

THERMISTOR-RECORDER

INTERFACE

MANUAL

ES-1097

J. Valdmanis  
Engineering Services Section  
Hydraulics Division  
National Water Research Institute  
Canada Centre for Inland Waters  
Burlington, Ontario

October 1980

Revised - December 1981



## TABLE OF CONTENTS

### 1. INTRODUCTION AND GENERAL DESCRIPTION

### 2. SPECIFICATIONS

### 3. INSTALLATION INSTRUCTIONS

### 4. OPERATING INSTRUCTIONS

### 5. DRAWINGS & APPENDICES

Thermistor Recorder Interface Panel, SKE 80-86A

Thermistor Recorder Interface Schematic, SKE 80-085B

Thermistor Recorder Interface Chart Scales, and

Calibration Points Nashwaak River Thermistor Recorder Box SKE-8160A

Time Response of unbooted Thermistor SKE-8161A

Mathematical Linearization of Fenwal 4K Thermistor, SKE 80-088A

Fenwal Electronics - Production Data Sheet

HP 7155B - Operating instruction sheets

Estimation of Interior Temperature of Insulated Box  
with Heat Source (Reference Memo by F. Roy)

1981 Thermistor Calibration Curves

## SECTION 1 - INTRODUCTION AND GENERAL DESCRIPTION

This thermistor-recorder interface unit (SKE-086A) was designed and built by N.W.R.I. for the Water Survey of Canada. It is intended for a particular measurement task:- to measure accurately freezing and thawing river temperatures (New Brunswick's Nashwaak River). Thus, the interface is designed to be most linear and accurate in the range 0 to 2°C.

The concept was to adapt available hardware to the task. A type of thermistor was chosen which has shown excellent stability at N.W.R.I. Fixed Temperature Profiler (FTP) thermistors are used which match the Fenwal 4K iso-curve, and which physically mate to an RMS 2-PIN underwater connector. The output is connected to a strip chart recorder.

The circuit is a simple resistive one plus switching for calibration as seen in SKE 80-085B. The high bridge impedances of the circuit mean that it is prone to being disturbed by ambient noise. It is assumed that the thermistor cable will be housed in metallic conduit; otherwise the noise spikes could be excessive.

Critical bridge resistors are the "Vishay" type for low temperature coefficients and excellent long-term stabilities. Internal Trimpots allow for setting of standard calibration values, and external trimpots enable small offset and gain adjustments of different thermistors. The "Cal 0°C" and Cal 2°C" positions enable a check of recorder accuracy.

## SECTION 2: SPECIFICATIONS

Input	Thermistor (Fenwal 4K iso-curve) temperature/resistance characteristic $11400\ \Omega$ @ $0^{\circ}\text{C}$ , $10422\ \Omega$ @ $2^{\circ}\text{C}$ . 4-pin MS connector.
Output	$0^{\circ}\text{C}$ to $2^{\circ}\text{C}$ setting gives 0 mV DC to 10 mV DC $\pm 0.1^{\circ}\text{C}$ accuracy $\pm 0.01^{\circ}\text{C}$ resolution $0^{\circ}\text{C}$ to $20^{\circ}\text{C}$ setting gives 0 mV DC to 10 mV DC $\pm 1^{\circ}\text{C}$ accuracy, ( $.1^{\circ}\text{C}$ resolution, non linear) Note: recorder should have $> 1\ \text{M}\ \Omega$ input impedance. Dual banana plugs each connector
Front Panel Controls	Power on/off, 0.2 A fuse holder, $2^{\circ}\text{C}/20^{\circ}\text{C}$ scale selector, Function selector (Read/ $0^{\circ}\text{C}/2^{\circ}\text{C}/\text{zero}$ ), $0^{\circ}\text{C}$ (offset) $2^{\circ}\text{C}$ (gain) calibration trim.
Size	27 cm W x 8 cm H x 20 cm D approx.
Mass	approx. 1 kg
Power	115 V AC, 60 Hz, less than 0.2 A
Thermistor Cables	20 meter, 2 cond., 4-pin MS connector, 2-pin F. RMS connector, 35 meter extension (2-pin RMS connectors)
Recorder (suggested)	H.P. 7155B input selected @ 1 mV/cm
Chart Capacity	2100 cm. (Max 43 days @ 30 min/cm chart speed)
Temperature Operating Range	
	$0^{\circ}\text{C}$ to $40^{\circ}\text{C}$ (Recorder and Interface)
Thermistor	75 seconds without boot (to 63%)
Time Constant	180 seconds with boot (to 63%)
Thermistor	Negligible without boot
Self-Heating	$< 0.02^{\circ}\text{C}$ with boot (est)
Total Watts Dissipation of System	25 watts

## SECTION 3: INSTALLATION INSTRUCTIONS

### 3.1 Thermistor

The thermistor should be lubricated before connection into the RMS connector for easier insertion and removal and for waterproofing.

The RMS connector/thermistor should be firmly held in place and protected from mechanical damage when in field. The rubber boot may be used for protection.

The connecting cable, including extension, should be routed through a conducting conduit for shielding advantages as well as for mechanical protection. For connections see the schematic drawing SKE-80-085B.

Note: Do not cause the thermistor, a fragile sensor, to strike a hard object such as the floor. Wrap the thermistor cable end with foam when transporting.

### 3.2 Recorder

The system has been calibrated with an HP 7155B recorder.

Any other recorder input, such as from a DVM, may affect scaling and offset values.

Please note that sporadic noise on the signal may be minimized by lifting one 115 V AC "U" ground (i.e. from the recorder or the interface) because that eliminates one small ground loop. Removing one end of the shield earth at the recorder or the interface (green terminal) usually is not effective in noise minimization.

#### SECTION 4: OPERATING INSTRUCTIONS

1. Choose strip chart recorder to have 1 mV/cm. input. Check to make sure that variable gain pot is off (if recorder has one)
2. Set interface box to "0 - 2°C range", and on "zero" selector.
3. Connect, plug in (if not done), turn recorder and interface power switches ON.
4. Set ZERO on recorder to be 1 major division (1 cm ) from the right.
5. Select chart speed as required. (Follow recorder manual when using recorder).
6. Turn selector switch to CAL 2°C. The pen should go to the left. If it goes off scale to the right reverse the signal leads.
7. Turn selector switch to CAL 0°C. The pen should be close to the original zero. Even then it is possible to achieve equally accurate results simply by adjusting the recorder ZERO dial.
8. Turn selector switch to CAL 2°C again. The pen should move very close to the proper 2°C reading. The CAL 2°C front panel potentiometer should not require adjustment with the thermistors # 297 and #298 supplied. See sketch SKE 8160.
9. If water temperature is above 2°C use the 0 to 20°C scale, but do not change adjustments (excepting "0°C cal" selection with recorder zero adjustment to 0°C). Note that above about 14°C non-linearity exceeds 0.5 C°. See mathematical linearization curve attached. SKE 80-088A.  
In practice the error does not exceed 0.3C° to 20°C (SKE 8160A.)
10. When leaving recorder on long term monitoring remember to:
  - (a) put on slowest chart speed;
  - (b) turn chart drive on;
  - (c) check paper quantity;
  - (d) check that pen is down;
  - (e) selectors on "READ" and on 0-2°C (for winter work).
11. If the unit is to be operated in very cold temperatures, it should be placed in an insulated box with a thermostatically controlled heater. (Commercial 3°C "Heating Tape" is fine). See attached memo in appendix for heat rise calculation example.

NOTE: Do not attempt to re-calibrate the thermistors using the internal potentiometers. A precision temperature bath is needed. Copies of the calibration runs are attached for reference. The internal pots match thermistors #297 and #298 supplied. Probably the front panel pots will also not need adjustment if the recorder remains stable.

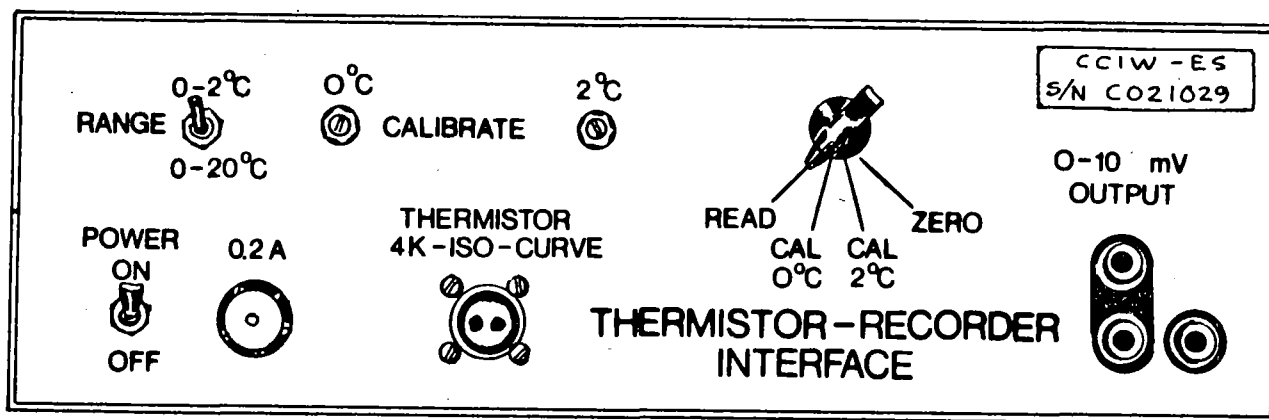
For further information consult with the N.W.R.I., Engineering & Computing Support Group:

John Valdmanis  
Tel. (416) 637-4293  
P.O. Box 5050  
Burlington, Ontario, Canada.  
L7R 4A6



