DANFYSIK

ULTRASTAB 864U-2000
CURRENT TRANSDUCER

USER'S MANUAL

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M A N U A L

ULTRASTAB 864U

Current Transducer system

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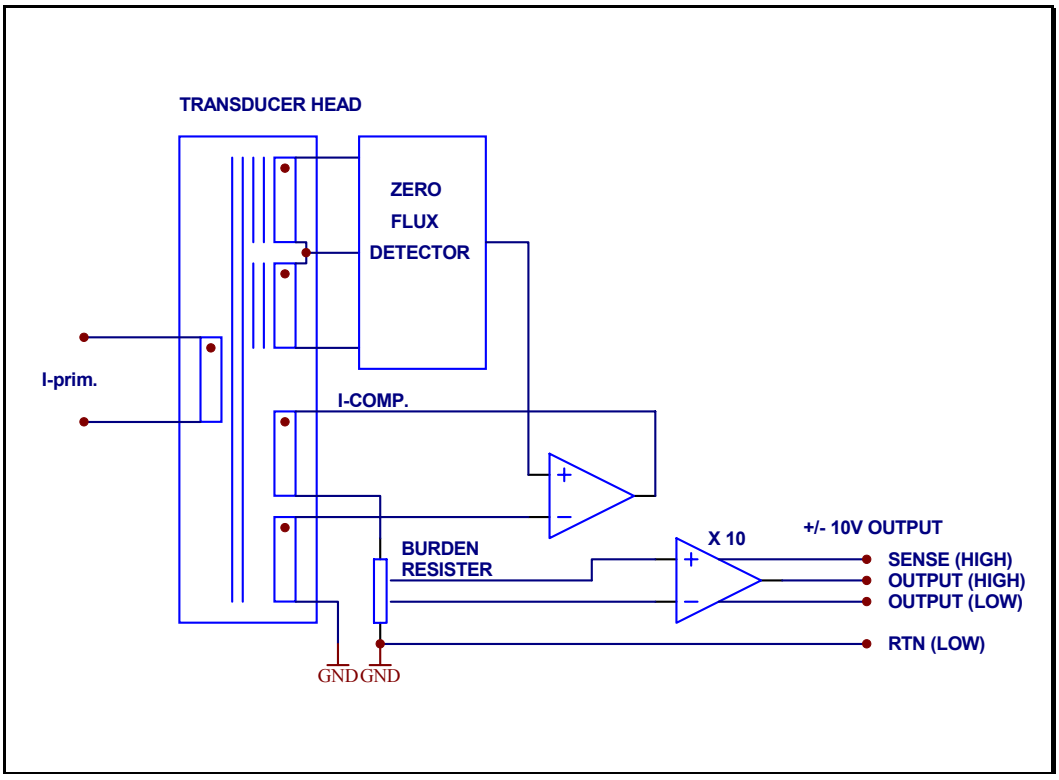
1.1 INTRODUCTION.

The ULTRASTAB 864U assembly is a current transducer, designed for precision current measurement.
The modular concept is prepared for installation in current controlled power supplies, gradient amplifiers or similar equipment.
It consists of an Electronics part mounted on a single EURO-CARD and a programable CURRENT TRANSDUCER HEAD, which can be programmed in steps of 125A from 1000A to 2000 A.

1.1.1 Working principle.

The ULTRASTAB 864U is a unique design based on the zero flux principle, for galvanically isolated current measurement.

With the primary current fed through the transducer centre hole and current flowing, the electronics will generate a current in the built-in compensation winding, counter-balancing the primary ampere turns.



A very sensitive detector circuit will detect, when zero flux is obtained, and an analog 0 to + - 10V signal will be generated at the output terminals in a direct 0 to 100 % proportion to the primary current.

1.3 **Warranty**

DANFYSIK A/S warrants the equipment delivered from the company to be free from any defects in materials and workmanship for a period of:

12 Months from the date of installation or max. 18 months from the date of shipment. Whichever is shortest.

Within this warranty period DANFYSIK A/S will repair or replace any defective parts free of charge either on the customers site or at our factory at our choice.

DANFYSIK A/S will pay or reimburse the lowest two way freight charges on any items returned to DANFYSIK A/S or our designated agent/representative provided prior written authorization for such return has been given by DANFYSIK A/S.

This warranty shall not apply to any equipment which our inspection shows to our satisfaction, to have become defective or unworkable due to mishandling, improper maintenance, incorrect use, or any other circumstances, not generally acceptable for equipment of a similar type.

DANFYSIK A/S reserves the right on standard products to make changes in design without incurring any obligation to modify previously manufactured units.

The foregoing is the full extent of the warranty and no other warranty is expressed or implied. If no event Danfysik shall be liable for special damage arising from the delivery, late delivery, or use of the equipment.

If any fault develops the following steps should be taken:

Notify DANFYSIK A/S giving full details of the problems and include Model, Type, Serial number, and Order number.

On receipt of this information DANFYSIK A/S will send you either service information or instructions for shipping.

All shipments of DANFYSIK A/S equipment should be made according to our instructions and shipped in the original or a similar package.
For smaller parts a cardboard carton will be sufficient, providing the parts are wrapped in plastic or paper and surrounded with at least 10 centimetres of shock-absorbing material.

