**SVM 2038**
Rev.00 12-2012

# INVERTEC® 160SX

*For use with machines having code numbers:* 52101


## SERVICE MANUAL

LINCOLN ELECTRIC EUROPE
www.lincolnelectric.

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# TECHNICAL SPECIFICATIONS

| INPUT | | | |
|---|---|---|---|
| Input Voltage Range<br>from 115 to 230Vac ±15%<br>Single Phase | Input Power at Rated Output<br>3.07kVA @ 100% Duty Cycle<br>5.17kVA @ 30% Duty Cycle | EMC Class<br>A | Frequency<br>50/60Hz |

| RATED OUTPUT AT 40°C | | |
|---|---|---|
| Duty Cycle (@ Input Voltage)<br>(Based on a 10 min. period) | Output Current | Output Voltage |
| 100% (@ 115Vac) | 70A | 22.8Vdc (Stick) |
| 30% (@ 115Vac) | 100A | 24.0Vdc (Stick) |
| 100% (@ 115Vac) | 100A | 14.0Vdc (TIG) |
| 30% (@ 115Vac) | 150A | 16.0Vdc (TIG) |
| 100% (@ 230Vac) | 100A | 24.0Vdc (Stick) – 14.0Vdc (TIG) |
| 30% (@ 230Vac) | 160A | 26.4Vdc (Stick) – 16.4Vdc (TIG) |

| OUTPUT RANGE | |
|---|---|
| Welding Current Range<br>5 – 160A | Maximum Open Circuit Voltage<br>≤80Vdc (CE model)<br>12Vdc (AUSTRALIA model) |

| RECOMMENDED INPUT CABLE AND FUSE SIZES | |
|---|---|
| Fuse (delayed) or<br>Circuit Breaker (“D” characteristic) Size<br>16A | Input Power Cable<br>3 x 2.5mm$^2$ |

| PHYSICAL DIMENSIONS | | | |
|---|---|---|---|
| Height<br>244mm | Width<br>148mm | Length<br>385mm | Weight<br>9.0kg |
| Operating Temperature<br>-10°C to +40°C | | Storage Temperature<br>-25°C to +55°C | |

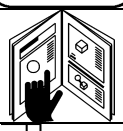
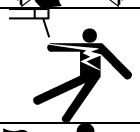
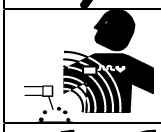
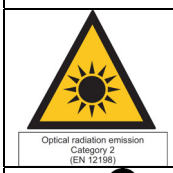
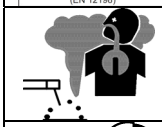
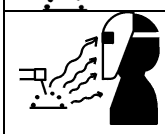
# Accessories

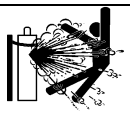
| | |
|---|---|
| K10513-17-4V | TIG torch with tap, 4m. |
| K10513-17-8V | TIG torch with tap, 8m. |

# SAFETY

## 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 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

The Invertec 160SX is a wide input voltage range: before installing and turning it on, check the supplied input voltage, phase, and frequency. The allowable input voltage range, phase, and frequency are indicated in the technical specification section of this manual and on the machine's rating plate. 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

The machine is 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: from 115V to 230V ± 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.

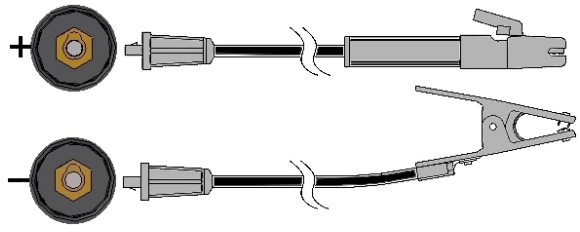
## Output Connections

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.

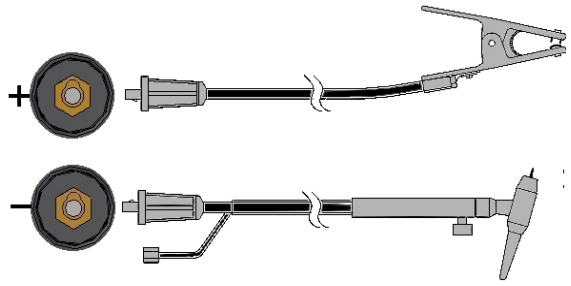



Connect the electrode cable to the (+) terminal and the work clamp to the (-) terminal. Insert the connector with the key lining up with the keyway and rotate approximately ¼ turn clockwise. Do not over tighten.

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:

- 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 all LEDs are turned ON then OFF. After that the Power ON LED blinks until the machine has completed the Start-Up sequence.

- 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.

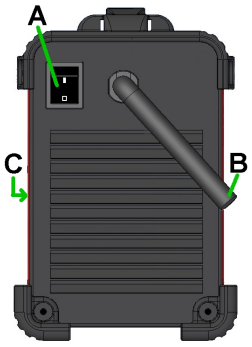

### Front Panel Controls

| | |
|---|---|
|  | 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. |
|  | 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. |
|  | 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.<br><br>**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).<br><br>**The VRD LED is ON** when the Output Voltage is below 12V with the Machine at idle (no welding time).<br><br>For others machines this function is disabled (the LED is always OFF). |

| | |
|---|---|
|  | Welding Mode Switch: With three positions, controls the welding mode of the machine: two for Stick welding (Soft and Crisp) and one for Lift TIG welding.<br>• Soft Stick: For a welding with a low spatter presence.<br>• Crisp Stick: For an aggressive welding, with an increased Arc stability.<br>• 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. |
|  | Meter: The meter displays the preset welding current before welding and the actual welding current during welding. |

**Error condition list.**
If occurs, try to turn Off the machine, wait for a few seconds, then turn ON again. If the error remains, a maintenance is required. Please contact the nearest technical service center or Lincoln Electric and report the 3-digit code displayed on the meter of the Front Panel.

| Error code table<br>Slow blinking: about 1 time per second<br>Fast blinking: about 10 time per second | |
|---|---|
| 9.01 | **Input overvoltage**<br>LED is blinking slow.<br>Indicates that an Input Voltage Overrange protection is active; the Machine restarts automatically when the Input Voltage returns in the correct range. |
| 9.02 | **Input undervoltage**<br>LED is blinking fast.<br>Indicates that an Input Voltage Underrange protection is active; the Machine restarts automatically when the Input Voltage returns in the correct range. |
| 9.03 | **DC bus short circuit**<br>LEDs blinks slow together.<br>Indicates that an Internal Power Circuitry fault condition is detected.<br><br>To restore the machine:<br>Turn OFF then ON the Mains Switch to restart the machine. |
| 9.04 | **Boost voltage lock out**<br>LEDs blinks slow alternatively.<br>Indicates that an Internal Auxiliary Voltage fault condition is detected.<br><br>To restore the machine:<br>Turn OFF then ON the Mains Switch to restart the machine. |
| 9.05 | **Inverter voltage lock out**<br>LEDs blinks fast alternatively.<br>Indicates that an Internal Auxiliary Voltage fault condition is detected.<br><br>To restore the machine:<br>Turn OFF then ON the Mains Switch to restart the machine. |
| 9.06 | **DC bus overvoltage**<br>LEDs blinks slow together.<br>Indicates that an Internal DC bus Overvoltage condition is detected.<br><br>To restore the machine:<br>Turn OFF then ON the Mains Switch to restart the machine. |
| 9.09 | **Communication lost**<br>All LEDs are OFF. The display shown “9.09”.<br>Indicates that a fault condition in the communication bus is detected.<br><br>To restore the machine:<br>Turn OFF then ON the Mains Switch to restart the machine. |




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

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

C. Fan: This machine has a F.A.N. (Fan As Needed) circuitry inside. The machine automatically turns it ON or 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 will be turned OFF and, at same time, the output will be disabled. To restore the output and the fan, simply restart to weld.

# Electromagnetic Compatibility (EMC)

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 is compliant with EN 61000-3-12 and EN 61000-3-11 if the public low voltage system impedance at the point of common coupling is lower than 0,34 Ω. It is the responsibility of the installer or user of the equipment to ensure, by consultation with the distribution network operator if necessary, that the system impedance complies with the impedance restrictions.

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

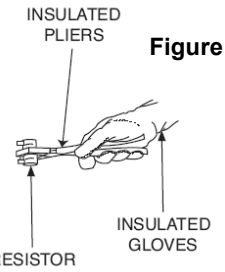
**ELECTRIC SHOCK** can kill

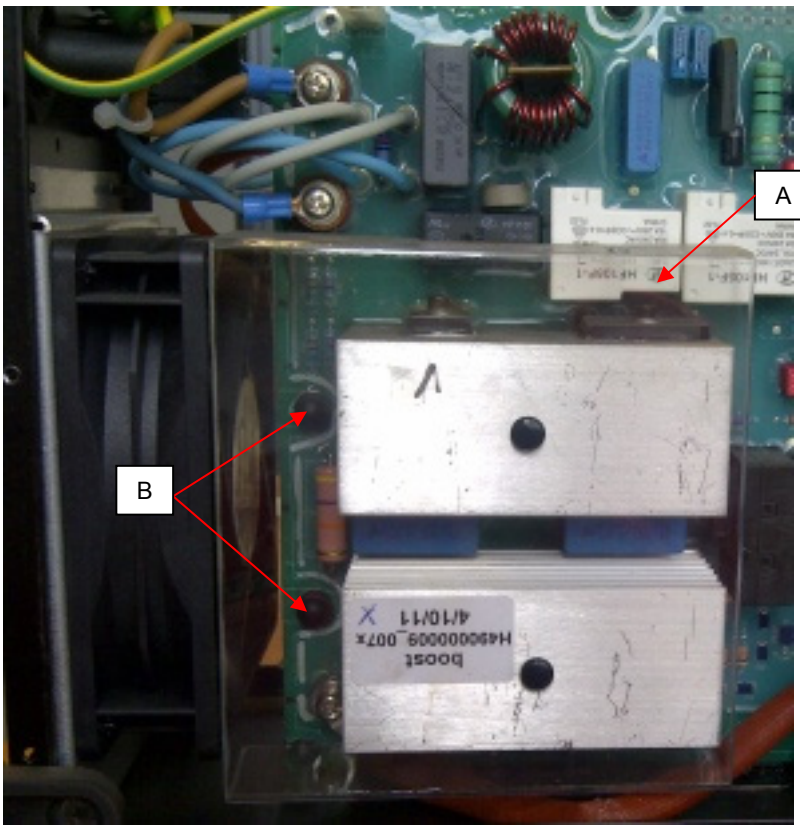
Have an electrician install and service this equipment
Turn the input power off at the fuse box before working on equipment
Do not touch electrically hot parts
Prior to performing preventive maintenance, perform the following capacitor discharge procedure to avoid electric shock.

## INPUT FILTER CAPACITOR DISCHARGE PROCEDURE

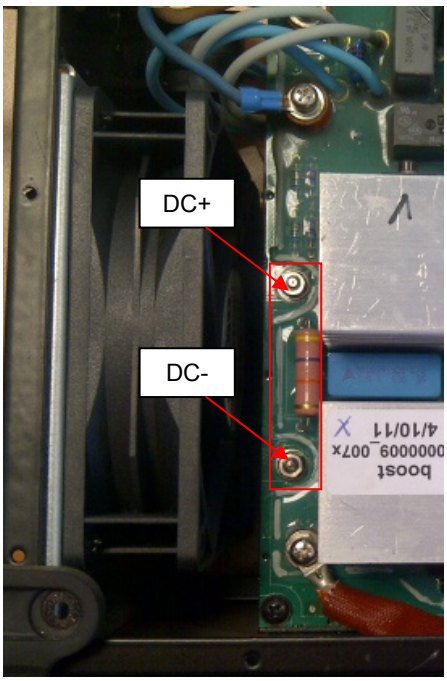
1. Remove input power to Invertec® 160SX
2. Remove the cover following the instruction available in this Service manual.
3. Obtain a high resistance and high wattage resistor ( 500-1000 ohms and 25 watts minimum ). This resistor is NOT supplied with the machine. NEVER USE A SHORTING STRAP FOR THIS PROCEDURE.
4. Remove the transparent plexiglass protection (A) and the two insulating caps (B), **See Figure 1**
5. Locate, under the insulating caps, the two terminals **DC+** and **DC –** on the Input Boost Board. **See Figure 2**
6. Use electrically insulate gloves and insulated pliers, **See Figure 2a**. Hold the body of the resistor and connect the resistor leads across the two terminals. Hold the resistor in place for 10 seconds. DO NOT TOUCH CAPACITOR TERMINALS WITH YOUR BARE HANDS.
7. Check the voltage across the two terminals. Voltage should be zero. If any voltage remains, repeat this procedure.

**Figure 2a**




**INPUT BOOST BOARD**
**Figure 1**




**INPUT BOOST BOARD**
**Figure 2**

## 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

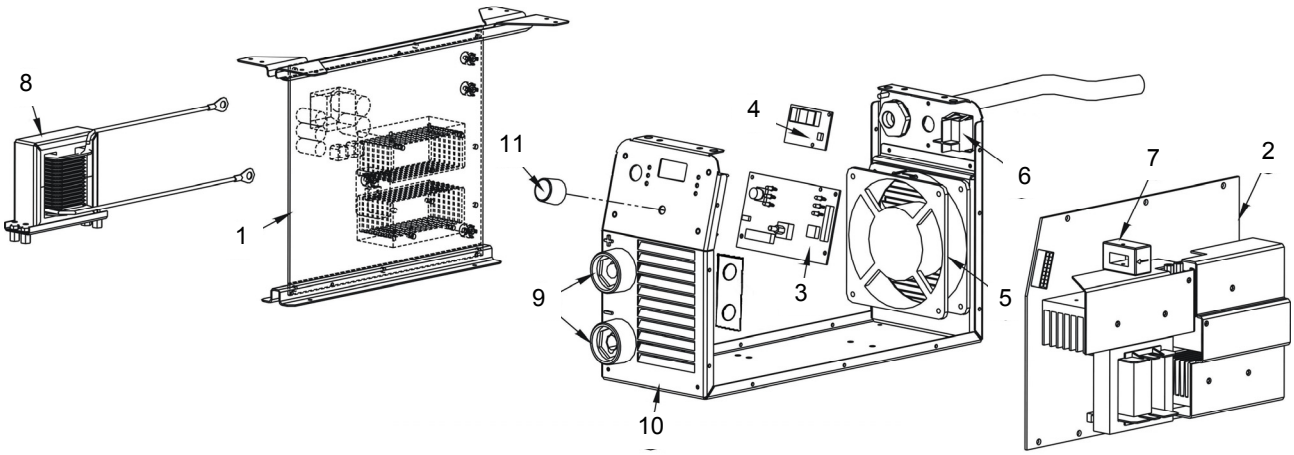
Thermal detection device protect the machine from excessive operating temperatures. Excessive temperatures may be caused by a lack of cooling air or operating the machine beyond the duty cycle and output rating. If excessive operating temperatures should occur, the yellow LED will light and the detection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

# INVERTEC® 160SX

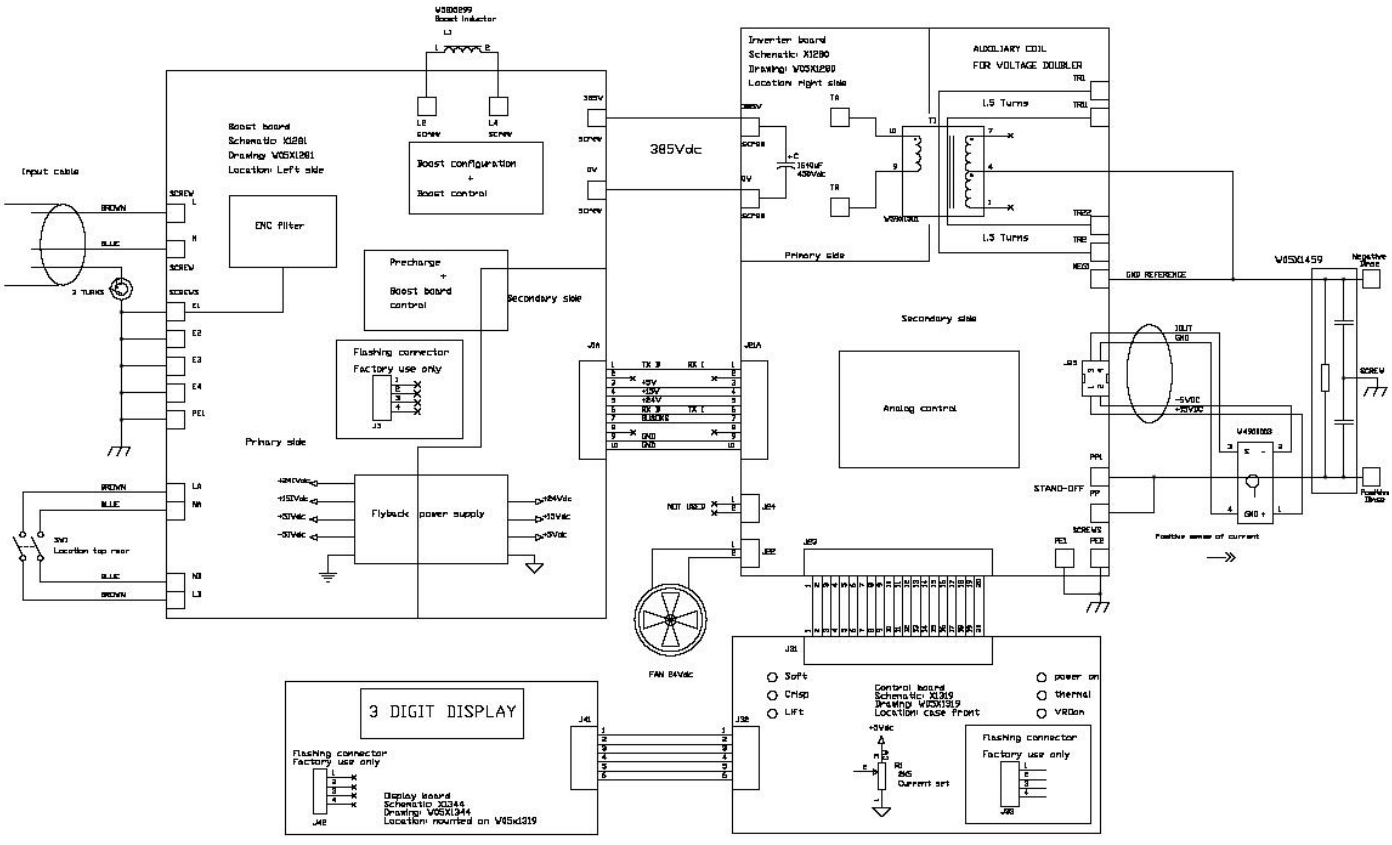
1. Input Boost Board
2. Inverter Board
3. Control Board
4. Display Board
5. Fan
6. Mains Switch
7. Hall Sensor
8. Boost Inductance
9. Output Studs
10. Main Frame
11. Knob



