BESELER

PM4L

color analyzer/instruction manual

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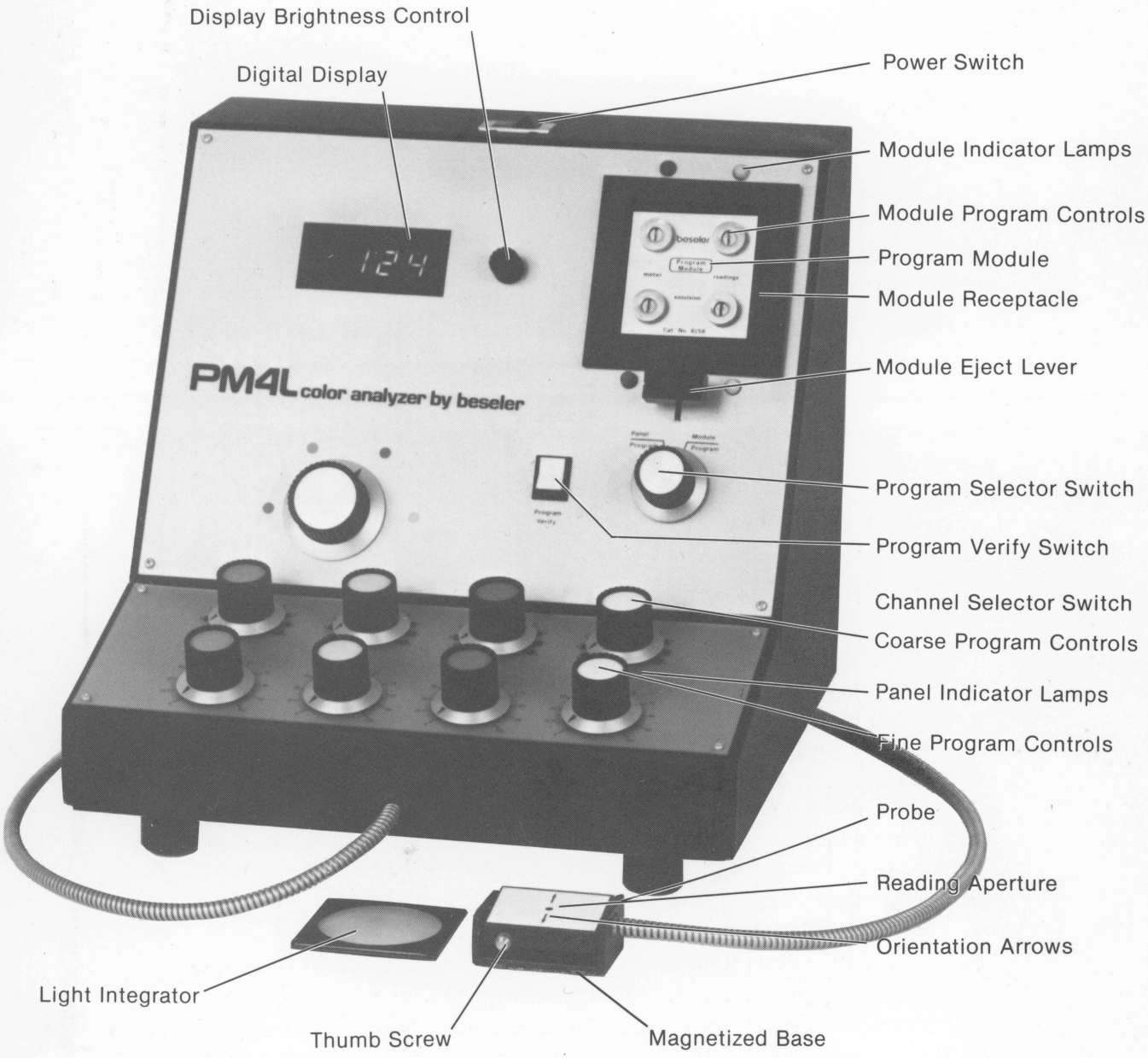


SPECIFICATIONS

Line Input: 120 Volts AC, 50/60 Hz.

Line Fuse: 3 AG, 250 M/A slow-blow Littelfuse, Buss or equivalent

Power Consumption: 20 Watts

Electrical Construction: Solid State; Internally Stabilized

Light Detector: Photo-Multiplier

Warm Up: Instantaneous

Readout: ½-In. High Variable Brightness LED Digital Display

Probe: 2⅛″ x 1⅜″ x ⅞″; incorprates locking cosine correction; coupled to analyzer by 4′ steel armor clad fiber-optic cable.

Density Range: Greater than 4.00

Low Light Sensitivity: 0.0002 foot candles

Exposure Time Range: 0.1 to 199.9 seconds

Program Memory:

1. Panel—reprogrammable, dual (coarse and fine) potentiometers allow use of infinite number of programs (color balance and exposure) in/out.

2. Module—Instantly retrievable reprogrammable plug-in modules allow for storage of any number of complete, self-established programs.

Case Construction: Grounded all metal case

Case Dimensions: 10¼″ x 11$^{1}/_{16}$ x 10¾″

Net Weight: 13 lbs.

Shipping Weight: 16 lbs.

Shipping Dimensions: 15$^{15}/_{16}$″ x 13$^{15}/_{16}$″ x 12″

The "Safeguards" statement reproduced below is in accordance with Underwriters Laboratories "Standard for Safety, UL 122, Photographic Equipment."

IMPORTANT SAFEGUARDS ©

When using your photographic equipment, basic safety precautions should always be followed, including the following:

1. Read and understand all instructions.
2. Close supervision is necessary when any appliance is used by or near children. Do not leave appliance unattended while in use.
3. Care must be taken as burns can occur from touching hot parts.
4. Do not operate appliance with a damaged cord or if the appliance has been dropped or damaged—until it has been examined by a qualified serviceman.
5. Do not let cord hang over edge of table or counter or touch hot surfaces.
6. If an extension cord is necessary, a cord with a suitable current rating should be used. Cords rated for less amperage than the appliance may overheat. Care should be taken to arrange the cord so that it will not be tripped over or pulled.
7. Always unplug appliance from electrical outlet when not in use. Never yank cord to pull plug from outlet. Grasp plug and pull to disconnect.
8. Let appliance cool completely before putting away. Loop cord loosely around appliance when storing.
9. To protect against electrical shock hazards, do not immerse this appliance in water or other liquids.
10. To avoid electric shock hazard, do not disassemble this appliance, but take it to a qualified serviceman when some service or repair work is required. Incorrect reassembly can cause electric shock hazard when the appliance is used subsequently.

