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1. General Description

ABM Intensity-Controlling Power Supply systems are designed to produce significantly improved printing performance due to their ability to operate and precisely control the exposing source over a wide range of intensities. The capability allows the process engineer to develop an exposure matrix, and then select the optimum time/intensity

relationship needed to produce the desired printing quality. The user inputs the desired intensity/time function, and the controller then delivers the selected parameters to an accuracy of better than ±2%. This accuracy is maintained throughout the life of the lamp.

This state-of-the-art intensity-controlling power supply is a solid state design with line and load regulation. When the desired intensity is set, the supply controls the average power and maintains proper operating temperature of the lamp.

ABM's power supplies are capable of operating all mercury vapor short arc lamps having negative pressure inert gas fill characteristics which allow a breakdown ionization voltage of 180 volts or less. The system provides direct optical feedback for precise intensity control or constant power control over its specified wattage range.

2. Specifications

Specifications for 2,000 Watt UV systems with constant power/constant intensity.

2.1 Mechanical (Power Supply Size)

UV 200 to 500 Watt:

Length	17.00 inches
Width	10.5 inches
Height	6.00 inches
Weight	Approx. 50 lbs

DUV 500 Watt / UV 1,000 Watt:

Length	19.00 inches
Width	13.5 inches
Height	7.00 inches
Weight	Approx. 50 lbs

DUV 1,000 Watt / UV 2,000 Watt:

Length	22.75.00 inches
Width	16.00 inches
Height	9.00 inches
Weight	Approx. 50 lbs

2.2 Electrical

Input Voltage	110-220 VAC
Input Frequency	50/60 HZ
Starting Voltage	2,000 to 30,000 VDC
Open Circuit Voltage	160-180 VDC

2.3 Interfaces To UV Exposure System

Lamp Connectors	Anode, RED / Cathode, BLACK
Fan Connector	3-Prong (Male)
Sensor Connector	3-Prong (Female)
Interlock Remote Start	4-Prong (Male/Square)
AUX Interface	4-Prong (Male/Round) Not In Use
Earth Ground	Ground Nut

2.4 Operating Range (Power in Watts)

200 Watt	130-260W (idle @ 180 to 200)
350 Watt	200-425W (idle @ 275 to 325)
500 Watt (uv/duv)	375-625W (idle @ 450 to 500)
1,000 Watt (uv/duv)	750-1250W (idle @ 950-1000)
2000 Watt (uv/duv)	1700-2200W (idle @ 1800 to 1900)

2.5 Optical Sensors

UV	DUV/UV
UV-365nm (A Channel)	DUV-220nm (A Channel)
UV-400nm (B Channel)	UV-400nm (B Channel)

DUV

DUV-220nm (A Channel)
DUV-254nm (B Channel)

2.6 Typical Front Panel Layout

Power Switch	Turns power supply on or off
Start Switch	Momentary contact, provides breakdown voltage to ignite the lamp
Meter Select Switch (intensity or power) (watts).	Switch at right position; meter reads power Switch in left position; meter reads intensity units (mW/cm^2)

Meter Select Switch (voltage or current)	Switch in right position; meter reads lamp current (amps). Switch in left position; meter reads lamp voltage (volts).
Mode Select Switch Constant Intensity (C/I) Constant Power (C/P)	Selects systems operating mode. Switch in right position; system operates in constant power mode. Switch in left position; system operates in constant intensity mode.
Intensity Cal Pot	This ten-turn potentiometer calibrates the system's built-in intensity meter to user's external intensity meter.
Hour Timer	Analog Display, Supply/Lamp Hours

Intensity Set Pot	This ten-turn potentiometer sets the desired intensity when system operates in intensity controlling mode.
Power Set Pot	This ten-turn potentiometer sets the power level when system operates in constant power mode. Set "IDLE" power in constant intensity and power management modes.

NOTE: The dual channel systems have an additional switch for selecting channel A or channel B

3. Operating Information

3.1 AC Power Source

This power supply is intended to be operated from a single or three-phase, earth-referenced power source. The unit has a three or five-wire power cord with a three or five-terminal polarized plug for connection to the power source and safety-earth. The safety-earth terminal of the plug is directly connected to the power supply chassis. For shock protection, insert this plug only into the proper matching outlet with a safety-earth contact.

The power requirements of voltage, line frequency and the maximum wattage drawn, are listed in the information supplied with the equipment. The system is capable of operating at voltages from 110 VAC to 220 VAC and frequencies of 40 to 70 HZ. Each unit is wired internally for the power option specified on the purchase order.

