SECTION 6 : INSTRUMENTATION

6.1 A transistorized Power Supply System for Beckman DU Spectrophotometer

J. K. Samuel, M. R. Ponkshe and D. R. Fulbaduwa

Beckman DU spectrophotometer is mainly a battery-operated instrument deriving the various voltages required by its electronic circuits from a power pack of dry batteries and a 6V accumulator-battery charger combination which supplies power to the tungsten lamp. The dry batteries run down due to normal use and leakages and have to be regularly replaced. As their shelf life is short, a constant supply of fresh batteries has also to be assured. A highly stabilized, transistorized power supply system was designed and fabricated for the purpose of replacing all the batteries mentioned above. Each group of batteries is replaced by an individual power supply unit. The basic principle of a representative unit is shown in the block diagram of Fig. 61.

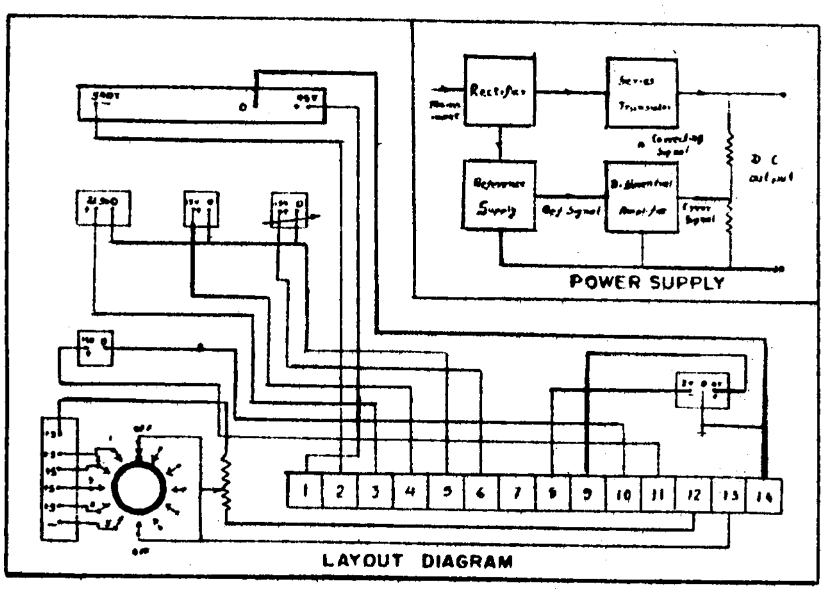


Figure 61: Power supply to Beckman Spectrophotometer

A differential amplifier compares a fixed fraction of the output voltage against a reference voltage and provides a correcting signal to the series transistor so as to compensate for any change in the output voltage. The stability of the units against load variation (from no load to full load) and $\pm$ 15% mains voltage fluctuations was estimated to be $\pm$ 0.05%.

The system consists of the following supplies:

1. One unit with output voltage of 22.5 V at a maximum load current 10 m.a.
2, 3. Two identical units with output voltages of 15 V each at 10 m.a
4. One unit with output variable from 10 V to 15 V and having a current capacity of 10 m.a.
5. One 7.5 V unit from which 1.5V, 3.0V, 4.5V and 6.0V tappings can be obtained at a maximum load of 5 m.a.
6. A high voltage unit with output voltages of -540 V and + 45 V at a load current of 0.2 m.a. (max).
7. A high current unit with an output of 6V capable of giving upto 6 amps replaces the accumulator - battery charger combination and provides the supply required by the powerful tungsten lamp light source. The supply is also split up into two branches of -2V and +4V as per requirements in the Beckman circuitry where these voltages are used as the filament supplies for 2531 and 2532 amplifier tubes.

The replacement of the batteries by this power supply system has already been effected and is now facilitating continuous operation of the spectrophotometer without any breakdown and readjustment period of time normally associated with the use of dry batteries.

6.2 A master clock pulse generator

J. K. Samuel and D. R. Fulbadwa

All the timers associated with the various counting systems use the mains frequency (nominally quoted as 50 Hz) as their source of timing pulses. As this frequency is subject to day-to-day seasonal variations, the counting times also becomes subject to the same extent of fluctuations. Of late, frequency variations of up to 4% were noticed. In order to eliminate these uncertainties in timings, a highly stablized master clock pulse generator was designed and fabricated. The logic diagram is shown in Fig. 62.

