ORTEC®

INSTRUCTION MANUAL
MODEL 422
DUAL DECADE
ATTENUATOR

Serial No. _____

Purchaser _____

Date Issued _____

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TABLE OF CONTENTS

A NEW STANDARD TWO-YEAR WARRANTY FOR ORTEC ELECTRONIC INSTRUMENTS

ORTEC warrants its nuclear instrument products to be free from defects in workmanship and materials, other than vacuum tubes and semiconductors, for a period of twenty-four months from date of shipment, provided that the equipment has been used in a proper manner and not subjected to abuse. Repairs or replacement, at ORTEC option, will be made without charge at the ORTEC factory. Shipping expense will be to the account of the customer except in cases of defects discovered upon initial operation. Warranties of vacuum tubes and semiconductors, as made by their manufacturers, will be extended to our customers only to the extent of the manufacturers' liability to ORTEC. Specially selected vacuum tubes or semiconductors cannot be warranted. ORTEC reserves the right to modify the design of its products without incurring responsibility for modification of previously manufactured units. Since installation conditions are beyond our control, ORTEC does not assume any risks or liabilities associated with methods of installation other than specified in the instructions, or installation results.

QUALITY CONTROL

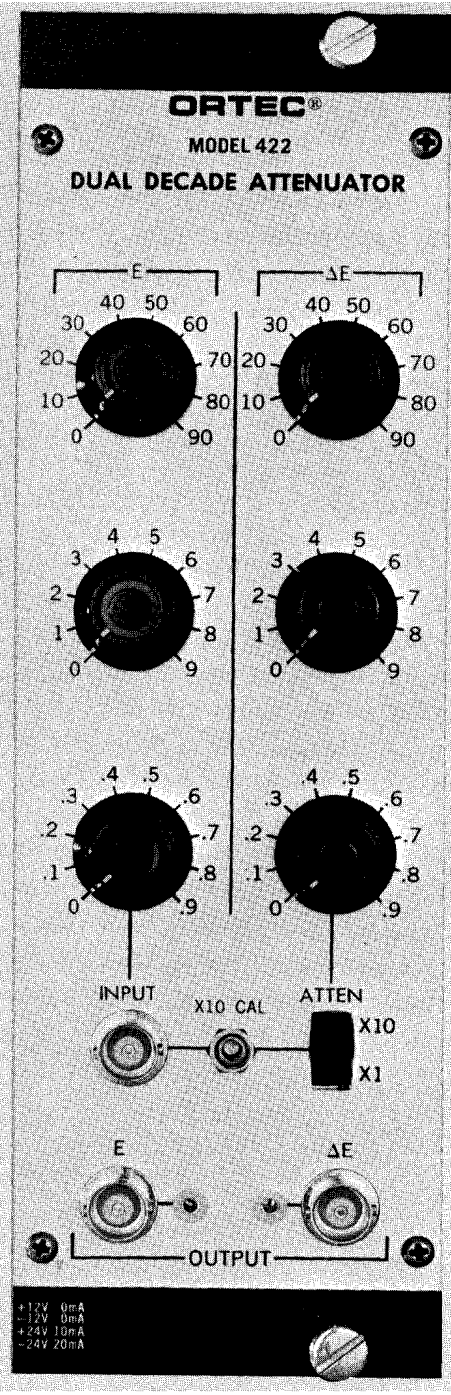
Before being approved for shipment, each ORTEC instrument must pass a stringent set of quality control tests designed to expose any flaws in materials or workmanship. Permanent records of these tests are maintained for use in warranty repair and as a source of statistical information for design improvements.

REPAIR SERVICE

ORTEC instruments not in warranty may be returned to the factory for repairs or checkout at modest expense to the customer. Standard procedure requires that returned instruments pass the same quality control tests as those used for new production instruments. Please contact the factory for instructions before shipping equipment.

DAMAGE IN TRANSIT

Shipments should be examined immediately upon receipt for evidence of external or concealed damage. The carrier making delivery should be notified immediately of any such damage, since the carrier is normally liable for damage in shipment. Packing materials, waybills, and other such documentation should be preserved in order to establish claims. After such notification to the carrier, please notify ORTEC of the circumstances so that we may assist in damage claims and in providing replacement equipment if necessary.