2. RECEIVING AND UNPACKING.

2.1. RECEIVING THE GOODS

The shipping package and the ULTRASTAB should be thoroughly inspected for signs of obvious physical damage immediately upon receipt.
All materials in the package should be checked against the enclosed packing list and the list of standard delivery below. DANFYSIK A/S will not be responsible for any shortages unless notified immediately.

ULTRASTAB 864U. Standard Delivery:

- Electronics part on Eurocard.
- Transducer head with connection cable and plug.
- Manual.

2.2. INSTRUCTIONS FOR UNPACKING

The ULTRASTAB is shipped in a cardboard carton.

If the equipment is damaged in any way, a claim should be filed with the shipping agent, and a full report of the damage should be forwarded to Danfysik A/S or our local agent/representative immediately.
Upon receipt of this report, you will be issued instructions for the repair, replacement or return shipment.
Please include the Type No., Serial No., and Order No. for the ULTRASTAB on any communication with DANFYSIK or our representative.

3.1 INSTALLATION

1.Check that the specified DC voltages and currents are available, and the ambient temperature is within the recommended range.
Please refer to wiring diagram 88400 and the specification sheets in this manual.

2.Install the electronics Eurocard in a crate in vertical position with a 64 pin socket connector, (Plug P1).

3.Plug P1, (64 pin).
Establish connections for supply voltages and output signals to the plug.
It is recommendable to fuse all supply connections.

4. Plug P2, (25 pin sub D).
Connect the Transducer Head to the Eurocard via plug/socket P2.
(all terminals on plug P2 are also present on plug P1. I.e., if so preferred, the transducer head connection cable can be soldered to the socket of P1.)
It is extremely important that this cable is mechanically secured with the two connector screws.
Standard cable length is 2.5 metre.
The transducer head may be installed in any orientation, but be careful to keep it away from power transformers, and other units producing magnetic stray fields.

5.The output signal is present on plug P1 at terminals 17 / 18 / 19 / 20.
Please note, the four wire connections for optimum performance in the following section.
Please also note, that it is recommendable to use a short cable for the output voltage.
(Capacitive load less than 3 nF).

6. The system can now be used, i.e. the current to be measured can be switched on. Please see section 4.1.

3.2 INTERLOCK CIRCUIT

The interlock circuit is present at plug P1 at the terminals No. AC30, 31, and 32. The terminals are floating contacts from a relay.
The contacts can be used in the general safety interlock circuit of e.g. a power supply.

ULTRASTAB 864U.

P1 Card connector.

Please see diagram no. 88400 for Card connections.

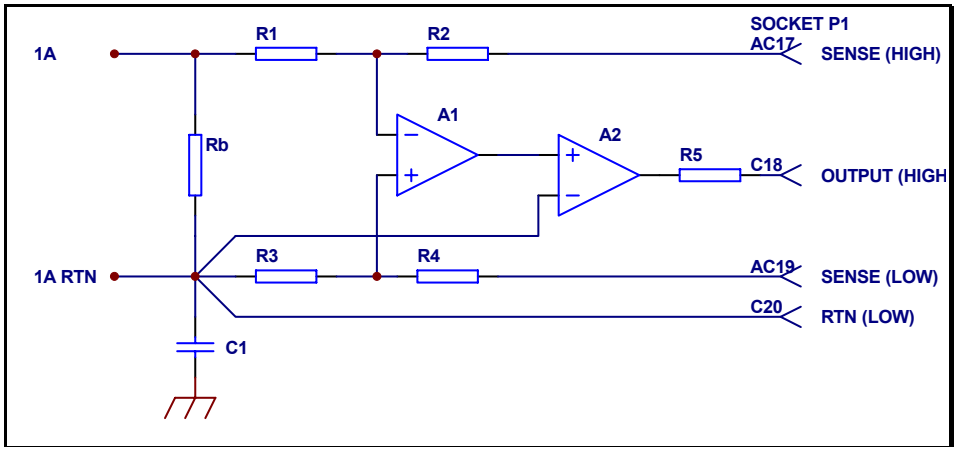
AC 1 (NC).
AC 2 + 15 V, 1.3 A.
AC 3 (NC).
AC 4 BURDEN RESISTOR 0.
AC 5 (BURDEN RESISTOR 0).
AC 6 - 15V, 1.3 A.
AC 7 (NC).
AC 8 BURDEN RESISTOR +
AC 9 (NC).
AC 10 (NC).
AC 11 (NC).
AC 12 0
AC 13 (NC).
AC 14 (NC).
AC 15 (NC).
A 16 +15 V
C 16 - 15 V
AC 17 Output - signal sense
AC 18 Output - signal
AC 19 Output - RTN sense
AC 20 Output - RTN
AC 21 (Compensation winding).
AC 22 (Feed back winding).
AC 23 (Compensation winding).
AC 24 (Feed back winding).
A 25 (Jumper connection for type 2000 A head).
C 25 (Jumper connection for type 2000 A head).
AC 26 (Cable check - missing cable).
A 27 (Detector winding).
C 27 (Detector winding).
AC 28 (Detector winding).
AC 29 (Detector winding).
AC 30 NC - Interlock relay.
AC 31 NO - Interlock relay.
AC 32 N - Interlock relay.

ULTRASTAB 864U.

