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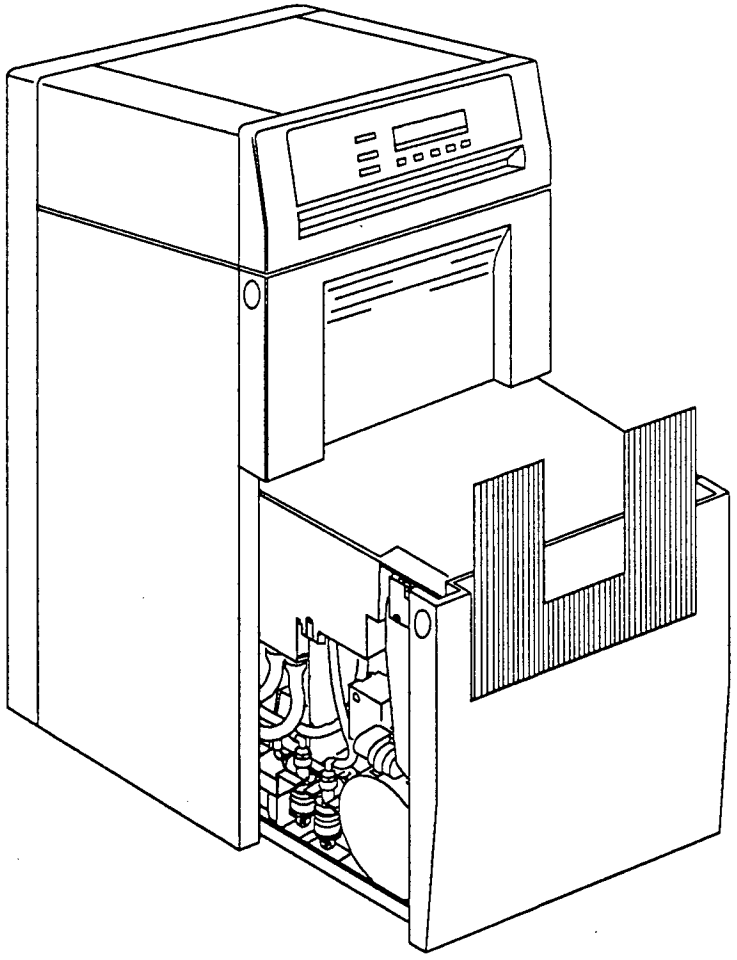
THEORY GUIDE
for the
Kodak X-Omat 270 RA PROCESSOR
in a
Kodak X-Omat MULTILOADER 300



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SECTION 1
Product Description

The *Kodak X-Omat* 270 RA Processor is a general-purpose radiographic processor. It uses a conventional roller transport system to accommodate both roll and sheet film.

Features of the 270 RA Processor include microprocessor control, an improved operator interface, improved error detection and indicators, and "smart" replenishment. The 270 RA Processor also provides 4 operator-selectable film cycles, which run at 4 default transport speeds:

- K/RA
- Rapid
- Standard
- Extended

Each cycle has default parameters for transport speed, developer, and fixer replenishment volumes and for developer, fixer, and dryer temperatures. These default parameters are stored in memory but can be modified by the operator. A battery supplies uninterrupted power to memory so that the parameters do not have to be reentered each time the Processor is deenergized.

All cycles, except for the K/RA cycle, use standard RP chemicals and film. The K/RA cycle, however, requires the new RA chemicals and film.

The 270 RA Processor is available in two versions:

- stand-alone Processor
- integrated Processor that is incorporated into the *Kodak X-Omat* Multiloader 300.

This publication addresses the integrated version only. For the Theory Guide for the stand-alone Processor, see publication Part No. 2B6847.

NOTE

The software in the Processor is occasionally upgraded, which affects the operation of the Processor. The information in this Theory Guide applies to version 2.50 software.

Processor Operation

The Multiloader 300 feeds patient film into the Processor. The film is then transported through the machine by a network of motor-driven rollers known as the film transport assembly.

The film travels through 2 chemical tanks and a wash system, where the following solutions are applied to the film:

(1) **Developer**

This solution converts the invisible latent image on the film to a visible image.

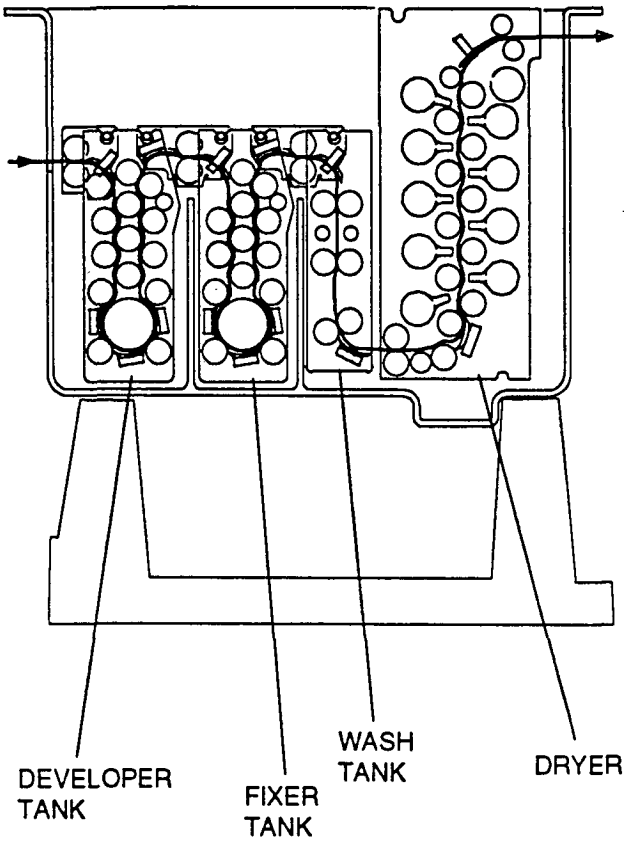
(2) **Fixer**

This solution stops the continued development of the visible image by removing unused silver halide crystals from the film. The RP fixer also increases the permanency of the visible image by hardening the emulsion. The RA fixer, however, does not include a hardener because the film has a pre-hardened emulsion.

(3) **Water**

The water removes all excess fixer from the film, which prepares the film for drying. This ensures a permanent image on the film.

Upon exiting the wash tank, the film is transported through a dryer. In the dryer, a blower circulates warm air across the surface of the film. The dry, processed film then exits the Processor.



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The 500 circuit board monitors and controls Processor functions. The role of this circuit board is described in more detail elsewhere in this publication.

While the film moves through the various chemical tanks, the Processor is controlling several other functions. These functions create optimum processing conditions in the tanks:

- **Maintaining the Correct Temperature of the Developer and Fixer**

  This function is accomplished by controlling the developer heater and the fixer heater. The heaters are located inside the developer and fixer thermowells. The solution thermistors sense the temperature of the developer and fixer in the thermowells.

- **Cooling the Developer**

  This function is accomplished by energizing 2 solenoids; the wash water solenoid, which is on the Multiloader bulkhead, and the developer cooling solenoid. When the wash water solenoid opens, water is supplied to the wash rack. The water collects around a heat exchanger at the bottom of the wash tank. When the developer cooling solenoid energizes, developer flows through the heat exchanger. The cooler water surrounding the heat exchanger effectively cools the developer solution.

- **Replenishing the Developer and Fixer Tanks**

  This function is accomplished by activating the developer and fixer replenishment pumps each time 0.15 m^2 (238 $in.^2$) of film are measured by the Multiloader 300. The amount of solution added to the tanks during each replenishment cycle is specified by the operator. External replenisher tanks or an automixer is connected to the Processor to supply the developer and fixer solutions.

- **Maintaining the Correct Temperature in the Dryer**

  This function is accomplished by energizing a blower motor and air heaters to circulate warm air across the surface of the film. A dryer thermistor senses the temperature of the air in the dryer. The Processor also includes a manually resettable safety thermostat to sense abnormal temperatures and shut off the heater.

- **Transporting the Film through the Processor**

  This function is accomplished by energizing the main drive motor when film is detected by the Multiloader 300. The drive motor drives the rollers that transport the film from the entrance rollers, through the Processor, and to the exit.

  The drive motor controller provides a feedback signal, which allows the processor control software to compensate for varying torque loads and maintain a constant transport speed.

- **Diagnostic Features**

  The Processor also includes special software that allows the Processor to interface with an IBM compatible portable computer. This feature increases diagnostic capabilities and provides quick updating of processor software. With the portable computer, new software can be downloaded directly into the Processor, rather than installing new memory chips.

SECTION 2
System Initialization

When power is applied, the software checks the setup and operation of the Processor. The system initializes variables, I/O ports, serial communications ports, the film detector, and the Multiloader 300 display panel.

The initialization begins with a self-check to verify correct operation of the Processor. The self-check verifies the:

(1) Operation of the internal RAM and external RAM

(2) Checksum of the main program EEPROM

(3) Checksum of the bootstrap PROM

(4) Operation of external input/output devices

If the self-check locates an error, the Processor will display a fatal E001 error. If the self-check is successful, the initialization continues and the Processor:

(5) energizes the wash water solenoid, allowing water to flow into the Processor

(6) energizes the dryer blower and air heater

(7) checks the developer and fixer solution levels

If the levels are not correct, the replenishment cycle activates and the tanks are filled. If the level does not reach the correct level within 4 minutes, a tank fill error occurs.

(8) energizes the recirculation pump after the solutions reach their operating levels

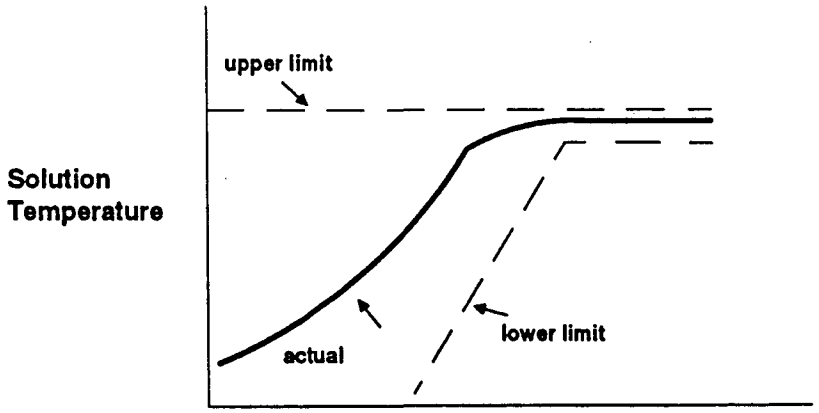
This circulates the developer and fixer solutions through the thermowells where they are heated, if necessary. A ready condition will be displayed when the solutions reach their operating temperatures. If the temperature increases too slowly, however, an error condition occurs.

The microprocessor uses algorithms and controls to monitor the temperature of the solutions. The temperatures should increase at a normal rate within 15 - 20 minutes. The chart below illustrates the relationship between temperature and time.

If the initialization sequence is completed successfully, the Processor will display a "Ready" message.

NOTE

The status LED DS7, located on the 500 circuit board, flashes on and off at ½-second intervals when the software is operating correctly.



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Film Detection

Now that the Processor is ready, the operator can process film by loading a film cassette into the Multiloader 300. As the cassette enters, the Multiloader determines the size of the cassette, which indicates the length and width of the film. This information is sent to the Processor for replenishment area calculation.

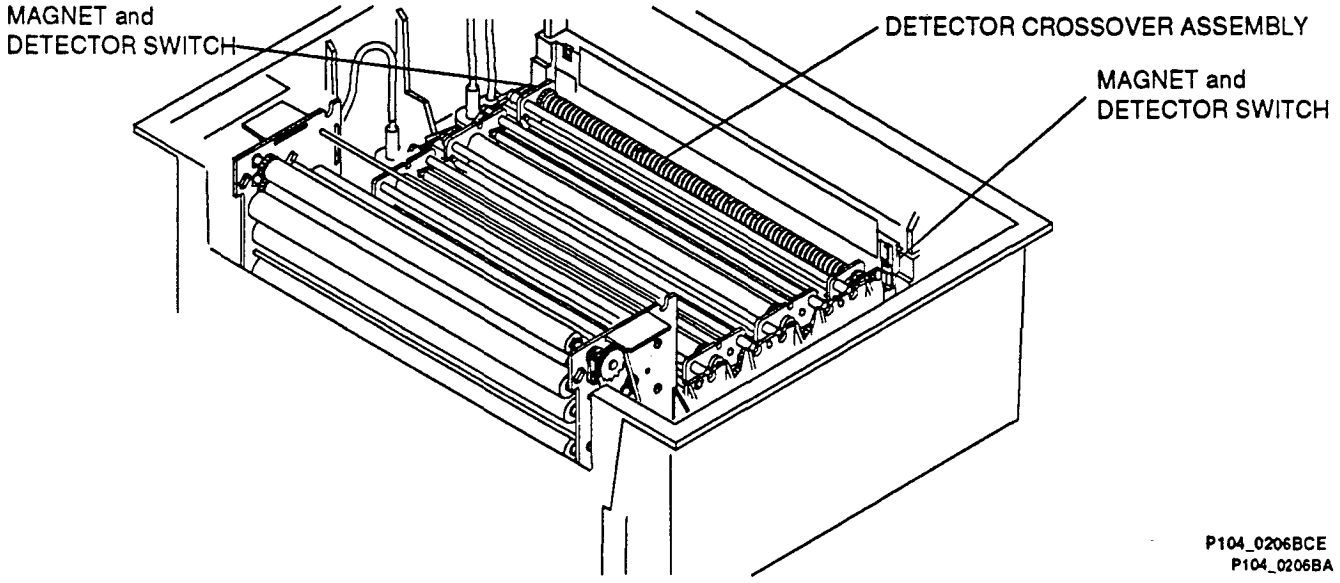
When the Processor enters the operating mode, the following occurs:

(1) The main drive activates.

(2) The wash water solenoid energizes, providing water to the wash rack after an amount of time and allowing the lead edge of the film to start exiting the fixer rack. This is done to conserve water.

(3) The dryer blower and heater energize.

The lead edge of the film then causes the entrance rollers on the detector crossover to separate. As the rollers move up, the magnets on either end will actuate one or both of the detector switches S1 and S2.



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Drive System

Now that the feed signal has been sent, the circuit for the drive system activates. See the figure on the next page.

The processor-in switch must be actuated before the drive engages. If the switch is deactuated, the transport driver is disabled and an error code, E128, is displayed. The transport driver is also disabled if the operator has accessed the "GO TO SETUP" option from the main menu. The transport driver will start when the Processor is pushed into the Multiloader and the operator returns to the main menu.

Speed Control

Now the microprocessor can engage the drive. The quad power supply supplies +24 V DC through fuse F2 to the drive motor controller. The 500 circuit board then outputs a variable speed value (from 0 - 6 V DC) to the speed input terminal of the drive motor controller. The speed value varies, depending on the speed of the selected processing cycle.

The voltage to the speed input terminal is varied by a digital-to-analog (D/A) converter chip on the 500 circuit board. The digital speed value is written to the D/A converter, where it is converted into an analog value (0 - 6 V DC). The higher the digital value, the higher the analog value. The analog value then enters the speed input terminal, which causes the drive motor to change speed. The higher the analog value, the faster the speed of the drive motor.

Because rapid changes in motor speed cause excessive current draw, the full speed value cannot be written immediately to the D/A converter. Instead, the drive motor is gradually increased to the desired speed. This is accomplished by ramping the D/A value from 0 to the set speed value. This ramping takes approximately 1 second to complete.

Speed Check

The drive motor is a brushless, variable-speed, DC motor. It contains a pulse generator, which sends feedback signals to the motor controller, indicating the speed of the drive motor. The motor controller converts the analog signals into digital signals, and sends them to the 500 circuit board. The microprocessor uses this information to either increase or decrease the speed of the drive motor until it is correct.

The feedback pulses are produced at a rate of 12 per revolution of the drive motor. The pulses are counted by the microprocessor.

Transport Errors

- **Inoperative Transport Error (Fatal Error E004)**

  If the feedback pulse count for 1 second is less than 5, the count value is calculated as zero transport speed and an inoperative transport error occurs (fatal error E004). An E004 also occurs if the D/A converter count reaches its maximum or minimum value (255 or 0).

