Department PHYSICS
Subject HADRON DIPOLE LOG
Name STEVENS / SPIEGEL
Address T.J.N.A.F. Hall "A"

National® Brand
Computation Notebook
11 3/4" x 9 1/4", 4 x 4 Quad., 75 Sheets
43-648

0 73333 43648 8

AVERY DENNISON
Office Products
Chicopee, MA 01022

HADRON DIPOLE

Quench Protection Circuits

1. Megger tests

a. From P2 to J11 cable

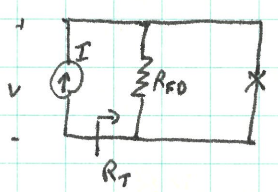
1. VLAP > 999 M-Ω
2. VLBN > 999 M-Ω
3. VMAP > 999 M-Ω
4. VLAN > 999 M-Ω
5. VMBP > 999 M-Ω
6. VMAN > 999 M-Ω
7. VLBP > 999 M-Ω
8. VMBN > 999 M-Ω

2. Quench Voltages

		INPUT SIGNALS	
1) VLAP – VLAN	Loop	+0.071 mV	–0.070 mV
2) VLBN - VLBP	Loop	+0.073 mV	–0.068 mV
3) VMAP – VMAN	Loop	+1.190 V	–0.770 mV
4) VMAN – VMBN	Loop	+1.160 V	–1.800 V

9/30/96

Resistance of D.C. cables only in parallel with dump resistor (fast):



I = 200 A
V = 0.20 V

$R_T = R_{FD} // R_{cables} = \underline{0.001\,\Omega}$ –[initials]

9/30/86 1:30 P.M.

Tested to 2000 A with short circuit – No faults, regulates O.K. –[initials]
ran for ~ 5 minutes

Note: Local voltage sense lines #18 & #19 are connected to #79 & #78 respectively.
This location is the input to the choke, not the output of the choke.

10/1/96 3:10 P.M.

Dump resistor (fast) resistance : R_{DMP} : 0.13359 as determined by kelvin bridge

coil resistance to ground without power supply: R = 100 MΩ @ 250 VDC

Strain Gauges @ I=0 ; Bias voltage : 503 mV for both amplifiers, Multiplier = 200

Multiplexor #1, Amplifier #1 (leftmost):

Switch position (channel)	Strain Gauge #	Location	Value @ I=0
1	SG1	EM1	+2
2	SG2	EM2	+80
3	SG3	EM3	+9
4	SG4	EM4	-43
5	SG13	300L	-197
6	SG6	EM6	+3
7	SG7	EM7	-3
8	SG14	300R	-192
9	SG9	600L	+2
10	SG10	600R	-147

Multiplexor #2, Amplifier #2 (rightmost):

Switch Position (channel)	Strain Gauge	Location	Value @ I=0
1 (11)	SG5	EM5	+57
2 (12)	SG8	EM8	+39
3 (13)	SG11	100	-188
4 (14)	SG12	200	-162
5 (15)	SG15	400	+114
6 (16)	SG16	500	-24

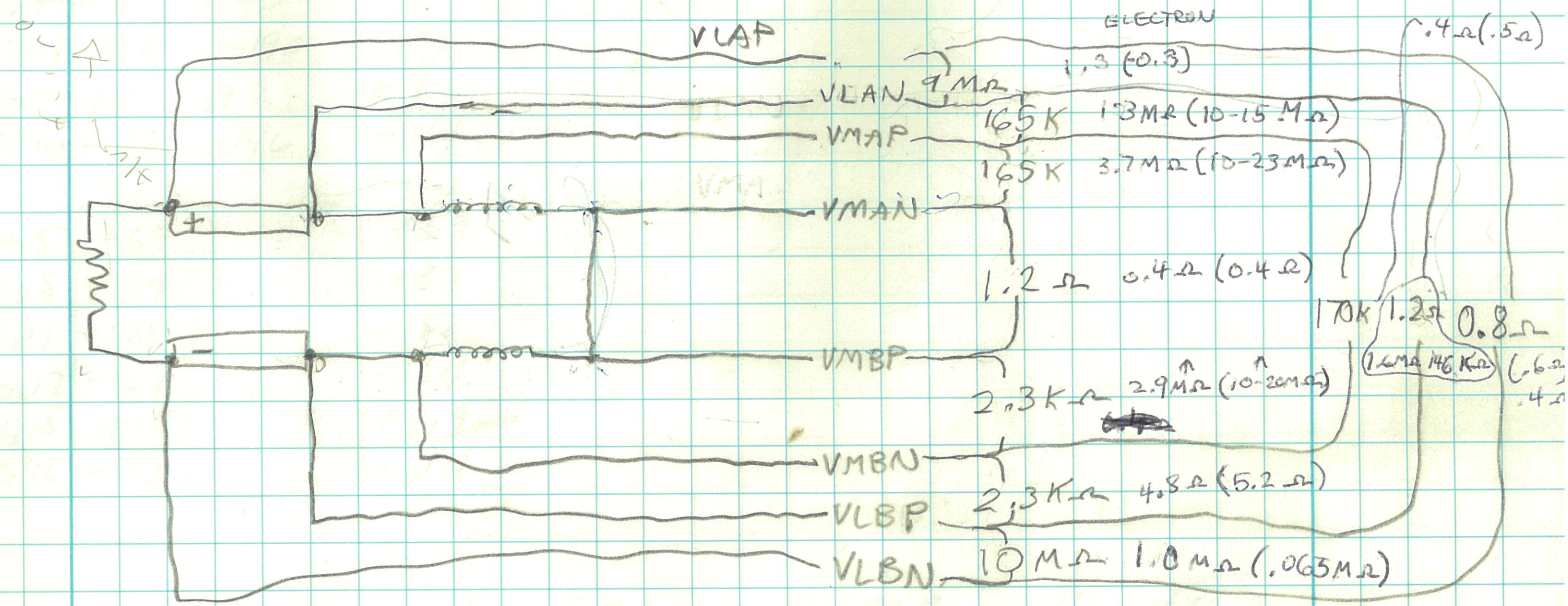
- Both amplifiers were calibrated such that they both read the same values for the same strain gauges - one was calibrated against the other with the amplifier balance adjustment. -fp (ch. 11-16 calibrated against ch. 1-10)

- The amplifier for ch. 1-10 was adjusted to produce the maximum number of zero strain on the gauges in combination with the multiplexor balance adjustments. fp

10/1/96 6:00 P.M.

coil and power supply resistance to ground = 4.18 MΩ without prot. ckt connected
= 40 KΩ with " " "

40 k could be due to the parallel contributions of the ~200k input impedances seen by the protection circuit (8 or 7 resistances total) to ground, this implies that the protection circuit power supply is referenced to ground.



	0	200	400	600
SG1	+2	+2	+1	
SG2	+80	+80	+80	
SG3	+9	+9	+5	
SG4	-43	-46	-52	
SG13	-197	-197	-198	
SG6	+3	+3	+2	
SG7	-3	-3	-3	
SG14	-192	-190	-183	
SG9	+2	+2	+1	
SG10	-147	-146	-144.	
SG5	+57		+59	
SG8	+39		+37	
SG11	-188		-188	
SG12	-162		-164.	
SG15	+114		+113	
SG16	-24		-24.	

INSTITUTED A FAST DUMP @ 400A. BURNT OUT CONTACTOR ON THE MS BREAKER. FOUND THE FAST DUMP AND SLOW DUMP RESISTORS WERE REVERSED.

10/2/96 ORDERED NEW BREAKER FROM GE
10/4/96 BREAKER RECEIVED AND INSTALLED.
10/7/96 CHECKED OUT BREAKER
ATTEMPTED TO POWER MAGNET
TRIP ON NEGATIVE LEAD
10/8/96. DISCONNECTED POWERSUPPLY
RAN INTO SHORT ALL LOGICS GOOD.
TRIED MEASURING MAGNET
INDUCTANCE. NOT SUCCESSFUL
RAN SUPPLY THROUGH FAST
DUMP RESISTOR.

10/2/96

PROTECTION CIRCUIT TEST SUBSEQUENT TO ACCIDENT

		+ POLARITY	− POLARITY
VLAP − VLAN	=	+0.071	−0.070
VLBN − VLBP	=	+0.072	−0.069
VMAP − VMAN	=	+1.19	−0.77
VMAN − VMBN	=	+1.16	−1.80

10/7/96 -[signature]

Items checked after M3 failure:

- All 12 SCR's o.k.
- Capacitor bank (output filter) is o.k.
- Slow Discharge (free-wheeling) diodes o.k.
- Protection circuits o.k. as noted above.
- Insulation test of magnet: R > 2 MΩ
- Ran power supply through fast dump resistor and measured 0.134 Ω at V=8V, I=60A

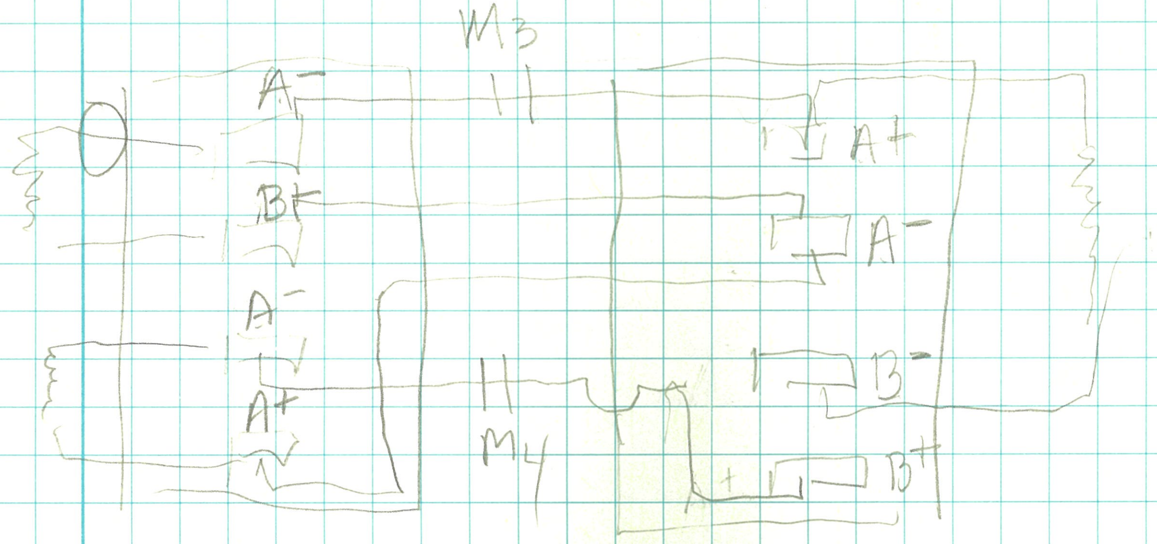
Insulation test of magnet with protection circuit: R = 110 k.
Resistance to ground through protection circuit was previously 40k. The 110k is the contribution by only the warm end lead voltage taps (2). The 110k remains the same if the internal voltage taps are connected or not. It appears after further testing that the voltage taps inside the magnet. When we turn on the power supply to the magnet, we immediately see a lead voltage fault and a lead voltage of several hundred millivolts. This is evidence that one lead voltage tap (cold end) is floating (disconnected), while the warm end tap is at power supply output potential. -[signature]

October 7, 96 Monday

1015 Set up zero current on strain gauges.

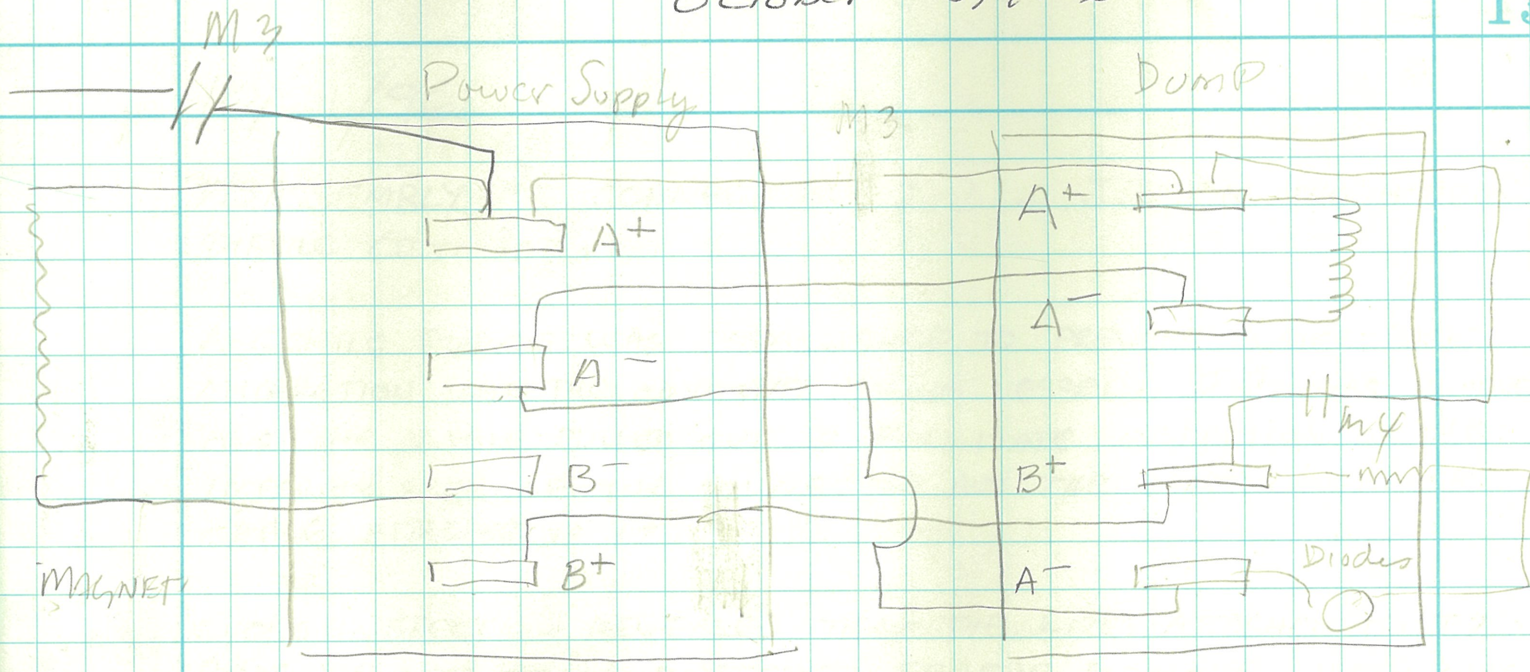
	SG1	2	EM1	SG11	57
	2	79	EM2	12	36
	3	11	EM3	13	−189
	4	−39	EM4	14	−163
13	~~5~~	−197	300L	15	110
	6	5	EM6	16	−22
	7	0	EM7		
14	~~8~~	−188	300R		
	9	3	600L		
	10	−143	600R		

Connections on H4
rotary switchboard.



