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NUCLEAR INSTRUMENT MODULE MAINTENANCE MANUAL

PART 25

32 v dc TO 115/6.3 v, 60 cycle INVERTER,

ORNL MODEL Q-2625

J. L. Anderson

ABSTRACT

The 32-v dc to 60-cycle inverter is a dc-to-ac inverter that operates from an input of +28 to +36 v dc and delivers outputs of 115 v and 6.3 v, rms, square wave, 60 Hz. The 115-v output has a 25-w capacity and the 6.3-v output is rated at 10 w. The inverter is a standard plug-in module of the ORNL Modular Reactor Instrumentation Series.

The circuits, application, maintenance procedures, and acceptance tests for the unit are described.

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1 DESCRIPTION

1.1 General

The 32-v dc to 60-cycle ac inverter, ORNL Model Q-2625, is a dc-to-ac inverter that operates from an input of +28 to +36 v dc and delivers outputs of 115 v and 6.3 v, rms, square wave, 60 Hz. The 115-v output has a 25-w capacity and the 6.3-v output is rated at 10 w.

1.2 Construction

The dc-to-ac inverter is constructed in a module 4.25 in. wide, 4.72 in. high, and 11.90 in. deep. It is a standard "three-unit" plug-in module of the Modular Reactor Instrumentation Series depicted on ORNL drawing Q-2600-1 through Q-2600-6.

1.3 Application

The dc-to-ac inverter provides 115 v and 6.3 v, 60 Hz, from a nominal 32-v station battery system to supply vital instruments when normal ac power is lost. No output filtering is employed, and application is limited to loads which can tolerate square-wave form. The initial intended applications were to power strip-chart recorders and their signal amplifiers whose operation during ac power outage is vital (115 v) and to drive the mechanical choppers of a number of vital operational amplifiers in reactor safety and control systems.

The inverter supply has good line regulation, moderate load regulation, and is short-circuit proof.

1.4 Specifications

1.	Output voltages:	117 ± 10 v rms, 25 w, 60 Hz (square wave); 6.3 ± 0.6 v rms, 10 w, 60 Hz (square wave).
2.	Input power:	+32 ± 4 v dc, 2.1 amp maximum.
3.	Overload protection:	Undamaged by and self-recovering from short-circuited output.
4.	Line regulation:	Less than ±2%, 28 to 36 v dc.
5.	Load regulation:	Less than ±5%, 0 to 35 w total.
6.	Waveform:	Nominal square wave, free of excessive ringing or sharp spikes.
7.	Adjustments:	None

8. Starting: Self-starting under any line and load conditions within specifications.

9. 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 32 v dc to 115/6.3 v, 60 cycle Inverter.

1. Q-2625-1 Circuit.
2. Q-2625-2 Details.
3. Q-2625-3 Metalphoto Panel.
4. Q-2625-4 Printed Circuit Board.
5. Q-2652-5 Assembly.
6. Q-2625-6 Transformer Specification.
7. Q-2625-7 Parts List.