P2 (D - SUB25) Transducer head connections only.

1 Shield (Compensation winding).
2 Feed back winding.
3 Compensation winding.
4 (For optional fine control).
5 (For optional fine control).
6 (NC).
7 (NC).
8 R24
9 +15V
10 (NC).
11 Cable check - missing cable.
12 Detector winding.
13 Detector winding.
14 Feed back winding.
15 Compensation winding.
16 (NC).
17 (NC).
18 (NC).
19 (NC).
20 (NC).
21 (NC).
22 (NC).
23 Detector winding.
24 Detector winding.
25 Shield - Detector winding.

3.3 The four Terminal Output Signal Connections



In order to obtain the highest performance from the *ULTRASTAB 864U* the output circuitry is designed as a 4 terminal system.

The figure shows the output amplifier (simplified) used in the *ULTRASTAB* electronics module.

The voltage across Rb at full input current is 1 V. The amplifiers A1 and A2 are connected as a differential amplifier system with a gain of 10 determined by the ratio R2/R1 = R4/R3 = 10.

A2 is connected to have a gain of 10 so that the low noise amplifier A1 will have a gain of 1 and consequently will have its full bandwidth.

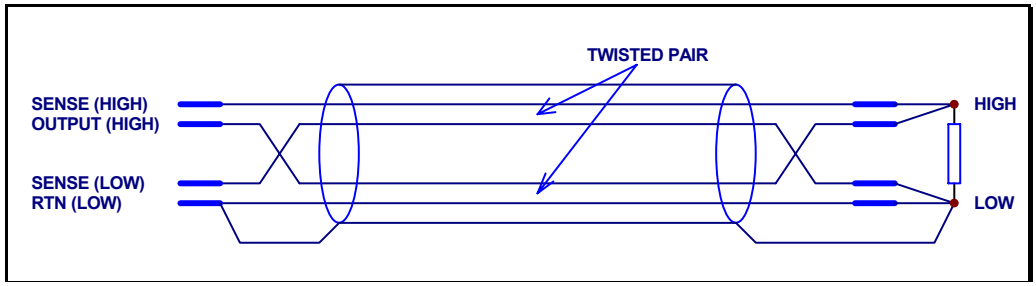
Output Connections in General

When a load is connected to the output terminals a current will flow resulting in a voltage drop in the cable and across the contact resistance in the connector. In order to, prevent this from altering the calibration a four terminal solution is used.

The resistors R2 and R4 are connected to the "sense terminals" allowing the load current to have any value between zero and 5 mA without violating the calibration accuracy. The absolute calibration of the *ULTRASTAB* is made with the sense terminals HI: P1 pin AC17 and LO : P1 pin AC19 connected to the corresponding output terminals HI: pin C19 and LO: pin C20.

Output Connections with Cable and low Impedance Load

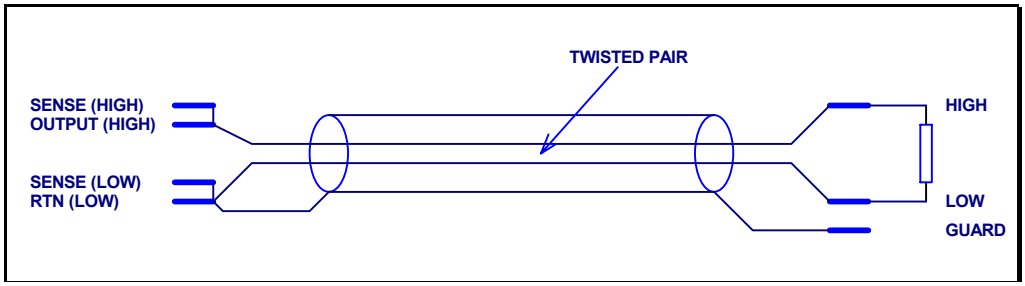
In the case where a cable is needed between a low impedance load and the *ULTRASTAB* one twisted pair should be used for Hi and Lo, and another pair for the sense wires with the screen connected as shown. The resistance in the sense wires will act as an increment of R2 and R4 and consequently the calibration will be changed.



As an example a wire, 2.3 metres long with a cross section of 0.5 square mm will have a resistance of 87 mΩ. This will alter R2 by 0.087 / 10.000 = 8.7 ppm.
R3 and R4 have the effect of reducing the influence of common mode currents running between the *ULTRASTAB* and the load.
The common mode rejection is about equal to the relative accuracy of R2 = R4 and R1 = R3. The common mode rejection ratio is about 60 dB or x 1000.

Output Connection with Cable and high Impedance Load

In the case , where a high impedance battery powered DVM or a differential amplifier is used, it is recommended to connect the sense wires to the outputs on the external P4 connector, and run a HI and a LO wire as twisted pair with common screen.



General Limits and Noise

The output amplifier has a cut off frequency of about 60 MHZ., and it is sensitive to excessive capacitive loading (> 3 nF).
This is another reason for using the shortest possible cable and it is mandatory that the LO terminal is connected to the LO input of the load unless it is a differential amplifier. The reason for this is that the capacitance (C1) in the mains transformer in the *ULTRASTAB* as well as the one in the load circuitry can form a common code loop through the ground and in this way introduce noise.

