



ELECTRONICA  
SERVICE  
AN302/NL  
Quad DC Amplifier  
Operating and Service Manual

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Fabr. Tektronix

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an reparatie / revisie

Z.O.Z.

PLUG IN

AN302/NL  
Quad DC Amplifier  
Operating and Service Manual

This manual applies to instruments  
"Rev 04" on rear panel

## STANDARD WARRANTY FOR EG&G ORTEC INSTRUMENTS

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### QUALITY CONTROL

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

### REPAIR SERVICE

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

### DAMAGE IN TRANSIT

Shipments should be examined immediately upon receipt for evidence of external or concealed damage. The carrier making delivery should be notified immediately of any such damage, since the carrier is normally liable for damage in shipment. Packing materials, waybills, and other such documentation should be preserved in order to establish claims. After such notification to the carrier, please notify EG&G ORTEC of the circumstances so that assistance can be provided in making damage claims and in providing replacement equipment if necessary.

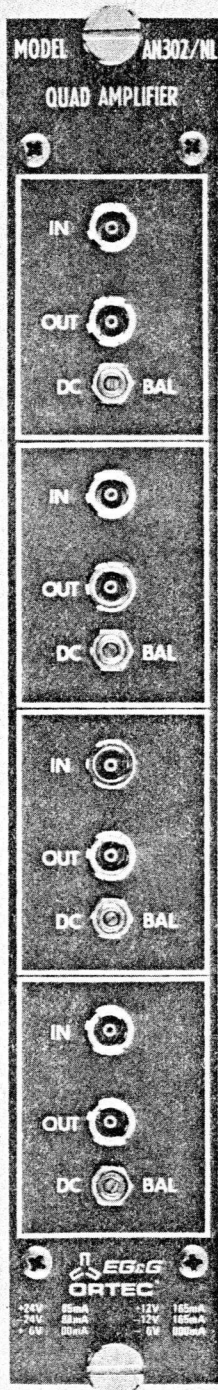
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Schematic AN302/NL-0101-S1

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## EG&G/ORTEC AN302/NL QUAD DC AMPLIFIER MANUAL

### 1. CHARACTERISTICS

Each of the four independent sections of the AN302/NL DC Amplifier provides a noninverted signal that is equal to the input signal amplified by a factor of about 4.5. Either unipolar or bipolar signals can be accommodated and are linear within the output range of +1 V to -1 V. The unit is packaged as a single-width NIM module (per TID-20893) for installation in a NIM-standard Bin and Power Supply.

Each of the four sections has a nominal gain of 4.5 in a  $50\Omega$  system. The sections can be connected in cascade to provide a total gain of about 20, 90, or 400 within the linear output range. Excellent output stability and very low noise permit cascading two, three, or all four sections as required for each specific application.

The AN302/NL features high bandwidth with 1.2 ns risetime and falltime. It is designed to amplify high speed signals such as the output of fast photomultiplier tubes. Its dc coupling and rapid recovery from overload makes it especially suited for processing long pulses, amplifying them faithfully without significant overshoot, baseline shift, or droop.

The amplifier may be used to precede discriminators, linear gates, or fast current integrators. Its low noise makes it particularly suited to single photon counting applications.

### 2. SPECIFICATIONS

#### 2.1. INPUTS

**IN** Single LEMO connector per section, dc-coupled, bipolar.

**Impedance**  $50\Omega$ .

**Linear Range**  $\pm 220$  mV.

**Reflection**  $<5\%$  from  $\pm 10$ -V transient with 1-ns risetime.

**Protection**  $\pm 10$  V dc;  $\pm 50$  V transient.

**Offset**  $<\pm 50$   $\mu$ V.

#### 2.2. OUTPUTS

**OUT** Single LEMO connector per section, dc-coupled; bipolar.

**Linear Range**  $\pm 1$  V on  $50\Omega$ .

**Rise and Fall Times** Typically 1.2 ns.

**Overshoot**  $<3\%$  for 1-ns risetime input signal.

**Offset** Adjustable to  $\pm 100$   $\mu$ V on  $50\Omega$ .

#### 2.3. CONTROLS

**DC BAL** One 22-turn front panel potentiometer per section; adjusts the output offset within the range of  $\pm 100$   $\mu$ V on  $50\Omega$ .