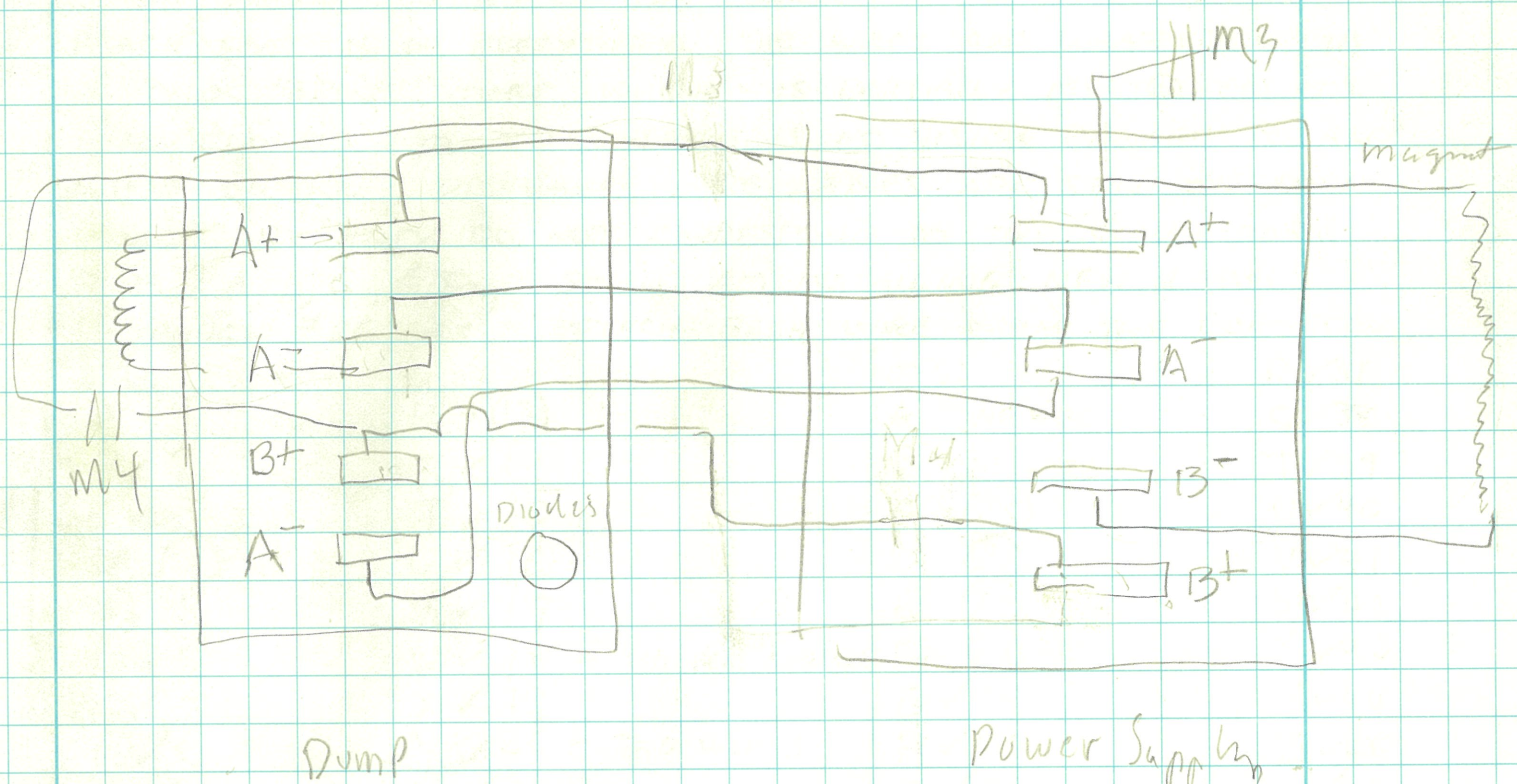
actual wiring

October 8, 1996



ELECTRON ARM

Connections on EA



HADRON ARM

Connections on HA

10/21/96

DISASSEMBLY OF CONNECTORS J-2 & J3 ON THE HADRON DIPOLE CRYOSTAT.

A GENTLE PURGE WAS ESTABLISHED TO PREVENT WATER BACK-MIGRATION INTO THE CRYOSTAT HELIUM VESSEL. J-2 WAS REMOVED AND THE CABLE PULLED OUT TO FACILITATE INSPECTION OF THE INTERIOR SIDE OF THE CONNECTOR AND THE SHORT LENGTH OF CABLE ATTACHED TO IT.

CLOSE INSPECTION REVEALED THAT THE WIRES ATTACHED TO J2 PINS M AND N SUFFERED SEVERE DAMAGE, WITH ONE WIRE VIRTUALLY VAPORIZED, AND THE OTHER WIRE BRITTLE, BURNED AND SO DELICATE THAT IT BROKE WHEN TOUCHED + MOVED. ALL WIRES ON BOTH CONNECTORS ARE 26 GA. SOLID LAQUERED "MAGNET" OR "COIL" WIRE. PINS M. AND N WERE MELTED/VAPORIZED ON THE BACK OF THE CERAMISEAL CONNECTOR, LEAVING A FLAT "PUDDLE" OF SLAG ON THE CERAMIC IN THE AREA OF THE PINS. THE SLAG PUDDLE IS ABOUT 1/4" IN DIAMETER, AND EXTENDS TO THE METAL HOUSING OF THE CONNECTOR. A THICK DEPOSIT OF BLACK SOOT IS ON EVERYTHING. THE WIRES ARE WRAPPED WITH A NYLON "SPIRAL" TUBE, WHICH WAS PARTIALLY MELTED ON ITS END CLOSEST TO J2. THERE IS NO VISIBLE DAMAGE TO ANY WIRES ON J3. DR. WANG'S WIRE LABLES ARE STILL ON EACH WIRE, BUT THEY DO NOT CORRESPOND TO THE CONNECTOR PINS "A, B, C, ETC., SO I AM INSTALLING NEW LABELS #1 THROUGH #26, AS I DETACH EACH WIRE FROM THE CONNECTOR.

J2:

A ~ 1		R ~ (13)	
B ✓ 2		S ✓ 14	
C ✓ 3		T ✓ 15	
D (4)		U ✓ 16	
E ✓ 5		V ✓ 17	
F ✓ 6		W ✓ 18	— NO HEAT SHRINK
G ✓ 7		X ✓ 19	
H ✓ 8		Y ✓ 20	~ TWO WIRES
J ✓ 9		Z ✓ 21	
K ✓ 10		a ✓ 22	
L ✓ 11	~~THREE~~ FOUR WIRES	b ✓ 23	
M ✓ NO WIRE 49		c ✓ 24	
N NO WIRE 50			
P 12			

J3:

A ~ NO WIRE	R ✓ 37
B ~ NO WIRE	S ✓ 38
C ~ (25)	T ✓ 39
D (26)	U ✓ 40
E (27)	V ✓ 41
F (28)	W ✓ 42
G ✓ 29	X ✓ 43
H ✓ 30	Y ✓ 44
J ✓ 31	Z ✓ 45
K ✓ 32	a ✓ 46
L ✓ 33	b ✓ 47
M ✓ 34	c ✓ 48
N ✓ 35	
P ✓ 36	

11/26/96, 2:10 P.M.

- Dynapower is connected in short-circuit at cryostat and isolated from ground.
- Set regulator jumpers to: ZFCT, short circuit
- Crow bar set to 800 A.
- Turned p/s on to 600A & appeared to be stable; V = 0.53V ;
- Set p/s to remote
- Brought I to 550 A in 100A steps. At each transition, the output oscillated at [redacted] +/- 50A and decayed to ~2% of setpoint and oscillated around setpoint.
- [redacted]Output voltage waveform looks good - No missing pulses or erratic firing.
- Set up regulator for shunt feedback, short circuit.
- Set crow bar for 2000 A.
- Power supply [redacted] regulates well with shunt short circuit mode [redacted] - ran to 1800 A. [redacted]. Output voltage waveform is [redacted] O.K.
- Replaced regulator with E.A. regulator.
- E.A. Regulator works O.k. at ZFCT, short-circuit mode
- " " [redacted] work in shunt, short-circuit mode - Acts identically to Hadron Arm regulator, except for an offset.
- Set E.A. regulator to ZFCT, short circuit
- Operated in remote to 1800 A & regulated O.k.
- Operated in remote with shunt short circuit setting to 1800A & regulates O.k.
- Put in H.A. regulator, set to ZFCT short Ckt; operated in remote; regulation is erratic. - problem is with regulator board
- Set H.A. regulator to shunt short circuit; operated in remote; operated to 1800 A, regulates O.k.

  Note: Voltage output waveform indicates that one cycle is dropped at 1800A. The effect is greatly reduced at 1200A and disappears at 1000 A.

- Set Regulator to ZFCT, short circuit,
- Set Crow bar to 800A.
- Set control to local
- Current leads are now isolated from ground & disconnected from magnet & isolated from each other.
- Test for presence of dump resistor:

  Set regulator for test mode, shunt short circuit

  Set V = 10V, Increase I until V = 10V on meter

  measure I of one lead of fast dump resistor with clamp-on ammeter:

  @ V = 10.05V, I = 15.1 A $R = \frac{10.05V}{15.1A \cdot 5} = 133.1\ m\Omega$

This agrees with R = 133.6 mΩ as measured by Kelvin bridge

- Measure I through slow dump resistor with M4 closed:
  I = 0.1A → diodes <u>are</u> reverse biased.
  $I_T = 0.1 \cdot 5 = \underline{0.5A}$

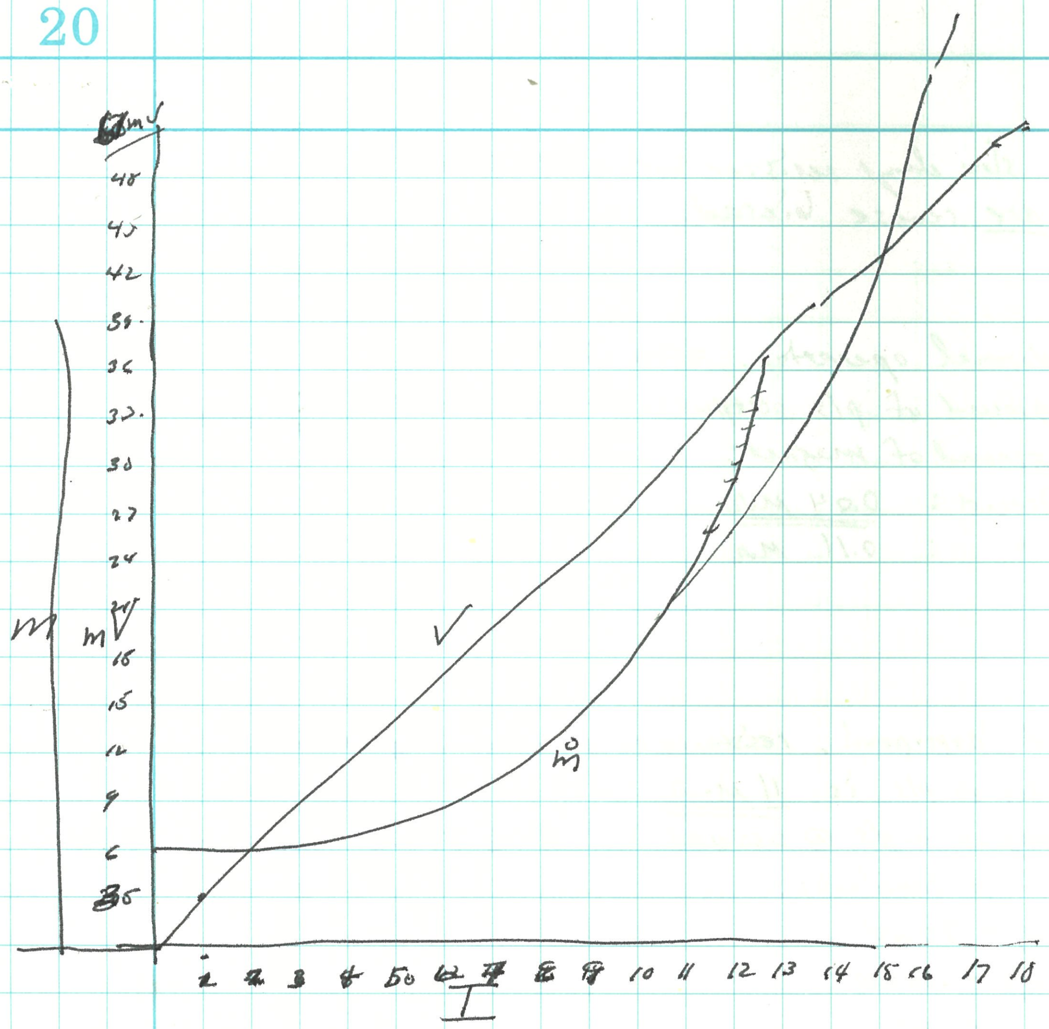
- Set regulator to Normal operation, ZFCT feedback.
- Insulation test to ground of p/s outputs at 250 VDC: <u>R = 31 MΩ</u>
- Insulation test to ground of magnet:
  with protection circuit: <u>0.04 MΩ</u>
  without " " : 0.11 MΩ

