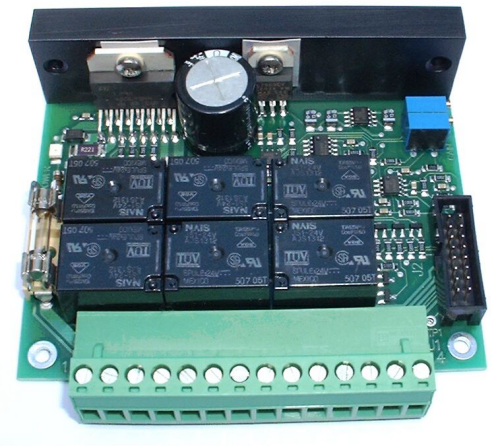
Plasma torch height control system for profile cutting machines - control PCB.

Features:

- DC 24V output for standard brushed permanent magnet motor
- constant torch height control done by means of sampling the arc voltage
- initial height sensing prior to cut
- adjustable gain and up/down speed
- single DC 24V supply
- PCB size 100 x 80 x 30 mm



General description:

The R953A control system is an interface between CNC controller or tracing head and Plasma unit. R953A provides all necessary signals for controlling the up/down movement of the cutting torch.

Detailed description:

A switch mode servo driver drives the motor. For simplicity of interfacing the speed feedback (tacho, encoder, etc.) has been omitted and the back EMF voltage from the winding of the motor is integrated and used as a speed feedback for the driver. The driver can deliver close to 2 amperes peak current at nearly 100 % duty cycle. When the up (or down) input is activated, this connects the positive (or negative) supply to input of the driver.

The arc voltage must be externally divided into less than 5 volts. This signal is applied to ARC_VOLTAGE_1 and _2. The difference between arc voltage and reference voltage is amplified and fed to the servo driver. The speed of the movement is proportional to the difference of these voltages. The reference voltage is a preset value of the arc voltage, 0 to +5V, delivered from panel mount potentiometer or analogue output from the CNC.

The auto sequence logics are used for the initial height sensing. When enabled (+AUTO) and +PLASMA signal is toggled on (from manual START switch or CNC controller), the torch is lowered down, the +24V_AIR and +24V_PROXY outputs are activated. The +24V_AIR is used for solenoid controlling a spring returned air cylinder, which lowers the proximity switches to the height of tip of the torch. When the torch is lowered to the cutting height, the proximity switch is activated (the NPN_PROXY input switched to 0V), the down movement and +24V_AIR output are deactivated, what retract the proxy switches to the safe position and plasma on relay is activated, this starts the plasma cut. When +PLASMA is off the up movement is activated.

