ORIEL
PHOTOMULTIPLIER DETECTION SYSTEM
Model 7070
Instruction Manual

INSTRUCTION MANUAL
ORIEL PHOTOMULTIPLIER
DETECTION SYSTEM
MODEL 7070

PLEASE READ THESE INSTRUCTIONS COMPLETELY BEFORE OPERATING THIS EQUIPMENT

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TABLE OF CONTENTS

SECTION 1 - INTRODUCTION

The ORIEL Model 7070 Detection System is an instrument designed for a wide variety of applications in the measurement of light radiation. This highly sensitive, extremely stable unit can, with the appropriate external sensor, allow measurements to be made over the range of 2000 Angstroms to 1.1 microns thereby encompassing the ultraviolet, visible and near infrared portions of the spectrum.

The 7070 has a self-contained, front panel adjustable power supply suitable for exciting both photo-diode sensor, (Oriel 7050-7056) and photomultiplier tubes (Oriel 7060-7066 Series).

SECTION 2 - SPECIFICATIONS

NOTE:

Allow a 15 minute warm-up period when first applying power to the unit.

Sensor Readout *

Operating Temperature Range:	14 degrees C to 40 degrees C
Overall accuracy at 27 degrees C Ambient:	+/- .1% (+/- .001 digital)
Linearity:	.05%
Gain Drift vs Temperature:	0.07%/degrees C
Zero Drift:	+/- .001 digital

BCD Output Description

The parallel BCD output lines are at +5V logic level (positive logic), capable of driving 2 LPTTL loads.

*NOTE: These specifications pertain to the readout circuit only. The performance of the entire system is limited by that of the photosensors.

The multiplexed BCD output lines are at +5V logic level (negative logic), capable of driving 4 CMOS loads. The load pulses are at +5V logic level (positive logic), capable of driving 2 CMOS loads.

ANALOG RECORDER OUTPUT: 100mV full scale, source impedance = 200 ohms

HIGH VOLTAGE POWER SUPPLY

Output: Adjustable from -10V to -1000 VDC

Stability at Ambient Temperature = 27 degrees C +/- 0.1%

Stability over operating temperature range = +/- 0.25%

SECTION 3 - AC LINE CONSIDERATION

If the AC line cord is not otherwise labebelled, the Oriel Model 7070 Radiometer is shipped wired for operation on 115 VAC, 50-60 Hz line voltage. It is only necessary to plug it into a standard 3 prong wall outlet to achieve immediate operation.

** If 220/230 volt operation is desired, the following steps should be carried out, WITH ALL POWER DISCONNECTED.

* NOTE: For shipments to Europe, the instrument may have already been converted for 220/240 volts input. This will be indicated by a tag on the AC line cord.

a.- Remove the 8 screws holding on the top cover, and then remove top cover.

b.- At the left rear corner of the main circuit card (near rear panel fuse holder), locate the 4 screw terminals and loosen the 4 top nuts.

c.- Remove both shorting jumpers (1-2, and 3-4).

d.- Replace one jumper across the two middle terminals (2-3), and discard the second jumper.

e.- Tighten the 4 top nuts.

f.- Replace cover and 8 holding screws.

g.- Cut off the 3 pin AC plug at the end of the line cord, and replace with a new 220/230 volt plug to match your AC line receptacle.

Connect wires as follows:

GREEN - earth ground

BLACK - high side of AC line

WHITE - low or neutral side of AC line

h.- The Radiometer is now configured for operation on 220/230 volts, 50-60 Hz.

