IRT 6302-006

AUTOMATED DENSITOMETER AD-103 WITH FLASH TUBE INSPECTION GAUGE MODEL AFTG-3

Operations Manual

Prepared for

OLIN CORPORATION
Technical Systems Operation
Marion, Illinois

Under

Government Contract 300812/F33657-78-C-0096
Purchase Order TS015120

May 25, 1981

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CHAPTER 1

INTRODUCTION

The Automated Densitometer, Model AD-103 with Flash Tube Inspection Gauge, Model AFTG-3, is a computer-controlled dual gauge developed by IRT Corporation to satisfy the requirements for flash tube associated defect inspections of GAU-8/A primed cartridge casings. The system automatically inspects the casings for the amount of igniter pellet material within the flash tube, compares the amount to internally set limits, and provides an accept/reject signal to the production line.

The heart of the system is a PDP 11/03 computer which controls the entire operation and provides a means for digitally processing the signals for maximum reliability and precision. The gauge consists of the computer, radioactive sources, source housings, detector systems and casing transport system. The stand-alone unit accepts primed cases from the rotary unscrambler table, makes the inspection, and transports the accepted casings to the load-and-assemble machine. The computer controls the gating mechanisms which cycles casings in and out of the gauge and the mechanism for automatic removal of unacceptable casings. The system will reject casings with missing pellets, flash tubes, and/or primers. The system is designed to be "fail safe" in that a positive accept signal is required to open the gate to the load-and-assemble machine.

The next chapter describes the system operation and subsequent chapters present a detailed description of the system and procedures for calibration, operation and maintenance. The appendices provide component manuals and other information.

CHAPTER 2

SYSTEM OPERATION

2.1 PRINCIPLE

The inspection technique is a photon radiation transmission method. It utilizes the phenomenon of gamma radiation interacting with material in its path, resulting in absorption and scattering of a portion of the incident beam. The three processes of gamma interaction are (1) photoelectric, (2) Compton scattering, and (3) pair production. The degree to which each process contributes to the total absorption is dependent upon the photon energy, the atomic number, and the amount of the absorber material. The attenuation of the photon beam can be described by a simple exponential law:

$$R_T = R_o e^{-\mu\rho x}$$

where R_T = detector response with a sample in the path of the beam, R_o = detector response with no sample in the path of the beam, μ = mass absorption coefficient (cm^2/g), ρ = material density (g/cm^3), and x = material thickness (cm). The mass absorption coefficient accounts for all three absorption processes mentioned above.

The dependency of this mass absorption coefficient upon the photon energy, atomic number of material, and the amount of material requires a photon source of sufficient energy to penetrate the primer material and yet be of sufficient sensitivity to variations in the ignitor material to provide a measurable signal differential.

The system measures the photon beam transmitted through the inspected casings and compares this signal to the uncollided beam (no casing present) and generates a corrected inspection measurement value. This value is then compared to an accept/reject threshold value set into the system. This accept/reject threshold is determined from the measurement of calibration standards. This method of measurement (comparison to the uncollided beam) makes the system self calibrating and compensates for the decay of the source with time, variation of background, and minor electronic drift.

2.2 OPERATIONAL SEQUENCE

Figure 1 shows an overall view of the system angled from the exit end of the gauge. The two casings on the left have been through the inspection and are progressing to the load-and-assemble machine. There are two casings to the right of these, one obscured by the frame, which have just left the inspection area and two casings in the inspection area; additional casings are stacked up awaiting entrance. Figure 2 shows a close-up view and the reject mechanism. Figure 3 is a close-up view showing the registration and V-blocks, the source housing and the dual piston entrance gate. The actual gate pins are obscured by the sensors and the support mechanism.

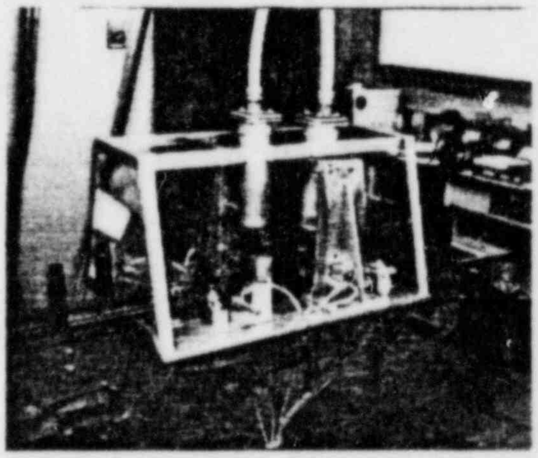

Figure 1. Overall view of gauge

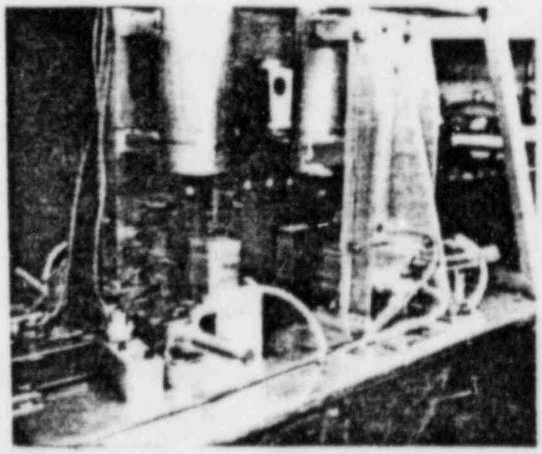

Figure 2. Close-up view of system

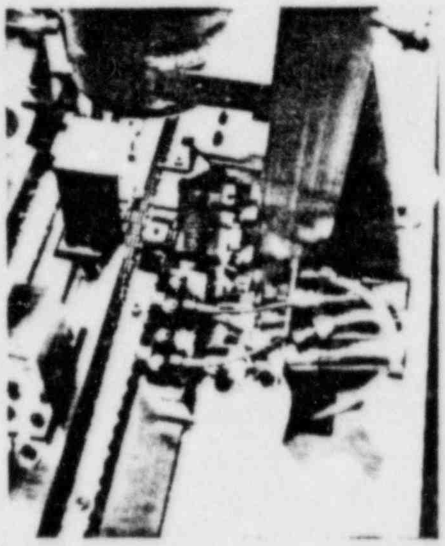

Figure 3. View of source housing, V-block and entrance gate

Primed casings enter the gauge in two columns from the rotary unscrambler table onto the transfer belt and are individually admitted to the inspection area. Entrance into the inspection area is controlled by means of air-operated pistons actuated by signals from the computer. A dual gate for each gauge is used to ensure that only a single casing enters the inspection station. Only one of the two gates is open at any one time. Gate two opens upon command whenever a casing is sensed at that station and the system is set for an inspection. Gate 1 works in tandem with the V-block arrestor pin and opens immediately after a casing has been inspected. Once the casing passes the second gate, it is transported to the inspection station, once sensed here by sensor 3 the computer signals the V-block to close and starts the inspection. An arrestor pin stops the casing at the inspection station in line with the V-block to aid in clamping. Once inspected the clamp opens and the arrestor pin is withdrawn and the casing is transported towards the load-and-assemble machine. If the casing is acceptable, the reject arm is signalled to retract and allow the casing to proceed. If the casing is unacceptable, no signal is given and the reject arm catches the casing. A sensor, sensor 4 at the reject station, detects the casing and signals the reject arm to retract, thereby pushing the rejected casing aside over an opening in the main frame. An additional sensor, sensor 5, along the line to the load-and-assemble machine is used to block entrance of casings into the inspection area if there is a backlog of casings awaiting pickup by the load-and-assemble machine.

The system operates in a "fail-safe" mode in that an "accept" signal is required to move the reject arm from the transport line. All gates, the arrestor pin and the reject arm are spring loaded in and come out with power. Figure 4 shows an electronic schematic of the system.

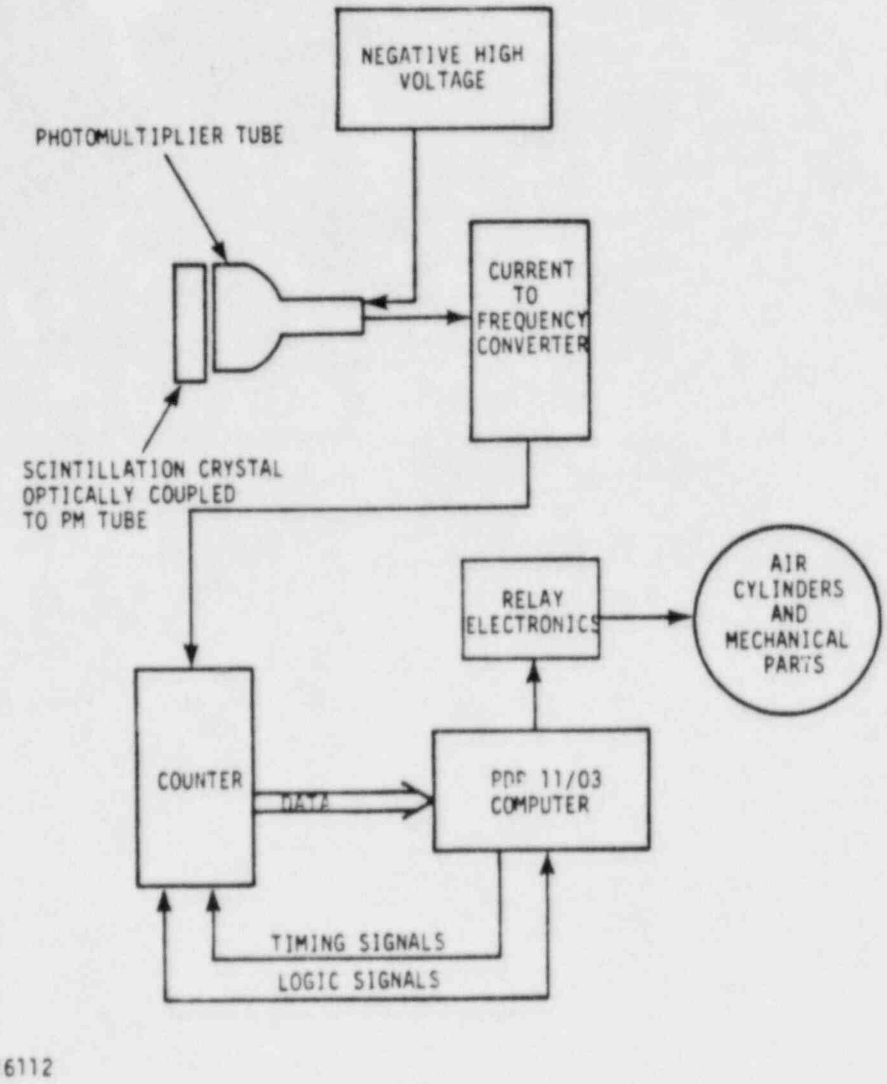

Figure 4. Flash tube inspecton gauge electronic configuration

2.3 ACCEPT/REJECT DECISION

The system makes a 5/60 second calibration reading through air following each inspection and makes a series of these reading whenever the system is idling, i.e., if no casings are being admitted at the entrance gate. This data is stored in the memory for reference and is exponentially summed over the most recent 12 bits of data to generate an updated one-second calibration count. This current number is multiplied by the value set in the threshold module to give the basis for the accept/reject decisions made by the computer following each inspection. This number is the count limit for an acceptable casing; any casing with a count in excess of this value will be rejected. The upper threshold is set as protection against anomously low counts which may indicate a malfunction of the inspection system or some foreign material in the casing. The inspection count time is 0.9 of a second. Following each inspection count the computer compares the inspection count with the product of the current calibration count and the threshold input. If the inspection count is between the two set thresholds the casing is acceptable. An accept signal is generated which retracts the reject arm, allowing the casing to proceed to the load-and-assemble machine and another casing is admitted to the system.

If the inspection count is outside these limits no accept signal is generated and the reject arm will catch the casing and remove it from the line.

This measurement technique is statistical by nature, both in the calibration count and inspection count because of the nuclear process so there is a certain probability of an incorrect decision. Proper setting of the threshold input is necessary to bias the decision toward occasionally rejecting an acceptable part to minimize or eliminate accepting an unacceptable part. Once properly calibrated the system will perform reliably and consistently with a low probability of accepting out-of-tolerance parts.

2.4 SYSTEM WARNING DEVICE

The system is equipped with a warning light:

- continuous on indicates that the system is operating
- ~~rapid blinking indicates that the computer has halted~~
- slow blinking indicates that there is some problem with the I_o calibration count
- continuous off indicates that the system is in the "bypass" mode or light is burned out.

2.5 BYPASS OPERATION

The system has a bypass mode which allows direct transport of casings from the rotary unscrambler table to the load-and-assemble machine.

A bypass switch located on Panel A in the electronics cabinet supplies power to the entrance gate solenoid valve, the arrestor solenoid valve and the reject solenoid valve. These are then held in the retracted positon and allow the casings to pass unmolested through the machine.

CHAPTER 3

DESCRIPTION OF THE SYSTEM

The system has two basic units:

1. The gauging unit consisting of the radioactive sources, source housings and collimators, detection systems, and transport system, and
2. A control console which contains the computer and nuclear electronics components.

A third (secondary) unit is an vapor-tight junction box which interconnects the two basic units and contains the solenoid valves and transport control switch.

3.1 CONTROL CONSOLE

3.1.1 Cabinet

The control console unit is a dust-proof vapor-tight cabinet 6 feet tall by 2 feet wide by 2.5 feet deep. It has two full-length lockable doors, front and back, and is equipped with an external off-on switch which secures power to the entire system. An internal power switch controls power to the computer and transport system, but allows the other electronics to remain powered. There are three cable connections to this unit located on top. One provides for incoming line power, the second interconnects to the gauge detector system, and the third connects to the junction box to interface with the transport system controls.

3.1.2 Computer and Input/Output Modules

The computer is a PDP 11/03. This system is a packaged version of the LSI-11 microcomputer. The computer has a 4K word memory, a processor, an arithmetic chip, and power supply. Four additional boards are plugged into the computer frame: two parallel interface boards, one PROM board, and one serial interface board.

One parallel interface board links the preset inputs module to the computer. The other parallel interface controls the 772 counter and the input/output modules. The PROM board contains the permanent operating program for the gauge. The serial interface board is used for communication with a service terminal or with an optional printer. The input/output module system is used as an isolation interface between the computer and the gauge hardware. These modules provide over 1500 volts of isolation between the computer's +5 volt DC control signals the 115 volt AC and 12 VDC hardware controls. This modular system helps to diagnose problems related to gauge control. The modular system is easily expandable to cover future changes or revisions. The modules themselves are solid state, providing a high degree of reliability.

3.1.3 Nuclear Electronics

The nuclear electronics unit is a NIM system consisting of an ORTEC 402A NIM BIN and power supply containing three modular units. An ORTEC 456 High Voltage Power Supply provides negative high voltage to the photomultiplier tubes. The IRT Preset Input module Model PI-100 provides for setting threshold inputs to the computer and for displaying certain computer output information necessary for setting up and adjusting the system. The ORTEC 439 Digital Current Integrators receive the current output signal from the photomultiplier tubes and converts it to a frequency (digitized) signal to the counter. The ORTEC 772 Counters accept and hold the digitized output of the current integrators (counts) until the computer requests that the data be transferred.

Additional details of these units are provided in Chapter 8, entitled "Manuals and Specification Sheets".

3.2 GAUGING UNIT (Refer to Figures 1, 2, and 3)

3.2.1 Transport System

The casing transport system consists of a split steel belt driven by an explosion-proof motor through a pulley/timing belt drive system. The belt runs at a constant speed and transports the casings from the rotary unscrambler table into the gauge and to the load-and-assemble machine. The casings are secured on the belt by guide rails. Power is supplied from the console through the junction box switch.

3.2.2 Entrance and Exit Gates

The entrance and exit gates are solenoid-operated Bimba air pistons (spring loaded in the closed position) with steel pins attached to the shafts. The pins extend over the belt drive to restrain casings. The pistons are controlled by the computer through solenoid valves located in the junction box.

3.2.3 Registration Plate and V-Block Clamp

The plate and clamp provide the means for holding the casing rigidly in the inspection station. The V-block is shaped to fit the casing for proper registration and is made of aluminum with a hard anodized finish. The plate is tool steel on a tapered block and is the fixed registration. The V-block is attached to a Bimba air piston and, when in the inspect mode, the V-block is extended under air pressure position. The operation is controlled by the computer through solenoid valves in the junction box.

3.2.4 Casing Sensor

The casing sensors are Turck Model NI5-K11-YO inductive sensors which signal the computer information concerning the position of casings. This information then allows the computer to determine operational sequences. The sensors function like switches but do not require intimate contact with the casings. Sensor signals are fed to Turck multi-safe amplifiers at the console.

3.2.5 Detector Unit

The detector unit consists of thick-walled aluminum tubes containing an EMI 9856B photomultiplier tubes optically coupled to a Bicron 2R2 sodium iodide scintillation crystals, dynode voltage distribution chains, and a lead shield/collimator units. The scintillator absorbs the gamma rays and emits visible light which is detected by the photomultiplier tubes amplified and transmitted to the nuclear electronics. The collimator in conjunction with the source collimator defines the inspection path.

3.2.6 Radioactive Source and Housing

The radioactive sources are Amersham Model AMC 16 containing nominally 45 millicuries of the isotope ^{133}Ba each. The isotope is contained on a ceramic disk which is encapsulated in a stainless steel capsule with a diameter of 0.43 inch and a height of 0.42 inch. The active source diameter is 0.30 inch.

The source is contained in a tungsten cylinder which rotates within a lead shield. The source is held in place within the tungsten cylinder by a threaded steel plug. The cylinder is held in the operate position (source directed upward) by a spring-loaded detent pin which engages the source-positioning arm. Disengaging this detent pin allows the cylinder to rotate downward under gravity so that it is within the lead shield. Rotating the arm ~30 degrees further puts the source in the storage position. A hole in the rotating arm is then aligned with a hole in the transport system support frame so that a padlock can be inserted to lock the source in the storage position. It is recommended that the source be left in the operate position except for maintenance work above the source.

3.3 JUNCTION BOX

This is an vapor-tight box which contains the solenoid valves and interconnecting wiring terminals and provides cable interfacing between the control console and transporter. In addition, it has an on/off switch which can control the operation of the drive mechanisms and solenoid valves.

CHAPTER 4

SYSTEM SETUP PROCEDURES

4.1 SWITCH SETTINGS

The individual module controls are usually left on so that the entire system can be powered from the main power switch. The following paragraphs describe the various subsystem controls and their normal settings for a standard power-on.

4.1.1 Computer

The computer has the following controls:

1. Three computer front panel switches which must be in the UP position.
2. A power-on switch at the rear of the computer which must be set to ON.

4.1.2 NIM BIN

The NIM BIN supplies power to the ORTEC 439 Digital Current Integrator and the ORTEC 772 Counter. The switch located on the right-hand side of the NIM BIN must be set to ON. The NIM BIN also contains the IRT Preset Input Module Model PI-100 powered from the computer and its internal supply. Also mounted in the bin is an ORTEC 456 High Voltage Power Supply which contains its own power. Front panel illustrations of the ORTEC units are provided in the manuals in Chapter 8. Figure 5 is an illustration of the Preset Input Module. The switch settings for each of the modules are as follows:

4.1.2.1 <u>ORTEC 439 Digital Current Integrator</u>

1. BALANCE/TRIGGER: N/A
2. POLARITY: Negative
3. TEST/STANDBY/OPERATE: OPERATE

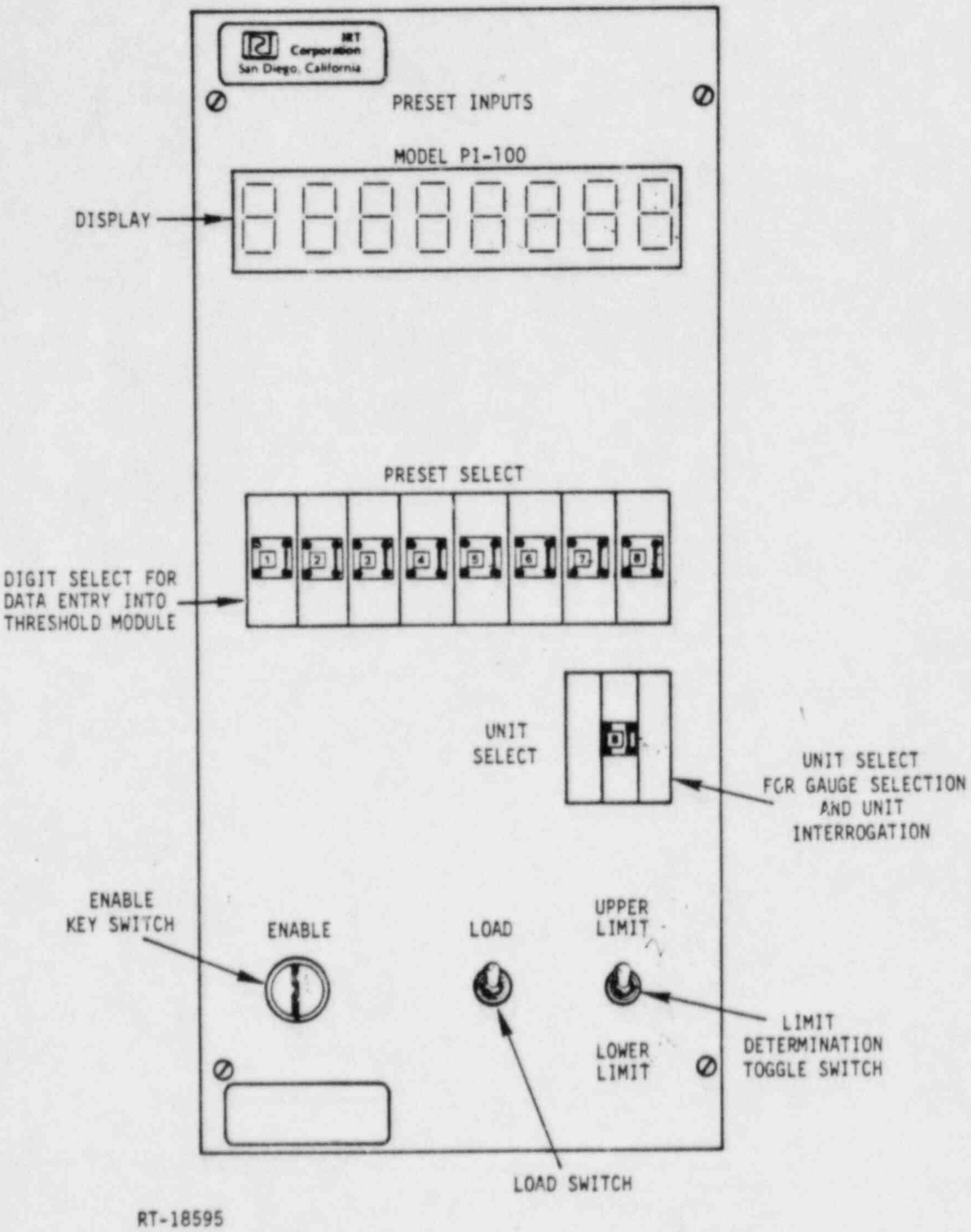

Figure 5. Front panel of Preset Input Module

4. MULTIPLIER: 10^3

5. CURRENT FS: 10^{-9}

6. COUL/PULSE: 10^{-10}

4.1.2.2 ORTEC 772 Counter. The controls on the counter must be set as follows:

1. MASTER/NORM/SLAVE: SLAVE
2. COUNT/STOP: COUNT

4.1.2.3 IRT PI-100 Preset Input Module. The controls on the input module need not be set for startup but must be set for proper operation as described in subsections 5.3 and 5.4.

1. ENABLE: KEY WITHDRAWN
2. LIMIT DETERMINATION SWITCH: See subsection 5.3
3. UNIT SELECT THUMBWHEEL: See subsection 5.3
4. PRESET SELECT THUMBWHEELS: See subsection 5.3.

4.1.2.4 ORTEC 456 High-Voltage Power Supply. The controls on the high-voltage power supply must be set as follows:

1. POWER: ON
2. POLARITY (REAR): NEG.
3. VOLTAGE: 6 position switch to zero.

   5 position switch to 500

   Potentiometer to zero

   See subsection 5.2 for setting of proper operation voltage.

4.1.3 Circuit Breakers

A two-pole circuit breaker, located on the rear electrical panel, controls all power for the system.

4.1.4 Emergency Stop

The system is equipped with an emergency stop switch on the junction box which controls both the motor and solenoid power. The normal setting of the emergency stop switch is ON.

4.2 WARMUP TIME

Within the system there are a number of electronic modules which require temperature stabilization. Optimum results are achieved if the system is allowed to warm up for a minimum of two hours.

NOTE

It is recommended that power to the electronics be left ON at all times.

4.3 INITIAL STARTUP

The system is self-starting, so that once power is turned on it is ready to begin operation. Following the calibration and setting the proper voltage and threshold limits, the system is ready to begin inspection.

CAUTION

Even with the main power switch turned OFF, the system has live voltage internally.

In response to application of main power, the inspection gauge motor/transfer belt will start running provided the cover interlock is engaged and the EMERGENCY STOP switch is on.

1. Feed the transfer belt with cartridges to be inspected.
2. Allow the gauge to inspect eight to ten cartridges before starting the load-and-assemble machine.

4.4 PRODUCTION OPERATION

The system will now operate in a continuous manner as cartridges are supplied from the rotary unscrambler.

CHAPTER 5

SYSTEM CALIBRATION

The following calibrations must be performed on the system after it has reached temperature stabilization; approximately two hours after power is turned on.

5.1 CURRENT INTEGRATOR

1. Set the TEST/STANDBY/OPERATE selector to STANDBY.
2. Set BALANCE/TRIGGER switch to BALANCE.
3. Using a small flat blade screwdriver, adjust the balance screw until the upper meter (BALANCE/TRIGGER METER) reads exactly zero (center).
4. Set BALANCE/TRIGGER switch to TRIGGER.
5. Adjust the TRIGGER screw until the upper meter reads zero.
6. Repeat steps 2 through 5 until no readjustment is required. (There is a small interaction between the trigger/balance adjustments.)
7. Set TEST/STANDBY/OPERATE selector to OPERATE.

5.2 PHOTOMULTIPLIER OPERATING HIGH VOLTAGE ADJUSTMENT

CAUTION

The high voltage can deliver a fatal electric shock.

This voltage adjustment is made using the 10-turn potentiometer on the front panel of the ORTEC 456 High-Voltage Power supply (the 6-position switch is at zero and the 5-position switch is at 500, as specified in subsection 4.1.2.4) and the potentiometers on the High Voltage Distribution Module. This potentiometer has a range of 0 to 100 volts and therefore each full turn is equivalent to 10 volts.

NOTE

The inspection area must be clear and the source in the operate position.

The adjustment fine tunes the photomultiplier to give a calibration count, I_o, of approximately 10,000 counts in a one-second time interval and is essential for proper system operation.

Turn potentiometer clockwise from zero while observing the current integrator current input meter (lower meter) and adjust until one current meter indicates full scale (switch settings must be as described in subsection 4.1.2.1). Make sure other gauge meter does not exceed full scale.

Set unit select thumbwheel on position 9 and limit determination switch to lower for gauge 1 and upper for gauge 2 on Preset Input Module. The one-second I_o value will then be displayed on the Preset Input Module. Since the I_o determination is dynamic, the display will not be constant but will cycle (last two digits will normally undergo constant change).

Fine tune the potentiometers on the high-voltage distribution module until the average I_o is between 9975 and 10025 for each gauge.

NOTE

Clockwise will increase count rate and counterclockwise will decrease count rate--small potentiometer changes will make large changes in the count rate. There is a short lag time between changes and a stable count rate.

Recheck I_o several times before proceeding.

NOTE

This calibration must be made after the current integrator calibration.

5.3 THRESHOLD SETTING DETERMINATION

The setting of the threshold, T, is determined from the calibration data obtained by testing the inspection masters. The threshold input controls the accept decision by

$I < I_o \times T$, otherwise reject.

where

I = gauge reading with primed casing

I_o = reference (gauge reading with no primed casing). See subsection 5.2.

T = threshold switch value.

The threshold value can also be empirically determined by using the inspection masters to arrive at a T setting which discriminates between two and three pellets. This procedure is detailed in the next section.

5.4 PRESET INPUT THRESHOLD SETTING

The PRESET INPUTS module Model PI-100 is designed to store the threshold limits for the inspection gauge. Please refer to Figure 5.

To set the lower threshold limit:

1. Insert the key into the ENABLE lock; turn key clockwise.
2. Thumb the threshold value, T, into PRESET SELECT.
3. Thumb a 1 into UNIT SELECT.
4. Select lower limit.
5. Push LOAD switch up for one second. Release switch; value will appear in display.

   <u>NOTE</u>: Computer must be on for value to appear in display.

6. Repeat 2 through 5 for gauge 2. (Thumb in 2 in step 3.)
7. If wrong value is programmed, repeat steps 2 through 5.
8. Turn ENABLE key counterclockwise. Remove key.

The upper threshold is set in the same manner with the upper limit selected in step 4. This limit is set to reject on unusually low readings, i.e., too much igniter or some malfunction.

The computer outputs operational data for temporary storage to the PRESET INPUTS module. The UNIT SELECT numbers will provide the display information given in Table 1 with LOWER LIMIT selected.

To obtain the proper level to set into the Preset Input Module for the accept/reject decision it is necessary to obtain statistical data from a set of defect masters

Table 1. Display Information Provided for UNIT SELECT Numbers

Unit Select Number	Display	
0	Operation number - place in program	Upper Gauge 2 Lower Gauge 1
1	Gauge 1 Threshold Value	Upper high load Lower low load
2	Gauge 2 Threshold Value	
3	Not used	
4	Production data	Upper number of rejects Lower number of inspections
5	Not used	
6	Not used	
7	Not used	
8	Accept/Reject Value (I_o x Threshold)	Upper Gauge 2 Lower Gauge 1
9	I_oValue	
10	Actual Count	
11	I_o control	Upper minimum acceptable % Lower minimum acceptable [illegible]
12	Not used	
13	Not used	
14	Not used	
15	Not used	

(primed casings with two pellets in the flash tube). After the system has been set up and calibrated as per Chapter 4 and subsections 5.1 and 5.2, and after I_o is stabilized near 10,000, run the set of defect masters through the inspection gauge individually and record the count following each inspection. Count is displayed in Preset Input Module if UNIT SELECT thumbwheel is set at 10. Record the count for each measurement--a minimum of 15 measurements is necessary so the defect masters may have to be cycled through the systems several times.

Determine statistically the mean count value for the set of measurements and the standard deviation. The mean count, X, is determined by

$$\overline{X} = \frac{\Sigma_i X_i}{N}$$

where

X_i is the individual count

N is the number of counts

The standard deviation σ is determined by

$$\sigma = \sqrt{\frac{\Sigma(X-\overline{X})^2}{N}}$$

The threshold, T, is set such that the level (I_o x threshold setting) is 4.0 to 4.5 σ below the mean count value.

For example, if

$$I_o = 10{,}000$$

$$\overline{X} = 4{,}500$$

$$\sigma = 40$$

Then

$$I_o \times T = 4500 - (4 \times 40)$$

$$T = \frac{4500-160}{10{,}000}$$

$$= 0.4340$$

The preset value to be entered into the Preset Input Module would then be 4340 right adjusted. The computer is set to account for the decimal point with the numbers right adjusted. Entering this number is described in the following section.

Once entered into the Preset Input Module the accept/reject limit (I_oxT) can be seen on the display by selecting **8** on the UNIT SELECT thumbwheel. Again there will be a statistical variation because of the variation in I_o.

Following the calibration and setting of the accept/reject value the defect masters should be cycled through the system to verify that they are rejected.

This same kind of statistical data should be obtained with a set of accept masters (primed cases with three pellets) to check that the rejection of acceptable unit is not excessive.

In this case the limit should be set at approximately 2.5 σ above the mean count value of this set.

Minor adjustments to the threshold setting may have to be made but the final setting must be biased toward the occasional rejection of an acceptable unit.

CHAPTER 6

RADIOACTIVE SOURCE INSTALLATION AND REMOVAL

6.1 RADIATION SAFETY

CAUTION

Radioactive materials emit energy which has the power to damage living tissue.

This unit uses a radioactive source in the measurement process and hence involves a possible radiation hazard.

When in the operate position, the dose rate at the closest approach of personnel (outside of the protective cover) is less than 1 millirem/hr and does not constitute a significant radiation hazard.

Inside the cover there are areas which are relatively dangerous if the main trunk of the body were present for a long period of time. Fortunately the whole body cannot reach these areas without undue torture. Directly above the source the dose rate is of the order of 50 millirem/hr and adjacent to this location, where the rejected casing is removed, the dose rate is <1 millirem per hour.

With the source in the storage position the dose rate at any location on the device is less than 1 millirem/hr, even in contact with the source shield. No significant radiation hazard exists.

Installation or removal or replacement of the source must only be done by qualified personnel who are familiar with techniques for handling radioactive material and are aware of proper procedures and radiation hazards.

It should not be necessary to remove the source from the system once the system is installed and in operation. Locking the source in the stored position is adequate for purposes of security and safety.

6.2 INSTALLATION

To install the source, first remove the protective cover from the main frame and remove source storage lever (side of main frame). Rotate source housing such that plug is visible. Place the source container atop base plate on main frame.

The following procedures are recommended to safely install the source. Figure 6 shows source capsule, collimator, and source housing. <u>NOTE</u>: This is a one-person operation--casual observers are discouraged.

1. Remove plug from source housing.
2. Insert collimator--chamfered end down.
3. Remove the top of the source container and place alongside bottom section (container serves as a shield while manipulating source).
4. With tweezers or tongs remove source from container and place behind container with smooth side down. *<u>CAUTION</u>: Dose rate at contact with source is in excess of 1R/hr.*
5. Push source support onto source and lower into source housing atop collimator.
6. Insert threaded plug--plug should clear surface of source housing.
7. Rotate source housing 90 degrees counter-clockwise and reattach lever on side of frame. Keep even spacing on both sides of bracket.
8. Put storage container away and replace protective cover.

6.3 REMOVAL

Again remove protective cover, place source container atop base plate on main frame as for installation, and remove source storage lever.

1. Remove plate from bottom of main frame below source.
2. Rotate source housing to expose threaded plug. Remove plug.
3. Insert 1/4 inch diameter, 12 inch long rod into source housing from below. Push collimator source and source support upwards.
4. Pick up source/source support with tongs or tweezers and place source inside container. Disengage source from source support.

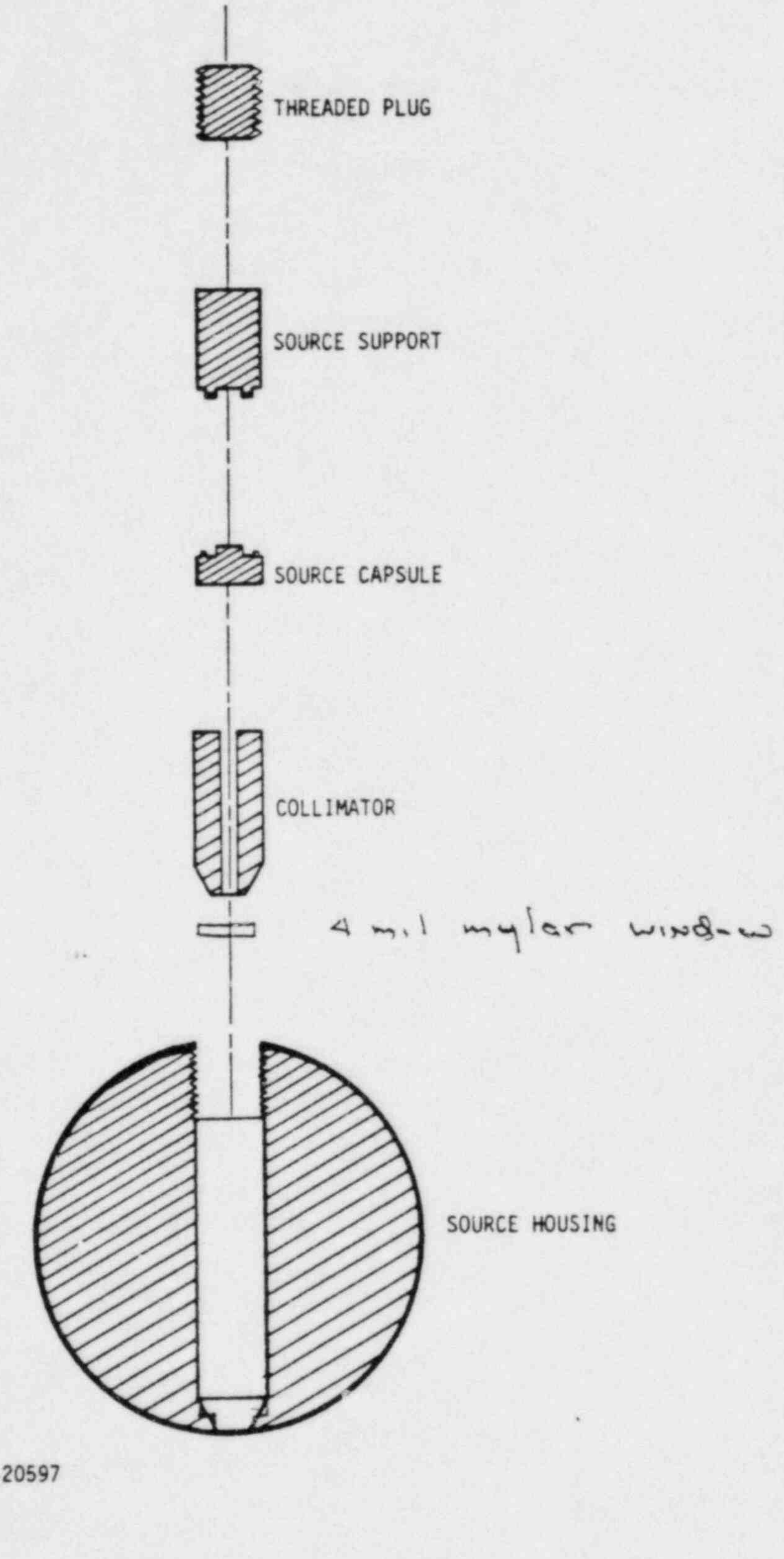

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Figure 6. Threaded plug, collimator, source support, source capsule, and source housing

5. Remove rod slowly until it is determined source is disengaged, and place top on source container. Tape source container shut and put in storage.
6. Reinsert collimator source support for safekeeping, and replace protective cover and source storage lever.

CHAPTER 7

MAINTENANCE

The system is mechanically designed to be maintenance free. All moving parts are self lubricated where necessary. Preventive maintenance as described below is necessary.

Routine mechanical adjustment and alignment maintenance as well as the calibrations as described in earlier sections and in Chapter 8, "Manuals and Specification Sheets", are required for smooth operation. Check transport system for debris and clean weekly with a vacuum. Clean collimator opening daily, or as necessary, with cotton swab to remove any debris.

On a semiannual basis a standard leak test must be performed on the radioactive source. Since the source is contained in the source housing under the collimator, this test can be performed by taking a smear at the closest approach to the source, i.e., source housing or with a swab, inside the collimator. Take note of warning in Chapter 6.

