ORTEC
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Model 464 Position-Sensitive Detector Analyzer

ORTEC

Model 464 Position-Sensitive Detector Analyzer

Operating and Service Manual

This manual applies to instruments
"Rev. 02" (on rear panel)

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STANDARD WARRANTY FOR ORTEC INSTRUMENTS

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QUALITY CONTROL

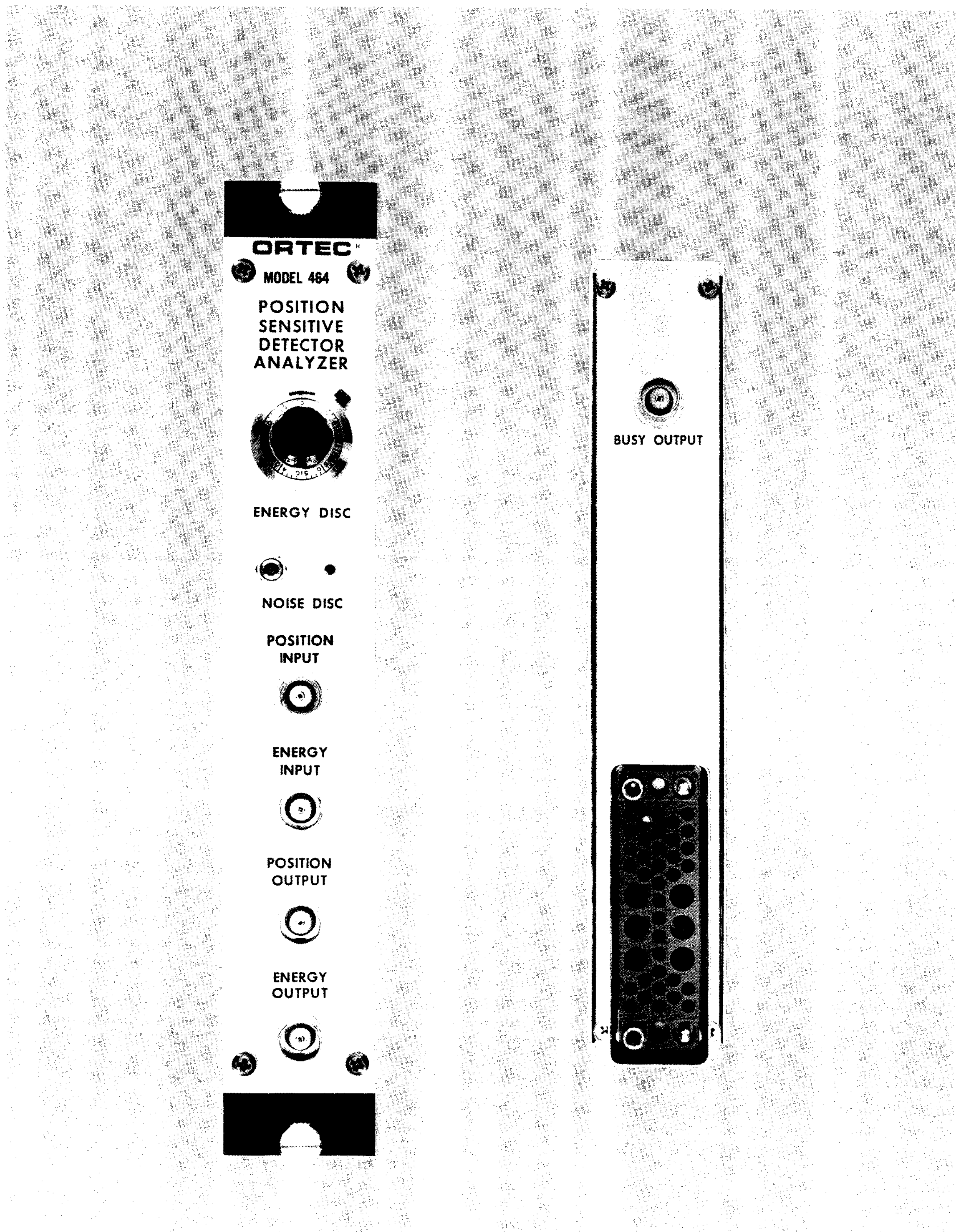
Before being approved for shipment, each ORTEC instrument must pass a stringent set of quality control tests designed to expose any flaws in materials or workmanship. Permanent records of these tests are maintained for use in warranty repair and as a source of statistical information for design improvements.

REPAIR SERVICE

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



ORTEC
MODEL 464
POSITION SENSITIVE DETECTOR ANALYZER
ENERGY DISC
NOISE DISC
POSITION INPUT
ENERGY INPUT
POSITION OUTPUT
ENERGY OUTPUT
BUSY OUTPUT

ORTEC 464 POSITION-SENSITIVE DETECTOR ANALYZER

1. DESCRIPTION

1.1. PURPOSE

The ORTEC 464 Position-Sensitive Detector Analyzer accepts and analyzes two input signals that originate in an ORTEC P Series Position-Sensitive Detector. One of the signals has a peak pulse amplitude proportional to the full energy absorbed from an event in the detector. The other signal has a peak pulse amplitude that is a significant fraction of that for the full-energy pulse, and the fractional ratio indicates the relative point of impingement of the event along the length of the detector.

The 464 generates two output signals, either or both of which can be examined with one or more single-channel analyzers and mating scalers or with a multichannel analyzer. The choice between these units depends on the number of points of interest in the analytical results. The energy output of the 464 duplicates the energy input pulse amplitudes and can be used for energy spectroscopy. The position output peak amplitude is +10 V when the two input pulse amplitudes are equal and is a proportional fraction of +10 V when they are not. The position output can be examined to determine the distribution of points of impingement of the events along the length of the detector.

A preamplifier and an amplifier are required in each of the two input channels between the detector and the 464, and their relative gains and pulse shaping-time constants must be equal for proper analysis. Each of the output circuits from the 464 is compatible with the input requirements of either single-channel or multichannel analyzers.

1.2. PHYSICAL DESCRIPTION

The 464 is a NIM-standard single-width module that must be operated in a standard bin and power supply together with other related instrument modules. It accepts the two required input signals through BNC connectors on the front panel, normally connected from 460 Delay Line Amplifiers in the system. Either or both outputs can be used, depending on the type of information that is desired, and both are available through BNC connectors on the front panel.

There are two discriminators in the 464 that determine whether an input signal amplitude is sufficient to constitute a pulse of interest. The Noise Disc control is screwdriver-adjustable and is normally set to prevent response to noise in the system, in the range of 50 to 500 mV at the full-energy input. The Energy Disc control is a 10-turn precision potentiometer that can be adjusted through the entire 1- to 10-V dynamic range of the input through the energy channel and to thus discriminate against pulses that represent energies below a level of interest.

