I.O.S.

AUTOMATIC CALIBRATION
OF THE TEMPERATURE CHANNEL
ON AANDERAA RECORDING CURRENT METERS

BY

D. FLATT

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BIDSTON

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INTRODUCTION

Observations of shelf and ocean currents have been made by the Institute of Oceanographic Sciences, Bidston, for many years using the Aanderaa recording current meter (RCM4 and 5). Calibration of the Aanderaa current meters is done routinely as part of predeployment preparation. In order to save effort calibration of the temperature sensor has been automated, taking full advantage of present day microprocessor based systems.

A "National Semiconductor" computer board (BLC 80/10) and appropriate interfaces have been used to automate an existing calibration system. Interfaces were needed for the Aanderaa (RCM), Hewlett Packard 2801A quartz thermometer (H/P2801A) and the Lauda R20 electronic controller of the temperature controlled bath. The mains supply to the thermometer and the bath units is controlled by a solid state relay, to enable these units to be turned off by the BLC 80/10 at the end of the calibration.

All data from the H/P 2801A and the Aanderaa RCMS are printed on a suitable hardcopy terminal with RS 232C interface. A system layout is shown in Figure 1.

A typical output for a standard calibration run is shown in Figure 6. This calibration has four readings at four different temperature settings. The first and last columns are the temperature reading of the H/P 2801A, the third column is the current meter thermistor channel. The rest of the columns are the other current meter data channels and form no part of the calibration. This output shows how well the temperature bath and current meter thermistor have stabilised after each change in bath temperature setting. The time between readings is 40 minutes.

From the data, coefficients are found for a double coefficient formula. The accuracy of the system is 10m°C, which is better than the 24m°C resolution of the Aanderaa RCM. (Aanderaa 1981).

PROCESSOR

The National Semiconductor BLC 80/10A single board computer is based on an 8080 microprocessor. It is designed to be suitable for general purpose computing and control. The board has 48 programable input/output lines and serial interfaces. The on-board memory is 1024 bytes of random access memory (RAM) and 4096 bytes of read only memory (ROM) stored on four 2708 EPROMS. On-board interfaces include RS-232C.

This board along with all the power supplies and interfaces is mounted in a standard 19" instrument case.

HEWLETT PACKARD (H/P) 2801A QUARTZ THERMOMETER INTERFACE

The output from the H/P 2801A is taken from the recorder socket (J7) at the back of the instrument. It is quoted to be BCD 4 2′ 2 1 with voltage levels -2.5 to 0 volts for the high level and -35 to -24.5 volts for the low level at an impedance of 100k .

The five least significant digits of the H/P 2801A are fed to ports 4, 5 and 6 of the BLC 80/10 and the print command (data ready) is fed to bit 2, port 3.

The interface between the H/P 2801A and the input ports of the BLC 80/10 (Figure 2) uses optic isolators (RS 307-064) to convert the output from the H/P 2901A, typically -2.5 to -35V, to a 0 to 5V input to the BLC 80/10. The data format from the H/P is 4 2′ 2 1, which is converted using software into a straight binary form.

AANDERAA RCM INTERFACE

The circuit diagram for the Aanderaa interface is shown in Figure 3.

The positive pulse to start the Aanderaa is provided by the operation of a reed relay (RS 349 383). The reed relay is operated by a high level from bit 7, port 3 of the BLC 80/10, fed via a COSMOS 4050 Hex Buffer.

The data output from the Aanderaa is fed into an optic isolator (RS 307-064). This overcomes the problem of the Aanderaa being positive earth, the rest of the equipment having negative earth. A COSMOS 4093 Schmitt trigger is used to shape the resultant output and feed it into the BLC 80/10, bit 0, port 3.

LAUDA CONTROL UNIT R20 INTERFACE

The control unit was modified so that a resistor chain could be switched in place of the existing control rheostat (Figure 4). An existing slide switch at the back of the unit was used for this purpose. The values for the resistor chain were chosen to give 16 temperature steps from 3°C to 19°C, covering the range required. The resistors of the chain are switched in and out using reed relays (RS 349-383) driven by COSMOS 4050 Hex Buffers, these in turn are driven from bits 4, 5, 6 and 7 port 6 of the BLC 80/10.

