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ORIEL

Ratio/Log Unit
Model 76002

OPERATING INSTRUCTIONS

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INSTRUCTION MANUAL

ORIEL RATIO/LOG UNIT

MODEL 76002

Please read these instructions completely before operating this equipment.

If there are any questions or problems regarding the use of this equipment, please contact:

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Stratford. CT 06497-0872
(203) 377-8282

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- or -

The Representative from whom this equipment was purchased.

885:lc

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SECTION I - INTRODUCTION

The Model 76002 Ratio/Log Unit is a microprocessor-based instrument operating on two signals. It provides linear or logarithmic functions of each signal independently and/or the ratio of the two signals.

Each input signal goes through analog offset and gain controls and then through a low-pass filter before being converted to a digital number in an analog to digital converter. The microprocessor then operates on the digital signal according to the function selected on the function switch. Since signal processing is digital, the accuracy of ratio and logarithmic operations is well defined. These processing circuits are not subject to analog drift.

Two function switches are provided, one for each output signal. Any of the 10 functions may be selected for either output signal. Thus great versatility of data taking and recording is achieved. For example, input signal A may be used as output 1 and log A/B as output 2. The analog signals are suitable for recorder or oscilloscope presentation. A digital panel meter monitors each output channel separately. The digital information is also available in multiplexed BCD format for computer interfacing.

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DIGITAL SIGNAL PROCESSING

The following will provide a background review (and some examples) of the use of digital processing techniques in handling analog signals. For example, the output of a spectrometer may be contaminated with noise which makes it difficult to distinguish some of its spectral features. Passing the output through a low pass analog filter can reduce the noise with respect to th signal and improve its readability. This approach is widely used and provides acceptable results. Component values may change causing drift in the signal level, and thus making it difficult to implement the long time constants needed with very slow signals. Also, some complex functions such as a sliding average filter are not realized with analog components.

By contrast, digital signal processing systems such as ORIEL's 76002 Ratio/Log unit use microprocessor based digital systems to treat analog signals. A major limitation of uP-based systems had been their frequency range, but presently available uP's can now process signals with frequencies in excess of 100 Hz. This is adequate for many optical applications. Their ability to implement a wide variety of complex functions, and their stability over very long periods are advantageous in optical signal analysis.

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SAMPLED DATA SYSTEMS

Since a digital signal processor is a type of sampled data system, we will briefly explain the theory of such systems. The elements of a system are shown in the block diagram of Fig. 1, which illustrates both analog and digital sampled data systems. In both cases the incoming analog signal is sampled by the sampling switch which closes for a brief period at regular intervals. The result is a series of narrow pulses which follow the envelope of the analog signal and we intuitively see that if samples are taken more frequently they provide a better representation of the original signal. In practice the sampling rate is often several times the bandwidth of the input signal.

Any given input signal can be shown as a function of its frequency components as in Fig. 2.

When this signal is sampled at a frequency f_s which is greater than twice its maximum frequency f_m, the modulated signal's spectrum is as shown in Fig. 2B. Here we see that modulated components appear centered around f_s, $2f_s$, etc., but that the spectral ranges do not overlap. Suppose, however, that we reduce the sampling frequency, as in Fig. 2C. Now the modulated ranges do overlap, and result in aliasing noise when the signals are demodulated after processing. To avoid this we may filter the analog signal with a low pass filter, termed an antialising

