APC 300

Service Manual

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V 2.xx

ERBE

APC 300 No. 10132-010 Standard Version

ISO 9001
EN 46001

CE 0124

APC 300 No. 10132-011 UL Version

ISO 9001
EN 46001

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for APC 300 International and UL Version

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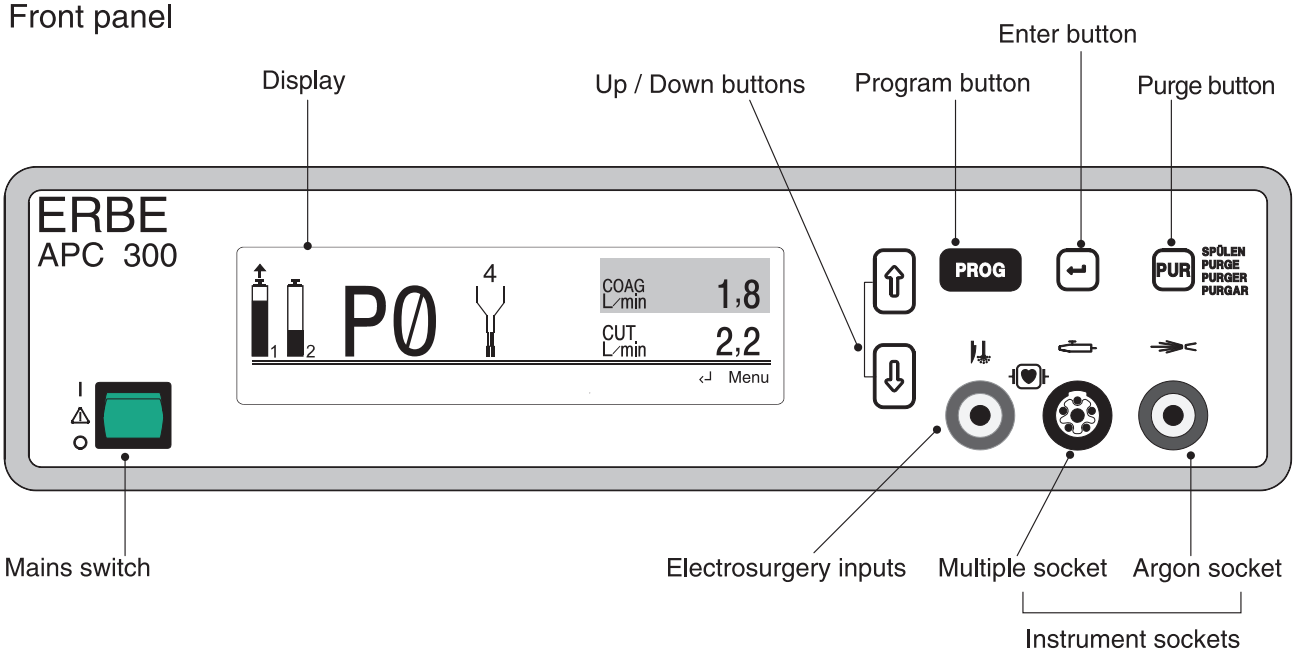
ERBE APC 300

Service Manual

Front panel



Imprint at the top cover of the UL version

Caution
Before connecting, and for additional instructions for the use of this equipment, refer to operating instruction manual.

Caution
Electrosurgery may present a hazard to patients with pacemakers. Consult qualified medical personnel.

Caution
Electric shock hazard.
DO NOT remove top cover. Refer servicing to qualified personnel.

Caution
Sparking at the active electrode is a common occurrence.
DO NOT perform procedures if flammable or explosive media are present, i.e. anesthetics, bio-intestinal gases, etc.

Caution
Risk of burns and fire.
Replace electrode cables upon evidence of deterioration.

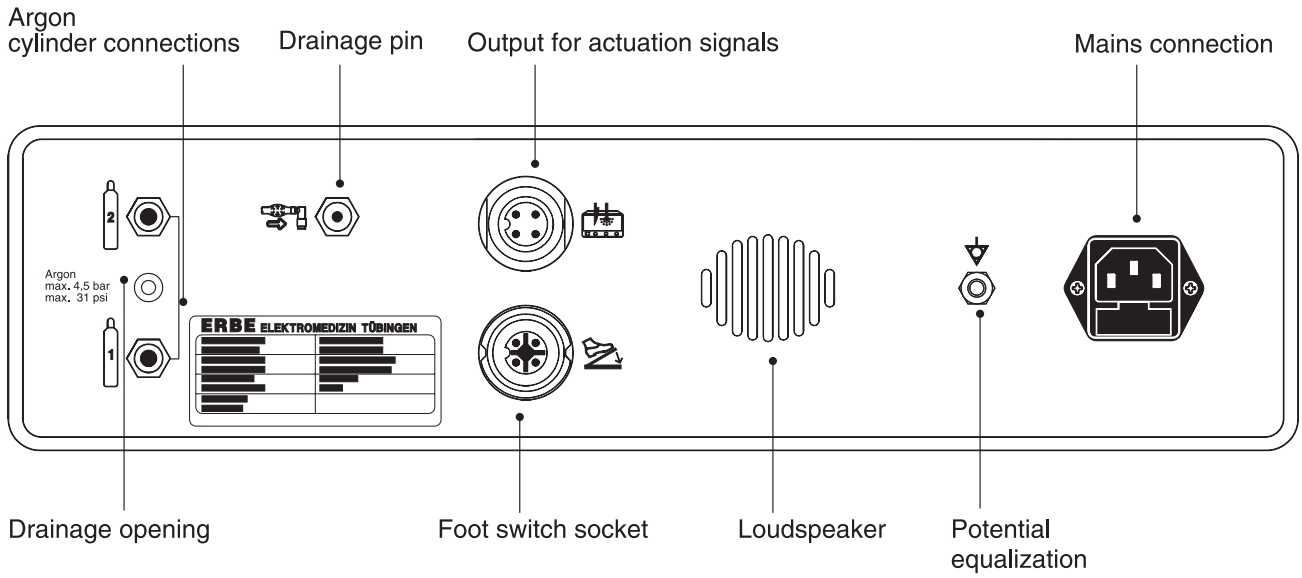
Warning
Hazardous RF-output current.
This equipment is for use only by qualified medical personnel.

Danger
Explosion hazard if used in the presence of flammable anesthetics

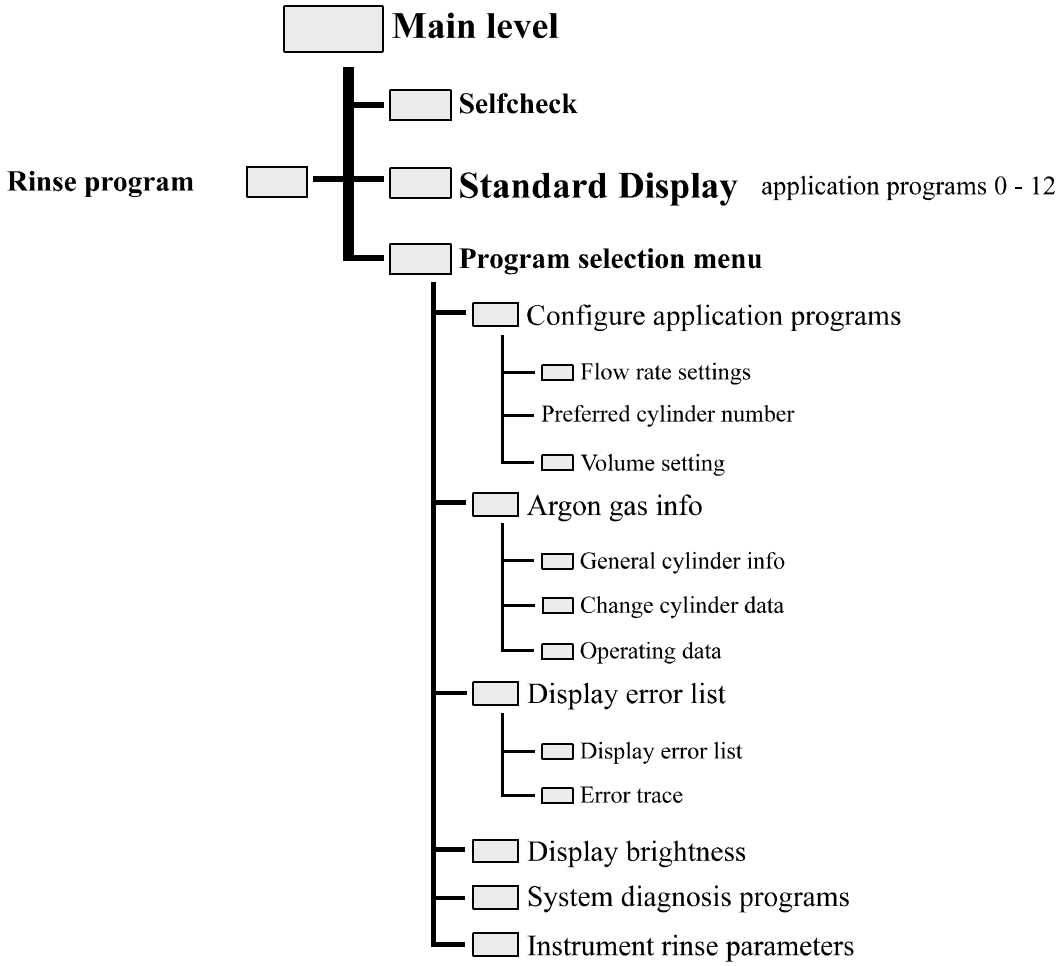
Note
Patient connection electrically isolated.

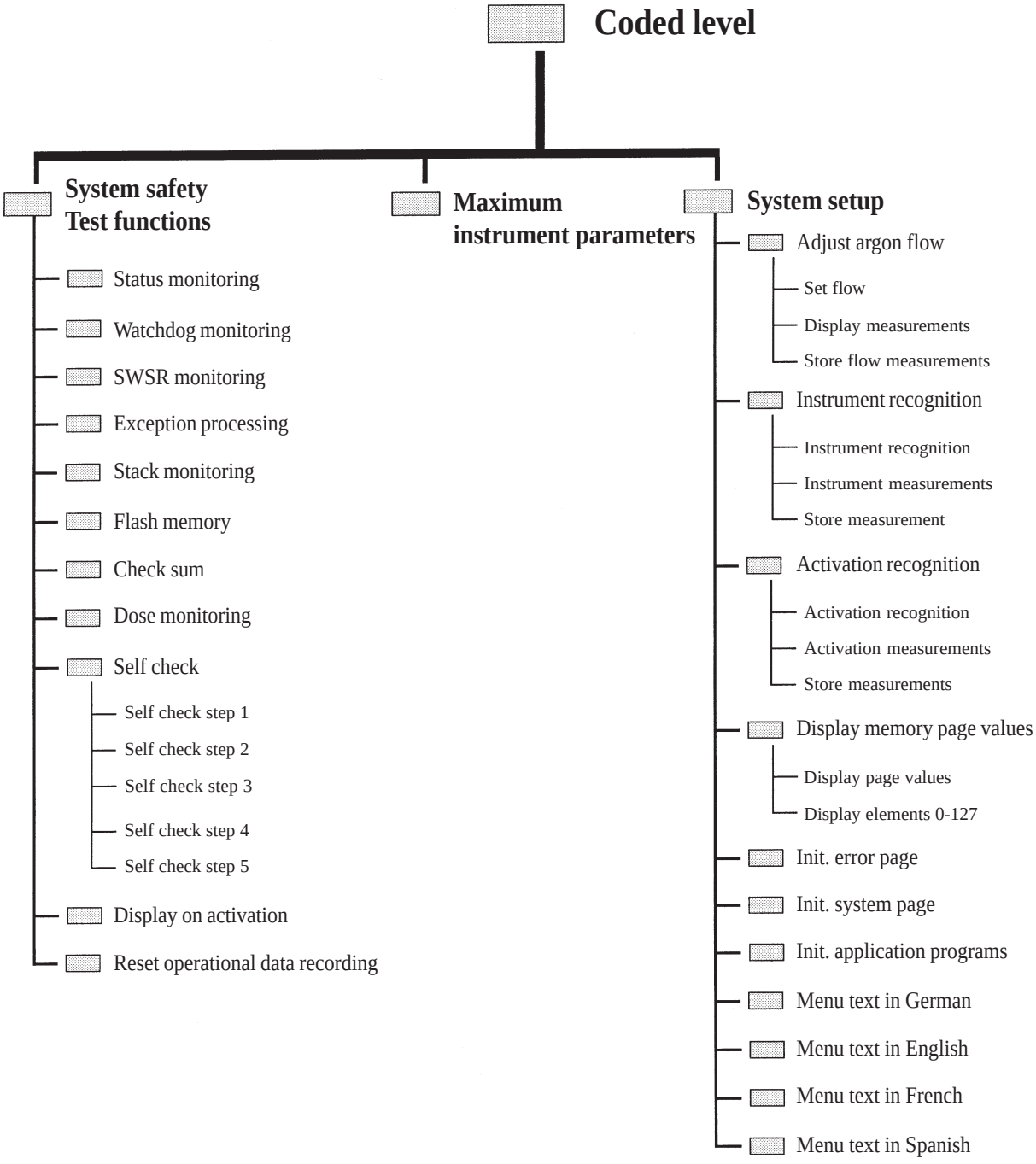
Note
Grounding reliability can only be achieved when the equipment is connected to an equivalent receptacle marked "Hospital Only" or "Hospital Grade".

Rear panel



Program structure APC 300




Coded level
System safety
Test functions
Status monitoring
Watchdog monitoring
SWSR monitoring
Exception processing
Stack monitoring
Flash memory
Check sum
Dose monitoring
Self check
Self check step 1
Self check step 2
Self check step 3
Self check step 4
Self check step 5
Display on activation
Reset operational data recording
Maximum
instrument parameters
System setup
Adjust argon flow
Set flow
Display measurements
Store flow measurements
Instrument recognition
Instrument recognition
Instrument measurements
Store measurement
Activation recognition
Activation recognition
Activation measurements
Store measurements
Display memory page values
Display page values
Display elements 0-127
Init. error page
Init. system page
Init. application programs
Menu text in German
Menu text in English
Menu text in French
Menu text in Spanish

Contents

Please notice: All values in the displays are shown in [bar] or [mbar]. 1 bar = 14.5 psi.

1 Safety notes for servicing

WARNING The safety instruction WARNING denotes a danger which can cause injury to persons.

CAUTION The safety instruction CAUTION denotes a danger which can cause damage to property.

ATTENTION The safety instruction ATTENTION denotes a danger which can cause failure of the device.

Safety precautions against the threat of electric shocks

WARNING! Only connect the APC 300 using the power cord supplied by ERBE, or one of at least the same quality, to a properly installed grounded outlet. If you use an equipment cart, this also applies to the power cord of the cart. The power cord must bear the national mark of conformity.

For safety reasons, multiple outlets and extension cords should not be used. If their use is unavoidable, they, too, must be provided with proper grounding.

WARNING! Unplug the power cord from the outlet before exchanging parts of the device or cleaning it.

WARNING! Do not plug in a mains cable which is wet into the device or into a outlet.

WARNING! Do not touch any unprotected wires or conductive surfaces while the device is disassembled and is under voltage. Never carry a grounding belt while working with a device under voltage.

WARNING! The unit is protected by mains fuses. If one of these fuses blows, the unit must not be used on patients until it has been checked by a properly trained technician. Only replacement fuses of the rating specified on the unit's name plate may be used.

WARNING! High-frequency voltages of over 1000 V are needed to ionize argon. Check that there is no damage to the electrical insulation of the applicators and all cords prior to use.

Dangers when handling argon cylinders

WARNING! Gas cylinders may only be transported with valve protection (cylinder cap).

WARNING! Protect the argon cylinder from being warmed by heaters or open fires.

WARNING! Argon cylinders may only be connected to the APC 300 with the pressure reducer and hoses provided by ERBE!

WARNING! No force of any kind should be exerted on cylinders, cylinder connections or the pressure reducer. Secure the argon cylinder during transport, storage and use from tipping over or falling down by means of chains, straps, safety belts. Always use the safety belt on the mobile equipment cart.

WARNING! The input pressure at cylinder connections 1 and 2 of the APC 300 must not exceed 4.5 bar (65.25 psi). If the unit is connected to a central argon supply, the input pressure must not exceed 2.5 bar (36.25 psi).

WARNING! Damaged cylinders must not be used. Mark them. Inform the argon supplier immediately. Only use argon cylinders conforming to your national safety standards.

WARNING! The APC 300 may only be operated with argon. A cylinder containing a dangerous or improper gas could be connected to the cylinder connection of the unit. Check each cylinder to ensure that it really does contain argon. Identification must not be damaged or missing.

WARNING! Argon is heavier than air. If it builds up in the air being breathed, it can displace the oxygen, so that there is a danger of suffocation. Symptoms of oxygen deficiency are drowsiness, rising blood pressure and breathing difficulties. In an atmosphere of pure argon, sudden and unexpected loss of consciousness and suffocation occur.

A short hissing noise will be heard when the gas valves are opened due to the argon flowing into the hoses. If this hissing continues for longer than 2 seconds when a cylinder is opened, there is a leak and the argon cylinder must be closed again immediately. The unit may not be used until the leak has been repaired. Make sure that the hoses are tightly connected to the APC 300. The same applies to the pressure reducer connection to the argon cylinder. Close the safety valve of the argon cylinders after use.

Environment

ATTENTION: The APC 300 can be operated at a room temperature of between +10 and +40° C. The effective humidity can be between 30% and 75%, non-condensing. If these tolerances are exceeded in either direction, the unit may break down.

ATTENTION: If the APC 300 has been stored or transported at temperatures below +10 °C, especially below 0 °C, the unit requires about 3 hours to acclimatize at room temperature.

ATTENTION: The APC 300 must be set up in a way that permits air to freely circulate around the case. The unit must not be set up in narrow niches or shelves.

CAUTION! The APC 300 is protected against penetration by liquids according to EN 60-601-2-2. The case is not absolutely water tight. For this reason, do not set up the unit in the direct vicinity of tubes or vessels containing liquids.

Electrostatically sensitive components

CAUTION! This device contains electrostatically sensitive components. Work at an anti-static workplace while repairing the device. Wear a grounding armband while working with electrostatically sensitive components. Hold the circuit boards by their non-conducting corners. Use an anti-static container for transporting electrostatically sensitive components and the circuit boards.

2 General Description of Clinical use

APC equipment combines argon gas with a monopolar power source. The electrode in the argon channel of the applicator is connected to an electrosurgical generator.

The APC applicator ionizes the argon gas where it remains ionized approximately 2-10 mm distal to the tip of the applicator. lonized Argon gas is electrically conductive. This allows the current to flow between the applicator and the tissue. Current density upon arrival at the tissue surface causes coagulation. The application of the energy to the tissue is uniform, and contact free.

The Argon plasma beam acts not only in a straight line (axially) along the axis of the applicator, but also lateralIy, radially and "around the corner" as it seeks conductive bleeding surfaces. Following physical principles, the plasma beam has a tendency to turn away from already coagulated (high impedance) areas toward bleeding or still inadequately coagulated (low impedance) tissue in the areas receiving treatment. This automatically results in evenly applied, uniform surface coagulation.

3 Installation

First-time operation

The APC 300 has been checked for proper and safe operation prior to shipment. In order to guarantee that the unit functions safely after transport and installation by the operator, it may only be put in operation after:

1. It has been subjected to a functional check in conjunction with the electrosurgical unit at the location of operation, and
2. those responsible for operating this combination of equipment have been instructed by the manufacturer or supplier on the proper use of this combination of equipment with reference to the operating instructions.

Mains fuses

The unit is protected by mains fuses. If one of these fuses blows, the unit must not be used on patients until it has been checked by an experienced technician. Only use replacement fuses of the rating specified on the unit's name plate.

Installation on the equipment cart

APC 300

The APC 300 is normally installed on an ERBE-equipment cart Type 20185-008 International version, 20185-009 UL version. It also carries the argon gas cylinder(s) and the high-frequency surgical unit required for operation.

Electrosurgical unit

The electrosurgical units ERBOTOM ACC 450 and ICC 350 are equipped with a high-frequency leakage current monitor which samples for high-frequency leakage current in the grounding and potential equalization conductors in these units. For this reason the units must be installed on the APC 300 in such a way that their cases are not in electrical conducting contact with the APC 300 casing: i.e. the aforementioned electrosurgical units must be electrically insulated and installed on the surface provided on the APC 300.

Location of equipment cart in the operating theatre

If the electrosurgical unit and the APC 300 are installed together on an equipment cart, this system must be kept outside any operating theatre subject to danger of explosion. Read the operating instructions of the electrosurgical units under *Explosion protection* →.

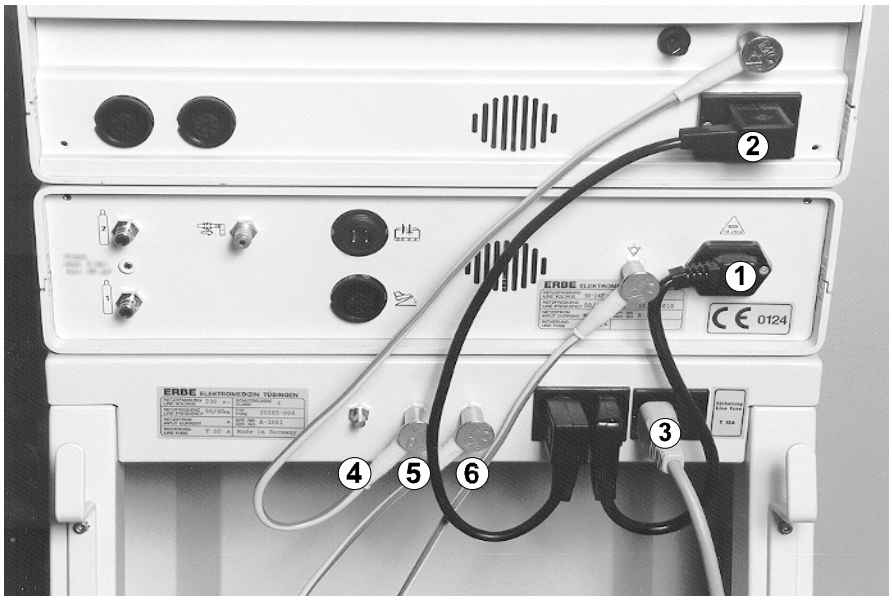
Electrical Installation on the equipment cart

Only connect the APC 300 using the power cord supplied by ERBE, or one of at least the same quality, to the equipment cart's power connection. The power cord must bear the national mark of conformity. The power cord is connected to a properly installed grounded outlet.

Apart from the APC 300 and the electrosurgical unit, no other appliances must be connected to the mains outlets of the equipment cart.

For safety reasons, multiple outlets and extension cords should not be used. If their use is unavoidable, they, too, must be provided with proper protective grounding.

