Service manual
Mastertig MLS 3003 ACDC

Version 1.2

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Technical data

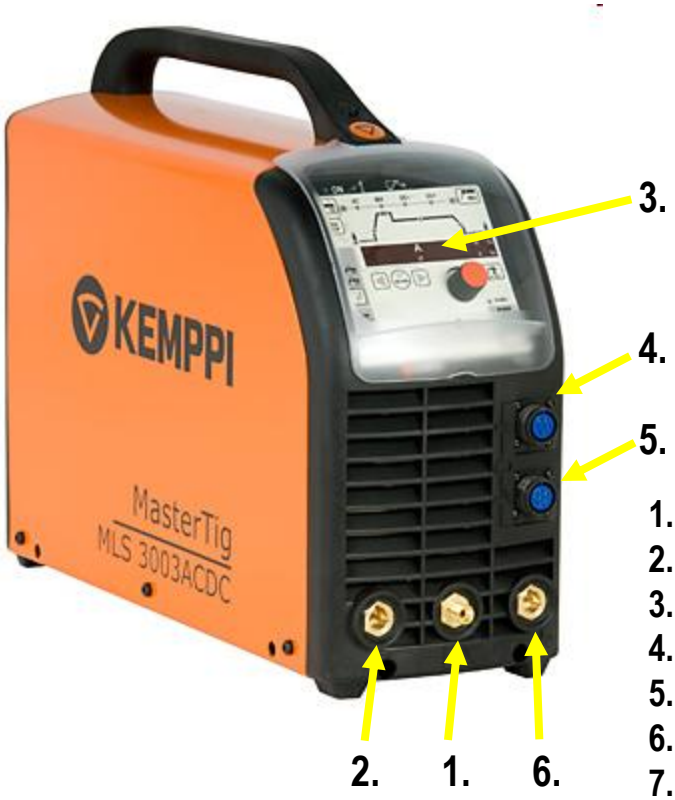
Mains Voltage	**3 ~ 230 V - 10% … 460 V +10%, 50/60 Hz**			
Mains cable	**H07RN-F 4G2.5, length 5 m**			
Fuse	**20/ 16A delayed fuse**			
Rated power	**40%**		**100%**	
	TIG	**300A**	**TIG**	**190A**
	MMA	**250A**	**MMA**	**190A**
Minimum Current	**TIG 3A (AC 5A) / MMA 10A**			
Open circuit Voltage	**58 V**			
Power Factor at nominal values	**0,95**			
Efficiency at nominal values	**80-84 % (250A / 30V)**			
	77-81 % (300A / 22V)			
Open circuit power	**TIG < 13W**			
	MMA 190W			
Electrode sizes to be welded	**1,5 - 5,0 mm**			
Size (l x w x h)	**500 x 180 x 390 mm**			
Weight	**25 kg**			

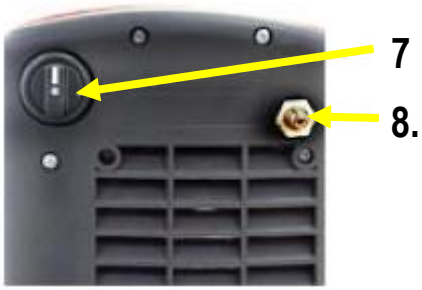
Maximum power can be achieved with 20 kVA generator for the power source.

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

Measured values may differ by the type and model of multimeter used.

User interface





1. Gas connector for TIG torch
2. Welding current connection (negative)
3. Operation panel
4. Remote controller connection
5. TIG -torch control connection
6. Welding current connection (positive)
7. Main switch
8. Gas connector

Error code	Description
Err 3	Overvoltage
Err 4	Over heating
Err 6	Internal fault, secondary voltage over the limit.
Err 8	Maximum overheat time, machine doesn't cool down fast enough. Only machine shutdown and restart removes error.
Err 61	Water connection, water cooled gun connected without cooler.
COO Ler	Cooler error: - Cooling liquid over- / under pressure state - Overheated alarm
BuS Err	Communication between panel and power source isn't possible
Err rSt	System error, machine makes reset itself.

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Setup functions

Entering the advanced setup press and hold the setup and Return buttons at the same time. Changing the level press Setup button shortly

Welding current upslope time *	A1	ON	The upslope time depends on the welding current
		OFF	The upslope time is fixed
Welding current downslope time *	A2	ON	The downslope time depends on the welding current
		OFF	The downslope time is fixed
TIG Antifreeze *	A3	ON	TIG Antirfeeze is ON
		OFF	TIG Antifreeze is OFF
MMA Antifreeze *	A4	ON	MMA antifreeze is ON
		OFF	MMA antifreeze is OFF
VRD *** (MMA open circuit voltage)	A7	ON	VRD-function: MMA open circuit voltage < 35 Vdc
		OFF	Normal open circuit voltage is 50 Vdc
2T-function´s downslope cutoff	A8	ON	On 2T-function the downslope is cut off by a quick press on the start switch
		OFF	Quick press on the start switch has no function
Tacking automatics	A9	ON	Tacking automatics is ON; no downslope, if the weld is shorter than 3 s
		OFF	Tacking automatics is OFF
Current upslope speed	A10	ON	If upslope time is 0,0 s, it goes to 0,2 s from the halfway of currents > 100 A.
		OFF	Maximum current upslope speed
Method selection by remote controller *	A12	ON	Method selection; TIG: minimum end of the range of the remote controller, MMA: the maximum end of the remote controller range
		OFF	The remote controller works as a normal current adjustment

* Setting is always on ** Adjustable also by the Quick Setup *** Requires VRD card

Setup functions

Start current level	A13	ON	Start current level in use
		OFF	Start current level not in use
Current ”freezing”	A14	ON	During downslope the current can be ”frozen” onto a certain level, using the start switch
		OFF	”Freeze” function is OFF
TIG -torch auxiliary switches (RTC 20) *	A15	ON	Torch auxiliary switches are used to select memory channels
		OFF	Torch auxiliary switches adjust welding current
TIG -torch auxiliary switches (RTC 20) activation *	A16	ON	Auxiliary switches are always active
		OFF	Auxiliary switches are active only when torch control is selected
Cooling unit flow control *	A17	ON	Flow control is active
		OFF	Flow control is not active
Cooling unit control *	A19	ON	Controlled run
		OFF	Continous run
Coolant temperature watch *	A20	ON	Temperature watch is active
		OFF	Temperature watch is not active
Remote controller automatic detection *	A21	ON	Automatic detection is ON
		OFF	Automatic detection is OFF
End current level	A22	ON	4T-LOG: End current level is in use
		OFF	MINILOG: End current level is not in use
Tungsten electrode type ***	A23	NOR	Normal = Gray tungsten
		GRN	GRN = Green tungsten

* Setting is always on ** Adjustable also by the Quick Setup ***Depends on panel software version

Setup functions

Contact ignition current *	B1	20	Factory setting 20 A
		3…230	Adjustment range 3…230 A
Spark ignition duration *	B2	1.0	Factory setting 1,0 s.
		0.2…2.0	Adjustment range 0,2…2,0 s.
Downslope cutoff level *	B3	10	Factory setting 10 % of the welding current
		5…40	Adjustment range 5…40 % of the welding current
Factory settings recall *	B5	OFF	Factory setting
		PAN	Recalls factory settings to the panel, but keeps memory channels
		ALL	Recalls factory settings and empties the memory channels
Downslope interruption – upslope angle *	B6	1	Upslope speed maximum
		2	According to the upslope setting
		3	According to the downslope
Non-linear downslope (Current drop in the beginning of downslope)	B7	OFF	Factory setting
		0…50	Adjustment range 0…50 % of welding current
Torch switch long press *	B8	0.4	Factory setting 0,4 s.
		0.3…1.0	Adjustment range 0,3…1,0 s.
Cooling unit post running time *	B9	OFF	Factory setting 4 min.
		ON	Post-running time 30 s.

* Setting is always on ** Adjustable also by the Quick Setup

Setup functions

Spot welding spot-time *	B10	OFF	Factory setting 0,0…15,0 s.
		ON	0…150 s.
MMA dynamics **	B11	0	Factory setting
		-9…0…9	Adjustment range -9 = soft arc, 9 = rough arc
MMA ignition pulse **	B12	0	Factory setting
		-9…0…9	Adjustment range -9 = minimum overrun, 9 = maximum overrun
Start current level *	B13	10	Factory setting 10 % of the welding current
		OFF	Minimum current
		5…40	Adjustment range 5…40 % of the welding current
Display recovery time	B14	5.0	Factory setting 5,0 s.
		1.0…20,0	Adjustment range 1,0…20,0 s.
2T Hot Start duration **	B15	1.0	Factory setting 1,0 s.
		0.1…5.0	Adjustment range 0,1…5,0 s.

