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INVERTEC® 150S

For use with machines having code numbers: 52067 - 52096

SERVICE MANUAL

LINCOLN ELECTRIC EUROPE
www.lincolnelectric.eu

INDEX OF CONTENTS

TECHNICAL SPECIFICATIONS

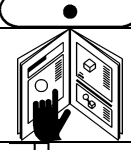
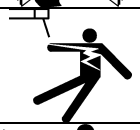
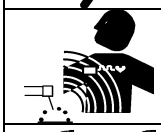
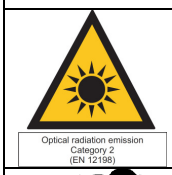
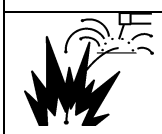
<table>
<tr><th colspan="4">INPUT</th></tr>
<tr><td>Input Voltage
230V ± 15%
Single Phase</td><td>Input Power at Rated Output
150S
2.5kW @ 100% Duty Cycle
4.2kW @ 30% Duty Cycle</td><td>EMC Class
A</td><td>Frequency
50/60Hz</td></tr>
<tr><th colspan="4">RATED OUTPUT AT 40℃</th></tr>
<tr><td>Duty Cycle
(Based on a 10 min. period)
100%
30%</td><td colspan="2">Output Current
90A
140A</td><td>Output Voltage
23.6Vdc
25.6Vdc</td></tr>
<tr><th colspan="4">OUTPUT RANGE</th></tr>
<tr><td colspan="2">Welding Current Range
10 – 140A</td><td colspan="2">Maximum Open Circuit Voltage
45Vdc (CE model)
32Vdc (AUSTRALIA model)</td></tr>
<tr><th colspan="4">RECOMMENDED INPUT CABLE AND FUSE SIZES</th></tr>
<tr><td>Fuse (delayed) or
Circuit Breaker (“D” characteristic) Size
16A</td><td>Input Power Cable
3 x 2.5mm^2</td><td colspan="2">Type of Plug
(Included with Machine)
SCHUKO 16A / 250V or
AUSTRALIAN 15A / 250V</td></tr>
<tr><th colspan="4">PHYSICAL DIMENSIONS</th></tr>
<tr><td>Height
244mm</td><td>Width
148mm</td><td>Length
365mm</td><td>Weight
6.7kg</td></tr>
<tr><td colspan="2">Operating Temperature
-10℃ to +40℃</td><td colspan="2">Storage Temperature
-25℃ to +55℃</td></tr>
</table>

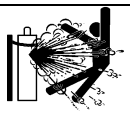
SAFETY

01/11

WARNING

This equipment must be used by qualified personnel. Be sure that all installation, operation, maintenance and repair procedures are performed only by qualified person. Read and understand this manual before operating this equipment. Failure to follow the instructions in this manual could cause serious personal injury, loss of life, or damage to this equipment. Read and understand the following explanations of the warning symbols. Lincoln Electric is not responsible for damages caused by improper installation, improper care or abnormal operation.

	WARNING: This symbol indicates that instructions must be followed to avoid serious personal injury, loss of life, or damage to this equipment. Protect yourself and others from possible serious injury or death.
	READ AND UNDERSTAND INSTRUCTIONS: Read and understand this manual before operating this equipment. Arc welding can be hazardous. Failure to follow the instructions in this manual could cause serious personal injury, loss of life, or damage to this equipment.
	ELECTRIC SHOCK CAN KILL: Welding equipment generates high voltages. Do not touch the electrode, work clamp, or connected work pieces when this equipment is on. Insulate yourself from the electrode, work clamp, and connected work pieces.
	ELECTRICALLY POWERED EQUIPMENT: Turn off input power using the disconnect switch at the fuse box before working on this equipment. Ground this equipment in accordance with local electrical regulations.
	ELECTRICALLY POWERED EQUIPMENT: Regularly inspect the input, electrode, and work clamp cables. If any insulation damage exists replace the cable immediately. Do not place the electrode holder directly on the welding table or any other surface in contact with the work clamp to avoid the risk of accidental arc ignition.
	ELECTRIC AND MAGNETIC FIELDS MAY BE DANGEROUS: Electric current flowing through any conductor creates electric and magnetic fields (EMF). EMF fields may interfere with some pacemakers, and welders having a pacemaker shall consult their physician before operating this equipment.
	CE COMPLIANCE: This equipment complies with the European Community Directives.
	ARTIFICIAL OPTICAL RADIATION: According with the requirements in 2006/25/EC Directive and EN 12198 Standard, the equipment is a category 2. It makes mandatory the adoption of Personal Protective Equipments (PPE) having filter with a protection degree up to a maximum of 15, as required by EN169 Standard.
	FUMES AND GASES CAN BE DANGEROUS: Welding may produce fumes and gases hazardous to health. Avoid breathing these fumes and gases. To avoid these dangers the operator must use enough ventilation or exhaust to keep fumes and gases away from the breathing zone.
	ARC RAYS CAN BURN: 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. Use suitable clothing made from durable flame-resistant material to protect you skin and that of your helpers. Protect other nearby personnel with suitable, non-flammable screening and warn them not to watch the arc nor expose themselves to the arc.
	WELDING SPARKS CAN CAUSE FIRE OR EXPLOSION: Remove fire hazards from the welding area and have a fire extinguisher readily available. Welding sparks and hot materials from the welding process can easily go through small cracks and openings to adjacent areas. Do not weld on any tanks, drums, containers, or material until the proper steps have been taken to insure that no flammable or toxic vapors will be present. Never operate this equipment when flammable gases, vapors or liquid combustibles are present.
	WELDED MATERIALS CAN BURN: Welding generates a large amount of heat. Hot surfaces and materials in work area can cause serious burns. Use gloves and pliers when touching or moving materials in the work area.

	SAFETY MARK: This equipment is suitable for supplying power for welding operations carried out in an environment with increased hazard of electric shock.
	CYLINDER MAY EXPLODE IF DAMAGED: 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. Always keep cylinders in an upright position securely chained to a fixed support. Do not move or transport gas cylinders with the protection cap removed. Do not allow the electrode, electrode holder, work clamp or any other electrically live part to touch a gas cylinder. Gas cylinders must be located away from areas where they may be subjected to physical damage or the welding process including sparks and heat sources.

INSTALLATION AND OPERATOR INSTRUCTIONS

Read this entire section before installation or operation of the machine.

Location and Environment

This machine can operate in harsh environments. However, it is important that simple preventative measures are followed to assure long life and reliable operation:

- Do not place or operate this machine on a surface with an incline greater than 15° from horizontal.
- Do not use this machine for pipe thawing.
- This machine must be located where there is free circulation of clean air without restrictions for air movement to and from the air vents. Do not cover the machine with paper, cloth or rags when switched on.
- Dirt and dust that can be drawn into the machine should be kept to a minimum.
- This machine has a protection rating of:
  - 150S: IP23

  Keep it dry when possible and do not place it on wet ground or in puddles.
- Locate the machine away from radio controlled machinery. Normal operation may adversely affect the operation of nearby radio controlled machinery, which may result in injury or equipment damage. Read the section on electromagnetic compatibility in this manual.
- Do not operate in areas with an ambient temperature greater than 40°C.

Input Supply Connection

Check the input voltage, phase, and frequency supplied to this machine before turning it on. The allowable input voltage is indicated in the technical specification section of this manual and on the rating plate of the machine. Be sure that the machine is grounded.

Make sure the power available at the input connection is adequate for normal operation of the machine. The fuse rating and cable sizes are both indicated in the technical specification section of this manual.

Input Supply From Engine Driven Generators

- 150S:

  The machines are designed to operate on engine driven generators as long as the auxiliary can supply adequate voltage, frequency and power as indicated in the "Technical Specification" section of this manual. The auxiliary supply of the generator must also meet the following conditions:
  - Vac peak voltage: below 410V.
  - Vac frequency: in the range of 50 and 60Hz.
  - RMS voltage of the AC waveform: 230Vac ± 15%.

  It is important to check these conditions because many engine driven generators produce high voltage spikes. Operation of this machine with engine driven generators not conforming to these conditions is not recommended and may damage the machine.

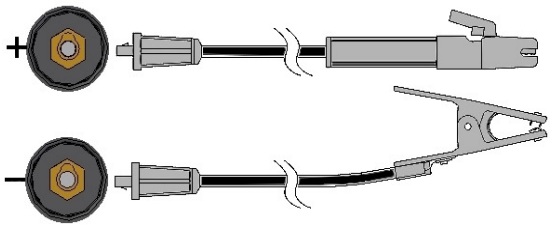
Output Connections

A quick disconnect system using Twist-Mate™ cable plugs is used for the welding cable connections. Refer to the following sections for more information on connecting the machine for operation of stick welding (MMA) or TIG welding.

- (+) Positive Quick Disconnect: Positive output connector for the welding circuit.
- (-) Negative Quick Disconnect: Negative output connector for the welding circuit.

Stick Welding (MMA)

First determine the proper electrode polarity for the electrode to be used. Consult the electrode data for this information. Then connect the output cables to the output terminals of the machine for the selected polarity. Shown here is the connection method for DC(+) welding.

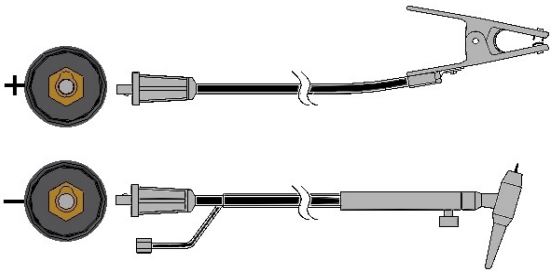


Connect the electrode cable to the (+) terminal and the work clamp to the (-) terminal. Insert the connector with the key lining up with the keyway and rotate approximately ¼ turn clockwise. Do not over tighten.

For DC(-) welding, switch the cable connections at the machine so that the electrode cable is connected to (-) and the work clamp is connected to (+).

TIG Welding

This machine does not include a TIG torch necessary for TIG welding, but one may be purchased separately. Refer to the accessories section for more information. Most TIG welding is done with DC(-) polarity shown here. If DC(+) polarity is necessary switch the cable connections at the machine.



Connect the torch cable to the (-) terminal of the machine and the work clamp to the (+) terminal. Insert the connector with the key lining up with the keyway and rotate approximately ¼ turn clockwise. Do not over tighten. Finally, connect the gas hose to the gas regulator on the cylinder of gas to be used.

Allowable TIG processes:

- 150S: Lift TIG

Arc Force

Auto Adaptive Arc Force (with MMA welding):

During MMA welding is activated the function Auto Adaptive Arc Force that increases temporary the output current, used to clear intermittent connections between the electrode and the weld puddle that occur during stick welding.

This is an active control feature that guarantees the best arrangement between the arc stability and spatter presence. The feature "Auto Adaptive Arc Force" has instead of a fixed or manual regulation, an automatic and multilevel setting: its intensity depends by the output voltage and it is calculated in real time by the microprocessor where are also mapped the Arc Force levels. The control measure in each instant the output voltage and it determines the amount of the peak of current to apply; that value is enough to breaks the metal drop that is being transferred from the electrode to the workpiece as to guarantee the arc stability, but not too high to avoid spatters around the welding puddle. That means:

- Electrode / workpiece sticking prevention, also with low current values.
- Spatters reduction.

The welding operations are simplified and the welded joins looks better, also if not brushed after the welding.

With the MMA welding are also enabled the following features:

- Hot Start: This is a temporary increase in the initial welding current. This helps ignite the arc quickly and reliably.
- Anti-Sticking: This is a function that decreases the output current of the machine to a low level when the operator makes an error and sticks the electrode to the work piece. This decrease in current allows the operator to remove the electrode from the electrode holder without creating large sparks that can damage the electrode holder.

Refer to the section below for more details.

Controls and Operational Features

Machine Start-Up:

When the machine is turned ON, an auto-test is executed; during this test only the Thermal LED is ON; after few seconds the Thermal LED turns OFF and the Power ON/OFF LED lights up.

- 150S: The Machine is ready to operate when on the Front Control Panel lights up the Power ON LED with one of the three LED of the Welding mode command.

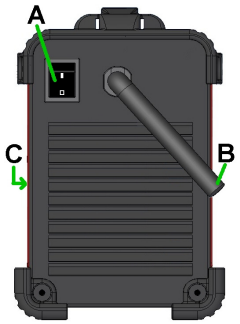
Front Panel Controls

	Output Current Knob: Potentiometer used to set the output current used during welding.
	Power ON/OFF LED: This LED lights up when the machine is ON. 150S: If blinking, this LED indicates that an Input Voltage Overrange protection is active; the Machine restarts automatically when the Input Voltage returns in the correct range.
	Thermal LED: This indicator will turn on when the machine is overheated and the output has been disabled. This normally occurs when the duty cycle of the machine has been exceeded. Leave the machine on to allow the internal components to cool. When the indicator turns off, normal operation is again possible.
150S 	VRD LED's (enabled on Australian Machines only): This machine is provided by VRD (Voltage Reduction Device) function: this reduces the voltage at the output leads. **The VRD function is enabled by factory default only on machines that meet the AS 1674.2 Australian Standards.** (C-Tick logo "✓" on/near the Rating Plate applied on the machine). **The VRD LED is ON** when the Output Voltage is below 32V with the Machine at idle (no welding time). For others machines this function is disabled (the LED is always OFF).

150S 	<u>Welding Mode Switch:</u> With three positions, controls the welding mode of the machine: two for Stick welding (Soft and Crisp) and one for Lift TIG welding. • Soft Stick: For a welding with a low spatter presence. • Crisp Stick: For an aggressive welding, with an increased Arc stability. • Lift TIG: When the mode switch is in the Lift TIG position, the stick welding functions are disabled and the machine is ready for Lift TIG welding. Lift TIG is a method of starting a TIG weld by first pressing the TIG torch electrode on the work piece in order to create a low current short circuit. Then, the electrode is lifted from the work piece to start the TIG arc.

A. <u>Power Switch:</u> It turns ON / OFF the input power to the machine.

B. <u>Input cable:</u> This machine is provided with a plugged input cord. Connect it to the mains.



C. <u>Fan:</u>
- 150S: This machine has a F.A.N. (Fan As Needed) circuitry inside. The machine automatically reduces the speed of the fan or turns it OFF. This feature reduces the amount of dirt which can be drawn inside the machine and reduces power consumption. When the machine is turned ON the fan will turn ON. The fan will continue to run whenever the machine is welding. The F.A.N. feature is active after that the machine doesn't weld for more than 10 minutes, the fan speed will return to the maximum speed if a welding operation restarts.

Electromagnetic Compatibility (EMC)

01/11

This machine has been designed in accordance with all relevant directives and standards. However, it may still generate electromagnetic disturbances that can affect other systems like telecommunications (telephone, radio, and television) or other safety systems. These disturbances can cause safety problems in the affected systems. Read and understand this section to eliminate or reduce the amount of electromagnetic disturbance generated by this machine.

