CERTIFICATION

In addition to the LIMITED WARRANTY, Technidyne Corporation certifies that the Opacimeter Model BNL-3, to which this manual applies, has been designed and manufactured in accordance with TAPPI (Technical Association of the Pulp and Paper Industry) Standard T425 and ASTM (American Society for Testing and Materials) Standard D589. The data shown below was taken immediately before shipment of the instrument showing agreement with Technidyne/NBS opal glass opacity standards and IPC paper opacity standards. One Technidyne opal glass opacity standard is included with each new instrument for verification of calibration by the user.

FACTORY CALIBRATION DATA

DATE 10/28/87 TC 802

MODEL BNL-3 OPACIMETER SERIAL # 2406

AGREEMENT WITH OPAL GLASS STANDARDS (IF PURCHASED):

STD. NO	TECHNIDYNE VALUE	MEASURED VALUE	DIFFERENCE
E1248	75.2	75.1	-0.1
E1260	78.6	78.6	0.0
E1275	82.1	82.0	-0.1
E1173	88.3	88.2	-0.1
E1301	94.4	94.4	0.0

AGREEMENT WITH IPC PAPER STANDARDS (DIFFERENCES SHOWN):

X -0.10 Y +0.04 Z +0.10

TECHNIDYNE

BNL-3 OPACIMETER

INSTRUCTION MANUAL

TABLE OF CONTENTS

TTM3551-1
7/01/1987

TABLE OF CONTENTS

CON'T

TECHNIDYNE BNL-3 OPACIMETER

1. GENERAL INFORMATION

1.1 Background Information

The Technidyne Model BNL-3 Opacimeter and its predecessors the Bausch and Lomb Opacimeter and Diano Opacimeter have served the pulp and paper industry for more than 40 years. Technidyne, North America's leading manufacturer of opacity and brightness testers, took over the manufacture of the Opacimeter in 1977 from Diano Corporation. Technidyne continues to offer service and replacement parts for all old B & L, Diano and Technidyne Opacimeters.

In 1980 the National Bureau of Standards turned their opacity standardization program over to Technidyne. Calibrated opal glass standards, traceable to NBS, are available from Technidyne in standard sets of 4 or individually with values ranging from 75-95% TAPPI opacity.

1.2 Definitions

Opacity is the property of a sheet of paper which allows it to hide from view an object placed behind it. The two commonly used types of opacity are:

TAPPI OPACITY - defined as the ratio of light reflected from a single sheet of paper when the sheet is backed by a perfectly black body to that when the sheet is backed by a white body of 89% reflectance.

PRINTING OPACITY - is defined as the ratio of the light reflected by a single sheet of paper when the sheet is backed by a perfectly black body to that when the sheet is backed by multiple sheets of the same paper sufficient to make the stack completely opaque.

In the determination of both TAPPI and Printing Opacity, two measurements are taken (one with a black backing and one with a white backing), and the opacity value is the ratio of these two readings. For this reason the term "contrast ratio opacity" is used to differentiate opacity measured in this way from opacity determined by transmission measurements. Further definitions and specifications relating to the TAPPI standard Opacimeter can be found in TAPPI Official Test Method T-425. The Technidyne BNL-2 Opacimeter adheres strictly to all of the specifications and requirements of TAPPI Official Test Method T-425.

2. DESCRIPTION OF OPACIMETER

With reference to Figure 1, the TECHNIDYNE/BNL-3 Opacimeter optical system employs an incident projection system to collect the illumination from the quartz-tungsten-halogen lamp (No. 1), and directs the beam of light through a circular opening in the front face of the cube. The size of the beam is primarily determined by the position of the aperture (No. 3). The incident illumination reflecting off the sample (No. 7), and the backing material (either the white body No. 8 or the black body No. 9) is collected in the integrating cube No. 6.

The inside walls of the integrating cube are coated with a very high-reflectance white barium sulphate paint which causes multiple reflections and, therefore, diffusion of the light. The cube collects and mixes the light rays reflected from the sample. A silicon photocell (No. 10) outputs a signal which is proportional to the light level in the cube. The signal output from the photocell is amplified (No. 11) and fed into a microprocessor (No. 12). The microprocessor stores the white body reading and computes the black body/white body ratio which is displayed (No. 13) as opacity. The microprocessor also outputs all readings to the serial RS232 and parallel BCD ports for external printer or computer inputs.

3. UNPACKING AND START UP

3.1 Unpacking

As the instrument is carefully unpacked a visual observation should be made to determine if damage has occurred in shipment. If the instrument is damages, please report the damage immediately to the shipping company who delivered the instrument and to Technidyne Corporation. Also check carefully to see that the following accessories were received with the instrument:

- 1 P/N 400497-002 Opal Glass Opacity Standard
- 1 ~~P/N 406004~~ Cleaning Solution for Opal Glass Standards - 50 ml bottle
- 1 P/N 575014 Power Cord
- 1 P/N 201164 Dust Cover
- 1 P/N 170108 Spare Lamp (mounted inside back door)
- 1 TTM 3551 Instruction Manual
- 1 Technidyne Seminar Manual

3.2 Setting Up

The BNL-3 Opacimeter should be set up on a solid table or bench with sufficient space on all sides so that air can circulate freely for cooling purposes.

ALLOW THE INSTRUMENT TO REACH ROOM TEMPERATURE BEFORE PLACING IT IN OPERATION. SUDDEN CHANGES IN TEMPERATURE MAY CAUSE THE LENSES TO FOG AND THEREFORE, THE INSTRUMENT MAY NOT OPERATE PROPERLY UNTIL IT HAS STABILIZED AT ROOM TEMPERATURE.

Plug the power cord into the back of the instrument. If the label on the back of the instrument indicates that it requires 115 volts AC, plug it into an appropriate receptacle. **THE RECEPTACLE SHOULD BE WELL GROUNDED FOR PROPER OPERATION.**

If the instrument is marked for 230 volts AC operation, it may be necessary to install a plug on the end of the instrument power cord before connecting to the 230 volt power receptacle. If this is done the green lead must be connected to earth ground.

