OAK RIDGE NATIONAL LABORATORY LIBRARIES
3 4456 0549654 9

CENTRAL RESEARCH LIBRARY
DOCUMENT COLLECTION

OAK RIDGE NATIONAL LABORATORY
operated by
UNION CARBIDE CORPORATION
NUCLEAR DIVISION
for the
U.S. ATOMIC ENERGY COMMISSION

ORNL-TM-1638, Part 16
COPY NO. - 65
DATE - January 9, 1968

NUCLEAR INSTRUMENT MODULE MAINTENANCE MANUAL

PART 16

VERNISTAT ADJUSTABLE FUNCTION GENERATOR, ORNL MODEL Q-2616

E. N. Fray

ABSTRACT

The circuit, application, and maintenance instructions for a Vernistat Adjustable Function Generator are described. The Vernistat is a commercial instrument adapted for use with Wide-Range Counting Channels of the ORNL Modular Reactor Instrumentation series Q-2600.

OAK RIDGE NATIONAL LABORATORY
CENTRAL RESEARCH LIBRARY
DOCUMENT COLLECTION
LIBRARY LOAN COPY
DO NOT TRANSFER TO ANOTHER PERSON
If you wish someone else to see this document, send in name with document and the library will arrange a loan.

NOTICE This document contains information of a preliminary nature and was prepared primarily for internal use at the Oak Ridge National Laboratory. It is subject to revision or correction and therefore does not represent a final report.

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

A. Makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission, or employee of such contractor, to the extent that such employee or contractor of the Commission, or employee of such contractor prepares, disseminates, or provides access to, any information pursuant to his employment or contract with the Commission, or his employment with such contractor.

CONTENTS

Page

1. DESCRIPTION 4
   1.1 General 4
   1.2 Construction 4
   1.3 Application 5
   1.4 Specifications 5
   1.5 Applicable Drawings 5

2. THEORY OF OPERATION 6

3. OPERATING INSTRUCTIONS 8
   3.1 Installation 8
   3.2 Operating Controls 8
   3.3 Connections 8

4. MAINTENANCE INSTRUCTIONS 8

OAK RIDGE NATIONAL LABORATORY LIBRARIES

3 4456 0549654 9

1. DESCRIPTION

1.1 General

The Vernistat Adjustable Function Generator is composed of two separate, but integral units: (1) a Function Adjusting Assembly, and (2) an Interpolating Vernistat Potentiometer. A function is set up simply by manually adjusting the positions of sliders on the Function Adjusting Assembly panel. The panel is marked off in rectangular coordinates, with percent output as the ordinate and shaft position as the abscissa. The sliders provide a visual plot of the function that is set into the function generator. By rotation of the shaft of the interpolating vernistat with an excitation voltage applied, the output voltage curve conforms to a series of straight-line interpolations between voltages set up by the slider. Clockwise rotation scans the function from left to right, i.e., from slider 1 to slider 34.

1.2 Construction

1.2.1 Vernistat Function Adjusting Assembly

The Function Adjusting Assembly is approximately 1 x 7 x 8 in. and contains: (1) a 101-tap voltage divider; (2) a 34-pole, 101-position printed-circuit switch; and (3) a function adjusting panel.

The voltage divider has a total of 101 equally spaced taps. These taps divide the input voltage into 100 equal-voltage increments.

The 34-pole, 101-position switch is a rectangular coordinate array. A printed-circuit grid consists of 101 parallel lines connected sequentially to the voltage-divider taps. Each of the 34 sliding contacts can be moved independently across the grid lines so that each slider may contact any of the 101 voltage divider taps. The voltage divider taps are spaced at 1% increments, and therefore any voltage may be selected to within ±0.5%.

A panel, marked off in rectangular coordinates, mounts directly over the printed circuit switch so that the 34 sliders protrude through slots in the panel and may be manually adjusted. The Y-axis is proportional to voltage, and the X-axis is proportional to the position of the Interpolating Vernistat shaft. The X-axis represents a range of approximately 11 shaft turns.

1.2.2 Interpolating Vernistat Potentiometer

The Interpolating Vernistat consists of: (1) a series of commutator bars which correspond to the sliders of the Function Adjusting Assembly; (2) a switching mechanism; and (3) a 360° toroidal resistance element, precisely tapped at 120° intervals. Connection of the Function Adjusting Assembly to the commutator bars of the Interpolating Vernistat is made

through a multiconductor cable. This cable is an integral part of the Interpolating Vernistat and plugs into the Function Adjusting Assembly. This is the only connection made to the Function Adjusting Assembly.