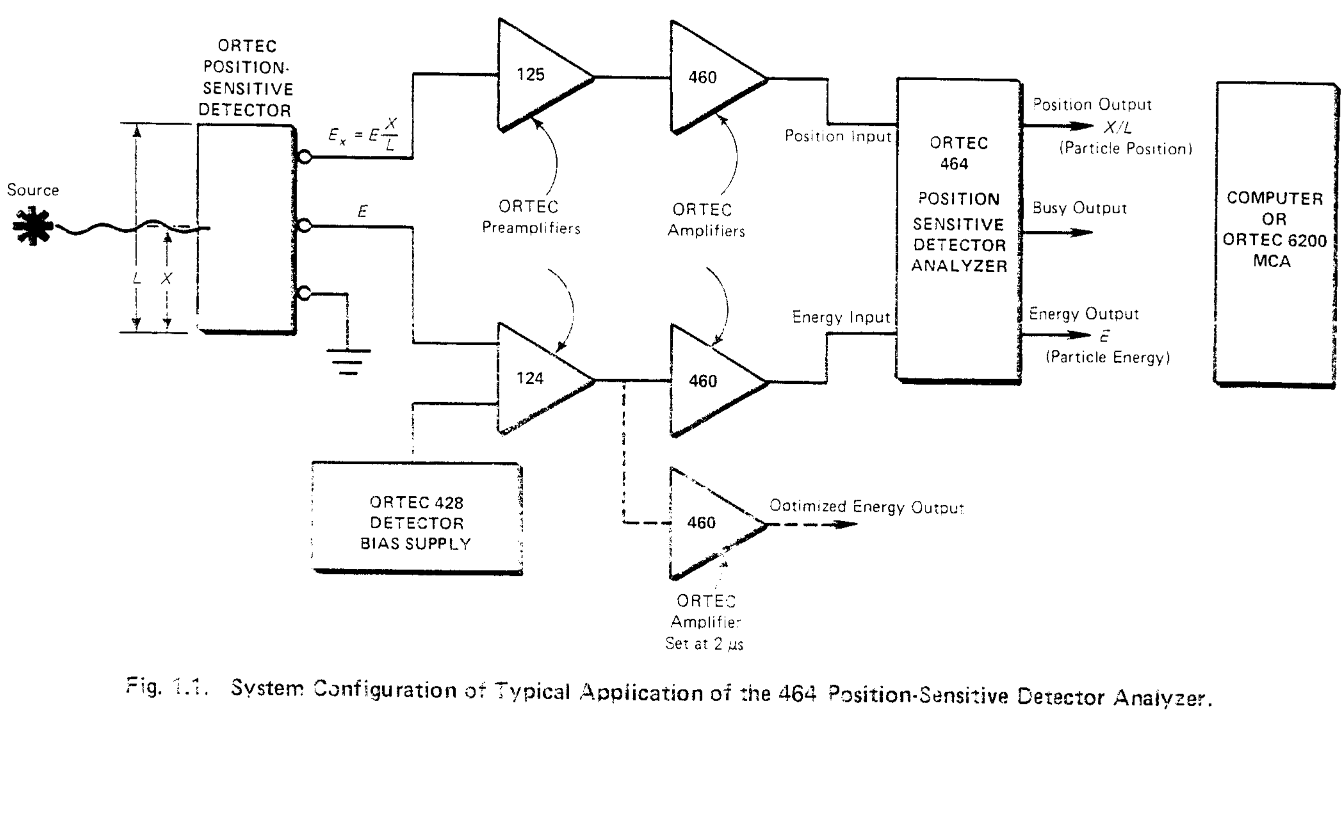


Fig. 1.1. System Configuration of Typical Application of the 464 Position-Sensitive Detector Analyzer.

A Busy Output signal is generated through the intervals when signals are being processed in the 464. It can be monitored, counted, or used for external gating control or other functions as desired. When input pulses are processed, there is normally an interval of about 12 μs during which the signal is present at the Busy Output connector.

1.3. RELATED EQUIPMENT

The basic design of the 464, coming from the Institute of Physics at the University of Aarhus in Aarhus, Denmark, serves a system that includes an ORTEC P Series one-dimensional position-sensitive surface barrier detector, one 124 Preamplifier and one 125 Preamplifier, two 460 Delay Line Amplifiers, and a 428 Detector Bias Supply. These system components are connected as shown in Fig. 1.1.

Since the optimum shaping of the energy signals for use in the 464 differs from the optimum shaping for energy analysis, a third 460 Delay Line Amplifier may be used as shown in the optional circuit indicated in Fig. 1.1.

The 460 Delay Line Amplifiers and the 428 Detector Bias Supply are also NIM-standard modules that can be operated in the same bin and power supply with the 464. The preamplifiers are not modules but obtain their operating power, through the 460 Amplifiers, from the bin and power supply.

2. SPECIFICATIONS

2.1. PERFORMANCE

Integral Nonlinearity The integral nonlinearity of the division of the position input signal by the energy input signal will be better than 1% for position inputs in the range of 0.2 to 10 V and for energy inputs in the range of 1 to 10 V.

Temperature Coefficient The position output signal will change <0.01%/°C over a range of 20 to 50°C.

2.2. CONTROLS

Energy Disc Front panel 10-turn potentiometer for selecting the energy above which signal processing is performed and thereby rejecting all energy inputs below the selected value, resulting in a reduction of the dead time of the system.

Noise Disc Front panel 10-turn screwdriver potentiometer for setting a threshold level just above the noise. When the input exceeds this level, all succeeding pulses are locked out by the input gate until the input pulse decays back down through this level to prevent pulse pileup after the peak of the desired pulse is sensed.

2.3. INPUTS

Energy Input Front panel BNC connector accepts unipolar positive delay-line-shaped, semi-Gaussian-shaped, or bipolar positive-portion-leading input signals over a range of 1 to 10 V. $Z_{in} \cong 1000\Omega$, dc-coupled; maximum input without saturation, ≅10.5 V.

Position Input Front panel BNC connector accepts positive delay-line-shaped, semi-Gaussian-shaped, or bipolar positive-portion-leading input signals over a range of 0.2 to 10 V. $Z_{in} \cong 1000\Omega$, dc-coupled; maximum input without saturation, ≅10.5 V.

2.4. OUTPUTS

Energy Output Front panel BNC connector provides 0- to 10-V positive output occurring 6 μs after E_T input peak; rise time, ≅2 μs; dc-coupled, $Z_o = 93.1\Omega$, pulse width, 5 μs.

Position Output Front panel BNC connector provides 0- to 10-V positive output occurring 6 μs after E_T input peak; rise time, 2 μs; dc-coupled, $Z_o = 93.1\Omega$; pulse width, 5 μs.

Busy Output Rear panel BNC connector provides 5-V positive output; rise and fall times, ≅0.5 μs; pulse width, ~12 μs, $Z_o = 51\Omega$.

2.5. ELECTRICAL AND MECHANICAL

Power Required +24 V, 150 mA; +12 V, 160 mA; −24 V, 75 mA; −12 V, 75 mA.

Dimensions NIM-standard single-width module (1.35 by 8.714 in.) per TID-20893.

3. INSTALLATION

3.1. GENERAL

The 464 is designed for installation and operation in an ORTEC 401/402 Series Bin and Power Supply or equal. The Bin and Power Supply is designed for relay rack mounting and is usually installed in a rack that houses other electronic equipment. Therefore any vacuum tube equipment or other heat source that operates in the same rack with the 464 must be sufficiently cooled with circulating air to prevent localized heating of the transistorized and integrated circuits in the 464. The maximum safe operating temperature limit for the 464 is 50°C (120°F), and the temperature of equipment mounted in racks can easily exceed this limit unless precautions are taken.

3.2. CONNECTION TO POWER

All the operating power must be obtained from the standard bin and power supply in which the 464 is installed for operation. Always turn off the power before inserting or removing instrument modules. The ORTEC NIM modules are designed so that a full complement of modules in the Bin will not overload the Bin power supply. However, this may not be true when the Bin contains modules of other than ORTEC design, and Power Supply distribution voltages should be checked when other modules are inserted. The ORTEC 401/402 Series Bin and Power Supply has test points on the Power Supply control panel to monitor the dc voltages.

