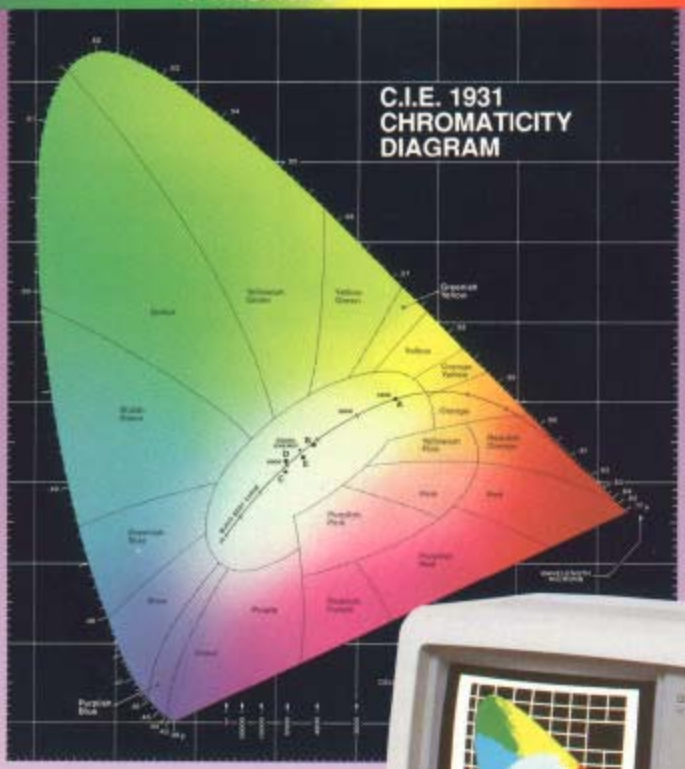
PR®-1980B Pritchard® SpectraRadiometer™ Systems

Spectra® Pritchard® SpectraScan®



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SECTION 1
THE PATENTED PRITCHARD OPTICAL SYSTEM

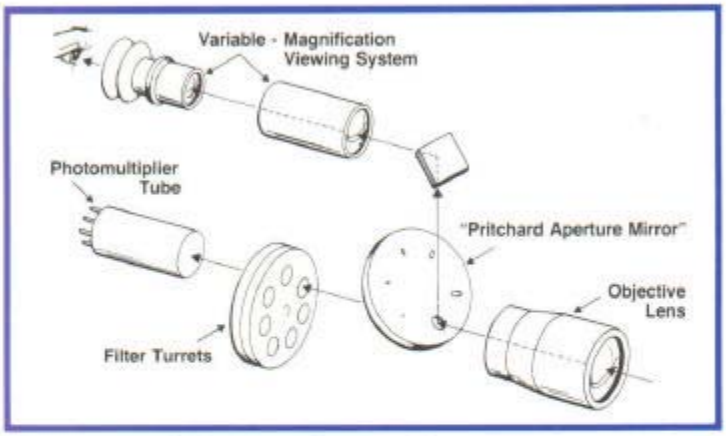


Figure 1: Pritchard Optical System.

The Pritchard Optical System, after more than three decades, is still widely accepted as the most accurate and versatile in use today. As shown in the diagram, the objective lens forms an image at the Pritchard mirror. The light being measured passes through the selected aperture and the filter turrets to the photomultiplier tube. The balance of light at the Pritchard mirror surface is reflected into the patented, variable magnification viewing sysem.* The operator sees a bright, erect, magnified image in the center of which is a black dot. The dot is created by the hole in the mirror, and since only light passing through the hole is being measured, the dot accurately and unambiguously defines the measuring field within the viewing field. The measuring and viewing system is self-aligning. There are no mirrors, fiber optics or other optical impediments in the measuring path, so no polarization error is introduced. A metallic mirror, fabricated with as many as 6 apertures is the heart of this unique system*. Rotating the mirror places a different size aperture on the optical axis, which changes the angular coverage of the measuring field. Five different angular measuring fields from 2 minutes (2') to 3 degrees (3°) are standard, and are available merely by turning a knob. An optional sixth aperture such as a slit aperture is available, as well as numerous optical accessories covering a wide range of light measurement applications. For example, see the patented MicroScanner Spatial Scanning Attachment.

*U.S. Patent 3,813,172 and 3,799,680

The PR-1980B family of Pritchard Tele/Micro SpectraRadiometers is available in a wide variety of configurations to meet your specific spectral, spatial or spectral/spatial requirements. The standard spectral range of the PR-1980B is 370-730 nm. PR-1980B Extended Spectral Range Options are 360-830 nm, 290-830 nm; or with special selection, 360-860 nm or 290-860 nm.

Spectral Scanning System Control Console/Computer Options include the /SC, /USC-1 and /USC-2. The same Console/Computer Options are available for the Spectral/Spatial Scanning System with the SC-80A MicroScanner Linear Spatial Scanner.

For added versatility, all PR-1980B Pritchard SpectraRadiometers retain all the basic capabilities of the PR-1980A Pritchard Photometer when operated in the "A" (Photometer) mode. This "A" Mode of Operation is discussed in Section 5.

Typical Applications

- QC of color CRTs
- Color temperature of CRTs
- QC of color panel displays
- Radiance and colorimetry of light sources
- Primary instrument standard for MIL Spec color
- Color matching
- LED sorting by color and/or intensity
- Color-related human factors studies
- Metameric studies
- Spectral transmission studies
- Spectral reflectance studies
- MTF/contrast measurement of displays
- Automotive lighting
- Airport/aircraft lighting
- Spectrophotometry/colorimetry
- Visual task studies
- Roadway lighting
- Ground truth studies
- Color and intensity distribution of flat panel displays
- Automatic test and evaluation of displays
- QUAL testing

SECTION 2
SPECTRAL SCANNING SYSTEMS

PR-1980B/USC-1 System

Systems Descriptions

PR-1980B/SC, /USC-1 & /USC-2 Spectral Scanning Systems

The PR-1980B/SC, /USC-1 & /USC-2 Pritchard SpectraRadiometers™ are the definitive color measurement systems in the industry today. They significantly reduce the complexity of computer assisted spectroradiometric/spectrocolorimetric scanning, and have been instrumental in taking this technique out of the laboratory environment and making it available as a general quality control or production test procedure.

The systems stress simple, error-free operation, much the same way as the patented** AutoComp,™ AutoRange,™ and AutoZero™ automatic features of the PR-1980A Photometer simplify measurements and reduce human errors. Indeed, all the capabilities and features of that industry-standard instrument are included in the PR-1980B/SC, /USC-1 & /USC-2.

Powerful user friendly software programs have been specifically written to minimize program initiation procedures, often reducing them to a single keystroke command.***

The standard range PR-1980B Pritchard SpectraRadiometer Systems are complete, integrated spectral scanning systems covering the spectrum from 370–730 nanometers. They reflect years of experience in designing human-engineered instrumentation. The operating controls are all conveniently located and easily understood. Operating procedures are simple, and even inexperienced personnel can quickly learn to get maximum utility from the systems. Programs are menu driven to guide the operator throughout the measuring procedure.

Because the monochromator and accompanying optics for spectroradiometric operation are built right into the basic Pritchard Optical Head, the well-recognized performance of the PR-1980A Photometer is totally retained—and this versatile instrument comes fully factory precalibrated. There is no need to "recalibrate" the instrument just before use, as is the case with other spectroradiometric instruments. A single control instantly converts any PR-1980B Pritchard SpectraRadiometer System into the industry standard PR-1980A precision photometer.

**U.S. Patent, 3,818,198

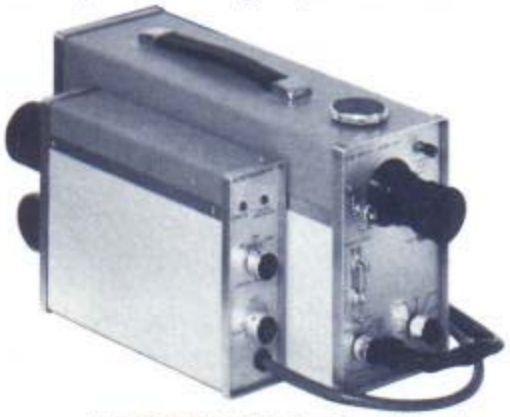
***Note: Computers, software and interfaces are *not* included. See Sections 6 and 7 for software and interface options.

PR-1980BX/SC, /USC-1 & /USC-2 Extended Range Spectral Scanning Systems

The PR-1980BX Systems include all the basic features of the PR-1980B SpectraRadiometers, with the added capability of extended spectral range. While the standard PR-1980BX Extended Range Systems cover the spectral range of 360 to 830 nm, various options allow the instruments to measure from as low as 290 nm in the near-ultraviolet to as high as 860 nm in the near-infrared (see Table C). A system of order-sorting filters eliminates stray light and second-order effects while a thermoelectric photomultiplier cooling system improves sensitivity (signal-to-noise ratio) by at least 3 to 1, and stability by a decade, over a wide range of ambients. Optional quartz optics are available to extend ultraviolet "vision" all the way down to 290 nm. (For further spectral extensions to 1100 nm, see PR-1980C Pritchard Low-Level SpectraRadiometer, Product Bulletin No. 650.)

System Components

The PR-1980B/SC Pritchard SpectraRadiometer Spectral Scanning Systems consist of the PR-1980B-OR Optical Head containing the optical system, the PR-1980B-SC Control Console containing the system electronics, and the required interconnecting cables. The /USC-1 and /USC-2 also include the UCI-80 Universal Computer Interface Levels 1 or 2 and specified software. The PR-1980BX/SC substitutes the PR-1980B-X Extended Spectral Range Optical Head.



PR-1980B-OR Optical Head

The PR-1980B-OR Optical Head includes the Pritchard aperture mirror, variable magnification viewing system, objective lens, two self-contained, seven-position filter turrets, and a specially selected and seasoned low-noise S-20 photomultiplier tube (other detectors are available as factory-installed options—see Extended Range versions). The forward filter turret contains 4 neutral density filters, an open position, and 2 polarization filters. The rear turret contains the CIE matched photopic filter, red filter, blue filter, internal calibration source, an open position, and two positions for optional

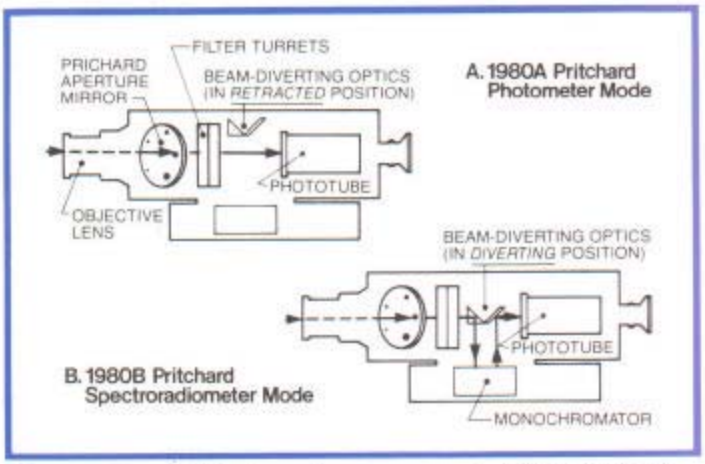


Figure 2: Optical system converts (A) PR-1980A Pritchard Photometer to (B) PR-1980B SpectraRadiometer.

filters (such as tristimulus, scotopic or LED filters). Photometric pulse capability is also optionally available.

This Optical Head differs from the PR-1980 A-OP in that, in addition to the Pritchard Optical System and its controls, it includes the scanning holographic grating monochromator and its controls. (See Figure 2.)

A unique spectral dispersing alternate optical system has been added to facilitate spectroradiometric measurements. Three pre-calibrated bandwidth slits are included—1, 5 and 10 nm (FWHM)—and are switch selectable. A key feature of this alternate optical path is its ability to be readily switched from photometer to spectroradiometer. A single control on the PR-1980B-OR Optical Head handles the conversion from photometric to spectroradiometric operation.

PR-1980B-X Optical Head

This Optical Head is the same as the PR-1980B-OR, but includes an extended multialkali photo-multiplier tube, wide-range monochromator, order sorter, and thermoelectric cooler. (Some systems also have quartz optics.)

Control Console Configurations

The PR-1980B SpectraRadiometer Systems are available in these Control Console Configurations: /SC, /USC-1, and /USC-2.

/SC Control Console

The PR-1980B-SC Control Console actually consists of two separate consoles, one mounted above the other. The lower console is actually a PR-1980A-CD. None of its controls have been changed. Using these controls only, it is possible to use the system as a manual Luminance Photometer. All operational functions in this mode are those of the PR-1980A Photometer ("A" mode). (See Product Bulletin No. 630.)

PR-1980B/SC Control Console

The upper console contains those controls associated with the PR-1980B for spectral scanning. The system can be operated manually as well as under host computer control. The digital wavelength indicator is also on the upper console and functions in either the computer assisted mode or the manual mode.

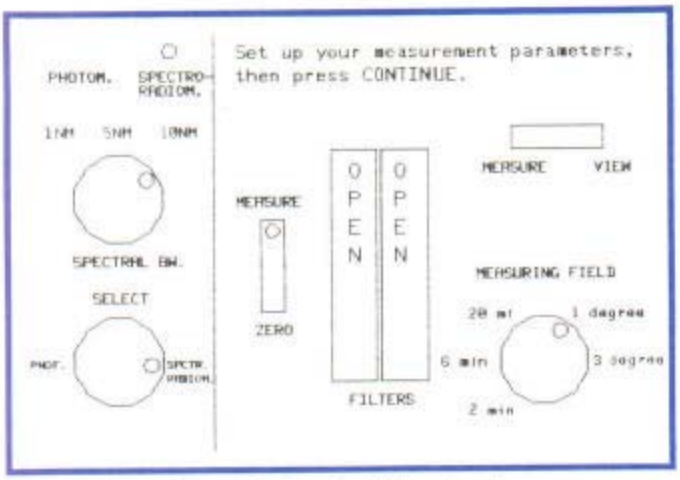


Figure 3: Graphic Optical Head setup on HP-9816/26/36 computer controllers with MOD 6 and 7 Software.