ORTEC®
MODEL 422
DUAL DECADE ATTENUATOR
E
ΔE
INPUT
X10 CAL
ATTEN
X10
X1
E
ΔE
OUTPUT
+12V 0mA
-12V 0mA
+24V 10mA
-24V 20mA

MODEL 422
DUAL DECADE ATTENUATOR

1. DESCRIPTION

1.1 General Description

The ORTEC 422 Dual Decade Attenuator is designed primarily to be used with the ORTEC 423 Particle Identifier. The Dual Decade Attenuator is useful in simulating two coincident input signals into the respective E and ΔE preamplifiers for a particle identifier system. When properly calibrated, the Dual Decade Attenuator output can be read directly from the front panel controls in equivalent input energy in MeV. The unit can also be used as a general purpose decade attenuator to attenuate pulse voltage signals that are derived from a common source such as an ORTEC 419 Pulse Generator.

1.2 Description of Basic Function

The basic function of the Dual Decade Attenuator is to provide two separate decade attenuators that can independently attenuate a common input signal and direct the separate fractions of this signal into two independent paths. This effectively provides a coincident double pulse generator; the amplitudes of each of the two outputs can be independently adjusted via the three decade switches on each channel. The 422 is primarily used as an accessory to the 423 Particle Identifier and therefore has one channel on the front panel designated as the E and the second channel designated as the ΔE channel, corresponding to the E and ΔE preamplifiers in a particle identifier system. Each channel has an integral voltage amplifier with an internal gain adjustment that is used to accurately match the gain characteristics of each channel. Therefore, the input voltage to output charge gain of each channel is identical for identical decade switch settings when using the associated charge terminators. The 422 is provided with calibrated charge terminators for each channel such that the output from the decade attenuator and its associated pulse generator can be fed directly into the input of charge sensitive preamplifiers.

2. SPECIFICATIONS

2.1 General Specifications

The ORTEC 422 is housed in a standard AEC Nuclear Instrument Module. It is two modules wide and weighs 2.8 pounds. It contains no internal power supply and therefore must obtain the necessary operating power from a Nuclear Standard Bin and Power Supply such as the ORTEC 401A/402A. All signals in and out of the module are on front panel BNC connectors. Each output BNC connector has an associated front panel oscilloscope test point and the input power is via the standard connector on the rear panel. Two brackets are provided on the rear panel for storage of the charge terminators when they are not in use.

2.2 Decade Attenuator Specifications

Input: Normal input from an ORTEC 419 Pulse Generator, positive or negative 0-2 volts with a rise time of less than 10 nanoseconds and a fall time of 400 μsec. The input can also accommodate other unipolar or bipolar waveshapes up to a maximum voltage of ±7 volts.

Input Impedance: 100 ohms

Linearity: Integral nonlinearity of the internal amplifier less than 0.1% from 0.2 to 7 volts

Decade Accuracy: Tens and units decades 1%, one-tenth decade 5%

Output Voltage: Maximum linear output ±7 volts

Output Voltage Rise Time: Rise time less than 60 nsec for a step function input

Output Droop: For a step function input, the droop on the output is approximately 50 μV/μsec with the output open circuit.

Output Impedance: Approximately 1 ohm, ac coupled

Output Equivalent Charge: The maximum equivalent output charge per volt input with the charge terminators supplied is approximately 50 MeV, referred to a silicon detector.

Temperature Coefficient: <0.01%/°C (for internal amplifier and units and tens decade resistors)

Operating Temperature Range: 0 to 50°C

Power Required: +24V 10 mA
-24V 15 mA

Mechanical: Two NIM modules wide and designed to meet the recommended interchangeability standards outlined in AEC Report TID-20893 (Rev.). The module is 1.35 inches wide, 8.7 inches high, 9.75 inches long, and weighs 2.8 pounds.

3. INSTALLATION

3.1 General Installation Considerations

The 422, used in conjunction with the 401A/402A Bin and Power Supply, is intended for rack mounting. Therefore, it is necessary to ensure that vacuum tube equipment operating in the same rack with the 422 has sufficient cooling air circulating to prevent any localized heating of the all semiconductor circuitry used throughout the 422. The temperature of equipment mounted in racks can easily exceed 120°F (50°C) unless precautions are taken. Cooling fans mounted in racks should be arranged so that the cooling air does not blow directly on the module, but rather enhances the normal convection cooling.