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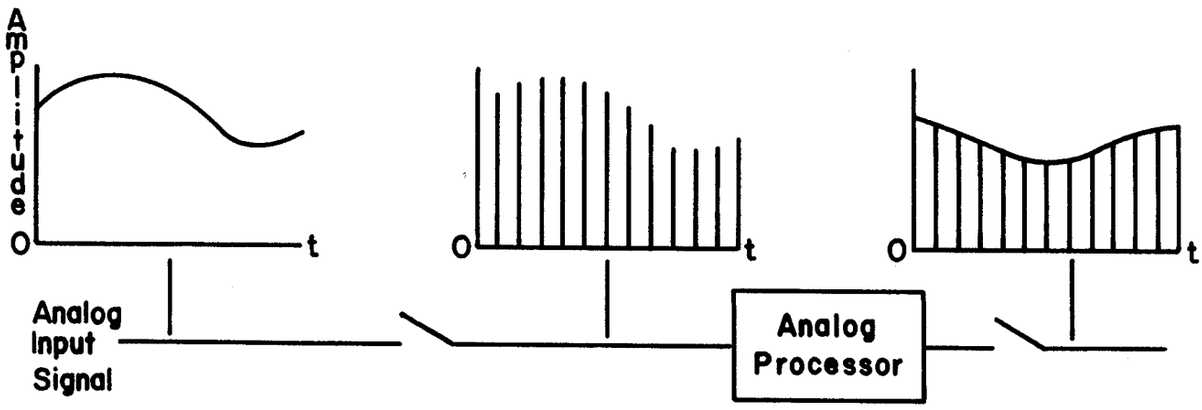


Fig.1A Analog Sampled Data System

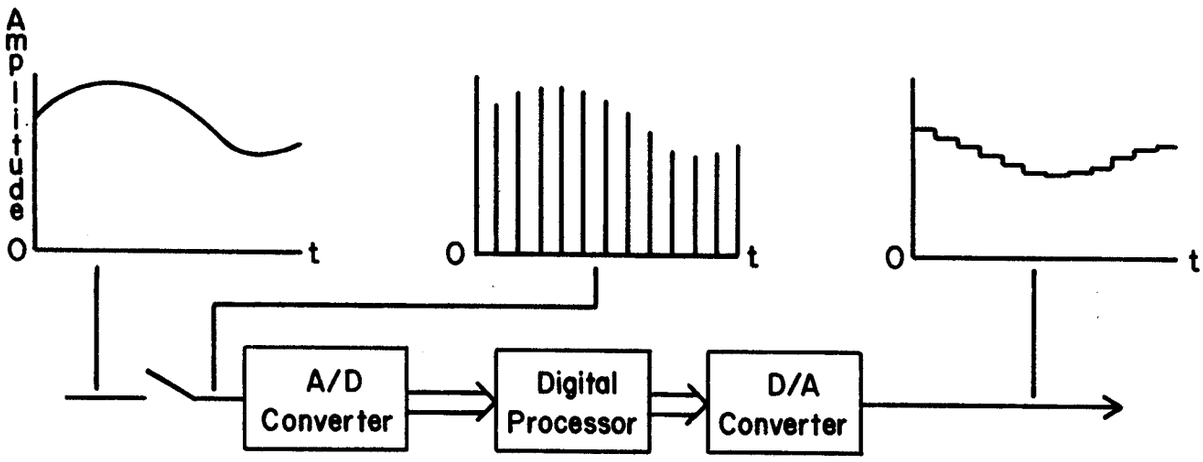
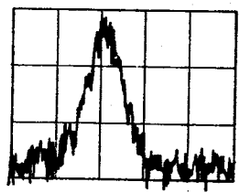


Fig.1B Digital Sampled Data System

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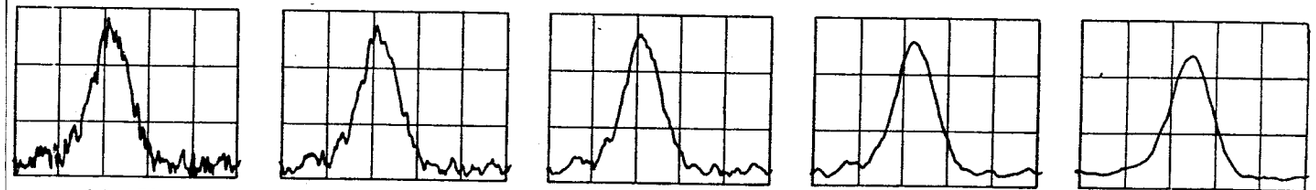
USE OF LOW-PASS FILTER TO SMOOTH NOISY PEAK SIGNAL

INPUT



UNFILTERED

OUTPUT



0.5 SEC. 1.0 SEC. 2.0 SEC. 4.0 SEC. 8.0 SEC.

LOW-PASS FILTER RESPONSE TIME

FIGURE 2

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filter, before it reaches the sampler. This is accepteble if the higher frequency components are not needed or desired. Then we see that the filtered signal and its harmonics, shown as dashed lines in Fig. 2C, no longer overlap and the aliasing noise has been eliminated.

