THE DATA COLLECTION INTERFACE USED BY THE BNL DATA ACQUISITION AND ANALYSIS COMPLEX*

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ABSTRACT

The Data Collection Interface used by the BNL Data Acquisition and Analysis Complex[1] provides a convenient generalized means of interconnecting a series of unrelated devices into as many as eight logically independent arrays. For each array data are read from the devices, packed together to form convenient descriptor addresses and then transmitted to the computer to be stored in an independent spectrum of arbitrary size and number of dimensions.

INTRODUCTION

The evolution of experimental physics in recent years has clearly demonstrated the need for ever increasing sophistication and complexity in the area of data acquisition. It is no longer true that a simple pulse-height analyzer will suffice. Instead, it is often necessary to collect data simultaneously into a series of arrays each with different size and number of dimensions and each associated with the occurence of a different class of "event" in the experimental situation. Furthermore, it is often necessary to collect these data from a large selection of data-acquisition "devices" where the use and interrelationship of these devices changes from experiment to experiment.

The Data Collection Interface (DCI) serves two relatively independent functions. First, it provides a convenient generalized means of interconnecting a series of unrelated logical devices into arrays, one for each class of event. Second, the DCI reads data from the devices, packs the data together to form a convenient descriptor address, and then transmits that address to the computer. A photograph of the first BNL user station is shown in Figure 1.

INTERCONNECTING DEVICES

Control of the first function is exercised through an 8 x 8 array of lighted pushbutton switches which connect the eight logical devices to the eight event line controls. A logical device may be attached to any or all event lines. A logical device may consist of one or more physical devices operating in concert and producing an unlimited number of data bits. Typical logical devices might include analog-to-digital converters (ADC's), scalers, banks of scalers, encoders, spark chamber readouts, switches, DC levels, independent pulse-height analyzers, etc. Each logical device is connected to the DCI through a modular device coupler which is unique to the device.

Control of the second function is exercised through an 8 x 8 array of thumbwheel switches with positions 1 through 16. With these switches the experimenter may select the number of data bits to be collected from the data field of each logical device. The number of bits required may vary from event line to event line for each device. For a given event line the data bits from the attached devices are packed together to form a descriptor address which ends on a halfword boundary. In selecting data bits from a device, the DCI senses the size of data field provided (e. g., the conversion gain of an ADC) and abstracts the required number of bits from the most significant portion of the data field. If the number of data bits required is greater than the number provided, leading zeros will be inserted in the most significant locations.

CONTROLS

Overall control of the DCI may be exercised by either the experimenter or computer. In particular, each event line may be turned on or off or triggered, each logical device may be turned on or off or reset and the entire DCI may be turned on or off or reset. The experimenter may exercise these controls through pushbutton switches on the control panel. External signals may be used to trigger or inhibit each event line independently or turn off or on or inhibit the entire DCI. The event-line inhibit was provided primarily so that singles and coincidence spectra may be measured simultaneously without introducing excessively high count rates for the singles. To do so, the coincidence event line(s) operate continuously while the singles event line(s) are sampled repeatedly to effect a lower count rate.

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When an event-line control receives a TRIGGER signal it transmits the signal to all the devices attached to that line. The event line then becomes BUSY and waits for all devices to respond with CONVERSION COMPLETE. When the last device responds, the DCI services all event lines on a priority basis. Data are read from all devices attached to each event line.

A device is not RESET until all triggered event lines to which it is attached have been serviced. Each device keeps all other event lines to which it is attached BUSY until it is RESET. The event-line controls are protected against non-responding devices by resetting without servicing after a fixed delay. Any attached device may also cause resetting without servicing (e. g., an overflow signal from the upper level discriminator of an ADC would initiate such action).

The DCI also contains a local control panel. This permits the DCI to be taken off line and operated locally in order to monitor its operations.

The use of the DCI can most easily be understood by a series of examples shown in Figures 2, 3, and 4 in which have been configured a simple pulse-height analyzer (Figure 2), two two-parameter and two single parameter analyzers (Figure 3) and a two parameter, three single parameter and a three parameter analyzer (Figure 4). It should be noted in Figure 4 that the same data from the ADC in device position 4 may be used as many as three times for a single conversion. These three times correspond to servicing event lines 3, 5, and 7 selecting 8, 10 and 8 bits of data respectively.

