Model 533
Dual Sum and Invert Amplifier
Operating and Service Manual

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ORTEC® Part No. 733410
Manual Revision B

1202

Advanced Measurement Technology, Inc.

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

WARRANTY

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

ORTEC's exclusive liability is limited to repairing or replacing at ORTEC's option, items found by ORTEC to be defective in workmanship or materials within one year from the date of delivery. 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 ORTEC fails to manufacture or deliver items called for in this agreement or purchase order, 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 ORTEC be liable for special or consequential damages.

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, 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.

CONTENTS

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.

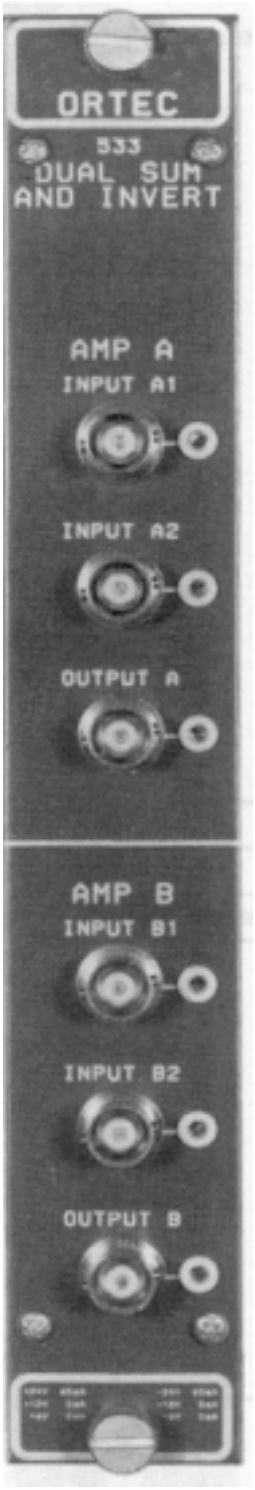
Cleaning Instructions

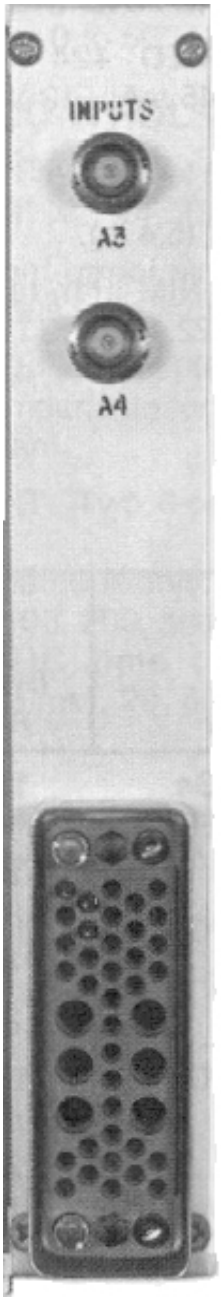
To clean the instrument exterior:

- 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
533
DUAL SUM
AND INVERT
AMP A
INPUT A1
INPUT A2
OUTPUT A
AMP B
INPUT B1
INPUT B2
OUTPUT B


INPUTS
A3
A4

ORTEC MODEL 533
DUAL SUM AND INVERT AMPLIFIER

1. DESCRIPTION

The ORTEC Model 533 Dual Sum and Invert Amplifier is a versatile instrument for general purpose use. It has two inverting operational amplifiers, each of which has multiple inputs to permit summation of signals form separate circuits. By cascading the two amplifier sections, its function becomes a noninverted summation of up to four inputs. Alternatively, each amplifier section may be used to invert its inputs with no crosstalk between the two sections.

Amplifier A has four inputs through BNC connectors, two of which are on the front panel and two on the rear panel. Any one input, any combination of inputs, or all four inputs may be used, and the summed and inverted signal is furnished through Output A on the front panel. The gain from each input to the output is unity. The amplifier has a rise of <50 ns, a bandwidth from dc to 7.0 MHZ, and does not include any shaping. The output impedance is <0.1Ω for line drive and fan-out capability.

Amplifier B has two inputs, both located on the front panel. Otherwise, the characteristics for this section are identical to those for the Amplifier A section.

2. SPECIFICATIONS

2.1. PERFORMANCE

VOLTAGE GAIN Unity for each input; tolerances ≤±2%.
BANDWIDTH dc to 7.0 MHZ (T_r ≤50 ns).
INTEGRAL NONLINEARITY <0.05%
TEMPERATURE INSTABILITY
Gain ≤±0.005%/°C**.**
Output DC Level <±50 µV/°C.

2.2. INPUTS

Four identical inputs for Amplifier A and two for Amplifier B; each accepts 0 to 10 V rated span, 12 V mas, positive or negative, unipolar or bipolar; Z_{in}~ 666 Ω, dc-coupled. Inputs A1, A2, B1, and B2 on front panel; Inputs A3 and A4 on rear panel, all BNC connectors.

