Service manual

Ver. 1.0

MASTER 1400

MASTER 2800

MASTER 1500

MASTER 3500

MASTER 2200

MASTERTIG 1500

MASTERTIG 2200

MASTERTIG 2800

MASTERTIG 3500

KEMPPI
The Joy of Welding

Contents

General

Master- and **Mastertig**-power sources are MMA and TIG power sources designed for demanding professional use.
Master- and **Mastertig**-power sources are IGBT-inverters, controlled by PWM-principle. Operation frequency is approx. 18 kHz.

5 power source sizes are available; 1~ 140 A, 1~ 150 A, 3~ 220 A, 3~ 280 A and 3~ 350 A

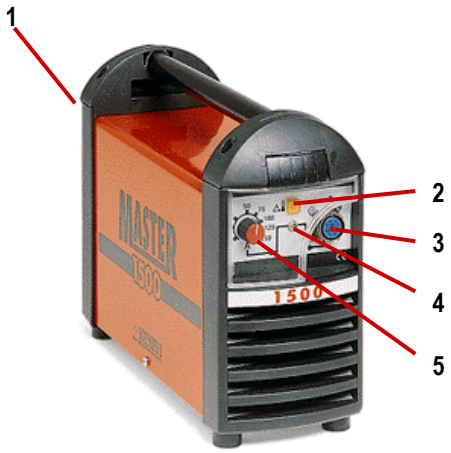
Technical data, switches and connectors

Master 1400

1 Main switch S001 and welding current connectors
2 Overheat protection signal lamp
3 Current adj. potentiometer

Supply voltage 1~,50/60 Hz	220V –10%….240V +6%
Connection power 20% ED 60% ED 100% ED	140 A/ 6,2 kVA 105 A/ 4,4 kVA 75 A/ 2,9 kVA
Supply cable/ fuses	3 x 1,5S / 16 A slow
Welding current range MMA	15 A / 20,0 V..140 A / 25,6 V
Suitable electrode sizes	∅ 1,5…..3,25 mm
Welding power adj.	stepless
OCV	Approx. 80 V
Efficiency	80% (140 A / 25,6V)
Idling power	Approx. 10 W
Degree of protection / Casing class	IP 23
Weight	10 kg

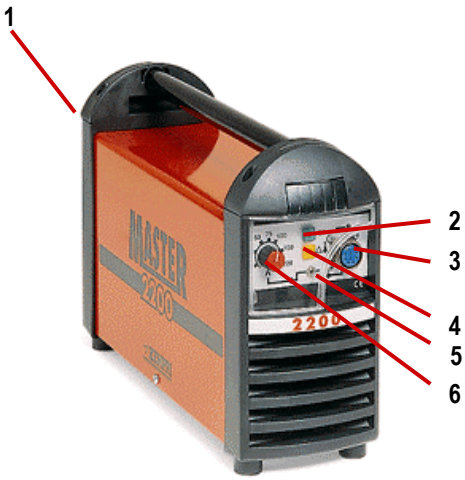
Master 1500



1 Main switch S001, welding current connectors and dynamics adjustment
2 Overheat protection signal lamp
3 Remote controller connection
4 Local / remote control
5 Current adjustment potentiometer

Supply voltage 1~,50/60 Hz	220V –10%….240V +6%
Connection power 20% ED 60% ED 100% ED	150 A / 6,6 kVA 105 A / 4,4 kVA 75 A / 3,0 kVA
Supply cable/ fuses	3 x 1,5S / 16 A slow
Welding current range MMA *(TIG*	15 A / 20,5 V..150 A / 26,0 V *5 A / 10,2 V..150 A / 16,0 V)*
Suitable electrode sizes	∅ 1,5…..3,25 mm
Welding power adjustment	stepless
OCV	Approx. 80 V
Efficiency	80% (150 A / 26,0 V)
Idling power	Approx. 10 W
Degree of protection / Casing class	IP 23C
Weight	10,5 kg *(TIG, 13,5 kg)*
Auxiliary devices	Remote controllers C 100C, C 100D

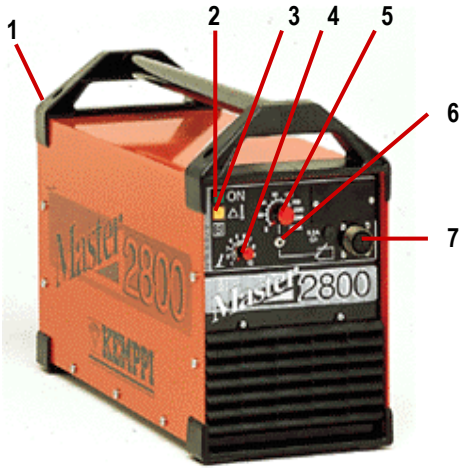
Master 2200



1 Main switch S001, welding current connections and dynamics adjustment
2 I/0-signal lamp
3 Remote controller connecyor
4 Overheat protection signal lamp
5 Remote / local control selection
6 Current adjustment potentiometer

Supply voltage 3~,50/60 Hz	380V –10%….415V +6%
Connection power 25% ED 60% ED 100% ED	220 A / 8,4 kVA 145 A / 5,5 kVA 110 A / 3,5 kVA
Supply cable / fuses	4 x 1,5S / 10 A slow
Welding current range MMA *(TIG*	15 A / 20,5 V…220 A / 28,8 V *5 A / 10,2 V…220 A / 18,8)*
Suitable electrode sizes	∅ 1,5…4,0 (5,0) mm
Welding power adjustment	stepless
OCV	Approx. 80 V
Efficiency	82% (220 A / 28,8V)
Idling power	Approx. 10 W
Degree of protection / Casing class	IP 23C
Weight	12,5 kg *(TIG, 16 kg)*
Auxiliary devices	Remote controllers C 100C, C 100D

Master 2800 and 3500



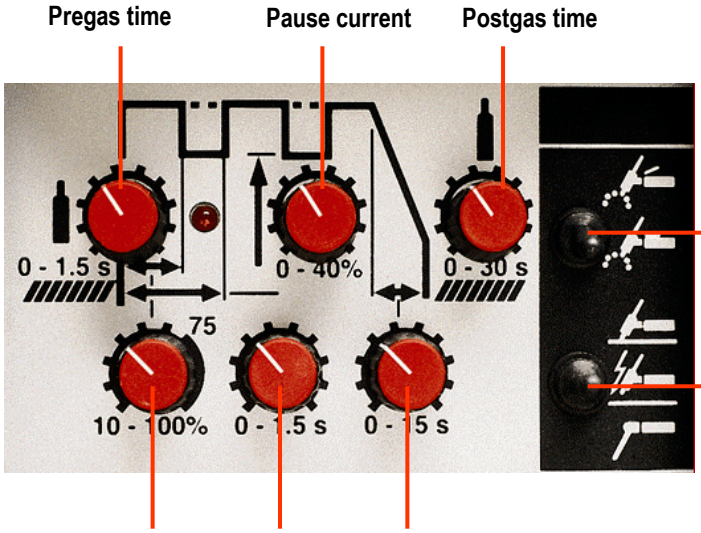
1 Main switch S001 and welding current connectors
2 I/0-signal lamp
3 Overheat protection signal lamp
4 Dynamics adjustment
5 Current adjustment potentiometer
6 local / remote control
7 Remote controller connector

Supply voltage 3~,50/60 Hz	380V –10%….415V +6%	380V –10%….415V +6%
Connection power 35% ED 60% ED 100% ED	280 A / 11,5 kVA 213 A / 8,5 kVA 165 A / 6,0 kVA	350 A / 15,0 kVA 267 A / 11,0 kVA 207 A / 8,0 kVA
Supply cable/ fuses	4 x 1,5S / 10 A slow	4 x 2,5S / 16 A slow
Welding current range MMA *(TIG* Suitable electrode sizes	15 A / 20,5 V…280 A / 31,2 V *5 A / 10,2 V…280 A / 21,2 V)* ∅ 1,5…n. 5,0 mm	15 A / 20,5 V…350 A / 34,0 V *5 A / 10,2 V…350 A / 24,0 V)* ∅ 1,5…n. 6,0 mm
Welding power adjustment	stepless	stepless
OCV	Approx. 75 V	approx. 75 V
Efficiency	83% (280 A/ 31,2 V)	83% (350 A/ 34,0 V)
Idling power	approx. 25 W	approx. 25 W
Degree of protection / Casing class	IP 23	IP 23
Weight	22 kg *(TIG, 27 kg)*	25 kg *(TIG, 30 kg)*
Auxiliary devices	Remote controllers C 100C, C 100D, C100T, MSD 1	Remote controllers C 100C, C 100D, C100T, MSD 1

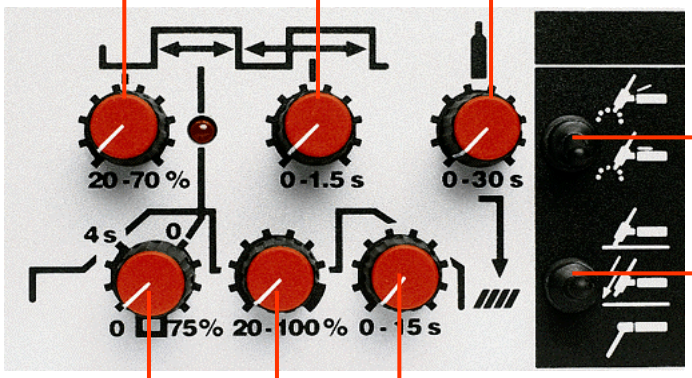
Mastertig 1500 and 2200

1 Main switch S001, dynamics adjustment and welding current connections
2 Current adjustment potentiometer
3 Overheat protection signal lamp
4 Local / remote control selection
5 Remote controller connector