CHAPTER 8

MANUALS AND SPECIFICATION SHEETS

Models 401A and 401B
Modular System Bins
Model 402A
Power Supply
Operating and Service Manual

This manual applies to instruments marked
401A "Rev 40" on rear panel
401B "Rev 08" on rear panel
402A "Rev 37" on rear panel

Printed in U.S.A.

2818 05C 0679

STANDARD WARRANTY FOR EG&G ORTEC INSTRUMENTS

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EG&G ORTEC's exclusive liability is limited to repairing or replacing at EG&G ORTEC's option, items found by EG&G ORTEC to be defective in workmanship or materials within one year from the date of delivery. EG&G ORTEC's liability on any claim of any kind, including negligence, loss or damages arising out of, connected with, or from the performance or breach thereof, or from the manufacture, sale, delivery, resale, repair, or use of any item or services covered by this agreement or purchase order, shall in no case exceed the price allocable to the item or service furnished or any part thereof that gives rise to the claim. In the event EG&G ORTEC fails to manufacture or deliver items called for in this agreement or purchase order, EG&G ORTEC's exclusive liability and buyer's exclusive remedy shall be release of the buyer from the obligation to pay the purchase price. In no event shall EG&G ORTEC be liable for special or consequential damages.

QUALITY CONTROL

Before being approved for shipment, each EG&G 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

If it becomes necessary to return this instrument for repair, it is essential that Customer Services be contacted in advance of its return so that a Return Authorization Number can be assigned to the unit. Also, EG&G ORTEC must be informed, either in writing or by telephone [(615) 482-4411], of the nature of the fault of the instrument being returned and of the model, serial, and revision ("Rev" on rear panel) numbers. Failure to do so may cause unnecessary delays in getting the unit repaired. The EG&G ORTEC standard procedure requires that instruments returned for repair pass the same quality control tests that are used for new-production instruments. Instruments that are returned should be packed so that they will withstand normal transit handling and must be shipped **PREPAID** via Air Parcel Post or United Parcel Service to the nearest EG&G ORTEC repair center. The address label and the package should include the Return Authorization Number assigned. Instruments being returned that are damaged in transit due to inadequate packing will be repaired at the sender's expense, and it will be the sender's responsibility to make claim with the shipper. Instruments not in warranty will be repaired at the standard charge unless they have been grossly misused or mishandled, in which case the user will be notified prior to the repair being done. A quotation will be sent with the notification.

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 EG&G ORTEC of the circumstances so that assistance can be provided in making damage claims and in providing replacement equipment if necessary.

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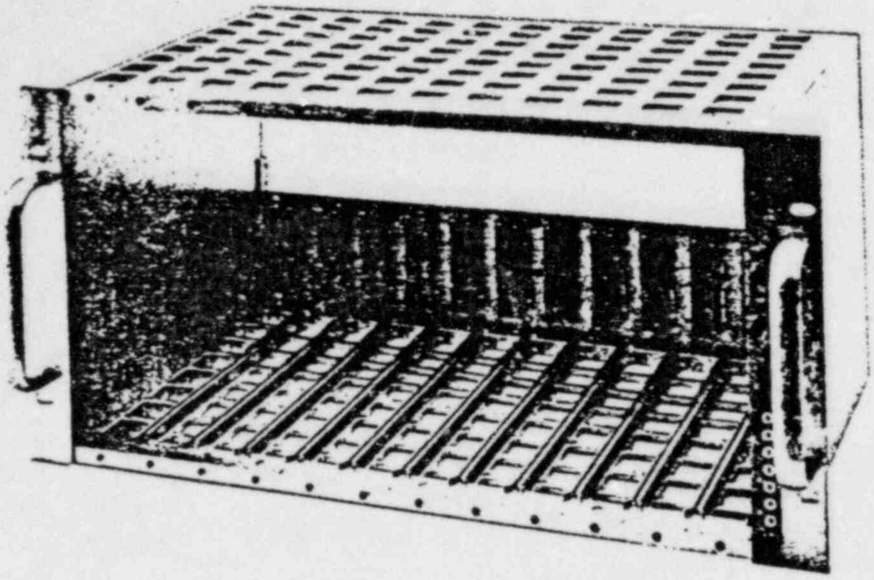
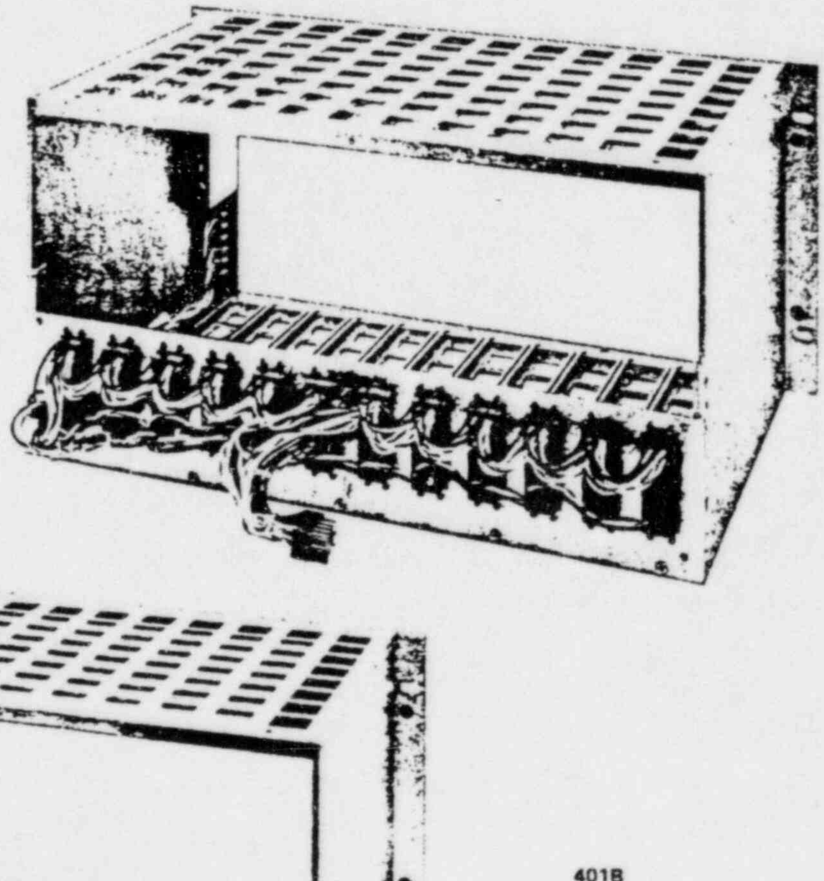
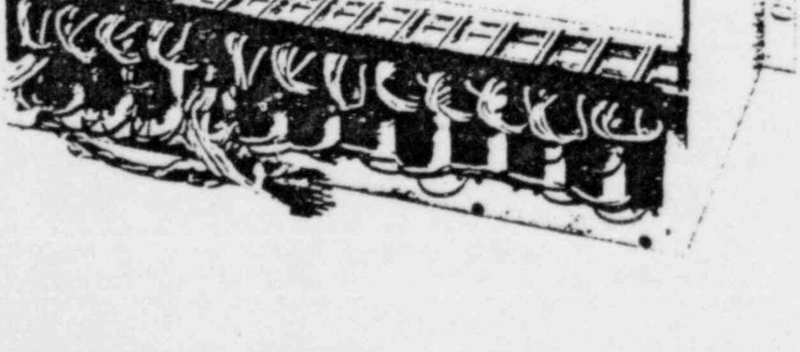


401A or 401B

401A





401B

ORTEC 401A AND 401B MODULAR SYSTEM BINS

1. DESCRIPTION

1.1. AEC STANDARD MODULE PROGRAM

The ORTEC 401A(B) Modular System Bin conforms to the recommended standards of AEC Report TID-20893 (Rev.), "Standard Nuclear Instrument Modules." This report, the work of a committee of equipment users from AEC-related institutions, provides standards for a modular instrument system that allow electrical and mechanical interchangeability of units made in conformance with the standards. The standards prescribe the necessary mechanical dimensions and connector types to ensure mechanical interchangeability. They also specify standard power supply voltages and pin assignments in the connectors so that electrical interchangeability is assured, at least with respect to the main connector joining module to bin.

The standards currently specify power supply voltages of plus and minus 6, 12, and 24 V dc and of 115 V ac delivered to assigned module connector pins. The available current specified to each pin has undergone some change with successive issues of the standards. Refer to the most recent issue of TID-20893 (Rev.) and addenda for current requirements. Also, since power supplies of earlier manufacture conformed to earlier versions of the standards, the user should familiarize himself with the specifications of the particular supply in use to determine the available current at each voltage.

Twelve basic module widths of 1.35 in. each are provided in a standard bin. Modules may be of single width or any multiple thereof as required by the individual module design. However, all 12 module connectors are provided in the standard bin, allowing any desired combination of module location. Two module and bin heights are provided by the standards, 8¾ in. and 5¼ in. These standard heights, as well as the basic external mounting dimensions of the bin, conform to the established ASA standards for relay rack mounting of electrical equipment. Therefore the TID-20893 (Rev.) standard bins will mount in standard relay racks along with other rack-mounted equipment.

The TID-20893 (Rev.) standards deal only with requirements for electrical and mechanical interchangeability. They do not deal with circuit designs or methods except to the extent of the power supply voltage standards.

In addition to the firm requirements designated as "Standards" in TID-20893 (Rev.), there are "Preferred Practices" which deal with subsidiary matters in the interest of suggested further compatibility. Included in the Preferred Practices are standard linear and logic signal parameters which, if observed, allow compatible interconnections between instruments.

1.2. ORTEC MODULAR INSTRUMENTS

ORTEC Modular Nuclear Instruments conforming to the standards of TID-20893 (Rev.) are designed for insertion and operation in a 401A(B) Bin with an attached mating power supply. In addition to meeting the basic requirements of TID-20893 (Rev.), each ORTEC module also provides two additional compatibility features:

1 Where applicable, the standard linear and logic signal parameters of the Preferred Practices of TID-20893 (Rev.) are used, providing compatible interconnections between instruments.

2 The power supply demand of any given ORTEC module is limited to no more than its proportional share of the occupancy of Bin space. In this way, the user does not have to compute the power supply total demand and compare this to the capability of the supply. Any system of ORTEC modules will automatically be compatible with the available Bin power.

These ORTEC instrument modules are made only in the 8¾-in.-high standard module package. The panel space requirements of this type of research instrumentation have precluded the use of the smaller 5¼-in. standard height.

1.3. ORTEC 401A(B) MODULAR SYSTEM BIN

The ORTEC 401A Modular System Bin provides mounting space for 12 standard module widths of the 8¾-in.-high type. The 12 corresponding module connectors are provided, with necessary wiring for distribution of all of the standard power supply voltages. The ORTEC 401B Bin is identical except that the standard power supply voltages are distributed to the module connectors through bus bars instead of wires. These power distribution circuits terminate in the standard connector prescribed by TID-20893 (Rev.) for connection to the power supply. A small control panel, not occupying any of the available module space, is located at the right side of the Bin, providing control switch test points, a control switch, and indicator lamps for the power supply. Further description of the 401A(B) Bin is given in the remaining sections of this manual.

1.4. POWER SUPPLY CONSIDERATIONS

The power supply provisions of TID-20893 (Rev.) allow either a supply mounted on the rear of the standard bin or an external supply, possibly furnishing power to several standard bins. Specified mounting-screw dimensions and a standard power connector make the bin-mounting power supplies interchangeable when they are made to the TID-20893 (Rev.) standards.

The ORTEC 402A or 402H Power Supply, which conforms to the requirements of TID-20893 (Rev.) in force at time of manufacture, is usually furnished with the 401A(B) Bin. Please refer to the instruction manual provided with each Power Supply.

2. SPECIFICATIONS

MECHANICAL TOLERANCES In accordance with TID-20893 (Rev.) provide for interchangeability of all standard modules.

PANEL DIMENSIONS Standard Relay Rack, 8¾ in. high, 19 in. wide.

DEPTH BEHIND PANEL Without Power Supply, 10.5 in. (26.6 cm); with 402A Power Supply, 16.0 in. (40.6 cm); with 402H Power Supply, 18.0 in. (45.7 cm).

MODULE CONNECTORS 12 each connectors as specified by TID-20893 (Rev.).

INSTALLED WIRING All connectors of the 401A are wired in parallel for +6 V, -6 V, +12 V, -12 V, +24 V, -24 V, high-quality power return and 115 V ac, in accordance with TID-20893 (Rev.) pin assignments, with interface connector furnished for connection to power supply as required by TID-20893 (Rev.). The 401B is equipped with laminated bus bars on the +6 V, -6 V, +12 V, -12 V, +24 V, -24 V (AWG #14 equivalent) and for the power ground return (AWG #10 equivalent).

CONSTRUCTION Extruded aluminum side members. Die-cast aluminum top and bottom members containing module guides and cadmium-plated steel rear connector plate. Iridite or cadmium finished, with convenience handles on front panel mounting members.

WEIGHT 28 lb net with 402A Power Supply; shipping weight 35 lb. 36 lb net with 402H Power Supply; shipping weight 43 lb.

3. INSTALLATION INSTRUCTIONS

3.1. POWER SUPPLY INPUT VOLTAGE

The ORTEC 402A or 402H Power Supply that usually accompanies the 401A(B) Bin may be used on either 115 V or 230 V, 50 or 60 Hz, input power. The conversion from one voltage to the other is accomplished by a slide switch located on the rear of the Power Supply, labeled as to voltage choice. The Power Supply will be shipped with the voltage set according to the customer's order instructions. However, it is prudent to check this switch for proper setting before operating the supply on 230 V. The power transformer is tapped for a simple conversion to 100-V or 200-V input levels.

Note that when the Power Supply is operated from 115-V input power, a direct connection provides the 115-V ac power to the assigned pins in the module connectors and the amount of 115-V power available is limited only by the fuse. However, when input power is 230 V, the 115-V ac power provided for the module connectors is limited by transformer ratings in the Power Supply, as stated in the Power Supply specifications.

The fuse supplied installed in the Power Supply is the proper one for input voltage selection as shipped. If a field change of input voltage is made, the proper fuse change should be made as outlined in the Power Supply instruction manual.

3.2. INSTALLATION IN RACK

The mounting provisions of the 401A(B) Bin conform to the well-established ASA standards for rack mounting equipment. The mounting holes at the edge of the panel will match the standard spacing of tapped 10-32 holes provided in the standard relay rack. The use of the usual oval-head screws and cup washers is recommended. Mechanical support of the Bin may be entirely from the panel members. However, the use of horizontal guide brackets to support the bottom of the Bin will facilitate removal of the Bin from the rack and will remove strain from the Bin and rack.

The basic design of the TID-20893 (Rev.) standard bin and modules provides for cooling by natural convection flow. Several bins can be mounted above each other without heat problems in the usual installation. However, one should not mount heat-producing vacuum tube equipment or other large sources of heat in the same cabinet with the standard bin without accounting for the temperature rise.

The use of cooling fans in equipment cabinets will reduce the operating temperature of the enclosed equipment. However, it will also invariably couple the circuits involved more tightly to the temperature variations of the environment. In systems installations requiring the ultimate in stability of operating parameters, the best practice is to provide only for natural convection cooling of the equipment. This provides long time constants between the equipment and external temperature variations, with resultant smaller variations, even though the average absolute temperature may be higher.

ORTEC modules are designed with all major signal connections on the front panel to the greatest extent possible. In some cases secondary connections are located on the rear of the module when necessary due to panel space limitations. If systems are contemplated that require use of rear panel connections to any great extent, the user may find it convenient to leave open gaps between installed bins for convenience in making front-to-rear connections.

4. OPERATING INSTRUCTIONS

4.1. CONTROL PANEL FUNCTIONS

ON-OFF Switch interrupts both sides of the input power line.

POWER Pilot lamp indicates that ac input power is being supplied to the power transformer primary. Either a blown fuse or a temperature cutout will extinguish this lamp.

TEMP Warning pilot lamp is illuminated if the Power Supply temperature rises to within ~20°C of the maximum safe operating temperature. When the maximum safe temperature is reached, an internal cutout in the Power Supply removes power and neither lamp will be illuminated.

TEST JACKS Located on the panel allow convenient checking of the Power Supply voltages from the front panel without disassembly of the supply.

4.2. POWER SUPPLY LIMITATIONS

The available current at each voltage is dependent on the Power Supply. Since the requirements of TID-20893 (Rev.) have been changed from time to time, the actual capability of any given power supply will depend on its date of manufacture. The instruction manual for the particular power supply in use should be consulted.

The power requirements of individual modules are stated on their front panels. The user should verify that the Power Supply capability is not exceeded in any given system in one bin. Note that a system composed entirely of ORTEC modules will not require this verification, since each ORTEC module uses no more power than its proportional share based on panel space occupancy in the Bin.

4.3. INSERTION AND REMOVAL OF MODULES

No damage will result to the Power Supply from insertion or removal of modules while power is on. However since the sequence of power application to a module is indeterminate when inserted with Bin power on, it is prudent to turn off the Bin power when modules are being changed or inserted.

5. CIRCUIT DESCRIPTION

The Bin circuit consists only of passive power distribution wiring. The accompanying wiring diagram provides full information on the wiring.

Power Supply circuit information is contained in the 402A or 402D Power Supply instruction manual immediately following the Bin wiring diagram.

Note the provisions of two "ground" connections in the module connector. Pin 42 is a "high quality ground," and Pin 34 is the "power return ground." The intent is that the high quality ground normally carry negligible current and serve as the reference ground in sensing circuits.

The pins in the module are assigned according to a schedule Refer to TID-20893 (Rev.) for details on pin assignments.

6. MAINTENANCE INSTRUCTIONS

Because of the passive nature of the Bin wiring, maintenance will probably be limited to the addition or removal of wiring. To retain the interchangeability features of the TID-20893 (Rev.) standards, all wiring changes or additions should be done with careful reference to the standard pin assignment schedule, a synopsis of which is given in the figure on page 9 and the table on page 10.

The connector pins specified for use with the standard bins attach to wires by means of a crimped joint. A hand crimping tool is required for this purpose, and is used after the contacts have been pushed into place in the connector block. Removal of a contact also requires the use of a special tool, called a pin-socket extractor.

Assembly details for the connectors and blocks are shown in ORTEC drawing 401-0002, included in this manual. Note that there are two alternate manufacturing sources for the component parts: AMP, Inc., of , Harrisburg, Pennsylvania, and Winchester Electronics of Oakville, Connecticut. Each source also provides a hand-crimping tool and a pin-socket extractor. The proper tool for each application must be selected from the same manufacturing source as the connector block and connectors in order to ensure compatibility.

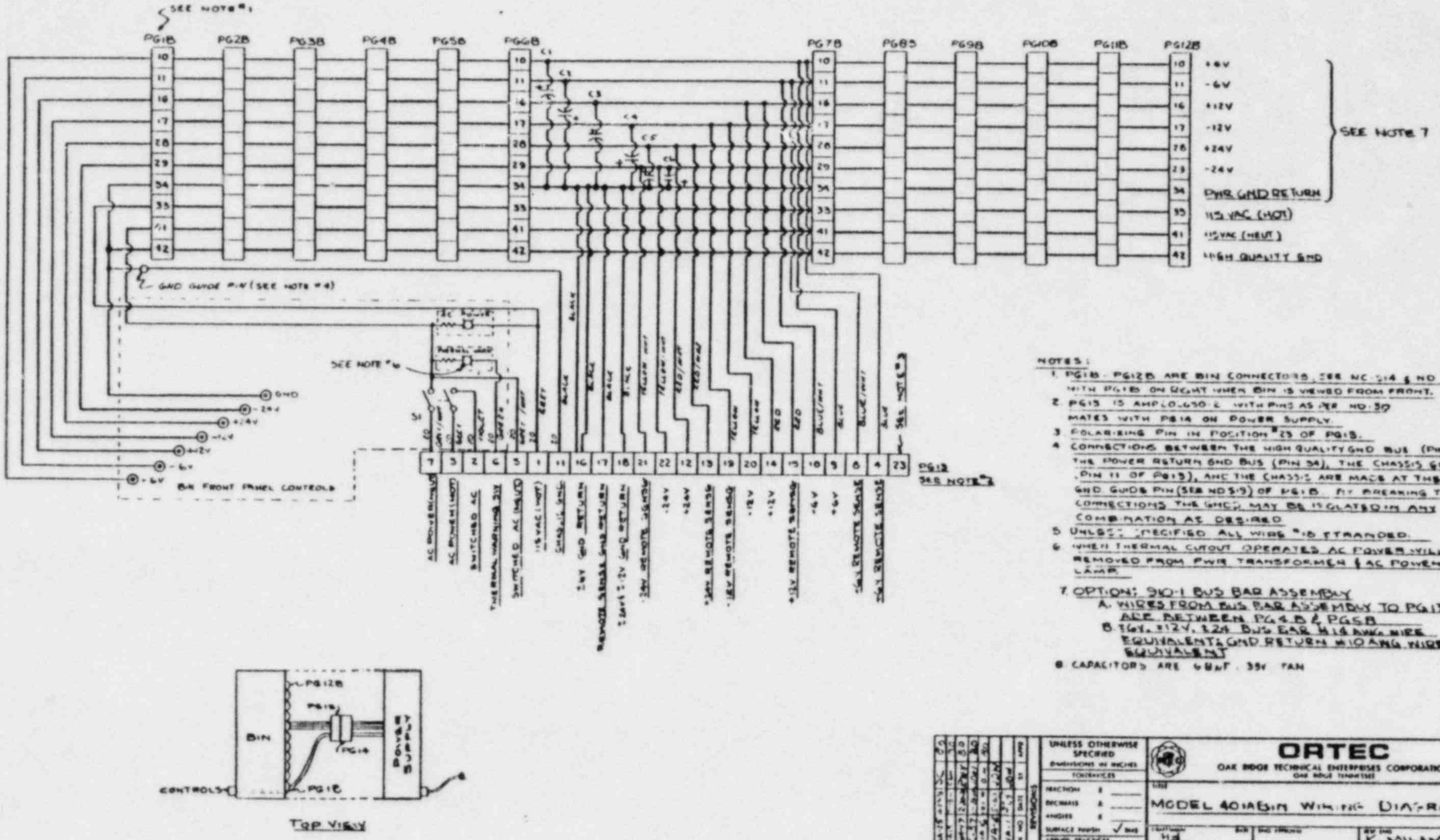
As listed in the details in drawing 401-0002, the AMP connector block for bin mounting is their #202516-3 and is blue. The equivalent Winchester block is WIN 111-20854 and is orange. The connector block that is mounted on a module that is designed for insertion into the bin can have either an AMP 204186-5 (green) or a WIN 111-20853 (gray) identification.

The hand-crimping tool for use with AMP products is an AMP 90067, which is ORTEC part number 9097-65313. The hand-crimping tool for use with Winchester products is their part 107-0903-2A.

The AMP pin-socket extractor is their part number 305183, ORTEC part number 42947. The Winchester pin-socket extractor is their 107-1015, ORTEC part number 44694.

Either of these tools can be obtained from an authorized distributor of AMP or Winchester parts, respectively, or directly from the manufacturer. They may also be ordered from ORTEC.

The connector pins that are used in the bin and modules are available in several types. Consult TID-20893 and its referenced drawings for suitable types. Additional related information is included in Tables 1, 2, and 3 on ORTEC drawing 401-0002 (see page 11).



NOTES:

1. PG1B - PG12B ARE BIN CONNECTORS, SEE NC-514 & ND 519) WITH PG1B ON RIGHT WHEN BIN IS VIEWED FROM FRONT.
2. PG13 IS AMPLO.650-2 WITH PINS AS PER ND-517 MATES WITH PG14 ON POWER SUPPLY.
3. POLARIZING PIN IN POSITION #23 OF PG13.
4. CONNECTIONS BETWEEN THE HIGH QUALITY GND BUS (PIN 42), THE POWER RETURN GND BUS (PIN 34), THE CHASSIS GND (PIN 11 OF PG13), AND THE CHASSIS ARE MADE AT THE GND GUIDE PIN (SEE ND519) OF PG1B. BY BREAKING THESE CONNECTIONS THE GNDS MAY BE ISOLATED IN ANY COMBINATION AS DESIRED.
5. UNLESS SPECIFIED ALL WIRE #18 STRANDED.
6. WHEN THERMAL CUTOUT OPERATES AC POWER WILL BE REMOVED FROM PWR TRANSFORMER & AC POWER LAMP.
7. OPTION: 910-1 BUS BAR ASSEMBLY
   A. WIRES FROM BUS BAR ASSEMBLY TO PG13 ARE BETWEEN PG4B & PG5B
   B. ±6V, ±12V, ±24 BUS BAR #14 AWG WIRE EQUIVALENT; GND RETURN #10 AWG WIRE EQUIVALENT
8. CAPACITORS ARE 68µF, 35V TAN

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
LTR	ECN NO	DATE	BY	APP			

REVISIONS

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

ORTEC
OAK RIDGE TECHNICAL ENTERPRISES CORPORATION
OAK RIDGE TENNESSEE

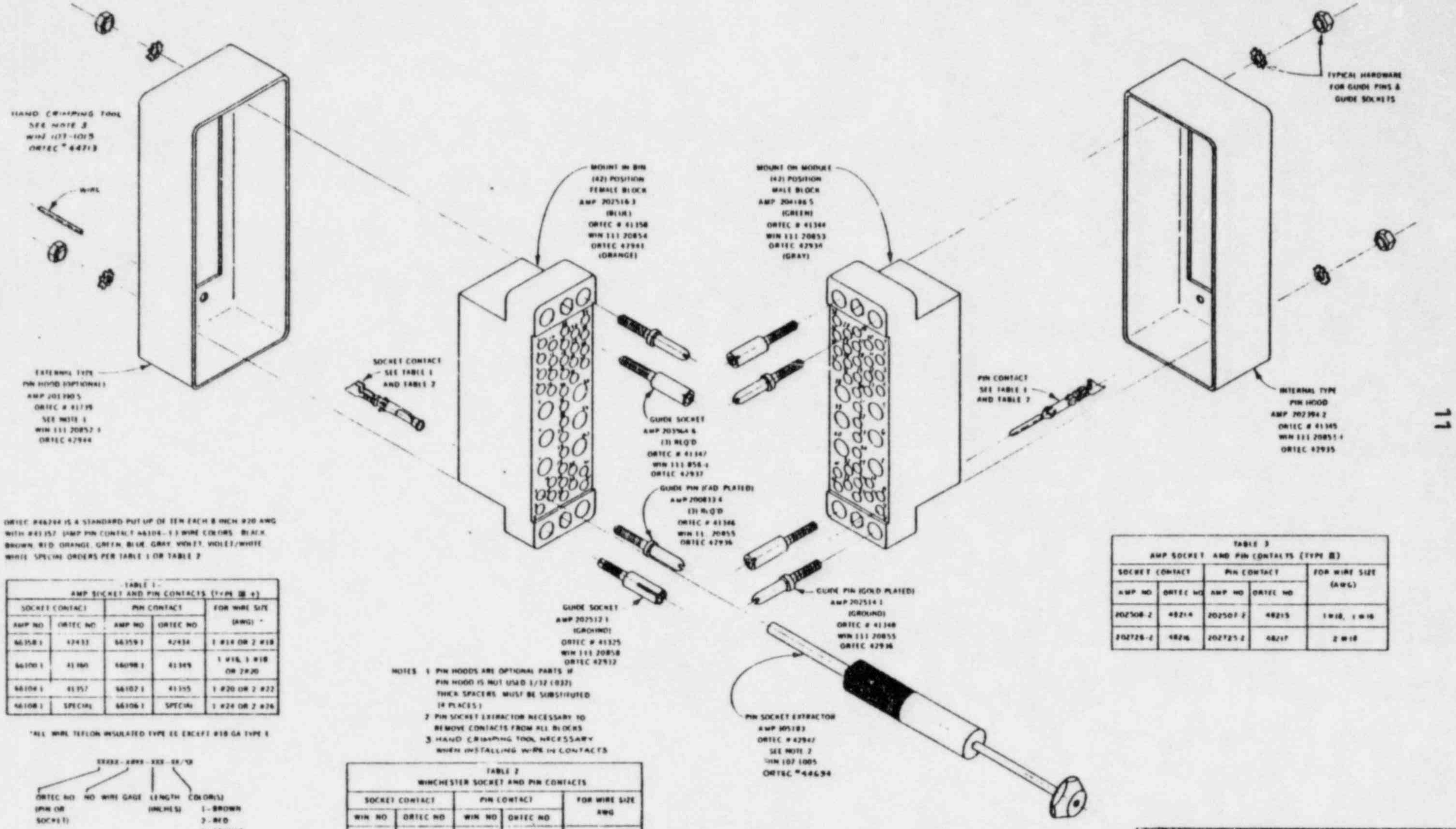
TITLE
MODEL 401A BIN WIRING DIAGRAM

DRAFTSMAN HJ
CHECKED DLP 11-14-66
ENG APPROVAL
MFG APPROVAL AV
REV ENG K. MILAM
DRAWING NO 401A-0120-31

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	Spare
*10	+6 volts	32	Spare
*11	−6 volts	*33	115 volts ac (Hot)
12	Reserved Bus	*34	Power Return Ground
13	Spare	**35	Reset (Scaler)
14	Spare	**36	Gate
15	Reserved	**37	Reset (Auxiliary)
*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		

Pins marked (*) are installed and wired in ORTEC 401A and 401B Modular System Bins.
Pins marked (*) and (**) are installed and wired in EG&G/ORTEC–HEP M250/N and M350/N NIMBINS.



ORTEC #46244 IS A STANDARD PUT UP OF TEN EACH 8 INCH #20 AWG WITH #41357 (AMP PIN CONTACT 66104-1) WIRE COLORS: BLACK, BROWN, RED, ORANGE, GREEN, BLUE, GRAY, VIOLET, VIOLET/WHITE, WHITE. SPECIAL ORDERS PER TABLE 1 OR TABLE 2

- TABLE 1 -
AMP SOCKET AND PIN CONTACTS (TYPE III +)

SOCKET CONTACT		PIN CONTACT		FOR WIRE SIZE (AWG) *
AMP NO	ORTEC NO	AMP NO	ORTEC NO	
66358 1	42433	66359 1	42434	1 #14 OR 2 #18
66100 1	41360	66098 1	41349	1 #16, 1 #18 OR 2#20
66104 1	41357	66102 1	41355	1 #20 OR 2 #22
66108 1	SPECIAL	66106 1	SPECIAL	1 #24 OR 2 #26

*ALL WIRE TEFLON INSULATED TYPE EE EXCEPT #18 GA TYPE E

XXXXX - X#XX - XXX - XX/XX

ORTEC NO (PIN OR SOCKET) — NO WIRE GAGE — LENGTH (INCHES) — COLOR(S)

1 - BROWN
2 - RED
3 - ORANGE
4 - YELLOW
5 - GREEN
6 - BLUE
7 - VIOLET
8 - GRAY
9 - WHITE
10 - BLACK

EXAMPLE: SOCKET CONTACT FOR 2 #22 WIRES, 10 INCHES LONG, COLORS, ONE RED, ONE BLACK. 41357 2#22 10 2/10

NOTES:
1. PIN HOODS ARE OPTIONAL PARTS. IF PIN HOOD IS NOT USED 1/32 (.032) THICK SPACERS MUST BE SUBSTITUTED (4 PLACES)
2. PIN SOCKET EXTRACTOR NECESSARY TO REMOVE CONTACTS FROM ALL BLOCKS
3. HAND CRIMPING TOOL NECESSARY WHEN INSTALLING WIRE IN CONTACTS

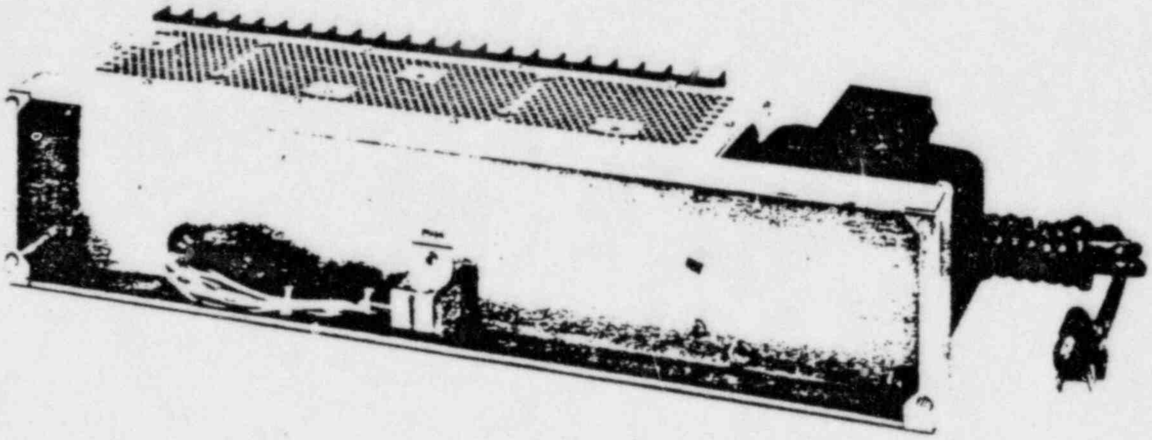
TABLE 2
WINCHESTER SOCKET AND PIN CONTACTS

SOCKET CONTACT		PIN CONTACT		FOR WIRE SIZE AWG
WIN NO	ORTEC NO	WIN NO	ORTEC NO	
100 0816S	42940	100 0811P	42938	1#14,2#20
100 0817S	42943	100 0812P	42939	1#16,1#18 OR 1#20 OR 2#22
100 0820S	44696	100 0815P	44695	2#18

TABLE 3
AMP SOCKET AND PIN CONTACTS (TYPE II)

SOCKET CONTACT		PIN CONTACT		FOR WIRE SIZE (AWG)
AMP NO	ORTEC NO	AMP NO	ORTEC NO	
202508-2	48214	202507-2	48215	1#18, 1#16
202726-2	48216	202725-2	48217	2#18

ORTEC INCORPORATED
100 MIDLAND ROAD OAK RIDGE, TENNESSEE 37830
42 POSITION CONNECTER & HARDWARE
2-1
401-0002



ORTEC 402A POWER SUPPLY

1. DESCRIPTION

The ORTEC 402A Power Supply is designed to be mounted in the space provided on the rear of the 401A(B) Modular System Bin. The Supply was designed to exceed the recommended power supply specifications, Appendix A of TID-20893 (Rev.), Type 1, Class A, adopted by the AEC Committee on Nuclear Instrument Modules.

The 402A was designed for both foreign and domestic usage. Input voltage mains of 115 V ac or 230 V ac, 50-65 Hz, may be used. A simple circuit modification permits operation on 100-V or 200-V input mains; see Section 6. A convenience indicating switch located on the rear of the Supply clearly identifies the intended main to use. The primary circuits are fused, and a three-conductor NEMA-standard power cord is included.

The Supply furnishes four standard dc voltages: +12 V at 2 A, -12 V at 2 A, +24 V at 1 A, and -24 V at 1 A, with a maximum power capability of 72 W at 50°C. A high-efficiency heat sink allows additional power dissipation (see "Specifications"). The dc outputs are regulated, short-circuit protected, current limited, and thermal protected.

The 115 V ac is supplied to the Bin connector independent of input mains. The 115-V ac power available is limited only by the Power Supply fuse when operating from 115-V ac mains. When operating from 230-V ac mains, the 115-V ac is derived by autotransformer action and is limited to 50 VA output with a dc load on the power supply of 72 W.

A control panel is provided on the 401A(B) Bin for operating and monitoring the 402A Power Supply. An On-Off switch, power indicating lamp, thermal warning lamp, and convenience dc monitor jacks are provided. The thermal warning lamp is lighted when the internal temperature rises to within 20°C of the maximum safe operating temperature. The Power Supply is automatically cut off by an internal switch should the temperature exceed the maximum safe operating temperature.

The Power Supply regulator amplifiers are located on the two identical plug-in printed circuit boards, which may be interchanged for maintenance purposes. Spare regulator boards are available. The regulating transistors and current monitoring resistors for the current limiting are mounted on a specially designed high-efficiency heat sink.

The power transistors are virtually indestructible due to their power handling capability, current limiting, and short-circuit protection. All-silicon semiconductors, 85°C capacitors with conservative working voltage ratings, and high-quality carbon and metal film resistors are combined to produce this Power Supply which exceeds the TID-20893 (Rev.) requirements.

The dc output voltages are adjustable over a ±1-V range from their nominal ratings through holes in the top of the Power Supply cover plate. The 15-turn adjustment potentiometers are precision wire wound for superior adjustment resolution and resettability of the output voltages.

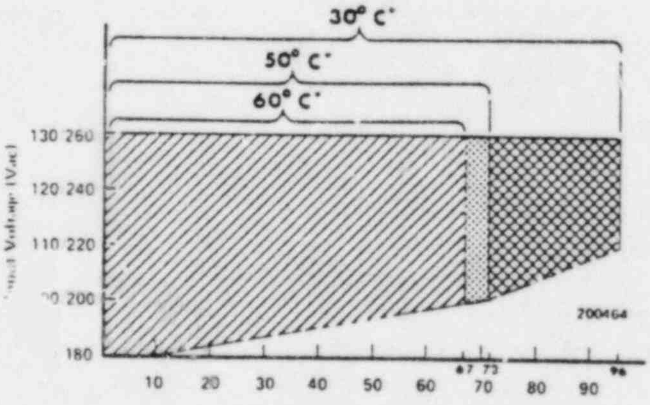
2. SPECIFICATIONS

The specifications for the 402A Power Supply meet or exceed those set forth by the AEC Committee on Nuclear Instrument Modules, TID-20893 (Rev.), Appendix A, Type 1, Class A.

INPUT 103-129 V ac, 50-65 Hz, or 210-258 V ac, 50-65 Hz. Input current at 115 V is 1.8 A for a 72-W dc output.

DC OUTPUT Output at the following ratings: +12 V at 2 A, -12 V at 2 A, +24 V at 1 A, -24 V at 1 A, maximum output power to 50°C ambient, 72 VA, operation to 60°C ambient with current derated not more than 3%/°C. Under certain conditions the 72-VA power limitation may be exceeded to a maximum of 96 VA (see Fig. 2.1).

115 VOLT AC OUTPUT 115-V ac output limited only by the supply fuse when operating from 115-V ac mains. Output is limited to 50 VA at 72-VA dc load while operating from 230-V ac mains.



*Ambient Temp.

Fig. 2.1. Maximum Safe Operating Range.

REGULATIONS ±0.05% over the combined range of zero to full load and input voltage of 103-129 V ac over any 24-hr period at a constant ambient temperature and rated line and load after a 60-min warmup.

STABILITY ±0.3% after a 24-hr warmup of constant line, load, and ambient temperature over a six-month period.

TEMPERATURE COEFFICIENT Less than 0.01%/°C over a range of 0°C to 60°C.

THERMAL PROTECTION A thermal warning switch will be activated when the ambient temperature approaches within 20°C of the safe operating temperature. A thermal cutout switch disables the Power Supply when the temperature exceeds the safe operating temperature.

NOISE AND RIPPLE The output noise and ripple are less than 3 mV peak to peak, as observed on a 50-MHz bandwidth oscilloscope.

VOLTAGE ADJUSTMENT ±0.5% minimum range, resettability ±0.05% minimum of supply voltage; typical ±1 V of specified voltage.

RECOVERY TIME Less than 50 μsec to return to within ±0.1% of rated voltage for any change in input voltage and load current from 10 to 100% full load.

