

Fermilab

TM - 658

2231.100

Modification of the Vernier
Power Supplies in the
Meson Beam Lines

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Power Supply Manufacturer

Electronic Measurements Inc.
405 Essex Road
Neptune, New Jersey 07753

Type. Model No. SCR40-125

input is 3ϕ , 480VAC

40 VDC at 120 amps output

History of the Problem

This supply never performed satisfactorily because of the regulator's inability to cope with the 480 VAC line variations that occur when the Accelerator and large supplies in the Meson Lines ramp.

Motor-generator sets were installed as a solution. This was ineffective as the SCR's on the power supply inputs chop up the 480 VAC sine wave input to the extent that one power supply affects another.

Solution

The regulation system was very complex with many compensation paths. We decided to simplify the approach by designing a new regulator card with two compensation loops. The other condition was to utilize the present system to the extent that only the regulator card be changed.

Comments on the Modified Regulator Circuit

Current Mode

The error voltage is the difference between the shunt voltage and product (calibration current) x (R current set). This is amplified and then integrated before going on to the voltage-current crossover and the output amplifier.

The integrator gives us a very high gain at low frequency and hence no long term error voltage.

The value for RC were arrived at experimentally. With RC=15 ms the system would oscillate. A very slow system would be unable to cope with the line changes. Hence a compromise value of RC=33 ms was arrived at. To further enhance the ability to cope with fast line changes, $R_r C_r$ was added to improve the high frequency response.

The use of good quality Op-amps makes the calculated system drift with temperature (30 ma/⁰C max) acceptable.

This can be improved upon by a better Op-amp or an oven if necessary. Actual temperature drift measurements are about $3.0 \text{ ma}/^{\circ}\text{C}$ with the Burr-Brown BB3500 Op-amp.