Rotation of the shaft of the Interpolating Vernistat switches the taps of the interpolating resistance element, one at a time along the commutator, and simultaneously controls the potentiometer output wiper. There are approximately three interpolations per shaft turn of the Interpolating Vernistat.

1.3 Application

The Vernistat Adjustable Function Generator provides a convenient means of generating mathematical and empirical nonlinear functions.

The function generator is used in the Wide-Range Counting Instrument to modify a linear position signal so that it is equal to the logarithm of the neutron attenuation.

1.4 Specifications

1.4.1 Vernistat Function Adjusting Assembly

1.	Adjustable points on rotation axis:	34.
2.	Resolution of slides adjustment:	1%.
3.	Maximum input voltage:	50 v.
4.	Ambient temperature range:	0 to 55°C.

1.4.2 Interpolating Vernistat Potentiometers

These are size 18, 11-turn continuous rotation units.

1.	Linearity:	±0.02%.
2.	Maximum output impedance:	540 ohms.
3.	Minimum output-voltage increment:	0.01%.
4.	Ambient temperature range:	0 to 55°C.

1.5 Applicable Drawings

The following is the drawing number (ORNL Instrument and Controls Division number) and subtitle for the Vernistat Adjustable Function Generator:

1. Q-2616-1 Circuit.

2. THEORY OF OPERATION

Figure 1 shows the electrical relation of the Vernistat Interpolator commutator bars, interpolating resistance element, and output wiper. By synchronization of the switching of the interpolating resistance element taps along the commutator bars with the movement of the potentiometer wiper arm, the voltage output consists of a series of linear interpolations of the voltages between adjacent commutator bars. The interpolating resistance element, used repetitively for each shaft turn, is a 360° toroidal potentiometer precisely tapped at 120° intervals.

Switching of the resistance element taps from one commutator bar to the next only requires about 30° of shaft rotation, while a complete interpolation requires approximately 120°. Therefore, the switching process of the interpolating resistance element is a noncritical operation. No discontinuities of output occur, since in each instance as the output wiper approaches a new commutator bar, the next interpolating resistance element section is already in position. Switching of the taps of the interpolating resistance element along the commutator bars is accomplished with a planetary gear reduction, as described in the paragraphs below.

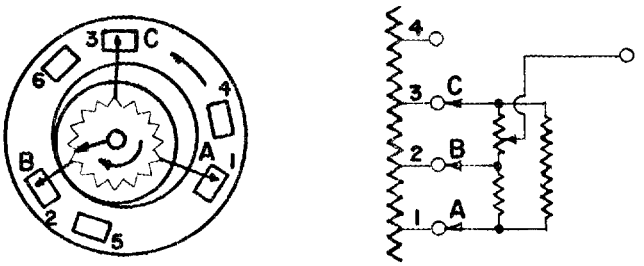
The output wiper is so synchronized with the switching operation that it is always on an energized section of the resistance element. This results in continuous, smooth interpolation throughout the output voltage range.

The heart of the switching mechanism is a planetary gear reduction, which consists of three elements; an internal tooth gear having as many teeth as there are commutator bars, a planetary gear with one tooth less, and an eccentric on the shaft which keeps the two gears in mesh. These gears are shown schematically by the eccentric circles in Fig. 1. Because of the one-tooth difference, one shaft rotation results in a counter-rotation of the planetary gear, which is equivalent to the angular spacing between commutator bars.

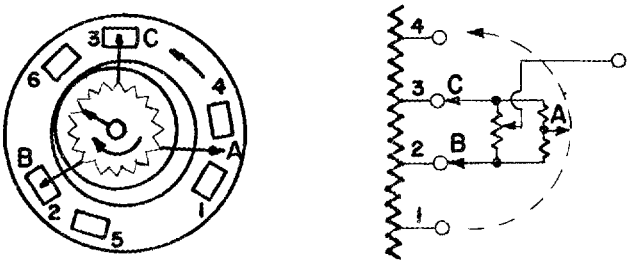
The resistance element is mounted on the planetary gear and rotates with it at a reduced speed. The commutator wipers, which are connected to the resistance element taps, are also mounted on the planetary gear. The output wiper is attached to the vernistat shaft. Because the resistance element rotates, the output wiper moves from one tap to the next in less than 120° of the shaft rotation.

The 34 sliders of the Function Adjusting Assembly are equal in number to the commutator bars in the Interpolating Vernistat. Eleven shaft turns (3960°) are required to generate an entire 34-chord function. Each chord represents 116.47° (3960°/34) of shaft rotation.