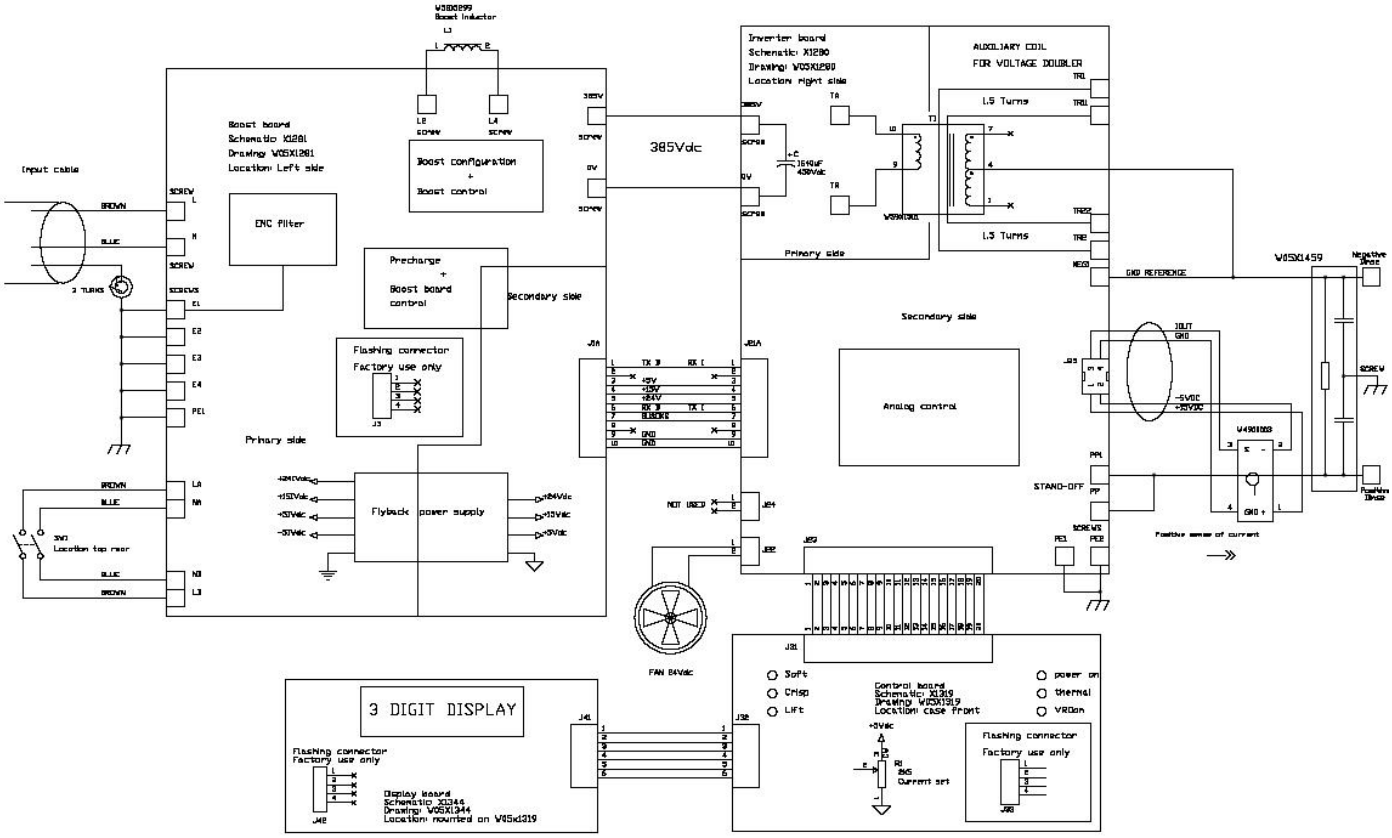
# THEORY OF OPERATION

- General description
- Main Input Switch, Input Rectifier, Soft/Start Input Relay, Boost and Power Factor Correction, Auxiliary Voltages Board
- Inverter Board, Output Section
- Control Board and Display Board
- Protection Circuits
- IGBT operation

## BLOCK DIAGRAM



# GENERAL DESCRIPTION



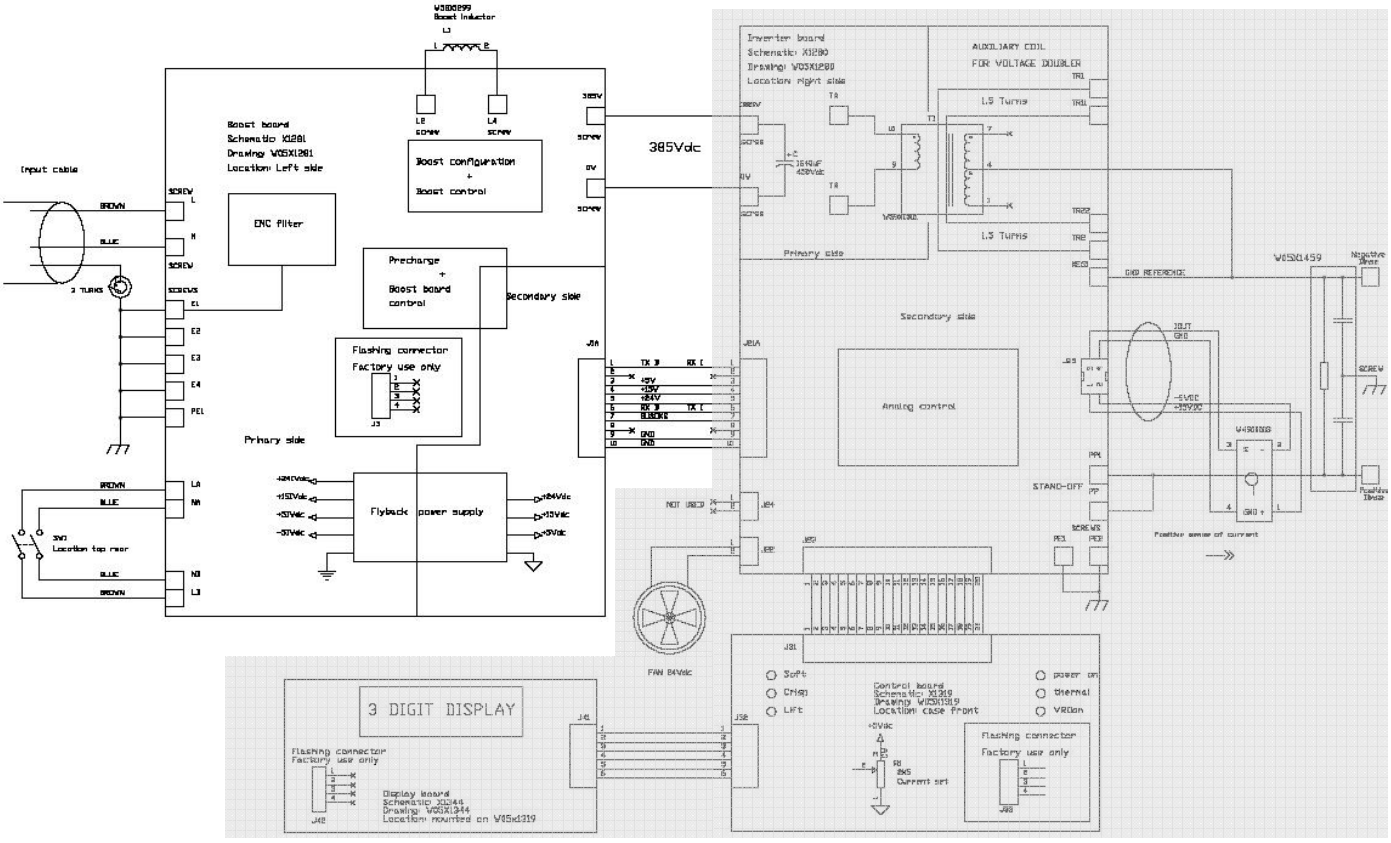

## GENERAL DESCRIPTION

The INVERTEC® 160SX is an industrial arc welding power source which utilizes single phase input power, to produce regulated constant current output. The welding response of this Invertec has been optimized for stick (SMAW) and LIFT TIG (GTAW). The unit is ideal for industrial applications where portability is important.
The INVERTEC® 160SX produce a welding output from 5 to 160 amperes. It will operate on single phase input power from 115VAC to 230VAC. It is environmentally hardened to an IP23 rating for operating in difficult environments.

## EMC FILTER

EMC filter circuit, parts of the Boost PCB, prevents noise from the machine from being transmitted along the main power line and vice versa, necessary to be in accordance with all relevant directives and standards.

# MAIN INPUT SWITCH, INPUT RECTIFIER, SOFT START/INPUT RELAY, BOOST AND POWER FACTOR CORRECTION, AUXILIARY VOLTAGES BOARD




## MAIN INPUT SWITCH, INPUT RECTIFIER, SOFT START/INPUT RELAY, BOOST AND POWER FACTOR CORRECTION, AUXILIARY VOLTAGES BOARD

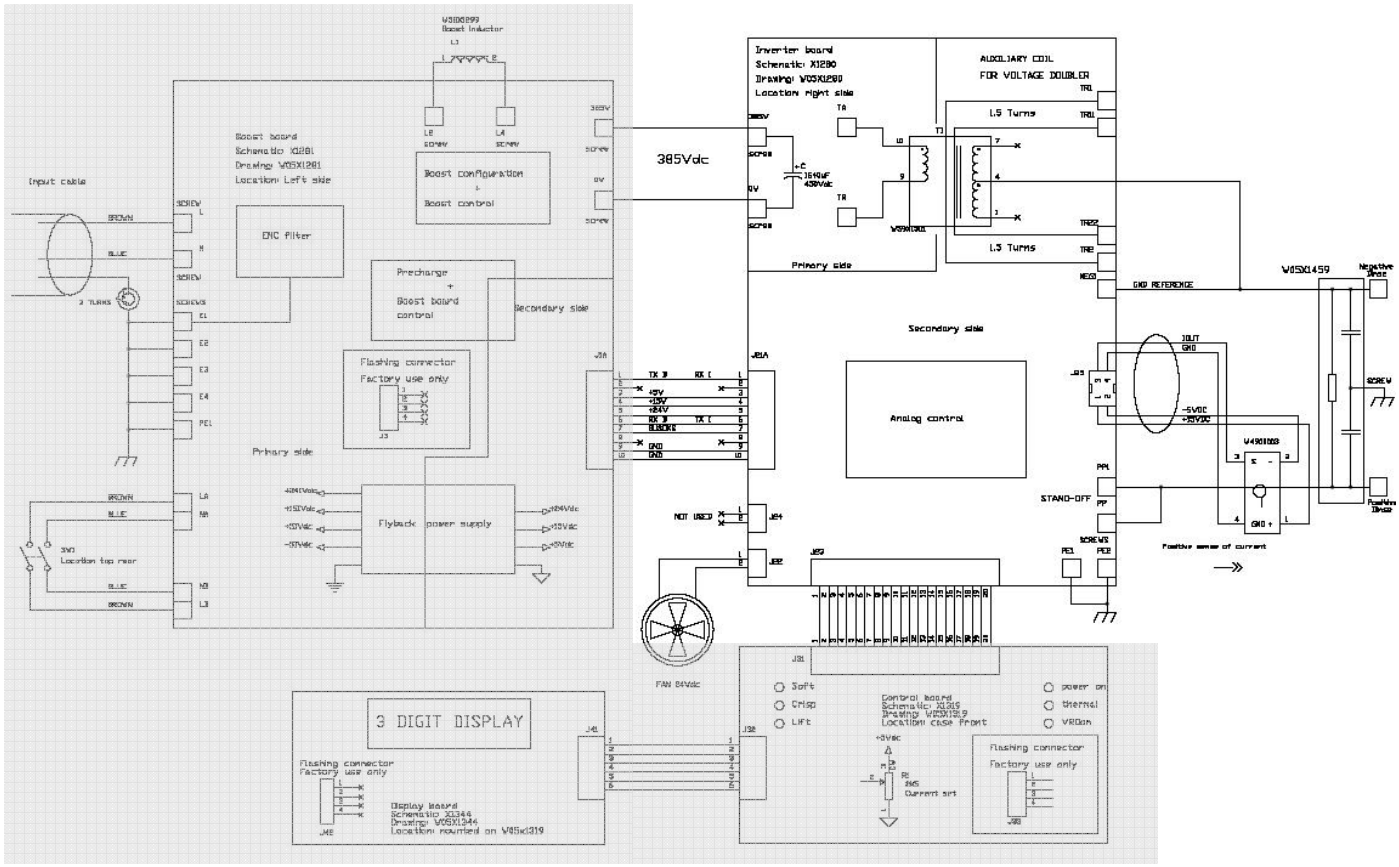
The INVERTEC® 160SX can be connected from 115Vac to a 230Vac +/- 15% single phase input voltage.
This unit can be also connect to engine driven generators but it must follow the below conditions:

- Vac peak voltage: below 410V.
- Vac frequency: in the range of 50 and 60 Hertz.
- RMS voltage of the AC waveform: from 115Vac to 230Vac ± 15%.

The INVERTEC® 160SX automatically adjusts to operate with different AC input voltages. No reconnect switch settings are required.

The AC input power is connected to the Boost Board. First stage on the Boost board is the RFI filter than the AC input power is applied to an input rectifier through a soft-start circuit consisting of a 50 ohm PTC and a relay.
The Boost board uses the incoming voltage also to create the auxiliary voltages. These auxiiary voltages are used to power the circuitry of the unit. Under normal operating conditions the Boost board activates the soft start relay RL3 after input power is applied to the machine. The 50 ohm PTC will be“shorted out” by the relays RL1 contacts as soon as the correct value is detected across the DC bus capacitors by the Boost logic circuit. The boost switch is active when the input voltage is below 385 Vdc. The output of the Boost circuit is filtered and applied to the IGBT controlled full wave bridge inverter.

# INVERTER BOARD (INVERTER-OUTPUT)




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

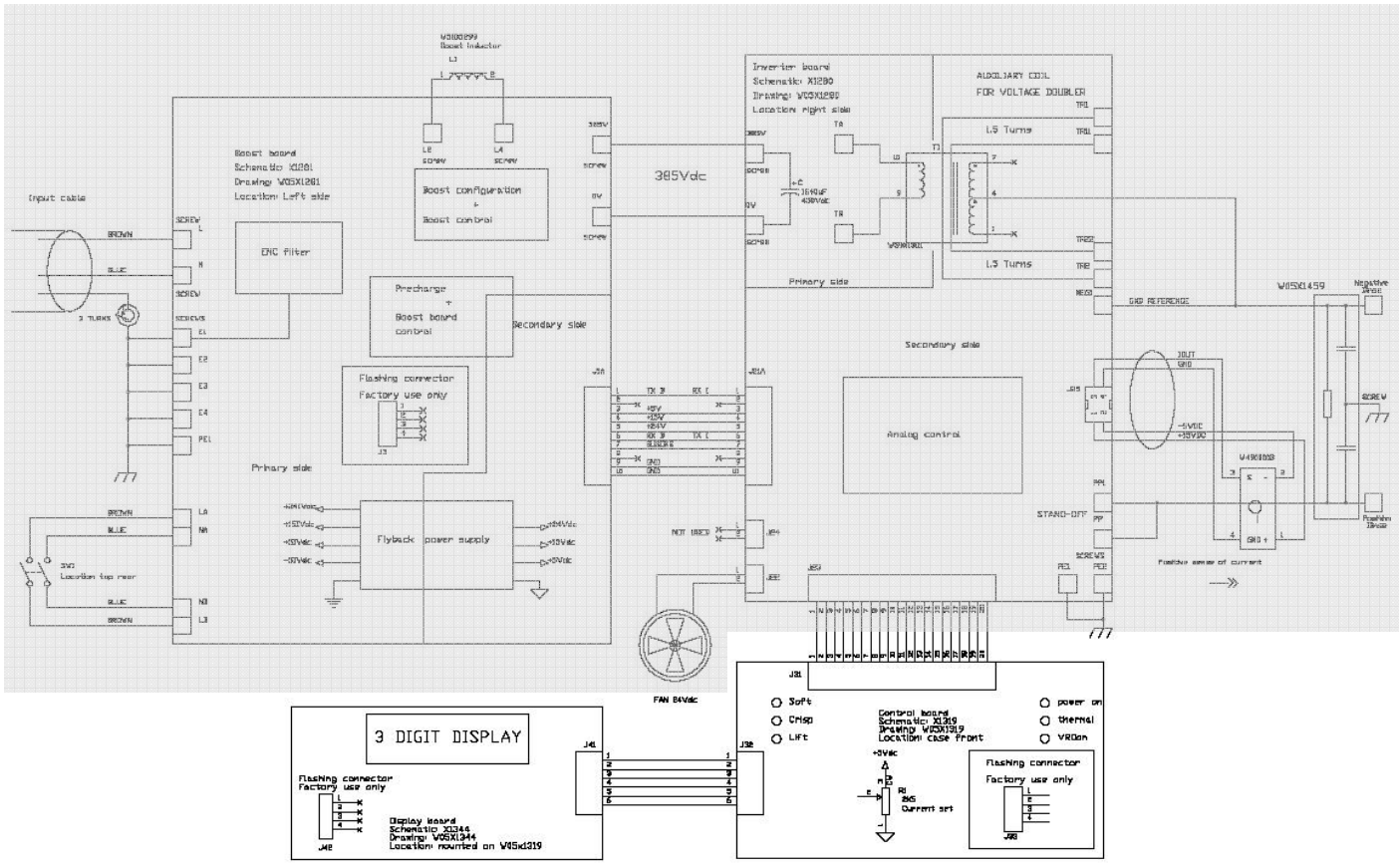
When the input filter capacitors are fully charged they act as power supplies for the IGBT switching circuit.
The IGBTs supply the main transformer winding with 70KHz current flow.
The IGBTs act as a switch assembly. This assembly feeds the primary winding of the main transformer. When current is pulsed 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 and to the output rectifier bridge heatsink.

The main transformer, located outside the inverter board, insulate the primary circuit from the secondary circuit.

The output circuit is also part of the Inverter board and the 4 rectifier modules receive the high frequency AC output from the main transformer secondary winding and rectifies it to a DC voltage level. A doubler circuit increase the output voltage to be able to perform cellulosic welding; a filtered DC output is applied to the machine's output terminals.
An output hall current probe read the output current and send the signal to the analog control loop that manage the output current.

# CONTROL BOARD AND DISPLAY BOARD




## Control Board (User Interface) and Display Board

Control Board takes signals (Iout, Vout, Iset), shows the proper value on the display and generate the proper set reference for inverter board: manages stick function (soft crisp,hot start, arc force, antisticking). Manages input error (overvoltage), fan and thermal error. Information exchange with Inverter and Boost board are via serial protocol. The Weld Controller is a micro-processor that uses these signals along with input from the Mode Switch and 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 Controller 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® 160SX is 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 three thermal devices located on the output diodes, inverter IGBT and Boost IGBT heatsinks; they 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 devices are 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.

