE INSTALLATION

Install the welding cables to your Frontier® 400X as follows.

⚠ WARNING

1. The engine must be OFF to install welding cables.
2. Remove the flanged nuts from the output terminals.
3. Connect the electrode holder and work cables to the weld output terminals. The terminals are identified on the case front.
4. Tighten the flanged nuts securely.
5. Be certain that the metal piece you are welding (the “work”) is properly connected to the work clamp and cable.
6. Check and tighten the connections periodically.

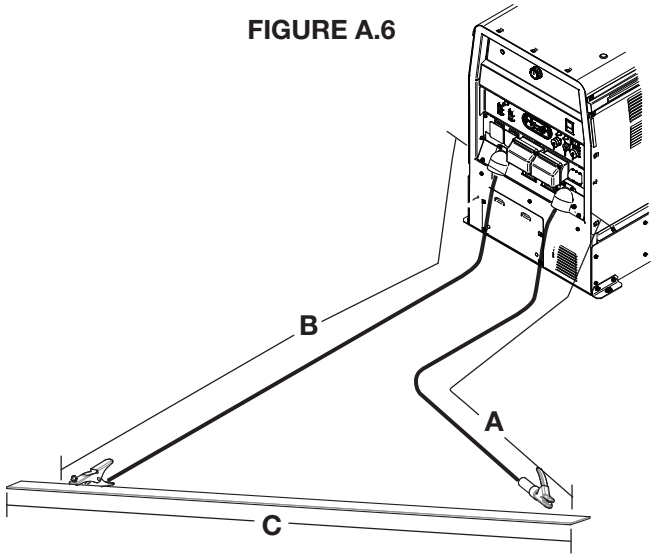
⚠ CAUTION

- **Loose connections will cause the output terminals to overheat. The terminals may eventually melt.**
- **Do not cross the welding cables at the output terminal connection. Keep the cables isolated and separate from one another.**

CABLE INDUCTANCE AND ITS EFFECTS ON WELDING

Excessive cable inductance will cause the welding performance to degrade. There are several factors that contribute to the overall inductance of the cabling system including cable size, number of loops, and total loop area. The loop area is defined by the separation distance between the electrode and work cables and the overall welding loop length. Welding loop length = electrode cable (A) + work cable (B) + work path (C) (See Figure A.6).

FIGURE A.6



To minimize inductance always use the appropriate size cables, and whenever possible, run the electrode and work cables in close proximity to one another to minimize the loop area. Since the most significant factor in cable inductance is the welding loop length, avoid excessive lengths and do not coil excess cable. Excess cable should be placed in a straight or zig-zag pattern between the machine and work per Figure A.7.

If a spooling mechanism is used to store the welding cables, unspool the cables. Avoid leaving more than 30 feet of cable on each storage spool, and for best performance, completely unspool the welding cables.

For long work piece lengths, a sliding ground should be considered to keep the total welding loop length as short as possible.

CROSSLINC TECHNOLOGY

This machine features CrossLinc technology, which allows for remote control of the welding output via the weld cables rather than a control cable. As result, the control cable is no longer needed when connected to a CrossLinc compatible wire feeder or remote control.

This machine will function with all CrossLinc compatible wire feeders except for the oldest LN-25X models. Incompatible models include:

Code # 12432

Code # 12504

REMOTE CONTROL CONNECTIONS

The Frontier® 400X is equipped with a 12-pin remote connector for attaching remote control accessories.

NOTE: To connect accessories with a 6-pin connector, use the 6-pin to 12-pin adapter (K2909-1).

REMOTE OUTPUT CONTROL

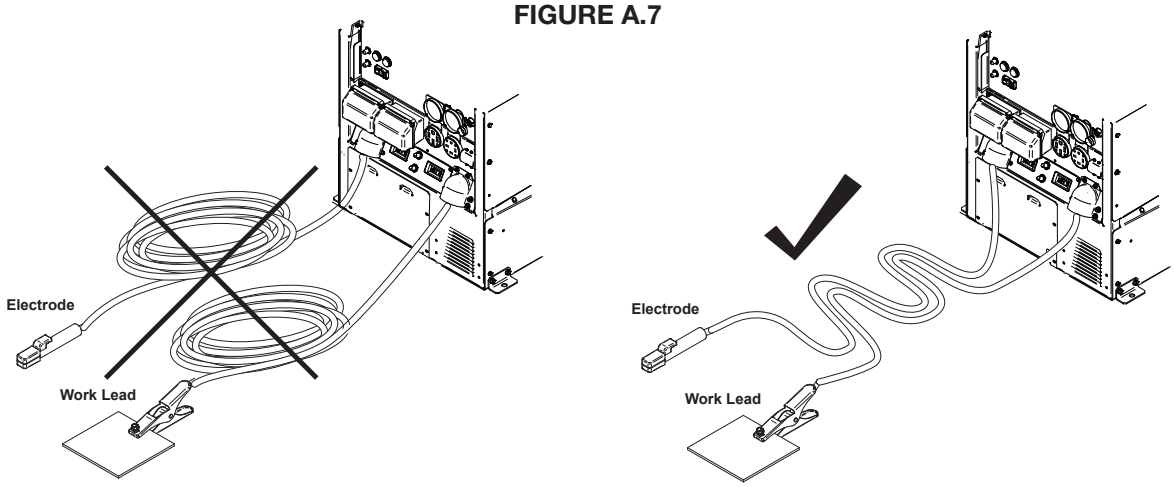
To enable remote control capabilities, turn on remote control with the button on the user interface. When remote control is enabled, output is controlled through the 12-pin connector and the output control knob on the Frontier will be disabled.

When a CrossLinc device is connected, the remote output control is disabled, and the CrossLinc device is in control of the output.

REMOTE WELD TERMINALS

By default, the weld terminals are ON when a weld mode is selected. To use a remote output control switch or a foot pedal, the weld terminals can be changed to remote in the weld settings within each weld mode.

FIGURE A.7



ACCESSORY CONNECTION DIAGRAMS

⚠ WARNING

Shut off welder before making or removing any electrical connections.

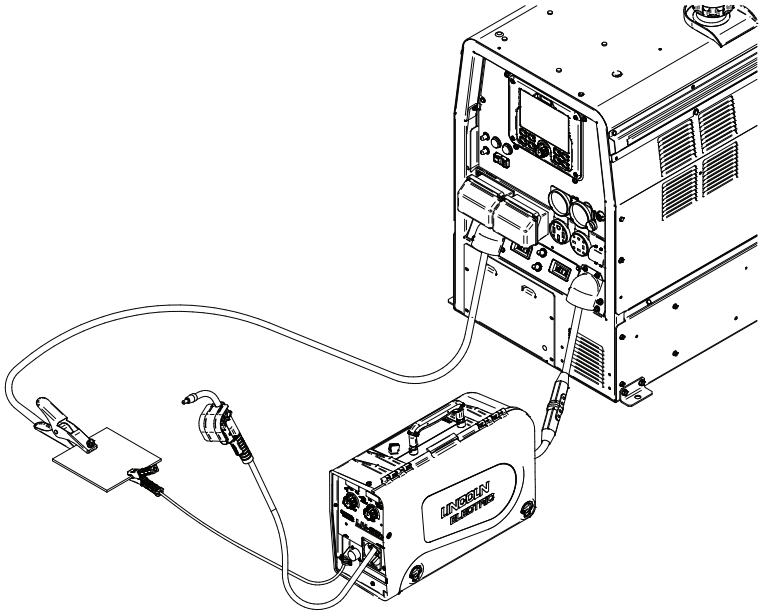
When connecting an accessory to the Frontier® 400X, the following steps should be taken:

- Shut off the welder.
- Connect your leads for the desired accessory. For electrode positive, connect the electrode cable to the "+" terminal of the welder and work cable to the "-" terminal of the welder.

For electrode negative, connect the electrode cable "-" terminal of the welder and work cable to the "+" terminal of the welder. Installation diagrams for common setups are included on the following pages.

CROSSLINC WIRE FEEDER SETUP EXAMPLE

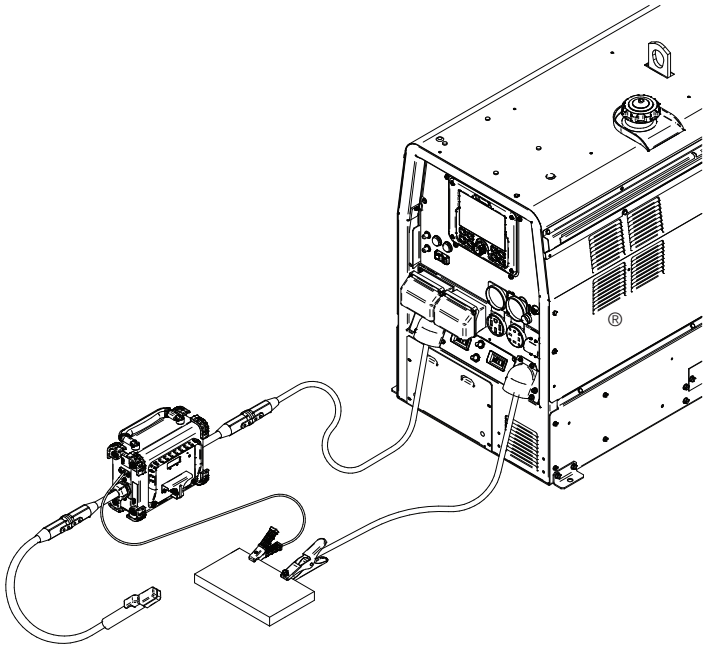
FIGURE A.8



Description	Product Number	QTY
Frontier® 400X Welder/ Generator	K3484-1	1
LN-25X Wire Feeder	K4267-2	1
K126® PRO Innershield® 350A FCAW-S Welding Gun	K126-12	1
Electrode Cable - 2/0, 50 ft. (15.3 m), Black	K2485-2	2
Electrode Cable - 2/0, 10 ft. (3.1 m), Black	K2483-2	1
Work Clamp	K910-1	1
Cable Connectors - TWECO to Lug Adaptor	K2487-1	2

CROSSLINC REMOTE SETUP EXAMPLE

FIGURE A.9

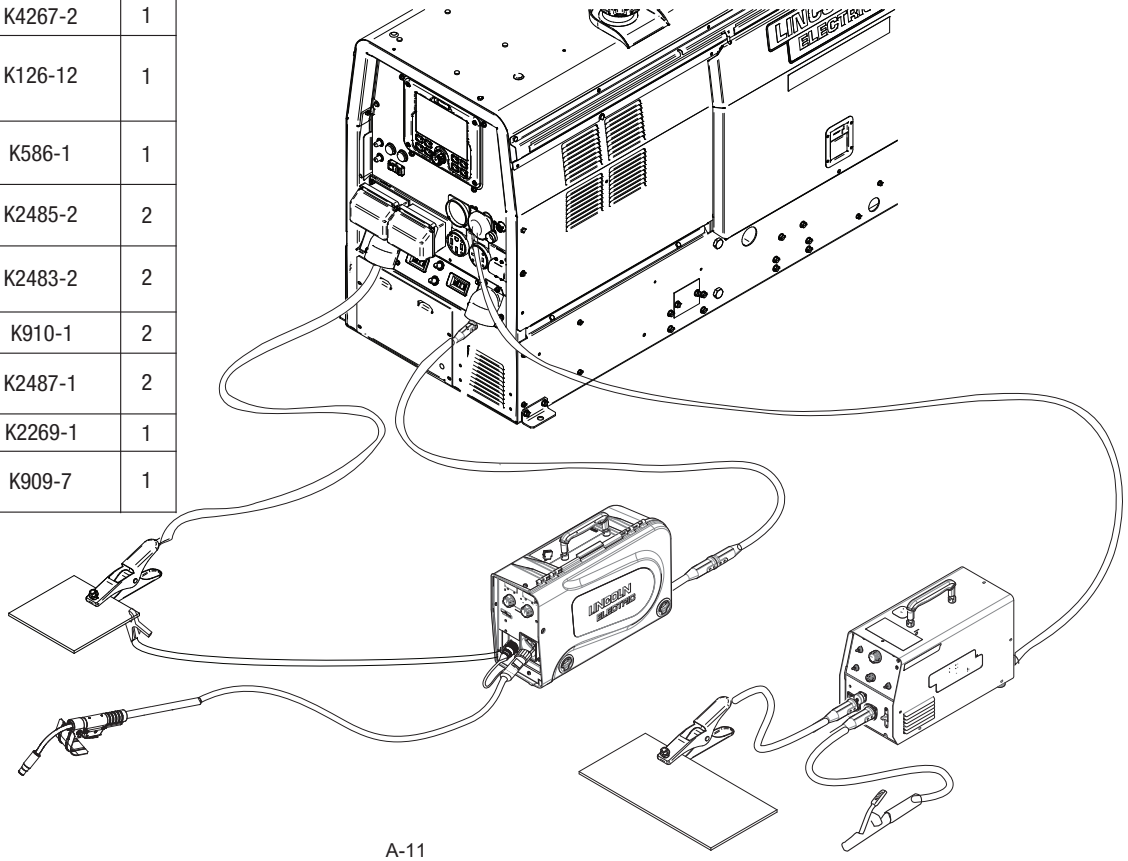


Description	Product Number	QTY
Frontier® 400X Welder/ Generator	K3484-1	1
CrossLinc® Remote	K4345-1	1
EH-305D Electrode Holder	K909-7	1
Electrode Cable - 2/0, 50 ft. (15.3 m), Black	K2485-2	2
Electrode Cable - 2/0, 10 ft. (3.1 m), Black	K2483-2	1
Work Clamp	K910-1	1
Cable Connectors - TWECO to Lug Adaptor	K2487-1	2

DUAL ARC SETUP EXAMPLE - CROSSLINC WIRE FEEDER AND INVERTER WELDER

Description	Product Number	QTY
Frontier® 400X Welder/ Generator	K3484-1	1
LN-25X Wire Feeder	K4267-2	1
K126® PRO Innershield® 350A FCAW-S Welding Gun	K126-12	1
Gas Regulator and Hose Kit	K586-1	1
Electrode Cable - 2/0, 50 ft. (15.3 m), Black	K2485-2	2
Electrode Cable - 2/0, 10 ft. (3.1 m), Black	K2483-2	2
Work Clamp	K910-1	2
Cable Connectors - TWECO to Lug Adaptor	K2487-1	2
Invertec® V276	K2269-1	1
EH-305D Electrode Holder	K909-7	1

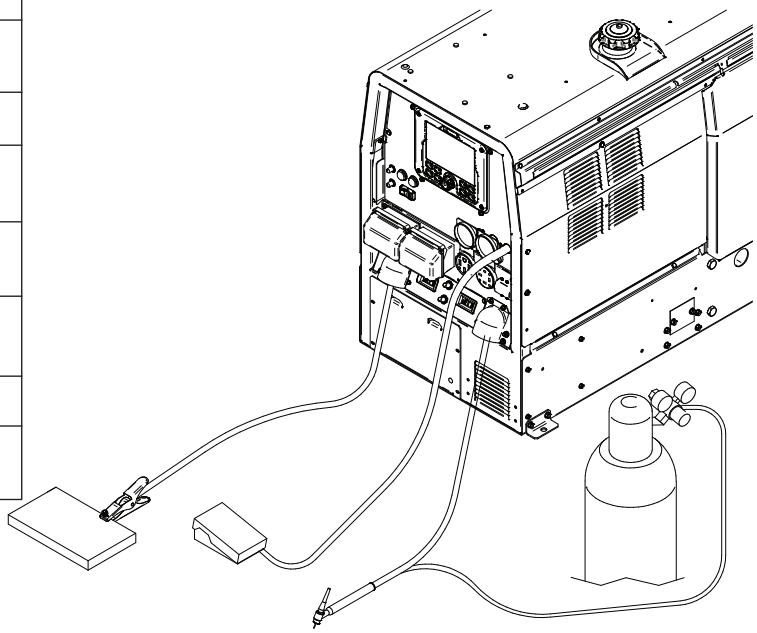
FIGURE A.10



TIG SETUP WITH FOOT PEDAL EXAMPLE

Description	Product Number	QTY
Frontier® 400X Welder/ Generator	K3484-1	1
PTA-26V TIG Torch - 25 ft. (7.6 m)	K1783-9	1
Foot Pedal	K870-2	1
Gas Regulator and Hose Kit	K586-1	1
Electrode Cable - 2/0, 50 ft. (15.3 m), Black	K2485-2	2
Electrode Cable - 2/0, 10 ft. (3.1 m), Black	K2483-2	1
Work Clamp	K910-1	1
Cable Connectors - TWECO to Lug Adaptor	K2487-1	2

FIGURE A.12



OPERATION

SAFETY PRECAUTIONS
Read and understand this entire section before operating your Frontier® 400X.

⚠ WARNING

Do not attempt to use this equipment until you have thoroughly read the engine manufacturer's manual supplied with your welder. It includes important safety precautions, detailed engine starting, operating and maintenance instructions, and parts lists.

ELECTRIC SHOCK can kill.


- **Do not touch electrically live parts or electrode with skin or wet clothing.**
- **Insulate yourself from work and ground**
- **Always wear dry insulating gloves.**

ENGINE EXHAUST can kill.


- **Use in open, well ventilated areas or vent exhaust outside**
- **Do not stack anything near the engine.**

MOVING PARTS can injure.


- **Do not operate with doors open or guards off.**
- **Stop engine before servicing.**
- **Keep away from moving parts**

The serviceability of a product or structure utilizing the welding modes is and must be the sole responsibility of the builder/user. Many variables beyond the control of The Lincoln Electric Company affect the results obtained in applying these programs. These variables include, but are not limited to, welding procedure, plate chemistry and temperature, weldment design, fabrication methods and service requirements. The available range of a welding mode may not be suitable for all applications, and the builder/user is and must be solely responsible for welding mode selection.

RECOMMENDED APPLICATIONS

WELDER - The Frontier ™ 400X provides excellent constant current DC welding output for stick (SMAW) and TIG (GTAW) welding, as well as excellent constant voltage DC welding output for MIG (GMAW), Innershield (FCAW), Outershield (FCAW-G) and Metal Core (GMAW-C) welding. In addition the Frontier ™ 400X can be used for Arc Gouging with car-bons up to 5/16"(8.0 mm) in diameter.

GENERATOR - The Frontier™ 400X provides smooth 120/240 VAC single phase and 240V three phase output for auxiliary power and emergency standby power.

The Frontier ™ 400X is **NOT RECOMMENDED** for pipe thawing.

⚠ WARNING

Pipe Thawing with an arc welder can cause fire, explosion, damage to electric wiring or to the arc welder if done improperly.

The use of an arc welder for pipe thawing is not approved by the CSA, nor is it recommended or supported by Lincoln Electric.

ADDDING FUEL

⚠ WARNING

DIESEL FUEL can cause fire.

- **Stop engine while fueling.**
- **Do not smoke when fueling.**
- **Keep sparks and flame away from tank.**
- **Do not leave unattended while fueling.**
- **Wipe up spilled fuel and allow fumes to clear before starting engine.**
- **Do not overfill tank, fuel expansion may cause overflow.**

USE ULTRA-LOW SULFUR DIESEL FUEL ONLY

- **Remove the fuel tank cap.**
- **Fill the tank. DO NOT FILL THE TANK TO THE POINT OF OVERFLOW.**
- **Replace the fuel cap and tighten securely.**
- **See Engine Owner's Manual for specific fuel recommendations.**

BREAK-IN PERIOD

The engine will use a small amount of oil during its "break-in" period. The break-in period is about 50 running hours. Change the oil after the first 50 hours of operation. Thereafter, follow the engine service and maintenance schedule located in the Engine Operator's Manual.

⚠ CAUTION

During break-in, subject the engine driven welder to moderate loads. Avoid long periods running at idle. Before stopping the engine, remove all loads and allow the engine to cool several minutes.

ENGINE OPERATION

Before starting the engine:

- Be sure the machine is on a level surface.
- Open side engine door and remove the engine oil dipstick and wipe it with a clean cloth. Reinsert the dipstick and check the level on the dipstick.
- Add oil (if necessary) to bring the level up to the full mark. Do not overfill. Close engine door.
- Check radiator for proper coolant level. (Fill if necessary).
- See Engine Owner's Manual for specific oil and coolant recommendations.

STARTING THE ENGINE

1. Remove all plugs connected to the AC power receptacles.
2. Set RUN / STOP / IDLE switch to AUTO IDLE / RUN position.
3. Press the GLOW PLUG button to preheat the engine before starting if needed. Then, press and hold the START button until the machine turns over.
4. Release the engine START button switch immediately when the engine starts.
5. The engine will run at high idle speed for approximately 12 seconds and then drop to low idle speed. Allow the engine to warm up at low idle for several minutes before applying a load and/or switching to high idle.

NOTE: Allow a longer warm up time in cold weather.

⚠ CAUTION

- **Do not allow the starter motor to run continuously for more than 20 seconds.**
- **Do not push the START button while the engine is running because this can damage the ring gear and/or the starter motor.**

STOPPING THE ENGINE

Remove all welding and auxiliary power loads and allow the engine to run at low idle speed for a few minutes to cool the engine.

Turn off the engine by placing the RUN / STOP / IDLE switch in the STOP position.

NOTE: A fuel shut off valve is located on the fuel pre-filter.

TYPICAL FUEL CONSUMPTION

Refer to the table below for typical fuel consumption of the Frontier™400 X Engine for various operating scenarios.

(Perkins 403F-15T) Fuel Consumption

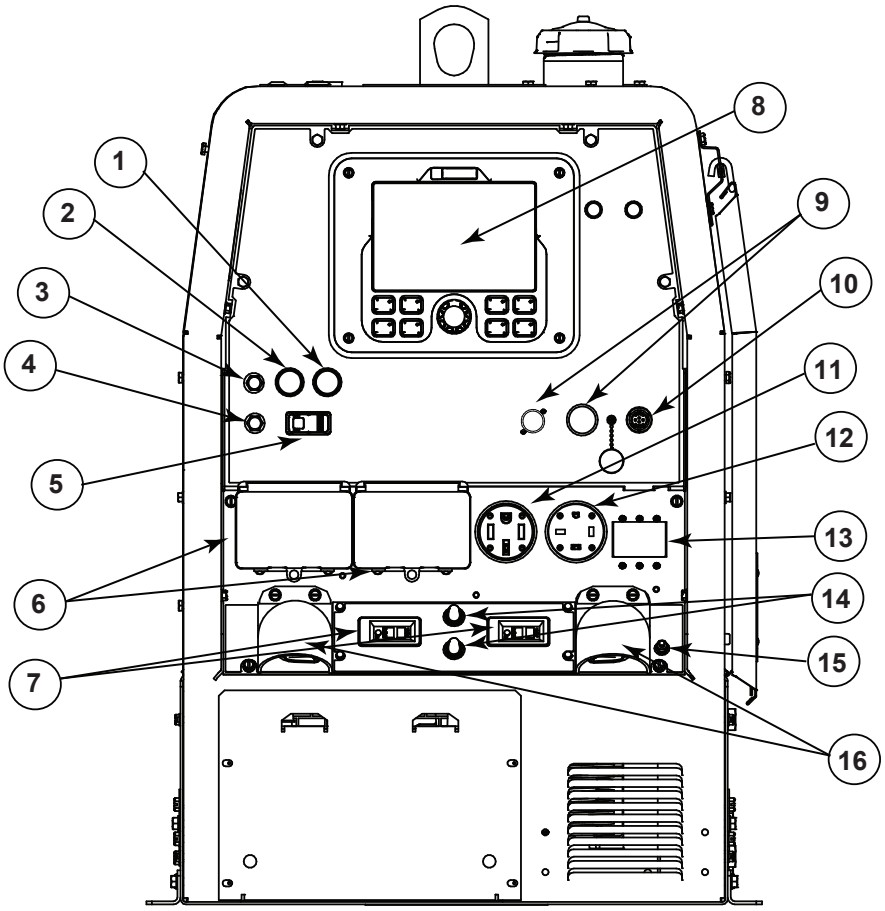
	GAL. / HR.	L / HR.	RUN TIME (HRS.) WITH FULL TANK*
High Idle, no load	0.56	2.11	35.84
Low Idle, no load	0.34	1.28	59.14
Welding - 100A @ 24V	0.68	2.56	29.57
Welding - 200A @ 28V	1.18	4.48	16.90
Welding - 300A @ 32V	1.23	4.64	16.32
Welding - 325A @ 33V	1.31	4.96	15.26
Welding - 400A @ 26V	1.33	5.02	15.07
Auxiliary - 10kW Single Phase Power	1.12	4.26	17.79
Auxiliary - 11kW Three Phase Power	1.21	4.58	16.54

*Full Tank equals 20 gal. (75.7L)

CONTROLS AND SETTINGS

All welder and engine controls are located on the case front panel.
Refer to Figure B.1 and the explanations that follow.

FIGURE B.1 CASE FRONT PANEL CONTROLS



SYSTEM CONTROLS

1. START PUSH BUTTON - Energizes the starter motor to crank the engine.

2. GLOW PLUG PUSH BUTTON - Activates the glow plugs when pushed. Hold for approximately 10 seconds prior to engine starting in cold weather. Glow plug should not be activated for more than 20 seconds continuously.

3. 10A BREAKER FOR 40V APEX® SYSTEM

4. 10A BREAKER FOR 12V ENGINE BATTERY

5. RUN / STOP / IDLE SWITCH - The switch has three positions. The right position is OFF, the middle position is AUTO IDLE / RUN, and the left position is HIGH IDLE / RUN.

a. In the OFF position, the engine will turn off.

b. In the HIGH IDLE position, the engine runs at the high idle speed controlled by the governor.

c. In the AUTO IDLE position, the idler operates as follows:

- When switched from HIGH to AUTO or after starting the engine, the engine will operate at full speed for approximately 12 seconds and then go to low idle speed.
- When the electrode touches the work or power is drawn for lights or tools (approximately 100 watts minimum) the engine accelerates and operates at full speed.
- When welding ceases and the auxiliary power load is turned off, a fixed time delay of approximately 12 seconds starts.
- If the welding or auxiliary power load is not restarted before the end of the time delay, the idler reduces the engine speed to low idle speed.
- The engine will automatically return to high idle speed when the welding load or auxiliary power load is reapplied.

6. 120 VAC SINGLE PHASE RECEPTACLES - NEMA 5-20R receptacles that provides 120 VAC single-phase auxiliary power. Each receptacle has a 20 amp rating.

7. GFCI MODULES - Protects the 120 VAC duplex receptacles.

8. GRAPHICAL USER INTERFACE - Controls and displays information about the machine. See section USER INTERFACE CONTROLS for operation information.

SYSTEM CONTROLS CONT.

9. APEX® SYSTEM CONNECTORS - Optional connectors available via separate kit. Kit includes needed components to power an APEX® System.

10. 12-PIN CONNECTOR - Used for attaching optional remote control equipment. The K2909-1 (12-pin to 6-pin) adapter can be used for attaching to accessories requiring the 6-pin connector.

11. 120/240 VAC SINGLE PHASE RECEPTACLE - A NEMA 14-50R receptacle that provides 240 VAC or can be split for 120 VAC single-phase auxiliary power. This receptacle has a 50 amp rating. Refer to the AUXILIARY POWER RECEPTACLES section in the INSTALLATION chapter for further information about this receptacle

12. 240 VAC THREE PHASE RECEPTACLE - A NEMA 15-50R receptacle that provides 240 VAC three-phase auxiliary power. This receptacle has a 50 amp rating.

13. 50A BREAKER FOR 120V/240V AND 240V RECEPTACLES

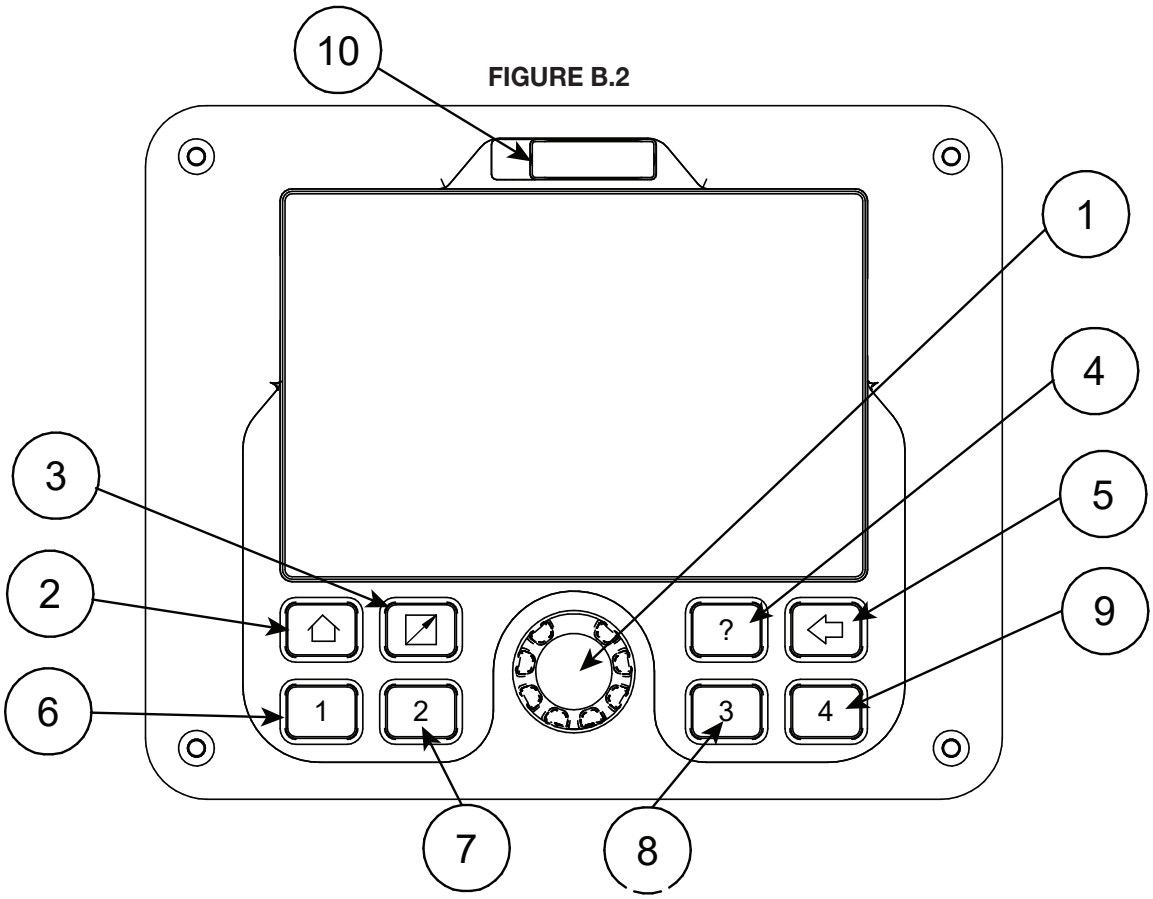
14. 20A BREAKER FOR 120V RECEPTACLE

15. GROUND STUD - Provides a connection point for connecting the machine case to earth ground. Refer to MACHINE GROUNDING in the INSTALLATION section for proper machine grounding information.

16. WELD TERMINALS - These 1/2" - 13 studs with flange nuts provide welding connection points for the electrode and work cables. For positive polarity welding the electrode cable connects to the "+" positive terminal and the work cable connects to this "-" negative terminal. For negative polarity welding the work cable connects to the "+" positive terminal and the electrode cable connects to this "-" negative terminal.

USER INTERFACE CONTROLS & NAGIVATION

FIGURE B.2



1. KNOB AND PUSH BUTTON - Rotate the knob to adjust values and move through the menus and push the knob to select values.

2. HOME BUTTON - Will return you to the home screen from any menu.

3. REMOTE BUTTON - Enable/Disable Remote Control

4. HELP / READY.SET.WELD® - Press to get more information about a highlighted feature or setting. After selecting a welding process, press to enter READY.SET.WELD®.

READY.SET.WELD® is a guided setup feature that provides a recommended output range based off a given material, material thickness, electrode type, and electrode diameter.

5. BACK - Return to the previous screen.

6. MEMORY 1 - Recall saved Memory 1 process and settings or press and hold to store new memory.

7. MEMORY 2 - Recall saved Memory 2 process and settings or press and hold to store new memory.

8. MEMORY 3 - Recall saved Memory 3 process and settings or press and hold to store new memory.

9. MEMORY 4 - Recall saved Memory 4 process and settings or press and hold to store new memory.

10. USB PORT - Conduct machine updates by inserting a USB drive.

HOME SCREEN AND WELD MODE SELECTION

Use the knob to navigate between the following weld processes; press the knob to select desired welding mode as shown in Figure B.3.

The machine comes with the available welding modes:

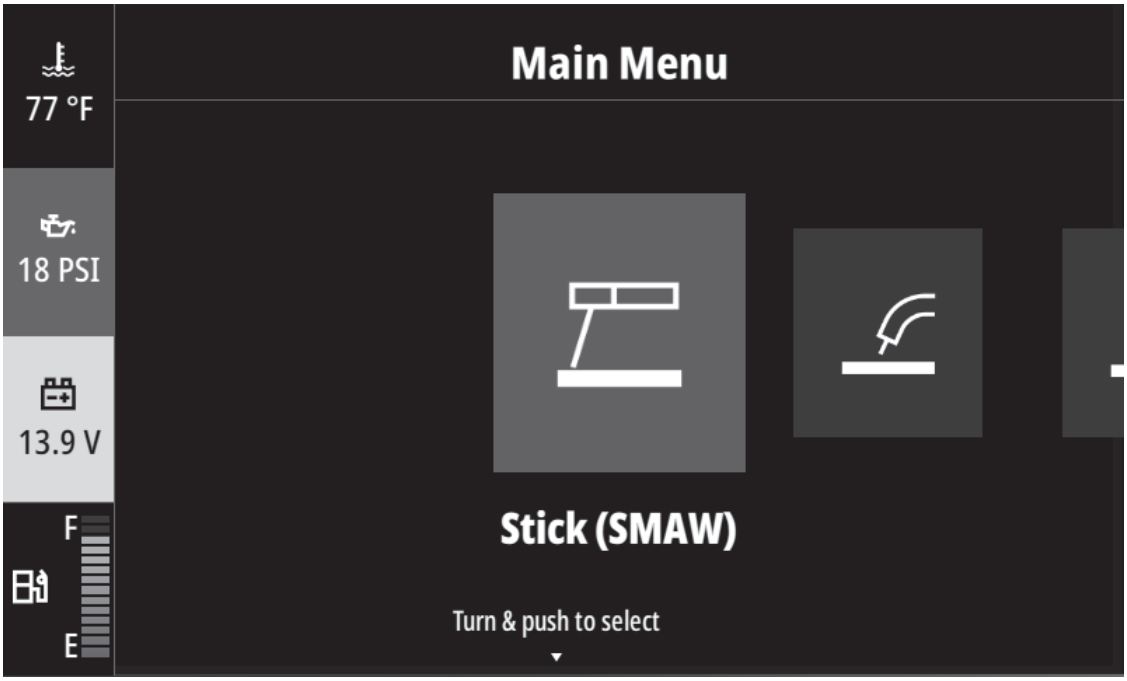
1. Stick (SMAW)
2. Flux-Cored Self-Shielded Wire (FCAW-S)
3. Flux-Cored Gas-Shielded Wire (FCAW-G)
4. MIG (GMAW)
5. Gouging (CAC-A)
6. TIG (GTAW)
7. Pipe (SMAW)**

**Only available on Frontier 400X Pipe model

Selecting a weld mode determines the output characteristics of the Frontier™ 400X power source. The proper weld mode should be used based off desired application. Many variables beyond the control of The Lincoln Electric Company affect the results obtained in applying these programs. These variables include, but are not limited to, welding procedure, plate chemistry and temperature, weldment design, fabrication methods and service requirements.

See the WELDER OPERATION section for more details on each weld mode.

FIGURE B.3



WELD MODE SCREEN

After selecting the weld process, use the center knob to adjust the welding output (See Figure B.4).

In constant current modes, the knob adjusts the welding amperage; while in constant voltage modes, the knob adjusts the welding voltage.

On the left hand side of the screen, the operator can see status indicators of the machine. From top to bottom:

1. ENGINE TEMPERATURE - Displays the engine coolant temperature.
2. OIL PRESSURE - Displays the engine oil pressure when the engine is running.
3. BATTERY VOLTAGE - Displays the battery voltage and indicates that the charging system is fuctioning properly.
4. FUEL LEVEL - Displays the level of diesel fuel in the fuel tank.

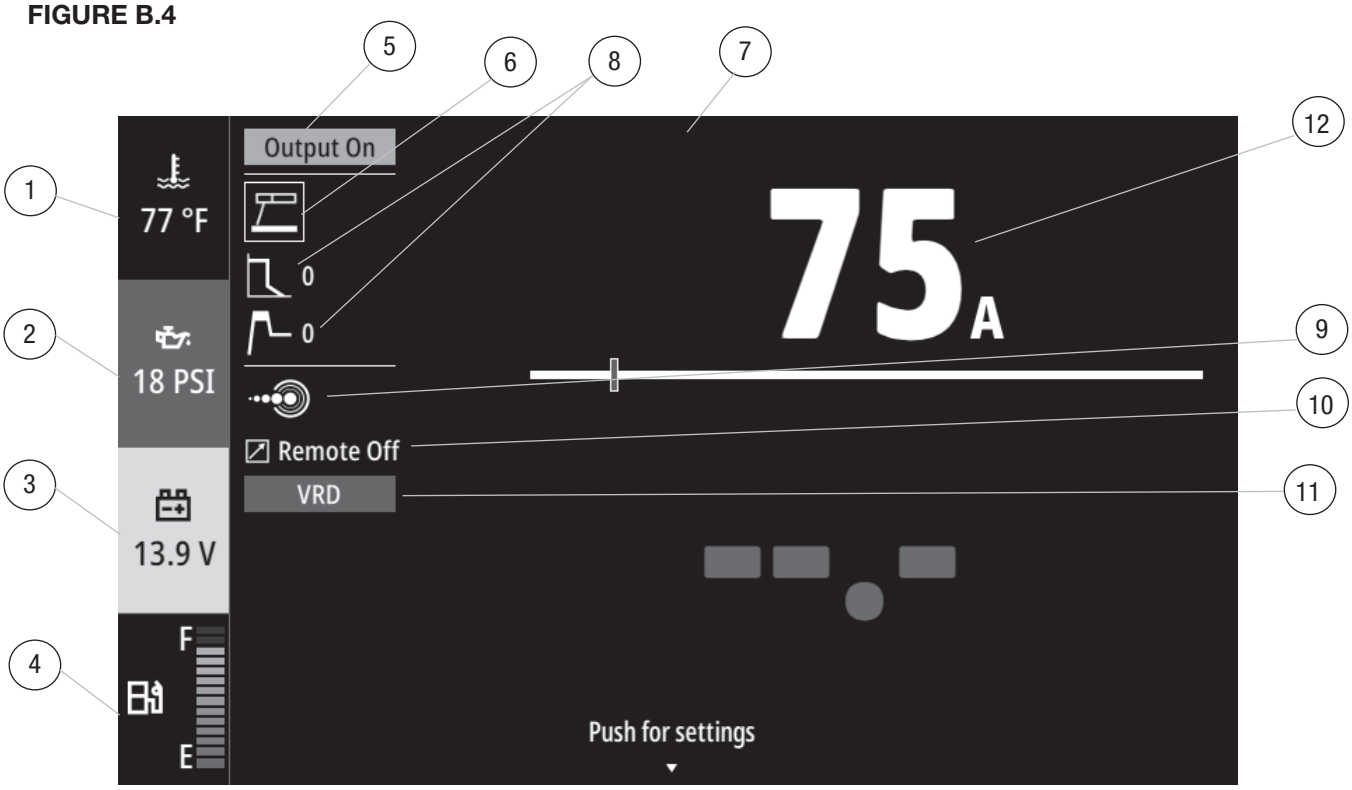
If the machine status moves outside of the recommended operating ranges, the icons will change color:
Black - Normal operation
Yellow - Warning
Red - Critical

A warning message will appear. The operator will need to click to acknowledge it.

Next to the engine indicators are weld setting and operation indicators. From top to bottom:

5. OUTPUT STATUS - identifies if the welding studs are ON or OFF.
6. WELDING MODE - indicates the current welding mode of the machine.
7. STANDBY TIMER - When Auto Stop/Start is enabled, a countdown timer will appear on the top of the screen (Timer display not shown in Figure B.4).
8. WELD MODE SETTING - Specifies the weld mode setting such as Arc Force and Hot Start. Press the knob to access the mode settings. See the WELD MODE SETTINGS section for more details.
9. CROSSLINC INDICATOR - Shows the machine is actively communicating with a CrossLinc accessory.
10. REMOTE STATUS - Indicates if a remote output control is ON or OFF.
11. VRD INDICATOR - When VRD is active, a red indicator will appear on the UI if the OCV (Open Circuit Voltage) is equal to or greater than 30V and a green light will appear if the OCV is less than 30V. **NOTE**: These indicators do not appear during welding, See page A-2 to change the ON/OFF position of the VRD switches.
12. WORK POINT - Indicates the output where the machine has been set.

FIGURE B.4



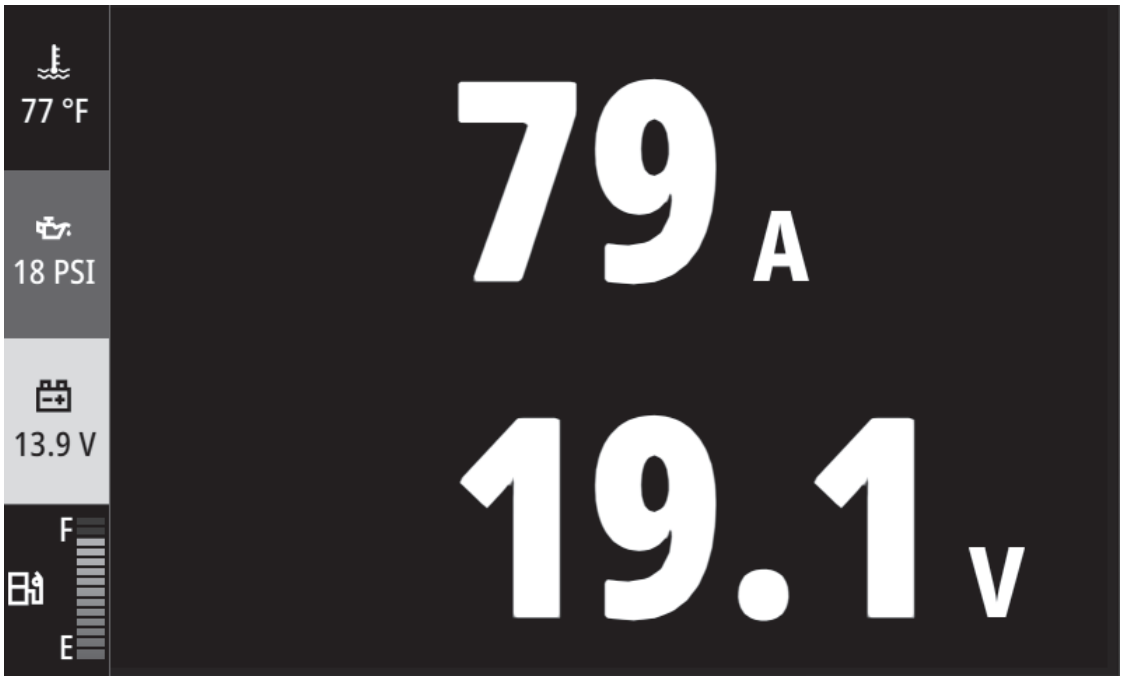
ACTIVE WELD SCREEN

After striking an welding arc, the screen with change to the ACTIVE WELD SCREEN to show the real time amperage and voltage. Once the arc been terminated, the screen will flash the amperage and voltage for approximately 5 seconds, and the UI will automatically return to the weld mode screen. This allows the operator to read the actual current and voltage just prior to when welding was ceased.

The accuracy of the meters is +/- 3%.

When CrossLinc® wire feeder with True Voltage Technology (TVT) is connected, the screen will display the actual machine output. This will vary from the preset voltage on the wire feeder because TVT compensates for the voltage drop in the welding loop.

FIGURE B.5

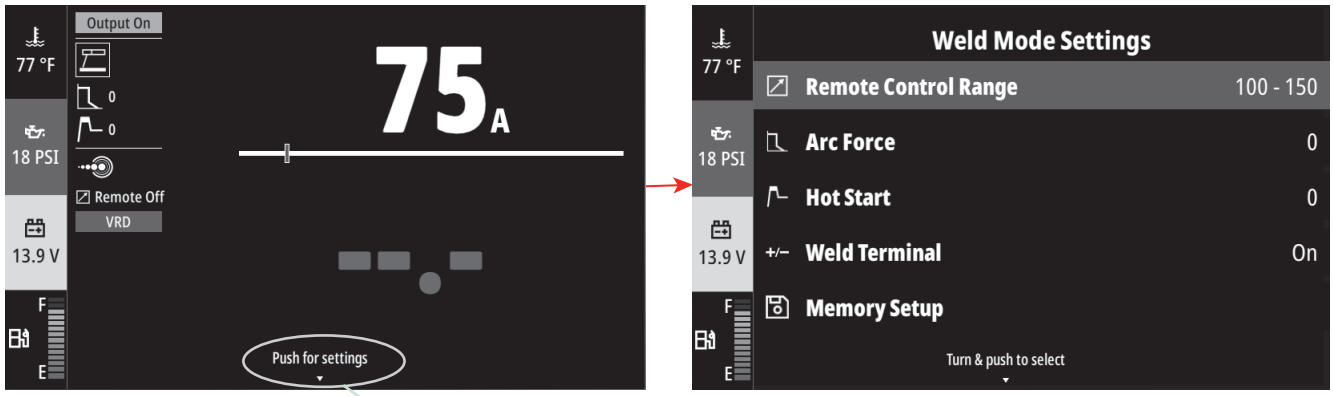


WELD MODE SETTINGS

Within an active welding process, press the knob to view additional arc options.

Each mode offers several welding options to fine tune the arc welding performance. The options available will depend on the weld mode selected. Welding settings are remembered between each weld mode.

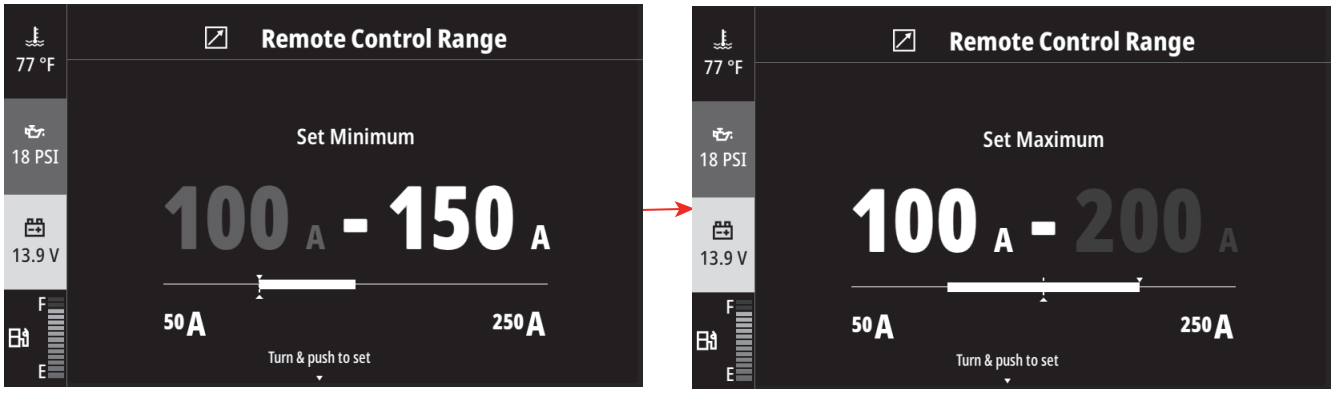
FIGURE B.6



Push knob to access the Weld Settings screen

- Remote Control Range - Allows the user to refine the output range that can be controlled remotely.

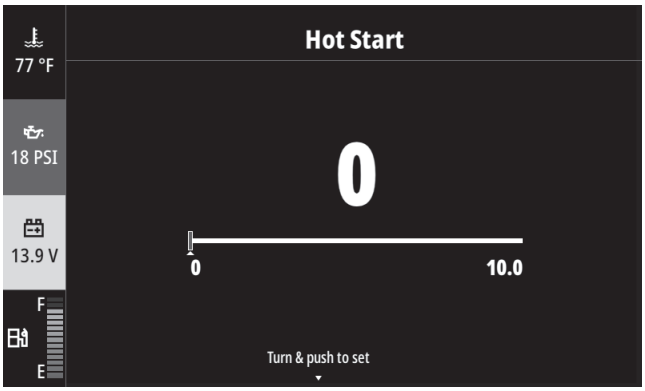
FIGURE B.7

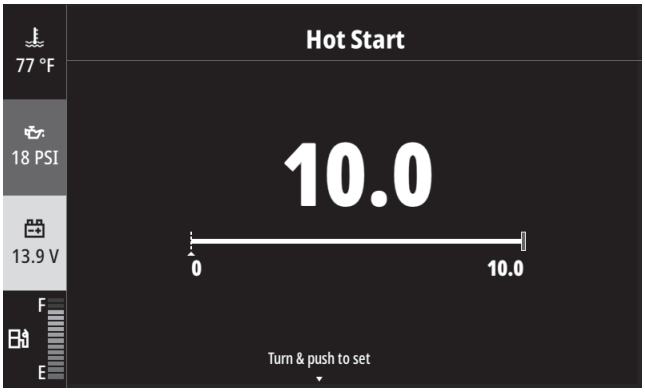


WELD MODE SETTINGS CONT

- Hot Start - Provides a temporary increase of the output current during the start of a weld. This helps ignite the arc quickly and reliably, preventing the electrode from sticking. The setting can be adjusted from 0 (Off) to +10. The higher the value the greater the output current during arc strike.

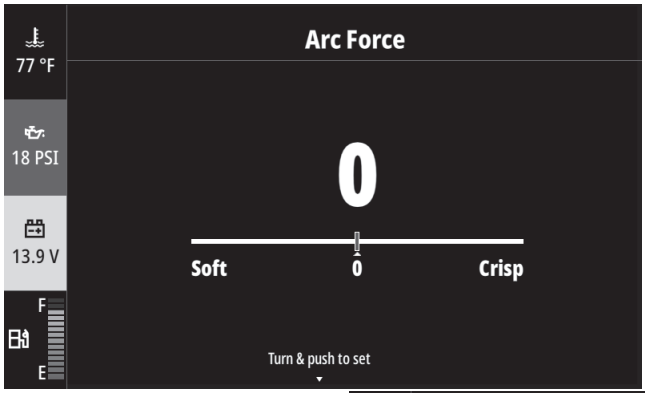
FIGURE B.8

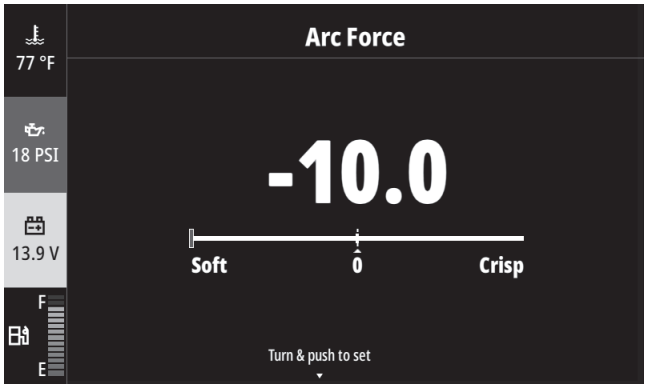


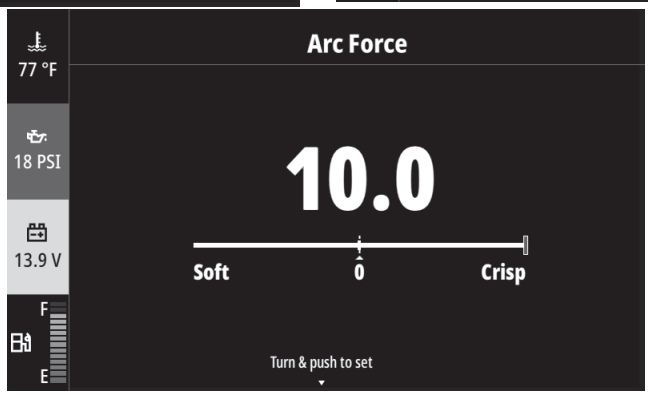


- Arc Force - Used to prevent the electrode from sticking during welding. It provides a temporary increase in current when the arc length becomes very short. Increasing the value from -10 (Soft) to +10 (Crisp) increases the short circuit current and prevents sticking of the electrode to the plate while welding, while decreasing the value reduces the amount of spatter.

FIGURE B.9





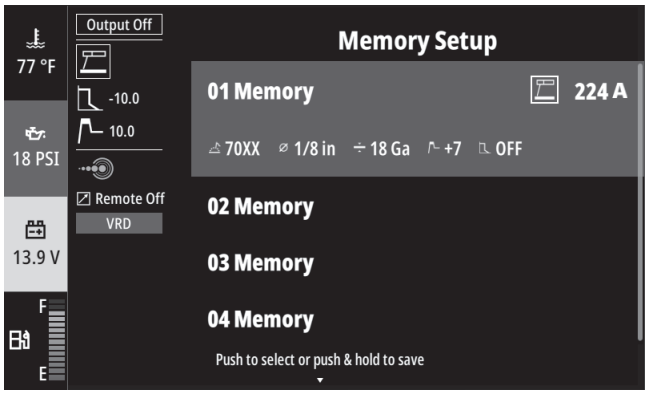


- Pinch - Changes the rate of current rise will change when the electrode short circuits to the work. Increasing the pinch from -10 to +10 may reduce spatter, while decreasing the pinch will make the puddle more fluid, resulting in a flatter and smoother weld bead.

WELD MODE SETTINGS CONT

- Weld Terminal - Allows the operator to select if the welding terminals are always electrically hot or turned on or off via a remote trigger.
- Memory Mode - Allows the operator save a memory based off the current weld mode and welding settings or recall a previously saved memory.

FIGURE B.10



- Frequency - Adjusting the frequency from “OFF” to a value between 0.1-20 Hz will turn on pulse TIG. The frequency changes the number of pulses per second. Pulse TIG can help to minimize burn through on thin materials by reducing the heat input.
- Percent Peak Current - If pulse frequency is ON, this setting changes percentage of time spent at the peak current vs the background current. The operator can set the value from 5% up to 95%, which affects the amount of heat input into the weld. The default setting is 50%.
- Remote Accessory Type - Allows the operator to change between a Foot Pedal or Hand Control.
- Start Type - Choose between Touch Start and Scratch Start. Touch Start is a cleaner process needing only a light, quick touch of the tungsten to the work piece. Scratch start requires dragging the tungsten across the work much like striking a match. Scratch start can be easier to use but could potentially contaminate the weld and the tungsten.

NOTE: Touch Start mode avoids tungsten contamination without the use of a high frequency unit. During the time the tungsten is touching the work, there is very little voltage or current and, in general, this avoids tungsten contamination. Then, the tungsten is gently lifted off the work in a rocking motion, which establishes the arc. To stop the arc, simply lift the TIG torch away from the work piece. When the arc voltage reaches approximately 30 volts, the arc will go out and the machine will automatically reset to the touch start current level. The tungsten may then be retouched to the work piece to restrike the arc. The arc may also be started and stopped with an amptrol or arc start switch.

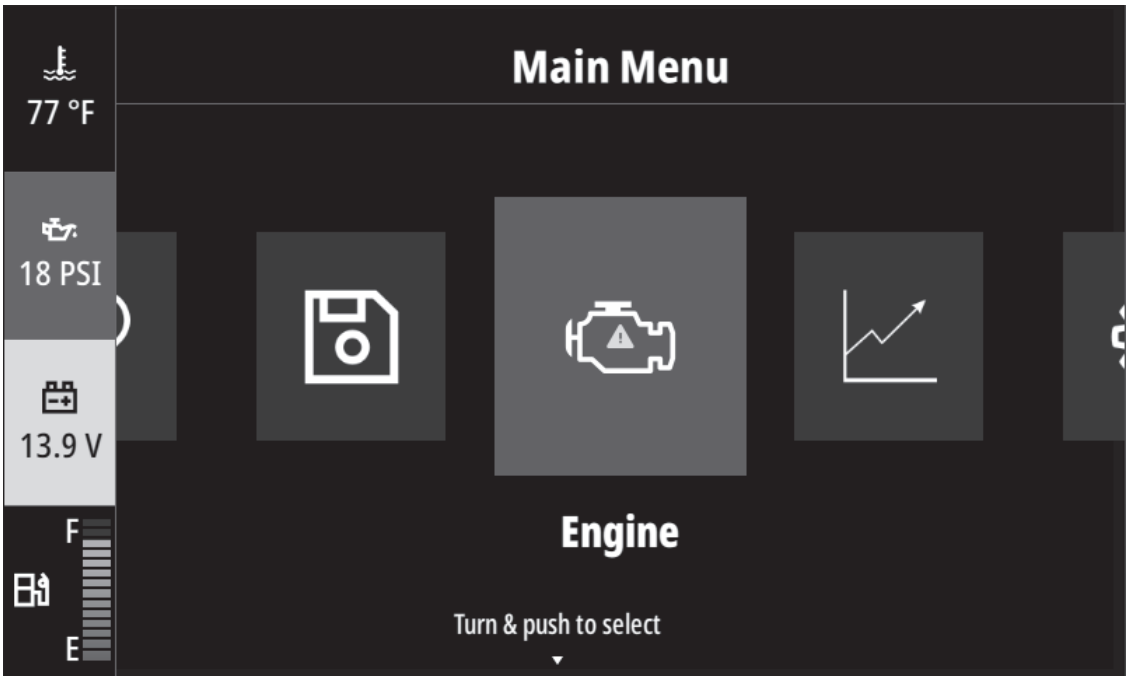
While using TOUCH START TIG mode, it is important to use the proper welding cable size to ensure expected performance levels.

ENGINE STATUS SCREEN

The Engine Status Screen provides information about the engine servicing and operation. In the MAIN MENU, use the knob to scroll and press to select the ENGINE SCREEN (See Figure B.11).

If a yellow indicator is present, the machine has an active alert.

FIGURE B.11

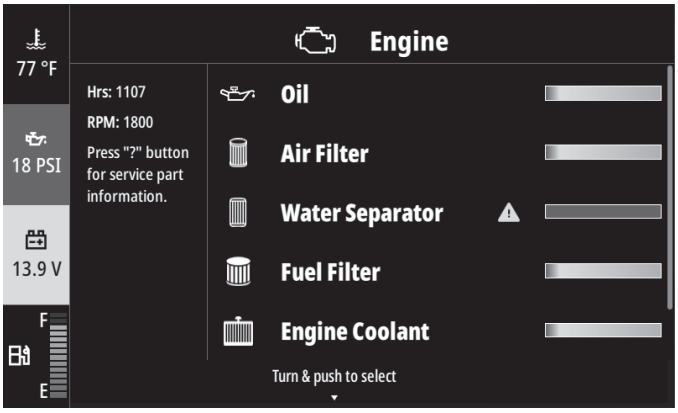


ENGINE STATUS SCREEN CONT

Within the screen, six engine parts are monitored for service:

- Oil
- Air Filter
- Water Separator
- Fuel FIlter
- Engine Coolant
- Alternator Belt

FIGURE B.12

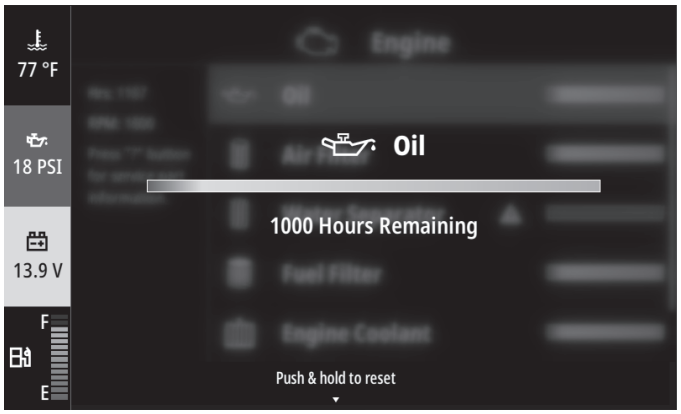


The status bars are based off the recommended service intervals and indicate the remaining time before service is required. A warning indicator will appear if a service item is nearing the end of its service life. The default warning threshold is 10%. The threshold can be configured in the SETTINGS menu.

Green = Normal operation
Yellow = Service is required soon
Red = Service is overdue

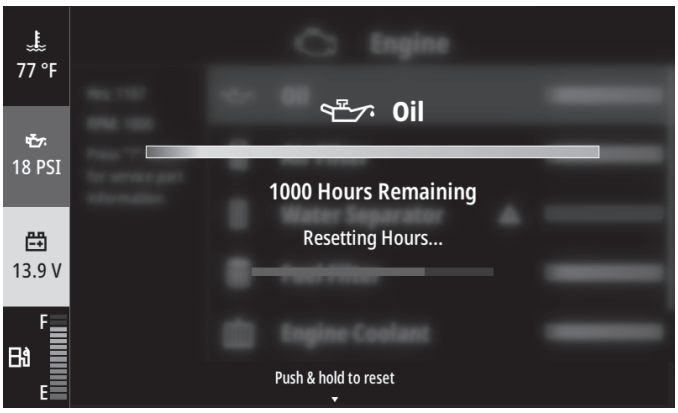
To view detailed information about each item, highlight and select the item from the list to display the number of hours remaining before service is required.

FIGURE B.13



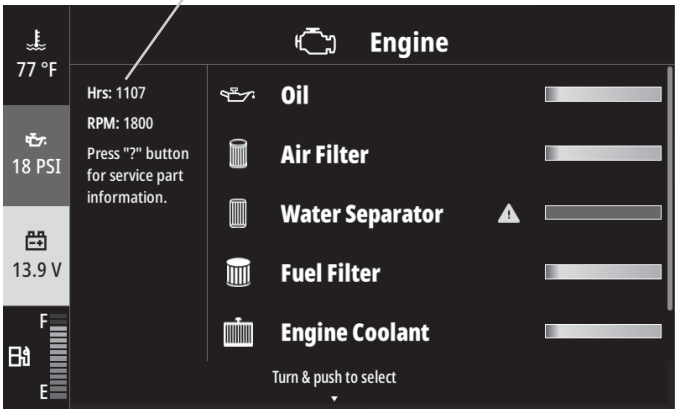
After service has been performed on an item, select it from the list and press and hold the knob for 5 seconds to reset the service indicator.

FIGURE B.14



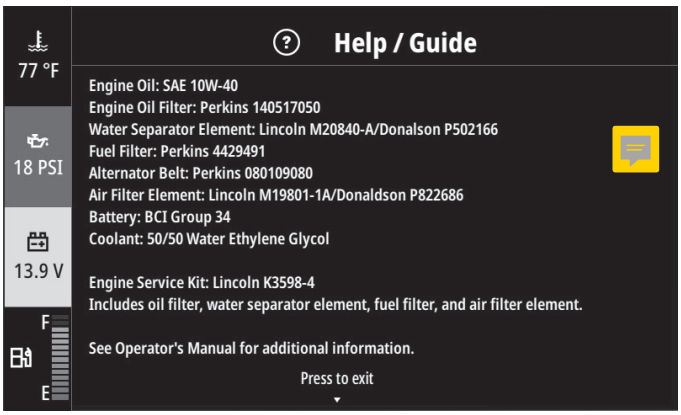
Also within the ENGINE STATUS SCREEN, the engine hours and RPMs can be found near the upper left-hand corner.

FIGURE B.15



If the HELP (?) button is pressed in this screen, a list of service parts will appear for the engine. The screen can be cleared by pressing the knob.

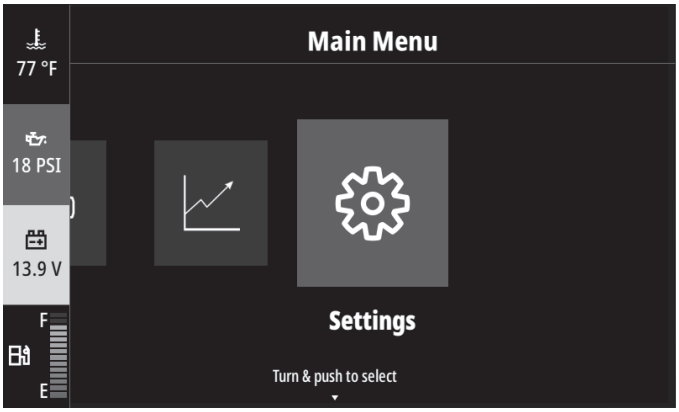
FIGURE B.16



SETTINGS SCREEN

The SETTINGS menu allows the operator to customize the machine to their preferences (See Figure B.17).

FIGURE B.17

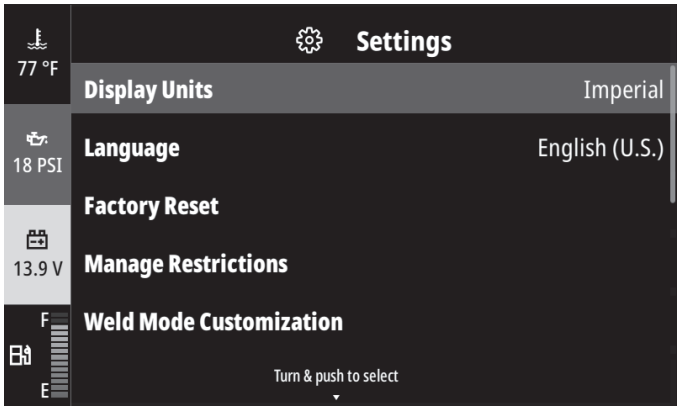


Inside the screen, the additional machine options listed below:

- Display Units - Choose between Imperial and Metric units
- Language - Choose between English, Spanish, or French
- Factory Reset - Restore Factory Default Settings
- Manage Restrictions - Set up or disable Supervisor and Operator PIN numbers (See MANAGING RESTRICTIONS section below)
- Weld Mode Customization – Enable or disable weld modes depending on preferences
- Engine Service Alerts - Change the percentage of item life remaining before an alert will be displayed
- Clock - Set/Display the local time
- Auto-Stop/Start - Enable or Disable the Auto-Stop/Start Function (See AUTO STOP/START section below)

  Note: If Auto Stop/Start is Enabled, options will appear to set the No Load and Standby Periods
- Display Brightness - Adjust the brightness of the display from 5-100%
- Diagnostics Information – Find information about the machine Serial Number, Code Number, K Number, Engine Serial Number, and Machine Hours.
- Software Version – Check the software version of the User Interface and the Chopper Control Boards

FIGURE B.18



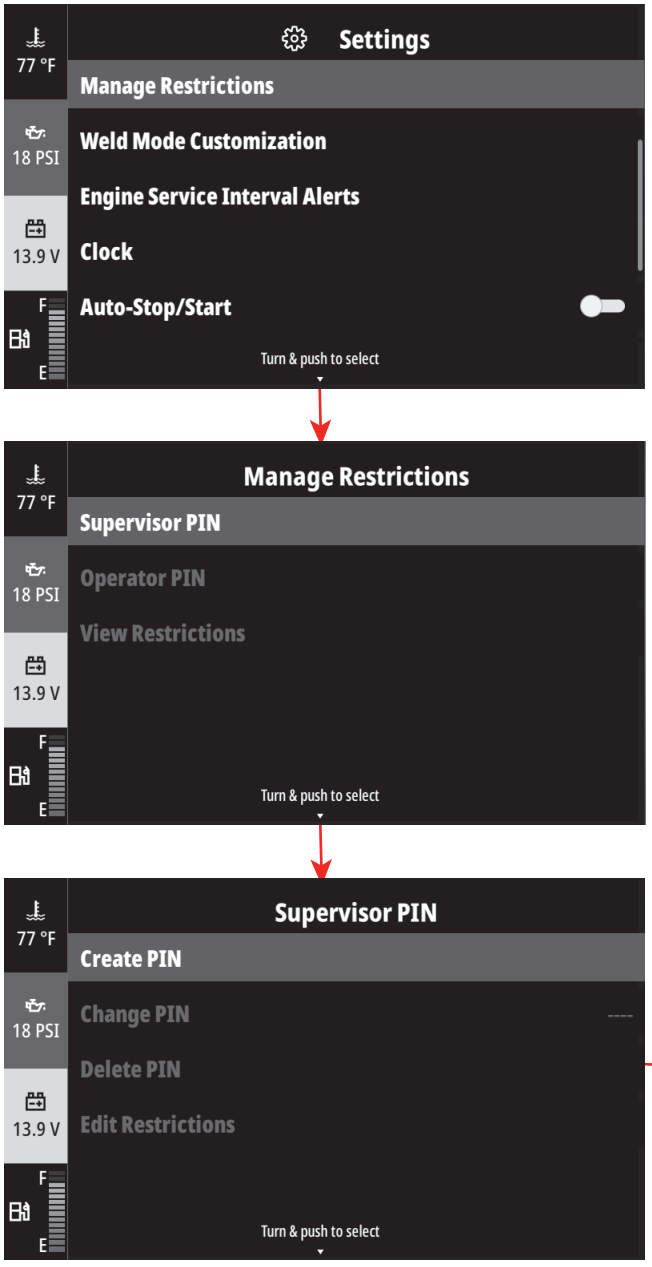
MANAGING RESTRICTIONS

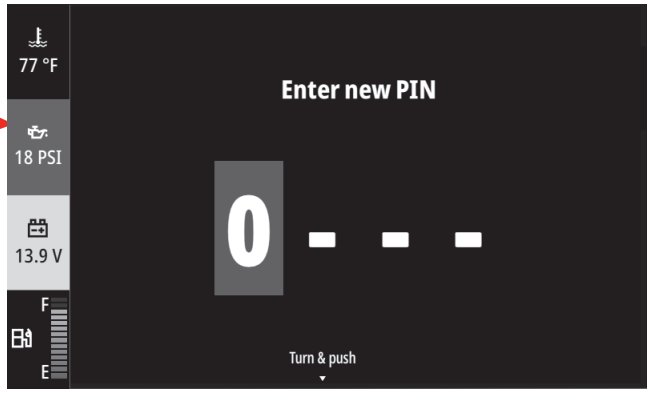
Do not forget the PIN (personal identification number)! The PIN may only be reset by a Lincoln authorized service shop.

