Process Control

Basic Concepts
OPC Analog Systems
OPC Digital Systems
Selenium Analog Systems

Basic Concepts

Process control is a system that automatically changes machine processes to compensate for changes in the environment or the machine condition. The objective of process control is to stabilize the quality of image output. The practical result is a decrease in the frequency of service calls, thus increasing customer satisfaction and decreasing service cost.

The box to the right lists the machine conditions that process control compensates for.

Target Machine Conditions

- Dirty optics
- Exposure lamp deterioration
- Dirty charge corona wire/grid
- Change of drum sensitivity
- Deterioration of developer

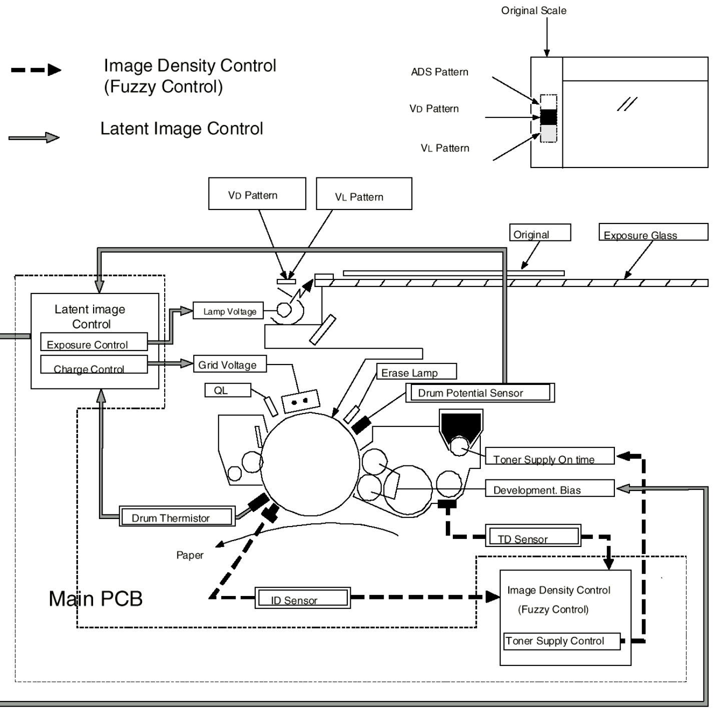
In this section (Basic Concepts) we will take an overall look at process control. Then we will look at the details of process control using several example machines. We will look at two OPC analog machines—one using a potential sensor (*model A095*) and one using a V sensor (*model A074*). Then we will study an OPC digital system (*model A229*). Finally, we will look at selenium drum analog systems (models *A029* and *A058*).

NOTE: Unlike other parts of the Core Technology Manual, we don't pull out and compare example sub-units of process control but instead look at the process control systems of the example machines in their entirety. This is because process control components are interactive and best studied as a whole.

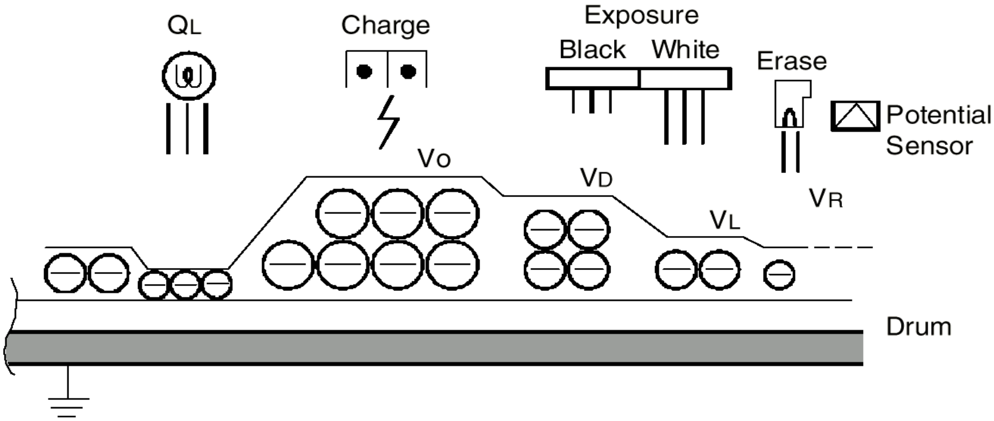
Latent Image Control and Image Density Control

This illustration represents a copier model that uses two process control methods. One compensates for variation in the drum potential (latent image control) and the other controls the toner concentration and toner supply amount (image density control).

All process control components affect one or the other (or both) of these methods.



Latent Image Control



The figure shows the changes of the drum potential during the copy process.

V_O	Drum potential just after charging the drum.
V_D (Dark Potential)	Drum potential just after exposing the black pattern (V_D pattern)
V_L (Light Potential)	Drum potential just after exposing the white pattern (V_L pattern)
V_R (Residual Voltage)	Drum potential just after the exposure of the erase lamp.

Image Density Control

The following sensors control image density.

- Toner density sensor (TD sensor)
- Image density sensor (ID sensor)

Data from the TD sensor is used to keep the toner concentration in the developer at a constant level. However, the image on the OPC drum varies due to the variation of toner chargeability (influenced by the environment) even if the toner concentration is constant. By the ID sensor compensation, toner concentration is changed to keep the image density on the OPC drum constant.

The following items are controlled to maintain a constant copy image density:

- Toner supply clutch on time
- Toner supply level data (V_{REF}) of the TD sensor

NOTE: Some machines do not have a TD sensor and use only an ID sensor for image density control.

Terminology and Abbreviations

The following list explains the meaning of some of the terms and abbreviations used when describing process control.

V_O (Original Potential)	The drum potential after the drum is charged.
V_D (Dark Potential)	The drum potential in black image areas after exposure. Standard V_D is the potential measured after exposing a black pattern.
V_L (Light Potential)	The drum potential in white image areas after exposure. Standard V_L is the potential measured after exposing a white pattern.
V_R (Residual Voltage)	The drum potential after the drum has been exposed by the erase lamp.
Potential Sensor	A sensor used to measure the strength of the charge on the OPC drum surface (drum potential).
V_L Pattern	A standard white pattern used for reference. On some machines the V_L pattern is actually a light gray tone rather than pure white.
V_D Pattern	A standard black pattern used for reference.
ID Sensor	A photosensor that measures the image density (reflectivity) of the drum and of a test pattern (ID sensor pattern). The output of this sensor is used to control toner supply.

ID Sensor Pattern	A standard pattern that is exposed and developed for sensing by the ID sensor.
V_{SG}	The ID sensor output when checking the erased drum surface.
V_{SP}	The ID sensor output when checking the ID sensor pattern image.
V_{LAMP}	Exposure lamp voltage.
V_{B} or V_{BB}	Development bias.
TD Sensor	Toner density sensor—it measures the concentration of toner in the developer.
V_{REF}	A targeted control reference for the TD sensor. When V_{TD} becomes too low, toner is added to the developer to bring V_{TD} back to the V_{REF} value.
V_{TD}, V_{T}, or V_{OUT}	The output voltage of the TD sensor.
V Sensor	A reflective photosensor similar to the ID sensor that is used to indirectly measure the drum potential. It was used prior to the development of the potential sensor system and will be found in earlier models using process control.
V_{G} or V_{GRID}	Charge corona grid potential.

