INSTITUTE OF OCEANOGRAPHIC SCIENCES
DEACON LABORATORY

INTERNAL DOCUMENT No. 310

MultiMet Temperature Sensor maintainence and calibration

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1992

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DOCUMENT DATA SHEET

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PUBLICATION DATE 1992

TITLE

MultiMet temperature sensor maintenance and calibration.

REFERENCE

Institute of Oceanographic Sciences Deacon Laboratory, Internal Document, No. 310, 52pp. (Unpublished manuscript)

ABSTRACT

The report details the procedures for MultiMet air temperature sensor preparation, maintenance, and calibration.

New sensors must be prepared for marine environment, with careful attention being paid to minimising the environmental effects both to the mechanical and electrical effects caused by corrosion.

Sensor calibration methods are described and the software tools to check the calibration by use of the database named MetDb are outlined.

Re-calibration and maintenance of sensors returned from deployment is detailed.

KEYWORDS

AIR TEMPERATURE SENSOR
METDB
MULTIMET
PSYCHROMETER

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1. OVERVIEW

The report details the procedures for MultiMet Air Temperature sensor preparation, maintenance, and calibration.

New sensors must be prepared for Marine environment, with careful attention being paid to minimising the environmental effects both to the mechanical and electrical effects caused by corrosion.

Each individual interface circuit is 'temperature compensated' by checks made over the sensor temperature operating range to minimise drift caused by component temperature characteristics. The interface electronics is allocated to a specific sensor. This pairing is necessary to ensure that characteristics of both sensor and interface is known and is constant throughout both calibration and deployment.

Sensor calibration methods are described and the software tools to check the calibration by use of the database named MetDb are outlined.

Section 4 and 5 detail the methods used on the return of a sensor from deployment for re-calibration and maintenance.

2. INTRODUCTION

Sensors used by the IOS Meteorological Programs number about 100. As these are maintained and used by many different people, agreed procedures, data storage and retrieval methods must be of a standardised format. But to provide this continuity a framework for the tasks must be clearly available to all involved in the Meteorological Program.

To increase the sensors ability to survive in the Marine environment it is necessary to prepare them for the salty atmosphere where they will be used. The sensors are 'customised' to reduce corrosion effects on the housing component parts and on the electrical connections to the elements.

Calibration of temperature sensors has evolved from a manual procedure to the currently used computer controlled system. The automation of the calibration procedure allowed the data processing and storing of data on MetDb also to become automatic.

The sensor, whose housing containing the platinum resistance elements, has its own customised electronic interface, manufactured by IOS. This interface contains an oscillator whose frequency variation is determined by the change of resistance with temperature of the platinum element.

The electronic interface circuits used for all the temperature sensors are based on a development for the IOS Tide Gauge Project (GWILLIAM & COLLAR, 1974). The interface circuits has been altered by including four modifications to suit MultiMet input circuitry. These changes have been a gradual process and have been made only when new units were manufactured.

This means that not all units are to the same standard. But, all with care, will give high quality data.

To ensure data security and minimisation of human errors, the recording of sensor details are automated by the operations carried out through the Sensor Management System. All sensor history and calibrations are stored by the Sensor Management System onto a database, MetDb. Access to the database, which is stored on the Wormley Network File Server, is via a terminal. The calibration data collection and the control of the temperature tank is performed by a PC Clone. At completion of the calibration process the Controller, which has on-line access to MetDb, provides automatic documentation to the sensor History File and appends the new calibration to previous data sets.

3. PROCEDURES FOR NEW SENSORS AND ELECTRONIC INTERFACE

3.1. Process Description

The process in bringing new sensors to an operational status requires three stages before calibration can be commenced. These are :-

1. Preparation of Interface Circuitry
2. Preparation of Sensor for the marine environment
3. Entry of sensor details into the MetDb database

3.1.1. Interface Circuitry

In a Psychrometer there are two platinum resistance elements each of which has its separate interface oscillator circuit. The change in value of the resistance elements, with respect to temperature, controls the output frequency of the interface oscillator. In an Air Temperature sensor there is only one element and requires only one interface circuit.

3.1.2. Sensor Preparation

The sensors have not been manufactured for the marine environment and must be better protected to meet the corrosive atmosphere.

3.1.3. Documentation Sensor Details

Once all the electronic procedures have been completed the details of the sensor and electronics must be entered into MetDb. This has a high priority as good documentation of the sensor calibrations is essential. Without preparation of MetDb 'Details file' it will not be possible to carry out a calibration. The 'Details file' is required as part of the calibration software security checks to ensure that calibrations are recorded against the correct sensor.

3.2. Preparation and Test of Interface Circuits

3.2.1. Printed Circuit Board Assembly

1. Check all components against the parts list. Note that R 1 and R 2 are different values for Wet and Dry bulb. The Dry electronics is nearest the 8 way LEMO connector, (see Appendix A2.2.)

2. Assemble screen around the transformer and solder to the small PCB.

3. Mount and solder all components into place except the sensor connector (CON 2), which is no longer used.

4. Connect a short wire between the earth on the transformer PCB and main PCB, (see drawing in Appendix A2.2.2.).

5. Remove excess flux from the PCB.

6. Insert the integrated circuits into their sockets.

3.2.2. Test and Set up of the Electronic Circuits

1. Ensure that all components are mounted on the PCB and are as the parts list.

2. Ensure the sensor connector (CON 2) is not installed, it is not used because of the variability in contact resistance and hence introduction of measurement uncertainty. The power/signal output connector is the only two part connector used in the circuit.

3. Connect a 100 Ω low temperature coefficient resistor with a twisted pair screened lead to each circuit on the PCB at the location for CON 2 as shown in the table below. There are some leads already made up and are in the calibration room.

Wire colour	Position on PCB
Red	D
Blue and screen	E

4. Connect the Power lead with the low pass filter to the power / output Molex connector harness. A total of 10 circuits (5 PCBs) can be connected up using this lead.

5. Apply a voltage of between 16 - 24 V. dc. (say 20 V. dc.) as in the table below.

Wire colour	Power supply
Pink	+ 20 V terminal
Green / Yellow	0 V terminal

6. Connect a frequency meter between the 22 kΩ resistor and the 10 nF capacitor and connect the Green / Brown lead to ground.

7. Select the circuit required with the thumbwheel switch. The measured interface should be oscillating at about 1.5 k Hz.

8. Connect up a voltmeter to the Yellow / Red lead. It should read approximately 4 V. ac. (10 V pk-pk.).

9. Connect up an oscilloscope to the same place as the voltmeter. Monitor the waveform for distortion, noise and check the frequency.

10. If there is no signal output adjust the 1 MΩ gain potentiometer R 4.

11. If the circuit does not oscillate the see note below.

12. Adjust the 1 MΩ gain potentiometer R4. If the gain is to low i.e. about 2.5 V. ac. (6 V pk-pk.) the oscillator frequency becomes very erratic, if the gain is to high i.e. about 6 V. ac. (15 V pk-pk.) the oscillator stops. To set the gain correctly decrease the gain until the oscillator becomes erratic then slowly increase the gain until the oscillator has a steady output, increase the gain only very slightly passed this point.

Note on possible causes and remedies if circuit does not oscillate.

1. Referring to the circuit diagram, check the dc. levels and waveforms at outputs of ICs etc. and also the dc. - dc. converter.

2. If all dc power supply levels are correct and there is no obvious fault, then break the oscillator loop. This is best performed on the transformer PCB as the tracks are larger and more robust than on the main PCB (see Appendix A2.2.1.).

3. Apply an ac. signal to the circuit input and monitor the output signal waveform shape and frequency. The output signal should be the same or very slightly larger in amplitude and have about the same phase angle (at 1.5 k Hz.) as the input.

4. If no signal is available at the output, trace through the circuit to determine where the signal disappears. After the fault has been located and repaired, solder a short length of tinned copper wire across the gap on the transformer PCB.

3.2.3. Selection of the Temperature Compensation Resistor

1. The procedure is to measure the frequency of oscillation at different temperatures.

2. Place circuits in an environmental chamber with the power/output leads and the resistor outside of the environmental chamber. The resistors should be lagged to prevent short term fluctuations, thus remaining at ambient room temperature. Condensation will effect the electronics at lower temperatures therefore close the ends of interface tubes with absorbent paper. The tube should be earthed.

3. Apply a voltage of between 16 - 24 V dc. (say 20 V dc.) as in the table below

Wire colour	Power supply
Pink	+ 20 V terminal
Green / Yellow	0 V terminal

4. Connect a frequency meter between the 22 kΩ resistor and the 10 nF capacitor and connect the Green / Brown lead to ground.

5. Select the circuit required with the thumbwheel switch. The oscillator should be oscillating at about 1.5 k Hz.

6. Connect up a voltmeter to the Yellow / Red lead. It should read approximately 4 V. ac. (10 V. pk-pk.).

7. Connect up an oscilloscope to the same place as the voltmeter. Monitor the wave form for distortion, noise and check the frequency.

8. Set the environmental chamber to 0 °C. Allow time for the chamber and the electronics to reach the required temperature and to the stabilise. This may take up to six hours.

9. Stabilisation has been reached when there is no drift of frequency measured over a half hour period. Measurements are taken of the output frequency and voltage. Also check on amplitude stability and waveform distortion.

10. Repeat checks as detailed in stage 9 at 15 °C and 30 °C. The check at 15 °C is a check on the linearity of frequency change.

11. It may be found that the oscillator becomes erratic or stops when at a different temperature therefore the gain may need to be adjusted by a very small amount. If adjusted at 0 °C condensation occurs and would need to be dried out before continuing.

12. Remove the electronics from the environmental chamber and from the tube.

13. The value of the resistor is determined by a computer program (TEMPCOMP.BAS) written in GWBASIC. Details of the program and its output are in Appendix 3.

14. Calculate the change in frequency over the temperature range 0 °C and 30 °C. The maximum amount of compensation that can be applied is about ±9 Hz.

15. Read off the value of the required compensation resistor verses frequency change from the printout, (see Appendix A3.)

16. If the uncompensated circuit shows decreasing frequency with increasing temperature the thermistor and series resistor is connected across the resistor R 9 B.

17. If the frequency increases with temperature the network is connected across the sensor, Pin D and Pin E. There is provision for both positions on the PCB. (See Appendix A2.2.).

18. Solder the temperature compensation resistor in place.

19. Repeat the test to determine if the compensation is successful.

20. If a high value of resistance was introduced into the circuit the calculated value can result in a larger frequency shift than when the circuit was uncompensated. If necessary repeat the procedure with the another value or use uncompensated. A frequency difference of about 1 to 2 Hz is considered the best that can be reasonably achieved.

21. Disconnect the Power / Signal lead and unsolder the resistors leads.

3.3. Preparation of a Vector Psychrometer

3.3.1. Vector Psychrometers Marine Customisation

Most instruments used at sea soon show the effects of exposure and corrosion, leading to mechanical or electrical problems, and difficulty in dismantling. It is therefore worth spending some time in preparing new instruments for shipboard use before they are deployed, and giving further attention at reasonable intervals during service.

Any of the screws used to assemble the units can get corroded into place, especially when in tapped holes in aluminium alloy parts. Trying to remove the screw often results in the head shearing off; the remainder then has to be drilled out, and the hole re-tapped. Don't be too reassured by the reference to 'stainless' screws in Vector Instruments data sheets, this does not necessarily mean stainless steel. Some screws are cadmium or nickel plated brass.

The original water bottle holders are too flimsy for use where exposure to high winds may occur, and are replaced with a more robust design, (see Appendix C1.1., Drawing No. I.O.S./5515/78.)

The fans are more suitable to enclosed use, e.g. in electronic equipment rather than for exposure to the elements at sea. Once water gets into the motor housing, the rather delicate commutator brush springs, bearings etc., get corroded, and a black coating tends to build up on the commutator, causing the motor to slow down and eventually stop.

3.3.2. Sensor Preparation

1. All screws should be removed and have their threads greased before the instrument is used. Vaseline or Silicone grease can be used. Finnigan's 'Waxoyl', used for anti-rust protection on cars etc., has been found useful, as it can be easily applied, poked down screw-holes etc., with a small paint-brush.

2. Remove the screw-terminal block used for the sensor connections and solder the sensor wires directly to the paired cable cores as follows :-

Wire Colour	Connects to
Red and Green	Red lead on Dry PRT
Blue and Yellow	Black lead on Dry PRT
Brown and White	Red lead on Wet PRT
Black and Violet	Black lead on Wet PRT

3. Vaseline is applied to the solder connections and are then covered with small bore heat-shrink sleeving.

4. The exposed soldered connections to the fan connector, inside the case, should be covered with Vaseline and also the connector on the outside.