To avoid high frequency disturbance, and to protect the patient, connect the potential equalization pins of the electrosurgical unit and the APC 300 to the equipment cart via potential equalization conductors. Connect the potential equalization of the equipment cart to the potential equalization of the operating theatre.



NOTE

The CE 0124 sign is not at the UL version.

(1) power cord from APC 300 to equipment cart

(2) power cord from ICC to equipment cart

(3) power cord of the equipment cart

(4) Potential equalization equipment cart - operating theatre

(5) Potential equalization equipment cart - ICC

(5) Potential equalization equipment cart - APC 300

Environmental conditions

The APC 300 can be operated at a room temperature of between 10 and 40 °C. The effective humidity can be between 30% and 75%, non-condensing. If these tolerances are exceeded in either way, the unit may break down.

The APC 300 must be set up in a way that permits air to freely circulate around the case. The unit must not be set up in narrow niches or shelves.

The APC 300 is protected against penetration by liquids according to EN 60-601-2-2 . The case is not absolutely watertight. For this reason, do not set up the unit in the direct vicinity of tubes or vessels containing liquids. Do not place any liquids on the APC 300.

4 Gas supply

Central gas supply

The maximum permissible input pressure is 2.5 bar (36.25 psi). The APC 300 must be modified by a technician if a central argon supply is used.

Connecting argon cylinders

The input pressure at cylinder connections 1 and 2 of the APC 300 may not exceed 4.5 bar (65.25 psi).

ERBE advises working with two argon cylinders with a volume of 5 liters and a pressure of 200 bar (2900 psi). The APC 300 has been programmed by ERBE to operate with this type of cylinder. If you wish to use other types of cylinders, you must reprogram the cylinder data in the menu *Argon gas information* under menu point *Changing cylinder data*.

To change cylinders, the APC 300 must be switched on.

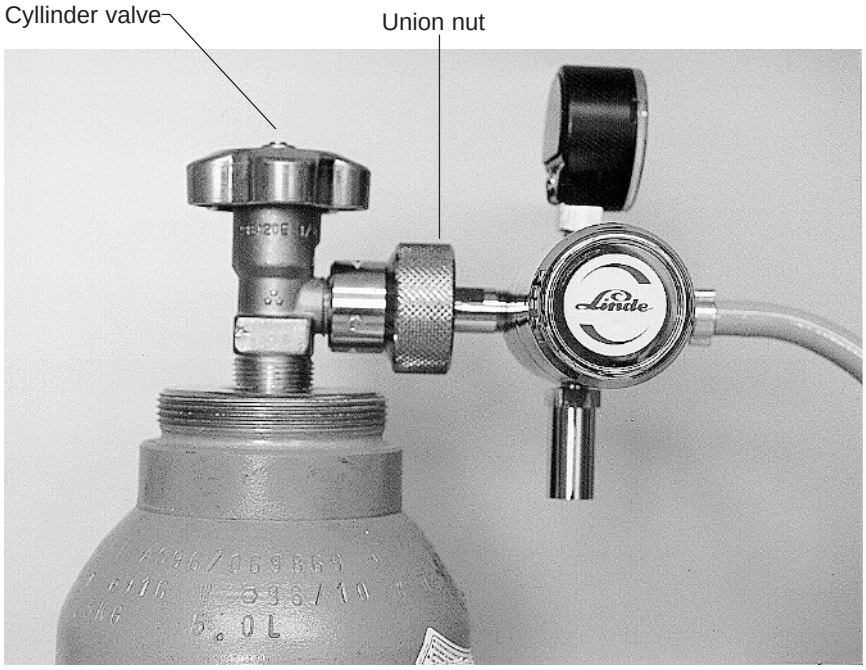
Unmounting cylinder

1. Shut the cylinder valve. The cylinder valve may be a little stiff.
2. Remove the pressure hose of the argon cylinder at the rear of the APC 300.
3. Place the hose opening on the drainage pin at the rear of the APC 300 and press. The hose contains a residue of argon which escapes with a loud hissing noise.
4. The union nut of the pressure reducer should only be unscrewed to the left and removed by hand.

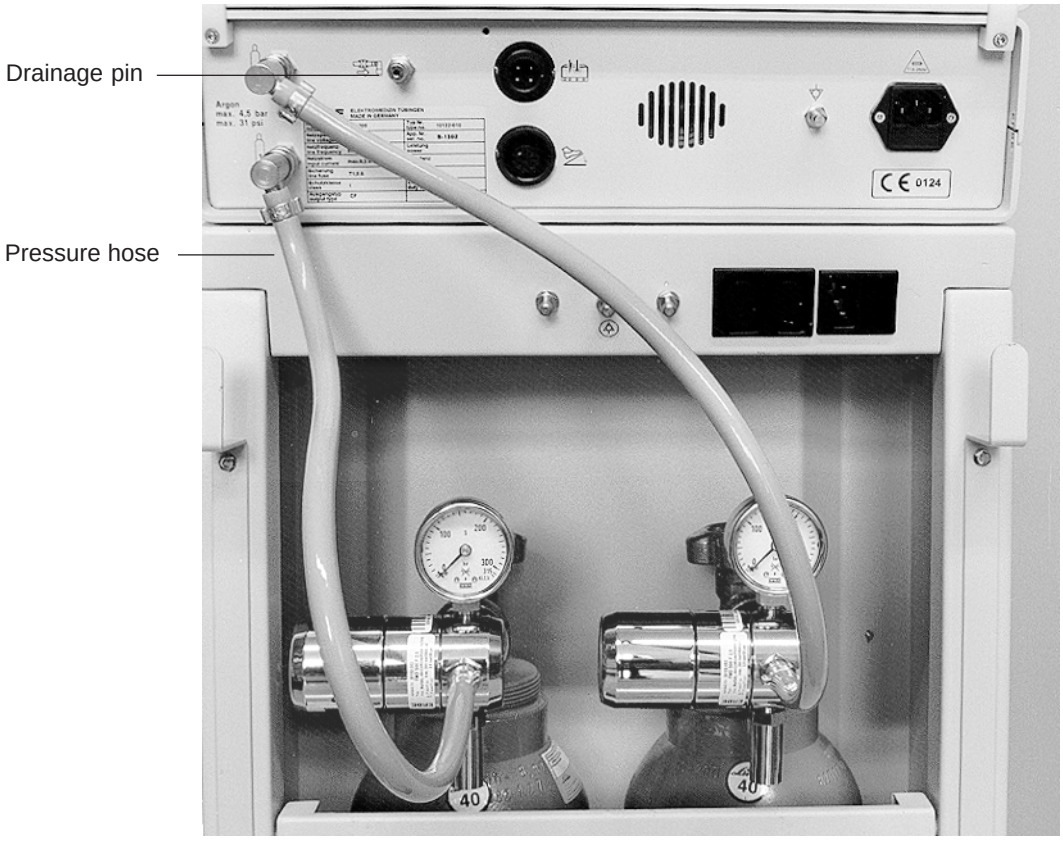
Mounting cylinder

1. The pressure reducer should only be screwed onto the new cylinder to the right by hand.
2. Open the cylinder valve.
3. Put the pressure hose onto the cylinder connection of the APC 300.

The system will now automatically be rinsed with argon by the APC 300. If the presure hose and pressure reducer are fitted tightly, no further hissing noises should be audible!



Connecting pressure reducer to cylinder



Connecting pressure hoses

NOTE
The CE 0124 sign is not on the UL version.

5 Description of the front and rear panels

Diagrams on folding leaf clockwise

Operating elements on the front panel

Display

On the display, the graphical interface (shell) of the APC 300 is shown. The shell is the interface between the operator and the unit's software. Using the shell, the instrument's COAG flow and CUT flow, as well as all the functions of the APC 300, can be controlled and the unit modified to suit your requirements. See CHAPTER 7 *Description of the graphical interface of the APC 300* in APC 300 Handbook →.

UP / DOWN buttons

The UP / DOWN keys are used to set the flow parameters. For instance, up: increases COAG flow, down: decreases COAG flow.

In addition, the UP / DOWN keys are used for marking menu items in selection menus. All the APC 300's menus have the same structure. There is a cursor in the second line. If you press the up or down keys, the cursor runs up and down the menu items.

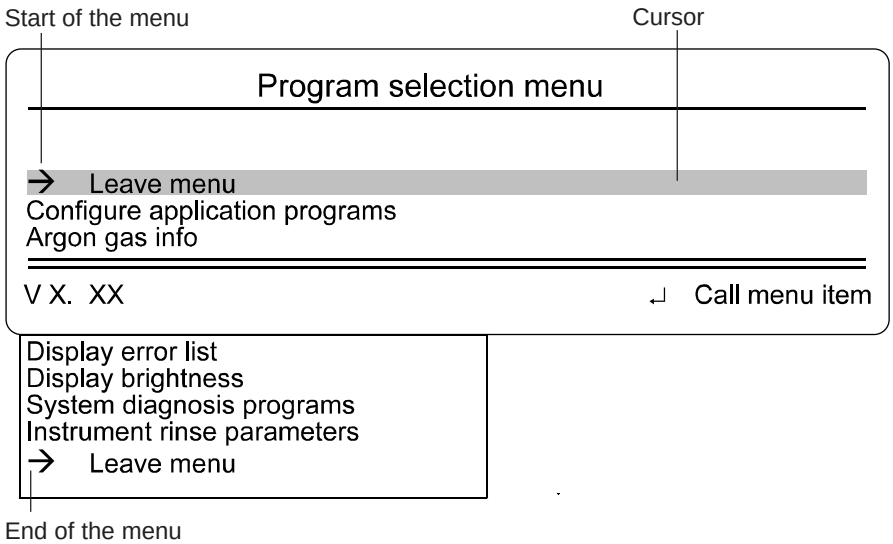
PROGRAM button

The APC 300 possesses 13 application programs. Using these, you can, among other things, program and store COAG flow and CUT flow settings for a particular instrument.

Using the program key, the selected application program is started.

ENTER button

The enter key is used to alternate between the standard display and the program selection menu and for calling the menu item marked. Its current function is always shown on the bottom, at the right of the display.



PURGE button

Using the purge key, the rinse program is called. Before an instrument is actuated for the first time it must be rinsed with argon.

Instrument outlets

Argon outlet
Argon output. Insert the instrument's argon gas connection into this outlet.

Multiple outlet

Input of finger switch signals, instrument recognition, output of high-frequency current. Insert the instrument's multiple plug into this outlet.

Meaning of the symbol 

The unit has been built in compliance with Type CF (cardiac floating) and it has a patient leakage current of less than 10 µA. The APC 300 is protected against defibrillator voltages.

HF inputs

The high-frequency current of the electrosurgical unit is conducted to the APC 300 via this outlet. Insert the high-frequency lead into the outlet. Connect it to the CUT / COAG outlet of an ERBE electrosurgical unit. The ICC 300 and 350 possess two CUT /COAG outlets. Please refer to the CHAPTER 8 entitled *Actuation concepts* in APC 300 Handbook → to discover which outlet is used for which concept.

Mains switch

Before the unit is switched on, the APC 300 should be installed and configured as described in CHAPTERS 4 and 8 →in APC 300 Handbook .

Switch on the APC 300 about 5 minutes before starting an application. The unit requires this amount of time to reach its thermal equilibrium and to conduct self checks and functional tests.

Self checks
After being switched on, the unit conducts a self check in which the pressure sensors are tested. If an error is identified, the message *Selfcheck Error* appears on the standard display. The unit of flow *[L/min]* is not shown. Despite this error, the COAG flow and CUT flow can still be set and the unit utilized.

If a self check error occurs, the APC 300 should only be used in an emergency when no reserve unit is available as an argon overdose could occur. This is, however, less of a threat than the non-availability of the APC 300 in an emergency.

Functional test

The unit conducts a functional test in which the keys on the front panel, the foot and the finger switches are checked. In addition, the APC 300 identifies whether a supply of argon gas is available. The supply level in the gas cylinders may also be identified. Errors are displayed in plain language and signalled by an audible signal.

Meaning of the symbol 

Only use the APC 300 if you are familiar with its operation and properties.

Operating elements on the rear panel

Argon cylinder connections

Only argon gas cylinders or a central argon supply may be connected to these cylinder connections.

Cylinders with a capacity of 5 liters or other volumes can be connected. The pressure reducer supplied by ERBE must be installed on the argon cylinders. The cylinders may only be connected using the pressure hoses supplied by ERBE. The input pressure for the gas cylinders is maximally 4.5 bar (65.25 psi).

If the APC 300 is connected to a central argon supply, the maximum input pressure is 2.5 bar (36.25 psi).

WARNING! The APC 300 may only be operated with argon. A cylinder containing a dangerous or improper gas could be connected to the cylinder connection of the unit. Check each cylinder to ensure that it really does contain argon. Identification must not be damaged or missing.

Argon cylinders may only be connected to the APC 300 with the pressure reducer and hoses provided by ERBE.

Please read the APC 300 Handbook CHAPTER 5 *Changing cylinders* →. Please read sections *Danger of pressure explosions* and *Dangers associated with handling of argon* in CHAPTER 2 *Notes on safety* →.

Drainage pin

There is a residual amount of argon in the pressure hoses of empty argon cylinders. In order to empty the hose when changing the cylinder, the hose is pressed onto the drainage pin.

Output for actuation signals

The actuation signals (foot or finger switch of the instrument) are conducted to the electrosurgical unit via this outlet. Insert the connection lead 20189-022 or 20132-063 into this outlet and connect it to one of the foot switch outlets at the rear of the electrosurgical unit. Please refer to CHAPTER 8 *Actuation configurations* → in APC 300 Handbook to discover which outlet and which lead is used for which configuration.

Power cord

WARNING! Only connect the APC 300 using the power cord supplied by ERBE, or one of at least the same quality, to a properlyly installed grounded socket. The power cord must bear the national mark of conformity. If you use the equipment cart provided by ERBE, the power cord of the APC 300 is connected to the outlet of the cart.

For safety reasons, multiple outlets and extension cords should not be used. If their use is unavoidable, they, too, must be provided with proper protective grounding.

Please read the section *Electrical installation on the equipment cart* in the Handbook CHAPTER 3 entitled *Installation* →.

Potential equalization connections

To avoid high-frequency disturbance, and to protect the patient, connect the potential equalization pin of the APC 300 to the equipment cart via potential equalization conductors.

Loudspeaker

Over the loudspeaker of the APC 300, actuation and warning signals are emitted. Always place the APC 300 / the equipment cart in a position where the audible signals can be heard clearly.

Foot switch outlet

A single- or two-pedal foot switch can be connected to this socket. Please refer to CHAPTER 8 entitled *Actuation configurations* in APC 300 Handbook → to discover which outlet is used for which concept.

Drainage opening

During the self check, argon is expelled through this opening.

6 Technical Data

Technical Data

APC 300 Typ Sp. No. 10132-010 Standard version

APC 300 Typ Sp. No. 10132-011 UL version

Supply voltage	100-230 V 50 / 60 Hz
Current input	0.3 A
Mains fuse	T 1 A
Protective Class according to EN 60 601-1 IEC 601-1	I, CF
Potential equalization	Yes
Cylinder connections	2 connections, 2 cylinders 5 l recommended
Input pressure of cylinder connections when gas cylinders are connected	Minimum 2.5 bar (36.25 psi), maximum 4.5 bar (65.25 psi)
Maximum input pressure of cylinder connections when central gas supply is connected	2.5 bar (36.25 psi)
Maximum cylinder pressure	200 bar (2900 psi)
Minimum purity of argon	99.998 %
Maximum gas flow rate	from 0.1 l/min to 9 l/min regulated argon flow with pressure limitation
Modes of actuation	Foot switch or finger switch
Automatic instrument identification	Yes
Automatic flow setting	Yes
Plain language error messages	Yes
Weight of APC 300	6.8 kg
Size of APC 300	W x H x D 410 x 105 x 380 cm W x H x D 161 x 41 x 150 inches
Size of equipment trolley	410 x 820 x 445 cm 161 x 213 x 175 inches

7 Circuit diagram, circuit descriptions

The circuit diagram of the APC 300

In conjunction with suitable electrosurgical equipment (e.g. from the ERBE ICC series), the **A**rgon **P**lasma **C**oagulator APC 300 is an argon coagulator controlled and regulated by microcomputer.

The **mains voltage** in the range of 90V to 230V nominal arrives via a **power line filter** (to limit EMC problems) and the **mains fuses** at a **switching power supply** which adjusts the highest permissible power voltage range and produces and stabilizes the required operational voltages + 12 V, + 5 V and - 12 V.

The **argon** emerges from the supply cylinders via a separate **pressure reducer** to a **pneumatic unit** in which several electrically controlled valves are located for controlling and regulating the flow of the argon. In addition, a 0.8 µ filter is integrated to remove particles in the gas flow.

The valves of the pneumatic unit are set by the **microcomputer unit** (MCU 68332) both through the proportional valve driver and the valve controller and valve driver.

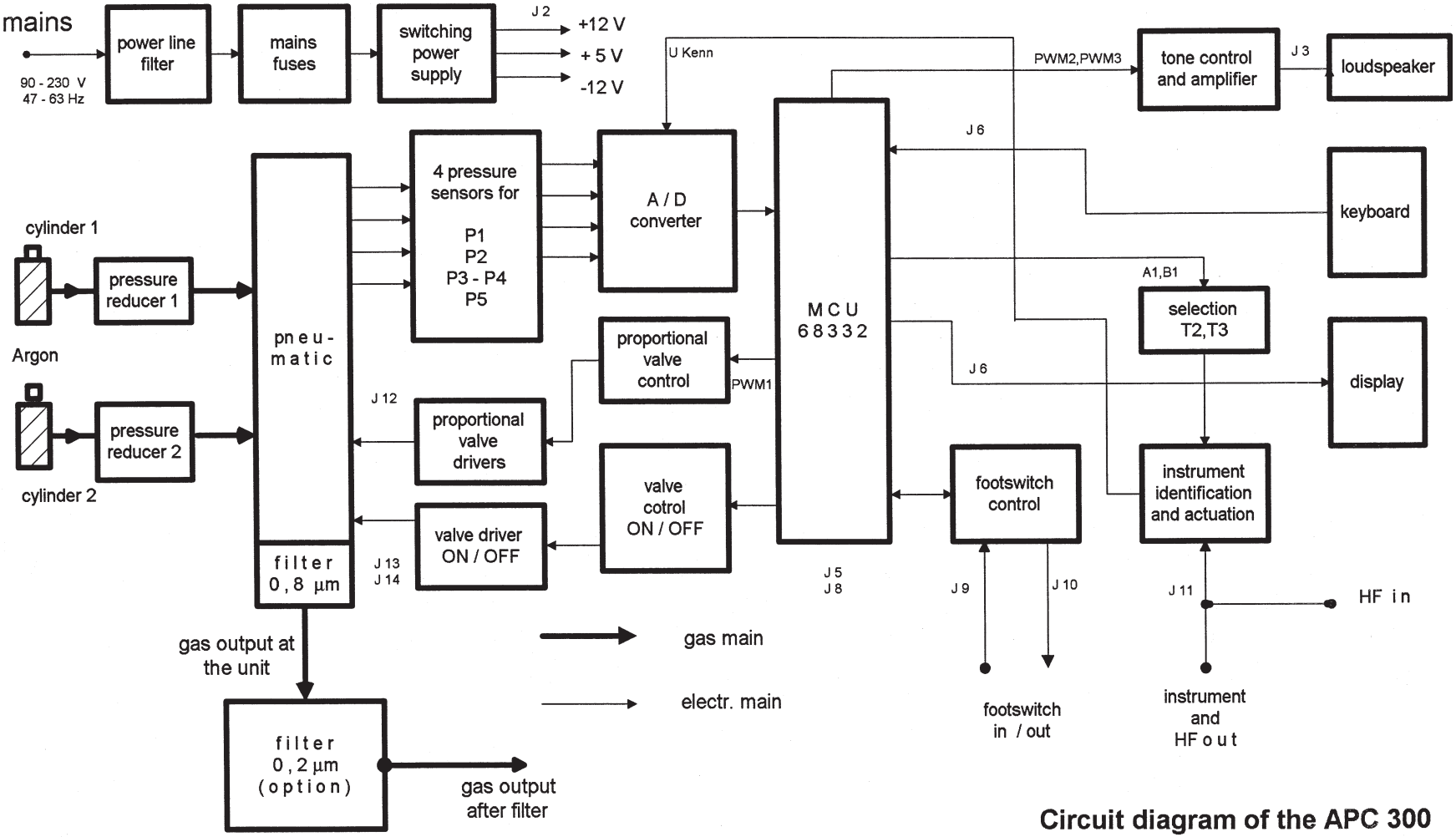
From the pneumatic unit, hose connections lead to four **pressure sensors** by means of which the gas flow is regulated and the proper function of the gas unit can be tested. The analog output signal of the pressure sensors is fed through an analog/digital converter to the microcomputer unit for evaluation.

A fluorescent display tube (**display**), a **keyboard** and a **loudspeaker** serve as interfaces for communication between the user and the APC 300.

The display receives its data from the microcomputer unit. Inputs to the keyboard are fed to the microcomputer unit and the audible signals are generated in the microcomputer unit, processed in the tone controller and amplified before being sent out through the loudspeaker.

The APC 300 can be actuated both via footswitches and via finger switches. The **footswitch control unit** conducts the signals to the controller of the APC 300 and to the electrosurgical equipment.

Several different types of instruments, requiring different performance parameters, can be connected to the APC 300 as desired. The APC 300 can be actuated via the instrument connected. At the same time, it is automatically recognized, which instrument is connected and which working parameters are stored for this instrument. The **instrument and actuation identification facility,** which conveys its signals to the microcomputer unit, is present for this purpose.



Circuit diagram of the APC 300

Circuit description of the APC 300

The **A**rgon-**P**lasma-**C**oagulator APC 300 consists of the following components and circuit boards

- main board 30132 - 021
- MCU 68332 30132 - 043
- front panel 30132 - 067
- switching power supply 40132 - 101
- pneumatic control block, complete 40132 - 090
- fluorescent display tube 50602 - 039

The **circuit diagram** shows the links between the different function groups.
The different function groups are each described individually.

The main board (30132 - 021)

The main board contains the following function groups:

- 4 pressure sensors
- A/D converter with serial data transfer
- monitor for instrument and actuation identification
- footswitch control unit
- controller of the proportional valve
- controller of the other valves with valve drives
- controller for the signal tones
- level converter
- connectors to the MCU unit and the display
- clock pre-scaler, target memory and bus driver.

The main board contains four **pressure sensors IC 21 to IC 23**, with which the

- cylinder pressure of cylinder 1 with IC 23, measured quantity p 1
- cylinder pressure of cylinder 2 with IC 24, measured quantity p 2
- output pressure with IC 21, measured quantity p 5
- differential pressure with IC 22, measured quantity p 3 - p 4 (corresponds to actual flow) can be measured.

