EG&G ORTEC
Subsidiary of EG&G, Inc.

Model 462
Time Calibrator
Operating and Service Manual

Model 462
Time Calibrator
Operating and Service Manual

Printed in U.S.A.

EG&G ORTEC Part Number 733340
Manual Revision C

2952 0393

IMPORTANT NOTICE

Your Model 462 has undergone a circuit upgrade. The schematic diagram in this manual reflects the latest version but the circuit description and maintenance sections are not to latest design. Functionally the newer instrument is the same **except** that the first peak as seen in Figure 1.1, 1.2, 1.3, 4.1, and 4.2 is approximately equal in height to the succeeding peaks.

CONTENTS

ILLUSTRATIONS

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

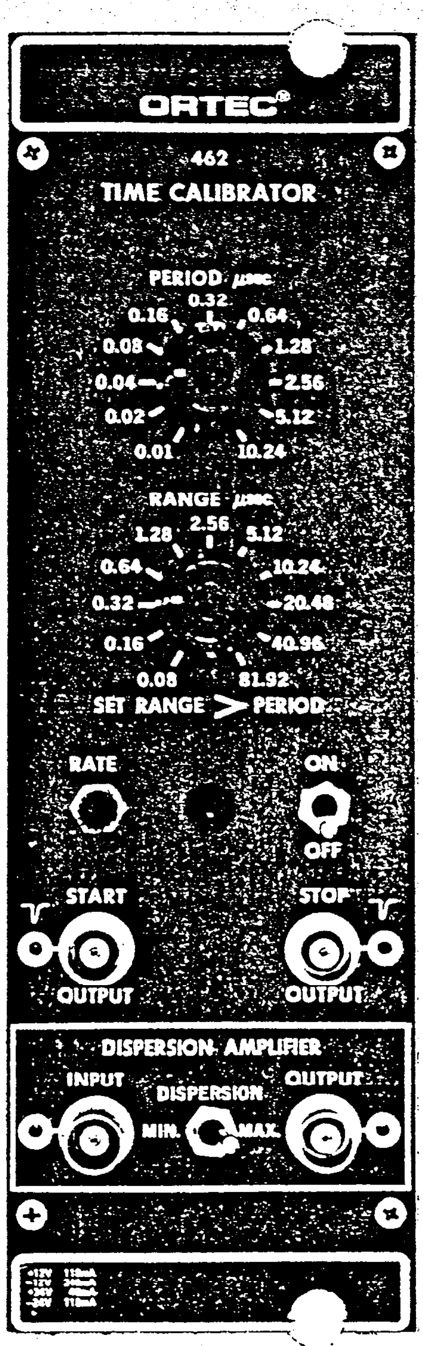
Before being approved for shipment, each EG&G ORTEC instrument must pass a stringent set of quality control tests designed to expose any flaws in materials or workmanship. Permanent records of these tests are maintained for use in warranty repair and as a source of statistical information for design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

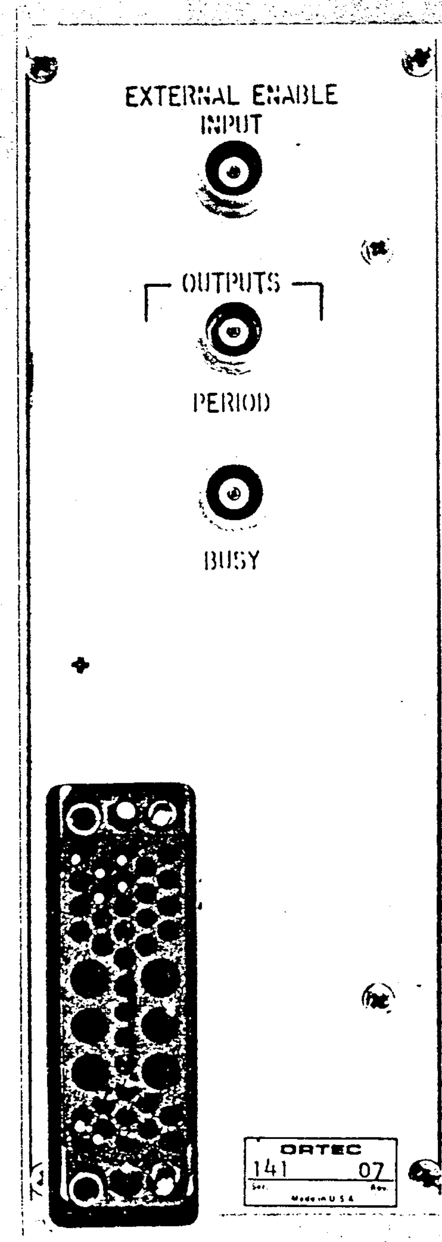
Repair Service

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, by telephone [(615) 482-4411], by telex (6843140) or by facsimile transmission [(615) 483-0396], 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.


ORTEC
462
TIME CALIBRATOR
PERIOD µsec
0.01 0.02 0.04 0.08 0.16 0.32 0.64 1.28 2.56 5.12 10.24
RANGE µsec
0.08 0.16 0.32 0.64 1.28 2.56 5.12 10.24 20.48 40.96 81.92
SET RANGE > PERIOD
RATE
ON
OFF
START
STOP
OUTPUT
OUTPUT
DISPERSION AMPLIFIER
INPUT
DISPERSION
MIN.
MAX.
OUTPUT


EXTERNAL ENABLE
INPUT
OUTPUTS
PERIOD
BUSY
ORTEC
141
07

ORTEC 462 TIME CALIBRATOR

1. DESCRIPTION

1.1. PURPOSE

The ORTEC 462 Time Calibrator generates logic signals at precise time intervals that can be used to test and calibrate a Time to Pulse Height Converter such as the ORTEC 437A, 447, or 457. The time base is a precision 100-MHz crystal-controlled oscillator that is calibrated against WWV, the National Bureau of Standards frequency, and is temperature-compensated for accuracy throughout the normal operating range of 0 to 50°C. The time intervals, their range, and their repetition rate are all selectable in the 462.

