

**Model 462
Time Calibrator
Operating and Service Manual**

Advanced Measurement Technology, Inc.

a/k/a/ ORTEC[®], a subsidiary of AMETEK[®], Inc.

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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, by telephone [(865) 482-4411] or by facsimile transmission [(865) 483-2133], 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 designated 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 should follow the same procedure and ORTEC will provide a quotation.

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.

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SAFETY INSTRUCTIONS AND SYMBOLS

This manual contains up to three levels of safety instructions that must be observed in order to avoid personal injury and/or damage to equipment or other property. These are:

DANGER Indicates a hazard that could result in death or serious bodily harm if the safety instruction is not observed.

WARNING Indicates a hazard that could result in bodily harm if the safety instruction is not observed.

CAUTION Indicates a hazard that could result in property damage if the safety instruction is not observed.

Please read all safety instructions carefully and make sure you understand them fully before attempting to use this product.

In addition, the following symbol may appear on the product:



ATTENTION – Refer to Manual



DANGER – High Voltage

Please read all safety instructions carefully and make sure you understand them fully before attempting to use this product.

SAFETY WARNINGS AND CLEANING INSTRUCTIONS

DANGER Opening the cover of this instrument is likely to expose dangerous voltages. Disconnect the instrument from all voltage sources while it is being opened.

WARNING Using this instrument in a manner not specified by the manufacturer may impair the protection provided by the instrument.

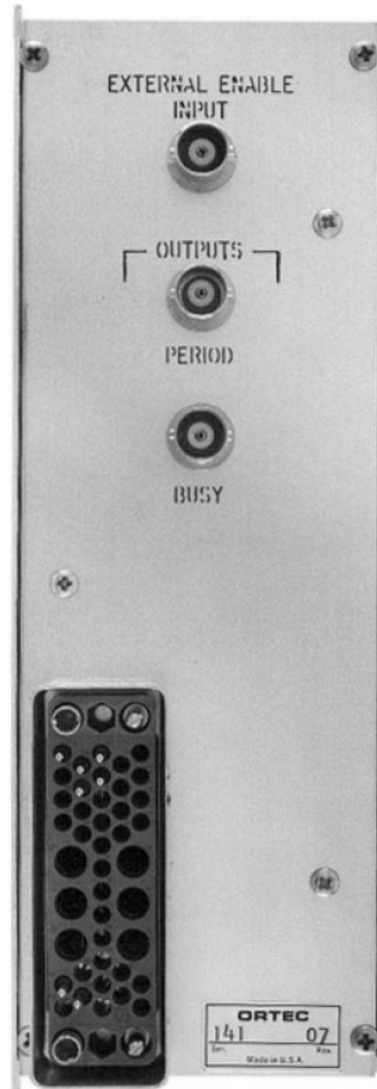
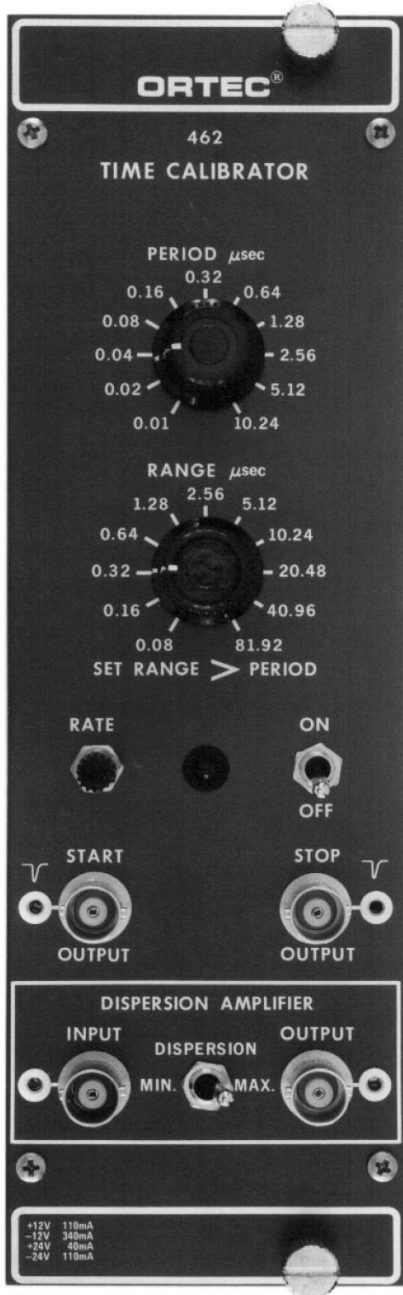
Cleaning Instructions

To clean the instrument exterior:

- Unplug the instrument from the ac power supply.
- Remove loose dust on the outside of the instrument with a lint-free cloth.
- Remove remaining dirt with a lint-free cloth dampened in a general-purpose detergent and water solution. Do not use abrasive cleaners.