5. Assemble the LEMO connectors on the sensor cables as follows :-

Wire Colour	Pin Number
Red	1
Green	2
Blue	3
Yellow	4
White	5
Brown	6
Black	7
Violet	8

6. Apply Vaseline internally, around the soldered connections, and externally around mating surfaces and cable clamp of the LEMO connector.

7. Remove the supplied water bottle holders and replace with one fabricated from 16 gauge aluminium alloy sheet, (see Appendix C1.1., Drawing No. I.O.S./5515/78).

8. Secure the bottle with nylon cord or cable ties.

9. Position a 10 mm. length of 8 mm. diameter rubber tubing on the wick tube inside the bottle lid, to prevent the tube being forced out of the bottle in high winds.

10. Fill the cavities of the plastic end-caps on top of the motor with Vaseline.

11. Where the cable enters the casing of the motor put some Vaseline.

12. Write the Vector serial numbers on the inside and outside of the case and on the lid with a waterproof marker.

13. Put the serial number on the cable near the LEMO connector with Thomas & Betts cable markers (see Appendix A2.2.5. Parts List).

3.3.3. Mounting and Earthing Arrangements for Printed Circuit Board in Sensor Tube

1. As the space on the PCB is not sufficient to mount directly on the end cap, make the small mounting board (see Appendix E1.1., Drawing No. I.O.S./5515/81).

2. Drill two 3 mm. holes in the sensor end of the PCB to suit the mounting board, (see Appendix E1.1., Drawing No. I.O.S./5515/81).

3. Attach the mounting board to the end cap that has an earthing screw with 4 mm. stainless steel screws (see Appendix B1.1.2., Drawing No. I.O.S./5515/30).

4. Attach the PCB to the mounting board with 3 mm. stainless steel nuts and screws.

5. Solder two lengths of grey wire to pin 4 - Connector 1 on both sets of electronics on the underside of the PCB.

6. Trim the wires so that they are long enough to connect to the earth position on the end cap.

7. Solder the wires to a 3 mm. solder tag.

8. Attach to the end cap with a 3 mm. stainless steel screw and spring washer.

9. Ensure the countersunk holes in the tubes are bear metal. If not remove anodising using a countersink bit (see Appendix B1.1.1., Drawing No. I.O.S./5515/28).

10. Pass the leads through the end cap and insert the electronics in the tube.

11. Earth the tube with a 3 mm. countersunk stainless steel screw. Check for earth continuity.

3.3.4. Final Assembly of Printed Circuit Board Within Electronics Tube

1. Connect up the 8 way LEMO connector with 2 cables using 2 core screened cable as follows :-

Cable	Wire Colour	Pin numbers
Dry	Red	1 & 2
Dry	Blue and screen	3 & 4
Wet	Red	5 & 6
Wet	Blue and screen	7 & 8

2. Apply a very small amount of Silicone grease to the connector threads and rubber sealing ring.

3. Feed the leads through the end cap and screw the connector into the end cap.

4. Solder the screened leads to the PCB at Connector 2 for both Wet and Dry interfaces as follows :-

Wire Colour	Position
Red	D
Blue and screen	E

5. Connect up the 4 way LEMO connector with 2 cables using 2 core screened cable as follows :-

Cable	Wire colour	Pin number
Dry	Red	1
Dry	Blue	2
Dry	screen	3
Wet	Red	1
Wet	Blue	4
Wet	screen	3

6. Label the leads Wet or Dry as appropriate.

7. Apply a very small amount of Silicone grease to the threads and rubber sealing ring.

8. Feed the leads through the end cap and screw the connector into the end cap.

9. Position the rubber 'O' ring on the end cap and apply a very small amount of Silicone grease to the rubber 'O' ring.

10. Feed the leads through the tube and secure the end cap with a 3 mm. stainless steel screw. Ensure the countersunk hole is bare metal.

11. Write on the tube the electronics numbers e.g. 1W, 2D with a waterproof marker.

12. Cut the screened cables to sufficient length to connect to the Molex connectors on the PCB and connect a 4 way Molex connector to each of the screened cables as follows :-

Wire Colour	Pin number
Blue	1
Red	2
screen	5

13. Connect up the Molex connectors.

14. Position the rubber sealing ring on the other end cap and apply a very small amount of Silicone grease to the rubber sealing ring.

15. Carefully feed the leads into the tubes while inserting the electronics.

16. Secure tube to end cap with a 3 mm. stainless steel screw. Ensure the countersunk hole is bare metal.

17. Check the earth continuity from the connector to the tube.

18. Put some PVC tape over the end caps and end of the tube to protect the earthing screws.

19. Assign the interface circuit to a particular Psychrometer and write the serial number on the tube with a waterproof marker.

20. Enter into the database as described in Section 3.5 - New Sensor Detail Entry into MetDb Database.

3.4. Preparation of Air Temperature Sensor

3.4.1. Sensor preparation

The air temperature sensors use the same electronic circuit as the Psychrometers so the procedures are very similar.

The air temperature sensor is mounted directly onto one of the end caps therefore the wiring is simplified by direct sensor connection to interface printed circuit board.

3.4.2. Mounting and Earthing Arrangements of Printed Circuit Board in Sensor Tube

1. As the space on the PCB is not sufficient to mount directly on the end cap, make the small mounting board, (see Appendix E1.1., Drawing No. I.O.S./5515/81).

2. Drill two 3 mm. holes in the end of the PCB near the Power / Signal Molex connector (CON 2) to suit the mounting board, (see Appendix A2.2.2.).

3. Attach the mounting board to the end cap, which has an earthing screw, with 4 mm. stainless steel screws (see Appendix B1.2.1., Drawing No. I.O.S./C5597/39).

4. Attach the PCB to the mounting board with 3 mm. stainless steel screws.

5. Solder a length of grey wire to pin 4 - connector 1 on the underside of the PCB.

6. Trim the wire so that it is long enough to connect to the earth position on the end cap.

7. Solder the wire to a 3 mm. solder tag.

8. Attach to the end cap with a 3 mm. stainless steel screw and spring washer

9. Ensure the countersunk holes in the tubes are bear metal. If not remove anodising using a countersink bit. Use a long Psychrometer tube if the PCB has not been cut in half.

10. Insert the electronics in the tube passing the leads through the end cap.

11. Earth the tube with a 3 mm. countersunk stainless steel screw.

3.4.3. Final Assembly of Printed Circuit Board Within Electronics Tube

1. Only one interface circuit is needed. After the temperature compensation tests are complete, select the circuit with the best temperature compensation.

2. Remove the tube, the earth connection and the PCB from the end cap.

3. Cut the PCB in half but near to were the Molex connector was removed (CON 2), leaving as much circuit board near to the Power / Signal connector (CON 1) as possible, (see Appendix A2.2.2.).

4. If not previously done in the initial assembly, drill two 3 mm. holes in the end of the PCB nearest the Power/ Signal connector (CON 1) to suit the mounting board, (see Appendix E1.1., Drawing No. I.O.S./5515/81.).

5. Attach the PCB to the mounting board with 3 mm. stainless steel screws.

6. If the grey earth wire is too long, unsolder, trim to length and re-solder.

7. Reconnect the solder tag to the end cap with a 3 mm. stainless steel screw and spring washer.

8. Connect up the 4 way LEMO connector with a 2 core screened cable as follows:-

Wire Colour	Pin number
Red	1
Blue	2
Screen	3

9. Apply a very small amount of Silicone grease to the threads and rubber sealing ring of the LEMO connector.

10. Feed the lead through the end cap and screw the connector into the end cap.

11. Cut the screened cable to sufficient length to connect to the Molex connector on the PCB and connect a 4 way Molex connector to the screened cable as follows:-

Wire Colour	Pin number
Red	3
Blue	1
screen	5

12. Connect up the Molex connectors.

13. Apply a very small amount of Silicone grease to the rubber 'O' ring on the sensor probe.

14. Feed the sensor screened lead through the Air Temperature end cap, (see Appendix B1.2.1., Drawing No. I.O.S./5597/39), and screw in the sensor.

15. Position the rubber sealing ring in the groove of the end cap.

16. Apply a very small amount of Silicone grease to the rubber 'O' ring.

17. Feed the lead through a short air temperature tube, (see Appendix B1.2.3., Drawing No. I.O.S./5597/41).

18. Secure the tube to the air temperature end cap with a 3 mm. stainless steel screw. Ensure the countersunk hole is bare metal.

19. Position the rubber sealing ring in the groove of the end cap attached to the electronics.

20. Solder the sensor cable to the PCB in position of CON 2 as follows :-

Wire Colour	Position
Red	D
Blue / screen	E

21. Write the serial number on the tube with a waterproof marker.

22. Apply a very small amount of Silicone grease to the rubber sealing ring.

23. Carefully feed the sensor cable back into the tube while inserting the electronics into the tube.

24. Secure the end cap with a 3 mm. stainless steel screw. Ensure the countersunk hole is bare metal and also check earth continuity between the connector and the tube.

25. Secure the plastic screen to the air temperature end cap with 4 mm. stainless steel screws.

26. Put some PVC tape over the end cap and end of tube to protect the earthing screws.

27. Enter into the database as described in Section 3.5 - New Sensor Detail Entry into MetDb Database.

3.5. New Sensor Detail Entry into MetDb Database

1. Switch on at the mains and switch on the uninterruptible power supply and the Tandon computer. At the prompt shown type the command shown.

2. Enter password: **multimet<cr>**

3. Sometimes establishing a network connection to the Wormley server, can fail. Reboot the PC, **<ctrl/alt/del>** , and this will try again to connect the Wormley server. This method will ensure the PC is in the correct directory for the system software.

4. To start the software run the batch file MET.BAT by typing

met<cr>

5. Select from the menu with the cursor keys

Allocation Menu **<cr>**

New Sensor Entries **<cr>**

Air Temperature **<cr>**

7. Make a written note of the MultiMet number as it will be needed later.

6. Enter the sensor type e.g. **TT<cr>** or **TD<cr>**

7. Enter the serial number e.g. **VI1006<cr>**

8. Enter **M<cr>** to indicate that the sensor is in maintenance.

9. Exit using the Menu commands.

10. Edit the Details file using "Word" as follows. At DOS prompt shown type as shown.

11. C:\>**word g:\ametdb\metdb_da\details.nnn<cr>**

12. Where 'nnn' is the MultiMet number, as noted in stage 8

13. Enter the information required, sensor ID, (sensor type, manufacturer code and last 4 digits of the serial number e.g. **TTVI1006,** Description, Manufacturer, Type, Serial Number, Purchase date, Cost, Electronics No., Spare Parts list and any applicable comments.

14. Exit and Save Word using the menu.

4. SENSOR CALIBRATION

4.1. Calibration of Psychrometer

4.1.1. General Calibration Policy

Within logistical constraints, sensors are calibrated within a period one month prior to deployment and again within one month after being returned to IOS. If a sensor is returned 'faulty' a calibration will be completed, if possible, before any repair work is carried out. A second calibration will then be carried out after the repair or modification.

A maximum of 4 Psychrometers can be calibrated each time.

4.1.2. Procedure for Calibration

If this is the first time a sensor is to be calibrated check, using disc utility i.e. 'DS' or 'Xtree', for the existence of a History file on MetDb. Without the History File a calibration cannot be performed, as this file is 'opened' during the calibration sequence. See notes in Section 4.1.4.

1. Remove the base of the Psychrometer by unscrewing the nylon screw underneath the case.

2. Remove the water bottle holder secured with two stainless steel screws and the wick from the Wet PRT. Care is needed with the PRTs as a knock may alter the calibration.

3. Place on the rack positioned on the Grant calibration tank immediately, to minimise opportunity for damage to the PRTs.

4. Ensure the water level in the calibration tank is at the lower edge of the 'water level indicator', top up if necessary with tap water.

5. Connect up the Psychrometers to the electronics, check that it has the same serial number.

6. Ensure that the black RS 232 lead connected to the F25 thermometer is plugged into the RS 232 socket on the computer. If the grey RS 232 lead is connected to the computer, disconnect first.

7. Switch the on the uninterruptible power supply, Tandon computer, Grant calibration tank and cooler, F25 thermometer and the bench power supply.

