DATALOGGING AT CAMPBELLTOWN HOSPITAL SOLAR THERMAL ARRAY

A) Introduction:

For a precise performance analysis of the Campbelltown solar thermal system the temperatures at various locations of the mirror array, the insolation and the flow rate of the solar processed steam are continuously monitored round the clock and the measured data are stored in a computer. The schematic diagram of the plant showing the arrangement of collector mirrors, location of sensors and fluid/steam flowpaths are shown in Figure 1.

At present an on line datalogging procedure using an intelligent datalogger (Model DT-100, Manufacturer: Dataelectronics Pty. Ltd., Melbourne) connected to an AMIGA-500 home computer (Manufacturer: Commodore Computer Inc. USA) has been accomplished. The datalogger is operated by AMIGA in the TERMINAL MODE using the WOMBAT communication software and the logged data are stored in a disk. The schematic block diagram showing the sensor connections and signal flowpaths are shown in Figure 2.

The temperatures of the solar array at six different locations (TC2....TC7) as well as the feed water temperature (TC1) and the ambient temperature (TC8) are measured with J-Type thermocouples (APPENDIX A). The incident solar irradiation on the plane of the mirrors is monitored by a locally made Si-Photodiode pyranometer. All sensors are connected to a ten channel signal conditioning unit constructed at our laboratory. The channels c1...c9 of the unit are connected with AD-597 Temperature to Voltage converter chip whereas channel c10 with AD-515 Operational amplifier at unity gain voltage buffer mode (APPENDIX B).

Monitoring of steam flow rate is performed by a sophisticated steam flow measurement system (Manufacturer: Spirex Circo Pty. Ltd,UK). The wet steam from the collector is allowed to run through a steam trap and then a steam flow rate transducer (M-101) which is connected to steam meter signal conditioner (M-301). A microprocessor operated flexible readout system (M-200) connected with the conditioner displays the instantaneous or average value of the steam flow rate as well as delivers dc voltage signal proportional to steam flow rate (Figure 2).

Signals corresponding to temperature and insolation (c1.....c10) as well as steam flow rate tapped from steam meter (c11) are fed to the datalogger through a shielded cable. The datalogger is connected to the AMIGA-500 computer through a RS-232 serial interface cable.

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B) Wiring of the datalogger:

The internal wiring of the datalogger facilitating proper connection between output signals from the conditioner and the internal electronic circuitery of the datalogger is performed as follows:

The upper circuit board of the datalogger has a horizontal array of 50 wire wrap lugs divided in two equal groups. Each of them is connected to two DB-25 female connector mounted on the back of the logger. At the right hand side of the circuit board there are two parallel arrays of lugs of 12 pins each (Analog channels).

All odd numbered lugs (L1,L3,L5...L25) of the horizontal array as well as the -ve terminals right array (pins P1,P2,P3,...P12) are connected to analog ground (GND). The even numbered lugs (L2,L4...L24) are connected to the +ve pins of the analog channels (Ch1,Ch2...Ch12) by wire wrapping technique. The connection between the datalogger and the rest of the world is checked thoroughly by placing dummy voltage signals at DB-25 connector. The wiring schematics of the datalogger and the RS-232 communication cable are shown in Figures 3a and 3b respectively.

C) Programming of the Datalogger:

The communication between the datalogger and the host computer or terminal requires the follwing serial interface parameter set up:

1200 baud
Parity disabled
1 stop bit
8 data bits
XON/XOFF enabled

"XON/XOFF enable" means the handshake mode of communication between the datalogger and the computer or terminal emulator via communication software, which is in this case AMIGA/WOMBAT.

