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Rad Chem Data Acquisition Chassis Users Manual

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MASTER

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Contents

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ABSTRACT

The Shiva Laser at LLL requires many forms of diagnostics to measure and analyze fusion experiments. This manual describes the operation of a Micro-Processor controlled data acquisition system designed at LLL to measure Neutron Activation during fusion experiments on the Shiva Laser.

Introduction

The Rad Chem Data Acquisition Chassis' primary goal is to provide a means of acquiring the pertinent data necessary to the Rad Chem Experiments (Neutron Activation) on the Shiva Laser.

A micro-processor's small size coupled with its ability to analyze and control complex operations best suit it for many control applications. Designing this micro-processor based data acquisition system allowed for flexibility in implementing the functions needed to accomplish this task.

Some features:

- Capable of four counting inputs
- Local front panel readout of four counting inputs plus time of day clock
- Hardcopy printout of data using built in alphanumeric printer
- Optional Running Modes are user selectable
- Internal Real Time Clock
- Remote Control via a remote computer
- User Selectable - *Run Number, Sample Rate and Sample Interval*
- Front Panel Display Intensity Control
- Internal self-testing diagnostics
- Fiber Optic Input for zero-time trigger
- High Voltage Control Output for external power supplies
- Computational ability to compute and record averages

Functional Characteristics and Specifications

Inputs:

Scaler Inputs - (Beta, Gamma, Coincidence and Guard) Each capable of a max count of 999,999. These are high impedance inputs requiring TTL level signals. Each input is diode protected against high levels and negative signals. These inputs must be connected to a low impedance source. If left unconnected the scalers will appear to count at 1 count/second. Max count rate is 2 MHZ.

Fiber Optic Zero Time Input - This input is fiber optically coupled via an internal fiber optic receiver.[3] This is a DC level light sensitive input required to indicate zero time has occurred on a running experiment.

Remote EIA Input - This input is used to remotely control the chassis via a remote computer. This interface is EIA RS-232C[4] compatible. This input is active when the front panel keyboard is used to select Remote operation. Data format is 1 start bit, 2 stop bits, 8 data bits, no parity at 300 baud.

Outputs:

High Voltage Control Output - This is a TTL level signal used to control (ON/OFF) a number of remote high voltage power supplies. A TTL high level (+5V) will turn "on" the remote supplies while a TTL low (0^V) will turn them "OFF".

Printer - The 20-column alphanumeric printer installed within the chassis is optionally either "on" or "off" by user choice. The front panel keyboard is used to select this option.

Keyboard - *Following is the functional description of each key on the* front panel keyboard. (Figure 8.)

Keys Ø→9 - These keys are used to input the necessary running parameter data, time of day, etc.

Enter Key - This key is used to enter the previously selected data.

Setup Key - This key is used to enter the Setup Mode.

Remote Key - This key is used to transfer command input and output to the Remote EIA device. This is an alternate action key (i.e. every other press alternates between Remote and Local mode).

Printer Key - This key is used to either select or disable the internal alphanumeic printer (alternate action).

Count Run Key - This key is used to start the Count Run sequence.

Density Run Key - This key is used to start the Density Run sequence. This run mode always turns the printer "on" for recording data.

Abort Key - This key is used to halt a previously selected running sequence.

Indicator Lites - Following is the functional description of each lite on the front panel.

Enter Sample Interval Lite - Indicates to the user that now is the time to enter the Sample Interval length. This is the total length of time the run is for. Range 1Ø → 9999 seconds.

Enter Sample Rate Lite - Indicates to the user that now is the time to enter the Sample Rate length. This is the length of time at which data is taken. Range 1Ø → 9999 seconds.

Enter Run Number Lite - Indicates to the user that now is the time to enter the Run Number. This is an arbitrary user selected number to identify each run sequence. Range Ø → 9999.

Run Lite - Indicates that a run is in progress.

Zero Time Lite - Indicates that the zero time fiber optic signal has occurred.

Printer Lite - Indicates that the printer has been selected for output logging of data.

High Voltage Lite - Indicates that the high voltage control output has been activated.

Remote Lite - Indicates that the chassis is under Remote control. The chassis can be returned to local control only by pressing the Remote key again.

Operating Instructions

Following is the general operating procedures to properly set up and operate the Rad Chem Data Acquisition Chassis:

Initial Power-Up - When the unit is initially powered "on", the entire display is filled with 8's. This informs the user that a power failure has occurred and also illuminates all digit segments in the 30 displays for a general checkout.

