

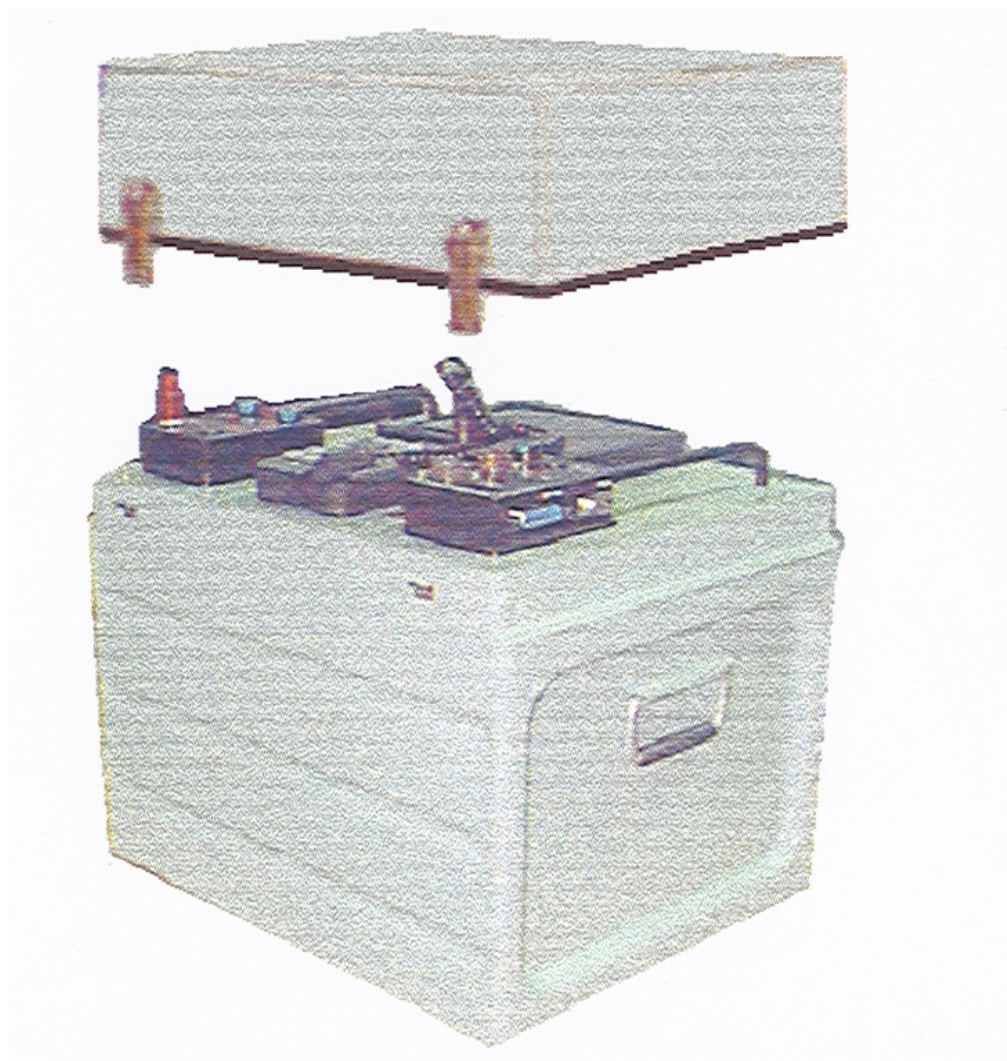


COMPUTER CONTROLLED AIR DATA TEST SET 2

TYPE D60340MK

Calibration Reference Manual PIM415-R

March 2010



CONTENTS

<u>SUBJECT</u>	<u>PAGE</u>
INTRODUCTION	1
DESCRIPTION	3
1. Introduction	3
2. Maximum Operating Limits	4
3. Clock Date and Time	8
4. Calibration Constants	9
CALIBRATION	13
1. Introduction	13
2. Equipment Required	13
3. Calibration Procedure	14
A. Static Channel (Altitude) Calibration	14
B. Entry of Calibration Constants	16
C. Pitot Channel (Airspeed) Calibration	18
APPENDIX	23

LIST OF TABLES

<u>TABLE NO</u>	<u>TITLE</u>	<u>PAGE</u>
1	Equipment Required	13
2	Static Channel Calibration Points	15
3	Pitot Channel Calibration Points	21

LIST OF ILLUSTRATIONS

<u>FIG. NO.</u>	<u>TITLE</u>	<u>PAGE</u>
1	CCU Front Panel Layout	3
2	RCDU Layout	5
3	Maximum Operating Limits	6
4	RCDU Main Menu	6
5	Operation Setup & Defaults Sub—Menu	7
6	Password Controlled Sub—Menu	7
7	Change Clock Time & Date Formats Display	8
8	Typical Error Correction Graph	9
9	Selecting Calibration Units	10
10	Entry of Calibration Constants	10
11	Static Channel Calibration	14
12	Typical Extrapolation Graph	18
13	Pitot Channel Calibration	19
14	Pressure Control Mode	20

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INTRODUCTION

This reference manual describes the procedure for calibrating the Penny & Giles Aerospace Limited Computer Controlled Air Data Test Set 2 (CCADTS 2) Type D60340MK.

CCADTS 2 is a totally self-contained unit providing all necessary vacuum and pressure sources required for 1st Line testing of aircraft altitude and airspeed cockpit indicators and associated warning systems. For further information on CCADTS 2, refer to Penny & Giles Operators Manual PUB144.

If any difficulty is experienced in the use of this manual, contact the following for assistance:

Product Support
Penny & Giles Aerospace Limited
1 Airfield Road
Christchurch
Dorset BH23 3TH
UK

Telephone: 44 (0) 1202 409409
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E-mail: support@pennyandgiles.com

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DESCRIPTION

1. INTRODUCTION

This manual contains information to enable calibration to be completed on the Computer Controlled Air Data test Set 2 (CCADTS 2). It should be noted, however, that Penny & Giles recommend that the equipment be returned either to them or to an authorized Service Centre for calibration. Penny & Giles shall not be responsible for any damage to the equipment arising from the use of incorrect calibration techniques.

The CCADTS 2 is a computer-controlled system which generates pitot and static pressures in order to test air data equipment and engine intake control systems. The pitot and static channels are controlled in conjunction with one another to simulate airspeed and altitude conditions.