This machine has been designed to operate in an industrial area. The operator must install and operate this equipment as described in this manual. If any electromagnetic disturbances are detected the operator must put in place corrective actions to eliminate these disturbances with, if necessary, assistance from Lincoln Electric. The Class A equipment is not intended for use in residential locations where the electrical power is provided by the public low-voltage supply system. There may be potential difficulties in ensuring electromagnetic compatibility in those locations, due to conducted as well as radiated disturbances. This equipment does not comply with IEC 61000-3-12. If it is connected to a public low-voltage system, it is responsibility of the installer or user of the equipment to ensure, by consultation with the distribution network operator if necessary, that the equipment may be connected.

Before installing the machine, the operator must check the work area for any devices that may malfunction because of electromagnetic disturbances. Consider the following.

- Input and output cables, control cables, and telephone cables that are in or adjacent to the work area and the machine.
- Radio and/or television transmitters and receivers. Computers or computer controlled equipment.
- Safety and control equipment for industrial processes. Equipment for calibration and measurement.
- Personal medical devices like pacemakers and hearing aids.
- Check the electromagnetic immunity for equipment operating in or near the work area. The operator must be sure that all equipment in the area is compatible. This may require additional protection measures.
- The dimensions of the work area to consider will depend on the construction of the area and other activities that are taking place.

Consider the following guidelines to reduce electromagnetic emissions from the machine.

- Connect the machine to the input supply according to this manual. If disturbances occur if may be necessary to take additional precautions such as filtering the input supply.
- The output cables should be kept as short as possible and should be positioned together. If possible connect the work piece to ground in order to reduce the electromagnetic emissions. The operator must check that connecting the work piece to ground does not cause problems or unsafe operating conditions for personnel and equipment.
- Shielding of cables in the work area can reduce electromagnetic emissions. This may be necessary for special applications.

MAINTENANCE

WARNING

ELECTRIC SHOCK can kill

- Have an electrician install and service this equipment.
- Turn the input power off at the fuse box before working on equipment.
- Do not touch electrically hot parts.
- Prior to performing preventive maintenance, perform the following capacitor discharge procedure to avoid electric shock

INPUT FILTER CAPACITORS DISCHARGE PROCEDURE

This procedure will drain off any charge stored in the four capacitors that are part of the Inverter Board assembly. This procedure MUST be performed, as a safety precaution, before conducting any test or repair procedure that requires you to touch internal components of the machine.

1. Remove input power to Invertec 150S machine
2. Remove the cover following the instruction available in this Service manual.
3. As there is no access to the terminals **DC+** and **DC-** with the main board installed on the machine frame, it is necessary to wait minimum 10 seconds after disconnecting the machine from the input line, before starting any disassembly operation. During these 10 seconds the flyback power supply circuit, part of the inverter board, will reduce the voltage across the filter capacitors to a safe level (below 50Vdc).
4. Obtain a high resistance and high wattage resistor (25-1000 ohms and 25 watts minimum). This resistor is NOT supplied with the machine. NEVER USE A SHORTING STRAP FOR THIS PROCEDURE.
5. Locate the resistor **R92** that is directly connected to the terminals **DC+** and **DC –** on the main board, **See Figure 1** and check the voltage across it, it should be zero; if not follow the next step.
6. Use electrically insulate gloves and insulated pliers. **See Figure 1a**. Hold the body of the resistor and connect the resistor leads across the resistor R92. Hold the resistor in place for 10 seconds. DO NOT TOUCH CAPACITOR TERMINALS WITH YOUR BARE HANDS.
7. Check the voltage across the resistor R92. Voltage should be zero. If any voltage remains, repeat this procedure.

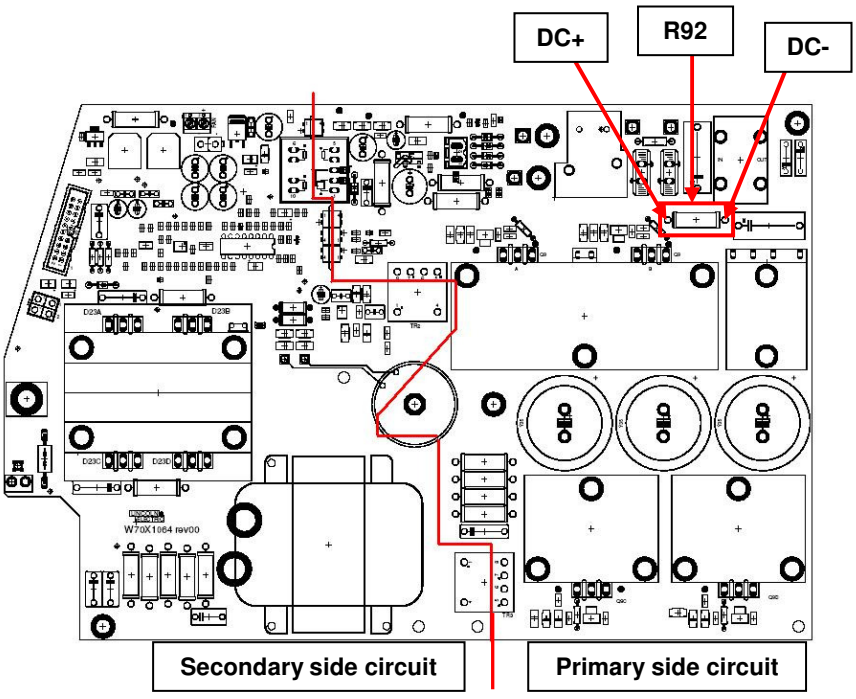


Figure 1 - Capacitors discharge location

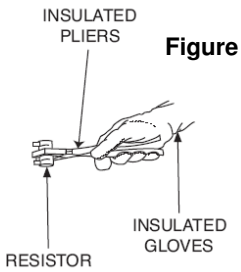


Figure 1a

ROUTINE MAINTENANCE

1. Keep the welding area around the machine clean and free of combustible materials. No debris should be allowed to collect which could obstruct air flow to the machine
2. Every 6 months the machine should be cleaned with a low pressure and dry airstream. Keeping the machine clean will result in cooler operation and higher reliability.
3. Examine the sheet metal case for dents or breakage. Repair the case as required. Keep the case in good condition to insure that high voltage parts are protected and correct spacing are maintained. All external sheet metal screw must be in place to ensure case strength and electrical ground continuity.

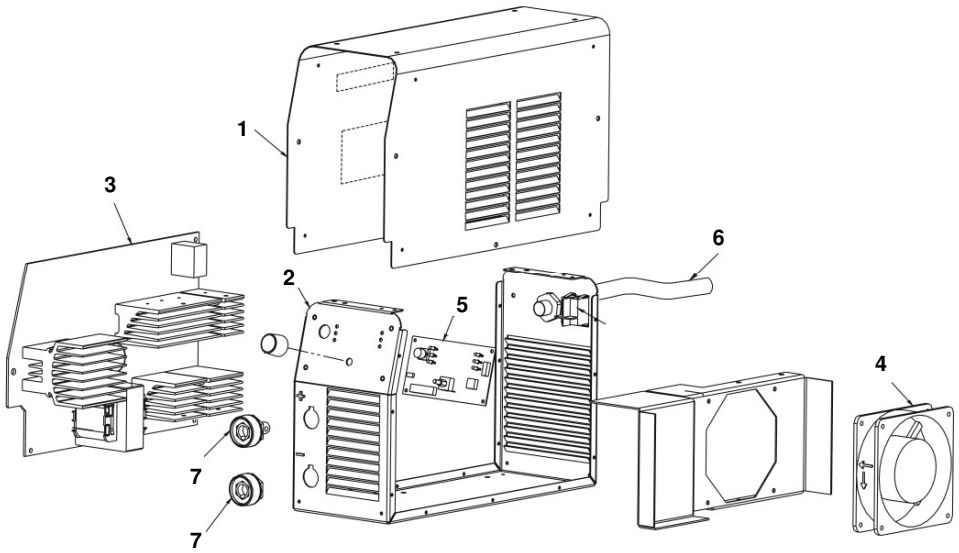
THERMAL PROTECTION

Thermal detection device protect the machine from excessive operating temperatures. Excessive temperatures may be caused by a lack of cooling air or operating the machine beyond the duty cycle and output rating. If excessive operating temperatures should occur, the yellow LED will light and the detection device will prevent output voltage or current.

These detection device are self-resetting once the machine cools sufficiently. If the thermostat shutdown was caused by excessive output or duty cycle and the fan is operating normally, the power switch may be left on and the reset should occur within a 15 minute period. If the fan is not turning or the air intake louvers were obstructed , then the power must be switched off and the fan problem or air obstruction must be corrected.

MAJOR COMPONENTS LOCATION

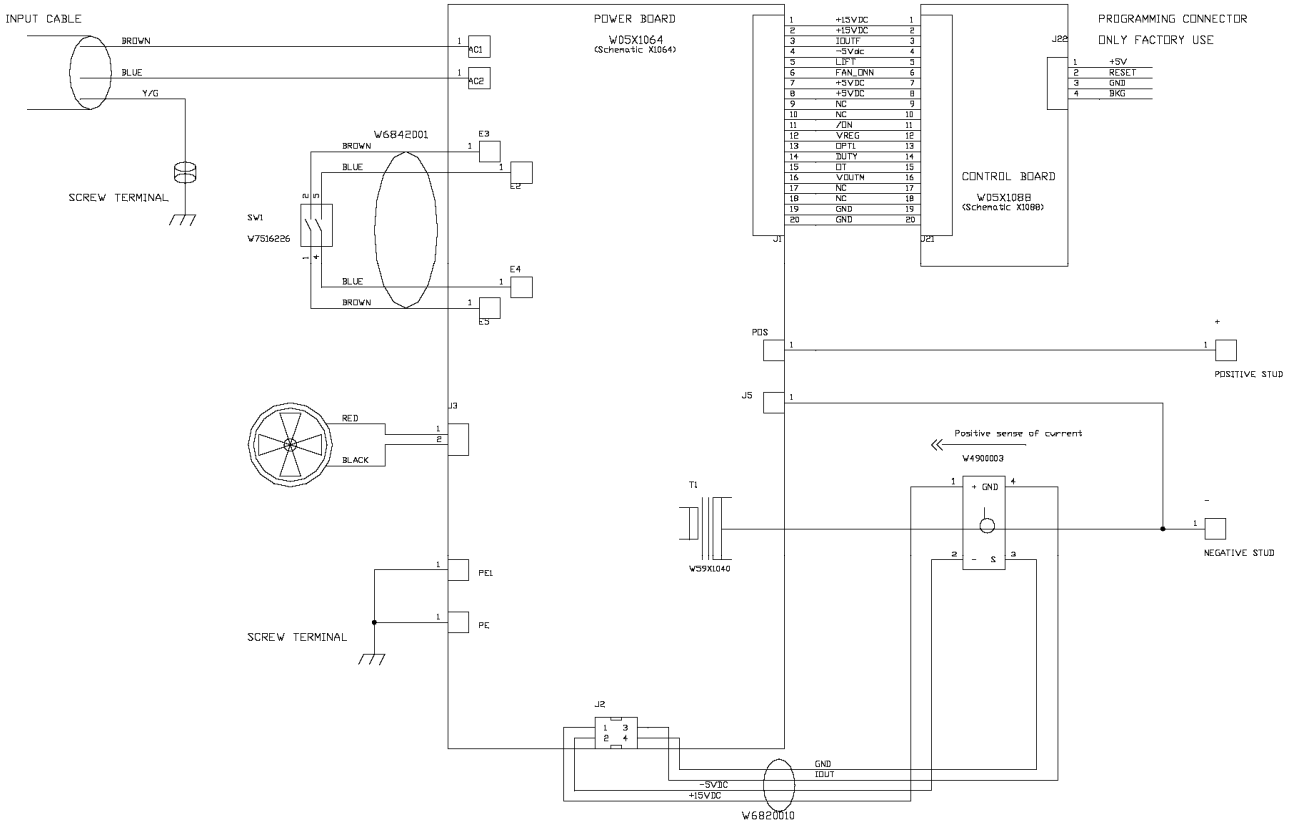
1. Wraparound
2. Main Frame
3. Inverter Board
4. Fan
5. Control board
6. Input cable
7. Output dinse connectors



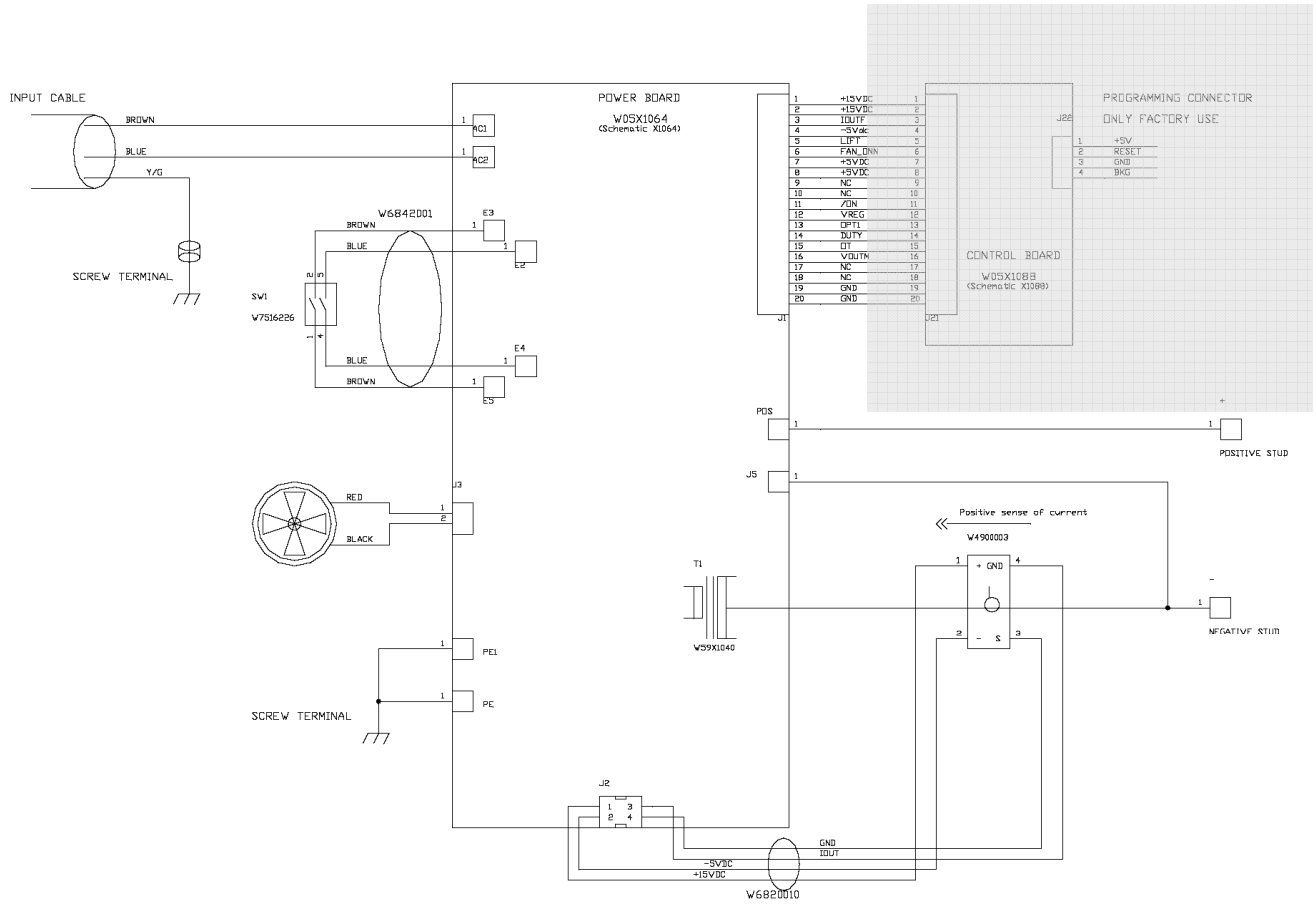
THEORY OF OPERATION

- General description
- Input Line Voltage, Auxiliary Voltage, Precharge
- Inverter Board , Main Transformer, Output Rectifier, Choke and Output Current Probe
- Control Board
- Protection Circuits and IGBTs operation

BLOCK DIAGRAM



MAIN BOARD (INPUT-INVERTER-OUTPUT)



GENERAL DESCRIPTION

The Invertec 150S is an inverter based welding power sources that offers soft, crisp Stick and LIFT TIG process modes.