SECTION 5: DRAWINGS

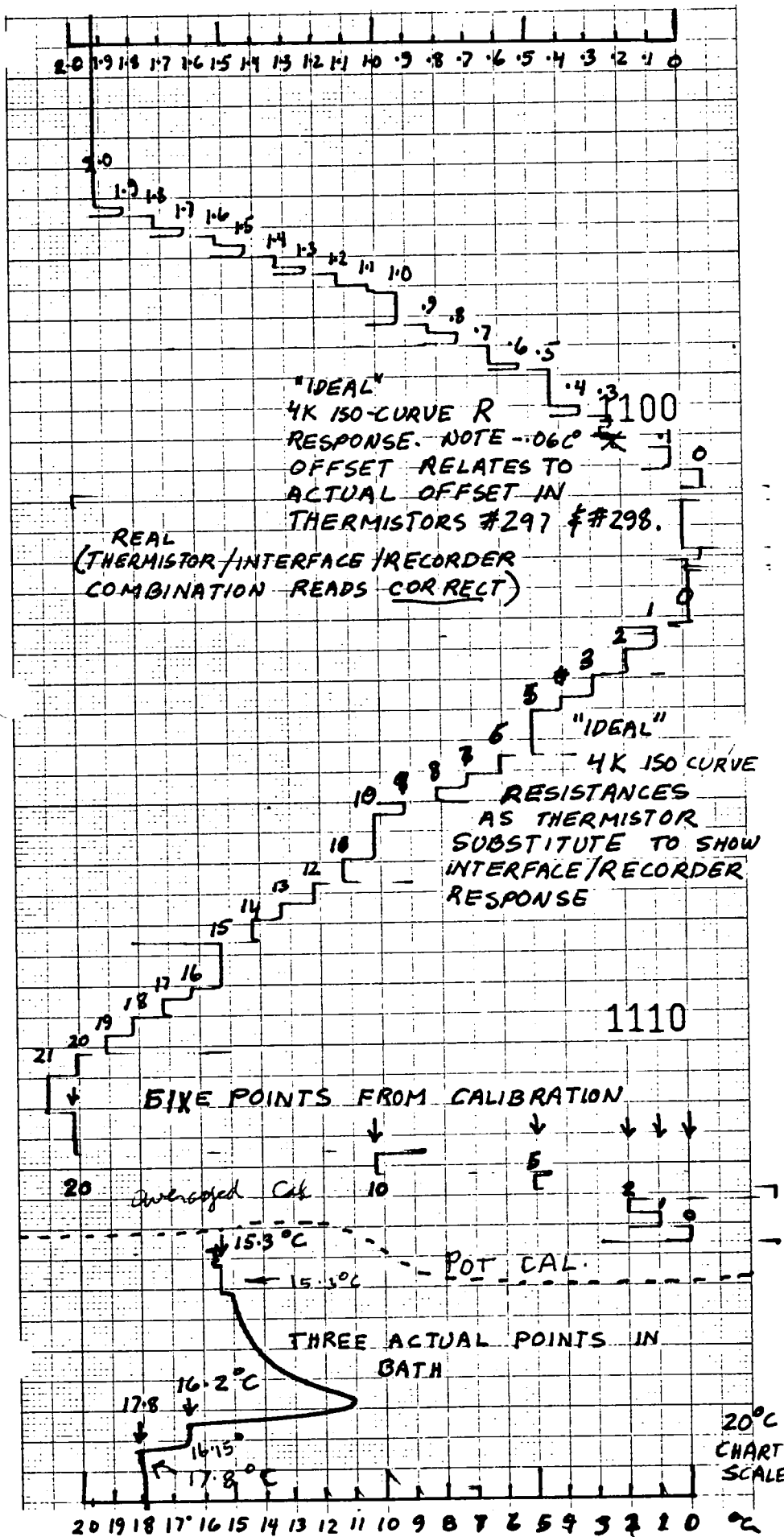




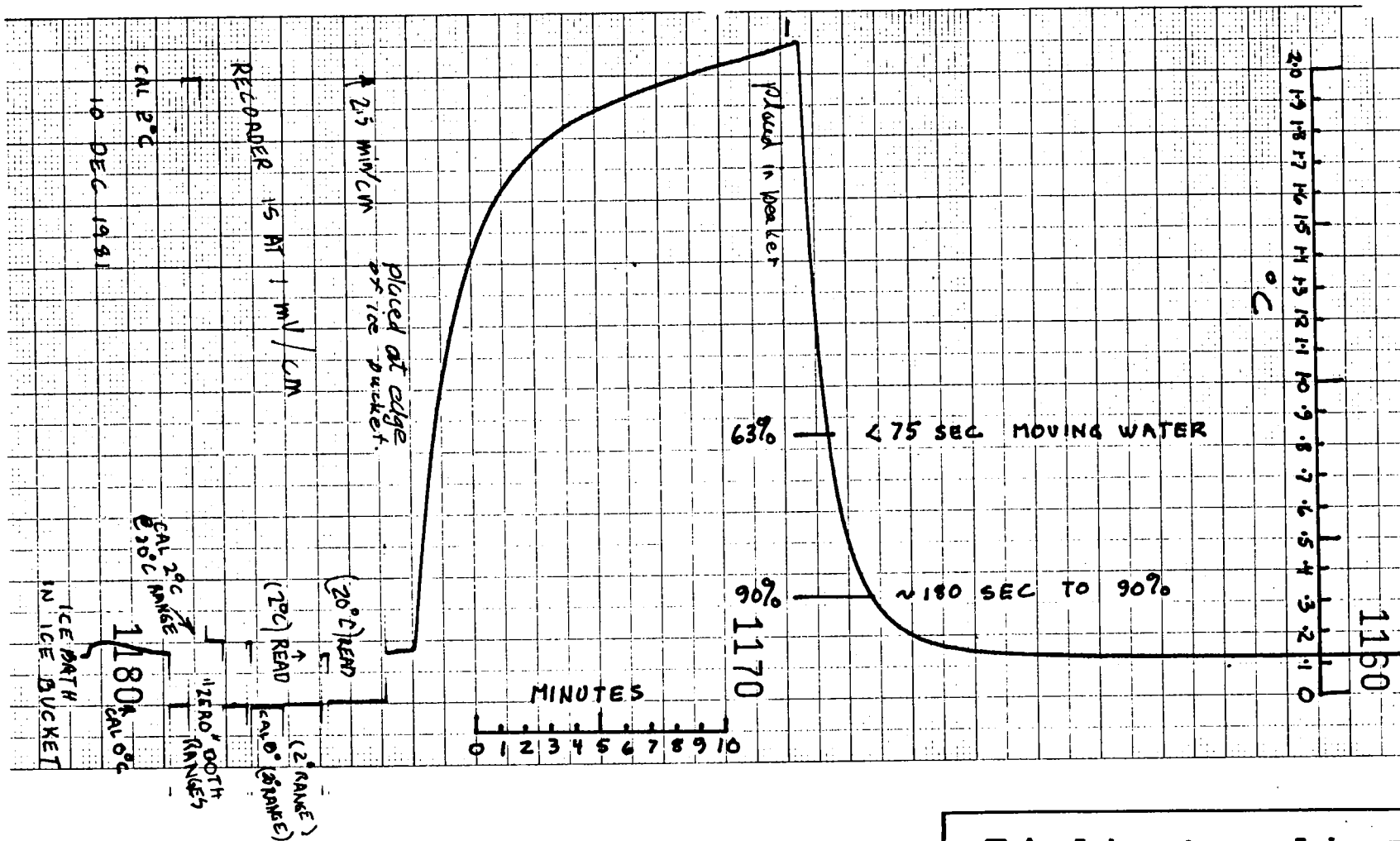
NATIONAL WATER RESEARCH INSTITUTE - ENV. CANADA		
THERMISTOR-RECORDER INTERFACE PANEL		
J. VALDMANIS PENG. ENG. SECT.	23 OCT. 1980	SKE 80-086A







Environment Canada Centre Canadien des Eaux Interieures Canada Centre for Inland Waters		Environment Canada Centre Canadien des Eaux Interieures Canada Centre for Inland Waters	
TITLE SOME CALIBRATION POINTS - NASHWAAK RIVER TEMPERATURE RECORDER			
DESIGNED BY	CHECKED BY	APPROVED BY	
DRAWN BY J.V.	CHECKED BY	DRAWING NO. SKE-8160A	
SCALE	DATE 15 DEC 81	SHEET OF	