The fundamental programming technique for the operation of the datalogger is given below:

i) Load WOMBAT
ii) Set communication parameters as above
iii) Type RESET 4 (RETURN)

Display on the screen:

LOGGER 0 24k RAM
Calibrating....
Done

iv) Set time: Type T=hh:mm:ss (RETURN)
v) Set day: Type D=nnn (RETURN)
vi) Set data modifying Polynomials: Type

Y1=0,0.1"Celsius" (RETURN)
Y2=0,30.7"W/sqm" (RETURN)
Y3= 0,1.0"Lit/s" (RETURN)

vii) Log data from channels 1 to 8 (temperature) channel 10 (insolation), channel 11 (steam flow rate), average the data for 5 seconds and display them in every 10 minutes with time of sampling and day number: Type

```
R10M A5S T D 1..8V(Y1) 10V(Y2) 11V(Y3)
                               (RETURN)
```

Display on the screen:

```
T=12:00:00
D=100
Ch1= 25Celsius
Ch2= 120Celsius
Ch3= 130Celsius
 :     :
Ch8= 80Celsius
Ch10= 900W/sqm
Ch11= 100Lit/s
```

The coefficients of the polynomials Y1, Y2 and Y3 have been estimted by calibration experiments seperately. These coefficients could be omitted from the datalogger program as shown above to increase the speed of the data transfer. They could be used at the final stage of data manipulation for the proper tabular or graphical presentation of data.

The above program is inaequate for operation of the logger in "stand alone" mode. A simple program INIT has been developed to overcome this problem.

PROGRAM INIT:

```
/m/n/u
p22=44
R10M A5S T D 1..11V
```

This INIT program is written at the beginning of the properly fomatted data disks for stand alone operation. The working datalogging program and the operation sequence is given below:

i) START UP AMIGA (Start up disk in df0)
ii) RUN WOMBAT (WOMBAT in df1)
iii) REMOVE WOMBAT from df1
iv) PUT DATA DISK in df1
v) TYPE RESET 4 (RETURN)
vi) TYPE T=hh:mm:ss (RETURN)
vii) SEND FILE (in WOMBAT Window):

dfl:INIT (RETURN)

viii) CAPTURE TEXT TO FILE (in WOMBAT Window):

dfl: "FILE NAME" (RETURN)

CHANGE OF DISK:

ix) STOP CAPTURE TEXT (in WOMBAT Window):
x) CHANGE DISK (put new data disk in df1)
xi) GO TO STEP iv

In Figures 4a and 4b the graphical representation of the logged performance data of the plant on a sunny day (4a) and a cloudy one are shown. A compact reference guide of the DT-100 datalogger is shown in APPENDIX C.

D) Summary:

The datalogging system presented here is working for last five months without any major problem in Campbelltown district hospital.

Development of a modem and associted electonic circuits for the remote operation of this system through telephone line is in progress.

E) Figure legends:

Figure 1: Schematic diagram showing the arrangement of collecting mirrors, sensors and fluid flowpaths at the Campbelltown Dist.Hospital solar thermal power plant.

Figure 2: Block diagram showing the sensor connections and signal flowpaths.

Figure 3a: Wireing schematics of the DT-100 datalogger.

Figure 3b: Wiring diagram of RS-232 communication cable.