#### 2.4. PERFORMANCE

**BANDWIDTH** dc to 300 MHz; noninverting.

**NOMINAL GAIN** 4.5 per section.

**NOISE**  $<50$   $\mu$ V rms referred to the input.

**NONLINEARITY**  $<\pm 2\%$  for output to  $\pm 1$  V.

**INSTABILITY**  $<\pm 100$   $\mu$ V/ $^{\circ}$ C referred to the output.

**OVERLOAD RECOVERY**  $<4$  ns for a X20 overload.

**PROPAGATION DELAY** 2 ns per section typical.

**OPERATING TEMPERATURE RANGE** 0 to  $50^{\circ}$ C.

**CROSSTALK**  $<1\%$  between adjacent channels.

#### 2.5. ELECTRICAL AND MECHANICAL

**DIMENSIONS** Single-width module per TID-20893.

**CONNECTORS** LEMO 00C50.

**COLOR** Red.

**POWER REQUIRED** +12 V, 165 mA; -12 V, 165 mA; +24 V, 85 mA; -24 V, 88 mA.



### 3. APPLICATIONS

#### 3.1. GENERAL

Any section of the AN302/NL can be used to increase the amplitude and retain the polarity of an input signal by a factor of about 4.5. It accepts and processes either unipolar or bipolar input signals.

A typical application is for the very small amplitude signal that is available from the output of a photomultiplier tube in a single photon detecting system. When it is amplified without distortion, the signal is compatible with the input range of many more processing instruments than would otherwise be possible.

The high bandwidth and low noise operation of the AN302/NL permit it to be used for this general function

without introducing any significant distortion due to noise, response time, or other interferences.

#### 3.2. CASCADING

When an amplification greater than the factor provided by a single section is desired, the input signal can be cascaded through additional sections of the AN302/NL. Each section provides the nominal gain of 4.5 so, for example, cascading the signal through three sections will provide an amplification factor of about 90.

When all four sections of the AN302/NL are connected in cascade, the total amplification factor is about 400. The only restriction is that the limits for linearity at the output are +1 V and -1 V.

### 4. CIRCUIT DESCRIPTION

Component designations in this circuit description refer to schematic diagram AN302/NL-0101-S1, which is in the back of the manual. Since the four sections of the instrument are identical, only one will be discussed. All components in the circuit for the section that is located at the top of the printed circuit use 100-series reference designations, and the duplicate components in the other sections use equivalent designations in the 200-, 300-, and 400-series.

Figure 4.1 is a simplified block diagram of one section in the AN302/NL. It operates as a split-phase operational amplifier in which the lower frequency components of the input signal are amplified through dc-coupled IC101 and the higher frequency components are amplified through ac-coupled Q101. The amplified low- and high-frequency components are summed and furnished through Q102 and Q103 to the output.

The function of R105 is to adjust the input dc level to zero. This component is located on the printed circuit near the rear of the circuit for the related section of the instrument. R102 provides the 50 $\Omega$  termination that is required for the

input signal. Diodes D101, 102, and 103 provide overload protection for the input.

The low-frequency gain is fixed by feedback resistor R115 and input resistor R113. The high-frequency gain is fixed by resistors R120 and R109. The function of C106 is to adjust the high-frequency response characteristics.

Transistors Q102 and Q103 operate in parallel to reinvert the signal that is summed from Q101 and IC101. This provides an output polarity that is the same as either input polarity at any time.

Inductors L103, 104, and 105 aid in maintaining the high-frequency shaping of the fast signals that are processed in the amplifier. Inductors L101, 102, 106, and 107 isolate the active circuits from the power supply dc levels to prevent feedback through the power supply.

IC1 accepts control from all four dc input power levels and generates +20 V and -20 V for distribution to the amplifier circuits. The +12 V and -12 V dc input power levels from the bin and power supply are carefully filtered and are also distributed to the amplifier circuits.

