SERVICE MANUAL
MinarcTig Evo 200

CONTENTS

1. READ THIS FIRST

230VAC 50/60Hz and 390VDC or higher are inside the machine

Before removing any covers or commencing any testing or measurement disconnect the power source from the mains voltage

Dangerous DC voltage may still exist after the removal of the input voltage. Machine discharges the voltage while it is turned off, but it is always better to ensure this by measuring the voltage

Wait at least one minute for the capacitors to become discharged.

Digital multimeters (later DMM) may give different values depending the specifications they have. For example diode measuring values may vary between the DMM models. In this manual Fluke 179 DMM is used.

This machine has all the control circuits in the primary side and special attention must be considered while working with the internal parts.

The device may be repaired only by a person legally authorized to perform electric work.

2. GENERAL

MinarcTig Evo is a new generation small TIG and MMA machine. It is based on MinarcTig 180, but the power section and design are totally new. Machine has power factor correction in the primary side to meet the latest European regulations.

The MinarcTig Evo machines are for DC TIG and MMA-welding.

MinarcTig Evo 200 can be connected to the mains supply of 230VAC 1~. PFC makes possible to weld with the full power (TIG 200A) even when modern circuit breakers are used.

MinarcTig Evo panel card software can be reprogrammed in the field with Datamaster 2.

Overvoltage watch is 290VAC and under voltage watch is 150VAC.

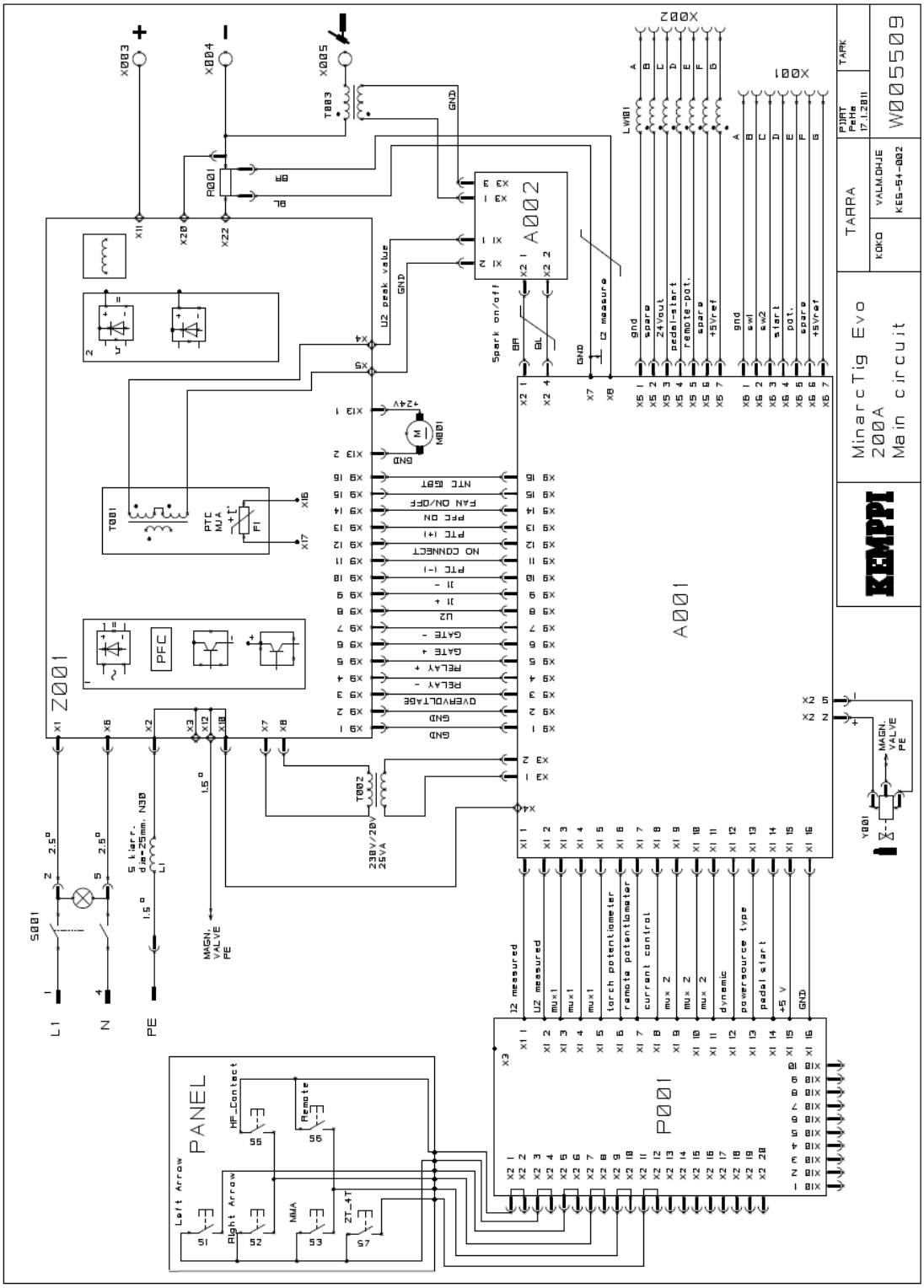
Current range is 5-200A in TIG and 10-170A in MMA mode.

3. TECHNICAL INFORMATION

3.1. Technical data

MinarcTig Evo 200		
Connection voltage	1~50/60 Hz	230V ± 15%
Rated power	25 % ED TIG	200 A/4.5 kVA
	35 % ED MMA	170 A/ 5.8 kVA
Supply current, I^{1max}	TIG	19.8 A
	MMA	25.3 A
Supply current, I^{1eff}	TIG	12.1 A
	MMA	15.0 A
Connection cable	HO7RN-F	3G1.5 (1.5mm^2, 3m)
Fuse	Type C	16A
Duty cycle 40° C	TIG	35 % ED 200 A/18 V
		100 % ED 140 A/15.6 V
	MMA	35 % ED 170 A/26.8 V
		100 % ED 110 A/24.4 V
Welding range	TIG	5 A/10.2 V - 200 A/18 V
	MMA	10A/20.4 V – 170 A/26.8 V
No-load voltage; peak		95 V (VRD 30V)
Idle power	TIG	10 W
	MMA	30 W
Power factor at 100 % ED	TIG	0.98
	MMA	0.98
Efficiency at 100 % ED	TIG	76 %
	MMA	82 %
Arc striking voltage		6-12kV
MMA welding electrodes	MMA	Ø 1.5mm – 4 mm
External dimensions LxWxH	Height with handle	449x210x358 mm
Weight		11 kg (without cable)
Temperature class		F (155º C)
EMC class		A
Degree of protection		IP23S
Operating temperature range		-20…+40º C
Storage temperature range		-40…+60º C
Standards IEC60974-1 IEC60974-3 IEC60974-10 IEC61000-3-12		