4.1 SWITCHING ON AND OPERATING INSTRUCTIONS

When the instructions for installation in pos. 3.1 have been completed, the ULTRASTAB electronics can be switched ON.

Please note:
This unit must be switched on before the actual primary current source is applied, in order to avoid excessive saturation of the iron core in the transducer head.

1. Switch ON the DC power.
   The Green LED - NORMAL OPERATION on the PC board will be "ON"

2 The total assembly is in NORMAL OPERATION, and an analog voltage proportional to the measured current will be generated by the electronics circuitry at the output terminals.

   NORMAL OPERATION means: Cable connected, measured current within 115 % of selected maximum current.

3. The system can now be used. Highest performance is not reached until it has been ON for at least two hours.

4. If the Green LED,- NORMAL OPERATION is not "ON", recheck that all connections are properly made and secured by the screws.

5. If any problem should occur during this operation, please read Section 5 of this manual: General description of the Electronics, or contact our local representative or Danfysik direct.

6. All performance data refers to max. current for the type 2000A transducer head.
   In order to obtain maximum accuracy of the instrument, lower currents can be measured by applying more primary turns through the transducer head and divide the output signal with the number of turns.
   For high sensitivity measurements it is important to distribute the turns with even space all around on the transducer head.

7. The offset adjustment is carried out with the potentiometer R48.

RECOMMENDATION

To obtain maximum performance always switch ON control power **before** applying the current which shall be measured through the transducer head.
Nothing will be damaged if this sequence is not followed but the saturation effect may cause a drift in the offset.

5.1 GENERAL DESCRIPTION OF THE ELECTRONICS

The ULTRASTAB 864U electronics is mounted on an Eurocard.

The circuit board is equipped with two connectors:

The rear end has connector P1 for power supply, analog output current, ground connection and an optional connections to the transducer head.
The front end has connector P2 for the transducer cable, providing connections between the electronics and the transducer head.
Please refer to schematic No. 88434 and circuit board assembly drawing No. 88123.

The circuit receives signals from the zero flux detector and drives the compensation current in such a way that the secondary ampere turns of the transducer head counter-balances the primary ampere turns. At the same time the voltage across the secondary winding is kept to a minimum - I. e. it approaches the ideal current transformer.

5.2 THE EUROCARD CIRCUIT BOARD ASSY

The module contains circuits for:

A. Low voltage power supply.
B. Zero flux detector.
C. Compensation current circuit.
D. Output amplifier with burden resistor
E. Interlock circuit.

A. Low voltage power supply.

The low voltage power supply is shown in the upper left corner of the schematic No. 884xx.
The zero flux detector is powered through the voltage regulator IC 10.

B. Zero flux detector.

The zero flux detector is detecting, and via a feed back circuitry controlling that the flux in the transducer head is brought to zero.
In this situation the compensating current in the transducer head is directly proportional to the primary current via the transfer ratio of the turns.
A free running oscillator is driving the detector circuit.
The oscillator operation can be checked at test point TP 6.

C. Compensation current circuit.

The compensating current circuit is controlled from the zeroflux detector. The amplifiers involved are IC 5, IC 6 and IC 8.

D. Output amplifier with burden resistor.

Please refer to schematic 88074.
This circuit bord converts the nominal 0 to 1A secondary current to a corresponding 0 to 10V. Output voltage.
It is mounted on a heatsink and connected to the eurocard via a dual flexstrip.

E. Interlock circuit.

When the compensating winding cannot cancel the ampere turns of the primary current, the zero detector windings will saturate and the magnetizing currents will go to a high value.
The voltage on TP 4 being the average of the two driver outputs will go low. This is detected by IC 7 A driving the LED "Normal" and the relay RL 1 off.

The relay contacts are available for an external interlock system. At the same time IC 4 B switches the connection to the output amplifier from the ZERODETECTOR to the bistable circuit IC7 B.

The compensation amplifier IC 8 now starts sweeping the compensating current. In case the primary current is below say half its maximum rated value, the compensating current will at some time cancel the primary ampere turns.

The cores will now be desaturated and the circuit will "lock in".
The interlock circuit receives an AC signal from the ZERODETECTOR driver via a jumper in the transducer head. This signal is rectified and it drives Q 3 which is part of the interlock chain.
In this way both a missing driving signal and a missing cable connection are detected.

5.3 CURRENT TRANSDUCER HEADS

Please see drawing 88001.
The transducer head has an Aarrow sticker@ on the side face. With the main current flowing in the direction of the arrow, a negative voltage will be developed across an external Burden resistor.
(In the case, that the 864I Eurocard electronics is delivered with a +/- 10V output module, and then named 864U- the output voltage will be positive with the current flowing in the direction of the arrow.).
The transducer heads can be mounted in any orientation, and the influence from external stray fields is low.
The transducer head contains fragile materials in the zero detector assembly, and care should be taken in handling.
The electronics is factory adjusted to the transducer head for zero offset, i.e. optimum performance.
If readjustment of the zero offset is necessary, resistor R 48 shall be adjusted with zero primary current through the transducer head.
Please refer to R 48 and schematic 88434.

6.0 MAINTENANCE

The ULTRASTAB 864U assembly does not require any maintenance under normal operation.
If faults should occur, please refer to schematic No.88434 and the Theory of Operation section in this manual.
The schematic contains information about voltage levels, at the test points (TP..).