2.3. OUTPUTS

One output on front panel for each Amplifier, A and B, completely independent form each other; range 0 to ± 10 V linear; Z_{in} < 0.1 Ω; BNC connectors

2.4. ELECTRICAL AND MECHANICAL

POWER REQUIREMENTS +12 V, 0 mA; -12 V, 0 mA; +24 V, 65 mA; -24 V, 65 mA.

WEIGHT
Shipping 2.2 kg (5 lb).
Net 0.9 kg (2 lb).

DIMENSIONS Standard single-width NIM (1.35 by 8.714 in.) per TID-20893 (Rev).

3. INSTALLATION

3.1. GENERAL

The 533, used in conjunction with an ORTEC 4001C/4002A Series Bin and Power Supply, is intended for rack mounting. It is necessary to ensure that the 533 has sufficient cooling air circulating to prevent any localized heating of the all-transistor circuitry used throughout the module. The temperature of equipment mounted in racks can easily exceed the recommended maximum unless precautions are taken. The 533 should not be subjected to temperatures in excess of 120°F (50°C).

3.2. CONNECTION TO POWER

The 533 contains no internal power supply and must therefore obtain power from a Nuclear Standard bin and power supply such as the ORTEC 4001C/4002A. The bin power supply should be turned off when modules are inserted or removed. The ORTEC 4001C/4002A Series is designed so that it is not possible to overload the bin power supply with a full complement of modules in the bin; since, however, this may not be true when the bin contains modules other than those of ORTEC design, the power supply voltage should be checked after the modules are inserted. The ORTEC 4001 C/4002A has test points on the power supply control panel to monitor the dc voltages. When using the 522 outside the 4001C/4002A bin and power supply, be sure that the jumper cable used properly accounts for the power supply grounding circuits set forth in the recommended AEC standards of TID-20893 (Rev). Both high-quality and power return ground connections are provided to ensure proper reference feedback into the power supply, and these must be preserved in remote cable installations. Be careful to avoid ground loops when the module is operated outside the bin.

3.3. SIGNAL CONNECTIONS TO THE 533 INPUTS

The 533 inputs are compatible with all output signals of the modular electronic instruments. The signal range of the input is from 0 to 10 V. The input range is from dc to pulses as narrow as 100 ns. The 533 characteristics of low noise, dc-coupling, and wide bandwidth make it ideal for following preamplifiers or summing shaping amplifier outputs.

The input connector should be determined int eh characteristic impedance of the connecting coaxial cable when cable lengths exceed approximately 5 ft. The input impedance of each input is approximately 1000 Ω.

It is recommended that RG-62/U or RG-63/U coaxial cable be used due to their relatively higher impedances (93 Ω and 125 Ω, respectively). If 50 Ω coaxial cable must be used, be sure that the driving source can drive terminated 50 Ω cable. Normally, nonlinearity of a system will vary directly with the amount of power being driven; therefore quite often the best method of linearly driving 50 Ω coaxial cable which needs to be terminated is that of series drive. For example, a series resistance of 50 Ω is placed between the driving source and the coaxial line for sources whose driving impedance is <2 Ω. When the line is terminated at the receiving end, the output signal will be divided and only half of it will appear at the receiving end; however, the receiving end may be left open-circuited, and the cable is terminated back at the driving impedance end. In this case, the driven power is very low and the signal is not attenuated.

3.4. LINEAR OUTPUT SIGNAL CONNECTIONS AND TERMINATING IMPEDANCE

There are three general methods of termination used. The simplest of these is shunt termination at the receiving end of the cable. A second method is series termination at the sending end. The third is a combination of series and shunt termination, where the cable impedance is matched both in series at the sending end and in shunt at the receiving end. The most effective method is the combination, but terminating by this method reduces the amount of signal strength at the receiving end to 50% of that which is available in the sending instrument.

To use shunt termination at the receiving end of the cable, connect the low impedance of the sending device through 93 Ω cable to the input of the receiving instrument. Then use a BNC tee connector to accept both the interconnecting cable and a 100 Ω resistive terminator at the input connector of the receiving instrument. Since the input impedance of the receiving instrument is normally 1000 Ω or more, the effective instrument input impedance with the 100 Ω terminator will be of the order of 93 Ω, and this correctly matches the cable.

For series termination, use the 93 Ω output of the sending instrument for the cable connection. Use 93 Ω cable to interconnect this into the input of the receiving instrument. The 1000 Ω (or more) normal input impedance at the input connector represents an essentially open circuit, and the series impedance in the sending instrument now provides the proper termination for the cable.

For the combination of series and shunt termination, use the 93 Ω output in the sending instrument for the cable connection and use 93 Ω cable. At the input for the receiving instrument, use a BNC tee to accept both the interconnecting cable and a 100 Ω

resistive terminator. Note that the signal span at the receiving end of this type of receiving circuit will always be reduced to 50% of the signal span furnished by the sending instrument.

