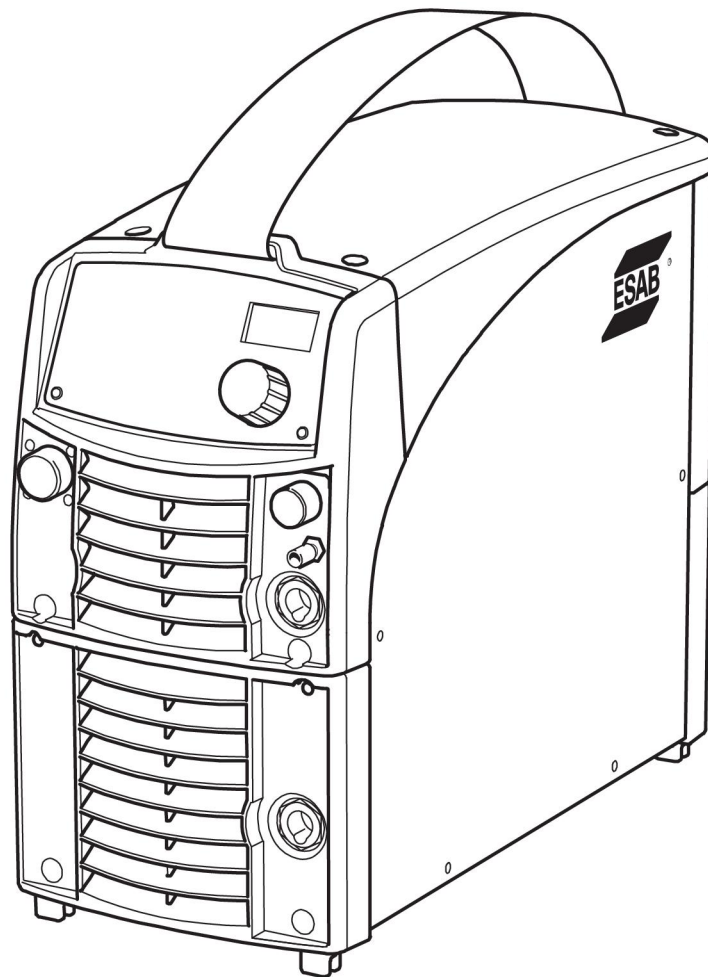




Caddy™

# ***Tig 2200i AC/DC***



## **Service manual**

---

<b>READ THIS FIRST</b> .....	<b>4</b>
<b>INTRODUCTION</b> .....	<b>5</b>
<b>TECHNICAL DATA</b> .....	<b>6</b>
<b>WIRING DIAGRAM</b> .....	<b>8</b>
<b>Component description</b> .....	<b>8</b>
<b>Tig 2200i AC/DC</b> .....	<b>10</b>
<b>DESCRIPTION OF OPERATION</b> .....	<b>12</b>
<b>1 MMC module</b> .....	<b>12</b>
<b>2AP1 Power supply board</b> .....	<b>12</b>
2AP1:1 Interference suppressor circuit .....	12
2AP1:2 Primary circuit .....	13
2AP1:3 Secondary circuit .....	14
2AP1 Component positions .....	15
<b>10AP1 TIG board</b> .....	<b>15</b>
10AP1 Component positions .....	16
<b>15AP1 Power board</b> .....	<b>18</b>
Charging circuit .....	18
Power factor corrector (PFC) .....	18
Gate driver stages .....	19
Switching circuit .....	19
Supply to 2AP1 .....	19
15AP1 Component positions .....	20
<b>15AP2 Secondary board</b> .....	<b>20</b>
15AP2 Component positions .....	21
<b>18AP1 AC control board</b> .....	<b>21</b>
18AP1:1 Power supply .....	22
18AP1:2 CAN bus .....	23
18AP1:3 Temperature monitoring .....	24
18AP1:4 Arc voltage monitoring .....	24
18AP1:5 Fan power supply .....	25
18AP1:6 Switch driver .....	25
18AP1 Component positions .....	26
<b>18AP2 AC power board</b> .....	<b>26</b>
18AP2:1 Switching circuits .....	27
18AP2:2 Temperature monitoring .....	27
18AP2:3 Fan power supply .....	27
18AP2 Component positions .....	28

<b>20AP1 Control board</b> .....	<b>28</b>
20AP1:1 Power supply .....	29
20AP1:2 The CAN bus .....	30
Starting sequence .....	31
Communication interruptions .....	31
Terminating resistors .....	31
20AP1:3 Control panel interface circuits .....	31
20AP1:4 Pulse width modulator .....	32
20AP1:5 Temperature monitoring .....	32
20AP1:6 Shunt and current control amplifier .....	33
20AP1:7 Arc voltage feedback .....	33
20AP1:8 TIG functions .....	34
20AP1:9 Welding process control .....	34
20AP1:10 Cooling unit control .....	36
20AP1 Component positions .....	37
<b>REMOTE CONTROLS</b> .....	<b>38</b>
<b>FAULT CODES</b> .....	<b>39</b>
<b>Fault log</b> .....	<b>39</b>
<b>Summary of fault codes</b> .....	<b>39</b>
<b>Fault code description</b> .....	<b>40</b>
Welding data unit .....	40
Power source .....	41
AC unit .....	42
<b>SERVICE INSTRUCTIONS</b> .....	<b>45</b>
<b>What is ESD?</b> .....	<b>45</b>
<b>Service aid</b> .....	<b>45</b>
<b>Checking the semiconductor module of 15AP1</b> .....	<b>47</b>
<b>Checking rectifier and freewheel diodes</b> .....	<b>48</b>
<b>Checking the IGBT modules of AC power board 18AP2</b> .....	<b>49</b>
<b>Checking the gate signals to AC power board 18AP2</b> .....	<b>51</b>
<b>Calibration of the arc voltage display</b> .....	<b>53</b>
<b>Checking the gate pulses</b> .....	<b>54</b>
<b>Soft starting</b> .....	<b>55</b>
<b>Mounting components on the heat sink</b> .....	<b>56</b>
<b>SPARE PARTS</b> .....	<b>59</b>

---

## READ THIS FIRST

---

Maintenance and repair work must be performed by an experienced person, and electrical work only by a trained electrician. Use only recommended replacement parts.

This service manual is intended for use by technicians with electrical/electronic training for help in connection with fault-tracing and repair.

Use the wiring diagram as a form of index for the description of operation. The circuit boards are divided into numbered blocks, which are described individually in more detail in the description of operation. Component names in the wiring diagram are listed in the component description.

Use the spare parts list as a guide to where the components are located in the equipment. The spare parts list is published as a separate document, see the "SPARE PARTS AND ACCESSORIES" chapter in this manual.

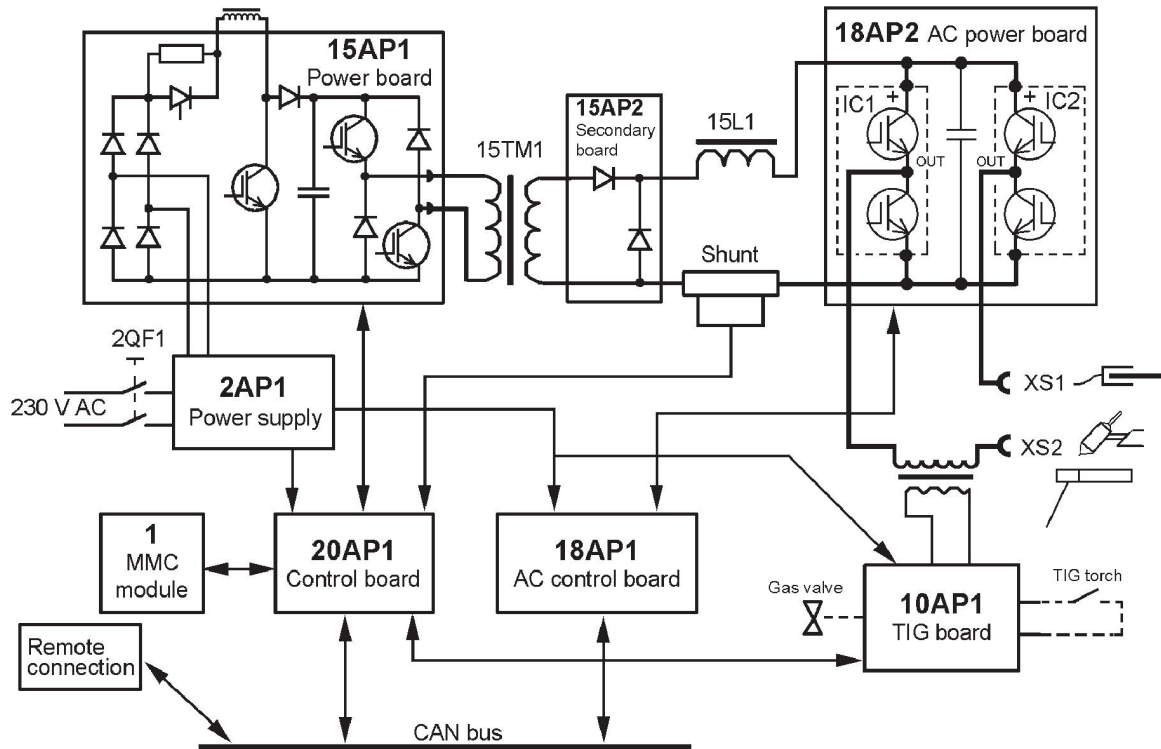
This manual contains details of all design changes that have been made up to and including October 2008.

The manual is valid for: Tig 2200i AC/DC with serial no. 718-xxx-xxxx, 828-xxx-xxxx, 843-xxx-xxxx.

**The Tig 2200i AC/DC is designed and tested in accordance with international and European standards IEC/EN 60974.**

**On completion of service or repair work, it is the responsibility of the person(s) performing the work to ensure that the product still complies with the requirements of the above standard.**

## INTRODUCTION

**Design structure of the power source**

*Block diagram of the Tig 2200i AC/DC*

The power source is transistor-controlled, operating on the inverter principle. It consists of a number of function modules, as shown in the block diagram above. Each module has a module number, which is always included as the first part of the name/identification of components in the module.

The modules have the following main functions:

**1 MMC module**

Control panel and display board.

**2 Mains module**

Mains interference suppressor, mains switch, auxiliary transformer, contactor.

**10 TIG module**

Torch switch interface, HF unit, gas valve.

**15 Power module**

This module is a single forward converter, operating at a switching frequency of 65 kHz. IGBT transistors are used as the switching elements. All power semiconductors are built into modules.

**18 AC module**

Comprises all AC TIG functions.

**20 Processor board module (controller module)**

This is the controller board, 20AP1, that monitors and controls the power source. The micro processor of the board comprises the welding data unit.

## TECHNICAL DATA

<b>Tig 2200i AC/DC</b>	
<b>Mains voltage</b>	230V ± 10 %, 1~ 50 / 60 Hz
<b>Mains supply</b>	Z <sub>max</sub> 0.28 ohm
<b>Primary current</b>	
I <sub>max</sub> TIG	27 A
I <sub>max</sub> MMA	25 A
<b>Fuse</b> (anti-surge or type C MCB)	16 A
<b>Open-circuit power</b>	40 W
<b>Setting range</b>	
TIG AC* / DC	3 - 220 A
MMA	4 - 160 A
<b>Permissible load at TIG AC / DC</b>	
20 % duty cycle	220 A / 18.8 V
60 % duty cycle	150 A / 16.0 V
100 % duty cycle	140 A / 15.6 V
<b>Permissible load at MMA</b>	
30 % duty cycle	160 A / 26.4 V
60 % duty cycle	120 A / 24.8 V
100 % duty cycle	110 A / 24.4 V
<b>Power factor</b> at maximum current	
TIG	0.99
MMA	0.99
<b>Efficiency</b> at maximum current	
TIG	66 %
MMA	74 %
<b>Ignition voltage</b> (U <sub>pk</sub> )	11.5 kV
<b>Open-circuit voltage</b> without VRD function with VRD function	See Chapter "Description of operation" < 35 V
<b>Operating temperature</b>	-10 to +40°C
<b>Transportation temperature</b>	-20 to +55°C
<b>Constant sound pressure in open-circuit</b>	<70 db (A)
<b>Dimensions l × w × h</b>	418 x 188 x 345 mm
<b>Weight</b>	15.7 kg
<b>Shielding gas</b>	All types intended for TIG welding
max pressure	5 bar
<b>Insulation class transformer</b>	H
<b>Enclosure class</b>	IP 23
<b>Application class</b>	<span style="border: 1px solid black; padding: 2px;">S</span>

*\*) The minimum current during AC welding depends on the alloy used for the aluminium plates and their surface cleanliness.*

**Duty cycle**

The duty cycle refers to the time as a percentage of a ten-minute period that you can weld or cut at a certain load without overloading. The duty cycle is valid for 40°C / 104°F, or below.

**Enclosure class**

The **IP** code indicates the enclosure class, i. e. the degree of protection against penetration by solid objects or water.

Equipment marked **IP23** is intended for indoor and outdoor use.

**Application class**

The symbol **S** indicates that the power source is designed for use in areas with increased electrical hazard.

## WIRING DIAGRAM

---

The power source is based on a number of function modules. These are described in the component descriptions on the following pages. Wire numbers and component names in the wiring diagram show to which module each component belongs.

**Circuit boards within each module** have names such as 15AP1 - 15AP99.

- 15 = module association, 1-69
- AP = circuit board
- 1 = individual identification number, 0-99

**Circuit boards within modules** are named in a similar way.

### Component description

Component	Description
1	MMC module: control panel and display board, see chapter "Description of Operation".
2	Mains module.
2AP1	Power supply board.
2L1-2L7	Ferrite ring cores.
2QF1	Mains switch.
2XS1	Flat pin sockets. <b>Important:</b> to obtain a proper electric connection, the complete cord set must be replaced if the sockets have to be replaced.
10	TIG module.
10AP1	TIG board.
10TV1	HF transformer.
10YV1	Gas valve, 230 V AC.
15	Power module.
15AP1	Power board.
15AP2	Secondary board.
15C1	Smoothing capacitor, 2200 uF.
15D1	Diode module with rectifier and freewheel diodes.
15EV1	Fan.
15L1	Inductor.
15L2	PFC Inductor ( <b>P</b> ower <b>F</b> actor <b>C</b> orrector)
15RS1	Shunt. 60 mV at 100 A.
15ST1	Thermal switch, fitted in the winding of main transformer 15TM1. See chapter "Description of Operation".
15ST2	Thermal switch, fitted on the heat sink. See chapter "Description of Operation".
15TM1	Main transformer.
18	<b>AC module.</b> Wire numbers 1800-1999.

<b>18AP1</b>	AC control board. See chapter "Description of Operation".
<b>18AP2</b>	AC power board. See chapter "Description of Operation".
<b>18EV1</b>	Fan, 24 V DC. See chapter "Description of Operation".
<b>18L1</b>	Ferrite ring core.
<b>20AP1</b>	Controller circuit board. See chapter "Description of Operation"
<b>20L1, 20L2</b>	Ferrite ring core.



**CAUTION!**

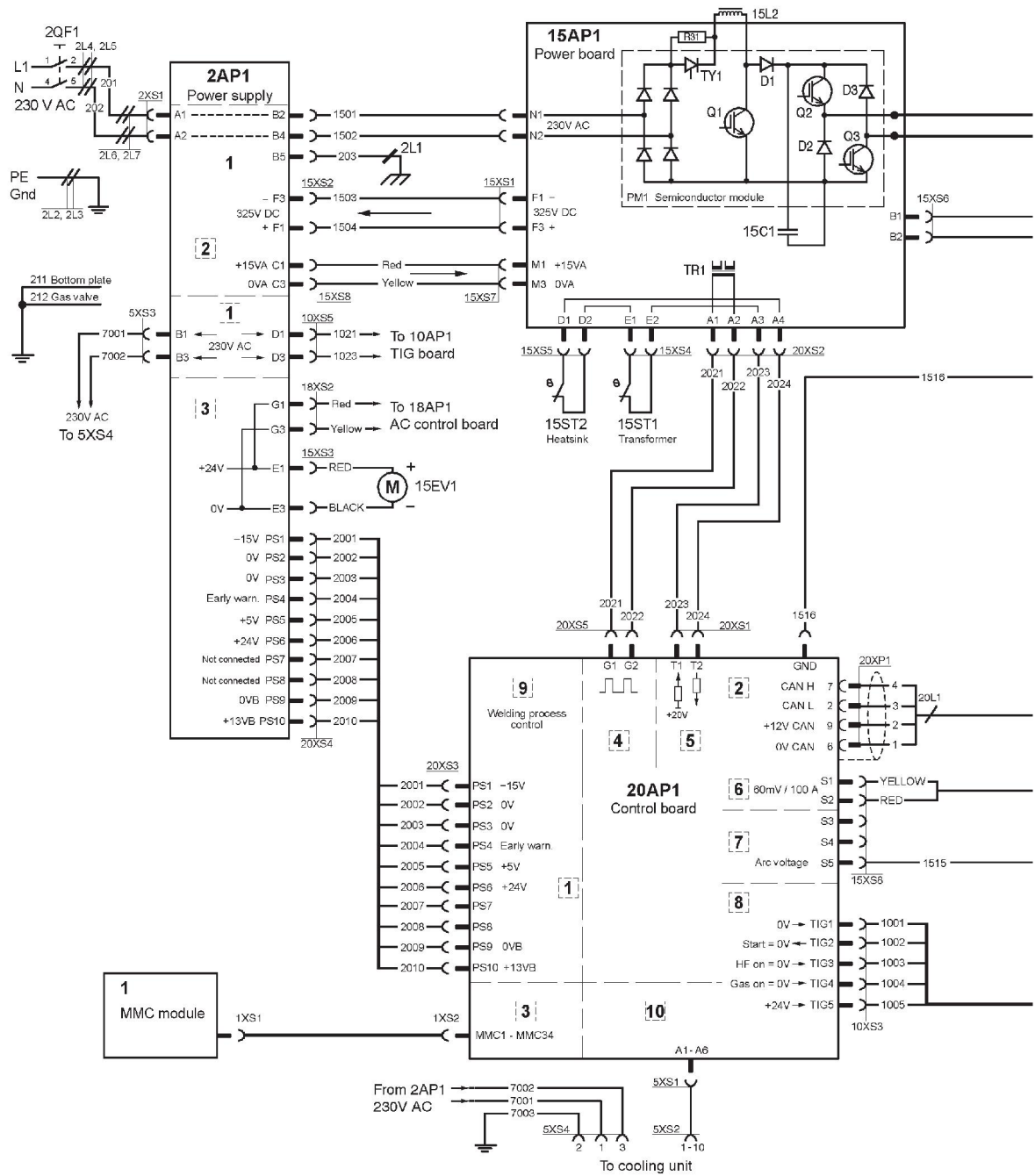
STATIC ELECTRICITY can damage circuit boards and electronic components.

- Observe precautions for handling electrostaticsensitive devices.
- Use proper static-proof bags and boxes.

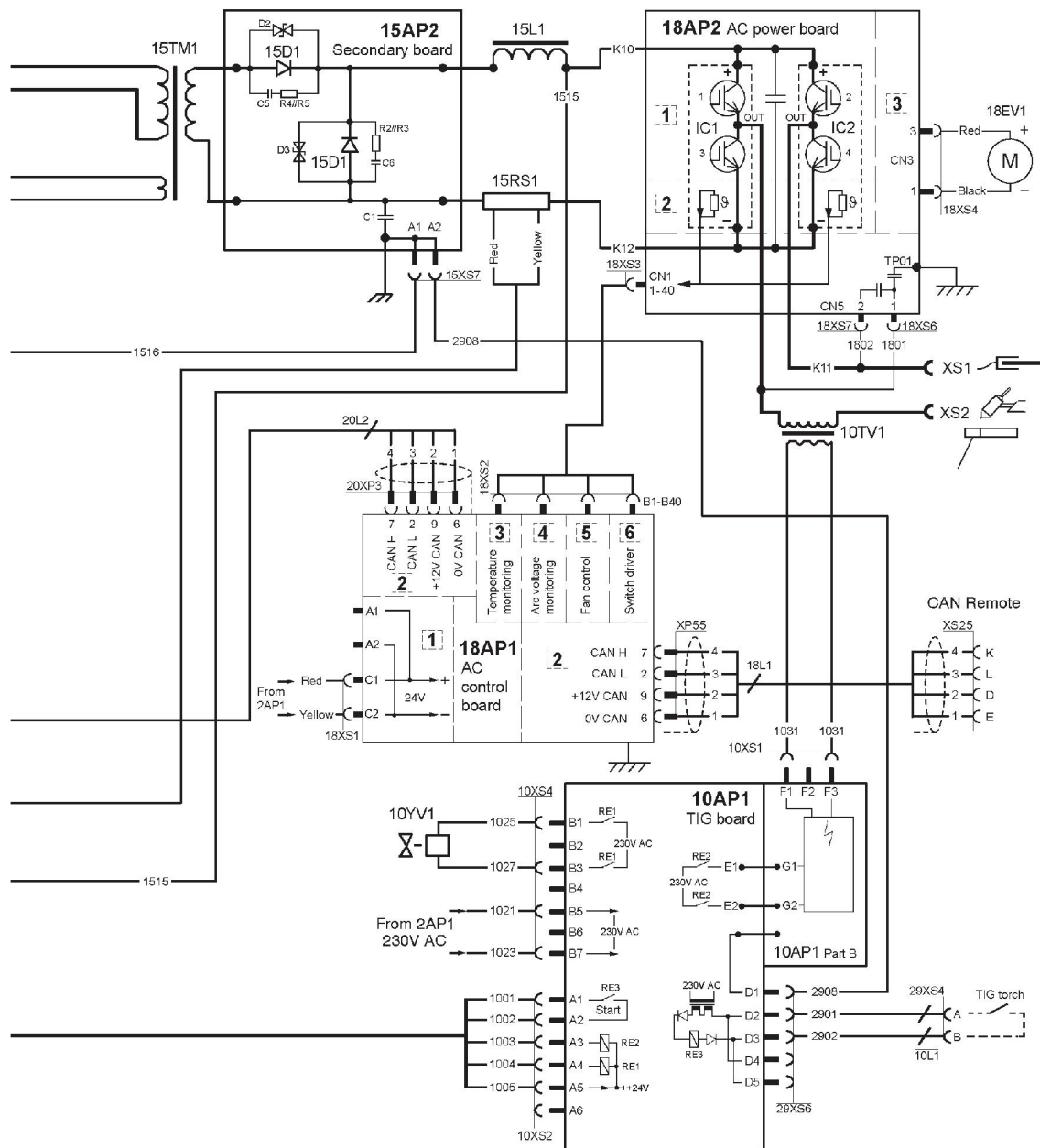


**ESD**

# Tig 2200i AC/DC



WIRING DIAGRAM



## DESCRIPTION OF OPERATION

This description describes the function of circuit boards and other components in the power source. It is divided into sections, numbered to correspond to the circuit board numbers and divisions into function blocks.