Please note:

Faults within the calibrated components and the zero flux detector can only be repaired by returning the ULTRASTAB 864u assembly to Danfysik A/S or our local representative.
Failure to do this will make the warranty null and void.

APPENDIX C. - SALES REPRESENTATIVE AND SERVICE.

DANFYSIK A/S,
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JAPAN
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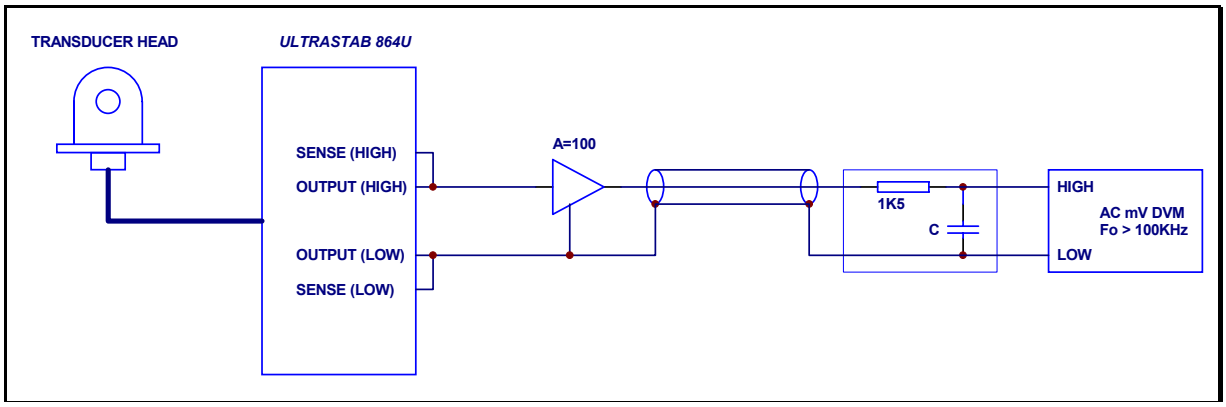
Fax No.:(3) 5644 7627

APPENDIX D - TEST AND CALIBRATION OF ULTRASTAB

D.1Noise Measurements on *ULTRASTAB 864U*

All *ULTRASTAB 864*U electronic units are tested for noise figures before leaving the factory.

This Appendix D.1 describes the method used in details, and can be used for rechecking the instruments in the field.



The filtering technique can also be used to limit the bandwidth of the *864U* in applications, where a more narrow bandwidth is acceptable and a lower noise figure is desirable.

An amplifier with a gain of 100 and a bandwidth exceeding 1 MHZ is connected directly to the P4 terminals of the *ULTRASTAB* unit to be tested (please see fig. in section 4.4 case B).

A coaxial cable connects the output of the amplifier with the input of a single pole low pass filter mounted on the terminals of the digital voltmeter (DVM).

The capacitor C is selectable so that cut off frequencies form 10 Hz to 100 kHz can be selected in decade steps.
The voltmeter used is a FLUKE DVM measuring AC RMS. Set in the 200 mV range this gives 1 ppm/mV referred to the 10 V output from the *ULTRASTAB* unit.

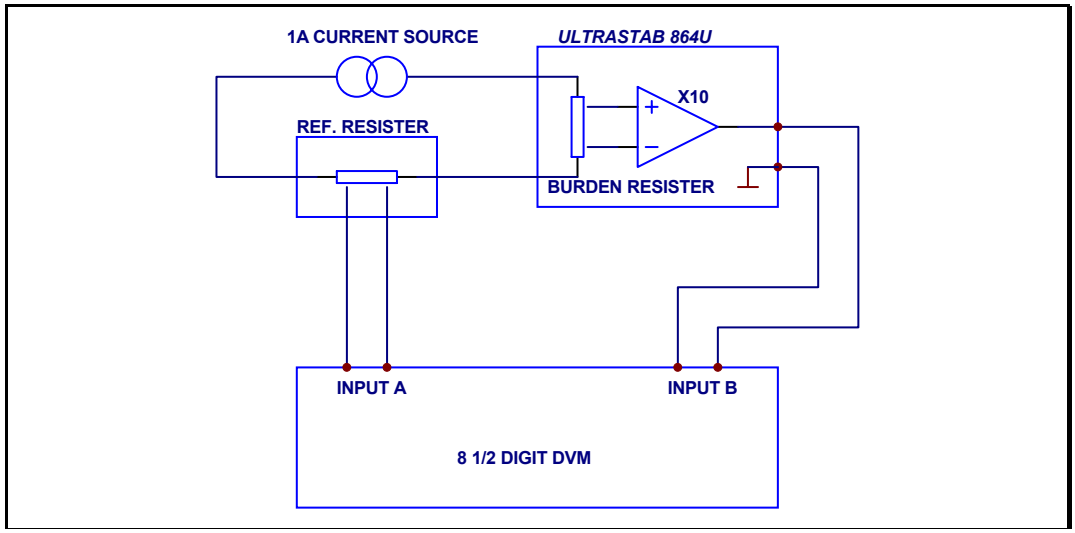
The table shows measurements for 2 selected heads and it is seen that the values are closely proportional to the square root of the frequency band used. This compares well with the situation of amplifiers.

