TC 948
HIGH VOLTAGE SUPPLY

Represented throughout the world, TENNELEC, Inc. designs and manufactures state-of-the-art electronics for the consumer, medical, research and industrial markets. Inquiries about any of the variety of products and services available from TENNELEC should be addressed to TENNELEC, Inc., 601 Turnpike, Oak Ridge, Tennessee 37830, USA.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 INTRODUCTION.</td>
<td>1</td>
</tr>
<tr>
<td>2.0 SPECIFICATIONS.</td>
<td>1</td>
</tr>
<tr>
<td>2.1 PERFORMANCE.</td>
<td>1</td>
</tr>
<tr>
<td>2.2 CONTROLS, CONNECTORS AND DISPLAYS.</td>
<td>1</td>
</tr>
<tr>
<td>2.3 GENERAL INFORMATION.</td>
<td>2</td>
</tr>
<tr>
<td>3.0 FIRST-TIME OPERATION.</td>
<td>2</td>
</tr>
<tr>
<td>4.0 CIRCUIT DESCRIPTION</td>
<td>2</td>
</tr>
<tr>
<td>5.0 SERVICING</td>
<td>3</td>
</tr>
<tr>
<td>5.1 GENERAL SERVICING INSTRUCTIONS</td>
<td>3</td>
</tr>
<tr>
<td>5.2 FREQUENCY ADJUSTMENT</td>
<td>3</td>
</tr>
<tr>
<td>5.3 OUTPUT VOLTAGE CALIBRATION</td>
<td>4</td>
</tr>
<tr>
<td>6.0 SHIPPING DAMAGE</td>
<td>4</td>
</tr>
<tr>
<td>7.0 WARRANTY.</td>
<td>4</td>
</tr>
</tbody>
</table>

# TABLE OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1 TC 948 Calibration points</td>
<td>4</td>
</tr>
</tbody>
</table>
1.0 INTRODUCTION

TENNELEC's TC 948 High-Voltage Supply is designed to furnish high current and high-voltage for scintillation detectors in a minimum of bin space. The output is continuously adjustable from 50V to +1500V with a current of 0 to 1mA. Packaged in a single width NIM module, the TC 948 can be used with the appropriate modules to form either a dual isotope counting system or a dual detector system in a portable, six-wide minbin.

Automatic fault protection against overloads, arcing and short circuits is provided. A front-panel lamp indicates if the protection circuits have been activated. The unit is powered completely from the bin.

2.0 SPECIFICATIONS

2.1 PERFORMANCE

Output: Continuously adjustable between +50 and +1500V with a current range of 0 to 1mA.

Ripple and Noise: Less than 10mV peak-to-peak to 50 MHz.

Stability: Less than 0.01% drift in output voltage per hour measured under constant load, line voltage, and ambient temperature after warm-up.

Resolution: Better than 1V. Repeatability is 0.03% or 3V (whichever is greater). The calibration accuracy is better than 1% of the maximum output voltage setting.

Temperature Coefficient: 100ppm or 0.01%/°C change in output voltage after warm-up over the 0° to 50°C operating temperature range.

2.2 CONTROLS, CONNECTORS AND DISPLAYS

Voltage Control: Calibrated ten-turn dial permits setting of the output voltage over the 50 to 1500V range.

High-Voltage Indicator: Front-panel lamp lights when the TC 948 is ON.

Fault Indicator Lamp: Front-panel lamp lights when the fault protection circuitry has been activated. It indicates arcing, overload or short circuiting.

OFF/ON Switch: Front-panel switch turns supply ON or OFF. When in the ON position, the high-voltage indicator lamp lights.

Output Connector: One SHV safety high-voltage receptacle on rear-panel.

Power: NIM standard power connector. The TC 948 requires +24vdc @ 55mA; -24vdc @ 70ma; +12vdc @ 170mA; -12vdc @ 160mA.
2.3 GENERAL INFORMATION

Packaging: No. 1 NIM Standard module.

Accessories: One instruction manual.

Net Weight: 2 lbs 2 ozs (0.96 Kg).

Shipping Weight: 5 lbs 2 ozs (2.33 Kg).

Warranty: One year.

3.0 FIRST TIME OPERATION

Every instrument from TENNELEC, Inc. is thoroughly checked before it leaves the plant. However, it is possible for damage to occur during shipping. Visually check the Model TC 948 upon receipt for possible external damage. If it appears to be damaged, proceed with the instructions given in the SHIPPING DAMAGE section of this manual.

It is recommended that the power supply of the bin be OFF when the module is inserted.

4.0 CIRCUIT DESCRIPTION (See Block Diagram)

The TC 948 is basically an operational amplifier with two major stages.

The low-voltage amplifier is a conventional operational amplifier. Q903 is a dual FET for good temperature stability and drift characteristics, and IC 901 is used for the second gain stage for the same reasons. Q901 and Q902 are the output drivers for the positive and negative outputs, respectively. Resistors R3, R4 and R5, R34 are the load resistors for Q901 and Q902. Stabilization is accomplished with R904, C901, C1, and C2. Diodes D1 and D2 protect Q903. The variable input voltage is obtained through R2 (10-turn potentiometer) from D13.