* Setting is always on ** Adjustable also by the Quick Setup

Setup functions

Pregas time minimum *	C1	0.0	Factory setting 0,0 s.
		0.0 …2.0	Adjustment range 0,0…2,0 s.
Postgas time minimum *	C7	1.0	Factory setting 1,0 s.
		0…10	Adjustment range 0…10 s.
AC balance minimum *	C16	-80	Factory setting -80 %
		-80… -10	Adjustment range -80…-10 %
Pregas time maximum *	D1	1	Factory setting 1 s.
		0…10	Adjustment range 0…10 s.
Postgas time maximum *	D7	30	Factory setting 30 s.
		15… 150	Adjustment range 15…150 s.
AC balance maximum *	D16	10	Factory setting 10 %
		0…20	Adjustment range 0…120 %

* Setting is always on ** Adjustable also by the Quick Setup

Setup functions

AC frequency **	E1	60	Factory setting 60 Hz
		50…250	Adjustment range 50…250 Hz
AC waveform **	E2	Sqr	Square wave
		Sin	Sinus wave
Half cycle AC	E3	5	Factory setting 5 A
		5…20	Adjustment range 5…20 A
AC balance **	E4	-25	Factory setting -25 %
		-50…10	Adjustment range -50…10 %
Negative ignition current *	E5	100	Factory setting 100 %
		100…500	Adjustment range 100…500 % (Limited by the max. of the power source)
Positive ignition current *	E6	50	Factory setting 50 %
		30…150	Adjustment range 30…150 % (Limited by the max. of the power source)
Positive ignition sequence time *	E7	10	Factory setting 10 = 0,01 s
		0…20	Adjustment range 0…20 = 0,0…0,02 s
Ignition cycle total time */***	E8	0.20	Setting 0,20 s.
		0.01…1,0	Adjustment range 0,01…1,0 s.
MIX TIG cycle time **	E9	0.6	Factory setting
		0.1…1,0	Adjustment range 0,1…1,0 s.

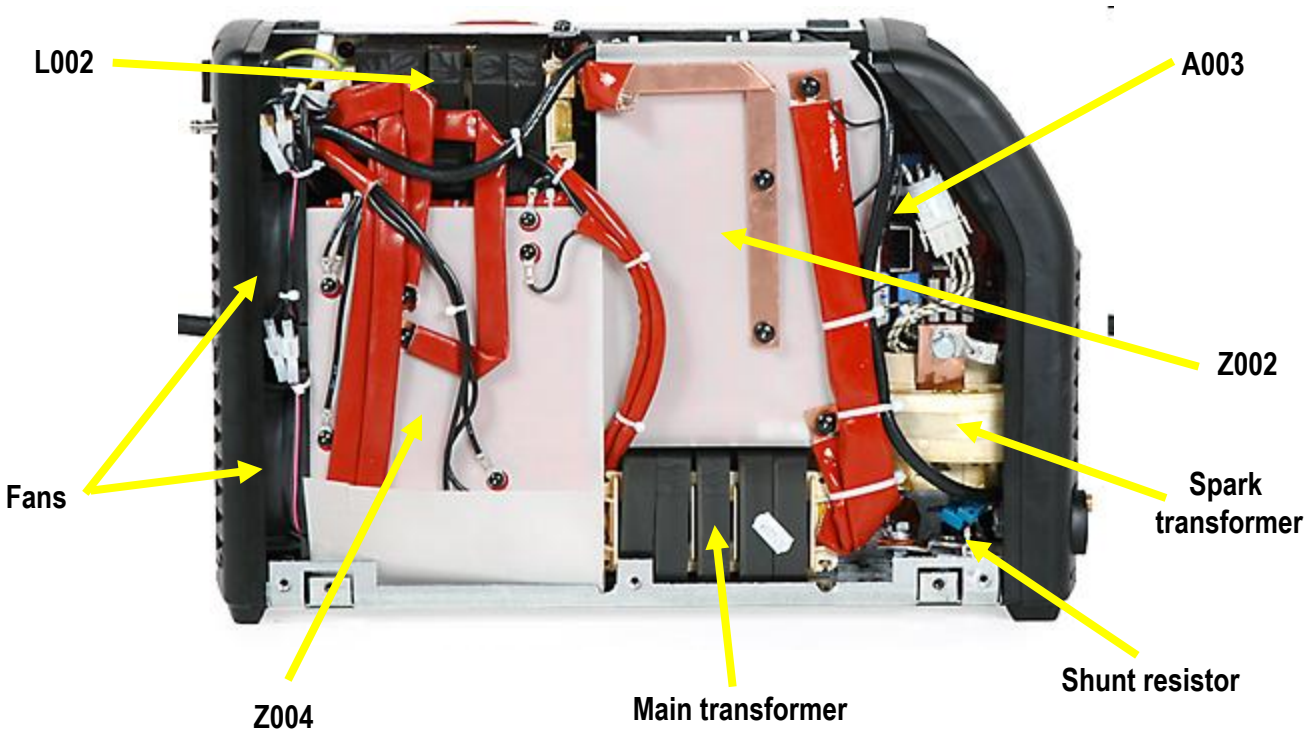
* Setting is always on ** Adjustable also by the Quick Setup *** Note panel software version

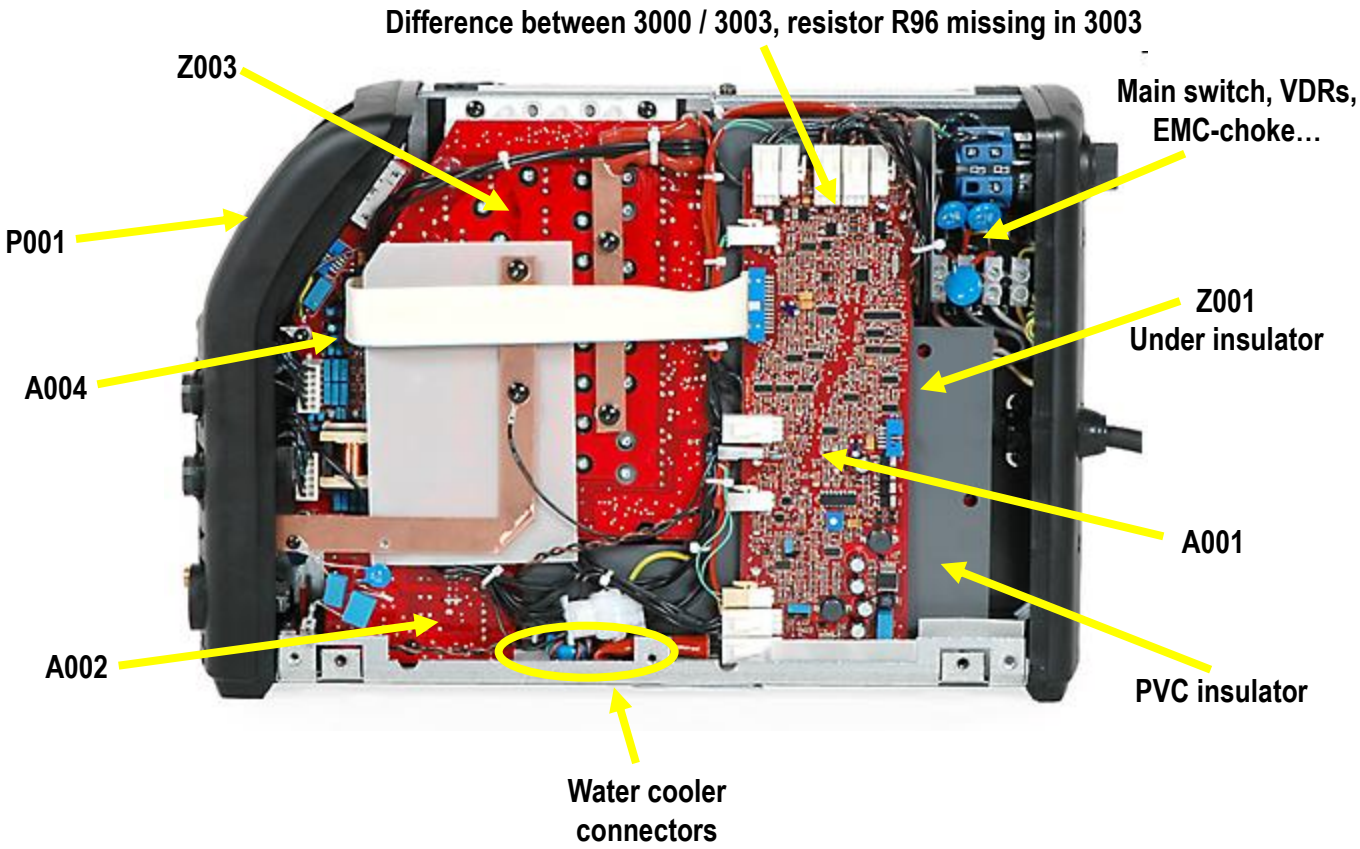
Setup functions

MIX TIG AC pulse ratio **	E10	50	Factory setting 50 %
		10…90	Adjustment range 10…90 %
MIX TIG DC level **	E11	100	Factory setting 100 %
		50…150	Adjustment range 50…150 %
Spotwelding time *	E12	10	Factory setting 10 ms.
		1…200	Adjustment range 1…200 ms.