CLOCK

Timing intervals of 0.5, 1, 5, 10, 30 or 40 minutes are supplied to the BLC 80/10 (bit 1, port 3) from an Aanderaa clock, using a COSMOS 4093 as a buffer (Figure 3). The timing interval is selected by a multipole switch on the front panel. The choice of timing interval is dependent on the temperature change required, e.g. 40 minutes for a four degree change.

MAINS UNIT

This is a solid state relay, (RS 349-670), which controls mains supply to the Lauda bath units and the Hewlett Packard thermometer. A high level from bit 4, port 1 of the BLC 80/10 keeps these units switched on in a fail safe mode.

OPERATING PROGRAM

The program is stored on a 2708 EPROM, occupying 532 bytes of memory with starting address 0C00. The flow chart for the program is shown in Figure 5.

The first part of the program loads into RAM a table of values needed to give the required number of readings for a standard calibration, normally four readings at four temperatures, 17°, 12°, 6° and 3°C. If other readings or temperatures are required different values can be typed into RAM at this point. Typing in another GO command will now execute the rest of the program.

First the mains to the H/P 2801A and the Lauda Bath unit is turned on. Then a value is taken from the table in RAM and the table address is decremented. If this value is zero, 'END' is printed, the mains turned off and the routine terminated. Any other value will set the Lauda control unit, and the temperature bath will try to attain the set temperature. The time it takes to do this will depend on the temperature change it is being asked to undergo. For four degree steps the time is about 35 minutes.

The program now waits for a clock pulse, the time interval between pulses is set manually, for a standard calibration it is set to 40 minutes. When a clock pulse is received the temperature reading of the H/P 2801A is printed. The BLC 80/10 then starts the Aanderaa RCM, prints the data and then prints the temperature reading of the H/P 2801A. The two readings of the H/P 2801A are taken about 20 seconds apart and how close these values are to each other gives some indication of how well the temperature bath has stabilised. A line feed and carriage return completes the reading.

The number of readings to be taken is decremented, and if more readings at that temperature are required the program loops back to wait for a clock pulse. If no further readings are required the program loops back to get the next RAM table reading. This continues until the table value is zero and the program terminates.

CONCLUSION

The system has proved itself reliable enough to be run overnight unattended, so reducing electrical and acoustic noise in the Laboratory. The temperature calibrations produced are now done to a standard format with a high level of repeatability and a minimum of effort. This enables the time spent on post and pre cruise calibrations to be kept to a minimum, with the facility to do more detailed calibration if required.

Using this system the standard calibration run takes ten hours and an accuracy of 10m$^{\circ}$C is achieved.

REFERENCES

AANDERAA 1981. Operating Manual RCM 4/5.

APPENDIX

1) RAM used by program

Stack pointer - 3FE0

Start of table reading - 3FEA

Temporary store - 3FFC

(No. channels)

Temporary store - 3FFD

(No. scans)

Store table location address - 3FFE - 3FFF

Store no. of scans 3FEA (Normally 4)

Store no. of channels 3FEB (Normally 6)

2) Change of standard calibration

To alter number of scans at each temperature setting change the value at location 3FEA.

To alter the temperature settings Hex. values from 00 to 0F, corresponding to temperature range 3 to 19°C, are placed in sequence starting at memory location 3FEC. The address of the last location used is then stored at 3FFE - 3FFF.