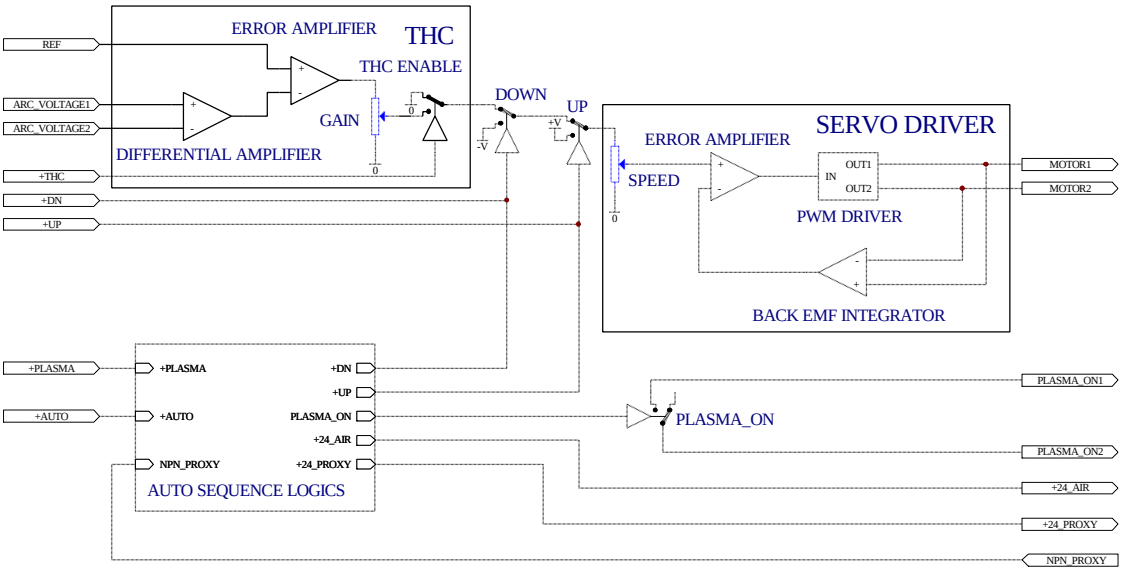


Fig. 1.

Interfacing:

Fig 2. and 3. shows the typical connection of R953A (953-000) control system. Both examples use same interface to the plasma unit, CNC controller and cutting torch. The differences are only in the connection of mode selection switches. The whole control system must be supplied from DC 24V power supply; capable delivering enough current for all outputs (motor, solenoid, etc.) plus few hundreds of milli-amperes for R953A PCB. Usually, the 4 amperes power supply is enough.

