

BASIC OPERATING PROCEDURE

The following procedure is intended as a guide and checklist for the basic operation of the Heath EU-700/E Monochromator as a fixed-wavelength monochromator and as a scanning spectrometer. This operational sequence is suggested for systematic operation of the Monochromator, but can be modified at will without risk of damage to the instrument. To utilize the unusual versatility of the scanning system, with respect to servo chart recorder synchronization,

Basic operation of the Monochromator should include the following check points:

1. Check the Monochromator Unit for proper placement on a firm base, and attach the source and detector devices.
2. Connect the wavelength Control Unit to the Monochromator Unit and plug the power cord into the proper AC service outlet.
3. Set the SLIT WIDTH to the desired reading on the digital counter.
4. Insert the appropriate aperture disc behind the light seal coupling. See Section 7 for information on selecting the aperture disc.
5. Check the following controls and switches on the Control Unit for the proper initial setting:

SCAN RATE, . . . set to appropriate value,
as discussed under Controls and Connectors.

SCAN, OFF.

SLEW, OFF.

INT-EXT, INT or EXT, depending
on scan-rate requirements.

6. For operation of the Monochromator at a specified wavelength value, set the digital WAVELENGTH counter to the desired value by combined use of the SLEW and SCAN switches. The following procedure is suggested:

- a. Using the SLEW controls, set the WAVELENGTH counter to approximately 5 angstroms less than the desired value.
- b. With the SCAN RATE set at 0.5 or 1 angstrom per second, hold the SCAN switch in the MOMENTARY position and step up to the desired wavelength reading. For precise wavelength setting within 0.1 angstrom of the peak of a narrow emission line, such as from a hollow-cathode discharge, set the SCAN RATE switch at 0.1 angstrom per second and use photo-detector readout to indicate the line peak.

7. For operation as a scanning spectrometer:

- a. Set the WAVELENGTH counter to the starting value of the scan in the same manner as in Step 6.
- b. Set the SCAN RATE to an appropriate value with regard to the spectral character of the input radiation, and to the pen response of the servo chart recorder, if used. Atomic or molecular emission spectra require a SCAN RATE of 0.5 angstrom per second or less with typical chart recorders having a pen period of 1 second. Spectral continua or broad-band absorption spectra permit a SCAN RATE setting as high as 20 angstroms per second.
- c. Set the SCAN switch to CONTINUOUS, then return the switch to the OFF position after the desired wavelength range has been scanned.

SLEW SWITCH

A specific wavelength region can be rapidly approached by means of a high-speed slewing drive controlled by the two lever-action switches marked SLEW on the front of the Control Unit (Figure 4-3). The switch labeled DECREASE, or the switch labeled INCREASE changes the wavelength at a rate of more than 5000 angstroms per minute. By momentarily depressing the proper SLEW switch to the MOMENTARY position, the wavelength setting can be decreased or increased in small increments. By raising the proper switch lever to the CONTINUOUS position, wavelength will be increased or decreased until manually returned to the center OFF position. If left in the CONTINUOUS position, the wavelength will change at the slewing rate until stopped by an automatic limit switch near either end of the leadscrew at approximately 0 or 10,000 angstroms. Because of a double-clutch drive system, it is acceptable to leave the SCAN switch in the CONTINUOUS position while operating the SLEW switches.

CHART RECORDER OUTPUT TERMINALS

This pair of terminals, located on the rear panel of the wavelength Control Unit, are used for chart recorder synchronization.

For example, if the external oscillator frequency is 6 Hz, and the SCAN RATE switch is set at 1 Å/sec, then

$$\text{scan rate} = \frac{6 \times 1}{600} = 0.01 \text{ Å/second}$$

A great number of other scan rates may be obtained by using an external oscillator and other positions of the SCAN RATE switch. However, the external oscillator frequency must not be greater than required to produce a scan rate of 20 angstroms per second.

SCAN SWITCHED OUTLET

On the rear panel of the Control Unit is an AC line voltage outlet marked SCAN SW'D. See Figure 4-4. Power is present at this outlet only when the SCAN RATE switch is in any position except off, and the SCAN switch is in either the MOMENTARY or CONTINUOUS position. This outlet can be used for synchronization of other devices with Monochromator scanning operations. **CAUTION:** Maximum power output from this outlet must be limited to 60 watts (0.5 ampere, 120 volts, 60 Hz, or, 0.25 ampere, 240 volts, 50/60 Hz).

