ABEM
A Nitro Consult Company

Instruction Manual

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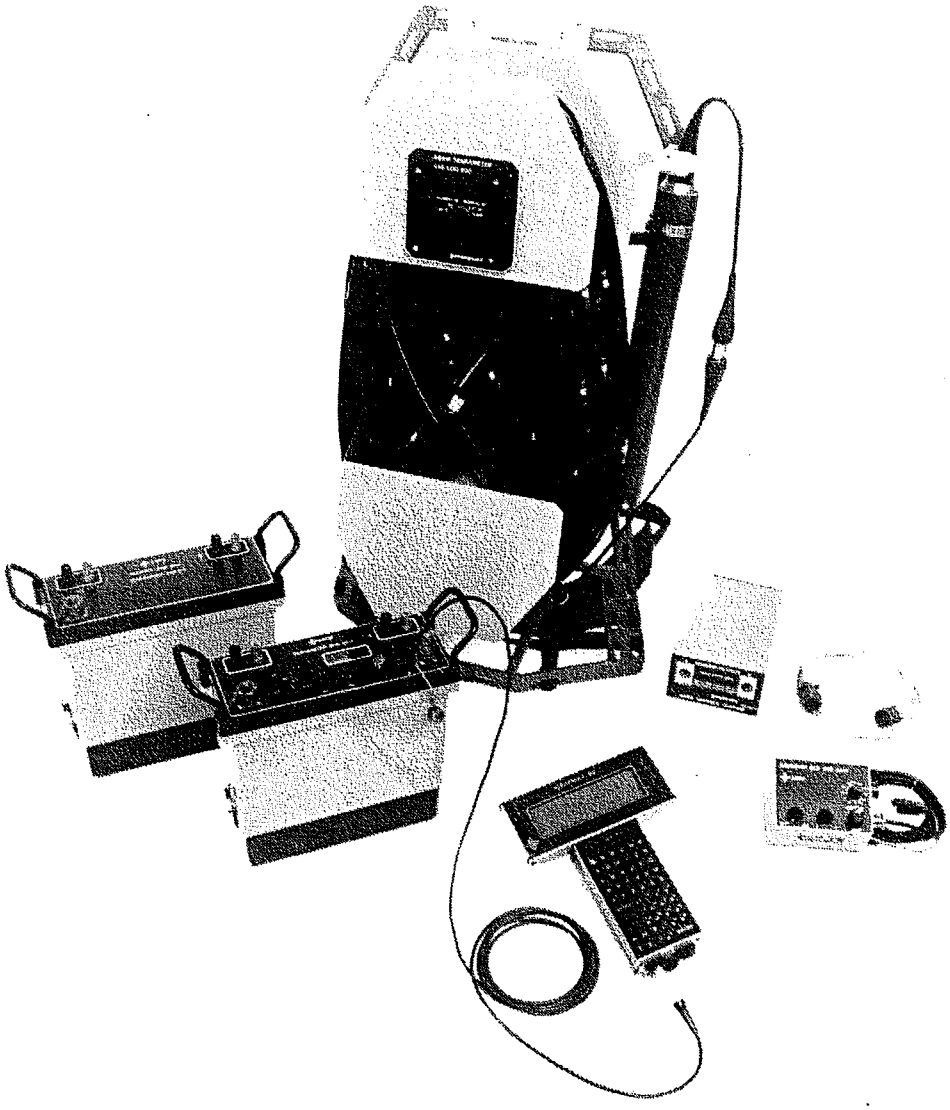
Terrameter SAS 300 C



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1 INTRODUCTION

This Instruction Manual covers operation, maintenance and, where appropriate, reduction of data. A careful study of this manual is recommended before starting to work with the equipment.

ABEM instruments are carefully checked at all stages of production and are thoroughly tested before leaving our factory. They should provide many years of satisfactory service if handled and maintained according to the instructions given in this manual.

ABEM will be pleased to receive occasional reports from you concerning your use of and experience with the equipment. We also welcome your comments on the contents and usefulness of this manual. When writing please be sure to include the instrument types and serial numbers.

In view of our policy of progressive development, we reserve the right to alter specifications without prior notice

List of revisions					
No.	Date	Inserted by	No.	Date	Inserted by

Fig. 1.1 List of revisions

1.1 UNPACKING AND INSPECTING

Use great care when unpacking the Instrument. Check the contents of the box or crate against the packing list that is included. Inspect the instrument and accessories for loose connections and inspect the instrument case for any damage that may have occurred because of rough handling during shipment.

Shipping damage claims

File any claim for shipping damage with the carrier immediately after discovery of the damage and before the equipment is put into use. Forward a full report to ABEM, making certain to include the ABEM delivery number, instrument type(s) and serial number(s).

All packing materials should be carefully preserved for future re-shipment, should this become necessary.

1.2 WARRANTY

ABEM warrants each instrument manufactured by them to be free from defects in material and workmanship. ABEM's liability under this warranty is limited in accordance with the terms of Clause 9 of General Conditions for the Supply of Plant and Machinery for export prepared under the auspices of the United Nations Economic Commission for Europe, Geneva, March 1953. It covers the servicing and adjusting of any defective parts (except tubes, transistors, fuses and batteries). The Warranty is effective for twelve (12) months after the date of Bill of Lading or other delivery document issued to the original purchaser, provided that the instrument is returned carriage paid to ABEM, and is shown to ABEM's satisfaction to be defective. If the fault has been caused by misuse or abnormal conditions, repairs will be invoiced at cost.

Should a fault occur that is not correctible on site, please send full details to ABEM. It is essential that instrument type and serial number are included and, if possible, the original ABEM delivery number. On receipt of this information, disposition instructions will be sent by return. Freight to ABEM must be pre-paid. For damage or repairs outside the terms of the Warranty, ABEM will submit an estimate before putting the work in hand.

Be sure to fill in the warranty registration card (included with the equipment) correctly and return it to ABEM promptly. This will help us process any claims that may be made under the warranty.

1.3 REPACKING AND SHIPPING

ABEM packing is designed for the instruments concerned and should be used whenever shipping becomes necessary. If original packing materials are unavailable, pack the instrument in a wooden box that is large enough to allow some 80 mm of shock absorbing material to be placed all around the instrument. This includes top, bottom and all sides. Never use shredded fibres, paper or wood wool, as these materials tend to pack down and permit the instrument to move inside its packing box.

Do not return instruments to ABEM until shipping instructions have been received from ABEM.

2 GENERAL

The Terrameter SAS system consists of a basic unit called the Terrameter SAS 300C which can be supplemented as desired with the SAS 2000 Booster, the SAS Log 200 and the Geomac III field computer.

SAS stands for Signal Averaging System - a method whereby consecutive readings are taken automatically and the results are averaged continously. The continously updated running average is presented automatically on the display. This continues until the operator is satisfied with the stability of the result. SAS results are more reliable than those obtained using single-shot systems. Moreover, SAS results are easier to check than results obtained using signal stacking (enhancement).

The SAS 300C (basic unit) can be used for self potential surveys and resistivity surveys.

The SAS 2000 Booster (optional) supplements the SAS 300C in situations where the voltage and/or current must be increased.

The booster is normally slaved to the SAS 300C, but it can also be operated separately in special applications such as charge potential studies and dipole-dipole surveys.

A convenient carrying harness that can be used for the SAS 300C or the SAS 2000 Booster is available.

The SAS Log 200 (also optional) provides an efficient, simple way of extending your survey into wells and drillholes. It consists of a 200 m cable with logging probe, electrodes, temperature transducer and resistivity cell, all mounted on a backpacking frame.

The Geomac III is a portable, hand-held field computer with extensive and versatile I/O capabilities. Full MS-DOS compatibility enables it to run programs already developed for regular PCs. The graphic display emulates CGA on a 240x64 pixel LCD screen.

2.1 TERRAMETER SAS 300C - GENERAL

The Terrameter SAS 300C can operate in two modes:

- In the resistivity surveying mode, it comprises a batterypowered, deep-penetration resistivity meter with an output sufficient for a current electrode separation of 2000 metres under good surveying conditions. Discrimination circuitry and programming separates DC voltages, self potentials and noise from the incoming signal. V/I is calculated automatically and displayed in digital form in kiloohms, ohms or milliohms. The overall range thus extends from 0.05 milliohms to 1999 kiloohms. The range can be extended down to 0.002 milliohms by means of the SAS 2000 Booster.
- In the voltage measuring mode, the SAS 300C comprises a self potential instrument that measures natural DC potentials. The result is displayed in V or mV. The overall range extends from 1μV to 500 V. Non-polarizable electrodes are available for self potential surveys.

The Terrameter SAS 300C contains three main units, all housed in a single casing: the transmitter, the receiver and the microprocessor. The electrically isolated transmitter sends out well-defined and regulated signal currents. The receiver discriminates noise and measures voltages correlated with transmitted signal current (resistivity surveying mode) and also measures uncorrelated DC potentials with the same discrimination and noise rejection (voltage measuring mode). The microprocessor monitors and controls operations and calculates results.

In geophysical surveys, the SAS 300C permits natural or induced signals to be measured at extremely low levels, with excellent penetration and low power consumption. Moreover, it can be used in a wide variety of applications where effective signal/noise discrimination is needed. It can be used to determine the ground resistance of grounding arrangements at power plants and along power lines and (in a pinch) it can even be used as an ohmmeter. In industrial applications, temperature, strain, pressure etc. can be measured using standard transducers in high-noise environments.

Transmitter designed for deep penetration

The transmitted current is commutated in a waveform suitable for resistivity surveying.

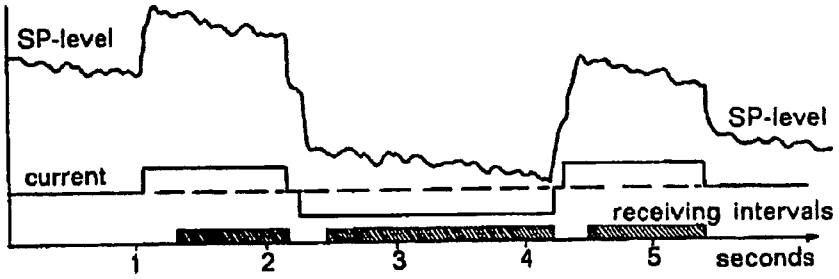


Fig. 2.1 Transmitted current waveform

The response voltage signal (plus self-potential and ground noise) is measured by the receiver at discrete time intervals when the eddy currents, the induced polarization and the cable transients have decayed to low levels.

Standard factory current-output programming (in combination with the receiving principle) provides skin impedance effects equivalent to approximately 0.4 Hz for 3.6 seconds of current flow. The operator can, however, select two other time scales equivalent to 0.2 and 0.1 Hz. These should only be used under extreme depth and resistivity conditions since the corresponding time cycles (7.2 and 14.4 seconds of current flow) increase power consumption. For normal use, the standard factory programming is equivalent to DC surveying.

The current amplitude is set by the operator to suit the actual survey conditions. It can be set to 0.2, 0.5, 1, 2, 5, 10 and 20 mA at 160 V maximum current electrode potential. The range can be extended to 500 mA or to 400 V by using the optional Terrameter SAS 2000 Booster.

Receiver designed for signal extraction

Penetration and accuracy limits are imposed mainly by noise caused by telluric currents, power transmission lines and electrochemical variations at the potential electrodes.

A unique integrator combined with an ingenious measurement strategy permits the Terrameter SAS 300C receiver to extract the signal from man-made and natural noise, even when using low, safe signal voltage levels. This measurement strategy includes analog filtering, digital signal processing, rejection of induced polarization (IP) effects and rejection of the transient phase of the signal current.

DC potential measurement

If the Function Selector switch is set to "V", DC potential (self-potential) measurements can be done. Thanks to extremely linear circuits, the voltage can be read and displayed to 3 or 4 significant digits.

Power line noise is effectively suppressed. At low railway frequencies (15-20 Hz), noise suppression is 70 dB while suppression in the 50-60 Hz range is 85 dB.

The aforesaid noise suppression figures are for a single signal reading. However, when the Terrameter SAS 300C is used in the signal averaging mode, the microprocessor takes repeated measurements and calculates the running average (up to 64 readings). Statistically distributed voltage noise is thus reduced by a factor of $\sqrt{N}$, where N is the number of readings.

Resistance measurement

In the resistance measuring mode, the Terrameter SAS 300 measures voltage responses created by the transmitter current while rejecting both DC (SP) voltage and noise. V/I is automatically calculated and displayed digitally in kiloohms (kΩ), ohms (Ω) or milliohms (mΩ).

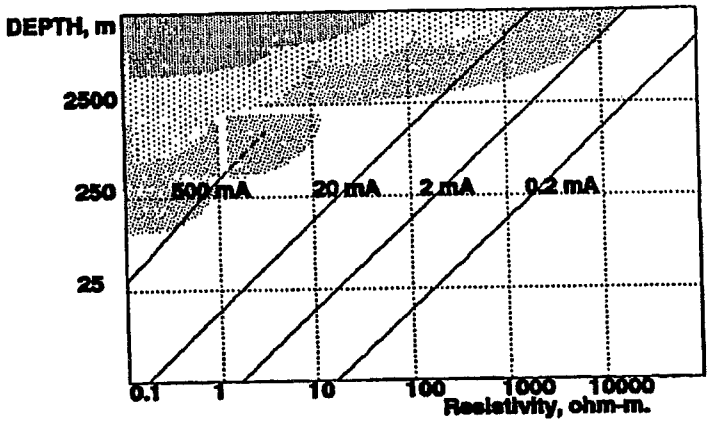


Fig. 2.2 Penetration depth curves

The relevant receiver resistance range is automatically selected. The result is displayed to 3 or 4 digits. When the transmitter is operating at 20 mA, the Terrameter SAS 300C has a resolution of 0.05 milliohms for a single reading. When the Terrameter SAS 2000 Booster is used to obtain a current of 500 mA, the resolution for a single reading is 0.002 milliohms.

To take full advantage of the outstanding capabilities of the Terrameter SAS 300C, meticulous care must be observed in the arrangement of cables and electrodes used in the field. Current leakage and creep can substantially reduce the attainable accuracy and sensitivity and thus the depth penetration.

The diagram in Fig. 2.2 shows the maximum SAS penetration depth (at different exitation currents) versus resistivity for a homogeneous ground. It is assumed that the maximum MN/2 value is 0.2•AB/2 and that the potential difference exceeds 50 μV, corresponding to an accuracy of 2%. The shaded area in the top left part of the diagram is inaccessible due to skin depth limitation (at a period of T = 3.6 sec).

Microprocessor monitors and controls measurements

The SAS300C microprocessor controls and monitors all measurements to ensure optimal accuracy and sensitivity and to make certain that the instrument is used correctly. When the operator presses the MEASURE

button, the microprocessor runs a thorough check on circuits and switch positions. It also checks the battery condition and the useability of selected parameters. The complete check-up procedure takes only one second and, if necessary, warnings and information comprising beeper signals and simple error codes tell the operator to change parameters or to check circuits. When satisfied, the microprocessor automatically starts the measurement cycle, and after all readings have been taken it puts the instrument into the standby mode with the final result displayed.

Digital RS 232 output

A digital output connector is included for communication with a field computer or transmission of the measured values to a printer or a digital tape recorder. The connector is located at the lower right corner of the Terrameter front panel.

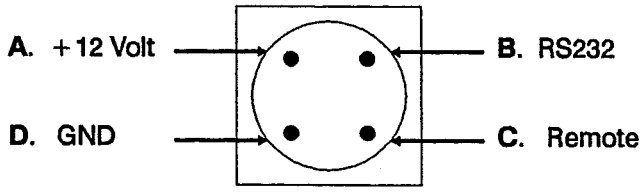


Fig. 2.3 Pin configuration on the SAS300C KPT male connector

Description of the pins:

A: Can be used together with GND on pin D for 12V power supply

B: RS232 serial output. It complies to the RS232 specification of signal voltages and operates at 300 baud. The output format is as follows:

Voltage:	V = 1.234E-2 <CRLF>	(12.34 mV)
Battery:	B = 1.234E+1 <CRLF>	(12.34 V)
Resistance:	R = 1.234E-3 <CRLF>	(1.234 mΩ)

Note: <CRLF> means the ASCII sequence <carriage return> <line feed>.

Exponential representation is used and the code is followed by a carriage return - linefeed sequence. One start bit, seven data bits and two stop bits are transmitted. Transmission takes place after the final measurement cycle of a multi-cycle measurement. Note that no intermediate measurements are output.

C: Remote control of SAS300C. When raising the voltage from 0 to at least 2 Volt on pin C the SAS300C starts a measuring cycle.

D: GND

The SAS300C can conveniently be controlled from an external computer, e.g. the ABEM GEOMAC III field computer. The sequence of BASIC program code in Fig. 2.4 illustrates how the communication can be handled. In the appendix in the back of this manual is shown the 3 wiring diagrams for the connection cables for GEOMAC III, PC/AT and PC/XT computers.

The program package SASMASTER from ABEM, running on the GEOMAC III or any other PC/XT/AT, will conveniently take care of the control and data collection in the field.

```
...
OPEN "COM1:300,N,8,2" FOR RANDOM AS #3
PRINT #3, &H0, &H0, &H0, &H0
b$ = ""
DO
  a$ = INPUT$(1, #3)
  b$ = b$ + a$
LOOP UNTIL a$ = CHR$(10)
CLOSE #3
n = INSTR(b$, "=")
Value = VAL(MID$(b$, n+1, 9))
...
```

Fig. 2.4. A fragment of Microsoft ®QuickBASIC™ program code for communication with the SAS300C from a PC computer.The Terrameter reading is saved in the variable named Value.
QuickBASIC™ is a registered trade mark of Microsoft Corporation.

2.2 TERRAMETER SAS 2000 BOOSTER - GENERAL

The excitation current used for surveying can be increased by means of the Terrameter SAS 2000 Booster to obtain greater depth penetration or overcome exceptionally high or low conductivity. It is thus an invaluable aid in situations where electrode separations of more than 2000 meters are needed, where difficulties are encountered in grounding current electrodes (desert conditions for example) and where very high currents are needed (salt marshes for example). The current levels are thus extended to cover a range of 0.2-500 mA. The maximum transmitter voltage is 400 V.

Normally, the SAS 2000 Booster is controlled from the SAS 300C. However, it can be operated separately from the SAS 300C in situations where two operators wish to conduct surveys at long distances from each other without using any connection cables between the instruments.

The dimensions of the SAS 2000 Booster are the same as those of the SAS 300C, and both are provided with the same type of NiCd rechargeable battery pack. The booster has a weight of 6.3 kg including battery.

2.3 TERRAMETER SAS LOG 200 - GENERAL

The Terrameter SAS LOG 200 logging system can be used together with the Terrameter SAS 300C. It is intended for logging to depths up to 200m.

Measuring modes:

- Short normal (16") resistivity
- Long normal (64") resistivity
- Lateral (18") resistivity
- Self potential
- Temperature
- Fluid resistivity (can be used to estimate TDS)

The SAS LOG 200 consists of a 200m cable with logging probe electrodes, temperature transducer and resistivity cell, all mounted on a backpacking frame. After the SAS LOG 200 has been connected to the SAS 300C and to two ground electrodes, a selector switch on the backpacking frame can be used to select any of the above modes of operation. The cable (with down-hole logging probe) is lowered into the

hole step by step and readings are taken at each station by pressing the MEASURE button on the SAS 300 C.

This simple logging system makes it possible to delineate formation boundaries with regard to infiltration, porosity and permeability by means of self potential and resistivity measurements. Under favourable circumstances, water flow boundaries can be detected by measuring temperature changes. Moreover, the resistivity of the water can be measured in situ so that the total amount of total dissolved solids (TDS) can be estimated. Zones of high salinity can thus be localized and sealed off by means of casing and cementing.

Upon special order, a 300m version (SAS LOG 300) can be delivered.

3 OPERATING INSTRUCTIONS

These operating instructions explain only how to handle the equipment itself.

Instructions for conducting the different types of surveys are available in other documents.

3.1 TERRAMETER SAS 300C INSTRUCTIONS

3.1.1 Controls and terminals

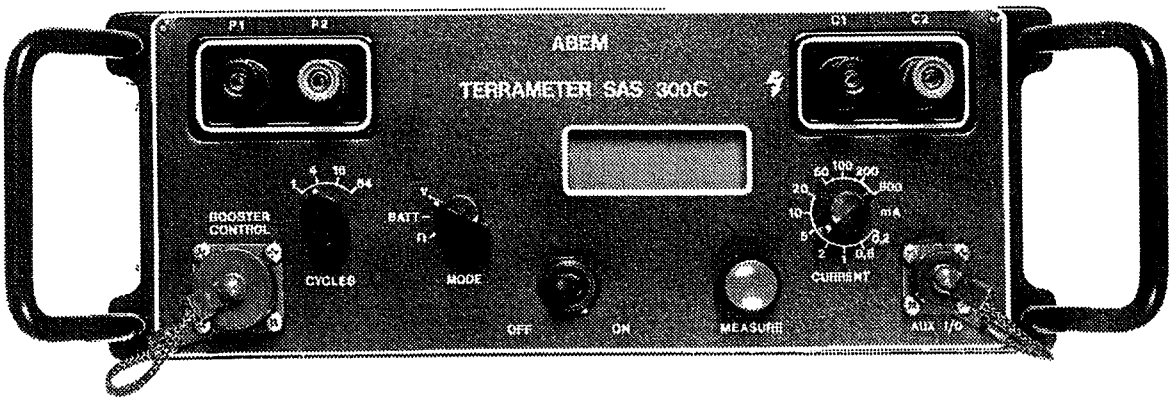


Fig. 3.1 SAS 300C panel with contacts and terminals.

Controls

The Terrameter SAS 300C has the following five controls:

- SAS (Signal Averaging System) selector (also called the CYCLES selector).
  This 4-position selector is used to choose either the single reading mode or 4, 16 or 64 automatically averaged readings.
- MODE selector.
  This selector selects either the resistivity mode or the voltage mode. When this selector is turned to the battery check position, the battery voltage is measured.
- ON/OFF switch.
  Switches power on and off.
- CURRENT selector.
  This 11-position selector selects the current for the built-in transmitter (0.2 mA to 20 mA in seven steps). Four extra-high power settings ranging from 50 mA to 500 mA are available with the optional Terrameter SAS 2000 Booster.
- MEASURE pushbutton.
  When you depress the MEASURE pushbutton, the microprocessor runs through its automatic diagnostics program and, if everything is

satisfactory, starts the Terrameter SAS 300C measurement procedure automatically. When measurement is complete, the SAS 300C is returned to the standby mode with the result on the digital display.

Terminals

The current electrode terminals are to the right on the control panel. The potential electrode terminals are at left. Note that both the terminal circuits are protected by semiconductors. Lightning, high voltage cattel fences or other high voltage sources may, however, damage the instrument. Lightning miles away may induce hundreds of volts in long cable layouts, and this entails risk for both personnel and equipment.

You should never take measurements during a thunderstorm.

If a thunderstorm should come up while you are taking measurements, disconnect the cables from the terminals without touching any bare conductors. Never leave the cables connected to the SAS 300C overnight, since a thunderstorm may occur.

To reduce risk for leakage currents between adjacent electrodes smear a very thin film of silicone grease on the panel face around and between the terminals. A tube of silicone grease is included with your SAS 300C.

Connectors

To the left of the panel is the BOOSTER CONTROL connector, and to the right the AUX I/O connector. The latter is for RS232 communication and remote control of the Terrameter, see section 2.1.

Display and beeper

A liquid crystal display (LCD) presents data, warnings and instructions for the operator. A beeper signal is also provided which helps the operator interpret the displayed information. Protect the LCD against strong sunlight - for longer LCD life.

3.1.2 DAILY CHECK

Conduct a daily battery check as follows:

- Turn the function selector to the BATT (battery) position. Turn the ON/OFF switch to the ON position and press the MEASURE button. Wait five seconds.
- If the battery is properly charged, the display will read 12.5 - 15 V. If the reading is less than 11.5 V, the battery will soon need recharging. Charge as instructed in section 4.2.
- If nothing appears on the display, or if the beeper does not sound, the battery is probably completely discharged (microprocessor is then incapable of issuing any error code signals to the operator).
- Do not forget to switch the power off after making this battery check.

3.1.3 VOLTAGE MEASURING MODE (SP) SURVEYS

- Connect the voltage that is to be measured to terminals P1(-) and P2(+). If you are measuring self potential (SP), non-polarizable electrodes must be used. Beware of thunderstorms. Any high voltages from cattle fences or the like picked up by the cables connected to the SAS 300C can damage the instrument.

- Turn the power on. The display shall show 000. Set the function selector to the V position. Turn the CYCLES selector to position 4. Press the MEASURE button.
- Observe the four readings that appear successively on the display. If they are nearly equal, the noise level is acceptably low and you can proceed with your SP survey by taking single readings. Single readings are obtained by turning the CYCLES selector to position 1. If the readings are not nearly equal, i.e. if the noise level is not acceptable, turn the CYCLES selector to position 16 or even 64, thus obtaining 16 or 64 cycles.
- If error codes appear on the display, follow the instructions set forth in section 3.1.7.

3.1.4 RESISTIVITY SURVEYING MODE

It is advisable to carry out Schlumberger measurements as shown in the diagram 3.2 with ample separation (5 m) between potential and current cables due to the fact that crosstalk can occur. This is particularly important when there is a long distance between A and B.

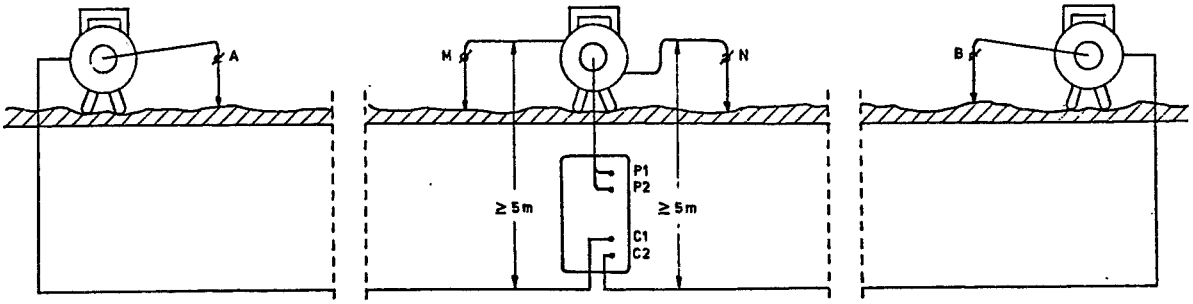


Fig. 3.2 Resistivity surveying setup.

Stainless steel potential electrodes are preferable, although ordinary steel electrodes are acceptable.

- Position the SAS 300C half way between the potential electrodes (M and N). Connect terminals P1 and P2 to terminals M and N respectively. Use an ABEM sounding cable set or a 2-conductor cable of good quality with the conductors separated at the electrode end.
- Connect the current electrodes (A and B) to terminals C1 and C2 respectively. Run these cables in parallel adjacent to the SAS 300C, and arrange them symmetrically with respect to the potential electrodes. Beware of thunderstorms. Any high voltages (from cattle fences or the like) picked up by the cables connected to the SAS 300C can damage the instrument.
- Turn the MODE selector to the Ω position. Turn the CYCLES selector to position 4. Turn the CURRENT selector to position 20 mA. Switch the power on and press the MEASURE button.
- If error code 1 (see section 3.1.7) appears and the beeper sounds repeatedly, reduce the current step by step until the beeper stops sounding. Then wait for a reading to appear on the display. If beeping does not stop, check the transmitter cables and current electrodes for bad connections.

Observe the four readings that appear successively on the display. If they are nearly equal, the noise level is satisfactory low. However, if the third and fourth readings differ significantly from the others, turn the CYCLES selector to position 16 or even 64, thus obtaining 16 or 64 cycles. Alternatively, you can increase the current by improving the current electrode grounding or using the SAS 2000 Booster.