UCI-80 Universal Computer Interface

/USC-1 Control Console

The Universal Computer Interface (UCI-80-1) is a self-contained module that mounts beneath the PR-1980B/SC Control Console. Its operation is based on a Z80B microprocessor. It contains its own power supply and communicates with the same HP computers as the PR-1980B/SC except over the IEEE-488 interface instead of BCD and GPIO interfaces, thereby allowing HP-9816 host control without bus expander. This system uses MOD 7 software (written in HPL) which resides in the HP 9816/26/36 computers. (See Sections 5, 6 and 7.)

/USC-2 Control Console

The Universal Computer Interface (UCI-80-2) uses the same module housing as the UCI-80-1 and its operation is also based on the Z80B. It includes a new proprietary command language called Universal Computer Interface Command Language (UCICL) residing in EPROMs. This new UCICL firmware provides the ultimate in flexibility of operation. It can run with any host computer that has either an IEEE-488 or RS-232C output port.

The UCICL firmware is capable of interpreting simple word, clause or function commands from the host computer and sending the appropriate operational instructions to the system. Electronic disks in the UCI-80-2 provide storage of files during measurements. Optional IBM PC or compatible host software (MOD 9) is also available to fully operate /USC-2 Systems. (See Sections 6 and 7.)

When ordered at the system level, the /USC-2 includes an IEEE-488 interface board, interconnecting cable and MOD 9 Software.

SECTION 3
SPECTRORADIOMETRIC AND PHOTOMETRIC SENSITIVITY

Spectroradiometric and Photometric Sensitivity

The sensitivity ratings of the PR-1980B are based on the capability for making meaningful and accurate spectroradiometric, photometric and colorimetric measurements. Called Threshold Spectral Radiance, Figure 4 illustrates sensitivity as a function of wavelength for the two most commonly used *cooled* photomultiplier tubes (PMTs) with a signal-to-noise ratio of 100:1. The threshold spectral radiance for *uncooled* PMTs is about three times higher (i.e., sensitivity is about three times less for *uncooled* PMTs).

The shapes of these curves reflect the combination of spectral characteristics of the PMTs and all other optical components. PMTs display the most prominent spectral characteristics. The standard range (S-20) PMT exhibits lower noise than the extended red (S-25) PMT, so the S-20 can measure lower level sources in the visible spectral range.

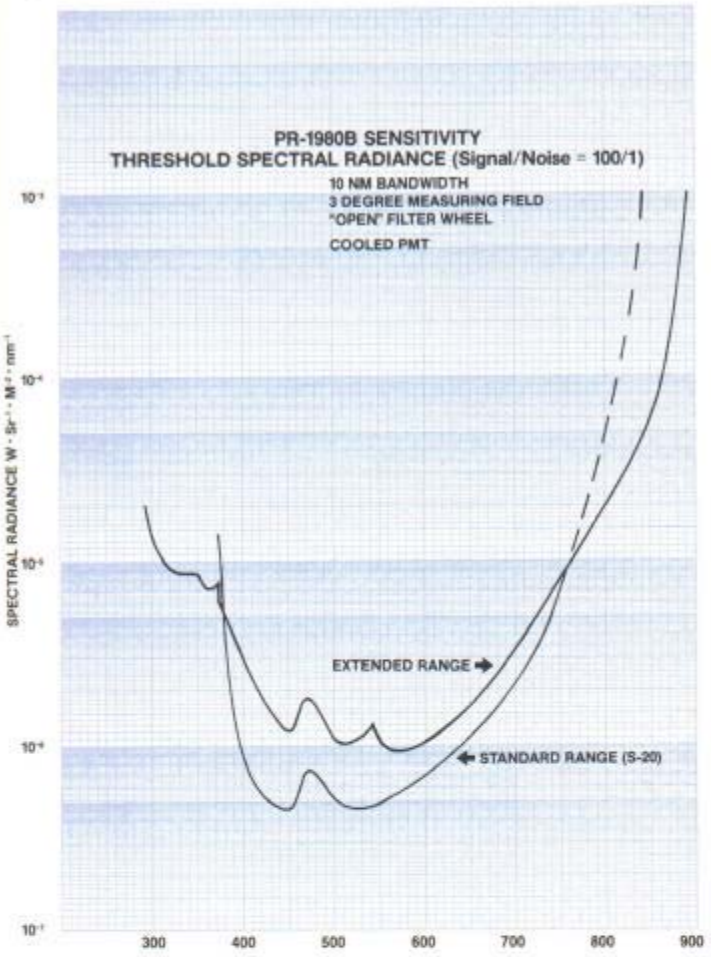


Figure 4: PR-1980B Threshold Spectral Radiance.

A more useful parameter for judging the capability to measure specific light sources is Threshold Spectral Luminance. The following formulas and tables allow the user to estimate the lowest luminance level at which accurate spectral measurements can be made of specific light sources. For threshold spectral luminance, 75% of the radiance of a source is derived from summing spectral radiance values which are greater than the threshold spectral radiance (signal-to-noise ratio of 100:1). Table A gives factors which are primarily spectrum dependent, i.e., source, bandwidth and PMT. Table B gives factors which are primarily related to geometry, i.e., accessory lens and measuring aperture. Note that the factors given in **both** tables are relative to the standard configuration, i.e., a cooled S-20 PMT, 10 nm bandwidth, Illuminant A source, OL-7 Lens, 3° measuring aperture, and no neutral density (ND) filters.

Threshold Spectral Luminance Calculation

(100:1 Signal to Noise)

$$\text{Threshold Spectral Luminance} = 2.0 \times 10^{-2} \times A \times B \times 10^{ND\#} \text{ footLamberts}$$
$$= 6.8 \times 10^{-2} \times A \times B \times 10^{ND\#} \text{ cd/m}^2$$

Choose a factor from Table A representing the source to be measured, the PMT used and the spectral bandwidth; and a factor from Table B representing the lens and the field aperture. Choose the ND filter to be used. Use the appropriate formula above to calculate threshold spectral luminance in either English or metric units.

Reference: 1 cd/m² (lumen · sr⁻¹ · m⁻²) = .2919 footLambert (fL)
1 fL ($1/\pi$ lumen · sr⁻¹ · ft⁻²) = 3.426 cd/m²
1 lux (lumen · m⁻²) = .0929 footcandle (fc)
1 fc (lumen · ft⁻²) = 10.76 lux

For example, to compute the threshold spectral luminance of a P-22 white color TV phosphor set for a 5nm bandwidth cooled S-20 PMT, MS-80A lens, 1° aperture and no ND:

$$\text{Threshold Spectral Luminance:} = 2.0 \times 10^{-2} \times 2.6 \times 10.7 \times 1$$
$$= 0.56 \text{ fL}$$
$$= 1.9 \text{ cd/m}^2$$

TABLE A (factor A)*

	S-20 PMT (STD)			S-25 PMT (Ext. Range)		
	10nm	5nm	1nm	10nm	5nm	1nm
Illuminant A (2856K)	1.00	4.0	100	1.61	6.4	161
2000K Blackbody	.61	2.5	61	.94	3.8	94
Red Color TV (P56)	1.20	5.1	127	2.33	10.1	278
Green Color TV (P-1)	.41	1.6	41	.79	3.2	79
Blue Color TV (P55)	.074	.30	7.4	.172	.69	17.2
White Color TV (P22)	.66	2.6	66	1.42	5.7	142
Blue/Yellow CRT (P4)	.93	3.7	93	1.96	7.8	196
Green CRT (P43)	.82	2.9	54	1.32	4.2	91
Green CRT (P31)	.65	2.6	65	1.50	6.0	150
Red LED 660nm	.058	.23	5.8	.087	.35	8.7
Orange LED 635nm	.29	1.15	29	.41	1.66	41
Yellow LED 588nm	.48	1.90	48	.72	2.9	72
Green LED 566nm	.42	1.67	42	.75	3.0	75
Siemens Blue LED	.47	1.88	47	1.07	4.3	107
Illuminant E	.99	4.0	99	1.86	7.4	186

*For *cooled* PMTs. For *uncooled* PMTs, multiply all values by 3.0.

PR-1980B TABLE B: FIELD COVERAGE AND RELATIVE SENSITIVITY FOR LENSES AND APERTURES

LENS OR ACCESSORY			Focusing Range	Lens-To-Subject Distance	FIELD APERTURE					
Category		Model			3°	1°	20'	6'	2'	0.4' × 40' SLIT
FOCUSABLE		7 in. Standard Lens OL-7	4 ft. (1.22 m) to infinity	1000 ft. (305 m) (1)	663 in. (16.85 m) 1.000	209 in. (5.31 m) 10.00	66.2 in. (1.68 m) 100.0	20.9 in. (531 mm) 1000	6.68 in. (169 mm) 10,000	1.34 × 134 in. (33.8 mm × 3.36 m) 2500
		OL-3.5 (2)	2 ft. (610 mm) to infinity	1000 ft. (305 m) (1)	1326 in. (33.68 m) 1	418 in. (10.62 m) 10	132 in. (3.36 m) 100	41.8 in. (1.06 m) 1000	13.36 in. (339 mm) 10,000	2.68 × 268 in. (68.1 mm × 6.81 m) 2500
		Wide Field Lens WFL-10	0 in. (0 mm) to infinity	10 in. (254 mm) (1)	3.17 in. (80.5 mm) 0.970	1.00 in. (25.4 mm) 9.70	0.317 in. (8.05 mm) 97.0	0.100 in. (2.54 mm) 970	0.032 in. (0.81 mm) 9700	0.006 × 0.6 in. (0.15 × 15 mm) 2400
	Used With OL-7	Illuminance (3) Baffle IB-80B	4 ft. (1.22 m) to infinity	1000 ft. (305 m) (1)	663 in. (16.85 m) 0.0013	N/A	N/A	N/A	N/A	N/A
		Supplementary Lens SL-40 A	21 in. to 57 in. (533 mm to 1.45 m)	40 in. (1) (1.02 m)	2.22 in. (56.4 mm) 1.05	0.700 in. (17.8 mm) 10.5	0.221 in. (5.61 mm) 105	0.070 in. (1.78 mm) 1050	0.022 in. (0.56 mm) 10,500	0.004 × 0.4 in. (0.1 × 10 mm) 2800
		Supplementary Lens SL-20 A	14 in. to 24 in. (356 mm to 609 mm)	20 in. (1) (508 mm)	1.11 in. (28.2 mm) 1.04	0.350 in. (8.89 mm) 10.4	0.111 in. (2.82 mm) 104	0.035 in. (0.89 mm) 1040	0.011 in. (0.28 mm) 10,400	0.002 × 0.2 in. (0.05 × 5.0 mm) 2600
		Supplementary Lens SL-10 A	8 in. to 11 in. (203 mm to 279 mm)	10 in. (1) (254 mm)	0.555 in. (14.1 mm) 1.030	0.175 in. (4.45 mm) 10.3	0.055 in. (1.40 mm) 103	0.018 in. (0.46 mm) 1030	0.006 in. (0.15 mm) 10,300	0.001 × 0.1 in. (0.025 × 2.5 mm) 2600
		MicroSpector LF-19 A	FIXED	2.7 in. (68.6 mm)	0.199 in. (5.07 mm) 1.09	0.063 in. (1.60 mm) 10.9	0.019 in. (0.50 mm) 109	0.006 in. (0.18 mm) 1090	0.002 in. (0.05 mm) 10,900	0.0004 × 0.04 in. (0.01 × 1.0 mm) 2700
		Cosine (5,6) Receptor CR-100	N/A	N/A	N/A 4.3	N/A 43	N/A 430	N/A 4300	N/A 43,000	N/A 11,000
		Fiber Optic (6) Probe FO-80B	N/A	N/A	N/A 15	N/A 150	N/A 1500	N/A 15,000	N/A 150,000	N/A 37,000
	Used With MS-80A	LED Receptor (4) LR-80B	N/A	N/A	0.20 in (50.8 mm) 9×10^{-8}	N/A	N/A	N/A	N/A	N/A
FIXED FOCUS		14 in. Lens OL-14	FIXED Infinity Only	1000 ft. (1) (305 m) to infinity	332 in. (8.43 m) 1.1	105 in. (2.67 m) 11	33.1 in. (841 mm) 110	10.5 in. (265 mm) 1100	3.34 in. (85 mm) 11,000	0.67 × 67 in. (17 mm × 1.7 m) 2700
	Macro Lenses	MacroSpector MS-60A	FIXED	6.6 in. (168 mm)	0.387 in. (9.83 mm) 1.07	0.122 in. (3.09 mm) 10.7	0.039 in. (0.96 mm) 107	0.012 in. (0.31 mm) 1070	0.004 in. (0.10 mm) 10,700	0.0008 × 0.08 in. (0.02 × 2.0 mm) 2700
		MacroSpector MS-610	FIXED	24 in. (610 mm)	0.387 in. (9.83 mm) 1.42	0.122 in. (3.09 mm) 14.2	0.039 in. (0.96 mm) 142	0.012 in. (0.31 mm) 1420	0.004 in. (0.10 mm) 14,200	0.0008 × 0.08 in. (0.02 × 2.0 mm) 3500
		MS-5X	FIXED	0.7 in. (17.8 mm)	0.078 in. (1.98 mm) 1.05	0.024 in. (0.61 mm) 10.5	0.008 in. (0.20 mm) 105	0.002 in. (0.061 mm) 1050	0.0008 in. (0.020 mm) 10,500	0.0002 × 0.02 in. (0.005 × 0.50 mm) 2600
		MS-7X	FIXED	0.7 in. (17.8 mm)	0.055 in. (1.40 mm) 1.15	0.017 in. (0.443 mm) 11.5	0.006 in. (0.142 mm) 115	0.002 in. (0.044 mm) 1150	0.0006 in. (0.016 mm) 11,500	0.00011 × 0.0112 in. (0.0028 × 0.28 mm) 2800
		MS-10X	FIXED	0.6 in. (15.2 mm)	0.039 in. (0.99 mm) 2	0.012 in. (0.30 mm) 20	0.004 in. (0.10 mm) 200	0.001 in. (0.025 mm) 2000	0.0004 in. (0.010 mm) 2000	0.00008 × 0.008 in. (0.002 × 0.2 mm) 5000
		MS-25X	FIXED	0.6 in. (15.2 mm)	0.015 in. (0.393 mm) 14.1	0.005 in. (0.124 mm) 141	0.002 in. (0.04 mm) 1410	0.0005 in. (0.012 mm) 14,100	0.0002 in. (0.004 mm) 141,000	0.00003 × 0.003 in. (0.0008 × 0.08 mm) 35,000
		MS-50X	FIXED	0.3 in. (7.6 mm)	0.008 in. (0.197 mm) 29	0.002 in. (0.062 mm) 290	0.0008 in. (0.0198 mm) 2900	0.0002 in. (0.0061 mm) 29,000	0.00008 (0.0020 mm) 290,000	0.00002 × 0.002 in. (0.00051 × 0.051 mm) 73,000
MicroScanner SC-80A		1X	FIXED	4.5 in. (113 mm)	0.387 in. (9.83 mm) 1.2	0.122 in. (3.09 mm) 12	0.039 in. (0.96 mm) 120	0.012 in. (0.31 mm) 1200	0.004 in. (0.10 mm) 12,000	0.0008 × 0.08 in. (0.02 × 2.0 mm) 3000
		2X	FIXED	2.1 in. (53 mm)	0.194 in. (4.92 mm) 1.2	0.061 in. (1.55 mm) 12	0.019 in. (0.49 mm) 120	0.006 in. (0.155 mm) 1200	0.002 in. (0.05 mm) 12,000	0.0004 × 0.04 in. (0.01 × 1.0 mm) 3000
		5X	FIXED	0.6 in. (15.3 mm)	0.096 in. (2.19 mm) 2.4	0.027 in. (0.69 mm) 24	0.0087 in. (0.22 mm) 240	0.0027 in. (0.068 mm) 2400	0.0009 in. (0.023 mm) 24,000	0.0002 × 0.02 in. (0.005 × 0.5 mm) 6000
		10X	FIXED	0.44 in. (11.2 mm)	0.047 in. (1.19 mm) 5.3	0.015 in. (0.38 mm) 53	0.0047 in. (0.12 mm) 530	0.0015 in. (0.037 mm) 5300	0.0005 in. (0.012 mm) 53,000	0.0001 × 0.01 in. (0.0025 × 0.25 mm) 13,000
		20X	FIXED	0.44 in. (11.1 mm)	0.025 in. (0.62 mm) 1.6	0.0077 in. (0.20 mm) 16	0.0025 in. (0.063 mm) 160	0.00076 in. (0.019 mm) 1600	0.00025 in. (0.006 mm) 16,000	0.00005 × 0.005 in. (0.0012 × 0.12 mm) 4000