The pressure sensors are connected via **hose connections** to the pneumatic block of the APC 300.

The output signals of the pressure sensors are amplified in the **instrument amplifier IC 15 to IC 19** and then fed to the A/D converter IC 13. From here, the digital signals are transferred via a serial connection to the MCU 68332.

For small flow values the output signal ANA2 of the OP amplifier IC 16 can be further amplified in the OP IC 17, so that the output quantity ANA5 is better adjusted to the shift of the A / D converter and can be processed more efficiently.

The **A/D converter IC 13** converts the analog measured quantity of the the pressure sensors, the monitor output voltage U_KENN, the reference voltage Ref = 10 V and the negative supply voltage Vee = - 12 V into digital quantities and transfers these in queued serial mode to the MCU 68332.

The operation amplifier IC 14 amplifies the reference voltage formed by the A/D converter from 2.5 V to 10 V. In order to detect errors in the APC 300 the amplified reference voltage is compared with the negative supply voltage. The APC 300 allows various accessories to be connected, which must each be operated with the optimal gas flow defined for them. It is thus advantageous for the APC to be able to identify automatically which accessory is currently connected in order to be able to select the optimal setting automatically.

Equally, the APC 300 can identify whether and when it is actuated via an instrument. In order to realise this function a monitor which can identify which instrument is connected to the APC 300 and which actuation state it is in is required.

The circuit diagram of the **instrument and actuation identification monitor** is in the right-hand half of sheet 1 of the main board.

In priciple the monitor is an oscillator whose signal is caught via a transformer and fed to the instrument in order to separate the potentials. This oscillator can now be damped to different degrees with the defined resistances in the instrument, by means of which the amplitude of the oscillator changes. The change in amplitude is evaluated.

In the present circuit the left-hand part of the OP amplifier IC 3, represents an oscillator which oscillates at a frequency of about 60 kHz. The oscillator can be switched on and off via transistor T 1.

The oscillation produced is fed to two OP amplifiers of the circuit IC 3 in turn, which function as a voltage-controlled current source due to their inverse feedback via resistance R 24, and feed the transformers UE 1 and UE 2.

Transformers UE 1 and UE 2 are alternately switched against ground by the MCU via the target memory IC 4 and the transistors T2 and T3, so that each of these transformers is actuated alternately for about 6 msec. In this manner the alternately damped signal can be unambiguously attributed to the instrument or actuation by the MCU.

Via the plugged connection J 11, leads go to the surgical instrument connected, in which there are two defined resistances.

One of these resistances leads to transformer UE 1 via a pushbutton key. When the key is pressed, the transformer UE 1 is damped depending on the resistance value, from which the APC 300 can recognize an *actuation intention*. (Actuation identification). The circuit can recognize 10 different values.

The other resistance in the instrument is permanently connected to transformer UE 2 and damps it. By varying the resistance, 10 different states can be decoded. This is the means by which the APC 300 can recognize up to 10 different *instruments*, whereby the APC 300 can call the operating modus allocated to the respective instrument. (Instrument identification).

After an active band pass (IC 7 , R 31 - R 36, C 23, C 24 and C 26), which filters the high-frequency interfering signal, the signal damped by the measurement resistances is rectified by the Schottky diode D1. The capacitor C 13 forms a mean of the signal together with resistance R 9. The rectified signal produced thus is decoupled via the fourth OP of the IC 3 as voltage follower and fed to A/D converter IC 13. The digitized voltage value is evaluated in the MCU.

The APC 300 can be actuated both via a footswitch and via the handle of the surgical instrument. Parallel to the APC 300 the accompanying electrosurgical equipment must also be actuated, since the high-frequency voltage is required to ignite the argon plasma. The electrosurgical equipment is to be controlled from the APC 300 with potential separation via the footswitch cable.

For this reason a **footswitch control unit** which fulfills all the conditions mentioned is needed.

This footswitch control unit is represented on sheet 2:

The footswitch is connected to plug J 9. It is connected to the electrosurgical equipment via plug J 10. Here the +12 V supply voltage is present at contact 1, contact 2 enables the coagulation channel to be actuated. Contact 3 actuates the cut channel.

The contact allocation of plug J 9 is shown in the circuit diagram, the letter A represents the cut channel and B, the coagulation channel.

The relay contacts REL 1 to REL 4 show the switching condition when the APC 300 is switched off. From this it is possible to recognize that the +12 V supply voltage of the electrosurgical equipment is looped through to the footswitch, as the switched output lead of the footswitch is looped back to the high-frequency surgical equipment. This means that the electrosurgical equipment can be actuated directly via the footswitch when the APC 300 is off. **Therefore, it is not necessary to unplug the footswitch from the APC 300 and plug it into the** electrosurgical **equipment, or even to switch on the APC 300 to operate the electrosurgical equipment on its own.**

However, if the APC 300 is switched on, the contacts of relays REL 1 and REL 2 are switched over. The footswitch

now obtains its + 12 V supply voltage via plug J 9, contact 1 directly from the APC 300 supply. The switching signals of the footswitch now no longer go directly through to plug J 10, but are switched to connections FB and FA of the APC 300, where they reach the MCU for processing. The actuation signals from the actuation monitor also come to the MCU.

If the MCU now recognizes that an actuation has occurred - via footswitch or finger switch - the MCU will see that when the cut channel is actuated, relay REL 4 is switched to, and when the coagulation channel is actuated, relay REL 3 is switched to. As a result, the electrosurgical equipment now receives the appropriate control voltages via its own voltage supply isolated from the APC 300.

The APC 300 is able to regulate a prescribed flow volume precisely. To do this, it is necessary to record the actual flow via sensors, to compare it with the required value and to control a directly controlled system in which a **proportional valve** will set the flow in such a manner that the deviation from the required value is as small as possible.

The proportional valve is realized in the APC 300 as follows:

The MCU generates a pulse-width modulated signal whose pulse width depends on the required lift of the piston in the valve. This signal is present at measurement point MP 6. Next, it is “filtered“ in the low pass R 48, C 39 which sets up a mean value at the input of the operation amplifier IC 20. IC 20 is switched as a voltage follower and decouples the voltage before it comes to the input of the OP amplifier (2nd part of the IC 20) which together with the Darlington power transistor T 12, and its negative feedback resistances R 57 and R 58, acts as a voltage-controlled current source. Via the plugged connection J 12, the current flows from the proportional valve through this current source and thus sets the desired argon gas flow.

For controlling the gas flow, other valves known as **two/two-way valves** are required. They are only able to switch the gas flow on or off and do not behave proportionately. To control them it is sufficient to switch the field current on or off.

The MCU transfers the **control pattern** of the **valves** via Port 3 to the target memory IC 12, an 8-fold D-flipflop in which the pattern is stored. The control leads VT 1 to VT 8 are each led to the respective bases of eight Darlington power transistors T4 to T11 which are connected via the plugged connections J 13 and J 14 to the control leads of the valves.

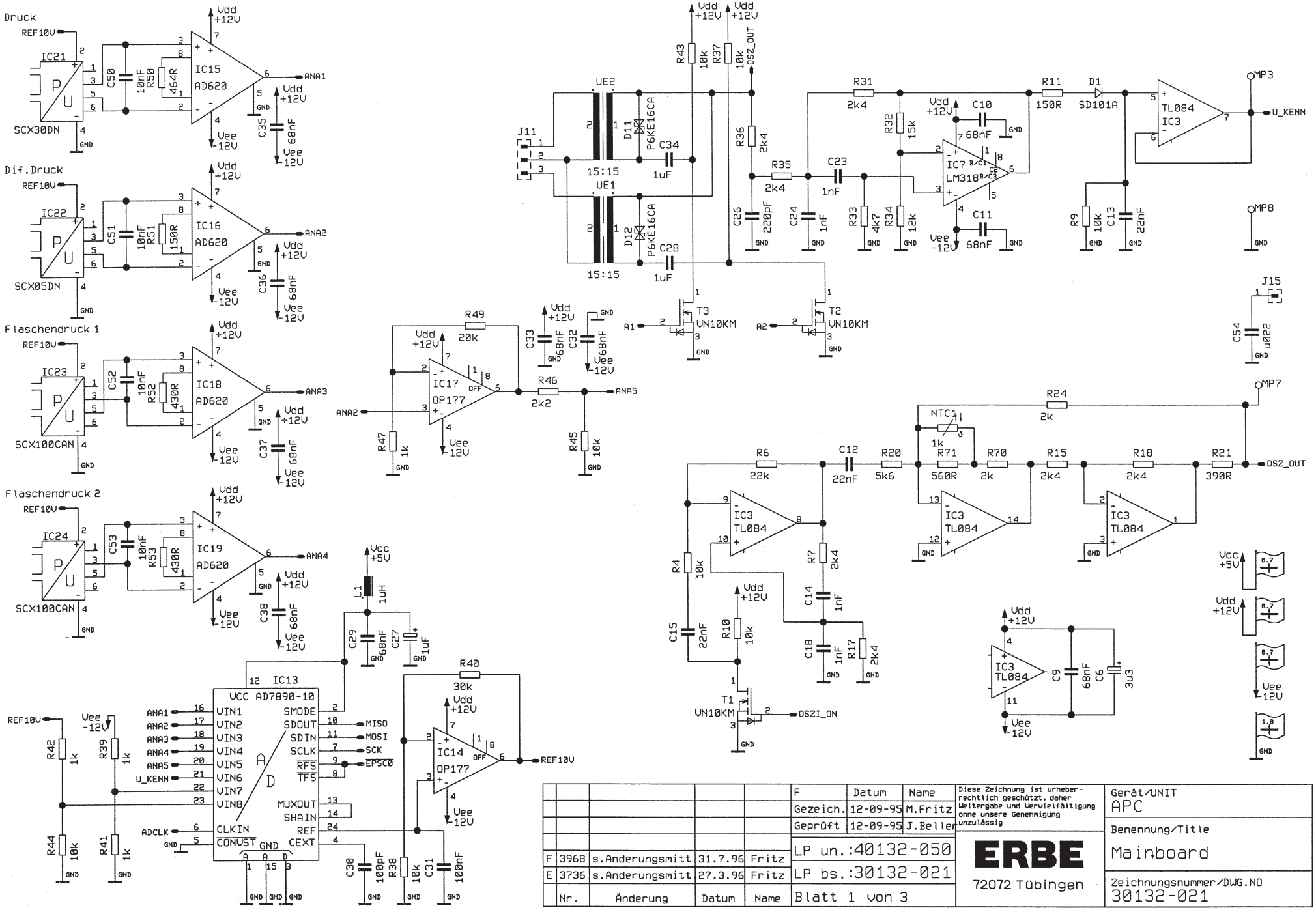
The **tone control** and generation of the signal tone frequencies takes place in the MCU. The MCU produces the **tone frequency** directly, as well as a pulse-width modulated signal for controlling the **volume**, the pulse width of the signal corresponding to the volume. The signal is available at the connection PWM 3 via the bus driver IC 6 and filtered by means of the RC low pass R 25, C 20. As a voltage follower, the subsequent OP amplifier IC 5 decouples the signal, inverts it and amplifies it.

The tone frequency signal is available at the PWM 2 and is mixed via resistors R 28 and R 29. The network R30,C19,C17 and R1 conducts a sound formation to make the tone sound more pleasant. The tone frequency is amplified in amplifier IC 2 in such a way that a loudspeaker can be operated via plug J 3.

The hex buffer IC 9 acts as a level converter which converts CMOS levels into TTL levels (e.g. the footswitch signals FA and FB).

The **frequency divider IC 4** divides down the clock frequency for operating the A/D converter IC 13.

The **microcomputer unit MCU 68332** is positioned directly on the main board via two multiple-plugged connections.



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					Geprüft	12-09-95	J.Beller
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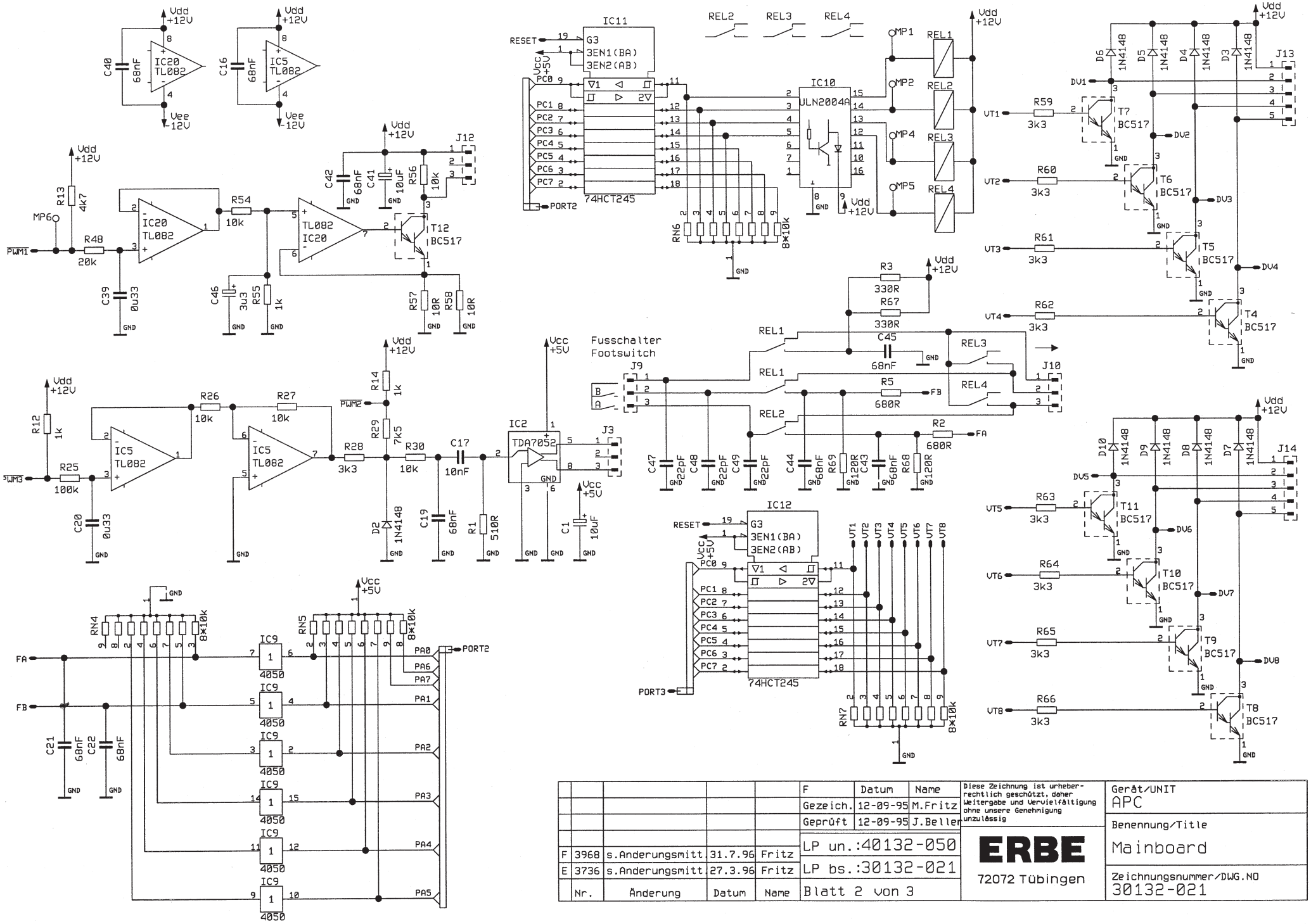
E	3736	s.Anderungsmitt.	27.3.96	Fritz	LP bs.:30132-021		
	Nr.	Änderung	Datum	Name	Blatt 1 von 3		

ERBE
72072 Tübingen

Gerät/UNIT
APC

Benennung/Title
Mainboard

Zeichnungsnummer/DWG.NO
30132-021



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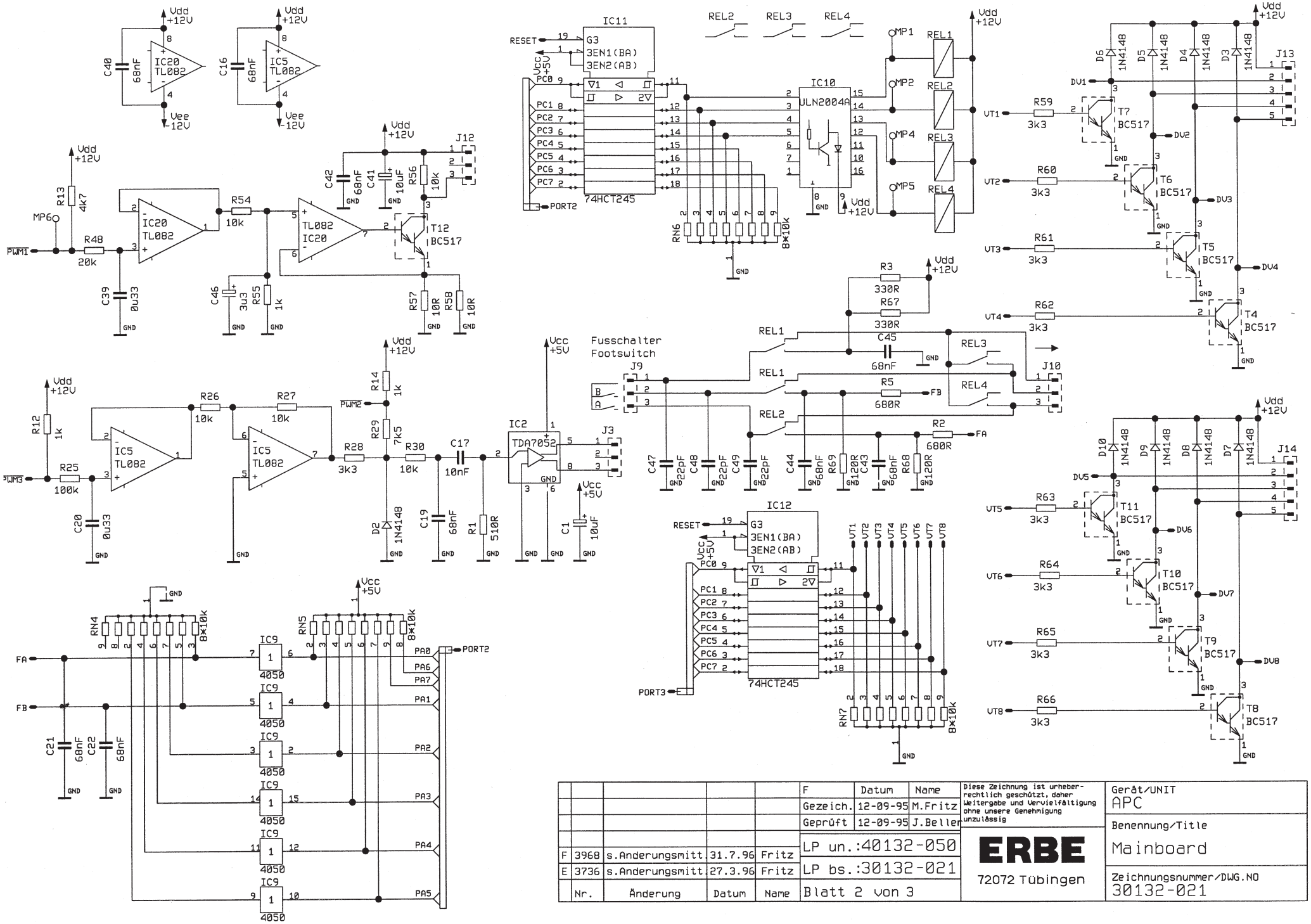
					Geprüft	12-09-95	J.Beller		Benennung/Title Mainboard
F	3968	s.Anderungsmitt	31.7.96	Fritz	LP un.:40132-050			ERBE 72072 Tübingen	
E	3736	s.Anderungsmitt	27.3.96	Fritz	LP bs.:30132-021				Zeichnungsnummer/DWG.NO 30132-021
	Nr.	Änderung	Datum	Name	Blatt 2 von 3				



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					Geprüft	12-09-95	J.Beller	
					LP un.:40132-050			
F	3968	s.Anderungsmitt	31.7.96	Fritz	LP bs.:30132-021			
E	3736	s.Anderungsmitt	27.3.96	Fritz				
	Nr.	Änderung	Datum	Name	Blatt 2 von 3			

ERBE
72072 Tübingen

Gerät/UNIT
APC

Benennung/Title
Mainboard

Zeichnungsnummer/DWG.NO
30132-021

The microcomputer unit MCU 68332 (30132 - 043)

The **MCU 68332 board** assumes **the central control and regulation of all processes** in the APC **300**. The components used are highly integrated and applied to both sides of the printed circuit board as surface mounted devices (SMD). As it is exceedingly difficult to locate errors and to repair this circuit board, it is recommended that no attempts at locating errors or conducting repairs are made outside the manufacturer's factory. In the case of an following information the circuit will only be described in terms of function blocks. The exact function and tasks of each component will not be described in detail.

The following functional components are located on the printed circuit board:

- the microcontroller MC 68332 in 32 bit technology
- the flash-memory components KM 29 C 010
- the RAM components KM 68 1000
- the programmable interface component 82 C 55
- the GAL 16V 8
- the 8 Bit D-flipflops 74 HC 245
- the 4 : 16 demultiplexer 74 HC 154
- the MAX 691 as voltage monitor and watchdog
- the quartz crystal for the basic clock of 32.768 kHz.

The **microcontroller MC 68332** contains a full microcomputer circuit in 32 bit technology which works with an external clock of 32.768 kHz, but internally this clock is increased to 16 MHz by means of a built-in PLL circuit. Since all instructions are processed very rapidly, it is possible to let the microcontroller conduct even fast regulatory processes.

The MCU can read in in data serially via the QSM (Queued Serial Module) and then re-emit the control signals as pulse-width modulated signals. This is made possible by the built-in TPU (Time Processing Unit).

The MCU contains 2 KBytes internal RAM. As this is not sufficient to control all functions, it is supplemented by two **external RAM components** KM 68 1000 with 128 KBytes each.

The user program and other data are stored in the **flash memories KM 29 C 010**.

Flash memories are non-volatile memories electrically programmable and rapidly electrically erasable which are comparable to EPROMS, but have an extremely high storage and function density. As flash memories require neither programming nor erasing devices, they can remain in the circuit. The programming of the components takes place on board, i.e. no external programming is provided for as is the case for EPROMs. The program is loaded from a PC via plug J3.

Checking of the storage components takes place by means of check sum in a system check.