- Negative resistance readings can occur for two reasons:
  - The current or the potential electrodes have been connected with reversed polarities.
  - The noise level may be much higher than the signal level (long distances between A and B and low current). If this is causing single negative readings, signal averaging must be used.
- If other error codes appear on the display, follow the instructions set forth in section 3.1.7.

3.1.5 CHANGING THE CYCLE TIME

The SAS 300C has three different cycle times corresponding to current flow periods of 3.6, 7.2 and 14.4 seconds. The desired cycle time is selected by means of a jumper on the main printed circuit board. The factory setting is 3.6 seconds, which covers any normal application.

The following diagram illustrates the timing of the events taking place within the SAS 300C.

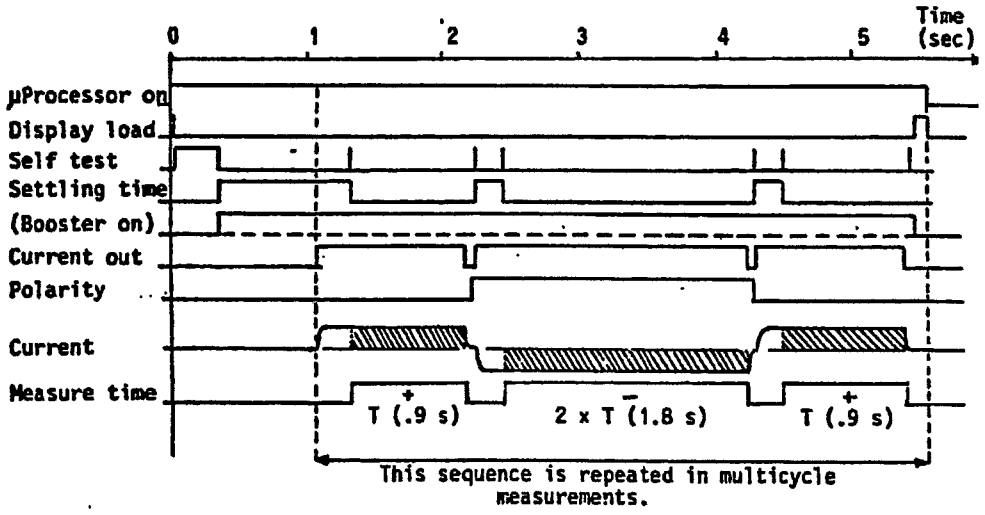


Fig. 3.3 Timing diagram of SAS 300C. T is 0.9, 1.8 or 3.6 s

The start/check period begins when the MEASURE button is pressed. If everything is found satisfactory, all circuits enter their running status after a 1.06 second start/check period.

The above diagram shows that idle time has been provided to permit the current and potential circuits (cables, electrodes, ground eddies, SP voltage) to stabilize before measurements are taken. There is also ample time for current and potential to decay before the polarity relays are set.

Current flow cycle times are compared with overall cycle times below.

To change the cycle time, proceed as follows:

Remove the four screws located below the handles and lift the instrument out of its casing by the handles. Place it on a table with the components

Current flow cycle time	Jumper	Overall cycle time
3.6 sec (4T)	g	5.5 sec
7.2 sec (8T)	f	9.1 sec
14.4 sec (16T)	e	16.25 sec

upward and the control panel in front (facing you).

In area F3 (see Fig 3.4 at left on the main printed circuit board there is a jumper area designated e f g).

When the SAS 300C is delivered from the factory, the jumper is at position g, which corresponds to 3.6 seconds. Move the jumper to position f for a current flow time of 7.2 seconds. Move it to position e for 14.4 seconds.

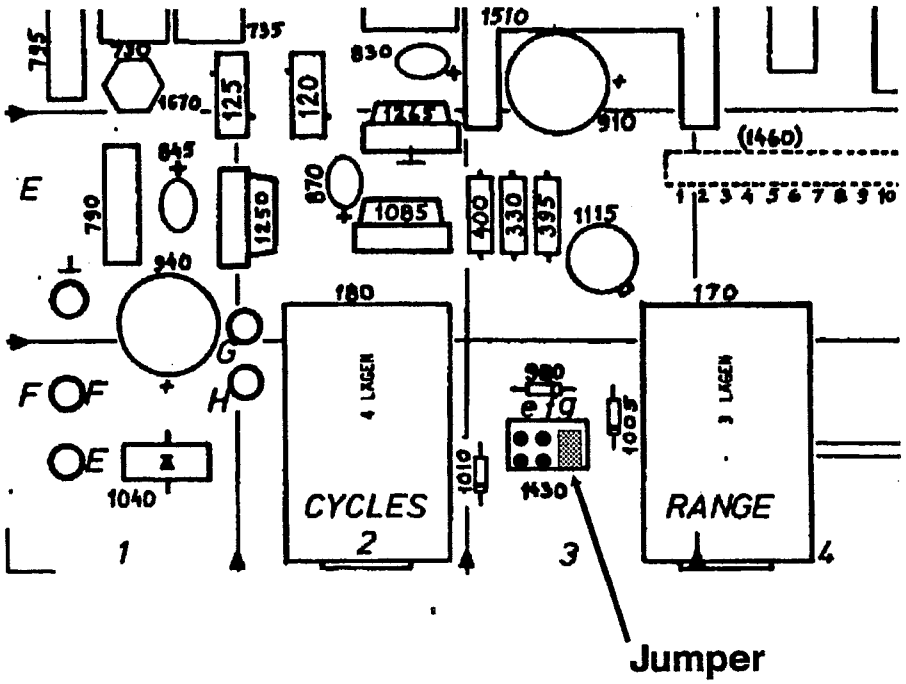


Fig. 3.4 Diagram showing cycle time jumper position.

IMPORTANT

Static electricity can damage the delicate semiconductor components in the circuitry. Do not touch any circuitry needlessly with your hands or your tools. Always discharge yourself by touching a grounded object before handling the internal parts of the SAS 300C. Protect your workshop against static electricity. Never connect a capacitor to the transmitting terminals or the transmitter circuit since surge discharge currents can burn out the polarity change relay.

3.1.6 ERROR CONSIDERATIONS

Accuracy may be defined as the agreement of a measurement with the known "true" value of the quantity being measured. Inaccuracy is caused by inaccurate components like resistors, amplifiers and references. Low accuracy indicates a presence of a systematic error. Precision is the ability to reproduce the same values for a set of parallel observations.

Resolution is concerned with the ability to distinguish two or more slightly different measurements. The internal resolution of the SAS 300C is 1 μV for the voltage mode and (10^{-6}/I) Ω for the resistance mode, e.g. 0.05mΩ when I = 20 mA.

The accuracy of the SAS 300C is better than 2% in the resistance mode and better than 1% $\pm$50 μV (offset) in the voltage mode. In the voltage mode errors caused by offset may exceed 1% if very small voltages are measured. In the resistance mode the offset error is eliminated due to the commutated waveform - even if only one measuring cycle is performed.

Fig. 3.5 below illustrates the difference between accuracy and precision.

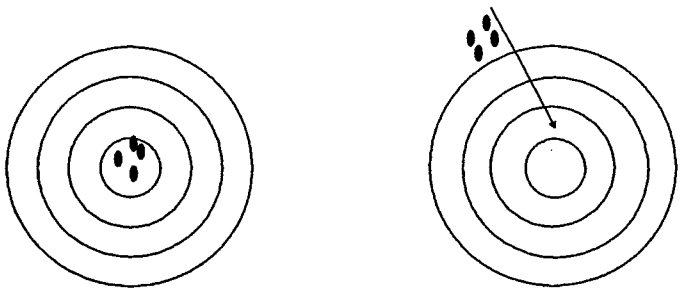


Fig. 3.5 Accuracy versus precision. The shots to the left shows high accuracy, the shots to the right high precision but low accuracy.

3.1.7 ERROR CODES, CAUSES AND REMEDIES

The following table gives an explanation of the error codes which can appear on the SAS 300C display.

Error codes	Causes	Remedies
1	Transmitter cables or groundings have too high resistance for the selected current (can also be caused by bad connections), i.e. SAS 300C is, due to circumstances, unable to produce the selected current.	Reduce current step by step until beeper stops sounding. If beeper does not stop, check transmitter cabling.
4	Current selector setting has been changed during measurement.	Repeat measurement.
5	Measurements stopped due to transmitter current drop. or The SAS 2000 Booster, if connected, has overheated or has too low a battery voltage. The error code will be replaced, after one second, by the latest calculated result.	Reduce transmitter current one step and try again. If error code appears again check transmitter cable and groundings or check the Booster. Let Booster cool down if overheated. Charge Booster battery if voltage is below 10.5 Volt
6	Measurements stopped due to overloading of the receiver by a high noise level.	Reduce transmitter current one step and try again.
7	Operator trying to transmit more than 20 mA without Booster.	Reduce current to 20 mA or lower or use Booster.

Error codes	Causes	Remedies
10	Special diagnostic code. PROM error or loose PROM	Contact ABEM
11	Special diagnostic code	Contact ABEM
12	Battery voltage too low	Charge battery and check voltage
13	Non-standard power supply that provides too high a voltage is being used	Use standard battery pack or adjust power supply to right voltage.
14	CYCLES selector is between two positions or is faulty.	Check selector position and performance.
15	MODE selector is between two positions or is faulty.	Check selector position and performance.
16	CURRENT selector is between two positions or is faulty.	Check selector position and performance.
17	Special diagnostic code	Contact ABEM
18	Cycle time jumper is not correctly set.	Read instructions in section 3.1.5 and check jumper.
20	Fault in input amplifier or transmitter.	See section 7.3.1
21	Component fault in input amplifier unit No. 9136 3100 21	See section 7.3.1
22	Component fault in transmitter circuit.	See section 7.3.1
Irregular beeps occur. Display of results is delayed. No error code is displayed.	Transmitter current drops occasionally below selected value or Receiver is occasionally overloaded by signal and excessive noise combined or Measurement proceeds with delay: Only undisturbed data cycles are accepted.	Reduce transmitter current one step and try again.

3.2 TERRAMETER SAS 2000 BOOSTER

3.2.1 CONTROLS and TERMINALS

The BATTERY TEST terminals can be used to test the battery voltage. SAS 300C can be used as voltmeter as mentioned in section 3.1.3, use the MODE setting V. For separate SAS 2000 operation, the cable that is attached permanently to the governor box is connected to the BATTERY TEST terminals which provide only the very low power needed by the governor box (SAS 2300). This output is protected by a 1 A fuse.

The BOOSTER CONTROL connector is for the cable that runs to either the SAS 300C or the governor box.

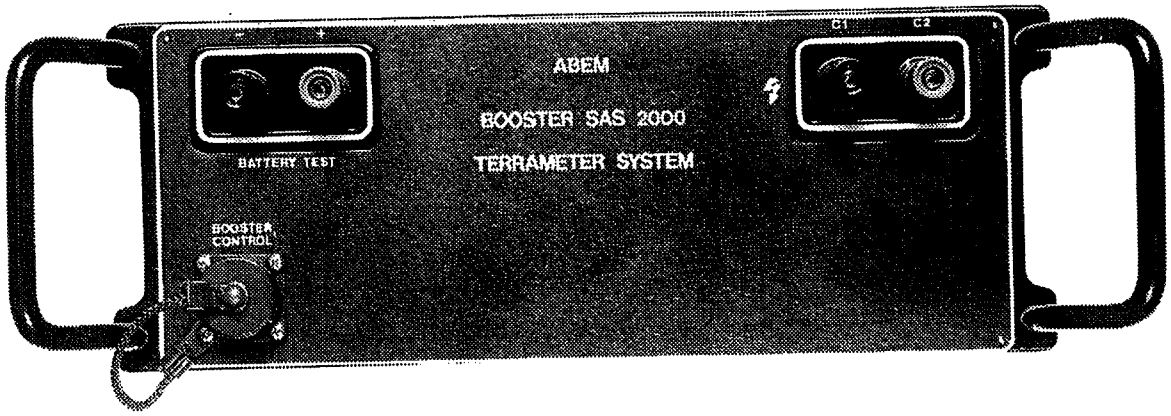


Fig 3.6 SAS 2000 Booster

The governor box and its controls are described in section 3.2.5.

The SAS 2000 Booster contains circuits that provide an alarm in either the SAS 300C or the governor box:

- If the temperature inside the booster casing rises too high (as indicated by an internal thermal relay).
- If the battery voltage drops too low.
- If the operator has selected a transmitter current that is too high.

If any of the above occur and the SAS 300C is connected to the SAS 2000 Booster, an alarm sounds on the SAS 300C and error code 1 or 5 is displayed when the MEASURE button is depressed.

If either of the first two situations mentioned above occurs and the governor box is connected instead, a beeper sounds in the governor box when the ON/OFF switch is turned on (unless the SAS 2000 battery is fully discharged). If the third type of situation occurs, the alarm is not issued until the SEND button is depressed.

If an alarm occurs, check the battery voltage and/or allow the SAS 2000 Booster to cool down and try again or reduce the selected current step by step until the warning signal disappears.

When the SAS 2000 Booster is slaved (connected) to the SAS 300C, you must use the C1 and C2 current electrode terminals on the SAS 2000 Booster instead of the C1 and C2 terminals on the SAS 300C.

The maximum output voltage available from the SAS 2000 Booster varies with the current setting that is being used and with the battery voltage. These relationships are tabulated below for a battery voltage of 12.5 V.

Transmitter current in mA	Min. available voltage
0.2-100	400
200	200
500	80

IMPORTANT

When the SAS 2000 Booster is connected to the governor box and turned on, there is a minimum current drain of 1 A from the battery. This means that you must not leave the SAS 2000 turned on while it is not in use. When the booster is connected to the SAS 300C it is only turned on during current transmission.

3.2.2 DAILY CHECK

Check the battery. One convenient method is to use the SAS 300C as a voltmeter to measure the voltage at the SAS 2000 Battery Test terminals. If the battery is properly charged, the display will read 12.5 - 15 V. If the reading is less than 11.5 V, the battery will soon need recharging.

The SAS 2000 Booster consumes considerable power. This means that you should always start with a freshly charged battery and should always have a spare battery pack with you.

3.2.3 SLAVE MODE

When the SAS 2000 Booster is controlled by the SAS 300C, the booster simply replaces the SAS 300C's built-in 3 W transmitter with its own 40 W transmitter, thus making available a higher excitation current.

Slaving is accomplished by running a cable from the BOOSTER CONTROL connector on the SAS 300C to the BOOSTER CONTROL connector on the SAS 2000 Booster. Current is then available only from the SAS 2000 Booster.

3.2.4 SEPARATE OPERATION

The SAS 2000 Booster can be operated separately from the SAS 300C. This is accomplished by connecting a governor (control) box to the end of the cable that normally runs to the SAS 300C. The governor box (SAS 2300) is described in section 3.2.5.

Using walkie-talkies for coordination, the two operators (one for the SAS 300C and one for the booster) can then carry out dipole-dipole or charge-potential (mise-a-la-masse) measurements at long distances from each other without using any measurement or control cables. For these measurements the SAS 300C only measures potential difference

between the potential electrodes. The SAS 300C must then be in the voltage measuring mode (section 3.1.3). The use of non-polarizable electrodes is recommended.

The ΔV caused by a specific current is measured and calculated using two or - even better - three potential readings.

When the 2-reading method is used, the SAS 300C operator first measures the SP at the potential electrodes (V_0). He then immediately requests the SAS 2000 operator to transmit a positive current, and immediately takes a new potential reading V_1^+ (section 3.2.5) with the current on. He then requests the SAS 2000 operator to switch off the power. The ΔV caused by the transmitted current is simply the difference between readings:

$$\Delta V = V_1^+ - V_0$$

This method of measurement consumes the least power. The 3-reading method should be used if the SP is drifting. The SAS 300C operator first requests a positive current from the SAS 2000 operator and takes a first potential reading V_1^+ with the current on. He then requests a negative current of the same magnitude and takes the second potential reading V_1^- with the current on. Finally, he requests positive current again and takes the third potential reading V_3^+ and then asks the SAS 2000 operator to switch off the power.

The potential difference is then calculated as:

$$\Delta V = (V_1^+ - 2V_2^- + V_3^+)/4$$

3.2.5 GOVERNOR BOX (SAS 2300)

When the SAS 2000 Booster is to be used separately, the governor (control) box SAS 2300 is connected instead of the SAS 300C and via the same cable. Moreover, the permanently connected 2-conductor cable on the governor box must be plugged into the BATTERY TEST terminals on the SAS 2000 Booster. The governor box is provided with a switch which can be used to select a current of 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100, 200 or 500 mA. There is also a switch to select current polarity.

The ON/OFF switch turns on the high voltage power supply and the control circuits in the SAS 2000 Booster. Since the current drain is approximately 1 A when the equipment is not being used, power should always be turned off immediately after use.

The SEND button (corresponds to the MEASURE button on the SAS 300C) causes current to be sent out from the C1 and C2 terminals on the SAS 2000 Booster.

3.3 TERRAMETER SAS LOG 200 - INSTRUCTIONS

3.3.1 CONTROLS, TERMINALS AND LOGGING CABLE

The Terrameter SAS LOG 200 consists of a 200 m long logging cable with a logging probe, a 6-position MODE selector and circuitry for connecting a Terrameter SAS 300C, a current return electrode and a potential reference electrode. The circuitry and the cable are mounted and transported on a convenient backpacking frame.

The logging cable has seven nylon-insulated conductors and a polyurethane jacket. The centre conductor is made of stainless steel with a breaking strength of 800 N. Three cylindrical current takeouts designated A, B and C are located 5.6 m, 1.2 m and 0.4 m from the probe

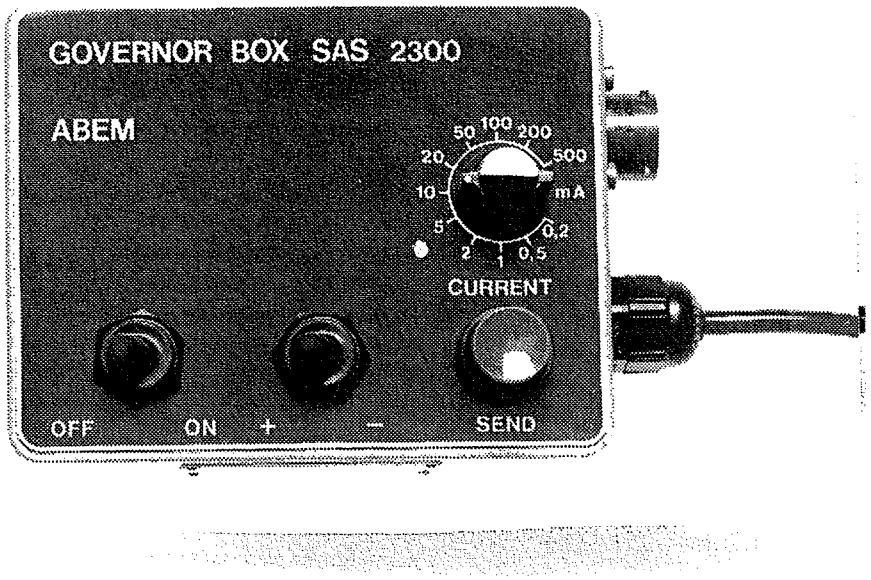


Fig 3.7 Governor box

respectively, see figure on next page. The cable is marked at 1 m intervals, starting at the logging probe.

The stainless steel upper end of the logging probe serves as an electrode (D). The lower inside end of the probe - the chamber - has one ring electrode (E) and a centre electrode (F). The centre electrode also contains the temperature transducer. The end of the chamber is set at an angle to improve circulation of fluid in the chamber as the probe moves. Three holes in the chamber wall permit air to escape, thus ensuring good contact with the fluid.

A control cable connects the 10-position connector on the SAS LOG 200 to the connector on the SAS 300C.

A 4-conductor cable is permanently attached to the SAS LOG 200. It is connected to the potential (P1, P2) and current (C1, C2) terminals on the Terrameter SAS 300C.

The return current terminal is connected to a return current electrode placed not less than 75 m from the well to be surveyed. This electrode must be properly grounded.

The potential reference terminal is connected to a referene potential electrode (ABEM stainless steel electrode) not less than 50 m from the well and in the opposite position from the return current electrode.

WARNING

Make certain that the Terrameter SAS 300C is turned off while handling the logging cable and probe. The cable and probe electrodes can carry potentials of 180 V when the MEASURE button on the SAS 300C is pressed.

To take measurements, the logging probe is lowered to the desired depth below the ground water table and the 6-position MODE selector on the

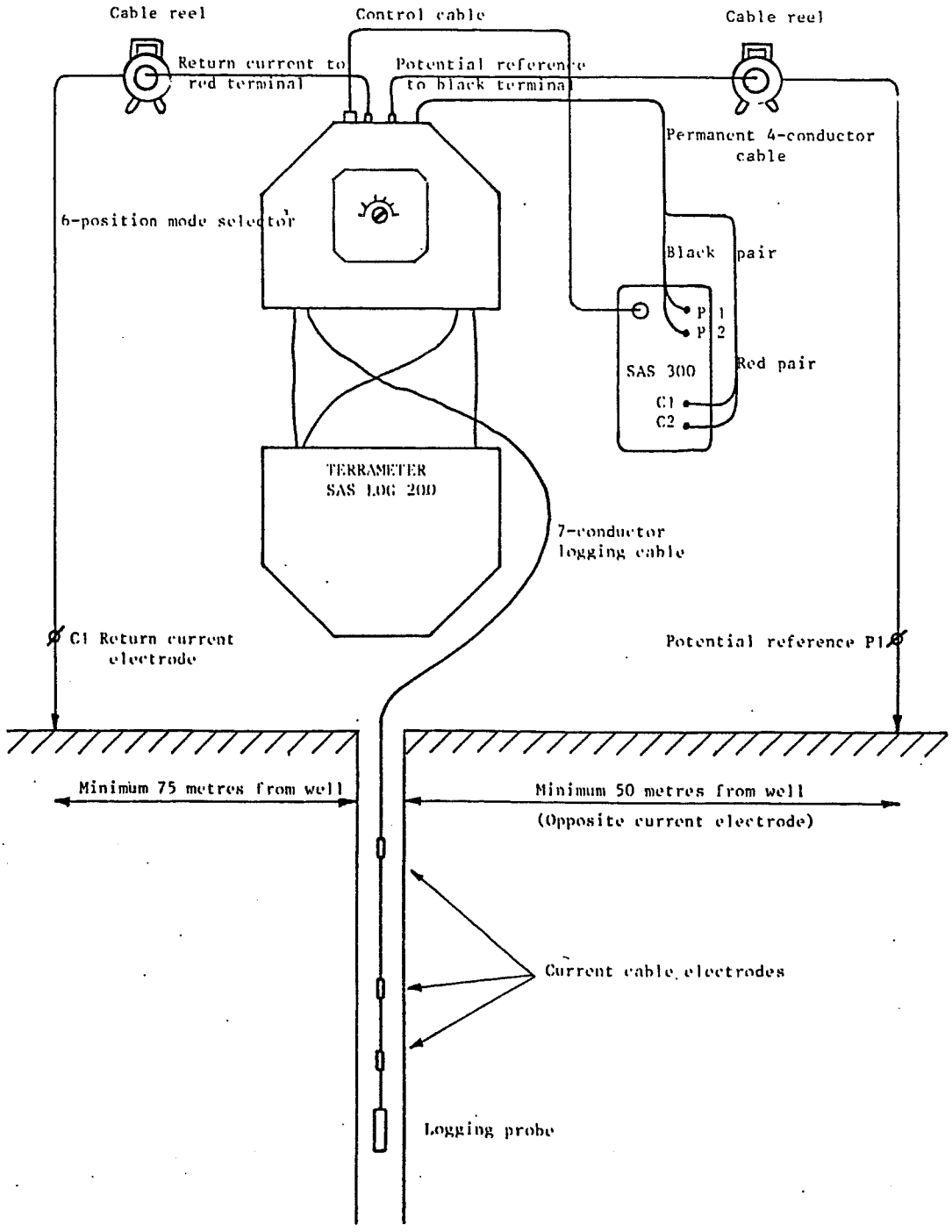


Fig 3.8 Terrameter SAS LOG 2000 well logging setup.

SAS LOG is set to the desired position. The Terrameter SAS 300 is turned on and measurements are taken as explained in the sections which follow.

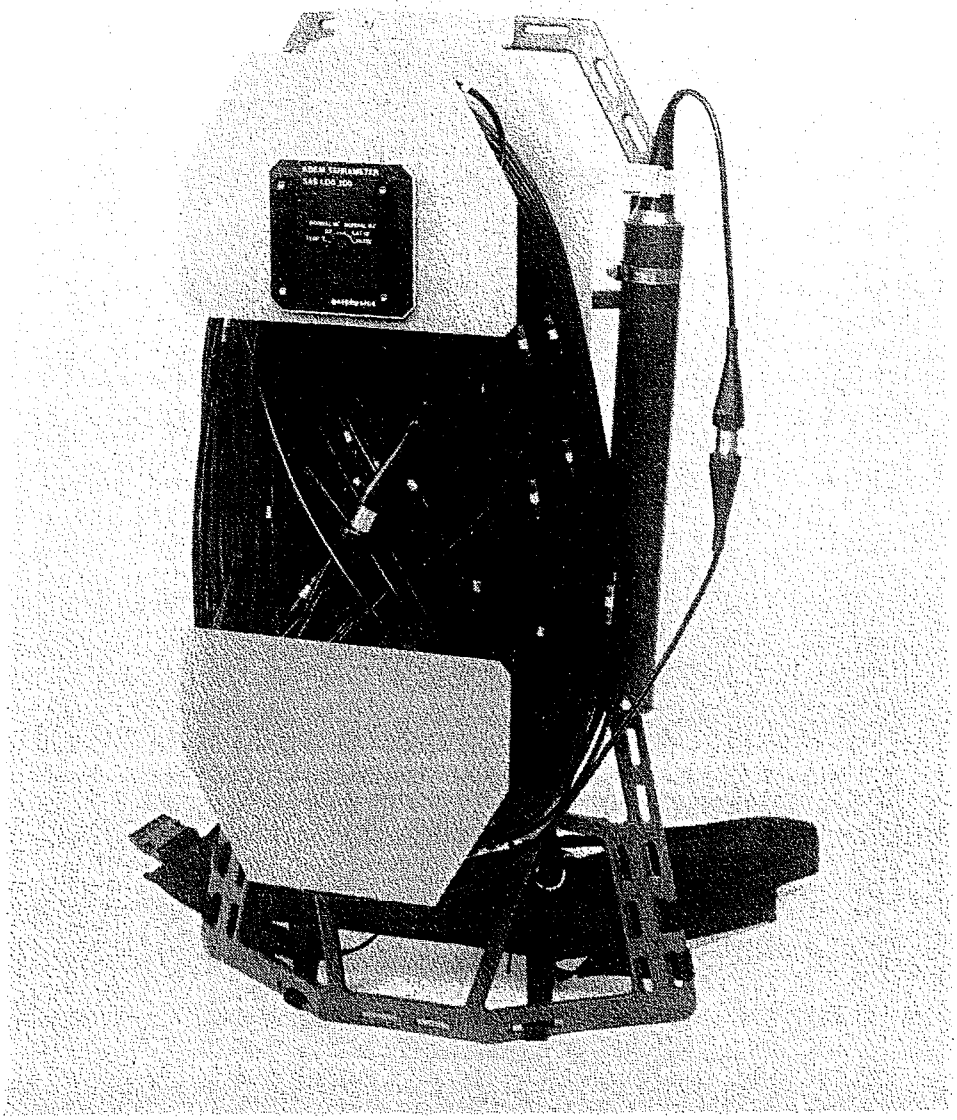


Fig. 3.9 The SAS LOG 200

3.3.2 TEMPERATURE LOGGING

- Set the SAS 300C in Ω mode and select current 0.5 mA
- Set the MODE switch on the SAS LOG 200 to TEMP ^{0}C
- Press the MEASURE button on the SAS 300C. The reading is in ^{0}C (i.e. 1 Ω is equivalent to 1 ^{0}C)

If the CURRENT selector is not at the 0.5 mA position, the SAS 300 issues an alarm (beeper signal) and error code 1 appears. Temperature is measured to an accuracy of ±1^{0}C within the 0^0... +20^{0}C range and ±0.1^{0}C within the +20^{0}C... +50^{0}C range, thus permitting local termperature gradients to be studied in detail.

