C.E.R.N./EP
NA4 Note 78/39
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A SATAN[1] CONTROLLED HIGH VOLTAGE DISTRIBUTION SYSTEM

1) Introduction

Modern high energy experiments make use of a large number of Photomultipliers and then require a simple system of setting and checking the high tensions.

The system discussed here and proposed by C. Rubbia uses a main High Voltage power supply and a remote controlled distribution box (Fig.1). Each distribution box can power up to sixty channels of high voltage.

The remote control is achieved by means of the computer controlled SATAN system[1]. This note will give the details of the distribution system, of the dialogue with SATAN and finally of the interlock and protection system.

2) The distribution box

The distribution box must give the possibility of fanning out and at the same time of regulating separately the high-voltage on each channel.

2.1) The Photomultiplier High Tension Distributor card.

The whole, circuit is floating at the High Tension input value (i.e. -2500V). The high voltage regulation is achieved by sinking current from the feedback resistor of an high voltage transistor (Fig.3).

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(1) Serial Asynchronous Transmission System for Nuclear Instrumentation SEN, SATAN MASTER Unit type SMU 2084 and SATAN SLAVE Unit type SSU 400

The current source is provided by a Digital to Analog Converter coupled to the base of the transistor by a voltage follower.

The DAC is loaded by a shift register. The information about the voltage is received serially from the control card. Since each card has four different channels and outputs to P.M.'s,a demultiplexer selects the shift register to be loaded.

For each channel two potentiometers allow the fine regulation of the maximum autput voltage and of the range of the variation.

2.2) The control card.

The control card transfers information from the Satan Slave Unit to the floating cards. The insulation between the system at ground and the one at High Voltage is done with optocouplers (2). On the control card there are four 8 bit shift registers to allow checking the information with a read after write operation on the 16 bit SATAN word (Fig.4).

As it will be explained in the next section eight bits contain the information about the voltage to be set and six bits represent the channel address. The address decodification is done as a word is written : four lines select the card and two the channel on the card.

After the computer has checked the correct transmission of the word, the 8 voltage bits still present in the second shift register are loaded into the corresponding channel. This is done using the $1 \rightarrow 0$ transition of the SATAN "disable" line which starts an automatic cycle : a clock signal is started and the eight bits and the clock itself are sent to the selected channel.

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(2) Fairchild FCD 820 C or equivalent

2.3 Description of the box

The actual box containes 15 PMHT Distributor cards, each one housing the regulation for four channels (Fig.2). The low tension supply for the logic and analog devices(i.e. + 5V and -15V) is given by a voltage regulator card, whose common is also floating (Fig.5)

There are three 5V regulators,each feeding 5 cards. The regulators have separate fuses mounted on the printed board. This card provides also the 5V regulated reference for the DAC's.

The control card serves as interface between the floating system and the SATAN Slave Unit. The latter is connected on the back of the control card. All these units are housed in a vetronite high tension insulating box.

Another regulator, (generating +5V and +12V) feeds the SATAN Slave unit and the ground connected part of the control card. This card is protected with its own fuses on the printed board.

On the front panel there is the Mains switch and the connector for the interlock system (5V A.C.). On the rear panel there are the 60 outputs (SHV Standard High Voltage Connectors), the two LEMO 00 connectors for the SATAN party line, the mains power plug with the two main fuses (400 mA slow blow each). The high tension input connector is also located at the back in the bottom right corner and is painted red for easy recognition.

3) Dialogue with Computer

The Computer CAMAC-SATAN program should contain the following steps :

