M A N U A L
ULTRASTAB 860R
Current Transducer

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1. SAFETY

1.1 Usage precautions and recommendations

The following precautions are recommended to insure your safety and to provide the best conditions of this instrument. If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

1.2 Terms and symbols

These terms and symbols may appear in this manual or on the product.

	**WARNING**: warning statements identify condition or practices that could result in injury or loss of life.
	**CAUTION**: Caution statement indentify conditions or practices that could result in damage to the product.
	**DANGER**: High Voltages
	Protective Conductor Terminal

1.3 AC Power input

AC power input should be within the range of the selected line voltages +/-10%.

To avoid electrical shock, the power cord protective grounding conductor must be connected to earth ground.

1.4 Fuse

The unit is delivered with a T1A fuse. For continued fire protection, replace the fuse with the specified type and rating only.

To replace the fuse disconnect the mains cord. Open the cover of the AC socket with a flat screwdriver. Pull out the fuse holder and replace the fuse.

2. INTRODUCTION AND SPECIFICATIONS

2.1 Introduction

The Danfysik *ULTRASTAB 860R* current transducer program is a unique design based on a zero flux principle for current measurement in the ranges 0 to 600 Amp and 0 to 2000 Amp.

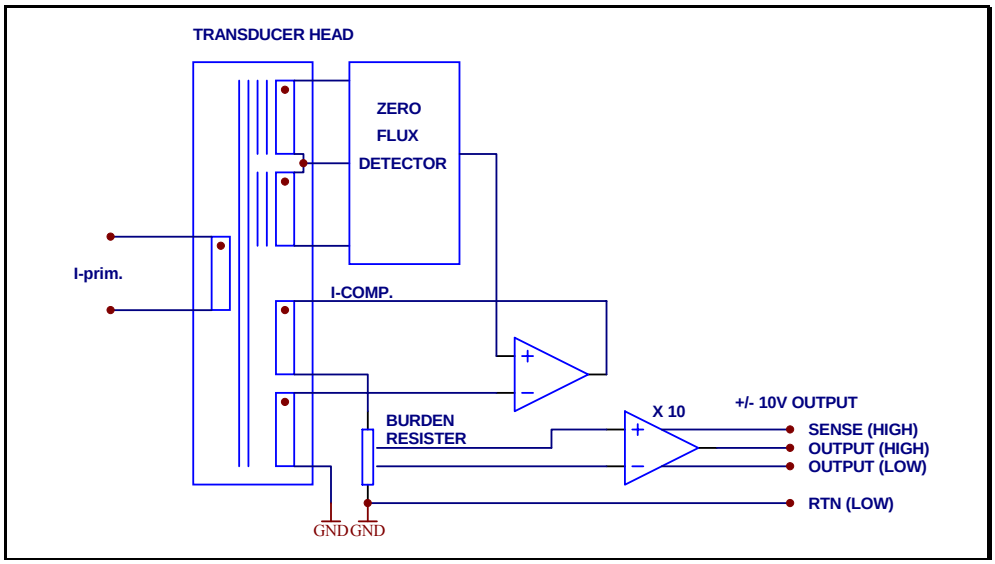
The *ULTRASTAB 860R* is designed for precision current measurement and for use as current feedback element in current stabilized power supplies, where high performance is required. A very low temperature coefficient, combined with high resolution and a very wide frequency band are the unique data for *ULTRASTAB 860R*.

2.1.1 Working Principle

With the primary current conductor 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 ±10 Volts signal will be generated at the output terminals in a direct 0 to 100 % proportion to the primary current.

The 860R electronics module can drive either a type 600 Amp or a type 2000 Amp transducer head.

The transducer heads have a separate winding, which can be used for current summing, eg when used together with a NMR Teslameter for field stabilization.



2.2 **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.

3. RECEIVING AND UNPACKING

3.1 Receiving the Goods

The shipping package and the *ULTRASTAB* should be throughly inspected for signs of obvious 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 860R. Standard Delivery:

- Electronics
- Transducer Head
- Programming plug
- Connection cable with plugs
- Mating cable plug for FINE CONTROL INPUT
- Mating cable plug for ANALOG OUTPUT
- Mating cable plug for INTERLOCK
- AC power cord
- 2 Spare fuses
- 2 terminals for test leads
- Manual

3.2 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 Model No., Type No., Serial No., and Order No. for the *ULTRASTAB* on any communication with DANFYSIK or our representative.

3.3 Mounting requirements

The ULTRASTAB 860R must be mounted horizontally and with free air passage in front and behind the unit. This ensures proper cooling of the instrument during use.

3.4 Installation

1. Check that the mains voltage and frequency matches to the local requirements. If not, the proper voltage on the selector wheel, 100, 115, 215, 230 Volt AC must be selected to match the line voltage before switching the instrument on.