When using the high precision for temperature gradient studies, ample time must be allowed to permit the probe to reach thermal equilibrium vis-a-vis the fluid. Move the probe slightly up and down a few times while waiting for equilibrium to be established. Temperature logging should be the first log at each station, since undisturbed water is required.

3.3.3 SELF POTENTIAL (SP) LOGGING

The SP should be measured in a separate run to avoid electrode polarization effects which occur during resistivity measurements.

To reduce electrode polarization, attributable to previous resistivity measurement or long storage in air, the electrodes should be depolarized before SP logging starts.

Proceed as follows:

- Connect all cables and electrodes as explained in section 3.3.1 and lower the logging probe into the well (below the water level).
- Set the SAS 300C is in voltage measuring mode (V) and the SAS LOG 200 is in SP mode. Remove the banana plug on the reference potential cable from the black terminal on the SAS LOG 200 and connect it to the red banana plug on the SAS 300C P2 terminal and let it remain there for at least five minutes.
- Move the banana plug back to the black terminal on the SAS LOG 200 and wait for another five minutes to let the system stabilize.

Measurement can then proceed. When the MEASURE button is pressed, the voltage that is displayed will be he potential between the remote potential reference electrode and the upper electrode (D) on the logging probe.

3.3.4 RESISTIVITY LOGGING

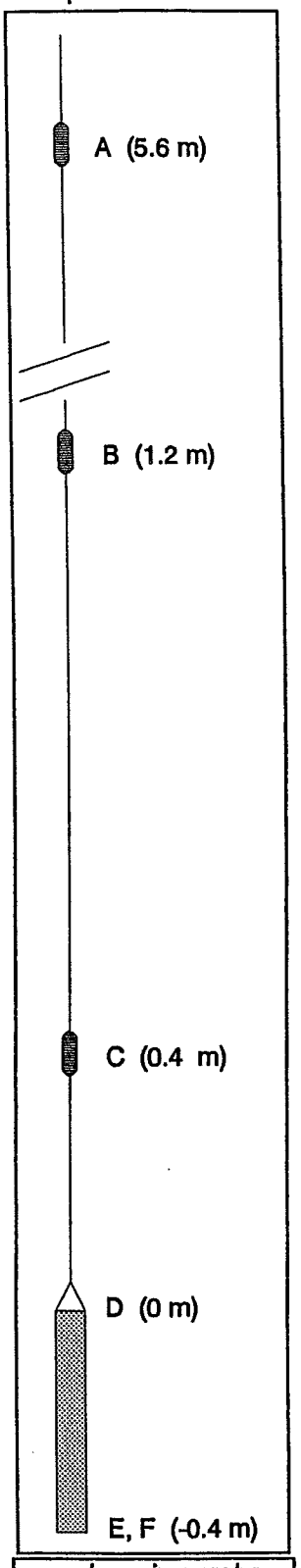
- Set the SAS 300C MODE selector to Ω.
- Set the SAS 300C CURRENT selector to 20 mA.

Resistivity measurements should not be made during an SP logging run (se section 3.3.3).

FLUID RESISTIVITY LOGGING

Set the MODE selector on the SAS LOG 200 to the FLUID position and press the MEASURE button on the SAS 300C. Current (20 mA) is injected via the ring electrode (E), while the potential is measured between the upper probe electrode (D) and the centre electrode (F). The SAS LOG 200 needs no conversion factor here.

$$\rho_{fluid} = R_{displ} \quad (\Omega m)$$



Logging probe with current takeouts.

Well diameter in mm.	Multiply R_{displ} by
50 - 60	1.08
60 - 70	1.06
70 - 80	1.04
80 - 90	1.03
90 - 100	1.01

Table 3.1 Corrections for small-diameter wells.

The corrections in table 3.1 should be made for small-diameter wells:

SHORT NORMAL LOGGING

Set the SAS LOG 200 MODE selector to the NORMAL 16" position and press the MEASURE button on the SAS 300C. Current is then injected via the upper probe electrode (D). The corresponding response voltage is measured between the round potential reference and the ring electrode (E) at the bottom of the probe. A network in the SAS LOG 200 causes the SAS 300C to display R_{displ} in Ω or mΩ. This value is proportional to the resistivity of the surrounding medium (no hole corrections).

$$\rho = 100 \times R_{displ} \ (\Omega m)$$

If the displayed value is $R_{displ} = 175$ mΩ, the resistivity will be $100 \times 0.175 = 17.5$ Ωm.

LONG NORMAL LOGGING

Set the SAS LOG 200 MODE selector to the NORMAL 64" position and press the MEASURE button on the SAS 300C. Current is then injected via cable electrode (B) while the potential is measured at the ring electrode (E) at the bottom of the probe. A network in the SAS LOG 200 provides the same conversion constant as that used for short normal logging (see above)

$$\rho = 100 \times R_{displ} \ (\Omega m)$$

LATERAL LOGGING

Set the SAS LOG 200 MODE selector to the LAT 18" position and press the MEASURE button on the SAS 300C. Current is injected via cable electrode (A), and the potential is measured between the ring chamber electrode (E) at the bottom of the probe and cable electrode (C).

The network in the SAS LOG 200 now provides a conversion factor that differs from that used for short normal and long normal logging. As a result:

$$\rho = 1000 \times R_{displ} \ (\Omega m)$$

3.3.5 FLUID RESISTIVITY AND ESTIMATION OF TDS

The Terrameter SAS LOG 200 can be used to measure the resistivity of a fluid, thus enabling you to determine the Total Dissolved Solids (TDS) in the fluid.

Resistivity is a function of water temperature, and a standard temperature (usually 25^0C) must be specified for reporting resistivities or conductivities. For resistivity, the approximate conversion formulas for common standard temperatures are:

$$\rho_{18} = \rho_T (0.62 + 0.021\ T)$$

$$\rho_{20} = \rho_T (0.58 + 0.021\ T)$$

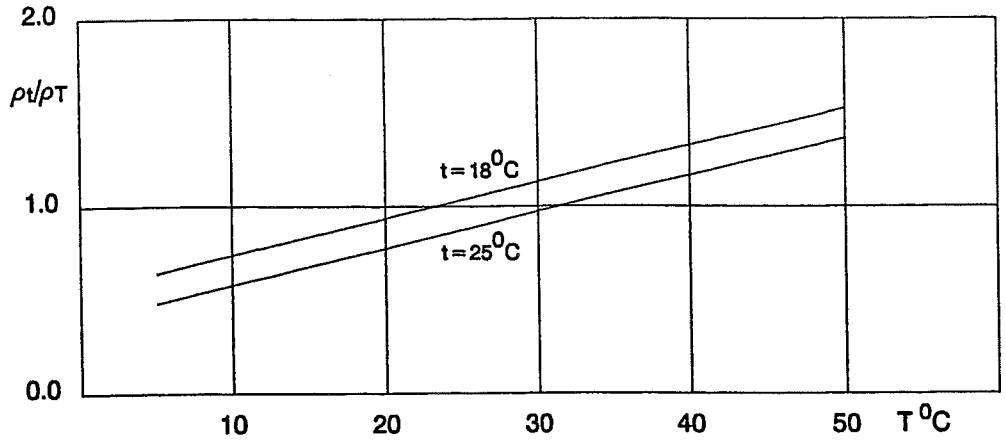


Fig. 3.10 Graph showing correction factor curves for standard temperature resistivities.

$$\rho_{25} = \rho_T (0.48 + 0.021\ T)$$

where T is ^{0}C whitin the 5-50^{0}C range.

Concentrations by weight

Concentrations of the common ions found in ground water are often reported by weight in parts per million (ppm). One ppm defines one part by weight of the ion to a million parts by weight of water, and it is numerically equivalent to milligrams per litre. TDS is also reported as ppm.

The following diagram (Fig. 3.11) illustrates the relationships between resistivity and TDS for various salt solutions and for an average of natural ground waters.

The TDS estimation for an average of natural ground waters is:

$$TDS_{ppm} = 6400/\rho_{25} \quad (\text{where } \rho_{25} \text{ is in } \Omega m)$$

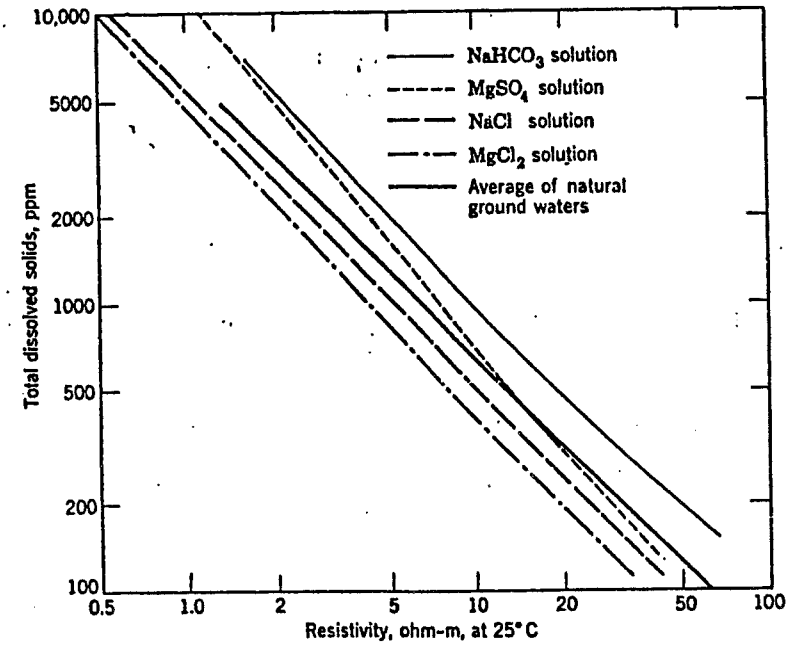


Fig. 3.11 Resistivity-concentration curves for various salt solutions and natural ground waters (from Agric. Handbook 60, U.S. Dept. Agric.)

4 BATTERY

The SAS 300C is powered by a NiCd battery pack. The SAS 2000 Booster is powered by a NiCd battery pack of the same type.

The ABEM UBC Universal Battery Charger can be powered from either a AC main or a vehicle battery.

4.1 NI-CD BATTERY PACK

Modern field instruments need a reliable source of power. Today, this can best be provided by sealed rechargeable nickelcadmium (Ni-Cd) batteries. They can be discharged and recharged 1000 times or more and they can be overcharged continously (no time limit when charged with the ABEM UBC).

The SAS 300C and SAS 2000 are provided with a Ni-Cd battery pack that clips conveniently onto the bottom of the instrument.

Storage

There is no limit on storage time. Ni-Cd batteries can be stored for years, either charged or discharged. Stored batteries lose their charge (self-discharge) gradually, and this takes place more rapidly at higher ambient temperatures. However, even if a battery loses all of its charge during storage, satisfactory operation can be restored after one or two charge/discharge cycles. During storage, batteries should be disconnected from instruments. Batteries can be stored at ambient temperatures ranging from -40^0 to $+65^0$C.

Safety precautions

» DO NOT damage an Ni-Cd battery or expose it to fire. It may burst or release toxic materials.

» DO NOT short circuit the battery since this will result in high discharge currents, causing dangerous heating.

Since the Ni-Cd batteries are sealed you will normally not come into contact with the electrolyte. You should nonetheless be aware that the electrolyte used in both sealed and vented Ni-Cd batteries is potassium hydroxide. If you should get it in your eye, even a small amount can cause serious injury. Immediate flushing with water for 15 minutes plus follow-up medical attention is absolutely necessary. If the electrolyte gets on your skin, use vinegar or some other mild acid for neutralization.

Finally, it should be remembered that the cadmium in an Ni-Cd battery is a toxic metallic element that should not be disposed of in the usual way, since it represents a serious threat to the environment.

4.2 UBC UNIVERSAL BATTERY CHARGER

General

The ABEM UBC Universal Battery Charger is recommended for use with the ABEM Terrameter SAS System. However, other battery chargers that also provide a constant charging current of about 400 mA at the desired output voltage can also be used. The UBC is designed to recharge Ni-Cd batteries in the field and in your workshop. This versatile, compact and convenient charger provides full input/output flexibility.

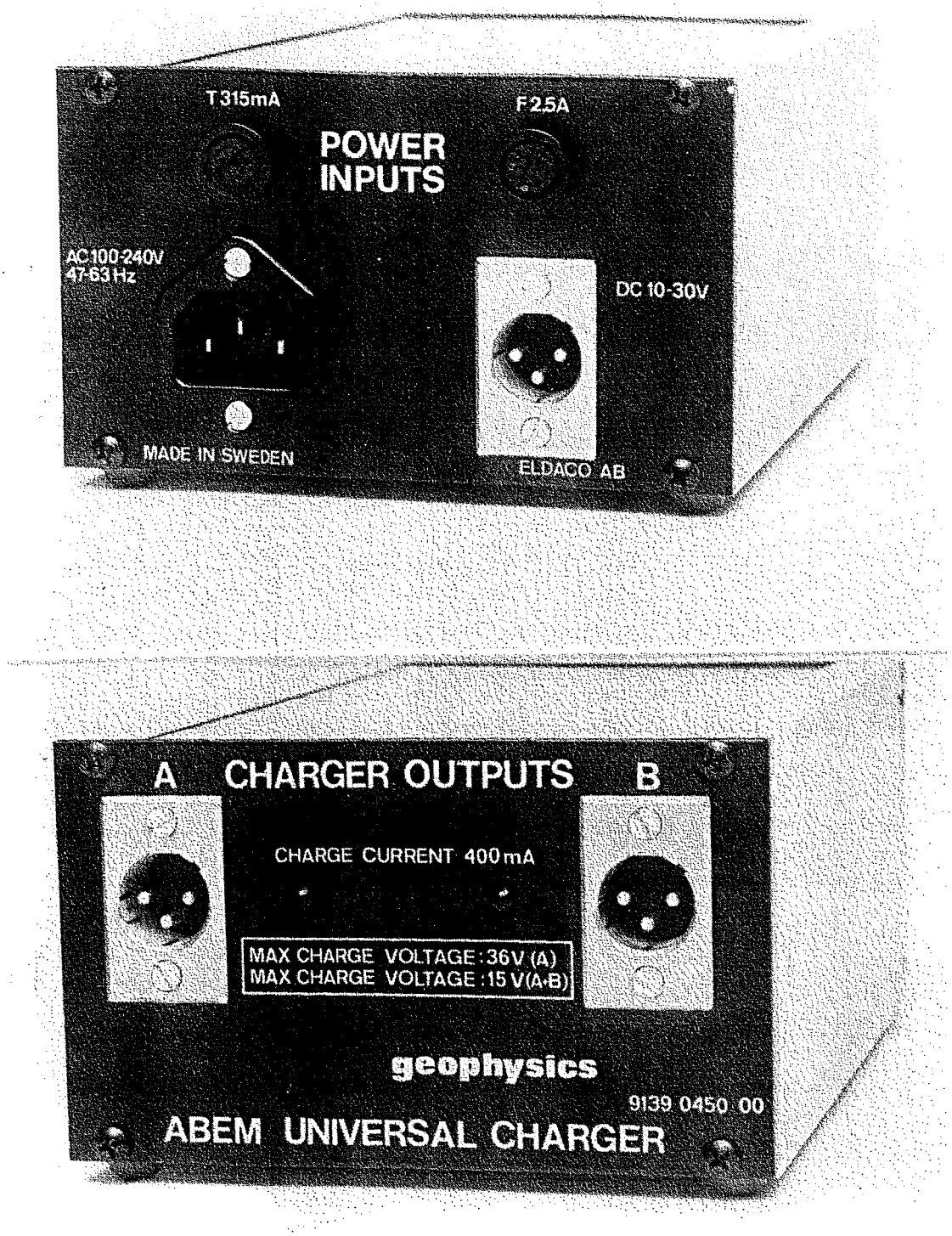


Fig. 4.1 ABEM Universal Battery Charger, front and back.

Input

The UBC accepts the following power inputs, and permits you to change from one to another without troublesome rewiring or relinking:

- 12 V batteries (vehicle batteries)
- 24 V batteries (vehicle batteries)
- 110 V 60 Hz mains
- 220 V 50 Hz mains

The full input ranges are 10-30 V DC and 100-240 V AC, 47-63 Hz.

Output

The UBC is especially convenient for charging ABEM instruments. The standard output cables are provided with connectors compatible with the battery packs used in ABEM instruments.

The UBC can:

- Charge one 12 V battery pack (in the Terrameter SAS 300C for example)
- Charge, simultaneously, two 12 V battery packs (in the Terrameter SAS 300C and SAS 2000 Booster for example)
- Charge one 30 V battery pack
- WARNING: Do not charge 2 completely drained batteries simultaneously! this may cause the input fuse to blow.
- Note that you should never try to charge two batteries in parallel from the same outlet.
- Note also that your UBC charger is not waterproof. If you used it outdoors, rainwater can accumulate on top and leak into the circuitry.

4.2.1 CHARGING INSTRUCTIONS

Connect the charger to the mains outlet or to the DC power source. If the charger is to be connected to the mains (100-240 V AC, 47-63 Hz), use input cable no 9139 7100 31. If the charger is to be connected to a vehicle battery or any other DC supply (minimum 10 V, maximum 30 V), use input cable No.9136 0000 82. Observe the polarity (black clip to the negative (-) terminal).

If the charger gets too hot, an internal protector cuts off the input current automatically (LED or LEDs are extinguished). Should this happen, let the charger cool off and then start charging again.

If the input current is too high, the fuses will blow. Ten spare fuses for AC and DC input are included with your UBC.

Charging one or two 12 V battery packs

Connect the battery pack(s) to the battery charger output(s) via output cable(s). A red indicator lamp (light-emitting diode) at each of the two charger outputs indicate when charging goes on properly.

To charge two completely drained batteries, connect only one battery and charge for 15 minutes before connecting the second one.

Charging one 30 V battery pack

Connect the battery pack to charger output A via a special cable (output B should not be used).

Recommended recharging intervals (rough estimates)

SAS 300C Terrameter in regular use.	Weekly
SAS 2000 Booster in regular use	Daily (you may even have to change battery packs during the day)
ABEM instruments in storage	Charging not required. One or two charge/recharge cycles may be necessary to restore satisfactory operation after long-term storage.

Charging times

The UBC provides what is known as an overnight charge (slow charge). This charging rate (constant current of 400 mA) is high enough to charge a fully discharged battery in 14 to 16 hours. However, in most cases, the battery is not fully discharged and the time needed to reach full charge will thus be shorter. 10 hours is usually sufficient. Charging longer than overnight (overcharging) should be avoided since it wastes energy.

Temperature limits

Your Ni-Cd battery can be discharged and charged continuously within the cell temperature limits set forth below:

Discharge: -20^0C to $+65^0$C
Charge: $+5^0$C to $+65^0$C

Note that the cell temperature is defined as the temperature measured directly on the cell casing, and thus differs from the ambient temperature. However, for practical purposes, the cell temperature and ambient temperature can be considered the same during discharge at the rates encountered in geophysical instruments, since no significant amounts of heat are generated within the battery. This also applies to charging at the rate provided by the UBC. But there is a difference during overcharging, which should not be carried out above 50^0C.

Maximum ambient temperature limit are thus:

Normal discharge:	65^0C	
Charging with the UBC:	$+65^0$C	except for
Overcharging:	$+50^0$C	

5 ELECTRODES

Two types of electrodes are available from ABEM:

Stainless steel or **Non-polarizable** electrodes

5.1 STEEL ELECTRODES

Resistivity surveys can be conducted using current electrodes made of ordinary steel. Potential electrodes made of ordinary steel can also be used under favourable circumstances but here stainless steel is preferred.

ABEM electrodes are made of stainless steel.

5.2 NON-POLARIZABLE ELECTRODES

Self potential surveys require non-polarizable electrodes. The ABEM Terrameter type of electrode consists of a durable, plastic, transparent container that surrounds a copper conductor inserted into a wooden rod. When in use, the container is filled with saturated copper sulphate solution ($CuSO_4$) which seeps through the porous wood into the ground and thus provides excellent contact. You can make sure that the copper sulphate solution is saturated by adding a handful of copper crystals. If they remain visible (do not go into solution) you know your solution is saturated.

Since the container is transparent, you can easily see when it needs refilling. After using an electrode, always clean it and replace the electrode cover to prevent leakage and drying out.

Topping up

Non-polarizable electrodes should be kept approximately 90 % full of saturated copper sulphate. A quick visual check indicates when topping up is necessary.

6 CABLE SETS

Three cable sets are available. The hand cables are for applications requiring up to 500 m lengths of cable and the drum cable set is for applications that require up to 1000 m lengths of cable.

The sounding cable set is intended to facilitate Schlumberger soundings. The cables incorporate heavy gauge conductors with excellent insulation to ensure good survey results. Moreover, there are convenient, short hookup cables that reduce setup times and permit you to position the cable drums as desired.

Another important feature of the sounding cable set is easy expandability. If you should have to run longer cables, you can purchase additional drums and connect them in series with your present drums. This means that four drums can be used conveniently for Wenner surveys.

6.1 SOUNDING CABLE SET

The sounding cable set consists of:

Current cables

Wound on two separate plastic reels, each containing 750 m of 0,75 mm^2 wire.

Potential cables:

Two separate 50 m lengths of 1 mm^2 wire wound in parallel on a single reel that is provided with a short reel-to-instrument hookup cable.

6.2 HAND CABLE

The standard hand cable is a reel with 500 m of stranded plastic-insulated, single-conductor 0.75 mm^2 wire. The reel has its own crank. One reel weights 8 kg.

7 SERVICING THE TERRAMETER SAS SYSTEM

The Terrameter SAS System is designed to withstand the normal wear and tear encountered in field work.

7.1 GENERAL PRECAUTIONS

Excessive vibration, temperature and moisture exposure should be avoided:

- Do not transport the instrument loose on vehicle floors or truck beds.
- Avoid excessive temperature exposure such as direct sunshine in hot weather.
- Do not expose the instrument to rain for long periods. It is splash proof but not submersion proof.

7.2 STORAGE AND HUMIDITY

When not in use, instruments should be stored in dry premises.

If the instrument is exposed to excessive humidity during a long period, it can be dried by lifting the circuitry out of the case and letting it dry in the sun or near a stove. Remember, however, that static electricity can damage the circuitry. See paragraph headed IMPORTANT at the end of section 3.1.5.

7.3 PERIODIC CHECKS

7.3.1 TERRAMETER SAS 300C - CHECKS

The proper functioning of most of the SAS 300C circuitry can be checked using a reference resistor having a known value of approximately 15000 ohms and a power rating of 10 W.

A suitable resistor (5 % accuracy) is attached to this manual and should be measured upon receipt to determine its precise resistance. The following procedure will check the SAS 300C and also check the resistance of your resistor.

The resistor should be kept along with the instrument and the test should be performed at least weekly.

- Set CYCLES selector to 1.
- Set MODE selector to Ω.
- Set CURRENT selector to 20 mA.
- Connect the resistor as shown in Fig 7.1

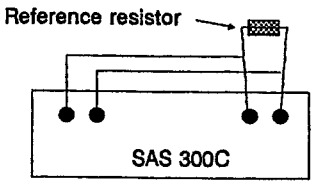


Fig 7.1

If you press the MEASURE button, error code **1** shall appear on the display. Please note that if error code 1 does not appear there is a major failure in the instrument.

When the CURRENT selector setting is changed to 10 mA the precise resistance value will appear.

Enter this value here: _____ for future reference.

If in future checks, minor changes in the resistance readings occur (within 1 %) they can be attributed to temperature changes etc.

7.3.2 TERRAMETER SAS 2000 BOOSTER - CHECKS

After a satisfactory test of the Terrameter SAS 300C, most of the circuitry in the Terrameter SAS 2000 Booster can be tested as follows:

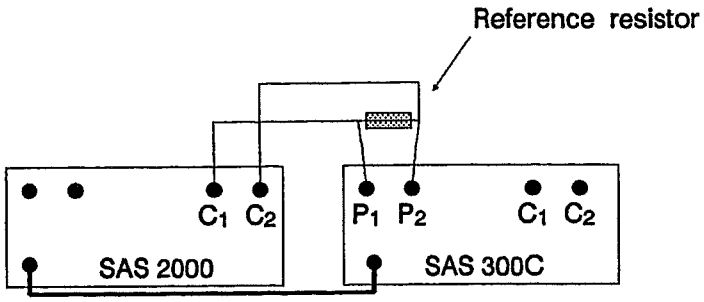


Fig 7.2 Setup for checking the SAS 2000 Booster

Connect the SAS 300C and the SAS 2000 with the reference resistor as shown in Fig 7.2. The batteries in both instruments must be properly charged.

- Set the CYCLES selector to 1. Set the MODE selector to Ω. Set the CURRENT selector to 50 mA on the SAS 300C. Proceed as follows to check the instrument:
- If you press the MEASURE button error code **1** shall appear on the display:
- When the CURRENT selector setting is changed to 20 mA the resistance of your resistor shall appear.

7.3.3 GOVERNOR BOX (SAS 2300) CHECKS

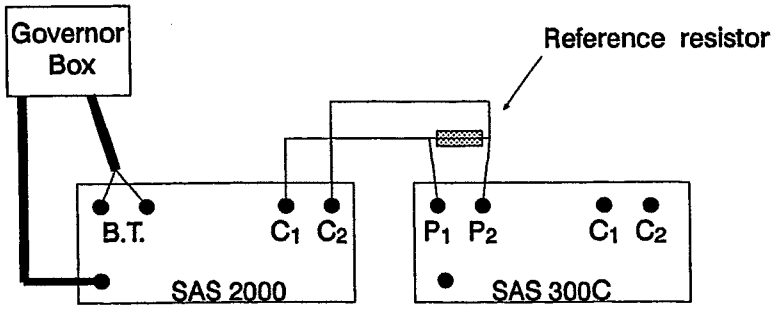


Fig 7.2 Setup for checking the governor box

After a satisfactory test of the Terrameter SAS 300C and the Terrameter SAS 2000 Booster, the governor box can be tested as follows:

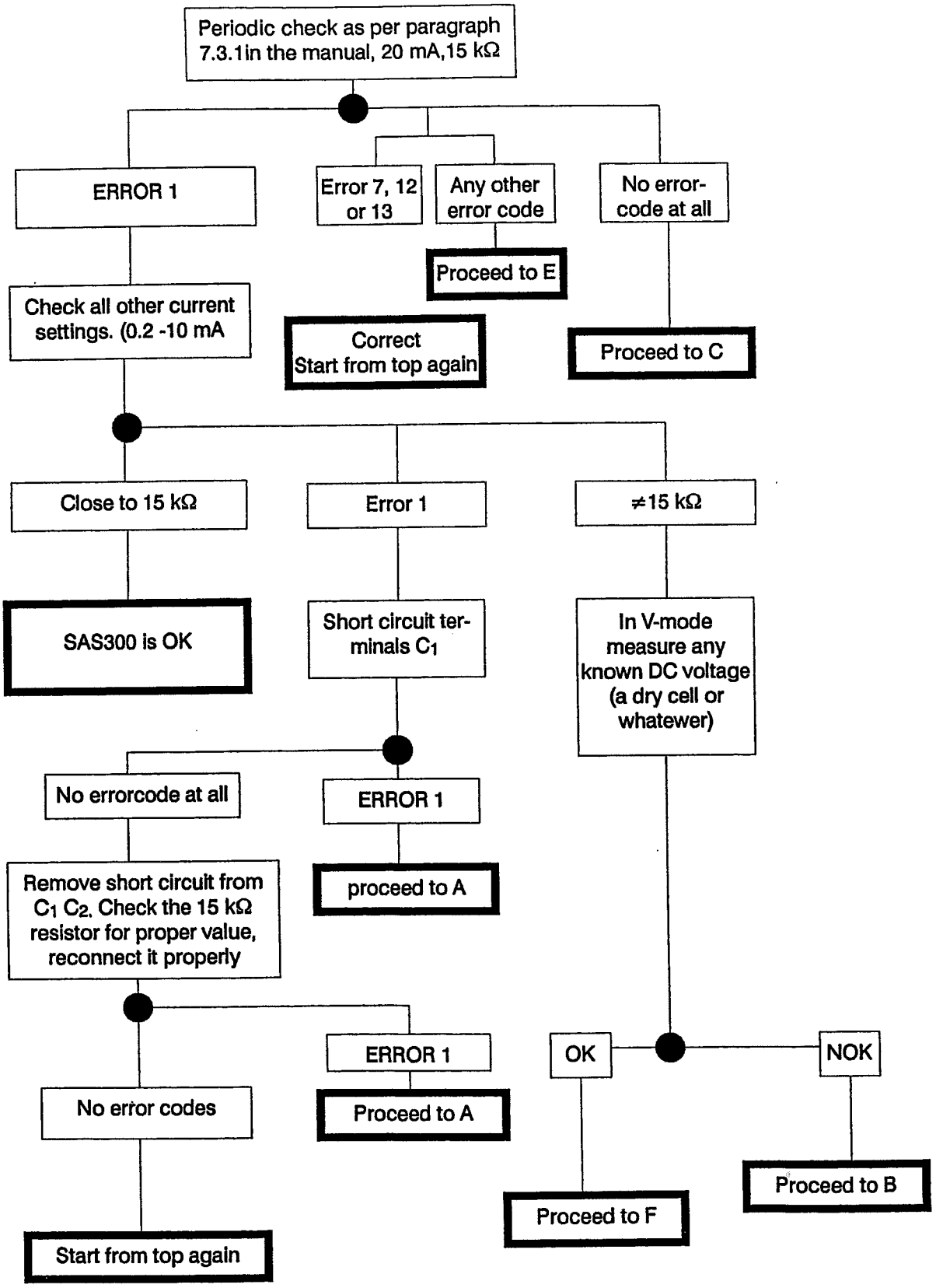
- Connect the governor box to the SAS 2000 Booster, and connect the reference resistor to the SAS 300C - SAS 2000 Booster as shown in Fig. 7.2.