3.3 Start Up

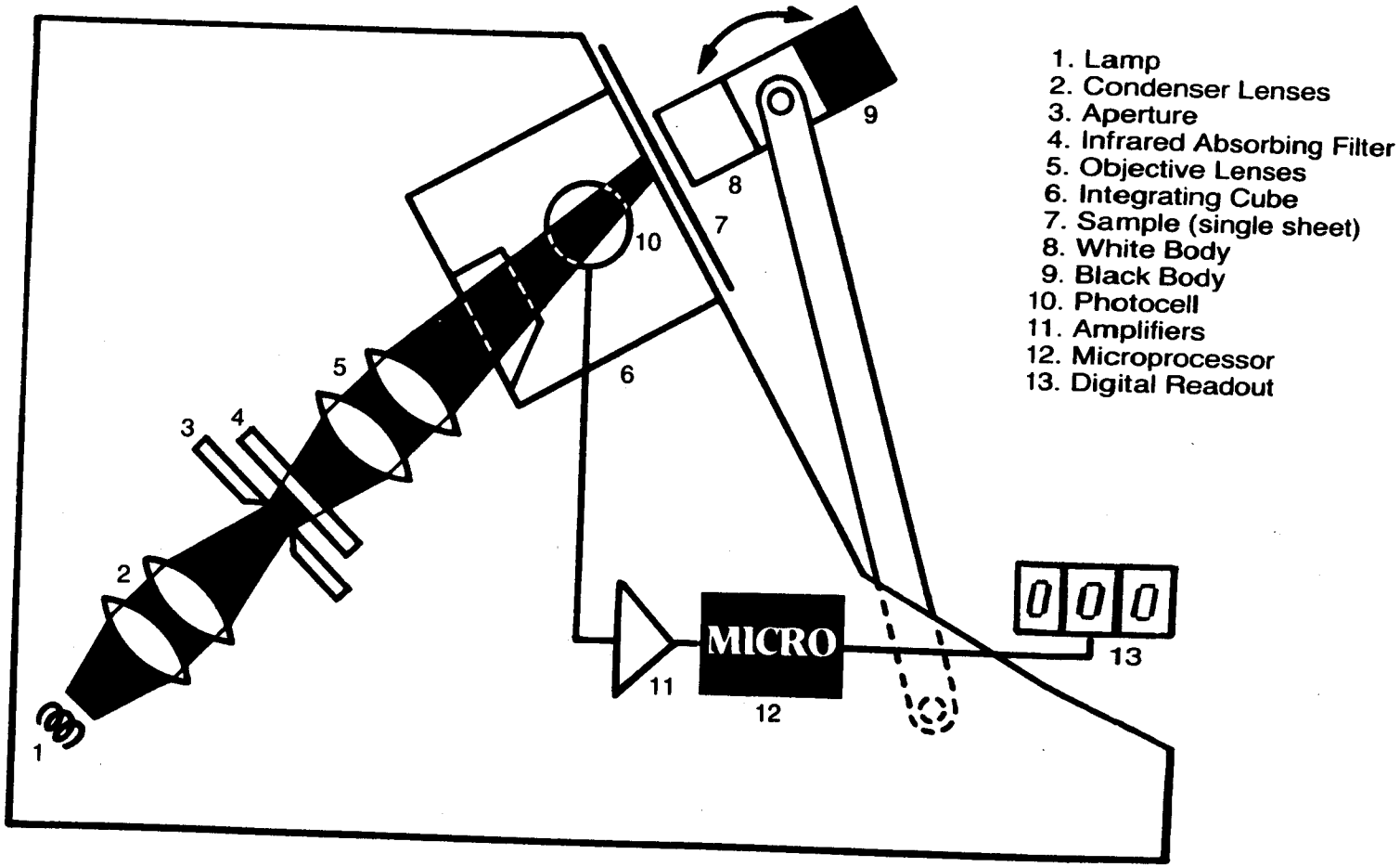
Press the red power switch on the instrument front panel to turn on the power to the instrument. Within seconds the digital display should illuminate, the fan motor should be audible, and the digital display should illuminate. Place a piece of paper over the sample opening to see that the main illuminator lamp has been lighted.

The instrument should be allowed to warm up 15-30 minutes before proceeding with calibration. It is recommended that the instrument be operated continuously (24 hours per day) wherever possible.

CAUTION

DO NOT UNPLUG THE INSTRUMENT POWER CORD BEFORE TURNING THE INSTRUMENT OFF WITH POWER SWITCH ON THE FRONT PANEL. UNPLUGGING AN OPERATING INSTRUMENT MAY RESULT IN DAMAGE TO ELECTRONIC COMPONENTS.

Opacimeter Schematic Diagram



1. Lamp
2. Condenser Lenses
3. Aperture
4. Infrared Absorbing Filter
5. Objective Lenses
6. Integrating Cube
7. Sample (single sheet)
8. White Body
9. Black Body
10. Photocell
11. Amplifiers
12. Microprocessor
13. Digital Readout

Figure 1

4. CALIBRATION

4.1 Standards (See Sec. 10 Care and Use of Standards)

The state of calibration of the BNL-3 Opacimeter may be checked utilizing the Technidyne/NBS opal glass standard which was provided with the instrument.

4.2 Checking Calibration

4.2.1 Allow the instrument to warm up to 15-30 minutes.

4.2.2 Check to see that the OPACITY/SCATTERING switch on the front panel is in the OPACITY position. If not, press to change.

4.2.3 Clean the opal glass opacity standard and face of the cube. Place it on the instrument with the bottom (short dimension) of the standard resting on the support (shelf) at the bottom of the integrating cube and the ground face in contact with the front face of the cube. The standard should be centered left to right over the sample opening. Do not touch the measured areas with the fingers, and keep these areas clean.

4.2.4 Back the standard with the White Body.

CAUTION

THE WHITE BODY MUST BE PRESSED FIRMLY AGAINST THE BACK OF THE STANDARD AND HELD IN THIS POSITION WHILE THE WHITE BODY SWITCH IS PRESSED. BECAUSE OF THE THICKNESS OF THE OPAL GLASS STANDARD THE WHITE BODY WILL NOT LIE FLAT AGAINST THE STANDARD UNLESS FORCED TO DO SO.