3.2 Connection to Power - Nuclear Standard Bin, ORTEC 401A/402A

The 422 contains no internal power supply; therefore, it must obtain power from a Nuclear Standard Bin and Power Supply such as the ORTEC 401A/402A. It is recommended that the bin power supply be turned off when inserting or removing modules. The ORTEC 400 Series is designed so that it is not possible to overload the bin power supply with a full complement of modules in the bin; however, this may not be true when the bin contains modules other than those of ORTEC design and in this case, the power supply voltages should be checked after insertion of the modules. The ORTEC 401A/402A has test points on the power supply control panel to monitor the actual dc voltages.

3.3 Connection to Input Pulse Generator

The input to the 422 is dc coupled and has an input impedance of 100 ohms. Connection to a pulse generator such as an ORTEC 419 or 204 is accomplished by simply connecting the input connector of the 422 to the attenuated output of the 419 or 204. Connection to pulse generators other than the ORTEC units is equally simple, so long as due consideration is given to the fact that the 422 has a 100 ohm input impedance. Unless the 422 is driven from a pulse generator with an output impedance of 100 ohms, the ΔE-X1-X10 attenuation switch will not be properly calibrated, although attenuation will occur when the switch is set from the X1 to the X10 position. The internal amplifier in the 422 is dc coupled to the input connector, and therefore, pulse generators having a high dc level on their output, i.e., greater than approximately 2 volts, should not be directly connected to the input of the 422.

4. OPERATING INSTRUCTIONS

4.1 Front Panel Controls - Description and Familiarization

Decade Switches

The decade switches on the E and the ΔE channel provide a 10-position switch to allow selection of a fraction of the input voltage to be applied to the output. The fractional output is set by the sum of the three decade switches on the front, i.e., the tens decade, the units decade, and the one-tenth decade. The decade resistors in the tens and units decades are 1% metal film resistors and the decade resistors in the one-tenth decade are 5% carbon resistors. The accuracy of these resistors is sufficient for the applications and purposes intended for the 422 (refer to Section 1.2).

ΔE Attenuator

The ΔE attenuator switch provides a X1-X10 overall attenuator for the three decade switches in the ΔE channel. The 422 input must be driven from a source impedance of 100 ohms for the X1-X10 switch to be calibrated. If it is not driven from a pulse generator with an output impedance of 100 ohms, recalibration on the X10 position is necessary.

X10 CAL

A X10 calibration potentiometer is provided on the front panel to accurately adjust the ΔE X10 attenuator. This is a 20-turn trimpot screwdriver adjustment.

4.2 Initial Testing and Observation of Waveforms

Refer to Section 6.1 of this manual for information on testing performance and observing waveforms.

4.3 Connector Data

CN1 - INPUT

The INPUT BNC connector on the front panel provides an input impedance of 100 ohms, dc coupled. Maximum input voltage is approximately 7 volts. In the normal operation, the input to CN1 will be from a pulse generator such as the ORTEC 419, which has a 100 ohm output impedance, and the two units will be connected via RG-62/U cable. Cable lengths less than approximately four feet should be used if possible.

CN2 - E OUPUT

The E OUTPUT BNC connector on the front panel provides an output driving source of approximately 1 ohm and is ac coupled. Maximum output voltage on this

connector is approximately 7 volts. The E OUTPUT is normally fed to the E charge terminator through cable such as RG-62/U with the charge terminator connected to the input of the preamplifier.

CN3 - ΔE OUTPUT

The specifications of the ΔE OUTPUT are identical to the E OUTPUT.

4.4 Typical Operating Conditions

The 422 is intended primarily as an input device for E and ΔE charge sensitive preamplifiers used in conjunction with an ORTEC 423 Particle Identifier. When used in this configuration, the 422 and its associated charge terminators and input pulse generator allow the equivalent charge at the input to the preamplifiers to be read directly from the decade settings of the 422 in equivalent MeV of energy. This is accomplished by calibrating the input voltage with the associated 422 charge terminators such that an equivalent 99.9 MeV input is being fed to the charge terminators when the 422 decade switches are set fully clockwise. In some applications, it is more convenient to have the ΔE decade channel read from 0-9.99 MeV instead of 0-99.9 MeV. In this case, the ΔE attenuator switch is set to the X10 position. An important consideration to keep in mind is that the charge terminators associated with the E and ΔE outputs of the 422 are not interchangeable. This is due to the fact that the discrete capacitors located in the charge terminators do not have exactly the same value in both charge terminators. This differential capacitance value is compensated for by the internal gain in the respective amplifiers of the E and ΔE channels of the 422. The associated charge terminators for the E and ΔE side are individually calibrated with the 422 and marked at the factory and should not be interchanged. Figure 4.1 illustrates the typical method of using the 422.