- Set the MODE selector on the SAS 300C to V.
- Set the CURRENT selector on the governor box to 50 mA and turn on the governor box.
- When the SEND button on the governor box is pressed, the beeper in the governor box will sound, indicating that 50 mA cannot be forced through a 15 kΩ resistor.
- Set the CURRENT selector on the governor box to 20 mA, hold down the SEND button on the governor box and take a voltage reading with the SAS 300C. The reading will be approximately 300 V, i.e. 20 mA x 15 kΩ.
- Reverse the direction of current using the ± switch on the governor box to see that the sign of the voltage reading on the SAS 300C changes.

7.3.4 TERRAMETER SAS LOG 200 - CHECKS

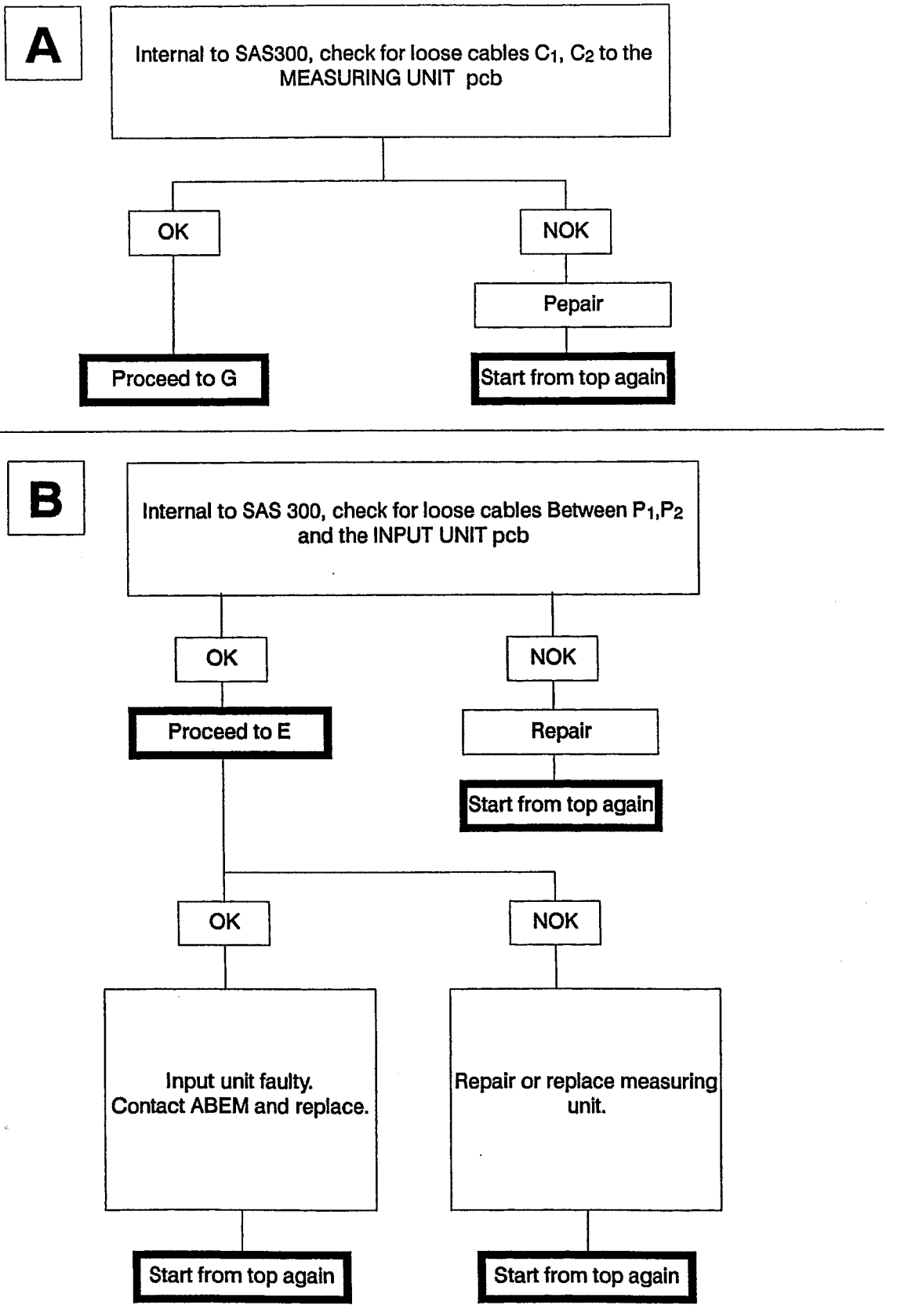
A full check of the SAS LOG 200 is quite complicated and must be done in the ABEM laboratory. However, the thermometer and the fluid resistivity cell can be checked fairly accurately using a fluid of known temperature and resistivity in a suitable container.

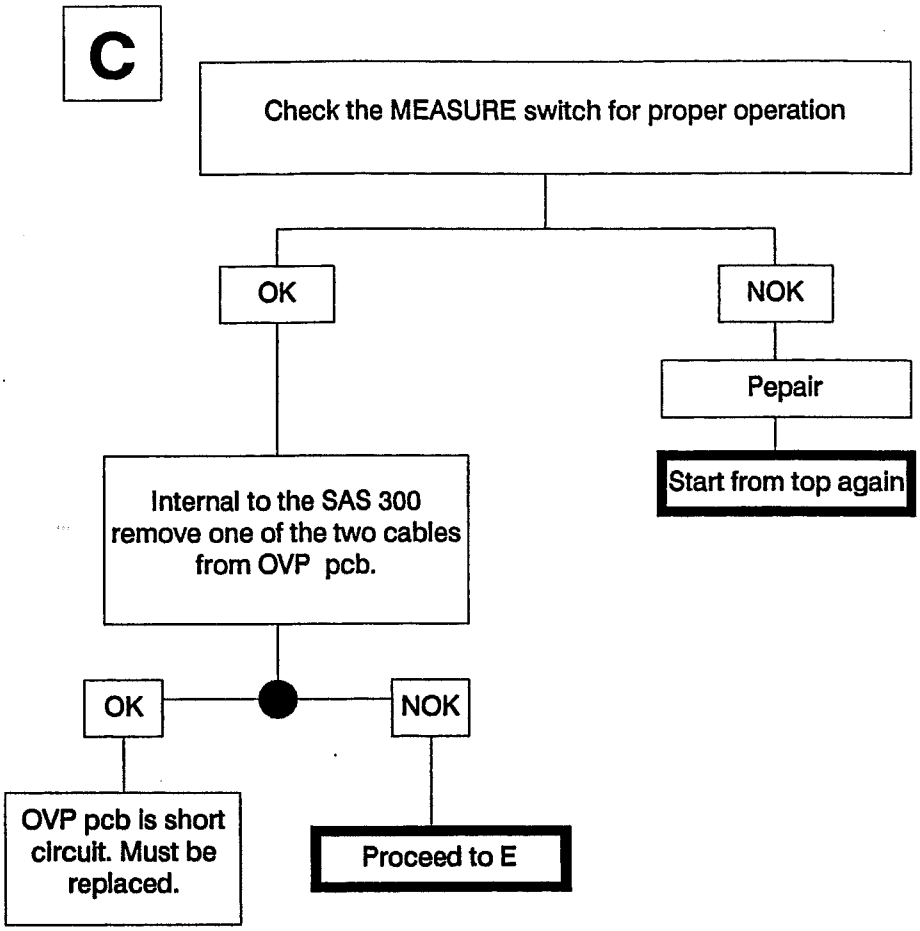
To test the fluid resistivity cell, the entire logging probe must be submerged well below the fluid surface. The return current terminal and the potential reference terminal must be well separated from each other and also from the logging probe.

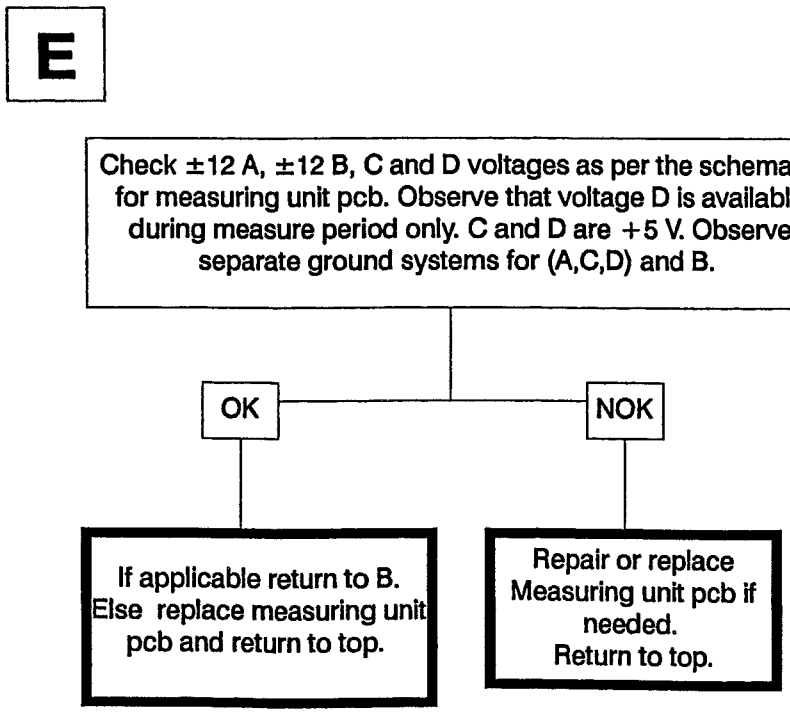


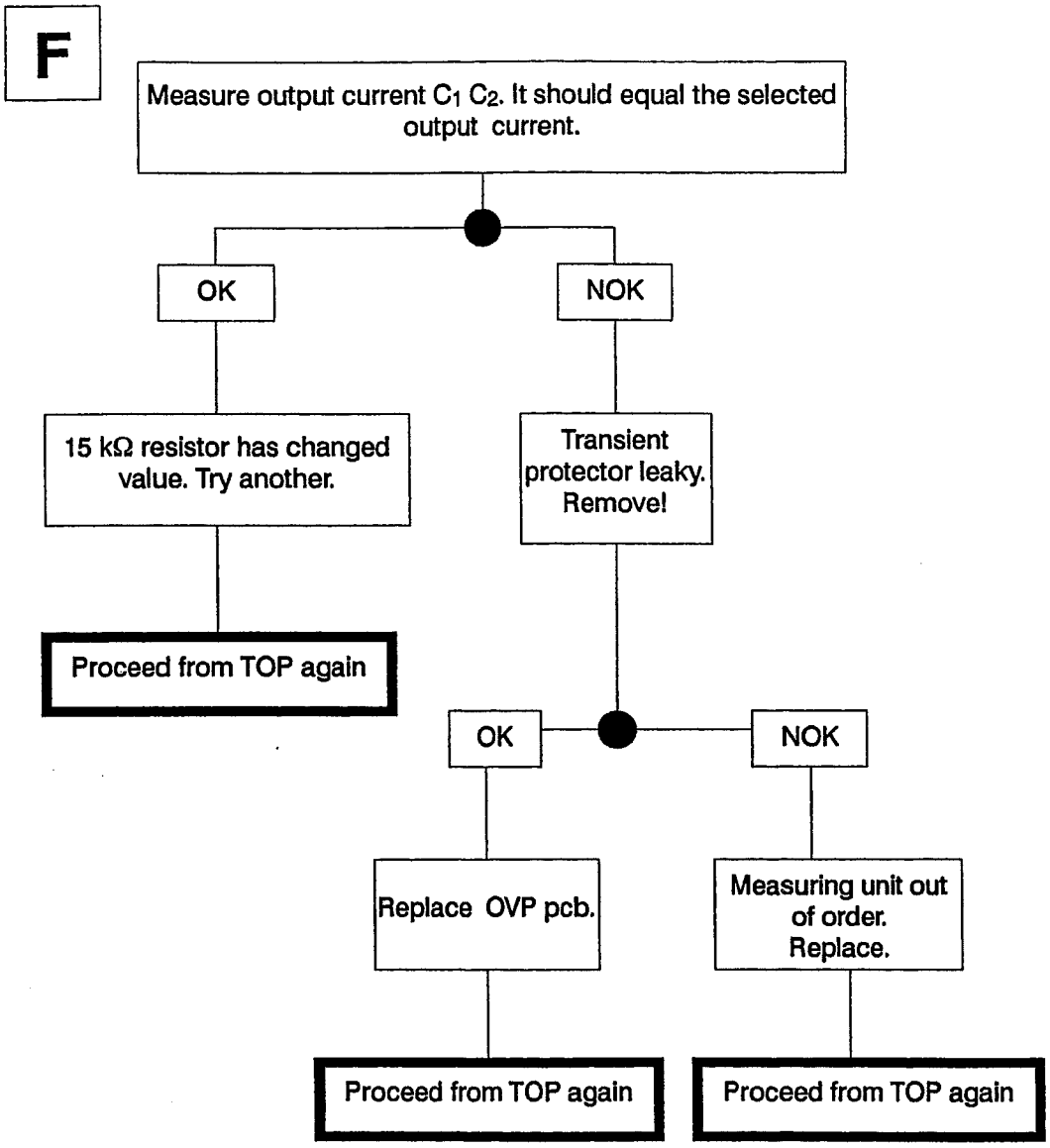
● = Press the "MEASURE"-button!

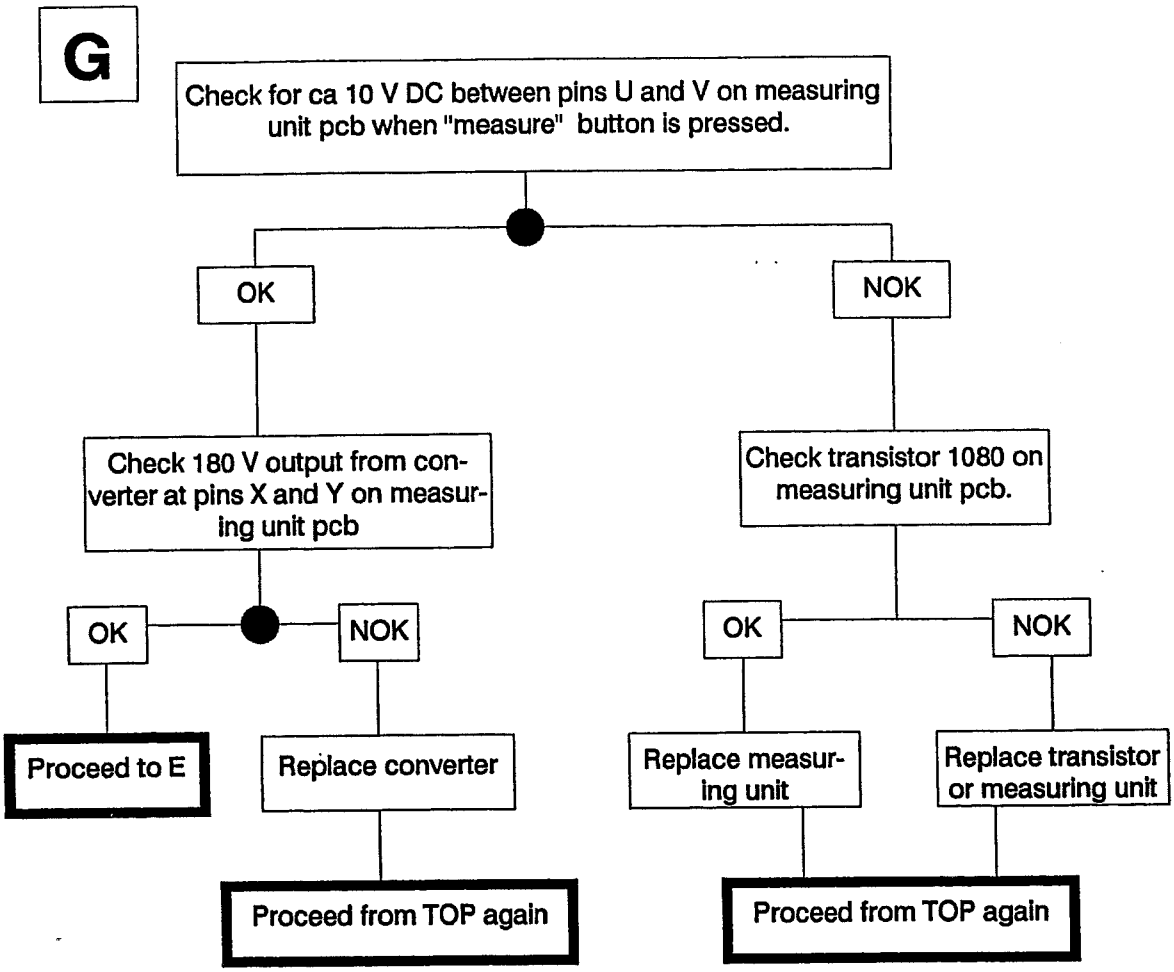
Bold line box indicates exit from the page!


A
Internal to SAS300, check for loose cables C1, C2 to the MEASURING UNIT pcb
OK
NOK
Pepair
Proceed to G
Start from top again
B
Internal to SAS 300, check for loose cables Between P1,P2 and the INPUT UNIT pcb
OK
NOK
Proceed to E
Repair
Start from top again
OK
NOK
Input unit faulty. Contact ABEM and replace.
Repair or replace measuring unit.
Start from top again
Start from top again


C
Check the MEASURE switch for proper operation
OK
NOK
Pepair
Start from top again
Internal to the SAS 300 remove one of the two cables from OVP pcb.
OK
NOK
OVP pcb is short circuit. Must be replaced.
Proceed to E


E
Check ±12 A, ±12 B, C and D voltages as per the schematic for measuring unit pcb. Observe that voltage D is available during measure period only. C and D are +5 V. Observe separate ground systems for (A,C,D) and B.
OK
NOK
If applicable return to B. Else replace measuring unit pcb and return to top.
Repair or replace Measuring unit pcb if needed. Return to top.


F
Measure output current C_1 C_2. It should equal the selected output current.
OK
NOK
15 kΩ resistor has changed value. Try another.
Transient protector leaky. Remove!
Proceed from TOP again
OK
NOK
Replace OVP pcb.
Measuring unit out of order. Replace.
Proceed from TOP again
Proceed from TOP again


G
Check for ca 10 V DC between pins U and V on measuring unit pcb when "measure" button is pressed.
OK
NOK
Check 180 V output from converter at pins X and Y on measuring unit pcb
Check transistor 1080 on measuring unit pcb.
OK
NOK
OK
NOK
Proceed to E
Replace converter
Replace measuring unit
Replace transistor or measuring unit
Proceed from TOP again
Proceed from TOP again

8 SPECIFICATIONS

This section presents specifications for the Terrameter SAS 300C, Terrameter SAS 2000 Booster, Terrameter SAS LOG 200 and UBC Universal Battery Charger.

8.1 TERRAMETER SAS 300C - SPECIFICATIONS

Transmitter	Selectable currents	0.2, 0.5, 1, 2, 5, 10, 20 mA
	Excitation voltage, max	160 V (320 V p-p)
Receiver	Input impedance	10 MΩ, min
	Input range	0 - 500 V
	Resolution (precision)	± 1 μV
	Accuracy	1% ± 50 μV
	Noise rejection	95 dB at 50-60 Hz 85 dB at 16-20 Hz
System data	ΔV/I range	0 - 1.9 MΩ
	ΔV/I precision	0.05 mΩ (at 20 mA, one reading)
	ΔV/I accuracy	2% ± precision (at 1 MΩ)
	Selectable cycle times	3.6, 7.2, 14.4 sec
	Selectable total averaging period (1-64 readings)	3.6 - 920 sec
Temperature range	Within specificaton	0° ... +60°C
	Operating	-10° ... +70°C
Power supply		Rechargeable 12 V NiCd battery, 4 Ah.
Fuse		10 A Fast blow 5x20 mm
Battery capacity		3500 - 5000 single cycle measurements per charge
Weight		5.6 kg incl battery
Dimensions		WxLxH 105 x 325 x 300 mm

8.2 TERRAMETER SAS 2000 BOOSTER - SPECIFICATIONS

Transmitter	Selectable currents	0.2, 0.5, 1, 2, 5, 10, 20, 50, 100, 200, 500 mA
	Excitation voltage, max	400 V (800 V p-p)
System data	ΔV/I precision	0.02 mΩ (500 mA, 1 reading)
	ΔV/I accuracy	2% ±precision (at 1 MΩ)
Temperature range	Within specificaton	0° ... 60°C
	Operating	-10° ... $+70^{\circ}$C
Power supply		Rechargeable 12 V NiCd battery, 4 Ah.
Battery capacity		800 - 3500 single cycle measurements per charge
Weight		6.3 kg incl battery
Dimensions		WxLxH 105 x 325 x 300 mm

8.3 TERRAMETER SAS LOG 200 - SPECIFICATIONS

Cable length		200 m
Logging probe diameter		35 mm
Survey modes	16" short normal	0.05 - 100000 Ωm
	64" long normal	0.5 - 100000 Ωm
	18" lateral	0.5 - 100000 Ωm
	Fluid resistivity	0.05 - 100000 Ωm
	Self potential	0.05 - 1000 mV
	Temperature, range	0^{0} ... $+50^{0}$
	Temperature, precision	0.01°C (0° ... $+20^{\circ}$C)
	Temperature, precision	0.1°C (20° ... $+50^{\circ}$C)
	Temperature, accuracy	1°C
Weight		14.0 kg
Dimensions		WxLxH 880 x 440 x 230 mm
Power supply		Uses SAS 300C battery

8.4 UBC UNIVERSAL BATTERY CHARGER - SPECIFICATIONS

Input	10 - 30 V DC, from any battery or DC power supply OR 100 - 240 V AC, 47 - 63 Hz from mains.
Output	Two separate charging circuits (outputs A and B), each of which provides 400 mA ±5 % at a maximum output voltage of 15 V OR Single charging circuit (output A) which provides 400 mA ±5 % at a maximum output voltage of 36 V
Cell temperature	0° to 65°
Overheating protection	Internal protector cuts off input current
Fuses	315 mA fuse for AC input 2.5 mA fuse for DC input
Two indicator lamps	One LED for each output lights up when charging current exceeds 280 mA
Weight	6.3 kg incl battery
Dimensions	WxLxH 125 x 80 x 210 mm

Item	Description	Qty*	Order Code	Orig
	STANDARD FIELD EQUIPMENT			
1	ABEM Terrameter SAS 300C system	1	9133 0012 06	SE
2	Sounding cable set	1	9136 0000 90	SE
3	Steel electrode	4	9133 0012 61	SE
4	Service kit for SAS 300C	1	9133 0012 14	SE
	ALTERNATIVE BATTERY CHARGERS (At least one needed for a working system)			
5	CCC Battery charger for Terrameter *220 V*, or:	1	9133 0012 18	NO
6	CCC Battery charger for Terrameter *110 V*	1	9133 0012 19	NO
7.1	ABEM UBC Universal Battery Charger 10-30V DC or 100-240V AC 47-63 Hz	1	9133 0012 90	SE
7.2	Charger output cable for 12V battery pack (UBC must have 1 or 2 such cables)	2	9136 0000 81	SE
	OPTIONAL EQUIPMENT			
8	ABEM SAS 2000 Booster Transmitter	1	9133 0015 75	SE
9	Service kit for SAS 2000	1	9133 0015 53	SE
10	Non-polarisable electrode	2	9135 3218 10	SE
11	Governor box for remote control of SAS 2000, with cable & connector	1	9133 0015 07	SE
12	Carrying harness fitting SAS 300 or SAS 2000	1	9138 3000 00	SE
13	Wenner cable set (4 x 500 m)	1	9133 0015 46	SE
14	SAS LOG 200 well logging set	1	9133 0012 65	SE
15	Service kit for SAS LOG 200	1	9133 0015 47	SE
16	Remote location service tools kit	1	9133 0012 29	SE
	INTERPRETATION PACKAGE FOR TERRAMETER OPERATORS			
17	*Please see under flap 11 for resistivity software packages by Interpex Ltd*			US
18	Standard graphs for curve-fitting interpretation of resistivity soundings (published by EAEG)	1	9138 5000 11	NL
19	Pad of 50 log-log papers, base 62.5 mm	1	9138 5000 13	SE
20	Schlumberger array field protocol 50 sheets	1	9138 5002 16	SE
21	Terradisc "slide-rule" calculator	1	9138 5001 55	SE

Qty* : Recommended minimum quantity for a working system
Prices are UNIT PRICES

Item	Description	Qty*	Order Code	Orig
	ABEM SAS-MASTER AUTOMATIC FIELD DATA ACQUISITION SYSTEM			
22	ABEM SAS-MASTER software	1		
	- on 5.25" disk		9133 0012 08	SE
	- on 3.5" disk		9133 0012 07	
	Note: SASMASTER runs on most PC/XT or PC/AT laptop or field (handheld) computers			
	RS-232C INTERCONNECT CABLES			
23	Cable SAS 300C to PC/XT (25-pole)	1	9136 0001 85	SE
24	Cable SAS 300C to PC/AT (9-pole)	1	9136 0001 84	SE
25	Serial output connector fitting SAS 300C output	1	9139 6001 02	US
	SPARE PRINTED CIRCUIT BOARDS			
1	Input unit board		9136 3100 21	SE
2	Measuring unit board SAS 300C		9136 3101 03	SE
3	Transient protection board, SAS 300		9136 3100 25	SE
4	Display module board SAS 300C		9136 3101 04	SE
5	DC/DC converter board (180 V)		9136 3100 76	SE
6	Power unit board SAS 2000		9136 3100 22	SE
7	Transient protection board, SAS 2000		9136 3100 28	SE
8	Printed Circuit Board for SASLOG 200		9136 3100 26	SE
	OPTIONAL SPARE PARTS			
9	Terrameter 12 V power pack in clip-on tray		9133 0012 62	SE
10	Rechargeable battery element 12 V		9139 0400 00	SE
11	Liquid Crystal Display (LCD)		9139 4004 01	SE
12	Selector knob		9138 7010 00	SE
13	Sealing rings for selector knob		9138 3000 01	
14	(Knob cover is discontinued)			
15	Level switch on/off		9139 2010 03	JP
16	Push button switch with cable		9133 0012 28	SE
17	Push button, red		9139 2010 01	JP
18	Toggle seal boot		9139 2010 04	
19	Washer		9133 0015 09	
20	Washer		9133 0015 10	
21	3 pin battery connector male		9139 6000 04	SE
22	3-pin battery connector female		9139 6000 10	SE
23	Fuses 315 mAT (box of 10)		9139 2000 37	
24	Fuses 2.5 AF (box of 10)		9139 2000 20	
25	Fuses 1 AF (box of 10)		9139 2000 03	
26	Fuses 10 AF (box of 10)		9139 2000 01	
27	Tube silicon grease		9138 1000 07	
28	Red terminal post		9139 6000 17	
29	Black terminal post		9139 6000 18	
30	Red banana plug		9139 6000 37	
31	Black banana plug		9139 6000 38	
32	Plastic reel empty		9138 3000 08	DE

