# MODEL INA 24718
# CRYOSTAT
# INSTRUCTION MANUAL

Isotech North America
158 Brentwood Drive, Unit 4
Colchester, VT 05446

Phone: 802-863-8050
Fax: 802-863-8125

www.isotechna.com
sales@isotechna.com

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## 1.Introduction and Principle

This special Cryostat has been designed for calibrating small sensors or unusual shaped sensor assemblies over cryogenic temperatures from approximately -180 deg.C. to -50 deg.C. to accuracies of approximately 0.01 to 0.02 deg.C. It enables temperature calibration to temperatures below those where chillers can operate efficiently.

The Cryostat comprises a closed ended stainless steel tube approximately 76mm diameter and 400mm long is attached beneath a flange carrying a special calibration assembly. This stainless steel tube assembly is lowered in to a container of Liquid Nitrogen in order to provide a relatively constant low temperature at -193 deg.C. which rises slowly as the liquid nitrogen boils off.

The internal copper equalising block calibration assembly can be adjusted to any desired temperature between -180 deg.C. and -50 deg.C. using a heater and temperature control system around the copper block calibration assembly.

## 2. Mechanical Description

Refer to drawing 24718 GA on page 8.

A stainless steel housing comprising a closed ended tube and flange (item 18 and 19) is attached by 6 bolts and 'O' ring seal to an upper flange (item 20)

A tube (item 21) exits the upper flange. It has two purposes :-

(i) To bring out the measurement signals and feed back power to heat the copper equalising calibration block / heater assembly inside the stainless steel housing via a hermetically sealed Lemo multi-pin socket and plug (item 24).

(ii) To connect to a valve and Klein flange (item 29 and 28) via a stainless steel vacuum pipe (item 23) permitting the Cryostat to be vacuumed.

The connections from the Cryostat Lemo plug are taken to a control box that controls the temperature inside a copper calibration equalising block.

The stainless steel housing contains a temperature controlled test / copper calibration equalising block (refer to drawing page 9) that has been drilled to form a test cavity in to which the unit under test (UUT) and any reference probe can be accommodated. This test cavity is approximately 42mm. diameter and 45mm. deep. The UUT once installed is sealed in place using a screwed lid and 'O' ring seal in the lower side of this calibration block assembly..

A stainless steel hollow tube (item 25) exits the top of the copper block and runs through the upper flange of the stainless steel housing to a Swage-lock fitting and silicone rubber washer. The UUT and reference thermometer wires run through this tube to be connected to the measuring instruments (see section 4. Operation)

A second tube also runs from the copper block through the upper flange. It gives the connection from the copper block to the flange rigidity and is not used for any other purpose.

NOTE: The main inner chamber of the stainless steel cryostat is maintained at a constant vacuum while the Test / calibration chamber is at normal atmosphere, with a 'Swage-lock' flange seal at the end of the cable entry tube.

## 3. Electrical Control and Measurement

Refer to Electrical Control and Measurement System diagram page 10.

Inside the Cryostat is a copper block that houses the UUT and reference thermometer. Surrounding the copper block is a heater of low voltage and wattage. To control the temperature of the copper block a 3wire PT100 sensor is embedded in the block, connected to the main block controller to drive the copper block heater. Around this heater are a number of layers of mylar insulant.

It is normal practice in high performance Cryostats to have between the copper block and the stainless steel outer housing a further copper tube which is also heated to act as a shield between the block and housing temperature which is close to – 190 deg. C. This Cryostat has a heated shield and its temperature is controlled by measuring both the block and shield temperatures and setting a difference between them. The outer shield is also insulated and a layer of reflective foil reduces radiant losses to the inner surface of the outer housing at Liquid Nitrogen temperatures. The differential shield control system maintains the shield at a temperature close to the copper test/calibration block. Between the outer Cryostat tube at close to -190deg.C. and the required control temperature of the calibration block. If only a single stage control system on the calibration block was used it would be very difficult with the large differential temperatures up to 140Deg.C from liquid nitrogen to -50deg.C.to control closely the calibrations to 0.01deg.C. The result is that with a low differential temperature set on the shield controller then the main calibration block controller only has to control over a range of a few degrees, e.g. 4 if the shield controller differential offset is set to 4 Deg. The differential system uses 2 type T thermocouples connected in series opposition to the controller input.