Notes: Numbers shown in blue are relative sensitivity factors.

(1) Field coverage is proportional to distance. For example, coverage at 100 ft. is 1/10 the coverage at 1000 ft.

(2) Field coverage is twice (2x) OL-7 coverage, but it cannot be used with IB-80B or LR-80B.

(3) The results of this threshold sensitivity calculation are in the units of footcandles, lux and W · Sr^{-1} with a 3° field aperture only.

(4) This factor and the source factor (A) must be applied only to the threshold luminance in cd/m^2 to give threshold luminous intensity in candelas.

(5) The results of this threshold sensitivity calculation are in the units of footcandles, lux and W · Sr^{-1}.

(6) The CR-100 and FO-80 have lower blue transmission than other accessories. These factors may be higher for predominantly blue light sources (not for ultraviolet).

TABLE C: PR-1980B WAVELENGTH RANGE SELECTION

All the options below apply without change when the /SS Spatial Scanner is added to the system.#

Desired Spectral Range (nanometers)	System Model Number	Required and Elective Options				
		OPTION 20 Thermoelectric Cooler**	OPTION 21-0 Extended Multi-alkali Phototube	OPTION 30 Quartz Optics* #	OPTION 35 Quartz ND Filters*	OPTION 40 Wide-Range Monochromator and Order-Sorter System
370-730	PR-1980B	Recommended	—	—	—	—
360-830	PR-1980BX	Required	Required	—	—	Required
360-860	PR-1980BX	Required	Requires 21-1	—	—	Required
290-830	PR-1980BX	Required	Required	Required	Recommended*	Required
290-860	PR-1980BX	Required	Requires 21-1	Required	Recommended*	Required

NOTES:

* Option 30, Quartz Optics, includes a Quartz Objective Lens and internal quartz optics, but does **NOT** include Quartz ND Filters. To order Quartz ND filters (for operation at levels below 360nm), specify Opt 35 in addition to Opt 30.

** The thermoelectric cooler provides a 3X increase in detectivity (signal-to-noise) and stabilization of sensitivity against ambient temperature changes. Recommended for operation from 370nm to 730nm; REQUIRED for operation below 370nm and above 730nm.

\# No Quartz lenses available for SC-80A MicroScanner

SECTION 4

SPECTRAL/SPATIAL SCANNING SYSTEMS

PR-1980B/SS System

Systems Descriptions

PR-1980B/SS, /USS-1 & /USS-2 Spectral/Spatial Scanning Systems

The PR-1980B/SS, /USS-1 & /USS-2 include all the capabilities of the PR-1980B/SC and add the significant enhancement of spatial scanning. In addition to spectral scanning, they provide high-resolution spatial scanning capability without requiring that either the instrument or the target be moved during the scan. And they permit spectral and spatial scans to be intermixed in any desired sequence either under full computer control or manual control.

The linear spatial scanning capability is provided by the unique, patented* MicroScanner® Optical System (SC-80A-OP Optical Head), which translates the image of the target with reference to the Pritchard's optical system. The MicroScanner unit replaces the standard objective lens of the PR-1980B-OR. Under computer control, the objective lens of the MicroScanner traverses up to one full inch (25mm) of the target in increments as fine as 0.1 mil up to 1000 total steps, regardless of lens magnification. Under manual control, the scan speed is continuously variable between 4 and 180 mils/minute, also scanning up to one full inch of target.

*U.S. Patent No. 4,279,507

The versatility of the PR-1980B/SS, /USS-1 & /USS-2 Computer Controlled Spectral/Spatial Scanner Systems allow operation as a photometer, microspectroradiometer/colorimeter, spatial scanning microphotometer, or any combination of the above as the needs of the particular application dictate.

PR-1980B/USS Spectral/Spatial Scanning System with Universal Computer Interface

The PR-1980B/USS is identical to the PR-1980B/SS, with the added versatility of being able to operate with virtually any computer or intelligent terminal on the market. This capability is provided by the Universal Computer Interface (UCI-80) which is available in two Levels. Level 1 is tailored to users of the HP-9816/26/36 computers, eliminates the need for BCD and 16-bit interfaces and scans much faster than a standard system. It includes MOD 7 Software. Level 2 enables the system to operate with any computer having IEEE-488 or RS-232C I/O ports, and requires the operator to write his own software. But, for IBM PC and compatible computers, Photo Research offers full Operating Software for complete Level 2 performance (Opt. 93-0).

PR-1980BX/SS, /USS-1 & /USS-2 Extended Range Spectral/Spatial Scanning Systems

The PR-1980BX/SS, /USS-1 & /USS-2 Systems include all the basic features of the PR-1980B/SS with the added extended spectral range capability. Various options allow the instrument to "see" from 290 nm in the near-ultraviolet to 860 nm in the near-infrared. A unique system of order-sorting filters eliminates stray light and second order effects, while a thermoelectric photomultiplier cooling system improves detectivity (signal-to-noise ratio) by at least 3 to 1, and stability by a decade, over a wide range of ambients. No quartz options are available for the MicroScanner.

System Components

The PR-1980B/SS Computer Controlled Spectral/Spatial Scanner consists of the PR-1980B-OR Optical Head; the MicroScanner optical attachment, SC-80A-OP; the /SC Control Console containing the system electronics and controls, and the interconnecting cable. The /USS-1 also includes the UCI-80-1 Universal Computer Interface and MOD 7 Software. When ordered at the system level, the /USS-2 includes the UCI-80-2 with UCICL Firmware, IEEE-488 interface board and cable and MOD 9 Software for the IBM PC or compatible computer. The PR-1980BX/SS substitutes the PR-1980B-X Optical Head.

PR-1980B-OR Optical Head with SC-80A-OP MicroScanner Optical Head

The MicroScanner System consists of the PR-1980B-OR Optical Head with the SC-80A MicroScanner. The objective lens of the MicroScanner is stepper-motor driven, so that the scanner traverses up to a full inch (25mm) of the target regardless of lens magnification. The MicroScanner Optical Head is equipped with the 1x objective lens. When ordering the MicroScanner Optical Head as part of a system (e.g. 1980B/SS, 1980B/USS, etc.) a special 0.4 minute X 40 minute slit aperture is included in the sixth position of the Pritchard mirror. Photometric pulse capability is also optionally available. (See Section 8.) Quartz optics are **NOT** available for the SC-80A.

PR-1980B-X Optical Head with SC-80A-OP MicroScanner Optical Head

This optical head is the same as the PR-1980B-OR with SC-80A-OP MicroScanner, but includes an extended range multialkali phototube, wide-range monochromator and order sorter, and thermoelectric cooler. Quartz optics are **NOT** available for the SC-80A.

Control Console Configurations

Control Console/Computer configurations /SS, /USS-1 and /USS-2 are the same as those described under Spectral Scanning System Components, above.

*IBM is a registered trademark of International Business Machines Corporation.

SECTION 5
"A" (PHOTOMETER) MODE OF OPERATION

In the "A" Mode of Operation, the functions of the PR-1980B SpectraRadiometer systems are identical to those of the PR-1980A Photometer, and its operation is just as simple and foolproof. The activation of a single control on the Optical Head instantly converts a PR-1980B SpectraRadiometer into a PR-1980A Photometer.

Still the proven leader in precision photometric/colorimetric light measuring instruments after more than three decades, the Spectra Pritchard Photometer is known for its superior performance, reliability, high sensitivity and maximum versatility in the lab or in the field. It features the patented Pritchard Optical System described in Section 1. This system includes built-in attenuators, polarizers, colorimetry filters and field apertures interchangeable from 2 arc-minutes to 3 degrees. Many special apertures are also available as options.

The instrument also combines five dynamic features possessed by no other light measuring system—our patented** AutoComp,* AutoRange™ and AutoZero™ features plus detector overload protecton and internal calibration verification. Together these features virtually eliminate human error and manual computations, while maintaining a precise, error-free direct readout.

**U.S. Patent 3,818,198

"A" Mode Optical Head Operation

When the mode switch is in the "Photometer" position, the Optical Head is functionally identical to the PR-1980A-OP Optical Head. It contains the patented Pritchard aperture mirror, the patented variable magnification viewing system, objective lens, two self-contained seven-position filter turrets, and a specially selected and seasoned low-noise S-20 photomultiplier tube (other detectors available as factory-installed options).

Internal Calibration Verification is as simple as one, two, three.

1. Set the Function Switch to Zero Amplifier and check/adjust.
2. Set the Function Switch to AutoZero Dark Current with the Measure Shutter closed.
3. Place the Function Switch to Internal Calibration, rotate the Rear Filter Wheel to CAL, open the Measure Shutter and check/adjust the CAL value for both "A" and "B" Mode operation.

Detector Overload Protection is a significant feature of Pritchard systems. To prevent damage to the sensitive detector from excessive light flux, the overload circuit is activated, clamping detector current to a safe level and activating an audible alarm. Detector Overload is active in both "A" and "B" Modes.

"A" Mode Control Console Operation

All the controls affecting "A" Mode (Photometer) operation are located on the lower control console, which is actually the PR-1980A-CD Control Console.

The PR-1980A-CD Control Console contains the readouts, controls and system electronics for the PR-1980A Photometer. Included are the AutoComp,* AutoRange™ and AutoZero,™ detector overload protection circuit and other outstanding features, which virtually eliminate human error.

The AutoComp Direct Readout System* is a self-contained computer which automatically calculates the correct readout for all possible combinations of filters, apertures, and settings. This readout is supplied in the form of a number from 0.01 to 19.99 on a digital meter. A multiplier readout is also provided, which can be varied from 10^{-8} to 10^{7}, depending on the various combinations of settings.

*U.S. Patent, 3,818,198

AutoRanging automatically changes the electrical sensitivity to provide an optimum reading over any of four ranges. Coupled with the 3½-digit readout, AutoRanging provides a usable reading—without operator adjustment—over a light range of 10,000 to 1. The range control may also be locked manually on any single range.

AutoZero provides completely automatic nulling of phototube dark current.

"A" Mode Special and Enhanced Versions

Several versions of the basic PR-1980A are available for specialized applications. (See Product Bulletin No. 630.)

SECTION 6
PR-1980B SPECTRARADIOMETER CONTROL SYSTEMS AND SOFTWARE

The PR-1980B SpectraRadiometer is available in three different system control configurations.

1— The PR-1980B/SC Control System
2— The UCI Level 1 Control System (UCI-80-1)
3— The UCI Level 2 Control System (UCI-80-2)
All three can operate both the Spectral Scanning Systems and the Spectral/Spatial Scanning Systems.