Qty* : Recommended minimum quantity for a working system
Prices are UNIT PRICES

Item	Description	Qty*	Order Code	Orig
1	**ABEM Terrameter SAS 300C system**		9133 0012 06	
1.1	SAS 300C basic unit with NiCd 12 V power pack in clip-on tray	1	9133 0012 00	SE
1.2	Documentation kit, including:		9133 0012 15	SE
	Instruction manual SAS 300C	2	9138 5002 83	
	Schlumberger array protocol	1	9138 5002 16	
	Test resistor 5W 15kOhm	1	9139 3011 31	
	Geo Memo 3/69	1		
	Geo Memo 5/72	1		
	Warranty Registration Card	1		
1.3	Tools and spares for SAS 300C comprising:	1	9133 0012 09	SE
	Tool bag	1	9138 3000 02	
	Insulating tape, roll	1	9138 5000 15	
	Engineers plier	1	9138 6000 05	
	Instrument plier	1	9138 6000 00	
	Sealing ring for selector knob	5	9138 3000 01	
	Red terminal post	2	9139 6000 17	
	Black terminal post	2	9139 6000 18	
	Red banana plug	4	9139 6000 37	
	Black banana plug	4	9139 6000 38	
	Tube silicon grease	1	9138 1000 07	
	Screwdriver 2.3 x 50	1	9138 6000 02	
	Phillips screwdriver	1	9138 6000 01	
	Fuses 10 AF	10	9139 2000 01	
	Washer	4	9133 0015 09	
	Washer	4	9133 0015 10	
	Liquid Crystal Display (LCD)	1	9139 4004 01	
2	**Sounding cable set:**		**9136 0000 90**	
2.1	750 m 0.75 mm² current cable on plastic reel	2	9136 0000 85	SE
2.2	2 x 50 m 0.75 mm² potential cables wound on one plastic cable reel	1	9136 0000 86	SE
2.3	2 m interconnect cable black	2	9139 7100 71	SE
2.4	2 m interconnect cable, red	2	9139 7101 04	SE
2.5	Crocodile clip	4	9133 0012 93	SE

Qty* : Quantity included when ordering the main item
Prices are **UNIT PRICES**

Item	Description	Qty*	Order Code	Orig
4	**Service kit for SAS 300C**		**9133 0012 14**	
4.1	Toggle seal boot	1	9139 2010 04	
4.2	Push button switch with cable	1	9133 0012 28	
4.3	Push button, red	1	9139 2010 01	
4.4	Fuses 315 mAT	10	9139 2000 37	
4.5	Fuses 2.5 AF	10	9139 2000 20	
4.6	Fuses 10 AF	10	9139 2000 01	
4.7	Red terminal post	2	9139 6000 17	
4.8	Black terminal post	2	9139 6000 18	
4.9	Red banana plug	4	9139 6000 37	
4.10	Black banana plug	4	9139 6000 38	
4.11	Sealing rings for selector knob	3	9138 3000 01	
4.12	Washer	4	9133 0015 09	
4.13	Washer	4	9133 0015 10	
4.14	Rechargeable battery element	1	9139 0400 00	
4.15	3-pin battery connector female	1	9139 6000 10	
4.16	3-pin battery connector male	1	9139 6000 04	
4.17	Lever switch On/Off	1	9139 2010 03	
7.1	**ABEM UBC Universal Battery Charger**	1	9133 0012 90	SE
7.1.1	UBC charger unit	1	9139 0450 00	SE
7.1.2	DC input cable	1	9136 0000 82	SE
7.1.3	AC input cable	1	9139 7100 31	SE
7.1.4	Fuses 315 mAT	10	9139 2000 37	
7.1.5	Fuses 2.5 AF	10	9139 2000 20	
8	**SAS 2000 Booster transmitter**		**9133 0015 75**	
8.1	SAS 2000 booster unit	1	9133 0015 50	SE
8.2	2 m interconnecting communication cable from SAS 300 to SAS 2000	1	9136 0000 37	SE
9	**Service kit for SAS 2000:**		**9133 0015 53**	
9.1	Tool bag	1	9138 3000 02	
9.2	Rechargeable power pack 12V	1	9133 0012 62	
9.3	Tube silicon grease	1	9138 1000 07	
9.4	Fuses 1 AF	10	9139 2000 03	
9.5	Fuses 10 AF	10	9139 2000 01	
9.6	Red terminal post	2	9139 6000 17	
9.7	Black terminal post	2	9139 6000 18	
9.8	Red banana plug	4	9139 6000 37	
9.9	black banana plug	4	9139 6000 38	
10	**Non-polarisable electrode** includes:		**9135 3218 10**	
10.1	Spare kit comprising:	1	9135 3218 52	SE
10.1.1	Wooden stick	1	9135 3210 39	
10.1.2	Washer	1	9135 3210 37	
10.1.3	Sealing ring	1	9135 3210 40	
10.1.4	O-ring 39.2 x 3	1	0663 2133 00	
10.1.5	O-ring 32.93 x 3.53	1	0663 9188 00	
10.2	$CO\ SO_4$ (1 kg per 2 electrodes)	1	9138 1000 03	SE

Qty* : Quantity included when ordering the main item

Item	Description	Qty*	Order Code	Orig
13	**Wenner cable set:**		**9133 0015 46**	
13.1	Hand cable 500 m, 0.75 mm² on plastic reel with interconnect cable 2m	4	9136 0001 50	SE
14	**SAS LOG 200 well logging set**		**9133 0012 65**	
	Partially consists of:			
14.1	Logging cable 200 m with electrodes	1	9136 0001 06	DE
14.2	Panel complete	1	9133 0015 42	SE
14.3	Cable drum	1	9133 0015 20	SE
14.4	2 m interconnect communication cable from SAS 300 to SAS LOG 200	1	9136 0000 37	SE
15	**Servicing kit SAS LOG 200**		**9133 0015 47**	
15.1	PCB SAS Log 200	1	9136 3100 26	SE
15.2	Selector knob	1	9138 7010 00	SE
15.3	Red terminal post	1	9139 6000 17	
15.4	Black terminal post	1	9139 6000 18	
15.5	Red banana plug	2	9139 6000 37	
15.6	Black banana plug	2	9139 6000 38	
16	**Remote location service tools kit**		**9133 0012 29**	
16.1	Digital multimeter	1	9138 6000 11	
16.2	Soldering pencil 15 W	1	9138 6000 07	
16.3	Lead-tin solder	1	9138 6000 10	
16.4	U-ring wrench 7 mm	1	9138 6000 08	
16.5	U-ring wrench 17 mm	1	9138 6000 09	

Qty* : Quantity included when ordering the main item
Prices are **UNIT PRICE**

SHIPPING DETAILS

Annexure
Aug 1994

Item Number	Net Weight Kg	Gross Weight Kg	Dimension cm
1	7	9	40 x 40 x 32
1 - 5	38	50	74 x 64 x 44
1 - 12	60	72	74 x 64 x 44
14	11	23	92 x 52 x 32

Item	Description	Qty	Order Code	Orig
	Individual system components			
1.	Multimac 4-32 Distributor kit, comprising:		9133 0009 41	SE
1.1	Distributor box with interconnect cable to SAS 300C and serial RS-232 communication cable to computer (with 9-pin D-sub connector)	1	9133 0009 25	
1.2	Multimac software (on both 5 1/4" and 3.5" disks)	1	9133 0009 38	
1.3	Multimac 4-32 instruction manual	2	9133 0009 39	
1.4	Warranty registration card	1	9138 5000 03	
1.5	2 m black interconnect cable with banana connectors	2	9139 7100 71	
1.6	2 m red interconnect cable with banana connectors	2	9139 7101 04	
2	Cable reel, empty	1	9138 3000 08	
3	Two-conductor cable	1m	9138 7100 70	
4	Electrode "snap-on" connector ass'y	1	9133 0009 40	
5	Electrode "snap-on" connector (including mounting by ABEM)	1	9133 0009 40-m	
6	Addressable Electrode Switcher	1	9133 0009 20	
7	Threaded spike for switcher	1	9133 0009 33	

You can design your own Multimac array by using components from this list, plus a Terrameter SAS 300 C (or an upgraded SAS 300B), a laptop computer (or the Geomac III from ABEM) and steel electrodes or spikes. Or you can choose a standard array from ABEM, se two examples below. Moreover, ABEM will be pleased to select and design suitable arrays for your application on request.

Standard Multimac arrays:

8.	Multimac S, standard array for Schlumberger Soundings AB/2 ≤ 243 m Comprising:	1	9133 0009 42	SE
8.1	Distributor Kit, see above for details	1	9133 0009 41	
8.2	Current cable with 16 snap-on connectors at 1.00m 1.44 2.08 3.00 4.33 6.24 9.00 13.00 18.70 27.00 38.90 56.20 81.00 117.00 168.00 243.00, on reel (Total length 245 m)	2	9133 0009 29	
8.3	Potential cable with 4 snap-on connectors at 0.2m 1.00 3.00 13.00 m, without reel (Total length 15 m)	2	9133 0009 30	
8.4	Electrode Switcher	40	9133 0009 20	

Add Terrameter, Geomac III or PC compatible computer and 34 steel electrodes (or 40 spikes) for a complete survey system

Item	Description	Qty	Order Code	Orig
9.	Multimac SW, standard array for Schlumberger and Wenner soundings AB/2 ≤ 243 m, or L ≤ 81 m	1	9133 0009 43	SE
	Comprising:			
9.1	Distributor kit, see above for details	1	9133 0009 41	
9.2	Current cable with 16 snap-on connectors at 1.00m 1.44 2.08 3.00 4.33 6.24 9.00 13.00 18.70 27.00 38.90 56.20 81.00 117.00 168.00 243.00, on reel (Total length 245 m)	2	9133 0009 29	
9.3	Potential cable with 13 snap-on connectors at 1.00 m, 1.44 2.08 3.00 4.33 6.24 9.00 13.00 18.70 27.00 38.90 56.20 81.00, on reel (Total length 83 m)	2	9133 0009 44	
9.4	Electrode Switcher	58	9133 0009 20	

Add Terrameter, Geomac III or similar computer and 32 steel electrodes (or 58 spikes) for a complete survey system

Item	Description	Qty	Order Code	Orig
	Individual system components			
1.	**ESE 464 system, including**	1	9133 0019 24	SE
1.1	Electrode Selector ES 464, complete with snap-on battery tray	1	9133 0019 00	SE
1.2	Current/Voltage cable, interconnecting Terrameter SAS unit with ES 464 Selector.	1	9133 0019 17	SE
1.3	Signal cable interconnecting Terrameter with Selector	1	9133 0019 15	SE
2.	LUND System Communications Kit, including	1	9133 0019 04	SE
2.1	Warranty registration card	1	9138 5000 03	
2.2	Instruction Manual	2		
2.3	Aquisistion software, 3.5" disk	1		
2.4	Processing software, on 3.5" disk	1		
2.5	Hardware protection key for item 2.4			
3	Field cable set for 2 m electrode spacing, with	1		
3.1	Electrode cable, with 21 take-outs at 2 m interval, total length 50 m	4	9133 0019 18	IR
3.2	Cable joint	2	9133 0019 20	SE
3.3	Cable-to-electrode jumper	75	9133 0019 19	SE
4	Field cable set for 5 m electrode spacing (as above but with four cables with 5 m electrode spacing, total length 110 m)	1		
5	Steel electrode	75	9133 0012 61	SE
6	Cable SAS300C to PC/AT	1	9133 0001 84	SE
7	Conversion kit SAS300B to SAS300C	1	9133 0012 16	SE

You can design your own LUND Imaging System by using components from this list, plus a Terrameter SAS 300 C (or an upgraded SAS 300B) and a laptop computer (or the Geomac III from ABEM)

Typical system for 2 m electrode spacing (160 m x 20 m plotted vertical image per layout):

Typical system for 5 m electrode spacing (400 m x 50 m vertical image per layout):

INPUT UNIT 9136 3100 21

POTENTIAL ELECTRODES

P2 A

P1 B

VARIABLE GAIN AMPLIFIER-FILTER -Gain-

Full Scale

CURRENT/FREQ. CONV.

Clock Ref

LIMIT DETECT.

250 kHz

0-55 kHz

0-55 kHz

(692) 68K1 (693) 68K1

CURRENT ELECTRODES

TRANSIENT ABSORBER 9136 310025

DISPLAY MODULE 9136 3100 20

ERROR % BAT kmΩVA

CURRENT (mA) 0.2 0.5 1 2 5 10 20 50 100 200 500

MODE

CYCLES

BASE TIME (JUMPER)

CODE JUMPER

SEND

POLARITY

BOOSTER CURRENT CODE

ALARM

RS 232

REMOTE

GND

SUMMER

BELL

I/O BUS

ADDRESS & CONTROL BUS

DATA BUS

MPU

ROM 2048x8 Prog

I/O

BCD/(8)

DC/DC CONV. 9136 310076 9-18V U=180V

U=2.5V

ON-OFF

FUSE

MEASURE

BATTERY 12V

IC SUPPLY CONNECTIONS

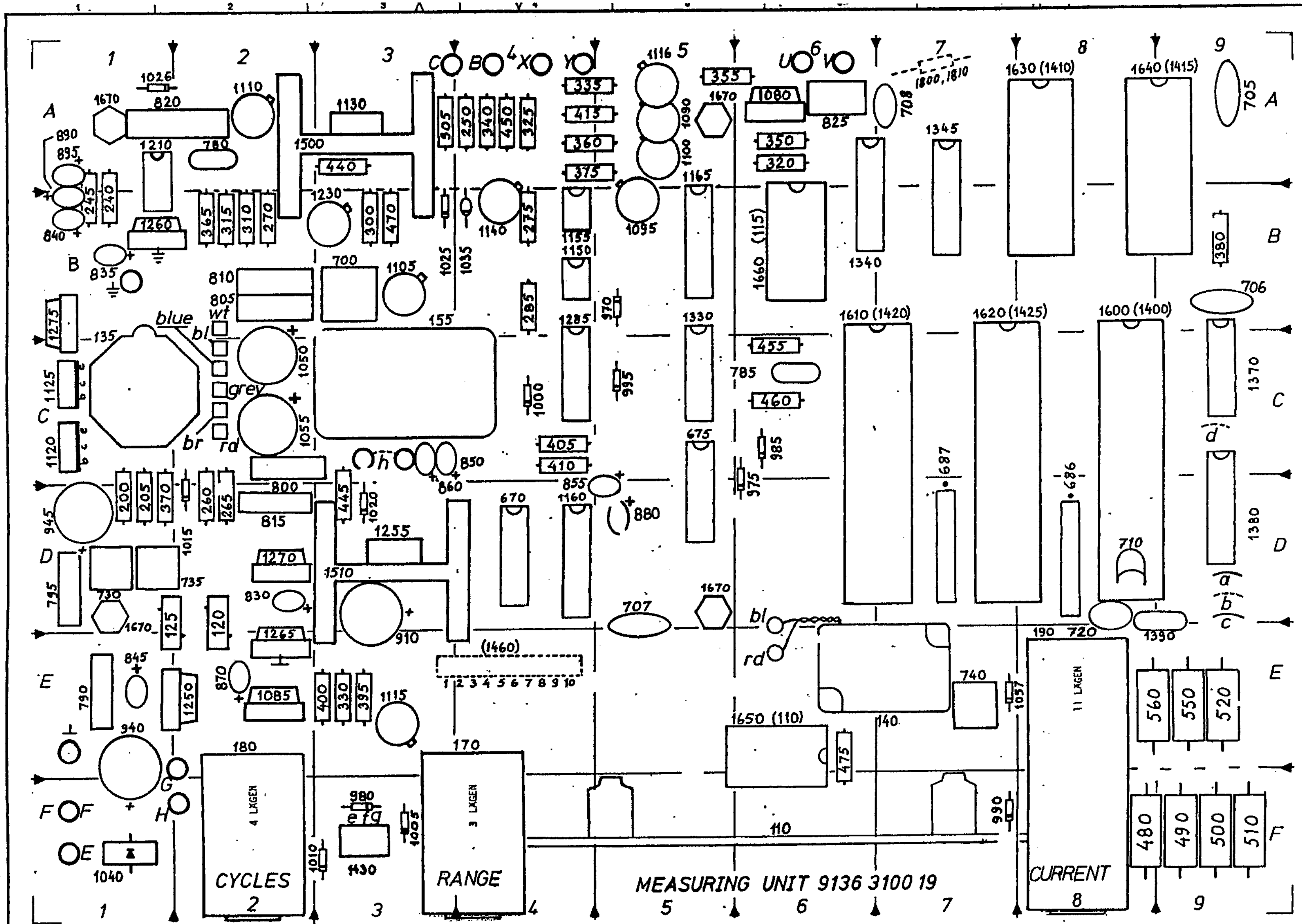
ITEM POS	0V	+C	+D	+12V
1160	8			9
1165	8			9
1285	7	14		
1330	7	14		
1340	8	16		
1345	8	16		
1370	7		14	
1380	8		16	
1400	1,21		8	
1410	12		24	
1415	12		24	
1420	7		26	
1425	7		26	

MATENHET (MEASURING UNIT) SAS 300C

ATLAS COPCO STANDARD 1350 K

9130 0102 63 B

1



100.0 mm

○ = 1440 (14 st)

□ = 1450 (6 st)

ANM.

1. Kondensator pos. 710 monteras under pos. 1400
2. Pos. 1460 monteras från lödsidan
3. Dessa komponenter monteras efter våglödning: pos. 135, 140, 170, 180, 190, 1460
4. Axellängden på pos. 170, 180 och 190 skall vara 13mm

E	Märkn.inf. Pos.1650,1660	
D	Pos.170 var 9 lägen + Jordn.pnk.2 st.	
C	Koordinatmarkering F i ruta F1 flyttad	
B	1430, 750, 985, 1450 införda	
Rev/Rev	Modified from/Ändrat från	Date/Datum

F Pos. 1800,1810 inf. Jordn. ändr.

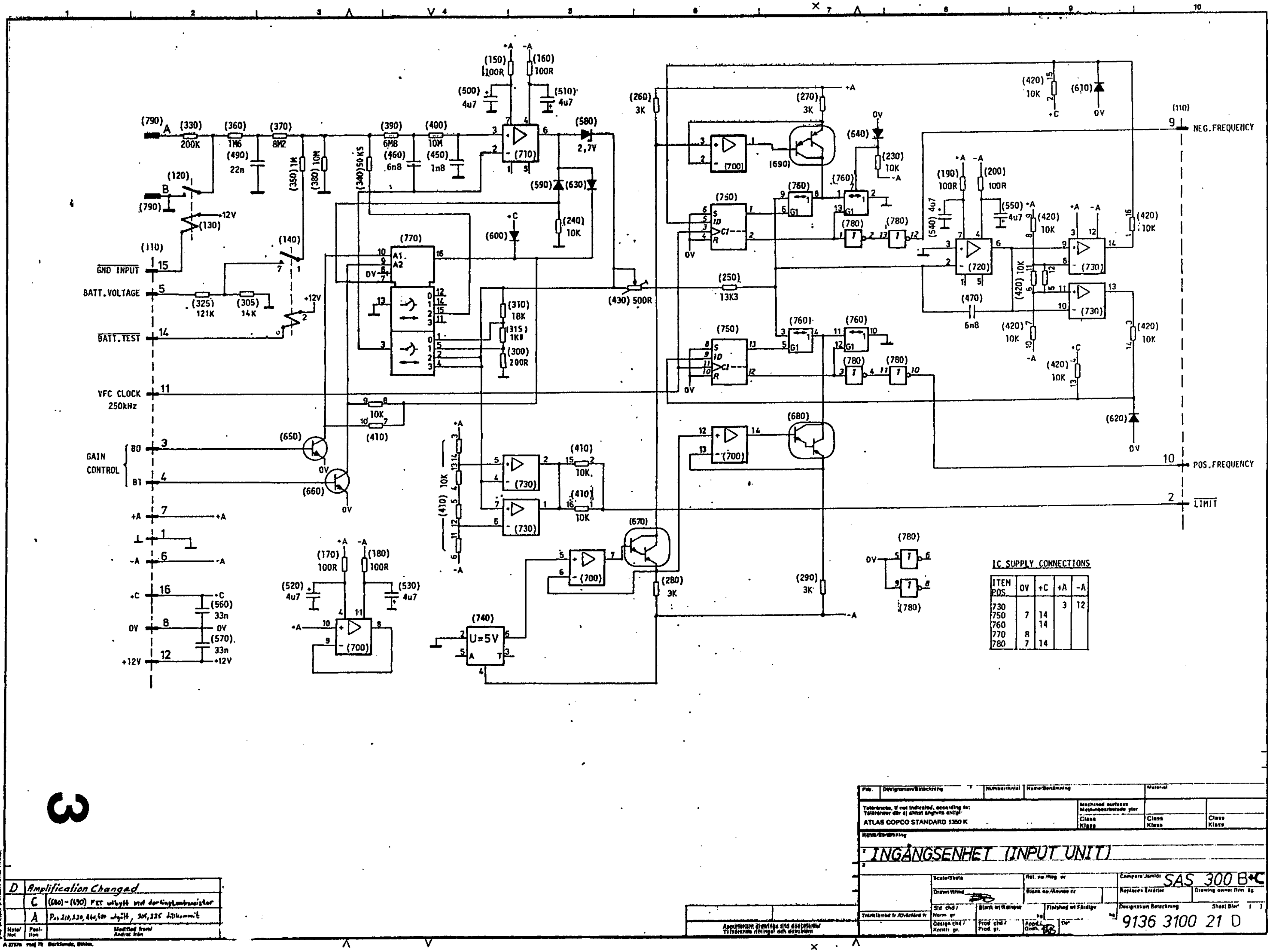
Tolerances, if not indicated, according to: ATLAS COPCO STANDARD 1350 K

MÄTENHET (MEASURING UNIT)

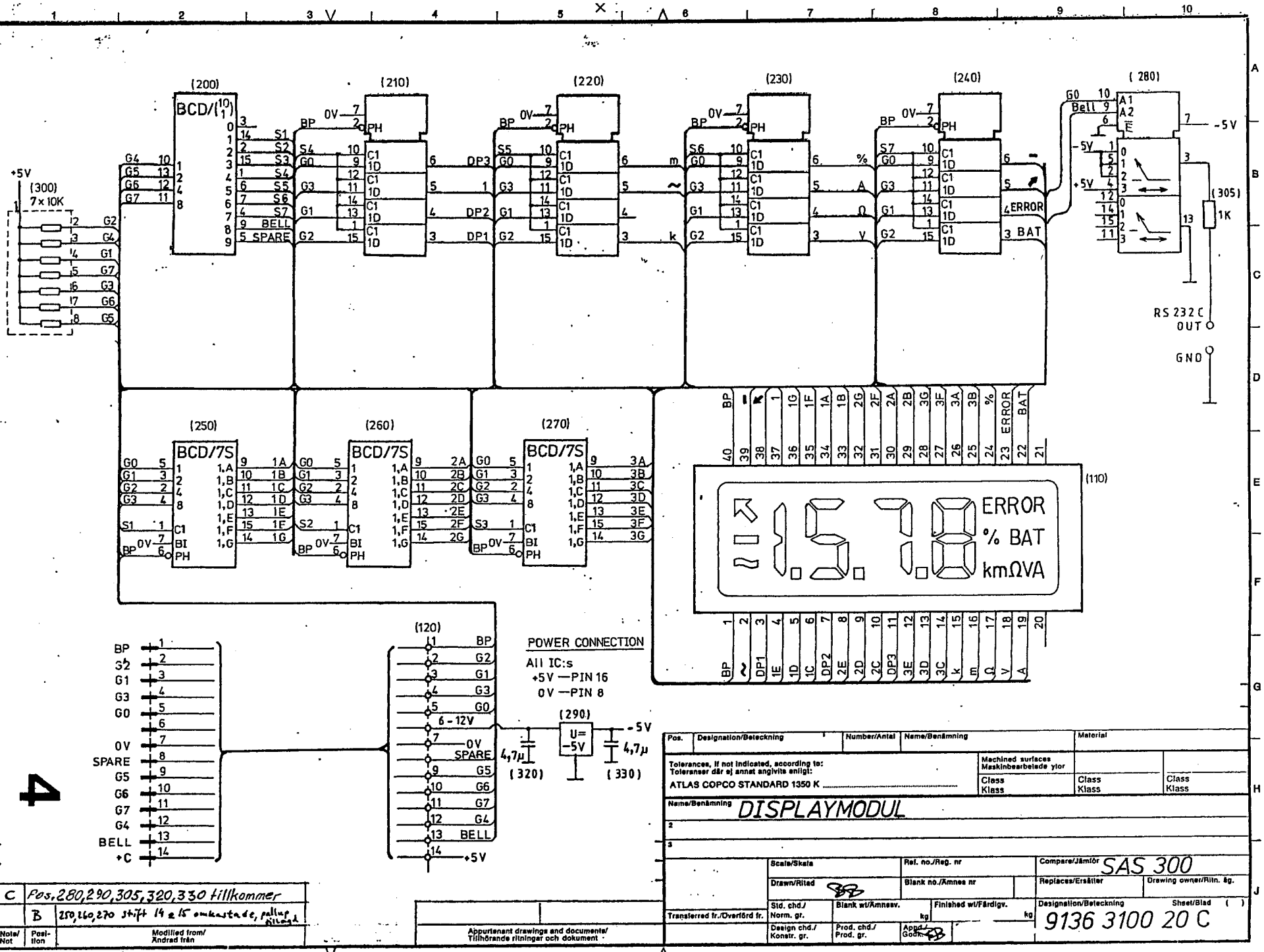
MONTERINGSRITNING OCH KOMPONENTTRYCKORIGINAL

Scale/Skala 2:1

9130 1900 09 F


NEG.FREQUENCY
POS.FREQUENCY
LIMIT
GND INPUT
BATT.VOLTAGE
BATT.TEST
VFC CLOCK
250kHz
GAIN
CONTROL
B0
B1
IC SUPPLY CONNECTIONS
ITEM POS. | 0V | +C | +A | -A
730 | | | 3 | 12
750 | 7 | 14
760 | | 14
770 | 8
780 | 7 | 14
INGÅNGSENHET (INPUT UNIT)
SAS 300 B+C
9136 3100 21 D
ATLAS COPCO STANDARD 1350 K
D Amplification Changed
C (680)-(690) FET utbytt mot darlingtontransistor
A Pos 210,220,440,450 utgått, 305,325 tillkommit
Modified from/Ändrat från

3



4

C Pos. 280, 290, 305, 320, 330 tillkommer

B 250, 260, 270 stift 14 & 15 omkastade, pallup ritning

Note/ Not	Position	Modified from/ Ändrad från

Pos.	Designation/Beteckning	Number/Antal	Name/Benämning	Material

Tolerances, if not indicated, according to: Toleranser där ej annat angivits enligt: ATLAS COPCO STANDARD 1350 K