The CCADTS 2 comprises a Remote Control and Display Unit (RCDU) and a main Calibrator/Control Unit (CCU) which houses the integral vacuum and pressure supplies, the pneumatic controls, the pressure control sensors and the processing circuits. The control and measurement system is based on a multi—processor architecture, utilizing 16—bit digital control and circuitry developed from airborne primary air data computers. Pitot and static connections to the pitot and static ports are made via colour—coded hoses (blue for static, red for pitot) and self—sealing adaptors. The adaptors protect the instrument under test by preventing pressure loss in the event of inadvertent disconnection whilst the system is pressurised. They too are colour—coded and are keyed to ensure correct connection is made.

The front panel of the CCADTS 2 Calibration / Control Unit is shown in Figure 1, with the Remote Control Display Unit shown in its storage position.

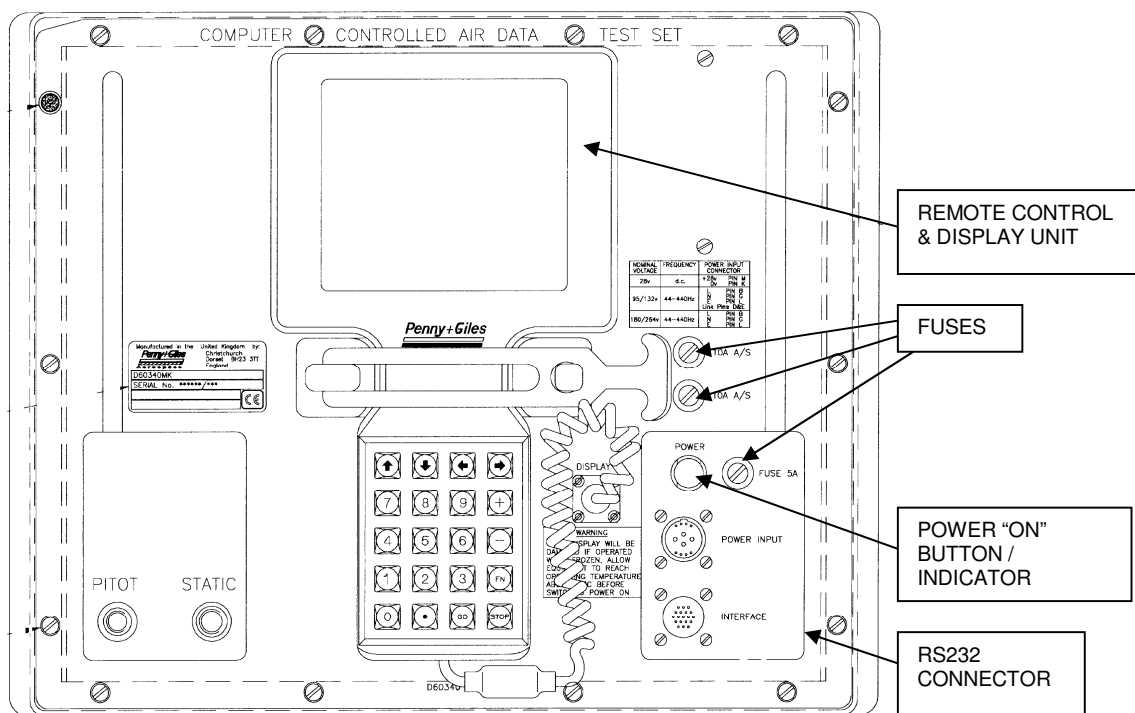


Figure 1 CCU Front Panel Layout

All CCADTS 2 functions can be accessed and controlled from the menus presented on the RCDU screen. The RCDU keyboard (Fig. 2) comprises a 5 by 4 key array with numbers 0 to 9, plus (+), minus (-) and decimal point (.). The four arrow keys ($\leftarrow \uparrow \rightarrow \downarrow$) on the top line of the keyboard are all cursor control keys. In addition to its basic function of making negative any input values, the minus sign is used together with the plus sign, to change the displayed units and nudge the controlled pressures. The plus key is only used for inputting a positive number if the previous number entered was a negative number. The GO key is used for entering parameters and also to start pressurization during control procedures. The FN key is used to access a number of Function options, such as Screen Contrast, and to enter the Customer password. The STOP key is used to exit from any mode and return to the previous menu page or, with multiple key presses, to the main menu. Any pressures within the system at that time will be held until another mode of operation is selected.

2. MAXIMUM OPERATING LIMITS

When power is applied to CCADTS 2, the equipment performs a systems test. If this has been successfully completed, the RCDU will display the 'Entry of Maximum Operating Limits' page (Fig. 3). This page can also be accessed via Option 2 on the RCDU main menu (Fig. 4).

NOTE: If the RCDU screen doesn't change from its opening screen, then the self-test routine has detected a fault and the user should contact the Customer Support Department of Penny & Giles at the address given on page 1 of this manual.

CCADTS 2 is supplied to the Customer with power-on default values for the maximum operating limits. These defaults, which can be redefined by the Customer, are designed to protect the equipment under test by providing an operating envelope which prevents the inadvertent entry of incorrect pressure values. The parameter values displayed on the 'Entry of Maximum Operating Limits' page are the power-on default values currently set for the equipment.

Prior to calibrating the CCADTS 2, they must be reset to the maximum values permissible for each parameter to enable the equipment to be calibrated over its complete operating range, as shown by the equipment label.

To change the limits, the Customer may alter the settings via the screen which appears on power up. However, these changes are only temporary and since the CCADTS 2 is powered down during the calibration procedure, the limits would need to be reset several times. It is therefore preferable to reset them via Main Menu Option 4, Operation Setup and Defaults. This ensures that the new defaults are retained when power is removed. When Option 4 is selected, the sub-menu in Fig. 5 is displayed. Press the function key, FN, and key in the Customer password supplied with the equipment. Press "GO" to enter. This gives access to the extended sub-menu shown in Fig. 6. Select Option 5, Select Maximum Operating Defaults.

CAUTION: BEFORE RETURNING THE EQUIPMENT TO SERVICE, THE POWER-ON DEFAULTS MUST BE RETURNED TO THE OPERATING VALUES SET NORMALLY. FAILURE TO DO SO MAY CAUSE DAMAGE TO THE EQUIPMENT UNDER TEST. IT IS THEREFORE RECOMMENDED THAT PRIOR TO RESETTING THE OPERATING LIMITS TO THEIR MAXIMUM VALUE, A RECORD SHOULD BE MADE OF THE CURRENT LIMITS TO ENSURE THAT THE CORRECT VALUES ARE RE-ENTERED ON COMPLETION OF CALIBRATION.