Measurement/Reference Thermometers

The calibration chamber uses a miniature calibrated reference PRT for the highest precision connected to the measurement bridge/system, in this case a TT17 digital thermometer with +/-O.O1deg.C precision for PRT inputs. The unknown test (UUT)probes are connected to other channels of the TT17 using the same connecting tube.

The calibration is performed by comparison of the calibrated probe to the unknown UUT inputs at several controlled set point temperatures once the system has reached a stable value. If a remote PC/Software control is arranged with the main controller PC port, then an automatic calibration at several required temperatures over the working range of the Cryostat can be made fully automatically e,g, when TT17EC software used.

## 4. Operation

To introduce the test probes to be calibrated (UUT) and the reference sensor it is necessary to take apart the Cryostat.

Loosen and remove the 6 bolts holding the flange and internal assembly to the stainless steel outer closed end tube. The internal assembly can then be carefully slid out of the tube. The user will see mylar insulation along the length of the internal assembly with a layer of reflective foil to minimise radiation heat losses. Handle the internal assembly carefully and place it on its side. Remove the copper cap with foil and internal O ring by unscrewing anti-clockwise with the special two prong tool provided. The UUT's and reference thermometer can be placed inside the cavity feeding the connecting leads up and out of the control tube (Item l5/l7 page 8). The copper cap and its 'O' ring seal can then be replaced. The wires are sealed as they exit the central tube using a Swagelock connection. The flange assembly is then re-assembled into the stainless steel outer container with its large O ring seal and the 6 bolts are re-tightened.

The Cryostat is now connected via the Klein flange/vacuum tube (item 28/23) to a vacuum pump and the system re-vacuumed. Observe the vacuum level on the pump or any gauge fitted to ensure there are no leaks and the system maintains a good vacuum. The vacuum switch (item 29) is then operated and vacuum pump disconnected. Cryostat is then lowered into the liquid nitrogen bottle supplied with LN installed. Check the level of LN is close to the top of the LN bottle neck and 'top-up' as necessary.

The cable supplied is connected from the LEMO socket (item 24) to the instrument control box . The controller is switched on and the main controller set to the required first calibration temperature. It is generally better/faster on manual control to operate at the lowest temperature first. The shield controller can be set initially to -20deg.C. to allow faster cooling. Once the desired temperature is reached the shield differential can be reduced to typically -5deg.C. Once the assembly has stabilised, the output of the UUT and reference can be recorded and the next temperature set.

Once the calibration is complete the Cryostat is removed from the Liquid Nitrogen and allowed to return to ambient temperature, at which point it can be taken apart and the process repeated with other sensors.

Note:- The controller PID settings can be checked on first operation of system to ensure good stability / control.
Plot the reference or UUT output and ensure when system comes in to control at the set value there is no oscillation. Temperature trace should be stable to within approximately +/-0.005 deg.C. over 25 minutes. With Cryostats, the response times can be quite slow, reaching final equilibrium after 30 or more minutes at some higher temperature levels. The typical PID terms are 20 deg.C. for the proportional band with Ti integration time of 900 to 1200 seconds. The Td derivative function can be zero. These terms can be

adjusted on any final system from the controller page and scroll keys using code 15 or 32 on code E. (Page key to “list ACCS” display ; Scroll key to “Code E” enter passcode then scroll to “Goto OPER” Go to PID list and using up arrow key select the PID term.

Automatic Calibration

When a suitable software system is used, such as TTI7EC / TTI7RW in conjunction with the TTI7 instrument, multichannel scanner cards plus PC control of the temperature control system and a PC, then automatic measurements and data logging with control of the Cryostat controller set-point can be made. This enables the controller and cryostat to be set to a number of different temperatures an d when the reference temperature monitored is stable to select, scan and measure the reference and unknown probes.

Print-out of the results for calculation is made or the results transferred in to a report writer and generation software such as TTI7RW to automatically prepare and print a report of each UUT tested.