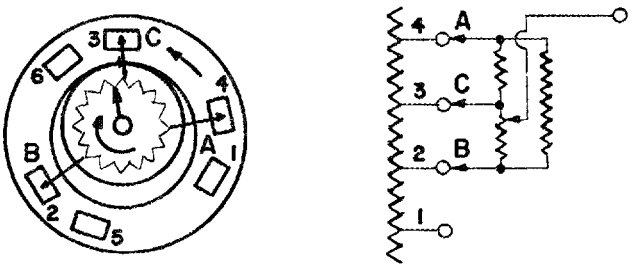
Sliders 34 and 1 are adjacent electrically; therefore, a repetitive function may be generated by continuous rotation of the input shaft.



The output wiper has just passed commutator bar 2 and is interpolating between bars 2 and 3. Resistance element tap A is just about to disengage from commutator bar 1.



As the output wiper moves in a clockwise direction, the output voltage changes linearly from the voltage on commutator bar 2 to that on commutator bar 3. Resistance element tap A has disengaged from commutator bar 1 and is switching to commutator bar 4.



The output wiper is approaching commutator bar 3. Resistance element tap A has completed switching and is in contact with commutator bar 4. Continued clockwise rotation of the output wiper will result in smooth interpolation past commutator bar 3.

Fig. 1. Electrical Relation of Vernistat Interpolator Commutator Bars, Interpolating Resistance Element, and Output Wiper.

3. OPERATING INSTRUCTIONS

3.1 Installation

In most cases, the input voltage is applied between the CW and CCW terminals of the interpolating potentiometer. The output may be taken between the OUT terminal and either the CW or CCW terminal. The standard cable length of the Interpolating Vernistat is 3 feet. For installation in the Wide-Range Counting Instrument, the unit is modified as shown on drawing ORNL Q-2626-6A R1, Instrument Department. The circuit diagram is shown in Fig. 2.

3.2 Operating Controls

A function is set up on the Adjustable Function Generator by manually moving the sliders to indicate the desired voltages. Each slider is provided with a detent mechanism which insures proper contact at the desired setting. An ordinary ball-point pen is a convenient tool for adjusting the sliders.

The function of voltages vs shaft position is obtained by rotating the shaft of the Interpolating Vernistat. Clockwise rotation scans the function from left to right, i.e., from slider 1 to slider 34.

Adjustment of the sliders of the Function Adjusting Assembly may be made during shaft rotation with the voltage divider excited. This allows adjustment of the generated function while monitoring the output.

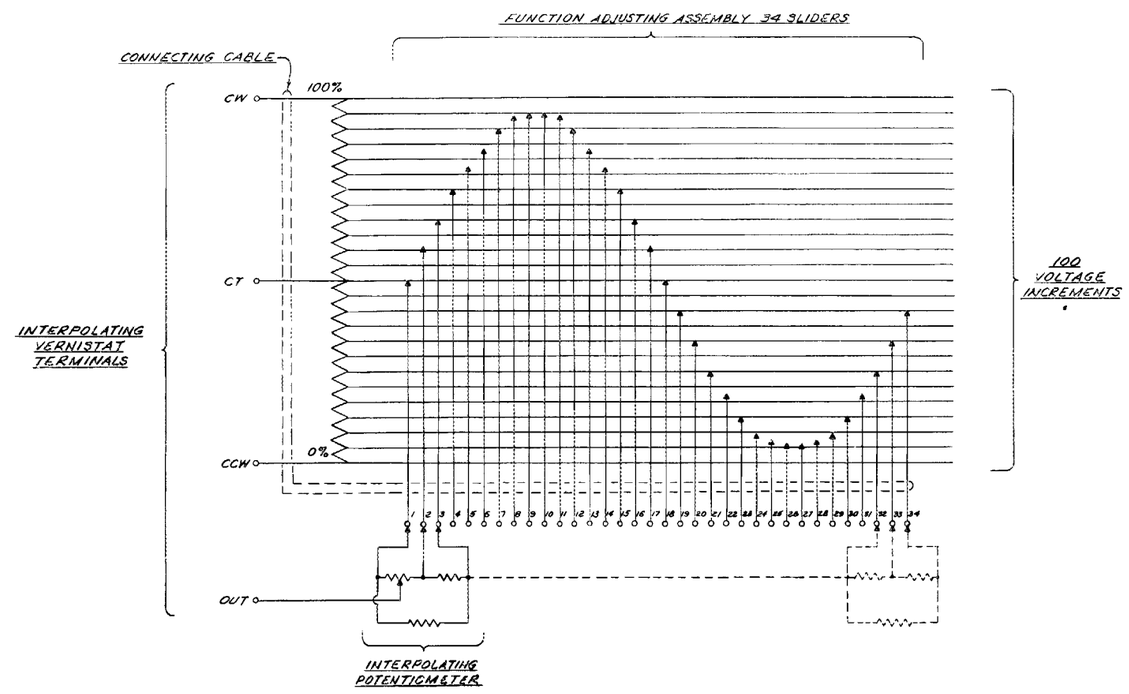
3.3 Connections

For a standard unit, input and output voltages are connected at the interpolating potentiometer. The two units are interconnected with a multiconductor cable whose standard length is 3 feet. The cable has a mating connecting (Winchester MRE-425-JTC6H) to the receptacle (Winchester H2P-J6) in the Function Adjusting Assembly.