2. Establish the Ground connection according to the local authority regulations and the requirements of the equipment.

3. Mount the provided connection cable between the ULTRASTAB 860R and the Transducer Head

4. Connect the output terminals on the rear socket as described in section 4.2

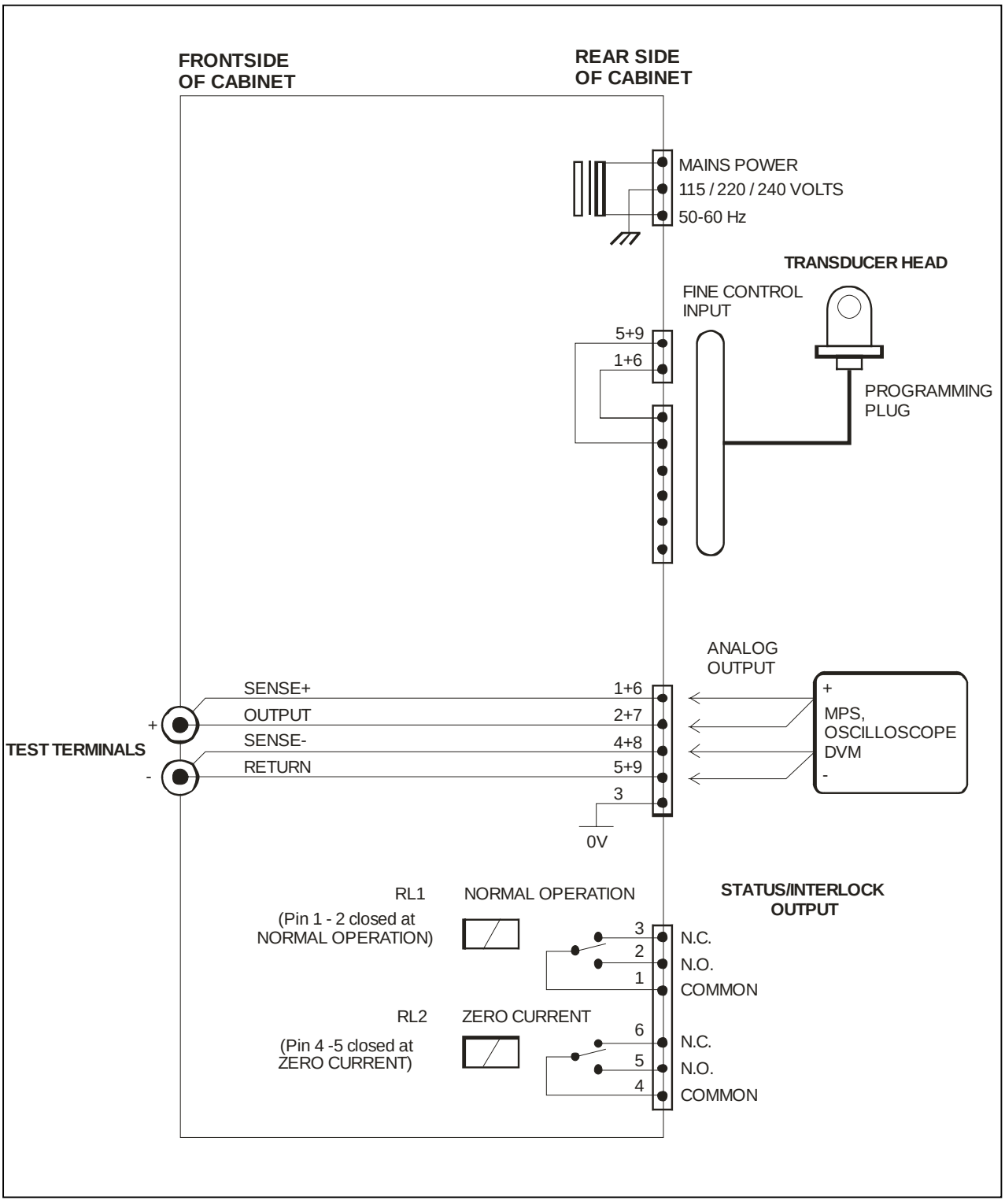
5. Check that all cables terminated in a plug are pushed fully home.

The transducer head and electronics can be installed 2.5 metre (optional 30 metres) cable distance from each other. The transducer head may be installed in any orientation.

The electronics is fully self-contained concerning power requirements and has connection on the rear panel for:

1. Transducer head
2. Analog fine control input
3. General failure interlock with floating contacts for:
   Saturation
   Internal PS failure
   Cable disconnected
4. Contact function for Zero Current (±0.1 %)

Please see next page showing: **"Connections to Electronics Unit"**.



ULTRASTAB 860R

CONNECTIONS TO ELECTRONIC UNIT
ULTRASTAB 860R

4. OPERATING INSTRUCTIONS

4.1 Switching ON and Operating Instructions

When the instructions for installation in pos. 3.3 have been completed the *ULTRASTAB* electronics can be switched ON.

1. Switch ON control power.
   The Green LED, - CONTROL POWER will light.

2. Wait for about 15 sec. and the Green LED, - NORMAL OPERATION will glow for a few seconds.
   After another 15 sec. the LED will be permanently on.

3. With the two Green LED's ON 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 with 115% of selected maximum current, and temperature within safe operating range.

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

5. If the Green LED, - NORMAL OPERATION does not light, recheck that all connections are properly made and secured by the screws.

   Please note that the LED, - NORMAL OPERATION will not light if the DVM is not connected correctly.

6. If the Red LED,- SATURATION is on, the current is exceeding 1.15 x Imax. (Programmed maximum current). Turn down the primary current to zero, switch OFF the electronics and install a programming plug matching to the actual maximum current. Restart.

7. If any problem should occur during this operation, please read Section 4 of the manual:
   Detailed description of the Electronics, or contact our local representative or Danfysik directly.