V_H (Halftone Potential)	A standard halftone drum potential. This value is used for laser power adjustment in the process control system of some digital products.

OPC Analog Systems

Model A095—Process Control Using a Potential Sensor

After long usage following installation or a PM, drum potential will gradually increase due to the following factors:

- Dirty optics or exposure lamp deterioration
- Dirty charge corona casing and grid plate
- Change of the drum sensitivity

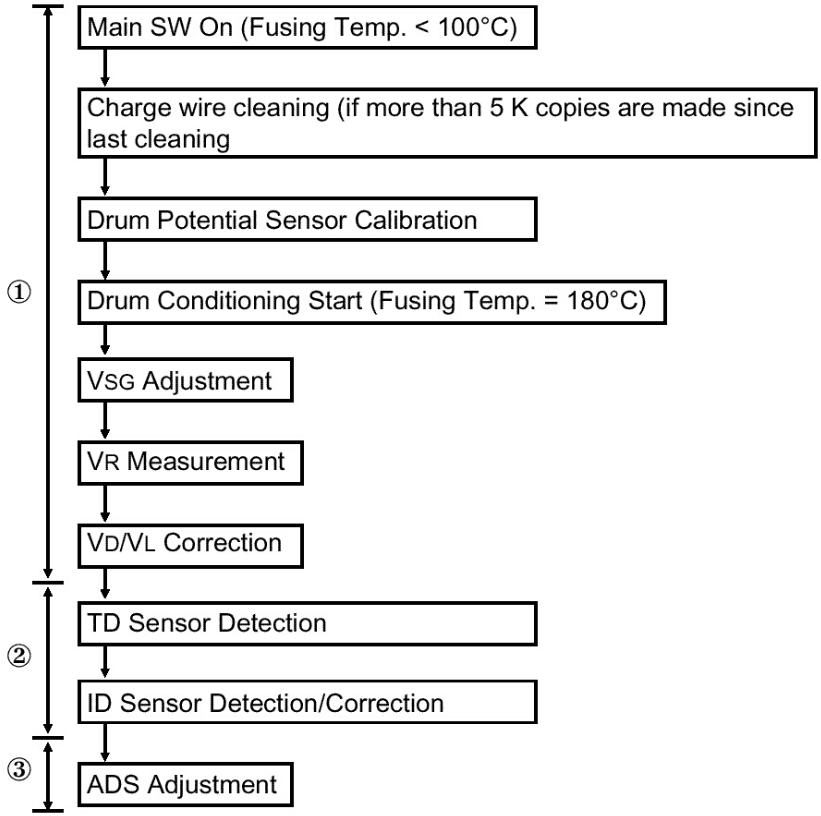
In this copier, the change in drum potential is detected by the drum potential sensor and the following items are controlled to maintain good copy quality.

- The grid bias voltage
- The exposure lamp voltage
- The development bias voltage.

A drum thermistor detects the drum temperature and this data is also used to control the above voltages. It is impossible to explain simply because it is controlled by methods developed in our laboratories using an artificial neural network.

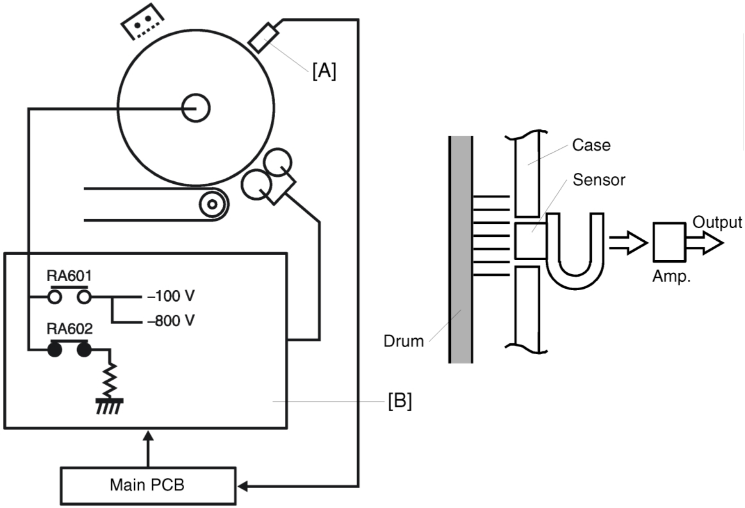
Process Control Data Initial Setting

The flow chart shows the steps performed when turning on the machine while the hot roller temperature is below 100°C. This initializes all the process control settings.



Latent Image Control

Drum Potential Sensor Calibration

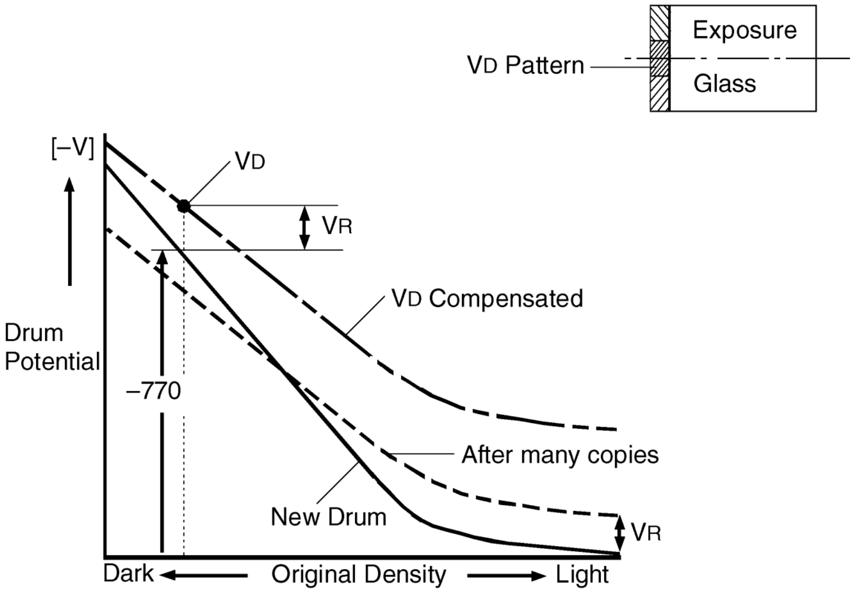


The drum potential sensor [A] detects the strength of the electrical potential on the drum. The output of the potential sensor depends on the strength of the electrical field on the drum. Since environmental conditions, such as temperature and humidity affect sensor output, the sensor output data is recalibrated during each process control initialization.