Environment  
Canada

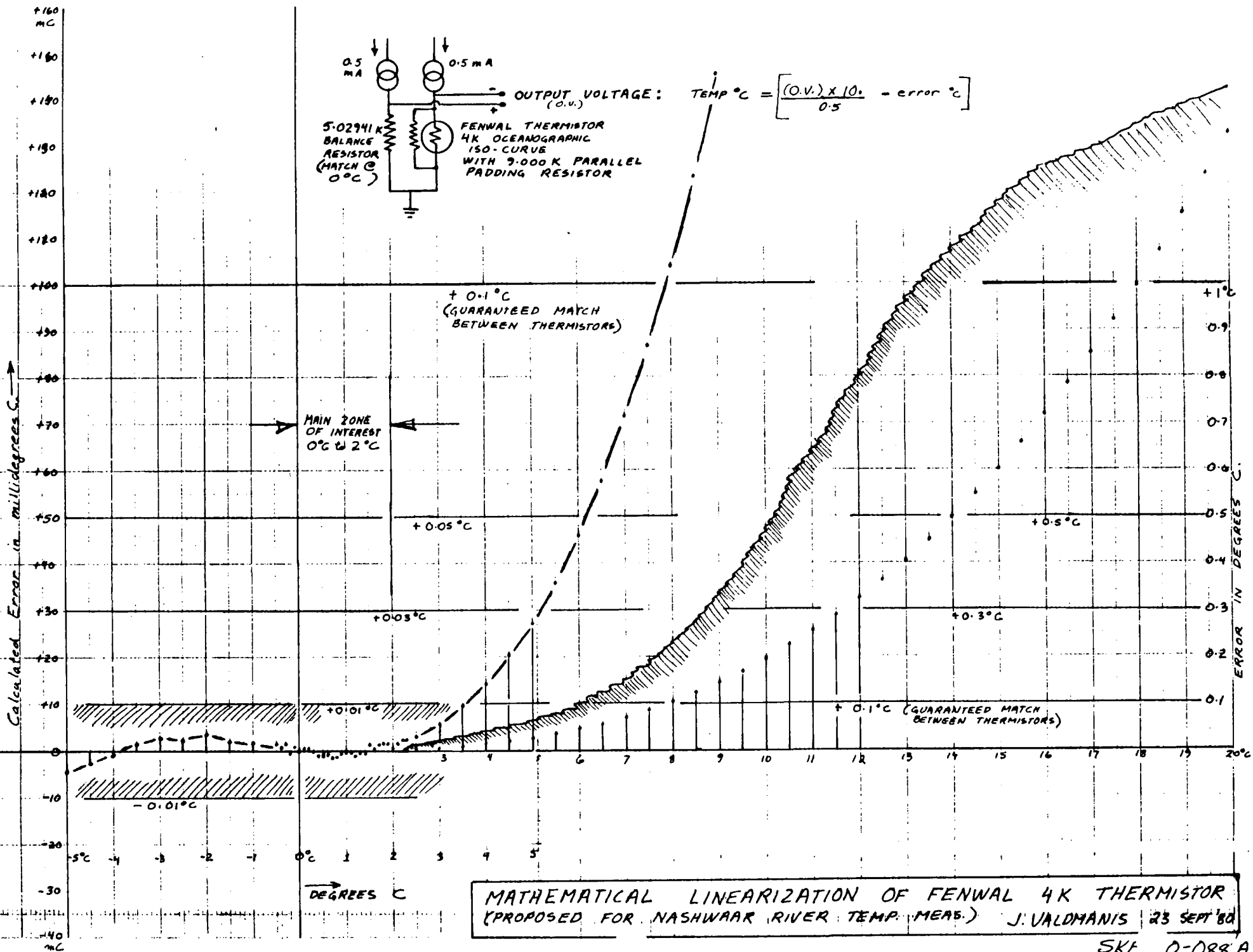
Canada Centre  
for Inland Waters

Environnement  
Canada

Centre Canadien  
des Eaux Interieures

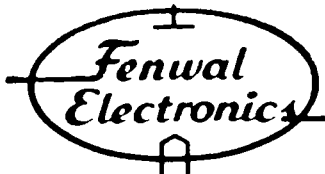
TITLE TIME RESPONSE OF UNBOOTED  
THERMISTOR 2°C → 0°C.  
- NASHWAAK RIVER TEMPERATURE  
RECORDER

DESIGNED BY	CHECKED BY	APPROVED BY
DRAWN BY J.V.	CHECKED BY	DRAWING NO. SKE-8161
SCALE	DATE 15 DEC 81	SHEET OF



SKE 0-088A





FENWAL ELECTRONICS  
Division of Walter Kidde & Company, Inc.  
63 FOUNTAIN ST., FRAMINGHAM, MASS  
TEL.: 617 872-8841 TWX 710 346 0678

## PRODUCT DATA SHEET

No. D-7  
OCEANOGRAPHIC  
ISO-CURVE  
(interchangeable)  
THERMISTORS

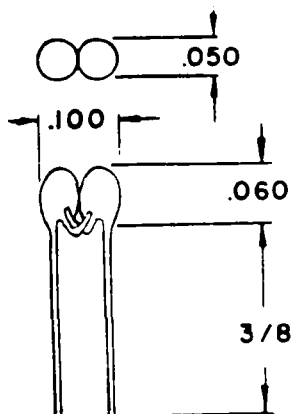


FIG. 1

### LARGE BEADS

.004 DIA. PT. IR. LEADS

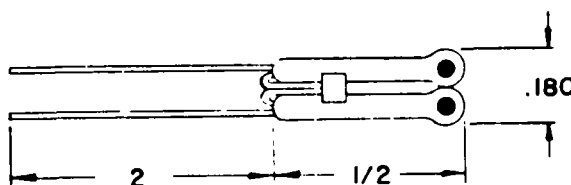


FIG. 2 STD. PROBE

.012 DIA. TINNED DUMET LEADS

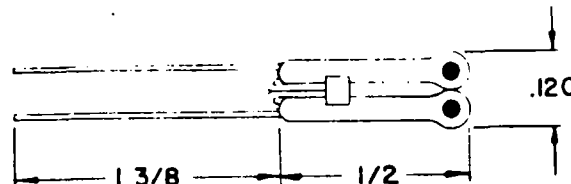


FIG. 3 MINI PROBE

.008 DIA. TINNED DUMET LEADS

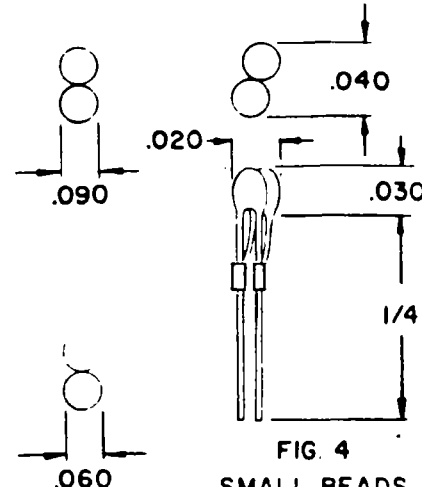


FIG. 4

### SMALL BEADS

.001 DIA. PT. IR. LEADS

**OCEANOGRAPHIC ISO-CURVE:** Glass encapsulated thermistors of either the bead or probe configuration, designed for Oceanography use, have the unique feature of complete R-T interchangeability coupled with exceptionally high stability characteristics.

**STANDARDIZED R-T CHARACTERISTICS:** Resistance is precision matched to a standard R-T Curve and is predictable accurately at any given point to  $\pm 0.1^\circ\text{C}$  over the temperature range.

**COMPLETE INTERCHANGEABILITY:** Allows for circuit standardization - eliminates necessity for individual circuit adjustment - allows exact replacement without calibrating thermistor or recompensating circuits.

**STABILITY:**  $0.05^\circ\text{Centigrade}$  per year change maximum.

### CHARACTERISTICS:

Condition	STANDARD PROBE		MINI-PROBE	
	D. C.	T. C.	D. C.	T. C.
Still Air	1.9 mw/ $^\circ\text{C}$	25 seconds	1.4 mw/ $^\circ\text{C}$	16 seconds
Moving Air 800 ft./min.	4.5 mw/ $^\circ\text{C}$	5 "	3.4 mw/ $^\circ\text{C}$	3 "
Still Water	9.0 mw/ $^\circ\text{C}$	1 "	7.0 mw/ $^\circ\text{C}$	0.4 "
Moving Water 20 ft./sec.	10.0 mw/ $^\circ\text{C}$	0.3 "	11.0 mw/ $^\circ\text{C}$	0.1 "

Condition	LARGE BEADS		SMALL BEADS	
	D. C.	T. C.	D. C.	T. C.
Still Air	0.8 mw/ $^\circ\text{C}$	2 seconds	0.2 mw/ $^\circ\text{C}$	1.0 sec.
Moving Air 800 ft./min.	3.0 mw/ $^\circ\text{C}$	1 "	0.8 mw/ $^\circ\text{C}$	0.3 "

(over)

D. C. (DISSIPATION CONSTANT): Equals power in milliwatts required to raise thermistor temperature 1°C. Measured with the thermistor suspended by its leads in a specified environment.

T. C. (TIME CONSTANT): Equals the time required by a thermistor to change 63% of the difference between its initial and final temperature. Measured with the thermistor suspended by its leads in a specified environment.

TYPICAL UNITS:

TYPE	STYLE	RESISTANCE 25°C	TEMP. RANGE °C	TEMP. TOL. OVER TEMP. RANGE
GB34PM62	Standard Probe	4002 $\Omega$	-5 to +35	$\pm 0.1^\circ\text{C}$
GB34MM132	Mini-Probe	4002 $\Omega$	-5 to +35	$\pm 0.1^\circ\text{C}$
GB34JM13	Large Bead	4002 $\Omega$	-5 to +35	$\pm 0.1^\circ\text{C}$
GB34JM14	Small Bead	4002 $\Omega$	-5 to +35	$\pm 0.1^\circ\text{C}$
GB32PM82	Standard Probe	2001 $\Omega$	-5 to +35	$\pm 0.1^\circ\text{C}$
GB32MM172	Mini-Probe	2001 $\Omega$	-5 to +35	$\pm 0.1^\circ\text{C}$
GB32JM19	Large Bead	2001 $\Omega$	-5 to +35	$\pm 0.1^\circ\text{C}$

\* U. S. Patent 3,109,227; Foreign Patents Pending  
Trademark of Fenwal Electronics, Inc.

