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HV Tester User's Guide

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1. Introduction

The high voltage tester is a computer controlled relay system that allows distribution of high voltage to a high voltage group in the high voltage plate or the module. The main function of the tester is to cycle high voltage through all high voltage groups in a high voltage plate or a module and record their current draw for qualification of high voltage stability.

2. System layout

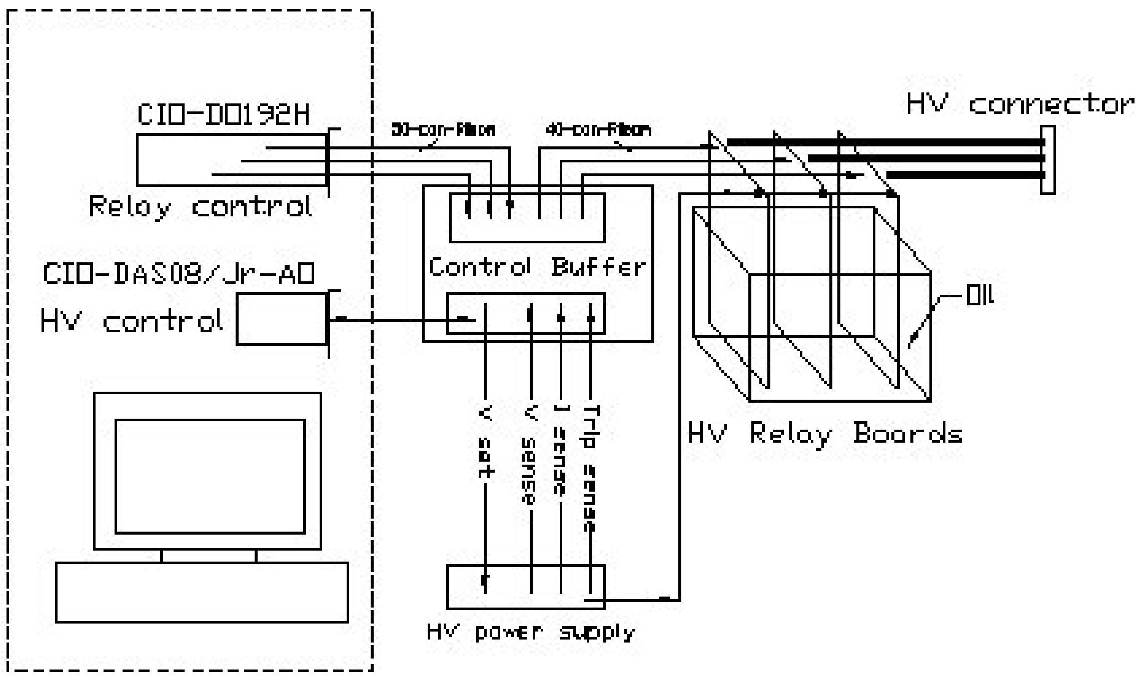

Figure 1 HV tester layout

The HV tester has 2 streams of control:

- a digital I/O board, CIO-DO192H, that controls on/off of relays on 3 relay boards
- an analog I/O board, CIO-DAS08/Jr-AO, that controls and monitors a HV power supply.

The digital signal from CIO-DO192H is TTL. The relay, Omron G2R-1-12VDC, however, requires a 12V input. A conversion using Allegro UDN2982A source driver is done on a “control buffer” board as shown in figure 1. The “c
interfaces between analog I/O and the HV power supply by providing:

a 0.5 sec time constant RC filter for “V sense” and “I sense”.

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signal pickup.

The relay, Omron G2R-1-12VDC, although rated 3000VAC 50/60Hz for 1 minute, does not work with 3000VDC in the air. To increase the dielectric strength, the 3 relay boards are submerged in 1.2 gal of VWR vacuum oil 19.