The High Voltage Control PCB [B] has two relay contacts. Usually RA602 grounds the drum. However, during the initial setting, the main PCB turns RA601 on and RA602 off and applies the recalibration voltage to the drum shaft. By measuring the output of the drum potential sensor when –100 V and –800 V are applied to the drum, the sensor output data is calibrated automatically. (The machine recognizes the relationship between actual drum potential and the potential sensor output.) To prevent toner attraction during potential sensor calibration, an equivalent bias voltage (-100 and -800) is applied to the development rollers.

V_R Measurement

The relationship between the drum potential and the original density is illustrated at right. To get consistent copy quality throughout the drum's life, this relationship must be maintained. Since this relationship changes due to various factors to the one represented by the dotted line, compensation is required. Factors causing these changes occur in the optics and charge sections and in drum sensitivity. The residual voltage (V_R) cannot be compensated even if exposure lamp voltage is increased. Therefore, the V_R change has to be compensated by other means.



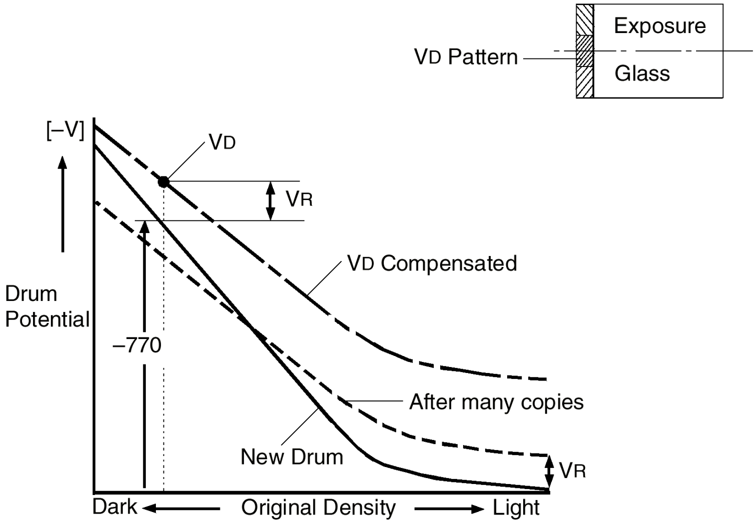
After drum conditioning the main control board turns on the erase lamps. Then the potential sensor checks the drum potential. This measured drum potential is in fact V_R. This V_R is used as the standard for the V_D and V_L corrections.

NOTE: In the figure above, the residual voltage (V_R) for the new drum is 0V. Actually, there is some residual voltage even on a new drum.

V_D Correction

The drum potential just after the black pattern (V_D Pattern) is exposed (V_D: Dark Potential) tends to lower during drum life due to a decrease in the drum's capacity to carry a charge. To check the actual V_D, the first scanner moves to the home position and the V_D pattern (Black) mounted on the bottom of the exposure glass bracket, is exposed on the drum.

The main control board measures V_D through the drum potential sensor and adjusts it to a target value by adjusting the grid bias voltage (V_{GRID}). On the other hand, there is a change of the drum residual voltage (V_R), so that the target V_D voltage is compensated as follows:



Target V_D Value: $V_D = V_R + (-770)$

The adjusted grid bias voltage (V_{GRID}) is kept in memory until the next process control data initial setting.

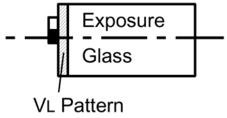
V_L Correction

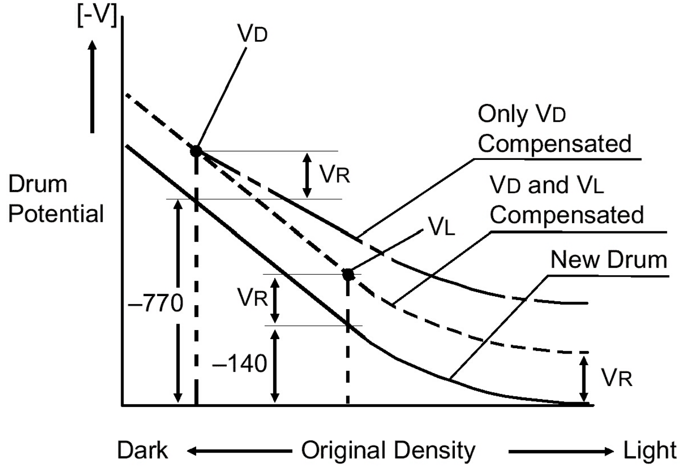
Dirty optics and exposure lamp deterioration decreases the intensity of the light that reaches the drum. In addition to this, the drum sensitivity also changes during the drum's life. These factors change the drum potential just after white pattern exposure (V_L: Light Potential).

To check the actual V_L, the lens moves to the V_L pattern check position. The V_L pattern (White) mounted on the bottom of the exposure glass bracket is exposed on the drum. The main control board measures V_L through the drum potential sensor and adjusts it to a target value by adjusting the exposure lamp voltage (V_{LAMP}). The residual voltage (V_R) change also affects V_L, so that V_L's target voltage is compensated as follows:

Target V_L Value: $V_L = V_R + (-140)$

The adjusted exposure lamp voltage (V_{LAMP}) is stored in memory until the next process control data initial setting.





V_R Correction

Potentials (V_R, V_D, V_L) are monitored by the potential sensor. (This is done only when the fusing temperature is less than 100°C after the machine is turned on.)

During the check cycle, the V_D and V_L patterns are exposed and the drum potential of the area exposed by each pattern is checked by the potential sensor.

Compare the curve of the V_D and V_L compensated drum potential with the curve of the new drum, they are parallel but the compensated potential is still higher (V_R) than the new drum potential. To prevent dirty backgrounds due to increased residual potential, development bias (V_{BB}) is applied as follows:

$$V_{BB} = V_R + (-220)$$

The adjusted development bias (V_{BB}) is stored in memory until the next process control initial setting.