3.2. Wiring diagrams



3.3. Construction

Left side

Front

Right side

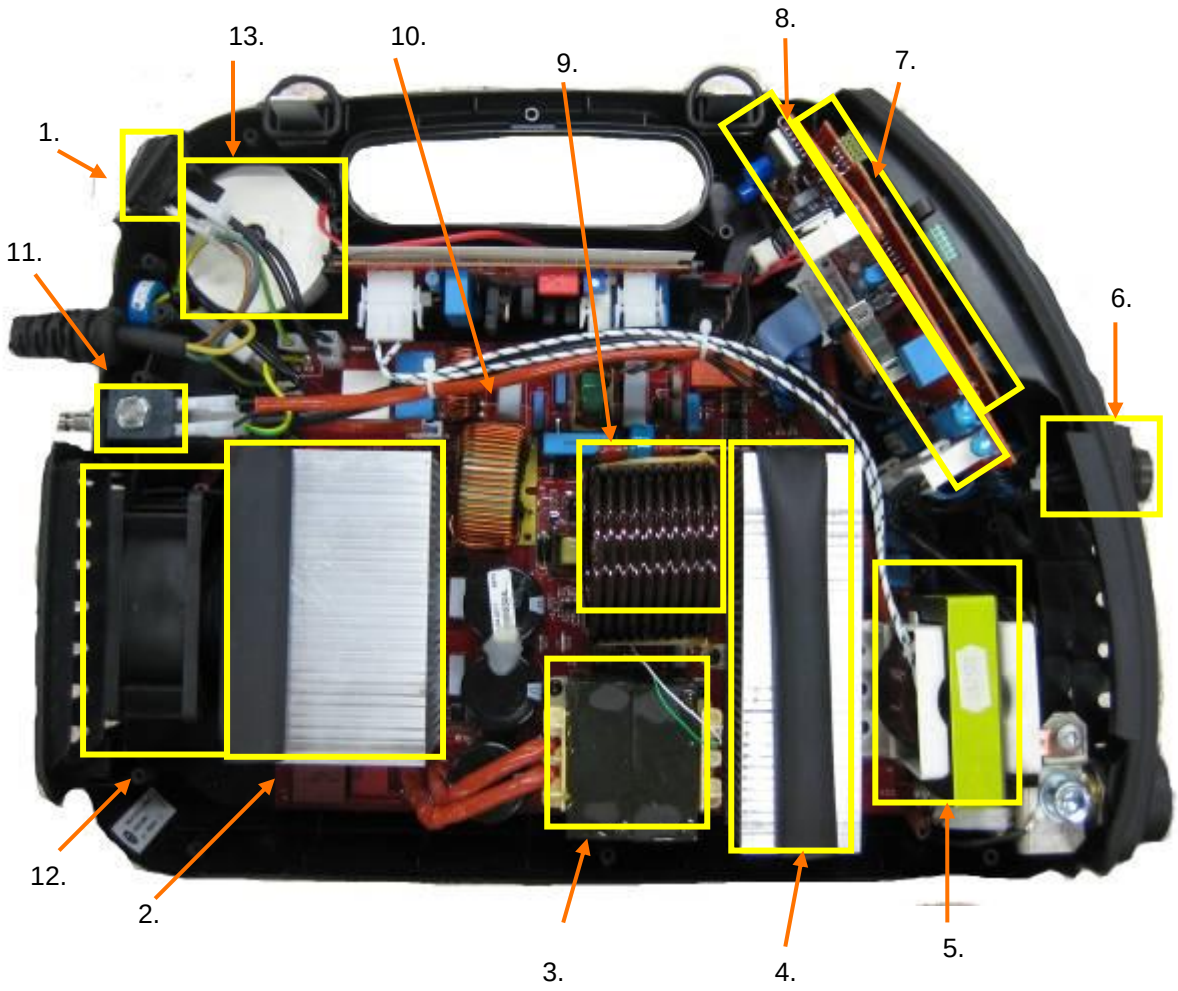
Back

Left side, side plate removed

Left side plate is installed with T20 (4 pieces) torx screws and side plate has to be removed before opening case.

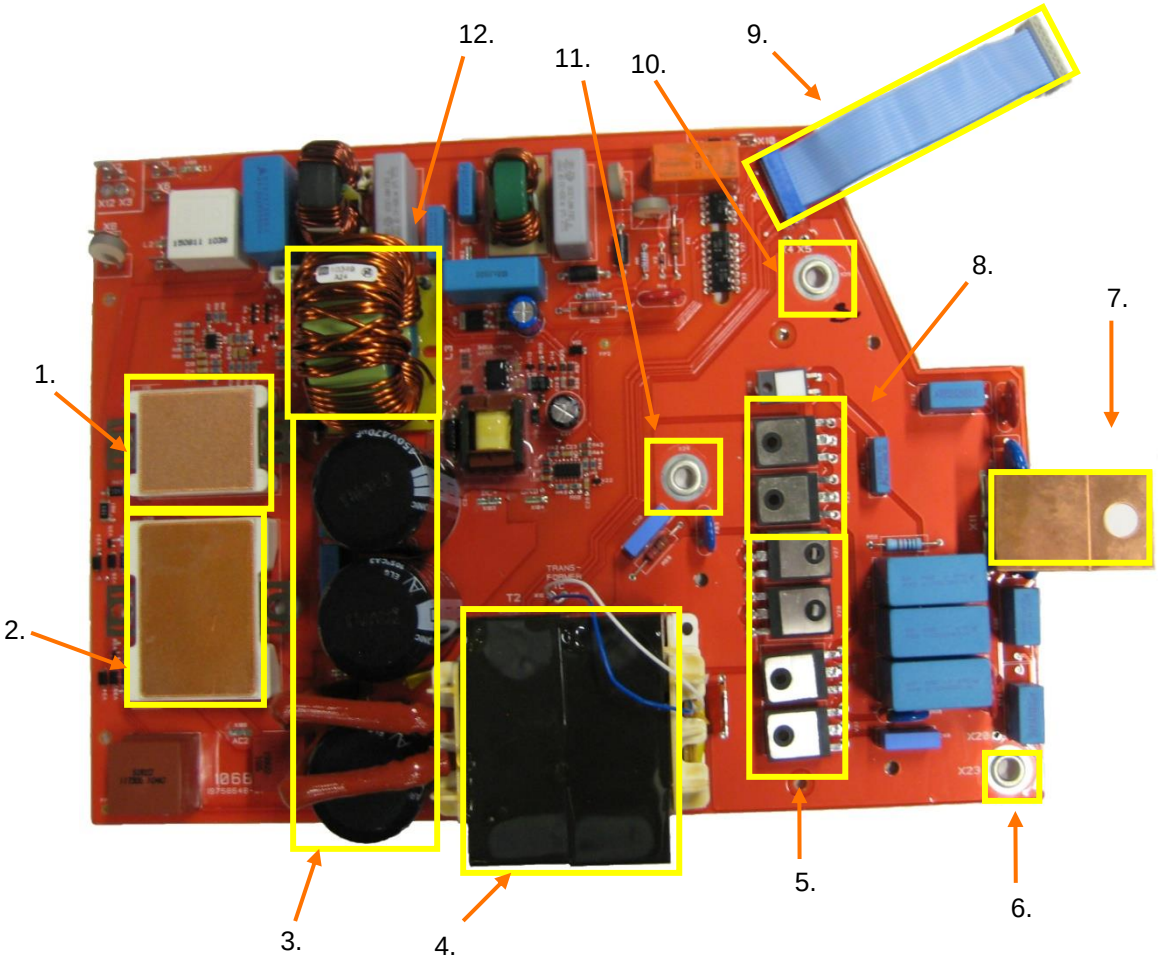
Case itself is kept in place with T15 (12 pieces) torx screws. Places marked in picture on the left.