<u>11/27/86</u> 1:30 P.M.
- After cleaning J2 with isopropanol, resistance to ground of magnet without quench detector electronics or p/s is <u>11 MΩ</u>
- Insulation test of magnet + p/s @ 250 VDC: R = 6.8 MΩ to ground
- Test of ~~magnet~~ magnet voltage interlocks:
  VLAP-VLAN: +71 mV, -70 mV
  VMAP-VMAN: +1.19 v, -770 mV
  VMAN-VMBN: +1.87 v, -1.81 v
  VLBN-VLBP: +69 mV, -74 mV
  All faults open M3 <u>and</u> M4 for a fast dump
- Test of cable interlock @ cryostat.: removed J2 at cryostat; M3 + M4 opened for a fast dump + cable interlock light went out.
- Tested lead flow faults - lead 1 or lead 2 opens M3 + M4 for a fast dump
  Lead #1 Trip point: <u>40 SLPM</u>
  Lead #2 " " : <u>40 SLPM</u>
- Tested He level trip: M3 + M4 opened for fast dump.
  Set He level trip point to <u>60%</u>

- Set V = 2.0v, I = 100A, turned on p/s.
- current did <u>not</u> stop at regulation setpoint - need to check jumpers on regulator.
- stop + emergency stop open M3, but close M4 <u>always</u>
- Tested slow dump (first) then fast dump time constants, and inductance: <u>L = 3.26 H</u>, <u>τ_{SD} = 260-280 sec</u>
  <u>τ_{FD} = 23 sec.</u>

<u>12/4/86</u> 10:30 A.M.

- Found jumper J10 was installed instead of J1
- p/s now regulates very well at established setpoints.
- Put E.A. p/s PLC in H.A. p/s → all problems associated with stop buttons and M4 went away + now works correctly. Need to copy E.A. PLC program to H.A. PLC.

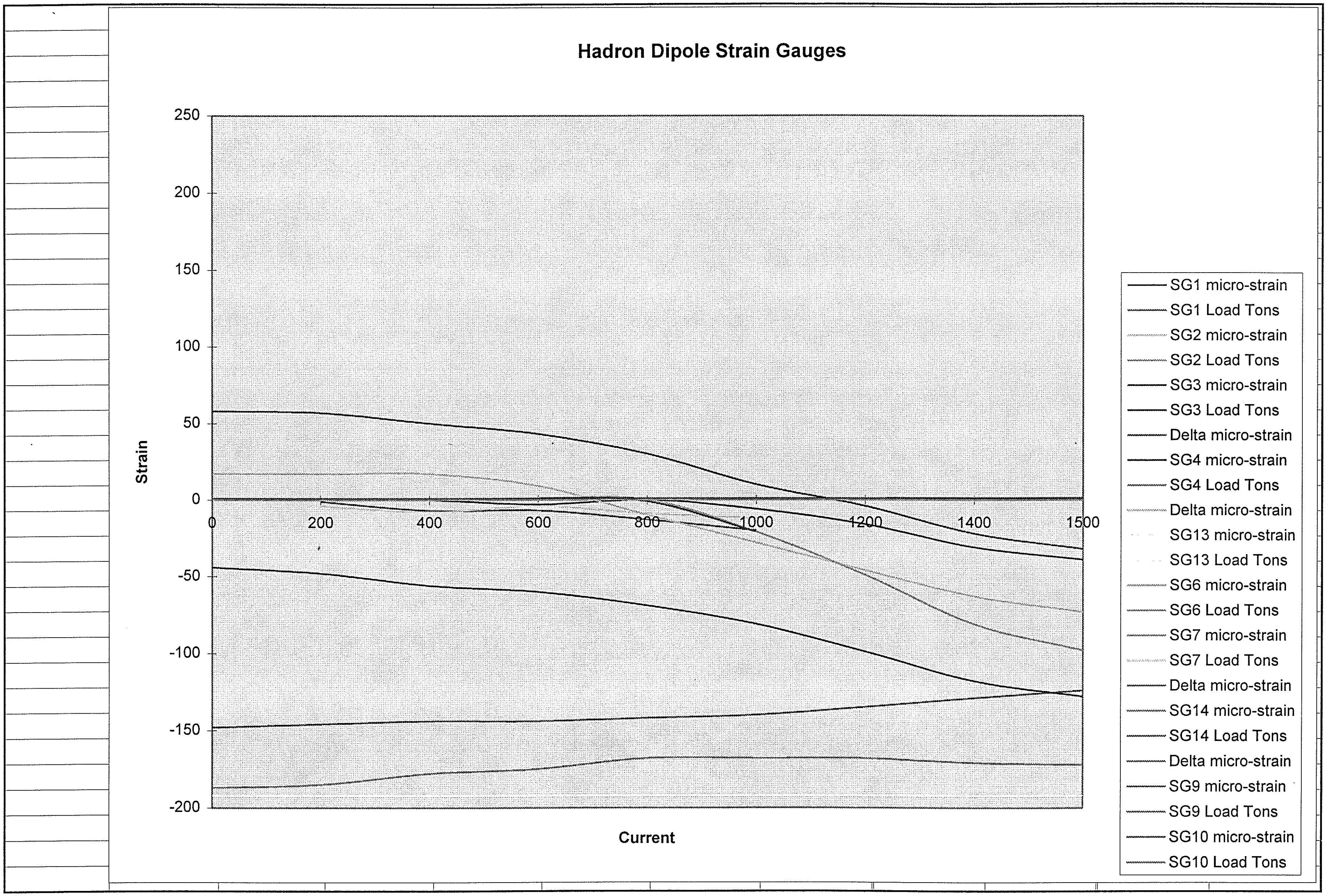


$$IR = \rho \frac{L}{A} I$$

$$I = I_0 e^{-\frac{t}{\tau}} \qquad \frac{t}{-\ln\left|\frac{I}{I_0}\right|} = \tau$$

Dipole Test 12/4/96 Dr. Burt Wang NOT present											
		EM1		EM2		EM3		EM4		300L	
	Current	SG1	SG1	SG2	SG2	SG3	SG3	SG4	SG4	SG13	SG13
	AMPS	micro-strain	Load Tons	micro-strain	Load Tons	micro-strain	Load Tons	micro-strain	Load Tons	micro-strain	Load Tons
Data	0	0	0	126	0	58	0	-44	0	-192	0
New Data	200	0	0	126	0	57	0.0118	-48	0.0292	-192	0.015
12/6/96	400	0	0	127	0.0116	50	0.0944	-56	0.0876	-192	0.015
	600	-3	0.021	143	0.1972	43	0.177	-60	0.1168	-192	0.015
	800	0	0	171	0.522	30	0.3304	-69	0.1825	-192	0.015
	1000	-6	0.042	197	0.8236	10	0.5664	-81	0.2701	-192	0.015
	1200	-16	0.112	218	1.0672	-4	0.7316	-99	0.4015	-192	0.015
	1400	-31	0.217	237	1.2876	-22	0.944	-118	0.5402	-192	0.015
	1500	-39	0.273	246	1.392	-32	1.062	-128	0.6132	-192	0.015
	1600		0		1.4616		0.6844		0.3212		0.591
	1700		0		1.4616		0.6844		0.3212		0.591
	1800		0		1.4616		0.6844		0.3212		0.591
	1900		0		1.4616		0.6844		0.3212		0.591
	2000		0		1.4616		0.6844		0.3212		0.591

EM6		EM7		300R		600L		600R		
SG6	SG6	SG7	SG7	SG14	SG14	SG9	SG9	SG10	SG10	Delta
micro-strain	Load Tons	micro-strain	Load Tons	micro-strain	Load Tons	micro-strain	Load Tons	micro-strain	Load Tons	icro-strain
17	0	0	0	-187	0	1	0	-148	0	
17	0.165	0	0.03	-185	0.0406	1	0	-146	0.0058	2
17	0.165	0	0.03	-178	0.0609	1	0	-144	0.0116	2
9	0.077	1	0.04	-175	0.0696	1	0	-144	0.0116	0
-10	0.132	0	0.03	-168	0.0899	1	0	-142	0.0174	2
-28	0.33	-21	0.18	-168	0.0899	1	0	-140	0.0232	2
-46	0.528	-49	0.46	-168	0.0899	1	0	-135	0.0377	
-63	0.715	-81	0.78	-171	0.0812	1	0	-129	0.0551	
-73	0.825	-98	0.95	-172	0.0783	1	0	-124	0.0696	
	0.022		0.03		0.5771		0.00285		0.4292	
	0.022		0.03		0.5771		0.00285		0.4292	
	0.022		0.03		0.5771		0.00285		0.4292	
	0.022		0.03		0.5771		0.00285		0.4292	
	0.022		0.03		0.5771		0.00285		0.4292	


Hadron Dipole Strain Gauges
250
200
150
100
50
0
-50
-100
-150
-200
Strain
0
200
400
600
800
1000
1200
1400
1500
Current
SG1 micro-strain
SG1 Load Tons
SG2 micro-strain
SG2 Load Tons
SG3 micro-strain
SG3 Load Tons
Delta micro-strain
SG4 micro-strain
SG4 Load Tons
Delta micro-strain
SG13 micro-strain
SG13 Load Tons
SG6 micro-strain
SG6 Load Tons
SG7 micro-strain
SG7 Load Tons
Delta micro-strain
SG14 micro-strain
SG14 Load Tons
Delta micro-strain
SG9 micro-strain
SG9 Load Tons
SG10 micro-strain
SG10 Load Tons

12/4/96

- Strain Gauges: • Ch1 + Ch2 bridge excitation set to 503 mV
  • Did not change amplifier zero or balance
  • Did not change multiplexer balance.

MULTIPLEXER #1 AMPLIFIER #1

CHANNEL	STRAIN GAUGE	LOCATION	VALUE I=0 12/4/96	12/6/96
1	SG1	EM1	+21	0
2	2	2	+96	127
3	3	3	+128	58
4	4	4	(−25)	−42
5	13	300L	(−187)	−191
6	6	EM6	+23	16
7	7	7	+16	−1
8	14	300R	(−169)	−189
9	9	600L	+22	0
10	10	600R	(−127)	−146

MULTIPLEXER #2 AMPLIFIER #2

CHANNEL	STRAIN GAUGE	LOCATION	12/4/96	12/6/96
1	SG5	EM5	+56	59
2	8	8	+35	37
3	11	100	(−189)	−189
4	12	200	(−164)	−164
5	15	400	+111	114
6	16	500	(−25)	−25

1:20AM: See I = 200A, V = 2.0V : Lead A: 68.0 SCPM ~~2.615~~ 3.4 mV; Lead B: 62.8 SCPM ~~0.0740~~ 2.6 mV; ZFCT = 1.0008; Panel: 200A, 0.19V

τ_s: 15.25 s / 200A–190A (24.75)
τ_F: 9.84 s / 155A–10A (22.45 s)

$L = 0.134 \cdot 22.45 = 3.00\ H$

$R_c = \frac{3}{297} = 10\ m\Omega$

1	SG1	EM 1	
2	2	2	+21
3	3	3	+96
4	4	4	+128
5	13	300L	(−29)
6	6	EM 6	(−187)
7	7	7	+23
8	14	300R	+16
9	9	600L	(−167)
10	10	600R	~~+22~~
			(−125)

@ 200A 12/4/96

1	595	EM15
2	8	8
3	11	100
4	12	200
5	15	400
6	16	500

1	+57
2	+36
3	(−189)
4	(−163)
5	+111
6	+24

- Set I=400A, V=4.0v
  - Lead A: 68 SLPM, 6.8 mV
  - Lead B: 62 SLPM, 5.5 mV
  - ZFCT = 2.00008 v
  - I=400A, V=0.37V
  - τ_s: 400A - 390A : 9.84s τ: 388 sec.
  - τ_F: 240A - 100A : 20.126 τ = 22.98 sec.