RECOMMENDATION

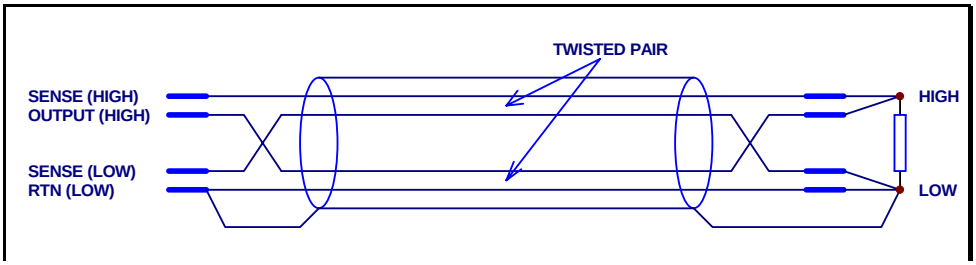
To obtain maximum performance always switch ON control power **before** applying the current which shall be measured through the transducer head. **Nothing** will be damaged if this sequence is not followed but the saturation effect may cause a drift in the offset.

4.2 How to adopt to the *ULTRASTAB 860R* output signal

In order to obtain the maximum performance of the *ULTRASTAB* system, it is recommended to follow the instructions listed below:

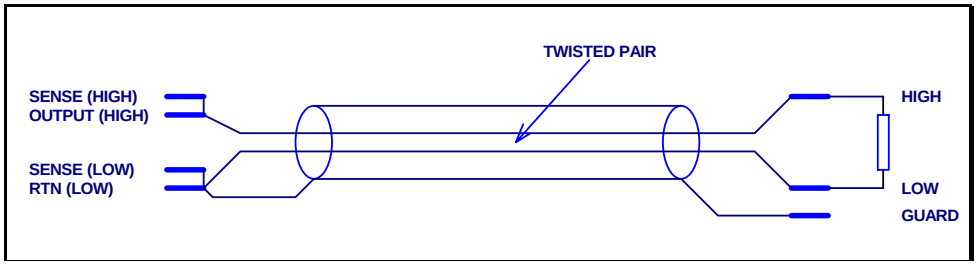
4.2.1 Connections to a low resistance load

In this case it is recommended to use a cable with two twisted pairs and a common screen. On twisted pair for the output HI, RTN LO, and another twisted pair for the sense wires as shown on the figure below.



4.2.2 Connection to DVM or other high impedance amplifier

In this case the sense wires should be connected to the output HI and RTN LO wires of the output on the external P4 connector.
It is recommended to use a cable with twisted pairs with a common screen as shown on the figure below.



A fully description of the output terminal system can be found in section 5.4.

4.2.3 Test terminals

On the front panel two test jacks are provided.The left jack is HI, and the right is LO. Please see schematic no. 88042.They are intended for a quick test only, using the test wires supplied with the *ULTRASTAB* together with a hand held DVM. The test sockets are made as jacks, that automatically makes up the four terminal connection when the test wires are inserted. It has the advantage that the *ULTRASTAB* can be tested without a properly wired P4 connector inserted. However it implies, that the test wires have to be removed when a P4 connector with the sense wires connected for precision measurements are used.

5. THEORY OF OPERATION

5.1 General Description of the Electronics

Please refer to main schematic no. 88042 showing the wiring of the electronic circuit, and schematic no. 82037 showing the detailed circuitry.

On schematic no. 88042 the electronic circuit board is shown as a black box. The main voltage is fed via a noise filter to the step down transformer.
The transformer has a secondary winding producing 9 Volts and two extra taps for bringing the voltage up to 11.5 Volts. These taps are used when the electronics is connected and adapted to either a 600 Amp or a 2000 Amp transducer head.
The circuit board has two connectors and the voltage change/matching is simply done by moving the cable plug from connector P5 to P6 when operating in the 2000 Amp range.
The rear panel of the cabinet has connectors for:

A. Status/zero current interlock output

Please see drawing on page 9.
This connector has two interlock functions.

Status Interlock - NORMAL OPERATION.

In the case of saturation one set of contacts on relay RL1 will open, and can be used in an external chain eg. for switching OFF a power supply.

Zero Current Interlock

Another set of contacts - on relay RL2 -are activated when the measured current is below $\pm$0.1 % of the programmed maximum current.
This function is implemented for interlock use in power supplies which have a polarity reversal switch on the output terminals.

Note:

In some cases when the instrument is used to measure AC current it can be desirable to decouple this function. The decoupling is done by moving the shortening plug P11 from position: PIN 1 + 2 to position: PIN 2 + 3.

B. **Analog Output**

This connector presents the analog voltage current. During normal operation, the voltage level will be between ±10 Volts.

C. **Transducer Head**

This connector provides the cable connection between the electronics and the transducer head. It is extremely important that the cable is mechanically secured with the two connector screws. Standard cable length is 2.5 metres.
Larger cables - up to 30 metres length can be purchased from Danfysik, or our local representative.