3.2 Mercury Arc Lamp

This power supply can be operated where the ambient air is between 10°C and 35°C. The power supply is cooled by air being drawn in through the side panels. Adequate clearance must be provided on all sides to allow air flow through the holes in the power supply cabinet. Failure to observe this requirement may result in serious damage to the power supply.

3.3 Mercury Arc Lamp

This power supply is designed for use with virtually all mercury short arc vapor lamps of negative pressure inert gas fill. With normal temperature operating conditions, the lamp filled with inert gas at a negative pressure will achieve full power in approximately five minutes with voltage and current parameters specified by the lamp manufacturer.

When overcooled, the mercury in the lamp is not completely vaporized, and the lamp will not come up to full power and maximum intensity. If the voltage reading is not within a

few volts of that specified, check to see that the cooling associated with the lamp-housing is according to specifications. Overcooling of the lamp will result in severely-reduced lamp life. (Lamp voltage will be below specification with an overcooled lamp)!

The following lamp criteria must be followed:

1. Always operate the lamp in a vertical position.

2. Always operate the lamp with the positive lead connected to the anode terminal.

3. The anode and cathode terminals of the lamp must always be isolated from ground and any conductive parts.

4. Use the proper lamps as specified by ABM.

3.4 Maintenance and Troubleshooting

Because of the unique design of the power supply's circuit and the special equipment required for a full diagnosis, only these selected tests should be carefully attempted by personnel trained in off-line maintenance of ABM power supply systems.

AC Power connection
Checking/Adjusting Line voltage and frequency adjustments
Power supply interface connections
Lamp condition
Full lamp cool-down (before restart attempt)
Power supply open circuit voltage
Power Supply starting current

4. Theory and Operation of the Intensity Controlling System

Constant Intensity Controllers are output power variable optical feedback controlled, power supplies for the mercury, xenon and xenon-mercury arc lamps used in contact, proximity, and projection mask alignment systems. Intensity controllers precisely maintain the lamps output as a user-selected exposure intensity. Controllers offer the most cost-effective method devised to optimize the printing performance of mask aligners. Direct optical feedback using sensors deliver the information needed for the controllers to compensate for lamp variations, and intensity degradation due to aging and input power changes. This significantly reduces downtime of the lamp due to extended life.

There are four (4) power conditions that should be fully understood by users of Intensity Controllers (1) the idle power (2) the maximum power available (3) the minimum power

and (4) the exposing power level. Maximum and minimum power is preset at the factory. These settings are dependent on lamp rating, its enclosure and the application. The exposing intensity is set by the operator anywhere between the minimum and maximum power limits. Idle-power and exposing power are both user adjustable in ABM controllers. These levels and how they relate to intensity will be discussed in the manual.

The intensity controller is in reality a variable output power system which is commanded via optical feedback to adjust its output power to meet a preset intensity.

Power adjustment occurs only during an expose (or lamp test) cycle. At all other times the system remains at the idle power level.

If the user selects an intensity lower than the intensity at the "idle" power level, the system will drive downward (in power) until it reaches the power level that delivers the selected intensity.

Conversely, if a higher intensity is desired, the system will power up until the power level is reached which delivers the intensity selected.

Constant Intensity Controllers circumvents these problems by maintaining the lamp at an optimum power level (idle) between exposures. The lamp operates in the idle condition, thermally stable and unstressed, until the shutter opens to initiate operation. Only then does the system drive up or down in power to meet the pre-set intensity level that produces the pre-set exposure level. (This pre-set intensity level is established by the process engineer, who has previously generated an exposure matrix to determine the optimum intensity/time settings).

When the exposure cycle ends, the lamp returns to idle. This insures that lamps operated in high intensity applications are not powered to continuously, or operated at low intensity allowed to overcool. The result has greatly improved exposure repeatability, longer lamp life and better yields.

The intensity produced by any particular lamp system depends heavily upon the optical system in which it is used. This intensity output can be varied over the operating range within maximum and minimum power limits factory set in the Controller.