The MANAGING RESTRICTIONS section of the settings menu may be used to restrict unauthorized access to the machine or operator access to the engine and settings menus. To enable restrictions, first set a Supervisor PIN and then set an Operator PIN. Use the knob to select each digit and press to accept it. To go back to the previous digits use the back button.

SUPERVISOR SECURITY - When the Supervisor PIN is enabled, the ENGINE and SETTING SCREENS may be restricted.

FIGURE B.19





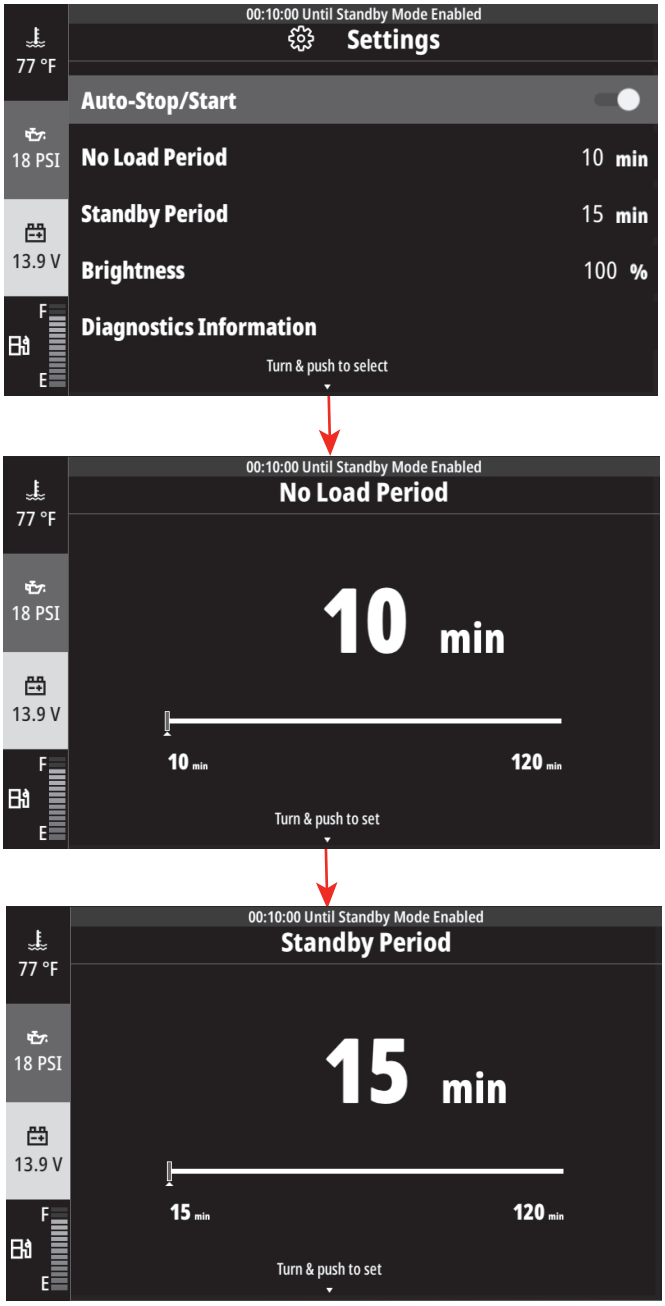
OPERATOR SECURITY - When the Operator PIN is enabled, the user interface will be locked and the engine will not start until the proper PIN has been entered. A time delay may be entered that will allow the user interface to remain unlocked and the machine to be restarted throughout the day without needing to reenter the PIN.

AUTO-STOP/START

Auto-Stop/Start is a feature that can help save significant fuel costs for users that do not weld continuously. When Auto-Stop/Start is enabled, the machine will automatically shut off the engine after a period of inactivity and remotely restart the engine when needed. To enable and use Auto-Stop/Start:

1. Enable Auto-Stop/Start in the Settings Menu.
2. Set the “No Load Period” (The period of time the engine will remain running without a load).
   a. Choose from 5 to 120 minutes in the Settings Menu
3. Set the “Standby Period” (The period of time the machine will allow a remote engine start before fully shutting down).
   a. Choose from 10 to 120 minutes in the Settings Menu
4. A countdown timer appears on the top of the user interface to indicate the remaining time until shutdown.

FIGURE B.20



To restart the engine remotely, tap the stick electrode to the work piece:

Stick Electrode

1. Tap and hold a stick electrode to the work piece for 0.1 to 1 second. Ensure that the electrode makes good electrical contact to the plate.
2. Pull electrode away from work piece and allow the engine to come up to speed

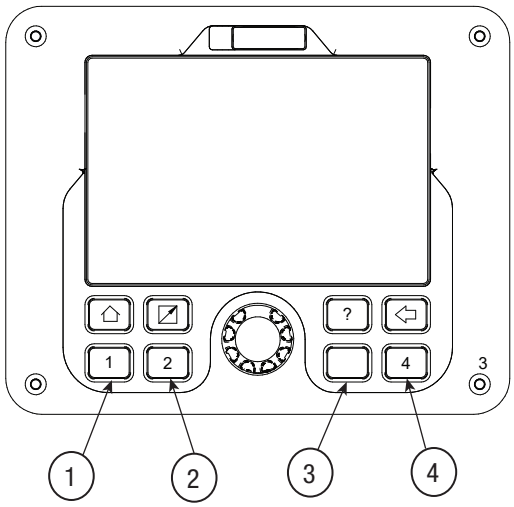
Note: Auto-Stop/Start will not work and will automatically be disabled if either the electrode is shorted to work when the engine shuts off or if welding electrode-negative polarity and the machine and the work piece share a common earth ground.

Additionally, the engine coolant temperature must be above 140° F (60°C) for before the engine will shutdown if Auto-Stop/Start is enabled.

MEMORY MODE OPERATION

The machine features 4 global memories slots, which can be used to save and recall settings. The operator can use the MEMORY MODE under the WELD MODE settings or the four buttons labelled 1 – 4 along the bottom of the user interface (See Figure B.21)

FIGURE B.21



To save a memory, hold the desired memory button until the screen indicates that the memory has been saved.

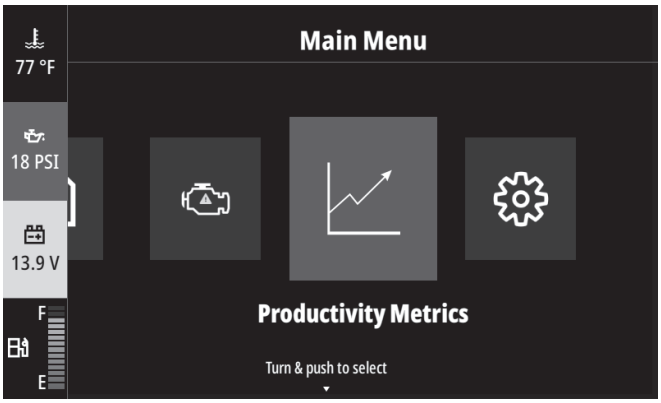
To recall a memory, press and release the desired memory button.

When a memory is selected, the corresponding memory LED will be lit. If any settings are changed, the LED will go out. The settings will revert to the saved values if the memory button is pressed again.

Memory usage with remote – If a memory is saved with a remote control connected, the remote control must be connected for the memory to function.

PRODUCTIVITY METRICS

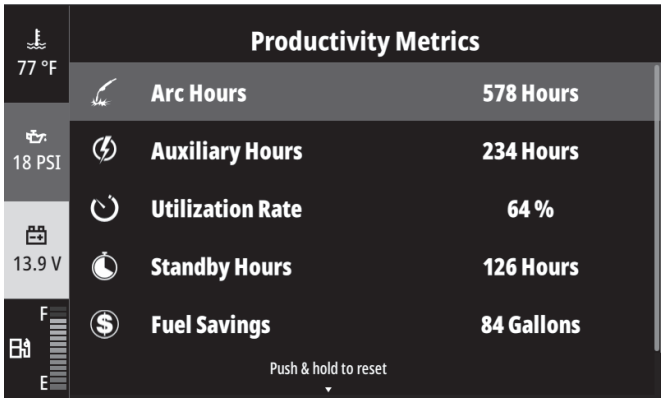
FIGURE B.22



The Productivity Metrics screen provides information and statistics on how the machine is being utilized. Five statistics are monitored:

- Arc Hours - Time spent using the machine for welding.
- Auxiliary Hours - Time spent using the auxiliary power on the machine.
- Utilization Percentage - Represents how efficiently the machine is being used. It shows the percentage of time the machine is being loaded with respect to the total hours on the machine.
- Standby Hours - The number of hours the machine is in Standby Mode.
- Fuel Saved w/ Auto-Start - The number of US gallons of fuel saved from utilizing the Auto-Stop/Start feature.

FIGURE B.23



In order to reset any of these metrics, rotate the knob until the desired item is highlighted in red. Then, press and hold the knob on the selected parameter for 5 seconds.

WELDER OPERATION

CROSSLINC® TECHNOLOGY

This machine has been equipped with CrossLinc® Technology to provide voltage and amperage control at the arc without the need for additional cables. CrossLinc technology allows for remote control of the welding output using the weld cables rather than a separate cable when connected to a CrossLinc compatible wire feeder or remote control.

To start CrossLinc, simply connect a CrossLinc enabled accessory to the machine using the standard weld power cable and the attached the sense lead from the accessory to work piece. When weld output is ON, the CrossLinc accessory will automatically link to the machine, and a CrossLinc indicator light will appear on both the accessory and machine to show active communication. No additional pairing of the machine to the device is needed.

When CrossLinc is active, the remote control is disabled and the CrossLinc device will set values remotely.

For Touch Start TIG applications, the machine should be placed on HIGH idle to ensure the most robust CrossLinc connection.

CrossLinc technology uses a communication protocol coupled in the electrode and work cables. For best performance the total voltage drop in the welding loop should be kept under 10V. CrossLinc is not compatible with High Frequency TIG. If high frequency is in the area, the cables need to routed as far as possible from each other. Also, follow all high frequency best practices, including a driven earth ground.

DUTY CYCLE

Duty cycle is the percentage of time the load is being applied in a 10 minute period. For example, a 60% duty cycle represents 6 minutes of load and 4 minutes of no load in a 10 minute period.

NOTE: The duty cycles for the IEC rated output and max output are listed on the rating plate of the machine.

PARALLELING

When paralleling machines in order to combine their outputs, all units must be operated in a constant current (CC) mode at the same output settings. To achieve this, select the STICK weld mode. Operation in other modes may produce erratic outputs, and large output imbalances between the units.

ARC GOUGING MODE

For optimal performance when arc gouging, select to the GOUGING weld mode and use the knob to adjust output current to the desired level for the gouging electrode being used according to the ratings in Table B.2 above.

For optimal performance when arc gouging, it is recommended to set the machine to HIGH IDLE.

NOTE: If desired the CV-WIRE mode can be used for arc gouging applications.

TABLE B.2

ELECTRODE DIAMETER	CURRENT RANGE DCEP (+)
1/8" (3.2 mm)	30-60 Amps
5/32" (4.0 mm)	90-150 Amps
3/16" (4.8 mm)	200-250 Amps
1/4" (6.4 mm)	300-400 Amps
5/16" (7.9 mm)	350-450 Amps

Maximum current setting is limited to 400 amps.

STICK (SMAW)

The Frontier® 400X can be used with a broad range of DC stick electrodes.

The Stick (SMAW) weld mode is designed for horizontal, vertical-up and over head welding with all types of stick electrodes, especially low hydrogen. Once the mode is selected, the output can be adjust by using the knob located on the user interface.

ARC FORCE sets the short circuit current during stick welding. Increasing the number from -10 (Soft) to +10 (Crisp) increases the short circuit current and prevents sticking of the electrode to the plate while welding. This can also increase splatter. It is recommended that the ARC FORCE be set to the minimum number without electrode sticking. Start with the knob set at 0.

TIG (GTAW)

The Frontier® 400X can be used in a wide variety of DC TIG welding applications.

Once TIG (GTAW) mode is selected, the operator has the option to select TOUCH START TIG or SCRATCH START from within the weld settings.

If TOUCH START TIG is selected, to initiate a weld, set the output to the desired current and the tungsten is touched to the work. During the time the tungsten is touching the work, there is very little voltage or current and, in general, this avoids tungsten contamination. Then, the tungsten is gently lifted off the work in a rocking motion, which establishes the arc.

To stop the arc, simply lift the TIG torch away from the work piece. When the arc voltage reaches approximately 30 volts, the arc will go out and the machine will automatically reset to the touch start current level. The tungsten may then be retouched to the work piece to restrike the arc. The arc may also be started and stopped with an amptrol or arc start switch.

NOTE: While using TOUCH START TIG mode, it is important to use the proper welding cable size to ensure expected performance levels.

If SCRATCH START is selected, the operator can scratch the tungsten against the work to initiate the arc.

Further, the operator can activate pulsed TIG by adjusting the frequency from “OFF” to a value between 0.1-20 Hz will turn on pulse TIG. The frequency changes the number of pulses per second. Pulse TIG can help to minimize burn through on thin materials by reducing the heat input.

If FREQUNCY is ON, the PERCENT PEAK CURRENT setting appears and allows the operator to change percentage of time spent at the peak current vs the background current. The operator can set the value from 5% up to 95%, which affects the amount of heat input into the weld. The default setting is 50%.

FLUX-CORED SELF-SHIELDED WIRE (FCAW-S), SELF-SHIELD GAS-SHIELDED WIRE (FCAW-G), AND MIG (GMAW) MODES

Connect a wire feeder to the Frontier™ 400X and set welder controls according to the instructions listed earlier in this section. The Frontier™ 400X permits it to be used with a broad range of flux cored wire (Innershield® and Outershield®) electrodes and solid wires for GMAW (MIG) welding. The machine features welding modes precisely tuned for each welding process. Once the welding mode has been selected, the welding can be fine adjusted using the PINCH setting. Turning the PINCH setting clockwise from -10 (soft) to +10 (crisp) changes the arc from soft and washed-in to crisp and narrow. It acts as an inductance control. The proper setting depends on the procedure and operator preference. Start with the knob set at 0.

PIPE (SMAW) MODE

****Only available on the Frontier 400X Pipe model****

The Pipe (SMAW) weld mode is designed specifically for downhill pipe welding applications to provide superior welding performance for cellulosic and low-hydrogen stick electrodes. Operators can utilize DigFX™ arc tuning controls to adjust for variabilities in the pipe and personal welding techniques.

Once the mode is selected, the output can be adjust by using the knob located on the user interface. DigFX™ is used to adjust response time of the machine to provide optimal arc and puddle characteristics. This setting provides the user with the ability to fine-tune the machine to fit the electrode, material, joint fit-up, and user technique. By changing the value towards -10 (Soft), the machine will create a softer welding arc with a more fluid puddle and less spatter, which is excellent for fill and cap passes as well as wide gaps. Meanwhile, by changing the value towards +10 (Stiff), the user will experience a stiffer welding arc with more drive and a narrow, fast-freezing puddle, which is excellent for root passes, especially with a tight or closed gap. The factory default setting is 0.

For best welding performance, the mode should be utilized with a 250 ft. (76.2 m) welding loop - 200 ft. (61.0 m) weld cable, 25 ft. (7.6 m) electrode holder, and 25 ft. (7.6 m) ground cable.

AUXILIARY POWER OPERATION

Start the engine and set the RUN / STOP / IDLE switch to the desired operating mode. Full power is available regardless of the welding control settings, if no welding current is being drawn.

The auxiliary power of the Frontier™ 400X consists of two 20 amp 120 VAC (5-20R) duplex receptacles with GFCI protection, one 50 amp 120/240 VAC single phase (14-50R) receptacle and one 50 amp 240 VAC three phase (15-50R) receptacle.

The auxiliary power capacity is 10,000 watts of 60 Hz, single phase power or 11,000 watts of 60 Hz, three phase power. The auxiliary power capacity rating in watts is equivalent to volt-amperes at unity power factor. The maximum permissible current of the 240 VAC output is 50 A. The 240 VAC single phase output can be split to provide two separate 120 VAC outputs with a maximum permissible current of 50 A per output to two separate 120 VAC branch circuits. Output voltage is within ± 10% at all loads up to rated capacity.

NOTE: The two 120V GFCI receptacles and the two 120V circuits of the 120/240V receptacle are connected to different phases and cannot be paralleled.

The auxiliary power receptacles should only be used with three wire grounded type plugs or approved double insulated tools with two wire plugs.

The current rating of any plug used with the system must be at least equal to the current capacity of the associated receptacle.

SIMULTANEOUS WELDING AND AUXILIARY POWER LOADS

The auxiliary power capacity previously stated is maintained without any welding load. If a welding load is present, the available auxiliary power will decrease.

Simultaneous welding and power loads are speciÿed in Table B.3. The permissible currents shown assume that current is being drawn from either the 120 VAC or 240 VAC supply (not both at the same time).

TABLE B.3

FRONTIER® 400X Simultaneous Welding and Power Loads

Weld		1 PHASE			3 PHASE			BOTH 1 & 3 PHASE	
Amps		WATTS	AMPS		WATTS	AMPS		WATTS	AMPS
0		10,000	42		11,000	27		10,000	-
100		8300	35		8500	20		8300	-
200	PLUS	5300	22	OR	5700	14	OR	5300	-
250		3500	15		3500	8		3500	-
300		400	2		800	2		400	-
400		0	0		0	0		0	0

TABLE B.4 FRONTIER® 400X PERKINS EXTENSION CORD LENGTH RECOMMENDATIONS

Current	Voltage	Load	Maximum Allowable Cord Length in ft. (m) for Conductor Size											
(Amps)	(Volts)	(Watts)	14 AWG		12 AWG		10 AWG		8 AWG		6 AWG		4 AWG	
15	120	1800	30	(9)	40	(12)	75	(23)	125	(38)	175	(53)	300	(91)
15	240	3600	60	(18)	75	(23)	150	(46)	225	(69)	350	(107)	600	(183)
20	120	2400			30	(9)	50	(15)	88	(27)	138	(42)	225	(69)
20	240	4800			60	(18)	100	(30)	175	(53)	275	(84)	450	(137)
25	240	6000					90	(27)	150	(46)	225	(69)	250	(76)
30	240	7200					75	(23)	120	(37)	175	(53)	300	(91)
38	240	9000							100	(30)	150	(46)	250	(76)
50	240	12000									125	(38)	200	(61)

Conductor size is based on maximum 2.0% voltage drop.

ACCESSORIES

CROSSLINC ACCESSORIES

LN-25X

True Voltage Technology (TVT) is now included with the LN-25X portable wire feeder. When used with a CrossLinc compatible power source, control cables are eliminated and voltage can be controlled right at the feeder. TVT compensates for voltage drop when using long welding power cables.

Order: K4267-2

Activ8X

Rugged, light-weight, portable across-the-arc wire feeder that fits up to an 8" dia. spool. Includes CrossLinc and TVT capability to remotely set voltage from the feeder without a control cable and to ensure the set voltage regardless of power cable lengths.

Order: K3519-1

Activ8X Pipe

Ideal pipeline solution for GMAW and FCAW welding applications in a rugged and compact design. Features root-to-cap weld processes – including STT® and Pulsed MIG – specifically optimized for cross country pipe welding.

Order: K4717-1

CrossLinc Remote

Utilized with CrossLinc compatible equipment to control output for CC-processes like stick or TIG welding. Remote control is added in-line with the welding power cable to allow for remote output control of the power source through the weld cable without additional control cables.

Order: K4345-1

GENERAL ACCESSORIES

Compact Medium Welder Trailer

Two-wheeled trailer with a standard 2" ball hitch for heavy-duty road, off-road, plant, and yard use. For highway use, consult applicable federal, state, and local laws regarding possible additional requirements. Optional fender and light package available.

K5270-1 Compact Medium Trailer

K5276-1 Fender Kit

K2640-2 Cable Rack

K5278-1 Spare Tire Kit

K5279-1 Fire Extinguisher Braket / Document Holder

Four-Wheeled Steerable Trailer

Four-wheeled trailer with a standard Duo-Hitch™ (2" Ball and Lunette Eye combination hitch) for plant and yard towing. Includes 13" wheels and an automatically engaging drawbar lock.

Order: K2641-2

Full KVA Power Plug Kit

Provides four 115V plugs rated at 20 amps each, and one dual voltage, full KVA plug rated at 115/230V, 50 amps.

Order: K802N

Full KVA Adaptor

Provides convenient connection through the full-KVA receptacle on engine-driven welders for portable power sources needing 240V AC 1-phase power (NEMA 6-50P).

Order: K1816-1

APEX® System Connector

A field install kit to add 5-pin and 4-pin to the front panel of the machine. Allows for capability with APEX systems for mechanized welding solutions.

Order: K5171-1

User Interface Protective Cover

Installed over the UI to provide extra protection against accidental impacts while on the jobsite or transporting the machine.

Order: K5226-1

Storage Cover

A flame retardant, mildew resistant, and water repellent cover to protect the engine drive when not in use.

Order: K5292-1

SERVICE KITS

Perkins® Engine Service Kit

One easy-to-purchase kit including all the needed engine filters to maintain peak welder performance. Includes air filter, fuel filter, oil filter, and fuel water separator.

Order: K3598-4

REMOTE CONTROLS

Remote Output Control

Portable control provides same dial range as the output control on the welder. The remote features a convenient 12-pin plug for easy connection to the welder.

Order: K857-2 25 ft (7.6 m)
K857-3 100 ft (30.4 m)

Remote Output Control w/ 120V Receptacles

Portable control features a convenient 12-pin plug for easy connection to the welder. Includes a detachable control box that can be stowed in a truck or job box to deter job site theft. The control box has a 120V duplex receptacle to power lights, grinders, and other tools right at the arc.

Order: K5312-1 125 ft (38.1 m)

12-pin to 6-pin Adaptor

Used to connect 6-pin remotes into the 12-pin connector on the front of the welder.

Order: K2909-1

Wireless Remote Control

A field installed kit to allow operators to add a wireless remote to the machine to switch between welding processes, adjust welding parameters, recall saved memories, and start/stop the machine from a distance.

Order: K5265-1

TIG ACCESSORIES

Pro-Torch PTA-26 TIG Torch

Air-cooled 200 amp torch (2 piece) equipped with valve for gas low control with 25 ft. (7.6 m) of cable length. Expendables parts kit available.

Order: K1783-9 PTA-26 TIG Torch
KP509 Magnum Parts Kit for PTA-26 TIG Torch

Foot Amptrol

Remote output control foot pedal for TIG welding with a 25 ft. (7.6 m) cable featuring a 12-pin connector.

Order: K870-2

Hand Amptrol

Remote output control hand control for TIG welding with a 25 ft. (7.6 m) cable featuring a 12-pin connector. Includes hook and loop straps to secure torch. (One size fits all Pro-Torch TIG Torches.)

Order: K963-4

Arc Start Switch

ON/OFF switch used for TIG welding when an Amptrol® is not used. Attaches to the TIG torch for convenient finger control - 25 ft. (7.6 m) of cable length.

Order: K814-2

WIRE FEEDERS & GUNS

K126 Pro Innershield® Gun

Feature replaceable liners, interchangeable backend, long life Magnum® PRO contact tips, improved heat resistant gun tubes, and better trigger lead protection. For self-shielded .062-5/64 in. (1.6-2.0 mm) wire with 15 ft. (4.5 m) cable. Includes K466-10 Connector Kit.

Order: K126-12

CABLE ACCESSORIES

Tweco® Adaptors

Allows for quick cable changeovers on the jobsite.

Order: K2487-1 Stud to Tweco Female Adapter – LENCO (CT-40FS)
K2946-1 Tweco Style Cam-Lock Adapter Plug for 2/0 (50 mm²) cable
K3416-70 Tweco Style Plug (Male, 1/0 thru 2/0)
K3416-90 Tweco Style Plug (Male, 3/0 thru 4/0)
K3417-70 Tweco Style Receptacle (Female, 1/0 thru 2/0)
K3417-90 Tweco Style Receptacle (Female, 3/0 thru 4/0)

POWER SOURCES

Square Wave TIG 200

Portable TIG and stick welding machine that provides smooth and stable AC TIG welding on aluminum and DC TIG welding on steel, stainless steel and chrome-moly.

Order: K5126-1

PowerMIG 210MP

Multi-process welder with MIG, stick, TIG, and flux-cored welding. The push-and-turn digital controls and color display screen make setup and operation intuitive and easy, while the all-metal wire drive and sturdy sheet-metal construction make it rugged and ready for any job. Runs off auxiliary power to provide an additional welding arc.

Order: K3963-1

Tomahawk 1000 Plasma Cutter

Cuts metal using the AC generator power from the engine-driven welder. Requires the T12153-10 Full-KVA Power Plug (NEMA 15-50P).

Order: K2808-1

Invertec V276

Proven, portable CC power source for Stick or TIG welding featuring digital weld meters. Runs off the auxiliary power to provide an additional welding arc.

Order: K4868-1

MAINTENANCE

SAFETY PRECAUTIONS

READ AND UNDERSTAND ENTIRE SECTION BEFORE OPERATING MACHINE.

⚠ WARNING

- **Have a qualified technician do the maintenance and troubleshooting work.**
- **Turn the engine off before working inside the machine.**
- **Remove guards only when necessary and replace them when the maintenance requiring their removal is complete.**
- **Always use the greatest care when working near moving parts.**

Read the Safety Precautions in front of this manual and the engine instruction manual before working on this machine.

Keep all equipment safety guards, covers and devices in position and in good repair. Keep hands, hair, clothing and tools away from V-belts, gears, fans and all other moving parts when starting, operating or repairing the equipment.

⚠ WARNING

HOT PARTS AND FLUID can burn or cause fire.

- **Do not touch hot parts with bare hands or allow hot fluid to contact skin.**
- **Allow equipment to completely cool before servicing.**
- **Handle hot parts using proper tools and wear heavy insulated welding gloves and clothing to prevent burns.**
- **Do not place unit on, over, or near combustible surfaces.**
- **Keep all flammable material away from unit**

⚠ WARNING

Before carrying out service, maintenance and/or repair jobs, fully disconnect power to the machine.

Use Personal Protective Equipment (PPE), including safety glasses, dust mask and gloves to avoid injury. This also applies to persons who enter the work area.

MOVING PARTS can injure.
• Do not operate with doors open or guards off.
• Stop engine before servicing.
• Keep away from moving parts.

Have qualified personnel do all maintenance and troubleshooting work.

ROUTINE AND PERIODIC MAINTENANCE

DAILY

- Check the engine oil level.
- Refill the fuel tank to minimize moisture condensation in the tank.
- Open the water drain valve located on the bottom of the water separator element 1 or 2 turns and allow to drain into a container suitable for diesel fuel for 2 to 3 seconds. Repeat the above drainage procedure until diesel fuel is detected in the container.
- Clean interior of machine with a low pressure air stream. Make a thorough inspection of all components.
- Look for signs of overheating, broken leads, or other obvious problems. Many problems can be uncovered with a good visiual inspection.

PERIODIC

Blow out the machine with low pressure air periodically. In particularly dirty locations, this may be required once a week.

BRUSH REMOVAL AND REPLACEMENT

It is normal for the brushes and slip rings to wear and darken slightly. Inspect the brushes when a generator overhaul is necessary.

⚠ WARNING

Do not attempt to polish slip rings while the engine is running.

ENGINE MAINTENANCE

Refer to the SERVICE PLAN section of the Engine Operator's Manual for the recommended maintenance schedule of the following:

a) Engine Oil and Filter

b) Air Cleaner

c) Fuel Filter and Delivery System

d) Alternator Belt

e) Battery

f) Cooling System

Refer to Table D.1 at the end of this section for various engine maintenance components.

AIR FILTER

⚠ WARNING

- **Excessive air filter restriction will result in reduced engine life.**
- **Never use gasoline or low flash point solvents for cleaning the air cleaner element. A fire or explosion could result.**
- **Never run the engine without the air cleaner. Rapid engine wear will result from contaminants, such as dust and dirt being drawn into the engine.**

The diesel engine is equipped with a dry type air filter. Never apply oil to it. Service the air cleaner per instructions on page D-3.

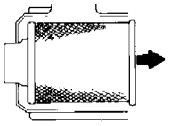
Replace the air filter element as needed per the service indicator. If no indicator is present, clean as needed and replace every 500 hours of operation. Under dusty conditions, replace sooner.

Service Instructions

Single- and Two-Stage Engine Air Cleaners

1 Remove the Filter

Rotate the filter while pulling straight out.

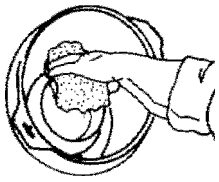


Unfasten or unlatch the service cover. Because the filter fits tightly over the outlet tube to create the critical seal, there will be some initial resistance, similar to breaking the seal on a jar. Gently move the end of the filter back and forth to break the seal then rotate while pulling straight out. Avoid knocking the filter against the housing.

If your air cleaner has a safety filter, replace it every third primary filter change. Remove the safety filter as you would the primary filter. Make sure you cover the air cleaner outlet tube to avoid any unfiltered contaminant dropping into the engine.

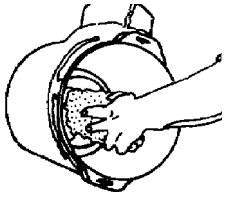
2 Clean Both Surfaces of the Outlet Tube and Check the Vacuator™ Valve

Use a clean cloth to wipe the filter sealing surface and the inside of the outlet tube. Contaminant on the sealing surface could hinder an effective seal and cause leakage. Make sure that all contaminant is removed before the new filter is inserted. Dirt accidently transferred to the inside of the outlet tube will reach the engine and cause wear. Engine manufacturers say that it takes only a few grams of dirt to "dust" an engine! Be careful not to damage the sealing area on the tube.



Outer edge of the outlet tube

Wipe both sides of the outlet tube clean.

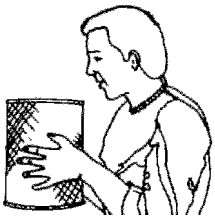


Inner edge of the outlet tube

If your air cleaner is equipped with a Vacuator Valve
Visually check and physically squeeze to make sure the valve is flexible and not inverted, damaged or plugged.

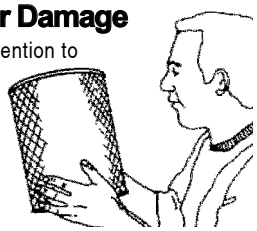
3 Inspect the Old Filter for Leak Clues

Visually inspect the old filter for any signs of leaks. A streak of dust on the clean side of the filter is a telltale sign. Remove any cause of leaks before installing new filter.



4 Inspect the New Filter for Damage

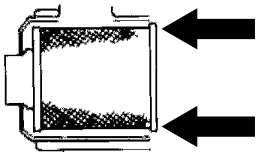
Inspect the new filter carefully, paying attention to the inside of the open end, which is the sealing area. NEVER install a damaged filter. A new Donaldson radial seal filter may have a dry lubricant on the seal to aid installation.



5 Insert the New Radial Seal Filter Properly

If you're servicing the safety filter, this should be seated into position before installing the primary filter.

Insert the new filter carefully. Seat the filter by hand, making certain it is completely into the air cleaner housing before securing the cover in place.



The critical sealing area will stretch slightly, adjust itself and distribute the sealing pressure evenly. To complete a tight seal, apply pressure by hand at the outer rim of the filter, not the flexible center. (Avoid pushing on the center of the urethane end cap.) No cover pressure is required to hold the seal. NEVER use the service cover to push the filter into place! Using the cover to push the filter in could cause damage to the housing, cover fasteners and will void the warranty.

If the service cover hits the filter before it is fully in place, remove the cover and push the filter (by hand) further into the air cleaner and try again. The cover should go on with no extra force.

Once the filter is in place, secure the service cover.

Caution

NEVER use the service cover to push the filter into place! Using the cover to push the filter in could cause damage to the housing, cover fasteners and will void the warranty.

6 Check Connectors for Tight Fit

Make sure that all mounting bands, clamps, bolts, and connections in the entire air cleaner system are tight. Check for holes in piping and repair if needed. Any leaks in your intake piping will send dust directly to the engine!

FUEL FILTERS

⚠ WARNING

When working on the fuel system

- **Keep naked lights away, do not smoke!**
- **Do not spill fuel!**

The Frontier® 400X is equipped with a fuel pre-filter / water separator before the electric lift pump and a fuel filter after the lift pump and before the injectors. Open the drain on the fuel pre-filter / water separator and drain out any water daily. Close drain when diesel fuel starts to come out. If excessive water is in the fuel, the engine will not start. The procedure for changing the filter is as follows.

1. Close the fuel shutoff valve.
2. Clean the area around the fuel filter head. Remove the filter. Clean the gasket surface of the filter head and replace the o-ring.
3. Fill the clean filter with clean fuel, and lubricate the o-ring seal with clean lubricating oil.
4. Install the filter as specified by the filter manufacturer.

⚠ WARNING

Mechanical over tightened will distort the threads, filter element seal or filter can.

COOLING SYSTEM

The cooling system of the engine needs to be checked and cleaned periodically. (Consult the Engine Owner's Manual for the proper procedures and frequency).

Coolant needs to be added at the radiator filler neck after removing cap when system is cool. Fill to top of filler neck. Engine will not start if coolant level is too low.

The coolant system is equipped with an internal expansion tank located inside the top radiator tank. This allows for normal thermal expansion and contraction of the engine coolant.

CHECKING AND REPLACING COOLANT

⚠ WARNING

HOT COOLANT can burn skin. Do not remove cap if radiator is hot.

Check the coolant level by observing the level in the radiator. Add 50/50 antifreeze / water solution if the level is low by removing the radiator cap and adding coolant into the radiator. Fill up to the tube in the radiator filler neck.

To drain the coolant, open the valve at the bottom of the radiator. Open the radiator cap to allow complete drainage. (Tighten the valve and refill with a 50/50 antifreeze/water solution.) Use an automotive grade (low silicate) ethylene glycol antifreeze. The cooling system capacity is 7.2 qts. (6.8L). Squeeze upper and lower radiator hoses while filling to bleed air from system coolant. Replace and tighten the radiator cap.

Periodically remove the dirt from the radiator fins.

Periodically check the fan belt and radiator hoses. Replace if signs of deterioration are found.

⚠ CAUTION

Always premix the antifreeze and clean tap water before adding to the radiator. It is very important that a precise 50/50 solution be used with this engine year round. This gives proper cooling during hot weather and freezing protection to -34° F (-37° C).

Cooling solution exceeding 50% ethylene glycol can result in engine overheating and damage to the engine. Coolant solution must be premixed before adding to radiator.

BATTERY HANDLING

⚠ WARNING

GASES FROM BATTERY can explode.

- **Keep sparks, flame and cigarettes away from battery.**

To prevent EXPLOSION when:

- **INSTALLING A NEW BATTERY - disconnect negative cable from old battery first and connect to new battery last.**
- **CONNECTING A BATTERY CHARGER - Remove battery from welder by disconnecting negative cable first, then positive cable and battery clamp. When reinstalling, connect negative cable last. Keep well ventilated.**
- **USING A BOOSTER - connect positive lead to battery first then connect negative lead to engine foot.**

BATTERY ACID CAN BURN EYES AND SKIN.

- **Wear gloves and eye protection and be careful when working near battery. Follow instructions printed on battery.**

PREVENTING ELECTRICAL DAMAGE

1. When replacing, jumping, or otherwise connecting the battery to the battery cables, the proper polarity must be observed. Failure to observe the proper polarity could result in damage to the charging circuit. The positive (+) battery cable has a red terminal cover.
2. If the battery requires charging from an external charger, disconnect the negative battery cable first and then the positive battery cable before attaching the charger leads. Failure to do so can result in damage to the internal charger components. When reconnecting the cables, connect the positive cable first and the negative cable last.

PREVENTING BATTERY DISCHARGE - Turn the RUN/STOP switch to stop when engine is not running.

PREVENTING BATTERY BUCKLING - Tighten nuts on battery clamp until snug.

CHARGING THE BATTERY -When you charge, jump, replace, or otherwise connect battery cables to the battery, be sure the polarity is correct. Improper polarity can damage the charging circuit. The Frontier® 400X positive (+) battery terminal has a red terminal cover.

If you need to charge the battery with an external charger, disconnect the negative cable first, then the positive cable before you attach the charger leads. After the battery is charged, reconnect the positive battery cable first and the negative cable last. Failure to do so can result in damage to the internal charger components.

Follow the instructions of the battery charger manufacturer for proper charger settings and charging time.

ENGINE OIL CHANGE

Drain the engine oil while the engine is warm to assure rapid and complete draining. It is recommended that each time the oil is changed the oil filter be changed as well.

- Be sure the unit is off. Disconnect the negative battery cable to ensure safety.
- Locate oil drain hose and valve in bottom of base and pull through the hole in the battery access panel on the welder.
- Remove the cap from the drain valve. Push valve in and twist counterclockwise. Pull to open and drain the oil into a suitable container for disposal.
- Close the drain valve by pushing in and twisting clockwise. Replace the cap.
- Re-fill the crankcase to the upper limit mark on the dipstick with the recommended oil. Replace and tighten the oil filler cap securely.
- Push oil drain hose and valve back into unit, re-connect negative battery cable, and close doors and engine top cover before restarting unit.Wash your hands with soap and water after handling used motor oil. Please dispose of used motor oil in a manner that is compatible with the environment. We suggest you take it in a sealed container to your local service station or recycling center for reclamation. DO NOT throw it in the trash, pour it on the ground, or down a drain.

SAE 10W-30 oil that meets API class CJ-4 or better is recommended for general, all temperature use, 5F to 104F (-15C to 40C).

See Engine Owner's Manual for more specific information on oil viscosity recommendations.

Oil Filter Change

- Drain the oil.
- Remove the oil filter with an oil filter wrench and drain the oil into a suitable container. Discard the used filter. Note: Care should be taken during filter removal to not disrupt or damage in any way the fuel lines.
- Clean the filter mounting base and coat the gasket of the new filter with clean engine oil.
- Screw the new filter on by hand until the gasket contacts the mounting base. Using an oil filter wrench, tighten the filter an additional 1/2 to 7/8 of a turn.
- Refill the crankcase with the specified amount of the recommended engine oil. Reinstall the oil filler cap and tighten securely.
- Start the engine and check for oil filter leaks.
- Stop the engine and check the oil level. If necessary, add oil to the upper limit mark on the dipstick.

TIGHTENING THE FAN BELT

If the fan belt is loose, the engine can overheat and the battery lose its charge. Check tightness by pressing on the belt midway between the pulleys. For tightness requirements, please refer to the Engine Owner's Manual.

NAMEPLATES / WARNING DECALS MAINTENANCE

Whenever routine maintenance is performed on this machine - or at least yearly - inspect all nameplates and labels for legibility. Replace those which are no longer clear. Refer to the parts list for the replacement item number.

ENGINE SERVICE

Perkins 403F-15T
24.7 HP
www.perkins.com

EVERY DAY OR EVERY 8 HOURS	FIRST SERVICE (20 / 50 HOURS)	EVERY 100 HOURS OR 3 MONTHS	EVERY 200 HOURS OR 6 MONTHS	EVERY 500 HOURS OR 12 MONTHS	EVERY 1000 HOURS OR ANNUALLY	ENGINE SERVICE (NOTE 2)	MAINTENANCE ITEM	TYPE OR QUANTITY
I							Coolant level	
			I				Concentration of antifreeze	50/50 Water/Ethylene Glycol
					R		Coolant (NOTE 3)	7.6 qt., 7.2 L
I							Engine oil level (NOTE 1)	
	R			R			Engine oil (NOTE 1 & 3)	6.5 qt., 6 L (including filter)
	R			R			Engine oil filter	Perkins #140517050
C							Drain water separator & fuel strainer	
				R			Water separator element	Donaldson #P502166 Lincoln #M20840-A
				R			Fuel filter canister	Perkins #4429491
			I				Tension of alternator drive belt	
			I				Alternator drive belt wear	
					R		Alternator drive belt	Perkins #T80109080
C							Air filter (earlier check may be req'd)	
				R			Air filter element	Donaldson #P822686 Lincoln #M19801-1A
					R		Renew the engine breather	
					I		Tighten cylinder head	
					I		Valve clearances	Intake .008", exhaust .008"
					I		Electrical systems	
					I		All nuts and bolts for tightness	
				I			Injector performance	Contact Perkins
I							Leaks or engine damage	
				I			Battery	BCI Group 34
					C		Clean turbocharger impeller casting and the turbocharger compressor casting	
							Engine Service Kit	K3598-4

I = Inspect **C** = Clean **R** = Replace

Notes:

(1) Consult Engine Operators Manual for oil recommendations.

(2) Consult Engine Operators Manual for additional maintenance schedule information.

(3) Fill slowly! Ensure correct quantity is used.

(4) Engine Service Kit includes oil filter, air filter, fuel filter & water separator element.

Above operations to be carried out by trained personnel with reference to the workshop manual where necessary.

These preventative maintenance periods apply to average conditions of operation. If necessary use shorter periods.

WARRANTY WORK PERFORMED ON THE ENGINE CONTAINED IN THIS MACHINE, IF NOT BILLABLE TO THE ENGINE MANUFACTURER, SHOULD BE PRE-APPROVED BY CALLING THE LINCOLN ELECTRIC COMPANY AT 888-935-3877

S33102 VM

GFCI MODULE

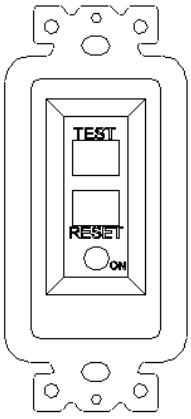
⚠ WARNING

- **An electric shock can result in serious injury or death.**
- **Always perform the GFCI test before using the generator. If the GFCI system fails the test, the machine must be repaired by an authorized service center.**
- **If the GFCI fails to trip when the test button is pressed ("ON" light does not go off or "STATUS light is RED) or fails to reset ("ON" light does not go on or "STATUS light is blinking) the device is inoperative and should be replaced immediately.**
- **If the GFCI tests properly without any appliance connected to it but trips each time an appliance is connected to it, the appliance has a ground fault and needs to be repaired or replaced. DO NOT USE THE APPLIANCE IF THIS CONDITION OCCURS: A REAL SHOCK HAZARD MAY EXIST.**
- **Due to the risk of power interruption, do not power life support equipment from this machine.**
- **GFCI's do not protect against short circuits or overloads.**
- **Unplug accessories and tools before attempting service.**
- **Close the front service doors protecting the receptacles when operating the machine.**
- **Do not test or reset the GFCI while at idle speed.**
- **If the LED blinks, stop using the GFCI receptacle and have it replaced by an authorized service center.**
- **Long extension cords or cords with poor insulation may allow enough leakage current to trip the GFCI.**

The GFCI module protects the (2) 120 VAC duplex receptacles. Two different types of modules are used in the machines.

Machines manufactured approximately September 2021 or earlier

The GFCI is an auto reset GFCI. It is identified by the "ON" LED located below the buttons.

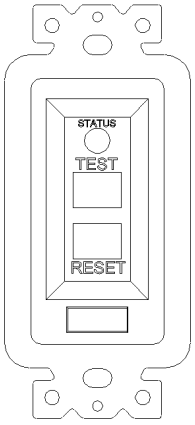


- Auto Reset: Immediately supplies power to the load when power is applied to the line.
- "ON" LED illuminates red when the load has power.

To test this GFCI, press the "TEST" button. The "ON" red LED should turn off. Then press the "RESET" button. The "ON" red LED should turn on. If the "ON" red LED does not turn off and on as indicated, the GFCI failed the test and should be replaced.

Machines manufactured approximately October 2021 or later

The GFCI is an auto reset, self-testing GFCI. It is identified by the "STATUS" LED located above the buttons.



- Auto Reset: Immediately supplies power to the load when power is applied to the line.
- "STATUS" LED illuminates Green when the GFCI is functioning properly.
- "STATUS" LED illuminates Red when the GFCI has "tripped". Press the reset button.
- "STATUS" LED illuminates flashing Red when the GFCI has failed and needs replaced.

While this GFCI has a self-testing feature, to manually test this GFCI, press the "TEST button. The "STATUS" LED should turn red. Then press the "RESET" button. The "STATUS" LED should turn green. If the "STATUS" LED does not turn red and green as indicated, or flashes red, the GFCI failed the test and should be replaced."

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FUNCTIONAL DESCRIPTION

The Frontier 400X is a diesel engine-driven welding power source capable of producing 400 amps at 26 VDC at a 60% duty cycle. The engine is coupled to a brush-type alternating current generator. This welding AC output is rectified and controlled by Chopper Technology to produce DC current for multi-purpose welding applications. The Frontier 400X is also capable of producing 10,000 watts of AC single phase auxiliary power at 100% duty cycle. It can also provide 11,000 watts of continuous AC three phase auxiliary power.

The welding control system uses state of the art Chopper Technology® for superior welding performance. The machine utilizes a robust 7" graphical user interface display for controls and advanced features.

The machine has been equipped with Crosslinc® Technology that enables communication between a wirefeeder and the Frontier for voltage control at the arc without the need for a control cable.

The Frontier 400X is made up of seven main circuits/components. They are the following:

- The Engine
- Engine Components, Sensors, Relays, and Controls
- The Stator/Rotor and Circuitry
- Auxiliary Power Circuitry
- Chopper Control PC Board
- LCD Display/User Interface
- 40V Bus Board

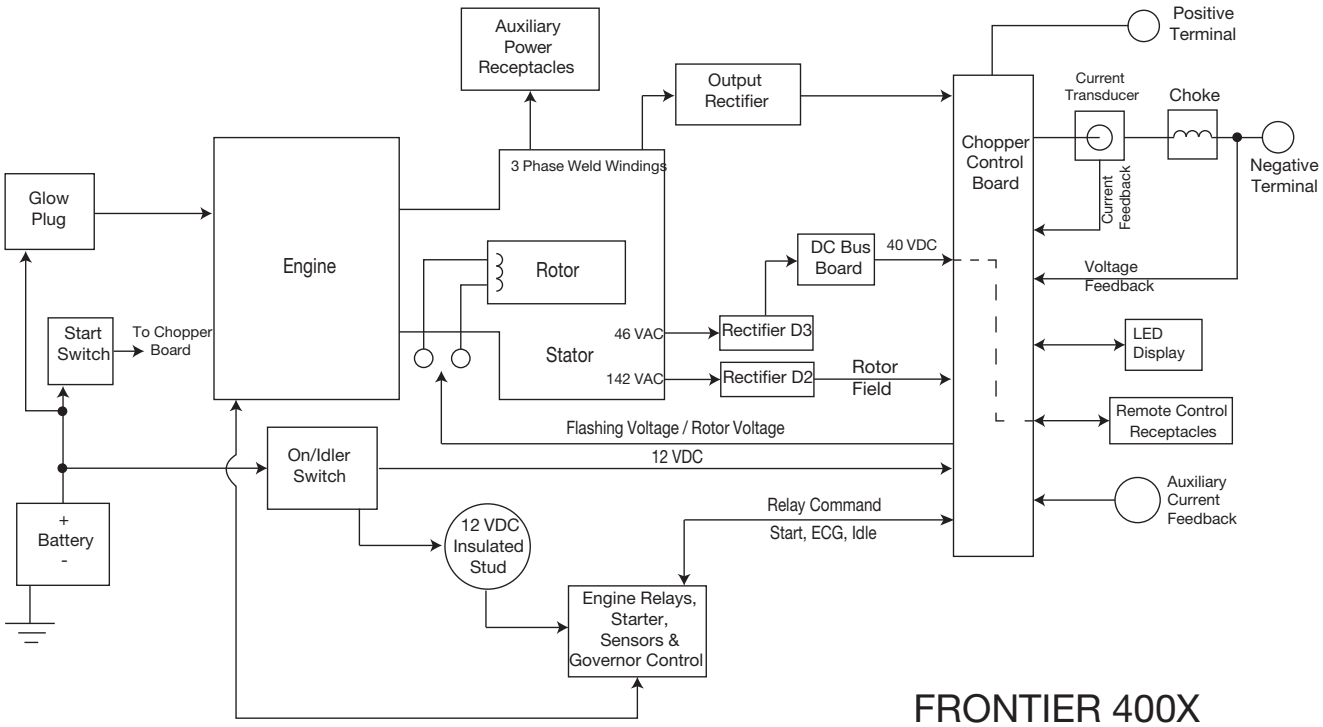


FIG. E.1

POWER UP

BATTERY, ENGINE, ROTOR/STATOR

The 12 VDC Battery supplies voltage to the Engine's glow plug switch, the start switch, and to the On/Off Idler Switch. The 12 VDC insulated stud is also supplied with battery voltage when the ON/Off Idler Switch is in the ON position. This 12 VDC insulated stud provides 12 VDC to the engine control relays. When the Engine, which is mechanically coupled to the Rotor, is started up and running the 12 VDC battery voltage is fed through the Chopper Control Board to the Rotor field coil via a brush and slip ring configuration. This excitation or "flashing" voltage magnetizes the Rotor lamination. The Chopper regulates the Rotor Field voltage. This rotating magnet induces a voltage in the stationary windings of the main stator. The engine will continue to stay running as long as the engine's sensors and controls are functioning normally.

The stator houses a three-phase winding for welding, a 120/240 VAC single phase tapped winding for auxiliary power, and a 240 VAC three phase winding for auxiliary power. Also, there is a 142 VAC winding, which is rectified by the D2 Diode Bridge, and applied to the Chopper Control Board for controlled rotor field voltage. Additionally there is 46 VAC winding that is rectified by the D3 Diode Bridge and applied to the 40V Bus Board. Another 46 VAC voltage is connected to the Chopper Control Board to monitor engine speed and stator output voltages.

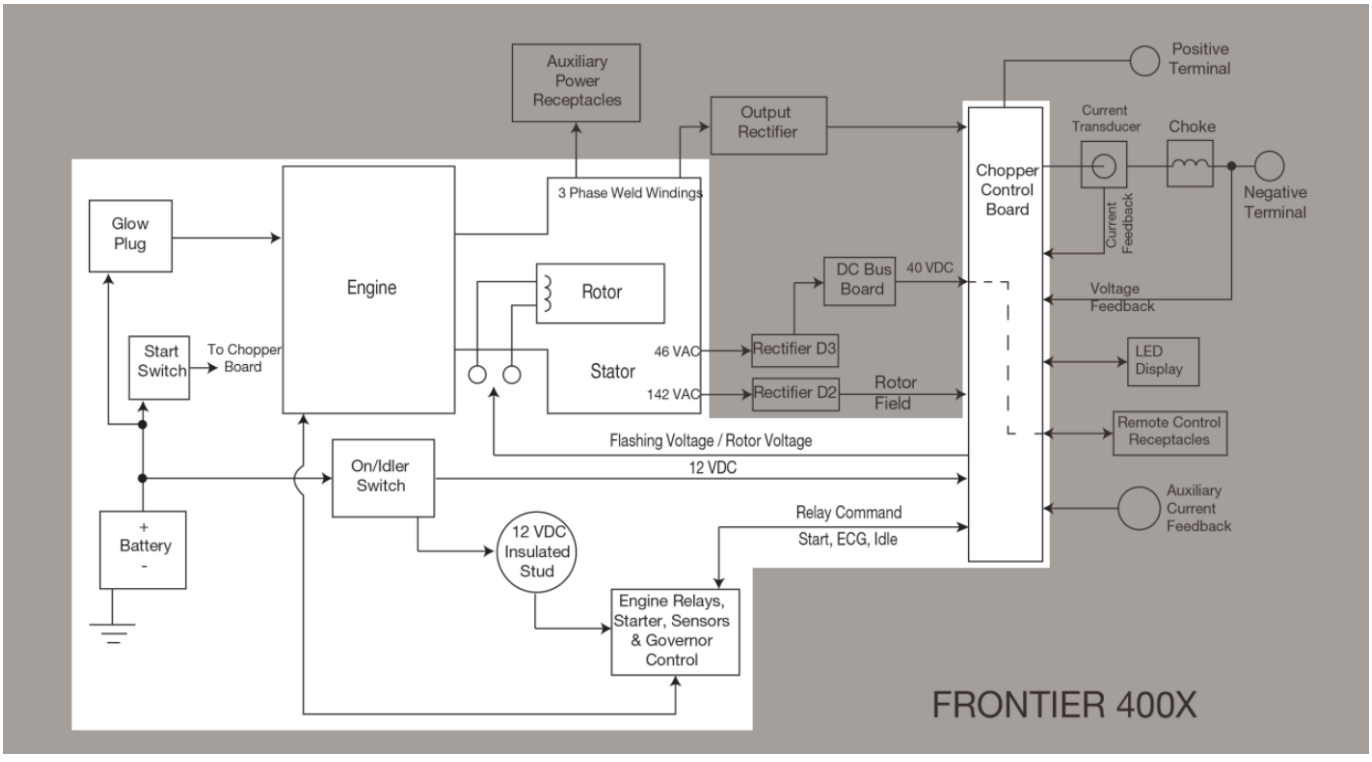


FIG. E.2

CONTROLS

LCD DISPLAY / USER INTERFACE

The display will turn on when the IDLE switch in placed into an ON position. Through the display, the operator can control the following settings within the machine:

- Add/Remove a PIN to control access to the machine
- Select weld mode and specific welding settings related to the weld mode such as remote control range, hot start, arc force, pinch, etc.
- Recall or save welding settings as memories for quick access.
- Check engine status – Includes engine hours, battery voltage, and remaining life for maintenance items
- Select machine settings such as units of measure, PIN options, hide/show weld modes and settings, set engine alerts, clock, language, etc.
- Enable/Disable auto-stop/start and adjust settings – Set No Load Period and Standby Period
- Diagnostics information – Lists machine serial number, engine serial number, code number, etc
- CC and CV test modes

The display will provide warning and fault notifications:

- Upcoming routing maintenance (Ex. Oil change required in XX hours).
- Machine faults – Ex. Low battery voltage, high oil pressure, high coolant temperature, etc.
- Standby countdown clock – If Auto-Stop/start is activated, the machine will countdown until for set period of time, then enter a “standby mode” once the period has elapsed with no activity (welding or auxiliary power)

ENGINE COMPONENTS, SENSORS, RELAYS AND CONTROLS

The Engine’s Alternator supplies charging current for the Battery Circuit. The Engine’s sensors will shut the engine off in the event of low oil pressure, or engine over temperature. The Engine Governor Controller controls the engine speed (low or high idle) dependent upon the signal from the CR1 Idle Relay. A Fuel Actuator and a Magnetic Pickup are also parts of the Sensors and Controls.

If no welding or auxiliary current is being drawn from the Frontier 400X the Chopper Control Board will activate the Idler Relay and the Engine Governor will take the Engine to low idle speed (1400 RPM). When output is sensed, either weld or auxiliary, the Chopper Control Board deactivates the Idler Relay and the Engine Governor will take the Engine to a high idle state (1800 RPM).

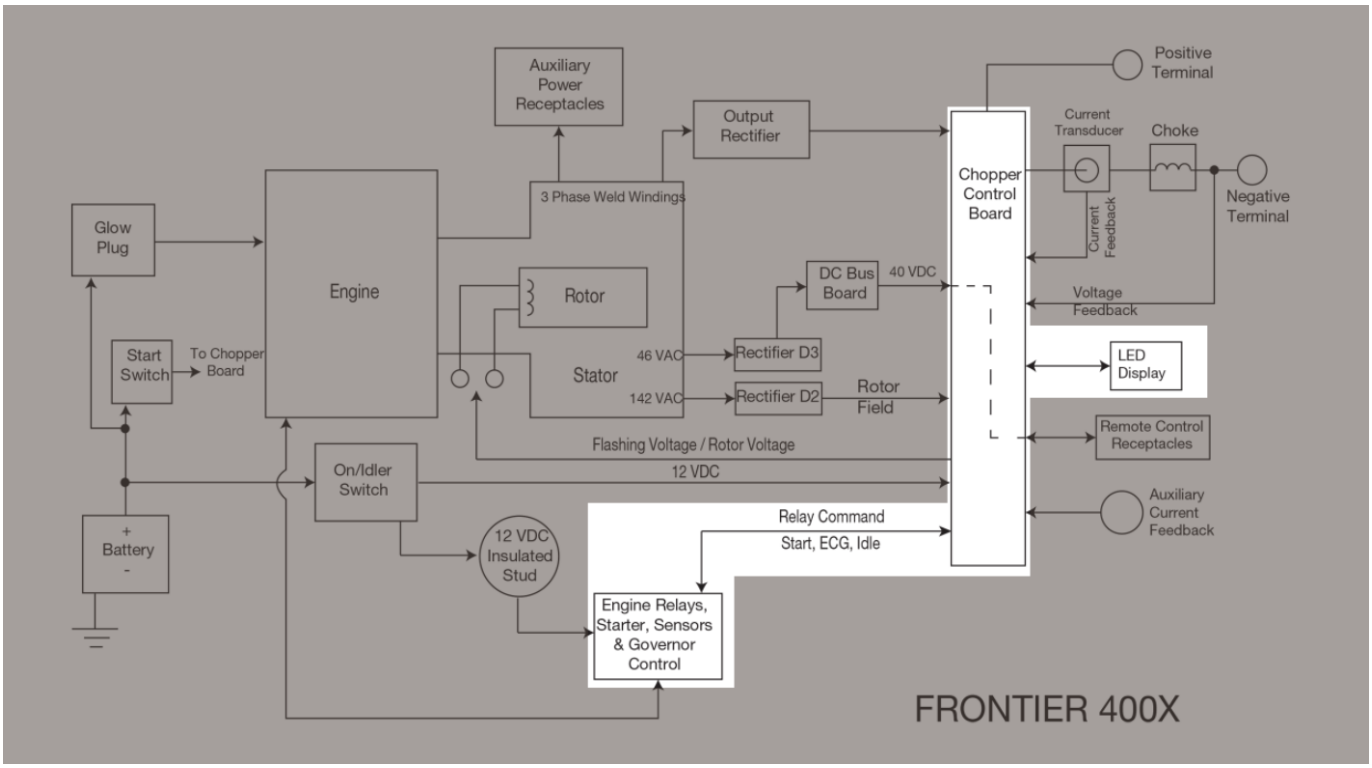


FIG. E.3

OUTPUT

OUTPUT RECTIFIER, CHOPPER CONTROL BOARD, OUTPUT CHOKE, DC BUS BOARD, AND, CURRENT TRANSDUCER (LEM)

The three phase stator weld windings are connected to a three phase rectifier bridge. The resultant DC voltage is applied to the capacitor/chopper circuitry that is incorporated within the Chopper Control Board. The capacitors function as filters and also power supplies for the chopper IGBTs. See IGBT Operation in this section. The IGBTs are high speed switches operating at 40 KHZ. These devices are switched on and off the by signals generated within the Chopper Control Board. See Pulse Width Modulation in this section. This “chopped” DC output is applied to the output terminal through a Choke and a Current transducer (LEM). The Choke functions as a current filter. Free- wheeling diodes are incorporated in the chopper circuitry to provide a current path for the stored energy in the choke when the IGBTs are in the off state. See Chopper Technology in this section. Output voltage and current (Current Transducer) feedback is sent to the Chopper Control Board for processing and control. The Chopper Control Board has many functions as follows:

- Receives input voltage from the 40 VDC Board that is passed through to the remote receptacles.
- Applies 12 VDC battery voltage to various components/circuits when required.
- Supplies flashing and field voltage to the Rotor.
- Interfaces with the remote receptacles.
- Supplies power to the LCD Display/User Interface and communicates through CAN.
- Monitors both welding current (LEM feedback) and auxiliary current (Toroid).
- Determines how the welding output should be controlled based on user commands (from the LCD Display/User Interface and voltage/ current feedback) to optimize the welding results. It sends the correct PWM signals to the IGBT driver circuitry.
- Interfaces with the Engine components and commands the various relays.

The D3 rectifier receives 46 VAC from a stator winding. The 40V Bus Board receives 59 VDC from the D3 rectifier circuit. The DC Bus Board produces a regulated 40 VDC that is applied to the Chopper Control Board and via the Chopper Board to the remote control receptacles.

AUXILIARY POWER

The 120/240 VAC single phase tapped windings, located in the stator, are connected to the appropriate receptacles located on the machine’s case front. The 240 VAC three phase windings are also connected to the appropriate receptacle located on the case front. All of these tapped auxiliary supplies are protected by circuit breakers and the 120 VAC circuit is protected by ground fault circuit interrupters (GFCI).

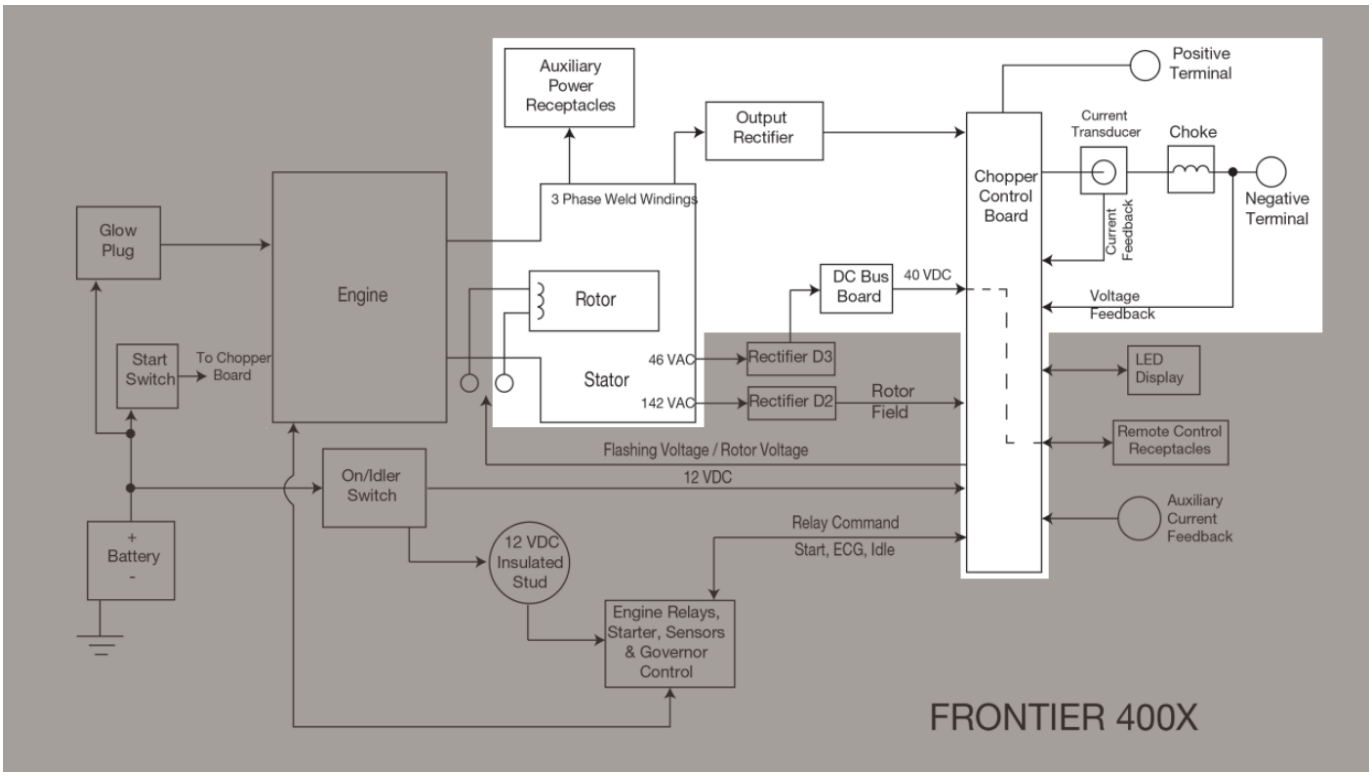


FIG. E.4

PROTECTIONS

AUXILIARY POWER

The auxiliary power supplies are protected from over current conditions by the following circuit breakers. The 240 VAC supplies, both three phase and single phase, are protected by CB1 a three pole 50 amp circuit breaker. The two 120 VAC receptacles are protected by CB2 and CB3, both are 20 amp circuit breakers.

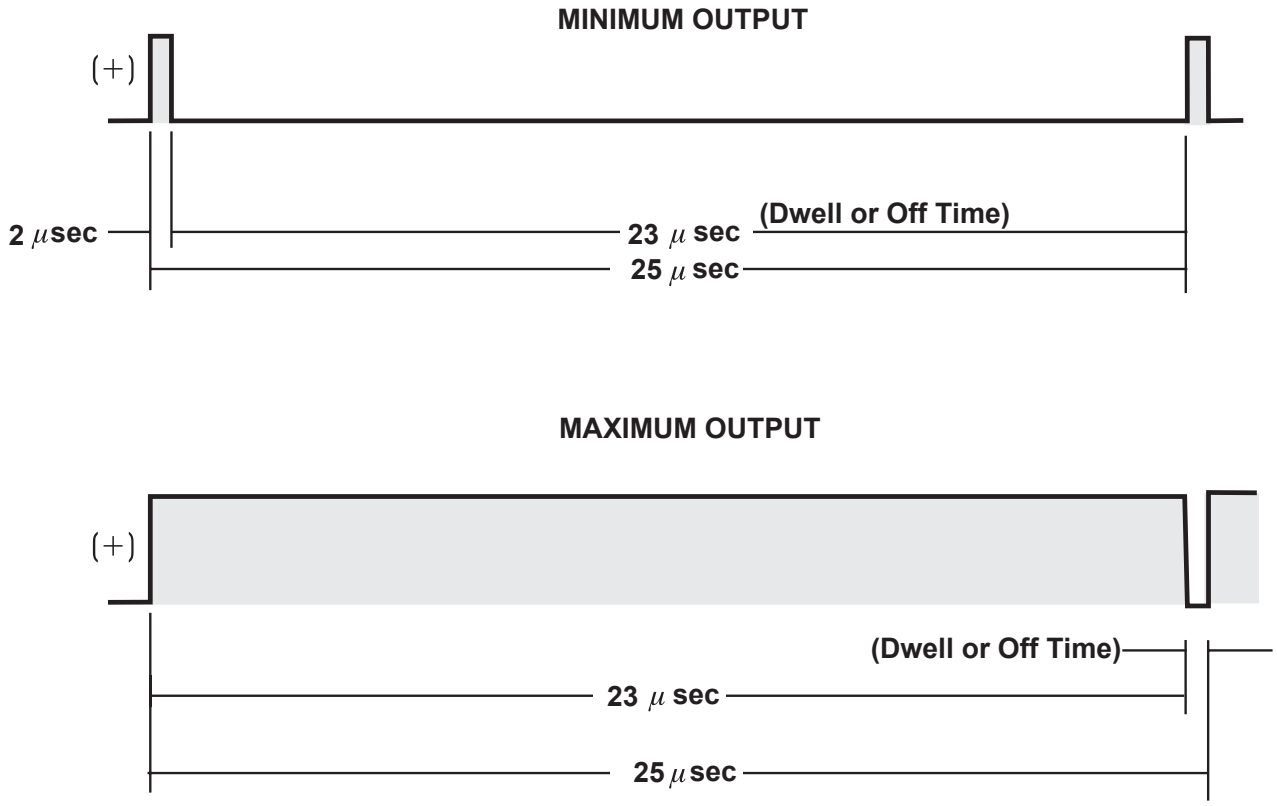
WELDING CURRENT

Based on the feedback from the current transducer (LEM) the welding current will be limited to a maximum of 550 amps. The Chopper Control Board will not allow the maximum welding current to be exceeded.