3.1) Write a word

F (16) A(0) Write the heading in the SATAN message

MSB															LSB
X	X	X	X	1	0	0	0	N	N	N	N	N	0	0	0

Where NNNNN is the number of the distributor box

F(16) A(1) Write Data containing the high voltage information and the address

MSB															LSB
X	X	A_5	A_4	A_3	A_2	A_1	A_0	V	V	V	V	V	V	V	V

Where V is the Voltage

$A_5A_4A_3A_2$ is the addressed card

A_1A_0 is the addressed line

F(25) A(0) Execution of the above message

3.2 Read a word

F(16) A(0) Write the Heading of the SATAN message

MSB															LSB
X	X	X	X	0	0	0	0	N	N	N	N	N	0	0	0

F(25) A(0) Execution of the above message

F(0) A(0) Read the word

3.3 Set the high tension

F(16) A(0) Write SATAN command for the transition 1 → 0 of "disable" line

MSB															LSB
X	X	X	X	0	1	0	0	N	N	N	N	N	X	X	X

F(25)A 0 Execution of the above message

F(16) A(0) Write SATAN command for the transition 0 → 1 of disable line

MSB												LSB
X	X	X	X	0	1	0	1	N	N	N	N	N	X	X	X

F(25) A(0) Execution of the above message

(bits marked X are unused)

4) Interlock and Protection

It happens often that for wanted or unwanted reasons (i.e. thunderstorms, power failures, emergency cut offs, need to temporarily disconnect the mains ...) the 220V line is cut off. The system must be protected since TTL logic has no memory in case of power failure. When power comes back, high tension could be distributed randomly to P.M.'s, and this can be harmful for P.M.'s and misleading for measurements.

Since the distributor boxes is normally far from the High Tension power supply and the system is sensitive to a power fail on one of the two lines, the interlock system must sense a power failure on both lines. Each interlock box, to be installed close to the Heinzinger P.S., has three inputs on the rear panel : 220V from the High Tension power supplies line and two 5V A.C. sense lines from the distributor boxes (Fig.6).

Any power failure cuts automatically High Tension off and switches the relative power failure light on. To reset the High Voltage, once the power is back on, turn down the H.V. power supply to zero, reset the interlocks by pushing the appropriate reset button

on the front panel. Then reload values and turn H.V. slowly on again. An on/off switch activates one or both interlock lines.

5) Conclusion

A prototype of distributor box has been succesfully tested on the P.M.'s of plane 1.

A future improvement to the distributor box will be to provide them with the possibility of reading the High Voltage really present at the outputs. A system like the one already employed for the M.W.P.C. [3] could be easily connected to it.

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(3)"A Fully Remote Controlled M.W.P.C. Detector"by F.Nanni

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APPENDIX

Characteristics

High Voltage outputs:

Regulation range:	510 V in 2 V steps
With an input voltage of:	-2500 V
the maximum output voltage is:	-2450 V for VVVVVVVV=00000000
the minimum output voltage is:	-1940 V for VVVVVVVV=11111111

Supply low voltage currents:

P.M.H.T. Distributor card:	+5 V	Floating	110 mA
	-15 V	Floating	35 mA
	+5 V	Floating Ref.	2 mA
Control card :	+5 V	Floating	75 mA
	+5 V		170 mA
SATAN Slave unit:	+5 V		500 mA
	+12 V		30 mA
Total supply current:	+5 V	Floating	1725 mA
	-15 V	Floating	525 mA
	+5 V		670 mA
	+12 V		30 mA

The Floating Low Tension Voltage Regulator delivers:

	-15 V	up to 1 A
on each of the three outputs	+ 5 V	up to 1 A
The SATAN Supply delivers:	+ 5 V	up to 1 A
	+12 V	up to 1 A

Fuses employed in the box:

a) On the Floating Low Voltage Regulator:

4 1 A microminiature fuses N° Schem. 06.73.50.038.0

b) On the Satan supply card

1 1 A microminiature fuse

1 50 mA microminiature fuse N° Schem. 06.73.50.012.0

c) On the rear panel (mains)