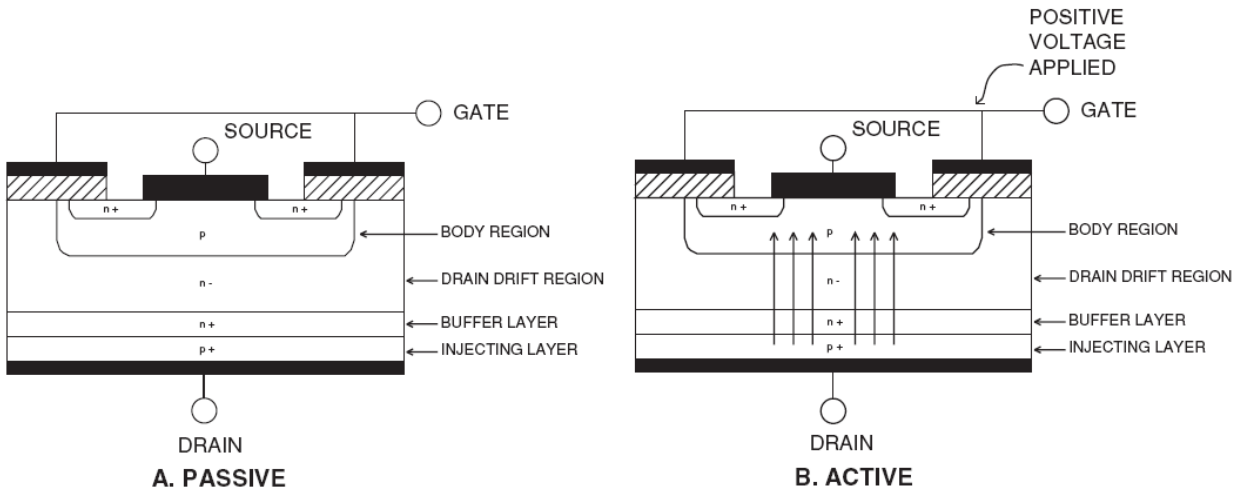
---

## 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.

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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 TEST**S. 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

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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.**

| 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<br>• ELECTROLYTIC CAPACITORS FAILURE<br>• BOOST IGBTs SHORT CIRCUITED | • PERFORM THE BOOST BOARD RESISTANCE TEST | • REPLACE THE BOOST BOARD |
| THE MACHINE IS DEAD, NO OUTPUT | • THERE IS NO POWER SUPPLY ON LINE<br>• THE POWER SUPPLY CABLE IS INTERRUPTED<br>• LINE SWITCH FAILURE<br>• THE BOOST BOARD IS DAMAGED | • CHECK THE PHASE INPUT VOLTAGE ON THE MACHINE<br>• CHECK THE POWER SUPPLY CABLE<br>• CHECK THE LINE SWITCH<br>• PERFORM THE RESISTANCE AND VOLTAGE TEST | • RECONNECT THE POWER SUPPLY<br>• REPLACE THE INPUT POWER CABLE<br>• REPLACE THE LINE SWITCH<br>• REPLACE THE BOOST BOARD |
| POWER GREEN LED ON FRONT PANEL IS FLASHING | • BOOST BOARD DEFECT<br>• CONTROL BOARD DEFECT | • PERFORM THE BOOST VOLTAGE CHECKS (FOCUS ON "BUSOKS" SIGNAL) | • REPLACE THE BOOST BOARD<br>• REPLACE THE CONTROL BOARD |
| ERROR 9.01 ON DISPLAY AND POWER GREEN LED ON FRONT PANEL IS FLASHING SLOW | • INPUT VOLTAGE OVER RANGE | • CHECK THE LINE VOLTAGE | • CONNECT THE MACHINE TO A VOLTAGE LINE THAT IS BETWEEN THE MACHINE RANGE OF 115 TO 230Vac +/-15% |
| ERROR 9.02 ON DISPLAY AND POWER GREEN LED ON FRONT PANEL IS FLASHING FAST | • INPUT VOLTAGE UNDER RANGE | • CHECK THE LINE VOLTAGE | • CONNECT THE MACHINE TO A VOLTAGE LINE THAT IS BETWEEN THE MACHINE RANGE OF 115 TO 230Vac +/-15% |
| ERROR 9.03 ON DISPLAY AND POWER GREEN LED, THERMAL LED, VRD LED ON FRONT PANEL ARE FLASHING SLOW | • INTERNAL POWER CIRCUITRY FAULT ON BOOST OR INVERTER | • PERFORM THE BOOST AND INVERTER RESISTANCE AND VOLTAGE CHECKS | • REPLACE THE BOOST OR THE INVERTER BOARD |
| ERROR 9.04 ON DISPLAY AND POWER GREEN LED, THERMAL LED, ON FRONT PANEL ARE FLASHING SLOW ALTERNATIVELY | • INTERNAL BOOST PRIMARY AUXILIARY VOLTAGE FAULT ( +15/1 ON BOOST BOARD OUT OF RANGE) | • PERFORM THE BOOST VOLTAGE CHECKS (FOCUS ON 15/1 VOLTAGE) | • REPLACE THE BOOST BOARD |
| ERROR 9.05 ON DISPLAY AND POWER GREEN LED, THERMAL LED, ON FRONT PANEL ARE FLASHING FAST ALTERNATIVELY | • INTERNAL INVERTER SECONDARY AUXILIARY VOLTAGE FAULT (+15Vdc ON SECONDARY CIRCUIT OUT OF RANGE) | • PERFORM THE BOOST AND INVERTER VOLTAGE CHECKS (FOCUS ON 15Vdc) | • REPLACE THE BOOST OR INVERTER BOARD |
| ERROR 9.06 ON DISPLAY AND POWER GREEN LED, THERMAL LED, ON FRONT PANEL ARE FLASHING SLOW TOGETHER | • DC BUS OVERVOLTAGE CONDITION | • PERFORM THE BOOST VOLTAGE CHECKS | • REPLACE THE BOOST BOARD |
| ERROR 9.09 ON DISPLAY AND ALL LEDs ARE OFF | • FAULT IN THE COMMUNICATION BUS | • CHECK THE HARNESS BETWEEN BOOST/ INVERTER - INVERTER/CONTROL BOARD<br>• PERFORM THE BOOST BOARD VOLTAGE TESTS (FOCUS ON TX AND RX VALUES) | • REPLACE THE DEFECT HARNESS<br>• REPLACE THE BOOST BOARD |
| THE MACHINE SUPPLIES ALWAYS THE MAX OUTPUT CURRENT INDIPENDLY FROM POTENTIOMETER SETTING | • CURRENT SENSOR CABLE IS NOT CONNECTED<br>• MAIN BOARD FAILURE | • CHECK THE SENSOR CABLE CONNECTIONS | • CONNECT THE CABLE<br>• REPLACE THE MAIN BOARD |
| THE MACHINE DISPLAY SHOWS 190A ALWAYS AND THERE IS NO OUTPUT | • CURRENT SENSOR IS NOT CORRECTLY SUPPLIED | • CHECK FOR -5Vdc AT CURRENT SENSOR CONNECTOR BETWEEN PIN 2 AND 4 | • REPLACE INVERTER BOARD |

# 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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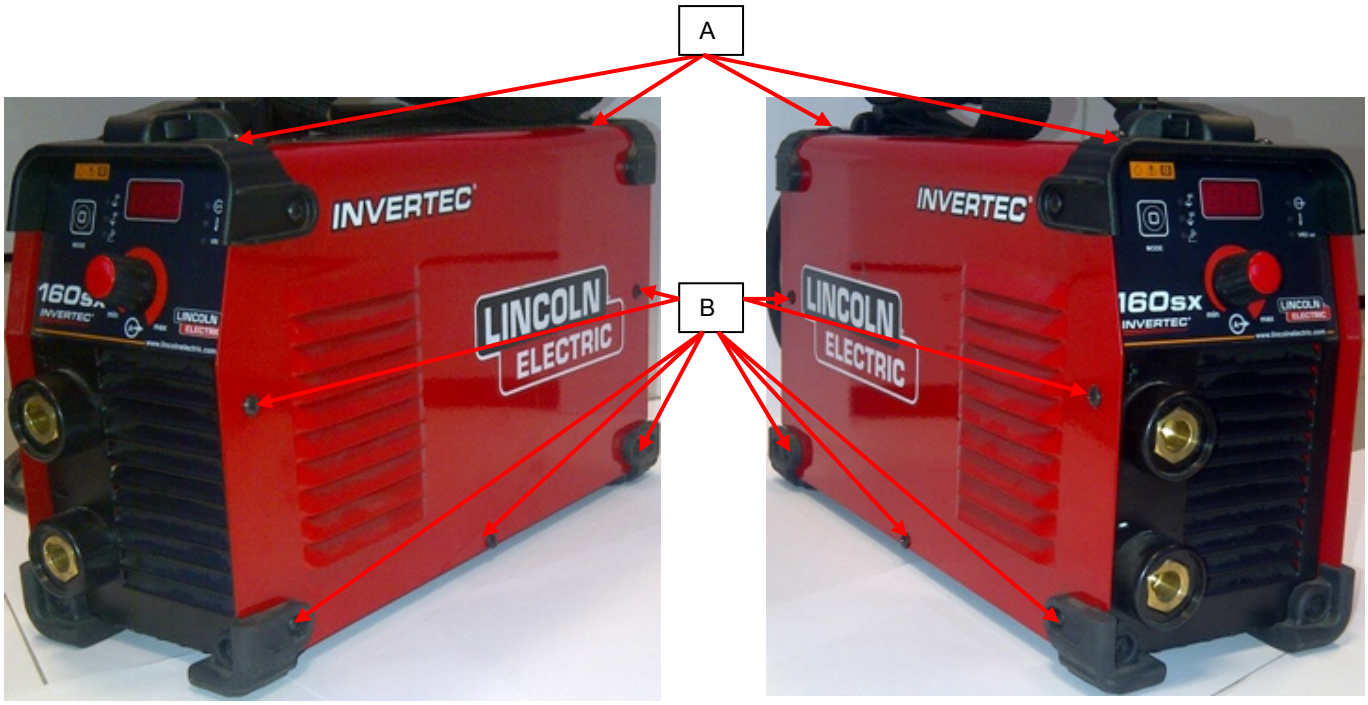
**DESCRIPTION**

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® 160SX - 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 supports (A). These screws are longer compared to the rest of the screws, keep them separate and use them back to these positions.
4. Remove the 10 screws of the wraparound (B).
5. Pull up the wraparound
6. Follow the next session to **perform the input filter discharge procedure**

# DC LINK CAPACITORS DISCHARGE PROCEDURE

WARNING

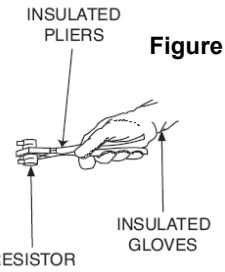
**ELECTRIC SHOCK** can kill

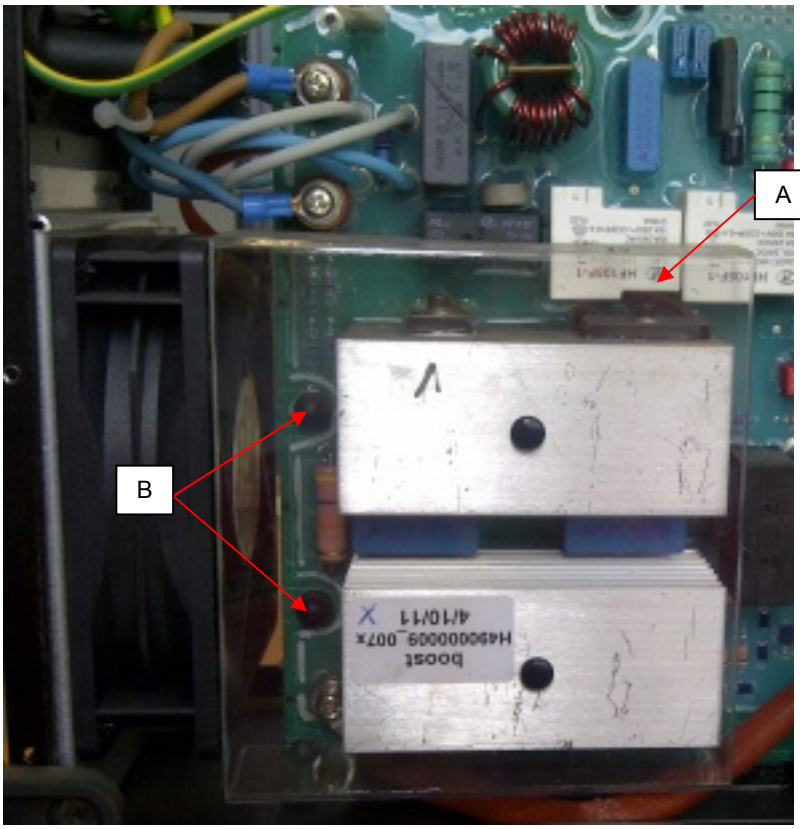
Have an electrician install and service this equipment.
Turn the input power off at the fuse box before working on equipment.
Do not touch electrically hot parts.
Prior to performing preventive maintenance, perform the following capacitor discharge procedure to avoid electric shock.

## INPUT FILTER CAPACITOR DISCHARGE PROCEDURE

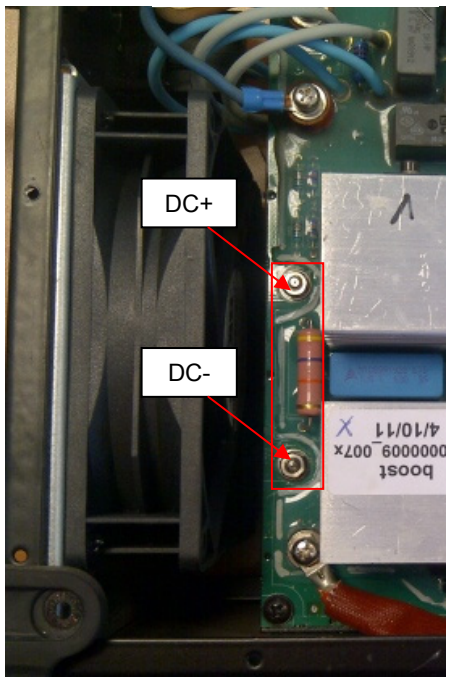
1. Remove input power to Invertec® 160SX
2. Remove the cover following the instruction available in this Service manual.
3. Obtain a high resistance and high wattage resistor ( 500-1000 ohms and 25 watts minimum ). This resistor is NOT supplied with the machine. NEVER USE A SHORTING STRAP FOR THIS PROCEDURE.
4. Remove the transparent plexiglass protection (A) and the two insulating caps (B), **See Figure 1**
5. Locate, under the insulating caps, the two terminals **DC+** and **DC –** on the Input Boost Board. **See Figure 2**
6. Use electrically insulate gloves and insulated pliers, **See Figure 2a**. Hold the body of the resistor and connect the resistor leads across the two terminals. Hold the resistor in place for 10 seconds. DO NOT TOUCH CAPACITOR TERMINALS WITH YOUR BARE HANDS.
7. Check the voltage across the two terminals. Voltage should be zero. If any voltage remains, repeat this procedure.

**Figure 2a**




**INPUT BOOST BOARD**
**Figure 1**




**INPUT BOOST BOARD**
**Figure 2**

# BOOST BOARD RESISTANCE TEST

## WARNING

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……..

**TEST DESCRIPTION**

This test will determine if the Boost Board is good or defect.

**MATERIALS NEEDED**

Volt/Ohmmeter
Wiring Diagram X1281

# BOOST BOARD RESISTANCE TEST (continued)

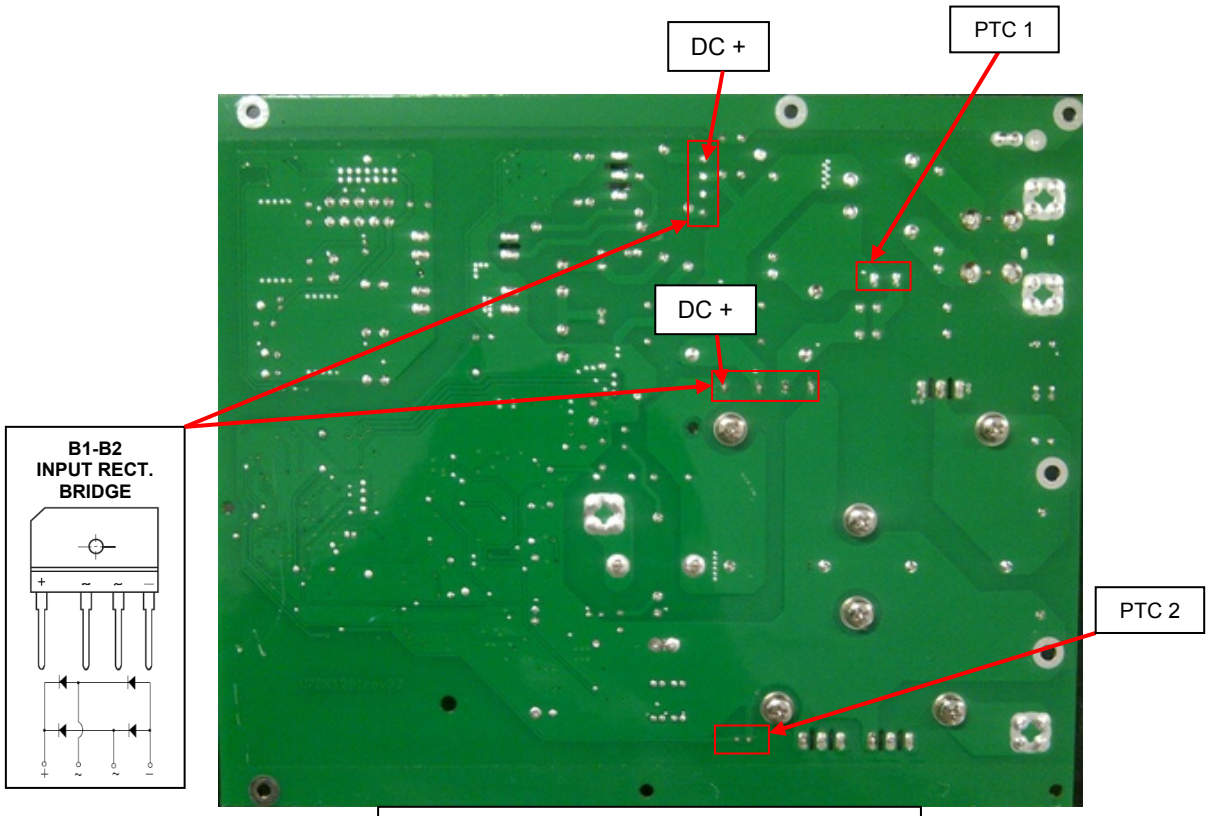


**Figure 1** – Boost Board

## TEST PROCEDURE

1. Remove main input power to the INVERTEC® 160SX
2. Perform the **Discharge procedure**
3. Follow the Boost Board disassembly operations available in this Service Manual.
4. Visually check for burned or damaged components.
5. If any components are physically damaged the main board should be replaced
6. Using the Volt-Ohmmeter (diode test mode) check the Input Rectifier Bridges **B1** and **B2** (see **Test Table 1**)
7. Using the Volt-Ohmmeter (ohm mode) check **PTC 1** value, shall be 50 Ohms @ 20°C, +/- 15%
8. Using the Volt-Ohmmeter (ohm mode) check **PTC 2** (IGBT heatsink) value, shall be 50 Ohms @ 20°C, +/- 15%

**Test Table 1 - Input Bridge B1 and B2 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 |

# BOOST BOARD RESISTANCE TEST (continued)

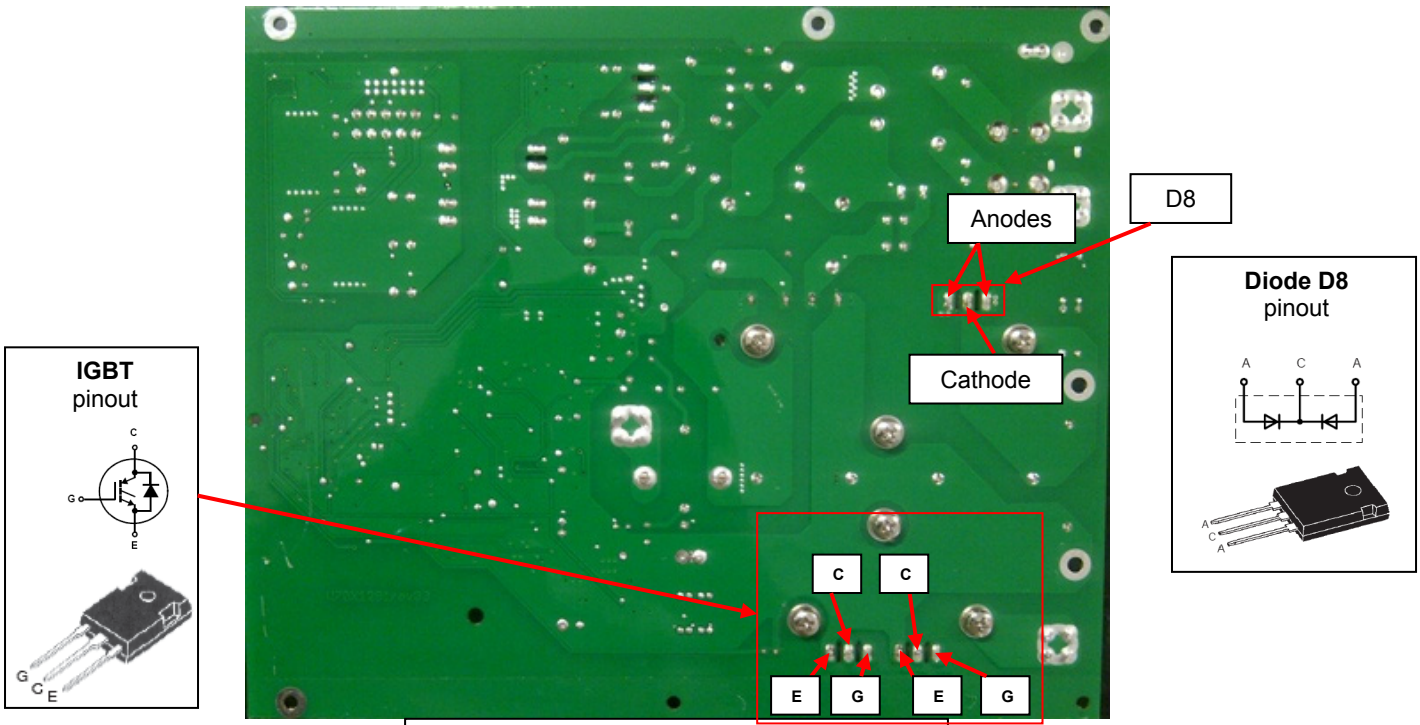


**Figure 1** – Boost Board

## TEST PROCEDURE

9. Check diode **D8**, with multimeter in diode test mode, for short, following the **Table tests 1**.
10. Check IGBT **Q5** and **Q6**, with multimeter in diode test mode, following the **Table tests 2**.