* Setting is always on ** Adjustable also by the Quick Setup

Construction





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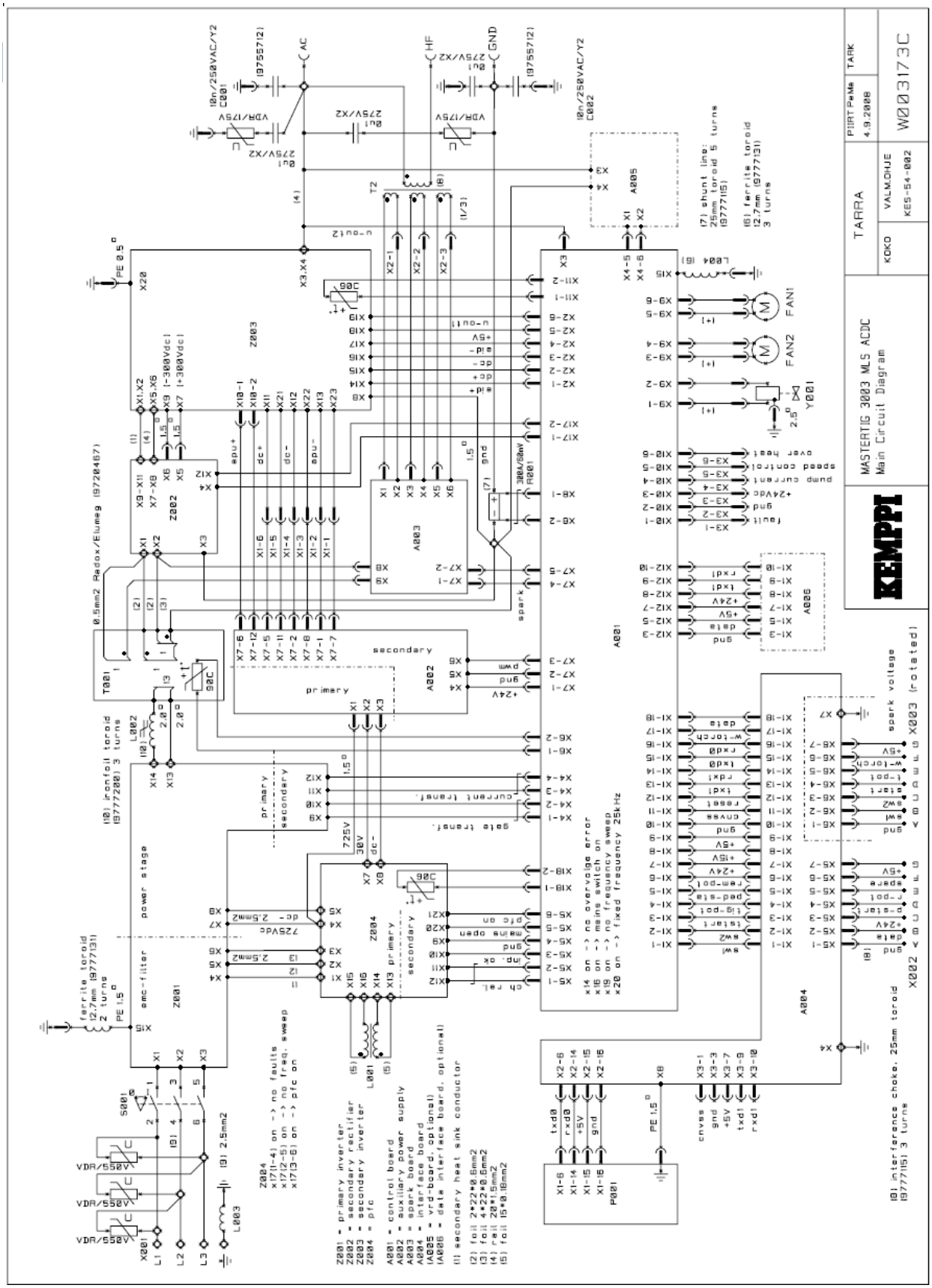

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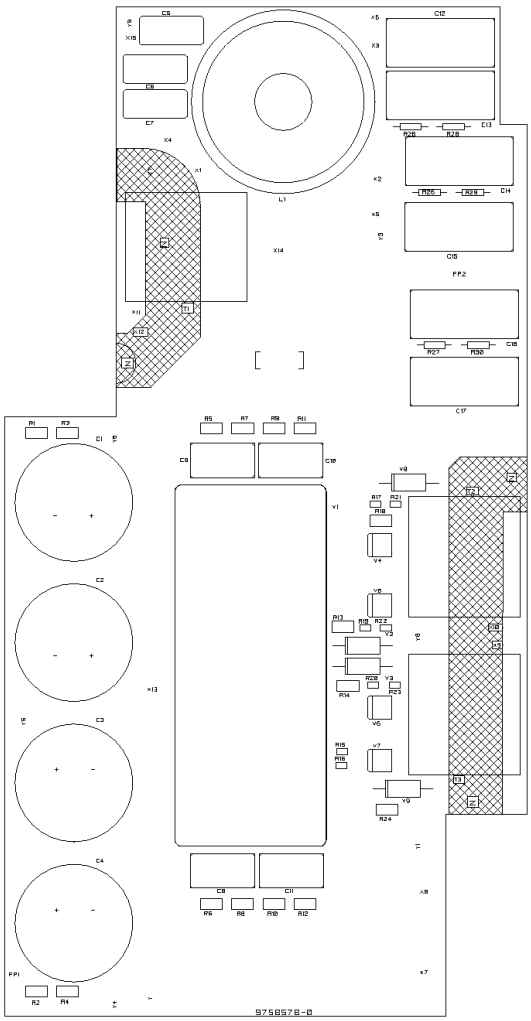
Main circuit card Z001

Functions and components:

Z001 primary inverter main functions
- full bridge topology
- switching frequency (50 … 25kHz) 25kHz
- electrolytic dc-link capacitors
- emc filtering
- gate and current transformers



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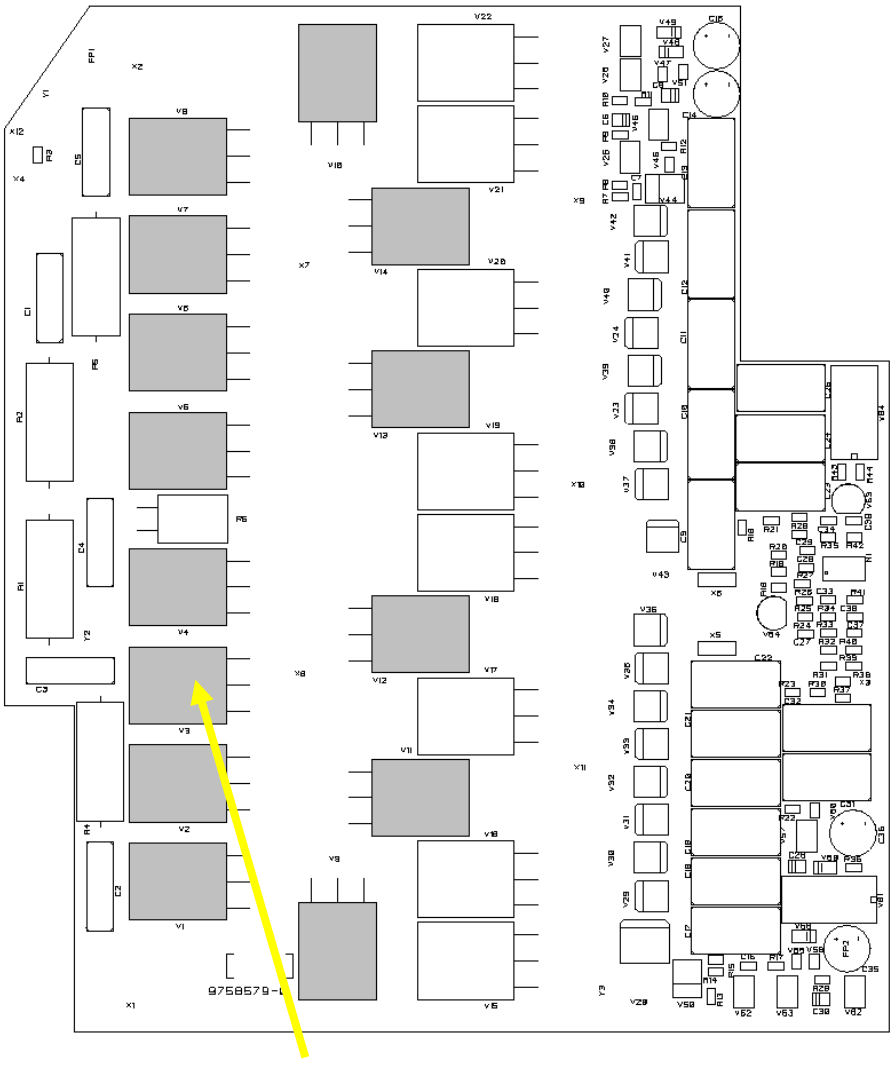
Secondary rectifier Z002

Functions and main components

Z002 secondary rectifier main functions
- rectifies two voltages +60Vdc and -60Vdc
- heat sink act as a conductor for positive terminal
- stabilizing voltages are made by diode - capacitor multiplier
- stabilizing voltage are regulated +-300Vdc (X5, X6)
- snubbers for diodes
- minus side diodes are insulated from heat sink by mica insulator