2 400 mA slow blow fuses

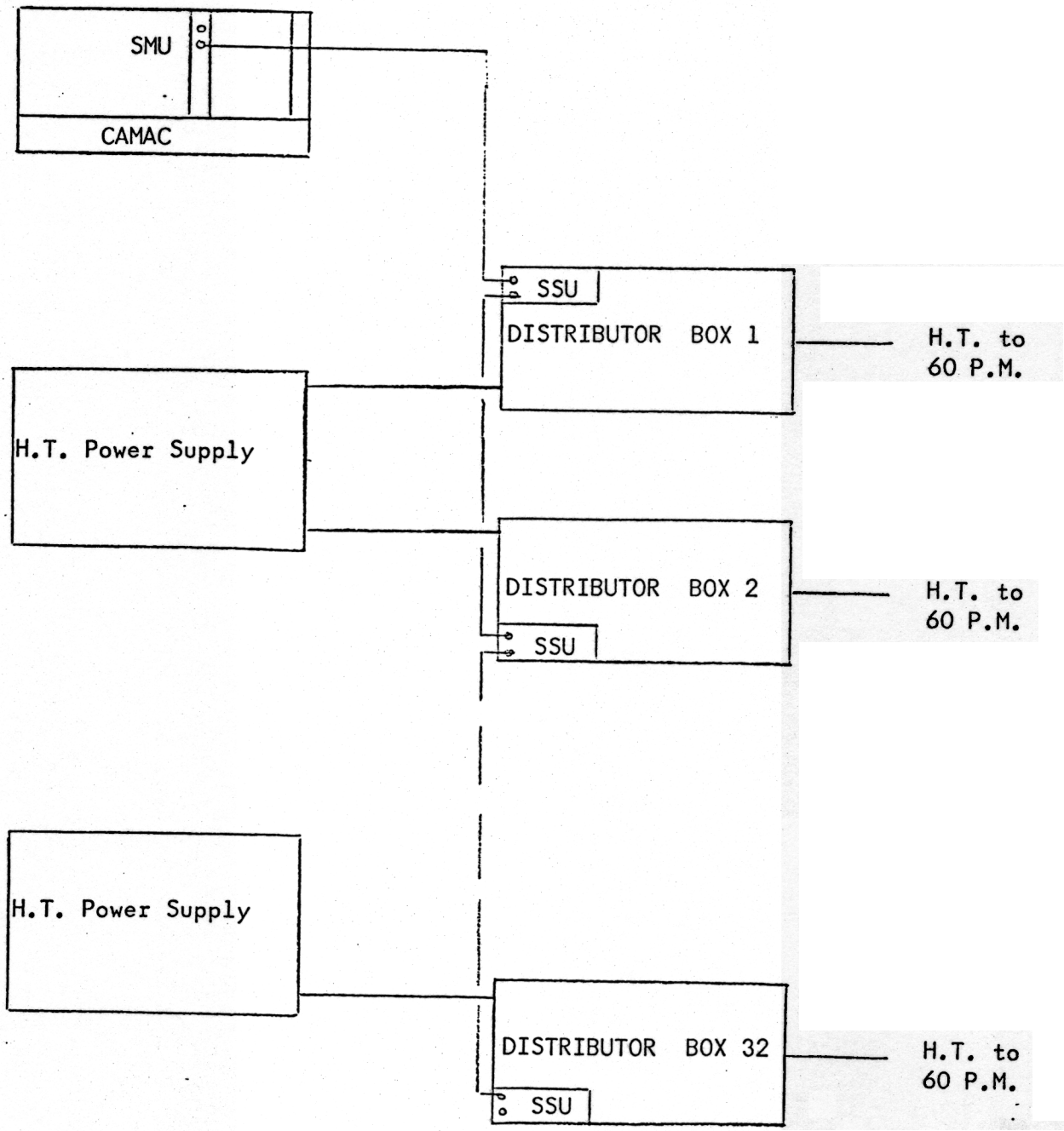

SMU
CAMAC
SSU
DISTRIBUTOR BOX 1
H.T. to
60 P.M.
H.T. Power Supply
DISTRIBUTOR BOX 2
SSU
H.T. to
60 P.M.
H.T. Power Supply
DISTRIBUTOR BOX 32
SSU
H.T. to
60 P.M.