**Diode D8 – Table tests 1**

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

**IGBT Q5 and Q6 - Table tests 2**

| *Positive Probe (RED)* | *Negative Probe (BLACK)* | *Value* |
|---|---|---|
| Emitter (E) | Collector (C) | *0.3V - 0.7V* |
| Collector (C) | Emitter (E) | OPEN |
| Emitter (E) | Gate (G) | *0.15V - 0.2V* |

# INVERTER BOARD RESISTANCE TEST

## WARNING

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**TEST DESCRIPTION**

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

**MATERIALS NEEDED**

Volt/Ohmmeter
Wiring Diagram X1280

# INVERTER BOARD RESISTANCE TEST (continued)

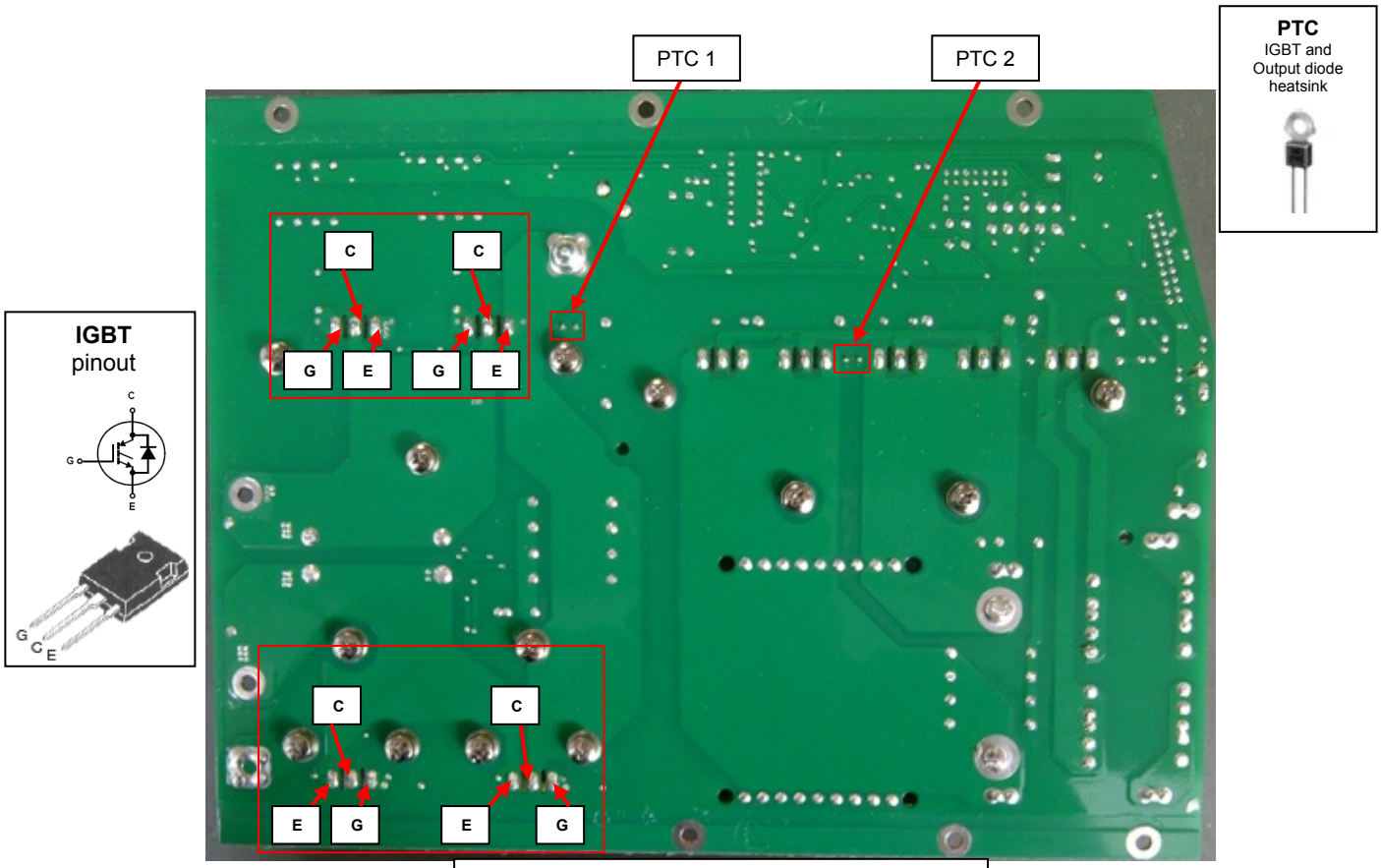



**Figure 1** – Inverter Board

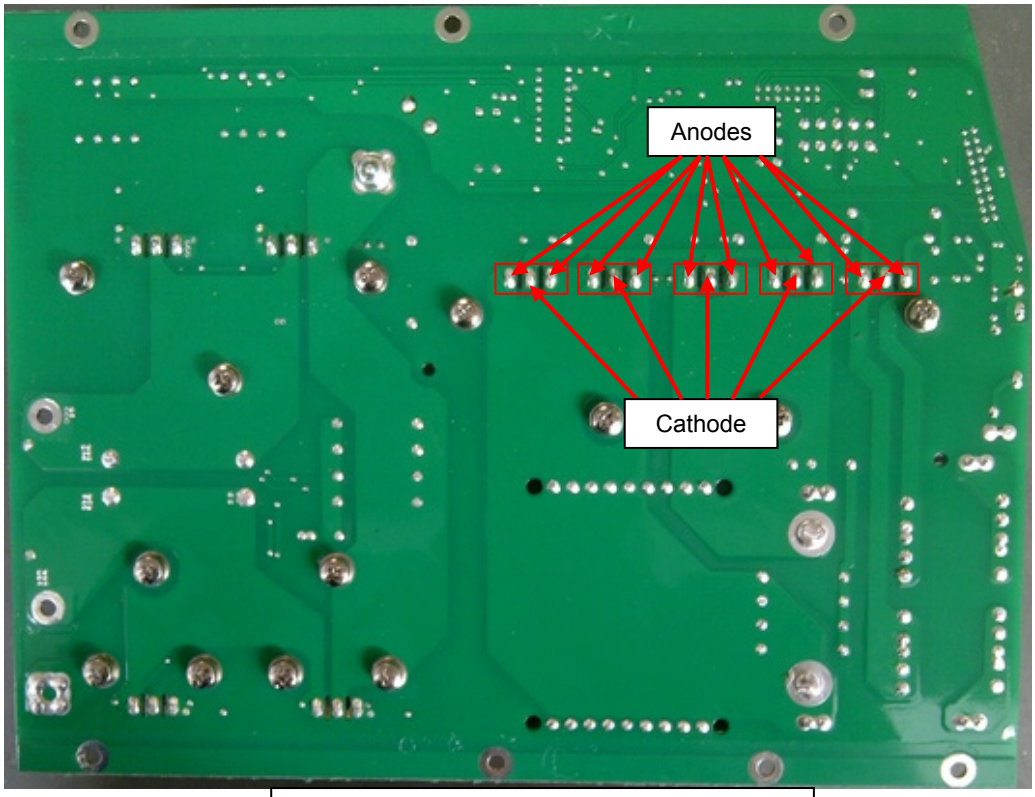
## TEST PROCEDURE

1. Remove main input power to the INVERTEC® 160SX
2. Perform the **Discharge procedure**
3. Follow the Inverter Board disassembly operations available in this Service Manual.
4. Visually check for burned or damaged components.
5. If any components are physically damaged the main board should be replaced
6. Using the Volt-Ohmmeter (ohm mode) check **PTC1** (IGBT heatsink), value shall be 46 Ohms @ 20°C +/- 10%, when mounted on the board.
7. Using the Volt-Ohmmeter (ohm mode) check **PTC2** (Output Diodes heatsink) value, shall be 40 Ohms +/- 10%, when mounted on the board.
8. Check each IGBT (Q9C1,Q9C2,Q11,Q12), with multimeter in diode test mode, following **Figure1** and the **Table tests 1** below.

**IGBT - Table tests 1**

| ***Positive Probe (RED)*** | ***Negative Probe (BLACK)*** | ***Value*** |
|---|---|---|
| Emitter (E) | Collector (C) | *0.3V - 0.7V* |
| Collector (C) | Emitter (E) | *Capacitors charge* |
| Emitter (E) | Gate (G) | *0.2V - 0.3V* |

# INVERTER BOARD RESISTANCE TEST (continued)



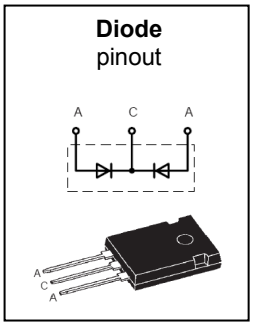




**Figure 1** – Inverter Board

9. Check the output diodes D15,D16,D17,D18,D24), with multimeter in diode test mode, for short, following the **Table tests 2** below (see **Figure 1**)

**Diode D15,D16,D17,D18,D24 – Table tests 2**

| Positive Probe (RED) | Negative Probe (BLACK) | Value |
|---|---|---|
| anode | cathode | 0.28V - 0.7V |
| cathode | anode | OPEN |

# BOOST BOARD VOLTAGE 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 help to determine if the correct input voltage is being applied to the boost board and also if the correct regulated voltages are being processed.

**MATERIALS NEEDED**

Volt/Ohmmeter
Wiring Diagram X1281

# BOOST BOARD VOLTAGE TEST (continued)

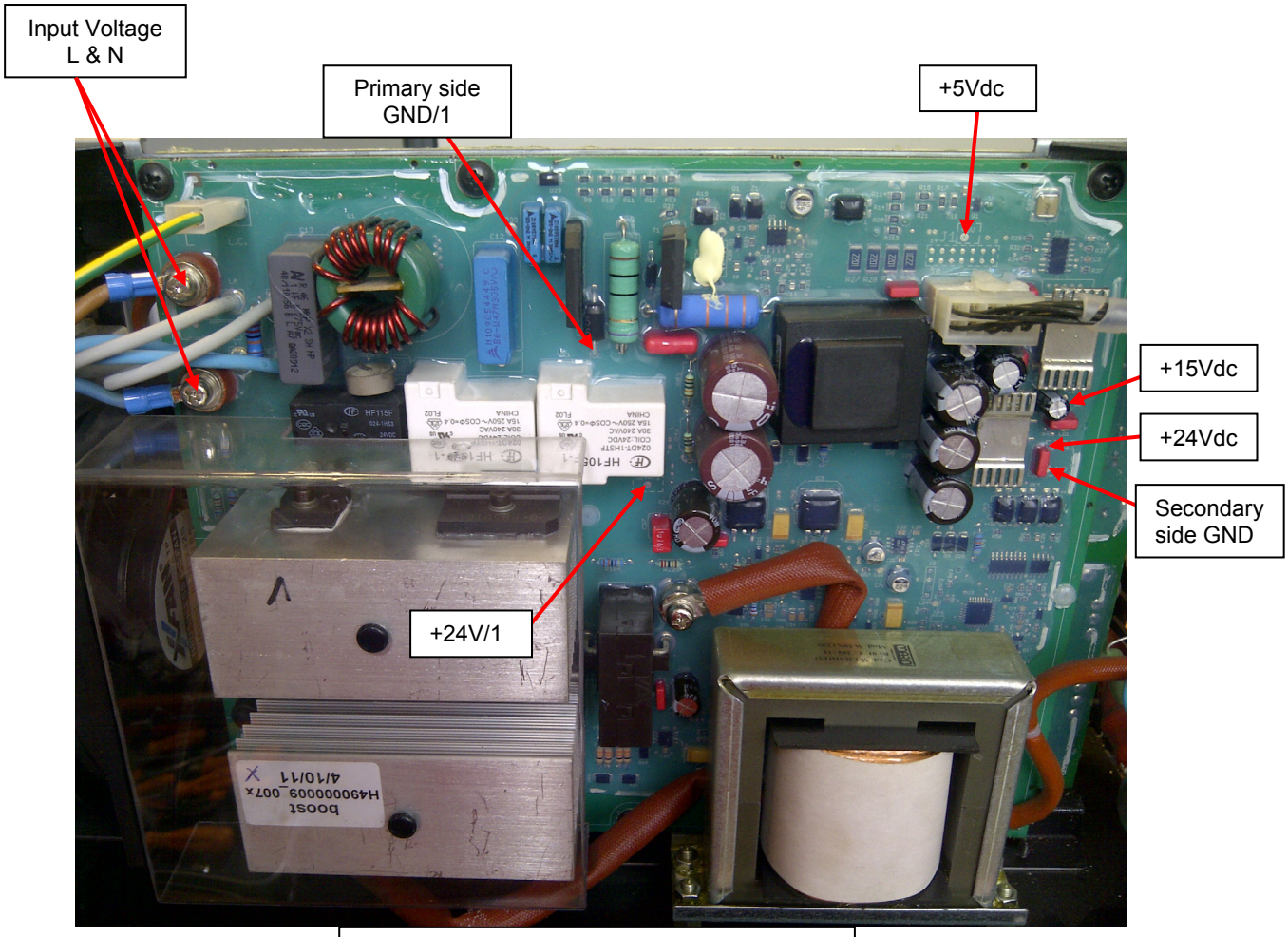


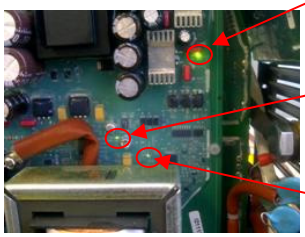

**Figure 1** – Inverter Board

## TEST PROCEDURE

**WARNING!**
DO NOT connect together GND/1 and GND

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

1. Remove main input power to the INVERTEC® 160SX
2. Follow the case removal procedure available in this Service Manual
3. Remove the air deflectors following the removal procedure available in this Service Manual
4. Apply 230Vac +/- 15% to the INVERTEC® 160SX
5. Turn the machine mains input switch to ON position
6. Check for 230Vac +/- 15% between L & N connections
7. Check for primary side auxiliary voltage supply +24Vdc between points **GND/1 (anode D25)** and **+24V/1**
8. Check for insulated auxiliary voltage supply: **+24Vdc, +15Vdc (see also LED1=ON), +5Vdc** (all +/- 15%) between **GND** and all dedicated test points, see **Figure 1**
9. Check for 385Vdc +/- 15% between DC+ and DC- terminals, see **Figure 2**



**LED1**
**Green light = +15Vdc present**

**LED2**
**Green light = - 5Vdc present**
**(for Boost current sensor)**

**LED4**
**Green light = uC processor correctly programmed**

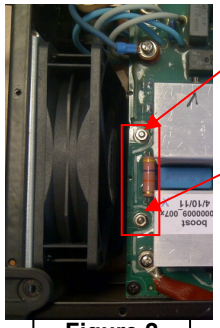
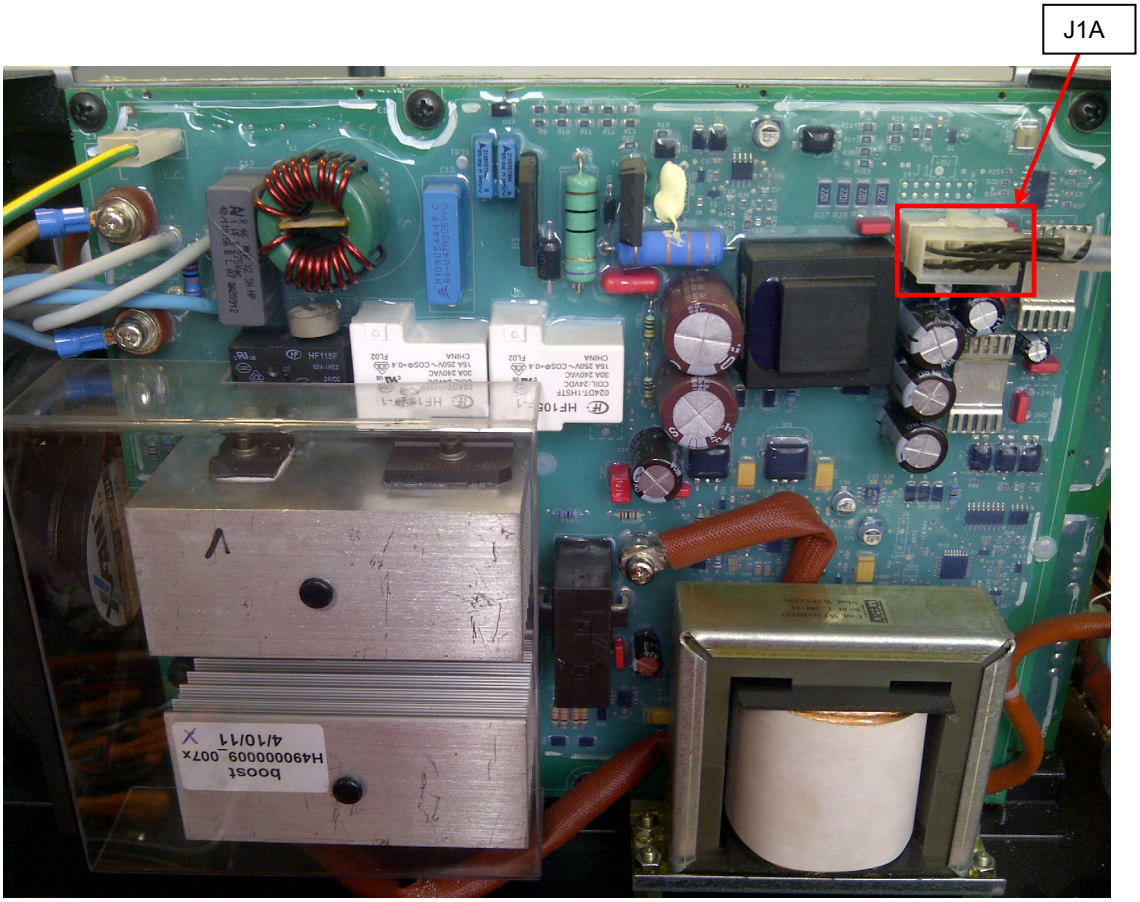



**Figure 2**

# BOOST BOARD VOLTAGE TEST (continued)




## TEST PROCEDURE(continued)

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

10. Follow the below tables to perform the voltage tests on connectors J1A

| Pin# | Description | Use pin 9 as GND ref. | Notes |
|---|---|---|---|
| **1** | TX_B | 0-5V (typical value 3,9Vdc) | Serial protocol transmission |
| **2** | Not used | Not used | Not used |
| **3** | +5V | +5V | +5V power supply |
| **4** | +15V | +15V | +15V power supply |
| **5** | +24V | +24V | +24V power supply |
| **6** | RX_B | 0-5V (typical value 4,6Vdc) | Serial protocol transmission |
| **7** | BUSOKS | 0Vdc=Bus OK<br>5Vdc= Bus problem | DC bus ok signal |
| **8** | +5V | +5V | +5V power supply |
| **9** | GND | GND | Secondary GND for power supply |
| **10** | +15V | +15V | +15V power supply |

**NOTE:** The fan runs at low speed during start-up sequence, after start-up sequence the fan runs at full speed. During idle condition (after 10 minutes of inoperation) the fan is turned OFF.