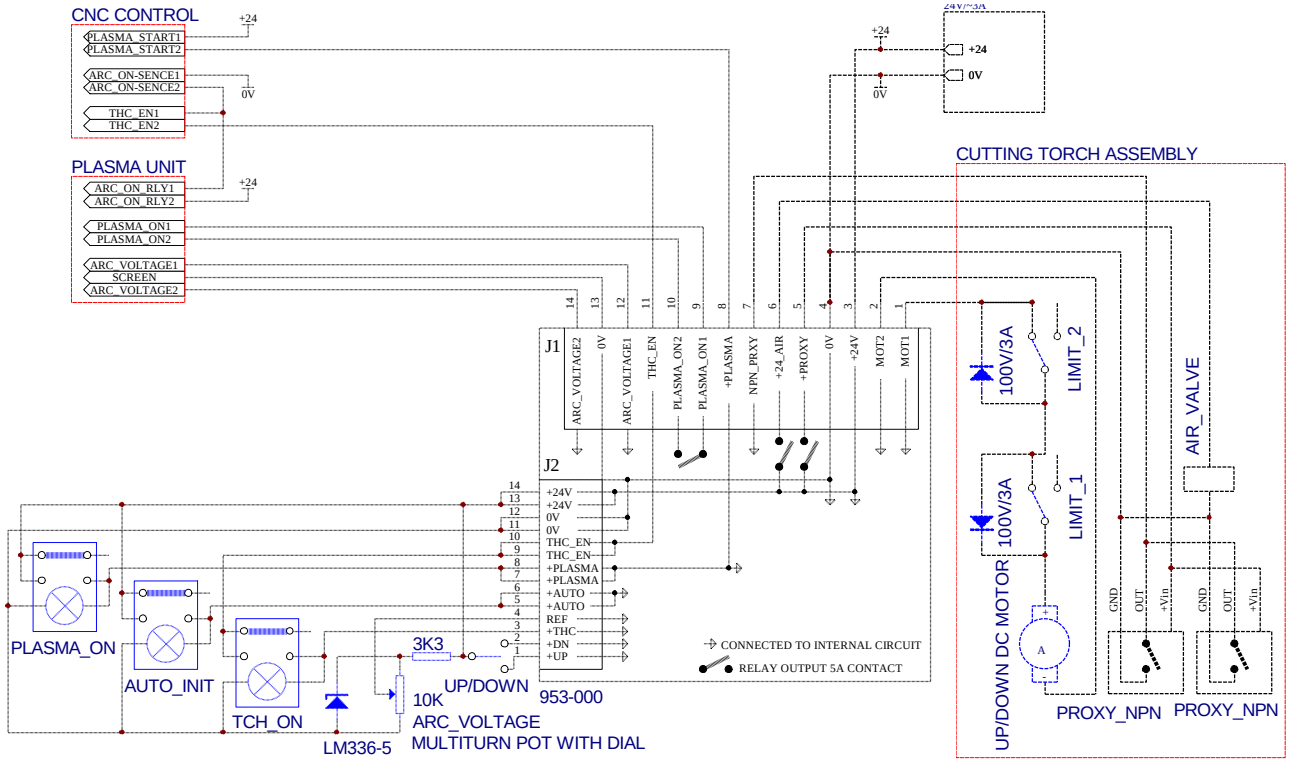


Fig. 2.

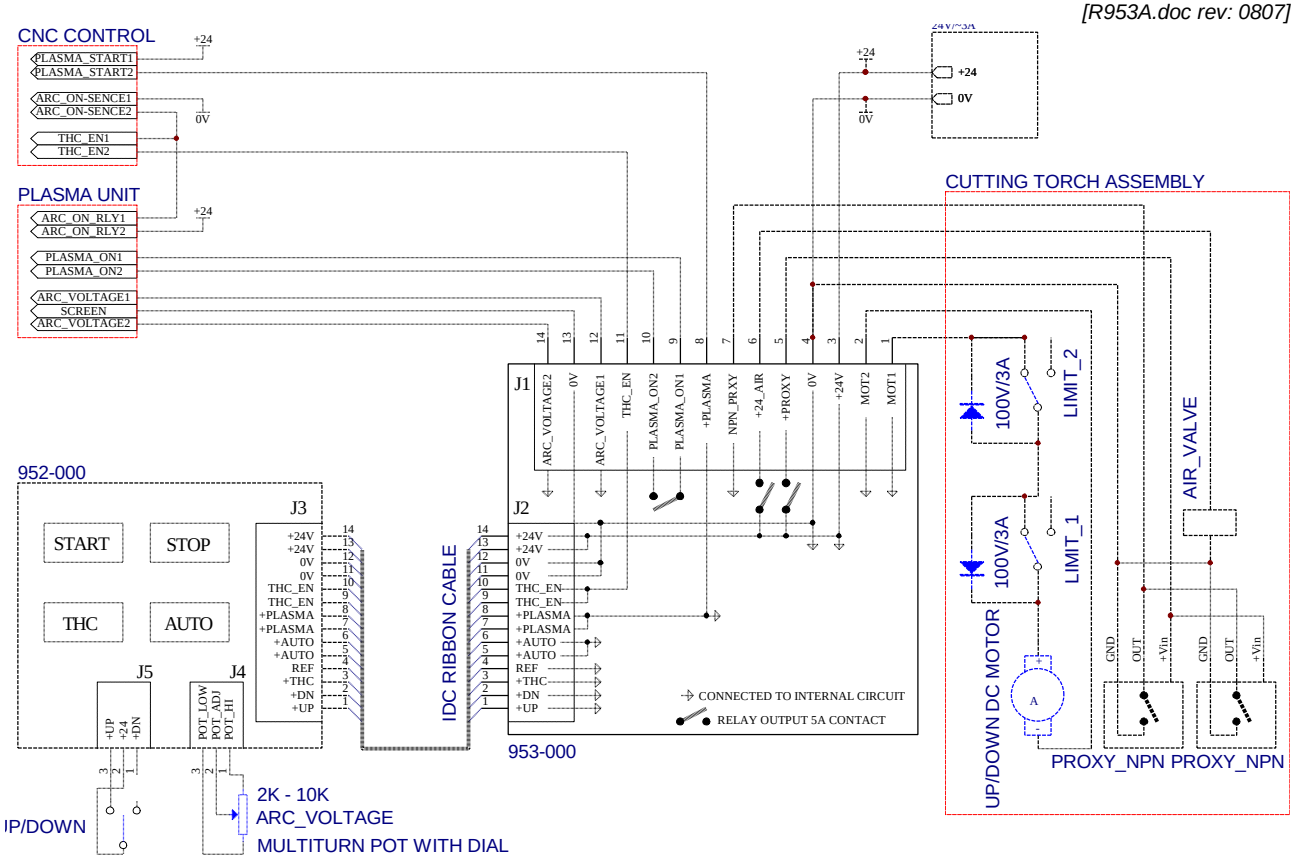


Fig. 3.