INPUT LINE VOLTAGE, AUXILIARY VOLTAGE AND PRECHARGE

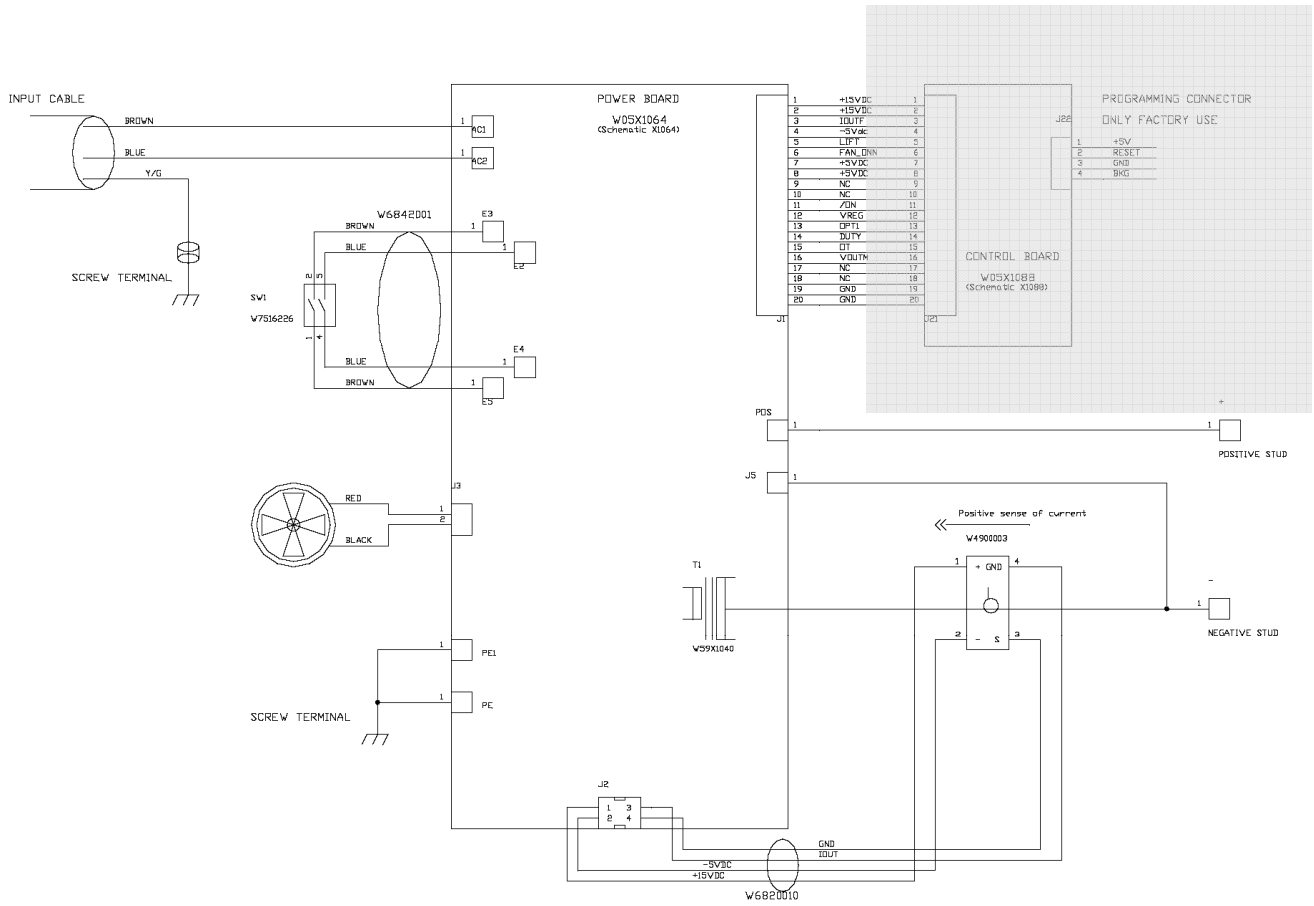
The Invertec 150S can be connected to a 230V single phase input voltage.
This unit can be also connect to engine driven generators but it must follow the below conditions:

- Vac peak voltage: below 410V.
- Vac frequency: in the range of 50 and 60 Hertz.
- RMS voltage of the AC waveform: 230Vac ± 15%.

The 230V 1 phase input power AC is conneted to the machine, through an input cable, directly to the main board. Once the input switch is moved to ON position the 230 Vac +/- 15% voltage is applied to the input circuits and the following activities will starts:

- +24Vdc is generated by the flyback power supply circuits
- +15Vdc, +5Vdc, -5Vdc are generated by linear regulator
- Control circuit and PTC manage the pre-charge phase. Pre-charge phase takes about 5 second to be completed.
- Control and protection from input power supply overvoltage.

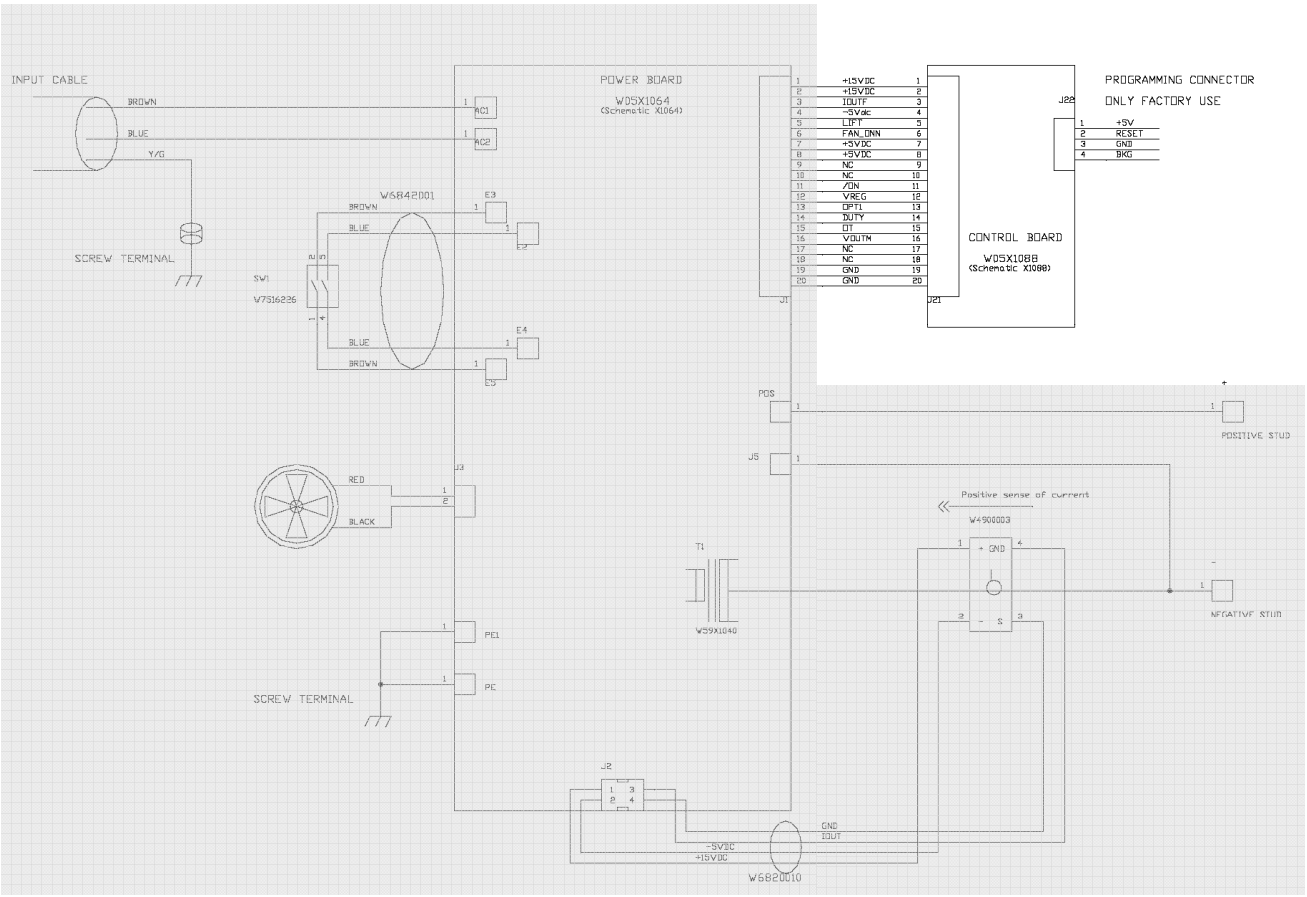
MAIN BOARD (INPUT-INVERTER-OUTPUT) (continued)



INVERTER BOARD, MAIN TRANSFORMER, OUTPUT RECTIFIER, OUTPUT CHOKE AND OUPUT CURRENT PROBE

When the input filter capacitors are fully charged they act as power supplies for the IGBT switching circuit.
The IGBTs supply the main transformer winding with 70KHz current flow.
The inverter board also monitors the filter capacitors for overvoltage. If this occurs, the appropriate error signal is sent to the control board to disable the machines output and to turn on the thermal/voltage Overload LED.
The IGBTs act as a switch assembly. This assembly feeds the primary winding of the main transformer. When current is pulsed through this primary winding, a resultant current is produced on a secondary winding of the main transformer. Current transformer located on the inverter board monitor the primary current. If the primary current become abnormally high, the inverter control circuit will shut off the IGBTs, thus disabling the machine's output. A thermal protector is also present, to the inverter heatsink, to protect the IGBTs from overheating conditions.
The main transformer insulate the primary circuit from the secondary circuit. Power transformer ratio is 5.5 that means the output voltage without PWM control is 60Vdc.
The output rectifier receives the high frequency AC output from the main transformer secondary winding and rectifies it to a DC voltage level. As the current is passing throught the output choke a filtered DC output is applied to the machine's output terminals.
An output current probe read the output current and send the signal to the analog control loop that manage the output current.

CONTROL BOARD



Control Board (User Interface)

Control Board takes signals (Iout, Vout, Iset) and generate the proper set reference for inverter board: manages stick function (soft crisp,hot start, arc force, antisticking). Manages input error (overvoltage), precharge of capacitor phase, fan and thermal error. It feeds this information to the WeldController. The Weld Controller is a micro-processor that uses these signals along with input from the Mode Switchand the Control Potentiometer to make decisions and change the machine mode and output to satisfy the requirements as decided by the operator. These changes are relayed to the PWM circuit on the Inverter Board to regulate the gate signals to the IGBT"s.

The Weld Controler also responds to thermal and input errors to shut down the machine output. The error information is then displayed by the LEDs on the front panel.

OVERLOAD PROTECTION

Invertec 150S are electrically protected from producing higher than normal output currents. An electronic protection circuit limits the current to within the capabilities of the machine.

THERMAL PROTECTION

There are one thermal device located on the output diodes heatsink;it protect the machine from excessive operating temperature.
Excessive temperature may be caused by a lack of cooling air or by operating the machine beyond the duty cycle and output rating. If excessive operating temperature should occur, the Thermal LED indicator on the control board, will turn ON and the thermostat will prevent output current.

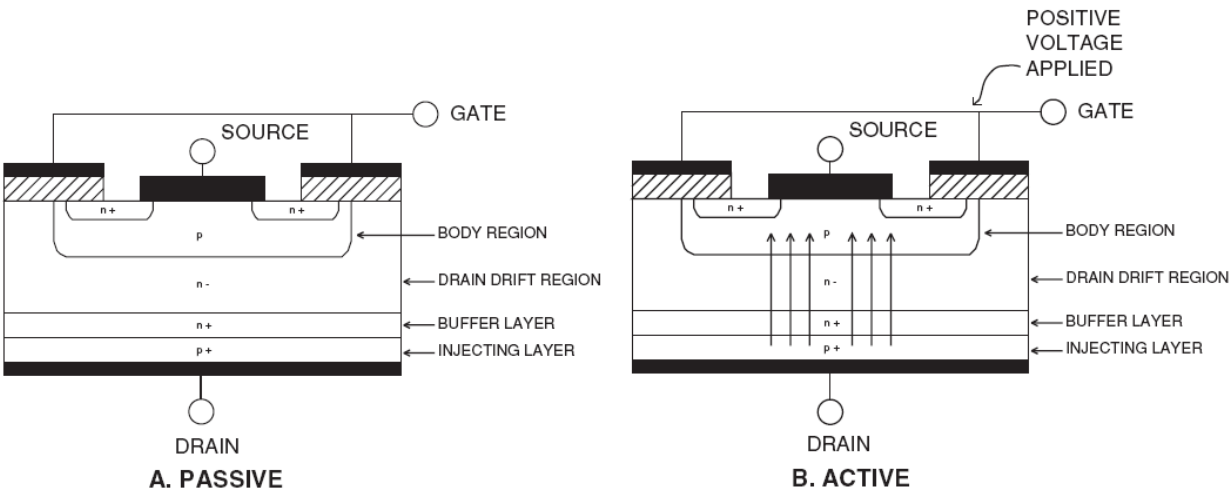
The thermal protection device is self-resetting once the machine cools sufficiently. If the shut down was caused by excessive output or duty cycle and the fan is operating normally, the power switch may be left on and the reset should occur within about 15 minute period. If the fan is not turning or the air intake louvers are obstructed, the input power must be removed and the fan problem or air obstruction must be corrected.

INSULATED GATE BIPOLAR TRANSISTOR (IGBT) OPERATION

An IGBT is a type of transistor. IGBTs are semicon-ductors 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.

IGBT



TROUBLESHOOTING AND REPAIR SECTION

- How to use troubleshooting Guide
- Troubleshooting Guide
- Case cover removal and capacitor discharge procedure

HOW TO USE TROUBLESHOOTING GUIDE

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 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.