The 76002 has a constant sampling frequency of 100 Hz at all settings and also has an internal low pass filter with a 10 Hz bandwidth. It thus has no aliasing problems but is limited to signals with maximum frequencies of 10 Hz.

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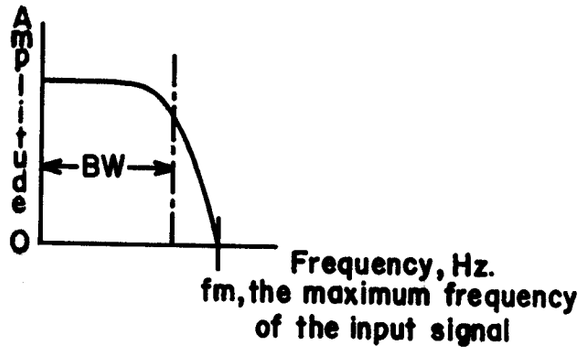


Fig. 2A Frequency spectrum

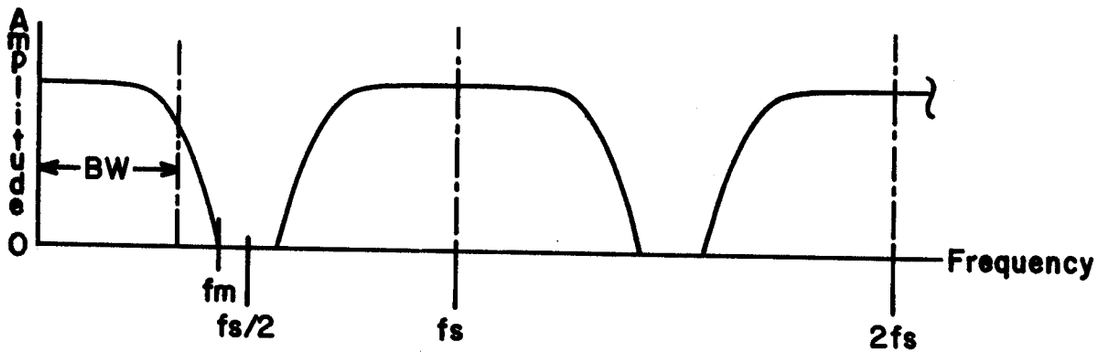


Fig. 2B Frequency spectrum of sampled analog signal

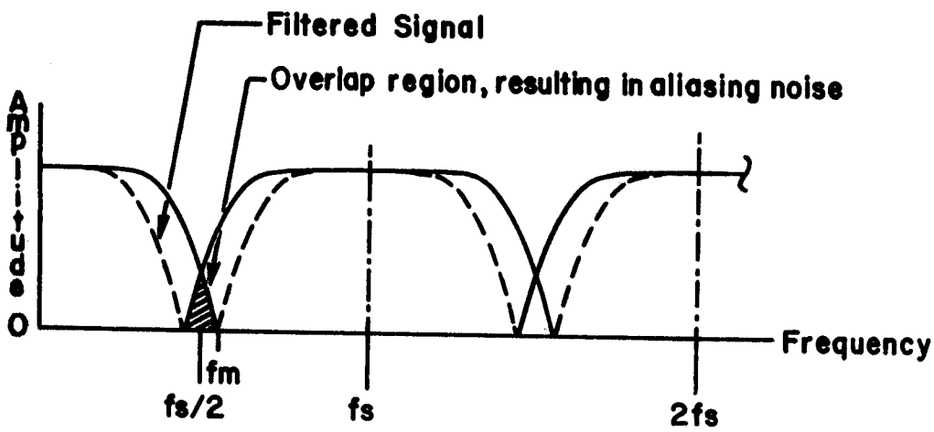


Fig. 2C Frequency spectrum of sampled signal with Sampling frequency too low.