- **Loss of Transport Speed Control Error (Nonfatal Error E041)**

  If the speed of the drive motor is 3 inches/minute above or below the setpoint for a period of 10 seconds, a loss of transport speed control error (nonfatal error E041) will occur. If this error exists for 2 minutes, it will change to an inoperative transport error (E004).

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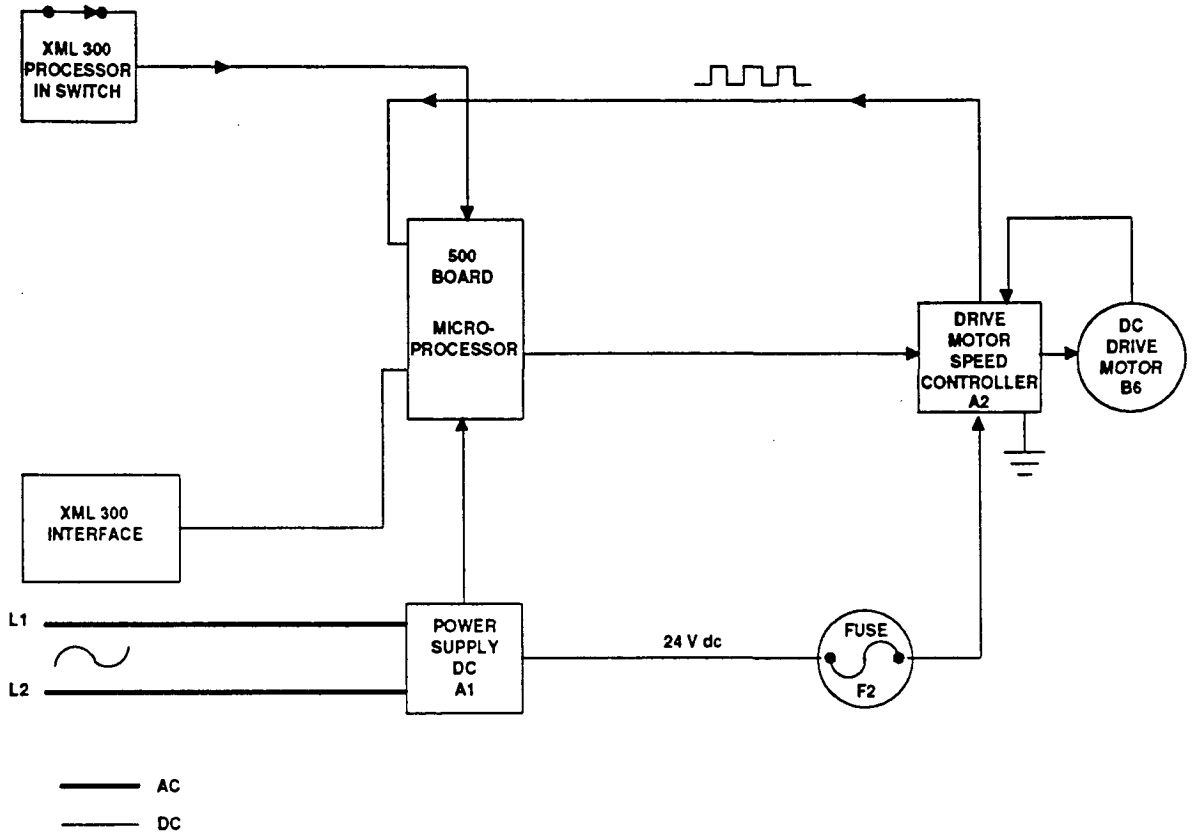
D.C. DRIVE MOTOR CONTROL



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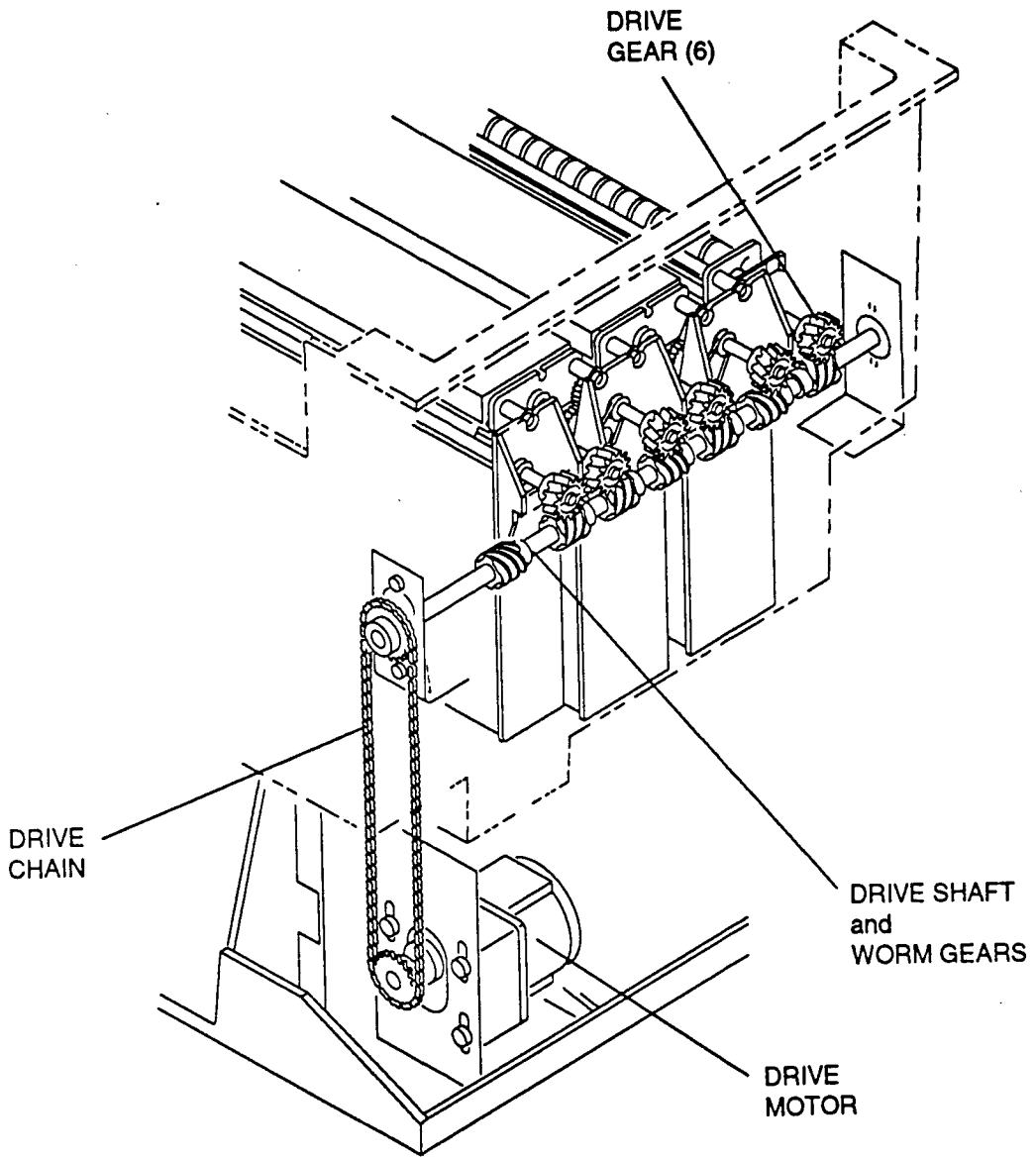
Drive Components

The drive motor supplies drive to a network of rollers called the film transport assembly. The drive is provided through a drive chain, shaft, and worm gears. Each worm gear then meshes with a drive gear on the racks in the film transport assembly.



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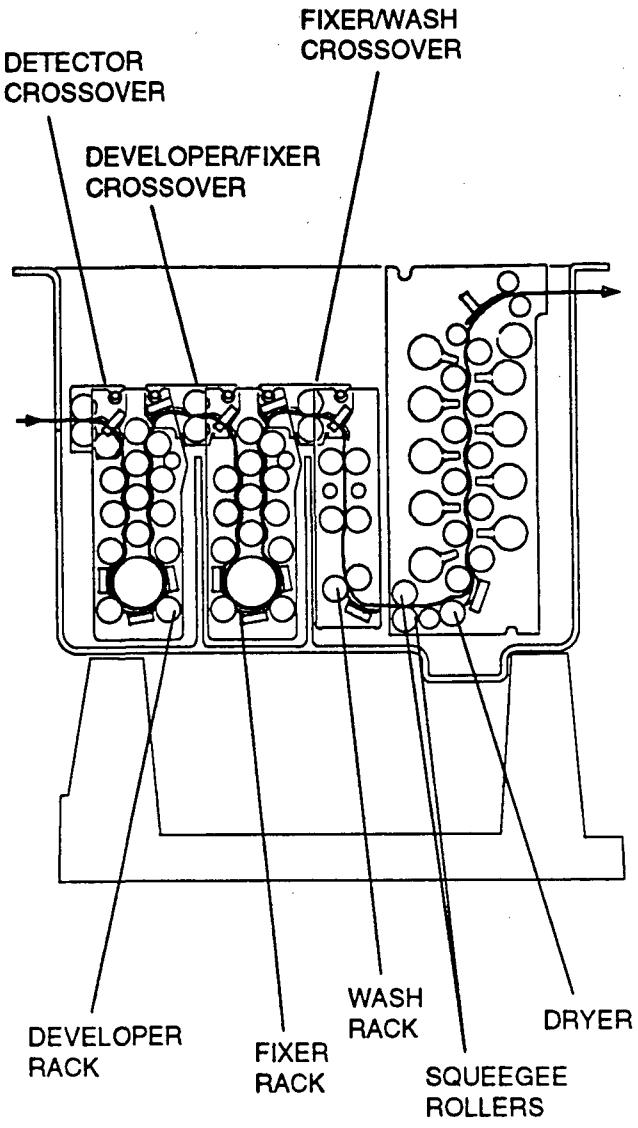
Film Transport Assembly

Now that drive is supplied to the film transport assembly, the detector crossover transports the film into the Processor. When the trailing edge has traveled 7.6 cm (3 in.) into the Processor, a signal is sent to the Multiloader 300. This indicates that another sheet of film can be sent to the Processor.

The film is transported to the developer rack, the fixer rack, the wash rack, and the dryer rack. The racks consist of a series of rollers driven by chains and gears. Although the developer and fixer racks are similar, they cannot be interchanged. This is especially important to prevent chemical residues from contaminating other solutions.

Between each rack is a crossover assembly that transports the film between racks. The pressure applied by the rollers also removes any remaining solutions from the film surface before it enters the next rack.

When the film leaves the wash rack, it passes into the dryer rack. Here, squeegee rollers remove remaining droplets of water across the film surface, to encourage fast, uniform drying. The rollers in the dryer rack then move the film through the dryer rack and out of the Processor into the receiving tray.



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SECTION 4
Processing

Overview

As the film moves through the film transport assembly, the film passes through several tanks where the film is processed. The processing procedure involves 4 different stages. These stages and how they are controlled are described in this section.

Developer Tank

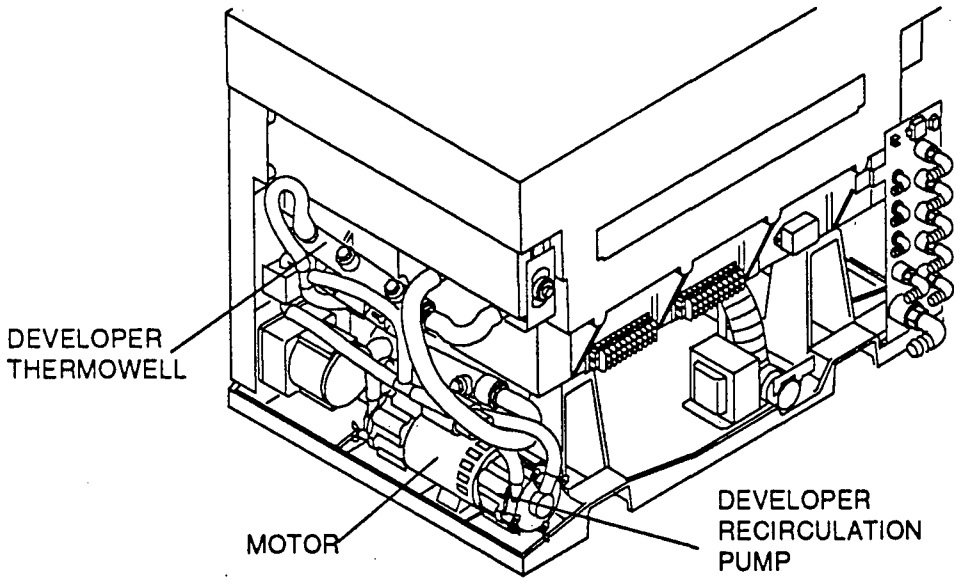
The film enters the developer tank first. In this tank, a developer solution converts the invisible latent image on the film to a visible image.

The processing tank contains approximately 8½ litres (2¼ gallons) of developer solution. The solution in the external container is a mixture of developer chemical and water. The solution is replenished automatically from an external tank of solution or automixer. For more information about replenishment, see page 33.

Developer Recirculation

The developer recirculation pump circulates the developer solution continuously through a thermowell where it is heated when necessary. The developer also passes through a filter.

The developer recirculation pump is magnetically coupled with a motor. The developer and fixer recirculation pumps use the same motor.



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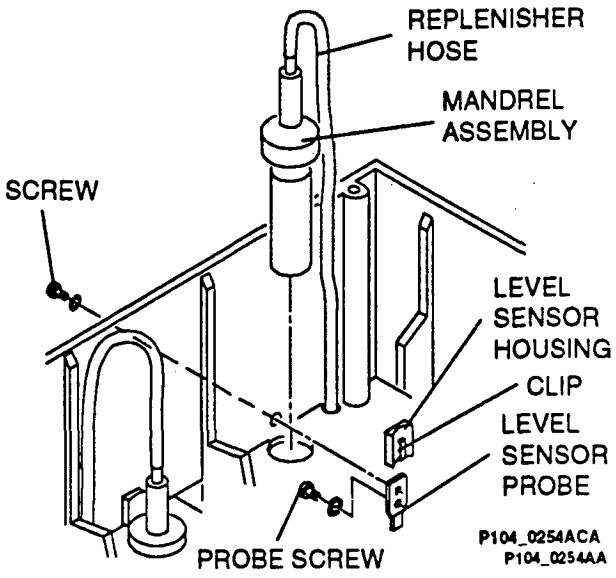
Developer Level Detection

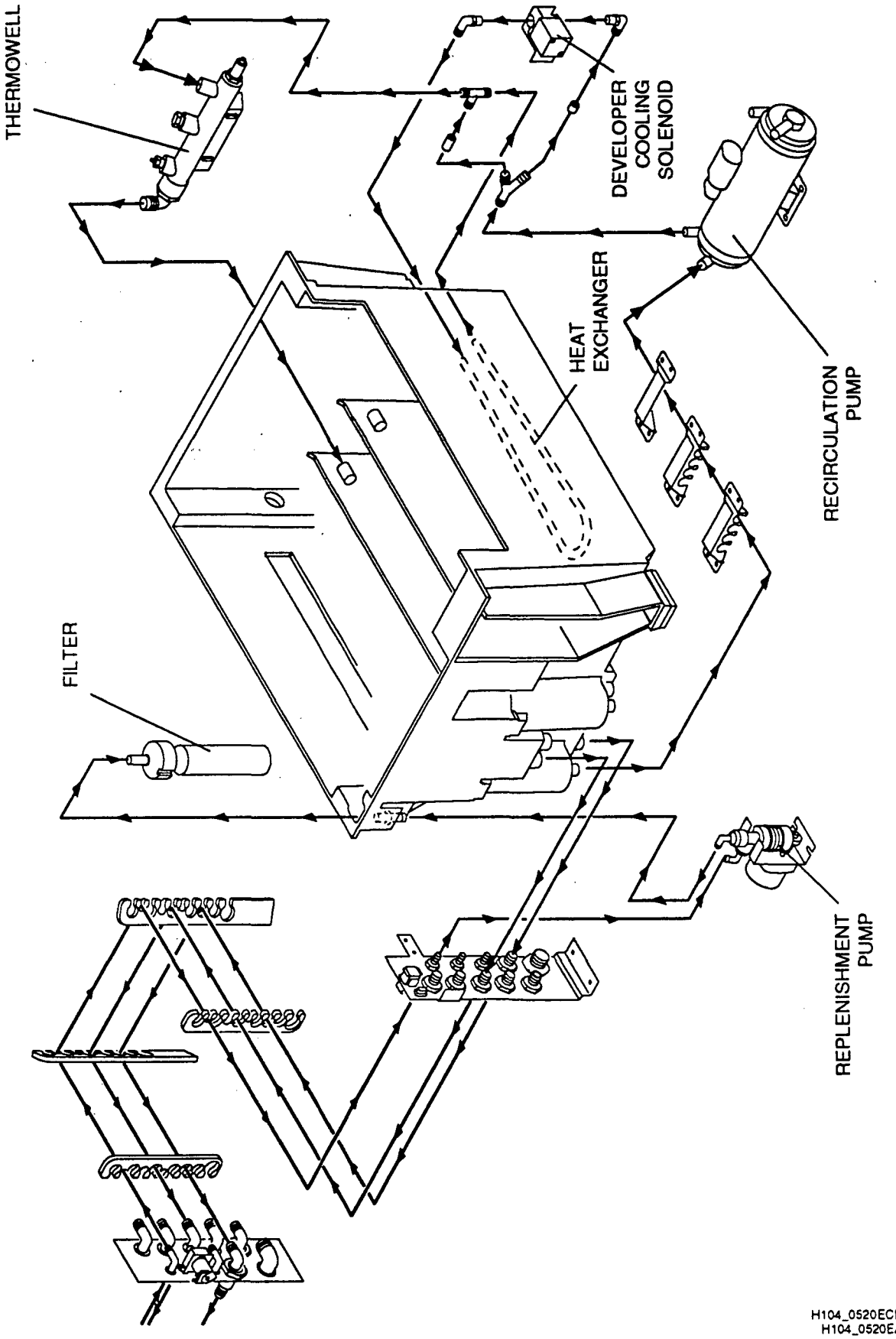
Recirculation takes place only when both the developer and fixer tanks are full. A full condition is detected by a sensor in the level sensing reservoir.