SAVE THESE INSTRUCTIONS

INTRODUCTION

The Beseler PM4L Color Analyzer is an advanced color comparator incorporating a bright illuminated digital display. It has provisions for storing color balance and exposure programs in either a self-contained memory bank or any number of accessory plug-in program modules. Once programmed, the instrument will allow you to quickly determine the color filtration and printing time needed for producing beautiful color prints. Determining the paper grade and exposure for black and white printmaking can also be accomplished with this analyzer.

The utmost in sensitivity and reliability is achieved through the use of solid state circuitry in conjunction with a photo-multiplier light detector. Error due to fluctuations in line voltage is eliminated, as the analyzer is internally stabilized. Additionally, the electrical design of the instrument provides protection against temporary "blinding" or damage to the photo-multiplier from exposure to room lighting.

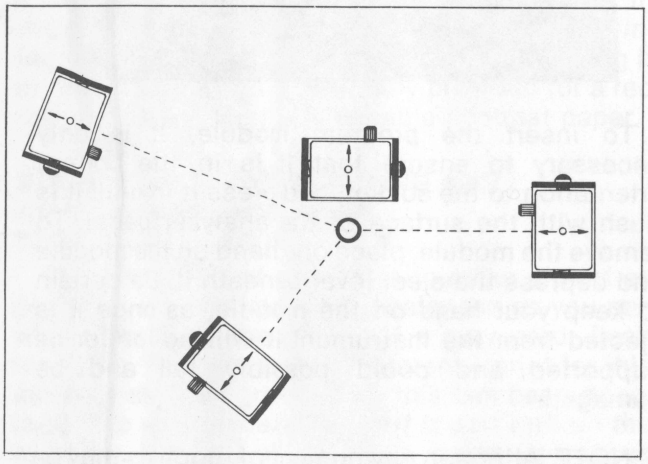
Although the PM4L is easy to operate and virtually maintenance-free, please carefully read the contents of this manual in order to obtain optimum satisfaction from the analyzer. This manual will provide you with the necessary information to fully utilize the capabilities of the instrument, and the time taken to read it will be well spent. Since the text will refer frequently to the various parts on the analyzer, it will be helpful to keep the PM4L illustration (inside front cover) folded out while reading. Components familiarization and step-by-step programming and analyzing procedures are outlined in Section I. Additional data elaborating on each procedure, plus detailed information on specific situations, black and white printing and analyzing for paper grade and exposure can be found in Section II.

SECTION I

COMPONENTS FAMILIARIZATION

Power Switch—Located on the top of the analyzer cabinet, the power switch controls the electrical power to the instrument's solid state circuitry. When switched on, with the power cord inserted in the proper voltage electrical receptacle, the digital display will illuminate with a numerical readout.

The Probe—The probe on the PM4L incorporates a cosine correction feature which is used whenever it is necessary to read a point on the projected image which is not directly underneath the enlarging lens. This will very often be the case when, for example, it is desired to read a flesh tone where the subject is off to one side of the picture. To utilize this feature, the probe must be oriented so that either of the arrows on the probe is pointed toward the lens, which in most cases will be toward the center of the picture (see illustration). Cosine correction is most readily achieved when the Channel Selector is in the White position and the White Coarse Control is adjusted to give a digital readout of approximately "100". After the thumb screw is loosened, the probe face is tilted until the digital display reaches its lowest number. The thumb screw is then tightened to secure the probe at the corrected angle.



Once this adjustment has been made, the probe must not be moved. Any movement of the probe base or readjustment of the probe angle during either programming or analyzing will result in erroneous readings. As the base of the probe is magnetized, it will stay positioned on steel easels. This feature also permits the probe to be stored anywhere on the analyzer housing when not in use.

Digital Display—The LED digital display illuminates numerical readouts for filtration when the channel selector is in the cyan, yellow or magenta positions, and printing time when the channel selector is in the white position. There will be instances, especially when reading low light levels, when the display will fluctuate between two readings. This shifting, which is normal, is attributed to the high sensitivity of the photo-multiplier circuitry. If the readout does not stabilize after a few moments, it is likely that the

analyzer is trying to indicate an intermediate numerical value. A very slight adjustment of the appropriate progam control (if programming), or the lens aperture or amount of filtration in the optical path (if analyzing) should alleviate the readout variations.

Negative numerical readouts indicate an insufficient amount of filtration and the need to **add** the indicated number of units shown to obtain a "000" readout. Positive numerical readouts (" + " symbol does not show on readout) indicate an excess amount of filtration and the need to **subtract** the indicated number of units shown to obtain a "000" readout.

The printing time circuit is calibrated to read out from 0.1 to 199.9 seconds. The numerical readout indicates the exposure time required to make a print of the correct density.

Display Brightness Control—A provision for adjusting the display's brightness is incorporated into the PM4L as an operator convenience. After switching on the analyzer, turn the brightness control to adjust the intensity of the illuminated readout to your personal preference.

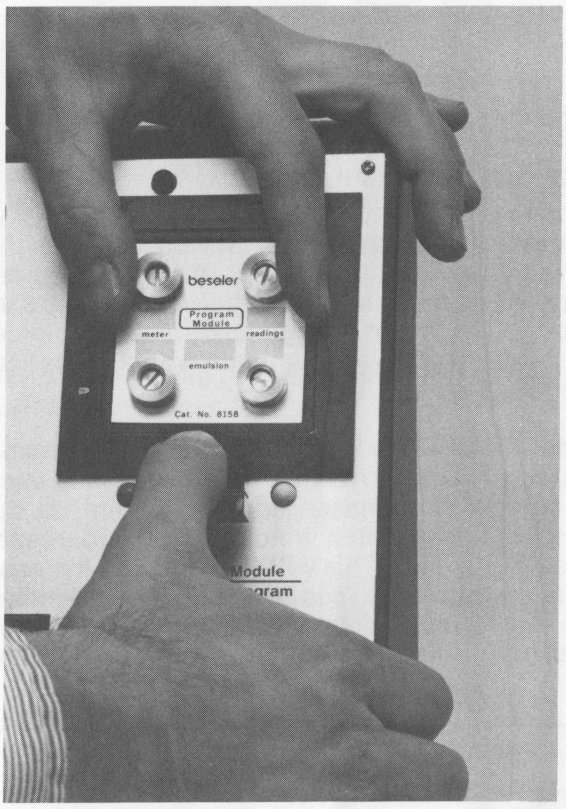
Program Selector Switch—The program selector switch designates which program memory system (panel controls or module controls) is operative. When turned to the PANEL PROGRAM position, the coarse and fine panel program controls are operative for programming the analyzer, and for analyzing a negative. When turned to the MODULE PROGRAM position, the module controls are operative for programming the analyzer and analyzing a negative.