To enter new values, position the cursor over the value to be altered using the cursor keys and change the original value via the numeric keypad. If an attempt is made to enter an out-of-range value, an appropriate error message is displayed at the bottom of the screen. The value for each parameter must be set to equal the limit for that parameter shown in brackets below it. For example, if the limit for Altitude is shown as 80000 feet, then the default Maximum Altitude, if different, must be set to 80000 feet.

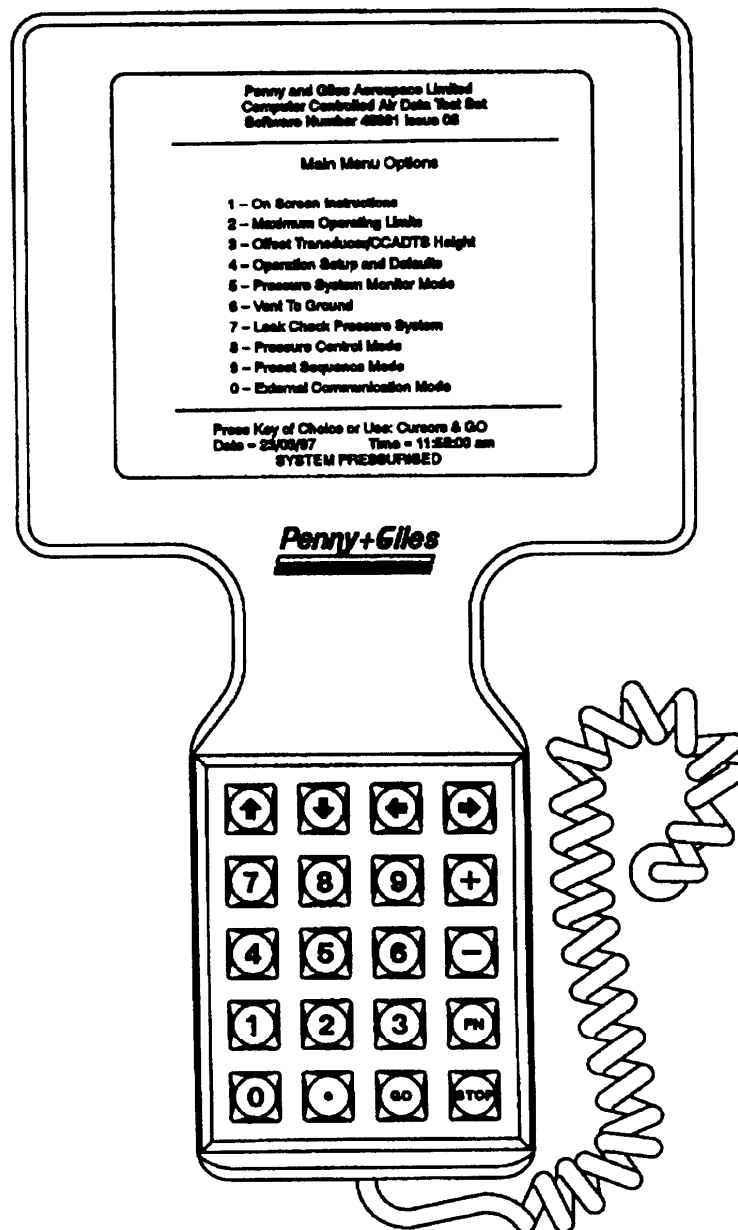


Figure 2 RCDU Layout

Entry of Maximum Operating Limits Maximum Altitude = 45000 feet (limit: 80000 feet) Maximum Airspeed = 500.0 knots (limit: 1000.0 knots) Maximum Mach Number = 0.890 (limit : 4.000) Maximum Altitude Rate = 5000 feet/mm (limit : 20000 feet/mm) Maximum Airspeed Rate = 300 knots/mm (limit: 2000 knots/mm)
Use Cursor Buttons to Edit Limits Press STOP to return to main menu

FIGURE 3 Maximum Operating Limits

Penny and Giles Aerospace Limited Computer Controlled Air Data Test Set Software Number 48981 Issue 07
Main Menu Options 1 - On Screen Instructions 2 - Maximum Operating Limits 3 - Offset Transducer/CCADTS Height 4 - Operation Setup and Defaults 5 - Pressure System Monitor Mode 6 - Vent To Ground 7 - Leak Check Pressure System 8 - Pressure Control Mode 9 - Preset Sequence Mode 0 - External Communication Mode
Press Key of Choice or Use: Cursors & Go Date = 07/07/97 Time = 11:55:00 AM SYSTEM PRESSURISED

FIGURE 4 RCDU Main Menu

Operation Setup and Defaults 1 - Internal/External Pressure Source 2 - Mach Number Corrections 3 - Select Default Control Units 4 - Volume Settlement Periods
Use Cursor Buttons to Edit Limits Press STOP to return to main menu

FIGURE 5 Operation Setup and Defaults

Operation Setup and Defaults 1 - Internal/External Pressure Source 2 - Mach Number Corrections 3 - Select Default Control Units 4 - Volume Settlement Periods 5 - Select Maximum Operating Defaults 6 - Change Clock Time and Date 7 - Entry of Calibration Constants
Press Key of Choice or Use: Cursors & Go Press STOP to return to main menu

FIGURE 6 Password Controlled Sub-Menu

NOTE: Minimum Altitude is preset at the factory and cannot be altered by the customer. Unless otherwise specified, the limit for Minimum Altitude is reset to - 3000 feet.

Once all parameters are correctly entered, accept them by pressing the STOP key. Press the STOP key a second time to return the RCDU display to the main menu. The software automatically re-programs the new limits into the EEPROM within the CCU Communications Processor.

Power down the equipment, wait 5 seconds then re-apply power. The new power-on defaults are passed from the Communications Processor to the RCDU during the Self-Test period.

3. CLOCK DATE AND TIME

If the Date and Time displayed on the RCDU are incorrect they must be reset via the extended sub-menu shown in Fig. 6. Select Option 6, Change Clock Time and Date.

With the cursor positioned adjacent to the Date Format (Fig. 7), the +/- keys toggle the format between 'dd/mm/yy' and 'mm/dd/yy'.

With the cursor adjacent to the time format, the +/- keys toggle the format between '12 hour' and '24 hour'. When setting time in the 12-hour format, the +/- keys toggle between 'AM' and 'PM'.

Using the cursor keys, enter the correct date and time and press GO to accept the data. Press the STOP key twice to return to the main menu.