CIRCUIT PROTECTION The input line to the power supply is fused. In addition, electronic circuitry provides output current limiting, to prevent damage to the supply, and provides automatic recovery when the demand is removed.

OUTPUT IMPEDANCE Less than 0.3Ω at any frequency to 100 kHz.

OUTPUT CONNECTOR All power and control circuits terminate in a connector, specified by TID-20893 (Rev.), which mates with the Bin interface connector, completing the necessary control and Power Supply wiring.

DIMENSIONS 16.825 in. wide,. 3.438 in. high, 5.500 in. deep; conforms to AEC Drawing ND515.

WEIGHT 13 lb net; with 401A(B) Bin 27 lb net. Shipping weight for 401A(B)/402A 35 lb gross.

3. INSTALLATION

The 402A Power Supply is normally supplied factory-connected to an ORTEC 401A(B) Modular System Bin. However, the supply is designed to TID-20893 (Rev.) specifications and may be attached, in the space provided, to any bin manufactured to TID-20893 (Rev.) specifications.

For attachment to other than ORTEC 401A(B) Bin, please refer to the appropriate instruction manual. The On-Off switch and other controls necessary to operate the Supply are part of the Bin and not furnished with the Power Supply.

For attachment to 401A(B) Bin the following steps are advised:

1. Place the Bin on a table with the back part facing you. Place the Power Supply in the proper mounting position, leaving enough space between the two pieces to attach the interface connector.
2. Mate the interface connector, being careful to align the polarizing pins. Fold and form all wiring close to the connector edges to prevent any wires from being pinched and producing a short circuit in succeeding steps.
3. Mount the Power Supply to the Bin by securely tightening the four 10-32 screws, being careful not to pinch any wires or to use undue force on any parts.

When attaching the 402A Power Supply to older 401 Bins, it is necessary to first remove the left and right side covers and stand the Bin on its front face (handles down). From this point on, assembly is the same; upon completion the side plates should be replaced.

4. OPERATING INSTRUCTIONS

The available current from the Power Supply is specified by TID-20893 (Rev.), Appendix A, Type 1, Class A, supply. Under certain conditions these specifications may be exceeded (see Fig. 2.1.) Care must be used to ensure natural convection of heat dissipated by the heat sinks and power transformer. For best results, when using at maximum power loadings the Bin and Power Supply should be in an open space, placed upon blocks at least 1 in. off the table mounting surface to allow maximum ventilation. When used in a rack, maximum attention should be paid to placement of other heat-generating equipment. Adequate unobstructed space on all sides is necessary for convection ventilation and cooling. If the Bin contains other heat-generating equipment, a blower may be advisable to remove the dissipated heat.

When it is necessary to rack mount several Bins and Power Supplies, especially when other heat-generating equipment is located within the rack, the term "ambient temperature" becomes less clearly defined. A better guide to maximum power loading capability is to monitor the heat sink temperature. In no case allow the heat sink temperature to continuously run above 85°C. Although this is not the maximum operation temperature, any additional temperature rise due to other conditions of the system may force the Supply out of tolerance and may cause it to automatically shut down operation. Should your operation produce a temperature of 85°C, a blower to remove the dissipated heat is indicated.

5. CIRCUIT DESCRIPTION

The 402A Power Supply produces four dc output voltages. A power transformer transforms the input ac line voltage into four separate low-voltage sources. The sources or windings are full-wave-rectified, capacitor-filtered, and regulated by electronic series regulator circuits. The regulator circuits provide short circuit, current limiting, and reverse current protection.

Each of the four series regulator circuits is identical in operation; they are physically different only in component values for each Supply. The regulator essentially operates in two modes: First and normal is the voltage regulation mode; second is the constant-current or current-limiting protection mode.

The regulation will operate in the voltage regulation mode at any current output up to and including the full rated output of a particular supply. When current output beyond the rated output is required, which includes a direct short across the output terminals, the regulator automatically shifts into a constant-current mode. This provides current limiting and protection of the regulator's circuitry and components. When excessive current demands are removed, the regulator resumes the voltage regulation mode.

For operation of the regulator, please refer to circuit Drawing 402A-1100-S1. For convenience, only the +24-V regulator will be discussed, and the following is an explanation of the regulation in the normal voltage regulation mode.

Transistors Q6 and Q7 operate as a differential amplifier pair, comparing the reference voltage of D4 at the base of Q6, with a portion of the output voltage divided down through R16, R17, and R18. Trim potentiometer R17 is used to adjust the output voltage to the specified level. A difference voltage at the collector of Q7 is dc amplified by Q4 and Q2. The collector of Q2 drives emitter-follower Q1, which supplies the necessary current to drive the remotely located series power transistor. This transistor is heat-sink-mounted to dissipate the power consumed in the regulation process.

In the constant-current or limiting mode, remotely located resistor R1, in series with the output, senses the output current level and produces a proportional voltage rise. The sense voltage is compared to the output voltage at the base of Q5. For output current levels less than or equal to the rated output, Q5 remains back-biased and will have no effect on the regulator performance. However, when the output current exceeds the rated output, Q5 becomes forward-biased and conducts, causing Q2 to conduct harder, thereby reducing the available base drive current to emitter-follower Q1 and the series pass regulator transistor. As a result, the output voltage is reduced until the output current is within the required limits. Upon removal of the short circuit or excessive current demand, the regulator resumes the normal voltage regulation mode.

6. MODIFICATION

The transformer in this ORTEC 402A Power Supply has a tap in each of the primary windings to permit operation with a nominal 100/200 V ac input. The tap for one primary is a yellow wire and for the other primary is a white wire. These leads are covered with shrinkable tubing over the ends and are included in the bundle of leads from the transformer.

To operate the 402A Power Supply from either a 100 or 200 V ac power source, use the following steps to change the primary winding connections:

1. Remove the top cover from the 402A Power Supply.

2. Remove the two plug-in regulator boards.

3. Locate the unused yellow and white wires and remove the shrinkable tubing from the wire ends.

4. Disconnect the black wire from the 115/230 VAC switch and connect the yellow wire to the switch terminal in place of the black wire.

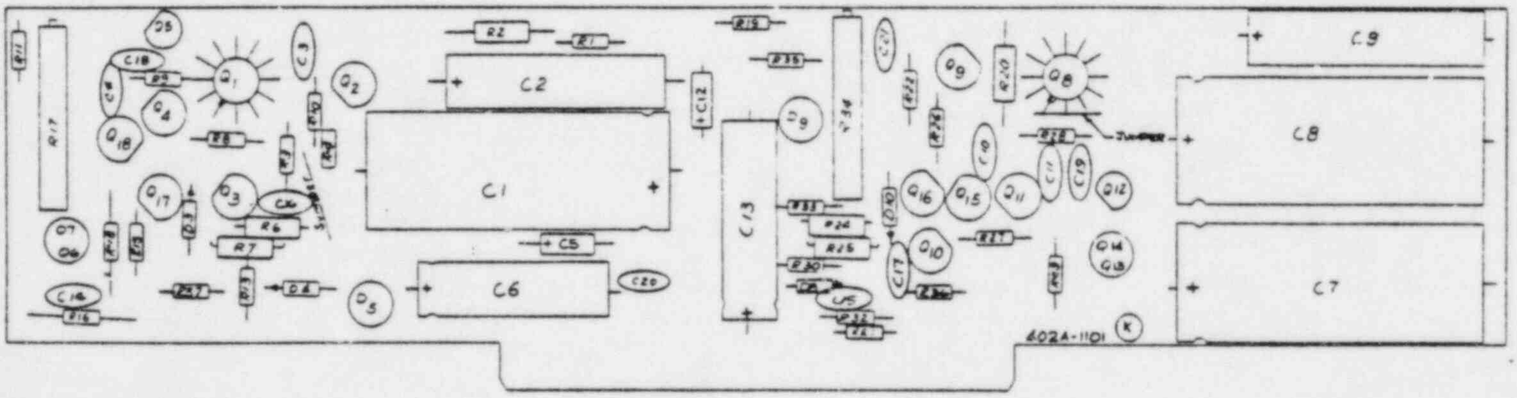
5. Disconnect the black/white and red wires from the 115/230 VAC switch and connect the white wire to this switch terminal.

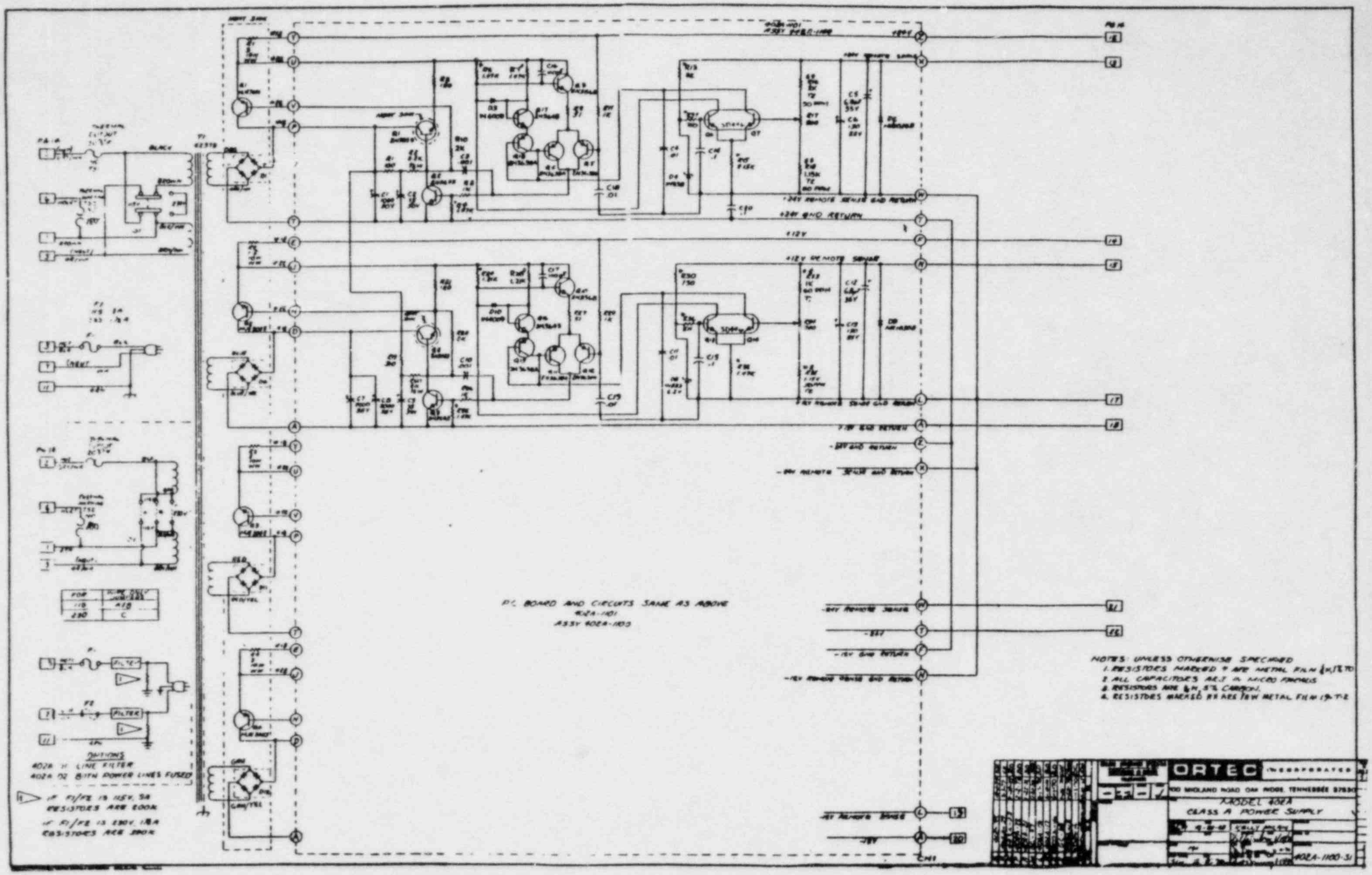
6. Use shrinkable tubing or electrical insulation tape to cover the bare end of the black wire.

7. Connect the black/white and red wires together and wrap the ends with electrical insulating tape.

8. Return the two plug-in regulator boards and the top cover to the 402A Power Supply.

The 402A is now wired for 100/200 V ac line operation instead of 115/230 V ac. Ensure that the switch selects the proper range before applying power to the unit.





NOTES: UNLESS OTHERWISE SPECIFIED
1. RESISTORS MARKED * ARE METAL FILM ¼W,1% TO
2. ALL CAPACITORS ARE IN MICRO FARADS
3. RESISTORS ARE ¼W, 5% CARBON.
4. RESISTORS MARKED ** ARE ⅛W METAL FILM 1% T-2

ORTEC INCORPORATED
100 MIDLAND ROAD OAK RIDGE, TENNESSEE 37830
MODEL 402A
CLASS A POWER SUPPLY
402A-1100-31

Models 772 and 772H
Counters
Operating and Service Manual

This manual applies to instruments marked
"Rev 12" on rear panel

Printed in U.S.A.

2948 01C 0779

STANDARD WARRANTY FOR EG&G ORTEC INSTRUMENTS

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EG&G ORTEC's exclusive liability is limited to repairing or replacing at EG&G ORTEC's option, items found by EG&G ORTEC to be defective in workmanship or materials within one year from the date of delivery. EG&G ORTEC's liability on any claim of any kind, including negligence, loss or damages arising out of, connected with, or from the performance or breach thereof, or from the manufacture, sale, delivery, resale, repair, or use of any item or services covered by this agreement or purchase order, shall in no case exceed the price allocable to the item or service furnished or any part thereof that gives rise to the claim. In the event EG&G ORTEC fails to manufacture or deliver items called for in this agreement or purchase order, EG&G ORTEC's exclusive liability and buyer's exclusive remedy shall be release of the buyer from the obligation to pay the purchase price. In no event shall EG&G ORTEC be liable for special or consequential damages.

QUALITY CONTROL

Before being approved for shipment, each EG&G 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

If it becomes necessary to return this instrument for repair, it is essential that Customer Services be contacted in advance of its return so that a Return Authorization Number can be assigned to the unit. Also, EG&G ORTEC must be informed, either in writing or by telephone [(615) 482-4411], of the nature of the fault of the instrument being returned and of the model, serial, and revision ("Rev" on rear panel) numbers. Failure to do so may cause unnecessary delays in getting the unit repaired. The EG&G ORTEC standard procedure requires that instruments returned for repair pass the same quality control tests that are used for new-production instruments. Instruments that are returned should be packed so that they will withstand normal transit handling and must be shipped **PREPAID** via Air Parcel Post or United Parcel Service to the nearest EG&G ORTEC repair center. The address label and the package should include the Return Authorization Number assigned. Instruments being returned that are damaged in transit due to inadequate packing will be repaired at the sender's expense, and it will be the sender's responsibility to make claim with the shipper. Instruments not in warranty will be repaired at the standard charge unless they have been grossly misused or mishandled, in which case the user will be notified prior to the repair being done. A quotation will be sent with the notification.

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 EG&G ORTEC of the circumstances so that assistance can be provided in making damage claims and in providing replacement equipment if necessary.

CONTENTS

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ORTEC®
772
COUNTER
OVERFLOW
DISPLAY TEST
MASTER
NORM
SLAVE
COUNT
STOP
DISC
RESET
POS IN
NEG IN
GATE


SER.
INPUT
GATE
RESET
OFLOW
IN/OUT

ORTEC 772 and 772H COUNTERS

1. DESCRIPTION

The 772 Counter is a general-purpose 6-decade scaler that accepts and counts NIM-standard fast negative logic pulses, slow positive logic pulses, or positive analog pulses. An input discriminator is built into each of the input circuits. For the negative input circuit the discriminator has a fixed threshold at −250 mV. For the positive input circuit the discriminator level is adjustable through a range of 0.1 to 10 V. An input gate is also included to permit automatic control with timed counting intervals and/or to permit counting of coincidence events.

The 772 data can be printed, together with data from any other ORTEC printing modules, by an ORTEC 777 Line Printer or, through an ORTEC 432A Printout Control, by an ORTEC 222 Teletype.

This module is designed for use either as a single Counter or as one of up to 50 Counters that are all operated in a complex counting system with or without data printout. When an ORTEC 773 Timer-Counter is included in the system, it can furnish preset time control for counting intervals in all the other modules in the system, and the time information can be included in the printed record or can be eliminated as desired.

The 772 is packaged in a NIM-standard single-width module. It includes all the connectors and controls that will be used for either manual or automatic operation and indicates the accumulated count with 7-segment light-emitting diodes (LED) in a direct-reading display with automatic blanking of insignificant zeros.

A gate indicator, which is also an LED, lights to show when the 772 is in a counting condition. The gate is controlled by the manual Count/Stop switch, by the gate signal input circuit with connectors on both the front and rear panels, and by a common line signal through the standard ORTEC printing loop In/Out connector on the rear panel.

The Counter overflows at 10^6 counts and continues to count beyond this level. If the Counter overflows, an LED on the front panel lights to show this condition; the indicator remains lit from the first overflow until the unit is reset. At each overflow an output pulse is also furnished through a rear panel connector and may be used for connection into another Counter for an increased counting capacity.

Reset is generated automatically when power is first applied to the unit and can be provided manually or by a signal through a rear panel BNC connector or through a common line in the standard ORTEC printing loop through the In/Out connector on the rear panel.

The seven segments in each of the six characters of the digital display can be tested at any time by pressing the Display Test switch on the front panel. When this switch is pressed, all seven segments in each digit should light to provide a reading of 888 888.

The 3-position locking toggle switch on the front panel marked Master/Norm/Slave selects the functional control of this module when it is connected in a standard ORTEC printing loop. It responds to a common preset signal for any switch position and also responds to local gate control and reset for any switch position. But with the switch set at Master, this module can also furnish gate control and reset to all the Slave modules in the system. When the switch is set at Slave, this module accepts gate control and reset from the system common lines. When the switch is set at Norm, it will neither furnish gate control and reset to the common lines nor accept these signals from the common lines. This operating selection permits the 772 to be used in combination with other printing modules with a very flexible control relationship.

The ORTEC 772H operates identically to the 772 but requires that the bin and power supply in which it is operated furnish +6 V dc as a power source. The ORTEC 401B/402H Bin and Power Supply is typical of the equipment required for this purpose.

2. SPECIFICATIONS

2.1. PERFORMANCE

Count Capacity 6 decades, for 000 000 through 999 999.

Counting Rates Negative input, 100 MHz; positive input, 20 MHz.

Discriminators Negative input trigger level fixed at −250 mV; positive input trigger level adjustment range 100 mV to 10 V; drift is <10 mV/°C from 0°C to 50°C.

Pulse Pair Resolution Positive input, 50 nsec; negative input, 10 nsec; minimum duty cycle, 40% at either input at maximum counting rate.

Automatic Clear Generated when power is turned on initially or after a power failure.

2.2. INDICATORS

Display 6 direct-reading 7-segment LED digits with automatic blanking of insignificant zeros.

Overflow LED, illuminated from the first overflow until reset.

Gate LED, illuminated while unit is in the counting condition.

2.3. CONTROLS

Display Test Push-button switch illuminates all segments of each digit in the display when depressed; display reads 888 888.

Master/Norm/Slave 3-position locking toggle switch selects the counter's function when the module is connected in a data acquisition system. Master selects control over all slaves in the system by furnishing control signals through the common gate and reset lines. Norm isolates this module from system control through gate and reset lines. Slave accepts control from another module in the system, operating as a Master, that furnishes the system gate and reset signals.

Disc Single-turn screwdriver potentiometer sets the discrimination level for positive input signals; range 100 mV to 10 V.

Reset Push-button switch resets display and internal logic to an initial zero condition when pressed.

Count/Stop Toggle switch selects counting or noncounting condition of the unit manually.

2.4. CONNECTORS

Pos In Front and rear panel type BNC connectors accept positive unipolar or positive-leading bipolar signals to ±25 V maximum. Input amplitude must exceed the adjusted discriminator level for a minimum of 20 nsec to be counted. Z_{in} = 1 kΩ to ground, dc-coupled.

Neg In Front panel type BNC connector accepts NIM-standard fast negative signals, 14 mA into 50Ω, with 4-nsec minimum width. Input is protected to ±25 V at 10% duty cycle and has a fixed −250-mV discriminator level.

Gate Front and rear panel type BNC connectors accept NIM-standard slow positive logic signals to control the counter gate and the gate indicator. An open circuit or the application of a signal with ≥+3-V amplitude enables the counting; ≤+1.5 V inhibits counting; input protected for 25 V maximum; 100-nsec minimum pulse width; driving source must be capable of sinking 0.5 mA of positive current.

Reset Rear panel type BNC connector accepts NIM-standard slow positive logic signal to reset the unit to an initial condition. A signal ≥+3 V resets; ≤+1.5 V does not reset; 25 V maximum; 100-nsec minimum pulse width. Z_{in} = 2 kΩ to ground, dc-coupled.

Oflow Rear panel type BNC connector furnishes NIM-standard positive logic output, +5 V for 2 μsec, whenever the counter overflows from 999 999 to zero. Driving source impedance ≤10Ω, dc-coupled.

In/Out Rear panel Amphenol type 57-40140 connector includes four common data lines and all system logic for the standard ORTEC printing and/or counting system interconnections.

2.5. OPTION

772H Counter The 772H Counter is a complete unit, equal in performance to the 772; requires +6 V from Bin and Power Supply.

2.6. ELECTRICAL AND MECHANICAL

Power Required For the 772 Counter, +12 V, 80 mA; −12 V, 165 mA; +24 V, 75 mA; −24 V, 80 mA; 115 V ac (50 or 60 Hz), 50 mA. An internal power supply generates the +5-V source that is required by the integrated circuits; protected by a chassis-mounted 1-A 3AG fuse.

For the 772H Counter, +12 V, 80 mA; −12 V, 165 mA; +24 V, 75 mA; −24 V, 80 mA; +6 V, 550 mA. Must be operated in an ORTEC 401B/402H Bin and Power Supply or equivalent.

Dimensions Standard NIM single-width module (1.35 X 8.714 in.) per TID-20893.

2.7. ACCESSORY INCLUDED

Cable One ORTEC 772-C1 printing system control cable for interconnection with other ORTEC printing Counters, Timers, Digital Ratemeters, etc., in an ORTEC standard printing loop.

3. INSTALLATION

3.1. GENERAL

The 772 Counter operates on input power that must be furnished from a Nuclear-standard Bin and Power Supply such as the ORTEC 401/402 Series. If any vacuum tube equipment is operated in the same rack with the 772, there must be sufficient cooling air circulating to prevent any localized heating of the integrated circuitry used throughout the 772. The temperature of equipment mounted in racks can easily exceed the maximum limits of 120°F (50°C) unless precautions are taken.

3.2. CONNECTION TO POWER

Turn off the Bin Power Supply when inserting or removing any modules. The ORTEC modules are designed so that it is not possible to overload the Power Supply with even a full complement of modules in the Bin. Since, however, this may not be true when the Bin contains modules other than those of ORTEC design, the Power Supply voltages should be checked after all modules have been inserted. The 401/402 has test points on the Power Supply control panel to permit monitoring the dc voltages easily.

The 772 requires 115 V ac as one of its power inputs. Some bins and power supplies, as well as jumper cables, may not be wired to include this power. In the event that the unit fails to operate in a new installation, check the bin and/or cable to determine whether the 115-V ac circuit is included.

The 772H version requires +6 V dc at 550 mA. It must be used with an ORTEC 401B/402H Bin and Power Supply or equivalent to satisfy this power requirement. No ac power is required for the 772H.

3.3. COUNTER INTERCONNECTION

When a counting system contains more than one 772 Counter or 773 Timer-Counter, the units are connected together as shown in Fig. 3.1. The In/Out connector on the rear panel of each module is used for this loop interconnection, and one cable is furnished with each of the printing modules to permit the loop to be formed. For nonprinting systems the order of interconnections is not important, but for printing systems the order of printing is 1 through *n* in sequence as shown in Fig. 3.1. Figure 3.2 shows how the 772-C1 cable provides the In and Out connections separately.

Normally, after the modules have been connected together in a system, one of the modules will be selected as the Master for the system and the remaining modules will all be Slaves. If an ORTEC 773 Timer-Counter is included in the system, it will usually be used to control the counting intervals with preset time, and the 773 will then logically be set as Master. All the 772 Counters in the system will be set for Slave.

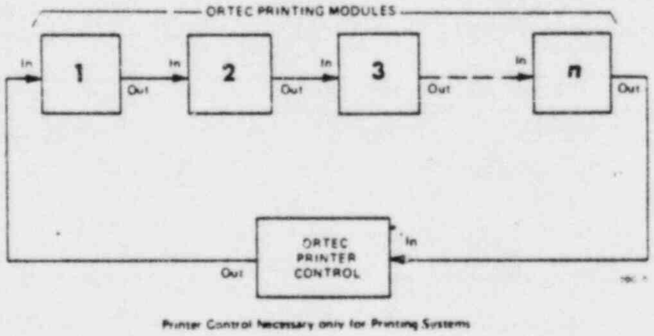


Fig. 3.1. Counter Interconnection for System Operation.

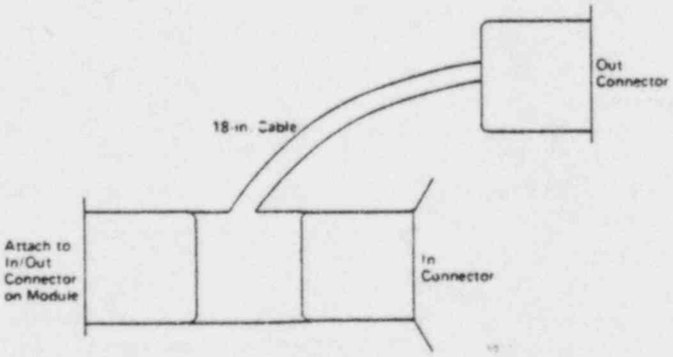


Fig. 3.2. Detail of 772-C1 Printing System Cable.

3.4. SIGNAL CONNECTIONS

Count Inputs The 772 accepts and counts either fast negative logic pulses or slow positive logic pulses. It can also accept positive analog pulses. Determine the type of input pulses that will be furnished and use the appropriate input.

Positive logic or analog signals can be connected to either the front or rear panel BNC connector. These two connectors are ***not isolated*** from each other; so signals from two sources should not be connected simultaneously to the two Pos In connectors. The input circuit in the 772 is dc-coupled to eliminate baseline shifts associated with changing counting rates. For signals with an average dc level greater than ±25 V, external capacitive coupling must be provided by the user. For dc levels below ±25 V, connection to the input can be made safely without damage to the 772. However, for the Counter to respond to any signals through the positive input circuit, there must be transitions of the signals at the adjusted Disc level. The adjustment range of the Disc is 0.1 to 10 V.

Negative logic signals must be furnished to the front panel Neg In connector. The input impedance in this circuit is 50Ω, dc-coupled, the standard impedance for which the fast negative logic pulse is defined. There is a fixed threshold level of −250 mV in this input circuit, and the input pulse needs to exceed this level for only 4 nsec to be counted.

The flexibility of the 772 makes it possible to count almost any positive input pulse wider than 20 nsec and greater than 100 mV or any negative input pulse wider than 4 nsec and greater than 250 mV. There are two important points to remember when supplying signals to the input: (1) The signal should not cross the threshold level more than one time. Signals with overshoot, ringing, etc., will be counted more than once if the discriminator level is raised to the level at which the perturbations occur. (2) Signals with slow rise and fall times should be as clean (noise-free) as possible because of the high gain and bandwidth of the 772 discriminator. As a slow signal approaches the threshold, a small spurious noise pulse can traverse the threshold and return, causing an extra count to be added to the contents of the scaler.

Gate Input The gate input signal can be connected to the 772 by either the front- or rear-panel-mounted BNC connector. As in the case of the count input connectors, no isolation is provided between the two inputs; therefore two signal sources are ***not*** to be connected simultaneously to the gate input. With no connection made to the gate input, the input voltage level is about +6 V, and the scaler gate will permit the unit to operate. To cut off the gate, the gate input must be pulled down to below +1.5 V but not below −5 V. To do this, the driving circuit must be capable of absorbing 0.5 mA from the gate input circuit. The gate circuit will permit counting when the Gate input is at +3 V or greater.

Reset Input The reset input signal can be connected to the 772 by means of the rear-panel-mounted BNC connector. To reset the scaler to zero, a positive signal of +3 V or greater originating from zero potential with a minimum width of 100 nsec should be used. The input impedance is approximately 2 kΩ dc-coupled to ground. Negative signals will not perform any useful function at the reset input. The input circuitry will not be harmed as long as the input signal level does not exceed ±25 V.

Overflow Output The overflow signal is available through a rear-panel-mounted Oflow BNC connector. A positive 5-V signal appears at the output each time the contents of the Counter change from 999 999 to 0. The output signal is 2 μsec wide; Z_o is $<10\Omega$, dc-coupled.

In/Out System Connector Signals An adapter cable, 772-C1, is furnished with the 772 to attach to the In/Out connector and to make separate connectors available for the In and Out system interconnections. The signals on the In and Out connectors are listed in Table 3.1. The physical details of the 772-C1 cable are shown in Fig. 3.2; the system In connector is located on the opposite end of the connector block from the portion that attaches to the In/Out connector on the rear of the module, and the Out connector is on the remote end of the 18-in. multiwire cable that extends to the next module in the loop.

Pin 7 on the In/Out connector is the Previous Module Finished (PMF) signal from pin 7 of the In connector. Pin 13 on the In/Out connector is the This Module Finished (TMF) output to pin 7 of the Out connector. All the remaining pins are wired point-to-point between all three connectors in the cable.

Pins 12 and 14 carry an identification of 432 Off and This Module Printing signals respectively. These are used in other ORTEC printing modules if their count capacity is other than 6 decades; so they are wired through the loop but are not used in the 772.

Table 3.1

In Connector		Out Connector	
Pin	**Description**	**Pin**	**Description**
1	Data 1	1	Data 1
2	Data 2	2	Data 2
3	Data 4	3	Data 4
4	Data 8	4	Data 8
5	Print	5	Print
6	Print Advance	6	Print Advance
7	Previous Module Finished	7	This Module Finished
8	System Gate	8	System Gate
9	System Preset	9	System Preset
10	System Reset	10	System Reset
11	Ground	11	Ground
12	432 Off	12	432 Off
13	Spare	13	Spare
14	This Module Printing	14	This Module Printing

The functions of signals through the 14 pins of the In/Out connector are as follows:

Pins 1–4 – Data Lines Transfer the four bits of each digit from the assigned instrument to the Printout Control. Each instrument includes an isolated program control that drives these common lines only during its turn for printing.

Pin 5 – Print Prepares the instrument for data transfer during printing.

Pin 6 – Print Advance Advances the scanner in each instrument for readout of each of its digits during printing.

Pin 7 – Previous Module Finished Starts the actual data transfer from an instrument when it is its turn to be printed.

Pin 8 – System Gate Carries a gate-off signal to all instruments set for Slave operation in the system loop. The signal originates in a Master instrument, and this can be the 772. When the 772 is set for Slave, the system gate line will affect that Counter. When the 772 is set for Master, a gate input will be imposed on the system gate line. A Counter that is set for Norm is isolated from the system gate line.

Pin 9 – System Preset Carries a preset signal to all instruments in the system loop. A preset condition gates off all modules in the system.

Pin 10 – System Reset Carries a reset signal to all instruments in the system loop except any that may be set for Norm. This signal originates in a Master module or in the 432A Printout Control.

Pin 11 – Ground Carries a common zero potential line to all modules in the system loop.

Pin 12 – 432 Off Has no effect on the 772.

Pin 13 – This Module Finished Signals the next instrument to start its data transfer.

Pin 14 – This Module Printing Has no effect on the 772.

4. OPERATING INSTRUCTIONS

4.1. FRONT PANEL CONTROLS AND INDICATORS

The following functions are indicated and controllable from the front panel:

Count/Stop Manually controls counting of the 772; Count position permits counting, and Stop position inhibits counting.

Gate Indicator An LED indicates the condition of the input gate. When it glows, the 772 is able to count input pulses. When it is dark, the 772 is inhibited from counting.

Reset A push-button switch resets the contents of the Counter to zero when it is depressed.

Disc A single-turn potentiometer selects the threshold level of the internal discriminator that is used for the positive input circuit only. The range of the control is +0.1 through 10 V. Normally, for counting logic signals, the level should be adjusted about half way between the lowest expected true-signal amplitude and the maximum false-signal amplitude. For use with linear signals assure that the signals have only one point of inflection, or some signals may cross the threshold more than one time and produce erroneous counts.

Master/Norm/Slave A 3-position locking toggle switch that controls the functional position of the 772 when it is used in an ORTEC printing system. This switch does not affect the operation of the Counter unless printer loop cables are connected to the rear panel. See Sections 4.4 and 4.5 for further information.

Overflow Indicator An LED lights if the counter capacity of 999 999 counts is exceeded, and remains lighted until the unit is reset.

Display Test A push-button switch permits a quick check of the digital display. When it is pressed, all seven segments of each of the six digits will be lighted, regardless of the counter contents, and the display will read all "eights."

Digital Display Six 7-segment characters with logically selected blanking for each segment display the Counter contents at all times except during printing intervals and the display test interval. Each digit is displayed during printing while it is being furnished to the printer.

4.2. INITIAL OPERATION OF COUNTER

1. Install the 772 into a 401/402 series Bin and Power Supply or equivalent and turn on the power.

2. Press Reset. The display should now indicate that the contents of the Counter are zero.

3. Press Display Test. The display should read 888 888, and should return to 0 when the switch is released.

4. Set the Count/Stop switch at Count and the Gate indicator should light. Set the switch at Stop and the light should go out.

5. Connect a signal to the Input connector on either the front or rear panel.

6. Set the Count/Stop switch at Count.

7. Turn the Disc control counterclockwise until the 772 starts to count.

8. Ground the Gate input and observe that counting stops and the indicator LED is not lighted. Remove the ground and restore the counting condition.

9. Set the Count/Stop switch at Stop, and counting should stop and the indicator should again not be lighted.

4.3. COUNTING SETUP WITH ONE COUNTER

Proceed as outlined in Section 4.2 but omit those steps used in "testing" the instrument. Be sure that the input signals do not exceed the ±25-V maximum limits.

4.4. COUNTING SETUP WITH MULTIPLE COUNTER-TIMER MODULES

Preferred Setup In a multiple-counter setup each Counter should be inserted into the Bin and Power Supply and connected together with the printer loop cables as shown in Fig. 3.1 (without the Printer Control). For nonprinting systems the sequential arrangement of the cables is not important.

With the units properly connected together the individual count and gate signal connections are made to the respective Counters. When all units are installed, testing of individual Counters can be performed by operating each unit in either its Master or Norm mode. This frees the unit under test from all other units in the system except for a preset condition. If the gate indicator does not light or if the Counter does not accumulate counts during this phase, check to see whether a Timer in the system has reached preset time. Any module that reaches preset will stop all modules from counting. This can be eliminated during the setup phase by resetting the Timer and turning it off.

After the individual Counters have been set up and tested for proper operation, the Master/Norm/Slave switches can be set as desired. Normally in a counting system one Counter or Timer will be selected as the Master and all the others will be set for Slave. With this arrangement the entire counting system can be controlled for reset and gating from the Master. The Count/Stop switch on the Master or its gate input could be used to start and stop accumulation in all the Counters and Timers, and the Reset push button on the Master would reset all of the system. In addition to the overall system gating control from the Master, if any gate input signals are furnished to any of the Slave units or if any have a reset signal or manual command, each such signal will affect only the Slave unit in which it originates. It is important to remember that a Counter selected to operate in the Norm mode cannot be started or stopped by a Master unit, but will respond only to a preset signal in the system in addition to any signals that originate in that particular module.

Alternate Connections for One or Two Counters with a Timer The module interconnection scheme shown in Fig. 3.1 is the preferred manner of connecting more than one Counter or Timer into a data system because of the flexibility it offers and the simplicity of interconnections. There is, however, an alternate connection for a simple setup involving a 773 Timer-Counter and one or two 772 Counters without using the printer loop cables. A coaxial cable connected from the rear panel Intval (Interval) connector of the 773 to the Gate input connector on each Counter will allow the Count/Stop switch on the Timer to start and stop counting and timing together, providing all Counters are set for the Count condition. When the 773 reaches preset time, the Counters stop counting.

If in the setup described in the previous paragraph the 773 Timer-Counter had been operated as a Counter, the 773 data would have represented the number of counts above its threshold per N (preset condition) counts from another source that was being counted in the 772. The ratio of two counting rates can be determined in this manner.

4.5. PRINTING SYSTEMS

The 772 Counter is designed to operate as part of an automatic data acquisition system, from which all data can be printed by either an ORTEC 777 Line Printer or, with an ORTEC 432A, by an ORTEC 222 (modified Teletype). The 772 Counter is operated the same for either of these two serial printing accessories.

The 772, upon command, provides the data stored in its counting register to the 777 Line Printer or the 432A Printout Control and the 222 Teletype in a serial-by-character format. The data are fed out in six groups (characters), from the most significant digit to the least significant digit, at a rate determined by the printout accessory. Each group or character is composed of four bits of information in a 1-2-4-8 BCD code, with logical one being about +6 V and logical zero about 0 V. Figure 4.1 shows the sequence of events for a single Counter that contains the accumulated count level 705 849. As a note of explanation, the Print Command signal originates in the 432A or 777. It can be initiated manually, be triggered externally, or be initiated automatically by a module in the system reaching a preset condition. The Start Data Transfer is supplied from the 432A or 777 to Counter 1 (Fig. 3.1), from Counter 1 to Counter 2, from Counter 2 to Counter 3, etc. In other words, as each module finishes transferring its data, it sends a signal to the following module to allow its data transfer to begin. In the system the Start Data Transfer signal is called Previous Module Finished on the In connectors of the cables and This Module Finished on the Out connectors.

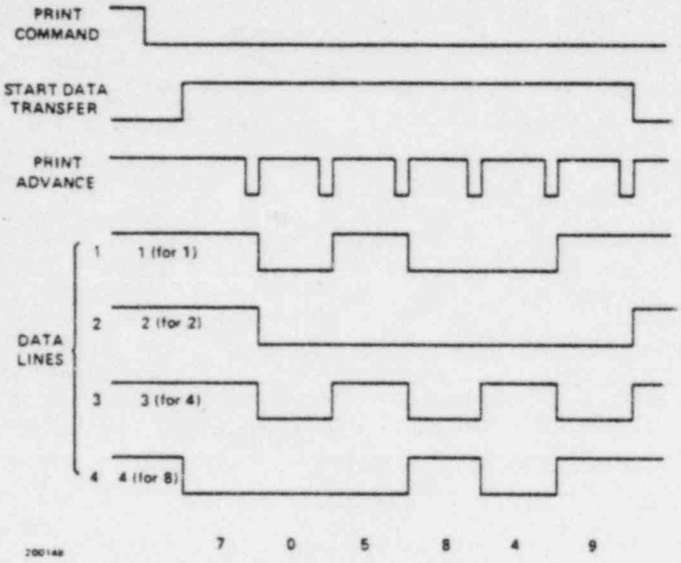


Fig. 4.1. Signal Sequence for Transferring Data for 705 849 from a Printing Scaler to the Printout Control.