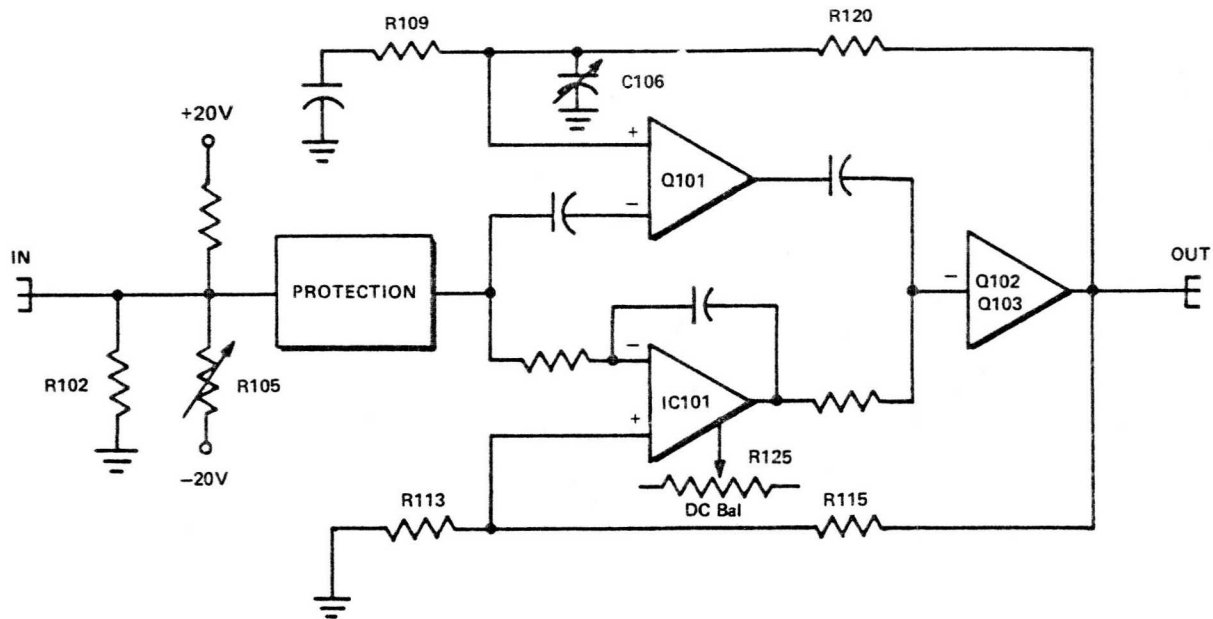


Fig. 4.1. Simplified Block Diagram of One Section of the AN302/NL.

## 5. MAINTENANCE AND CALIBRATION

### 5.1. PREVENTIVE MAINTENANCE

Give reasonable attention to mechanical details. Keep the signal connectors clean at all times. Periodically remove the two cover plates and inspect the interior of the module for dust accumulation or other undesirable conditions. Clean as often as necessary according to local conditions (normally about once every 12 months should be adequate).

### 5.2. CORRECTIVE MAINTENANCE

Corrective maintenance generally consists of replacing defective components such as resistors, capacitors, diodes, transistors, and integrated circuits, or replacing missing hardware, and of tightening loose hardware. Do not use excessive force when tightening screws or nuts.

When replacing components on a printed circuit board, be sure that the board is not damaged by excessive heating. When unsoldering leads, grip the lead that is to be removed with pliers or some similar tool that acts as a heat sink. Heat the solder joint as little as possible while maintaining a steady pull on the lead to assure its prompt removal. Remove excess solder from the board with a solder-puller. Do not redrill holes in the printed circuit board since many are plated through the board. When the integrity of a plated-through hole is in doubt, solder the component lead on both sides of the board.

When a defective component is to be removed from a printed circuit board, the preferred method is to cut both or all leads to the component and to then remove each of the leads from the board.

### 5.3. CALIBRATION

So that the input can respond to signal variations of either polarity, it is balanced at zero volts in a bleeder network, connected from +20 V to -20 V as shown in schematic AN302/NL-0101-S1. Use the following procedure to calibrate each of the four inputs independently:

1. Furnish power to the module for at least five minutes.
2. Use 50 $\Omega$  cable to connect the In connector of section 1 to a digital voltmeter.
3. Adjust R105 as necessary to set the input dc level at 0 V  $\pm$  1 mV. R105 is the single-turn 500 $\Omega$  potentiometer that is mounted on the printed circuit near the rear of the circuit for section 1; the reference designation is etched on the back side of the board.
4. Repeat the measurement and adjustment for the input circuit in each of the other three sections of the module.

When no signal is furnished to the In connector, the dc level for its corresponding Out connector should also be at 0 V.