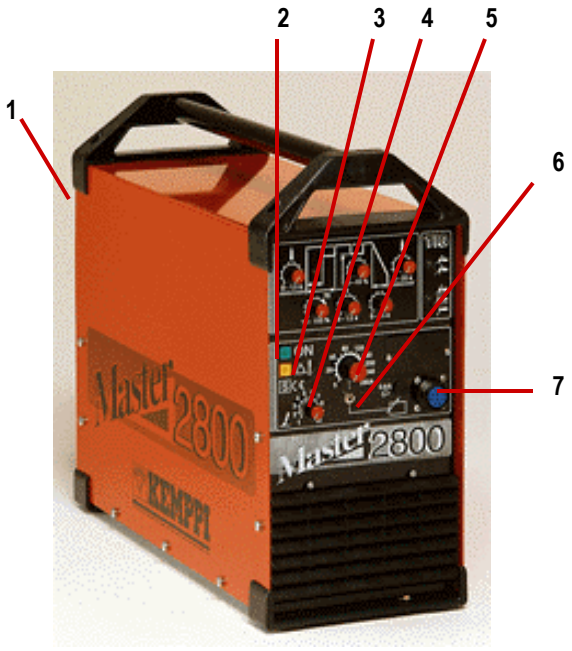
Pulse panel



Minilog-panel

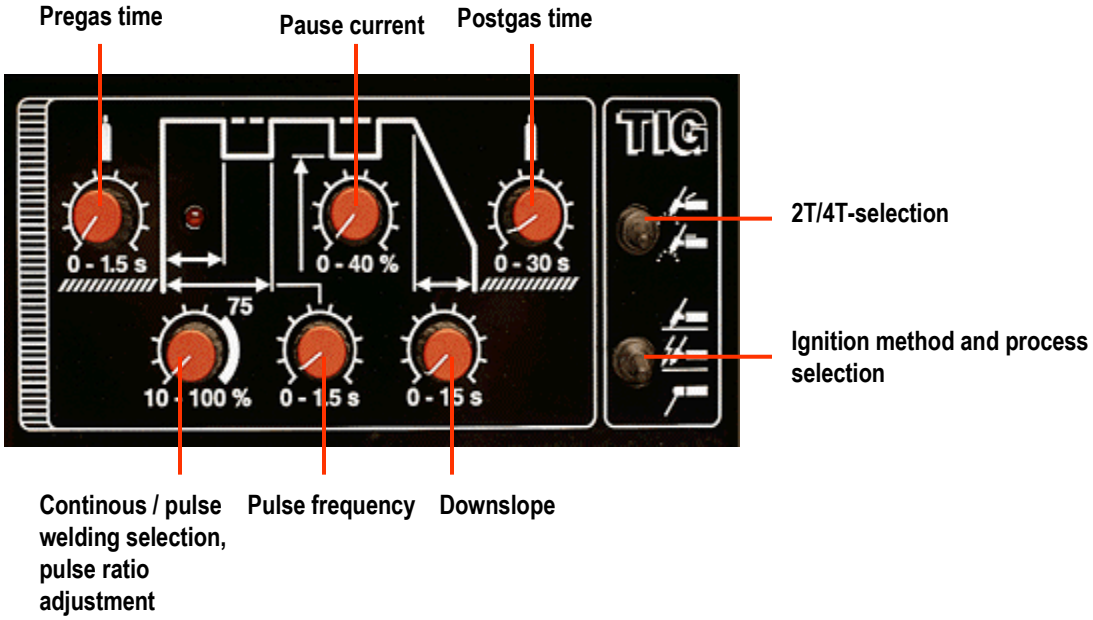


Mastertig 2800 and 3500

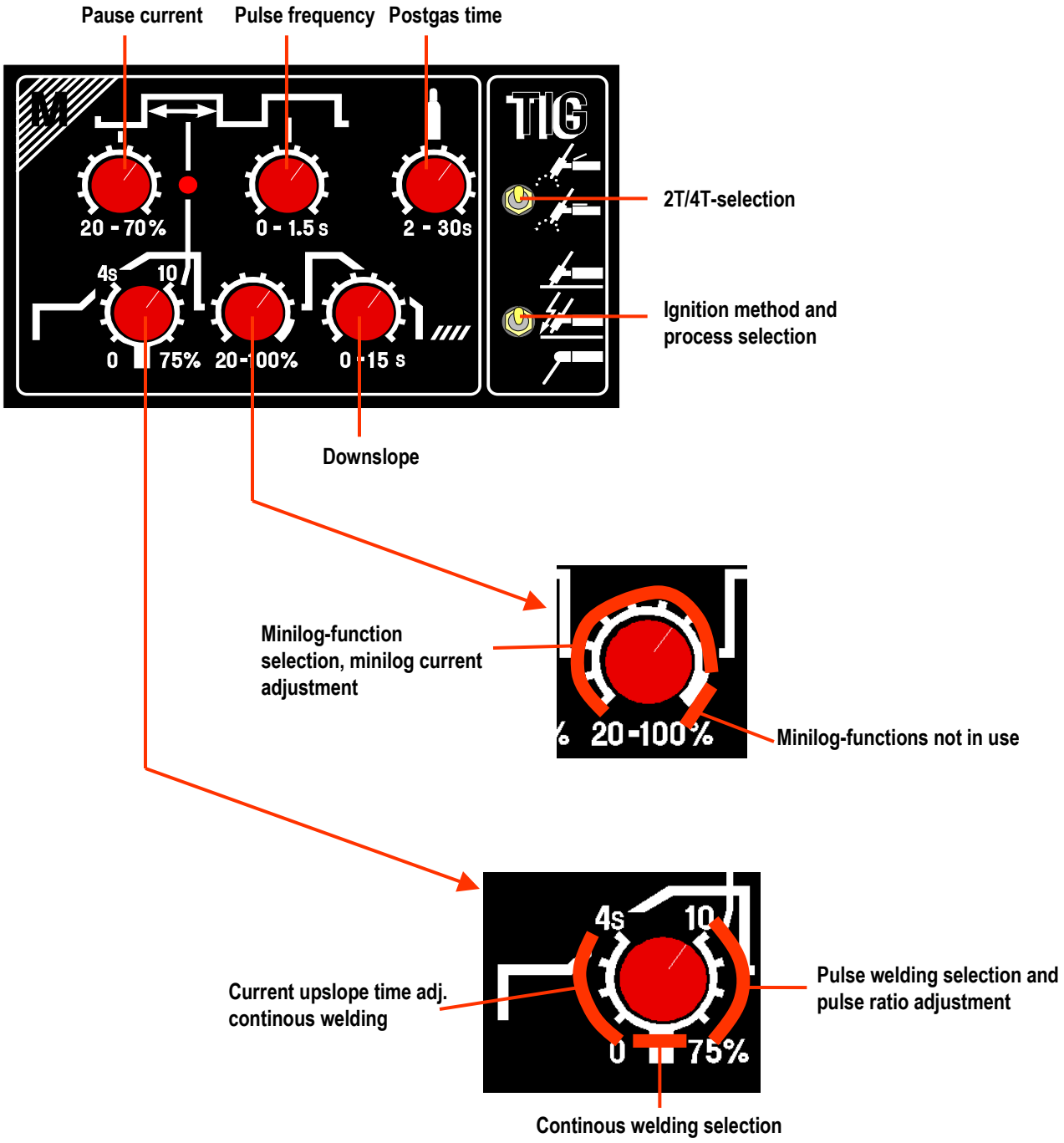


1 Main switch S001 and welding current connectors
2 I/0-signal lamp
3 Overheat protection signal lamp
4 Dynamics adjustment
5 Current adjustment potentiometer
6 Local / remote control selection
7 Remote controller connector

Pulse panel



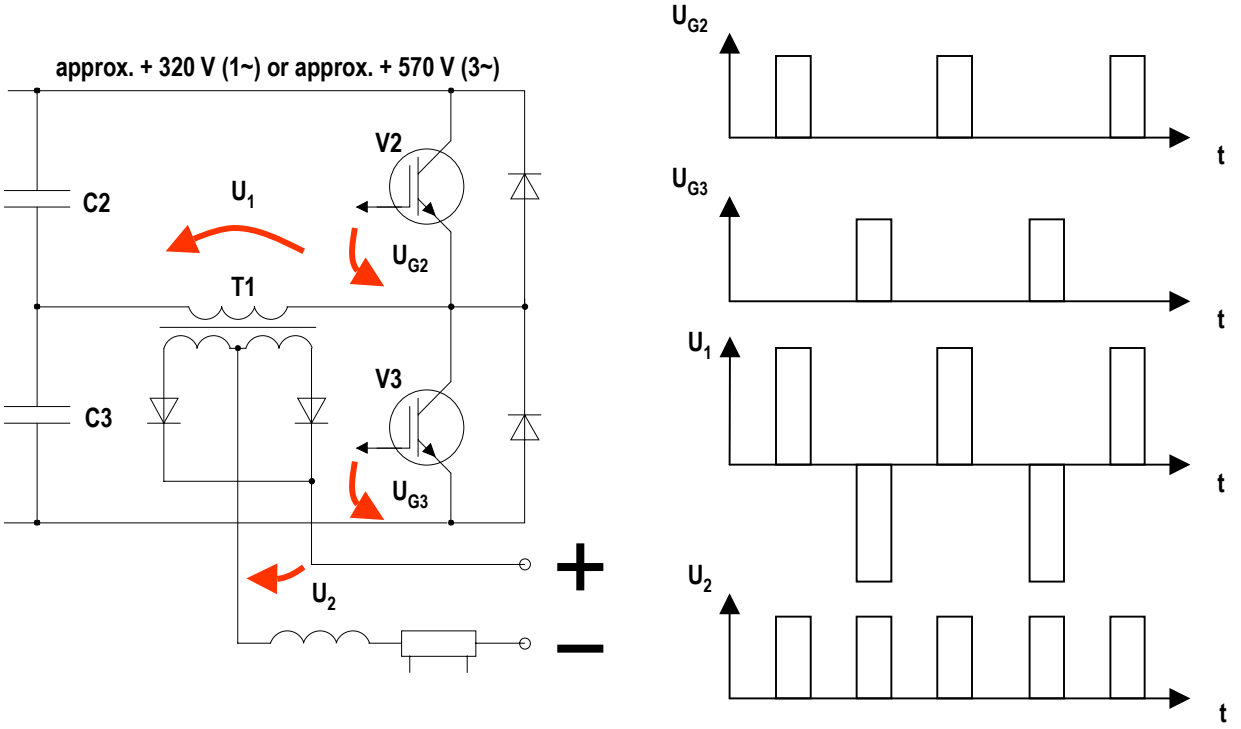
Minilog-panel

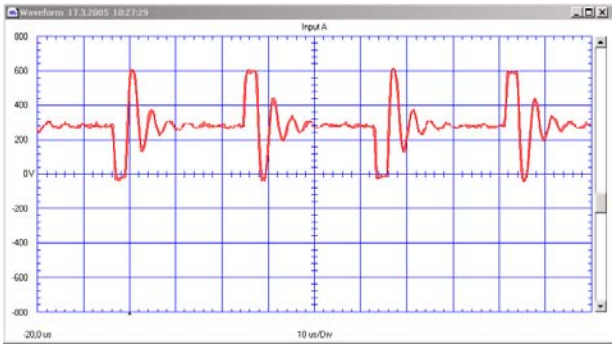


Operation principle

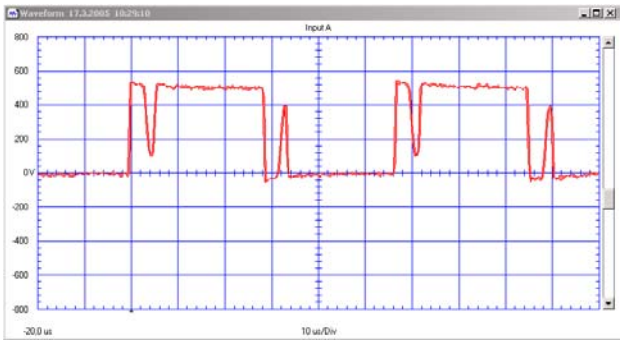
The power stage in **Master**- and **Mastertig**- power sources is a traditional half-bridge, where the intermediate circuit´s dc-voltage is halved by load capacitors C2 and C3. IGBT-transistors are used as power switches. When both IGBTs are not conductive, no power is transferred. When the upper IGBT (V2) is conductive, there is positive voltage in the main transformer´s (T1) primary, and when the lower IGBT (V3) is conductive there is negative voltage in the main transformer´s (T1) primary.