6 - Change Clock Time & Date Formats	
Date Format	= dd/mm/yy
Time Format	= 12 hour
Enter Date	15/02/09
Enter Time	12:00:00AM
Use + and - to change units Use cursor to change and STOP for menu	

FIGURE 7 Change Clock Time & Date Formats Display

4. CALIBRATION CONSTANTS

Pressure sensing within CCADTS 2 is carried out by two vibrating-cylinder type pressure sensors, which provide a frequency output directly proportional to the measured pressure. For accuracy, each transducer is provided with integral temperature compensation. Additionally, their basic quoted accuracy can be improved by the application of manual correction factors, or calibration constants, which are input by the Operator during the calibration procedure. These calibration constants, which are also referred to as pressure residuals, are the corrections required to counteract the difference, or error, between the measured pressure determined by the transducers, and the true pressure generated by the Primary Calibration Standard. Ideally, this error should be zero. Therefore if an error of +0.03 mbar is obtained for a calibration point, i.e. CCADTS 2 reading is +0.03 mbar above the true pressure, then a correction of -0.03 mbar must be applied to reduce the error to zero (Fig. 8).

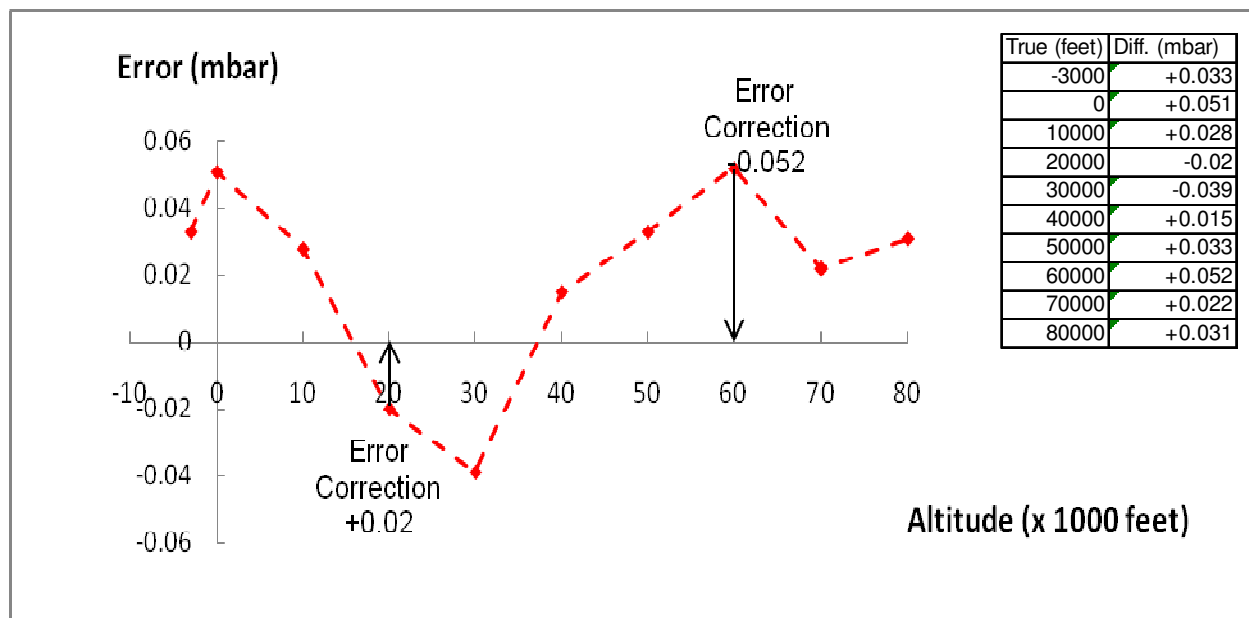


Figure 8 Typical Error Correction Graph.

Prior to commencing the calibration procedure, the calibration constants entered during the previous calibration must be reset to zero.

CAUTION: DO NOT ENTER THIS OPTION FOR ANY REASON UNLESS INTENDING TO CHANGE THE VALUES OF THE PRESSURE RESIDUALS. THE NORMAL METHOD OF EXIT FROM AN OPTION DOESN'T OPERATE WITH THIS OPTION AND THE OPERATOR CANNOT EXIT UNLESS ALL PRESSURE RESIDUALS HAVE BEEN STEPPED THROUGH, A DATE ENTERED, AND THE STOP KEY PRESSED. WHEREUPON THE DATA IS AUTOMATICALLY REPROGRAMMED INTO THE EEPROM WITHIN THE CCU COMMUNICATIONS PROCESSOR. ENTERING THIS OPTION FOR REASONS OTHER THAN CALIBRATION RUNS THE RISK OF THE PRESSURE RESIDUALS STORED WITHIN THE EEPROM BEING INADVERTENTLY ALTERED.

Select Option 7 from the extended sub-menu shown in Fig. 6. The RCDU displays a screen which prompts the Operator to choose the preferred pressure units for the constants (Fig. 9). Select 1 or 2 and press GO.

Pressing GO a second time gives rise to the prompt for the first pressure residual to be entered (Fig. 10),

7 – Entry of Calibration Constants 1 – mbar 2 - inHg
Press Key of Choice of Use: Cursors & GO Press STOP to return to menu

Figure 9 Selecting Calibration Units

7 – Entry of Calibration Constants *1 – mbar 2 - inHg Set Static Pressure No. 0 = 27.615 mbar Pressure Residual = 0.000
Press Key of Choice of Use: Cursors & GO Press STOP to return to menu

Figure 10 Entry of Calibration Constants

Reset all pressure residuals for the static channel to zero. If the units selected are mbar, then enter '.000'. If the pressure residuals are to be entered in inHg, they must be entered as '.00000' (The leading zero before the decimal point is omitted.) Press the GO key after entering each pressure residual to accept the new data. Since the pitot and void pressure residuals will be zero already, step through by pressing GO for each pressure residual displayed.

- NOTES:**
- 1. No pressure residuals are entered for the pitot channel because the accuracy of this channel is referenced to the static channel and the pitot readings are found to give rise to negligible differences between the true pressure and the measured pressure.**
 - 2. Void pressure residuals are zero because the CCADTS 2 has no void channel.**

Enter a date for the next calibration when prompted and press the STOP key to return to the password-controlled sub—menu. The date doesn't have to be accurate; it is simply needed to complete the routine and permit the software to automatically reprogram the new data into the EEPROM within the CCU Communications Processor.