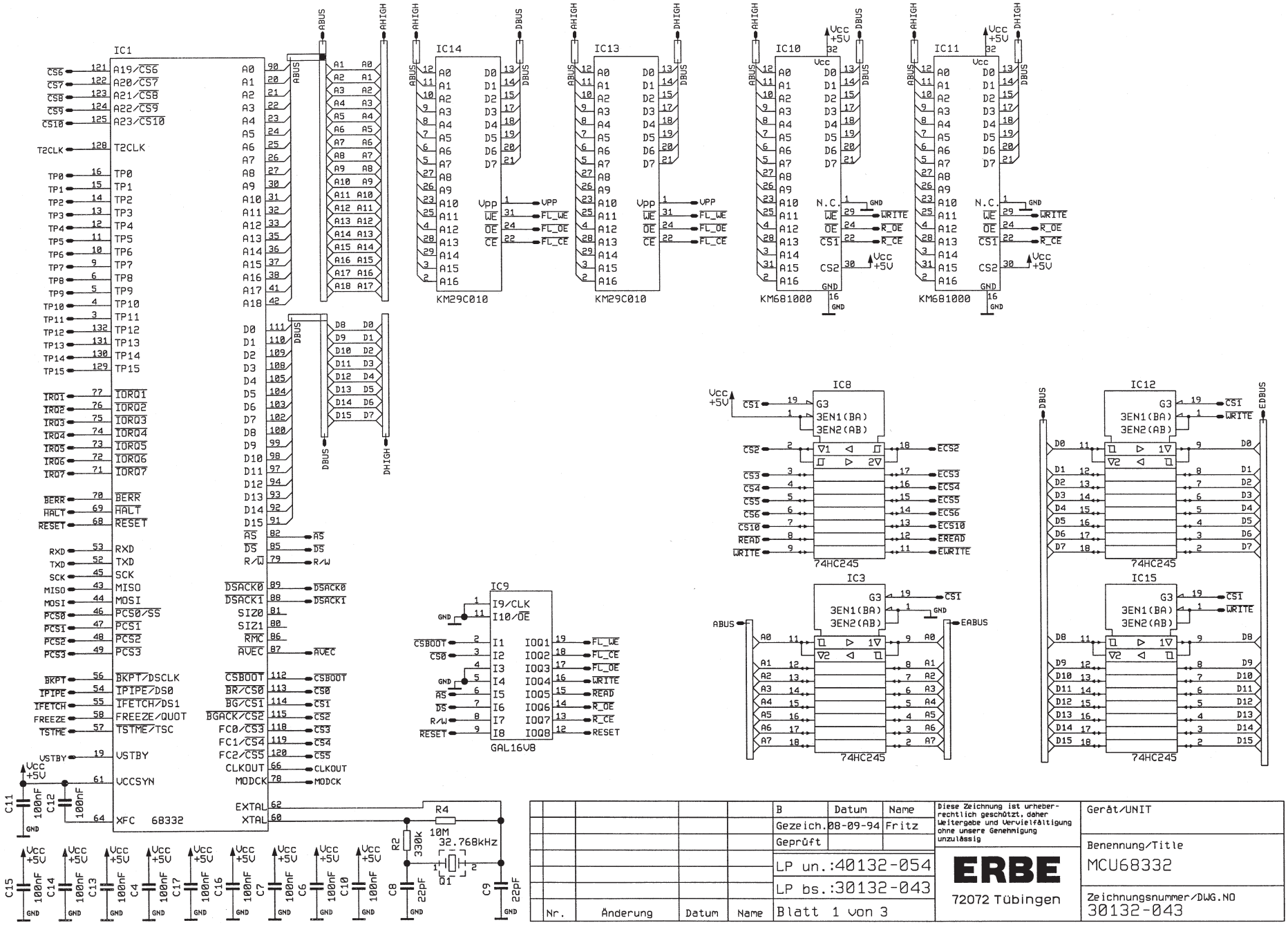
The **programmable peripheral interface components 82C55** (PPS) form three further bus systems at their outputs, ports 1 to 3, via which the MCU data is transferred to the peripherals.

The component **MAX 691** monitors the supply voltage. When switched on, the circuit causes a reset of the computer system to a defined starting state and by means of a built-in "**watchdog circuit**" deals with the monitoring and functionality of the software processing.

The **GAL 16V 8** is an externally programmable logic component which mainly conducts address decoding.

The **8-bit D flipflops 74HC245** supply the buffered external address and data buses.

For operating the APC 300 with the MCU 68332 an **extensive safety concept** has been drawn up which ensures that hardware errors, software errors, external interference, access problems and many other things are recognized, the errors processed, stored and the overall system put in a secure state.



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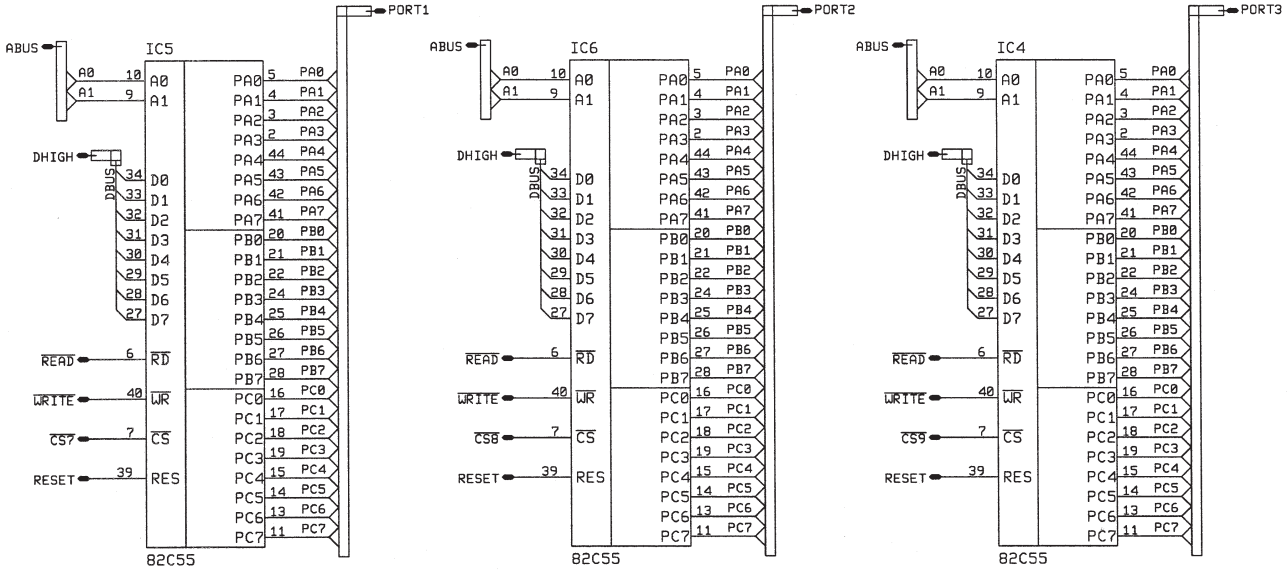
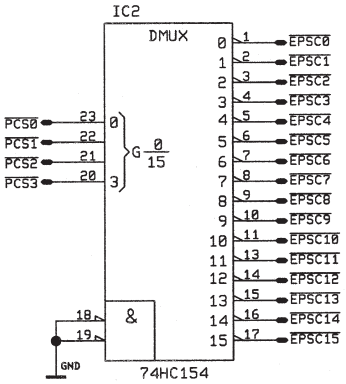
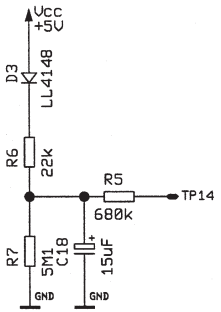
					Geprüft				Benennung/Title
					LP un.:40132-054			ERBE	MCU68332
					LP bs.:30132-043			72072 Tübingen	Zeichnungsnummer/DWG.NO
Nr.	Änderung	Datum	Name		Blatt 1 von 3				30132-043







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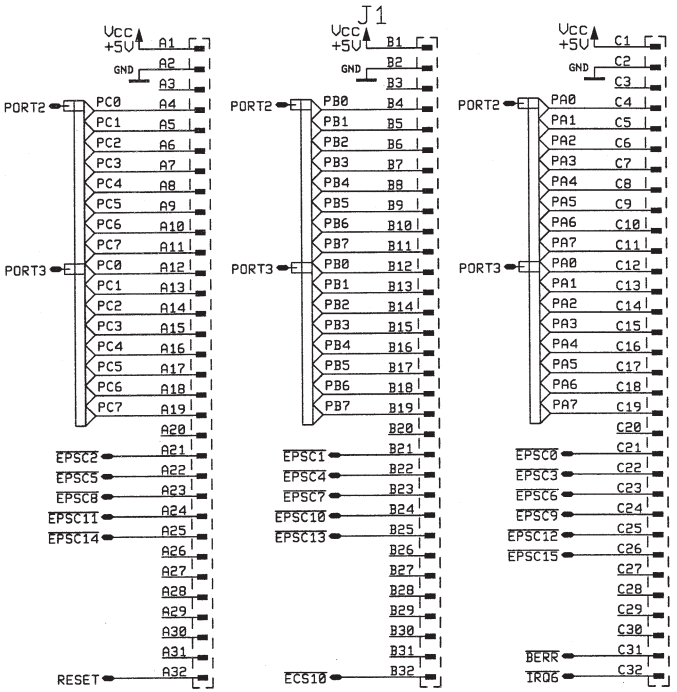
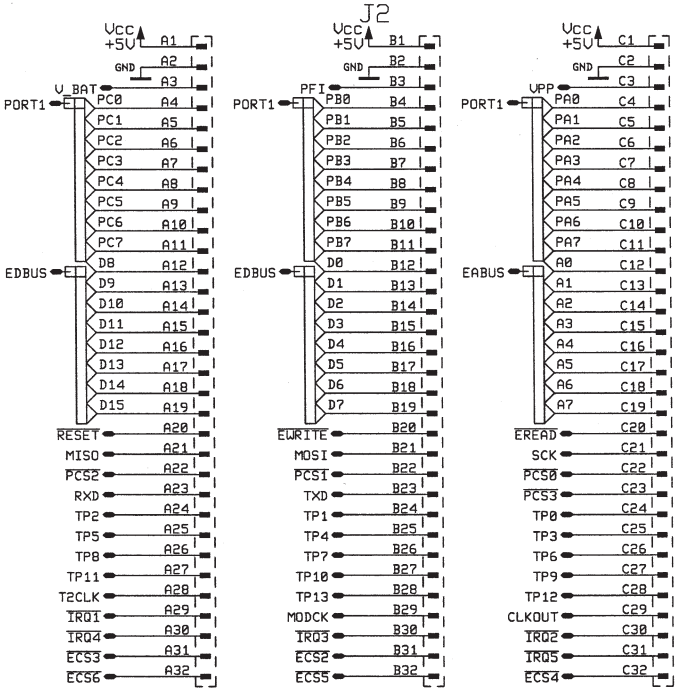
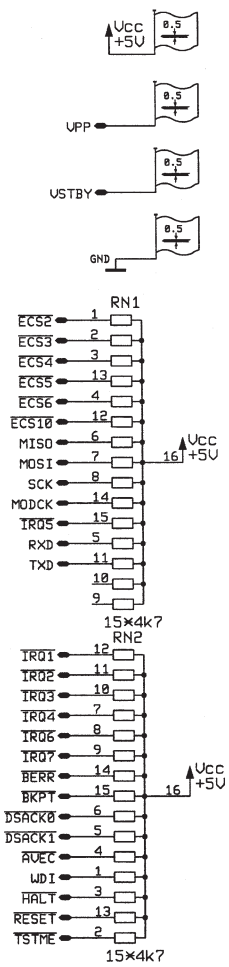
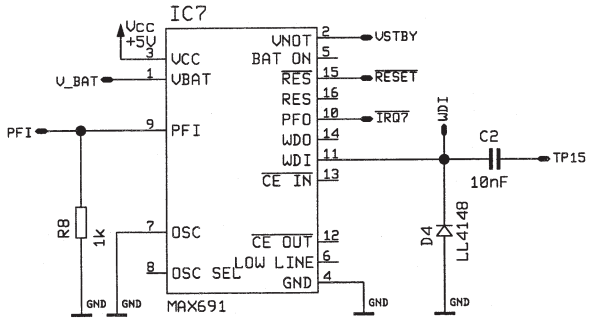
					Geprüft			
					LP un.:40132-054			ERBE
					LP bs.:30132-043			72072 Tübingen
	Nr.	Änderung	Datum	Name	Blatt 2 von 3			

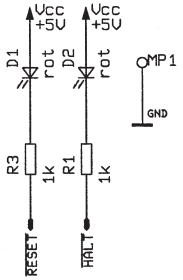
Gerät/UNIT	
Benennung/Title	MCU68332
Zeichnungsnummer/DWG.NO	30132-043

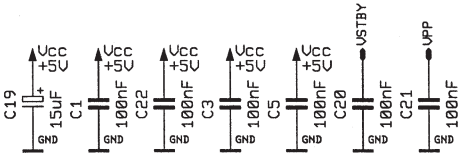


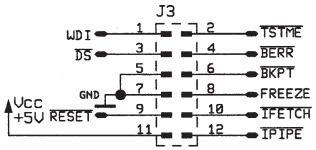












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					Geprüft			
					LP un.:40132-054			ERBE
					LP bs.:30132-043			72072 Tübingen
	Nr.	Änderung	Datum	Name	Blatt 3 von 3			

Gerät/UNIT	
Benennung/Title	MCU68332
Zeichnungsnummer/DWG.NO	30132-043

The pneumatic unit (40132 - 090)

The function of the **pneumatic unit** is to control and record all quantities concerning the argon gas. It represents the link between the argon supply cylinders and the surgical instruments in the APC 300.

The argon in the steel cylinder is compressed to a pressure of up to 200 bar (2900 psi) when the cylinder is completely full. This pressure is too high for direct operation of the APC 300. Therefore it is first lowered to a maximum operational pressure of 4.5 bar (65.25 psi) using a **pressure reducer**. The output pressure of the pressure reducer is, however, not kept exactly constant, but it adjusts itself according to the **dynamic expansion curve** of the **pressure reducer**.

The dynamic expansion curve represents the output pressure of the pressure reducer in relation to the input pressure (= cylinder pressure). Thus, for example, for a cylinder pressure of 200 bar (2900 psi) there is an output pressure of 2.5 bar (36.25 psi) and for a cylinder pressure of 10 bar (145 psi) there is an output pressure, of 4.5 bar (65.25 psi). Between these two extremes the dynamic expansion curve is linear, so that by measuring the output pressure the cylinder pressure can be deduced at any time.

For this reason, after the pressure reducer, a **pressure converter** is connected to each of the two cylinders. This device converts the physical quantity “pressure” into an electrical voltage which can then be measured in the APC 300, thereby allowing th**e cylinder pressure and, thus, the fill level of the argon cylinder to be deduced.**

In the pneumatic unit, after the pressure sensor, there is an electrically controlled valve (V1 or V2) with which the two argon sources can be actuated or switched off at will.

The subsequent **proportional valve** permits the gas flow to be dosed via its variable electrical control.

The gas flow is measured by the pressure reduction at a **nozzle**. The differential pressure p = p3 - p4 is a measure for the gas flow (in analogy to the voltage decrease at a resistance in an electric circuit, in which the voltage decrease at the resistance is a measure for the current flow!).

Parallel to the nozzle, a bypass can be switched **via valve V4** which lets a larger volume of gas through than the nozzle and thus extends the measurement range of the nozzle to larger flows.

Valve V6 releases the output of the APC 300 to the instrument. The gas can then flow to the instrument connected.

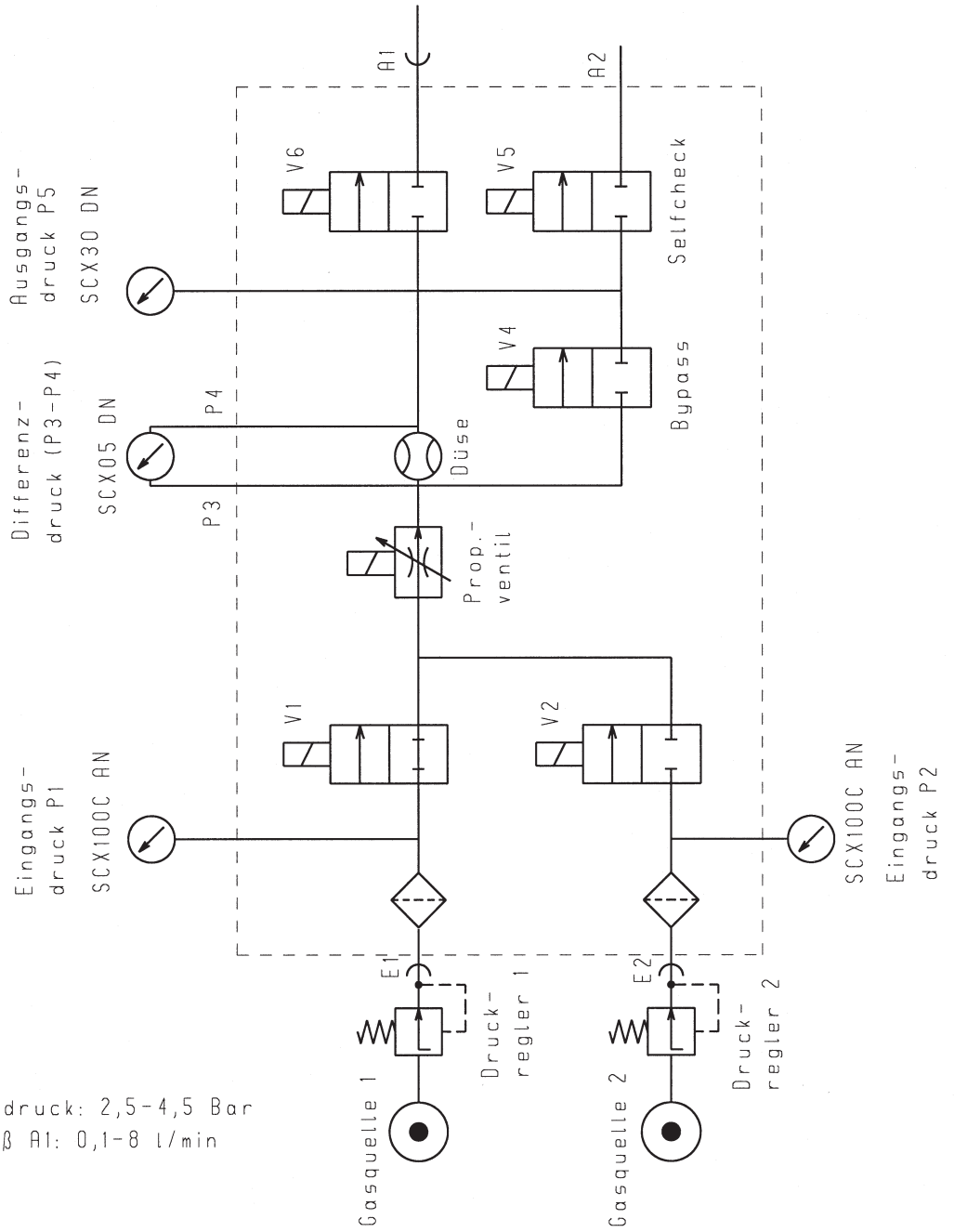
Valve V5 controls a **test output** for **self check** purposes, via which gas can be released in a controlled manner in order to test the function of the pneumatic block by means of a defined leakage. This test is conducted by the microcomputer unit **MCU 68332**.

When the power supply is switched on and a new gas cylinder is connected, the self check function is initiated. The self check proceeds in individual test steps. The test steps can be conducted individually in the “System safety test functions” menu.

If an error is found during the self check, the message “self check error” is issued on the fluorescent display tube.

Within the self check the following are checked:

- whether both input pressure sensors are functioning
- whether measurement of the output pressure is functioning
- whether the flow sensor and the proportional valve are functioning
- whether the expansion of the measurement range by means of the bypass is functioning
- whether all valves are functioning
- whether the two gas cylinders are full.



ⓑ

Eingangsdruck: 2,5-4,5 Bar
Durchfluß A1: 0,1-8 l/min

Werkstoff	Werkstoff-Nr.	ERBE Werkstoff-Nr	Rohmaße	Gewicht kg/Stck
Diese Zeichnung ist urheberrechtlich geschützt, daher Weitergabe und Vervielfältigung ohne unsere Genehmigung unzulässig	Maße ohne Toleranzangabe nach DIN 7168 mittel Kanten gratfrei	Oberflächenbeschaffenheit n. DIN	Maßstab .	EEE00255
			APC300	

	Datum	Name
Gezeich.	28.03.95	Reusch
Geprüft	28.03.95	Bartel
Norm		

Benennung

APC Pneumatik-Schaltbild

.

ERBE

72072 Tübingen

Zeichnungsnummer

10132-010 /4

Index	Nr.	Änderung	Datum	Name
b	3845	war 2-4Bar	08.03.96	VB.
a		V3 entfällt	31.05.95	VB.

Status

Ers. für: | Ers. durch:

The fluorescent display tube (50602 - 039)

The purpose of the **fluorescent display tube** is the provision of visual communication between the APC 300 and the user. The display is graphical.

The graphical interface gives the user information about the fill level of the argon cylinders, the cylinder currently in use, the program set, the accessories connected, the parameters set and the current values. The menu-based selection made possible by the graphical display of the APC 300 simplifies operation considerably.

The display receives its data via the main board from the MCU. Storage of the display data is updated in regular, short intervals. The data is then written once again from the MCU into the RAM of the display.

The fluorescent display is an industrial standard model. Therefore the function of the circuit will not be described here. The components used are highly integrated and applied to both sides of the printed circuit board as surface mounted devices (SMD). As it is exceedingly difficult to locate errors and repair this circuit board, it is recommended that no attempts at locating errors or conducting repairs are made outside the manufacturer's factory. In the case of an error which can be traced to the display, this board is usually replaced with a new one.

The switching power supply (40132 - 101)

The **switching power supply** serves to supply voltage to the APC 300.

It produces regulated output voltages of +12V, + 5V and - 12V with a power-end input voltage range of 90 V to 240 and a frequency of 50 Hz to 60 Hz.

The switching power supply is an industrial standard model. Therefore the function of the circuit will not be described here.

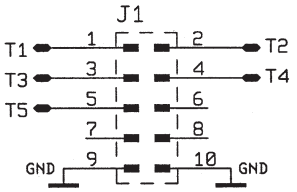
Attention! When the APC 300 is opened, special care must be taken, as parts of the switching power supply are at mains potential!

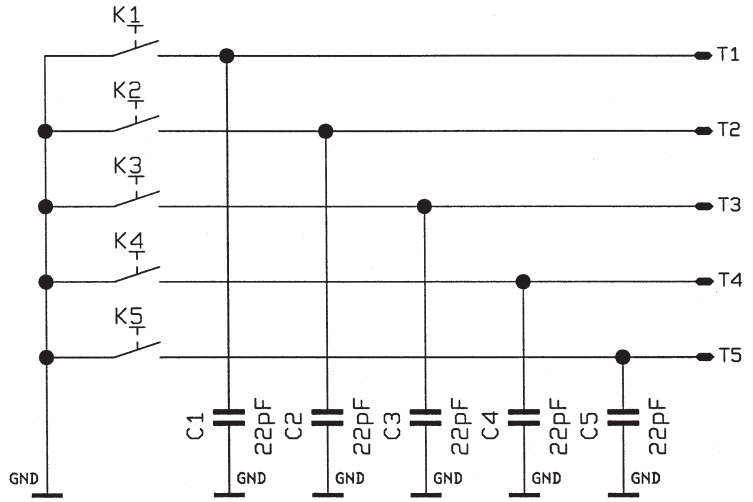
The APC keyboard (30132 - 067)

The **APC keyboard** is for communication between the user and the APC 300.