CNC controller:

A dry relay contact should be activated between PLASMA_START1 and PLASMA_START2 to start the plasma unit. A 24 V output from CNC controller connected to PLASMA_START2 can be used instead of relay output. The controller to signalize to the CNC that manual start of the plasma has been activated can also sense this line. A DC 24 V can be sensed between ARC_ON-SENSE1 and ARC_ON-SENSE2. This is usually used to start the motion of machine. If the CNC controller requires a dry contact or different level of signal, insert a coil of additional 24V relay between ARC_ON-SENSE1 and ARC_ON-SENSE2 and with contact of the relay simulate the level, which is required. The CNC controller should provide a normally closed contact, which disables the THC while the machine, does not cut at full cutting speed (e.g.. when is slowing down on the sharp corners or during lead-in or lead-out). This contact should be connected between THC_EN1 and THC_EN2.

PLASMA UNIT:

The plasma unit must be able to be started from external contact. This contact is between PLASMA_ON1 and PLASMA_ON2. As well the plasma unit must have an output, which signalize that the arc is on. This is usually done by a current relay inside the plasma unit, which close the contact between ARC_ON_RLY1 and ARC_ON_RLY2. If this signal is not a dry contact or DC +24V, connect a coil of additional relay to this signal (coil rated same as value of this signal e.g.. AC 110V) and use contact of this relay to close ARC_ON_RLY1 and ARC_ON_RLY2 lines. Many of plasma units have already build in a voltage divider of the arc voltage. This is usually 25:1, 50:1 or 100:1. The voltage from this divider should be applied to ARC_VOLTAGE1 andARC_VOLTAGE2. A twisted pare screened cable should be used and screen should be terminated only on one end. If the plasma unit does not have suitable voltage divider installed, please see section *Selection of voltage divider for arc voltage*. This divider should be fitted inside, or very close to, the plasma unit to decrease the possibility of radiation of noise from arc current.

CUTTING TORCH MOVEMENT ASSEMBLY:

The up and down movement of the torch must be motorized and driven by standard permanent magnet DC 24V motor. The limit switches for upper and lower limit should be normally closed and the contact should be bridged with diode that allows driving only to the opposite direction of the position of the limit. If initial height sensing is used, one or more normally open NPN type proximity switches should be used together with solenoid valve for air, which activates the spring, returned air cylinder for lowering the proxy switches to the height of the tip. The proximity switches can be substituted with mechanical switches with extended actuators and air cylinder together with solenoid valve can be substituted with electromechanical solenoid. The electromechanical solenoid should lower the actuators of the switches below the tip of torch, and when the actuator tough the plate solenoid should retract the switches above the tip of torch.

Mode selection switches:

In the second example (Fig.3.), connection to switches is simplified by using the R952 PCB. This PCB is also available from Rutex. See appendix B for description of this PCB. When installing this PCB, four switches (PLASMA START, PLASMA STOP, AUTO and THC) are fitted on the front panel and R952 PCB is directly soldered onto these switches. The up/down switch and the potentiometer for arc voltage are connected via screw-in terminals. The R952 and R953A PCB are connected with 16 ways ribbon cable. The first example (Fig. 2.) is hardwired version of R953A PCB.

Test circuit:

The Fig. 4. shows a bench test circuit of R953A board. This setup should be used before the first installation or when testing a different type of motor etc.