The following sequence of events illustrates how a multiple-counter printing system with a 432A Printout Control and a Teletype operates:

1. A Print Command is generated manually, by a trigger, or by a preset condition.

2. All Counters and Timers in the system stop accumulating and remain static for 1 or 2 sec.

3. All displays are blank except the most significant character in the display of Counter 1; this digit is lighted until the digit has been printed by the output device.

4. Each of the remaining five digits in Counter 1 is printed in succession, and, as each digit is being printed, it is also illuminated in the display of the Counter.

5. A space is generated in the printed format after the six digits that represent the data in Counter 1.

6. The six digits for Counter 2 are printed in succession.

7. A space is formed as in step 5.

8. This sequence repeats until the last Counter has finished printing. Carriage return and line feed replace the space function at appropriate times in the program.

9. After the last set of data has been printed, one of two basic modes can be selected at the 432A: (a) the system will remain in a static or noncounting mode until a new cycle is started, and the display will be turned on, or (b) a system reset is generated and data accumulation will be repeated.

The program for use with the ORTEC 777 Line Printer operates as follows:

1. A Print Command is generated manually, by a trigger, or by a preset condition.

2. The 777 prints the entire data word. Since the 777 capacity is 7 digits per word, the first digit will automatically be a zero when any 6-digit counter or timer is being printed out.

3. The 777 has a line feed and advances the paper so that the next data word will appear on the next line.

4. The six digits for Counter 2 are transferred to the 777.

5. The 777 prints the second data word and then has a line feed.

6. This sequence repeats until the last counter has finished printing. A double line feed in the 777 indicates completion of the data set.

7. After the last set of data has been printed, one of two basic modes can be selected by the 777: (a) the system will remain static or noncounting until a new cycle is started, and the displays in the modules will be turned on, or (b) a system reset is generated and data accumulation will be repeated.

5. CIRCUIT DESCRIPTION

5.1. GENERAL

Figure 5.1 is a block diagram that shows the relations between the circuit components in the 772 Counter. The complete schematic of the 772 is shown in 772-0101-S1 at the back of the manual.

As shown in Fig. 5.1, input pulses can be furnished through either the positive or the negative input circuit and then be subjected to gating before they are counted. Reset of the counting register can originate locally or from the system reset line. The control logic also includes routing to and from the system lines according to the selection that is made with the Master/Norm/Slave switch.

The 24 data lines, for the six 4-bit word groups from the counting register, are gated, one word at a time, to the four common data lines. These data lines lead into a decoder for the display and to the output for the printing loop. An internal scanner gates the four bits for a digit onto the four common lines and also selects the proper location in the display for that digit.

During nonprinting intervals the scanner is driven by an internal oscillator that operates at about 1 kHz and continually recycles the scan through the six digits. During printing intervals the internal oscillator is turned off and the scan is advanced at the rate of the printing accessory.

5.2. POSITIVE INPUT CIRCUIT

Positive input pulses can be accepted through either the Pos In connector on the front panel or the Input connector on the rear panel. They are dc-coupled into IC 32, a differential comparator. A dc level is applied to the negative input of IC 32 from the front panel Disc control, R66. If the input pulse amplitude exceeds the discriminator bias, a pulse is generated that can pass through Q16 and IC 31-3 to gate IC 31-15. If the gate is enabled, the pulse is furnished to the clock input of IC 29 for one count in the counting register.

5.3. NEGATIVE INPUT CIRCUIT

Negative input pulses can be accepted through the Neg In connector on the front panel. An input pulse that exceeds the fixed bias level at −250 mV passes through Q15 to gate IC 31-14. If the gate is enabled, the pulse is furnished to the clock input of IC 29 for one count in the counting register.

5.4. GATING

Local gating is controlled by either the toggle switch S3 or by a signal through either the front or rear panel Gate BNC connector.

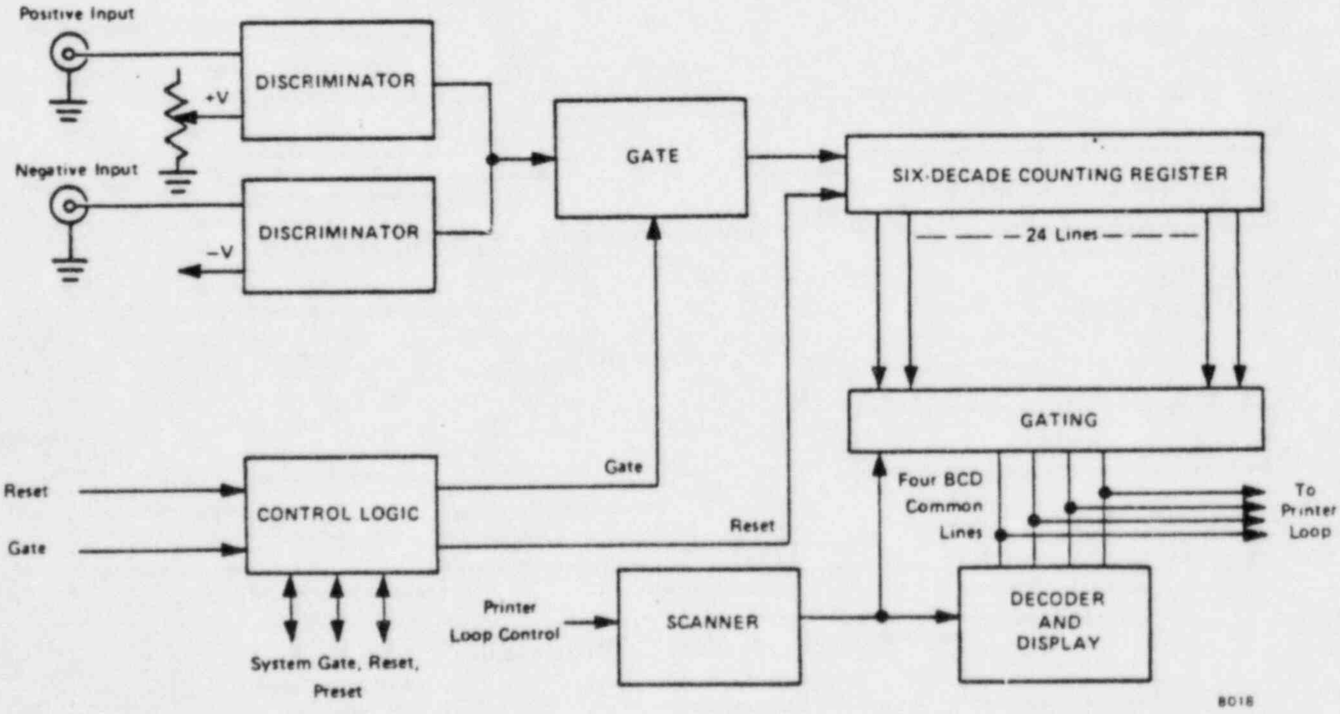


Fig. 5.1. Block Diagram of ORTEC 772 Counter.

With switch S3 set at stop, as shown in the schematic, IC 26-3 is held low. The signal passes through IC 25-8, IC 24-2, and IC 26-8 to make pin 8 of IC 26 high. The Gate LED will not light because there is no voltage difference across it. This signal then passes through Q18 and Q17 and furnishes a high at both pins 11 and 12 of IC 31, so neither input circuit gate is enabled. When switch S3 is set at count, the status of the circuit is inverted to light the LED and to enable both input gates.

With switch S3 at count the local gate control can still be affected by an input through either Gate BNC connector. When the input is shorted to ground (or drawn down to ≤+1.5 V), this is coupled through Q19 to force IC 28-8 high; when IC 28-8 is high, the LED is not lighted and both gates are disabled. When the input circuit is either open or has a signal ≥+3 V, IC 28-8 is low and the LED lights and the input gates are enabled.

5.5. COUNTING REGISTER

The counting register includes IC's 29, 30, and 14 through 18. IC 29 and IC 30 provide four D flip-flops that are connected as a 1-2-4-8 BCD decade. These packages feature fast response and permit counting the fast negative input pulses at a rate of up to 100 MHz. IC 13 is a logic level translator for the four bits of the least significant digit. IC 14 through IC 18 are decade packages that complete the ripple counter for the second through sixth digits.

The overflow output from IC 18 is coupled through C17 to generate an output pulse through the Oflow BNC connector on the rear panel unless the signal is false, caused by a reset rather than by a count accumulation. The first overflow after a reset will also set flip-flop IC 19-3 and 16 to light LED2 until the next reset.

The four bits for each of the six digits are furnished through gates to the four common data lines. Each of the six digits is furnished through a gate that is enabled by a signal from an internal scanner, and the gates involved are IC's 3 through 8. The scanner signals are identified as Z1 through Z6 respectively for the most- to least-significant digit. For example, when the Z1 signal is present, the four bits from IC 18 are transferred to the four common lines through the four gates in IC 8.

5.6. SCANNER

The internal scanner generates the Z1 through Z6 signals in sequence and gates the most significant digit onto the common lines first, followed by each less significant digit in order. When no print signal is furnished from the printer loop (nonprinting condition), an internal oscillator advances the scanner. When a print signal is present (through a printing interval), the scanner counts print advance signals between a PMF input signal and a TMF output signal; so it scans through the available digits only one time during the printing cycle.

The internal oscillator uses IC 22-2 and -4 to generate an output signal at about 1 kHz. The output feeds through IC 21-3, unless a print signal is present, then through IC 21-11 to the clock input of divide-by-6 counter IC 11. The 1-, 2-, and 4-bit outputs of IC 11 are furnished to decoder IC 10, and the 8-bit input to IC 10 is grounded (= zero). When IC 10 has all four input bits at zero, it identifies 0 at the output and generates a Z1 signal at IC 9-2. The next oscillator pulse changes the count in IC 11 and is decoded in IC 10 to generate Z2 at IC 9-4. This continues until each signal, Z1 through Z6, has been generated in turn and an oscillator pulse advances the Counter out of the Z6 condition to Z1 again.

Control of the scanner during a printing cycle is discussed in Section 5.8.

5.7. DECODER AND DISPLAY

The four bits that are present on the common lines at any time identify one of the six digits. This combination is decoded in IC 1 to furnish the correct configuration of blanking and illumination to the seven LED segments at the anodes of each of the six digits in the display, LED3. The scanner signal will have selected which of the six digits is to be gated onto the common lines and the same scanner signal completes a cathode path for the proper digit in the display. For example, when Z6 is present, the signal at pin 6 of LED3 selects the least significant digit in the display and its illuminated segments will identify the character that is gated through IC 3 onto the four common lines.

For reference, the seven segments are identified ***a*** through ***g***. Viewed from the front of the display, segment ***a*** is across the top; ***b*** is the upper half of the right side; ***c*** is bottom right; ***d*** is across the bottom; ***e*** is the lower left; ***f*** is the upper left; and ***g*** is across the center. Any digit, 0 through 9, can be illuminated by selectively blanking the segments. When switch S1 is pressed, IC 1 provides no blanking for any segment and the display should illuminate all segments for a reading of 888 888.

IC 19-11 and -8 provide the control to completely blank all insignificant zeros in the display. At Z1 time, for the most significant digit, IC 1 receives a signal from IC 19-8 to blank all segments if a zero is present. Internal logic in IC 1 resets the blanking control through IC 19-11 when it receives an identification of any digit other than zero through the four common input lines or from switch S1. So until there is a digit other than 0, nothing will be shown in the scan of the display. When the scan reaches Z6, for the least significant digit, the signal at pin 9 of IC 19-8 removes the blanking control to IC 1 if it had not been removed before that time, and the least significant digit is displayed whether it is zero or not.

5.8. PRINTING CIRCUIT

A printing loop is formed by cabling the printing modules to either an ORTEC 777 Line Printer or (through an

ORTEC 432A Printer Control) an ORTEC 222 Teletype in a circuit as shown in Fig. 3.1. In normal operation the Counters and Timers in the system can count until a system preset signal occurs; then all modules stop counting and the accumulated data are transferred to the Printer, one module at a time. At system preset all modules stop and the 777 or 432A generates a print output.

In the 772 the system preset is accepted through Q8 to turn off the input gate through IC's 24-4, 24-6, 25-8, 24-2, and 26-8 and Q18 and Q17. This prevents any change in the counting register. The print signal is accepted through Q4 to inhibit oscillator gate IC 21-3, to reset the scanner to Z1 through IC 22-12 and IC 21-6 to IC 22-8, and to clamp all four gates of IC 2 to provide a "code 15" input to IC 1 and to thus blank the display. The module then waits until its turn in the system to be printed out. This is signaled by a PMF (Previous Module Finished) signal from the printer loop that originates in the control module if the 772 is Counter 1 in the configuration of Fig. 3.1 or is the TMF (This Module Finished) output from the previous module for any of the other positions in the loop.

At PMF the signal releases the reset of IC 20, releases the reset latch at IC 22-8 through IC's 21-8 and -6, releases the blanking clamp to IC 2, and enables gates IC 12 to transfer the data from the common lines in the 772 to the system common lines and from there through the control module to the Printer. Since Z1 has been preselected, the most significant digit is transferred to the Printer and is also shown in the display. At print advance, when the digit has been accepted by the Printer, the signal through Q5 and IC 21-11 advances the scanner, etc. This continues until the trailing edge of Z6 clocks IC 20 to set to isolate the 772 from the system printing lines, to blank the display, and to furnish a TMF output signal to the system loop. When the entire system has been printed out, the control module determines the next sequence and will remove preset, generate system reset, or whatever is appropriate to the program that has been selected.

5.9. MASTER/NORM/SLAVE CIRCUITS

When switch S2 is set at Master, the internal reset and gate signals in the 772 can be furnished out to the system reset and system gate lines for control of any other modules that are set for Slave operation. IC 27-11 permits the signals at IC 27-8 to be furnished out to the system gate line through Q11. IC 23-8 is inhibited from passing any signals that may be furnished from the system gate line through Q10 and IC 24-8.

With switch S2 set at Master, IC 23-6 permits any reset signals that are furnished from the internal circuit through IC 26-11 to pass through IC 24-10 and Q6 to drive the system reset line.

If switch S2 is set at Slave, the above conditions are reversed: IC 27-11 is low and prevents the internal gate signal from reaching the system gate line, while IC 23-8 permits the system gate line signal to be accepted into the 772. Gate IC 23-6 inhibits the local reset signals from reaching the system reset line, but a system reset signal can be accepted through Q7, IC 24-12, and IC 23-12 to generate a local reset.

If switch S2 is set at Norm, the system gate and system reset lines are isolated from the internal functions in the 772. This is obtained by inhibit to IC 23-6, IC 23-12, IC 23-8, and IC 27-11.

5.10. LOCAL RESET

Local reset is generated at IC 25-6 if any of its inputs goes low. The inputs originate with switch S4, power-up reset through Q9, from the rear panel Reset connector through Q12 and IC 28-12, or from system reset through Q7, IC 24-12, and IC 23-12. When IC 25-6 goes high, all six decades of the counting register are reset to zero; if in this process the 8 bit of IC 18 were reset, an Oflow output would be generated if not inhibited by IC 28-4.

Local reset is inverted by IC 28-10 to reset flip-flop IC 19-3 and -6 if it had been set by an overflow, and LED1 will then be turned off. The inverted signal is also returned to IC 25-8 to turn off the gate and its indicator during reset.

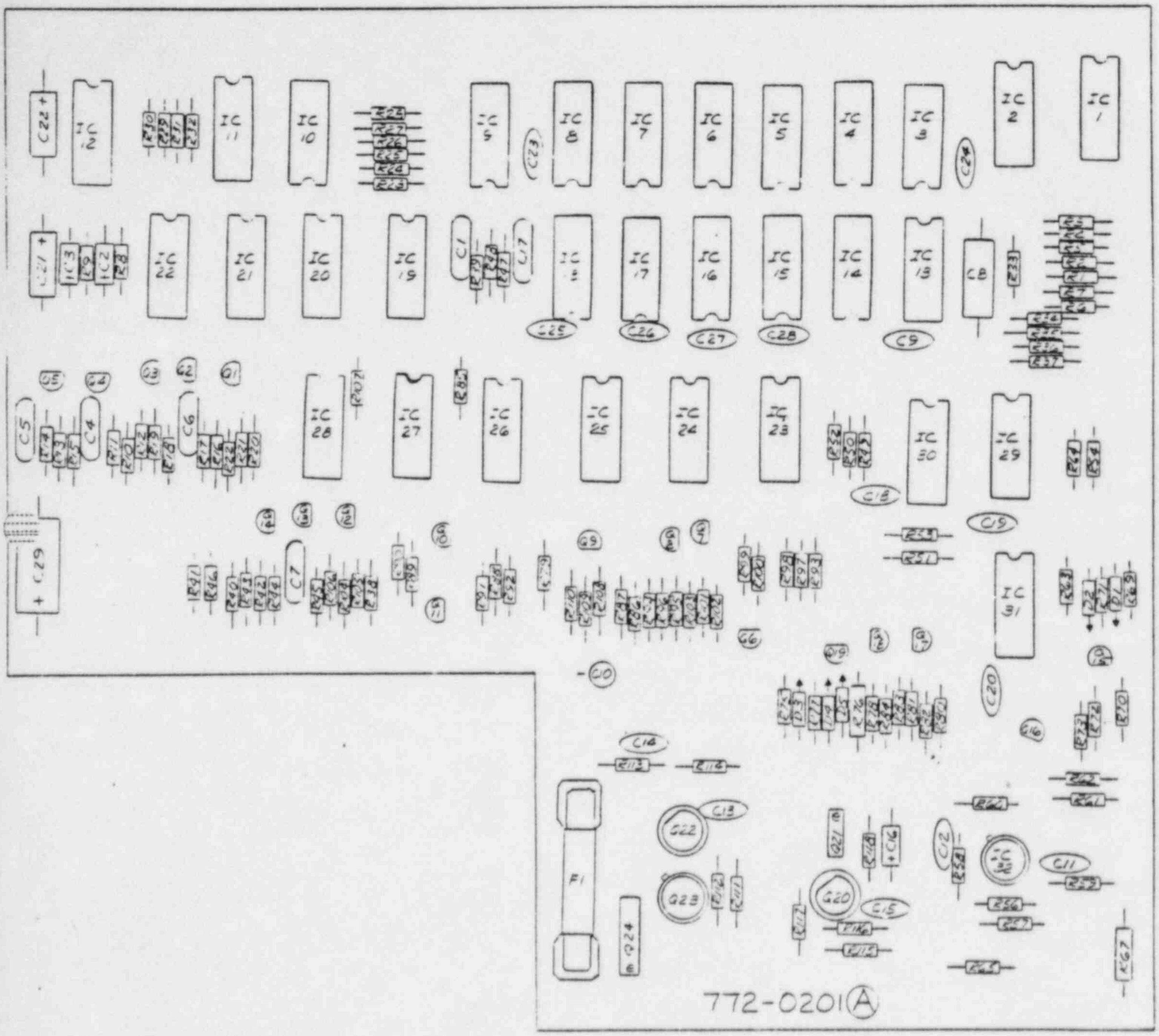
5.11. POWER SUPPLIES

There are two internal power supplies in the 772 Counter. One generates −5.2 V, required for operation of the ECL integrated circuit packages, and the other generates +5 V, required for the operation of all other integrated circuits.

Transformer T1 furnishes secondary voltage that is full-wave rectified and filtered on the power supply chassis. Q22, Q23, and Q24 form a regulator for the +5-V output, and fuse F1 protects the power supply from overload. The fuse is type 3AG with a rating of 1 A, fast acting.

The 772H version does not contain this portion of the +5-V power supply, consisting of the components on the power supply chassis (775-0100-1). It obtains its +5-V power from the +6-V source in the ORTEC 401B/402H Bin and Power Supply. In this version the collector of Q24 is connected directly to pin 10 of the rear panel module connector.

The −5.2-V source, in both the 772 and 772H versions, is obtained from the −12-V input from the Bin and Power Supply. Q20 and Q21 form a regulator for this supply. The three ECL-type packages that require this supply are IC's 29, 30, and 31.


C22
IC 12
IC 11
IC 10
IC 9
C23
IC 8
IC 7
IC 6
IC 5
IC 4
IC 3
C24
IC 2
IC 1
C21
IC 22
IC 21
IC 20
IC 19
C1
C17
IC 18
IC 17
IC 16
IC 15
IC 14
IC 13
C8
R33
C25
C26
C27
C28
C9
Q5
Q4
Q3
Q2
Q1
C5
C4
C6
IC 28
IC 27
IC 26
IC 25
IC 24
IC 23
IC 30
IC 29
C18
C19
C29
C7
IC 31
C10
C20
C14
R113
R114
C13
Q22
Q23
F1
Q24
Q21
C16
C12
IC 32
C11
Q20
C15
R67
772-0201Ⓐ

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	Spare
*10	+6 volts	32	Spare
*11	−6 volts	*33	115 volts ac (Hot)
12	Reserved Bus	*34	Power Return Ground
13	Spare	**35	Reset (Scaler)
14	Spare	**36	Gate
15	Reserved	**37	Reset (Auxiliary)
*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		

Pins marked (*) are installed and wired in ORTEC 401A and 401B Modular System Bins.
Pins marked (*) and (**) are installed and wired in EG&G/ORTEC–HEP M250/N and M350/N NIMBINS.

6. MAINTENANCE

6.1. GENERAL

The basic performance of the 772 Counter can be tested by following the procedure outlined in Section 4.2. This will not check the unit to its published specifications.

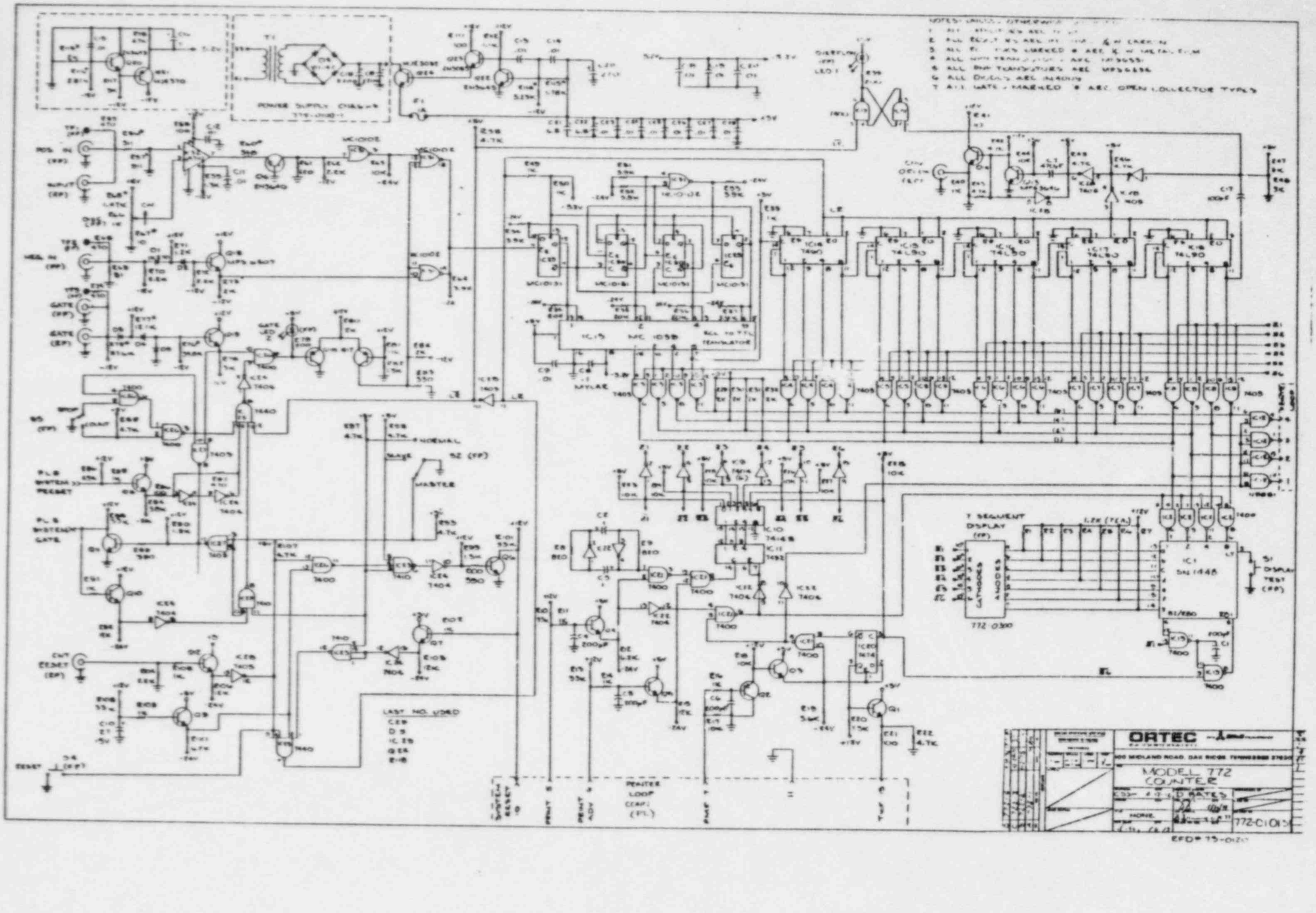
If the unit fails to respond properly during testing, use the information in Section 5 to determine the fault. Schematic 772-0101-S1 is included at the back of this manual.

6.2. FUSE REPLACEMENT

If the front panel display and indicators will not light, remove the module from the bin and take off the left side panel for access to the inside of its rear panel. Inspect fuse F1, mounted in a fuseholder on the rear panel. This fuse protects the +5-V power source, and the indicators cannot be lit unless this power is present. Replace the fuse with a 1-A fast-acting type 3AG fuse only.

6.3. FACTORY REPAIR

This instrument can be returned to ORTEC for service and repair at a nominal cost. Our standard procedure for repair ensures the same quality control and checkout that are used for a new instrument. Always contact the Customer Service Department at ORTEC, (615) 482-4411, before sending in an instrument for repair to obtain shipping instructions and so that the required Return Authorization Number can be assigned to the unit. Write this number on the address label and on the package to ensure prompt attention when it reaches the ORTEC factory.


NOTES: UNLESS OTHERWISE SPECIFIED
1 ALL CAPACITORS ARE IN µF
2 ALL RESISTORS ARE IN OHMS, ¼ W CARBON
3 ALL RESISTORS MARKED * ARE ¼ W METAL FILM
4 ALL NPN TRANSISTORS ARE MPS3563
5 ALL PNP TRANSISTORS ARE MPS6536
6 ALL DIODES ARE IN4009
7 ALL GATES MARKED * ARE OPEN COLLECTOR TYPES
POWER SUPPLY CHASSIS
POS. IN (FP)
INPUT (FP)
NEG. IN (FP)
GATE (FP)
GATE (RP)
OVERFLOW (FP)
IC15 MC1035 ECL TO TTL TRANSLATOR
MYLAR
74L90
7490
MC10131
MC10102
NORMAL
MASTER
S2 (FP)
P.L.S. SYSTEM PRESET
P.L.S. SYSTEM GATE
CNT RESET (RP)
RESET
LAST NO. USED
7 SEGMENT DISPLAY (FP)
CATHODES
ANODES
772-0300
IC1 SN7448
DISPLAY TEST (FP)
SYSTEM RESET
PRINT
PRINT ADV
PRINTER LOOP CONN (FL)
ORTEC
100 MIDLAND ROAD, OAK RIDGE, TENNESSEE 37830
MODEL 772 COUNTER
NONE
772-C1015
EFD# 75-0120

Model 456
High Voltage Power Supply
Operating and Service Manual

This manual applies to instruments marked
"Rev 46" on rear panel

Printed in U.S.A.

2922 04C 0879

STANDARD WARRANTY FOR EG&G ORTEC INSTRUMENTS

EG&G ORTEC warrants that the items will be delivered free from defects in material or workmanship. EG&G ORTEC makes no other warranties, express or implied, and specifically **NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.**

EG&G ORTEC's exclusive liability is limited to repairing or replacing at EG&G ORTEC's option, items found by EG&G ORTEC to be defective in workmanship or materials within one year from the date of delivery. EG&G ORTEC's liability on any claim of any kind, including negligence, loss or damages arising out of, connected with, or from the performance or breach thereof, or from the manufacture, sale, delivery, resale, repair, or use of any item or services covered by this agreement or purchase order, shall in no case exceed the price allocable to the item or service furnished or any part thereof that gives rise to the claim. In the event EG&G ORTEC fails to manufacture or deliver items called for in this agreement or purchase order, EG&G ORTEC's exclusive liability and buyer's exclusive remedy shall be release of the buyer from the obligation to pay the purchase price. In no event shall EG&G ORTEC be liable for special or consequential damages.

QUALITY CONTROL

Before being approved for shipment, each EG&G 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

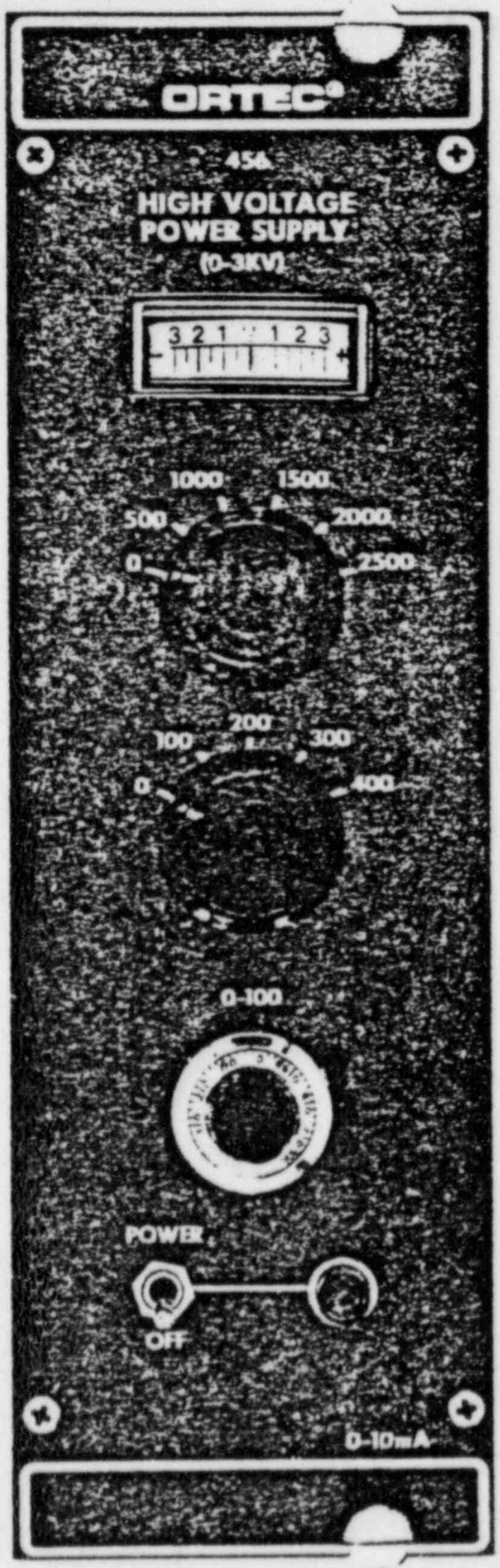
If it becomes necessary to return this instrument for repair, it is essential that Customer Services be contacted in advance of its return so that a Return Authorization Number can be assigned to the unit. Also, EG&G ORTEC must be informed, either in writing or by telephone [(615) 482-4411], of the nature of the fault of the instrument being returned and of the model, serial, and revision ("Rev" on rear panel) numbers. Failure to do so may cause unnecessary delays in getting the unit repaired. The EG&G ORTEC standard procedure requires that instruments returned for repair pass the same quality control tests that are used for new-production instruments. Instruments that are returned should be packed so that they will withstand normal transit handling and must be shipped **PREPAID** via Air Parcel Post or United Parcel Service to the nearest EG&G ORTEC repair center. The address label and the package should include the Return Authorization Number assigned. Instruments being returned that are damaged in transit due to inadequate packing will be repaired at the sender's expense, and it will be the sender's responsibility to make claim with the shipper. Instruments not in warranty will be repaired at the standard charge unless they have been grossly misused or mishandled, in which case the user will be notified prior to the repair being done. A quotation will be sent with the notification.

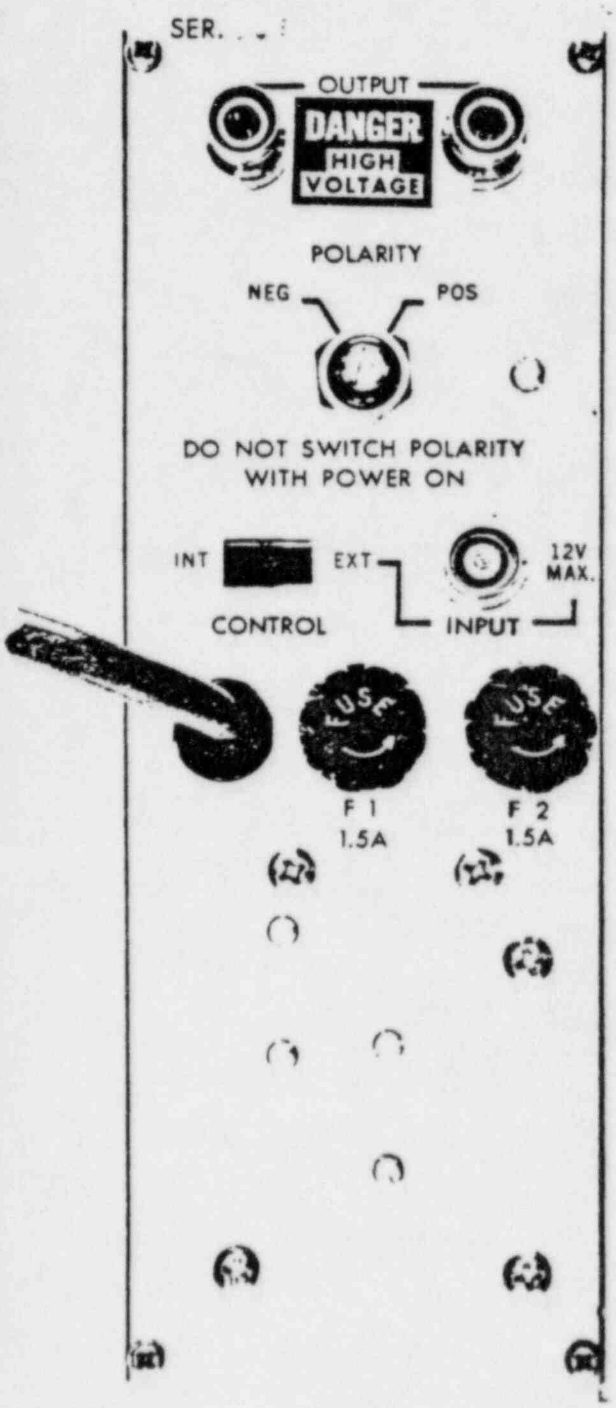
DAMAGE IN TRANSIT

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 EG&G ORTEC of the circumstances so that assistance can be provided in making damage claims and in providing replacement equipment if necessary.

CONTENTS

ILLUSTRATION


ORTEC®
456
HIGH VOLTAGE
POWER SUPPLY
(0-3KV)
3 2 1 0 1 2 3
1000
1500
500
2000
0
2500
200
100
300
0
400
0-100
POWER
OFF
0-10mA


SER.
OUTPUT
DANGER
HIGH
VOLTAGE
POLARITY
NEG
POS
DO NOT SWITCH POLARITY
WITH POWER ON
INT
EXT
12V
MAX.
CONTROL
INPUT
FUSE
FUSE
F 1
1.5A
F 2
1.5A

ORTEC 456 HIGH VOLTAGE POWER SUPPLY

1. DESCRIPTION

The ORTEC 456 High Voltage Power Supply is a standard double-width NIM module that provides either polarity of output voltage from 50 to 3000 V, 0 to 10 mA. The adjusted output voltage of the selected polarity is available simultaneously through two SHV rear-panel connectors. An internal slide switch permits operation on either 115- or 230-V ac input power, furnished through a power line cord and connector; both sides of the input power line are fused in the 456.

The 456 features a front-panel indicating meter, nominal 16-kHz internal oscillator frequency, optional external regulation for stabilizer applications, and low-noise output. It provides the well-regulated and highly stable voltage that is required for proper operation of photomultiplier tubes, ionization chambers, and lithium-drifted semiconductor detectors.

WARNING

THIS INSTRUMENT PRODUCES VOLTAGES THAT CAN BE HAZARDOUS. ALWAYS SWITCH POWER OFF AND WAIT FOR THE METER TO RETURN TO CENTER-SCALE ZERO BEFORE CONNECTING OR REMOVING CABLES AND BEFORE CHANGING THE OUTPUT POLARITY.

2. SPECIFICATIONS

PERFORMANCE

OUTPUT POLARITY Positive or negative, selected by switch on rear panel.

OUTPUT RANGE 50 to 3000 V; min usable voltage 10 V.

OUTPUT LOAD CAPACITY 0 to 10 mA.

REGULATION ≤0.0025% variation in output voltage for combined line and load variations within operating range at constant ambient temperature.

TEMPERATURE STABILITY ≤±50 ppm/°C after 30 min warmup, operating range 0 to 50°C.

LONG-TERM DRIFT <0.01%/hr and <0.03%/24-hr variation in output voltage at constant input line voltage, load, and ambient temperature after 30 min warmup.

OUTPUT RIPPLE <15 mV peak to peak, 5 Hz to 5 MHz.

OVERLOAD PROTECTION Built-in overload and short-circuit protection with max output current limit of ≈12 mA. Overload is indicated by low-frequency oscillations on front-panel meter.

CONTROLS

POWER OFF Toggle switch on front panel is used to energize unit when power cord is plugged into an appropriate source, and an adjacent indicator lamp shows when power is applied to the 456.

OUTPUT LEVEL One 6-position switch, one 5-position switch, and a 10-turn precision potentiometer; output level is sum of the 3 selections ±0.25%.

POLARITY A rear-panel switch selects either Positive or Negative output polarity.

CONTROL A slide switch on the rear panel selects the reference source for the output voltage.

Int Selects the internal reference source; the front-panel controls select the output amplitude, and the rear-panel switch is used to select either polarity.
Ext Selects the external reference source; output voltage is proportional to reference input.

INPUTS

AC POWER LINE 103-129 V or 206-258 V, 47-65 Hz, 50 W nom; power supplied through 3-wire captive line cord with standard NEMA connector; both sides of line are fused in the 456.

EXTERNAL CONTROL Full range of output voltage can be based on an external reference level furnished through a rear-panel BNC connector; control voltage range is 0 through ~±9 V dc; this input protected by a nominal 9-V zener.

OUTPUTS

REGULATED DC OUTPUT The adjusted and regulated voltage, with selected polarity, is furnished simultaneously to the SHV connectors on rear panel.

INDICATOR

METER A front-panel zero-center indicating meter shows the polarity and approximate amplitude of the adjusted output voltage.

ELECTRICAL AND MECHANICAL

DIMENSIONS Standard double-width module, 2.70 x 8.714 in. per TID-20893 (Rev.).

POWER REQUIREMENTS 115 or 230 V 47-65 Hz, 50 W nom; no dc power requirements.

WEIGHT (Shipping) 10 lb (4.5 kg).

WEIGHT (Net) 8 lb (3.6 kg).

ACCESSORIES AVAILABLE

Standard ORTEC 12-ft-long adapter cables are available for the SHV output connectors to accommodate the high voltage input connector on the preamplifier or detector, or other accessory that is to have the output power level applied.