The 1st digit in the Time display will be flashing to inform the user that the time of day is to be set at this time. The user should proceed to enter the correct time of day. The flashing digit will advance with each new digit entered and loop back to the 1st digit until the correct time is in the display. When the time (set in the display) actually occurs, the user must press the "Enter" key to inform the unit to start the Real Time clock. If you desire to reset the Real Time Clock, this can only be done by turning power "off" and repeating the above sequence.

Run Parameter Setup - The Run parameter setup mode is entered by pressing the "Setup" key. The "Enter Sample Interval" lite will illuminate to inform the user which parameter he is about to enter. If a previous parameter has been entered, it will be displayed at this time in the Beta Counts Display. The 1st digit in the Beta Counts display will be flashing to inform the user that the "Sample Interval" value is to be entered at this time. The user should proceed to enter the correct "Sample Interval" at this time. The flashing digit will advance with each new digit entered and loop back to the 1st digit until the correct value is in the display. If the user desires not to change the parameter, pressing the "Enter" key at anytime enters what was in the display to the parameter buffer.

The above procedure is repeated with both the "Sample Rate" and the "Run Number" parameters. When all three parameters have been entered the unit is ready for a run sequence.

Starting a Run Sequence - To start a run sequence the user should press one of the two available run modes, either "Count Run" or "Density Run" (each will be described in detail later). To stop a running sequence prior to its normal completion, the user has the option of pressing the "Abort Key". This will stop the run and print an "Aborted" message at the printer if it was previously selected.

The printer can optionally be selected "on" or "off" during a Count run by alternately pressing the "Printer" key.

Count Run - (See Figure 3.) This run sequence is selected by pressing the "Count Run" key. This run sequence is used for general purpose counting of the inputs. The front panel displays are used to observe the counting while in progress. The printer can optionally be used to record the count results and the internally computed averages if desired. The printer output format is organized to speed printing and minimize the use of paper. (See Figure 4.)

Density Run - (See Figure 5.) This run sequence is selected by pressing the "Density Run" Key. This run sequence is used for data acquisition during an experiment. The unit initializes everything internally and waits for the Zero Time input to occur. When it occurs, the time is recorded on the printer and then the unit waits for the operator to signify that the sample has been loaded into the detector assembly. The operator signifies this by pressing any key on the keyboard. The Sample Load Time is then printed and High Voltage is turned "on". The run then proceeds as normal until the end of the Sample Interval or until the Abort Key is pressed. The print out format is similar to the Count Run except for the initial Zero Time and Load Time messages (See Figure 6).

Special Run Features - Normally, the unit's maximum Sample Interval parameter would be 9999 seconds, but this has been selected as a special case. When a Sample Interval of 9999 seconds is selected, either on a "Count Run" or a "Density Run", the unit actually has an infinite Sample Interval (or until the paper runs out, if the printer is selected). This feature allows the unit to operate over very long periods of time for special applications.

The Sample Rate and Sample Interval parameters are checked for valid range when starting a run sequence. If either is less than 10 seconds, an error message is sent to the front panel display to alert the user, and the run is aborted. The error message consists of a display full of "⊏" characters.

Remote Operations - The unit has been designed to allow complete remote control and data transfer via a remote computer. This control is implemented through the rear panel Remote EIA connector. Remote control is accomplished by sending and receiving RS-232C[4] ascii characters. When remote control is selected, all future input and output will be directed to the remote controlling device.

Sending Commands - Following is a list of commands and the equivalent ascii character which must be sent by the remote controlling device for remote command:

Commands	Ascii Equivalent (HEX)
Numbers 0 → 9	30 → 39
Enter	3A
Setup	3B
Abort	3D
Printer	40
Density Run	41
Remote	42
Count Run	43

Receiving Data - Data is received at the remote controlling device in ascii. The data is in the same format as that which is printed on the alphanumeric printer under local control. The remote controlling device must send a "Printer" command to insure the printer is "on" before data will be sent to the remote device. The complete protocol necessary for remote operation is listed below.

Remote Protocol

	Remote Device		Data Acquisition Chassis
1.	Send "Abort" function	→	Clears any previous commands
	Send "Printer" function	→	Enables data to be sent
	Send "Setup" function	→	Enable entry of parameters
4.	Send "Sample Interval" data (4 digits)	→	Sets up Sample Interval
5.	Send "Enter" function	→	Enters previous data
6.	Send "Sample Rate" data (4 digits)	→	Sets up Sample Rate
7.	Send "Enter" function	→	Enters previous data
8.	Send "Run Number" data (4 digits)	→	Sets up Run Number
9.	Send "Enter" function	→	Enters previous data
10.	Send run type (i.e. Count Run, Density Run)	→	Starts run sequence
11.	Receive data	←	Send data
12.	Send "Abort" function to stop prematurely	→	Halts any previous run sequence and clears any previous commands

Protocol Notes

1. Each command function sent will be echoed to insure proper receival of the command, if the printer command function is sent first.