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SECTION II - SPECIFICATIONS

AC Power Input:	115/230 VAC, 50/60 Hz, 0.6 Amps
2 INPUT SIGNALS -	
Input resolution:	12 bits, 0.025%
Polarity reversing switch:	for inverted signals
Gain control:	.01-100 in high gain position with 10 turn potentiometer
Sensitivity:	10 mv input provides full scale output
Maximum input signal:	+/- 10 Volts. Offset +/- 1.0 Volts
Low pass filter time constants:	0.02, 0.04, 0.16, 0.32, 0.64, 1.3, 2.6 seconds for full scale change
Input calibrate:	feeds input A to output #1 input B to output #2 at 0-100% scale regardless of function or scale setting
Input filter:	fifth order elliptic low pass 3db bandwidth is @ 10 Hz. Rejection is @ 40 db at 20 Hz
Input impedance:	100 k

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FRONT PANEL CONTROLS AND SWITCHES

Power Switch:	Turns unit on
Reset Button:	Initializes the filter time constant and processor
Output Calibrate Switch:	Sets the output to zero or full scale depending on the position of the switch
Low Pass Filter Time Constant Switch:	Selects the filter time constant for the input signals
Input Calibrate Switch:	Sets both inputs to a straight through function, displaying that value
Fault Indicator:	Will light when there is a mismatch between function or scale for either output
Function Switch:	Each number corresponds to the table above it
Scale Switch:	Each letter corresponds to the table above it
Offset Control and Switch:	Offsets the input signal allowing it to work within the range of the 76002. Offset switch changes the offset voltage by a factor of five (5)
Gain Control:	Controls the gain of the input signal to the A/D converter

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REAR PANEL CONTROLS AND SWITCHES

Polarity Switches:	Changes the polarity of the input signal
Gain Switches:	Changes the input amplification factor by 10
Input BNC Connectors:	Input to the 76002 log/ratio unit
Output BNC Connectors:	Chart recorder output from the 76002 log ratio unit. May be used with other devices.
Adjust Controls (screwdriver):	Adjusts output level of 76002 (o to +1V)
Line Voltage Switch:	Selects line voltage: 110/220
Circuit Breakers:	Protects unit

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SECTION III - OVERVIEW

The Ratio/Log unit is an electronic device which measures the ratio and the log of the ratio of two direct current analog voltage signals. Output is displayed on LCD numeric readouts. In addition, a 0-1 volt analog output for a strip-chart recorder is provided. A front panel switch selects the output function: A, B, A/B, B/A, log (1/A), log (1/B), log (A/B), and log (B/A), where A and B are two input signals. For the recorder output, log (log (A/B)) and log (log (B/A)) functions are also provided. Other front panel switches select the recorder output scale expansion and the response time of the input low-pass filters.

A unique feature of the unit is that two independent output channels are provided. Separate LCD displays and recorder outputs are provided and the function and recorder scale expansion may be independently selected for each channel.

All internal operations of the unit, including low-pass filtering, calculations, and output scale expansion, are performed digitally by efficient microprocessor algorithms. Thus the "log cells" are completely insensitive to temperature and to component aging. The conformity to true log response is limited only by the digital resolution of the inputs (12 bits), and all internal calculations are done to a precision exceeding 12 bits.

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OPERATION

1. Starting Up

Switch on the power switch, momentarily depress the reset push button, and allow 10 minutes warm up.

2. Input Calibration

The front panel gain controls can be used to adjust the front-end gain so that full-scale response can be obtained with any DC input signal from 100mv to 10 volts. Signals down to 10mv can be accommodated by switching the rear-panel gain switch to X10. Both inputs have offset controls with two switch-selected ranges and polarity switches for those situations in which the input signal is accompanied by a fixed offset voltage.

Setting the input gain and offset controls depends upon the operation of the signal source whose outputs provide the inputs to the ratio/log unit. First, set the input polarity switch on the ratio/log unit to correspond to the polarity of the signal (i.e. the direction of signal voltage change corresponding to a signal increase). Then, adjust the signal source to give a (nominally) zero output. With the ratio/log unit in the A (or B) mode, adjust the corresponding offset control until the value on the display just barely drops below 0.001. This should be done with the offset range switch set to "LOW" if possible, but if more offset is needed, switch to "HIGH", and the gain control full CCW. Now, adjust the signal source to give a (nominally)

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full-scale output and adjust the input gain control to read 1.000 on the display. Then, double-check the zero setting. Repeat for the other channel.