4.2.5 Press the WHITE BODY switch on the front panel to read 100.0 +/- 0.1 on the digital meter.

4.2.6 Rotate the Black Body/White Body holder, and back the standard with the Black Body.

4.2.7 Read the value from the digital meter.

4.2.8 Repeat this procedure to read other standards if available. If the readings obtained agree with the values indicated on the standards within ±0.3, calibration is completed.

4.3 White Body Positioning Adjustment

4.3.1 If the readings obtained on the standards do not agree with the values indicated on the standards within ±0.3, an adjustment of the white body positioning is necessary to return the instrument to a good state of calibration. To reposition the white body, remove the white body assembly from its holder by gripping the knurled ring and rotating it while sliding it out of the tube. Loosen the tiny (#0-80) set screw on the side of the holder, and rotate by hand the rear knurled ring slightly. **Clockwise rotation will decrease the opacity reading and counterclockwise rotation will increase the reading.**

NOTE: Inability to reach the proper calibration value because the white body must be pressed into contact with the cover glass indicates that the reflectance of the white body surface has deteriorated and the white body assembly should be returned to the factory for refurbishment.

CAUTION

DO NOT TURN THE WHITE BODY INTO CONTACT WITH THE COVER GLASS. THE GLASS WILL BREAK.

Damage to the white body by improper calibration procedures is not covered by the warranty.

4.4 Recheck Calibration

4.4.1 The state of calibration should be checked frequently using Technidyne/NBS opal glass opacity standards or Institute of Paper Chemistry paper opacity standards. When using IPC paper standards read and average all 10 sheets in each pad. The average value obtained should agree with the IPC average within ±0.3 opacity units.

4.5 Zero Check

To check the zero place the black body over the sample opening. The meter should read 0.0 ± 0.2. If the reading is higher than 0.2 the black body should be cleaned or replaced. If excessively in error, contact Technidyne for assistance.

5. SAMPLE PREPARATION

5.1 Sample Preparation

5.1.1 Obtain a sample in accordance with TAPPI sampling procedure T-400 which is free from watermarks or blemishes and cut at least 5 specimens, each 5 cm wide by 12 cm long, (2 in. x 4 3/4 in.).

Do not touch the test areas with the fingers, and keep these areas perfectly clean and free from folds and wrinkles.

Note: Usually neither the side or direction of fibre orientation makes any significant difference in the readings obtained. If the effect is found to be appreciable:

a) cut all specimens with the same orientation (i.e. with the 12 cm length in the machine direction and the 5 cm width in the cross machine direction,

b) consistently present the same side of the sheet to the instrument against the sample opening, and

c) state the conditions used when reporting the data.

6. OPERATION - MEASUREMENT OF TAPPI OPACITY

6.1 Measuring Light Samples

6.1.1 Place a single specimen sheet on the instrument with the 2" wide edge of the sheet resting on the support at the bottom of the integrating cube. The sheet should be centered side to side over the sample opening.

6.1.2 Back the sheet with the white body by positioning it flat against the sheet.

6.1.3 Press the **WHITE BODY** switch to set the digital readout to 100.0. If the meter reading does not go to 100.0 +/-0.1 see Sec. 6.2.

6.1.4 Rotate the black body/white body holder and back the sample with the black body.

6.1.5 Read TAPPI Opacity from the digital readout.

6.1.6 Repeat this procedure for the remaining 4 specimens and report the average of the 5 readings taken.

6.2 Measuring Dark Samples

6.2.1 Very dark materials ($R_{0.89}$ less than 10.0) may not reflect enough light to provide a stable and repeatable opacity reading. To test the validity of opacity measurements on a very dark sample, place the sample on the instrument and take several opacity measurements without moving the sample. If the meter will not display 100.00 ± 0.1 when the **WHITE BODY** switch is pressed, or if the opacity readings are not repeatable within ±0.2, then the following procedure for the measurement of dark samples should be employed.

6.2.1.1 Set the **OPACITY/SCATTER** switch to the **SCATTER** position.

6.2.1.2 Place the white ceramic scattering standard over the sample opening, press the black body firmly against the back of the standard, and set the **GAIN** adjust knob to the correct value for the scattering standard.

6.2.1.3 Place the sample over the sample opening, back with the white body and read $R_{0.89}$.

6.2.1.4 Back the sample with the black body and read R_0.

6.2.1.5 Calculate TAPPI opacity; TAPPI Opacity = $100\ R_0/R_{0.89}$.

7. MEASUREMENT OF PRINTING OPACITY

7.1 Place a single specimen sheet on the instrument as indicated in 6.1.1 and back the sheet with an opaque pad of specimen sheets (a sufficient number of sheets should be used such that doubling the pad does not change the reading).

7.2 Press the **WHITE BODY** switch to set the digital readout to 100.0.

7.3 Remove the opaque pad of sheets leaving only a single specimen sheet over the sample opening, and back it with the black body.

7.4 Read Printing Opacity from the digital readout.

7.5 Repeat this procedure for the remaining 4 specimen sheets and report the average of the 5 readings taken.

8. SCATTERING AND ABSORPTION CALIBRATION AND MEASUREMENT

8.1 Calibration

8.1.1 Press the **OPACITY/SCATTERING** switch to illuminate the red **SCATTERING** indicator light.

8.1.2 Place the white ceramic scattering standard P/N 200948-002 over the sample opening. Open the small door located below the front panel and adjust the **GAIN** adjustment until the correct value for the standard is displayed. This adjustment sets the instrument to read Absolute Reflectance values at a wavelength of 572 nanometers. Close the door.

8.2 Measuring R_0 and R_∞

8.2.1 Place a single sheet of the specimen to be measured over the sample opening and back it with the black body. Read and record the digital meter reading R_0 but do not allow the specimen to move.

8.2.2 While holding the single sheet specimen in place over the sample opening back the sheet with multiple sheets of the same specimen (a sufficient number of sheets should be used such that doubling the pad does not change the reading). Read and record the digital panel meter reading R_∞.

8.2.3 R_0 and R_∞ should be measured for a minimum of 5 specimens and the average values calculated. Using the equations provided in the next section, calculate scattering and absorption powers and coefficients.

8.2.4 To resume normal opacity measurement operations switch the **OPACITY/SCATTER** switch back to the **OPACITY** position. The operator may now alternate between the **OPACITY** and the **SCATTER** positions without readjusting the **GAIN** adjustment. If scattering measurements are being periodically taken the gain setting should be frequently checked using the scattering standard while in the **SCATTER** switch position.