When the tank is full, the developer level sensor probe is immersed in the solution, providing a path to ground on the developer heater case. This lowers the resistance of the circuit. The microprocessor, which monitors the circuit, detects the lower resistance and determines a full solution level. When the level is not high enough to cover the probe, the resistance of the circuit is higher. The microprocessor detects the high resistance and determines a low-level condition.



NOTE

- If the level sensor probe is not immersed in developer solution for 10 consecutive readings (approximately 5 seconds), the solution is considered low.
- If the level sensor probe is immersed in solution, the developer solution is considered at the operating level.
- The level sensor probe may not function correctly if water is in the tank instead of developer, because water does not have the same conductivity as the developer solution.



Developer Plumbing Diagram

Developer Recirculation Control Circuit

The diagram below shows the recirculation control circuit. For more details, see the AC and DC circuit diagrams at the end of this theory guide.

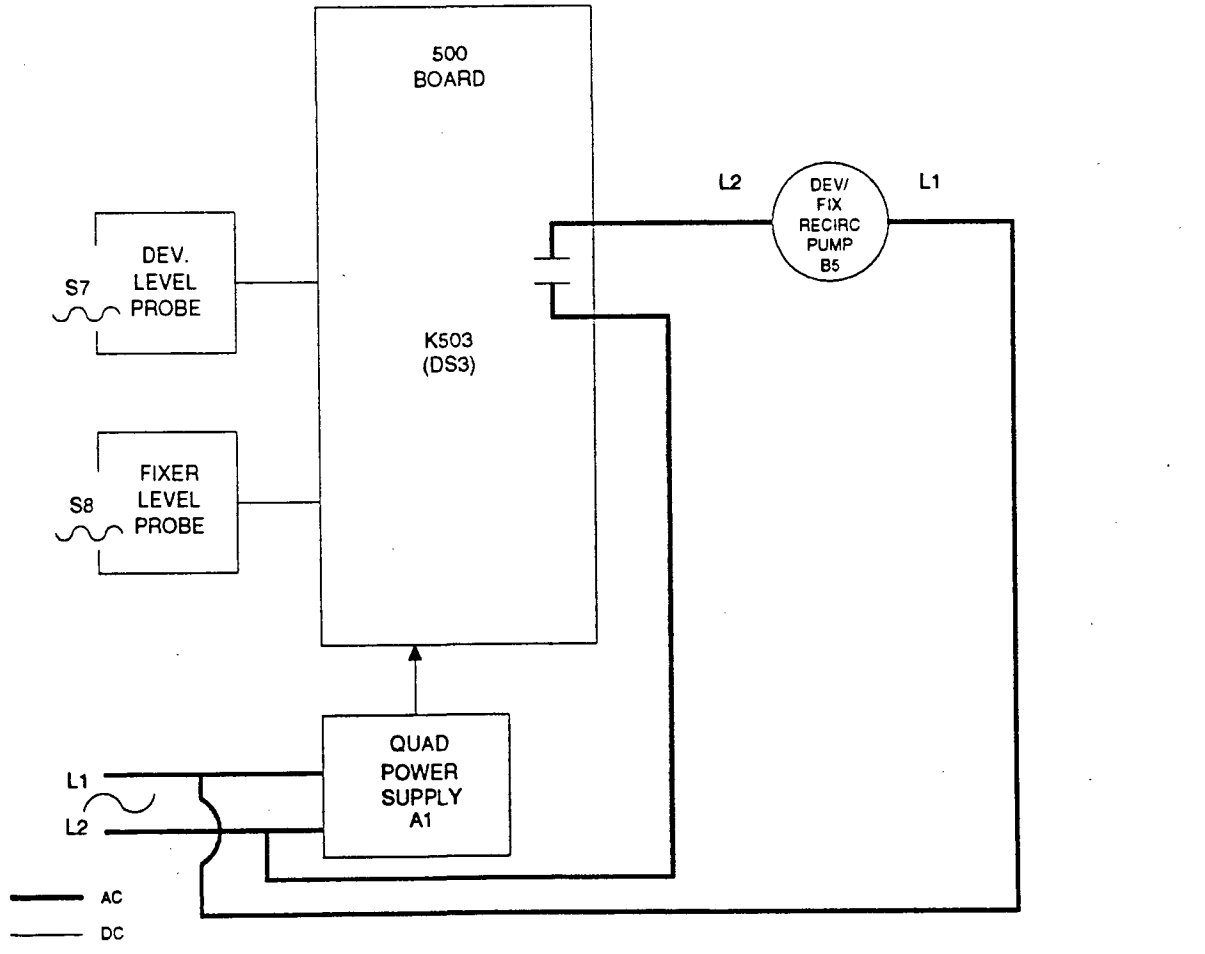
Before recirculation will begin, both the developer and fixer solutions must be at the correct levels in the tanks. This occurs when the probes for the developer and fixer level sensors are immersed in solution, providing a path to ground.

If the solution levels are correct and power is applied to the Processor, the microprocessor energizes the recirculation relay K503 (and LED DS3). This provides power to the recirculation pump, causing it to energize and recirculate the developer.

NOTE

- When an enable relay is energized, the corresponding LED on the 500 circuit board will also energize.
- Relays that are designated with a K (for example, K501) are electromechanical relays, which are mounted on the 500 circuit board. Relays that are designated with SSR (for example, SSR U3) are solid state relays, which are mounted in the electrical box.

BLOCK DIAGRAM
DEVELOPER/FIXER RECIRCULATION CONTROL



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Developer Temperature Control

Monitoring the Temperature

While the developer is recirculating, a thermistor in the thermowell monitors the temperature of the solution. The resistance of the thermistor changes inversely with the temperature of the solution. This data is sent to the microprocessor, which controls the heating and cooling systems. For more information about the control circuitry of the thermistor, see page 39.

The temperature is determined by performing an analog-to-digital (A/D) conversion on the resistance of the thermistor. This data is then converted to a temperature by means of a software algorithm. The temperature is then compared to the setpoint to determine if heating or cooling is required. The temperature is read every ¾ second.

Heating System

The developer solution temperature must be controlled to provide optimum conditions for processing film. A heater, located inside the thermowell, pulses at different duty cycles to maintain the optimum temperature. The microprocessor controls the duty cycle of the heater based on the data received from the thermistor.

The heating of the developer is controlled by a proportional method, which operates in the following manner:

(1) The heater is turned on full until the temperature of the solution is less than 0.28°C (0.5°F) below the setpoint.

(2) The heater operates on a duty cycle of 60% until the temperature of the solution is less than 0.17°C (0.3°F) below the setpoint.

(3) The heater operates on a duty cycle of 40% until the temperature of the solution is less than 0.06°C (0.1°F) below the setpoint.

(4) The heater operates on a duty cycle of 20% until the setpoint temperature is reached.

(5) When the setpoint temperature is reached, the developer heater shuts off.

Cooling System

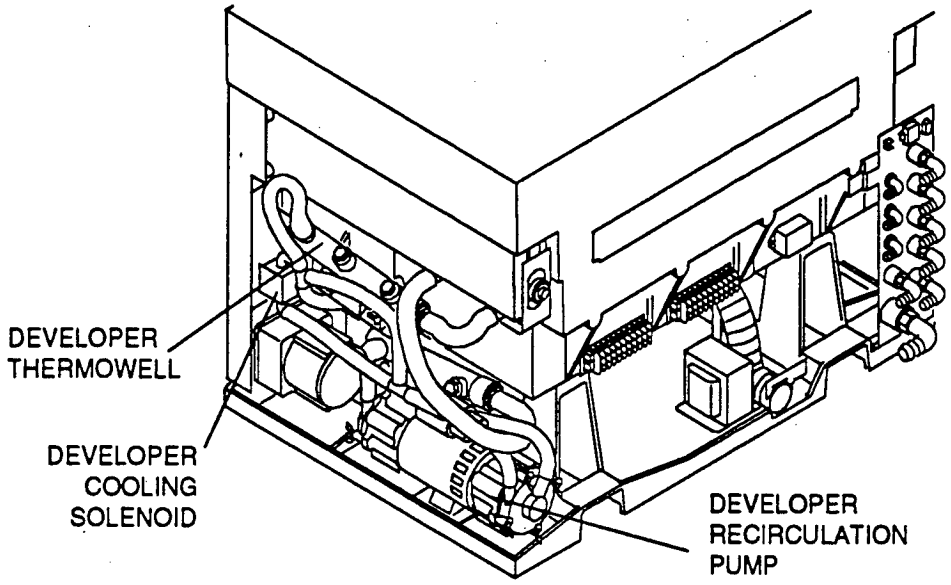
When the temperature of the developer is 0.17°C (0.3°F) higher than the setpoint for 5 consecutive readings, the cooling system is activated. The wash water solenoid, which is on the Multiloader bulkhead, must be energized before cooling can begin. This solenoid supplies water to the area around the heat exchanger in the bottom of the wash tank.

The developer cooling solenoid L2 then energizes, allowing some of the developer to circulate through the heat exchanger. The water surrounding the heat exchanger effectively cools the developer. The cooler developer then returns to the main recirculation line.

The cooling cycle continues until the developer temperature is 0.06°C (0.1°F) below the setpoint for 1 reading of the developer thermistor. The developer cooling solenoid then deenergizes, shutting off the developer supply to the heat exchanger.

Temperature Display

The developer temperature displayed on the Multiloader 300 display panel is calculated by averaging 10 consecutive temperature readings. Therefore, it is updated approximately every 7 seconds.



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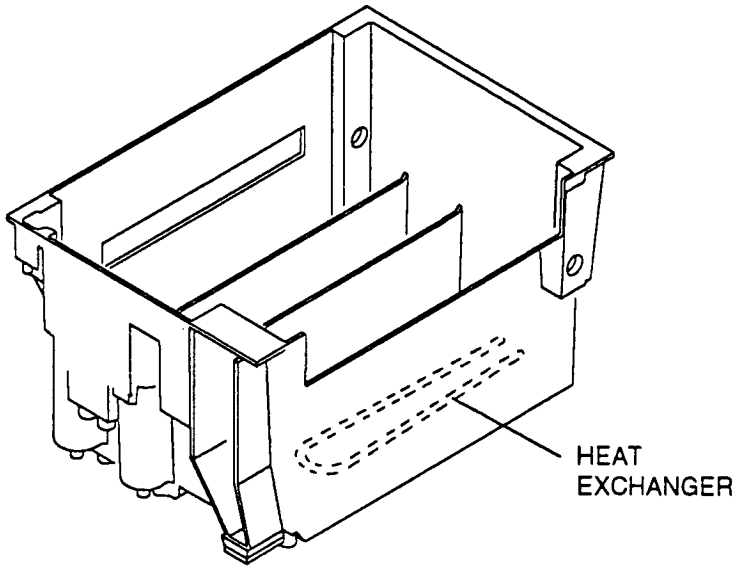

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Temperature Control Errors

The developer heating and cooling systems are responsible for maintaining the developer at the current processing cycle temperature setpoints under all operating conditions. If the developer solution falls outside the tolerance zone, and the software cannot correct the temperature within a specified time limit, the Processor will display an error message.

The developer solution should stabilize at the setpoint temperature within 20 minutes after start-up or a cycle change, and within 5 minutes during normal operation. If the rate of change for the developer temperature is not within the specifications, the Processor will display one of the following error messages:

- **Unable to Determine Developer Temperature (E034)**

  If the thermistor is opened or shorted, or if the temperature control A/D converter is not operating correctly, an E034 will be displayed (if it is the highest priority). This error cannot be cleared unless the Processor is deenergized and then energized again. For more information about this condition, see the thermistor control section on page 39.

- **Loss of Developer Heating Ability (E037) and Loss of Developer Cooling Ability (E038)**

  The rate at which the developer solution is heated and cooled is checked. If the rate is not correct, the appropriate error code will be displayed (if this error is the highest priority). These errors are cleared when either the rate corrects itself or the setpoint temperature is reached.

  The cooling rate is checked as long as cooling is needed. The heat rate is checked only when:

  - the developer heater is on full
  - the temperature of the solution is above 29°C (84°F)
  - the replenishment pumps are not on

NOTE

- minimum heating rate = an increase of 1.1°C (2.0°F) every 2 minutes
- minimum cooling rate = a decrease of 0.05°C (0.1°F) every 3 minutes

Developer Temperature Control Circuit

The diagram on the opposite page identifies the main components and the electrical requirements for the developer temperature control circuit. For more detailed circuit information, see the AC and DC circuit diagrams at the end of this theory guide.

NOTE

The recirculation pump, the heating circuit, and the cooling circuit will not activate if the developer and fixer tanks are not full. The developer and fixer level probes inform the microprocessor when the tanks are full. When the tanks are full, relay K503 is energized, turning on the recirculation pump, and the heater enable relay K504 is energized. Then the microprocesor will react to the temperature input received from the developer thermistor.