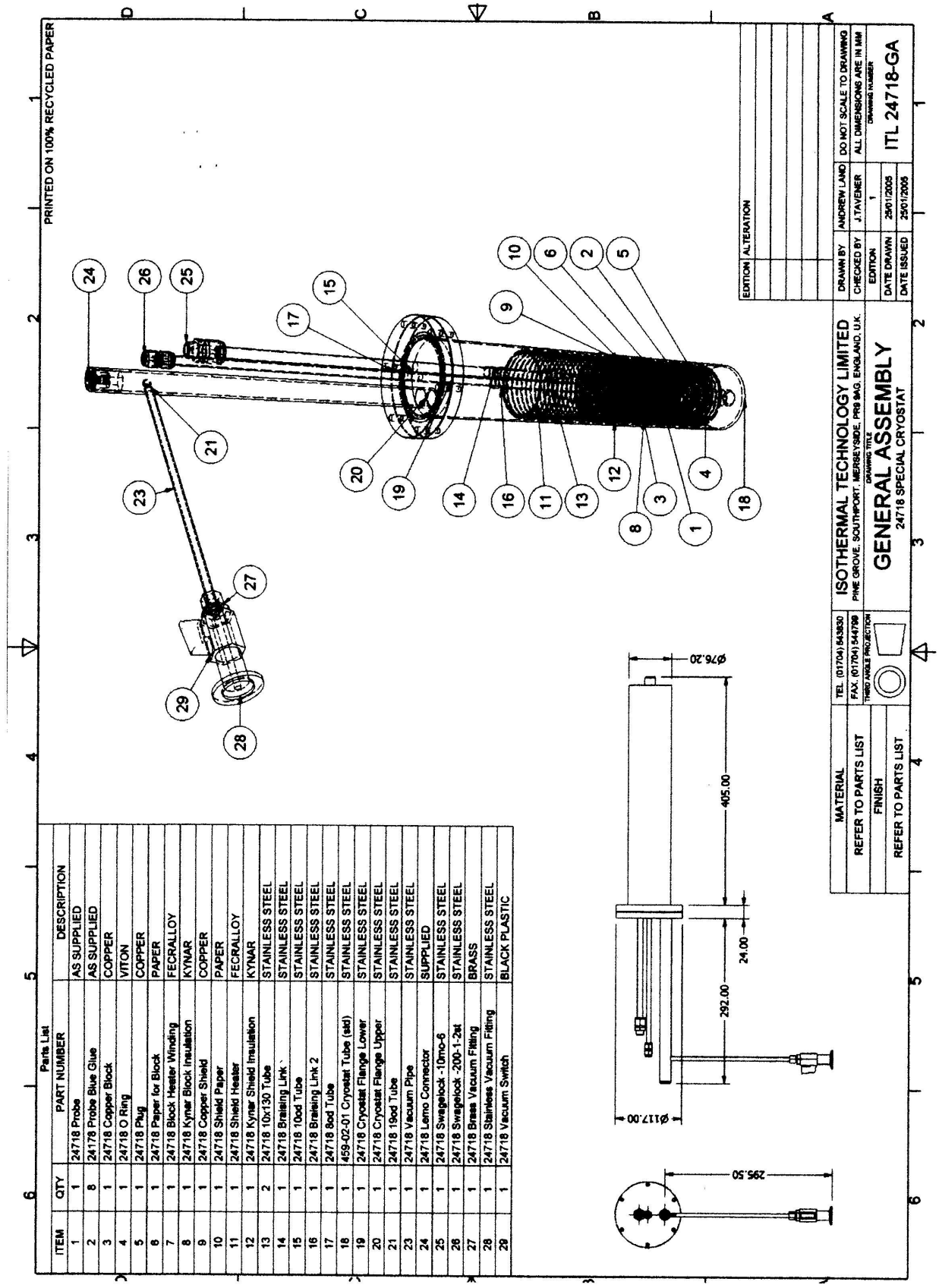
This system enables unattended, automatic calibration to be performed once the system has been set up in the Cryostat as detailed above.