2. Data sent and received is seven-bit ascii. The eighth bit is not used or needed.

3. Data format is:

Start Bits	1
Stop Bits	2
Data Bits	8
Parity	None
Baud Rate	300

4. Interfacing conforms to standard RS-232C signaling; see Figure 7 for suggested remote terminal connection.

Internal Self-Testing Diagnostics - The internal software has several built in diagnostics which can be useful when diagnosing problems associated with the hardware or software of the unit.

1. Under normal operation when the unit is not running either a Count Run or a Density Run, the software stored internally is continually checking itself. This is accomplished by computing a check character on the internally stored program and comparing this check character to a previously computed character which was stored when the unit was initially built. If the two check characters do not match, an error code is displayed to alert the user. The error code will fill the display full of "u" characters.

2. Internally there exists a complete set of diagnostics to help isolate and debug the hardware of the unit. To activate a diagnostic routine the user must first select which diagnostic routine he wishes to run with an internal dip switch mounted on the main control board. This switch is tested each time the unit is initially powered up. Therefore, to select a diagnostic the user must first turn the unit "off", select the diagnostic, and turn the unit "on". The diagnostic will then be activated on power up.

Internal Diagnostic Descriptions

1. Printer Test - This diagnostic prints all the printable ascii characters on the built in alphanumeic printer.

2. Display Test - This diagnostic displays all the possible characters in the front panel display. The number is advanced by one each time any key on the front panel keyboard is pressed.

3. <u>Keyboard Test</u> - This diagnostic is used to test the keys and their location in the keyboard matrix. A two-digit number is displayed in the front panel display for each key pressed. The following table lists each key's two-digit location in the matrix:

Key 0 = 19	Remote = Ø3
Key 1 = 1Ø	Count Run = Ø4
Key 2 = 11	Printer = Ø⊐*
Key 3 = 12	Density Run = Øu*
Key 4 = Ø8	Enter = 18
Key 5 = Ø9	Setup = 1⊏*
Key 6 = Ø⊏*	Abort = 1u*
Key 7 = ØØ	
Key 8 = Ø1	
Key 9 = Ø2	

*These are the display fonts generated by the display decoder.

4. <u>Ram Memory Test</u> - This diagnostic is used to check out the internal ram memory. The memory is alternately filled with all ones and all zeros. If an error is found when reading the data back, an error code message is sent to the front panel display. The error message is a display full of the character pair "69".

5. <u>Counter Test</u> - This diagnostic is used to check out the four internal counters. An external pulser should be applied to all the rear panel counter inputs. The front panel display for each counter should count the number of pulses applied. This checks out the internal counters in a total count recording mode.

If any key in the front panel keyboad is pressed, the counter checkout routine is changed to a frequency measuring routine. The frequency of each counter input is displayed in its appropriate display.

6. Remote EIA Test - This diagnostic is used to check out the internal UART and the remote terminal interface connections. This diagnostic will echo any character sent via a remote device.

Circuit Description - (See Figure 1.) The hardware design of this unit is based on the Intel 8085[1] 8-bit micro-processor. This design relies extensively on the family of support chips provided for this micro-processor. The 8085 CPU (Central Processor Unit) has available to it 256 bytes of ram (located in the 8155) and 4096 bytes of EPROM memory (located in 2-2716's) for program storage.

The 8155[1] also has available 22 input/output lines which are used for interfacing the alphanumeric printer, the high voltage control and the test mode switches. There also exists a 14-bit counter timer in the 8155 which is used to generate the 16x clock necessary for the 8251 baud rate generator.

The 8251[2] USART is used for interfacing and communications with a remote controlling device.

The four 8253[2] counters are used for the counting functions as well as general purpose counters for the Sample Interval, Sample Rate and real time clock functions. Each of these chips contain three 16-bit counters.

The 8279[2] Keyboard and Display Interface is used to interface all of the front panel functions. The keyboard matrix scanning and display refresh are all accomplished with this chip.

The Zero Time trigger is interfaced via a fiber optic interface module[3] to an interrupt input on the CPU.

All of the support chips mentioned above are programmable. Each has the ability to function and operate in many different modes. The inquisitive reader should seek the software listing and hardware schematics for further details.

