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NUCLEAR INSTRUMENT MODULE MAINTENANCE MANUAL

PART 38

ION CHAMBER POWER SUPPLY, ORNL MODEL Q-2638

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ABSTRACT

The circuit, application, maintenance procedures and acceptance tests for an ionization chamber power supply are described. The circuit is a dc-to-dc converter that operates from an input of +32 v dc and delivers an output of +250 v dc at up to 5 ma. The power supply is packaged in a standard "2-unit" plug-in module of the ORNL Modular Reactor Instrumentation series.

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1. DESCRIPTION

1.1 General

The Ion Chamber Power Supply, ORNL model Q-2638, is a dc-to-dc converter that operates from an input of +28 to +36 v dc and delivers an output of approximately +250 v at 5 ma.

1.2 Construction

The power supply is constructed in a module 2.83 in. wide, 4.72 in. high, and 11.90 in. deep. It is a standard "2-unit" plug-in module of the Modular Reactor Instrumentation series depicted on ORNL drawings Q-2600-1 through Q-2600-6.

1.3 Application

The power supply provides a voltage of +250 v for polarizing an ion chamber from a nominal power source of +32 v. It delivers full output voltage for loads up to 1 ma and is completely overload-proof, delivering at least 1 ma into a short circuit.

1.4 Specifications

1.	Output voltage:	+250 ± 25 v dc at 1 ma (up to 300 v at no load is acceptable).
2.	Input power:	+32 ± 4 v dc and 200 ma maximum.
3.	Output current:	Rated 5 ma continuously; will deliver ~ 50 ma into a 3-kilohm load, or 1 ma minimum into a short circuit.
4.	Overload protection:	Undamaged by any overload, including a short circuit.
5.	Load regulation:	Less than 15%, 5 μa to 5 ma.
6.	Line regulation:	Less than 10%, 28 to 36 v dc.
7.	Output ripple:	Less than 50 mv at 5 ma load; frequency is approximately 8 KHz.
8.	Adjustments:	None.
9.	Starting:	Self-starting under any line and load conditions within specifications.
10.	Ambient temperature range:	0 to 55°C.

1.5 Applicable Drawings

The following list gives the ORNL Instrumentation and Controls Division drawing numbers and subtitles for the Ion Chamber Power Supply. The circuit is an exact duplicate of the power supply in the chamber High Voltage Supply and Flux Amplifier, ORNL model Q-2602, and reference is made to those drawings where applicable.

1.	Q-2638-1	Cicruit and Details.
2.	Q-2638-2	Parts List.
3.	Q-2638-3	Metalphoto Panel.
4.	Q-2602-4	Printed Circuit Board.

The assembly and detail drawings of the plug-in chassis system are Q-2600-1 through Q-2600-6.

2. THEORY OF OPERATION

The power supply is designed to operate from a nominal 32-v station battery with a terminal voltage variation from 28 to 36 v dc. This wide variation makes necessary a voltage preregulator consisting of transistors Q1, Q2, Q3, and Q4.

The preregulator output voltage is sensed by resistors R7 and R8 and applied to the base of amplifier stage Q3. A reference voltage (16.8 v) generated by zener diode string D2, D3, and D4 is applied to the emitter of Q3. The amplified difference appears at the collector of Q3 and is applied to driver Q2 and pass transistor Q4. A constant collector current is provided for Q3 by transistor Q1, zener diode D1, and the associated network.

The preregulator output (test point TP1) is filtered by C1, C2, and R9 and is applied to the dc-to-dc converter.

Q5, Q6, T1, and the associated circuitry comprise a free-running square-wave oscillator. D5, D6, and D7 assure that the circuit will be both self-protecting and self-starting. Capacitors C4 and C5 round the edges of the square-wave somewhat to avoid the generation of sharp, high-frequency spikes which may be coupled to other circuits.

A square wave of approximately 250 v peak-to-peak amplitude and frequency of approximately 8 kHz appears on winding 1-3 of transformer T1. This voltage is rectified by diode bridge D8-D11 and is filtered by a pi-section RC filter composed of C6, C7, and R14. The output is approximately 250 v dc with less than 50 mv of 8 or 16 kHz ripple.