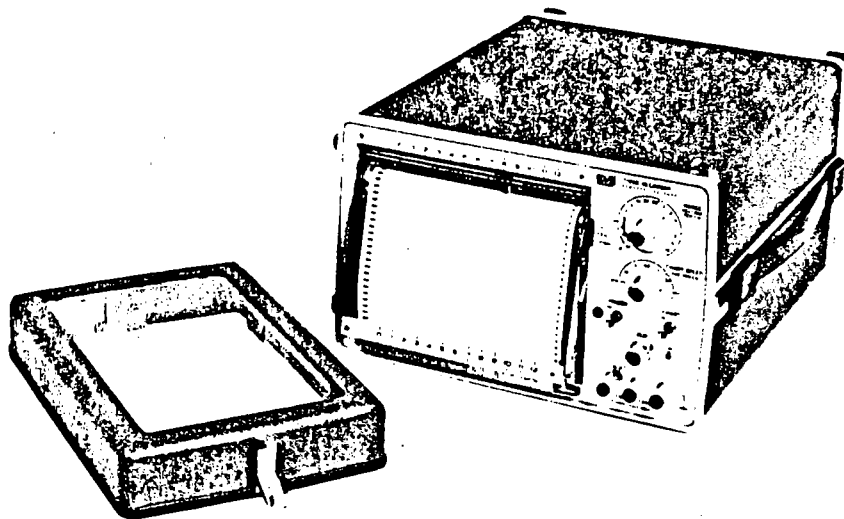
# OCEANOGRAPHIC 4K ISO-CURVE

°C	h	°C	h	°C	h	°C	h	°C	h	°C	h	°C	h	°C	h	°C	h	°C	h
-5.0	14336	-1.0	11928	3.0	9969.5	7.0	8369.2	11.0	7055.2	15.0	5971.5	19.0	5073.9	23.0	4327.5	27.0	3704.3	31.0	3182.1
.9	14269	.9	11874	.1	9925.5	.1	8333.1	.1	7025.5	.1	5947.0	.1	5053.6	.1	4310.5	.1	3690.1	.1	3170.2
.8	14203	.8	11820	.2	9881.6	.2	8297.2	.2	6996.0	.2	5922.5	.2	5033.3	.2	4293.6	.2	3676.0	.2	3158.3
.7	14137	.7	11767	.3	9838.1	.3	8261.5	.3	6966.6	.3	5898.2	.3	5013.1	.3	4276.8	.3	3661.9	.3	3146.5
.6	14072	.6	11713	.4	9794.7	.4	8225.9	.4	6937.3	.4	5874.0	.4	4993.0	.4	4260.0	.4	3647.9	.4	3134.7
.5	14006	.5	11661	.5	9751.5	.5	8190.5	.5	6908.2	.5	5849.9	.5	4973.0	.5	4243.4	.5	3633.9	.5	3123.0
.4	13942	.4	11608	.6	9708.6	.6	8155.3	.6	6879.2	.6	5826.0	.6	4953.1	.6	4226.8	.6	3620.0	.6	3111.4
.3	13877	.3	11556	.7	9665.9	.7	8120.3	.7	6850.3	.7	5802.1	.7	4933.3	.7	4210.2	.7	3606.2	.7	3099.7
.2	13813	.2	11503	.8	9623.3	.8	8085.5	.8	6821.6	.8	5778.4	.8	4913.5	.8	4193.8	.8	3592.4	.8	3088.2
.1	13749	.1	11452	.9	9581.0	.9	8050.8	.9	6793.0	.9	5754.7	.9	4893.9	.9	4177.4	.9	3578.7	.9	3076.7
4.0	13686	0.0	11400	4.0	9539.0	8.0	8016.3	12.0	6764.6	16.0	5731.2	20.0	4874.4	24.0	4161.1	28.0	3565.1	32.0	3065.2
.9	13623	.1	11349	.1	9497.1	.1	7981.9	.1	6736.3	.1	5707.8	.1	4854.9	.1	4144.9	.1	3551.5	.1	3053.8
.8	13560	.2	11298	.2	9455.4	.2	7947.7	.2	6708.1	.2	5684.5	.2	4835.5	.2	4128.7	.2	3537.9	.2	3042.4
.7	13497	.3	11247	.3	9414.0	.3	7913.7	.3	6680.1	.3	5661.3	.3	4816.3	.3	4112.6	.3	3524.5	.3	3031.1
.6	13435	.4	11196	.4	9372.7	.4	7879.9	.4	6652.2	.4	5638.2	.4	4797.1	.4	4096.6	.4	3511.1	.4	3019.8
.5	13373	.5	11146	.5	9331.7	.5	7846.2	.5	6624.4	.5	5615.2	.5	4778.0	.5	4080.7	.5	3497.7	.5	3008.6
.4	13312	.6	11096	.6	9290.8	.6	7812.7	.6	6596.8	.6	5592.3	.6	4758.9	.6	4064.8	.6	3484.4	.6	2997.4
.3	13251	.7	11046	.7	9250.2	.7	7779.3	.7	6569.3	.7	5569.5	.7	4740.0	.7	4049.0	.7	3471.2	.7	2986.3
.2	13190	.8	10997	.8	9209.7	.8	7746.1	.8	6541.9	.8	5546.1	.8	4721.2	.8	4033.3	.8	3458.0	.8	2975.2
.1	13129	.9	10948	.9	9169.3	.9	7713.1	.9	6514.7	.9	5524.3	.9	4702.4	.9	4017.6	.9	3444.9	.9	2964.2
3.0	13069	1.0	10899	5.0	9129.5	9.0	7680.2	13.0	6487.6	17.0	5501.8	21.0	4683.7	25.0	4002.0	29.0	3431.8	33.0	2953.2
.9	13009	.1	10850	.1	9089.6	.1	7647.5	.1	6460.6	.1	5479.5	.1	4665.1	.1	3986.5	.1	3418.8	.1	2942.2
.8	12949	.2	10801	.2	9050.0	.2	7614.9	.2	6433.7	.2	5457.2	.2	4646.6	.2	3971.0	.2	3405.9	.2	2931.3
.7	12890	.3	10753	.3	9010.6	.3	7582.6	.3	6407.0	.3	5435.1	.3	4628.2	.3	3955.6	.3	3394.0	.3	2920.5
.6	12831	.4	10705	.4	8971.3	.4	7550.3	.4	6380.4	.4	5413.1	.4	4609.4	.4	3940.3	.4	3380.1	.4	2909.7
.5	12772	.5	10658	.5	8932.3	.5	7518.2	.5	6353.9	.5	5391.1	.5	4591.6	.5	3925.1	.5	3367.3	.5	2898.9
.4	12714	.6	10610	.6	8893.4	.6	7486.3	.6	6327.6	.6	5369.3	.6	4573.1	.6	3909.9	.6	3354.6	.6	2888.2
.3	12656	.7	10563	.7	8854.7	.7	7454.5	.7	6301.4	.7	5347.5	.7	4555.3	.7	3894.8	.7	3341.9	.7	2877.6
.2	12598	.8	10516	.8	8816.3	.8	7422.9	.8	6275.3	.8	5325.9	.8	4537.3	.8	3879.7	.8	3329.3	.8	2867.0
.1	12541	.9	10469	.9	8778.0	.9	7391.5	.9	6249.3	.9	5304.4	.9	4519.4	.9	3864.8	.9	3316.8	.9	2856.4
2.0	12484	2.0	10422	6.0	8739.9	10.0	7360.1	14.0	6223.4	18.0	5282.9	22.0	4501.6	26.0	3849.9	30.0	3304.3	34.0	2845.9
.9	12427	.1	10376	.1	8702.0	.1	7329.0	.1	6197.7	.1	5261.6	.1	4483.8	.1	3835.0	.1	3291.8	.1	2835.4
.8	12370	.2	10330	.2	8664.3	.2	7298.0	.2	6172.1	.2	5240.4	.2	4466.1	.2	3820.2	.2	3279.4	.2	2824.9
.7	12314	.3	10284	.3	8626.8	.3	7267.1	.3	6146.6	.3	5219.2	.3	4448.5	.3	3805.5	.3	3267.1	.3	2814.6
.6	12258	.4	10238	.4	8589.4	.4	7236.4	.4	6121.2	.4	5198.2	.4	4431.0	.4	3790.9	.4	3254.8	.4	2804.2
.5	12202	.5	10193	.5	8552.2	.5	7205.8	.5	6096.0	.5	5177.2	.5	4413.5	.5	3776.3	.5	3242.5	.5	2793.9
.4	12147	.6	10148	.6	8515.3	.6	7175.4	.6	6070.9	.6	5156.4	.6	4396.2	.6	3761.8	.6	3230.3	.6	2783.6
.3	12091	.7	10103	.7	8478.5	.7	7145.1	.7	6045.9	.7	5135.6	.7	4378.9	.7	3747.3	.7	3218.2	.7	2773.4
.2	12037	.8	10058	.8	8441.9	.8	7115.0	.8	6021.0	.8	5115.0	.8	4361.7	.8	3732.9	.8	3206.1	.8	2763.2
.1	11982	.9	10014	.9	8405.4	.9	7085.0	.9	5996.2	.9	5094.4	.9	4344.6	.9	3718.6	.9	3194.1	.9	2753.1
																35.0			2743.0

SELECTED PAGES

OPERATING AND SERVICE MANUAL

FOR NASHWAAK TEMP. RECORDING

**STRIP CHART  
RECORDER****7155B**HEWLETT  PACKARD

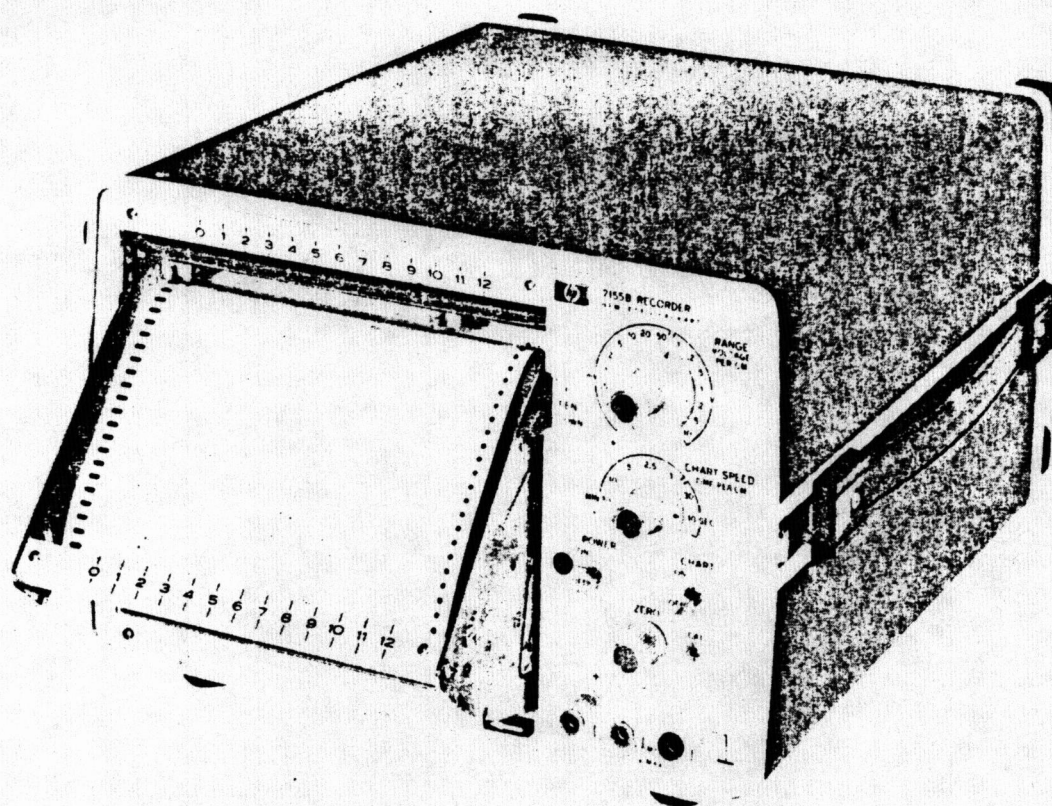


Figure 1-1. Model 7155B Portable Strip Chart Recorder

## SECTION I

### GENERAL INFORMATION

#### 1-1. INTRODUCTION.

1-2. This manual contains operating and service instructions for the HP 7155B Portable Strip Chart Recorder, and is arranged in eight sections as follows: General Information, Installation, Operating Instructions, Theory of Operation, Maintenance, Parts List, Circuit Diagrams and Backdating. If further information is required, contact the nearest Hewlett-Packard Sales and Service Office. A list of these offices is located at the back of this manual.