For your convenience, ORTEC stokes the proper terminators and BNC tees, or you can obtain them from a variety of commercial sources.

4. OPERATING INSTRUCTIONS

The 533 is typically used in a linear system following the main pulse shaping amplifier(s). However, it may be used as a summing amplifier prior to pulse shaping in the main amplifier or as a fan-in for logic signals. It has no controls and will simply provide in each output the inverted sum of the related inputs whenever these occur.

The connotation of Summing Amplifier is true only when there is a time coincidence of arrival of the input pulses. If the input signals do not arrive in time coincidence, the inputs may be considered a linear fan-in unit. The 533 is directly compatible with and can be driven from any linear or logic signal or it can be used to sum the outputs from preamplifiers, either shaping or nonshaping. Unless the charge conversion gain of each preamplifier is quite high, some degradation in the signal-to-noise ratio may be expected in high resolution systems when summing the preamplifier outputs, since the noise from each unit must be summed in quadrature.

5. MAINTENANCE

5.1. TESTING PERFORMANCE OF THE DUAL SUM AND INVERT AMPLIFIER

The following information is intended as an aid in the installation and checkout of the 533. These instructions give information on waveforms at test points and output connectors.

TEST EQUIPMENT The following, or equivalent, test equipment is needed:

1. ORTEC 419 or 448 Pulse Generator
2. Tektronix Model 580 Series Oscilloscope
3. 100 Ω BNC terminators
4. High-impedance dc voltmeter
5. ORTEC 572 Amplifier or equivalent

PRELIMINARY PROCEDURES The module should first be checked for possible damage due to shipment. The other preliminary procedures are as follows:

1. Connect ac power to the ORTEC 4001C/4002A Bin and Power Supply. Turn off power.
2. Plug the module into the bin and check for proper mechanical alignment.
3. Switch on the ac power and check the dc-power supply voltages at the test points on the 4002 power supply control panel.

AMPLIFIER A AND B There are no internal adjustment to be made to the 533; therefore testing is simply a matter of observation of input and output waveforms as follows:

1. Feed the output of the pulse generator into the input of the 572 Amplifier.
2. Set the amplifier controls as follows:
   Gain ~5
   Time Constants 0.5 or 1 µs
3. Feed the Bipolar Output of the amplifier to the A1 input of the 533 through RG-62/U cable, and terminate the cable at the input of the 533 with a 100 Ω terminator.
4. Adjust the pulse generator for an output of 500 mV from the 533.
5. The output at Output A of the 533 should be 500 mV and prompt with respect to the input signal.
6. Move the input signal and terminator from the A1 Input, and connect it to the A2 Input.
7. Again, the output should be 500 mV and prompt with respect to the input. Repeat steps 5 and 6 for Inputs A3 and A4. Raise the amplitude of the signal from the amplifier to check the output under high signal conditions. The amplifier should saturate at approximately 11 V.
8. Repeat steps 3 through 7 for Inputs B1 and B2, testing the results at Output B.

5.2. SUGGESTIONS FOR TROUBLESHOOTING

In situations where the 533 is suspected of malfunction, it is essential to verify such malfunction is terms of simple pulse generator pulses at the input and output. The 533 must be disconnected from its position in any system, and routine diagnostic analysis performed with a test pulse generator and an oscilloscope. Testing should not be performed with a source and detector until the Dual Sum and Invert Amplifier performs satisfactorily with the test pulse generator. The testing instruction given in Section 5 should provide assistance in locating and repairing the malfunction. The side plates can be removed completely from the module to permit oscilloscope and voltmeter observation with a minimal chance of accidentally short-circuiting portions of the etched board. Table 5.1 is also presented here as a typical set of dc-voltage measurements against which any unit can be tested.

5.3. FACTORY SERVICE

This instrument can be returned to the ORTEC factory for service and repair at a nominal cost. Our standard procedure for repair ensures the same quality control and checkout that are used for a new instrument. Always contact ORTEC Customers Services (865) 482-4411 before sending an instrument for repair to obtain shipping instructions and so that the required Return Authorization Number can be assigned to the unit. Write this number of the address label and on the package to ensure prompt attention when it reaches the ORTEC factory.

5.4. TABULATED TEST POINT VOLTAGES ON ETCHED BOARD

Table 5.1 indicates the dc voltages measured on the etched circuit board. In some instances the circuit will perform satisfactorily even though, due to component variations, there may be some voltages that measure outside the given limits; therefore the voltages given here should not be taken as absolute values, but rather are intended to serve as an aid in troubleshooting.

Table 5.1

Location	Voltage
A1 pin 2	+23.5
4	+21.7
5	±0.030
12	0
13	+23.7
20	-23.5
U1 pin 2	0
3	0
4	-15.0
6	±0.030
7	+15.0
A2 pin 2	+23.5
4	+21.7
5	±0.030
12	0
13	+23.7
20	-23.5
U2 pin 2	0
3	0
4	-15.0
6	±0.030
7	+15.0

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.