Average Figures measured on *ULTRASTAB 864U*

Filter cut off Frequency.C	Capacitor	1000A	2000A head
10 Hz.	10 uF.	0.08 ppm.	0.06 ppm.
100 Hz.	1 uF.	0.3 ppm.	0.9 ppm.
1 kHz	100 nF.	0.6 ppm.	2.0 ppm.
10 kHz.	10 nF.	3.3 ppm.	14.0 ppm.
50 kHz.	2 nF.	7.4 ppm	7.3 ppm

D.2 ULTRASTAB 864U - Absolute calibration and Offset adjustment

All *ULTRASTAB 864U* assemblies are absolute calibrated before leaving the factory.
The class of DVM and precision shunt needed for the purpose is rather high and it is



recommended to send the *ULTRASTAB* assembly direct back to DANFYSIK or to our local sales representative in the case, where re-calibration is needed.

The figure shows the set up used for the absolute calibration of the *ULTRASTAB 864U*.
The Reference Resistor is temperature stabilized in a oilbath. The 8 2 digit DVM DATRON type 1281 has two input ports which measures the voltage across the Reference resistor and the voltage output from the *ULTRASTAB 864U*
The calibration of as well the standard resistor as the voltmeter at DANFYSIK are traceable to National and International Standard Laboratories.

The calibration is basically a calibration of the current to voltage converter circuitry in which a +-1A (compensation) current is converted to a +-10V analog output voltage via a Burden resistor and a x10 amplifier.

The current conversion in the transducer head has a fixed (not variable) transfer ratio, which can not change during actual service. The transfer ratio of the transducer heads is tested during production of the individual heads where the no of turns is controlled to be absolute precise, ie the winding tolerance is +-0.

Check of Calibration.

Before actual check of calibration can start the 864U must warm up for at least 1 hour.
Please note that the transducer head is not connected during the calibration check..

Offset of the output amplifier.
The analog output voltage shall be below +-0.00001V, measured on the output socket at the rear side of the cabinet .If adjustment is necessary trimmer R8 on the output amplifier board shall be used.

Gain measurement of the Output Amplifier.
Via the socket P1 a +-1A is applied from an external source. The output voltage is measured on P1 socket. The voltage shall be +-10V within +- 500 microV.

D3. Offset adjustment.

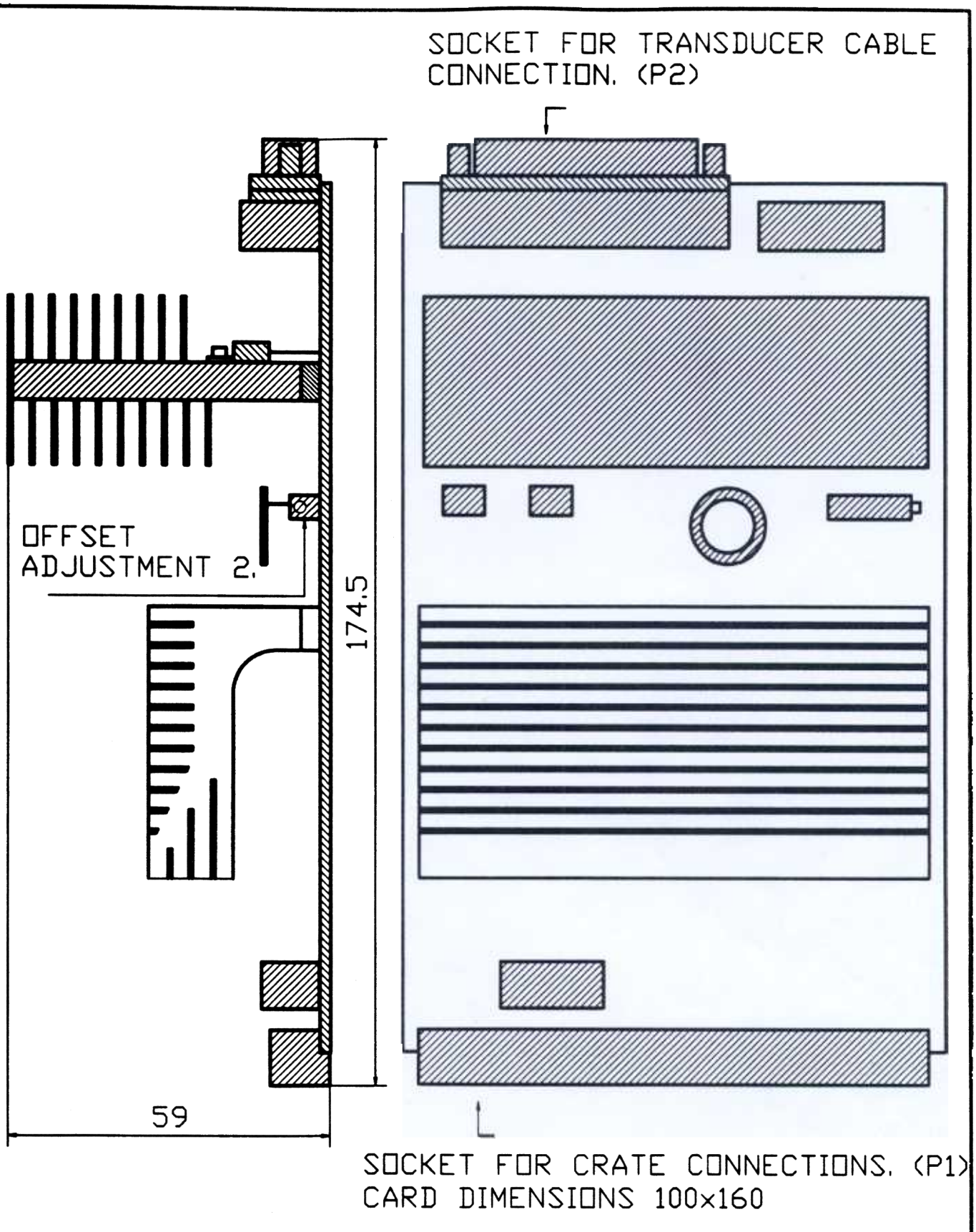
1.Switch on the 864U for 1 hours heating up and stabilization. (During initial adjustment the electronic unit is switched on for one week burn in period before any adjustment is started).