Panel Program Controls (Coarse, Fine)—For each of the four channels, there are two program controls (potentiometers). The upper controls (calibrated A-K) provide quick, coarse adjustment through each channel's entire range. The lower controls (calibrated 1-100) offer continuous, fine adjustment.

Channel Selector Switch—Tunes in the desired channel (Cyan, Yellow, Magenta, White). When the switch is rotated to the appropriate channel, a corresponding colored indicator lamp is illuminated on the panel for convenience in the darkroom. Lamps for the Panel Program mode are located between the coarse and fine panel controls; Module Program indicator lamps are arranged around the module receptacle.

Program Module and Receptacle—In addition to the panel program controls, plug-in program modules may be used to store a variety of programs. For example, if you use several different sizes or surfaces of color paper, it is likely that each size or surface will be a different emulsion number, with a different color balance requirement and, therefore, it will be necessary to have a separate program for each emulsion. By storing each emulsion program in its own program module, all that is required when changing from one emulsion to the next is to change program modules. Similarly, you may want to store programs for different film types or different subjects (portraits, landscapes, etc.), each in its own module.

The modules are programmed by inserting a small slot head screwdriver into the miniature potentiometers on the module and turning the screwdriver to adjust the Digital Display readout. With the program selector switch in the Module Program position, the channel selector will activate the appropriate potentiometer and illuminate a colored indicator light adjacent to it. The potentiometers may be turned over a range of 10 revolutions, permitting exceptional accuracy in the entering of programs.



To insert the program module, it is only necessary to ensure that it is in the correct orientation to the socket, and press it in until it is flush with the surface of the analyzer panel. To remove the module, place one hand on the module and depress the eject lever beneath it. Be certain to keep your hand on the module, as once it is ejected from the instrument it will no longer be supported and could possibly fall and be damaged.

NOTE: Although any number of modules may be used for any one analyzer, it is not possible to take

a module which has been programmed on one instrument and use it to analyze on another instrument. Module programs can only be used on the instrument on which they were entered.

Program Verify Switch—The PM4L provides a unique program verification feature which permits the user to electronically check the program in a program module. After entering a program into a program module (which is explained in the section on programming) it is only necessary to depress the verify switch and note the Digital Display readout. By doing this for each channel, and keeping a record of the display readout for each, it is possible to check the program in that module any time in the future. You merely depress the verify switch and determine that the readings are as initially recorded.

When the program verify switch is actuated, the probe becomes inactive, and the meter reading is not influenced by light falling on the probe. Note that this switch will return to the normal position when it is released. The module face plate provides space for writing verification numbers or other program information. The spaces are of an eraseable material to permit changing the information as new programs are entered.

Circuitry—The PM4L incorporates solid state circuitry in conjunction with a photomultiplier light detector for the utmost in sensitivity and reliability. The analyzer is internally stabilized, so error due to fluctuations in line voltage is eliminated. In addition, the electrical design of the instrument provides protection against temporary "blinding" or damage to the photomultiplier from exposure to room lighting. Therefore, the PM4L may be left on for as long as you are working, regardless of how many times or for how long the probe is exposed to room light.

Light Integrator—When a program to determine the "average" color of a negative is desired, a diffuser, or Light Integrator, is needed to integrate the colors. The integrator, supplied with the PM4L, will readily fit into all Beseler enlargers, either in the sliding drawer above the lens, or in the accessory filter holder below the lens. This integrator will fit most other enlargers by placing it in the holder which is generally provided for a red safety filter or filters for variable contrast paper.

STEP-BY-STEP PROGRAMMING AND ANALYZING PROCEDURES

SPOT PROGRAMMING

The first step, of course, is to make a print as perfectly exposed and color balanced as you can which contains the image of a gray card, flesh tone, etc. This will be your reference print for this specific spot program. Once this has been done, leave the enlarger *exactly as it is* and turn on the analyzer. Turn off all the room lights, as well as any safelight you might be using, turn the Display Brightness Control to adjust the intensity of the illuminated Digital Display to a comfortable level, and proceed as follows:

SPOT PROGRAMMING

1. Place the PROBE under the projected image of the gray card (or flesh tone, etc.). The aperture in the center of the PROBE is the reading area and must be directly under the area you are interested in reading.

2. Turn the PROGRAM SELECTOR SWITCH to PANEL PROGRAM and the CHANNEL SELECTOR to the WHITE position.

3. With the PROBE set at its horizontal (normal) position and either of the arrows pointing toward the lens, adjust the COARSE WHITE CONTROL to get a Digital Display reading of approximately "100". Loosen the THUMB SCREW on the PROBE and tilt the probe face toward the enlarging lens, at the same time watching the DIGITAL DISPLAY. When the Digital Display reaches its lowest number, the probe angle is properly set, and the THUMB SCREW should be tightened.

4. Turn the CHANNEL SELECTOR to the CYAN position and adjust the CYAN COARSE CONTROL to get a reading as close as possible to "000" on the Digital Display. Then, using the FINE CYAN CONTROL, make the final adjustment to get a Digital Display readout of "000".

5. Move the CHANNEL SELECTOR to the YELLOW position and repeat the zeroing procedure above 0.

6. Move the CHANNEL SELECTOR to the MAGENTA position and zero the Digital Display in the same manner.

7. Move the CHANNEL SELECTOR to the WHITE position. However, instead of adjusting the WHITE controls for a "000" readout, turn the controls until the Digital Display reads the same exposure time you used to make your reference print. This will be your STANDARD PRINTING TIME for all future prints with this specific program.

After completing steps 1 through 7, go back through the channels and be sure that the Digital Display reads "000" on all three color channels and returns to your STANDARD PRINTING TIME on the WHITE channel. Make any small adjustments that might be necessary. The analyzer is now programmed to remember the exact color balance and exposure which produced the REFERENCE COLOR in your REFERENCE PRINT.

The position of each panel program control (coarse and fine) should be noted for later reentering of the selected spot program. To reenter this program at any time in the future, it is only necessary to reset the controls to their respective settings.