SECTION 4 - CONTROLS AND FUNCTIONS

A. FRONT PANEL:

POWER SWITCH - (Illuminated)	Used to turn power on to the Radiometer.
VOLTS -	Used to set the high voltage power supply output level. This control has an integral lock, which reduces the possibility of erroneously changing the high voltage setting.
MEASURE - (Voltage/Current)	Used to switch the digital front panel readout between the high voltage power supply output (range 000 to -1000V)

MEASURE (continued)	and the detector current readout (range .000 to 1.999 A.).
RESPONSE - (fast/med/slow)	Used to select system response time (from 5% to 95% of full signal) fast = 0.1 sec (0.4 sec on 10-9 Ampere Range) med = 1.0 sec slow = 10 sec
AMBIENT SUPPRESS -	Used to cancel out dark current of sensors, or to set sensor current to zero for any ambient light condition. Both course (rotary switch) and fine (potentiometer) controls are provided. This control has an integral dial lock.
MULTIPLIER -	Used to select the desired sensitivity of photodetector in amperes.
ATTENUATION -	Used to attenuate the reading on the front panel meters. Range of operation is 0db @ CAL, and over 20db @ full CCW. NOTE: this control must be in the CAL position for long term repeatability of measurements, or for absolute current readings.

ZERO - (on/off)	Used to disconnect both sensor input and ambient suppress input, so that meter zeroing may be accomplished.
ZERO - (potentiometer)	Used to zero panel meters when ZERO switch is on.
DIGITAL PANEL METER -	Used to measure high voltage power supply output (000- -1000V) when the MEASURE switch is in the VOLTAGE position, and measure sensor current (.000 to 1.999 times MULTIPLIER setting in amperes), when the MEASURE switch is in the CURRENT position.
ANALOG PANEL METER -	Used to measure sensor current at all times; convenient for output peaking. Range: 0 to 2.

B. REAR PANEL:

SENSOR SIGNAL CONNECTOR - (BNC)	Used to make connection with the external sensor.
REMOTE READOUT CONNECTOR - (25 pins)	Used to connect remote readout device(s), printer(s), computer inferface, etc. Has both parallel and multiplexed BCD data from front panel Digital Panel Meter.
HIGH VOLTAGE CONNECTOR - (RF)	Used to connect high voltage power supply output to sensor.

RECORDER JACKS - Used to connect to external recorder or oscilloscope. This output is always connected to the Analog Panel Meter.

SECTION 5 - OPERATION WITH A PHOTOMULTIPLIER SENSOR

1. Connect the signal cable from the photomultiplier detector to the BNC jack on the rear panel (upper left hand corner).
2. Check that the VOLTS control on the front panel of the Radiometer is turned fully counter clockwise.
3. Check the high voltage cable from the photomultiplier detector to the RF jack on the rear panel (lower right hand corner).
4. Turn the MULTIPLIER switch to 10-5, and check that Attenuator is turned full clockwise to the detented CAL position.
5. Turn the Radiometer power switch to ON, and set the MEASURE switch to the CURRENT position.
6. Set the ZERO switch to ON, and adjust ZERO control for .000 on the digital panel meter.

   NOTE: Meter may be zeroed on the 10-9 MULTIPLIER position, and will usually retain zero, +/- .001 for all other scales.
7. Set the ZERO switch to OFF, and allow a 15 minute warm-up period before proceeding to Step 8.
8. While observing both the digital and analog panel meters, adjust the VOLTS control from Zero to the proper voltage level to the photomultiplier detector. Usually this falls

in the range at 500 to 800 volts for the standard Oriel detectors, and is displayed on the digital panel meter. The analog panel meter is displaying detector current, which should not be allowed to exceed 1 x 10-5 Amperes.

9. Set the integral lock on the VOLTS control, and set the MEASURE switch to CURRENT. The digital panel meter will now display detector current, providing more precise readings than are available on the analog panel meter.

NOTE: After the tube is in place and the operating range is known, the high voltage can be left adjusted to the proper value and the instrument merely turned off and on as desired.

The detector sensitivity is increased with increasing voltage. Operation between 100 and 1000 volts allows a very wide range of sensitivity to match a given radiation level. The noise and dark current also increase as drive voltage is increased. Generally the best signal/noise ratio is obtained in the range from 500 to 700 volts for those photomultipliers normally used with this instrument.

* <u>CAUTION:</u>

If source intensity of measurement is unknown, the 10-5 Amp maximum current could be exceeded, resulting in damage to the photo tube. When in doubt, proceed as in Step 8.