8. At the prompt shown, type in command as shown

9. Enter password: **multimet<cr>**

10. Sometimes establishing a network connection to the Wormley server, can fail. Reboot the PC , **<ctrl/alt/del>**, and this will try again to connect the Wormley server. This method will ensure the PC is in the correct directory for the system software.

11. To start the software run the batch file MET.BAT by typing

met<cr>

12. When the menu is displayed select the following using the cursor keys.

Calibration Menu **<cr>**

Tank **<cr>**

13. When prompted enter your initials, followed by a **<cr>**

14. Follow the instructions on the computer to enter the number of sensors. Use the cursor keys to make the selection, then press **<esc>** when finished.

15. Enter the serial number e.g. **VI1006** for each sensor then press **<esc>**

16. Connect up the sensors as instructed by the computer. A table of frequency readings are displayed on the screen for each channel. These should be centred approximately 1.7 k Hz at a water temperature of 15 °C.

17. If all is working correctly, press **<cr>**. There is a slight software induced pause.

18. For a routine sensor calibration the default values can be accepted by pressing **<cr>** for start temperature (0 °C), **<cr>** for stop temperature (35 °C) and **<cr>** for step temperature (5 °C)

19. After the computer initialisation of the F25 thermometer, a display of the temperature cycle is shown and an estimate of the time the calibration will take.

20. If this is suitable press **Y<cr>** to continue the calibration.

21. The calibration takes about 4-5 hours depending on the tank starting temperature. After completion of a calibration the tank will return to about 15 °C.

4.1.3. Post Calibration Procedure

1. The amplitude and the frequency of the output signal is measured. The computer measures and records the frequency during calibration, therefore for consistency, it is advisable to use the computer to measure the frequency for this test. Also check with a frequency meter or Multimeter (with frequency measuring facility) to ensure the computer is reading frequency correctly. The Dry and Wet outputs are available as two BNC terminated coaxial cables. The Dry is indicated with some Blue tape and the Wet with Yellow tape. They are normally connected to the oscilloscope.

2. Unplug the lead form the Calibration Interface (to remove the power from the interface tube), then unplug the Psychrometer (PRTs) from the interface tube.

3. Plug in the Test Plug (fixed value resistors), then plug the lead marked channel 5 / 6 into the interface tube.

4. Start the calibration in the normal way except only enter one serial number e.g. **VI1006**.

5. Wait until the 2 frequencies in channel 5 and 6 are displayed and note the readings. Channel 5 is the Dry bulb and channel 6 the Wet bulb.

6. If more than one Psychrometer is to be tested, unplug channel 5 and 6 lead and then the Test Plug. Then repeat steps 2, 3 and 5.

7. Unplug the channel 5 and 6 lead and then the test plug.

8. Plug in the Psychrometer (PRT's) into the interface tube then replace the channel 5 and 6 lead.

9. Exit the program with **<ctrl/pause>** then type

system<cr>

10. At the prompt type

C:\>**word g:\ametdb\metdb_da\history.nnn<cr>**

11. Where nnn is the MultiMet number of the Psychrometer written on the tube.

12. Enter the current date and headings in the same form as a previous post calibration test. If this is the first calibration then look at another history file.

13. Measure the Dry (Blue) and Wet (Yellow) output voltages using a multimeter and enter the results in the same way as a previous post calibration test. The tank temperature should be approximately 18 °C for this test.

14. Measure the peak to peak amplitude on the oscilloscope and enter the results in the same way as a previous post calibration test.

15. Enter the frequency readings the same way.

16. Observe the waveform and add a suitable comment.

17. The motor is checked immediately a sensor is returned to maintenance, and is repaired if necessary. To check the motor plug in the Cannon connector. If it is not working or is noisy, add a suitable comment to history file.

18. Exit and save the file using the menu.

19. If more than one Psychrometer is to be tested, unplug channel 5 and 6 lead and then the Psychrometer. Then repeat steps 10 to 18 for each Psychrometer.

20. Remove the Psychrometers from the calibration tank and dry probes with absorbent paper.

21. Replace the case and fold up the lead and secure with tape.

4.1.4. Procedure for 'First' Sensor Calibration

For Printer formatting purposes in is necessary to manually insert a 'page break' at the top of the first calibration file of a new sensor.

1. A new sensor calibration data is stored in the directory structure g:\ametdb\metdb\tdjjjyya.nnn where

'jjj' is Julian day number

'yy' is year

'a' indicates the first calibration on that day, with subsequent calibrations 'b', 'c' etc.

'nnn' is the MultiMet number.

2. To edit the Database run the batch file MET.BAT by typing.

met<cr>

3. When the menu is displayed select the following using the cursor keys.

Metdb <cr>

4. Press **<alt>** and when the menu is displayed select.

Load... <cr>

5. Type the following

g:\ametdb\metdb_da\tdjjjyya.nnn<cr>

6. Press **<alt/e>** and when the menu is displayed select.

Insert page... <cr>

<cr>

7. Press **<alt>** and when the menu is displayed select.

Exit... <cr>

Y<cr>

4.2. Air Temperature Sensor Calibration

1. Calibration of air temperatures sensors is very similar to Psychrometers. There is provision to calibrate two air temperature and two Psychrometers at the same time.

2. Fix the mounting plate (see Appendix D1., Drawing No. I.O.S./5515/80) to the rack with 3 mm. screws

3. Remove the plastic screen and using the same screws fix the air temperature sensor to the plate. Take care with the sensors, a knock can alter the calibration.

4. Start the calibration as if for a Psychrometer, except enter number in the menu box **Air Temps.**

5. The channel numbers start from '21' not '5 / 6' as for Psychrometers.

6. When the calibration has finished unplug the sensor and remove from the base plate. Frequency and Voltage measurements are not done.

7. Dry the probe and screw the plastic screen to sensor and return to its protective box.

8. If this is the first calibration a page break will need to be added in the same way as described for a Psychrometer, see section 4.1.4.

5. MAINTENANCE

5.1. Psychrometer Maintenance

5.1.1. Cases

The die-cast alloy cases are very prone to corrosion, once any salt water gets under the paint. Eventually the paint layer lifts away from the surface, and the corrosion spreads rapidly underneath it.

Local cleaning and 'touching up' may slow down the rot. If the case is badly corroded the only answer is to strip down the whole unit, shot-blast the case and lid, and re-paint with a suitable white enamel. Finnigan's 'Hammerite' or 'Smoothrite' have been used on some cases.

5.1.2. Fans

The fans are not meant to be user-serviced, but if they slow down or stop it is often possible to 'effect' short term repair.

Carefully lever off the end cap and clean the commutator and other internal parts, provided that the brush gear is still sound. If the armature is not rotating freely, a squirt of WD-40 down into the casing may help.

If the motor still will not turn or is very noisy, replace with a new motor. Put Vaseline on the mounting screws, top cover screws and cover the plastic top with Vaseline. Also use some Vaseline where the cable enters the casing.

5.1.3. Wicks

The wicks should be removed and replaced with clean or new wicks. The sensor probes are in several different lengths so chose a wick with the entry hole in the correct place.

To clean the wicks they should be boiled with detergent to remove scale and algae growth. New wicks should also be cleaned.

5.1.4. Interface Electronics

Do not open the tube unless absolutely necessary. If the earthing screws are disturbed it is possible the calibration may change. Before opening a tube, check the earth continuity between the connector and the tube.

If the sensor output varies when the tube is tapped lightly, the fault may be a poor earth connection to the transformer PCB. Connect a short lead from the earth screw on the

transformer PCB to ground. If this cures the fault solder a short length of lead from screw to the earth on the main PCB, (see Appendix A2.2.2.).

If the fault is not easy to trace, open the oscillator loop, this is usually done on the transformer PCB. Apply a signal of about 1.5 k Hz. to the input and a similar signal of the same or slightly higher amplitude and about the same phase angle should appear at the output. If not then trace the circuit through until the fault is found. After the repair bridge the gap on the PCB with a short length of tinned copper wire, (see Appendix A2.2.2.).

5.2. Air Temperature Sensor

There is far less to go wrong with the air temperature sensor compared with the Psychrometers. Much of what has been said about the interface circuit of the Psychrometers applies to the Air Temperature interface circuit.

The plastic screen may need the salt to be washed off with clean water. The interface tubes may also need cleaning. The 4 mm. Stainless steel screws should have some Vaseline applied to them.

6. CIRCUIT MODIFICATIONS

6.1. Psychrometer Interface Circuits

The following modifications to the interface electronics has been done to some of the units, and may need to be done to the remaining units.

1. The gain of the buffer amplifier (I.C.2) is increased by adding R.17 and R.18. This modification was implemented in 1989. As the oscillator amplitude output varies quite considerably from unit to unit, this modification is not always needed. Also the feedback resistor value may need to be a different value to obtain a voltage output of between 6 and 10 volts peak to peak.

2. The buffer amplifier (I.C.2) is changed to an ac. amplifier by adding C.19 and R.19. This modification was implemented in 1989.

3. The gain adjustment range of the oscillator amplifier (I.C.1) is limited by adding R.20. This modification was implemented in 1989.

4. To balance the bridge at a different temperature R.7 is reduced to 1kΩ. When tested with the standard resistors the frequency is higher. This modification was implemented in 1989.

5. Wet bulb sensor electronics have R.1 and R.2 increased to 10k6Ω. This reduces the wet bulb frequency to prevent the two oscillators from tracking. This modification was implemented in 1989.

6. To improve the automatic gain control D.2 and D.3 are shorted out and R.5 increased to 100kΩ. This causes the output amplitude to be reduced and may require the gain to be increased by a larger value of feedback resistor. This modification was implemented in 1990.

7. The transformer is earthed with a short length of wire rather than rely on the transformer fixing screws. If the transformer case is not earthed the output is very unstable in both amplitude and frequency. This modification was implemented in 1991.

7. REFERENCE LIST

BIRCH, K. G. & PASCAL, R. W. 1987 A meteorological system for research applications - MultiMet.

Fifth International Conference on Electronics for Ocean Technology, Heriot Watt University, Edinburgh, 7-12

PASCAL, R. W., WILLIAMS, A. L. & AHMED, R. 1991 A user's guide to MultiMet sensor and calibration facility.

IOSDL Internal Report No 298

GWILLIAM, T. J. P. G. & COLLAR, P. G. 1974 A strain gauge pressure sensor for measuring tides on the continental shelf.

I.O.S. Report No. 14.

8. GLOSSARY

Calibration tank	Tank of water that is temperature controlled to calibrate the temperature probes.
Compensation resistor	Resistor used to compensate for changes in frequency due to temperature. Used together with a Thermistor.
Dry bulb	A PRT not covered with a wick. See Wet bulb.
Interface circuit (electronic)	The electronic circuit that outputs a frequency that depends on the resistance of the PRT.
MultiMet	Signal conditioning, data logging and computer interface equipment designed by IOS, for logging meteorological measurements.
MetDb files,	Text Data Base on which is stored the Calibration the Details and History files of the meteorological instruments.
PRT	Precision Resistance Thermometer. The resistance changes depending on temperature.
Psychrometer	Meteorological instrument that measures wet and dry bulb temperatures in moving air.
Tandon Computer	The computer in the calibration room.
Temperature Sensor	The Psychrometer and the Interface Electronics.
Temperature Probes	The PRTs in the temperature sensors.
Thermistor	A resistor that changes resistance with temperature, used in the compensation circuit.
Vector Instruments	The Manufactures of the Psychrometers used.
Wet bulb	A PRT covered with a wick feed with water from a bottle attached to the Psychrometer.
WORD	The word processing software on the Tandon Computer.

APPENDIX A

A1. ELECTRONIC INTERFACE CIRCUIT OVERVIEW

The operation of the electronic interface is based around a bridge network, (R.7 to R.10, the temperature compensation components R.13 and R.14 and the P.R.T. sensor). A capacitor (C.16) is placed across one arm of the bridge to produce a phase shift dependant on the state of bridge balance. The output from the bridge is fed to a phase shift network (R.1, R.2, C.1 and C.2). The output from the phase shift network is amplified (I.C.1 and associated components) and applied to the input arms of the bridge via a transformer (T.1). The output of the amplifier is rectified (D.4) and filtered (R.5 and C.15) which drives the gate of a F.E.T. (Tr.1). This transistor provides the a.g.c. signal to stabilise the output amplitude. The output of the amplifier is also buffered by the ac. coupled amplifier (I.C.2 and associated components) to provide the output waveform of sufficient amplitude for the MultiMet input circuit.