#### 1-3. DESCRIPTION.

1-4. The 7155B Portable Strip Chart Recorder (Figure 1-1) is a single channel laboratory or field recorder. It is designed to operate over large variations of ambient temperature ( $-28^{\circ}\text{C}$  to  $+65^{\circ}\text{C}$ ), power line voltage (AC 85 to 130V, 115V nominal, or 172 to 260V, 230V nominal, or DC 10.5 to 34V), AC line frequency (48 to 440 Hz) and operating altitude (feet are provided on three surfaces). A 16-position range switch provides calibrated sensitivities from .1 mV/cm to 10 V/cm (1.2 mV to 120V full scale), and a vernier provides overlapping between ranges. The signal inputs are isolated from ground and are protected against intermittent normal mode signals up to 250V peak and common mode signals up to 200V peak, regardless of the recorder sensitivity. The 12 cm wide by 21 m long chart is divided into 1 cm major divisions and 1 mm minor divisions in both directions. The chart drive provides seven chart speeds from 30 min/cm to 10 sec/cm controlled by a front panel switch. Chart speed accuracy is independent of power line frequency.

1-5. The 7155B is designed for ease in operation and maintenance. To this end the recorder has a disposable pen writing system, and all power line fuses are located on the back panel. Most of the electronics are contained on four plug-in printed circuit assemblies, and there are only four electrical adjustments (seven adjustments and five assemblies if Option 008 is installed).

1-6. The capabilities of the 7155B can be supplemented by three options, which provide an internal battery and charger (Option 008), a remotely controlled event marker (Option 006), and right hand zero (Option 005).

#### 1-7. IDENTIFICATION, MANUAL CHANGES AND BACKDATING.

1-8. This instrument has a two-part serial number. The first four digits and the letter comprise the serial number prefix. The last five digits form the sequential suffix that is unique to each instrument. The contents of this manual apply directly to instruments having the same serial number prefix(es) as listed under SERIAL NUMBERS on the title page.

1-9. An instrument manufactured after the printing of this manual may have a higher serial prefix than that listed on the title page, which indicates that the instrument is different from those documented in this manual. The manual for this instrument is supplied with a yellow Manual Change Supplement that contains "change information" that documents the differences. In addition to change information, the supplement may contain information for correcting errors in the manual. For information concerning a serial number prefix not listed on the title page or in the Manual Change Supplement, contact your nearest Hewlett-Packard Sales/Service Office. The addresses are tabulated on the last two pages of this manual.

#### NOTE

On the title page of this manual, below the manual Part Number, is a Microfiche Part Number. This number may be used to order 4 x 6-inch microfilm transparencies of the manual. The microfiche package also includes the latest Manual Change Supplement, as well as all pertinent Service Notes.

1-10. Instruments manufactured prior to the printing of this manual may have serial prefixes lower than that listed on the title page. Differences between instruments with the prefix listed on the title page and instruments with lower prefixes are documented in Section VIII of this manual.

#### 1-11. SPECIFICATIONS.

1-12. Specifications for the recorder are listed in Table 1-1.

Table 1-1. HP Model 7155B Specifications

Input Ranges: 0.1 mV/cm through 10 V/cm in a 1, 2, 5 sequence with overlapping vernier (12 cm full scale).

Type of Input: Single-ended, floating.

Input Resistance: 1M $\Omega$  nominal.

Maximum Allowable Source Resistance: 5k $\Omega$  for rated response.

Common Mode Rejection: 100 dB dc and 80 dB from 48 to 440 Hz ac with 1k $\Omega$  source imbalance (high terminal).

Full Scale Response Time: 0.6 seconds to within rated accuracy.

Overshoot: 1% of full scale maximum.

Accuracy (at 25°C):  $\pm 0.4\%$  of full scale on calibrated range (includes linearity and deadband). Temp Coefficient  $\pm 0.01\%$  per °C.

Range Accuracy (at 25°C):  $\pm 0.4\%$  of full scale  $\pm 0.2\%$  of deflection (includes linearity and deadband). Temp Coefficient  $\pm 0.01\%$  per °C.

Chart Speeds: 30, 10, 5, 2.5, 1 min/cm; 30, 10 s/cm.

Chart Speed Accuracy:  $\pm 1\%$ .

Environmental (Operating): -28°C to +65°C, less than 95% relative humidity (40°C).

Writing Mechanism: Disposable ink pens.

Grid Width: 12 cm.

Chart Length: 21 meters (70 ft).

Pen Lift: Mechanical.

Weight: Net 14 kg (30 pounds) with battery option installed. Battery weight 3.2 kg (7 pounds).

Power: External ac (48 to 440 Hz, 85 to 130V, 115V nominal, or 172V to 260V, 230V nominal).

External dc (10.5 to 34V, 0.5 amp typical, 0.9 amp maximum independent of voltage).

Battery: 12V, 7.5 amp-hour battery provides typically 9 hours of operation (at 25°C) before recharging is required.

**1-13. OPTIONS.**

1-14. The following is a list of options available for the 7155B. Table 1-2 lists the Part Numbers of Field Installation Kits available. Option 008 is illustrated in Figure 1-2.

a. **RIGHT HAND ZERO (OPTION 005).** Positive voltage input causes pen to deflect from right to left.

b. **EVENT MARKER (OPTION 006).** Isolated contact closure on rear panel causes approximately 0.06 cm (0.025 inch) deflection of event pen. Marking occurs along left hand edge of paper.

c. **INTERNAL BATTERY (OPTION 008).** The jelled electrolyte battery typically operates the recorder for nine hours on a single charge (at 25 °C). Recharging is from external AC only and requires approximately 14 hours to full charge. Instrument may be operating while charging, but operation in the INTERNAL BATTERY/AC STANDBY mode will increase the time necessary to fully charge the battery.

d. **ADDITIONAL MANUALS (OPTION 910).** Extra copies of this manual may be obtained by ordering Option 910. This option is intended to simplify ordering extra manuals at the time the instrument is ordered.

**1-15. ACCESSORIES SUPPLIED.**

1-16. Accessories supplied with the recorder are listed in Table 1-3.

**1-17. SUPPLIES/ACCESSORIES AVAILABLE.**

1-18. Supplies and accessories available for use with the recorder are listed in Table 1-4.

Table 1-2. Field Installation of Optional Equipment

OPTION	DESCRIPTION	PART/INSTALLATION KIT NUMBER	ESTIMATED TIME TO INSTALL
005	Right Hand Zero	07155-69018	1 Hr
006	Event Marker	07155-69017	5 Hr
008	Internal Battery	07155-69010* 07155-69012**	3 Hr
* Standard Instrument ** With Option 006 installed			



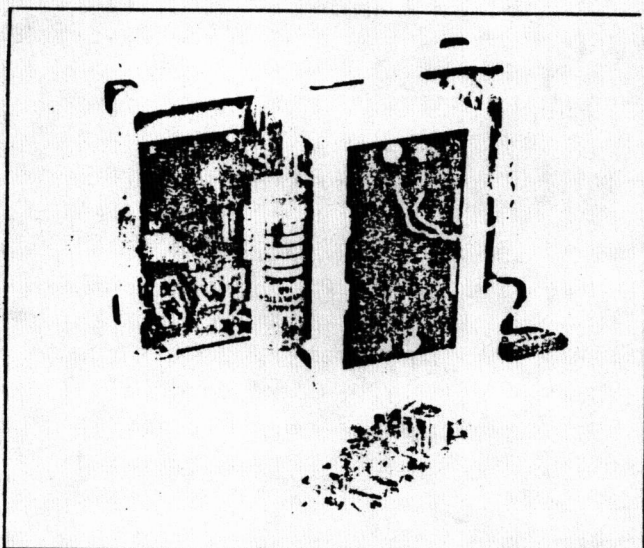


Figure 1-2. Internal Battery (Option 008)

Table 1-3. Accessories Supplied

	Part Number
Operating and Service Manual	07155-90001
Chart Paper 21.3 m (70 ft)	9280-0278
Power Cord 2.3 m (7.5 ft)	8120-1538
Accessory Kit – Standard	07155-60090
Accessory Kit – Option 006	07155-60095
<b>NOTE</b> Refer to Table 6-1 for parts in Standard Accessory Kit 07155-60090 and Table 6-2 for parts in the Option 006 Accessory Kit 07155-60095.	

Table 1-4. Supplies and Accessories Available

Description	HP Part No.
<b>CHART PAPER</b>	
Metric, 21 m (70 ft)	9280-0278
<b>DISPOSABLE PENS (Package of 3)</b>	
Red Servo Pen	07155-60014*
Blue Servo Pen	07155-60016
Red Event Marker Pen	07155-60015*
Blue Event Marker Pen	07155-60017
<b>EXTENDER BOARDS</b>	5060-0256 5060-0257 5060-0258
<b>SHIPPING CARTON, consisting of the following parts:</b>	
Outer Carton	9211-1733
Inner Carton	9211-1842
Post (8 each)	9220-0621
Pad (1 each)	9220-2033
Pad, Die Cut (1 each)	9220-2045
*Part of Accessory Kit (see Tables 6-1 and 6-2).	