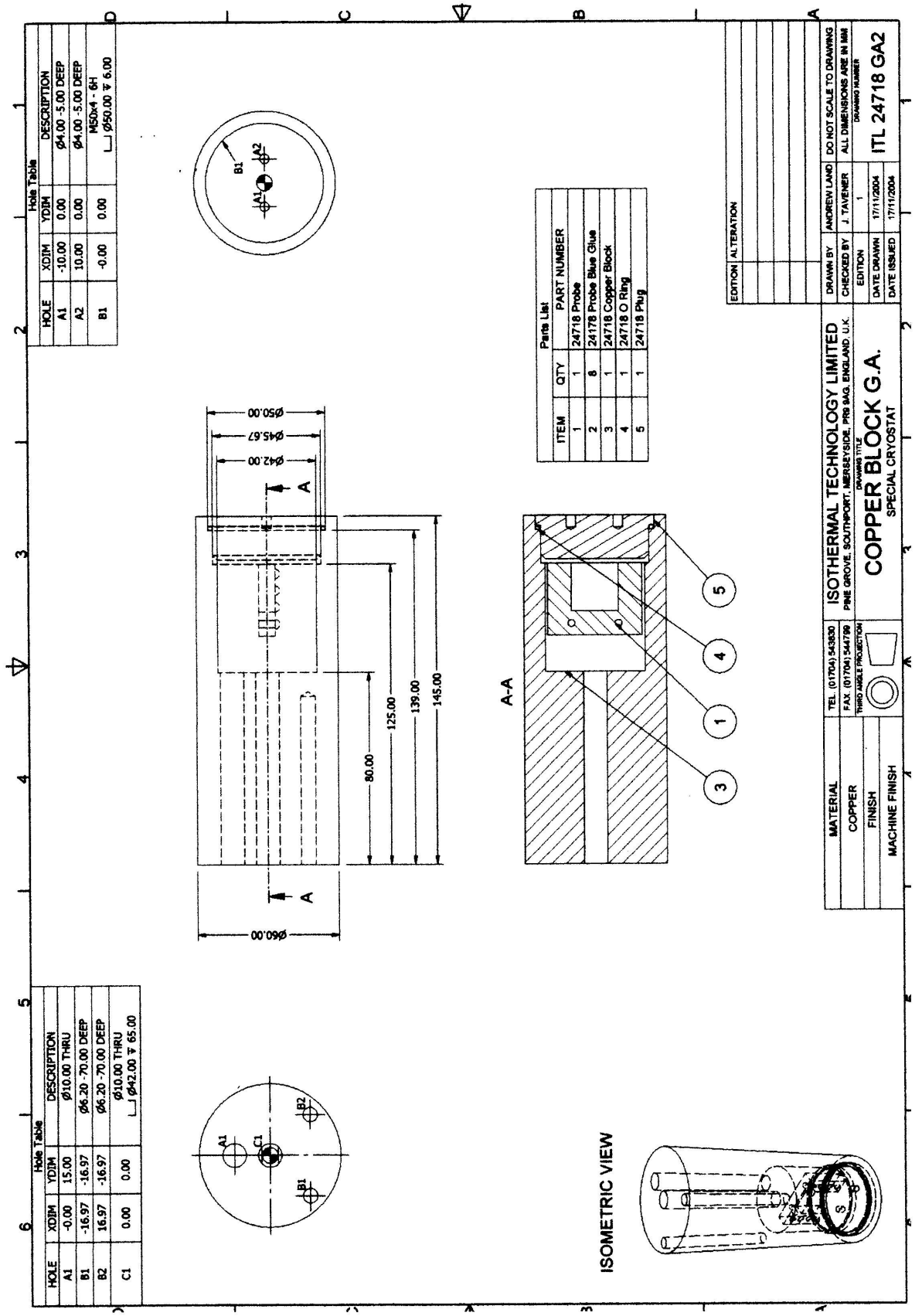
Automatic Calibration Operation

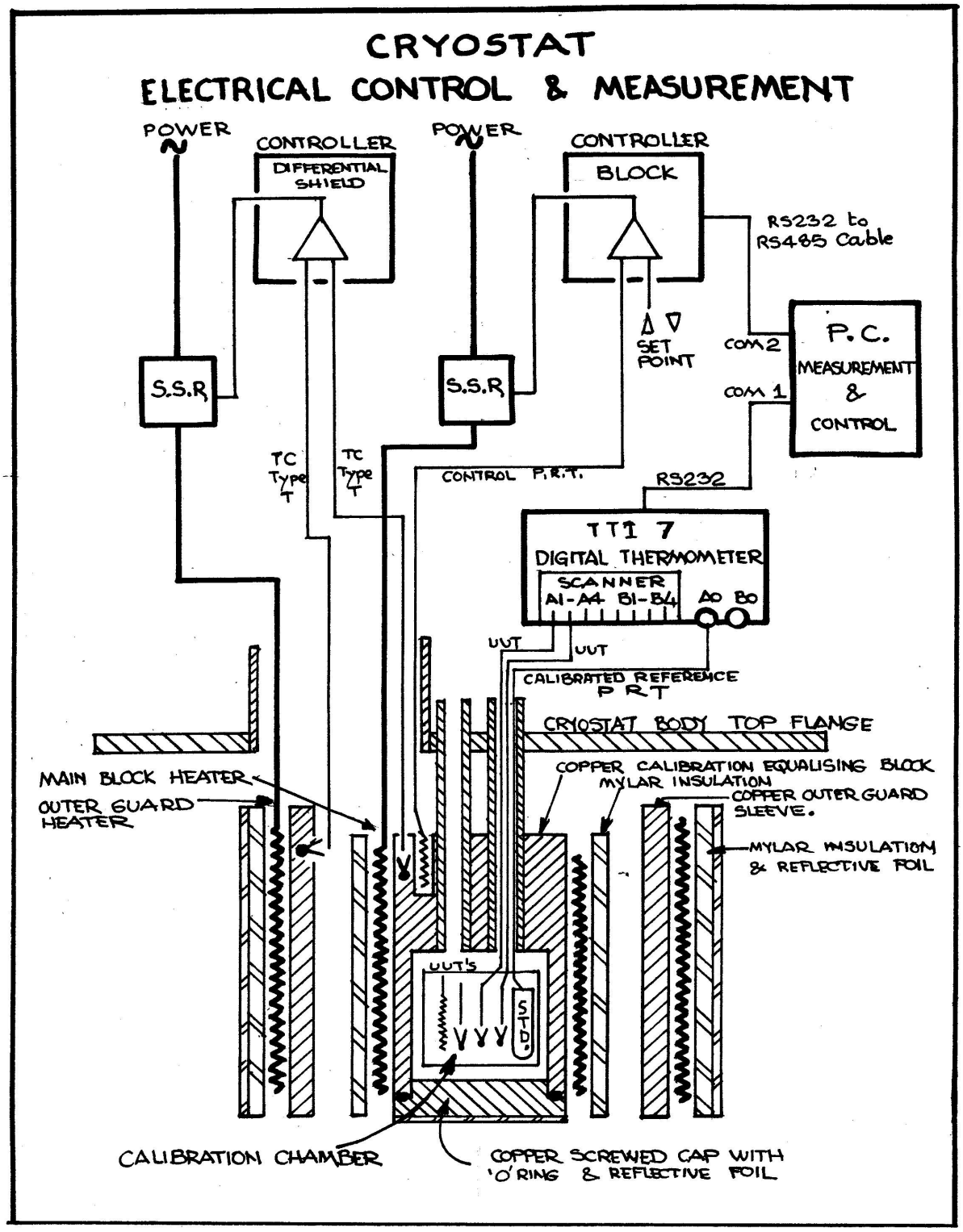
The measuring system is set up as illustrated in the diagram on page 10 with the TTI7 instrument RS232 PC port connected to RS232 COM 1 port on the PC. The Cryostat controller RS485 port is connected using the Yellow lead provided to the PC RS232 COM 2 port.

Connect the reference PRT probe to channel A0 on the front panel of the TTI7 instrument and remaining test probes to relevant PRT or TC scanner card channels A1 to A4 and/or B1 to B4.

Refer to the TTI7EC software instruction manual to set up and run the auto-cal calibration system. When tests completed at a number of calibration points, the calibration file of data can be downloaded to prepare final report or entered to the TTI7RW report writer and a certificate of calibration printed for each probe.