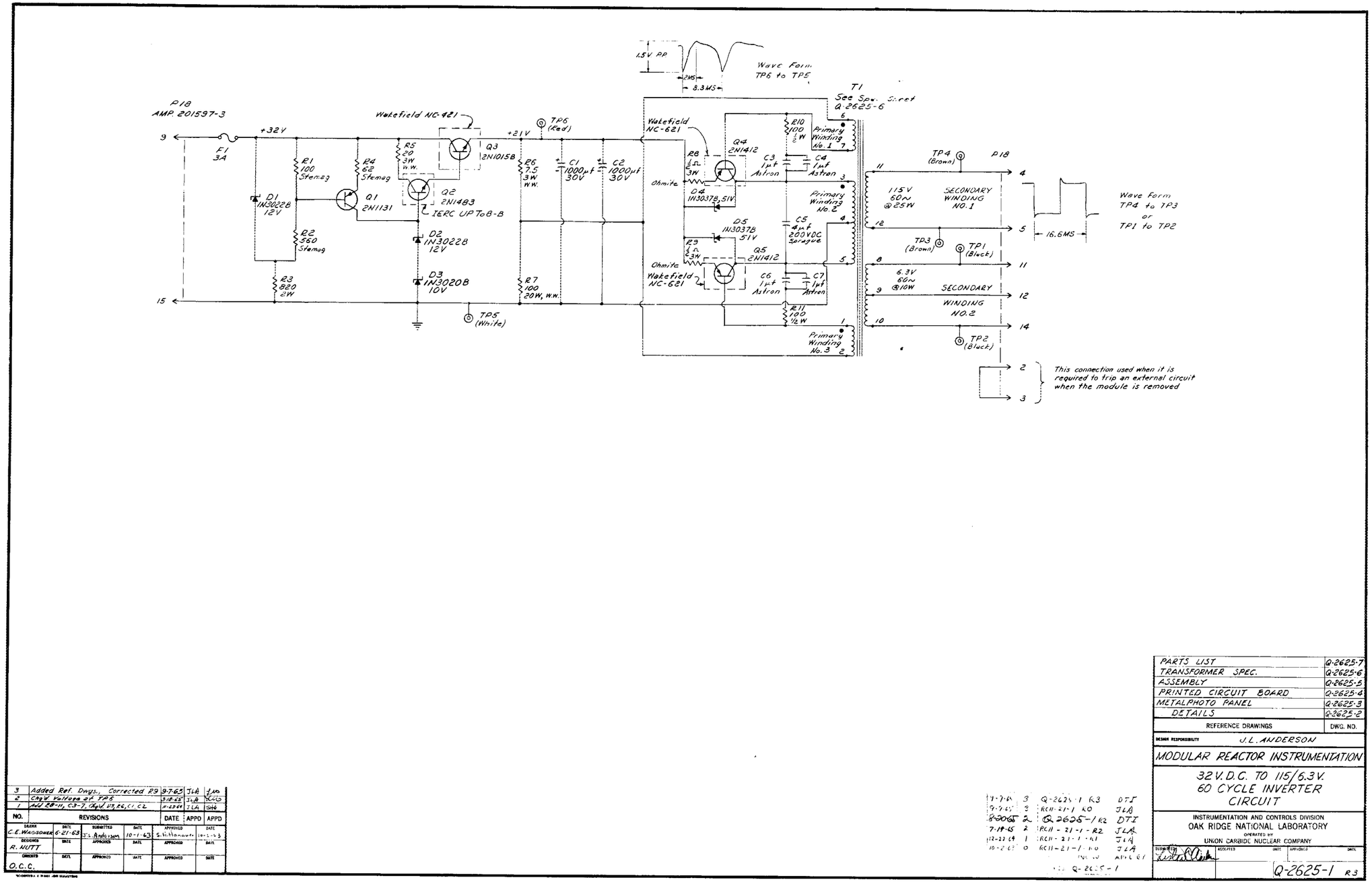
The assembly and detail drawings of the plug-in chassis system are Q-2600-1 through Q-2600-6.

2. THEORY OF OPERATION

This dc-to-ac inverter is made up of two basic circuits, a dc preregulator and an oscillating converter. The module 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 dc voltage preregulator, which consists of transistors Q1, Q2, and Q3 (Fig. 1).

A stable reference voltage of 22 v for the preregulator is generated by passing a constant current through Zener diodes D2 and D3. This 22-v reference appears at the base of transistor Q2. Transistors Q2 and Q3 form a Darlington-pair emitter follower, and the voltage of the emitter of Q3 is held constant at +21 v. Filtering and high-frequency regulation are provided by capacitors C1 and C2. Transistor Q1, diode D1, and associated resistors comprise the constant current circuit for the 22-v reference diodes.

Test points TP6 and TP5 are provided for measuring the preregulator output.