The power supply consists of a +12 V. regulator (I.C.3 and associated components) to provide the positive rail for the amplifiers This also supplies a voltage inversion converter (I.C.4 and associated components) to provide -12 V. for the negative rail.

There are three different circuit diagrams, which show the modifications as implemented to improve different aspects of the interface performance (see Appendix A2.)

These are :-

1. Original circuit .

2. Changes to increase circuit gain.

3. Regulation of output signal amplitude.

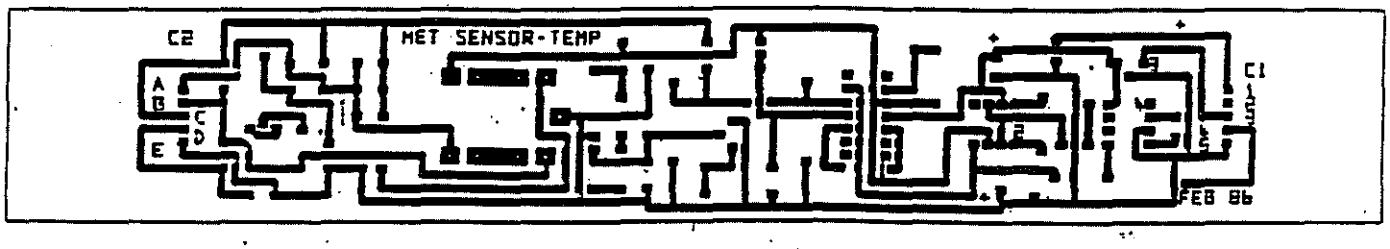
There has not been a policy of back-modification of earlier circuit interface electronics to the new specifications. Therefore it is important that when working on a circuit to be aware of which circuit diagram is applicable.

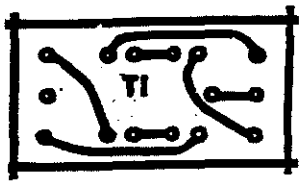
The importance of the earth connections within the circuit and the housing cannot be stressed to much. The failure to maintain good earth continuity within each circuit and the housing can result in frequency 'step' changes in either individual or both circuits. With this criteria in mind care must taken to ensure that the transformers are securely mounted onto the main PCB. Any failure to mount the transformer correctly will become evident shortly after the sensor has been deployed. It is highly possible that the circuit will perform perfectly during calibration, but the mechanical working caused by an incorrectly mounted transformer will soon cause a break in the earth continuity.

A2. CIRCUIT LAYOUT

A2.1. Mk 1 Printed Circuit Board

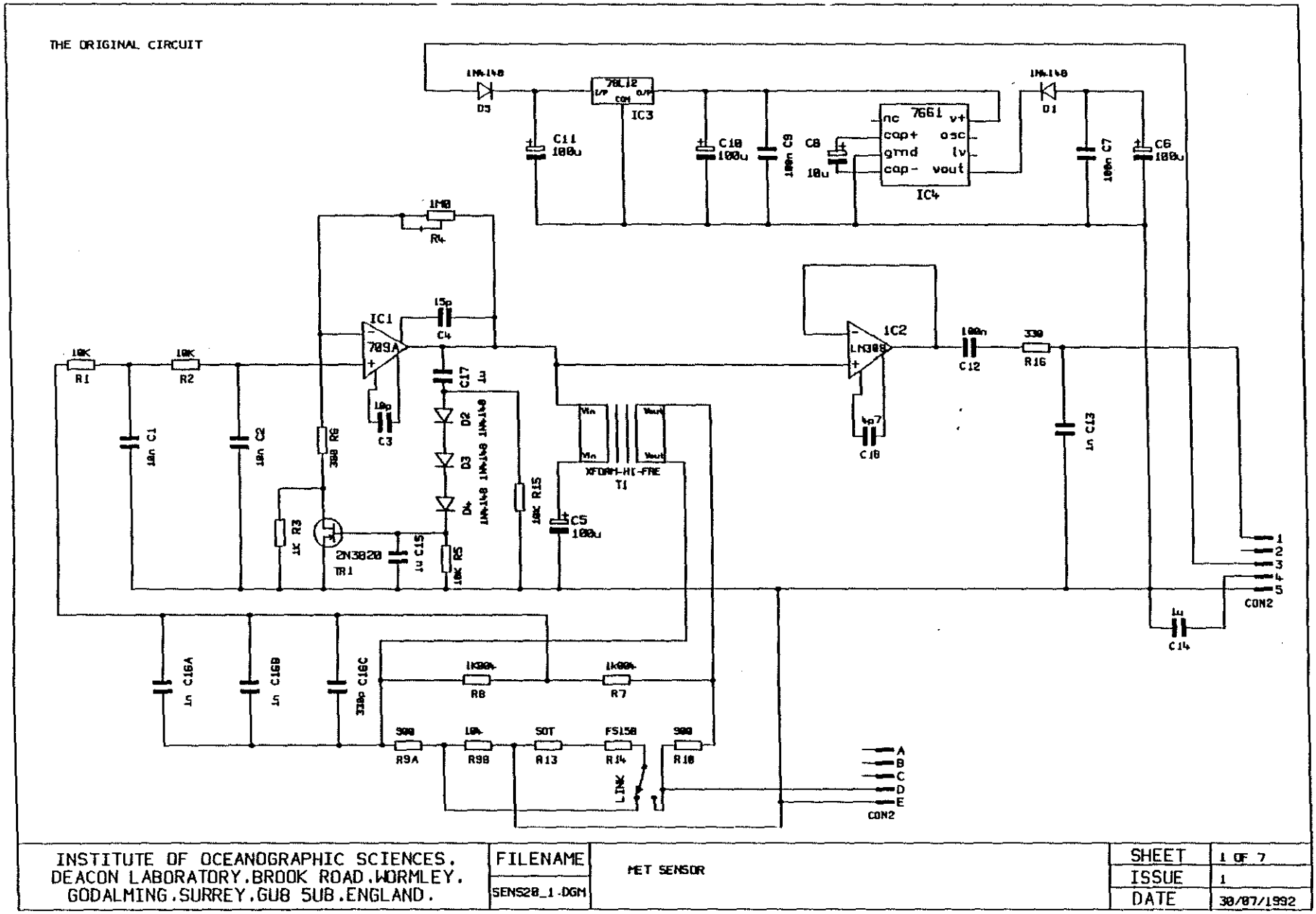
A2.1.1. Printed Circuit Artwork





A2.1.2. Circuit Diagram

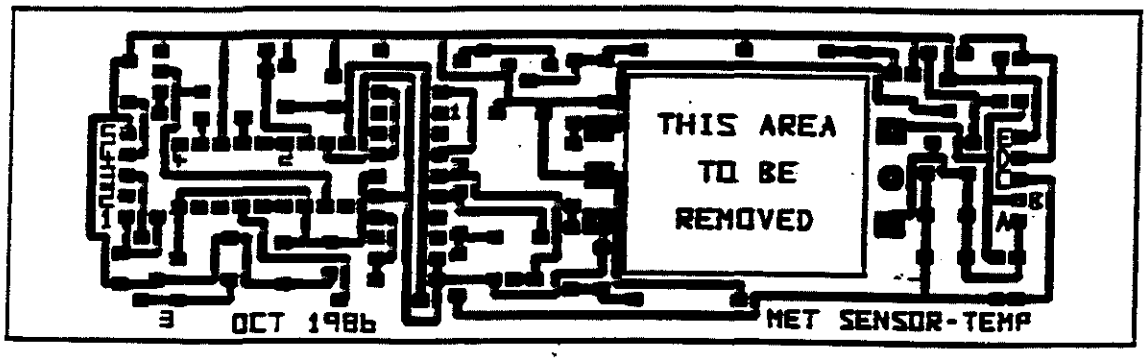
SENS20_1.DGM 04Aug1992 11:03 (1+0+2 31) R0 C ...\MAIN\EPS100P.PXY P3 A 10.50 15

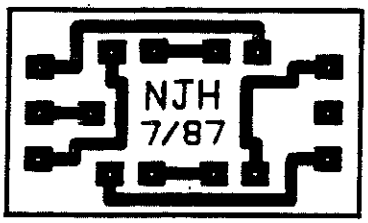


INSTITUTE OF OCEANOGRAPHIC SCIENCES. DEACON LABORATORY.BROOK ROAD.WORMLEY. GODALMING.SURREY.GU8 5UB.ENGLAND.	FILENAME	MET SENSOR	SHEET	1 OF 7
	SENS20_1.DGM		ISSUE	1
			DATE	30/07/1992