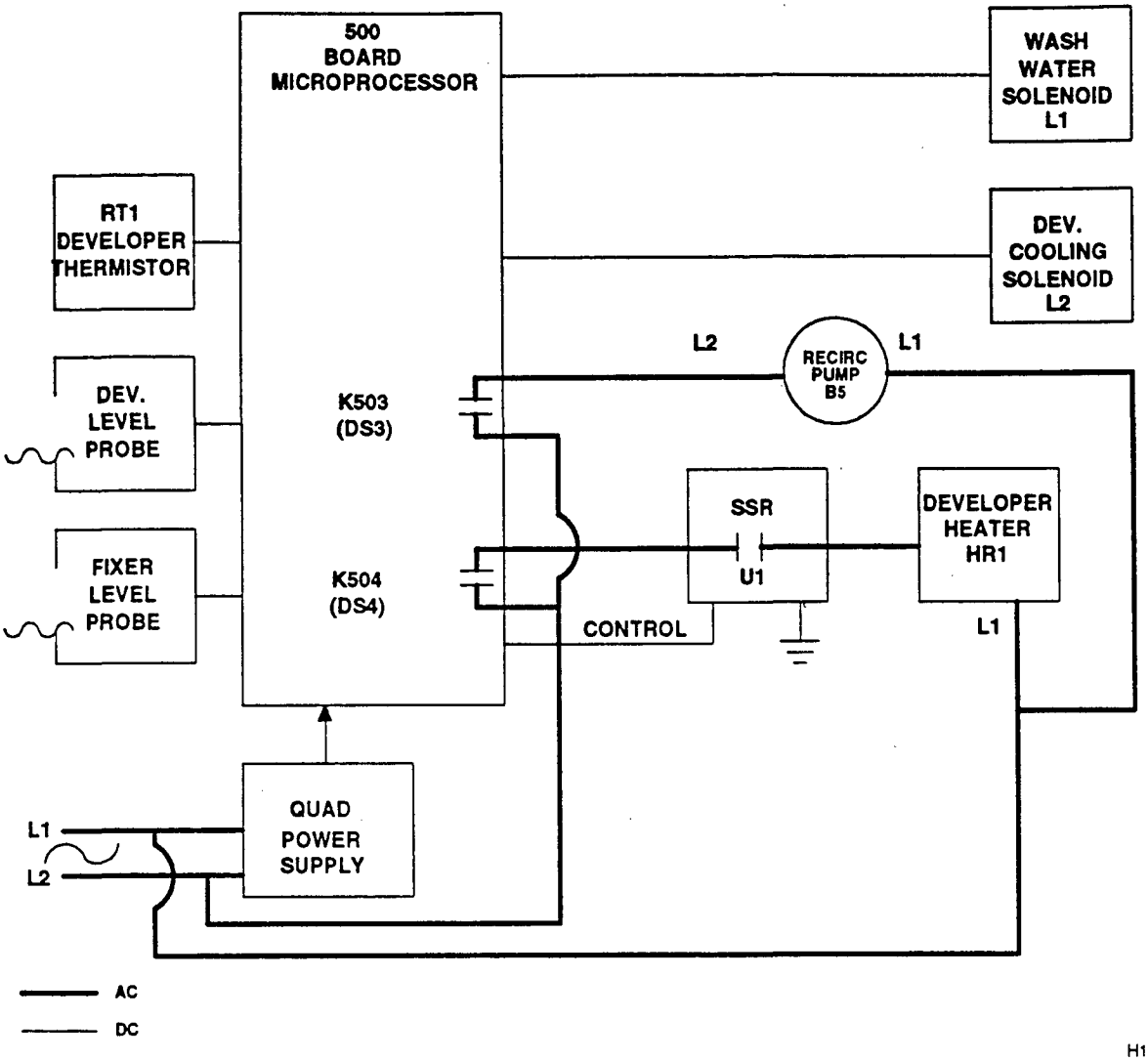
If the temperature is below the setpoint, the microprocessor applies DC voltage to the developer heater control U1 relay. When U1 energizes, the developer heater turns on. The developer heater operates continually, but at different duty cycles, depending on the difference between the detected temperature and the setpoint.

If the temperature is above the setpoint, the microprocessor turns off the developer heater and activates the wash water solenoid (if it is not already energized) and the developer cooling solenoid. The developer cooling solenoid opens the path to the heat exchanger in the wash section, allowing developer to enter the heat exchanger and be cooled by the wash water.

NOTE

- When an electromechanical relay energizes, the corresponding LED on the 500 circuit board also energizes.
- Relays that are designated with a K5 (for example, K501) are electromechanical relays, which are mounted on the 500 circuit board. Relays that are designated with SSR (for example, SSR U3) are solid state relays, which are mounted in the electrical box.

BLOCK DIAGRAM
DEVELOPER TEMPERATURE CONTROL



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Fixer Tank

After the film is developed, it leaves the developer tank and is transported into the fixer tank. This tank contains fixer solution, which stops the development of the visible image on the film. It also increases the permanency of the visible image. The fixer solution accomplishes this by removing unused silver halide crystals from the film.

The fixer tank is almost identical in operation to the developer tank. It is both filled and replenished automatically from an external container of fixer solution. For more information about the replenishment cycle, see page 33.

Fixer Recirculation

Like the developer, fixer is recirculated by a recirculation pump continuously through a thermowell where a thermistor monitors the temperature of the solution. The fixer recirculation pump is magnetically coupled with the same motor as the developer recirculation pump.

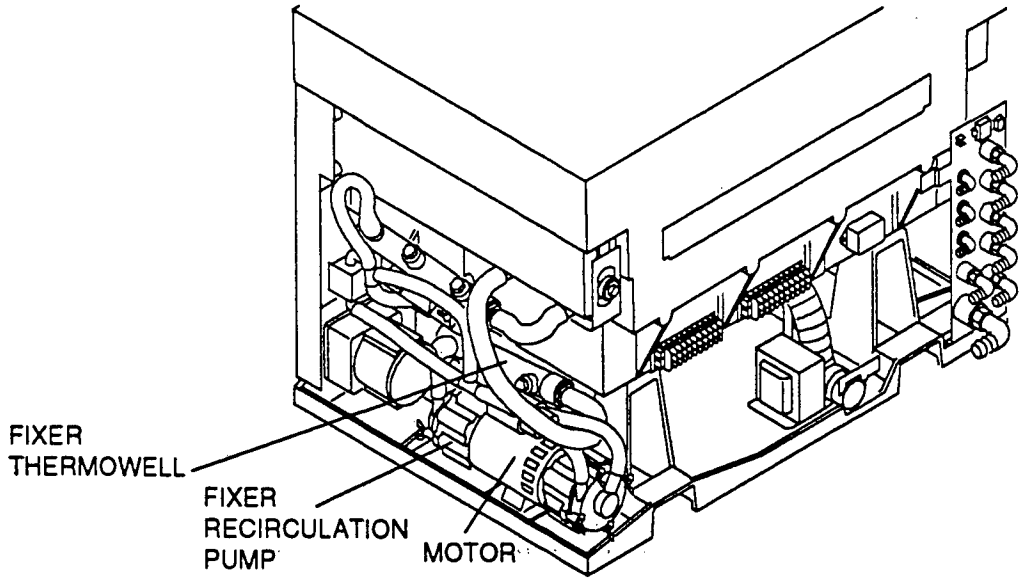
Fixer Level Detection

Recirculation takes place only when both the fixer and developer tanks are full. A full condition is detected by a sensor in the level sensing reservoir. When the tank is full, the fixer level sensor probe is immersed in solution, providing a path to ground on the fixer heater case. This lowers the resistance of the circuit. The microprocessor, which monitors the resistance of the circuit, detects the lower resistance and determines a full solution level. When the level is not high enough to cover the probe, the circuit has a high resistance. The microprocessor detects the high resistance and determines a low-level condition.

- If the level sensor probe is not immersed in fixer solution for 10 consecutive readings (approximately 5 seconds), the solution is considered low.
- If the level sensor probe is immersed in solution, the fixer solution is considered at the operating level.

NOTE

The level sensor probe may not function correctly if water is in the tank instead of fixer, because water does not have the same conductivity as the fixer solution.



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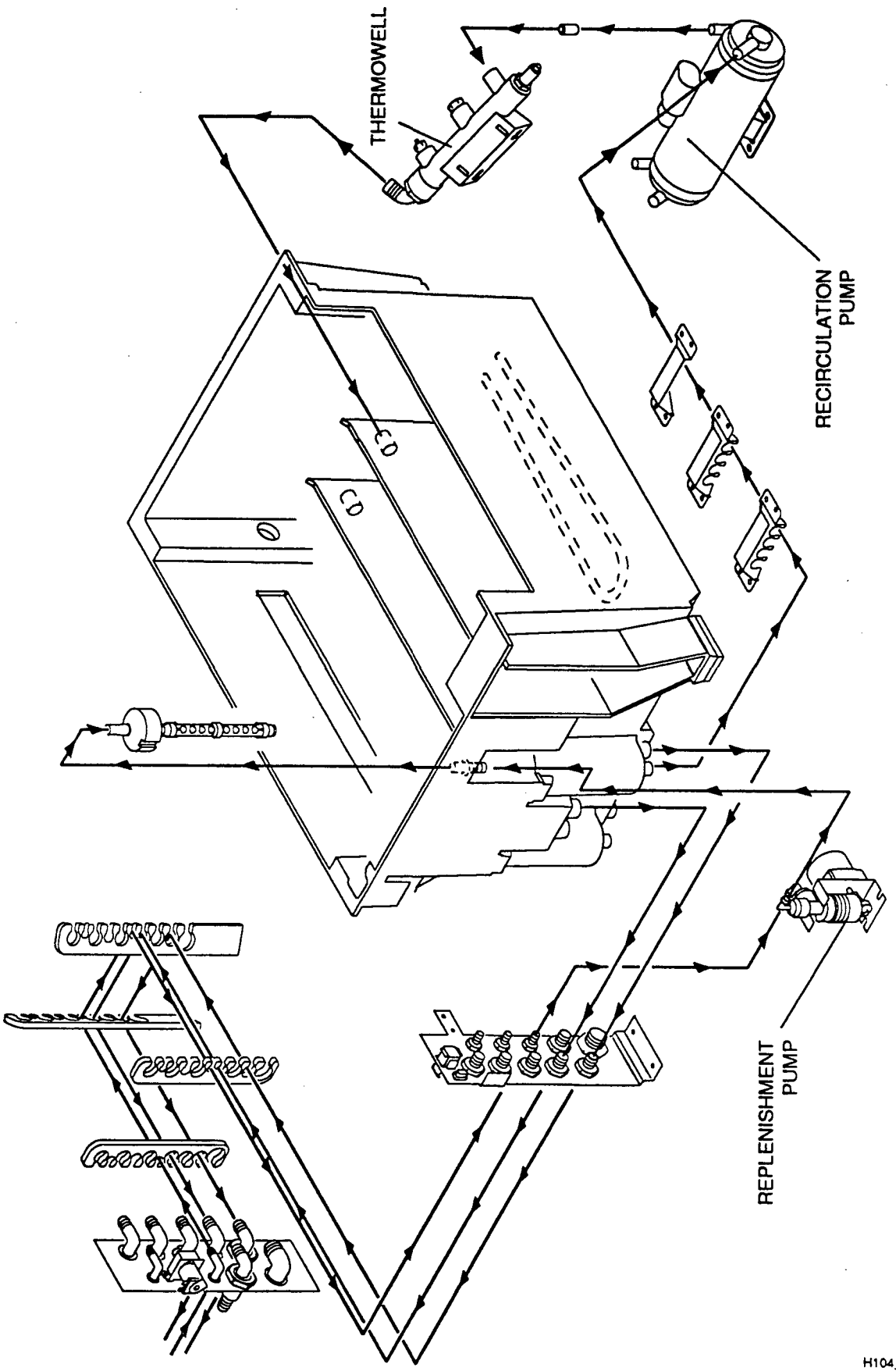


Fixer Plumbing Diagram

Fixer Recirculation Control Circuit

A diagram of the circuit appears below. For more detailed information, see the AC and DC circuit diagrams at the end of this theory guide.

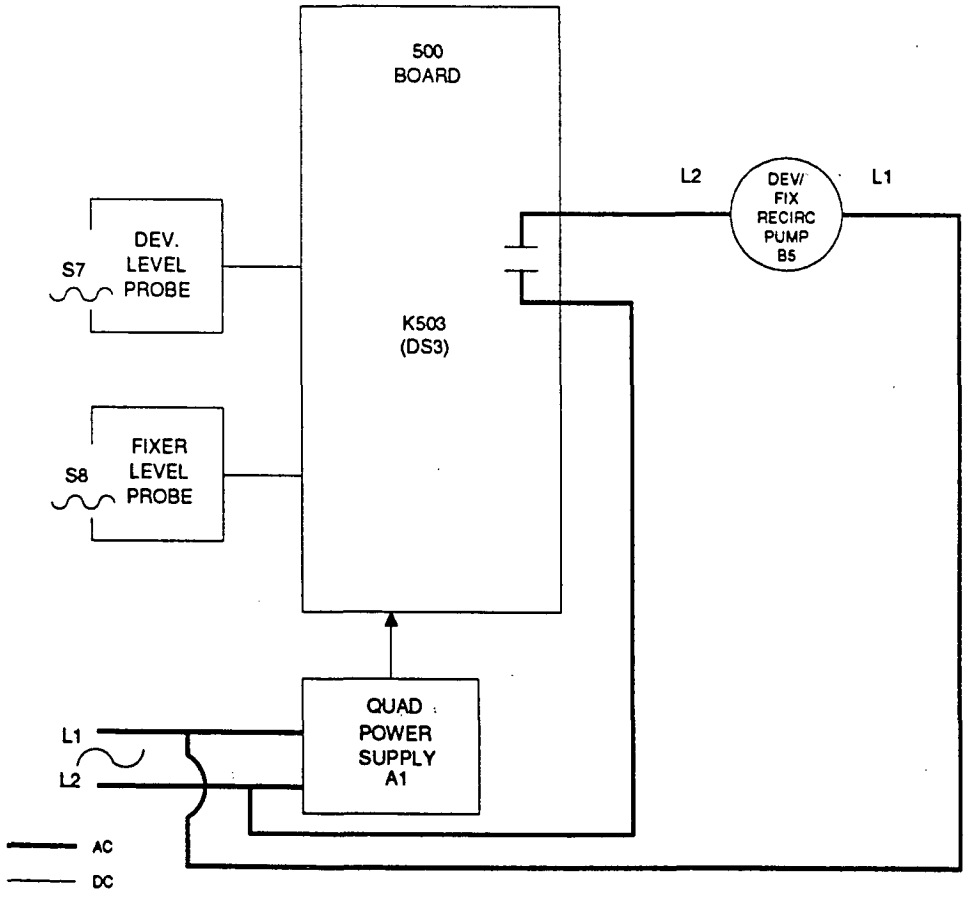
Before recirculation will begin, both the developer and fixer solutions must be at the correct levels in the tanks. This occurs when the probes for the developer and fixer level sensors are immersed in solution, providing a path to ground.

If the solution levels are correct and power is applied to the Processor, the microprocessor energizes the recirculation relay K503 (and LED DS3). This provides power to the recirculation pump, causing it to energize and recirculate the fixer.

NOTE

- When an enable relay is energized, the corresponding LED on the 500 circuit board will also energize.
- Relays that are designated with a K5 (for example, K501) are electromechanical relays, which are mounted on the 500 circuit board. Relays that are designated with SSR (for example, SSR U3) are solid state relays, which are mounted in the electrical box.

BLOCK DIAGRAM
DEVELOPER/FIXER RECIRCULATION CONTROL



H108_9017DC

Fixer Temperature Control

Monitoring the Temperature

While the fixer solution is circulating, a heater in the thermowell heats the solution to increase its effectiveness. This is especially important to support the faster processing cycles. Like the developer thermowell, a thermistor in the fixer thermowell will monitor the temperature of the fixer solution. The fixer heater is either completely on or completely off. Its duty cycle is not regulated like that of the developer heater. For more information about the control circuitry of the thermistor, see page 39.

The temperature is determined by performing an analog-to-digital (A/D) conversion on the resistance of the thermistor. This data is then converted to a temperature by means of a software algorithm. The temperature is then compared to the setpoint to determine if heating is required.

Heating System

The fixer, which operates more effectively at higher temperatures, does not have to be cooled. The fixer heater operates at full capacity when the fixer is below the setpoint. When the temperature is above the setpoint, the heater is turned off.

Like the developer, the fixer solution should stabilize at the setpoint temperature within 20 minutes after start-up or cycle change and within 5 minutes during normal operation. If the rate of change for the fixer temperature is not within specifications, the Processor will display an E039 error message.

Temperature Display

The current fixer temperature can be displayed by pressing a key on the Multiloader 300 display panel.

Temperature Control Errors

The temperature control function checks for the following errors:

- **Unable to Determine Fixer Temperature (E035)**

  If the thermistor is not working correctly, an E035 will be displayed (if it is the highest priority). This error cannot be cleared unless the Processor is deenergized and then energized again. For more information about this condition, see the thermistor control section on page 39.