Step 1. LOCATE PROBLEM (SYMPTOM). Look under the column labeled “PROBLEMS”. This column describes possible symptoms that the machine may exhibit. Find the listing that best describes the symptom that the machine is exhibiting. Symptoms are grouped into three main categories: Output Problems, Function Problems, and LED Function Problems.

Step 2. PERFORM EXTERNAL TESTS. The second column, labeled “CHECKS”, lists the obvious external possibilities that may contribute to the machine symptom. Perform these tests/checks in the order listed. In general, these tests can be conducted without removing the case wrap-around cover.

Step 3. PERFORM COMPONENT TESTS. The last column, labeled “RECOMMENDED COURSE OF ACTION ” lists the most likely components that may have failed in your machine. It also specifies the appropriate test procedure to verify that the subject component is either good or bad. If there are a number of possible components, check the components in the order listed to eliminate one possibility at a time until you locate the cause of your problem.

All of the referenced test procedures referred to in the Troubleshooting Guide are described in detail at the end of this chapter. Refer to the Troubleshooting and Repair Table of Contents to locate each specific Test Procedure. All of the referred to test points, components, terminal strips, etc., can be found on the referenced electrical wiring diagrams and schematics. Refer to the Wiring Diagrams Section Table of Contents to locate the appropriate diagram

WARNING

ELECTRIC SHOCK can kill

- Have an electrician install and service this equipment
- Turn the input power off at the fuse box before working on equipment
- Do not touch electrically hot parts
- Prior to performing preventive maintenance, perform the following capacitor discharge procedure to avoid electric shock

---

Sometimes machine failures appear to be due to PC board failures. These problems can sometimes be traced to poor electrical connections. To avoid problems when troubleshooting and replacing PC boards, please use the following procedure:

1. Determine to the best of your technical ability that the PC board is the most likely component causing the failure symptom.
2. Check for loose connections at the PC board to assure that the PC board is properly connected.
3. If the problem persists, replace the suspect PC board using standard practices to avoid static electrical damage and electrical shock.
4. Test the machine to determine if the failure symptom has been corrected by the replacement PC board.

NOTE: Allow the machine to heat up so that all electrical components can reach their operating temperature.

5. Remove the replacement PC board and substitute it with the original PC board to recreate the original problem.
   - If the original problem does not reappear by substituting the original board, then the PC board was not the problem. Continue to look for bad connections in the control wiring harness, junction blocks, and terminal strips.
   - If the original problem is recreated by the substitution of the original board, then the PC board was the problem. Reinstall the replacement PC board and test the machine.
6. Always indicate that this procedure was followed when warranty reports are to be submitted.

NOTE: Following this procedure and writing on the warranty report, “INSTALLED AND SWITCHED PC BOARDS TO VERIFY PROBLEM,” will help avoid denial of legitimate PC board warranty claims.

TROUBLESHOOTING

!! WARNING !! **BEFORE CONNECT POWER SUPPLY, MAKE A CAREFUL VISUAL INSPECTION INSIDE THE MACHINE , CHECK ALL THE BOARDS AND HARNESS.**

= GENERAL PROBLEMS =

PROBLEMS / SYMPTOMS	POSSIBLE AREAS OF MISADJUSTMENT(S)	CHECK	RECOMMENDED COURSE OF ACTION
THE LINE CIRCUIT BREAKER TRIPS WHEN POWER SWITCH IS " ON"	• INPUT POWER BRIDGE IS IN SHORT CIRCUIT • ELECTROLYTIC CAPACITORS FAILURE • IGBTs SHORT CIRCUITED	• MULTIMETER CHECK • VISUAL INSPECTION AND MULTIMETER CHECK • VISUAL INSPECTION AND MULTIMETER CHECK	• REPLACE W05X1064 INVERTER BOARD
THE MACHINE HAS, NO OUTPUT, NO FAN RUNNING	• THERE IS NO POWER SUPPLY ON LINE • THE POWER SUPPLY CABLE IS INTERRUPTED • LINE SWITCH FAILURE • THE INVERTER BOARD IS DAMAGED	• CHECK THE PHASE INPUT VOLTAGE ON THE MACHINE • CHECK THE POWER SUPPLY CABLE • CHECK THE LINE SWITCH • CHECK INVERTER BOARD FOR VISIBLE	• RECONNECT THE POWER SUPPLY • REPLACE THE INPUT POWER CABLE • REPLACE THE LINE SWITCH • REPLACE THE INVERTER BOARD
ANY LED ON FRONT PANEL IS ON AND THE FAN RUN FAST	• CONTROL BOARD IS NOT FLASHED • FLAT CABLE IS NOT CONNECTED ON INVERTER BOARD	---------- ----------	• REPLACE CONTROL BOARD • CONNECT FLAT CABLE

= OUTPUT PROBLEMS =

THE MACHINE SUPPLIES MORE THEN THE MAX CURRENT FOR LESS THEN 1s AND AFTERWARDS NO OUTPUT CURRENT INDIPENDLY FROM POTENTIOMETER SETTING	• CURRENT SENSOR CABLE IS NOT CONNECTED • INVERTER BOARD FAILURE	• CHECK THE SENSOR CABLE	• CONNECT THE CABLE • REPLACE THE INVERTER BOARD
THE MACHINE DOES NOT HAVE MAXIMUM OUTPUT	• THE CONTROL BOARD IS OUT OF CALIBRATION	----------	• REPLACE CONTROL BOARD
THE OUTPUT VOLTAGE IS NOT REGUALTED (ALWAYS <80VDC MEASURED WITH TRUE RMS MULTIMETER)	• CONTROL BOARD CABLE DEFECT • NEG CABLE FROM INVERTER BOARD IS NOT CONNECTED TO NEGATIVE DINSE	• CHECK IF CABLE IS DAMAGED • CHECK IF THE CABLE IS CONNECTED TO THE OUTPUT DINSE	• REPLACE CONTROL BOARD • CONNECT THE CABLE TO OUTPUT DINSE

CASE COVER REMOVAL AND DC LINK CAPACITOR DISCHARGE PROCEDURE

WARNING

Service and repair should be performed only by 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 your Local Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed.

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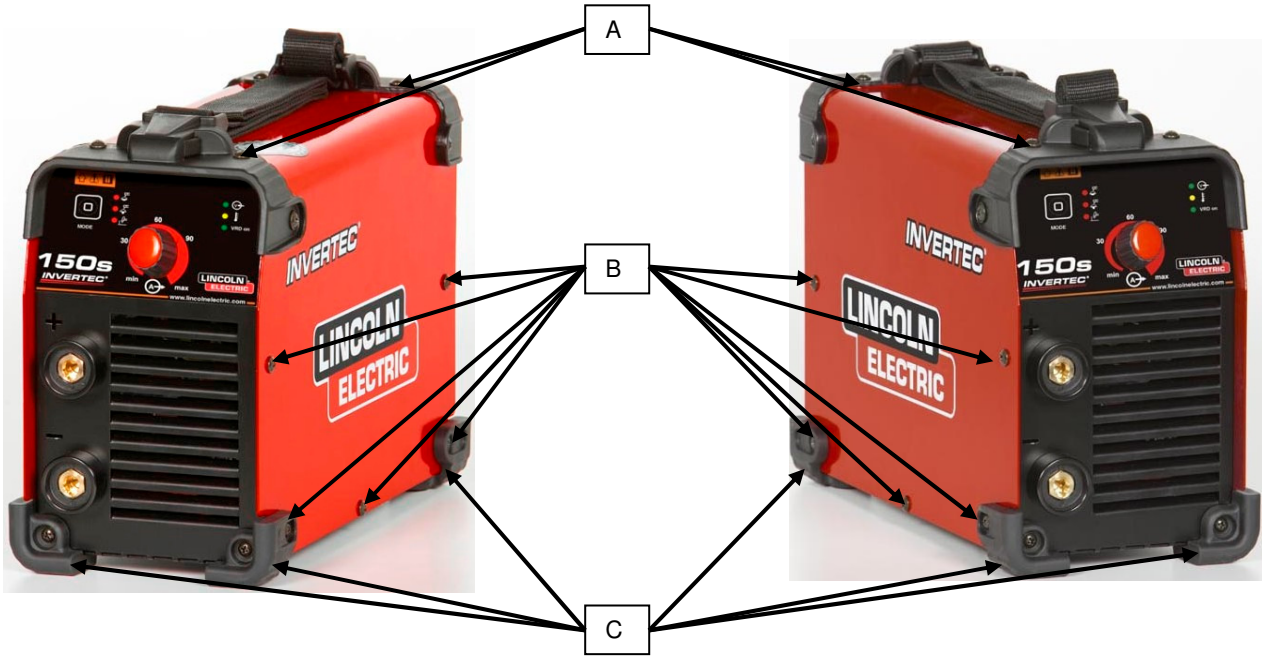
DESCRIPTION

This procedure will aid the technician in the removal and replacement of the case sheetmetal cover and discharging the DC link capacitor making it safe for the technician to workon the machine.

MATERIALS NEEDED

Phillips screwdriver PH02

INVERTEC® 150S - CASE COVER REMOVAL



Procedure:

1. Disconnect Input Power from the machine!
2. Turn on/off switch to off position.
3. Remove the 4 screws of the front and rear plastic handle (A).
4. Remove the 10 screws of the wraparound (B).
5. Don't remove the 4 bottom rubber corners (C).
6. Pull up the wraparound
7. Follow the next session to **perform the input filter discharge procedure**

DC LINK CAPACITORS DISCHARGE PROCEDURE

WARNING

ELECTRIC SHOCK can kill

- Have an electrician install and service this equipment.
- Turn the input power off at the fuse box before working on equipment.
- Do not touch electrically hot parts.
- Prior to performing preventive maintenance, perform the following capacitor discharge procedure to avoid electric shock

INPUT FILTER CAPACITORS DISCHARGE PROCEDURE

This procedure will drain off any charge stored in the four capacitors that are part of the Inverter Board assembly. This procedure MUST be performed, as a safety precaution, before conducting any test or repair procedure that requires you to touch internal components of the machine.

1. Remove input power to Invertec 150S machine
2. Remove the cover following the instruction available in this Service manual.
3. As there is no access to the terminals **DC+** and **DC-** with the main board installed on the machine frame, it is necessary to wait minimum 10 seconds after disconnecting the machine from the input line, before starting any disassembly operation. During these 10 seconds the flyback power supply circuit, part of the inverter board, will reduce the voltage across the filter capacitors to a safe level (below 50Vdc).
4. Obtain a high resistance and high wattage resistor (25-1000 ohms and 25 watts minimum). This resistor is NOT supplied with the machine. NEVER USE A SHORTING STRAP FOR THIS PROCEDURE.
5. Locate the resistor **R92** that is directly connected to the terminals **DC+** and **DC –** on the main board, **See Figure 1** and check the voltage across it, it should be zero; if not follow the next step.
6. Use electrically insulate gloves and insulated pliers. **See Figure 1a**. Hold the body of the resistor and connect the resistor leads across the resistor R92. Hold the resistor in place for 10 seconds. DO NOT TOUCH CAPACITOR TERMINALS WITH YOUR BARE HANDS.
7. Check the voltage across the resistor R92. Voltage should be zero. If any voltage remains, repeat this procedure.

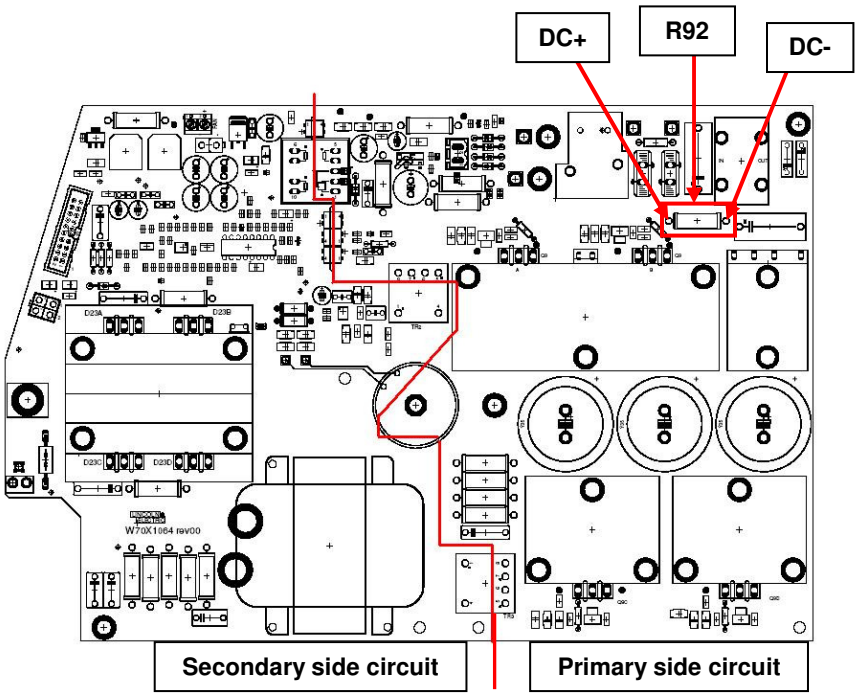


Figure 1 - Capacitors discharge location

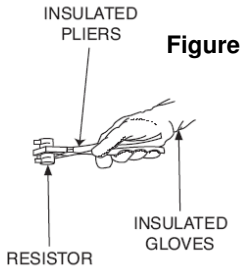


Figure 1a

MAIN BOARD RESISTANCE TEST

WARNING

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 your Local Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed.
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TEST DESCRIPTION

This test will determine if the main board has any " shorted " or "open" components.