For application to the Wide-Range Counting Instrument, the connections are shown on drawing Q-2626-6A R1.

4. MAINTENANCE INSTRUCTIONS

This unit is designed to operate with no periodic maintenance and no adjustments, except for programming which is not a maintenance procedure.



COMMUTATOR BAR OR SLIDER	WIRE COLOR WIDE STRIP	WIRE COLOR NARROW STRIP	CONNECTOR PIN
1	Black	Brown	A
2	Black	Red	B
3	Black	Orange	C
4	Black	Yellow	D
5	Black	Green	E
6	Black	Blue	F
7	Black	Violet	H
8	Black	Gray	J
9	Brown	Black	K
10	Brown	Brown	L
11	Brown	Red	M
12	Brown	Orange	N
13	Brown	Yellow	P
14	Brown	Green	R
15	Brown	Blue	S
16	Brown	Violet	T
17	Brown	Gray	U
18	Red	Black	V
19	Red	Brown	W
20	Red	Red	X
21	Red	Orange	Y
22	Red	Yellow	Z
23	Red	Green	AA
24	Red	Blue	BB
25	Red	Violet	CC
26	Red	Gray	DD
27	Orange	Black	EE
28	Orange	Brown	FF
29	Orange	Red	HH
30	Orange	Orange	JJ
31	Orange	Yellow	KK
32	Orange	Green	PP
33	Orange	Blue	RR
34	Orange	Violet	SS
CCW or COM	Black		LL
CW or IN	Red		MM
CT	Brown		NN

WIRING AND INTERCONNECTION DATA

NOTE:

FUNCTION ADJUSTING ASSEMBLY, PERKIN-ELMER CORP. MODEL DC250. VERNISTAT INTERPOLATING POTENTIOMETER PERKIN-ELMER CORP. MODEL 2X5.

NO.	REVISIONS	DATE	APPD	APPD

DATE	REV.	SEPIA DRAWING NO.	APPD. BY
9-9-65	0	Q-2616-1	DTJ
9-9-65	0	RC13-13-3A	JLA
9-9-65	0	RC11-13-3A	JLA

ISSUED FROM Q-2616-1

LIMITS ON DIMENSIONS UNLESS OTHERWISE SPECIFIED
FRACTIONS: ±
DECIMALS: ±
ANGLES: ±
SCALE:

REFERENCE DRAWINGS | DWG. NO.

DESIGN RESPONSIBILITY J.L. ANDERSON

MODULAR REACTOR INSTRUMENTATION

ADJUSTABLE FUNCTION GENERATOR CIRCUIT

INSTRUMENTATION AND CONTROLS DIVISION
OAK RIDGE NATIONAL LABORATORY
OPERATED BY
UNION CARBIDE CORP.

Q-2616-1 R0

Fig. 2. Adjustable Function Generator Circuit.

ORNL-TM-1638
Part 16

INTERNAL DISTRIBUTION

1-20. J. L. Anderson
21. D. S. Asquith
22. A.E.G. Bates
23. C. J. Borkowski
24-33. W. D. Brown
34-35. C. T. Carney
36-38. O. C. Cole
39. C. C. Courtney
40. R. A. Dandl
41. J. T. De Lorenzo
42. E. P. Epler
43. C. S. Harrill
44. C. F. Holloway
45. G. A. Holt
46. W. H. Jordan
47. W. E. Lingar
48. C. E. Mathews
49. T. L. McLean
50. R. V. McCord
51. L. C. Oakes
52. G. R. Owens
53. R. W. Peelle
54-56. W. Ragan
57. J. L. Redford
58. P. Rubel
59. J. B. Ruble
60. G. S. Sadowski
61-62. R. W. Tucker
63. D. D. Walker
64. K. W. West
65. H. N. Wilson
66-67. Central Research Library
68. Document Reference Section
69-73. Laboratory Records Department
74. Laboratory Records, ORNL R.C.
75. ORNL Patent Office
76-90. Division of Technical Information Extension
91. Laboratory and University Division, ORO