Power is adjusted by altering the IGBT timings (PWM). The main transformer (T1) secondary voltages are rectified by a full-wave rectifier.



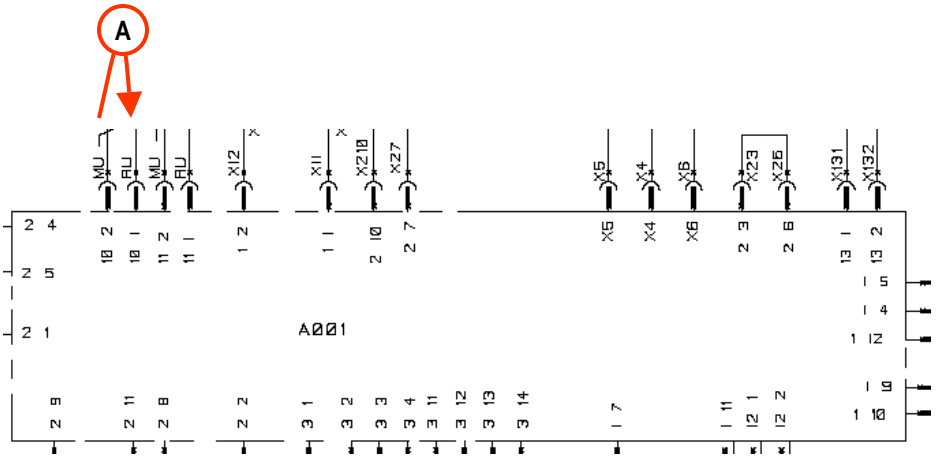


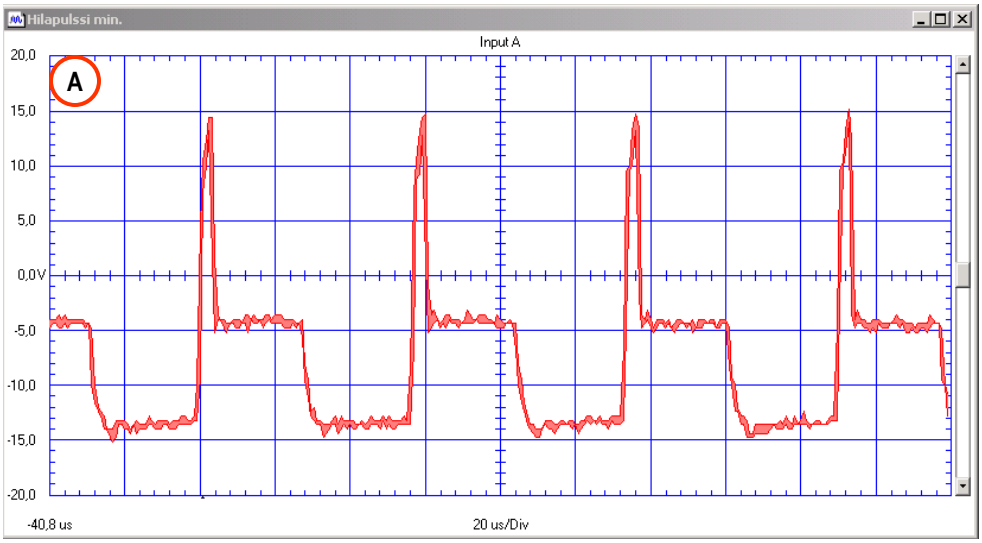
Voltage over the lower IGBT V3 with minimum power (3~)



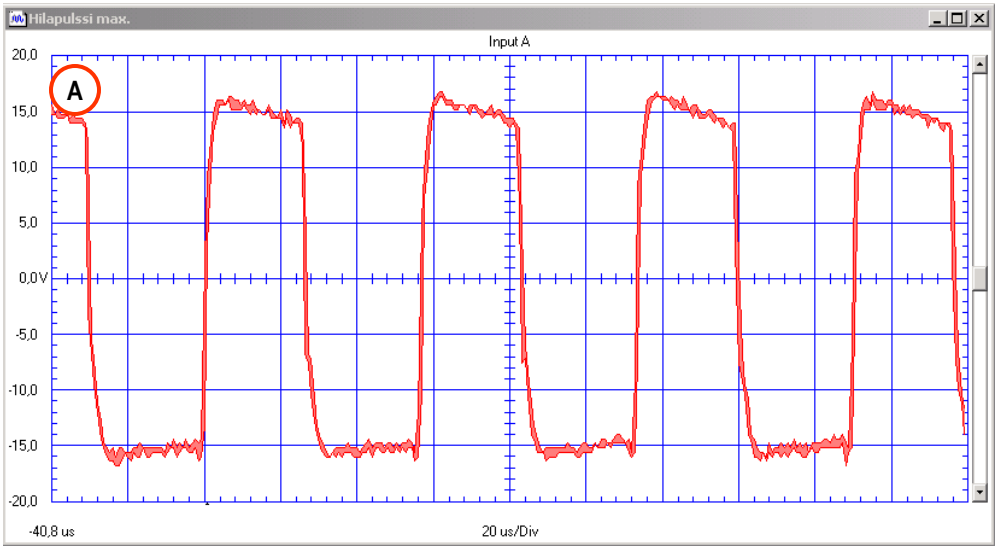
Voltage over the lower IGBT V3 with maximum power (3~)

IGBT gate pulse *(Master / Mastertig 2800/3500)*



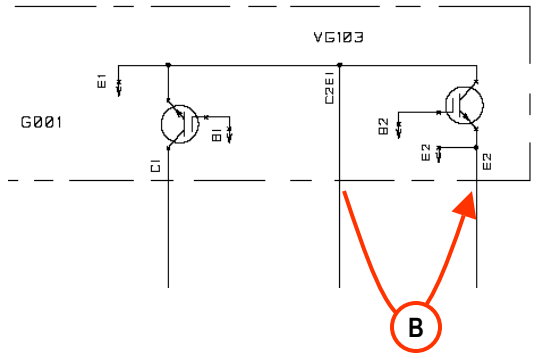


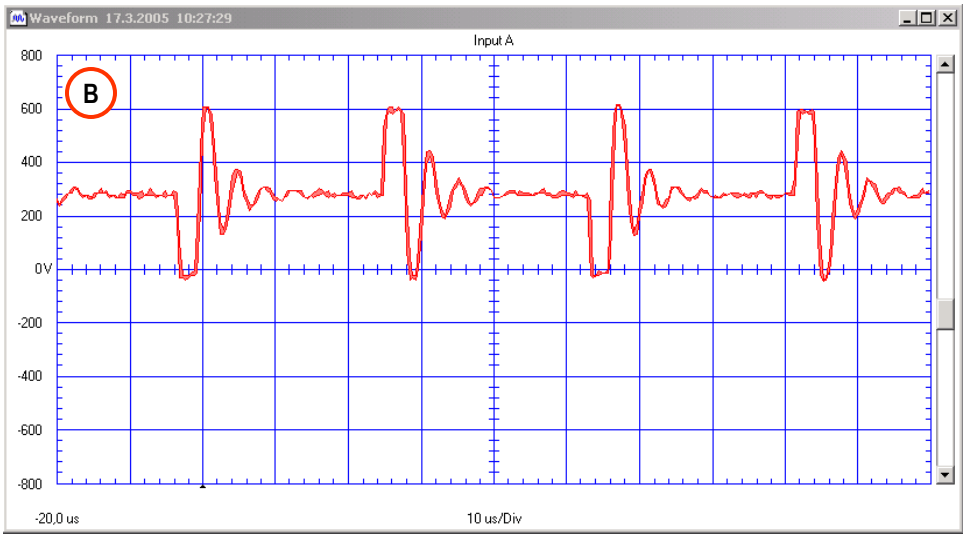
IGBT gate pulse with minimum power (2800/3500). Inverter operating frequency approx. 19 kHz (measuring point A).



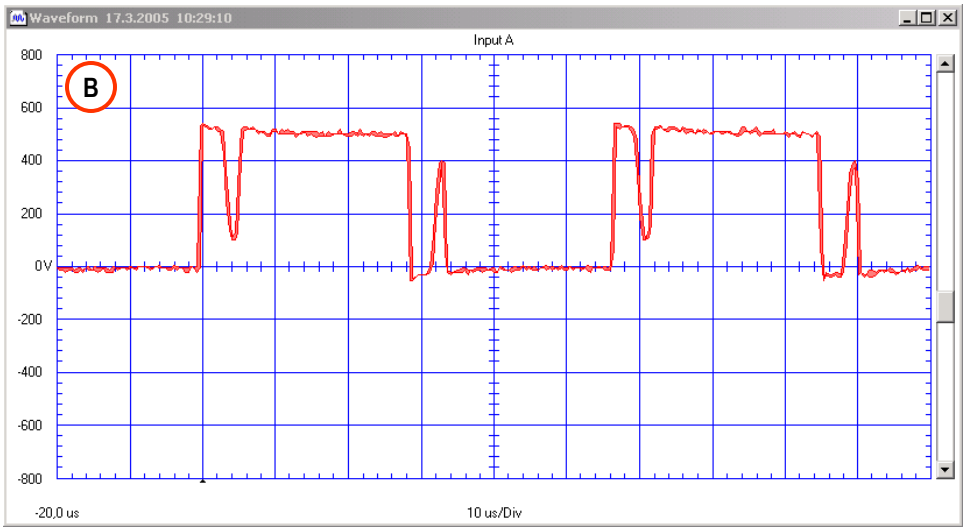
IGBT gate pulse with maximum power (2800/3500). Inverter operating frequency approx. 19 kHz (measuring point A).