MATERIALS NEEDED

Volt/Ohmmeter
Wiring Diagram X1064

MAIN BOARD RESISTANCE TEST (continued)

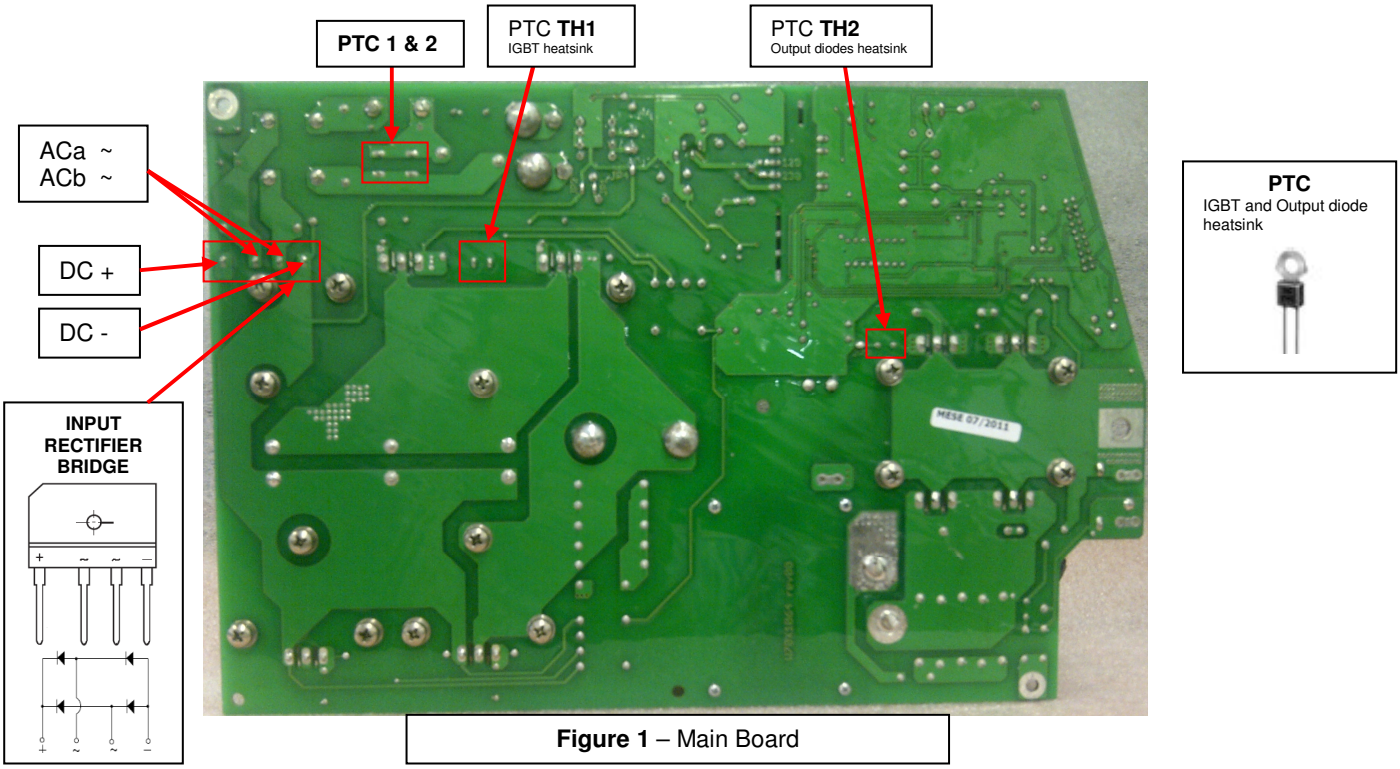


Figure 1 – Main Board

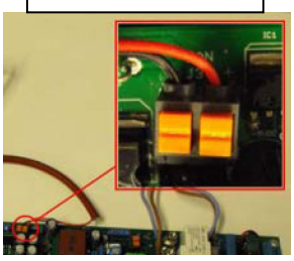
TEST PROCEDURE

1. Remove main input power to the INVERTEC® 150S
2. Follow the main board disassembly operations available in this Service Manual.
3. Perform the **Discharge procedure**
4. Visually check for burned or damaged components.
   If any components are physically damaged the board should be replaced
5. Using the Volt-Ohmmeter (diode test mode) check the Input Rectifier (see **Test Table 1**)
6. Using the Volt-Ohmmeter (ohm mode) check **PTC 1&2** value, shall be 25 Ohms @ 20°C, +/- 10%
7. Using the Volt-Ohmmeter (ohm mode) check PTC **TH1** (IGBT heatsink) value, shall be 50 Ohms @ 20°C, +/- 10%
8. Using the Volt-Ohmmeter (ohm mode) check PTC **TH2** (Output Diodes heatsink) value, shall be 46 Ohms @ 20°C, +/- 10%
9. Disconnect the red and black fan wires from connector J3 and using a Volt-Ohmmeter (ohm mode) check the fan winding resistance (red probe with red wire and black probe with black wire); it shall be 290Kohms. As this is DC fan the value is indicative because it can vary from fan brand to brand.

Test Table 1 - Input Bridge test table

Positive Probe (RED)	*Negative Probe (BLACK)*	*Value*
ACa	**+**	*0.3V - 0.7V*
ACb	**+**	*0.3V - 0.7V*
+	**ACa**	*OPEN*
+	**ACb**	*OPEN*
-	**ACa**	*0.3V - 0.7V*
-	**ACb**	*0.3V - 0.7V*
ACa	**-**	*OPEN*
ACb	**-**	*OPEN*

Figure 1
Fan Connector **J3**



MAIN BOARD RESISTANCE TEST (continued)

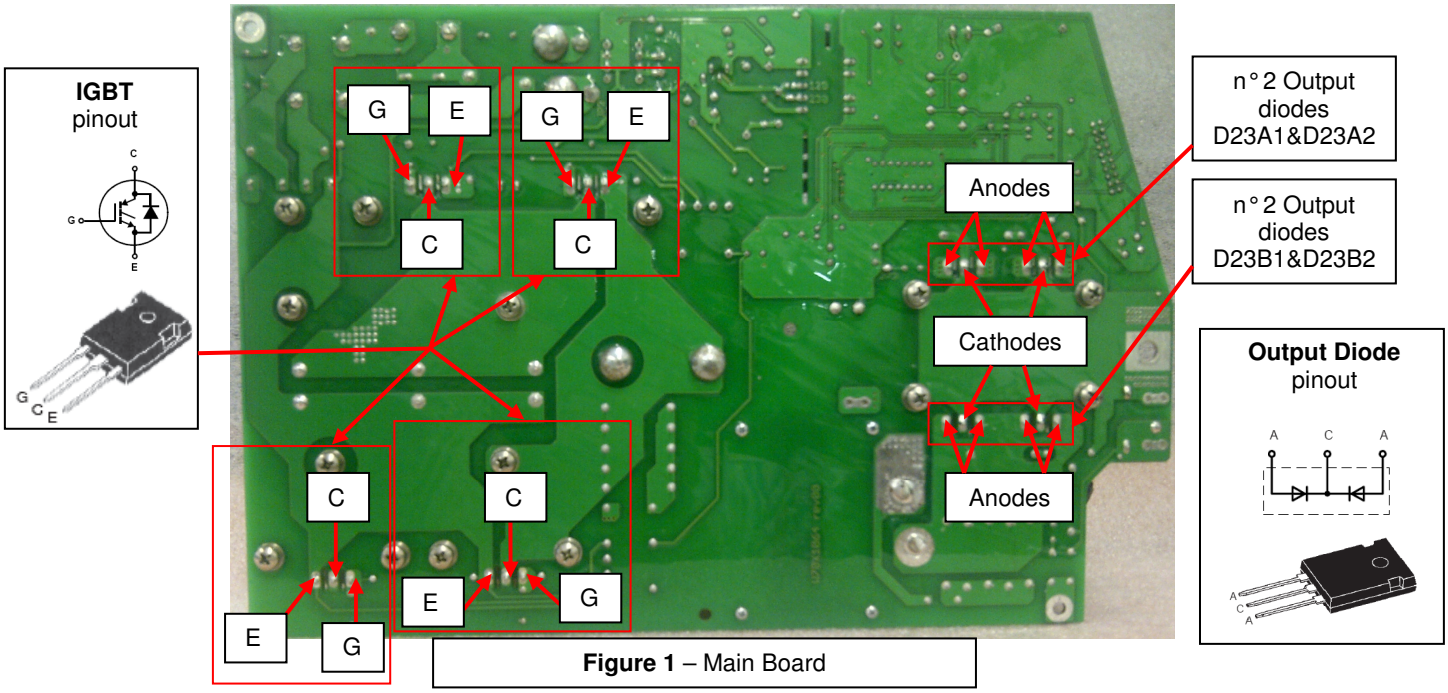


Figure 1 – Main Board

TEST PROCEDURE (continued)

10. Check each IGBT (Q9A,Q9B,Q9C,Q9D), with multimeter in diode test mode, following the **Table tests 1** below.
11. Check each output diode (D23A1,D23A2,D23B1,D23B2), with multimeter in diode test mode, for short following the **Table tests 2** below. Take note that D23A1 & D23A2 are in parallel as same as D23B1 & D23B2, this means that if you have short circuit you need to unsolder all the diodes till you find the real shorted one.

IGBT - Table tests 1

Positive Probe (RED)	***Negative Probe (BLACK)***	***Value***
Emitter (E)	Collector (C)	*0.3V - 0.7V*
Collector (C)	Emitter (E)	OPEN
Emitter (E)	Gate (G)	*0.3V - 0.7V*

Output Diodes – Table tests 2

Positive Probe (RED)	**Negative Probe (BLACK)**	**Value**
anode	cathode	0.3V - 0.7V
cathode	anode	OPEN

Note:
Actual voltage readings will vary depending on the meter being used. Similar tests on all devices should give similar results

MAIN BOARD VOLTAGE TEST

WARNING

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TEST DESCRIPTION

This test will help to determine if the correct input voltage is being applied to the main board and also if the correct regulated voltages are being processed on the main board.

MATERIALS NEEDED

Volt/Ohmmeter
Wiring Diagram X1064

MAIN BOARD VOLTAGE TEST (continued)

⚠ WARNING

DO NOT CONNECT THE SAME SCOPE GROUND BETWEEN HIGH SIDE AND LOW SIDE

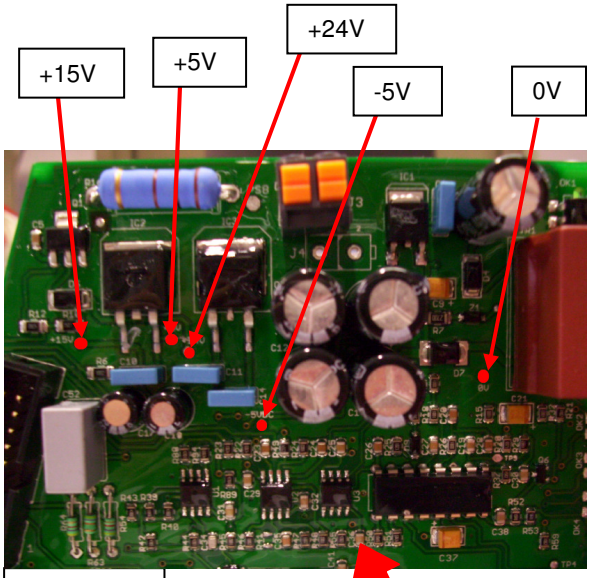


Figure 1B

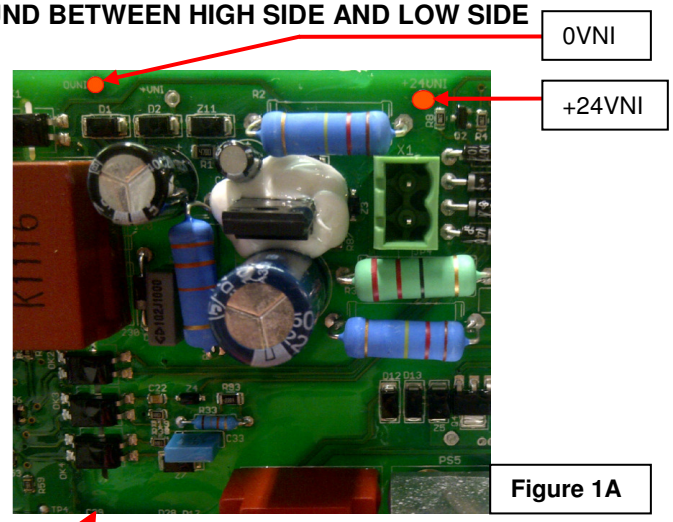


Figure 1A

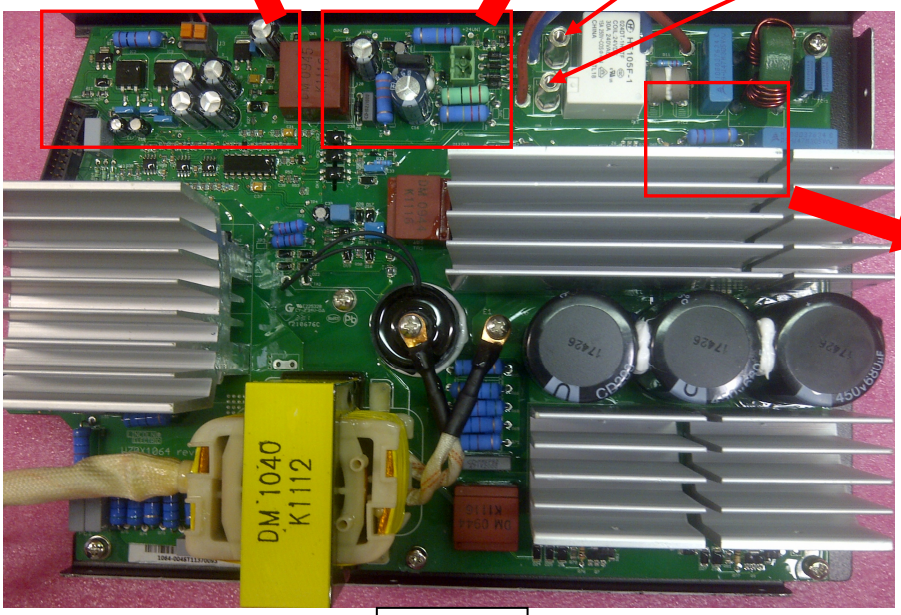


Figure 1

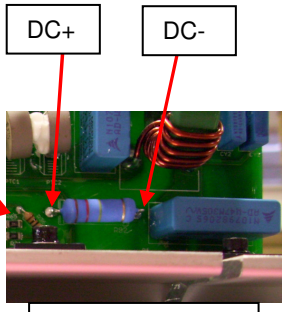


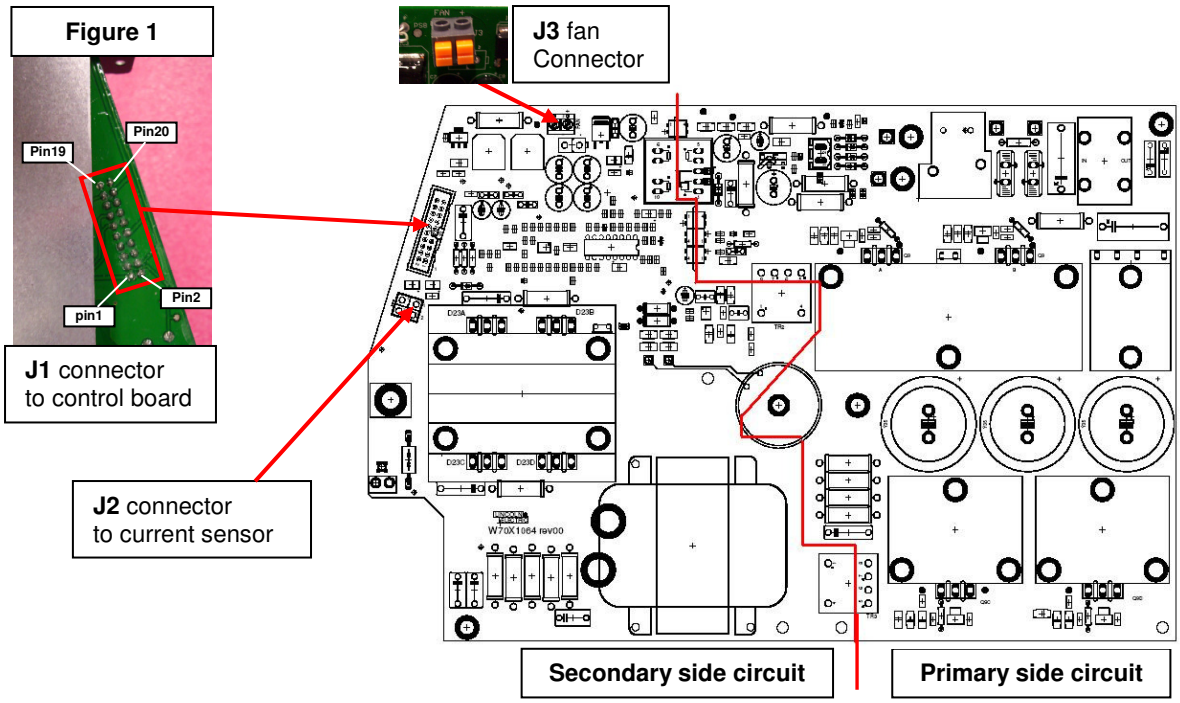
Figure 1C - R92

TEST PROCEDURE

⚠ Use always electrically insulate gloves during this test procedure

1. Remove main input power to the INVERTEC® 150S
2. Follow the case removal procedure available in this Service Manual
3. Apply 230V +/- 15% to the INVERTEC® 150S
4. Turn the machine mains input switch to ON position and wait few seconds till the auto test is finish and the power LED on front panel is steady green
5. Check for 230Vac +/- 15% between “Phase” and “Neutral” connections, see **Figure 1**
6. Check for 320 Vdc +/- 15% between R92 terminals, see **Figure 1C**
7. Check for primary flyback power supply +24Vdc between the two test points +24VNI and 0VNI, see **Figure 1A**
8. Check for auxiliary power supply: +24Vdc,+15Vdc, +5Vdc, -5Vdc (all +/- 15%) between common 0V test point reference and dedicated test points, see **Figure 1B**

MAIN BOARD VOLTAGE TEST (continued)



TEST PROCEDURE (continued)

⚠ **Use always electrically insulate gloves during this test procedure**

9. Follow the below tables to perform the voltage tests on connectors J1, J2 and J3. Take note that J1 is a flat cable connector; the only way to check signals is from the solder side, see **Figure 1**.