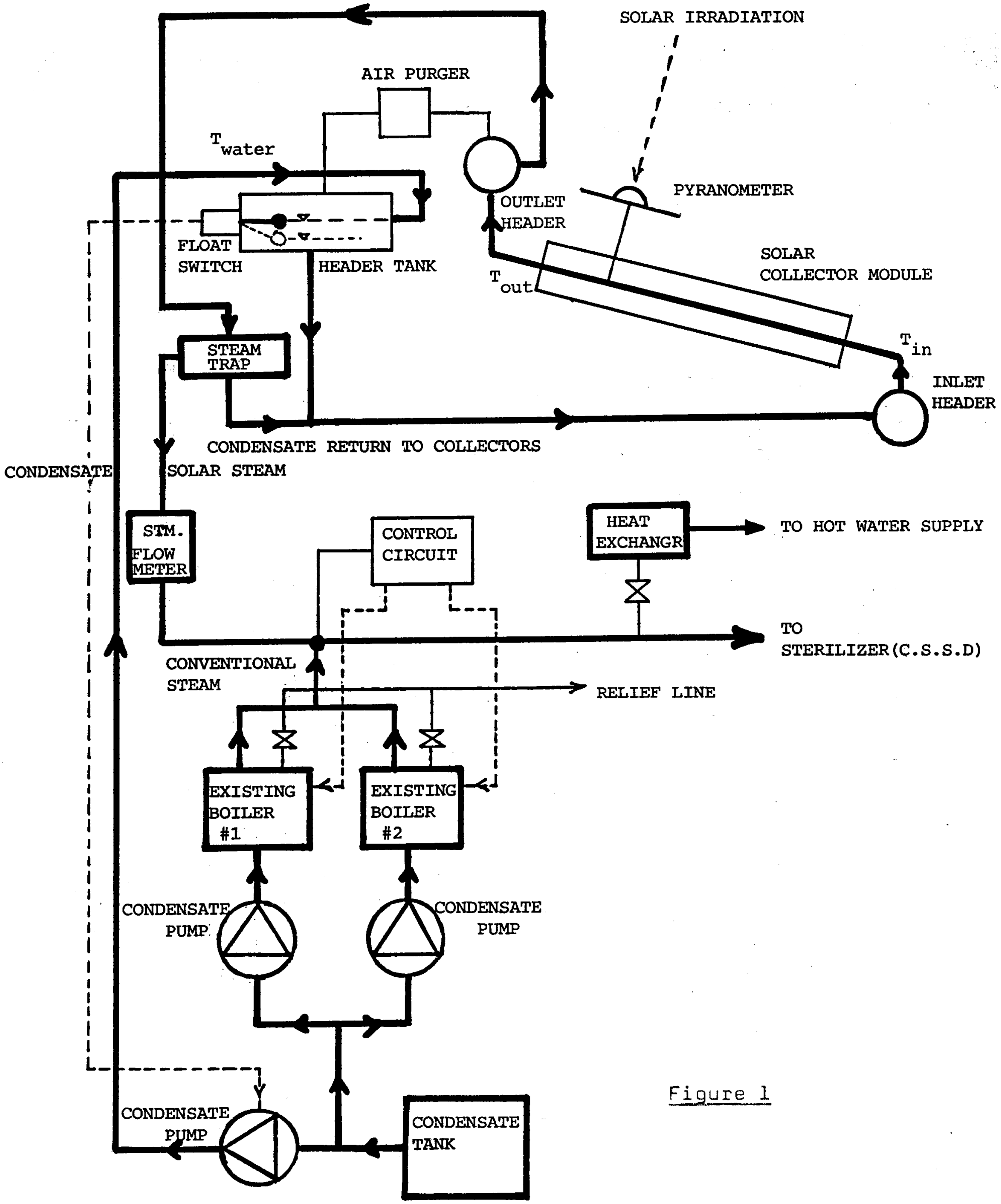
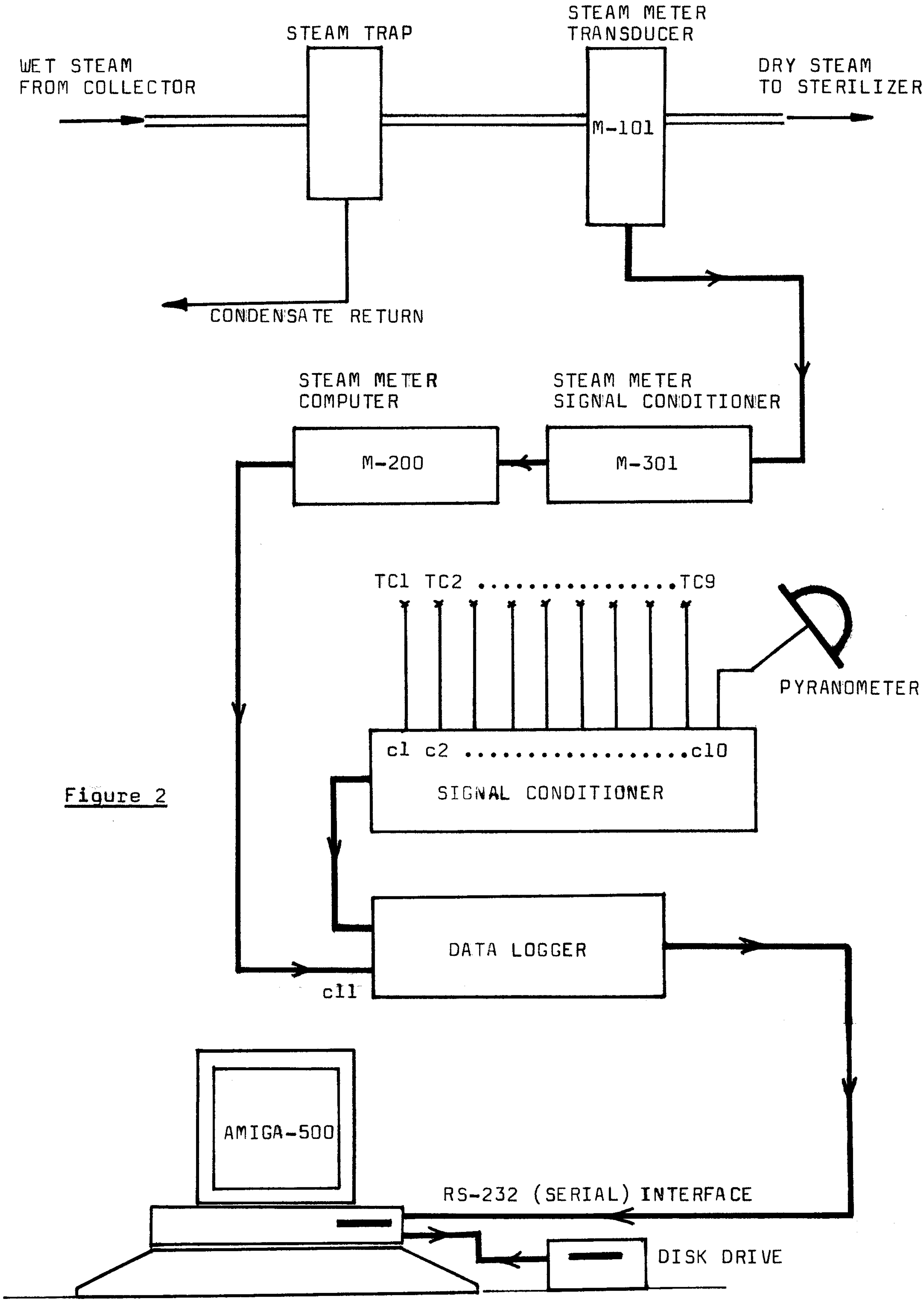