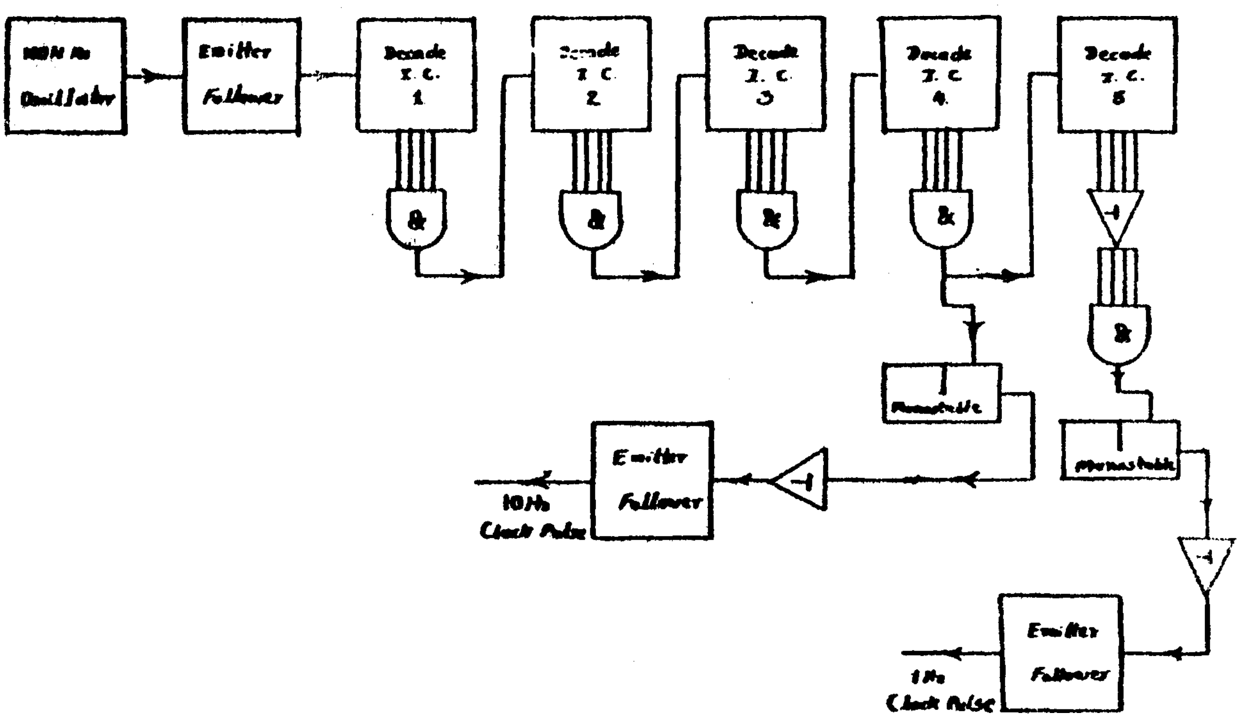


Figure 62: Master clock pulse generator logic diagram

A 100 KHz piezo-electric crystal whose frequency is defined to an accuracy of better than 0.001%, controls the master oscillator. The oscillator output is buffered through an emitter follower and then passed through five successive decade stages. Each stage is an integrated circuit chip. The outputs after the fourth decade and fifth decade give 10Hz and 1 Hz clock pulses respectively.

Both the 10 Hz and 1 Hz pulses are individually shaped to a width of 5 μsec and a height of 14 V using a monostable and a driving stage with very low output impedance. The outputs are taken through co-axial cables all along the walls in both the counting rooms and distributed at 4 different outlet points through junction boxes and BNC sockets for connection to various timers of counting systems. 10 Hz pulses are utilized by EC preset timers and 1 Hz clock pulses are required by the timers designed in this division.

6.3. A printing unit in Modular form

J. K. Samuel and M.S. Satsangi

The control circuitry required for using a Sodeco printer in an automatic operating cycle was designed and fabricated. The logic diagram is shown in Fig.63.