Each output from the 462 consists of a pair of start and stop pulses for the Time to Pulse Height Converter. Each pair of pulses is exactly *N* integral time intervals apart, where *N* is a multiple (2 or more) of the selected period set on the 462. The period selection consists of 11 binary steps from 10 nsec to 10.24 μsec. For example, if the period selected is 40 nsec, the intervals that would be produced would include 80, 120, 160, 200, 240, etc., nsec. Each timed interval is triggered by a random generator, and the 462 circuit is arranged so that the probability that N = any multiple greater than 2 is about equal, and the probability for $N = 2$ is about doubled. The time spectrum that can be obtained from the Time to Pulse Height Converter then consists of a series of sharp peaks at the multiples of the selected period, and the first peak will have about twice the count total as each of the other peaks in the spectrum to simplify its identification and ensure that the lower end of the spectrum has not been biased off in the electronics.

Figure 1.1 is a time spectrum that was obtained from a 462 output. The 462 Period switch was set at 80 nsec (0.08 μsec) for this spectrum. The first peak in the spectrum, for 160 nsec, has accumulated about twice as many counts as any of the other peaks, and peaks have been obtained for 160, 240, 320, 400, 560, 640, 720, 800, and 880 nsec. Note that each peak except the one for 800 nsec has been accumulated into just one of the 256 analyzer channels that were used. The 800-nsec peak has been counted into two adjacent channels.

A Range switch on the 462 permits selection of the maximum multiple, *N*, for a given application and must logically be set for an interval that is greater than the selection with the Period switch. The Range switch selections are also binary steps starting at 80 nsec, with a maximum setting of 81.92 μsec. In Fig. 1.1 the Range switch was set at 1.28 μsec, and time intervals were

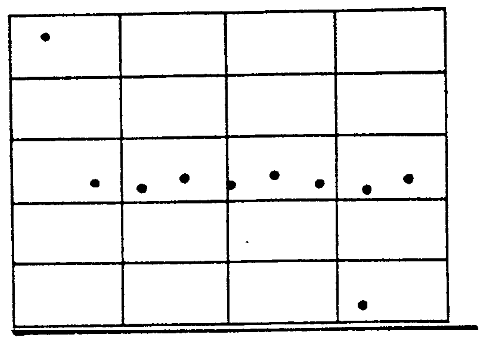


Fig. 1.1. Typical Timing Calibration Spectrum Using 256 Analyzer Channels.

produced that were greater than the 880-nsec maximum peak shown in the spectrum. However, the range of the 457 Time to Pulse Height Converter was set for 800 nsec full scale, which accounts for the lack of any of the longer time intervals in the spectrum even though they were produced by the 462.

A Rate adjustment is included on the front panel to control the average rate of the random generator and thus control the average output rate of the start and stop output pulse pairs. The range of this control is from about 100 to 50,000 counts/sec.

An On/Off switch on the front panel, when set at On, permits operation to be gated through an External Enable Input rear panel connector if desired or to be continuous (without any gating). An indicator on the front panel lights when the instrument is actually producing the start and stop output pulse pairs.

The 462 also includes a peak dispersion amplifier that can mix semi-Gaussian noise with the analog output of the Time to Pulse Height Converter before it is furnished into the multichannel analyzer. When this circuit is used, it spreads each peak in the spectrum by about 10 channels FWHM per 1000 analyzer channels. This feature can be used to help identify the peak centroid within a fraction of one channel. Figure 1.2 illustrates the same information as Fig. 1.1, with the TPHC output passing through the Dispersion Amplifier in the 462 and with its toggle switch set at Max. For a further comparison, Fig. 1.3 shows the same spectrum, with dispersion, obtained with a 1024-channel conversion rather than the 256-channel conversion of Figs. 1.1 and 1.2.

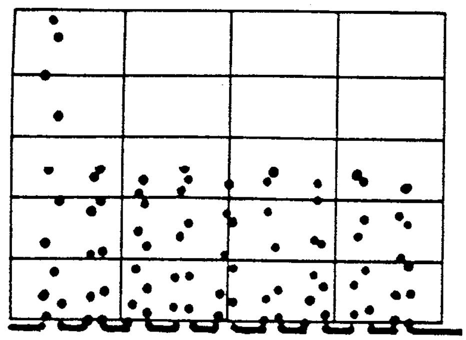


Fig. 1.2. The Spectrum of Fig. 1.1 with Dispersion.

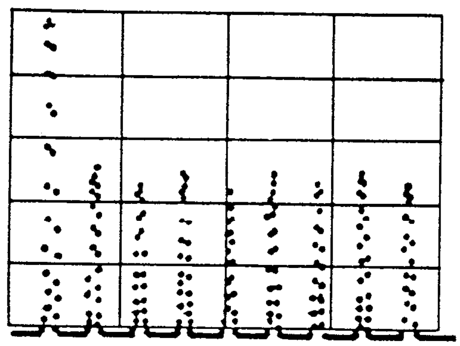


Fig. 1.3. The Spectrum of Fig. 1.1 with Dispersion Using 1024 Analyzer Channels.

1.2. PHYSICAL DESCRIPTION

The 462 Time Calibrator is a double-width module that furnishes fast negative NIM logic pulses into the start and stop inputs of a Time to Pulse Height Converter. The time intervals between the start and stop pulses are precise multiples of a selected basic period. The Period selector switch on the front panel selects binary multiples of 10 nsec from 10 nsec through 10.24 μsec. A constant train of output pulses at the selected period rate is available through a rear panel connector marked Period Output.

A Range switch on the front panel selects the maximum multiple of the Period selection that will be effective. Its settings, also binary, are from 80 nsec through 81.92 μsec. This switch must always be set for an interval that is greater than the Period selection for logical operation.

The combinations of settings of the Period and Range switches determine the number of time intervals that will be furnished into the Time to Pulse Height Converter. For example, if the Period switch is set at 0.16 (μsec) and the Range switch is set at 1.28, the time intervals that will be furnished will be randomly distributed between 320, 480, 640, 800, 960, and 1120 nsec.