FIG 1

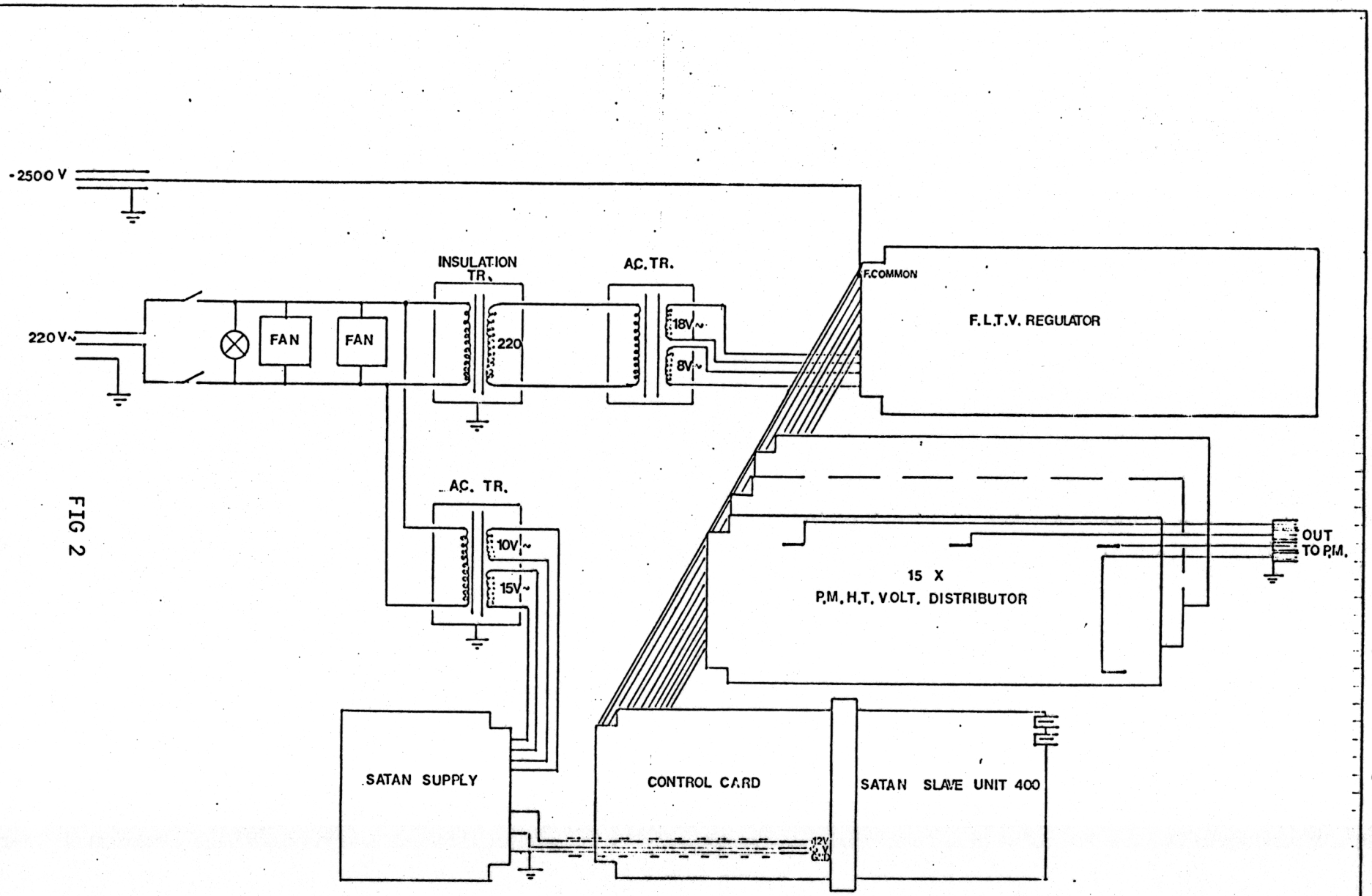


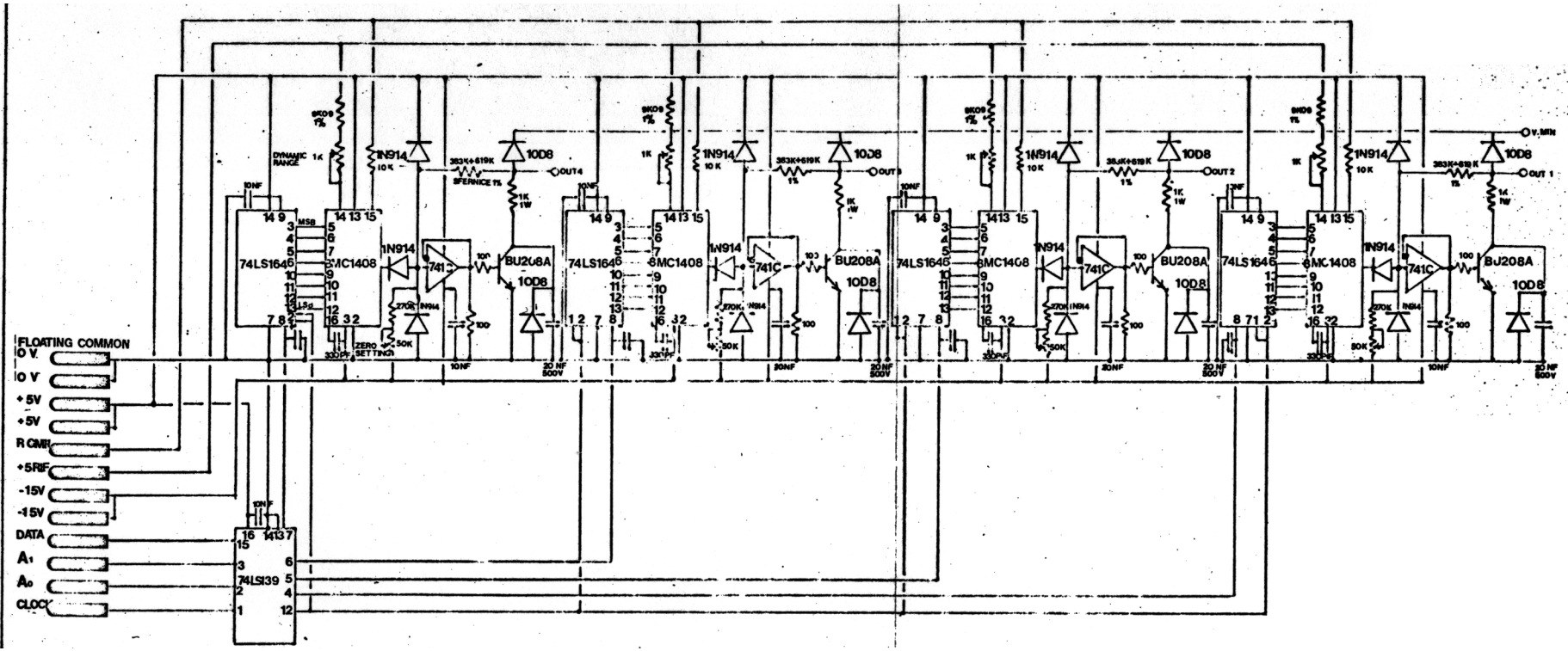
FIG 2

GENERAL LAYOUT

DESSINE
CONTROLE
REMPLACE
REMPLACE PAR
REDUCTION

CERN Lab

INDICE DATE NOM ZONE MODIFICATION



P.M.H.T. VOLT. DISTRIBUTOR		
CERN Lab		