## SECTION II

### INSTALLATION

#### 2-1. INTRODUCTION.

2-2. This section provides instructions for installation of the recorder. Included herein are instructions for incoming inspection, damage claims, option installations, preparation for use, power requirements, storage and shipment.

#### 2-3. INCOMING INSPECTION.

2-4. Upon receipt of the packaged instrument, inspect the shipping carton for damage or indication of severe stress. If the shipping carton is damaged upon receipt, request the carrier's agent be present when the instrument is unpacked. Inspect the instrument for cracks, broken parts, scratches, dents, etc.

#### 2-5. DAMAGE CLAIMS.

2-6. If the instrument has been damaged during shipment immediately notify the carrier and nearest Hewlett-Packard Sales and Service Office. A list of these offices is located at the rear of this manual. Retain the shipping carton and padding material for the carrier's inspection.

#### 2-7. PREPARATION FOR USE.

2-8. The recorder is shipped with the pens and chart paper not installed. Before using the recorder the pens and paper must be installed, and if Option 008 is installed, the batteries must be connected.

2-9. To install the pens, proceed as follows:

- a. Place PEN control to UP (see Figure 2-1, Detail A).

#### NOTE

The servo pen is identified by the letter "R" embossed on the top front of the pen. The event marker pen has the letter "L" on the top front.

- b. Insert a servo pen (HP Part Number 07155-60014 or 07155-60016) into the servo penholder as far as it will go (see Figure 2-1, Details A and B). Remove the pen tip cover.

- c. If the event marker (Option 006) is installed, insert an event marker pen (HP Part Number 07155-60015 or 07155-60017) into the event marker penholder as far as it will go.

2-10. To install the chart paper, proceed as follows:

- a. Move the magazine index latch in the direction of the arrow (see Figure 2-2).
- b. Pivot the front of the magazine up and pull the magazine out of the recorder.
- c. Install the chart roll in the magazine (see Figure 2-3 or the decal on the side of the magazine).
- d. Align the mounting cutouts of the magazine with the mounting hubs on the recorder (see Figure 2-4).
- e. Push the magazine onto the hubs until it stops.

#### CAUTION

Failure to insert the magazine fully may cause damage to the magazine when the following step is started. Do not force the magazine down.

- f. Pivot the front of the magazine down until the magazine index latch detents.

2-11. If Option 008 is installed, proceed as follows:

#### WARNING

Before commencing this procedure, make certain the 7155B POWER switch is OFF, and that the 7155B is disconnected from all power sources and external cabling. Failure to do so may expose personnel to hazardous voltages. This procedure should be performed by qualified service personnel.

- a. Remove the top cover of the recorder.

ground is isolated from chassis and analog ground, and is used by the remaining recorder electronics.

- b. If Option 006 is installed, make event marker control signal connection into recorder through the terminal strip on the rear panel (see Figure 2-6, Detail B).

#### NOTE

The right hand terminal (see Figure 2-6, Detail B) on the event marker terminal strip and the negative terminal of the EXTERNAL DC connector are connected to DC power ground (PGD) within the instrument. The external event marker control unit must be isolated from ground to avoid loops and possible short circuits when using DC power sources with positive ground (negative DC supplies).

### 2-14. POWER REQUIREMENTS AND CONNECTIONS.

- 2-15. The recorder operates on the following power inputs:

- a. 85 to 130 Vac or 172 to 260 Vac selectable by a jumper plug in the AC power input module, 48 to 440 Hz.

#### CAUTION

Prior to operation from an AC power source, verify that the AC power module jumper plug is installed to match the line voltage, and the correct fuse is installed.

- b. 10.5 to 34 Vdc, 0.9A maximum, negative, positive or isolated ground.

#### NOTE

During DC or battery operation the recorder case should be connected to an external ground point.

- c. AC or DC operation is selected by the SOURCE switch (see Figure 2-6, Detail B).

- 2-16. The recorder is fused as follows:

- a. 115 Vac: 1 Amp Normal Blow Fuse in AC power module protects the AC line.
- b. 230 Vac: 0.5 Amp Normal Blow Fuse in AC power module protects the AC line.

- c. DC: 1 Amp Normal Blow on rear panel protects the DC source.

- d. Battery: 1.5 Amp Normal Blow on rear panel protects the internal battery (Option 008 only).

2-17. The AC power cord (Part Number 8120-1538), supplied with the recorder complies with Underwriter Laboratories, Inc. (UL) requirements only when used with power sources of nominally 115 Vac. For nominal 230 Vac line operation, the power cord must be replaced or modified. To modify the cord for 230V operation in the U.S., replace the 115V plug with a UL-approved 250 Vac plug as shown in Figure 2-7. Figure 2-8 shows the power plugs that are used in the United States and other countries. The plug rating and HP Part Number for the plug and power cord are shown beside each plug. If the correct power cable is not available notify the nearest Hewlett-Packard Sales and Service Office and a replacement cable will be provided.

2-18. A DC power connector (HP Part Number 1251-2614) is supplied with the accessory kit. For DC operation, wire the connector as shown in Figure 2-9 and plug it into the recorder EXTERNAL DC input (see Figure 2-6).

### 2-19. OPTION INSTALLATION.

2-20. Table 1-2 lists the options that can be installed in the field, and the part numbers of the Installation Instructions and kits available for each option.

### 2-21. STORAGE.

#### CAUTION

Always remove the chart paper when storing or shipping the recorder. Sudden shocks with the chart paper installed can distort the paper roll, causing subsequent chart drive problems.

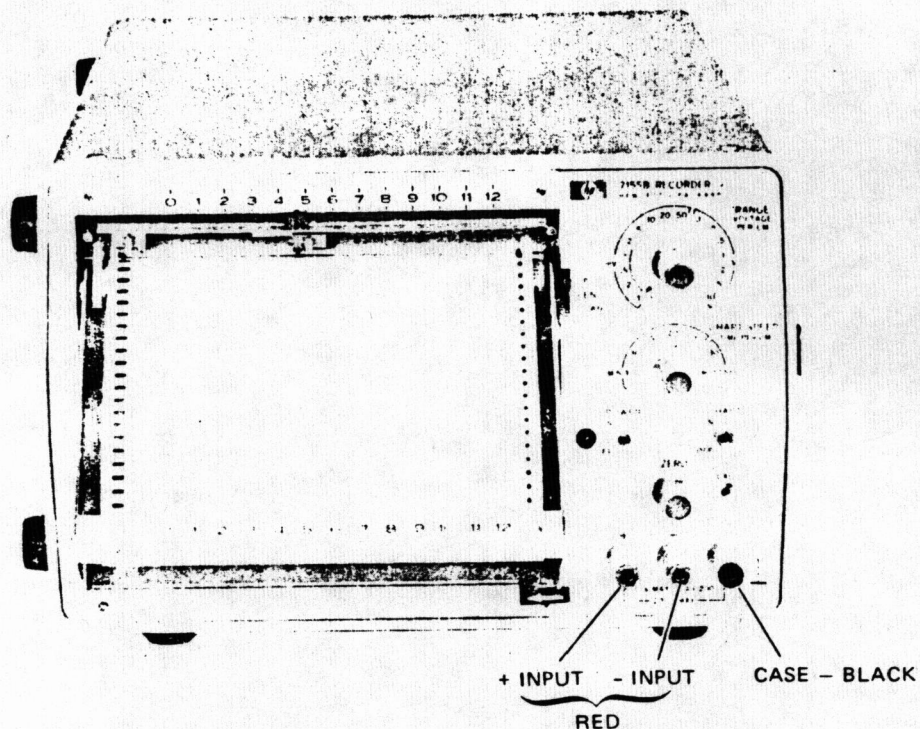
2-22. When a recorder is to be stored for an extended period of time, perform the following procedures:

- a. Charge the batteries fully (if Option 008 is installed). See paragraph 5-40.
- b. Remove the chart paper from the magazine.
- c. Remove the pens from the recorder.

#### NOTE

Battery life will be extended if the batteries are stored at temperatures below +30°C (+85°F).

Detail A



Detail B

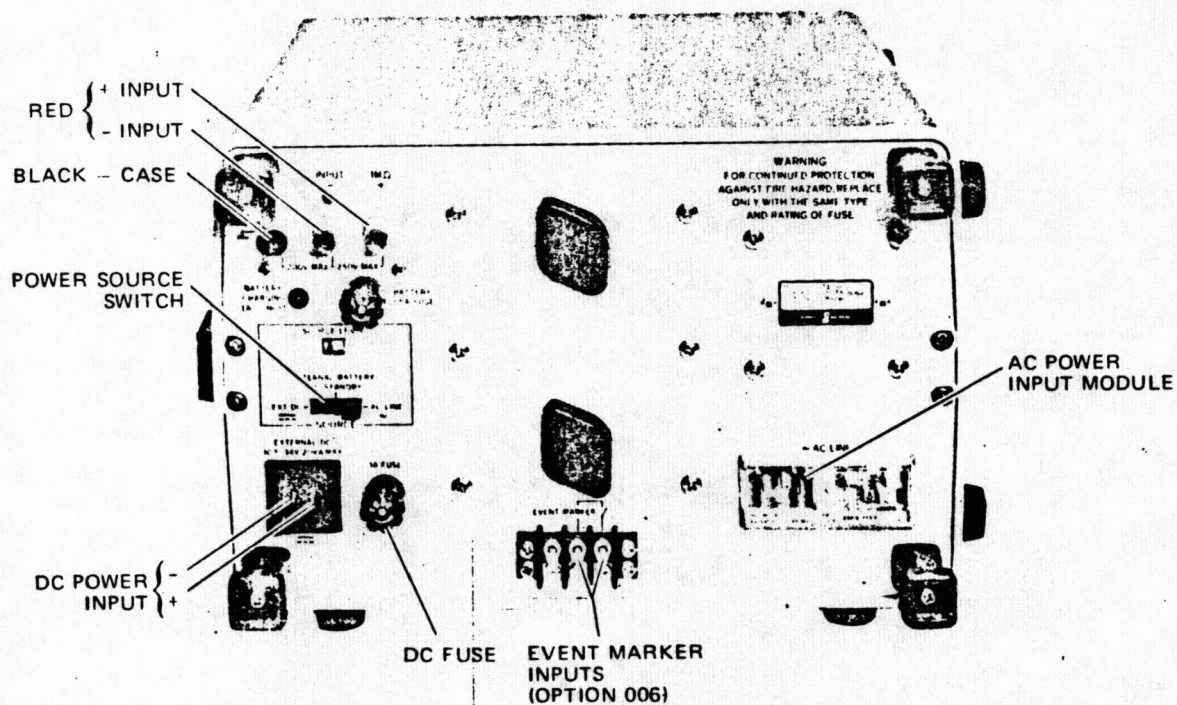


Figure 2-6. System Connections



## SECTION III

### OPERATION

#### 3-1. INTRODUCTION.

3-2. This section provides operating instructions for the Model 7155B Portable Strip Chart Recorder. Included herein are listings of front and rear panel controls and indicators, electrical requirements, and instructions for loading chart paper and disposable pens.