PRINTED ON 100% RECYCLED PAPER
Parts List
ITEM | QTY | PART NUMBER | DESCRIPTION
1 | 1 | 24718 Probe | AS SUPPLIED
2 | 8 | 24178 Probe Blue Glue | AS SUPPLIED
3 | 1 | 24718 Copper Block | COPPER
4 | 1 | 24718 O Ring | VITON
5 | 1 | 24718 Plug | COPPER
6 | 1 | 24718 Paper for Block | PAPER
7 | 1 | 24718 Block Heater Winding | FECRALLOY
8 | 1 | 24718 Kynar Block Insulation | KYNAR
9 | 1 | 24718 Copper Shield | COPPER
10 | 1 | 24718 Shield Paper | PAPER
11 | 1 | 24718 Shield Heater | FECRALLOY
12 | 1 | 24718 Kynar Shield Insulation | KYNAR
13 | 2 | 24718 10x130 Tube | STAINLESS STEEL
14 | 1 | 24718 Brasing Link | STAINLESS STEEL
15 | 1 | 24718 10od Tube | STAINLESS STEEL
16 | 1 | 24718 Brasing Link 2 | STAINLESS STEEL
17 | 1 | 24718 8od Tube | STAINLESS STEEL
18 | 1 | 459-02-01 Cryostat Tube (std) | STAINLESS STEEL
19 | 1 | 24718 Cryostat Flange Lower | STAINLESS STEEL
20 | 1 | 24718 Cryostat Flange Upper | STAINLESS STEEL
21 | 1 | 24718 19od Tube | STAINLESS STEEL
23 | 1 | 24718 Vacuum Pipe | STAINLESS STEEL
24 | 1 | 24718 Lemo Connector | SUPPLIED
25 | 1 | 24718 Swagelock -10mo-6 | STAINLESS STEEL
26 | 1 | 24718 Swagelock -200-1-2st | STAINLESS STEEL
27 | 1 | 24718 Brass Vacuum Fitting | BRASS
28 | 1 | 24718 Stainless Vacuum Fitting | STAINLESS STEEL
29 | 1 | 24718 Vacuum Switch | BLACK PLASTIC
Ø76.20
405.00
24.00
292.00
Ø117.00
295.50
MATERIAL
REFER TO PARTS LIST
FINISH
REFER TO PARTS LIST
TEL. (01704) 543830
FAX. (01704) 544799
THIRD ANGLE PROJECTION
ISOTHERMAL TECHNOLOGY LIMITED
PINE GROVE, SOUTHPORT, MERSEYSIDE, PR9 9AG, ENGLAND, U.K.
DRAWING TITLE
GENERAL ASSEMBLY
24718 SPECIAL CRYOSTAT
EDITION | ALTERATION
DRAWN BY | ANDREW LAND
CHECKED BY | J.TAVENER
EDITION | 1
DATE DRAWN | 25/01/2005
DATE ISSUED | 25/01/2005
DO NOT SCALE TO DRAWING
ALL DIMENSIONS ARE IN MM
DRAWING NUMBER
ITL 24718-GA


Hole Table
HOLE XDIM YDIM DESCRIPTION
A1 -10.00 0.00 Ø4.00 -5.00 DEEP
A2 10.00 0.00 Ø4.00 -5.00 DEEP
B1 -0.00 0.00 M50x4 - 6H ⌴ Ø50.00 ₸ 6.00
Hole Table
HOLE XDIM YDIM DESCRIPTION
A1 -0.00 15.00 Ø10.00 THRU
B1 -16.97 -16.97 Ø6.20 -70.00 DEEP
B2 16.97 -16.97 Ø6.20 -70.00 DEEP
C1 0.00 0.00 Ø10.00 THRU ⌴ Ø42.00 ₸ 65.00
Parts List
ITEM QTY PART NUMBER
1 1 24718 Probe
2 8 24178 Probe Blue Glue
3 1 24718 Copper Block
4 1 24718 O Ring
5 1 24718 Plug
Ø50.00
Ø45.67
Ø42.00
Ø60.00
80.00
125.00
139.00
145.00
A-A
ISOMETRIC VIEW
EDITION ALTERATION
MATERIAL
COPPER
FINISH
MACHINE FINISH
TEL. (01704) 543830
FAX. (01704) 544799
THIRD ANGLE PROJECTION
ISOTHERMAL TECHNOLOGY LIMITED
PINE GROVE, SOUTHPORT, MERSEYSIDE, PR9 9AG, ENGLAND. U.K.
DRAWING TITLE
COPPER BLOCK G.A.
SPECIAL CRYOSTAT
DRAWN BY ANDREW LAND
CHECKED BY J. TAVENER
EDITION 1
DATE DRAWN 17/11/2004
DATE ISSUED 17/11/2004
DO NOT SCALE TO DRAWING
ALL DIMENSIONS ARE IN MM
DRAWING NUMBER
ITL 24718 GA2


CRYOSTAT
ELECTRICAL CONTROL & MEASUREMENT
POWER
CONTROLLER
DIFFERENTIAL SHIELD
POWER
CONTROLLER
BLOCK
RS232 to RS485 Cable
S.S.R
S.S.R
SET POINT
COM 2
COM 1
P.C.
MEASUREMENT & CONTROL
TC Type T
TC Type T
CONTROL P.R.T.
RS232
TTI 7
DIGITAL THERMOMETER
SCANNER
A1-A4 B1-B4 A0 B0
UUT
UUT
CALIBRATED REFERENCE PRT
CRYOSTAT BODY TOP FLANGE
MAIN BLOCK HEATER
OUTER GUARD HEATER
COPPER CALIBRATION EQUALISING BLOCK
MYLAR INSULATION
COPPER OUTER GUARD SLEEVE.
MYLAR INSULATION & REFLECTIVE FOIL
UUT's
STD.
CALIBRATION CHAMBER
COPPER SCREWED CAP WITH 'O' RING & REFLECTIVE FOIL