If the 464 is operated outside the Bin and Power Supply with an extension cable, be sure that the extension cable includes the Power Supply grounding circuits specified in the recommended standards of TID-20893. Both high-quality and power-return ground connections are specified to ensure proper reference voltage feedback into the Power Supply, and these must be preserved through extension cables. Be careful to avoid ground loops when the module is operated outside the Bin.

3.3. INPUT CONNECTIONS

Figure 1.1 is a typical system configuration for the two inputs into the 464. For proper position analysis in the 464 it is important that the two signal paths provide equal gains and time-constant shaping selections and also that cable lengths are equal to preserve critical timing relationships.

Although it is implied in Fig. 1.1 that the input pulses to the 464 be furnished from 460 Delay Line Amplifiers, any pair of pulse amplifiers may be used. **Delay line shaping with 0.5- or 1.0-μs time constants has been found to be the best for optimum position resolution,** but each input can accept unipolar semi-Gaussian shaped or bipolar pulses with a positive leading portion as long as both circuits are the same.

Each of the two input circuits in the 464 is dc-coupled. So that ac coupling can be used when desired for these circuits, each input includes a jumper that can be removed to cause the input signals to be furnished through a 0.47-μF capacitor into the 464 circuits. The jumpers are located on the printed circuit and are marked E05 for the energy input circuit and E06 for the position input circuit.

3.4. OUTPUT CONNECTIONS

Coincident output pulses are provided for the position and energy outputs. The pulse shape through each output is optimized for use with analog-to-digital converters. Since these pulses are in coincidence, they can be furnished directly into a two-parameter multichannel analyzer to obtain spectra that are related to position on the detector, or either output can be furnished through a single-channel analyzer to gate a single-parameter multichannel analyzer for the alternate output circuit. Either output circuit can be analyzed independently if desired.

The Busy Output connector on the rear panel furnishes a control signal that rises to about +5 V for about 12 μs each time an input is accepted into the 464. This signal can be used to monitor the count rate, control some auxiliary gating, measure dead time, or furnish some other logical criterion for operation in the experiment.

3.5. WARMUP REQUIREMENTS

The analog-divider integrated circuit in the 464 requires a warmup period for stabilization before position information can be generated accurately. Permit a minimum warmup time of 30 min, and do not remove or interrupt the power before or during operation unless additional warmup time is allowed following such interruption.

4. OPERATION

4.1. GENERAL

When the 464 is installed in a NIM-standard Bin and Power Supply and power is turned on for the Bin, the 464 is turned on. It will then generate two output signals that are in coincidence for each pair of input signals that are furnished to the module.

There are only two adjustments on the 464 front panel, and both are discriminator levels that relate to the input pulse amplitude through the energy input circuit. The Noise Disc control can be adjusted with a screwdriver and should be **set at the minimum level that eliminates response to noise inputs;** this can be monitored at the adjacent test point on the front panel. The 10-turn precision Energy Disc control, with 1000 direct-reading dial divisions, selects a minimum acceptable energy level based on the amplifier output pulse range and operates in a range of 1 through 10 V.

As long as the measured energies are ~1 MeV or more and are represented by energy input pulses at the 464 within the linear range of 1 through 10 V, each corresponding position input pulse within the range 0.2 through 10 V will be less than or equal to the energy pulse amplitude. The 464 measures the ratio of position pulse amplitude to energy pulse amplitude and generates a position output pulse that identifies the ratio. The relations are based on (0 V = a ratio of 0) to (10 V = a ratio of 1) and are linear through this range.

4.2. TIMING CONSIDERATIONS

The logic of the 464 determines when an input peak amplitude occurs for the energy input pulse and gates off both input circuits at that time. The position output is generated and based on the relative amplitudes through the two channels at the peak detect time. Thus it is important that the peak of the position input pulse occur at the same time to ensure a proper comparison to be made. This requires that both channels use identical shaping-time constants and that the circuits between the units in each channel use identical cable lengths.

4.3. AMPLITUDE CONSIDERATIONS

The gain of each of the two independent pulse processing circuits that lead to the inputs of the 464 must be equal, and the dc offsets (if any) that are furnished from the two main amplifiers must be minimized. A difference of gains will produce incorrect position output information and a difference of dc offset will degrade the linearity, especially in the lower portion of the dynamic range.

4.4. OPTIMUM SYSTEM OPERATION

A complete discussion of system operation with a typical system is given in ORTEC Application Note AN-39. This application note includes a discussion of the function of each circuit element and the effects of its adjustments, plus an explanation of ballistic deficit, which is a phenomenon peculiar to these types of measurement.

Since the optimum time-constant shaping for purposes of position information and of energy information can be quite different, the use of a separate energy channel for energy spectroscopy is recommended and is suggested in the optional circuitry shown in Fig. 1.1.

5. CIRCUIT DESCRIPTION

5.1. GENERAL

The 464 PSD Analyzer accepts two related analog input signals and generates two independent analog outputs as shown in the block diagram of Fig. 5.1. The energy input path leads through a gating circuit to provide the energy output pulses, and this path has unity gain so that the output pulse peak amplitudes will duplicate the input pulse peak amplitudes and can be used for energy spectroscopy.

When the energy input amplitude rises through the noise and energy discriminator levels, each discriminator responds independently. Both responses are required in order to generate an output. When the peak of the energy input pulse is sensed, the noise discriminator response starts the generation of a busy output and this gates off both input paths; no further input variations can affect the outputs until both energy and position outputs have been furnished and until the input amplitude decays down below the noise discriminator level. At the peak detect time the response from the energy discriminator triggers a delay monostable that will enable both the energy and the position outputs at the monostable recovery.

The peak amplitude of the energy input pulse is held in its stretcher circuit. The amplitude present in the position input circuit at the time the energy peak is detected is also held in its independent stretcher, and its peak is assumed to be present. The two stretched peak amplitudes are furnished through the analog divider to generate a position