1	57
2	36
3	(−189)
4	(−164)
5	111
6	(−22)

- Set I=600A, V=4.0v
  - Lead A: 68.5 SLPM, 10.1 mV
  - Lead B: 63.3 SLPM, 8.3 mV
  - ZFCT: 3.00010 v
  - I= 601A V= 0.55v
  - τ_s: ~~590~~ 601A - 590A, 7.34s, τ = 397.3 sec.
  - τ_F: 555A - 200A, 23.12s, τ = 22.65 sec.

1	61
2	35
3	(−189)
4	(−164)
5	111
6	(−24)

- Set I=800A, V=6.0v
  - Lead A: 69.8 SLPM, 13.3 mV
  - Lead B: 64.4 SLPM, 11.1 mV
  - ZFCT: 4.00004 v
  - I= 802A V= 0.73v
  - τ_s: 802A - 780A : 11.68 sec. : τ = 419.9 s
  - τ_F: 735A - 300A : 19.23 sec. : τ: 21.46 s

- Set I= 1000A, V=6.0v
  - Lead A: 71.0 SLPM, 16.4v
  - Lead B: 65.5 SLPM, 13.9v
  - ZFCT: 5.00006 v
  - I = 1003 A V= 0.94v
  - τ_s : 1003A - 970A, 13.71s τ = 409.8 sec.
  - τ_F : 920A - 300A, 23.53s τ = 21.0 sec.

$R = \frac{2.81 H}{409.8 sec} = 6.8\ m\Omega$

$L = 2.81\ H$

- Set I = 1200A, V = 6.0v
  Lead A: 71.3 SLPM, 18.7 mV
  Lead B: 66.4 SLPM, 16.8 mV
  ZFCT: 6.00025 v
  I = 1204A V = 1.09v
  τ_s: 1204A - 1160 A ; 14.4 s τ = 386.8 s
  τ_F: 1100 A - 400 A ; 20.31 s τ = 20.08 s

- Set I = 1400A, V = 6.0v
  Lead A: 78.1 SLPM, 20.9 mV
  Lead B: 72.2 SLPM, 18.9 mV
  ZFCT: 7.00077 v
  I: 1405A V = 1.28v

- Set I = 1500A, V = 6.0v
  Lead A: —
  Lead B: —
  ZFCT: —
  I = — V = —

$\tau = \frac{t}{-\ln\left|\frac{I}{I_0}\right|}$

τ_s: 1445A - 1350A , 22.04 sec : τ =
τ_F: 1200A - 200A, 40.09 sec : τ = 22.4 s

12/5/96

Raised current to 1800A. Sitting at that value for past 15 minutes.

SG's #2

1	78
2	42
3	-189
4	-164
5	111
6	-23

Similar to earlier data

Other strain gauges on computer tracking yesterdays data.

We heard a noise, twice, last night at about 1500 A. We checked strain gages but could see nothing. Values are considerably below what we had for dipole #1. Noise could be attributed to vacuum tank moving relative to the iron.

12-5-96.

Up to 1000A there does not appear to be any shifting or settling of loads Concerned as likely strain gauges indicate lower values.
I have attached the data from last night

At 1000A one can compare the hadron arm magnet to the electron arm

		HA	EA	A
EM1	SG1	0.042 T	0.511 T	factor 10
EM2	SG2	0.0236 T	0.12 T	– factor 7.
EM3	SG3	0.5663 T	3.57 T	factor 7
EM4	SG4	0 2701 T.	1.03 T	factor 4.

Even if one makes for allowances these loads are small Compared to the capability of the links

At 1500A.

	HA	EA.	factor.
EM1	0.273 T	1.456 T	6
EM2	1.392 T.	2.23 T	+ 2
EM3	1.062 T	6.11 T	6
EM4	0. 6132 T.	2.85 T	∠ 5.

We will increase current slowly and Watch strain gages.

12-6-96.

Yesterday we discovered that the supply transfer line had an excessive vacuum pressure ~ 300± microns. We changed the mechanical pumps but it didn't improve. We added a 60 l/s turbo and the vacuum is now down to 17 μ's. and the ice which had formed on the line is gone. We can now test.

We also changed the zeros on the strain gauges. late on 12/4/96. because of my concern that the loads were so low. The strain gauges at zero current have returned to their earlier values.

Unit 1

SG1	EM1	0
SG2	EM2	127
SG3	EM3	58
SG4	EM4	-42
SG13	300L	-191
SG6	EM6	16
SG7	EM7	-1
SG14	300R	-189
SG9	600L	0
SG10	600R	-146.

Unit 2.

SG 5	59
SG 8	37
SG 11	-189
SG 12	-164
SG15	114
SG 16	-25.

12/6/96

Powered magnet up to the 1500A level. and checked fast dump. When we did this the level gauge at the bottom dropped acting like there was a warm pocket at the bottom of the magnet. The temperature sensor at the bottom TP 26 also increased from 16 (4K) K to 26K? Lead flows also increased as the pressure built up to 1.8 ATM. Flow was so bad that we were requested to stop so that we wouldn't trip off Hall B.

High heating can be attributable to eddy currents and/or some local heating in the cryostat. When things moved the other day (noise that we heard) something could be moving in the field causing heating. ??? We don't know.

After discussions with Larry Cardman and John O'Meara we decided to curtail testing.

Attempted to power to low values ~1000A so that J. LeRose could measure his Hall probes. Magnet tripped and levels also dropped — same effect as at 1500A only lesser in extent.

James and I checked insulation resistance to ground with a meter and saw megohms. We then got the megger (250V) and measured ~50K Ω (210). This could be the connector which we will check.

We tested the trip points they haven't changed! So why magnet tripped is not clear.

We connected the center tap ground on the power supply. If there is heating due to resistance to ground we thought this would lower the voltage — hence the heating.

12/6/86, 4:00 P.M. -JP

- Earlier, p/s had difficulty charging to 1000A because of intermittent quench faults. I cleaned the voltage control potentiometer and the effect was reduced. I slowly increased voltage from zero to 6V, and a quench showed up after 600A. This problem, and the apparent He vessel heating can be due to a resistive short to ground in the coil, of sufficiently low resistance to deliver several watts into helium at only 600A. - He level on bottom probe did not drop at 600A discharge. Lead A: ~730 SCFM Lead B: ~720 SCFM after discharge.
- Resistance to ground of p/s and magnet: 0.21 MΩ (without protection ckt)
- Resistance to ground of p/s and magnet with all instrument cables disconnected except top He level probe: 0.04 MΩ
- Replaced all instrument cables: R = 0.21 MΩ
- Installed protection circuit test box at cryostat connectors.
- Verified that quench and lead trip points have not changed.
- Charged magnet to 100A @ 1.0V, and saw asymmetry in magnet voltage between coil A and coil B:

  VMAP - VMAN: 0.75 V

  VMAN - VMBN: 0.25 V

Also measured to ground:

  VLAP - GND:

  VLBN - GND:

Measurements were made with dump resistor center tap resistor disconnected and ground fault circuit off

- Switched on dump resistor center tap resistor (10 kΩ, 5W) to ground. Magnet voltages are unchanged, VLAP-GND and VLBN-GND are now 0.5 V when charging at 1.0V.

- Adjusted R34 on quench protection circuit to balance the protection circuit with the magnet so that "VMD" signal is zero on magnet charge-up. Could not bring to zero, but reduced effect by 50%. R34 was originally centered. Balance adjustment had no obvious effect on quench faults. May try to increase R34 from 10k to 50k tomorrow to improve balance.

-

12/7/96

- Inductance measurement @ V = 1.0v:
  charge time: rise of 20A in 12.45 sec:

$$V = L\frac{\Delta I}{\Delta t} : \quad L = V\frac{\Delta t}{\Delta I} = (1)\frac{12.45}{20A} = \underline{0.62H}$$

Slow discharge: 40A - 25A in 10.11 sec

$$I = I_0 e^{-\frac{t}{\tau}} : \quad \tau = \frac{-t}{\ln\left|\frac{I}{I_0}\right|} = \frac{-10.11}{\ln\left|\frac{25}{40}\right|} = \underline{21.5\,sec}$$

$$\tau = \frac{L}{R} : \quad L = \tau \cdot R = 21.5 \cdot 10m\Omega = \underline{0.22H}$$

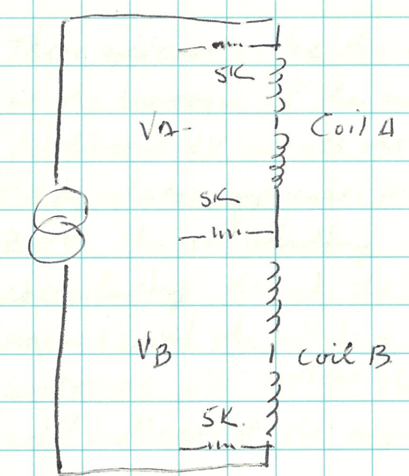
- Will measure with chart recorder at higher currents.

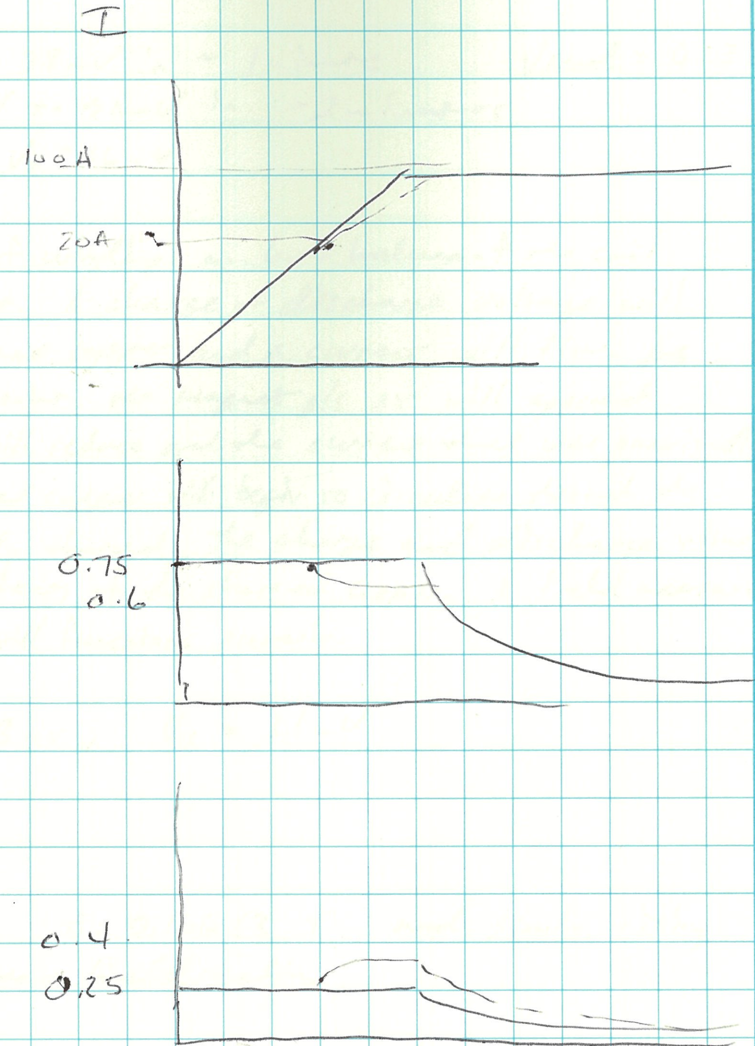
305A - 55A : 70.28 s

τ_{sn} = 38.81 sec   100A · 35A   37 sec

~~12/9/96~~

12/09/96.





1). Check instrumentation circuit.

✓ 2). measure coil resistances

3). Disconnect everything and measure coil inductance

✓ 4). Measure inductance of coil to the up and down ramping.

✓ 5). Check supply regulation by it self

110KΩ .0250VDC 6) Measure ground fault current ramping and ramp down. Does apparent ground fault change with ramping

✓ 7). Measure field EA & MA

12/9/96

Set $I = 150A$, $V = 0.32V$ regulated
$V_A = 78mV$, $V_B = 98mV$
V_A dropped from 90mV to 78mV in ~ 1 minute $V_{panel} = 0.33V$
V_B dropped from ~130mV to 98mV in ~2 minutes
after 20 min. V_A = 16 mV, V_B = 16mV

- There appears to be shorting of windings on back between the coil at the bottom of the magnet. A charge or discharge voltage will produce a ΔV across the shorted copper and a current will flow. As the regulator approaches its setpoint, the magnet p/s ΔV will approach zero. The coil winding ΔV will reduce and the current that was previously circulating through the shorted copper will begin to circulate through the magnet until the coil is ~ fully charged. The charge and discharge time constants will reflect the effects of the shorted copper. A field measurement will indicate if the magnet still functions properly.

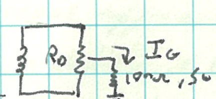
- after 70 minutes, V_A = ~3mV, V_B = 3.1mV
panel: $I = 150A$, $V = 0.15v$

~~...~~

- forced lock on NMR: B = 0.16613 T and slowly rising
- going to 200 A for better field reading.

- @ $I = 200A$, $V_A = 73mV$, $V_B = 90mV$
panel: $V = 0.34v$, $I = 200A$

- after 10 min @ 200A: $V_A = 30.8$, $V_B = 39.3mV$, $V_{panel} = 0.26v$, $I = 200A$.
after 25 min @ 200A: $V_A = 13mV$, $V_B = 16.4mV$, $V_{panel} = 0.22v$, $I = 200A$
" 45 " V_A = ~4.3mV, $V_B = 6.0mV$ $V_{panel} = 0.20v$, $I = 200A$

- Slowly discharged magnet to zero
- placed ammeter between 10Ω, 5W dump resistor center tap and ground
- charged magnet to 100A.
regulating @ 100A, I_G = 0.0 mADC 

- $I_G = 0$ for charging and discharging.