10. The photomultiplier detectors have some signal current without any light input due to a variety of electrical leakages. This "Dark Current" varies with tube voltage. This current, or current resulting from ambient light, may be cancelled out by using the AMBIENT SUPPRESS controls. With the source or detector optically blanked, set the AMBIENT SUPPRESS switch to the appropriate full scale range. (ie, if the current is 0.5 x 10-8 amperes, set the AMBIENT SUPPRESS switch to 10-8). Then, turn the AMBIENT SUPPRESS potentiometer to zero the meter.

11. When making relative light measurements, it is often desirable to set an arbitrary light level at full scale (1.000) on the meter(s). This is particularly true when setting a reference for making direct Transmission or Reflection measurements. The Attenuation control allows continuously adjustable sensitivity of the measuring circuit.

SECTION 6 - CIRCUIT DESCRIPTION

Drawing number 7070-4-1001-1 is a complete schematic diagram of the 7070 Radiometer. The sensor current processing is accomplished in three stages: an input buffer amplifier, a system response amplifier, a front panel digital volt-meter.

The input buffer amplifier (A104) is a very stable, high input impedance operational amplifier. With the use of selected scaling resistors, it converts detector current to voltage.

The system response amplifier (A105) amplifies the output of A104; and with the use of selected feedback capacitors, it establishes system response. The output of the response amplifier is connected to the analog panel meter, a scaling circuit for the external recorder output, and via the MEASURE selector switch to the digital panel meter. The digital panel meter is a digital voltmeter which converts the scaled analog voltage to a digital readout. The meter also generates multiplexed BCD information, which is converted to parallel BCD format on the BCD Latch Circuit card.

The output from the BCD Latch Circuit card is connected to J106 on the rear panel. The functions, by pin number, are listed below:

J106-1	+	(parallel)	J106-14	.001	(parallel)
J106-2	1	(parallel)	J106-15	2 EXP3 (LO)	(mux'd)
J106-3	.8	(parallel)	J106-16	2 EXP2 (LO)	(mux'd)
J106-4	.4	(parallel)	J106-17	2 EXP1 (LO)	(mux'd)
J106-5	.2	(parallel)	J106-18	2 EXP0 (LO)	(mux'd)
J106-6	.1	(parallel)	J106-19	MINUS	(mux'd)
J106-7	.08	(parallel)	J106-20	1 STROBE	(mux'd)
J106-8	.04	(parallel)	J106-21	0.1 STROBE	(mux'd)
J106-9	.02	(parallel)	J106-22	.01 STROBE	(mux'd)
J106-10	.01	(parallel)	J106-23	.001 STROBE	(mux'd)
J106-11	.008	(parallel)	J106-24	No Contact	
J106-12	.004	(parallel)	J106-25	Ground	
J106-13	.002	(parallel)			

Also present in the unit are a low voltage power supply (providing internal voltage levels of +5VDC, +15VDC and -15VDC), and a high voltage power supply.

The high voltage power supply major elements are a voltage comparator (A103) and a series pass transistor (Q101). An additional active component (Q102) senses excess current drain on the power supply (approximately 4 milliamperes) and turns off the series pass transistor (Q101).

One input to the voltage comparator is the attenuated high voltage output, and the other input is the wiper of the front panel VOLTS control. The voltage comparator controls the conduction of the series pass transistor, increasing or decreasing conduction as necessary to increase or decrease the high voltage output, so as to maintain equality across the voltage regulator input terminals.

SECTION 7 - TROUBLE SHOOTING

Repairs or internal adjustments to this equipment should only be attempte by an experienced electronic technician. Improper use of test equipment o tools can easily damage components within the unit or compound existing problems.

If trouble is encountered, the top cover should be removed and a visual inspection made for shorts, broken wires and obviously damaged or broken components.

If nothing obvious is visible, below are some key test point locations, along with expected signals (or readings) under the conditions prescribed.

a) Check of input buffer stage

1.-Zero check -

Place ZERO switch to ON, Attenuator Control to CAL. Locate termination point on main circuit card of grey wire originating within the can on the front panel, and connect a voltmeter or oscilloscope between that point and ground.