### 1 MMC module

The MMC module consists of an operator's control panel and a display board.

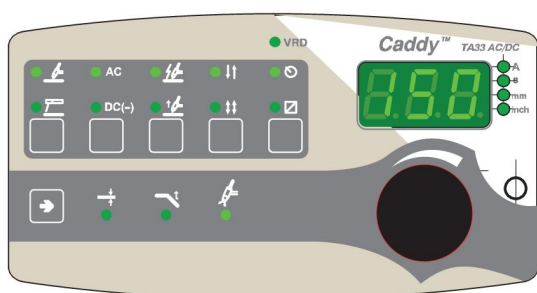
The control panel is used for setting and displaying welding data. The welding data are stored by the control board of the power source.

The control panels are described in separate instruction and service manuals.

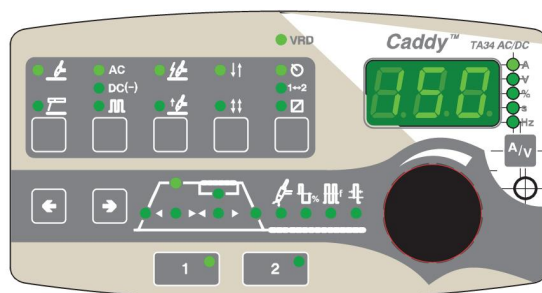
**TA33 AC/DC** intended for MMA-, AC TIG- and DC TIG welding without pulsing.

**TA34 AC/DC** intended for MMA-, AC TIG- and DC TIG welding with pulsing.

#### TA33 AC/DC



#### TA34 AC/DC

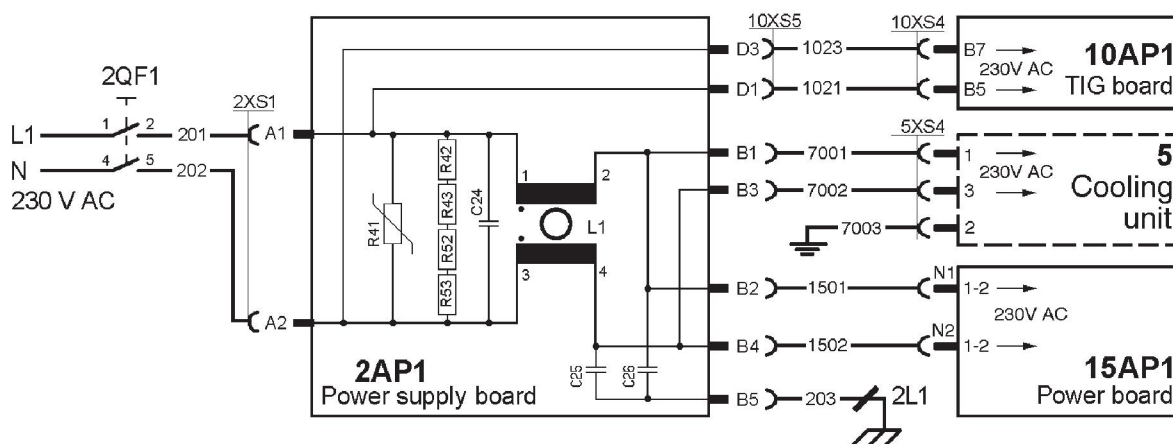


*Pushbuttons are used for parameter selection and a knob for parameter settings, current, time etc.*

### 2AP1 Power supply board

The power supply board filters the mains voltage and generates internal supply voltages for the machine.

#### 2AP1:1 Interference suppressor circuit

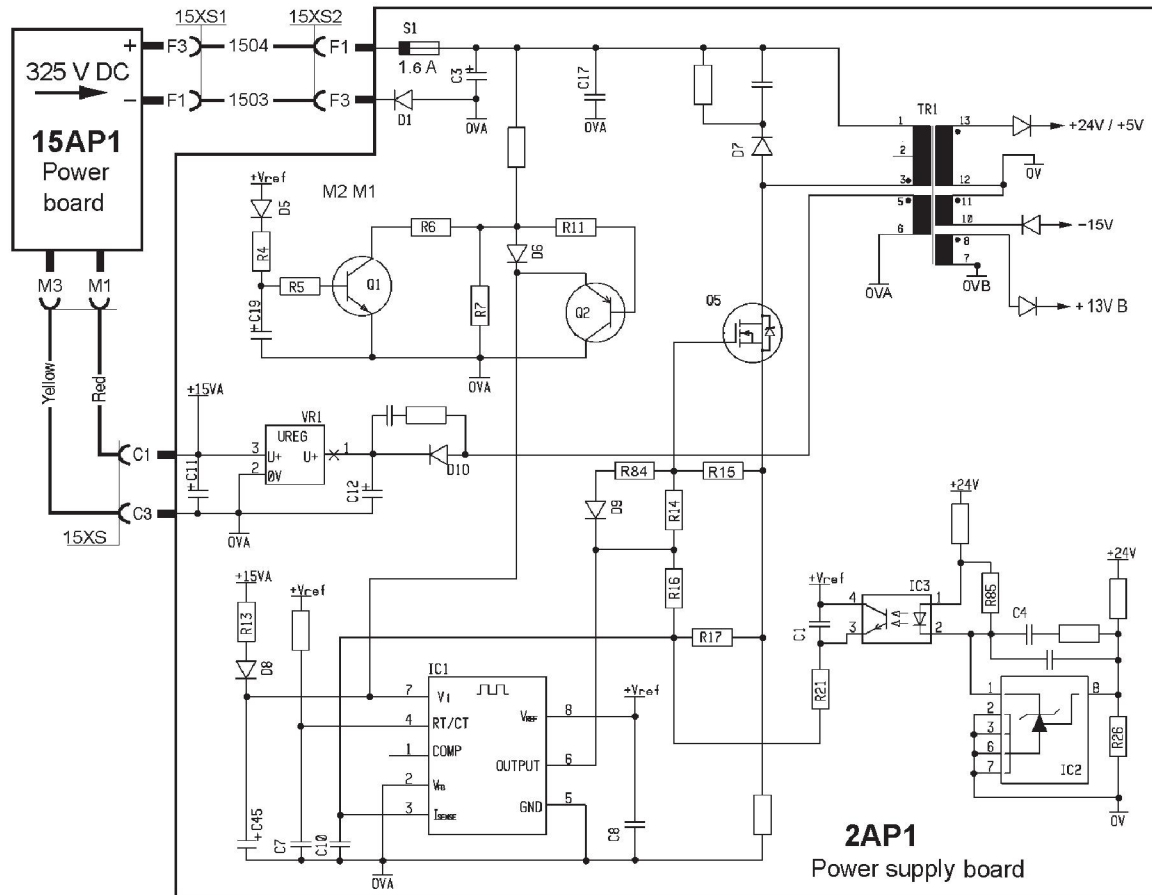


#### **WARNING!**

Dangerous voltage - mains voltage.

The mains voltage is filtered by the power supply board. Power board 15AP1 rectifies the mains voltage. TIG board 10AP1 uses the mains voltage for supply to the HF generator and the gas valve.

## 2AP1:2 Primary circuit



### WARNING!

Dangerous voltage - mains voltage.

The primary circuit is supplied with 325 V DC from the power board, 15AP1. S1 is a fuse with high rupturing capacity.

Transistor Q5 is the switching element in a switched voltage supply. The secondary voltage, +24 V, is sensed by IC2 and controlled by IC1.

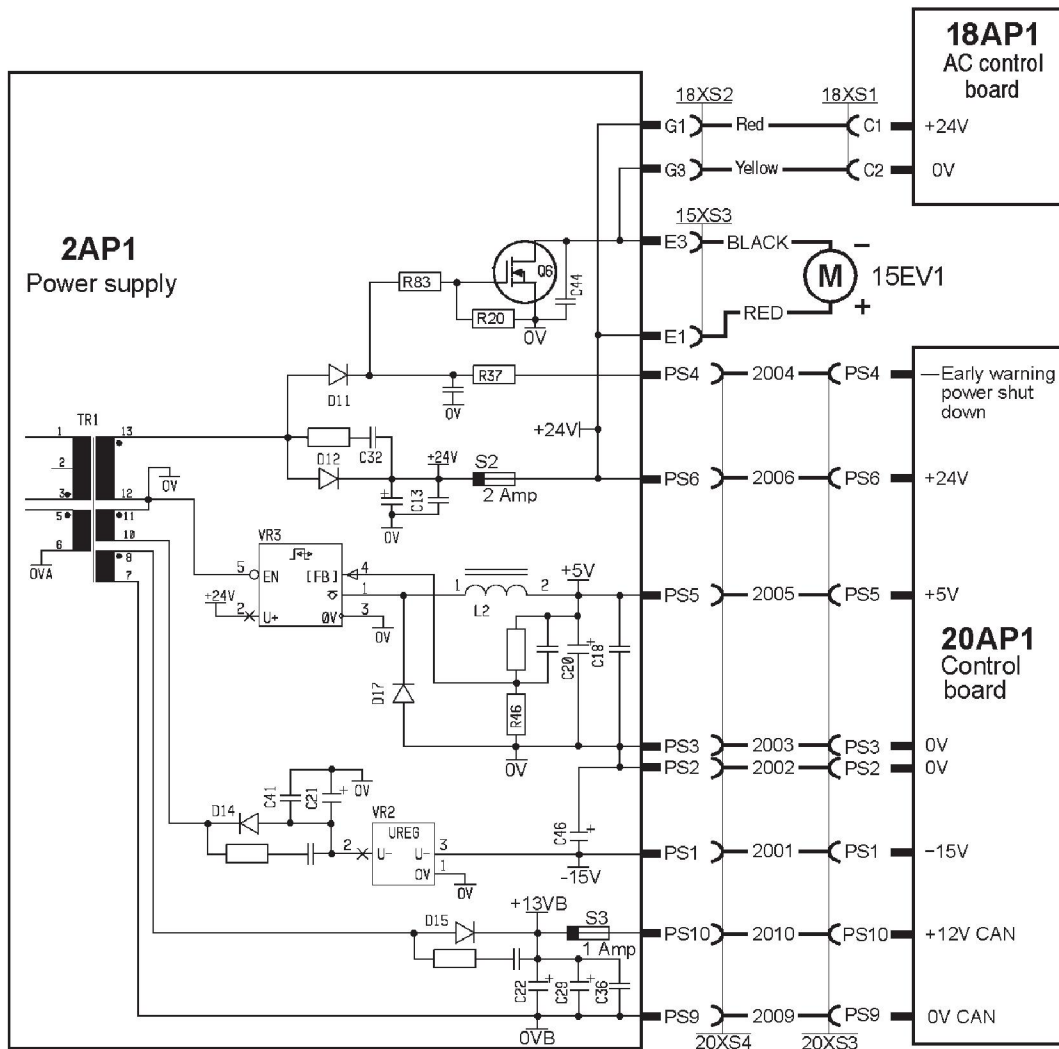
The isolation voltage of transformer T1 and optocoupler IC3 is 4 kV.

### +15V A

Internal power supply to 2AP1 and power supply to the PFC circuits of the power board, 15AP1.

The voltage is controlled by VR1, it has a tolerance of  $\pm 0.75V$ .

## 2AP1:3 Secondary circuit



The secondary circuit delivers the following voltages:

### +24 V

The voltage is controlled by IC1 on the primary side. It has a tolerance of  $\pm 0.6$  V.

### +5 V

The voltage is controlled by VR3. It has a tolerance of  $\pm 0.25$  V.

### -15 V

The voltage is controlled by VR2. It has a tolerance of  $\pm 0.75$  V.

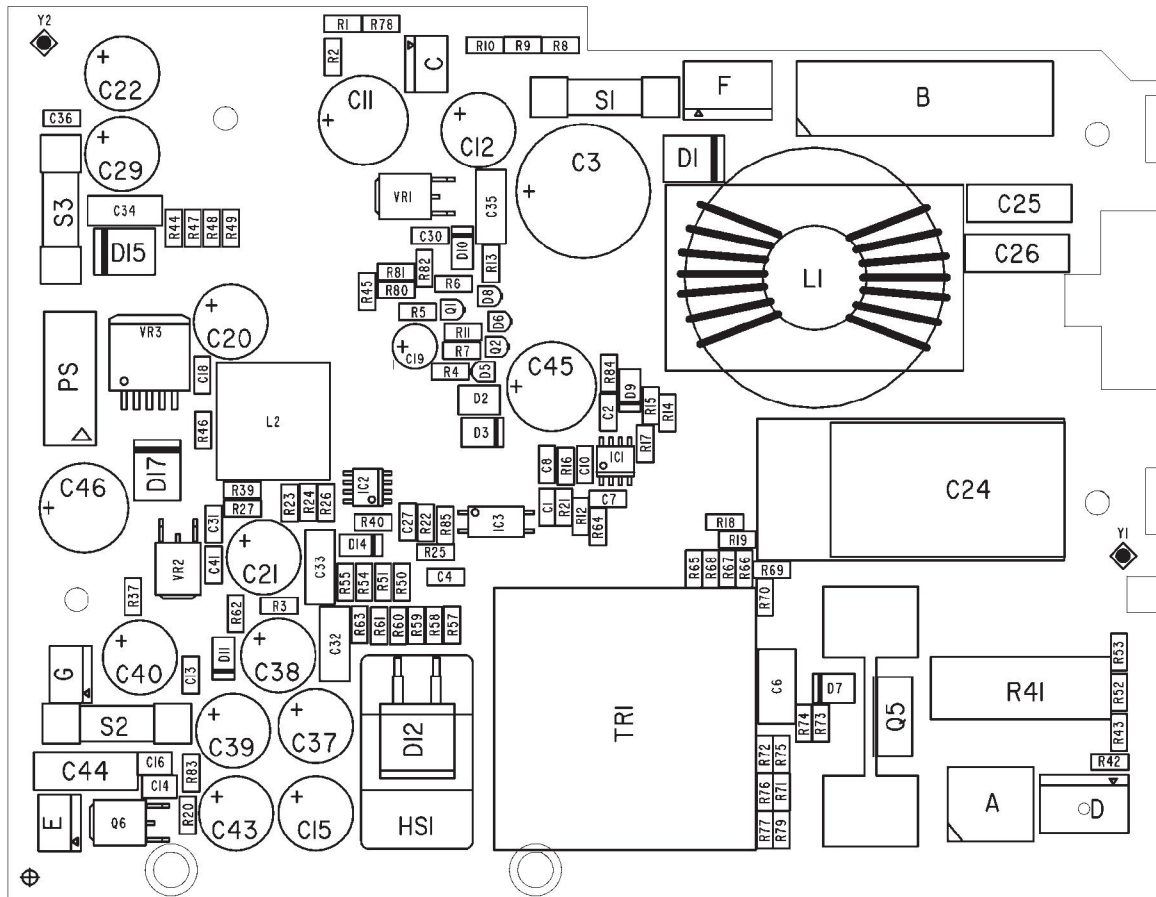
### +13 VB (+12V CAN)

This voltage is unregulated. It has a tolerance of  $\pm 1.5$  V.

### Early warning power shut down

If the voltage goes low, output PS4 generates a warning signal to the processor on circuit board 20AP1 (see section "20AP1 Control Board" in this chapter). Transistor Q6 switches off the fan, 15EV1, at the same time.

## 2AP1 Component positions



### WARNING!

Dangerous voltage - mains voltage.

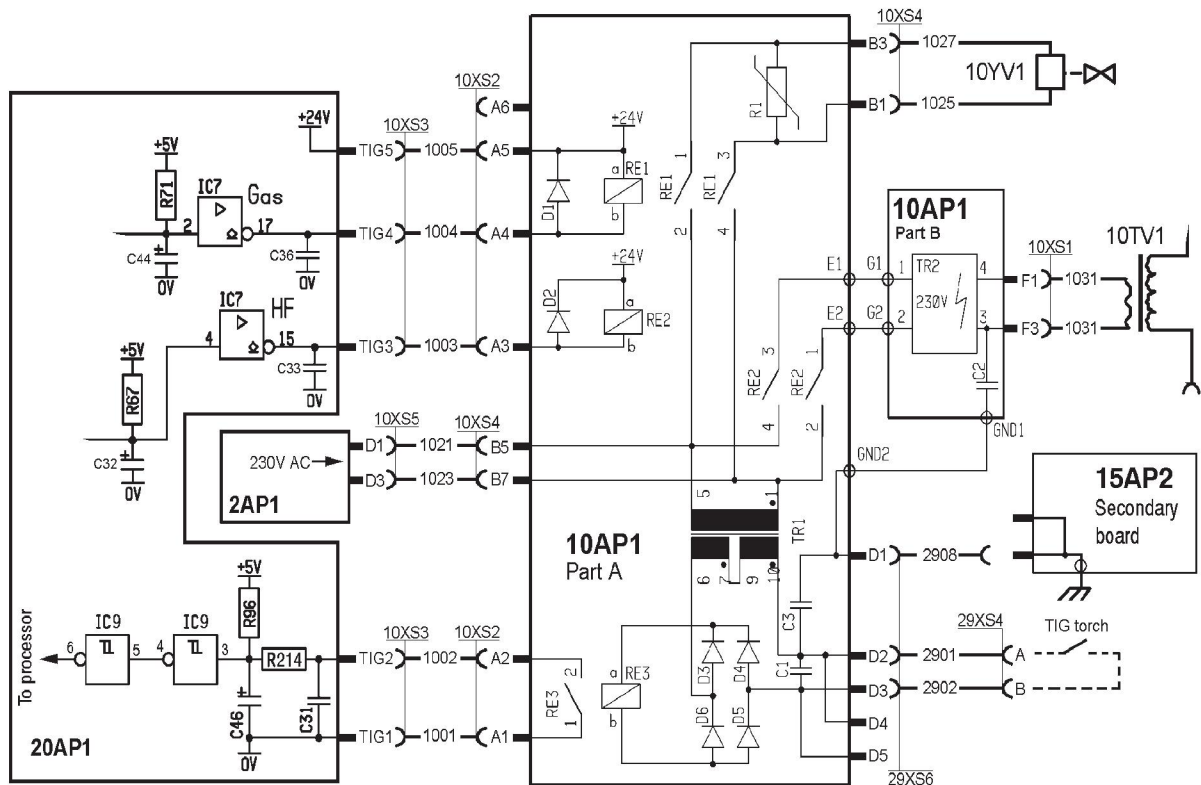
## 10AP1 TIG board



### WARNING!

Dangerous voltage - mains voltage.

The relay contacts, the gas valve 10YV1, the HF generator TR2 and the primary side of transformer TR1 are connected to 230 V mains voltage.



The processor on circuit board 20AP1 controls the HF generator and gas valve.

### HF generator

When the welding torch switch is operated, and the open-circuit voltage is over 50 V, relay RE2 closes and turns on the HF generator, TR2. It remains activated until the arc strikes, or for a maximum of 0.5 seconds.

The voltage on the primary side of HF transformer 10TV1 is about 550 V. The secondary voltage is about 11 kV if a 4 metre long welding torch is connected. If the welding torch is 16 metre long, the HF spark is about 8 kV.

Due to electromagnetic interference regulations, the energy in the HF ignition spark is limited, and so the HF spark weakens with increasing length of the torch. The HF ignition is satisfactory for welding torches up to 16 metres.

### Gas valve

When the torch switch is operated, relay RE1 closes and energizes the gas valve.

When the torch switch is released and the gas post-flow time has elapsed, the gas valve is deactivated.

### TIG torch switch

The secondary windings of transformer TR1 and rectifier bridge D3-D6 produce 24 V DC.

This voltage energizes relay RE3 when the torch switch is closed.

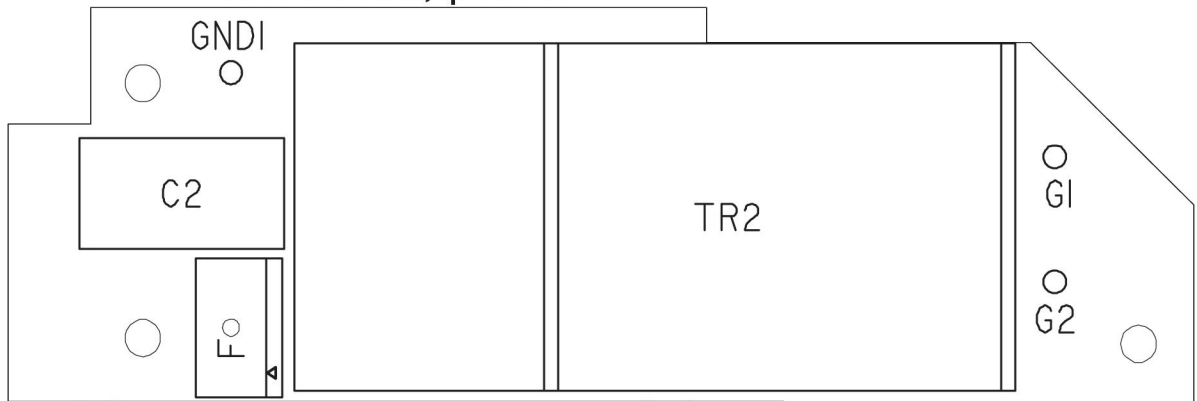
### 10AP1 Component positions



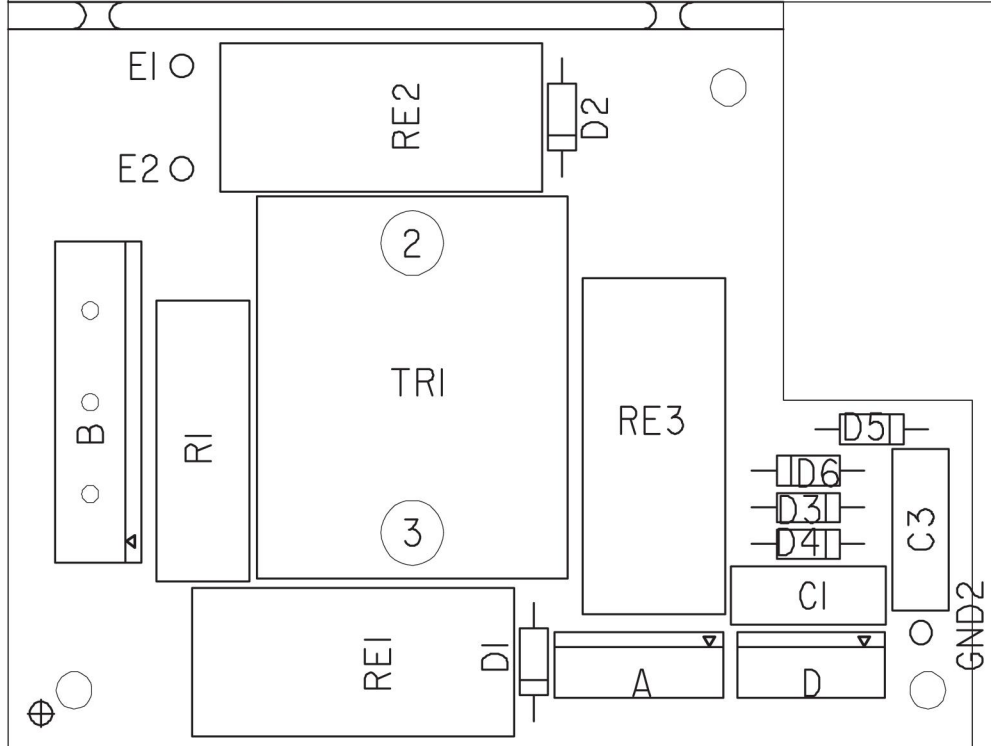
#### WARNING!