3.3.1. Inner structure



1. Main switch
2. Primary heat sink
3. T001 main transformer
4. Secondary heat sink
5. Spark transformer
6. Remote control socket
7. P001 panel card
8. A001 control card
9. Secondary choke
10. Z001 main circuit card
11. Y001 magnetic valve
12. M001 fan
13. T002 Auxiliary transformer

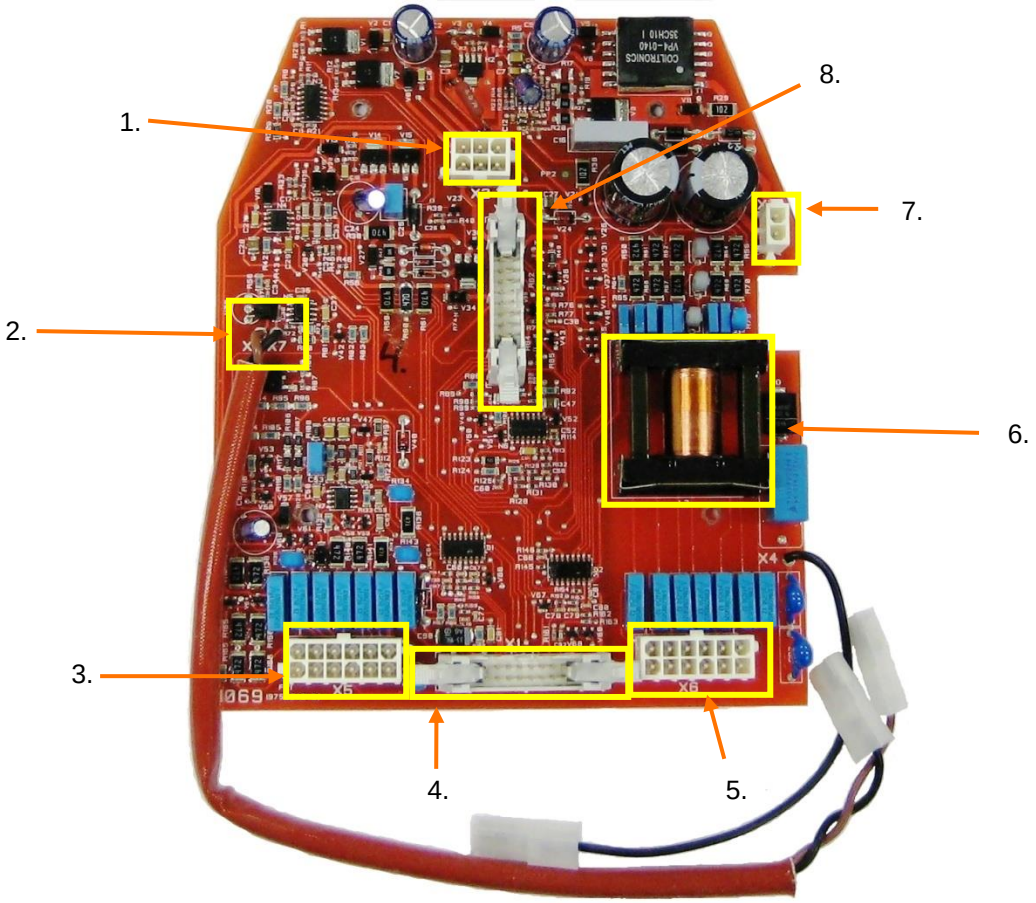
3.3.2. Z001 main circuit card structure



1. Primary rectifier and PFC module
2. IGBT module
3. DC-link capacitors
4. Main transformer
5. Secondary diodes, zero side
6. Work return connection
7. Positive output connection
8. Secondary diodes, positive side
9. Flat cable to A001 card
10. Secondary choke input connection
11. Secondary choke output connection
12. PFC choke

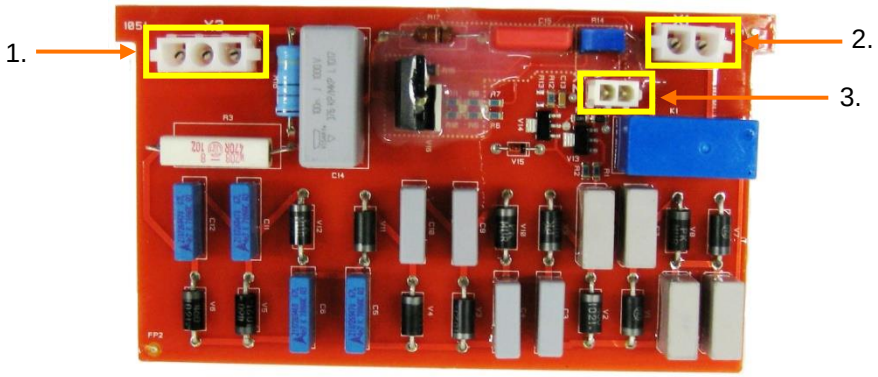
Note that primary and secondary heat sinks and secondary choke are not in the picture BUT they are still part of the Z001 card.

3.3.3. A001 control card structure



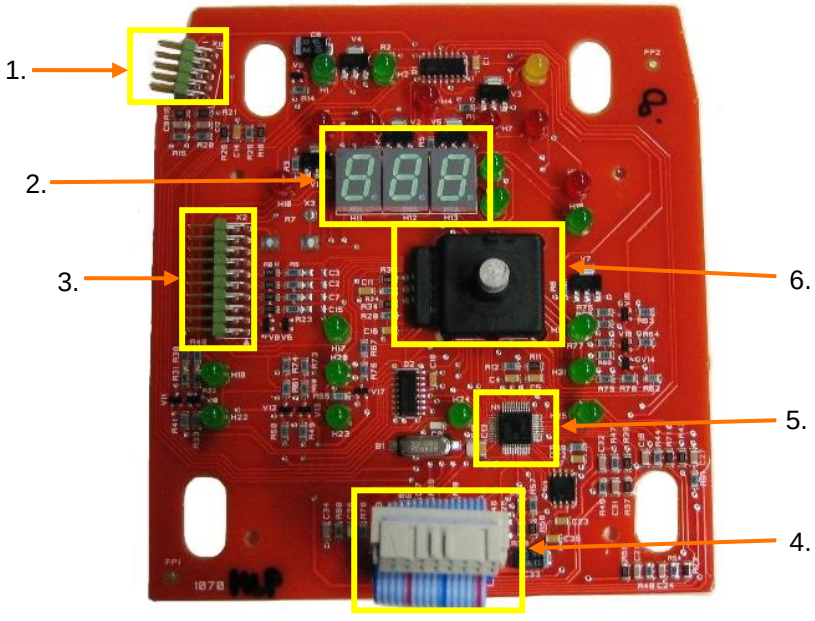
1. X2 connector to A002 control card
2. Shunt connection to the A001 card (X8 brown, X7 black)
3. X5 Remote control connector
4. X1 connector to P001 panel card
5. X6 connector to TIG torch control line
6. Filter choke for TIG remote connection
7. X3 connector to auxiliary transformer
8. X1 flat cable connector from P001 to A001 card

3.3.4. A002 spark card structure



1. X3 Spark transformer connector (output)
2. X1 Main transformer secondary connector (input)
3. X2 Control card connector (Spark ON/OFF)

3.3.5. P001 panel card structure



1. X10 Service connector for Datamaster 2
2. 7-Segment display
3. X2 membrane panel connector
4. X1 control card flat cable connection
5. Panel microprocessor
6. Pulse potentiometer

3.4. Description of operation

MinarcTig Evo has the following parts and components:

- Main circuit card Z001
- Control card A001
- Spark card A002
- Panel card P001
- Main switch S001
- EMC choke L001
- Auxiliary transformer T002
- Spark transformer T003
- Cooling fan M001
- Shunt R001
- Gas valve Y001
- TIG torch control connector X001
- Remote control connector X002
- Main output terminals (Dix connectors) X003 and X004
- TIG torch connector X005
-

Cooling fan is in the back of the machine and fresh air intake is through the rear grill. Air flows through the heat sinks and exits in the front of the machine.

Note that both Z001 and A001 cards have +24VDC, but they are in different potential, Z001 in primary and A001 in secondary.

3.4.1. Z001 Main circuit card

Main circuit card coil components and their functions:

- Main transformers transformer ratio is 3,67:1; its primary winding is 11 turns (wire) and secondary 3 (foil). The transformer has a 160°C PTC for over heat protection. While temperature rises the resistance stays under 100Ω until the breakdown point, then the PTC goes to high-resistance mode (>10kΩ). Control logic stops the inverter if the resistance value rises over 1,5kΩ.
- Secondary choke L4 inductance is 5µH and its winding has 10 turns. The choke slows the secondary voltage changes and works as energy storage in the deep short circuits.
- PFC choke works together with PFC circuit. It has 66 turns.