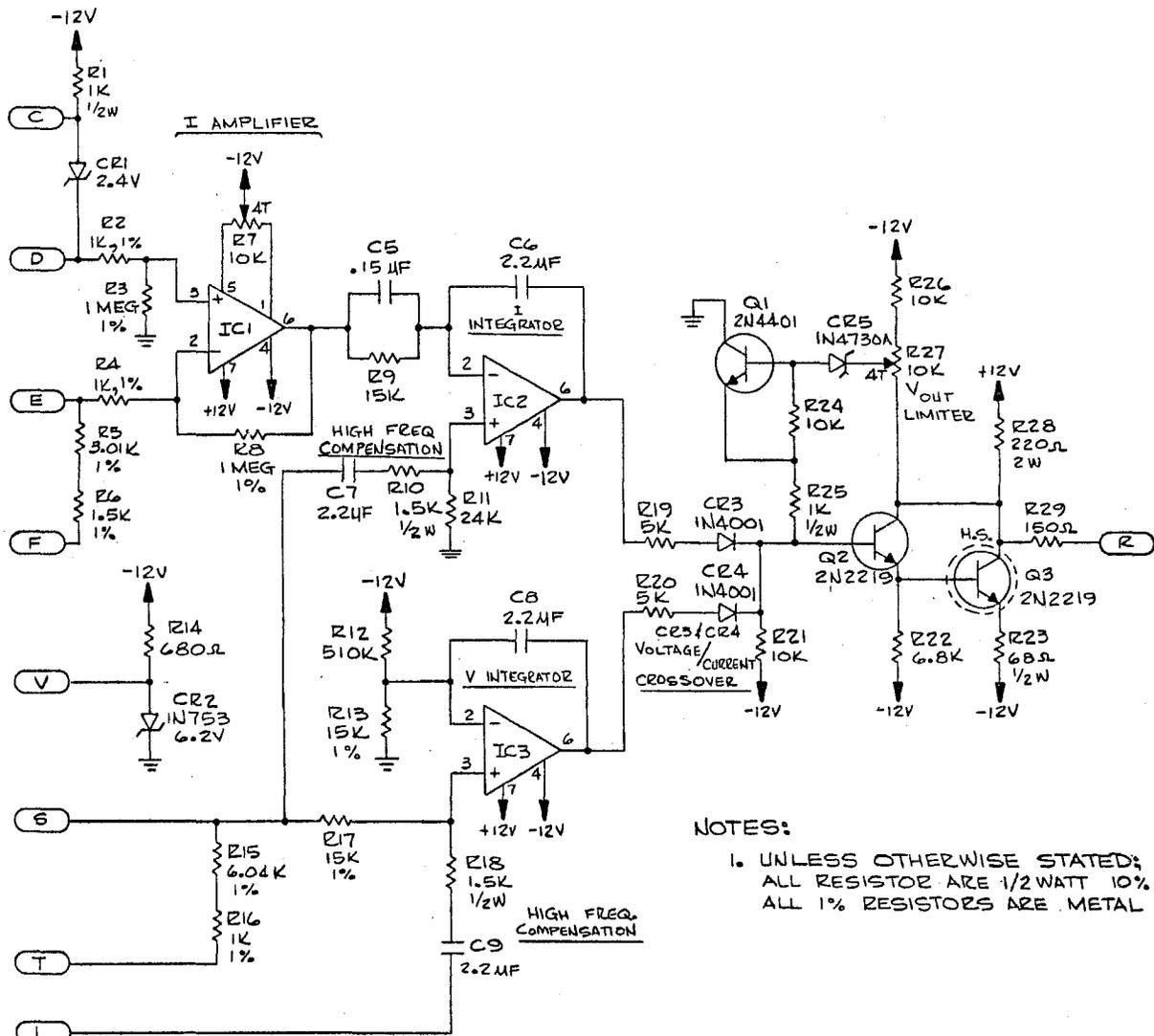
Voltage Mode

The need of a high gain preamp for the error voltage is not necessary before integration. A high frequency loop consisting of $R_f C_f$ to the integrator was necessary to eliminate high frequency oscillations at low voltages. Again the RC value of 33 ms was the best compromise.

General

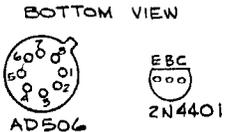
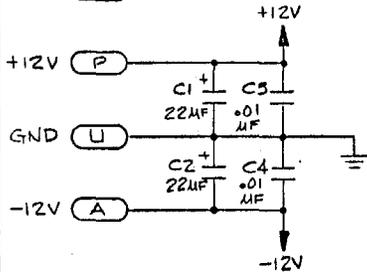
The new regulator exhibits a 30% overshoot response to a step change in the input. This enables the supply to hold its value to $\pm 20 \text{ ma}$ during an accelerator cycle which causes $\pm 15 \text{ VAC}$ variations on the $3\phi 480 \text{ VAC}$ line. The power supply holds the above specification over its entire range of voltage and current. (One of the most common complaints was low current oscillations).

This modification was installed for the 1st time during December 1975. Since then the modification of the other Meson Verniers has been part of an ongoing upgrading of the electronic systems. As of this note the capabilities of more than 20 modified supplies has been tested and proven during Meson Lab operations.



NOTES:

- 1. UNLESS OTHERWISE STATED; ALL RESISTOR ARE 1/2 WATT 10%.
- ALL 1% RESISTORS ARE METAL FILM 1/2W



ITEM NO.	PART NO.	DESCRIPTION	QTY REQ.
Q2/3	2N2219	TRANSISTOR,	2
Q1	2N4401	"	1
R27		POTENTIOMETER, 10K, 4TURN	2
R21		RESISTOR, 1K, 1/2W, 10%	2