Dangerous voltage - mains voltage.

### TIG board, part B



### TIG board, part A



## 15AP1 Power board



### WARNING!

Dangerous voltage - mains voltage.

Never make any measurements on this board when the machine is connected to the mains supply.



### CAUTION!

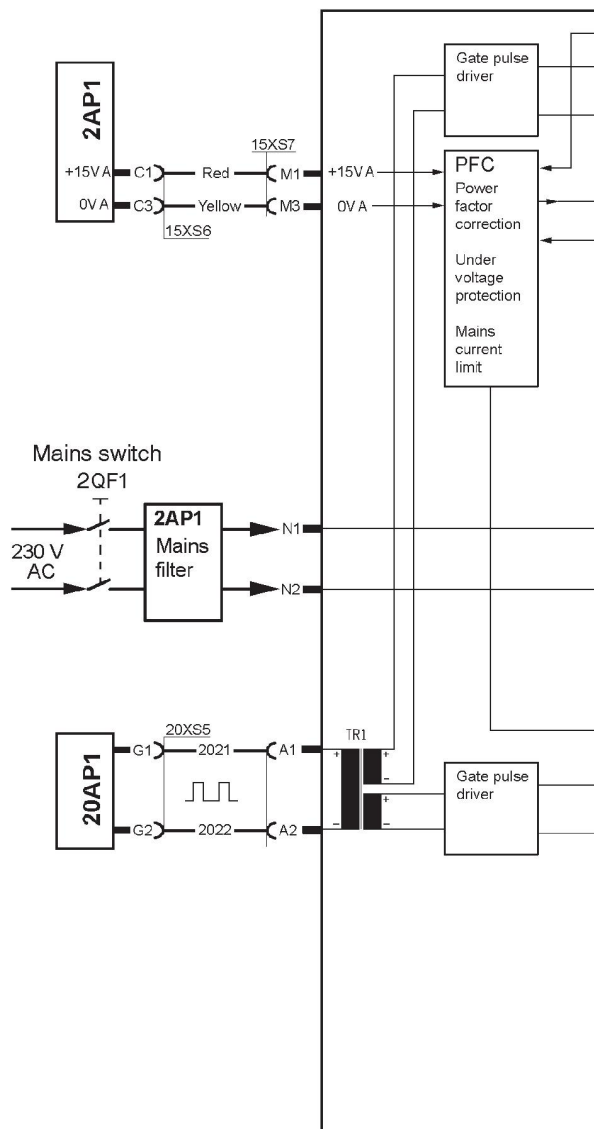
There are different versions of the power board available. See the spare parts list to find the correct spare part for the machine.

The power module is a single forward converter, operating at a switching frequency of 65 kHz. The switch transistors are built into a semiconductor module, PM1. See chapter "Service Instructions" for measurement instructions.

If the power board has failed, a replacement board must be mounted in accordance with the instructions in chapter "Service Instructions".

The power board carries the mains rectifier, the charging circuit, the PFC circuit, the gate circuits and the switching circuits.

The mains rectifier, the switching transistors and parts of the charge and PFC circuits are integrated in a semiconductor module, PM1, which is part of the power board.



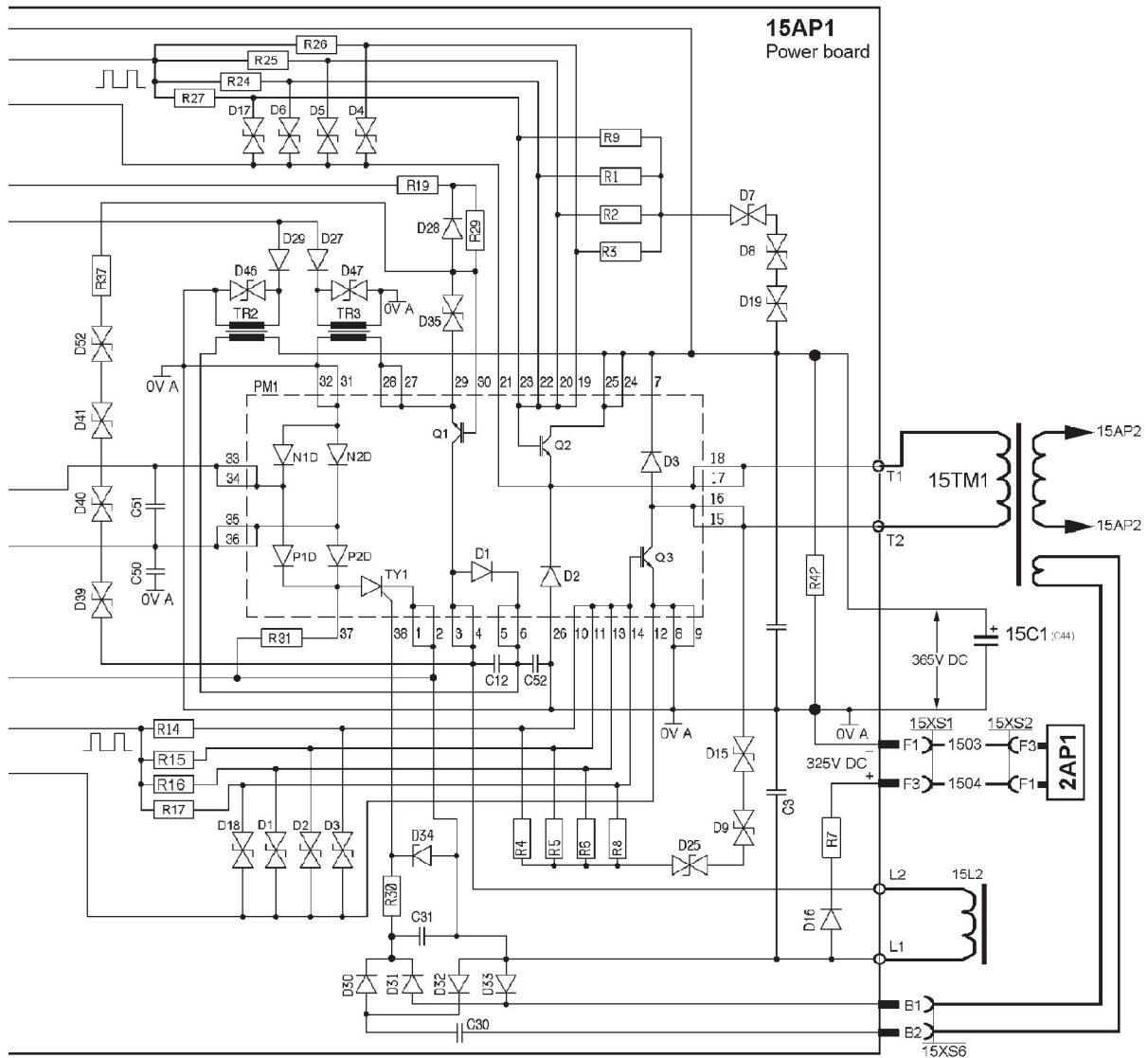
### Charging circuit

When the mains power supply is turned on, the rectified mains voltage charges smoothing capacitor 15C1 via resistor R31. Thyristor TY1 short-circuits charge resistor R31 when the machine is loaded. If TY1 did not conduct, resistor R31 would burn out when the unit is on load.

### Power factor corrector (PFC)

The aim with the power factor corrector is to keep the mains current sinusoidal and in phase with the mains voltage. The PFC circuit holds the intermediate voltage at 365 V. At mains currents above 26 A the PFC does not work, the intermediate voltage is then 325 V or less.

When the PFC is working properly the voltage across capacitor 15C1 is 365 V.



**Gate driver stages**

Transformer TR1 is a gate driver transformer for galvanic isolation of the drive circuits from controller board 20AP1.

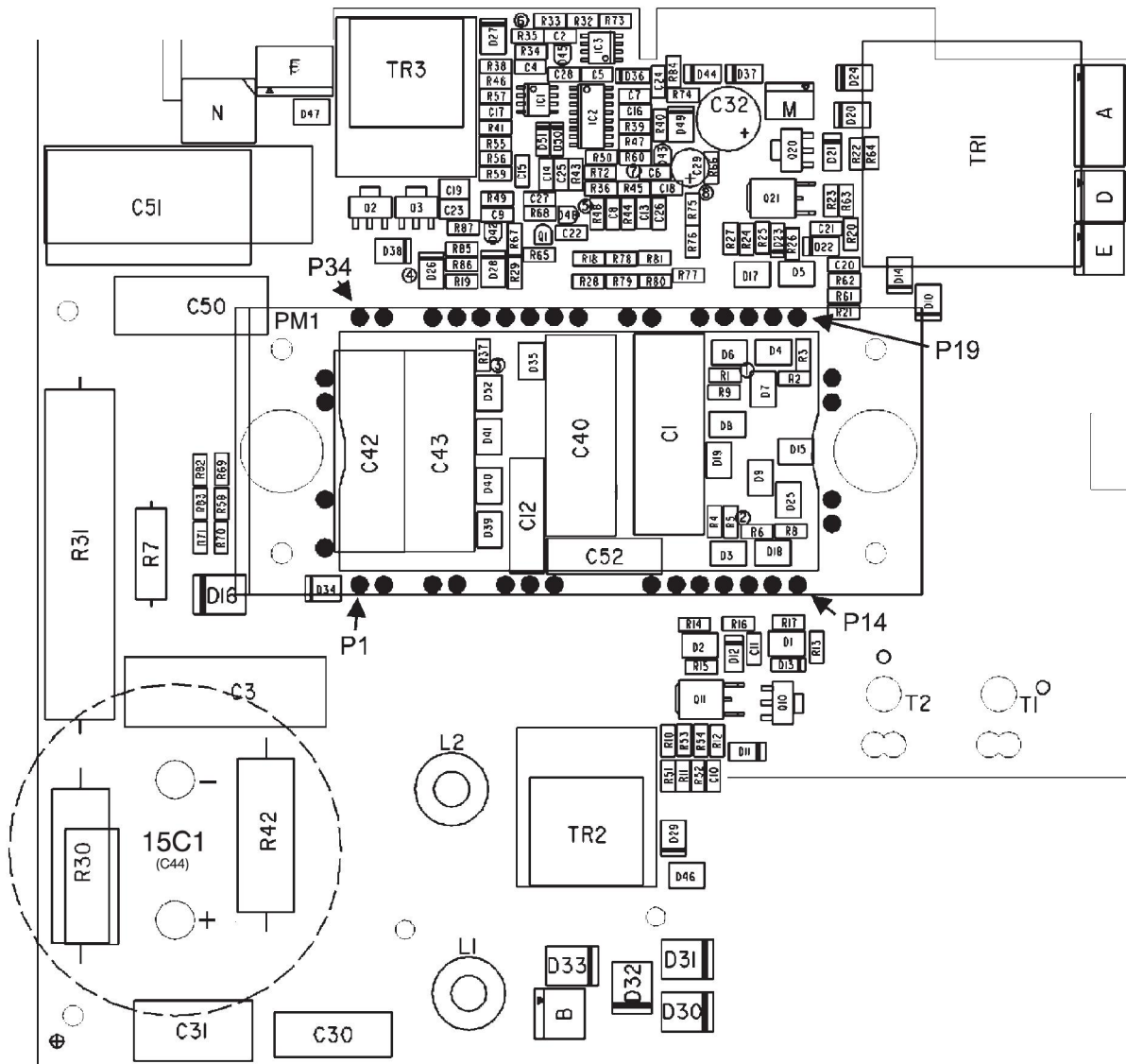
**Switching circuit**

The switching transistors are integrated in the semiconductor module, PM1.

**Supply to 2AP1**

The board supplies power supply board 2AP1 with 325 V DC (pins F1 and F3, connector 15XS1).

### 15AP1 Component positions



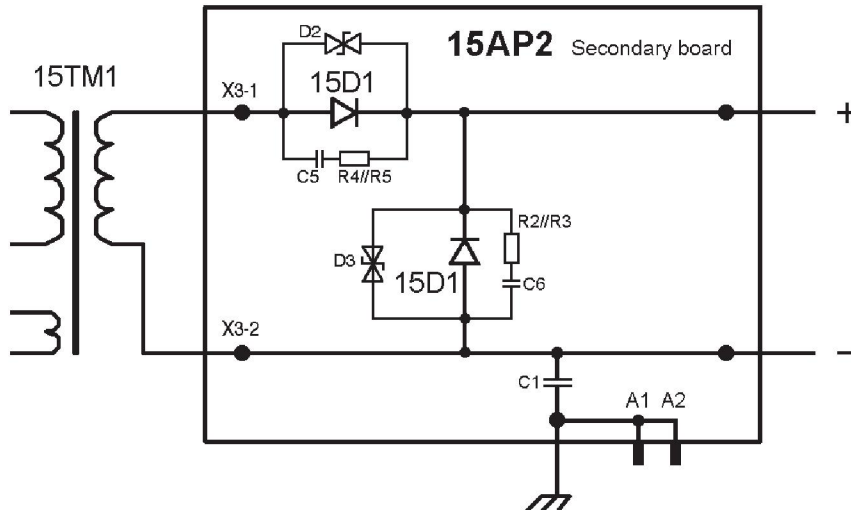
Pin positions of the semiconductor module:

(Seen from the component side of the board).

Pin 1 marked P1 starts in the down-left corner and continuous anticlockwise around the semiconductor module.

### 15AP2 Secondary board

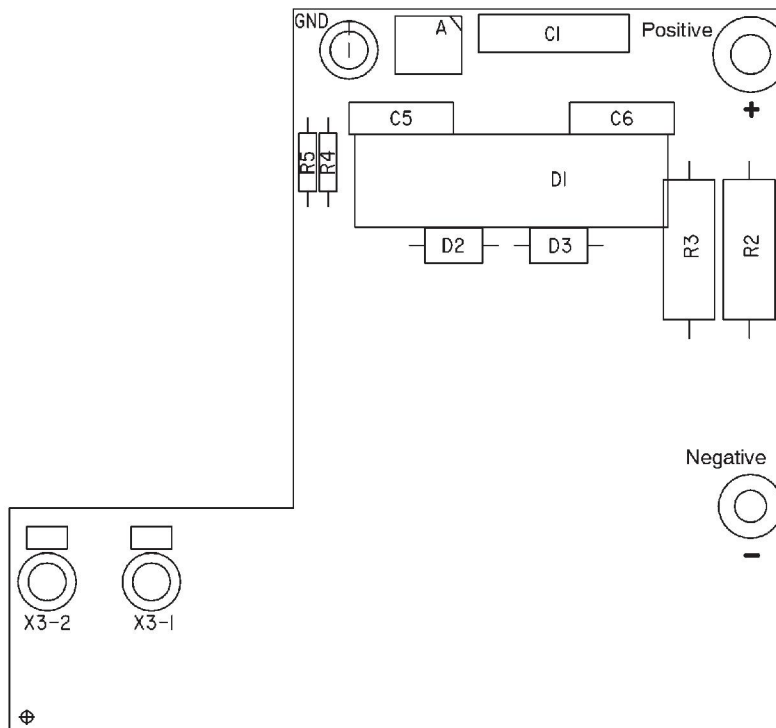
The secondary board is fitted on the main transformer 15TM1, diode module 15D1 and inductor 15L1.



Diode module 15D1 comprises two diodes, rectifier and freewheel diode. During the time interval between two voltage pulses from transformer 15TM1, the freewheel diode maintain the welding current from inductor 15L1.

If the diode module has failed, a replacement module must be fitted in accordance with the instructions in section "Mounting components on the heat sink".

### 15AP2 Component positions



### 18AP1 AC control board

Sections 18AP1:1 to 18AP1:6 refer to the wiring diagram in section "Wiring Diagram".

The processor on the AC control board monitors the temperature in the AC power modules. The AC control commands are generated by the processor on circuit board 20AP1 and executed by the local processor.

### Circuit board identity

The AC control board has a machine ID, a hardware ID and a unit type number. To read this you need the ESAT service kit, see chapter "Service Instructions".

- The machine ID determines which type of power source the board is intended for.
- The hardware ID shows design and type of circuit board.
- The unit type is used for identification on the can bus.

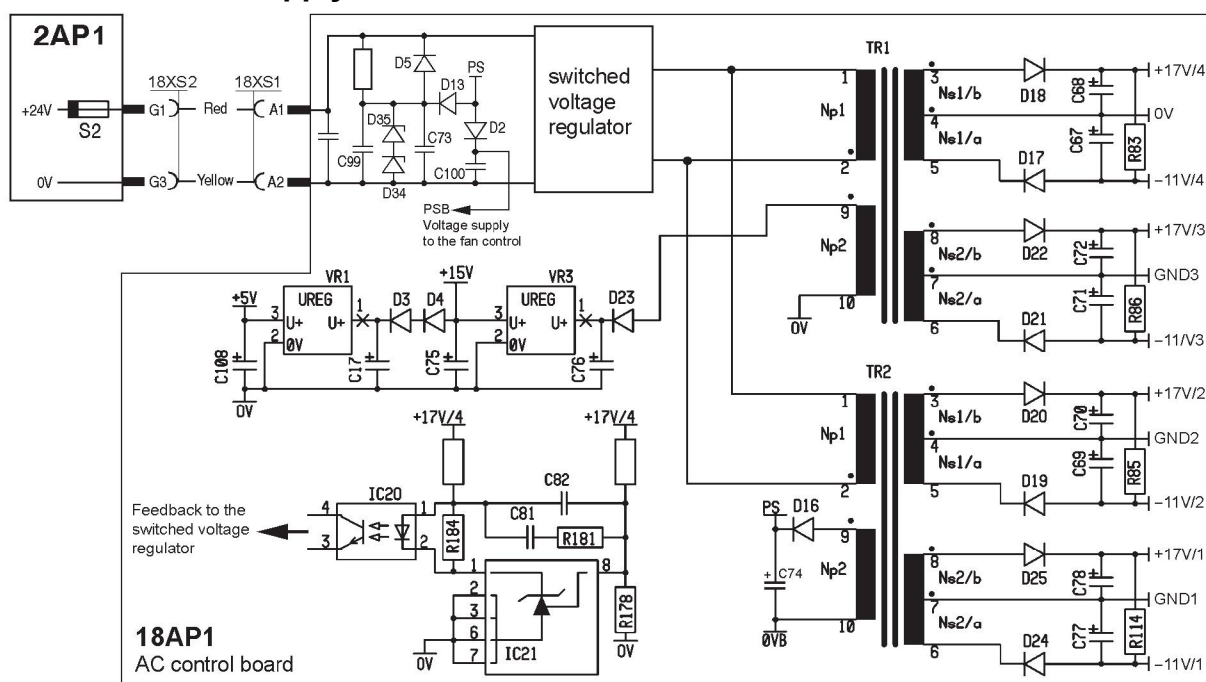
The ID numbers of this board are:

Machine ID = 1

Hardware ID = 1

Unit type = 5

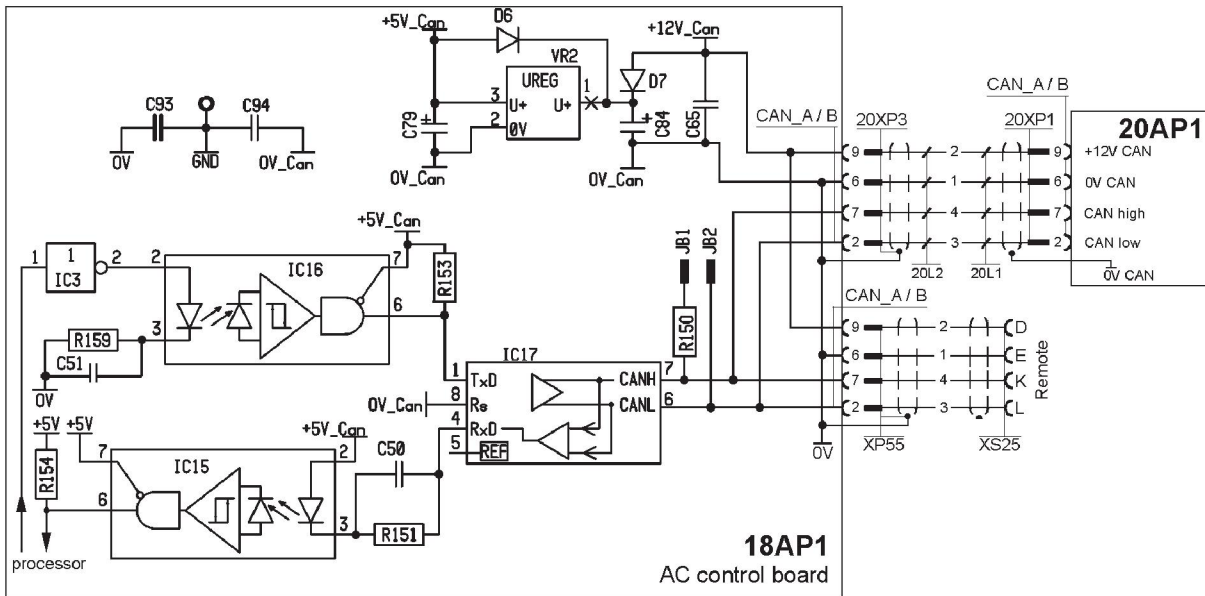
### 18AP1:1 Power supply



The AC control board comprises a switched voltage regulator. This is used in order to provide galvanic separation of the IGBT drive voltages, 4 x 17 V and 4 x -11 V. The voltages can be tested by checking the gate signals to the AC power board, see chapter "Service Instructions". If the -11 volt is outside the limits 10.45 to 11.55 V, fault code 9 is displayed.