Voltage over the lower IGBT *(Master / Mastertig 2800/3500)*



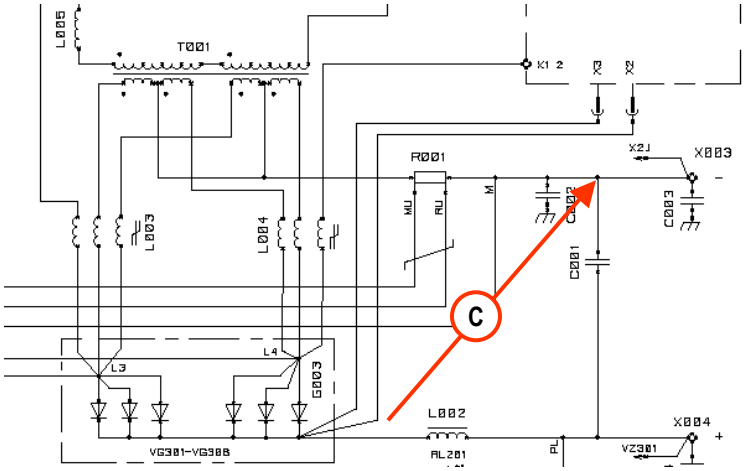


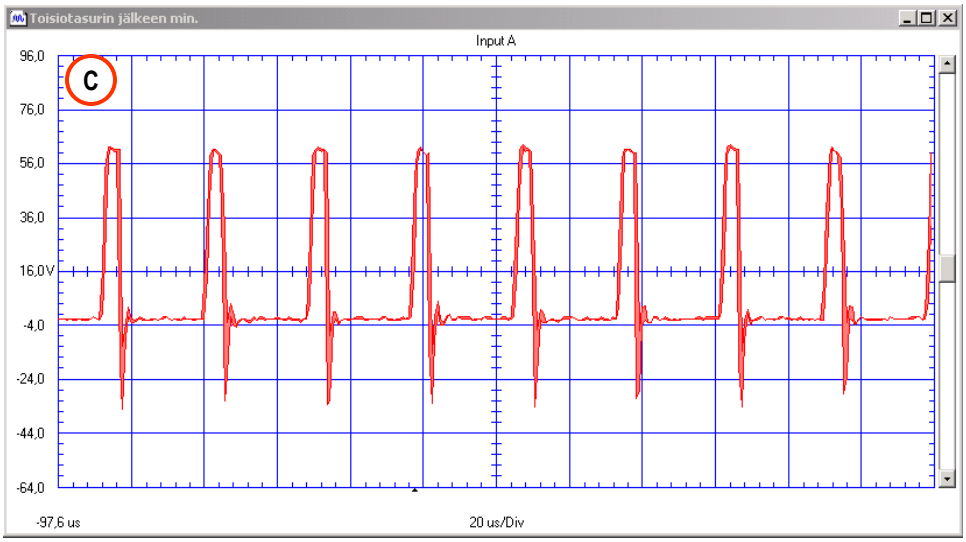
Voltage over the lower IGBT with minimum power (2800/3500). Inverter operating frequency approx. 19 kHz (measuring point B).



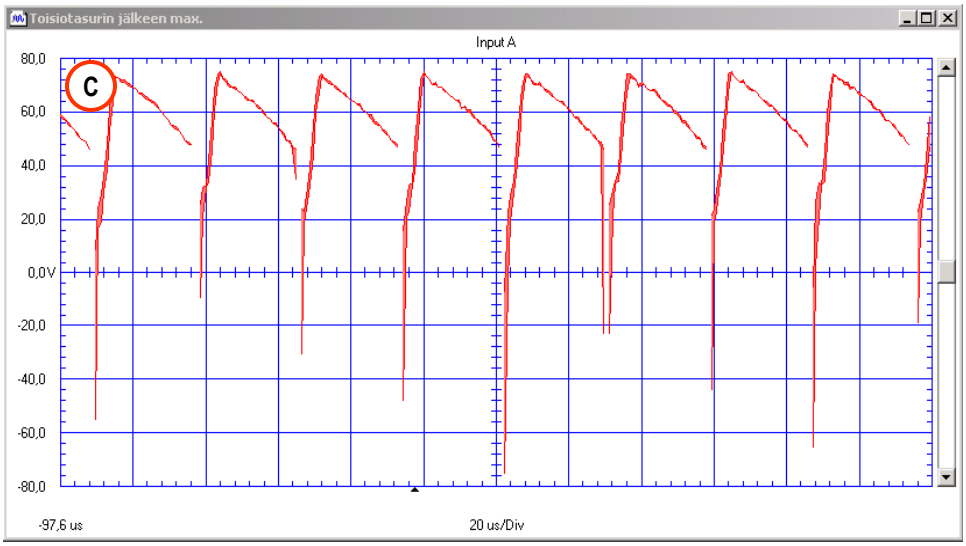
Voltage over the lower IGBT with maximum power (2800/3500). Inverter operating frequency approx. 19 kHz (measuring point B).

Voltage after the secondary diodes *(Master / Mastertig 2800/3500)*



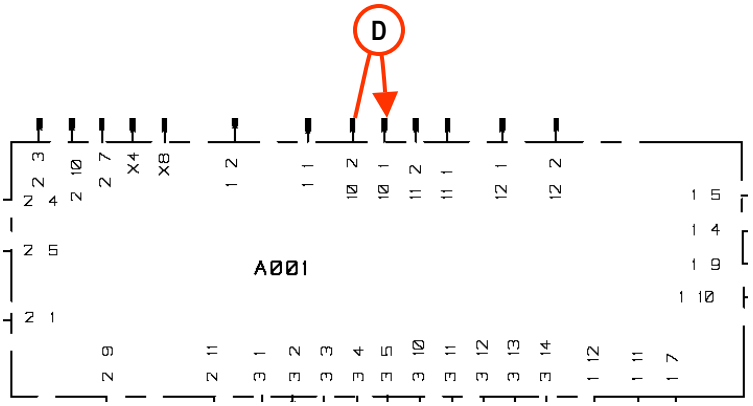


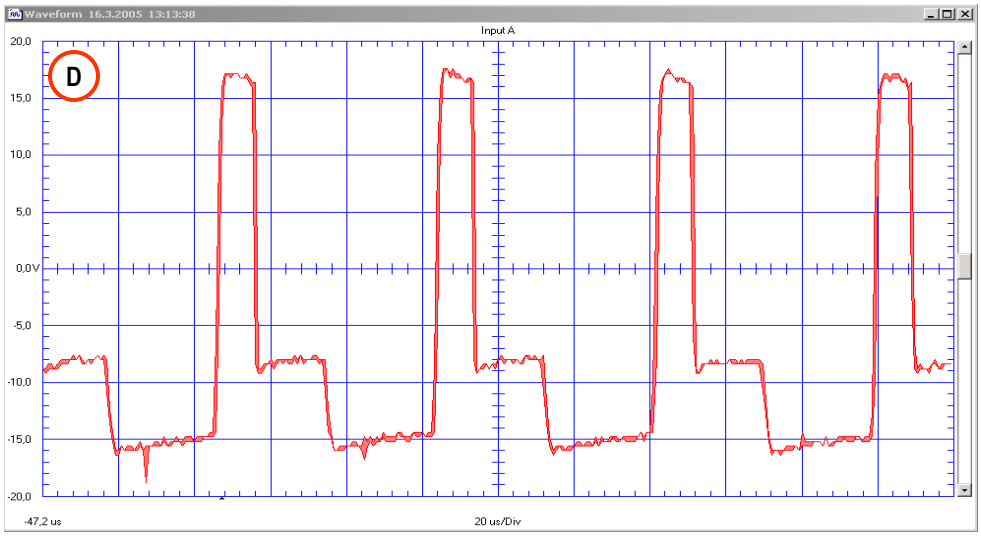
Voltage over the secondary diodes with minimum power(2800/3500). Frequency is approx. 38 kHz (measuring point C).



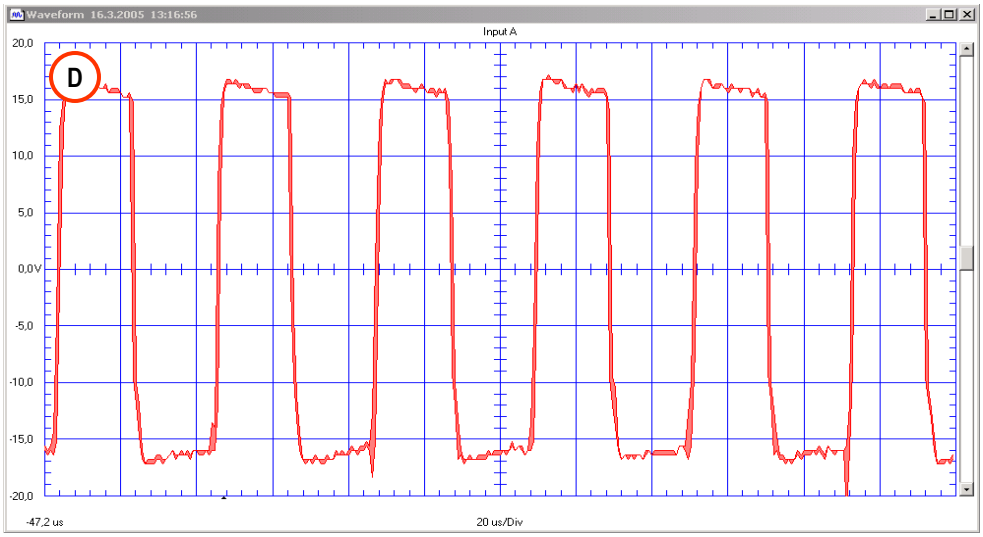
Voltage over the secondary diodes with maximum power (2800/3500). Frequency approx. 38 kHz (measuring point C).

IGBT gate pulse *(Master / Mastertig 1400/1500/2200)*



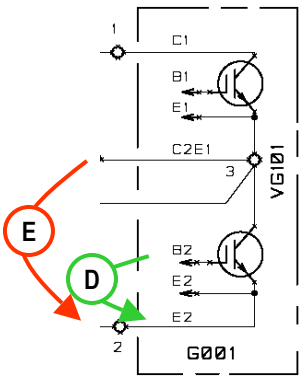


IGBT gate pulse with minimum power (1400/1500/2200). Inverter operating frequency approx. 18 kHz (measuring point D).

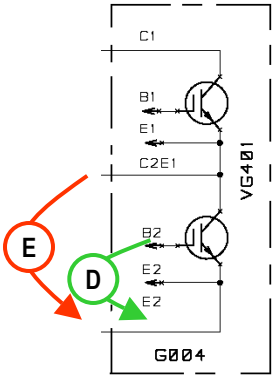


IGBT gate pulse with maximum power (1400/1500/2200). *NOTE.* Inverter operating frequency approx. 25 kHz (measuring point D).