ENGINE PROTECTION

In the case of low oil pressure, or high coolant temperature, the engine will shut down. The engine is also protected from excessive low or high RPM.

TYPICAL IGBT OUTPUTS



PULSE WIDTH MODULATION

The term PULSE WIDTH MODULATION is used to describe how much time is devoted to conduction in the cycle. Changing the pulse width is known as MODULATION. Pulse Width Modulation (PWM) is the varying of the pulse width over the allowed range of a cycle to affect the output of the machine.

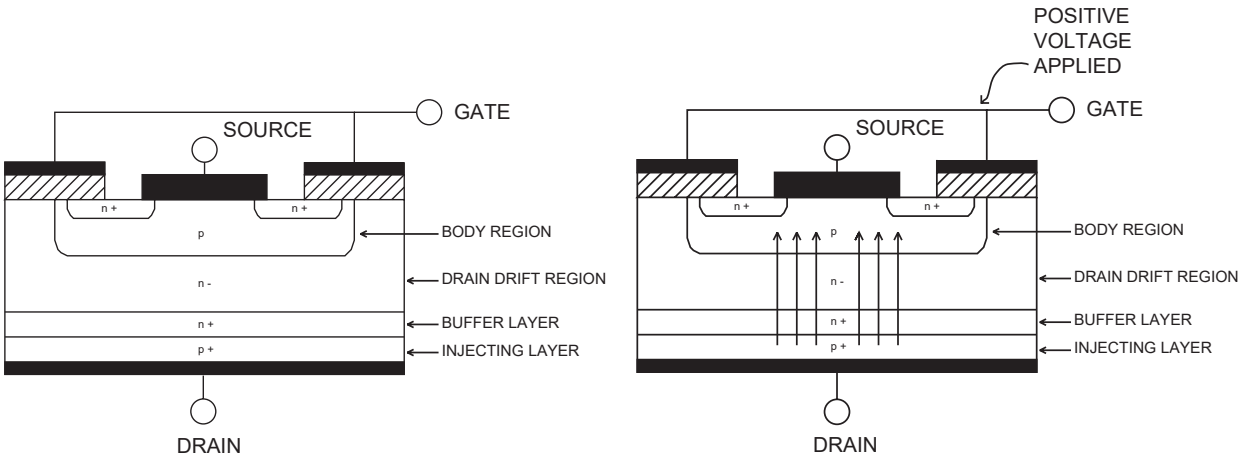
MINIMUM OUTPUT

By controlling the duration of the gate signal, the IGBT is turned on and off for different durations during a cycle. The top drawing shows the minimum output signal possible over a 25-microsecond time period. The positive portion of the signal represents one IGBT group conducting for 2 microsecond. The dwell time (off time) is 23 microseconds. Since only 2 microseconds of the 25-microsecond time period is devoted to conducting, the output power is minimized.

MAXIMUM OUTPUT

By holding the gate signals on for 23 microseconds and allowing only 2 microseconds of dwell time (off time) during the 25-microsecond cycle, the output is maximized. The darkened area under the top curve can be compared to the area under the bottom curve. The more darkened area under the curve, the more power is present.

IGBT OPERATION



INSULATED GATE BIPOLAR TRANSISTOR (IGBT) OPERATION

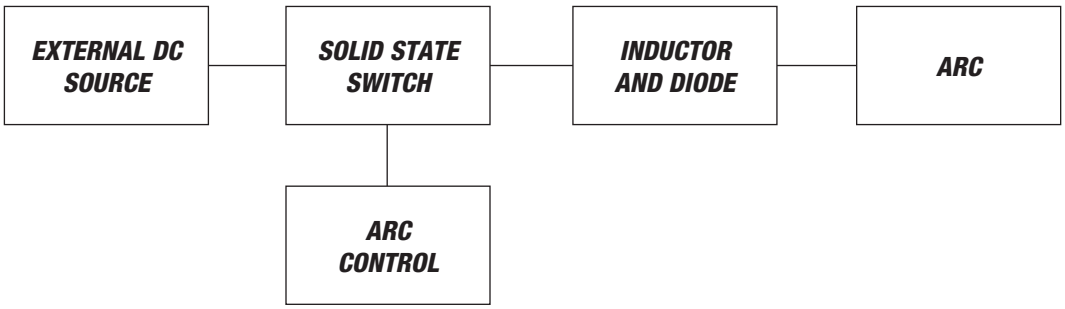
An IGBT is a type of transistor. IGBTs are semiconductors well suited for high frequency switching and high current applications.

Drawing A shows an IGBT in a passive mode. There is no gate signal, (zero volts relative to the source) and therefore, no current flow. The drain terminal of the IGBT may be connected to a voltage supply; but since there is no conduction the circuit will not supply current to components connected to the source. The circuit is turned off like a light switch in the OFF position.

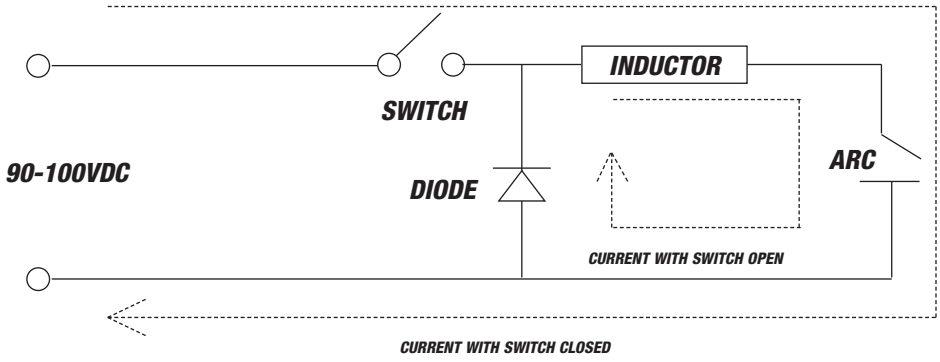
Drawing B shows the IGBT in an active mode. When the gate signal, a positive DC voltage relative to the source, is applied to the gate terminal of the IGBT, it is capable of conducting current. A voltage supply connected to the drain terminal will allow the IGBT to conduct and supply current to circuit components coupled to the source. Current will flow through the conducting IGBT to downstream components as long as the positive gate signal is present. This is similar to turning ON a light switch.

CHOPPER TECHNOLOGY FUNDAMENTALS

The new era of welding machines such as the Frontier 400X, employ a technology whereby a DC source is turned on and off (chopped up) at high speed, then smoothed through an inductor to control an arc. Hence the name “Chopper.” The biggest advantage of chopper technology is the high-speed control of the arc, similar to the inverter machines. A block diagram for this is as follows:



In this system, the engine drives a three-phase alternator, which generates power that is rectified and filtered to produce approximately 90-100VDC. The current is applied through a solid state switch to an inductor. By turning the switch on and off, current in the inductor and the arc can be controlled. The following diagram depicts the current flow in the system when the switch is open and closed.



When the switch is closed, current is applied through the inductor to the arc. When the switch opens, current stored in the inductor sustains flow in the arc and through the diode. The repetition rate of switch closure is 40Khz, which allows ultra-fast control of the arc. By varying the ratio of on time versus off time of the switch (Duty Cycle), the current applied to the arc is controlled. This is the basis for Chopper Technology: Controlling the switch in such a way as to produce superior welding.

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TROUBLESHOOTING

HOW TO USE TROUBLESHOOTING GUIDE

⚠ WARNING

Service and Repair should only be performed by Lincoln Electric Factory Trained Personnel. Unauthorized repairs performed on this equipment may result in danger to the technician and machine operator and will invalidate your factory warranty. For your safety and to avoid Electrical Shock, please observe all safety notes and precautions detailed throughout this manual.

This Troubleshooting Guide is provided to help you locate and repair possible machine malfunctions. Simply follow the three-step procedure listed below.

The following "problems/symptoms" are a guide to solving issues that may be obvious with welding equipment. This document is not intended to be comprehensive. For further assistance see the Theory of Operation Section in this manual.

Step 1. LOCATE PROBLEM (SYMPTOM).

Look under the column labeled "PROBLEM (SYMPTOMS)". This column describes possible symptoms that the machine may exhibit. Find the listing that best describes the symptom that the machine is exhibiting.

Step 2. POSSIBLE CAUSE.

The second column labeled "POSSIBLE CAUSE" lists the obvious external possibilities that may contribute to the machine symptom.

Step 3. RECOMMENDED COURSE OF ACTION

This column provides a course of action for the Possible Cause, generally it states to contact your local Lincoln Authorized Field Service Facility.

If you do not understand or are unable to perform the Recommended Course of Action safely, contact your local Lincoln Authorized Field Service Facility.

If for any reason you do not understand the test procedures or are unable to perform the tests/repairs safely, contact your Lincoln Authorized Service Facility for technical troubleshooting assistance before you proceed.
WWW.LINCOLNELECTRIC.COM/LOCATOR

Observe all Safety Guidelines detailed throughout this manual

PROBLEMS (SYMPTOMS)	POSSIBLE CAUSE	RECOMMENDED COURSE OF ACTION
POWER UP PROBLEMS		
Major mechanical or electrical damage is evident.	1. Contact your local Lincoln Authorized Field Service Facility.	1. Contact the Lincoln Electric Service Department at 1-888-935-3877.
The Engine will not crank when the start button is pushed.	1. Make sure the On/Idle/ Stop Switch is set to Auto or High Idle 2. Make sure the CB5 Circuit Breaker is closed. 3. Check the Battery and Connections. 4. Check for loose or faulty connections at the 12 VDC insulated Stud.	1. Perform the **Start Button Test**. 2. Perform the **CB5 Circuit Breaker Test.** 3. Perform the **On/Idle/Stop Switch Test**. 4. Perform the **CR2 Relay Test**. 5. Perform the **Starter Motor Test**. 6. The Chopper Control Board May be Faulty.
The Engine will crank but not start when the start button is pressed.	1. Make sure the glow Plug Button is pressed. 2. Make sure there is adequate fuel in the tank. 3. Check for loose or faulty connections at the 12 VDC insulated Stud. 4. If the engine is cranking slow the battery may need charged. 5. Make sure the fuel shut off is in the open position.	1. Perform the **Glow Button Test.** 2. Perform the **CR3 Relay Test.** 3. Perform the **Electronic Governor Controller Test**. 4. The Chopper Control Board May be Faulty.
The Engine starts but shuts down shortly after starting.	1. Check to make sure there is sufficient oil in the engine. 2. The engine coolant temperature may be too high. 3. Make sure there is sufficient fuel in the tank.	1. Perform the **Electronic Governor Controller Test**.
The Engine will not shut off.	1. Make sure the On/Idle/Stop Switch is in the off position	1. Perform the **On/Idle/Stop Switch Test.** 2. Perform the **CR2 Relay Test.** 3. The Chopper Control Board May be Faulty.

If for any reason you do not understand the test procedures or are unable to perform the tests/repairs safely, contact your Lincoln Authorized Service Facility for technical troubleshooting assistance before you proceed.
WWW.LINCOLNELECTRIC.COM/LOCATOR

Observe all Safety Guidelines detailed throughout this manual

PROBLEMS (SYMPTOMS)	POSSIBLE CAUSE	RECOMMENDED COURSE OF ACTION
OUTPUT PROBLEMS		
No welding output or auxiliary power. The engine operates normally.	1. Check the brushes for wear and proper contact to the slip rings. 2. Check for damaged welding output terminals, auxiliary receptacles and associated wiring. See the Wiring Diagram.	*1.* Perform the ***Rotor Test.*** *2.* Perform the ***D2 Diode Test.*** *3.* Perform the ***Stator Windings Test.*** *4.* The Chopper Control Board May be Faulty.
There is no welding output in any mode. The auxiliary power is normal and the engine operates normally.	1. Disconnect any external control cables. If the problem is solved there may be a problem with the cables or accessories.	1. Check for broken or faulty leads in the weld current carrying path between the Chopper Control Board and the welding output terminals. See the Wiring Diagram. 2. Perform the ***D1 3 Phase Rectifier Test.*** 3. Perform the ***L1 Choke Test.*** 4. Perform ***the Stator Winding Test.*** 5. The Chopper Control Board May be Faulty. 6. The UI Display Board may be faulty.
There is no auxiliary power at one or more of the receptacles. The welding output is normal and the engine runs normally.	1. Ensure the auxiliary power circuit breakers are not tripped. 2. Check for loose or faulty connections at the receptacles, the circuit breakers, and the ground fault circuit interrupters. See the Wiring Diagram.	1. Perform ***the CB1,CB2, and CB3 Circuit Breakers Tests.*** 2. Perform ***the Auxiliary Receptacles Test.*** 3. Perform the ***GFCI Tests***. 4. Perform the ***Stator Winding Test.***
The machine has low welding voltage output and low auxiliary voltage output.	1. Make sure engine is running at high speed (1800 RPM)	1. If the engine will not go to 1800 RPM perform the ***CR1 Relay Test, and the On/Idle/Stop Switch Test.*** 2. Perform the ***Rotor Test.*** 3. Perform the ***D2 Diode Test.*** 4. Perform the ***Stator Winding Test.*** 5. The Chopper Control May be Faulty.

If for any reason you do not understand the test procedures or are unable to perform the tests/repairs safely, contact your Lincoln Authorized Service Facility for technical troubleshooting assistance before you proceed.
WWW.LINCOLNELECTRIC.COM/LOCATOR

Observe all Safety Guidelines detailed throughout this manual

PROBLEMS (SYMPTOMS)	POSSIBLE CAUSE	RECOMMENDED COURSE OF ACTION
OUTPUT PROBLEMS cont.		
The machine will weld but the welds are "COLD". The engine runs at normal speed and the auxiliary power is normal.	1. If maximum welding output cannot be obtained check for loose or faulty connections at the high current carrying conductors. See the wiring diagram. 2. Check the external welding cables for loose or faulty connections.	1. Perform the ***D1 3 Phase Rectifier Test.*** 2. Perform the ***Stator Winding Test.*** 3. Perform the ***Current Transducer Test.*** 4. Perform the ***L1 Choke Test.*** 5. The UI Display Board may be faulty. 6. The Chopper Control Board May be Faulty.
The welding output cannot be controlled.	1. Make sure no accessories are connected to either of the remote receptacles.	1. Perform the ***Current Transducer Test.*** 2. The Chopper Control May be Faulty. 3. The UI Display Board may be faulty.
There is no 40VDC present at the Remote Receptacles.	1. Check for loose or faulty connections at leads #51A, #51B, #52A and #52B. See the wiring diagram.	1. Perform the ***D3 Diode Test.*** 2. Perform the ***CB4 Circuit Breaker Test.*** 3. Perform the ***40V Bus Board Test.***
FUNCTION PROBLEMS		
The Engine will not Idle down to low speed. (1400) when the ON/Idler Switch is in the AUTO position and no output current is being drawn from the weld terminals or the auxiliary receptacles. Open Circuit Voltage and auxiliary output is normal when ON/Idler Switch is in the HIGH position.	1. Make sure the On/Idle/Stop Switch is in the Auto position.	1. Perform the ***On/Idle/Stop Switch Test.*** 2. Perform the ***CR1 Relay Test.*** 3. Perform the ***Electronic Governor Controller Test.*** 4. Perform *the* ***Current Transducer Test.*** 5. The Chopper Control Board May be Faulty.
The Engine will not go to high speed (1800RPM) when attempting to weld and the ON/Idler Switch is in the AUTO position. Open Circuit Voltage and auxiliary output is normal when ON/Idler Switch is in the HIGH position.	1. Check for loose or faulty connections at the output terminals and the weld cables.	1. Perform the ***CR1 Relay Test.*** 2. Perform the ***On/Idle/Stop Switch Test.*** 3. Perform the ***Electronic Governor Controller Test.*** 4. Perform *the* ***Current Transducer Test.*** 5. The Chopper Control Board may be faulty***.***

If for any reason you do not understand the test procedures or are unable to perform the tests/repairs safely, contact your Lincoln Authorized Service Facility for technical troubleshooting assistance before you proceed.
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Observe all Safety Guidelines detailed throughout this manual

PROBLEMS (SYMPTOMS)	POSSIBLE CAUSE	RECOMMENDED COURSE OF ACTION
FUNCTION PROBLEMS cont.		
The Engine will not go to high speed (1800RPM) when drawing current from the auxiliary receptacles. ON/Idler Switch is in the AUTO position. Open Circuit Voltage and auxiliary output is normal when ON/Idler Switch is in the HIGH position.	1. Make sure at least one ampere of current is being drawn from the auxiliary receptacles.	1. Perform the ***CR1 Relay Test.*** 2. Perform the ***On/Idle/Stop Switch Test.*** 3. Perform the ***Electronic Governor Controller Test*.** 4. The auxiliary power sensing toroid may be faulty. Check leads #261 and #260 for loose or faulty connections. See the wiring diagram. 5. The Chopper Control Board May be Faulty.
The battery does not stay charged. The Engine runs normally.	1. The battery may be faulty. 2. The Engine's fan belt may be loose.	1. Perform the ***D4 Diode Test.*** 2. Perform the ***Alternator Test.***
The Engine speed (RPM) cannot be controlled. Runs faster or slower when the ON/Idle switch is in the HIGH position.	1. Make sure the On/Idle/Stop Switch is in the correct position.	1. Perform **the *Engine Governor Controller Test.***

If for any reason you do not understand the test procedures or are unable to perform the tests/repairs safely, contact your Lincoln Authorized Service Facility for technical troubleshooting assistance before you proceed.
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TEST PROCEDURES

HOW TO USE THE TEST REFERENCE CHART

⚠ WARNING

Service and Repair should only be performed by Lincoln Electric Factory Trained Personnel. Unauthorized repairs performed on this equipment may result in danger to the technician and machine operator and will invalidate your factory warranty. For your safety and to avoid Electrical Shock, please observe all safety notes and precautions detailed throughout this manual.

The Test Reference Chart is a nonspecific, operations based troubleshooting aide intended to identify components involved in a particular machine function. The left side of the chart consists of a listing of all major components in the machine. Across the top of the chart the three main machine functions are listed. This chart is provided to help you quickly identify possible faulty components, simply identify the particular function and refer to its specified column for a list of its related components. Simply follow the steps below.

Step 1. IDENTIFY MACHINE FUNCTION

There will be three columns with a "MACHINE FUNCTION" listed at the top. You can choose from "POWER UP", "PRIMARY OUTPUT" or 'AUXILIARY OUTPUT". Choose the column that best describes the symptom that the machine is exhibiting a problem with. Examples are as follows:

- POWER UP - machine wont turn on, blows fuses, no display
- PRIMARY OUTPUT - no welding output, no wire feed, cannot control output, poor welding characteristics
- AUXILIARY OUTPUT - does not power feeder, no power from 120V receptacle,

Step 2. IDENTIFY RELATED COMPONENTS

If a component is used in a particular "MACHINE FUNCTION" it will be marked in the corresponding column. These components serve a purpose for the identified "MACHINE FUNCTION" and could be related to the symptom identified as a possible faulty component.

RELATED COMPONENT LIST	MACHINE FUNCTION FRONTIER 400X/400X PIPE		
	POWER UP	WELDING OUTPUT	AUXILIARY OUTPUT
BATTERY	X		
ALTERNATOR	X		
D4	X		
ON/IDLE/STOP SWITCH	X		
START BUTTON	X		
CB5	X		
CR2	X		
CR3	X		
STARTER	X		
GLOW PLUG BUTTON	X		
CHOPPER CONTROL BOARD	X	X	X
E.G.C.	X		
D2		X	X
ROTOR		X	X
STATOR		X	X
D1 3 PHASE RECTIFIER		X	
L1 CHOKE		X	
CR1		X	X
CURRENT TRANSDUCER		X	
CB1			X
CB2			X
CB3			X
CB4			X
D3			X
40V BUS BOARD			X
AUXILIARY RECEPTACLES			X

If for any reason you do not understand the test procedures or are unable to perform the tests/repairs safely, contact your Lincoln Authorized Service Facility for technical troubleshooting assistance before you proceed.

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Refer to Safety pages for explanation of hazards:

40V BUS BOARD TEST PROCEDURE

TEST DESCRIPTION:

This procedure will determine the proper function of the 40V Bus Board using Active tests.

MATERIALS NEEDED:

3/8” wrench
Digital Multi-Meter
Wiring Diagram
Machine Schematic
Required P.P.E.

TEST PROCEDURE:

1. The 40V Bus Board is located on the back side of the front panel. It can be accessed from the right side of the machine, for physical orientation of the 40V Bus Board refer to Figure F.1.

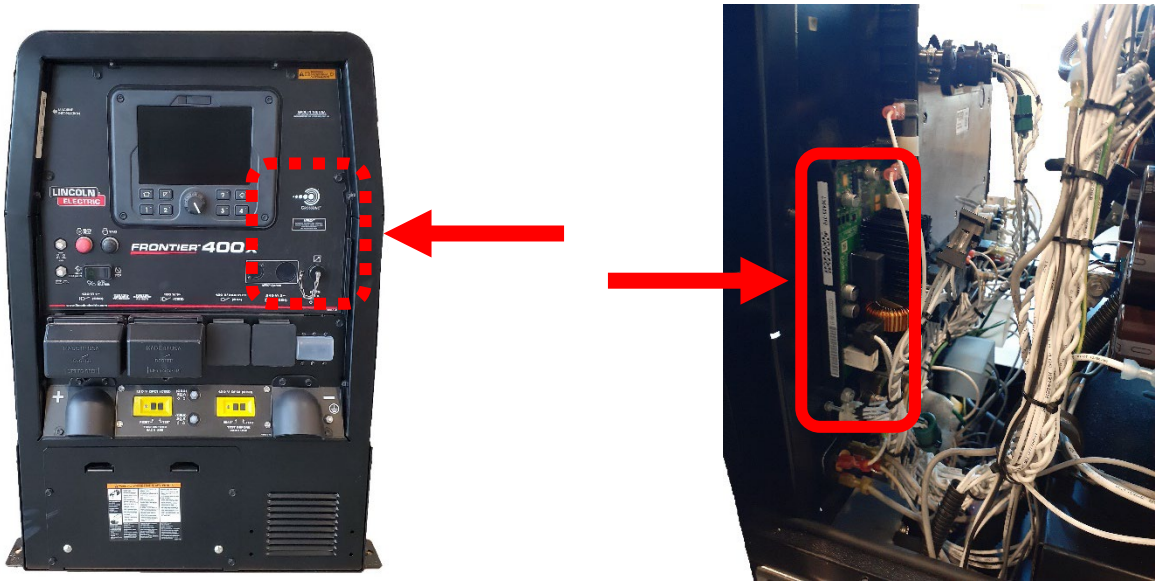


Figure F.1

2. Perform the “Case Cover Removal” as required to gain access to the 40V Bus Board for testing.

3. Perform the Active Testing.

A. ACTIVE TESTING

A.1. Remove any external accessories plugged into the S2 (5 pin) and S1 (12 pin) amphenols.

A.2. Ensure the engine is running and “ON/Idle/Stop” switch set to high idle.

A.3. Locate and observe LED 1, refer to Figure F.2.

- If LED 1 is illuminated (red) and constant proceed to Step 4.
- If LED 1 is NOT illuminated, proceed with the Active Testing below.

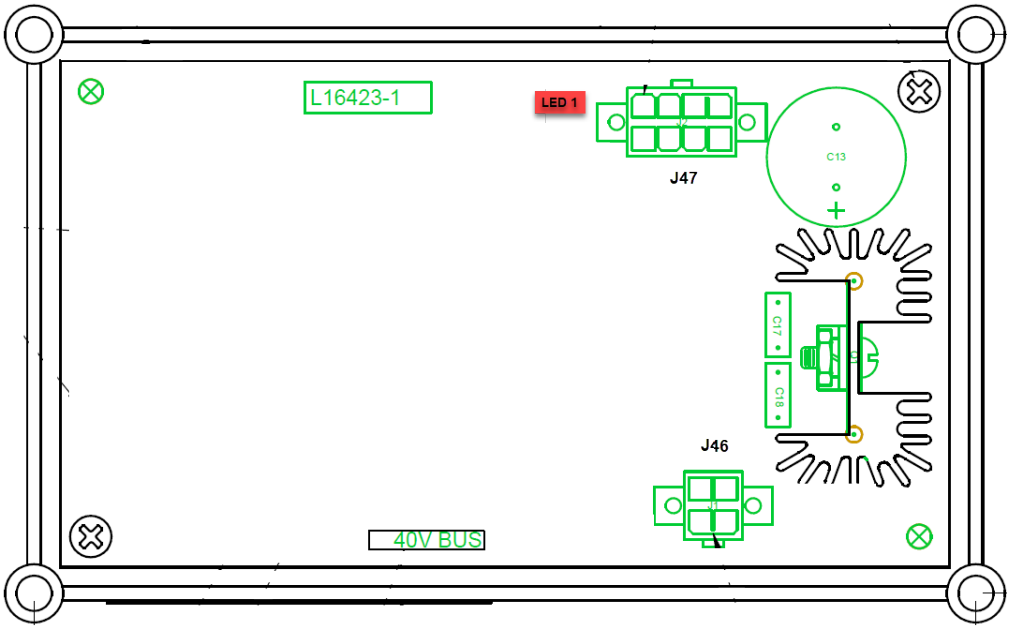


Figure F.2

A.4. Using a Digital Multi-Meter (set to DC) perform the measurements identified in Test Table 1 below, refer to Figure F.2 for test point locations.

40VDC Bus Board Active Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
40V Bus Board Input	ON/Idle/Stop Switch set to High Idle.	J46 - 2	J46 - 3	~55 VDC

Table 1

A.5. If all measurements are correct and LED 1 is not illuminated it indicates a defective 40V Bus Board that will require replacement, refer to “40VDC Bus Board Removal and Replacement” procedure.

4. If problems with the machine persist, refer to the “Test Reference” chart for other possible faulty components.

Refer to Safety pages for explanation of hazards:

ALTERNATOR TEST PROCEDURE

TEST DESCRIPTION:
This procedure will determine proper function of the Alternator using Active tests.

MATERIALS NEEDED:
3/8” wrench
1/2” wrench
Digital Multi-Meter
Wiring Diagram
Machine Schematic
Required P.P.E.

TEST PROCEDURE:
1. The Alternator is in front of the fan shroud towards the rear of the machine, on the left side and can be accessed from left side of the machine, for physical orientation of the Alternator refer to Figure F.1.

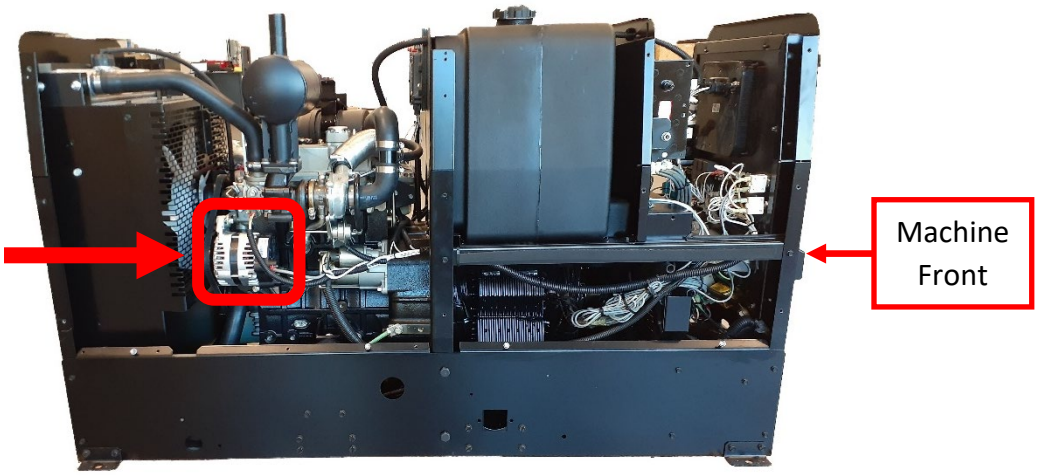


Figure F.1

2. Perform the “Case Cover Removal” as required to gain access to the Alternator for testing.

3. Perform the Active testing.

A. ACTIVE TESTING

A.1. Ensure the engine is running and “On/Idle/Stop” switch set to “High Idle”.

A.2. Using a Digital Multi-Meter (set to DC) perform the measurements identified in Test Table 1 below, refer to Figure F.2 for test point locations.

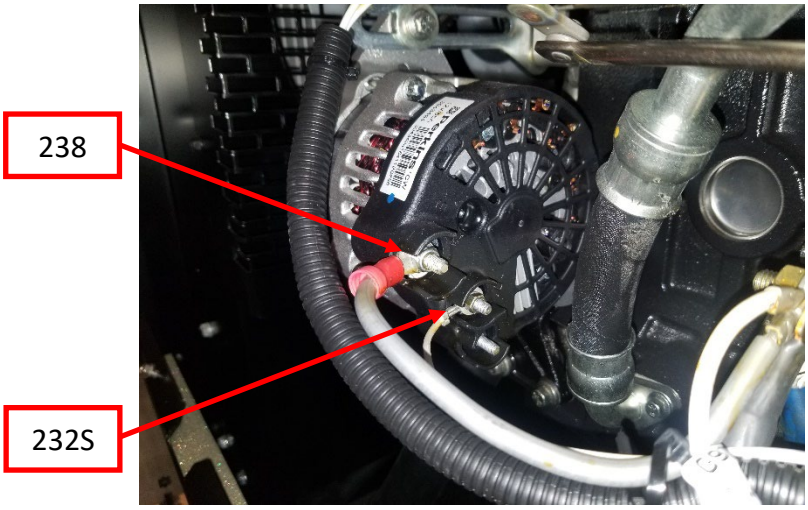


Figure F.2

Engine Alternator Active Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
Alternator Charging	Engine running. On/Idle/Stop Switch Set to High Idle.	Positive Terminal	Negative Terminal	13.7 VDC - 14.2 VDC
Alternator Charging	Engine running. On/Idle/Stop Switch Set to High Idle.	Lead 238 ALT (B+)	Chassis Ground	13.7 VDC - 14.2 VDC
Alternator Charging	Engine running. On/Idle/Stop Switch Set to High Idle.	Lead 232S (D+)	Chassis Ground	13.7 VDC - 14.2 VDC

Table 1

A.3. If any measurement is incorrect this component may be faulty.

4. If problems with the machine persist, refer to the “Test Reference” chart for other possible faulty components.

Refer to Safety pages for explanation of hazards:

CB1 CIRCUIT BREAKER TEST

TEST DESCRIPTION

This procedure will determine proper function of the CB1 circuit breaker using Static and Active tests.

MATERIALS NEEDED

3/8” wrench
Phillips head screw driver
Digital Multi-Meter
Wiring Diagram
Machine Schematic
Recommended P.P.E.

TEST PROCEDURE:

1. The CB1 circuit breaker is located on the front panel. It can be accessed from the right side of the machine, for physical orientation of CB1 circuit breaker refer to Figure F.1.

Figure F.1

2. Perform the “Case Cover Removal” as required to gain access to CB1 for testing.

3. Perform the Static and Active Testing.

A. STATIC TESTING

A.1. Ensure the engine is not running and the “On/Idle/Stop” switch is in the “Stop” position and that CB1 is in the UP (not tripped) position.

A.2. Label and disconnect the following CB1 connections from behind the front panel, for physical location of connections refer to Figure F.2.

- Lead 3
- Lead 4
- Lead 6
- Lead 3B
- Lead 4A
- Lead 6C

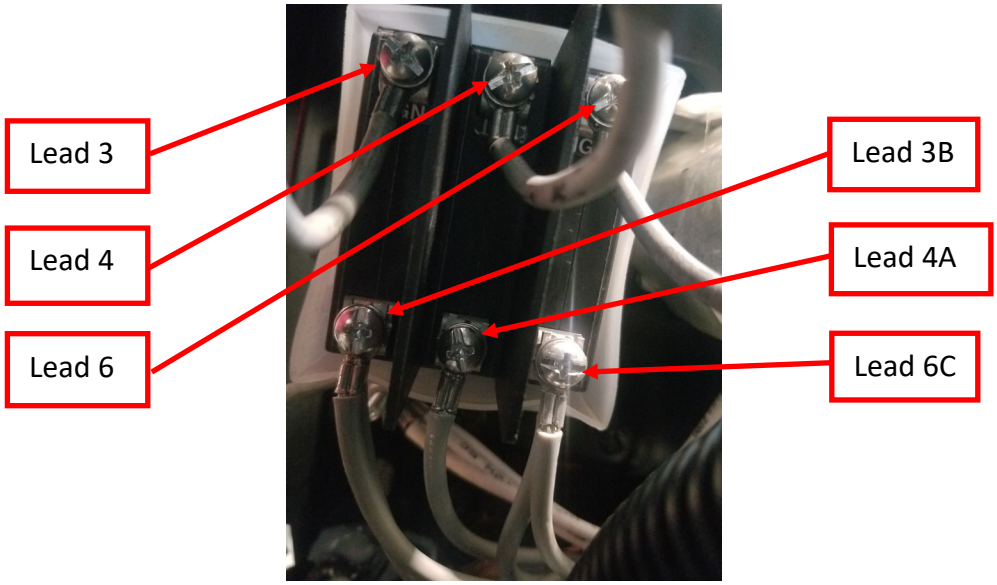


Figure F.2

A.3. Using a Digital Multi-Meter (set to resistance) perform the measurements identified in Test Table 1 below, refer to Figure F.2 for test point locations.

Circuit breakers Static Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
CB1	Engine not running CB1 Not Tripped	Terminal 3	Terminal 3B	<1 Ohm
CB1	Engine not running CB1 Not Tripped	Terminal 4	Terminal 4A	<1 Ohm
CB1	Engine not running CB1 Not Tripped	Terminal 6	Terminal 6C	<1 Ohm

Table 1

A.4. If measurements are correct reconnect all connections removed in “Step A.2” and proceed to “B. ACTIVE TESTING”.

A.5. Any failed measurement indicates a defective CB1 circuit breaker that will require replacement.

B. ACTIVE TESTING

B.1. Ensure the engine is running and “On/Idle/Stop” switch set to high idle and that CB1 is UP (not tripped) position.

B.2. Using a Digital Multi-Meter (set to AC) perform the measurements identified in Test Table 2 below, refer to Figure F.3 for test point locations.

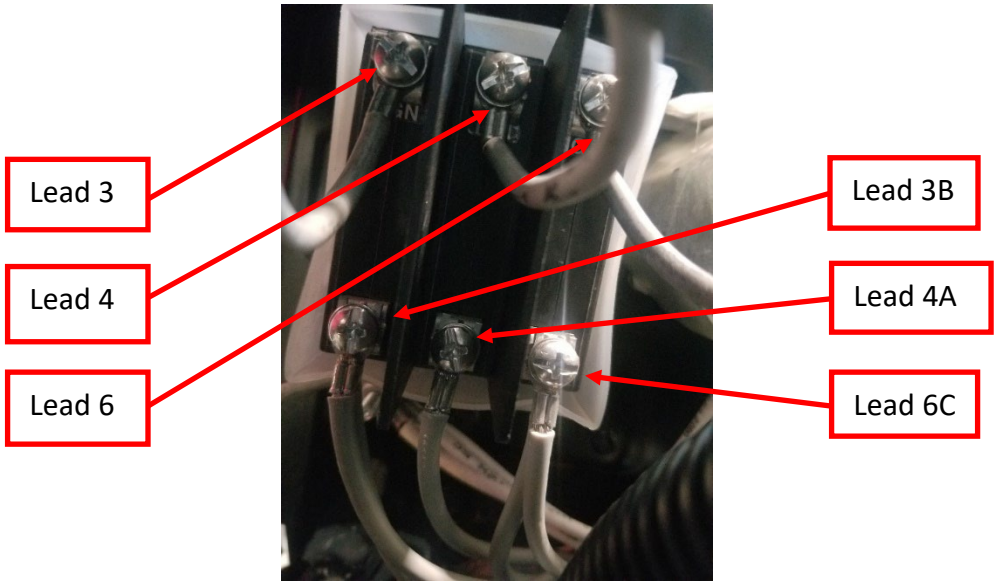


Figure F.3

Circuit breakers Active Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
CB1 Input	Engine running CB1 Not Tripped	Terminal 3	Terminal 6	~240 VAC
CB1 Input	Engine running CB1 Not Tripped	Terminal 3	Terminal 4	~240 VAC
CB1 Input	Engine running CB1 Not Tripped	Terminal 4	Terminal 6	~240 VAC
CB1 Output	Engine running CB1 Not Tripped	Terminal 3B	Terminal 4A	~240 VAC
CB1 Output	Engine running CB1 Not Tripped	Terminal 4A	Terminal 6C	~240 VAC
CB1 Output	Engine running CB1 Not Tripped	Terminal 6C	Terminal 3B	~240 VAC

Table 2

B.3. If the input measurements are correct and the output measurement are not correct this component may be faulty.

4. If problems with the machine persist, refer to the “Test Reference” chart for other possible faulty components.

Refer to Safety pages for explanation of hazards:

CB2 CIRCUIT BREAKER TEST

TEST DESCRIPTION

This procedure will determine proper function of the CB2 circuit breaker using Static and Active tests.

MATERIALS NEEDED

3/8” wrench
5/16” wrench
Digital Multi-Meter
Wiring Diagram
Machine Schematic
Recommended P.P.E.

TEST PROCEDURE:

1. The CB2 circuit breaker is located on the front panel. It can be accessed by removing the GFCI panel, for physical orientation of CB2 circuit breaker refer to Figure F.1.

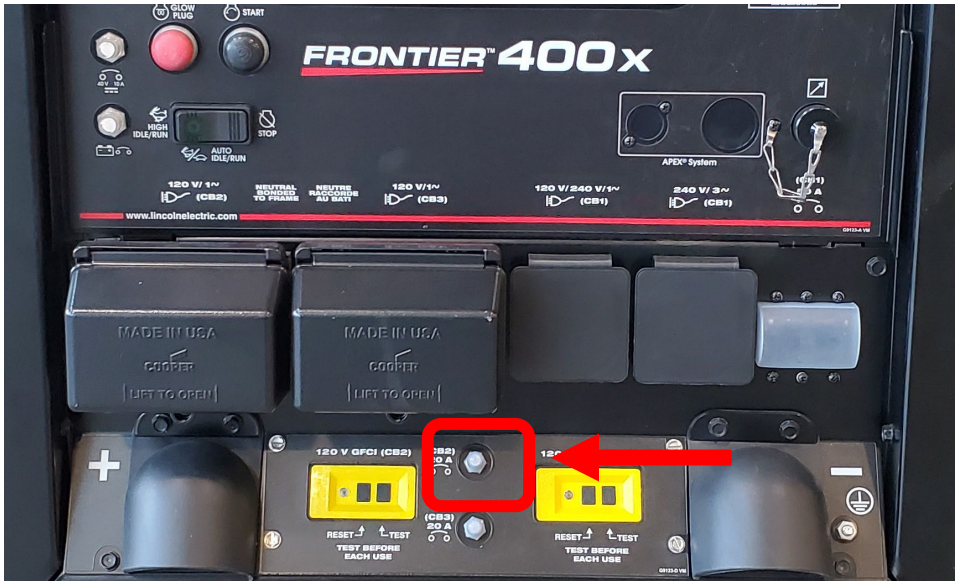


Figure F.1

2. Perform the “Case Cover Removal” as required to gain access to CB2 for testing.

3. Perform the Static Testing.

A. STATIC TESTING

A.1. Ensure the engine is not running and the "On/Idle/Stop" switch is in the "Stop" position and that CB2 is in the UP (not tripped) position.

A.2. Label and disconnect the following CB2 connections from behind the front panel, for physical location of connections refer to Figure F.2.

- Lead 6E
- Lead 6F

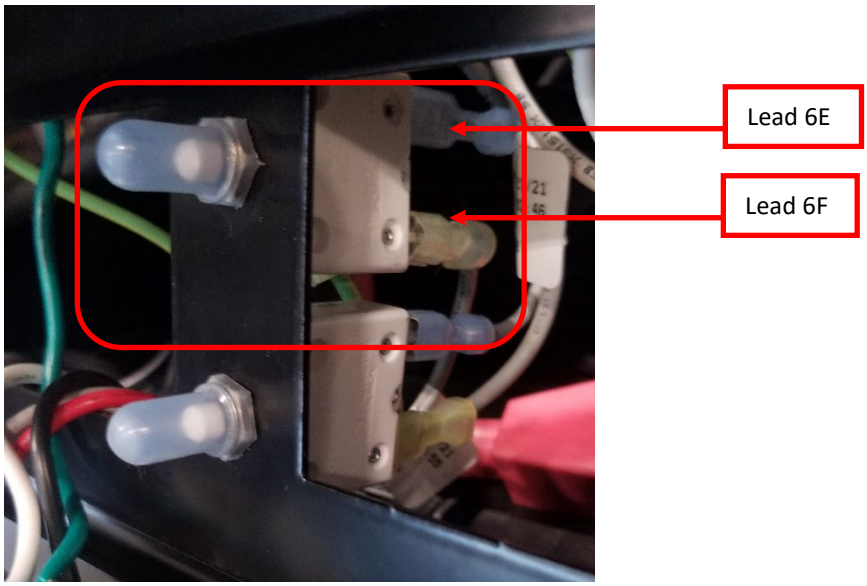


Figure F.2

A.3. Using a Digital Multi-Meter (set to resistance) perform the measurements identified in Test Table 1 below, refer to Figure F.2 for test point locations.

Circuit breakers Static Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
CB2	Engine not running CB2 Not Tripped	Lead 3D	Lead 3E	<1 Ohm

Table 1

A.4. Any failed measurement indicates a defective CB2 circuit breaker that will require replacement.

4. If problems with the machine persist, refer to the "Test Reference" chart for other possible faulty components.

Refer to Safety pages for explanation of hazards:

CB3 CIRCUIT BREAKER TEST

TEST DESCRIPTION

This procedure will determine proper function of the CB3 circuit breaker using Static tests.

MATERIALS NEEDED

5/16” wrench
Digital Multi-Meter
Wiring Diagram
Machine Schematic
Recommended P.P.E.

TEST PROCEDURE:

1. The CB3 circuit breaker is located on the front panel. It can be accessed from the front side of the machine behind the GFCI panel assembly, for physical orientation of CB3 circuit breaker refer to Figure F.1.

Figure F.1

2. Perform the “Case Cover Removal” as required to gain access to CB3 for testing.

3. Perform the Static Testing.

A. STATIC TESTING

A.1. Ensure the engine is not running and the “On/Idle/Stop” switch is in the “Stop” position and that CB3 is in the DOWN (not tripped) position.

A.2. Label and disconnect the following CB3 connections, for physical location of connections refer to Figure F.2.

- Lead 3D
- Lead 3E

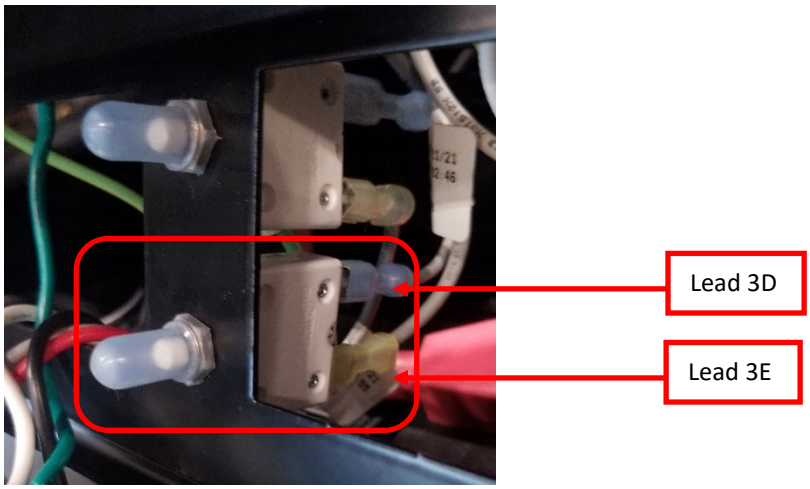


Figure F.2

A.3. Using a Digital Multi-Meter (set to resistance) perform the measurements identified in Test Table 1 below, refer to Figure F.2 for test point locations.

Circuit breakers Static Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
CB3	Engine not running CB3 Not Tripped	Terminal 3D	Terminal 3E	<1 Ohm

Table 1

A.4. Any failed measurement indicates a defective CB3 circuit breaker that will require replacement.

4. If problems with the machine persist, refer to the “Test Reference” chart for other possible faulty components.

Refer to Safety pages for explanation of hazards:

CB4 CIRCUIT BREAKER TEST

TEST DESCRIPTION

This procedure will determine proper function of the CB4 circuit breaker using Static and Active tests.

MATERIALS NEEDED

3/8” wrench
Digital Multi-Meter
Wiring Diagram
Machine Schematic
Recommended P.P.E.

TEST PROCEDURE:

1. The CB4 circuit breaker is located on the front panel. It can be accessed from the left side of the machine behind the front panel assembly, for physical orientation of CB4 circuit breaker refer to Figure F.1.

Figure F.1

2. Perform the “Case Cover Removal” as required to gain access to the CB4 for testing.

3. Perform the Static Testing.

A. STATIC TESTING

A.1. Ensure the engine is not running and the "On/Idle/Stop" switch is in the "Stop" position and that CB4 is in the DOWN (not tripped) position.

A.2. Label and disconnect the following CB4 connections, for physical location of connections refer to Figure F.2.

- Lead 46
- Lead 46A

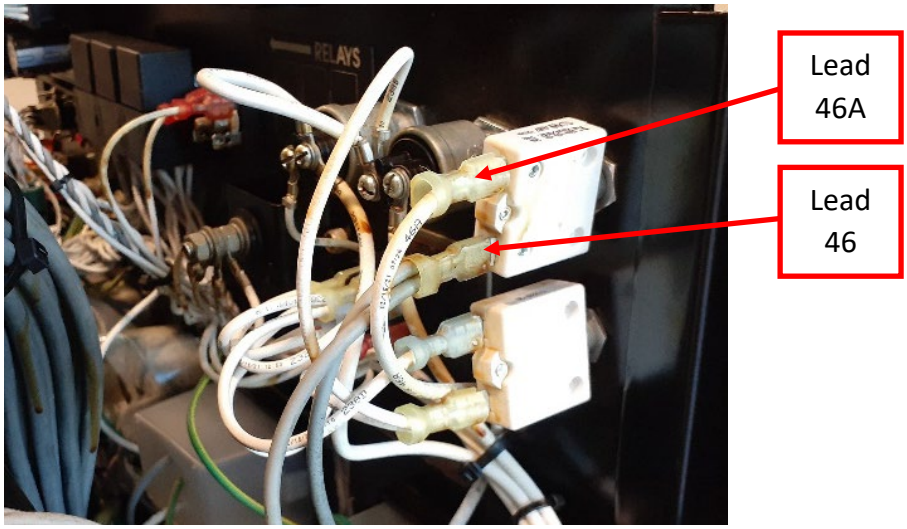


Figure F.2

A.3. Using a Digital Multi-Meter (set to resistance) perform the measurements identified in Test Table 1 below, refer to Figure F.2 for test point locations.

Circuit breakers Static Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
CB4	Engine not running CB4 not tripped	Terminal 46	Terminal 46A	<1 Ohm

Table 1

A.4. Any failed measurement indicates a defective CB4 circuit breaker that will require replacement.

4. If problems with the machine persist, refer to the "Test Reference" chart for other possible faulty components.

Refer to Safety pages for explanation of hazards:

CB5 CIRCUIT BREAKER TEST

TEST DESCRIPTION

This procedure will determine proper function of the CB5 circuit breaker using Static and Active tests.

MATERIALS NEEDED

3/8” and 5/16” wrench
Digital Multi-Meter
Wiring Diagram
Machine Schematic
Recommended P.P.E.

TEST PROCEDURE:

1. The CB5 circuit breaker is located on the front panel. It can be accessed from the left side of the machine behind the front panel assembly, for physical orientation of CB5 circuit breaker refer to Figure F.1.

Figure F.1

2. Perform the “Case Cover Removal” as required to gain access to the CB5 for testing.

3. Perform the Static Testing.

A. STATIC TESTING

A.1. Ensure the engine is not running and the “On/Idle/Stop” switch is in the “Stop” position and that CB5 is in the DOWN (not tripped) position.

A.2. Label and disconnect the following CB5 connections, for physical location of connections refer to Figure F.2.

- Lead 238D
- Lead 238E

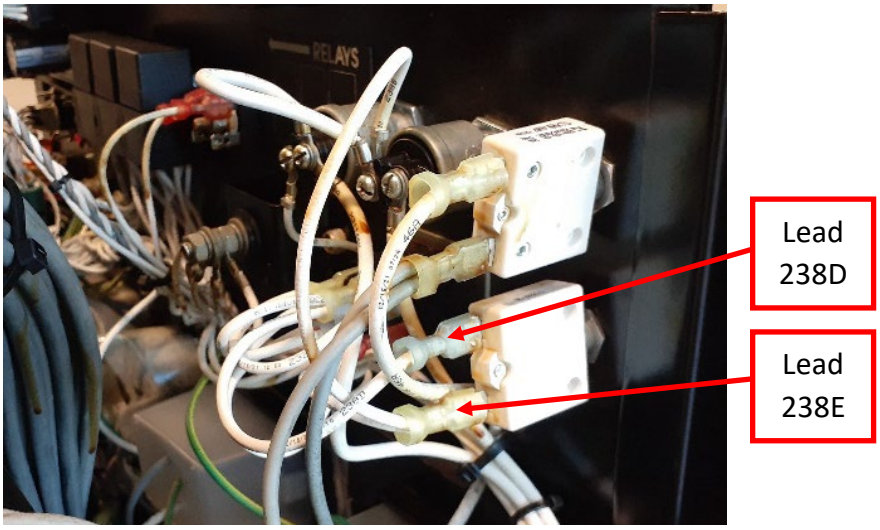


Figure F.2

A.3. Using a Digital Multi-Meter (set to resistance perform the measurements identified in Test Table 1 below, refer to Figure F.2 for test point locations.

Circuit breakers Static Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
CB5	CB5 not tripped	Terminal 238D	Terminal 238E	<1 Ohm

Table 1

A.4. Any failed measurement indicates a defective CB5 circuit breaker that will require replacement.

4. If problems with the machine persist, refer to the “Test Reference” chart for other possible faulty components.

Refer to Safety pages for explanation of hazards:

L1 CHOKE TEST

TEST DESCRIPTION

This procedure will determine proper function of the L1 Choke using Static and Active tests.

MATERIALS NEEDED

3/8” wrench
7/16” wrench
½” wrench
Digital Multi-Meter
Wiring Diagram
Machine Schematic
Recommended P.P.E.

TEST PROCEDURE:

1. The L1 Choke is located on the lower right side of the machine, behind the output studs. It can be accessed from the right side of the machine, for physical orientation of the L1 Choke refer to Figure F.1.

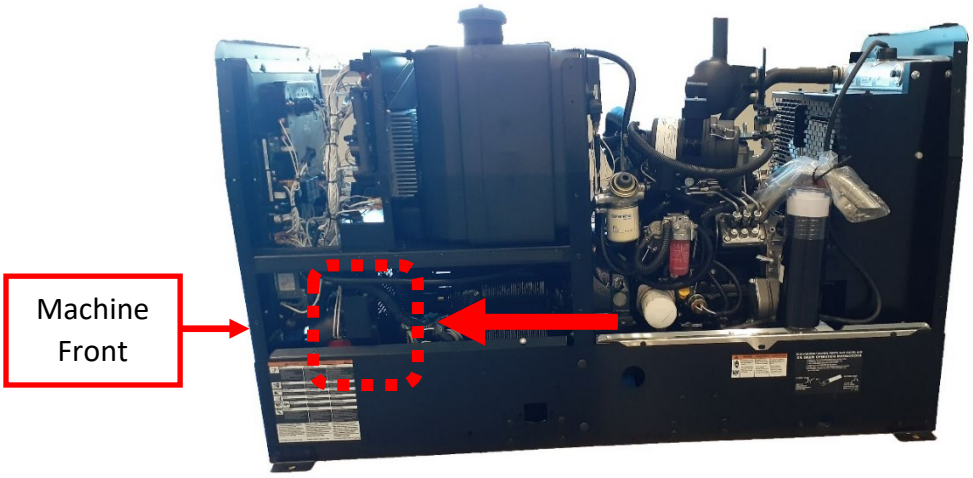


Figure F.1

2. Perform the “Case Cover Removal” as required to gain access to the L1 Choke for testing.

3. Perform the Static and Active Testing.

A. STATIC TESTING

A.1. Ensure the engine is not running and the “On/Idle/Stop” switch is set to “Stop” position.

A.2. Label and disconnect the following L1 Choke connections, for physical location of connections refer to Figure F.2.

- Lead W7
- Lead W8

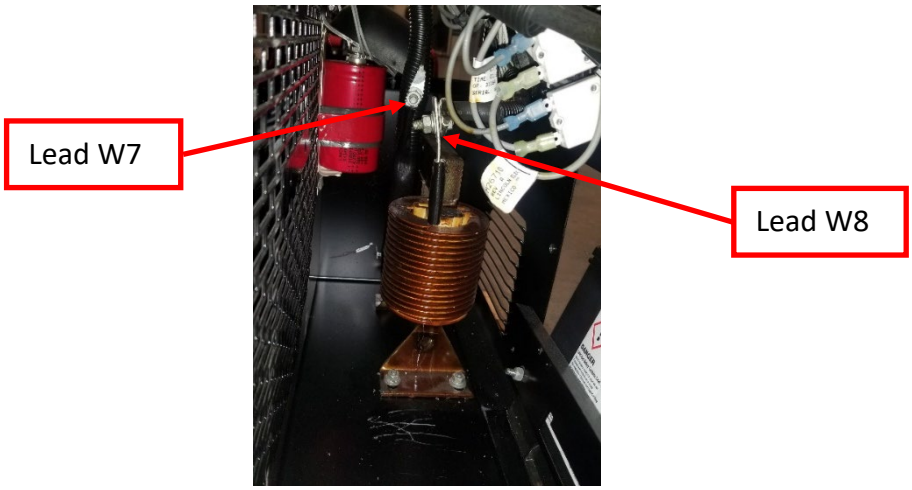


Figure F.2

A.3. Using a Digital Multi-Meter (set to resistance) perform the measurements identified in Test Table 1 below, refer to Figure F.2 for test point locations.

L1 Choke Static Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
L1 Choke	Terminals W7 and W8 Disconnected	Terminal W7	Terminal W8	<1 Ohm
		Terminal W7	Ground	OL

Table 1

A.4. If measurements are correct reconnect all connections removed in “Step A.2” and proceed to “B. ACTIVE TESTING”.

A.5. Any failed measurement indicates a defective L1 Choke that will require replacement.

B. ACTIVE TESTING

B.1. Ensure the engine is running and “On/Idle/Stop” switch set to “High idle”. Using the User Interface, place the machine in “Stick” mode and turn the output on.

B.2. Using a Digital Multi-Meter (set to DC) perform the measurements identified in Test Table 2 below, refer to Figure F.3 for test point locations.

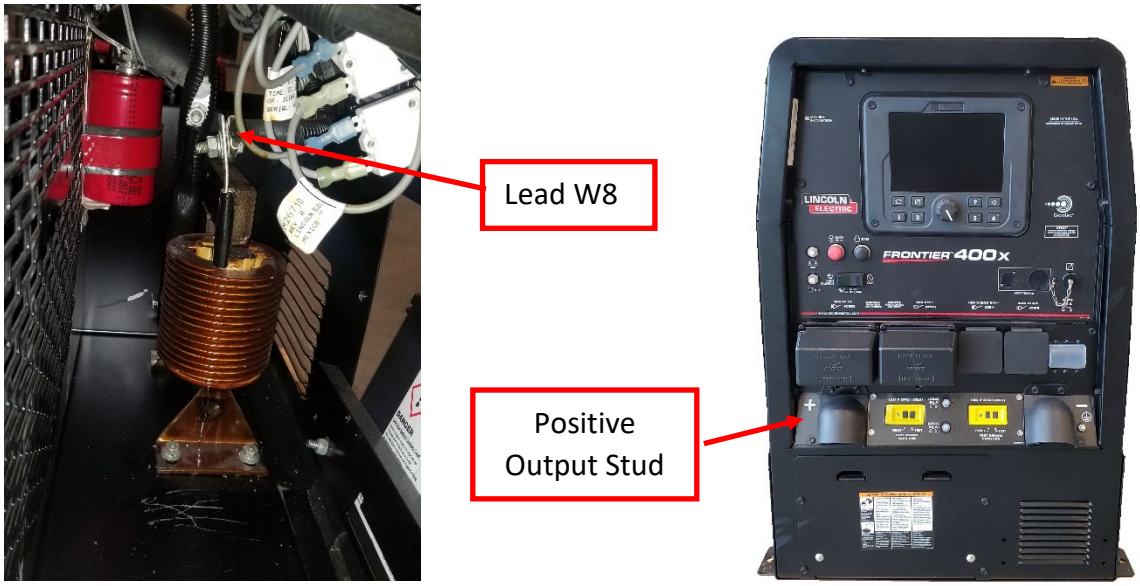


Figure F.3

L1 Choke Active Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
L1 Choke	On/Stop/Idle switch set to High Idle Stick mode, Output on	Terminal W8	Positive Output Stud	OCV

Table 2

B.3. If any measurement is incorrect this component may be faulty.

4. If problems with the machine persist, refer to the “Test Reference” chart for other possible faulty components.

Refer to Safety pages for explanation of hazards:

CR1 RELAY TEST

TEST DESCRIPTION

This procedure will determine proper function of the CR1 relay using Static and Active tests.

MATERIALS NEEDED

3/8” wrench
Needle nose pliers
Digital Multi-Meter
Wiring Diagram
Machine Schematic
Required P.P.E.

TEST PROCEDURE:

1. The CR1 relay is located behind the front panel. It can be accessed by lowering the front panel of the machine, for physical orientation of CR1 relay refer to Figure F.1.

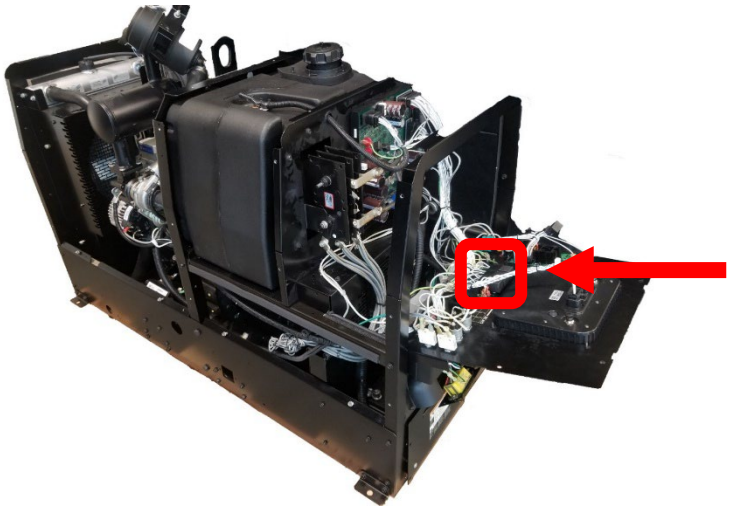


Figure F.1

2. Perform the “Case Cover Removal” as required to gain access to CR1 for testing.

3. Perform the Static and Active Testing.

A. STATIC TESTING

A.1. Ensure the engine is not running and the “On/Idle/Stop” switch is in the “Stop” position.

A.2. Locate and remove CR1 from its socket, for physical location of connections refer to Figure F.2.

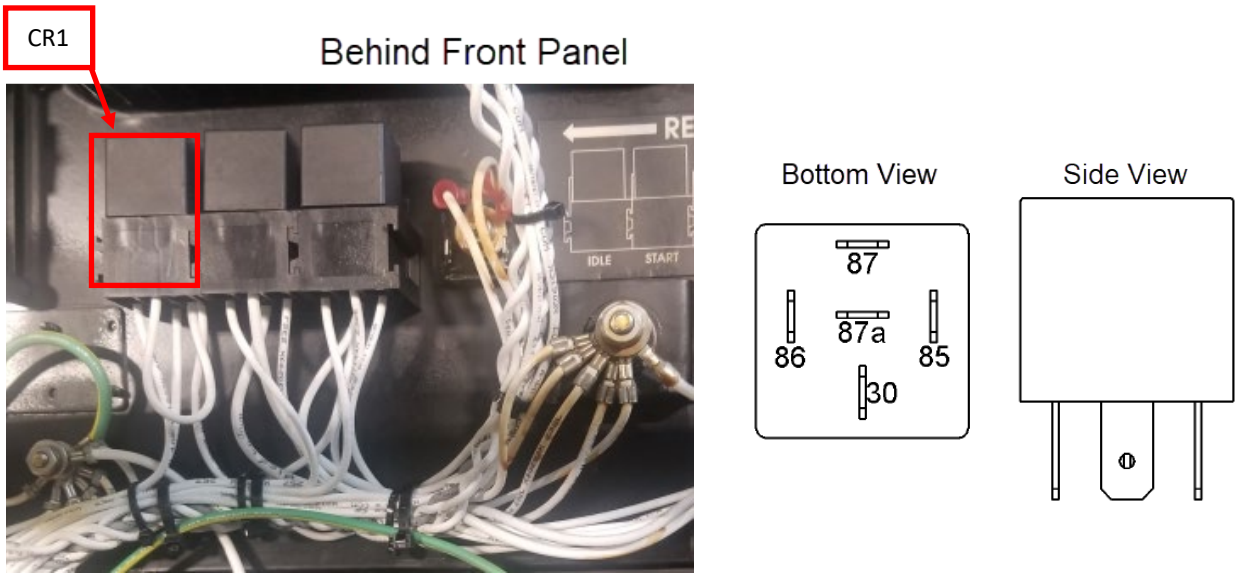


Figure F.2

A.3. Using a Digital Multi-Meter (set to resistance) perform the measurements identified in Test Table 1 below, refer to Figure F.2 for test point locations.

Relays Static Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
CR1 Idle Relay Coil	CR1 Relay removed from socket	Terminal 86	Terminal 85	~90 Ohms
CR1 Idle Relay Contacts		Terminal 30	Terminal 87	OL

Table 1

A.4. If measurements are correct reconnect CR1 removed in “Step A.2” and proceed to “B. ACTIVE TESTING”.

A.5. Any failed measurement indicates a defective CR1 relay that will require replacement.

B. ACTIVE TESTING

B.1. Ensure the engine is running and “On/Idle/Stop” switch set to Auto idle.

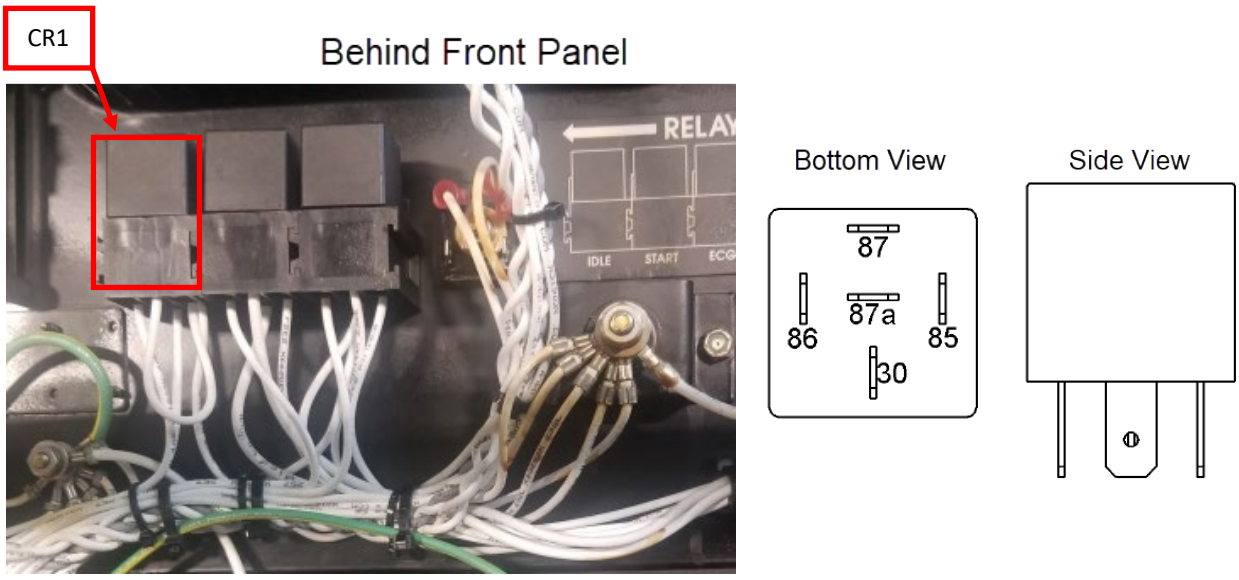


Figure F.3

B.2. Using a Digital Multi-Meter (set to DC) perform the measurements identified in Test Table 2 below, refer to Figure F.3 for test point locations.

Relay Active Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
CR1 Coil Input	Wait 20 seconds after start	Leads 232L Terminal 86	Lead 405 Terminal 85	~12 VDC
CR1 Relay Output		Lead 232M Terminal 30	Lead 406 Terminal 87	0 VDC

Table 2

B.3. If the input measurements are correct and the output measurement are not correct this component may be faulty.

4. If problems with the machine persist, refer to the “Test Reference” chart for other possible faulty components.

Refer to Safety pages for explanation of hazards:

CR2 RELAY TEST

TEST DESCRIPTION

This procedure will determine proper function of the CR2 relay using Static and Active tests.

MATERIALS NEEDED

3/8” wrench
Needle nose pliers
Digital Multi-Meter
Wiring Diagram
Machine Schematic
Required P.P.E.

TEST PROCEDURE:

1. The CR2 relay is located behind the front panel. It can be accessed by lowering the front panel of the machine, for physical orientation of CR2 relay refer to Figure F.1.

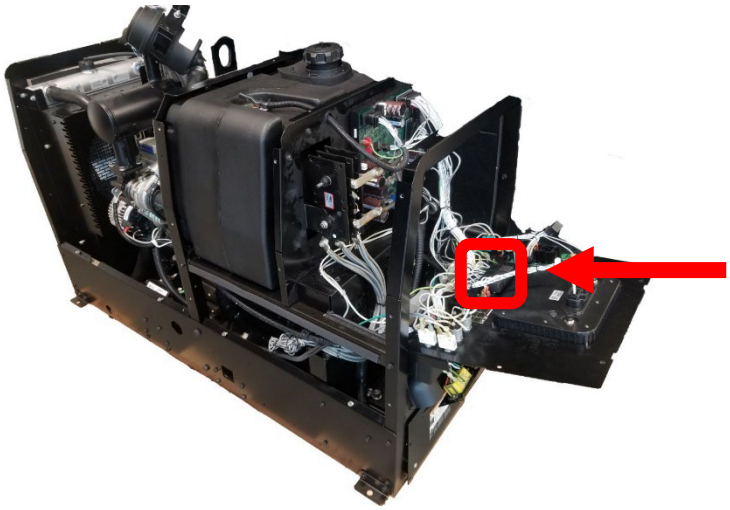


Figure F.1

2. Perform the “Case Cover Removal” as required to gain access to CR2 for testing.

3. Perform the Static and Active Testing.

A. STATIC TESTING

A.1. Ensure the engine is not running and the “On/Idle/Stop” switch is in the “Stop” position.