NOTE: The gain setting should not have any effect on opacity readings.

NOTE: If you run out of gain adjustment before reaching the assigned value of the scattering standard it is necessary to remove the top cover and adjust potentiometer R9 on PC board #101114 which is mounted on the side of the cube.

8.3 Calculate Coefficients of Scattering (s) and Absorption (k) from R_0, R_∞

R_0 = reflectance value obtained with zero reflectance backing

R_∞ = reflectance value obtained with multiple sheet backing

NOTE: Convert these values from percent to decimals before using in the equations below. For example: $R_0 = 82.5\% = .825$.

W = basis weight g/m^2

$a = 0.5\,[1/R_\infty + R_\infty]$

$b = 0.5\,[1/R_\infty - R_\infty]$

$x = [1 - aR_\infty] / [bR_\infty]$

Scattering power $sW = (0.5/b)\ \ln\,[(x+1)/(x-1)]$

Scattering coefficient $s = sW/W$

Absorption power $kW = (asW) - sW$

Absorption coefficient $k = kW/W$

Scattering power and absorption power are unitless values. Scattering coefficient and absorption coefficient have inverse basis weight units. The scattering and absorption coefficients have been multiplied by 1000 to keep them from being inconveniently small, making the units m^2/kg as recommended by ISO standard 5641 and TAPPI TI 080404 (old number 0184).

NOTE: Technidyne QC software is available for the automatic execution of these computations.

9. MAINTENANCE

9.1 Lamp Replacement

As the lamp nears the end of its useful life, fluctuations may occur up to 1 day before it completely fails. If fluctuations continue after lamp replacement contact Technidyne. Replace the main illuminator lamp only with TECHNIDYNE P/N 170108 QTH Lamp, GE TYPE 1974.

CAUTION

OLDER MODEL BNL-2 OPACIMETERS (SERIAL NO'S BELOW 2169) USE THE GE TYPE 1962 LAMP WHICH LOOKS EXACTLY LIKE THE 1974 LAMP. THE TYPE NUMBER IS STAMPED ON THE BRASS LAMP BASE. DO NOT USE THE 1962 LAMP IN BNL-3 OPACIMETERS.

9.1.1 Disconnect the power plug from the power main.

9.1.2 Open the access door on the back of the instrument. A replacement bulb is affixed to the inside of this door.

9.1.3 With a screwdriver disconnect the two lamp leads from the terminal block. Do not disconnect the green ground lead.

9.1.4 Remove the large knurled nut which holds the lamp in position and remove the lamp from its socket.

9.1.5 Place the new lamp in the socket (using tissue to prevent touching the bulb), and retighten the knurled nut to clamp the lamp firmly in place. Take care to orient the lamp in the socket so that one indexing tab on the lamp base and the lamp leads slip through the wide slot in the lamp socket and the other indexing tab on the lamp base slips into the narrow slot in the lamp socket.

9.1.6 Using a tissue to prevent leaving finger prints, gently grip the lamp bulb and test to be sure it is secure in the socket. If it moves retighten the knurled nut. DO NOT CROSSTHREAD.

9.1.7 Reconnect the lamp leads to the terminal block. Position the leads so that the insulation does not touch the lamp at any point.

CAUTION

DO NOT TOUCH HOT OR COLD LAMP WITH FINGERS.

BE SURE POWER IS OFF WHEN INSTALLING LAMP.

IF NECESSARY, REMOVE GREASE OR FINGERPRINTS FROM LAMP BY CLEANING WITH A GREASE-FREE SOLVENT SUCH AS ACETONE BEFORE TURNING POWER ON.

TO PROTECT LAMP FROM FINGERPRINTS, USE A TISSUE FOR HANDLING.

DANGER

THE LAMP OPERATES AT A TEMPERATURE OF 700° C AND SERIOUS BURNS MAY RESULT FROM TOUCHING IT. DO NOT TOUCH THE LAMP OR SOCKET WHILE HOT WHEN MAKING ADJUSTMENTS.

DO NOT LOOK DIRECTLY AT THE ILLUMINATED LAMP WITHOUT DARK GLASSES OR OTHER EYE PROTECTION.

9.2 Lamp Positioning

After replacing a lamp check to see if the filament image is centered and focused as follows:

Arrange the instrument to allow the light beam to project out of the sample opening and on a wall or sheet of paper parallel to the front face of the integrating cube and approximately 2-3 feet away. The filament image observed should be in a good state of focus and centered in the beam. If lamp repositioning is required loosen the two screws which clamp the lamp socket holder to the base and slide the holder side to side to center the filament image horizontally. To center the image vertically loosen the clamp screw holding the lamp socket and slide the lamp up and down. When the best state of centering has been achieved, securely tighten the clamp screw and the base screws.

If the filament image is out of focus it is necessary to reposition the set of condenser lenses which are located immediately in front of the lamp. Loosen the screw which holds the lens set. A slotted hole is provided to facilitate movement of the lens set forward and backward in the mounting tube. When the best state of focus has been achieved, retighten the holding screw. The filament image should now be well focused and centered in the light beam.

When a sheet of paper is laid over the sample opening a sharply defined circular spot of light should be observed. The circular light spot should be diffusely illuminated (no filament image), centered in the aperture and there should be a clearance of approximately 2mm between the edge of the light spot and the aperture. The spot size should 3/8 inch (9.5 ± .5mm).

If the light spot is off center or out of focus a realignment of the optical system is required. Contact Technidyne for assistance.

CAUTION

AFTER REPLACING OR READJUSTING THE LAMP, REPEAT THE CHECKS AND ADJUSTMENTS GIVEN IN SECTION 4 TO INSURE PROPER OPERATION AND CALIBRATION.

9.3 Diagnostic Switch

9.3.1 A diagnostic switch is located behind the small door below the front panel to assist in troubleshooting. This switch should be kept in the **OPERATE** position whenever the instrument is being used for calibration or operation. The other switch positions may be used as follows:

9.3.2 **5V** - The 5 volt position allows the operator to observe the output of the 5 volt power supply in the instrument. This output can be observed on the digital display. The 5 volt supply should read 5.00 ± 0.25 volts and be stable within ±0.02.