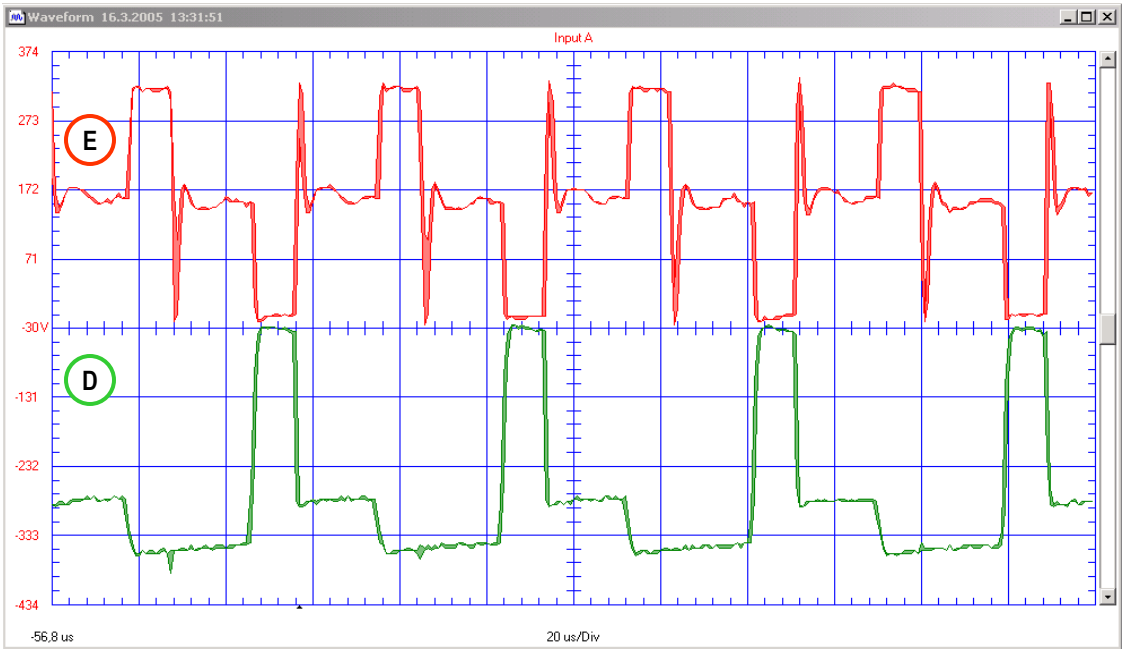
Voltage over the lower IGBT *(Master / Mastertig 1400/1500/2200)*



Master 1400/1500

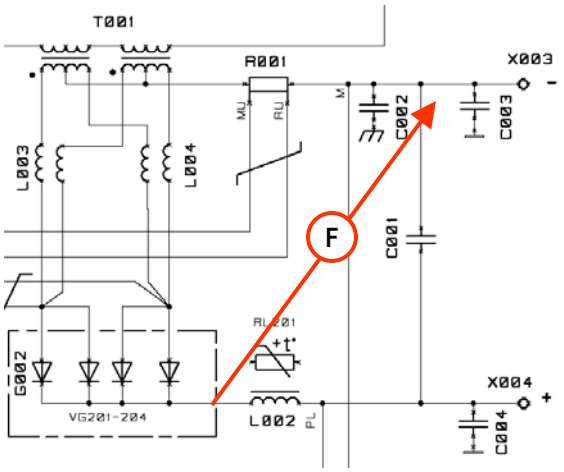


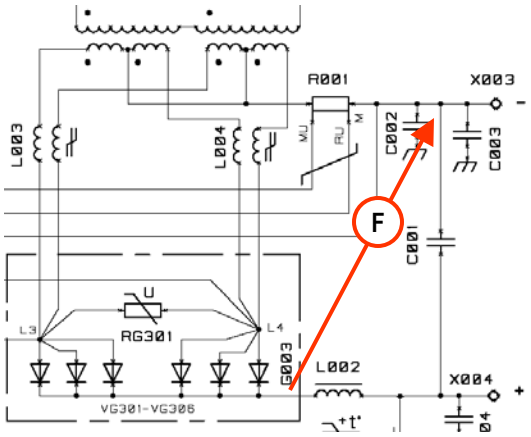
Master 2200

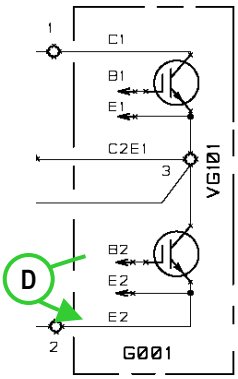


Lower IGBT control (Gate pulse; measuring point D / Voltage over the lower IGBT; measuring point E).

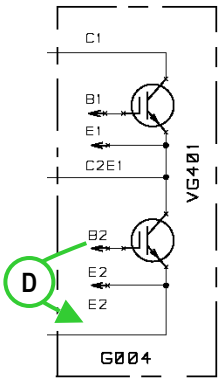
Voltage after the secondary diodes *(Master / Mastertig 1400/1500/2200)*



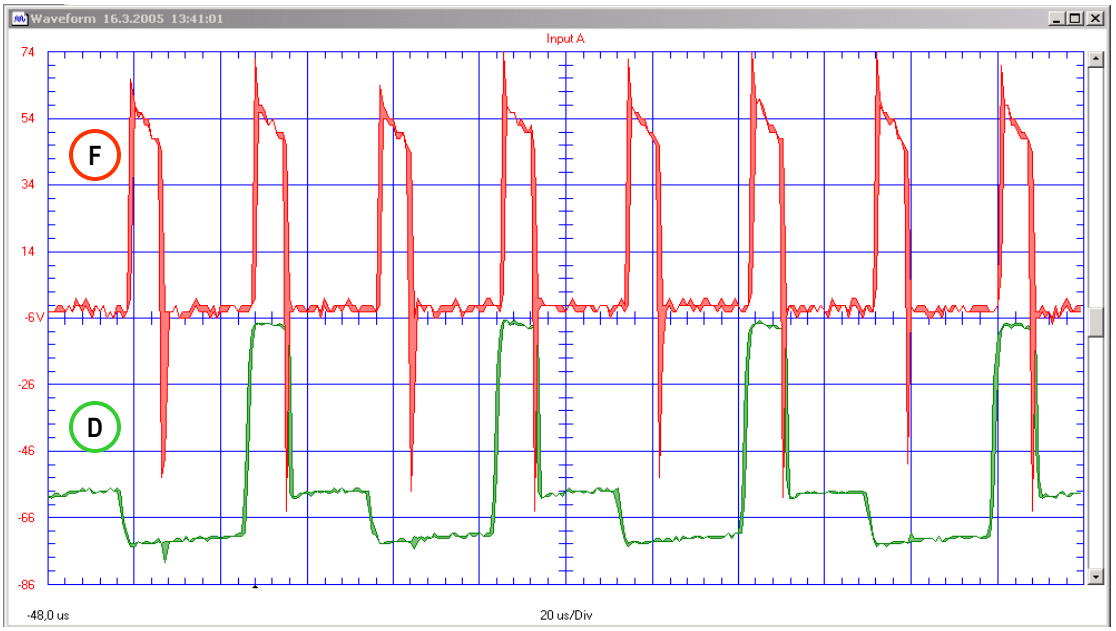




Master 1400/1500



Master 2200



Voltage after the secondary diodes (measuring point F) and lower IGBT gate pulse (measuring point D).

Troubleshooting

The machine may be repaired only by an authorized and licensed technician or workshop!

First do a visual check to find the possible loose connectors, broken wires or signs of overheating.

Also check the condition of the welding cables, welding guns / torches and all consumable parts.

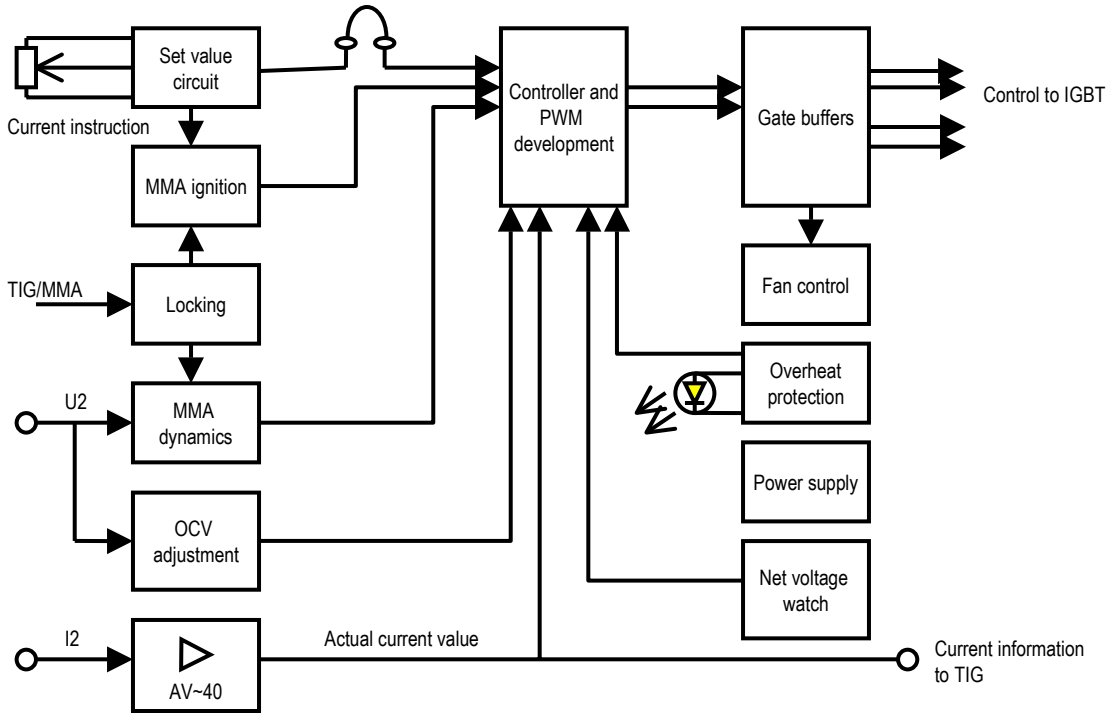
Troubleshooting diagram

DISTURBANCE	POSSIBLE CAUSE	REMEDY
The power source will not start. MMA open circuit voltage is 0 V	Net fuses have blown	Check the net fuses
	Faulty supply cable	Check the supply cable condition
	Faulty main switch	Check the main switch condition
	Faulty current adjustment potentiometer	Check the potentiometer condition
	Faulty local / remote control selection switch (2200-3500)	Check the control method selection switch condition
	Faulty auxiliary transformer	Check the auxiliary transformer condition
	Faulty primary side power semiconductor	Check the condition of the primary rectifier and the IGBT-module
	Faulty control card A001	Check the control card A001 condition (see page 27)
	Faulty control card A002 (Mastertig)	Check the control card A002 condition (see pages 28 and 29)
	Faulty flat cable between control cards A001 and A002	Check the flat cable condition (see page 23)
The net fuses blow during startup.	Faulty primary side power semiconductor	Check the condition of the primary rectifier and IGBT-module
	Faulty main circuit card	Check the condition of the smoothing and load capacitors.
		Look for possible signs of insulation damages on main circuit card.
	Faulty secondary unit	Check the secondary diodes condition.
	Note! 1-phase Master- and Mastertig-power sources may blow net fuses during the first startup, without being anything wrong in the power source. This is because the DC-link capacitors have relatively high charging current! This phenomenon is found especially with automatic fuses.	