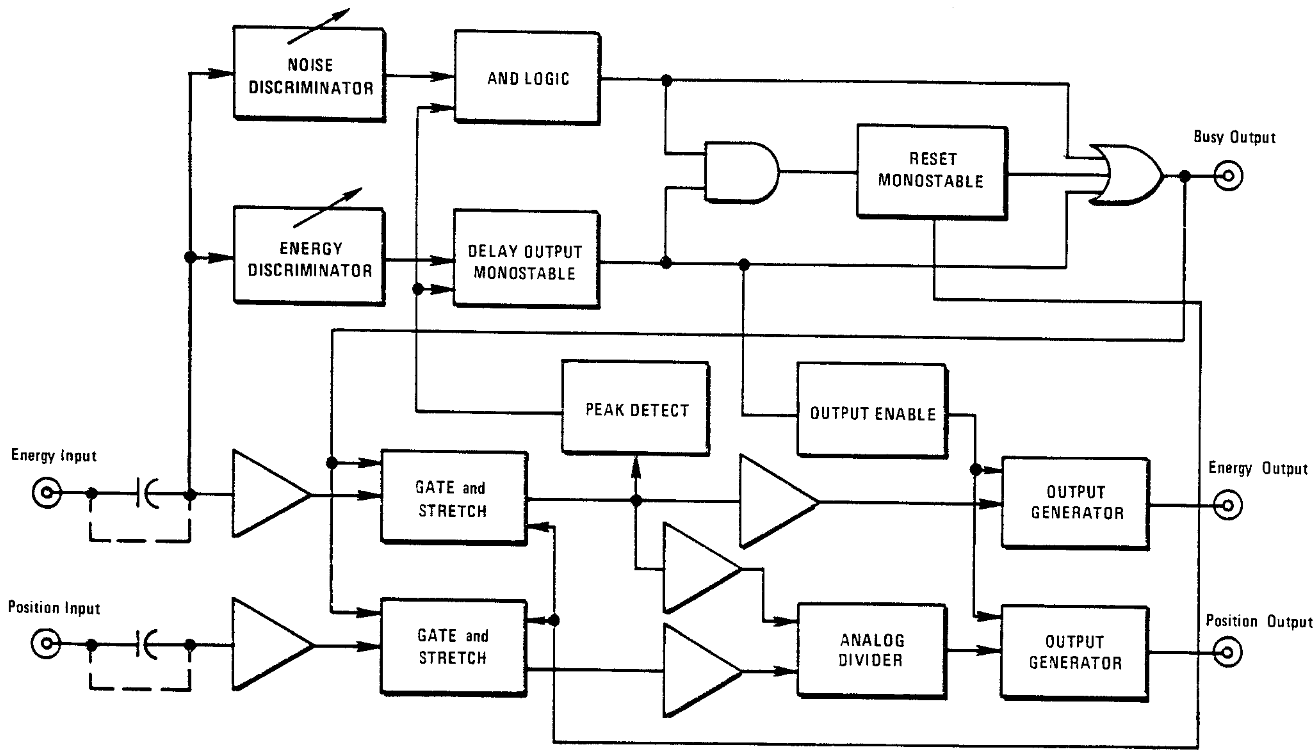


Fig. 5.1. Block Diagram of the 464 PSD Analyzer.

output signal proportional to their ratio in the range of 0 to +10 V. For example, if the position signal is 30% of the energy signal amplitude, the analog divider will generate an output of +3 V.

The delay monostable triggers an output monostable that enables both the energy and the position outputs to be generated. The amplitude available for the energy output is equal to the peak amplitude of the energy input. The amplitude available for the position output is a signal between 0 and +10 V that is generated in the analog divider.

At the end of the output monostable time its recovery triggers a reset monostable whose main function is to quickly discharge the stretch capacitors in both input circuits and prepare for the next pair of input signals.

The busy output is generated from the peak detect time until the completion of the reset function. This interval is about 12 μs. At the end of the busy output interval the input gates are enabled to accept the next pair of input signals, and the cycle is complete.

Refer to schematic 464-0101-S1 and to the component assembly drawing, 464-0200, that are included at the back of the manual for the circuit analysis that follows. A list of replaceable parts is included for further identification of the components that are included in the 464.

5.2. ENERGY INPUT

The energy input signal, in a range of +1 through +10 V, is furnished through CN2 on the front panel. If jumper E05 remains in the circuit, the input signal is dc coupled to all of its internal paths and the output dc level furnished from the driving amplifier should be adjusted to 0 V. If the jumper is removed, the signal is ac coupled through C40.

Half of the input amplitude is furnished from divider R4 and R28 to pin 2 of IC7, where it is compared to the adjusted level of the energy disc control. The range marked on the panel is +1 to +10 V, while the effective range at pin 3 of IC7 is actually +0.5 to +5 V. When the energy amplitude exceeds the threshold, IC7 generates a positive output through its pin 7.

The input amplitude is also furnished through divider R130 and R13 so that 50% of this amplitude is furnished to pin 2 of IC8, where it is compared to the adjusted level of the noise disc control. The range of the noise disc control is actually about +10 to +225 mV, so the noise discriminator always responds to a smaller input amplitude than the energy discriminator, even when it is set for minimum energy signals. When the input amplitude exceeds the noise discriminator threshold, IC8 generates a positive output through its pin 7.

The energy input amplitude is also furnished through Q28, Q30, and Q31 to charge stretch capacitor C51 until a peak is detected. The capacitor charge is fed back through Q32, Q33, and Q34 to the emitter of Q30 and Q30 is cut off when the input amplitude starts to decrease; this peak detection controls Q39 and generates the peak detect signal in IC16.

At peak detect, IC1(6) goes low to initiate the busy interval through IC5(8), IC6(3), IC6(6), and IC6(8). The low output at IC6(8) is inverted by Q43 and coupled through Q44 to turn on Q29 and short the input circuit to ground. No further input signal variations can affect the peak stored on C51 until reset occurs. The low at IC6(8) is also inverted by Q41 and coupled through Q42 to furnish the busy output through CN3 on the rear panel. The stretched peak stored in C51 is retained until the capacitor is discharged through Q35 at a signal from IC4.

Potentiometer R77, on the printed circuit, adjusts the zero baseline level for the energy input circuit under quiescent conditions.

5.3. POSITION INPUT

The position input signal, in a range of +0.2 through +10 V, is furnished through CN1 on the front panel. If jumper EO6 remains in the circuit, the input is dc coupled to Q15 and the output dc level furnished from the driving amplifier should be adjusted to 0 V. If the jumper is removed, the signal is ac coupled through C18.

The input amplitude is furnished through Q15, Q17, and Q18 to charge stretch capacitor C20 until a peak is detected. At peak detect time in the energy channel the busy signal from IC6(8) through Q43 and Q44 turns on Q16 and shorts the input to ground. No further input signal variations can affect the peak stored on C20 until reset occurs. The peak stretched signal is retained on C20 until the capacitor is discharged through Q22 at a signal from IC4.

Potentiometer R27, on the printed circuit, adjusts the zero baseline for the position input signal circuit under quiescent conditions.

5.4. PEAK DETECT

The energy input signal is furnished through Q28 to the base of Q30. The level stored on C51 is fed back through Q32, Q33, and Q34 to the emitter of Q30. As the input signal starts to increase, Q30 is turned on and remains turned on through the rise time of the pulse. This condition also turns on Q39 and furnishes a high input at pin 3 of IC16, so the output at IC16(7) is low.

When the peak is reached and the input amplitude starts to decrease, Q30 is cut off because its emitter level has followed the charge level on C51, and this cuts off both Q31 and Q39. There is no discharge path for C51, so the peak amplitude is retained. The input at pin 3 of IC16 goes to ground and, since it is now more negative than the input at pin 2, IC16 generates a positive peak detect output signal at its pin 7. As explained in Sections 5.2 and 5.3, the input circuits are gated off and the peak detect signal remains locked on until reset occurs.

5.5. POSITION OUTPUT GENERATION

The stretched peak of the position input is coupled from C20 through Q19, Q20, and Q21, through jumper EO3 to IC13(3). The stretched peak of the energy input is coupled from C51 through Q32, Q33, and Q34, through jumper EO1 and through buffer IC12 to IC13(6). Buffer IC12 is an amplifier with a gain of unity.

The function of IC13 is to divide the amplitude at its pin 3 by the amplitude at pin 6 and to generate an output level proportional to the ratio of the input signals. When the ratio is 0, indicating a measurement at the reference end of the position sensitive detector, the output at IC13(4) is 0 V; as the ratio increases toward 1 the output increases linearly toward +10 V. R53 and R56 adjust the slope and level for high range signals, and R55 and R54 adjust the slope and level for the low end of the output range. Together, these four potentiometers are used to calibrate the linearity of response through the range of operation for IC13.

The output of IC13 at pin 4 is clamped at ground through Q23 until output monostable IC3 is triggered. When Q23 is cut off and the output generator (a gated amplifier) is permitted to furnish the signal through IC14 and Q24 to CN5, the level that is furnished through CN5 is equal to the level generated in IC13.

The function of the jumpers, EO1 and EO3, is to permit each of the two input levels to be furnished from an external source during calibration. The jumpers must both be in place in the printed circuit during normal operation so that both signals are present at the IC13 input.