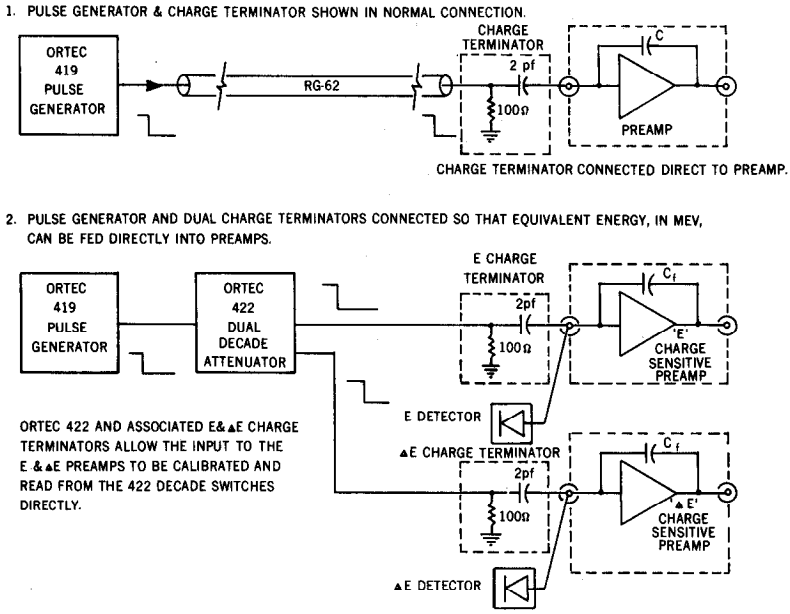


FIG. 4-1 INSTALLATION OF MODEL 422

5. CIRCUIT DESCRIPTION ETCHED BOARD 422-0101

The 422 consists of two identical channels. Each channel has a three decade Kelvin-Varley attenuator associated with it and an amplifier with a variable gain following the Kelvin-Varley decade attenuators. The advantage of the Kelvin-Varley attenuators is that the input impedance to the attenuator is constant, independent of the attenuator switch position. A π attenuator is in series with the ΔE decade attenuator and provides a X1 or X10 position. In the X10 position, the attenuator can be precisely calibrated by adjusting R66. The amplifier following the attenuators is a noninverting operational amplifier with feedback resistor R73 and load resistor R74. The gain of the amplifier is given by 1 + R73/R74. It can be seen then that the gain of the amplifier can be varied from approximately 1 to 3. The output voltage from the amplifier is taken from the collector of Q2. Transistors Q2 and Q3 provide the output power drive for the amplifier and transistor Q1 is the voltage amplification stage.

6. MAINTENANCE

6.1 Testing Performance of the Dual Decade Attenuator

6.1.1 Introduction

The following paragraphs are intended as an aid in the installation and checkout of the 422. These instructions present information on the waveforms at the output connectors and test points.

6.1.2 Test Equipment Required

The following or equivalent test equipment is needed:

1. Hewlett-Packard VTVM 412A
2. Tektronix Oscilloscope 545 with 1A1 Plug-In
3. ORTEC 419 Pulse Generator with calibrated charge terminator
4. ORTEC 410 Linear Amplifier

6.1.3 Preliminary Procedures

1. Visually check the module for possible mechanical damage.
2. Connect the ac power to a Nuclear Standard Bin such as the ORTEC 401A/402A
3. Plug the module into the Bin and check for proper mechanical alignment.
4. Switch the ac power on and check the dc power supply voltages at the test points on the 401A Power Supply control panel.

6.1.4 422 Pulse Tests

1. Feed the 419 attenuated into the 410. Set the controls on the 410 to the following positions:

   INPUT POLARITY: POSITIVE
   INTEGRATION: 0.2
   COARSE GAIN: X9
   2nd DIFFERENTIATOR: DL
   FINE GAIN: 3.0
   INPUT ATTENUATOR: X10
   1st DIFFERENTIATOR: DL

2. Adjust the controls on the 419 as necessary to obtain a 3-volt pulse at the 410 unipolar output.
3. Feed the 410 unipolar output to the 422 input.

4. Adjust the internal E CAL trimpot to obtain a 5-volt output at the E output connector, CN2.
5. Adjust the internal ΔE CAL trimpot to obtain a 5-volt output at the ΔE output connector, CN3.
6. Dial the E and ΔE tens decade switches down from 90 to zero. The output amplitude should decrease by approximately 0.5 volts per step.
7. Dial the E and ΔE ones decade switches down from nine to zero. The output amplitude should decrease by approximately 50 mV per step.
8. Set the E decade switches to 5. Dial the one-tenths decade switches down from 0.9 to zero. Check that each step decreases the output about equally.