#### 3-3. CONTROLS, CONNECTORS AND INDICATORS.

3-4. Front panel controls, connectors and indicators are illustrated and described in Figure 3-1. Rear panel controls, connectors and indicators are illustrated and described in Figure 3-2.

#### 3-5. ELECTRICAL REQUIREMENTS.

3-6. The recorder can operate on 85 to 130 (115 nominal) or 172 to 260 (230 nominal) Vac, 48 to 440 Hz, or 10.5 to 34 Vdc. Refer to paragraph 2-14 for detailed information on electrical connections.

#### 3-7. CHART PAPER LOADING AND PEN INSTALLATION.

3-8. Refer to paragraphs 2-7 through 2-10 for paper and pen installation.

#### NOTE

The chart is marked in cm, and the length of chart remaining is printed every 30 cm.

#### 3-9. OPERATION.

3-10. This section outlines the basic procedures used to operate the 7155B.

#### WARNING

When the recorder is connected to an external AC or DC power source, and even though the front panel POWER switch is OFF, hazardous voltages still exist on the interior of the instrument (rear panel assembly). Disconnect any

external power sources if the cover is to be removed. With the POWER switch ON voltages up to 400V peak-to-peak are present within the recorder.

3-11. To set up the recorder power system, proceed as follows:

a. Set the SOURCE switch to EXT DC if a DC power source is being used, or to AC LINE if the power is from an AC power source.

b. If an AC source is selected, verify that the jumper plug inside the AC power module (see Figure 3-2, Detail A) matches the nominal line voltage and that the fuse is the correct rating.

c. Connect an appropriate power cord (see Figures 2-8 and 2-9) between the recorder and the power source.

d. If Option 008 is installed, and battery and/or standby operation is desired, set the SOURCE switch to INTERNAL BATTERY/AC STANDBY. Normal AC line operation will result unless AC power is removed, at which time the recorder will continue operation on battery power.

#### NOTE

To insure activation of the LOW BATTERY VOLTAGE SHUTDOWN circuitry, the SOURCE switch should be set with the POWER switch OFF. If the recorder fails to operate in the INTERNAL BATTERY/AC STANDBY mode, switch POWER OFF then ON to reset the low voltage shutdown circuitry.

3-12. This section outlines use of the recorder controls to set up the recorder servo system for normal operation.

a. Preset the 7155B controls:

POWER: ON

CHART: OFF

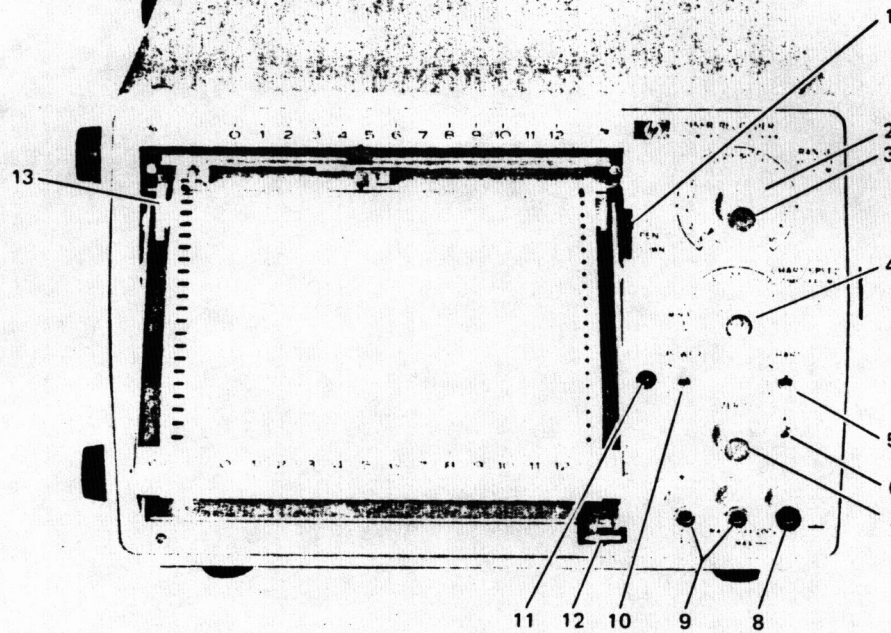
CHART SPEED: N/A

RANGE: Provides on-scale indications as required

VERNIER: Fully CW

PEN: UP

b. Connect a jumper between the (+) and (-) signal inputs. Adjust ZERO control to position the servo



- |    |                         |  |
|----|-------------------------|--|
| 1. | PEN LIFT Control        | Raises the pens off the chart when not in use.   |
| 2. | RANGE Switch            | Sets the sensitivity of the recording system in volts of input signal per cm of pen deflection on the chart. The settings are accurate to within the recorder accuracy specifications when the vernier control is in the CAL position.   |
| 3. | CAL (Vernier) Control   | Allows the recording system sensitivity to be adjusted to values in between those indicated on the RANGE switch.   |
| 4. | CHART SPEED Switch      | Sets the speed of the chart advance.   |
| 5. | CHART Switch            | Turns the chart drive on or off.   |
| 6. | CAL Potentiometer       | Used to calibrate the recording system sensitivity to within specification. This is a maintenance adjustment. Refer to paragraph 5-101.  |
| 7. | ZERO Control            | Used to manually adjust the position of the servo pen to a desired reference point.  |
| 8. | Input Connector (1)     | Provides a chassis ground connection point at the recorder.  |
| 9. | Signal Input Connectors | Accept input data to control position of servo pen. Input signals applied to the input connectors with indicated polarity will provide an upscale pen deflection proportional to the difference of potential between the (+) and (-) connectors. Front panel signal input connectors are connected in parallel with similarly marked connectors on the rear panel. |

Figure 3-1. Front Panel Controls and Connectors (Sheet 1 of 2)

10.	POWER Switch	Applies to power to the recorder. Refer to warning in paragraph 3-10.
11.	POWER Indicator	Lights when recorder is drawing power from the selected source.
12.	Magazine Index Latch	Retains the magazine in the recorder and allows the magazine to operate in three different positions.
13.	Magazine Drive Thumbwheel	Used to manually advance the chart.

Figure 3-1. Front Panel Controls and Connectors (Sheet 2 of 2)

pen as desired (above the zero line on the chart for recording unipolar or DC signals, or above the centerline of the chart for recording bipolar or AC signals).

## NOTE

Both the signal input and the servo system are protected against damage by intermittent normal mode signals up to 250V peak and common mode signals up to 200V peak, regardless of the RANGE switch setting.

c. Remove the jumper and connect the (+) and (-) signal inputs to the signal source to be recorded. For maximum common mode rejection, the (-) signal input should be connected to the point nearest ground impedance at the signal source.

d. Place PEN control DOWN.

e. To set up the chart drive, turn the CHART switch ON, and set the CHART SPEED switch to provide the desired chart speed.

f. If Option 006 is installed, connect the event marker control to the event marker terminals (see Figure 2-5, Detail B).

3-13. A list of operating techniques which simplify operation of the 7155B follows:

a. The chart magazine may be operated without a take-up spool, by allowing the chart to feed out the bottom of the magazine. In this mode of operation, the front cover should not be installed, and the chart magazine should not be pivoted in all the way, or the chart will not feed properly.

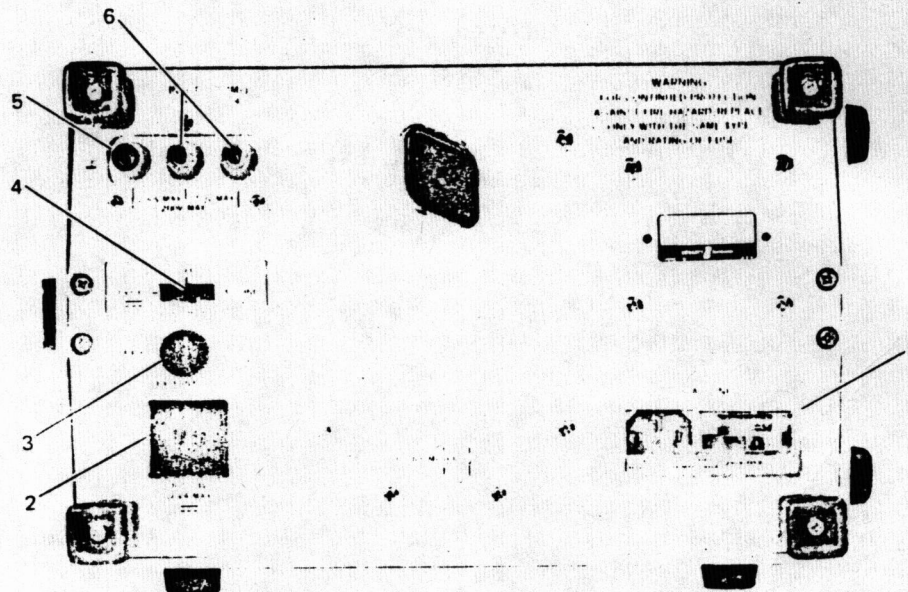
b. The chart may be advanced manually (see Figure 3-1), but the clutch in the chart drive will require part of a revolution to engage after manual advance. At slow chart speeds the time involved may be significant, during which the chart will not move. This time may be shortened by turning the CHART SPEED switch to 10 sec/cm until the chart starts to move, then returning the switch to the desired setting.

c. In dusty environments the recorder requires cleaning sooner than the normal six-month intervals. To minimize this, operation of the recorder with the front cover on is recommended. Signal connections should be made to the rear panel signal inputs, and the chart must be taken up in the magazine, not fed out the front of the recorder.