A.2. Locate and remove CR2 from its socket, for physical location of connections refer to Figure F.2.

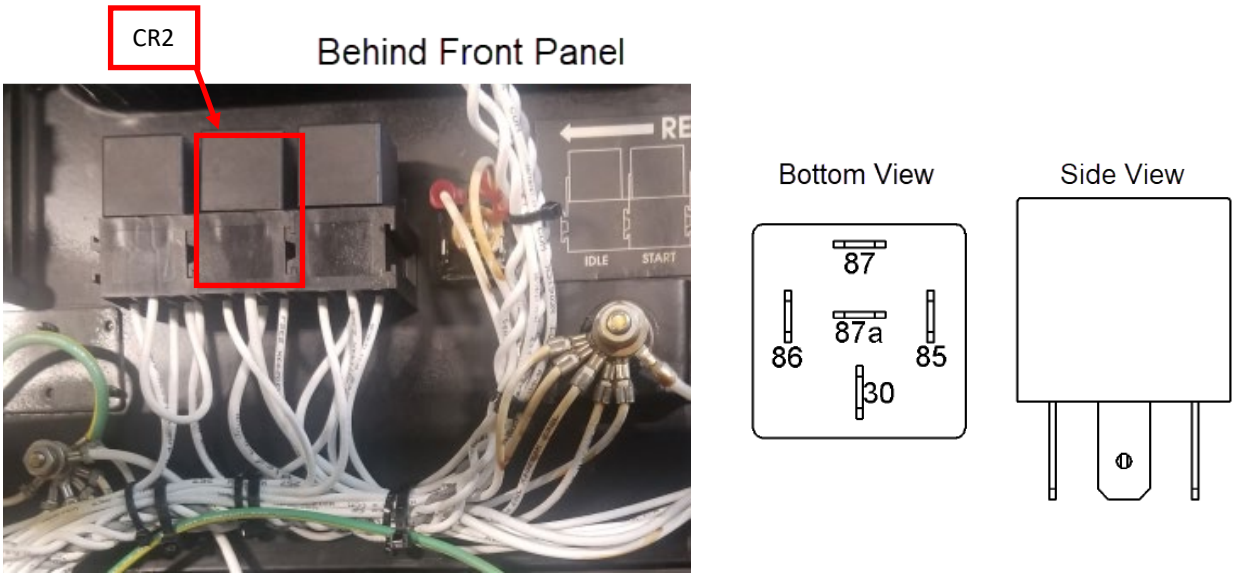


Figure F.2

A.3. Using a Digital Multi-Meter (set to resistance) perform the measurements identified in Test Table 1 below, refer to Figure F.2 for test point locations.

Relay Static Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
CR2 Start Relay Coil	Relay removed from socket	Terminal 86	Terminal 85	~90 Ohms
CR2 Start Relay Contacts		Terminal 30	Terminal 87	OL

Table 1

A.4. If measurements are correct reconnect CR2 removed in “Step A.2” and proceed to “B. ACTIVE TESTING”.

A.5. Any failed measurement indicates a defective CR2 relay that will require replacement.

B. ACTIVE TESTING

B.1. Ensure the engine is running and “On/Idle/Stop” switch set to Auto idle.

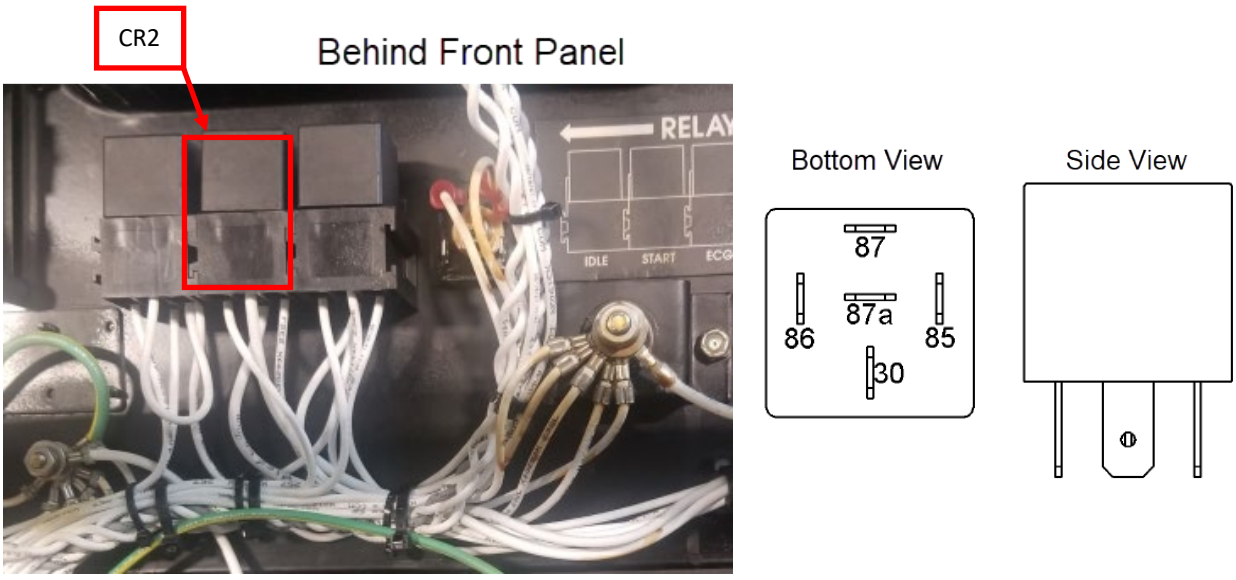


Figure F.3

B.2. Using a Digital Multi-Meter (set to DC) perform the measurements identified in Test Table 2 below, refer to Figure F.3 for test point locations.

Relay Active Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
CR2 Coil Input	Start Button Pressed	Lead 232J Terminal 86	Lead 285 Terminal 85	~12 VDC
CR2 Relay Output		Lead 238E Terminal 30	Lead 231A Terminal 87	0 VDC

Table 2

B.3. If the input measurements are correct and the output measurement are not correct this component may be faulty.

4. If problems with the machine persist, refer to the “Test Reference” chart for other possible faulty components.

Refer to Safety pages for explanation of hazards:

CR3 RELAY TEST

TEST DESCRIPTION

This procedure will determine proper function of the CR3 relay using Static and Active tests.

MATERIALS NEEDED

3/8” wrench
Needle nose pliers
Digital Multi-Meter
Wiring Diagram
Machine Schematic
Required P.P.E.

TEST PROCEDURE:

1. The CR3 relay is located behind the front panel. It can be accessed by lowering the front panel of the machine, for physical orientation of CR3 relay refer to Figure F.1.

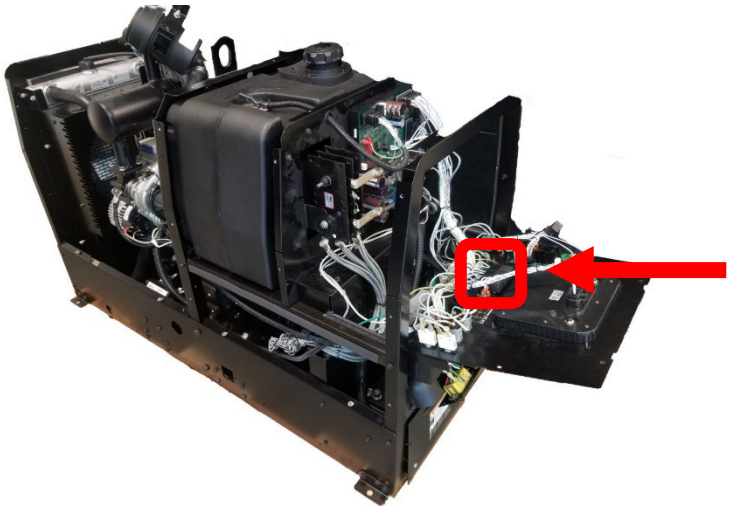


Figure F.1

2. Perform the “Case Cover Removal” as required to gain access to CR3 for testing.

3. Perform the Static and Active Testing.

A. STATIC TESTING

A.1. Ensure the engine is not running and the “On/Idle/Stop” switch is in the “Stop” position.

A.2. Locate and remove CR3 from its socket, for physical location of connections refer to Figure F.2.

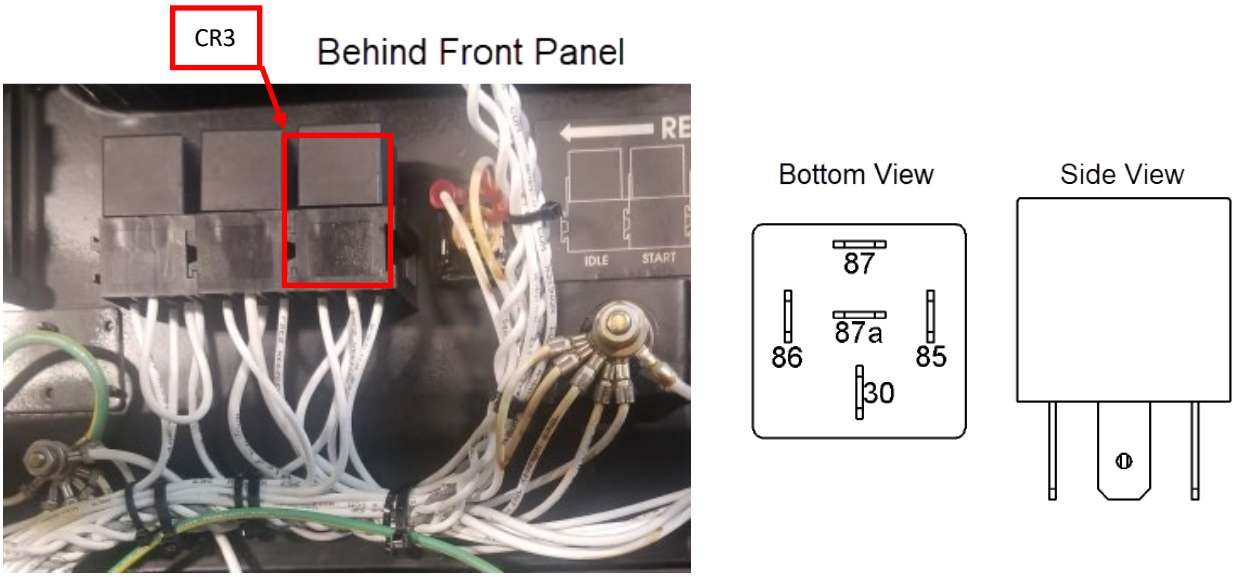


Figure F.2

A.3. Using a Digital Multi-Meter (set to resistance) perform the measurements identified in Test Table 1 below, refer to Figure F.2 for test point locations.

Relay Static Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
CR3 EGC Relay Coil	CR3 Relay removed from socket	Terminal 86	Terminal 85	~90 Ohms
CR3 EGC Relay Contacts		Terminal 30	Terminal 87	OL

Table 1

A.4. If measurements are correct reconnect CR3 removed in “Step A.2” and proceed to “B. ACTIVE TESTING”.

A.5. Any failed measurement indicates a defective CR3 relay that will require replacement.

B. ACTIVE TESTING

B.1. Ensure the engine is running and “On/Idle/Stop” switch set to Auto idle.

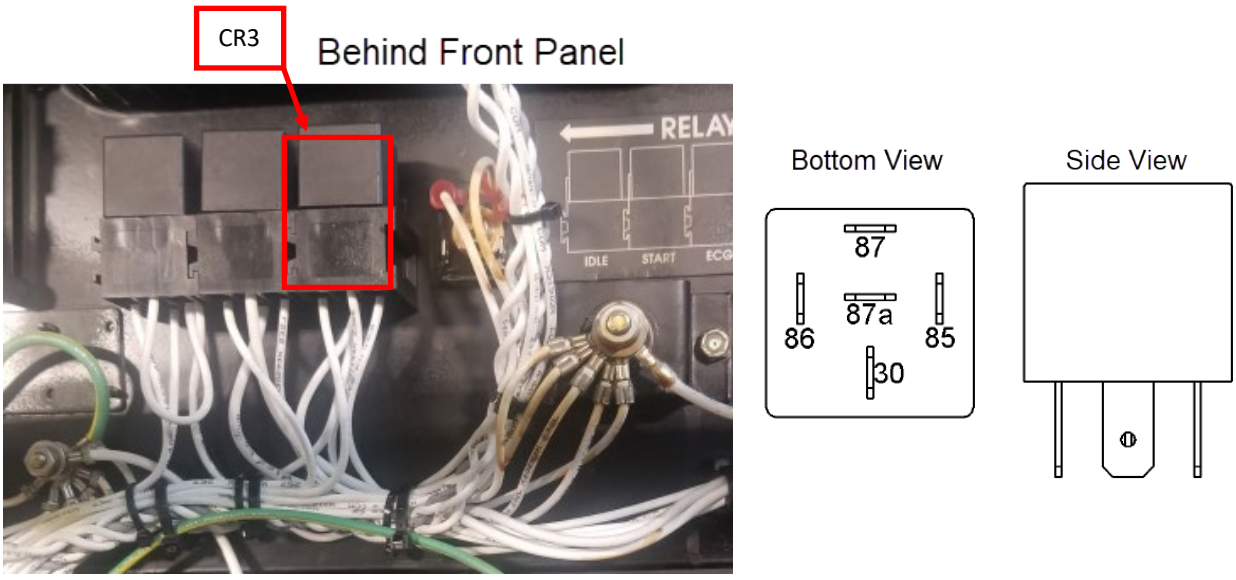


Figure F.3

B.2. Using a Digital Multi-Meter (set to DC) perform the measurements identified in Test Table 2 below, refer to Figure F.3 for test point locations.

Relay Active Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
CR3 Coil Input	Run/Stop/Idle switch set to AUTO	Lead 232Q Terminal 86	Lead 286 Terminal 85	~12 VDC
CR3 Relay Output		Lead 232E Terminal 30	Lead 232 Terminal 87	0 VDC

Table 2

B.3. If the input measurements are correct and the output measurement are not correct this component may be faulty.

4. If problems with the machine persist, refer to the “Test Reference” chart for other possible faulty components.

Refer to Safety pages for explanation of hazards:

CURRENT TRANSDUCER TEST PROCEDURE

TEST DESCRIPTION:
This procedure will determine proper function of the Current Transducer using Active tests.

MATERIALS NEEDED:
3/8” wrench
Digital Multi-Meter
Load Bank
Wiring Diagram
Machine Schematic
Recommended P.P.E.

TEST PROCEDURE:

1. The Current Transducer is located behind the front panel, in front of the Chopper Control Board. It can be accessed from either side of the machine, for physical orientation of the Current Transducer refer to Figure F.1.

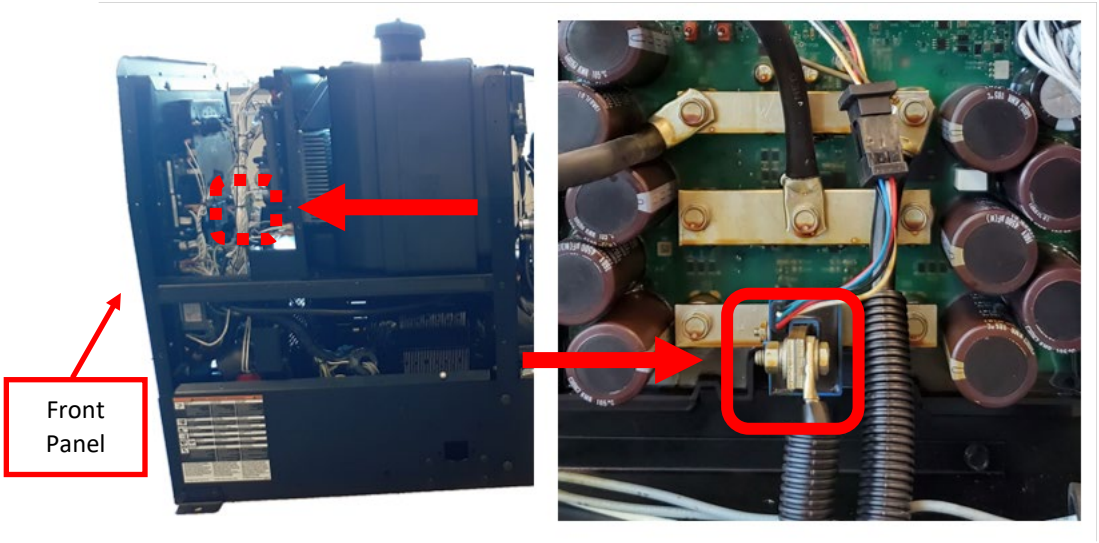


Figure F.1

2. Perform the “Case Cover Removal” as required to gain access to the Current Transducer for testing.

3. Perform the Active Testing.

A. ACTIVE TESTING

A.1. Properly connect Load Bank to the output studs.

A.2. Ensure the engine is running and “On/Idle/Stop” switch set to high idle, adjust the load bank and the machine to obtain 100 or 200 amps (see Table 1, set the machine to “Stick” mode, set the output to “On”.

A.3. Using a Digital Multi-Meter (set to DC) perform the measurements identified in Test Table 1 below, refer to Figure F.2 for test point locations.

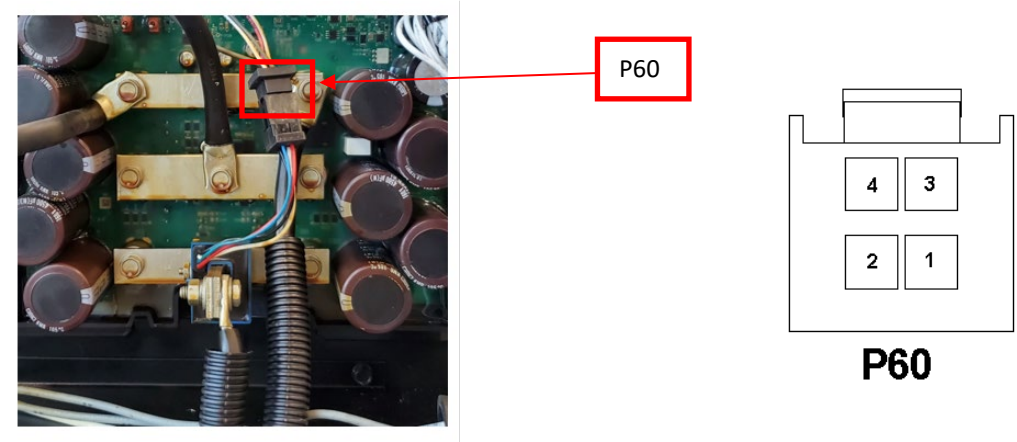


Figure F.2

CURRENT TRANSDUCER ACTIVE TEST				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
Transducer Input	Engine Running	P60 Pin 1	P60 Pin 4	~+15 VDC
Transducer Input	Engine Running	P60 Pin 2	P60 Pin 4	~-15 VDC
Transducer Feedback	Engine Running and Output on Loaded 100A	P60 Pin 3	P60 Pin 4	~.8 VDC
Transducer Feedback	Engine Running and Output on Loaded 200A	P60 Pin 3	P60 Pin 4	~1.6 VDC

Table 1

A.4. If the input measurements are correct and the output measurement are not correct this component may be faulty.

4. If problems with the machine persist, refer to the “Test Reference” chart for other possible faulty components.

Refer to Safety pages for explanation of hazards:

D1 3 PHASE RECTIFIER TEST

TEST DESCRIPTION

This procedure will determine proper function of the D1 3 Phase Rectifier using Static and Active tests.

MATERIALS NEEDED

3/8” wrench
7/16” wrench
Digital Multi-Meter
Wiring Diagram
Machine Schematic
Recommended P.P.E.

TEST PROCEDURE:

1. The D1 3 Phase Rectifier is behind the front panel on the left side of the machine. It can be accessed from the left side, for physical orientation of the D1 3 Phase Rectifier refer to Figure F.1.

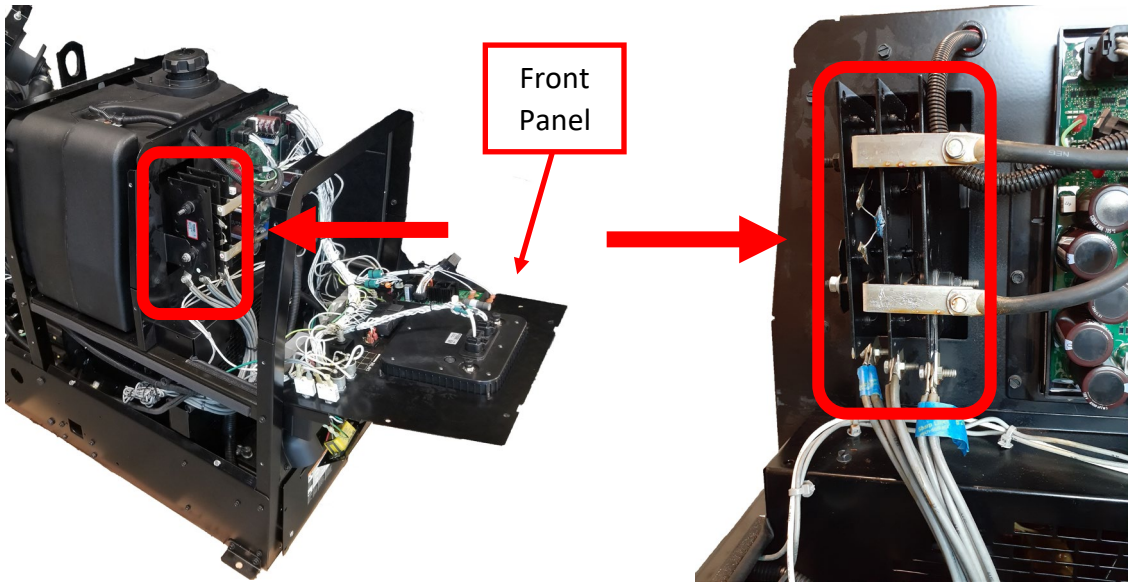


Figure F.1

2. Perform the “Case Cover Removal” as required to gain access to the D1 3 Phase Rectifier for testing.

3. Perform the Static and Active Testing.

A. STATIC TESTING

A.1. Ensure the engine is not running and the “On/Idle/Stop” switch is set to “Stop” position.

A.2. Label and disconnect the following D1 3 Phase Rectifier connections, for physical location of connections refer to Figure F.2.

- Lead W1
- Lead W2
- Lead W3
- Lead W4
- Lead W5
- Lead W6
- Lead B1
- Lead B2
- Lead B4
- Lead B5

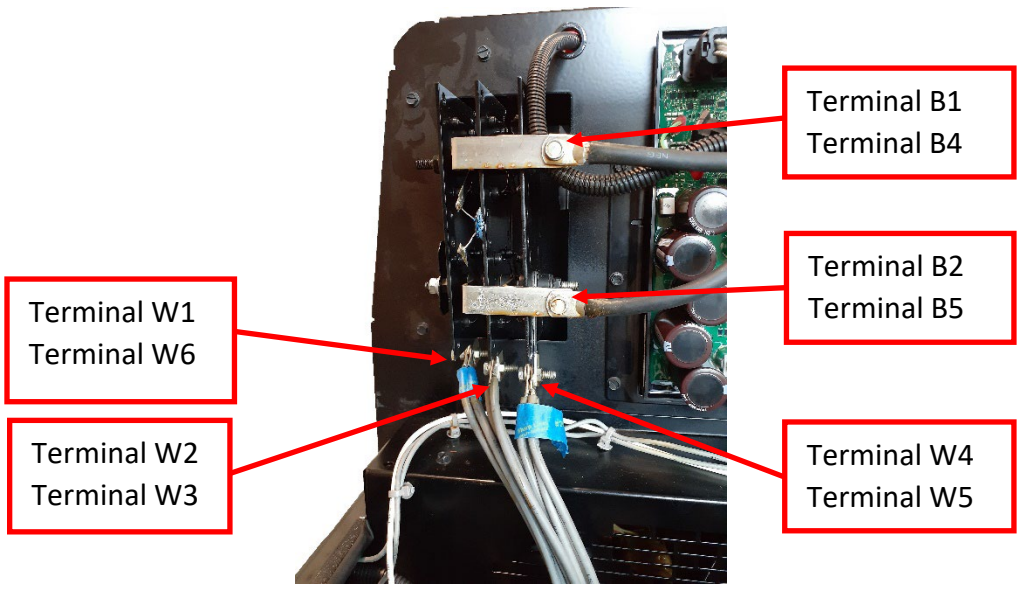


Figure F.2

A.3. Using a Digital Multi-Meter (set to Diode) perform the measurements identified in Test Table 1 below, refer to Figure F.2 for test point locations.

D1 3 Phase Rectifier Static Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
3 Phase Rectifier Diodes	Leads W1/W6, W2/W3, W4/W5, B1/B4, and B2/B5 disconnected	Terminal W1/W6	Terminal B2 & B5	0.3 – 0.7 VDC
		Terminal W2/W3	Terminal B2 & B5	0.3 – 0.7 VDC
		Terminal W4/W5	Terminal B2 & B5	0.3 – 0.7 VDC
		Terminal B1 & B4	Terminal W1/W6	0.3 – 0.7 VDC
		Terminal B1 & B4	Terminal W2/W3	0.3 – 0.7 VDC
		Terminal B1 & B4	Terminal W4/W5	0.3 – 0.7 VDC

Table 1

A.4. If measurements are correct reconnect all connections removed in “Step A.2” and proceed to “B. ACTIVE TESTING”.

A.5. Any failed measurement indicates a defective D1 3 Phase Rectifier that will require replacement.

B. ACTIVE TESTING

B.1. Ensure the engine is running and “On/Idle/Stop” switch set to “High idle”.

B.2. Using a Digital Multi-Meter (set to AC or DC) perform the measurements identified in Test Table 2 below, refer to Figure F.3 for test point locations.

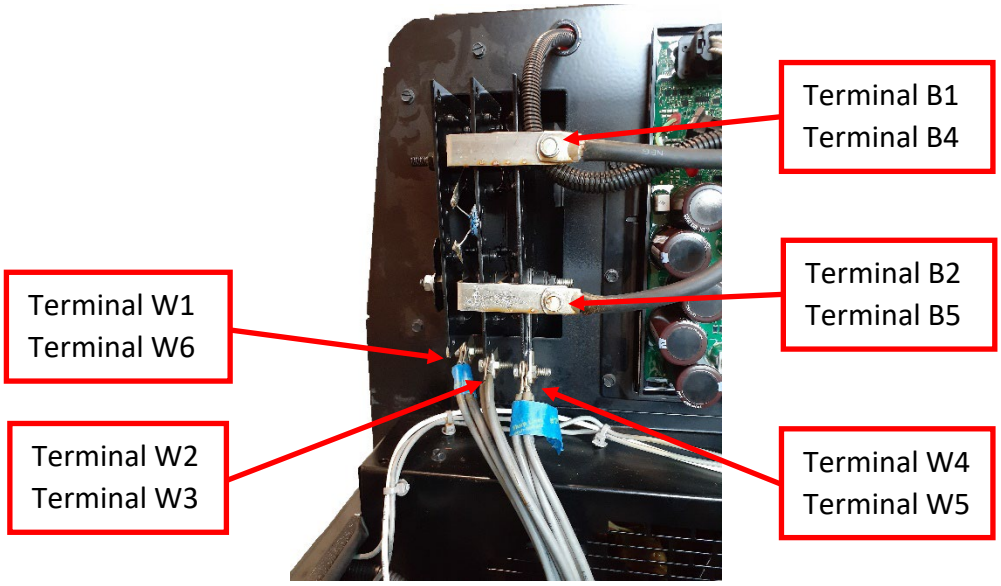


Figure F.3

D1 3 Phase Rectifier Active Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
Phase 1 AC input	Run/Stop/Idle switch set to HIGH	Terminal W1/W6	Terminal W2/W3	~80 VAC
Phase 2 AC input		Terminal W2/W3	Terminal W4/W5	~80 VAC
Phase 3 AC input		Terminal W4/W5	Terminal W1/W6	~80 VAC
3 Phase Rectifier Output		Terminal B2 & B5	Terminal B1 & B4	~105 VDC

Table 2

B.3. If the input measurements are correct and the output measurement are not correct this component may be faulty.

4. If problems with the machine persist, refer to the “Test Reference” chart for other possible faulty components.

Refer to Safety pages for explanation of hazards:

D2 RECTIFIER TEST PROCEDURE

TEST DESCRIPTION:

This procedure will determine proper function of the D2 Rectifier using Static and Active tests.

MATERIALS NEEDED:

3/8” wrench
Needle Nose Pliers
Digital Multi-Meter
Wiring Diagram
Machine Schematic
Required P.P.E.

TEST PROCEDURE:

1. The D2 Rectifier is behind the front panel on the right side and can be accessed from the right side of the machine, for physical orientation of Stator refer to Figure F.1.

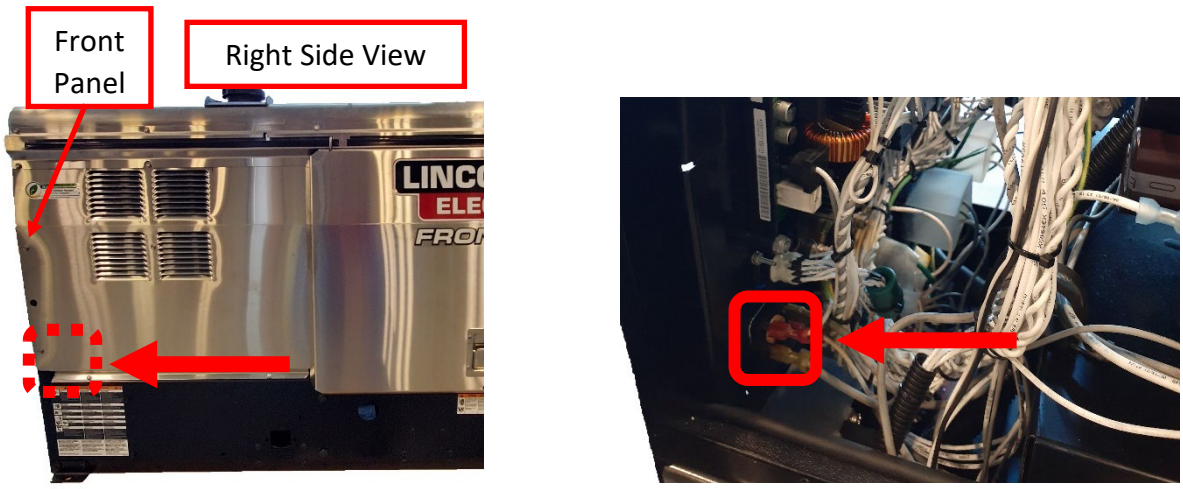


Figure F.1

2. Perform the “Case Cover Removal” as required to gain access to the D2 Rectifier for testing.

3. Perform the Static and Active testing.

A. STATIC TESTING

A.1. Ensure the engine is not running and the “On/Idle/Stop” switch is in the “Stop” position.

A.2. Label and disconnect the following D2 Rectifier leads, for physical location of connections refer to Figure F.2.

- 5M
- 7
- 7A
- 8

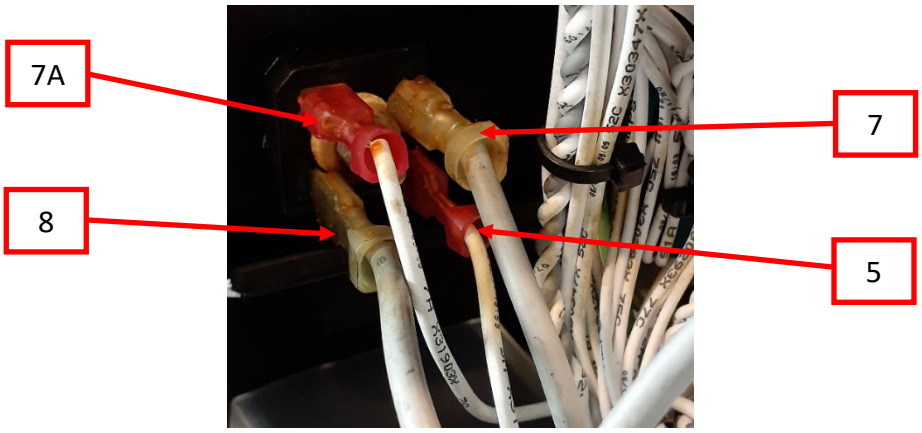


Figure F.2

A.3. Using a Digital Multi-Meter (set to diode) perform the measurements identified in Test Table 1 below, refer to Figure F.2 for test point locations.

D2 Static Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
D2 Rectifier	Leads 7, 8, 7A, and 5M Disconnected	Terminal 7	Terminal 7A	0.3 – 0.7 VDC
		Terminal 8	Terminal 7A	0.3 – 0.7 VDC
		Terminal 5M	Terminal 7	0.3 – 0.7 VDC
		Terminal 5M	Terminal 8	0.3 – 0.7 VDC

Table 1

A.4. Any failed measurements in Table 1 indicates a defective D2 Rectifier that will require replacement, refer to “D2 Rectifier Removal and Replacement” procedure.

A.5. If all measurements are correct reconnect all connections removed in “Step A.2” and proceed to “ACTIVE TESTING”.

B. ACTIVE TESTING

B.1. Ensure the engine is running and “On/Idle/Stop” switch set to High idle.

B.2. Using a Digital Multi-Meter (set to AC or DC) perform the measurements identified in Test Table 2 below, refer to Figure F.3 for test point locations.

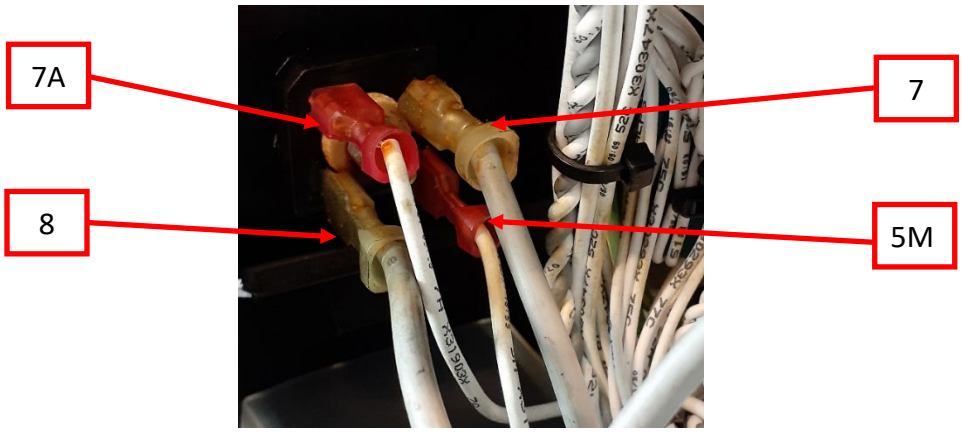


Figure F.3

D2 Active Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
D2 Rectifier Input	Leads 7, 8, 7A, and 5M Reconnected	Lead 7	Lead 8	~140 VAC
D2 Rectifier Output		Lead 7A	Lead 5M	~200 VDC

Table 2

B.3. If the input measurements are correct and the output measurement are not correct this component may be faulty.

4. If problems with the machine persist, refer to the “Test Reference” chart for other possible faulty components.

Refer to Safety pages for explanation of hazards:

D3 RECTIFIER TEST PROCEDURE

TEST DESCRIPTION:

This procedure will determine proper function of the D3 Rectifier using Static and Active tests.

MATERIALS NEEDED:

3/8” wrench
Needle Nose Pliers
Digital Multi-Meter
Wiring Diagram
Machine Schematic
Required P.P.E.

TEST PROCEDURE:

1. The D3 Rectifier is behind the front panel on the right side and can be accessed from the right side of the machine, for physical orientation of Stator refer to Figure F.1.

Figure F.1

2. Perform the “Case Cover Removal” as required to gain access to the D3 Rectifier for testing.

3. Perform the Static and Active testing.

A. STATIC TESTING

A.1. Ensure the engine is not running and the “On/Idle/Stop” switch is in the “Stop” position.

A.2. Label and disconnect the following D3 Rectifier leads, for physical location of connections refer to Figure F.2.

- 45
- 46A
- 65A
- 66A

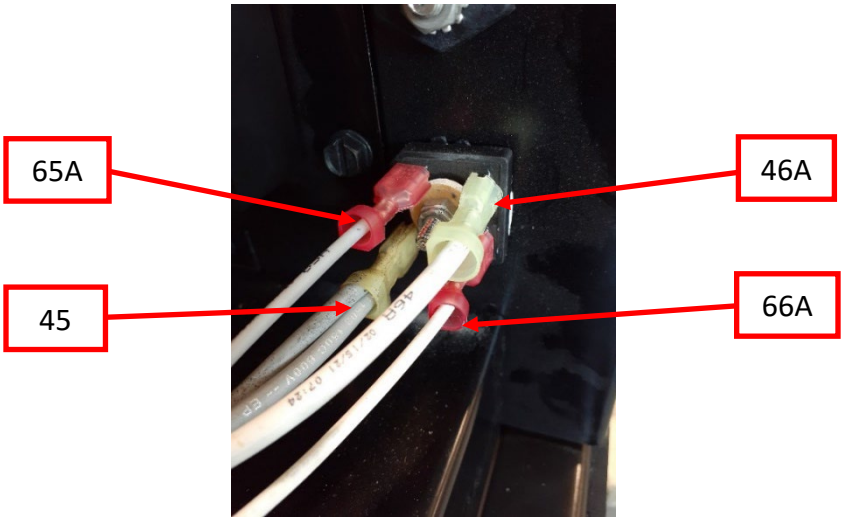


Figure F.2

A.3. Using a Digital Multi-Meter (set to diode) perform the measurements identified in Test Table 1 below, refer to Figure F.2 for test point locations.

D3 Static Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
D3 Rectifier	Leads 46A, 45, 65A, and 66A Disconnected	46A	65A	0.3 – 0.7 VDC
		45	65A	0.3 – 0.7 VDC
		66A	46A	0.3 – 0.7 VDC
		66A	45	0.3 – 0.7 VDC

Table 1

A.4. Any failed measurements in Table 1 indicates a defective D3 Rectifier that will require replacement, refer to “D3 Rectifier Removal and Replacement” procedure.

A.5. If all measurements are correct reconnect all connections removed in “Step A.2” and proceed to “ACTIVE TESTING”.

B. ACTIVE TESTING

B.1. Ensure the engine is running and “On/Idle/Stop” switch set to High idle.

B.2. Using a Digital Multi-Meter (set to AC or DC) perform the measurements identified in Test Table 2 below, refer to Figure F.3 for test point locations.

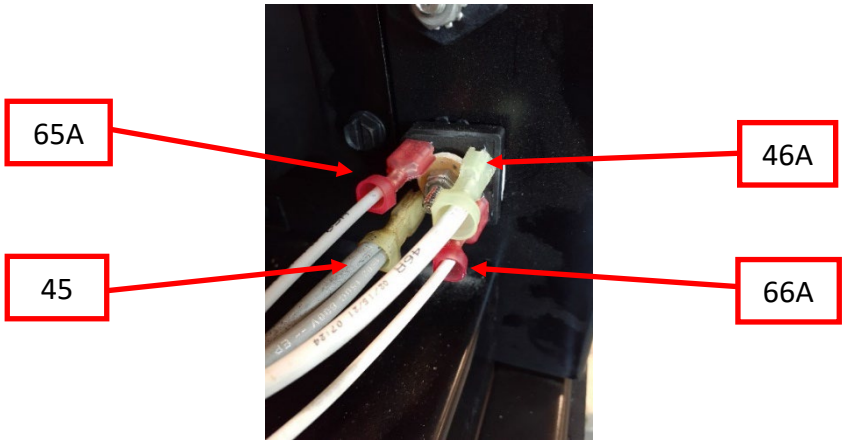


Figure F.3

D3 Active Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
D3 Rectifier Input	Leads 46A, 45, 65A, and 66A Reconnected	45	46A	~42 VAC
D3 Rectifier Output		65A	66A	~55 VDC

Table 2

B.3. If the input measurements are correct and the output measurement are not correct this component may be faulty.

4. If problems with the machine persist, refer to the “Test Reference” chart for other possible faulty components.

Refer to Safety pages for explanation of hazards:

D4 RECTIFIER TEST PROCEDURE

TEST DESCRIPTION:

This procedure will determine proper function of the D4 Rectifier using Static and Active tests.

MATERIALS NEEDED:

3/8” wrench
Needle Nose Pliers
Digital Multi-Meter
Wiring Diagram
Machine Schematic
Required P.P.E.

TEST PROCEDURE:

1. The D4 Rectifier is behind the front panel towards the bottom-center and can be accessed from behind the front panel of the machine, for physical orientation of Stator refer to Figure F.1.

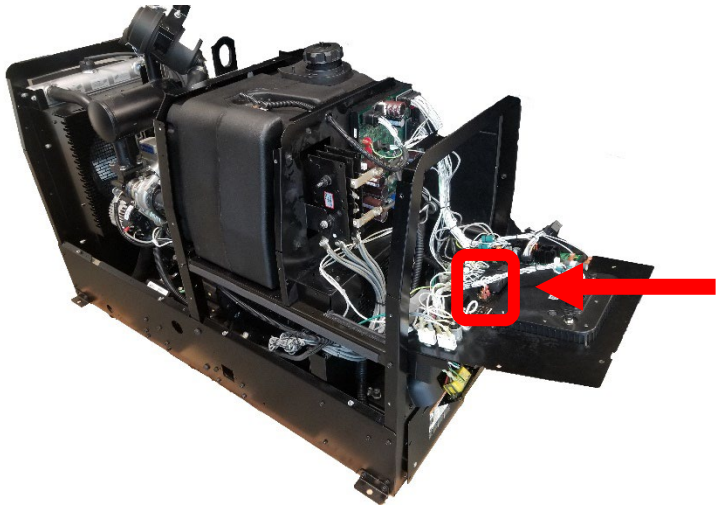


Figure F.1

2. Perform the “Case Cover Removal” as required to gain access to the D4 Rectifier for testing.

3. Perform the Static and Active testing.

A. STATIC TESTING

A.1. Ensure the engine is not running and the “On/Idle/Stop” switch is in the “Stop” position.

A.2. Label and disconnect the following D4 Rectifier leads, for physical location of connections refer to Figure F.2.

- 232R
- 232S

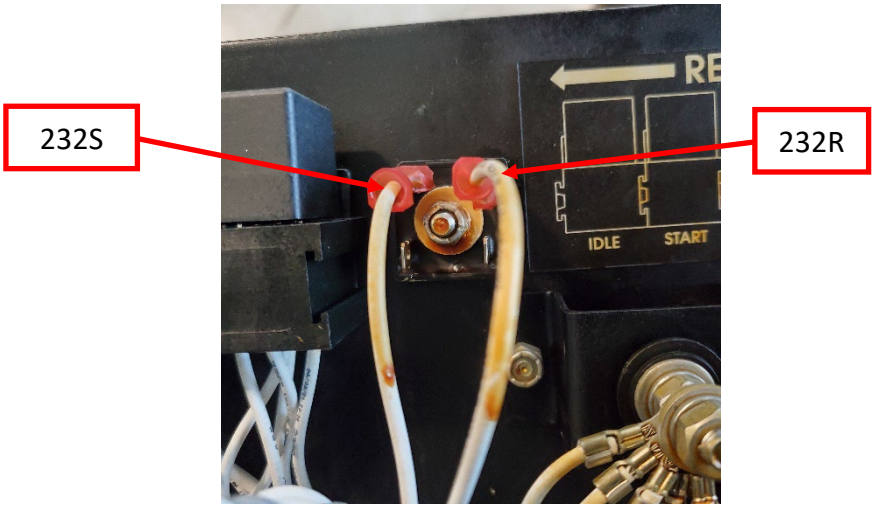


Figure F.2

A.3. Using a Digital Multi-Meter (set to diode) perform the measurements identified in Test Table 1 below, refer to Figure F.2 for test point locations.

D4 Static Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
D3 Rectifier	Leads 232R and 232S Disconnected	Terminal 232R	Terminal 232S	0.3 – 0.7 VDC

Table 1

A.4. Any failed measurements in Table 1 indicates a defective D4 Rectifier that will require replacement, refer to “D4 Rectifier Removal and Replacement” procedure.

A.5. If all measurements are correct reconnect all connections removed in “Step A.2” and proceed to “ACTIVE TESTING”.

B. ACTIVE TESTING

B.1. Ensure the engine is running and “On/Idle/Stop” switch set to High idle.

B.2. Using a Digital Multi-Meter (set to AC or DC) perform the measurements identified in Test Table 2 below, refer to Figure F.3 for test point locations.

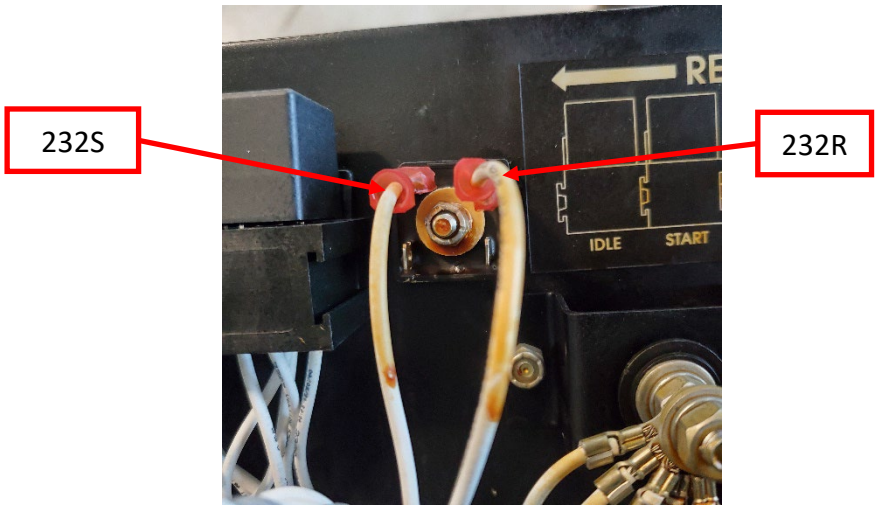


Figure F.3

D4 Active Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
D4 Rectifier Input	Leads 232R and 232S Reconnected	Lead 232R	Lead 5S	~12 VDC
D4 Rectifier Output		Lead 232S	Lead 5S	~12 VDC

Table 2

B.3. If the input measurements are correct and the output measurement are not correct this component may be faulty.

4. If problems with the machine persist, refer to the “Test Reference” chart for other possible faulty components.

Refer to Safety pages for explanation of hazards:

ELECTRONIC GOVERNOR CONTROLLER (EGC TEST PROCEDURE

TEST DESCRIPTION:

This procedure will determine proper function of the EGC using Active tests.

MATERIALS NEEDED:

3/8” wrench
Digital Multi-Meter
Wiring Diagram
Machine Schematic
Required P.P.E.

TEST PROCEDURE:

1. The EGC is behind the center support (attached to lift bale) on the upper right side and can be accessed from right side of the machine, for physical orientation of EGC refer to Figure F.1.

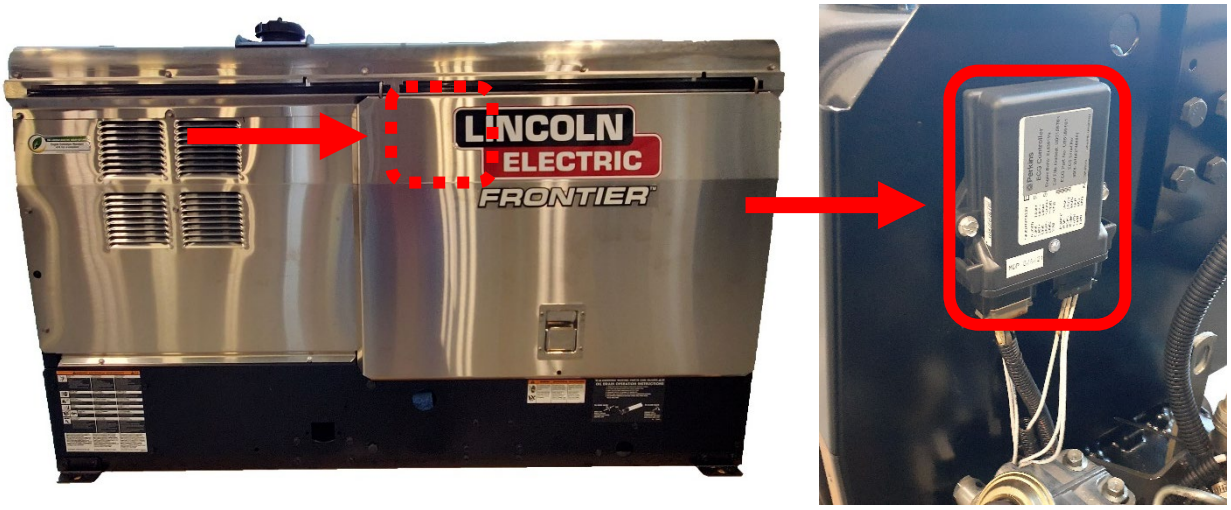


Figure F.1

2. Perform the “Case Cover Removal” as required to gain access to the EGC for testing.

3. Perform the Active testing.

A. ACTIVE TESTING

A.1. Ensure the engine is not running and “On/Idle/Stop” switch set to “Stop”.

A.2. With the engine not running set the “On/Idle/Stop” switch set to “High Idle” and observe the following, refer to Figure F.2 for LED location.

- The EGC LED illuminates red momentarily.
- The fuel actuator audibly “pulls in”.

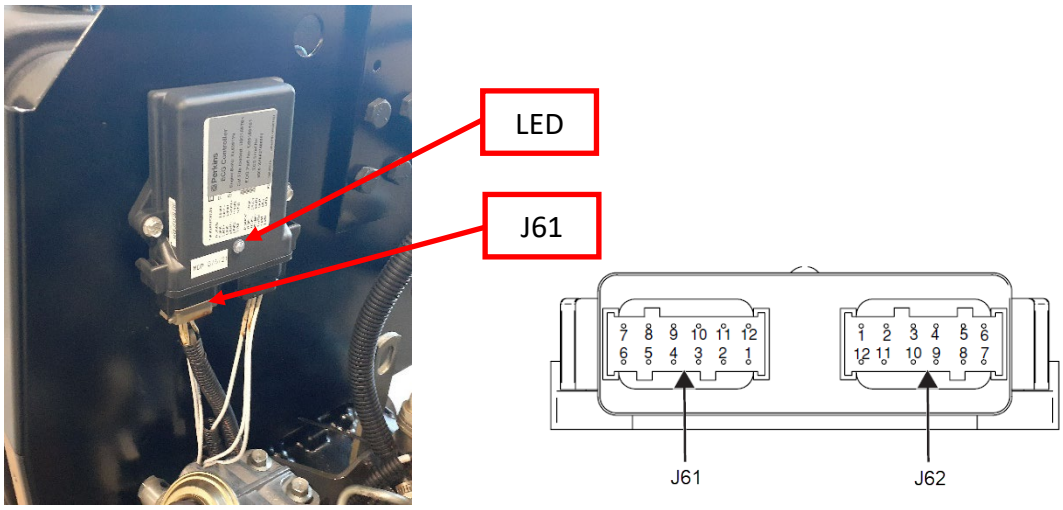


Figure F.2

A.3. Any failed observations from step A.2. indicates a defective EGC that will require replacement, refer to “EGC Removal and Replacement” procedure.

A.4. If all observations are correct reconnect proceed to step A.5. and continue testing.

A.5. Using a Digital Multi-Meter (set to DC) perform the measurements identified in Test Table 2 below, refer to Figure F.2 for test point locations.

EGC Active Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
EGC Module	Engine NOT Running Run/Stop/Idle switch set to AUTO	J61 pin 9	J61 pin 4	~12 VDC

Table 2

A.6. If any measurement is incorrect this component may be faulty.

4. If problems with the machine persist, refer to the “Test Reference” chart for other possible faulty components.

Refer to Safety pages for explanation of hazards:

STARTING MOTOR TEST PROCEDURE

TEST DESCRIPTION:

This procedure will determine proper function of the Starting Motor using Active tests.

MATERIALS NEEDED:

3/8” wrench
1/2” wrench
Digital Multi-Meter
Wiring Diagram
Machine Schematic
Required P.P.E.

TEST PROCEDURE:

1. The Starting Motor is located and can be accessed from the left side of the machine, for physical orientation of Stator refer to Figure F.1.

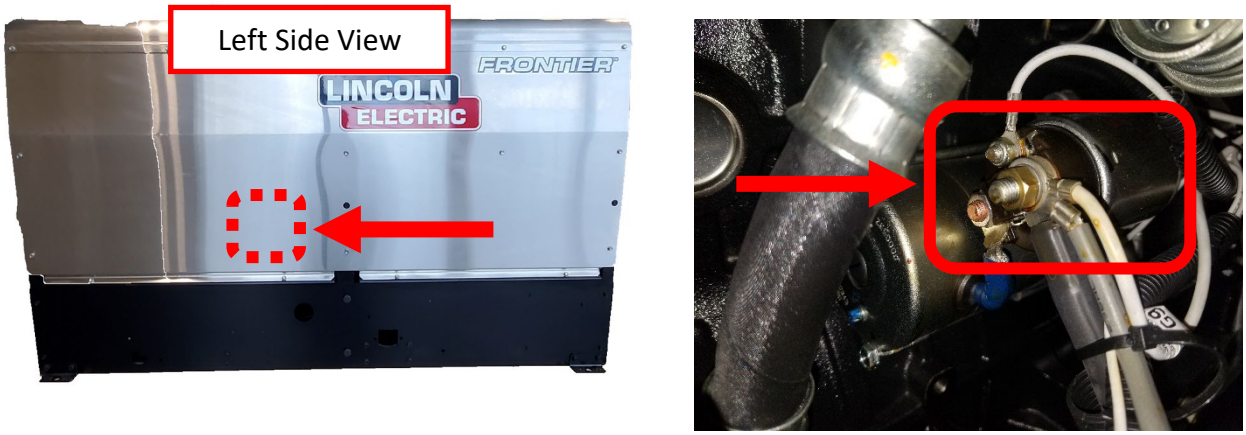


Figure F.1

2. Perform the “Case Cover Removal” as required to gain access to the Starting Motor for testing.

3. Perform the Active testing.

A. ACTIVE TESTING

A.1. Ensure the engine is not running and “On/Idle/Stop” switch set to “STOP”.

A.2. Using a Digital Multi-Meter (set or DC) perform the measurements identified in Test Table 1 below, refer to Figure F.2 for test point locations.

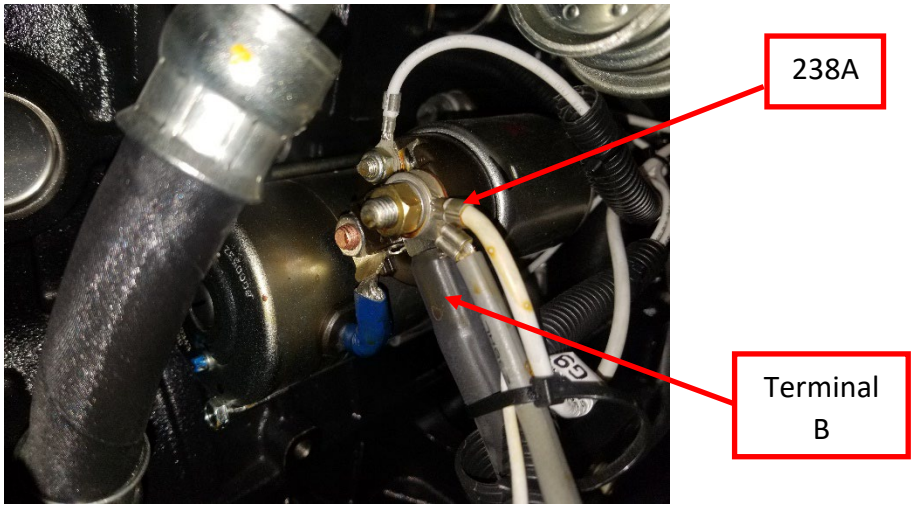


Figure F.2

Starting Motor Active Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
Starter Motor Solenoid Input From Battery	Engine not running.	Positive Lead (Terminal B)	Chassis Ground	~12.6 VDC
Starter Motor Solenoid Output To Start Button	Engine not running	Lead 238A (Start Button)	Chassis Ground	~12.6 VDC

Table 1

A.3. If the input measurements are correct and the output measurement are not correct this component may be faulty.

A.4. If all measurements are correct proceed to step A.5.

A.5. Ensure the engine is not running and “On/Idle/Stop” switch set to “High Idle”, depress the “Start Button” while taking measurements.

A.6. Using a Digital Multi-Meter (set or DC) perform the measurements identified in Test Table 2 below, refer to Figure F.3 for test point locations.

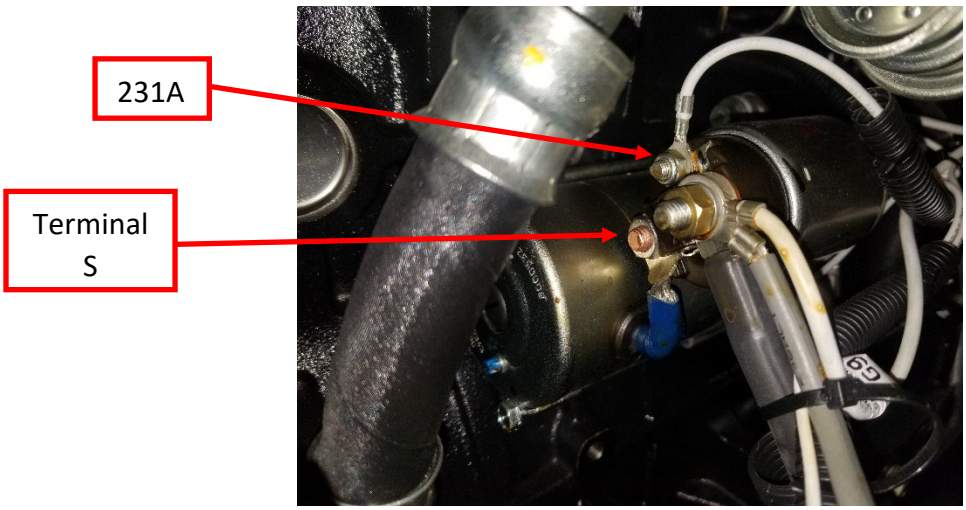


Figure F.3

Starting Motor Active Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
Starter Motor Solenoid Input From Relay	Pressing Start Button	Lead 231A	Chassis Ground	~12.6 VDC
Starter Motor Solenoid Output To Starter Motor	Pressing Start Button	Terminal S	Chassis Ground	~12.6 VDC

Table 2

A.7. If the input measurements are correct and the output measurement are not correct this component may be faulty.

4. If problems with the machine persist, refer to the “Test Reference” chart for other possible faulty components.

Refer to Safety pages for explanation of hazards:

GLOW PLUG BUTTON TEST PROCEDURE

TEST DESCRIPTION:

This procedure will determine proper function of the Glow Plug Button using Static and Active tests.

MATERIALS NEEDED:

3/8” nut driver
Digital Multi-Meter
Wiring Diagram
Machine Schematic
Required P.P.E.

TEST PROCEDURE:

1. The Glow Plug Button is on the front panel and can be accessed from the left side of the machine, for physical orientation of Stator refer to Figure F.1.

Figure F.1

2. Perform the “Case Cover Removal” as required to gain access to the Glow Plug Button for testing.

3. Perform the Static and Active testing.

A. STATIC TESTING

A.1. Ensure the engine is not running and the “On/Idle/Stop” switch is in the “Stop” position and the Battery is dis-connected.

A.2. Using a Digital Multi-Meter (set to resistance) perform the measurements identified in Test Table 1 below, refer to Figure F.2 for test point locations.

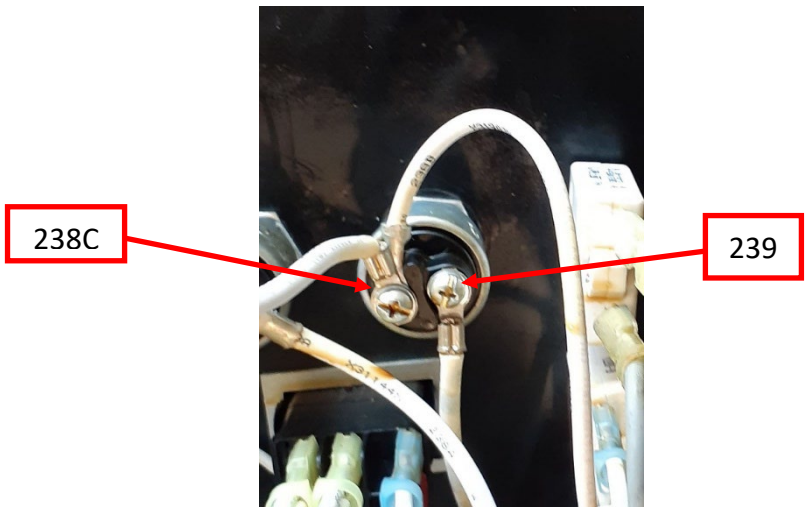


Figure F.2

Glow Plug Button Static Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
Glow Plug Button	Glow Plug button pressed.	Lead 238C	Lead 239	<1 Ohm
Glow Plug Button	Glow Plug button not pressed.	Lead 238C	Lead 239	OL

Table 1

A.4. Any failed measurements in Table 1 indicates a defective Glow Plug Button that will require replacement, refer to “Glow Plug Switch Removal and Replacement” procedure.

A.5. If all measurements are correct reconnect the Battery and proceed to “ACTIVE TESTING”.

B. ACTIVE TESTING

B.1. Ensure the engine is running and “On/Idle/Stop” switch set to High idle.

B.2. Using a Digital Multi-Meter (set to DC) perform the measurements identified in Test Table 2 below, refer to Figure F.3 for test point locations.

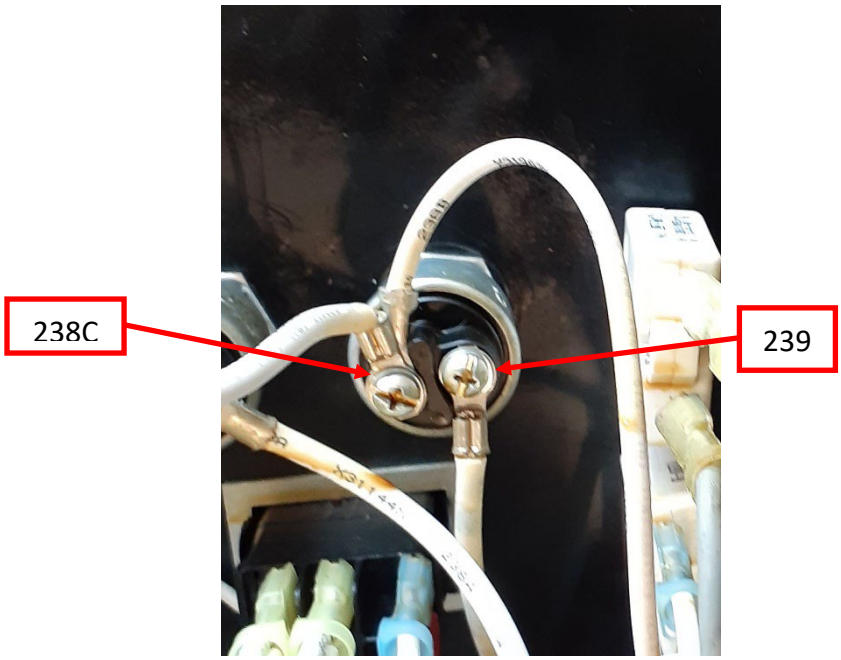


Figure F.3

Glow Plug Button Active Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
Glow Plug Button Input	Glow Plug button not pressed.	Lead 238C	Lead 239	~12 VDC
Start Button Output	Glow Plug button pressed.	Lead 238C	Lead 239	0 VDC

Table 2

B.3. If the input measurements are correct and the output measurement are not correct this component may be faulty.

4. If problems with the machine persist, refer to the “Test Reference” chart for other possible faulty components.

Refer to Safety pages for explanation of hazards:

JJ10 120/240 VAC AUXILIARY RECEPTACLE TEST PROCEDURE

TEST DESCRIPTION:

This procedure will determine proper function of the J10 120/240VAC auxiliary receptacle using Active tests.

MATERIALS NEEDED:

3/8” wrench
Flat head screw drivers
Phillips head screw driver
Digital Multi-Meter
Wiring Diagram
Machine Schematic
Recommended P.P.E.

TEST PROCEDURE:

1. The Auxiliary Receptacles are located on the front panel. They can be accessed from the front panel of the machine, for physical orientation of the Auxiliary Receptacles refer to Figure F.1 below.

Figure F.1

2. Perform the “Case Cover Removal” as required to gain access to the Auxiliary Receptacles for testing.

3. Perform the Active Testing.

A. ACTIVE TESTING

A.1. Ensure the engine is running and “On/Idle/Stop” switch set to high idle.

A.2. Using a Digital Multi-Meter (set to AC) perform the measurements identified in Test Table 1 below, refer to Figure F.2 for receptacle locations.

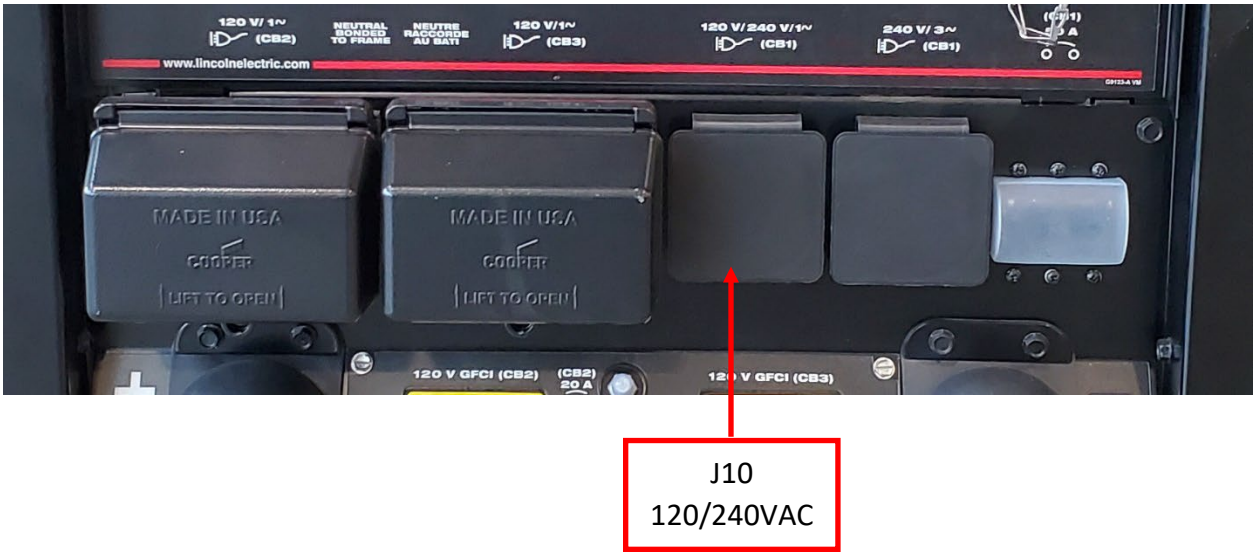


Figure F.2

Auxiliary Receptacles Active Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
120 / 240 VAC Single Phase Receptacle (J10)	Engine Running Run/Stop/Idle switch set to HIGH	X (Leads 3C)	Y (Leads 6D)	~240 VAC
		X (Leads 3C)	W (Lead 5D)	~120 VAC
		Y (Leads 6D)	W (Lead 5D)	~120 VAC

Table 1

A.3. If any measurement is incorrect this component may be faulty.

4. If problems with the machine persist, refer to the “Test Reference” chart for other possible faulty components.

Refer to Safety pages for explanation of hazards:

J11 120 VAC AUXILIARY RECEPTACLE TEST PROCEDURE

TEST DESCRIPTION:

This procedure will determine proper function of the J11 120VAC auxiliary receptacle using Active tests.