PR-1980B/SC Control System (See MOD 6 Software)

In this configuration the PR-1980B is operated under the control of the HP 9816/26/36 series of desktop computers (except 9836C). Communication is through BCD and GPIO interfaces using MOD 6 Software (written in HPL).

MOD 6 Software (No UCI) Spectral (Option 84-1) and Spectral/Spatial (Option 86-1)

This software culminates over four years of development in spectral and spatial measurement technology. MOD 6 Software is available for the PR-1980B/SC Control System in either 3½" or 5¼" media.

MOD 6 is a user-interactive program, capable of performing a wide range of measurements. For example, single-interval spectral or spatial scans, multi-interval spectral or spatial scans, spectral scans at 'n' positions, spatial scans at 'n' wavelengths, spatial data 'smoothing,' ratio, log, product, sum, difference, logarithmic plotting, manual data entry, data point interpolation, CIE L*u*v*a*b* calculations, Color Difference computations, and many more.

UCI Level 1 Control System (UCI-80-1) (See Option 46-0 and MOD 7 Software)

System flexibility is enhanced with the Universal Computer Interface (UCI), Level 1. Based on the Z-80B microprocessor, this system allows operation with the same HP computers as the PR-1980B-SC version, except that communication is faster via a single HPIB (IEEE-488) interface. This system configuration is equipped with MOD 7 Software—a MOD 6 clone, designed to adapt the system for use with the IEEE-488 interface thereby allowing HP-9816 host control without bus expander.

MOD 7 Software (for UCI Level 1) Spectral (Option 84-2) and Spectral/Spatial (Option 86-2)

The introduction of the UCI-80-1 Universal Computer Interface with its IEEE-488 interface resulted in the development of MOD 7 Software. It is identical in function to MOD 6 Software above in performance and output results, but with reduced scanning times, and is available in either 3½" or 5¼" media.

MOD 7 Software is available for the UCI Level 1 Control System only.

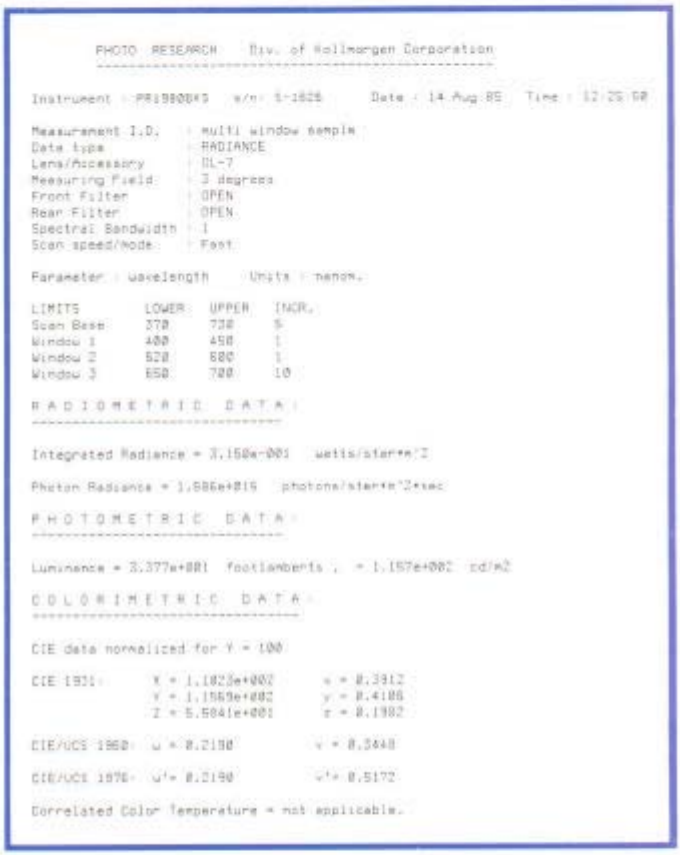


PHOTO RESEARCH Div. of Kollmorgen Corporation

Instrument : PR1980B/S s/n: S-1826 Date : 14 Aug 85 Time : 12:25:58

Measurement I.D.	multi window sample
Data type	RADIANCE
Lens/Accessory	OL-7
Measuring Field	3 degrees
Front Filter	OPEN
Rear Filter	OPEN
Spectral Bandwidth	1
Scan speed/mode	Fast

Parameter : wavelength Units : nanom.

LIMITS	LOWER	UPPER	INCR.
Scan Base	370	730	5
Window 1	400	450	1
Window 2	520	680	1
Window 3	650	720	10

RADIOMETRIC DATA:

Integrated Radiance = 3.150e-001 watts/ster*m^2

Photon Radiance = 1.686e+015 photons/ster*m^2*sec

PHOTOMETRIC DATA:

Luminance = 3.377e+001 footlamberts , = 1.157e+002 cd/m2

COLORIMETRIC DATA:

CIE data normalized for Y = 100

CIE 1931:	X = 1.1823e+002	x = 0.3912
	Y = 1.1569e+002	y = 0.4186
	Z = 5.5041e+001	z = 0.1902
CIE/UCS 1960:	u = 0.2190	v = 0.3448
CIE/UCS 1976:	u'= 0.2190	v'= 0.5172

Correlated Color Temperature = not applicable.

Figure 5: Typical printout showing setup and parametric data (common to all software).

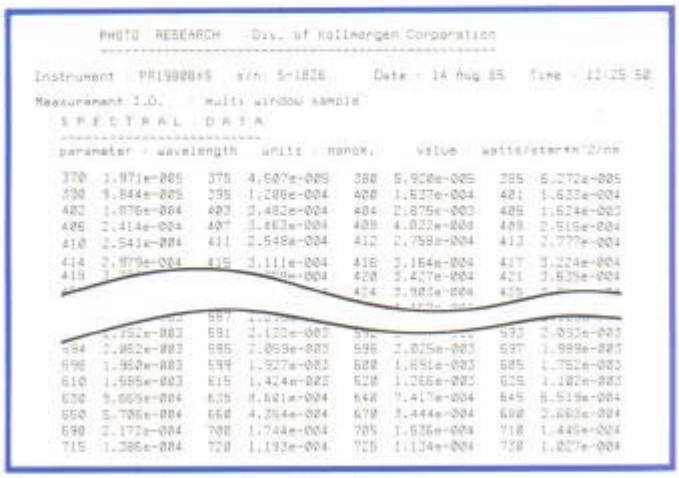


PHOTO RESEARCH Div. of Kollmorgen Corporation

Instrument : PR1980B/S s/n: S-1826 Date : 14 Aug 85 Time : 12:25:58

Measurement I.D. : multi window sample

SPECTRAL DATA

parameter : wavelength	units : nanom.	value	watts/ster*m^2/nm
370 1.971e-005	375 4.687e-005	380 5.926e-005	385 6.272e-005
390 9.844e-005	395 1.286e-004	400 1.537e-004	405 1.633e-004
410 1.676e-004	415 1.482e-004	420 1.875e-003	425 1.624e-003
430 2.414e-004	435 3.863e-004	440 4.822e-004	445 2.515e-004
450 2.541e-004	455 2.548e-004	460 2.758e-004	465 2.777e-004
470 2.979e-004	475 3.111e-004	480 3.164e-004	485 3.224e-004
490 3.[illegible]	495 [illegible]e-004	500 3.427e-004	505 3.639e-004
[illegible]	[illegible]	520 3.982e-004	525 [illegible]
[illegible]	[illegible]	[illegible]	[illegible]
580 2.332e-003	585 2.120e-003	590 [illegible]	595 2.093e-003
600 2.062e-003	605 2.059e-003	610 2.025e-003	615 1.999e-003
620 1.952e-003	625 1.927e-003	630 1.851e-003	635 1.752e-003
640 1.585e-003	645 1.424e-003	650 1.266e-003	655 1.182e-003
660 9.805e-004	665 8.681e-004	670 7.417e-004	675 6.519e-004
680 5.706e-004	685 4.954e-004	690 3.444e-004	695 2.663e-004
700 2.177e-004	705 1.744e-004	710 1.536e-004	715 1.445e-004
720 1.386e-004	725 1.193e-004	730 1.134e-004	735 1.027e-004

Figure 6: Typical printout showing power vs. wavelength (common to all software).

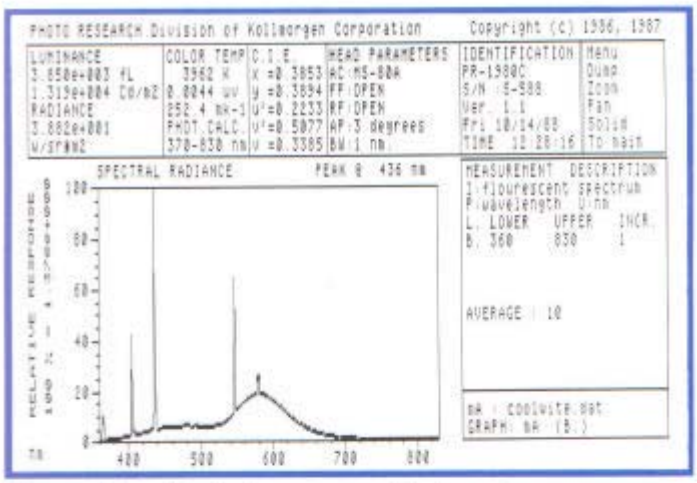


Figure 7: Typical screen plot showing power vs. wavelength, MOD 9 Software.

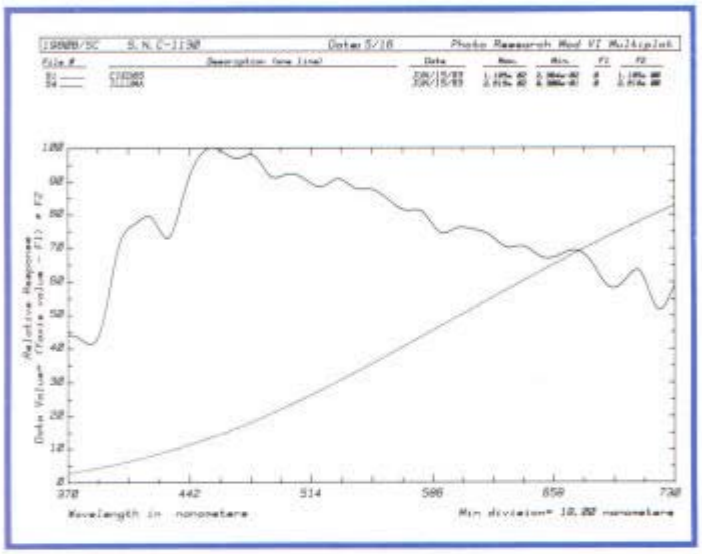


Figure 8: Hard copy multiplot, MOD 6 and 7 Software.

UCI Level 2 Control System (UCI-80-2) (See UCICL Firmware, Option 46-1 and MOD 9 Software)

The latest development in PR-1980B Spectra-Radiometer control systems is the UCI Level 2 package. This system (also Z-80B based) utilizes Universal Computer Interface Command Language (UCICL) logic, residing in EEPROMs located in the UCI Console, to interpret commands sent from a host terminal/computer.

All PR-1980B Systems scan fastest under UCI-80-2 control.

UCICL Firmware (Included in Option 46-1)

This entirely new firmware package is designed to operate with the UCI-80-2 Universal Computer Interface, and provides unparalled flexibility.

The UCICL Firmware can function either as a stand-alone control system (as in an automated test application), or as a low-level language to the MOD 9 Software package.

The stand-alone UCICL control system enables **any** computer capable of communicating over RS-232C or IEEE-488 interfaces to be used to operate the PR-1980B SpectraRadiometer. The user accesses the UCICL by sending UCICL commands, which define measurement parameters and perform measurement functions, to the UCI console. UCICL commands are assembled by the user, and may range in complexity from a single word to several interrelated command clauses, therefore providing the operator with complete control over the sophistication of spectroradiometric and microphotometric measurement.

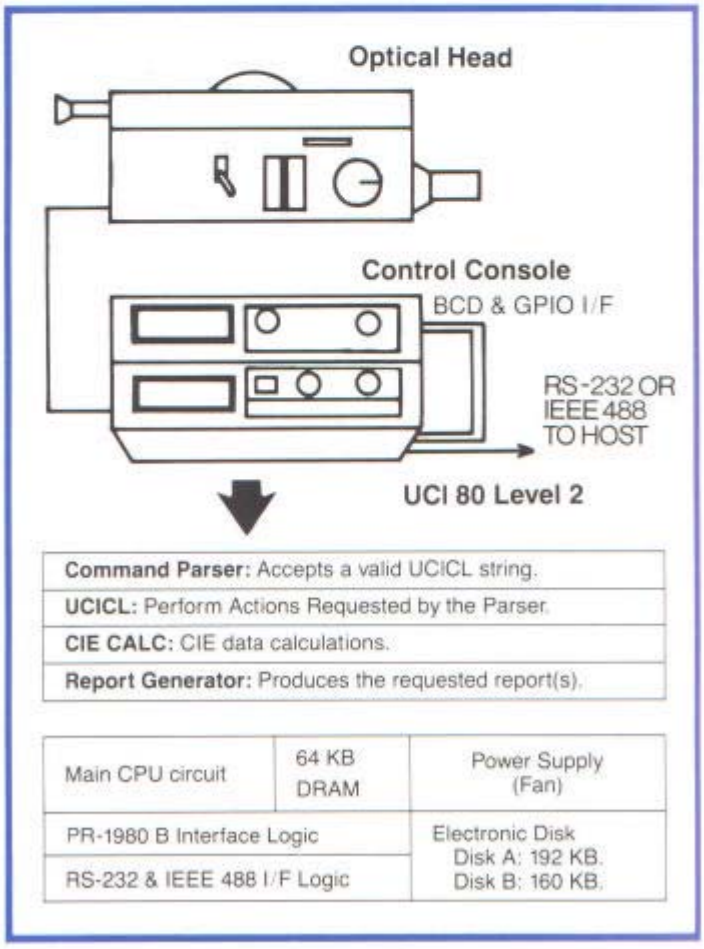


Figure 9: PR-1980B UCI-80-2 with UCICL firmware.