Main circuit card itself provides the following functions:

- DC-link soft start charging and over voltage disconnecting circuit. It avoids full power connection if primary has short circuit or main supply voltage rises over the safety limit. Relay control is in A001 card.
- EMC filtering circuit filters EMC disturbances from main supply voltage to the machine and vice versa.
- The single-phase rectifier/PFC module rectifies the mains voltage (nominal 230VAC) to PFC circuit, approx nominal value of 320VDC. Rectifier holds four power diodes. PFC circuit is integrated in the same module with rectifier diodes. PFC circuit (IGBT,

diode and PFC choke) keeps the primary currents and voltage in the same phase. This rises the power factor up to 0,98. PFC is boost type and raises the DC-link voltage up to 390VDC.

- Power section is based on dual forward architecture with 60 kHz switching frequency. IGBTs have two stages: ON/conducting and OFF/demagnetizing. OFF-stage must last longer comparing to ON-stage because main transformer needs to be demagnetized or otherwise it goes to saturation.
- IGBT module has integrated NTC resistor for over heat protection: In 0-40° C environment temperature range resistance varies between 14-2,8kΩ if the machine is cool (values are not exact because some components affect the measured value). In the overheat situation NTC resistance reduces and machine stops the inverter at the 500Ω point. Note that NTC has descending nominal curve: When temperature rises resistance lowers.
- Z001 card has auxiliary power supply that delivers auxiliary voltages to Z001 card. There are two secondary voltages: +16VDC for the IGBT gate driver circuits and +24VDC for the cooling fan and charging relay.
- DC-link with three 470µF electrolytic capacitors. Machine current is measured in the DC-link and feedback goes to the A001 card.
- Secondary rectifier has two working and four demagnetizing diode packages. Each package holds two diodes so total quantity is double.
- Cooling fan control circuit. Control signal comes from the P001 card. Note that cooling fan uses +24VDC that is in the primary side.
- Dual forward inverter gate driver circuit. Control signal is coming from the A001 card.
- Spark protection against HF ignition sparks

3.4.2. A001 Control card

- MMA dynamics function. Adjustment is made in panel setup.
- A001 card has auxiliary power supply; it rectifies the auxiliary transformers secondary voltage 20VAC to 28VDC. Switching circuit regulates it to +24VDC, and produces unregulated +8VDC, from which a +5VDC regulated supply is generated.
- PWM circuit for controlling the inverter. Secondary current is measured in the shunt and feedback is used to make correct adjustments. PWM circuit adjusts also open circuit voltage and its level can be selected from panel software (+95VDC or 30VDC VRD).
- Secondary voltage measuring. Value is delivered to P001 card.
- Connection to P001 card.
- Gas valve control circuit. P001 microprocessor gives control signal to A001 card.
- Control to DC-link soft start charging relay and over voltage watch.
- PFC control circuit. Control signal comes from the microprocessor on the P001 card.
- Under voltage watch. It shuts down the inverter and information is delivered to microprocessor on the P001 card.

- Main transformer PTC and IGBT NTC monitoring circuits. It shuts down the inverter and information is delivered to microprocessor on the P001 card.
- Remote controller and TIG torch control connections. P001 card reads the signals.

3.4.3. A002 spark card

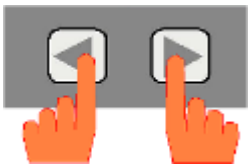
- Generates voltage to spark transformer and switches it on and off. Voltage is generated from the main transformer secondary.
- Trimmer R14 can be adjusted to change the voltage between 7,8-14,7kV. A002 card (both original and spare part card) is factory adjusted and does not need to be re-adjusted in service.
- A002 card is controlled by P001 panel card.

3.4.4. P001 panel card

- Microprocessor has many different operations:
  - Controls panel LEDs and 7-segment display.
  - Reads membrane switches and pulse potentiometer.
  - Reads remote controller and TIG torch control signals (via A001).
  - Controls cooling fan, gas valve, spark ignition and PFC operations.
  - Reads over and under voltage watch circuit and over temperature circuit stages.
  - Controls serial bus and saves calibrations data.
- Service connector for programming devices like Datamaster 2. Panel processor can be re-programmed via this connector.
- Panel card holds most of the input and output devises to the user, like LEDs, 7-segment display, and pulse potentiometer.
- Connection to membrane panel.

3.4.5. Setup parameters

To enter the setup you have to press back and forward arrows for three seconds:



Press 3 seconds for entering setup

Parameter	Explanation
A.	
1	TIG slopes to minimum current
0*	TIG current at arc stop is 15 % of welding current
b.	
1	no load voltage 30 V (VRD function)
0*	no load voltage 95 V
C.	
1	by 2T the downslope is cut off by short (<0,4 s) action of the torch switch
0*	current can be sloped down and up again
d.	
3	Minilog + SearcArc
2	4T-LOG + Minilog
1*	Minilog
0	4T-LOG
E.	Current Level at ignition (with upslope)
5-40%	Range
20 % *	Factory default
F.	
1	Factory settings recall
0*	Factory default
h.	Pregas time minimum
0.0- 2.0 s	Range
0.0 s*	Factory default
J.	Postgas time minimum
0-10 s	Range
1 s*	Factory default
L.	Pregas time maximum
5-20 s	Range
10 s*	Factory default
o.	Postgas time maximum
15-99 s	Range
30 s*	Factory default
S.	MMA Dynamics adjustment
-3…5	Range
0*	Factory default

- * (asterix) presents the factory default setting

3.4.6. Error codes

Error code	Explanation
E.2	Supply voltage is too low
E.3	Supply voltage is too high
E.4	Main transformer overheated
E.6	Secondary voltage too high (safety limit 113 V)
E.13	Panel card and control card versions do not match. One of them is AU version and another one non-AU version.
E.40	IGBT NTC overheated

4. SERVICE INSTRUCTIONS

4.1. Programming

MinarcTig Evo 200 has a microprocessor on the P001 card. It can be reprogrammed using Datamaster 2 (DM2 later in this document) service device. Panel card has 10-pin connector X10 where DM2 flat cable can be connected.

Both normal MinarcTig and MLP versions use the same software. First software must be uploaded to the DM2 using Datamaster 2 PC software, which is provided on a CD included with the DM2. Once the software is installed on the PC, it can then be transferred to the DM2 via a USB cable. Now the DM2 is ready to be used for MinarcTig update.

Open the MinarcTig case and connect the 10-pin connector to panel X10. Switch on the MinarcTig and start updating and wait until downloading is completed. Once it is finished, DM2 can be disconnected and the new software is ready to be used. Software version can be checked by switching on the machine and then pressing one of the panel buttons. 7-Segment display shows the software version.

See more DM2 information in the user manual.