5.6. ENERGY OUTPUT GENERATION

The energy peak amplitude that is furnished through EO1 to the analog divider is also furnished through divider R131 and R96 to pin 4 of IC15. However, until output monostable IC3 is triggered, this signal is clamped to ground through Q37. When Q37 is cut off by IC3, the energy peak amplitude is coupled through IC15 and Q38; the gain of the stage is such that the original peak amplitude is duplicated in the output pulse that is furnished through CN6, the energy output BNC on the front panel.

5.7. LOGIC

At peak detect time, gates IC1(6) and IC1(3) are enabled. If the noise discriminator has not been triggered, there is no is detected. The capacitor charge is fed back through Q32, Q33, and Q34 to the emitter of Q30 and Q30 is cut off when the input amplitude starts to decrease; this peak detection controls Q39 and generates the peak detect signal in IC16.

At peak detect, IC1(6) goes low to initiate the busy interval through IC5(8), IC6(3), IC6(6), and IC6(8). The low output at IC6(8) is inverted by Q43 and coupled through Q44 to turn on Q29 and short the input circuit to ground. No further input signal variations can affect the peak stored on C51 until reset occurs. The low at IC6(8) is also inverted by Q41 and coupled through Q42 to furnish the busy output through CN3 on the rear panel. The stretched peak stored in C51 is retained until the capacitor is discharged through Q35 at a signal from IC4.

Potentiometer R77, on the printed circuit, adjusts the zero baseline level for the energy input circuit under quiescent conditions.

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The position input signal, in a range of +0.2 through +10 V, is furnished through CN1 on the front panel. If jumper EO6 remains in the circuit, the input is dc coupled to Q15 and the output dc level furnished from the driving amplifier should be adjusted to 0 V. If the jumper is removed, the signal is ac coupled through C18.

The input amplitude is furnished through Q15, Q17, and Q18 to charge stretch capacitor C20 until a peak is detected. At peak detect time in the energy channel the busy signal from IC6(8) through Q43 and Q44 turns on Q16 and shorts the input to ground. No further input signal variations can affect the peak stored on C20 until reset occurs. The peak stretched signal is retained on C20 until the capacitor is discharged through Q22 at a signal from IC4.

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When the peak is reached and the input amplitude starts to decrease, Q30 is cut off because its emitter level has followed the charge level on C51, and this cuts off both Q31 and Q39. There is no discharge path for C51, so the peak amplitude is retained. The input at pin 3 of IC16 goes to ground and, since it is now more negative than the input at pin 2, IC16 generates a positive peak detect output signal at its pin 7. As explained in Sections 5.2 and 5.3, the input circuits are gated off and the peak detect signal remains locked on until reset occurs.

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The function of IC13 is to divide the amplitude at its pin 3 by the amplitude at pin 6 and to generate an output level proportional to the ratio of the input signals. When the ratio is 0, indicating a measurement at the reference end of the position sensitive detector, the output at IC13(4) is 0 V; as the ratio increases toward 1 the output increases linearly toward +10 V. R53 and R56 adjust the slope and level for high range signals, and R55 and R54 adjust the slope and level for the low end of the output range. Together, these four potentiometers are used to calibrate the linearity of response through the range of operation for IC13.

The output of IC13 at pin 4 is clamped at ground through Q23 until output monostable IC3 is triggered. When Q23 is cut off and the output generator (a gated amplifier) is permitted to furnish the signal through IC14 and Q24 to CN5, the level that is furnished through CN5 is equal to the level generated in IC13.

The function of the jumpers, EO1 and EO3, is to permit each of the two input levels to be furnished from an external source during calibration. The jumpers must both be in place in the printed circuit during normal operation so that both signals are present at the IC13 input.

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5.7. LOGIC

At peak detect time, gates IC1(6) and IC1(3) are enabled. If the noise discriminator has not been triggered, there is no response in the 464 because the amplitude of the energy signal is so small that it is equivalent to a noise pulse. C51 will have charged to the small amplitude and cannot discharge, but this does not matter because the stretch capacitor will continue to charge from the level to which it has been charged when the first acceptable pulse is furnished, so there is no distortion.

If the energy signal has sufficient amplitude to trigger the noise discriminator but not the energy discriminator, the peak detect signal generates a low at IC1(6) to trigger IC4 through IC5(6), IC1(8), and IC1(11), and to start a busy signal through IC5(8), IC6(3), IC6(6), and IC6(8). The signal at IC6(8) goes low; it is inverted by Q41 and coupled through Q42 to switch the output level from 0 to +5 V, and it is also inverted by Q43 and coupled through Q44 to furnish +5 V to the base of Q16 and Q29. IC4 is triggered at the reset of IC8, which occurs when the input signal amplitude decays through the discriminator threshold. When IC4 is triggered, it furnishes a negative output from pin 1 to continue the busy interval and a positive output from pin 6 to turn on Q22 and Q35; these transistors offer quick discharge paths for the two stretch capacitors, C20 and C51 respectively. At the end of the reset interval, the busy interval is terminated and initial logic conditions are effective.

If the energy signal has sufficient amplitude to trigger both discriminators, the logic of the above paragraph is effective and, in addition, the times for the delay monostable, IC2, and output monostable, IC3, are used to delay the trigger time for the reset monostable, IC4, and to extend the busy interval through IC5(8). When output monostable IC3 is triggered at the recovery of 6-μs monostable IC2, the positive output at IC3(6) is furnished through jumper E04 to the bases of Q11 and Q25. The signal through Q11, Q12, and Q14 cuts off Q23 and permits the position output to be furnished through CN5. Through the same time interval, the signal through Q25, Q26, and Q27 cuts off Q37 and permits the energy output to be furnished through CN6.

At the end of the output monostable time, 5 μs, provided IC8 has been reset, the reset monostable is triggered and discharges the stretch capacitors. At the end of the reset interval, which is about 12 μs after peak detect unless delayed by slow recovery of IC8, the busy interval is terminated and the initial conditions are restored to permit the 464 to accept a new pair of signals for processing.

The function of jumper E04 is to furnish a continuous enable signal to both Q11 and Q25 during calibration and test, but to accept the control signals from IC3 during normal operation.

5.8. POWER DISTRIBUTION

Each of four dc power levels is accepted through a filter from the bin and power supply and is furnished to the circuits on the printed circuit board. Power requirements include ±12 V and ±24 V.

Integrated circuit IC17 accepts an input from +12 V and generates a +5 V output for use in IC2, IC3, and IC4. Integrated circuit IC18 accepts +24 V and −24 V and generates both +15 V and −15 V; these levels are both used for analog divider IC13.

6. MAINTENANCE AND CALIBRATION

6.1. TEST EQUIPMENT REQUIRED

The following test equipment, or equal, is required to test the specifications of the 464:

Digital voltmeter

DC supply that can be set at 1 V ±1 mV and 10 V ±10 mV

Dual trace oscilloscope, Tektronix 547 or equivalent

ORTEC 419 Pulse Generator

ORTEC 451 or 471 Amplifier

ORTEC 406A Single Channel Analyzer

NOTE

Integrated circuit IC13 is in a temperature-stabilizing oven. Ensure at least 30 minutes of uninterrupted power application before calibration is attempted.

6.2. DIVIDER ZERO CALIBRATION

1. Remove jumpers E01 and E03. Move jumper E04 to its position 2. Connect the digital voltmeter to the Position output.

2. Connect point X, pin 3 of IC13, to ground. Connect the source of 1 V/10 V to point Z at the E01 jumper.

3. See the component location drawing, printed with schematic 464-0101-S1 at the back of the manual. Identify the location for potentiometers R53 through R56 on the printed circuit board.