- **Loss of Fixer Heating Ability (E039)**

  This is the rate at which the fixer solution is heated is checked. The minimum acceptable heating rate is an increase of 1.2°C (2.0°F) every 2 minutes. If the rate is not correct, an E039 is displayed (if it is the highest priority). This error is cleared when either the rate corrects itself or the setpoint temperature is reached. The heat rate error is only checked when:

  - the fixer heater is on full
  - the temperature of the solution is above 29°C (84°F)
  - the replenishment pumps are not on

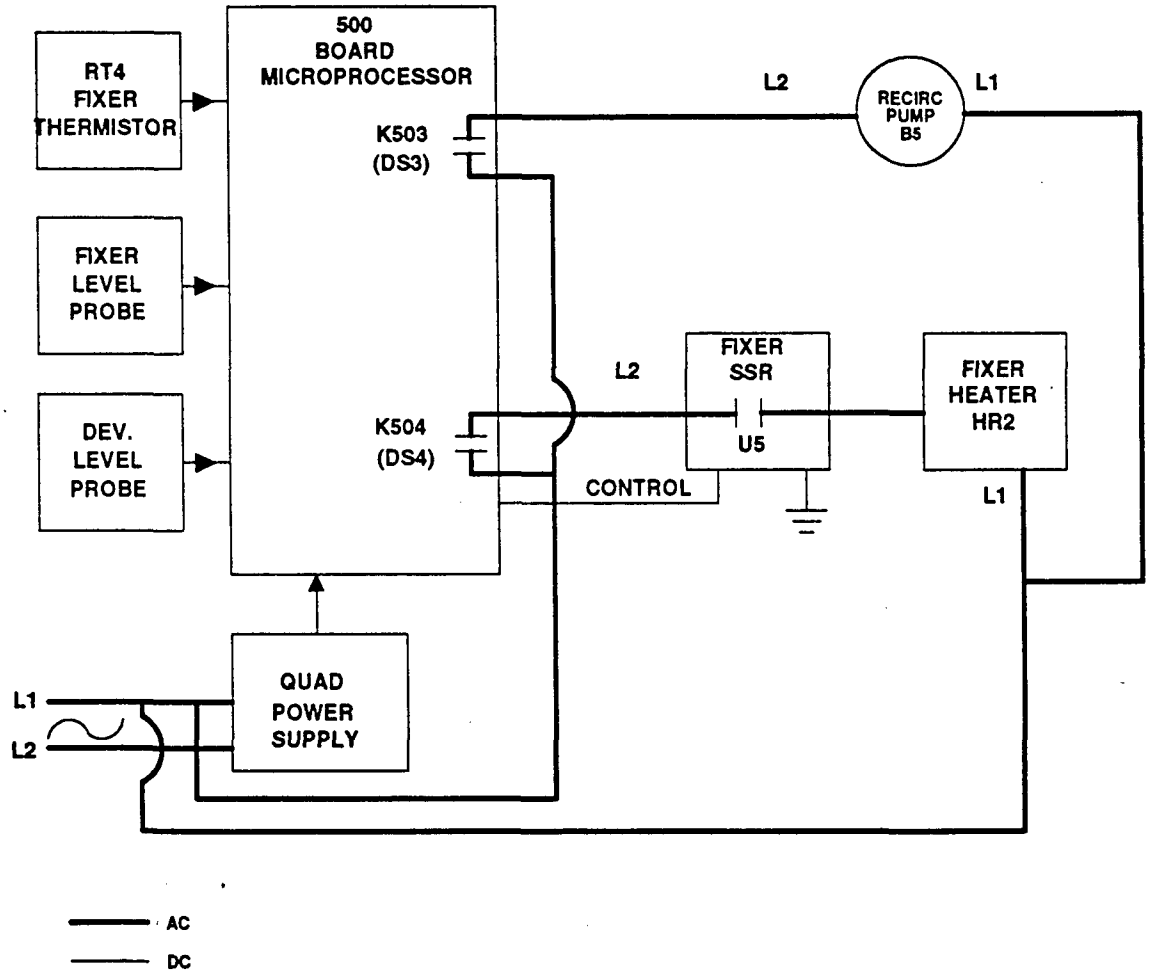
Fixer Temperature Control Circuit

The circuit that controls the fixer heating cycle is illustrated below. The fixer and developer temperature control circuits are similar, except that the fixer does not include a cooling circuit.

The fixer and developer tanks must be filled before the heating circuit will activate. Once the fixer level sensor probe and the developer level sensor probe provide a path to ground, the microprocessor sends DC voltage to energize two relays: K503 and K504. When relay K503 (LED DS3) energizes, the AC voltage activates the fixer recirculation pump. Relay K504 (LED DS4), which enables the heater circuit, sends AC voltage to the solid state relay U5. Relay K504 is shared with the developer temperature control circuit.

Now the microprocessor applies DC voltage to the fixer heater solid state relay U5, which activates the fixer heater when necessary. The fixer heater operates continually when the fixer temperature is below the setpoint.

BLOCK DIAGRAM
FIXER TEMPERATURE CONTROL



H104_9023DC

Wash Tank

After the latent image has been developed and made permanent, the film leaves the fixer tank and enters the wash tank. The wash rack supplies fresh water to the film, removing all excess developer and fixer solutions from the film. This is necessary because residual chemicals will cause artifacts on the film during the drying process and reduce the permanency of the image.

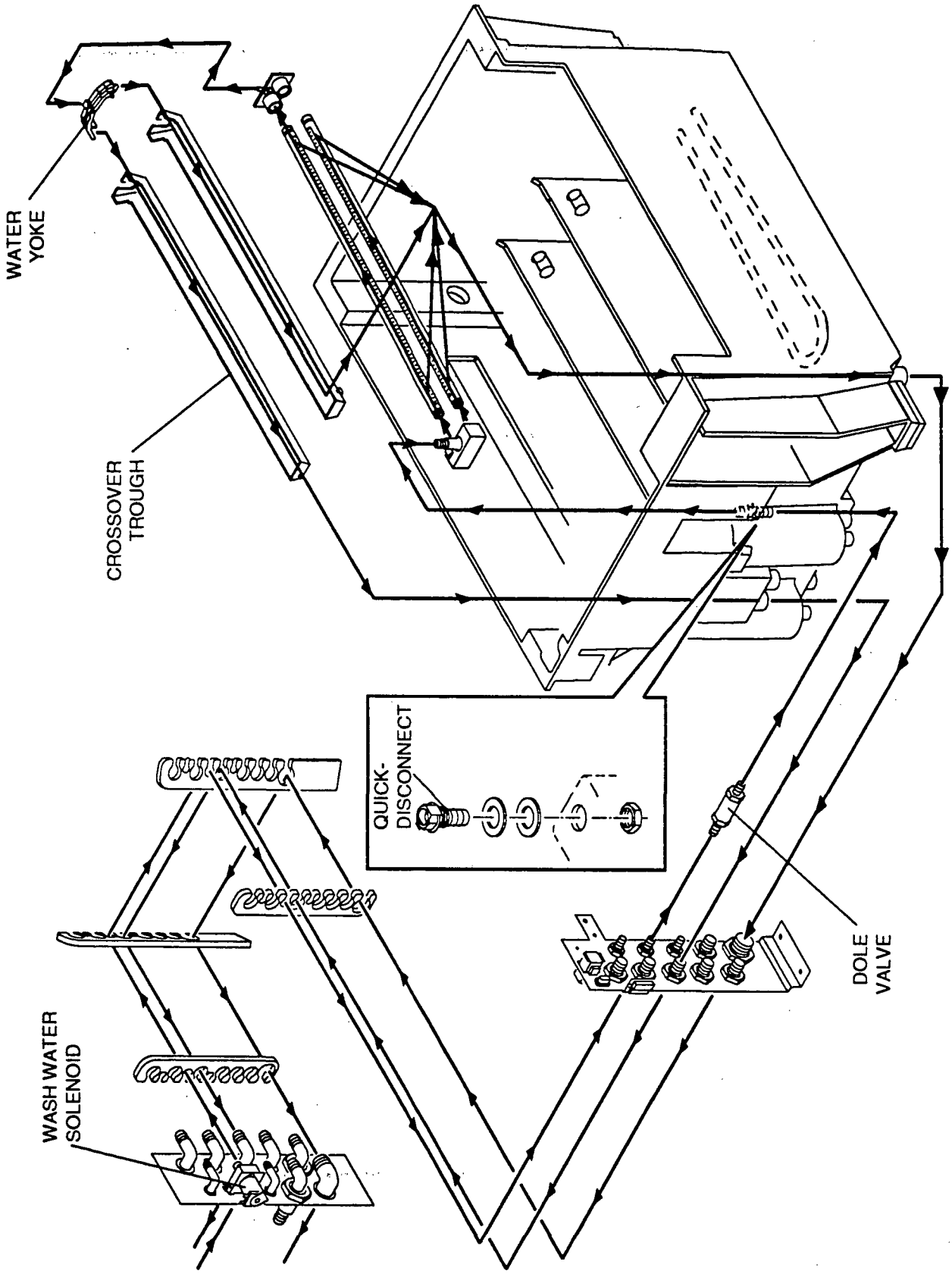
Wash water is supplied through the customer's external water supply. The temperature of the water must be 4 - 30°C (40 - 85°F). The water temperature must remain at least 6°C (10°F) below the operating setpoint of the developer temperature. The incoming water should be filtered.

A hose connects the water supply at the rear of the Processor. A wash water solenoid, located in the Multiloader 300, controls the flow of water. The wash water solenoid:

- opens just **before** film enters the wash rack. This supplies water to the rack at a rate of 3.8 L (1 gal) per minute, ±10%.
- closes just **after** the film leaves the wash rack, provided no additional films enter the Processor.
- opens and closes to provide water to the heat exchanger to cool the developer.

The water flows from the wash water solenoid, through the quick-disconnect assembly to the wash rack and crossover assembly. If the connection at the quick-disconnect assembly is not correct, the water flow will stop and no water will enter the wash rack.

When the Processor is turned off, the wash tank drains completely to minimize biological growth.



Wash Water Plumbing Diagram

Water Control Circuit

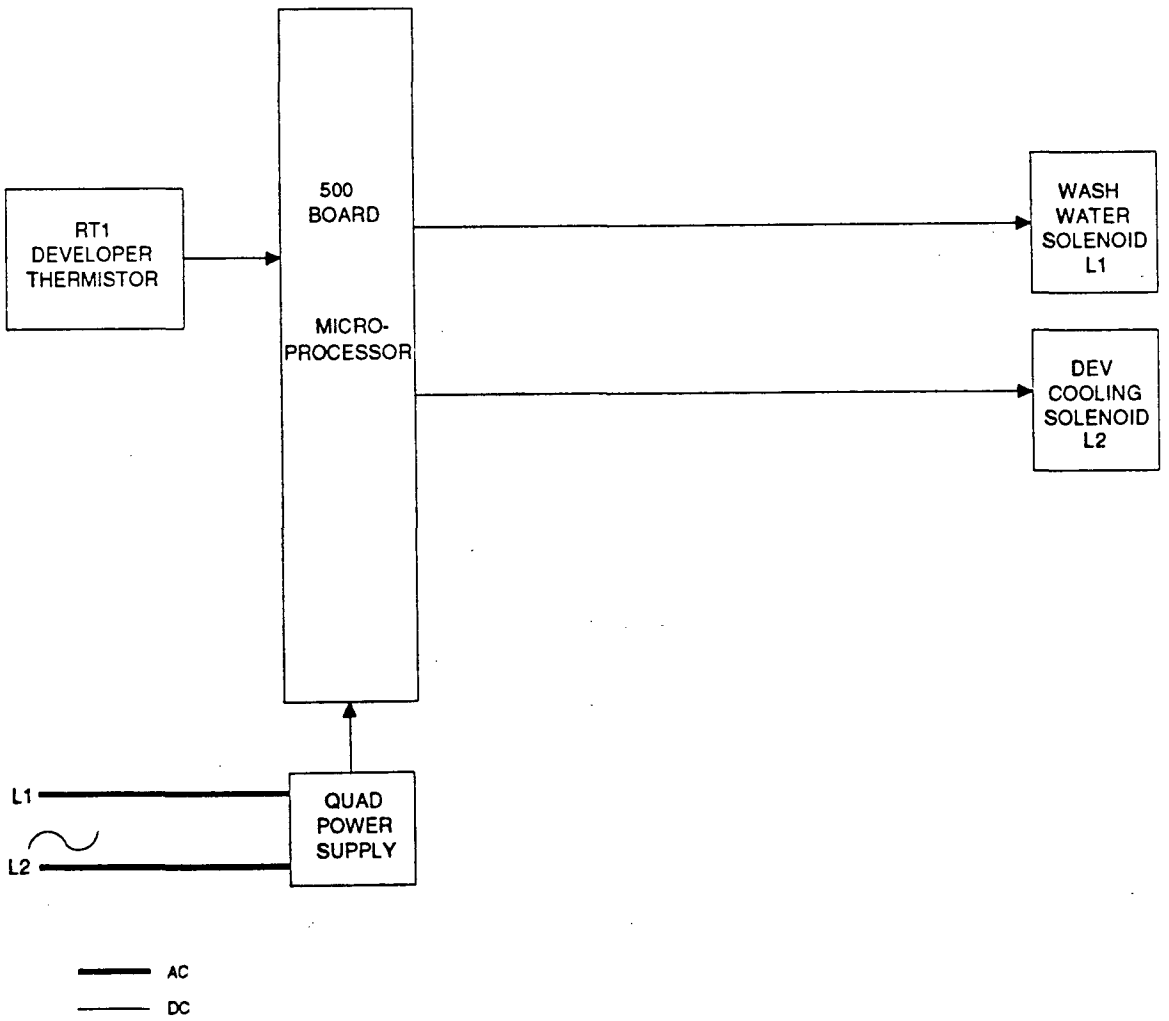
The wash water control circuit activates just before film enters the wash rack. The microprocessor then energizes the wash water solenoid, which allows water to flow into the wash tank. The solenoid remains energized as long as film is being processed. When the Processor enters the standby mode (that is, when no film is present for processing), the microprocessor deenergizes the wash water solenoid and stops the water flow to the Processor.

When the developer thermistor detects a developer temperature (0.17°C or 0.3°F) higher than the setpoint, the microprocessor energizes the wash water solenoid and the developer cooling solenoid.

The developer cooling solenoid opens the path to the heat exchanger, allowing developer to enter the heat exchanger at the bottom of the wash tank. The circulation of developer through the heat exchanger will cool the developer.

Once the developer thermistor detects a temperature below the setpoint, the microprocessor deenergizes the developer cooling solenoid, which stops the developer flow through the heat exchanger. If the Processor is in the standby mode, the wash water solenoid will deenergize also. If the Processor is in the operating mode, however, the wash water solenoid remains energized.