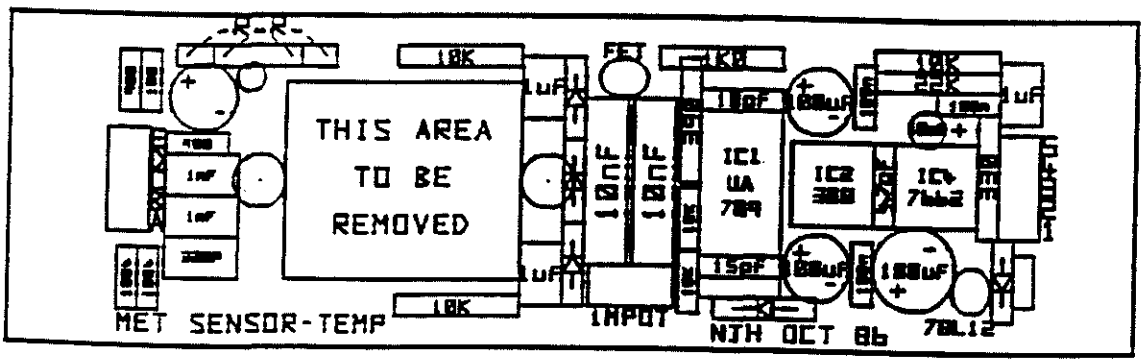
A2.2. Mk 2 Printed Circuit Board

A2.2.1. Printed Circuit Artwork

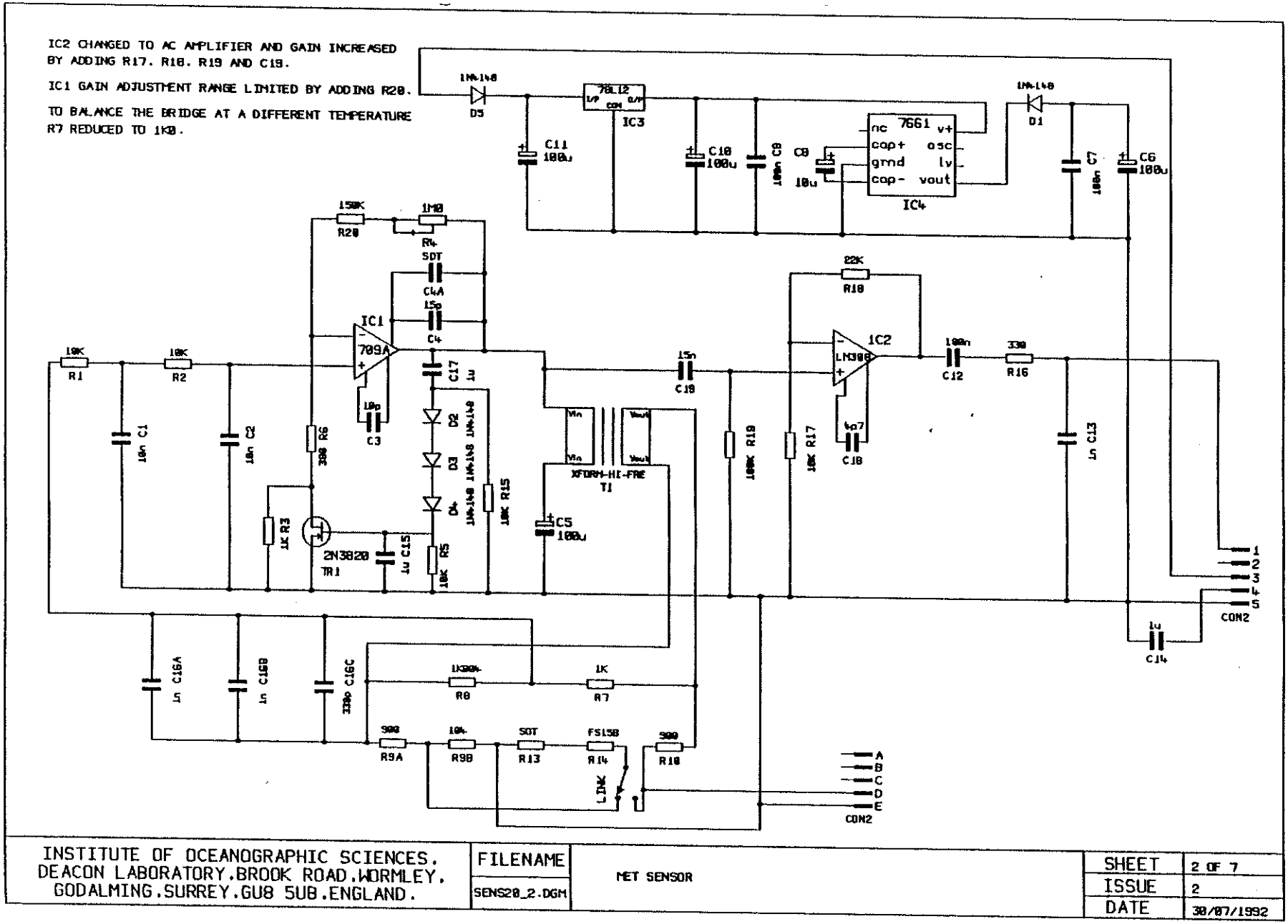




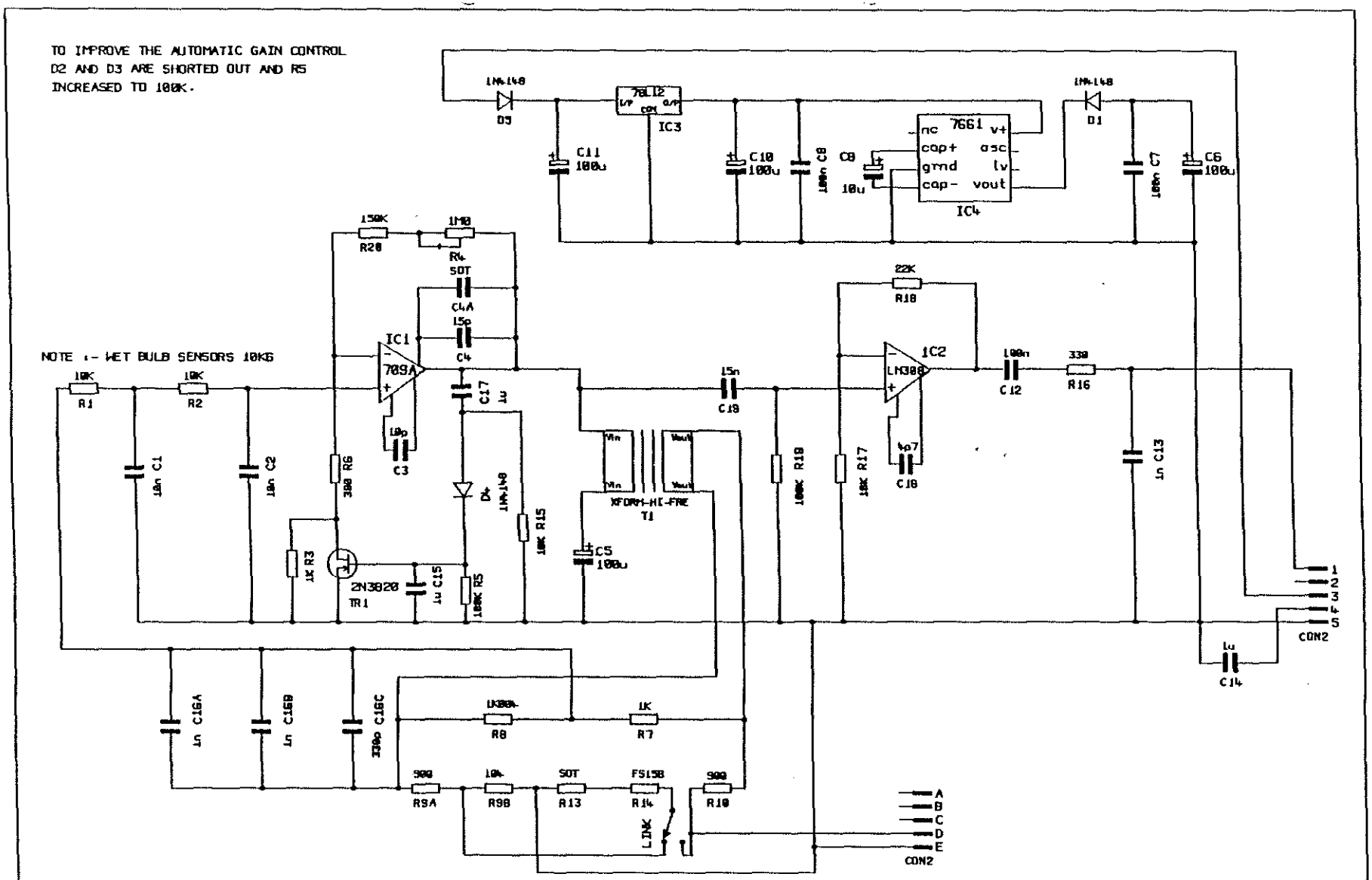
A2.2.2. Printed Circuit Board Component Layout



SENS20_2.DGM 04Aug1992 11:16 (1+0+2 31) R0 C ...\MAIN\EPS100P.PXY P3 A 10.50 15



SENS20_3.DGM 04Aug1992 11:22 (1+0+2 31) R0 C ...\MAIN\EPS100P.PXY P3 A 10.50 15



INSTITUTE OF OCEANOGRAPHIC SCIENCES. DEACON LABORATORY.BROOK ROAD.WORMLEY. GODALMING.SURREY.GU8 5UB.ENGLAND.	FILENAME: SENS20_3.DGM	MET SENSOR	SHEET: 3 OF 7
			ISSUE: 3
			DATE: 30/07/1992

Electronic Component Description					Identification		
Circuit Diagram Symbol	**Name**	**Rating**	**Grade**	**Type**	**Trade or Suppliers Name**	**Reference Number**	**Alternatives or Remarks**
R 1	Resistor	10 kΩ	0.1 %	Vishay Type S102J	Vishay Mann		
R 2	Resistor	10 kΩ	0.1 %	Vishay Type S102J	Vishay Mann		
R 1	Resistor	10.6kΩ	0.1 %	Vishay Type S102J	Vishay Mann		
R 2	Resistor	10.6kΩ	0.1 %	Vishay Type S102J	Vishay Mann		
R 3	Resistor	1 kΩ		Metal Oxide	IOSDL Stores		
R 4	Potentiometer	1 MΩ		Cermet pcb. mtg.	Farnell Electronic Comps.	752 - 208 + 1 MΩ	
R 5	Resistor	10 kΩ		Metal Oxide	IOSDL Stores		
R 6	Resistor	380 Ω		Metal Oxide	IOSDL Stores		
R 7	Resistor	1 kΩ	0.01 %	Vishay Type S102J	Vishay Mann		
R 8	Resistor	1004 Ω	0.01 %	Vishay Type S102J	Vishay Mann		
R 9 A	Resistor	900 Ω	0.01 %	Vishay Type S102J	Vishay Mann		
R 9 B	Resistor	104 Ω	0.01 %	Vishay Type S102J	Vishay Mann		
R 10	Resistor	900 Ω	0.01 %	Vishay Type S102J	Vishay Mann		
R 11	Thermistor	FS15-B		S.T.C.	IOSDL Stores		Use either R 11 / R 12
R 12	Resistor	S.O.T.		Metal Oxide	IOSDL Stores		or R 13 / R 14 for
R 13	Resistor	S.O.T.		Metal Oxide	IOSDL Stores		temperature compen-
R 14	Thermistor	FS15-B		S.T.C.	IOSDL Stores		sation network.
R 15	Resistor	10 kΩ		Metal Oxide	IOSDL Stores		
R 16	Resistor	330 Ω		Metal Oxide	IOSDL Stores		
R 17	Resistor	10 kΩ		Metal Oxide	IOSDL Stores		
R 18	Resistor	22 kΩ		Metal Oxide	IOSDL Stores		
R 19	Resistor	100 kΩ		Metal Oxide	IOSDL Stores		
R 20	Resistor	150 kΩ		Metal Oxide	IOSDL Stores		

Remarks	Issue	Date	Remarks	Issue	Date	Remarks	Issue	Date

Psychrometer Interface Circuit.	**Electronics Comps Drg No. I.O.S./SENS 20**
	Compiled By : **PKS**
Institute Of Oceanographic Sciences	**Sheet Number** :4 of 7
	Date :17/03/92

Electronic Component Description					Identification		
Circuit Diagram Symbol	Name	Rating	Grade	Type	Trade or Suppliers Name	Reference Number	Alternatives or Remarks
C 1	Capacitor	10 nF		Silvered Mica	IOSDL Stores		
C 2	Capacitor	10 nF		Silvered Mica	IOSDL Stores		
C 3	Capacitor	10 pF		Polystyrene (Suflex)	IOSDL Stores		
C 4	Capacitor	15 pF		Polystyrene (Suflex)	IOSDL Stores		
C 4A	Capacitor	S.O.T.		Polystyrene (Suflex)	IOSDL Stores		
C 5	Capacitor	100 µF	16 V d.c.	Electrolytic	IOSDL Stores		
C 6	Capacitor	100 µF	16 V d.c.	Electrolytic	IOSDL Stores		
C 7	Capacitor	100 nF		Ceramic	IOSDL Stores		
C 8	Capacitor	10 µF		Tantalum	IOSDL Stores		
C 9	Capacitor	100 nF		Ceramic	IOSDL Stores		
C 10	Capacitor	100 µF	16 V d.c.	Electrolytic	IOSDL Stores		
C 11	Capacitor	100 µF	35 V d.c.	Electrolytic	IOSDL Stores		
C 12	Capacitor	100 nF		Ceramic	IOSDL Stores		
C 13	Capacitor	1 nF		Ceramic	IOSDL Stores		
C 14	Capacitor	1 µF		Polyester	IOSDL Stores		
C 15	Capacitor	1 µf		Polyester	IOSDL Stores		
C 16 A	Capacitor	1 nF		Silvered Mica	IOSDL Stores		
C 16 B	Capacitor	1 nF		Silvered Mica	IOSDL Stores		
C 16 C	Capacitor	330 pF		Silvered Mica	IOSDL Stores		
C 17	Capacitor	1 µF		Polyester	IOSDL Stores		
C 18	Capacitor	4 .7 pF		Polystrene (Suflex)	IOSDL Stores		
C 19	Capacitor	15 nF		Ceramic	IOSDL Stores		

Remarks	Issue	Date	Remarks	Issue	Date	Remarks	Issue	Date

Psychrometer Interface Curcuit.	**Electronics Comps Drg No. I.O.S./SENS 20**
	Compiled By : **PKS**
	Sheet Number :5 of 7
Institute Of Oceanographic Sciences	**Date** :17/03/92

Electronic Component Description					Identification		
Circuit Diagram Symbol	Name	Rating	Grade	Type	Trade or Suppliers Name	Reference Number	Alternatives or Remarks
T 1	Transformer	1:2	Audio	Miniature	RS Components Ltd.	228 - 393	Screening can 217 - 810
D 1	Diode	1N4148	Silicon	General Purpose	IOSDL Stores		
D 4	Diode	1N4148	Silicon	General Purpose	IOSDL Stores		
D 5	Diode	1N4148	Silicon	General Purpose	IOSDL Stores		
Tr 1	Transistor	2N3820		Field Effect	IOSDL Stores		
IC 1	Integrated Circuit	709 A		Op - amp.	IOSDL Stores		
IC 2	Integrated Circuit	LM308		Op - amp.	IOSDL Stores		
IC 3	Integrated Circuit	78L12		Voltage regulator	RS Components Ltd.	306 - 207	648 - 494
IC 4	Integrated Circuit	7661		Voltage converter	RS Components Ltd.	633 - 773	
CON 1	Connector			5 pin Molex	Farnell Electronic Comps.	146 - 698	
	Mating Shell			5 pin Molex	Farnell Electronic Comps.	146 - 256	
	Crimp Terminal			Molex	Farnell Electronic Comps.	143 - 116	143 - 201
	IC base			14 Pin	IOSDL Stores		
	IC base			8 Pin	IOSDL Stores		
	IC base			8 Pin	IOSDL Stores		
	Main pcb						
	Transformer pcb						
	Mounting board						
	Transformer spacers			Tufnol Tube			
	Solder tag	3 m.m.			IOSDL Stores		
	End cap				IOSDL Workshop	IOS / C5597 40	
	End cap (Air temp.)				IOSDL Workshop	IOS / C5597 39	
	Tube (psychrometer)				IOSDL Workshop		
	Tube (Air temp.)				IOSDL Workshop	IOS / C5597 41	