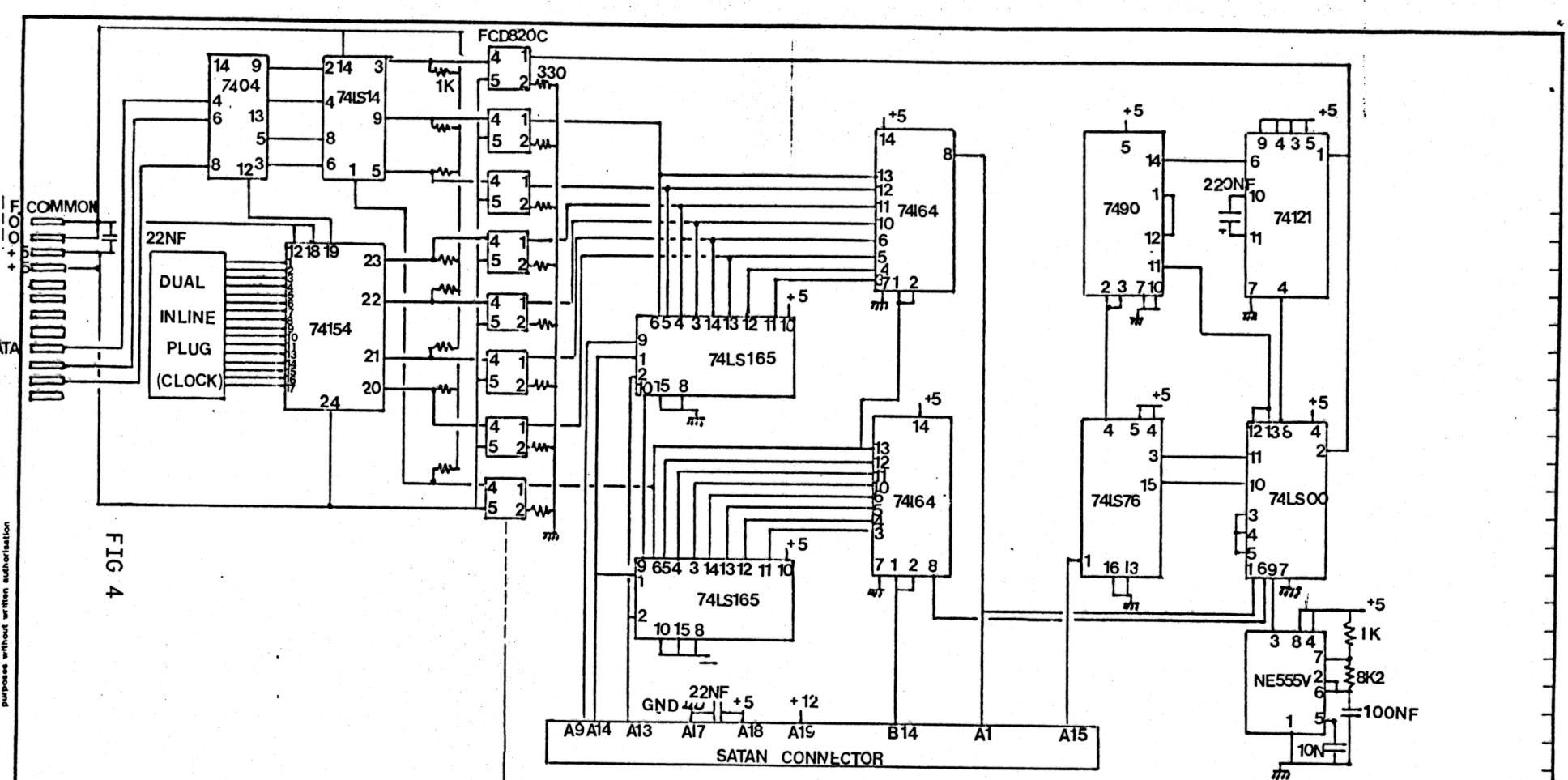


FIG 4

Projection européenne
First angle projection

Nb. p. unité / Nb. p. unit	Description	Rep. Item	Matière-Material	Cotes brutes-Rough dimensions	N° SCEM-Observations--Fournisseurs éventuels
II / I					

Rub. — Exécution

Rugosité - Roughness				
Ancien Old	▽	▽▽	▽▽▽	▽▽▽▽
Nouveau New	N 12 ▽	N 9 ▽	N 6 ▽	N 3 ▽
Ra (µm)	50	6,3	0,8	0,1

Tolérances générales General tolerances (mm)

De / A	0 / 6	> 6 / 30	> 30 / 120	> 120 / 315	> 315 / 1000	> 1000 .....
	±0,05	± 0,1	± 0,15	± 0,2	± 0,3	± 0,5