Additional Spot Programming instructions and hints can be found in Section II.

INTEGRATED PROGRAMMING

As with spot programming, the first step is to make a print as perfectly exposed and color balanced as you can, which is your reference. In the case of integrated programming, the subject matter should be representative of the type of photograph you expect to be printing in the future. You may in fact want to create several integrated programs for city scenes, landscapes, candids, etc. In any event, having exposed and processed your reference print, leave everything on the enlarger exactly as it is and proceed as follows:

INTEGRATED PROGRAMMING

1. Adjust the PROBE to its normal position; that is, that the tilting section is set horizontally.

2. Position the INTEGRATOR in the optical path of the enlarger, as close to the lens as is convenient, and turn on the enlarger. At this point you will no longer see the image projected onto the easel. Instead, the easel will be covered with a uniform illumination, which represents the average color of your REFERENCE NEGATIVE and the filters that were used to print it.

3. Position the PROBE directly underneath the enlarging lens. Adjust for correct cosine. *Do not permit the probe to move at all while you are programming.*

4. Turn the CHANNEL SELECTOR to CYAN and adjust the CYAN COARSE CONTROL to bring the digital display as close as possible to "000". Then using the CYAN FINE CONTROL, make the final adjustment to exactly zero the display.

5. Move the CHANNEL SELECTOR to the YELLOW position and zero the display ind the same manner.

6. Move the CHANNEL SELECTOR to MAGENTA and zero the display once again.

7. Move the CHANNEL SELECTOR to WHITE. Now, rather than adjusting for a "000" display, turn the White Program Controls until the Digital Display reads the exact exposure time which was used to make your REFERENCE PRINT. This will be your STANDARD PRINTING TIME for all future prints with this specific program.

After completing steps 1-7 above, go back through all four channels to ensure that the Digital Display returns to "000" on CYAN, MAGENTA and YELLOW, and that it indicates your STANDARD PRINTING TIME on the WHITE channel. The analyzer is now programmed to analyze the average color of any negative and to determine the correct filtration and exposure to match the print to your REFERENCE PRINT.

After you have determined your integrated program, record the exact setting of each program control (coarse and fine). You can reenter this program into your PM4L analyzer at any time by resetting the panel controls to the positions you have recorded.

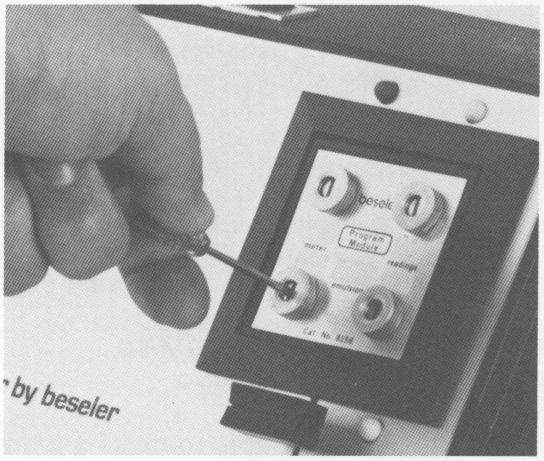
Additional integrated programming instructions and hints can be found in Section II.

MODULE PROGRAMMING

1. Insert the PROGRAM MODULE into the receptacle on the face of the analyzer. Turn the PROGRAM SELECTOR SWITCH to the MODULE PROGRAM position.

2. Position the probe and correct the cosine in the same manner as described for programming with the panel controls. If you are entering a SPOT PROGRAM, be certain to orient the probe as described in the section on SPOT PROGRAMMING.

3. With the CHANNEL SELECTOR in the CYAN position, use the small screwdriver supplied to turn the CYAN CONTROL in the PROGRAM MODULE until the Digital Display reads "000". In the same way, bring the Digital Display to "000" on the YELLOW and MAGENTA channels.



4. Turn the selector to the WHITE position and adjust the WHITE CONTROL until the Digital Display reads out your STANDARD PRINTING TIME (the exposure time used to make your REFERENCE PRINT).

The program is now entered into the module and will remain there until the module controls are reset. Module controls should be reset only when the Module is properly inserted in the receptacle.

Additional module programming information can be found in Section II.

PROGRAM VERIFICATION

To make sure the program in the analyzer is the one you want to use, follow the procedure outlined below.

MODULE PROGRAM VERIFICATION

1. Insert the Program Module to be verified into the Module Receptacle and switch the Program Selector to the MODULE PROGRAM position.

2. Rotate the Channel Selector to the Cyan position. Depress the Program Verify Switch which will deactivate the Probe circuit and illuminate a *numerical verification readout* on the Digital Display. Allow the readout to cease fluctuating and then record the displayed numerals in pencil on the module face plate next to the Cyan Module Control or in a notebook.

3. In the same manner, record the *numerical verification readouts* for the Yellow, Magenta and White channels.

PANEL

It is not generally necessary to use this feature for a PANEL PROGRAM, as the dual set of program controls are calibrated and allow programs to be reentered with a high degree of precision.

Additional program verification data can be found in Section II.

ANALYZING PROCEDURE

The procedure for analyzing is the same whether you are using a program entered into the PANEL CONTROLS or a PROGRAM MODULE. When using the PANEL CONTROLS, turn the PROGRAM SELECTOR SWITCH to PANEL PROGRAM and set the PANEL CONTROLS to the references you recorded when the program you will be using was initially entered into the analyzer. When using the PROGRAM MODULE, turn the PROGRAM SELECTOR SWITCH to MODULE PROGRAM and insert the appropriate module into the analyzer.

With your *unknown negative* in the enlarger, compose and focus the projected image on the easel to the exact dimensions you desire. Switch off all room lights, including any safelights. Turn the Digital Brightness Control to adjust the intensity of the illuminated Digital Display to a comfortable level.

If you are using a Spot Program, position the probe on the easel so the projected image of the Reference Color falls on the reading aperture. If the Reference Color is not in the center of the projected image, be certain to position the Probe with either arrow pointed toward the lens and set the angle of the Probe to get the lowest Digital Display readout when the Channel Selector is in the White position, then tighten the thumb screw.

For Integrated Programs, insert the Light Integrator into the optical path of the enlarger (in the same manner as when the analyzer was programmed) and place the Probe, set in its normal position, directly under the lens. Be certain that the position of the Probe will not move at all while you are analyzing and proceed as follows.[1]

ANALYZING

1. Turn the Program Selector to the program memory mode with which you will analyze.

2. Position the Probe in the same manner utilized in the Spot Programming Procedure or the Integrated Programming Procedure, whichever is appropriate.