The +5 V and +15 V are used for internal power supply on the board. If the +5 V is outside the limits 4.75 to 5.25 V, fault code 4 is displayed. If the +15 V is outside the limits 14.25 to 15.75 V, fault code 8 is displayed. Measuring points are shown in section "18AP1 Component Positions".

**18AP1:2 CAN bus**



*Bus communication circuits*

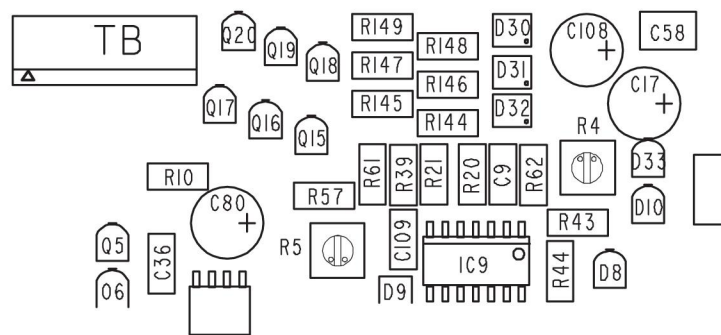
The circuit board includes a driver for the CAN bus, IC17, which handles the communication with the other units of the system.

**Starting sequence**

On power-up, the board's CAN controller reads the bus speed from the micro processor: 400 kbit/s.

The light-emitting diodes D30, D31 and D32 displays the starting sequence from power-up: D30 lights red. Then D30, D31 and D32 lights green.

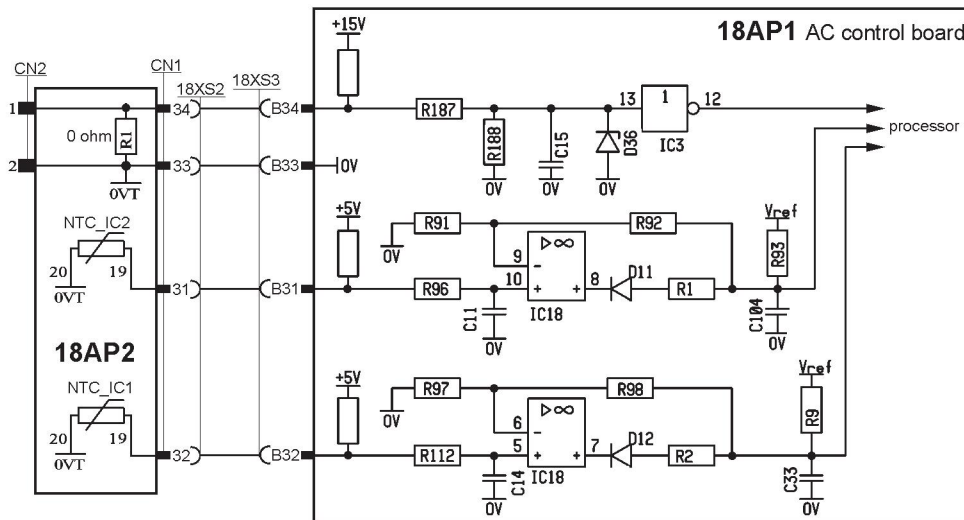
When the board has been initiated, and the power source is in the application program, D30 flashes continuously with a green light.



*LEDs D30, D31 and D32 on circuit board 18AP1*

Read more about the CAN bus in section "20AP1:2 The CAN bus".

### 18AP1:3 Temperature monitoring



Principle diagram of the temperature monitoring circuits

The temperature monitoring circuit senses the temperature of the IGBT modules, IC1 and IC2, that are fitted to circuit board 18AP2. Two NTC resistors, NTC\_IC1 and NTC\_IC2, are used as sensors.

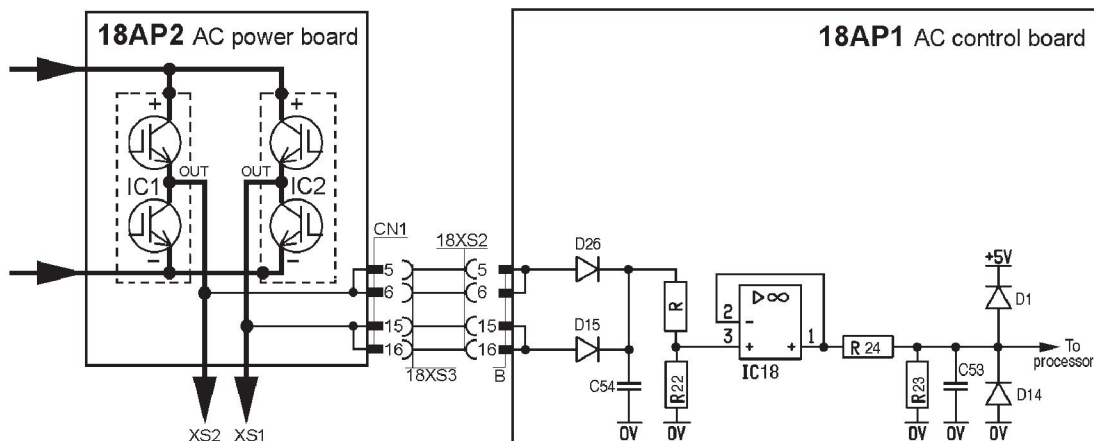
The output of the monitoring circuit is sensed by the processor, which in turn stops the machine if overtemperature occurs.

If the temperature exceeds 110°C the power source is stopped. It cannot be restarted until the temperature is below 55°C.

If overtemperature is sensed by NTC\_IC1, fault code 7 is displayed and if overtemperature is sensed by NTC\_IC2, fault code 6 is displayed.

To check the NTC resistors: see section "Checking the gate signals to AC power board 18AP2".

### 18AP1:4 Arc voltage monitoring

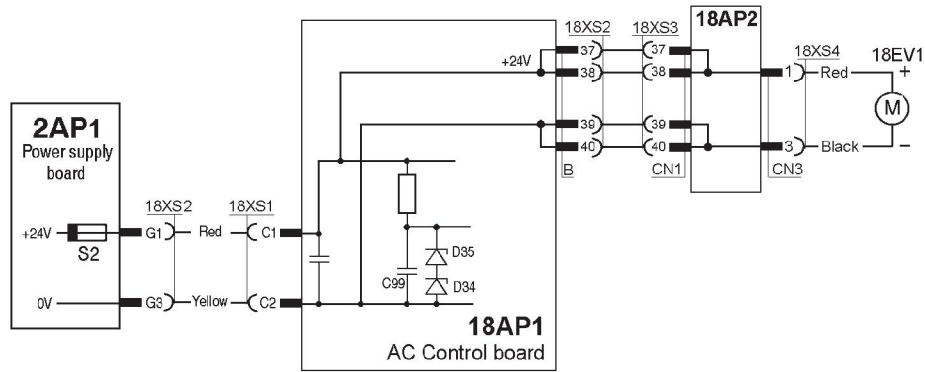


The arc voltage monitoring circuits measures the output voltage from the power source. The voltage is displayed by the control panel.

See section "Calibration of the arc voltage display" for calibrating instructions.

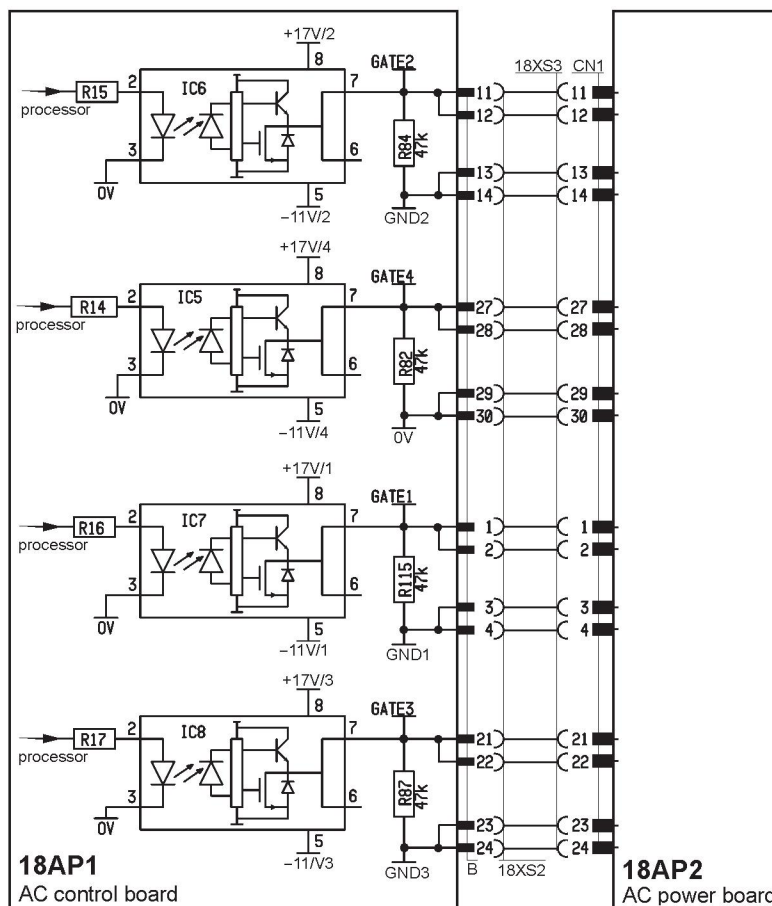
The welding process control and no-load voltage reduction are maintained by circuit board 20AP1, see section "20AP1:7 Arc voltage feedback".

### 18AP1:5 Fan power supply



The fan is supplied at 24 V DC from the power supply board,

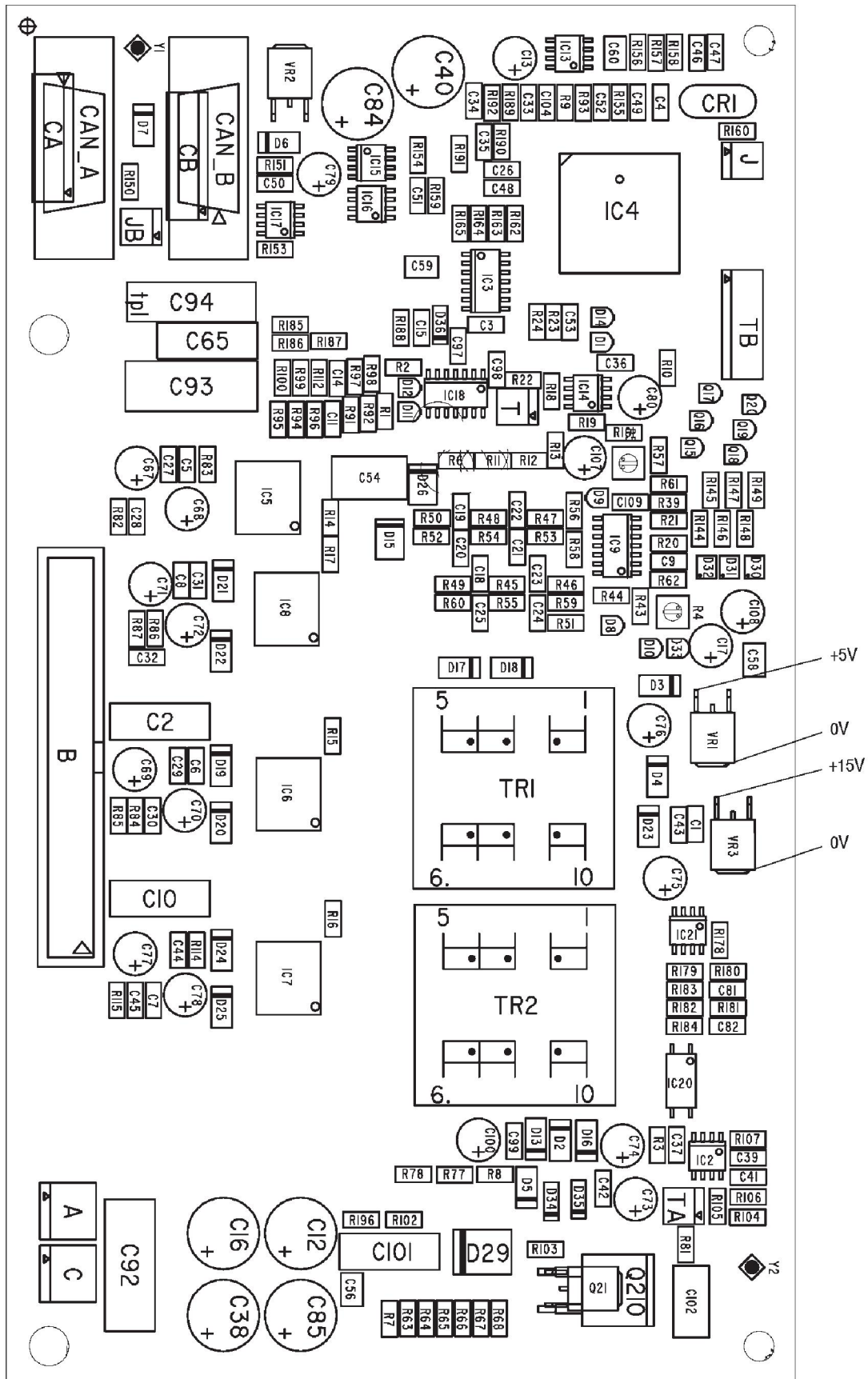
### 18AP1:6 Switch driver



See also 18AP2:1 Switching circuits in section "18AP1 Component positions".

The gate signals can be measured on circuit board 18AP2. See section "Checking the gate signals to AC power board 18AP2" for test instructions.

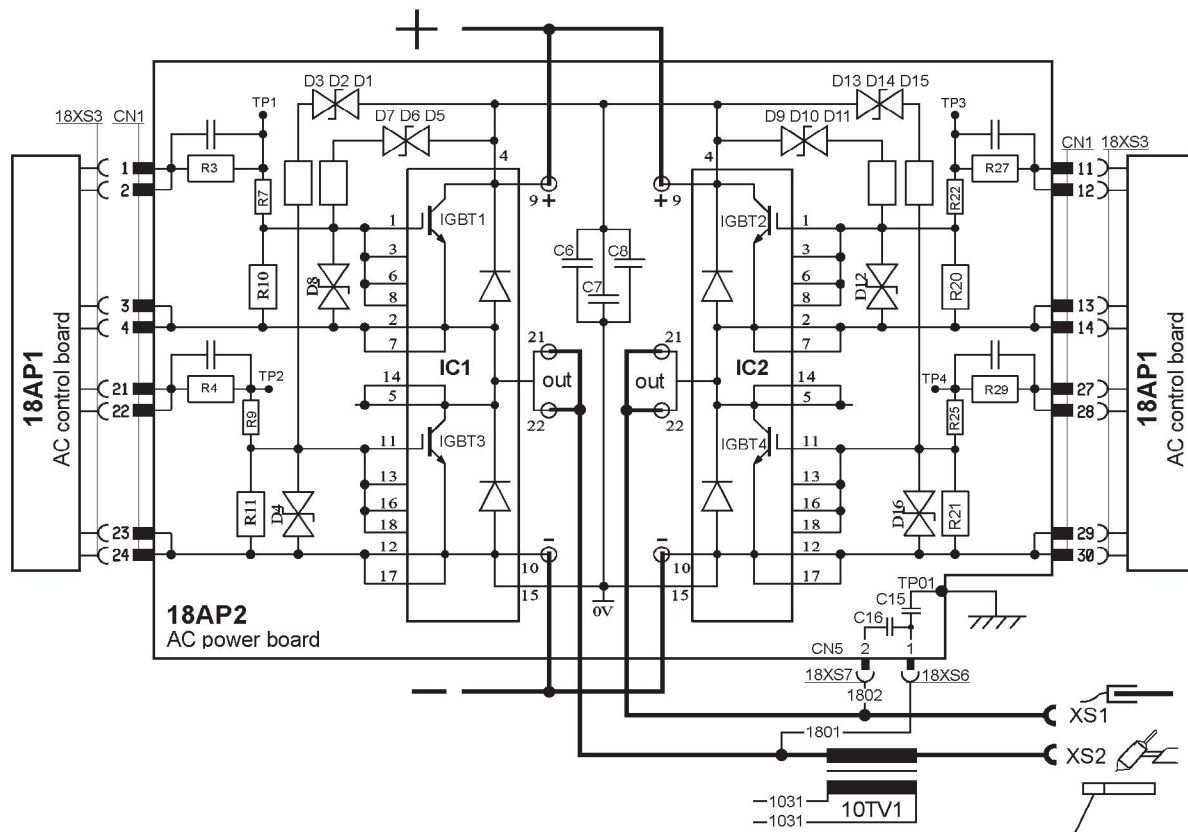
### 18AP1 Component positions



### 18AP2 AC power board

Sections 18AP2:1 to 18AP2:3 refer to the section "Wiring Diagram".

## 18AP2:1 Switching circuits



The circuit board carries two IGBT modules IC1 and IC2, with 2 IGBTs each. In the description below the IGBTs are named IGBT1, IGBT2, IGBT3 and IGBT4. The IGBTs are controlled by the processor.

All IGBTs are conducting during the starting sequence of the power source (mains switch power on).

### MMA

IGBT1 and IGBT4 are conducting.(positive electrode).

If MMA with negative electrode is selected, IGBT2 and IGBT3 are conducting.

### TIG DC

When welding start is activated IGBT1 and IGBT4 conducts.(positive electrode).

During welding IGBT2 and IGBT3 are conducting (negative electrode).

### TIG AC

When welding start is activated IGBT1 and IGBT4 conducts.

During welding IGBT1 and IGBT4 conducts in turns with IGBT2 and IGBT3.

### IGBT gate signals

The IGBT gate signals can be measured across varistors D4, D8, D12 and D16. See section "Checking the gate signals to AC power board 18AP2" for test instructions.

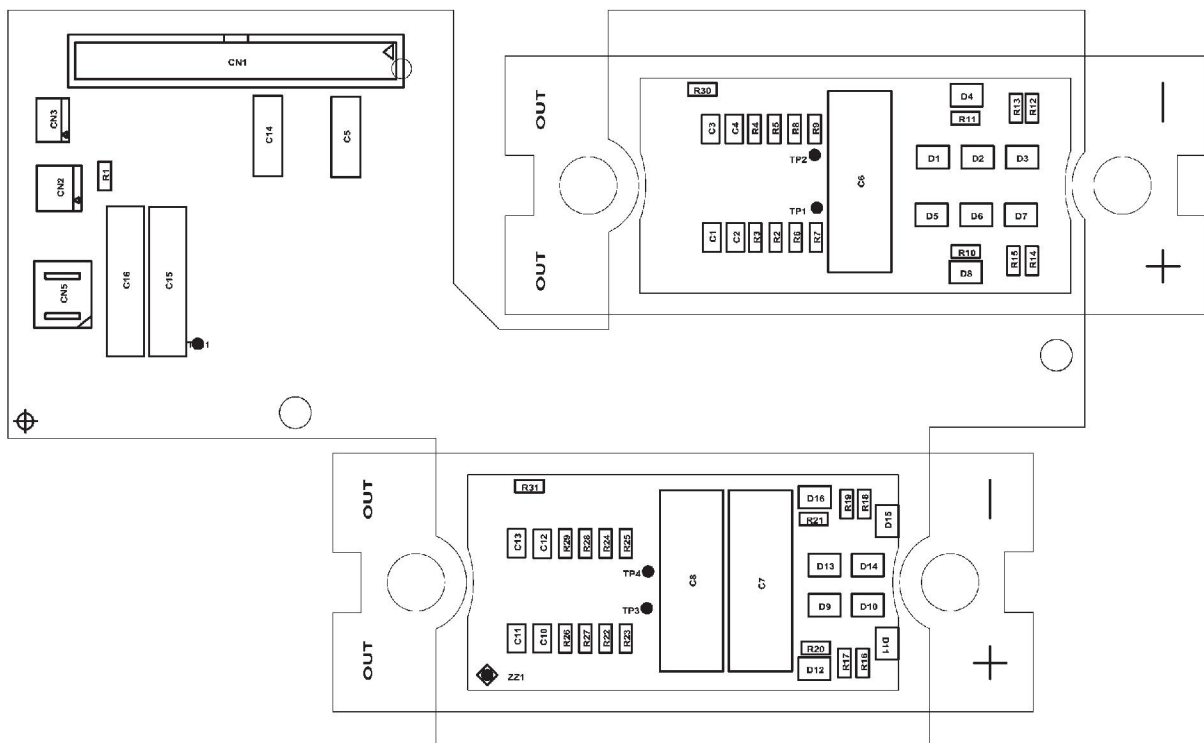
## 18AP2:2 Temperature monitoring

See 18AP1:3 in section "18AP1:3 Temperature monitoring".

## 18AP2:3 Fan power supply

See 18AP1:5 in section "18AP1:5 Fan power supply".

## 18AP2 Component positions



## 20AP1 Control board

The processor on the control board monitors and controls the various functions of the power source.

The control board is used in combi mode. In combi mode the board handles the control of the power source, the welding data unit and the MMC panel.

If the circuit board is faulty, it must be replaced. After replacing the circuit board, soft-start the machine. See the instructions in chapter "Service Instructions".

### Circuit board identity

#### Power source unit

The control board has a machine ID, a hardware ID and a unit type number. To read this you need the ESAT service kit, see chapter "Service Instructions".