2.The adjustment shall be carried out at normal operation temperature.

3.A high precision DVM (8 2 Digit Datron) is used during the zero offset calibration work. The DVM is connected to the analog output.

4.First offset adjustment step is carried out with no transducer head connected. Potentiometer R8 on the output amplifier board is adjusted until the DVM shows <5µV.

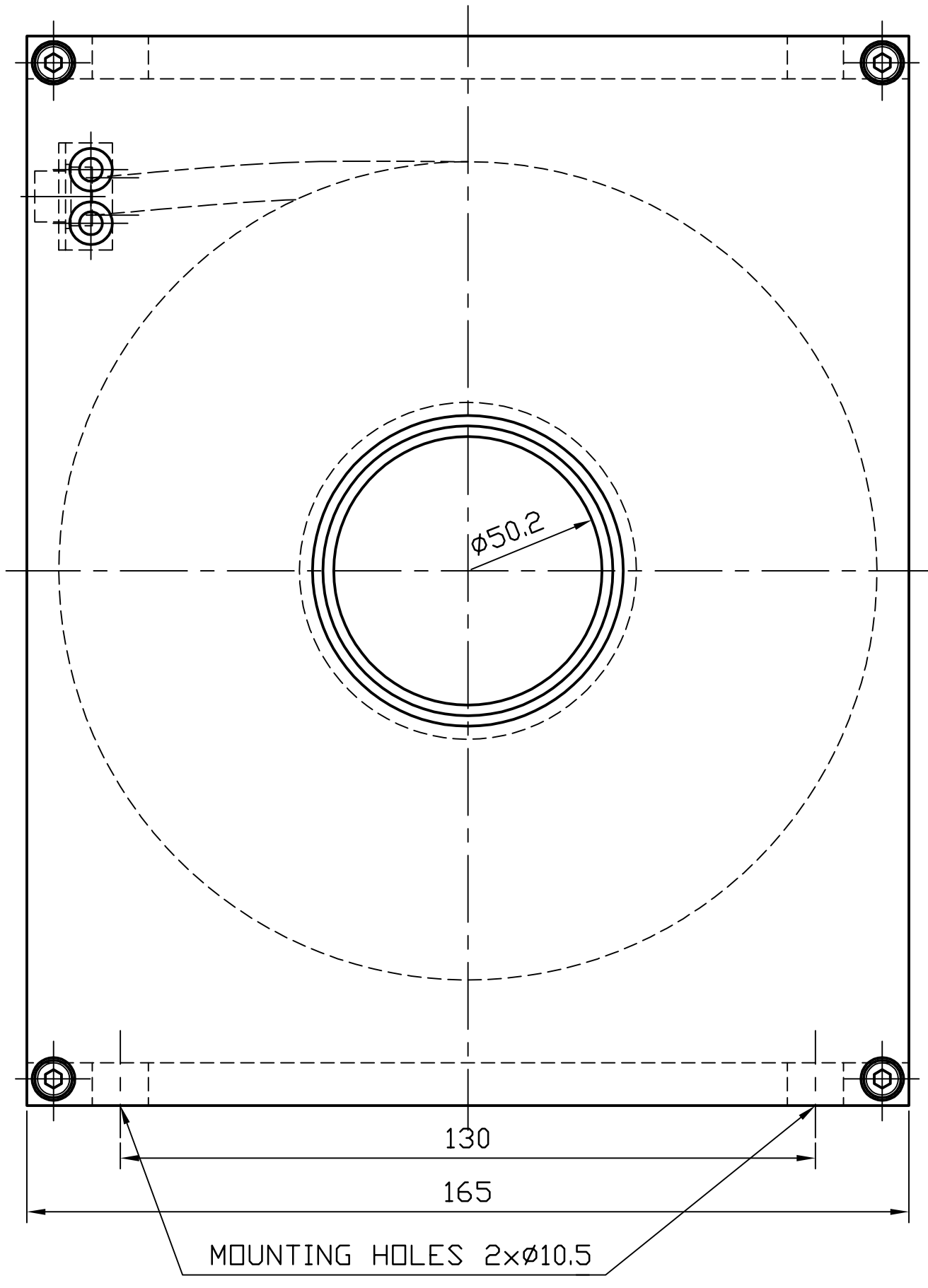
5.Next offset adjustment step is carried out with the transducer head connected. Potentiometer "OFFSET ADJ" on the eurocard is adjusted until DVM shows <5µV).