6.2 Internal Amplifier Gain Adjustments

The internal amplifier gain adjustments provide a variable gain for the amplifier so that small inequalities in the E and ΔE charge terminators may be internally balanced out in the respective E and ΔE amplifiers.

In addition to the equipment needed in Section 6.1, a 109A Preamplifier and 408 Biased Amplifier are needed for this section. To calibrate the E and ΔE channels, proceed as follows:

1. Calibrate a system composed of a 419, 109A, 410, and 408 such that a 10 MeV equivalent input to the 109A from the 419 and its associated calibrated charge terminator will give an 8-volt output from the 408 Biased Amplifier. Set the controls on the above mentioned instruments as follows:

109A:	GAIN X1	408:	GAIN X10 BIAS LEVEL 700
419:	As necessary to give a 10 MeV equivalent charge via the charge terminator at the 109A input	410:	INPUT POLARITY Positive INPUT ATTENUATOR As necessary FINE GAIN As necessary COARSE GAIN As necessary INTEGRATION 0.5 1st DIFF 0.5 μsec 2nd DIFF 0.5 μsec

2. Remove the charge terminator associated with the 419 from the 109A input. Do not change the controls of the 109A, 410, or 408 for the remainder of

3. Feed the attenuated output from the 419 directly to the 422 input.

4. Set the 422 E and ΔE decades to tens-10, units-0, tenths-0. Notice that this corresponds to 10 MeV input settings when calibrated.

5. Feed the 422 E output through its associated E charge terminator to the input of the 109A. Adjust the output of the 419 until the 408 output is 8 volts. If 8 volts cannot be obtained by raising the 419 attenuated output voltage to its maximum value, adjust the E CAL trimpot clockwise until 8 volts are obtained at the 408 output. At this step, do not change the controls of the 419 for the remainder of this test.

6. Remove the charge terminator from the input of the 109A, but leave it connected to the 422 E output. Feed the 422 ΔE output through its associated ΔE charge terminator to the input of the 109A.

7. Adjust the ΔE CAL trimpot until the 408 output is again 8 volts.

   NOTE: At this point in the test, the internal amplifier and associated charge terminator on the E and ΔE channels of the 422 have been calibrated and equally balanced. This balance has been effected by feeding a known energy (10 MeV) into the 109A Preamplifier, and then separately feeding an input from the E and ΔE channels of the 422 such that an equivalent input of 10 MeV is fed into the preamplifier input.