BLOCK DIAGRAM
WATER CONTROL



H104_9014DC

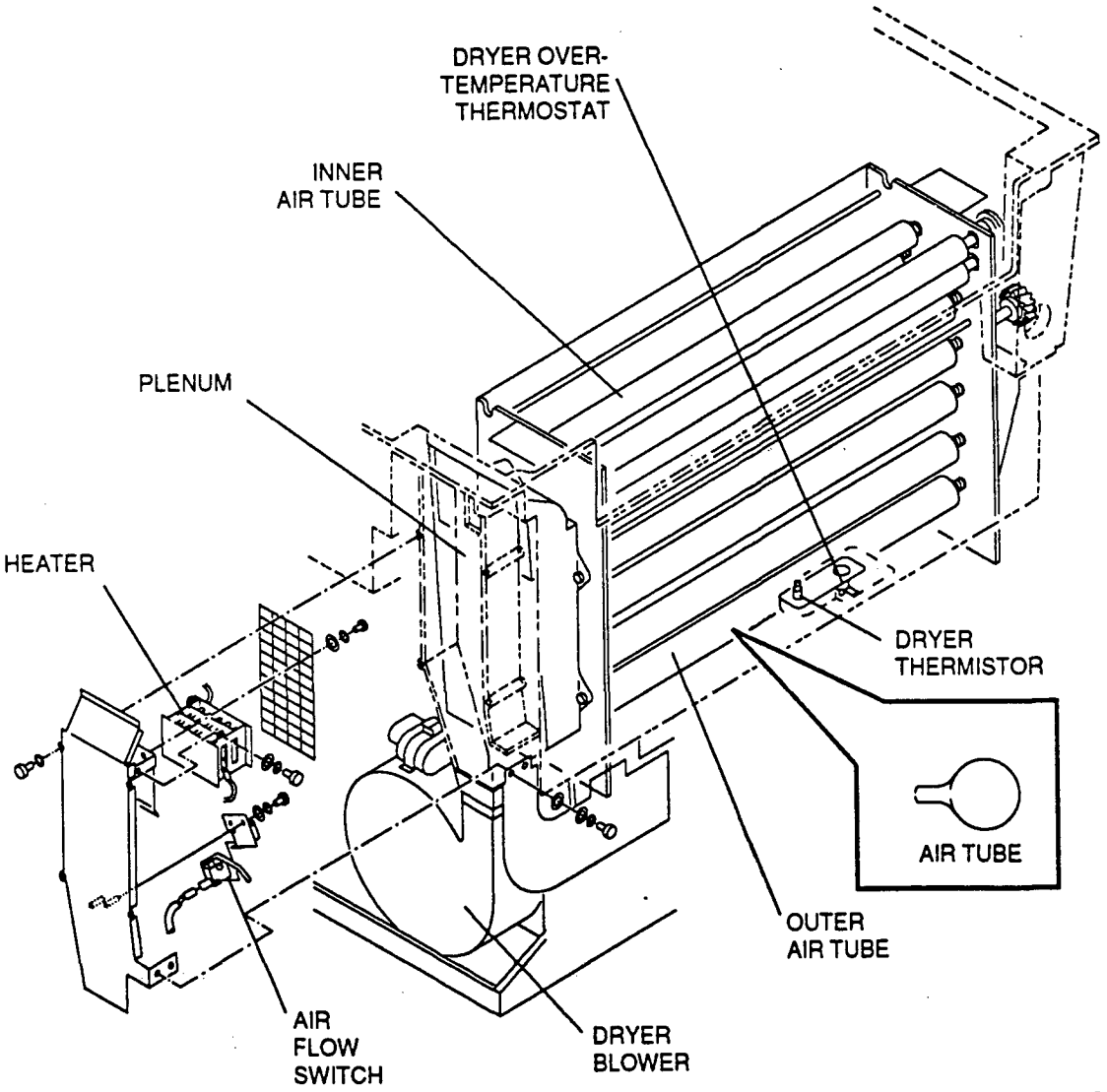
Dryer

As the film leaves the wash tank, it passes into the dryer rack. The squeegee rollers in the dryer rack remove any remaining droplets of water across the film surface to encourage faster drying time and eliminate water spots.

The film then enters the vertical transport of the dryer, where inner and outer air tubes circulate hot air across the film. The air tubes are located on both sides of the dryer. This means that both sides of the film are dried at the same time.

The dryer blower motor provides the air supply for the air tubes. The blower energizes when film is detected by the Multiloader 300. A dryer heater heats the air to a temperature within 32 - 68°C (90 - 155°F). The temperature in the dryer is sensed by a thermistor, and can be adjusted in 1°C (or 1 °F) increments through the display panel. For more information about the operation of the thermistor, see page 39.

The Processor has an overtemperature thermostat. If the temperature becomes excessive, the overtemperature thermostat will shut off the dryer heater. The thermostat must be manually reset before the heater can operate again.



H104_0474DCA
H104_0474DA

Dryer Temperature Control

The temperature of the air is determined by converting the resistance of the dryer thermistor into temperature. This value is then compared to the setpoint.

The dryer blower and heater will cycle on and off while in the standby mode. The dryer blower and heater will remain off for 45 seconds if the transport speed is greater than 50 inches per minute. If the transport speed is less than 50 inches per minute, the dryer blower and heater will remain off for 4 minutes. Then the blower will energize and 5 seconds later, the temperature is checked. If the temperature is below the setpoint, the heater energizes and stays on until the setpoint is reached. Once the setpoint is reached, the heater and blower deenergize and the cycle is repeated. The heater operates at different duty cycles, depending on the difference between the setpoint and the detected temperature. The heater stays on full when the temperature is more than 0.6°C (1°F) below the setpoint. If the temperature of the dryer is less than 0.6°C (1°F) below the setpoint, the dryer heater will cycle on and off with a 90% duty cycle. If the temperature of the dryer is less than 0.6°C (1°F) above the setpoint, the dryer heater will cycle with a 25% duty cycle.

During normal operation (when the Processor is not in standby mode), the dryer blower runs continuously.

The dryer temperature is not displayed. The setpoint is available on the Multiloader display panel and can be changed in increments of 1°C (or 1°F).

Temperature Control Errors

The temperature control function checks for the following errors:

Dryer Overtemp Data Error (E002)

If the dryer temperature exceeds the maxiumum value of the A/D converter (approximately 74°C or 165°F), an overtemperature condition exists. The error E002 will be displayed, and the Processor will shutdown after the last film exits.

Loss of Dryer Airflow or Dryer Overtemperature Thermostat (E005)

An error E005 will be displayed if either of the following conditions occur:

- The dryer airflow is not sufficient.
- The dryer temperature exceeds approximately 74°C (165°F) and the overtemperature thermostat opens.

Unable to Determine Dryer Temperature (E036)

If the thermistor is not working correctly, an E036 will be displayed (if it is the highest priority error). This error cannot be cleared unless the Processor is deenergized and then energized again. For more information about this condition, see the thermistor control section on page 39.

Inoperative Dryer Error (E040)

The rate at which the air in the dryer is heated is checked. The minimum acceptable heating rate is an increase of 0.28°C (0.5°F) every 2 minutes. If the rate is not correct, the error E040 will be displayed (if it is the highest priority error).

The heat rate error is only checked when:

- the dryer heater is operating
- film is not present in the Processor
- after initialization is completed at power-up

Dryer Under Setpoint Temperature Warning (E134)

If the dryer setpoint temperature is changed to a higher value, this error will be displayed until the new setpoint is reached.

Dryer Temperature Control Circuit

For more detailed information on the electrical circuit that controls the dryer components, see the AC and DC circuit diagrams at the end of this theory guide.

NOTE

Relays that are designated with a K5 (for example, K501) are electromechanical relays, which are mounted on the 500 circuit board. Relays that are designated with SSR (for example, SSR U3) are solid state relays, which are mounted in the electrical box.

When the Processor leaves standby mode, the following events occur:

(1) Relay K502 is energized, turning on the dryer blower.

(2) The dryer blower creates air flow, which actuates the air flow switch S3.

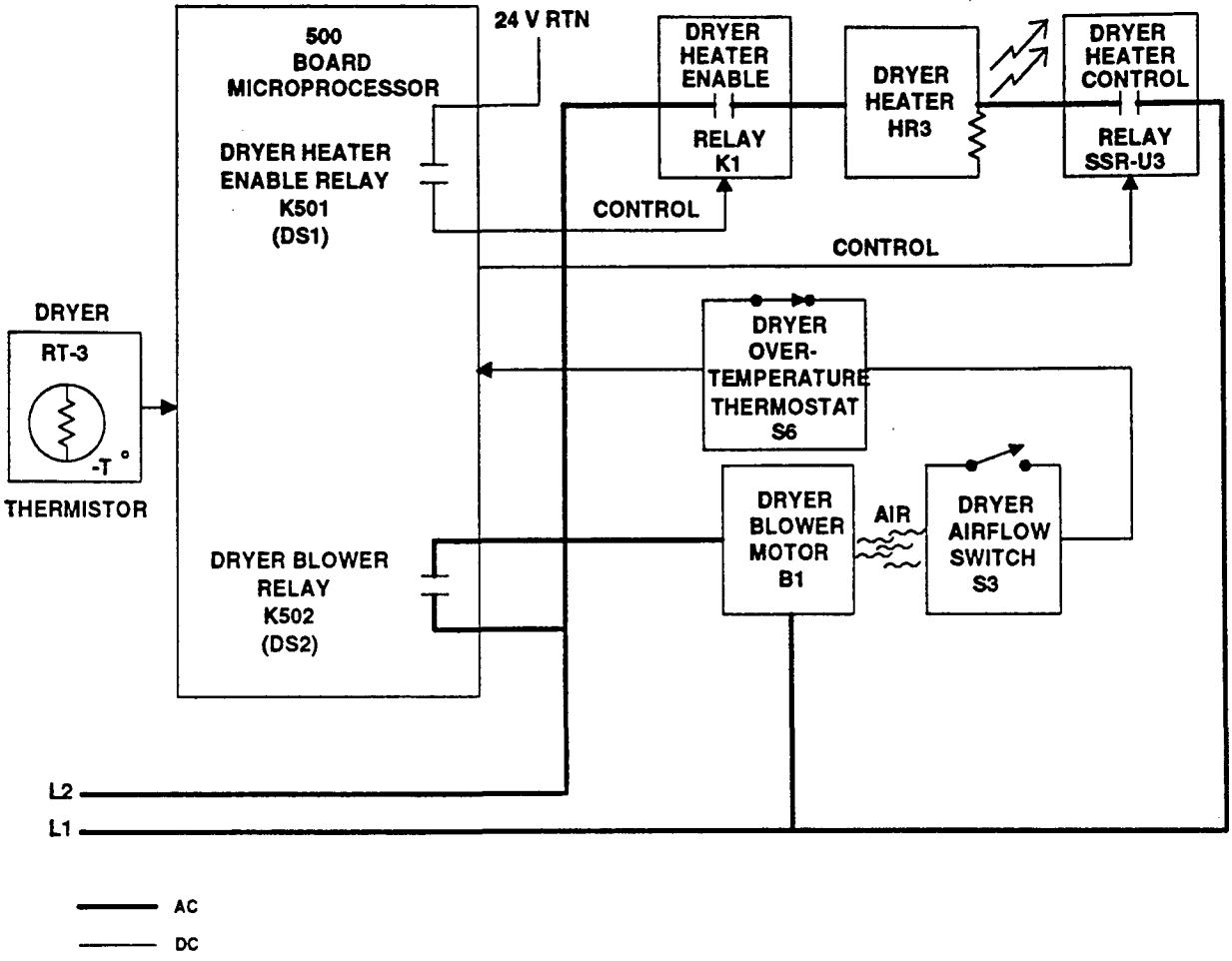
(3) The actuation of the air flow switch in combination with a signal from the microprocessor energizes the dryer heater enable relay K501.

(4) Relay K501 energizes relay K1, which enables the dryer heater HR3.

The microprocessor will now react to the temperature input that is received from the dryer thermistor. If the dryer temperature is below the setpoint, the microprocessor applies DC voltage to the dryer heater control relay U3. When the relay energizes, the dryer heater turns on. The dryer heater operates continually, but at different duty cycles, depending on the difference between the detected temperature and the setpoint. The heater stays on full when the temperature is more than 0.6°C (1°F) below the setpoint. If the temperature of the dryer is less than 0.6°C (1°F) below the setpoint, the dryer heater will cycle on and off with a 90% duty cycle. If the temperature of the dryer is less than 0.6°C (1°F) above the setpoint, the dryer heater will cycle with a 25% duty cycle. The dryer blower operates continuously, as long as the Processor is not in standby mode.

A dryer overtemperature thermostat S6 is installed in the dryer to protect the Processor in case the dryer heater circuit malfunctions. The overtemperature thermostat is wired in series with the dryer air flow switch. If the dryer temperature exceeds approximately 74°C (165°F), the dryer overtemperature thermostat will electrically open and will deenergize relay K501. This in turn will deenergize relay K1 and turn the dryer heater off.

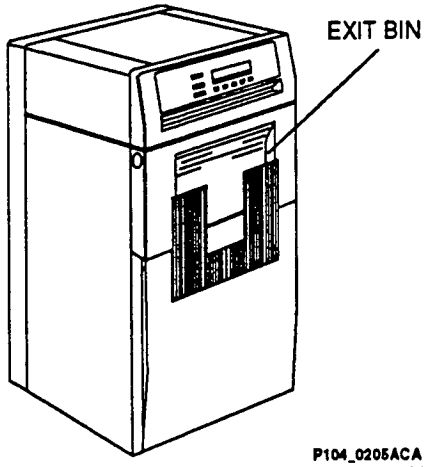
BLOCK DIAGRAM
DRYER TEMPERATURE CONTROL



H104_9025DC

Exit

As the film leaves the dryer, it passes into the exit bin on the Multiloader 300.



P104_0205ACA
P104_0205AA

Standby Mode

If no new film enters the Processor, the Processor will enter the standby mode approximately 15 seconds after a film has exited. Because the Processor does not have an exit detector, the software determines when the film has exited, based on the transport speed and length of the film path.

There are two types of standby mode, Continuous and Interval. The customer selects the desired standby mode through the Multiloader 300 display panel.

The following events occur when the Processor enters the standby mode:

(1) The water supply, unless needed for developer cooling, remains off.

(2) The developer and fixer temperature is maintained at the setpoint.

(3) The dryer temperature is maintained at the setpoint. The dryer heater and blower will cycle on and off. During each cycle, the blower activates and the dryer temperature is read. If the temperature is below the setpoint, the heater and blower are turned on until the temperature reaches the setpoint. The heater and blower will then turn off and remain off for 45 seconds or 4 minutes, depending on the transport speed. Then the cycle will be repeated.

(4) The drive motor operation changes, depending on the type of standby mode selected by the operator through the display panel. See the following descriptions.

Continuous Standby Mode

The drive motor remains energized, but operates at a very low speed (20 inches per minute) after the film has exited.

Interval Standby Mode

The drive motor is energized for 90 seconds after every 8 minutes of Processor inactivity to allow wetting of the crossover rewet rollers. Then:

(1) The drive motor turns on and runs at the set speed.

(2) The wash water turns on.

(3) The 90-second timer begins. When the 90-second timer expires:

a. The drive motor turns off.

b. The water shuts off.

c. The 8-minute timer begins to initiate the cycle again.

The Processor will automatically exit the standby mode and enter the operating mode when film is detected by the film detector.

SECTION 5
Replenishment

While film is being processed, the chemicals in the developer and fixer solutions are absorbed into the film. This results in a depletion of chemicals in the tank. New chemicals, therefore, must be added periodically to maintain an effective level of chemical activity.

In this Processor, developer and fixer solutions are replenished automatically to maintain the correct chemical activity and level of solutions in each tank. Two pumps, one for developer and one for fixer, pump new solution from external containers that are connected to the Processor. The new solutions are pumped directly into the developer and fixer tanks where they enter the recirculation system.

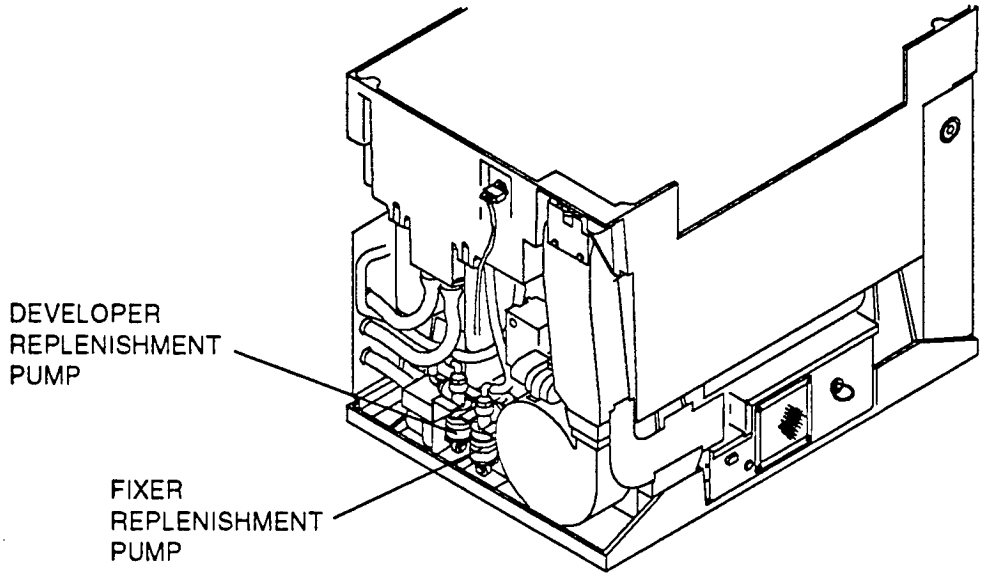
The replenishment pumps can be disabled to allow maintenance of the Processor. There are 2 methods of disabling the replenishment pumps:

- **Pulling the Processor out of the Multiloader 300**

  This disables the replenishment pumps and displays the error code E128.