Machined surfaces Maskinbearbetade ytor — Class Klass

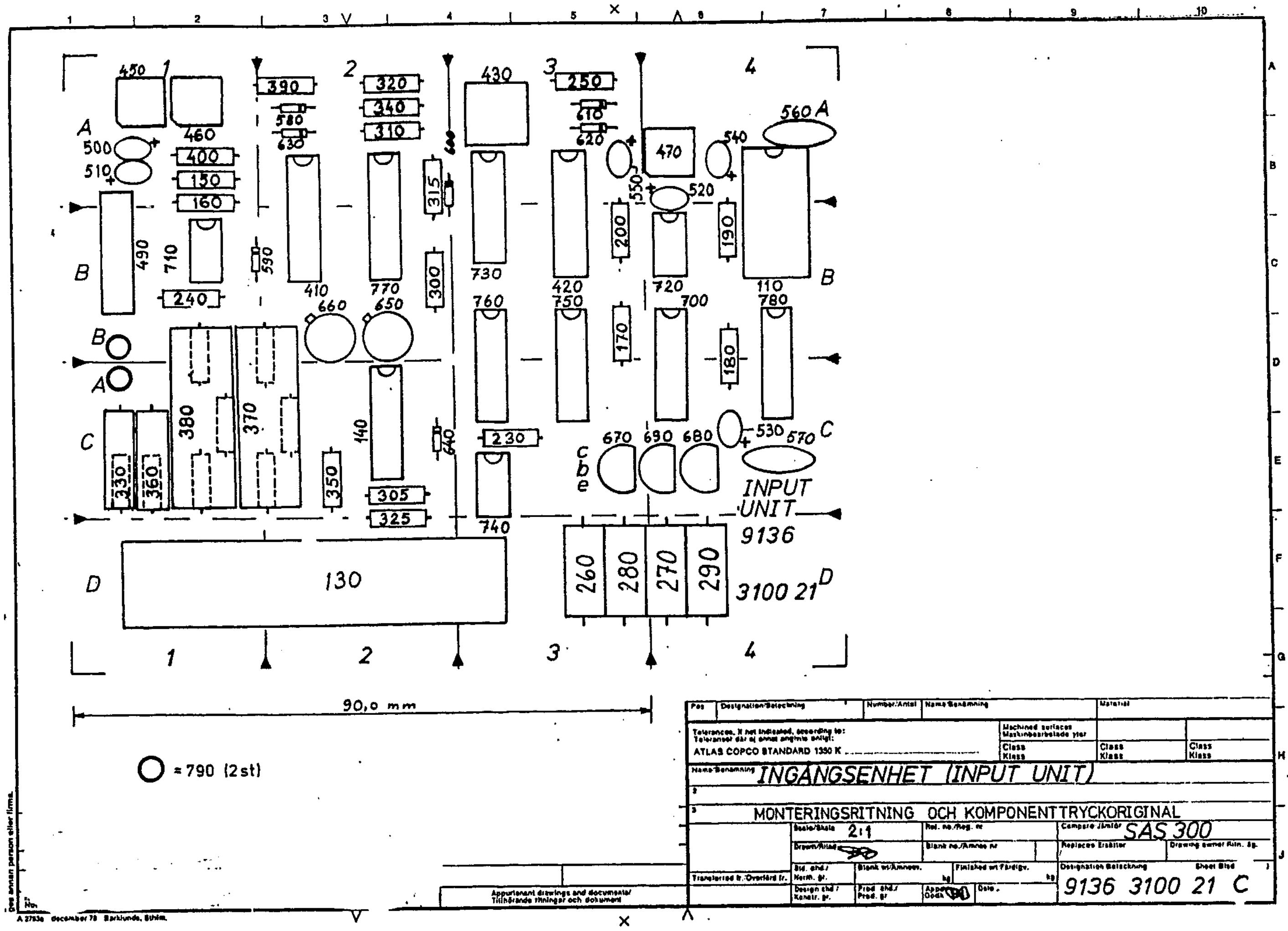
Name/Benämning: DISPLAYMODUL

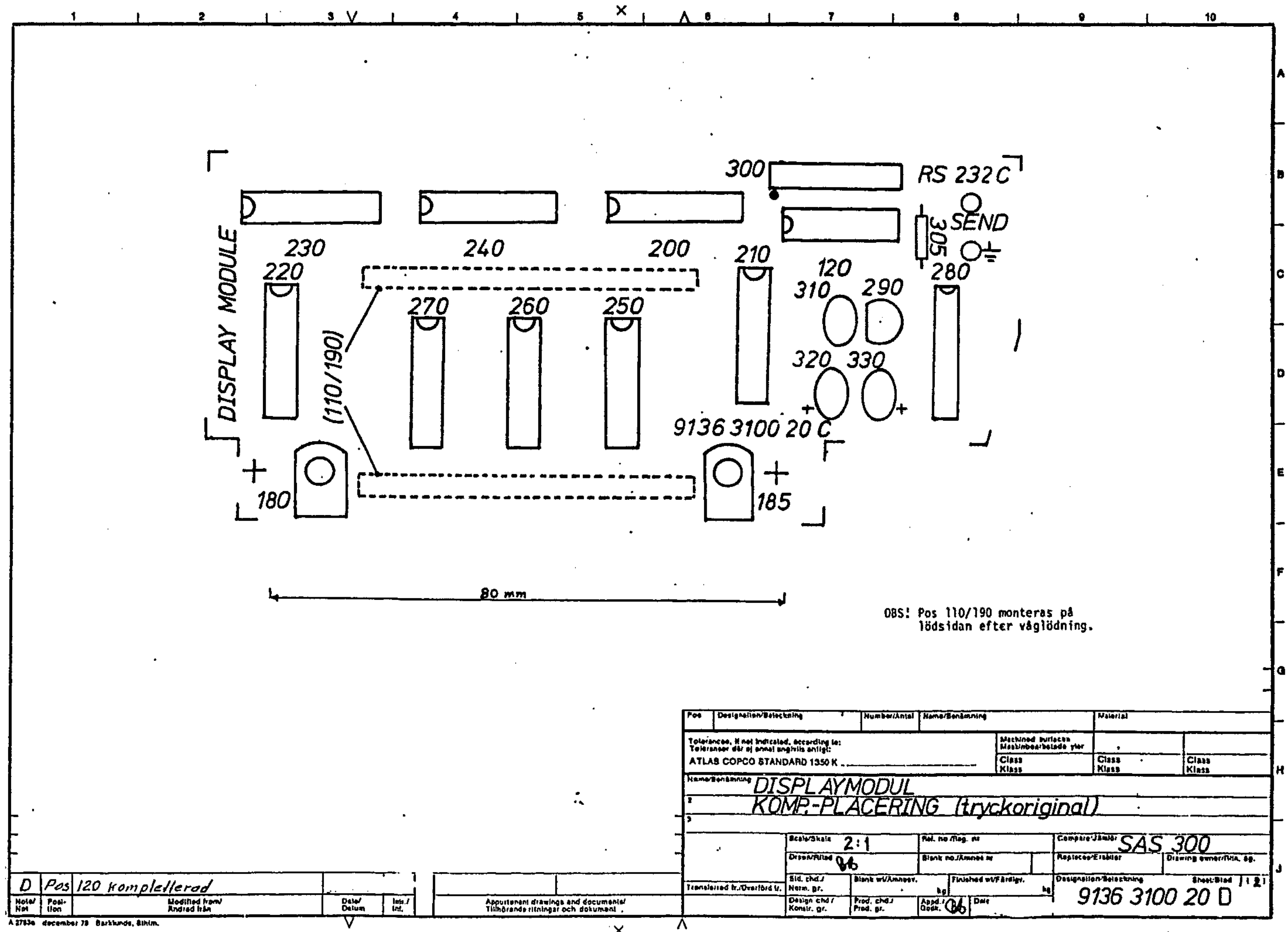
Scale/Skala	Ref. no./Reg. nr	Compare/Jämför: SAS 300
Drawn/Ritad: SBB	Blank no./Amnes nr	Replaces/Ersätter — Drawing owner/Ritn. äg.
Std. chd./ Norm. gr. — Blank wt/Amnesv. — Finished wt/Färdigv. kg		Designation/Beteckning: 9136 3100 20 C — Sheet/Blad ( )
Design chd./ Konstr. gr. — Prod. chd./ Prod. gr. — Appr./ Godk.: SBB		

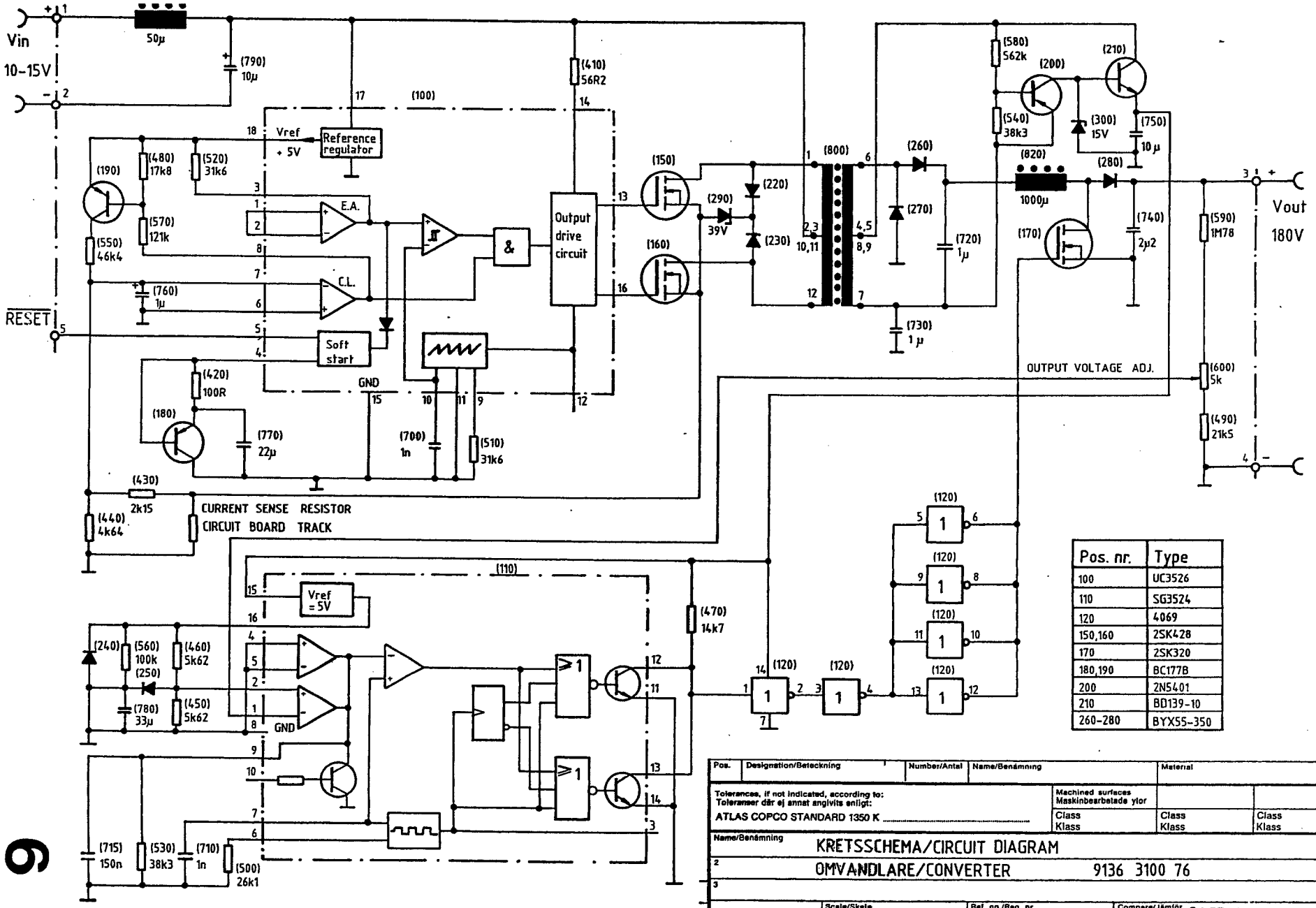
Transferred fr./Överförd fr.

Appurtenant drawings and documents/ Tillhörande ritningar och dokument

A 2753a december 78 Barklunds, Sthlm.


INPUT UNIT 9136 3100 21
90,0 mm
○ = 790 (2st)
ATLAS COPCO STANDARD 1350 K
INGÅNGSENHET (INPUT UNIT)
MONTERINGSRITNING OCH KOMPONENTTRYCKORIGINAL
2:1
SAS 300
9136 3100 21 C


DISPLAY MODULE
RS 232 C
SEND
9136 3100 20 C
80 mm
OBS! Pos 110/190 monteras på lödsidan efter våglödning.
ATLAS COPCO STANDARD 1350 K
DISPLAYMODUL
KOMP-PLACERING (tryckoriginal)
2:1
SAS 300
D Pos 120 komplellerad
9136 3100 20 D



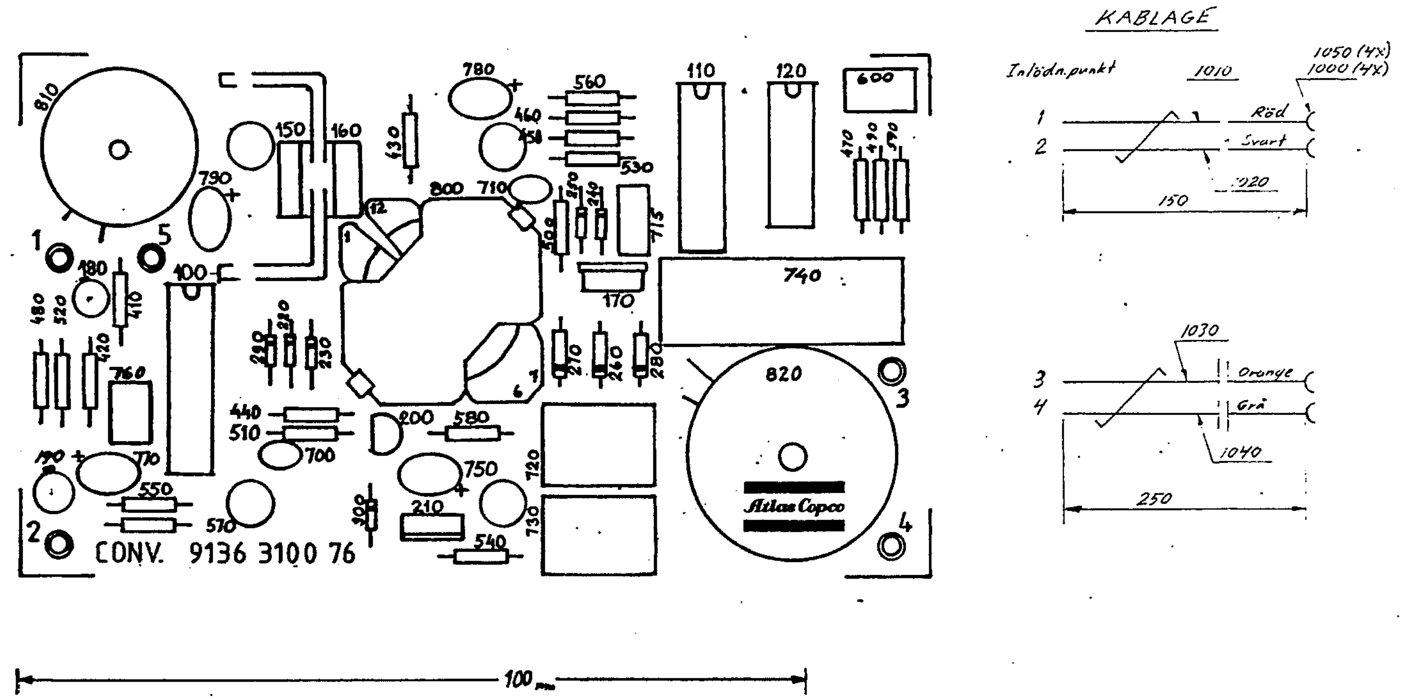
Pos. nr.	Type
100	UC3526
110	SG3524
120	4069
150,160	2SK428
170	2SK320
180,190	BC177B
200	2N5401
210	BD139-10
260-280	BYX55-350

Pos.	Designation/Beteckning	Number/Antal	Name/Benämning	Material
Tolerances, if not indicated, according to: Toleranser där ej annat angivits enligt: ATLAS COPCO STANDARD 1350 K			Machined surfaces Maskinbearbetade ytor	Class Klass / Class Klass / Class Klass
Name/Benämning	KRETSSCHEMA/CIRCUIT DIAGRAM			
2	OMVANDLARE/CONVERTER	9136 3100 76		
3				

Scale/Skala	Ref. no./Reg. nr	Compare/Jämför SAS300		
Drawn/Ritad BB/GILARIS	Blank no./Ämnes nr	Replaces/Ersatter	Drawing owner/Ritn. ág.	
Sid. chd./ Norm. gr.	Blank wt/Ämnesv. kg	Finished wt/Färdigv. kg	Designation/Beteckning	Sheet/Blad ( )
Transferred fr./Överförd fr.	Design chd./ Konstr. gr.	Prod. chd./ Prod. gr.	Appd./ Godk.	Date
				9130 0101 41 A

Note/ Not	Position	Modified from/ Ändrad från	Date/ Datum	Intr./ Inf.	Appurtenant drawings and documents/ Tillhörande ritningar och dokument

A 2753a augusti 82 Barklunds, Sthlm.



Pos.	Designation/Beteckning	Number/Antal	Name/Benämning	Material

Tolerances, if not indicated, according to: / Toleranser där ej annat angivits enligt: ATLAS COPCO STANDARD 1350 K

Machined surfaces / Maskinbearbetade ytor — Class / Klass — Class / Klass — Class / Klass

Name/Benämning: DC/DC CONVERTER 9136 3100 76

2 Komponentplaceringsritning & Komp.-tryckoriginal

3

Scale/Skala	2:1	Ref. no./Reg. nr		Compare/Jämför	SAS 300
Drawn/Ritad	AB	Blank no./Ämnes nr		Replaces/Ersätter	Drawing owner/Ritn. äg.
Transferred fr./Överförd fr.	Std. chd./Norm. gr.	Blank wt/Ämnesv. kg	Finished wt/Färdigv. kg	Designation/Beteckning	Sheet/Blad ( )
	Design chd./Konstr. gr.	Prod. chd./Prod. gr.	Appd./Godk.	Date	9130 0500 35C

Appurtenant drawings and documents / Tillhörande ritningar och dokument

Note/Not	Position	Modified from/Ändrad från	Date/Datum	Intr./Inf.
C		Kablage hartillkommit, 2 nya symboler		
B		740 = 760 bytt / flyttad		AJ

A 2753e augusti 82 Barklunds, Sthlm.

Note	Modified from/Ändrad från	Date	Intr.	Note	Modified from/Ändrad från	Date	Intr.
B	Pos. 120, 130 utgår			C	Kompletterad		

Fig. 1 Kretsschema

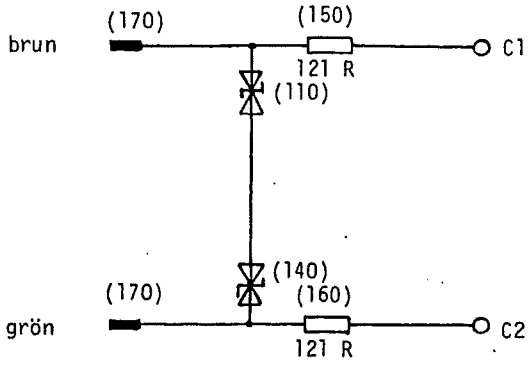
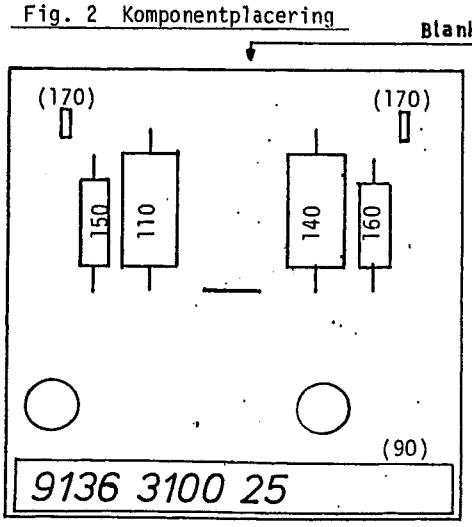


Fig. 2 Komponentplacering



Nummerskylt (90) maskinskrivs på självhäftande papper. Plats till höger för tillverkningsvecka el. dyl.

Tolerances, if not indicated, according to: Toleranser där ej annat angivits enligt: ATLAS COPCO STANDARD 1350 K	Machined surfaces Maskinbearbetade ytor Class Klass	Class Klass	Class Klass

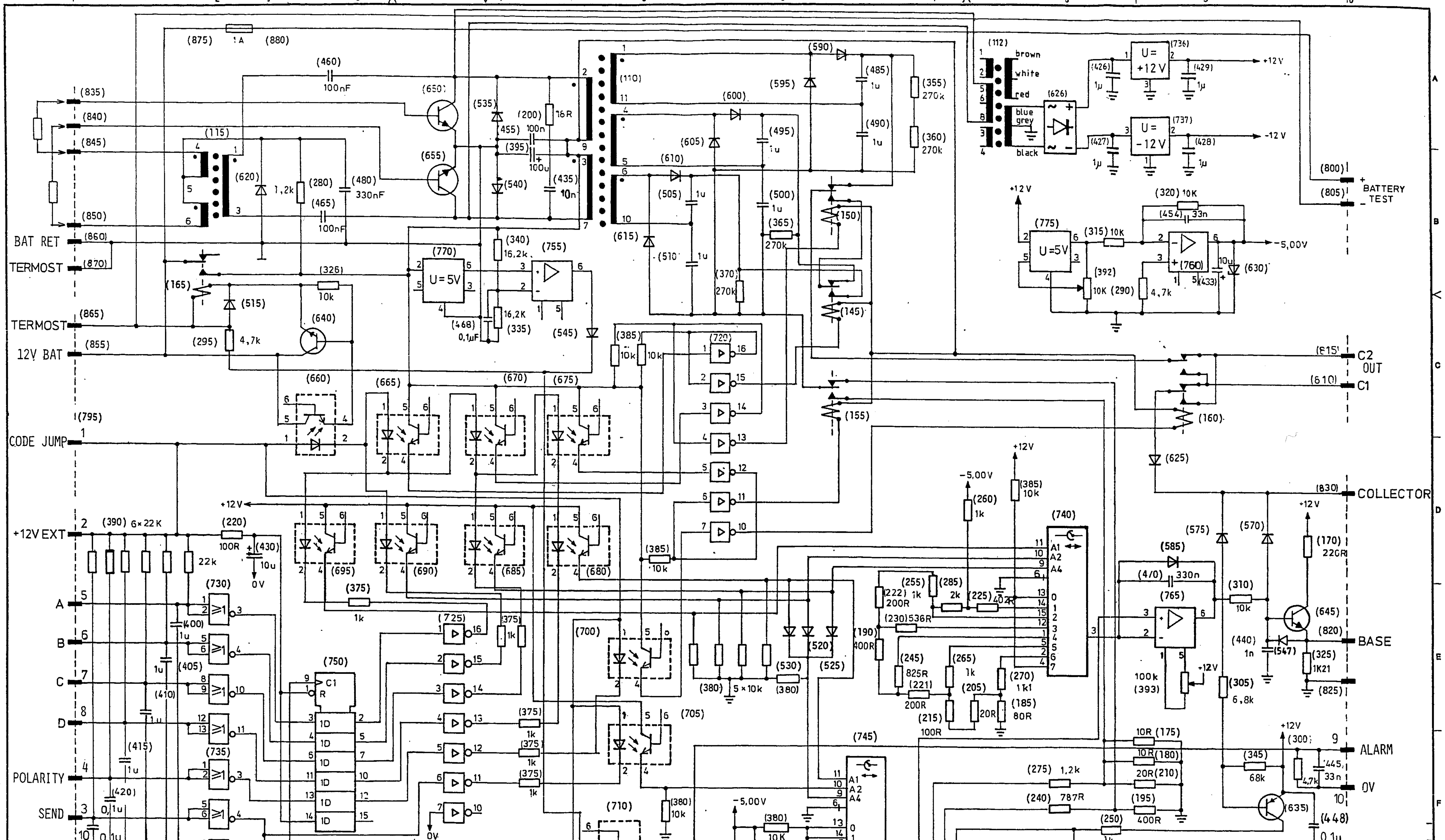
Name Benämning: Kretsschema och komponentplacering

2 TRANSIENTSKYDD

3

	Scale/Skala 2:1	Ref. no./Reg. nr	Compare Jämför SAS300
	Drawn/Ritad BB	Blank no /Ämnes nr	Replaces Ersatter / Drawing owner/Ritn. ag.
Transferred fr /Överförd fr.	Std. chd./ Norm. gr. / Blank wt/Ämnesv. kg	Finished wt Färdigv. kg	Designation Beteckning 9136 3100 25 C / Sheet-Blad ( )
	Design chd./ Konstr. gr. / Prod. chd./ Prod. gr.	Appd./ Godk. / Date	

A 2754a december 78 Barklunds, Sthlm.



POS	12V BAT	12V EXT	12V	0V	⊥	⏚	-5V	-12V
(720)	9				8			
(725)		9			8			
(730)		14		7				
(735)		14		7				
(740)			16			8	7	
(745)			16			8	7	
(750)		16		8				
(755)	7				4			
(760)			7					4
(765)			7					4

Note/Not	Position/Pos	Modified from/Ändrat från	Date/Datum	Intr./Inf
3		12V-Förserjm ändr. Pos 547, tillk. 580 utgår	85-07-22	PL

Pos | Designation/Beteckning | Number/Antal | Name/Benämning | Material

Tolerances, if not indicated, according to:
Toleranser där ej annat angivits enligt:
ATLAS COPCO STANDARD 1350 K

Machined surfaces / Maskinbearbetade ytor
Class Klass | Class Klass | Class Klass

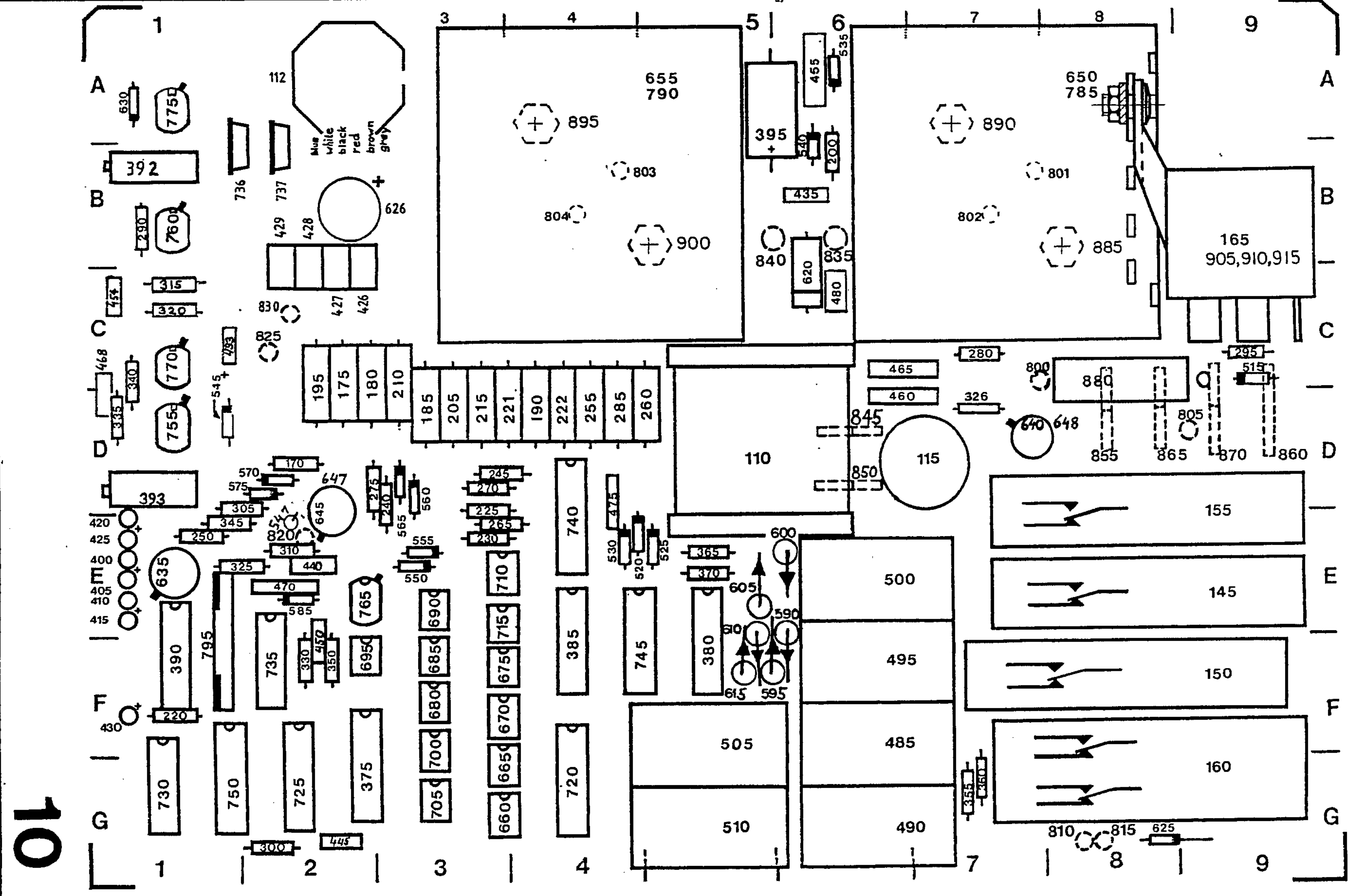
Name Benämning: BOOSTER PCB

Scale Skala | Ref no Req nr | Compare Jämför
Drawn Ritad: YS | Blank no Ämnes nr | Replaces Ersätter | Drawing owner Ritn. ag.
Transferred fr Överförd fr | Std chd Norm gr | Blank wt Ämnesv kg | Finished wt Färdigv kg | Designation Beteckning | Sheet
Design chd Konstr gr | Prod. chd. Prod. gr. | Appd Godk | Date

9136 3100 22 H

9

A 2752a maj 79 Barklunds, Sthlm.