At any time during the operation of the ratio/log unit, the zero and full-scale settings can be checked easily by pressing the INPUT CALIBRATE button. This immediately switches output channel 1 to the A mode and output channel 2 to the B mode (and the recorder outputs to the 0-100% range).

3. Output Calibration

When the analog (recorder) outputs are used to drive a chart recorder, the recorder zero and span (input range) controls can be easily adjusted by using the OUTPUT CALIBRATE switch, which unconditionally forces the output to zero or to full-scale (1.0 volts).

The Output Level Potentiometers are used if a 0-1 volt output is too high for any given recorder. They are located on the rear panel.

4. Function and Recorder Range Selection

The left-hand function and range switches correspond to the left-hand numeric display and to the #1 output channel. Similarly, the right-hand function and range switches and the numeric display correspond to the #2 output channel. The recorder range switches affect only the analog (recorder) output; they have no

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effect on the numeric displays. The numeric displays are auto-ranging; the decimal point will shift automatically to display the result of the selected function.

On the log (1/A), log (1/B), log (A/B), and log (B/A) functions, the numeric displays are bipolar, that is, they can display both positive and negative numbers. For example, if log (A/B) reads 0.500, then log (B/A) will read -0.500. On the other functions, the numeric displays will display only positive numbers. The recorder outputs provide only positive outputs, negative outputs are clipped to zero, except on the +/- .5 and +/- .025 ranges, where zero is at mid-scale (.5 volts output, corresponding to 50% recorder deflection).

The 11 recorder range switch positions are divided into two sections: the first four ranges apply to the A, B, A/B and B/A functions, and the next seven ranges apply to the log (1/A), log (1/B), log (A/B), log (B/A) functions. (The double-log functions do not use the range switch.) For the A and B functions, the ranges are expressed as percent transmission (100A/B). For the log functions, the ranges are expressed in (unitless) values of log (A/B), etc. (equivalent to absorbance units used in Spectrophotometry). For the log (1/A) and log (1/B) functions, A and B are interpreted as numbers between 0 and 1, that is, exactly as displayed on the numeric display in the A and B modes.

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If there is ever any question concerning the calibration of the recorder output, it is useful to keep in mind that the numeric readouts always display the value of the selected function directly, regardless of the range switch position.

The double-log functions log (log (A/B)) and log (log (B/A) are output only to the recorder outputs. During their use, the numeric display reads log (A/B) or log (B/A). This is because the double log function is used primarily for graphical output to a chart recorder; the numerical value of the double log is not ordinarily useful in itself. The analog output covers five decades of absorbance; zero volts corresponds to log (A/B) =

the maximum value of log (A/B) is 3.6, a full-scale output will never occur. Nevertheless, the 0.2 volt per decade calibration makes it easy to mark the decades on standard chart paper which has 10 major divisions full-scale. The range switch is not utilized on this function, since the full range of measurable values of log (A/B) are displayed on one scale.

The total range of each function and its resolution (difference between adjacent distinguishable values) is limited primarily by the resolution of the input analog-to-digital conversion, which is 12 bits or about 1 part in 4000. The limitations on range and resolution are listed in Table 1.

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NOTE: If at any time the analog chart recorder output exceeds the full scale value then a rescaling of the output takes place, and the recorder will begin from a minimum value again. This "wraparound" feature occurs whenever a 1 volt output is exceeded.

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TABLE 1

RANGE AND RESOLUTION LIMITATIONS

Function	Total Range	Resolution		
		Absolute, Near Zero	Relative (% of Reading) at a Reading of 1	10
A, B	0-1	.0003	0.1%	---
A/B, B/A	0-10	.0003	0.1%	0.2%
LOG	0-3.6	.0001	See Table 2	

TABLE 2

RELATIVE RESOLUTION OF LOG FUNCTION

Reading	Relative Resolution (% of Reading)
.001	10%
.01	1%
.1	0.1%
1	0.1%
2	0.3%
3	3%

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5. Response Time

The two input signals A and B are smoothed by sliding-average low-pass filters in order to reduce noise in these signals before the ratio and log calculations are performed. A front-panel switch selects the response time of the filters, i.e. the time required for the filters to respond completely to a step change in input signal. The response times of the A and B filters are identical.