D. **FINE - CONTROL INPUT**

This connector allows connection to a separate set of windings on the transducer head. These windings have 100 turns for the 600 Amp type and 300 turns for the 2000 Amp type.
Passing a current of up to 100 mA. through these windings produces 10 or 30 ampere turns on the transducer head. Since the zero detection level of the head is always the sum of the total number of ampere turns on the head, this winding can be used as:

1. Fine adjustment winding for a power supply.

2. A modulation input if it is desired to vary the power supply current around a centre value.

3. A feed back signal from a NMR measuring system and in this way make a field stabilization of a magnet.

5.2 The Electronic Circuit Board Assy

Please refer to schematic no. 82046 and layout drawing no. 82025

The circuit consists of:
- Low voltage power supply
- Compensation output amplifier
- Zero flux detector
- Output amplifier with Burden resistor
- Temperature stabilizer circuit
- Interlock circuitry

5.2.1 The low Voltage Power Supply

This power supply is shown in the upper left corner of the drawing. Four green LED's indicates normal rectifier operation.
Voltage stabilization is done by IC11, IC12, IC16, and IC17.
Four fuses on the circuit board protects the auxiliary transformer in the case of component failure in the power supply or the electronic circuitry which does not trip the main fuse.

5.2.2 The Compensation Output Amplifier

This circuit consists of IC6 and IC8 and it receives signals from the feedback winding on the transducer head and the zero flux detector.
The net result is that the output is driven in such a way that the secondary ampere turns of the transducer head balances the primary ampere turns. At the same time the voltage across the secondary winding is kept to a minimum - ie. it approaches the ideal current transformer.

5.2.3 The Zero Flux Detector

The Zero flux detector is detecting, and via a feedback 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 TP6.

5.2.4 The Output Amplifier and Burden Resistor

This circuit converts the nominal 0 to 1 Amp. secondary current to a corresponding 0 to 10 V. output voltage.
The circuit incorporates a high stability Burden resistor connected to a high gain amplifier followed by a x 10 output amplifier.
Four high precision resistors ensure that one ampere in the Burden resistor is converted to 10 Volts on the output.
Remote sensing is used.
The resistors R86 and R87 are factory selected so that the 10 Volts output voltage corresponds to 1 Amp. <50 ppm.

5.2.5 The Temperature Stabilizer

A temperature to current converter IC13 is incorporated in the assembly.
The amplifier IC14 compares the temperature signal on R17 - R19 with the reference signal from IC20 and controls the Peltier element via the power amplifier IC15 so that the assembly temperature is kept constant independent of the current load of the Burden resistors and the ambient temperature.
The absolute temperature is in the region of 35 to 40 centigrade.

5.2.6 The Interlock Circuit

A. NORMAL OPERATION relay function (RL1).
Please refer to schematic on page 10.

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 limited by the resistors R5, R6, and R31.

The voltage on TP4 being the average of the two driver outputs will go low. This is detected by IC7-A driving the LED "NORMAL OPERATION" and the relay RL1 off. The relay contacts are available for an external interlock system. At the same time IC4-B switches the connection to the output amplifier from the zero detector to the bistable circuit IC7-B.

The output amplifier 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 de-saturated and the circuit will "lock in".
The interlock circuit receives an AC signal from the zero detector driver via a jumper in the transducer head. This signal is rectified and it drives Q2 which is part of the interlock chain.
In this way both a missing driving and a missing cable connection are detected.

B. Zero current relay function.
This function is controlled by a comparator - IC21 -which measures the analog output voltage. When the output voltage is below 10 mV=0,1%, Q3 will be controlled ON, relay RL2 will be energized and LED - D26 will light.

Note:

Interlock signals is for indication only. They may not be used as a part of an emergency stop circuit.

5.3 Current Transducer Heads

The electronics of the *ULTRASTAB 860R* can drive either a 600 Amp or a 2000 Amp transducer head. Please see drawing no's. 88000 and 88001.
The circuit board has two connectors, and the voltage change/matching is simply done by moving the cable plug from the connectors P5 to P6, when operating in the 2000 Amp range.

The transducer heads can be mounted in any orientation, and the influence from external stray fields is low, as can be seen from the specifications sheet.
The transducer head contains fragile materials in the zero detector assembly, and care should be taken in handling.

5.3.1 Programming the Transducer head

The transducer head is connected to the electronics via a special cable.
For a maximum output current of 320 Amp for the 600 Amp transducer head and 1000 Amp for the 2000 Amp transducer head, the cable can be connected directly. Please see drawing no. 82097 of a standard cable.
If any other maximum current within the range is required, a PROGRAMMING PLUG must be inserted between the transducer head and the cable.
The programming plug makes the interconnections between the separate windings in the transducer head and sets the maximum current for the assembly.