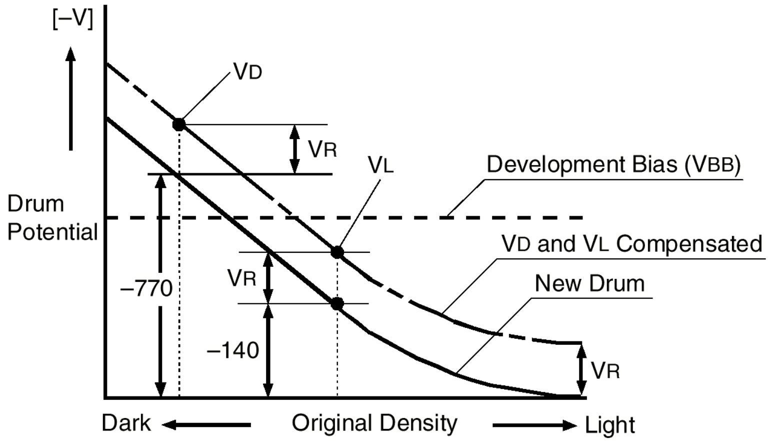
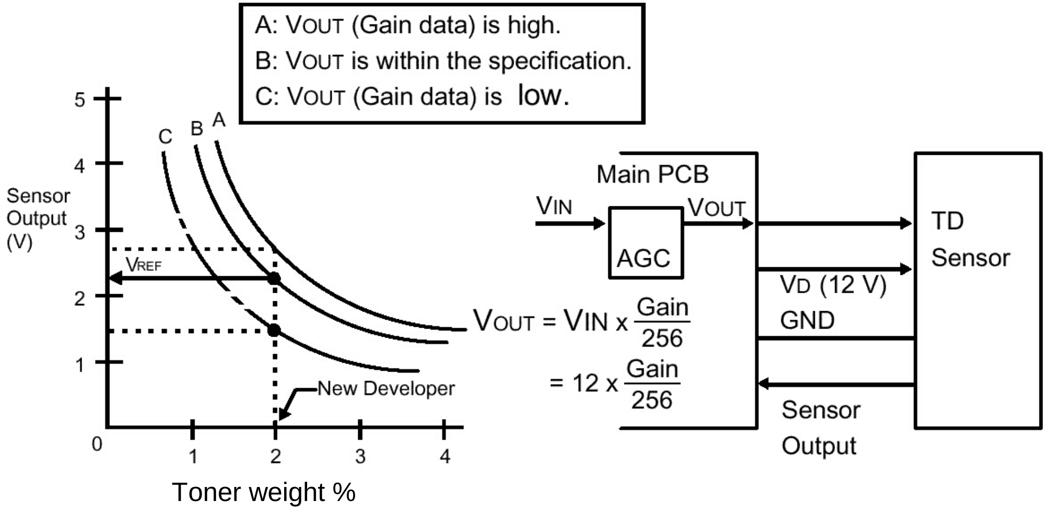


Image Density Control

Toner density sensor (TD sensor)



Developer consists of carrier particles (iron) and toner particles (resin and carbon). Inside the development unit, developer passes through a magnetic field created by coils inside the toner density sensor. When the toner concentration changes, the voltage output by the sensor changes accordingly.

When new developer with the standard toner concentration (2.0% by weight, 20 g of toner in 1000 g of developer for the illustrated machine) is installed, developer initial setting must be performed by using SP mode.

During this setting, the output voltage (V_{OUT}) from the auto gain control circuit (AGC) on the main control board PCB varies to change the output voltage from the toner density (TD) sensor. This is done by changing the gain data as follows.

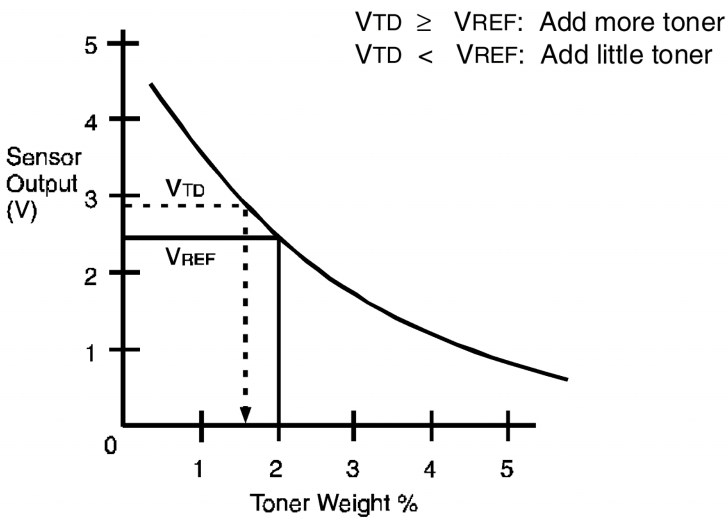
$$V_{OUT} = V_{IN} \times \frac{\text{Gain Data}}{256} = 12 \times \frac{\text{Gain Data}}{256}$$

If the data is high, V_{OUT} becomes high, and the sensor output voltage becomes high. As a result, the sensor characteristic becomes as illustrated by curve A. If the data is low, V_{OUT} becomes low, and the sensor output voltage becomes low. As a result, the sensor characteristic shifts as illustrated by curve C.

By selecting the proper gain data, the sensor output is set within the targeted control level (V_{REF}, $V_{REF} = 2.5 \pm 0.1$ V). Now, the sensor characteristic is illustrated by curve B and the TD sensor initial setting is completed. The selected gain data is stored in memory, and V_{OUT} from the auto gain control circuit stays constant during the toner sensor detection cycle.

Toner Supply Criteria

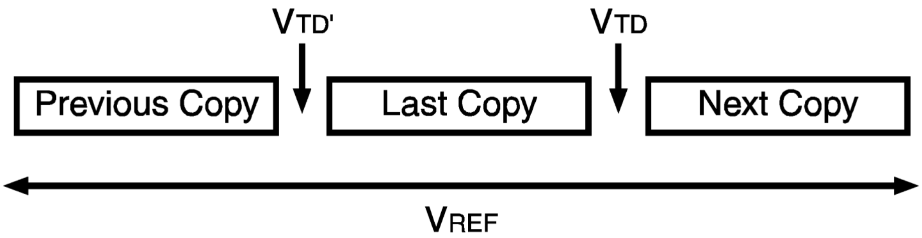
At every copy cycle, toner density in the developer is detected once. The sensor output voltage (V_{TD}) during the detection cycle is compared with the toner supply level voltage (V_{REF}).



Toner Supply Clutch on Time

To stabilize toner concentration, toner supply amount (toner supply clutch on time) is controlled by referring to VREF and VTD. The toner supply amount is calculated at every copy. The toner supply amount is determined by using the following factors.

1. VREF – VTD
2. VREF – VTD' (VTD' = VTD of the previous copy cycle)



By referring to these factors, the machine recognizes the difference between the current toner concentration (VTD) and the target toner concentration (VREF). The machine also understands how much toner concentration has changed and predicts how much the toner supply amount will probably change.

By changing the toner supply amount precisely, toner concentration (image density) is kept at a constant level. Since the toner supply clutch on time updating is under fuzzy control, the relation among VTD, V TD', VREF cannot be expressed by a simple algebraic formula.

VREF Correction

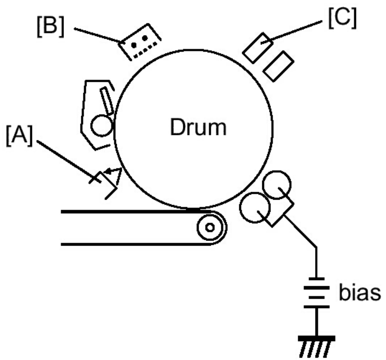
The image on the OPC drum changes due to variation of toner chargeability (influenced by the environment) even if the toner concentration is constant. The image density sensor (ID sensor) directly checks the image on the OPC drum and shifts VREF data (under fuzzy control) to keep the image on the OPC drum constant, as explained in the next section.