By means of the keyboard all required data inputs for operating the argon plasma coagulator are entered.

On the printed circuit board there are 5 key buttons K1 to K5 for entering data, 5 capacitors C1 to C5 as blocking capacitors and plugged connection J1 for transferring the signals to the MCU 68332.





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					Geprüft	07-06-95	J.Beller		Benennung/Title APC-TASTATUR
					LP un.: 40132-070				
					LP bs.: 30132-067			ERBE 72072 Tübingen	
	Nr.	Änderung	Datum	Name	Blatt 1 von 1				Zeichnungsnummer/DWG.NO 30132-067

8 Test and adjustment instructions

Measurement equipment and testing facilities

WARNING

Only use original ERBE measurement equipment and testing facilities.

- Flow meter (suspended-body device) 0.1 [l/min] to 1 [l/min], scale 0.1 [l].
- Flow meter (suspended-body device) 1 [l/min] to 10 [l/min], scale 0.5 [1].
- Manometer 0 to10 bar (145 psi), class 0.2 % FS.
- Pressure-reducing regulator which can be set from 2 to 5 bar (9 - 72.5 psi) output pressure.
- Connecting hose for connecting pressure-reducing regulator to the APC 300.
- Test hose with plug for connection between APC 300 gas output and the flow meter: **Test hose No. 20100-022**
- Connecting hose for checking for tightness.
- Stopper for the APC 300 gas output, checking for tightness.
- Testbox 10 to 120 Ω: **Test box No. 20100-021**
- Measurement line for connecting to Testbox: **Measurement line No. 20100-023**

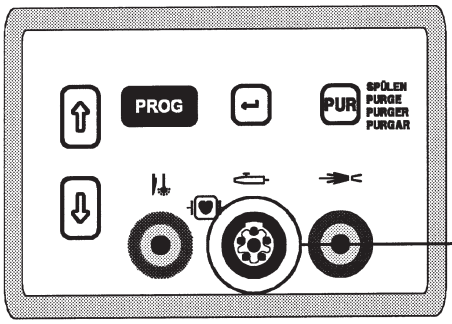
Code level, identification numbers

WARNING

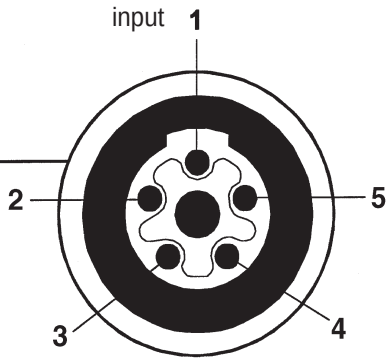
After entering the coded level, you can delete or change the settings significant for safety.

Identification number	Key	Function
481	ENTER, PROG, DOWN	System-Setup
385	UP, PROG, PURGE	Maximum instrument parameters
631	PURGE, PURGE, UP, DOWN	System safety test function

Adjustment of instrument recognition

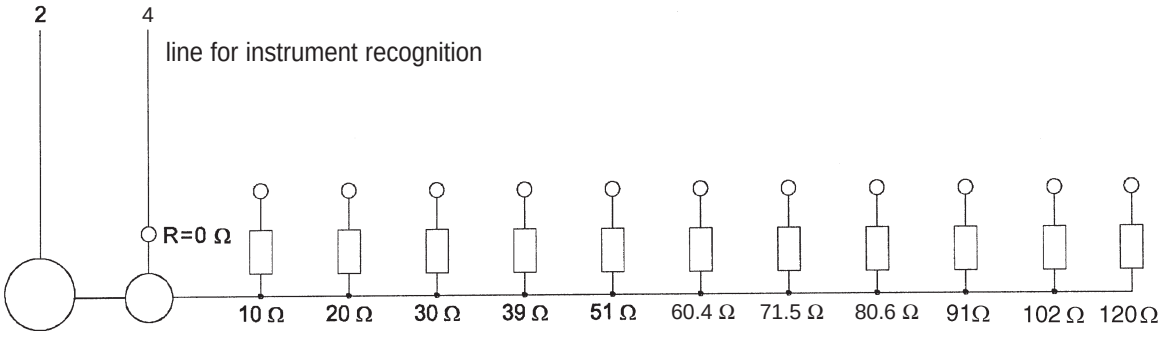


❶ Front panel



❷ instrument connection
plan of outlet

measurement line

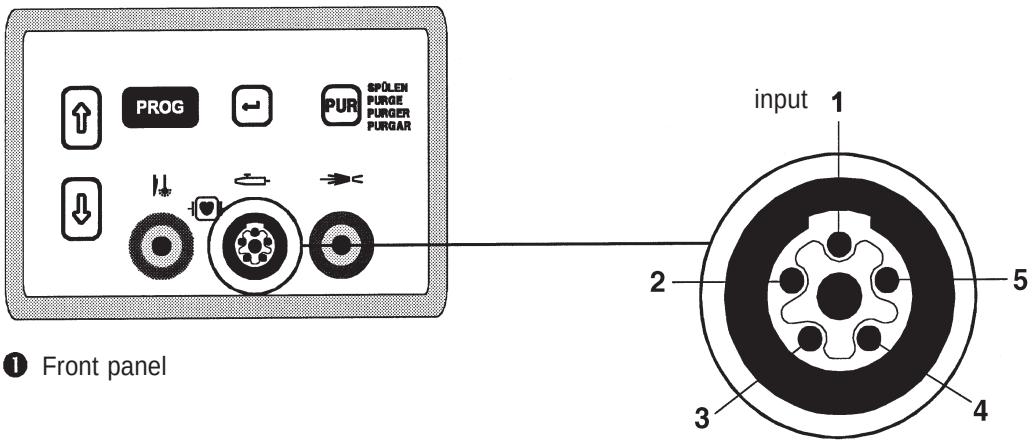


❸ Testbox, tolerance 1 %

Adjustment instructions

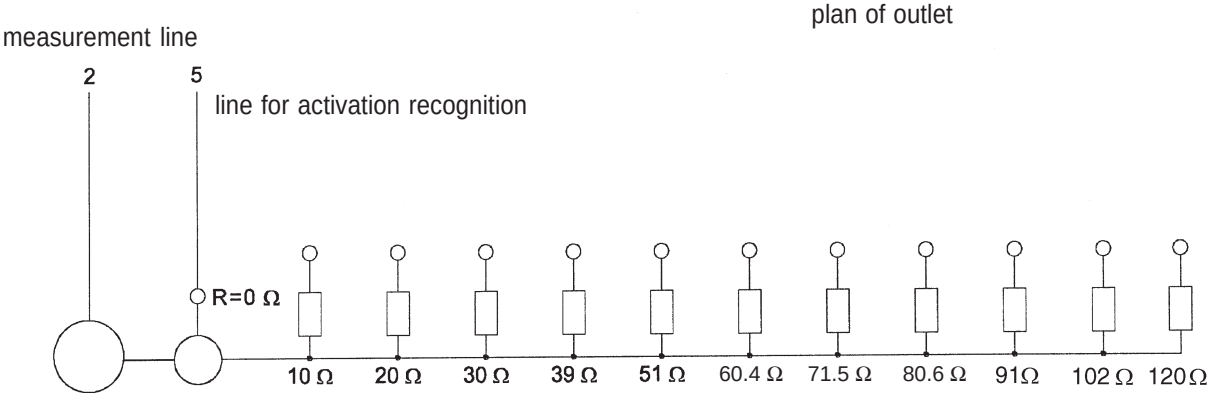
1. Plug measurement line into input 2 of the instrument connection. Plug line for instrument recognition into input 4 of the instrument connection.
2. Connect measurement line and line for instrument recognition to the testbox R = 0...120 Ω.
3. Switch on APC, pressing both UP and DOWN keys.
4. Enter code for calling system setup. Call instrument recognition.
5. With UP key set R = 0 Ω. APC display: Instrument recognition [Ohm]: 0
6. Set testbox R = 0 Ω.
7. APC display: Instrument 0
8. Store with program key.
9. Repeat steps 4 to 6 with adjustment R= 10...120 Ω.
   APC display: Instrument recognition [Ohm]: 10 ...120
   APC display: Instrument 1...10
10. Adjustment check: set testbox R = 0...120 Ω.
    APC display: Instrument 0...10

Adjustment of activation recognition



❶ Front panel

❷ instrument connection plan of outlet

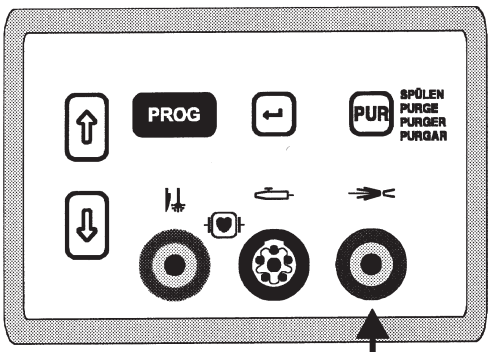


❸ Testbox, tolerance 1 %

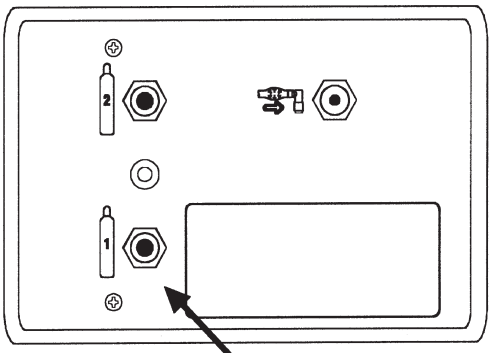
Adjustment instructions

1. Plug measurement line into input 2 of the instrument connection. Plug line for activation recognition into input 5 of the instrument connection.
2. Connect measurement line and line for activation recognition to the test box R= 0...120 Ω.
3. Switch on APC, pressing both UP and DOWN keys.
4. Enter code for calling system setup. Call activation recognition.
5. With the UP key set R = 0 Ω. APC display: activation recognition [Ohm]: 0
6. Set resistance series R = 0 Ω.
7. APC display: Activ. No. 0
8. Store with program key.
9. Repeat steps 4 to 6 with adjustment R = 10...120 Ω.
   APC display: activation recognition [Ohm]: 10 ...120
   APC display: Activ. No. 1...10
10. Adjustment check: set test box R = 0...120 Ω.
    APC display: Activ. No. 0...10

Adjustment of argon flow

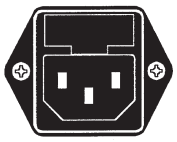


Front panel



Back panel

100 - 230 V
50-60 Hz



❶ Power supply

❸ Plug for gas connection

❷ Argon gas cylinder with pressure regulator

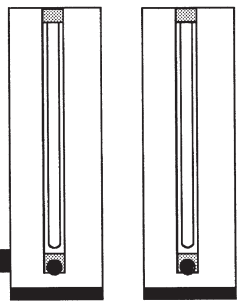
Input pressure at cylinder connection 1 with pressure regulator set at a constant P= 2.5 bars , 36.25 psi (tolerance ± 0.5 bar, 7.25 psi for 1 [l] flow)

Instructions

1. Set up the APC, accessories and flow meter as shown. First connect APC applicator with the test hose to flow meter 1 [l].
2. Switch on APC, pressing both the UP and DOWN keys.
3. Enter code for calling system setup. Call adjustment of argon flow.
4. Set adjustment [ml] 100 with the return key.
5. Continue to adjust using the UP and DOWN keys until the flow meter displays 100 [ml].
6. Store with program key.
7. Repeat steps 4 to 6 with adjustment [ml] 200...1000.
8. Connect APC applicator with the test hose to flow meter 0 [1] (Fig. 6).
9. Repeat steps 4 to 6 with adjustment [ml] 2000...9000.
10. WARNING! After adjustment: Leave System Setup.Check all adjustments between 100 ml and 9000 ml under normal condition.

❹

Connection hose about 1 m long



❺ flow meter 1l
range 0...1000 ml
scale 0.1 l

❻ flow meter 10 l
range 2...10 l
scale 0.5 l, 1 l

Test functions

Select program selection menu / system diagnosis programs.

Conduct tone generator test

Test tone 1, CUT.
Test tone 2, COAG.
Test tone 3, PURGE.

Conduct display test

Test keyboard

Press all keys one after the other.

Test activation signals.

Activate CUT footswitch, COAG footswitch, CUT finger switch and COAG finger switch one after the other.

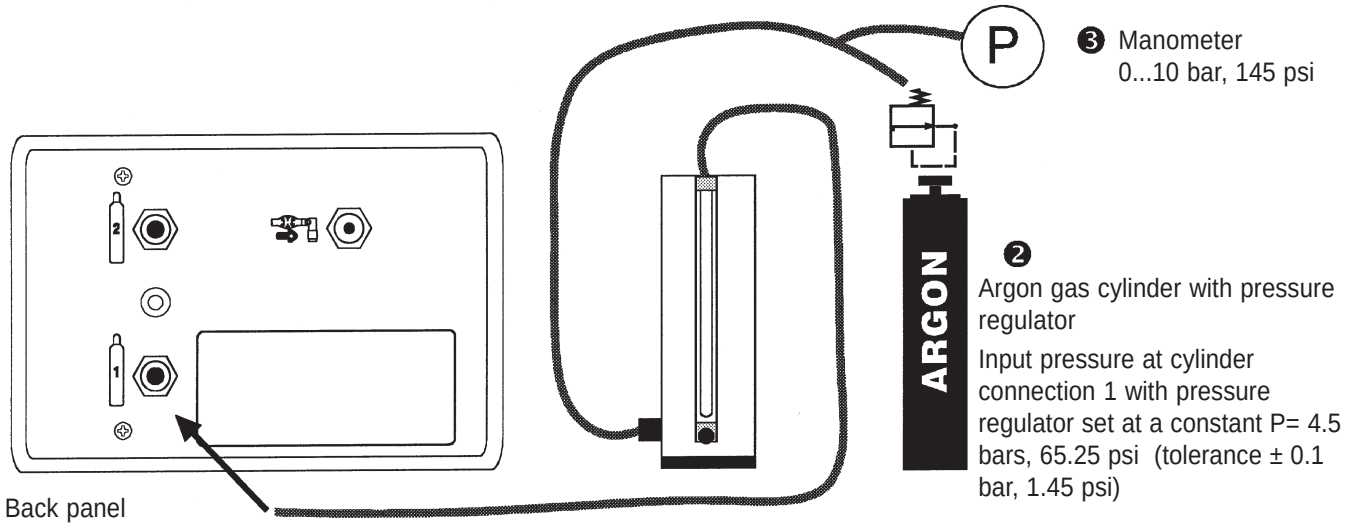
Test supply voltage

Test supply voltage -12V. Valid display range -12500 to - 11500 [mV].

Test reference voltage

Test reference voltage +10V. Valid display range +10000 [mV].

Checking for leaks



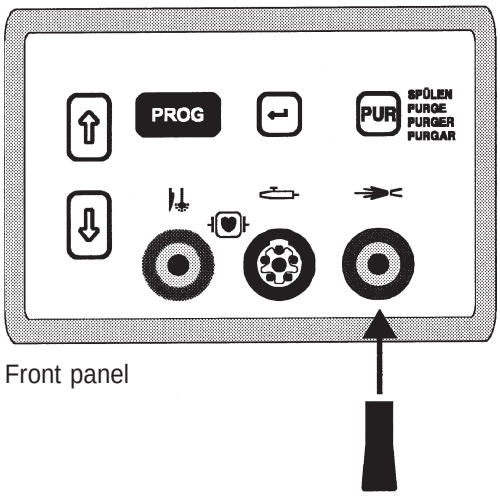
❸ Manometer
0...10 bar, 145 psi

❷ Argon gas cylinder with pressure regulator

Input pressure at cylinder connection 1 with pressure regulator set at a constant P= 4.5 bars, 65.25 psi (tolerance ± 0.1 bar, 1.45 psi)

Back panel

❶ flow meter 1l
range 0...1000 ml
scale 0.1 l



Front panel

❹ Stopper

Instructions

1. Set up the APC with the connecting hose for testing for leaks.
2. Set input pressure at the pressure regulator to 4,5 bar (tolerance ± 0,1 bar). Read off pressure on the manometer.
3. Screw stopper onto the argon outlet of the APC 300.
4. Set program 0, COAG-Flow 2.0 [1/min]. Instrument=0.
5. Active APC-COAG footswitch for about 15 sec. The system is filled with argon.
6. After about 15 sec. no flow should be measurable on the flow meter.
7. Set COAG-Flow to 0.5 [1/min].
8. Repeat step 5.

Testing footswitch signals to the electrosurgical equipment

Connect APC 300 with the footswitch cable to the electrosurgical equipment.
Test activation of the CUT function and the COAG function.

Gas function test

Flow l/min	Cylinder	Instrument No.	Activation
0.1	1	0	COAG, foot
0.5	1	4	COAG, finger
1.0	1	0	COAG, foot
5.0	1	4	COAG, finger
9.0	1	0	COAG, foot
0.1	2	0	CUT, finger
0.5	2	4	CUT, foot
1.0	2	0	CUT, finger
5.0	2	4	CUT, foot
9.0	2	0	CUT, foot

When the gas function is activated no output error must occur.

Continuous test

Continuous test

Operate the APC 300 with a gas supply (nitrogen or argon) with an input pressure of 3 bar (13.5 psi) and without a connection cable at 1.2 times the power supply voltage and an ambient temperature of 40°C over a period of 2 hours. ED 25 %.
See final test log.

Memory page values, initialization

Initializing the error page

After this menu item has been selected, the contents (the elements) of memory pages 1 to 40 can be inspected. On page 1, for instance, there are elements 0 to 15. When working in conjunction with the ERBE FUE it is possible that you will be asked to state one or more elements.

ATTENTION
When you call this menu item the error list and the error trace list on the main level of the APC are deleted. You can then no longer view the stored errors of the users.

WARNING ⚠

Initializing the system page

When you select this menu item, you delete the adjustments for argon flow, instrument recognition and activation recognition. Before using the APC, all adjustments must be input again. If you do not do this the error message: I 201 system page not initialized appears.

Initializing the application programs

WARNING ⚠

When you select this menu item, you delete all application settings. You initialize the standard settings of the APC. These are the same for all programs.

Standard settings

on initializing application programs

Instrument no.	COAG flow l/min	CUT flow l/min	Permissible output pressure mbar (psi)	CUT function	Preferred cylinder no.
0	2.0	3.6	2000 (29)	on	1
1	0.1	0	1000 (14.5)	off	1
2	0.3	0	1000 (14.5)	off	1
3	2.0	0	1000 (14.5)	off	1
4	1.8	3.6	2000 (29)	on	1
5	1.8	0	1000 (14.5)	off	1
6	3.0	0	1000 (14.5)	off	1
7	1.4	1.4	1000 (14.5)	on	1
8	1.4	0	2000 (29)	on	1
9	not yet used	not yet used	not yet used	not yet used	not yet used
10	not yet used	not yet used	not yet used	not yet used	not yet used

On initializing application programs the activation tone for CUT, COAG, PURGE is set to medium volume.

Limiting parameters

Instrument no.	COAG flow l/min	CUT flow l/min
0	9.0	9.0
1	0.1	0
2	0.5	0
3	2.4	0
4	9.0	9.0
5	9.0	0
6	5.0	0
7	2.4	2.4
8	4	0
9	not yet used	not yet used
10	not yet used	not yet used

Standard settings in the rinse parameters program

Instrument no.	rinse flow l/min	rinse duration sec.
0	2,0	2.0
1	0.1	2.0
2	0.5	2.0
3	0.5	2.0
4	0.5	2.0
5	0.5	2.0
6	0.5	2.0
7	0.5	2.0
8	0.5	2.0
9	not yet used	not yet used
10	not yet used	not yet used

9 Finding errors

Finding errors in the APC 300

If your APC 300 is not functioning as expected, please first re-read the operating instructions of the APC 300 to confirm how a unit is intended to function. This will help to determine what, in comparison is not functioning properly in your unit.

Sometimes an operating error or a improper setting is the cause of a suspected error; which can be determibed by reviewing the operating instructions.

If you still have problems with your APC 300, the following sections of this manual should be able to help you locate and correct any error.

In the remaining part of this manual, APC 300 error messages concerning the electronics and the argon supply are discussed.

Further information about the function of the APC 300 are to be found in the section of this manual entitled “Circuit descriptions”.

WARNING 

Take care when touching parts in the interior of the open device while the device is connected to the mains. Always unplug the power cable if this is possible. Various components of the switching power supply are at mains voltage and must, therefore, only be touched by an instrument not connected to the power supply.

For measurements with the oscilloscope or other measuring instruments, the measuring point MP 8 is provided as ground reference.

CAUTION

The circuit of the APC 300 contains electrostatically sensitive components. When repairing the unit or conducting measurements on it, please only work at an electrostatically secured workplace, and additionally, use a grounding armband when working with electrostatically sensitive components. Touch the components at their non-conductive surfaces, and use antistatic containers for transporting electrostatically sensitive components and printed circuit boards.

When functions fail, or other problems arise in conjunction with the APC 300, the following general points apply:

- If an error message appears on the display and possibly remains there, briefly switch the APC 300 off and then on again after waiting a few seconds. The unit then conducts a “self check” to check the APC 300 for errors. If this error message **no longer** appears after that, nor during further work, this was only a brief, one-off malfunction and work with the APC 300 can continue. The error remains in the error memory, however, so that the authorized service personnel can react to it at the next routine check. If the error message reappears, however, the cause must be located.
- In the case of a total failure of the APC 300, always first check whether the mains voltage is ok and whether the outlet and mains cable are functioning properlywith **another device**.
- The line fuses at the rear of the APC 300 should also be checked, and, if necessary, replaced by new fuses.
- First submit the APC 300 to a visual inspection in which you look for damage and alterations.

- Also take note of all circumstances which could cause a malfunction such as **loose cables or cables which have come off**, unusual noises, unusual displays, and take note of parts which have broken off, burned or changed colour. Then look at the plugged connections to see **whether the plugs are plugged into the outlet far enough and the leads directly at the entrance point of the plug are OK.**
- If only one specific function has failed, concentrate on those parts of the APC 300 which influence or control this function. In case of a malfunction with functional display or with no error message on the display, the error may be located in **defective accessories**. For example, there may be a defect in the footswitch, in the instrument, or a broken connection. In this case, the cause of the error can be confimed by exchanging the accessory used.
- If several functions fail at the same time, concentrate on the part of the APC 300 which controls **precisely this set of functions**.