- The machine ID defines which type of power source the board is intended for.
- The hardware ID shows design and type of circuit board.
- The unit type is used for identification on the CAN bus.

The ID numbers of the Tig 2200i AC/DC are:

Machine ID = 34

Hardware ID = 4

Unit type = 2

#### Welding data unit and MMC

The machine ID for the MMC part of the control board determines which type of control panel that is used. The machine ID can be changed by ESAT.

The ID numbers of the different control panels are:

TA33 AC/DC machine ID = 23

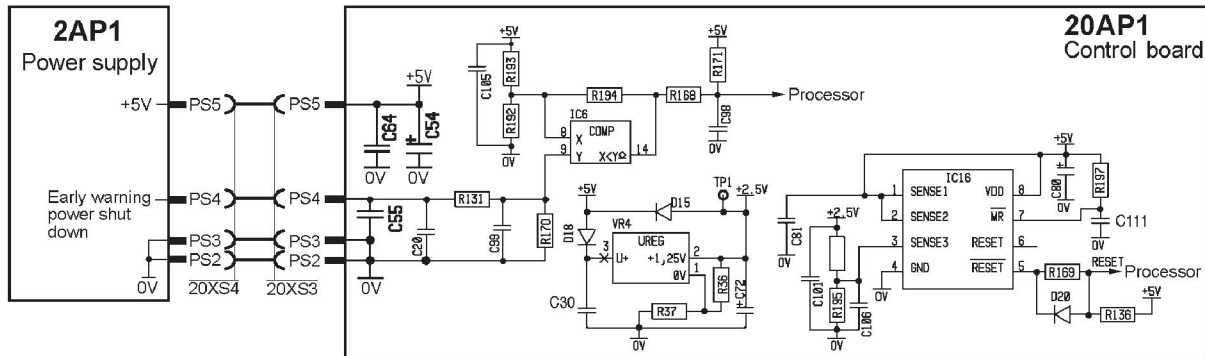
TA34 AC/DC machine ID = 19

Hardware ID = 4

Unit type = 0

### 20AP1:1 Power supply

#### +5V and +2.5V

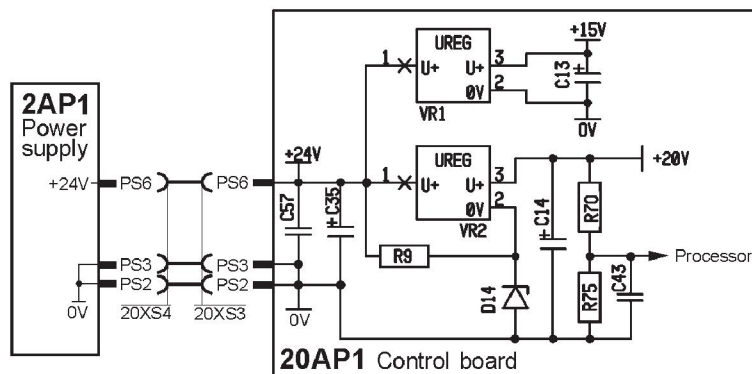


IC6 monitors the 24 V voltage supply to the 5 V regulator on circuit board 2AP1. IC16 monitors the 5 and 2.5 V supplies. Regulator VR4 supplies the processor with +2.5 V.

The voltage on terminal PS4 is normally about 24 V, when this drops below 20 V, pin 14 of IC6 goes low, providing the processor with a low power supply voltage signal. The processor then stores current data and generates fault code E4. When the 5 and 2.5 V voltages are passing below their treshhold values, the processor receives a reset signal from IC16.

Fault code E4 is not displayed at normal power off.

#### +15V and +20V

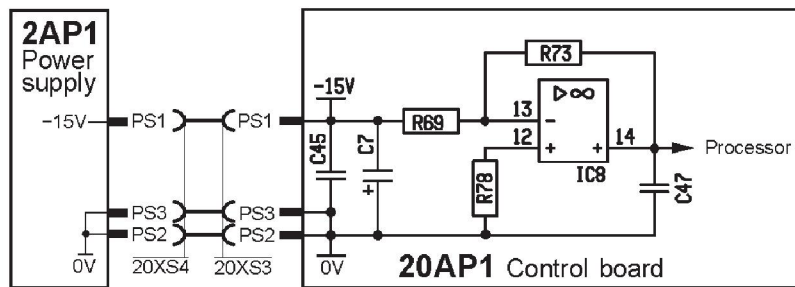


Voltage regulator VR2 produces an output voltage of +20 ±1.0 V, which supplies the pulse width modulator output stage.

Potential divider R70/R75 supplies 2.6 V to the processor. This provides a signal that the power supply is available.

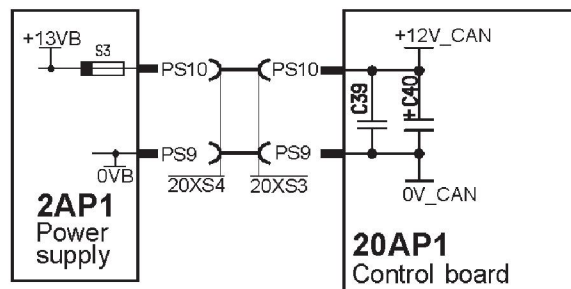
Voltage regulator VR1 produces an output voltage of +15 V, and this, together with the -15 V supply, powers the analogue circuits.

**-15V**



The -15 V power supply is monitored by the processor.

**+12 V\_CAN**

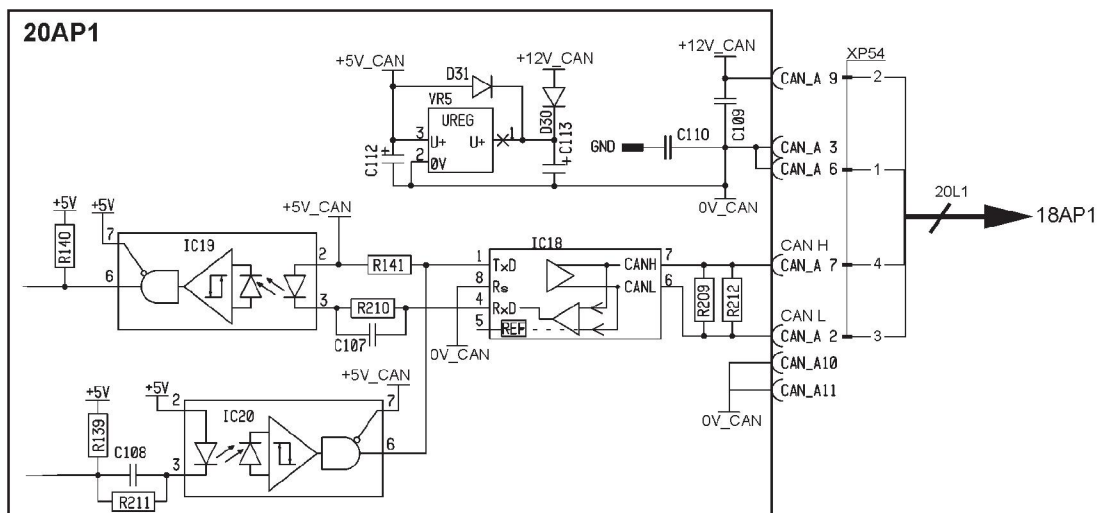


The +13VB from 2AP1 is used to supply the CAN circuits of the equipment.

This supply is referred to as + 12V\_CAN, its neutral point, 0V\_CAN, is separated from the electronic neutral (0 V).

The tolerance of the voltage is 11.5 to 14.5 V.

**20AP1:2 The CAN bus**



*Bus communication circuits to and from the control board*

A standardised communication (CAN - **C**ontroller **A**rea **N**etwork) bus is used for communication between the units of the machine. Communication speed is 400 kbit/s.

The +12V\_CAN and 0V\_CAN power supply is unregulated and is galvanically isolated from other parts of the control board.

The shell of the CAN-connectors and the shield of the CAN cables are connected to 0V\_CAN.

GND in the diagram is connected to the power source chassis.

Voltage regulator VR5 supplies a 5 V power supply to the CAN circuits on 20AP1.

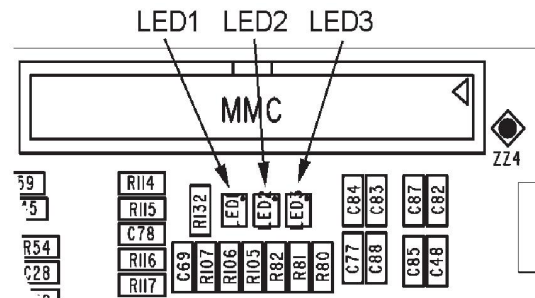
### Starting sequence

On power-up, the board's CAN controller reads in the bus speed from the micro processor: 400 kbit/s.

The circuit board displays the starting sequence from power-up.

LED1 lights red. Then LED1, LED2 and LED3 lights green.

When the board has been initiated, and the power source is in the application program, LED1 flashes continuously with a green light.



LEDs on circuit board 20AP1

### Communication interruptions

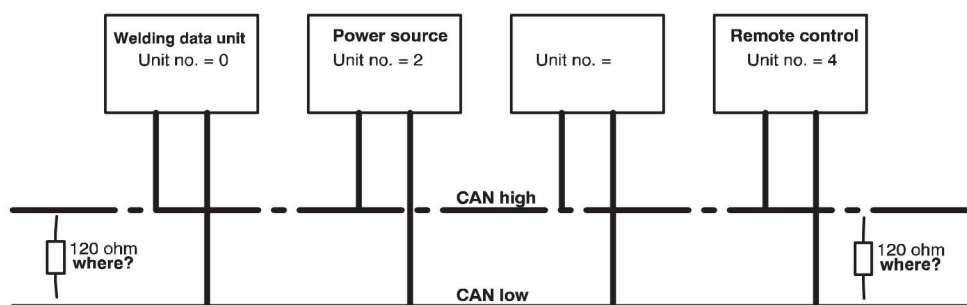
If the CAN bus fails, the control panel will normally generate a fault message.

Check the following points in the event of problems with CAN communications:

- The terminating resistor. The CAN bus resistance must lie in the range 50-130 ohm: the optimum value is 60 ohm. To check the resistance, turn off the power source and measure the resistance between pins L and K in connector socket XS25.
- All screen connections must be sound. Measure the resistance between the shell of the CAN connector connected to 20AP1 and the shell of CAN connector XP55 connected to 18AP1. There must be a short circuit between those two end points.
- Good contact with the chassis connections from/to the circuit boards and suppressor capacitors. See the main circuit diagram.
- The connection cable between units. Check that the correct type of cable is being used. Check that each signal is being carried by the correct core. CAN H and CAN L must be carried by the twinned pair.

### Terminating resistors

In order to avoid communication interference, the ends of the CAN bus must be terminated by resistive loads.

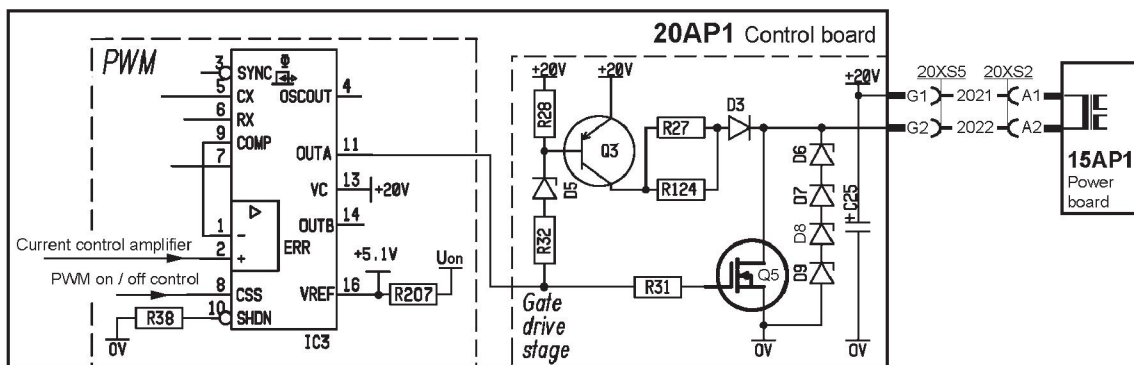


Principle diagram of the CAN bus and connecting up of the terminating resistors

### 20AP1:3 Control panel interface circuits

See the service manual for the TA33 AC/DC and TA34 AC/DC control panels, filename: 0740 800 180.

### 20AP1:4 Pulse width modulator

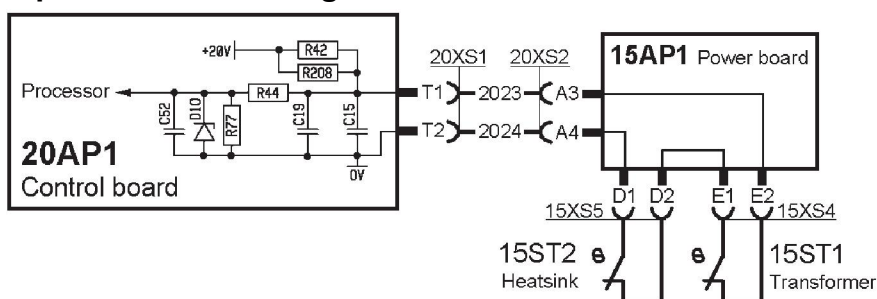


The pulse width modulator determines the frequency and pulse time of the switching transistors' control pulses. IC3 controls the pulse frequency, the pulse time and inhibition of pulses.

The pulse frequency is 65 kHz +/- 1kHz, with a maximum pulse width of 43 - 44 % of the cycle width. See chapter "Service Instructions" for screen traces of waveforms and measurement instructions.

Transistor Q5 controls the primary winding of the pulse transformer on circuit board 15AP1.

### 20AP1:5 Temperature monitoring



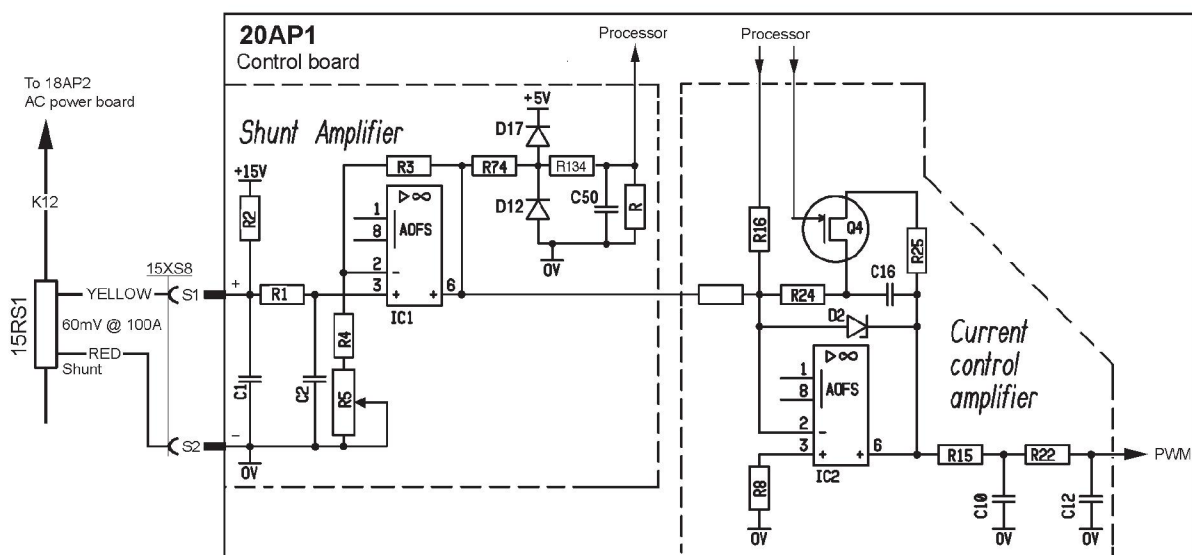
The thermal overload switches, 15ST1 and 15ST2, are normally closed. Terminal T2 of the circuit board is at 0 V.

15ST2, which is fitted on the heat sink, opens at 75 °C. 15ST1, which is fitted in the winding of the main transformer, 15TM1, opens at 130 °C.

If either of the switches operates, the power source is stopped, fault code E06 is displayed.

The power source cannot be restarted until it has cooled sufficiently for the switch(es) to reclose.

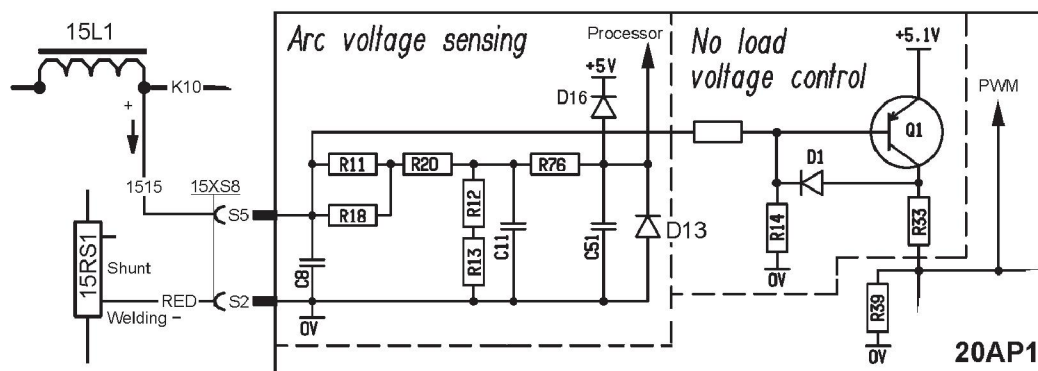
## 20AP1:6 Shunt and current control amplifier



The shunt produces 60 mV at a welding current of 100 A. The shunt response is linear to the welding current.

If the shunt is not connected to the circuit board, resistor R2 supplies about 1.4 to 1.9 V to the shunt input. This blocks the current control amplifier, i.e. the machine does not deliver any welding current.

## 20AP1:7 Arc voltage feedback



This circuit measures and scales the arc voltage to a suitable level for the processor. 64 V arc voltage produces a voltage signal of 5.0 V at the cathode of diode D13. This signal is used as an input to the welding process controller.

The arc voltage signal for the display panel is provided from the welding current outlets. See '18AP1:4 Arc voltage monitoring' on page 22 and calibration instruction in chapter "Service Instructions".

### Open-circuit voltage control

*Version 1 of 20AP1:*

The open-circuit voltage control holds the voltage at about 70 V.

*Version 2 of 20AP1:*

The open-circuit voltage control holds the voltage at 46 - 60 V.

When the VRD (voltage-reducing device) function is active, the open-circuit voltage is < 35 V (19 - 26 V). The VRD function can only be activated or deactivated by the ESAT, see chapter "Service Instructions".

**NOTE!**

Spare part boards are delivered with the VRD function deactivated.

See the component positions diagram in section "20AP1 Component positions" for identification of circuit board versions.

**TIG**

The open-circuit voltage is about 90 V. Arc voltages above 45 V are defined as no welding. Output voltage is produced only when TIG welding is in progress. If the open-circuit voltage/arc voltage is above 45 V for more than 100 milliseconds the open-circuit voltage control is activated and then the output voltage is shut down.

**MMA**

- The machine generates the actual open-circuit voltage, see: "Open-circuit voltage control" above.
- Touch the electrode on to the workpiece. When the open-circuit voltage goes below 45 V (16 V when VRD is active), the open-circuit voltage control is disabled.
- When the current exceeds 8 A the hot start current is activated.
- When the arc voltage exceeds 52 V, welding stops and the open-circuit voltage control is activated.

**20AP1:8 TIG functions****LiftArc TIG start**

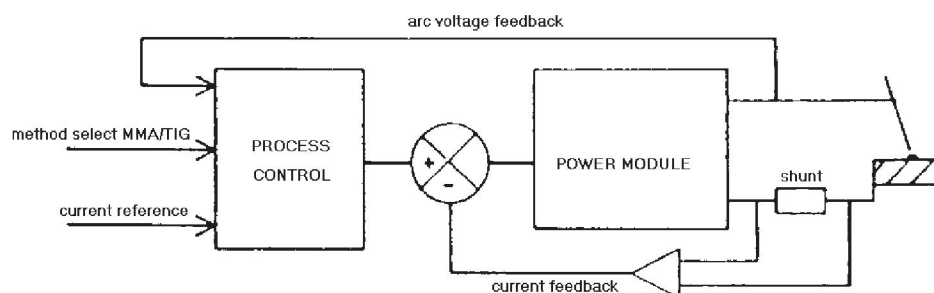
- Touch the electrode on to the workpiece.
- Press the torch trigger. The machine produces a current of about 6 A.
- Lift the electrode from the workpiece. The arc strikes and the current increases to 30 A.
- When the arc voltage exceeds 8 V, the current increases / decreases to the set current.

**HF TIG start**

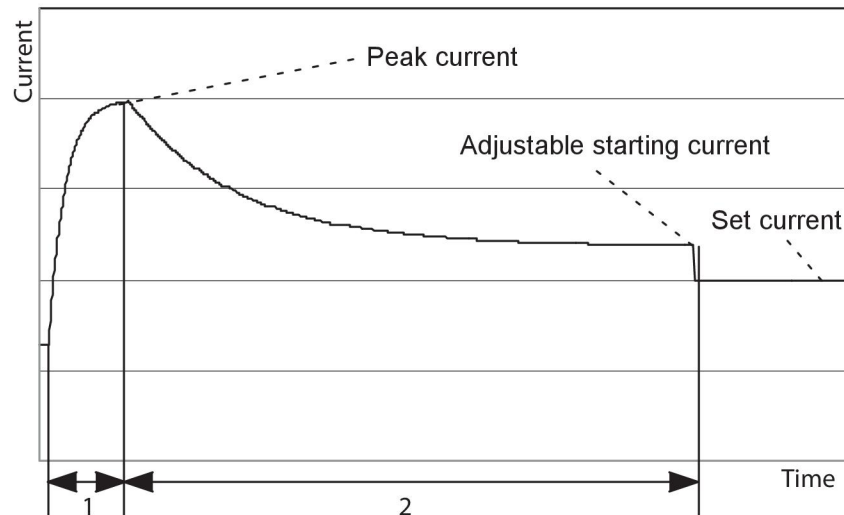
See: section "10AP1 TIG board".

**20AP1:9 Welding process control**

The processor inputs are the set values of welding data and the arc voltage. The processor also calculates a set value signal for welding current, and supplies this to the current control amplifier.