ORTEC C-36-12 SHV to SHV 75Ω Cable Assembly
ORTEC C-35-12 SHV to Kings KV-59-22 75Ω Cable Assembly
ORTEC C-34-12 SHV to MHV 75Ω Cable Assembly

RELATED EQUIPMENT

Each of the two outputs of the 456 can be used as a power source for any application that is within the operating limits of the power supply. Both output levels are identical and of the same polarity. The load on the 456 output circuit is the sum of the individual loads connected to both output connectors.

This power supply is ideal for use with either one detector or a pair of detectors where the voltage level requirements are the same for both detectors. The appropriate types of detectors for which the 456 is designed include scintillation, ionization chambers, and lithium-drifted semiconductor detectors.

3. INSTALLATION

3.1 GENERAL

The 456 is normally used in conjunction with other modular electronics and may be installed in an ORTEC 401A Bin. As such, it can be rack mounted. Therefore any other equipment that may be installed in the same rack must be sufficiently cooled by circulating air to prevent any localized heating of the circuits in the 456. The temperature of equipment operating in racks can easily exceed the recommended maximum unless precautions are taken. The 456 should not be subjected to temperatures in excess of 50°C (120°F).

3.2 CONNECTION TO POWER

The 456 contains all required power supplies to operate and receives input power by way of a 3-wire captive line cord with a standard NEMA male connector when connected to a suitable source. An internal slide switch permits the selection of the proper input circuit for either 115- or 230-V ac nominal power input. This power supply may be operated entirely removed from a 401A Bin if desired, since it is totally self-contained and requires no dc operating power levels from the Bin. However, precautions should be taken to ensure that personnel know of the shock hazard at the rear connectors, and air space should be provided at the top and bottom of the instrument.

3.3 CONNECTING INTO A SYSTEM

1. Check to see that the power switch is in the Off position.

2. Plug the ac power cord into the appropraite receptacle.

3. Check the polarity switch on the rear panel and set it for either positive or negative output polarity as required for the application.

4. Connect a high-voltage cable from either output connector on the 456 to the instrument to be powered. Use the other output connector if a second instrument is to be operated at the same output voltage.

5. Set the front-panel selector switches and potentiometer for the desired voltage level. This is normally specified with the instruments to which the voltage is to be applied. The adjusted output voltage will be the sum of the settings of all three controls.

6. Turn on the power with the toggle switch on the front panel. The indicator lamp next to the switch will light to show that input power is being applied. The indicating meter at the top of the front panel will also deflect to show both the polarity and the amplitude of the adjusted output voltage.

3.4 CONNECTING AN EXTERNAL REFERENCE INPUT

An output voltage level can be controlled by an external reference level that is furnished through the rear-panel BNC connector when the Control slide switch is set at Ext. The range of input voltage is 0 to ∼9 V to provide an output level to 3000 V. The front-panel voltage level controls are ineffective for external reference operation.

For positive output the polarity selector switch on the rear panel is set at Positive, and the external reference should be positive. For negative output the polarity switch is set at Negative and the external reference should be negative. The external reference voltage should be stable and filtered since the output is linearly proportional to this reference. The external reference should be capable of driving the 47 kΩ input impedance.

4. CIRCUIT DESCRIPTION

4.1. GENERAL

Figure 4.1 is a simplified block diagram of the 456 circuits. Schematics 456-0101-S1 and 456-0301-S1 are included at the back of the manual.

The 456 requires an ac power input, regardless of the use of an internal or an external reference level. The selected reference level is applied to a precision regulator and controls the low voltage input level to an internal nominal 16 kHz oscillator. The oscillator output voltage is stepped up for the high voltage output through a converter transformer, and this is rectified and filtered to produce the output to each output connector.

The front-panel indicating meter is connected to the output connectors and monitors the voltage present at these connectors. This is an excellent safety feature since it indicates whenever there is a voltage present at the connectors, as well as the output polarity and the approximate level.

4.2. REGULATION

IC302 is a differential input amplifier that receives inputs from the voltage control board and the output divider string. This is an error signal that is amplified by IC301 and furnished to the regulating transistor, Q317. Q315 is used as a constant-current transistor. Q318 is a driver for the pass transistor, Q104. The overload transistor is Q316 and it samples the voltage across R102.

A preregulator controls Q103. The current to turn Q103 on is supplied through D304, R309, and C302. Q302 is actually turned on by current through R311, R310, and D305 into the base of Q302. Q311 and Q312 keep the voltage across pass transistor Q104 at a low value by shunting base current from Q302. When there is an overload, the base current for Q302 is shunted away by the action of Q313, which is turned on by current from overload transistor Q316. To prevent SCR spikes, Q103 is prevented from being triggered by Q301 if there is any voltage across Q103. This allows the SCR to be triggered only at those times when the voltage across it is at or very near zero.

When Q103 is triggered one time, Q303 through Q310 ensure that it will be triggered a second time. This prevents saturation of the input transformer by ensuring that current passes through the transformer in both directions. Q303, Q304, and Q305 are speedup transistors that trigger a flip-flop, Q306 and Q307. When Q307 is turned on, Q310 supplies current to Q302 to trigger Q103 the second time.

The preregulator can be bypassed for troubleshooting purposes. To bypass the preregulator, short the anode and cathode of Q103 together; this can be done by shorting pins 13 and 14 of Regulator Board 456-0301 to each other. This allows the voltage to go high on the collector of Q104 and requires care when loading the output to prevent exceeding the power dissipation rating of Q104.

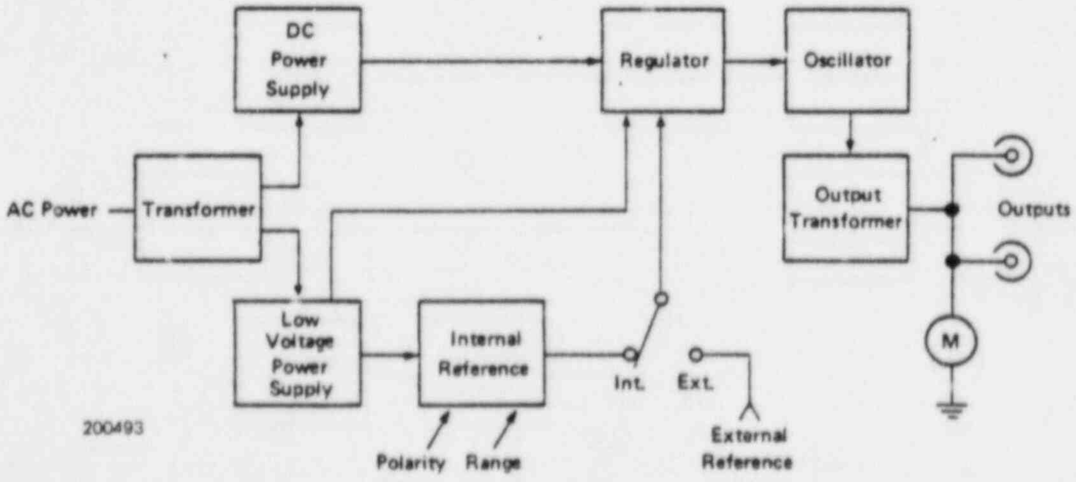


Fig. 4.1. Simplified Block Diagram of ORTEC 456.

5. CORRECTIVE MAINTENANCE

5.1 GENERAL

These units should rarely require more than cleaning to prevent leakage paths from being created by dust collection. If an apparent malfunction is noted, it is important to determine if it is within the High Voltage power supply by disconnecting it from its position in a circuit and performing routine diagnostic tests with a voltmeter and oscilloscope. The power supply is short-circuit protected, and under a short circuit the output voltage will drop to zero. If an external short circuit has been applied to the output, the short circuit must be removed before the power supply will again produce its adjusted full voltage. If this supply is operating at or near rated output current when short circuit occurs, it may be necessary to lower voltage setting to allow supply to recover properly.

5.2 TROUBLESHOOTING SUGGESTIONS

Troubleshooting procedures for this power supply should consist of simply removing the output loads and measuring the output voltage, and then applying a load and monitoring the output voltage again to see whether the output voltage is regulated. Internal dc measurements may be performed in the field since typical dc voltages are indicated in the schematic diagram. Be cautious when measuring voltage within this power supply because of the personnel hazard associated with the high voltages. The 456, or any other standard ORTEC product, may be returned to the factory for repair service at any time for a nominal cost. Our standard procedures for repair include the same extensive quality control tests that a new instrument receives.

The following table lists some possible problems that may occur in an ORTEC 456 High Voltage Power Supply, together with one or more possible causes for each of these problems.

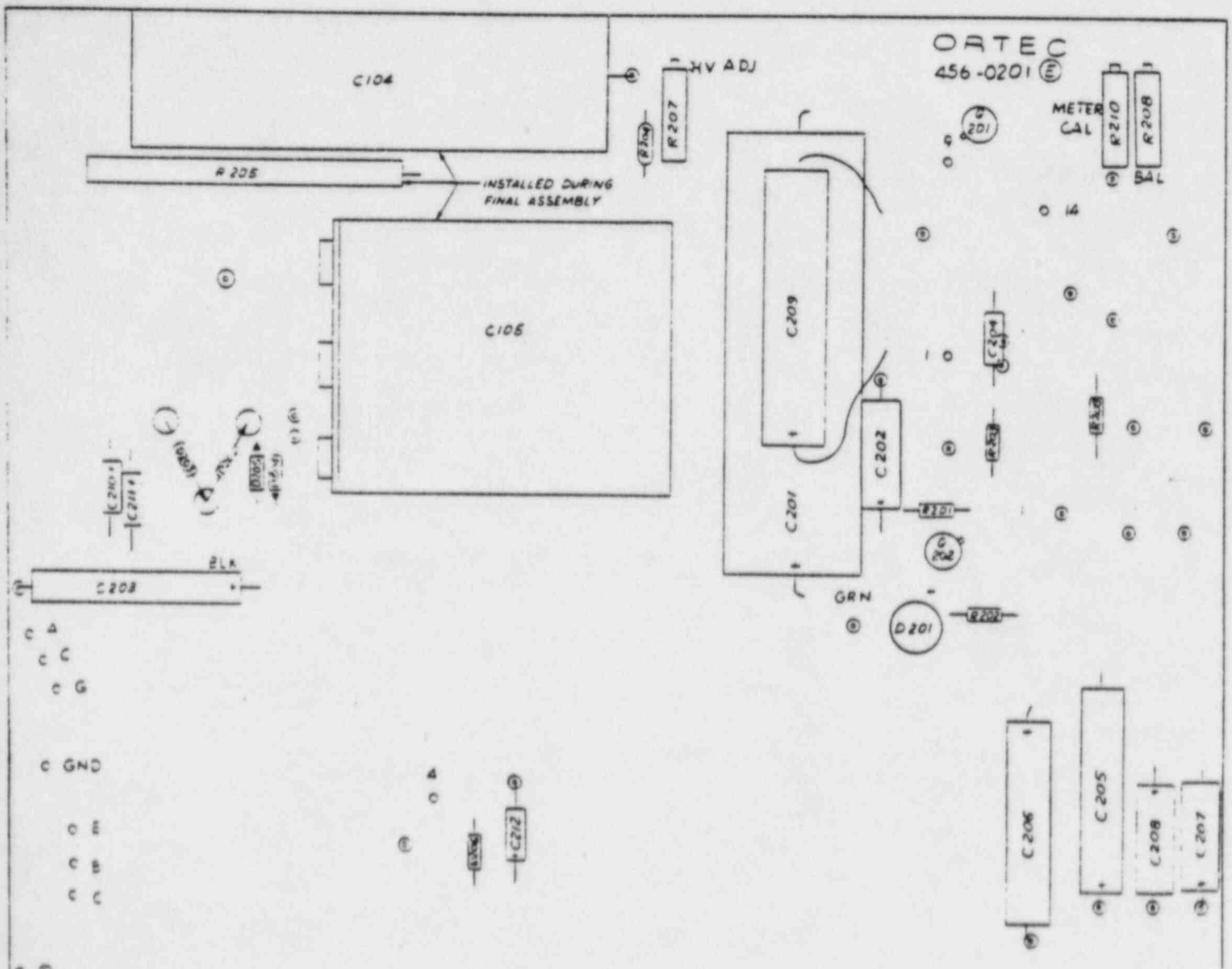
Table 5.1.

Problem	Possible Causes
Blows input fuses	Check internal 115/230 switch. Oscillator stopped. Q101 or Q102 shorted. D101 defective. One or more of the following capacitors shorted: C101, C102, C201, C203.
No output with Control switch set at Ext.	Q103 open. Q104 open. No reference voltage input. Q101 or Q102 open.
Output ok at high setting, but does not drop properly when controls are set to zero.	Leaky Q104.
Output ok at low setting, but will not increase to high levels.	Q101 or Q102 defective. Low reference voltage.
Output oscillates at a low frequency.	Supply is overloaded.

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	Spare
*10	+6 volts	32	Spare
*11	−6 volts	*33	115 volts ac (Hot)
12	Reserved Bus	*34	Power Return Ground
13	Spare	**35	Reset (Scaler)
14	Spare	**36	Gate
15	Reserved	**37	Reset (Auxiliary)
*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		

Pins marked (*) are installed and wired in ORTEC 401A and 401B Modular System Bins.
Pins marked (*) and (**) are installed and wired in EG&G/ORTEC–HEP M250/N and M350/N NIMBINS.


ORTEC
456-0201 E
C104
HV ADJ
R207
R205
INSTALLED DURING
FINAL ASSEMBLY
C105
C209
C202
C201
R201
C204
METER
CAL
R210
R208
BAL
14
D201
R202
GRN
BLK
C203
C210
C211
A
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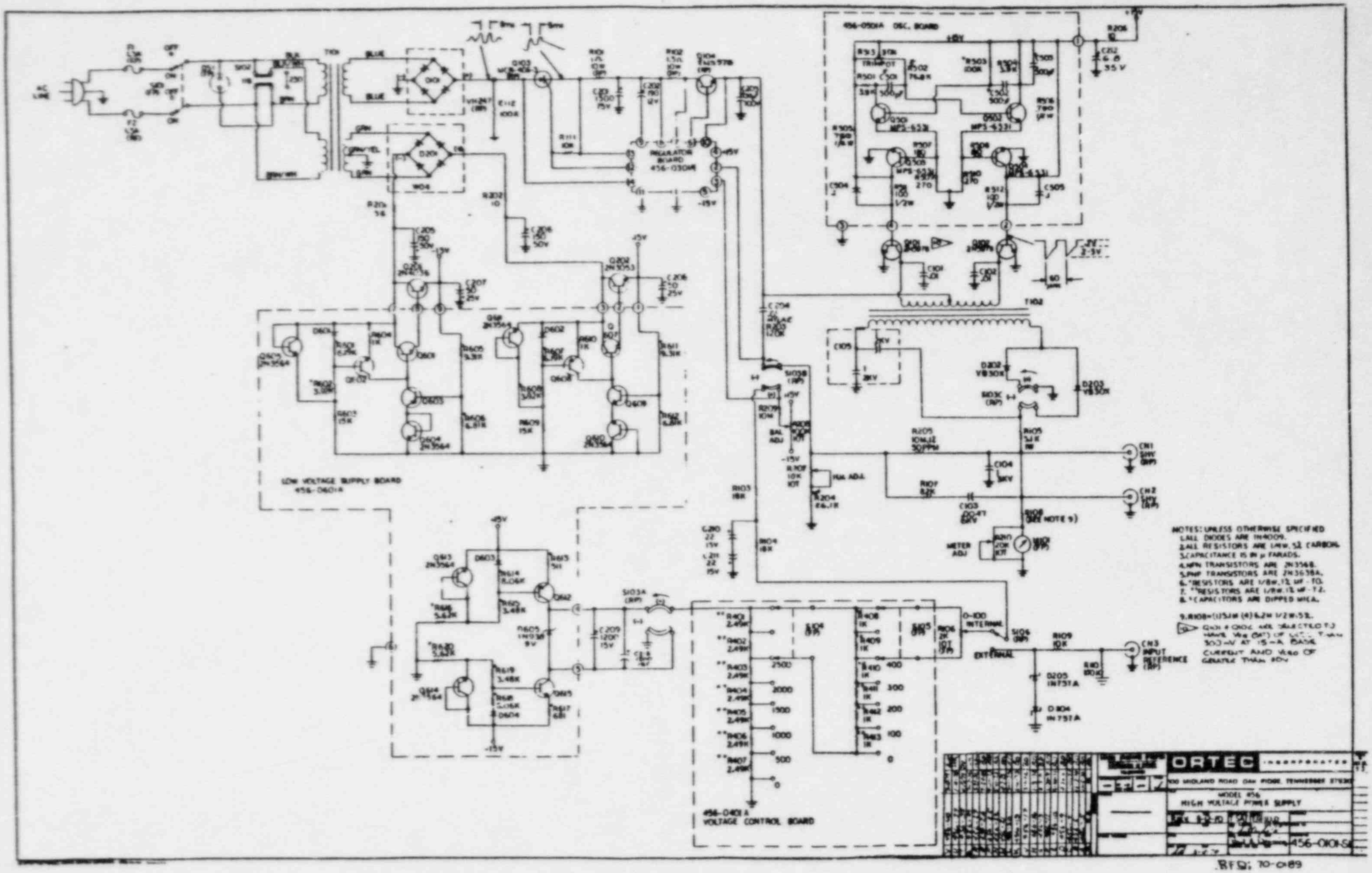
C212
C206
C205
C208
C207



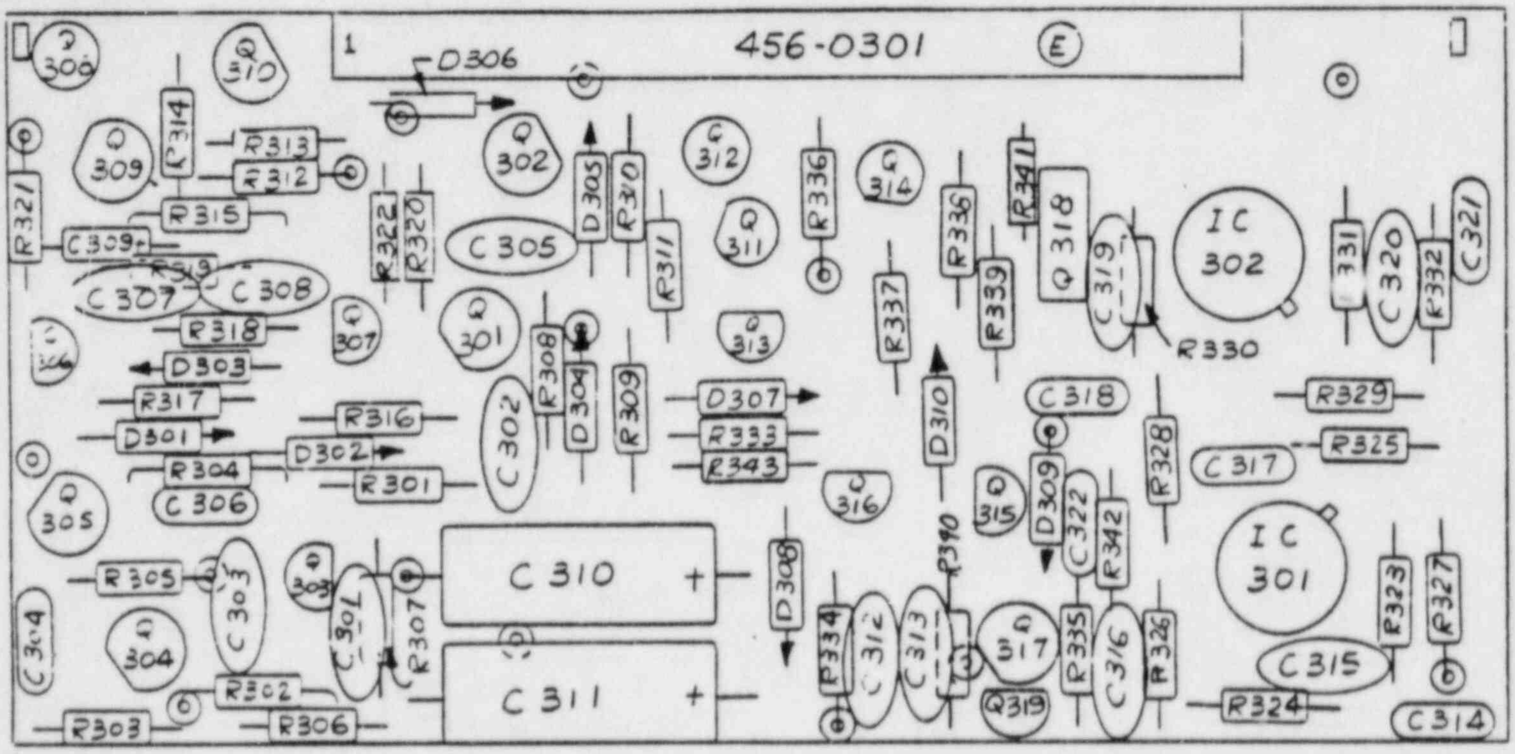
NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL DIODES ARE 1N4009.
2. ALL RESISTORS ARE 1/4W, 5% CARBON.
3. CAPACITANCE IS IN μ FARADS.
4. NPN TRANSISTORS ARE 2N3568.
5. PNP TRANSISTORS ARE 2N3638A.
6. *RESISTORS ARE 1/8W, 1% MF-T0.
7. **RESISTORS ARE 1/8W, 1% MF-T2.
8. *CAPACITORS ARE DIPPED MICA.

9. R108=(1)52M (4) 6.2M 1/2W, 5%.

10 Q101 & Q102 ARE SELECTED TO HAVE V_{CE} (SAT) OF LESS THAN 300 mV AT 15 mA BASE CURRENT AND V_{CEO} OF GREATER THAN 80V

ORTEC INCORPORATED
100 MIDLAND ROAD OAK RIDGE, TENNESSEE 37830
MODEL 456
HIGH VOLTAGE POWER SUPPLY
456-0101-S

RFQ: 70-089


1
456-0301
E
D306
Q 309
Q 310
R314
R313
R312
Q 302
D305
R310
Q 312
R336
Q 314
R341
Q 318
IC 302
R331
C320
R332
C321
Q 309
R321
R315
R322
R320
C305
R311
Q 311
R338
R339
C309
R319
C307
C308
C319
R337
R330
Q 301
Q 313
R318
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C306
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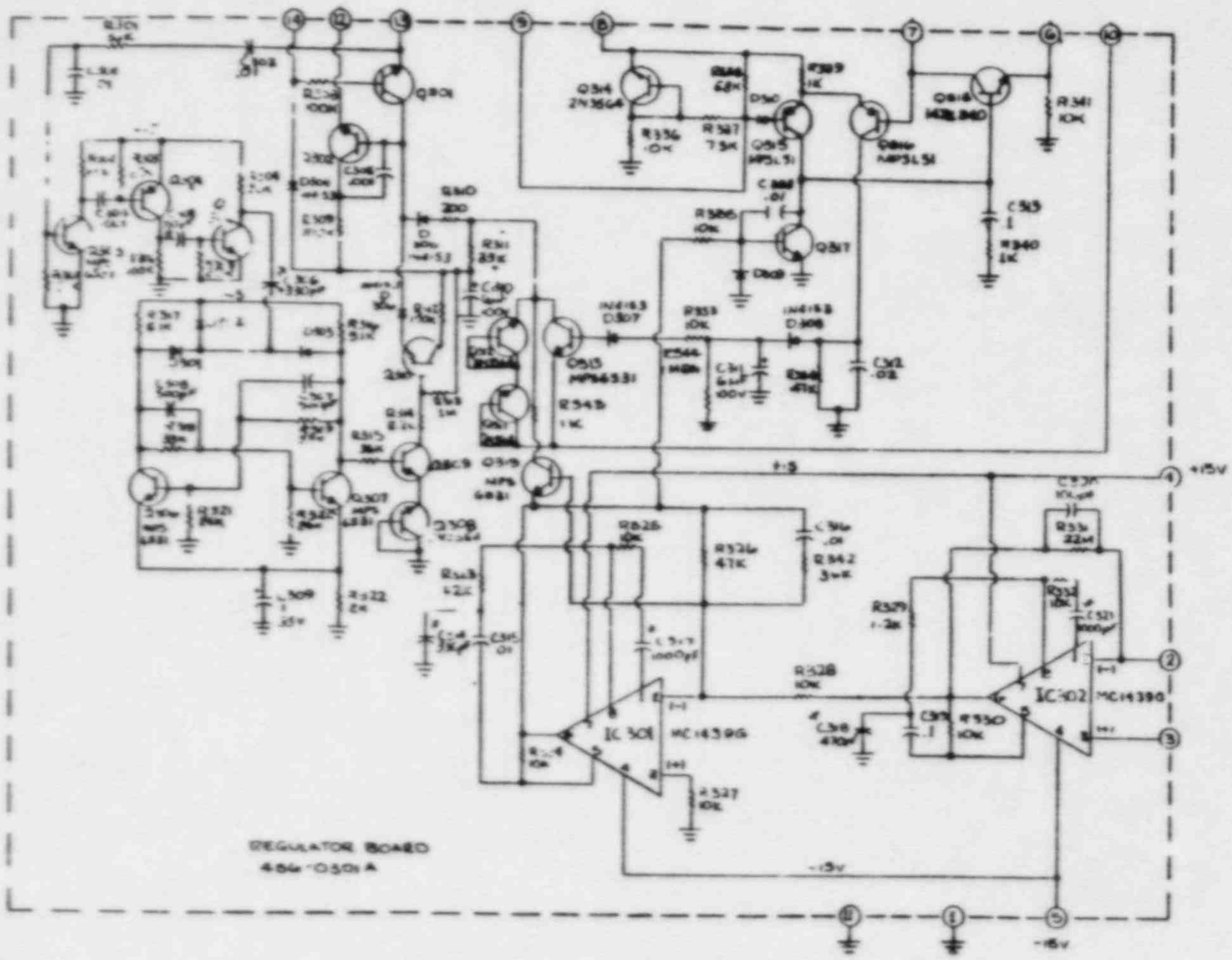
R329
R317
R316
C302
R333
R325
D301
D302
R343
R328
C317
R304
R301
Q 316
Q 315
D309
C322
R342
IC 301
Q 305
C306
R340
C310
R305
C303
Q 303
C301
R307
D308
C304
Q 304
R334
C312
C313
Q 317
R335
C316
R326
R323
R327
C315
C311
R302
Q319
R324
R303
R306
C314

NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL DIODES ARE IN4009
2. ALL RESISTORS ARE 1/4 W 5% CABON
3. CAPACITANCE IS IN μ FARADS
4. NPN TRANSISTORS ARE 2N3568
5. PNP TRANSISTORS ARE 2N3638A
6. # CAPACITORS ARE DIPPED MICA



R344
C521
D512
Q519
IC302

ORTEC INCORPORATED
100 MIDLAND ROAD OAK RIDGE, TENNESSEE 37830

MODEL 456
REGULATOR BOARD

DC 8-4-70 T SATTERFIELD 456-0101-31

GR 9-3-71

456-0501

Model 439
Digital Current Integrator
Operating and Service Manual

This manual applies to instruments marked
"Rev 33" on rear panel

Printed in U.S.A.

2806 01C 0479

STANDARD WARRANTY FOR EG&G ORTEC INSTRUMENTS

EG&G ORTEC warrants that the items will be delivered free from defects in material or workmanship. EG&G ORTEC makes no other warranties, express or implied, and specifically **NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.**

EG&G ORTEC's exclusive liability is limited to repairing or replacing at EG&G ORTEC's option, items found by EG&G ORTEC to be defective in workmanship or materials within one year from the date of delivery. EG&G ORTEC's liability on any claim of any kind, including negligence, loss or damages arising out of, connected with, or from the performance or breach thereof, or from the manufacture, sale, delivery, resale, repair, or use of any item or services covered by this agreement or purchase order, shall in no case exceed the price allocable to the item or service furnished or any part thereof that gives rise to the claim. In the event EG&G ORTEC fails to manufacture or deliver items called for in this agreement or purchase order, EG&G ORTEC's exclusive liability and buyer's exclusive remedy shall be release of the buyer from the obligation to pay the purchase price. In no event shall EG&G ORTEC be liable for special or consequential damages.

QUALITY CONTROL

Before being approved for shipment, each EG&G 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

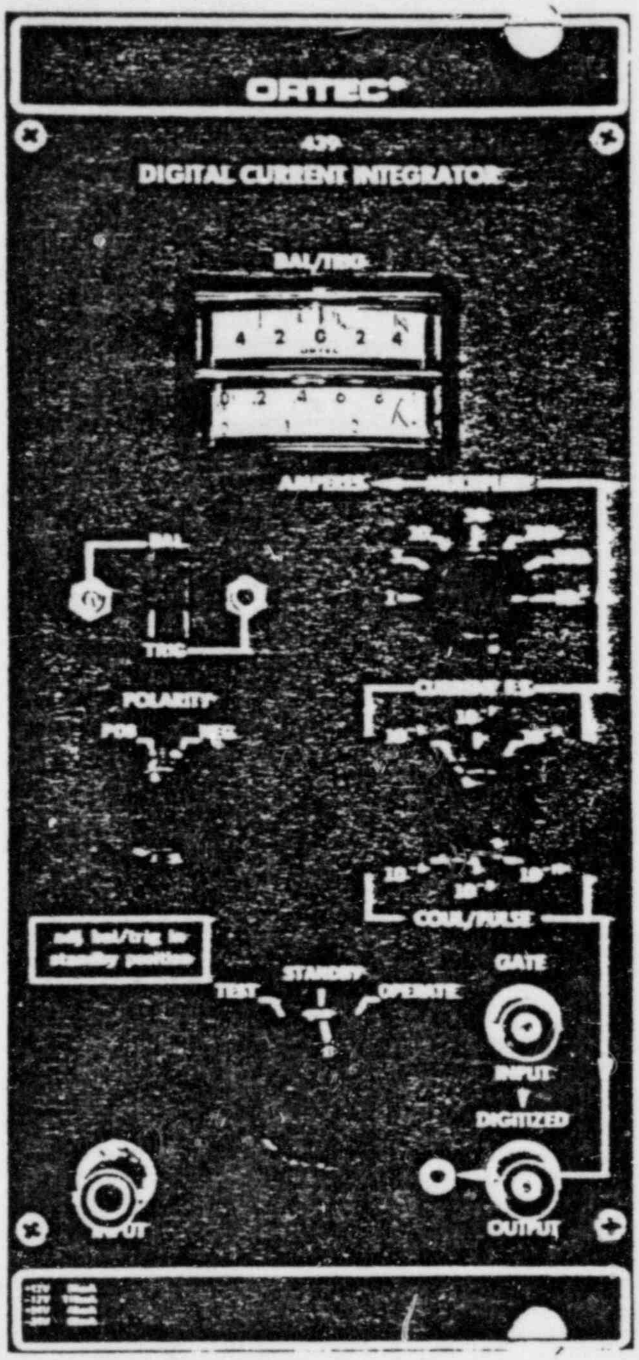
If it becomes necessary to return this instrument for repair, it is essential that Customer Services be contacted in advance of its return so that a Return Authorization Number can be assigned to the unit. Also, EG&G ORTEC must be informed, either in writing or by telephone [(615) 482-4411], of the nature of the fault of the instrument being returned and of the model, serial, and revision ("Rev" on rear panel) numbers. Failure to do so may cause unnecessary delays in getting the unit repaired. The EG&G ORTEC standard procedure requires that instruments returned for repair pass the same quality control tests that are used for new-production instruments. Instruments that are returned should be packed so that they will withstand normal transit handling and must be shipped **PREPAID** via Air Parcel Post or United Parcel Service to the nearest EG&G ORTEC repair center. The address label and the package should include the Return Authorization Number assigned. Instruments being returned that are damaged in transit due to inadequate packing will be repaired at the sender's expense, and it will be the sender's responsibility to make claim with the shipper. Instruments not in warranty will be repaired at the standard charge unless they have been grossly misused or mishandled, in which case the user will be notified prior to the repair being done. A quotation will be sent with the notification.

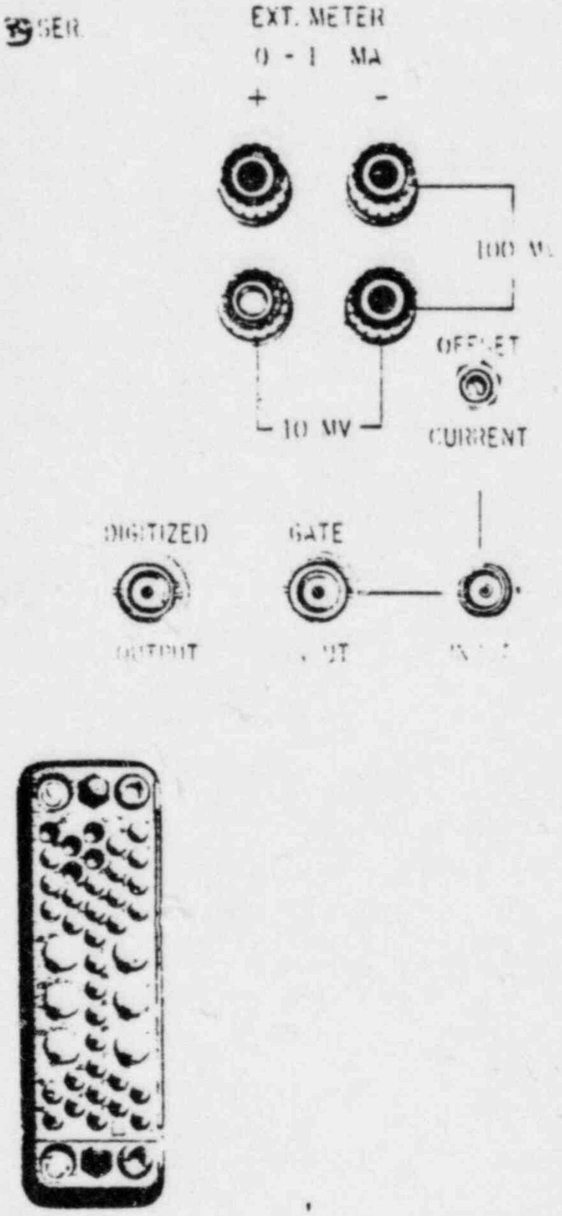
DAMAGE IN TRANSIT

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 EG&G ORTEC of the circumstances so that assistance can be provided in making damage claims and in providing replacement equipment if necessary.

CONTENTS

LIST OF FIGURES


ORTEC
439
DIGITAL CURRENT INTEGRATOR
BAL/TRIG
AMPERES
MULTIPLIER
BAL
TRIG
POLARITY
POS
NEG
CURRENT
COUL/PULSE
adj bal/trig in standby position
TEST
STANDBY
OPERATE
GATE
INPUT
DIGITIZED
OUTPUT
INPUT


SER.
EXT. METER
0 - 1 MA
+
-
100 MV
10 MV
OFFSET
CURRENT
DIGITIZED
OUTPUT
GATE
INPUT
INPUT

439 DIGITAL CURRENT INTEGRATOR

1. DESCRIPTION

The ORTEC 439 Digital Current Integrator* was designed to accurately measure the direct current or the average value of pulse currents such as accelerator beam currents. The ORTEC 439 digitizes the input current by producing an output pulse for specific values of input charge. A front-panel switch permits the selection of three different amounts of charge (10^{-10}, 10^{-8}, or 10^{-6} Coulomb) required to produce an output pulse. This gives the user the option of more than one count rate for a given input current. The instrument has a digitizing rate from 0-10 kHz to provide wide dynamic range on each setting and high-resolution readout without meter interpolation. When combined with a preset scaler such as the 431, this instrument forms a digital charge integrator. When it is combined with a digital ratemeter such as the 434, a digital electrometer is obtained.

A front-panel meter is provided to read the input current. Full-scale analog outputs of 1 mA, 100 mV and 10 mV are provided on rear-panel binding posts. There are 15 ranges from 1 x 10^{-9} to 1 x 10^{-2} A for obtaining full-scale readings for the front-panel meter and the analog outputs.

BNC connectors are provided on the front and rear panels for the application of a gate signal to inhibit the digitized output. This gate may be used to remotely control the 439 or it may be used to inhibit the digitized output with the multichannel analyzer dead-time pulse.

2. SPECIFICATIONS

PERFORMANCE

LEAKAGE IMPEDANCE FROM INPUT TO GROUND $>1 \times 10^{10}\,\Omega$.

INPUT LEAKAGE CURRENT $<1 \times 10^{-12}$ A.

TEMPERATURE STABILITY 0.05%/°C, 0 to 50°C.

DIGITIZED OUTPUT ACCURACY ±0.2% of reading from 100 nA to 10 mA dc; typical accuracy ±0.3% of reading at 50 nA. Count rate on 10^{-10} Coulomb/pulse range limited to 1 kHz.

DIGITIZED REPRODUCIBILITY 0.01%.

ANALOG ACCURACY Front-panel meter, 2%; rear-panel binding posts, 1.0%.

CONTROLS

INPUT CHARGE PER OUTPUT PULSE Selectable by front-panel switch, 10^{-10}, 10^{-8}, or 10^{-6} Coulomb/pulse.

TEST CURRENT Selectable by front-panel switch; produces a digital output of ~1 kHz on each Coulomb/pulse setting.

INPUTS

SIGNAL INPUT Through SHV connectors on front and rear panels.

Impedance Virtually ground with maximum excursion of <±5 mV.
Current Polarity Positive or negative.
Current Range 1 x 10^{-9} to 1 x 10^{-2} A.

GATE INPUT Signal normally enabled in absence of an input or when the dc value is nominally +6 V; BNC connectors on front and rear panels.

To Enable Output +3 V or greater.
To Inhibit Output +1.5 V or less (e.g., can be shorted to ground by a relay).
Maximum Input +25 V, -10 V.
Duty Cycle Limitation None, dc-coupled.
Input Impedance $>1000\Omega$; driving source must be capable of sinking 1 mA of current from a positive source.

OUTPUTS

DIGITIZED Signal +5 V, 500 ns wide; 0 to 10 kHz; BNC connectors on front and rear panels.

ANALOG

Front-Panel Meter 0-1 and 0-3 scales serving all multiplier ranges; there are 15 full-scale ranges.
Rear-Panel Binding Posts 0 to 1 mA full scale, 0 to 100 mV full scale; 0 to 10 mV full scale; there are 15 full-scale ranges.

PHYSICAL DATA

POWER REQUIRED +24 V, 45 mA; +12 V, 95 mA; -24 V, 45 mA; -12 V, 110 mA.

DIMENSIONS NIM-standard triple-width module (4.05 in. wide by 8.714 in. high) per TID-20893 (Rev.).

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*Based on a design by F. M. Glass, ORNL. See F. M. Glass *et al.*, "A New Approach to Direct Current Integration," **IEEE Trans. Nucl. Sci. NS-14 (1)**, 143-146 (February 1967).

3. INSTALLATION

3.1 GENERAL

The 439, used in conjunction with the 401A/402A Bin and Power Supply, is intended for rack mounting; therefore any vacuum tube equipment operated in the same rack must be sufficiently cooled by circulating air to prevent any localized heating of the all-transistorized circuitry used throughout the 439. The temperature of equipment mounted in racks can easily exceed the recommended maximum temperature of 120°F (50°C) unless precautions are taken.