4.2. Measurements and tests

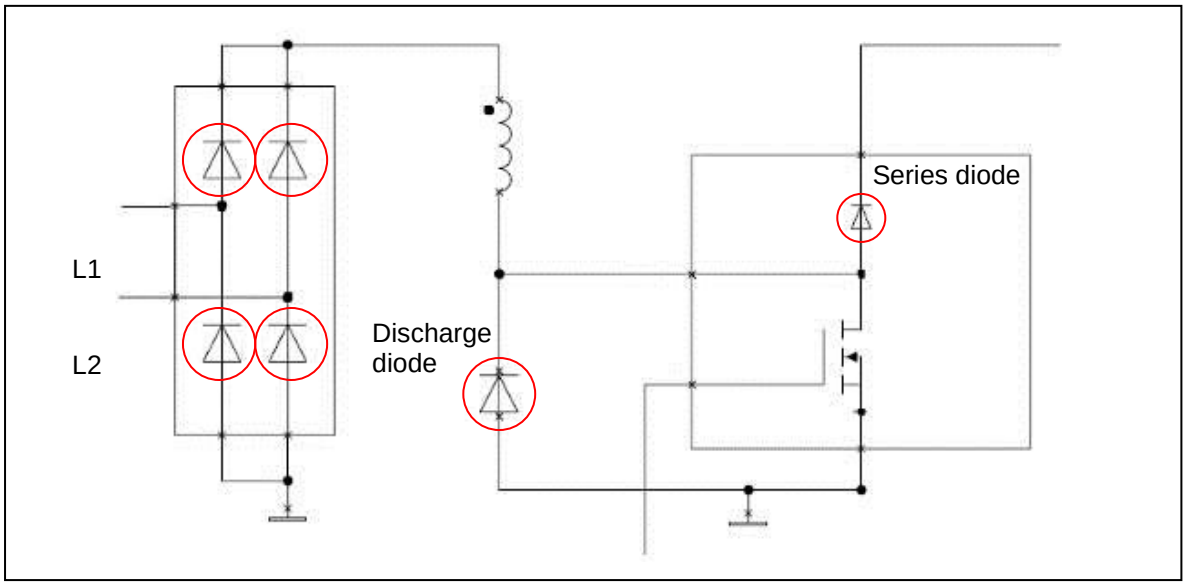
4.2.1. Z001 Main circuit card

Power stage is divided in to two parts: rectifier/PFC module and IGBT module. They can be tested separately by using simply digital multimeter.

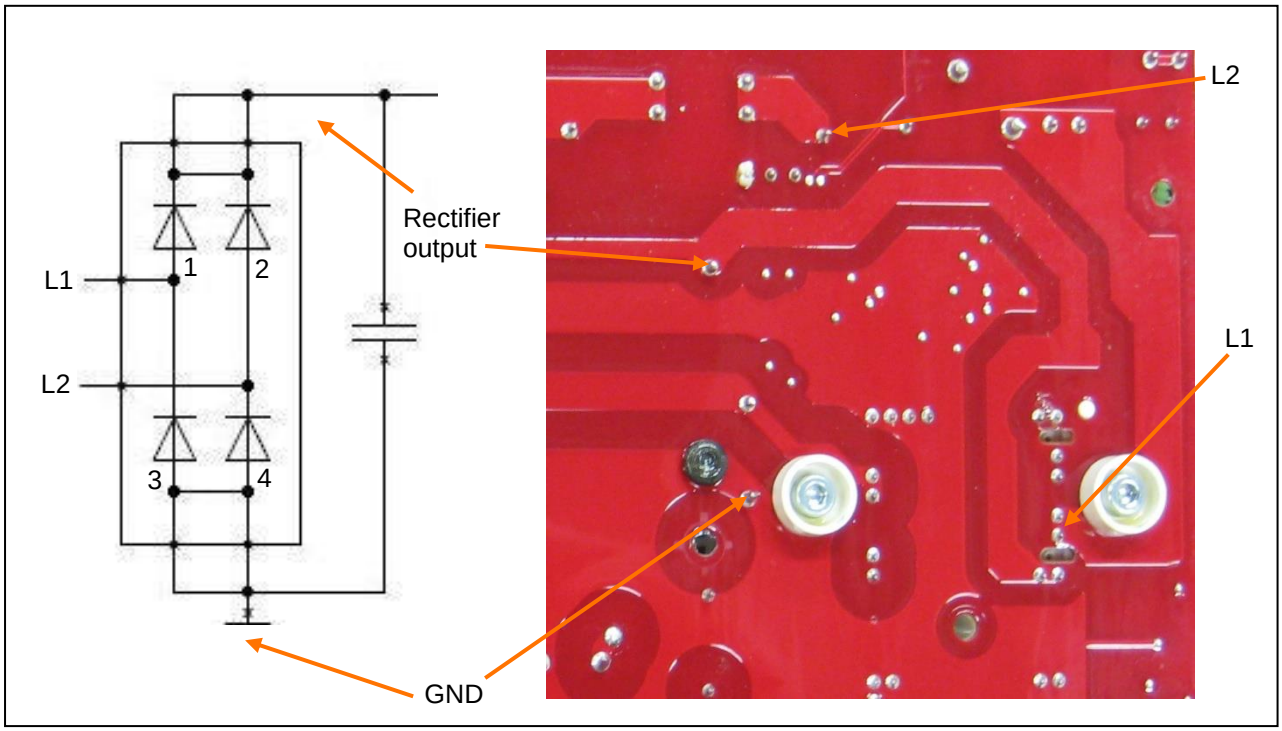
4.2.1.1. Input rectifier and PFC circuit

*Main supply voltage must **not** be connected during the rectifier/PFC module diode measuring.*

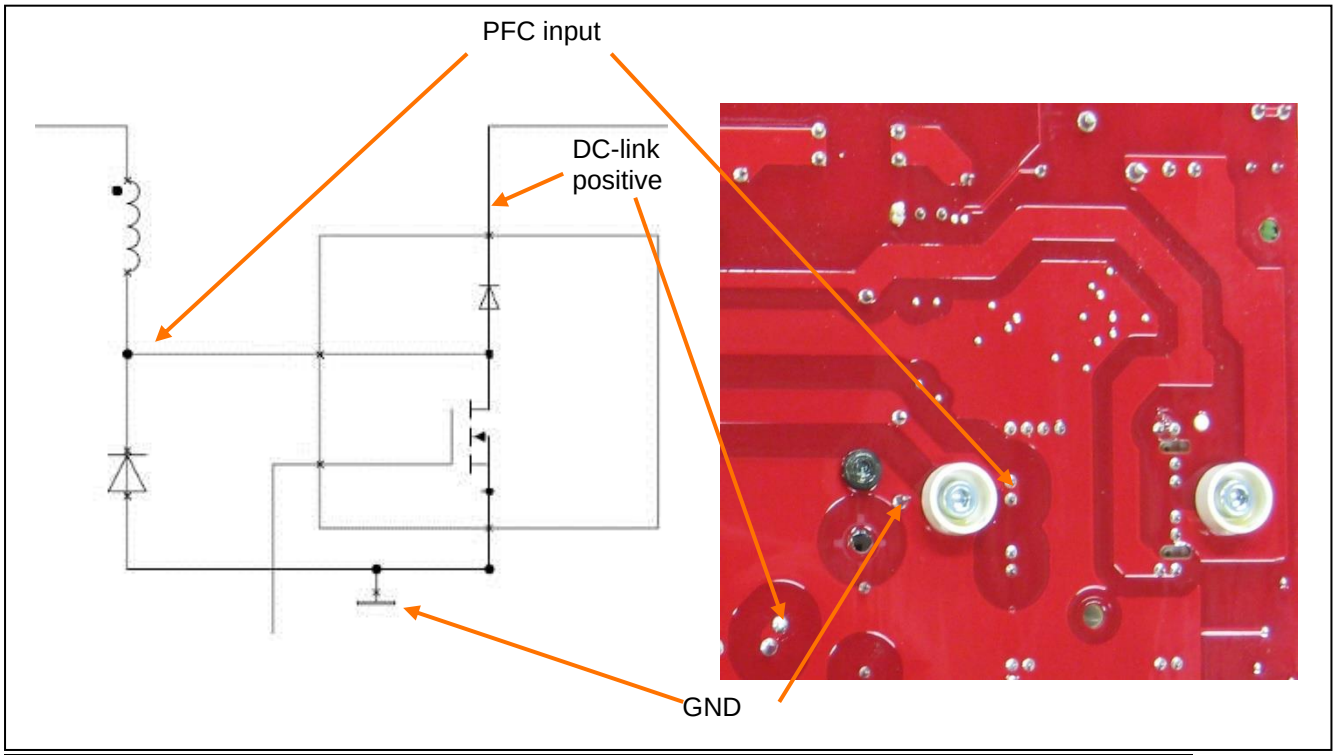
In many case of primary side failures input rectifier or the PFC circuit diodes may get defective. Rectifier and PFC diodes can be measured one at a time. PFC has one diode in series with IGBT and one discharge diode.