3. Rotate the Channel Selector to the Cyan position and adjust the lens aperture until the illuminated readout on the Digital Display is "000". This may require that the lens be set in between click stops, which is quite normal.

4. Turn the Channel Selector to the Yellow position. If your *unknown negative* requires more yellow filtration than you have in the enlarger, the illuminated readout will appear as a negative (−) number. If you have too much yellow filtration in the enlarger, the readout will appear as a positive number ("+" symbol does not show on readout). The amount of yellow filtration that needs to be added or subtracted will be that number illuminated on the Digital Display. If your enlarger is equipped with a continuously variable colorhead, adjust the yellow filtration until the Digital Display on the PM4L reads "000". If you are using color printing filters, add or subtract the amount of yellow filtration indicated on the Digital Display.

5. Rotate the Channel Selector to the Magenta position and adjust the amount of magenta filtration in the enlarger so the Digital Display reads "000".

Footnote 1: The procedure presented here assumes that you are printing a color negative which will require a yellow and magenta filter pack. If you are working with transparencies or with negatives which require cyan filtration, it will be necessary to slightly modify the analyzing procedure. These conditions, along with other less typical situations, are dealt with under "SPECIAL CASES" in Section II.

6. Repeat steps 3 through 5 above, until the analyzer reads "000" continuously on all three color channels.

7. Carefully rotate the Channel Selector to the White position. Adjust the lens aperture so the illuminated readout equals your *standard printing time* (time used to make *reference print* for program you are using). Alternately, for any setting of the lens aperture, the correct printing time will be illuminated on the Digital Display. It is preferable, however, to keep the exposure time constant and adjust the lens aperture where possible, due to the printing characteristics of the color paper.

You should now have the proper filtration and printing time to correctly reproduce your *reference color.* If you were using an integrated program, remember to remove the Light Integrator from the optical path prior to making your exposure.

Additional analyzing instructions and hints can be found in Section II.

SECTION II

ADDITIONAL INSTRUCTIONS AND INFORMATION

BASIC OPERATING PRINCIPLES

Radiant energy (light) being emitted by the enlarger is received by a photodetector within the probe. A change in light level causes a corresponding change in voltage to one side of a LED (light emitting diode) digital voltmeter. The other side of the voltmeter receives voltage which is determined by the program controls. For any light level within the range of the analyzer, the program controls can be adjusted to alter the numerical readout on the digital display. Once this is done for a given light level, the instrument will always be able to indicate when that same light level is reaching the photodetector.

When a program control potentiometer is adjusted to zero the readout on the digital display, we are in effect "telling" the analyzer to remember a given light level. This is referred to as *programming.* Having done this, the instrument can be used to measure light levels at any time in the future. Depending on whether the digital display yields a negative or positive numerical readout, we can tell whether the photodetector is receiving more or less light than the amount for which it was programmed. Furthermore, by adjusting the amount of light being measured (with a lens diaphragm, for example), we can determine when the same light level for which the instrument was programmed is reached by observing when the digital display reads "000". This is referred to as *analyzing.* The analyzer is, in fact, comparing the amount of light it is receiving to the amount of light it received when it was programmed.

Since color print materials are comprised of three separate emulsion layers, each of which is sensitive to one primary color (red, green or blue), we are concerned with the amount of exposure each layer receives. By introducing filters into the optical path of the analyzer, we are able to separately measure the amount of red, green and blue light reaching the print material. The relative amount of red, green and blue light reaching the print material is referred to as the *color balance.* Determining this color balance for any negative or transparency we want to print is the primary function of a color analyzer, such as the PM4L.

APPLICATION OF THE PM4L

THE REFERENCE PRINT

Many people are surprised to learn that before they can use their analyzer to make a good print, they must first make one *without* the analyzer.

As we noted earlier, the analyzer is primarily concerned with determining the relative amounts of red, green and blue light required to make a color balanced print. The variables which affect this requirement are rarely appreciated, but they include such diverse factors as the type of film used, when and where it was manufactured, the time of day a picture was taken and what the weather was that day, what kind of enlarger, filters, paper, chemicals and processor you use, and how and where you look at the print after it is finished.

It can be seen, then, that before the analyzer can tell you how much red, green and blue light you need in a given situation, you must first tell it how much you want, considering the circumstances. In order to do this, you must have a system to make color prints, and you must use it to make one. The type of print that you make will be dictated by the type of print you will want to make in the future and the type of program you will be using, but, in any event, it must be as perfectly exposed and color balanced as possible. This is your REFERENCE PRINT, and it is the standard that the analyzer will use for all future prints.

It is also necessary to carefully select the negative used to make this print, as this becomes your reference negative, and it must resemble in some aspect the type of negative you will be using

in the future. The requirements for reference negatives are discussed in the section on programming, and you may find it worthwhile to shoot a reference negative specifically for use with the analyzer before attempting to use the instrument.

PROGRAMMING

There are two distinct types of programs, which we refer to as SPOT PROGRAMS and INTEGRATED PROGRAMS. Each type has its own advantages and disadvantages, and each is best adapted to a particular type of subject matter. Selecting the appropriate program for a particular negative is the first step in using the analyzer. Your PM4L has the capability of handling as many programs as you wish and, therefore, provides you with a great deal of flexibility in your color printing.

Spot Programming

We can use the analyzer's ability to "remember" color by spot reading a part of the projected image of our *reference negative* which contains a color we will want to reproduce in the future. The most common examples would be flesh color or an 18% gray. Gray cards of approximately 18% reflectance are frequently used in studio photography as a reference, since it is always known exactly what color should show up in the final print. The fact that it is possible to directly compare the original gray card with the one in the print makes for an extremely critical method of determining accurate color rendition. It is in fact quite difficult at times for a color printer to determine how a print should look, particularly where there are no visual references, such as people, trees, sky, etc. By printing to match the gray card, one is assured that all other colors are correctly reproduced as well.[2]

Since we seldom want the gray card in the final photograph, it is usually placed in a part of the picture where it can be cropped out later. A separate photograph may be taken of the gray card itself. Providing that the same lighting and film are used to photograph the gray card as are used to photograph the subject, we can use the gray card as an analytical device to determine the correct filtration to use when printing the actual subject. This application particularly lends itself to the use of a color analyzer, and it is for this reason that we will discuss spot programming as it relates to the use of a gray card. However, in practive, any color which reoccurs from one photograph to the next may be used for setting up a spot program. See Section I for step-by-step Spot Programming instruction.