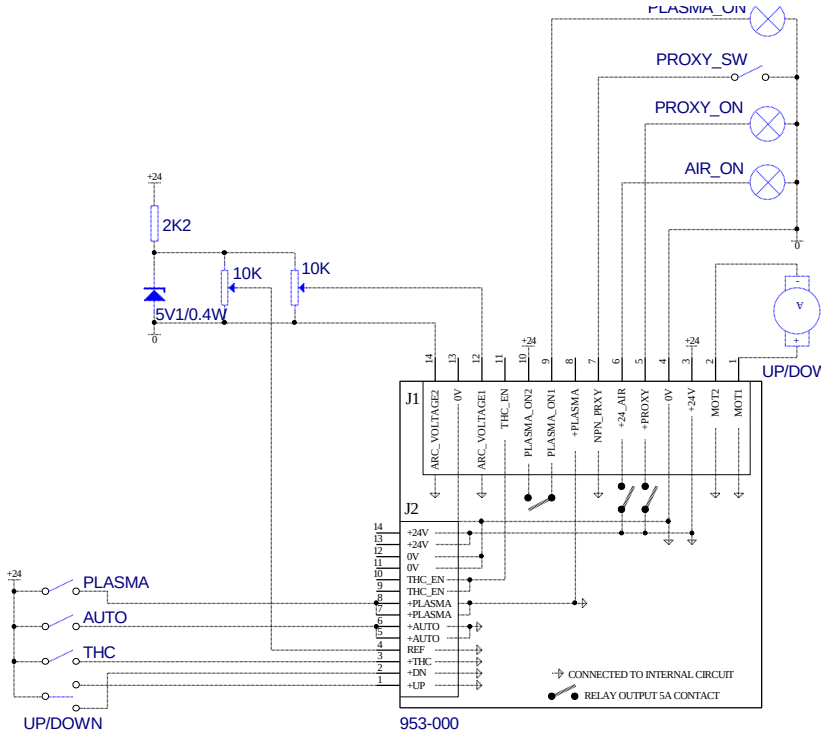


Fig. 4.

Selection of voltage divider for plasma arc.

The function of voltage divider is to divide the arc voltage in ratio that the output voltage from the divider does not exceed 5V. When THC operates correctly and certain voltage (REF J2 pin 4) is preset, the height of the torch is adjusted so that reference voltage (J2 pin 4) is equal to divided voltage from arc.

For example a 50:1 divider is used and required arc voltage is 125 volts. The reference voltage must be preset to 125 / 50 = 2.050 volts.

When using R953A PCB, which has 5V reference diode on board, with standard 10-turn multi turn potentiometer with 15 turns dial a voltage can be directly read from dial of this pot. The low side of this pot must be adjusted to 1 volt, high side to 3 volts and dial set from 50 to 150. With 50:1 divider, the preset voltage 2.050 will be read on dial as 125 +/- tolerances.

When selecting values of resistors for voltage divider an input impedance of 20-kilo ohms on ARC VOLTAGE inputs (across pin 12 and 14 of J1) should be taken in account in case of use high value resistors. The output of the divider should be bypassed by the capacitor (in ten or hundreds of nanofarads) to attenuate high frequency from arc and protected by a high-speed low voltage transient suppresser (such General Instrument SA5.0, SGS-Thomson BZW03P5V8, AVX-Kyocera VA100005A150).

A standard 50 : 1 divider is also available from Rutex (p/n R983).

Installation and adjustment.

During the initial installation the arc voltage should be supplemented with a low current variable DC supply 0-300V (or range of expected arc voltage). Plus of this supply should be connected to ground, negative to input of voltage divider (not directly to R953A board!!!). Correct polarity of connection of voltage divider should be verified by an error LED located on the R953A. If the LED lit up, when the power is on and the arc voltage is applied, swap wires between pin 12 and 14 of J1.

They are only 2 pots for adjustment. The SPEED pot should be set while toggling the UP/DOWN switch and adjusting up & down speed of torch lifter for required speed. For most of the application this can be set to about 20 V DC measured across the motor. The GAIN pot should be adjusted by simulating normal cut by changing the voltage from DC supply connected to the voltage divider. The GAIN pot should be adjusted to maximum available gain just before the point when the correction starts overshooting.