The subsequent troubleshooting assumes that the APC 300 **was working perfectly** in the manufacturer's factory at the end of the final test, and, in the meantime, **a new source of failure** has arisen which must be located.

The troubleshooting process is designed in such a manner that it helps **the user and the hospital technician** to locate errors which have arisen and to correct them themselves if possible. It can often give the authorized customer service technician useful hints for locating the cause of the error and can thus reduce the time the device is not functioning.

The troubleshooting process is **not intended for the experienced service technician** who is looking for help in especially difficult cases.

The troubleshooting process is based on the diagnosis routines of the APC 300 which issue an error number and the error discovered in plain language on the display. The test depth of the diagnosis routine is so great that the cause of the error can often be identified unambiguously with the error message.

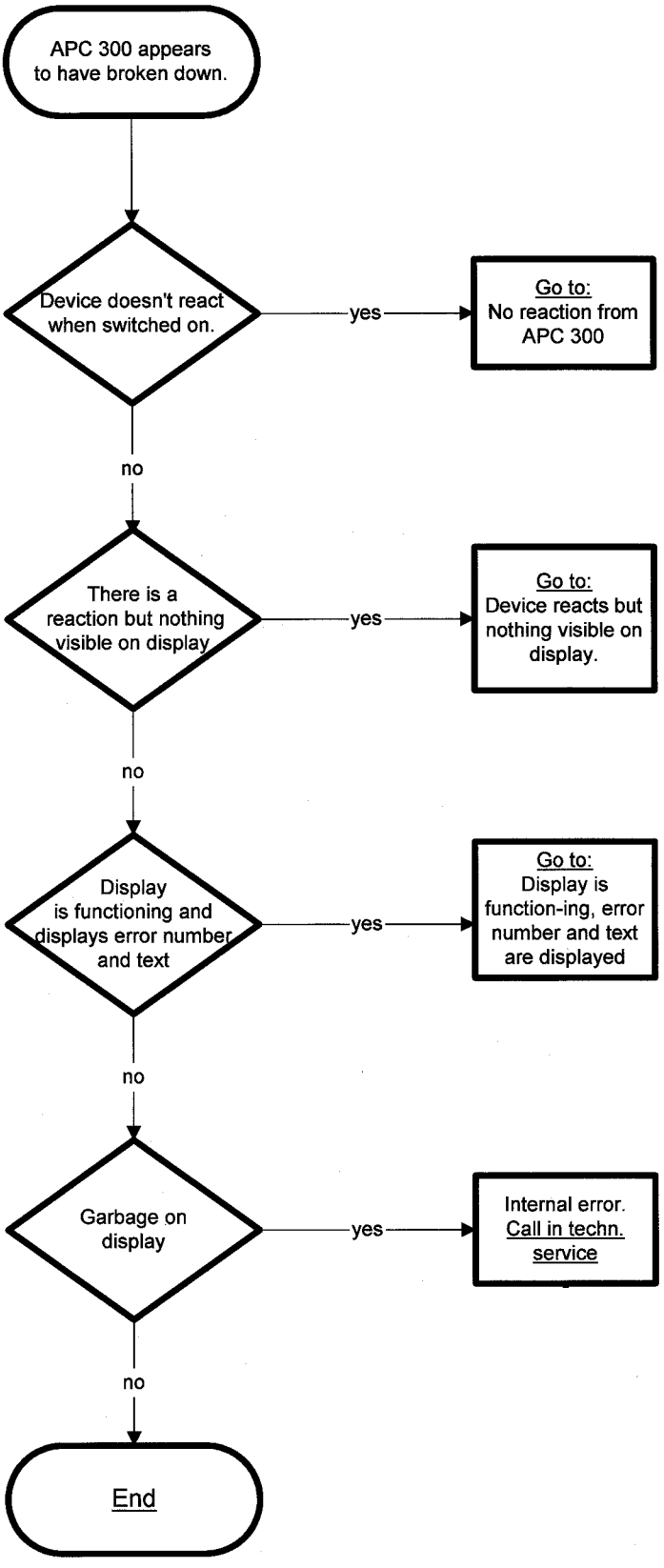
The troubleshooting process takes these error messages as its starting point. The size error trees usually have can thus be reduced considerably.

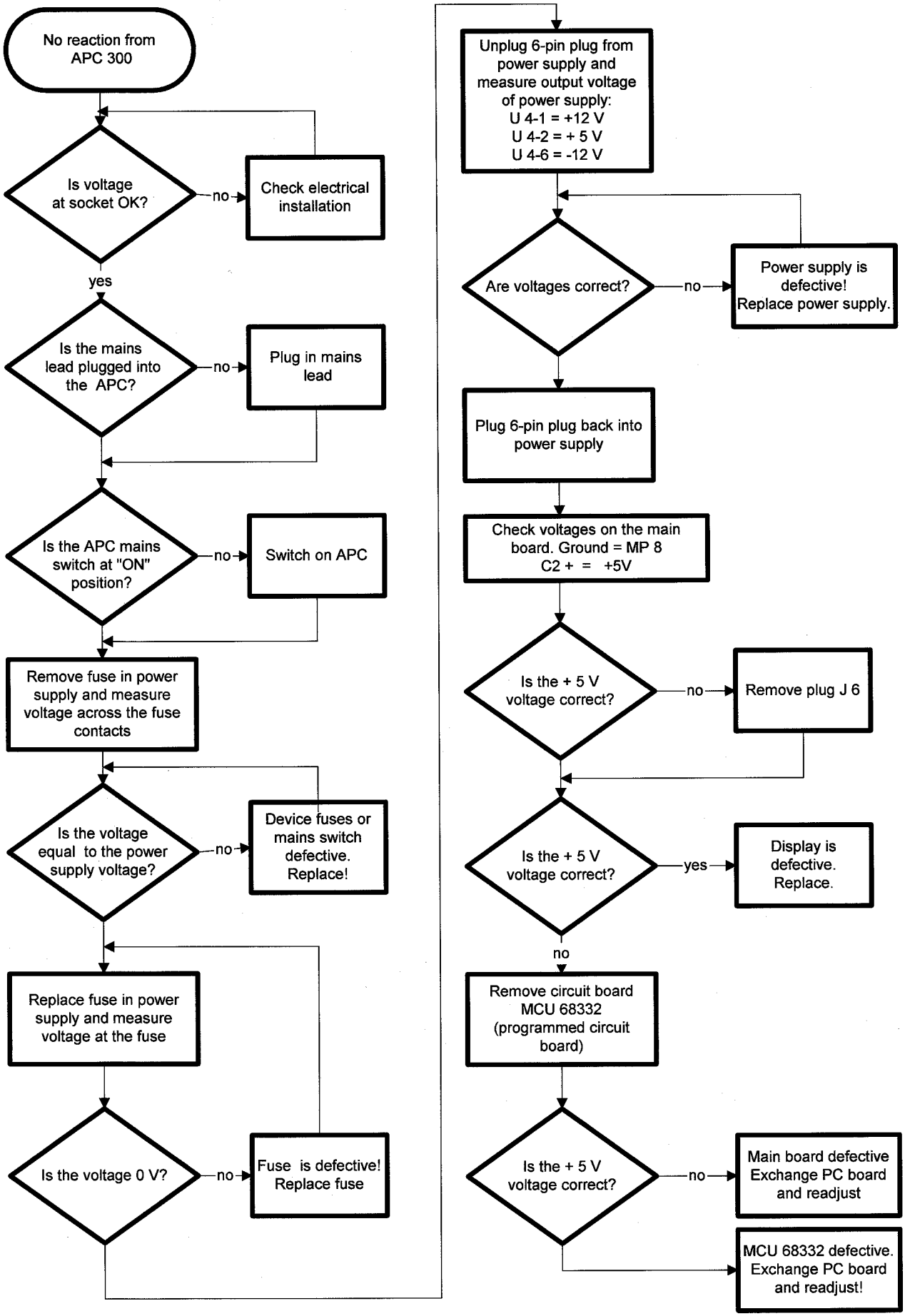
According to our studies, a considerable proportion of causes of errors lies not in the device itself but in the environment. For this reason the user and the hospital technician can often find the cause of the error themselves by means of the troubleshooting process, and correct it without having to open up the device.

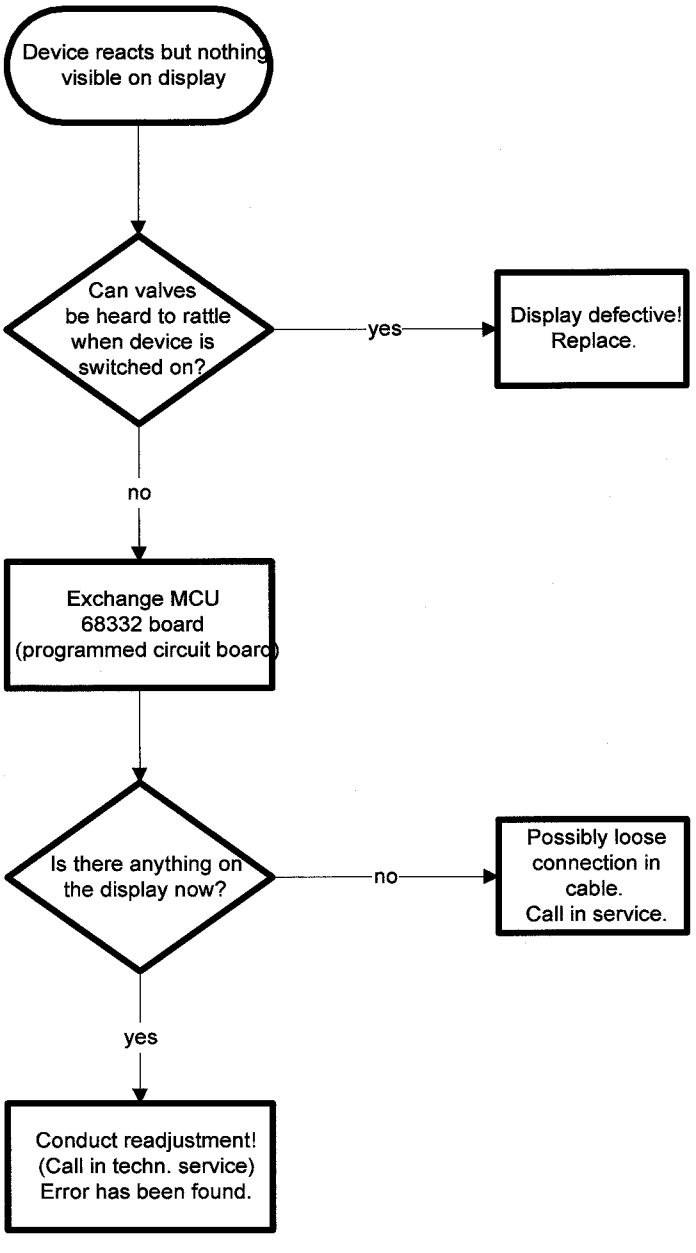
On the other hand, a technical service of the APC 300 often requires considerable measurements to be conducted, with appropriately expensive and rarely available measurement tools. This work is not restricted to replacing defective components or assemblies, but requires detailed knowledge and expertise in the function and adjustment of the device.

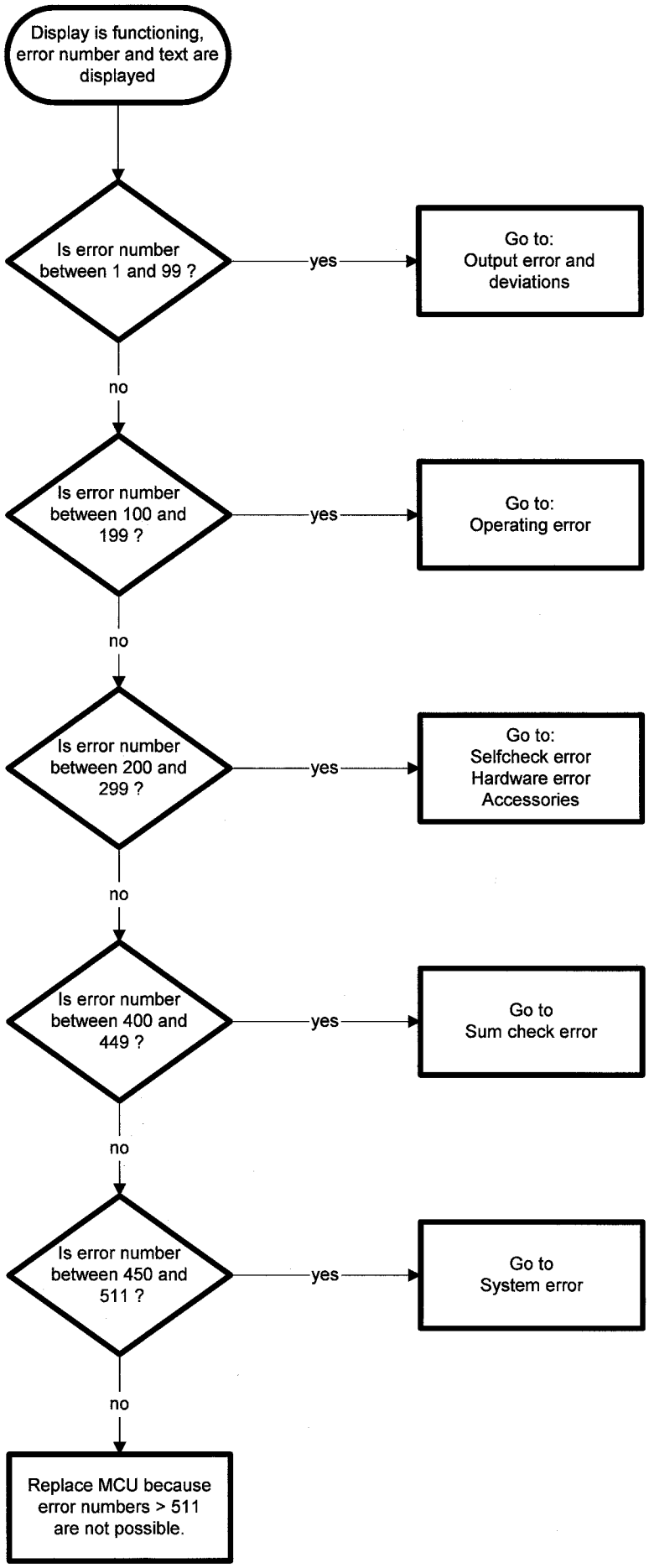
Therefore, we assume that the user and hospital technician will be in a position to perform minor repairs themselves. These include, for example, replacing defective fuses, power supplies, outlets and display lamps as well as replacing the power control board and the display. Further repairs, such as replacing the main board and the microcomputer circuitry necessitate a new adjustment of the entire unit, for which extensive knowledge and the pertinent measurement instruments are necessary.

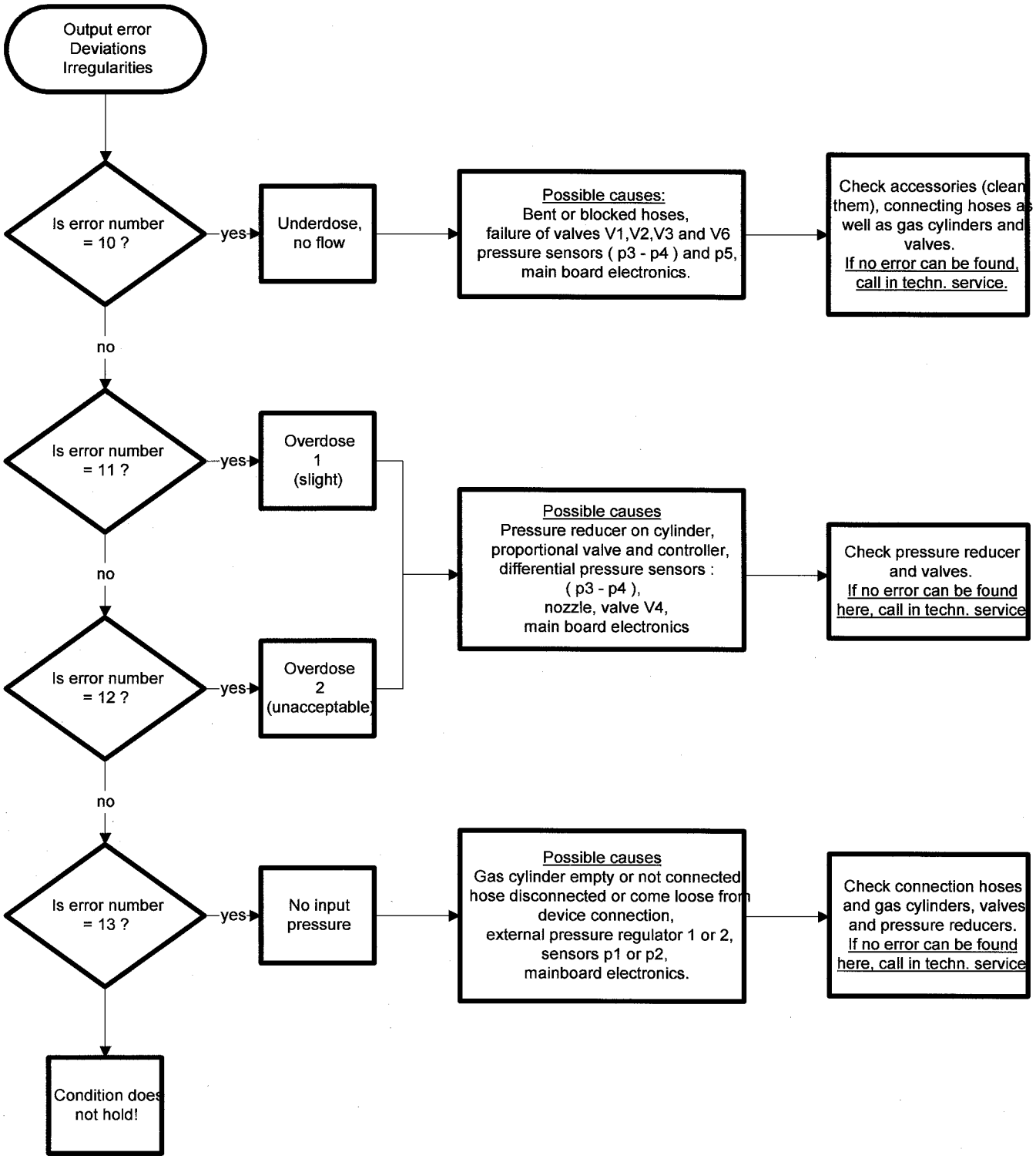
The troubleshooting process therefore supports the jobs which are possible including replacing printed circuit boards, whereby it is necessary to point out that more detailed error searches require a new adjustment and an authorized service technician.

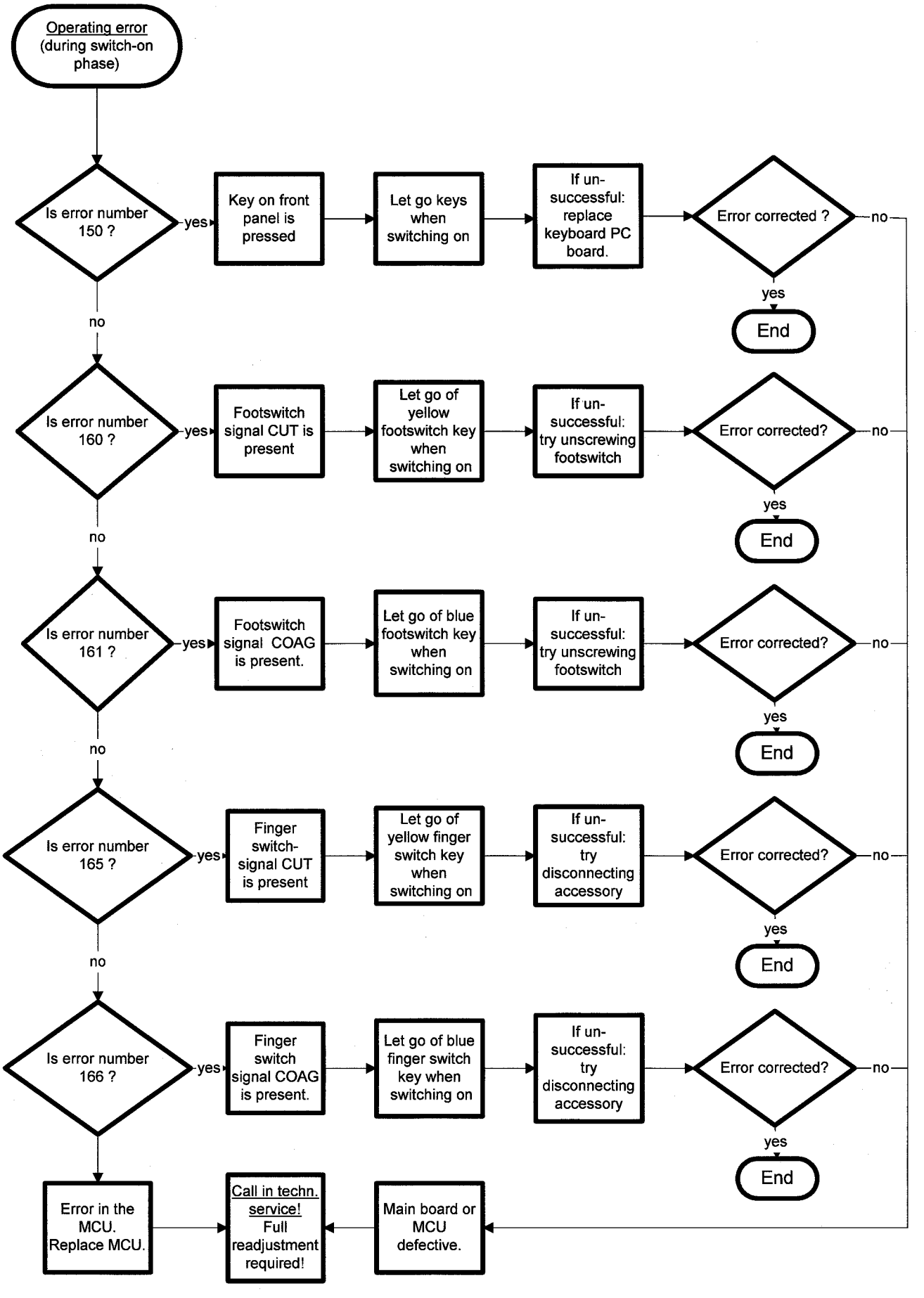

APC 300 appears to have broken down.
Device doesn't react when switched on.
yes
Go to: No reaction from APC 300
no
There is a reaction but nothing visible on display
yes
Go to: Device reacts but nothing visible on display.
no
Display is functioning and displays error number and text
yes
Go to: Display is function-ing, error number and text are displayed
no
Garbage on display
yes
Internal error. Call in techn. service
no
End