REFERENCES

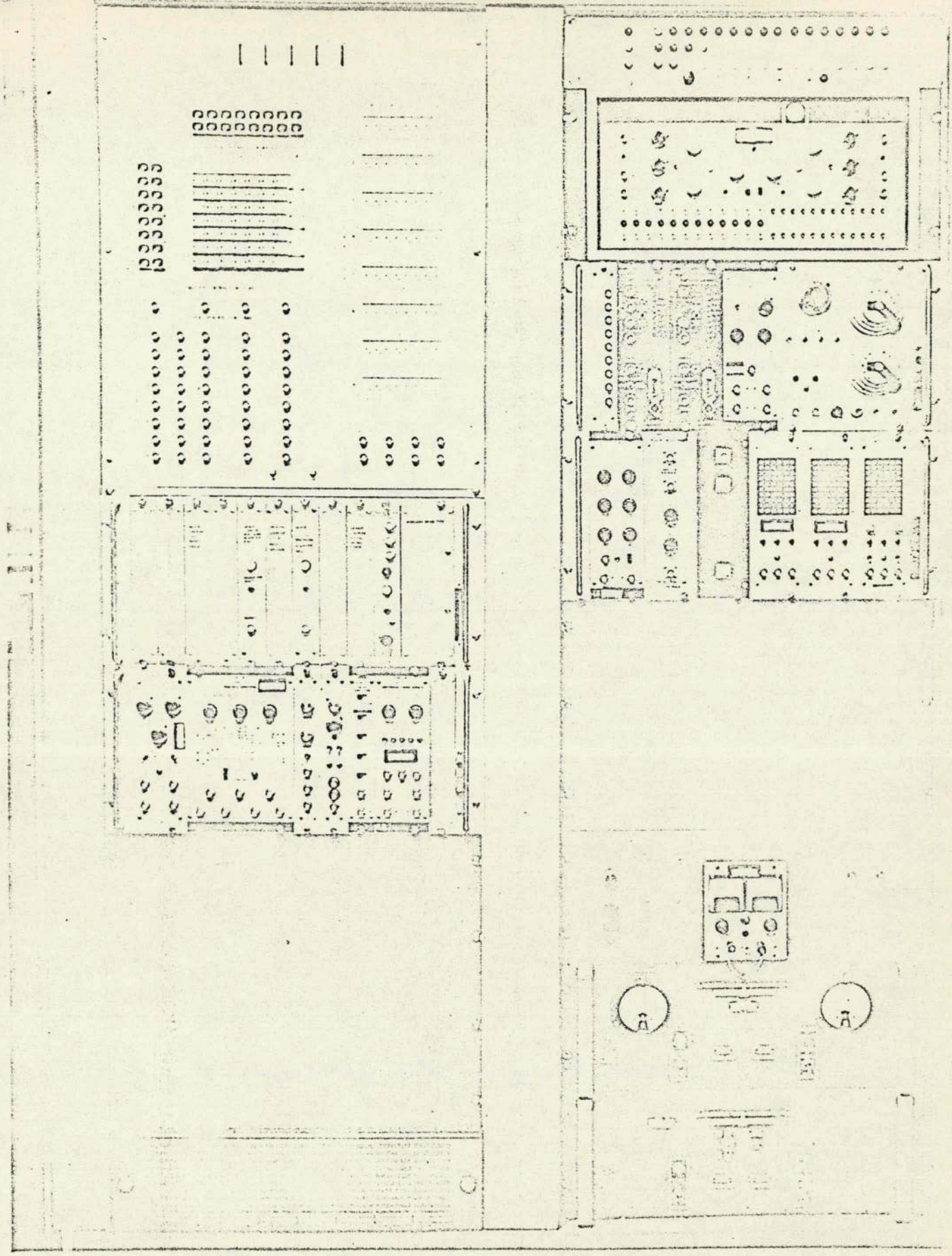
[1] P. C. Rogers, "The Data Acquisition and Analysis Complex for the BNL Low Energy Accelerator Facility," IEEE Transactions for Nuclear Science, February, 1969.