SOLAR IRRADIATION
AIR PURGER
T water
PYRANOMETER
OUTLET HEADER
FLOAT SWITCH
HEADER TANK
T out
SOLAR COLLECTOR MODULE
STEAM TRAP
T in
INLET HEADER
CONDENSATE RETURN TO COLLECTORS
CONDENSATE
SOLAR STEAM
STM. FLOW METER
CONTROL CIRCUIT
HEAT EXCHANGR
TO HOT WATER SUPPLY
TO STERILIZER(C.S.S.D)
CONVENTIONAL STEAM
RELIEF LINE
EXISTING BOILER #1
EXISTING BOILER #2
CONDENSATE PUMP
CONDENSATE PUMP
CONDENSATE PUMP
CONDENSATE TANK

Figure 1



STEAM TRAP
STEAM METER
TRANSDUCER
WET STEAM
FROM COLLECTOR
DRY STEAM
TO STERILIZER
M-101
CONDENSATE RETURN
STEAM METER
COMPUTER
STEAM METER
SIGNAL CONDITIONER
M-200
M-301
TC1 TC2 ....TC9
PYRANOMETER
c1 c2 ....c10
SIGNAL CONDITIONER
DATA LOGGER
c11
AMIGA-500
RS-232 (SERIAL) INTERFACE
DISK DRIVE