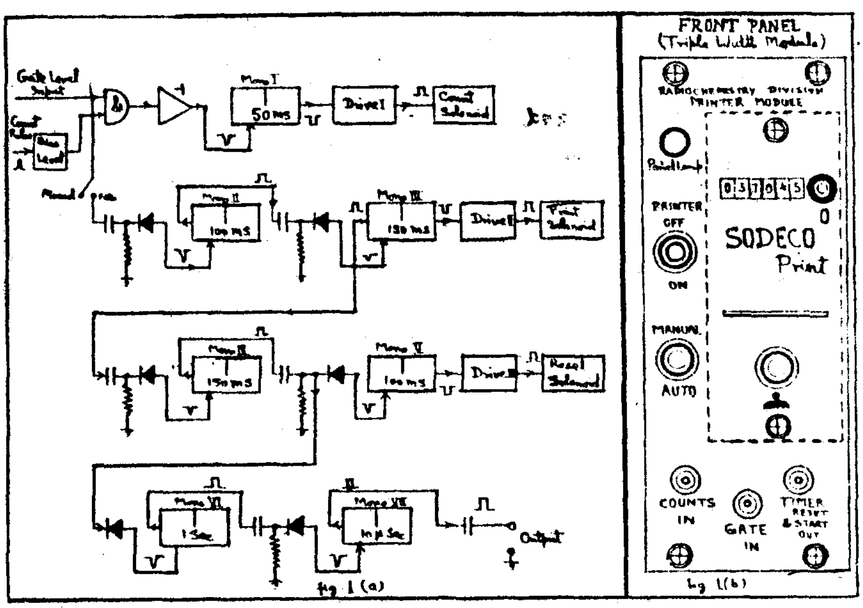


Figure 63: Printer Module Block Diagram

The unit permits accumulation of low count rates (upto 10 per sec. regular pulses) on a drum and print out of the accumulated numbers at the end of a preset time. After the print out, the printer resets itself and provides the necessary output pulse required for resetting the time and restarting the automatic counting cycle.

6.4 Flash photolysis set up

P. K. Bhattacharyya and R. D. Saini

A flash photolysis apparatus was built to study the aqueous systems of interest such as the transient chemistry of actinides and to correlate the role of these transients with the radiation chemistry of actinide solutions.

In the present flash photolysis system the flash discharge tube along with the experimental solution is kept in a glove box. The energy of the intense flash is absorbed by the system making it possible to produce enough concentration of the transient species so as to understand the nature of the transients and their reaction kinetics with the help of absorption spectroscopy. Light from a high pressure xenon lamp is focussed onto the sample solution through the quartz windows fitted in the glove box by means of several lenses. The general arrangement along with the positions of monochromator and photomultiplier is shown in the block diagram in Fig. 64.