The intensity produced is monitored by sensors mounted so they receive radiation from the exposure beam. The sensors receive energy directly proportional to the actual intensity measured at the exposure plane. The narrow bank optical selected sensors convert the energy falling on them into an electrical signal which is sent to control circuits. The date is compared with the pre-set value,, and the lamp power (watts) is automatically adjusted to make the exposure intensity (mW/cm) equal the pre-set intensity level. The sensors are designed using photo-detectors coupled with computer

designed absorption glass filters which tailor the spectral response to stimulate the exposure of the photoresist. It is essential that the sensor respond to the same spectral region as the material to be exposed if precise repeatable exposure is to be achieved. Most controllers come equipped with dual sensors having two filter/detector combinations each of which may track a different response curve. Typical sensor system employ the UV-365B and UV-400B spectrum to track most common negative and positive UV photoresists.

5. Simplified Description of Operation

ABM's line of mercury arc power supply and intensity controller systems are modular solid state designs with full transformer isolation. A capacitor and choke, plus sensing circuits provide filtering to keep output ripple less than 0.2% The starting circuit provides over voltage ignition which offers greater start reliability.

During the initial "on" condition, the lamp operates with very low resistance (impedance). As the lamp warms, the mercury vaporizes and pressure in the lamp envelope builds, increasing the lamps impedance stabilizing the current level. At this point, the regulation circuit takes over to maintain the lamp at the pre-set idle wattage.

The regulation circuit (in the idle mode) has a fixed reference point and is active when the shutter is closed. A second circuit overrides the first when the shutter is opened and sensor is activated by light energy. This override circuit drives power up or down until the lamp intensity (monitored by the sensor) meet the pre-set intensity value and restores balance to the circuit.

In order for the built-in panel meter to display a meaningful intensity reading in mW/cm^2 (intensity units), it must be calibrated against some external standard UV power meter having a spectral response that matches the response of the sensor package in the optical loop. The external UV power meter should be NIST traceable and read in mW/cm^2. The calibration potentiometers on the front panel (one for each control channel) are used to change the intensity at the exposure plane without regard to pre-set (reference) values. When both the external UV power meter reading and the front panel display reading are matched, the system is calibrated on that control channel. Each control channel requires individual calibration.

6. Optical Loop Operation

Silicon photo-detectors with absorption glass filters are mounted within the light path, receiving the energy in the selected spectral region. The sensor converts this energy into a proportional electrical analog signal (current) which is delivered to a current to a voltage amplifier (signal conditioner).

Calibration potentiometers are provided on the front panel for gain adjustment, one for each control channel. The output is compared to a reference signal from the intensity setting potentiometer (also located on the front panel).

When exposure begins, voltages from the sensor, amplifiers and the reference signal are evaluated by an analog multiplier. The previously balanced idle condition is interrupted and the system must drive up or down to rebalance itself. The sensor monitors intensity, and its data must be made to match the pre-set level to achieve circuit balance between power, intensity and pre-set level. When the shutter closes, the sensor signal is eliminated and the analog multiplier returns the system to a balanced idle condition again.

The system dynamics are limited by minimum and maximum lamp power wattage settings. In the event the optical loop cannot achieve a balanced condition at the maximum power limit, a signal is produced to activate an audible alarm, indicating that the pre-set intensity demand is beyond reach. This usually occurs because a lamp has lost output efficiency with age and must be replaced. It could also occur from an attempt to pre-set an intensity level beyond the operating range of the system (which would exceed the safe operating parameter of the lamp).

7. Intensity Controller Installation

The Controller requires about one inch of space on each side for ventilation air flow. The rear panel should not be obstructed, permitting both cable access and unrestricted exhaust.

Connect the red (+) anode and the black (-) cathode cables from exposure source to appropriate output connectors, which are clearly marked on the rear panel. Tighten couplings firmly, but not excessively. Observe polarity!
Plug the sensor connector into receptacle located at upper right of rear panel.

7.1 Calibration of intensity controlling power supply

Initial Front Panel Settings (ABM power supply)

POWER Switch	**Off Position**
INTENSITY/POWER Meter Select Switch	**WATTS Position**
CURRENT/VOLTS Meter	

Select Switch	**VOLTS Position**
C/I-C/P Select Switch	**C/P Position**
All Knobs (five total)	**Counter Clockwise**

1. Turn Main POWER on.

2. Depress START switch no more than 10 seconds continuously (until lamp starts). After five minutes of warm up, adjust power set to idle wattage. Lamp type: **200w** (set to 180-200w**)**, **350w** (set to 275-325w), **500w** (set to 450-500w), **1,000w** (set to 950-1,000w), **2,000w** (set to 1800-1900w).

3. Open shutter on the lightsource system and using a calibrated intensity meter (ABM 150, 100A, B, C or equivalent), measure light intensity in center of exposure beam (at expose level) with appropriate wavelength probe.