Check the diodes using the multimeter diode function to measure their threshold voltage. Diodes must be measured both forward bias and reverse bias condition to make sure they are fine. See following pictures and tables to make sure all the measurements are done.



Diode	Positive test lead	Negative test lead	Result
Diode 1 forward bias	L1	Rectifier output	0,2-0,7VDC
Diode 3 reverse bias	L1	GND	No value
Diode 1 reverse bias	Rectifier output	L1	No value
Diode 3 forward bias	GND	L1	0,2-0,7VDC
Diode 2 forward bias	L2	Rectifier output	0,2-0,7VDC
Diode 4 reverse bias	L2	GND	No value
Diode 2 reverse bias	Rectifier output	L2	No value
Diode 4 forward bias	GND	L2	0,2-0,7VDC

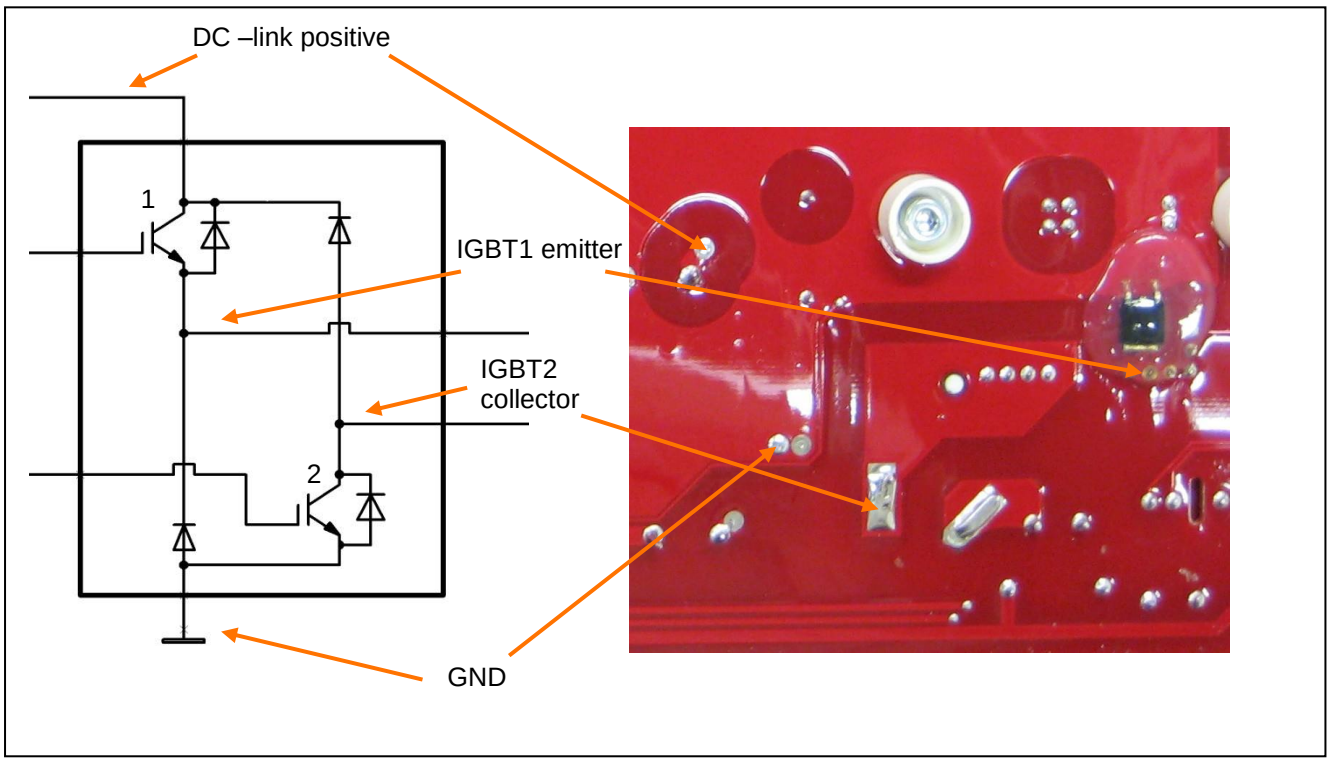


Diode	Positive test lead	Negative test lead	Result
Series diode forward bias	PFC input	DC-link positive	0,4-0,9VDC
Discharge diode reverse bias	PFC input	GND	No value
Series diodes reverse bias	DC-link positive	PFC input	No value
Discharge diode forward bias	GND	PFC input	0,3-0,7VDC

4.2.1.2. IGBT

*Main supply voltage must **not** be connected during the IGBT module diode measuring.*

IGBT module can be tested by multimeter if using the diode tester function. Module holds four diodes and in many cases they may be defective if IGBT is damaged. They can be measured separately only if main transformer primary is disconnected.



IGBT	Positive test lead	Negative test lead	Result
IGBT 1 diode + upper separate diode; forward bias condition	IGBT1 emitter/IGBT 2 collector	DC-link positive	0,2-0,7VDC
IGBT 2 diode + lower separate diode; reverse bias condition	IGBT1 emitter/IGBT 2 collector	GND	No value
IGBT 1 diode + upper separate diode; reverse bias condition	DC-link positive	IGBT1 emitter/IGBT 2 collector	No value
IGBT 2 diode + lower separate diode; forward bias condition	GND	IGBT1 emitter/IGBT 2 collector	0,2-0,7VDC

If the transformer primary is disconnected, IGBT 1 emitter and IGBT 2 collector connection points can be used separately to measure diodes one by one. In this case the table must checked twice: first using the IGBT 1 emitter point only and then the IGBT 2 collector point.

4.2.1.3. Secondary rectifier

*Main supply voltage must **not** be connected during the secondary rectifier diode measuring.*

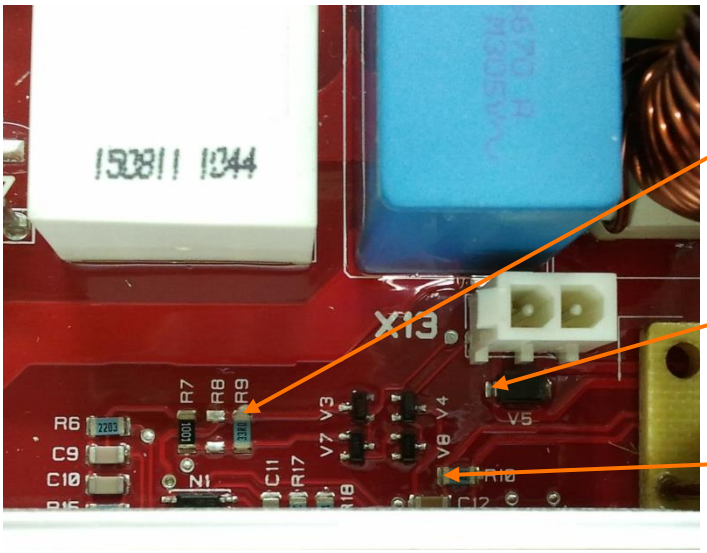
Use a digital multimeter to test the secondary diodes. Diodes are in groups, so it is not possible to measure them one by one unless they removed from the board and measured separately.

Diode	Positive test lead	Negative test lead	Result
Forward bias	Negative output terminal	Positive output terminal	0,2-0,6VDC
Reverse bias	Positive output terminal	Negative output terminal	No value

4.2.1.4. Voltages

The Z001 main circuit card has the DC-link voltage after the input rectifier and several auxiliary voltages made by the auxiliary PSU.