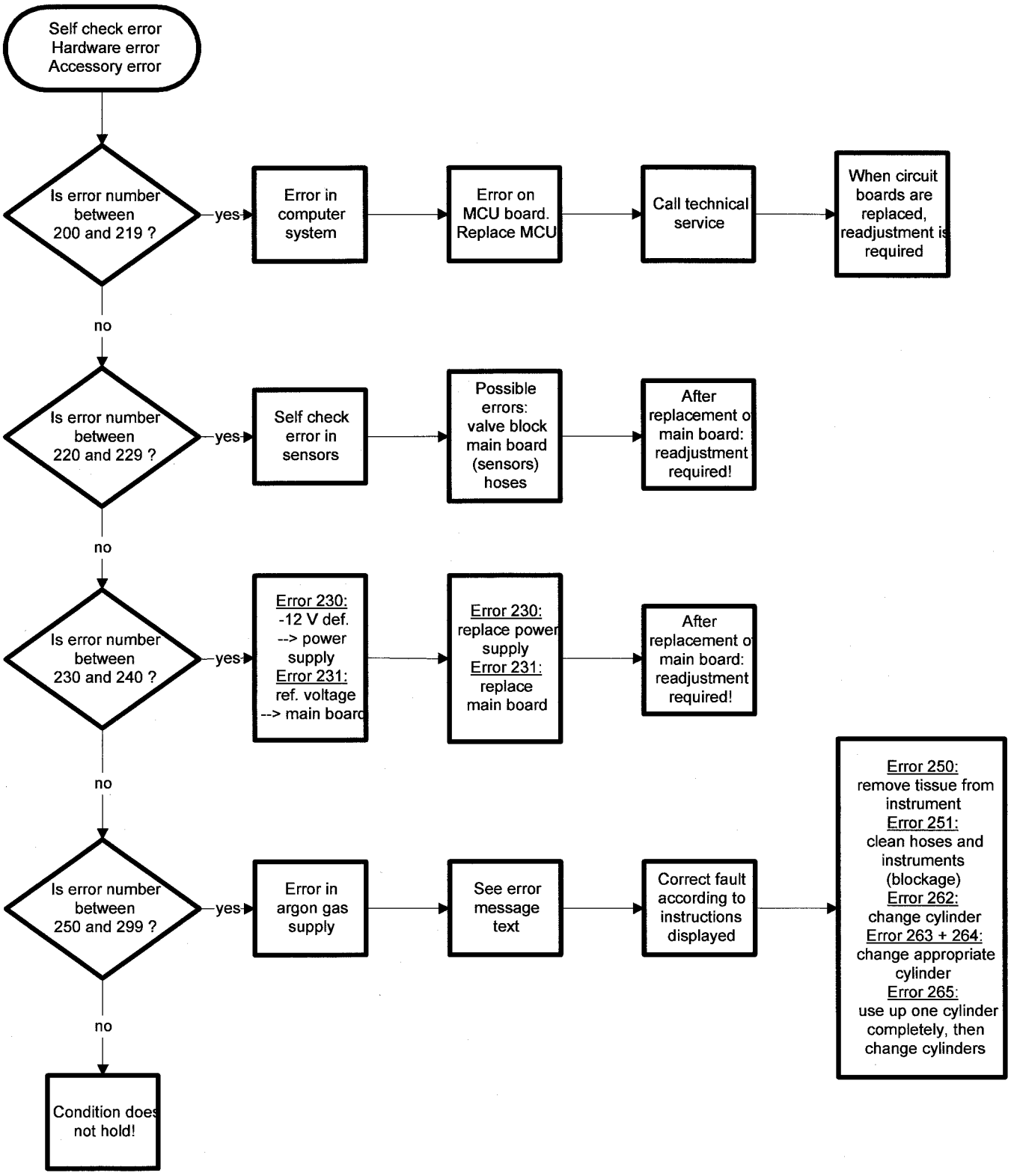

No reaction from APC 300
Is voltage at socket OK?
no
Check electrical installation
yes
Is the mains lead plugged into the APC?
no
Plug in mains lead
Is the APC mains switch at "ON" position?
no
Switch on APC
Remove fuse in power supply and measure voltage across the fuse contacts
Is the voltage equal to the power supply voltage?
no
Device fuses or mains switch defective. Replace!
Replace fuse in power supply and measure voltage at the fuse
Is the voltage 0 V?
no
Fuse is defective! Replace fuse
Unplug 6-pin plug from power supply and measure output voltage of power supply:
U 4-1 = +12 V
U 4-2 = + 5 V
U 4-6 = -12 V
Are voltages correct?
no
Power supply is defective! Replace power supply.
Plug 6-pin plug back into power supply
Check voltages on the main board. Ground = MP 8
C2 + = +5V
Is the + 5 V voltage correct?
no
Remove plug J 6
Is the + 5 V voltage correct?
yes
Display is defective. Replace.
no
Remove circuit board MCU 68332 (programmed circuit board)
Is the + 5 V voltage correct?
no
Main board defective Exchange PC board and readjust
MCU 68332 defective. Exchange PC board and readjust!

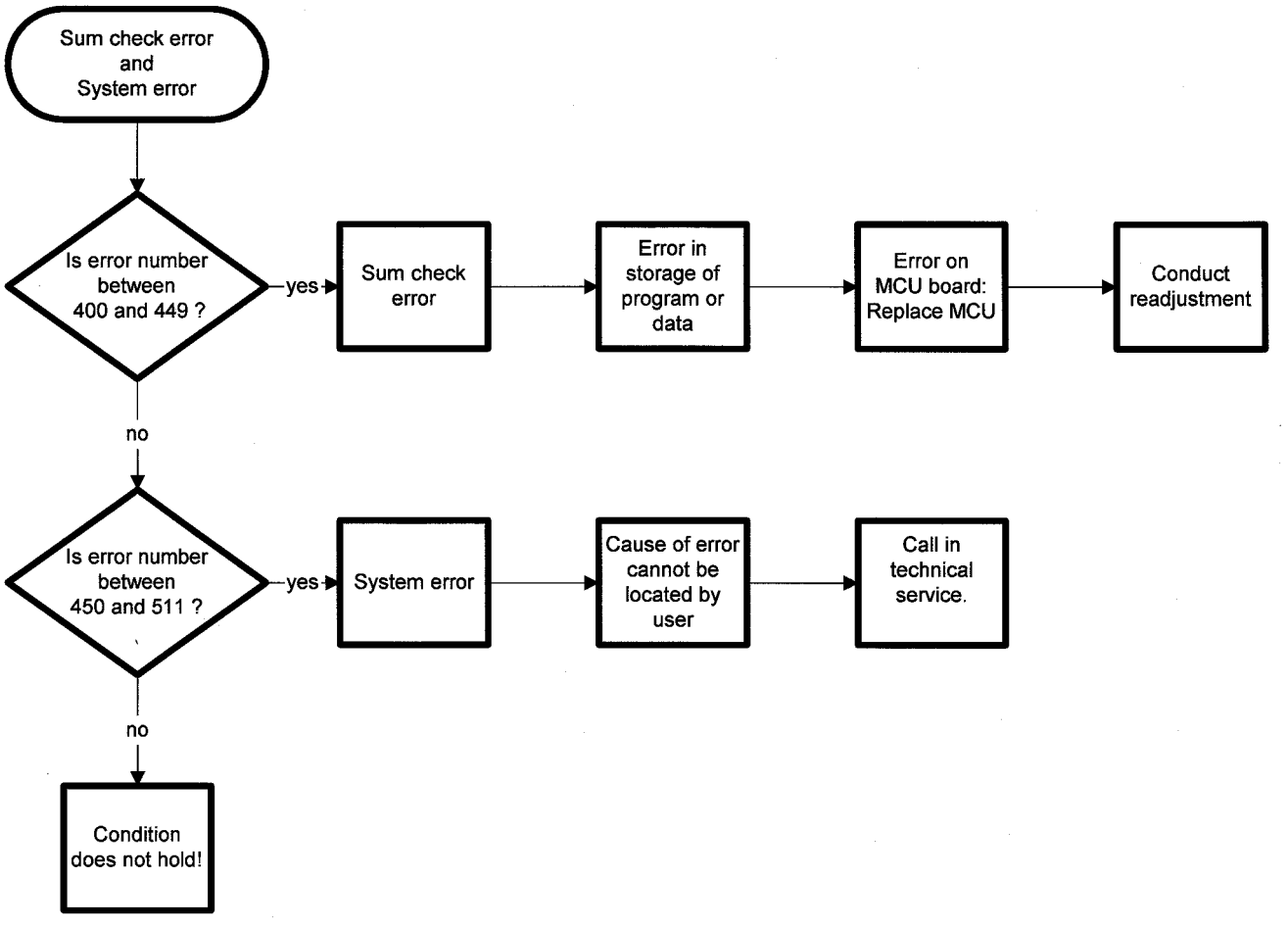

Device reacts but nothing visible on display
Can valves be heard to rattle when device is switched on?
yes
Display defective! Replace.
no
Exchange MCU 68332 board (programmed circuit board)
Is there anything on the display now?
no
Possibly loose connection in cable. Call in service.
yes
Conduct readjustment! (Call in techn. service) Error has been found.


Display is functioning, error number and text are displayed
Is error number between 1 and 99 ?
yes
Go to: Output error and deviations
no
Is error number between 100 and 199 ?
yes
Go to: Operating error
no
Is error number between 200 and 299 ?
yes
Go to: Selfcheck error Hardware error Accessories
no
Is error number between 400 and 449 ?
yes
Go to Sum check error
no
Is error number between 450 and 511 ?
yes
Go to System error
no
Replace MCU because error numbers > 511 are not possible.


Output error
Deviations
Irregularities
Is error number = 10 ?
yes
Underdose, no flow
Possible causes:
Bent or blocked hoses,
failure of valves V1,V2,V3 and V6
pressure sensors (p3 - p4) and p5,
main board electronics.
Check accessories (clean them), connecting hoses as well as gas cylinders and valves.
If no error can be found, call in techn. service.
no
Is error number = 11 ?
yes
Overdose 1 (slight)
no
Is error number = 12 ?
yes
Overdose 2 (unacceptable)
Possible causes
Pressure reducer on cylinder,
proportional valve and controller,
differential pressure sensors :
(p3 - p4),
nozzle, valve V4,
main board electronics
Check pressure reducer and valves.
If no error can be found here, call in techn. service
no
Is error number = 13 ?
yes
No input pressure
Possible causes
Gas cylinder empty or not connected
hose disconnected or come loose from device connection,
external pressure regulator 1 or 2,
sensors p1 or p2,
mainboard electronics.
Check connection hoses and gas cylinders, valves and pressure reducers.
If no error can be found here, call in techn. service
Condition does not hold!


Operating error (during switch-on phase)
Is error number 150 ?
yes
Key on front panel is pressed
Let go keys when switching on
If un-successful: replace keyboard PC board.
Error corrected ?
no
yes
End
no
Is error number 160 ?
yes
Footswitch signal CUT is present
Let go of yellow footswitch key when switching on
If un-successful: try unscrewing footswitch
Error corrected?
no
yes
End
no
Is error number 161 ?
yes
Footswitch signal COAG is present.
Let go of blue footswitch key when switching on
If un-successful: try unscrewing footswitch
Error corrected?
no
yes
End
no
Is error number 165 ?
yes
Finger switch-signal CUT is present
Let go of yellow finger switch key when switching on
If un-successful: try disconnecting accessory
Error corrected?
no
yes
End
no
Is error number 166 ?
yes
Finger switch signal COAG is present.
Let go of blue finger switch key when switching on
If un-successful: try disconnecting accessory
Error corrected?
no
yes
End
Error in the MCU. Replace MCU.
Call in techn. service! Full readjustment required!
Main board or MCU defective.


Self check error
Hardware error
Accessory error
Is error number between 200 and 219 ?
yes
Error in computer system
Error on MCU board. Replace MCU
Call technical service
When circuit boards are replaced, readjustment is required
no
Is error number between 220 and 229 ?
yes
Self check error in sensors
Possible errors: valve block main board (sensors) hoses
After replacement o main board: readjustment required!
no
Is error number between 230 and 240 ?
yes
Error 230: -12 V def. --> power supply Error 231: ref. voltage --> main board
Error 230: replace power supply Error 231: replace main board
After replacement o main board: readjustment required!
no
Is error number between 250 and 299 ?
yes
Error in argon gas supply
See error message text
Correct fault according to instructions displayed
Error 250: remove tissue from instrument Error 251: clean hoses and instruments (blockage) Error 262: change cylinder Error 263 + 264: change appropriate cylinder Error 265: use up one cylinder completely, then change cylinders
no
Condition does not hold!


Sum check error and System error
Is error number between 400 and 449 ?
yes
Sum check error
Error in storage of program or data
Error on MCU board: Replace MCU
Conduct readjustment
no
Is error number between 450 and 511 ?
yes
System error
Cause of error cannot be located by user
Call in technical service.
no
Condition does not hold!

Service support through test programs

As has already been mentioned several times, extensive hardware and test software is integrated in the APC 300 to discover device and operating errors, and to present these to the user in plain language on the display.

When it is switched on, and after every cylinder change, the APC 300 conducts a **self check** in which a large number of functions is tested and evaluated. **During operation** of the APC 300 **the device also continually tests the safety of operations and that specified limit values are maintained, and presents deviations from normal conditions immediately on the display.**

In this way the user has optimum conditions and can concentrate on his or her work. The technician, too, can call up a stored **list of the errors which have arisen** with **hints** of the possible causes of the error **in plain text** in the selected language.

Thus it was possible to use these test routines for troubleshooting purposes, and is why it was possible to greatly reduce the extent of the error trees in the error search routine.

To support the service technician, there are other **system diagnosis programs** besides the test functions mentioned; programs which simplify the error searching process even further. Some of these diagnosis programs are available to the user and the hospital technician at any time and can be called up through the menu, whereas others on the coded level are only available to the authorized technician, being present as hidden menu items, since, if applied in a manner not intended, the hidden programs can damage the adjustment of the APC 300 and thus have a negative effect on the safety of the unit.

By **pressing the enter key** for longer than about 3 seconds the operator comes to the program selection menu of the system diagnosis programs.

The following routines are found there:

- Configure application programs
- ARGON gas info
- Display error list
- Adjust display brightness
- System diagnosis programs
- Instrument rinse parameters.

By selecting the line “leave menu” with the up/ down keys and after confirmation with the enter key you are now back in normal operating mode.

Program selection menu

Configure application programs

branches to the menu

Configure application programs

Flow rate settings

allows a setting for the CUT flow and the COAG flow for each instrument 0 to 10.
In this menu the program number can be changed.
The settings are stored under the selected program number.

Preferred cylinder number

Selection of the preferred cylinder.
If the cylinder set is connected, gas is taken from the preferred cylinder when gas is actuated.

Volume settings

allows settings for volume for CUT, COAG and PURGE for each program to be made and stored. Each tone set must be stored separately.

ARGON gas Info

branches to the menu

Gen. cylinder info

displays contents [L] and input pressure [bar] of cylinders 1 and 2.
The cylinder data,
cylinder pressure [bar] and cylinder contents [L] for cylinder 1 + 2, are displayed.

Change cylinder data

The cylinder data,
cylinder pressure [bar] and cylinder contents [L] for cylinder 1 + 2, can be altered.
The altered settings are stored.

Display error list

branches to the menu

Error display menu

Display error list

shows the error list with a total for the number of errors which have occurred.
The list is scrolled with the up/down keys.

Error trace

shows the error trace list which lists each individual in the order it occurred.
The list is scrolled with the up/down keys.

Display brightness

allows the brightness of the display to be set.
The brightness setting is stored.

System diagnosis programs

contains the most important routines for the service technician
branches to the
System diagnosis selection menu

Tone generation test

allows the different tones to be tested and actuated without storing them.

Display test

The display is written with all available characters.

Test keyboard

Here, the keys on the front panel can be checked.
The number of the key pressed is issued.

Test actuation signals

The function of the footswitch and finger switch is tested.
The actuated function is displayed in plain language on the display.

Display output pressure

shows all measurements and the mean of them with the associated pressure [mbar].

Flow measurement range 1

shows all measurements and the mean of them with associated flow [mL].

Flow measurement range 2 and 3

shows all measurements and the mean of them with associated flow [mL].

Display cylinder pressure 1

shows all measurements and the mean of them with associated pressure of cylinder 1 in [mbar] and the associated cylinder contents [L].

Display cylinder pressure 2

shows all measurements and the mean of them with associated pressure of cylinder 2 in [mbar] and the associated cylinder contents [L].

Instrument identification

shows all measurements of the monitor and the mean of them for the instruments connected with the address determined and the actuation state.

Actuation identification

shows all measurements of the monitor and the mean of them for the actuation number with the actuation determined and the instrument address.

Supply voltage -12 V

shows all measurements of the monitor and the mean of them for the negative supply voltage with the voltage determined therefrom [mVolt].

Reference voltage +10 V

shows all measurements of the monitor and the mean of them for the reference voltage +10 V with the voltage determined therefrom [mVolt].

Proportional valtve test

The gas flow can be set by means of the up/down keys and can be checked at the output outlet with the flow meter.

Relay and valve test

Switching of the valves and relays can be tested with this program.
With the up/down keys the following states can be set:

- all relays and valves switched off.
- all valves switched on
- valve 1 switched on
- valve 2 switched on
- valve 3 switched on
- valve 4 switched on
- valve 5 switched on
- valve 6 switched on
- valve 7 switched on
- valve 8 switched on
- all relays and valves switched on
- relay 1 switched on
- relay 2 switched on
- relay 3 switched on
- relay 4 switched on.

This enables deductions to be made as to whether a certain valve or relay is still functioning or defective, or whether the main board control is functioning or defective.

Note: The valve numbers correspond to the possible switch combinations and are not identical to the valve numbers in the representation of the valve block!

Instrument rinse parameters

branches to the menu

Instrument rinse parameters

allows the rinse flow [L/min] and rinse duration [sec] to be set separately for each instrument 0 to 10.

The settings are stored.

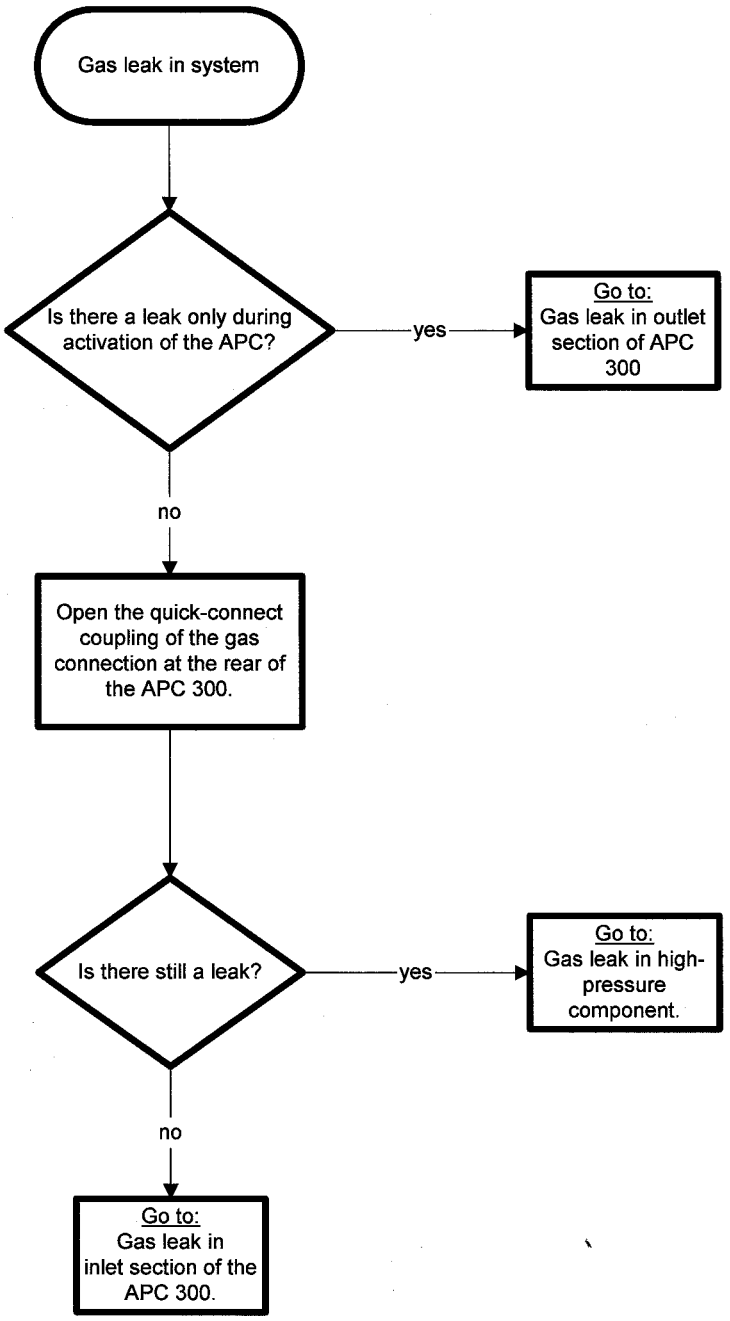
10 Finding errors when there is a leak in the argon gas unit

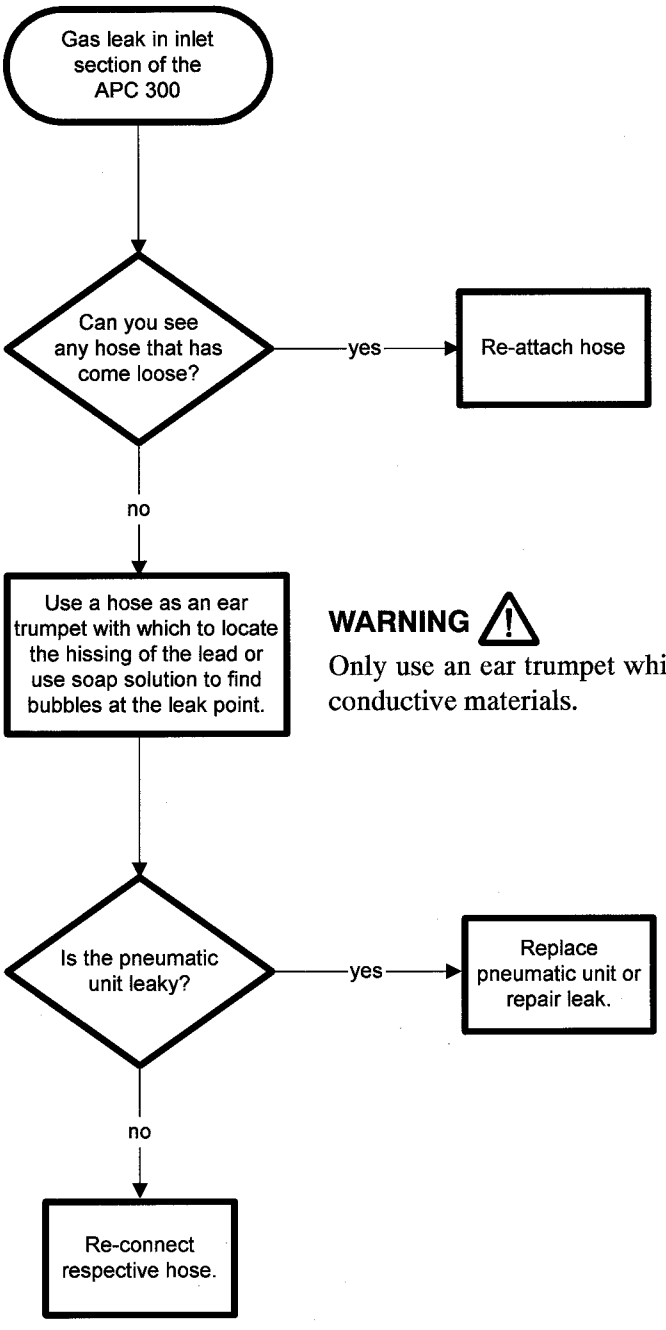
NOTES ON SAFETY WARNING ⚠

10 rules for working with gas cylinders

There are many regulations and rules concerning work with gas cylinders; some of the most important are listed below.