- Set R34 balance adjustment to center and attempted to balance by adjusting a shunt resistance across R33.

- A given balance for one voltage does not apply to another charging voltage.
- The oscillations occurring during regulation still trip p/s regardless of how well balanced it is. This variable balance may be due to the effects of the internal shorts of windings.
- Try using only diodes for slow dump – may reduce effect of negative voltage regulation.

12/10/96

- Disconnected p/s from magnet to test current into dump resistor.
- Resistance to ground of P/S outputs only @ 250 VDC: R = 46.5 MΩ
- " " " " magnet only @ 250 VDC: R = 0.11 MΩ without prot. ckt.
  R = 0.04 MΩ with prot. ckt.
- Set regulator to shunt short circuit, set feedback to shunt
- Set V = 10v
- @ V_{int} = 10v, I = 15A/terminal · 5 terminals = 75A

$\frac{10v}{75A} = 0.133\ \Omega$

$V = L\frac{\Delta I}{\Delta t}$

- changed regulator to ~~shunt~~ ZFCT short circuit, ZFCT feedback
- bolted together ~~&~~ cables at magnet & isolated from ground for short circuit test.
- Set V = 1.0v, I = 0
- @ I = 200 A, V = 0.18v R = 0.9 mΩ

- Hooked up LakeShore p/s to dipole with #2 cable
  - Set V = 5.0v
  - Turned off ramp control and I step limit
  - Set IMAX = 125A, VMAX = 10.0v.
  - Set up chart recorder on magnet coils A + B
  I = 0 - 40A, 10 s, V = 3.1v L = 0.78H
  @ I = 100A, V = 2.08v drop along cables

- Operated E.A. dipole w/ Dynapower p/s at 200A. Turned up current from 150A to 200A by hand in current regulation mode.
  - Time constant for coil A and coil B voltages approaching zero is much smaller.
  - " " " B-field to approach stability is much smaller
  - noise is seen on both coils A + B, while it is seen only on coil A on the H.A. dipole.
  - recorded coil A + coil B voltages with chart recorder.
  - H.A. coil B was measured to have ~25% of the charging voltage, which may indicate more ~~[illegible]~~ shorted windings. This may also act as less of an antenna for noise.

12/11/96

- Set up chart recorder on H.A. dipole Coil A + Coil B w/ LakeShore p/s to measure charge + discharge times to 100A.
  charging at 3.0V, Discharging at 3.0V. (Actual = 3.07V)

- Set Vset = 30.0V, Iset = 100A. – no heating noticed

- Set up chart recorder for LakeShore voltage and current outputs, + recorded charge + discharge times.

- Disconnected LakeShore p/s +
- Measured magnet inductance with HP LCR meter Model # 4263B
  - freq. = 100 Hz @ 1V
  - zeroed leads
  - Set to parallel resistance + inductance model.

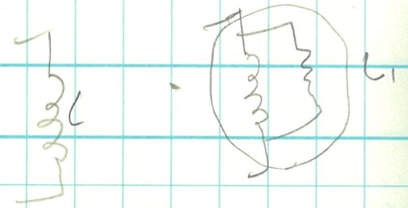
  - measured VMAP-VMBN at breakout box – ~~results inconclusive – inductance fluctuated around 200 with ± 10mH noise.~~ L = 420 mH, R = 29.7 Ω
  - measured across terminals at magnet: L = 39.1 mH, 30.2 Ω.

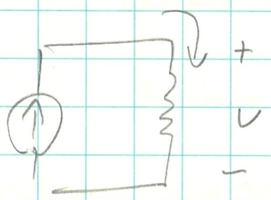
- Kelvin bridge measurement of magnet resistance measured at magnet terminals: R = 0.0183 Ω, with fluctuations.

- measured Inductance again:
  Set average to 32, medium sampling rate
  VMAP-VMBN = ~200 mH, R_p = ~256 Ω
  VMAP-VMAN : ~200 mH, R_p = ~262 Ω
  VMAN-VMBN = ~ –2.7 mH, R_p = ~2.8 Ω

- Set up chart recorder to measure VMAP-VMAN, VMBP-VMBN (no joint) and found no difference in response compared to VMAP-VMAN, VMAN-VMBN.

- also looked at VMAN-VMBP with Fluke 79 voltmeter on 300mV scale, during charge, regulation, and discharge, and found the voltage to be always 0.0 mV. – there is no voltage drop across the center joint.


L
L1


+
v
-

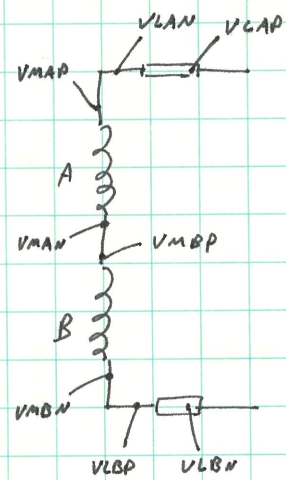
12/12/96

- charge magnet to 100A w/ LakeShore & monitor tap voltages:
- Set I=100, V=3.0V.

- @ I=0 : VLAP - VLAN : 0.0mV
  VLAP - VMAP = 0.0 mV
  VLAN - VMAP = 0.0mV
  VMAN - VMBP = 0.0mV
  VMBN - VLBP = 0.0mV
  VLBP - VLBN = 0.0mV
  VMBN - VLBN = 0.0mV

- @ I=100A : Lead A: 54.8 SLPM , Lead B = 53.8 SLPM.

  VLAP - VLAN = 2.1mV
  VLAP - VMAP = 2.1mV
  VLAN - VMAP = 0.0mV
  VMAN - VMBP = 0.0mV
  VMBN - VLBP = 0.0mV
  VMBN - VLBN = 1.8mV
  VLBP - VLBN = 1.8mV



Lead A = 55.0 SLPM, Lead B = 53.9 SLPM

- @ I = 100A , 90 min. after start :
  VLAP - VLAN = 1.9mV
  VLAP - VMAP = 1.9mV
  VLAN - VMAP = 0.0mV
  VMAN - VMBP = 0.0mV
  VMBN - VLBP = 0.0mV
  VMBN - VLBN = 1.7mV
  VLBP - VLBN = 1.7mV

✓ VMAP - VMBN = ~3.9mV noisy
✓ VLAP - VLBN = ~6.0 mV noisy
VMAP - VMAN = ~ 1.5mV noisy
VMBP - VMBN = ~ 1.8 mV not noisy (~0.1 mV)

VLAP - Gnd : 27.5 mV
VLAN - Gnd : 26.5 mV
VMAP - Gnd : 26.0 mV
VMAN - Gnd : 25.0 mV
VMBP - Gnd : 28 mV
VMBN - Gnd : 26 mV
VLBP - Gnd : 26 mV
VLBN - Gnd : 27 mV

Lead A: 53.6 SLPM , Lead B = 52.3 SLPM

12/13/96

- Warmed up magnet from 16 K to 24 K
- Installed Hall probe between VMA probes
- Set up chart recorder for coils A & B
- Set V = 10.0 V, I: 50.0 A.
- from 0-50 A, took 5.0 sec. @ 10.0 -
- Voltages stabilized very quickly
  @ I = 50.02 A, V: 1.54 V , 10 min. after start.
  Coil A = 315 mV (VMAP - VMAN)
  Coil B = 259 mV (VMBP - VMBN)

	@ I = 0 :	@ I = 50 A : 45 min.
VLAP-VLAN	0.0 mV	3.2 mV
VLAN-VMAP	0.0 mV	-0.1 mV
VMAP-VMAN	0.0 mV	343 mV
VMAN-VMBP	0.0 mV	0.1 mV
VMBP-VMBN	0.0 mV	280 mV
VMBN-VLBP	0.0 mV	-0.1 mV
VLBP-VLBN	0.0 mV	3.3 mV

measured w/ Fluke 79 DMM.

after 45 min : P/S I = 50.02 A, V = 1.60 V
VMAP-VMAN = 343 mV
VMBP-VMBN = 289 mV

VLAP-GND = 345 mV
VLAN-GND = 341 mV
VMAP-Gnd = 341 mV
VMAN-Gnd = 10 mV

VMBP-Gnd = 13 mV
VMBN-Gnd = -255 mV
VLBP-Gnd = -255 mV
VLBN-Gnd = -255 mV

- Set I = 100A, ~~V=1A~~ V = 5.0v
- Set up chart recorder for B_{Gauss} vs. $I_{p/s}$

at 100 Amps

VLAP − VLAN = 6.6 mV
VLAN − VMAP = −0.4 mV
VMAP − VmAN = 948 mV
V_{man} − VmBP = 0
VmBP − VmBN = 756 mV
VmBN − VLBP = 0
VLBP − VLBN = 7.2 mV

raped up to 100 from 50 — Vmax = 5V ↓
raped down to 0 from 50
raped up 0 to 100
raped down 100 to 0

12/16/96

- Filled magnet & set up chart recorder for B vs. I using previous settings.
- Turn on LakeShore, I = 100A, V = 5.0V at ~14:50
- Ramped down to I = 0 ~ 17:03

12/17/96

- 9:10 A.M. – Gaussmeter reads 6.43 mT and still dropping. from ~17 mT @ 18:30 yesterday.
- Disconnecting LakeShore p/s & attaching Dynapower p/s to magnet
- Resistance of slow discharge circuit:
  ~~at~~ shorting cables only: ~~0.1051~~ 0.1051 mΩ/cable = 0.0526 mΩ for 2 cables in parallel
- ramped to 200A by hand
- Slow decay resistor time constant seems to be dominated by diode resistance.
  The p/s appears to go into regulation faster, but still trips out quench circuit (but not lead circuit) at ~100A.
- Reached 200A @ 11:30 A.M.

- 6:00 P.M. - AFTER 6½ HOURS AT 200A THE VOLTAGE ACROSS COIL "A" FLOATS FROM +2 TO −1 mVDC, WHILE THE VOLTAGE ACROSS COIL "B" IS +0.2 mVDC, ± 0.2 mV. WHEN VIEWED ON AN O-SCOPE, THE TWO VOLTAGES APPEAR TO BE OUT OF PHASE ≈30°. WHEN READ AS AN A/C VOLTAGE BY THE FLUKE METERS, I SEE 600 mVAC ON COIL "A", AND 5 mVAC ON COIL "B".

12/17/96 (CONTINUED)

6:17 P.M. – DURING RAMP-DOWN OF THE DIPOLE I OBSERVED AN ODD PHENOMENOM: I WAS RAMPING DOWN AT −0.7 V AND PASSED 80A WHEN I NOTICED THAT THE VOLTAGE METER NO LONGER FLUCTUATED WITH MY INCREMENTAL ADJUSTMENT OF THE CURRENT POTENTIOMETER, BUT RATHER WAS "STUCK" AT −0.7 V. I STOPPED TURNING THE POTENTIOMETER AND WATCHED THE CURRENT FIRST FALL BELOW ~~[illegible]~~ 60A AND THEN SLOWLY INCREASED – BY ITSELF – TO 81 A, AND THEN STARTED BACK DOWN. WHEN IT AGAIN DRIFTED BELOW 60A I LOOKED AWAY TO WRITE THESE NOTES AND A FEW MOMENTS LATER THE QUENCH PROTECTION CIRCUIT TRIPPED AND BEGAN A FAST DUMP. DURING THE TIME THE VOLTAGE WAS "STUCK" AT −0.70 V, I OBSERVED 0.731 VDC ACROSS THE SLOW-DUMP RESISTOR DIODES.

THE ABOVE EFFECT IS SIMILAR TO AN ODD PHENOMENON THIS MORNING WHILE RAMPING UP TO 200A. AT 156 A, I LOST CONTROL OF THE VOLTAGE. WHEN I STOPPED TURNING THE CURRENT KNOB, THE VOLTAGE CONTINUED TO INCREASE ALMOST TO THE VOLTAGE LIMIT (2V) BEFORE SLOWLY FLOATING BACK DOWN TO SOMETHING REASONABLE. ARE THESE TWO EFFECTS RELATED? WHAT CAUSES THEM? WILL THEY BE PROBLEMATIC AT HIGHER FIELD?

– Mark Stevens

1/2/97 -[initials]

Jumpers across KM 8-5 + KM 9-6

- The magnet and p/s interlock circuit was re-wired such that all external (magnet) interlocks produce a slow discharge. A fast discharge can still be initiated by opening M4 and pressing either the "stop" or "Emergency Stop" buttons.
- Interlock response verification:

  VLAP-VLAN = +71mV, -71mV
  VLBP-VLBN = +71mV, -71mV
  VMAP-VMAN = +1.20v, -0.78v
  VMAN-VMBN = +1.18v, -1.82v

All parameters are tested with power supply on (M3 + M4 closed) and all initiated a slow dump.

Helium level trip verified to operate o.k. + initiates a slow discharge

- Lead flow Newport meters were modified to produce a fault on low and high flows. These faults produce a slow discharge (verified to be o.k).
A slow discharge is produced when:
  40SLPM > Lead A > 90 SLPM
  40SLPM > Lead B > 90 SLPM

- Verified that local "stop" and "Emergency Stop" open M3, and the M4 switch will open M4 when switched to "Fast" discharge

- Turned on p/s to 100A @ 1:00 P.M. + set until 3:15 p.m.
  - Initiated a slow discharge from 100A.