CAUTION To prevent moisture inside of the instrument during external cleaning, use only enough liquid to dampen the cloth or applicator.

- Allow the instrument to dry completely before reconnecting it to the power source.



ORTEC 462 TIME CALIBRATOR

1. DESCRIPTION

1.1. PURPOSE

The ORTEC Model 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 Model 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 Model 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 ns to 10.24 μ s. For example, if the period selected is 40 ns, the intervals produced would include 80 ns, 120 ns, 160 ns, 200 ns, 240 ns, etc. 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 ns (0.08 μ s) for this spectrum. The first peak in the spectrum, for 160 ns, 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 ns. Note that each peak except the one for 800 ns has been accumulated into just one of the 256 analyzer channels that were used. The 800-ns peak has been counted into two adjacent channels.

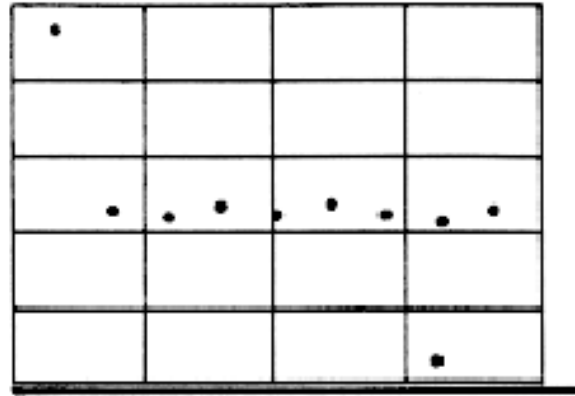


Fig. 1.1. Typical Timing Calibration Spectrum Using 256 Analyzer Channels.

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 ns, with a maximum setting of 81.92 μ s. In Fig. 1.1 the RANGE switch was set at 1.28 μ s, and time intervals were produced that were greater than the 880-ns maximum peak shown in the spectrum. However, the range of the Model 457 Time to Pulse Height Converter was set for 800 ns 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 10,000 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.

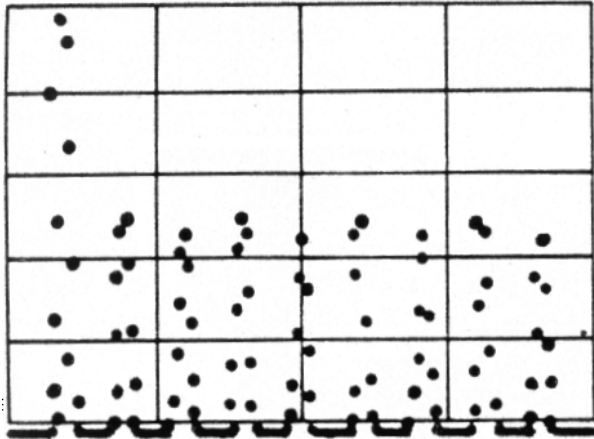


Fig. 1.2. The Spectrum of Fig. 1.1 with Dispersion.

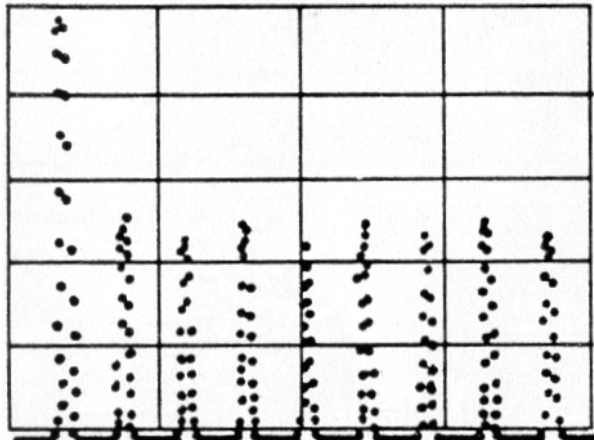


Fig. 1.3. The Spectrum of Fig. 1.1 with Dispersion Using 1024 Analyzer Channels.

1.2. PHYSICAL DESCRIPTION

The 462 Time Calibrator is a double-width module that furnishes fast negative NIM logic pulses in 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 ns through 10.24 μ s. 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 ns through 81.92 μ s. 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 (μ s) 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 ns.