UNSWITCHED OUTLET

Also on the rear panel is an AC line voltage convenience outlet, marked UNSW'D, for use with accessory instruments. Line voltage is present at this outlet whenever the wavelength Control Unit is connected to an AC line. Maximum power from this outlet should be limited to 600 watts (5 amperes, 120 volts, 60 Hz, or, 2.5 amperes, 240 volts, 50/60 Hz).

INT-EXT SWITCH

This switch selects the internal or an external frequency source for wavelength scan. The switch should be in the INT position when the calibrated switch-selected Scan Rate values are desired. The switch should be in the EXT position when an external frequency source is used to provide other scan rates, or for programming of the scan rate. The UNCAL light on the front panel glows to indicate when the INT-EXT switch is in the EXT position.

EXTERNAL INPUT

The output of a fixed or variable-frequency oscillator can be connected at the EXT INPUT terminals to provide scan rates different from those indicated by the front-panel SCAN RATE selector switch, and also to provide programmed variable-rate scanning.

The following formula is used to determine the scan rate when using an external oscillator signal:

$$\text{scan rate (Å/sec)} = \frac{F(\text{ext}) \times SR}{F(\text{int})}$$

where: F (ext) = external oscillator frequency (Hz)
F (int) = 600 Hz = fixed internal oscillator frequency
SR = SCAN RATE switch position

CHART RECORDER OUTPUT SWITCH

This 4-position rotary switch selects the proper ratio of pulses for synchronizing the stepping motor in the Monochromator Unit to specific types of servo chart recorder stepping motor drive systems.

CHART RATIO SELECTOR SWITCH

This switch, located at the left side on the front panel is used to establish the desired ratio of servo chart recorder speed with respect to the Monochromator scanning rate.

MONOCHROMATOR UNIT- CONTROLS AND CONNECTORS

NOTE: Monochromator Unit controls and connectors are shown in Figure 4-1 and 4-2.

OPERATION

SLIT WIDTH CONTROL

The only control located on the Monochromator Unit is the Slit Width control, as shown in Figure 4-1. The entrance and exit slits are ganged together and are operated by the single knob.

Slit width is indicated on a 4-digit counter that reads directly in microns. For example, the counter shown in Figure 4-1 indicates a slit width of 120 microns for both the entrance and the exit slits.

One complete turn of the knob changes the slit width by 50 microns. Limit stops on the knob shaft prevent the slits from being over-closed, or opened too far. As with other measuring devices, maximum accuracy and precision is obtained when the slit width setting is made in a positive direction.

WAVELENGTH INDICATOR

Wavelength is read on a 5-digit counter as illustrated in Figure 4-1. The wavelength indicated in the figure is 2345.1 angstroms.

CONTROL UNIT CONNECTOR

Located near the bottom of the rear panel is a 15-pin male connector for electrically connecting the Monochromator Unit to the Control Unit. See Figure 4-2.