Press STOP a second time to return to the main menu then power down the CCADTS 2. When power is re-applied, the new pressure residuals will be transferred to the RCPU during the Self-Test period.

With all pressure residuals set to zero, the CCADTS 2 may now be calibrated.

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CALIBRATION

1. INTRODUCTION

CCADTS 2 must be calibrated against a Primary Calibration Standard, which is itself traceable to a National Standard. Following calibration against such a standard, the CCADTS 2 may be classed as a Secondary Standard item of equipment.

Calibration shall be carried out under the following conditions:

Temperature:	+15°C to +30°C
Air Pressure:	860 to 1060 mbar (25.396 to 31.302 inHg), Absolute
Relative Humidity:	20 to 70%

2. EQUIPMENT REQUIRED

The equipment required to carry out calibration is listed in Table 1.

Table 1 Equipment Required

REF.	ITEM
1	Power Supply Unit - Rated to provide the CCADTS 2 normal operating voltage, i.e. one of the following options: 21 to 32 V d.c., 200 W 110 V a.c., 60 Hz, 250 VA 115 V a.c., 400 Hz, 250 VA 240 V a.c., 50 Hz, 250 VA
2	Primary Calibration Standard - Capable of generating Absolute Pressure over the range 20 to 1130 mbar (0.59 to 33.37 inHg) and with an accuracy of ± 0.01 mbar (± 0.0003 inHg) or better at high altitudes.
3	Primary Calibration Standard - Capable of generating Differential Pressure over the range 0 to 2500 mbar (0 to 73.83 inHg) and with an accuracy of ± 0.01 mbar (± 0.0003 inHg) or better at low airspeeds.
4	Pressure Source — A high purity source (e.g. Nitrogen or Dry Air).
5	2 off Flexible Hoses — Inner diameter (bore) 0.25 in, length 15 ft (max) and fitted with self-sealing adaptors.

CAUTION: WHEN SELECTING A PRIMARY CALIBRATION STANDARD, NOTE THAT A MERCURY-TYPE MANOMETER WILL DEGRADE THE CALIBRATION ACCURACY OF THE CCADTS 2. THIS IS BECAUSE THE MERCURY VAPOUR EXPELLED FROM THESE DEVICES WILL AFFECT THE PERFORMANCE OF THE DENSITY-SENSITIVE TRANSDUCERS IF ALLOWED TO INGRESS INTO THE CCADTS 2 CHASSIS. IF ONE IS USED, IT IS ESSENTIAL THAT AN IN-LINE FILTER BE FITTED. THIS DEGRADATION IS NOT, HOWEVER, PERMANENT; THE ACCURACY WILL BE AFFECTED ONLY WHILST THE EQUIPMENT IS SUBJECT TO THE MERCURY VAPOUR.

3. CALIBRATION PROCEDURE

A. Static Channel (Altitude) Calibration

CAUTION: AT THE REQUEST OF THE CUSTOMER, SOME CCADTS 2 HAVE A LOWER LIMIT THAN 80000 FEET SET FOR MAXIMUM ALTITUDE. SIMILARLY, SOME CCADTS 2 MAY NOT OPERATE DOWN TO -3000 FEET. DO NOT ATTEMPT TO OPERATE THE CCADTS 2 OUTSIDE THE MAXIMUM LIMITS SET FOR IT, AS SHOWN ON THE EQUIPMENT LABEL. IF AN ATTEMPT IS MADE TO DO SO, THE EQUIPMENT WILL VENT, WHICH MAY CAUSE DAMAGE TO THE PRIMARY CALIBRATION STANDARD.

- (1) Connect the equipment in accordance with Fig. 11 and apply power.

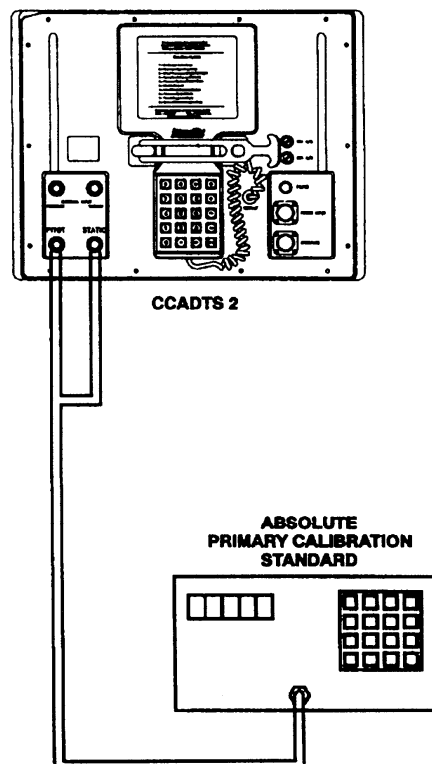


Figure 11 Static Channel Calibration

- (2) Following Self-Test the RCDU will display the 'Entry of Maximum Operating Limits' page. Confirm that the values for each parameter match the limits shown in brackets. If not, follow the procedure in paragraph 2 of the INTRODUCTION to amend them
- (3) Press the STOP key to gain access to the RCDU main menu.
- (4) Select Option 5, Pressure System Monitor Mode. In this mode CCADTS 2 has no facility for pressure control and merely monitors pressures within the system.

- (5) Ensure the RCDU screen displays STATIC PRESSURE in the preferred units. If ALTITUDE is displayed, select it via the cursor key and toggle the +/- keys until STATIC PRESSURE is displayed. The displayed units will automatically change from height units to pressure units. The preferred pressure unit can then be selected via the +/- keys, as before.
- (6) Monitor the Static Pressure whilst slowly reducing the pressure in the system to that corresponding to the Maximum Altitude the CCADTS 2 can model. For example, if the CCADTS 2 under calibration can model an Altitude of 80000 feet, reduce the pressure to approx. 30 mbar, or 0.874 inHg.

NOTE: Due to the large volume of gas which is contained within the CCADTS 2, care is needed in controlling the reduction in pressure since the RCDU display will fluctuate rapidly.

- (7) When pressure has been achieved, slowly increase pressure until the RCDU reads a Static pressure equivalent to the Minimum Altitude the CCADTS 2 can model. (i.e. approx. 1125 mbar, or 32.783 inHg, for an Altitude of -3000 feet).
- (8) Repeat the procedure in paragraphs 3.A.(6) and 3.A.(7) to cycle the CCADTS 2 a second and third time to ensure that the high purity pressure medium has completely filled the system, eradicating any previous pressure medium.
- (9) Calibrate the static channel by applying pressures to the CCADTS 2 to simulate altitudes between -3000 feet and 80000 feet (or to the nearest point within the individual equipment operating limits), in accordance with Table 2. For each calibration point, read off and record the measured value, i.e. the 'Actual' value of Static Pressure as displayed on the RCDU, and also the true pressure generated by the Primary Calibration Standard. Tabulate the results on a Set-up Sheet similar to the sample sheet provided in the Appendix (pages 23 to 26). For each point calculate the difference between the true pressure and the measured pressure.

