COO-1422-100

MASTER

A DIRECT DIGITAL READOUT SYSTEM FOR MEASUREMENT OF BONE MINERAL CONTENT USING PHOTON ABSORPTIOMETRY

by

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Previous reports have described the system developed for giving an immediate direct digital readout of bone mineral and bone width (Mazess and Cameron, 1968, 1969; Mazess et al, 1970). The unit is designed for input from a conventional single channel analyzer, and cost of components and construction is about $2000. A block diagram (Figure 1) and schematic of this unit are included with this report. One such unit has been in use in our laboratory for research purposes and field studies for the past 30 months. Another unit has been used for clinical measurements for about 9 months. In addition, three units have been constructed for other laboratories. The only difficulties encountered so far with these instruments have been the persistent failures of the commercial digital panel meters (API Instrument Co.) and occasional failures of the commercial power supplies (Analog Devices).

RESULTS

A. Measurements of Standard

Measurements were made of a standard having three chambers containing dipotassium hydrogen phosphate solution over a five month period with the direct readout device. During this period four different sources of I-125 were used. Generally measurements of the standard were made twice a day: once in the morning and again in the afternoon. The coefficients of variation obtained with four different sources are given in Table 1.

Changing sources had no systematic effect on the mean values of bone mineral and bone width, nor did it affect the coefficients of variation for bone mineral content. There seemed to be some effect on bone width, which suggested that the source may have been loose within its container in some cases. The mean coefficient of variation for bone mineral was between 1 to 2%, and for bone width it was 0.5 to 1%. These results were obtained with an I_o^* between 1000 and 7000 cps. The variability associated with the sources was on the order of that associated with scanning per se.

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DISCLAIMER

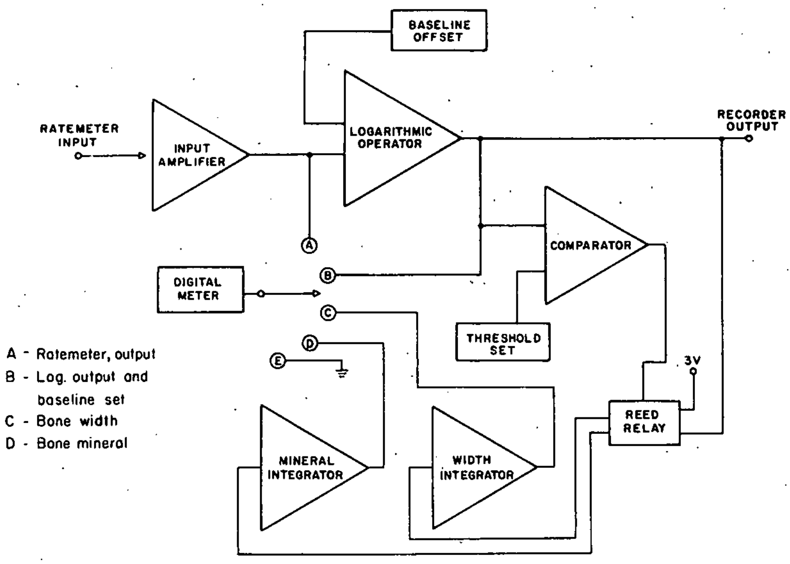
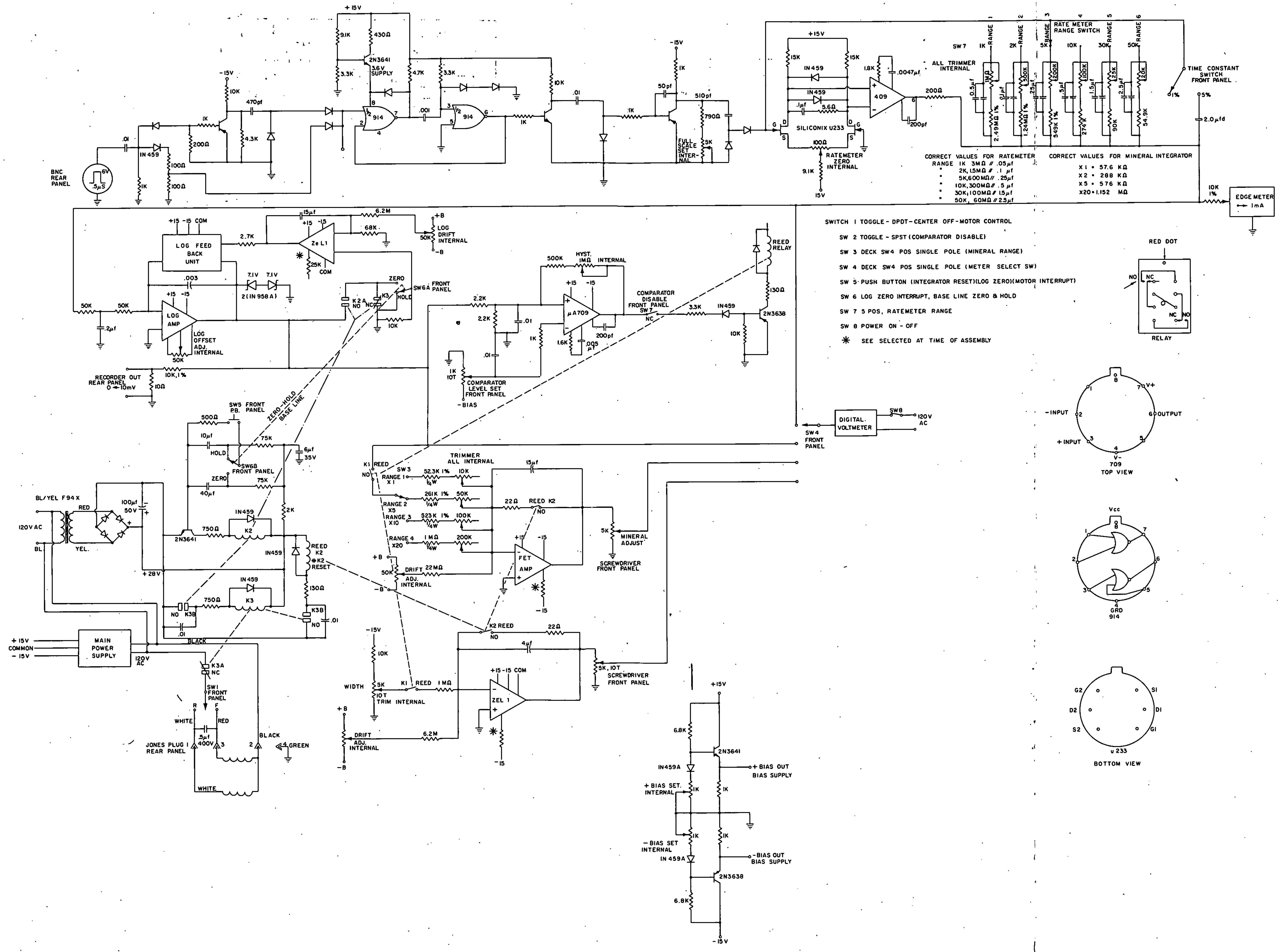