Remarks	Issue	Date	Remarks	Issue	Date	Remarks	Issue	Date

Psychrometer Interface Circuit	**Electronics Comps Drg No. I.O.S./SENS 20**
	Compiled By : **PKS**
	Sheet Number :6 of 7
Institute Of Oceanographic Sciences	**Date** :17/03/92

Electronic Component Description					Identification		
Circuit Diagram Symbol	Name	Rating	Grade	Type	Trade or Suppliers Name	Reference Number	Alternatives or Remarks
	Rubber O ring			0365 - 30	IOSDL Stores		
	LEMO 4 way			Fixed socket	LEMO	ERA 3E 304 CNL	
	LEMO 8 way			Fixed socket	LEMO	ERA 3E 308 CNL	
	LEMO 4 way			Free plug	LEMO	FFA 3E 304 CNA C70Z	
	LEMO 8 way			Free plug	LEMO	FFA 3E 308 CNA C65Z	
	Cable markers			WM - A - Z	Farnell Electronic Comps.	WM A Z	
	Rubber tubing			10 x 8 m.m. dia.	IOSDL Stores		
	Clear heat shrink			20 x 2.4 m.m. dia.	Farnell Electronic Comps.	107 - 463	

Remarks	Issue	Date	Remarks	Issue	Date	Remarks	Issue	Date

Psychrometer Interface Circuit	**Electronics Comps Drg No. I.O.S./SENS 20**
	Compiled By : **PKS**
	Sheet Number :7 of 7
Institute Of Oceanographic Sciences	**Date** :30/03/92

A3. TEMPERATURE COMPENSATION - BASIC SOFTWARE

The original BASIC program named COMRES.BAS, was written in BBC BASIC and run on a Spectrum. It is used to determine the value of resister verses temperature. The thermistor used is the FS15-B and the test temperatures were 50 °C and 20 °C. These give the resistance values as shown below

50 °C = 25 kΩ 20 °C = 90 kΩ

The original program was written with these values. The BASIC program was then modified for the test temperatures 0 °C and 30 °C and these values are listed below.

0 °C = 250 kΩ 30 °C = 70 kΩ

There were also some other modifications to extend the range of resistor values from 0 to 200 kΩ.

The current program has been rewritten in GWBASIC and is named TEMPCOMP.BAS. To start the program run the batch file TC.BAT by typing tc<cr> The listing of the program is as follows:-

```
10 PRINT "        RESISTOR     FREQ. DIFF"
20 PRINT "         K OHMS          HZ."
30 FOR X = 0 TO 200 STEP 5
40 Y=(((X+250)*1000)*100)/(((X+250)*1000)+100)
50 A=(((X+70)*1000)*100)/(((X+70)*1000)+100)
60 C=(100-Y)*88.2
70 D=(100-A)*88.2
80 P=C-D
90 PRINT "         "X"          "P
100 NEXT
110 SYSTEM
```

The results from the print out have been entered in the table below.

Resistor k Ω	Freq. Diff. Hz.	Resistor k Ω	Freq. Diff. Hz.
0	-9.055384	105	-2.553703
5	-8.286918	110	-2.448056
10	-7.620735	115	-2.349138
15	-7.037320	120	-2.256276
20	-6.523215	125	-2.169470
25	-6.068325	130	-2.087375
30	-5.662560	135	-2.009990
35	-5.298514	140	-1.937315
40	-4.970805	145	-1.868678
45	-4.674051	150	-1.802733
50	-4.404886	155	-1.740825
55	-4.159273	160	-1.682282
60	-3.935193	165	-1.626430
65	-3.729282	170	-1.573942
70	-3.540193	175	-1.524147
75	-3.365236	180	-1.476370
80	-3.203737	185	-1.430612
85	-3.055023	190	-1.386873
90	-2.915730	195	-1.345152
95	-2.786531	200	-1.306123
100	-2.666080		

APPENDIX B

B1. MECHANICAL HARDWARE

This section contains the drawings of the mechanical hardware used to house the sensor electronic interface printed circuit boards.

All details of the end caps, housing tubes are reproduced from the drawings used to manufacture the components and are therefore mechanically accurate in all details.

Both the tube and end cap drawings show the modifications that have occurred during the course of circuit development. It is important to understand the significance of the changes. These are in two areas

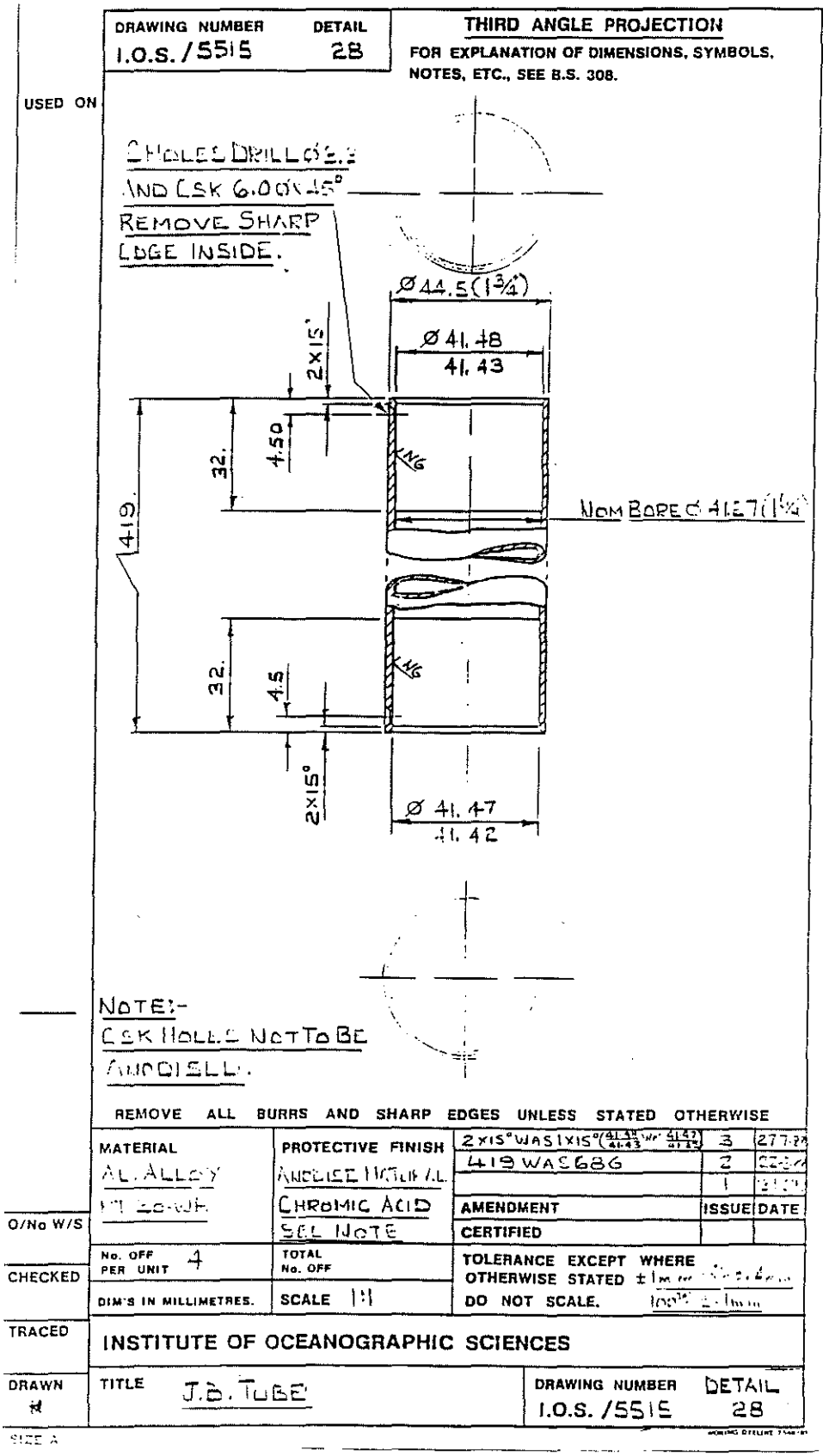
1. Decrease in the Tube length because of the re-design of the PCB.

2. The need for all parts of the housing to be in electrical contact, acting as an overall screen to the circuit.

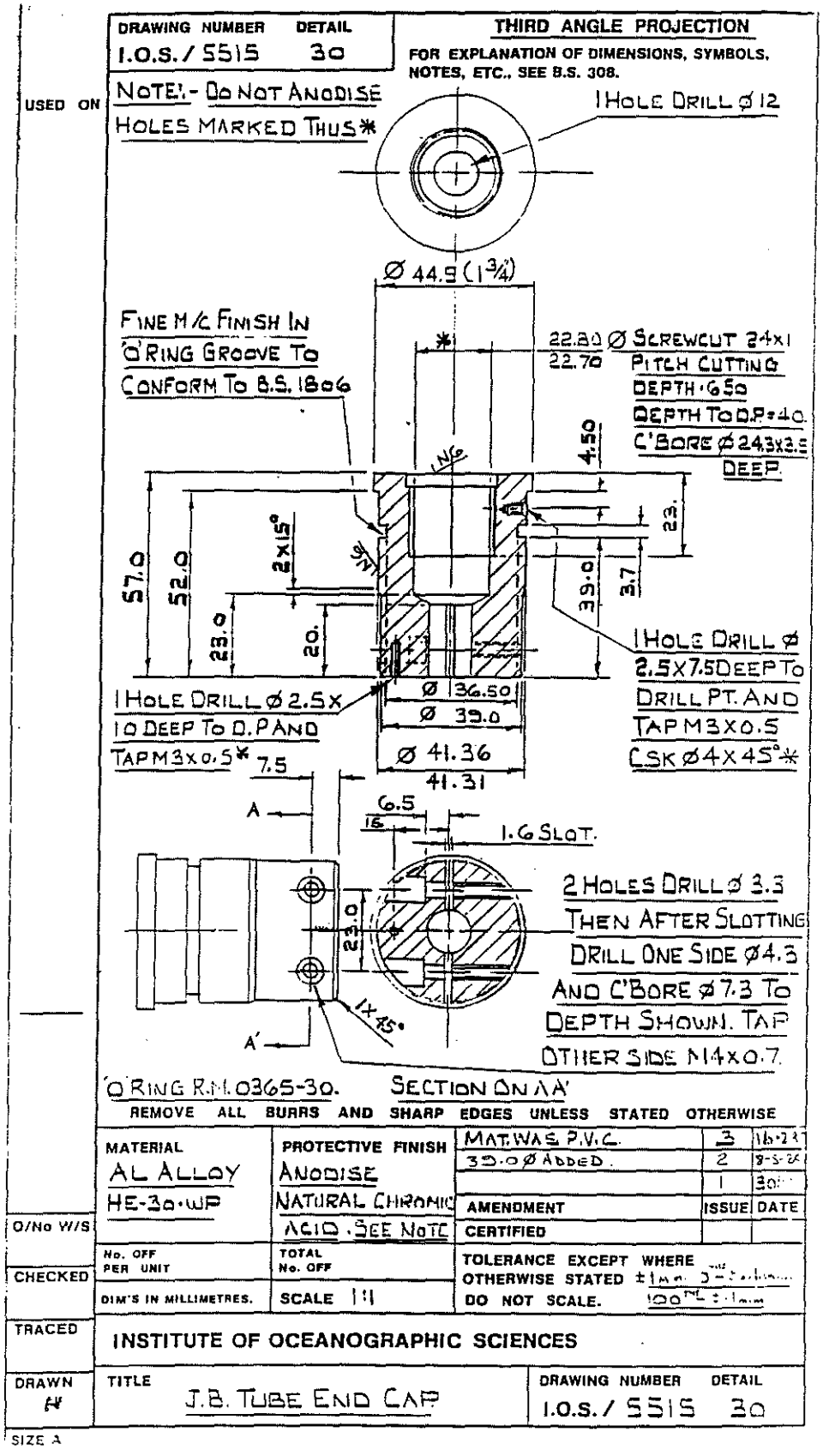
The conductivity between the end caps, tube, connector, sensor, and PCB is essential. To achieve this goal none of end cap screw threads are anodised. The countersunk holes in the tube ends, which secure the end caps, should also have any anodising removed. After mechanical assembly of the tubes is complete, electrical conductivity between all components must be ensured by measurements made with a Multimeter.