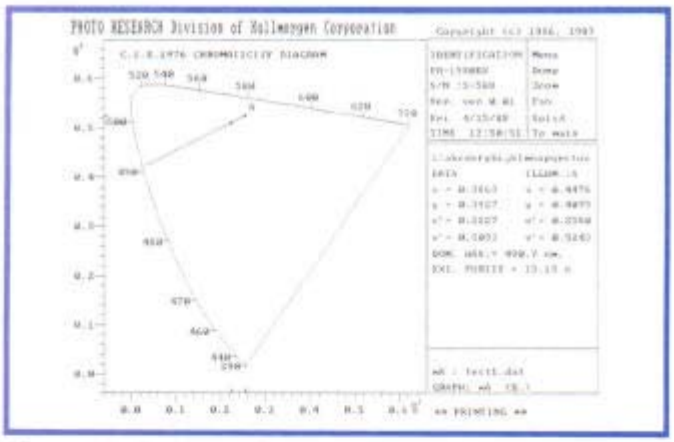


Figure 10: Typical MOD 9 CIE chromaticity diagram plot.

MOD 9 Software For UCI Level 2 System Operations (Options 93-0 or 93-1)

For IBM-PC (and compatible) users, MOD 9 software is available which uses a UCICL-based, menu-driven program through the IEEE-488 interface. The DOS-based MOD 9 software package provides all the capabilities offered in the HPL-based MOD 6 and MOD 7 packages, plus monochrome or color and ZOOM graphics enhancements. Available in either 3½" or 5¼" media, it utilizes the UCICL firmware in the UCI Level 2 Console. With MOD 9, pre-defined functions are selected by the user from on-screen menus, and the appropriate UCICL command string is sent to the UCI console. The MOD 9 Software thus functions as a high-level language to the UCI, by assembling UCICL commands into measurement functions, and offering them to the user in the on-screen menus.

The function-oriented MOD 9 program provides full spectroradiometric and spatial measurement capabilities, plus graphics enhancements, and allows them to be performed by personnel having relatively little training. By virtue of the UCICL-based design, the user also has the option of exiting the MOD 9 program and implementing the stand-alone UCICL firmware program, enabling the user to send self-constructed macro commands directly to the UCI console via application-specific software.

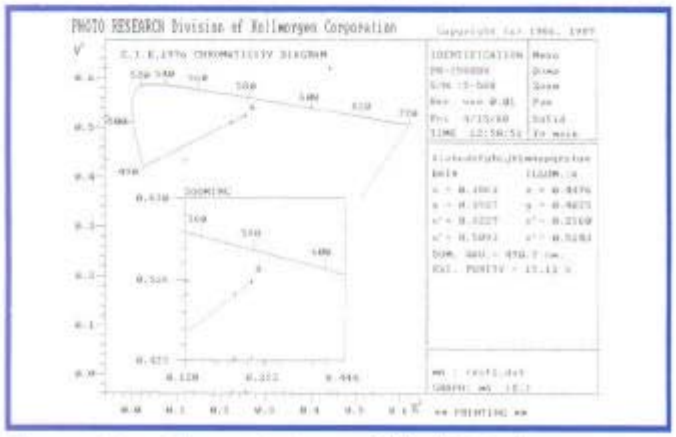


Figure 11: Zoom feature of Mod 9 Software.

SECTION 7
INTERFACE AND COMPUTER REQUIREMENTS

The standard (non-UCI) PR-1980B Systems are:

1—PR-1980B/SC
Spectral Scanning
2—PR-1980B/SS
Spectral/Spatial Scanning
3—PR-1980BX/SC
Spectral Scanning, Extended Range
4—PR-1980BX/SS
Spectral/Spatial Scanning, Extended Range

1—HP 9826/36A Computer Controllers

These two computers can be integrated with the PR-1980B Systems with one exception. The *HP 9836C which has a color CRT cannot operate the PR-1980B system software.* The block diagram on page 13 portrays the configurations for these computers with the standard PR-1980B Systems. Because the HP 9826A does not have an integral printer, an external printer is required to run the software. The recommended printer is the HP Think Jet Model 2225A. Other printers may possibly be used, consult the factory before assuming another printer is acceptable.

When these computers are used with the PR-1980B/SC both a GPIO and a BCD interface are required. These interfaces consist of plug-in cards for the computer and cables that attach to these cards and the Control Console of the PR-1980B. These interfaces and cables are specified as follows:

GPIO: HP 98262A Option 001 15 foot cable
BCD: HP 98623A Option 001 15 foot cable

The option cited provides for the cable as well as the interface card. If these cables are ordered separate from the interface card, i.e., no option on the card part number, their part numbers are:

GPIO Cable: HP5061-4209 15 foot cable
BCD Cable: HP5061-4217 15 foot cable

In either case above, the cables must be terminated on the end which connects to the PR-1980B console. It is recommended that this termination be done by Photo Research. Instructions are available for those customers who wish to do their own termination.

The HP 9826/36A includes a built-in HPIB (IEEE 488) interface and one HPIB (IEEE 488) cable. This cable is dedicated to the external printer.

The HP 2225A Printer will produce a graphics screen dump, but this is plotted in the CRT screen size. An additional plotter is needed for 8½ X 11 or larger hard copy plots or multi-plots. For 8½ X 11 plots the recommended plotter is the HP 7470A or HP 7475.

Either of the plotters described above require an additional HPIB Cable, P/N 10833A 3.3 foot cable.

Two additional items must be specified for the HP 9826/36A computers. They are:

1. HPL 2.0 or 2.1 Option 655 for 5¼" internal disk drive
2. HP 98256A 256 Kbyte RAM board

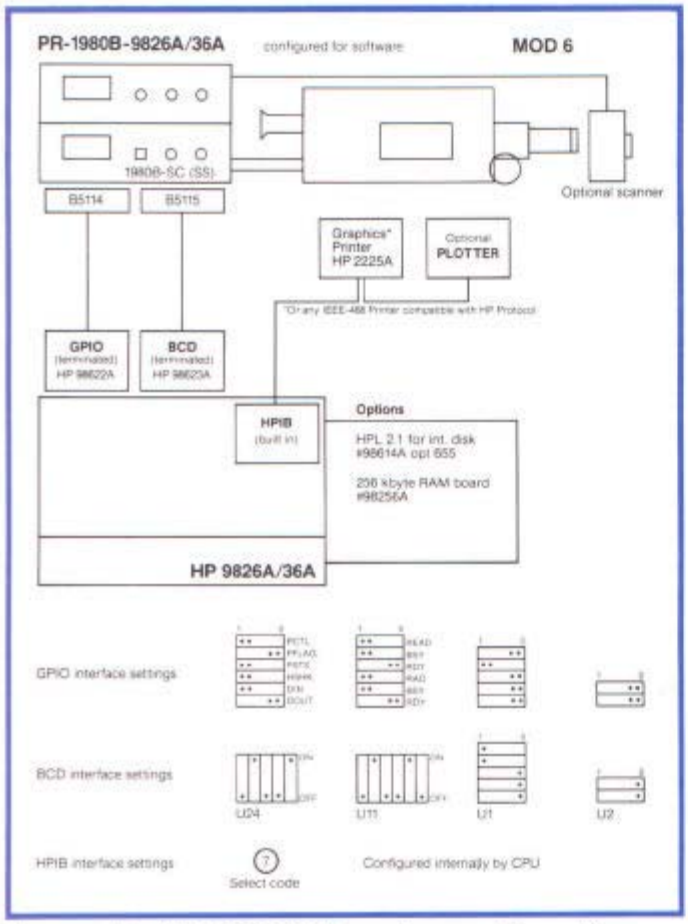


Figure 12: HP 9826/36A system configuration without UCI.

2—HP 9816A Computer Controller

NOTE: The HP 9816 Computer cannot be used with the standard PR-1980B Systems configurations described above without an I/O expander due to the lack of sufficient I/O ports in the HP 9816. Two are required and only one is available. The block diagram below portrays the configuration for this computer with the I/O expander instead of the UCI.

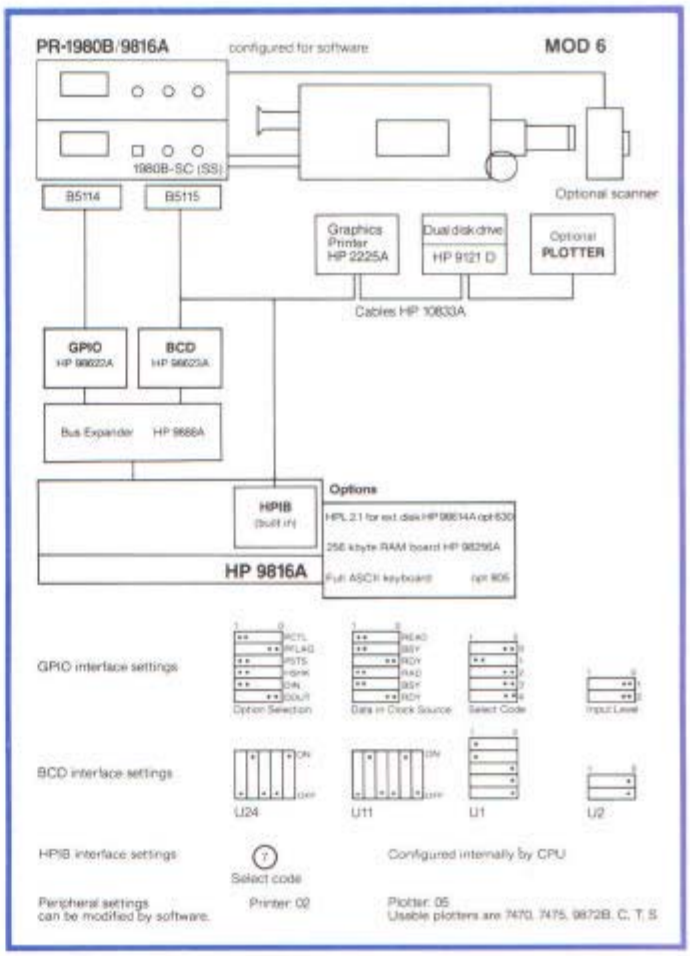


Figure 13: HP 9816A system configuration without UCI.

Universal Computer Interface Level 1

The UCI-80-1 versions of the PR-1980B Systems are:

1—PR-1980B/USC-1
Spectral Scanning
2—PR-1980B/USS-1
Spectral/Spatial Scanning
3—PR-1980BX/USC-1
Spectral Scanning, Extended Range
4—PR-1980BX/USS-1
Spectral/Spatial Scanning, Extended Range

The system configurations for the UCI versions of the PR-1980B Systems are covered in detail below.

1—HP 9816A Computer Controller

The HP 9816 computer can be used without the I/O expander ONLY with the UCI-80-1, Universal Computer Interface, versions of the PR-1980B Systems. The block diagram below describes the system configuration of this combination.

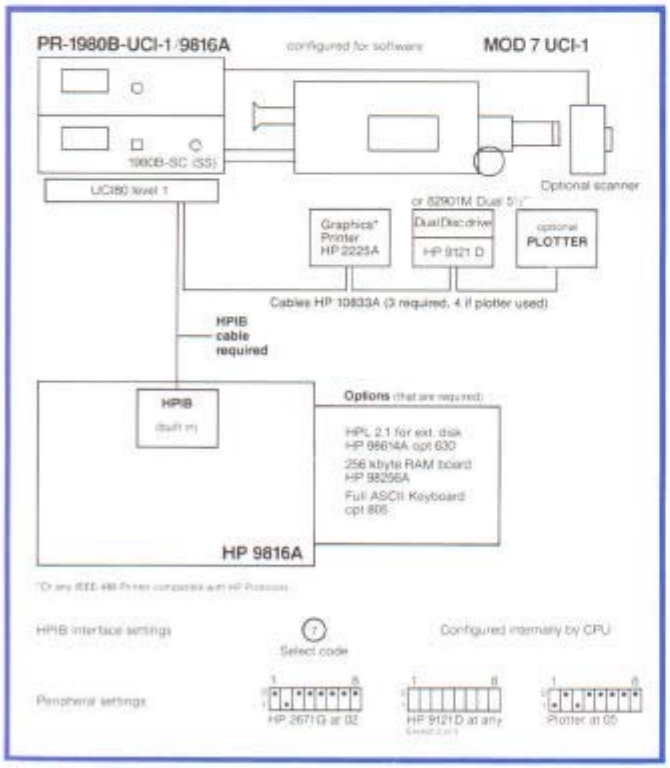


Figure 14: HP 9816A system configuration with UCI-80-1.

When these computers are used with the UCI-80-1 versions of the PR-1980B Systems, only the HPIB interface connections can be used. One HPIB cable, 6.6 feet long, is supplied with the HP 9816 Computer. This cable will serve to connect the computer to the UCI-80-1. The recommended printer is the HP 2225A Graphics Printer, which requires an additional HPIB Cable, P/N 10833A.

The HP 2225A Printer will produce a graphics screen dump, but this is plotted in the CRT screen size. An additional plotter is needed for 8½ X 11 or larger hard copy plots or multiplots. For 8½ X 11 plots the recommended plotter is the HP 7470A or HP 7475. Either of the plotters described above require an additional HPIB Cable, P/N 10833A 3.3 foot cable.