Between the HV relay boards and the testing HV plate are the protection resistor packs and the HV cables. The resistor packs are sets of 1MΩ 0.5W resistors for current limitation in case of HV breakdown. The HV cables come with fuse box type connectors at the end and are specific to the type of HV plate being tested. The HV cable connection to the module is unique and must be matched to the choice of parameter file in the testing program to ensure correct testing sequence. Please see Appendix B for detail.

3. System Checkout

Before the system can be used, 2 things need to be checked:
a) Continuity: are all the relays and connections making good contact?
b) HV stability: is there any internal HV breakdown within the system?

To test continuity:

1) Assemble the system, including the HV resistor packs and HV cables.
2) Attach a fake kapton HV strip made of copper to the HV cable – to ground all outputs
3) Set HV power supply trip range to 100uA
4) Run Hvtest program with HV = 200V, and set Trip limit to 1
5) HV should trip on every output. If not, there is a discontinuity along that output.

To test HV stability:

1) Assemble the system, including the HV resistor packs and HV cables.
2) Attach a fake kapton HV strip make of pure kapton to the HV cable – to isolate all output.
3) Set HV power supply trip range to 100uA
4) Run Hvtest program with full voltage setting (3000V)
5) HV should not trip. If tripped, there's an internal breakdown. The current draw from this measurement also serves as a calibration for dc offset.