Grey diodes must be insulated

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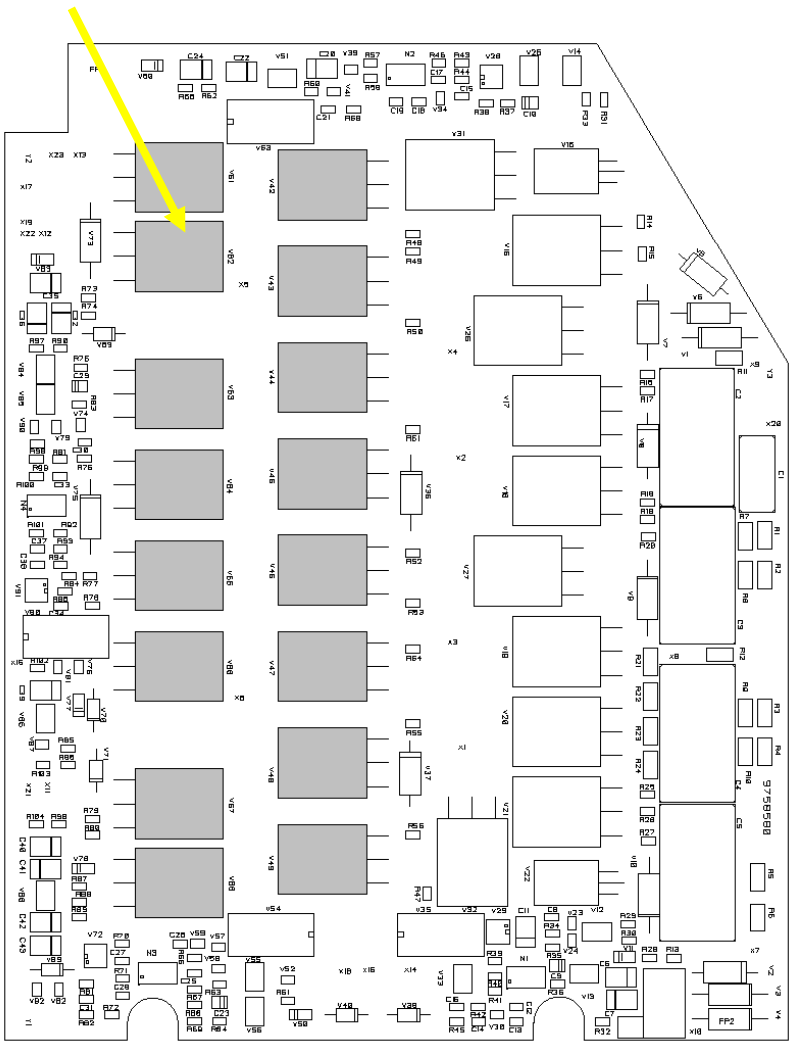
Secondary inverter Z003

Functions and main components

Z003 secondary inverter main functions
- acts as a four level switch matrix (DC+, DC-, Aux+, Aux-) (heat sink, X5, X7, X9)
- heat sink act as a conductor for positive terminal
- minus side IGBTs are insulated from heat sink by mica insulator
- gate drive circuits
- protection against gate drive under voltage
- optical isolation between control card gate drives

Grey igbts must be insulated



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Pre-inverter (PFC) card Z004

Functions and connectors:

- rectifies input input ac-voltages
- provides soft start feature
- soft-start ptc-resistor
- soft start relay
- input over voltage, under voltage and phase missing detection
- increases rectified input voltage to 725Vdc
- topology boost with two parallel paths
- switching frequency 25kHz
- maximum igbt current 40A peak
- output power 10kW with 230Vac supply

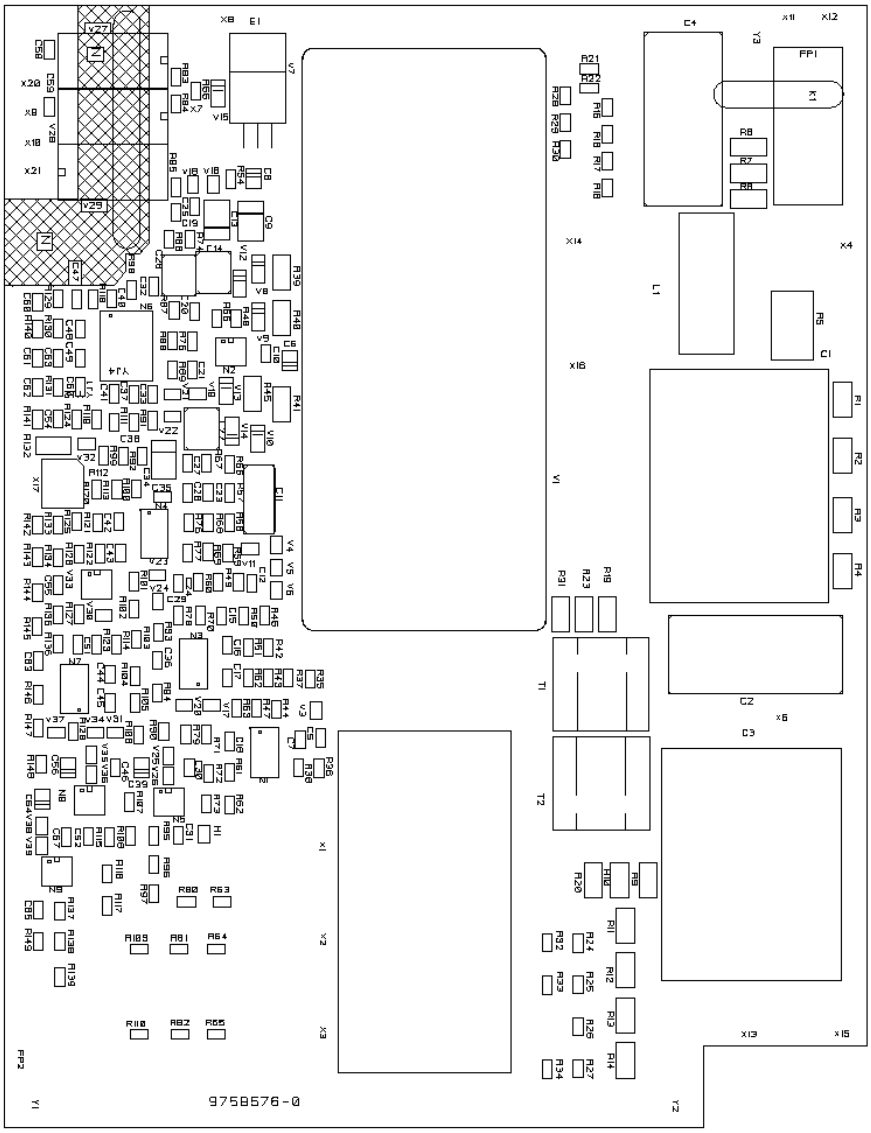
Factory settings for jumpers:
- X17 (1-4) = off
- X17 (2-5) = off
- X17 (3-6) = off

X17 (1-4)
no faults

X17 (2-5)
no freq. sweep

X17 (3-6)
pfc on

H1 reference
no visual meaning



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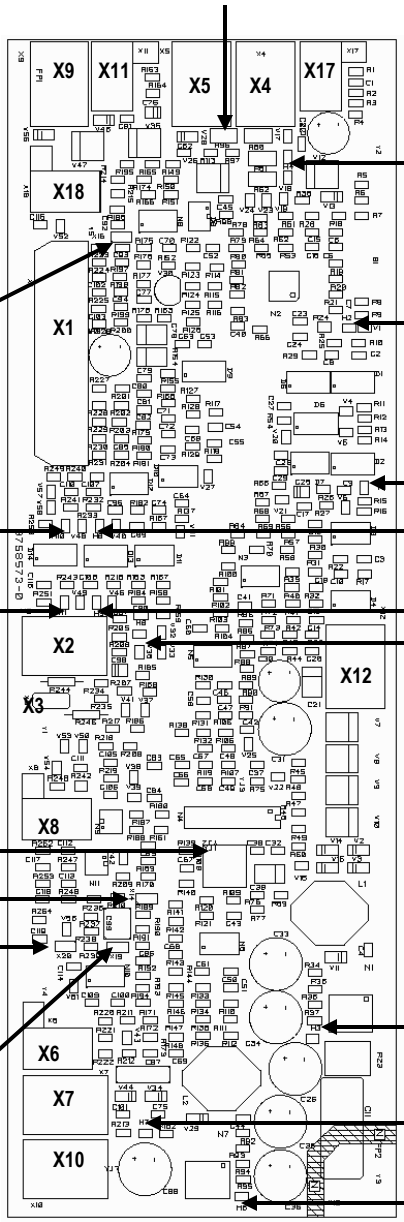
A001 Control card

Functions and connectors

A001 Control Card Main Functions
- current control (primary X4, secondary X8)
- spark control (X7)
- secondary inverter control (X2)
- pre- inverter (pfc) and charge relay control (X5)
- panel interface (X1)
- magnetic valve control (X9)
- fan control (X9)
- interface to water cooling unit (X10)
- secondary over voltage fault (X3, X2-6)
- over temperature fault (X6, X11, X18)
- gate voltage fault
- 15V and 5V generation
- location of software