This same technique can be used whenever you are entering a spot program into the analyzer, regardless of what color you are using as a reference. However, it is important to realize that when using flesh tone programs, there are many different colors on the average person's skin, and that skin color can vary dramatically from one person to the next. It is, therefore, better practice to have several flesh tone programs corresponding to the types of complexions you expect to photograph. The same limitations apply to programs of sky, foliage or wood colors. The value of a gray card, considering these variables, becomes readily apparent. It is not useful to program for blacks or whites, as these tones in a color photograph do not generally convey any color information, and it is quite possible to have a terribly color balanced print with excellent blacks and whites.

Integrated Programming

Quite often it is the case that photographs do not contain a color which can be singled out to use as a reference, or it is simply not convenient to do so. In these cases, we can use an alternate technique, which we call the INTEGRATED PROGRAM.

Integrated programs make the basic assumption that were we able to blend all the colors in a photograph into one uniform color (the way we can mix paints), then that color would be the same for every photograph we might make. This eliminates the need for a specific reference color in the photograph, since we are working only with the "average" color of each photograph. In practice, we "average" or "integrate" the colors of the subject by projecting the negative onto the easel through a diffuser or "Light Integrator".

It is intuitively obvious that not all photographs will integrate to the same color. An extreme closeup of a vivid purple flower will not have the same "average" color as, say, a portrait.[3] However, many scenics and candids lend themselves surprisingly well to this type of pro-

Footnote 2: That is, assuming the color reproduction system is capable of rendering the entire visual color gamut correctly on a print. This is seldom, if ever, the case and we often have to be content with color photographs in which some colors may not be accurately rendered. This is a problem well outside the scope of this manual, and we shall not concern outselves with it other than to mention it here. For the same reason, we will not explore the possibilities of deliberate color distortion, although many of these techniques produce aesthetically pleasing and sometimes useful results.

Footnote 3: In this particular case, if the analyzer were programmed on the photograph of the purple flower, and that program was used to analyze the portrait, the analyzer would try to make the portrait purple to match the color in its memory. This is a perfectly normal and correct thing for an analyzer to do, and it is referred to as "Subject Failure", which places the blame in the correct place and tells us that it is the subject which fails to match the analyzer's program and not the analyzer which fails. Understanding this principle provides a valuable insight into the correct use of an analyzer in *any* situation, and it cannot be overemphasized.

gram, and in the absence of any other specific color reference, it may be used to significant advantage. See Section I for step-by-step integrated programming instructions.

Module Programming

When programs are used repeatedly, it is generally convenient to enter each program into a separate PROGRAM MODULE. A program stored in a module may be brought into use in a matter of seconds merely by inserting the module into the module receptacle and switching the PROGRAM SELECTOR SWITCH to the MODULE PROGRAM Position. The same general rules of programming apply whether you are programming with the panel controls or with a PROGRAM MODULE.

Once the probe is positioned correctly (and the cosine correction made), it must not be moved until the program is entered. Programs are entered into the module by turning the module's controls with the small screwdriver supplied. These controls, unlike the panel controls, may be turned as many revolutions as necessary to make the required adjustment to the Digital Display readout. The effective range of these controls is ten revolutions of each control, though they will not be damaged if turned beyond the end of their range. Note: You can only program a module when it is inserted in the receptacle, never when it is disconnected from the analyzer. See Section I for step-by-step module programming instructions.

Program Verification

Where several modules are in use, or when the program in a module is likely to be changed frequently, it will be helpful to use the PROGRAM VERIFICATION feature of the PM4L to be certain that a module has the correct program. See Section I for step-by-step Program Verification instructions.

The *numerical verification readouts* are for reference and do not indicate filtration or exposure. Once the numerical verification readouts have been recorded, they can be verified or reentered at any time. Simply move the Program Selector Switch to the Module Program position, depress the Program Verify Switch and adjust each control until the illuminated readout corresponds to the respective numerical verification readout.

ANALYZING

Up to this point, the instructions in Section II have explained the methods used in programming the PM4L color analyzer. In each case we have experimentally arrived at a filtration and exposure which produced an acceptable color print, and then selected some aspect of that print to use as a reference in making future prints. What we have done in programming that reference into the analyzer is to enter into the analyzer's memory a record of the relative amounts of red, green and blue light which produced that reference color (a gray card, for example) correctly on the print. In analyzing, the instrument compares the projected image of your new negative, which we refer to as the UNKNOWN NEGATIVE, to the memory it has of the projected image of the REFERENCE NEGATIVE. It then determines when they are matched, with respect to the relative amounts of red, green and blue they contain. All other things being equal, such as the processing and paper emulsion, the REFERENCE COLOR will be correctly reproduced on the print made from your UNKNOWN NEGATIVE. See Section I for step-by-step analyzing instructions

Analyzing When Using Color Printing Filters

You may find that making the filtration adjustment indicated by the Digital Display when using color printing filters does not bring the readout to zero. This does not indicate an error on the part of the analyzer, but merely reflects a discrepancy between the nominal values of the filters and the analyzer's response. If this should occur, add or subtract enough filtration to zero the display.

There are many reasons why your analyzer display will not always agree with the values assigned to color printing filters (or for that matter, to the calibrations on a colorhead), yet if you exactly zero the display on all channels, you can be certain that you have exactly recreated the color which the analyzer had stored in its memory. In short, where there is a discrepancy between values assigned to a filter or colorhead, always do what the analyzer indicates.

SPECIAL CASES

In most cases, the procedure outlined above and in Section I will be sufficient to analyze any color negative. However, extreme variations in magnifications or photographing conditions may require some of the following special procedures.

Digital Display Cannot be Zeroed on Cyan with Lens Aperture

Most enlarging lenses have a range of about five stops. This is sufficient, in nearly all cases, to compensate for changes in the enlarging magnification. However, when extreme changes in negative density or magnification occur, you may find that the aperture cannot be adjusted to procuce a readout of "000" on the Cyan channel.

Should this ocur, adjust the aperture so the illuminated readout is as close to "000" as possible. Then, when analyzing on the Yellow and Magenta channels, adjust the filtration to obtain the same readout. In other words, you are selecting an alternate "zeroing" number for the three color channels.