DISTURBANCE	POSSIBLE CAUSE	REMEDY
The power source will not deliver full power	A net fuse has blown	Check the net fuses
	Faulty supply cable	Check the supply cable condition
	Faulty main switch	Check the main switch condition
	Faulty primary side power semi-conductor	Check the primary rectifier and IGBT-module
	Faulty control card A001	Check the correct pulse ratio adjustment from control card A001 to IGBT gate (see pages 12 and 15)
	Faulty main circuit card	Check the main circuit card capacitors and their connections
	Faulty secondary unit	Check the condition the secondary diodes
	Faulty main transformer	Check the main transformer ferrites
	Faulty control card A002 (Mastertig)	Check the flat cable signals between control cards A001 and A002; pins 1 and 2 against the card´s GND (see pages 28 and 29)
	Faulty flat cable between control cards A001 and A002	Check the flat cable´s condition (see page 23)
The power source will not operate on TIG	Check power source´s operation on MMA. Disconnect the flat cable from control card A001 and connect a shortcircuit loop to the flat cable connector X3, between pins 1 and 2. If the power source doesn´t work on MMA , then the TIG process can not work either.	
	Faulty flat cable between control cards A001 and A002	Check the flat cable condition (see page 23)
	Faulty control card A002	Check control card condition (see pages 28 and 29)
TIG-spark ignition doesn´t work. Scratch ignition method is OK. On MMA the machine works OK.	Faulty flat cable between control cards A001 and A002	Check the flat cable condition (see page 23)
	Faulty control card A002	Check the control card A002 condition (see pages 28 and 29)
	Faulty control card A004 (2800/3500)	Check the control card A004 condition (see page 30)

DISTURBANCE	POSSIBLE CAUSE	REMEDY
TIG-process logic functions are not working correctly	Faulty adjustment potentiometer Faulty flat cable between control cards A002 and A003 Faulty control card A002	Check the adjustment potentiometers Check the flat cable (see page 23) Replace control card A002 (see pages 28 and 29)
Mastertig 3500 W-cooling unit doesn´t stay on, when operated by it´s start switch	Faulty pressure switch Faulty control card A005	Check the pressure switch Check the control card A005 relays
Mastertig 3500 W-cooling unit doesn´t start, when operated by it´s start switch	The fuse F002 has blown Faulty switch Faulty auxiliary transformer T004 Pump is jammed Faulty startup capacitor Faulty pump motor	Check the fuse and the fuse holder Check the switch Check the auxiliary transformer T004 Check and clean the pump Check the startup capacitor. Check the pump motor

Control card A001 block diagram



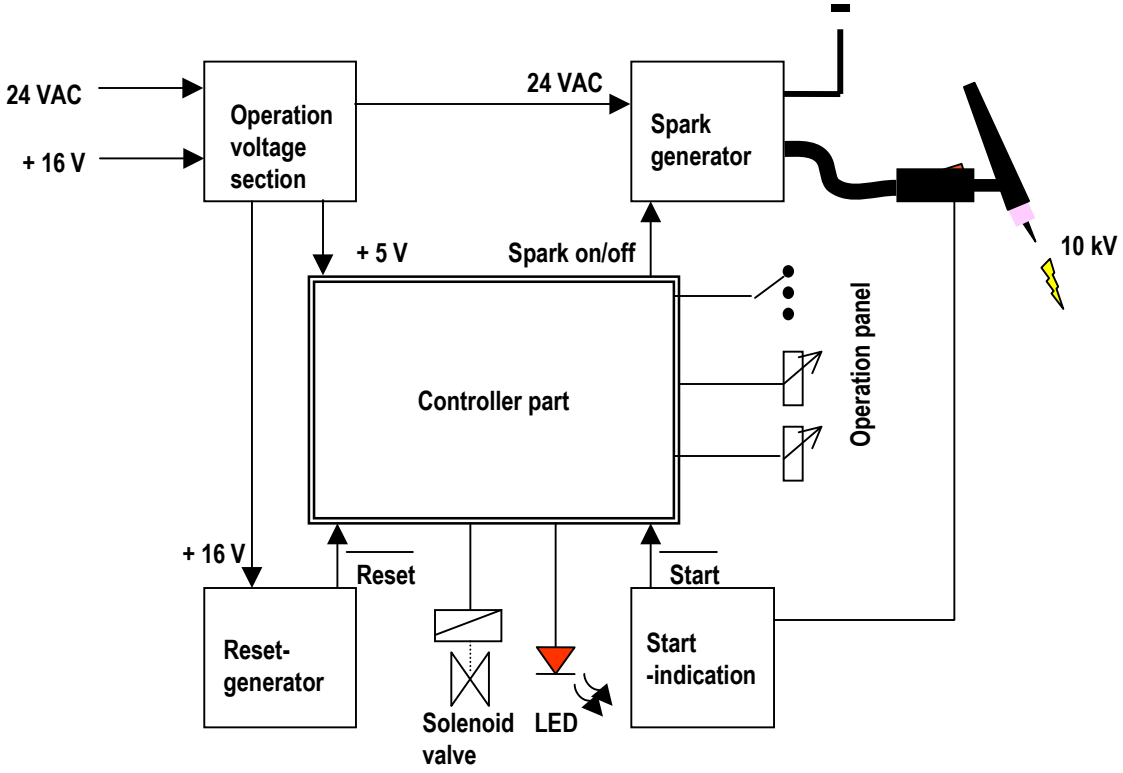
The functions of power source´s control card A001 are built around the PWM-controller SG 3526.

Gate buffer
PWM-controller develops PWM-signals, that are amplified in the gate buffer and taken via a control transformer to the IGBT-module´s gates.
Set value circuit
Set value circuit prepares the signal coming from the potentiometer suitable for the PWM-controller and protects the electronics from potentiometer circuit´s insulation faults and possible overvoltages.
MMA ignition
The MMA ignition circuit develops an overcurrent spike to the set value current in order to ease the ignition.
MMA Dynamics
The dynamics circuit develops overcurrent spikes to the set value current during short circuits.
Locking
The locking circuit prevents the MMA ignition current and dynamics operation on TIG.
OCV controller
The OCV circuit controls the power stage during idling so that the power losses are minimized.
Shunt amplifier
Current signal amplifier amplifies the shunt voltage suitable for the PWM-controller.
Fan control
PWM-signal is used to control the fans on/off. During idling the PWMcontroller´s pulse ratio is so low , that the fans are off. The fans start after 30 seconds from the start of welding, regardless of the welding current level. Post-welding cooling is active for 5 minutes.
Overheat protection
Overheat protection is activated by PTC-resistors.
Power supply
The power supply section forms the auxiliary voltages needed by control card A001. The power supply section also provides undervoltage watch.
Net voltage watch
Net voltage watch circuit stops the power stage, in case the net voltage rises above certain limit.

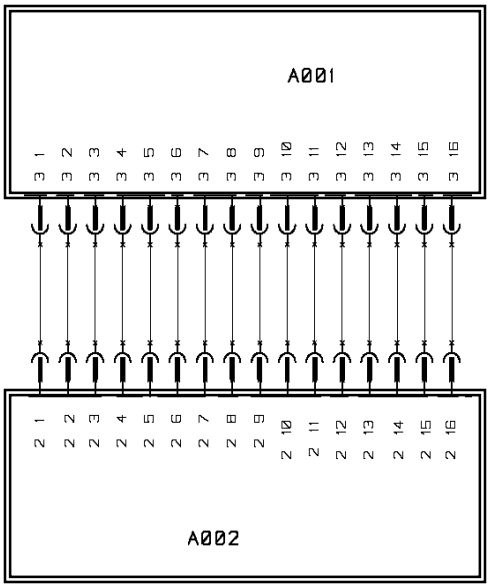
Mastertig-power source´s TIG-section

The TIG-section provides these programmatic functions:

- Pre- and postgas timings
- Up- and downslopes
- Tacking automatics
- Switch functions (2T/4T)
- Pulse functions
- Pulse led control
- Ignition spark control and watch
- Contact ignition control and watch
- Power source start and set value

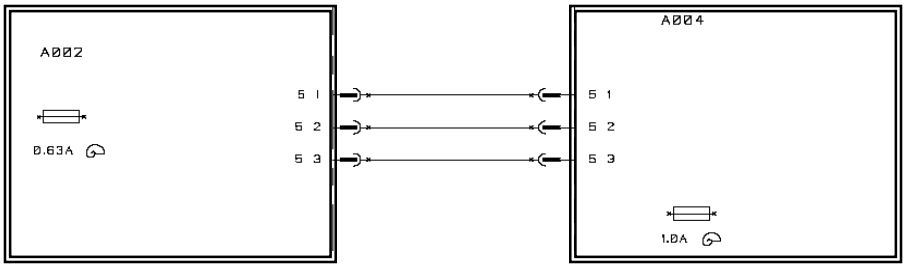


Signals between control cards A001 and A002 *(Mastertig 1500-3500)*



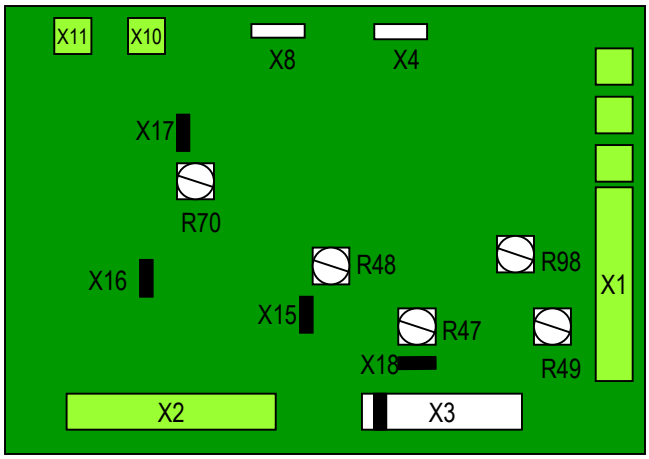
1	Current set value from power source (0,5…5 Vdc)
2	Current set value to power source (0,5…5 Vdc)
3	GND
4	GND
5	GND
6	GND
7	
8	Output voltage information from power source (OCV on MMA is approx. 75 Vdc)
9	
10	
11	
12	
13	MMA/TIG-selection (TIG = 4,5 Vdc, MMA = 0 V)
14	26 Vac from power source
15	26 Vac from power source
16	16 Vac from power source