MLS3000 = R96 on / MLS3003 R96 off



H4 = gate drive on

H2 = output over voltage

H1 = pre inverter (pfc) on

H8 = secondary dc-

H9 = secondary aid+

H6 = secondary dc+

H3 = +15Vdc

H7 = +24Vdc

H5 = +5Vdc

X16 jumper on = "mains switch always on"

Factory settings
- X16 = off
- X14 = off
- X20 = off
- X19 = on
- R108 = 25kHz

H10 = HF (spark)

H11 = secondary aid-

R108 = "switching frequency adjust"

X14 jumper on = "no over or under voltage error"

X20 jumper on = "fixed frequency 25kHz"

X19 jumper on = "no frequency sweep"

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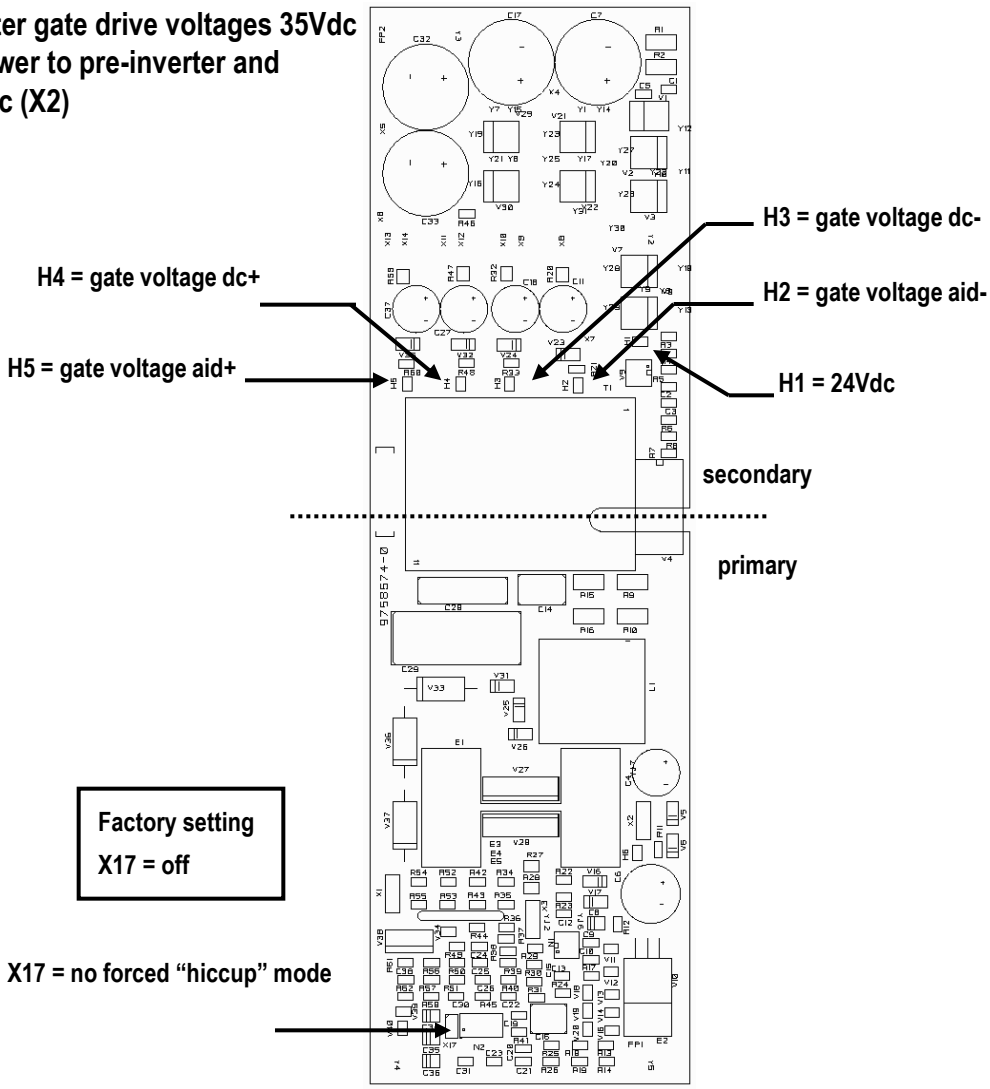
A002 Auxiliary power card

Functions and connectors

A002 Auxiliary Power Supply Main Functions
- output voltage 24Vdc
- input voltage range (450 … 750)Vdc (X1, X3)
- output power 100W continuous with forced cooling
- switching frequency 100kHz
- topology flyback
- forced “hiccup” mode in overload (X17 off)
- over voltage switch off about 830Vdc
- low voltage wake-up 200Vdc
- supply 24Vdc also to water cooler unit
- floating secondary inverter gate drive voltages 35Vdc
- supply also auxiliary power to pre-inverter and primary diode card 35Vdc (X2)



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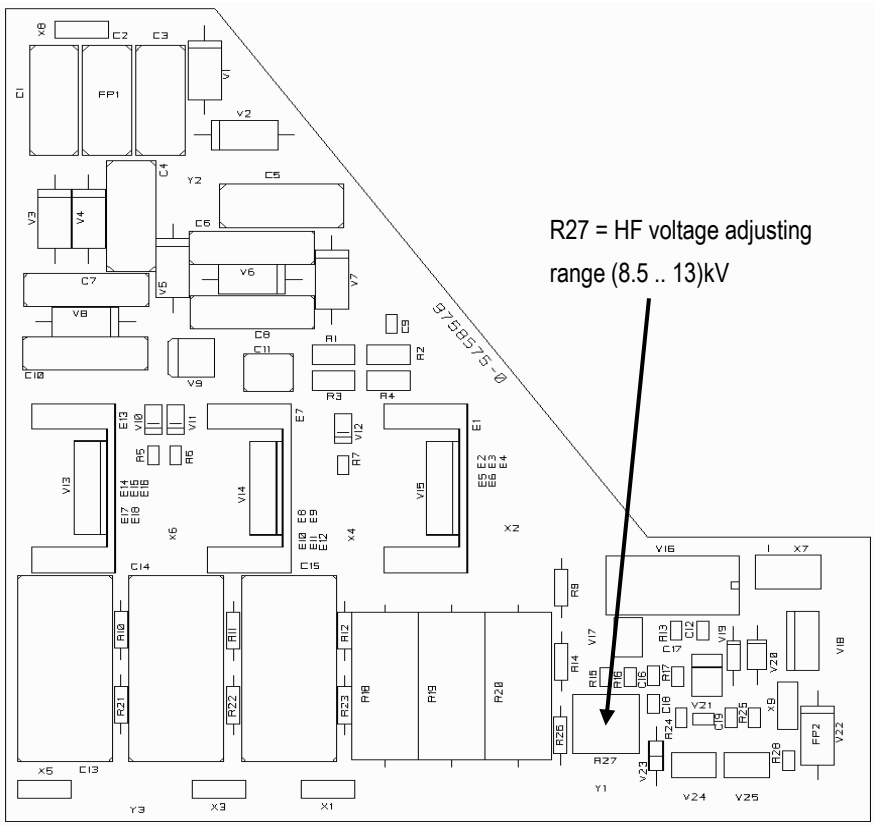
A003 Spark card

Functions and connectors

A003 HF generator card Main Functions
- supply voltage 180Vac (main transformer) (X8, X9)
- three parallel power igbts
- HF-transformers primary voltage about 500Vdc
- max. spark repetition frequency 500Hz with forced cooling (start control, X7)



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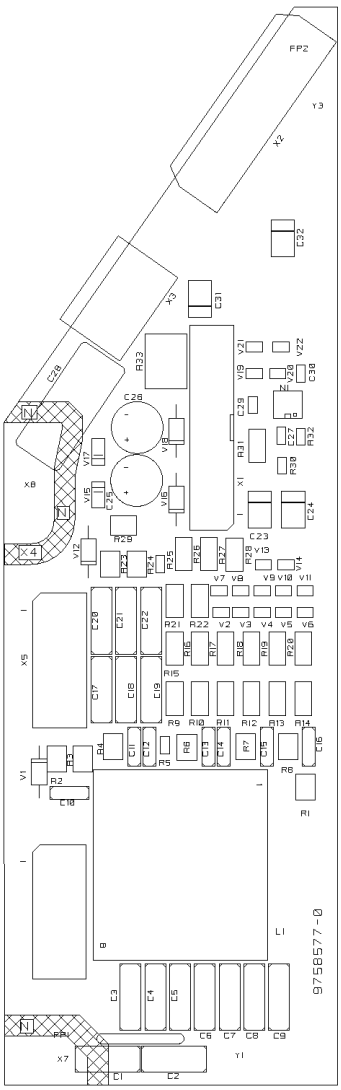
A004 Interface card

Functions and connectors

A004 interface card main functions
- panel bus interface (X2)
- link between control card A001 and outside world (X1)
- service and programming interface (X3)
- tig control interface with protection against spark and +-100Vdc (X6)
- remote control interface with protection against spark and +-100Vdc (X5)