Actually, any numerical readout may be used for analyzing, provided that the Digital Display indicates the *same value on Cyan, Yellow and Magenta.* For example, you might find that when adjusting the aperture to obtain a "000" readout on Cyan, the closest you can get is a readout of "-30". At this point, "-30" then becomes the numerical readout which you should match (by means of adding or subtracting filtration) on the Yellow and Magenta channels. Note, however, that this does not at all influence the reading on the White channel. Analyzing for printing time must be done in the normal manner.

Digital Display Cannot be Zeroed on Yellow or Magenta

Occasionally, you may find that the illuminated readout indicates that you should subtract yellow or magenta filtration, even though you have removed all of that respective filtration from the filter pack. This suggests that your negative will probably require cyan filtration.

If this ocurs, readjust the lens aperture to obtain a "000" readout on the channel (Yellow or Magenta) which will not yield a "000" readout with filtration. Then, go back to the Cyan channel and add cyan filtration until the readout is "000". Continue with the analyzing procedure on the third color channel. Repeat the steps so that all three color channels continuously show a "000" readout. Then, switch to the White channel and proceed again, in the normal manner, to determine the printing time.

Cyan/Yellow or Cyan/Magenta Filter Packs (Printing Color Transparencies)

Typically, when making your *reference print* from a color transparency or a color negative shot under unusual lighting conditions,[4] the final filter pack will contain cyan filtration. The cyan filtration may be combined with either yellow or magenta, but never both of these colors. After programming the analyzer with such a filter pack, you should assume that any similar transparencies or negatives will also print with either cyan/yellow or cyan/magenta filtration. Therefore, when analyzing such negatives or transparencies, set the Channel Selector on the color which was absent from the original filter pack used in programming (Yellow or Magenta). Then, adjust the lens aperture until the Digital Display reads "000".

The appropriate color filtration is then used to obtain a "000" readout on the other two color channels. The White channel is used in the normal manner to determine the exposure time.

Footnote 4: An example of a negative shot under unusual lighting conditions might be where tungsten balanced color film was exposed under daylight or fluorescent lighting without a correction filter. These negatives would subsequently be off-color and might requre a cyan/yellow or cyan/magenta filter pack in order to obtain a print with correct color rendition.

CHANGING COLOR PAPER EMULSIONS

The manufacturers of color printing materials make every reasonable effort to produce each batch, or emulsion number, with the same printing characteristics, but variations inevitably find their way into the process. The result is that different emulsions will require different filtrations when color printing, even if everything else is held constant.

A color program is only accurate when prints are made with the same printing material (same emulsion number) as used in producing your *reference print.* Using a program for analyzing a negative to be printed on a color emulsion with different printing characteristics than those used to make the reference print will impair the accuracy of the program and, thereby, yield an unsatisfactory print. To avoid this problem, a new program must be developed for use with each different paper emulsion number. The most obvious and precise way of determining the changes for the new program is to make a new *reference print* from your *reference negative* and then enter a program for the filtration and exposure used.

Additionally, the paper manufacturer's printing data which usually appear on the outside of the package may be used to adjust the program when changing emulsions. However, it is important to realize that the exact printing characteristics of a given emulsion depend to a great extent on how the paper was stored after it left the factory. The manufacturer's data should be considered as an approximation only. This data is generally presented in the form of plus or minus filtration for cyan, yellow or magenta and an exposure factor. To apply these numbers to an analyzer program, follow the procedure below. It is necessary to have the printing data from your original emulsion as well as the data for the new emulsion.

CHANGING COLOR PAPER EMULSIONS

1. For each color, find the filtration adjustment on the original package of paper and on the new package of paper. Subtract the value of the original emulsion from the value of the new emulsion for each color. This is your *program adjustment factor.*

2. Divide the new emulsion exposure factor by the original emulsion exposure factor. Multiply this value by your *standard printing time.* The result is your NEW *standard printing time.*

3. Set up as if you were going to analyze a negative, with the appropriate program set into the analyzer and the probe positioned in the appropriate manner under the projected image on the easel.

4. Analyze the negative; that is, adjust for an illuminated readout of "000" on the three color channels, and a readout of the *standard printing time* on White.

5. For each color where a change is indicated, turn the Channel Selector to that color. Now, adjust that analyzer Program Control until the numerical readout corresponds to your *program adjustment factor* for that color. A positive *program adjustment factor* indicates that the new readout should be negative, while for a negative factor the new readout should be positive.

6. Turn the Channel Selector to the White position and adjust the White Program Control until the Digital Display reads your NEW *standard printing time.*

The analyzer may now be used in the normal manner. Adjusting filtration to obtain a "000" readout on the color channels will automatically introduce the appropriate correction for the new emulsion printing characteristics. The exposure factor of the new emulsion is compensated for since you have now changed your *standard printing time.*

Example: Your original emulsion printing data was -10M, +05Y with an exposure factor of 75. The *standard printing time* for your reference print was 15 seconds. The new emulsion printing data is +10M, +15Y with an exposure factor of 100.

New emulsion filtration adjustment:	+10M	+15Y
Original emulsion filtration adjustment:	(−) −10M	(−) +05Y
Program adjustment factor:	+20M	+10Y

To determine the NEW *standard printing time:*

$$\text{Original Standard Printing Time} \times \frac{\text{New Exposure Factor}}{\text{Old Exposure Factor}} = \textit{NEW Standard Printing Time}$$

which, for our example, is:

$$15 \times \frac{100}{75} = 20 \text{ seconds.}$$

Now, set up the enlarger and analyzer as described in steps 3 and 4 above. On the Magenta channel, adjust the Magenta Program Control so the Digital Display reads "-020" (remember, a positive *program adjustment factor* should read as a negative numerical readout, and vice versa). On the Yellow channel, adjust the Yellow Program Control until the numerical readout is "-010". On the White channel, the White Program Control should be adjusted so the Digital Display reads "020.0" seconds. Your program is now adjusted to the new emulsion.

BLACK & WHITE PRINTING

When printing with black and white emulsions, the PM4L may be used to determine exposure time and paper grade. When using the analyzer to determine exposure, a simple programming step is required for each type of paper that is used. This is similar to the method for determining exposure for color papers, with the exception that in black and white printing a shadow area is generally used to determine exposure.

A shadow area is defined as that part of a negative which is *just beginning* to show detail which you are interested in reproducing on the print. Note that this is not necessarily the lightest part of the negative, but will frequently be a dark piece of clothing, hair, furniture or simply inside a shadow cast by the primary source of illumination. Some judgment is required here which, for the most part, is a matter of experience and personal preference.