NO.	REVISIONS	DATE	APPD	APPD
3	Added Ref. Dwgs., Corrected R9	9-7-65	JLA	[illegible]
2	Chg'd Voltage at TP5	3-18-65	JLA	[illegible]
1	Add R8-11, C3-7, Chg'd V3, R6, C1, C2	11-23-64	JLA	SHG

DRAWN	DATE	SUBMITTED	DATE	APPROVED	DATE
C.E. WAGGONER	6-21-63	J.L. Anderson	10-1-63	S. Hittmann	10-2-63
DESIGNED	DATE	APPROVED	DATE	APPROVED	DATE
R. NUTT					
CHECKED	DATE	APPROVED	DATE	APPROVED	DATE
O.C.C.					

9-7-65	3	Q-2625-1 R3	DTI
9-7-65	3	RC11-21-1 R0	JLA
8-20-65	2	Q-2625-1 R2	DTI
7-19-65	2	RC11-21-1-R2	JLA
12-22-64	1	RC11-21-1-R1	JLA
10-2-63	0	RC11-21-1-R0	JLA

PARTS LIST	Q-2625-7
TRANSFORMER SPEC.	Q-2625-6
ASSEMBLY	Q-2625-5
PRINTED CIRCUIT BOARD	Q-2625-4
METALPHOTO PANEL	Q-2625-3
DETAILS	Q-2625-2
REFERENCE DRAWINGS	DWG. NO.

DESIGN RESPONSIBILITY J.L. ANDERSON

MODULAR REACTOR INSTRUMENTATION

32 V.D.C. TO 115/6.3 V.
60 CYCLE INVERTER
CIRCUIT

INSTRUMENTATION AND CONTROLS DIVISION
OAK RIDGE NATIONAL LABORATORY
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Q-2625-1 R3

Fig. 1. 32 v dc to 115/6.3 v, 60 cycle Inverter, ORNL Model Q-2625.

Q4, Q5, T1, and their associated circuits comprise a free-running square-wave oscillator inverter. Networks consisting of C4, C5, and R10, and C6, C7, and R11 along with 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. Diodes D4 and D5 protect Q4 and Q5 from damage by spikes which may occur as a result of sudden load changes.

A voltage divider, R6 and R7, biases the bases of Q5 and Q6 into conduction. R8 and R9 limit the transistor currents in the nonoscillating condition to a little less than the oscillating currents. If a short circuit or heavy overload occurs on the output (transformer secondary), the oscillations will cease and currents will be limited to safe values for all components. When the overload is removed, the forward bias assures self-starting.

3. OPERATING INSTRUCTIONS

3.1 Installation

The 32 v dc to 115/6.3 v, 60 cycle Inverter 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 to the circuit; however, the output may be lethal and care should be exercised to avoid contact with exposed wiring.

3.2 Operation

There are no operating controls or adjustments.

3.3 Connections

All connections are made through the rear connector P18 when the module is inserted. A jumper between 2 and 3 is provided so that, if the module is removed from a drawer, a warning signal will be given.

3.4 Precautions

Since the output of the inverter 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 and both secondary voltages. The preregulator output test point TP6 is red, and the dc ground return TP5 is white. The 115-v dc secondary test points TP3 and TP4 are brown, and the 6.3-v ac test points TP1 and TP2 are black. 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	30.7	30.2	22.0
Q2	21.5	22.0	31.6
Q3	21.0	21.5	32.0
Q4	-	2.1 p-p ac	38 p-p ac
Q5	-	2.1 p-p ac	38 p-p 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 maximum rated load on the outputs. All ac voltages were measured with a calibrated oscilloscope, Tektronix model 531.