8. Set the ΔE attenuator switch to X10. Set the ΔE decade switches to 90, 9, and 0.9.

9. Adjust the X10 CAL trimpot on the front panel for an 8-volt output on the 408.

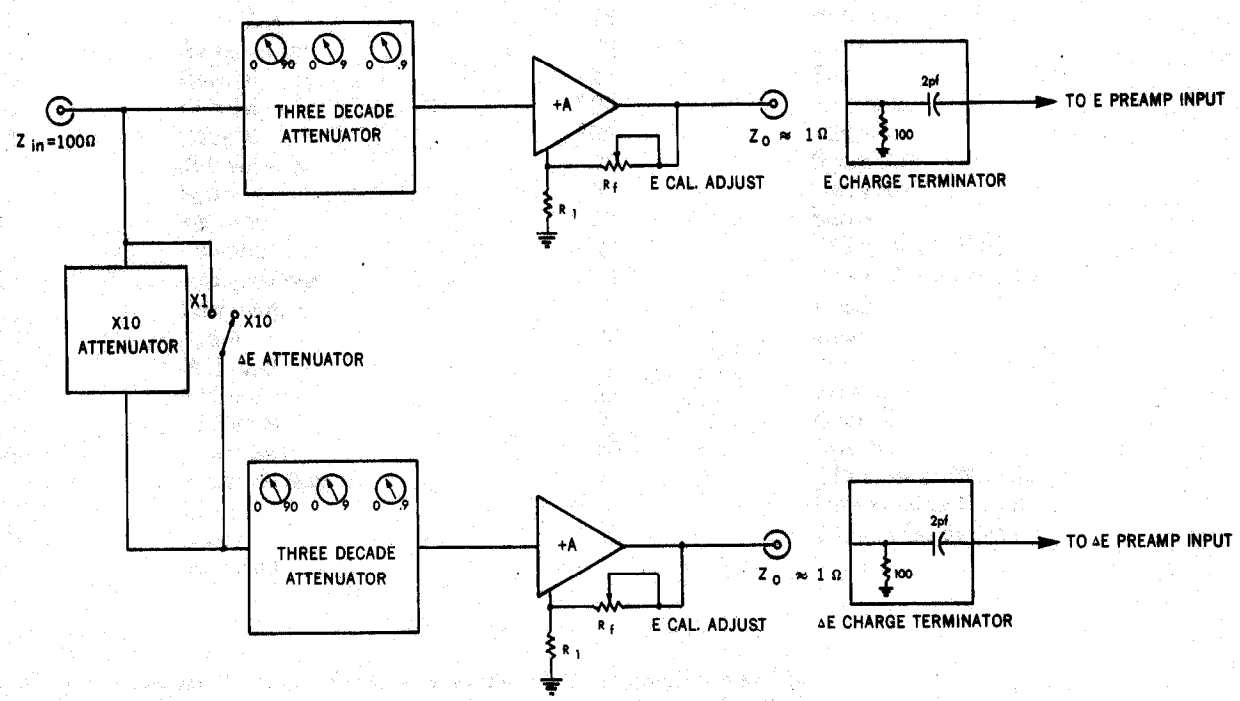
6.3 Suggestions for Troubleshooting

In situations where the 422 is suspected of malfunction, it is essential to verify such malfunction in terms of simple pulse generator impulses at the input and output. In consideration of this, the 422 must be disconnected from its integral position in a system and routine diagnostic analysis performed with a test pulse generator as an input and an oscilloscope as the output measuring devices. It is imperative that testing not be performed with the 422 connected into a system until the pulse generator-oscilloscope tests have been performed and satisfactory results obtained. The testing instructions of Section 6.1 and 6.4 of this manual and the circuit description of Section 5 should provide assistance in locating the region of trouble and repairing the malfunction. The guide plate and shield cover can be completely removed from the module to enable oscilloscope and voltmeter observations with a minimal chance of accidentally short-circuiting portions of the etched board. The 422 may be returned to ORTEC for repair service at nominal cost. The standardized procedure requires that each repaired instrument receive the same extensive quality control tests that a new instrument receives.

6.4 Tabulated Test Point Voltages

The following voltages are intended to indicate the typical dc voltages measured on the etched circuit board. The voltages should not be taken as absolute values, but rather are intended to serve as an aid in troubleshooting.