3.2 CONNECTION TO POWER

The 439 contains no internal power supply but must obtain necessary operating power from a Nuclear Standard Bin and Power Supply, such as the ORTEC 401A/402A. It is recommended that the Bin and Power Supply be turned off when modules are inserted or removed. The 400 Series is designed so that it is not possible to overload the Bin and Power Supply with a full complement of modules in the Bin; however, this may not be true when the Bin contains modules of other than ORTEC design, and in such instances Power Supply voltages should be checked after the modules are inserted. ORTEC 401A/402A has test points on the Power Supply control panel to monitor the dc voltages.

3.3 INPUT CONNECTION FOR DC CURRENT

Input SHV connectors are provided on the front and rear panels. To ensure maximum accuracy, the impedance of the current source should be kept as high as possible ($>10^{10}\Omega$), even though the 439 dynamic input impedance is very low. The input varies less than 3 mV from ground during operation. This small voltage variation should present no leakage problems except in those cases where water-cooled target current is measured. The current source impedance (R_S in Fig. 3.1) required to make a 0.1% accuracy measurement can be calculated by the formula

$$R_S \geqslant \frac{3}{I}\ .$$

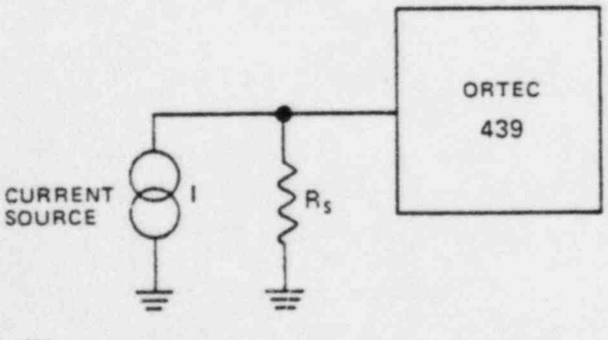


Fig. 3.1. Source Impedance Requirements.

For example, to measure 1 μA to an accuracy of 0.1%, a source impedance of at least 3 MΩ is required. If a 1% accuracy were acceptable, R could be reduced to 300 kΩ. The following table may be helpful to determine the source impedance required to measure the current in your system.

Measured Current (A)	Source Impedance (Ω) Required for Accuracies of	
	0.1%	1%
1×10^{-9}	3×10^{9}	3×10^{8}
10×10^{-9}	3×10^{8}	3×10^{7}
100×10^{-9}	3×10^{7}	3×10^{6}
1×10^{-6}	3×10^{6}	3×10^{5}
10×10^{-6}	3×10^{5}	3×10^{4}
100×10^{-6}	3×10^{4}	3×10^{3}

Be careful to avoid ground loops when installing the 439. If a coaxial cable is used to connect the current source to the input of the 439, it may be necessary to leave the cable shield ungrounded at the current source. Of course, it would be advantageous to locate the 439 as near as possible to the current source to avoid long ground returns.

3.4 INPUT CONNECTION FOR PULSED CURRENT

The beam current from many accelerators arrives in the target area as a pulsed beam, whose rate varies from the megahertz range to a few pulses per second. Problems may be encountered when high peak currents occur or when the charge in a beam current pulse exceeds one-tenth the amount selected by the Coulomb/pulse range selected on the 439. These problems can be overcome by adding a low leakage capacitor to the input of the 439. This capacitor will act as a storage element for the charge until the 439 can process it (see Section 5.1 for a functional description of the 439). If it becomes necessary to add a capacitor to the input when the 10^{-6} Coulomb/pulse range is used, then 30 to 50Ω should be added in series with the input of the 439 as shown in Fig. 3.2.

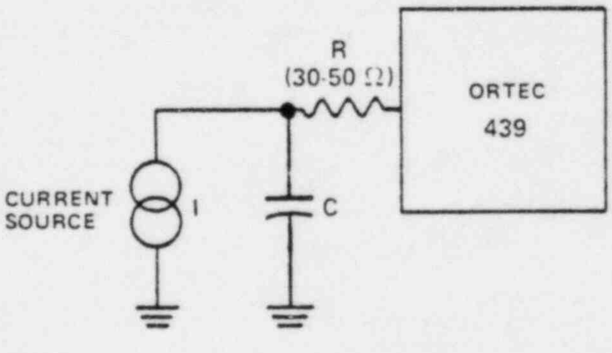


Fig. 3.2. Input Storage Network for 10^{-6} Coulomb/Pulse Range.

Whenever practical, the value of C should be large enough so that the charge in each beam pulse does not create a voltage of more than 10 mV on C. For instance, if each beam pulse contained 10^{-9} Coulomb of charge, the 10^{-10} Coulomb/pulse range could be used on the 439 if a capacitor of the following size were added to the input:

$$C = \frac{Q}{V} = \frac{10^{-9}}{10^{-2}} = 0.1\ \mu F.$$

Of course, this assumes that the average current does not exceed the dynamic range of the 10^{-10} Coulomb/pulse range.

3.5 CONNECTOR DATA

INPUT SHV connectors are provided on the front and rear panels for connection to the 439 input. SHV connectors are used because of their low-leakage characteristics. Care should be taken to keep the 439 input circuitry as clean as possible in order to prevent leakage paths to ground. The Test-Operate switch should be positioned to Standby before making connections to or from the input. Even though the input circuitry is protected against overvoltage, transients drive the input amplifier into saturation, producing a temporary imbalance in the input amplifier due to the long time required for the MOS-FET's to recover from overload.

DIGITIZED OUTPUT The output is dc-coupled and is provided on both the front and rear panels through BNC connectors. A standard logic pulse 5 V in amplitude and 500 µs wide is produced each time the required amount of charge is received at the input. The width of this pulse can be altered as desired by changing the value of C15. The amplitude can be increased by increasing the value of R93.

GATE INPUT The gate input signal is connected to the 439 by front- and rear-panel BNC connectors. With no connection made to the gate input, the input voltage level is about +6 V and the gate will permit digital pulses to appear at the Digitized Output connector when an appropriate amount of charge is received at the input. When the gate input is pulled below +1.5 V, the digital output pulses are blocked and do not appear at the Digitized Output connector. To pull the gate input below +1.5 V, the driving circuit must be capable of absorbing 1 mA from the gate input circuit. The gate circuit will permit normal operation of the 439 when the gate input is at +3 V or greater.

4. OPERATING INSTRUCTIONS

4.1 TEST-OPERATE SWITCH

The Test-Operate is a three-position switch which controls the function of the instrument:

STANDBY This position grounds the input of the 439, preventing the application of transients to the input amplifier and should therefore be selected before applying power to the 439, making any connections to or from the Input connectors, or changing the Polarity or Current F. S. switches. This position must be selected when adjusting the input amplifier by use of the Bal and Trig potentiometers (see Section 4.3).

OPERATE This is the position in which the instrument will normally be used. In this position the input amplifier is connected to the input connectors (SHV's) on the front and rear panels.

TEST In this position an internal test current is provided to produce an output of approximately 1000 Hz on all Coulomb/pulse ranges. This current is not meant to be used as a calibration but merely as a reference test current once the unit has been calibrated.

4.2 POLARITY SWITCH

The polarity switch should be set to the polarity of the input current to be measured.

4.3 BAL/TRIG SWITCH

The Bal/Trig switch, in conjunction with the two front-panel screwdriver adjustment potentiometers, the Bal/Trig Meter and the Test-Operate switch, is used to balance and adjust the 439 input amplifier. Uninterrupted power should be applied to the 439 for approximately 20 min before the instrument is used. This is necessary because of the long-term drift characteristics exhibited by MOS-FET's. The following adjustments should be made on the 439 before it is used:

1. Set Test-Operate switch to Standby.
2. Set Bal/Trig switch to Bal.
3. Adjust Bal potentiometer to zero the Bal/Trig Meter.
4. Set Bal/Trig switch to Trig.
5. Adjust Trig potentiometer to zero the Bal/Trig Meter.
6. Set Bal/Trig switch to Bal; recheck meter zero.

Note: The accuracy of the 439 is not affected as long as the Bal and Trig adjustments are within ±4 divisions of zero.

The adjustment of the input amplifier should be rechecked by placing the Test-Operate switch to Standby each time the power is applied to the instrument and at convenient intervals.

4.4 CURRENT F.S. AND COULOMB/PULSE SWITCH

The Current F.S. and Coulomb/pulse switch controls the amount of charge that must be injected at the input to obtain a digital output pulse (10^{-10}, 10^{-8}, or 10^{-6} Coulomb). The Coulomb/pulse range is read from the bottom side of the double-indicating knob on the switch. The top index of this knob in conjunction with the multiplier switch indicates the amount of current required at the input to produce a full-scale deflection on the ampere meter. Currents up to 1 μA can be measured on the 10^{-10} Coulomb/pulse range with 0.01% repeatability; however, the accuracy of the measurement may be in error by as much as 1% for currents ranging from 100 nA to 1 μA. The 10^{-8} Coulomb/pulse range should be used for accurate measurements of currents in this range. Inaccuracies begin to appear on the 10^{-10} Coulomb/pulse range when the digitized output rate exceeds 1000 Hz.

4.5 MULTIPLIER SWITCH

The position of the Multiplier switch determines the multiplier to be applied to the Current F.S. reading in order to produce a full-scale deflection on the Ampere Meter. The rear-panel analog outputs (0-10 mV, 0-100 mV, 0-1 mA) have the same current input requirements for full-range signals as the Ampere Meter and are affected in a similar manner by the Multiplier switch.

4.6 INTERNAL TEST CHECK

After power has been applied to the 439 for a few minutes and the Bal and Trig trim potentiometers have been adjusted properly, the test position on the Test-Operate switch should produce a digitized output rate of approximately 1000 Hz and a full-scale reading on the Ampere Meter when 10^2 is selected on the Multiplier switch.

4.7 OFFSET CURRENT ADJ.

A potentiometer is provided on the rear panel to adjust the input offset current over a range of approximately ±10 pA. See Section 6.1.2 of this manual for the procedure to measure and adjust the input leakage current of the 439. The 439 input leakage current is adjusted to less than 1 pA at the factory and should not require additional adjustment.

4.8 USE OF DIGITIZED OUTPUT

In order to take full advantage of the accuracy and versatility of the 439, the digitized output pulse must be counted by a scaler. Depending on the application, it may be desirable for this scaler to have a preset time or scale capability, as does the ORTEC 431. This would permit integration for a preset time or until a preset quantity of charge is obtained. If it is desirable to know at what rate an event or process is occurring, then a scaler with an internal time base such as the ORTEC 434 or 715 is needed.

Even though the 439 was designed primarily to measure accelerator beam current, it performs equally well for measuring current or charge from any source. All that is required is a transducer which will convert the variable to be measured to a current or charge.

5. CIRCUIT DESCRIPTION

5.1 GENERAL

The 439 Digital Current Integrator produces a digital output pulse for a given quantity of charge entering the input. (See Dwgs. 439-0101-B1 and 439-0101-S1.) Input Amplifier A1 is a differential amplifier which uses MOS-FET's as input transistors in order to maintain high input impedance to ground and a low-leakage current. A capacitor is used as a feedback element for A1 to make it an integrator. A1 is followed by a free-running discriminator with a fixed threshold voltage of -500 mV. The input to the discriminator is switched so that a negative signal is received from A1 regardless of the input current polarity. The discriminator output is fed to a pulse-shaping circuit which produces a pulse of precise width independent of count rate and temperature. This pulse is routed to a voltage clamp to control the pulse amplitude and then through a low-leakage transistor switch to produce a voltage across a resistor (R3) connected to the input. Since this pulse has a controlled amplitude and width, a precise amount of current is added to or subtracted from the input for a controlled time. The charge represented by this current and time ($Q = It$) is the necessary charge required at the input to produce a digital output pulse. When this charge is added to or subtracted from the input (depending on the polarity of the input current), the output of A1 is reset above the threshold of the discriminator. As current continues into the input, the output of A1 gradually decreases until the discriminator threshold is again exceeded and another pulse is created. The amount of charge fed back to the input during each pulse is determined by the value of R1, R3, and R4. The values of these resistors vary by a factor of 100, causing the charge/pulse ranges to be 10^{-10}, 10^{-8}, and 10^{-6} Coulomb/pulse. The feedback capacitor is changed each time these resistors are switched to control the output voltage excursions of A1 to ±500 mV during operation.

The output of the pulse-shaping circuit is also fed to a count rate circuit and a gate and driver circuit. The count rate circuit converts the digital output rate to an analog signal. The analog signal is displayed on the front panel by a meter and is available on the rear panel as a 0- to 1-mA, 0- to 100-mV, or 0- to 10-mV signal. The range of the count rate circuit is controlled by the multiplier switch. The gate and driver circuit produces a digital output pulse each time a pulse is received from the pulse shaper circuit, provided that the gate is in the pass mode. If the gate level is below +1.5 V, the signal to the driver circuit will be blocked.

5.2 CIRCUIT DESCRIPTION

Amplifier A1, as shown in the block diagram, is composed of Q7-Q15. This is a differential amplifier throughout with both ends brought out on the emitters of Q14 and Q15. R24, the Bal potentiometer mounted on the front panel, should be adjusted so that equal current flows in Q7 and Q8. R23 is also mounted on the front panel and should be adjusted so that the voltage at Q14 and Q15 emitters is 0 V. This is the Trig adjustment. Q29 and Q30 form a drive circuit for the Bal/Trig Meter which is used to monitor the adjustment of the Bal and Trig potentiometers. The input to the meter drive circuit is taken from the emitter of either Q14 or Q15, depending on whether the Bal or the Trig adjustment is being monitored. Q5, Q6, and R6 compose a protection circuit for Q7 in case a high voltage is applied to the input. The open loop gain of A1 is approximately 3 x 10^4; however, R38 and R39 establish a resistive feedback network to set the gain at 260. Therefore as the output of A1 moves through excursions of +500 mV, the input voltage varies ±2.5 mV. Q16 and Q17 form a free-running discriminator with a fixed threshold voltage of -500 mV. The free-running rate of this discriminator is approximately 13 kHz. The negative pulse at the collector of Q17 is fed to the pulse shaper which is composed of Q18-Q23. The width of the pulse created by this shaper circuit is controlled by R68. The 10^{-10} Coulomb/pulse range is calibrated by adjusting the pulse width with this potentiometer. Four circuits are driven from the emitter of Q23: the transistor switch and voltage clamp circuit, the inverter circuit, the gate and driver circuit, and the count rate circuit. The transistor switch circuit includes Q1 and Q2, which have 90 mV back bias on their base-emitter junctions in the quiescent condition to decrease the leakage current and increase the impedance seen at their emitters. The voltage reference for the clamp circuit is established by Zener diodes D34 and D35. The voltage pulse from Q23 is clamped at this reference voltage and developed across R3, R1, and R4, depending on the Coulomb/pulse range selected. The feedback capacitor (C3, C1, or C2) is switched each time the range resistor is changed to limit the excursion at the output of A1 to ±500 mV. These resistors and capacitors are switched by reed relays, since a low-capacitance, low-leakage switch is required. The 10^{-8} and 10^{-6} Coulomb/-pulse ranges can be calibrated by adjusting R2 and R5, respectively. If the polarity of the input current is negative, a positive pulse is fed to the switch and clamp circuit from the emitter of Q23. If the polarity of the input current is positive, a negative pulse is fed to this circuit from the inverter (Q27, Q31). The output gate and driver circuit is capacitively coupled to the emitter of Q23. If the gate is in the pass position, the pulse-shaping circuit formed by Q32 and Q33 sends a 500-ns 6-V pulse to the driver transistor (Q35, Q41) each time a pulse is received from Q23. The width of this pulse can be changed by changing C15, and the amplitude can be changed by changing the value of R93. When the gate is in the pass position, Q34 is off; when it is in the block position, Q34 is saturated, shorting the pulse from Q23. The state of Q34 is determined by the gate control circuit (Q37 and Q38). Q38 turns on to saturate Q34 when the gate input voltage falls below +1.5 V.

The amplitude of input pulses to the count rate circuit is clamped at +12 V; this level is established by voltage divider R83 and R84 and furnished through D18. A common calibration for all ranges of the Multiplier switch is obtained from R81 and applied through emitter-follower Q43 to regulate the +12-V level actually applied to Q26 through D18. The time constant for the output analog and meter circuit is set at approximately 0.7 s, but it can be increased or decreased by simply increasing or decreasing the value of C13. Q25 forms a drive circuit for the front-panel current meter and the rear-panel analog outputs. Q36 provides meter protection for the front-panel current meter, and D21 gives protection for external meters. Zero adjustment of the meter and analog output signals is provided by Q28 and R77.

Q39 and Q40 establish stable voltages for positive and negative test currents. These voltages are adjustable by trim potentiometers R15 and R14. During factory check-out, these voltages are adjusted to produce a digitized output of 1000 Hz on the 10^{-10} Coulomb/pulse range after the instrument has been calibrated. The digitized output should be within 1% of 1000 Hz on the 10^{-8} and 10^{-6} Coulomb/pulse ranges, since the tolerance on the resistors establishing the test current for these ranges is 1%.

6. MAINTENANCE

6.1 TESTING PERFORMANCE

The following information on front-panel controls and testing procedures is intended as an aid in the installation and checkout of the 439.

6.1.1 Test Equipment

The following or equivalent test equipment is needed:

NIM Bin and Power Supply, ORTEC 401A/402A.
Extender cable, ORTEC 401-C3.
A current source with a known accuracy of better than 0.1%.

Note: If a voltage and a resistor are used to form a current source, the voltage source should have a value greater than 5 V. The accuracy of the 439 is 1000 ppm, which is better than the temperature and/or voltage coefficients of most high-value resistors.

Counter with an internal time base.

Oscilloscope.
Schematic and block diagram of 439.

6.1.2 Preliminary Procedures

1. Visually check the module for damage due to shipment.

2. Connect ac power to the Nuclear Standard Bin and Power Supply, ORTEC 401A/402A.

3. Plug module into Bin and check for proper mechanical alignment.

4. Switch on ac power and check the dc Power Supply voltage at the test points on the 401A control panel.

5. Set the 439 Test-Operate switch to Standby.

Note: The Test-Operate switch should be set to Standby at any time Bal and Trig adjustments are made or the polarity or current range is changed.

6. After uninterrupted power has been applied to the 439 for approximately 20 min, set Bal/Trig switch to Bal.

7. Adjust the Bal potentiometer to zero the Bal/Trig Meter.

8. Set the Bal/Trig switch to Trig.

9. Adjust the Trig potentiometer to zero the Bal/Trig Meter.

10. Set the Bal/Trig switch to Bal and recheck meter zero.

Note: The accuracy of the 439 is not affected as long as the Bal and Trig adjustments are within ±4 divisions of zero; however, an attempt should be made to keep them adjusted to zero. During operation the Bal/Trig Meter will not necessarily indicate zero. No attempt should be made to adjust the Bal or Trig until the Test-Operate switch is placed to the Standby position. The adjustment of the input amplifier should be rechecked at convenient intervals and each time power is applied to the instrument.

11. Set Coulomb/pulse switch to 10^{-10}.

12. Set Multiplier switch to 10^2.

13. Set Test-Operate switch to Test.

14. Monitor the Digitized Output with a scaler. The digital rate should be approximately 1000 Hz, and the front-panel meter should read full scale with the Multiplier switch on 10^2.

15. Using the precaution mentioned in the Note in step 5, check the 10^{-8} and 10^{-6} Coulomb/pulse range on the Test position. A digital rate of approximately 1000 Hz should be obtained.

16. The input leakage current of the 439 can be checked by removing all connections from the input connectors, selecting the 10^{-10} Coulomb/pulse range and setting the Test-Operate switch to the Operate position. If the Bal/Trig Meter moves to the right, Neg polarity should be selected. The output count rate should be less than 1 pulse per 100 s. If the leakage current is greater than 1 pulse per 100 s, it should be adjusted to zero with the Offset Current Adj potentiometer on the rear panel.

17. Check the calibration of the 439 by applying a known current to the input connector and measuring the digitized output rate.

Note: The 439 is calibrated at the factory on the 10^{-10}, 10^{-8}, and 10^{-6} Coulomb/pulse range for a positive current and the 10^{-10} Coulomb/pulse range for negative current. If a negative current is measured on the 10^{-8} or 10^{-6} Coulomb/pulse range as calibrated at the factory, an error as large as 1% may be observed. These ranges can be calibrated for negative current by adjusting R2 and R5. Check Section 6.2 of this manual for calibration procedures.

6.2 CALIBRATION PROCEDURE

6.2.1 Digital

The 10^{-10} Coulomb/pulse range is calibrated by adjusting the width of the pulse created by the pulse-shaping circuit. This pulse width is normally about 44 μs and is adjusted by R68 for positive and negative calibration. Calibration of the 10^{-8} and 10^{-6} Coulomb/pulse is accomplished by adjusting R2 and R5. Since a change in the width of the pulse from the pulse-shaping circuit affects the calibration of all ranges, the 10^{-10} Coulomb/pulse range must be calibrated first. The polarity of the current to be measured in the experiment should be selected before calibrating the 10^{-8} and 10^{-6} Coulomb/pulse ranges. When calibrating the 439 it is desirable to apply a current to the input which will produce approximately the following count rates:

Range (Coulomb/pulse)	Count Rate (Hz)
10^{-10}	1000
10^{-8}	10 000
10^{-6}	10 000

6.3 SUGGESTIONS FOR TROUBLESHOOTING

Set the Test-Operate switch to the Standby position and recheck the Bal and Trig adjustment following the procedure given in Section 4.3 of this Manual. If these adjustments cannot be made as described, the malfunctioning is in the input amplifier, A1, and the instrument should be returned to the factory for repair. If an attempt is made to repair the instrument locally, Sections 5 and 6.4 and the block diagram and schematic should be referred to.

After the Bal and Trig adjustments have been made, the Polarity and Current Range switches should be checked for proper settings. If pulsed current is being measured, refer to Section 3.4 for assistance. If further information is needed, contact the factory.

The testing instructions in Section 6.1 of this manual and the circuit description in Section 5 along with the voltage table in Section 6.4 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.

6.4 FACTORY REPAIR

This instrument can be returned to the ORTEC factory for service and repair at a nominal cost. Our standard procedure for repair ensures the same quality control and checkout that are used for a new instrument. Always contact Customer Services at ORTEC, (615) 482-4411, before sending in an instrument for repair to obtain shipping instructions and so that the required Return Authorization Number can be assigned to the unit. Write this number on the address label and on the package to ensure prompt attention when it reaches the ORTEC factory.

6.5 TABULATED TEST POINT VOLTAGES ON ETCHED BOARD

The following voltages are intended to indicate the typical dc voltages measured on the etched circuit board. The voltages given here should not be considered as absolute values, but should merely be used as an aid in troubleshooting.

Notes:

1. All voltages were measured from ground with a voltmeter having an input impedance of 10 MΩ or greater.

2. Voltages are dc values with no current applied to the input.

3. Set the Test-Operate switch to Standby. Adjust the Bal and Trig trim potentiometers as stated in Section 4.3.

4. Set the Polarity switch to Positive.

5. Set the Coulomb/pulse range to 10^{-10}

Q1b	-	0.100	Q23e	-	0.500
Q2b	+	0.100	Q26e		0
Q3e	-	14.0	Q26c	+	16.5
Q12b	-	8.9	Q27C		0
Q13b	-	8.9	Q28c		0
Q14e		0	Q29e	-	0.500
Q15e		0	Q31e	+	0.600
Q16b		0	Q33e	-	12.08
Q17b	-	0.500	Q35e		0
Q19c	+	22	Q37b	+	2.7
Q20c	+	0.1	Q37e	+	3.3
Q22e	+	2.0	Q39e	+	2
Q21c	+	1.2	Q40e	-	2
			Q43e	+	12

Note: If a current source made from a high-value resistor and a voltage source is used, a minimum of 5 V should be used across the resistor. Most high-value resistors have extreme voltage and/or temperature coefficients; so this should be taken into consideration.

The following steps should now be taken:

1. Set the Test-Operate switch to Standby.

2. Set the Multiplier switch to 10^3.

3. Set the Bal/Trig switch to Bal.

4. Adjust Bal trim potentiometer to zero the Bal/Trig Meter.

5. Set the Bal/Trig switch to Trig.

6. Adjust the Trig trim potentiometer to zero the Bal/Trig Meter.

7. Connect the digitized output of the 439 to a scaler that has an internal time base.

8. Set the Coulomb/pulse switch to 10^{-10}.

9. Set the Polarity switch to the polarity of the test current.

10. Connect a current source to the 439 input. (The desired value of this current source is 100 nA; this should produce a digitized output rate of 1000 Hz.)

11. Set Test-Operate switch to Operate.

12. Adjust trim potentiometer R68 to give the desired digitized output rate. Access to all calibration adjustments is available through the top cover of the 439.

13. Set the Test-Operate switch to Standby.

14. Connect a test current source of opposite polarity to the 439 input and check the calibration of the 439 for the opposite polarity.

The 10^{-10} Coulomb/pulse range is now calibrated. The 10^{-8} and the 10^{-6} Coulomb/pulse range should be calibrated for the same polarity as the current to be measured in the experiment.

15. Set the Test-Operate switch to Standby.

16. Set the Coulomb/pulse switch to 10^{-8}.

17. Set the Polarity switch to polarity of input test current.

18. Connect a test current (approximately 100 μA) to the 439 input.

19. Set the Test-Operate switch to Operate.

20. Adjust the 10^{-8} calibrate trim potentiometer to obtain the desired digitized output.

21. Set the Test-Operate switch to Standby.

22. Set the Coulomb/pulse switch to 10^{-6}.

23. Connect a 10-mA test current to the 439 input.

24. Set the Test-Operate switch to Operate.

25. Adjust the 10^{-6} calibrate trim potentiometer to obtain the desired digitized output.

26. Set the Test-Operate switch to Standby.

The digitized output of the 439 is now calibrated.

6.2.2 Analog

1. Set the Test-Operate switch to Standby.

2. Adjust the Bal and Trig trim potentiometers in steps 1 through 6 above.

3. Connect a digital voltmeter across the 100-mV terminals on the rear panel.

4. Connect the digitized output to a scaler with an internal time base.

5. If count rate is not zero, adjust the meter zero trim potentiometer until the digital voltmeter reads zero.

6. Connect a variable current source to the input. (A variable voltage source of zero to 25 V and a 2.5 kΩ resistor in series with the 439 input may be used.)

7. Set the Polarity switch to the same polarity as the variable current source.

8. Set the Coulomb/pulse range switch to the proper range.

9. Set the Test-Operate switch to Operate.

10. Set the Multiplier switch to 10^3.

11. Adjust the variable current source to obtain 10 000 Hz digitized output rate.

12. Adjust the Multiplier calibrate potentiometer until the voltmeter reads 100 mV.

13. Adjust the variable current source until a digitized output rate of 3000 Hz is obtained.

14. Set the Multiplier switch to 300.

Digital voltmeter should read 100 mV ±1 mV.

15. Adjust the variable current source until the digitized output rate reads 1000 Hz.

16. Set the Multiplier switch to 10^2.

Digital voltmeter should read 100 mV ±1 mV.

17. Adjust the variable current source until the digitized output rate is 300 Hz.

18. Set the Multiplier switch to 30.

Digital voltmeter should read 100 mV ±1 mV.

19. Adjust the variable current source until the digitized output rate is 100 Hz.

20. Set the Multiplier switch to 10.

Digital voltmeter should read 100 mV ±1 mV.

21. Adjust the variable current source until the digitized output rate is 30 Hz.

22. Set the Multiplier switch to 3.

Digital voltmeter should read 100 mV ±1 mV.

23. Adjust the variable current source until the digitized output rate is 10 Hz.

24. Set the Multiplier switch to 1.

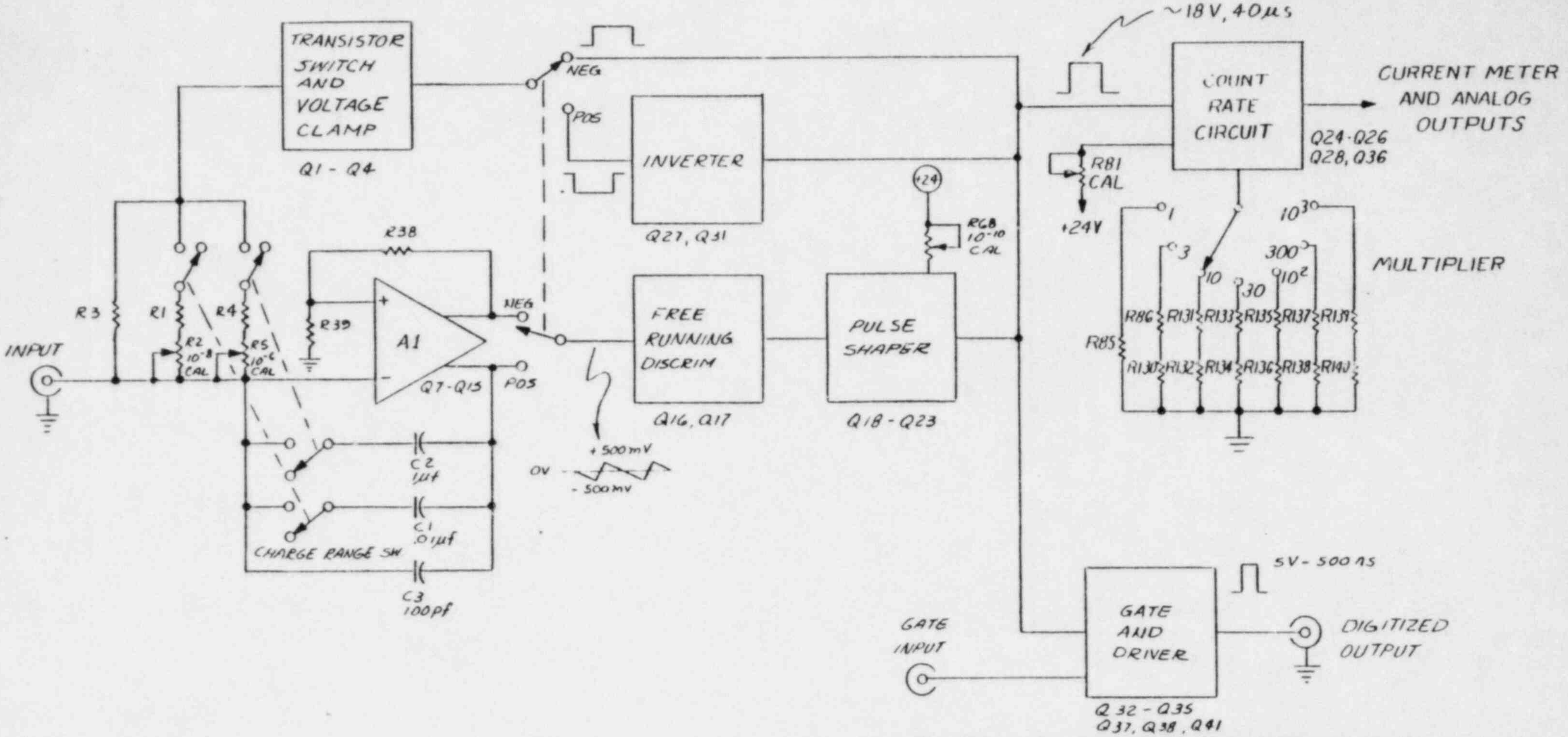
Digital voltmeter should read 100 mV ±1 mV.

The analog portion of the 439 is now calibrated.

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	Spare
*10	+6 volts	32	Spare
*11	−6 volts	*33	115 volts ac (Hot)
12	Reserved Bus	*34	Power Return Ground
13	Spare	**35	Reset (Scaler)
14	Spare	**36	Gate
15	Reserved	**37	Reset (Auxiliary)
*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		

Pins marked (*) are installed and wired in ORTEC 401A and 401B Modular System Bins.
Pins marked (*) and (**) are installed and wired in EG&G/ORTEC−HEP M250/N and M350/N NIMBINS.



REV	ECN NO	DATE	
C	439-13	10-29-71	BD
B	439-6	5-12-69	HK
A	439-2	9-11-68	JDW

REVISIONS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS IN INCHES
TOLERANCES

FRACTIONS	DECIMALS	ANGLES	FINISH
±1/64	XX ±.01 XXX ±.005	±0°30'	✓ RMS

MATERIAL

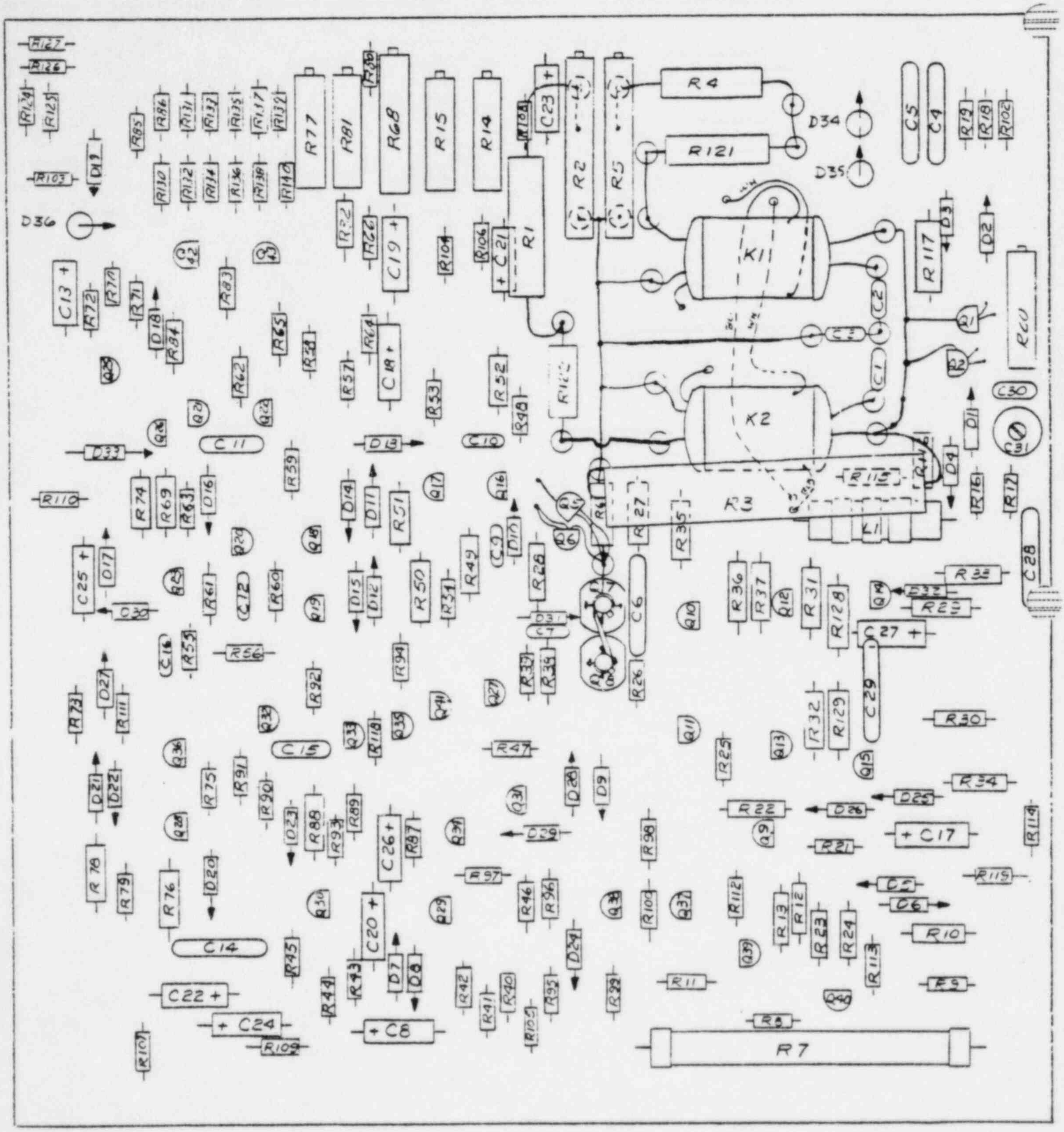
APPLIED PRACTICES

ORTEC INCORPORATED

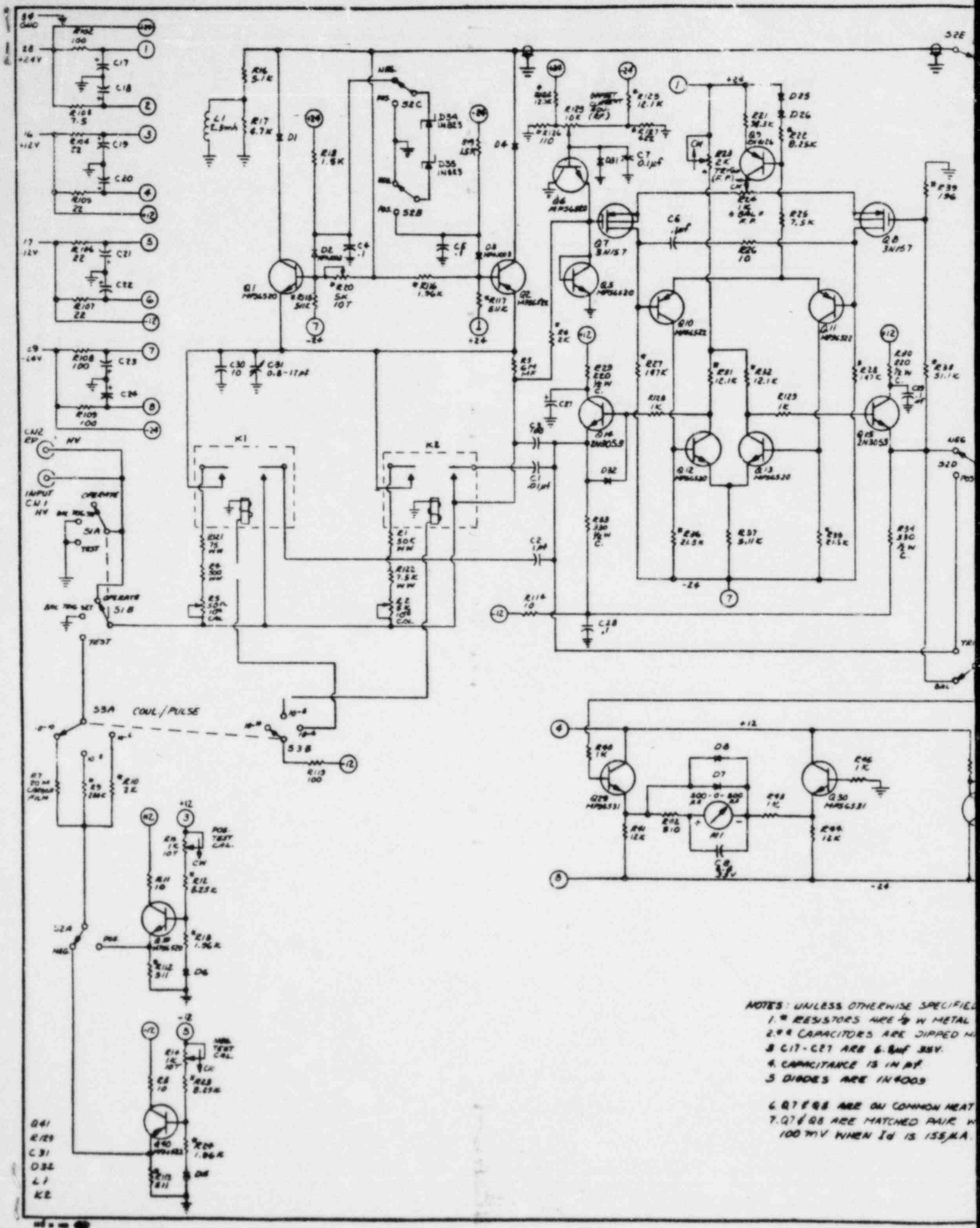
100 MIDLAND ROAD, OAK RIDGE, TENNESSEE 3783