APPENDIX A

Connector J1 (14 pin KLIPPON connector)

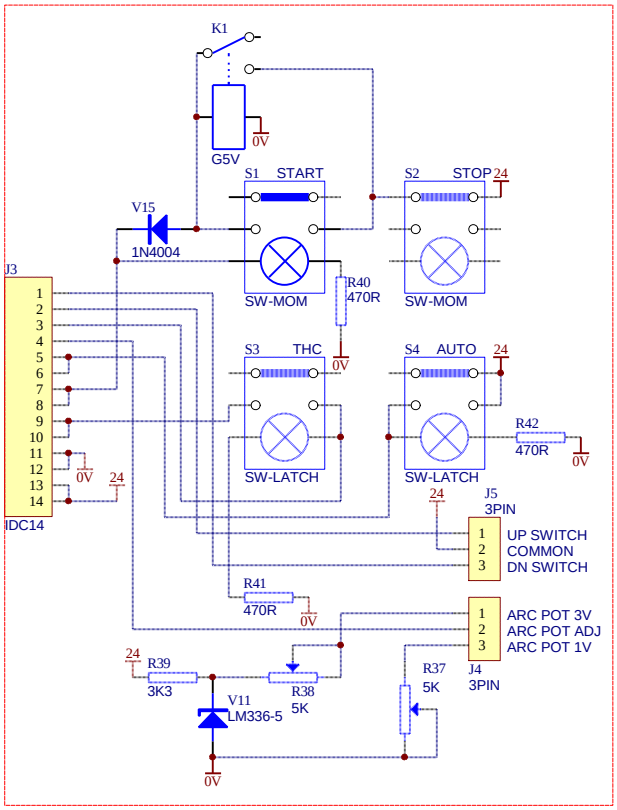
pin #	Name	Description	Notes
1	MOT1	output for DC motor	24V PWM output 20-30kHz
2	MOT2	output for DC motor	24V PWM output 20-30kHz
3	+24V	Supply DC+24V	maximum 36V
4	0V	Supply return 0V	
5	+PROXY	+24V output for supplying proxy switches	Output is activated when plasma input (J1 pin 8) or plasma switch (J2 pin 7&8) is activated and AUTO (J2 pin 5&6) is selected
6	+24V_AIR	+24V output for supplying mechanisms for lowering switches for initial height sensing	Output is activated after plasma input (J1 pin 8) or plasma switch (J2 pin 7&8) is activated and AUTO is selected, until NPN_PROXY (J1 pin 7) is activated.
7	NPN_PROXY	input - active, when switched to 0V	Output from NPN proxy switches or mechanical switches activated when torch is lowered to initial height.
8	+PLASMA	Input - +24V active	Control from CNC to start the plasma. Same as J2 pin 7&8.
9	PLASMA_ON1	Relay output	Connected to Plasma unit; plasma start
10	PLASMA_ON2	Relay output	Connected to Plasma unit; plasma start
11	THC_EN	Input - +24V active	Enables function of height sensing. This input must be interlock with the ARC ON RELAY from plasma unit and CORNER SLOW DOWN output from CNC controller. Directly linked to J2 pin 9&10
12	ARC_VOLTAGE1	Analog input from voltage divider (+V)	Differential input in range -5 to +5 V
13	0V	Screen of arc voltage cable	Screen of the cable should be grounded only on this end
14	ARC_VOLTAGE2	Analog input from voltage divider (-V)	Differential input in range -5 to +5 V

Connector J2 (14 pin IDC connector*)