Figure 2

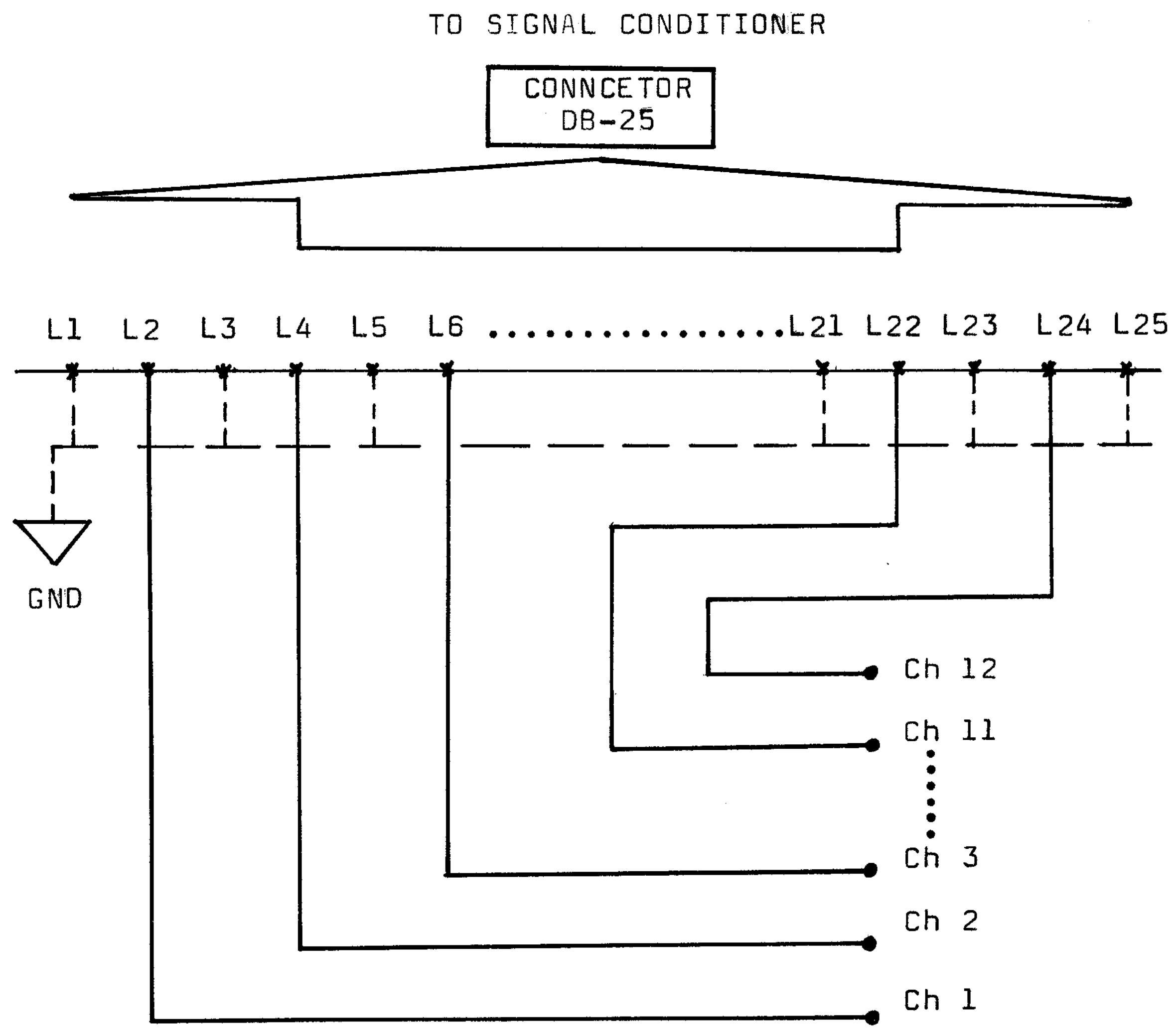
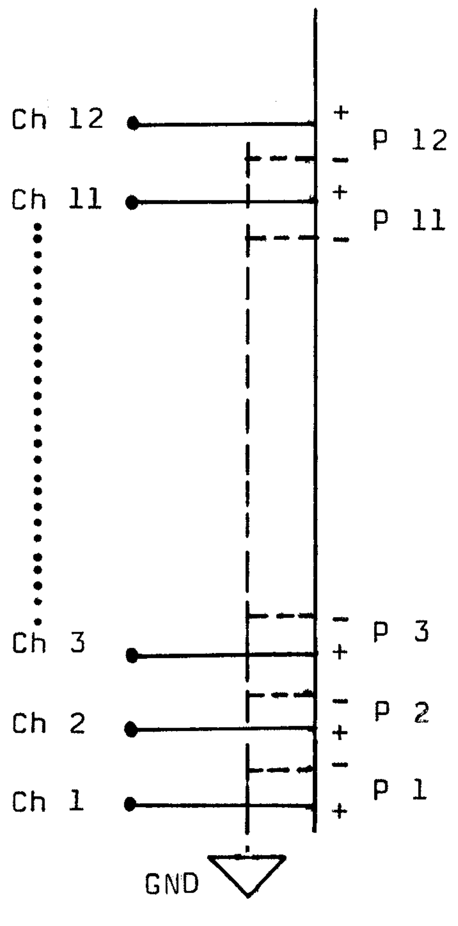