4. Adjust R55 for a minimum output voltage change when the voltage at point Z is switched between 1 V and 10 V. Make the adjustments on R55 only with 1 V applied at point Z.

5. Apply 10 V at point Z and adjust R54 for an output level of 0 V ±5 mV.

6. Repeat steps 4 and 5 to ensure that the output voltage remains at 0 V ±5 mV when the input at point Z is switched between 1 V and 10 V.

7. Disconnect point X from ground. Furnish the 1 V/10 V source to both point X and point Z.

8. Adjust R53 for a minimum change of output voltage when the source to both points X and Z is switched between 1 V and 10 V. Adjust R53 only while the input is at 1 V.

9. If R53 requires a major adjustment to function properly, return to step 4 and repeat through step 8.

10. Set the input to points X and Z at 10 V. Adjust R56 for 10 V ±10 mV at the Position output. Check to see that the output remains at 10 V ±10 mV when the input at points X and Z is switched to 1 V.

11. Repeat steps 8 through 10 as required to obtain the 10 V ±10 mV output when the input to both points is either 1 V or 10 V.

12. Disconnect the 1 V/10 V supply from points X and Z. Restore jumpers E01 and E03 to the printed circuit.

13. Adjust R27 as required for a Position output at 0 V ±5 mV.

14. Connect the digital voltmeter to the Energy output. Adjust R77 as required for a reading of 0 V ±5 mV.

6.3. DIVIDER FINAL CALIBRATION

1. Connect the equipment as shown in Fig. 6.1.

2. Set the pulser and amplifier controls as required to obtain an output of 10 V from the amplifier.

3. Set the 406A for Normal mode with ULD at 10.00 and LLD as high as possible.

4. Move the 406A Input connection from the amplifier output circuit to the 464 Position output. Adjust the 406A LLD for a half-trigger.

5. Use the X10 Attenuator on the pulser to switch the amplifier output amplitude between 1 V and 10 V. Adjust R53 in the 464 until the 406A half-triggers with either 1 V or 10 V applied from the amplifier.

6. Apply 10 V from the amplifier and check the Position output voltage level. If it is not 10 V, adjust R56 as required.

7. If R56 required adjustment in step 6, repeat from step 4.

6.4. TEST POINT VOLTAGES

The following voltages are intended to indicate typical operating voltages in the 464.

Table 6.1. Typical dc Voltages.

Checkpoint	Typical Voltage	Checkpoint	Typical Voltage
Q15E	+0.5	IC13(2)	+15
Q28E	+0.5	IC13(5)	−15
Q21E	0	IC16(8)	+12
Q34E	0	IC16(4)	−5.5
IC7(8)	+12	IC14(8)	+15
IC7(4)	−5.5	IC14(5)	−15
IC8(8)	+12	IC17(2)	+5
IC8(4)	−5.5	IC17(1)	+12
IC12(8)	+15	IC18(7)	−15
IC12(5)	−15	Q14C	+1
IC15(8)	+15	Q27C	−1
IC15(5)	−15	Q42E	0

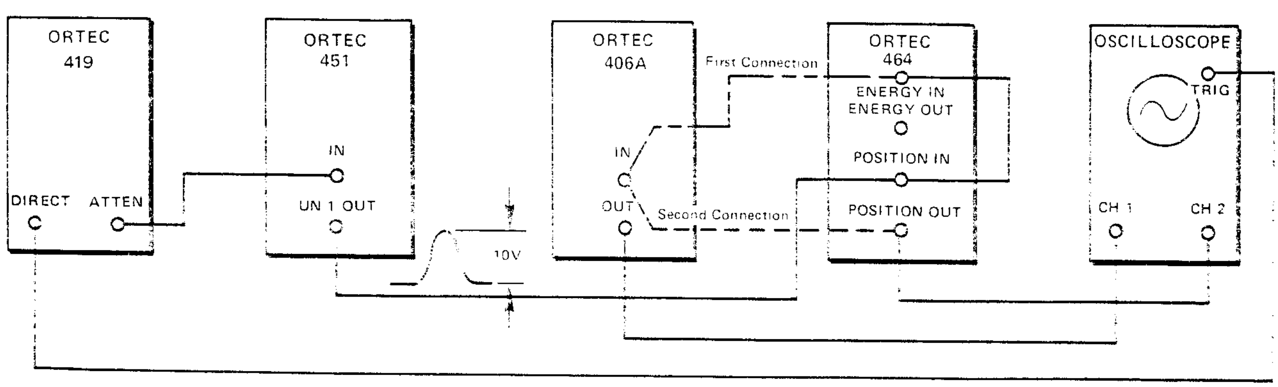


Fig. 6.1. Test Setup for Final Calibration.

APPENDIX

REPLACEABLE PARTS

ORDERING INFORMATION

The Replaceable Parts List shown below contains information needed for ordering spare and/or replacement parts. Each listing indicates the reference designator number, the part number, a description of the component, and the part manufacturer and manufacturer's part number.

All inquiries concerning spare and/or replacement parts and all orders for same should include the model serial, and revision ("Rev" on rear panel) numbers of the instruments involved and should be addressed to the Customer Service Department at 100 Midland Road, Oak Ridge, Tennessee 37830. The Manager of Customer Services can be reached by telephone at (615) 482-4411. The minimum order for spare and/or replacement parts is $25.00.

ORDERING INFORMATION FOR PARTS NOT LISTED

In order to facilitate the ordering of a part not listed below, the following information should be submitted to the Customer Service Department:

1. the instrument model number,
2. the instrument serial number,
3. revision ("Rev" on rear panel) number,
4. a description of the part,
5. information as to the function and location of the part.

The solid-state-device (diodes, transistors, and integrated circuits) types installed in your instrument may differ from those shown in the schematic diagram and parts list. In such cases, necessary replacements can be made with either the type shown or the type actually installed in the instrument.

Replaceable Parts List

Description	ORTEC Part No.	Reference Designations
Capacitors		
22 pF Mica 5% 500V	40883	C19, 41
47 pF Mica 2% 500V	41711	C6, 47
68 pF Mica 5% 500V	41702	C27
82 pF Mica 2% 500V	41705	C4
100 pF Mica 2% 500V	40886	C11, 13
470 pF Mica 5% 500V	40892	C25, 28, 45
820 pF Mica 2% 300V	41707	C8, 9
1000 pF Polystyrene	60596	C20, 51
0.002 μF 10% 1KV Disc	43629	C23, 24, 30, 31, 43, 44
0.0022 μF 10% 200V Mylar	40913	C10
0.0047 μF 5% 200V Mylar	40914	C12
0.01 μF 20% 50V DI	40855	C36, 37
0.1 μF 50V Disc	40846	C35
0.47 μF 63V MKS POLY WIMA	63652	C18, 40
6.8 μF 20% 35V Tan	49542	C1, 2, 3, 5, 7, 14, 15, 16, 17, 21, 22, 26, 29, 32, 33, 38, 39, 42, 46, 48, 49, 50, 52, 53, 54, 55
220 μF 20% 10V	40953	C34
Diodes		
1N756 Diode MOT	41127	D2, 4, 5, 9, 10, 12, 15, 16
1N4153 Diode 75V SYL	44217	D1, 3, 6, 7, 8, 11, 13, 14, 17

Replaceable Parts List (continued)