Use the following procedure to calibrate each of the four outputs after the inputs have been calibrated to 0 V:

1. Use  $50\Omega$  cable to connect the Out connector of section 1 to a digital voltmeter.
2. Adjust the front panel DC Bal control, R125, to set the dc level at  $0\text{ V} \pm 1\text{ mV}$ . R125 is a 10K 22-turn screwdriver potentiometer.
3. Repeat the measurement and adjustment for the output circuit in each of the other three sections of the module.

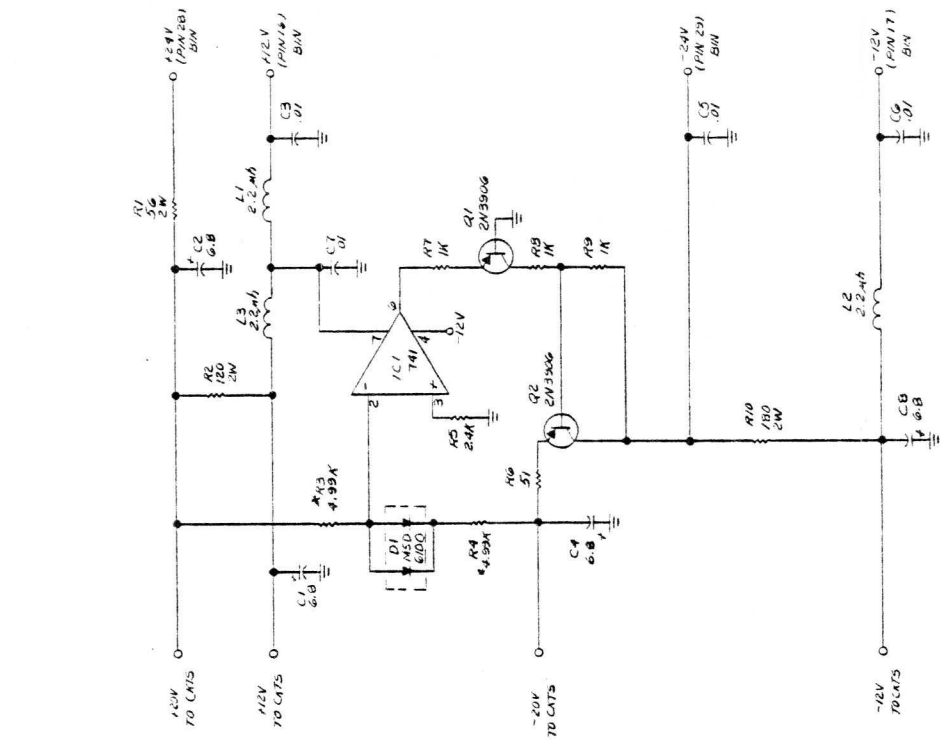
Connect an HP215A Pulser or equivalent to the In connector of section 1 on the AN302/NL, and use  $50\Omega$  cable to furnish the Out signal from section 1 into a Tektronix 7904 oscilloscope, or equal. Adjust the HP215A to provide a  $-22\text{ mV}$  signal with a width of 20 ns into the amplifier. The output amplitude should be about 100 mV. Adjust C106 on the printed circuit board until both the positive and negative overshoot on the leading and trailing edges of the output signal is less than 3%. The risetime and

falltime of the output pulse includes the risetimes of the pulse generator and oscilloscope together with the response characteristic of the AN302/NL, and the total should be no more than 1.7 ns measured between the 10% and 90% amplitude levels on the output signal. Repeat this calibration of the trimmer capacitor for each of the other three sections in the AN302/NL.