As a general rule and in the absence of any other consideration, a useful shadow area may be regarded as that part of the negative which has a density of 0.10 above the base + fog density (gross density of film base and unexposed emulsion). This can be measured in any unexposed area, such as between the film frames or on an unexposed end of the film.

It is not necessary to program the PM4L for determining paper grade. After measuring for the contrast ratio of the negative, you can simply find the appropriate paper grade in the CONTRAST RATIO TABLE. Paper grades are numbers which are assigned to emulsions of different contrasts. Low paper grade numbers indicate an emulsion which is said to be "Low Contrast" or "soft". This means that a given change in exposure produces a relatively small change in print density.

Low contrast papers are, therefore, suited to the reproduction of positives with a *large density range,* since this translates into large illuminance (or exposure) differences across the projected image on the easel. It can be seen that a paper which will accept a wide range of exposure and still produce a density (or tonal) difference on the print for every density difference on the negative is required for a high-contrast negative. Furthermore, we would like our shadows to be represented on the print by very nearly the darkest black that the paper can produce, and our highlights to be represented by very nearly the lightest white of which the paper is capable.

In the case of negatives having a *small density range,* we require a paper which produces relatively large changes in print density for small changes

in exposure. We can then produce a print with a full range of tones from black to white, even though the density range of our negatives is small. Papers of this type are given high paper grade numbers, and are referred to as "High Contrast" or "hard" papers.

It can be seen that the principle is to match the negative contrast to the paper contrast—high contrast negatives requiring low contrast paper and low contrast negatives requiring high contrast papers. The procedure outlined below will enable you to use the PM4L for this purpose.

EXPOSURE PROGRAMMING

For each type of paper you will be using, it will be necessary to program the appropriate exposure information into the analyzer. In order to do this, it will first be necessary to make a pefectly exposed *reference print* on that paper. The *reference print* should have an easily identifiable shadow area which is reproduced as dark as possible while still holding some detail. Having made the *reference print,* do not make any changes to the enlarger elevation or lens aperture. Switch off all safelights, turn the enlarger on and proceed as follows:

PROGRAMMING FOR EXPOSURE PROCEDURE

1. Turn the Program Selector to the program memory mode you wish to use.

2. Rotate the Channel Selector to White and position the Probe under that portion of the projected image which corresponds to a shadow in the print. As previously described, this is the lightest part of the negative in which some detail is present. Proper orientation of the Probe is discussed under the section, COMPONENT FAMILIARIZATION—Probe.

3. Adjust the White Program Controls until the illuminated readout corresponds to the exposure time used to make your *reference print.* Record either the exact numerical setting of the White Program Control or depress the Program Verify Switch and record the *numerical verification readout.* Your analyzer is now programmed to determine exposure whenever you use the same paper as was used to produce the *reference print.* You will probably want to repeat this procedure for every paper you intend to use.

ANALYZING FOR PAPER GRADE PROCEDURE

1. Once the enlarger is set up for printing your *unknown negative,* turn off all room lights (including safelights) and switch on the enlarger.

2. Turn the Program Selector to the PANEL PROGRAM Position.

3. With the Channel Selector on White, position the Probe under the projected image of a shadow area, that is, the lightest part of the negative in which there is detail. Proper orientation of the Probe is discussed under the section, COMPONENT FAMILIARIZATION — Probe.

4. Adjust the White Program Control until the Digital Display reads "001.0".

5. Locate a highlight area on the projected image of the negative. This will be the darkest part of the negative where detail is still evident (do not use extremely dark areas, such as might be caused by reflections from a shiny surface or light source). Position the Probe under the projected image of the highlight you have located. If reading off-axis, be sure the orientation arrows are pointing toward the lens axis; make your cosine correction.

6. The numerical readout which is illuminated on the Digital Display is an indicator of the contrast ratio. Example: A readout of "004.0" denotes a contrast ratio of 1:4. Similarly, readouts of "008.0", "015.0" and "020.0" represent contrast ratios of 1:8, 1:15 and 1:20 respectively. A readout such as "006.5" indicates a ratio of 1:6½ and can be rounded off to 1:7.

7. Consult the CONTRAST RATIO TABLE to determine the correct paper grade or variable contrast filter to use for this particular negative.

8. If you are printing with variable contrast paper, insert the appropriate filter into the enlarger at this time.

CONTRAST RATIO TABLE

RATIO	PAPER GRADE/FILTER
Less than 1:4	#5
1:4 - 1:6	#4
1:6 - 1:9	#3
1:9 - 1:15	#2
1:15 - 1:25	#1
Greater than 1:25	#0

NOTE: The above calibrations are based on recommendations outlined in ANSI PH2.2-1-66, Appendix D. The numbers assigned to different paper grades by the paper manufacturer do not always coincide with these values, and it is therefore not uncommon for, say, a grade 3 of one manufacturer to be equivalent to a grade 2 or a grade 4 of another manufacturer. Often, the manufacturer will supply data in regard to the density range which its various grades of paper will accept. Such data, generally referred to as "Scale Index", should be used where it is available.

Having determined the correct paper grade to use, you can now enter the exposure program for that paper into the analyzer and proceed to analyze for exposure time. When using variable contrast papers, a separate exposure program for each contrast filter will produce optimum results. If it is known that two papers, or two contrast filters on a variable contrast paper, have the same printing speed, then the same program may be used for both.

Be sure to place the required variable contrast filters in the enlager before analyzing for exposure.

ANALYZING FOR EXPOSURE PROCEDURE

1. Adjust the White Program Control to either the Program Scale reference number or the *numerical verification readout* (whichever was recorded in the PROGRAMMING FOR EXPOSURE PROCEDURE).

2. With the Channel Selector on White, properly position the Probe under the projected image of a shadow area.

3. The Digital Display will now read out the correct printing time to use for your *unknown negative.* The aperture may be adjusted to read out a longer or shorter exposure time, if this is desired.

MAINTENANCE

The only maintenance that may be required is the replacement of the indicator lamps adjacent to the program controls and memory module receptacle. Should one of these lamps burn out, pull off the colored lamp cover and unscrew the lamp from its socket. Replace with Beseler part number 625-15-09.

Do not permit dirt to accumulate in the probe aperture as this will affect the accuracy of the instrument. Avoid, where possible, storing or using the instrument in locations where the relative humidity is extremely high.

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