Four additional items must be specified for the HP 9816 computer, they are:

1. HPL 2.0 or 2.1 Option 630 for 3½" external disk drive, Option 655 for 5¼"
2. HP 98256A 256 Kbyte RAM board
3. HP 9816 Option 805 Full ASCII keyboard
4. HP 9121D Dual Disk Drive, 3½" floppy disks or HP 82901M Dual Disk Drive, 5¼" floppy disks

2—HP 9826/36A Computer Controllers (HP 9836C not supported)

When these computers are used with the UCI-80-1 versions of the PR-1980B Systems, only the HPIB interface connections are required. One HPIB cable, 6.6 feet long, is supplied with the HP 9826/36A Computer. This cable will serve to connect the computer to the UCI-80-1. The recommended printer is the HP 2225A Printer, and requires an additional HPIB Cable, P/N 10833A 3.3 foot cable. The block diagram below describes the system configuration of these combinations.

The HP 2225A Printer will produce a graphics screen dump, but this is plotted in the CRT screen size. An additional plotter is needed for 8½ X 11 or larger hard copy plots or multiplots. For 8½ X 11 plots the recommended plotter is the HP 7470A or 7475. Larger plots can be obtained with the HP 9872C plotter.

Two additional items must be specified for the HP 9826/36 computers. They are:

1. HPL 2.0 or 2.1 Option 655 for 5¼" internal disk drive
2. HP 98256A 256 Kbyte RAM board

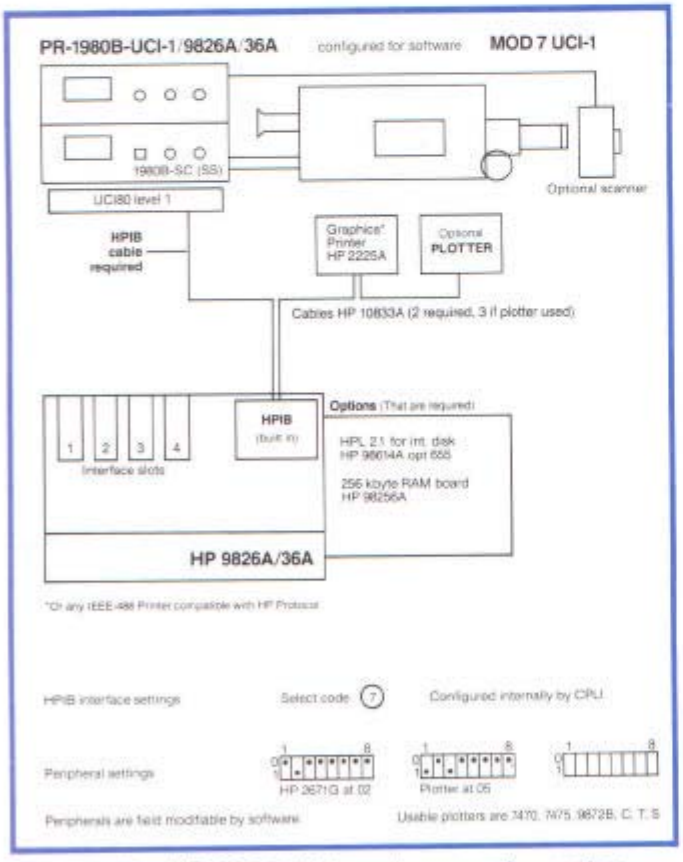


Figure 15: HP 9826/36A system configuration with UCI-80-1.

Universal Computer Interface Level 2

The UCI-80-2 versions of the PR-1908B with the IBM PC/XT/AT are:

1—PR-1980B/USC-2 Spectral Scanning
2—PR-1980B/USS-2 Spectral/Spatial Scanning
3—PR-1980BX/USC-2 Spectral Scanning, Extended Range
4—PR-1980BX/USS-2 Spectral/Spatial Scanning, Extended Range

When the IBM PC or Compatible computer is used with the UCI Level 2 version of the PR-1980B under control of MOD 9 Software, communication is through an IEEE-488 port.

Minimum computer hardware requirements are:

1. MS-DOS (or PC-DOS) 3.0 or above
2. One 5¼" disk drive (two if no hard disk in Host)
3. A minimum of 512K RAM
4. IEEE-488 Interface Card, National Instruments Model GPIB-PC2A and interconnecting cable*
5. CGA 640 X 200 interlaced monitor capable of receiving RGB input. IBM-CGA compatible graphics card.
6. (For color) EGA-compatible monitor (e.g. NEC Multisync or equivalent) and EGA graphics adaptor
7. Math coprocessor (strongly recommended)

Hard copies of the Spectral or Spatial results are obtainable with EPSON or HP Laser Jet Series II compatible printers.

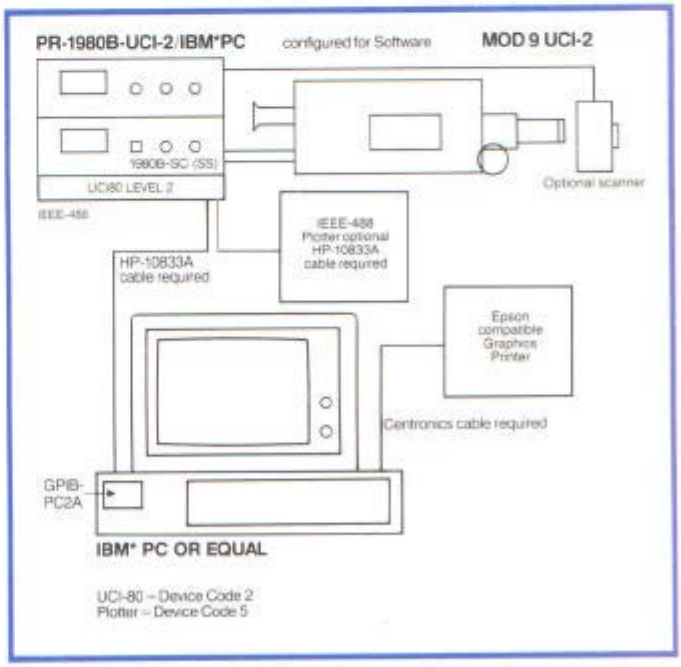


Figure 16: IBM-PC system configuration with UCI-80-2.

*Included if /USC-2 ordered at system level

SECTION 8
OPTION AND ACCESSORY DESCRIPTIONS

Internal Aperture Options*

OPTION 01—*0.4 Min. × 40 Min. Horizontal Aperture* This rectangular slit horizontal aperture is designed for Line Width Measurements when operating in the Spaital Scanning Mode. Other aspect ratio slit apertures are listed below (standard with /SS systems).

OPTION 02—*2 Min. × 2 Degrees Horizontal Aperture*

OPTION 03—*0.4 Min. × 4 Min. Vertical Aperture*

OPTION 04—*1 Min. Circular Aperture*

OPTION 05—*15 Min. Circular Aperture*

OPTION 06—*30 Min. Circular Aperture*

OPTION 07—*2 Min. × 10 Min. Horizontal Aperture*

OPTION 08—*Trapezoidal Aperture for right-side roadway luminance measurements (Includes WFL-10 Lens)*

OPTION 09—*0.4 Min. × 40 Min. Horizontal Aperture and 0.4 Min. × 4 Min. Vertical Aperture*

OPTION 10—*0.4 Min. × 10 Min. Horizontal Aperture*

OPTION 19—*Other special Non-standard Apertures*

*Only one can be selected

Internal Detector Options

OPTION 20—*Thermoelectric PMT Cooler*
This option consists of a thermoelectric cooler unit integrally mounted in the photomultiplier tube assembly. It is recommended for those applications where low intensity sources are to be measured and the maximum stability and signal-to-noise ratios are desired. It regulates the PMT temperature at approximately 5°C.

OPTION 21-0—*Extended Multialkalai Response S-25 PMT*
With this option the standard S-20 PMT (370 nm to 730 nm) is replaced with an S-25 PMT. The upper operating range is extended to 830 nm with a peak sensitivity at around 620 nm (requires OPT 20).

OPTION 21-1—*Special Selection of S-25.*
Extends upper wavelength to 860 nm (requires OPT 20).

Internal Filter Options

OPTION 30—*Quartz Optics*
Quartz optics extends the operating range from 360nm down to 290nm in the ultraviolet region.
See OPTION 35.

OPTION 31—*Scotopic Response Filter*
The Scotopic Response Filter in the photometer tailors the response of the system to the scotopic (low light level or dark) response of the eye (V'). Thus the system is capable of duplicating the human eye under these low light conditions.

OPTION 32—*TF-80 Tristimulus Filters (Set of four includes calibration)*
The four individually trimmed colorimetric response filters make it possible to use the PR-1980B as an accurate 4-filter colorimeter [uses the standard photopic (Y) plus X_r, X_b and Z.]

OPTION 33-0*—*LED Measuring Filter 630nm to 670nm.*

OPTION 33-1*—*LED Measuring Filter 670nm to 700nm.*
*The narrow emission range of LEDs requires that the photopic response of the system be matched as closely as possible over a limited bandwidth. Two special LED filters are available; LED-630 for orange red LEDs, and LED-670 for far red LEDs.

OPTION 35—*Quartz Neutral Density Filters*
For more intense sources these neutral density filters are available to augment the OPTION 30 optics for accurate near UV measurement at high light levels.

System Options

OPTION 40-0—*Wide Range Monochromator*
This monochromator and order sorting filters are needed to extend the spectral range of the standard PR-1980B to PR-1980BX extended spectral range versions.

OPTION 41-0—*SC-80A-OP MicroScanner Spatial Scanner Optical Head (See Section 4)*
This Option includes only the Optical Head itself. The controls for the MicroScanner are installed in the PR-1980B-SC Control Console. The SC-80A-OP is furnished with a 1X lens unless otherwise specified. Additional lenses can be ordered separately. This option is used for linear spatial scanning on PR-1980B Spectral/Spatial Scanning Systems. (Quartz optics are **NOT** available.)

OPTION 43—*Military Specifications Calibration*
When this option is selected the system is calibrated to MIL SPEC 7788E, 27160 (Polygon) and 25467 (Red Lighting) with a 3215 filter. Certification is supplied for the calibration.

OPTION 46-0—*UCI-80-1 Universal Computer Interface*
This is the Level 1 version of the UCI-80 and is configured to permit use with ONLY the HP 9816, 9826, and 9836 computers. It eliminates the two interconnect cables, i.e., BCD and GPIO, replacing them with a single IEEE-488 (HPIB) cable. (See Software OPTIONS 84-2 and 86-2).

OPTION 46-1—*UCI-80-2 Universal Computer Interface*
The Level 2 version of the UCI-80 is configured to permit use with any computer having either an IEEE-488 or RS-232C interface. Option 46-1 includes UCICL Control Language Firmware. The UCICL Firmware can function either as a stand-alone control system, or as a low-level language to the MOD 9 Software package for the IBM PC or compatible. The user accesses the UCICL by sending UCICL commands which define measurement parameters and perform measurement functions. UCICL commands, assembled by the user, may range in complexity from a single word to several interrelated lines of command clauses, thereby providing the operator complete control over the sophistication of microphotometric and spectroradiometric measurement. With the stand-alone UCICL system, virtually unlimited capabilities are possible, allowing the user to tailor measurements to specific applications, such as automated tests. (See Software Option 93-0 and 93-1.)

OPTION 48-0—The WIDEBAND option for the PR-1980B permits the user to display the waveform of a pulsed source in the "A" mode on an oscilloscope. The characteristics of the pulsed source are thus available for analysis such as peak luminance and rise/decay times.

OPTION 48-1—This option combines OPTION 48-0 with PULSE INTEGRATION such that not only the waveform is available but also the total energy of a single pulse or multiple pulses is determined in the "A" mode.

OPTION 49-2—*HP 9816/26/36 Terminated Cables*
Terminated BCD and GPIO cables for interfacing between PR-1980B/SC and /SS systems with HP 9816/26/36 computers. Interface boards must be purchased separately.

OPTION 51-0—*117V*
OPTION 51-1—*220V*
OPTION 51-2—*100V*
Select one for proper operation from the line power available.

OPTION 52-0—*English*
OPTION 52-1—*Metric*
Select one. English units are footLamberts, metric units are candelas per square meter (in the "A" mode).

Software Options

OPTION 86-1—*MOD 6 Software, Spectral/Spatial Scanning, HP 9816, 9826, and 9836 Computers.*
This software is supplied on three (3) floppy disks for running the PR-1980B/SS on the HP 9816 (specify disk size and keyboard type), 9826, and 9836 Computers. It provides for both SPECTRAL and SPATIAL scanning. NOTE: This software is **NOT** for the PR-1980B/USS-1 (See OPTION 86-2). Users must purchase the HP 98614A HPL 2.0 or above separately from OPTION 86-1. The HP 9836C with color monitor will **NOT** run this software.

OPTION 86-2—*MOD 7 Software, Spectral Spatial Scanning, HP 9816, 9826, and 9836 Computers and UCI-80-1.*
This software is supplied on three (3) floppy disks for running the PR-1980B/USS-1 on the HP 9816 (specify disk size and keyboard type), 9826, and 9836 Computers. It provides for both SPECTRAL and SPATIAL scanning. NOTE: Users must purchase the HP 98614A HPL 2.0 or above separately from OPTION 86-2. The HP 9836C with color monitor will **NOT** run this software.

OPTION 93-0—*MOD 9 Spectral/Spatial Monochrome 5¼" Software for IBM PC*
Software for 1980B/USC-2 and USS-2 operation from MS-DOS or PC-DOS environment via IEEE-488. Used only in conjunction with UCI-80 Level 2 and 5¼" IBM PC or compatible with GPIB-PC2A (IEEE-488) interface.

OPTION 93-1—*MOD 9 Spectral/Spatial Monochrome 3½" Software for IBM PC*
Same as 93-0 above except for 3½" disk drive.

Optical Attachments and Accessories

CRF-35—*A set of 20 Chromaticity Reference Filters*
These filters provide accurate chromaticity reference points in each of five color categories. Three reds, five greens, five blues, four whites, and an intermediate reference between red and yellow (when used with Source A).