MATERIALS NEEDED:

3/8” wrench
Flat head screw drivers
Phillips head screw driver
Digital Multi-Meter
Wiring Diagram
Machine Schematic
Recommended P.P.E.

TEST PROCEDURE:

1. The Auxiliary Receptacles are located on the front panel. They can be accessed from the front panel of the machine, for physical orientation of the Auxiliary Receptacles refer to Figure F.1 below.

Figure F.1

2. Perform the “Case Cover Removal” as required to gain access to the Auxiliary Receptacles for testing.

3. Perform the Active Testing.

A. ACTIVE TESTING

A.1. Ensure the engine is running and “On/Idle/Stop” switch set to high idle.

A.2. Using a Digital Multi-Meter (set to AC) perform the measurements identified in Test Table 1 below, refer to Figure F.2 for receptacle locations.

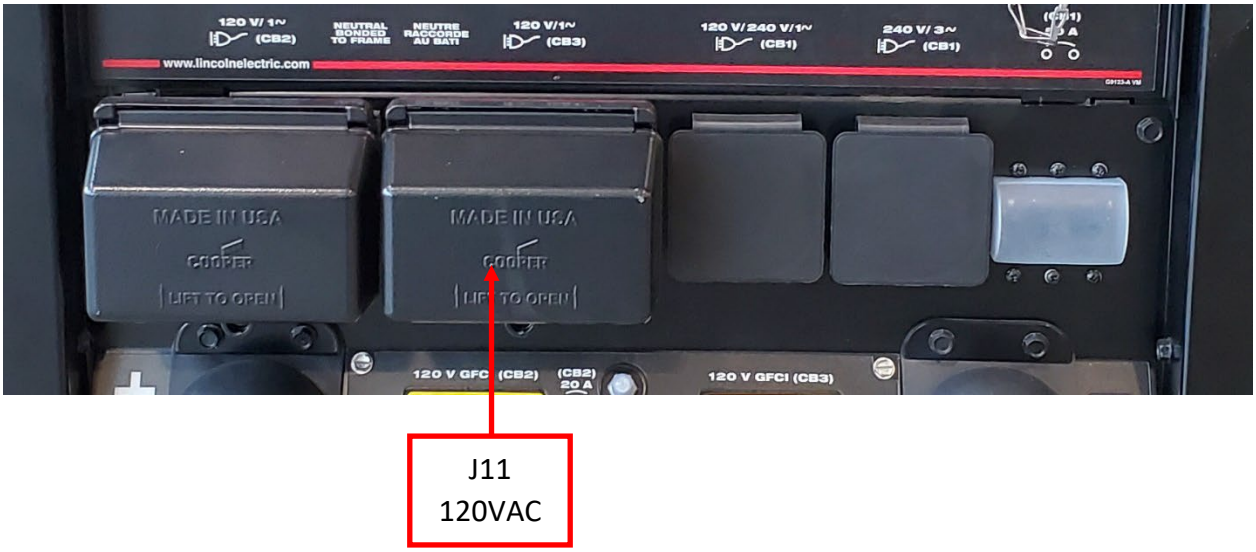


Figure F.2

Auxiliary Receptacles Active Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
120VAC Receptacle (J11)	Engine Running Run/Stop/Idle switch set to HIGH	Lead 6G	Lead 5E	~120 VAC

Table 1

A.3. If any measurement is incorrect this component may be faulty.

4. If problems with the machine persist, refer to the “Test Reference” chart for other possible faulty components.

Refer to Safety pages for explanation of hazards:

J12 120 VAC AUXILIARY RECEPTACLE TEST PROCEDURE

TEST DESCRIPTION:
This procedure will determine proper function of the J12 120VAC auxiliary receptacle using Active tests.

MATERIALS NEEDED:
3/8” wrench
Flat head screw drivers
Phillips head screw driver
Digital Multi-Meter
Wiring Diagram
Machine Schematic
Recommended P.P.E.

TEST PROCEDURE:
1. The Auxiliary Receptacles are located on the front panel. They can be accessed from the front panel of the machine, for physical orientation of the Auxiliary Receptacles refer to Figure F.1 below.

Figure F.1

2. Perform the “Case Cover Removal” as required to gain access to the Auxiliary Receptacles for testing.

3. Perform the Active Testing.

A. ACTIVE TESTING

A.1. Ensure the engine is running and “On/Idle/Stop” switch set to high idle.

A.2. Using a Digital Multi-Meter (set to AC) perform the measurements identified in Test Table 1 below, refer to Figure F.2 for receptacle locations.

Figure F.2

Auxiliary Receptacles Active Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
120VAC Receptacle Left Side (J12)	Engine Running Run/Stop/Idle switch set to HIGH	Lead 3F	Lead 5B	~120 VAC

Table 1

A.3. If any measurement is incorrect this component may be faulty.

4. If problems with the machine persist, refer to the “Test Reference” chart for other possible faulty components.

Refer to Safety pages for explanation of hazards:

JJ13 240 VAC 3 PHASE AUXILIARY RECEPTACLE TEST PROCEDURE

TEST DESCRIPTION:
This procedure will determine proper function of the J13 240VAC 3 Phase auxiliary receptacle using Active tests.

MATERIALS NEEDED:
3/8” wrench
Flat head screw drivers
Phillips head screw driver
Digital Multi-Meter
Wiring Diagram
Machine Schematic
Recommended P.P.E.

TEST PROCEDURE:
1. The Auxiliary Receptacles are located on the front panel. They can be accessed from the front panel of the machine, for physical orientation of the Auxiliary Receptacles refer to Figure F.1 below.

Figure F.1

2. Perform the “Case Cover Removal” as required to gain access to the Auxiliary Receptacles for testing.

3. Perform the Active Testing.

A. ACTIVE TESTING

A.1. Ensure the engine is running and “On/Idle/Stop” switch set to high idle.

A.2. Using a Digital Multi-Meter (set to AC) perform the measurements identified in Test Table 1 below, refer to Figure F.2 for receptacle locations.

Figure F.2

Auxiliary Receptacles Active Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
240 VAC 3 Phase Receptacle (J13)	Engine Running Run/Stop/Idle switch set to HIGH	X (Lead 3B)	Y (Lead 6C)	~240 VAC
		Y (Lead 6C)	Z (Lead 4A)	~240 VAC
		Z (Lead 4A)	X (Lead 3B)	~240 VAC

Table 1

A.3. If any measurement is incorrect this component may be faulty.

4. If problems with the machine persist, refer to the “Test Reference” chart for other possible faulty components.

Refer to Safety pages for explanation of hazards:

ROTOR TEST PROCEDURE

TEST DESCRIPTION:

This procedure will determine proper function of the Rotor using Static and Active tests.

MATERIALS NEEDED:

3/8” nut driver
Needle nose pliers
Digital Multi-Meter
Wiring Diagram
Machine Schematic
Required P.P.E.

TEST PROCEDURE:

1. The rotor is low centered and towards the front of the machine and can be accessed from either side of the machine, for physical orientation of Stator refer to Figure F.1.

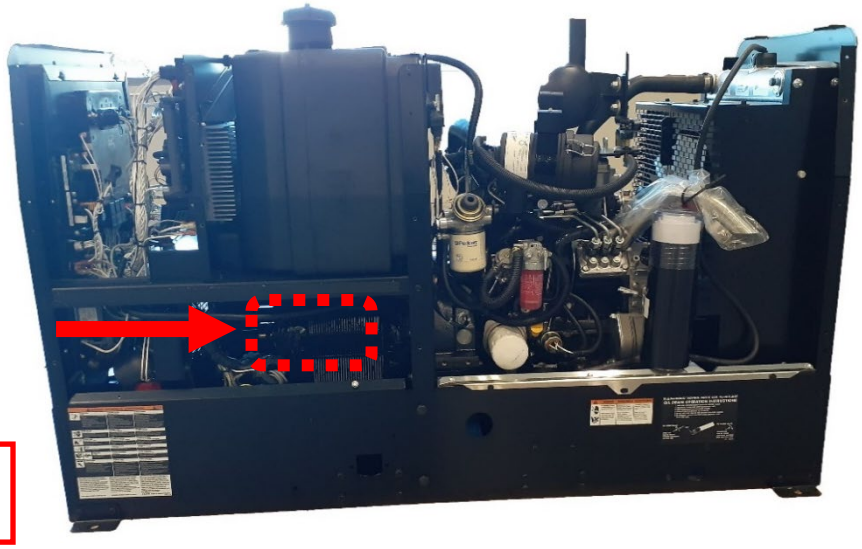


Figure F.1

2. Perform the “Case Cover Removal” as required to gain access to the Rotor for testing.

3. Perform the Static and Active testing.

A. STATIC TESTING

A.1. Ensure the engine is not running and the “On/Idle/Stop” switch is in the “Stop” position.

A.2. Label and disconnect the following Rotor leads, for physical location of connections refer to Figure F.2.

- 200B
- 201B

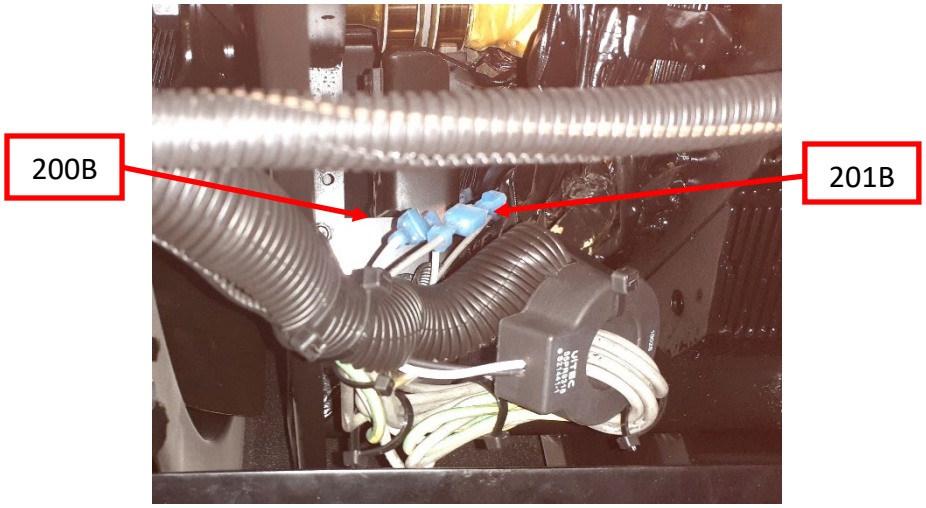


Figure F.2

A.3. Using a Digital Multi-Meter (set to resistance) perform the measurements identified in Test Table 1 below, refer to Figure F.3 for test point locations.

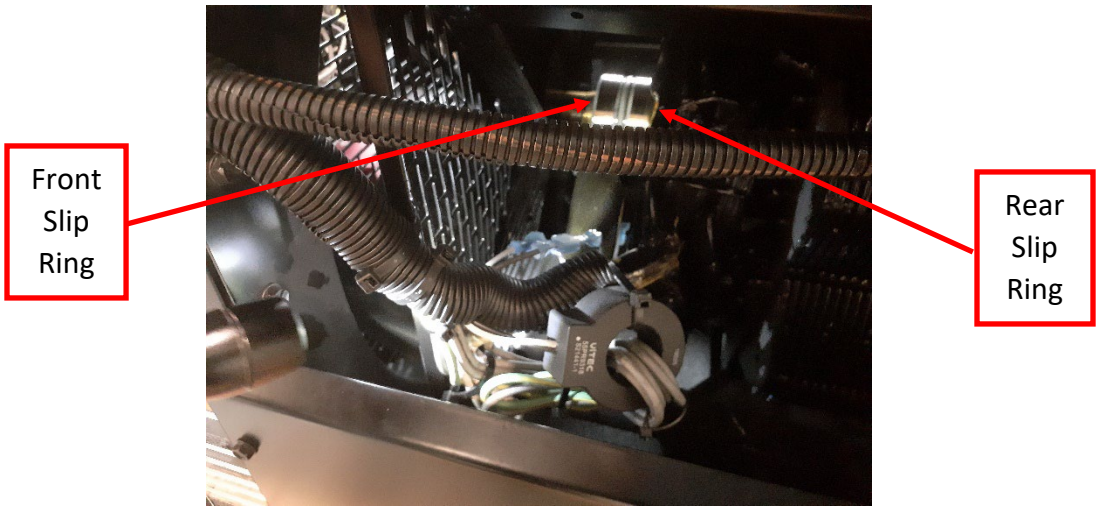


Figure F.3

Rotor Static Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
Rotor	Leads 200B and 201B Disconnected	Front Slip ring	Rear Slip ring	~25 Ohms
Rotor	Leads 200B and 201B Disconnected	Front or Rear Slip ring	Ground	OL

Table 1

A.4. Any failed measurements in Table 1 indicates a defective Rotor that will require replacement, refer to "Rotor Removal and Replacement" procedure.

A.5. If all measurements are correct proceed to "ACTIVE TESTING".

B. ACTIVE TESTING

B.1. Ensure the engine is running and "Run/Stop" switch set to High idle. **NOTE: ENSURE LEADS 200 AND 201 ARE DISCONNECTED.**

B.2. Using a Digital Multi-Meter (set to Resistance) perform the measurements identified in Test Table 2 below, refer to Figure F.4 for test point locations.

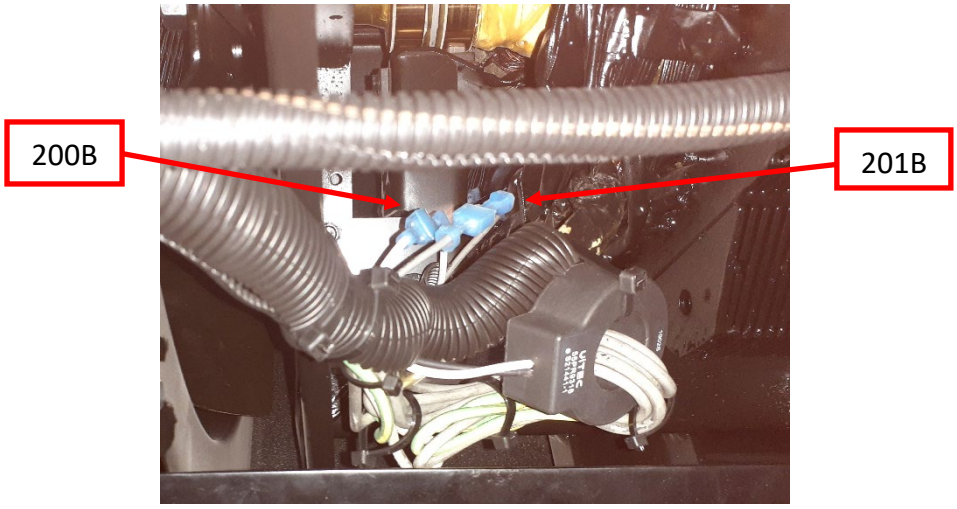


Figure F.4

Rotor Active Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
Rotor	Leads 200B and 201B Disconnected	Lead 200B	Lead 201B	~25 Ohms
Rotor	Leads 200B and 201B Disconnected	Lead 200B or Lead 201B	Ground	OL

Table 2

B.3. If any measurement is not correct this component may be faulty.

4. If problems with the machine persist, refer to the “Test Reference” chart for other possible faulty components.

Refer to Safety pages for explanation of hazards:

ON/IDLE CONTROL/STOP SWITCH TEST PROCEDURE

TEST DESCRIPTION:

This procedure will determine proper function of the On/Idle Control/Stop Switch using Static and Active tests.

MATERIALS NEEDED:

3/8” wrench
Needle Nose Pliers
Digital Multi-Meter
Wiring Diagram
Machine Schematic
Required P.P.E.

TEST PROCEDURE:

1. The On/Idle/Stop Switch is on the front panel and can be accessed from behind the front panel of the machine, for physical orientation of Stator refer to Figure F.1.

Figure F.1

2. Perform the “Case Cover Removal” as required to gain access to the On/Idle /Stop Switch for testing.

3. Perform the Static and Active testing.

A. STATIC TESTING

A.1. Ensure the engine is not running and the “On/Idle/Stop” switch is in the “Stop” position and the Battery is dis-connected.

A.2. Using a Digital Multi-Meter (set to resistance) perform the measurements identified in Test Table 1 below, refer to Figure F.2 for test point locations.

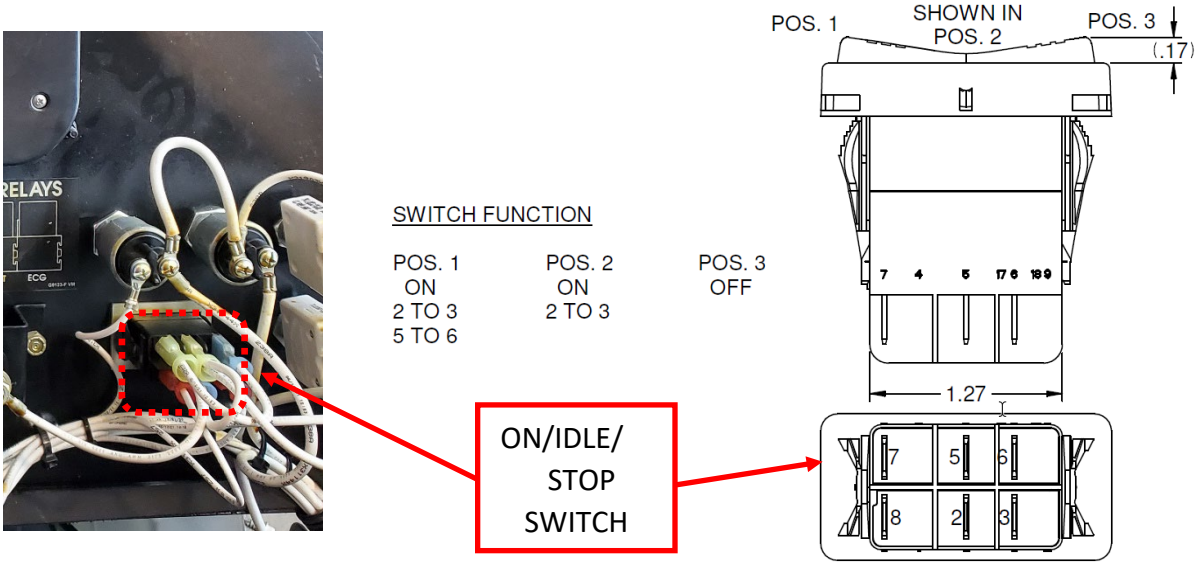


Figure F.2

On/Idle/Stop Switch Static Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
Run/Idle Control/Stop Switch	On/Idle/Stop Switch in High Idle (POS. 1)	Lead 238D (Terminal 2)	Lead 232B (Terminal 3)	<1 Ohm
	On/Idle/Stop Switch in Auto (POS. 2)	Lead 238D (Terminal 2)	Lead 232B (Terminal 3)	<1 Ohm
	On/Idle/Stop Switch in High Idle (POS. 1)	Lead 238F (Terminal 5)	Lead 257 (Terminal 6)	<1 Ohm
	On/Idle/Stop Switch in High Idle (POS. 2)	Lead 238F (Terminal 5)	Lead 257 (Terminal 6)	<1 Ohm
	On/Idle/Stop Switch in Stop (POS. 3)	Lead 238D (Terminal 2)	Lead 232B (Terminal 3)	OL
	On/Idle/Stop Switch in Stop (POS. 3)	Lead 238F (Terminal 5)	Lead 257 (Terminal 6)	OL

Table 1

A.4. Any failed measurements in Table 1 indicates a defective On/Idle/Stop Switch that will require replacement, refer to “D4 Rectifier Removal and Replacement” procedure.

A.5. If all measurements are correct reconnect the battery and proceed to “ACTIVE TESTING”.

B. ACTIVE TESTING

B.1. Ensure the engine is not running.

B.2. Using a Digital Multi-Meter (set to DC) perform the measurements identified in Test Table 2 below, refer to Figure F.3 for test point locations.

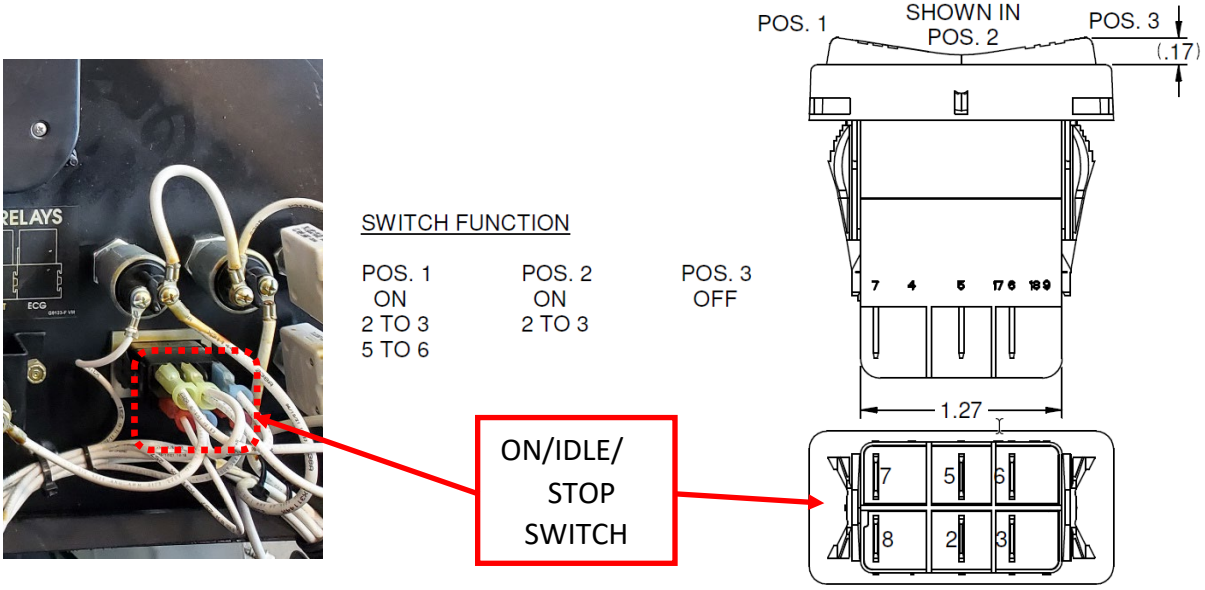


Figure F.3

On/Idle/Stop Switch Active Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
Run/Idle Control/Stop Switch	Run/ Stop Switch in High Idle (POS. 1)	Lead 238D (Terminal 2)	Lead 232B (Terminal 3)	0 VDC
	Run/ Stop Switch in Auto (POS. 2)	Lead 238D (Terminal 2)	Lead 232B (Terminal 3)	0 VDC
	Run/ Stop Switch in High Idle (POS. 1)	Lead 238F (Terminal 5)	Lead 257 (Terminal 6)	0 VDC
	Run/ Stop Switch in Auto (POS. 2)	Lead 238F (Terminal 5)	Lead 257 (Terminal 6)	~12 VDC
	Run/ Stop Switch in Stop (POS. 3)	Lead 238D (Terminal 2)	Lead 232B (Terminal 3)	~12 VDC
	Run/ Stop Switch in Stop (POS. 3)	Lead 238F (Terminal 5)	Lead 257 (Terminal 6)	~12 VDC

Table 2

B.3. If any measurement is incorrect this component may be faulty.

4. If problems with the machine persist, refer to the “Test Reference” chart for other possible faulty components.

Refer to Safety pages for explanation of hazards:

START BUTTON TEST PROCEDURE

TEST DESCRIPTION:
This procedure will determine proper function of the Start Button using Static and Active tests.

MATERIALS NEEDED:
3/8” wrench
Digital Multi-Meter
Wiring Diagram
Machine Schematic
Required P.P.E.

TEST PROCEDURE:
1. The Start Button is behind the front panel on the right side and can be accessed from the right side of the machine, for physical orientation of Start Button refer to Figure F.1.

Figure F.1

2. Perform the “Case Cover Removal” as required to gain access to the Start Button for testing.

3. Perform the Static and Active testing.

A. STATIC TESTING

A.1. Ensure the engine is not running and the “On/Idle/Stop” switch is in the “Stop” position and the Battery is dis-connected.

A.2. Using a Digital Multi-Meter (set to resistance) perform the measurements identified in Test Table 1 below, refer to Figure F.2 for test point locations.

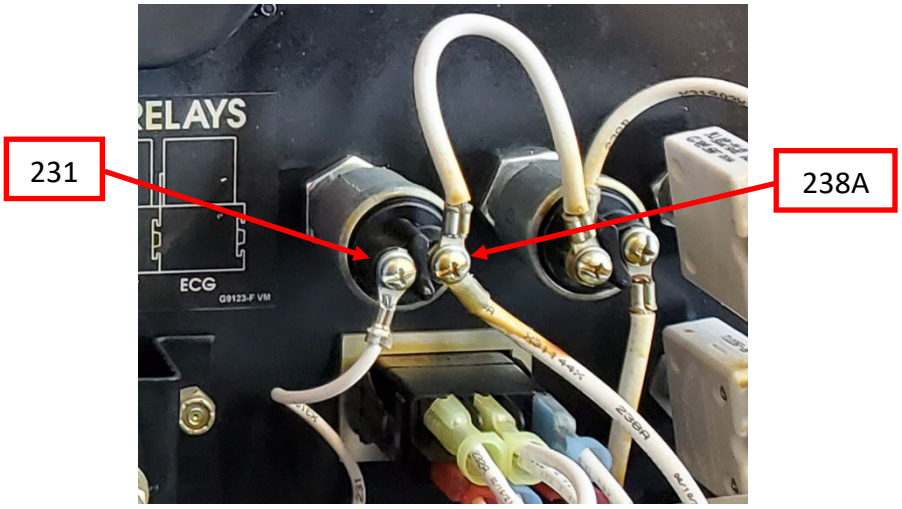


Figure F.2

Start Button Static Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
Start Button	Start button pressed.	Lead 231	Lead 238A	<1 Ohm
Start Button	Start button not pressed.	Lead 231	Lead 238A	OL

Table 1

A.3. Any failed measurements in Table 1 indicates a defective Start Button that will require replacement, refer to “Start Button Removal and Replacement” procedure.

A.4. If all measurements are correct reconnect the battery and proceed to “ACTIVE TESTING”.

B. ACTIVE TESTING

B.1. Ensure the engine is not running and “On/Idle/Stop” switch set to High idle.

B.2. Remove the CR2 Start Relay.

B.2. Using a Digital Multi-Meter (set to DC) perform the measurements identified in Test Table 2 below, refer to Figure F.3 for test point locations.

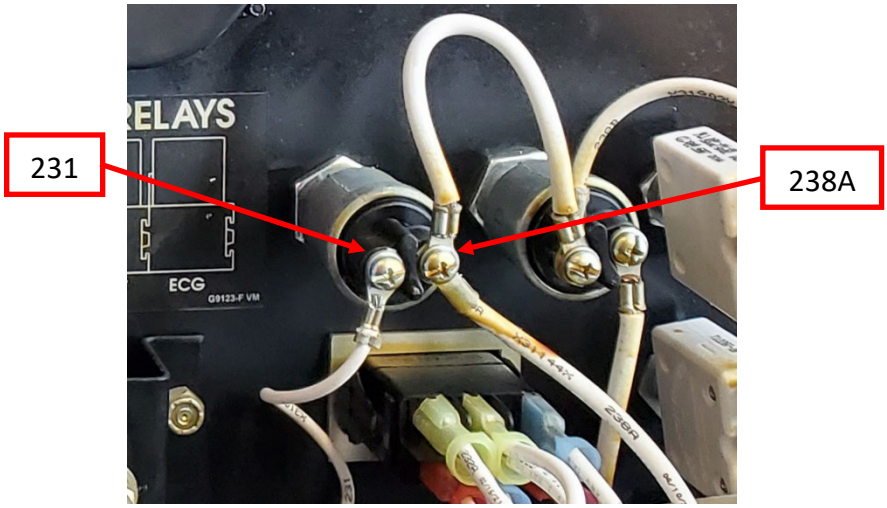


Figure F.3

Start Button Active Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
Start Button Input	Start button not pressed. CR2 Removed.	Lead 238A	Lead 231	~12 VDC
Start Button Output	Start button pressed. CR2 Removed.	Lead 238A	Lead 231	0 VDC

Table 2

B.3. If the input measurements are correct and the output measurement are not correct this component may be faulty.

4. If problems with the machine persist, refer to the “Test Reference” chart for other possible faulty components.

Refer to Safety pages for explanation of hazards:

STATOR TEST PROCEDURE

TEST DESCRIPTION:

This procedure will determine proper function of the Stator using Static and Active tests.

MATERIALS NEEDED:

3/8” wrench
7/16” wrench
Digital Multi-Meter
Wiring Diagram
Machine Schematic
Required P.P.E.

TEST PROCEDURE:

1. The Stator is located low, center and can be accessed from either side of the machine, for physical orientation of Stator refer to Figure F.1.

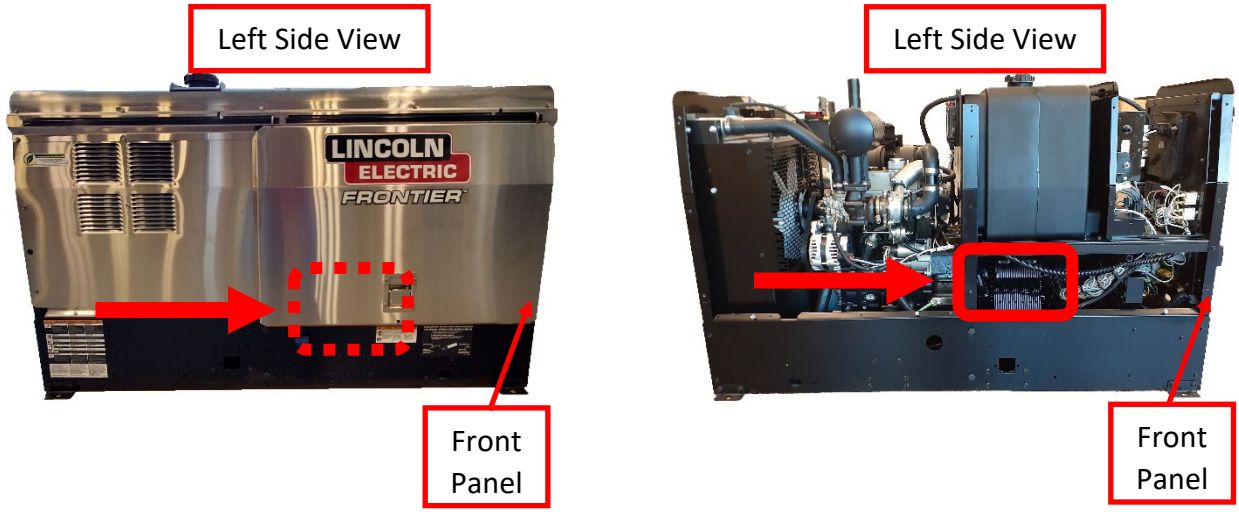


Figure F.1

2. Perform the “Case Cover Removal” as required to gain access to the Stator for testing.

3. Perform the Static and Active testing.

A. STATIC TESTING

A.1. Ensure the engine is not running and the “On/Idle/Stop” switch is in the “Stop” position.

A.2. Label and disconnect the following Stator connections, for physical location of connections refer to Figure F.2.

- W1
- W2
- W3
- W4
- W5
- W6
- 9A
- 4
- 5
- 5A
- 6
- 7
- 8
- 45
- 46

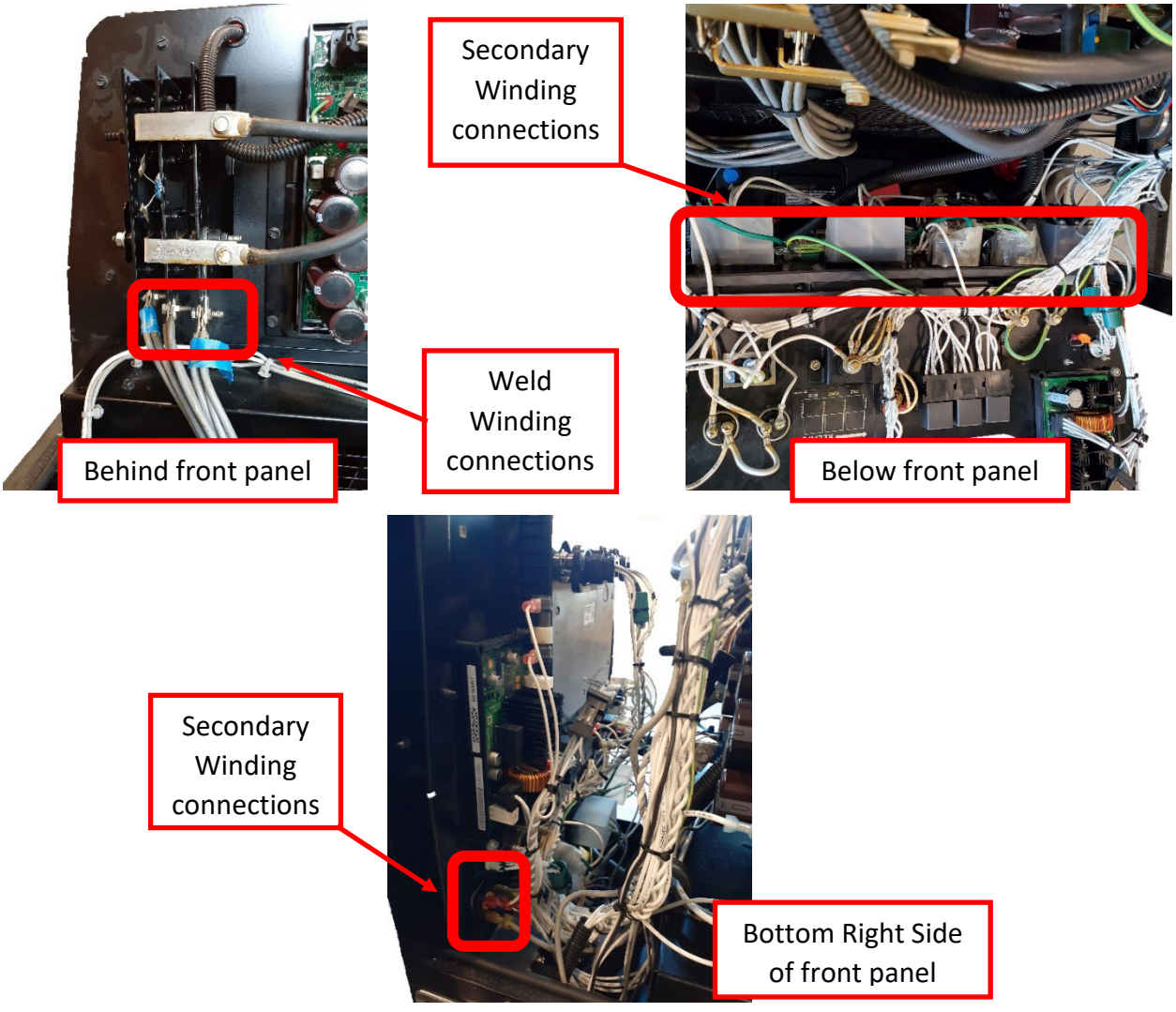


Figure F.2

A.3. Using a Digital Multi-Meter (set to resistance) perform the measurements identified in Test Table 1 below, refer to Figure F.2 for test point locations.

Stator Static Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
Stator Weld Windings	Terminals W1/W6, W2/W3, W4/W5, Disconnected	Terminal W1	Terminal W2	< 1 Ohm
		Terminal W3	Terminal W4	<1 Ohm
		Terminal W5	Terminal W6	<1 Ohm
		Terminal W1	Ground	OL
		Terminal W3	Ground	OL
		Terminal W5	Ground	OL
Stator Auxiliary Windings	Terminals 9A,3,4,5,5A,6,7,8,45,46 Disconnected	Lead 9A	Lead 5	<1 Ohm
		Lead 3 (CB1)	Lead 5	<1 Ohm
		Lead 4 (CB1)	Lead 5	<1 Ohm
		Lead 6 (CB1)	Lead 5	<1 Ohm
		Lead 7 (D2)	Lead 8 (D2)	<1 Ohm
		Lead 7 (D2)	Ground	OL
		Lead 45 (D3)	Lead 46 (CB4)	<1 Ohm
		Lead 45 (D3)	Ground	OL

Table 1

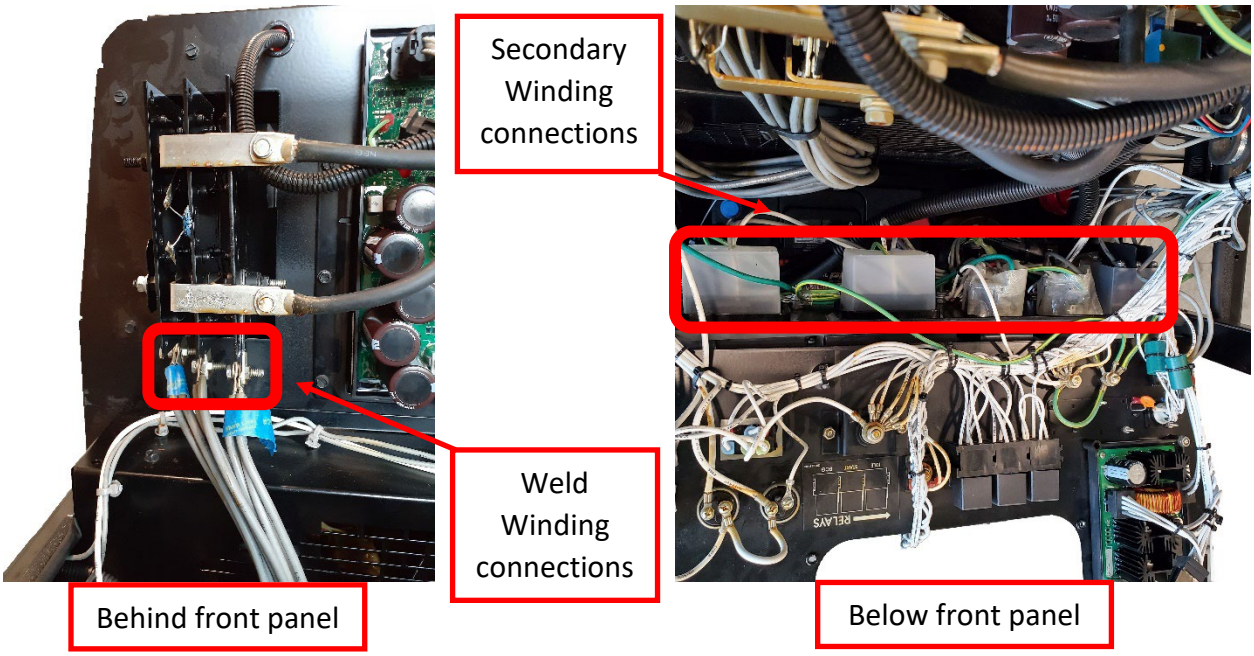
A.4. Any failed measurements in Table 1 indicates a defective Stator that will require replacement, refer to “Stator Removal and Replacement” procedure.

A.5. If all measurements are correct reconnect all connections removed in “Step A.2” and proceed to “ACTIVE TESTING”.

B. ACTIVE TESTING

B.1. Ensure the engine is running and “On/Idle/Stop” switch set to high idle.

B.2. Using a Digital Multi-Meter (set to AC) perform the measurements identified in Test Table 2 below, refer to Figure F.3 for test point locations.



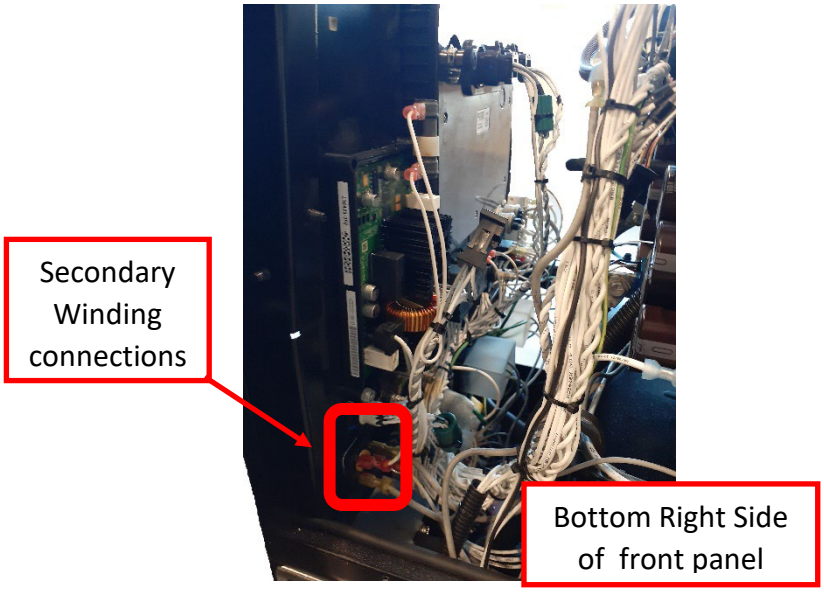


Figure F.3

Stator Active Test				
Component/Circuit Tested	Condition(s)	+Meter Lead	-Meter Lead	Expected Value
Phase 1 AC input	On/Idle/Stop switch set to HIGH	Terminal W1/W6	Terminal W2/W3	~80 VAC
Phase 2 AC input		Terminal W2/W3	Terminal W4/W5	~80 VAC
Phase 3 AC input		Terminal W4/W5	Terminal W1/W6	~80 VAC
Stator Auxiliary Windings	On/Idle/Stop switch set to High Idle	Lead 9A	Lead 5 or 5A	~42 VAC
		Lead 3 (CB1)	Lead 5 or 5A	~120 VAC
		Lead 4 (CB1)	Lead 5 or 5A	~120 VAC
		Lead 6 (CB1)	Lead 5 or 5A	~120 VAC
		Lead 7 (D2)	Lead 8 (D2)	~141 VAC
		Lead 45 (D3)	Lead 46 (D3)	~42 VAC

Table 2

B.3. If the input measurements are correct and the output measurement are not correct this component may be faulty.

4. If problems with the machine persist, refer to the “Test Reference” chart for other possible faulty components.

FRONTIER 400X

RETEST AFTER REPAIR

Perform the RETEST AFTER REPAIR procedure under the following conditions:

- If it is rejected under test for any reason that requires you to remove any part which could affect the machine's electrical characteristics.

OR

- If you repair or replace any electrical components.

ENGINE OUTPUT

Engine Mode	No Load RPM	Load RPM
Low Idle	1440 RPM	N/A
High Idle	1800 RPM	1800 RPM

WELDER DC OUTPUT (STICK)

Weld Mode	Output Control	Open Circuit Voltage	Load Voltage	Load Amps
Stick (CC)	Maximum	55-60 VDC	36-38 VDC	400 Amps

WELDER CV OUTPUT (WIRE FEEDING)

Weld Mode	Output Control	Open Circuit Voltage	Load Volts
Constant Voltage (MIG)	Maximum	55 – 60 VDC	10 – 45 VDC

TOUCH START TIG OUTPUT

Weld Mode	Output Control	Load Voltage	Load Amps
TIG	Maximum	18-22 VDC	5 – 400 Amps

AUXILIARY POWER OUTPUT

Open Circuit Voltage	Load Amps	Watts (Continuous)
240 VAC 3-Phase	50 Amps	11,000 Watts
240 VAC 1-Phase	50 Amps	10,000 Watts
120 VAC 1-Phase	20 Amps	10,000 Watts

CASE COVER REMOVAL AND REPLACEMENT PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will aid the technician in the removal and replacement of the Case Covers.

MATERIALS NEEDED

3/8” Nutdriver
Wiring Diagram

REMOVAL PROCEDURE

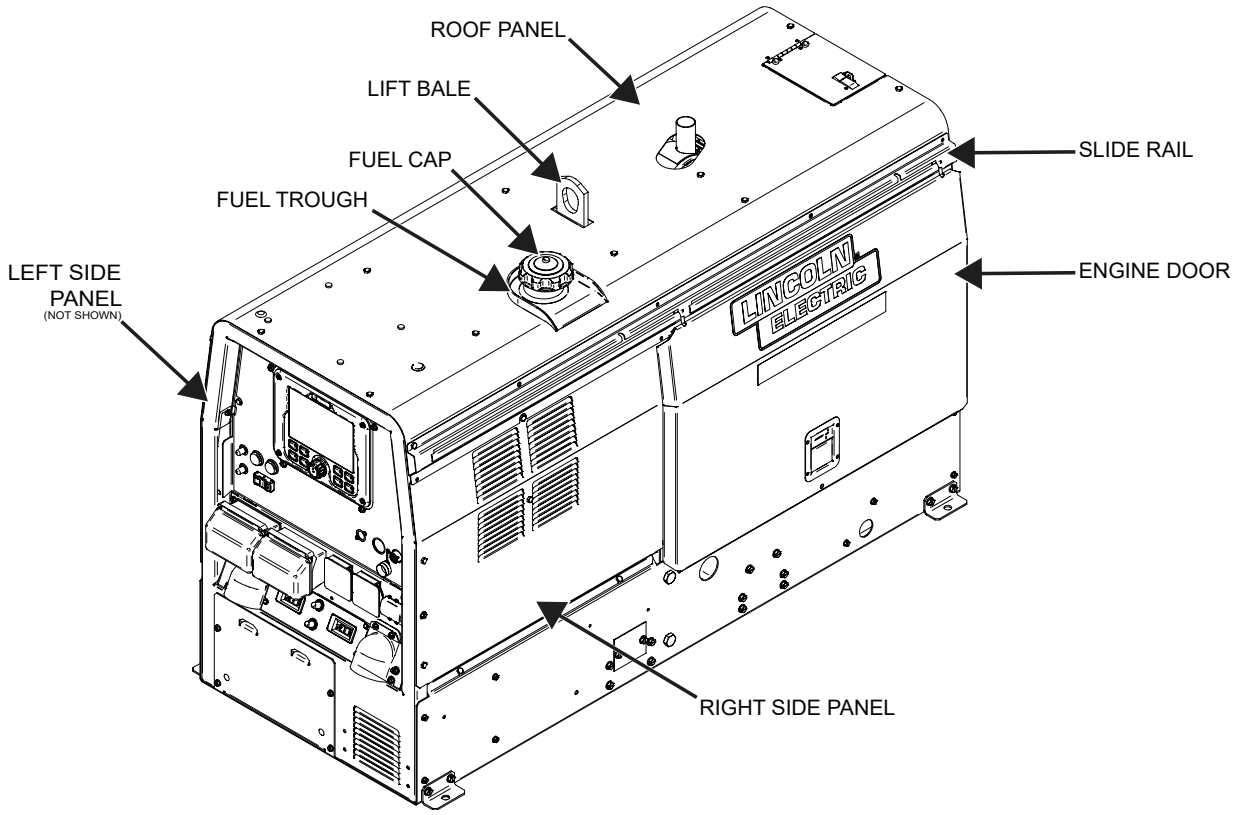
1. Turn off the engine of the Frontier 400X machine.
2. Carefully slide the engine door assembly off the door slide rail. See ***Figure F.1***.
3. Using a 3/8” nutdriver, remove the nine screws securing the slide rail to the machine. See ***Figure F.1***.
4. Using a 3/8” nutdriver, remove the 15 screws securing the roof panel to the machine. See ***Figure F.1***.
5. Carefully remove the lift bale cover. See ***Figure F.1***.
6. Carefully remove the fuel cap and fuel trough from the machine. See ***Figure F.1***.
7. With the help of an assistant, carefully remove the roof panel from the machine.
8. Attach the fuel cap.
9. Using a 3/8” nutdriver, loosen the two screws securing the right side panel to the machine. See ***Figure F.1***.
10. Using a 3/8” nutdriver, remove the five screws securing the right side panel to the machine. See ***Figure F.1***.
11. The right side panel can now be removed.
12. Using a 3/8” nutdriver, loosen the four screws securing the left side panel to the machine. See ***Figure F.1***.
13. Using a 3/8” nutdriver, remove the six screws securing the left side panel to the machine. See ***Figure F.1***.
14. The left side panel can now be removed.

15. Disconnect lead from the negative battery terminal. See Wiring Diagram.
16. Perform any tests / replacement procedure.

REPLACEMENT PROCEDURE

1. Carefully connect the lead to the negative battery terminal. See Wiring Diagram.
2. Carefully position the left side panel onto the machine.
3. Using a 3/8” nutdriver, attach the six screws securing the left side panel to the machine.
4. Using a 3/8” nutdriver, tighten the four screws securing the left side panel to the machine.
5. Carefully position the right side panel onto the machine.
6. Using a 3/8” nutdriver, attach the five screws securing the right side panel to the machine.
7. Using a 3/8” nutdriver, tighten the two screws securing the right side panel to the machine.
8. Carefully remove the fuel cap from the machine.
9. With the help of an assistant, carefully position the roof panel onto the machine.
10. Attach the lift bale cover to the machine.
11. Carefully attach the fuel cap and fuel trough to the machine.
12. Using a 3/8” nutdriver, attach the 15 screws securing the roof panel to the machine.
13. Carefully position the slide rail onto the machine.
14. Using a 3/8” nutdriver, attach the nine screws securing the slide rail to the machine.
15. Position the door assembly into the door slide.

Figure F.1 – Case component locations



CAPACITOR DISCHARGE PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will ensure that the large Capacitors on the Chopper Control Board have been discharged. This procedure should be performed whenever work is to be attempted on or near the Chopper Control Board.

MATERIALS NEEDED

Volt/Ohmmeter
Resistor (25-1000 ohms and 25 watts minimum)
Electrically Insulated Gloves
Electrically Insulated Pliers
Jumper Leads
Wiring Diagram

TEST PROCEDURE

1. Turn off the engine on the Frontier 400X machine.
2. Perform the ***Case Cover Removal Procedure***.
3. Locate the chopper control board. See ***Figure F.1***. See Wiring Diagram.
4. Using a volt/ohmmeter, measure the voltage at between terminals B5 and B4 on the chopper control board. See ***Figure F.2***. See Wiring Diagram. Voltage should read 0 VDC.
5. If any voltage is present, discharge the capacitors using a high wattage resistor (25-1000 ohms @ 25 watts minimum), electrically insulated gloves and pliers. Hold the resistor on the chopper control board terminals B5 and B4 for ten seconds. See ***Figure F.2***. See Wiring Diagram.
6. If any voltage is still present on chopper control board, repeat step 5 until reading is zero volts.
7. Locate the field capacitor, attached to the stator fan guard. See Wiring Diagram.
8. Using a volt/ohmmeter, measure the voltage at between the positive and negative terminals of the capacitor. See ***Figure F.3***. See Wiring Diagram. Voltage should read 0 VDC.
9. If any voltage is present, discharge the capacitor using a high wattage resistor (25-1000 ohms @ 25 watts minimum), electrically insulated gloves and pliers. Hold the resistor on the positive and negative terminals for ten seconds. See ***Figure F.3***. See Wiring Diagram.
10. If any voltage is still present on the capacitor, repeat step 9 until reading is zero volts.
11. Perform the ***Case Cover Replacement Procedure***.

Figure F.1 – Chopper control board location

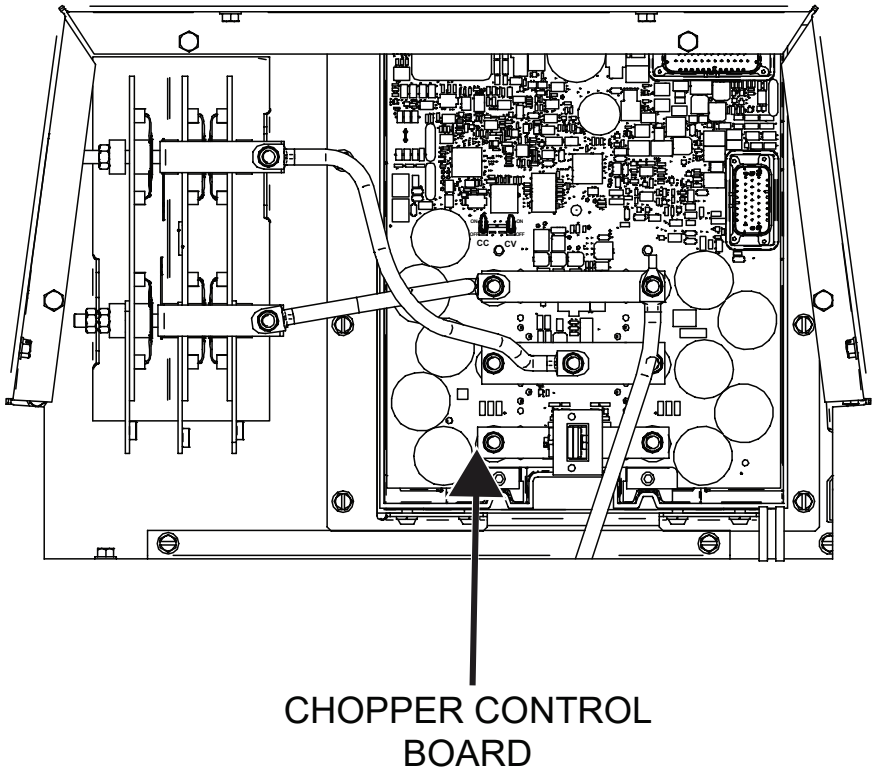


Figure F.2 – Chopper control board discharge

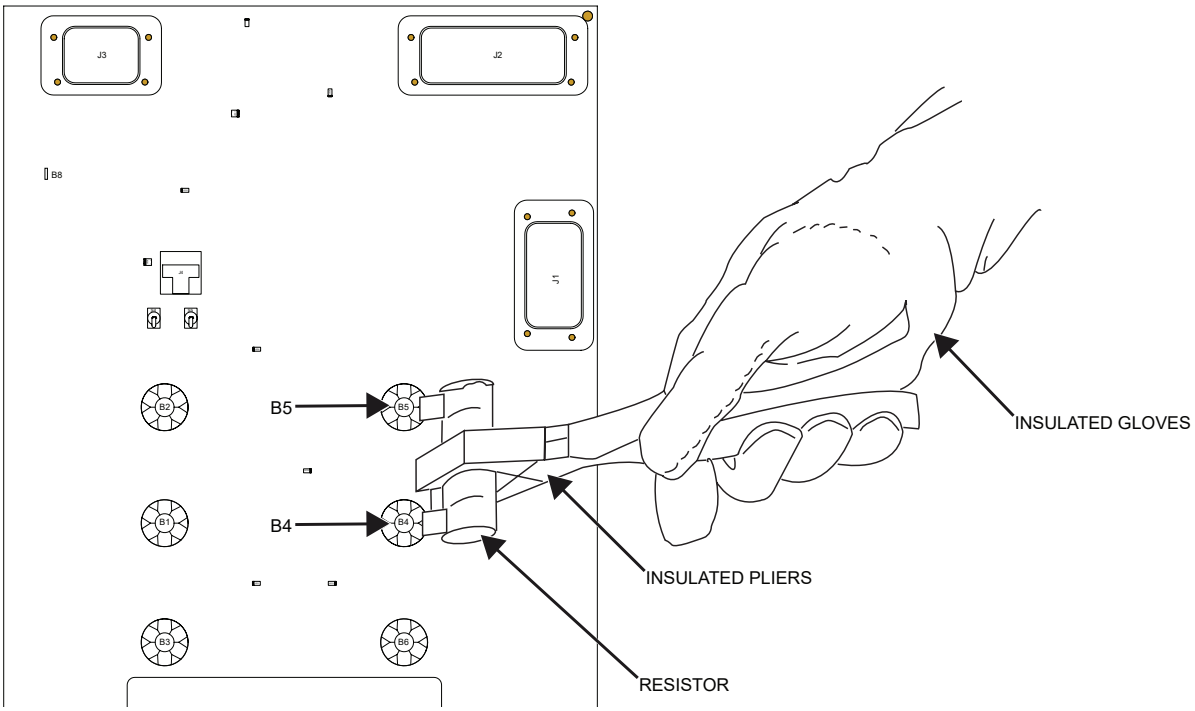
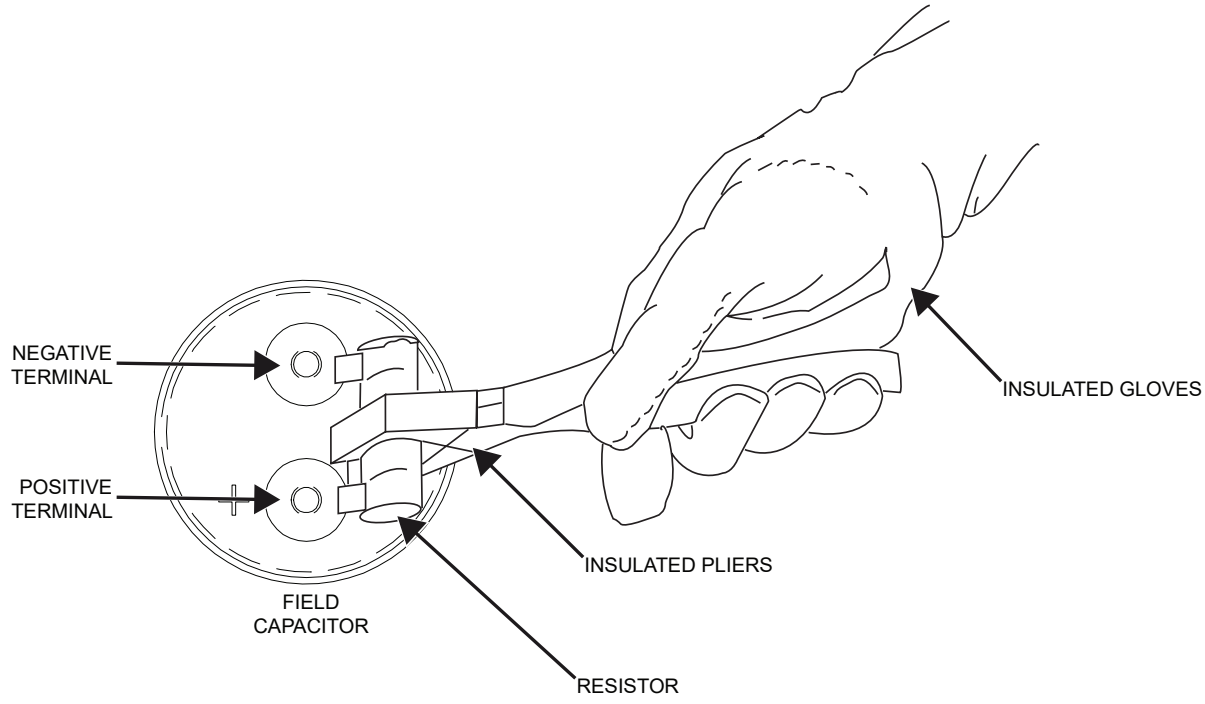


Figure F.3 – Field capacitor discharge



BATTERY REMOVAL AND REPLACEMENT PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will aid the technician in the removal and replacement of the Battery.

MATERIALS NEEDED

3/8” Nutdriver
7/16” Nutdriver
Wiring Diagram

REMOVAL PROCEDURE

1. Turn off the engine on the Frontier 400X machine.
2. Using a 3/8” nutdriver, remove the four screws securing the battery tray door to the machine. See ***Figure F.1***.
3. Label and disconnect the positive and negative battery cables from the battery. See ***Figure F.2***. See Wiring Diagram.
4. Carefully slide the battery tray as far out of the machine as allowed to gain access to the rear mounting hardware.
5. Using a 7/16” nutdriver, remove two nuts and carriage bolts securing the battery bracket to the battery tray. See ***Figure F.2***. Remove the battery bracket.
6. The battery can now be removed and replaced.

REPLACEMENT PROCEDURE

1. Carefully position the new battery into the battery tray.
2. Using a 7/16” nutdriver, attach two nuts and carriage bolts securing the battery bracket to the battery tray.
3. Carefully slide the battery tray most of the way into the machine. Leave enough room to attach the battery cable.
4. Connect the positive and negative battery cables to the battery. See Wiring Diagram.
5. Using a 3/8” nutdriver, attach the four screws securing the battery tray door to the machine.
6. Perform the ***Retest After Repair Procedure***.

Figure F.1 – Battery tray mounting hardware locations

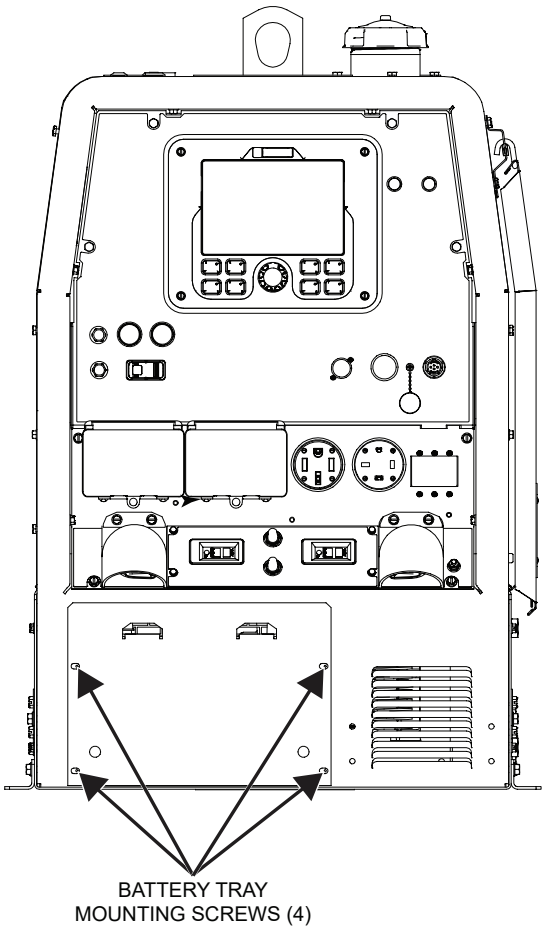
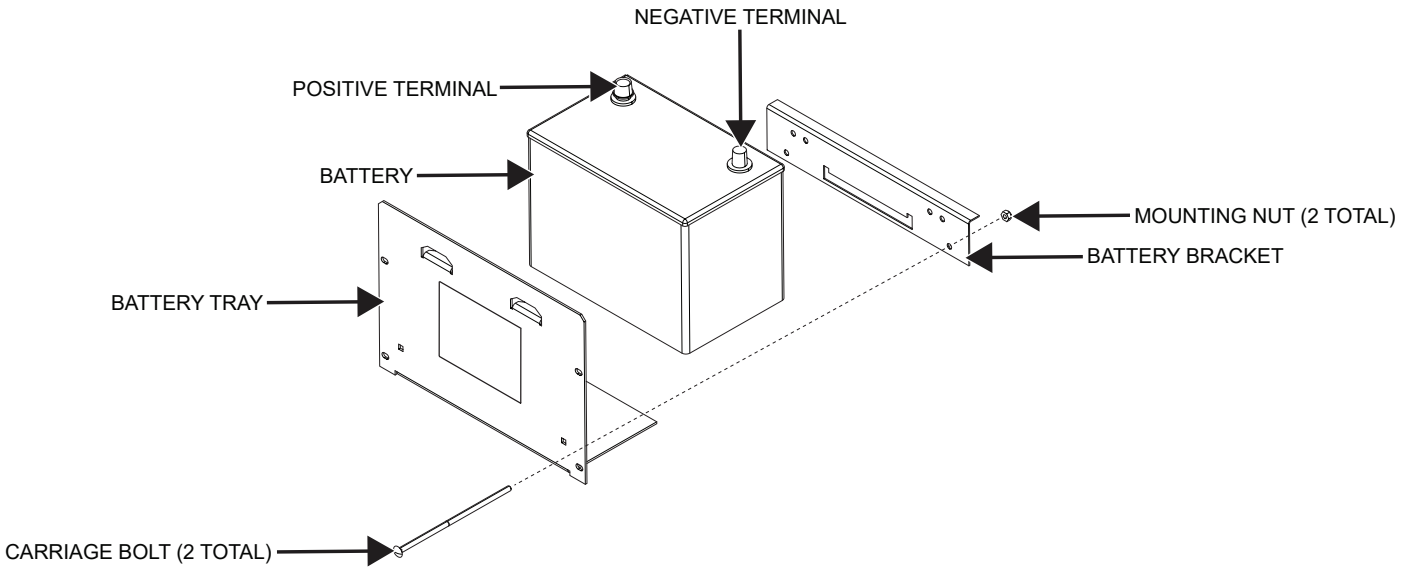


Figure F.2 – Battery mounting hardware locations



LCD DISPLAY REMOVAL AND REPLACEMENT PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will aid the technician in the removal and replacement of the LCD Display.

MATERIALS NEEDED

5/16” Nutdriver
Wiring Diagram

REMOVAL PROCEDURE

1. Turn off the engine on the Frontier 400X machine.
2. Perform the ***Case Cover Removal Procedure***.
3. Perform the ***Capacitor Discharge Procedure***.
4. Label and disconnect plugs J31 and J32 from the rear of the LCD display panel. See ***Figure F.1***. See Wiring Diagram.
5. Using a 5/16” nutdriver, remove the four screws securing the LCD display panel to the front panel of the machine. See ***Figure F.2***.
6. The LCD display panel can now be removed and replaced.

REPLACEMENT PROCEDURE

1. Carefully position the new LCD display panel into the machine.
2. Using a 5/16” nutdriver, attach the four screws securing the LCD display panel to the front panel of the machine.
3. Connect plugs J31 and J32 to the rear of the LCD display panel. See Wiring Diagram.
4. Perform the ***Case Cover Replacement Procedure***.
5. Perform the ***Retest After Repair Procedure***.

Figure F.1 – LCD display panel plug locations

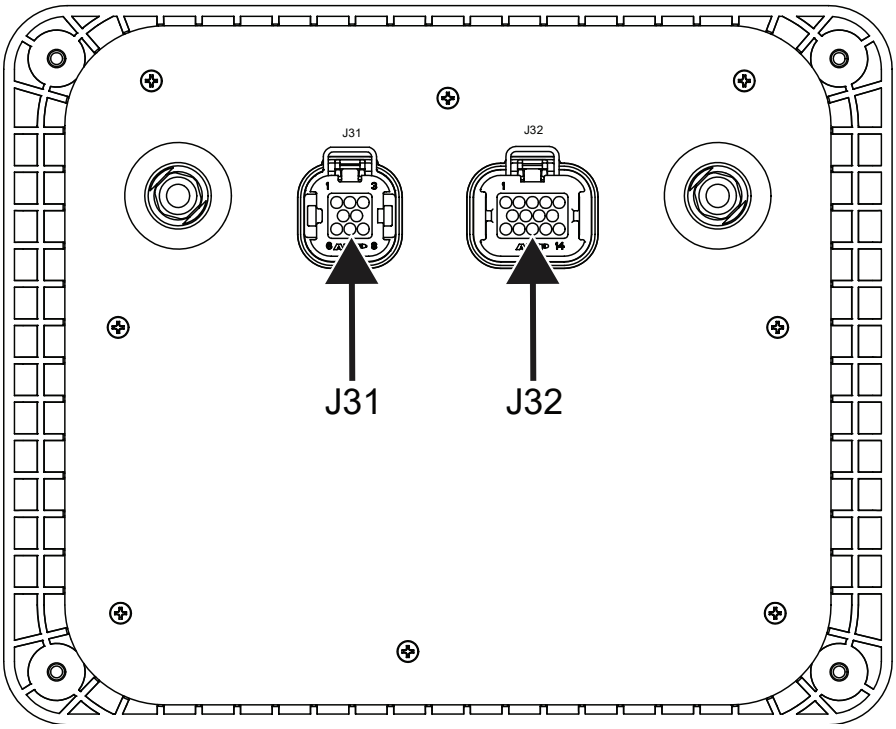
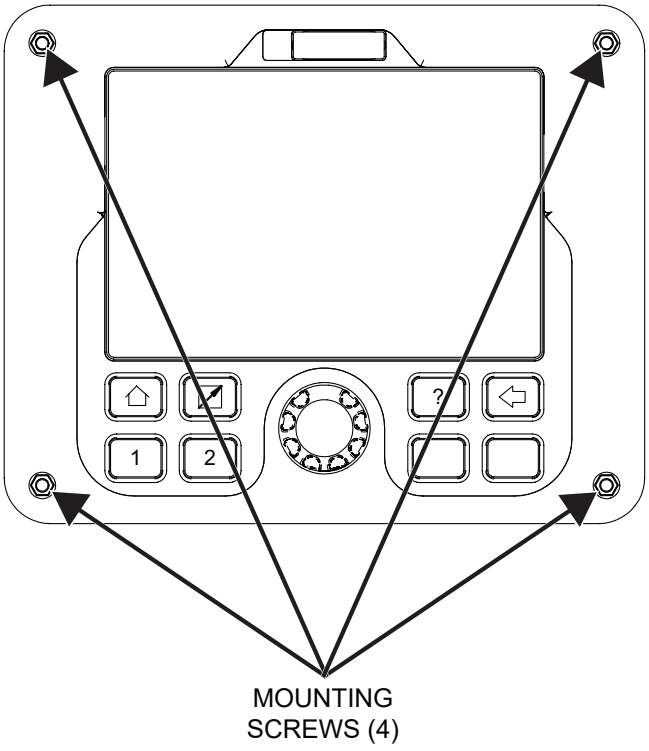


Figure F.2 – LCD display panel mounting screw locations



40 VDC BUS BOARD REMOVAL AND REPLACEMENT PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will aid the technician in the removal and replacement of the 40 VDC Bus Board.