NOTE: A convenient ground reference point is the black binding post on the rear panel. Adjustment of the front panel ZERO control should allow zeroing on all positions of the MULITPLIER switch.

2.-Gain check -

Using a precision current source (or precision voltage source with appropriate series resistor), connect -1 x 10-5 Amperes (-10 uA) into the BNC input jack at the upper left hand corner of the rear panel. Check that ZERO is OFF and AMBIENT SUPPRESS is OFF. Position MULTIPLIER to 10-5. The voltage reading on the termination grey wire (with respect to ground) should read +1VCD, +/- .005V.

3.-Calibration check -

Using a precision current source (or precision voltage source with appropriate series resistor), connect -1 x 10-7 Amperes (-0.1uA) into the BNC input jack at the upper left hand corner of the rear panel. Check that ZERO is OFF, AMBIENT SUPPRESS is OFF, and MULTIPLIER is positioned to 10-7.

The voltage reading on the termination point of the above mentioned grey wire (with respect to ground) should read +1VDC, +/-.005V.

If steps 1. or 2. do not prove out, operational amplifier A104 is probably faulty, and should be replaced. If steps 1. and 2. are ok, but step 3. is out of tolerance, the unit probably requires calibration. See SECTION 8 for proper calibration procedure. In the event adequate test equipment is not available, the unit should be returned to ORIEL for calibration.

b) Check of Response Amplifier

1.-Zero check -

Place ZERO switch to ON, Attenuator control to CAL. Perform zeroing of A104 as described in Step A-1) of this section. Turn Attenuator control full counter clockwise. Connect voltmeter between MEASURE switch terminal (WH/BRN/BLK wire) and ground. Adjust R141 (50K trimpot in right rear area of main circuit card) for 0 volt reading.

2.-Gain check -

Set ZERO to OFF, MULITPLIER to 10-5, AMBIENT SUPPRESS switch to 10-5, AMBIENT SUPPRESS potentiometer full counter clockwise.

Connect voltmeter between MEASURE switch terminal (WH/BRN/BLK wire) and main circuit termination point of grey wire originating within the front panel can. Voltage reading between the two above points should be 0+/-.040 volts.

If steps 1. or 2. do not prove out, operational amplifier A105 is probably faulty, and should be replaced. If A105 is replaced, an entire unit calibration (SECTION 8) should be performed.

c) Check of Digital Panel Meter

1.-Zero check -

Connect clip lead from MEASURE switch wiper (WH/RED/BLK wire) to ground. Digital Panel Meter should read .000+/-.002. Remove clip lead.

2.-Gain check -

Set ZERO to OFF, MULTIPLIER to 10-5, AMBIENT SUPPRESS switch to 10-5, MEASURE switch to CURRENT. Connect voltmeter between MEASURE switch wiper (WH/RED/BLK wire) and ground. Adjust AMBIENT SUPPRESS potentiometer for a voltmeter reading of -1VDC. The Digital Panel Meter should read -1.000+/-.040. If steps 1. or 2. are just out of tolerance, a unit calibration may be attemped. If, however, the readings are far out of tolerance, the meter is probably faulty and should be replaced.

d) Check of High Voltage Power Supply

1.-Connect voltmeter between high voltage output connector (lower right hand corner of rear panel) and ground.

2.-Turn the front panel VOLTS control full clockwise. The output voltage should read -1000+/-3 VDC.

- If the reading is far out of tolerance, or if regulation is erratic, the voltage comparator (A103) is probably faulty and should be replaced.

3.-Turn the front panel VOLTS control fully counter clockwise. The reading should drop -1, +/- 1 VDC.

- If the reading is excessively high, the series pass transistor (Q101) is probably leaky, and should be replaced.

4.-Turn the front panel VOLTS control 5 full turns in the clockwise direction. The reading should be -500+/-25VDC.

5.-Set the MEASURE switch to VOLTAGE. The front panel digital meter should repeat the output voltage, +/- 2.