FÖLJANDE KOMPONTER MONTERAS EFTER VÅG-LÖDNING:
POS. 110, 115, 145, 150, 155, 160, 165, 650, 655, 785, 790, 800, 805, 810, 815, 820, 825, 830, 835, 840, 845, 850, 855, 860, 865, 870, 885, 890, 895, 900, 905, 910

MONTERING AV POS 155, 145, 150
SE RITNING: 9139 2030 11,
POS 160
SE RITN. 9139 2030 12

OBS!

SAMTLIGA DIODER POS. 515–630 SKALL VÄNDAS SÅ ATT MÄRKNING ÄR SYNLIG EFTER MONTERING.

POS. 547 MONTERAS STÅENDE ENL. FIG.

10

Rev	Modified from / Ändrat från
F	512 V Försörjn. ändr. Pos. 547, tillk. 580 utgår
E	Pos. 392 tillk.
D	Pos. 465 ... Pos. 455 utgår
4	Div. just.

Tolerances, if not indicated, according to / Toleranser där ej annat angivits enligt: ATLAS COPCO STANDARD 1350 K

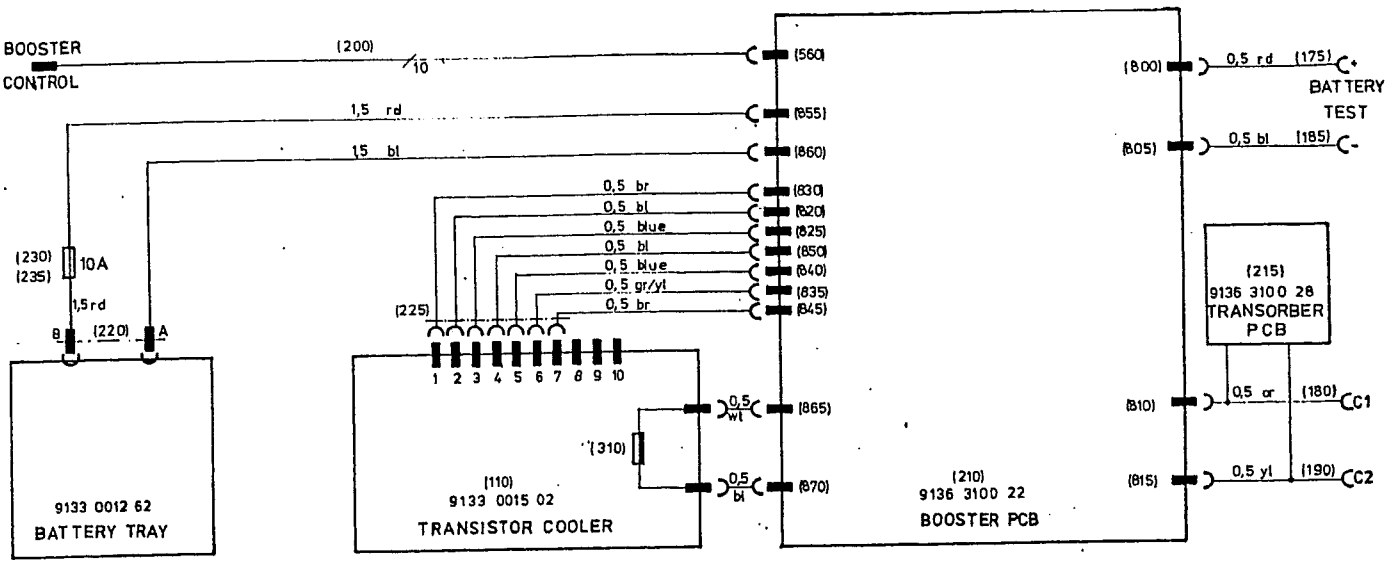
EFFEKTENHETSKORT SAS 2000

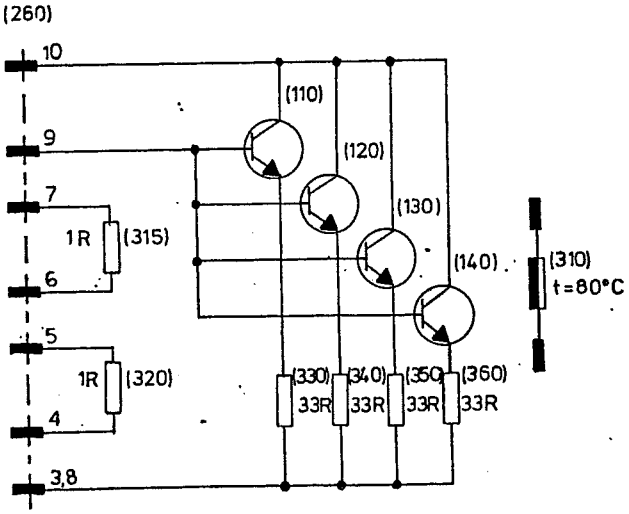
MONTERINGSRITNING OCH KOMPONENTTRYCKORIGINAL

Scale / Skala 2:1

Ritn med samma nr

9130 1900 10 F


BOOSTER CONTROL
(200)
10
1,5 rd
1,5 bl
(230)
(235)
10A
1,5 rd
B
(220)
A
9133 0012 62
BATTERY TRAY
(225)
0,5 br
0,5 bl
0,5 blue
0,5 bl
0,5 blue
0,5 gr/yl
0,5 br
1 2 3 4 5 6 7 8 9 10
(310)
(110)
9133 0015 02
TRANSISTOR COOLER
(560)
(655)
(660)
(630)
(620)
(625)
(650)
(640)
(635)
(645)
0,5 wt
(665)
0,5 bl
(670)
(210)
9136 3100 22
BOOSTER PCB
(800)
0,5 rd
(175)
+
BATTERY TEST
(805)
0,5 bl
(185)
-
(215)
9136 3100 28
TRANSORBER PCB
(810)
0,5 or
(180)
C1
(815)
0,5 yl
(190)
C2


(260)
10
9
7
1R
(315)
6
5
1R
(320)
4
3,8
(110)
(120)
(130)
(140)
(310)
t=80°C
(330)
33R
(340)
33R
(350)
33R
(360)
33R

Note	Modified from/Ändrad från	Date	Intr.	Note	Modified from/Ändrad från	Date	Intr.

Fig.1 Kretsschema

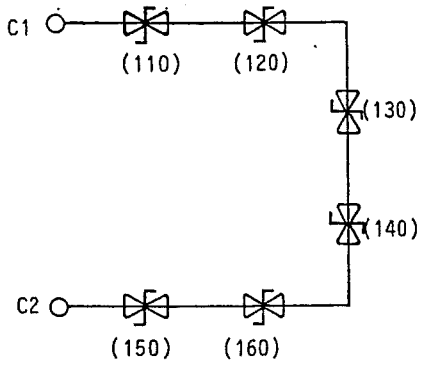
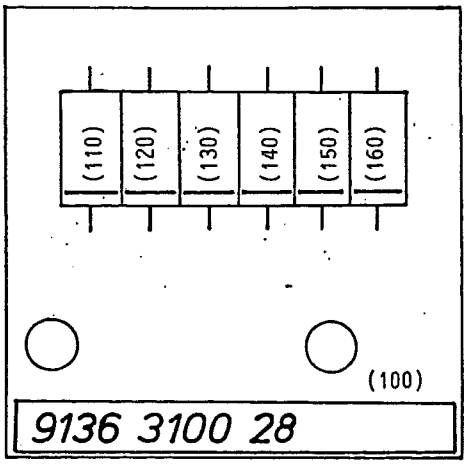


Fig.2 Komponentplacering



Nummerskylt (100) maskinskrivs på självhäftande papper. Plats till höger för tillverkningsvecka el. dyl.

Tolerances, if not indicated, according to: Toleranser där ej annat angivits enligt:	Machined surfaces Maskinbearbetade ytor		
	Class Klass	Class Klass	Class Klass

Name/Benämning: Kretsschema och komponentplacering

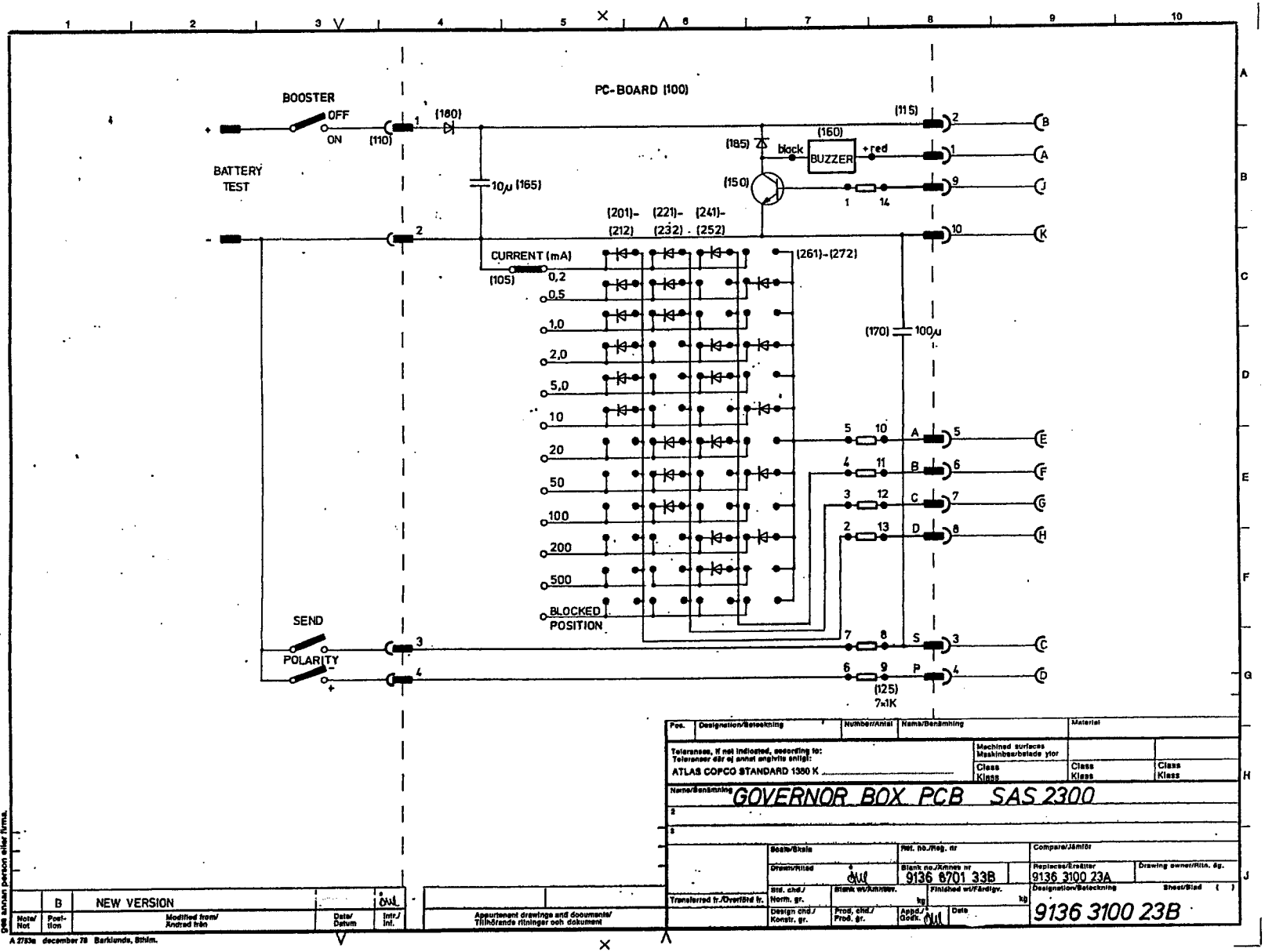
2: Transientskydd

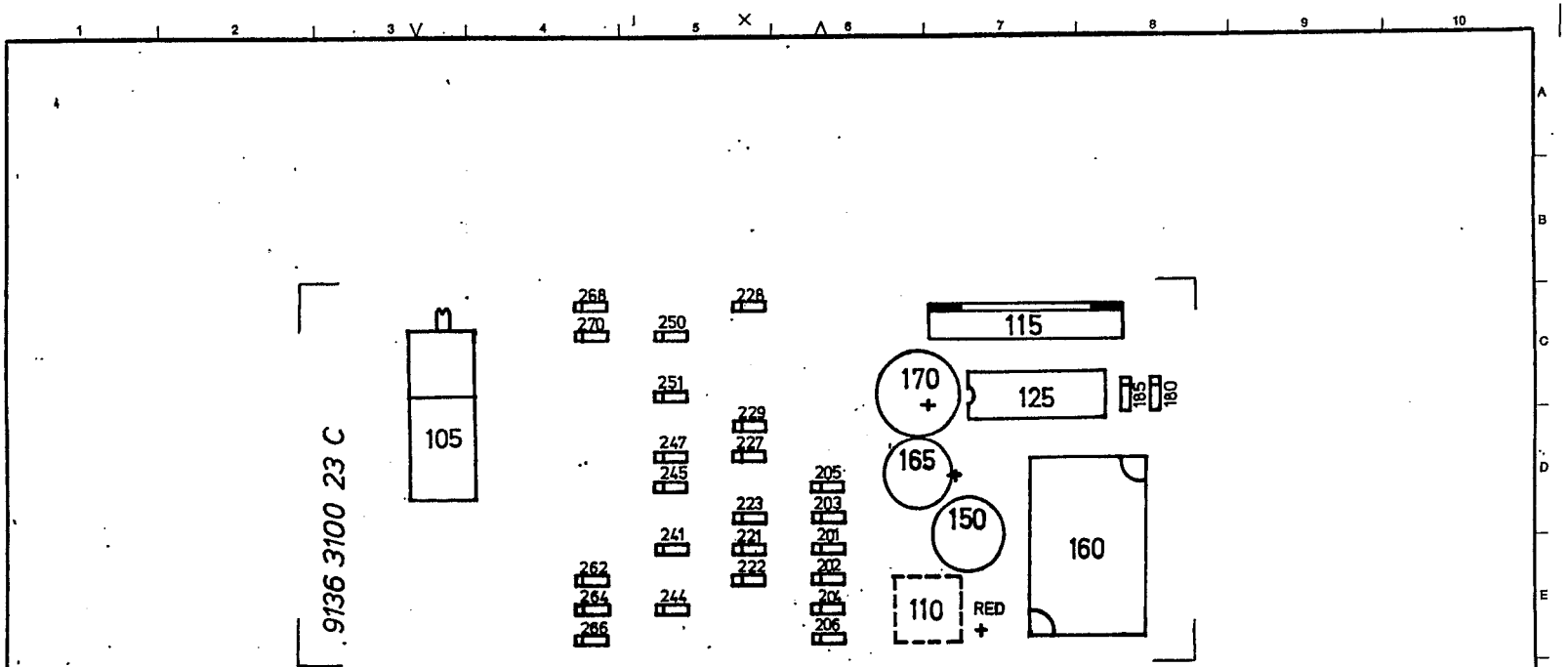
3:

	Scale/Skala 2:1	Ref. no./Reg. nr	Compare/Jämför SAS 2000
	Drawn/Ritad	Blank no./Ämnes nr	Replaces/Ersätter / Drawing owner/Ritn. ág.
Transferred fr./Överförd fr.	Std. chd./ Norm. gr.	Blank wt/Ämnesv. kg	Finished wt/Färdigv. kg
	Design chd./ Konstr. gr.	Prod. chd./ Prod. gr.	Appd./ Godk. Date

Designation/Beteckning: 9136 3100 28 A — Sheet/Blad ( )

A 2754a december 78 Barklunds, Sthlm.





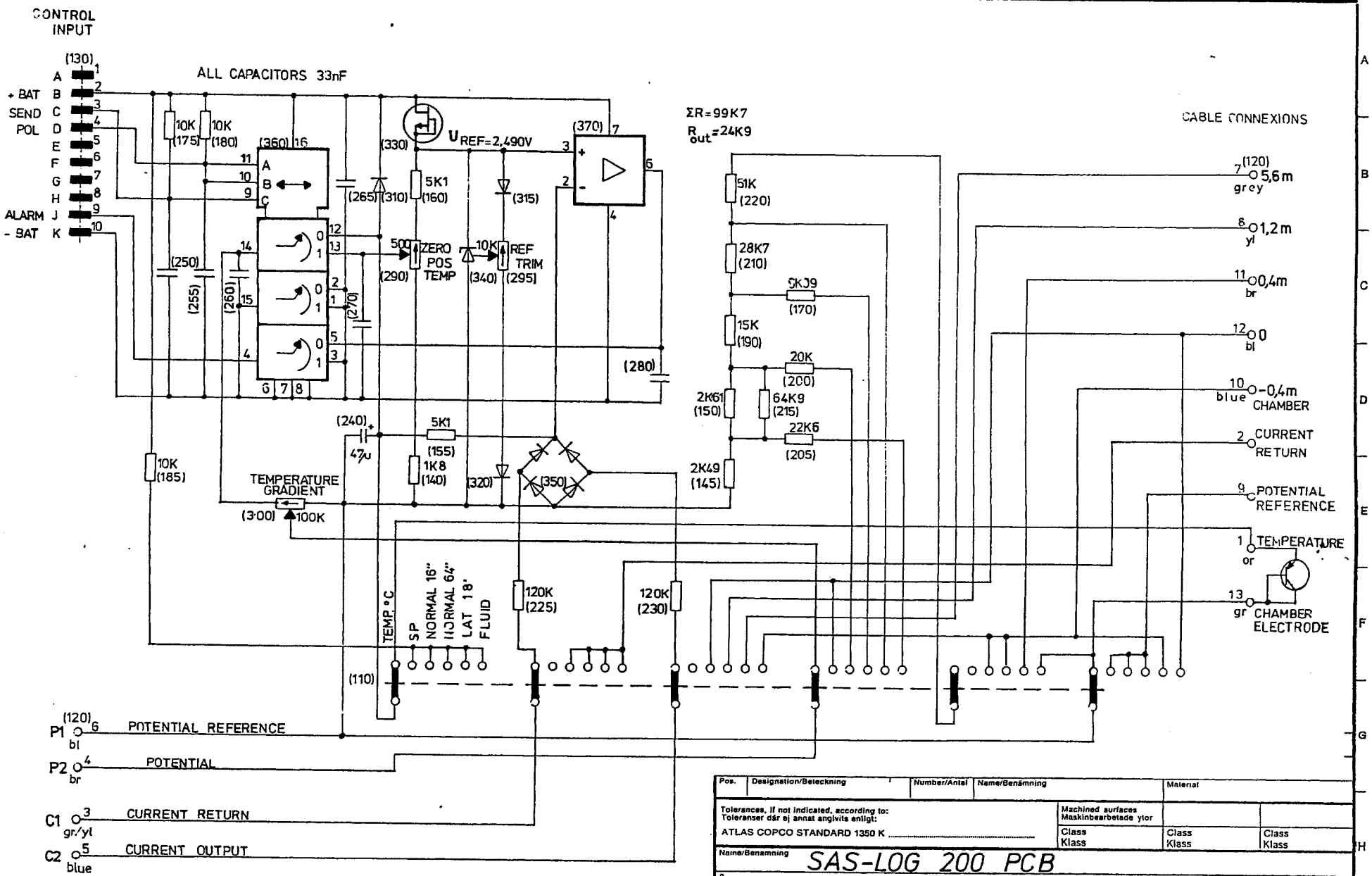
14

Pos.	Designation/Beteckning	Number/Antal	Name/Benämning	Material
Tolerances, if not indicated, according to: Toleranser där ej annat anges enligt: ATLAS COPCO STANDARD 1350 K			Machined surfaces Maskinbearbetade ytor	Class Klass / Class Klass / Class Klass
Name/Benämning	KOMPONENTTRYCK- & PLACERING SAS 2300			
Scale/Skala 2:1	Ref. no./Reg. nr	Compare/Jämför		
Drawn/Ritad DML	Blank no./Kmnes nr	Replaces/Ersätter	Drawing owner/Ritn. ag	
Std. chd./ Norm. gr.	Blank wt/Ämnesv.	Finished wt/Färdigv. kg	Designation/Beteckning 9130 0500 36 C	Sheet/Blad ( )
Transferred fr./Överförd fr.	Design chd./ Konstr. gr.	Prod. chd./ Prod. gr.	Appd./ Godk. DML Date	

Note/ Not	Position	Modified from/ Ändrad från	Date/ Datum	Intr./ Inf.
C		Ändr. till 115,5 x 48		

Appurtenant drawings and documents/ Tillhörande ritningar och dokument

A 2753e december 78 Barklunds, Ehlm.

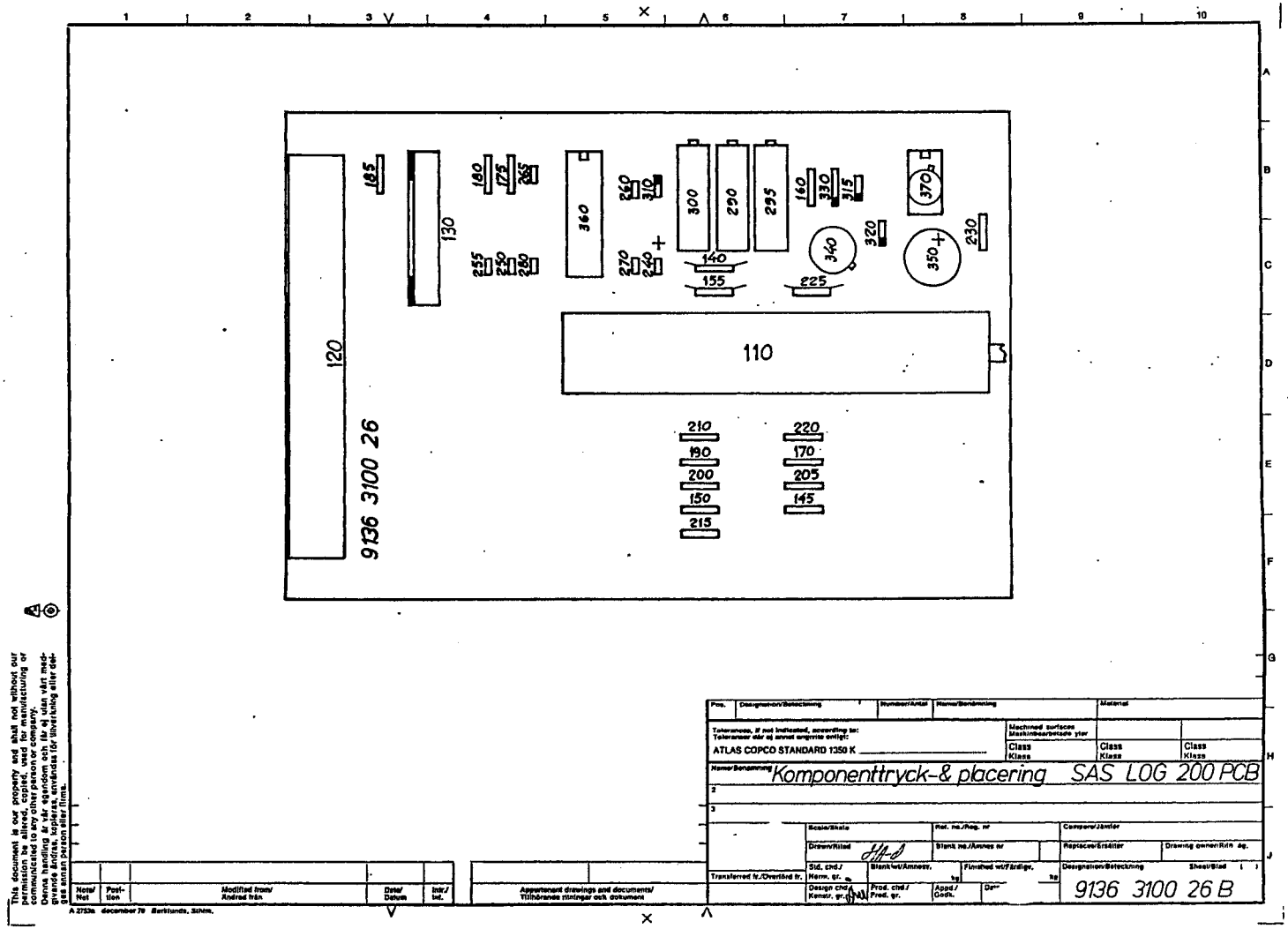


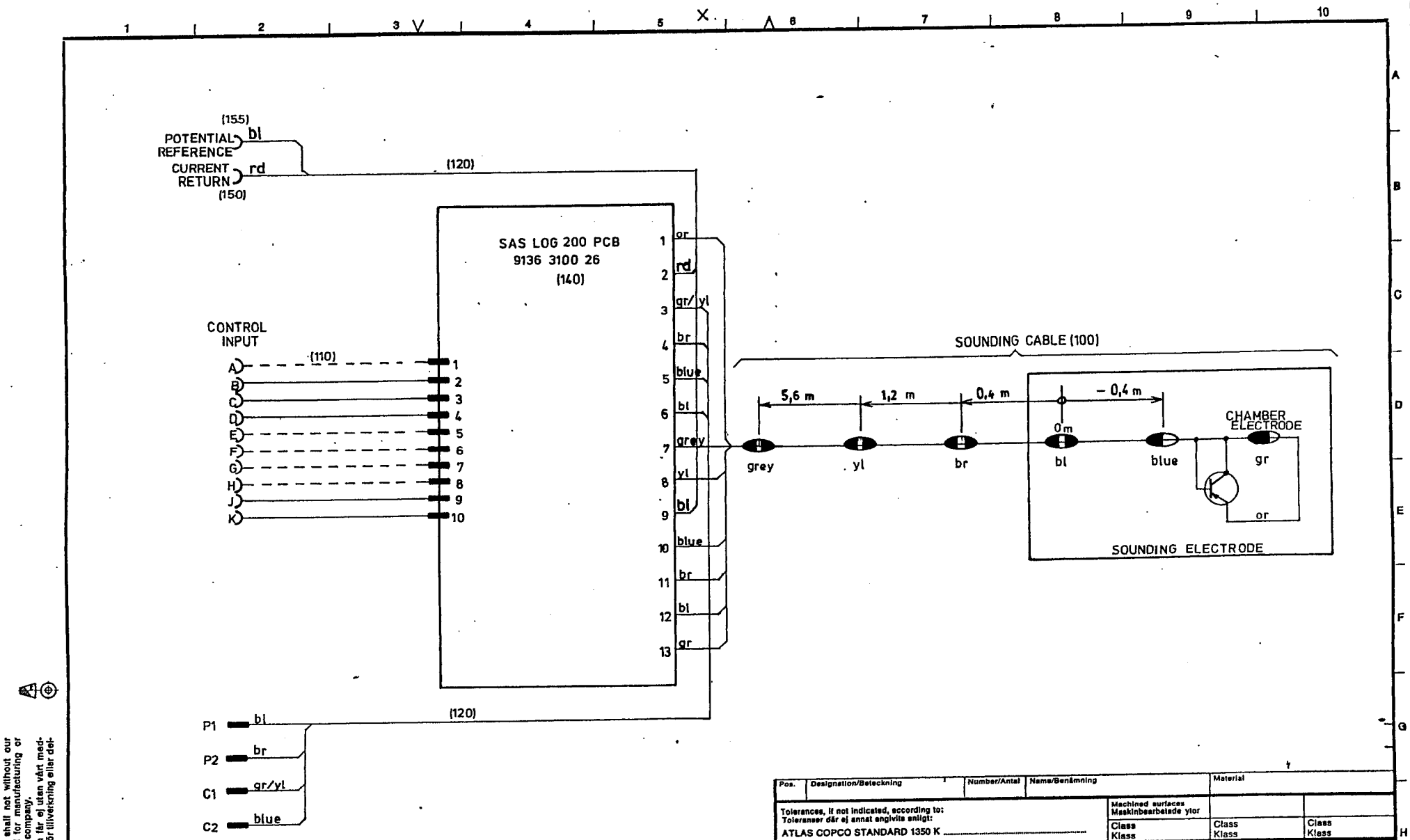
Pos.	Designation/Beteckning	Number/Antal	Name/Benämning	Material
	Tolerances, if not indicated, according to: Toleranser där ej annat angivits enligt: ATLAS COPCO STANDARD 1350 K		Machined surfaces Maskinbearbetade ytor	
			Class Klass	Class Klass / Class Klass
	Name/Benämning: SAS-LOG 200 PCB			
	Scale/Skala	Ref. no./Reg. nr	Compare/Jämför	
	Drawn/Ritad	Blank no./Ämnes nr	Replaces/Ersätter	Drawing owner/Ritn. ag.
	Std. chd./Norm gr.	Blank wt/Ämnesv. kg	Finished wt/Färdigv. kg	Designation/Beteckning: 9136 3100 26 B
	Transferred fr./Överförd fr.	Design chd./Konstr. gr.	Prod. chd./Prod. gr.	Appd./Godk. / Date

Note/Not	Position	Modified from/Ändrad från	Date/Datum	Intr./Inf.