The output voltage vs load current is shown in Fig. 1. When the output is short-circuited, the circuit continues to oscillate at a very low amplitude and supplies about 1 ma of current. The circuit will recover undamaged upon removal of the short circuit or overload. The complete circuit diagram is shown in Fig. 2.

3. OPERATING INSTRUCTIONS

3.1 Installation

The Ion Chamber Power Supply is a module in the ORNL Modular Reactor Instrumentation series. Like the other modules in this series, it has standard connectors and dimensions and has a pin- and hole-code on the rear plate so that the module will not be inserted in a wrong location in a drawer. The module is installed by placing it in its proper location, inserting the module firmly, and tightening the thumb screw. The module may be plugged in with power on without damage.

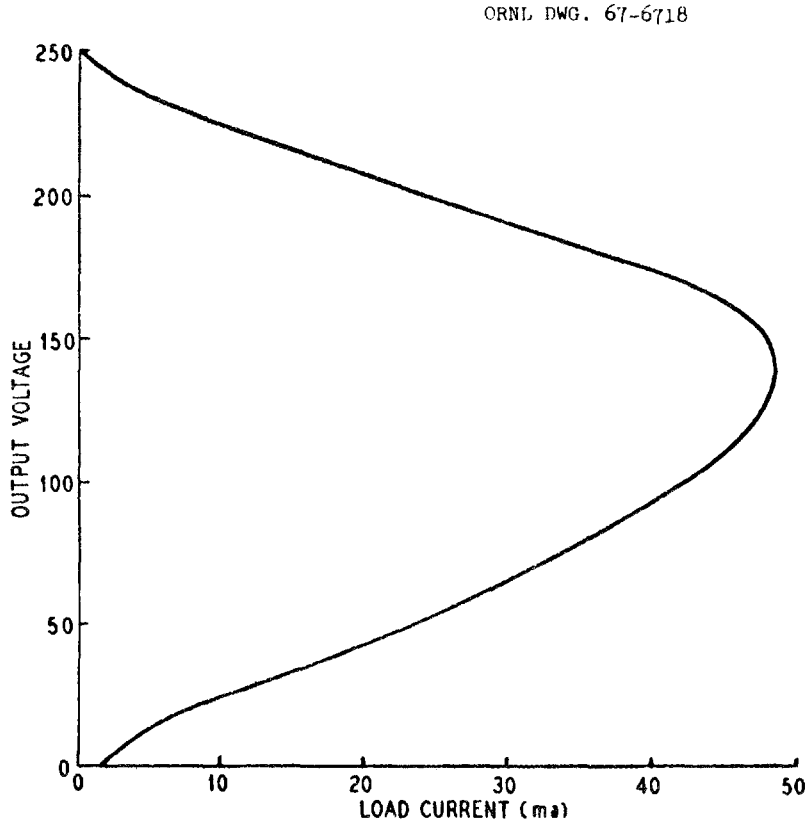

Fig. 1. Output Voltage vs Load Current for Chamber High-Voltage Supply, ORNL Model Q-2602.