- If the digital meter reading is out of tolerance, calibration should be performed.

SECTION 8 - CALIBRATION PROCEDURE

Total unit calibration should be performed in the order set forth, as some adjustments are dependent on the accuracy of other settings within the unit.

NOTE: Proper calibration requires the use of a precision current source (accuracy of +/-.01% or better) or a precision voltage source and precision resistor combination (combined accuracy of +/-.01% or better). If one of these is not available, attempts to calibrate the unit will result in degradation of performance. The unit should instead be returned to ORIEL for proper calibration.

a) Current Metering Circuitry

1.-Make the following initial front panel adjustments:

MEASURE	-	CURRENT
VOLTS	-	Full CCW
MULTIPLIER	-	10-9
MULTIPLIER ATTENUATOR	-	CAL (full CW)
AMBIENT SUPPRESS	-	OFF
RESPONSE	-	FAST
ZERO Switch	-	ON

2.-Adjust ZERO potentiometer for +/-.000

3.-Turn Attenuator control fully counter clockwise. The digital panel meter should read a maximum of +/-.001. If the reading is out of tolerance, adjust R141 (50K trimpot at right rear of main circuit card).

4.-Set Attenuator control back to CAL (full CW), ZERO switch to OFF, and MULTIPLIER to 10-5.

5.-Connect a precision -10 micro-ampere current source (or precision -10V voltage source with precision 1 Megohm resistor in series) to the signal input BNC connector (upper left hand corner of the rear panel).

6.-The digital panel meter should read 1.000+/-.001. If the meter reading is off, adjust digital panel meter gain adjust potentiometer (accessible via hole in rear meter panel).

7.-Change the setting on the precision current source to -1 micro-ampere (voltge source to -IV). Set MULTIPLIER to 10-6. Slide off metal can on front panel switch - being careful not to allow it to touch any active circuitry.

8.-Adjust R127 (100K trimpot, most CW in position of the set of 4 potentiometers on the rear of the MULTIPLIER switch) for a digital panel meter reading of 1.000.

9.-Change the setting on the precision current source to -0.1 micro-amperes (voltage source to -0.IV)). Set MULTIPLIER to 10-7.

10.-Adjust R129 (1 MEG trimpot, adjacent to R127 above) for a digital panel meter reading of 1.000.

11.-Change the setting on the precision current source to -.01 micro-amperes (voltage source to -.01V). Set MULTIPLIER to 10-8.

12.-Adjust R137 (1K trimpot, adjacent to R129 above) for a digital panel meter reading of 1.000.

13.-Change the setting on the precision current source to .001 micro-amperes (voltage source to -.001V). Set MULTIPLIER to 10-9.

14.-Adjust R134 (10K trimpot, adjacent to R137 above) for a digital meter reading of 1.000.

NOTE: The two most sensitive ranges of the MULTIPLIER (10-8 and 10-9) are highly susceptible to noise induced

errors when the protective can cover is removed. The accuracy of the gain settings may be impaired, and should be checked with the can cover in place. The calibration for these two positions may have to be repeated several times.

15.-Remove power from the Radiometer, replace can, and restore power.

b) High Voltage Power Supply

1.-Connect a precision voltmeter (accuracy of 0.1% or better) between the high voltage output connector center pin and ground.

2.-Slowly turn the front panel VOLTS control clockwise, observing the meter reading. The output should never be allowed to go higher than -1005 VDC.

NOTE: If 1000 volts output is attained before the VOLTS control is set to its maximum CW travel, reduce the output by adjusting R110 (2K trimpot, located just below and to the left of the front panel metal can, on the front of the main circuit card).

3.-With the VOLTS control set at maximum CW travel, adjust R110 (2K trimpot referenced in above note) for an output reading of -1002 VCD.

4.-Set MEASURE switch to VOLTAGE, and observe the reading on the front panel digital meter.

5.-Adjust R115 (10K trimpot at the front of the main circuit card. between and below the two front panel meters) for a digital panel meter reading of -1002.