9.3.3 **LAMP** - In this position the lamp voltage may be monitored with the digital display. The lamp voltage should be 7.00 ±.20 volts. The short term stability should be within ±0.02 volts. If the lamp voltage is incorrect it may be corrected by adjusting the **LAMP VOLTAGE ADJUST** potentiometer on the back of the instrument.

9.3.4 **+15V** - This position allows monitoring of the +15 volt power supply. The reading should be 15.00 ±.50 volts and should be stable within ±0.02 volts.

9.3.5 **-15V** - The -15 volt power supply may be monitored in this switch position. The reading should be -15.00 ±.50 volts and should be stable within ±0.02 volts.

9.3.6 If problems occur during the operation of the BNL-3 readings should be taken in all of the diagnostic switch positions, as described above, before contacting Technidyne for service assistance.

CAUTION

REMEMBER TO RETURN THE DIAGNOSTIC SWITCH TO THE OPERATE POSITION BEFORE CALIBRATING OR OPERATING THE INSTRUMENT.

9.4 Circuit Description for the A/D Converter Board (Reference Schematic #400542)

9.4.1 General

The BNL-3 A/D Converter is a single board computer based on the 8-bit Z-80 microprocessor. The board accepts one of six software selectable input voltages and

1) converts the analog voltages to digital signals
2) processes and displays the input selected on a 4 digit display
3) outputs data in a BCD format
4) outputs data in a serial RS-232 format

9.4.2 Analog Input Section

Analog input signals are input through connector J8. The inputs are:

* signals from the opacity detector board
* LAMP voltage test signal
* +5 VOLT test signal
* +15 VOLT test signal
* -15 VOLT test signal

The Analog signal from the BNL-3 opacity detector circuit board is wired to Pin 1 of J8 on the A/D Converter Board and is adjustable at R20. The output from R20 goes to the input of U18, an eight channel analog multiplexer.

The LAMP input signal is divided in half through a resistor divider (R4 and R9) and is provided as an input to the multiplexer (U18).

The -15 VOLT input is inverted and divided in half through U19 to provide a signal to the multiplexer of +7.5 volts.

The +5 VOLT test signal is input directly into U18, multiplexer.

The +15 VOLT test signal is divided in half through R12 and R11 and input to U18.

Addressing for the multiplexer U18 channels:

address (A0, pin 16; A1, pin 1; A2 pin 4) Number	Binary Code A0	A1	A2	Selected Signal
0	0	0	0	+15 VOLT test
1	0	0	1	-15 VOLT test
2	0	1	0	+5 VOLT test
3	0	1	1	preamp input
4	1	0	0	LAMP test
5	1	0	1	common reference

The Channel selection is made in software through the peripheral interface (U2).

The selected output from the multiplexer is buffered by op amp (U20) to provide the high impedance required by the output of the multiplexer and the low impedance required for the analog-to-digital converter (U15).

U15 is a 12 bit A/D converter providing the digital interface for the microprocessor. Offset adjustment is provided through R16 and gain adjustment through R19. This is not an instrument gain. Do not adjust. The 12 bit output is supplied as an 8-bit byte (high order byte of the 12 bits) and as the upper 4-bit nibble (lower 4 bits of the 12 bit converted signal).

9.4.3 Computer Section

The computer is a Z-80 (U11) microprocessor based system running at a clock frequency of 1.27 Mhz. The computer includes 2K bytes of random access memory (RAM U9), 8K bytes of erasable read only memory (EPROM U4), a serial channel (UART U3). Input/output access is through peripheral interface adapters (U1 and U2). Clocking for the microprocessor is supplied by U7 from the crystal oscillator output divided by 4: (5.0688 Mhz/4 = 1.267 Mhz). U7 also supplies the baud rate

clock for the serial channel input and output from the programmed output, pin 14, at 38.4 Khz. Pins 9, 10, 11, 12 provide the hardware programming for the clock dividers within U7. The UART (U3) internally divides this clock by 16 giving the 2400 baud rate (38.4 Khz/16 = 2400).

Address Decoding

Address decoding and selection signals for the various IC's is accomplished with the dual decoder (U10). One half of the decoder decodes the memory space into 8K segments and the other half of the decoder decodes the I/O space into 4-bit segments.

device	address
EPROM	0000-1FFFh (h=HEX number)
spare	2000-3FFFh
RAM (2K used)	4000-5FFFh (lower 2K of space is used)
PPI (U1)	0-3
PPI (U2)	4-7
A/D converter (U15)	8-0Bh
UART (U3)	0Ch-0Dh

9.4.5 Power-on Reset Section

The timing circuit (U12) provides a reset signal when power is initially applied to the computer or if pin 2 of the circuit is pulled momentarily low. The output from pin 3 of U12 is inverted by Q2 and supplies an inverted reset signal.

9.4.6 I/O Section

U1 and U2 provide the inputs and outputs for the BNL-3. Each of the two integrated circuits have three 8-bit ports designated port A, port B, and port C. U1 provides a BCD output. U2 is used for inputs and outputs for the panel controls and displays. The following are the individual bit assignments for each IC.

Port Designation	Pin #	function
U1 port A		
bit 0	4	BCD output 1's digit
bit 1	3	BCD output 2's digit
bit 2	2	BCD output 4's digit
bit 3	1	BCD output 8's digit
bit 4	40	BCD output 10's digit
bit 5	39	BCD output 20's digit
bit 6	38	BCD output 40's digit
bit 7	37	BCD output 80's digit
U1 port B		
bit 0	18	BCD output 100's digit
bit 1	19	BCD output 200's digit
bit 2	20	BCD output 400's digit
bit 3	21	BCD output 800's digit
bit 4	22	BCD output 1000's digit
bits 5-7 are not used		

Port Designation	Pin #	function
U1 port C		
bits 0-5 are not used		
bit 6	11	polarity output
bit 7	10	print output
U2 port A		
bit 0	4	selector switch LAMP position
bit 1	3	selector switch -15 VOLT
bit 2	2	selector switch +5 VOLT
bit 3	1	selector switch operate position
bit 4	40	selector switch +15 VOLT
bit 5	39	WHITE BODY push button input
bit 6	38	SCATT position input
bit 7	37	OPACITY position input
U2 port B		
bit 0	18	multiplexer channel select
bit 1	19	multiplexer channel select
bit 2	20	multiplexer channel select
bits 3-7 not used		
U2 port C		
bit 0-3 not used		
bit 4	13	WHITE BODY light
bit 5	12	display ENABLE output
bit 6	11	display DATA output
bit 7	10	display CLOCK output

9.4.7 Serial Format

The UART U3 and Quad line driver U5 provides the outputs and accepts the inputs for Serial Data at Connector J7.