MATERIALS NEEDED

3/8” Open-End Wrench
3/8” Nutdriver
Wiring Diagram

REMOVAL PROCEDURE

1. Turn off the engine on the Frontier 400X machine.
2. Perform the ***Case Cover Removal Procedure***.
3. Perform the *Capacitor Discharge Procedure*.
4. Label and disconnect plugs J46 and J47 from the rear of the 40 VDC bus bard. See ***Figure F.1***. See Wiring Diagram.
5. Using a 3/8” open-end wrench, remove the nut securing the resistor mount and the board to the top right mounting post. See ***Figure F.2***. See Wiring Diagram.
6. Using a 3/8” nutdriver, remove the nut securing the 40 VDC bus board to the lower left mounting post. See ***Figure F.2***.
7. Carefully remove the 40 VDC bus board from the mounting posts.
8. The 40 VDC bus board can now be replaced.

REPLACEMENT PROCEDURE

1. Carefully position the new 40 VDC bus board onto the mounting posts.
2. Using a 3/8” nutdriver, attach the nut securing the 40 VDC bus board to the lower left mounting post.
3. Using a 3/8” open-end wrench, attach the nut securing the resistor mount and the board to the top right mounting post. See Wiring Diagram.
4. Connect plugs J46 and J47 to the rear of the 40 VDC bus bard. See Wiring Diagram.
5. Perform the ***Case Cover Replacement Procedure***.
6. Perform the ***Retest After Repair Procedure***.

Figure F.1 – 40 VDC bus board plug and mounting hardware locations

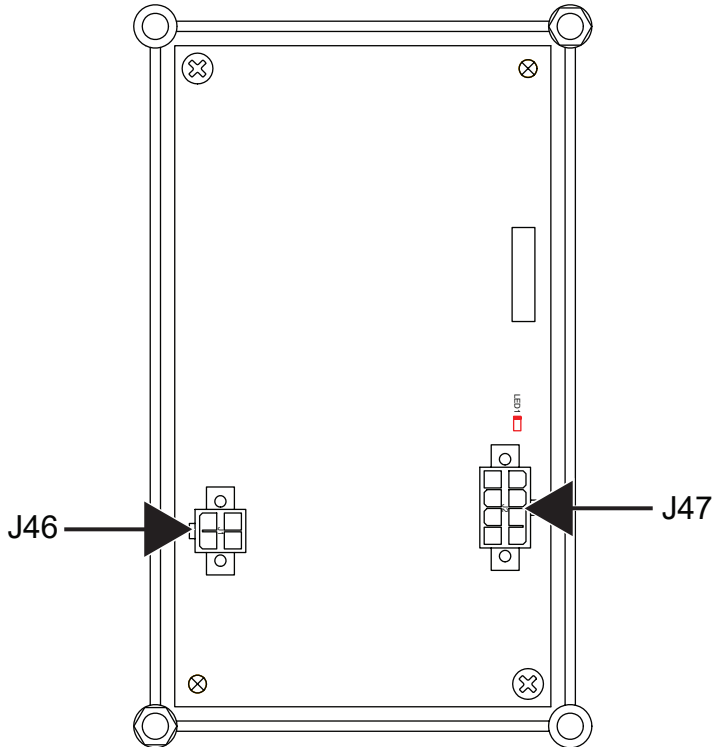
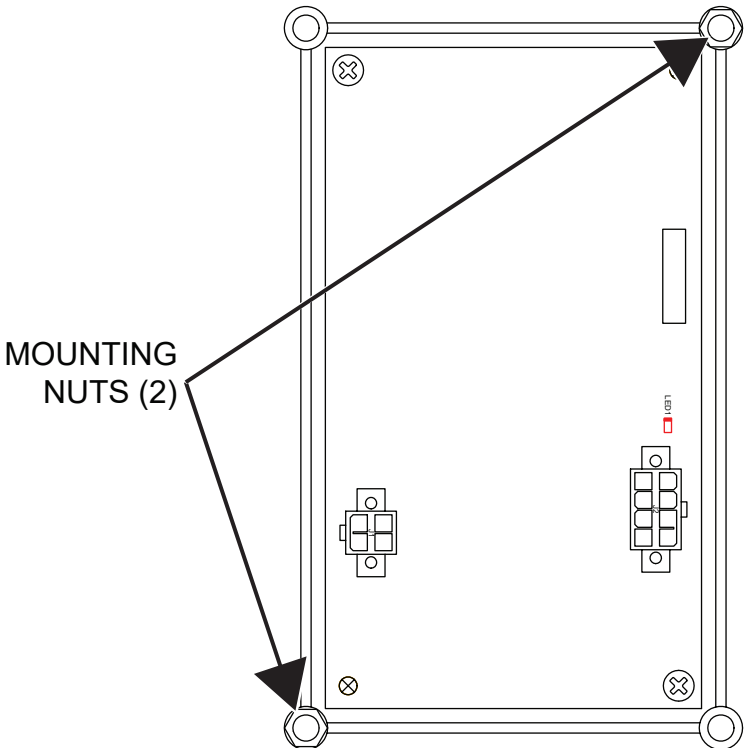


Figure F.2 – 40 VDC bus board plug and mounting hardware locations



CHOPPER CONTROL BOARD REMOVAL AND REPLACEMENT PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will aid the technician in the removal and replacement of the Chopper Control Board.

MATERIALS NEEDED

7/16” Nutdriver
3/8” Nutdriver
Wiring Diagram

REMOVAL PROCEDURE

1. Turn off the engine on the Frontier 400X machine.
2. Perform the ***Case Cover Removal Procedure***.
3. Perform the ***Capacitor Discharge Procedure***.
4. Label and disconnect plugs J1, J2 and J3 from the chopper control board. See ***Figure F.1***. See Wiring Diagram.
5. Label and disconnect lead GND-M from terminal B8 of the chopper control board. See ***Figure F.1***. See Wiring Diagram.
6. Using a 7/16” nutdriver, remove the bolt and washer securing the POS lead to terminal B2 on the chopper control board. See ***Figure F.1***. See Wiring Diagram.
7. Using a 7/16” nutdriver, remove the bolt and washer securing leads 209A and W9 to terminal B5 of the chopper control board. See ***Figure F.1***. See Wiring Diagram.
8. Reattach the bolts and washers to terminals B2 and B5 to secure the bus bar in place. See ***Figure F.1***. See Wiring Diagram.
9. Using a 7/16” nutdriver, remove the bolt and washer securing the NEG lead to the B1/B4 bus bar. See ***Figure F.1***. See Wiring Diagram.
10. Perform the ***Current Transducer Removal Procedure***.
11. Using a 3/8” nutdriver, remove the six screws securing the chopper control board to the machine. See ***Figure F.2***.
12. The chopper control board can now be removed and replaced.

REPLACEMENT PROCEDURE

1. Carefully position the new chopper control board into the machine.
2. Using a 3/8” nutdriver, attach the six screws securing the chopper control board to the machine.
3. Perform the ***Current Transducer Replacement Procedure***.
4. Using a 7/16” nutdriver, attach the bolt and washer securing the NEG lead to the B1/B4 bus bar. See Wiring Diagram.
5. Using a 7/16” nutdriver, remove the bolts and washers securing the bus bar to terminals B2 and B5 on the chopper control board.
6. Using a 7/16” nutdriver, attach the bolt and washer securing leads 209A and W9 to terminal B5 of the chopper control board. See Wiring Diagram.
7. Using a 7/16” nutdriver, attach the bolt and washer securing the POS lead to terminal B2 on the chopper control board. See Wiring Diagram.
8. Connect lead GND-M to terminal B8 of the chopper control board. See Wiring Diagram.
9. Connect plugs J1, J2 and J3 to the chopper control board. See Wiring Diagram.
10. Perform the ***Case Cover Replacement Procedure***.
11. Perform the ***Retest After Repair Procedure***.

Figure F.1 – Chopper control board plug and lead locations

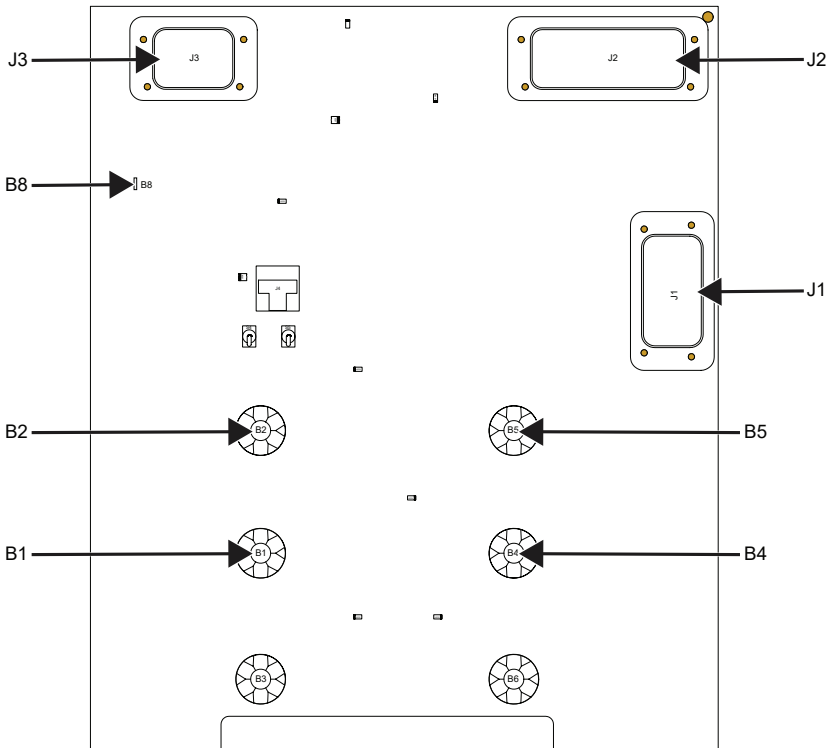
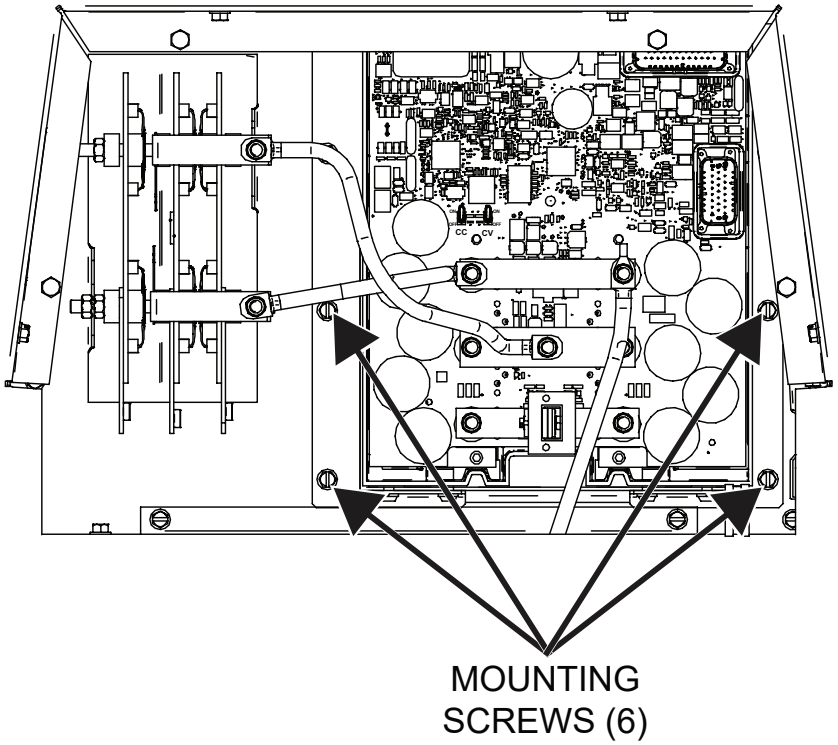


Figure F.2 – Chopper control board mounting hardware locations



CURRENT TRANSDUCER REMOVAL AND REPLACEMENT PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will aid the technician in the removal and replacement of the Current Transducer.

MATERIALS NEEDED

7/16” Nutdriver
7/16” Open-End Wrench
11/32” Open-End Wrench
Slotted Screwdriver
Wiring Diagram

REMOVAL PROCEDURE

1. Turn off the engine on the Frontier 400X machine.
2. Perform the ***Case Cover Removal Procedure***.
3. Perform the ***Capacitor Discharge Procedure***.
4. Label and disconnect plug J60/P60 from the inline Molex connection. See Wiring Diagram. Do not attempt to disconnect leads at the current transducer.
5. Using a 7/16” nutdriver, and a 7/16” open-end wrench, remove the bolt, nut, lock washer and two washers securing lead W7 to the B3/B6 bus bars on the chopper control board. See ***Figure F.1***. See Wiring Diagram. Label and disconnect lead W7.
6. Using a 7/16” nutdriver, remove the two bolts and washers securing the B3/B6 bus bars to the chopper control board. See ***Figure F.1***. See Wiring Diagram. Carefully remove the bus bars.
7. Using a 11/32” open-end wrench and a slotted screwdriver, remove the bolt, nut, lock washer and flat washer securing the current transducer to the bus bars. See ***Figure F.2***.
8. The current transducer can now be removed and replaced. Note orientation of the current transducer for replacement.

REPLACEMENT PROCEDURE

1. Carefully position the new current transducer onto the B3/B6 bus bars.
2. Using a 11/32” open-end wrench and a slotted screwdriver, attach the bolt, nut, lock washer and flat washer securing the current transducer to the B3/B6 bus bars.

3. Carefully position the B3/B6 bus bars onto the chopper control board.
4. Using a 7/16” nutdriver, attach the two bolts and washers securing the B3/B6 bus bars to the chopper control board.
5. Using a 7/16” nutdriver, and a 7/16” open-end wrench, attach the bolt, nut, lock washer and two washers securing lead W7 to the B3/B6 bus bars on the chopper control board. See Wiring Diagram.
6. Connect plug J60/P60 to the inline Molex connection. See Wiring Diagram.
7. Perform the ***Case Cover Replacement Procedure***.
8. Perform the ***Retest After Repair Procedure***.

Figure F.1 – B3 / B6 bus bar locations

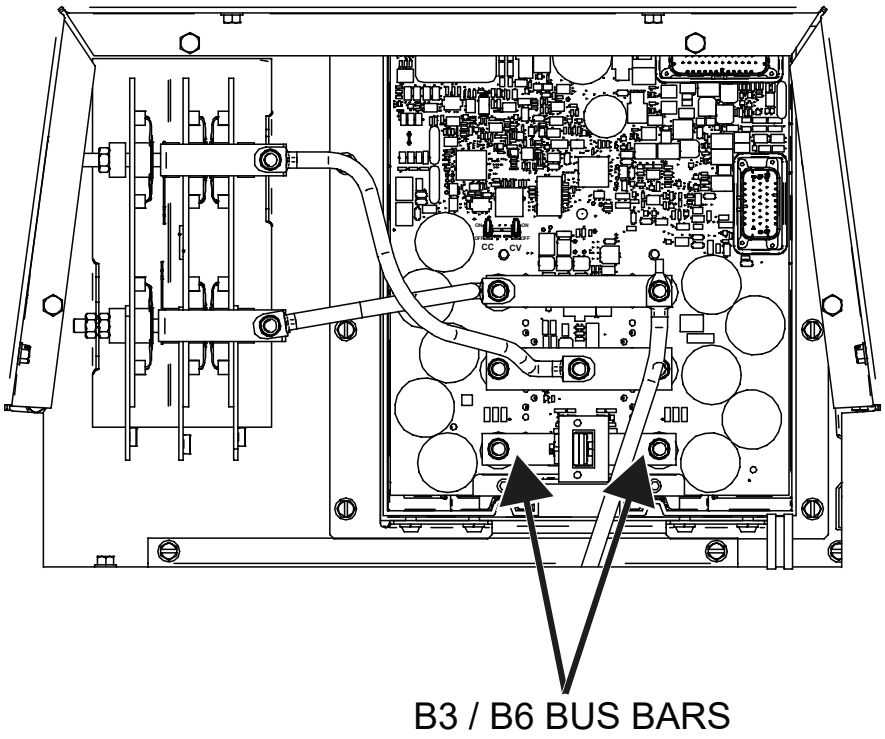
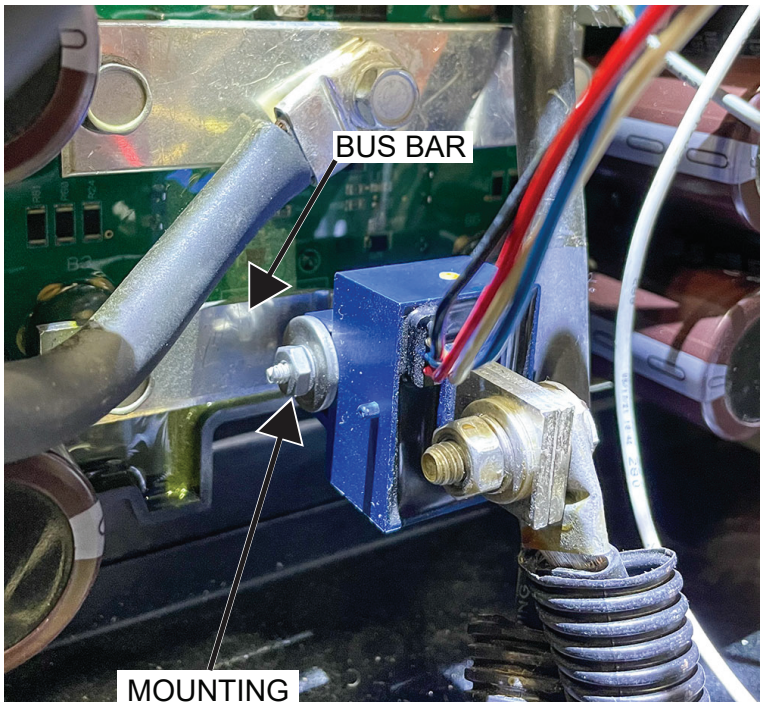


Figure F.2 – Current transducer mounting hardware location



OUTPUT RECTIFIER REMOVAL AND REPLACEMENT PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will aid the technician in the removal and replacement of the Output Rectifier.

MATERIALS NEEDED

7/16” Nutdriver
1/2” nutdriver
Wiring Diagram

REMOVAL PROCEDURE

1. Turn off the engine on the Frontier 400X machine.
2. Perform the ***Case Cover Removal Procedure***.
3. Perform the ***Capacitor Discharge Procedure***.
4. Using a 7/16” nutdriver, remove the bolt and washer securing the NEG lead to the negative terminal of the output rectifier. See ***Figure F.1***. See Wiring Diagram.
5. Using a 7/16” nutdriver, remove the bolt and washer securing the POS lead to the positive terminal of the output rectifier. See ***Figure F.1***. See Wiring Diagram.
6. Using a 7/16” nutdriver, remove the bolt and washer securing leads W1 and W6 to the AC terminal of the output rectifier. See ***Figure F.1***. See Wiring Diagram.
7. Using a 7/16” nutdriver, remove the bolt and washer securing leads W2 and W3 to the AC terminal of the output rectifier. See ***Figure F.1***. See Wiring Diagram.
8. Using a 7/16” nutdriver, remove the bolt and washer securing leads W4 and W5 to the AC terminal of the output rectifier. See ***Figure F.1***. See Wiring Diagram.
9. Using a 1/2” nutdriver, remove the two nuts, lock washers and flat washers securing the output rectifier to the mounting brackets. See ***Figure F.2***.
10. The output rectifier can now be removed from the mounting bracket and replaced.

REPLACEMENT PROCEDURE

1. Carefully position the new output rectifier onto the mounting brackets.
2. Using a 1/2” nutdriver, attach the two nuts, lock washers and flat washers securing the output rectifier to the mounting brackets.

3. Using a 7/16” nutdriver, attach the bolt and washer securing leads W4 and W5 to the AC terminal of the output rectifier. See Wiring Diagram.
4. Using a 7/16” nutdriver, attach the bolt and washer securing leads W2 and W3 to the AC terminal of the output rectifier. See Wiring Diagram.
5. Using a 7/16” nutdriver, attach the bolt and washer securing leads W1 and W6 to the AC terminal of the output rectifier. See Wiring Diagram.
6. Using a 7/16” nutdriver, attach the bolt and washer securing the POS lead to the positive terminal of the output rectifier. See Wiring Diagram.
7. Using a 7/16” nutdriver, attach the bolt and washer securing the NEG lead to the negative terminal of the output rectifier. See Wiring Diagram.
8. Perform the ***Case Cover Replacement Procedure***.
9. Perform the ***Retest After Repair Procedure***.

Figure F.1 – Positive, negative and AC terminal locations

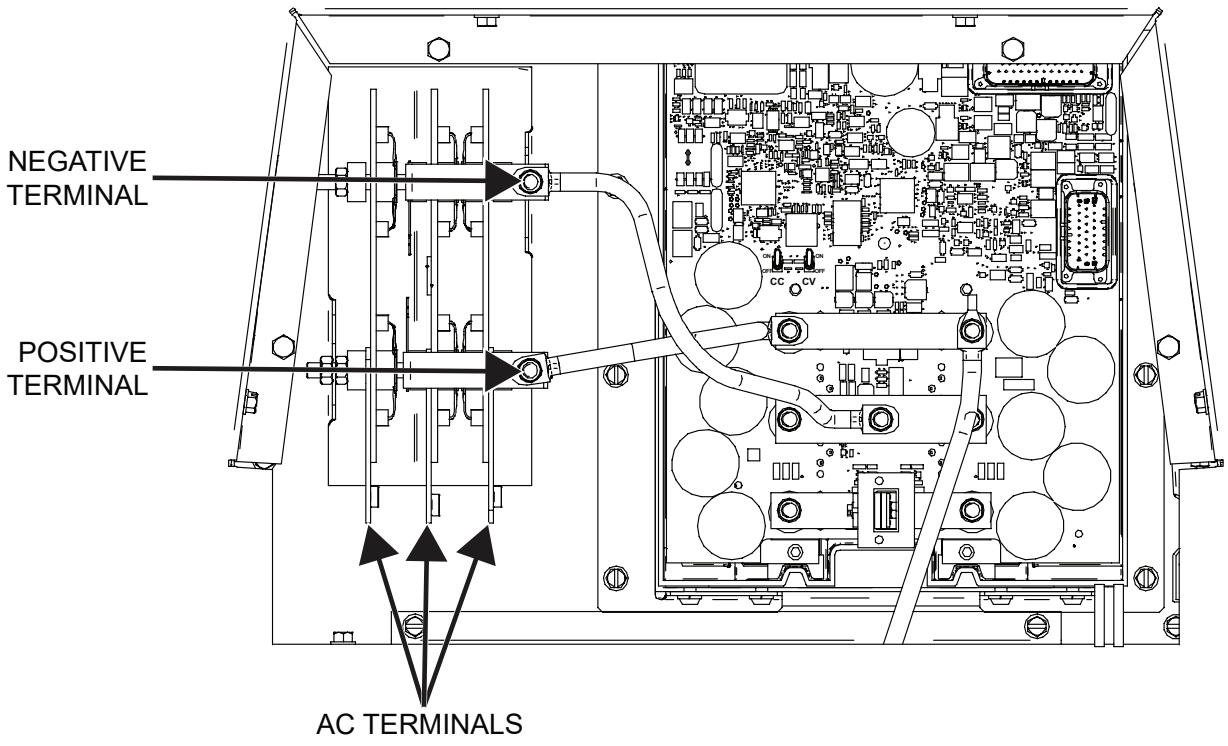
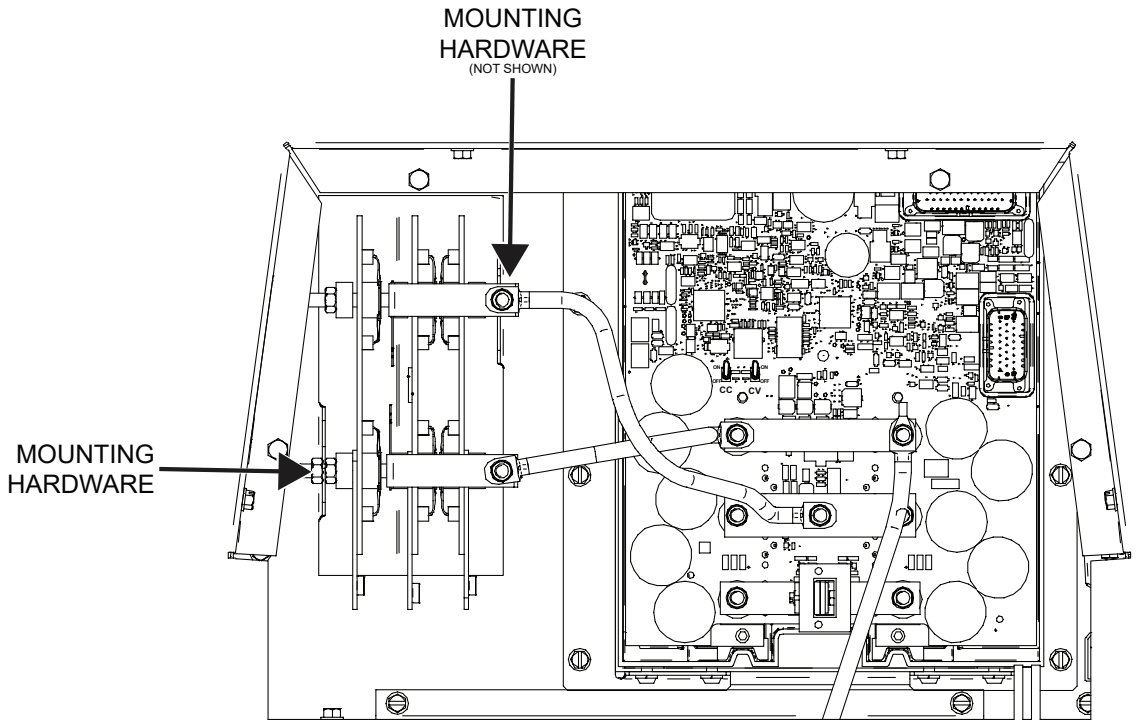


Figure F.2 – Output rectifier mounting hardware locations



D2 RECTIFIER REMOVAL AND REPLACEMENT PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will aid the technician in the removal and replacement of the D2 Rectifier.

MATERIALS NEEDED

3/8” Nutdriver
Dow Corning 340 Heat Sink Compound (Lincoln Part #T12837)
Wiring Diagram

REMOVAL PROCEDURE

1. Turn off the engine on the Frontier 400X machine.
2. Perform the ***Case Cover Removal Procedure***.
3. Perform the ***Capacitor Discharge Procedure***.
4. Label and disconnect leads 7A, 7, 8 and 5M from the terminals of the D2 rectifier. See ***Figure F.1***. See Wiring Diagram.
5. Using a 3/8” nutdriver, remove the nut and insulating washer securing the D2 rectifier to its mounting post. See ***Figure F.2***.
6. The D2 rectifier can now be removed from its mounting post and replaced.

REPLACEMENT PROCEDURE

1. Apply a thin coating of Dow Corning 340 heat sink compound to the mating surfaces of the D2 rectifier.
2. Carefully position the new D2 rectifier onto its mounting post.
3. Using a 3/8” nutdriver, attach the nut and insulating washer securing the D2 rectifier to its mounting post.
4. Connect leads 7A, 7, 8 and 5M to the terminals of the D2 rectifier. See Wiring Diagram.
5. Perform the ***Case Cover Replacement Procedure***.
6. Perform the ***Retest After Repair Procedure***.

Figure F.1 – D2 rectifier lead locations

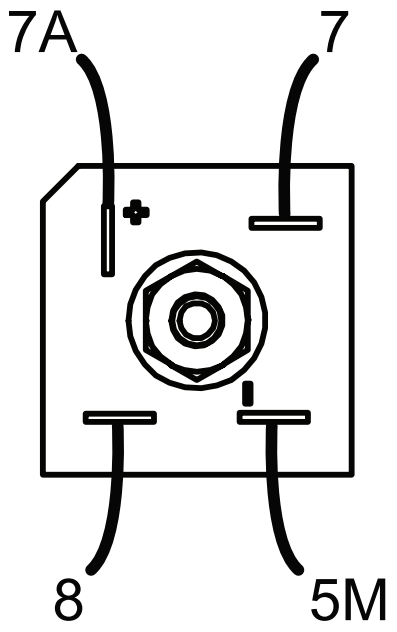
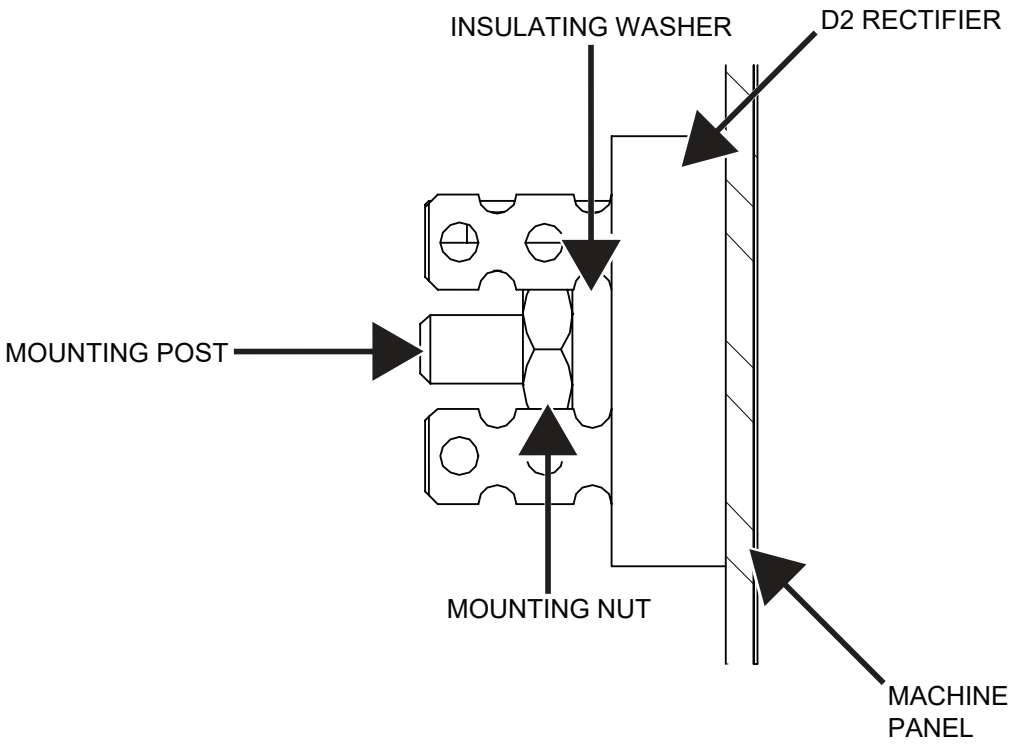


Figure F.2 – D2 rectifier mounting hardware locations



D3 RECTIFIER REMOVAL AND REPLACEMENT PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will aid the technician in the removal and replacement of the D3 Rectifier.

MATERIALS NEEDED

3/8” Nutdriver
Dow Corning 340 Heat Sink Compound (Lincoln Part #T12837)
Wiring Diagram

REMOVAL PROCEDURE

1. Turn off the engine on the Frontier 400X machine.
2. Perform the ***Case Cover Removal Procedure***.
3. Perform the ***Capacitor Discharge Procedure***.
4. Label and disconnect leads 65A, 45, 66A and 46A from the terminals of the D3 rectifier. See ***Figure F.1***. See Wiring Diagram.
5. Using a 3/8” nutdriver, remove the nut and insulating washer securing the D3 rectifier to its mounting post. See ***Figure F.2***.
6. The D3 rectifier can now be removed from its mounting post and replaced.

REPLACEMENT PROCEDURE

1. Apply a thin coating of Dow Corning 340 heat sink compound to the mating surfaces of the D3 rectifier.
2. Carefully position the new D3 rectifier onto its mounting post.
3. Using a 3/8” nutdriver, attach the nut and insulating washer securing the D3 rectifier to its mounting post.
4. Connect leads 65A, 45, 66A and 46A to the terminals of the D3 rectifier. See Wiring Diagram.
5. Perform the ***Case Cover Replacement Procedure***.
6. Perform the ***Retest After Repair Procedure***.

Figure F.1 – D3 rectifier lead locations

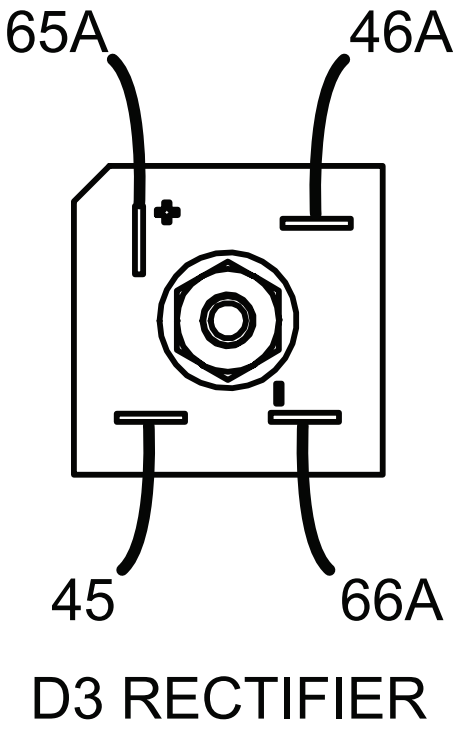
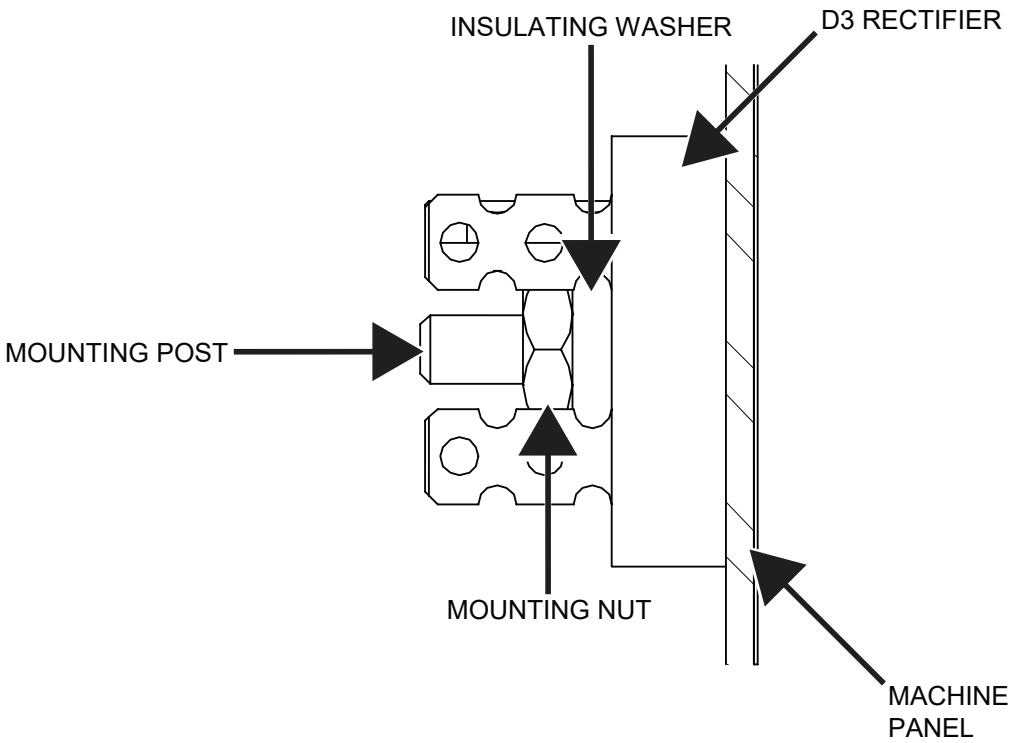


Figure F.2 – D3 rectifier mounting hardware locations



D4 RECTIFIER REMOVAL AND REPLACEMENT PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will aid the technician in the removal and replacement of the D4 Rectifier.

MATERIALS NEEDED

3/8” Nutdriver
Dow Corning 340 Heat Sink Compound (Lincoln Part #T12837)
Wiring Diagram

REMOVAL PROCEDURE

1. Turn off the engine on the Frontier 400X machine.
2. Perform the ***Case Cover Removal Procedure***.
3. Perform the ***Capacitor Discharge Procedure***.
4. Label and disconnect leads 232S and 232R from the terminals of the D4 rectifier. See ***Figure F.1***. See Wiring Diagram.
5. Using a 3/8” nutdriver, remove the nut and insulating washer securing the D4 rectifier to its mounting post. See ***Figure F.2***.
6. The D4 rectifier can now be removed from its mounting post and replaced.

REPLACEMENT PROCEDURE

1. Apply a thin coating of Dow Corning 340 heat sink compound to the mating surfaces of the D4 rectifier.
2. Carefully position the new D4 rectifier onto its mounting post.
3. Using a 3/8” nutdriver, attach the nut and insulating washer securing the D4 rectifier to its mounting post.
4. Connect leads 232S and 232R to the terminals of the D4 rectifier. See Wiring Diagram.
5. Perform the ***Case Cover Replacement Procedure***.
6. Perform the ***Retest After Repair Procedure***.

Figure F.1 – D4 rectifier lead locations

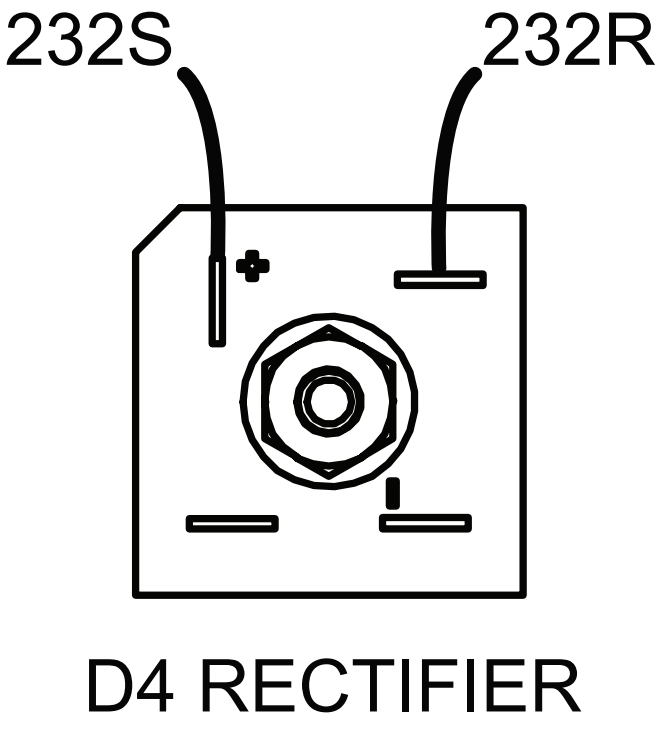
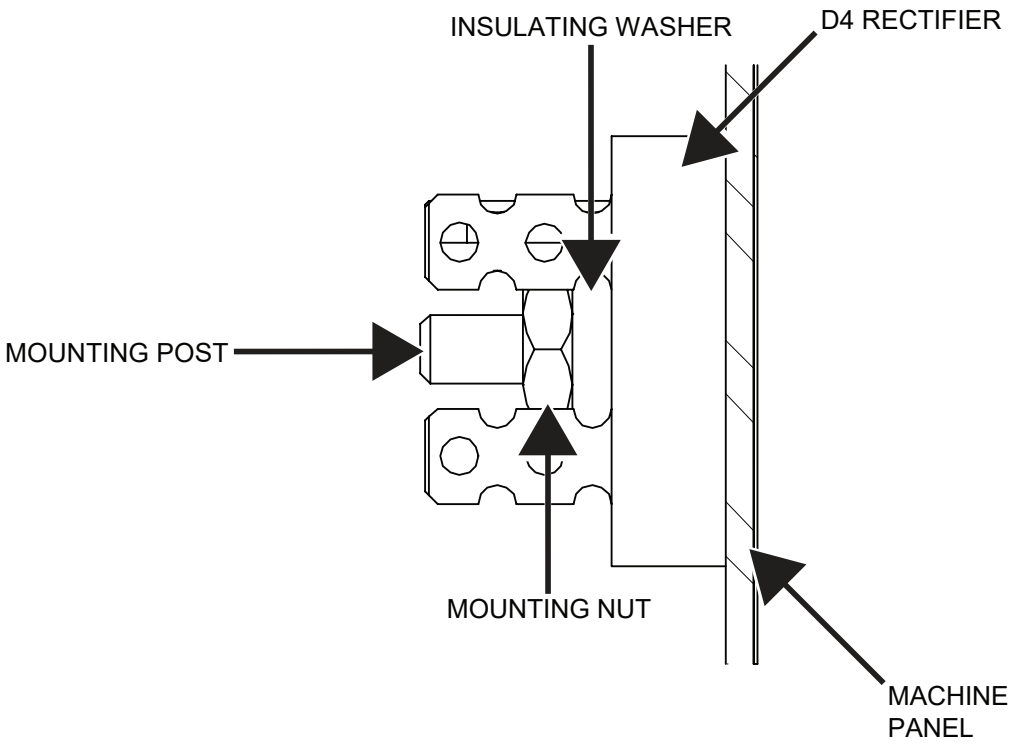


Figure F.2 – D4 rectifier mounting hardware locations



FUEL TANK REMOVAL AND REPLACEMENT PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will aid the technician in the removal and replacement of the Fuel Tank.

MATERIALS NEEDED

Fuel Siphon
Slotted Screwdriver
3/8” Nutdriver
Paper Towels
Fuel Storage Container
Locking Wrench
Wiring Diagram

REMOVAL PROCEDURE

1. Turn off the engine on the Frontier 400X machine.
2. Perform the ***Case Cover Removal Procedure***.
3. Perform the ***Capacitor Discharge Procedure***.
4. Using a fuel siphon, remove the fuel from the fuel tank and store in an appropriate fuel storage container.
5. Label and disconnect leads 229 and 5J from the fuel sender terminals. See ***Figure F.1***. See Wiring Diagram.
6. Carefully route fuel sender leads through the power module panel.
7. Using a slotted screwdriver, loosen the hose clamp securing the top fuel line to the fuel tank. Label and disconnect the fuel line.
8. Using a 3/8” nutdriver, remove the six screws securing the fuel tank front panel to the power module panel. See ***Figure F.2***.
9. Place the switch on the fuel filter into the ‘Off’ position.
10. Using a slotted screwdriver, loosen the hose clamp securing the lower fuel line to the fuel filter. **NOTE:** To avoid spills, temporarily wrap fuel hoses with paper towels to absorb any residual fuel. If there is any fuel left in the fuel tank, drain it into an appropriate fuel storage container.
11. Using a locking wrench, clamp the fuel line to prevent any fuel spills during the removal of the fuel tank.

12. Carefully maneuver the fuel tank out of the machine.
13. The fuel tank can now be replaced.

REPLACEMENT PROCEDURE

1. Carefully position the new fuel tank into the machine.
2. Carefully attach the lower fuel line to the fuel filter.
3. Using a slotted screwdriver, tighten the hose clamp securing the lower fuel line to the fuel filter.
4. Place the switch on the fuel filter into the 'On' position.
5. Using a 3/8" nutdriver, attach the six screws securing the fuel tank front panel to the power module panel.
6. Carefully attach the top fuel line to the fuel tank.
7. Using a slotted screwdriver, tighten the hose clamp securing the top fuel line to the fuel tank.
8. Carefully route fuel sender leads through the power module panel. See Wiring Diagram.
9. Connect leads 229 and 5J to the fuel sender terminals. See Wiring Diagram.
10. Perform the ***Case Cover Replacement Procedure***.
11. Perform the ***Retest After Repair Procedure***.

Figure F.1 – Fuel sender lead locations

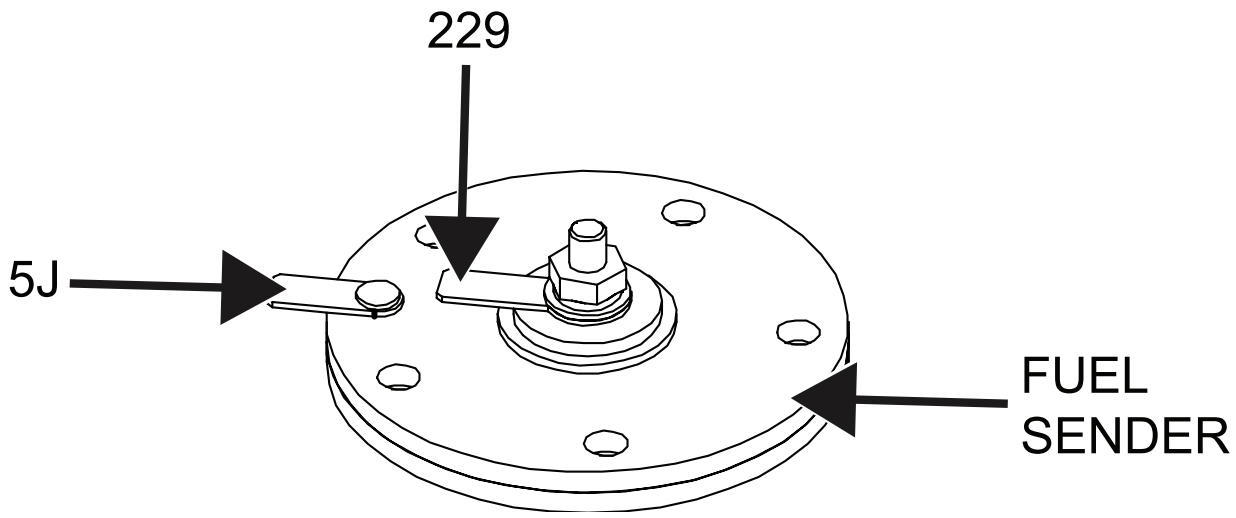
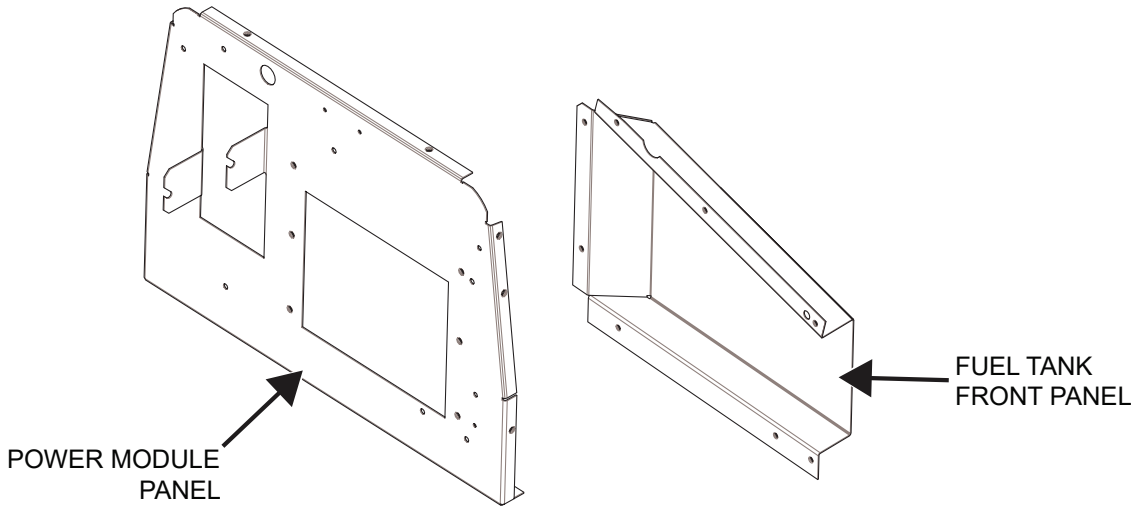


Figure F.2 – Fuel tank front panel and power module panel locations



GLOW PLUG BUTTON REMOVAL AND REPLACEMENT PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will aid the technician in the removal and replacement of the Glow Plug Button.

MATERIALS NEEDED

Slotted Screwdriver
Wiring Diagram

REMOVAL PROCEDURE

1. Turn off the engine on the Frontier 400X machine.
2. Perform the ***Case Cover Removal Procedure***.
3. Perform the ***Capacitor Discharge Procedure***.
4. Using a slotted screwdriver, remove the screw and washer securing leads 238C and 238B to the left terminal of the glow plug button. See ***Figure F.1***. See Wiring Diagram. Label and disconnect leads.
5. Using a slotted screwdriver, remove the screw and washer securing lead 239 to the right terminal of the glow plug button. See ***Figure F.1***. See Wiring Diagram. Label and disconnect leads.
6. Carefully unscrew the button cover from the front of the machine. See ***Figure F.2***.
7. Carefully maneuver the glow plug button out of the machine.
8. The glow plug button can now be replaced.

REPLACEMENT PROCEDURE

1. Carefully position the new glow plug button into the machine.
2. Carefully screw the button cover onto the glow plug button.
3. Using a slotted screwdriver, attach the screw and washer securing lead 239 to the right terminal of the glow plug button. See Wiring Diagram.
4. Using a slotted screwdriver, attach the screw and washer securing leads 238C and 238B to the left terminal of the glow plug button. See Wiring Diagram.
5. Perform the ***Case Cover Replacement Procedure***.
6. Perform the ***Retest After Repair Procedure***.

Figure F.1 – Glow plug button lead locations

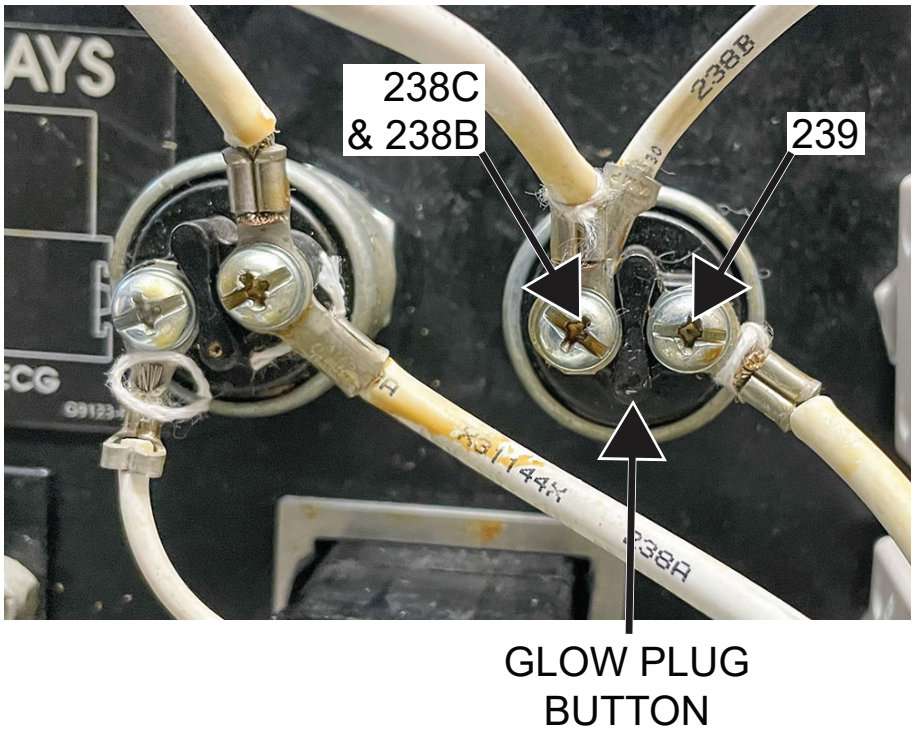
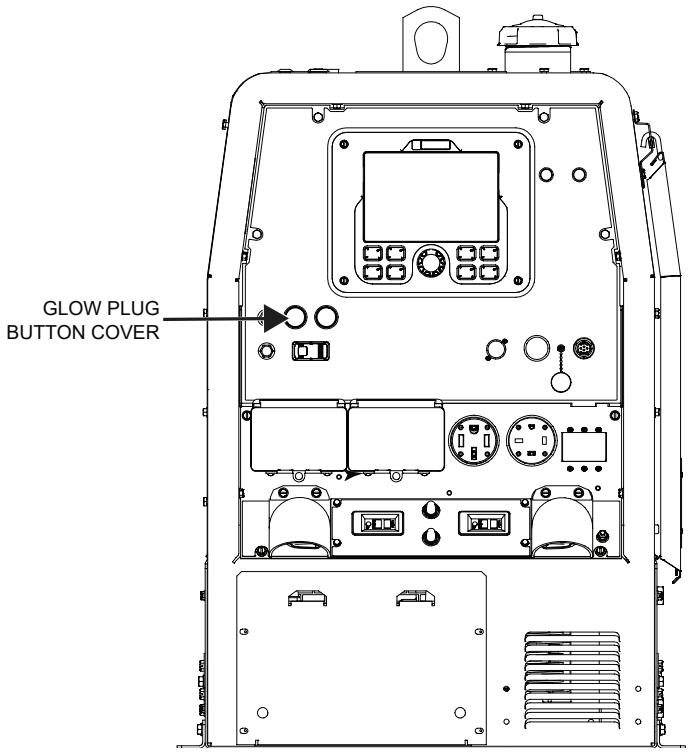


Figure F.2 – Glow plug button cover location



START BUTTON REMOVAL AND REPLACEMENT PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will aid the technician in the removal and replacement of the Start Button.

MATERIALS NEEDED

Slotted Screwdriver
Wiring Diagram

REMOVAL PROCEDURE

1. Turn off the engine on the Frontier 400X machine.
2. Perform the ***Case Cover Removal Procedure***.
3. Perform the ***Capacitor Discharge Procedure***.
4. Using a slotted screwdriver, remove the screw and washer securing lead 231 to the left terminal of the start button. See ***Figure F.1***. See Wiring Diagram. Label and disconnect lead.
5. Using a slotted screwdriver, remove the screw and washer securing leads 238A and 238C to the right terminal of the start button. See ***Figure F.1***. See Wiring Diagram. Label and disconnect leads.
6. Carefully unscrew the button cover from the front of the machine. See ***Figure F.2***.
7. Carefully maneuver the start button out of the machine.
8. The start button can now be replaced.

REPLACEMENT PROCEDURE

1. Carefully position the new start button into the machine.
2. Carefully screw the button cover onto the start button.
3. Using a slotted screwdriver, attach the screw and washer securing leads 238A and 238C to the right terminal of the glow plug button. See Wiring Diagram.
4. Using a slotted screwdriver, attach the screw and washer securing lead 231 to the left terminal of the start button. See Wiring Diagram.
5. Perform the ***Case Cover Replacement Procedure***.
6. Perform the ***Retest After Repair Procedure***.

Figure F.1 – Start button lead locations

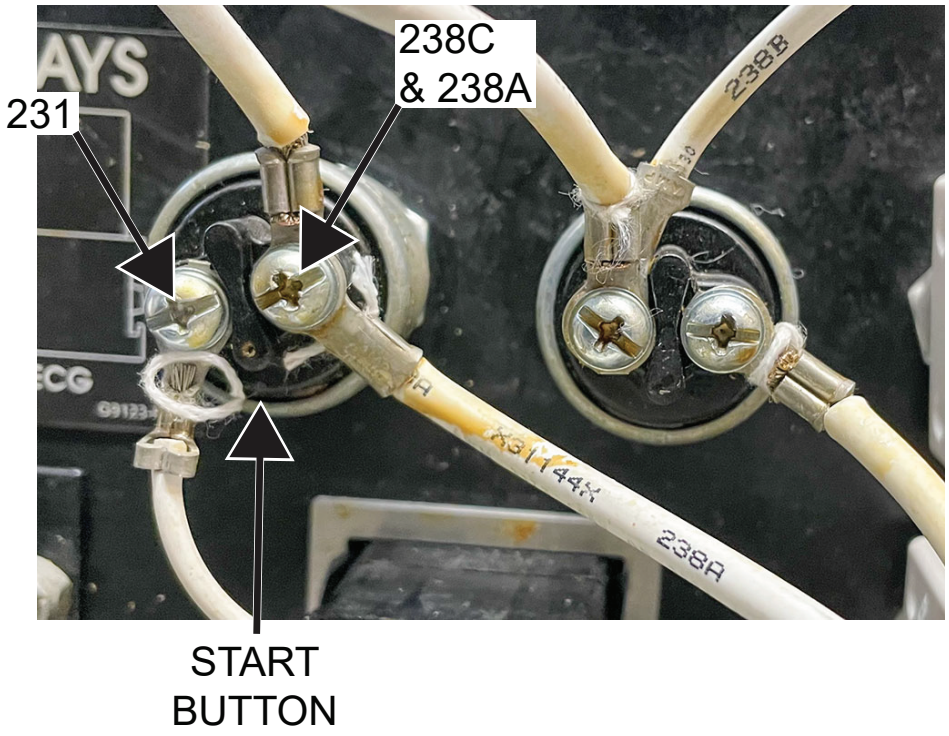
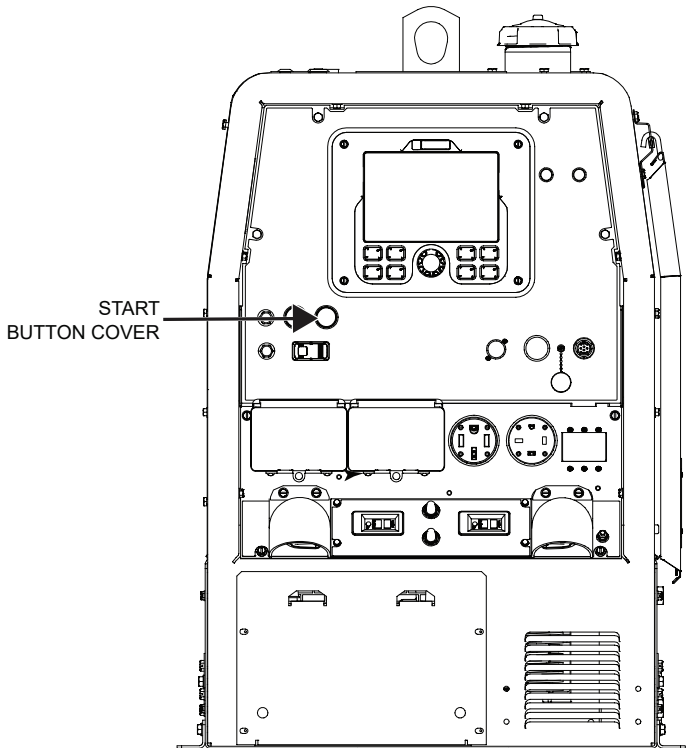


Figure F.2 – Start button cover location



CR1 IDLE RELAY REMOVAL AND REPLACEMENT PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will aid the technician in the removal and replacement of the CR1 Idle Relay.

MATERIALS NEEDED

3/8” Nutdriver
Wiring Diagram

REMOVAL PROCEDURE

1. Turn off the engine on the Frontier 400X machine.
2. Perform the ***Case Cover Removal Procedure***.
3. Perform the ***Capacitor Discharge Procedure***.
4. Carefully unplug the CR1 idle relay from the mounting socket. See ***Figure F.1***. See Wiring Diagram. Note relay orientation for reassembly.
5. Using a 3/8” nutdriver, remove the nut securing the relay mounting socket to the front panel of the machine. See ***Figure F.2***.
6. Carefully slide the relay mounting socket off the other relay mounting sockets.
7. Label and disconnect leads 405, 406, 232L and 232M from the relay mounting socket. See Wiring Diagram.
8. The CR1 idle relay can now be replaced.

REPLACEMENT PROCEDURE

1. Connect leads 405, 406, 232L and 232M to the relay mounting socket. See Wiring Diagram.
2. Carefully slide the relay mounting socket onto the other relay mounting sockets.
3. Using a 3/8” nutdriver, attach the nut securing the relay mounting socket to the front panel of the machine.
4. Carefully plug the CR1 idle relay into the mounting socket. See Wiring Diagram.
5. Perform the ***Case Cover Replacement Procedure***.
6. Perform the ***Retest After Repair Procedure***.

Figure F.1 – CR1 idle relay and mounting socket location

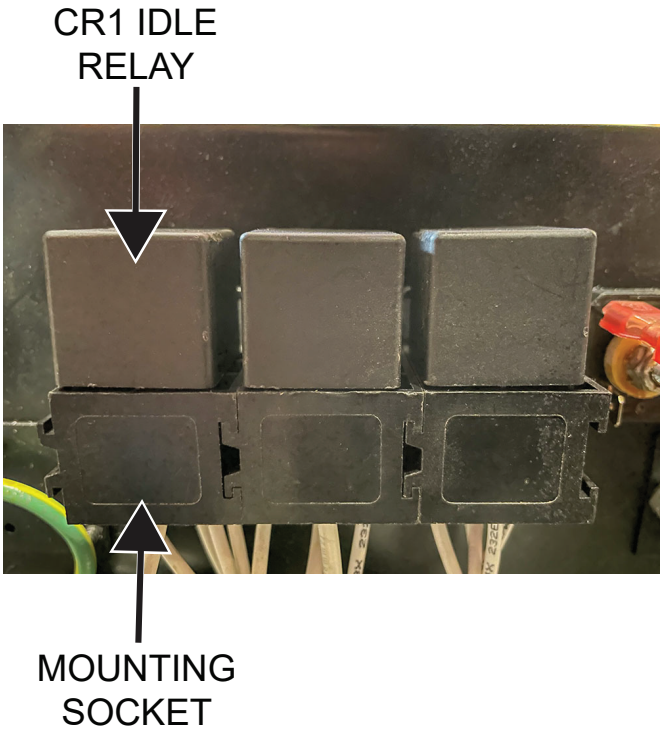
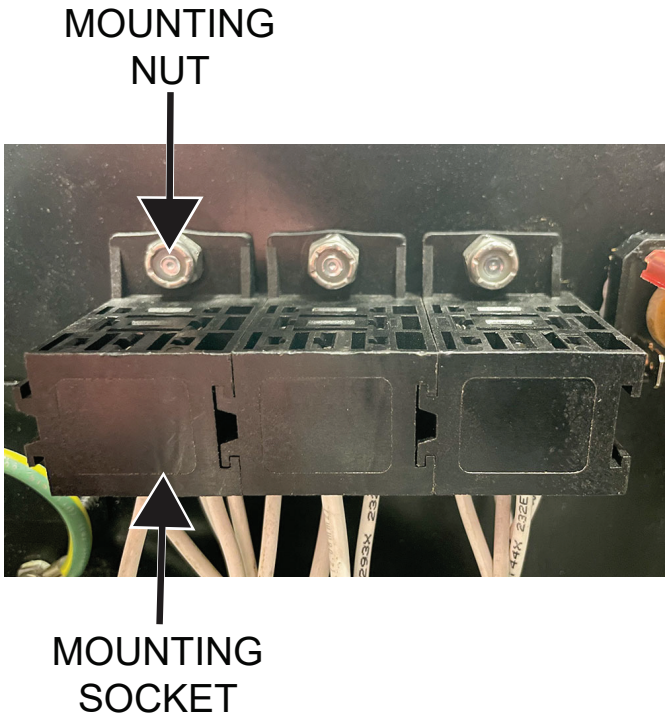


Figure F.2 – CR1 idle relay mounting nut location



CR2 START RELAY REMOVAL AND REPLACEMENT PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will aid the technician in the removal and replacement of the CR2 Start Relay.

MATERIALS NEEDED

3/8” Nutdriver
Wiring Diagram

REMOVAL PROCEDURE

1. Turn off the engine on the Frontier 400X machine.
2. Perform the ***Case Cover Removal Procedure***.
3. Perform the ***Capacitor Discharge Procedure***.
4. Carefully unplug the CR2 start relay from the mounting socket. See ***Figure F.1***. See Wiring Diagram. Note relay orientation for reassembly.
5. Using a 3/8” nutdriver, remove the nut securing the relay mounting socket to the front panel of the machine. See ***Figure F.2***.
6. Carefully slide the relay mounting socket off the other relay mounting sockets.
7. Label and disconnect leads 285, 231A, 232J and 238E from the relay mounting socket. See Wiring Diagram.
8. The CR2 start relay can now be replaced.

REPLACEMENT PROCEDURE

1. Connect leads 285, 231A, 232J and 238E to the relay mounting socket. See Wiring Diagram.
2. Carefully slide the relay mounting socket onto the other relay mounting sockets.
3. Using a 3/8” nutdriver, attach the nut securing the relay mounting socket to the front panel of the machine.
4. Carefully plug the CR2 start relay into the mounting socket. See Wiring Diagram.
5. Perform the ***Case Cover Replacement Procedure***.
6. Perform the ***Retest After Repair Procedure***.

Figure F.1 – CR2 start relay and mounting socket location

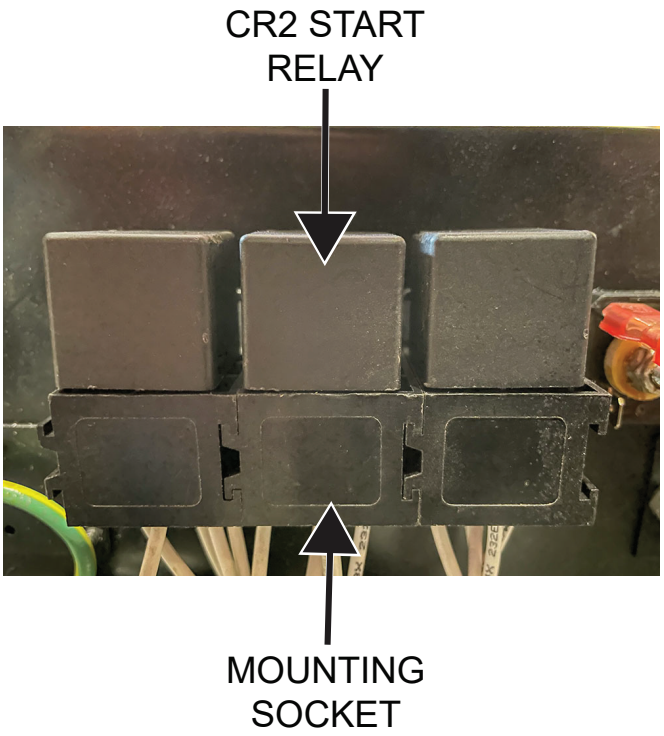
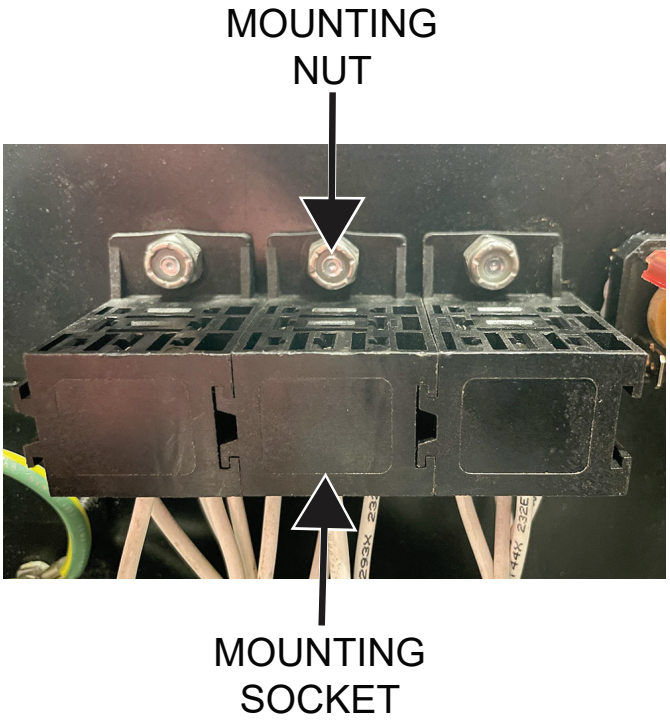


Figure F.2 – CR2 start relay mounting nut location



CR3 EGC RELAY REMOVAL AND REPLACEMENT PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will aid the technician in the removal and replacement of the CR3 EGC Relay.