Potentially, a start and stop pulse pair can be generated during each Range interval. However, a random generator must provide an internal Period pulse coincidence within the Range interval if an output pulse pair is to be generated in that Range interval. The Rate control on the front panel adjusts the average rate of the random generator, and the statistical chance for coincidence between each random generator output and a Period pulse will determine the actual output count rate. Coincidences are more probable at higher random generator rates and at shorter Period selections, and these must be adjusted together to provide satisfactory operation.

A Busy Output connector is included on the rear panel. The signal through this connector goes negative at each Start Output signal and returns to ground at the subsequent Stop Output. The function can be monitored with an oscilloscope, or the total number of output pulse pairs can be counted in an external scaler to determine the average rate.

The On/Off toggle switch on the front panel provides manual gating for operation of the 462. When the switch is set at On and no control is furnished through the External Enable Input connector on the rear panel, the indicator lamp lights and the instrument is operating. Optional external control can then be imposed through the rear panel connector to inhibit operation by grounding the connector circuit and to enable operation by furnishing an open circuit or a level >2.0 V through this connector.

The Start and Stop output connectors furnish standard fast negative NIM logic signals through a 1-kΩ output impedance for interconnection to the Start and Stop inputs, respectively, on a Time to Pulse Height Converter. Use 50Ω cable and termination for each of these signals. All ORTEC Time to Pulse Height Converters include 50Ω input impedance circuits, and additional termination is therefore not required.

The Dispersion Amplifier provides a separate function. The output from the Time to Pulse Height Converter is normally routed directly into the ADC of a multichannel analyzer. This would provide a time calibration spectrum like that shown in Fig. 1.1. With the 462 the output from the TPHC can be furnished through the Dispersion Amplifier and then to the ADC. When the Dispersion Amplifier toggle switch is set at Min, the signals are passed through without any changes. When the toggle switch is set at Max, a near-Gaussian noise signal is mixed with the TPHC output signals before they enter the ADC. This feature reduces the resolution of each peak in the spectrum as shown in Fig. 1.2, and the peak centroid location can be calculated more accurately, within a fraction of one analyzer channel. The semi-Gaussian noise is obtained from the random generator in the 462, and an amplitude control for the noise spreading is included on a printed circuit inside the module.

2. SPECIFICATIONS

2.1. PERFORMANCE

Calibration Period Accuracy Absolute accuracy ±10 psec for 10-nsec period and ±0.005% of total period for all other selections; factory-calibrated against National Bureau of Standards WWV.

Calibration Period Stability Within <10 ppm/°C of selected period; 100 ppm/year.

2.2. CONTROLS

Period μsec 11-position switch selects the basic interval steps between start and stop outputs; selections are 10, 20, 40, 80, 160, 320, and 640 nsec, and 1.28, 2.56, 5.12, and 10.24 μsec.

Range μsec 11-position switch selects the total calibration time scale in binary multiples of 80 nsec; selections are 80, 160, 320, and 640 nsec, and 1.28, 2.56, 5.12, 10.24, 40.96, and 81.92 μsec.

Rate Single-turn front panel trim potentiometer adjusts the random start-stop rate from about 100 to 50,000 counts/sec.

On/Off Toggle switch disables the 462 output for the Off position or enables the output (except when gated off) for the On position; the adjacent lamp lights when the output is enabled.

Dispersion Toggle switch marked Min and Max, selects the internal circuit effect between the Input and Output of the Dispersion Amplifier. The Min position selects a reproduction of the Input with a gain of 1 at the Output. The Max position provides for the addition of semi-Gaussian noise to the Input before it is furnished through the Output; the purpose is to reduce the resolution of the spectrum in order to calculate the peak centroid within a fraction of one channel.

2.3. INPUTS

External Enable Input Rear panel type BNC connector accepts gating logic to control unit when On/Off switch is set at On; >2.0 V or open enables, or nominal ground disables.

Dispersion Amplifier Input Front panel type BNC connector accepts ±10-V linear signals, typically from a Time to Pulse Height Converter; Z_{in} ~2 kΩ.

2.4. OUTPUTS

Start Output Front panel type BNC connector furnishes a NIM-standard fast negative logic pulse which occurs at random during each range burst as the result of a double internal coincidence: Z_0 1 kΩ.

Stop Output Front panel type BNC connector furnishes a NIM-standard fast negative logic pulse which occurs at an integral multiple (≥2) of the selected period following each Start output pulse; Z_0 1 kΩ.

Busy Output Rear panel type BNC connector furnishes a signal that is at −0.8 V for a 50Ω load during the interval from each start pulse until its subsequent stop pulse; Z_0 1 kΩ.

Period Output Rear panel type BNC connector furnishes a NIM-standard fast negative pulse at a fixed rate of 1/Period; can be used to check calibration or as a stable external time base; Z_0 1 kΩ.

Dispersion Amplifier Output Front panel type BNC connector provides ±10-V linear output, same polarity as the Dispersion Amplifier Input; Dispersion switch selects whether signal is an exact reproduction of the input or has ~100-mV FWHM random noise mixed with it; Z_0 <1Ω.

2.5. ELECTRICAL AND MECHANICAL

Power Required

+12 V, 110 mA;
−12 V, 340 mA;
+24 V, 40 mA;
−24 V, 110 mA.

Weight (Shipping) 6.5 lb (2.9 kg).

Weight (Net) 3.5 lb (1.56 kg).

Dimensions Double-width NIM-standard module (2.70 by 8.714 in.) per TID-20893 (Rev).

3. INSTALLATION

3.1. GENERAL

The ORTEC 401/402 Series Bins and Power Supplies are designed to accommodate NIM modules such as the 462 Time Calibrator and to furnish the required operating power to the module. Any of these Bins except the 401M Minibin is intended for rack mounting. It is important that any vacuum tube equipment that is operating in the same rack have sufficient cool air circulating to prevent localized heating of the all-transistor circuits in the 462 and in other modules installed in the Bin and Power Supply. Rack-mounted equipment subjected to the temperatures in vacuum tube equipment can exceed the maximum for which the transistorized circuits are designed unless this precaution is taken. The 462 should not be subjected to temperatures in excess of 120°F (50°C).