J1: Main Bd /Control Bd connector

Pin #	Description	Value (use pins 19 or 20 as 0V ref.)	Notes
1	Aux +15Vdc	+15Vdc +/- 2%	+15Vdc power supply
2	Aux +15Vdc	+15Vdc +/- 2%	+15Vdc power supply
3	I_OUT	From 0,4Vdc to 5,7Vdc +/- 5% 0,4Vdc=10A output / 5,7Vdc= 140A output	Output welding current feedback from current sensor probe
4	Aux -5Vdc	-5Vdc +/- 2%	-5Vdc power supply
5	I_LIFT	From 0,3Vdc to 12Vdc +/-5% 0,3Vdc when tunghsten shorted to piece	Lift TIG voltage reference
6	FAN_ONN	FAN ON = 15Vdc +/- 5%	Grounding for FAN signal from Control Board
7	Aux +5Vdc	+5Vdc +/- 2%	+5Vdc power supply
8	Aux +5Vdc	+5Vdc +/- 2%	+5Vdc power supply
9	SGND	SGND	Secondary GND for power supply (0V ref.)
10	RELE2	-	Not Used
11	/ON		Grounding for Power ON signal
12	VREG	1,3Vdc=24A(antistick) / 5,8Vdc=140A	Output current setting signal from Control Board
13	OPT1	13,6Vdc = machine ready to weld	Grounding for RL1 signal from Control Board
14	DUTY	From 0,4Vdc to 5,7Vdc +/- 5%	Output current setting signal from Control Board
15	OT		Grounding for Over Temperature signal from Control Board
16	VOUTM	From 0Vdc to 5Vdc +/- 5% 4Vdc = 45V OCV	Output Voltage reference
17	VOUTM	Same as pin 16	Output Voltage reference
18	RELE2	-	Not Used
19	SGND	SGND	Secondary GND for power supply (0V ref.)
20	SGND	SGND	Secondary GND for power supply (0V ref.)

J2:Current Sensor Connector

Pin #	Description	Value (use pin 4 as 0V ref.)	Notes
1	Aux +15Vdc	+15Vdc +/- 2%	+15Vdc power supply
2	Aux -5Vdc	-5Vdc +/- 2%	-5Vdc power supply
3	I_OUT	From 0Vdc to 5,7Vdc +/- 5% 5,7Vdc = 140A output	Output welding current feedback from current sensor probe
4	SGND	SGND	Secondary GND for power supply (0V ref.)

J3: Fan Connector

Pin #	Description	Value (use J2 pin 4 as 0V ref.)	Notes
1	0V	0Vdc=Fan ON / 12Vdc=Fan OFF	Fan Power supply
2	+24Vdc	+24Vdc +/- 2%	

CONTROL BOARD TEST

WARNING

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 your Local Lincoln Electric Service Department for electrical troubleshooting assistance before you proceed.

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TEST DESCRIPTION

The control board is not easy to be checked, as it works mainly with software; this section will help, as best as possible, to determine if the control board is faulty and how to interpret error codes.

MATERIALS NEEDED

Volt/Ohmmeter
Wiring Diagram X1088

CONTROL BOARD TEST (continued)

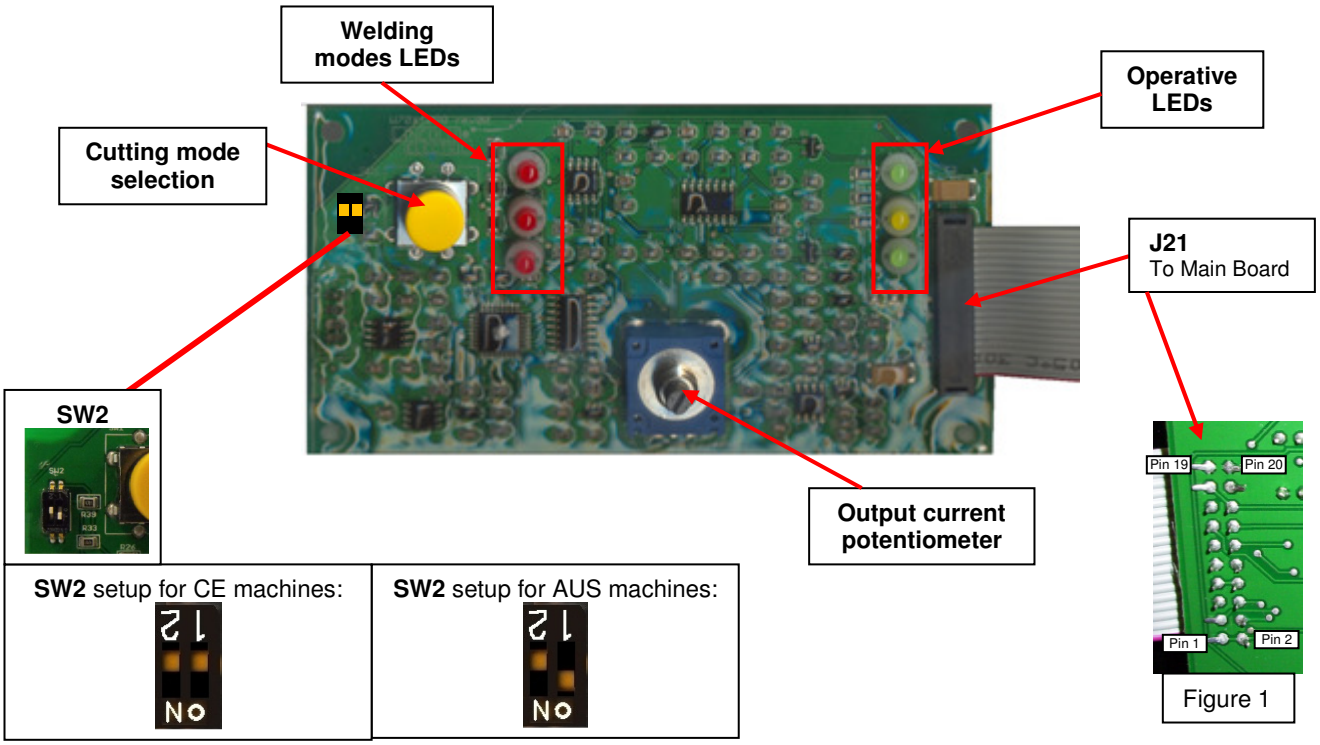


Figure 1

TEST PROCEDURE

1. Apply 230V +/- 15% to the Invertec® 150S
2. Turn the machine mains input swith to ON position and wait few seconds till the auto test is finish and the power LED on front panel is steady green.
3. Follow the below table to perform the voltage tests on connectors J21. Take note that J21 is a flat cable connector; the only way to check signals is from the solder side, see **Figure 1**. As these signal are the same as connector J1 on main board, this test is useful to understand if the flat cable is in good condition.

J21: Control Bd / Main Bd connector

Pin #	Description	Value (use pins 19 or 20 as 0V ref.)	Notes
1	Aux +15Vdc	+15Vdc +/- 2%	+15Vdc power supply
2	Aux +15Vdc	+15Vdc +/- 2%	+15Vdc power supply
3	I_OUT	From 0,4Vdc to 5,7Vdc +/- 5% 0,4Vdc=10A output / 5,7Vdc= 140A output	Output welding current feedback from current sensor probe
4	Aux -5Vdc	-5Vdc +/- 2%	-5Vdc power supply
5	I_LIFT	From 0,3Vdc to 12Vdc +/-5% 0,3Vdc when tunghsten shorted to piece	Lift TIG voltage reference
6	FAN_ONN	FAN ON = 15Vdc +/- 5%	Grounding for FAN signal from Control Board
7	Aux +5Vdc	+5Vdc +/- 2%	+5Vdc power supply
8	Aux +5Vdc	+5Vdc +/- 2%	+5Vdc power supply
9	SGND	SGND	Secondary GND for power supply (0V ref.)
10	RELE2	-	Not Used
11	/ON		Grounding for Power ON signal
12	VREG	1,3Vdc=24A(antistick) / 5,8Vdc=140A	Output current setting signal from Control Board
13	OPT1	13,6Vdc = machine ready to weld	Grounding for RL1 signal from Control Board
14	DUTY	From 0,4Vdc to 5,7Vdc +/- 5%	Output current setting signal from Control Board
15	OT		Grounding for Over Temperature signal from Control Board
16	VOUTM	From 0Vdc to 5Vdc +/- 5% 4Vdc = 45V OCV	Output Voltage reference
17	VOUTM	Same as pin 16	Output Voltage reference
18	RELE2	-	Not Used
19	SGND	SGND	Secondary GND for power supply (0V ref.)
20	SGND	SGND	Secondary GND for power supply (0V ref.)

ERROR CODES

If errors condition occurs, try to turn Off the machine, wait for a few seconds, then turn ON again. If the error remains, control tests described into this manual are required.

Voltage Lockout	 Blink	 Blink
	This occurs when an internal auxiliary undervoltage condition is detected. To restore the machine: • Turn OFF then ON the Mains Switch to restart the machine.	

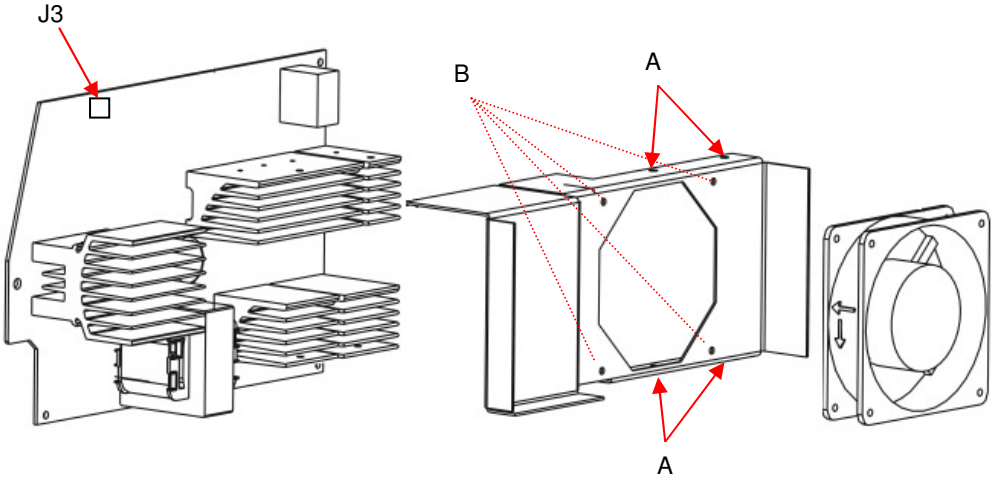
DISASSEMBLY OPERATIONS

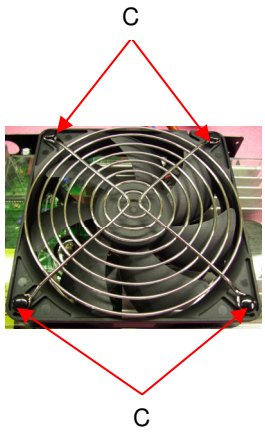
AIR FLOW CONVEYOR AND FAN ASSEMBLY REMOVAL AND REPLACEMENT PROCEDURE

⚠ WARNING

ELECTRIC SHOCK CAN KILL

- Disconnect input power before servicing.
- Do not operate with covers removed.
- Do not touch electrically live parts.
- Only qualified persons should install, use or service this equipment.