# INVERTER BOARD VOLTAGE 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.

……..

**TEST DESCRIPTION**

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

**MATERIALS NEEDED**

Volt/Ohmmeter
Wiring Diagram X1280

# INVERTER BOARD VOLTAGE TEST (continued)

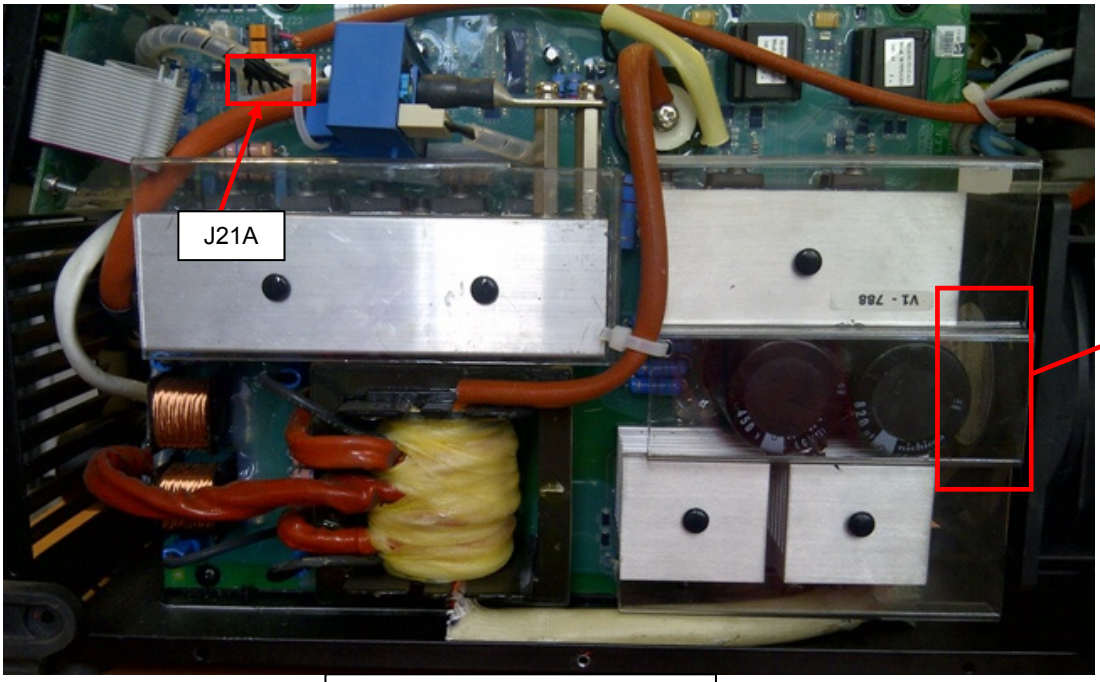
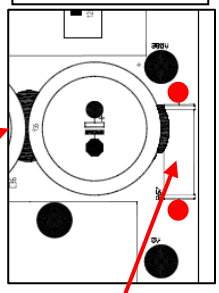



Figure 1

Figure 1A




## TEST PROCEDURE

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

1. Remove main input power to the INVERTEC® 160SX
2. Follow the case removal procedure available in this Service Manual
3. Remove the air deflectors following the removal procedure available in this Service Manual
4. Apply 230Vac +/- 15% to the INVERTEC® 160SX
5. Turn the machine mains input switch to ON position
6. Check for 385Vdc +/- 15% between R67 terminals, see **Figure 1A**
7. Check for 60Vdc +/- 15% output circuit voltage in Soft or Crisp mode. In idle condition the OCV will go down to about 7 Vdc.
8. Follow the below tables to perform the voltage tests on connectors J21A

| Pin# | Description | Use pin 9 as GND ref. | Notes |
|---|---|---|---|
| **1** | TX_B | 0-5V (typical value 3,9Vdc) | Serial protocol transmission |
| **2** | Not used | Not used | Not used |
| **3** | +5V | +5V | +5V power supply |
| **4** | +15V | +15V | +15V power supply |
| **5** | +24V | +24V | +24V power supply |
| **6** | RX_B | 0-5V (typical value 4,6Vdc) | Serial protocol transmission |
| **7** | BUSOKS | 0Vdc=Bus OK<br>5Vdc= Bus problem | DC bus ok signal |
| **8** | +5V | +5V | +5V power supply |
| **9** | GND | GND | Secondary GND for power supply |
| **10** | +15V | +15V | +15V power supply |

# INVERTER BOARD VOLTAGE TEST (continued)

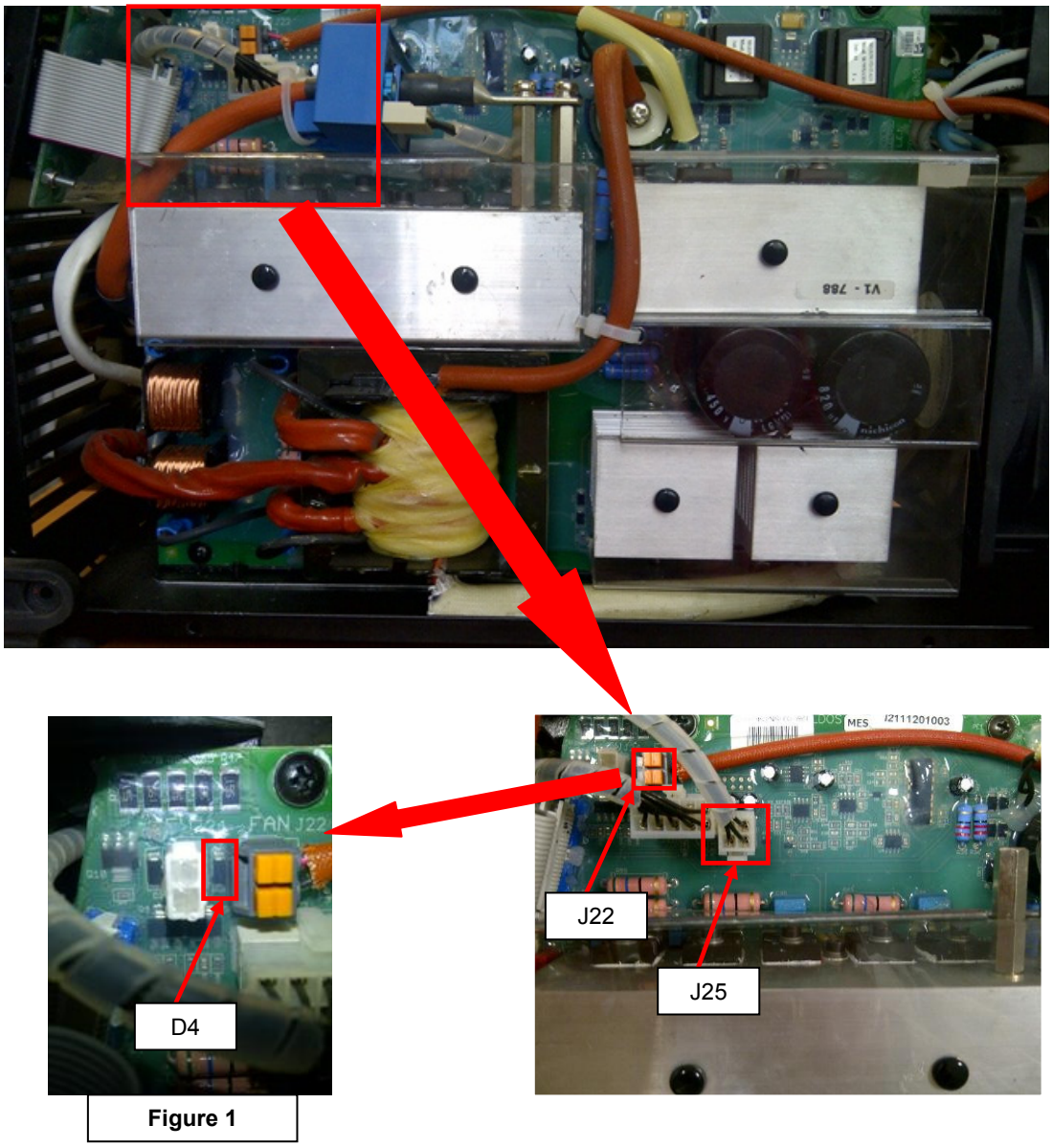



Figure 1

## TEST PROCEDURE

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

9. Follow the below tables to perform the voltage tests on connectors J25 and J22:

**J25: Current Sensor**

| Pin# | Description | Use pin 4 as GND ref. | Notes |
|---|---|---|---|
| **1** | +15V | 15V | +15V Power supply |
| **2** | -5V | -5V | -5V Power supply |
| **3** | I Out | 0V – 6,5V | Current Sense feedback |
| **4** | GND | GND | Secondary GND for Power supply |


**J22: Fan connector**

| Pin# | Description | Value | Notes |
|---|---|---|---|
| **1** | FAN_ON | 0-24V/GND | Fan ON/OFF |
| **2** | +24Vdc | 24V/GND | +24V Power supply |

**NOTE:** Fan connector J22 has no access to electrical points, Fan supply test can be done across diode D4 (see Figure 1)

# 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.
……

**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 X1319

# CONTROL BOARD TEST (continued)

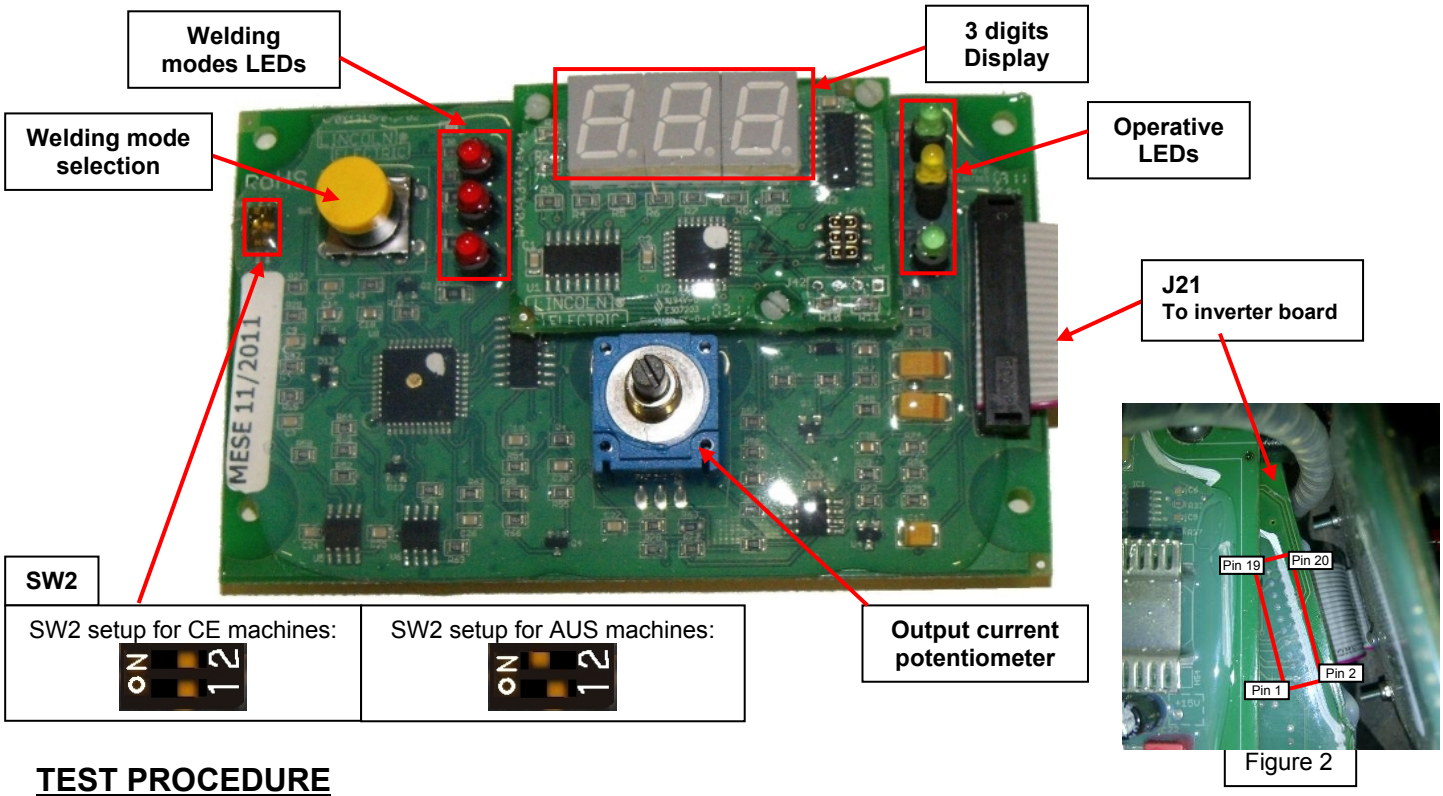



Figure 2

## TEST PROCEDURE

1. Remove main input power to the INVERTEC® 160SX
2. Follow the case removal procedure available in this Service Manual
3. Apply 230Vac +/- 15% to the INVERTEC® 160SX
4. Turn the machine mains switch to ON position
5. Follow the below table to perform the voltage tests on connectors J21. Take note that J21 is a flat cable connector; the best way to check signals is from the inverter board solder side, see **Figure 2**.

**J21: Control Bd / Inverter Bd connector**

| Pin# | Description | Use pin 19 or 20 as GND | Notes |
|---|---|---|---|
| **1** | +15V | +15V | +15V Power supply |
| **2** | +15V | +15V | +15V Power supply |
| **3** | IOUT | 6,5 V@160A | Current feedback from inverter curret sensor |
| **4** | -5V | -5V | -5V Power supply |
| **5** | LIFT | 11V in Soft and Crisp mode<br>8,5V in LIFt TIG mode | Values indicated are without welding |
| **6** | FAN_ON | 0,5V = during start-up or idle<br>15V= Fan ON | Fan on/off signal |
| **7** | +5V | +5V | +5V Power supply |
| **8** | +5V | +5V | +5V Power supply |
| **9** | VALVER | Not used | Not used |
| **10** | TX_I | 0-5V (typical value 4,6Vdc) | Serial protocol transmission |
| **11** | BUSOKS | 0Vdc=Bus OK<br>5Vdc= Bus problem | DC bus ok signal |
| **12** | VREG | 1V in Soft or Crisp mode no weld<br>11,5 in Lift TIG mode no weld<br>11,5V in idle condition all modes<br>~6,5V during weld at 160A | Output voltage reference |
| **13** | NC | NC | Not used |
| **14** | DUTY | ~1V in Soft or Crisp mode no weld<br>0V in Lift TIG mode no weld<br>~6,5V during weld at 160A | Duty cycle |
| **15** | OT | 0V = machine OK<br>5V = Thermal condition | Over temperature |
| **16** | ENABLE | 0V=Boost ON<br>5V=Boost OFF | Boost enable on/off signal |
| **17** | VOUTM | ~6V in Soft or Crisp mode no weld<br>0,7V in idle condition and Lift TIG<br>Variable from 0 to 5V during weld | Output voltage |
| **18** | RX_I | 0-5V (typical value 3,9Vdc) | Serial protocol transmission |
| **19/20** | GND | GND | Secondary GND for Power supply |

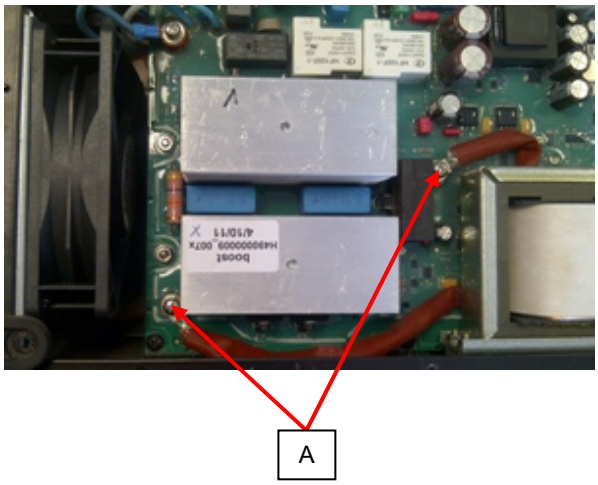
# ERROR CODES

**Error condition list.**
If occurs, try to turn Off the machine, wait for a few seconds, then turn ON again.
If the error remains, read the 3-digit code displayed on the meter of the Front Panel to identify the error condition.

| Error code table<br>Slow blinking: about 1 time per second<br>Fast blinking: about 10 time per second | |
|---|---|
| 9.01 | **Input overvoltage**<br>LED is blinking slow.<br>Indicates that an Input Voltage Overrange protection is active; the Machine restarts automatically when the Input Voltage returns in the correct range. |
| 9.02 | **Input undervoltage**<br>LED is blinking fast.<br>Indicates that an Input Voltage Underrange protection is active; the Machine restarts automatically when the Input Voltage returns in the correct range. |
| 9.03 | **DC bus short circuit**<br>LEDs blinks slow together.<br>Indicates that an Internal Power Circuitry fault condition is detected.<br><br>To restore the machine:<br>Turn OFF then ON the Mains Switch to restart the machine. |
| 9.04 | **Boost voltage lock out**<br>LEDs blinks slow alternatively.<br>Indicates that an Internal Auxiliary Voltage fault condition is detected.<br><br>To restore the machine:<br>Turn OFF then ON the Mains Switch to restart the machine. |
| 9.05 | **Inverter voltage lock out**<br>LEDs blinks fast alternatively.<br>Indicates that an Internal Auxiliary Voltage fault condition is detected.<br><br>To restore the machine:<br>Turn OFF then ON the Mains Switch to restart the machine. |
| 9.06 | **DC bus overvoltage**<br>LEDs blinks slow together.<br>Indicates that an Internal DC bus Overvoltage condition is detected.<br><br>To restore the machine:<br>Turn OFF then ON the Mains Switch to restart the machine. |
| 9.09 | **Communication lost**<br>All LEDs are OFF. The display shown “9.09”.<br>Indicates that a fault condition in the communication bus is detected.<br><br>To restore the machine:<br>Turn OFF then ON the Mains Switch to restart the machine. |

# DISASSEMBLY OPERATIONS

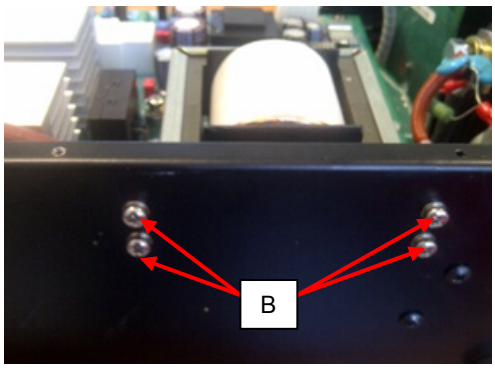
BOOST BOARD REMOVAL AND REPLACEMENT PROCEDURE

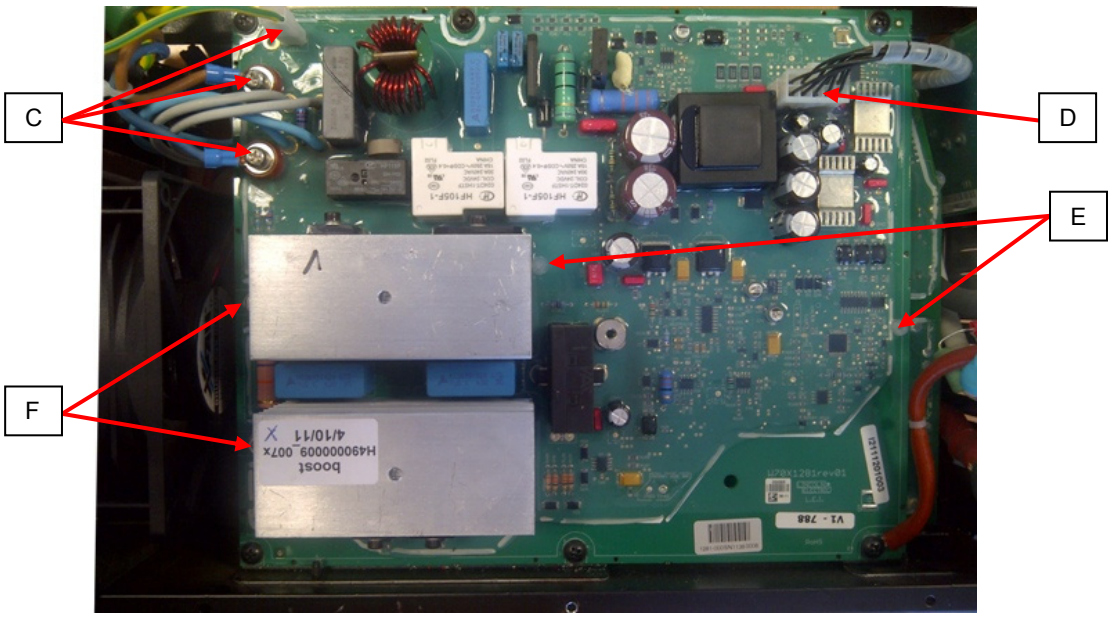



**WARNING**

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.