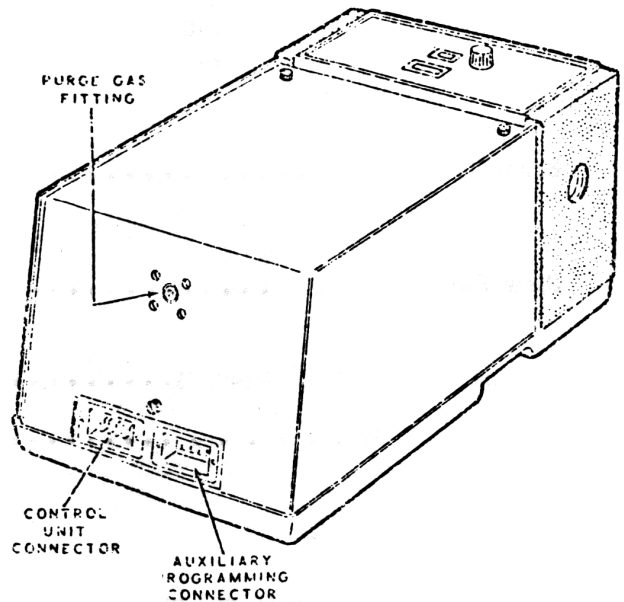


Figure 4-2 Monochromator rear panel

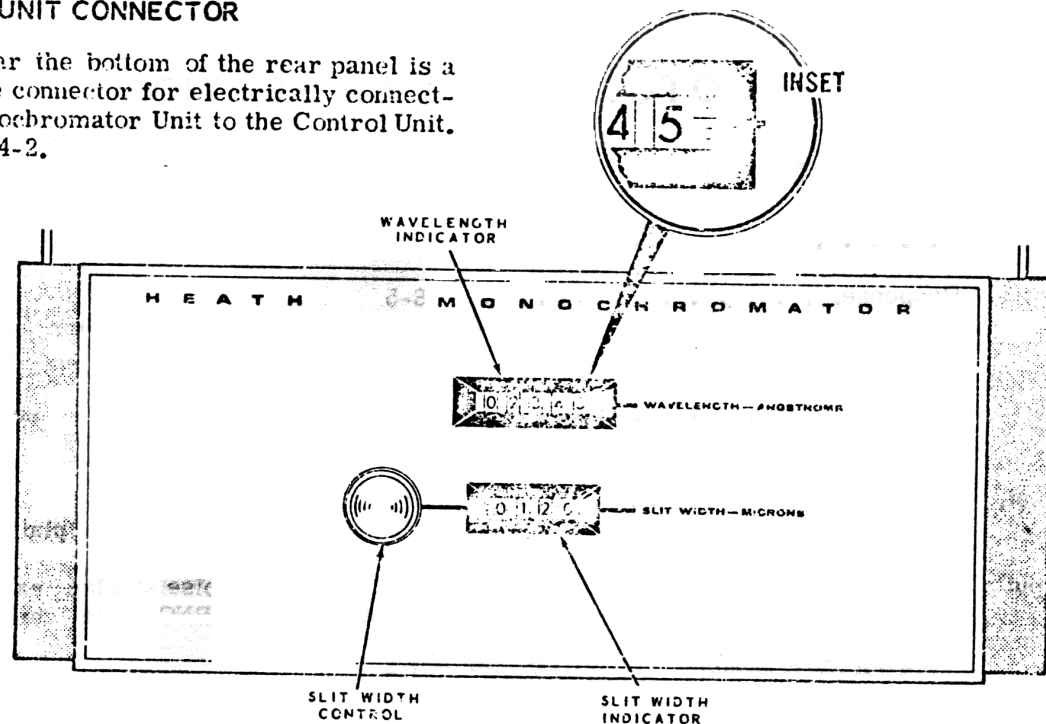


Figure 4-1 Monochromator control panel

CONTROL UNIT

An electronic digital system in the wavelength Control Unit supplies pulses to a stepping motor which drives the precision leadscrew and permits exact synchronization of wavelength scan with a strip-chart recorder at constant or variable scan rates.

Scanning Rates.	Nine digitally controlled scanning speeds: 0.05, 0.1, 0.2, 0.5, 1, 2, 5, 10, and 20 angstroms per second in the direction of increasing wavelength.
Slew Rates.	Rapid traverse in either direction at approximately 5400 angstroms per minute.
Internal Oscillator Frequency.	600 Hz, locked to 50 or 60 Hz line frequency.
External Input.	Any waveform with pulse width greater than 50 nanoseconds and amplitude between 2 and 10 volts with zero reference. Frequency limited only by divided frequency maximum of 100 Hz at motor driver input, point CPX.
Output Pulse Amplitude To Chart Recorder. .	+3.6 volts with no load.
Output Resistance.	700 ohms.
Pulse Rise And Fall Time.	Less than 1 μ s.

PHOTOMULTIPLIER SECTION

PHOTOMULTIPLIER TUBE

	1P28A.
Spectral Response.	S-5 (See RCA IP28 Data Sheet for Luminous Sensitivity, Dark Current and other specifications.)
Leakage.	Normal room lighting will cause less than a 1% change in the dark current value.
Output.	Directly from photomultiplier tube anode to BNC connector on reference plate.
Output Cable.	Four foot, low-noise shielded cable terminated at both ends with BNC cable connectors.

SPECIFICATIONS

MONOCHROMATOR UNIT

The Monochromator Unit contains the optical system, mechanical drive, and electric motors that operate on signals from the Control Unit.