- Set I to 200A (manually) @ 3:30 P.M. - reached target value at 3:45 P.M.
  - Initiated slow discharge @ 4:20 p.m.

- Set I to 300A manually + initiated slow discharge @ 5:45 P.M.
  265A → 245A: 12.66 sec.

Dipole Test 1/2/97 - Dr. Bert Wang NOT Present										
			EM1			EM2			EM3	
	Current	SG1	SG1	Delta	SG2	SG2	Delta	SG3	SG3	Delta
	AMPS	micro-strain	Load Tons	micro-strain	micro-strain	Load Tons	micro-strain	micro-strain	Load Tons	micro-strain
Data	0	0	0	0	127	0	0	58	0	0
1/2/97	100	0	0	0	127	0	0	57	0.684	-1
	200	0	0	0	127	0	0	57	0.684	0
New Data	300	0	0	0	127	0	0	57	0.684	0
1/3/97	400		0	0		1.512	-127		0	-57
	500		0	0		1.512	0		0	0
	600		0	0		1.512	0		0	0
	700		0	0		1.512	0		0	0
	800		0	0		1.512	0		0	0
	900		2.044	0		1.512	0		0	0
	1000		2.044	0		0	0		0	0
	1100		2.044	0		0	0		0	0
	Total Strain	0.0073		0	0.012		-127	0.012		-58
	Current	SG1	SG1	Delta	SG2	SG2	Delta	SG3	SG3	Delta
	AMPS	micro-strain	Load Tons	micro-strain	micro-strain	Load Tons	micro-strain	micro-strain	Load Tons	micro-strain

Stain Gages

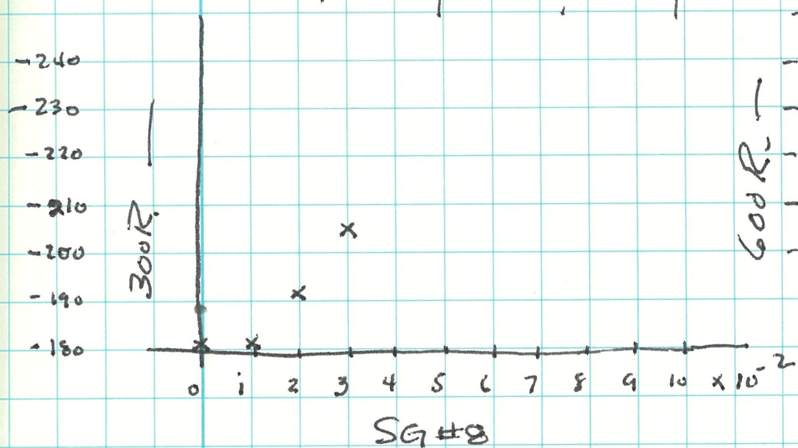
	EM4			300L			EM6			EM7
SG4	SG4	Delta	SG13	SG13	Delta	SG6	SG6	Delta	SG7	SG7
micro-strain	Load Tons	micro-strain	micro-strain	Load Tons	micro-strain	micro-strain	Load Tons	micro-strain	micro-strain	Load Tons
-43	0	0	-191	0	0	17	0	0	-1	0
-43	0	0	-191	0	0	16	0.011	-1	-1	0
-44	0.0073	-1	-191	0	0	16	0.011	0	-1	0
-48	0.0365	-4	-191	0	0	16	0.011	0	-1	0.01
	0.0511	48		0.543	191		0.187	-16		0
	0.0511	0		0.543	0		0.187	0		0
	0.0511	0		0.543	0		0.187	0		0
	0.0511	0		0.543	0		0.187	0		0
	0.0511	0		0.543	0		0.187	0		0
	0.0511	0		0.543	0		0.187	0		0
	0.0511	0		0.543	0		0.187	0		0
	0.0511	0		0.543	0		0.187	0		0
0.0073		43	0.003		191	0.011		-17	0.01	
SG4	SG4	Delta	SG13	SG13	Delta	SG6	SG6	Delta	SG7	SG7
micro-strain	Load Tons	micro-strain	micro-strain	Load Tons	micro-strain	micro-strain	Load Tons	micro-strain	micro-strain	Load Tons

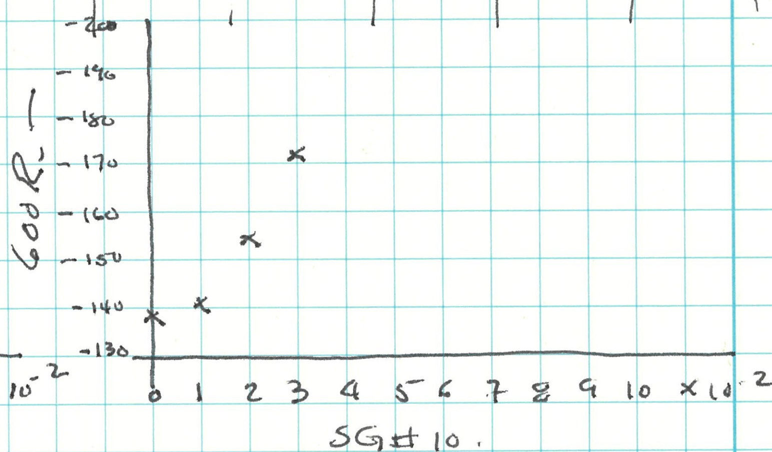
Stain Gages

		300R			600L			600R	
Delta micro-strain	SG14 micro-strain	SG14 Load Tons	Delta micro-strain	SG9 micro-strain	SG9 Load Tons	Delta micro-strain	SG10 micro-strain	SG10 Load Tons	Delta icro-strain
0	-181	0.0174	0	5	0.012	0	-138	0	0
0	-182	0.0145	0	5	0.012	0	-141	0.0096	0
0	-192	0.0145	0	5	0.012	0	-155	0.0224	0
0	-205	0.0522	0	5	0.012	0	-173	0.112	0
1		0.5423	0	5	0.012	0		0.4416	0
0		0.5423	0		0.003	-5		0.4736	7.8
		0.5423			0.003			0.4736	10.1
		0.5423			0.003			0.4736	12.3
		0.5423			0.003			0.4736	15.5
		0.5423			0.531			0.9184	16.15
		0.5423			0.531			0.9184	16.75
		0.5423			0.531			0.9184	17.185
1	0.0029		0	0.003		-5	0.0032		95.785
Delta micro-strain	SG14 micro-strain	SG14 Load Tons	Delta micro-strain	SG9 micro-strain	SG9 Load Tons	Delta micro-strain	SG10 micro-strain	SG10 Load Tons	Delta icro-strain

2 January 1997

CURRENT.		0000	0100	0200	0300	0400	0500	0600	0700	0800	900.	1000	
TIME			MS.		1720								
STRAINGAGE													
#1	#1	000	000	000	000								EM1
	2	+127	+127	+127	+127								2
	3	+058	+057	+057	+057								3
	4	-043	-043	-044	-048								4
	5	-191	-191	-191	-191								300L
	6	+017	+016	+016	+016								EM6
	7	-001	-001	-001	-001								7
→	8	-181	-182	-192.	-205.								300R
	9	+005	+005	+005	+005.								600L
→	10	-138	-141	-155	-173								600R
#2	#1	+058	+058	+058	+058								EM5
	2	+037	+036	+037	+037								8
	3	-190	-190	-189	-190								100
	4	-164	-165	-164	-164								200
	5	+112	+111	+112.	+112.								400
	6	-25	-026.	-026.	-25								500





Stain Gages

Dipole Test 1/2/97 - Dr. Bert Wang NOT Present										
			EM1			EM2			EM3	
	Current	SG1	SG1	Delta	SG2	SG2	Delta	SG3	SG3	Delta
	AMPS	micro-strain	Load Tons	micro-strain	micro-strain	Load Tons	micro-strain	micro-strain	Load Tons	micro-strain
Data	0	0	0	0	127	0	0	57	0	0
1/2/97	100	0	0	0	127	0	0	57	0	0
	200	0	0	0	127	0	0	57	0	0
New Data	300	0	0	0	127	0	0	57	0	0
1/3/97	400	0	0	0	171	0.54	44	30	0.36	-27
	500	-6	0.0438	-6	197	0.852	26	10	0.12	-20
	600	-16	0.1168	-10	218	1.104	21	-4	0.048	-14
	700	-31	0.2263	-15	237	1.332	19	-22	0.264	-18
	800	-39	0.2847	-8	246	1.44	9	-32	0.384	-10
	900	0	2.044	39	0	0	-246	0	0	32
	1000	0	2.044	0	0	0	0	0	0	0
	1100	0	2.044	0	0	0	0	0	0	0
	Total Strain	0.0073		0	0.012		-127	0.012		-57
	Current	SG1	SG1	Delta	SG2	SG2	Delta	SG3	SG3	Delta
	AMPS	micro-strain	Load Tons	micro-strain	micro-strain	Load Tons	micro-strain	micro-strain	Load Tons	micro-strain

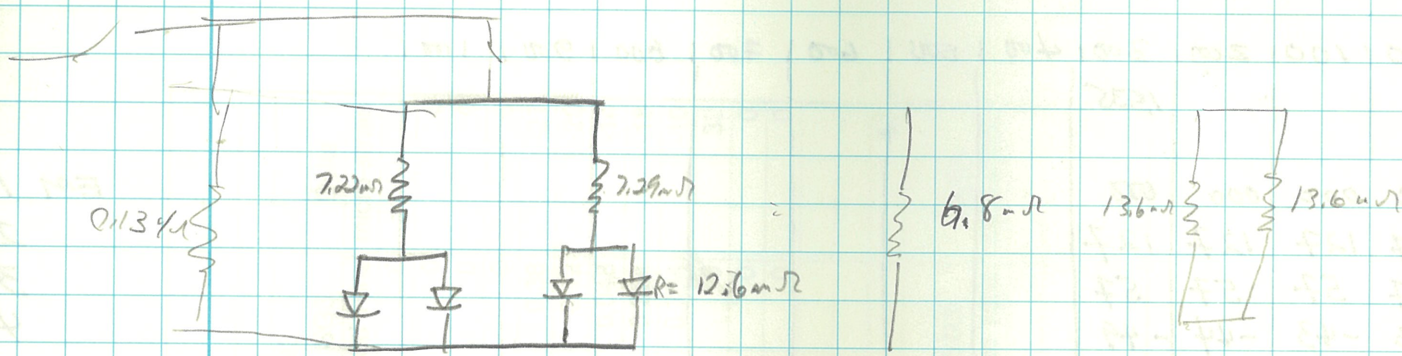
	EM4			300L			EM6			EM7
SG4	SG4	Delta	SG13	SG13	Delta	SG6	SG6	Delta	SG7	SG7
micro-strain	Load Tons	micro-strain	micro-strain	Load Tons	micro-strain	micro-strain	Load Tons	micro-strain	micro-strain	Load Tons
-43	0	0	-191	0	0	17	0	0	-1	0
-43	0	0	-192	0.003	-1	17	0	0	-1	0
-44	0.0073	-1	-192	0.003	0	17	0	0	-1	0
-49	0.0438	-5	-192	0.033	0	16	0.011	-1	-1	0
-96	0.6497	-47	-192	0.033	0	-10	0.297	-26	0	0
-153	1.0658	-57	-192	0.033	0	-28	0.495	-18	-21	0.21
-250	1.7739	-97	-192	0.033	0	-46	0.693	-18	-49	0.49
-356	2.5477	-106	-192	0.033	0	-63	0.88	-17	-81	0.81
-412	2.9565	-56	-192	0.033	0	-73	0.99	-10	-98	0.98
0	0.0511	412	0	0.543	192	0	0.187	73	0	0
0	0.0511	0	0	0.543	0	0	0.187	0	0	0
0	0.0511	0	0	0.543	0	0	0.187	0	0	0
0.0073		43	0.003		191	0.011		-17	0.01	
SG4	SG4	Delta	SG13	SG13	Delta	SG6	SG6	Delta	SG7	SG7
micro-strain	Load Tons	micro-strain	micro-strain	Load Tons	micro-strain	micro-strain	Load Tons	micro-strain	micro-strain	Load Tons

		300R			600L			600R		
Delta	SG14	SG14	Delta	SG9	SG9	Delta	SG10	SG10	Delta	
micro-strain	micro-strain	Load Tons	micro-strain	micro-strain	Load Tons	micro-strain	micro-strain	Load Tons	icro-strain	
0	-180	0	0	4	0	0	-137	0	0	
0	-184	0.0116	-4	4	0	0	-142	0.016	0	
0	-194	0.0406	-10	4	0	0	-157	0.064	0	
0	-197	0.0493	-3	5	0.003	1	-164	0.0864	0	
1	-168	0.0551	29	1	0	-4	-142	0.0192	0	
-21	-168	0.0551	0	1	0	0	-140	0.0256	7.8	
	-171	0.0464		1	0		-135	0.0416	10.1	
	-172	0.0435		1	0		-129	0.0608	12.3	
	-443	0.7424		1	0		-124	0.0768	15.5	
	0	0.5423		0	0.531		0	0.9184	16.15	
	0	0.5423		0	0.531		0	0.9184	16.75	
	0	0.5423		0	0.531		0	0.9184	17.185	
-20	0.0029		12	0.003		-3	0.0032		95.785	
Delta	SG14	SG14	Delta	SG9	SG9	Delta	SG10	SG10	Delta	
micro-strain	micro-strain	Load Tons	micro-strain	micro-strain	Load Tons	micro-strain	micro-strain	Load Tons	icro-strain	