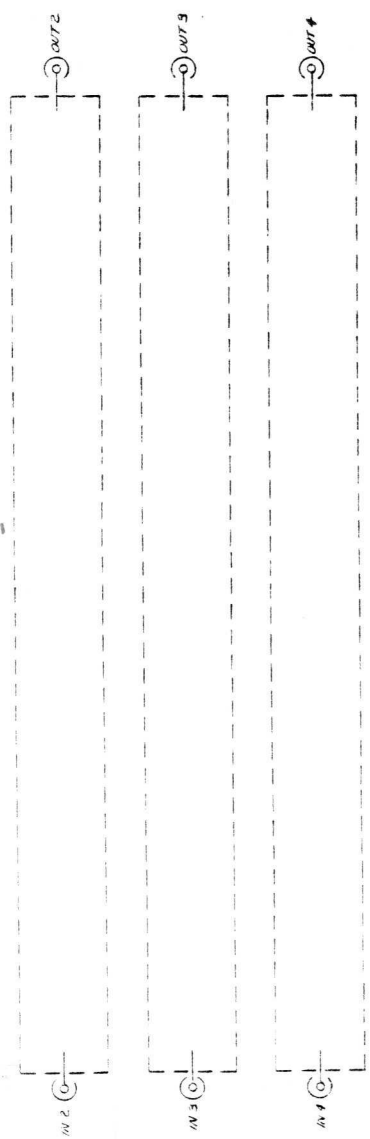
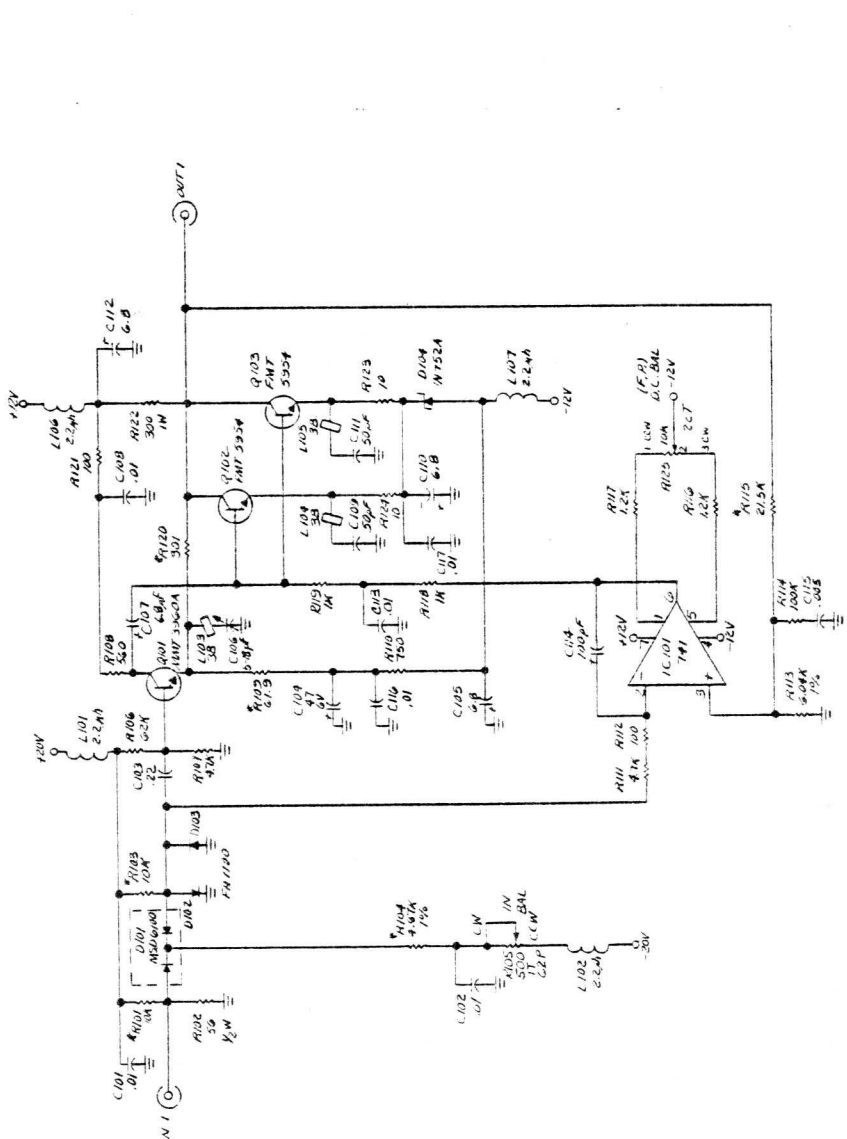
#### 5.4. FACTORY REPAIR

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

NOTES: UNLESS OTHERWISE SPECIFIED  
 1. RESISTORS ARE 1/4W 5% CARBON  
 RESISTANCE IN OHMS  
 2. RESISTORS MARKED \* ARE 1/8W, 1%  
 METAL FILM  
 3. CAPACITANCE IS IN MICRO FARADS



COMMON CMT



**ORTEC**  
 MODEL AM 302 / NL  
 RATIO AMPLIFIER

100 MIDLAND ROAD, DAK RIDGE, TENNESSEE 37028

DATE: 1-75  
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 DRAWN: J. J. PAULUS  
 CHECKED: J. J. PAULUS  
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