B1.1. Electronic Interface Housing for Vector Psychrometer

B1.1.1. Housing Tube - JB Tube I.O.S./5515/28

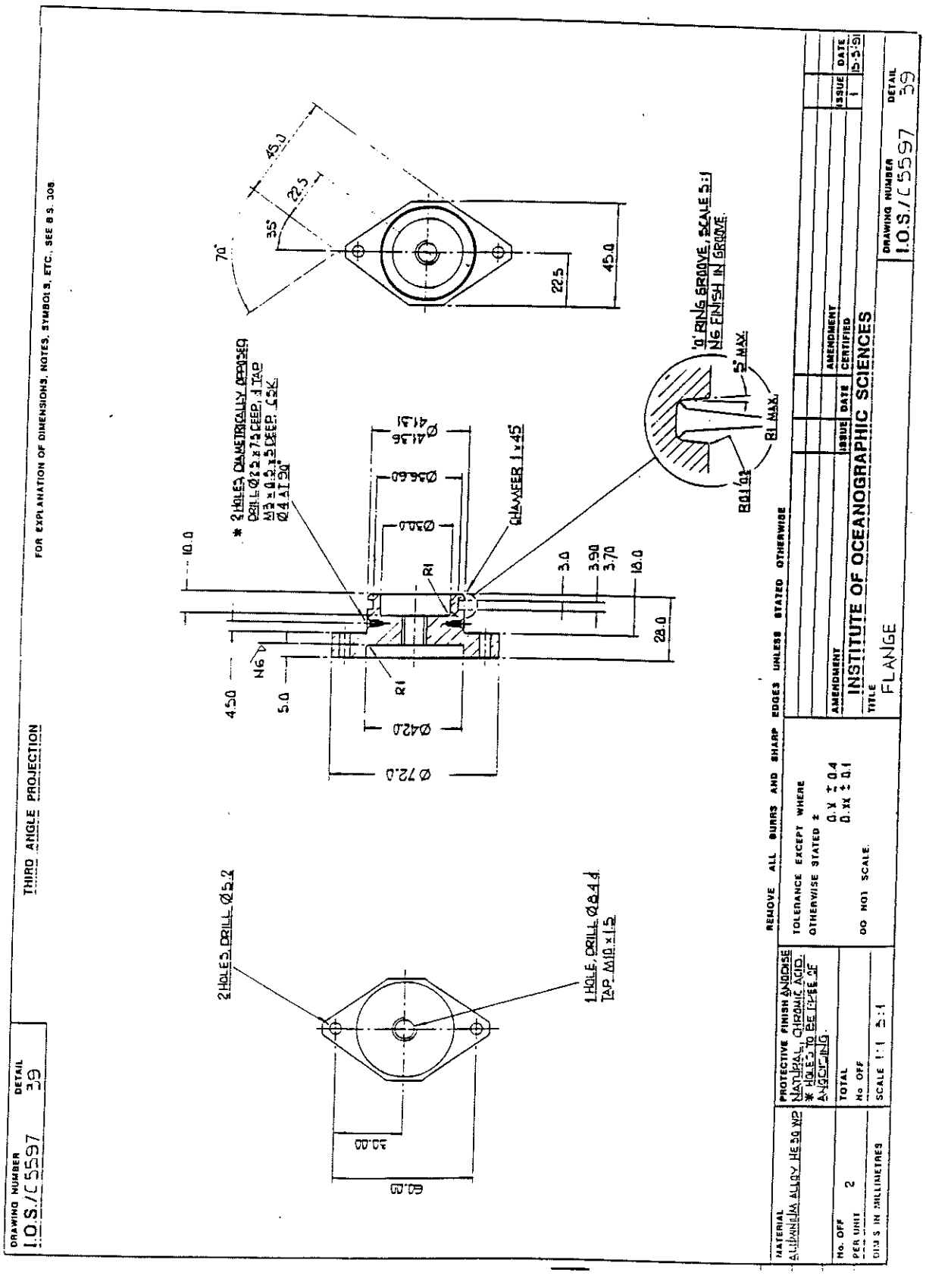


B1.1.2. End Cap - JB Tube End Cap I.O.S./5515/30



B1.2. Air Temperature Sensor

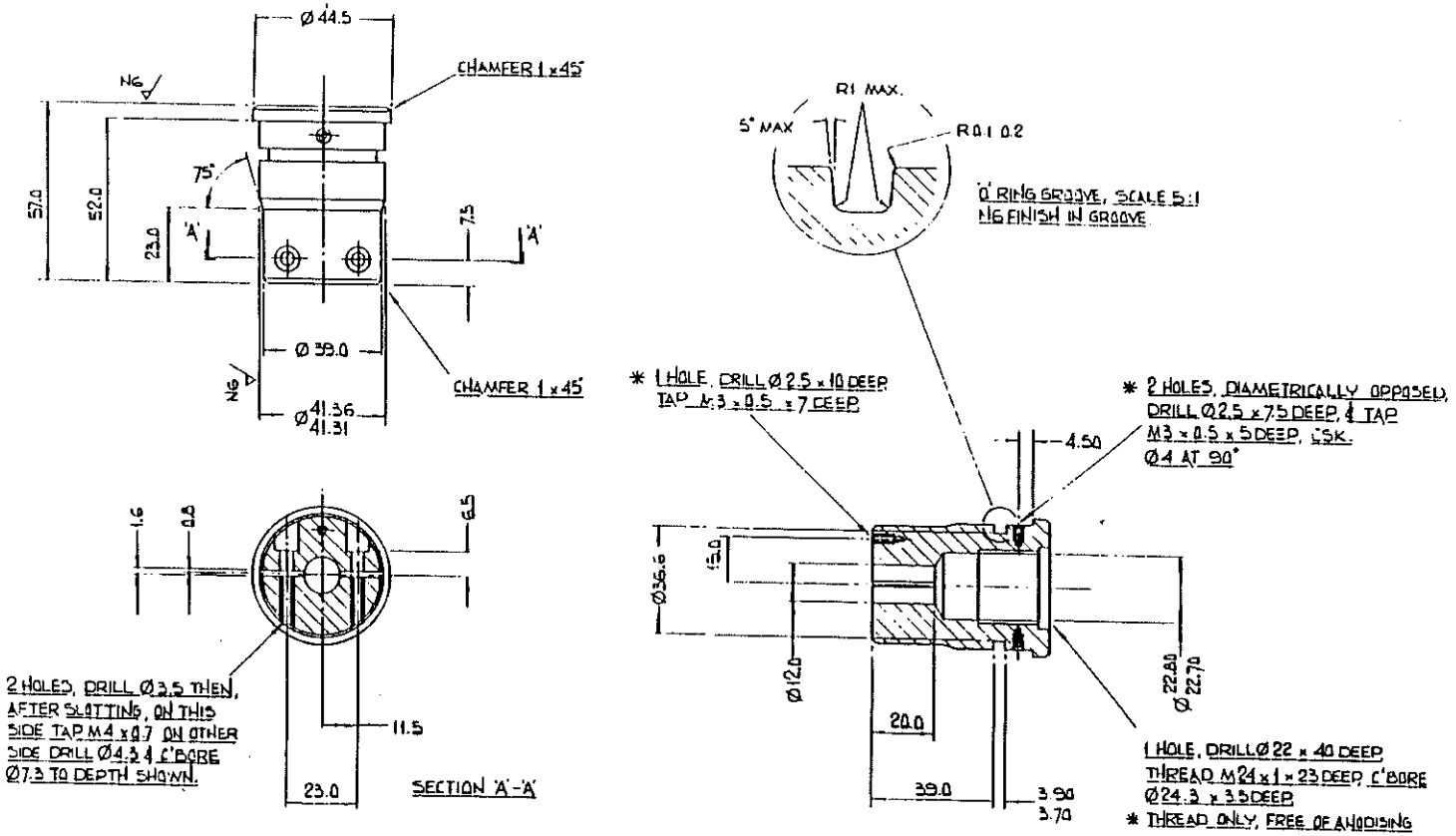
B1.2.1. End Cap with Screen Attachment Flange - I.O.S./C5597/39 Flange



DRAWING NUMBER	DETAIL
I.O.S./C5597	40

THIRD ANGLE PROJECTION

FOR EXPLANATION OF DIMENSIONS, NOTES, SYMBOLS, ETC., SEE B.S. 308.



REMOVE ALL BURRS AND SHARP EDGES UNLESS STATED OTHERWISE

MATERIAL: ALUMINIUM ALLOY HE 30 WP	PROTECTIVE FINISH: ANODISE NATURAL, CHROMIC ACID. * HOLES TO BE FREE OF ANODISING.	TOLERANCE EXCEPT WHERE OTHERWISE STATED ± 0.X ± 0.4, 0.XX ± 0.1	
No. OFF PER UNIT: 2	TOTAL No. OFF	DO NOT SCALE.	
DIMS IN MILLIMETRES	SCALE 1:1, 5:1		

AMENDMENT	ISSUE	DATE	AMENDMENT	ISSUE	DATE
			CERTIFIED	1	15.5.91

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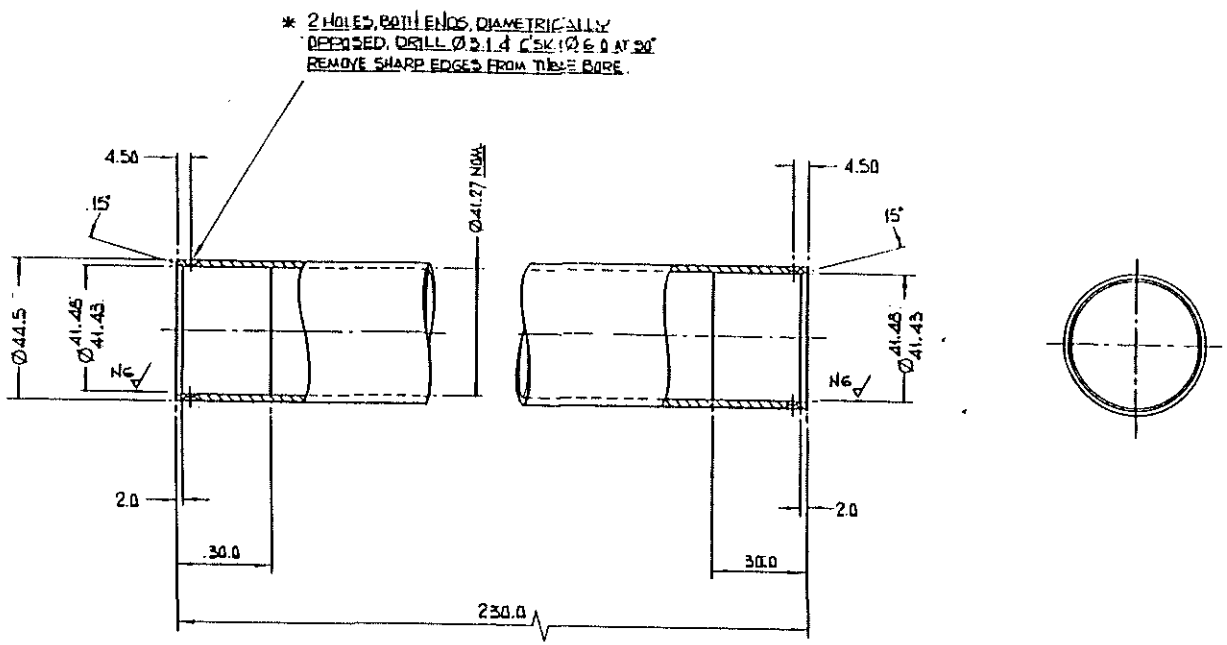
TITLE	DRAWING NUMBER	DETAIL
END CAP	I.O.S./C5597	40

DRAWING NUMBER	DETAIL
I.O.S./C5597	41

THIRD ANGLE PROJECTION

FOR EXPLANATION OF DIMENSIONS, NOTES, SYMBOLS, ETC., SEE B.S. 308



REMOVE ALL BURRS AND SHARP EDGES UNLESS STATED OTHERWISE

MATERIAL: ALUMINIUM ALLOY HT 30 WP	PROTECTIVE FINISH: ANODISE NATURAL, CHROMIC ACID. # HOLES TO BE FREE OF ANODISING	TOLERANCE EXCEPT WHERE OTHERWISE STATED ± :0.x ± 0.4 :0.xx ± 0.1	
No. OFF PER UNIT: 2	TOTAL No. OFF	DO NOT SCALE.	
DIM'S IN MILLIMETRES	SCALE: 1:1		