TO SIGNAL CONDITIONER
CONNCETOR
DB-25
L1 L2 L3 L4 L5 L6 ....L21 L22 L23 L24 L25
GND
Ch 12
Ch 11
Ch 3
Ch 2
Ch 1

Figure 3a


Ch 12
Ch 11
Ch 3
Ch 2
Ch 1
P 12
P 11
P 3
P 2
P 1
GND

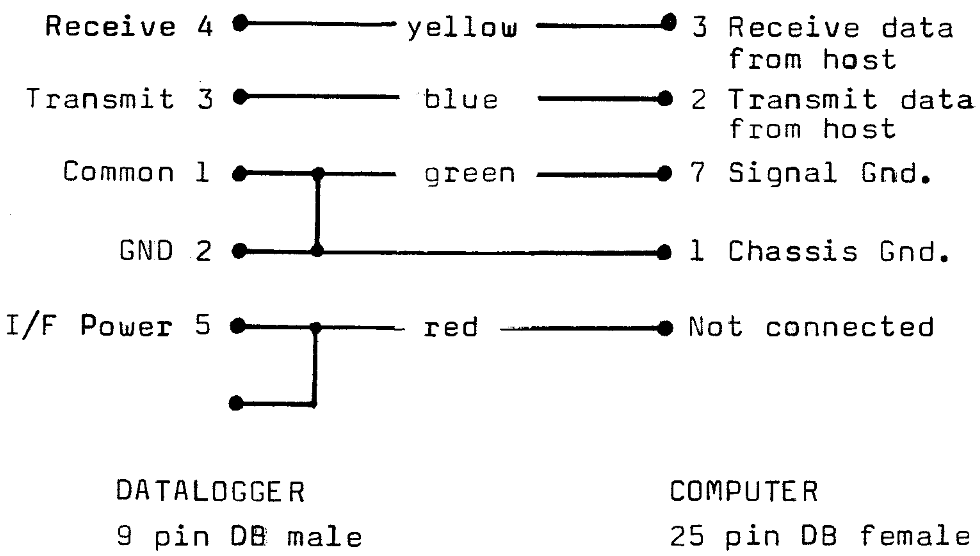
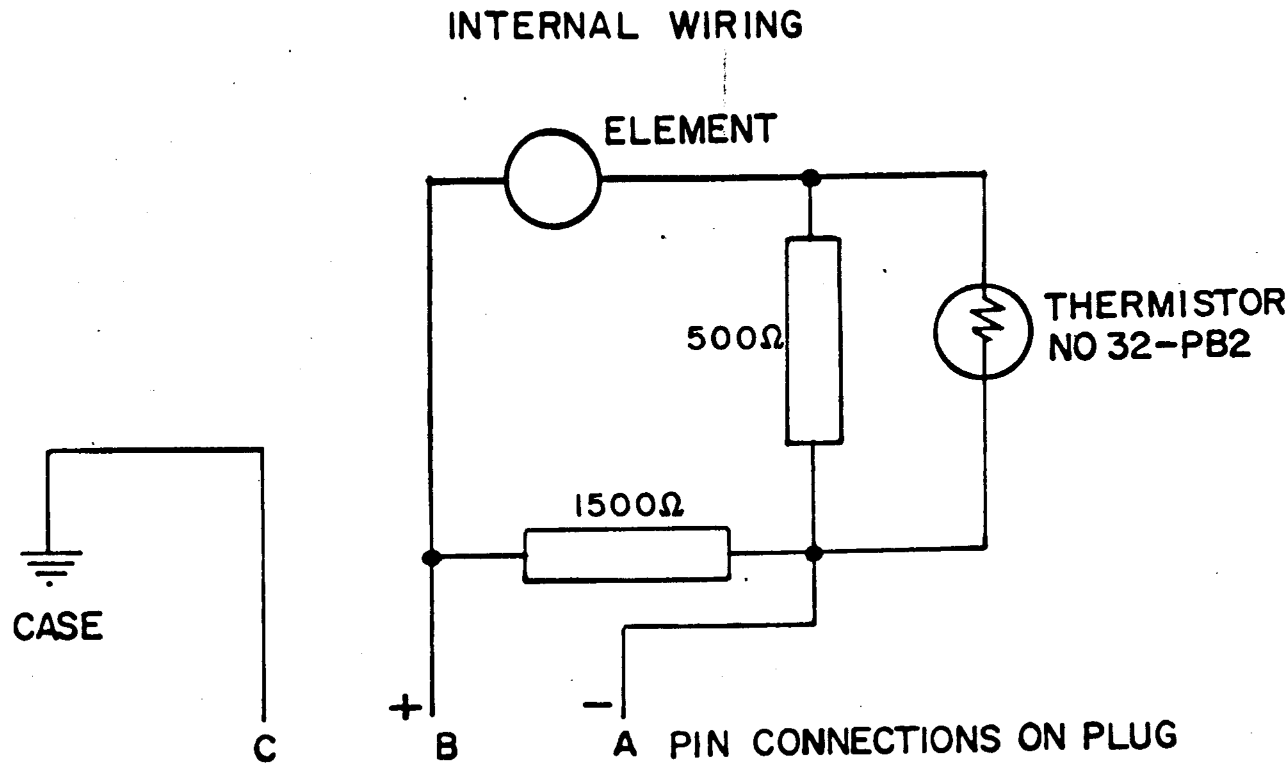
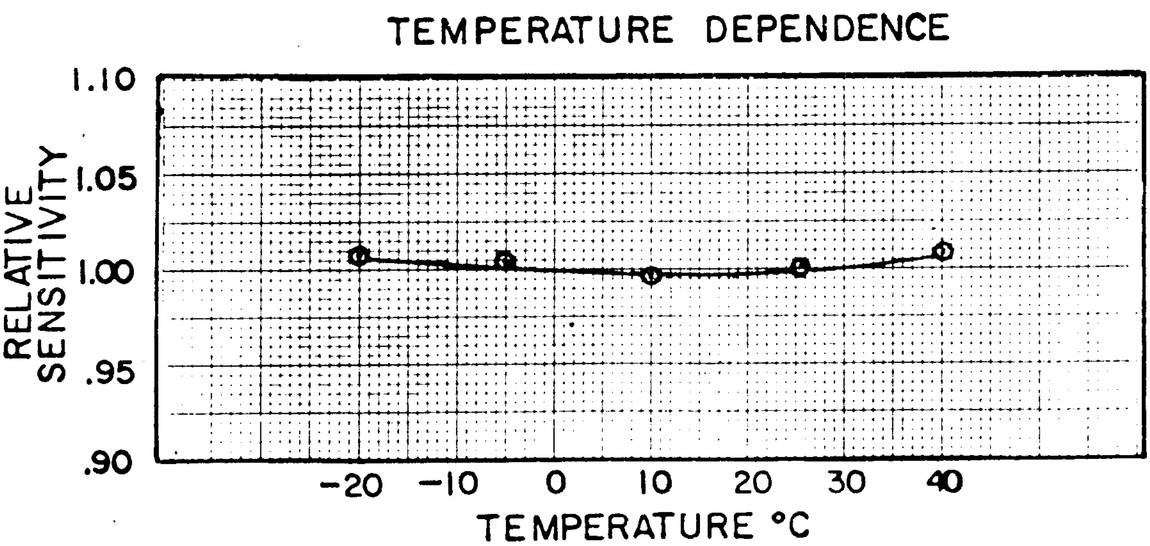

Receive 4
yellow
3 Receive data from host
Transmit 3
blue
2 Transmit data from host
Common 1
green
7 Signal Gnd.
GND 2
1 Chassis Gnd.
I/F Power 5
red
Not connected
DATALOGGER
9 pin DB male
COMPUTER
25 pin DB female

Figure 3b


INTERNAL WIRING
ELEMENT
500Ω
THERMISTOR
NO 32-PB2
1500Ω
CASE
+
−
C
B
A
PIN CONNECTIONS ON PLUG


TEMPERATURE DEPENDENCE
1.10
1.05
1.00
.95
.90
RELATIVE SENSITIVITY
−20
−10
0
10
20
30
40
TEMPERATURE °C