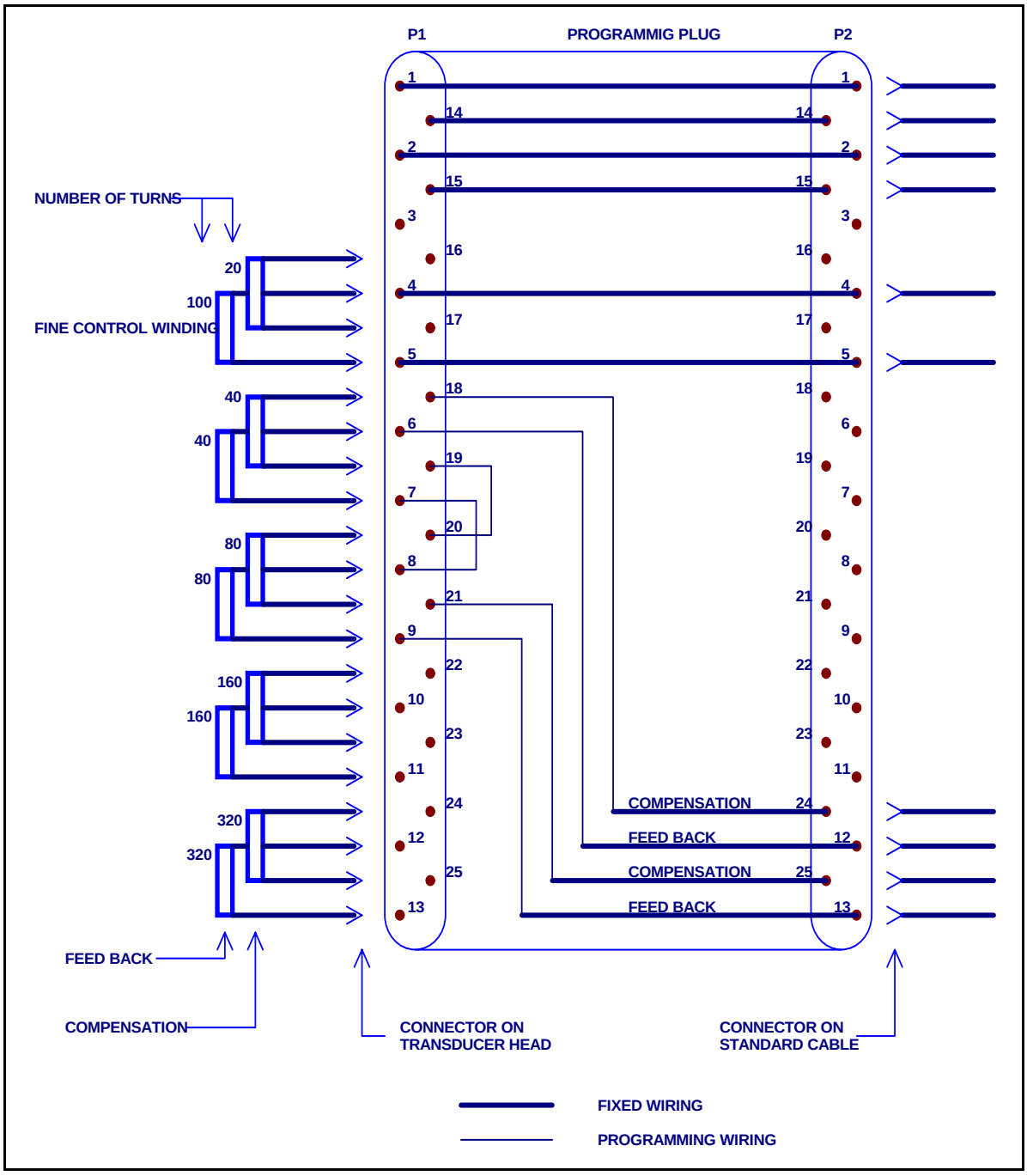
The *ULTRASTAB 860R* is delivered with one plug programmed to the users specifications.
rewiring to other max. output current is can be varied out by following the wiring lists shown on the next pages.

To reprogram the transducer head, make sure that the primary current through the transducer head is turned off. Turn off the ULTRASTAB 860R. Replace the programming plug with the new programming plug. Makes sure all cables are correctly connected. Turn on the ULTRASTAB 860R, and then turn on the primary current through the transducer head on.

5.3.2 **Zero Offset Adjustment**

Whenever a new transducer head is connected to the electronics 860R, eg. a shift from a type 600 to a type 2000 head, it may be necessary to make a zero offset adjustment. The basic function of the *ULTRASTAB* system is not effected by an offset, but the specific application of the system may require a low offset.
The zero offset potentiometer is accessible on the rear panel of the Electronics 860R. A high resolution DVM should be used, and there should be no primary current through the transducer head.
For general information a more detailed description of a total offset adjustment procedure can be read I appendix D2 on pages 27 and 28.

ADAPTION OF A PROGRAMMING PLUG



ON A 600 AMP TRANSDUCER HEAD

EXAMPLE OF PROGRAMMING PLUG FOR 120 AMP

MAX. CURRENT

AMP	TERMINAL NO. IN CONNECTION 1 AND 2 (P1 AND P2)	
120/375	FEEDBACK P2,12 to P1,6 (7-8) 9	to P2,13
	COMPENSATION P2,24 to P1,18 (19-20) 21	to P2,25