## REMOVAL PROCEDURE

**Necessary tool:**

- Phillips screwdriver PH02
- 7 mm Nutdriver

1. Remove input power to INVERTEC® 160SX
2. Remove the cover following the instruction available in this Service Manual.
3. Perform the **Discharge procedure.**
4. Remove the 2 screws (A) that fix the Boost choke cables to the Boost board.
5. Remove the 4 screws (B) that fix the Boost choke and remove the Boost choke from the machine.
6. Remove the 2 screws and the ground faston (C) that fix the input cable wires
7. Disconnect the harness connector J1A (D)
8. Remove the 2 small white plastic screws (E). Do it from Inverter side ((see page 41 point 8).
9. Using the 7mm Nutdriver, remove the 2 nuts and all washers (F)

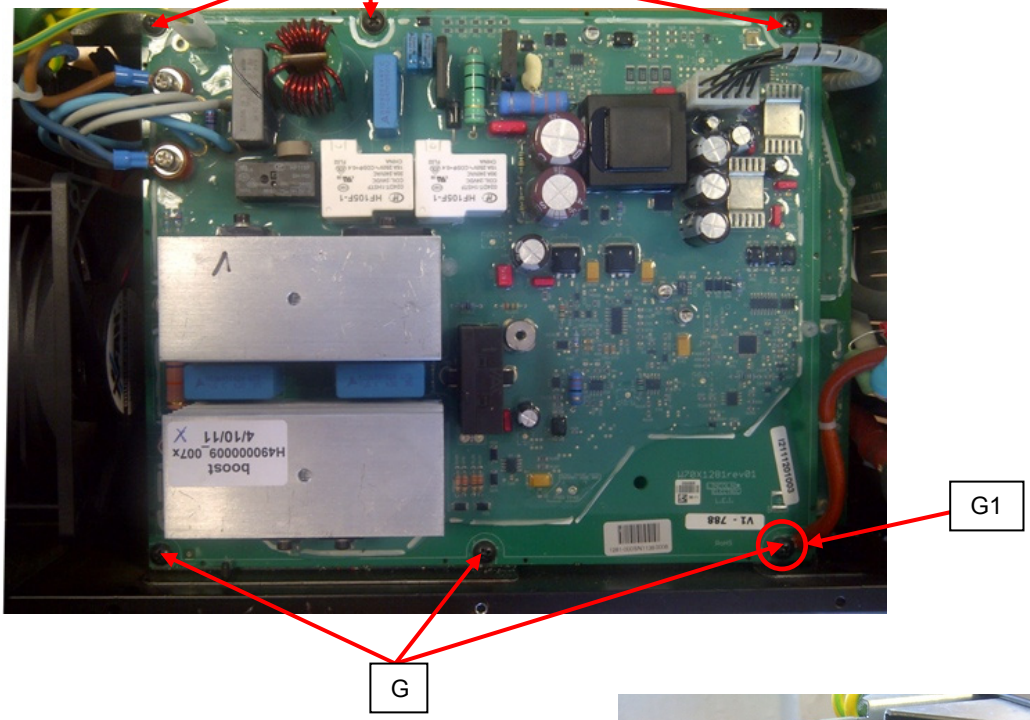
# DISASSEMBLY OPERATIONS

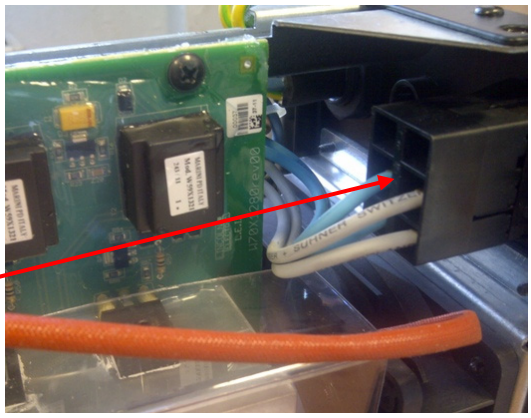
BOOST BOARD REMOVAL AND REPLACEMENT PROCEDURE (continue)

**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.



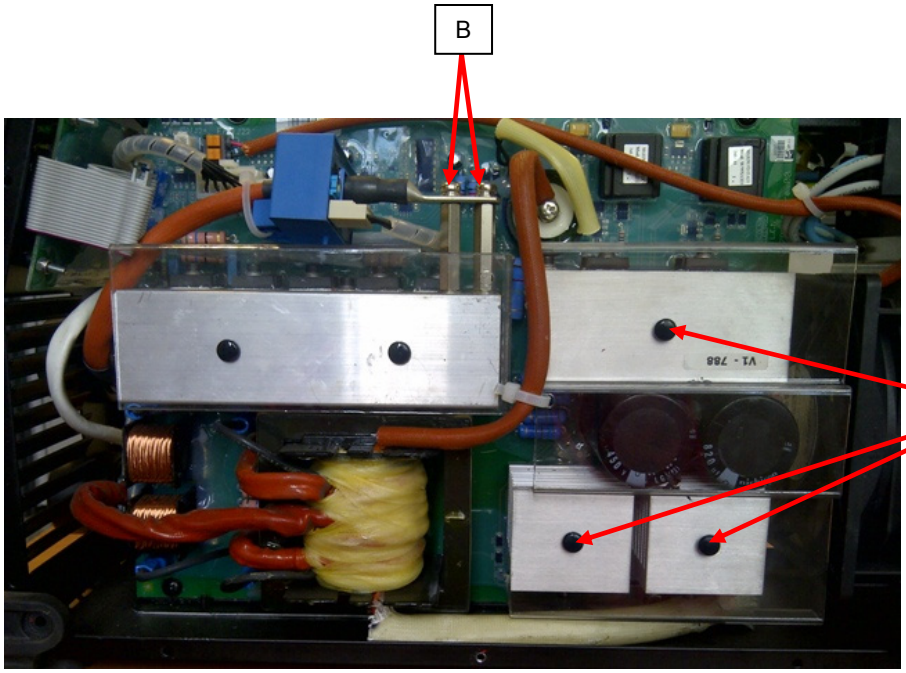




10. Remove the 6 screws (G) that fix the Boost board to the metal frame.
11. On position G1 take care of the ground connection from the output filter board.
12. Disconnect the plastic block connector from the mains switch (H)
13. Remove the Boost board from the machine.
14. **For the re-assembly operations,** make the previous steps in the reverse order.

**! Remember !** to connect again all the ground connections removed during the disassembly operations and the air deflectors.

# DISASSEMBLY OPERATIONS

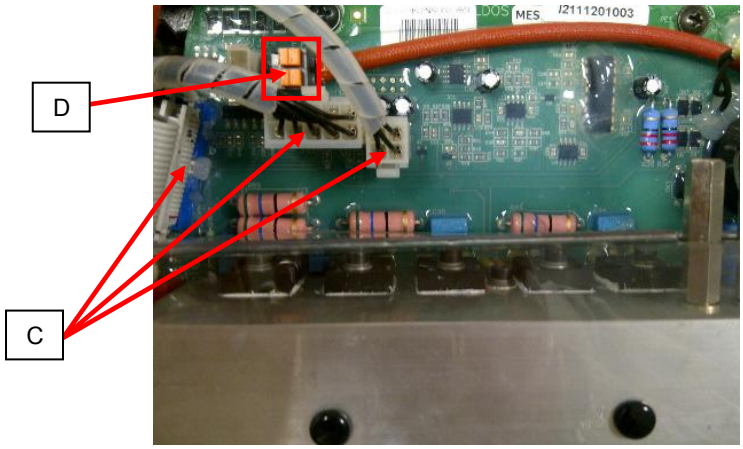
INVERTER BOARD REMOVAL AND REPLACEMENT PROCEDURE




**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.




## REMOVAL PROCEDURE

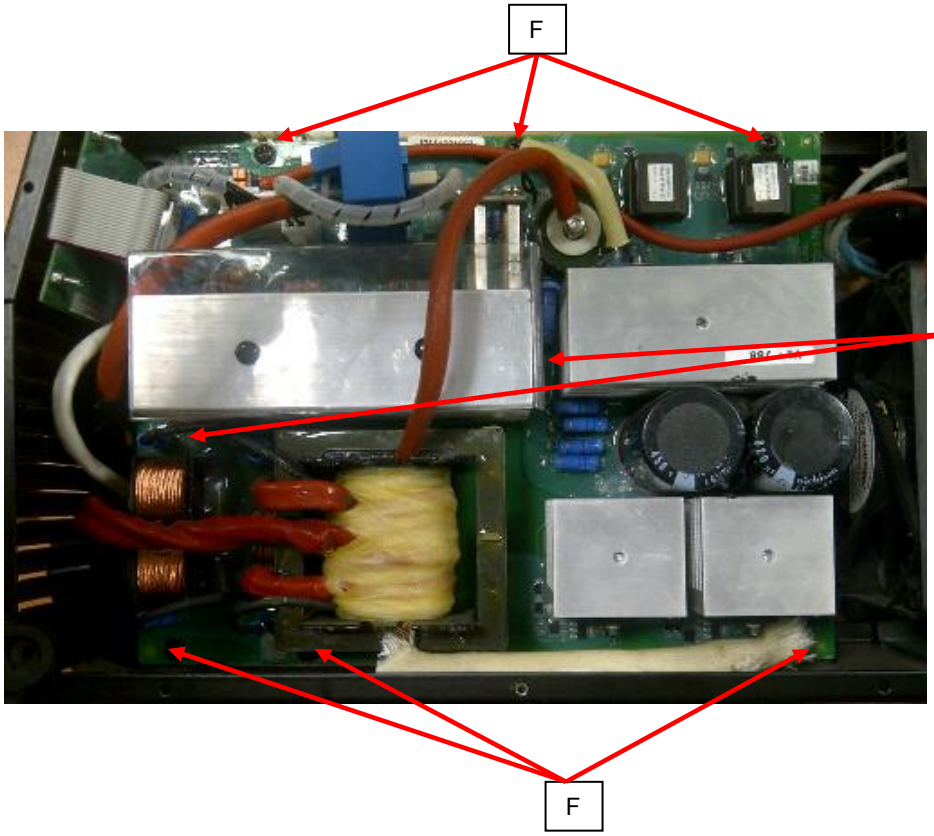
**Necessary tool:**

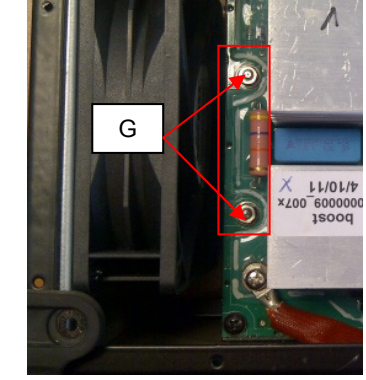
- Phillips screwdriver PH02
- 7 mm Nutdriver
- 17 mm wrench

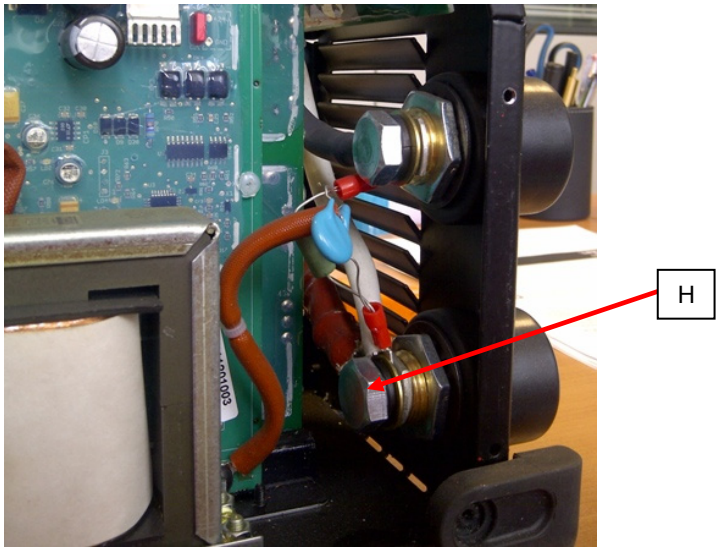
1. Remove input power to INVERTEC® 160SX
2. Remove the cover following the instruction available in this Service Manual.
3. Perform the **Discharge procedure.**
4. Remove the 3 plastic pins (A) that fix the transparent plastic air deflector and remove the plastic air deflector
5. Remove the 2 screws (B) that fix the positive output cable
6. Disconnect the connectors J25, J21A and J23 (C)
7. Disconnect the 2 fan supply wires from connector J22 (D)

# DISASSEMBLY OPERATIONS

INVERTER BOARD REMOVAL AND REPLACEMENT PROCEDURE



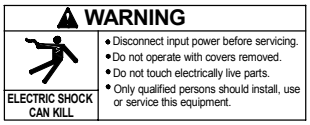



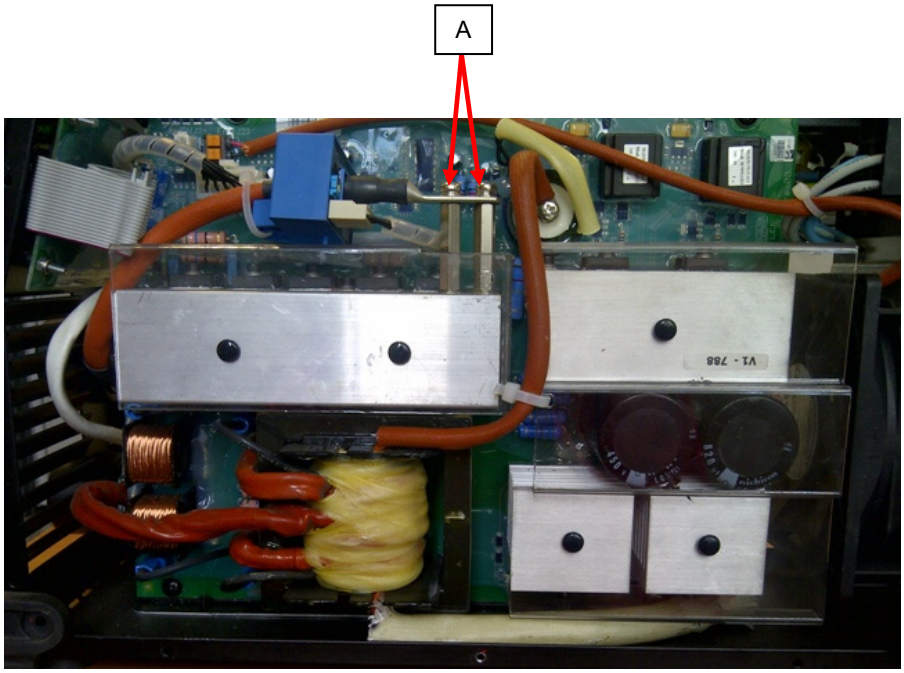

8. Remove the 2 small plastic screws (E)
9. Remove the 6 screws (F) that fix the inverter board to the machine frame
10. Using the 7mm Nutdriver, remove the 2 nuts and all washers (G)
11. Using the 17 mm wrench remove the two cables from the negative stud (H)
12. Remove the inverter board from the machine
13. **For the re-assembly operations,** make the previous steps in the reverse order.

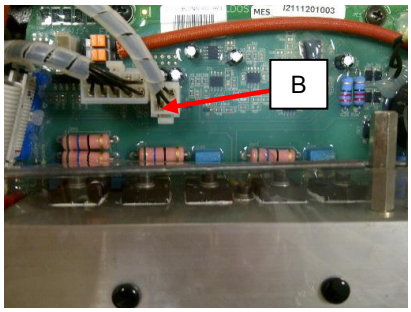
**! Remember !** to connect again all the ground connections removed during the disassembly operations and the air deflectors.

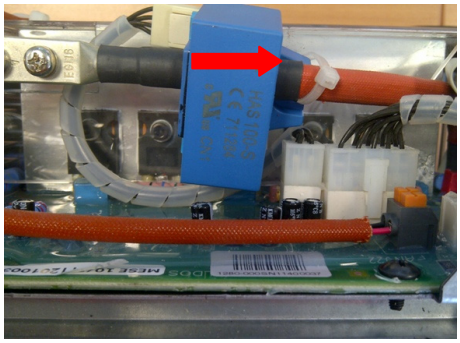
# DISASSEMBLY OPERATIONS

HALL CURRENT SENSOR REMOVAL AND REPLACEMENT PROCEDURE



## REMOVAL PROCEDURE

**Necessary tool:**

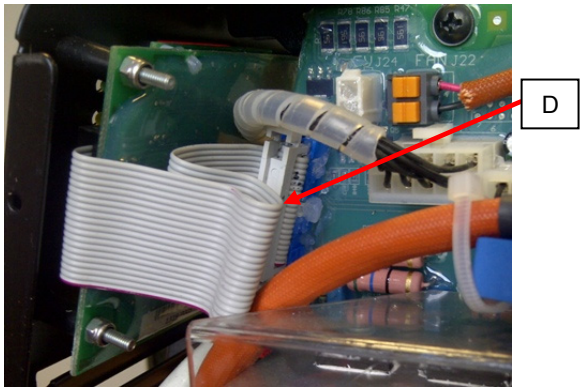
- Phillips screwdriver PH02

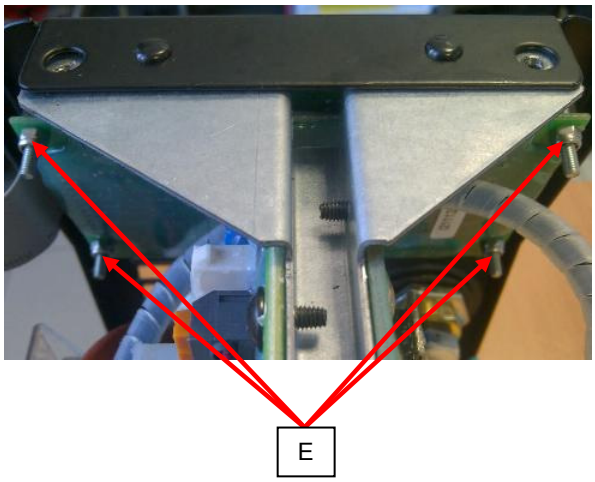
1. Remove input power to INVERTEC® 160SX
2. Remove the cover following the instruction available in this Service Manual.
3. Perform the **Discharge procedure.**
4. Remove the 2 screws (A) that fix the positive output cable
5. Disconnect the connector J25 (B)
6. Remove the Hall Current Sensor
7. **For the re-assembly operations,** make the previous steps in the reverse order, paying attention to the arrow sense of the Hall Current Sensor, see picture above.