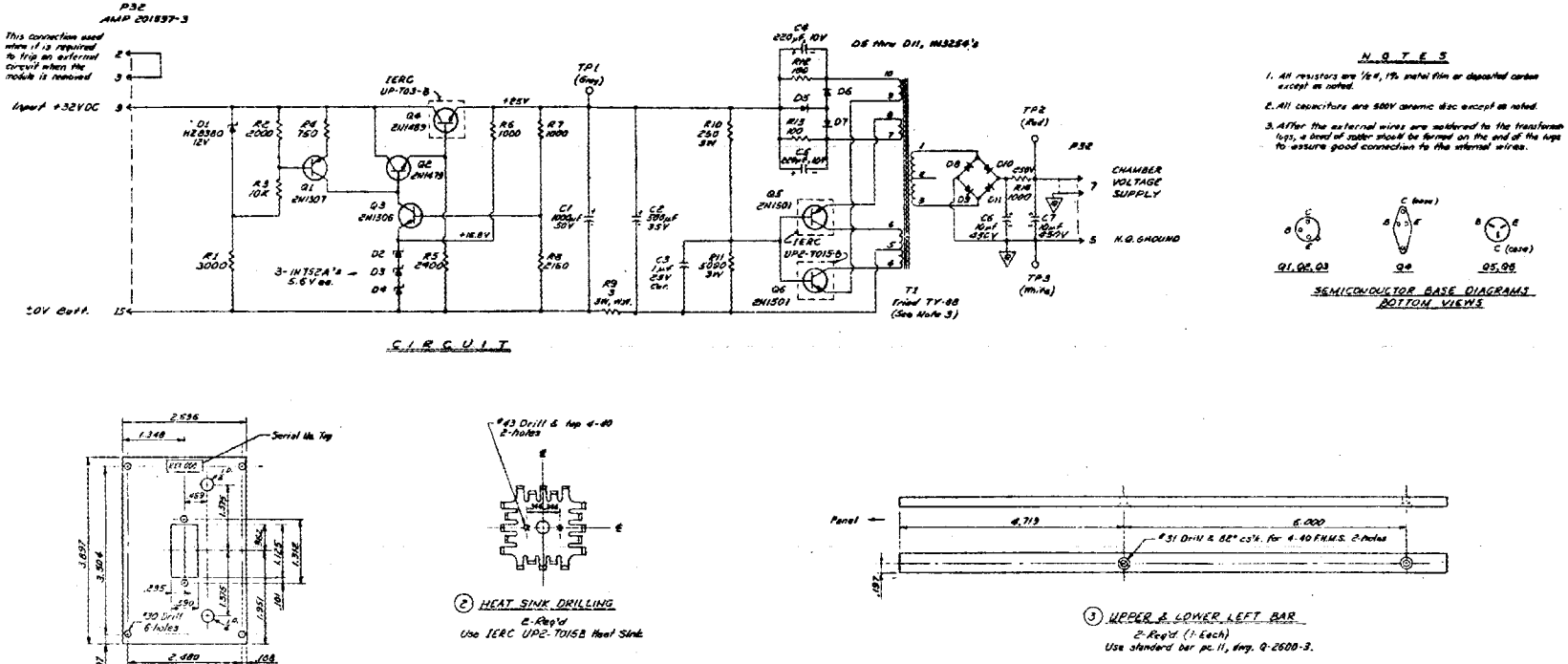

Fig. 2. Ion Chamber Power Supply Circuit, ORNL Model Q-2638.

3.2 Operation

There are no operating controls or adjustments.

3.3 Connections

All connections are made through the rear connector P32 when the module is inserted. A jumper between pins 2 and 3 is provided so that, if the module is removed from a drawer, a warning signal may be given.

3.4 Precautions

Since the output of the high-voltage supply can be lethal, care should be taken not to place fingers in the module while it is operating.

4. MAINTENANCE INSTRUCTIONS

4.1 General

This module is designed to operate continuously with a minimum of maintenance and no adjustment. Test points are accessible from the top of the module for checking the preregulator output, gray, +25 v, and the high voltage output, red, +250 v. Should a failure occur, any part listed in the Replaceable Parts List, Sect. 5, may be replaced.

4.2 Transistor Voltage Chart

The voltages of all transistors are listed in Table 1.

Table 1. Transistor Voltage Chart[a]

Transistor	Emitter	Base	Collector
Q1	30.3	30.0	25.6
Q2	25.8	26.6	32.0
Q3	16.8	17.0	25.6
Q4	25.0	25.8	32.0

Table 1. (continued)

Transistor	Emitter	Base	Collector
Q5	50.0 ac[b]	25.0 dc/56.0 ac	28.0 ac
Q6	50.0 ac	25.0 dc/56.0 ac	28.0 ac

[a]All dc voltages were measured with respect to ground with a 20,000 ohm/v voltmeter (Triplett 630), and all measurements were taken with a 300-kilohm load on the high voltage output. All ac voltages were measured with a 5000 ohm/v meter, Triplett Model 630.

[b]The ac frequency was approximately 8 kHz square wave.

5. REPLACEABLE PARTS LIST

A description and an ORNL Stores number for all replaceable parts are given in Table 2.