Software Description - The entire software package to run all the functions in this unit is contained in less than 4096 bytes of EPROM memory. The program is stored in EPROM so that the unit is immediately ready to operate at power up without any additional support hardware or special user knowledge.

The software was written and developed entirely using assembly language on a Tektronix 8002 Microprocessor Development Lab. Assembly language was selected to increase speed and minimize the amount of EPROM space needed to store the final software. A complete software listing is available from the author.

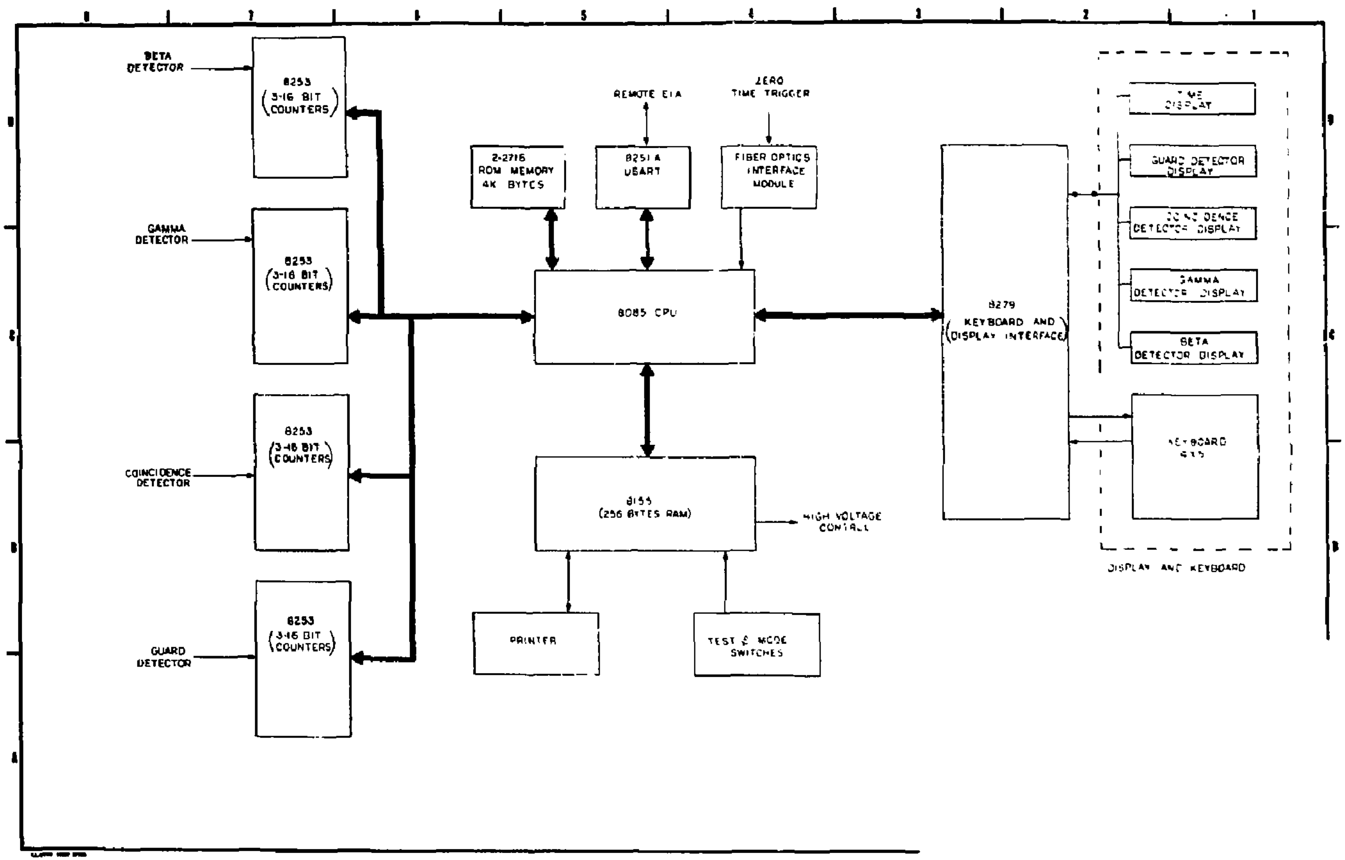
System Interconnection - (See Figure 2.) A general purpose interconnecting diagram is included for general information. The operation of each module is outlined in its associated operating and service manual.[5]

The system inteconnection, in reality, may vary slightly to facilitate special counting applications.