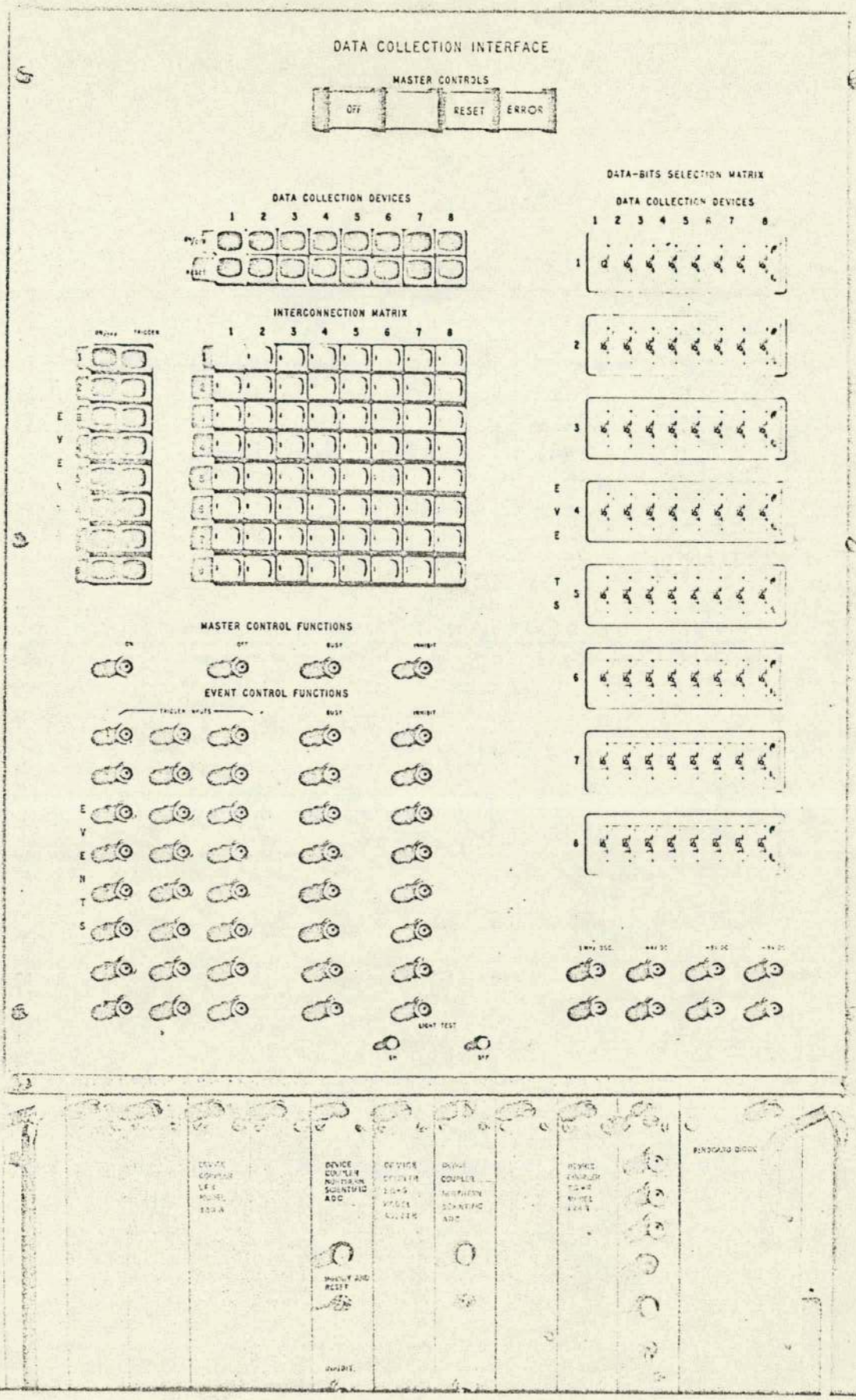
Figure 1. The BNL data collection interface showing the DCI control panel (upper left), device couplers (center left), local engineering control panel (upper right) and data collection devices (center right). The DCI control panel contains master controls (top), an 8 x 8 array of lighted pushbutton switches for interconnecting "devices" to "events", two columns of pushbutton switches for turning events "on" or "off" or triggering them, two rows of switches for turning devices "on" or "off" and resetting them, an 8 x 8 array of 16 position thumbwheel switches for selecting the number of bits required for each data transfer and finally an array of BNC input connections for overall DCI control and controls for each event line.

Figure 2. A simple multi- channel pulse-height analyzer has been configured by connecting device 1 (an ADC) to event 1. The device and event lines have both been turned on as has the entire DCI. With the thumbwheel switch in position 1, 1 set to 12, a 4096 (2^{12}) channel spectrum has been indicated.

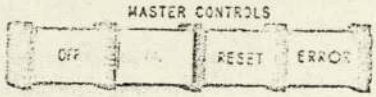
Figure 3. Two two-parameter and two single-parameter analyzers have been indicated in this more complicated configuration. Devices 1 and 4 (both ADC's) have been connected together on event lines 2 and 3 to form coincidence spectra of sizes 256 x 256 ($2^8 \times 2^8$) and 64 x 256 ($2^6 \times 2^8$). The singles spectra for these ADC's are indicated on event lines 4 and 5 with spectrum size 4096 (2^{12}) and 1024 (2^{10}) respectively.