Table 2 Static Channel Calibration Points

ALTITUDE (kFeet)	STATIC PRESSURE (mbar)	STATIC PRESSURE (inHg)
-3	1128.029	33.3107
0	1013.250	29.9212
10	696.817	20.5770
20	465.633	13.7501
30	300.896	8.8854
40	187.539	5.5380
50	115.972	3.4247
60	71.716	2.1178
70	44.377	1.3105
80	27.615	0.8155

- (10) Set the Primary Calibration Standard to generate the Pressure of the Day. When achieved, isolate it from the CCADTS 2. Disconnect the pipework from the CCADTS 2 ports, leaving them open to atmosphere.

- (11) The difference values obtained in paragraph 3.A.(9), with their sign reversed, are the calibration constants, or pressure residuals, which are entered by the Operator. To enter the residuals, follow the procedure given in paragraph 3.B. For calibration points outside the range of the CCADTS 2 being calibrated, the corresponding pressure residuals are extrapolated from those obtained during calibration using the formula provided.
- (12) When all pressure residuals have been entered, re-connect the equipment in accordance with Fig. 11 and repeat the procedure in paragraphs 3.A.(2) to (9). The new pressure differences obtained, however, are not entered as calibration constants, but are simply recorded on the official Calibration Sheet for the equipment (see the sample in the Appendix (pages 23 to 26). The first calibration run, or set-up run, determines the manual correction factors, or calibration constants, which must be entered to improve upon the basic accuracy of the transducers. The second run is the basis upon which CCADTS 2 calibration is claimed.
- (13) Confirm that the second set of RCDU 'Actual' pressures recorded for the static channel are within the following tolerances (tolerances apply only to measurements at ambient temperature):

± 0.199 mbar @ 1128.029 mbar	(0.00588 inHg @ 33.3107 inHg)
± 0.183 mbar @ 1013.250 mbar	(0.00540 inHg @ 29.9212 inHg)
± 0.164 mbar @ 300.896 mbar	(0.00484 inHg @ 26.8167 inHg)
± 0.088 mbar @ 91.198 mbar	(0.00259 inHg @ 2.6931 inHg)
± 0.065 mbar @ 27.615 mbar	(0.001 92 inHg @ 0.81 55 inHg)
- (14) Set the Primary Calibration Standard to generate the Pressure of the Day. When achieved, isolate it from the CCADTS 2. Disconnect the pipework from the CCADTS 2 ports, leaving them open to atmosphere. Remove power from the equipment.

B. Entry of Calibration Constants

CAUTION: AS PART OF THE PROCEDURE FOR ENTERING THE PRESSURE RESIDUALS, THE CCADTS 2 MUST BE POWERED DOWN FOR A FEW SECONDS TO ENSURE THAT DATA IS PASSED FROM THE EEPROM IN THE CCU COMMUNICATIONS PROCESSOR TO THE RCDU. IT IS ESSENTIAL THAT CCADTS 2 IS NOT POWERED DOWN WHILST STILL CONNECTED TO THE PRIMARY CALIBRATION STANDARD. PRESSURE OF THE DAY MUST FIRST HAVE BEEN ACHIEVED, AND THE EQUIPMENT ISOLATED.

With the CCADTS 2 powered up but isolated from the Primary Calibration Standard, the calibration constants, or pressure residuals, for the static channel are entered as follows:

- (1) Select Option 4 from the RCDU main menu. Press the FN key and when prompted, enter the Customer password supplied with the equipment. From the extended sub-menu which appears (Fig. 6), select Option 7, Entry of Calibration Constants. Select the preferred pressure units (Fig. 9) and press the GO key.
- (2) Pressing GO a second time gives rise to the prompt for the first pressure residual to be entered (Fig. 10).
- (3) Enter all pressure residuals for the static channel. If the units selected are mbar, then the pressure residuals must be entered with a maximum of 3 decimal places. If the pressure residuals are to be entered in inHg, they must be entered with a maximum of 5 decimal places. If the constant is CCADTS 2 under calibration has been factory set to operate over a narrower range than the full calibration range, the pressure residuals for the omitted calibration points must be determined by extrapolation from those measured.

- (4) The formula uses the pressure residuals for the last two points calibrated. For example, if the CCADTS 2 was calibrated only to 60000 feet, then to obtain the error for the 70000 feet calibration point, the measured errors for 60000 feet and 50000 feet are used. For the measured error at 80000 feet, the value for 70000 feet obtained by extrapolation would then be used with the value measured for 60000 feet. While this increases the error in the value extrapolated for the 80000 feet calibration point, it is immaterial to the operation of the calibrated CCADTS 2 since it will only be simulating altitudes of up to 60000 feet when in service. The extrapolation is used to complete the software routine and enable the best final correction to be made.

NOTE: Normally, the CCADTS 2 may require extrapolation only for the upper range of altitude. Where extrapolation is required for the -3000 feet calibration point, the formula will still apply; a backwards extrapolation is made using the first two calibration points measured.

- (5) The graph between any two adjacent points is considered to be a straight line, and the formula for extrapolation is as follows:

$$y_3 = \frac{(x_3 - x_1)}{(x_2 - x_1)} \times (y_2 - y_1) + y_1$$

where x_1 is the penultimate static calibration point measured
 x_2 is the ultimate static calibration point measured
 x_3 is the calibration point to be extrapolated
 y_1 is the corresponding penultimate measured error
 y_2 is the corresponding ultimate measured error
 y_3 is the unknown error.

All values are in pressure units.