*The process regulator control principle*

**Hot start MMA****Starting current, MMA welding mode**

1. Phase 1, fixed starting current depending on the set current.
2. Phase 2, hot start = adjustable starting current.

**MMA normal welding mode**

In the MMA normal welding mode, the welding current is briefly increased at the start of welding. The peak current, phase 1 in the diagram above, is engaged for 150 milliseconds.

The peak current is twice the normal welding current up to 150 A (i.e. twice the set value), subject to a maximum of 240 A.

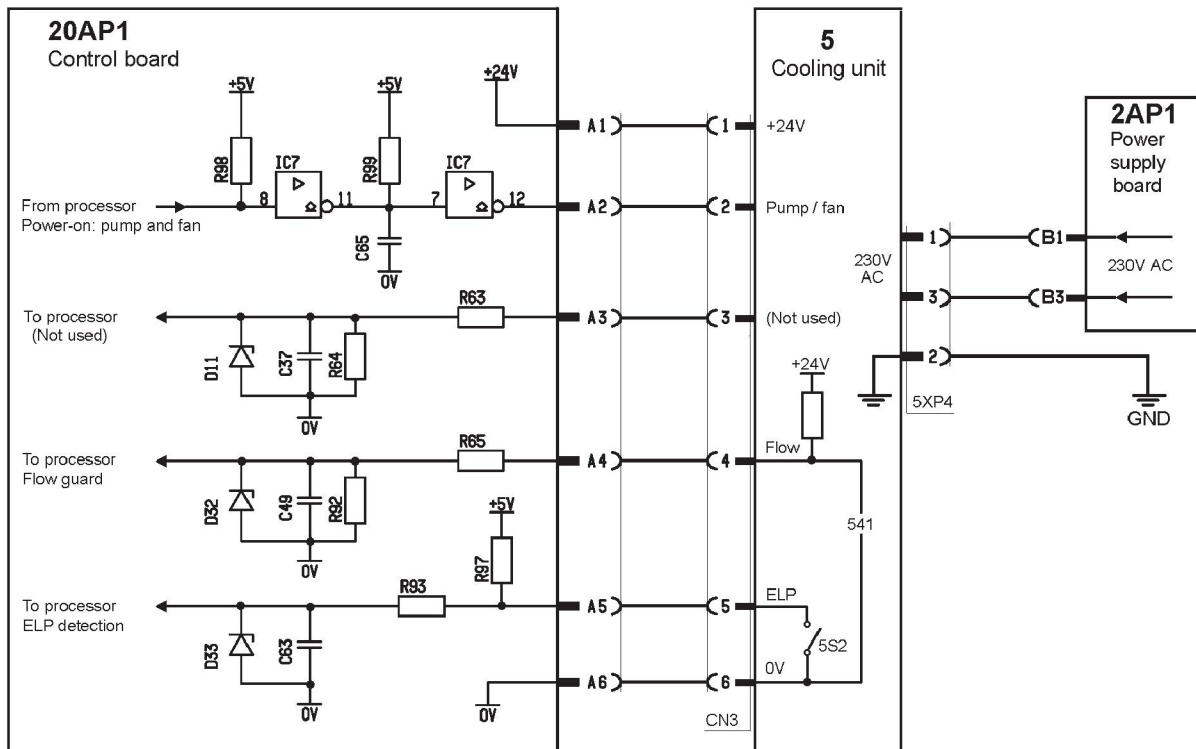
The hot start current, phase 2 above, is engaged for 1.5 seconds. It is set in per cent of the set current, but does never exceed the peak current.

**MMA drop welding mode**

In the MMA drop welding mode, the peak current is three times the set value, but the duration is shorter at only 50 ms.

The hot start current, phase 2 above, is engaged for 240 milliseconds. It is set in per cent of the set current, but does never exceed the peak current.

## 20AP1:10 Cooling unit control



### Starting the welding equipment

1. The welding data unit senses whether the water lock microswitch, 5S2, is closed or not.
2. If it is closed, a command to start the pump is generated, and a relay in the cooler starts the pump and the fan.
3. If welding does not start within 6.5 minutes, the pump is stopped.

The pump is stopped if the water lock microswitch opens.

### Starting to weld

1. The welder presses the welding torch trigger switch.
2. The water pump starts if the water lock microswitch is closed.
3. Welding starts.

### Stopping welding

1. The welder releases the trigger switch.
2. Welding stops.
3. The water pump continues to run for a further 6.5 minutes.

If welding is restarted while the pump is still running, the pump will continue to run as required, i.e. the 6.5 minute shutdown countdown is interrupted.

Flow guard can not be installed in the CoolMini. The flow guard input is jumpered with wire 541 in the cooler, the behaviour is as if the cooling water is always flowing.

Microswitch 5S2 in the water lock connector closes when a cooling water hose is connected to the blue water connector on the front of the cooling unit. The pump stops if the switch opens.



## REMOTE CONTROLS

---

A number of remote control units can be connected to the power source, these are described in a separate service manual.

## FAULT CODES

Fault codes are used in order to indicate and identify a fault in the equipment.

### Fault log

All faults that occur when using the welding equipment are documented as error messages in the fault log. When the fault log is full, the oldest message will automatically erase when the next fault occurs.

Only the most recent fault message is displayed on the control panel. To read the entire fault log, the machine must be connected to the ESAT: see service tools in chapter "Service Instructions".

Faults are monitored/detected in two ways: by test routines that are run on initiation and by functions that can detect a fault when it occurs.

The control panel displays a unit number to indicate which unit has generated the fault. The following unit numbers are used:

U0 = welding data unit

U2 = power source

U4 = remote control unit

U5 = AC unit

### Summary of fault codes

Code	Description	Welding data unit	Power source	Remote control unit	AC unit
*1	Memory error, EPROM	x	x	x	x
*2	Memory error, RAM	x	x		x
*3	Memory error, external RAM	x	x		x
4	+5 V power supply		x		x
6	High temperature		x		x
7	High temperature				x
*8	Power supply 1			x	x
*9	Power supply 2			x	x
12	Communication error (warning)	x	x	x	x
13	High temperature external				x
*14	Communication error (bus off)	x			
15	Lost messages	x	x	x	
16	High open-circuit voltage (VRD)		x		
*18	Lost contact with the power source	x			
*19	Memory error in data memory	x			
20	High inductance in the welding circuit		x		
*22	Transmitter buffer overflow	x	x		x
*23	Receiver buffer overflow	x	x		x
*25	Lost contact with AC unit	x			
*26	Program operating fault	x			

Code	Description	Welding data unit	Power source	Remote control unit	AC unit
*28	Stack overflow	x	x		x
*40	Incompatible units	x			

Fault codes marked with an asterisk ( \* ) are not displayed by the control panel. but they are stored in the fault log. To get access to the fault log use the ESAT service tool. See chapter "Service Instructions".

### Fault code description

This manual describes the fault codes for the power source. The fault codes for the other units are described in the manuals for these units.



**NOTE!**

The welding data unit is operated by the processor of the control board in the power source. The fault codes for the welding data unit are described in the service manual for the control panel.

### Welding data unit

Code	Description, welding data unit
19	<p><b>Memory error in data memory</b></p> <p>The error is thrown during startup if the software can not properly load data from memory.</p> <p>The error can occur because of the following:</p> <ol style="list-style-type: none"> <li>1. After software update (ESAT). Restart equipment again to clear the error.</li> <li>2. After a general reset (ESAT). Restart equipment again to clear the error.</li> <li>3. "Missing early warning signal", i.e. if the equipment unexpectedly lost power in such a way that it was not able to gracefully shut down. Restart equipment to clear the error.</li> <li>4. Memory hardware error. This is an unlikely cause for the error. First try to restart equipment again to clear the error. If that does not clear the error then perform a general reset of the equipment and restart twice to clear the error. If the error still persists then replace circuit board 20AP1.</li> </ol>

**Power source**

Code	Description, power source
1	<p><b>EPROM check sum error - program memory error</b></p> <p>Check sum test of the program memory, which is run only when initiating the power source after power-up. This fault does not disable any functions.</p> <p>The program memory is damaged. This is a serious fault, that can have unforeseen effects.</p> <p><b>Action:</b> Restart the machine. If the fault persists, load new software via ESAT. If the fault still persists, replace circuit board 20AP1, which carries the memory chip.</p>
2	<p><b>Microprocessor RAM error</b></p> <p>The microprocessor is unable to read/write from/to a particular memory address in its internal memory. This test is preformed only on initiation after power-up. This fault does not disable any functions.</p> <p><b>Action:</b> Restart the power source. If the fault persists, replace circuit board 20AP1, which carries the microprocessor chip.</p>
3	<p><b>Error in external RAM</b></p> <p>Read/write test of the processor's internal external RAM. This test is preformed only as part of initiation after power-up. The microprocessor is unable to read/write from/to a particular memory address in its external memory. This fault does not disable any functions.</p> <p><b>Action:</b> Restart the power source. If the fault persists, replace circuit board 20AP1, which carries the microprocessor chip.</p>
4	<p><b>5 V power supply too low</b></p> <p>The unregulated power supply voltage (+24 V) is too low: the smoothing capacitors cannot keep the voltage up enough for the processor to continue to operate. The processor stops all normal activities, expecting to be shut down.</p> <p><b>Action:</b> Turn off the mains power supply to reset the unit. If the fault persists, check the power supply to circuit board 20AP1.</p>
6	<p><b>High temperature</b></p> <p>The temperature monitoring circuit has operated. The power source is stopped, and cannot be restarted until the circuit has reset. See also chapter "Description of Operation".</p> <p><b>Possible causes:</b> Overloading, fan not working properly, cooling air inlets or outlets blocked or obstructed or dirt on the heat exchanger.</p>
12	<p><b>Communication error (warning)</b></p> <p>The load on the system CAN bus is temporarily too high, or there is electric noise on the bus.</p> <p><b>Action:</b> Check that all units are correct connected to the CAN bus. See also section "20AP1:2 The CAN bus" in chapter "Description of Operation".</p>
15	<p><b>Lost messages</b></p> <p>The bus CAN controller indicates that a message has been lost. No functions are disabled by this fault.</p> <p><b>Action:</b> Check that all units are correct connected to the CAN bus. See also section "20AP1:2 The CAN bus" in chapter "Description of Operation".</p>

Code	Description, power source
16	<p><b>High open-circuit voltage (VRD)</b></p> <p>The open-circuit voltage has been too high.</p> <p><b>Action:</b> Turn off the mains power supply to reset the unit. If the fault persists, check the arc voltage feedback: see chapter "Description of Operation".</p>
20	<p><b>High inductance in the welding circuit</b></p> <p>The power source cannot produce the desired current because the measured inductance in the welding circuit is too high. The fault indication is reset if the inductance reading receives a sufficiently low value at weld start. Resetting can also be achieved by turning off the power.</p> <p><b>Action:</b> Use shorter welding cables and ensure that the cables are not coiled up. Place the welding cable and connector cable next to each other. If possible, the inductance can be reduced by welding with a shorter arc.</p>
22	<p><b>Transmitter buffer overflow</b></p> <p>The control board is unable to transmit information to the other units at a sufficiently high speed.</p> <p><b>Action:</b> A break in the bus line can cause this fault. Check the CAN cabling. Turn off the mains power supply to reset the unit.</p>
23	<p><b>Receiver buffer overflow</b></p> <p>The control board is unable to process information from the other units at a sufficiently high speed. This fault is caused by abnormal loading of the microprocessor.</p> <p><b>Action:</b> Turn off the mains power supply to reset the unit.</p>

### AC unit

Code	Description, AC unit
1	<p><b>EPROM check sum error - program memory error</b></p> <p>Check sum test of the program memory, which is run only when initiating the power source after power-up. This fault does not disable any functions.</p> <p>The program memory is damaged. This is a serious fault, that can have unforeseen effects.</p> <p><b>Action:</b> Restart the power source. If the fault persists, load new software via ESAT. If the fault still persists, replace circuit board 18AP1, which carries the memory chip.</p>
2	<p><b>Microprocessor RAM error</b></p> <p>The microprocessor is unable to read/write from/to a particular memory address in its internal memory. This test is preformed only on initiation after power-up. This fault does not disable any functions.</p> <p><b>Action:</b> Restart the power source. If the fault persists, replace circuit board 18AP1, which carries the microprocessor chip.</p>

Code	Description, AC unit
3	<p><b>Error in external RAM</b></p> <p>Read/write test of the processor's internal external RAM. This test is preformed only as part of initiation after power-up. The microprocessor is unable to read/write from/to a particular memory address in its external memory. This fault does not disable any functions.</p> <p><b>Action:</b> Restart the power source. If the fault persists, replace circuit board 20AP1, which carries the microprocessor chip.</p>
4	<p><b>+5 V power supply on circuit board 18AP1</b></p> <p>The voltage is too high or too low: it must be within the range 4.75 - 5.25 V. This fault does not disable any functions.</p> <p><b>Action:</b> Turn off the mains power supply to reset the unit. If the fault persists, check the power supply to circuit board 18AP1.</p>
6	<p><b>High temperature NTC_IC2</b></p> <p>The temperature monitoring circuit has operated. The power source is stopped, and cannot be restarted until the circuit has reset. See also chapter "Description of Operation".</p> <p>Possible causes: Overloading, fan not working properly, cooling air inlets or outlets blocked or obstructed or dirt on the heat exchanger.</p>
7	<p><b>High temperature NTC_IC1</b></p> <p>The temperature monitoring circuit has operated. The power source is stopped, and cannot be restarted until the circuit has reset. See also chapter "Description of Operation".</p> <p>Possible causes: Overloading, fan not working properly, cooling air inlets or outlets blocked or obstructed or dirt on the heat exchanger.</p>
8	<p><b>+15 V power supply on circuit board 18AP1</b></p> <p>The voltage is too high or too low: it must be within the range 14.25 - 15.75 V. This fault does not disable any functions.</p>
9	<p><b>-11 V power supply on circuit board 18AP1</b></p> <p>The voltage is too high or too low: it must be within the range 10.45 - 11.55 V. This fault does not disable any functions.</p>
12	<p><b>Communication error (warning)</b></p> <p>The load on the system CAN bus is temporarily too high, or there is electric noise on the bus.</p> <p>Action: Check the equipment to ensure that only one remote control unit is connected. See also section "20AP1:3 The CAN bus" in chapter "Description of Operation".</p>
13	<p><b>High temperature external</b></p> <p>The temperature monitoring circuit has operated. The power source is stopped, and cannot be restarted until the circuit has reset.</p> <p>Fault code 13 does not normally occur at standard equipment. The sensing input is bridged by a resistor on circuit board 18AP2. See chapter "Description of Operation".</p>

Code	Description, AC unit
22	<p><b>Transmitter buffer overflow</b></p> <p>The control board is unable to transmit information to the other units at a sufficiently high speed.</p> <p><b>Action:</b> A break in the bus line can cause this fault. Check the CAN cabling. Turn off the mains power supply to reset the unit.</p>
23	<p><b>Receiver buffer overflow</b></p> <p>The control board is unable to process information from the other units at a sufficiently high speed. This fault is caused by abnormal loading of the microprocessor.</p> <p><b>Action:</b> Turn off the mains power supply to reset the unit.</p>
28	<p><b>Stack overflow</b></p> <p>The stack memory is full.</p> <p>This fault should never occur in reality: the fault code is intended as an aid during development work. Contact ESAB if the fault does occur.</p>

---

**SERVICE INSTRUCTIONS**

---

**CAUTION!**

STATIC ELECTRICITY can damage circuit boards and electronic components.

- Observe precautions for handling electrostaticsensitive devices.
- Use proper static-proof bags and boxes.

**ESD****What is ESD?**

A sudden transfer or discharge of static electricity from one object to another. ESD stands for Electrostatic Discharge.

*How does ESD damage occur?*

ESD can cause damage to sensitive electrical components, but is not dangerous to people. ESD damage occurs when an ungrounded person or object with a static charge comes into contact with a component or assembly that is grounded. A rapid discharge can occur, causing damage. This damage can take the form of immediate failure, but it is more likely that system performance will be affected and the component will fail prematurely.

*How do we prevent ESD damage?*

ESD damage can be prevented by awareness. If static electricity is prevented from building up on you or on anything at your work station, then there cannot be any static discharges. Nonconductive materials (e.g. fabrics), or insulators (e.g. plastics) generate and hold static charge, so you should not bring unnecessary nonconductive items into the work area. It is obviously difficult to avoid all such items, so various means are used to drain off any static discharge from persons to prevent the risk of ESD damage. This is done by simple devices: wrist straps, connected to ground, and conductive shoes.

Work surfaces, carts and containers must be conductive and grounded. Use only antistatic packaging materials. Overall, handling of ESD-sensitive devices should be minimized to prevent damage.

**Service aid**

We can offer a number of service tools that will simplify the service.

**Soft-starting tool SST 3**

The soft-starting tool SST 3 is made for ESAB's single phase inverters and for 3-phase inverters with 250 A output current. Ordering no. 0459 534 881.

The SST 3 is replacing the SST 1, which only can be used for the single phase inverters.

The tool includes:

Soft starting rectifier, cable set, voltage test board, gate pulse load and shunt voltage resistor for single phase inverters with analogue control board (Arc 151i A31, Arc 152i A31 and OrigoArc).

For the 3-phase machines there are: soft-starting-voltage adapter with current limit and temperature-switch jumper.

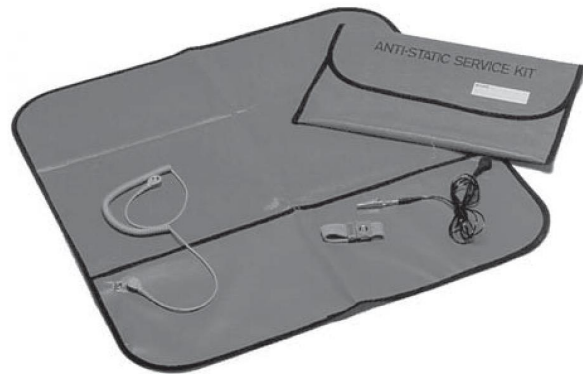
### **Antistatic service kit**

Ordering no. 0740 511 001

The kit makes it easier to protect sensitive components from electrostatic discharge.

Contents:

- A conductive mat (size 610 x 610 mm)
- A 1.5 metre long ground cable with a crocodile clip
- An adjustable wrist strap and cable with an inbuilt protective resistor



*Antistatic service kit*

### **ESAT service kit**

The software update is made from a PC, it has to be managed by a trained serviceman. For this a PC program called ESAT, ESAB Software Administration Tool, is needed. The PC is connected to the welding equipment by a cable connector and a CAN reader. From the ESAT it is possible to update the software. ESAT also contains service functions by which it is possible to control, change or read the different functions of the equipment.

For the installation and use of the ESAT you need a PC with operating system Windows.

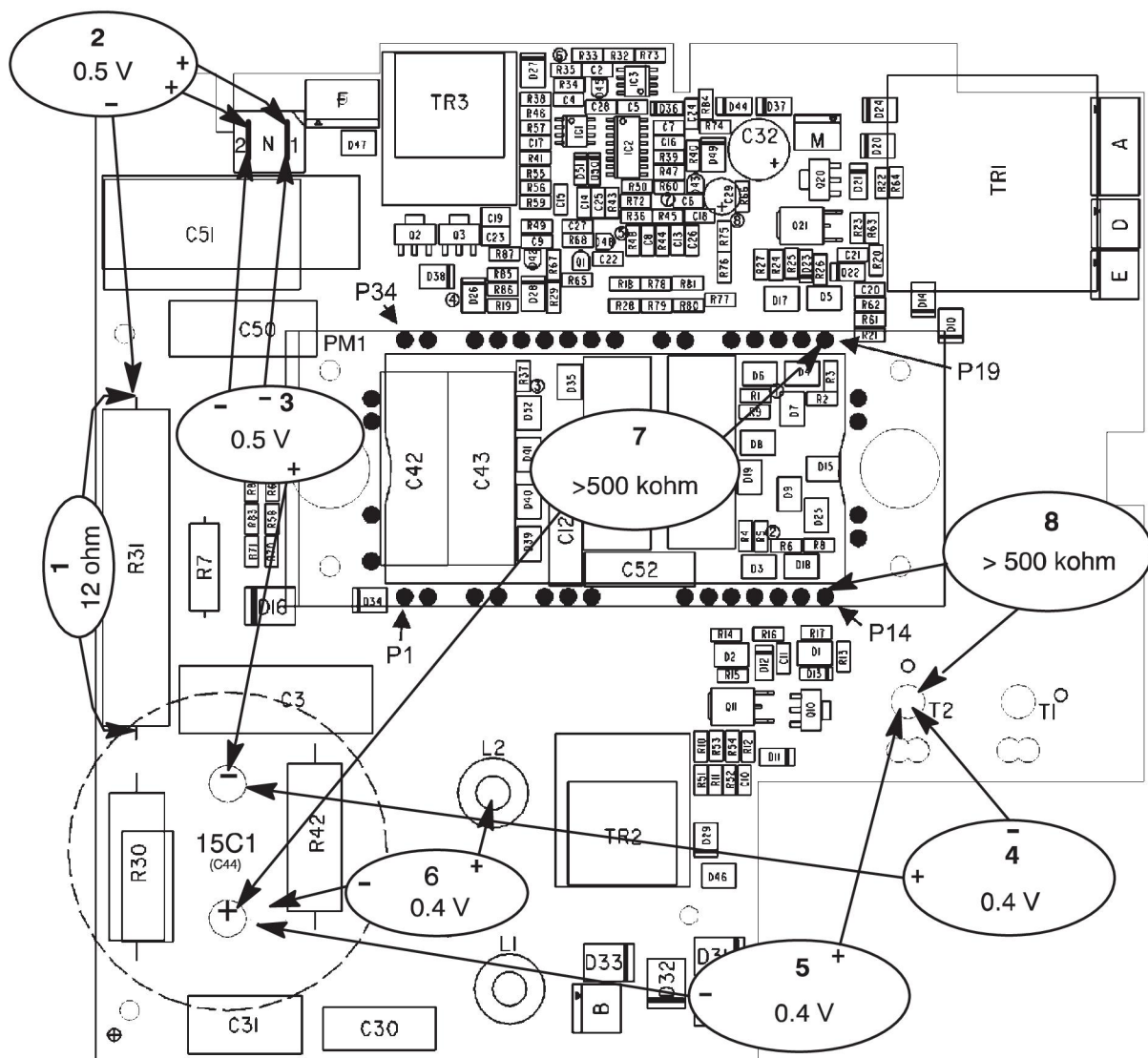
The ESAT service kit contents:

- CAN adapter with connection cables
- CD with software
- Instruction manual for ESAT

USB2CAN for connection to the USB port of the PC - ordering no: 0458 847 881

PPCAN for connection to the print port of the PC - ordering no: 0458 847 880

## Checking the semiconductor module of 15AP1



### Measuring points for the semiconductor module, PM1

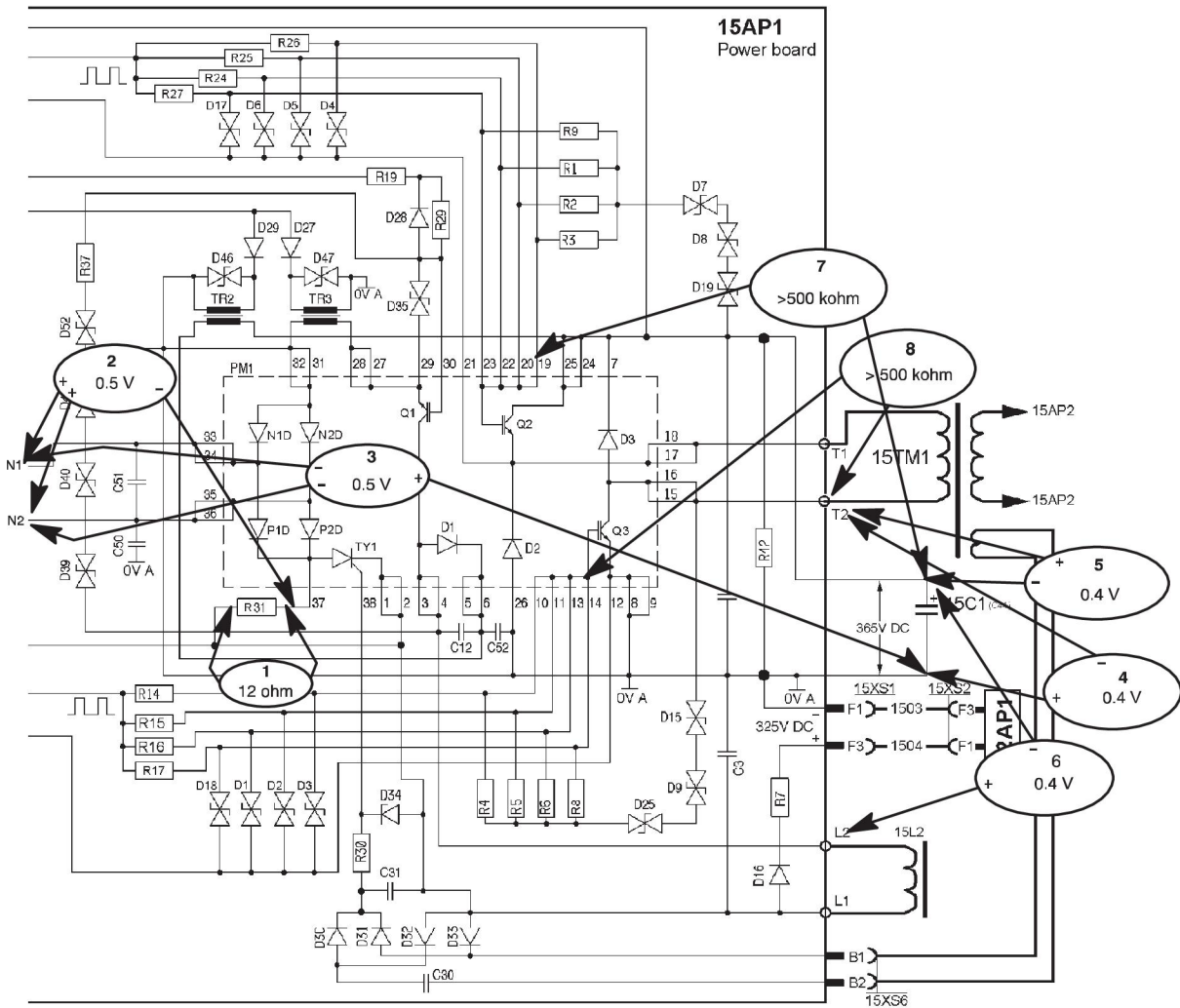
Disconnect the machine from the mains and follow the instructions below.

Measurements 2 - 6: Use a multimeter in diode test position to measure the diodes.

Measure with the positive and negative of the multimeter connected as shown in the picture above. The main transformer must be connected to terminals T1 and T2.

1. Resistor R31 (and thyristor TY1 in parallel): measure the resistance of R31. It must be 12 ohm (on some boards the resistance of R31 is 6.8 or 10 ohm, which are also approved values).
2. PM1, diode P1D: measure between resistor R31 and terminal N1.  
PM1, diode P2D: measure between resistor R31 and terminal N2.  
The forward voltage drop must be 0.4 to 0.6 V.
3. PM1, diode N1D: measure between the negative of capacitor 15C1 and terminal N1.  
PM1, diode N2D: measure between the negative of capacitor 15C1 and terminal N2.  
The forward voltage drop must be 0.4 to 0.6 V.
4. PM1, diode D2: measure between the negative of capacitor 15C1 and terminal T2. The forward voltage drop must be 0.3 to 0.5 V.

5. PM1, diode D3: measure between the positive of capacitor 15C1 and terminal T2. The forward voltage drop must be 0.3 to 0.5 V.
6. PM1, diode D1: measure between the positive of capacitor 15C1 and terminal L2. The forward voltage drop must be 0.3 to 0.5 V.
7. PM1, transistor Q2: measure the resistance between source, the positive of capacitor 15C1, and gate, pin 19 of the module. The resistance must be higher than 500 kohm.
8. PM1, transistor Q3: measure the resistance between source, terminal T2, and gate, pin 14 of the module. The resistance must be higher than 500 kohm.



Circuit diagram and measuring points for the semiconductor module

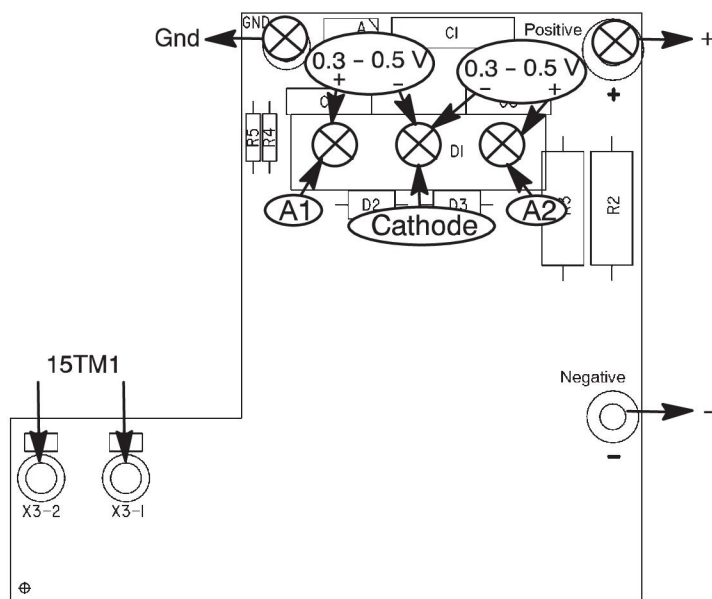
### Checking rectifier and freewheel diodes

1. Disconnect the machine from the mains.
2. Dismantle the housing of the power source.
3. Use a Torx key no. T25 to unscrew and remove five screws from circuit board 15AP2.

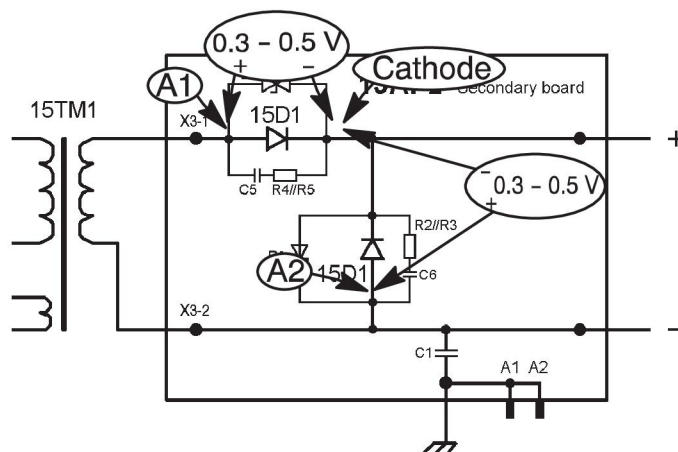
The screws are marked  on the picture below,

4. Bend out the circuit board so that it has no contact with the connections of the diode module.

5. Use a multimeter in diode test position to measure the forward voltage drop of the two diodes: see the picture below. The voltage drop must be 0.3 to 0.5 V.
6. If the diode module has to be replaced, follow the instructions in section "Mounting components on the heat sink" of this chapter.



Measuring points, circuit board 15AP2



Circuit diagram with measuring points, circuit board 15AP2

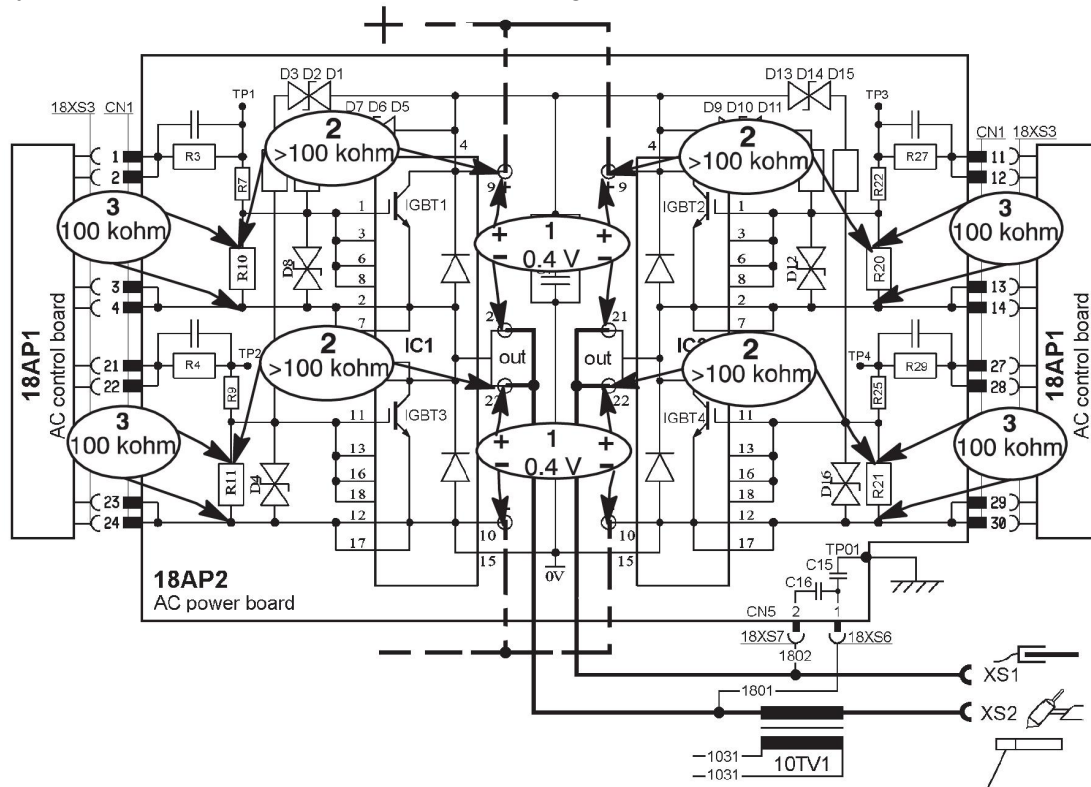
### Checking the IGBT modules of AC power board 18AP2

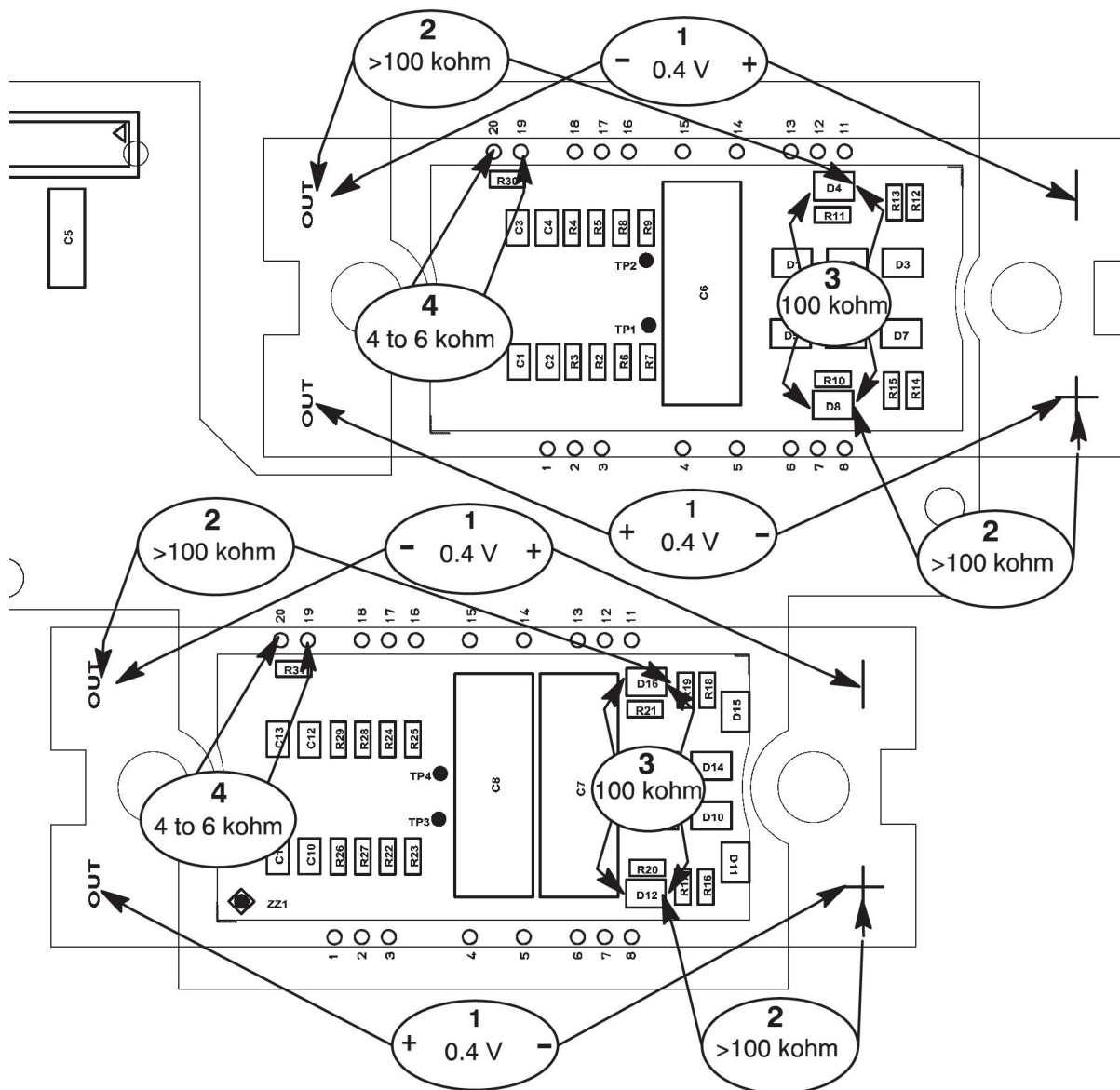
Disconnect the machine from the mains and follow the instructions below. The numbers of the instructions refer to the diagrams on this and next page.

Before measuring: disconnect connector 18XS3 from terminal CN1 and the positive and negative voltage supply bars from the circuit board.

1. Use a multimeter in diode test position. Measure with the positive and negative of the multimeter connected as shown in the pictures. The forward voltage drop of the diode must be 0.3 to 0.5 V.
2. Measure the resistance between collector and gate of the transistors, it must be higher than 100 kohm. The measured resistance is partly depending on the meter that is used, it may be in the range from 100 kohm to 4 Mohm. A faulty transistor is in most cases short-circuited between collector and gate.

3. Measure the resistance between emitter and gate of the transistors, it must be about 100 kohm. The measured resistance is the resistance of the gate resistor. A faulty transistor may have a short-circuit between emitter and gate.





Component positions AC power board 18AP2, measuring points IGBT modules

### Checking the gate signals to AC power board 18AP2

The gate voltage is +15 V when the IGBTs are conducting.

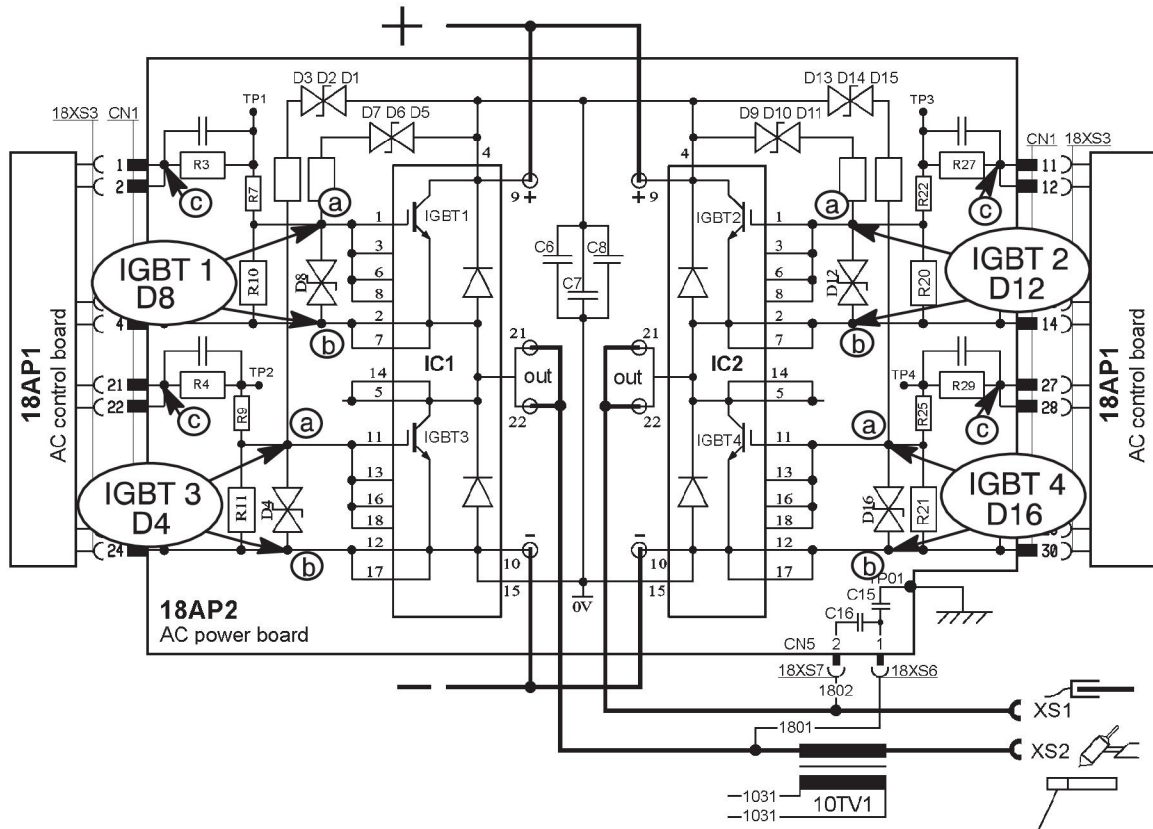
The gate voltage is -10 V when the IGBTs are open.

Measure the gate voltage across varistors D4, D6, D12 and D16.

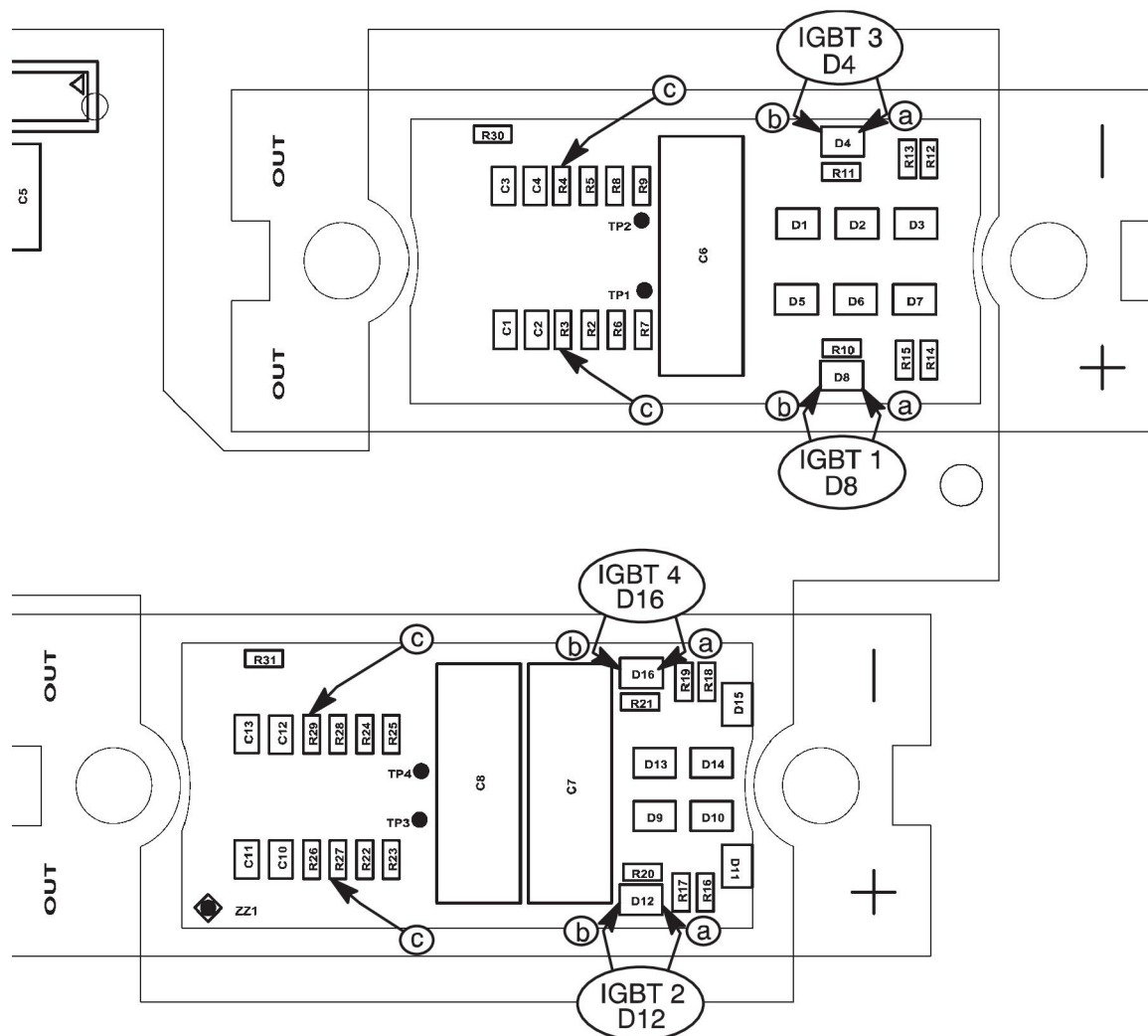
Measuring points a and b in the diagram.