3 Jan 1997

CURRENT	000	100	200	300	400	500	600	700	800	900	1000
TIME				1535							
GAGE											
#1 #1	000	000	000	000							
2	127	127	127	127							
3	57	57	57	57							
4	-43	-43	-44	-49							
5	-191	-191	-191	-191							
6	17	17	17	16							
7	-1	-1	-1	-2							
8	-180	-184	-194	-197							
9	4	4	4	5							
10	-137	-142	-157	-164							
#2 #1	58	58	58	58							
2	37	36	36	37							
3	-189	-190	-190	-189							
4	-163	-165	-165	-164							
5	112	111	111	112							
6	-25	-26	-26	-25							
CURRENT	000	100	200	300	400	500	600	700	800	900	1000

EM 1
2
3
4
300L
EM 6
7
300R
600L
600R
EM 5
8
100
200
400
500


0.134Ω
7.22mΩ
7.29mΩ
R= 12.6mΩ
6.8mΩ
13.6mΩ
13.6mΩ

1/3/97

- Removed jumper wires from slow dump resistor in an attempt to reduce the oscillations seen yesterday
- Measured value of slow dump resistor only w/ Kelvin bridge : R_{SD} = 7.22 mΩ // 7.29 mΩ
- Set I = ~~1~~00 A, ~~initiated~~ slow discharge
- Set I = 200 A, initiated slow discharge
  - noticed leadflow, helium level spike on charge up. - top fill valve closed once then opened
  - noticed 2 spikes ~~and~~ on discharge - top fill valve closed once then opened
  - Q2 lead flow responds identically to Q1 lead flow
- Set I to 300A, initiated slow discharge
- Set I to 200 A, initiated fast discharge.

1/6/97

- Set I to 400A, initiated slow dump
- Set I to 500A.

1/8/97

Set I to 600A, regulated @ approx. 12:00 AM. discharge at ~~[illegible]~~ ~2:45 A.M.
@ I = 600A. NMR = 0.7316005 T - Stable to last digits over 1 minute.

1/9/97

Set I to 200 A w/ short installed across slow dump resistor. let stabilize for ~15 min : NMR = ~~[illegible]~~ 0.231

Strain gauge channel #:

1	0
2	128
3	58
4	-45
5	-151
6	16
7	-1
8	-183
9	5
10	-144

Dipole Test 1/6/97 - Dr. Bert Wang NOT Present										
			EM1			EM2			EM3	
	Current	SG1	SG1	Delta	SG2	SG2	Delta	SG3	SG3	Delta
	AMPS	micro-strain	Load Tons	micro-strain	micro-strain	Load Tons	micro-strain	micro-strain	Load Tons	micro-strain
Data	0	0	0	0	127	0	0	57	0	0
1/6/97	100	0	0	0	127	0	0	57	0	0
	200	0	0	0	127	0	0	57	0	0
New Data	300	0	0	0	127	0	0	57	0	0
1/6/97	400	0	0	0	127	0.012	0	57	~~0.684~~	0
	500	-2	0	0	126	1.512	-127	52	0	-57
	600		0	0		1.512	0	42	0.18 0	0
	700		0	0		1.512	0		0	0
	800		0	0		1.512	0		0	0
	900		2.044	0		0	0		0	0
	1000		2.044	0		0	0		0	0
	1100		2.044	0		0	0		0	0
	Total Strain	0.0073		0	0.012		-127	0.012		-57
	Current	SG1	SG1	Delta	SG2	SG2	Delta	SG3	SG3	Delta
	AMPS	micro-strain	Load Tons	micro-strain	micro-strain	Load Tons	micro-strain	micro-strain	Load Tons	micro-strain

Stain Gages

	EM4			300L			EM6			EM7
SG4	SG4	Delta	SG13	SG13	Delta	SG6	SG6	Delta	SG7	SG7
micro-strain	Load Tons	micro-strain	micro-strain	Load Tons	micro-strain	micro-strain	Load Tons	micro-strain	micro-strain	Load Tons
-43	0	0	-191	0	0	17	0	0	-1	0
-43	0	0	-192	0.003	-1	17	0	0	-1	0
-44	0.0073	-1	-192	0.003	0	17	0	0	-2	0.01
-50	0.0511	-6	-192	0.033	0	16	0.011	-1	-2	0.01
-52	0.3285	-2	-192	0.033	0	16	0.011	0	-2	0.02
-54	0.0511	52	-191	0.543	192	15	0.187	-16	-2	0
-59	0.12 ~~0.0511~~	0		0.543	0		0.187	0		0
	0.0511	0		0.543	0		0.187	0		0
	0.0511	0		0.543	0		0.187	0		0
	0.0511	0		0.543	0		0.187	0		0
	0.0511	0		0.543	0		0.187	0		0
	0.0511	0		0.543	0		0.187	0		0
										0
0.0073		43	0.003		191	0.011		-17	0.01	
SG4	SG4	Delta	SG13	SG13	Delta	SG6	SG6	Delta	SG7	SG7
micro-strain	Load Tons	micro-strain	micro-strain	Load Tons	micro-strain	micro-strain	Load Tons	micro-strain	micro-strain	Load Tons

		300R			600L			600R	
Delta micro-strain	SG14 micro-strain	SG14 Load Tons	Delta micro-strain	SG9 micro-strain	SG9 Load Tons	Delta micro-strain	SG10 micro-strain	SG10 Load Tons	Delta icro-strain
0	-180	0	0	4	0	0	-137	0	0
0	-184	0.0116	-4	4	0	0	-142	0.016	0
-1	-192	0.0348	-8	5	0.003	1	-153	0.0512	0
0	-197	0.0493	-5	5	0.003	0	-164	0.0864	0
0	-220	0.0957	-23	5	0.012	0	-191	0.1376	0
2	-235	0.156 ~~0.5423~~	220	4	0.003	-5	-209	0.23 ~~0.4736~~	7.8
	-257	0.22 0.5423			0.003			0.4736	10.1
		0.5423			0.003			0.4736	12.3
		0.5423			0.003			0.4736	15.5
		0.5423			0.531			0.9184	16.15
		0.5423			0.531			0.9184	16.75
		0.5423			0.531			0.9184	17.185
1	0.0029		180	0.003		-4	0.0032		95.785
Delta micro-strain	SG14 micro-strain	SG14 Load Tons	Delta micro-strain	SG9 micro-strain	SG9 Load Tons	Delta micro-strain	SG10 micro-strain	SG10 Load Tons	Delta icro-strain

1/6/96 MONDAY.

CURRENT	000	100	200	300	400	500	600	700	800	900	1000	STRAIN GAGE
TIME			1030		1055	1705						
GAGE	(1215)			(1715)	(1105)	(1720)						
1#1	000	000	000	000	000	-002						Em1
2	127	127	127	127	127	126						2
3	57	57	57	57	57	52						3
4	-43	-43	-44	-50	-52	-54						4
5	-191	-191	-191	-191	-191	-191						300L
6	17	17	17	16	16	15						6
7	-1	-1	-2	-2	-2	-2						7
8	-180 (-177)	-184	-192	-197 (-210)	-220 (-201)	-235 (200)						300R
9	4	4	5	5	5	4						600L
10	-137 (-132)	-142	-153	-164 (-178)	-191 (-173)	-209 (-173)						600R
2#1	58	58	58	58	59	58						5
2	37	37	37	36	37	36						8
3	-189	-189	-190	-190	-189	-190						100
4	-163	-163.	-164	-164	-164	-165						200
5	112	112	111	111	112	111						400
6.	-25	-25	-25	-26.	-26	-26						500

ABOVE WITH SLOW RESISTOR (DUMP). INSTALLED.
BELOW WITH SLOW RESISTOR DUMP. SHORTED OUT.

	000	100	200	300	400	500	600
1			000			-002	-6
2			127			126	141
3			57			52	42
4			-45			-54	-59
5			-191			-191	-191
6			16			16	6
7			-2			-1	-1
8			-196			-227	-176
9			5			4	3
10			-160			-200	-146
1			58			57	58
2			37			37	36
3			-189			-191	-190
4			-164			-165	-165
5			111			110	110
6			-23			-25	-22
TIME			1000			1035	1435

1/7/97. TUESDAY
1/8/97 Wed
600 A
after 1 1/2 hrs
powered.

Hadron Dynapower Operational Modifications

James Proffitt 19-Sep.-1997

✓1. SW3: Force wiring to "remote" condition and remove switch
✓2. PLC TTL input module, slot 5:
   - Channel 2: Disconnect wire #200 and jumper input to COM (disable remote stop command).
   - Channel 3: Disconnect wire #201 and jumper input to COM (remote voltage sense).
   - Channel 4: Disconnect wire #202 and jumper input to COM (remote current sense).
✓3. On regulator module:
   - Remove relays CR1, CR2, CR3, CR4, CR5.
   - Install jumpers in CR1 and CR5 sockets to force circuit to use remote current feedback.
   - Install jumpers in CR2 socket to force circuit to use local error amplifier.
   - Install jumpers in CR3 socket to force circuit to use local voltage reference and remote current reference.
   - Install jumpers in CR4 socket to force circuit to use remote voltage feedback.
✓4. Connect remote voltage feedback cable from power supply regulator to magnet current lead flags through 1Kohm, 1/2w resistors to be located at the magnet.
✓5. Remove remote voltage reference 12-bit DAC, interconnecting cable, and wiring module.
✓6. Modify M3/M4 to be independent of PLC
   - Disconnect relays CR6, CR7, CR8, CR9 from the PLC DC output module in slot 4.
   - Wire CR6 to drive M3 and M4 such that M3 is open and M4 is closed when de-energized, and M3 is closed and M4 is open when energized.
   - Use the auxiliary contacts on M2 to drive CR6.
   - Connect the CR6 coil voltage to the STD-Bus digital input module, Channel ~~1~~. ~~[illegible]~~ 1 ✓
   - Place 535 MCM jumpers from output terminal B+ to output terminal A- (as indicated on schematic) such that when M4 closes, the magnet is shorted and current flows through the ZFCT.

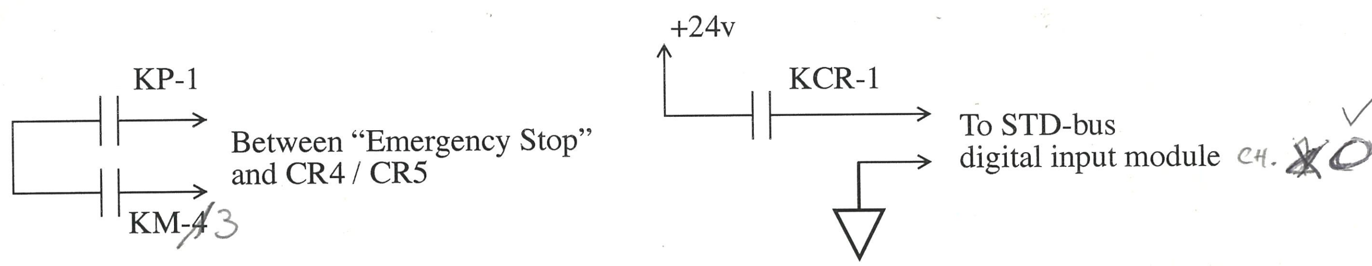
INSTALLED OCTOBER 1997

Mark Stevens

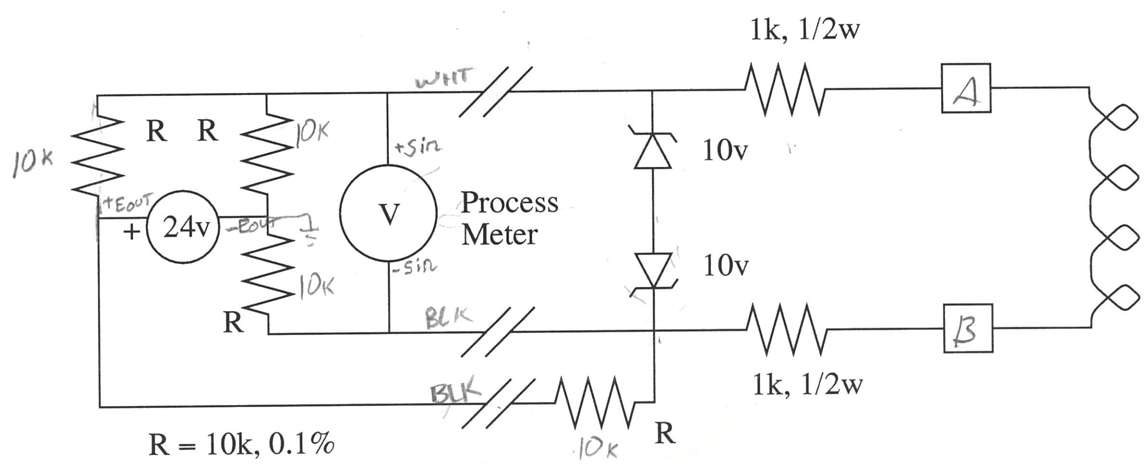
Hadron Dipole Protection Circuit Modifications
James Proffitt 19-Sep.-1997

The objective is to make all faults (except quench and lead voltage faults) initiate a controlled discharge through the STD-bus computer. Quench and lead voltage faults continue to affect the undervoltage release on M3. The main input power relay is latched on after startup to prevent the power supply from automatically turning off under any circumstances. The local power switch and emergency stop switch remain effective.