- (6) As an example, consider a CCADTS 2 which has been calibrated over the range -3000 feet to +60000 feet (see Fig. 12). The pressure residuals for the +70000 feet and the -80000 feet calibration points must be extrapolated from the formula. To obtain the pressure residual for the 70000 feet calibration point, the pressure residuals for the 50000 feet and 60000 feet calibration points are used. If the units of calibration are mbar, then the Static Pressure equivalent to 50000 feet is 115.972 mbar (x_1). The Static Pressure equivalent to 60000 feet is 71.716 mbar (x_2). If the measured errors are -0.022 (y_1) and -0.015 (y_2) respectively, then the error (y_3) for x_3 44 377 mbar (70000 feet) is found as follows:

$$y_3 = \frac{(44.377 - 115.972)}{(71.716 - 115.972)} \times (-0.015 - (-0.022)) + (-0.022) \text{ mbar}$$

i.e., $y_3 = -0.0107$ mbar

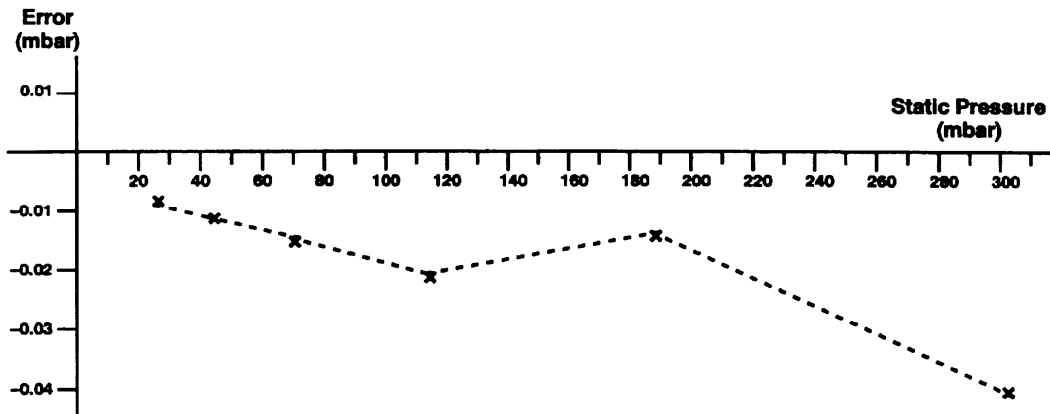
- (7) Similarly, the pressure residual for the 80000 feet, or 27.615 mbar, calibration point is found by substituting:

$x_1 = 71.716$ mbar
 $x_2 = 44.377$ mbar
 $x_3 = 27.615$ mbar
 $y_1 = -0.015$ mbar
 $y_2 = -0.0107$ mbar

This gives:

$$y_3 = \frac{(27.615 - 71.716)}{(44.377 - 71.716)} \times (-0.0107 - (-0.015)) + (-0.015) \text{ mbar}$$

i.e., $y_3 = -0.0081$ mbar



NOTE: Only the four lowest measured static calibration points are shown.

Figure 12 Typical Extrapolation Graph

- (8) As before when zeroing all pressure residuals (see INTRODUCTION), step through the pitot and void pressure residuals by pressing GO for each pressure residual displayed. No pressure residuals are entered for the pitot channel since, generally, the differences obtained between the true and measured values for this channel are considered negligible. In the unlikely event that the pitot channel accuracy is not within the tolerances defined in paragraph 3.C.(5), contact the Customer Support Department of Penny & Giles Aerospace Ltd. for further assistance.
- (9) Enter the date for the next calibration as 12 months hence from the current month/ year (or whichever calibration interval is preferred) and press the STOP key twice to return to the main menu. The software automatically reprograms the new limits into the EEPROM within the CCU Communications Processor.
- (10) Power down the equipment, wait 5 seconds then re-apply power. The new pressure residuals are passed from the Communications Processor to the RCDU during the Self-Test period.

C. Pitot Channel (Airspeed) Calibration

CAUTION: AT THE REQUEST OF THE CUSTOMER, SOME CCADTS 2 HAVE A LOWER LIMIT THAN 1000 KNOTS SET FOR MAXIMUM AIRSPEED. SIMILARLY, SOME CCADTS 2 MAY NOT OPERATE DOWN TO 20 KNOTS. DO NOT ATTEMPT TO OPERATE THE CCADTS2 OUTSIDE THE MAXIMUM LIMITS SET FOR IT, AS SHOWN ON THE EQUIPMENT LABEL. IF AN ATTEMPT IS MADE TO DO SO, THE EQUIPMENT WILL VENT, WHICH MAY CAUSE DAMAGE TO THE PRIMARY CALIBRATION STANDARD.

On completion of the static channel calibration, the pitot channel is calibrated.

- (1) Connect the equipment in accordance with Fig. 13.

NOTE: While Penny & Giles Aerospace recommend the use of a closed system for calibration, particularly where ambient pressure changes significantly, it is acceptable to leave the static channel open to atmosphere if using an absolute Primary Calibration Standard.

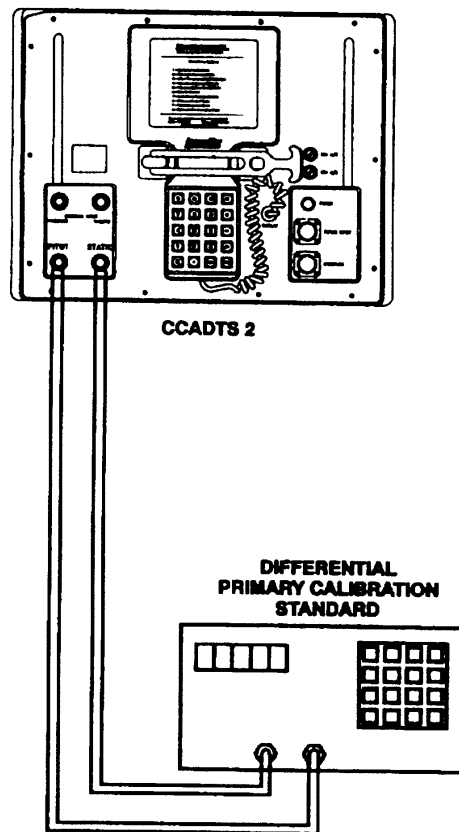


Figure 13 Pitot Channel Calibration

- (2) Apply power to the equipment.
- (3) To calibrate the pitot channel, the balance valves between the pitot and static channels must be closed. To close the valves, the CCADTS 2 must be placed in the Pressure Control Mode (Option 8 on the RCDU main menu). There is no option dedicated to the balance valves but when controlling to a specified Airspeed without reference to Altitude, the balance valves are driven shut, and will remain shut until the pressure is removed. When main menu Option 8 is selected, the sub-menu in Fig.14 appears. Select Option 5, Control Airspeed Only.