Location	Q1c	Q1e	Q4c	Q4e
Typical Value	16.6V	-0.62V	16.6V	-0.62V



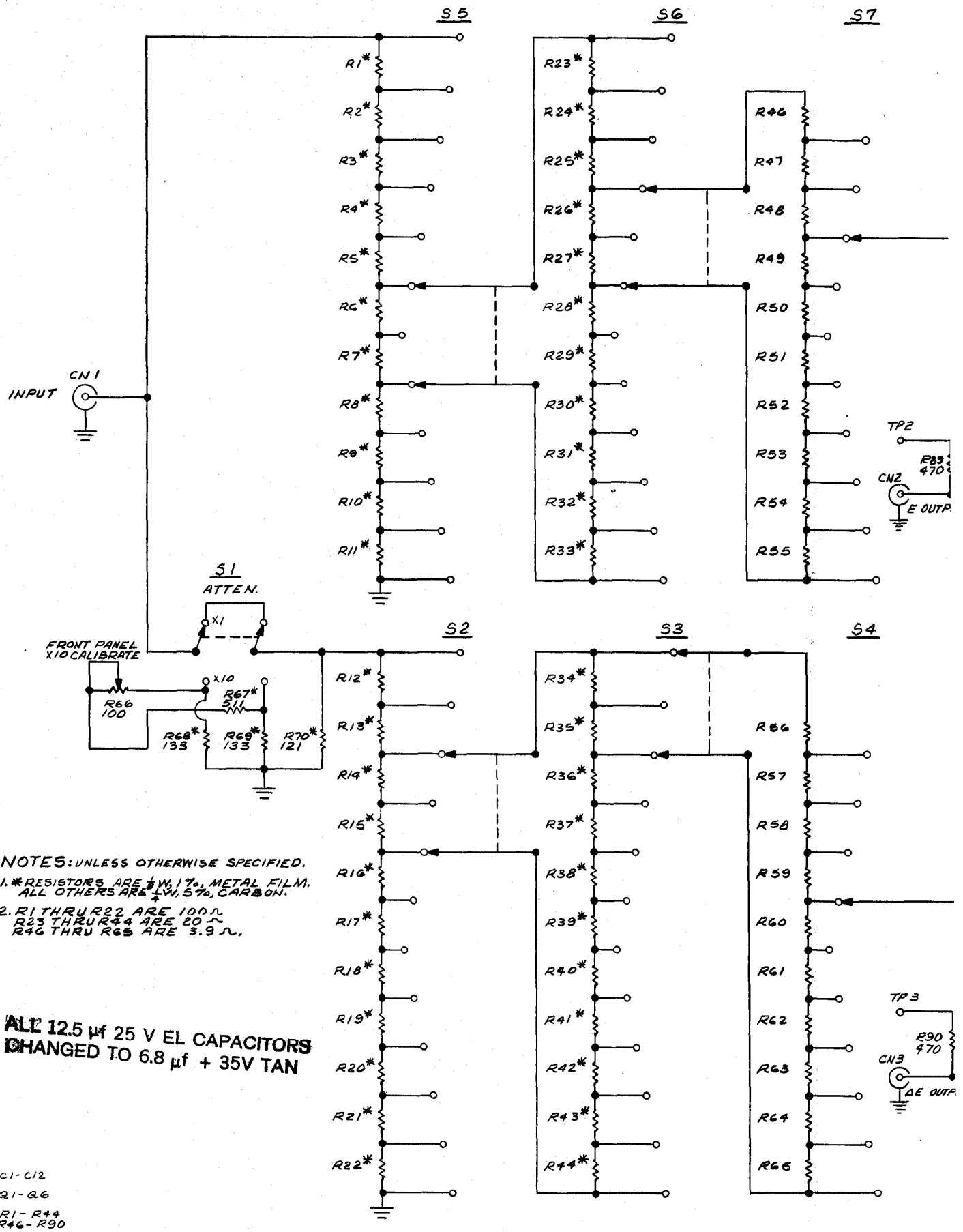
NOTE: THE E AND ΔE CHARGE TERMINATOR ARE NOT INTERCHANGEABLE.

Figure 6-1

BIN/MODULE CONNECTOR PIN ASSIGNMENTS
FOR AEC STANDARD NUCLEAR INSTRUMENT MODULES
PER TID-20893

Pin	Function	Pin	Function
1	+3 volts	23	Reserved
2	- 3 volts	24	Reserved
3	Spare Bus	25	Reserved
4	Reserved Bus	26	Spare
5	Coaxial	27	Spare
6	Coaxial	*28	+24 volts
7	Coaxial	*29	- 24 volts
8	200 volts dc	30	Spare Bus
9	Spare	31	Carry No. 2
*10	+6 volts	32	Spare
*11	- 6 volts	*33	115 volts ac (Hot)
12	Reserved Bus	*34	Power Return Ground
13	Carry No. 1	35	Reset
14	Spare	36	Gate
15	Reserved	37	Spare
*16	+12 volts	38	Coaxial
*17	- 12 volts	39	Coaxial
18	Spare Bus	40	Coaxial
19	Reserved Bus	*41	115 volts ac (Neut.)
20	Spare	*42	High Quality Ground
21	Spare	G	Ground Guide Pin
22	Reserved		

**These pins are installed and wired in parallel in the ORTEC 401A Modular System Bin.*



NOTES: UNLESS OTHERWISE SPECIFIED.