TITLE
DIGITAL CURRENT INTEGRATOR
BLOCK DIAGRAM

DRAFTSMAN JDWEBB DATE 5-10-68
RESPONSIBLE ENGINEER C MILAM
REFERENCE
CHECKED DATE
ENG. APPROVAL R Milam DATE 6/4/68
STOCK NO
SCALE ~
MFG. APPROVAL DATE
DRAWING NO 439-0101-B
DWG. ISSUED DATE
RELEASED FOR MFG DATE



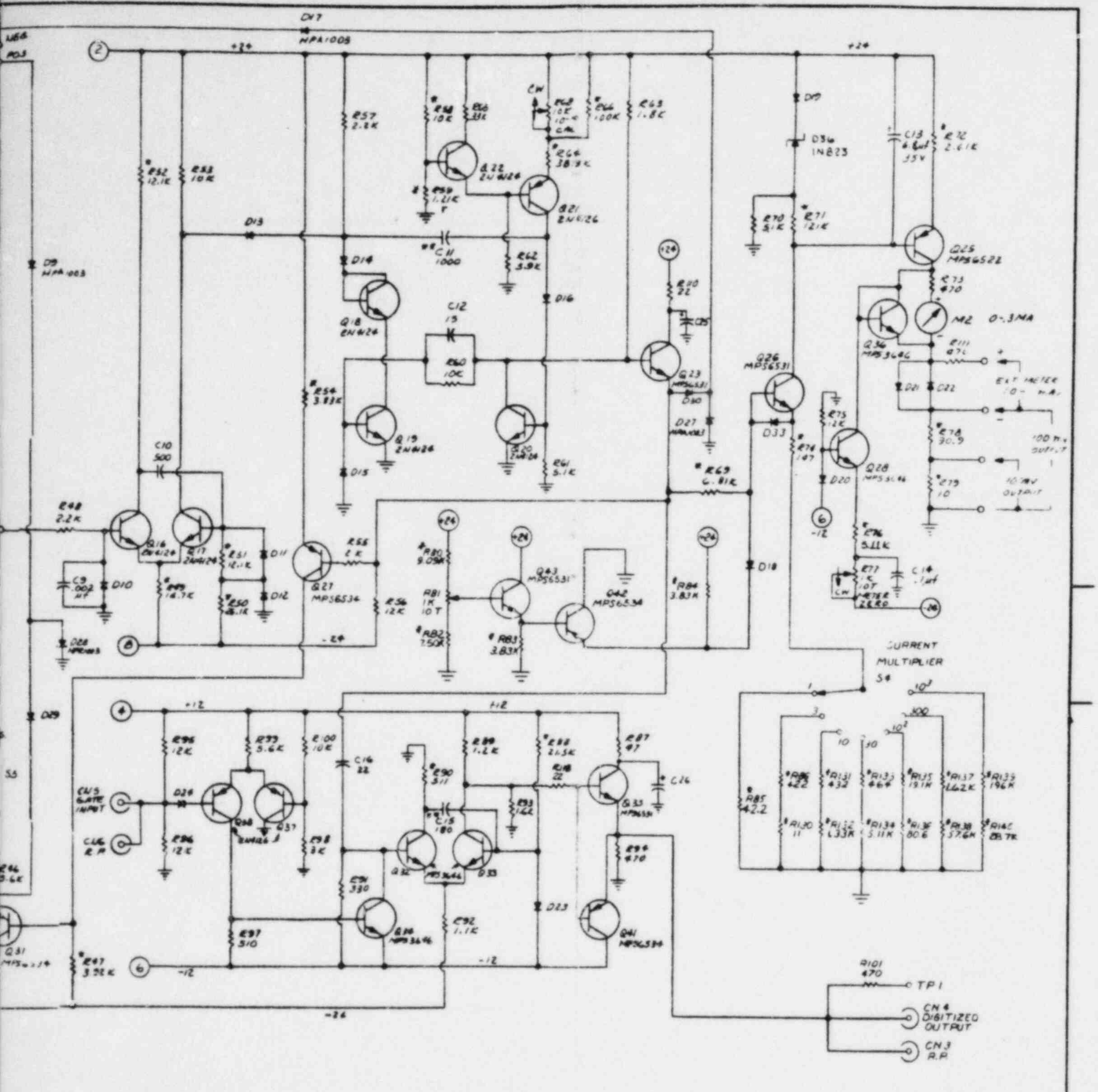
R127
R126
R124
R125
R103
D19
D36
R85
R86
R131
R132
R135
R117
R130
R112
R114
R136
R138
R140
R77
R81
R68
R15
R14
R1
R2
R5
R4
R121
D34
D35
C23 +
C5
C4
R119
R118
R102
K1
K2
R117
D3
D2
R22
R26
C19 +
R104
R106
C21
C13 +
R72
R74
R71
D18
R84
R83
R65
R38
R57
R64
C18 +
R53
R52
R48
R62
C2
C3
C1
Q1
Q2
C30
C31
D11
D4
R16
R17
D33
C11
R59
D13
C10
R110
R74
R69
R63
D16
D14
D11
R51
R3
R27
R35
R115
L1
C28
C25 +
D17
C30
R61
C12
R60
D15
D12
R50
R31
R49
R28
C6
C9
R36
R37
R31
R128
R33
D32
R23
C27 +
C16
R55
R56
R92
R94
D31
C7
R32
R34
R26
C29
R32
R129
R30
R73
D27
R111
C15
R118
R47
R25
D21
D22
R75
R91
R90
D23
R88
R93
R89
C26 +
R87
D29
D28
D9
R98
R22
D26
D25
R34
C17 +
R21
R114
R78
R79
R76
D20
C20 +
R97
R46
R96
R109
R112
R13
R12
R23
R24
D5
D6
R10
R115
C14
R45
D7
D8
R42
R41
R40
R95
D24
R99
R11
R113
R9
C22 +
C24
R44
R43
+ C8
R105
R8
R7
R107
R109



NOTES: UNLESS OTHERWISE SPECIFIE

1. * RESISTORS ARE 1/8 W METAL
2. ** CAPACITORS ARE DIPPED M
3. C17-C27 ARE 6.8µf 35V.
4. CAPACITANCE IS IN pf
5. DIODES ARE 1N4003

6. Q7 & Q8 ARE ON COMMON HEAT
7. Q7 & Q8 ARE MATCHED PAIR W
100 mV WHEN Id IS 155µA.



FILM, ALL OTHERS 1/4W 5% CARBON
A.

SINK.
TH VBE MATCHED TO WITHIN

TI
APERTURE
CARD

Also Available On
Aperture Card

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

ORTEC
OAK RIDGE TECHNICAL ENTERPRISES CORPORATION
OAK RIDGE TENNESSEE

MODEL 439
DIGITAL CURRENT INTEGRATOR

K. MILAM
439-0101-S1

8408200028-01

multi safe

AMPLIFIER - RELAY INTRINSICALLY SAFE

MODELS AVAILABLE

The Amplifier-Relays are available in two basic versions:

(a) one-channel units, having 1 Control circuit and 1 Output relay (SPDT or DPDT)

(b) two-channel units, having 2 independent Control circuits and Output relays (SPDT)

An additional feature are the power supplies. In addition to units with AC-supplies, units with DC-supplies are also available. The DC-supply devices have also been approved for intrinsic-safety applications. Therefore DC-supplied multi safe Amplifier-Relay units can be used in conjunction with logic systems requiring intrinsic-safety. No special precautions have to be taken with regard to the external DC-power supply. Connection to buffered DC-power supplies is also possible without affecting the intrinsically-safe feature of the Amplifier-Relays.

Type	inputs	output	control circuit fail-safe	added alarm relay
MS 1-11 Ex/..	1	spdt		
MS 1-12 Ex/..	1	dpdt		
MS 1-22 Ex/..	2	2-spdt		
MS 13-12 Ex/..	1	dpdt	x	
MS 13-22 Ex/..	2	2-spdt	x	
MS 13-121 Ex/..	1	2-spdt	x	x

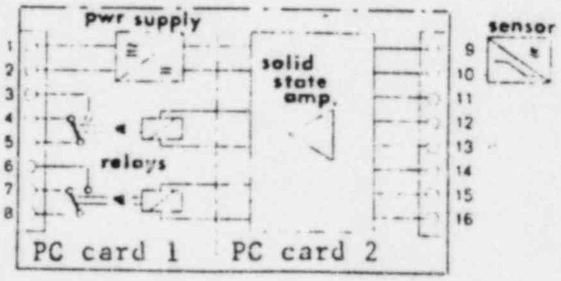
*Dots are replaced by supply voltage and number of LED's.

ELECTRICAL SPECIFICATIONS

Supply voltage (terminals 1 and 2)	12,24,42,110,220 VAC 50/60 Hz - approx. 1.5 VA
	12,24,48,60 VDC approx. 3.5W, 10% ripple
Control circuits (terminals 9 thru 16)	Intrinsically safe
Operating ratings	8.2V/7 mA
Max. input ratings	11V/20 mA
Operating range	1.2 mA - 2.1 mA
Hysteresis	approx. 0.2 mA
Max. external Ind.	19 mH
Max. external Cap.	1.5 μF
Output circuits (terminals 3 thru 8)	
Relay rating	250 VAC 4 A 60 VDC 0.5 A 24 VDC 4 A
Relay switching	max. 30 Hz
Pull-in	approx. 15 ms
Drop-out	approx. 20 ms

* A consideration only in intrinsically safe applications. Typical capacitance of a 3-conductor control cable with PVC insulation is approx. 0.5 nF/m.

CONSTRUCTION



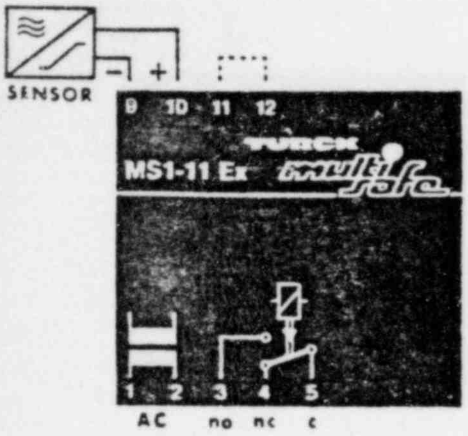
APPLICATIONS

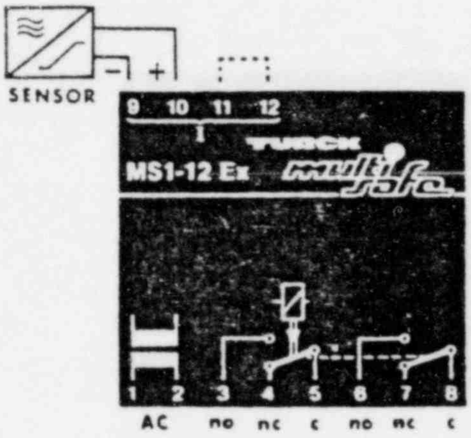
- Switching Amplifier for TURCK "blue range" analog proximity sensors.
- Contact protection relay.
- Transmitting control signals from explosion-hazardous areas into non-hazardous locations.

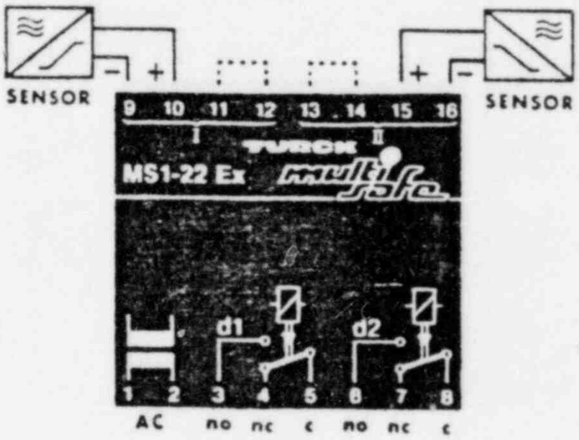
AMPLIFIER - RELAY

MS 1 - 11 Ex
MS 1 - 12 Ex
MS 1 - 22 Ex

CONNECTIONS



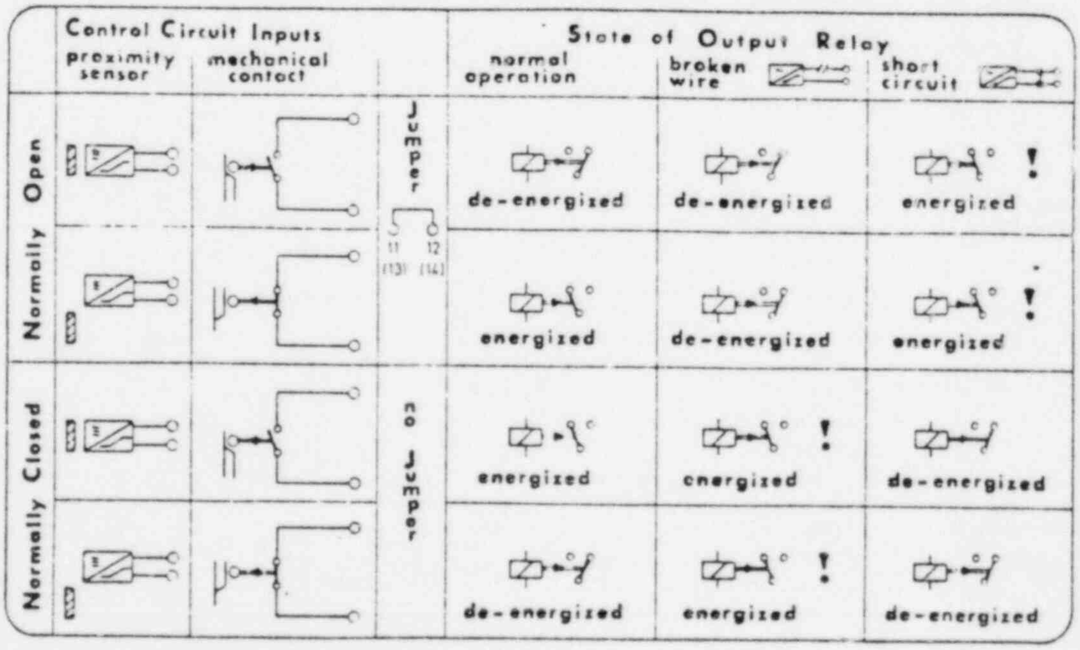




FUNCTION

The Output State of the Amplifier/Relays is programmable and depends on the input device used (proximity sensor, or N.O. mech. switch). (See function table).
If short or wire break occur in the control circuit, the output relay will not drop-out in every case. Therefore, the line contains models with fail-safe input circuits. Models with prefix (MS 13) contain this feature. The (MS 13) models are described on the following pages.

FUNCTION TABLE

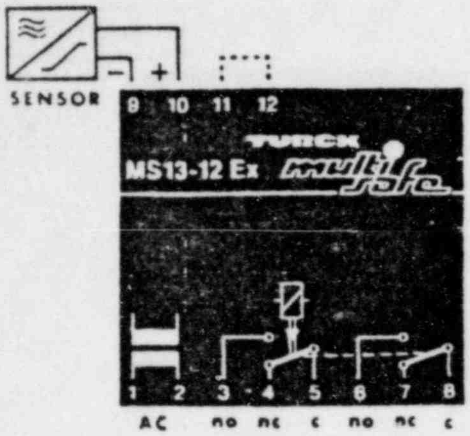


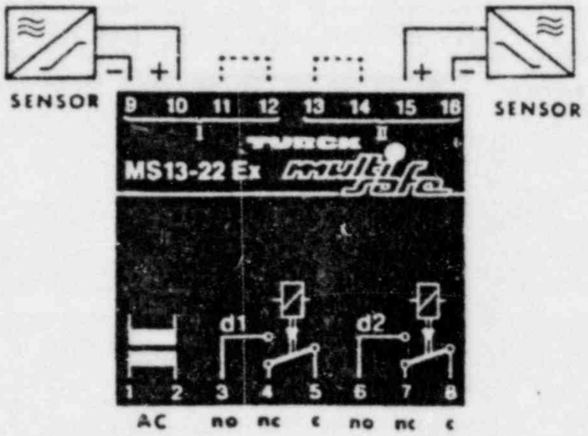
	Control Circuit Inputs			State of Output Relay		
	proximity sensor	mechanical contact		normal operation	broken wire	short circuit
Normally Open			Jumper 11 12 (13) (14)	de-energized	de-energized	energized !
				energized	de-energized	energized !
Normally Closed			no Jumper	energized	energized !	de-energized
				de-energized	energized !	de-energized

AMPLIFIER - RELAY

MS 13 - 12 Ex
MS 13 - 22 Ex

CONNECTIONS



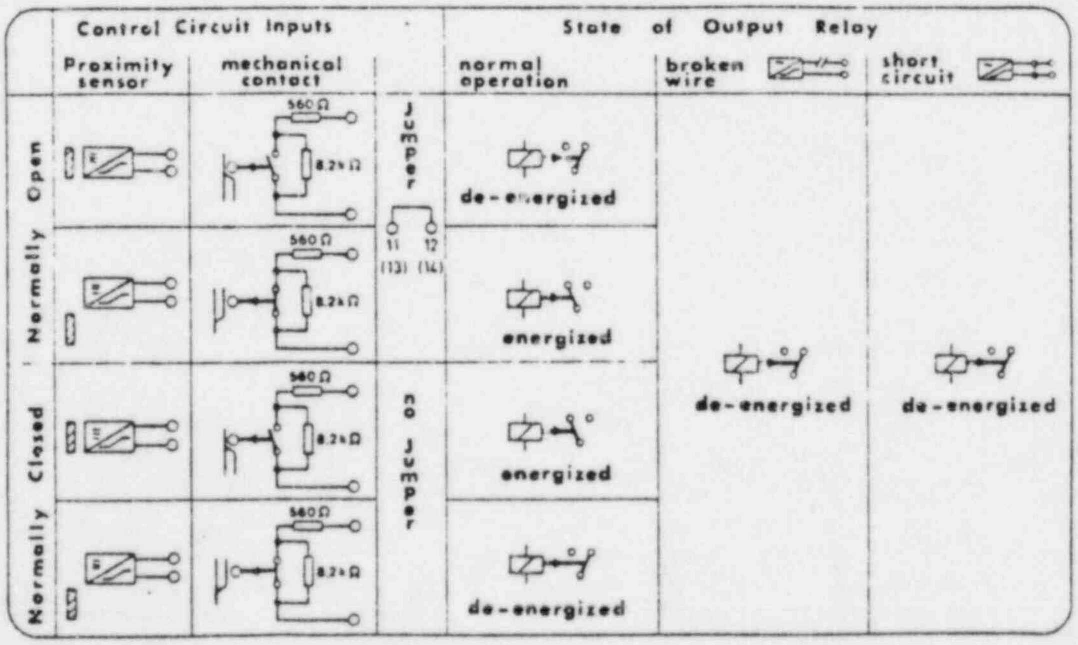


FUNCTION

The Output State of the Amplifier/Relays is programmable and depends on the input device used (proximity sensor, or mech. switch). See function table.

The input circuits of the MS 13 models are automatically monitored for wire-break or short-circuit. The current in the control circuit is constantly monitored through internal electronics and is compared to predetermined limits. If the control circuit current drops below 30uA (wire break) or rises above 3.5mA (short-circuit), the output relay automatically de-energizes. With mechanical contacts this fail-safe feature can only be maintained, if the current is kept within the aforementioned limit For this reason, a Series and a Paralle resistor of the values shown in the (Fu tion Table) below must be inserted into the control circuit in the immediate vi inity of the mechanical contact.

FUNCTION TABLE

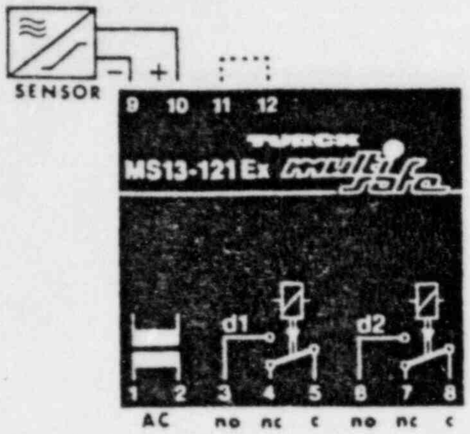


	Control Circuit Inputs			State of Output Relay		
	Proximity sensor	mechanical contact		normal operation	broken wire	short circuit
Normally Open		560 Ω 8.2kΩ	Jumper 11 12 (13) (14)	de-energized	de-energized	de-energized
		560 Ω 8.2kΩ		energized		
Normally Closed		560 Ω 8.2kΩ	no Jumper	energized		
		560 Ω 8.2kΩ		de-energized		

AMPLIFIER - RELAY

MS 13 - 121 Ex

CONNECTIONS

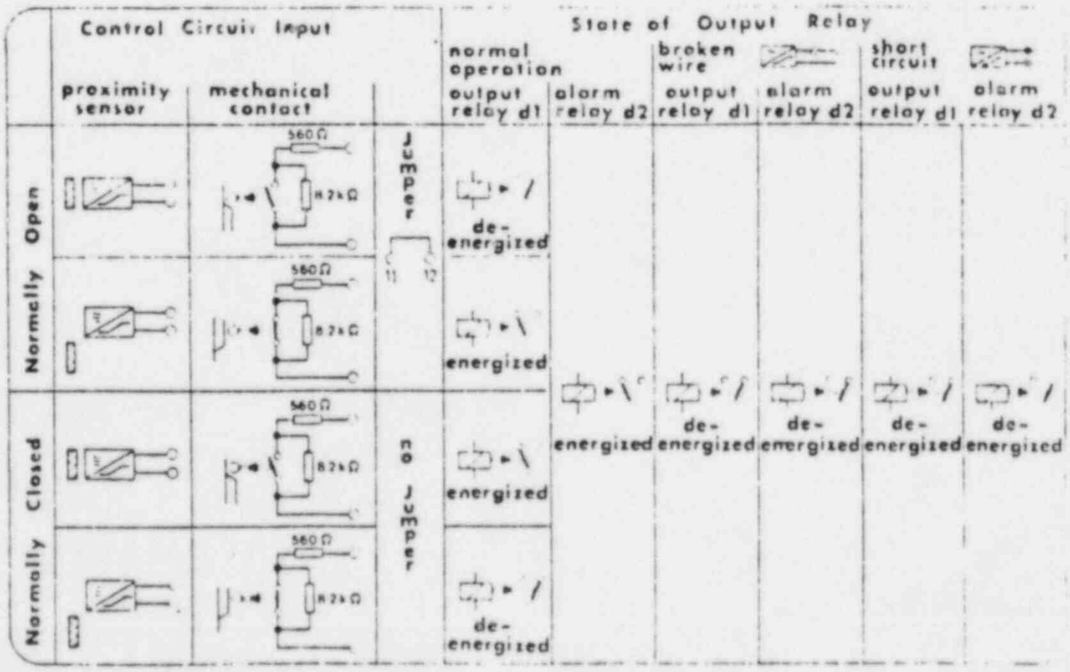


FUNCTION

Amplifier-Relay MS 13-121EX can be programmed the same as unit MS 13-12EX, (see function table).

In addition to the normal output relay, this unit contains a special alarm relay which is energized when power is applied to the unit, provided the control circuit is in normal working order. It de-energizes with the load relay when a wire-break or short-circuit condition occurs in the control circuit.

FUNCTION TABLE



	Control Circuit Input			State of Output Relay					
				normal operation		broken wire		short circuit	
	proximity sensor	mechanical contact		output relay d1	alarm relay d2	output relay d1	alarm relay d2	output relay d1	alarm relay d2
Normally Open		560 Ω 8.2kΩ	Jumper 11 12	de-energized	energized	de-energized	de-energized	de-energized	de-energized
		560 Ω 8.2kΩ		energized					
Normally Closed		560 Ω 8.2kΩ	no Jumper	energized					
		560 Ω 8.2kΩ		de-energized					

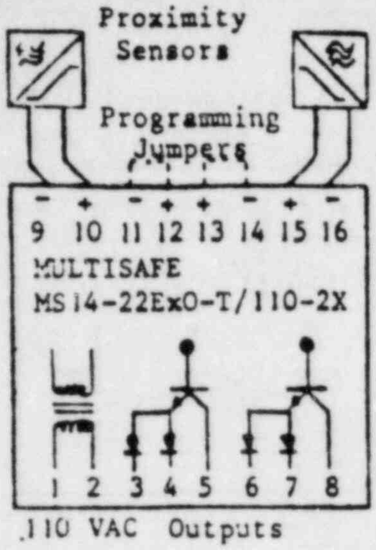
(Ex)iG5 Zone 0

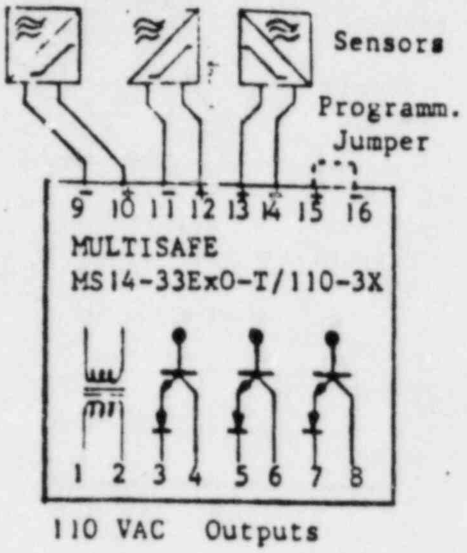
Intrinsically safe to EN 50 020
(European Standard for Intrinsic
Safety)

PTB No. III B/E 29505 S

MPLIFIER - RELAY

MS 14-22 ExO-T/110-2X
MS 14-33 ExO-T/110-3X





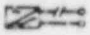
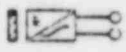
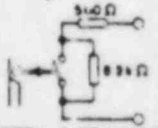
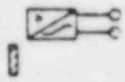
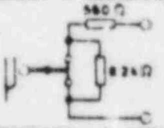
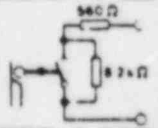
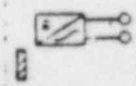
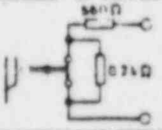
FUNCTION

The Output State of the Amplifier/Relays is programmable and depends on the input device used (proximity sensor, or mech. switch). See function table.
The input circuits of the MS 14 models are automatically monitored for wire-break. The current in the control circuit is constantly monitored through internal electronics and is compared to predetermined limits. If the control circuit current drops below 30uA (wire break), the output automatically de-energizes. With mechanical contacts this fail-safe feature can only be maintained, if the current is kept within the aforementioned limits For this reason, a Series and a Parallel resistor of the values shown in the (Function Table) below must be inserted into the control circuit in the immediate vicinity of the mechanical contact.

FUNCTION TABLE

On Model MS 14-22 both channels are programmable independently.

On Model MS 14-33 all three channels are programmed for the same function depending on whether terminals 15 & 16 are jumpered or not.

Control Circuit Inputs			State of Output Relay		
Proximity sensor	mechanical contact		normal operation	broken wire 	
		Jumper  11 12 (13) (14) 15 16	Output off	Output off	
			Output on		
		no Jumper	Output on		
			Output off		

TURCK multi prox inc

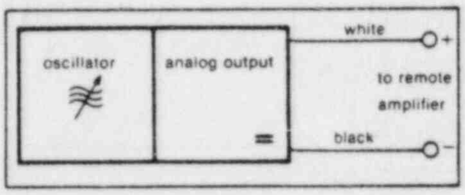
9715 Tenth Ave. No.
Minneapolis, MN 55441
Phone: (612) 544-7977 Telex: 29-0261

Hook-up Diagrams for Inductive and Capacitive Proximity Switches

Blue Range

with Analog Output for use with remote amplifiers (can be used in explosion-hazardous areas when wired to an intrinsically-safe amplifier)

Output designation: YO

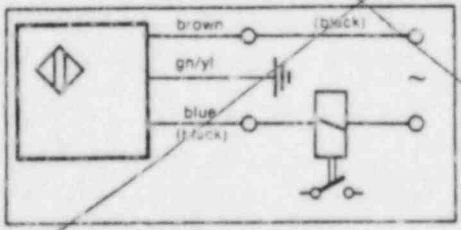


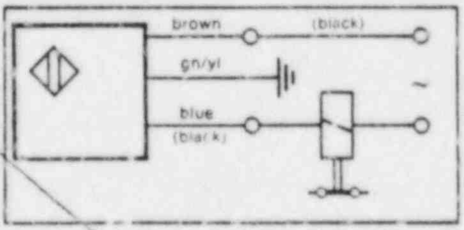
Red Range

AC-selfcontained switches with SCR-Output suitable for controlling AC-relays, motor starters, solenoids, or direct interfacing in AC-logic (PCs).

Output designation:

	(NO)	(NC)	(NO or NC)
20 - 90 V AC	AZ 1	RZ 1	UZ 1
80 - 250 V AC	AZ 2	RZ 2	UZ 2
20 - 250 V AC	AZ 3	RZ 3	UZ 3





Switches with insulated plastic housing or barrel do not have a ground wire.

WARNING: Do not operate AC-selfcontained switches without load in series with switch.

Shorting the load out will result in irreparable damage to the switch.

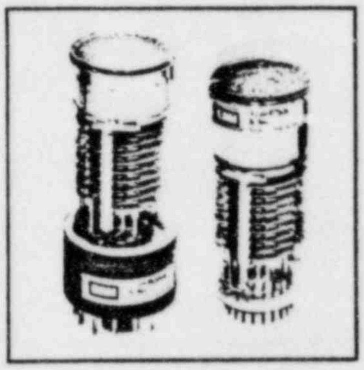
51mm (2·0in) dia.
10 dynodes

Cathode
S11, bialkali.

Window
Borosilicate or fused silica (Spectrosil).

Dynodes
10 venetian blind type with CsSb secondary emitting surfaces.

Base
B19A low loss pressed glass with matching P.T.F.E. (Teflon) socket. Capped (B14A) versions available, denoted by 'K' suffix, e.g. 9656 KB.

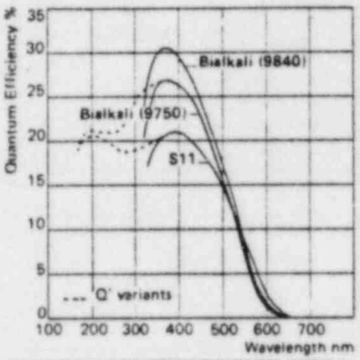


Applications

The 9656 S11 cathode type offers high performance in scintillation counting applications ranging from nuclear radiation monitoring to low energy X-ray spectrometry. The 9856 bialkali version is directly interchangeable and replaces the 9656S. The 9769 is a 9 dynode variant of the 9656 for improved output current linearity. When plugged into a socket wired for the 9656 a higher voltage is automatically applied between d_8 and d_9, improving linearity. Where the boron content of a standard borosilicate window is undesirable, a lime soda glass version (type 9836) is available, data on request.

The 9750 bialkali series is particularly suitable for low energy counting. The fused silica version (9750QB) minimises tube background and is used extensively for liquid scintillation spectrometry. A lower cost alternative is the 9805 which has a low potassium borosilicate window. The 9840 has an internal end window surface of pyramid shaped prisms for increased quantum efficiency.

The 9656L and 9656R are supplied resolution tested, details on page 31. This can also be applied to other tubes in this group.

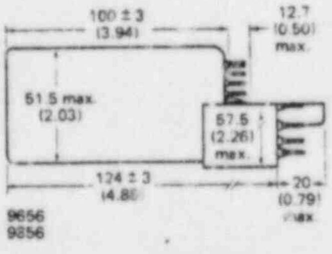


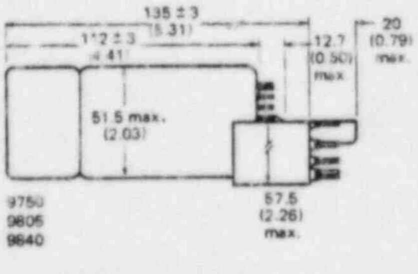
Selection Guide

Tube type	Spectral response	Wavelength range (nm)	Window material	Remarks
9656B	S11	320-650	borosilicate	Parent S11 type. General purpose scintillation counting
9656L	S11	320-650	borosilicate	Variants of 9656B supplied resolution tested for spectrometry applications
9656R	S11	320-660	borosilicate	Test data on page 31.
➔ 9856B	bialkali	320-630	borosilicate	Variant of 9656 with bialkali cathode. Low dark current. Replacement for 'S' version.
9750B	bialkali	320-630	borosilicate	Parent bialkali type. Low energy scintillation counting
9805B	bialkali	320-630	low potassium borosilicate	Variant of 9750 with low potassium glass envelope.
9750QB	bialkali	175-630	fused silica	Variant of 9750 with fused silica envelope
9840B	bialkali	320-640	borosilicate	Variant of 9750 with prismatic window. High peak Q.E.

Outline Drawings and Pin Connections

All dimensions in millimetres (inches in brackets).





PIN CONNECTIONS (viewed from below, counting clockwise from short pin or key)

TYPE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		Socket
9656, 9856, 9750, 9805, 9840	ic	d_1	d_2	d_3	d_4	d_5	d_6	d_7	d_8	d_9	d_{10}	a	ic	ic	ic	ic	ic	ic	k		B19A
9656K, 9750K, 9805K	d_1	d_2	d_3	d_4	d_5	d_6	d_7	d_8	d_9	d_{10}	a	ic	ic	k							B14A

Electrical Characteristics and Ratings (see note iii).

(data also applies to variants with fused silica windows, unless otherwise stated)

Tube type	CATHODE SENSITIVITY µA/lm		Corning blue		Peak Q.E. %	ANODE SENSITIVITY A/lm (iv)	V_{k-a} (V)		$I_{a(dark)}$ nA		Rise time ns	F.W.H.M. ns	Electron transit time ns
	min.	typ.	min.	typ.	typ.	for test	typ.	max.	typ.	max.	typ.	typ.	typ.
9656 B	50	80			21.0	50	1100	1500	2	15	12	25	65
9656 L	50	90			22.0	50	1100	1500	2	15	12	25	65
9656 R	80	100			23.0	50	1000	1300	1	5	12	25	65
9856 B		60	5	8	22.0	50	950	1400	0.15	1.5	12	25	65
9750 B		75	7	10	27.0	50	900	1400	0.1	1	8	15	50
9805 B		75	7	10	27.0	50	900	1400	0.1	1	8	15	50
9840 B		85	8	12	31.0	50	850	1300	0.15	1.5	8	15	50

TUBE TYPE (all grades)					RATINGS (absolute to I.E.C. 134, see note (iii)							
Tube type	No. of dynodes	Spectral response	Effective cathode diameter mm (in).	$C_{a\text{-}all}$ pF (ii)	ANODE SENSITIVITY A/lm	VOLTAGE (V) k-d_1	Between dynodes	k-a (i)	CURRENT I_k (peak) µA	I_a (av). mA	Ambient temperature °C	
			nom.	typ.	max.	max.	max.	max.	max.	max.	min.	max.
9656	10	S11	40 (1.57)	8	500	300	300	2000	0.3	0.2	− 80	60
9856	10	bialkali	42 (1.65)	8	500	300	300	2000	0.05	0.2	− 5	60
9750	10	bialkali	45 (1.77)	8	500	300	300	2000	0.05	0.2	− 5	60
9805	10	bialkali	45 (1.77)	8	500	300	300	2000	0.05	0.2	− 5	60
9840	10	bialkali	42 (1.65)	8	500	300	300	2000	0.05	0.2	− 5	60

Notes:

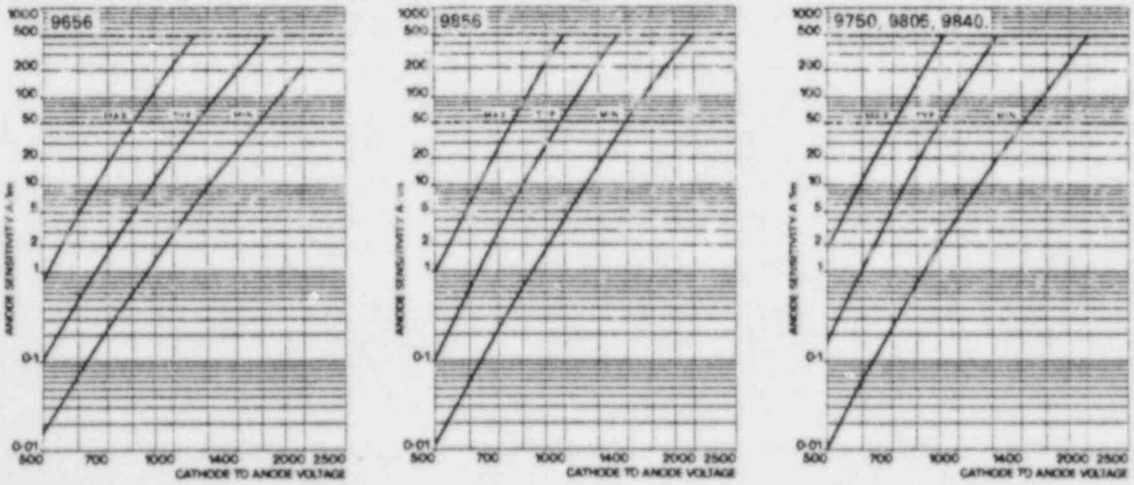
(i) Subject to not exceeding maximum ratud anode sensitivity.

(ii) Capacitance values quoted refer to glass base versions. Add 1.5pF for capped versions.

(iii) Electrical characteristics and ratings should be read in conjunction with explanatory notes on page 29.

(iv) Test data obtained at the stated anode sensitivity with voltage divider specified on page 29.

Anode Sensitivity versus Cathode to Anode Voltage



DEC (DIGITAL EQUIPMENT CORP)

LSI-11 PDP 11/03 COMPUTER

POSITION	MODULE	TYPE	FUNCTION
1 L&R	M7264	KD11-F	μ-COMPUTER W/4K MEMORY
2 L	M7940	DLV11 ~~DRV11~~	SERIAL INTERFACE ~~PARALLEL INTERFACE~~
2 R	M7941	DRV11	PARALLEL LINE UNIT
3 L	M7941	DRV11	PARALLEL LINE UNIT
3 R	M7941	DRV11	PARALLEL LINE UNIT
4 L	—		
4 R	M7942	MRV11-A	4K BY 16 BIT PROM

REPAIR : 314-991-6500
DIGITAL EQUIPMENT CORP.
FIELD SERVICE

APPENDIX

ACCEPTANCE AND PERFORMANCE

This section is provided as a guide for the performance of operational tests of the automated tandem flash tube inspection system. The use of a teletype-compatible printing device will simplify the recording of the gauge readings and a series of Inspection Masters which cover the range of specified pellet variation must be made available for sensitivity tests.