Figure 1a. Block diagram of log converter-integrator device.

Figure 1b. (Following page) Schematic diagram of ratemeter-log converter-integrator unit.



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BONE MINERAL INSTRUMENT
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B. Comparison of Direct Readout and Line Printer

Over a period of several months 61 patients were scanned with our clinical bone measuring system and the scan output data was simultaneously recorded by the digital line printer and integrated by the direct readout unit. Each patient was scanned at the mid-shaft and the distal portions of both the radius and the ulna. The bone mineral content was calculated from the digital line printer records of the scaler output and compared to the directly integrated digital readout.

The mean values obtained by the two techniques were virtually identical; there were very high correlations between the techniques and the standard errors of the estimates were low.

Table 2. Comparison of direct readout (DR) and line printer (LP) results on patients.

		RADIUS (n= 102)		ULNA (n= 102)	
		Mineral	Width	Mineral	Width
MEANS	(LP)	.984	1.598	.684	1.052
	(DR)	.978	1.595	.689	1.048
	CORRELATION	0.996	0.990	0.997	0.966
	S.E.E. (%)	2.8%	3.7%	3.5%	4.7%

The error in predicting bone mineral from one technique to the other was about 3% while the error for predicting bone width was about 4%. It is likely that the error is associated largely with the less reliable line printer technique, and that the direct readout values actually are correct. Our studies on phantoms indicate that the direct readout device has a precision of about 0.5 to 1.0%, and an accuracy of prediction of about 1%.

REFERENCES

1. Mazess, R.B. and Cameron, J.R. A portable scanning system with direct digital readout for absorptiometric determination of bone mineral content. USAEC Progress Report COO-1422-39 (1968).

2. Mazess, R.B. and Cameron, J.R. A portable unit for determination of bone mineral content by photon absorptiometry. USAEC Progress Report COO-1422-56 (1969).

3. Mazess, R.B., Cameron, J.R., and Miller, H. Preliminary report on a direct digital readout system for absorptiometric determination of bone mineral content. In: J.R. Cameron (ed) - Proc. Bone Measurement Conference, U.S.A.E.C. CONF-700515, CFSTI U.S. Dept. of Commerce, Springfield, Va. (1970) (also USAEC Progress Report COO-1422-69, 1970).

ACKNOWLEDGEMENT

This work is supported in part by the U.S. Atomic Energy Commission through Contract AT-(11-1)-1422.

COEFFICIENTS OF VARIATION

Source No	STANDARD CHAMBER								
	Small			Medium			Large		
	N	BMC	W	N	BMC	W	N	BMC	W
97	36	2.0	1.3	71	1.2	1.6	36	0.9	0.5
116	33	1.6	0.9	78	1.2	1.1	33	0.8	0.4
132	15	2.1	0.6	54	1.1	0.6	16	0.9	0.3
153	38	1.1	0.8	132	0.9	0.6	40	0.7	0.5
All	122	2.1	1.1	335	1.2	1.1	125	1.0	0.4
Mean	4	1.7	0.9	4	1.1	0.9	4	0.8	0.4

Table 1. Coefficients of variation for multiple scans of 3-step 3 chamber standard made with 4 different I-125 sources during 5 months from Jan. 1971 to May 1971. The additional scans for the medium size chamber include scans made of the standard after each patient.