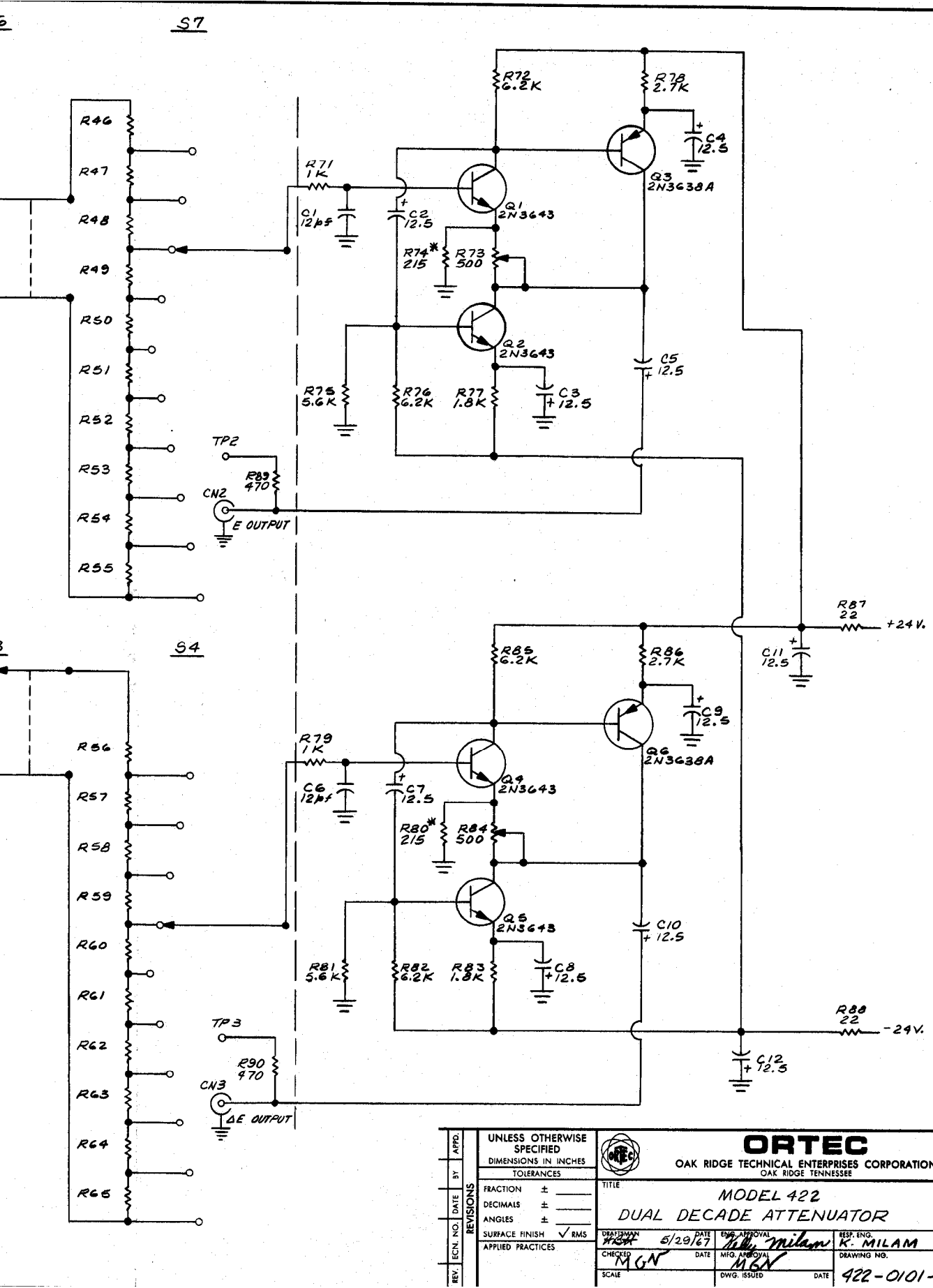
1. * RESISTORS ARE ¼W, 1%, METAL FILM. ALL OTHERS ARE ¼W, 5%, CARBON.
2. R1 THRU R22 ARE 100 Ω.
   R23 THRU R44 ARE 20 Ω.
   R46 THRU R65 ARE 3.9 Ω.

ALL 12.5 µf 25 V EL CAPACITORS CHANGED TO 6.8 µf + 35V TAN

C1-C12

Q1-Q6

R1-R44
R46-R90



REVISIONS	REV.	ECN. NO.	DATE	BY	APPD.

UNLESS OTHERWISE SPECIFIED
DIMENSIONS IN INCHES
TOLERANCES
FRACTION ±
DECIMALS ±
ANGLES ±
SURFACE FINISH ✓ RMS
APPLIED PRACTICES

ORTEC
OAK RIDGE TECHNICAL ENTERPRISES CORPORATION
OAK RIDGE TENNESSEE

TITLE
MODEL 422
DUAL DECADE ATTENUATOR

DRAFTSMAN	DATE 5/29/67	ENG. APPROVAL	RESP. ENG. K. MILAM
CHECKED MGN	DATE	MFG. APPROVAL MGN	DRAWING NO. 422-0101-S1
SCALE		DWG. ISSUED DATE	

The transistor types installed in your instrument may differ from those shown in the schematic diagram. In such cases, necessary replacements can be made with either the type shown in the diagram or the type actually used in the instrument.