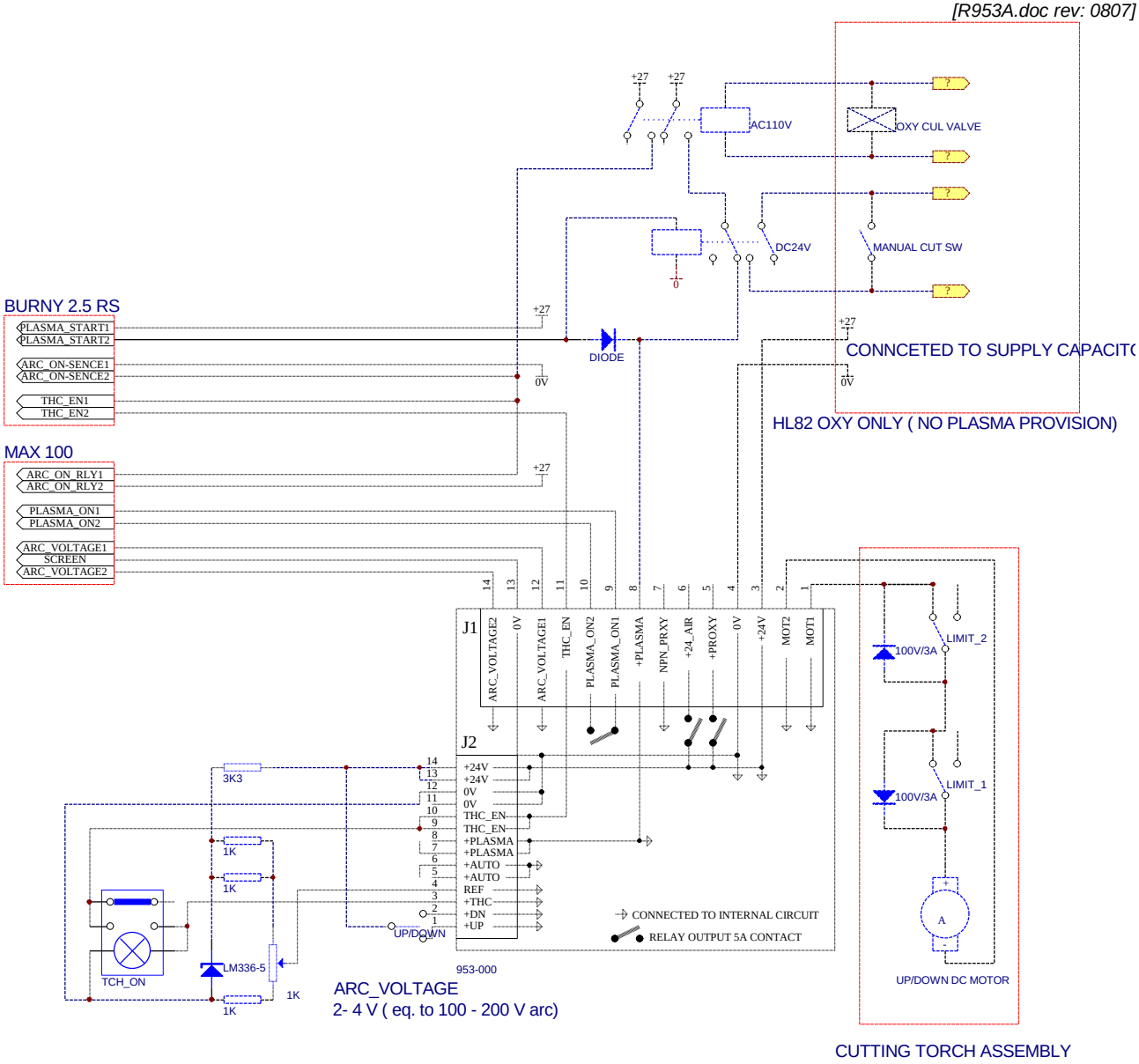
pin #	Name	Description	Notes
1	+UP	input 24V	activates movement UP of the motor
2	+DN	input 24V	activates movement down of the motor
3	+THC	input 24V	activates function of THC
4	REF	analogue input	preset of the arc voltage DC 0-5V
5&6	+AUTO	input 24V	enables automatic initial height sensing
7&8	+PLASMA	input 24V	when AUTO (J2 pin 5&6) not selected directly activates the plasma relay output (J1 pin 9 and 10); when AUTO (J2 pin 5&6) is selected activates the initial height sensing before activating the plasma relay output(J1 pin 9 and 10).
9&10	THC_EN	supply for THC switch	Directly linked to J1 pin 11.
11&12	0V	return of supply	same as J1 pin 4 & 13
13&14	+24V	supply 24V	same as J1 pin 3