Table 2. Replaceable Parts List

Part No.	ORNL Stores No.	Description
Q1	06-996-1960	Transistor, germanium, PNP, type 2N1307, T.I.
Q2	06-996-1985	Transistor, silicon, NPN, type 2N1479, RCA.
Q3	06-996-1940	Transistor, germanium, NPN, type 2N1306, T.I.
Q4	06-996-1986	Transistor, silicon, NPN, type 2N1489, Silicon Transistor Corp.
Q5 and Q6	06-996-1990	Transistor, germanium, PNP, type 2N1501, Honeywell.
D1	06-995-7910	Diode, zener, 12.0 v ± 5%, 250 mw, Hughes Aircraft Co. No. HZ-8380.
D2, D3, and D4	06-995-7910	Diode, zener, 5.6 v ± 5%, 400 mw, type 1N752A, Motorola.
D5, D6, D7, D8, D9, D10, and D11	06-995-7124	Rectifier, silicon, type 1N3254, clear plastic insulating sleeve, RCA.
C1	- - -	Capacitor, 100 μf -10 to +100%, 35 v dc working, -10 to +85°C operating temperature, type PSD, Callins Industries, Inc.

Table 2. (continued)

Part No.	ORNL Stores No.	Description
C2	- - -	Capacitor, 500 μf -10 to +100%, 35 v dc working, -10 to +85°C operating temperature, type PSD, Callins Industries, Inc.
C3	06-802-0090	Capacitor, 1 μf ± 20%, 25 v dc working, ceramic, monolithic, Sprague, No. 5C13.
C4 and C5	06-816-3040	Capacitor, 220 μf ± 10%, 10 v dc working, tantalum, clear plastic insulating sleeve, Sprague, No. 150D 227X 9010S2.
C6 and C7	06-804-3015	Capacitor, 10 μf -10 to +50%, 450 v dc working, Mallory, TC-72.
R1,[a]	06-932-0123	Resistor, 3 kilohm ± 1%.
R2	06-932-1113	Resistor, 2 kilohm ± 1%.
R3	06-932-0147	Resistor, 10 kilohm ± 1%.
R4	06-932-0089	Resistor, 750 ohm ± 1%.
R5	06-932-0117	Resistor, 2400 ohm ± 1%.
R6, R7, R14	06-932-0097	Resistor, 1000 ohm ± 1%.
R8	06-932-0114	Resistor, 2160 ohm ± 1%.
R9	06-933-6130	Resistor, 3 ohm ± 5%, 3 w, ww, axial leads, Ohmite, code 7/16-A-54-F.
R10	- - -	Resistor, 250 ohm ± 5%, 3 w, ww, axial leads, Ohmite, code 7/16-A-54-F.
R11	06-933-6300	Resistor, 5000 ohm ± 5%, 3 w, ww, axial leads, Ohmite, code 7/16-A-54-F.
R12, R13	06-9320113	Resistor, 100 ohm ± 5%, 1/2 w, composition carbon, Allen-Bradley, type EB.
T1	- - -	Transformer, epoxy molded, toroidal, 28 v dc input, 250/125 dc output, Triad, type TY-88.

[a]All resistors in this group from R1 to R14 are carbon film, "Stegmag," doubly impregnated with high temperature varnish, and are 0.5 w, type SIAK.

6. ACCEPTANCE TESTS

6.1 Test Equipment

The following test equipment is required:
1. One dc power supply, adjustable 28 to 36 v at 0.5 amp.
2. One high impedance dc voltmeter, 10 megohm, 0-300 v.
3. Oscilloscope, general purpose.

6.2 Acceptance Test

6.2.1 Output Voltage

Connect a variable voltage supply (28 to +36 v) from pin 9 to pin 15 (ground). With the input adjusted to +32 v, the output pin 7 should be +250 ± 25 v.

6.2.2 Self Starting

Disconnect the positive side of the supply voltage from pin 9. Add a 300-kilohm load on the high-voltage output and reduce the supply voltage to +28 v. Reconnect the supply and measure the output voltage with a voltmeter. With no appreciable delay the high-voltage output should rise to approximately +250 v dc.

6.2.3 Load Regulation

With the 28- to 36-v dc supply set at +32 v and with a 50-kilohm load on the high voltage output, measure the output voltage with a high impedance voltmeter. Remove the 50-kilohm load and measure the output with no load. The difference should not be more than 25 v.

6.2.4 Input Regulation

With a 300-kilohm load on the output, vary the input from +28 to +36 v. The change in the output should be less than 25 v.

6.2.5 Ripple

With a 50-kilohm load, connect an oscilloscope to the output and measure the ~ 8 kHz ripple present. The spikes should be less than 50 mv peak.

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