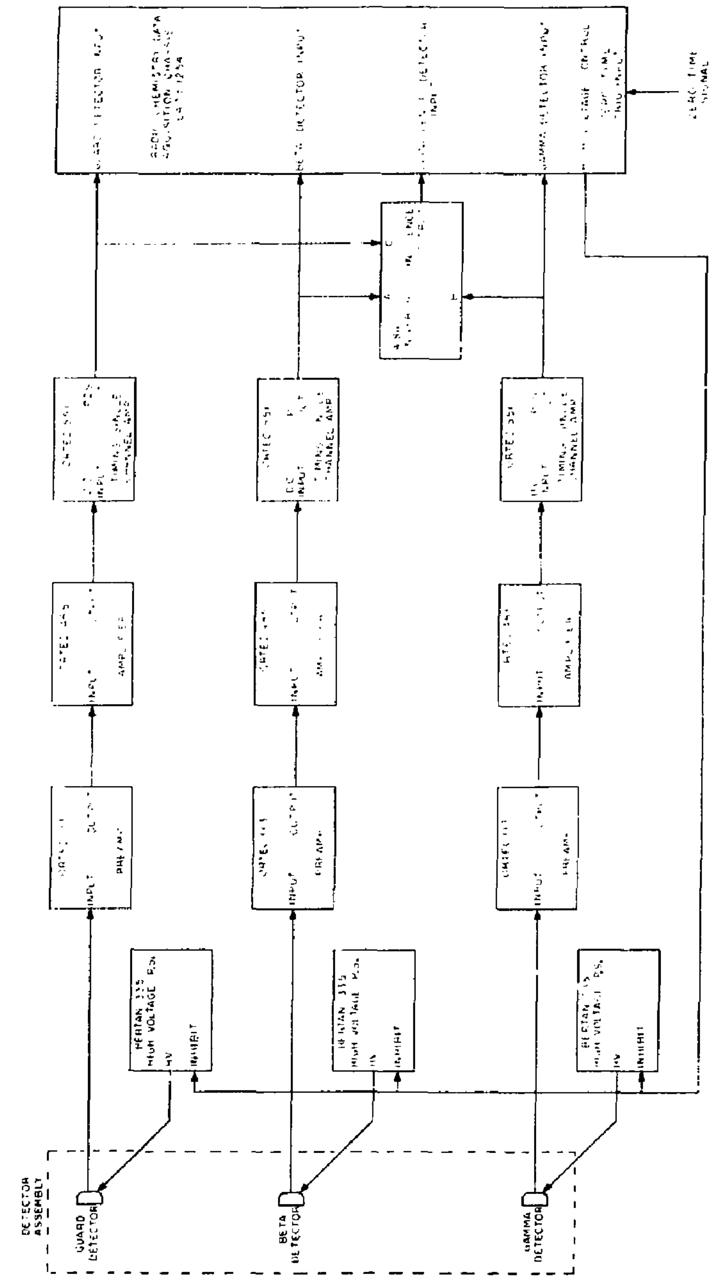
REFERENCES

1. Intel MCS-85 Users Manual
2. Intel Peripheral Design Handbook
3. Serial Fiber Optic Link - UCRL 79279 - J. P. Severyn
4. EIA Standard RS-232C
6. EG & G ORTEC Operating & Service Manuals
    Scintillation Preamplifier - 113
    Modular Bin and Power Supply - 401
    Timing Single Channel Analyzer - 551
    Amplifier - 485
    Universal Coincidence - 418A
6. Bertan Instruction Manual - Model 355