# DISASSEMBLY OPERATIONS

CONTROL BOARD REMOVAL AND REPLACEMENT PROCEDURE






## REMOVAL PROCEDURE

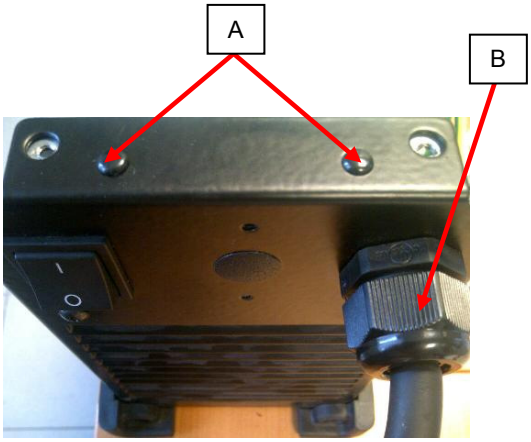
**Necessary tool:**

- 6 mm Nutdriver
- 5,5 mm wrench

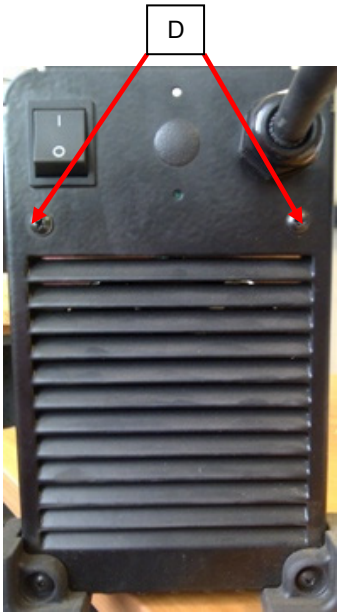
1. Remove input power to INVERTEC® 160SX
2. Remove the cover following the instruction available in this Service Manual.
3. Perform the **Discharge procedure.**
4. Remove the 2 small black plastic rivets (A), to be able to pull the front panel away and facilitate the control board removal.
5. Remove the red plastic cap (B) from the output potentiometer knob, using a small flat screwdriver.
6. Unscrew the small brass nut (C) using the 6mm nutdriver and remove the knob.
7. Remove the J23 connector (D) from the inverter board
8. Remove the 4 nuts (E) that fix the control board to the front panel.
9. Pull a bit the front panel and remove the control board
10. **For the re-assembly operations,** make the previous steps in the reverse order.

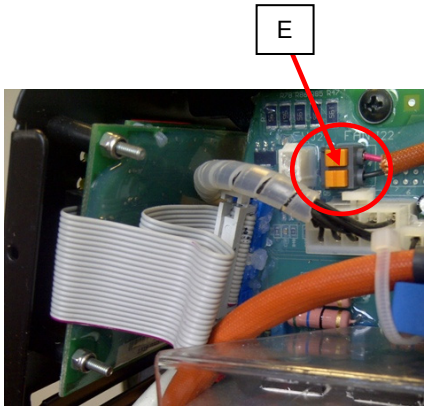
# DISASSEMBLY OPERATIONS

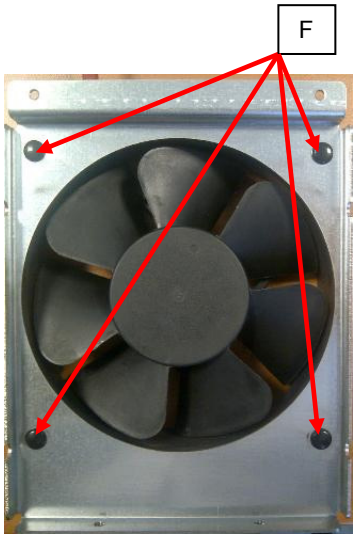
FAN REMOVAL AND REPLACEMENT PROCEDURE








## REMOVAL PROCEDURE

**Necessary tool:**

- Phillips screwdriver PH02

1. Remove input power to INVERTEC® 160SX
2. Remove the cover following the instruction available in this Service Manual.
3. Perform the **Discharge procedure.**
4. Remove the 2 small black plastic rivets (A), to be able to pull a bit the rear panel away from the central frame and facilitate the fan removal.
5. Unscrew the cable clamp (B)
6. Remove the 2 screws (C) on the rear bottom of the machine and the 2 screws (D) on the rear panel.
7. Disconnect the two fan supply wires from the connector (E).
8. Remove from the machine the fan together with its metal support
9. Remove the 4 black plastic rivets that fix the fan to the fan support and remove the fan.
10. **For the re-assembly operations,** make the previous steps in the reverse order.

# 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

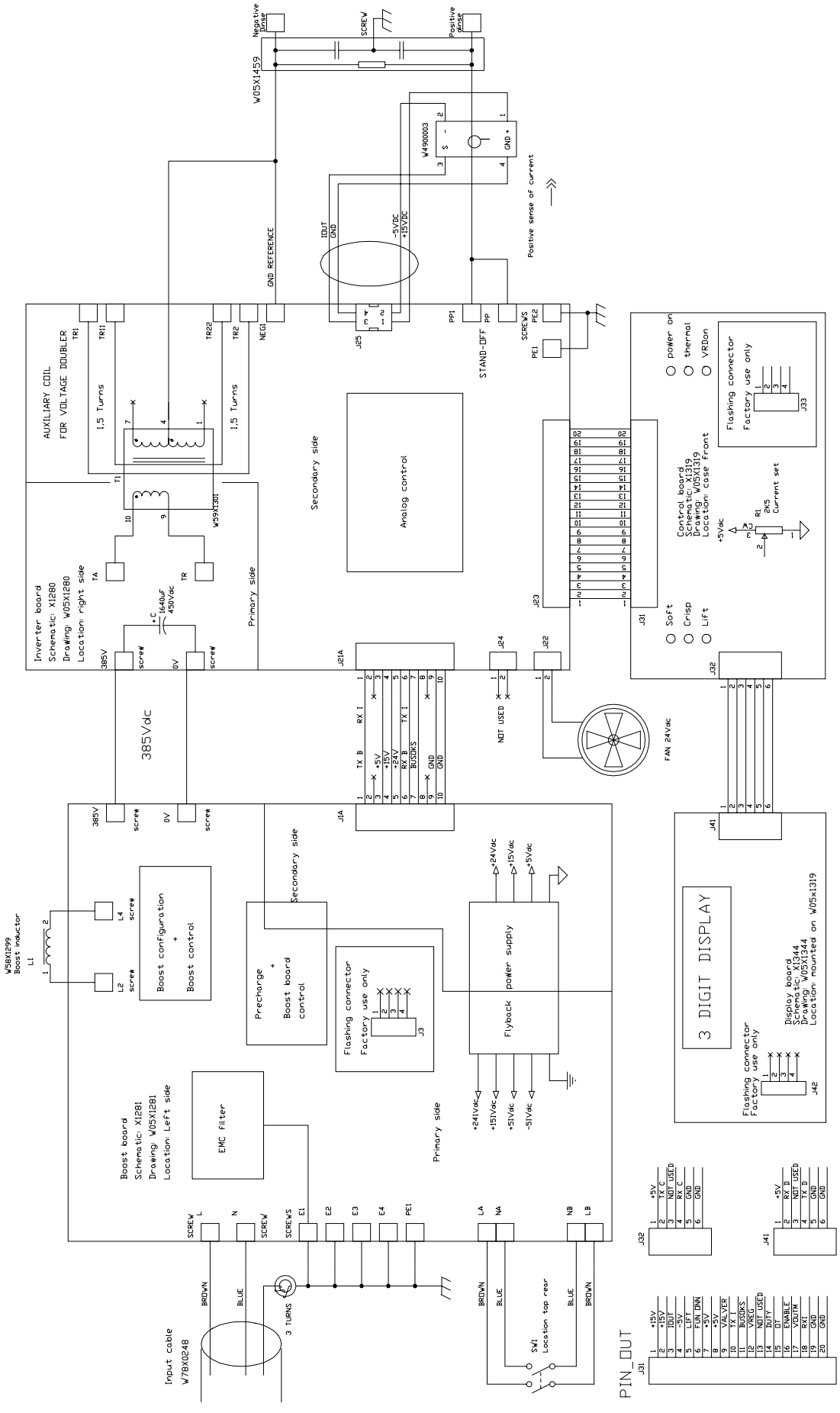
| Input Voltage | Input Current | Rated Output |
|---|---|---|
| 115Vac/1ph/50Hz | 16,2A max<br>26,3A max | 70A@100%<br>100A@30% |
| 230Vac/1ph/50Hz | 12,5A max<br>21,5A max | 100A@100%<br>160A@30% |

| | |
|---|---|
| Output current range | 5 – 160 Amps |

| | |
|---|---|
| Maximum Open Circuit Voltage | ≤80Vdc CE version<br>12Vdc Australian Version |