- **Activating the disabling function**

  This disables the replenishment pumps also. An error code (E130) will be displayed when the pumps are disabled using this function.



P104_0248BCA
P104_0248BA

Replenishment Modes

The Processor offers 2 types of replenishment, which can be selected by the operator through the Multiloader 300 display panel. Both replenishment modes use the film area sent by the Multiloader 300 to calculate replenishment needs.

- **Auto Replenishment Mode**

  This is the standard replenishment mode of the Processor. In this mode, replenishment will occur under 2 conditions:

  - The replenishment cycle is activated each time approximately 1500 cm^2 (238 $in.^2$) of film has been processed. This is equivalent to one 35 x 43 cm (14 x 17 in.) sheet of film. The amount of replenisher that is added for each 1500 cm^2 (238 $in.^2$) of processed film can be adjusted by the operator within a certain range. The default amounts are 60 mL of developer and 85 mL of fixer.
  - The Processor will also replenish to compensate for low film usage.

    Low-volume applications are those Processors that process less than 75 sheets of film in 24 hours (for continuous-run applications) or over 2 power-up cycles (where the last cycle is more than 3.5 hours). A low-volume application is further broken down, and different replenishment volumes are added accordingly for proper control:

Sheets on Current Film Count	Replenishment Added over 4 Hours
less than 55 sheets	1 litre (125 mL / ½ hour)
56 - 65 sheets	750 mL (93 mL / ½ hour)
66 - 74 sheets	400 mL (50 mL / ½ hour)

NOTE

The replenishment pumps will automatically turn on every half hour during the 4-hour period when extra replenisher is added. This is normal operating procedure; don't be alarmed.

- **Flooded Replenishment Mode**

  This mode activates the replenishment pumps so that a predetermined volume of developer and fixer will be added after every 5 minutes of operation and after approximately 1500 cm^2 (238 $in.^2$) of film has been processed. The amount of solution added to the tanks is predetermined in the software, and can be adjusted by the operator within a certain range. The flooded replenishment mode is intended for use in low-volume applications where 25 or fewer 35 x 43 cm (14 x 17 in.) sheets of film are processed per day.

Replenishment Calculation:

The on-time of the pumps is calculated by dividing the *flooded replenishment volume,* which is stored in memory, by the *replenishment pump flow rate.*

Filling the Developer and Fixer Tank

Solutions are also added to fill the tanks when necessary. There are 2 filling procedures, depending on the situation:

- **Topping Off the Tanks**

  This method is used when a low solution level is detected either during Processor initialization or normal operation. The corresponding replenishment pump is energized and solution is added to the tank. If the solution level is not correct within 4-minutes, a tank-fill error occurs.

- **Tank-Fill Mode**

  This method is used to fill an empty tank, which is usually necessary at Processor installation or after periodic maintenance has been performed.

  The tank-fill operation is activated through the Multiloader 300 display panel. When it is selected, the heaters, blower, and drive motor are disabled, and the appropriate replenishment pump activates. An error code (E129) is displayed while the tank-fill operation is in progress.

  The solution levels are checked constantly during the tank-fill operation. When the level sensor detects a correct solution level, the replenishment pump deenergizes, the error code E129 is removed, and the heaters, blower, and drive motor are enabled. If both tanks are not filled within 15 minutes, the pumps will deenergize and a tank-fill error will be displayed.

Replenishment Errors

The replenishment control checks for:

Developer Tank Fill Replenishment Error (E032) and Fixer Tank Fill Replenishment Error (E033)

These errors occur when the developer and fixer solutions do not reach the correct level within the allowed time limit (4 minutes when topping off the tanks, and 15 minutes during tank-fill mode). If a developer tank-fill error occurs, E032 will be displayed (if it is the highest priority error). If a fixer tank-fill error occurs, E033 will be displayed (if it is the highest priority error).

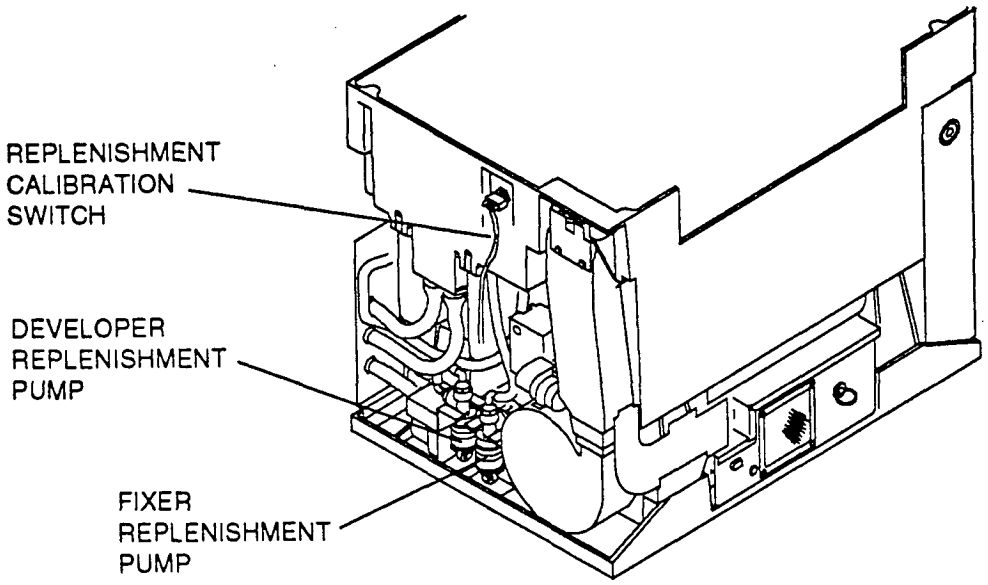
Calibration of the Replenishment Pumps

The flow of replenisher through the pumps is calibrated by the microprocessor. The operator or service person enables this function through the Multiloader 300 display panel or through the portable computer diagnostics. The replenishment calibration switch, which is on the inside of the processing tank, must be pressed and released to activate the selected replenishment pump. The pump turns on for a fixed time (approximately 5 seconds).

Now the operator measures the volume of solution and compares it to the amount of solution the Processor said it would output. This is displayed on the Multiloader 300 display panel. If they are the same, then the replenishment pump is calibrated correctly. If they are different, the operator enters the amount of solution output by the pump into the software via the display panel. The software then recalculates the actual flow rate of the pump.

NOTE

The volume measured during the calibration procedure is not the same as the replenishment volume added to the tank for a 35 x 43 cm (14 x 17 in.) film.



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P104_0248BA

Replenishment Control Circuit

The control circuit on the next page includes all the components and variables that activate the replenishment system. Like many other functions in the Processor, the processor-in switch must be actuated to enable the replenishment circuit.

After the processor-in switch is actuated, one of the following inputs will activate the replenishment circuit:

- **Multiloader 300**

  When 0.15 m^2 (238 $in.^2$) of film has been detected by the Multiloader 300, the microprocessor activates the replenishment circuit.

  The Multiloader 300 also tells the microprocessor if the flooded replenishment mode, tank-fill mode, or calibration mode has been selected by the user via the Multiloader 300 display panel. The microprocessor then activates the replenishment circuit when appropriate.

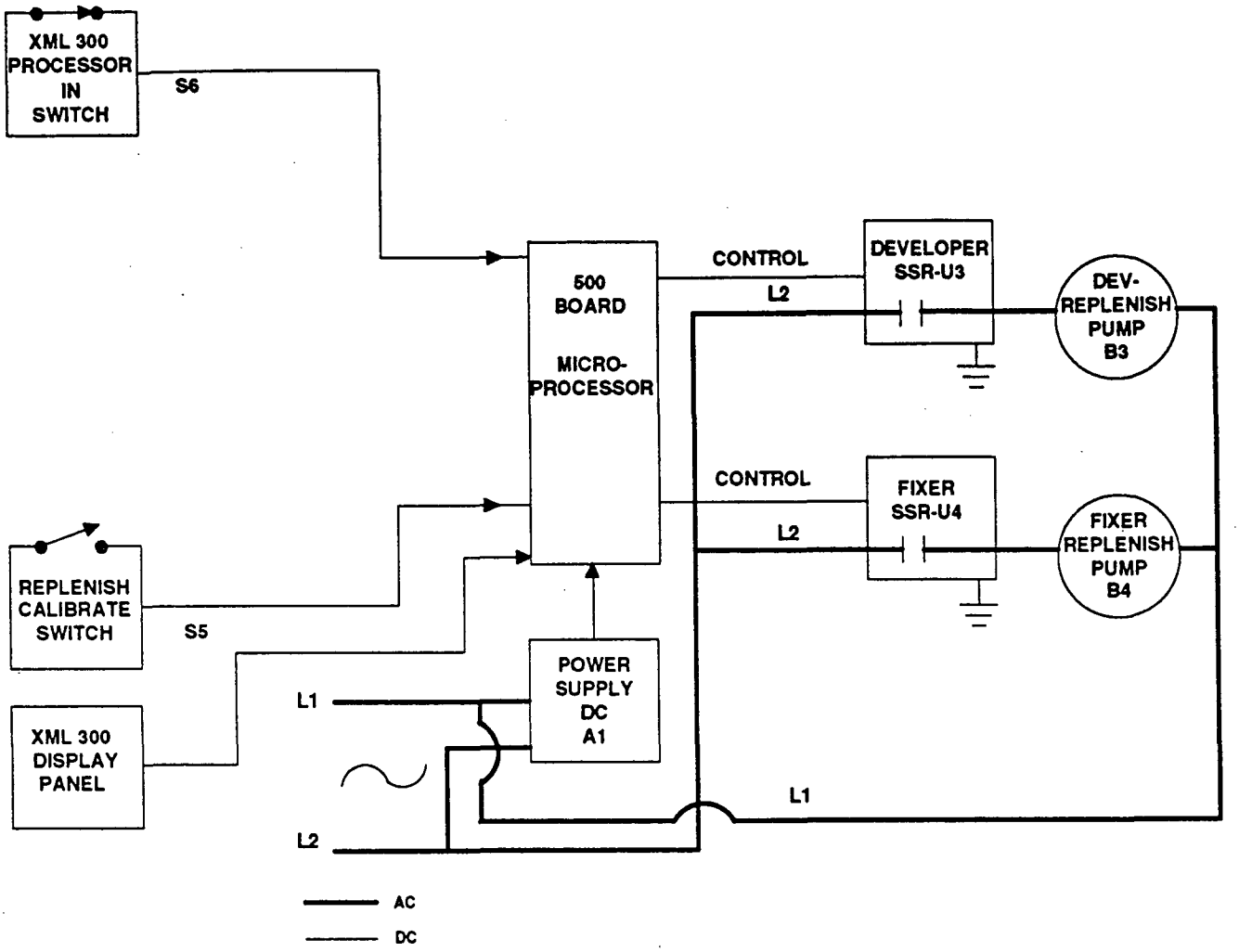
- **Replenishment Calibration Switch**

  If the calibration mode has been selected (through the Multiloader 300 display panel) and the replenishment calibration switch is actuated, the microprocessor activates the replenishment circuit.

To activate the replenishment circuit, the microprocessor sends DC voltage to the developer and fixer replenishment solid state relays U2 and U4. The relays energize, and AC voltage is supplied to the developer and fixer replenishment pumps. The pumps activate and the replenishment begins.

When the microprocessor determines that the appropriate amount of solution has been replenished, it removes the DC voltage to the solid state relays. This turns off the solid state relay, and the AC power is removed.

BLOCK DIAGRAM
DEVELOPER/FIXER REPLENISHMENT CONTROL



P104_9019DC

SECTION 6
Thermistors and Temperature Measuring

The temperature of the solutions and the dryer is determined on the microprocessor 500 circuit board by performing an analog to digital (A/D) conversion on the resistance of the thermistor. This data is then converted to a temperature by means of a software algorithm.

The Processor checks for 2 different malfunctions with the temperature circuit: wrong A/D temperature conversions and faulty thermistors. If one of these malfunctions occurs, the Processor will display one of the following errors:

- E034 Unable to determine developer temperature
- E035 Unable to determine fixer temperature
- E036 Unable to determine dryer temperature

The A/D temperature conversions are checked by reading a precision resistor on the 500 circuit board (instead of the thermistor) every ¾ second. If the A/D reads the precision resistor incorrectly for 5 consecutive readings, the A/D is considered to be inoperative.

If the A/D reading of the thermistors is outside of the allowed range for 5 consecutive readings, the thermistor is considered to be inoperative.

These checks are not performed until 5½ minutes after power-up. This delay prevents open thermistor errors due to cold solution temperatures brought on by a cold room ambient temperature.

SECTION 7
Power Distribution and Control

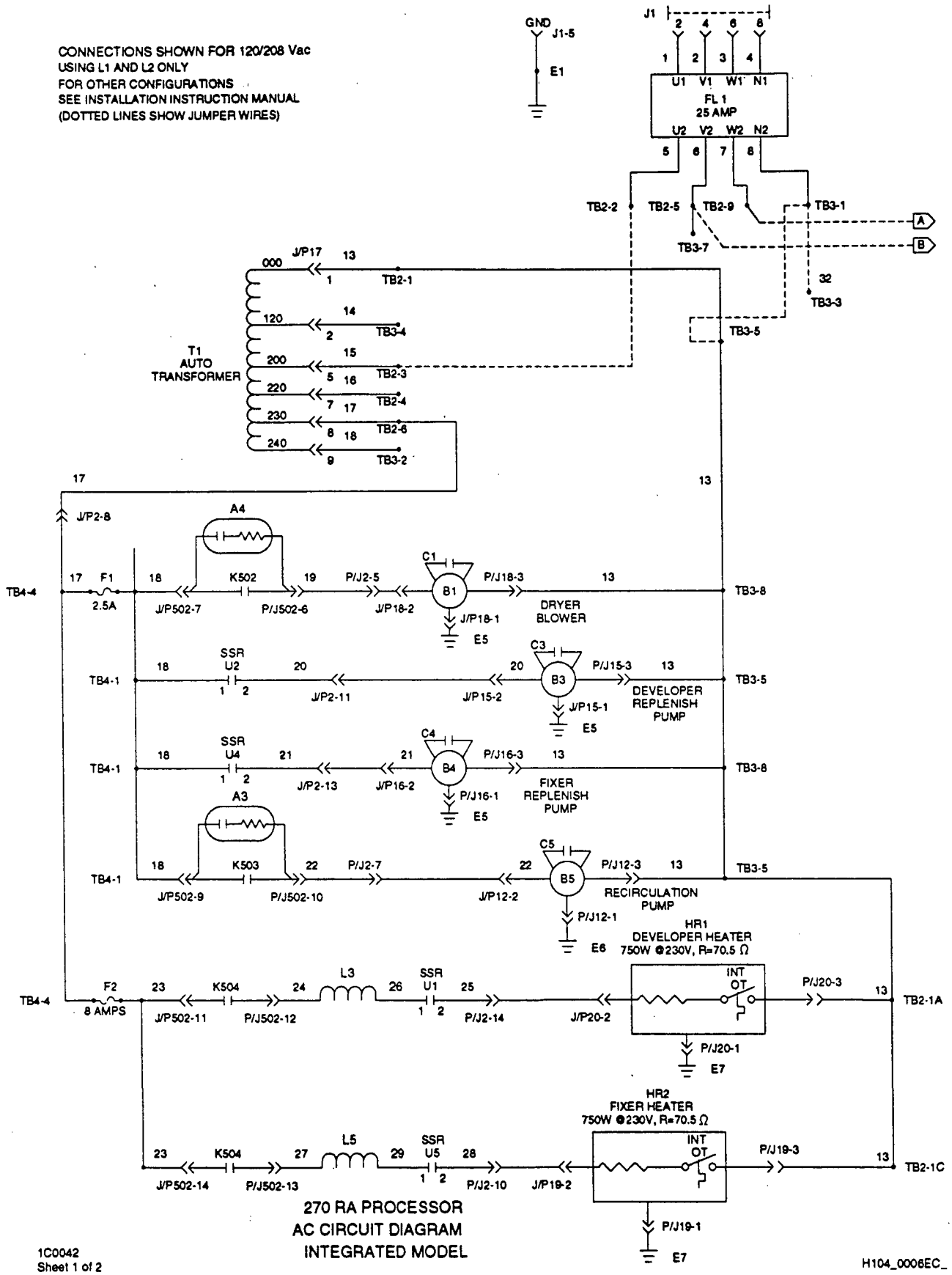
AC Distribution

The Processor runs on single-phase or 3-phase 200 - 240 V AC. The Site Specifications, Publication Part No. SS-3058, provides a complete list of all the various power configurations for which this Processor can be adapted.