WIRING OF THE PROGRAMMING PLUG FOR ADAPTION

TO MAXIMUM CURRENTS from 40 to 600 AMP. or from 125 TO 2000 AMP

Head type: 600/2000A

MAX. CURRENT AMP	TERMINAL NO. IN CONNECTOR 1 AND 2 (P1 and P2)
40/125	FEED BACK P2,12 to P1,6 7 ..... to P2,13 COMPENSATION P2,24 to P1,18 19 ..... to P2,25
80/250	FEED BACK P2,12 to P1,8 9 ..... to P2,13 COMPENSATION P2,24 to P1,20 21 ..... to P2,25
120/375	FEED BACK P2,12 to P1,6 (7-8) 9 ..... to P2,13 COMPENSATION P2,24 to PS,18 (19-20) 21 ..... to P2,25
160/500	FEED BACK P2,12 to P1,10 11 ..... to P2,13 COMPENSATION P2,24 to P1,22 23 ..... to P2,25
200/625	FEED BACK P2,12 to P1,6 (7-10) 11 ..... to P2,13 COMPENSATION P2,24 to P1,18 (19-22) 23 ..... to P2,25
240/750	FEED BACK P2,12 to P1,8 (9-10) 11 ..... to P2,13 COMPENSATION P2,24 to P1,20 (21-22) 23 ..... to P2,25
280/875	FEED BACK P2,12 to P1,6 (7-8 9-10) 11 ..... to P2,13 COMPENSATION P2,24 to P1,18 (19-20 21-22) 23 ..... to P2,25
320/1000	No programming plug required
360/1125	FEED BACK P2,12 to P1,6 (7-12) 13 ..... to P2,13 C0MPENSATION P2,24 to P1,18 (19-24) 25 ..... to P2,25
400/1250	FEED BACK P2,12 to P1,8 (9-12) 13 ..... to P2,13 COMPENSATION P2,24 to P1,20 (21-24) 25 ..... to P2,25
440/1375	FEED BACK P2,12 to P1,6 (7-8 9-12) 13 ..... to P,213 COMPENSATION P2,24 to P1,18 (19-20 21-24) 25 ..... to P,225
480/1500	FEED BACK P2,12 to P1,10 (11-12) 13 ..... to P2,13 COMPENSATION P2,24 to P1,22 (23-24) 25 ..... to P2,25