3.2. CONNECTION TO POWER

The 462 is designed per TID-20893 (Rev) and accepts its operating power requirements through a mating power connector when it is installed in an ORTEC 401/402 Series Bin and Power Supply. As a safety precaution, always turn off the power for the Bin before inserting or removing any modules. If all the modules installed in the Bin are ORTEC 400 and/or 700 Series instruments, there will be no overload on any portion of the Power Supply. However, if any modules are included that are not of ORTEC design, this protection may not be effective; monitor the dc voltages at the test points on the control panel of the Bin after all modules have been installed in the Bin and power is turned on, in order to determine that none of the four dc power levels has been reduced by an overload.

3.3. CONNECTION INTO A SYSTEM

The 462 furnishes both start and stop input pulses into a Time to Pulse Height Converter and provides accurately controlled timed intervals that can be used to check the response and calibration of the TPHC. A typical system interconnection for calibration is shown in Fig. 3.1. Connections are shown here for the use of both functions available in the 462, calibration signal generation and spectral dispersion.

By routing the output from the Time to Pulse Height Converter through the Dispersion Amplifier portion of the 462, the spectrum can be made either with or without dispersion. When the toggle switch is set at Min, there is no dispersion of the TPHC output. When the toggle switch is set at Max, the resolution of the time spectrum will be purposely degraded in order to locate the peaks within a fraction of one channel. This can aid in increasing the precision with which a spectrum is evaluated.

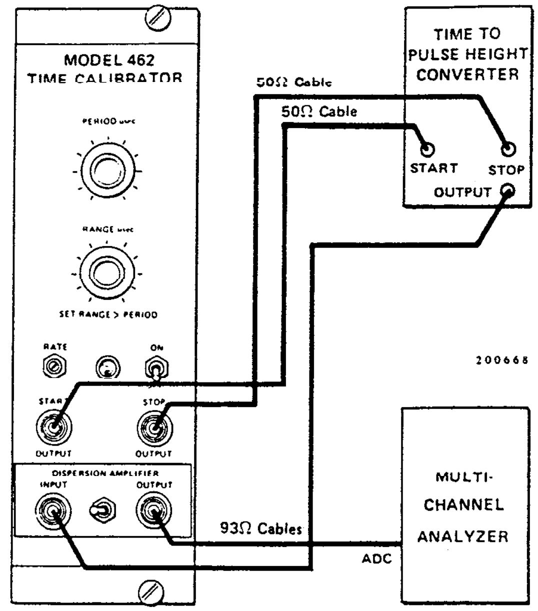


Fig. 3.1. Typical System Interconnections.

The 462 can be connected into an operating system for on-line operation if desired. When the On/Off switch is set at Off, the 462 will not affect the accumulation of the spectrum other than the possible application of the Dispersion Amplifier. At any time before, during, or after the accumulation of the normal spectrum, the 462 switch can be set at On and it can then provide time markers in the normal spectrum. Figure 3.2 shows the system interconnections for on-line operation of the 462. A type BNC tee connector is attached to the Start and Stop Output connectors of the 462 to accommodate the input from a detector-amplifier circuit and the output to the discriminator and TPHC. The TPHC output can be routed directly into the multichannel ADC or can be returned to the Dispersion Amplifier in the 462 before it is furnished into the ADC. Simple manual or automatic enable will furnish calibration peaks.

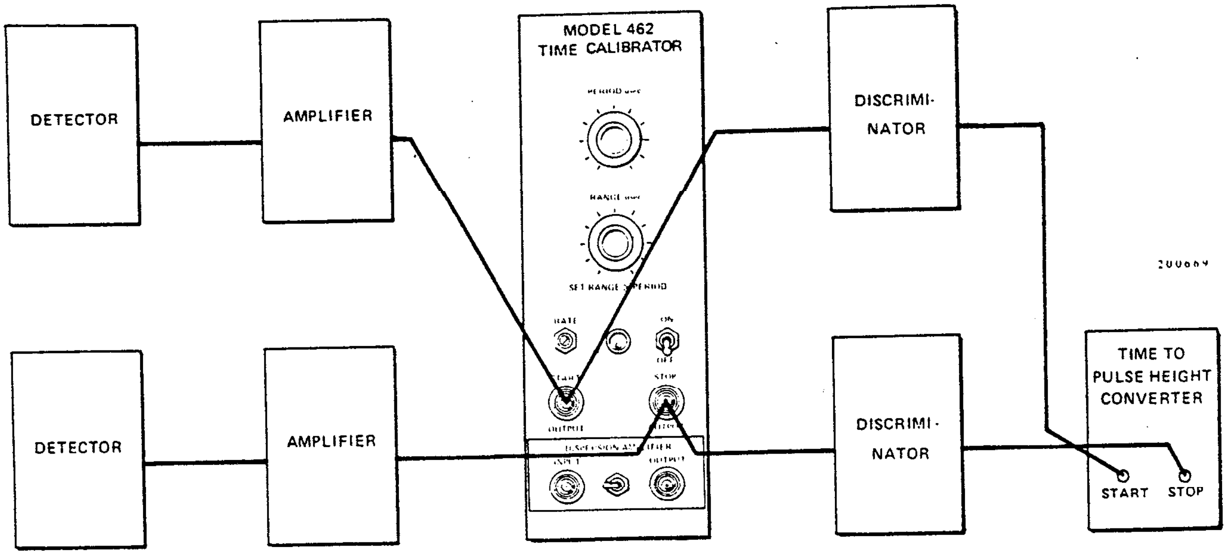


Fig. 3.2. Typical System Interconnections for On-Line Operation.

4. OPERATION

4.1. PERIOD SELECTION

Determine the Period interval that is desired and set it on the Period switch on the front panel. The intervals are in binary steps from 10 nsec through 10.24 μsec. The relation between the range selected with the Time to Pulse Height Converter and the Period selected on the 462 will determine how many multiples of the basic Period will be included in the total spectrum. For example, an ORTEC 457 TPHC could be set for a range of 40 μsec; if the 462 Period were then set at 5.12 μsec, there would be about 7 time markers available within the 457 range. If the 462 Period switch were set at 1.28 μsec, there could be as many as 31 time markers in the spectrum.