AMENDMENT	ISSUE	DATE	AMENDMENT CERTIFIED	ISSUE	DATE
				1	15-5-91

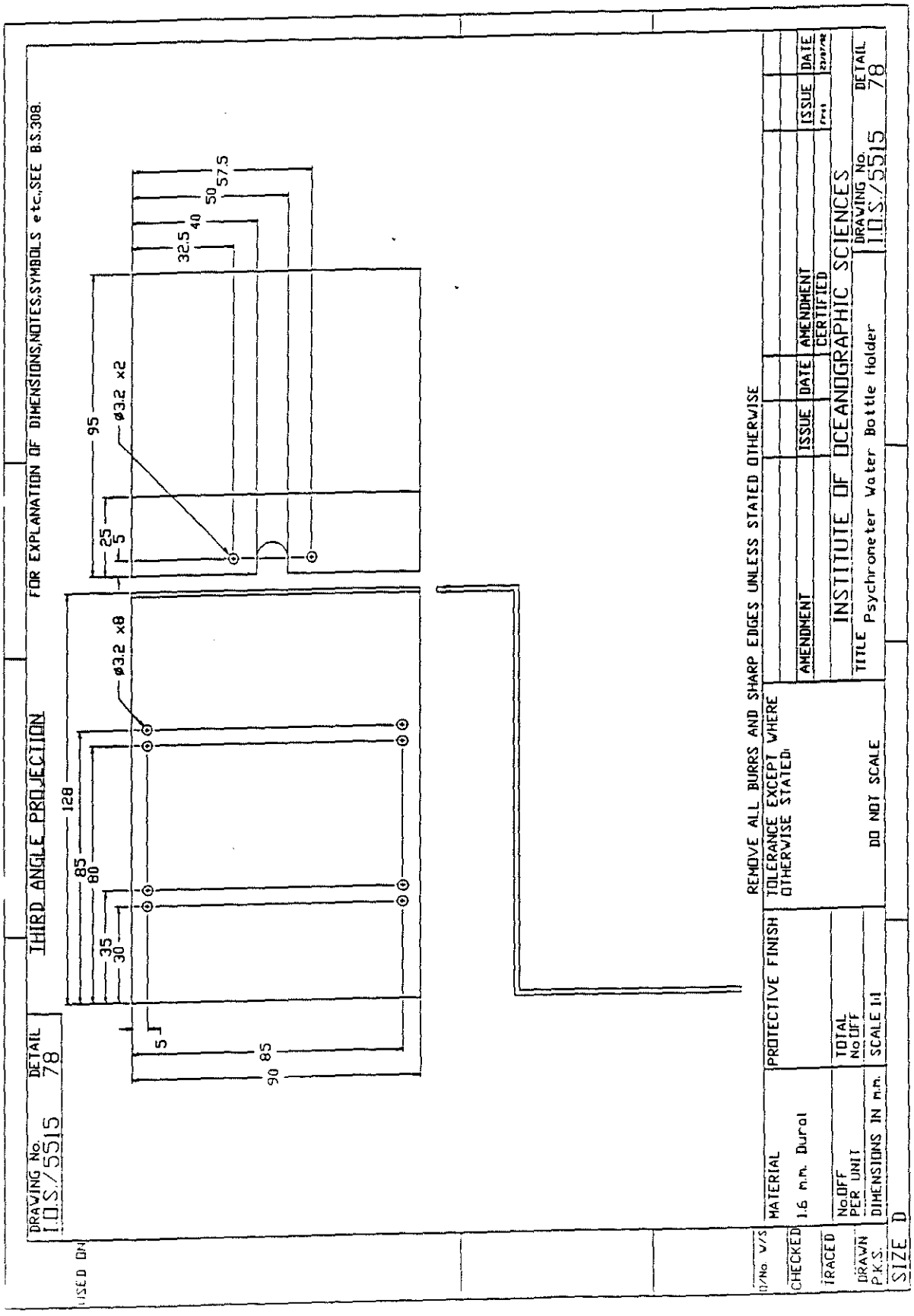
INSTITUTE OF OCEANOGRAPHIC SCIENCES

TITLE: TUBE

DRAWING NUMBER: I.O.S./C5597 DETAIL: 41

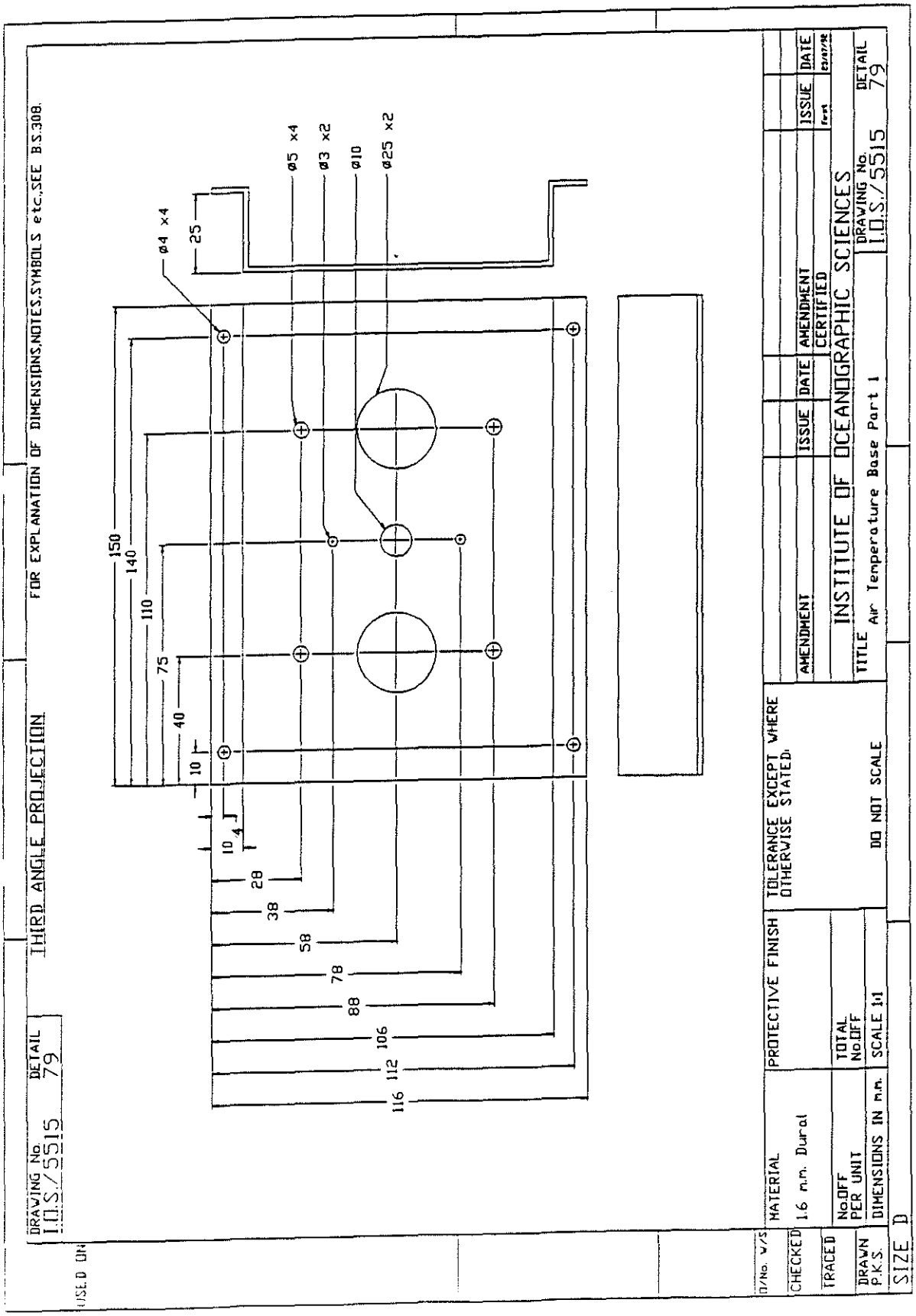
APPENDIX C

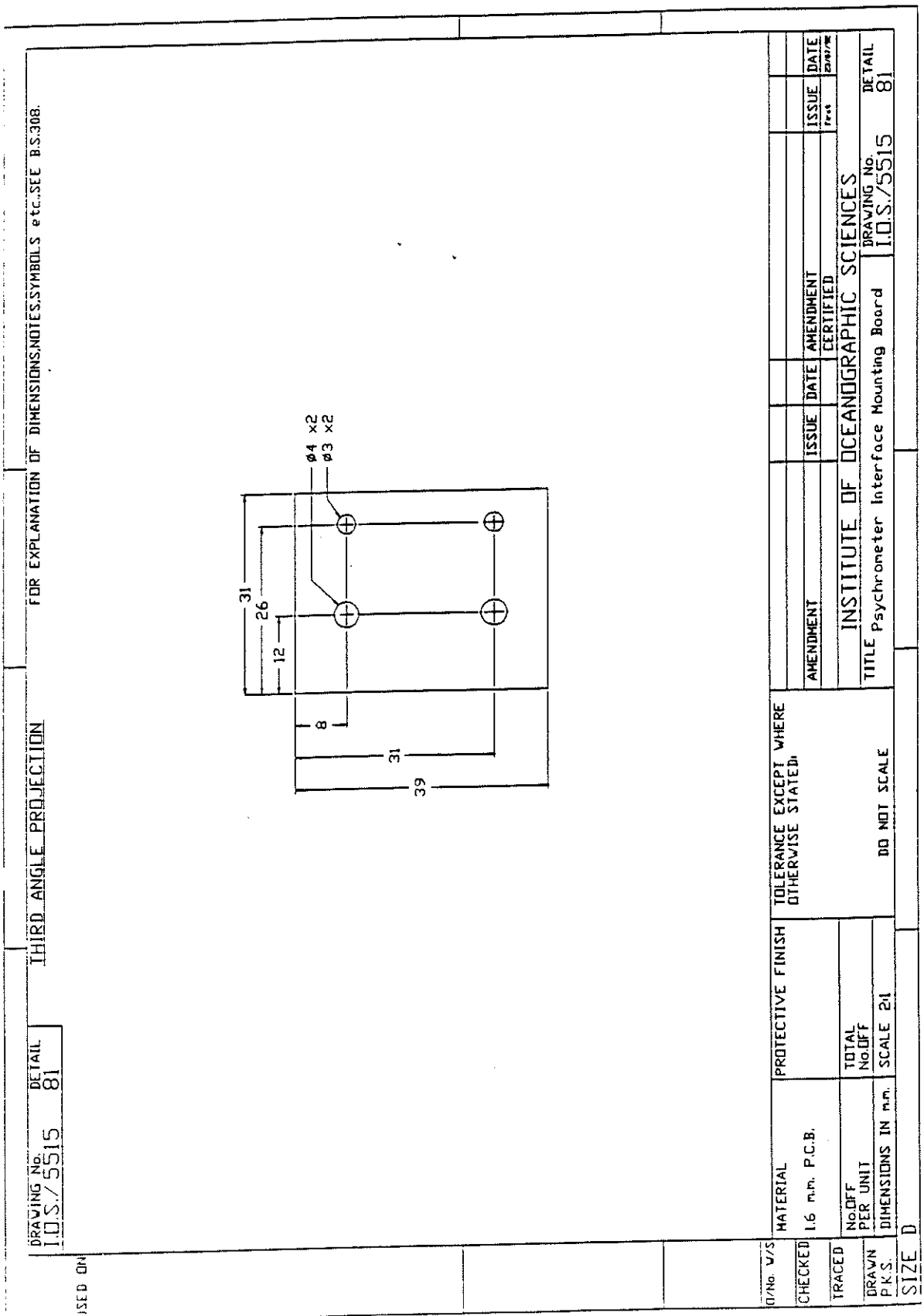
C1.1. Water Bottle Holder - I.O.S./5515/78 Psychrometer Water Bottle Holder



APPENDIX D

D1.1. Calibration Tank Clamp - I.O.S./5515/79 Air Temperature Base



APPENDIX E

E1.1. Printed Circuit Board Mounting - I.O.S./5515/81 Psychrometer Mounting Board