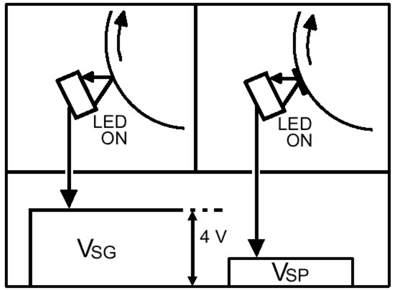
NOTE:
1. Toner end condition is detected by the toner end sensor.
2. The toner supply clutch turns on at the intervals between each copy process while image development is not being performed.

Image density sensor (ID sensor)

VSG and VSP are checked by the ID sensor [A]. The ID sensor is located underneath the drum cleaning section.

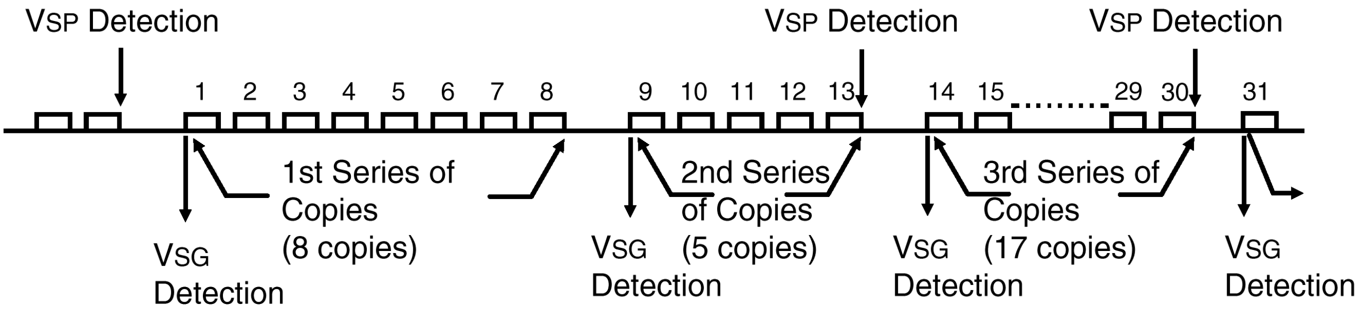
There is no ID sensor pattern in the optics, however, a pattern image is made on the OPC drum by the charge corona unit [B] and the erase lamp [C].





- VSG is the ID sensor output when checking the erased drum surface.
- VSP is the ID sensor output when checking the ID sensor pattern image.

To compensate for any variation in light intensity from the sensor LED, the reflectivity of both the erased drum surface and the pattern on the drum are checked.



In the above example, VSG is detected every time the machine starts copying. During VSG detection, the development sleeve rollers do not rotate and no development bias is applied.

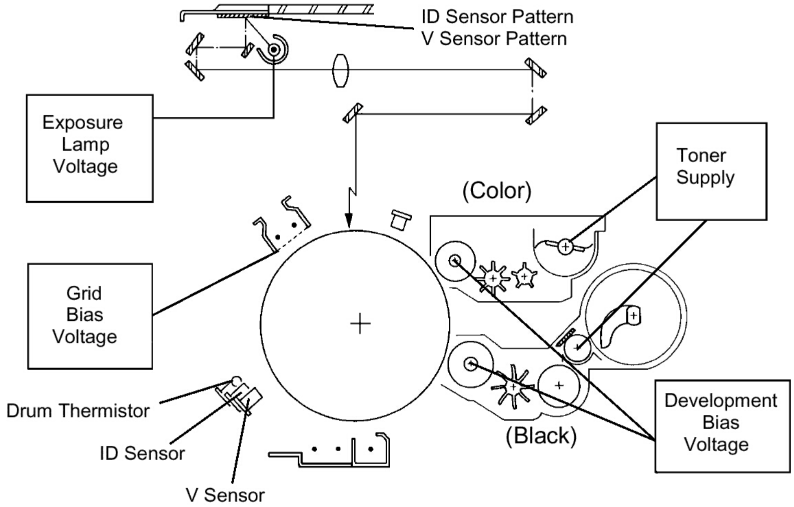
VSP is detected after copying is completed if 10 or more copies have been made since VSP was last detected. Since the transfer belt must be released when checking VSP, a VSP check cannot be done during continuous copying.

Model A074—Process Control Using a V sensor

The copy process around the drum and the copy image (image and background density) are controlled by many factors. The following items are controlled during the copy process to maintain good copy quality:

- exposure lamp (optics)
- grid bias (drum charge)
- development bias (development)
- toner supply (development)

The items above use various electrical components for the various process control functions. The most significant of these are for the control of the drum residual voltage, exposure lamp voltage and drum aging.

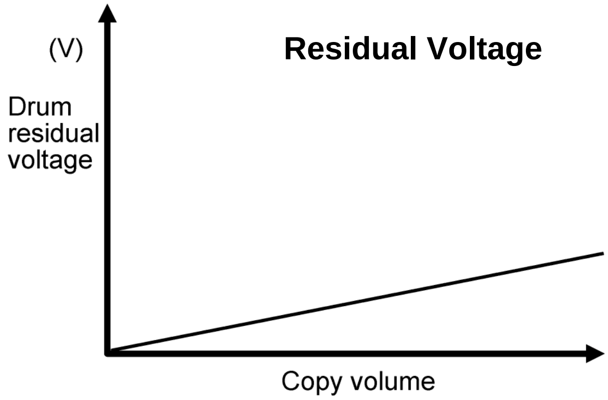


Overview

During the OPC drum's life, residual drum voltage gradually increases due to electrical fatigue. This may cause dirty background on copies. The V sensor is used to avoid this problem. The V sensor is located in the drum unit, near the ID sensor.

The CPU checks the drum residual voltage through the V sensor by directly sensing the V_R pattern on the drum surface. This V_R pattern detection is performed after the drum initial setting. After this, the CPU will do one V_R pattern detection every 200 copies for the next 2,000 copies, and every 1,000 copies after that. Also when V_R data correction is applied and the drum temperature goes over 25°C, this detection is performed.

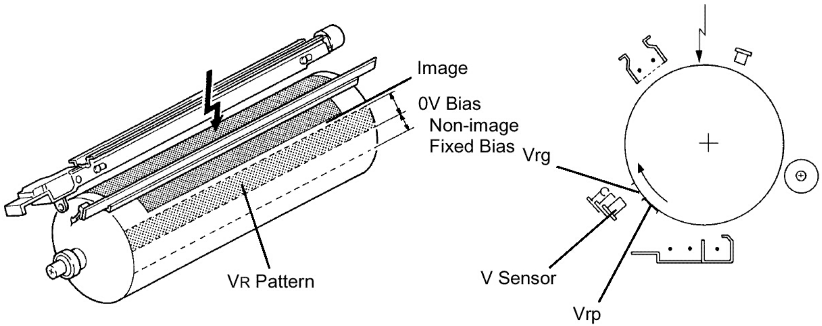
According to the data of V_R pattern detection, the CPU applies V_R correction to the grid bias voltage and the development bias voltage.



VR Pattern Control

The VR pattern is made on the drum before the original latent image, as in the case of the ID sensor pattern.