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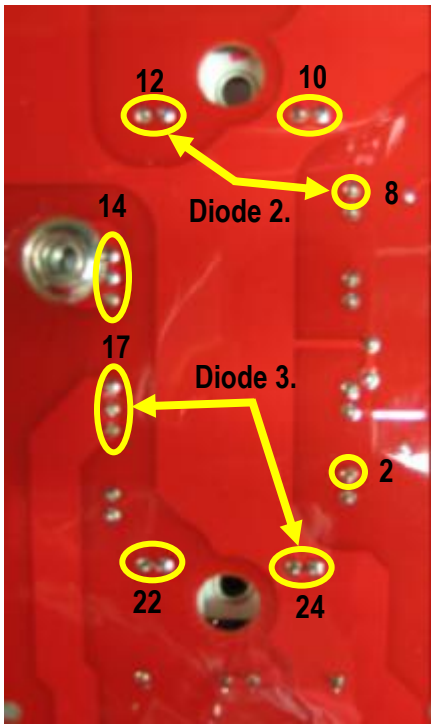
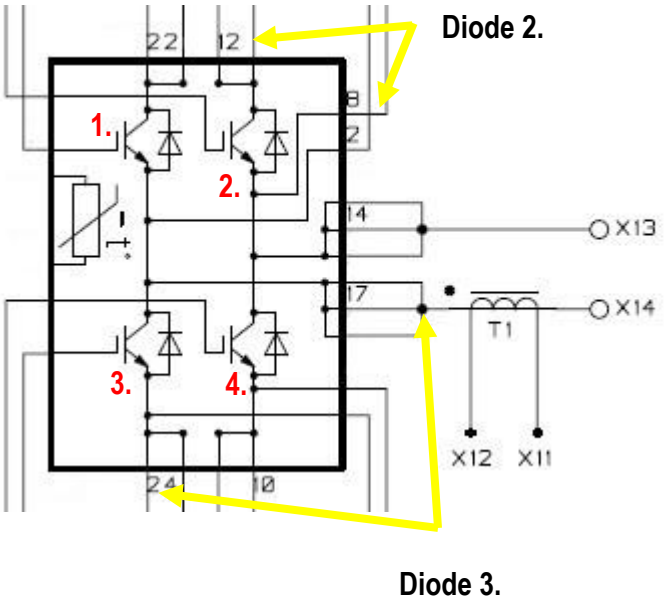
Measurements

Z001, Main circuit card :

- Power should be off !
- With these measurements you can find short circuits and partly open circuits that indicates fault in the machine.
- Measure diodes in forward and reverse direction. Forward diode threshold voltage is ~0,4V, reverse direction infinite. See the picture below for instructions.
- Repeat measurements for all four (4) instances. Pin locations marked in the pictures below.
- Remember that MLS 3000 ACDC and 3003 ACDC have different Z001 cards !





Diodes*	Measuring points	Value
1.	2 -> 22	~ 0,4 V
2.	8 -> 12	~ 0,4 V
3.	24 -> 17	~ 0,4 V
4.	10 -> 14	~ 0,4 V

* Diodes marked with red color in the right hand picture.

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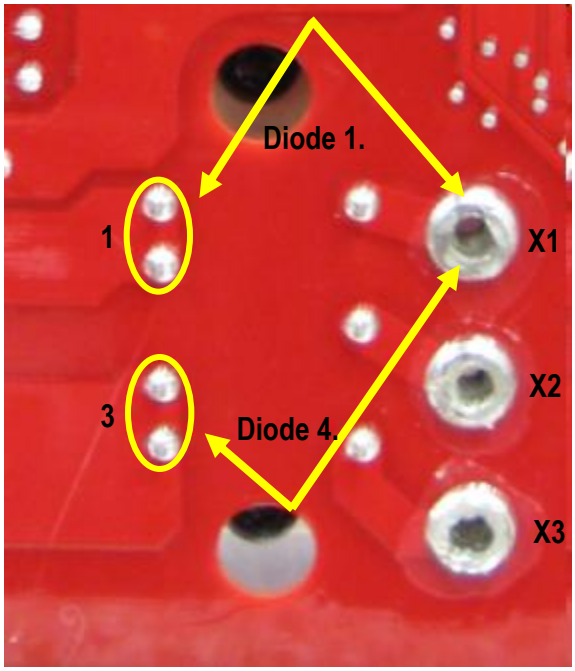
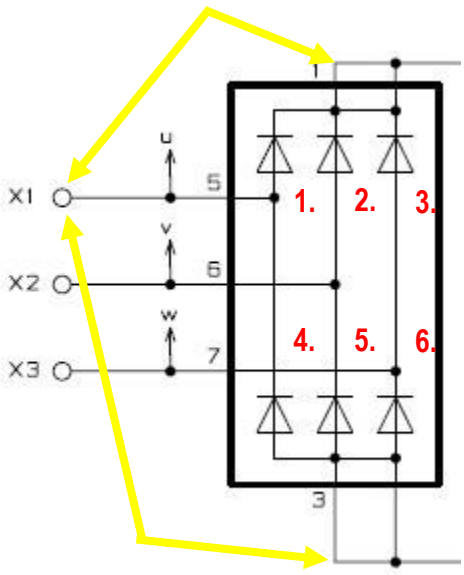
Measurements

Z004 Pre-inverter, rectifier:

- Power should be off !
- With these measurements you can find short circuits and partly open circuits that indicates fault in the machine.
- Measure diodes in forward and reverse direction. Forward diode threshold voltage is ~0,5V, reverse direction infinite. See the picture below for instructions.
- Repeat measurements for all six (6) instances. Pin locations marked in the pictures below.



Diode 1.



Diode 4.

Diodes*	Measuring points	Value
1.	X1 -> 1	~ 0,5 V
2.	3 -> X1	~ 0,5 V
3.	X2 -> 1	~ 0,5 V
4.	3 -> X2	~ 0,5 V
5.	X3 -> 1	~ 0,5 V
6.	3 -> X3	~ 0,5 V

* Diodes marked with red color in the right hand picture.

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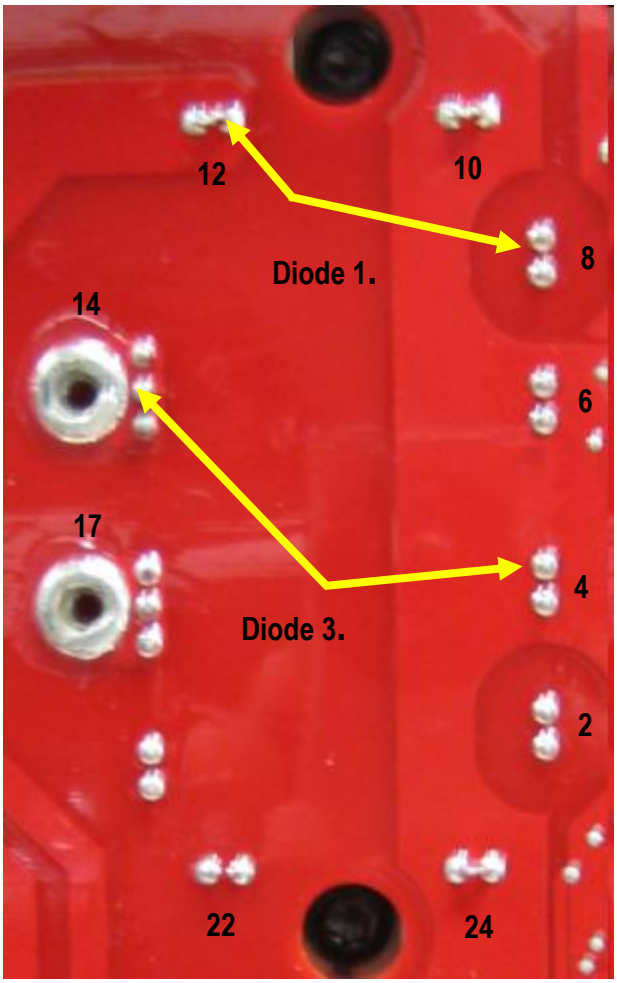
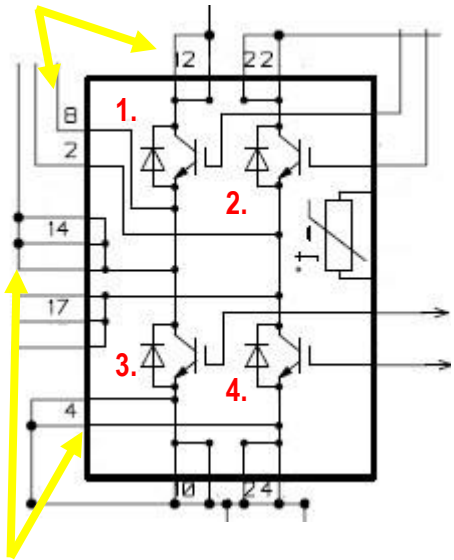
Measurements

Z004 Pre-inverter, IGBT:

- Power should be off !
- With these measurements you can find short circuits and partly open circuits that indicates fault in the machine.
- Measure diodes in forward and reverse direction. Forward diode threshold voltage is ~0,4 V, reverse direction infinite.
- Measuring points have been marked in the picture below. Four (4) measurements must be conducted to be sure of correct operation of Z004.



Diode 1.



Diode 3.

Diodes*	Measuring points	Value
1.	8 -> 12	~ 0,4 V
2.	2 -> 22	~ 0,4 V
3.	4 -> 14	~ 0,4 V
4.	4 -> 17	~ 0,4 V

* Diodes marked with red color in the right hand picture.