Abréviations, symboles Abbreviations, symbols — Normes CERN CERN Standards

Remplace N°

Remplacé par N°

Ensemble Assembly — Sl'ensemble S/assembly

Nom-Name	Date	Issue
Dessiné		
Contrôlé		
		A
		B
		C

PM HT VOLTAGE DISTRIBUTOR

CONTROL CARD

Echelle Scale

ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE
EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH
CERN LAB ..... CH-1211 GENÈVE 23

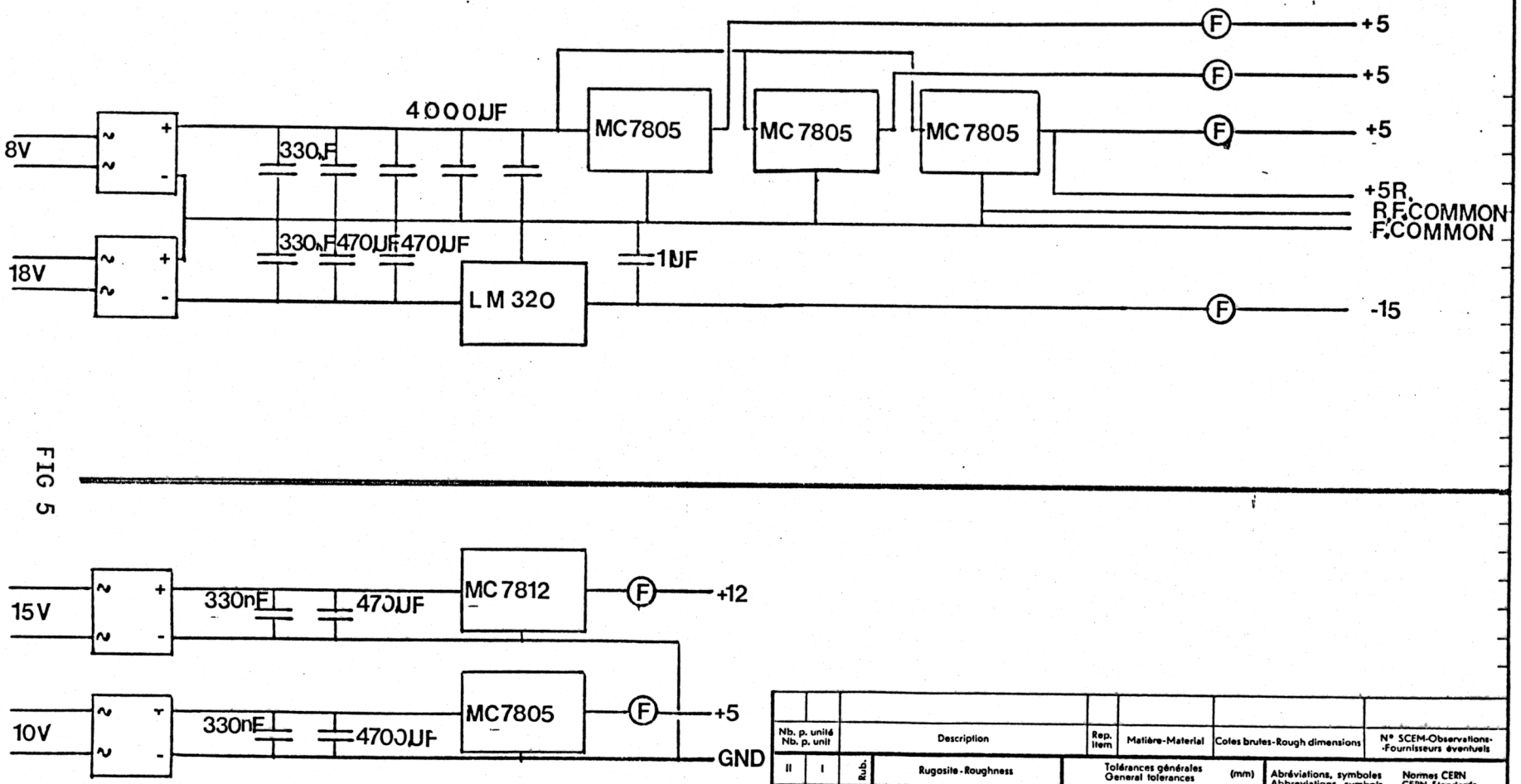


FIG 5

Projection européenne
First angle projection

Nb. p. unité / Nb. p. unit		Description	Rep. Item	Matière-Material	Cotes brutes-Rough dimensions	N° SCEM-Observations-Fournisseurs éventuels
II	I					