During VR pattern detection, the drum surface is charged with a fixed grid bias voltage: -500V + VG correction (Drum Rotation Time Control). At the same time all the blocks of the erase lamp unit turn on to illuminate this charged area of the drum.



The exposed area of the drum is developed with a fixed bias voltage for non-image area: -160V + VR correction + VR Data correction (Drum Temperature Control) + Black Bias correction. The V sensor checks the reflectivity of the bare area of the drum and this sensor output voltage is called Vrg. (Vrg is the same as Vsg detected by the ID sensor.) Next to this bare drum area, the drum is developed with VR pattern bias voltage (0V). If there is residual voltage on the drum, this area of the drum will attract some toner, making a VR pattern. The V sensor checks the reflectivity of the VR pattern and this sensor output voltage is called Vrp.

VR Correction

The CPU notes the ratio, of Vrp/Vrg. This VR pattern check is done 5 times in a row during the copy cycle and the CPU takes their average. The reference voltage of the V sensor output Vrg, is automatically adjusted to 4V at the same time as Vsg isadjusted.

VR Level	VrpxVrg x 100(%)	Grid bias correction voltage	Development bias correction voltage
0	100~84	±0 V	±0 V
1	83~58	–40 V	–40 V
2	57~41	–80 V	–80 V
3	40~28	–120 V	–120 V
4	27~0	–160 V	–160 V

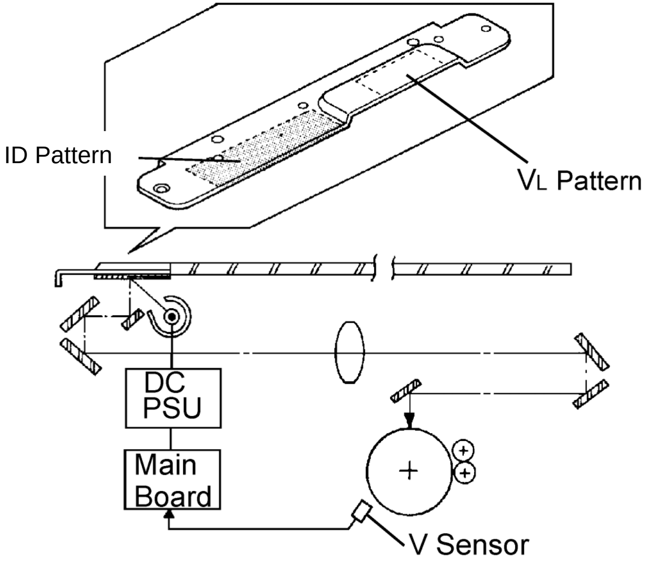
The grid bias voltage and the development bias voltage are corrected (VR correction) according to the ratio between Vrp and Vrg as shown in the above table.

VL Pattern Control Overview

Dirty optics or deterioration of the exposure lamp decreases the intensity of the light that reaches the drum via the optics cavity. As more copies are made during the drum's life, the photoconductive layer gets worn and drum sensitivity drops. The drum sensitivity also drops under low temperature condition.

VL pattern control is performed on this copier to prevent dirty backgrounds caused by the factors mentioned above. The V sensor is used for VL and for VR pattern control.

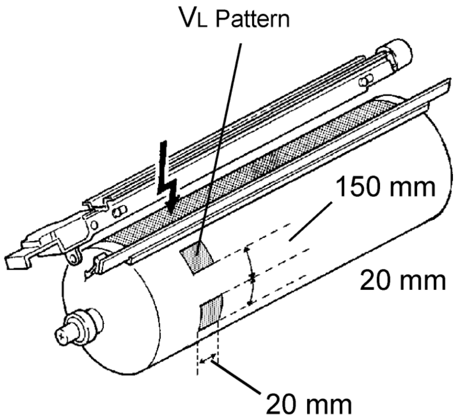
The VL pattern (light gray) is located on the bottom of the left scale bracket. When a copy job finishes, VL pattern detection occurs. The exposure lamp stays on for about 6 seconds while at the home position. The VL pattern is lit and a latent image is made on the drum. After this image is developed, its reflectivity is checked by the V sensor. The CPU notes the strength of reflectivity, and if the reflected light is too weak, the exposure lamp voltage is increased.



VL Pattern Detection

VL pattern detection is done after VR pattern detection, but unlike VR pattern detection it is done after the copy job is finished. This means after the drum initial setting, based on specific copy counts and when the drum temperature goes over 25°C under the VR data correction condition.

When VL pattern detection starts, the exposure lamp turns on, the main motor stays on, the charge corona, grid bias, all the blocks of the erase lamp, the pre-transfer and quenching lamps turn on. After about one drum revolution, the appropriate blocks of the erase lamp turn off and on to make a VL pattern on the drum surface. The drum surface is developed with non-image area bias for both the bare drum and VL pattern.



The V sensor checks the reflectivity of the bare drum (Vlg) and the VL pattern (Vlp). The CPU calculates the ratio between Vlp and Vlg (Vlp/Vlg).

The VL pattern is made 4 times with 150 mm distance between each pattern. The CPU takes the average of Vlp/Vlg (=Vdat).

V_L Correction

When the drum initial setting (SP mode #66) is performed and more than 7 black copies are made, the initial V_L detection is performed at the end of the copy job and the CPU stores the V_L reference value (initial Vlp/Vlg = Vref) in memory. ID sensor pattern detection and V_R pattern detection is done prior to this initial V_L detection.

V_L Level (%)	Lamp correction voltage
151~>	–1 V
101~150	±0 V
0~100	+1 V

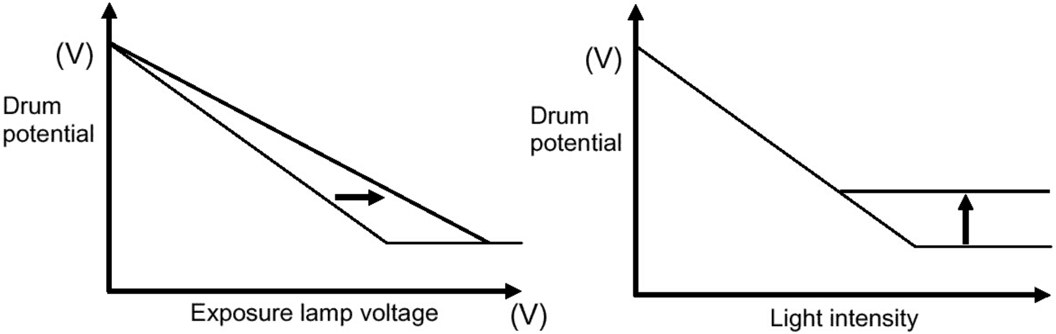
ID sensor pattern and V_R pattern detection are performed when black copies are made, even in the SP mode. V_L pattern detection is performed only when a black copy is made in enlarge or full size mode and not in the SP mode.

The V sensor output is automatically adjusted to 4V for both Vlg and Vrg) by SP mode. When the V_L pattern detection is performed during the copy operation, the CPU compares the Vdat with the Vref. According to the ratio between Vdat and Vref, the CPU applies the voltage correction to the exposure lamp (V_L Correction) as shown in the above table.