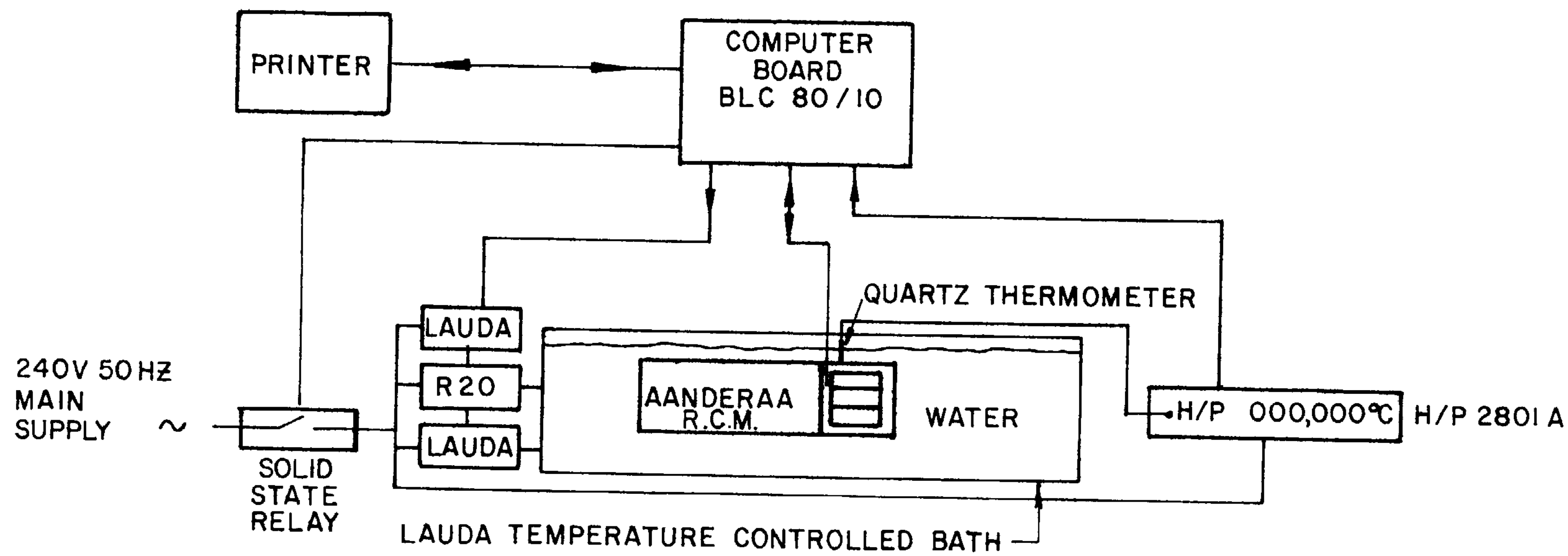

FIG. I SYSTEM LAYOUT

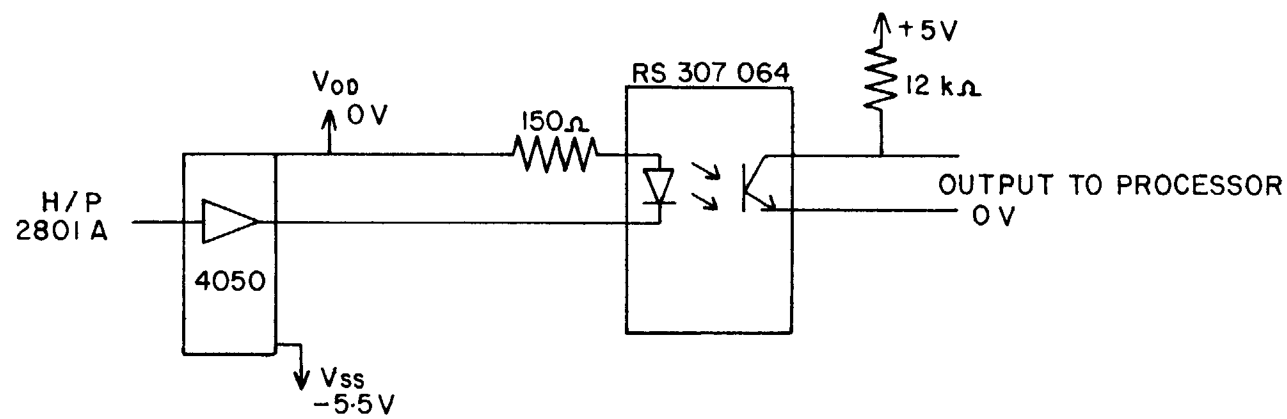

FIG. 2. HEWLETT PACKARD 2801 A INTERFACE

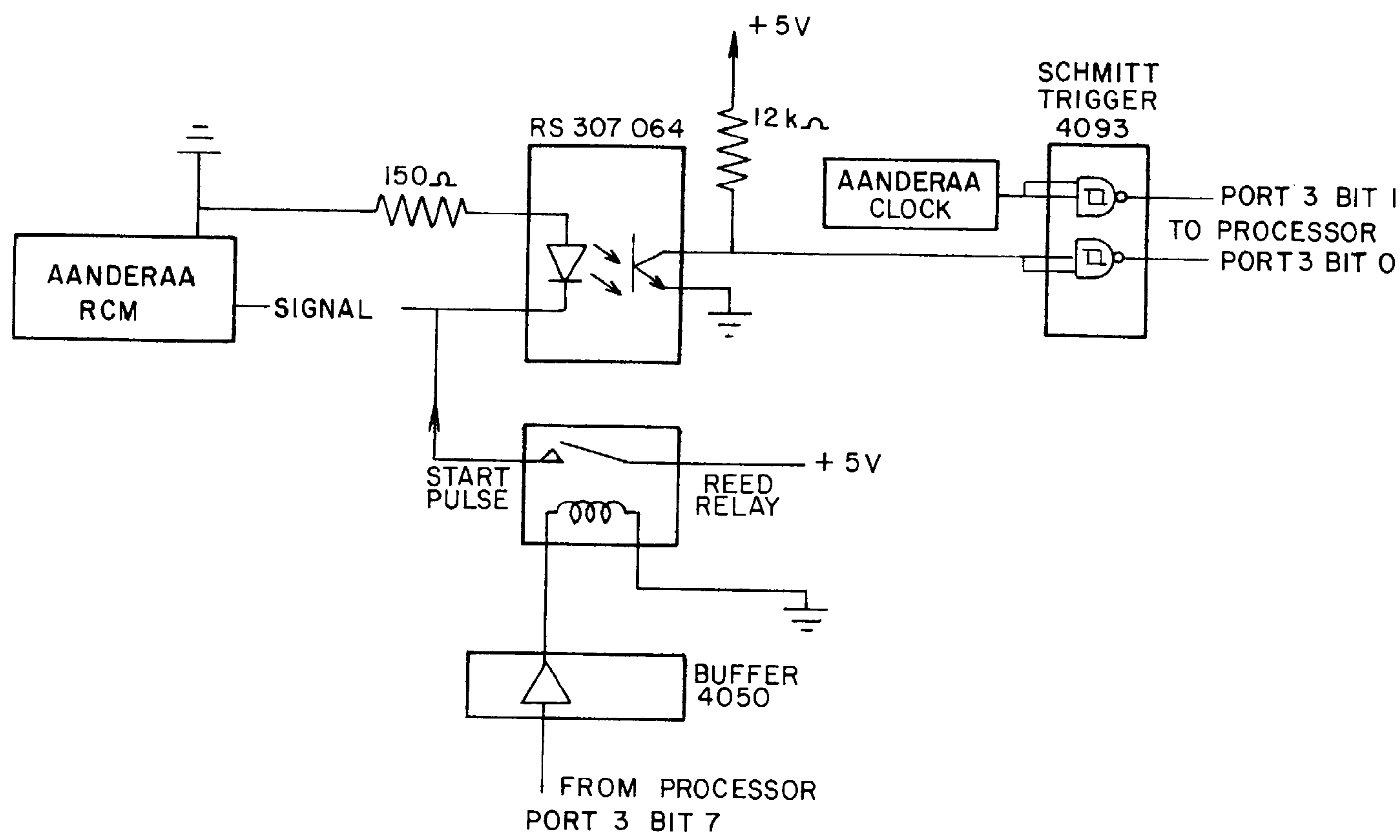

FIG. 3 AANDERAA AND CLOCK INTERFACE

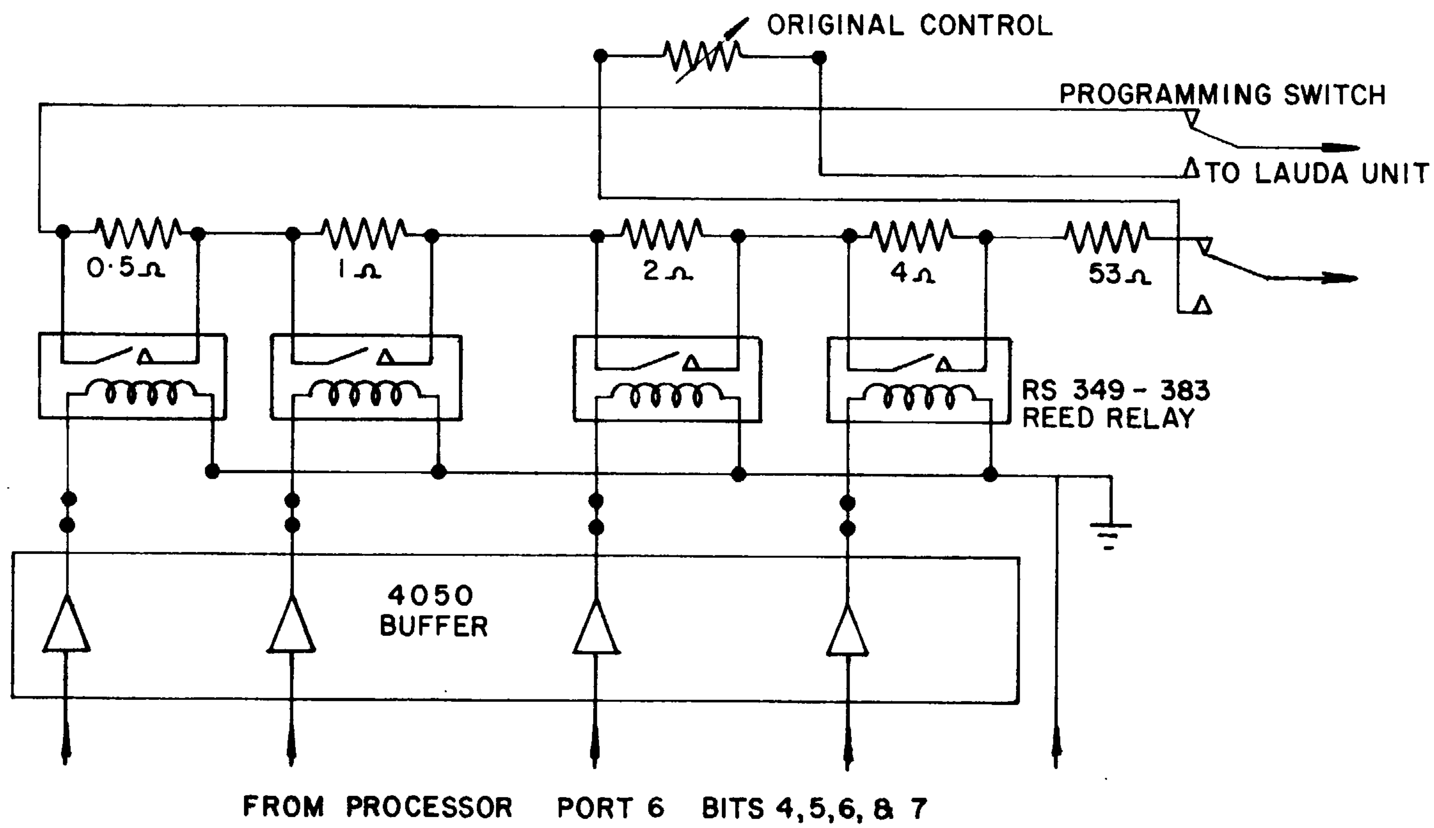

FIG. 4 LAUDA CONTROL UNIT R20

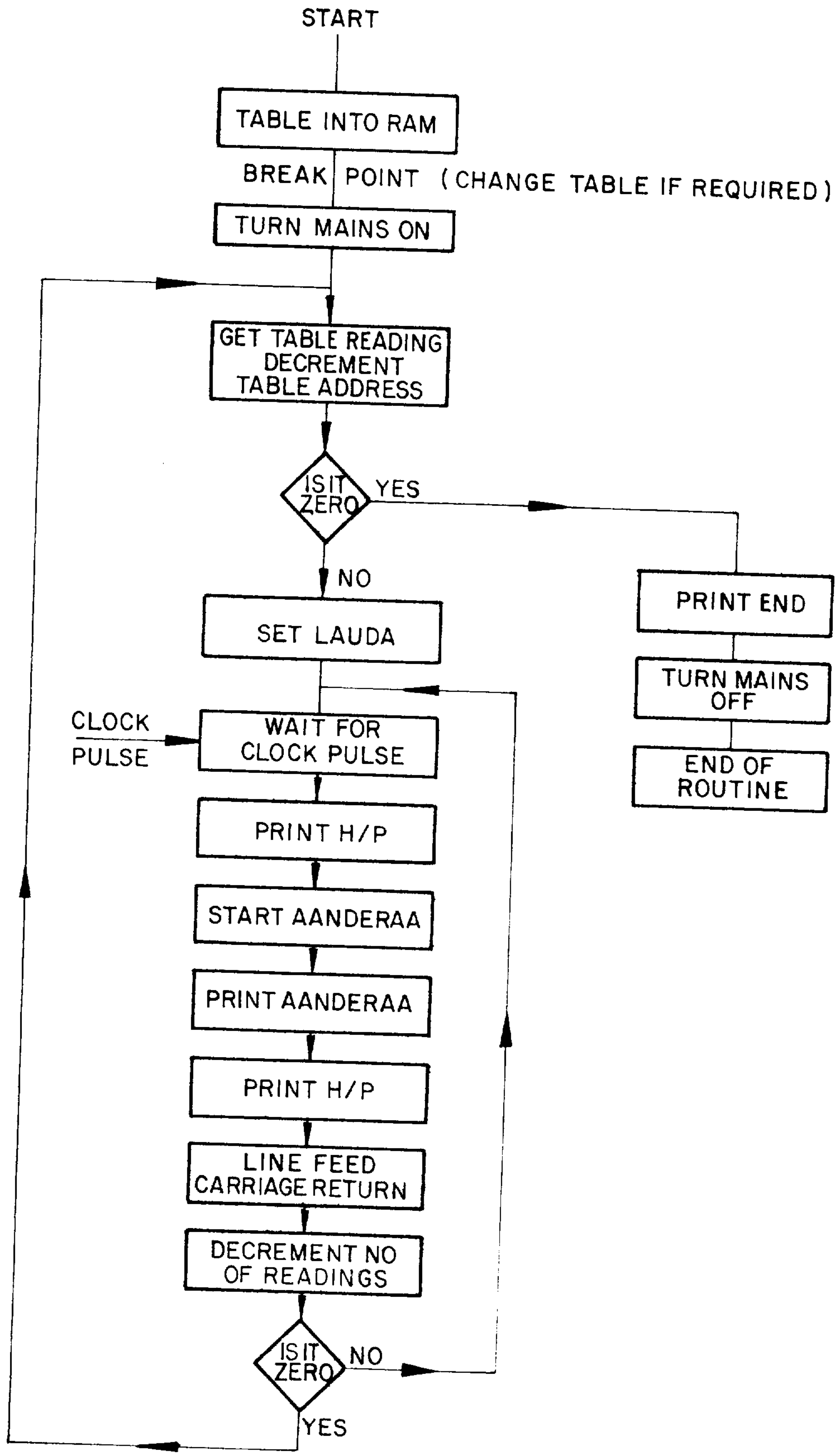

FIG. 5 FLOW DIAGRAM

```
BLC 80P Monitor Rev. 0

.GOCOO

 OC1B

.G

TEMP CAL 2/4/81 1749

17.388  00589  00864  00937  01023  00006  00053  17.386
17.384  00589  00864  01301  01023  00016  00053  17.383
17.382  00589  00864  00672  01023  00034  00053  17.382
17.394  00589  00864  00043  01023  00038  00053  17.394
12.237  00589  00651  00437  01023  00042  00053  12.229
12.166  00589  00647  00801  01023  00046  00053  12.164
12.162  00589  00647  00167  01023  00048  00058  12.165
12.168  00589  00647  00555  01023  00050  00053  12.167
07.154  00589  00431  00939  01023  00052  00053  07.107
05.937  00589  00376  00296  01023  00054  00053  05.937
05.937  00589  00376  00676  01023  00056  00053  05.939
05.938  00589  00376  00032  01023  00057  00053  05.938
03.042  00589  00248  00415  01023  00059  00053  03.042
03.047  00589  00248  00805  01023  00060  00053  03.046
03.054  00589  00248  00175  01023  00061  00053  03.053
03.054  00589  00248  00570  01023  00064  00053  03.054

 END OE15
```

Fig 6. Typical Output