IRT

AUTOMATED DENSITOMETER AD-103
WITH
FLASH TUBE INSPECTION GAUGE MODEL AFTG-3
ACCEPTANCE AND PERFORMANCE TEST

A.1 DRAWINGS AND DOCUMENTATION

The following items were provided to the purchaser:

Two copies of drawings in sufficient detail to show essential details of the equipment for purposes of maintenance and operation. [✓ Yes] No

Two Operating Manuals. [✓ Yes] No

A recommended spare parts list [✓ Yes] No

A.2 OPERATIONAL TESTS

A.2.1 The system is installed at the Buyer's facility and performs the following operations:

Receives primed cartridge cases from in-feed belt of the load-and-assemble machine. [✓ Yes] No

Verifies that there is a minimum of ignitor material present in the flash tube. [✓ Yes] No

Automatically rejects acceptable units. [✓ Yes] No

A.2.2 Calibration Reliability

The Automated Densitometer is adjusted to reject ten consecutive Defect Inspection Masters (primed Case Assembly containing an equivalent of two pellets). [✓ Yes] No

A.2.2.1 Calibration Data

Gauge 1

Accept Master (3 pellet)

Mean σ

I/I_o ________ ________

Reject Master (2 pellet)

Mean σ

I/I_o ________ ________

Initial Threshold Setting ________

Gauge 2

Accept Master (3 pellet)

Mean σ

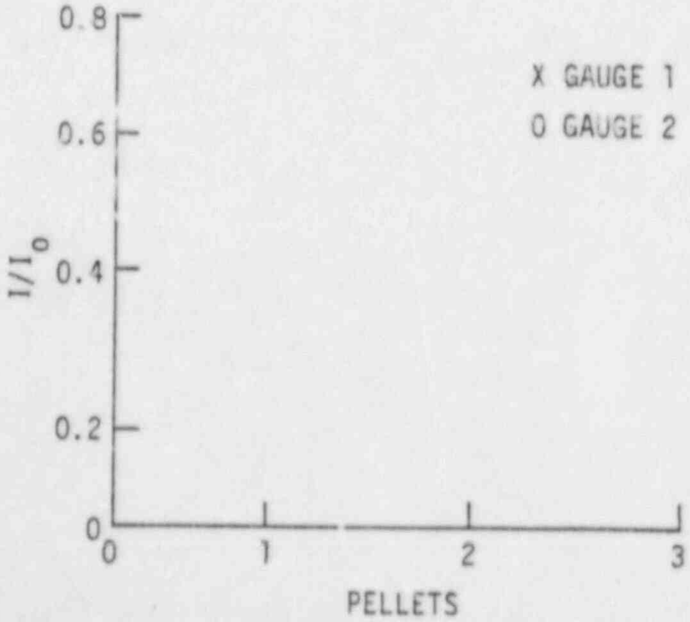
I/I_o ________ ________

Reject Master (2 pellet)

Mean σ

I/I_o ________ ________

Initial Threshold Setting



Following adjustment, 638 known defects (with two pellets each) mixed with 64 known good assemblies (with three pellets each) were fed into the machine. The machine rejected the 638 consecutive defective assemblies and accepted the 64 consecutive good ones.

Yes ✓ No ______

Test Performed by: ______________________ Date: ______________
IRT Representative K. CROSBIE

Test Witness: B. Reynolds
OLIN Representative

Signatures denote acceptance.

IRT Corporation

IRT

AUTOMATED DENSITOMETER AD-103

WITH

FLASH TUBE INSPECTION GAUGE MODEL AFTG-3

ACCEPTANCE AND PERFORMANCE TEST

1. INSPECTION RATE

Each gauge inspects casings at a minimal rate of 30 cases per minute.

Gauge 1

Number of casings inspected 20

Total time 39.2 sec

Calculated rate 30.6

Gauge 2

Number of casings inspected 20

Total time 38.7 sec

Calculated rate 31.0

Meets minimum rate Yes X No

2. AUTOMATIC REJECT REMOVAL

Both gauges provide for automatic removal of rejected casings from inspection line. (20 casings rejected by both #1 and #2.)

Yes X No

3. BYPASS OPERATION

With system in bypass mode, casings are transported directly through inspection system.

Yes X No

4. QUALIFICATION TEST

Each gauge must demonstrate the capability of 638 consecutive rejects of known defective casings and 64 consecutive accepts of known nondefective casings to show a 0.9975 probability of rejecting "defective" parts and a 0.975 probability of accepting nondefective parts with an 0.80 confidence level.

Calibration Data:

Accept masters

	Mean : I/Io × 10,000	σ
Gauge 1	4341.25	0.7059% (30.6)
Gauge 2	4411.45	0.706% (31)

Defect masters

	Mean: I/Io × 10,000	σ
Gauge 1	4646.96	0.956% (44)
Gauge 2	4721.35	0.887% (42)

Initial Threshold Setting

Gauge 1	4440	@ 4.7 σ	4471	@ 4 σ
Gauge 2	4514	@ 4.9 σ	4553	@ 4 σ
1	4449	@ 4.5 σ	4462	@ 4.2 σ
2	4532	@ 4.5 σ	4545	@ 4.2 σ

With the above threshold settings, both gauges demonstrated a minimum of 638 consecutive rejects and 64 consecutive accepts of defective and nondefective casings respectively.

Test Performed by ______________________ Date: ______________
IRT Representative

Tests Witnessed by B Reynolds Date: ______________
OLIN Representative

The system performed satisfactorily, meets the stated objectives, and is acceptable to OLIN Corporation.

B. Reynolds Date: ______________
OLIN Representative (Signature)

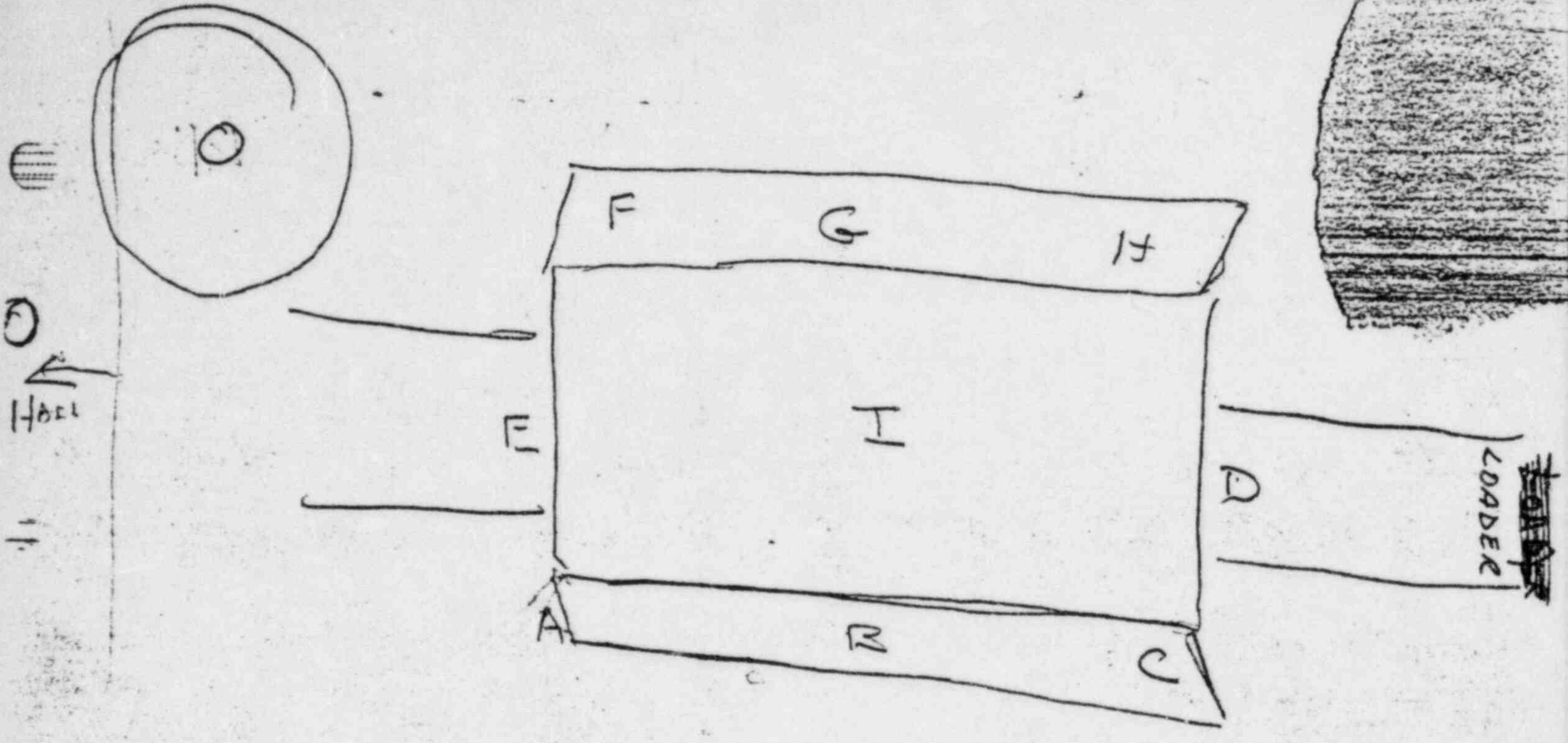
Crosbie's (Cont)

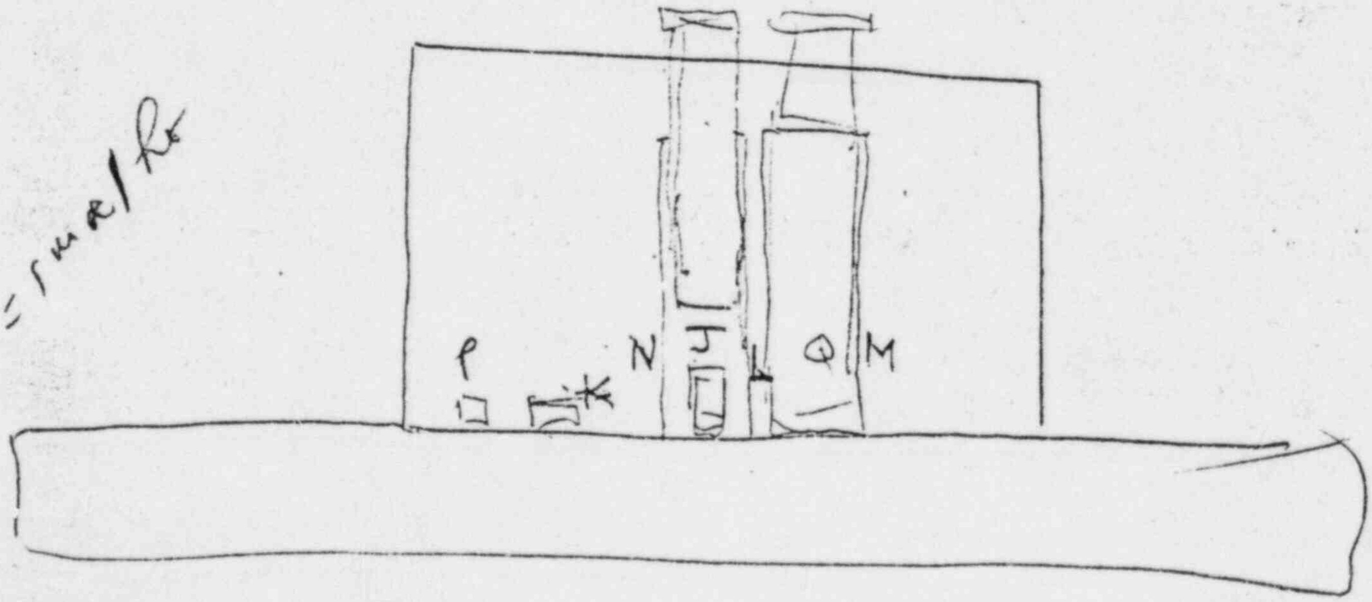
what is probability to pass false reject test?

TRUE Prej ON GOOD ASS'YS	PROB TO ACCEPT 64 of 64	REQUIRED K_p
0.025	0.198	1.9600
0.010	0.474	2.3263
0.005	0.726	2.5758 ~~2.7478~~
0.003	0.825	2.7478
0.002	0.880	2.8782
← .0018	← 0.894	←
0.0015	0.908	2.9677
0.0010	0.938	3.0902
0.0008	0.950	3.1559

Probability to pass rejects on bad product

TRUE Prej ON BAD ASS'YS	PROB TO REJECT 638/638	REQUIRED K_p
0.0025	0.203	2.813
0.001	0.528	3.0902
0.0005	0.727	3.2905
0.0002	0.880	3.5401
← .00018	← 0.892	
0.00015	0.909	3.630
0.0001	0.938	3.7190
0.00008	0.950	3.788
0.00001	0.994	4.265





2000 = 1mR/hr

A	150	
B	250	
C	150	
D	80	
E	180	
F	250	
G	250	
H	200	
I	250	
J	100,000	
K	450	
L	12000	
M	1500	
N	4000	
O	80	BKGD (BACKGROUND)
P	450	
Ⓠ	200,000	

B. REYNOLDS
CORRECTION - 6/4/81

— 30mm IRT AFTG-3 —

DETERMINATION OF REJECT PERCENTAGE

LET:

1) C_R = COMPUTER DISPLAY OF TOTAL REJECTED
2) M = NUMBER OF MASTERS RUN THROUGH GAGE.
3) R = TOTAL OF PRODUCTION PART REJECTIONS (FIRST GAGING)
4) A = NUMBER OF PRODUCTION PARTS ACCEPTED BY SECOND GAGING
5) S_R = NUMBER REJECTED BY A SECOND GAGING
6) C_G = COMPUTER DISPLAY OF TOTAL GAGED
7) I = NUMBER OF INDIVIDUAL PRODUCTION CASES GAGED
8) I_P = DAY'S PRODUCTION (ACCEPTED UNITS)

F_1 $C_R - M - (2S_R) = A$ = QUANTITY OF BORDERLINE CASES REJECTED BY FIRST GAGING

F_2 $C_R - M - S_R = R$ = QUANTITY REJECTED AT LEAST ONCE

F_3 $C_G - M - 2S_R = I_P$ = DAY'S PRODUCTION

F_4 $\frac{R}{I}$ = % PRODUCTION REJECT

F_5 $\frac{S_R}{I}$ = % TO BE HAND SCREENED (PROBABLE SCRAP)

F_6 $C_G - M - S_R = I$ = TOTAL UNITS GAGED

D. REYNOLDS
CORRECTION - 6/4/81

— 30mm IRT AFTG-3 —

DETERMINATION OF REJECT PERCENTAGE

LET:

1) C_R = COMPUTER DISPLAY OF TOTAL REJECTED
2) M = NUMBER OF MASTERS RUN THROUGH GAGE.
3) R = TOTAL OF PRODUCTION PART REJECTIONS (FIRST GAGING)
4) A = NUMBER OF PRODUCTION PARTS ACCEPTED BY SECOND GAGING
5) S_R = NUMBER REJECTED BY A SECOND GAGING
6) [illegible] C_G = COMPUTER DISPLAY OF TOTAL GAGED
7) I = NUMBER OF INDIVIDUAL PRODUCTION CASES GAGED
8) I_P = DAY'S PRODUCTION (ACCEPTED UNITS)

F_1 $C_R - M - (2S_R) = A$ = QUANTITY OF BORDERLINE CASES REJECTED BY FIRST GAGING

F_2 $C_R - M - S_R = R$ = QUANTITY REJECTED AT LEAST ONCE

F_3 $C_G - M - 2S_R = I_P$ = DAY'S PRODUCTION

F_4 $\frac{R}{I}$ = % PRODUCTION REJECT

F_5 $\frac{S_R}{I}$ = % TO BE HAND SCREENED (PROBABLE SCRAP)

F_6 $C_G - M - S_R = I$ = TOTAL UNITS GAGED

RECOMMENDED SPARE PARTS LIST

Name	Manufacturer	Model
Sensor	Turck	N15-K11-YO
Amplifier	Turck	MS13-22-EX/110
I/O Module	OPTO 22	OAC
I/O Module	OPTO 22	OIC
I/O Module	OPTO 22	IDC
Fuse	Littlefuse	275005
Relay	Potter/Brumfield	KRP11AG
Digital Current Integrator	Ortec	439
Counter	Ortec	772
Power Supply	Ortec	456
Preset Inputs Module	IRT Corporation	PI100
Photomultiplier Tube	EMI	9856B
Solenoid Valve	Mead	MB3122
Air Cylinder	Bimba	01-1-R
Air Cylinder	Bimba	04-0.5-R
Air Cylinder	Bimba	04-0.5
Air Cylinder	Bimba	04-1-R
Timing Belt	Gates	420H100
V-Block	IRT Corporation	RT133C0118

Amersham
AMERSHAM CORPORATION
A SUBSIDIARY OF THE RADIOCHEMICAL CENTRE

SEALED RADIOACTIVE SOURCE TEST REPORT

Model No.: BDCQ3805 Radioisotope: Barium-133 Nominal activity: 50 millicuries

Description: Gamma Sources Capsule: X91

ANSI Classification C64344 Special Form Certificate No.: -

Classifications are based on the testing of specimen sources and give the levels expected from production sources.

Recommended working life: 15 years

See other side for explanation

Source Serial number	Measurement		Leakage test		Contamination test
		date	type D	type M	type A
	millicuries		*See other side for description of tests* date passed	date passed	date passed
0378LS	42.5 emission	7 Sept 79	10 Sept 79	10 Sept 79	10 Sept 79
0379LS	41.2 emission	7 Sept 79	10 Sept 79	10 Sept 79	10 Sept 79

Notes

Customer: IRT Customer's Order No.: 21781

Amersham Order No.: S1088

Signed: George W. Date: 14 September 1979

Amersham
AMERSHAM CORPORATION
A SUBSIDIARY OF THE RADIOCHEMICAL CENTRE

2636 S. Clearbrook Dr., Arlington Heights, IL 60005
312/593-6300 or 800/323-6695 (Toll free)

In Canada
505 Iroquois Shore Rd., Oakville, ONT L6H 2R3
416/842-2720 or 800/268-5061 (Toll free)

Quality control

Testing for leakage and contamination

Stringent tests for leakage are an essential feature of radioactive sources production. The methods adopted depend on the design and intended application of the source, and also on statutory requirements. Where necessary, tests can be specially modified to meet particular requirements.

The standard methods used for testing radiation sources are listed below.

Wipe test A
The source is wiped with a swab or tissue, moistened with ethanol or water; the activity removed is measured. Limit: 0.005µCi.

Wipe test B
The source is wiped with a swab or tissue, moistened with ethanol or water; the activity removed is measured. Limit: 0.05µCi.

Bubble test D
The source is immersed in a suitable liquid (ethanediol) and the pressure in the vessel reduced to 100mm of mercury. No bubbles must be observed.

Immersion test F
The source is immersed in water at 50° C for 8 hours and the activity in the water measured.
Limit: 0.05µCi.

Immersion test L
The source is immersed in water at 50° C for 4 hours and the activity in the water measured.
Limit: 0.005µCi.

Immersion test M
The source is immersed in water which is raised to 100° C and held at that temperature for 10 min. The water is then removed, the source cooled, and the procedure repeated twice. Sources are passed if the activity extracted in the final procedure does not exceed 0.005µCi.

Helium mass spectograph test H
Limit: leak rate of 10^{-8} standard cm^3/sec.

Emanation test K
(scintillation counting test for radon)
The appliance is immersed in a solution of a phosphor in an organic liquid under vacuum; the leakage of radon is measured by liquid scintillation counting. (DWIGHT, D.J. Radiochemical Centre Report R. 176). The limit corresponds to about 5×10^{-11} Ci per 24 hours.

IAEA Special Form

'Special Form' is a test specification for sealed sources given in the IAEA transport regulations. (IAEA Safety Series No. 6, 1967/1973 revised edition†).

It is used in determining the maximum acceptable activities for various types of transport containers.

The required tests are:
impact test
percussion test
bending test (only for long, slender sources)
heat test
After each test the source must be subjected to leak testing.

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†1973 regulations not yet universally adopted.

Source working life

The *'recommended working life'* is our recommendation of the period within which the source should be replaced. The period given has been assessed on the basis of such factors as, toxicity of nuclide, total initial activity, source construction (eg capsule design, source insert type, etc), half-life of nuclide, typical application environments, operational experience, test performance data, etc.

Adverse environments could affect the appearance and integrity of a source. It is the user's responsibility to regularly inspect and test the source in order to assess at what point during the "recommended working life" the source should be replaced.

ANSI Classification

American National Standards Institute has proposed a system of classification of sealed radioactive sources based on safety requirements for typical uses (See ANSI N542–1977).

"This system provides a manufacturer of sealed radioactive sources with a set of tests to evaluate the safety of his products under working conditions. It also assists a user of such sealed sources to select types which suit the application he has in mind, especially where protection against the release of radioactive material is concerned."

The tests to which specimen sources are subjected are listed in Table 1.

Each test can be applied in several degrees of severity.

Test results are expressed as a five figure code to indicate the severity of the tests.

These figures are preceded by the letter C or E to show whether the source activity is less than or greater than certain limits. These limits depend upon the toxicity, solubility and reactivity of the active component of the source.

C indicates that the activity level of the source does not exceed the prescribed limit and
E that the limit is exceeded.

Table 1. Classification of sealed source performance standards

	Class						
Test	1	2	3	4	5	6	X
Temperature	No Test	−40° C (20 min) +80° C (1hr)	−40° C (20 min) +180° C (1hr)	−40° C (20 min) +400° C (1hr) and thermal shock 400° C to 20° C	−49° C (20 min) +600° C (1hr) and thermal shock 600° C	−40° C (20 min) +800° C (1hr) thermal shock 800° C to 20° C	Special Test
External pressure	No Test	25 kN/m² abs (3.6 lb/in²) to atmosphere	25 kN/m² abs to 2 MN/m² (290 lb/in²) abs	25 kN/m² abs. to 7 MN/m² (1 015 lb/in²) abs	25 kN/m² abs to 70 MN/m² (10 153 lb/in²) abs.	25 kN/m² abs to 70 MN/m² (24 656 lb/in²) abs	Special Test
Impact	No Test	50 g (1.8 oz) from 1 m (3.28 ft) and free drop ten times to a steel surface from 1.5m (4.92 ft)	200 g (7 oz) from 1 m	2 kg (4.4 lb) from 1 m	5 kg (11 lb) from 1 m	20 kg (44 lb) from 1 m	Special Test
Vibration	No Test	30 min 25 to 500 Hz at 5 g peak amp	30 min 25 to 50 Hz at 5 g peak amp and 50 to 90 Hz at 0.635 mm amp. peak to peak and 90 to 500 Hz at 10 g	90 min 25 to 80 Hz at 1.5 mm amp. peak to peak and 80 to 2000 Hz at 20 g	Not Used	Not Used	Special Test
Puncture	No Test	1 g (15.4 gr) from 1 m (3.28 ft)	10 g (154 gr) from 1 m	50 g (1.76 oz) from 1 m	300 g (10.6 oz) from 1 m	1 kg (2.2 lb) from 1 m	Special Test

Notes to Table 1.

1. Details of the testing procedures are given in ANSI N.542. A further class X can be used where a special test procedure has been adopted.
2. **External pressure**
   ^{100} kN/m^2 = 1 atmosphere (approx.)
3. **Impact test**
   The source, positioned on a steel anvil, is struck by a steel hammer of the required weight, the hammer has a flat striking surface, 25mm diam. with the edges rounded.
4. **Puncture test**
   The source, positioned on a hardened steel anvil, is struck by a hardened pin, 6mm long, 3mm diam., with hemispherical end, fixed to a hammer of the required weight.

Performance requirements for typical uses

Typical applications in which sealed radioactive sources may be used, with minimum performance requirements are also given in ANSI N542 (see Table 2 below). These recommendations take into account normal usage and reasonable accidental risks, but do not include exposure to the risk of fire, explosion or corrosion.

Table 2. Sealed source performance requirements for typical uses.

Sealed source use		Sealed source test and class				
		Temperature	Pressure	Impact	Vibration	Puncture
Industrial radiography	Unprotected source	4	3	5	1	5
	Source in device	4	3	3	1	3
Gamma gauges (medium and high energy)	Unprotected source	4	3	3	3	3
	Source in device	4	3	2	3	2
Beta gauges and sources for low energy gamma gauges or X-ray fluorescence analysis (excluding gas-filled sources)		3	3	2	2	2
Oil well logging		5	6	5	2	2
Portable moisture and density gauges (including hand held or dolly transported)		4	3	3	3	3
General neutron source application (excluding reactor start-up)		4	3	3	2	3
Calibration sources, activity greater than 30µCi		2	2	2	1	2
Gamma irradiation sources	Unprotected source	4	3	4	2	4
	Source in device	4	3	3	2	3
Ion generators (source-device combination may be tested)	Chromatography	3	2	2	1	1
	Static eliminators	2	2	2	2	2
	Smoke detectors	3	2	2	2	2
Medical	Radiography	3	2	3	1	2
	Gamma teletherapy	5	3	5	2	4
	Beta teletherapy	5	3	3	2	2
	Interstitial and intracavitary appliances*	5	3	2	1	1
	Surface applicators	4	3	3	1	2

*Sources of this nature may be subject to severe deformation in use. Manufacturers and users may wish to formulate additional or special test procedures.

If the sealed source has a 'C' classification,
Table 2 can be used directly to assess the suitability of the source for the proposed application provided that there is no significant fire, explosion or corrosion hazard.

If such a hazard does exist, the user and the manufacturer have to consider the following factors to determine whether additional testing is required:

1. consequences of loss of activity,
2. quantity of active material contained in the source,
3. radiotoxicity,
4. chemical and physical form of the material and the geometrical shape,
5. environment in which it is to be used,
6. protection afforded to the source or source-device combination.

If the sealed source has an 'E' classification,
Table 2 cannot be used directly.

To determine whether any additional testing is necessary, an evaluation of the fire, explosion and corrosion hazards must first be made and a separate evaluation of the use and design of the source.

Some of our source designs exceed the recommendations of Table 2 and may therefore be acceptable for the applications listed despite the 'E' classification.

Laboratory applications

The ANSI classification system does not refer explicitly to sources designed for research laboratory usage because of the wide variety of applications and environments in which such sources might be used.

Special applications

No test program can cover all possible combinations of environments to which a source may be exposed.

Users should therefore consult our technical staff before using sources in potentially adverse environments.

MMP 50,005
B. Reynolds
Approved
2-17-82

IRT AFTG THRESHOLD ESTABLISHMENT

Immediately prior to threshold establishment data recording, the maintenanceman for the loader shall check the AFTG for:

A. Balance/Trigger, Gages #1 and #2
B. Io count, Gages #1 and #2

I. Adjust Balance/Trigger for each gage as follows:

1. Set the Test/Standby/Operate selector to Standby.
2. Set Balance/Trigger switch to Balance.
3. Using a small flat blade screwdriver, adjust the balance potentiometer until the meter reads exactly zero.
4. Set Balance/Trigger switch to Trigger.
5. Adjust the trigger potentiometer until the meter reads exactly zero.
6. Repeat steps 2 through 5 until no readjustment is required. (There is a small interaction between the trigger and balance adjustments.)
7. Set Test/Standby/Operate selector to Operate.

NOTE: Balance/Trigger adjustments must be made before adjusting Io.

II. Adjust Io for each gage as follows:

1. Make sure that the area above the source is clear of all objects and debris.
2. Place the unit select thumbwheel on the preset inputs module on Position 9 and the limit determination switch on lower limit.
3. Adjust the Channel 1 potentiometer on the high voltage distribution module until the value displayed on the preset inputs module has a running average of 10,000. This value is the continuously updating value of Io. Since the value is constantly changing, the easiest way to be sure that Io has been set to 10,000 is to adjust the potentiometer until there are roughly as many nines as tens in the thousands place of the value displayed over a period of time. Gage 1 is now calibrated.
4. Place the limit determination switch of the preset inputs module in the upper limit position.
5. Repeat step 3 with the channel 2 potentiometer. This will complete calibration of gage 2.

NOTE: There is a short lag time between potentiometer adjustments and stabilization of Io. Wait 30 seconds for stabilization before calling adjustment complete.

III. Once maintenance or other qualified personnel has completed calibration adjustments as outlined above, the Q.A. representative shall press the data key on the printer. (NOTE: Make sure there is adequate paper for the data to be accumulated.) The data key light will light.

1. Key in Control A. To do this, both keys must be held down at the same time but they must be punched in the given order. So, key in Control (hold down key) A (then release both keys).
2. Key in #. To accomplish this, hold down Shift while punching # (which is on the same key as 3).
3. Key in 1.
4. Run one of the 2 pellet masters through Gage 1 to see if the printer is operating.
5. If the printer fails to operate, recheck the sequence of keying in the print command. Then repeat step 4.
6. If the printer prints data for the 2 pellet master, cycle 99 other individual 2 pellet masters through Gage 1. The printer should print Io, computed threshold, and I for each unit.
7. Key in Control A.
8. Key in #.
9. Key in 2.
10. Repeat steps 4, 5 and 6 for Gage 2.

Data accumulation is now complete.

11. Key in Control A.
12. Key in #.
13. Key in 1, 2.
14. Key in Local. The light on the Local key will light.

IV. Determination of the Threshold Baseline

Because Io is a floating number and the threshold and I float with it, the I count will have to be corrected to an Io count of 10,000.

I = Gage reading of primed case
Io = The reference number from which I and T are calculated
T = Computed Threshold
$\boxed{\text{To}}$ = Baseline Threshold value

To correct each I to a value that can be used to compute To, divide 10,000 by each Io and multiply by the corresponding value of I.

$$\frac{10{,}000}{Io} \times I = \text{Corrected value of } I = Ic$$

NOTE: The left hand coumn on the printout identifies the gage from which the following data was gathered. The second column gives the value of Io used at that gaging. The third column gives the computed threshold (T) value for that gaging. The fourth column gives the I count for the case being gaged.

1st Gaging
2nd Gaging

Gage No.	Io	T	I	Gage No.	Io	T	I
#2	9933	4514	4718	#2	9931	4513	4803
#2	9926	4511	4739	#2	9937	4516	4733

3rd Gaging
4th Gaging

Using the data from one gage, figure the average of all the corrected I counts. Since there will be 100 datum points used, this becomes

$$\frac{\Sigma Ic}{100} = Ic \text{ Average} = \overline{X}$$

Using the data from the same gage, figure the standard deviation (sd) for those values collected by the gage. This is most easily done with a calculator with a built in sd function but is shown below for those who prefer to work it out by themselves.

$$sd = \sqrt{\frac{\Sigma (Ic-\overline{X})^2}{N}}$$

Since there are 100 samples, N = 100

Now that the Ic average and the standard deviation have been computed, the threshold baseline can be computed. The threshold baseline (To) is equal to the difference between the Ic average ($\overline{X}$) and four standard deviations

$$To = \boxed{\overline{X}} - 4\ sd$$

If, for example, sd = 44 and $\overline{X}$ = 4503, then To would be equal to:

$$To = 4503 - 4(44) = 4503 - 176 = 4327$$

Now that the baseline threshold has been established for one gage, it must be established for the other by using the same method.

V. Once both baseline thresholds have been established, they must be entered into the preset inputs module.

1. Enter the value for Gage 1 To into the Preset Select thumbwheels.
2. Enter a 1 (for gage 1) into the unit select thumbwheel.
3. Set the limit determination switch to Lower limit.
4. Turn on the Enable key switch.
5. Lift the Load switch for one full second and release.
6. Place the limit determination switch on Upper limit.
7. Enter a value 400 less than To (just entered) into the Preset select thumbwheel.
8. Lift the Load switch one full second and release.
9. Enter the value for Gage 2 To into the Preset select thumbwheels.
10. Enter a 2 (for gage 2) into the Unit select thumbwheel.
11. Set the limit determination switch to Lower limit.
12. Lift the Load switch for one full second and release.
13. Place the limit determination switch on Upper limit.
14. Enter a value 400 less than To (just entered) into the Preset select thumbwheel.
15. Lift the Load switch one full second and release.
16. Turn off Enable and remove the key.

VI. Checking the set up

1. With adequate paper in the printer, press the Data key until the light comes on.
2. Run the six masters (used during normal production) through Gage 1.
3. Each master should have been rejected by the machine. Check the data collected by the printer to see that the difference between T and I is roughly 4 standard deviations for each master. If it is, then everything is properly set. If not, a mistake was probably made. Recheck your work.

```
""#2  9985  4538  4803""#2  9978  4535  4731
""#2  9978  4535  4733""#2 10002  4545  4605
""#2 10009  4549  4728""#2  9999  4544  4732
""#2  9996  4543  4732""#2  9994  4542  4754
""#2  9984  4537  4768""#2  9984  4537  4746 0
""#2  9978  4535  4776""#2  9960  4526  4659
""#2  9956  4525  4745""#2  9946  4520  4781
""#2  9956  4525  4836""#2  9952  4523  4765
""#2  9963  4528  4800""#2  9943  4519  4813
""#2  9949  4521  4786""#2  9961  4527  4717 20
""#2  9952  4523  4804""#2  9942  4518  4808
""#2  9937  4516  4751""#2  9951  4522  4756
""#2  9942  4518  4783""#2  9956  4525  4751
""#2  9960  4526  4796""#2  9941  4518  4669
""#2  9942  4518  4727""#2  9934  4515  4726 30
-------------------------------------------------
""#2  9921  4509  4745""#2  9914  4505  4759
""#2  9923  4510  4799""#2  9922  4509  4717
""#2  9930  4513  4778""#2  9934  4515  4745
""#2  9933  4514  4718""#2  9931  4513  4803
""#2  9926  4511  4739""#2  9937  4516  4733 40
""#2  9926  4511  4747""#2  9917  4507  4736
""#2  9928  4512  4761""#2  9937  4516  4756
""#2  9922  4509  4751""#2  9924  4510  4809
""#2  9911  4504  4787""#2  9904  4501  4743
""#2  9912  4505  4717""#2  9921  4509  4766 50
""#2  9936  4515  4778""#2  9938  4516  4812
""#2  9934  4515  4802""#2  9928  4512  4836
""#2  9916  4506  4712""#2  9910  4504  4829
""#2  9907  4502  4714""#2  9916  4506  4764
""#2  9922  4509  4762""#2  9935  4515  4783 60
""#2  9942  4518  4757""#2  9950  4522  4735
""#2  9949  4521  4605""#2  9938  4516  4808
""#2  9955  4524  4723""#2  9960  4526  4785
""#2  9949  4521  4763""#2  9924  4510  4833
""#2  9922  4509  4790""#2  9937  4516  4714 70
""#2  9940  4517  4738""#2  9948  4521  4709
""#2  9946  4520  4799""#2  9957  4525  4800
""#2  9947  4520  4719""#2  9953  4523  4818
""#2  9949  4521  4731""#2  9951  4522  4794
""#2  9938  4516  4800""#2  9936  4515  4803 80
""#2  9937  4516  4786""#2  9932  4514  4839
""#2  9952  4523  4688""#2  9952  4523  4765
""#2  9954  4524  4724""#2  9941  4518  4761
""#2  9944  4519  4689""#2  9958  4525  4769
""#2  9965  4529  4864""#2  9971  4531  4741 90
""#2  9991  4540  4708""#2  9993  4541  4744
""#2  9993  4541  4712""#2  9994  4542  4801
""#2  9980  4535  4757""#2  9975  4533  4729
""#2  9984  4537  4809""#2  9974  4533  4711
""#2  9996  4543  4661""#2  9983  4537  4783 100
^A
```

226589
(225285)
+ 220221
445506
446810

EXAMPLE FOR
GAUGE #2

$\bar{X} = 4781.8$

$\sigma = 50.3$

$4\sigma = 201.2$

$T_2 = 4580.6 = 4581$

T2 WAS 4545

INDICATES THAT THE UNIT WAS REJECTED

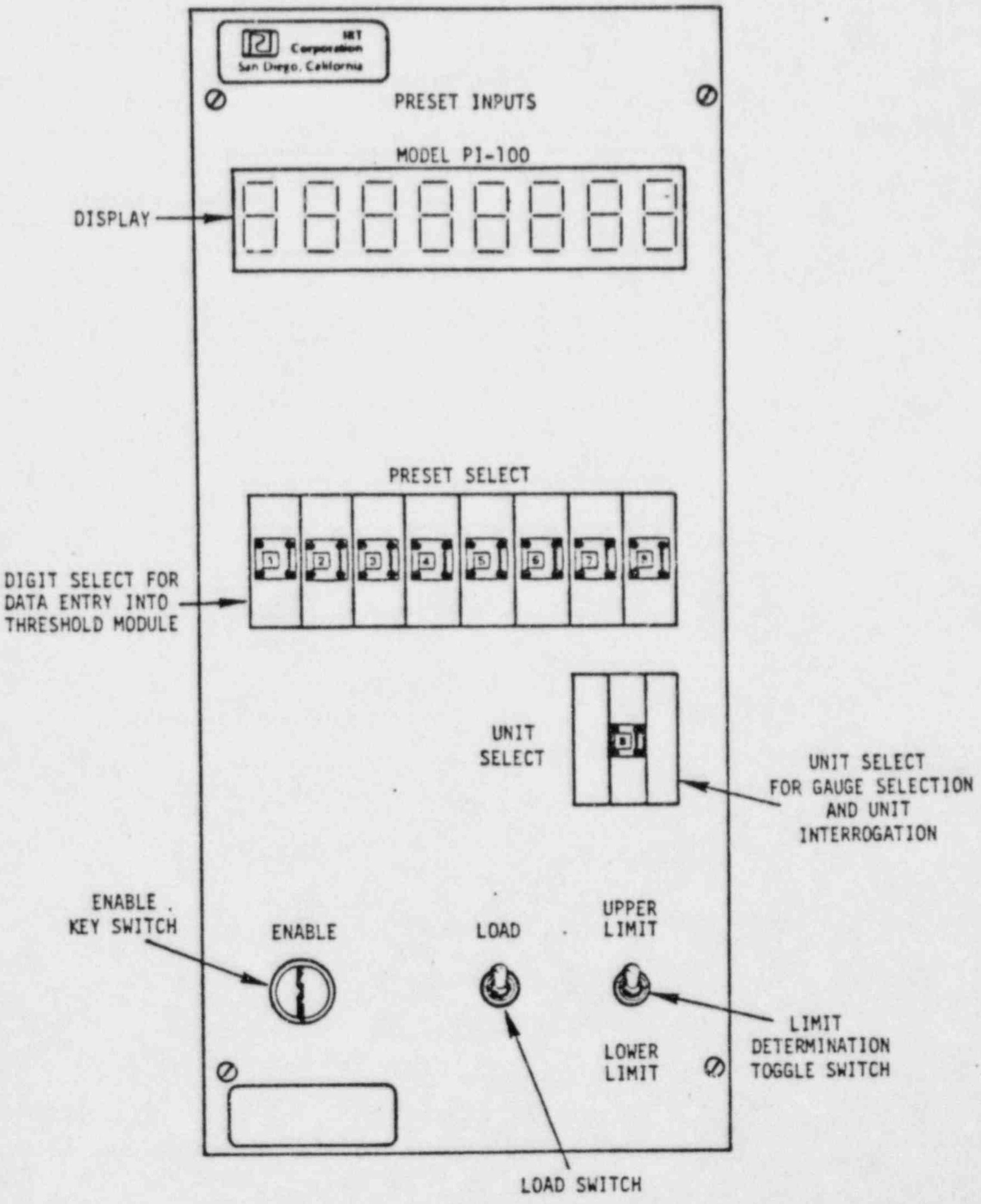

Figure 5. Front panel of Preset Input Module