The high-voltage amplifier section consists of a transformer, transformer drivers, and voltage doubler. Unijunction Q4 generates an approximate 50kHz spike which clocks flip-flop IC 1A. The output of IC 1 is two 25kHz square waves 180° out of phase. These square waves are applied to Q6 and Q7 which drive Q8 and Q9 respectively. Transistors Q8 and Q9 drive the transformer T1. Current is supplied to the center tap of T1 from a White follower stage consisting of Q10 and Q11. This is a gain-of-one stage with high input impedance and high output current capability. Power is supplied for the White follower stage from the Bin. The output of the high-voltage transformer is a square wave which is rectified by the voltage doubler made up of D7, D8, C11, C12, C13, C14, C25, and C26. The resulting dc output voltage is filtered by C15, R21, and C16 and applied to the output terminals through current limiting resistor R22.
The high-voltage OFF/ON Switch controls power to the White follower and shorts the J-K inputs of IC 1A to ground.

The fault lamp is driven from a circuit which senses the summing junction of the amplifier. Pin 7 of the A900 module is a point which looks at the summing junction after it has been amplified by Q903. In addition to the amplification, Pin 7 has another important feature: its voltage always goes positive if the summing junction breaks loose in either direction. This allows the base of Q1 to sense either undervoltage or overvoltage at the output of the supply by looking at Pin 7. This is an important feature because many internal failures in the power supply will cause the output voltage to go to full scale and this can damage detectors.

If the voltage at the base of Q1 goes over 8.5V (indicating that the summing junction has broken loose), Q3 turns on the FAULT lamp and shorts the reset input of IC 1A to ground, turning off IC 1A and the transformer drive. If this happened as a result of a short at the output, the voltage will stay off until the high-voltage switch is turned off and back on. If the FAULT lamp came on as a result of overvoltage (Q10 or Q11 shorted) a feedback loop will be set up through Q1 and Q2, Q3, and IC 1A and the transformer drivers. The feedback loop bypasses the last half of the A900 and Q10 and Q1 to control the output voltage.

If the power supply begins to draw excessive current from the Bin (for any reasons), a voltage drop will be created across R28 and R29. This will turn on Q12. When Q12 turns on, it will activate IC 1B. This will turn on Q13, lighting the FAULT lamp and removing the transformer drive, thus disabling the module. The circuit will stay in this condition until the HIGH-VOLTAGE switch is turned OFF, which resets the IC 1B.

5.0 SERVICING

5. GENERAL SERVICING INSTRUCTIONS

In the event of a component failure, replacement may be done in the field or the instrument may be returned to our plant for repair. There will be no charge for repairs that fall within the warranty.

THE TC 948 PRODUCES DANGEROUS VOLTAGE. USE CAUTION IF YOU ATTEMPT TO SERVICE THE UNIT.

5.2 FREQUENCY ADJUSTMENT

Turn the supply ON and bring the output voltage up to 1.5kV. Load the supply with a 1.5 megohm 2 watt load. Using a suitable meter, monitor the voltage drop across R28 (see Fig. 1). Adjust R12 for the minimum voltage across R28.
OUTPUT VOLTAGE CALIBRATION

The following instruments are used at TENNELEC for output voltage calibration of the TC 948:

1) An electrostatic voltmeter with 0.5% accuracy and $1 \times 10^{15} \Omega$ input impedance.

2) A d.c. differential voltmeter with an accuracy equal to ±0.01% of input plus 0.001% of range plus 10 μV.

The high-voltage output control is calibrated by R1 (see Fig. 1)

SHIPPING DAMAGE

Upon receipt of the instrument, examine it for shipping damage. Damage claims should be filed with the carrier. The claims agent should receive a full report; a copy of that report should be sent to TENNELEC, Inc., P.O. Box D, Oak Ridge, Tennessee 37830. The model number and serial number of the instrument must be included in the report. Any remedial action taken by TENNELEC, Inc. will be based on the information contained in this report.

7.0 WARRANTY

In connection with TENNELEC's warranty (inside front cover), TENNELEC suggests that if a fault develops, the customer should immediately notify the TENNELEC Nuclear Customer Service Manager. He may be able to prescribe repairs and to send replacement parts which will enable you to get the instrument operating sooner and at less expense than if you returned it.
Should return prove necessary, the TENNELEC Nuclear Customer Service Manager must be informed either IN WRITING, BY CABLE or BY TWX of the nature of the fault and the model number and serial number of the instrument. Pack the instrument well and ship PREPAID and INSURED to TENNELEC, Inc., 601 Oak Ridge Turnpike, Oak Ridge, Tennessee 37830. As stated in the warranty DAMAGE IN TRANSIT WILL BE REPAIRED AT THE SENDER'S EXPENSE as will damage that obviously resulted from abuse or misuse of the instrument.

Quotations for the repair of such damage will be sent for your approval before repair is undertaken.