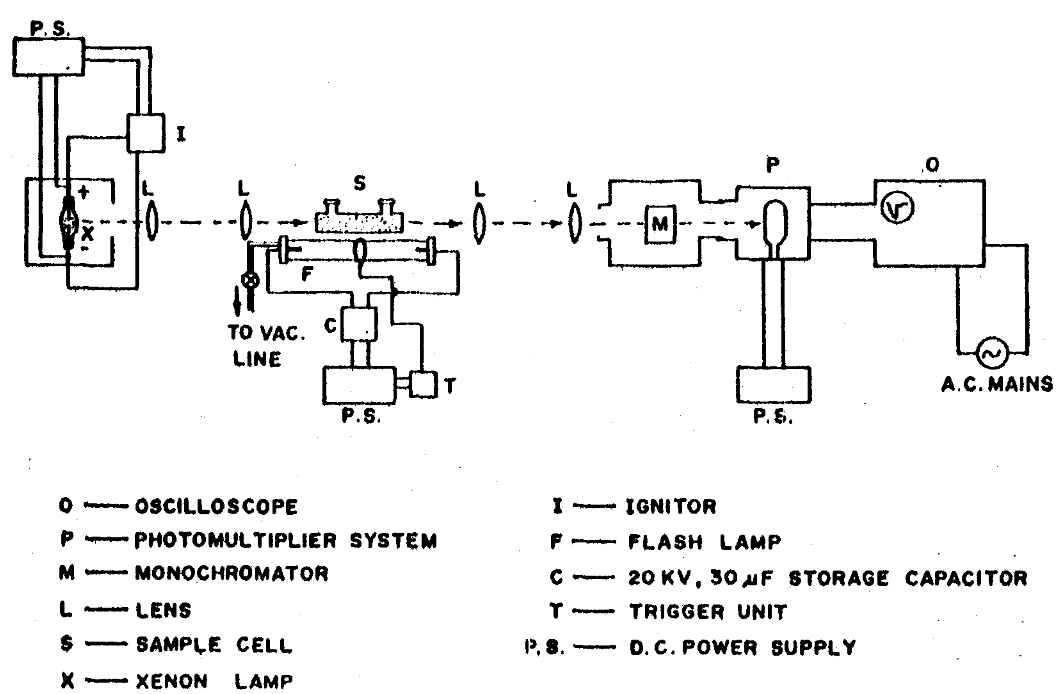


Figure 64: Flash photolysis set-up

Storage capacitor: Two storage capacitors each of 14 μF capacity are connected in parallel to a power supply system which is designed to charge the capacitors up to 20 KV. The power supply and the capacitors are mounted in a box and are properly insulated by 10 mm thick polyethylene sheet. The whole system is kept outside the glove box. The electrical connections from the capacitors to the flash tube are made by means of thick copper strip (2.5 cm width and 05 cm thick).

Flash tube: Two types of flash discharge tubes with demountable electrode-coupling assembly were designed, fabricated and tested for performance. The special design for couplings enables one to assemble a flash discharge lamp very quickly and conveniently - only quartz tubes are required. In one type the discharge takes place in a quartz tubing between two tungsten electrodes which were made from 6 mm dia tungsten rod pieces by tapering the ends to a sharp point. In the other design the ring shaped stainless steel electrodes were used and the discharge takes place in the annular space between two quartz tubes. The inner tube is in the form of a sample cell to hold the sample solution. As the sample can be uniformly photolysed from all the sides and large amount of flash energy can be absorbed by the sample, the efficiency of the second design is expected to be high.

Xenon lamp: A 450 watt (Osram XBO) xenon lamp is supported vertically on two teflon caps in a housing made from brass sheet. The lamp is cooled by air and the electrical leads are connected to the lamp through the teflon caps. The power supply gives a stabilised operating DC voltage of 17 volt after ignition of the lamp with an ignitor.

Experimental results: It was found that the flash tube of the first type after filling with argon (commercial) gas to 5 cm pressure of mercury can be discharged at 10 KV by means of a Trigger pulse of 20 KV which simultaneously triggers an oscilloscope. A typical profile of the present flash is shown in Fig. 65.

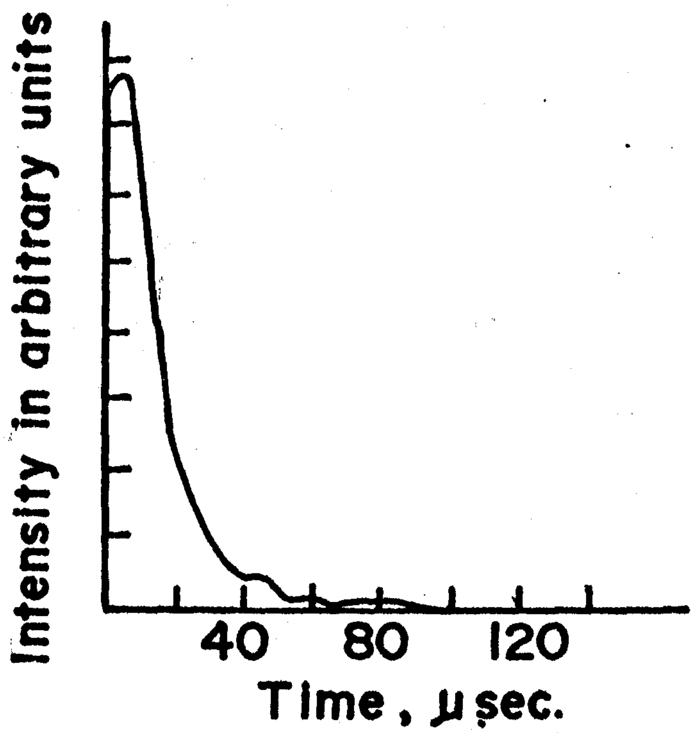


Figure 65: A typical profile of flash

The flash life is about 20 microseconds and is found to be reproducible for 6 flashes. The reproducibility of flash at the same voltage can be obtained by filling the flash tube after 5 to 6 flashes afresh with the argon gas. The total electrical energy dissipated by the flash is about 1400 J.