4. Set intensity/power meter to intensity position, adjust Cal knob until INTENSITY meter reading equals the intensity that was measured in step 3.

5. Set MODE select switch to C/I.

6. Adjust SET knob set to the desired exposure intensity on power supply meter. Lock knob.

7. If external intensity reading does not match power supply intensity set, rotate Cal knob to match. Lock knob.

This completes the setup procedure. The unit is now ready to operate. After initial setup is accomplished, it is not necessary to go through the setup procedure each time the system is turned on. Simply turn on the power supply and start lamp. The unit is ready to process parts in approximately five minutes.

8. Using the Intensity Controller

8.1 Intensity Checks

Intensity checks with a UV Power Meter should be performed regularly. (Frequency will be determined by experience developed during usage of your new Controller). Scheduled checks ensure that the Controller is functions properly. You will quickly discover that exposure intensity is maintained precisely at the pre-set value for the useful lifetime of the lamp. When making these intensity verifications, be sure the Controller is in the control mode, just as during production use and either C/I or C/P mode when making uniformity measurements.

The Controller's front panel meter serves as an on-line check after it has been initially calibrated. After confidence is gained in the system, this display's reading will probably suffice in lieu of frequent UV Power meter readings.

CAUTION: when performing maintenance checks be sure the system does not run for long periods of time at high or low power extremes. Put the system into "idle" (C/P).

NOTE: Experience has shown that when Intensity Controllers are initially installed, that operators cannot resist the temptation to tweak potentiometers needlessly. Such tweaking can cause variations in the process and will lead to very inconsistent system performance. This problem arises most frequently between personnel shift changes. If intensity checks between the external UV Power meter and the front panel display are continuously in disagreement, notify a factory representative. Altering adjustment on the lightsource without recalibrating the Controller will result in reduced performance. Additionally, if the exposure beam has a non-uniform pattern, contact an ABM representative.

8.2 How to Change Intensity

If you desire to change the exposing intensity, the procedure is very simple. The SET pot permits the user to vary the intensity anywhere within the operating range of the lamp, typically covering about a 2:1 intensity ratio.

Open the shutter, unlock the Set pots (outer ring), rotate the knob until the panel display reaches the desired exposure value. Be sure the INTENSITY/POWER meter's display is reading mW/cm^2. It is always wise to verify the new setting with an external UV power meter at the exposure plane.

If the maximum power alarm sounds when attempting to adjust a pre-set intensity level, it means the intensity desired is higher than can be delivered. A less demanding pre-set must be used. If the lamp is an older one, perhaps a new lamp will be able to obtain the demand without hitting the maximum power limit. Be aware, that if the pre-set intensity level is near to the maximum power limit, there is limited compensation available to make up for lamp degradation and it will not be long before the maximum power limit alarm sounds again.

8.3 Maximum Power alarm

the audible alarm sounds only when the lamp is out or when maximum power is applied to the lamp. If the alarm sounds during an exposure cycle, it is an indication of reaching the maximum power level. Then a decision must be made that either the lamp is to be replaced or the pre-set intensity level should be reduced. If usage is continued after the alarm sounds, the process will eventually start to degrade, demonstrating the effects due to underexposure.

Since the Controller can have up to two channels of control, the channel set using the higher intensity will be the first to activate the maximum power alarm. The other channel will continue to operate without setting off the alarm.

NOTE: Since mercury arc lamps degrade faster when repeatedly turned on and off than when operated continuously, ABM suggests that you do not turn the lamps off overnight; sometimes not even on weekends, as the idle mode is pre-set to achieve the longest stable life.

Considerable versatility is built into the Controller. It is very important for all attending personnel to be familiar with its operation and controls. When adjusting or monitoring performance, there must be no doubt about which intensity channel is in use, which wavelength each channel monitors, which value the front panel meter is set to display or if the system is in (C/P) or (C/I). Confusion about these functions can lead to operational problems.

8.4 Lamp Replacement & Recalibration

It is important that all lightsource adjustments for collimation, uniformity, etc. are done with the Controller in the C/P mode and before calibration of the system is attempted. If no changes have been made on source optics, recalibration is normally unnecessary.

To minimize lamp changes during production the exposing power (watts) should be monitored regularly. If the power level during an expose cycle is within 10-20 watts of the maximum level, lamp changes should be scheduled for the earliest convenient time.

WARNING: Do not attempt to change lamps without turning off controller.

8.4.1 Lamp Changing

Use procedure described in Lamp Housing Manual.