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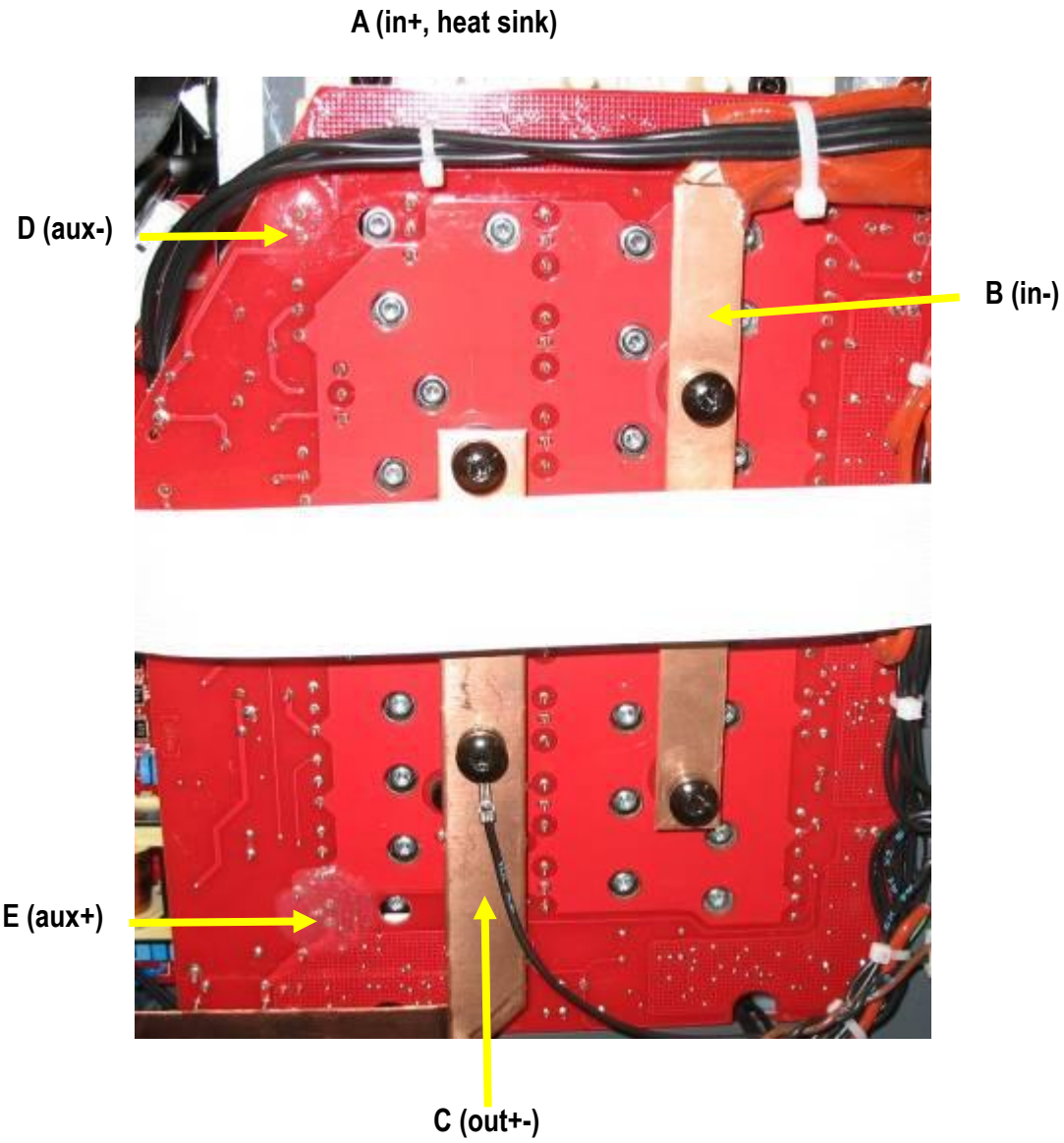
Measurements

Z003 Secondary inverter

- Power should be off
- Measure diodes and IGBTs in forward and reverse direction. Forward diode threshold voltage is about 0,45V, reverse direction high.
- C-A, C-E, B-C, D-B, ~0,45V diode threshold voltage
  B-E, 0,7V diode threshold voltage
  D-C, 0,85V diode threshold voltage



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Measurements

These tests have to be done after replacing any primary or secondary units. It absolutely important because possible short circuit (e.g. improperly installed mica insulator) might damage machine severely.

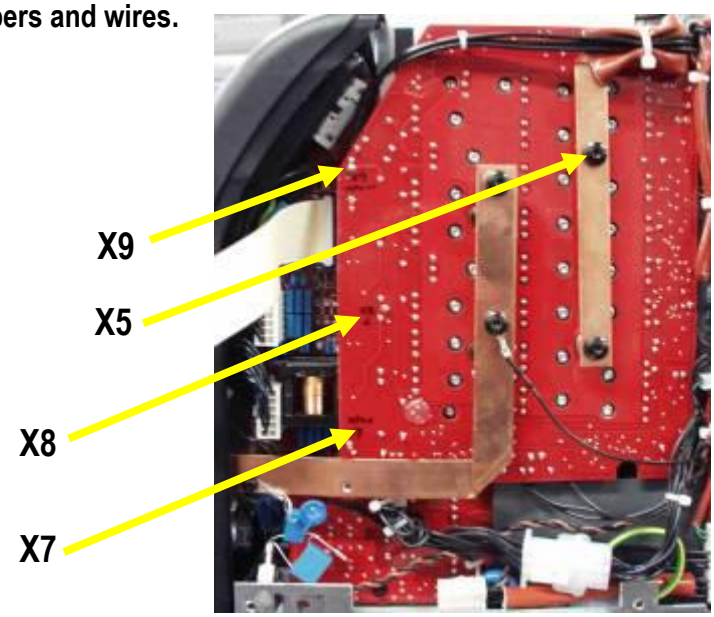
TESTING OF THE CONTROL CARD AND CONTROL CIRCUITS

1. Disconnect cooling fans (A001/X9)
2. Disconnect (HF, Spark generator card) A003/X8
3. Connect jumpers A001/X14 (overvoltage) and A001/X16 (main switch open) on control card A001
4. Disconnect A001/X7.
5. Connect Kemppi Multipower and digital multimeter with current measuring function to X7-1 (24 VDC) and X7-2 (GND).
6. Switch on Kemppi Multipower and watch current consumption and test the panel functionality.
7. < 300mA is OK (normally 120mA/24V without cooling fans and magnetic valve)
   - If current is over the limit you can disconnect other connectors from A001 to check where current using circuit is.
   - You can test cooling fans and gas valve by connecting A001/X9 (Current limit needs to be about 1A)
8. Turn off machine and disconnect power supply.
9. Connect A001/X7.
10. Restore jumpers and wires.

Measurements

TESTING OF THE POWER STAGE

1. Disconnect cooling fans (A001/X9).
2. Disconnect (HF, Spark generator card) A003/X8.
3. Connect jumpers A001/X14 (overvoltage) and A001/X16 (main switch open) on control card A001.
4. Remove insulation plate from the top of Z003.
5. Disconnect Z004/X7 and Z004/X6 to A002/X1. Leave X8 connected.
   Check again for correct cable !!!
   (In older models there is two different pads on Z004, X4 and X6. Disconnect X6)
6. Connect MLS-Service power DC+ (= 560Vdc) to wire connector X6 (goes to A002) and DC- to Z004/X8 (X6=560V, X8=0V).
7. Connect Kemppi Multipower with 98 Vdc (24+24+50 Vdc in series) between phases L2, L3.
8. Switch on MLS- Service power and check the panel functionality.
9. Switch on Multipower. Turn mains switch on.
10. Set the machine to MMA mode.
11. Measure following voltages (X8 = GND = -Dix) from Z003.
    - heat sink = + 9 … 11 Vdc
    - X5 = - 9 … 11 Vdc
    - X7 = + 62 ... 75 Vdc (refers to DC+ voltage if err 6 is reported)
    - X9 = - 58 ... 75 Vdc (refers to DC- voltage if err 6 is reported)
    - If voltages are OK then power stage and rectifier are OK.
12. Switch off machine, Multipower and MLS Service power.
13. Disconnect power supplies.
14. Restore jumpers and wires.