* - for a upward compatibly a 16-pin header is used with pin # 15 & 16 removed

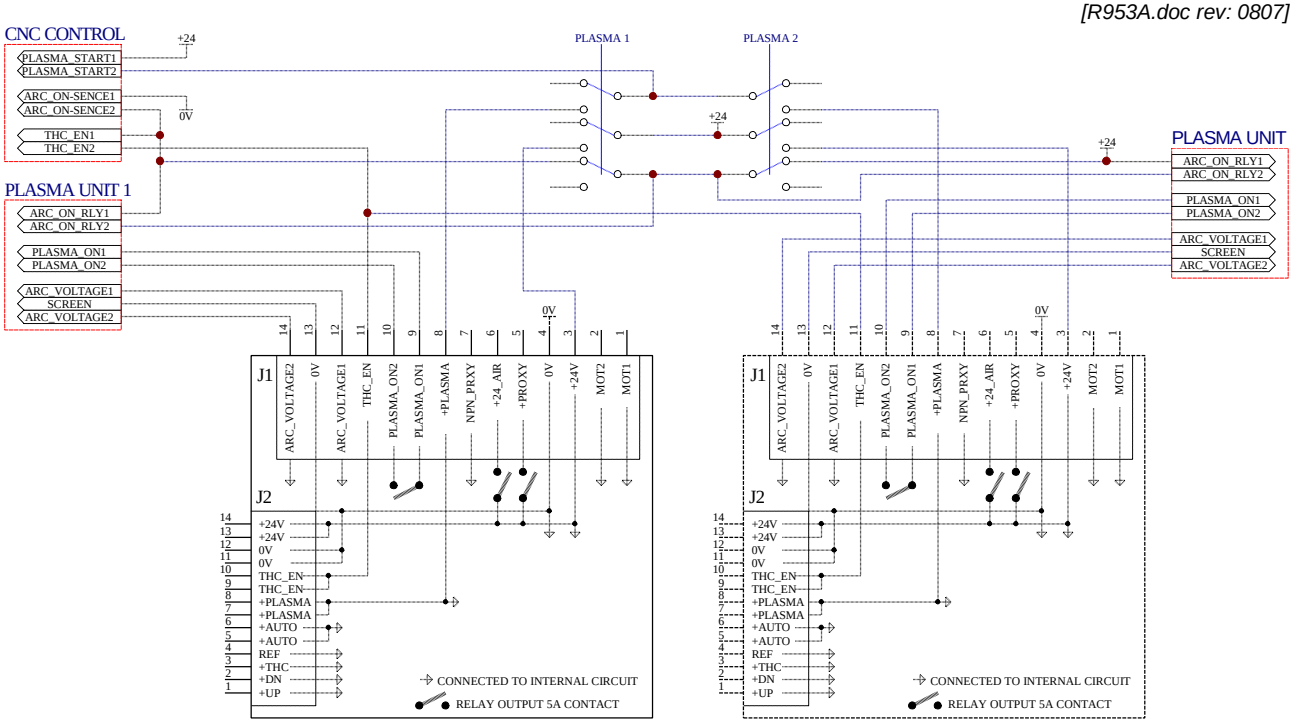
APPENDIX B



952-000 PCB



R953A (953-000) interfaced to the MAX100 plasma, Burny 2.5 controller and old type HL82 tracing head.



Two R953A (953-000) interfaced to one CNC and two plasma units