FIGURE CAPTIONS

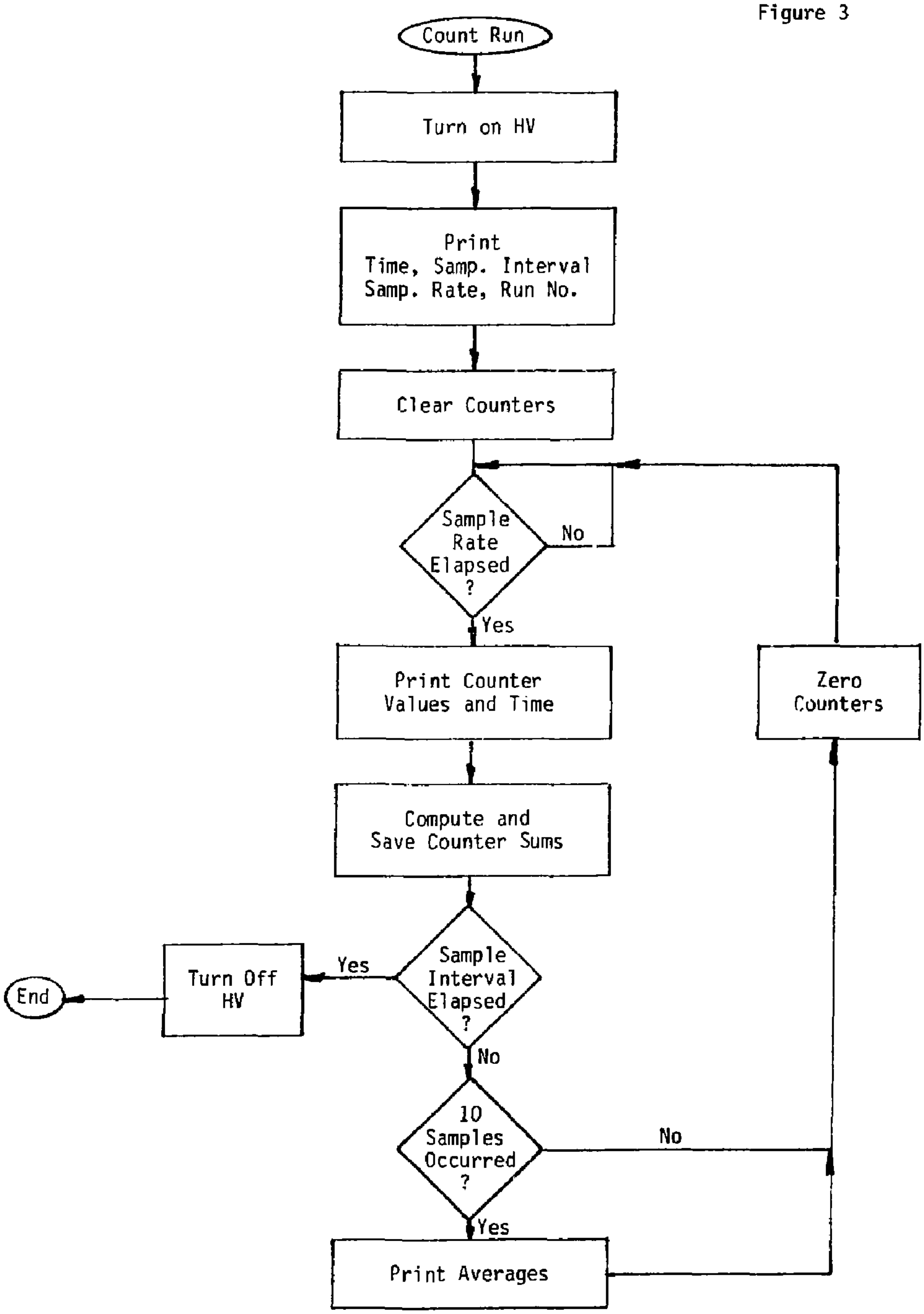


BLOCK DIAGRAM
Figure 1



SYSTEM INTERCONNECTIONS
Figure 2

COUNT RUN FLOWCHART
Figure 3

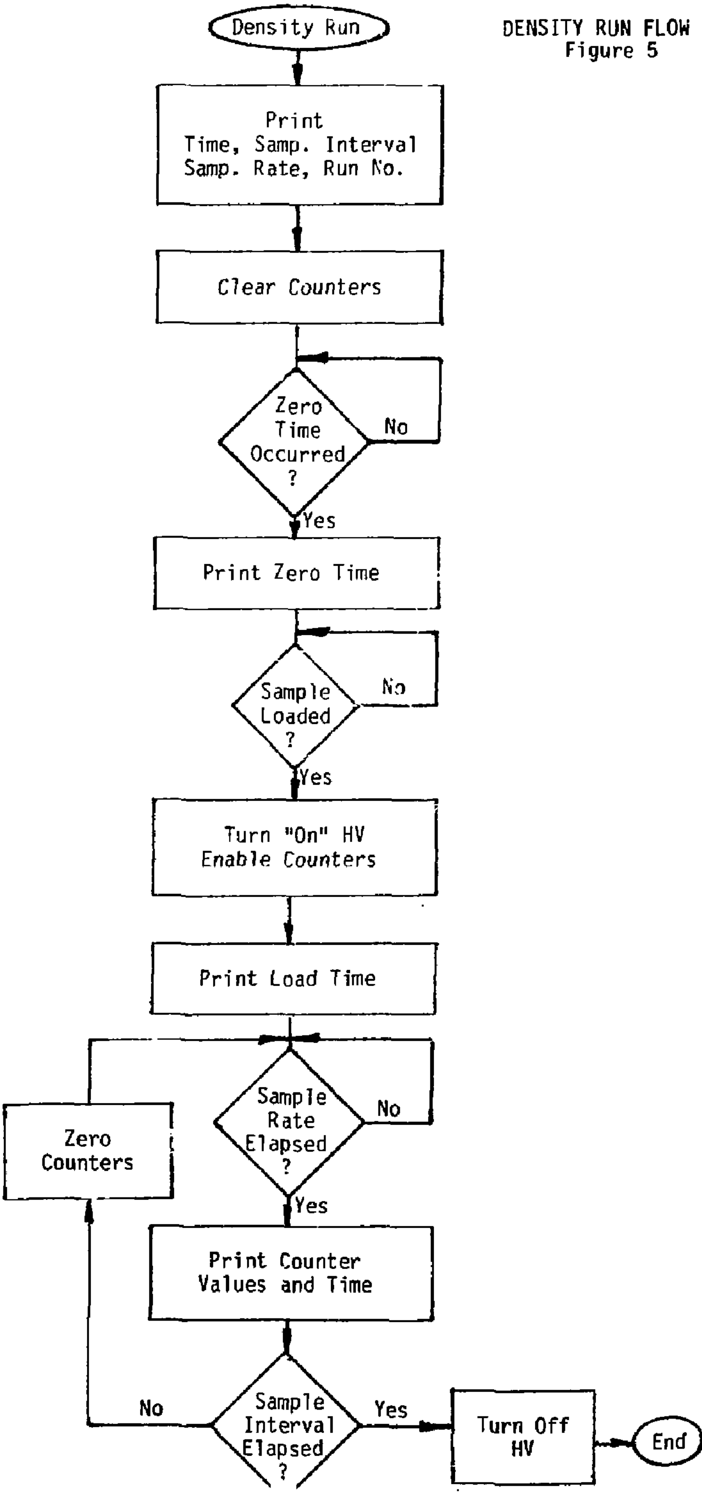


```
+ + + + + + + + + + + + + + + + + + + +
*
A V E R A G E
G D = 9 8 7 6 5 . 4
C N = 1 2 3 4 5 . 6
G A = 9 8 7 6 5 . 4
B E = 1 2 3 4 5 . 6
*
G D = 1 2 3 4 5 6
C N = 9 8 7 6 5 4
G A = 1 2 3 4 5 6
B E = 9 8 7 6 5 4
T M = 1 0 2 3 3 0
*
G D = 1 2 3 4 5 6
C N = 9 8 7 6 5 4
G A = 1 2 3 4 5 6
B E = 9 8 7 6 5 4
T M = 1 0 2 2 3 0
*
  R N           S R           S I
1 2 3 4       1 2 3 4       1 2 3 4


          C O U N T   R U N
+ + + + + + + + + + + + + + + + + + + + 
+ + + + + + + + + + + + + + + + + + + +
```