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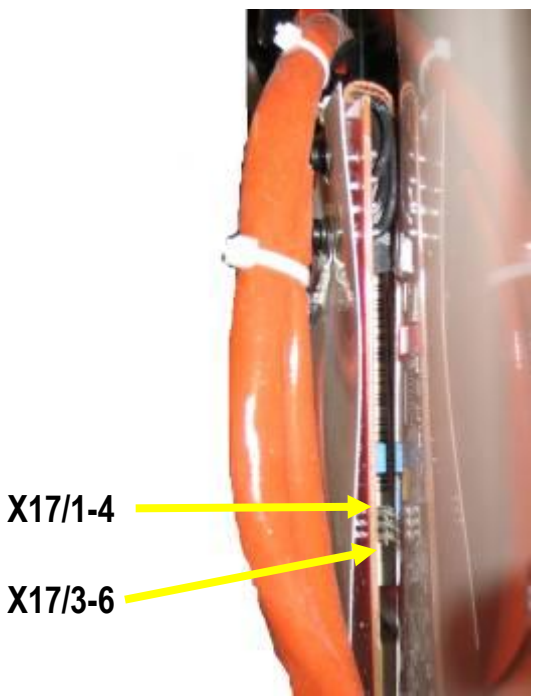
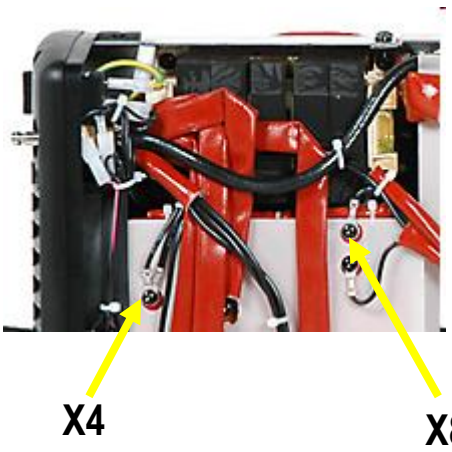
Measurements

TESTING OF THE PRE-INVERTER (PFC)

1. Disconnect cooling fans (A001/X9).
2. Disconnect (HF, Spark generator card) A003/X8.
3. Connect jumpers A001/X14 (overvoltage) and A001/X16 (main switch open) on control card A001.
4. Connect jumpers X17/(1-4) and X17/(3-6) on Z004.
5. Disconnect Z004/X6. In the newer model where X4 contains two cables, remove theX6 cable going to A002/X1.
6. Connect Kemppi Multipower with 22 VAC with current limit 2,5 A between phases L2, L3
7. Connect Kemppi MLS- Service power DC+ = 560Vdc to wire connector X6 and DC- to Z004/X8 (X6=560V, X8=0V). Again in newer model, connect DC+ to X6 cable going to A002/X1.
8. Switch on Multipower and MLS-Service power. Turn the machine on.
9. Put machine to TIG mode. Measure DC -link voltage from Z004/X8 and X4 pads.
10. DC -link voltage should raise to 720-740 VDC. You can discharge the DC-link with changing to MMA mode and back to TIG.
11. If voltage raises and stops to 720Vdc the pre-inverter is OK.
12. Restore jumpers and wires .





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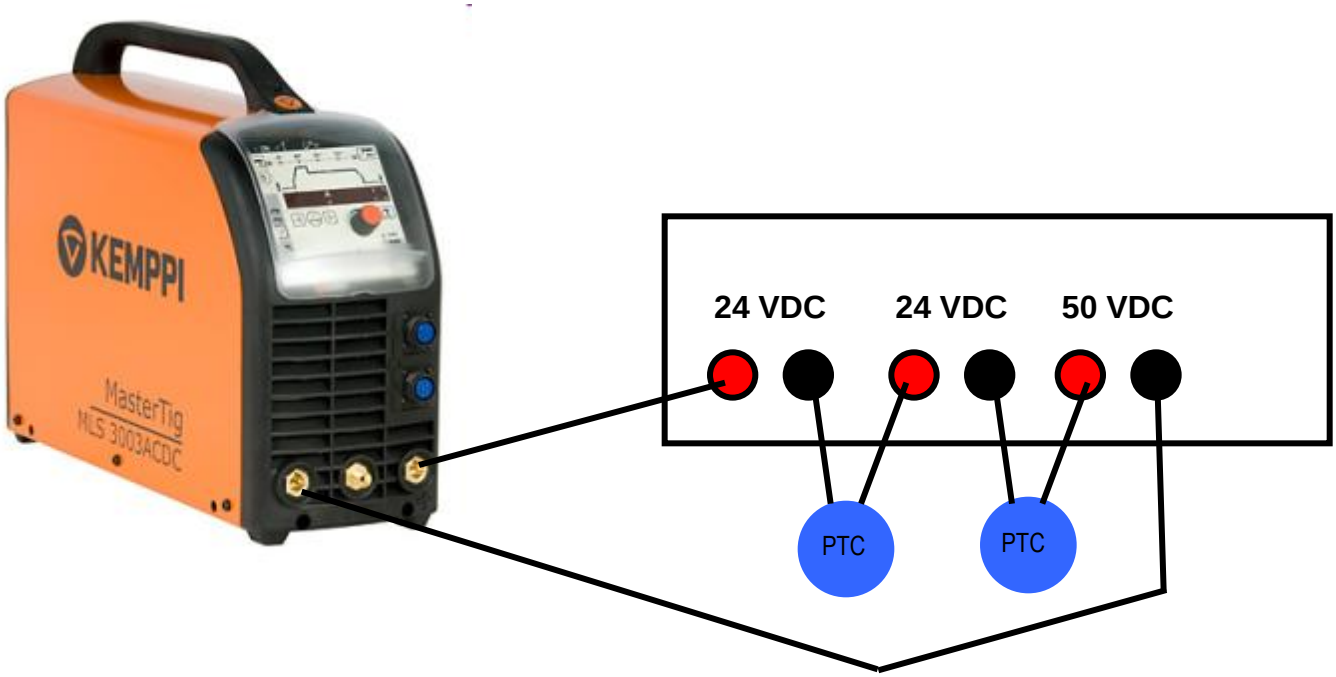
Measurements

TESTING OF THE SECONDARY OVER VOLTAGE WATCH

1. Connect MLS- Service power voltages (24+24+50)Vdc in series by using PTC-resistor.
2. Set the machine to DC- TIG mode.
3. Connect the test voltage to output DIX terminals of the machine.
4. If machine shows "Err 6" then it is OK.
5. Repeat the test with reversed polarity.



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Installation of semiconductors

IGBT mounting onto the heat sink

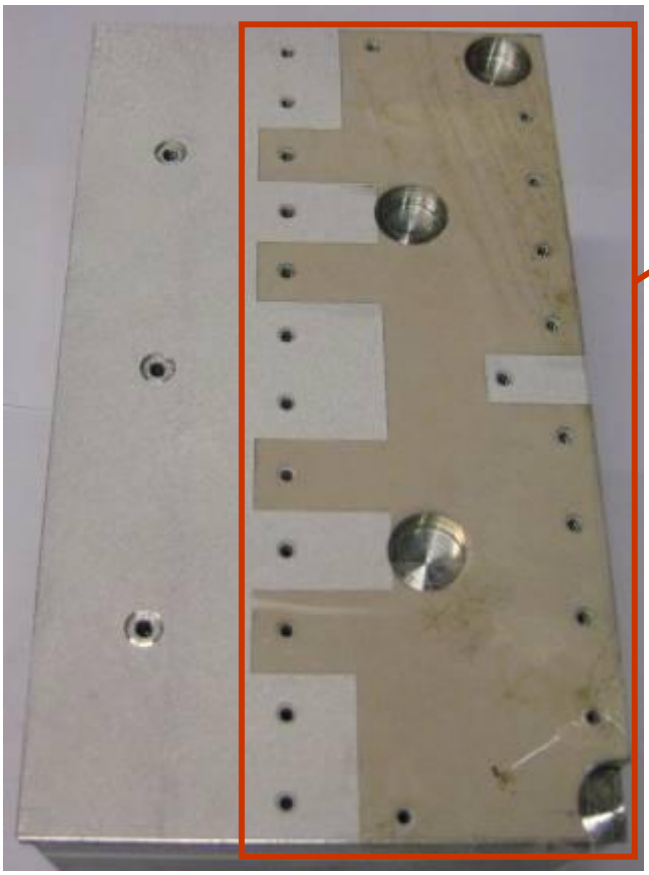
The installation surfaces must be clean, even very small particles (0,050mm) between the surfaces increase the gap between heat sink and module, causing module overheating and possibly destruction. Heat transfer paste is spread as an even layer about 0,1 mm thick, onto the modules base plate. The module is immediately attached to the heat sink, in order to avoid any dirt to get between the components. At first all M5 screws are tightened carefully to torque of 0,5…2 Nm, after which the module can be tightened to the nominal torque of 3 Nm. After a few minutes the screw torques are checked again to be 3 Nm.

Secondary unit

As described above but screws are torx T-10 and tightening torque 1,2 Nm. Diodes and discrete IGBTs can be tighten right away to this torque.

Installation of semiconductors

Secondary rectifier Z002



Negative side diodes are insulated from the heat sink by mica insulators. Mica insulators have to be replaced always, when the secondary diode card Z002 is separated from heat sink !!!

Heat transferring paste is applied as thin layers on both sides of the mica insulators. Absolutely no impurities are allowed on surface of the insulators when mounting them between the heat sink and the diodes!

Installation of semiconductors

Secondary inverter Z003

Negative side IGBTs are insulated from the heat sink by mica insulators. Mica insulators have to be replaced every time the main circuit card Z003 is disconnected from heat sink !!!

Heat transferring paste is applied as thin layers on both sides of the mica insulators. Absolutely no impurities are allowed on surface of the insulators when mounting them between the heat sink and the IGBTs!

Pre-inverter card Z004

For components on Z004, normal procedure must be done when changing the card. Clean thoroughly surface on the heat sink and place correct amount of heat sink paste to new parts. Tighten parts as normally, torque 3 Nm.

Notes