REMOVAL PROCEDURE

Necessary tool:

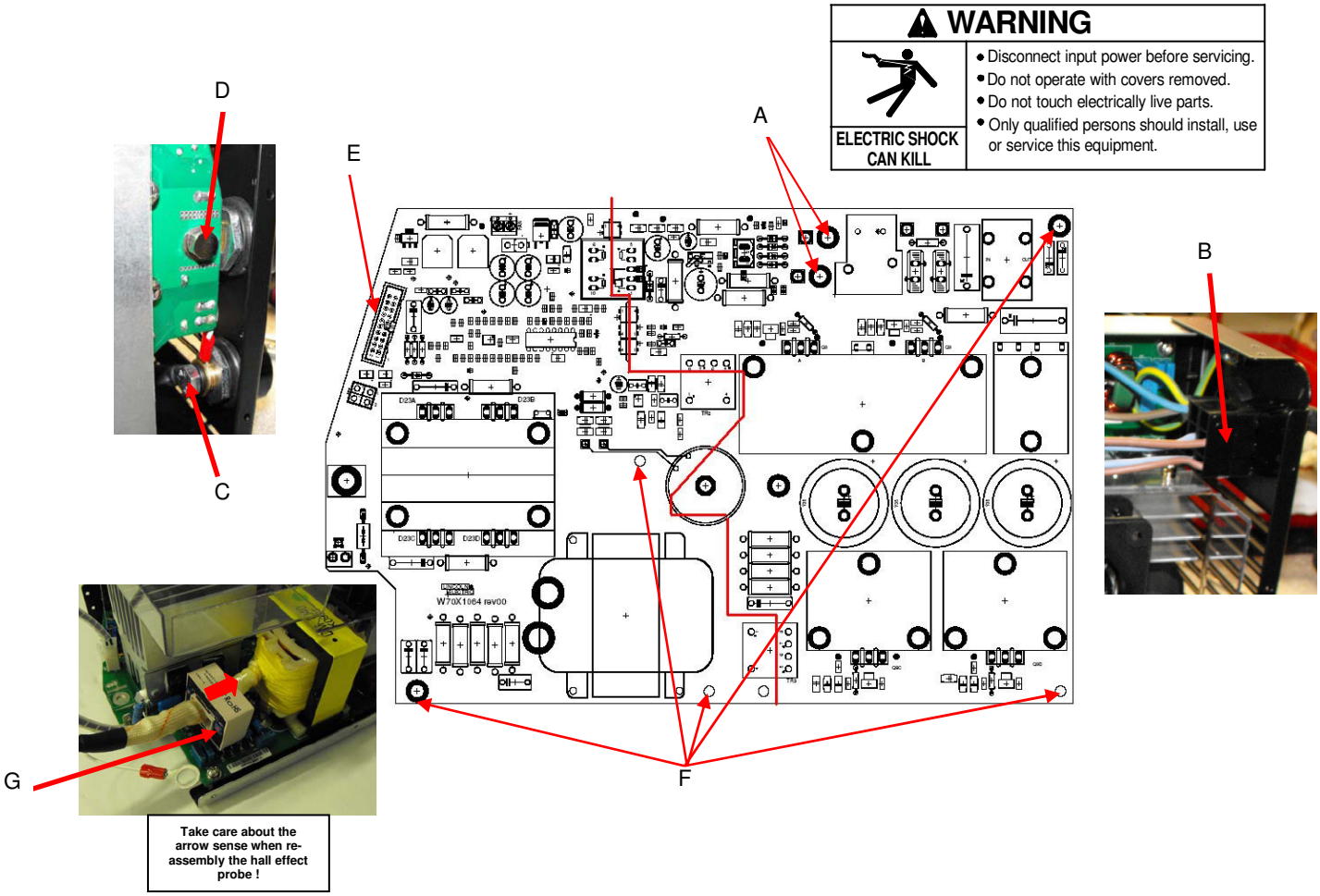
- Phillips screwdriver PH02
- Small pliers

1. Disconnect the fan supply wires,black and red, from connector J3 on main board
2. Remove the 4 screws that fix the plastic air flow conveyor to the inverter heatsink (A)
3. Pull out the plastic air flow conveyor from the main board
4. Remove the 4 plastic rivets that fix the fan to the air flow conveyor, using a small pliers (B)
5. Remove the 4 plastic rivets that fix the grid to the fan, using a small pliers (C)

For the re-assembly operations, make the previous steps in the reverse order.

DISASSEMBLY OPERATIONS

MAIN BOARD REMOVAL AND REPLACEMENT PROCEDURE



REMOVAL PROCEDURE

Necessary tool:

- Phillips screwdriver PH02
- 10 mm Nutdriver
- 13 mm Wrench

1. Remove the phase and neutral supply cables from their connecting points (A)
2. Disconnect the plastic block connector from the mains switch (B)
3. Unscrew the M8 bolt that connect the output cable transformer to the negative stud using the 13mm wrench (C)
4. Unscrew the M6 bolt that fix the printed circuit to the positive stud using the 10mm Nutdriver (D)
5. Disconnect the signal harness from connector J1 (E)
6. Remove the 5 screws that fix the main board to the central frame (F)
7. If you need to replace completely the main board, remove also the hall effect probe from the main transformer cable (G). **NOTE: when re-assembly the hall effect probe take care about the arrow sense!**

For the re-assembly operations, make the previous steps in the reverse order.

DISASSEMBLY OPERATIONS

CONTROL BOARD REMOVAL AND REPLACEMENT PROCEDURE

⚠ WARNING

ELECTRIC SHOCK CAN KILL

- Disconnect input power before servicing.
- Do not operate with covers removed.
- Do not touch electrically live parts.
- Only qualified persons should install, use or service this equipment.

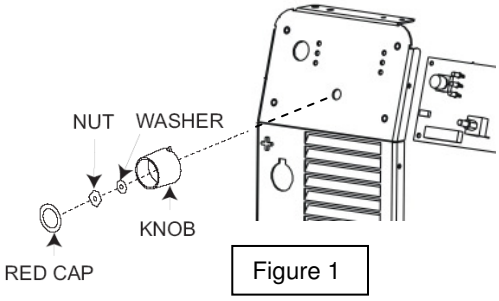
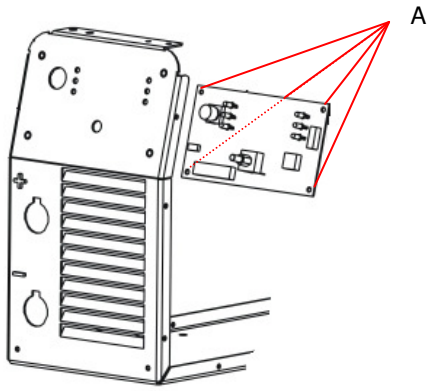


Figure 1



REMOVAL PROCEDURE

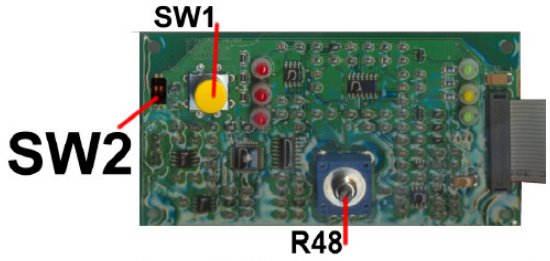
Necessary tool:

- 6 mm Nutdriver
- 5,5 mm Nutdriver

1. Using a thin knife blade, remove the red plastic cap on the end of the output knob, see Figure 1.
2. Using a 6mm nutdriver, remove the output knob mounting nut and washer located behind the red plastic cap previously removed, See Figure 1.
3. Disconnect the signal harness from the main board connector J1
4. Using a 5,5 mm nutdriver remove the 4 nuts located on the corners of the solder side of the control board (A)

For the re-assembly operations, make the previous steps in the reverse order.

During re-assembly operation of a new control board make sure about the position of the dip-switches, follow the instruction that are inside the new control board box. See extraction below:



Be careful! Here ----------→
represented here the SW2 orientation on PCB

Operative notes:

SW1 (Job selection) and R48 (Output current potentiometer) aren't involved by the P.C. Board setup.

SW2 (machine configuration) is the unique item that has to be configured following the table below

SW2 setup for CE machines:

INVERTEC 150S CE

SW2 setup for AUS machines:

INVERTEC 150S AUS

RETEST AFTER REPAIR

Should a machine under test be rejected for any reason requiring the removal of any mechanical part that could affect the machine's electrical characteristics, or if any electrical components are repaired or replaced, the machine must be retested.

Machine input and output

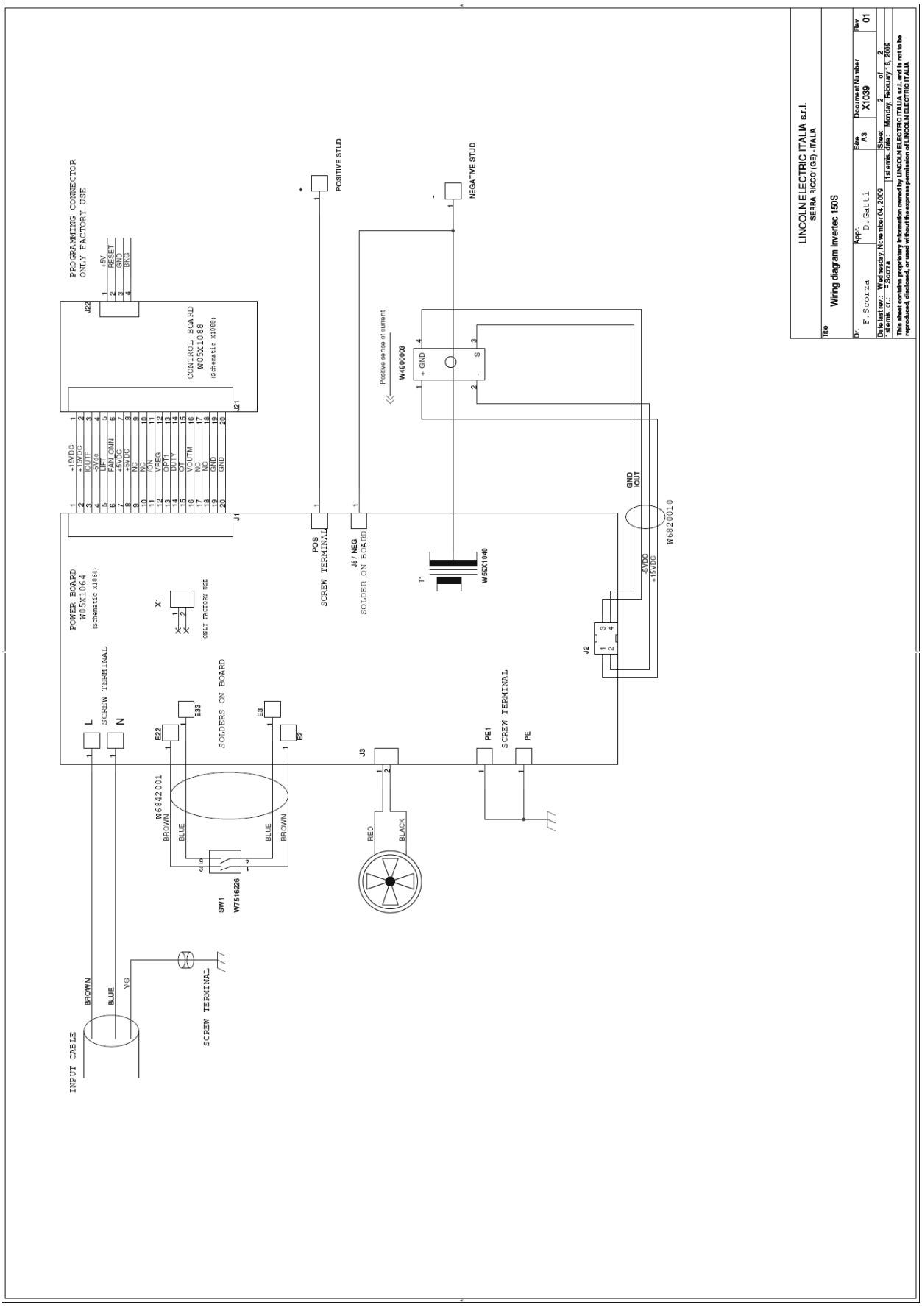
Input Voltage	Input Current	Rated Output
230Vac/1ph/50Hz	18,6A max 31A max	90A @ 100% duty cycle 140A @ 30% duty cycle