Appurtenant drawings and documents/Tillhörande ritningar och dokument

A 2753a december 78 Barklunds, Sthlm.


185
130
160
175
265
360
340
310
270
240
300
290
295
140
155
160
330
315
320
340
225
370
350
230
255
250
260
120
110
9136 3100 26
210
190
200
150
215
220
170
205
145
Komponenttryck-& placering SAS LOG 200 PCB
ATLAS COPCO STANDARD 1350 K
9136 3100 26 B



Pos.	Designation/Beteckning	Number/Antal	Name/Benämning	Material

Tolerances, if not indicated, according to:
Toleranser där ej annat angivits enligt:
ATLAS COPCO STANDARD 1350 K

Machined surfaces
Maskinbearbetade ytor

Class / Klass | Class / Klass | Class / Klass

Name/Benämning: SAS LOG 200

Scale/Skala	Ref. no./Reg. nr	Compare/Jämför	
Drawn/Ritad: dul	Blank no./Ämnes nr	Replaces/Ersätter	Drawing owner/Ritn. ag.
Std. chd./ Norm. gr.	Blank wt/Ämnesv. kg	Finished wt/Färdigv. kg	Designation/Beteckning: 9133 0012 65 C
Design chd./ Konstr. gr.	Prod. chd./ Prod. gr.	Appd./ Godk.: dul Date:	Sheet/Blad ( )

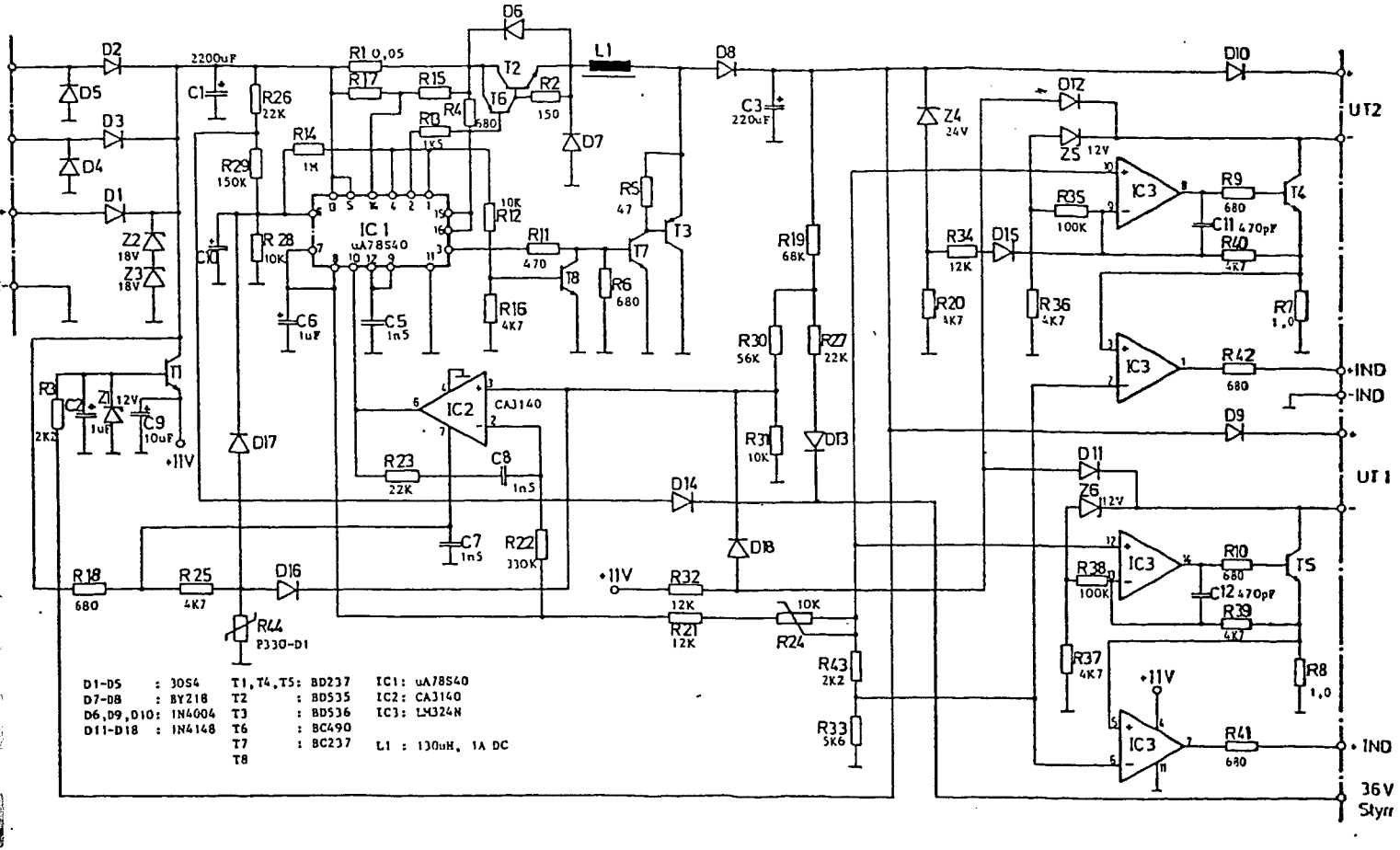
Transferred fr./Överförd fr.

Note/ Not	Position	Modified from/ Ändrad från	Date/ Datum	Intr./ Inf.
C		CORRECTED		

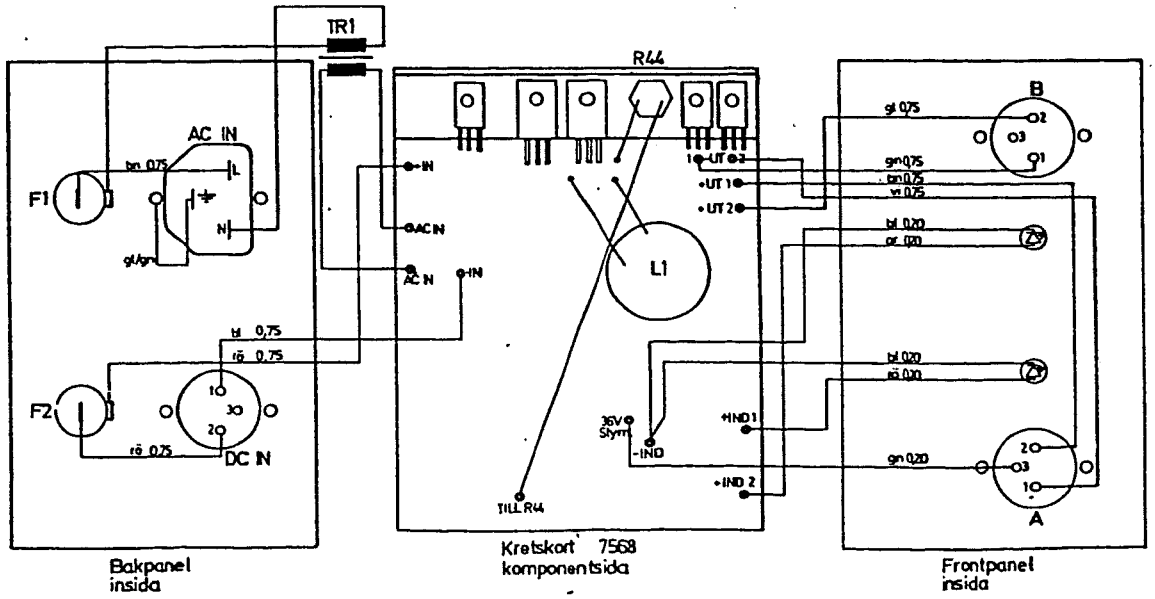
Appurtenant drawings and documents/ Tillhörande ritningar och dokument

A 2753a december 78 Barklunde, Sthlm.

77



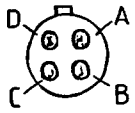
UBC Battery Charger PCB Circuit Diagram



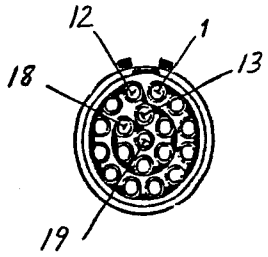
UBC Battery Charger Assembly Circuit Diagram

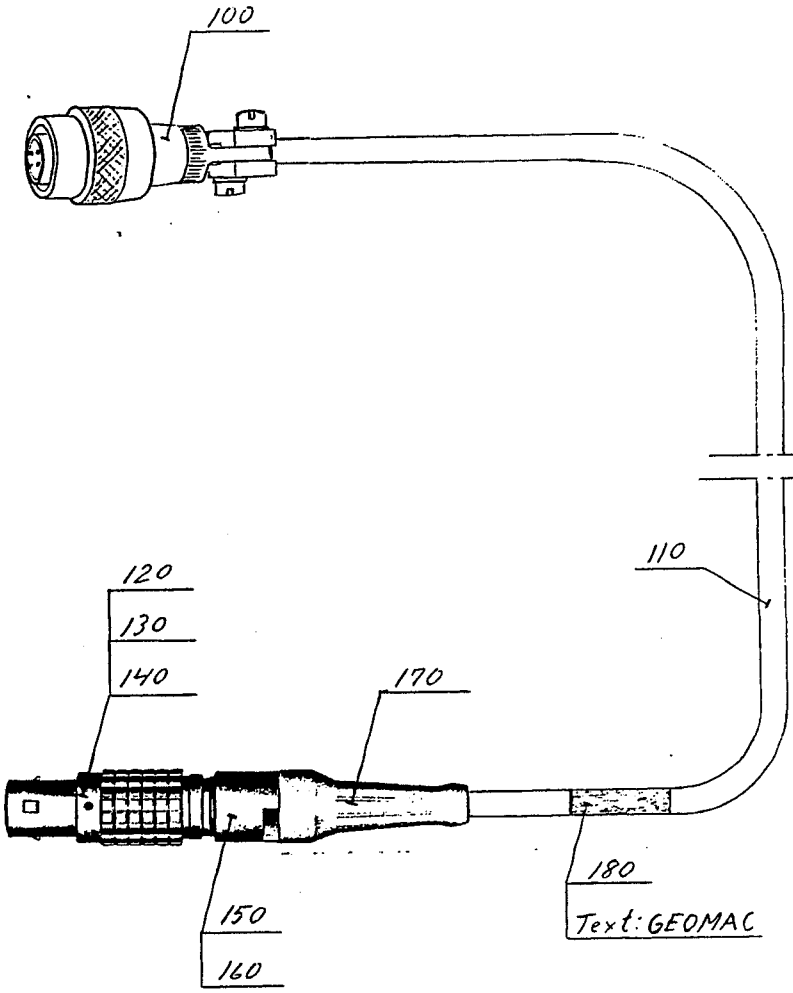
Front view

Socket



SAS 300 (100)		GEOMAC (120)
+12 V	A	
RS 232	B	3 RXD
REMOTE	C	7 PB4
GND	D	8 GND
		2 CTS
		13 RTS
		1 DCD
		12 DTR
		19 DSR





Pos.	Designation/Beteckning	Number/Antal	Name/Benämning	Material

Tolerances, if not indicated, according to: Toleranser där ej annat angivits enligt: STANDARD 1350 K

Machined surfaces Maskinbearbetade ytor: Class Klass | Class Klass | Class Klass

Name/Benämning: Cable SAS300-GEOMAC

2

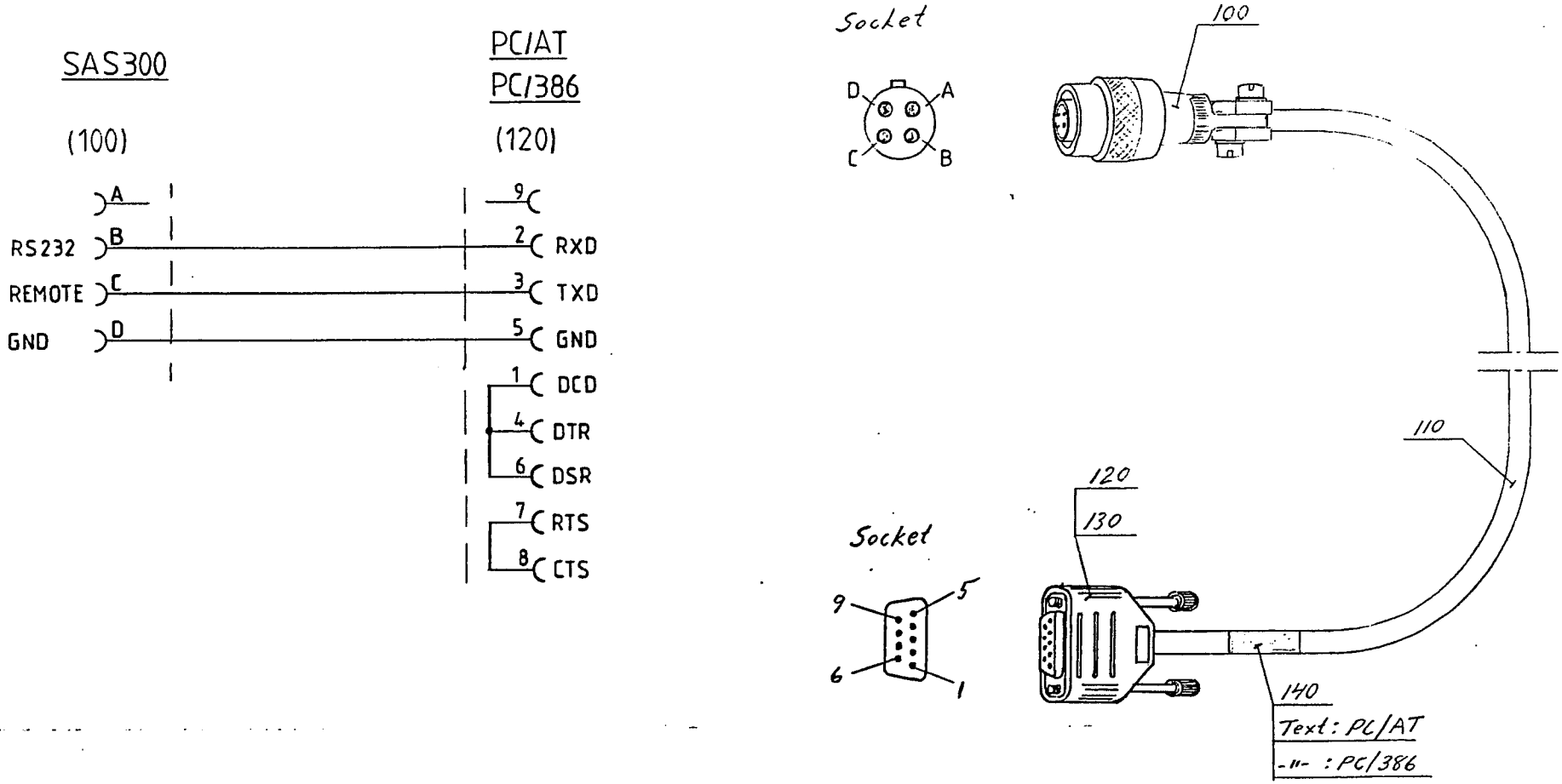
3: 9136 0001 83

Scale/Skala	Ref. no./Reg. nr	Compare/Jämför	
Drawn/Ritad SW.	Blank no./Ämnes nr	Replaces/Ersätter	Drawing owner/Ritn. äg.
Transferred fr./Överförd fr.	Std. chd./ Norm. gr.	Blank wt/Ämnesv. kg	Finished wt/Färdigv. kg
	Design chd./	Prod. chd./	Appd./ Date

Designation/Beteckning: 9130 0102 67 Sheet/Blad ( )

29

Front view



Pos.	Designation/Beteckning	Number/Antal	Name/Benämning	Material
Tolerances, if not indicated, according to: Toleranser där ej annat angivits enligt: STANDARD 1350 K			Machined surfaces Maskinbearbetade ytor	
			Class Klass	Class Klass
Name/Benämning	Cable SAS300 - PC/AT, PC/386			Class Klass
2				
3				9136 000184

	Scale/Skala	Ref. no./Reg. nr	Compare/Jämför	
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Transferred fr./Överförd fr.	Std. chd./ Norm. gr.	Blank wt/Ämnesv. kg	Finished wt/Färdigv. kg	Designation/Beteckning 9130 0102 68 Sheet/Blad ( )
	Design chd./ Konstr. gr.	Prod. chd./ Prod. gr.	Appd./ Godk. Date 89-09-22	

Note/ Not	Posi- tion	Modified from/ Ändrad från	Date/ Datum	Intr./ Inf

Appurtenant drawings and documents/ Tillhörande ritningar och dokument

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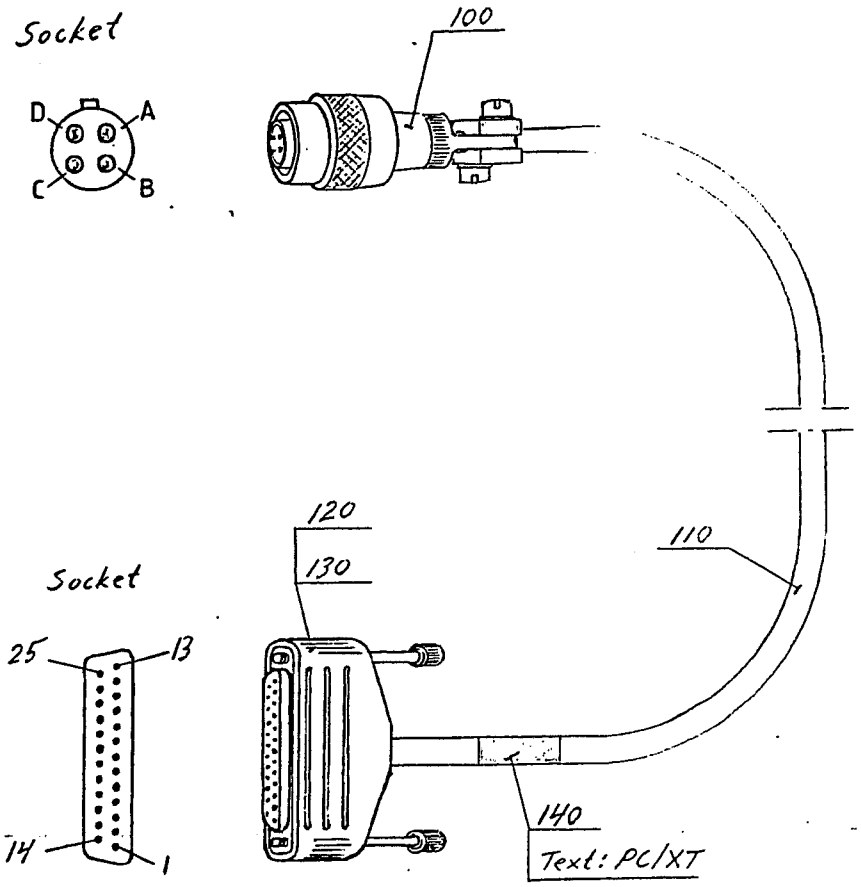
SAS 300 (100)		PC/XT (120)
	A	
RS232	B	3 RXD
REMOTE	C	2 TXD
GND	D	7 GND
		6 DSR
		8 DCD
		20 DTR
		4 RTS
		5 CTS

Front view



Pos.	Designation/Beteckning	Number/Antal	Name/Benämning	Material

Tolerances, if not indicated, according to: Toleranser där ej annat angivits enligt: STANDARD 1350 K

Machined surfaces Maskinbearbetade ytor: Class Klass | Class Klass | Class Klass

Name/Benämning: Cable SAS300 - PC/XT

2

3

9136 000185

Scale/Skala	Ref. no./Reg. nr	Compare/Jämför
Drawn/Ritad S.W.	Blank no./Ämnes nr	Replaces/Ersätter / Drawing owner/Ritn. ägare
Std. chd./ Norm. gr.	Blank wt/Ämnesv. kg	Finished wt/Färdigv. kg
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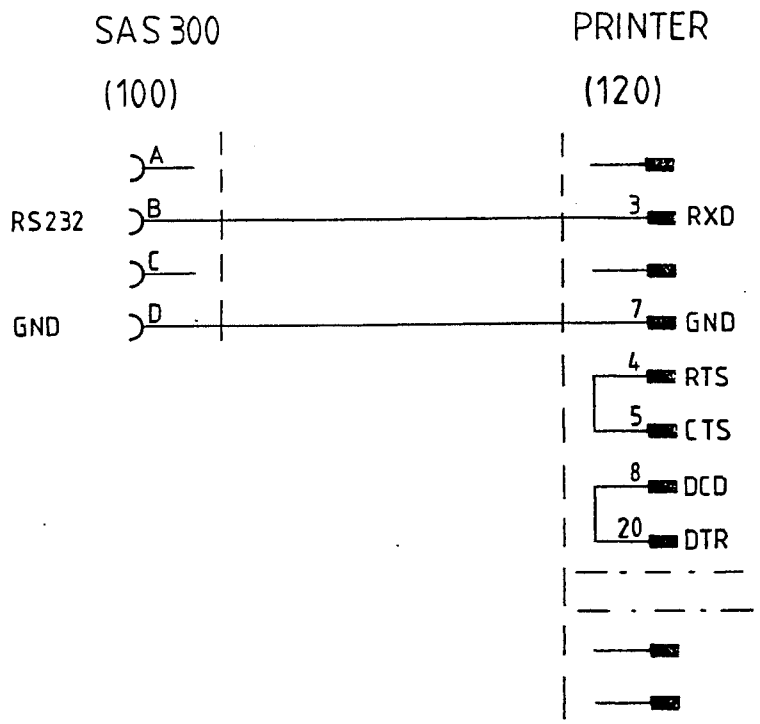
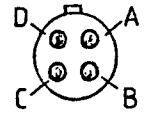
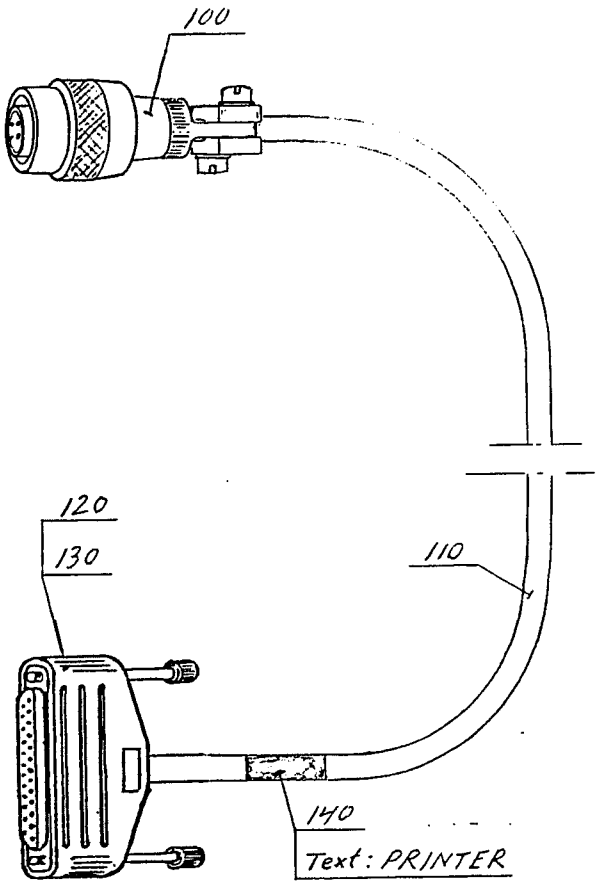
21



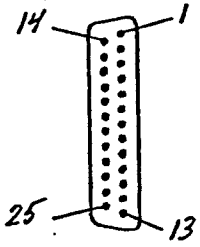
Front view

Socket





Pin



Pos.	Designation/Beteckning	Number/Antal	Name/Benämning	Material
Tolerances, if not indicated, according to: Toleranser där ej annat angivits enligt: ..ANDARD 1350 K			Machined surfaces Maskinbearbetade ytor	Class Klass
			Class Klass	Class Klass
Name/Benämning	Cable SAS300 - PRINTER			
2				
3				9136 0001 86

Scale/Skala	Ref. no./Reg. nr	Compare/Jämför
Drawn/Ritad S.W.	Blank no./Ämnes nr	Replaces/Ersätter / Drawing owner/Ritn. äg.
Transferred fr./Överförd fr. / Std. chd./ Norm. gr. / Blank wt/Ämnesv. kg / Finished wt/Färdigv. kg		Designation/Beteckning 9130 0102 70 Sheet/Blad ( )

22