Pin 1	Serial Data Out
Pin 2	Serial Return
Pin 3	Serial Data In -ASCII character 32 triggers transmission of data output.

Data Output Format: 3 digits, decimal point, 2 digits, CR LF (8 characters total)

Baud Rate = 2400

Format: 8 bit ASCII, parity disabled, 1 stop bit.

9.5 Other Maintenance

9.5.1 The air filter element on the back of the instrument should be removed and washed clean periodically - at least 4 times per year or more frequently depending upon the cleanliness of the operating environment. After removing the thumbscrews and the filter cartridge, pop out the center of the cartridge to remove the foam element.

9.5.2 The cover glass over the White Body should frequently be wiped clean with lint free tissue paper.

9.5.3 The White Body will normally need to be refurbished every 12 - 24 months. We recommend that a spare White Body Assembly P/N 101040-002 be obtained and used when the deteriorated White Body is returned for refurbishment.

9.5.4 If the instrument is under heavy usage, the White Body should be replaced every 6 - 12 months.

9.5.5 The integrating cube should be recoated at 2 - 5 year intervals. If the operating environment is dusty, dirty, or smoky, more frequent recoatings may be required. Contact TECHNIDYNE for information.

9.5.6 Under normal conditions there should be no need to disassemble or realign the optical system in the Opacimeter. Occasional wiping of the exposed lens surface with a dry cloth or lint free tissue will be helpful where the instrument is being operated in a dirty atmosphere.

If optical realignment is required to bring the instrument into calibration, contact TECHNIDYNE.

CAUTION

DO NOT USE TISSUES CONTAINING SILICONES OR ABRASIVES.

9.5.7 **DO NOT USE AN EXTERNAL VOLTAGE REGULATOR WHICH DISTORTS THE AC WAVE SHAPE.** The voltage regulation circuitry in the instrument is capable of regulating the lamp voltage to +/-0.15% or better for AC line variations of 100 volts to 130 volt. The "built-in" regulation for the electronic circuitry, powered by +/- 15 volts, regulates to better than +/-0.01%. Typical external regulators provide only +/- .5% regulation, which is much less than that provided by the instrument itself. Also many external regulators distort the AC wave shape entering the instrument, which prevents the "built-in" regulators from operating properly. If your line voltage goes below 100 volts, above 130 volts or varies excessively we recommend the use of Sola regulator Type 63-13-125.

External line filters which eliminate transient voltage spikes may be helpful where the power line is excessively noisy. **Good grounding is the key ingredient for stable-noise free operation.** We recommend the ISOBAR Tripp Lite noise filter and surge suppressor (Technidyne P/N 100980), as an external filter for the BNL-3.

9.6 Factory Service

Any device employing electronic, mechanical and electrical components will require servicing from time to time. Contact TECHNIDYNE for information concerning factory service or replacement parts. If you return your instrument to us for repair, please package the instrument with great care. Use a heavy double wall corregated box or wooden crate. Wrap the instrument completely with plastic sheeting to avoid moisture contact. **Use a minimum of 2 - 3 inches of cushioning material such as polystyrene "peanuts" on each side, top and bottom. If you use a wooden crate, DO NOT firmly fasten the instrument to the crate. Cushioning material must be used on all sides.** TECHNIDYNE will bill the user for any repairs resulting from shipping damage due to improper packaging.

10. CARE AND USE OF STANDARDS

10.1 Opacity Standards

There are two types of opacity standards recommended for use with the Technidyne Model BNL-3 Opacimeter. Opal glass opacity standards may be obtained from Technidyne Corporation and are normally supplied as a set of four standards in the opacity range from 75 to 95. Paper standards are available from The Institute of Paper Chemistry, Appleton, Wisconsin, consisting of three sets of ten sheets each with one set in the opacity range of 40 to 50, another set in the opacity range 80 to 90, and a third set in the opacity range above 90. The paper standards are available on individual order or on a subscription basis six times per year.

Both the opal glass and paper standards have advantages and disadvantages. The main advantage of the opal glass standards is that they are permanent in that their opacity values do not deteriorate rapidly (as in the case of paper) when they are handled with care. Paper standards, on the other hand, are closer to the physical and optical characteristics of the material normally measured on the opacimeter and provide a more complete check on the geometric, photometric, and spectral calibration of the instrument. For example, one of the paper standards has a slightly cream colored tint which provides a check on the spectral accuracy of the opacimeter. When the instrument reads this standard incorrectly and reads the two white standards correctly, an error in the wavelength response of the instrument is indicated. The primary disadvantage of paper standards is that they are very impermanent and must be discarded after a few weeks of usage.

10.1.1 Opal Glass Standards

The Opal Glass Standards provided by Technidyne Corporation are each 5 x 12 centimeters with a thickness ranging from 1 to 6 millimeters, polished on one face and fine ground on the other. An identifying number is located in the upper left-hand corner of each standard on its polished face and the calibration value is located in the upper right-hand corner. The standard is sized such that it can be placed on the instrument with the bottom of the standard resting on the support shelf at the bottom of the integrating cube. The short dimension of the standard should be centered over the sample opening. The fine ground face is in contact with the front face of the instrument and the black or white body is brought into contact with the polished face of the standard.

CAUTION

BECAUSE THE OPAL GLASS STANDARDS VARY IN THICKNESS THE WHITE BODY WILL NOT ALWAYS POSITION ITSELF FLUSH AGAINST THE FACE OF THE STANDARD. IT IS NECESSARY WHEN USING THE OPAL GLASS STANDARDS TO GRASP THE WHITE BODY AND FIRMLY PRESS IT AGAINST THE FACE OF THE OPAL GLASS STANDARDS TO ASSURE THAT THE COVER GLASS ON THE WHITE BODY IS FLUSH UP AGAINST THE STANDARD. THE LOCATING DETENT IN THE BLACK/WHITE BODY TUBE IS POSITIONED DURING MANUFACTURE SUCH THAT THE WHITE BODY WILL LIE FLAT AGAINST THE FRONT FACE OF THE INTEGRATING CUBE, THEREFORE, THIS DETENT MUST BE OVERCOME WHEN MEASURING THICK STANDARDS TO AVOID SERIOUS ERROR.