Description	ORTEC Part No.	Reference Designations
Temperature Stabilizer		
4ST3-4 Temp Stabilizer KLX	48649	H1
Integrated Circuits		
Type 309 5V Regulator	63755	IC17
Type 710HC	41815	IC7, 8, 16
Type 715HC	66149	IC12, 14, 15
Type AD530L (Mult Divider)	66150	IC13
Type SG3501T +15V Regulator	66151	IC18
Type SN7400N	44073	IC1, 6
Type SN7420N	44087	IC5
Type SN74121N	65448	IC2, 3, 4
Transistors		
2N3904	47860	Q16, 17, 19, 21, 24, 29, 30, 32, 34, 36, 38
2N3906	41089	Q15, 18, 20, 28, 31, 33, 39, 40
MPS-3640 EG&G AB0323	43652	Q14, 25, 26, 37
MPS-3646	43651	Q11, 12, 22, 27, 35, 41, 42, 43, 44
MPS-6507	43653	Q23
Resistors		
10Ω CC 1/4W 5%	40202	R114, 115, 125, 126, 127, 128, 132, 133, 134, 135
12Ω CC 1/4W 5%	40281	R43, 92
22Ω CC 1/4W 5%	40204	R58, 123
46.4Ω MF 1/8W 1% T-0	40483	R10
47Ω CC 1/4W 5%	40206	R41, 90
51Ω CC 1/4W 5%	40271	R24, 136
93.1Ω MF 1/8W 1% T-0	40589	R68, 102
100Ω MF 1/8W 1% T-0	40489	R1
100Ω CC 1/4W 5%	40209	R18, 23, 35, 46, 49, 63, 65, 67, 80, 83, 97, 98, 101
121Ω MF 1/8W 1% T-0	40577	R9
180Ω WW 3W 5% DLE CW-2C	40709	R129
330Ω CC 1/4W 5%	40216	R73
470Ω CC 1/4W 5%	40219	R104, 116
560Ω CC 1/4W 5%	40274	R122
681Ω MF 1/8W 1% T-0	40513	R29, 78
820Ω CC 1/4W 5%	40224	R74, 121
1K MF 1/8W 1% T-0	40515	R100
1K CC 1/4W 5%	40226	R20, 26, 34, 36, 38, 45, 84, 85, 87, 94, 105, 109, 112
1K BRN Trimpot 3229W-1-102	40822	R27, 77
1K 10-turn BRN Pot 3540	40818	R2
1K 20-turn BRN Pot 3006Y-IRCM102	43583	R8
1.33K MF 1/8W 1% T-0	40518	R3

Replaceable Parts List (continued)

Description	ORTEC Part No.	Reference Designations
1.5K CC 1/4W 5%	40229	R5, 12, 70, 107, 113, 117
1.8K CC 1/4W 5%	40230	R66, 103, 108
2.15K MF 1/8W 1% T-0	40523	R4, 13, 28, 130
2.2K CC 1/4W 5%	40232	R16, 17, 21, 22, 25
2.7K CC 1/4W 5%	40234	R106
3.3K CC 1/4W 5%	40236	R51, 110
3.9K CC 1/4W 5%	40237	R19, 69, 76, 120, 124
3.92K MF 1/8W 1% T-0	40590	R32, 81
4.64K MF 1/8W 1% T-0	40533	R48
4.7K CC 1/4W 5%	40238	R39, 88, 118
5K BRN Trimpot 3299W-1-502	43560	R56
5.62K MF 1/8W 1% T-0	40535	R7, 59, 60, 61, 62, 64, 96, 131
6.81K MF 1/8W 1% T-0	40537	R30, 79
8.2K CC 1/4W 5%	40243	R15
8.25K MF 1/8W 1% T-0	40539	R42, 57, 91
10K MF 1/8W 1% T-0	40545	R47, 50, 95, 99, 119
10K CC 1/4W 5%	40245	R14, 33, 37, 44, 71, 82, 86, 93, 111
15K CC 1/4W 5%	40248	R6
20K BRN Trimpot 3299W-1-203	43561	R53, 54, 55
21.5K MF 1/8W 1% T-0	40553	R40, 89
33K CC 1/4W 5%	40253	R11
82K CC 1/4W 5%	40289	R52
Miscellaneous		
10-turn HEL 2606 Dial	40425	Control for R2
MOD Male Shield WIN 111-20853-1	42934	p/o Power Connector
MOD Shield Block WIN 111-20851-1	42935	p/o Power Connector
Guide WIN 111-20855 EE89	42936	(2 used) p/o Power Connector
Contact Pin WIN 100-0812P	42939	(5 used) p/o Power Connector

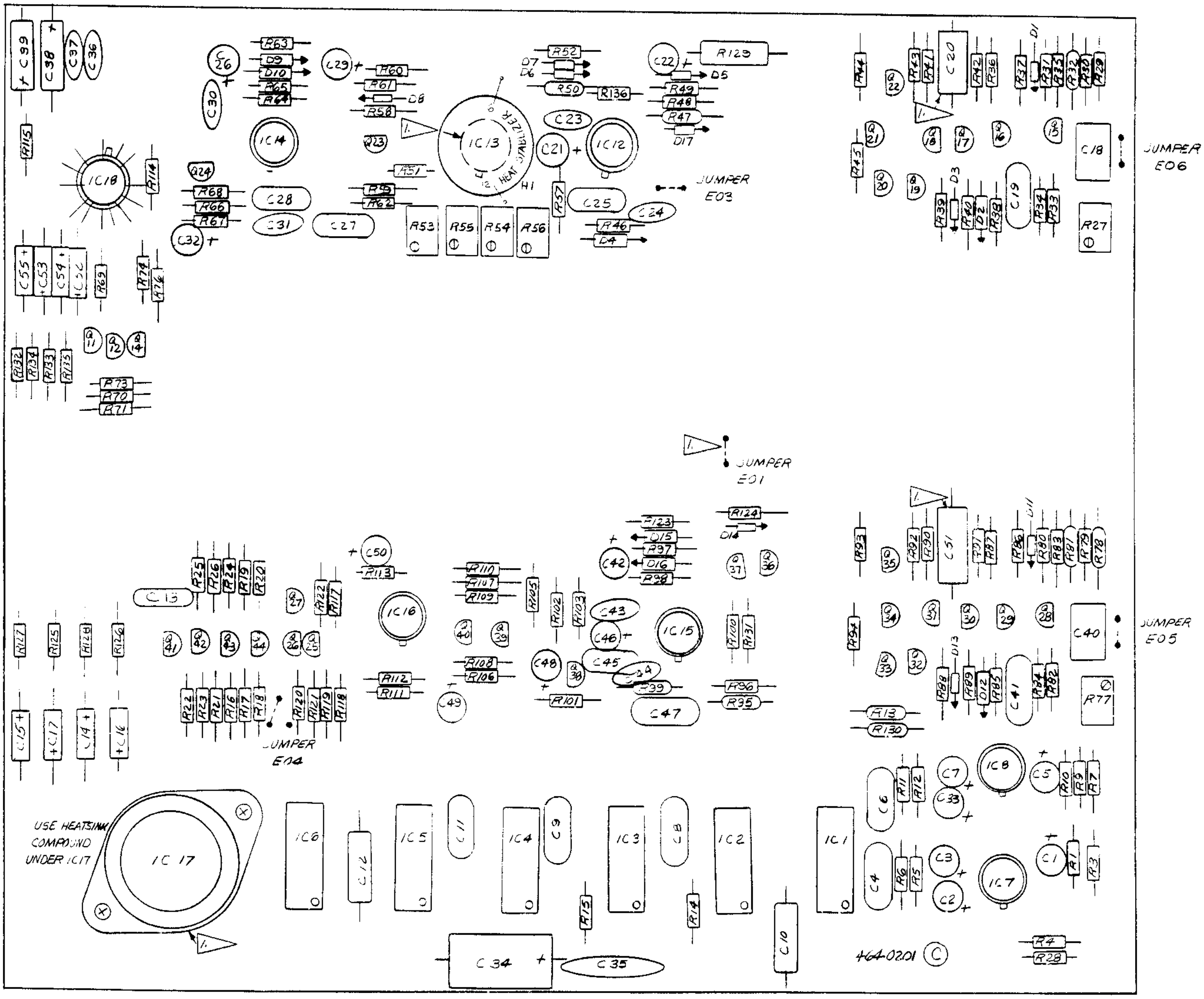
BIN/MODULE CONNECTOR PIN ASSIGNMENTS FOR AEC STANDARD NUCLEAR INSTRUMENT MODULES PER TID-20893