MATERIALS NEEDED

3/8” Nutdriver
Wiring Diagram

REMOVAL PROCEDURE

1. Turn off the engine on the Frontier 400X machine.
2. Perform the ***Case Cover Removal Procedure***.
3. Perform the ***Capacitor Discharge Procedure***.
4. Carefully unplug the CR3 EGC relay from the mounting socket. See ***Figure F.1***. See Wiring Diagram. Note relay orientation for reassembly.
5. Using a 3/8” nutdriver, remove the nut securing the relay mounting socket to the front panel of the machine. See ***Figure F.2***.
6. Carefully slide the relay mounting socket off the other relay mounting sockets.
7. Label and disconnect leads 286, 232, 232R, 232Q, and 232E from the relay mounting socket. See Wiring Diagram.
8. The CR3 EGC relay can now be replaced.

REPLACEMENT PROCEDURE

1. Connect leads 286, 232, 232R, 232Q, and 232E to the relay mounting socket. See Wiring Diagram.
2. Carefully slide the relay mounting socket onto the other relay mounting sockets.
3. Using a 3/8” nutdriver, attach the nut securing the relay mounting socket to the front panel of the machine.
4. Carefully plug the CR3 EGC relay into the mounting socket. See Wiring Diagram.
5. Perform the ***Case Cover Replacement Procedure***.
6. Perform the ***Retest After Repair Procedure***.

Figure F.1 – CR3 EGC relay and mounting socket location

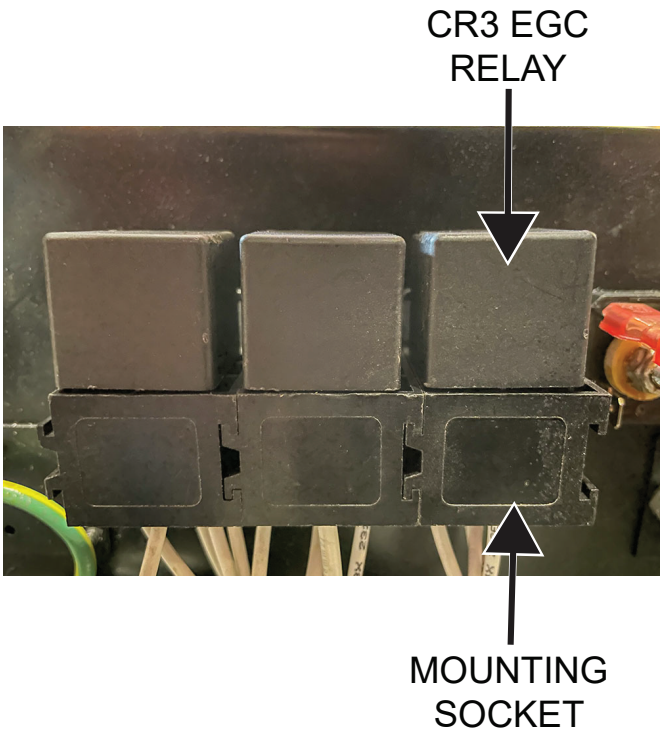
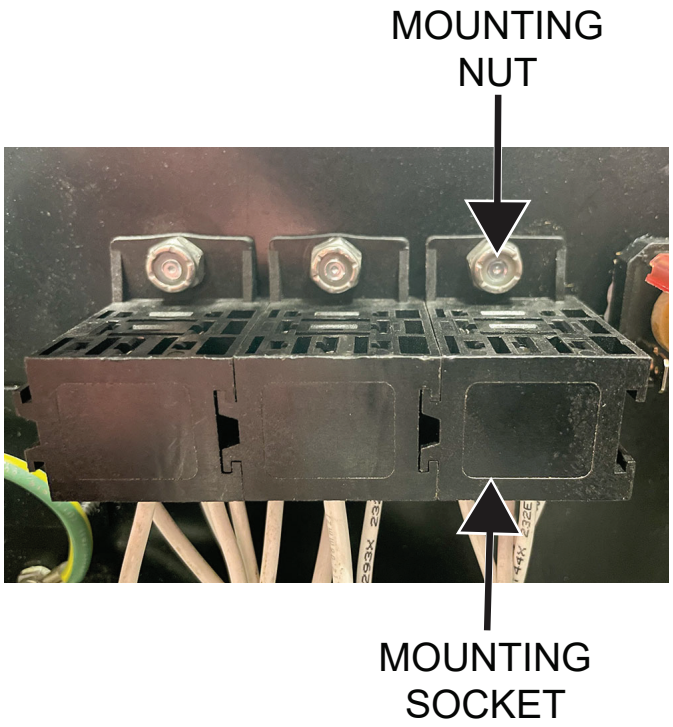


Figure F.2 – CR3 EGC relay mounting nut location



CB1 CIRCUIT BREAKER REMOVAL AND REPLACEMENT PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will aid the technician in the removal and replacement of the CB1 Circuit Breaker.

MATERIALS NEEDED

3/8” Nutdriver
Wiring Diagram

REMOVAL PROCEDURE

1. Turn off the engine on the Frontier 400X machine.
2. Perform the ***Case Cover Removal Procedure***.
3. Perform the ***Capacitor Discharge Procedure***.
4. Using a Philips screwdriver, remove the six screws and washers securing leads 3, 4, 6, 3B, 3C, 4A, 6C, 6D to the CB1 circuit breaker. See ***Figure F.1***. See Wiring Diagram. Label and disconnect leads.
5. Using a Philips screwdriver, remove the six screws and twelve washers securing the CB1 circuit breaker to the front panel. See ***Figure F.2***. Carefully remove the CB1 circuit breaker from the front panel.
6. Carefully remove the CB1 circuit breaker from the circuit breaker cover. Retain the circuit breaker cover for replacement.
7. The CB1 circuit breaker can now be replaced.

REPLACEMENT PROCEDURE

1. Carefully position the CB1 circuit breaker into the circuit breaker cover.
2. Carefully position the CB1 circuit breaker into the front panel.
3. Using a Philips screwdriver, attach the six screws and twelve washers securing the CB1 circuit breaker to the front panel.
4. Using a Philips screwdriver, attach the six screws and washers securing leads 3, 4, 6, 3B, 3C, 4A, 6C, 6D to the CB1 circuit breaker. See Wiring Diagram.
5. Perform the ***Case Cover Replacement Procedure***.
6. Perform the ***Retest After Repair Procedure***.

Figure F.1 – CB1 circuit breaker lead locations

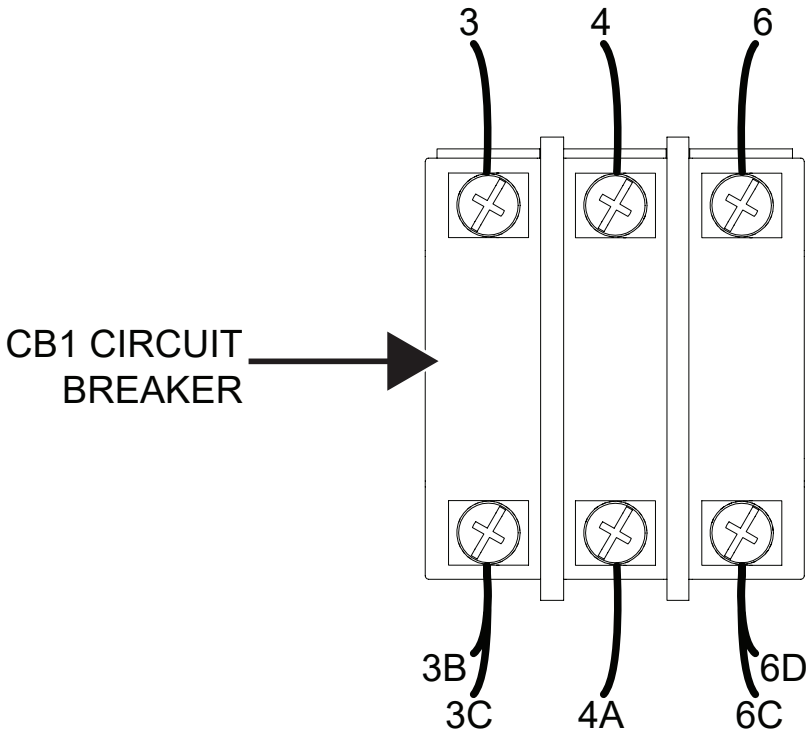
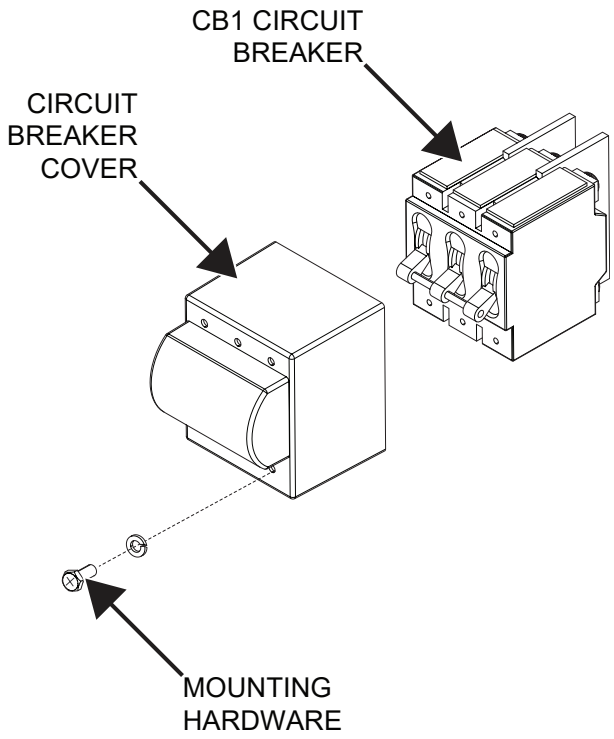


Figure F.2 – CB1 circuit breaker mounting hardware locations



CB2 CIRCUIT BREAKER REMOVAL AND REPLACEMENT PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will aid the technician in the removal and replacement of the CB2 Circuit Breaker.

MATERIALS NEEDED

Adjustable Wrench
Wiring Diagram

REMOVAL PROCEDURE

1. Turn off the engine on the Frontier 400X machine.
2. Perform the ***Case Cover Removal Procedure***.
3. Perform the ***Capacitor Discharge Procedure***.
4. Label and disconnect leads 3D and 3E from the terminals of the CB2 circuit breaker. See ***Figure F.1***. See Wiring Diagram.
5. Using an adjustable wrench, unscrew the button cover from the front panel of the machine. See ***Figure F.2***.
6. Carefully remove the CB2 circuit breaker from the front panel.
7. The CB2 circuit breaker can now be replaced.

REPLACEMENT PROCEDURE

1. Connect position the new CB2 circuit breaker into the machine.
2. Using an adjustable wrench, screw the button cover onto the front panel of the machine.
3. Connect leads 3D and 3E to the terminals of the CB2 circuit breaker. See Wiring Diagram.
4. Perform the ***Case Cover Replacement Procedure***.
5. Perform the ***Retest After Repair Procedure***.

Figure F.1 – CB2 circuit breaker lead locations

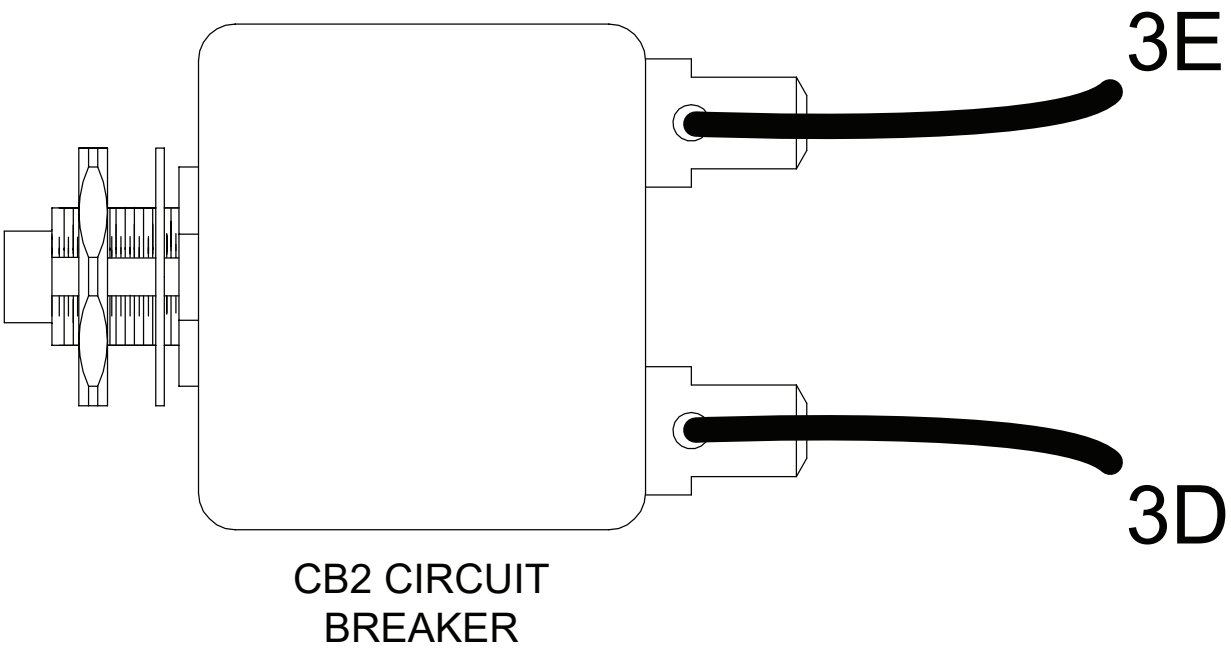
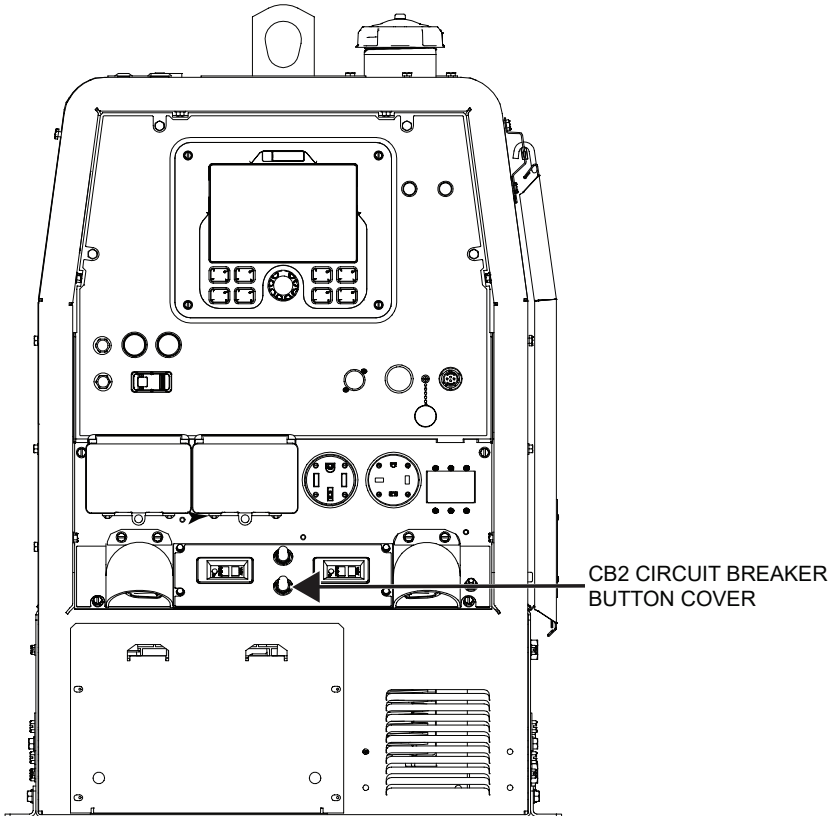


Figure F.2 – CB2 circuit breaker button cover location



CB3 CIRCUIT BREAKER REMOVAL AND REPLACEMENT PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will aid the technician in the removal and replacement of the CB3 Circuit Breaker.

MATERIALS NEEDED

Adjustable Wrench
Wiring Diagram

REMOVAL PROCEDURE

1. Turn off the engine on the Frontier 400X machine.
2. Perform the ***Case Cover Removal Procedure***.
3. Perform the ***Capacitor Discharge Procedure***.
4. Label and disconnect leads 6E and 6F from the terminals of the CB3 circuit breaker. See ***Figure F.1***. See Wiring Diagram.
5. Using an adjustable wrench, unscrew the button cover from the front panel of the machine. See ***Figure F.2***.
6. Carefully remove the CB3 circuit breaker from the front panel.
7. The CB3 circuit breaker can now be replaced.

REPLACEMENT PROCEDURE

1. Connect position the new CB3 circuit breaker into the machine.
2. Using an adjustable wrench, screw the button cover onto the front panel of the machine.
3. Connect leads 6E and 6F to the terminals of the CB3 circuit breaker. See Wiring Diagram.
4. Perform the ***Case Cover Replacement Procedure***.
5. Perform the ***Retest After Repair Procedure***.

Figure F.1 – CB3 circuit breaker lead locations

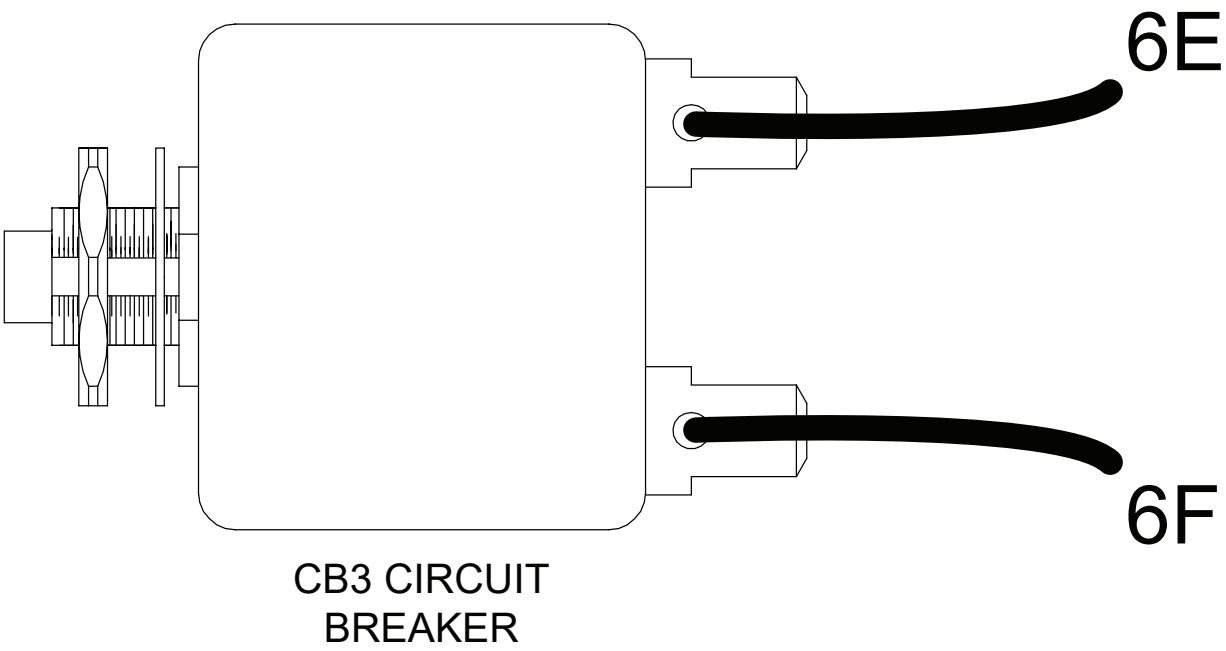
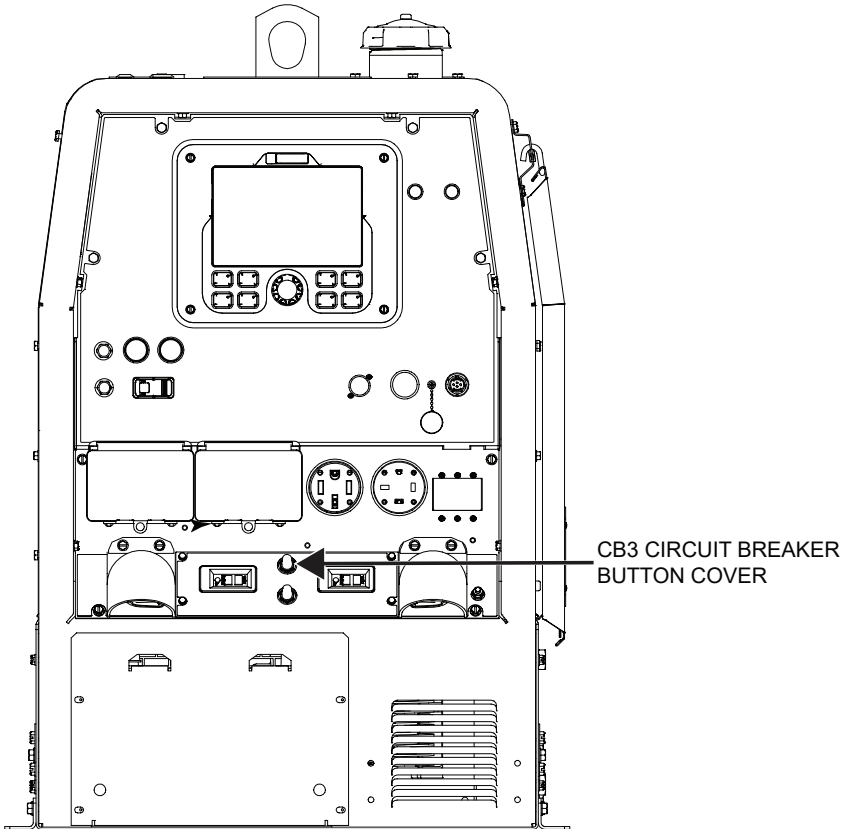


Figure F.2 – CB3 circuit breaker button cover location



CB4 CIRCUIT BREAKER REMOVAL AND REPLACEMENT PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will aid the technician in the removal and replacement of the CB4 Circuit Breaker.

MATERIALS NEEDED

Adjustable Wrench
Wiring Diagram

REMOVAL PROCEDURE

1. Turn off the engine on the Frontier 400X machine.
2. Perform the ***Case Cover Removal Procedure***.
3. Perform the ***Capacitor Discharge Procedure***.
4. Label and disconnect leads 46 and 46A from the terminals of the CB4 circuit breaker. See ***Figure F.1***. See Wiring Diagram.
5. Using an adjustable wrench, unscrew the button cover from the front panel of the machine. See ***Figure F.2***.
6. Carefully remove the CB4 circuit breaker from the front panel.
7. The CB4 circuit breaker can now be replaced.

REPLACEMENT PROCEDURE

1. Connect position the new CB4 circuit breaker into the machine.
2. Using an adjustable wrench, screw the button cover onto the front panel of the machine.
3. Connect leads 46 and 46A to the terminals of the CB4 circuit breaker. See Wiring Diagram.
4. Perform the ***Case Cover Replacement Procedure***.
5. Perform the ***Retest After Repair Procedure***.

Figure F.1 – CB4 circuit breaker lead locations

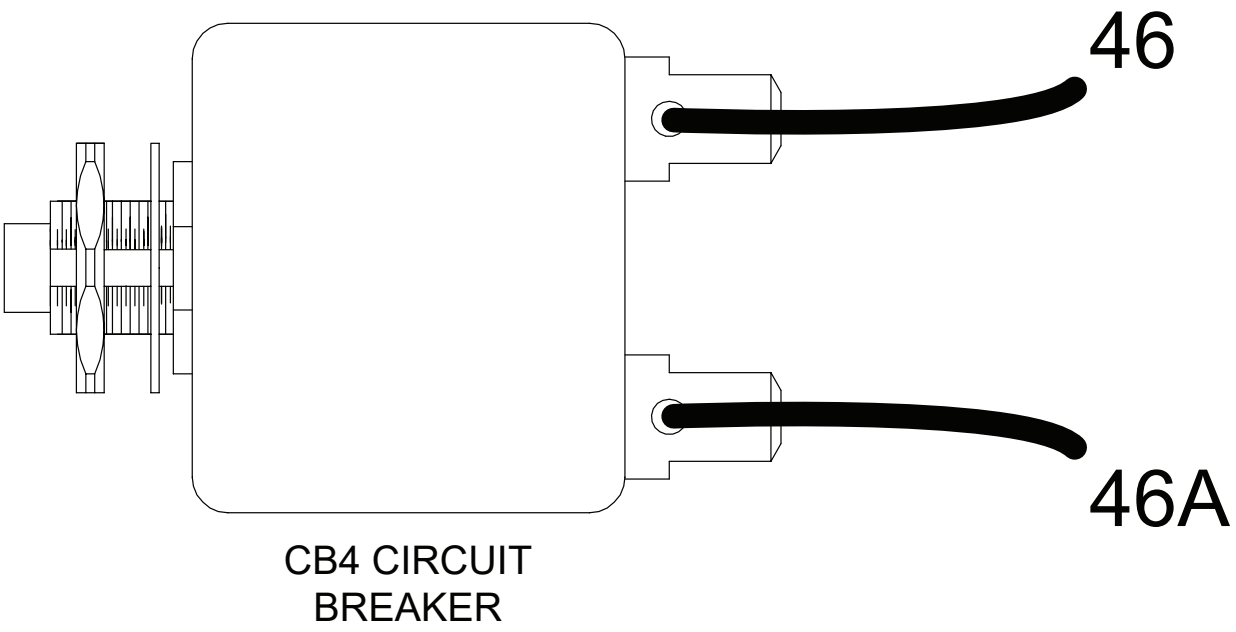
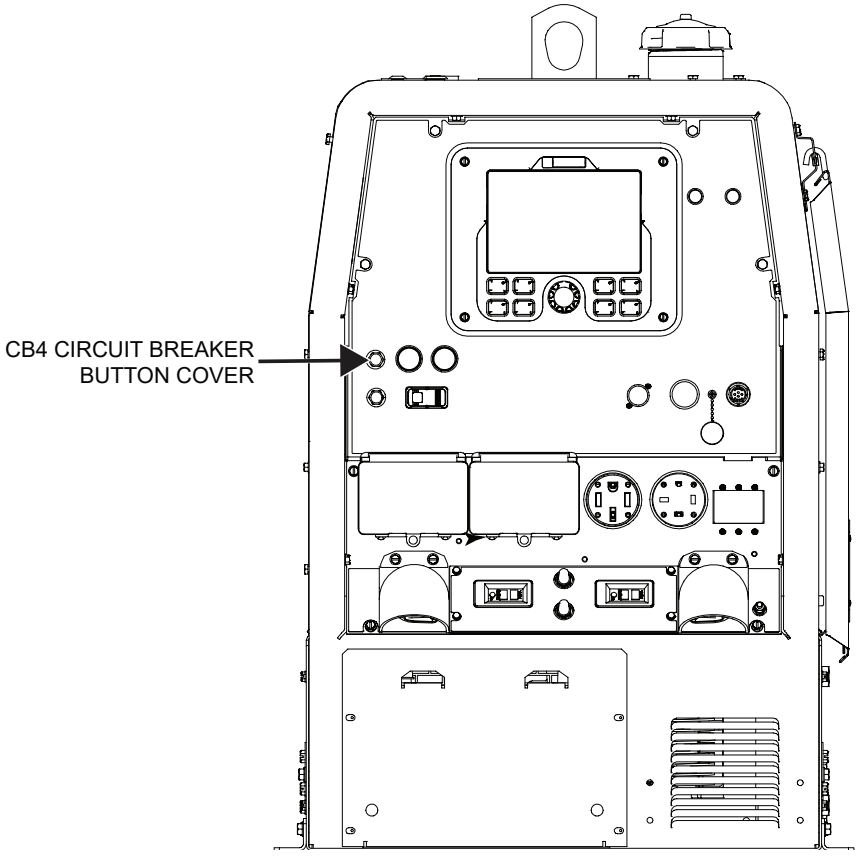


Figure F.2 – CB4 circuit breaker button cover location



ENGINE GOVERNOR CONTROLLER (EGC) REMOVAL AND REPLACEMENT PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will aid the technician in the removal and replacement of the Engine Governor Controller (EGC).

MATERIALS NEEDED

3/8” Nutdriver
Wiring Diagram

REMOVAL PROCEDURE

1. Turn off the engine on the Frontier 400X machine.
2. Perform the ***Case Cover Removal Procedure***.
3. Perform the ***Capacitor Discharge Procedure***.
4. Label and disconnect plugs J61 and J62 from the engine governor controller. See ***Figure F.1***. See Wiring Diagram.
5. Using a 3/8” nutdriver, remove the two screws securing the electronic governor controller to the lift bail panel. See ***Figure F.2***.
6. The electronic governor controller can now be replaced.

REPLACEMENT PROCEDURE

1. Carefully position the new electronic governor controller onto the mounting posts.
2. Using a 3/8” nutdriver, attach the two screws securing the electronic governor controller to the lift bail panel.
3. Connect plugs J61 and J62 to the engine governor controller. See Wiring Diagram.
4. Perform the ***Case Cover Replacement Procedure***.
5. Perform the ***Retest After Repair Procedure***.

Figure F.1 – Electronic governor controller plug locations

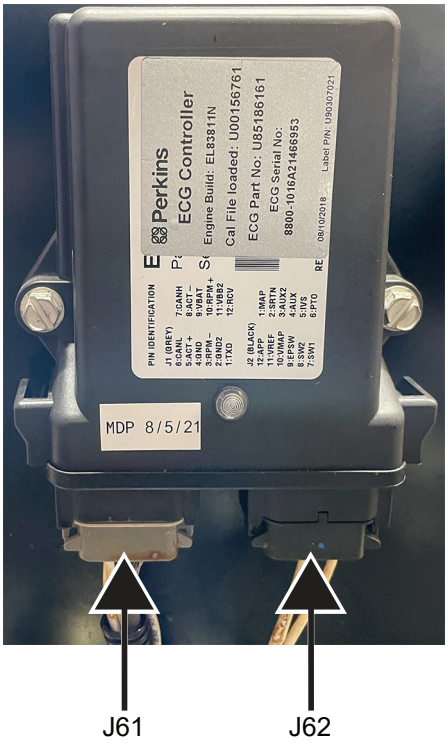
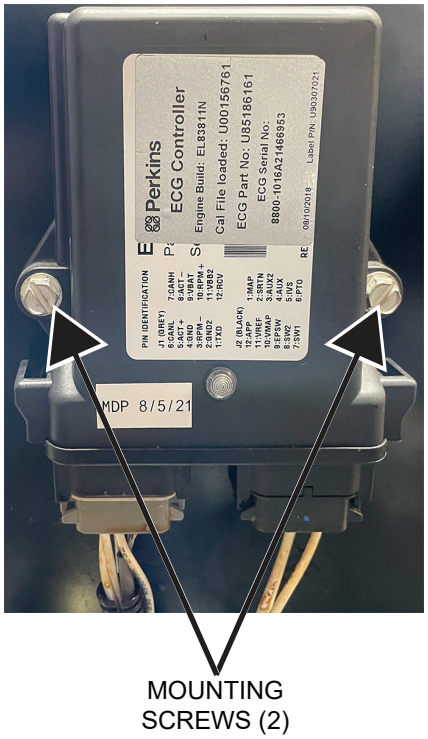


Figure F.2 – Electronic governor controller mounting hardware locations



BRUSH HOLDER REMOVAL AND REPLACEMENT PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will aid the technician in the removal and replacement of the Brush Holder Assembly.

MATERIALS NEEDED

3/8” Nutdriver
5/16” Nutdriver
Wiring Diagram

REMOVAL PROCEDURE

1. Turn off the engine on the Frontier 400X machine.
2. Perform the ***Case Cover Removal Procedure***.
3. Perform the ***Capacitor Discharge Procedure***.
4. Label and disconnect leads 200B and 201B from the in-line connections. See Wiring Diagram.
5. Using a 3/8” nutdriver, remove the two screws securing the brush holder bracket to the machine. See ***Figure F.1***.
6. Carefully maneuver the brush holder bracket out of the machine.
7. Using a 5/16” nutdriver, remove the two screws securing the brush holder to the brush holder bracket. See ***Figure F.2***.
8. The brush holder can now be removed and replaced.

REPLACEMENT PROCEDURE

1. Carefully position the brush holder into the brush holder bracket.
2. Using a 5/16” nutdriver, attach the two screws securing the brush holder to the brush holder bracket.
3. Carefully position the brush holder bracket into the machine.
4. Using a 3/8” nutdriver, attach the two screws securing the brush holder bracket to the machine.
5. Connect leads 200B and 201B to the in-line connections. See Wiring Diagram.
6. Perform the ***Case Cover Replacement Procedure***.
7. Perform the ***Retest After Repair Procedure***.

Figure F.1 – Brush holder bracket mounting screw locations

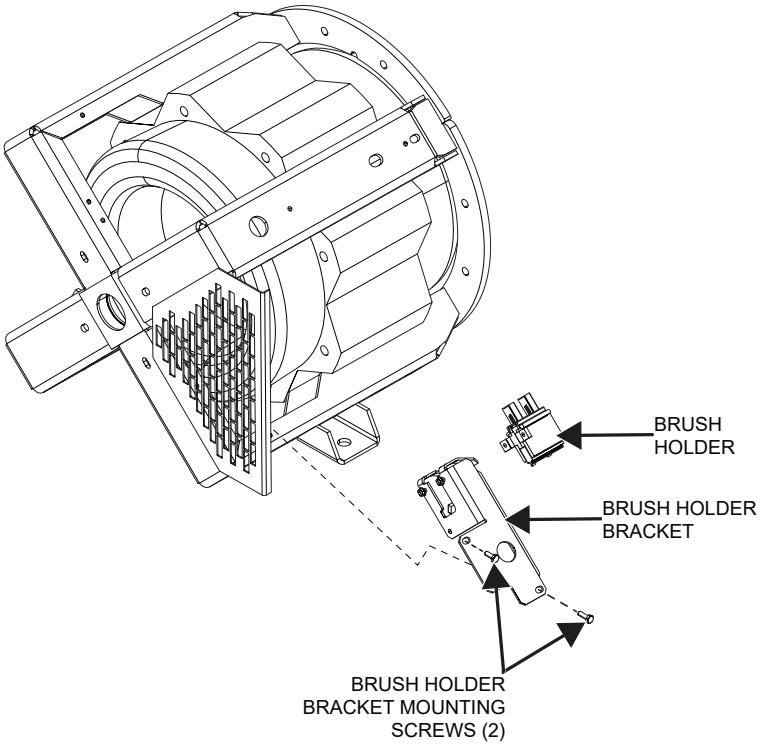
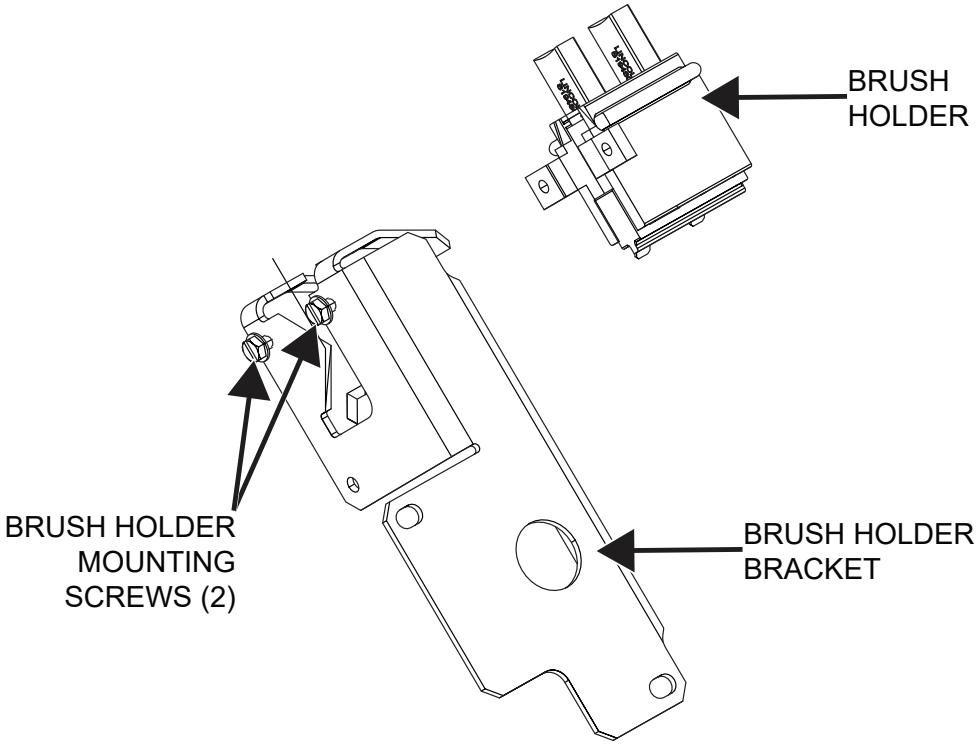


Figure F.2 – Brush holder mounting hardware locations



FRONT PANEL REMOVAL AND REPLACEMENT PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will aid the technician in the removal and replacement of the Front Panel. This procedure will allow for access to internal components for replacement.

MATERIALS NEEDED

3/8” Nutdriver
Scrap Piece wood
Wiring Diagram

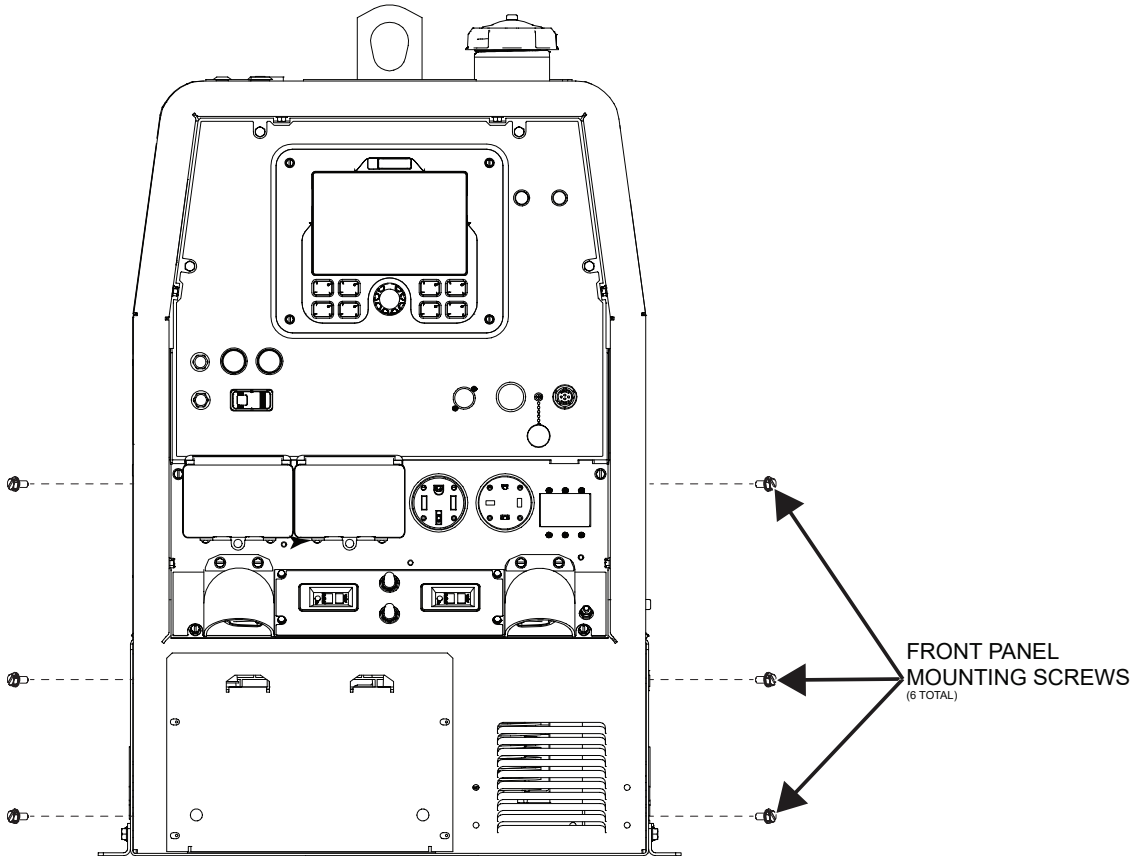
REMOVAL PROCEDURE

1. Turn off the engine on the Frontier 400X machine.
2. Perform the ***Case Cover Removal Procedure***.
3. Perform the ***Capacitor Discharge Procedure***.
4. Perform the ***Battery Removal Procedure***.
5. Using a 3/8” nutdriver, remove the six screws securing the front panel to the machine. See ***Figure F.1***.
6. Label and disconnect all leads and plugs necessary to allow for the front panel to be moved to the side of the machine. See Wiring Diagram. Cut cable ties as necessary.
7. Carefully maneuver the front panel out of the machine and over to the side.
8. Using a scrap piece of wood, support the front panel to relieve and strain on lead still connected.
9. Perform any tests and/or removal procedures.

REPLACEMENT PROCEDURE

1. Connect position the front panel into the machine.
2. Connect all previously disconnected leads and plugs to the front panel components. See Wiring Diagram. Replace cable ties as necessary.
3. Using a 3/8” nutdriver, attach the six screws securing the front panel to the machine.
4. Perform the ***Battery Replacement Procedure***.
5. Perform the ***Case Cover Replacement Procedure***.
6. Perform the ***Retest After Repair Procedure***.

Figure F.1 – Front panel mounting screw locations



OUTPUT CHOKE REMOVAL AND REPLACEMENT PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will aid the technician in the removal and replacement of the Output Choke.

MATERIALS NEEDED

1/2” Nutdriver
1/2” Open-End Wrench
7/16” Nutdriver
Wiring Diagram

REMOVAL PROCEDURE

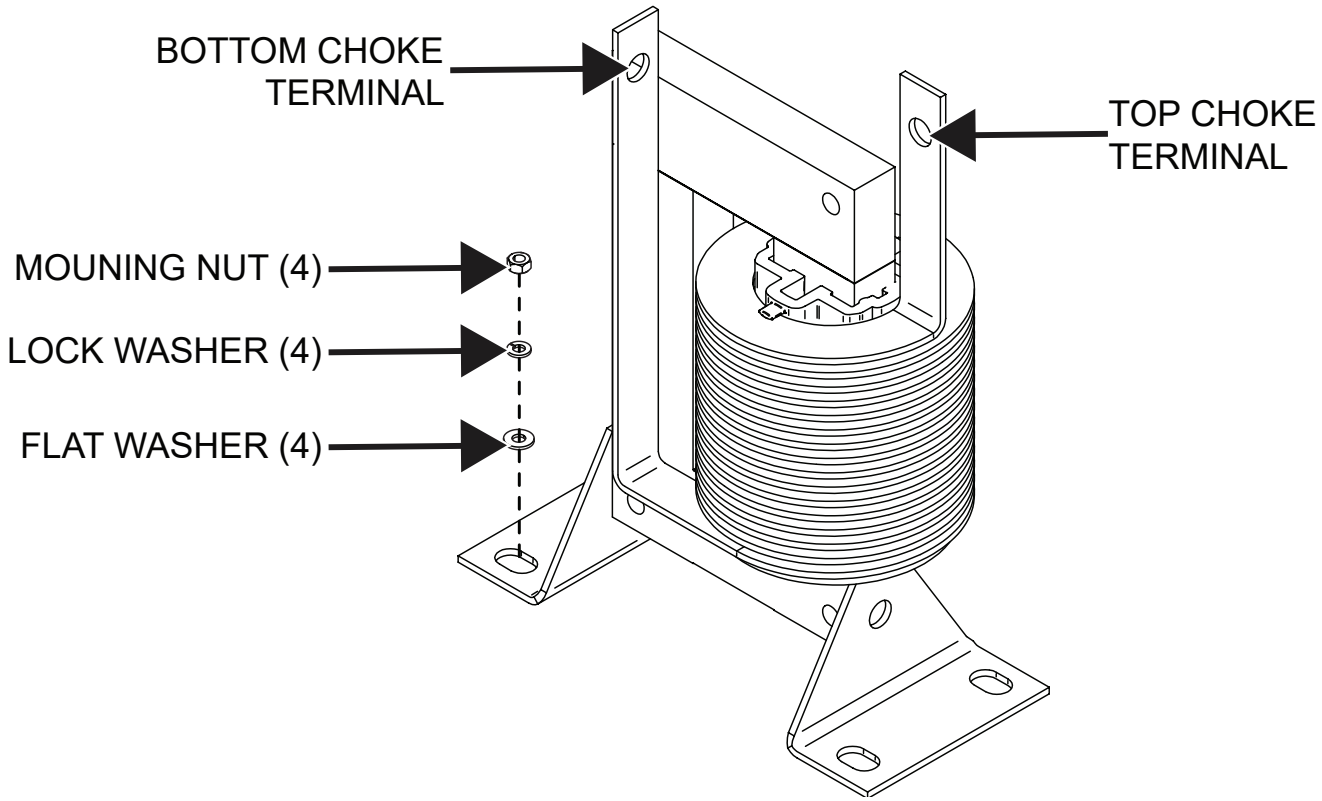
1. Turn off the engine on the Frontier 400X machine.
2. Perform the ***Case Cover Removal Procedure***.
3. Perform the ***Capacitor Discharge Procedure***.
4. Perform the ***Front Panel Removal Procedure***.
5. Using a 1/2” nutdriver and a 1/2” open-end wrench, remove the bolt, nut, lock washer and two flat washers securing lead W8 to the top output choke terminal. See ***Figure F.1***. See Wiring Diagram.
6. Using a 1/2” nutdriver and a 1/2” open-end wrench, remove the bolt, nut, lock washer and two flat washers securing lead W7 to the bottom output choke terminal. See ***Figure F.1***. See Wiring Diagram.
7. Using a 7/16” nutdriver, remove the four nuts, lock washers and flat washers securing the output choke to the machine. See ***Figure F.1***.
8. Carefully maneuver the output choke off its mounting posts.
9. The output choke can now be replaced.

REPLACEMENT PROCEDURE

1. Carefully position the new output choke onto its mounting posts.
2. Using a 7/16” nutdriver, attach the four nuts, lock washers and flat washers securing the output choke to the machine.
3. Using a 1/2” nutdriver and a 1/2” open-end wrench, attach the bolt, nut, lock washer and two flat washers securing lead W7 to the bottom output choke terminal. See Wiring Diagram.

4. Using a 1/2” nutdriver and a 1/2” open-end wrench, remove the bolt, nut, lock washer and two flat washers securing lead W8 to the top output choke terminal. See Wiring Diagram.
5. Perform the ***Front Panel Replacement Procedure***.
6. Perform the ***Case Cover Replacement Procedure***.
7. Perform the ***Retest After Repair Procedure***.

Figure F.1 – Output choke terminal and mounting hardware locations



CAPACITOR REMOVAL AND REPLACEMENT PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will aid the technician in the removal and replacement of the Capacitor.

MATERIALS NEEDED

7/16” Nutdriver
3/8” Nutdriver
Wiring Diagram

REMOVAL PROCEDURE

1. Turn off the engine on the Frontier 400X machine.
2. Perform the ***Case Cover Removal Procedure***.
3. Perform the ***Capacitor Discharge Procedure***.
4. Using a 7/16” nutdriver, remove the nut, lock washer and flat washer securing leads 65A and 65 to the positive terminal of the capacitor. Label and disconnect leads 65A and 65 from the capacitor. See ***Figure F.1***. See Wiring Diagram.
5. Using a 7/16” nutdriver, remove the nut, lock washer and flat washer securing leads 66A and 66 to the negative terminal of the capacitor. Label and disconnect leads 66A and 66 from the capacitor. See ***Figure F.1***. See Wiring Diagram.
6. Using a 3/8” nutdriver, remove the screw securing the capacitor bracket to the stator fan guard. See ***Figure F.2***.
7. The capacitor can now be removed and replaced.

REPLACEMENT PROCEDURE

1. Connect position the capacitor into the machine.
2. Using a 3/8” nutdriver, attach the screw securing the capacitor bracket to the stator fan guard.
3. Using a 7/16” nutdriver, attach the nut, lock washer and flat washer securing leads 66A and 66 to the negative terminal of the capacitor. See Wiring Diagram.
4. Using a 7/16” nutdriver, attach the nut, lock washer and flat washer securing leads 65A and 65 to the positive terminal of the capacitor. See Wiring Diagram.
5. See Wiring Diagram.

6. Perform the ***Case Cover Replacement Procedure***.
7. Perform the ***Retest After Repair Procedure***.

Figure F.1 – Capacitor terminal locations

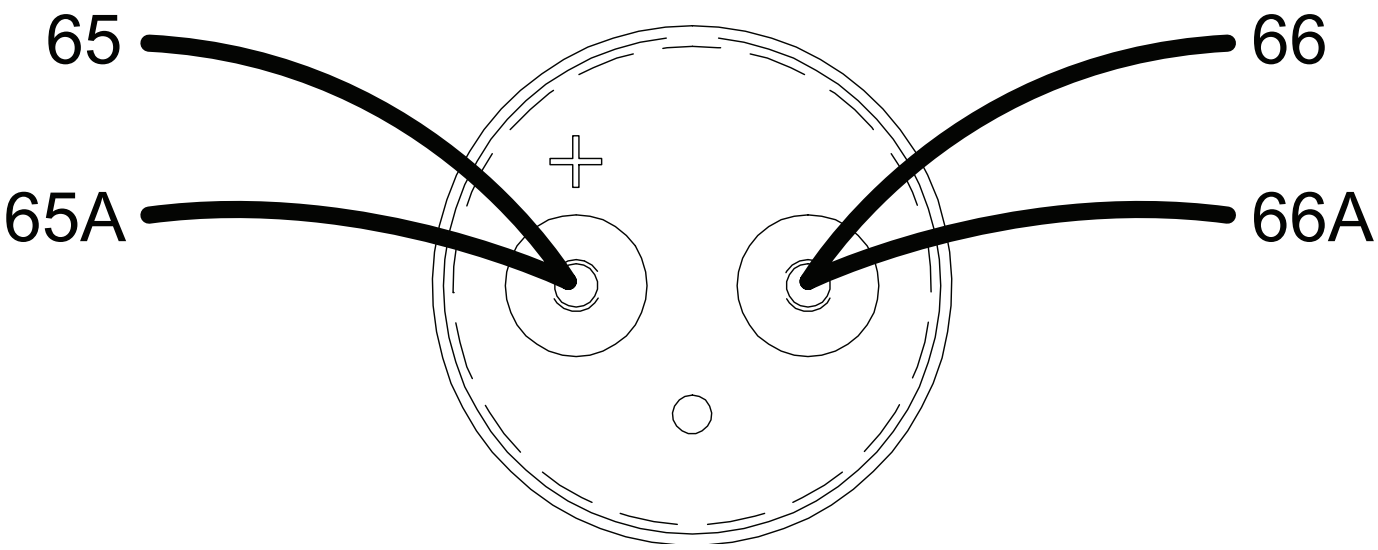
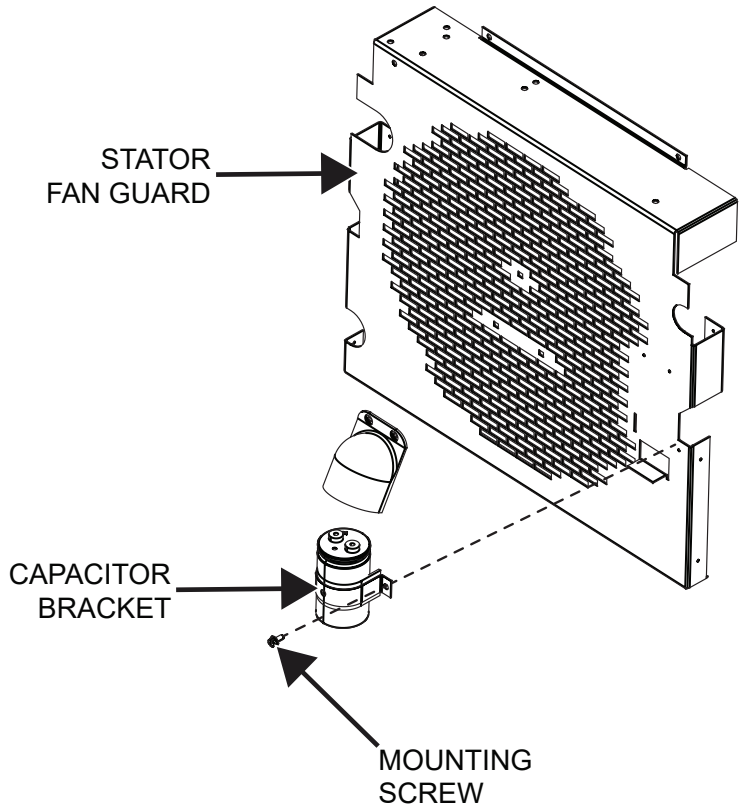


Figure F.2 – Capacitor bracket mounting hardware locations



STATOR FAN REMOVAL AND REPLACEMENT PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will aid the technician in the removal and replacement of the Stator Fan.

MATERIALS NEEDED

3/8” Nutdriver
7/16” Open-End Wrench
Wiring Diagram

REMOVAL PROCEDURE

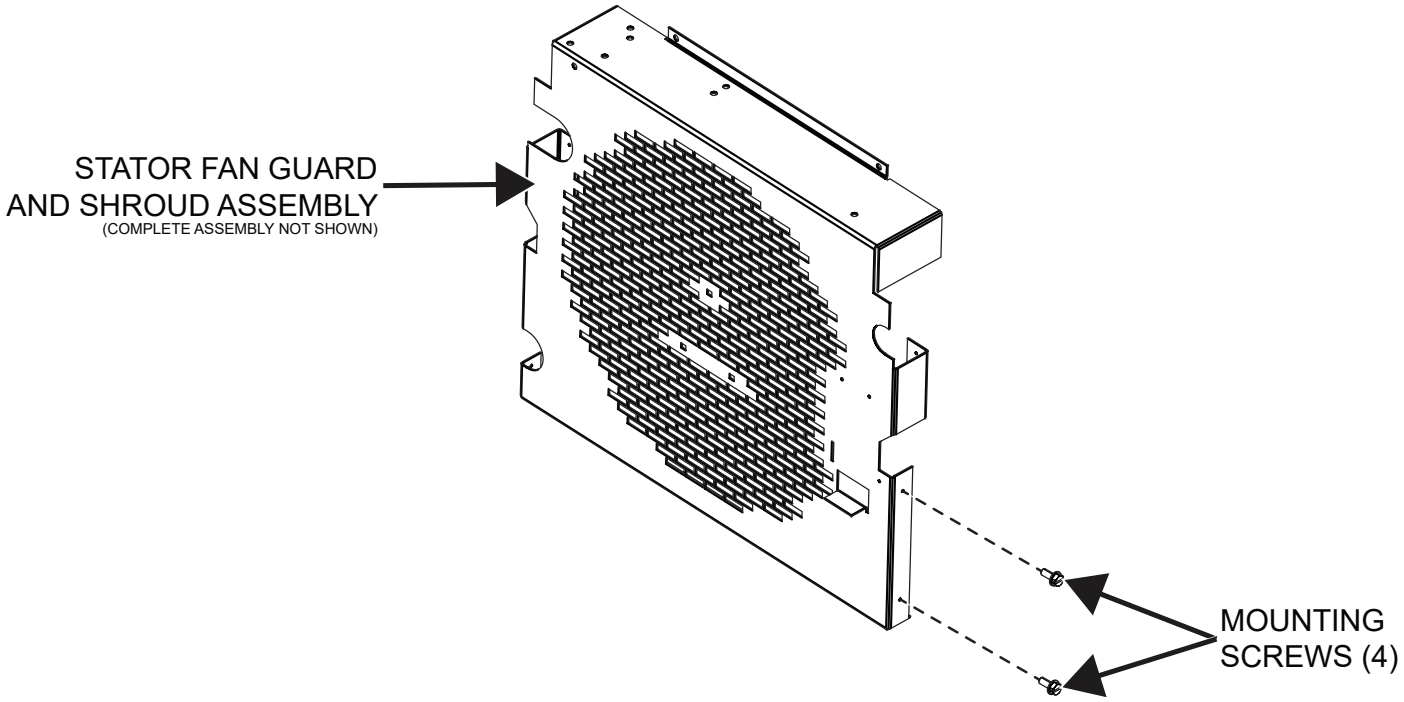
1. Turn off the engine on the Frontier 400X machine.
2. Perform the ***Case Cover Removal Procedure***.
3. Perform the ***Capacitor Discharge Procedure***.
4. Perform the ***Battery Removal Procedure***.
5. Perform the ***Front Panel Removal Procedure***.
6. Perform the ***Capacitor Removal Procedure***.
7. Perform the ***Output Choke Removal Procedure***.
8. Using a 3/8” nutdriver and a 7/16” open-end wrench, remove the bolt and nut securing the insulated cable strap to the frame of the machine. Route leads to allow for the removal of the stator fan guard and shroud assembly. Cut cable ties as necessary.
9. Using a 3/8” nutdriver, remove the four screws securing the stator fan guard and shroud assembly to the machine. See ***Figure F.1***.
10. Carefully maneuver the stator fan guard and shroud assembly out of the machine.
11. Use a small piece of wood to prevent the fan blades from turning during removal.
12. Using an adjustable wrench, remove the nut and lock washer securing the fan blade to the rotor shaft.
13. The stator fan can now be removed and replaced.

REPLACEMENT PROCEDURE

1. Carefully position the fan blade onto the rotor shaft.
2. Using an adjustable wrench, attach the nut and lock washer securing the fan blade to the rotor shaft.

3. Carefully position the stator fan guard and shroud assembly into the machine.
4. Using a 3/8” nutdriver, attach the four screws securing the stator fan guard and shroud assembly to the machine.
5. Using a 3/8” nutdriver and a 7/16” open-end wrench, attach the bolt and nut securing the insulated cable strap to the frame of the machine. Route previously moved leads through cable strap. See Wiring Diagram. Replace cable ties as necessary.
6. Perform the ***Output Choke Replacement Procedure***.
7. Perform the ***Capacitor Replacement Procedure***.
8. Perform the ***Front Panel Replacement Procedure***.
9. Perform the ***Battery Replacement Procedure***.
10. Perform the ***Case Cover Replacement Procedure***.
11. Perform the ***Retest After Repair Procedure***.

Figure F.1 – Stator fan guard and shroud assembly mounting hardware locations



STATOR AND ROTOR REMOVAL AND REPLACEMENT PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will aid the technician in the removal and replacement of the Stator and Rotor Assemblies.

MATERIALS NEEDED

Phillips Screwdriver
3/8” Nutdriver
3/4” Nutdriver
3/4” Open-End Wrench
Hoist And Appropriate Rigging
Steel or Wood Blocking
9/16” Open-End Wrench
Wiring Diagram

REMOVAL PROCEDURE

1. Turn off the engine on the Frontier 400X machine.
2. Perform the ***Case Cover Removal Procedure***.
3. Perform the ***Capacitor Discharge Procedure***.
4. Perform the ***Brush Holder Removal Procedure***.
5. Perform the ***Fuel Tank Removal Procedure***.
6. Perform the ***Stator Fan Removal Procedure***.
7. Perform the ***Output Rectifier Removal Procedure***.
8. Perform the ***Chopper Control Board Removal Procedure***.
9. Perform the ***D3 Rectifier Removal Procedure***.
10. Using a Philips screwdriver, remove the three screws and washers securing leads 3, 4 and 6 to the CB1 circuit breaker. See ***Figure F.1***. See Wiring Diagram. Label and disconnect leads 3, 4 and 6.
11. Route lead 3 and 6 thru the toroid. Take note of the direction and number of turns for reassembly
12. Label and disconnect lead 9A from the inline connection. See Wiring Diagram.
13. Label and disconnect leads 7 and 8 from the D2 rectifier. See ***Figure F.2***. See Wiring Diagram.
14. Label and disconnect lead 45 form the D3 rectifier. See ***Figure F.3***. See Wiring Diagram.
15. Label and disconnect lead 46 from the CB4 circuit breaker. See ***Figure F.4***. See Wiring Diagram.

16. Using a 3/8” nutdriver, remove the nut, lock washer and flat washer securing lead 5A to the neutral stud on the output panel. See Wiring Diagram. Label and disconnect lead 5A.
17. Using a 3/8” nutdriver, remove the nut, lock washer and flat washer securing lead 5 to the ground stud on the upper control panel. See Wiring Diagram. Label and disconnect lead 5.
18. Using a 3/8” nutdriver, remove the two screws securing the fuel tank tray and support rail to the machine. See ***Figure F.5***.
19. Using a 3/4” nutdriver and a 3/4” open-end wrench, remove the two bolts, nuts and four flat washers securing the stator frame to the machine. See ***Figure F.6***.
20. Using a hoist and appropriate rigging, slightly lift the stator frame off its mount.
21. Place steel or wood blocking under the flywheel housing to support the engine.
22. Using a 9/16” open-end wrench, remove the eight screws and lock washers securing the stator frame to the engine. See ***Figure F.7***.
23. Using a hoist and appropriate rigging, carefully remove the stator frame from the engine.
24. Using a hoist and appropriate rigging, support the rotor and shaft assembly.
25. Remove the eight screws and washers securing the rotor coupling disc to the engine.
26. The rotor assembly can now be removed.

REPLACEMENT PROCEDURE

1. Using a hoist and appropriate rigging, carefully mate the rotor and shaft assembly with the engine.
2. Attach the eight screws securing the rotor coupling disc to eh engine.
3. Using a hoist and appropriate rigging, carefully position the stator frame onto the engine.
4. Using a 9/16” open-end wrench, attach the eight screws and lock washers securing the stator frame to the engine.
5. Using a hoist and appropriate rigging, slightly lift the stator frame off its mount.
6. Carefully remove the wood or steel blocking from under the flywheel housing.
7. Using a hoist and appropriate rigging, lower the stator frame onto its mount.
8. Using a 3/4” nutdriver and a 3/4” open-end wrench, attach the two bolts, nuts and four flat washers securing the stator frame to the machine.
9. Using a 3/8” nutdriver, attach the two screws securing the fuel tank tray and support rail to the machine.
10. Using a 3/8” nutdriver, attach the nut, lock washer and flat washer securing lead 5 to the ground stud on the upper control panel. See Wiring Diagram.
11. Using a 3/8” nutdriver, attach the nut, lock washer and flat washer securing lead 5A to the neutral stud on the output panel. See Wiring Diagram.
12. Connect lead 46 to the CB4 circuit breaker. See Wiring Diagram.
13. Connect lead 45 to the D3 rectifier. See Wiring Diagram.
14. Connect leads 7 and 8 to the D2 rectifier. See Wiring Diagram.
15. Connect lead 9A to the inline connection. See Wiring Diagram.
16. Route leads 3 and 6 thru the toroid. Ensure the proper direction and number of turns.
17. Using a Philips screwdriver, attach the three screws and washers securing leads 3, 4 and 6 to the CB1 circuit breaker. See Wiring Diagram.
18. Perform the ***D3 Rectifier Replacement Procedure***.
19. Perform the ***Chopper Control Board Replacement Procedure***.

20. Perform the ***Output Rectifier Replacement Procedure***.
21. Perform the ***Stator Fan Replacement Procedure***.
22. Perform the ***Fuel Tank Replacement Procedure***.
23. Perform the ***Brush Holder Replacement Procedure***.
24. Perform the ***Case Cover Replacement Procedure***.
25. Perform the ***Retest After Repair Procedure***.