TYPICAL COUNT RUN PRINTOUT FORMAT
Figure 4

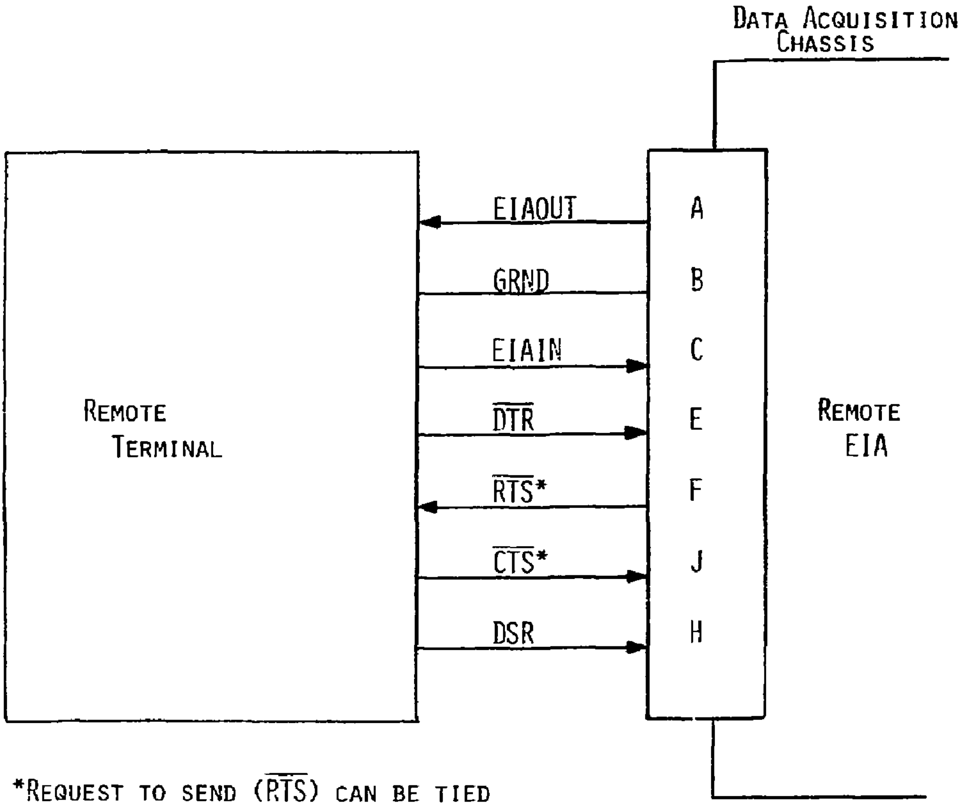
DENSITY RUN FLOW CHART
Figure 5



```
+ + + + + + + + + + + + + + + + + + + + +
+ + + + + + + + + + + + + + + + + + + + +
*
G D   1 2 3 4 5 6
C N = 9 8 7 6 5 6
G A = 1 2 3 4 5 6
B E = 9 8 7 6 5 6
T M = 1 0 3 7 5 8
*
G D = 1 2 3 4 5 6
C N = 9 8 7 6 5 4
G A = 1 2 3 4 5 6
B E = 9 8 7 6 5 4
T M = 1 0 3 6 5 0
*
S A M P   L O A D = 1 0 3 5 5 0
*
Z E R O   T I M E = 1 0 3 3 5 2
*
 R N           S R           S I
1 2 3 4      1 2 3 4      1 2 3 4
        D E N S I T Y   R U N
+ + + + + + + + + + + + + + + + + + + + +
+ + + + + + + + + + + + + + + + + + + + +
```

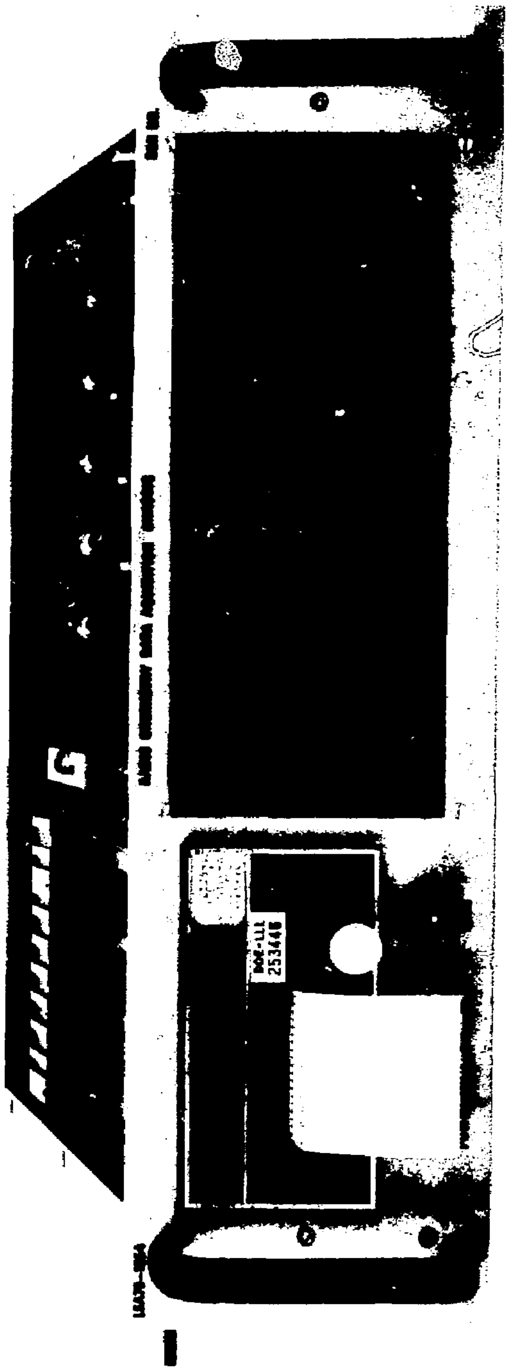
DENSITY RUN PRINTOUT FORMAT
Figure 6

Remote Terminal Interface



*Request to send (RTS) can be tied back to clear to send (CTS).

Figure 7



FRONT PANEL PHOTOGRAPH
Figure 8