WIRING OF THE PROGRAMMING PLUG FOR ADAPTION

TO MAXIMUM CURRENTS from 40 to 600 AMP or from 125 TO 2000 AMP

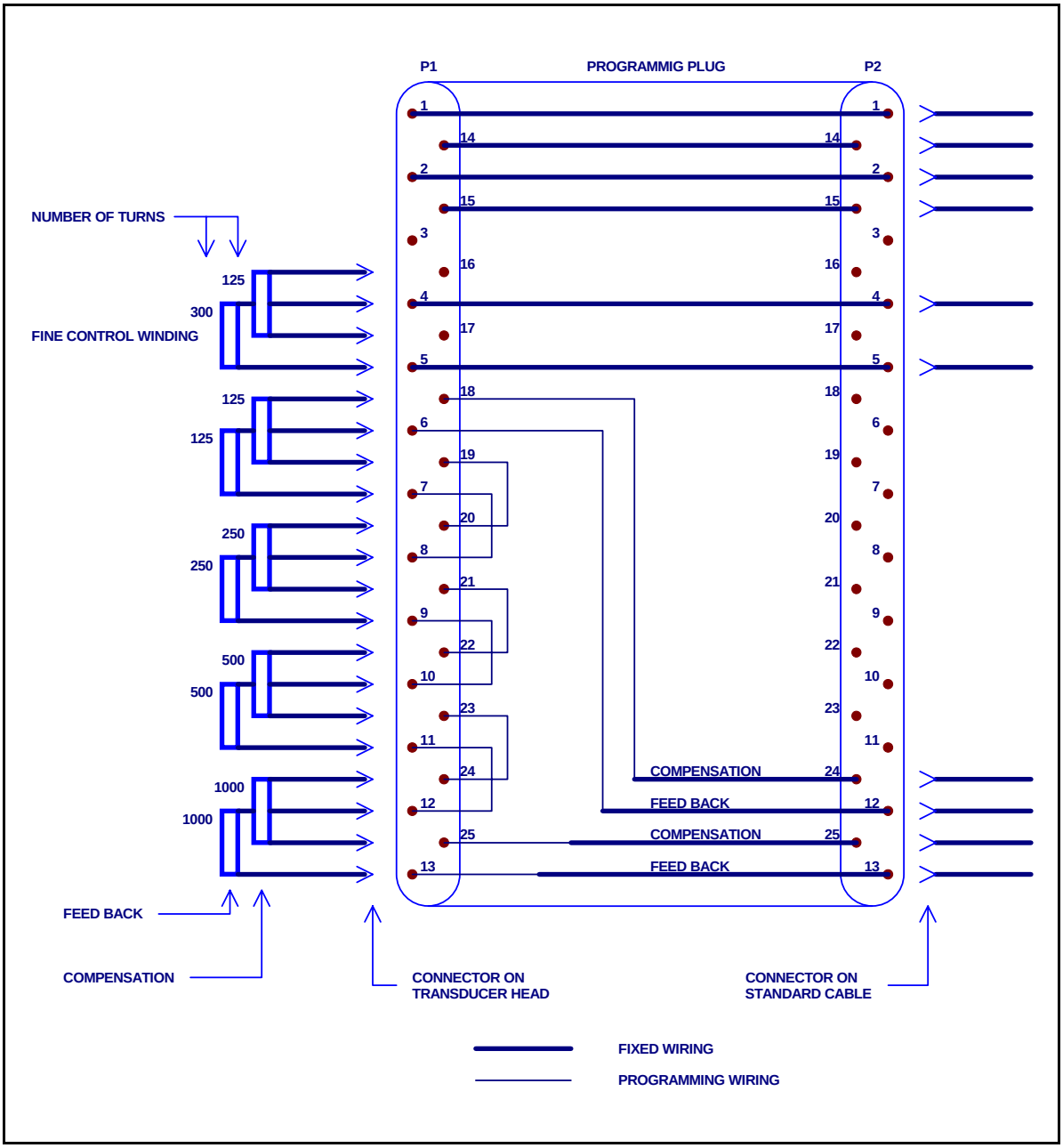
Continued

Head type: 600/2000A

MAX. CURRENT AMP	TERMINAL NO,. IN CONNECTOR 1 AND 2 (P1 AND P2)
520/1625	FEED BACK P2,12 to P1,6 (7-10 11-12) 13..... to P2,13
	COMPENSATION P2,24 to P1,18 (19-22 23-24) 25 ..... to P2,25
560/1750	FEED BACK P2,12 to P1,8 (9-10 11-12) 13..... to P,213
	COMPENSATION P2,24 to P1,20 (21-22 23-24) 25 ..... to P2,25
600/1875	FEED BACK P2,12 to P1,6 (7-8 9-10 11-12) 13 ..... to P2,13
	COMPENSATION P2,24 to P1,18 (19-20 21-22 23-24) 25..... to P2,25
2000	FEED BACK P2,12 to P1,6 (7-8 9-10 11-12) 13 ..... to P2,13
	COMPENSATION P2,24 to P1,16(17-18 19-20 21-22 23-24) 25... to P2,25

ADAPTION OF A PROGRAMMING PLUG

ON A 2000 AMP TRANSDUCER HEAD



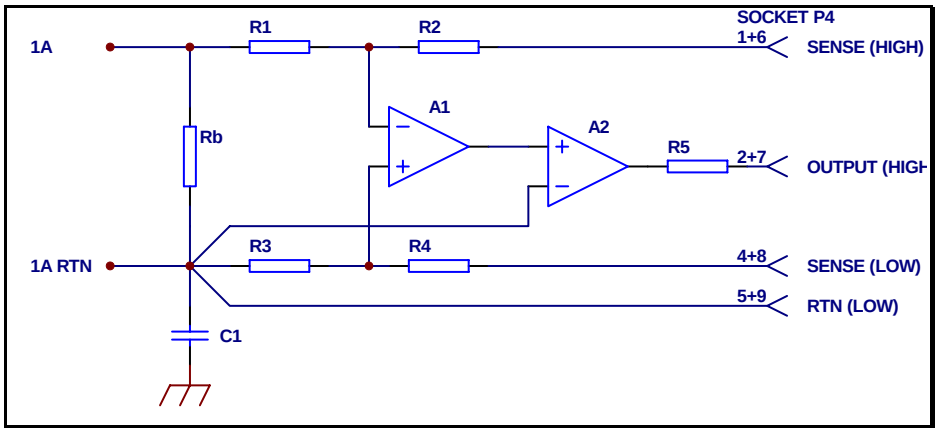
EXAMPLE OF PROGRAMMING PLUG FOR 1875 AMP.

MAX. CURRENT

AMP	TERMINAL NO. IN CONNECTOR 1 AND 2 (P1 AND P2)
600/1875 FEED BACK	P2,12 to P1,6 (7-8 9-10 11-12) 13.....to P2,13
COMPENSATION	P2,24 to P1,18 (19-20 21-22 23-24) 25.....to P2,25

5.4 The four Terminal Output Signal Connections

In order to obtain the highest performance from the *ULTRASTAB 860R* 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.

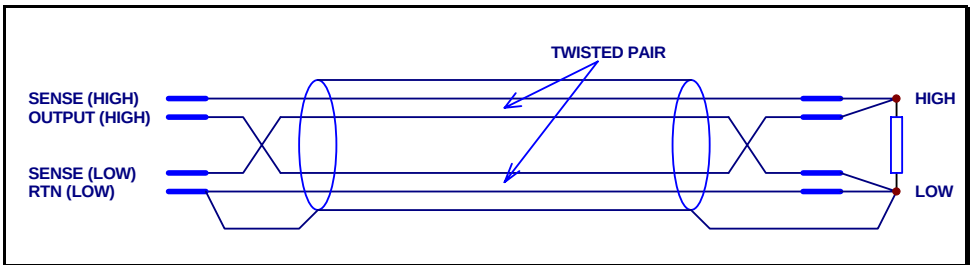
Output Connections in General

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: P4 pin 1,6 and LO : P4 pin 4,8 connected to the corresponding output terminals HI: pin 2,7 and LO: pin 5,9.

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.

6.0 MAINTENANCE

The *ULTRASTAB 860R* assembly does not require any maintenance under normal operation.
We recommend you to check that the cooling fan is running quietly once a year.
If faults should occur, please refer to schematic no. 88042 and the Theory of Operation section in this manual.
The schematic contains information about voltage levels, at the test points (TP..).

Please note:

1. Faults outside the Burden resistor and the output amplifier are serviceable by normal good service practice.

2. Faults within the calibrated components and the zero flux detector can only be repaired by returning the *ULTRASTAB 860* assembly to Danfysik A/S. Failure to do this will make the warranty null and void.