4.2. RANGE SELECTION

The Range switch must always be set at an interval that is greater than the selection of the Period switch on the 462. If time markers are to be distributed across an entire spectrum from the TPHC, the Range switch of the 462 must also be set for an interval that is greater than the range of the TPHC. In the above examples, with the TPHC range set at 40 μsec, the 462 Range switch must be set at either 40.96 or 81.92 μsec if time markers are to be distributed up through the maximum time in the spectrum.

4.3. RATE ADJUSTMENT

The potentiometer marked Rate on the front panel regulates the relative output rate of start and stop pulse pairs from the 462 into the Time to Pulse Height Converter. The range for this control is from about 100 output pulse pairs per second through about 50,000 pairs per second. If the 462 is being used exclusively for TPHC calibration, the rate can usually be advanced to a high level since only these signals will be processed by the TPHC and the multichannel analyzer. When the 462 is being used on-line to add markers into a time spectrum, adjust the Rate control down to a point where the marker count rate is compatible with the count rate of the basic time spectrum. This can be adjusted by visual inspection of a live display in the analyzer during operation.

4.4. ON-LINE OPERATION

With the system connected as shown in Fig. 3.2, the basic time spectrum can be accumulated while the 462 is either turned On or Off. When the 462 is turned On, the markers will be added into the spectrum. When the 462 is turned Off, the normal spectrum will be accumulated without any time markers from the 462.

4.5. USE OF DISPERSION AMPLIFIER

Most time spectra will have an inherent resolution that does not require the use of the Dispersion Amplifier in the 462 for a proper calculation of the peak centroid location. However, the Dispersion Amplifier Input and Output can be used to route the Time to Pulse Height Converter output through this function if desired. When the signals do pass through the Dispersion Amplifier portion of the 462, the front panel toggle switch can be set at Min to eliminate any dispersion or can be set at Max to introduce the intended peak spreading.

Frequently, it will be advantageous to accumulate the normal spectrum without dispersion and to add the time markers with dispersion during separate and sequential analyses and without erasure of the data between the runs.

4.6. BIASED OPERATION

When the 462 output is furnished through a Biased Time to Pulse Height Converter, such as the ORTEC 457, the lower portion of the spectrum can be biased off and the remainder be amplified for a more critical examination of some portion of interest in the overall spectrum. Figure 4.1 shows the result of operating with a biased amplifier in which the first time marker has been eliminated from the spectrum, and two subsequent markers have been included.

The conditions set for the biased spectrum of Fig. 4.1 were a 10-nsec Period setting on the 462 and a 50-nsec range on the ORTEC 457 Biased Time to Pulse Height Converter. The 462 Range was set at 80 nsec. The conversion gain of the analyzer was set for 1024 channels = 50 nsec basically, and then the 457 bias was increased for an offset of 384 channels. Using a 256-channel display, the post gain of the 457 was increased to position the two markers as shown in Fig. 4.1. Under these conditions it can be calculated that the time markers represent 30 and 40 nsec respectively.

The spectrum of Fig. 4.2 was obtained by adding dispersion to the system of Fig. 4.1. With the aid of a readout, the peak centroids were calculated at channel 32.55 for 30 nsec and at channel 215.44 for 40 nsec, and the calibrated distribution for this spectrum was 182.89 channels = 10 nsec, or about 54.7 psec = 1 channel.

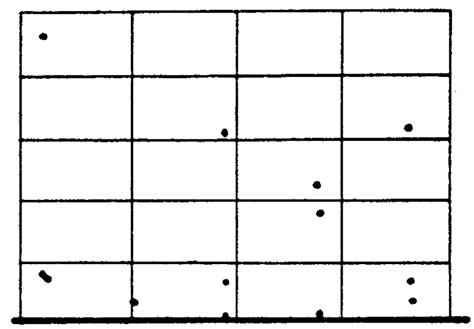


Fig. 4.1. Typical Biased Timing Spectrum with Time Markers Spaced for 10 nsec.

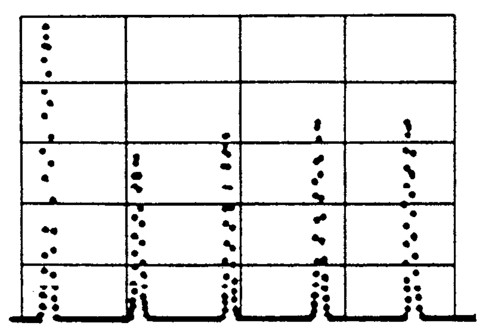


Fig. 4.2. The Spectrum of Fig. 4.1 with Dispersion.

5. CIRCUIT DESCRIPTION

5.1. GENERAL

The circuits of the ORTEC 462 Time Calibrator are shown in schematics 462-0201-S1, 462-0301-S1, and 462-0401-S1, all included at the back of this manual.

The Dispersion Amplifier consists of IC1 and IC2 on the 462-0301 printed circuit. The 5-V power supply is the circuit of Q1 through Q3 on the 462-0401 printed circuit. The remaining circuits are all included on printed circuit 462-0201; these include IC1 through IC8 for the oscillator and countdown, IC9 with Q11 and Q18 for the noise generator, and IC10, IC11, IC12, and IC13 for the coincidence output generator.

5.2. TIME BASE

The main time base of the 462 is a 100-MHz crystal-controlled oscillator IC1. This oscillator is factory-calibrated against the National Bureau of Standards frequency on station WWV, and its frequency is typically 100.00 MHz ±10 ppm. It is temperature-compensated to retain accuracy within the operating temperature range of 0 to 50°C. The output at IC1-8 and -13 has a period of 10 nsec.

The output at IC1-8 is furnished directly to the 0.01 (μsec) position of switch S1B, the Period selector. The output at IC1-13 is furnished into the binary countdown circuit at IC2-6. The output from each subsequent binary stage through IC3-14 is furnished to the appropriate contact on the Period switch S1B. The first four binary stages, IC2 and IC3, are ECL type 10,000 logic for speed and stability. The IC3-15 output is translated to TTL logic through Q2 and Q3, and the remaining binary stages are type TTL logic, IC4 through IC8, and their outputs return through the 0.32- through 10.24-μsec selections of the Period switch and are then translated back to ECL logic through Q4, Q5, and Q6.