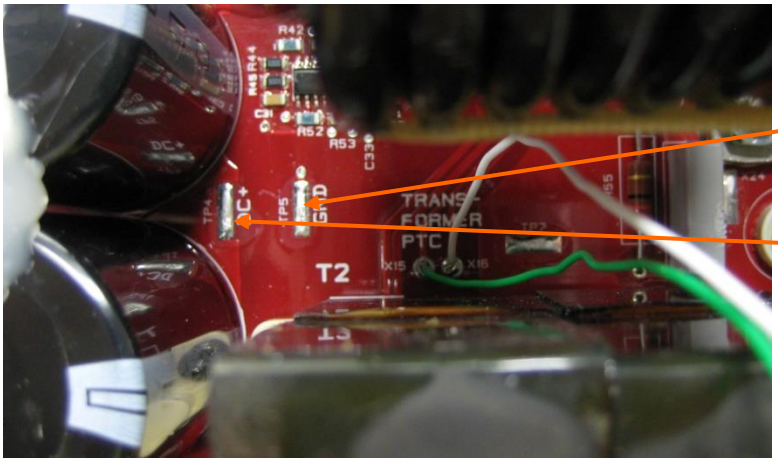
Note! These voltages are in the primary side. Even touching the ground level may affect electric shock because there is up to 120VDC between the ground and protective earth.



Primary GND,
R9 upper side connection point

+24VDC,
V5 left side connection point

+16VDC,
R10 left side connection point

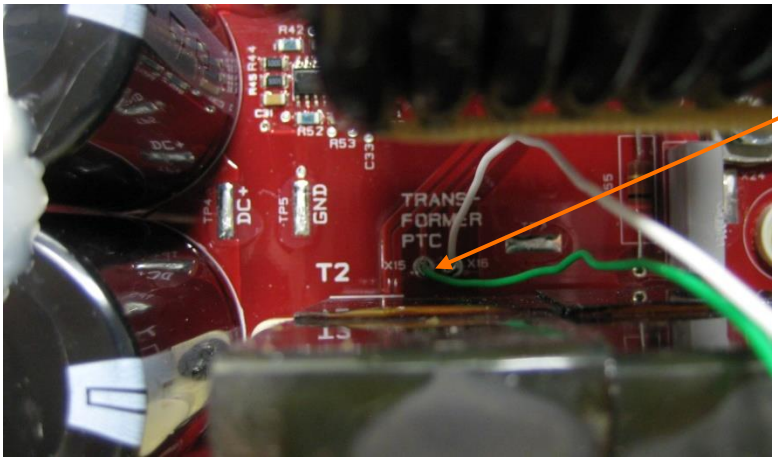


4.2.1.5. Overheat protection

Main transformer PTC is soldered to the Z001 main circuit card:

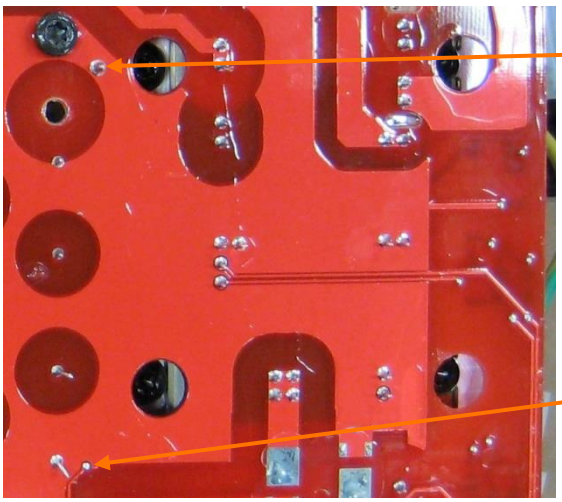
- Measure the resistance: It should be less than 100Ω
- In over temperature situation PTC goes to high-resistance mode (>10kΩ)
- Machine gives temperature alarm at 1,5kΩ
- A broken PTC has usually hundreds of kilo ohms resistance or no value at all.

Note that the PTC signal is only delivered onto the Z001, the control logic is on the A001 control card.



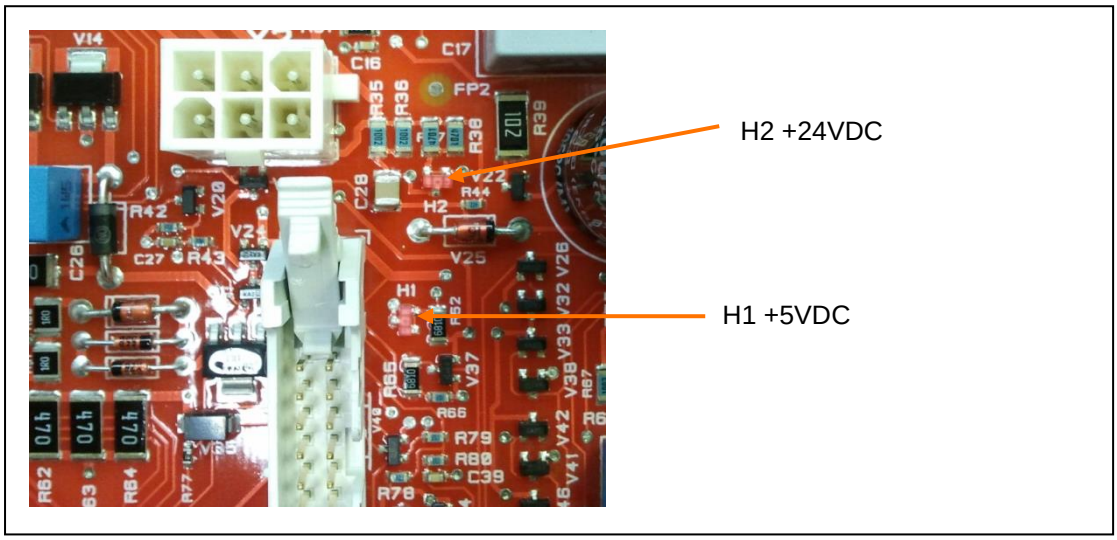
IGBT module NTC is integrated inside the module:

- Measure the resistance, it should be between 14-2,8kΩ in a cool machine (in environment temperature 0-40°C)
- While temperature rises, resistance lowers and at 500Ω point the inverter stops and gives overheat alert.
- A broken NTC has usually hundreds of kilo ohms resistance, no value at all or short circuit.
-



4.2.2. A001 control card

Control card voltages +5VDC and +24VDC can be quickly verified with LEDs on the A001 control card. Voltages are in secondary side.



4.2.3. Cooling fan

Cooling fan gets the power from +24VDC line. Voltage can be measured on the X13 connector (X13-1 +24VDC and X13-2 GND). Note that the cooling fan has delayed starting.

4.2.4. Low voltage tests

There is no possibility to do low voltage test for this machine.

4.2.5. Safety tests

Safety tests are made normally. Note that PE conductivity test point and chassis ground test point is in gas valve snap connector.

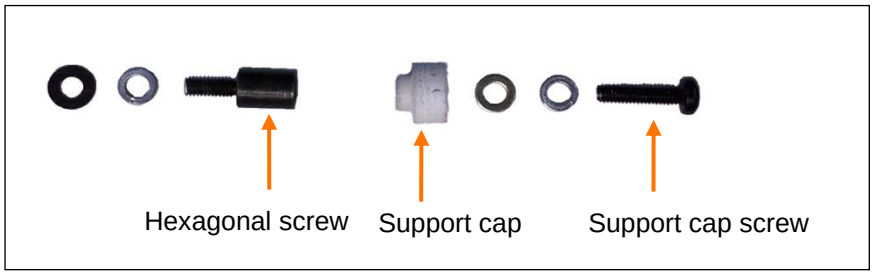
4.3. Semiconductor installation

It is a must to use torque screwdriver while tightening any power components onto the heat sink. See following sections for tightening torques.