Type Of Mount.	Single-pass Czerny-Turner mounting with folding mirrors to provide entrance and exit beams on a common optic axis.
Aperture Ratio.	f/6.8 at 2000 angstroms.
Focal Length.	350 millimeters.
Resolving Power.	Better than 1 angstrom; Line-profile half-width less than 0.5 angstrom, with 3 mm slit height.
Stray Light.	0.1% or less within $\pm 1\frac{1}{2}$ bandwidths of a given line.
Wavelength Range (mechanical).	Zero order to 10,000 angstroms, first order.
Wavelength Accuracy.	± 1 angstrom throughout usable wavelength range.
Wavelength Resetability.	± 0.1 angstrom on the basis of resetting on the maximum of a narrow emission line, with photo-detected recorder output as indicator.
Reciprocal Dispersion.	Approximately 20 angstroms per mm at exit slit with 1180 lines per mm grating, depending on wavelength.
Grating.	Precision plane grating replica; 48 mm x 48 mm ruled area. Standard grating of 1180 lines per mm, blaze wavelength 2500 angstroms. (Gratings of other line spacing and blaze will be made available in the future.)
Mirrors.	Aluminized first-surface mirrors with MgF_2 overcoating. Optical surfaces corrected to 1/4-wave mercury green line.
	Collimating and focusing mirrors: 50 mm diameter, parabolic, 350 mm focal length.
	Folding mirrors: 25 mm x 35 mm plane.
Slits.	Ground and polished straight knife edges, bilaterally adjustable; entrance and exit slit width ganged to single control.
Slit Width.	Continuously variable between 5 and 2000 microns; a 4-digit counter reads directly in microns.
Slit Height.	12 mm maximum; provision for intermediate heights of 0.5, 1, 3, and 5 mm.

APPENDIX III

CONTROL UNIT- CONTROLS AND CONNECTORS

NOTE: Control Unit controls and connectors are shown in Figure 4-3 and 4-4.

SCAN RATE SELECTOR SWITCH

One of nine calibrated wavelength scan rates (20, 10, 5, 2, 1, .5, .2, .1, or .05 angstroms per second) can be selected by the SCAN RATE selector switch that is located on the front panel of the wavelength Control Unit. See Figure 4-3. The OFF position of the SCAN RATE switch turns off all of the electronic circuits that control the scan motor and chart recorder drive motor.

UNCAL LIGHT

The UNCAL (uncalibrated) lamp lights when the INT-EXT switch on the rear of the Control Unit is in the EXT position. With the switch in the INT position (UNCAL lamp not lit) the scan rates are based on the internal 600 Hz oscillator and the

calibrated positions of the SCAN RATE switch. When the INT - EXT switch is in the EXT position, an external frequency source, connected to the EXT INPUT terminals, can be used to set the scan rates. The use of an external frequency source will be discussed later.

SCAN SWITCH

The scan motor that drives the wavelength scanning mechanism is started or stopped by the 3-position lever-type SCAN switch. Wavelength scan can be momentarily operated by holding the SCAN switch lever down to the MOMENTARY position. When the switch is released, spring action returns it to the center OFF position.

When the SCAN switch lever is raised to the CONTINUOUS position, wavelength scan continues until the lever is manually returned to the center OFF position, or the scan is stopped by an automatic limit switch at approximately 10,000 angstroms.