Signals between control cards A002 and A004 *(Mastertig 2800-3500)*



5/1	26 Vac
5/2	Spark generator on/off
5/3	Start switch detection
X6/3 (A004)	GND

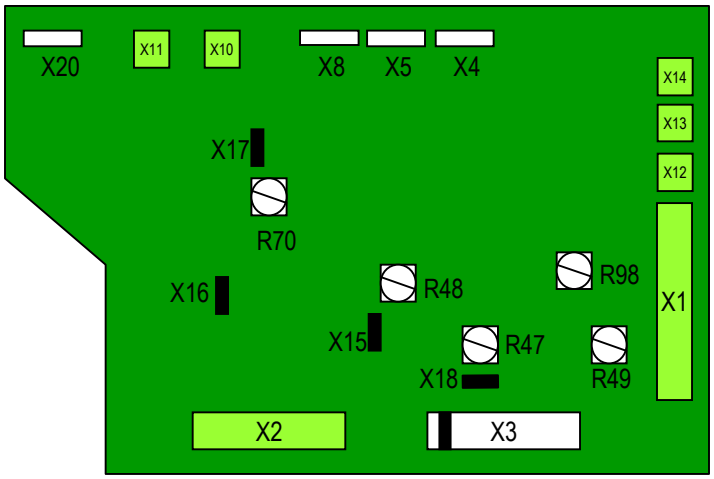
Control card A001 layout *(Master / Mastertig 1500)*



	Closed	Open	
X15		●	MMA
X15	●		Scratch-TIG
X16	●		
X17		●	
X18		●	OCV approx. + 80 V
X18	●		OCV approx.. + 40 V

R47 Maximum current
R48 MMA ignition current
R49 Minimum current
R70 Inverter frequency
R98 Set value min. (TIG)

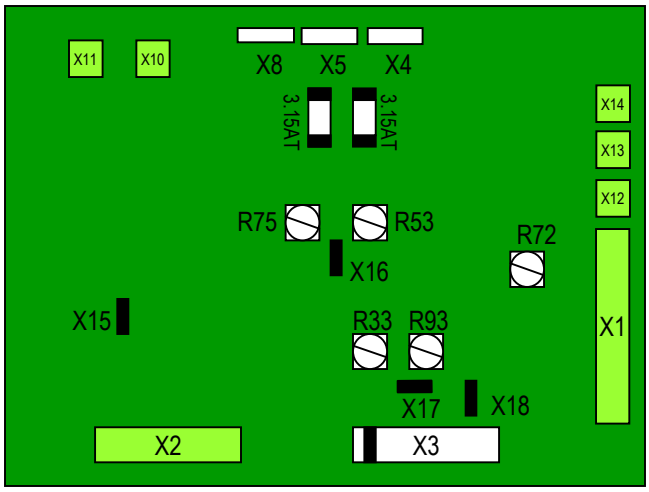
Control card A001 layout *(Master / Mastertig 2000/2200)*



	Closed	Open	
X15		●	MMA
X15	●		Scratch-TIG
X16	●		Net voltage 3~ 400 V
X16		●	Net voltage 3~ 460 V
X17	●		Net voltage 3~ 460 V
X17		●	Net voltage 3~ 400 V
X18	●		OCV approx. + 80 V
X18		●	OCV approx. + 40 V

R47 Maximum current
R48 MMA ignition current
R49 Minimum current
R70 Inverter frequency
R98 Set value min. (TIG)

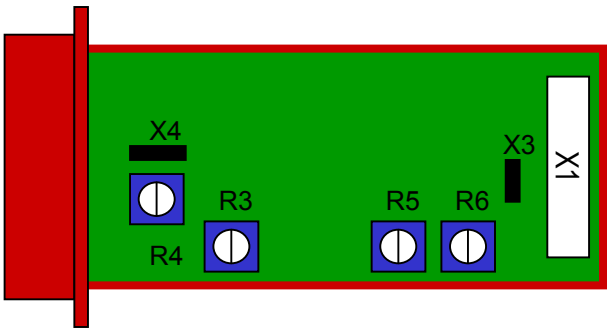
Control card A001 layout *(Master / Mastertig 2800/3500)*



	Closed	Open	
X18		●	MMA
X18	●		Scratch-TIG
X15	●		Net voltage 3~ 400 V
X15		●	Net voltage 3~ 460 V
X16	●		Net voltage 3~ 460 V
X16		●	Net voltage 3~ 400 V
X17	●		OCV approx. + 80 V
X17		●	OCV approx. + 40 V

R33 Maximum current
R53 MMA ignition current
R72 Minimum current
R75 Inverter frequency
R93 Set value min. (TIG)

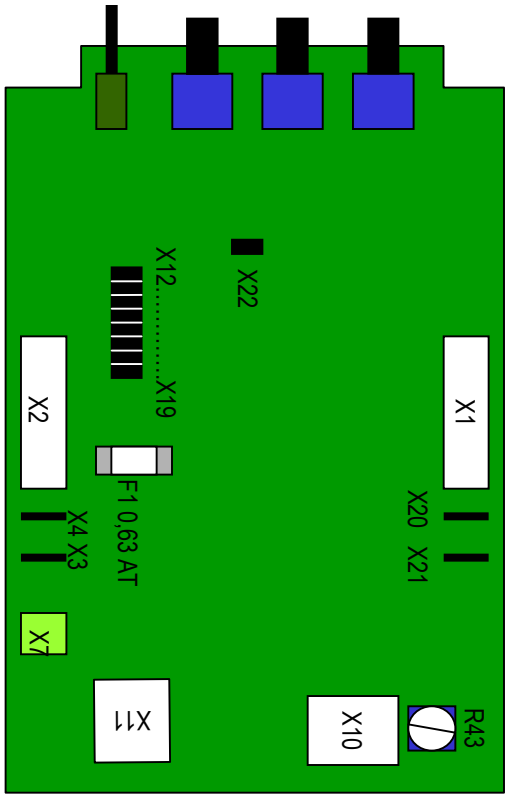
MSD 1-meter unit layout *(Master / Mastertig 2800/3500)*



R3 Set value current minimum
R4 Set value current maximum
R5 Voltage
R6 Current

X3 Short circuit loop must be disconnected in Mastertig 2800 / 3500-power sources
X4 Machine size coding (Master and Mastertig 2800 / 3500)

Control card A002 layout *(Master / Mastertig 1500/2200)*



R43 Spark voltage adjustment

JUMPERS

When a jumper is disconnected:

X12 Tacking automatics goes off

X13 Downslope time becomes non-linear, downslope times become longer with low currents

X14 Postgas becomes independent from set value, and adjustable linearly adjustable between 0 - 120s

X15 Downslope will go all the way to the minimum, and won´t be cut-off at 15 % level of the welding current

X16 Contact ignition current changes 40A -> 25A

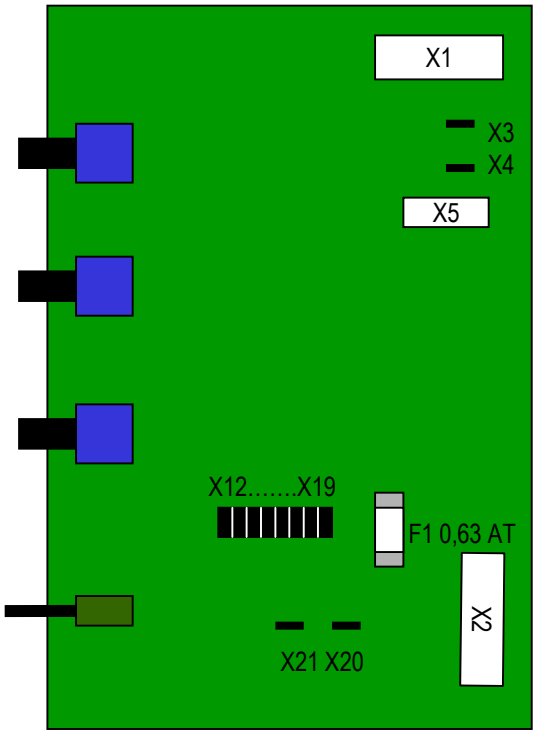
X17 Minilog-functions enabled

X18 Empty

X19 Current rise-up speed maximum

X22 ALWAYS KEEP CONNECTED!!

Control card A002 layout *(Master / Mastertig 2800/3500)*



JUMPERS

When a jumper is disconnected :

X12 Tacking automatics is off

X13 Downslope time is non-linear, downslope times become longer with low currents

X14 Postgas becomes independent from set value, and adjustable linearly adjustable between 0 - 120s

X15 Downslope will go all the way to the minimum, and won´t be cut-off at 15 % level of the welding current

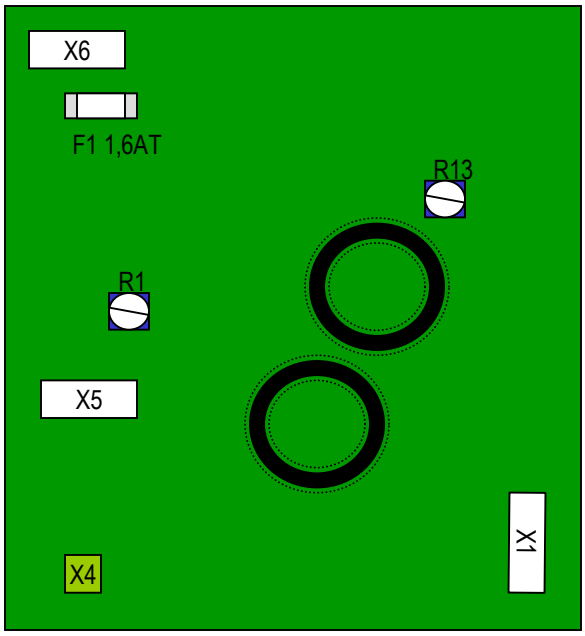
X16 Contact ignition current changes 40A -> 25A

X17 Minilog-functions enabled

X18 Empty

X19 Current rise-up speed maximum

Control card A004 layout *(Master / Mastertig 2800/3500)*



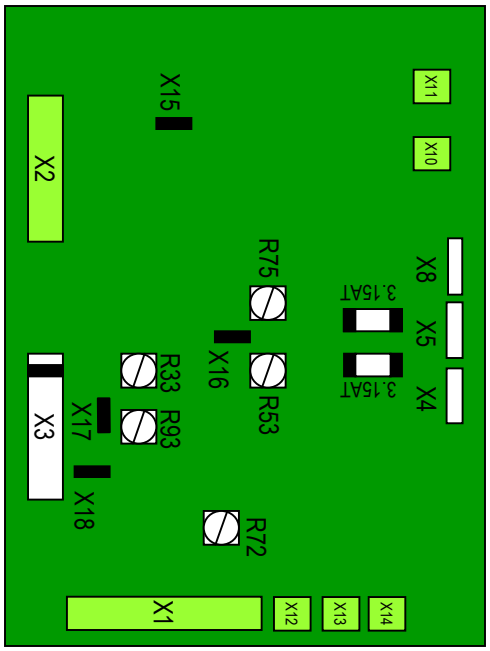
R1 Power (Spark)
R13 Voltage (Spark)

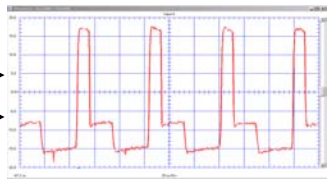
Control card A001 functional testing

Control card power supply ?
(2 x 13 Vac)

Temperature watch PTC ?