The Processor uses AC power to operate all motors, except the drive motor, which uses 24 V DC.

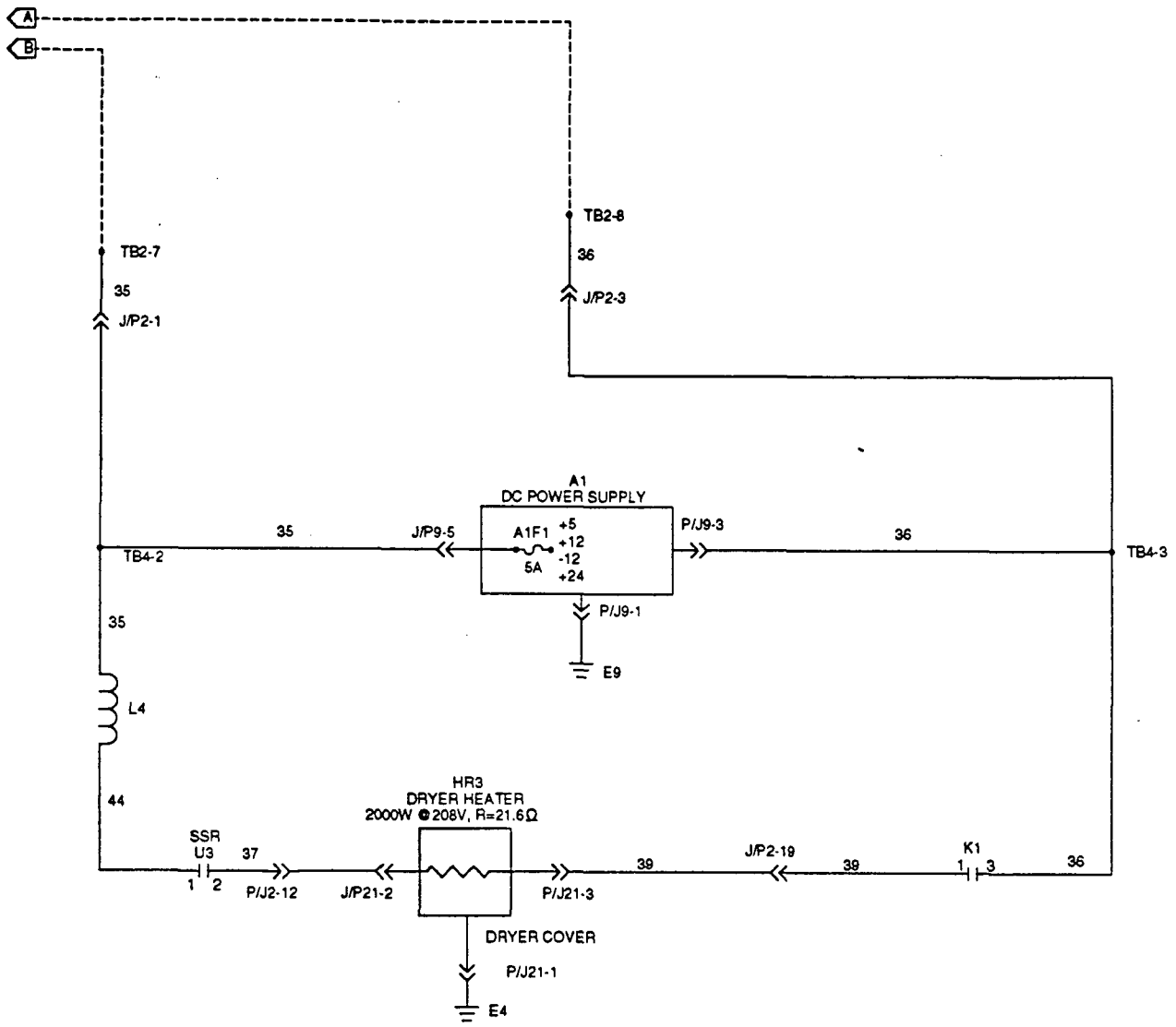
AC power also supplies the quad power supply, which converts the power into 4 DC voltages.

When the power enters the Processor, it is directed to a transformer. The transformer increases or decreases the incoming voltage and distributes the power to the components.



AC Circuit Diagram, Sheet 1 of 2

CONNECTIONS SHOWN FOR 120/208 Vac
USING L1 AND L2 ONLY
FOR OTHER CONFIGURATIONS
SEE INSTALLATION INSTRUCTION MANUAL
(DOTTED LINES SHOW JUMPER WIRES)



270 RA PROCESSOR
AC CIRCUIT DIAGRAM
INTEGRATED MODEL
H104_0007EC_

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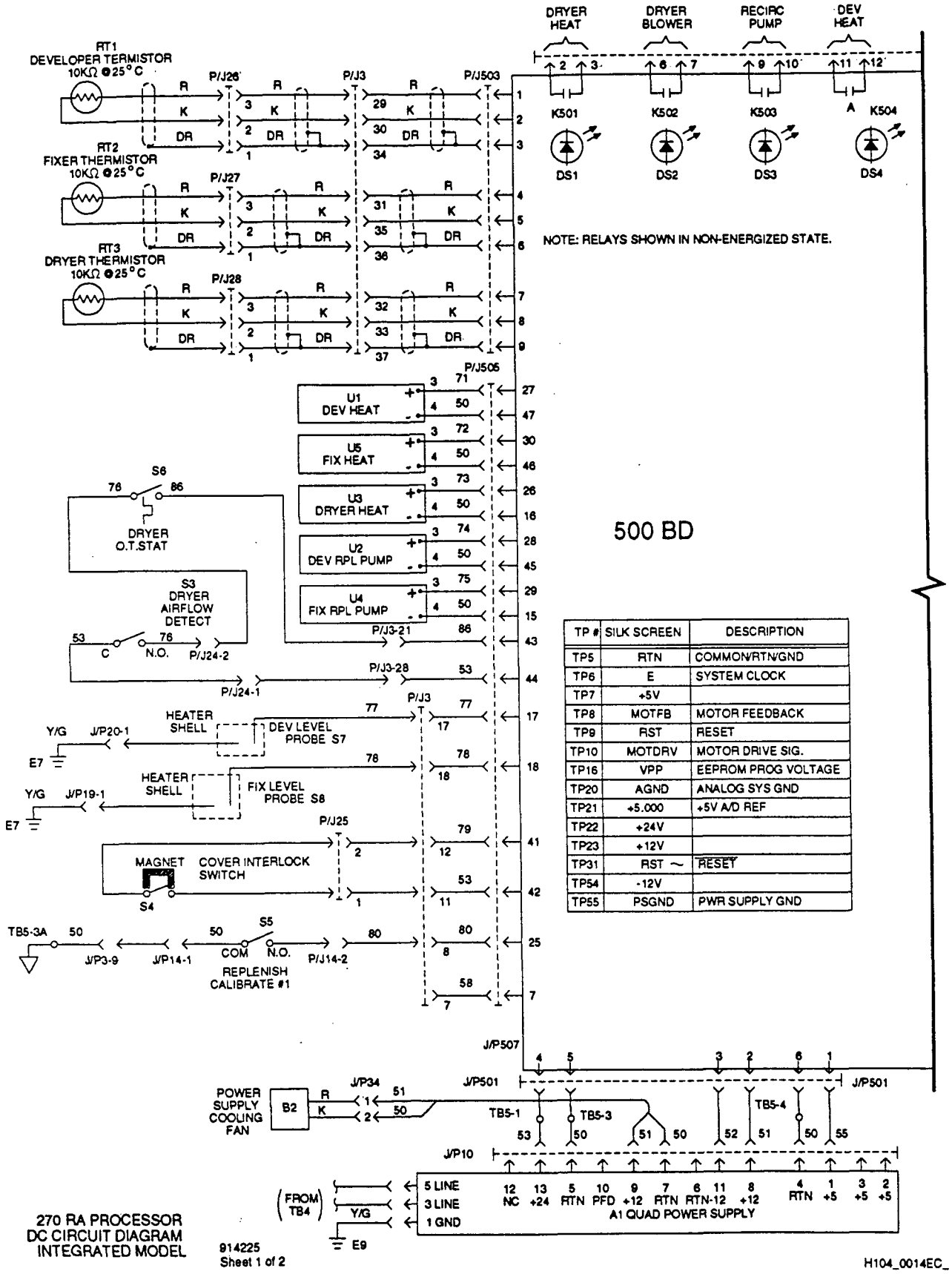
Sheet 2 of 2

AC Circuit Diagram, Sheet 2 of 2



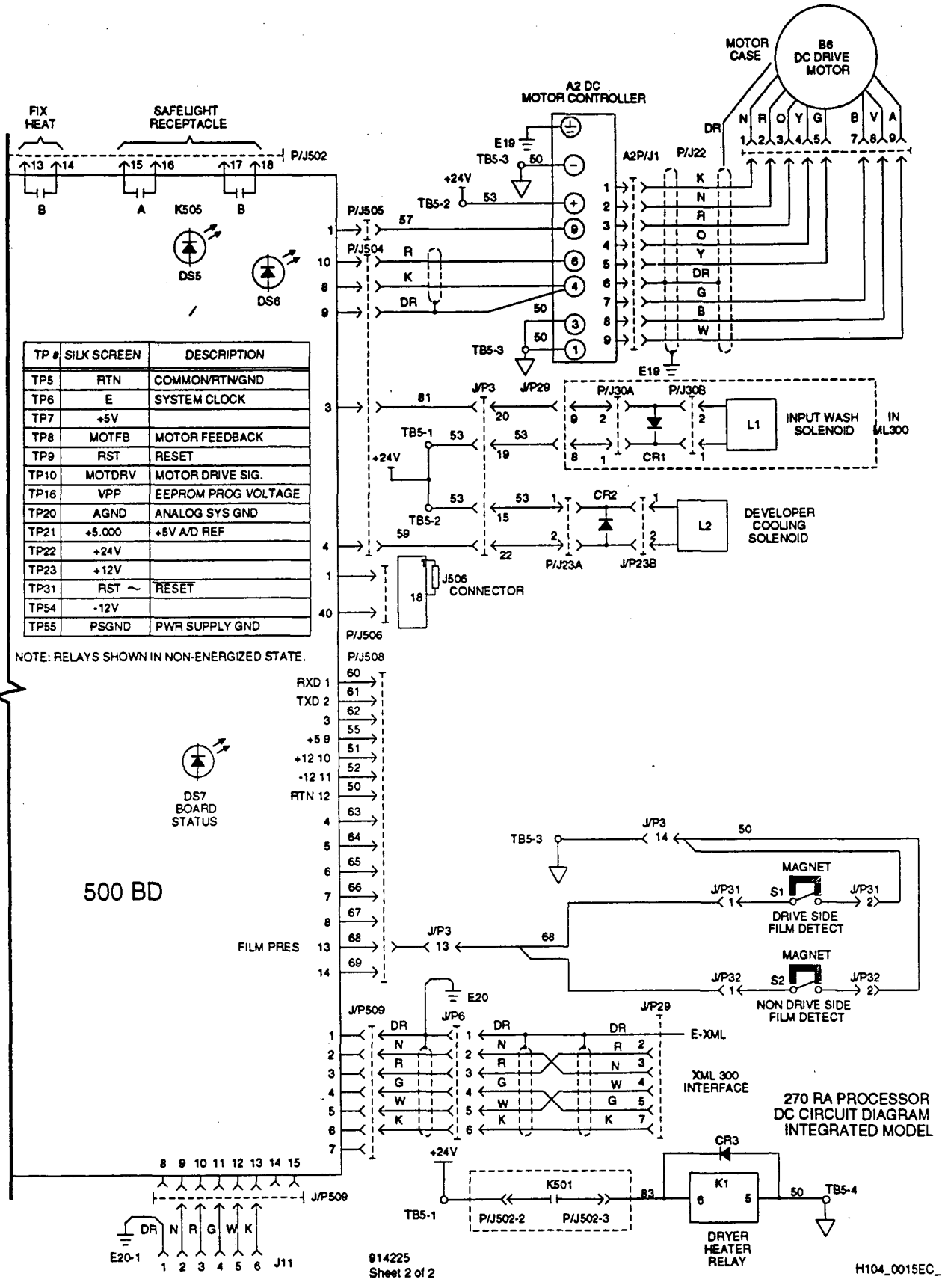
TP #	SILK SCREEN	DESCRIPTION
TP5	RTN	COMMON/RTN/GND
TP6	E	SYSTEM CLOCK
TP7	+5V	
TP8	MOTFB	MOTOR FEEDBACK
TP9	RST	RESET
TP10	MOTDRV	MOTOR DRIVE SIG.
TP16	VPP	EEPROM PROG VOLTAGE
TP20	AGND	ANALOG SYS GND
TP21	+5.000	+5V A/D REF
TP22	+24V	
TP23	+12V	
TP31	RST ~	RESET
TP54	-12V	
TP55	PSGND	PWR SUPPLY GND

270 RA PROCESSOR
DC CIRCUIT DIAGRAM
INTEGRATED MODEL

914225
Sheet 1 of 2

H104_0014EC_

DC Circuit Diagram, Sheet 1 of 2



TP #	SILK SCREEN	DESCRIPTION
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TP9	RST	RESET
TP10	MOTDRV	MOTOR DRIVE SIG.
TP16	VPP	EEPROM PROG VOLTAGE
TP20	AGND	ANALOG SYS GND
TP21	+5.000	+5V A/D REF
TP22	+24V	
TP23	+12V	
TP31	RST ~	RESET
TP54	-12V	
TP55	PSGND	PWR SUPPLY GND

NOTE: RELAYS SHOWN IN NON-ENERGIZED STATE.

DC Circuit Diagram, Sheet 2 of 2

DC Distribution

The quad power supply supplies the DC voltages used in the Processor. It converts the incoming AC voltage into +5, +12, -12, and +24 V DC. This voltage is distributed to the following components:

- **500 Circuit Board**
- **Drive Motor (+24 V DC)**

  The quad power supply provides +24 V DC through F2 to the drive motor controller. The 500 circuit board then sends 0 - 6 V DC to the drive motor controller circuit board. The voltage varies, depending on the required speed of the drive motor.

  The drive motor controller circuit board provides 2 functions:

  It controls the drive motor speed.

  It sends feedback pulses to the 500 circuit board indicating the speed of the drive motor. The 500 circuit board uses this information to increase or decrease the speed of the motor until it is correct.

- **Solid State Relays (+5 V DC)**

  The 500 circuit board switches 5 volts on or off to control 5 solid state relays. The solid state relays energize the following components:

  SSR-U1 - developer heater
  SSR-U2 - developer replenishment pump
  SSR-U3 - dryer heater
  SSR-U4 - fixer replenishment pump
  SSR-U5 - fixer heater

- **Electromechanical Relays (+24 V DC)**

  The 500 circuit board switches 24 volts on or off to control 6 electromechanical relays. The relays energize the following components:

  K501 - dryer heater enable
  K502 - dryer blower enable
  K503 - recirculation pump
  K504 - developer and fixer heaters enable
  K506 - drive motor controller

  NOTE

  The Processor uses the electromechanical relays mainly as enable relays and the solid state relays as control relays. For example, the developer heater is enabled by K504, but SSR-U1 actually controls the developer temperature.

Customer Equipment Services Division

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