The output from the Period switch is furnished both to IC10-4 for the coincidence circuit for a Start pulse, and to Q1 and Q21 for the output through the Period BNC connector on the rear panel.

The Range switch, S2, accepts TTL logic from the appropriate stages of the binary countdown circuit. For the 0.08-μsec switch setting the output from IC3-14 is translated to the TTL levels through Q17 and Q10. Each of the other selections is taken directly from a TTL stage. The output from the Range switch is coupled through Q7, Q8, and Q9 for the transfer from TTL to ECL logic and into IC10-9 for the coincidence circuit for the Stop pulse.

5.3. NOISE GENERATOR

The noise generator consists of a nearly white noise source, D8, followed by a wideband amplifier Q11, Q18, and IC9. The output at IC9-15 is a random-time pulse that is shaped by the one-shot multivibrator IC9D. The amplitude of the noise pulses is regulated by R48, located on the printed circuit board. The average frequency is controlled by Rate adjustment R2 on the front panel. The output from IC9-15 is gated into the coincidence circuits by Q23, which is controlled by both the On/Off switch S4 and by any signal furnished through the External Enable Input BNC connector on the rear panel.

5.4. COINCIDENCE OUTPUT GENERATOR

Coincidence between the Period signal from S1 and a noise pulse from the noise generator is necessary in order to set IC12-3. When this IC has been set, the next Period pulse generates a Start output through IC11-6 and -7. In order to reduce the time jitter of the output signals due to the finite width of the clipped Period pulse from IC11-2, a double coincidence system is used. The first coincidence of the noise pulse and the Period pulse occurs at IC11-14 and sets flip-flop IC12-3. This arms IC11-6 and -7 after a 5-nsec delay in DL1 so that the next Period pulse fires IC11-6 and -7. The output from IC11-7 forms the Start pulse through Q15 and Q16.

The output from IC11-6 sets the Busy flip-flop, IC13. This blocks response to any more Period pulses through IC11-6 and unblocks the Stop gate, IC10-6. At the end of the selected Range a signal is presented to IC10-6 from Range switch S2; this unblocks IC10-6 and allows the next Period pulse to set the stop flip-flop IC12-14. When IC12-14 is set, this enables gate IC10-14 and -15, and the next Period pulse forms the Stop pulse through IC10-15, Q13, and Q14. The signal at IC10-14 resets IC13, terminating the Busy output, resets IC12-3, and resets IC12-14, restoring the initial conditions after the pair of pulses has been generated; the start input is unblocked and the stop input is blocked.

The $\overline{\text{Range}}$ signal also blocks generation of start pulses through Q19 to prevent any further start-stop pulse pairs from being generated until the selected Range signal changes to the correct polarity. The Busy output uses fast negative NIM logic levels and is negative through each start-stop interval.

The 462 start and stop outputs may be gated on or off by switch S4 or by furnishing a positive logic signal to the External Enable Input on the rear panel. In either case Q23 is turned on to block random noise pulses from generating a start output. If the switch is On and the External Enable Input signal is pulled down to less than +2 V, no outputs will be generated. When the unit is able to generate outputs, Q23 is turned off and Q24 is turned on, and indicator lamp LED1 lights to show the condition.

5.5. DISPERSION AMPLIFIER

The dispersion amplifier is a separate entity consisting of linear amplifiers IC1 and IC2 on the 462-0300 printed circuit. A portion of the noise that is generated in D9 of the -0200 circuit is furnished through potentiometer R49, on the -0200 board, to switch S3. When S3 is set at Min, the noise is not furnished into IC1, but when the switch is set at Max, the noise passes through IC1 to be mixed with the signals from the dispersion amplifier input.

Noninverting operational amplifier IC2 has a gain of 1, determined by gain setting resistors R12 and R8 and by attenuator network R5 and R9. The networks surrounding Q1 and Q2 form overload and short-circuit protection for IC2. The output dc level is adjusted by potentiometer R11, on the -0300 printed circuit.

The amount of noise to be mixed with the TPHC output signals is controlled by R49 on the -0200 board and is amplified with a gain of 1 in IC1, determined by R2 and R1. The noise bandpass is controlled by C1,R1 and C2,R2 for low- and high-frequency cuts respectively.

5.6. 5-V POWER SUPPLY

The 462 has a self-contained power supply for the dc levels required by the integrated circuits. This supply is on the 462-0400 printed circuit and consists of 12-V transformer T1, full-wave diode bridge D1, and regulator transistors Q1, Q2, and Q3. These supplies, for both +5 V and −5 V, are fused to prevent damage to the instrument in case of any failure. Fuses F1 and F2 are both rated at 0.5 A, Slo-Blo. Regulation is furnished from the +12- and −12-V sources from the Bin and Power Supply.

5.7. TIMING AND LOGIC (See Fig. 5.1.)

Range signal R and $\overline{R}$ is furnished from switch S2. It has a selected period that is some binary multiple of 80 nsec and provides its levels to IC10-9. Although R and P′ in Fig. 5.1 are generated by the same basic oscillator, there is always some slight offset in time between them because of the propagation delays that are experienced in passing through the sequential binary countdown stages.

Period pulses P′ are shaped on the leading edge of the Period output pulses from the binary countdown circuit that are selected by switch S1. For reference in this discussion, the P′ pulses of interest are identified by the letters ***a*** through ***j***.

The shaped random noise pulses are shown in Fig. 5.1 with the designation RP. Their average periods are a function of the front panel Rate control.

A random coincidence within an R interval is necessary to initiate a cycle of operation. This could occur at any P′ from ***a*** through ***g***. In Fig. 5.1 the first random coincidence occurs at the P′ pulse ***c***. When this pulse occurs, it sets the Start FF, and the $\overline{Q}$ output at pin 3 of IC12 goes down. At the next P′ time, providing $\overline{\text{Busy}}$ is present, a Start output pulse is generated and the Busy FF, IC13, is set. The random coincidence shown at P′ ***e*** has no effect since Busy has been set.