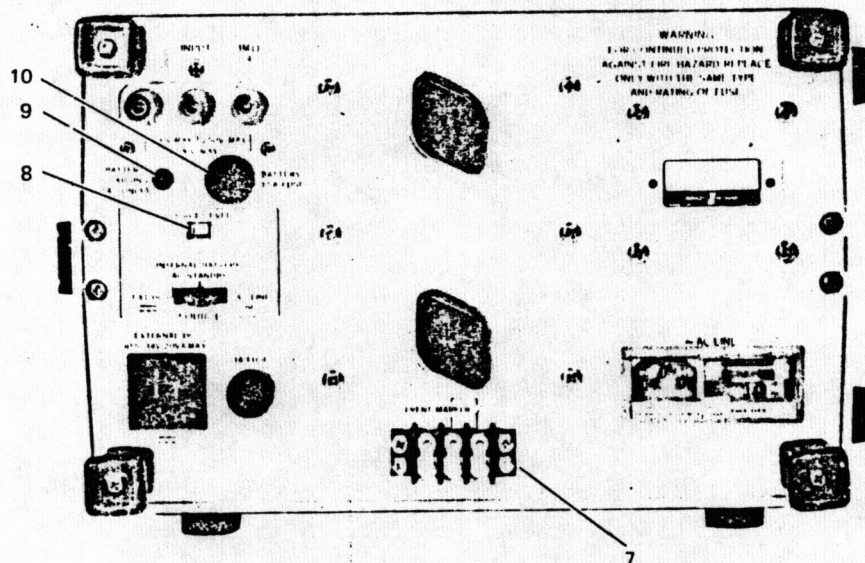
d. For fastest recharge rate on the battery (Option 008), the recorder should be operated with the SOURCE switch in the AC LINE position.

e. For operation off an AC line at ambient temperatures above +45°C, the SOURCE switch must be set to AC LINE, because the battery charger (Option 008) is disabled.





Detail A – Standard Instrument



Detail B – Option 006/008 Instrument

Figure 3-2. Rear Panel Controls, Connectors and Indicators (Sheet 1 of 2)



- |     |   |  |  |                      |                                       |  |        |             |  |         |                |  |                             |                 |
|-----|---|--|--|----------------------|---------------------------------------|--|--------|-------------|--|---------|----------------|--|-----------------------------|-----------------|
| 1.  | AC Power Module                             | Fused AC power cord socket and input voltage selector. The fuse value and jumper plug setting should conform to the requirements of the line voltage available (115V or 230V).   |  |                      |                                       |  |        |             |  |         |                |  |                             |                 |
| 2.  | EXTERNAL DC Power Input Connector           | Used to connect a 10.5 to 34 Vdc supply to the recorder.   |  |                      |                                       |  |        |             |  |         |                |  |                             |                 |
| 3.  | DC Power Fuse                               | Used to protect the DC power line.   |  |                      |                                       |  |        |             |  |         |                |  |                             |                 |
| 4.  | SOURCE Switch                               | Selects the power source for the recorder.   |  |                      |                                       |  |        |             |  |         |                |  |                             |                 |
| 5.  | Input Connector (1)                         | Provides a chassis ground connection point at the recorder.  |  |                      |                                       |  |        |             |  |         |                |  |                             |                 |
| 6.  | Signal Input Connectors                     | Accept input data to control position of servo pen. Input signals applied to the input connectors with indicated polarity will provide an upscale pen deflection proportional to the difference of potential between the (+) and (-) connectors. Rear panel signal input connectors are connected in parallel with similarly marked connectors on the front panel.                       |  |                      |                                       |  |        |             |  |         |                |  |                             |                 |
| 7.  | EVENT MARKER Terminal Strip<br>(Option 006) | Provides connection points for event marker control.   |  |                      |                                       |  |        |             |  |         |                |  |                             |                 |
| 8.  | SOURCE LEVEL Meter (Option 008)             | Monitors source voltage as follows:<br><table border="0"><tr><td></td><td><u>SOURCE Switch</u></td><td><u>Metered<br/>Voltage<br/>Source</u></td></tr><tr><td></td><td>EXT DC</td><td>EXT DC Line</td></tr><tr><td></td><td>AC LINE</td><td>+24 Vdc Supply</td></tr><tr><td></td><td>INTERNAL BATTERY/AC STANDBY</td><td>Battery Voltage</td></tr></table> |  | <u>SOURCE Switch</u> | <u>Metered<br/>Voltage<br/>Source</u> |  | EXT DC | EXT DC Line |  | AC LINE | +24 Vdc Supply |  | INTERNAL BATTERY/AC STANDBY | Battery Voltage |
|     | <u>SOURCE Switch</u>                        | <u>Metered<br/>Voltage<br/>Source</u>  |  |                      |                                       |  |        |             |  |         |                |  |                             |                 |
|     | EXT DC                                      | EXT DC Line  |  |                      |                                       |  |        |             |  |         |                |  |                             |                 |
|     | AC LINE                                     | +24 Vdc Supply   |  |                      |                                       |  |        |             |  |         |                |  |                             |                 |
|     | INTERNAL BATTERY/AC STANDBY                 | Battery Voltage  |  |                      |                                       |  |        |             |  |         |                |  |                             |                 |
| 9.  | BATTERY CHARGING Light                      | Indicates when the batteries are being charged. Will also light when the recorder is being operated in the INTERNAL BATTERY/AC STANDBY mode.   |  |                      |                                       |  |        |             |  |         |                |  |                             |                 |
| 10. | BATTERY FUSE (Option 008)                   | Protects the batteries.  |  |                      |                                       |  |        |             |  |         |                |  |                             |                 |

Figure 3-2. Rear Panel Controls, Connectors and Indicators (Sheet 2 of 2)



Government  
of Canada

Gouvernement  
du Canada

# MEMORANDUM

# NOTE DE SERVICE

F. Roy/NWRI/4311/1b

TO  
A  
J. Valdmanis  
Electronics Design Engineer  
Engineering Service Section  
National Water Research Institute

FROM  
DE  
F. Roy  
Mechanical Systems Design Engineer  
Engineering Service Section  
National Water Research Institute

SECURITY - CLASSIFICATION - DE SÉCURITÉ

OUR FILE / NOTRE RÉFÉRENCE

ES1-005 (NRR)

YOUR FILE / VOTRE RÉFÉRENCE

DATE  
December 9, 1981

SUBJECT  
OBJET

ESTIMATION OF INTERIOR TEMPERATURE OF INSULATED BOX WITH HEAT SOURCE

REF: J. Valdmanis /NWRI/4293/1b, 26 Nov. 1981, NASHWAAK RIVER

The following calculation is intended to provide some indication of the interior temperature of an insulated box with a recorder, as described in the reference memo.

## ASSUMPTIONS:

1. The heat source (recorder) generates 17 watts.
2. The insulated box is 0.6 m (2 ft.) to the side.
3. The box is constructed of 1/2" plywood wall with 2" type 3 expanded polystyrene insulation inside on all six sides. The lid is sealed, i.e. no leakage. The outside surface temperature is the same on all six sides, and is a still air temperature.
4. The box is in a closed hut, surrounded by still air.

Thermal "R" of box wall. Ref: "Thermal Insulation" CMHC Tech Summary NHA 5137 8/76  
CMHC Ottawa. Appendix E.

Outside surface film	.68
1/2" Plywood	.63
2" styrofoam	8.7
Inside surface film	.68
	<u>10.69</u>

$\frac{\text{ft}^2\text{-hr-}^\circ\text{F}}{\text{Btu}}$

or 1.88

$\frac{\text{M}^2\text{.K}}{\text{W}}$

Now heat loss q is given as:

$$q = c A \Delta t$$

$$c = \text{conductivity} = \frac{1}{R} = 0.53 \frac{\text{W}}{\text{M}^2\text{.K}}$$

A = wall area

$\Delta t$  = temperature difference

Wall area =  $6 \times .6 \times .6 = 2.16 \text{ M}^2$ .

Heat flow from source in box is 17 W given.

Then temperature difference between inside and outside of box to produce heat flow of 17 W.

$$\Delta t = \frac{q}{CA} = \frac{17}{.53 \times 2.16} = 14.8^\circ \text{C}$$

e.g. with  $+30^\circ$  outside ambient, inside box will be  $+45^\circ \text{C}$   
with  $-30^\circ$  outside ambient, inside box will be  $-15^\circ \text{C}$

It is understood that this equipment is installed in a shed of some kind. It is conceivable in early spring or summer that the combination of solar energy outside and energy from other equipment inside could raise the air temperature in the shed to  $40-45^\circ \text{C}$ . Under such circumstance, the recorder ambient temperature of  $55$  to  $60^\circ \text{C}$  inside its insulated box becomes hazardous to its health.

*F. Roy*  
F. Roy

c.c. - J. S. Ford  
A. Pashley

1. *Chrysomelidae*

## ENGINEERING SERVICES

for Inland Waters

[illegible]