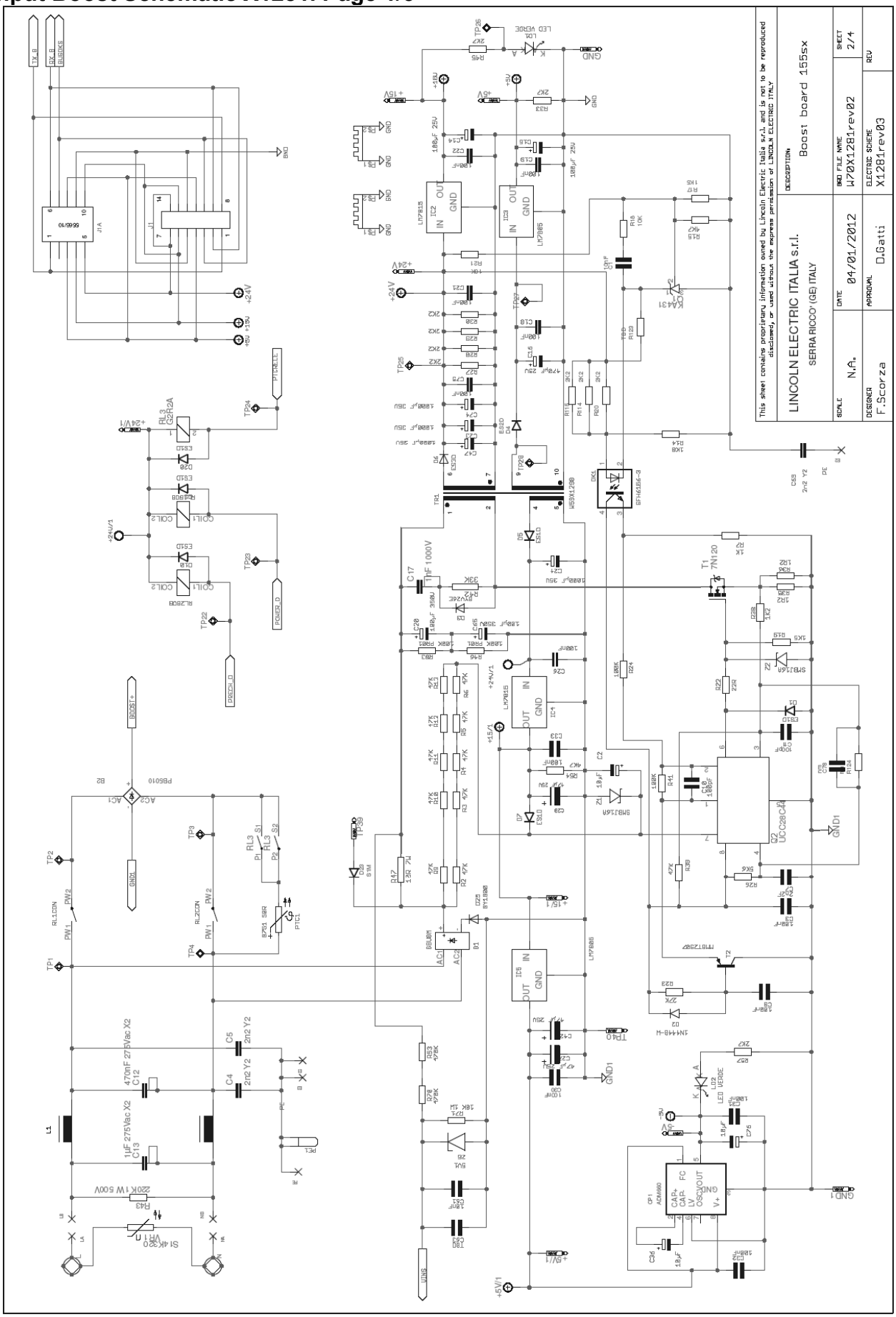
# ELECTRICAL SCHEMATICS

## Block Diagram



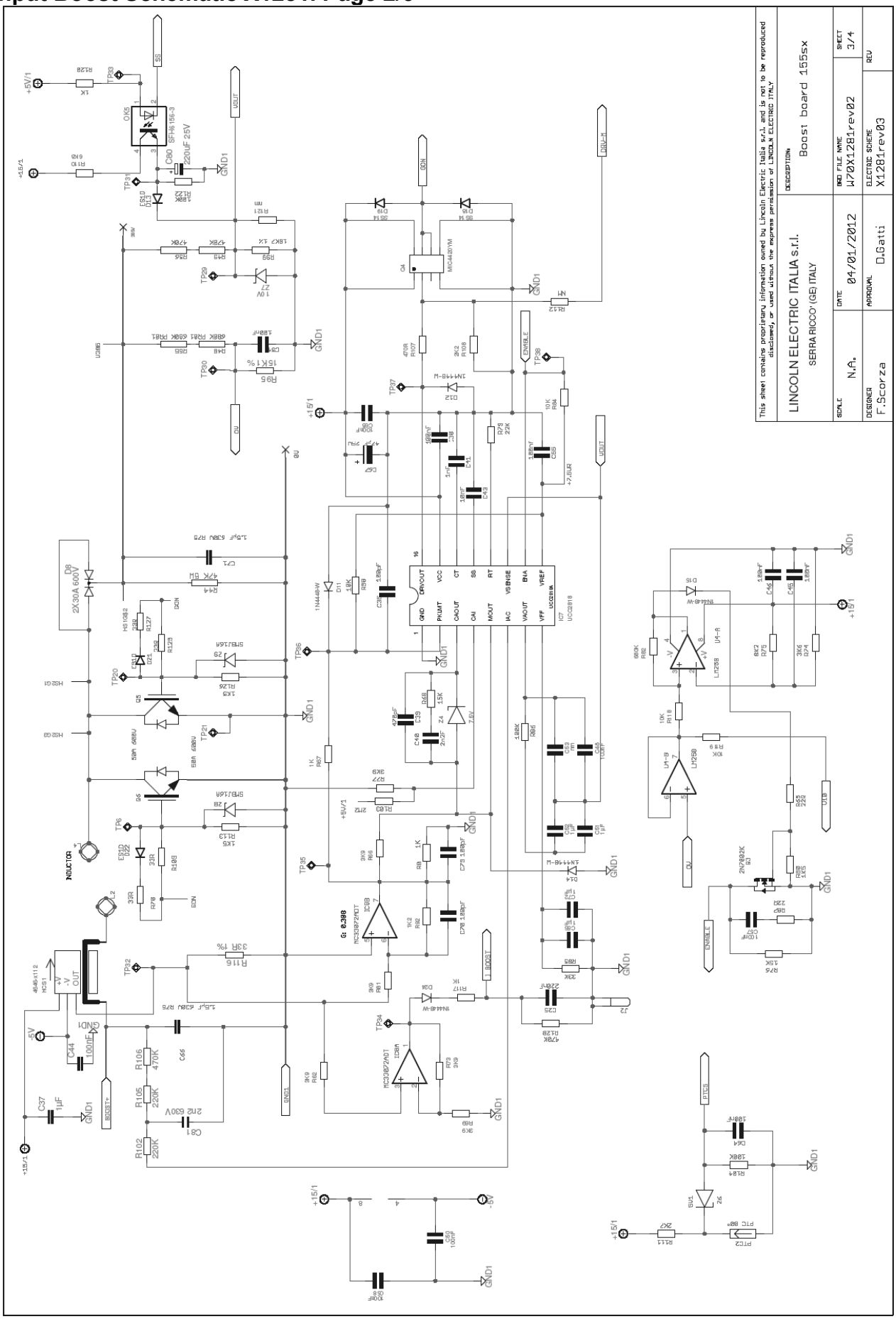
# ELECTRICAL SCHEMATICS

## Input Boost Schematic X1281. Page 1/3



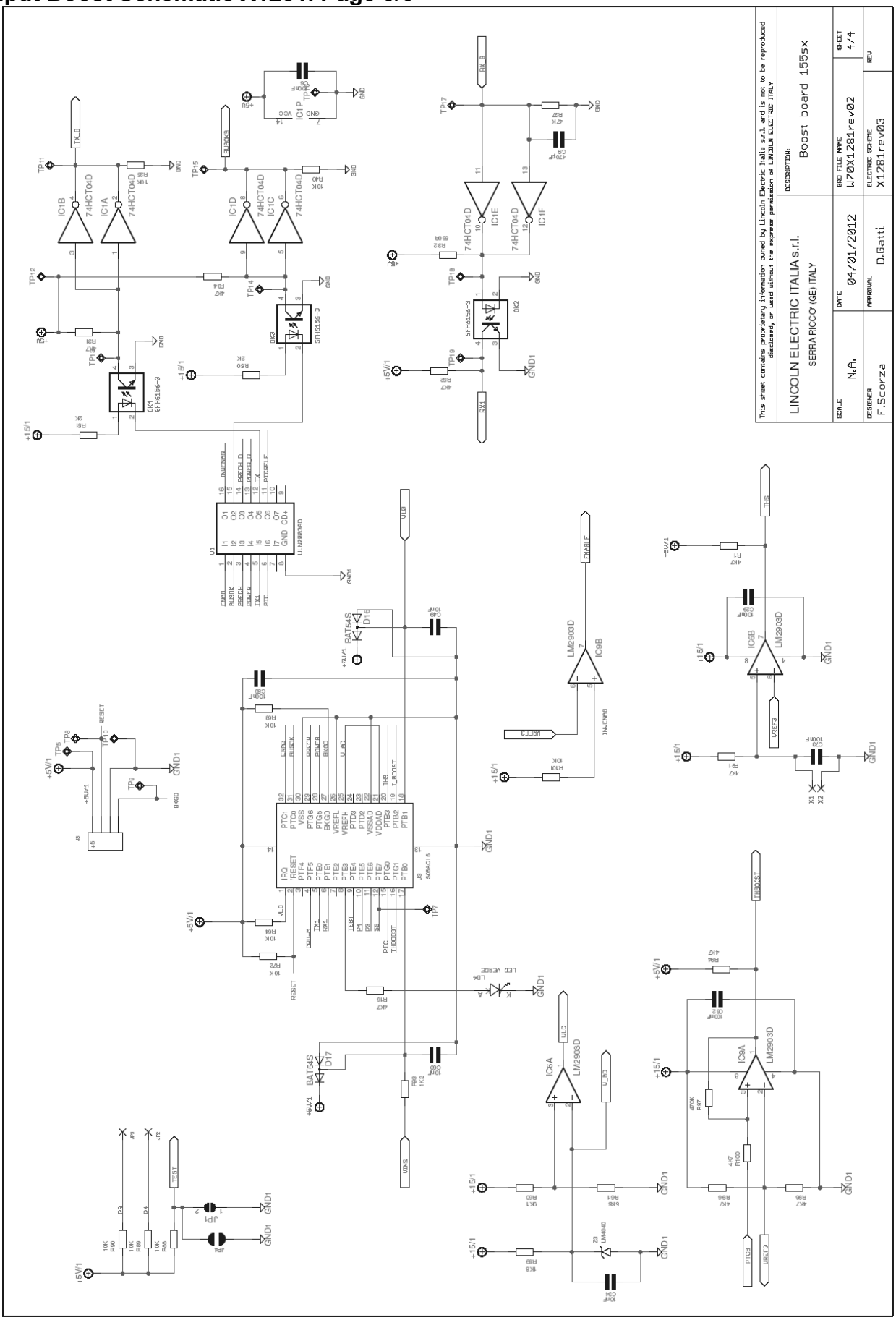
# ELECTRICAL SCHEMATICS

## Input Boost Schematic X1281. Page 2/3



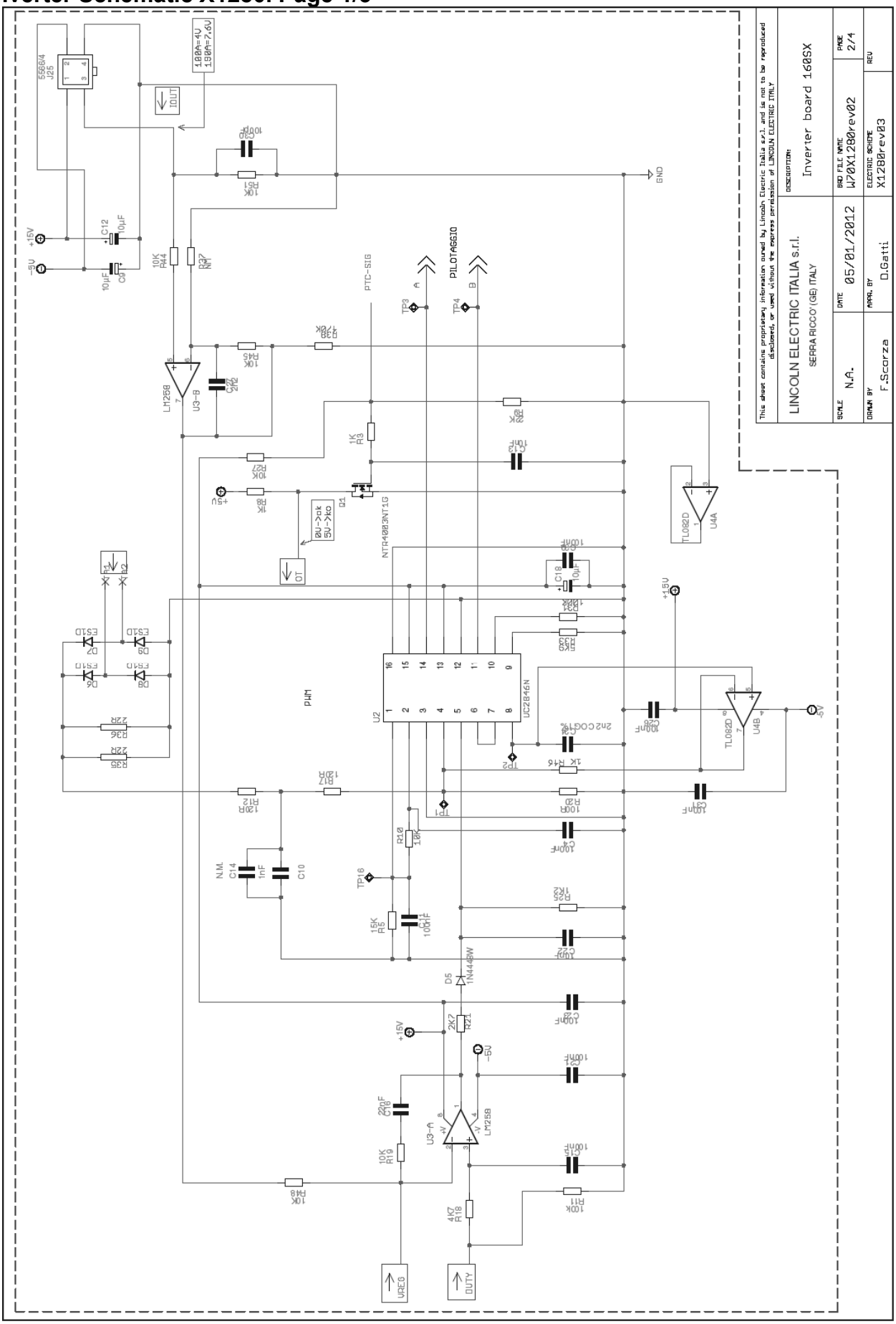
# ELECTRICAL SCHEMATICS

## Input Boost Schematic X1281. Page 3/3



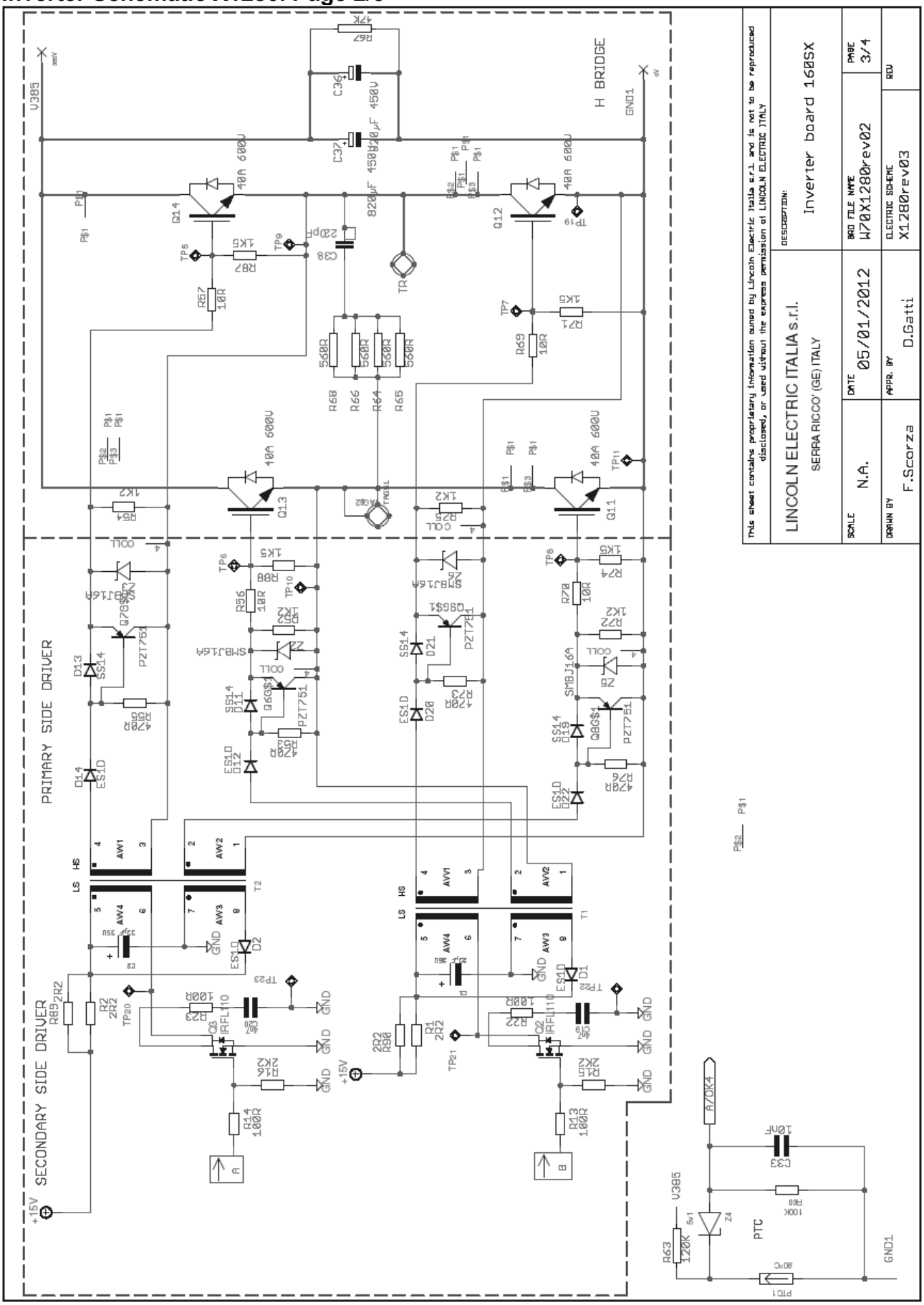
# ELECTRICAL SCHEMATICS

## Inverter Schematic X1280. Page 1/3



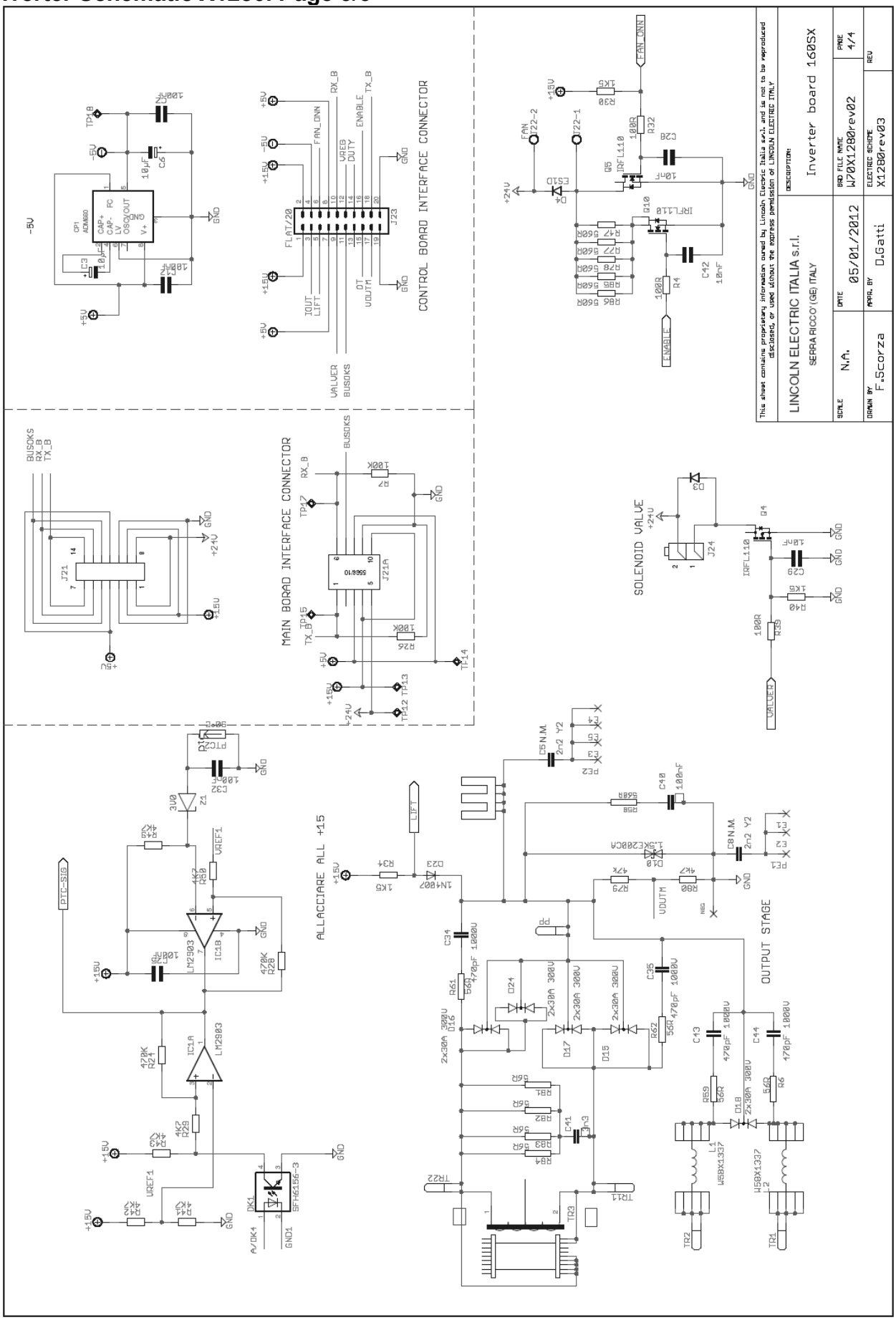
# ELECTRICAL SCHEMATICS

## Inverter Schematic X1280. Page 2/3



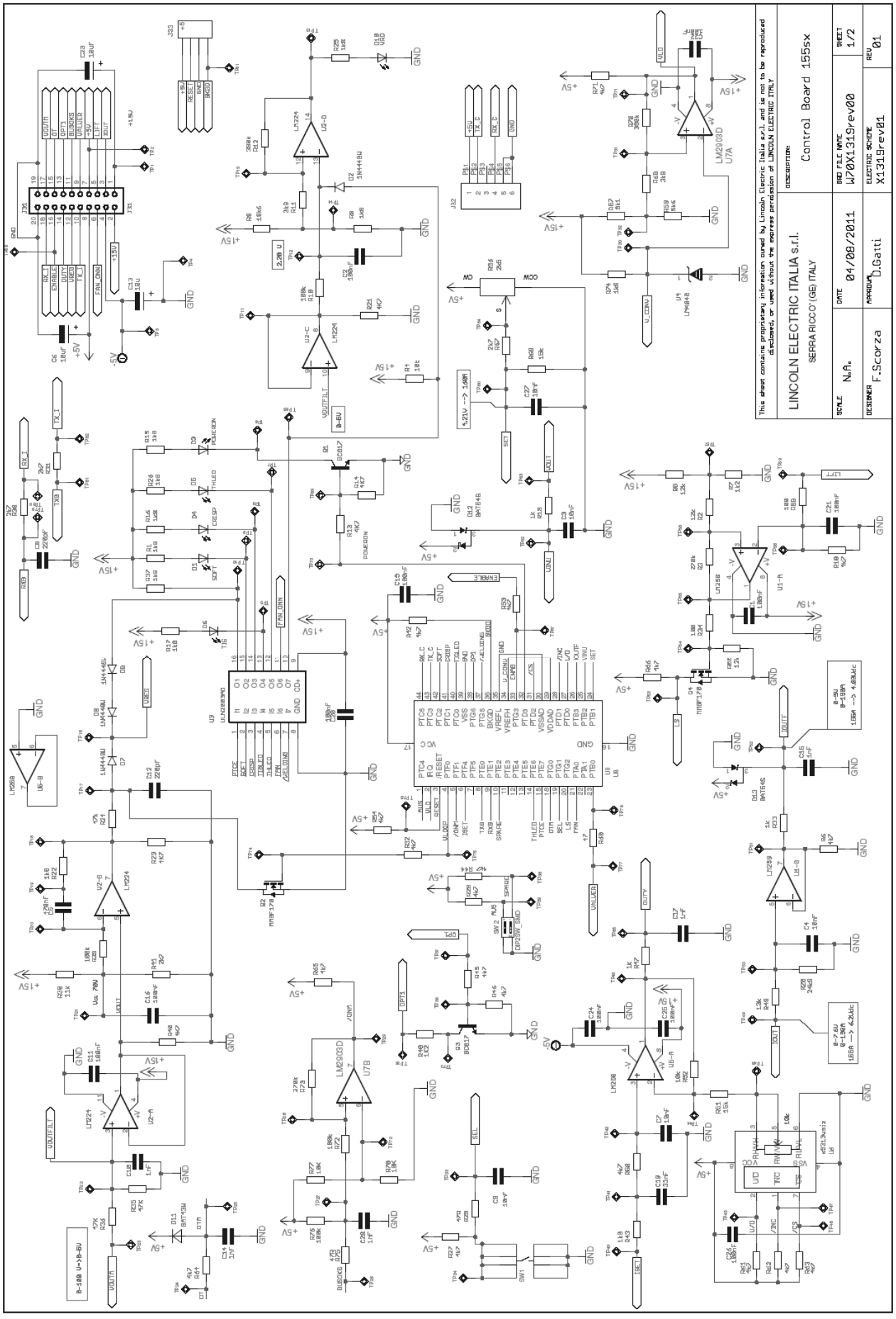
# ELECTRICAL SCHEMATICS

## Inverter Schematic X1280. Page 3/3



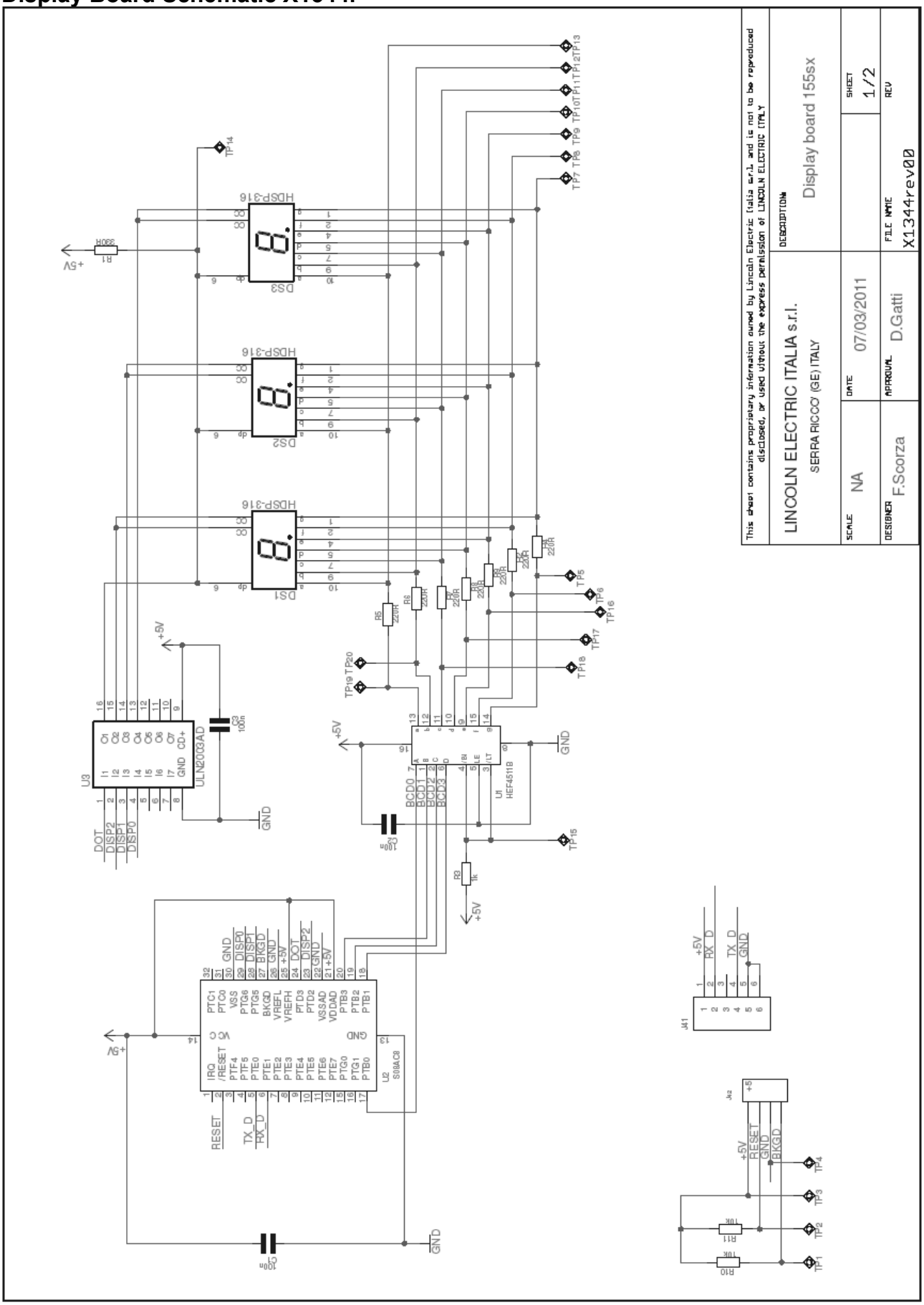
# ELECTRICAL SCHEMATICS

## Control Board Schematic X1319.



# ELECTRICAL SCHEMATICS

## Display Board Schematic X1344.



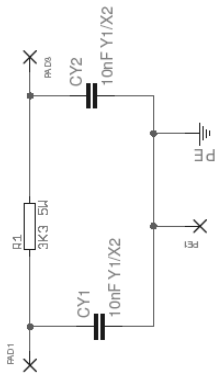
## Output Filter Board Schematic X1459.



LINCOLN ELECTRIC ITALIA s.r.l.
SERRA RICCO' (GE) ITALY

DESCRIPTION: Output filter dinse50

| | | | |
|---|---|---|---|
| SCALE N.A. | DATE 26/06/2012 | BRD FILE NAME W70X1459rev01 | PAGE 1/2 |
| DRAWN BY F.Scorza | APPR. BY D.Gatti | ELECTRIC SCHEME X1459rev01 | REV |



## NOTE