Vdat/Vref x 100 = V_L level (%)

The exposure lamp voltage for V_L pattern detection depends on all previous correction factors, and the new V_L correction factor is added to them. This result is then applied to the exposure lamp voltage till the next V_L pattern detection.

Drum Temperature Control



Under low temperature conditions drum sensitivity drops and drum residual voltage increases. This is a characteristic of the drum and may cause dirty backgrounds on copies. To compensate for this, a drum thermistor is installed to monitor the temperature around the drum.

When the main switch is turned on, the CPU checks the temperature through the drum thermistor. If the temperature is 25°C or less, the CPU applies appropriate corrections to the exposure lamp voltage (low temp. correction), to the grid bias voltage (V_R data correction), and to the development bias voltage (V_R data correction).

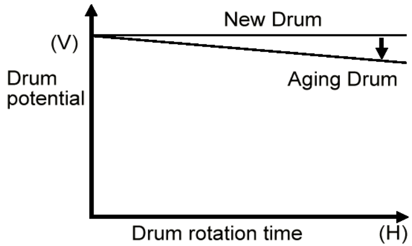
When the temperature goes over 25°C, the V_R pattern detection and V_L pattern detection are performed and the corrections above are canceled.

If the temperature is already over 25°C when the main switch is turned on, no correction is applied.

Drum Rotation Control And VG Correction

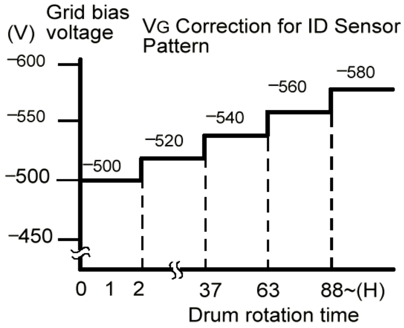
Overview

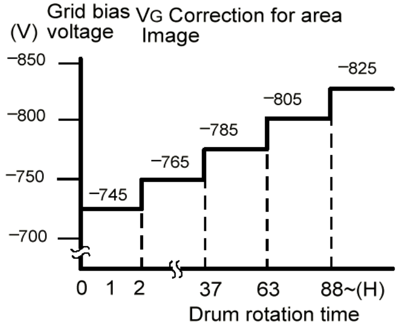
During the OPC drum's life the photo conductive layer gets worn and this causes a drop in drum sensitivity and a decrease in the drum potential after the drum charge. The CPU keeps track of the drum rotation time that corresponds to the wear of the drum surface. The grid bias voltage is increased at set intervals (VG correction).



VG Correction

If drum potential decreases after the drum charge, the ID sensor pattern on the drum becomes lighter, causing higher toner concentration in the developer. Also, copy image density becomes slightly lighter. To control toner density and copy image density, the drum potential is maintained by increments of the grid bias voltage at set intervals. (See graph.)





OPC Digital Systems

Based on model A229

Overview

The drum potential will gradually change because of the following factors.

- Dirty optics or exposure glass
- Dirty charge corona casing and grid plate
- Changes in drum sensitivity

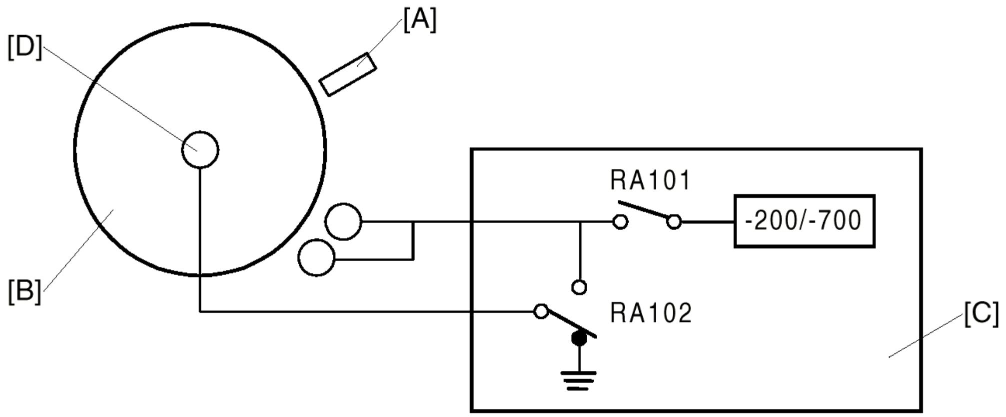
To maintain good copy quality, the machine does the following just after the main switch has been turned on (if the fusing temperature is less than 100 °C and Auto Process Control [SP] is selected).

1) Potential Sensor Calibration
2) V_{SG} Adjustment
3) V_G (Grid Voltage) Adjustment
4) LD Power Adjustment
5) V_{REF} Update

This process is known as ‘Process Control Initial Setting. The rest of this section will describe these steps in more detail.

Processes 1, 3, and 4 in the above list compensate for changes in drum potential. Processes 2 and 5 are for toner density control.

Drum Potential Sensor Calibration



The drum potential sensor [A] detects the electric potential of the drum surface [B].

Since the output of the sensor is affected by environmental conditions, such as temperature and humidity, the sensor needs recalibration at times. This is done during process control initial setting.

The development power pack [C] has two relay contacts. Usually RA102 grounds the drum. However, to calibrate the sensor, RA102 and RA101 switch over and apply the power pack output voltage to the drum shaft [D].

The machine automatically calibrates the drum potential sensor by measuring the output of the sensor when –200V and –700V are applied to the drum. From these two readings, the machine can determine the actual drum potential from the potential sensor output that is measured during operation.

During calibration, if the rate of change in drum potential sensor response to applied voltage is out of the target range, SC370 is logged and auto process control turns off. The V_G and LD power adjustments are skipped; V_G is set to the value stored in SP2-001-01, and LD power is set to the values stored in SP2-103.

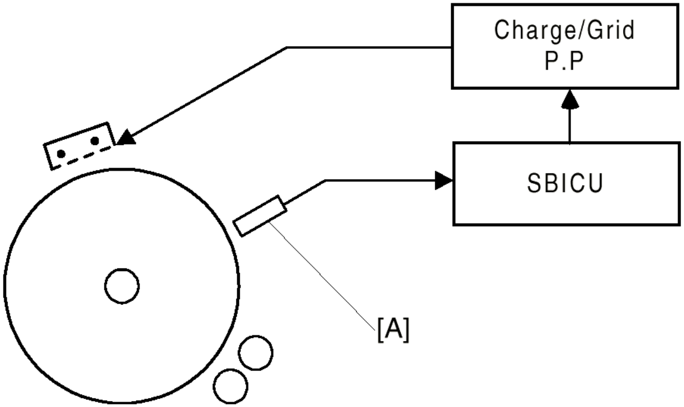
V_{SG} adjustment

This calibrates the ID sensor output for a bare drum to 4.0, ± 0.2V. It does this by changing the intensity of the light shining on the drum from the sensor. This is done automatically during process control initial setting, and it can also be done manually with SP3-001-002.