To change the response time, set the response time switch to the desired value and press reset. The new response time will not be engaged until reset is pressed. Longer response time will reduce noise but will cause the response to signal changes to be slower.

Additional care must be used in the selection of response time when the log functions are used to measure transient absorption signals, such as in the measurement of graphite furnace atomic absorption signals. The use of excessively long response time will result in poor linearity, that is, the peak height of the output signal will not be proportional to the actual magnitude of the absorbance of the input signals. This stems from the fact that the low-pass filtering occurs before the log conversion and not after. In such cases, the response time should be reduced and, if necessary to reduce noise, additional low-pass filtering should be applied after the ratio log unit (e.g. with an Oriel 76000 Signal Processor). In spite of this potential difficulty,

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however, some input filtering is desireable both to reduce noise and to help equalize small differences in the time response characteristics of the A and B signal sources.

Ratio measurement is commonly used in absorption, reflectance, and fluorescence spectroscopy in order to compensate for fluctuations in the light source intensity. In such applications, it is important that the response time of the two signals which are ratioed be identical, otherwise light source fluctuations will not be completely compensated. This problem is avoided in the Oriel Ratio/Log unit because the two inputs (signals A and B) are filtered identically by software-implemented filters.

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SECTION IV - CIRCUIT DESCRIPTION

Analog Interface Board - Refer to Schematic 76002-4-1101

Input Signal Op-Amp Portion -

The Input Signals at J3 and J4 are fed to Polarity Switches S1 and S7, along with the Gain Switches S2 and S6. The Polarity Switches reverse the polarity of the Input Signals. The Gain Switches set the gain of the Input op-amps by a factor of 1 or 10. The signals are fed to the additional op-amps and then through low pass filters. The cut-off frequency of each filter is 10 Hz. The signals out of the filters are fed to Sample and Holds A4 and A24. They are then fed to a 12 bit A/D Converter. The 12 digital lines are connected to a buss buffer. The microprocessor accesses this buffer for the data, and then executes the instructions which are selected by the front panel switch positions. The result is then sent to the appropriate D/A converter to provide an analog representation of the processed signal.

Microprocessor Portion:

The data from the A/D converter is processed by the microprocessor according to the setting of the function switches. The processed data is formatted by the Scale switches and transmitted by the 8 bit data buss to the appropriate output ports. The processed data is then converted into two 4 digit values and displayed by the LCD displays, and into an analog output by the D/A converters.

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Filter Board - Refer to Schematic 76002-3-1401

The Analog Filter Board is connected between the Analog circuitry and the Sample and Hold in order to prevent aliasing. The Filter is a unity gain-fifth order elliptic, with a cuttoff frequency of 10 Hz.

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INTERFACE OUTPUT-LSTTL COMPATIBLE

P1				
1				nc
2				nc
3				nc
4				nc
5	Least Sig. Digit	D1		Output
6		D2		"
7		D3	- Left Display "A" Channel	"
8	Most Sig. Digit	D4		"
9	Least Sig. Digit	D1		"
10		D2		"
11		D3	- Right Display "B" Channel	"
12	Most Sig. Digit	D4		"
13		M2	Right Display "minus"	"
14		M1	Left Display "minus"	"
15		DP1	Left Display Decimal Point	"
16		DP2	Right Display Decimal Point	"
17	Most Sig. Bit	B3		"
18		B2		"
19		B1	BCD Data Buss (multiplexed)	"
20		B0		"
21				nc
22				nc

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Digital Display Board - Refer to Schematic 76002-3-1301

The display board receives data from the microprocessor via an 18 conductor ribbon cable. This data is sent to the 2 decoder drivers which in turn drive 2 four digit displays.

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SECTION V - TROUBLESHOOTING

Due to the complex nature of the circuitry in the 76002, Oriel only recommends a visual inspection of the unit. A check of loose IC's, connectors, or broken wires may lead to the correction of a problem, but the troubleshooting of the digital circuitry should be referred to Oriel.