The opal glass standards should be cleaned frequently with Technidyne cleaning solution P/N 406004 and clean, lint free tissues. Handle the standard by the corners to avoid finger printing the measurement area. Do not slide the standards on the instrument or any other surface to avoid scratching and abrading the surfaces. For further information on the use of the standards, see TAPPI Standard T425. If the standards have received considerable wear they may be returned to Technidyne Corporation for restandardization.

10.1.2 Paper Standards

The calibrated paper standards provided by The Institute of Paper Chemistry are also approximately 5 x 12 centimeters for convenient use on the BNL-3 Opacimeter. Three pads of 10 sheets each comprise a complete set of standards. The TAPPI opacity values are provided for each sheet except for the cover (first) sheet in each pad. The instrument should be calibrated through the adjustment of the white body to agree very closely with the average value (average of the 10 sheets) assigned to the paper standard Y. Then all 10 sheets in standards X and Z should be checked and if the average values obtained agree to within +/-0.3 with the assigned average values, then the instrument is calibrated and functioning properly.

The paper standards should be handled carefully to avoid finger prints and dirt smudges. When not in use they should be kept together in a stack and stored in a low humidity dessicator. We do not recommend the use of a set of paper standards for more than two months.

10.2 Scattering Standard

A white ceramic absolute reflectance standard (P/N 200948-002) can be purchased from Technidyne for scattering and absorption determination. Each standard consists of a rectangular steel plate 5 x 12 cm (2 x 4 3/4 in.) coated with white ceramic on one side. The standard should be placed on the Opacimeter with the white ceramic surface against the sample opening and centered horizontally with the arrows pointing upward.

IMPORTANT NOTE: **During measurement the white ceramic standard must be firmly pressed against the sample opening by pressing the instrument black body against the back of the standard.**

Each standard is carefully measured with respect to the perfect diffuser and the absolute reflectance factor at 572 nm wavelength is indicated on the back of the standard.

The white ceramic absolute reflectance standard should be cleaned periodically using Windex containing ammonia and dry with clean, lint-free tissue. Handle this standard by the corners to avoid finger printing the measurement area. To avoid scratching or abraiding the measurement surface, do not slide the standard on the instrument or other surfaces.

We recommend that white ceramic standards be returned to Technidyne for periodic recertification. The standard will be checked for deterioration, cleaned and carefully remeasured. The degree of usage should determine the frequency of recertification.

11. TROUBLE-SHOOTING

The following is a list of problems which could be encountered on the BNL-3 and recommended checks for trouble shooting purposes.

	PROBLEM	CHECK
11.1	No power.	1. Is power cord plugged in? 2. Check fuse on back (2 amp S.B.)
11.2	Digital Display does not light up.	1. Check 5V supply with diagnostic switch (see Sec. 9.3.2) 2. Check connector J2 on A/D converter board and connector to display board.
11.3	Digital Display reads 00.0 only.	1. Check to see that diagnostic switch is in OPERATE position. 2. Check +15V and -15V supplies with diagnostic switch (Sec. 9.3.4 and 9.3.5).
11.4	All segments of the display are ON or the number displayed appears to be incorrect.	1. Check to see that diagnostic switch in in OPERATE position. 2. Place white body against the cube and press white body switch.
11.5	To check for bad segment in the display.	1. Place black body against the cube, then turn instrument OFF and back ON. Display should read 00.00.
11.6	Digital Display unstable.	1. Place white body against the cube and press white body switch. 2. Replace lamp (Sec. 9.1). QTH lamps become unstable shortly before they burn out. 3. Check AC ground. 4. Using diagnostic switch, check lamp voltage (Sec. 9.3) and all power supply voltages.
11.7	Does not read correct data.	1. Is diagnostic switch in OPERATE position? (see Sec. 9.3.1).
11.8	Indicator lights will not come on.	1. Check the indicator lamp located under the indicator cap, replace if necessary.
11.9	White body indicator light will not come on.	1. Check if diagnostic switch is in OPERATE position see Sec. 9.3.1. 2. Check if SCATTERING/OPACITY switch is in OPACITY position.

11.10	Main illuminator lamp does not light.	1. Check lamp voltage with diagnostic switch (Sec. 9.3.3). 2. Check 4 amp fuse on back of instrument. 3. Replace lamp. (see Sec. 9.1.1 and 9.2).
11.11	Will not calibrate. All values exceeding .3 tolerance on high side or all values exceeding tolerance on low side.	1. Check lamp voltage and set at 7.0 volts ±.01. 2. Change lamp (Sec. 9.1.1 and 9.2). 3. Check zero setting (see Sec. 4.5). 4. See Sec. 4.2.4 and 4.3.1 Calibration and White Body Adjustment.
11.12	Cannot obtain the scattering standard value due to lack of gain adjustment.	1. Remove the top cover and adjust potentiometer R9 on detector PC board #101114 which is mounted on the side of the cube. 2. Increase the value of resistor R9.
11.13	Meter does not read 100.0 ± .1 when WHITE BODY switch is pressed.	1. Sample is too dark to provide enough reflected light. See Sec. 6.2.

Technidyne Quotation

To	Date	Please indicate this number when ordering
Mike DiGrigoli	9/29/98	▶ Q-2877A
SCHWEITZER-MAUDUIT	Your Inquiry Dated 9/29/98	Terms Net 30 days
Center Street	Proposed Shipping Date 4 - 6 Weeks ARO	To Be Shipped Via UPS
Lee, MA	Salesman J. A. Baker	F.O.B. Factory — Ppd. X — Coll.