1. Switch on the machine
2. Select MMA mode and positive polarity. IGBT1 and IGBT4 must be conducting.
3. Select MMA mode and negative polarity. IGBT2 and IGBT3 must be conducting.

If the gate voltage is missing at any of the measurements, check the output from 18AP1 by measuring across measuring points c and b in the diagram.



Circuit diagram AC power board 18AP2, measuring points gate signals



Component positions AC power board 18AP2, measuring points gate signals

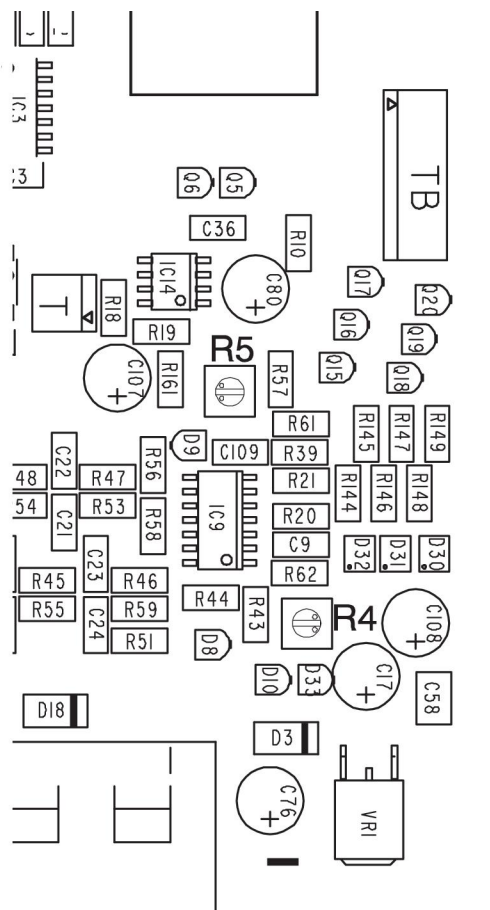
### Calibration of the arc voltage display

The arc voltage that is displayed by the machine can be calibrated using trimming potentiometer R4 and R5 on circuit board 18AP1. The board has been calibrated in the factory: further adjustment should not normally be necessary.

**Use an accurately calibrated external voltmeter to measure the voltage at the welding current terminals.**

Set the power source to the MMA welding mode.

1. Set a welding current of about 100 A, supplying it to a resistive load so that the voltage is 25 - 30 V. Using an external voltmeter, measure the voltage across the welding current terminals.
2. Using potentiometer R5, adjust the value shown on the display so that the voltage shown is about 0.2 - 1.6 V lower than the voltage at the welding current terminals. The difference between the measured and the displayed voltages compensates for the voltage drop in the welding current cables.
3. Select DC(-) on the control panel (reversed polarity).
4. Using potentiometer R4, adjust the value shown on the display so that the voltage shown is about 0.2 - 1.6 V lower than the voltage at the welding current terminals.



Position of potentiometers R4 and R5 on circuit board 18AP1

## Checking the gate pulses

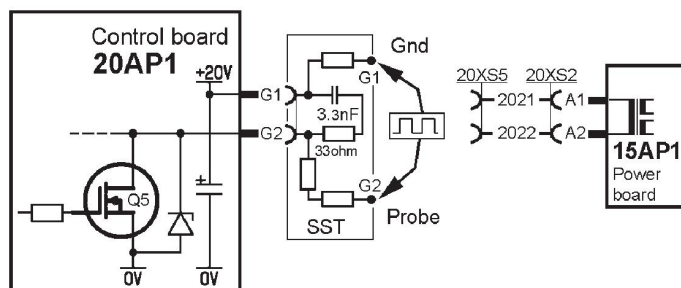
When checking the gate pulses, the machine can either be in soft-start mode or in normal operation mode.

### Special equipment

To measure the gate pulses, you need a gate pulse load. This is included in soft-starting tool SST 3, which is described in section "Service Aid" of this chapter.

### Instructions

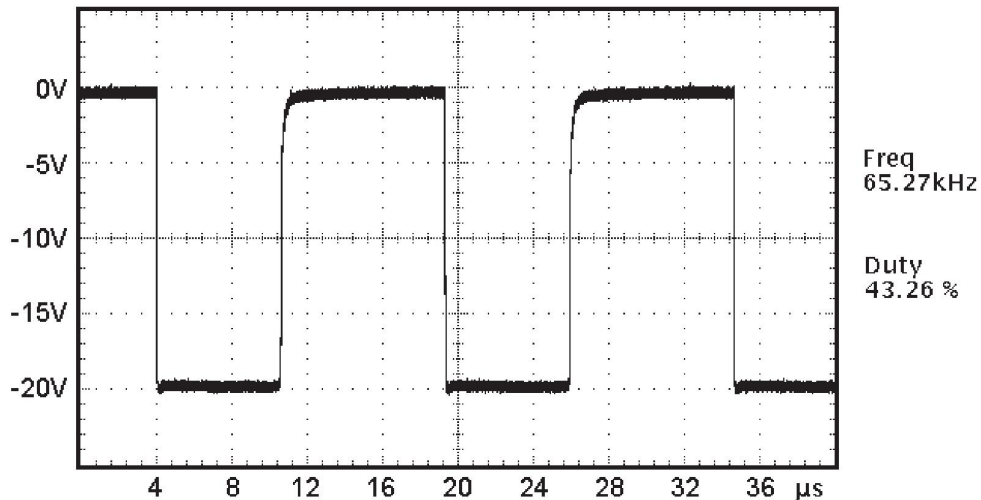
1. Disconnect the power source from the mains.
2. Disconnect connector 20XS5 from terminal G on control board 20AP1.
3. Connect the gate pulse test cable of the SST 3 to terminal G on control board 20AP1.



Measuring connection for the gate pulses

4. Switch on the power source.
5. Connect an oscilloscope to the SST 3, with the probe to terminal G2 and the screen to terminal G1 of SST 3.

6. Set the power source to MMA welding mode.
7. Measure the pulse frequency. It must be 65 kHz +/- 1kHz.
8. Measure the duration of the negative pulse. It must be 41 - 43 % of the cycle time, measured at a voltage level of -10 V.
9. The waveform of the pulses must be as shown below.



Gate pulses from circuit board 20AP1

### Soft starting

We recommend soft starting of the machine after replacing control circuit board 20AP1, power supply board 2AP1 and circuit boards or components in the power module. Soft starting supplies the power module with a low voltage in order to avoid injury to persons or damage to components.

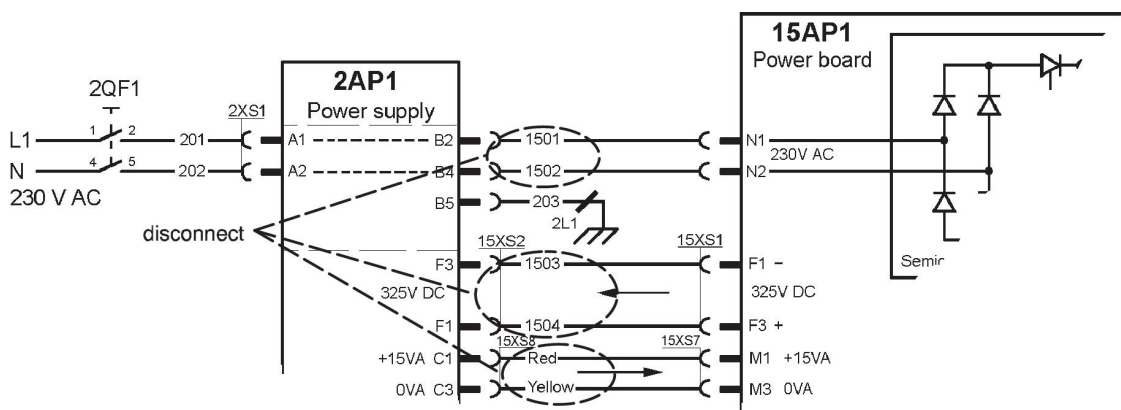
It is a good idea to use soft starting when fault tracing.

### Special equipment

To soft-start the machine you need soft-starting tool SST 3, this is described in section "Service Aid" of this chapter.

### Instructions

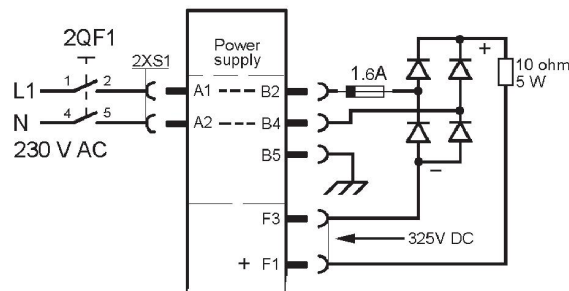
1. Disconnect wires 1501, 1502, 1503, 1504, red and yellow from circuit boards 2AP1 and 15AP1, see the circuit diagram below.



#### Disconnections prior to soft starting

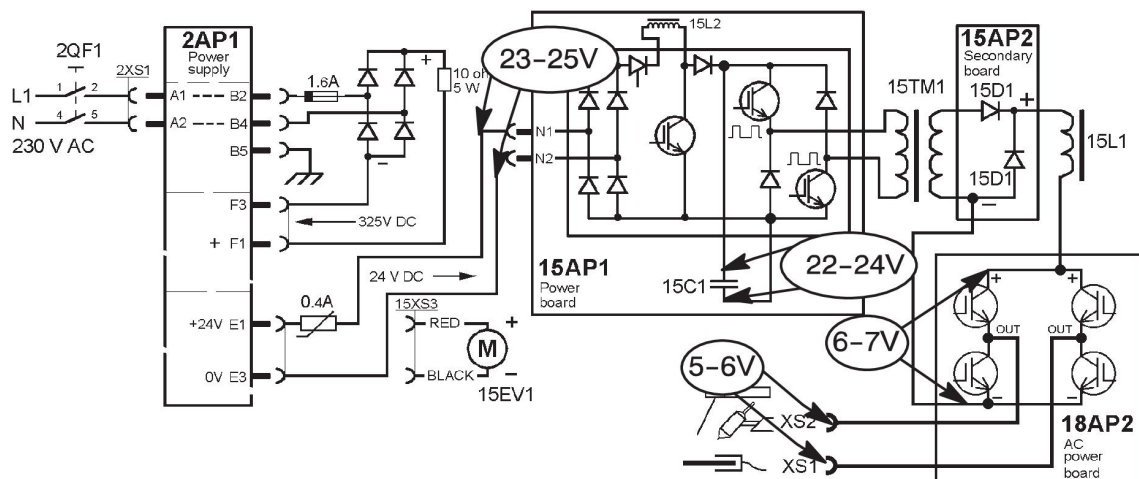
2. Connect the 230 V AC input of the SST 3 to terminals B2 and B4 on circuit board 2AP1.

3. Connect the 325 V DC output of the SST 3 to terminals F1 and F3 on circuit board 2AP1.



*The SST 3 connected to 2AP1*

4. Disconnect connector 20XS4 from terminal PS of power supply board 2AP1. Connect the voltage test cable of the SST 3 to terminal PS of power supply board 2AP1.
5. Connect the power source to the mains and turn on the mains switch.
6. Verify the output voltages from 2AP1, all LEDs on the SST 3 must light.
7. Switch off the power source. Disconnect the voltage test cable and reconnect connector 20XS4 to terminal PS of circuit board 2AP1.
8. Disconnect connector 15XS3 (supply to the fan) from terminal E of circuit board 2AP1. Connect the 24 V DC input of the SST 3 to terminal E of circuit board 2AP1.
9. Connect the 24 V DC output of the SST 3 to terminals N1 and N2 of power board 15AP1.



*Circuit connections and measuring points for soft starting*

10. Switch on the machine and set it to MMA mode.
11. Check that the DC voltage across smoothing capacitor 15C1 is 22-24 V.
12. Check that the DC voltage at the input of AC power board 18AP2 is about 6-7 V.
13. Check that the DC voltage at the welding terminals is about 5-6 V.
14. If all the measurements are as described above, reconnect the wires to restore the power source to normal operation mode and make a test weld.

The PFC circuits are not active in soft starting mode. To check that the PFC is working properly, measure the intermediate voltage when the machine is in normal operating mode. See: Power factor corrector in chapter "Description of Operation".

## Mounting components on the heat sink

### Thermal paste

Apply thermal conducting paste to the components before fitting them to the heat sink.

Start by cleaning the heat sink, and then apply a **very thin**, even layer of thermal paste to the contact surfaces of the components. The purpose of the paste is to fill out any hollows in the surfaces of the components and the heat sink. Those parts of the component and the heat sink that are in true metallic contact may already have good thermal contact.

Mount the components as described below.

See the spare parts list for the order number for thermal paste. Use only the paste recommended by us.

### Fitting instructions

#### 15AP1 Power board with semiconductor module

1. Clean the heat sink and apply thermal conducting paste to the semiconductor module as described above.
2. Fit the board and tighten the screws to a torque of 2.5 Nm, and then further tighten them to 4.5 Nm.
3. Tighten the screws that connect transformer 15TM1 and capacitor 15C1 to circuit board 15AP1 to a torque of 4.5 Nm.



#### CAUTION!

Incorrectly fitted components can cause failure. Do not tighten the screws to more than 4.5 Nm.



#### NOTE!

If capacitor 15C1 or transformer 15TM1 have to be replaced, the power board must be removed and then refitted as described above.

#### 15D1 Diode module

1. Clean the heat sink and apply thermal conducting paste to the diode module as described above.
2. Fit the module and tighten the screws to a torque of 2.5 Nm, and then further tighten them to 4.5 Nm.
3. Tighten the connections to circuit board 15AP2 to 4.5 Nm.
4. Tighten the screws that connect transformer 15TM1 and inductor 15L1 to circuit board 15AP2 to a torque of 4.5 Nm.



#### CAUTION!

Incorrectly fitted components can cause failure. Do not tighten the screws to more than 4.5 Nm.

#### 15ST2 Thermal overload switch

1. Clean the heat sink and apply thermal conducting paste to the thermal overload switch as described above.
2. Fit the thermal overload switch and tighten the screw to 2 Nm.

#### 18AP2: IC1, IC2, AC power board with IGBT modules

1. Clean the heat sink and apply thermal conducting paste as described above.
2. Fit the power board with the two IGBT modules to the heat sink.
3. Tighten the screws, that secure the modules to the heat sink, to a torque of 2.5 Nm, and then further tighten them to 4.0 Nm.
4. Fit the busbars to the modules and tighten the connections to the busbars to 4.0 Nm.



**CAUTION!**

Incorrectly fitted components can cause failure. Do not tighten the screws to more than 4.0 Nm.

## SPARE PARTS

---

The spare parts list is published in a separate document that can be downloaded from the Internet: [www.esab.com](http://www.esab.com)

<b>Product</b>	<b>Filename</b>
Tig 2200i AC/DC	0459 839 013
TA33, TA34	0459 839 014

# ESAB subsidiaries and representative offices

## Europe

### AUSTRIA

ESAB Ges.m.b.H  
Vienna-Liesing  
Tel: +43 1 888 25 11  
Fax: +43 1 888 25 11 85

### BELGIUM

S.A. ESAB N.V.  
Heist-op-den-Berg  
Tel: +32 15 25 79 30  
Fax: +32 15 25 79 44

### BULGARIA

ESAB Kft Representative Office  
Sofia  
Tel: +359 2 974 42 88  
Fax: +359 2 974 42 88

### THE CZECH REPUBLIC

ESAB VAMBERK s.r.o.  
Vamberk  
Tel: +420 2 819 40 885  
Fax: +420 2 819 40 120

### DENMARK

Aktieselskabet ESAB  
Herlev  
Tel: +45 36 30 01 11  
Fax: +45 36 30 40 03

### FINLAND

ESAB Oy  
Helsinki  
Tel: +358 9 547 761  
Fax: +358 9 547 77 71

### GREAT BRITAIN

ESAB Group (UK) Ltd  
Waltham Cross  
Tel: +44 1992 76 85 15  
Fax: +44 1992 71 58 03

ESAB Automation Ltd  
Andover  
Tel: +44 1264 33 22 33  
Fax: +44 1264 33 20 74

### FRANCE

ESAB France S.A.  
Cergy Pontoise  
Tel: +33 1 30 75 55 00  
Fax: +33 1 30 75 55 24

### GERMANY

ESAB Welding and Cutting  
GmbH  
Solingen  
Tel: +49 212 298 0  
Fax: +49 212 298 218

### HUNGARY

ESAB Kft  
Budapest  
Tel: +36 1 20 44 182  
Fax: +36 1 20 44 186

### ITALY

ESAB Saldatura S.p.A.  
Bareggio (Mi)  
Tel: +39 02 97 96 8.1  
Fax: +39 02 97 96 87 01

### THE NETHERLANDS

ESAB Nederland B.V.  
Amersfoort  
Tel: +31 33 422 35 55  
Fax: +31 33 422 35 44

## NORWAY

AS ESAB  
Larvik  
Tel: +47 33 12 10 00  
Fax: +47 33 11 52 03

## POLAND

ESAB Sp.zo.o.  
Katowice  
Tel: +48 32 351 11 00  
Fax: +48 32 351 11 20

## PORTUGAL

ESAB Lda  
Lisbon  
Tel: +351 8 310 960  
Fax: +351 1 859 1277

## ROMANIA

ESAB Romania Trading SRL  
Bucharest  
Tel: +40 316 900 600  
Fax: +40 316 900 601

## RUSSIA

LLC ESAB  
Moscow  
Tel: +7 (495) 663 20 08  
Fax: +7 (495) 663 20 09

## SLOVAKIA

ESAB Slovakia s.r.o.  
Bratislava  
Tel: +421 7 44 88 24 26  
Fax: +421 7 44 88 87 41

## SPAIN

ESAB Ibérica S.A.  
Alcalá de Henares (MADRID)  
Tel: +34 91 878 3600  
Fax: +34 91 802 3461

## SWEDEN

ESAB Sverige AB  
Gothenburg  
Tel: +46 31 50 95 00  
Fax: +46 31 50 92 22

ESAB International AB  
Gothenburg  
Tel: +46 31 50 90 00  
Fax: +46 31 50 93 60

## SWITZERLAND

ESAB Europe GmbH  
Neuhof Business Center  
Neuhofstr. 4  
Tel: +41 1 741 25 25  
Fax: +41 1 740 30 55

## UKRAINE

ESAB Ukraine LLC  
Kiev  
Tel: +38 (044) 501 23 24  
Fax: +38 (044) 575 21 88

## North and South America

### ARGENTINA

CONARCO  
Buenos Aires  
Tel: +54 11 4 753 4039  
Fax: +54 11 4 753 6313

### BRAZIL

ESAB S.A.  
Contagem-MG  
Tel: +55 31 2191 4333  
Fax: +55 31 2191 4440

### CANADA

ESAB Group Canada Inc.  
Mississauga, Ontario  
Tel: +1 905 670 02 20  
Fax: +1 905 670 48 79

### MEXICO

ESAB Mexico S.A.  
Monterrey  
Tel: +52 8 350 5959  
Fax: +52 8 350 7554

### USA

ESAB Welding & Cutting  
Products  
Florence, SC  
Tel: +1 843 669 44 11  
Fax: +1 843 664 57 48

## Asia/Pacific

### AUSTRALIA

ESAB South Pacific  
Archerfield BC QLD 4108  
Tel: +61 1300 372 228  
Fax: +61 7 3711 2328

### CHINA

Shanghai ESAB A/P  
Shanghai  
Tel: +86 21 2326 3000  
Fax: +86 21 6566 6622

### INDIA

ESAB India Ltd  
Calcutta  
Tel: +91 33 478 45 17  
Fax: +91 33 468 18 80

### INDONESIA

P.T. ESABindo Pratama  
Jakarta  
Tel: +62 21 460 0188  
Fax: +62 21 461 2929

### JAPAN

ESAB Japan  
Tokyo  
Tel: +81 45 670 7073  
Fax: +81 45 670 7001

### MALAYSIA

ESAB (Malaysia) Snd Bhd  
USJ  
Tel: +603 8023 7835  
Fax: +603 8023 0225

### SINGAPORE

ESAB Asia/Pacific Pte Ltd  
Singapore  
Tel: +65 6861 43 22  
Fax: +65 6861 31 95

## SOUTH KOREA

ESAB SeAH Corporation  
Kyungnam  
Tel: +82 55 269 8170  
Fax: +82 55 289 8864

## UNITED ARAB EMIRATES

ESAB Middle East FZE  
Dubai  
Tel: +971 4 887 21 11  
Fax: +971 4 887 22 63

## Africa

### EGYPT

ESAB Egypt  
Dokki-Cairo  
Tel: +20 2 390 96 69  
Fax: +20 2 393 32 13

### SOUTH AFRICA

ESAB Africa Welding & Cutting  
Ltd  
Durbanvill 7570 - Cape Town  
Tel: +27 (0)21 975 8924

## Distributors

*For addresses and phone numbers to our distributors in other countries, please visit our home page*

[www.esab.com](http://www.esab.com)



[www.esab.com](http://www.esab.com)