Figure F.1 – CB1 circuit breaker lead locations

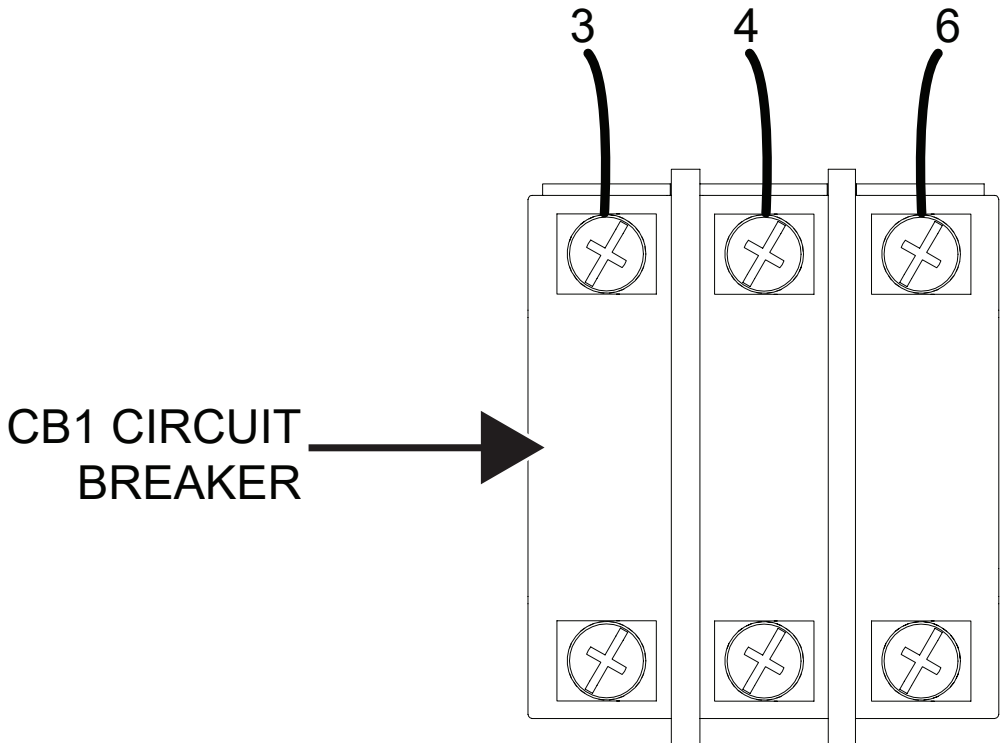


Figure F.2 – D2 rectifier lead locations

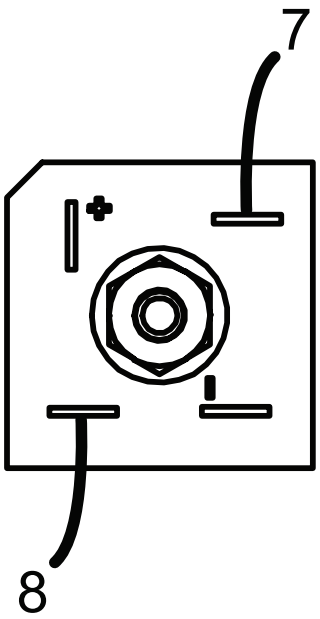


Figure F.3 – D3 rectifier lead locations

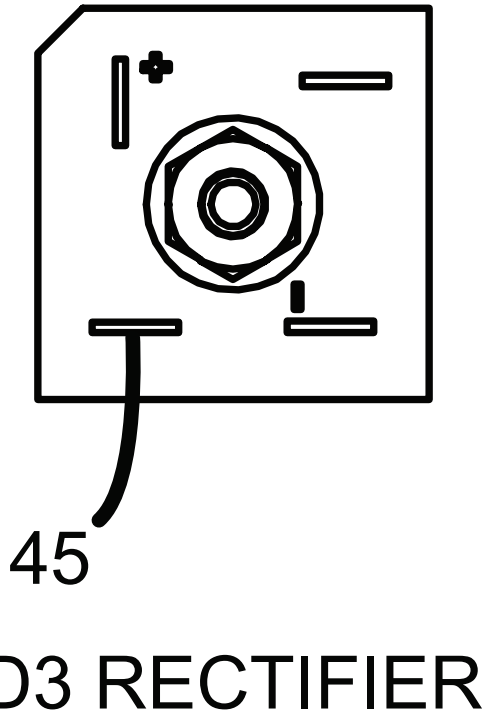


Figure F.4 – CB4 circuit breaker lead 46 location

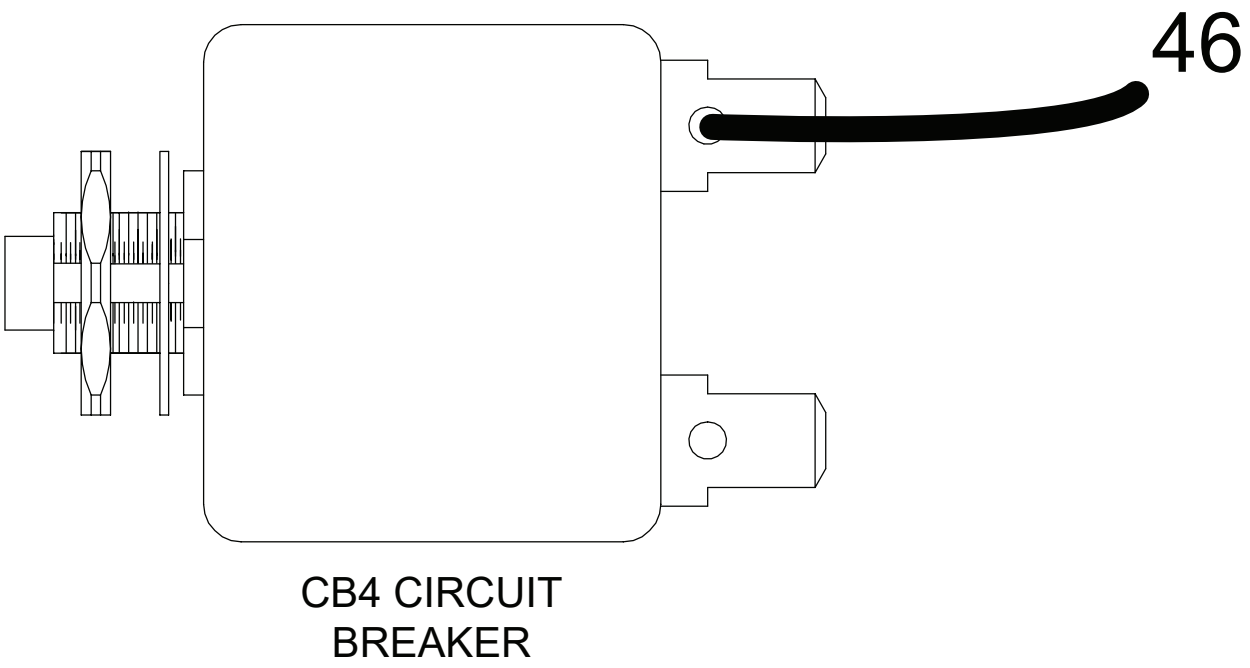


Figure F.5 – Fuel tank tray and support rail locations

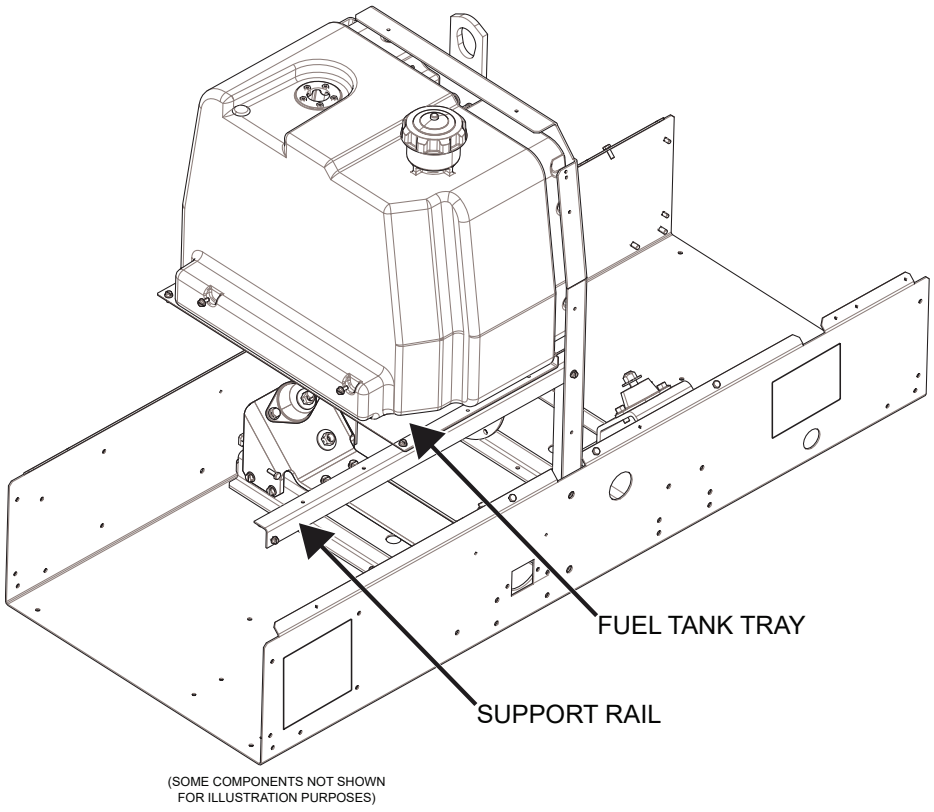


Figure F.6 – Stator frame mounting hardware locations

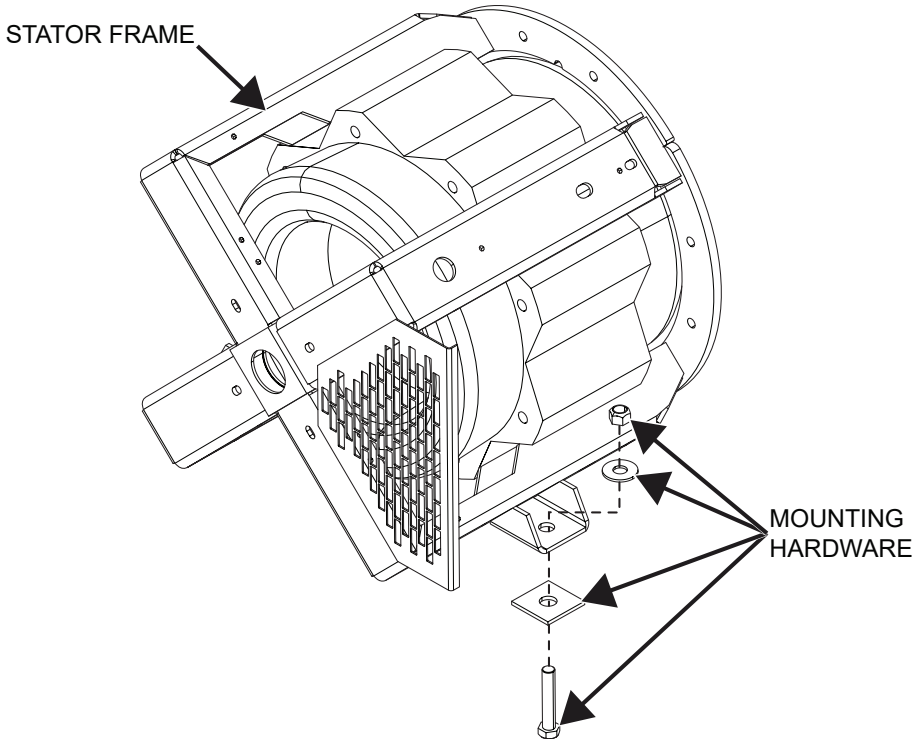
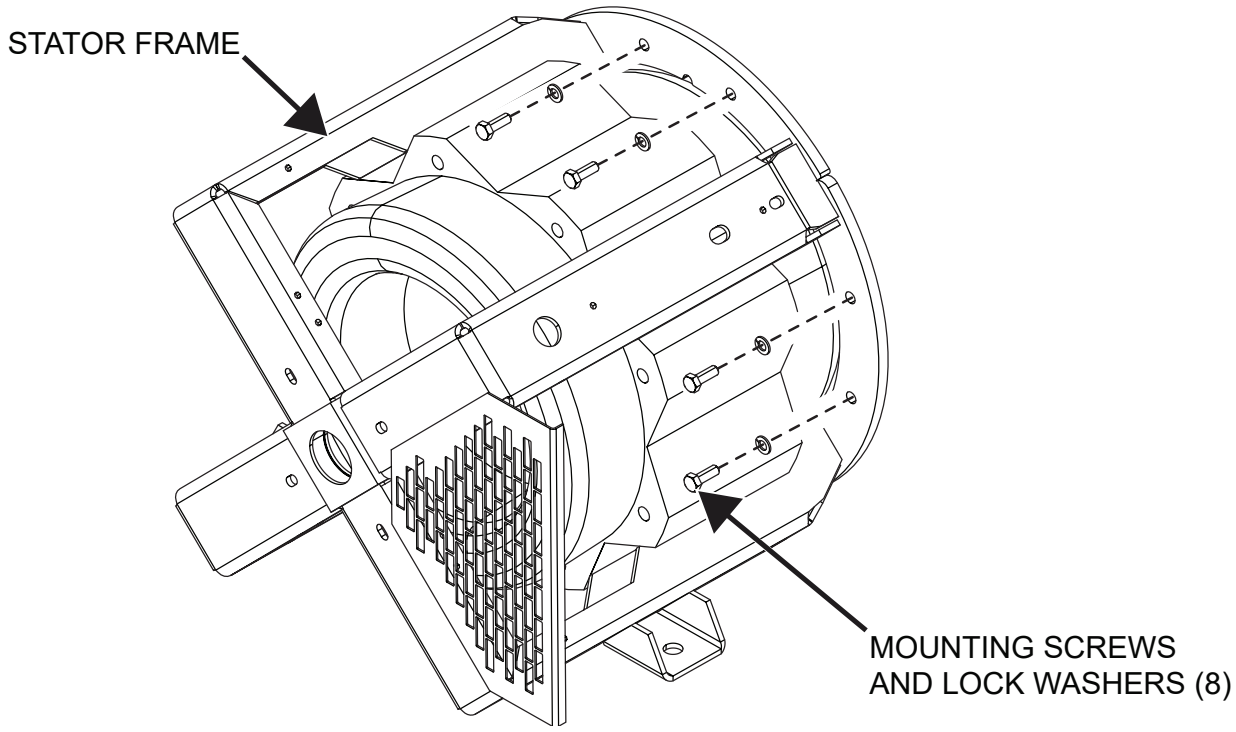


Figure F.7 – Stator frame to engine mounting hardware locations



120VAC RECEPTACLE(S) REMOVAL AND REPLACEMENT PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will aid the technician in the removal and replacement of the 120VAC Receptacles.

MATERIALS NEEDED

Phillips Screwdriver
Slotted Screwdriver
Wiring Diagram

REMOVAL PROCEDURE

1. Turn off the engine on the Frontier 400X machine.
2. Perform the ***Case Cover Removal Procedure***.
3. Perform the ***Capacitor Discharge Procedure***.
4. Perform ***Front Panel Removal Procedure***, to gain access to the rear of the receptacles.
5. Open the outlet cover to gain access to mounting screws. See ***Figure F.1***.
6. Using a Philips screwdriver, remove the two screws securing the mounting bracket and rubber cover to the front panel. See ***Figures F.2*** and ***F.3***.
7. Using a slotted screwdriver, remove the screw securing the outlet to the front panel. See ***Figure F.4***.
8. Using a Philips screwdriver, loosen the appropriate screw securing each lead (5E, 6G and GND-E on left receptacle and 5B, 3F and GND-E on right receptacle) to the receptacle. See Wiring Diagram.
9. The 120VAC receptacle can now be replaced.

REPLACEMENT PROCEDURE

1. Using a Philips screwdriver, tighten the appropriate screw securing each lead (5E, 6G and GND-E on left receptacle and 5B, 3F and GND-E on right receptacle) to the receptacle. See Wiring Diagram.
2. Carefully position the outlet into the machine.
3. Using a slotted screwdriver, attach the screw securing the outlet to the front panel.
4. Using a Philips screwdriver, attach the two screws securing the mounting bracket and rubber cover to the front panel.
5. Perform the ***Front Panel Replacement Procedure***.
6. Perform the ***Case Cover Replacement Procedure***.

7. Perform the ***Retest After Repair Procedure***.

Figure F.1 – 120 VAC receptacle cover locations

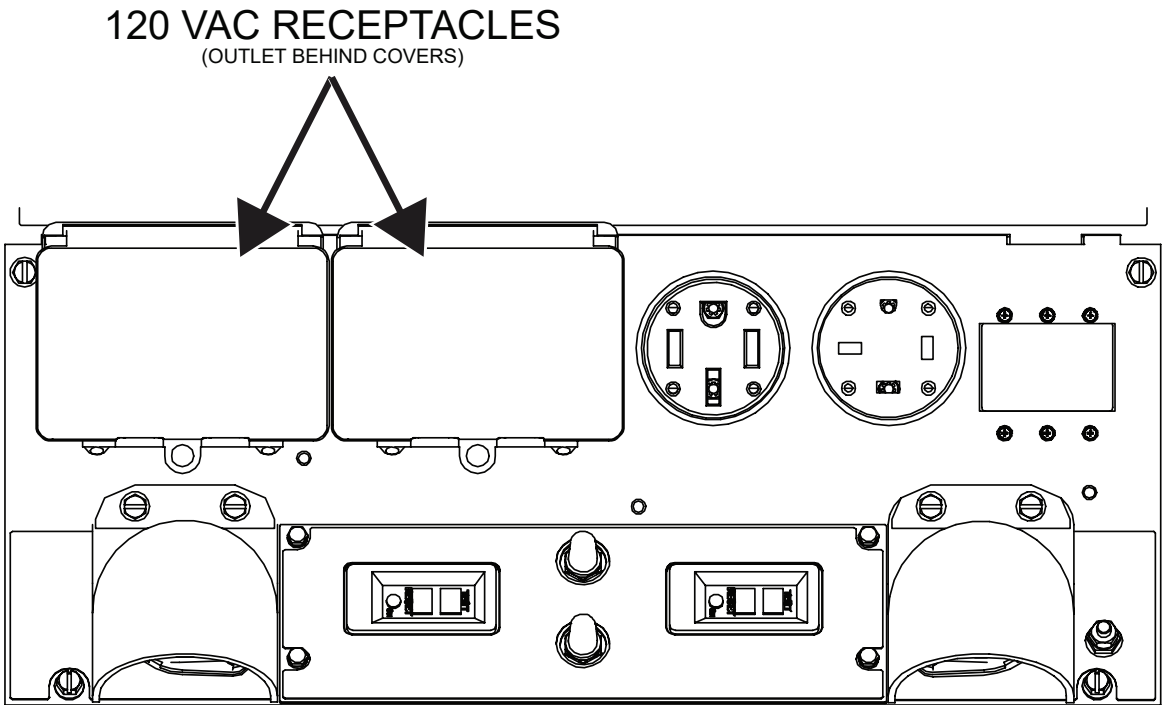


Figure F.2 – Mounting bracket and rubber cover mounting screw locations

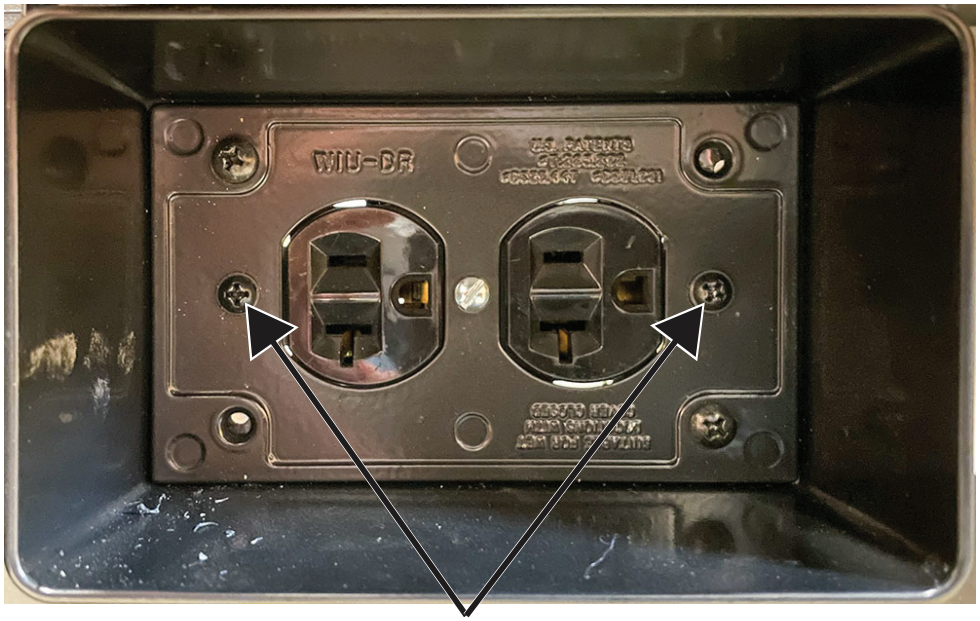


Figure F.3 – Receptacle, mounting bracket and rubber cover locations

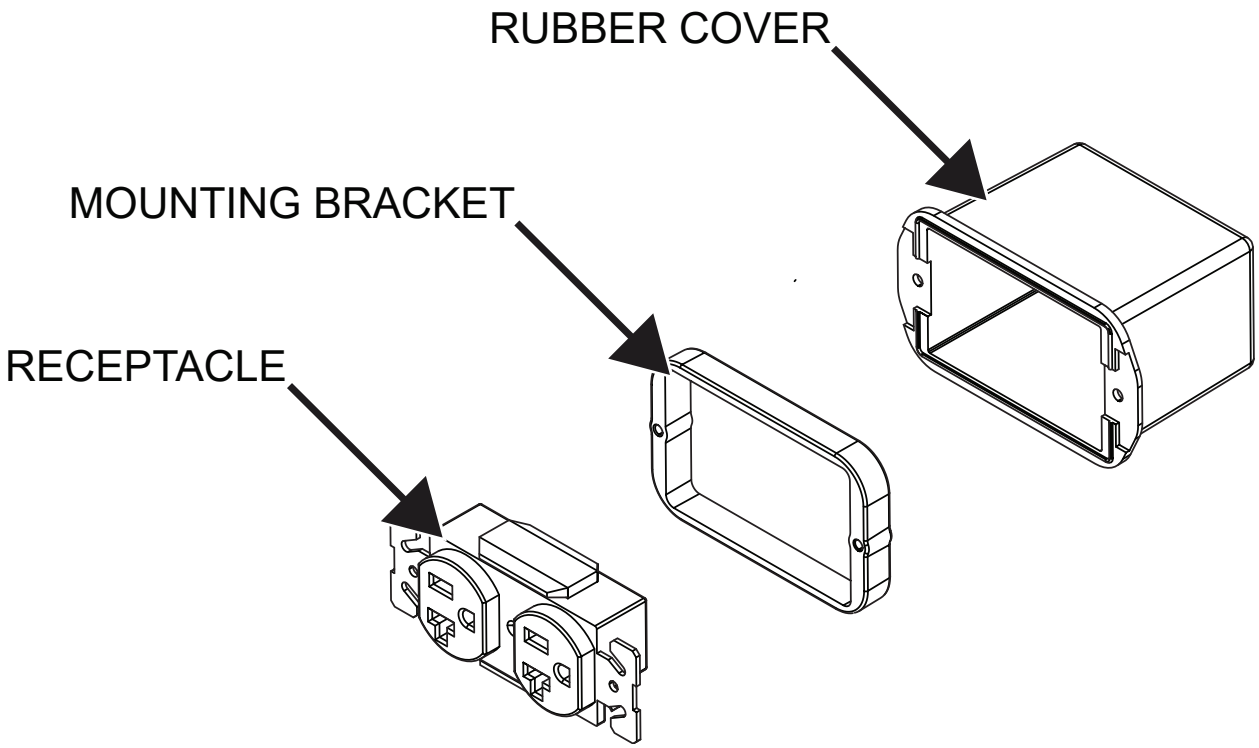
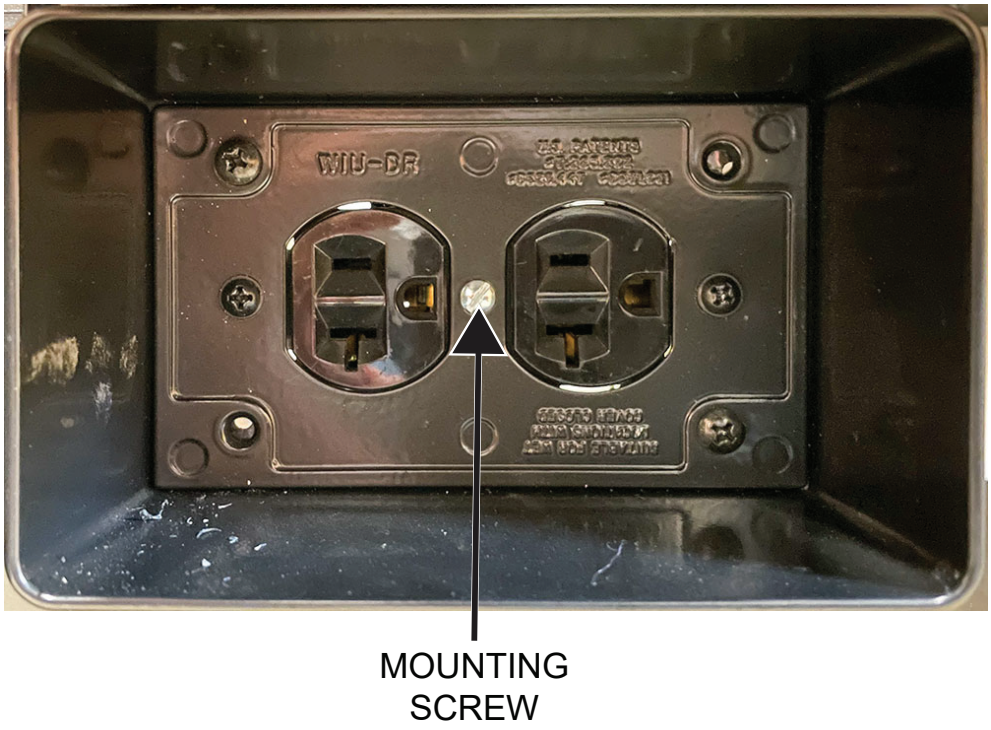


Figure F.4 – 120 VAC receptacle mounting screw location



GFCI RECEPTACLE(S) REMOVAL AND REPLACEMENT PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will aid the technician in the removal and replacement of the GFCI receptacle(s).

MATERIALS NEEDED

5/16” Nutdriver
Wiring Diagram

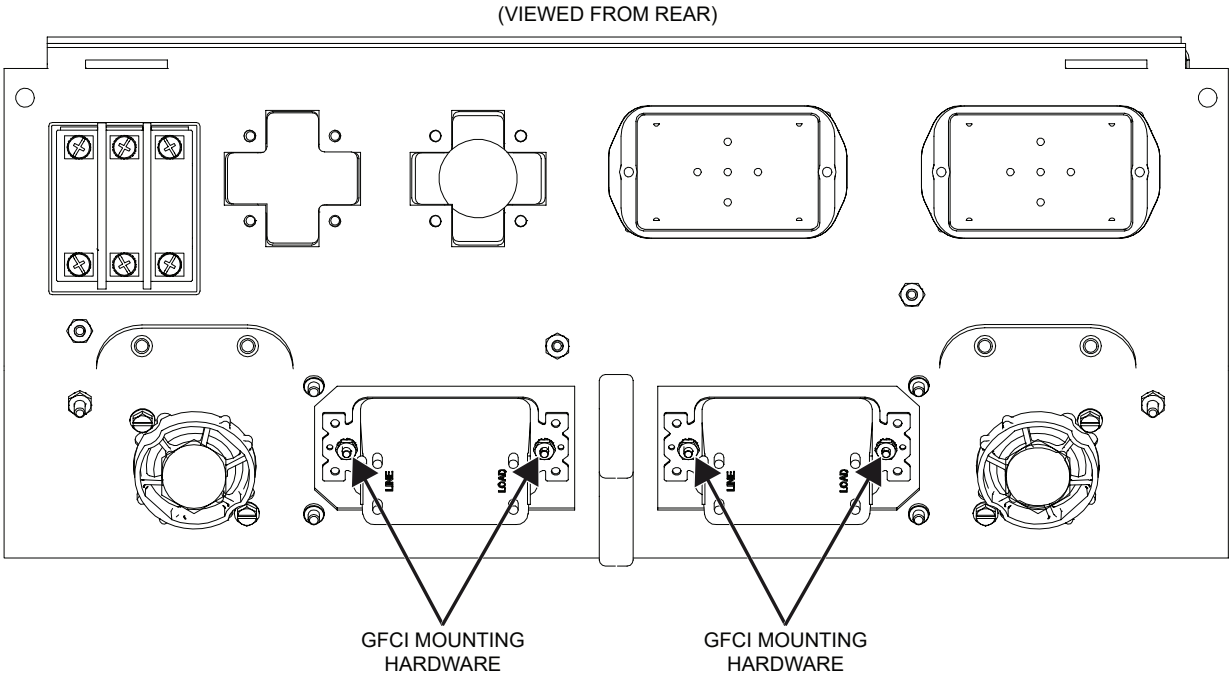
REMOVAL PROCEDURE

1. Turn off the engine on the Frontier 400X machine.
2. Perform the ***Case Cover Removal Procedure***.
3. Perform the ***Capacitor Discharge Procedure***.
4. Perform the ***Front Panel Removal Procedure***.
5. Label and disconnect the ground lead from the inline connection. See Wiring Diagram.
6. Label and disconnect plug J70B (left GFCI) or plug J70A (right GFCI) from the inline connection. See Wiring Diagram.
7. Using a 5/16” nutdriver, remove the two nuts and lock washers securing the GFCI receptacle to the front panel. See ***Figure F.1***.
8. The GFCI receptacle can now be replaced.

REPLACEMENT PROCEDURE

1. Carefully position the new GFCI receptacle into the front panel.
2. Using a 5/16” nutdriver, attach the two nuts and lock washers securing the GFCI receptacle to the front panel.
3. Connect plug J70B (left GFCI) or plug J70A (right GFCI) to the inline connection. See Wiring Diagram.
4. Connect the ground lead from the inline connection. See Wiring Diagram.
5. Perform the ***Front Panel Replacement Procedure***.
6. Perform the ***Case Cover Replacement Procedure***.
7. Perform the ***Retest After Repair Procedure***.

Figure F.1 – GFCI mounting hardware locations



ON / IDLER CONTROL / STOP SWITCH REMOVAL AND REPLACEMENT PROCEDURE

Service and repair should be performed by only Lincoln Electric factory trained personnel. Unauthorized repairs performed on this equipment may result in danger to the technician or machine operator and will invalidate your factory warranty. For your safety and to avoid electrical shock, please observe all safety notes and precautions detailed throughout this manual. If for any reason you do not understand the test procedures or are unable to perform the test/repairs safely, contact the Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed. Call 1-888-935-3877.

TEST DESCRIPTION

This procedure will aid the technician in the removal and replacement of the On / Idler Control / Stop Switch.

MATERIALS NEEDED

Wiring Diagram

REMOVAL PROCEDURE

1. Turn off the engine on the Frontier 400X machine.
2. Perform the ***Case Cover Removal Procedure***.
3. Perform the ***Capacitor Discharge Procedure***.
4. Carefully depress the tabs at the top and bottom of the of the rear side of the switch. See ***Figure F.1***.
5. Carefully maneuver the switch thru the front of the control panel.
6. Label and disconnect leads 232A (jumper lead), 238F (jumper lead), 238D, 232B, 5R and 257 from terminals 8, 2, 3, 7, 5 and 6 of the switch. See ***Figure F.2***. See Wiring Diagram.
7. Route leads back thru the control panel and remove the switch backing plate.
8. The switch can now be removed and replaced.

REPLACEMENT PROCEDURE

1. Carefully position the switch backing plate over the leads for the switch and route leads thru the front panel of the machine.
2. Connect leads 232A (jumper lead), 238F (jumper lead), 238D, 232B, 5R and 257 from terminals 8, 2, 3, 7, 5 and 6 of the switch. See Wiring Diagram.
3. Carefully press the switch into position on the control panel. The tabs on the switch should lock the switch in place on the switch backing plate.
4. Perform the ***Case Cover Replacement Procedure***.
5. Perform the ***Retest After Repair Procedure***.

Figure F.1 – Mounting tabs location

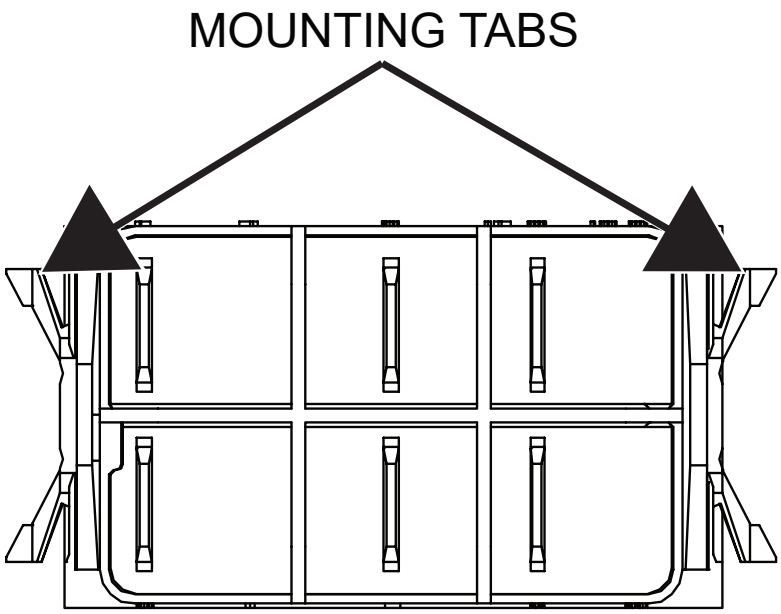
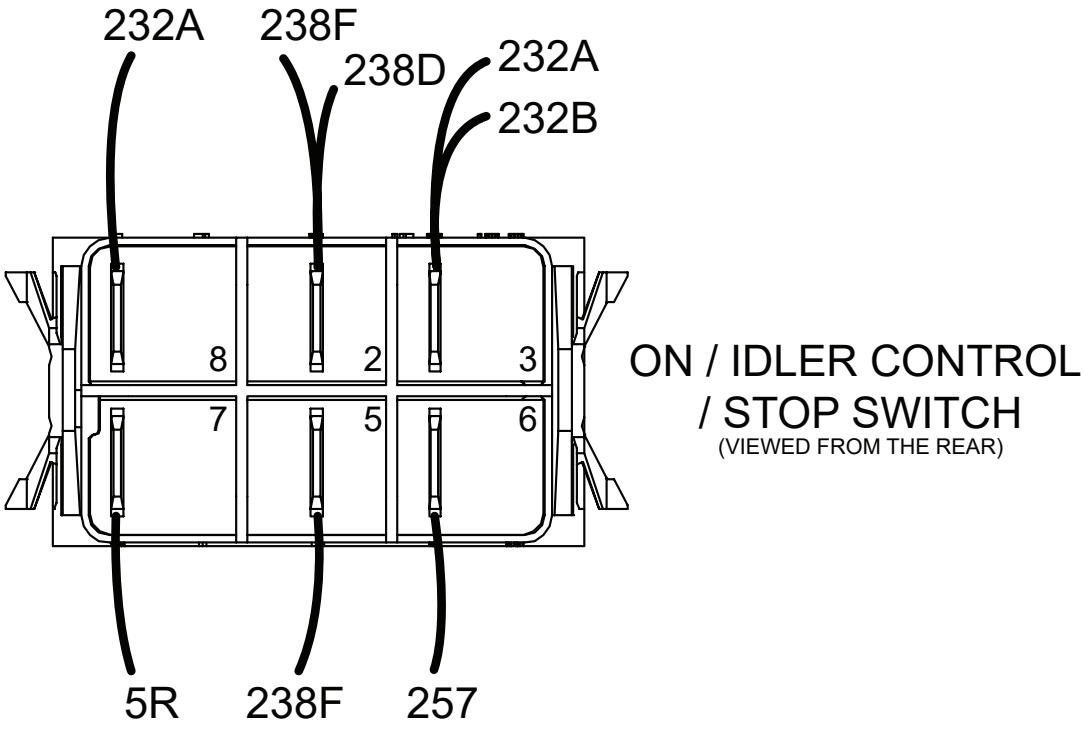
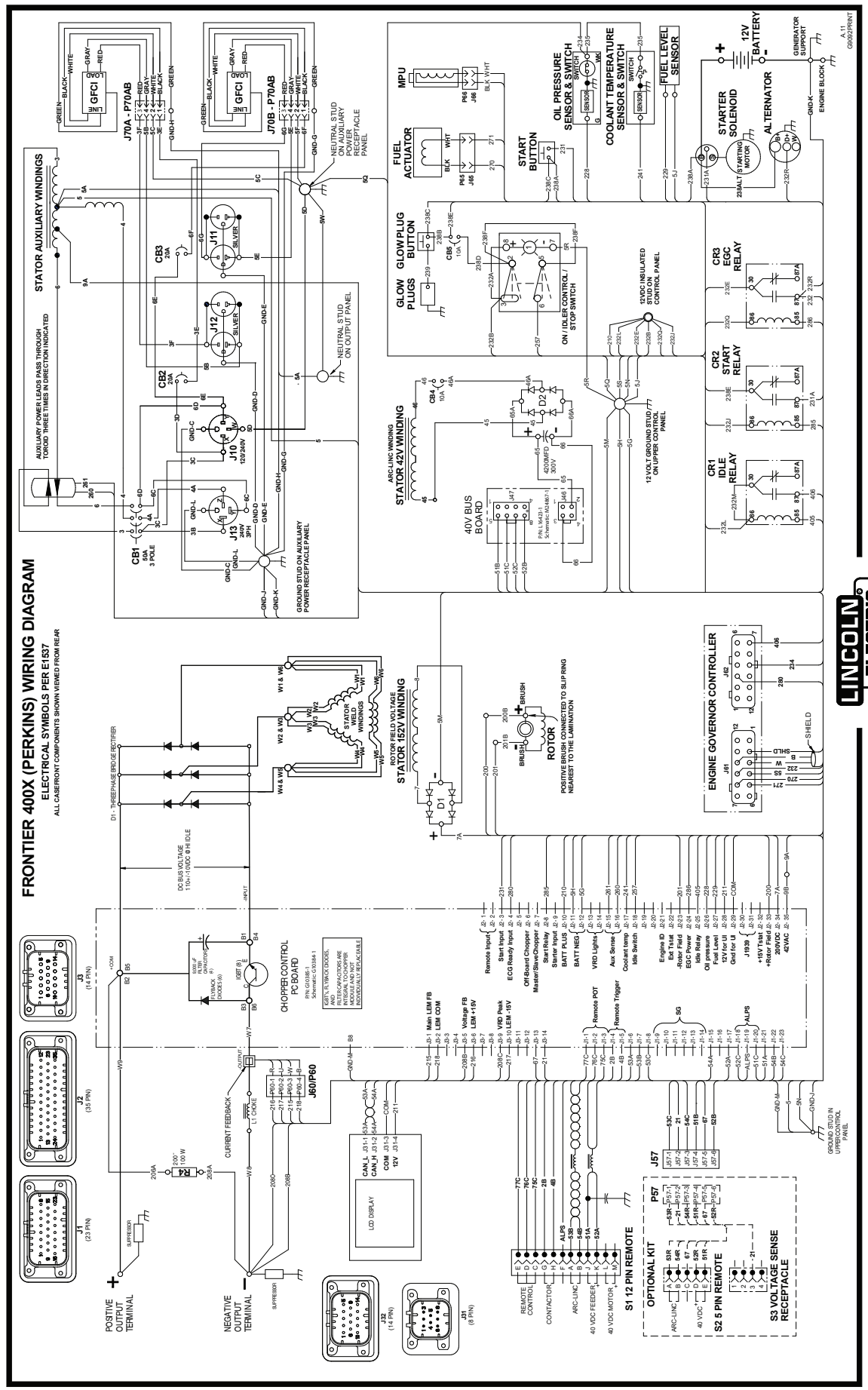
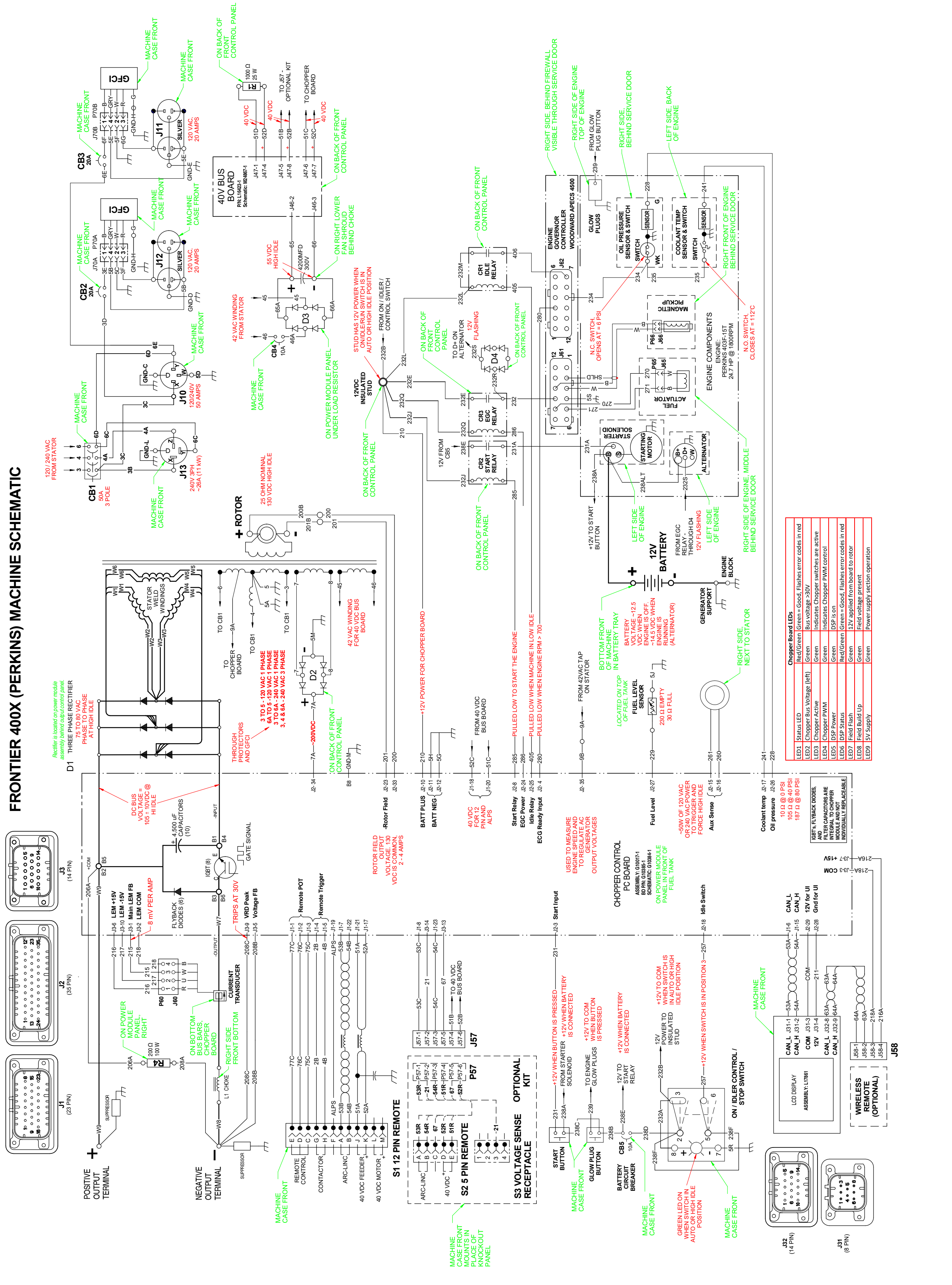


Figure F.2 – On / idler control / stop switch lead locations

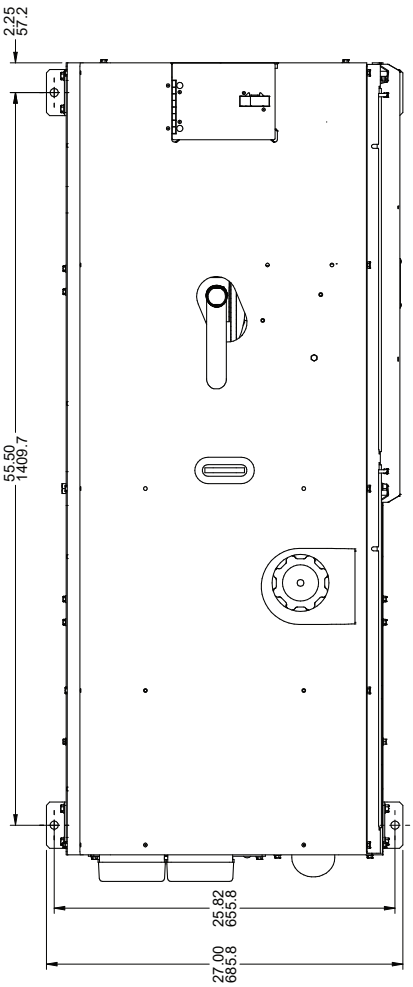


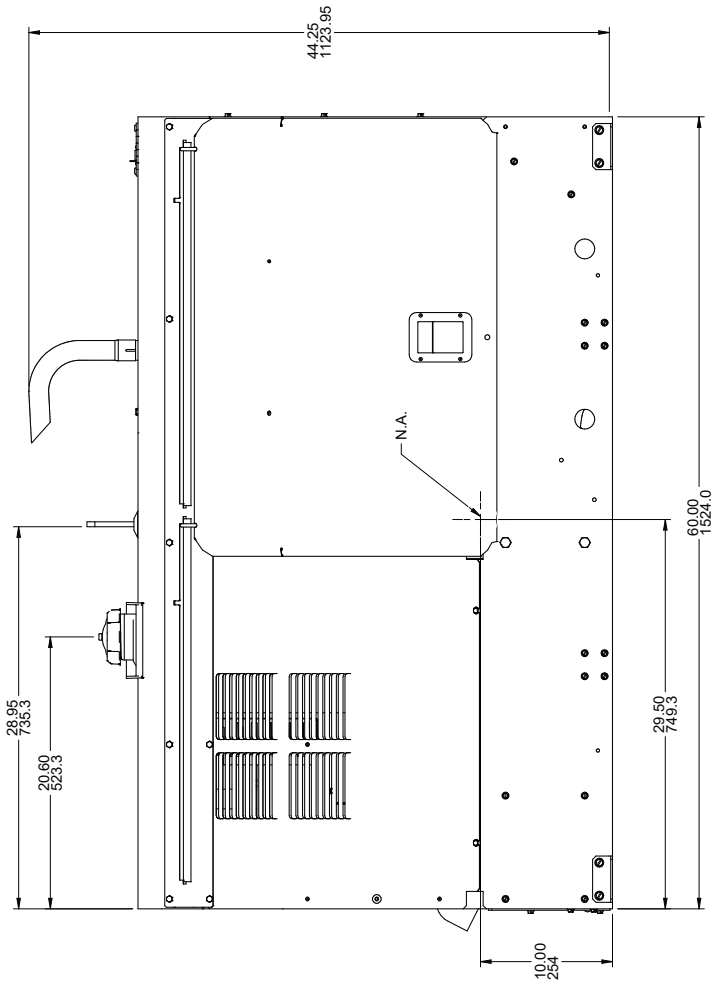


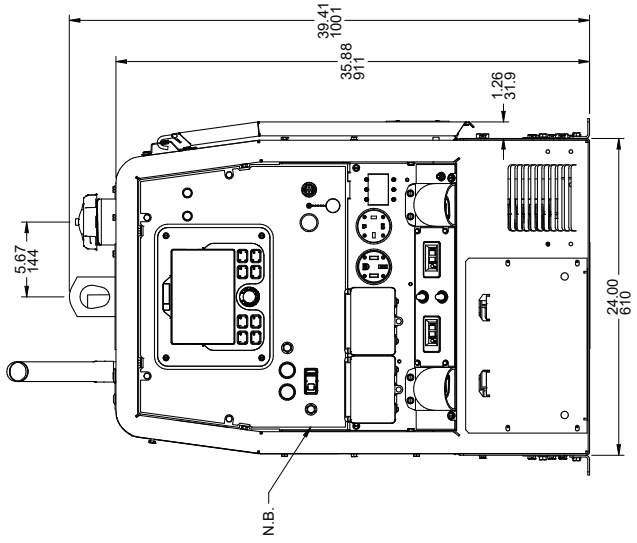
NOTE: This diagram is for reference only. It may not be accurate for all machines covered by this manual. The specific diagram for a particular code is pasted inside the machine on one of the enclosure panels. If the diagram is illegible, write to the Service Department for a replacement. Give the equipment code number.



		Chopper Board LEDs	
LED1	Status LED	Red/Green	Green = Good, Flashes error codes in red
LED2	Chopper Bus Voltage (left)	Green	Bus voltage >30V
LED3	Chopper Active	Green	Indicates Chopper switches are active
LED4	Chopper PWM	Green	Indicates Chopper PWM control
LED5	DSP Power	Green	DSP is on
LED6	DSP Status	Red/Green	Green = Good, Flashes error codes in red
LED7	Field Flash	Green	12V applied from board to rotor
LED8	Field Build Up	Green	Field voltage present
LED9	5V Supply	Green	Power supply section operation







N.A. CENTER OF GRAVITY WITH OIL IN ENGINE, COOLANT IN RADIATOR, AND EMPTY FUEL TANK.
N.B. CASEFRONT GRAPHICS MAY NOT MATCH ALL CODES.

2 Step – When the gun trigger is pulled, the welding system cycles through the arc starting sequence and into the main welding parameters. The welding system will continue to weld as long as the gun trigger is activated. Once the trigger is released, the welding system cycles through the arc ending steps.

3 Phase voltage – Three AC voltage sources that are phase shifted 120° with respect to each other.

4 Step – The 4 step trigger adds to the welder's comfort when making long welds by allowing the trigger to be released after an initial trigger pull. When the gun trigger is pulled, the welding system cycles through the arc starting sequence and into the main welding parameters. Welding stops when the trigger is pulled a second time and then released and the welding system cycles through the arc ending steps.

A-lead – The single wire used to configure the machine reconnect for various input Voltages.

AC (Alternating Current) – Voltage or current that changes polarity or direction, respectively, over time.

Active Condition – The machine is energized either by connection to a power source or has some kind of mechanical motion within the unit.

Alternator – An electric generator that produces alternating current. The main function of this device is to change mechanical energy into electrical energy. The mechanical energy can be supplied by either a motor or engine.

Ampere (Amp) – The standard measurement unit of current flow. Symbol: A

Anode – The positively charged electrode of a device.

Arc Control (Pinch) – Adjusts how quickly the current will rise when the wire is shorted to the work resulting in a soft or crisp arc.

Arc Force – A temporary increase of the output current during SMAW welding when the arc is too short.

Arc Length – The physical gap between the end of the electrode and the weld puddle.

Across the Arc – The device is electrically connected to the welding terminals. This device is powered by the same voltage that is used for welding.

Arc-link cable – Used between the power source and wire feeder in a bench system and between the power source, control box and wire drive in a boom system. This 5 pin cable supplies voltage from the power source to power the feeder and also transmits digital signals between the two.

Armature – The part of an electric device that includes the main current-carrying winding and in which the electromotive force is induced.

Armature Reaction – A force set up by the current induced in the armature of a generator that results in altering as to both magnitude and direction the flux due to the field magnet.

Asynchronous Welder Generator – An alternator that utilizes an air-gap rotating magnetic-field between a stator and a rotor to interact with an induced current in a rotor winding. It is sometimes called an induction generator.

Auxiliary Windings – Stator winding used to power the auxiliary connections.

Battery – A combination of two or more cells electrically connected to work together to produce electric energy.

Block Diagram – visual representation of a machine that utilizes simplified blocks to represent the principal parts or functions of the machine.

Boost Converter – The boost converter increases applied voltage to a higher level. This circuitry only applies to DC voltage and is only active if the applied voltage is below a predetermined value.

Bridge Rectifier – A type of full wave rectifier which uses four or more diodes in a bridge circuit configuration to efficiently convert the Alternating Current (AC) into Direct Current (DC).

Brushes – An electrical contact which conducts current between stationary wires and moving parts, most commonly in a rotating shaft.

Buck Converter – The buck converter decreases applied voltage to a lower level. This circuitry only applies to DC voltage and is only active if the applied voltage is above a predetermined value.

Buck/Boost Converter – The combined buck/boost circuitry is utilized to increase or decrease an applied voltage to a predetermined value.

CAN communication – Controller Area Network (CAN bus) is a robust vehicle bus standard designed to allow microcontrollers and devices to communicate with each other's applications without a host computer. It broadcasts messages to the nodes presented in a network.

Cathode – The negatively charged electrode of a device.

Capacitance – The ability of a body to store an electrical charge.

Capacitor – A device used to store an electric charge, consisting of one or more pairs of conductors separated by an insulator. Capacitance is measured in Farad's (F) and some capacitors are polarity sensitive which is typically noted on the device as such.

Circuit Breaker – A device to prevent excessive current flow in a circuit that may be caused by a short circuit or heavy loads. The circuit breaker will stop the flow of current (open) if such a situation occurs.

Collector – The positively charged electrode of a transistor device.

Commutator – A cylindrical ring or disk assembly of conducting members, individually insulated in a supporting structure with an exposed surface for contact with current-collecting brushes and mounted on the armature shaft, for changing the frequency or direction of the current in the armature windings.

Conductor – A type of material that allows the flow of charge (**electrical** current) in one or more directions

Connectors – Various devices for connecting one object to another.

Constant Current – A process where the power source keeps the current as constant as possible even when the operator varies the arc length. The voltage varies, formerly known as "variable voltage". Mainly used for Stick and TIG welding.

Constant Voltage – A process where the power source keeps the voltage as constant as possible and allows amperage to vary considerably. Mainly used for MIG and Flux core welding using wire feeders.

Contactor – A mechanically or electrically operated switch used in high current applications.

Control cable – A multistrand cable used for transmission of power, command and feedback information.

Crosslinc – A welding system communication technology. When using a Crosslinc enabled power source and wire feeder, welding voltage can be controlled remotely, through the welding cable without the use of an additional control cable.

Current – The flow of electrons through a conductor.

Current Transducer – A device used to detect DC current flow.

Cycle – One complete wave of alternating current or voltage.

DC (Direct Current) – A voltage or current that never crosses zero and maintains current flow in one direction.

Diode – A device used in a circuit that allows current to flow in one direction only. Typically current flow will occur if the diode's anode is more positive than its cathode. Typical configurations used can be: blocking, flashing, free-wheeling, full wave bridge rectifier, half wave rectifier.

Display – An electronic device with a screen used for displaying information.

Duty Cycle – The percentage of a ten (10) minute period that a power source can operate its rated load before exceeding its thermal limit.

Efficiency – The ratio of the output power divided by the input power.

Electrical Interference (noise) – Unwanted noise or other effects from electromagnetic radiation.

Electricity – The flow of electrons through a conductor from the source to a ground.

Electrode Negative – When the electrode is connected to the negative output terminal.

Electrode Positive – When the electrode is connected to the positive output terminal.

Electromagnetism – Magnetism developed by a current of electricity.

Emitter – The negatively charged electrode of a transistor device.

Encoder – An electro-mechanical device that converts the angular position or motion of a shaft or axle to digital output signals.

Excitation – The process of generating a magnetic field by means of an electric current. The source of this can be from a magnet or an external voltage source.

Excitation Windings – Stator winding that powers the excitation process in an alternator or generator.

Farads – The standard measurement unit of capacitance. Symbol: f

Feedback – To provide actual output information to a control circuit so as to maintain a constant output.

Feeder Winding – Stator winding that powers the wire feeders.

Field Windings – The stationary windings of a generator.

Field Current – The current flow through the Field Windings

Light Emitting Diode (LED) – A semiconductor device that emits light when an electric current passes through it.

Flashing – A generic term referring to the initial excitation of an electrical magnetic field.

Forward Biased – When voltage is applied to a semiconductor device in the direction that allows current to flow.

Frequency – The number of occurrences of a repeating event (cycles) per unit of Time.

Full Wave – A rectifier that converts alternating current into continuous current and that utilizes both halves of each cycle of the alternating current.

Fuse – An electrical safety device that operates to provide overcurrent protection of an electrical circuit. Its essential component is a metal wire or strip that melts when too much current flows through it, thereby interrupting current flow.

Gate – Is the control terminal in a semiconductor device. Typically a small voltage is applied to the Gate to trigger or latch the device.

Generator – An electric generator that produces direct current. The main function of this device is to change mechanical energy into electrical energy. The mechanical energy can be supplied by either a motor or engine.

GFCI (Ground Fault Circuit Interrupter) – A device which interrupts current flow when it senses an imbalance between the outgoing and incoming current.

Ground Connection – A safety connection from a welding machine frame to an earth ground.

Half Wave - A rectifier that utilizes one half cycle of alternating current and suppresses the other.

Henry – The standard measurement unit of inductance. Symbol: H

Hertz – The standard measurement unit of electrical frequency. Symbol: Hz

High Frequency – A high frequency used for arc ignition and stabilization when TIG welding.

Hot Start – Increases the output amperage for a designated amount of time at the start of a weld.

Insulated Gate Bipolar Transistor (IGBT) – A high speed solid state switching device that can be turned on by applying a voltage signal to the gate. When the gate signal is removed the IGBT will turn off. An IGBT will operate on DC voltage only.

Inductance – The tendency of an electrical conductor to oppose a change in the electric current flowing through it.

Inductor – A passive component which stores the electrical energy in a magnetic field when the electric current passes through it.

Interpole Coils – Utilized in generators. They counteract the effects of armature reaction.

Inverter – circuitry that changes direct current (DC) to alternating current (AC).

Life Cycle – The length of time a product is introduced to consumers until it's removal from the shelves.

Motor – An electrical device that converts electrical energy into mechanical energy.

Magnetic Field – The area around a magnet or coil in which there is magnetic force.

Magnetic Flux – The measurement of the total magnetic field lines that pass through a given surface area.

Magnetism – The force that arises from the motion of electric charges.

MOLEX – Is the vernacular term for a two-piece pin and socket interconnection that was pioneered by Molex Connector Company.

Negative Temperature Co-efficient (NTC) – A type of thermistor in which the resistance decreases in relation to a rise in temperature.

OCV (Open Circuit Voltage) –The potential voltage in the welding circuit before the arc is initiated or a load applied; measured in volts.

Ohms – The standard measurement unit of electrical resistance. Symbol: Ω

Ohm's Law – current passing through a conductor is proportional to the voltage over the resistance. I = V / R.

Parallel Circuit – a circuit that has multiple current paths.

Peak Value – The maximum value attained by the current during one cycle. There is a positive and negative peak.

Peak to Peak Value – The maximum value attained by both peaks during one cycle.

Phase – A relative variation or change of state or a cycle.

Phaseback (foldback) – A current limiting feature (a type of overload protection).

Pilot Arc – The electrical pathway between the torch nozzle and electrode tip. This function aids in the transfer of current from the electrode tip to the work piece.

Polarity – The polarity of the electrode as compared to the polarity of the work piece.

Positive Temperature Co-efficient (PTC) – A type of thermistor in which the resistance increases in relation to a rise in temperature.

Potentiometer – It is a variable resistor with three terminals. The middle terminal is adjustable. The potential at the third terminal can be adjusted to give any fraction of the potential voltage across the two outer terminals.

Power – The rate, over time, in which electrical energy is transferred within an electrical circuit.

Power Factor – The ratio of the real power that is used to do work to the apparent power that is supplied to the circuit.

Printed Circuit Boards – A physical device that houses one or more electrical circuits.

Pulsating DC – A periodic current which changes in value but never changes direction.

Rated Load – The average amperage and voltage the power source is designed to produce for a given specific duty cycle time period. For example, 400 amps, 36 load volts, at 60 percent duty cycle.

RCBO (Residual Current Breaker with Over-current) – A combination of a RCD and Circuit Breaker.

RCD (Residual Current Device) – Detects imbalance in the currents of the supply and return conductors of a circuit. Does not protect against shorts.

Reactor – An electrical magnetic component used to maintain current at constant levels by resisting any changes in the current.

Reconnect Panel – Used to configure the machine's internal components for various input power voltages

Rectification – The process of converting alternating current to direct current.

Relay – An electrically operated switch used in low current applications.

Resistance – The opposition to the passage of an electric current through a conductor. Measured in Ohms (Ω) and is not polarity sensitive.

Resistor – Used to regulate voltage and current levels in a circuit.

Reverse Biased – When voltage is applied to a semiconductor device in the direction that does not allows current to flow.

Rheostat – A two terminal adjustable resistor that may have its resistance value changed without opening the circuit in which it is connected, thereby controlling the current through the circuit.

Ripple – The residual periodic variation of the DC voltage within a power supply which has been derived from an alternating current source.

RMS (Root Means Squared) – The same amount of heat dissipation across a resistor as Direct Current.

Rotor – A rotating component of an electromagnetic system in an electric motor, or alternator.

RPM (Revolutions per minute) – A unit of rotational speed or the frequency of rotation around a fixed axis.

Saturation – The state reached when an increase in applied external magnetic field cannot increase the magnetization of the material further.

Saw Tooth Wave Form – A non-sinusoidal waveform. It is so named based on its resemblance to the teeth of a plain-toothed saw.

Schematic Diagram – A representation of the electronic components of a machine utilizing graphic symbols rather than realistic pictures.

Schematic Symbols – A standardized pictogram used to represent various electrical and electronic devices or function.

Series Circuit – a circuit that has only one current path.

Series - Parallel Circuit – a circuit that has both a single current path and multiple current paths.

Silicon Controlled Rectifier (SCR) – Very similar to a Diode in which it allows current to flow when the anode is more positive than the cathode. However, current flow will occur only if a small signal is applied to its Gate and will stop flowing when the voltage drops to zero or goes negative.

Shunt – A type of low value resistance used to detect circuit current.

Sinusoidal Wave Form – A curve that describes a smooth repetitive oscillation of a waveform.

Slip Rings – An electromechanical device that allows the transmission of electrical power from a stationary to a rotating structure. Normally a copper or brass circular device attached to a rotating member.

Solenoid – An electromechanical device that when energized acts like a magnet so that a movable core is drawn into the coil when a current flows and that is used especially as a switch or control for a mechanical device (such as a valve).

Source – Provides the electrical potential that is required for electricity to flow.

Spark Gap Generator – Used to initiate and maintain the arc in a TIG machine.

Square Wave Form – A type of waveform where the signal has only two levels. The signal transitions between these levels at regular intervals and the switching time is very rapid.

Standard Units of Measurement – Is a quantifiable language that helps everyone understand the association of the object with the measurement.

Static Condition – The machine is not connection to a power source and has no mechanical motion.

Stator – The stationary part of a rotary system, found in electric alternators, generators and electric motors.

Switch – A mechanical device used to interrupt the flow of current in a circuit. Switches are essentially binary devices: they are either completely on (closed) or completely off (open).

Tachometer – A device or circuit used to measure the rotations of a mechanical device.

Thermistor – A type of resistor in which resistance changes due to temperature, two main types: Positive Temperature Co-efficient (PTC), Negative Temperature Co-efficient (NTC).

Thermostat – A mechanical device that interrupts or closes a circuit when a pre-determined temperature limit is reached.

Toroid – A device used to filter unwanted electrical noise.

Trigger Interlock – The gun trigger will stay closed (activated) as long as welding current is flowing and will open (deactivate) when welding current stops.

Transformer – A device with a group of mutually-inductive coils used to magnetically induce AC power from one coil to the other. Typical examples are as follows:

> ***Isolation Transformer*** – A transformer usually used for circuit protection.
>
> ***Step Down Transformer*** – A transformer where the secondary voltage is lower than the primary voltage.
>
> ***Step Up Transformer*** – A transformer where the secondary voltage is higher than the primary voltage.
>
> ***Current Transformer*** – A type of transformer used as a current monitoring device.
>
> ***Power Transformer*** – A transformer that contains multiple primary windings to accommodate a variety of input voltages.

Twisted Pair – A cable consisting of two wires of a single circuit twisted around each other for the purposes of improving electromagnetic compatibility.

Voltage – The pressure or difference in electrical potential between two points in a circuit that causes current to flow.

Volts – The standard unit of measurement for Voltage. Symbol: V

User Interface – A device where interactions between operators and machines occur.

Watts – The standard measurement unit of electrical power. Symbol: W

Watts Law – power of an electrical circuit is the product of its voltage and current. P = I x V.

Weld Winding – Stator winding that provides the power for the welding components.

Welding Electrode – A consumable component of the welding circuit through which current is conducted between the electrode holder and the arc that becomes part of the weldment.

Welding Gun – In semi-automatic or automatic welding, a device to transfer current and guide the electrode wire into the arc puddle.

Wire Harness – A system of insulated conducting wires bound together with insulating materials.

Wiring Diagram – a simple visual representation of the physical connections and physical layout of the electrical system of the machine.

WFS (Wire Feed Speed) – The speed at which the consumable wire is fed into the weld joint puddle.

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WARNING	● Do not touch electrically live parts or electrode with skin or wet clothing. ● Insulate yourself from work and ground.	● Keep flammable materials away.	● Wear eye, ear and body protection.
Spanish **AVISO DE PRECAuCION**	● No toque las partes o los electrodos bajo carga con la piel o ropa mojada. ● Aislese del trabajo y de la tierra.	● Mantenga el material combustible fuera del área de trabajo.	● Protéjase los ojos, los oídos y el cuerpo.
French **ATTENTION**	● Ne laissez ni la peau ni des vêtements mouillés entrer en contact avec des pièces sous tension. ● Isolez-vous du travail et de la terre.	● Gardez à l'écart de tout matériel inflammable.	● Protégez vos yeux, vos oreilles et votre corps.
German **WARNuNG**	● Berühren Sie keine stromführenden Teile oder Elektroden mit Ihrem Körper oder feuchter Kleidung! ● Isolieren Sie sich von den Elektroden und dem Erdboden!	● Entfernen Sie brennbarres Material!	● Tragen Sie Augen-, Ohren- und Körperschutz!
Portuguese **ATENÇÃO**	● Não toque partes elétricas e electrodos com a pele ou roupa molhada. ● Isole-se da peça e terra.	● Mantenha inflamáveis bem guardados.	● Use proteção para a vista, ouvido e corpo.
Japanese **注意事項**	● 通電中の電気部品、又は溶材にヒフやぬれた布で触れないこと。 ● 施工物やアースから身体が絶縁されている様にして下さい。	● 燃えやすいものの側での溶接作業は絶対にしてはなりません。	● 目、耳及び身体に保護具をして下さい。
Chinese **警 告**	● 皮肤或濕衣物切勿接觸帶電部件及銲條。 ● 使你自己與地面和工件絕緣。	● 把一切易燃物品移離工作場所。	● 佩戴眼、耳及身體勞動保護用具。
Korean **위 험**	● 전도체나 용접봉을 젖은 헝겁 또는 피부로 절대 접촉치 마십시요. ● 모재와 접지를 접촉치 마십시요.	● 인화성 물질을 접근 시키지 마시요.	● 눈, 귀와 몸에 보호장구를 착용하십시요.
Arabic **تحذير**	● لا تلمس الاجزاء التي يسري فيها التيار الكهربائي أو الالكترود بجلد الجسم أو بالملابس المبللة بالماء. ● ضع عازلا على جسمك خلال العمل.	● ضع المواد القابلة للاشتعال في مكان بعيد.	● ضع أدوات وملابس واقية على عينيك وأذنيك وجسمك.

READ AND UNDERSTAND THE MANUFACTURER'S INSTRUCTION FOR THIS EQUIPMENT AND THE CONSUMABLES TO BE USED AND FOLLOW YOUR EMPLOYER'S SAFETY PRACTICES.

SE RECOMIENDA LEER Y ENTENDER LAS INSTRUCCIONES DEL FABRICANTE PARA EL USO DE ESTE EQUIPO Y LOS CONSUMIBLES QUE VA A UTILIZAR, SIGA LAS MEDIDAS DE SEGURIDAD DE SU SUPERVISOR.

LISEZ ET COMPRENEZ LES INSTRUCTIONS DU FABRICANT EN CE QUI REGARDE CET EQUIPMENT ET LES PRODUITS A ETRE EMPLOYES ET SUIVEZ LES PROCEDURES DE SECURITE DE VOTRE EMPLOYEUR.

LESEN SIE UND BEFOLGEN SIE DIE BETRIEBSANLEITUNG DER ANLAGE UND DEN ELEKTRODENEINSATZ DES HERSTELLERS. DIE UNFALLVERHÜTUNGSVORSCHRIFTEN DES ARBEITGEBERS SIND EBENFALLS ZU BEACHTEN.

			
● Keep your head out of fumes. ● Use ventilation or exhaust to remove fumes from breathing zone.	● Turn power off before servicing.	● Do not operate with panel open or guards off.	**WARNING**
● Los humos fuera de la zona de respiración. ● Mantenga la cabeza fuera de los humos. Utilice ventilación o aspiración para gases.	● Desconectar el cable de alimentación de poder de la máquina antes de iniciar cualquier servicio.	● No operar con panel abierto o guardas quitadas.	Spanish **AVISO DE PRECAuCION**
● Gardez la tête à l'écart des fumées. ● Utilisez un ventilateur ou un aspirateur pour ôter les fumées des zones de travail.	● Débranchez le courant avant l'entretien.	● N'opérez pas avec les panneaux ouverts ou avec les dispositifs de protection enlevés.	French **ATTENTION**
● Vermeiden Sie das Einatmen von Schweibrauch! ● Sorgen Sie für gute Be- und Entlüftung des Arbeitsplatzes!	● Strom vor Wartungsarbeiten abschalten! (Netzstrom völlig öffnen; Maschine anhalten!)	● Anlage nie ohne Schutzgehäuse oder Innenschutzverkleidung in Betrieb setzen!	German **WARNuNG**
● Mantenha seu rosto da fumaça. ● Use ventilação e exhaustão para remover fumo da zona respiratória.	● Não opere com as tampas removidas. ● Desligue a corrente antes de fazer serviço. ● Não toque as partes elétricas nuas.	● Mantenha-se afastado das partes moventes. ● Não opere com os paineis abertos ou guardas removidas.	Portuguese **ATENÇÃO**
● ヒュームから頭を離すようにして下さい。 ● 換気や排煙に十分留意して下さい。	● メンテナンス・サービスに取りかかる際には、まず電源スイッチを必ず切って下さい。	● パネルやカバーを取り外したままで機械操作をしないで下さい。	Japanese **注意事項**
●頭部遠離煙霧。 ●在呼吸區使用通風或排風器除煙。	●維修前切斷電源。	●儀表板打開或沒有安全罩時不準作業。	Chinese **警 告**
● 얼굴로부터 용접가스를 멀리하십시요. ● 호흡지역으로부터 용접가스를 제거하기 위해 가스제거기나 통풍기를 사용하십시요.	● 보수전에 전원을 차단하십시요.	● 판넬이 열린 상태로 작동치 마십시요.	Korean **위 험**
● ابعد رأسك بعيداً عن الدخان. ● استعمل التهوية أو جهاز ضغط الدخان للخارج لكي تبعد الدخان عن المنطقة التي تتنفس فيها.	● اقطع التيار الكهربائي قبل القيام بأية صيانة.	● لا تشغل هذا الجهاز اذا كانت الاغطية الحديدية الواقية ليست عليه.	Arabic **تحذير**

LEIA E COMPREENDA AS INSTRUÇÕES DO FABRICANTE PARA ESTE EQUIPAMENTO E AS PARTES DE USO, E SIGA AS PRÁTICAS DE SEGURANÇA DO EMPREGADOR.

使う機械や溶材のメーカーの指示書をよく読み、まず理解して下さい。そして貴社の安全規定に従って下さい。

請詳細閱讀並理解製造廠提供的説明以及應該使用的銀焊材料，並請遵守貴方的有関勞動保護規定。

이 제품에 동봉된 작업지침서를 숙지하시고 귀사의 작업자 안전수칙을 준수하시기 바랍니다.

اقرأ بتمعن وافهم تعليمات المصنع المنتج لهذه المعدات والمواد قبل استعمالها واتبع تعليمات الوقاية لصاحب العمل.

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