4.3.1. Rectifier/PFC module and IGBT

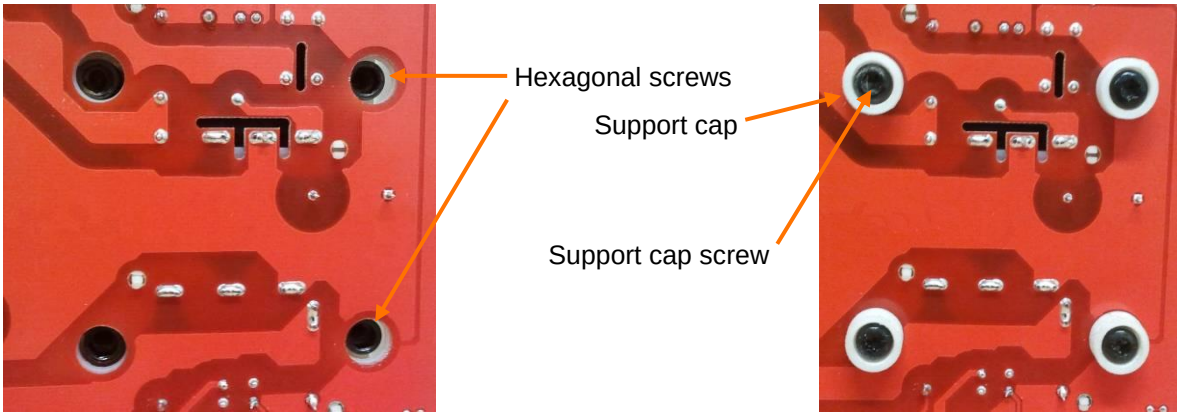
MinarcTig Evo 200 has a soldering input rectifier/PFC and IGBT modules and it is not possible to change them separately. Only reliable way to replace the module(s) is to change the whole Z001 main circuit card.

Heat sink paste should be spread on to the modules in an even layer by using clean fingers. Then the card should be immediately mounted onto the heat sink, this minimizes the possibility of any contamination (dirt etc.) getting between the components.



The hexagonal fixing screws on the IGBT module are tightened (stage 1) to 1 Nm. Then after a few minutes the module screws can be finally tightened (stage 2) to a torque of 2 Nm.

Once all the four hexagonal screws are tightened to right torque, the Module support cap screws can be fastened. The idea is to support the module onto the PCB with the plastic caps instead of the component soldered legs. The torx screws with caps can be tightened only up to 0,5 Nm, or otherwise the PCB may bend.



4.3.2. Secondary rectifier

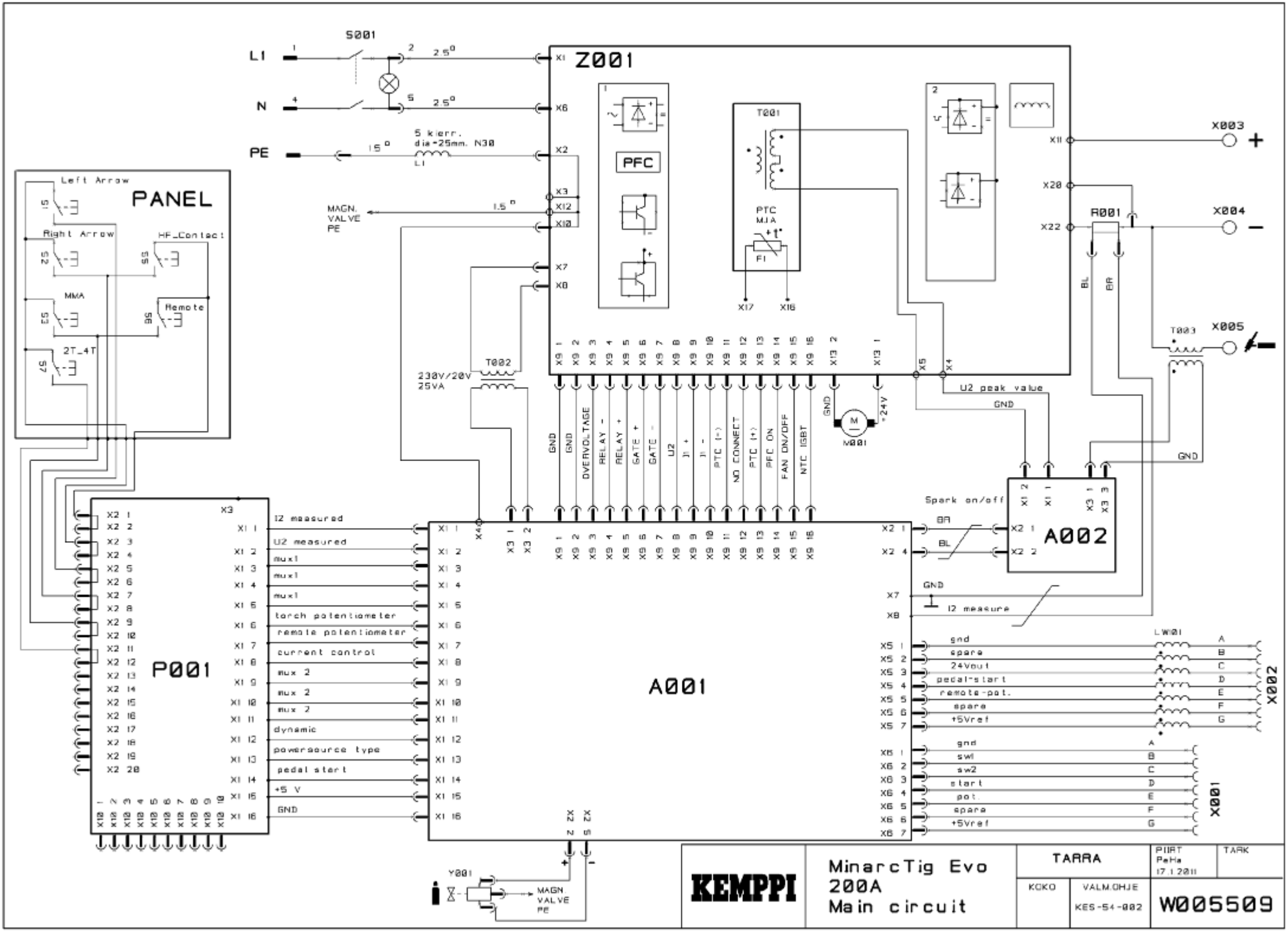
Heat sink transfer should be spread in an even layer onto the heat sink. Then card should be immediately mounted onto the heat sink. This minimizes the possibility of any contamination (dirt etc.) getting between the components.

The torx fixing screws in diodes are tightened to 1,2 Nm and resistor (with smaller case than diodes) to 0,8 Nm.

4.4. Final testing

After machine repair and low voltage tests it is good practice to make some load tests and test welds. Only then is it possible to guarantee the machine is working in real life welding conditions.

5. NOTES


S001
L1
N
PE
Z001
PFC
T001
PTC
M1A
F1
X17
X18
5 kierr.
dia=25mm. N30
L1
MAGN.
VALVE
PE
T002
230V/20V
25VA
PANEL
Left Arrow
Right Arrow
HF_Contact
MMA
Remote
2T_4T
P001
A001
A002
R001
T003
M001
X003
X004
X005
X001
X002
LW01
GND
+24V
U2 peak value
Spark on/off
I2 measure
I2 measured
U2 measured
torch potentiometer
remote potentiometer
current control
dynamic
powersource type
pedal start
+5 V
24Vout
pedal-start
remote-pot.
spare
+5Vref
sw1
sw2
start
pot.
Y001
KEMPPI
MinarcTig Evo
200A
Main circuit
TARRA
PIIRT
PeHa
17.1.2011
TARK
KOKO
VALM.OHJE
KES-54-002
W005509