If the ID sensor output cannot be adjusted to within the standard, SC350 is logged and toner density control is done using the TD sensor only.

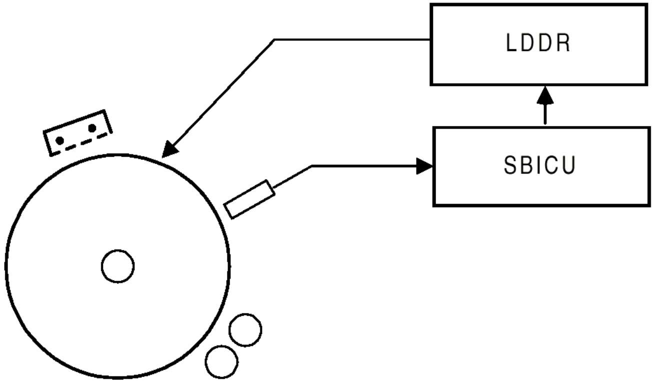
VG Adjustment

The potential on unexposed areas of the drum (VD) gradually changes during drum life. To keep VD constant, the grid voltage (VG) is adjusted during process control initial setting. The SBICU checks VD using the drum potential sensor [A]. If it is not within the target range (-900V +– 10V), the SBICU adjusts VG (Grid Voltage) through the Charge/Grid power pack to get the correct target voltage. The most recently detected values can be displayed with SP3-902-2 (VD) and 3-902-4 (VG). If the CPU cannot get VD within the target range by changing VG, VG is set to the previous value and SC 370 is logged. For details of how the machine determines an abnormal sensor detection see the A229 service manual (p7-9).



LD power adjustment

This adjustment uses the drum potential sensor to keep the ID sensor pattern at the same density, so that VREF will be updated correctly (see the next page). The VH pattern is developed using the current LD power (the density is the same as the ID sensor pattern). The drum potential sensor detects the potential on this pattern. The LD power is adjusted until VH becomes –300V +–20V. This is done only during process control initial setting.



The latest VH can be displayed using SP3-902-3. The corrected LD power can be displayed using SP3-902-5 (the default is stored in SP2-103-1-4). See "Laser exposure" for more details about laser power. If VH cannot be adjusted to within the standard within 25 attempts, LD power is set to the latest value (the one used for the 25th attempt) and SC 370 is logged. For details of how the machine determines an abnormal sensor detection.

VREF Update

The TD sensor reference voltage (VREF) is updated to stabilize the concentration of toner in the development unit as follows;

New VREF = Current VREF +   VREF

VREF is determined using the following Vsp/Vsg and VREF– VT table

		Vsp/Vsg (B)			
VREF– VT (A)		B < 0.055	0.055 < B =< 0.07	. . . .	0.15 < B
	A =< –0.2	0.25	0.22	:	–0.03
	–0.2< A =<–0.1	0.25	0.22	:	–0.05
	: :	: :	: :	: :	: :
	0.2 < A	0	0.05	:	–0.25

VT: TD Sensor Output

When SC350 (ID Sensor Abnormal) is generated, VREF is not updated. The machine uses the current value. VREF is updated during process control initial setting. It is also updated if both of the following conditions exist:

- 50 or more copies have been made since the last VREF update
- The copy job is finished

Selenium Analog Systems

Based on models A029 and A058

Image Density Control

Changing the strength of the positive bias voltage applied to the development roller sleeve controls image density. The bias voltage applied to the development roller sleeve reduces the potential between the development roller and the drum. This reduces the amount of toner transferred to the drum. So, the stronger the bias voltage is the lighter the resulting copy image will be.

The bias base level is set either by the operator through the manual image density keys (V1) or by the automatic image density system (V2). The CPU increases the bias base level as necessary to compensate for the rest time between copy runs and the drum temperature, both of which are affected drum sensitivity.

Bias Compensation Factors

While not a true process control system, the drum temperature and rest time compensation of these analog systems was a forerunner of the systems we have today. The rest time (V3) and drum temperature (V4) compensation factors affect only the development bias voltage value. These compensation factors are added to the manual (V1) or automatic (V2) image density base bias levels.

Rest Time Compensation (V3)

The CPU increases the bias level as necessary to compensate for the rest time between copy runs and the drum temperature, both of which affect drum sensitivity.

	<----------------------------------**V3**-------------------------------- >					
Copy #	1	2	3,4	5,6	7-11	12
Rest Time						
0 to 1 minute	30	30	0	0	0	0
1 to 6 minutes	60	30	0	0	0	0
6 to 30 minutes	90	60	30	0	0	0
0.5 to 3 hours	120	90	60	30	0	0
Over 3 hours	150	120	90	60	30	0

The drum sensitivity often drops slightly over the first few cycles of a copy run. This is because the light from the exposure lamp fatigues the drum slightly. The amount that it drops depends on the rest time between copy runs—the longer the rest time the greater the change.

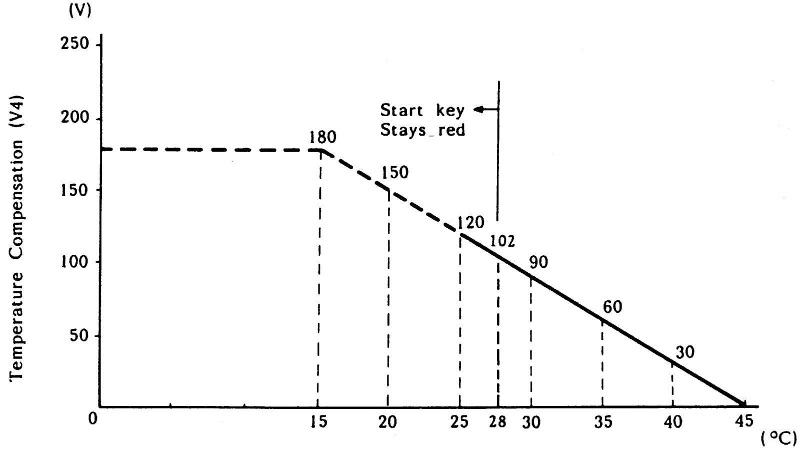
The A029/A058 copiers increase the bias at the beginning of each copy run to prevent variations in the image density of the first few copies. The bias increase is shown in the above table.

When the main switch is turned on, the CPU will automatically select the greater than three hours rest time compensation level.

Drum Temperature Compensation (V4)

When the switch on the bias power pack is on, the development bias power pack monitors the drum temperature through a thermistor, and it increases or decreases the bias voltage to compensate for temperature induced variations in drum sensitivity. The temperature compensation is -6 volts for each degree increase in drum temperature and is effective from 15°C to 45°C.

However, if the bias switch is off, the CPU assumes a drum temperature of 30°C. The power pack does not compensate for temperature, and V4 becomes +90 volts.



The increase in development bias between 15°C and 45°C