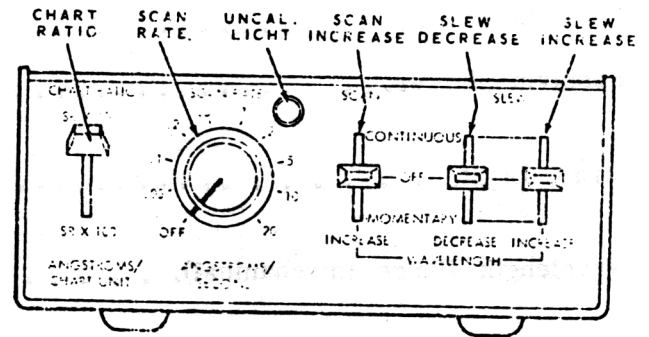


Figure 4-3 Control Unit front panel

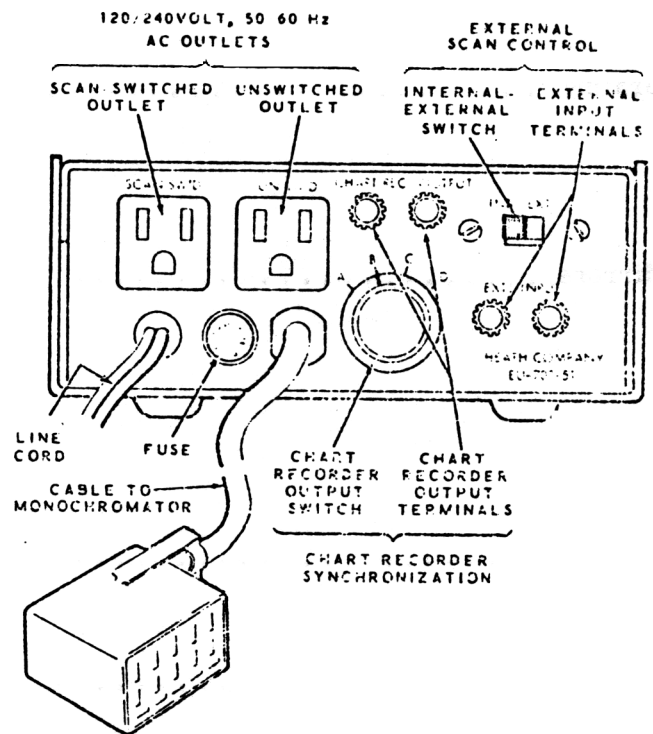


Figure 4-4 Control Unit rear panel

HAMAMATSU

TECHNICAL DATA

Feb. 1991

PHOTOMULTIPLIER TUBE R1477

Super-High Sensitivity Multialkali Photocathode(185nm to 900nm) 1-1/8 Inch Diameter, 9-stage, Side-On

FEATURES

- Super-High Cathode Sensitivity
 - Radiant at 450 nm 80 mA/W
 - Luminous 375 μ A/lm
 - Quantum Efficiency at 370 nm 24%
- Wide Spectral Response 185 to 900 nm
- Low Anode Dark Current 3 nA at 1000 V
(after 30 minute storage)

APPLICATIONS

- UV to IR Spectrophotometers
- Laser Detection Systems
- Pollution Monitors

The R1477 has a super-high sensitivity multialkali photocathode (even higher than the R928). The spectral response covers a wide range from 185 to 900 nm with a peak response at approximately 450 nm. The R1477 also features the combination of high gain and low dark current.

The R1477 is recommended for use in spectrophotometry and other low light level applications requiring super-high cathode sensitivity from the UV to the near IR regions of the spectrum.

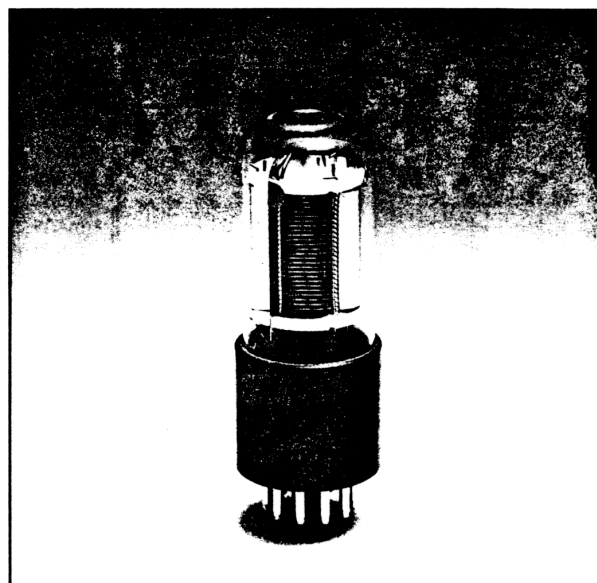


Figure 1: Typical Spectral Response

GENERAL

Parameters	Rating	Units
Spectral Response	185 to 900	nm
Wavelength of Maximum Response	450	nm
Photocathode		
Material	Multialkali	-
Minimum Effective Area	8 x 24	mm
Window Material	UV glass	-
Dynode		
Secondary Emitting Surface	Multialkali	-
Structure	Circular-cage	-
Number of Stages	9	-
Direct Interelectrode Capacitances		
Anode to Last Dynode	Approx. 4	pF
Anode to All Other Electrodes	Approx. 6	pF
Base	11-pin base JEDEC No.B11-88	-
Weight	Approx. 45 g	
Suitable Socket	E678-11A (option)	
Suitable Socket Assembly	E717-21 (option)	