REVISIONS

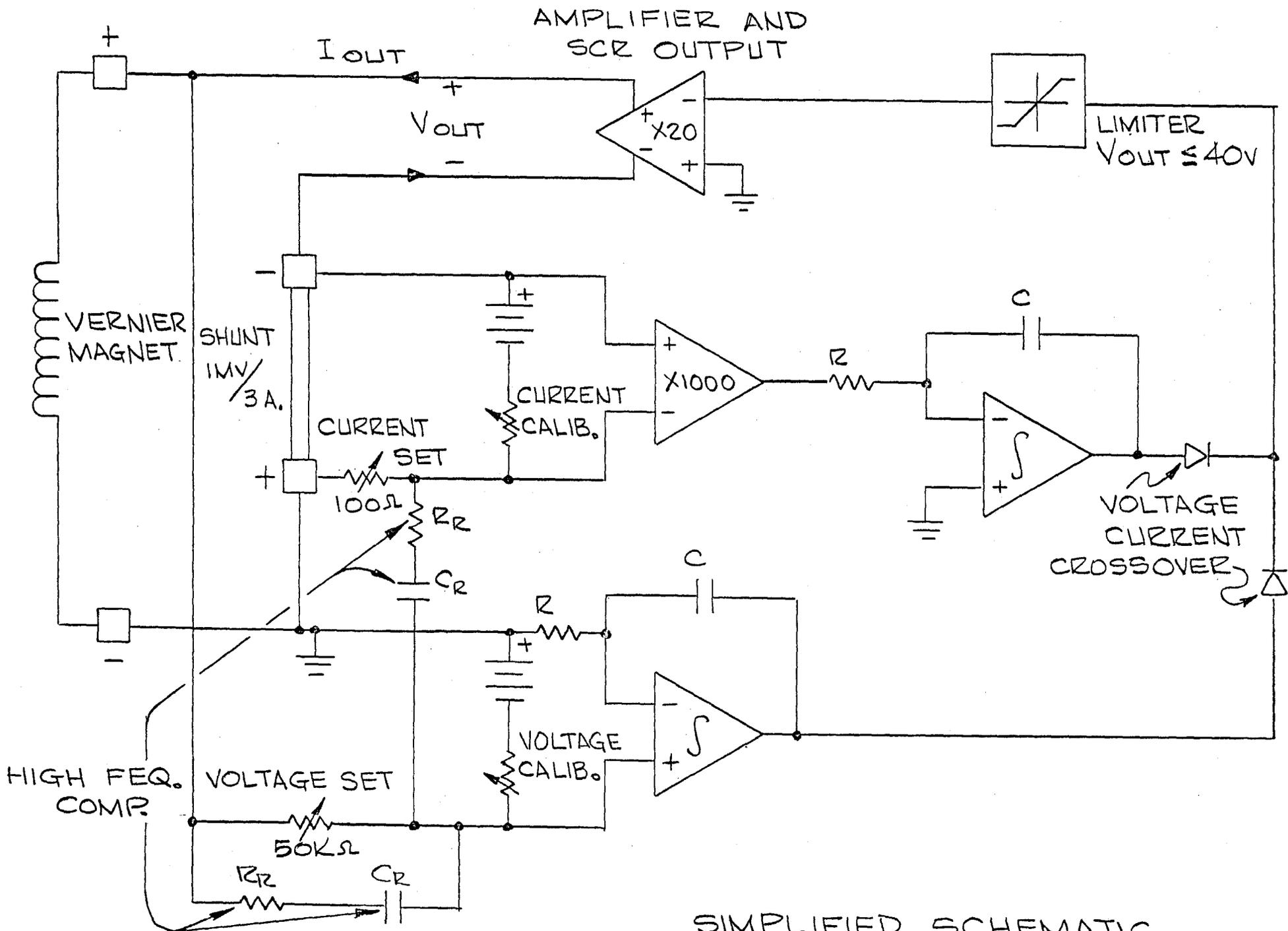
SYM	DESCRIPTION	DRAWN	DATE	FILM NO.
		APPD.	DATE	
R2, E4	RESISTOR, 1K, MF, 1%			3
E5	" , 1MEG, MF, 1%			2
R25	" , 3.01K, MF, 1%			1
R26	" , 1.5K, MF, 1%			1
R29	" , 15K, 1/4W, 10%			1
R10	" , 1.5K, 1/2W, 10%			2
R11	" , 24K, 1/4W, 10%			1
R12	" , 510K, 1/4W, 10%			1
R13	" , 15K, 1%, MF			2
R14	" , 680Ω, 1/4W, 10%			1
R15	" , 6.04K, MF, 1%			1
R16	" , 5K, 1/4W, 10%			2
R17	" , 10K, 1/4W, 10%			3
R22	" , 6.8K, 1/4W, 10%			1
R23	" , 68Ω, 1/4W, 10%			1
R28	" , 220Ω, 2W, 10%			1
R29	RESISTOR, 150Ω, 1/4, 10%			1
C6-C9	CAPACITOR, 2.2MF			4
C5	" , .15MF			1
C3	" , .01MF			2
C4	" , .01MF			2
C2	" , 22MF			2
CR5	IN4730A	DIODE, ZENER, 3.9VZ		1
CR3	IN4001	" ,		2
CR4	IN4001	" ,		2
CR1	IN753	" , ZENER, 6.4VZ		1
CR2		" , " , 2.4VZ		1
IC1-IC3	AD506	AMPLIFIER		3

PARTS LIST				
UNLESS OTHERWISE SPECIFIED		ORIGINATOR	J. STOFFEL	
FRACTIONS	DECIMALS	ANGLES	DRAWN	P.N. FEAC-330 1/2-1/2
±	±	±	CHECKED	
1. BREAK ALL SHARP EDGES 1/64 MAX.			APPROVED	
2. DO NOT SCALE DWG.			APPROVED	
3. DIMENSIONING IN ACCORD WITH USASI Y14.5 STD'S.			USED ON	
✓ MAX. ALL MACHINED SURFACES			MATERIAL-	

NATIONAL ACCELERATOR LABORATORY
U.S. ATOMIC ENERGY COMMISSION

MESON LABORATORY
 VERNIER POWER SUPPLIES
 D.C. AMPLIFIER (A100)

SCALE	FILMED	DRAWING NUMBER	REV.
NONE		2816-EC-94100	



SIMPLIFIED SCHEMATIC OF E/M REG. SYSTEM