FH-80—*Filter Holder for 2 X 2-inch filters*
This accessory is thread-mounted to the OL-7 Standard or MS-80A Objective Lenses and will hold up to two 2" X 2" (50mm X 50 mm) filters up to 0.17" (4.3mm) thick. With the filter holder attached the PR-1980B system can be adapted to special photometric or radiometric measurements.

FP-80B—*Fiber Optics Probe*
This accessory is a four foot long flexible probe that is useful in making measurements in cramped or inaccessible places with either the OL-7 or MS-80A Lens. Luminance measurements can be made within a fixed circular area 0.12 inches (3mm) in diameter. It is also calibrated for spectral radiance. **NOT** available for illuminance/irradiance.

GL-1961—*Glare Lens*
Used for determining the amount of disability glare contributing to total measurement. Used with the OL-7 Objective Lens and 1° aperture in the photometric ("A") mode **ONLY.**

LF-19A—*MicroSpectar LF-19A Lens*
This accessory lens converts the instrument into a 2X microphotometer/microspectroradiometer with a working distance of 2.7 inches (68.6 mm). It is thread-mounted to the standard OL-7 Objective Lens and best suited for close up measurements on very small areas. (See Table B)

MS-5X, -7X, -10X, -25X, -50X—*MicroSpectar Lens Series*
The MS lens series of fixed focal length, high throughput microscope objective lenses, when used in place of the OL-7 Objective Lens, convert the PR-1980B into a powerful microspectroradiometer/microphotometer/microcolorimeter (see Table B).

MS-80A—*MacroSpectar Close-up Lens*
1:1 close-up lens with a working distance of 6.6 inches (168 mm).

MS-610—*MacroSpectar Long Working Distance*
A 1:1 fixed focal length lens with a 24-inch working distance designed to be used with the 20 min aperture to measure 1 mm spot size. (See Table B).

OL-3.5—*TeleSpectar Lens*
A 3.5-inch telescope objective lens designed to achieve twice the measuring field and accept the same accessories as the OL-7 lens. Focusable from 2 feet to infinity.

OL-7—*The Standard 7-inch TeleSpectar Objective Lens*
This lens is the standard objective telescope lens supplied with the PR-1980A or PR-1980B/SC. It has a working distance of 4 feet (1.22m) to infinity. The front of this lens is threaded to accept mounting of accessory lenses and attachments.

OL-14—*TeleSpectar 14-inch Objective Lens*
This accessory infinity-focused telescope lens was developed for the purpose of achieving a measuring area equivalent to ½ the aperture size of the standard OL-7 Objective Lens (HUDs etc.).

SC-80A-nX—*MicroScanner Objective Lenses*
There are six microscope lenses in this family to provide the necessary versatility that line width scanning may require on a variety of displays. They are 1X, 2X, 5X, 10X, and 20X. The 5X, 10X, and 20X, require the SC-80-LA Adaptor for mounting the lenses on the MicroScanner Optical Head.

SC-80-LA—*Lens Adaptor*
Required for mounting microscope objective lenses, (except 1X and 2X) on the SC-80A-OP Optical Head. See SC-80A-nX MicroScanner Objective Lens description (above).

SL-n0A—*High Resolution Supplementary Lens*
There are three choices in this family of Supplementary High Resolution Lenses. They are 10A, 20A, and 40A. They are used with the standard OL-7 Objective Lens to reduce the near-focus range to distances of 10 inches or greater. The focus distances for each lens are listed in Table B.

WFL-10—*Wide Field Lens*
This lens is interchangeable with the OL-7 Standard Objective Lens and increases the angular coverage by approximately 5 times. The best choice where large areas must be covered when working space is limited.

Irradiance/Illuminance/ Intensity Attachments

CR-100—*Cosine Receptor*
A Cosine Receptor is designed to collect all illuminance irradiance falling on a surface from all sources within a hemisphere above the surface, and apply a weighting factor based on the angle of incidence. When used with the PR-1980B the system gives correct illuminance/irradiance readings from all sources regardless of angle of incidence. **NOT** for ultraviolet measurements.

IB-80B—*Incidence Baffle*
A fixed baffle which limits the acceptance angle of the PR-1980B such that the system can be used for low level illuminance and spectral irradiance measurement. Primarily used to measure small (point) sources, such as stars, miniature lamps, etc. It is thread-mounted to the OL-7 Standard Objective Lens and used with the 3° aperture **ONLY.**

LR-80B—*LED Receptor*
Used with the MS-80A Objective Lens **ONLY,** this accessory permits spectral measurement of luminous and radiant intensity by the PR-1980B systems.

RS-1—*Reflectance Standard, 2 X 2 inches (51 × 51 mm)*
This reflectance standard is a pressed barium sulfate powder plaque whose diffuse reflectance is nearly 100%. By focusing the PR-1980B on this plaque, placed at 45 degrees to the source in the "A" mode, the luminance readings in footLamberts convert directly to illuminance readings in footcandles. (For metric systems, luminance in $cd/m^2 \times \pi$ = illuminance in lux.) In the "B" mode, radiance $\times \pi$ = irradiance.

Miscellaneous Accessories

CC-80-CR—*Carrying Case for the PR-1980B Control Console*

CC-80-CRU—*Carrying Case for the PR-1980B/USC Control Console (with UCI)*

CC-80-OR—*Carrying Case for the PR-1980B Optical Head*

HPIB—*Interface Cable*
Interface cable to operate all /USC Systems.

LRS-450—*Luminance/Radiance/Color Temperature Standard*
A variable luminance standard from 0.1 to 1200 fL or 0.3 to 3400 cd/m^2 (also calibrated for spectral radiance and color temperature).

MM-31-80—*X Y Positioner, 12" of travel horizontal and vertical*
A positioning table upon which to mount the PR-1980B when several measurements are to be made on a small CRT or flat panel display. The optical head remains fixed and the test source is positioned for each sequential measurement.

PC-2A—*GPIB/IEEE-488 Interface Board*
Required for all /USC-2 and /USS-2 Systems with Software Options 93-0 and 93-1.

PC-80286—*PC/AT*
An IBM PC/AT compatible computer with dual 5¼" drive, MS-DOS, Turbo mode and math coprocessor.

PR-2303*—*Spectroradiometric Reference Light Source*
Used for spectroradiometric calibration checks of PR-1980B systems.

PR-2304*—*Reference Light Source for Spectral Transmittance and Calibration Checks*
Near equal-energy source for checking spectral studies of filter materials or relative system calibration checks (approximately 4700 Kelvins).

*These are not standards, and must be calibrated with each instrument and each accessory.

SC-80-CC—*Carrying Case for the SC-80A MicroScanner*

SCH-80—*Shielded Cable*
For use in environments where high ambient inductive EMF is present. Stainless steel braided shielding is fitted over Optical Head Interconnecting Cable.

TR-7—*Tripod, heavy duty with geared head*
This tripod provides the stability to mount the PR-1980B Optical Head for reliable measurements.

VF-80-PL—*Video Filter for Pulsed Light Option*
This accessory is a noise attenuator for use when making video (wideband) pulsed-light measurements. Required equipment when PL system is ordered. (OPTION 48-1)

VF-80-WB—*Video Filter for Wide Band Option*
Same as above but for OPTION 48-0.

WC-80—*Wavelength Calibrator (light source)*
The calibration accessory includes a lamp that emits spectrally pure lines and power supply with a mounting fixture to attach the lamp to the standard objective lens. The lamp provides narrow emission lines at several wavelengths across the operating range of the system to check wavelength accuracy and to perform wavelength recalibration (mercury and argon). WC-80 comes in a carrying case for storage.

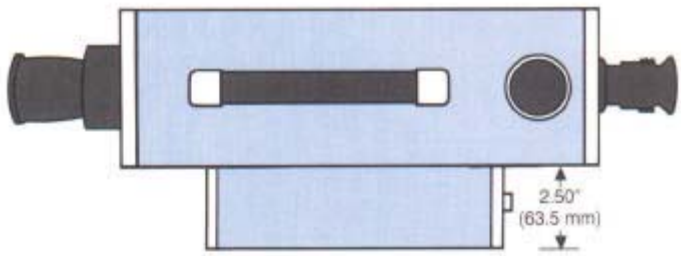
OPTION/ACCESSORY AVAILABILITY FOR PR-1980B SYSTEMS

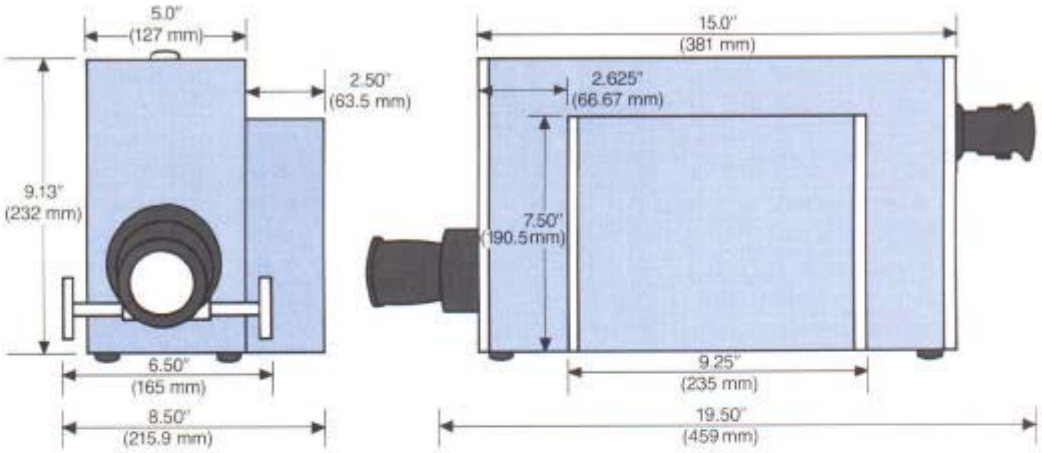
OPTIONS		1980B/SC	1980B/SS	1980BX/SC	1980BX/SS	1980B/USC-1	1980B/USS-1	1980BX/USC-1	1980BX/USS-1	1980B/USC-2	1980B/USS-2	1980BX/USC-2	1980BX/USS-2
01	.4° × 40° HORIZONTAL SLIT APERT.	O	*	O	*	O	*	O	*	O	*	O	*
02	2° × 2° HORIZONTAL SLIT APERT.	O	O	O	O	O	O	O	O	O	O	O	O
03	.4° × 4° VERTICAL APERTURE	O	O	O	O	O	O	O	O	O	O	O	O
04	1° CIRCULAR APERTURE	O	O	O	O	O	O	O	O	O	O	O	O
05	15° CIRCULAR APERTURE	O	O	O	O	O	O	O	O	O	O	O	O
06	30° CIRCULAR APERTURE	O	O	O	O	O	O	O	O	O	O	O	O
07	2° × 10° HORIZONTAL APERTURE	O	O	O	O	O	O	O	O	O	O	O	O
08	TRAPEZOIDAL APERTURE	A	A	A	A	A	A	A	A	A	A	A	A
09	0.4° × 40° HORIZONTAL APERTURE												
	& 0.4° × 4° VERTICAL APERTURE	O	O	O	O	O	O	O	O	O	O	O	O
10	.4° × 10° HORIZONTAL APERTURE	O	O	O	O	O	O	O	O	O	O	O	O
19	SPECIAL APERTURE	F	F	F	F	F	F	F	F	F	F	F	F
20	THERMOELECTRIC PMT COOLER	O	O	R	R	O	O	R	R	O	O	R	R
21-0	EXTENDED MULTIALKALI PMT	O	O	R	R	O	O	R	R	O	O	R	R
21-1	SELECTED LOW-NOISE S-25 PMT	O	O	O	O	O	O	O	O	O	O	O	O
30	QUARTZ OPTICS (SEE OPT 35)	O	O	O	O	O	O	O	O	O	O	O	O
31	SCOTOPIC FILTER	A	A	A	A	A	A	A	A	A	A	A	A
32	TRISTIMULUS FILTERS	A	A	A	A	A	A	A	A	A	A	A	A
33-0	LED FILTER (630-670nm)	A	A	A	A	A	A	A	A	A	A	A	A
33-1	LED FILTER (670-700nm)	A	A	A	A	A	A	A	A	A	A	A	A
35	QUARTZ ND FILTS (W/OPT 30)	O	N	O	N	O	N	O	N	O	N	O	N
40-0	WIDE RANGE MONOCHROMOTOR	N	N	*	*	N	N	*	*	N	N	*	*
41-0	SC-80AOP OPTICAL HEAD	N	*	N	*	N	*	N	*	N	*	N	*
43	MIL-SPEC CALIB. 7788E, 25467												
	27160 (NOT W/OPT. 22)	A	A	A	A	A	A	A	A	A	A	A	A
46-0	UCI-80-1 UCI CONTROL CONSL	N	N	N	N	*	*	*	*	N	N	N	N
46-1	UCI-80-2 (UCICL FIRMWARE)	N	N	N	N	N	N	N	N	*	*	*	*
48-0	WIDEBAND OUTPUT	A	A	A	A	A	A	A	A	A	A	A	A
48-1	WIDEBAND WITH PULSE	A	A	A	A	A	A	A	A	A	A	A	A
49-2	HP9826/36/16 TRMNTD CABLE	O	O	O	O	O	O	O	O	N	N	N	N
51-0	(117V), 51-1 (230V), OR												
	51-2 (100V) LINE VOLTAGE	S	S	S	S	S	S	S	S	S	S	S	S
52-0	(ENGLISH), OR												
	52-1 (METRIC) CALIBRATION	S	S	S	S	S	S	S	S	S	S	S	S
86-1	MOD6 SPE/SPA (HP9816/26/36)	N	O	N	O	N	N	N	N	N	N	N	N
86-2	MOD7 SPE/SPA (HP9816/26/36)	N	N	N	N	N	*	N	*	N	N	N	N
93-0	MOD 9 SPEC/SPA (IBM CMPTBL)	N	N	N	N	N	N	N	N	S	S	S	S
93-1	MOD 9 SPEC/SPA 3½"	N	N	N	N	N	N	N	N	N	S	N	S

* = Standard
A = 1980A (Photometer) Mode Only Option
F = Consult Factory
N = Not Available
O = Optional
R = Required
S = Specify Desired Selection

Consult factory for availability of quartz optics for accessories.