Here is our quotation on the goods named, subject to the conditions noted:

Quantity	Description	Price	Amount
1 ea.	**TECHNIDYNE MODEL BNL-3** Digital Readout Opacimeter with automatic push-button calibration, including: long life quartz-halogen lamp, high sensitivity photocell, integrating cube coated with Eastman Kodak high reflectance paint, serial RS232 and parallel BCD outputs, internal voltage regulator and surge supressor, selector switch for scattering measurement, spare lamp, dust cover and instruction manual. Also included is one Technidyne opal glass opacity standard and one set of paper opacity calibration standards for verification of certified agreement with TAPPI Official Test Method T425 and ASTM Standard D589. The BNL-3 meets Flexible Packaging Association's Specification B-8.	14700	$ 9,950.00
	OPTIONS		
1 ea.	**OPACITY STANDARDS** Calibrated opal glass opacity standards for use with the BNL-3 Opacimeter. A set consists of 4 opal glass standards with values within the opacity range of 75 to 95 including storage case and calibration certificate.		870.00
1 ea.	**WHITE CERAMIC ABSOLUTE REFLECTANCE STANDARD** OPTEAB25 - White Ceramic Absolute Reflectance Standard for Scattering and Absorption Determination		175.00
1 ea.	**AUTOMATIC AVERAGING PRINTER MODEL AP-1** Complete with foot switch, 12 paper rolls and instructions.		1,950.00

James

Quote Valid for 60 Days.

By Jeffrey A. Baker
Jeffrey A. Baker, National Sales Manager

Conditions: The prices and terms on this quotation are not subject to verbal changes or other agreements unless approved in writing by the Home Office of the Seller. All quotations and agreements are contingent upon strikes, accidents, fires, availability of materials and all other causes beyond our control. Prices are based on costs and conditions existing on date of quotation and are subject to change by the Seller before final acceptance.

Typographical and stenographic errors subject to correction. Purchaser assumes liability for patent and copyright infringement when goods are made to Purchaser's specifications.

Conditions not specifically stated herein shall be governed by established trade customs. Terms inconsistent with those stated herein which may appear on Purchaser's formal order will not be binding on the Seller.

TD/79/01

Technidyne Quotation

To	Date	Please indicate this number when ordering
Mike DiGrigoli	9/29/98	Q-2877B
SCHWEITZER-MAUDUIT	Your Inquiry Dated 9/29/98	Terms Net 30
Center Street	Proposed Shipping Date 4 Weeks ARO	To Be Shipped Via UPS
Lee, MA	Salesman J. A. Baker	F.O.B. Factory — Ppd. X — Coll.

Here is our quotation on the goods named, subject to the conditions noted:

Quantity	Description	Price	Amount
1 ea.	**TECHNIDYNE BRIGHTIMETER MODEL S4-M** S4-M Brightimeter basic unit with one filter for TAPPI/GE brightness measurement. Includes digital readout, dual-beam optics, AUTO-CAL feature, serial RS232 and parallel BCD outputs, one spare lamp, standard accessories, instruction manual, and one year warranty. One set of TAPPI brightness standards for verification of certified agreement with TAPPI Official Test Method T452 and ASTM Standard D985.		$11,950.00
	OPTIONS		
	1F - FLUORESCENCE MEASUREMENT Fully automatic measurement of fluorescent component including one acrylic fluorescent component standard.		1,800.00
	AUTOMATIC AVERAGING PRINTER, MODEL AP-1 Complete with foot switch, 12 paper rolls, and instructions.		1,950.00

Quote Valid for 60 Days.

By Jeffrey A. Baker/ee

Jeffrey A. Baker, National Sales Manager

Conditions: The prices and terms on this quotation are not subject to verbal changes or other agreements unless approved in writing by the Home Office of the Seller. All quotations and agreements are contingent upon strikes, accidents, fires, availability of materials and all other causes beyond our control. Prices are based on costs and conditions existing on date of quotation and are subject to change by the Seller before final acceptance.

Typographical and stenographic errors subject to correction. Purchaser assumes liability for patent and copyright infringement when goods are made to Purchaser's specifications.

Conditions not specifically stated herein shall be governed by established trade customs. Terms inconsistent with those stated herein which may appear on Purchaser's formal order will not be binding on the Seller.

Technidyne Quotation

Page 1 Of 1

To	Date	Please indicate this number when ordering
Mike DiGrigoli	9/29/98	▶ Q-2877C
SCHWEITZER-MAUDUIT	Your Inquiry Dated 9/29/98	Terms Net 30
Center Street	Proposed Shipping Date 8 - 10 weeks	To Be Shipped Via UPS
Lee, ME	Salesman J. A. Baker	F.O.B. Factory — Ppd. X — Coll.

Here is our quotation on the goods named, subject to the conditions noted:

Quantity	Description	Price	Amount
1 ea.	**MODEL 425 OPACITY TESTER** Tests opacity in accordance with TAPPI Official Test Method T425 using the contrast ratio paper reflectance using the 89% reflectance backing compared to the black body backing. Calibration is achieved using either opal tiles or calibrated paper tabs. Includes spare white body/black body, spare lamp, air compressor to actuate mechanisms, tool kit, and alignment brackets.		$12,445.00
	Auto-Feed Options		
	AF-005 Synchronized Auto-feed less printer For one to four instruments		4,400.00
	AF-005P Synchronized Auto-feed with printer Includes 40-column printer with cable, ribbons, and a case of paper, 4 1/2" dia. rolls		5,000.00
	AF-001 Auto-feed Drive for one instrument only, less printer		1,975.00
	AF-001P Auto-feed Drive for one instrument only Includes 40-column printer with cable, ribbons, and a case of paper 4 1/2" dia. rolls.		2,575.00

Quote Valid for 60 Days.

By Jeffrey A. Baker, National Sales Manager

Conditions: The prices and terms on this quotation are not subject to verbal changes or other agreements unless approved in writing by the Home Office of the Seller. All quotations and agreements are contingent upon strikes, accidents, fires, availability of materials and all other causes beyond our control. Prices are based on costs and conditions existing on date of quotation and are subject to change by the Seller before final acceptance.

Typographical and stenographic errors subject to correction. Purchaser assumes liability for patent and copyright infringement when goods are made to Purchaser's specifications.

Conditions not specifically stated herein shall be governed by established trade customs. Terms inconsistent with those stated herein which may appear on Purchaser's formal order will not be binding on the Seller.

FD/79/01