Set value information ?

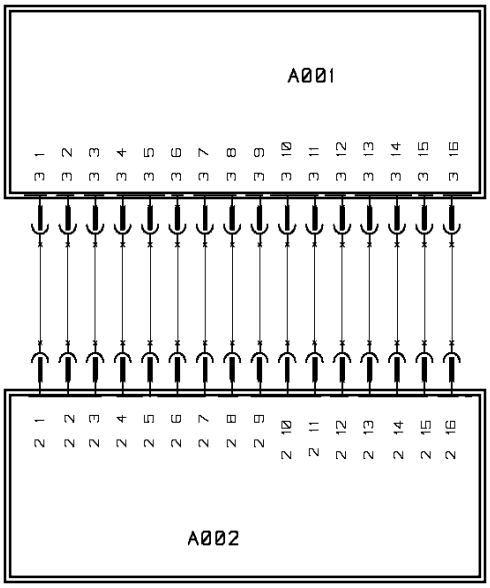




IGBT gate pulses

Control card A001 develops the IGBT gate pulses. If the power supply part is OK, the fuses are intact, the temperature watch PTCs are OK and correct set value info is received from the potentiometer, then the gate pulses should be seen on connectors X10 and X11. When the machine is idling, one must note that it is actually running intermittently.

Control card A002 functional testing

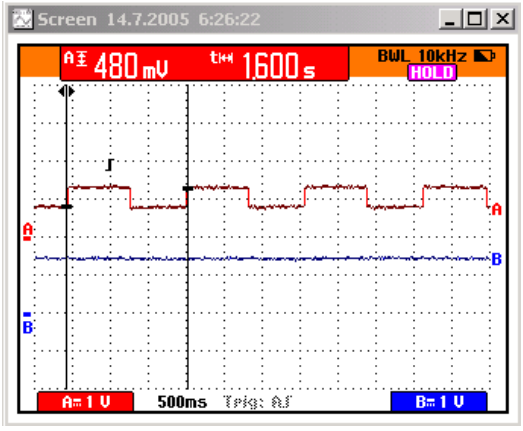


1	Current set value to power source (0,5…5 Vdc)
2	Current set value to power source (0,5…5 Vdc)
3	GND
4	GND
5	GND
6	GND
7	
8	Output voltage from power source (OCV on MMA 75 Vdc)
9	
10	
11	
12	
13	MMA/TIG-selection (TIG = 4,5 Vdc, MMA = 0 V)
14	26 Vac from power source
15	26 Vac from power source
16	16 Vdc from power source

The control card A002 uses the 24 Vac to control the solenoid valve and spark ignition, and transforms the + 16 V voltage to + 5 V for control electronics.

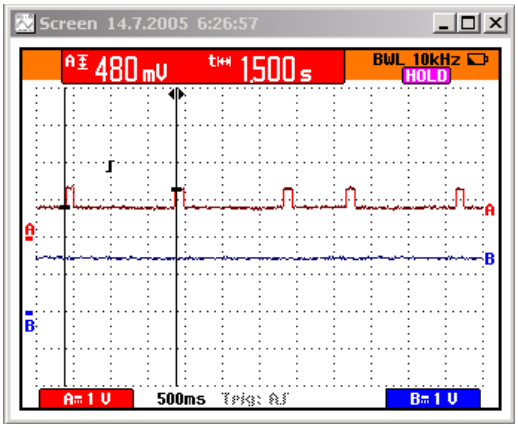
Control card A002 alters the signal taken from control card A001´s (pin 1) set value circuit according to the adjustments of the operating panel (pin2). It also controls the spark ignition and solenoid valve.

The power source is controlled by the signal from flat cable´s pin 2 and changes in the operating panel´s adjustments affect signal in pin 2. On TIG the pin 2 has voltage only when the start is active and the machine is loaded.
Examples of the voltages on flatcable´s pins 1 and 2:



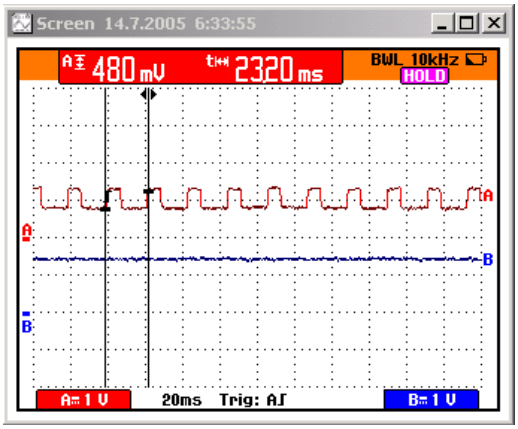
A=Pin 2 voltage
Pulse ratio approx. 50 %, pause current 40 % and cycle time 1,5 s (0,7 Hz)

B=Pin 1 voltage
Set value information from control card A001´s set value circuit



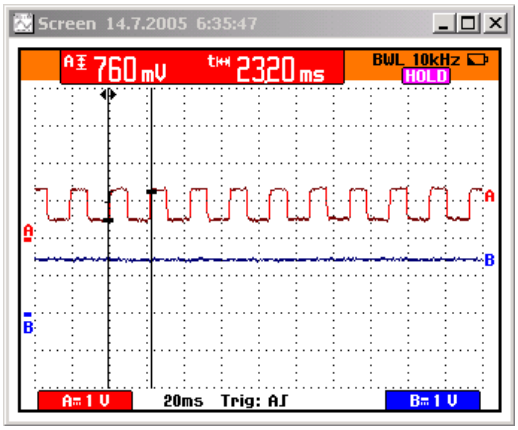
A=Pin 2 voltage
Pulse ratio approx. 10 %, pause current 40 % and cycle time 1,5 s (0,7 Hz)

B= Pin 1 voltage
Set value information from control card A001´s set value circuit



A= Pin 2 voltage
Pulse ratio approx. 50 %, pause current 40 % and cycle time approx. 0,2 s (50Hz)

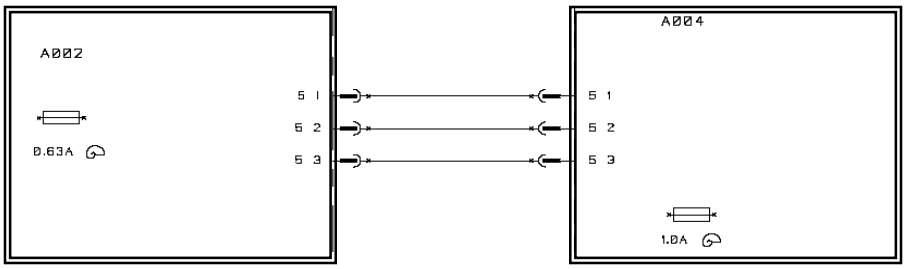
B= Pin 1 voltage
Set value information from control card A001´s set value circuit



A= Pin 2 voltage
Pulse ratio approx. 50 %, pause current min. and cycle time approx. 0,2 s (50Hz)

B= Pin 1 voltage
Set value information from control card A001´s set value circuit

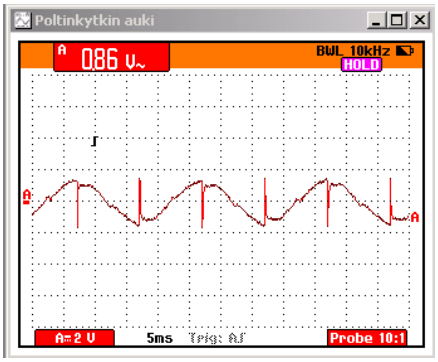
Control card A004 functional testing *(Mastertig 2800/3500)*



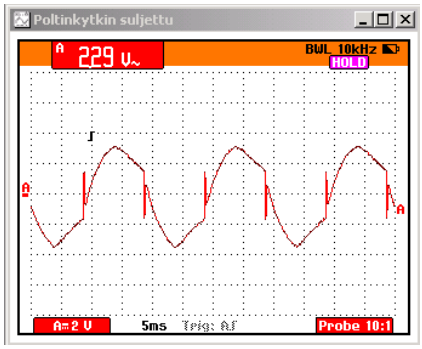
5/1	24 Vac
5/2	Spark generator on/off
5/3	Start switch detection
X6/3 (A004)	GND

Mastertig 2800/3500 control card A004 generates the ignition spark for TIG and it also reads the torchswitch states. The torch switch is separated from other electronics on the transformer, because the voltage inducted to the switch lines is almost full spark voltage (approx. 10 kV).

The torch switch state is measured by the connector X5/3, according to these voltage limits:



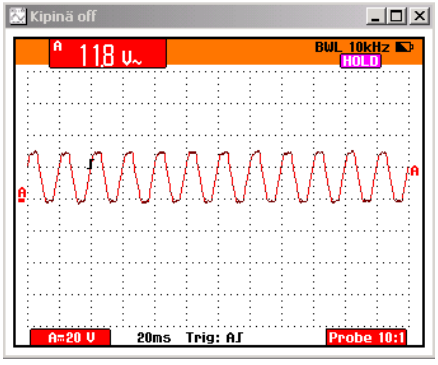
Torch switch open



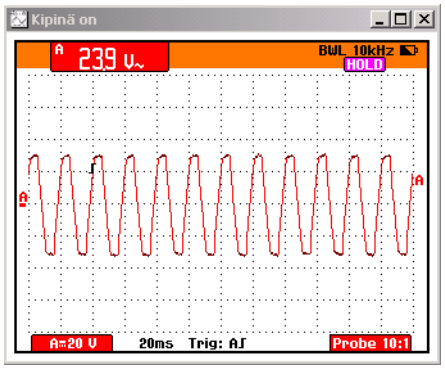
Torch switch closed

Measured between X5/3 and ground

After closing the torch switch the power stage will start and the output voltage will rise. Power for the ignition spark is taken from the power source´s output voltage, from which a spark of approx. 10 kV is developed. The spark generator is started via connector X5/2.



Ignition spark off



Ignition spark on

Measured between connectors X5/1 and X5/2

Notes