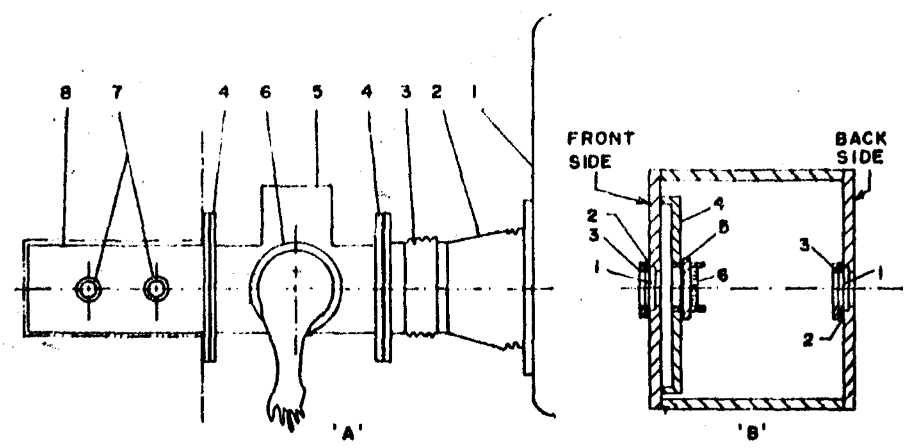
Further work to improve the reproducibility of the flash and to determine the fraction of energy of the flash absorbed by the sample is in progress.

6.5 A Glove Box Assembly for Perkin-Elmer Infrared Spectrophotometer

M. S. Subramanian, P. S. Srinivasan and P. D. Mithapara

A simple and inexpensive attachment to a glove box for recording the infrared spectra of radioactive materials with a Perkin-Elmer-237 infrared spectrophotometer was fabricated and installed which reduces the possibility of the spectrophotometer getting contaminated.

The assembly (Fig. 66) consists of a perspex transfer box attached to the exit port hole of the glove box with poly-propylene bellows and extending into the full depth of the sample chamber of the spectrophotometer which is housed in a separate inactive rectangular box. Two pairs of circular 1" holes are cut out on the opposite sides of this extension box and these are kept in line with the sample and reference beams. These circular cut outs are sealed airtight by 1" sodium chloride discs to allow the passage of infrared radiation. All sample preparations are carried out in the single module glove box and the prepared samples transferred to the sample chamber through the transfer box. Whenever servicing is required, the glove box along with the transfer box can be wheeled away leaving the spectrophotometer free and uncontaminated. The spectra of standard polystyrene film recorded in the spectrophotometer with and without glove box assembly were found to be identical.



1. SINGLE MODULE GLOVE BOX
2. TRUNCATED CONE WITH GLOVE PORT RING
3. BELLOWS
4. SQ. FLANGE
5. PERSPEX MINI BOX
6. STD. GLOVE PORT RING
7. SODIUM CHLORIDE DISCS (FRONT PANEL)
8. SAMPLE CHAMBER.

1. SODIUM CHLORIDE DISC
2. NEOP. GASKET
3. ALUMINUM RING
4. PERSPEX PLATE WITH SLOTS TO HOLD SAMPLE HOLDER.
5. SAMPLE HOLDER.
6. SAMPLE.

Figure 66: Sketch of the Glove Box assembly for infrared spectrophotometer (A) Front view (B) Sectional view of sample chamber

6.6 Setting up of a Faraday Magnetic Balance

K.H. Madraswala and C.K. Mathews

A Faraday Magnetic Balance was set up for measuring the magnetic susceptibilities of actinide compounds. It consists of a Cahn RG Electrobalance and a Polytronic electromagnet whose pole pieces were specially fashioned to produce a constant field gradient over a length of more than 1 cm. The electrobalance supported on a rigid support was enclosed in a glove box. The electrobalance was calibrated for 10 mg range using a calibrated weight of 5.0000 ± 0.0054 mg. As many calibrated weights in the above ranges were not available, some arbitrary weights made up of aluminium foils and nichrome wire and various combinations of these were weighed and the reproducibility and accuracy were determined for the electrobalance. The reproducibility was checked for a number of days. The electrobalance gave a sensitivity of 0.3 microgram in open environment and 0.5 microgram in the glove box for a 10 mg load. The reproducibility is 0.4 microgram and the average percentage error involved in the 0 to 10 mg range is 0.05%. The calibration of the Faraday Magnetic Balance using mercury cobaltotetrathiocyanate and ferrous ammonium sulphate is in progress.