Rub. — Exécution

Rugosité-Roughness

Ancien Old	▽	▽▽	▽▽▽	▽▽▽▽
Nouveau New	N 12 ▽	N 9 ▽	N 6 ▽	N 3 ▽
Ra (µm)	50	6,3	0,8	0,1

Tolérances générales / General tolerances (mm)

De A	0 6	>6 30	>30 120	>120 315	>315 1000	>1000 .....
	±0,05	± 0,1	±0,15	± 0,2	± 0,3	± 0,5

Abréviations, symboles / Abbreviations, symbols — Normes CERN / CERN Standards

Remplace N°

Remplacé par N°

Ensemble / Assembly — Sous-ensemble / Subassembly

Nom-Name	Date	Issue
Dessiné		
Contrôlé		
		A
		B
		C

Echelle / Scale

F.L.T.V. REGULATOR
SATAN SUPPLY

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EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH
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INTERLOCK

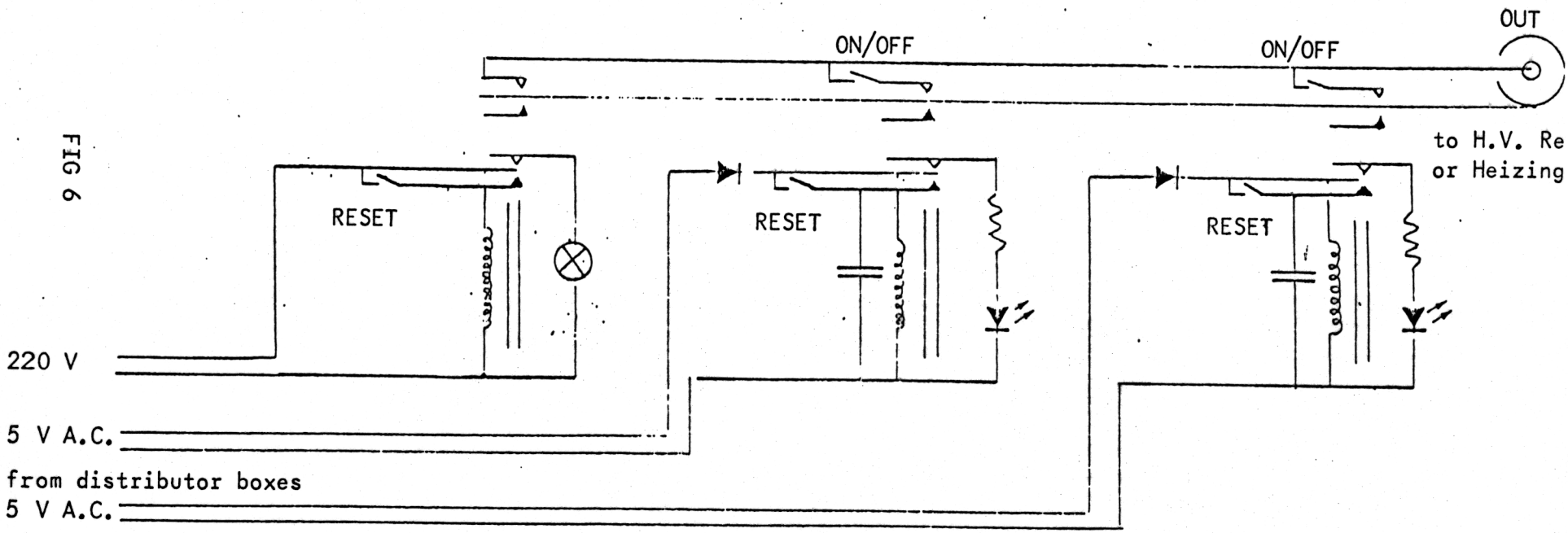

FIG 6