OPTICAL ACCESSORIES		1980B/SC	1980B/SS	1980BX/SC	1980BX/SS	1980B/USC-1	1980B/USS-1	1980BX/USC-1	1980BX/USS-1	1980B/USC-2	1980B/USS-2	1980BX/USC-2	1980BX/USS-2
CRF-35	CHROMATICITY FILTERS	O	O	O	O	O	O	O	O	O	O	O	O
FH-80	FILTER HOLDER (2" × 2")	O	O	O	O	O	O	O	O	O	O	O	O
FP-80B	FLEXIBLE PROBE	O	O	O	O	O	O	O	O	O	O	O	O
GL-1961	GLARE LENS	A	A	A	A	A	A	A	A	A	A	A	A
LF-19A	MICROSPECTAR LENS (2X)	O	O	O	O	O	O	O	O	O	O	O	O
MS-5X	MICROSPECTAR LENS (5X)	O	O	O	O	O	O	O	O	O	O	O	O
MS-7X	MICROSPECTAR LENS (7X)	O	O	O	O	O	O	O	O	O	O	O	O
MS-10X	MICROSPECTAR LENS (10X)	O	O	O	O	O	O	O	O	O	O	O	O
MS-25X	MICROSPECTAR LENS (25X)	O	O	O	O	O	O	O	O	O	O	O	O
MS-50X	MICROSPECTAR LENS (50X)	O	O	O	O	O	O	O	O	O	O	O	O
MS-80A	MACROSPECTAR LENS (1X)	O	O	O	O	O	O	O	O	O	O	O	O
MS-610	MACROSPECTAR LENS (1X)	O	O	O	O	O	O	O	O	O	O	O	O
OL3.5	3.5" TELESPECTAR LENS	O	O	O	O	O	O	O	O	O	O	O	O
OL-7	STANDARD 7" OBJ LENS	*	*	*	*	*	*	*	*	*	*	*	*
OL-14	14" TELESPECTAR OBJ LENS	O	O	O	O	O	O	O	O	O	O	O	O
SC-80-1X	MICROSCANNER LENS	N	*	N	*	N	*	N	*	N	*	N	*
SC-80-2X	MICROSCANNER LENS	N	O	N	O	N	O	N	O	N	O	N	O
SC-80-5X	LENS (SC-80-LA REQ'D)	N	O	N	O	N	O	N	O	N	O	N	O
SC-80-10X	LENS (SC-80-LA REQ'D)	N	O	N	O	N	O	N	O	N	O	N	O
SC-80-20X	LENS (SC-80-LA REQ'D)	N	O	N	O	N	O	N	O	N	O	N	O
SC-80-40X	LENS (SC-80-LA REQ'D)	N	O	N	O	N	O	N	O	N	O	N	O
SC-80-LA	LENS ADAPTER	N	O	N	O	N	O	N	O	N	O	N	O
SL-10A	HIGH RESOLUTION LENS	O	O	O	O	O	O	O	O	O	O	O	O
SL-20A	HIGH RESOLUTION LENS	O	O	O	O	O	O	O	O	O	O	O	O
SL-40A	HIGH RESOLUTION LENS	O	O	O	O	O	O	O	O	O	O	O	O
WFL-10	WIDE FIELD LENS	O	O	O	O	O	O	O	O	O	O	O	O
ILLUMINANCE/IRRADIANCE/ INTENSITY ATTACHMENTS													
CR-100	COSINE RECEPTOR	O	O	O	O	O	O	O	O	O	O	O	O
IB-80B	INCIDENCE BAFFLE	O	O	O	O	O	O	O	O	O	O	O	O
LR-80B	LED RECEPTOR W/MS-80A ONLY	O	O	O	O	O	O	O	O	O	O	O	O
RS-1	REFLECTANCE STANDARD	O	O	O	O	O	O	O	O	O	O	O	O
MISCELLANEOUS ACCESSORIES													
CC-80-CR		O	O	O	O	O	O	O	O	O	O	O	O
CC-80-CRU		N	N	N	N	O	O	O	O	O	O	O	O
CC-80-OR		O	O	O	O	O	O	O	O	O	O	O	O
HPIB	INTRFC CBL	O	O	O	O	R	R	R	R	R	R	R	R
LRS-450		O	O	O	O	O	O	O	O	O	O	O	O
MM-31-80		O	O	O	O	O	O	O	O	O	O	O	O
PC-2A	GPIB IEEE-488 INTFCBD	N	N	N	N	N	N	N	N	R	R	R	R
PC-80286	PC/AT	N	N	N	N	N	N	N	N	O	O	O	O
PR-2303		O	O	O	O	O	O	O	O	O	O	O	O
PR-2304		O	O	O	O	O	O	O	O	O	O	O	O
SC-80-CC		O	O	O	O	O	O	O	O	O	O	O	O
SCH-80	SHIELDED CABLE	O	O	O	O	O	O	O	O	O	O	O	O
TR-7		O	O	O	O	O	O	O	O	O	O	O	O
VF-80-PL	(W/OPT 48-1 ONLY)	A	A	A	A	A	A	A	A	A	A	A	A
VF-80-WB	(W/OPT 48-0 ONLY)	A	A	A	A	A	A	A	A	A	A	A	A
WC-80		O	O	O	O	O	O	O	O	O	O	O	O





SECTION 9
SPECIFICATIONS*

Spectroradiometric, Colorimetric and Photometric:

Measuring Capability: Spectral Radiance, Spectrally-computed Photopic and Scotopic Luminance, CIE Colorimetric values, Integrated Radiance, and Photon Radiance. All normal functions of the PR-1980A Pritchard Photometer (Luminance, Relative Colorimetry, etc.) are included.

Sensitivity Range: See sensitivity tables and figures.

Absolute Photometric Accuracy: Within ±4% of reading or ±2% of full-scale (whichever is greater), when measuring black body sources.

Photometric Polarization Error: Zero (no measurable polarization error) in the "A" mode only.

Spectroradiometric Absolute Accuracy: ±3% of reading from 400 to 730 nm, or ±5% of reading below 400 nm and above 730 nm; or ±2% of full scale on any range (whichever is greater).

Spectral Colorimetric Accuracy: ±0.001x,y at 2856 Kelvins.

Spectroradiometric Wavelength Range: 370 to 730 nm (standard). 360–830, 360–860, 290–830 & 290–860 are optional.

Spectral Bandwidth: 1, 5 or 10 nm (operator-selectable).

Wavelength Accuracy: ±1 nm from 50° to 100° F (10° to 37°C).

Wavelength Resolution: ±0.16 nm.

Wavelength Repeatability: ±0.5 nm (at constant temperature).

Wavelength Output Display: 4½-digit readout on spectroradiometer control console; also BCD output jack.

Wavelength Drive Intervals: 1 to 250 nm steps (under computer control at 400 nm/minute rate), or continuous drive from 25 to 400 nm per minute (operator-selectable under manual control).

Spectroradiometric Stray Light: Less than 0.1% of peak value.

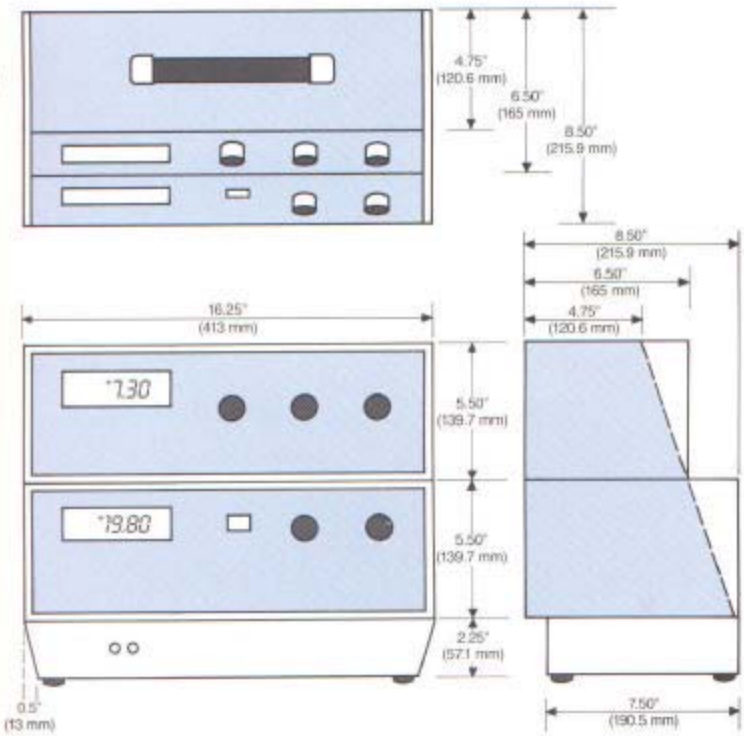
Photometric Filters: Built-in filters include an individually-trimmed photopic filter to match the spectral response to the standard CIE V (λ) function (380-750 nm); 10X, 100X, 1000X, and 10,000X neutral density attenuators; horizontal- and vertical-plane polarizing filters; red and blue relative-colorimetry filters.

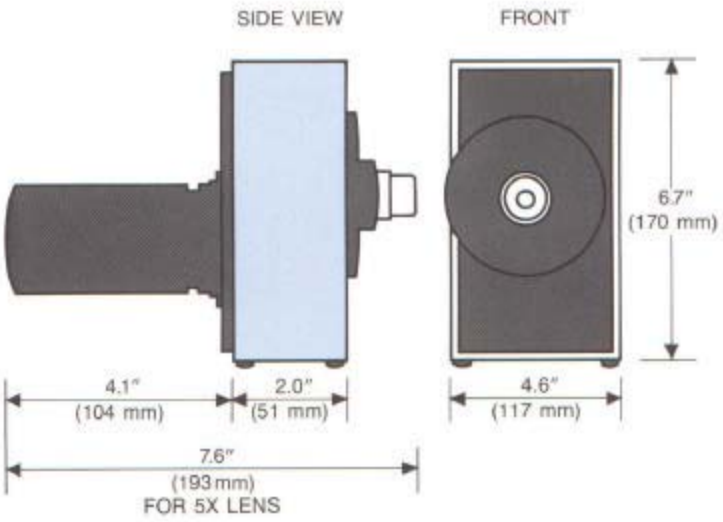
Objective Lens: Standard objective lens is 7" (178 mm) fl, f/3.5, focusable from 4 feet (1.2 m) to infinity.

Measuring Field Apertures: Up to 6 apertures built-in; 5 standard circular apertures provide angular coverage of 2', 6', 20', 1° and 3° (nominal values with standard 7" objective lens).

Viewing Field: Adjustable in 3 fixed increments (1.9°, 5.9°, and 11° nominal with standard 7" objective lens). Viewing magnification is user adjustable over range of approximately 6:1 (3.3x, 8.2x and 20.6x nominal with standard 7" lens).

*All specifications subject to change without notice.





Eyepiece: Erect image, focusing eyepiece with rubber eyecup.

Intensity Digital Readout: 3½-digit, non-blinking, bi-polar digital readout; reads from 0.00 to 19.99 (blanks in over-range condition).

Intensity Power-of-Ten Indicator: 2-digit, dimmer-controlled, self-luminous display; range of indicator is from 10^{-8} to 10^{7}.

Intensity Analog Output: 0-10 volts analog output signal jack capable of driving any analog device with impedance greater than 10,000 ohms. This output corresponds to the intensity display only.

Intensity Digital Output: BCD output jack with output signals for both the primary indicator and the power-of-ten indicator.

Time-Constant: 3-position "Response Speed" switch (on recessed control panel) sets time-constant to approximately 0.02, 0.20 or 2 seconds in "A" mode.

CIE Chromaticity Coordinate Capability: 0.0000 to maximum in x, y, u, v, u' and v'.

Correlated Color Temperature Capability: 1,800 to 20,000 Kelvins.

Operating Temperature Range: 32° to 110°F (0°C to 43°C) at 0 to 90% non-condensing relative humidity.

Size: Optical Head: 19½" (459 mm) long (with lens removed) × 8½" (216 mm) wide × 9" (229 mm) high. Control Console: 16¼" (413 mm) long × 8½" (216 mm) deep × 11¼" (286 mm) high. UCI: 16¼" (413 mm) long. 7.5" (190 mm) deep, 2¼" (57mm) high.

Weight: Optical Head: 26 pounds (11.8 kg). Control Console: 16½ pounds (7.5 kg). UCI: 3¼ pounds (1.7 kg).

Spatial:

MicroScanner (SC-80A) Linear Spatial Scanner:

Total Target Distance Scanned: Up to 1.0 inch (1,000 mils) independent of lens magnification. (Highest scan accuracy is at 0.5 in. ±0.2 in.)

Scan Speed: Variable from approximately 0.0036 inches (90 micrometers) to 0.180 inches (4.56 millimeters) per minute under manual control (under software control, scan speed depends on system configuration).

Minimum Scan Increment: 0.1 mil.

Full Scale Sensitivity: See sensitivity table.

Lens Magnification: 1X, 2X, 5X, 10X, 20X, 40X; 1X is standard.

Target Resolution Capability: 0.12 mil (0.003 mm) to 20 mils (0.5 mm). (See Table B)

Weight: Scanning Head: 3.7 pounds (1.7 kg)

Size: Scanning Head: 7.6" × 6.7" × 4.6" (193 × 170 × 117 mm).

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