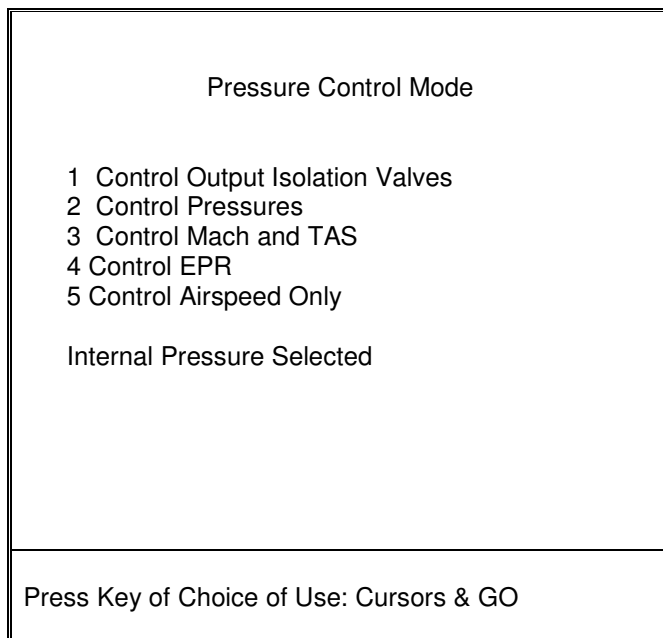


Figure 14 Pressure Control Mode

CAUTION: ENTERING THIS MODE CLOSES THE BALANCE VALVES. CCADTS 2 IS LEFT IN THIS MODE THROUGHOUT THE PITOT CHANNEL CALIBRATION PROCEDURE. HOWEVER, IT IS IMPORTANT NOT TO PRESS THE GO KEY WHILE IN THIS MODE AS THIS WILL INITIATE A PRESSURE CONTROL SEQUENCE WITH CCADTS 2 CONTROLLING TO THE LAST 'SET' PRESSURE. PRESSURES ARE GENERATED BY THE PRIMARY CALIBRATION STANDARD AND THE 'ACTUAL' PRESSURES ARE SIMPLY READ FROM THE RCDU, AS BEFORE.

- (4) Calibrate the pitot channel by applying pressures to the CCADTS 2 to simulate airspeeds between 20 knots and 1000 knots (or to the nearest point within the individual equipment operating limits), in accordance with Table 3. For each calibration point, read off and record the measured value, i.e. the 'Actual' value of Pitot Pressure as displayed on the RCDU, and also the true pressure generated by the Primary Calibration Standard. Tabulate the results on a Calibration Sheet similar to the sample sheet provided in the Appendix (pages 22 to 26). For each point calculate the difference in mbar between the true pressure and the measured pressure.
- (5) Confirm that the 'Actual' pressures obtained for each pitot channel calibration point are within the following tolerances (tolerances apply only to measurements at ambient temperature):

±0.052 mbar @ 0.649 mbar	(0.001 54 inHg @ 0.01 92 inHg)
±0.415 mbar @ 96.483 mbar	(0.01 226 inHg @ 2.8491 inHg)
±0.637 mbar @ 466.490 mbar	(0.01881 inHg @ 13.7754 inHg)
±1.169 mbar @ 2490.500 mbar	(0.03452 inHg @ 73.5444 inHg)

Table 3 Pitot Channel Calibration Points

AIRSPEED (Knots)	Prror PRESSURE (mbar)	prior PRESSURE (InHg)
20	0.649	0.0192
30	1.460	0.0431
40	2.596	0.0767
60	5.848	0.1727
100	16.303	0.4814
150	36.944	1.0909
200	66.335	1.9589
300	153.547	4.5342
400	283.945	8.3849
600	713.668	21.0746
800	1454.021	42.9372
1000	2490.500	73.5444

- (6) Calibration Standard to generate zero differential pressure. When achieved, press the RCDU STOP key to exit from the Control Airspeed Only mode and return to the main menu. Select Option 4, Operation Setup and Defaults. When the associated sub-menu is displayed, press FN and enter the password, as described in paragraph 2, INTRODUCTION. Select Option 5 from the extended sub-menu displayed and return all maximum operating limits to the values normally set for that CCADTS 2.
- (7) Isolate the CCADTS 2 from the Calibration Standard and disconnect the pipework from its ports, leaving them open to atmosphere. Switch off all power supplies. Calibration is now complete.

Following Calibration, the equipment should be subject to Altitude and Airspeed performance tests to confirm that Calibration has been carried out correctly. For further details, refer to the Penny & Giles Technical Manual PUB 376

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APPENDIX

CCADTS 2 STATIC CHANNEL SET-UP SHEET				
EQUIPMENT SERIAL NO.:			DATE:	
APPLIED PRESSURE (mbar, absolute)	APPLIED PRESSURE (inHg, absolute)	RCDU 'ACTUAL' PRESSURE (preferred units, absolute)	ERROR (preferred units, absolute)	CORRECTION (preferred units, absolute)
1128.029	33.3107			
1013.250	29.9212			
696.817	20.5770			
465.633	13.7501			
300.896	8.8854			
187.539	5.5380			
115.972	3.4247			
71.716	2.1178			
44.377	1.3105			
27.615	0.8155			
NEXT CALIBRATION DUE: SIGNED:				

CCADTS 2 STATIC CHANNEL CALIBRATION SHEET			
EQUIPMENT SERIAL NO.:		DATE:	
APPLIED PRESSURE (mbar, absolute)	APPLIED PRESSURE (InHg, absolute)	RCDU 'ACTUAL' PRESSURE (preferred units, absolute)	ERROR (preferred units, absolute)
1128.029	33.3107		
1013.250	29.9212		
696.817	20.5770		
465.633	13.7501		
300.896	8.8854		
187.539	5.5380		
115.972	3.4247		
71.716	2.1178		
44.377	1.3105		
27.615	0.8155		
NEXT CALIBRATION DUE:			
SIGNED:			

CCADTS 2 PITOT CHANNEL CALIBRATION SHEET			
EQUIPMENT SERIAL NO.:		DATE:	
APPLIED PRESSURE (mbar, absolute)	APPLIED PRESSURE (InHg, absolute)	RCDU 'ACTUAL' PRESSURE (preferred units, absolute)	ERROR (preferred units, absolute)
0.649	0.0192		
1.460	0.0431		
2.596	0.0767		
5.848	0.1727		
16.303	0.4814		
36.944	1.0909		
66.335	1.9589		
153.547	4.5342		
283.945	8.3849		
713.668	21.0746		
1454.021	42.9372		
2490.500	73.5444		
NEXT CALIBRATION DUE:			
SIGNED:			