APPENDIX C - SALES REPRESENTATIVE AND SERVICE

DANFYSIK A/S,
Moellehaven 31,
DK-4040 Jyllinge
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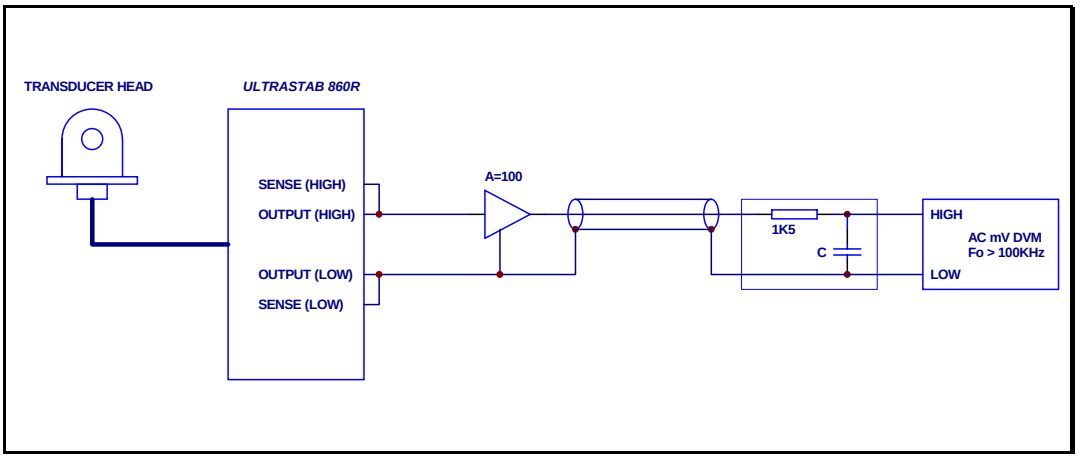
APPENDIX D - TEST AND CALIBRATION OF ULTRASTAB

D.1 Noise Measurements on *ULTRASTAB 860*

All *ULTRASTAB 860R* 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 *860R* 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 from 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 values are fairly constant between 600 and 120 selected turns, indicating that the values below 100 should only be used when the noise figure is less critical.
Please note that the 20 turns winding can only be used for interpolation and not on its own.
(The lowest max current for the transducer head is 40A.)

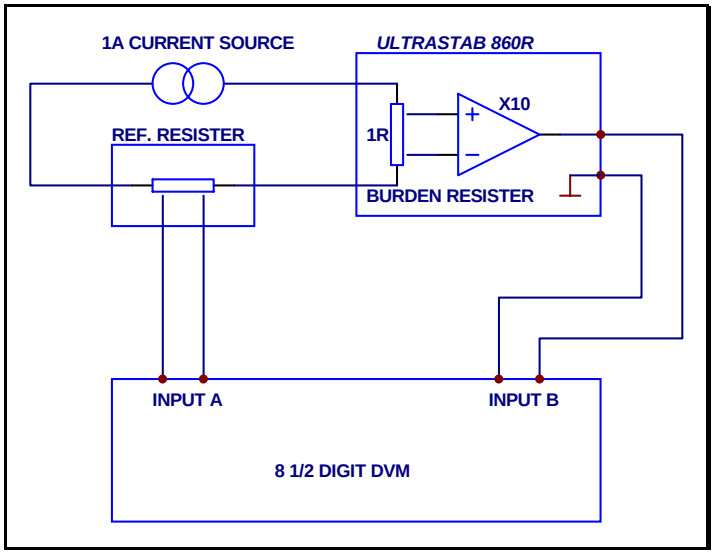
The table shows measurements for 3 selected values of amperes/turns, and if it is seen that the values are closely proportional to the square root of the frequency band used. This compares well with the situation of amplifiers.

Average Figures measured on *ULTRASTAB 860R*

Filter cut off Frequency.	Capacitor C	Amperes / Turns 600A	120A	40A
10 Hz.	10 uF.	0.06 ppm.	0.05 ppm.	0.06 ppm.
100 Hz.	1 uF.	0.16 ppm.	0.3 ppm.	0.9 ppm.
1 kHz	100 nF.	0.4 ppm.	0.6 ppm.	2.0 ppm.
10 kHz.	10 nF.	1.3 ppm.	2.3 ppm.	14.0 ppm.
50 kHz.	2 nF.	3.3 ppm.	-	-
100 kHz.	1 nF.	3.4 ppm.	4.9 ppm.	37.0 ppm.

D.2 ULTRASTAB 860R - Absolute calibration and Offset adjustment

All *ULTRASTAB 860R* 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 860R*.
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 860R*
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 860R 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 R92 on the circuit board shall be used.

Gain measurement of the Output Amplifier.
Via the socket TRANSDUCER HEAD (on the rear side of the cabinet) a +-1A is applied from an external source between pin 13 and pin 25 in the socket. The output voltage is measured on the ANALOG OUTPUT socket. The voltage shall be +-10V within +- 500 microV.

D3. Offset adjustment.

1. Switch on the 860R 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 "AJD1" inside the unit, is adjusted until the DVM shows <5µV.

5. Next offset adjustment step is carried out with the transducer head selected/programmed to lowest current range. (40A or 125A). Potentiometer "OFFSET ADJ" on the rear panel is adjusted until DVM shows <5µV).

6. Now program highest current range possible. If appropriate programming plug is available select 600A / 2000A. If only programming plugs for low currents are available a max current of 320A / 1000A can be programmed by using the connection cable directly, i.e. without programming plug.
   Check that the DVM reads <20µV (<2ppm). If not - repeat the procedure.

Note:

1. Lower offset than guaranteed in the specifications can be obtained by careful adjustment.
2. In the case where zero offset is of low importance replacement of transducer heads can be done without zero adjustment . The offset will be below 5 ppm under all circumstances.