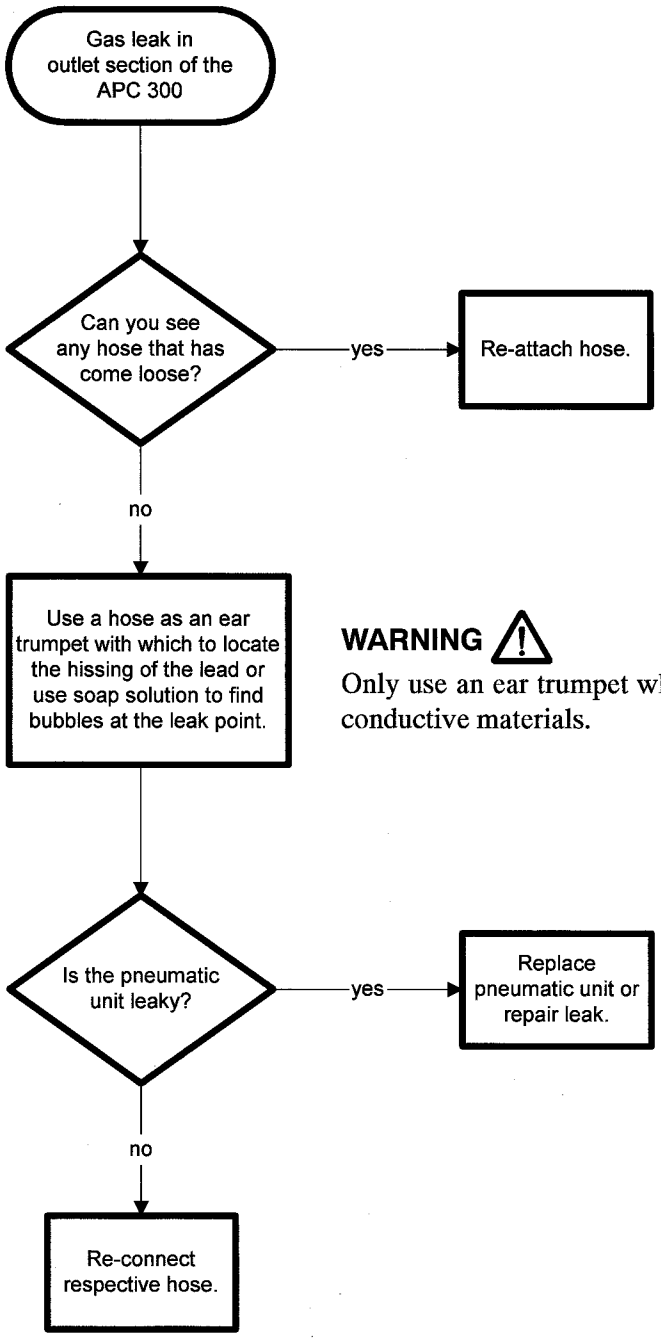
- Only experienced, trained persons may work with gases.
- GASES may only be taken from the CYLINDERS using the connected pressure reducing valves.
- GAS CYLINDERS must not be thrown and must be secured against tipping over or falling down (e.g. with chains, clamps or other fasteners).
- GAS CYLINDERS must be protected from heaters and open fires.
- Never transfer gases from one PRESSURIZED CYLINDER into another.
- The valve connections must be kept clean.
- CYLINDER labels (e.g. stickers) must not be damaged or removed.
- The valves and fittings on ARGON CYLINDERS must be kept free of oil and grease.
- GAS CYLINDERS which are damaged (e.g. damage to valves, fire damage) must not be used. They must be labeled clearly and the gas supplier must be asked how they are to be treated.
- GAS CYLINDERS may only be transported with permitted valve protection (e.g. valve cap) and with sufficient security against slipping or rolling about.


Gas leak in system
Is there a leak only during activation of the APC?
yes
Go to:
Gas leak in outlet section of APC 300
no
Open the quick-connect coupling of the gas connection at the rear of the APC 300.
Is there still a leak?
yes
Go to:
Gas leak in high-pressure component.
no
Go to:
Gas leak in inlet section of the APC 300.



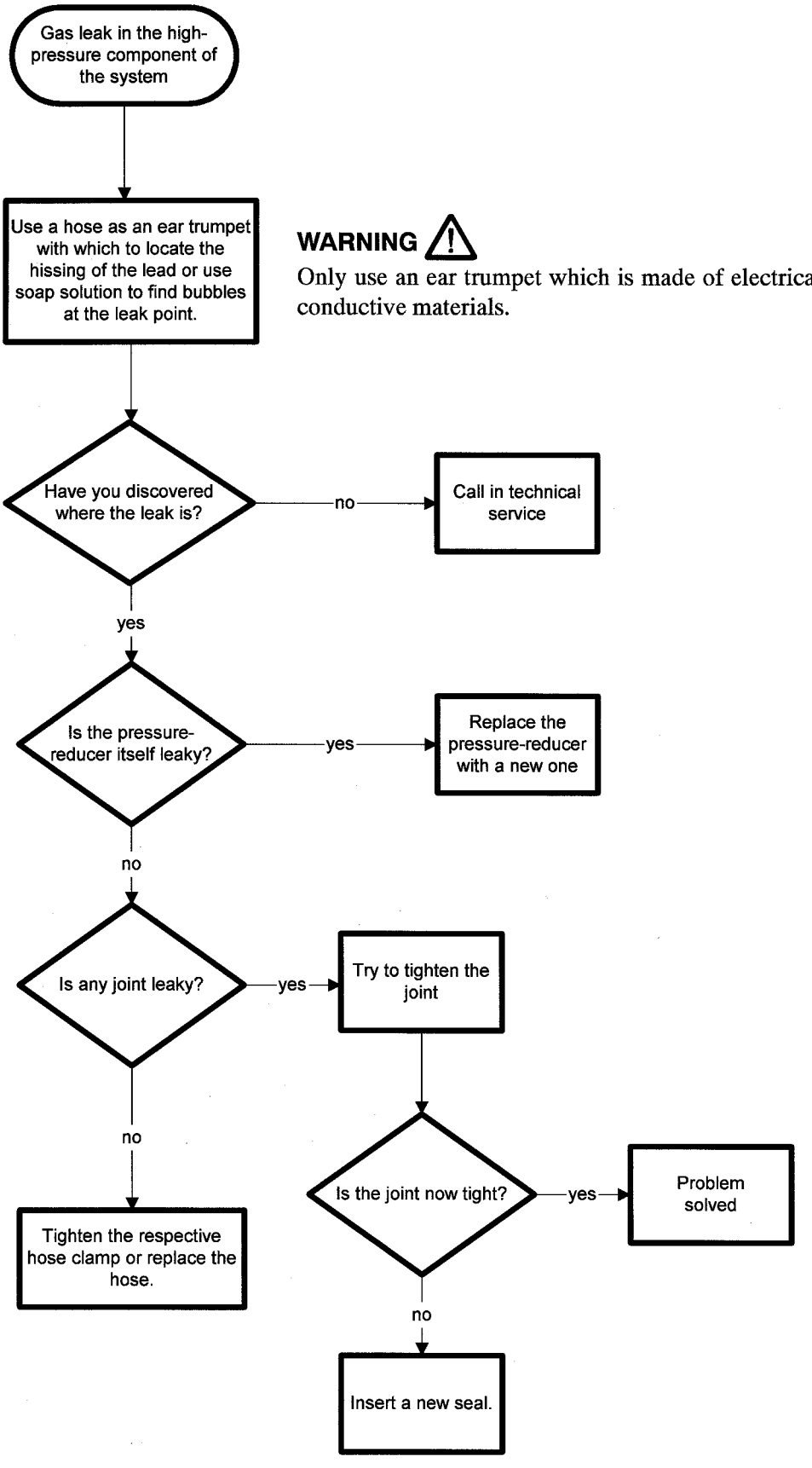
WARNING ⚠

Only use an ear trumpet which is made of electrically non-conductive materials.



WARNING ⚠

Only use an ear trumpet which is made of electrically non-conductive materials.



WARNING ⚠

Only use an ear trumpet which is made of electrically non-conductive materials.

11 Exchange of components and assemblies

Exchange of components or assemblies

This section describes the exchange of certain components and assemblies of the APC 300. Only the exchange of those parts which can be changed without any special tools or special testing implements will be described.

After components have been exchanged the APC 300 **must** always be **checked** to see whether it is functioning properly. In addition, the low-frequency leakage current and the protective ground conductor resistance must be measured, before the APC 300 can again be released for clinical use.

WARNING ⚠

Take care when touching parts in the interior of the open device while the device is connected to mains voltage. Always unplug the mains cable if possible**. Certain components of the switching power supply are at mains voltage** and for this reason they may only be touched by a device separated from mains voltage. If possible, use an isolating transformer.

For measurements with the oscilloscope or other measuring instruments, the measuring point MP 8 is provided as ground reference.

ATTENTION

The circuitry of the APC 300 contains electrostatically sensitive components. Work at an anti-static workplace while repairing the device and conducting measurements, and also wear a grounding armband while working with electrostatically sensitive components. Hold the circuit boards by their non-conducting surfaces and use an anti-static container for transporting electrostatically sensitive components and the circuit boards.

Recommended tools

2.5 mm screwdriver
4 mm screwdriver
8 mm screwdriver
Indented cross screwdriver no. 1
5.0 mm outlet driver
5.5 mm outlet driver (for M3 nuts).
6.0 mm outlet driver
8 mm fork wrench
12 mm fork wrench
14 mm fork wrench
Electric continuity tester
Multimeter

Testing and renewing line fuses

This section describes the testing and replacing of the line fuse or fuses at the rear and gives instructions about defective fuses.

Required tools:
4 mm screwdriver
Electric continuity tester.

- Unplug power cable from the outlets (from the device as well as from the power supply end!).
- The line fuses are located in the lower section of the device outlet. Depending on the regulations of the country of destination, there are one or two fuses.
- Using the blade of the screwdriver, grip the opening of the fuse drawer below the protective ground conductor contact and force it outwards.
- Now the drawer can be removed along with the fuses.
- Check the state of each fuse and test it for continuity with the continuity tester.
- Fuses which have no electrical continuity must be replaced with new fuses. Make sure in doing so that the nominal value of the fuses agrees with the specifications on the nameplate of the APC 300 (voltage, nominal current and characteristic)! Fuses with other faults (e.g. loose contact caps, broken glass) must also be exchanged.
- Replace fuses in the drawer and insert the drawer in the correct place with the strap facing upwards.

Note: Usually, line fuses are not faulty without cause. For this reason, if a line fuse is defective, you should always consider that there may be another internal defect which has blown the fuse. Only in rare cases does the fuse get blown by short-term peaks of current. In such a case, the APC 300 is functional again after the fuses have been changed. Otherwise, the cause of the overload must be found (e.g. short-circuit in the power circuit, short-circuit in the switching power supply, overloading of the the switching power supply).

Changing the device outlet with the power line filter

This section describes the removal and fitting of a device outlet combined with a power line filter and mentions various safety measures which should be taken.

Required tools:
Indented cross screwdriver no. 1
8 mm screwdriver

- Unplug power cable from the outlets (from the device as well as from the power supply end!).
- Open the APC. To do this, the two pan head screws on each side of the device and the four pan head screws in the rear section of the device cover must be removed.
- Remove the power lines and the protective ground conductor connection from the power line filter output in the interior of the device.

CAUTION ⚠

Please note or write down the colours of the connection leads and their positions. It is important for all leads to be returned to their original places after exchanging a part. (Brown strand towards the centre of the device, blue strand towards the side panel, yellow-green strand in the centre).

- Now remove both the cross-recessed screws from the exterior of the device outlet.
- Pull the device outlet with the power line filter backwards.
- Replace the device outlet with an **original component** with a power line filter.
- Push the device outlet from the rear into the rear wall and screw in again.
- Now the leads going into the device are re-connected to the power line filter. To do this, the cable outlet is placed on the contacts of the power line filter. The leads must be connected in their original configuration (same wire colours in same positions).
- Close up APC 300 again.
- Transfer the line fuses from the old device outlet to the new one, testing whether the nominal data of the fuses agree with the nameplate. If necessary, the fuses must be replaced with others which comply with the regulations.

Changing the power switch

This section describes the removal and fitting of a power switch in the APC 300
Required tools:
8 mm screwdriver
5.0 mm outlet driver

- Unplug power cable from the outlets (from the device as well as from the power supply end!).
- Open the APC. To do this, the two pan head screws on each side of the device and the four pan head screws in the rear section of the device cover must be removed.
- Remove the aluminum shield plate at the interior of the front panel by unscrewing the three hexagon stud bolts. Carefully pull out support washers. Slide the aluminum shield plate towards the centre of the device.
- Now the power switch is accessible from the interior of the device.
- Unplug the power voltage connection on the power control board.
- By hand, or with a screwdriver, press out the power outlet from the inside. The power outlet will come away from the front panel.
- Remove the power outlet completely from the front panel; the power switch leads are long enough for the switch to be replaced easily.
- Make a note of the color allocation of the connection wires (brown towards the interior of the device, blue towards the side panel).
- Remove the plugged connection wires.
- Exchange the power switch only with an original part.
- Re-plug the leads. (For the allocation of the wire colors see above).
- Press the power switch into the opening in the front panel provided. On the power switch rocker arm the red zero points upwards!
- Plug the plug into the power control board again.
- Arrange the connection lead to the device outlet again.
- Fasten the aluminum rear wall of the front panel again using the support washers and stud bolts so that the gap between the aluminum rear wall and the front panel is as small as possible.
- Close up the APC 300 by screwing the device cover on again.
- Perform function and safety check.

Exchanging the power control board

This section describes the exchange of the power control board in the APC 300

Required tools:
8 mm screwdriver
6 mm outlet driver

- Unplug power cable from the outlets (from the device as well as from the power supply end!).
- Open the APC. To do this, the two pan head screws on each side of the device and the four pan head screws in the rear section of the device cover must be removed.
- Unplug the two plugged connections of the power control board.
- Unscrew the four stud bolts with which the board is fastened to the housing.
- The power control board can now be removed and replaced by an original part.
- Screw the four stud bolts on again.
- Plug the two plugged connections in again.
- Close up the APC 300 by screwing the device cover on again.
- Functional and safety check.

CAUTION

The power control board is adjusted in the manufacturer's factory. The trimming potentiometers are sealed and must not be moved!

WARNING

Take care when touching parts in the interior of the open device while the device is connected to the mains. Always unplug the mains cable if this is possible. **Various components of the switching power supply are at mains voltage** and must therefore only be touched by an instrument not connected to the mains. If possible, use an isolating transformer.

For measurements with the oscilloscope or other measuring instruments, the measuring point MP 8 is provided as ground reference.

Exchanging the footswitch outlets

This section describes removing and fitting the footswitch outlets at the rear of the APC 300.

Required tools
8 mm screwdriver
2.5 mm screwdriver
5.5 mm outlet driver (for M3 nuts)

- Unplug power cable from the outlets (from the device as well as from the power supply end!).
- Open the APC. To do this the two pan head screws on each side of the device and the four pan head screws in the rear section of the device cover must be removed.

Dismantle outlets:

- Take time to look closely at the wiring and the construction before dismantling.
- Unplug the two plugs leading to the footswitch outlets from the main board. (Upper outlet (male) to J 10, main board, lower outlet (female) to J 9, main board).
- Remove the two upper and lower M3 nuts and their toothed lock washers using the 5.5 mm outlet driver.
- Now you can remove the mounting base with the two footswitch outlets.
- Make a note of the following connection configuration:

  upper outlet : pin 1 - black, pin 2 - blue, pin 3 - yellow

  lower outlet : pin 1 - black, pin 2 - blue. pin 3 - yellow, protective ground conductor- yellow/green.
- Remove the leads to the corresponding outlets using the 2.5 mm screwdriver.
- After removing the two M3 nuts with the toothed lock washers from the corresponding footswitch outlet, this can be pulled out towards the front through the retaining plate.
- Insert the new footswitch outlet in the same way. Fasten with the toothed lock washers and M3 nuts.

Reassembly:

- The further reassembly steps are in the converse order as in the dismantling instructions above.
- After completion of the task, check the APC 300 and close up the device again by by screwing the device cover on.

Exchanging the loudspeaker on the rear panel

This section describes the exchange of the loudspeaker for the audible signals.

Required tools:
5.5 mm outlet driver (for M3 nuts)
8 mm screwdriver

- Unplug power cable from the outlets (from the device as well as from the power supply end!).
- Open the APC. To do this, the two pan head screws on each side of the device and the four pan head screws in the rear section of the device cover must be removed.
- Remove the two AMP plugs of the loudspeaker lead.
- Loosen the three M3 fastening nuts of the loudspeaker by three turns.
- Remove the uppermost M3 nut complete with its support washer.
- Now the loudspeaker can be lifted out.
- Put the new loudspeaker in place again so that the flange of the loudspeaker is located under the two lower support washers.
- Put the upper support washer in place again with its M3 nut and screw the nut onto the thread.
- Now you can carefully tighten all three fastening screws.
- Replace the two AMP plugs on the lead.
- Try out the loudspeaker.
- Close up the APC 300 again with the cover and screws.

Exchanging the gas connections on the rear panel

This section describes the exchange of the gas connections on the rear panel of the APC 300.

Required tools:
8 mm fork wrench
12 mm fork wrench
14 mm fork wrench
8 mm screwdriver

- Unplug power cable from the outlets (from the device as well as from the power supply end!).
- Open the APC. To do this the two pan head screws on each side of the device and the four pan head screws in the rear section of the device cover must be removed.
- Undo the sleeve nut using the 12 mm fork wrench, then screw it off by hand and slide it over the gas hose.
- Remove the gas hose.
- Undo the gas outlet using the 14 mm fork wrench. Unscrew the nut. Remove the toothed lock washer.
- Remove the gas outlet outwards.
- Slide in the new gas outlet from outside.
- Put on the toothed lock washer from the interior of the APC 300.
- Screw in fastening nut and tighten using the 14 mm fork wrench.
- Put on gas hose, to which the sleeve nut is still loosely attached.
- Screw in the sleeve nut by hand and tighten using the 12 mm fork wrench
- Check the APC for gas leaks.
- Close up the APC 300 again with the cover and screws.

Exchanging the gas connection outlet on the front panel

This section describes the exchange of the gas connection outlet on the front panel of the APC 300.

Required tools:
8 mm fork wrench
12 mm fork wrench
14 mm fork wrench
8 mm screwdriver

- Unplug power cable from the outlets (from the device as well as from the power supply end!).
- Open the APC. To do this, the two pan head screws on each side of the device and the four pan head screws in the rear section of the device cover must be removed.

Dismantling:

- With the 8 mm fork wrench, screw off the gas connection and pull out the hose.
- With the 12 mm fork wrench, screw off the fastening nut.
- Pull off the outlet sleeve.
- Press the outlet through on the front and remove it.

Assembly:

- Put the new outlet in place on the front panel.
- From the interior of the APC 300, put the outlet sleeve in place (note the guiding groove).
- Screw the M8 nut in place again and tighten using the 12 mm fork wrench.
- Put the gas hose in place and tighten with the sleeve nut (8 mm fork wrench).
- Close up the APC 300 again with the cover and screws.

Changing argon cylinders

This section describes the processes required for changing an argon cylinder with the APC 300.

Required tools: none

For changing cylinders switch the APC 300 **on** or leave it **switched on.**

Removing a cylinder:

- Close the cylinder valve. The cylinder valve may be a little stiff.
- Remove the pressure hose from the argon cylinder connection at the rear of the APC 300.
- Put the opening of the pressure hose on the drainage bolt in place at the rear of the APC 300 and press it. In the hose there is still a small amount of argon. This will now escape with a hissing noise.
- Screw off the sleeve nut of the pressure reducer by hand in a counter-clockwise direction and remove the pressure reducer.
- Screw the valve protection (cylinder cap) onto the empty argon cylinder.
- Lift up the cover of the APC 300 gas cylinder compartment by its handles and remove the cover.
- Remove the gas cylinder.

Putting a cylinder in place:

- Make sure that the full cylinder is undamaged. Damaged cylinders must not be used! Make sure that nothing else besides **ARGON** is in the full cylinder, because the APC 300 may **only be operated with ARGON**!
- Unscrew the valve protection (cylinder cap) from the full argon cylinder.
- Place the cylinder in the cylinder compartment.
- Insert the cover of the cylinder compartment again.
- Screw on the sleeve nut of the pressure reducer by hand in a clockwise direction onto the new cylinder.
- Put the pressure hose in place on the free cylinder connection of the APC 300.
- Open the cylinder valve.

The APC 300 system will now by rinsed with argon automatically. If the pressure reducer and the hose is tight, **no more hissing** should be audible **after** the rinsing process!

If the hissing lasts for more than two seconds from the time the argon cylinder is opened, there is a leak, through which the argon is flowing continually. In this case, the cylinder valve must be closed again immediately.

Before using the APC 300 with this cylinder, the leak must be located and repaired!

For further details, please refer to the operating instructions (Chapter 6) and the section entitled “Notes on safety: 10 rules for working with gas cylinders”.

12 List of components and assemblies mentioned in Chapter 11

Qty	Part No.	Part
2	51611-054	International fuse T1.0 A /250 V, 5x20 mm
2	51611-089	Fuse UL T1.0 A /250 V, 5x20 mm
1	51400-012	Device outlet with power line filter
1	50502-069	Power switch
1	40132-101	Power control board
1	51604-00	Footswitch outlet
1	51604-077	Output for actuation signals
1	50610-009	Loudspeaker
2	51708-043	Argon cylinder connections at rear
1	30132-118	Argon outlet on the front panel
2	20132-004	Argon cylinder 5 l, International
2	20132-037	Argon cylinder 7 l, UL