Figure 4. A two-parameter, three single-parameter and a three-parameter analyzer have been indicated. Devices 1, 4 and 6 (all ADC's) are connected to event lines 3, 4, 5, 6 and 7 to form spectra of sizes 64 x 256, 4096, 1024, 64 and 256 x 256 x 16 respectively. To event line 8 has been connected a bank of eight 24-bit scalers in device position 8 to be read as eight 32-bit values at the end of the experiment (e. g., these could be monitoring the dead times of the other event lines).

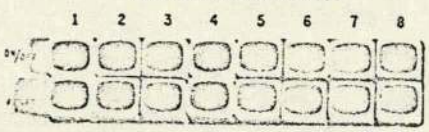



DATA COLLECTION INTERFACE
MASTER CONTROLS
OFF
RESET
ERROR
DATA COLLECTION DEVICES
1 2 3 4 5 6 7 8
INTERCONNECTION MATRIX
EVENTS
MASTER CONTROL FUNCTIONS
BUSY
INHIBIT
EVENT CONTROL FUNCTIONS
DATA-BITS SELECTION MATRIX
DATA COLLECTION DEVICES
LIGHT TEST

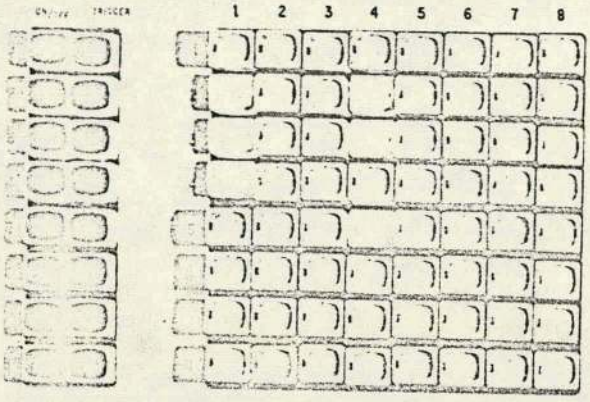
DATA COLLECTION INTERFACE