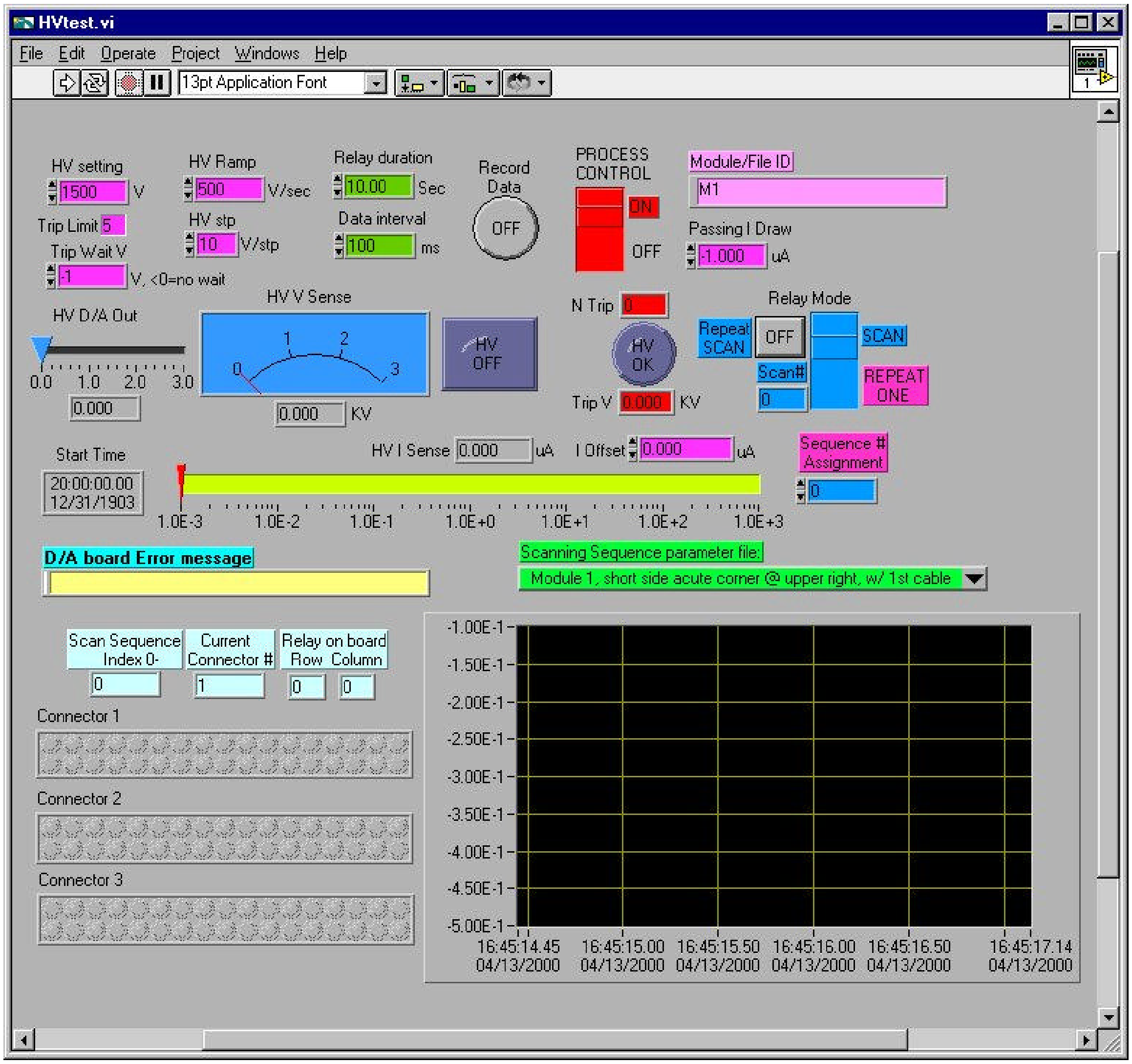
4. Software

There are 3 programs for hvtester: hvtest.vi, hvtest1.vi and hvread.vi. All programs are located in c:\users\hvtest

HVTEST.VI allows HV to go through the relays in a certain sequence and record the current draw one file per channel. It reads in 2 parameter files at the beginning of a run.

1) Con2bit.txt contains hardware mapping information, mapping over digital I/O bit, relay position and connector pin out on the relay board.
2) The other parameter file is chosen by user on a drop down menu to determine the scanning sequence. When scanning a module, this parameter file is equivalent to

the mapping between relay board pinouts and the HV group sequence on the HV plate. The HV group sequence starts at the short side acute corner and goes along the short side, continues until reaching the diagonally opposite corner. Because there are HV connections on each side of a module, one should be careful how the HV cables are connected to the module. Usually, the parameter file name on display contains brief information about how the cables should be connected.



ram features in HVTEST.VI from left to right and down are as following

HV setting

- **Trip Limit**: how many times the HV trips before giving up on a channel and going

- **Trip Wait V**: when HV trips, wait for
  trying to ramp it up again. When set to < 0, the computer will try to ramp the voltage from 0 up immediately while the real voltage is still on its way down.
- : decide how fast the high voltage will be ramped up or down in V/sec.

- **HV stp**: the voltage step size used for ramping the high voltage.
- **Relay Duration**: decides how long HV will stay on a channel after reaching the set voltage for data taking.
- **Data Interval**: time interval between data samples. Each data sample is actually an average of 10 continuous data points
- **Record Data**: when turned on the data will be written into a disk file
- **Process Control: the only way to stop the program properly. Stopping the program with any other method will leave high voltage and relay in uncertain state.** When set to off, the program can not be started.
- **Module/File ID**: will be used as prefix for the file name. The file name is further appended with the sequence number and the scan number, meanwhile prefixed with "I" if current draw didn't go down below "passing I draw", or "T" if HV tripped, and "F" if HV tripped more than "trip limit" times.
- **Passing I Draw**: set in uA. If current draw does not reach below this value the file name will be prefixed with an "I".
- **HV D/A Out**: voltage output of the D/A board for controlling HV power supply. 1V D/A output sets HV 1000V
- **HV V Sense**: HV output read from HV monitor (average of 10 continuous samples)
- **HV ON/OFF**: an indicator for HV On or Off
- **HV ok/trip**: an indicator for HV trip
- **N Trip**: how many times HV tripped on this channel
- **Trip V**: D/A output for HV setting when HV tripped.
- **Repeat Scan**: when ON will scan repeatedly by looping the parameter file.
- **Relay Mode**: When set to "scan" will go through the relay sequence determined by the parameter file. When set to "repeat one" will repeat on the current relay set by the "sequence # assignment"
- **Sequence # Assignment**: indicates and assigns which relay is to be turned on. Sequence # is the sequence in the parameter file starting from 1.
- **Start Time**: the time HV reach it's setting and data taking starts.
- **HV I Sense**: Current draw from the HV power supply measured through I monitor (average of 10 continuous samples)
- **I Offset**: DC offset of current draw to be subtracted before recording or display.
- **Scanning Sequence parameter file**: A drop down menu to choose the scanning sequence.
- **Scan Sequence Index**: indicates current sequence # of relay in the parameter file being turned on.
- **Current Connector #**: 1 through 34 indicates each connector pin location as indicated in the LED display below. 35 = switching ground to HV will set all output on HV at once. 36 = switching HV to ground, any relay turned ON will be at ground state. 37=35+36 = switching ground to HV and HV to ground, completely reversed. The numbering scheme for the 3 relay boards are 1-37 for relay board #1, 101-137 for relay board #2, 201-237 for relay board #3. However, the indicator only displays the last 2 digits.
- **Relay Board Row Column**: Indicates location of relay being activated on the relay board.