Output current range	10 – 140 Amps

Maximum Open Circuit Voltage	45 Vdc

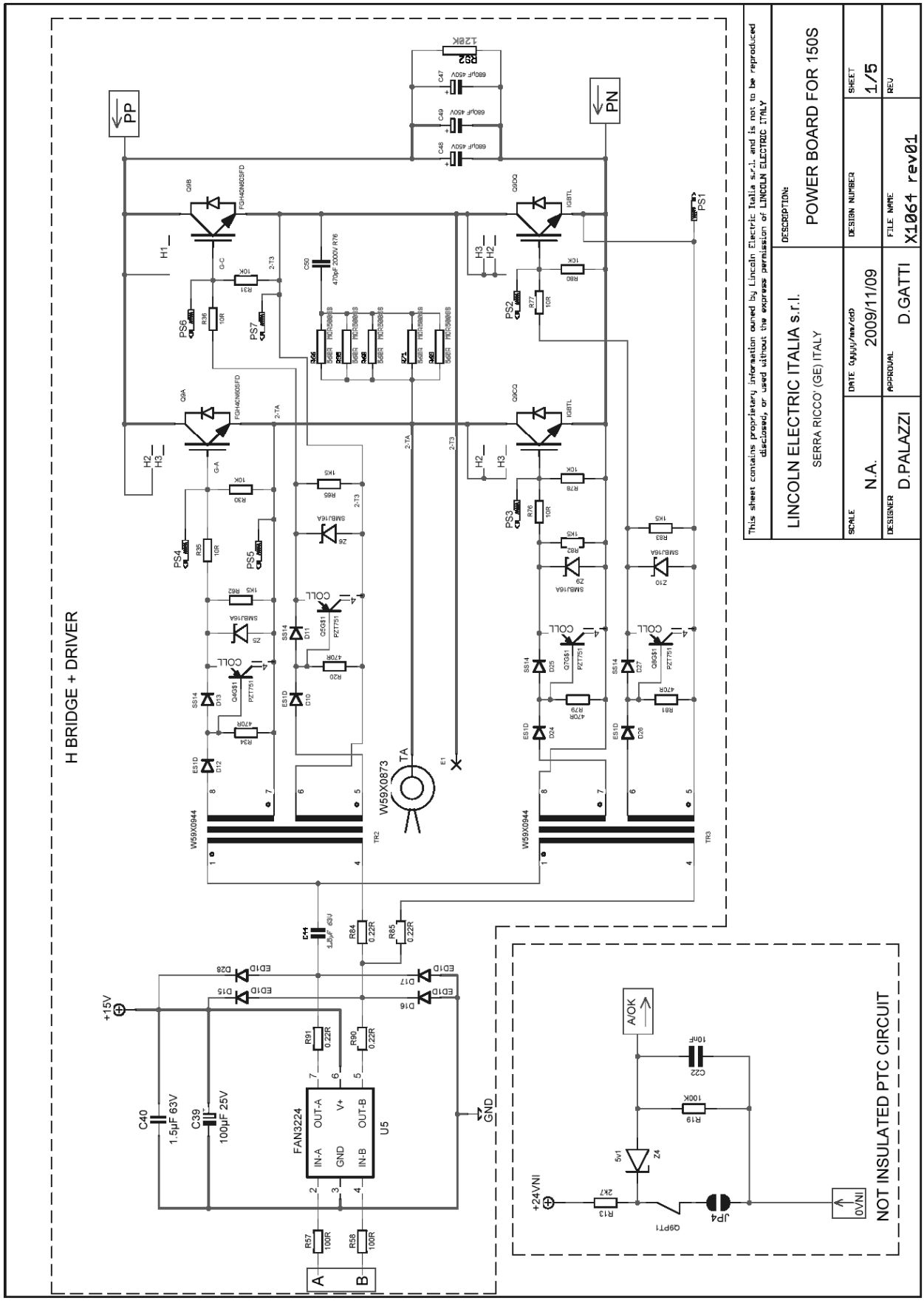
ELECTRICAL DIAGRAMS

Wiring Diagram X1039



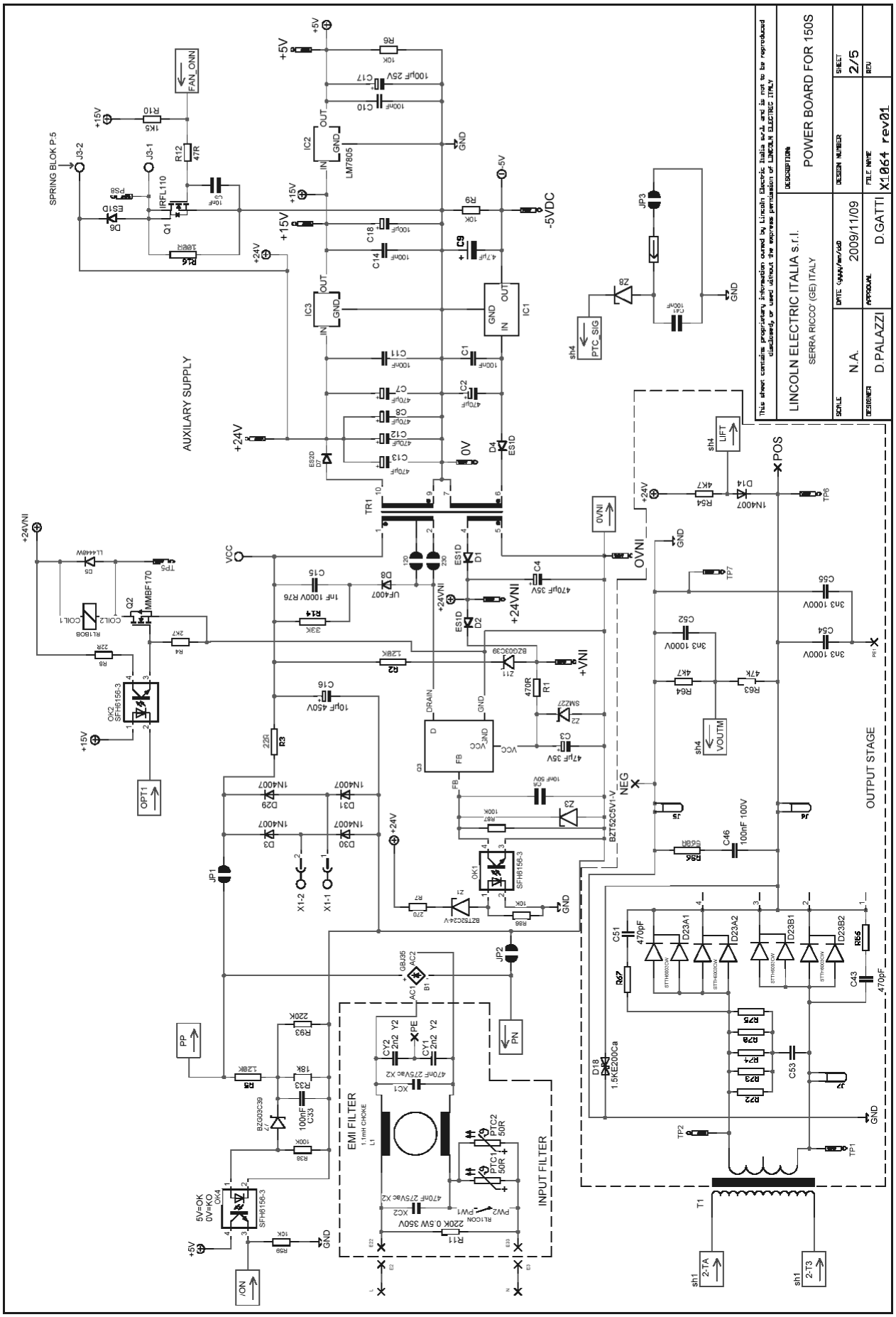
ELECTRICAL DIAGRAMS

Main Board Schematic X1064. Page 1/4



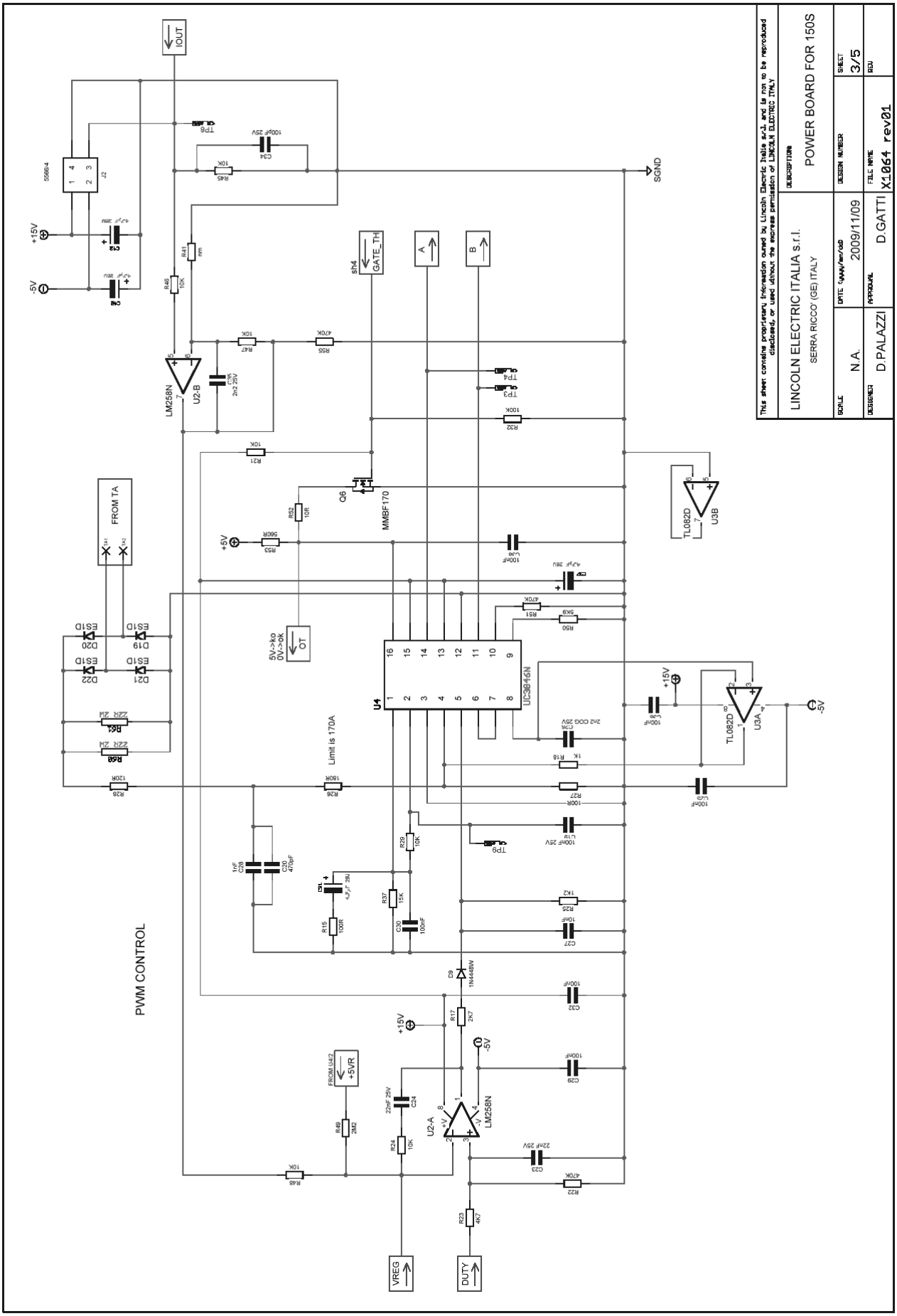
ELECTRICAL DIAGRAMS

Main Board Schematic X1064. Page 2/4



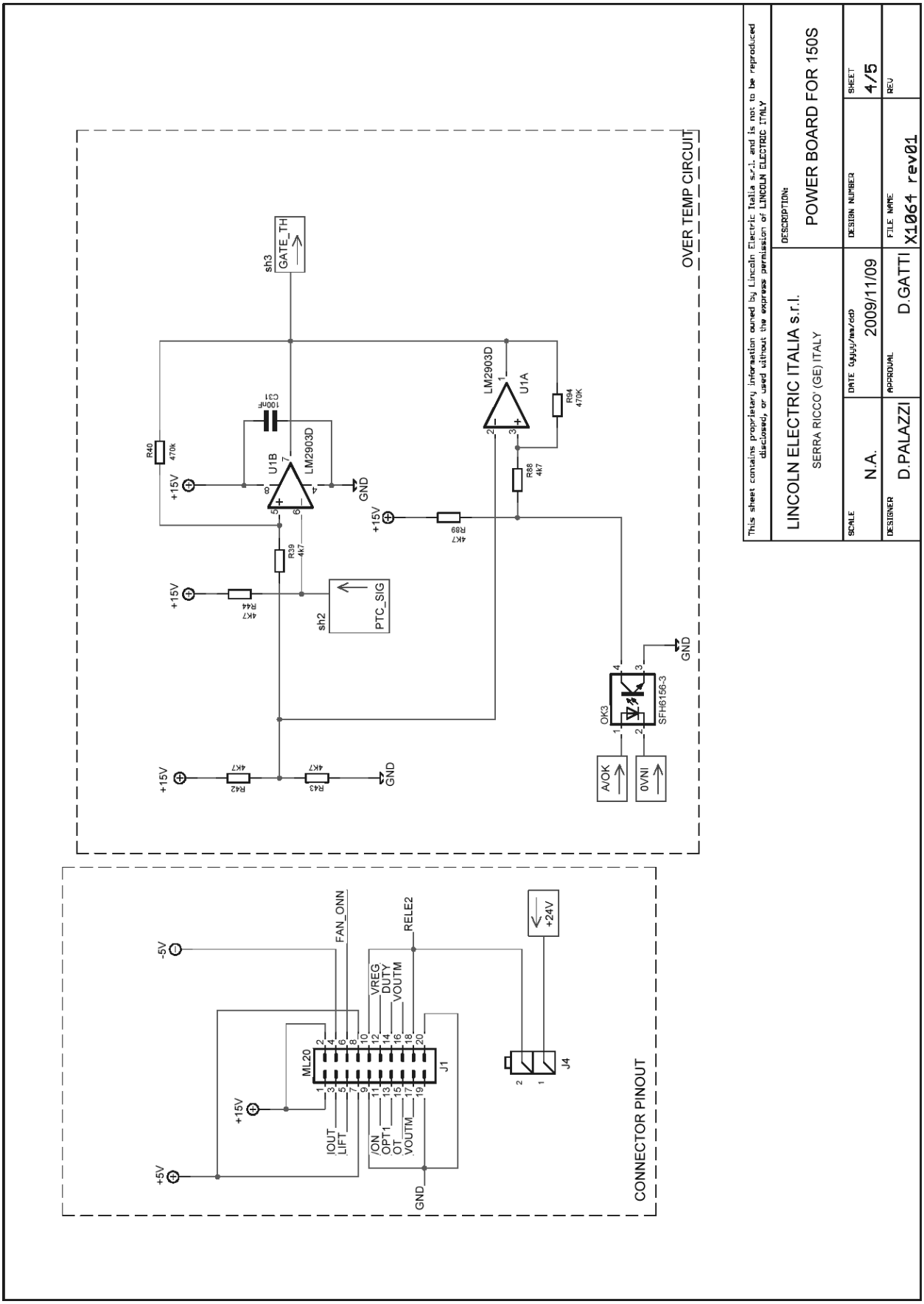
ELECTRICAL DIAGRAMS

Main Board Schematic X1064. Page 3/4



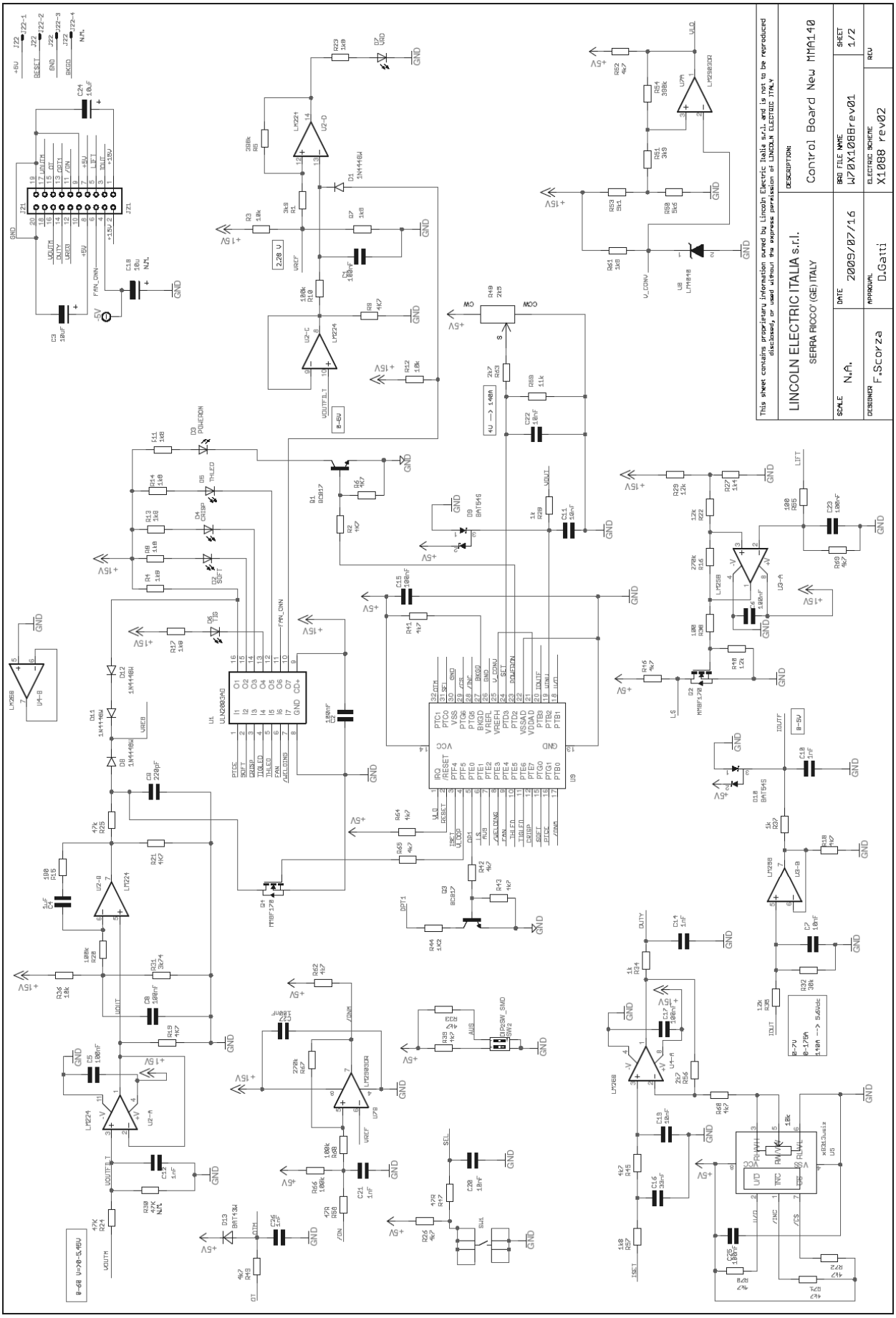
ELECTRICAL DIAGRAMS

Main Board Schematic X1064. Page 4/4



ELECTRICAL DIAGRAMS

Control Board Schematic X1088



NOTE