DATA COLLECTION DEVICES

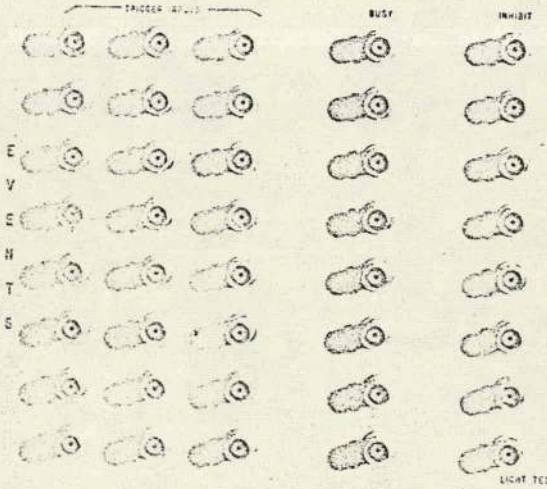


INTERCONNECTION MATRIX



MASTER CONTROL FUNCTIONS

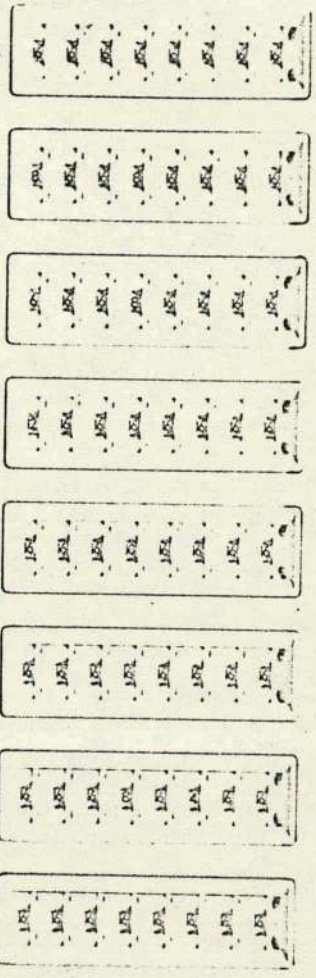
EVENT CONTROL FUNCTIONS

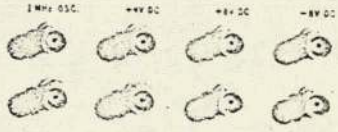


LIGHT TEST

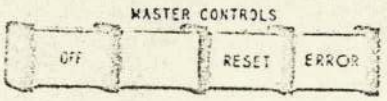
DATA-BITS SELECTION MATRIX

DATA COLLECTION DEVICES

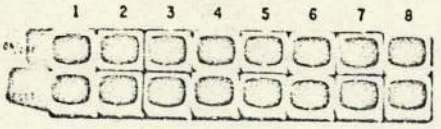




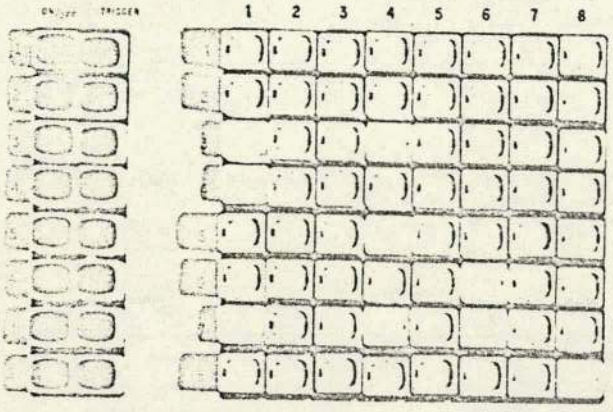
DATA COLLECTION INTERFACE



DATA COLLECTION DEVICES

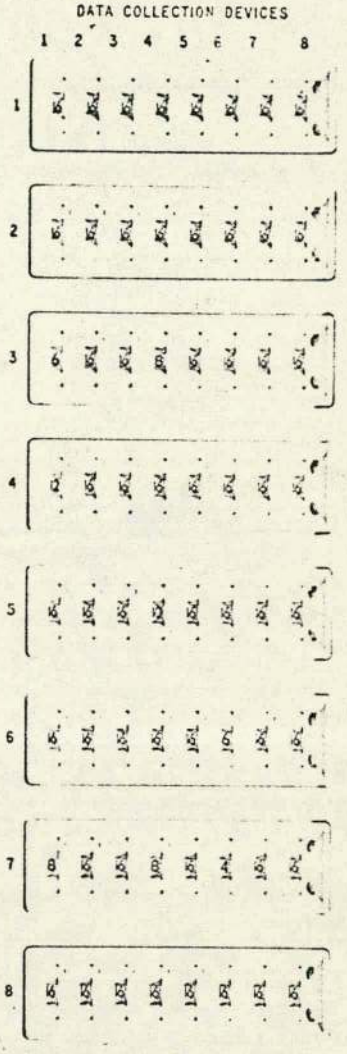


INTERCONNECTION MATRIX

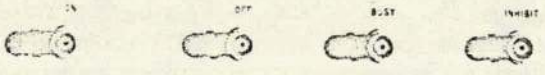


DATA-BITS SELECTION MATRIX

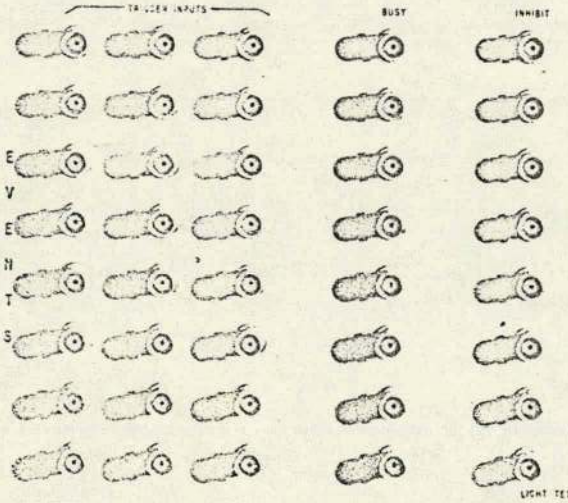
DATA COLLECTION DEVICES

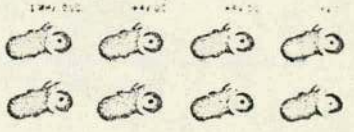


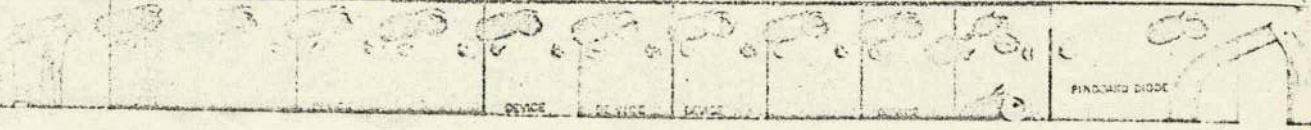
MASTER CONTROL FUNCTIONS



EVENT CONTROL FUNCTIONS







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