HVTEST1.VI does the same thing as HVTEST.VI except that it displays and records data on a per sequence basis rather than on a per channel basis, i.e. it displays data of an entire sequence on one screen and saves all the data into one file. This feature is particularly useful in getting an overall view and comparing differences among channels.

HVREAD.VI reads in data files written by HVTEST.VI and HVTEST1.VI and displays them. The time displayed is the absolute time when data were taken.

5. Operation Notes

Before running the program one should make sure that the cables are correctly connected.

When running hvtest.vi, most parameters can just use the default value. However, the following parameters often need to be assigned:

- HV setting
- Module file / ID
- Scanning sequence parameter file
- Passing I draw
- Record data / or not

To start the program click on the “right arrow” button near upper left corner of the window. **NEVER click on the “stop” button to stop the program**, instead, use the “process control” to stop the program properly.

Humidity can affect leakage current in the system and contribute to an offset in the current measurement. This leakage current sometimes can be as high as tens of uA. Baking the cables and the connectors ~ 80C for a few hours often helps.

Appendix A: con2bit.txt – channel mapping

Output register bits controlling each cable are modulus of 48. Bit 0 to 47 for cable #1, bit 48 to 95 for cable #2 ...etc. Connector number in each cable is arranged in modulus of 100. Number 1 to 37 are for cable #1, number 101 to 137 are for cable #2 …etc. In each cable, number 35, 36 and 37 do not exist on the boards' card-edge connector, however, they are used for the relay mode switches.

- Number 35 controls the "off state" of regular relays. Nominal value is ground.
- Number 36 controls the "on state" of regular relays. Nominal value is the HV line voltage.
- Number 37 is defined as 35+36 and sets all channels in a connector on high voltage.

In addition, there are 2 special "connector numbers" defined to serve special functions.

- Number 138 is defined as 37+137 and will set an entire type 1 or type 2 module on high voltage. This number is the last item in parameter file "connector 1 & 2".
- Number 238 is defined as 37+137+237 and will set a type 3 module on high voltage. This number is available as the last item in the parameter file "All 3 connectors"

For example, to set a type 1 or type 2 module on high voltage:

- At "scanning sequence parameter file" pull down menu choose "Connector 1 & 2 …"
- At "Relay mode" choose "Repeat One"
- At "Sequence # Assignment" type in "300" (a large number to default back to the last number in the sequence)

For a type 3 module use the steps above but choose the parameter file "All 3 connectors"

In connector sequence:

Bit #	row	column	connector
1	2	1	1
8	1	1	2
14	1	2	3
10	2	2	4
0	2	3	5
12	3	2	6
46	3	3	7
40	1	3	8
44	1	4	9
42	2	4	10
32	2	5	11
38	3	4	12
24	3	5	13
26	1	5	14
4	1	6	15
28	2	6	16
6	2	7	17
2	3	6	18
34	3	7	19
36	1	7	20
29	1	8	21
30	2	8	22
27	2	9	23
31	3	8	24
25	3	9	25
39	1	9	26
33	1	10	27
37	2	10	28
47	2	11	29
35	3	10	30
45	3	11	31
43	1	11	32
7	1	12	33
41	2	12	34
3	3	1	35
5	3	12	36

In bit sequence

Bit #	row	column	connector
0	2	3	5
1	2	1	1
2	3	6	18
3	3	1	35
4	1	6	15
5	3	12	36
6	2	7	17
7	1	12	33
8	1	1	2
9	0	0	0
10	2	2	4
11	0	0	0
12	3	2	6
13	0	0	0
14	1	2	3
15	0	0	0
16	0	0	0
17	0	0	0
18	0	0	0
19	0	0	0
20	0	0	0
21	0	0	0
22	0	0	0
23	0	0	0
24	3	5	13
25	3	9	25
26	1	5	14
27	2	9	23
28	2	6	16
29	1	8	21
30	2	8	22
31	3	8	24
32	2	5	11
33	1	10	27
34	3	7	19
35	3	10	30
36	1	7	20
37	2	10	28
38	3	4	12
39	1	9	26
40	1	3	8
41	2	12	34
42	2	4	10
43	1	11	32
44	1	4	9
45	3	11	31
46	3	3	7
47	2	11	29

Appendix B: High voltage group mapping & connector orientation

Six parameter files are used for module scanning sequences:

- m1ssacuL.txt for type 1 module front side
- m1ssacuR.txt for type 1 module back side
- m2ssacuR.txt for type 2 module front side
- m2ssacuL.txt for type 2 module back side
- m3ssacuL.txt for type 3 module front side
- m3ssacuR.txt for type 3 module back side

SsacuL stands for "Short Side Acute Corner Upper Left"
SsacuR stands for "Short Side Acute Corner Upper Right"
The parameter file is identified by rotating the module along the long axis until the shortest side is facing up, then, observe the position of its acute corner. The scanning sequence and corresponding trace/connector mapping of the HV group are shown in the following figures

Note that the way the cable can be attached to the module is unique. The 1st connector always goes to the side of kapton right next to the short side acute corner. There are one pair of ground wires on each connector. The orientation of that connector is defined by identifying that pair of ground wires with the "GND" indicated the following drawings.

The scanning sequence for each configuration is indicated in the following drawings. The drawings also show mapping among HV island – kapton traces – card edge connectors.