✓1. Remove KCR-1 and KCI-1 contacts from KM circuit.
✓2. Remove KCR-2 contacts from emergency stop circuit.
✓3. Remove CR4 and CR5 contacts from M3 undervoltage trip circuit.
✓4. Add relay KP to Dynapower and install KP contacts in "emergency stop" circuit and in "cryogenics ready" LED circuit.
✓5. Add install KM contacts in series with "Emergency Stop" circuit.
✓6. Connect KCR contacts to STD-bus digital input module.



7. Install process meter to interlock M3 undervoltage disconnect with magnet voltage. Monitor magnet voltage at current lead flags through 1Kohm, 1/2w resistors. Set interlock threshold to +/- 150% of the power supply charging voltage.



✓8. Remove Wang quench detector fault from KM circuit and install new quench detector fault into KP circuit.

INSTALLED OCTOBER 1997
Mark Stevens

1-23-97. THURSDAY ~~WEDN~~

RATE 0.2 AMPS/SEC USING ELECTRON REGULATOR

CURRENT	000	100	200	300	400	500	600	700	800	900	1000	1100
TIME	1000	1017	1030	1047	1117	1130	1145					
GAGE												
1 # 1	+1	0	0	0	0	0	-4					
2	+126	+126	+126	+126	+126	+125	+134					
3	+58	+58	+58	+58	+57	+54	+48					
4	-41	-43	-43	-48	-51	-53	-54					
5	-191	-191	-191	-191	-191	-191	-191					
6	+17	+16	+16	+15	+16	+15	+13					
7	0	0	0	0	0	0	0					
8	-181	-184	-194	-206	-198	-231	-240					
9	+5	+5	+5	+5	+5	+4	+5					
10	-134	-143	-157	-174	-169	-204	-211					
2 1	+56	+59	+59	+59	+58	+59	+58					
2	+34	+36	+36	+37	+36	+37	+36					
3	-191	-188	-188	-188	-189	-188	-189					
4	-165	-163	-163	-163	-164	-163	-163					
5	+111	+113	+113	+113	+112	+113	+113					
6	-26	-24	-24	-24	-26	-25	-24					

CURRENT	000	100	200	300	400	500	600	700	800	900	1000	1100
TIME	1440			1507	1525	15:38	1550	1600				
1 - 1	-1			0	-1	-2	-6	-9				
2	+125			+126	+125	+124	+131	+140				
3	+55			+56	+54	+51	+46	+40				
4	-44			-48	-52	-53	-55	-57				
5	-191			-191	-192	-192	-192	-192				
6	+16			+16	+15	+15	+13	+6				
7	-1			0	-1	-1	-2	-1				
8	-180			-208	-209	-234	-252	-273				
9	+4			+5	+4	+4	+3	+3				
10	-135			-175	-179	-206	-223	-242				
2 - 1	+57			57	+56	+56	+56	+57				
2	+35			35	+35	+35	+35	+34				
3	-190			-190	-190	-190	-190	-189				
4	-164			-164	-164	-164	-165	-165				
5	+111			+111	+111	+111	+111	+111				
6	-25			-26	-26	-26	-25	-24				

1/29/98

INSTALLED POWER FACTOR CORRECTING CAPACITORS AND VERIFIED THAT THE POWER SUPPLY COULD BE TURNED ON AND RAMPED (TO 100 AMPS).

INSTALLED THE BEST UNITY/I 3 PHASE UNINTERRUPTIBLE POWER SUPPLY. POWER-UP SEQUENCE FOLLOWS. LANDED BATTERY BANK CABLES AND TORQUED THEM IN ACCORDANCE WITH MANUFACTURERS' SPECIFICATION.

- **Dispose of Batteries Properly:** For assistance, call BEST's Technical Support Center at 1-800-356-5737 (U.S.A. or Canada) or call your local BEST office.

> **WARNING!**
>
> Do not dispose of batteries in a fire because the batteries could explode.
>
> Do not open or mutilate batteries. Released electrolyte is harmful to the skin and eyes and may be toxic.
>
> Batteries contain lead. Many state and local governments have regulations about disposing of used batteries. Dispose of batteries properly. For assistance, call BEST's Technical Support at 1-800-356-5737 or call your local BEST office.

PERFORMED 1/30/98 — Mark A Stevens

Section 300: Initial Startup and Phase Check

> **WARNING!**
>
> Some units have been programmed at the factory for "autostart." If programmed for "autostart," the unit will turn on **any time** mains (AC line) is applied (after a 60-second delay). For more information or to change this feature, see the user manual.
>
> Before continuing, read the warnings on the inside front cover of this manual.

After installing the unit, use this section to perform the initial startup and the phase check for the maintenance bypass cabinet (MBC). This section is for the **initial startup** only.

The steps in this section are for a unit with a BEST-supplied maintenance bypass cabinet (MBC).

Follow this Procedure Exactly! No Load Should Be Connected!

1. Make sure that all AC and DC power is off. ✓
2. Switch the UPS bypass switch to "UPS." ✓
3. Make sure that the main circuit breaker in the load panel is off so that the loads cannot receive power from the UPS. ✓

4. Open the UPS front door(s).

5. Remove the retaining brackets for the fuse holder containing DC fuses F001, F002, and F003. See Figure 3 or 5 in Section 201 for location of fuse holder.

6. At the mains AC input panel, switch on the input power to the UPS and maintenance bypass cabinet (MBC).

7. Switch the UPS AC disconnect switch "ON." The UPS display should show `System type xxkVA xxxV`, and an audible alarm should sound.

8. Within 20 seconds, the display should show `**Stand-by**`.

9. Check the phase rotation at the service panel and the unit. The unit will not start if the phase rotation is incorrect. **The phase rotation must be A, B, C and clockwise**.

10. When the audible alarm stops, push the green "on" button located inside the UPS front door. The display will show `Normal operation load power xx%`.

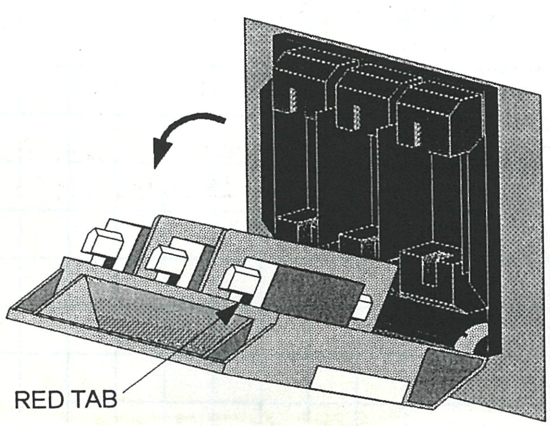
    NOTE: One or more alarms may occur. If the alarm(s) persists for more than 20 seconds, refer to the "Alarms" section of the user manual. If the unit activates a "battery monitor alarm," you should set the user parameter "battery monitor reset" to "ON."

11. Open DC fuse holder (F001, F002, F003). See Figure 13. For location of DC fuse holder, see Figure 3 or 5.

12. Place the DC fuses in the fuse holder. Make sure that the **red tab** on the fuse faces the **top** of the fuse holder. Make sure that the fuse locking tabs are aligned in the slots on the fuse holder. See Figure 13.

13. Press each fuse into place. The fuse will "click" into place when it is locked in correctly.

Figure 13: DC Fuse Holder



14. **Using an open palm**, close the fuse holder. ✓

15. If the unit has **external** batteries:

    a. Turn the pre-charge/discharge switch to the "pre-charge" position and hold it until the LED turns off. ✓

    b. Switch the battery DC disconnect (DCD) "ON." ✓

16. If the UPS is connected to a generator, verify that the unit operates properly on generator power before continuing. If the UPS operates properly on generator power, continue this procedure. If the UPS does not operate properly on generator power, phone BEST's Technical Support Center for assistance.

> **⚠ CAUTION**
>
> **Before** you switch the UPS bypass switch from "UPS" to "LINE", use the steps below to check for correct voltage, phasing, and system operating mode.

17. Program the unit into static bypass operation:

    a. Press [□] to access the user parameters. ✓

    b. Press the [↑] or [↓] key until the display shows `Bypass operation: OFF`. ✓

    c. Press [◷] to turn static bypass operation on. The display should show `Bypass operation`. ✓

18. At the maintenance bypass cabinet (MBC), make sure the UPS output voltage is approximately the same as the AC line input voltage (there may be slight differences). Use a true RMS voltmeter to measure the phase-to-neutral voltage at the MBC AC line input and the MBC output: ✓

	MBC AC Line Input	MBC Output
a.	*L1* to *neutral* 279.2 VAC	*L1* to *neutral* 283.0 VAC
b.	*L2* to *neutral* 278.6 VAC	*L2* to *neutral* 281.8 VAC
c.	*L3* to *neutral* 278.0 VAC	*L3* to *neutral* 281.1 VAC

✓

The voltages in the first column should be similar to the voltages in the second column. If the voltages are more than 10 volts apart for 208 V nominal or 25 volts apart for 480 V nominal, check the connections and correct any wiring problems before continuing. ✓

19. At the maintenance bypass cabinet (MBC), make sure the UPS output voltage and the AC line input voltage are in phase. To do this, measure the AC voltages between the following points at the MBC AC line input and the MBC output:

MBC AC Line Input		MBC Output	
a. *L1 input*	to	*L1 output*	4.35 VAC
b. *L2 input*	to	*L2 output*	4.14 VAC
c. *L3 input*	to	*L3 output*	3.40 VAC

These readings must not be more than 10 VAC. If they are, call BEST's Technical Support Center or your local BEST office.

20. At the maintenance bypass cabinet (MBC), measure the following:

a. *N input* to *Ground* .01 VAC
b. *N output* to *Ground* .000 VAC
c. *N input* to *N output* .01 VAC

"*N input* to *N output*" should not exceed "*N input* to *Ground*." If it does, call BEST's Technical Support Center.

21. Check for proper voltages at the bypass switch load output terminals and the load distribution panel(s).

DID NOT CHECK

	Bypass Switch Load Output	Load Panel Input
a.	*L1* to *neutral* 283 VAC	*L1* to *neutral* ______ VAC
b.	*L2* to *neutral* 281.8 VAC	*L2* to *neutral* ______ VAC
c.	*L3* to *neutral* 280.9 VAC	*L3* to *neutral* ______ VAC

22. Switch the UPS bypass switch to "BYPASS."

23. Recheck for proper voltages at the bypass switch load output and the load distribution panel(s).

DID NOT CHECK

	Bypass Switch Load Output	Load Panel Input
a.	*L1* to *neutral* 279.2 VAC	*L1* to *neutral* ______ VAC
b.	*L2* to *neutral* 278.4 VAC	*L2* to *neutral* ______ VAC
c.	*L3* to *neutral* 277.9 VAC	*L3* to *neutral* ______ VAC

24. Switch the UPS bypass switch to "UPS."

25. Return the UPS to normal operation mode:
    a. Press [key] to access the user parameters.
    b. Press the [↑] or [↓] key until the display shows `Bypass operation: ON`.
    c. Press [✱] to turn static bypass operation off. The display should show `Normal operation load power xx%`.

You can now apply loads to the system. As the last step of the installation, BEST recommends that you clear the events log. See Section 400, "Clearing the Events Log."

Section 400: Clearing the Events Log

The events log contains the 250 most recent UPS events, including alarms. To clear the events log, follow the steps below:

1. Simultaneously press [1 clock] and [2 INVERTER CURRENT]. The display should show `Key in password`.
2. Using the key pad, enter "920701." The display should show `Logging stack is reset`. The events log is now cleared.
3. Press [↵]. The display should show `Normal operation load power xx%`.

If the unit will not be used immediately, go to Section 500, "Shutdown Procedure."

1/31/98

WE PERFORMED A TEST OF THE UPS "BATTERY OPERATION" OUTPUT, A DISCRETE OUTPUT OF THE EXTERNAL CONNECTION BOARD. THE ADVERTISED 30 SEC. DELAY IS THERE, AND IT RESETS WITHOUT TRIPPING. IT OPERATES THE WAY WE WANT IT TO FOR USE AS A RAMP-DOWN COMMAND TO THE POWER SUPPLY. I AM INSTALLING AN INTERLOCK THROUGH THE LAST AVAILABLE CHANNEL OF THE PROTECTION SYSTEM RELAY CHASSIS, TO SEND THE POWER SUPPLY A "POWER-LOSS RAMP DOWN COMMAND". WITH THE 30 SECOND DELAY FROM THE UPS, THE CIRCUIT SHOULD IGNORE MINOR TRANSIENTS AND BE IMMUNE TO NUISANCE RAMP-DOWNS.

3/18/04

HADRON DIPOLE PROTECTION CIRCUIT TESTS
PERFORMED SUBSEQUENT TO MAINTENANCE
(INSTALLATION OF NEW LEAD FLAG HEATERS)

QUENCH VOLTAGES

1. VLAP - VLAN LOOP

2. VLBN - VLBP LOOP

3. VMAP - VMAN LOOP

4 VMAN - VMBN LOOP