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 $1\text{-k}\Omega$ 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 in 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 ps for 10-ns period and $\pm 0.005\%$ of total period for all other selections; factory-calibrated against National Bureau of Standards WWV.

Calibration Period Stability Within <10 ppm/ $^{\circ}\text{C}$ of selected period; 100 ppm/year.

2.2. CONTROLS

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

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

RATE Single-turn front panel trim potentiometer adjusts the random start-stop rate from about 100 to 10,000 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 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 BNC connector accepts $\pm 10\text{-V}$ linear signals, typically from a time-to-pulse-height converter; $Z_{in} \sim 2\text{ k}\Omega$.

2.4. OUTPUTS

Start Output Front-panel 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_o 1 k Ω .

Stop Output Front panel 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_o 1 k Ω .

Busy Output Rear-panel 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; $Z_0\ 1\text{ k}\Omega$.

Period Output Rear-panel BNC connector furnishes a NIM-standard fast negative pulse at a fixed rate of $1/\text{period}$; can be used to check calibration or as a stable external time base; $Z_0\ 1\text{ k}\Omega$.

Dispersion Amplifier Output Front-panel BNC connector provides $\pm 10\text{-V}$ linear output, same polarity as the DISPERSION AMPLIFIER INPUT, DISPERSION switch selects whether signal is an exact reproduction of the input or has $\sim 100\text{-mV}$ FWHM random noise mixed with it; $Z_0 < 1\Omega$.

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) 2.9 kg (6.5 lb).

Weight (Net) 1.6 kg (3.5 lb).

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

3. INSTALLATION

3.1. GENERAL

The ORTEC 4001/4002 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 a ORTEC 4001/4002 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.

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

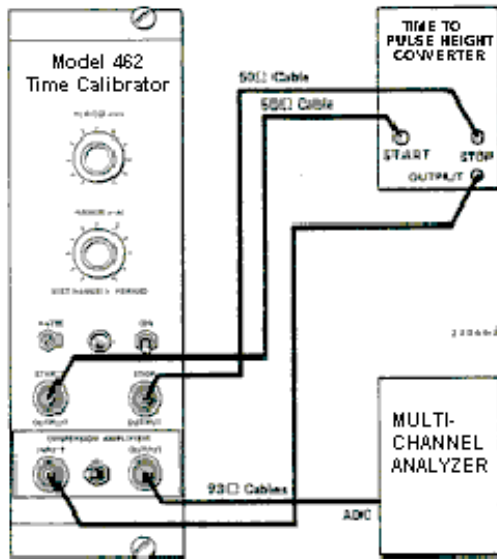


Fig. 3.1. Typical System Interconnections.

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 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 calibrations peaks.

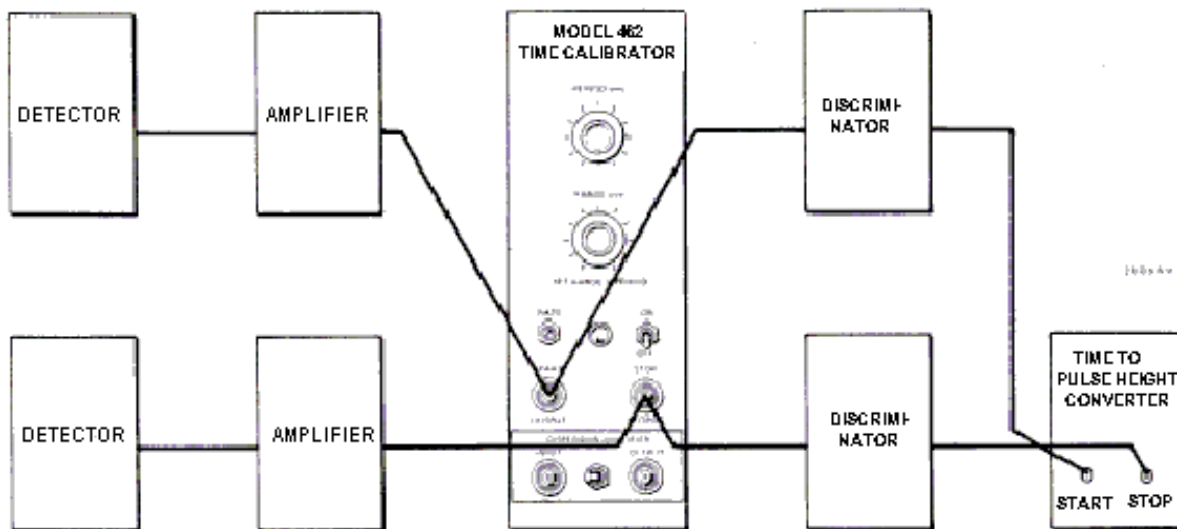


Fig. 3.2. Typical System Interconnections for On-Line Operation.