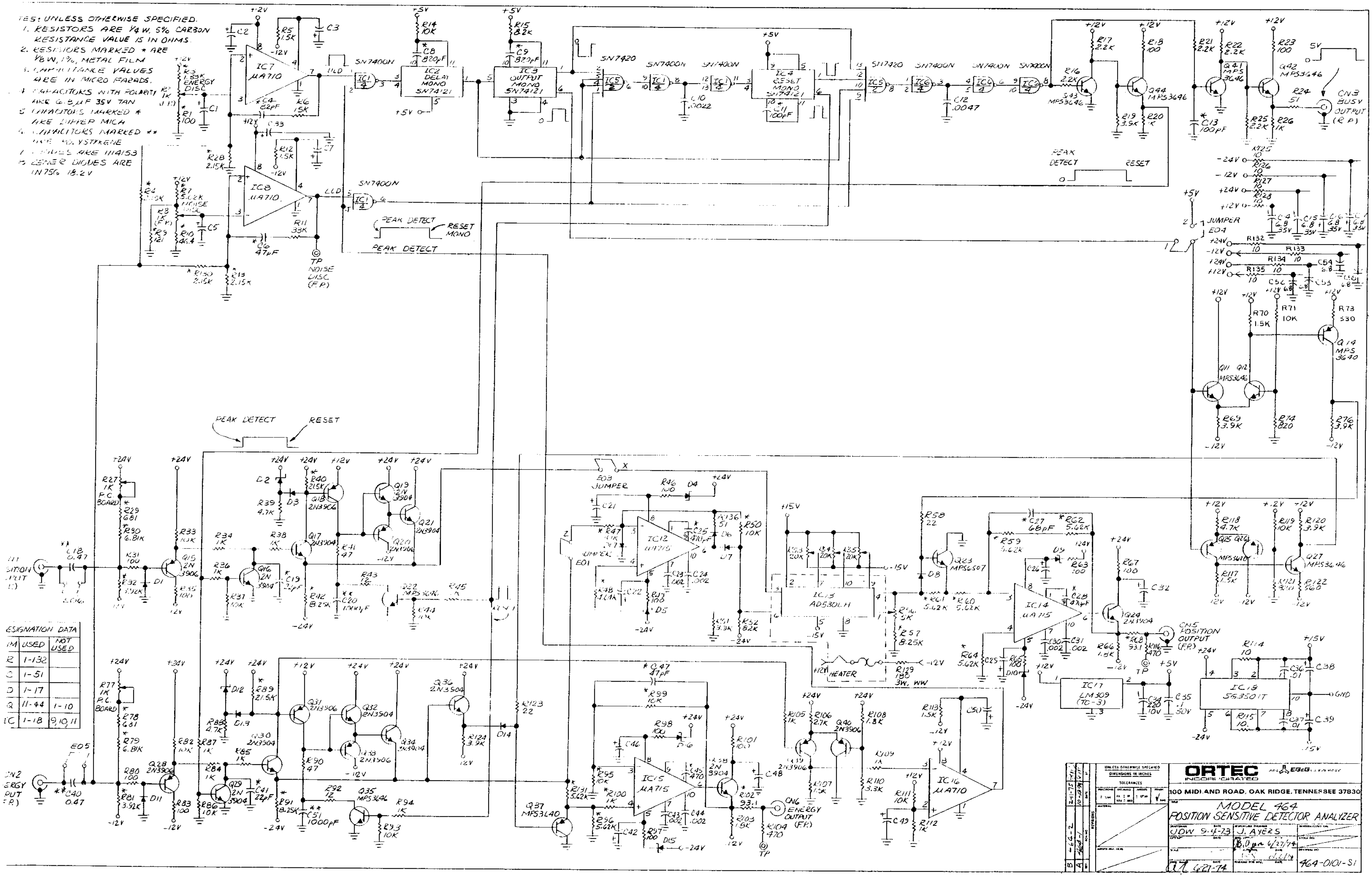
Pin	Function	Pin	Function
1	+3 volts	23	Reserved
2	−3 volts	24	Reserved
3	Spare Bus	25	Reserved
4	Reserved Bus	26	Spare
5	Coaxial	27	Spare
6	Coaxial	*28	+24 volts
7	Coaxial	*29	−24 volts
8	200 volts dc	30	Spare Bus
9	Spare	31	Spare
*10	+6 volts	32	Spare
*11	−6 volts	*33	115 volts ac (Hot)
12	Reserved 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.

NOTES.

1. INSTALL IC13, IC17, C20, HEATSINK, & C51 AFTER WAVE SOLDERING P.C. BOARD.




NOTES: UNLESS OTHERWISE SPECIFIED.
1. RESISTORS ARE 1/4 W, 5% CARBON RESISTANCE VALUE IS IN OHMS.
2. RESISTORS MARKED * ARE 1/8 W, 1%, METAL FILM
3. CAPACITANCE VALUES ARE IN MICRO FARADS.
4. CAPACITORS WITH POLARITY ARE 6.8 µF 35V TAN
5. CAPACITORS MARKED * ARE DIPPED MICA
6. CAPACITORS MARKED ** ARE POLYSTYRENE
7. DIODES ARE 1N4153
8. ZENER DIODES ARE 1N756 18.2V
DESIGNATION DATA
ITEM USED NOT USED
R 1-132
C 1-51
D 1-17
Q 11-44 1-10
IC 1-18 9,10,11
IC7 µA710
IC8 µA710
IC1 SN7400N
IC2 DELAY MONO SN74121
IC3 OUTPUT MONO SN74121
IC4 RESET MONO SN74121
IC5 SN7420
IC6 SN7400N
IC12 µA715
IC13 AD530LH
IC14 µA715
IC15 µA715
IC16 µA710
IC17 LM309 (TC-3)
IC18 SG3501T
ENERGY DISC
NOISE DISC (F.P.)
PEAK DETECT
RESET
RESET MONO
CN3 BUSY OUTPUT (R.P.)
CN5 POSITION OUTPUT (F.P.)
CN6 ENERGY OUTPUT (F.P.)
POSITION INPUT
ENERGY INPUT (F.P.)
JUMPER E04
JUMPER E03
JUMPER E01
E05
HEATER
P.C. BOARD
TP
GND
ORTEC INCORPORATED
100 MIDLAND ROAD, OAK RIDGE, TENNESSEE 37830
MODEL 464
POSITION SENSITIVE DETECTOR ANALYZER
JDW 9-4-73
J. AYERS
464-0101-S1