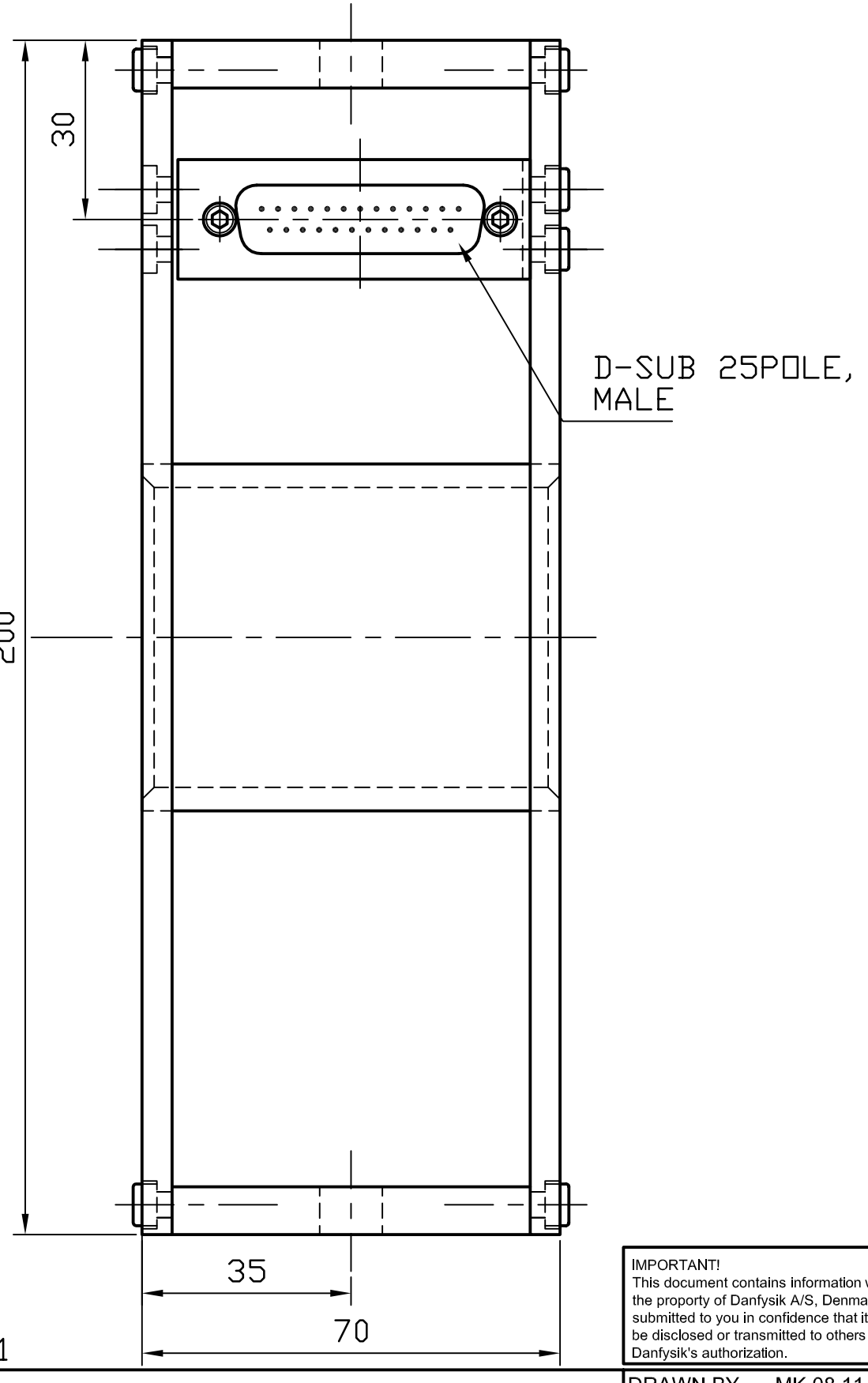


REV.:	MATERIAL:
MACHINING:	SURF. TREATMENT:
TOLERANCE:	DRAWN BY KP 03.06.97
SCALE: 1:1 (A4)	DESIGN APP. 4/6-97 PHC
	PROD.APP. 4/6-97 JB
	PROJ.ENGR.
	SUPERSEDING
DANFYSIK JYLLINGE DENMARK	DWG: 88398
CUSTM. ORDER NO.:	SUPERSEDED BY

ELECTRONICS ASSEMBLY ON EUROCARD ULTRASTAB 864U

FIRST ANGLE PROJECTION





SCALE 1:1

WEIGHT APP. 3.5Kg

FIRST ANGLE PROJECTION

TRANSDUCER HEAD
PROGRAMMABLE
TYPE 2000-1
ULTRASTAB 860/864

DRAWN BY	MK 08.11.00
DESIGN APP.	.
PROD.APP.	.
PROJ.ENGR.	PHC
DWG.NO.:	88737A

DANFYSIK

CUSTOMER: .	PROJECT NO. .	REVISION: A	SHEET 1 OF 1
FILE: .		DATE: MK 10.10.02	SIZE: A3

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