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 ns through 10.24 μ s. 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 μ s; if the 462 Period were then set at 5.12 μ s, there would be about 7

time markers available within the 457 range. If the 462 PERIOD switch were set at $1.28 \mu\text{s}$, 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 $40 \mu\text{s}$, the 462 RANGE switch must be set at either 40.96 or $81.92 \mu\text{s}$ 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 10,000 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 connect 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 analysis 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-ns period setting on the 462 and a 50-ns range on the ORTEC 457 Biased Time to Pulse Height Converter. The 462 range was set at 80 ns. The conversion gain of analyzer was set for 1024 channels = 50 ns 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 ns and 40 ns 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 ns and at channel 215.44 for 40 ns, and the calibrated distribution for this spectrum was $182.89 \text{ channels} = 10 \text{ ns}$, or about $54.7 \text{ ps} = 1 \text{ channel}$.

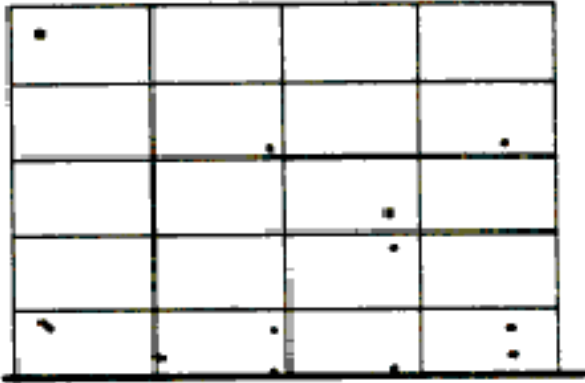


Fig. 4.1. Typical Biased Timing Spectrum with Time Markers Spaced for 10 ns.

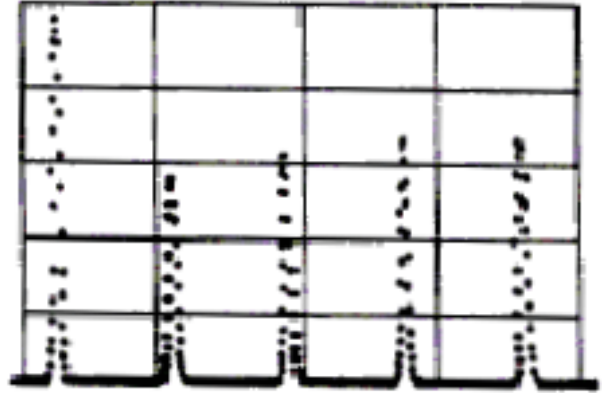


Fig. 4.2. The Spectrum of Fig. 4.1 with Dispersion.

5. MAINTENANCE

5.1. GENERAL

The following paragraphs are intended as an aid in the installation and checkout of the 462 Time Calibrator. These instructions 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.

- 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 4001/4002 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 4001 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 50 Ω cable and with a 50 Ω termination at the oscilloscope.

2. Set the time base of the oscilloscope at 50 ns/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 (μ s) for 10-ns 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 \sim -1.3 V on pin 5 of IC1. Check for -5.2 V \pm 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 μ s 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 $-1.3\text{ V} \pm 0.2\text{ V}$ 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 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, 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 $\pm 5\text{-V}$ supply fails, disconnect the +5 and -5-V wires from the 462-0200 printed circuit board to protect the integrated circuits and connect a $1\text{-k}\Omega$ 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 5.1 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.

5.2. FACTORY REPAIR

See the Warranty statement on page ii of this manual.

Table 5.1. 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 V	23	Reserved
2	-3 V	24	Reserved
3	Spare bus	25	Reserved
4	Reserved bus	26	Spare
5	Coaxial	27	Spare
6	Coaxial	*28	+24 V
7	Coaxial	*29	-24 V
8	200 V dc	30	Spare bus
9	Spare	31	Spare
*10	+6 V	32	Spare
*11	-6 V	*33	117 V 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 V	38	Coaxial
*17	-12 V	39	Coaxial
18	Spare bus	40	Coaxial
19	Reserved bus	*41	117 V ac (neutral)
20	Spare	*42	High-quality ground
21	Spare	G	Ground guide pin
22	Reserved		

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