When $\overline{R}$ occurs, slightly after P′ ***g***, the conditions are present for the next P′ ***(h)*** to set the Stop FF, and its

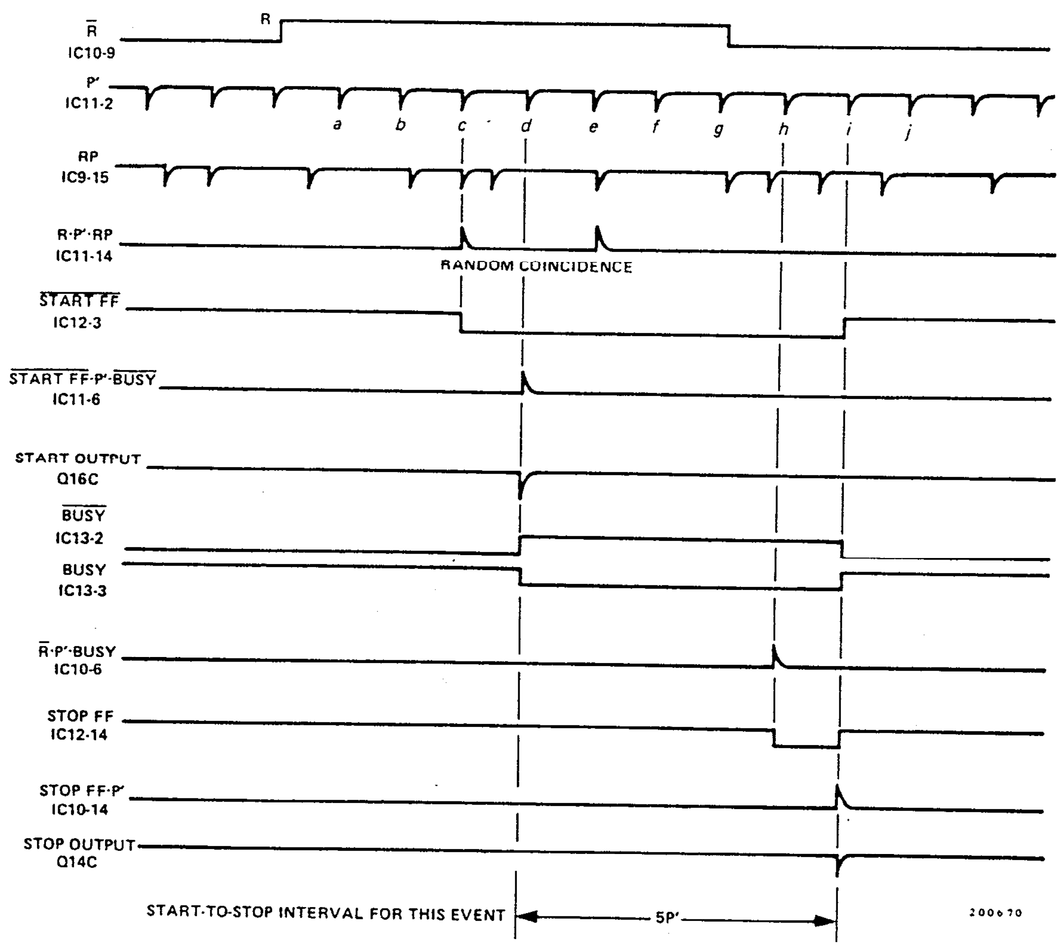


Fig. 5.1. Time Logic Sequence Chart for Double Derandomizing Coincidence in the 462.

output at IC12-14 goes down. At the next P′ *(i)*, a Stop output is generated. In this example, the Start-to-Stop interval is equal to exactly five Period intervals.

If the first random coincidence had occurred at P′ ***a***, this would have generated a start output at P′ ***b***, with a stop output at P′ *i*, and the Start-to-Stop output interval would have been exactly seven Period intervals. This is the longest output pulse pair interval that could be produced. If the first random coincidence had occurred at P′ ***f***, this would have generated a start output at P′ ***g*** with a stop output at P′ *i*, and the Start-to-Stop output interval would have been exactly two Period intervals, the shortest output pulse pair interval that could be produced.

If the first random coincidence had occurred at P′ ***g***, there would have been a start output at P′ *h*, the stop FF would have been set at P′ *i*, and the stop output would then have occurred at P′ *j*. This condition also provides an output pulse pair time that is equal to two Period intervals. Thus the probability that the shortest output time interval will be produced is twice the probability that any of the longer time intervals within the range will be produced.

The voltage levels that are shown for the signals in Fig. 5.1 are mostly ECL logic. For this, the high level is −0.8 V and the low level is −1.8 V. The only exceptions are the Start and Stop Outputs, which are NIM-standard fast negative pulses that go from 0 V to −0.8 V. The external Period and Busy outputs are not shown in Fig. 5.1, and they coincide in time with the internal signals; each of these outputs is at 0 V for false and goes to −0.8 V for true.

6. MAINTENANCE

6.1. GENERAL

The following paragraphs are intended as an aid in the installation and checkout of the 462 Time Calibrator. These instructions, together with the circuit descriptions and timing information in Section 5, should provide ample information to ensure that the instrument is operating satisfactorily and to isolate any trouble that may occur.

Test Equipment The following, or equivalent, test equipment is needed. Also, refer to Fig. 5.1 and to schematics 462-0201-S1, 462-0301-S1, and 462-0401-S1 at the back of the manual.

Fast Oscilloscope, such as Tektronix 454, 581, or 585
Voltmeter
Scaler with accurate time base, such as ORTEC 715.

Preliminary Procedures Visually check the module for possible damage due to shipment or handling and then perform the following steps:

1. Connect ac power to a nuclear-standard Bin and Power Supply such as the ORTEC 401/402 Series.

2. Plug the module into the Bin and check for proper mechanical alignment.

3. Switch the ac power on and check the dc Power Supply voltages at the test points on the 401 Power Supply control panel.

Frequency and Countdown Tests The following procedure should be used for frequency and countdown tests:

1. Connect the oscilloscope to the Period output BNC on the rear panel with 50Ω cable and with a 50Ω termination at the oscilloscope.