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WARRANTY AND RETURNS

WARRANTY

Oriel Corporation warrants that all goods described in this manual (except consumables such as lamps, bulbs, filters, ellipses, etc.) shall be free from defects in material and workmanship. Such defects must become apparent within the following period:

1. All products described here, except spare parts: one (1) year or 3000 hours of operation, whichever comes first, after delivery of the goods to buyer.

2. Spare parts: ninety (90) days after delivery of goods to buyer.

Oriel Corporation's liability under this warranty is limited to the adjustment, repair and/or replacement of the defective part(s). During the above listed warranty period, Oriel Corporation shall provide all materials to accomplish the repaired adjustment, repair or replacement. Oriel Corporation shall provide the labor required during the above listed warranty period to adjust, repair and/or replace the defective goods at no cost to the buyer ONLY IF the defective goods are returned, freight prepaid, to an Oriel Corporation designated facility. If goods are not returned to Oriel Corporation, and user chooses to have repairs made at their premises, Oriel Corporation shall provide labor for field adjustment, repair and/or replacement at prevailing rates for field service, on a portal-to-portal basis.

Oriel Corporation shall be relieved of all obligations and liability under this warranty if:

1. The user operates the device with any accessory, equipment or part not specifically approved or manufactured or specified by Oriel Corporation unless buyer furnishes reasonable evidence that such installations were not a cause of the defect. This provision shall not apply to any accessory, equipment or part which does not affect the safe operation of the device.

2. The goods are not operated or maintained in accordance with Oriel's instructions and specifications.

3. The goods have been repaired, altered or modified by other than Oriel authorized personnel.

4. Buyer does not return the defective goods, freight prepaid, to Oriel repair facility within the applicable warranty period.

IT IS EXPRESSLY AGREED THAT THIS WARRANTY SHALL REPLACE ALL WARRANTIES OF FITNESS AND MERCHANTABILITY. BUYER HEREBY WAIVES ALL OTHER WARRANTIES, GUARANTIES, CONDITIONS OR LIABILITIES, EXPRESSED OR IMPLIED, ARISING BY LAW OR OTHERWISE, WHETHER OR NOT OCCASIONED BY ORIEL'S NEGLIGENCE.

This warranty shall not be extended, altered or varied except by a written document signed by both parties. If any portion of this agreement is invalidated, the remainder of the agreement shall remain in full force and effect.

CONSEQUENTIAL DAMAGES -

Oriel Corporation shall not be responsible for consequential damages resulting from misfunctions or malfunctions of the goods described in this manual. Oriel's total responsibility is limited to repairing or replacing the misfunctioning or malfunctioning goods under the terms and conditions of the above described warranty.

INSURANCE -

Persons receiving goods for demonstrations, demo loan, temporary use or in any manner in which title is not transferred from Oriel, shall assume full responsibility for any and all damage while in their care, custody and control. If damage occurs, unrelated to the proper and warranted use and performance of the goods, recipient of the goods accepts full responsibility for restoring the goods to their condition upon original delivery, and for assuming all costs and charges.

RETURNS

Before returning equipment to Oriel for repair, please call the Customer Service Department at (203) 377-8282. Have your purchase order number available before calling Oriel. The Customer Service Representative will give you a Return Material Authorization number (RMA). Having an RMA will shorten the time required for the repair, because it ensures that your equipment will be properly processed. Write the RMA on the returned equipment's box. Equipment returned without a RMA may be rejected by the Oriel Receiving Department. Equipment returned under warranty will be returned with no charge for the repair or shipping. Oriel will notify you of repairs not covered by warranty, with the cost of the repair, before starting the work.

Please return equipment in the original (or equivalent) packaging. You will be responsible for damage incurred from inadequate packaging, if the original packaging is not used.

Include the cables, connector caps and antistatic materials sent and/or used with the equipment, so that Oriel can verify correct operation of these accessories.

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SECTION VII - SCHEMATICS

The following schematics are supplied with this manual:

76002-3-1301	Display
76002-3-1401	Low Pass Filter
76002-4-1201	Processor
76002-4-1101	Analog Interface
Block Diagram	

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