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	06-996-1710	Transistor, PNP, type 2N1131, T.I.
Q2		Transistor, NPN, type 2N1483, RCA.
Q3		Transistor, NPN, type 2N1015B, Sil Trans.
Q4, Q5	06-996-1983	Transistor, PNP, type 2N1912, RCA or Delco.
D1, D2	06-995-7096	Diode, Zener, 12 v, ±5%, type 1N3022B, Motorola.
D4, D5	06-995-7112	Diode, Zener, 51 v, ±5%, type 1N3037B, Motorola.
D3	06-995-7094	Diode, Zener, 10 v, ±5%, type 1N3020B, Motorola.
T1		Transformer, power, per specification dwg. Q-2625-6R1.
C1, C2		Capacitor, 100 μf, -10 + 100%, 3 v dcw, -10 + 85°C operating temp., 0.875 in. diam. x 2.50 in. long, type PSD, Callins Industries, Inc.
C3, C4, C6	06-812-3538	Capacitor, 1 μf, ±1%, 50 v dcw, metalized paper, Astron No. MQZF.5 - 1M-10, or Gudeman No. XMF88-A105.
C5	06-812-0958	Capacitor, 4 μf, ±10%, 200 v dcw, metalized paper, clear plastic insulating sleeve, Sprague No. 121P4059254.
R6	06-933-6160	Resistor, 7.5 ohms, ±5% 3 w, ww, vitreous enamel insulation, Ohmite code 7/16-A-54-F.
	06-933-6190	Resistor, 20 ohms, Ohmite code 7/16-A-54-F.
R7	06-934-0719	Resistor, 100 ohms, Ohmite code 7/16-A-54-F.
R8, R9	06-933-6030	Resistor, 0.5 ohm, Ohmite code 7/16-A-54-F.

Table 2. (continued)

Part No.	ORNL Stores No.	Description
R10, R11		Resistor, 100 ohms, ±5%, 1/2 w, A-B.
R3		Resistor, 820 ohms, ±5%, 2 w, A-B.
R4	06-932-0037	Resistor, 62 ohms, ±1%, 1/2 w, carbon film, Stemag, type STAK.
R1	06-932-0047	Resistor, 100 ohms, ±1%, 1/2 w, carbon film, Stemag, type STAK.
R2	06-932-0081	Resistor, 560 ohms, ±1%, 1/2 w, carbon film, Stemag, type STAK.
F1	06-874-3080	Fuse, micro, 3 amp, Littlefuse No. 273003.

6. ACCEPTANCE TESTS

6.1 Test Equipment

The following test equipment is required:

1. One dc power supply, adjustable 28 to 36 v at 2 amp.
2. One 625-ohm, 25-w resistor.
3. One 4-ohm, 10-w resistor.
4. One average-reading ac voltmeter calibrated in rms.
5. One multirange dc voltmeter with ±1% accuracy.
6. One oscilloscope, general purpose, with accurate timebase.

6.2 Description

This unit takes an unregulated battery voltage, nominally +32 v dc and converts, or inverts, it to 115 v and 6.3 v ac, 60 cycles. The output waveform is an unfiltered square wave. There are two sections to the circuit. Q1, Q2, and Q3 comprise a preregulator which permits an input variation of 28 to 36 v while maintaining the input to the actual inverter Q4 and Q5 at a constant 21 v. The inverter itself is a transformer-coupled free-running multivibrator whose output voltage and frequency are determined primarily by the transformer characteristics and the input voltage.

6.3 Acceptance Test

The acceptance test procedure is as follows:

1. Connect a 625-ohm, 25-w load from pin 4 to pin 5. Connect a 4-ohm, 10-w load from pin 11 to pin 14. A standard 25-w light bulb is satisfactory for the 25-w load.

2. Connect a +32 v dc adjustable power supply from pin 9 to pin 15 and adjust the voltage to +32.0 v.

3. Measure the voltage at the output of the preregulator (test point 6) with respect to ground (test point 5). The voltage should be 21.0 ± 1.2 v dc.

4. Vary the input voltage from 28 to 36 v. The preregulator outputs should vary not more than ± 0.5 v.

5. Measure the output voltage from test point 3 to test point 4 with an average-reading ac voltmeter calibrated in rms. The voltage should be 115 ± 10 v.

6. Measure the output voltage from test point 1 to test point 2 with the same meter used in step 5. The voltage should be 6.3 ± 0.6 v.

7. With an oscilloscope having an accurate time base, measure the output period (time for one complete cycle) on either output winding. The period should be 16.7 ± 1.7 msec.

8. Observe the output waveform. The shape should be a symmetrical square wave with clean spikes on the leading edges of not more than 10% of the peak to peak amplitude. The unit should be rejected if the spikes are larger or multiple ringing occurs.

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