2. Set the time base of the oscilloscope at 50 nsec/cm and the vertical deflection for 200 mV/cm. Use dc coupling.

3. Apply power to the 462 and switch it On. The front panel lamp should light to show an operational condition.

4. Set the Period switch at 0.01 (μsec) for 10-nsec pulse intervals. Observe 5 pulses/cm with an amplitude of −600 to −800 mV. This is the basic oscillator output at 100 MHz.

5. Change the Period switch setting to each of its other positions, and monitor the square wave output for each switch setting. Each setting should provide a 1-cycle output that has a period matching the switch setting, and the nominal amplitude should stay at about −800 mV.

6. If a scaler is available, monitor the frequency of the Period output to verify the output rate.

Some typical trouble symptoms, together with means of determining and correcting them, follow:

1. No output for any switch position; oscillator probably inoperative. Check for ~−1.3 V on pin 5 of IC1. Check for −5.2 V ±0.2 V on pins 2, 3, 4, 9, 11, and 12 of IC1. Change IC1 if the voltages are incorrect.

2. No output on 0.32 μsec or any succeeding larger Period setting; ECL-to-TTL translator not operating properly. Check Q2 and Q3 by observing a 0- to +5-V square wave on the collector of Q3. Check outputs that switch from about 0 to +5 V on pins 12, 9, 13, and 8 of IC4 through IC8. Check input to TTL-to-ECL translator Q4, Q5, and Q6; check at Q4B for signals at each Period switch position from 0.32 up; this should provide square waves from about

0 to +4 V. Test translator output at Q6E; this should provide square waves from about −0.8 to −1.8 V (the ECL logic levels). Test switch S1B by observing all Period selections on the wiper of S1B or at the base of Q1; ECL logic levels should be present. Measure −1.3 V ±0.2 V at the base of Q21, the Period output driver.

3. Period output present, but no Start or Stop outputs or Busy outputs; check the random noise generator. Connect the oscilloscope probe at pin 15 of IC9, set the Rate control to maximum clockwise, and check to see that the switch is On, the External Enable Input BNC is open, and the front panel light is on. Observe pulses as RP in Fig. 5.1, random and without correlation to triggers. Connect oscilloscope probe to Q18C and observe approximately 2-V peak-to-peak noise at a dc level of about +5 V. Check dc levels for Q11 and Q18. Check start-stop derandomizing coincidence; refer to Fig. 5.1, and observe each pulse at the indicated circuit point.

Dispersion Amplifier The Dispersion Amplifier is a completely separate and isolated circuit and may be checked with a pulse generator or other signal source with the toggle switch for the Start-Stop section of the instrument set at Off.

1. Connect a 0- to 10-V positive or negative signal source to the Dispersion Amplifier input and set the toggle switch at Min.

2. Observe the signal at the Dispersion Amplifier output; this should be the same signal as is furnished to the input.

3. Set the toggle switch at Max and observe the addition of noise to the signal, seen at the output.

Some typical trouble symptoms and their corrections follow:

1. No output occurs; IC2 not operating properly. Check for the correct voltages at all pins on IC2.

2. Noise is not integrated with signal; IC1 not operating properly. Check for the correct voltages at all pins on IC1.

Power Supply If the ±5-V supply fails, disconnect the +5- and −5-V wires from the 462-0200 printed circuit board to protect the integrated circuits and connect a 1-kΩ 1/2-W resistor across the output from each supply level to ground. Check for the proper voltage at each transistor pin. Check for only a slight 120-Hz ripple at the collectors of both Q1 and Q2. Restore the circuit connections after correcting any fault.

Table 6.1 is a list of typical voltage levels that should exist in an operational 462. Measurement of these voltages can often aid in the isolation and identification of any trouble that may be encountered in the circuits of the unit.

6.2. FACTORY REPAIR

The ORTEC 462 Time Calibrator may be returned to the factory for repair service at a nominal cost. Our standard procedure requires that each repaired instrument receive the same extensive quality control tests that a new instrument receives. Before returning the instrument, contact our Customer Service Department, (615) 482-4411, for information concerning shipment of the instrument.

Table 6.1. **Normal dc Voltages.**

Location	Approximate Voltage	Location	Approximate Voltage	Location	Approximate Voltage
462-0200 Printed Circuit		Q22B	−1.3	IC2-13	−13
IC1, 2,3,4,9,11,12	−5.2	Q16B	−1.3	IC2-14	0
IC1, 1,5	−1.3	**462-0300 Printed Circuit**		Q1B	+13.7
IC2, 8	−5.2	IC1-1	+9	Q1C	+23
IC3, 8	−5.2	IC1-3	0 (switch set at Min)	Q1E	+13
Q3B	−1.3	IC1-4	−11.8	Q2B	−13.7
Q3E	−2	IC1-5	+1.4	Q2C	−23
Q3C	0 to +5 (TTL)	IC1-6	0 (switch set at Min)	Q2E	−13
Q21B	−1.3	IC1-7	+11.8	**462-0400 Printed Circuit**	
Q8B	+1.3	IC1-8	+9	Q1C	+8.9
Q8C	0 to −1	IC2-1	+23	Q1B	+5.6
Q9E	−.8 to −1.8	IC2-2	0	Q1E	+4.9
Q20B	−1.3	IC2-3	−13	Q2C	−8.4
Q10B	−1.3	IC2-4	0	Q2B	−5.9
Q23E	+1.3	IC2-5	−0.7	Q2E	−5.2
Q11B	+4.1	IC2-6	−0.7	Q3C	−11.9
Q11E	+3.5	IC2-7	0	Q3B	−6.5
Q11C	+14	IC2-8	−0.8	Q3E	−5.9
Q18C	+4.5	IC2-9	−23		
Q18E	+14.5	IC2-10	Adjustable to 0		
IC9, 4,7,11	−1.3	IC2-11	+13		
Q14B	−1.3	IC2-12	0		

BIN/MODULE CONNECTOR PIN ASSIGNMENTS FOR STANDARD NUCLEAR INSTRUMENT MODULES PER DOE/ER-0457T

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	117 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	117 volts ac (Neut.)
20	Spare	*42	High Quality Ground
21	Spare	G	Ground Guide Pin
22	Reserved		

Pins marked (*) are installed and wired in EG&G ORTEC's 4001A and 4001C Modular System Bins.