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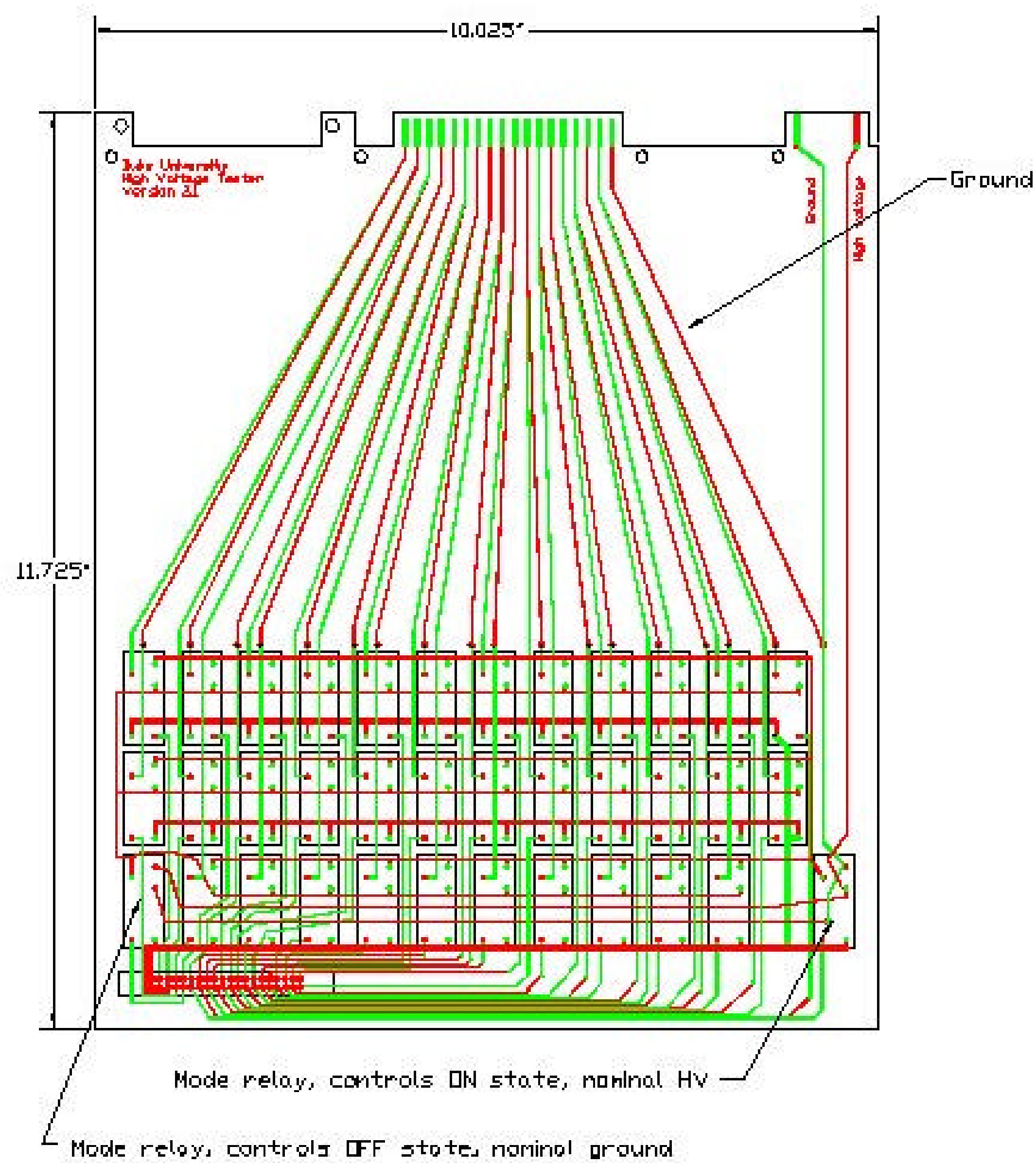
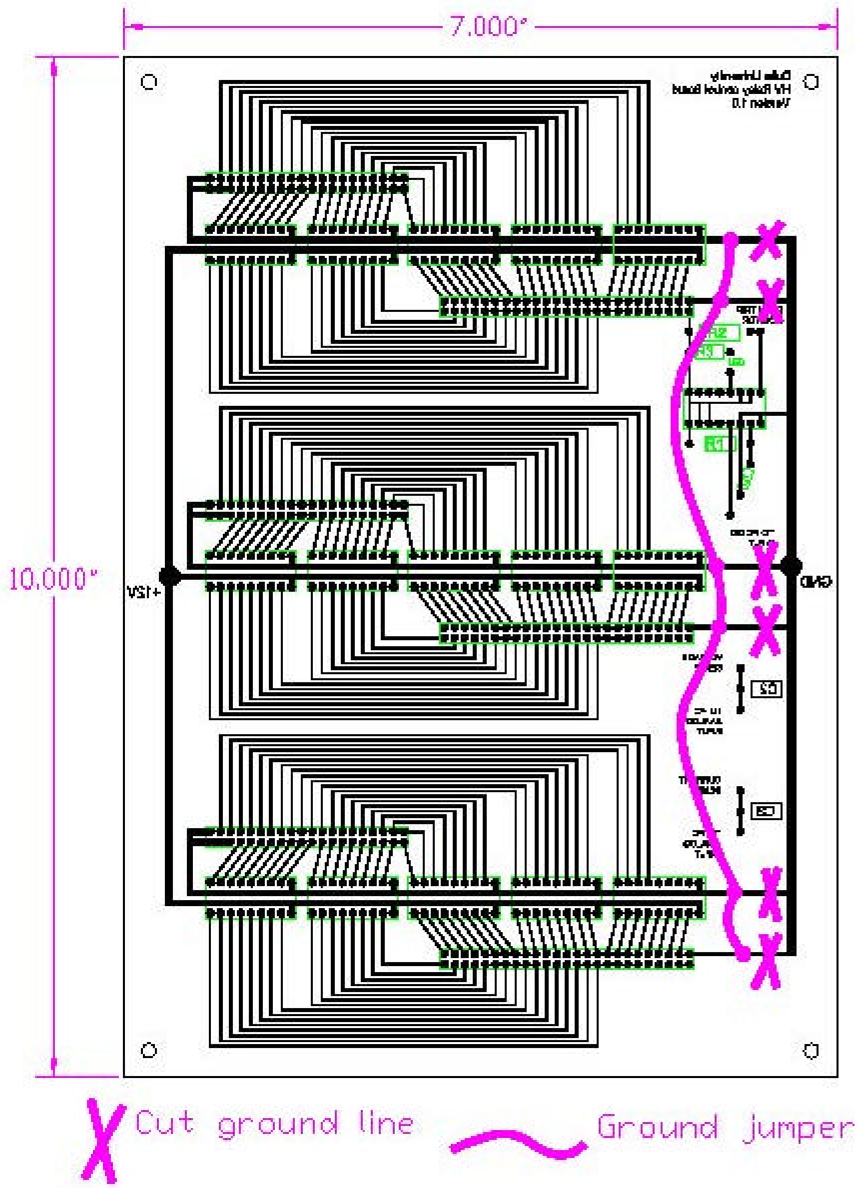
Appendix C: High Voltage Relay Board

HV relay board is a double-sided PCB consisting of 36 relays and controls ON/OFF of 34 HV line outputs to a card edge connector. Pin 35,36 of the card edge connector are HV ground.



Appendix D: Control Buffer Board

The control buffer board is a single sided PCB. It converts TTL output from CIO-DO192H to a 12V level for driving the relay. It also provides interface between the analog board and the HV power supply. In the old version UDN2985A chips were used. For some reason, when there's a HV trip the driver chips would fail. A solution to that was to separate the grounding between the analog and the digital signal. These modifications are shown as in the drawing. However, replacing UDN2985A with a higher power rating chip, UDN2982A also solved the problem.



Appendix E: Installation procedures.

The system is shipped in 6 boxes:

- Rack
- Shelf
- Computer
- Monitor
- HV box
- Accessories (control buffer box, cable, keyboard, mouse etc.)

The assembly procedures are :

1) Hook up the computer system.
2) Assemble the rack
3) Mount NIM bin (not supplied) at the bottom of the rack
4) Take out the control buffer box and mount it in the rack on top of the NIM bin.
5) Connect the 3 ribbon cables from computer to the control buffer box (open and replace the top cover of the control buffer box). The cables and connectors are numbered.
6) Connect the long round gray cable from the computer (DB-37 connector) to the front panel of the control buffer box (6-pin connector).
7) Connect the shorter cable between control buffer box and the HV power supply. Set HV power supply to "Remote".
8) Assemble shelf and install it in the rack above the control buffer box
9) Place HV box on the shelf
10) Add oil in the HV box until oil level is ¼" above the top relays (to pour in the oil, remove one of the relay boards by removing the nylon screws).
11) Connect a HV cable (not supplied) to the SHV connector on the HV box and the output of the HV supply.
12) In the accessory box look for 2 copper strips. They are the grounding strips for the fuse box connector.