IBM Technical Newsletter

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IBM 5415 Processing Unit
Models A and B
Theory-Maintenance Diagrams

This Technical Newsletter provides an Appendix B for the subject publication. This TNL is for World Trade distribution only and is not to be obsoleted with the next revision to the base manual. Pages to be inserted are:

Appendix B

Summary of Amendments

This TNL provides a description of the 5203 World Trade only RPQ Y91479.

Note: Please file this cover letter at the back of the manual to provide a record of changes.

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Appendix B. 5203 World Trade Only RPQ Y91479

CONTENTS

5203 Printer Attachment Changes

5415 Power Supply Changes

5203 PRINTER ATTACHMENT CHANGES FOR WORLD TRADE ONLY RPQ Y91479

General Description

The 5203 attachment in 5415 WT RPQ works exactly as the 5203 attachment in 5410 except OP END interrupt (interrupt level 5) and Unit Record Restart feature (interrupt level 6) which are added to fit the capability of 5415.

Notice that the Dual Feed Carriage feature is not supported by this RPQ.

The interrupt request occurs as a result of the following conditions:

1. Printing is accomplished - PRINT FL is turning off.
2. Carriage movement is finished - CARRIAGE BUSY is turned off.
3. NO OP condition is set by SIO instruction because of the error check in previous print cycle. Note that Interrupt SIO does not set NO OP condition latch.
4. The SIO skip or SIO space command is issued but carriage movement is inhibited; i.e. space = 0, space more than 3 lines, skip to the line which is already in alignment.

The following two instructions are implemented by this RPQ.

1.) SIO Interrupt Control

Start I/O (n code=011) is available for enabling, disabling, and/or resetting interrupt requests. This instruction is accepted unconditionally; i.e. during busy, not ready conditions. The instruction format is shown below.

Function	Op Code	DA	M	N	Control Code
SIO Interrupt Control	F3	1110	0	011	See Below

Control Code

Function	0	1	2	3	4	5	6	7
Enable Interrupt	1	Y	Y	X	X	X	X	X
Disable Interrupt	0	Y	Y	X	X	X	X	X
Reset Interrupt (Buffer Busy)	Y	1	Y	X	X	X	X	X
Reset Interrupt (Carriage Busy)	Y	Y	1	X	X	X	X	X

X - Don't Care - should be zero.
Y - Can be one if multiple interrupt control functions are desired, otherwise must be zero.

2.) Test I/O on Interrupt Pending

Operation End Interrupt Pending condition can be tested by use of a TIO (n code=011) instruction. The instruction format is shown below.

Function	Op Code	DA	M	N	Branch to Addr.
TIO Interrupt Pending	Z1	1110	0	011	

Note that additional information as to causes of interrupt requests by the 5203 attachment may be tested with existing instructions.

TIO	Z1	E2	Printer Busy
TIO	Z1	E4	Carriage Busy
SNS	Y0	E3	No Op (Byte 2, Bit 7)

Interrupt Control Instructions

			Cond A	Cond B
N≠3	Determined by 5410 attachment logic			
N=3	SIO	Unconditionally Accepted	0	1
	TIO	Interrupt Pending	1	0
		Interrupt not Pending	0	1

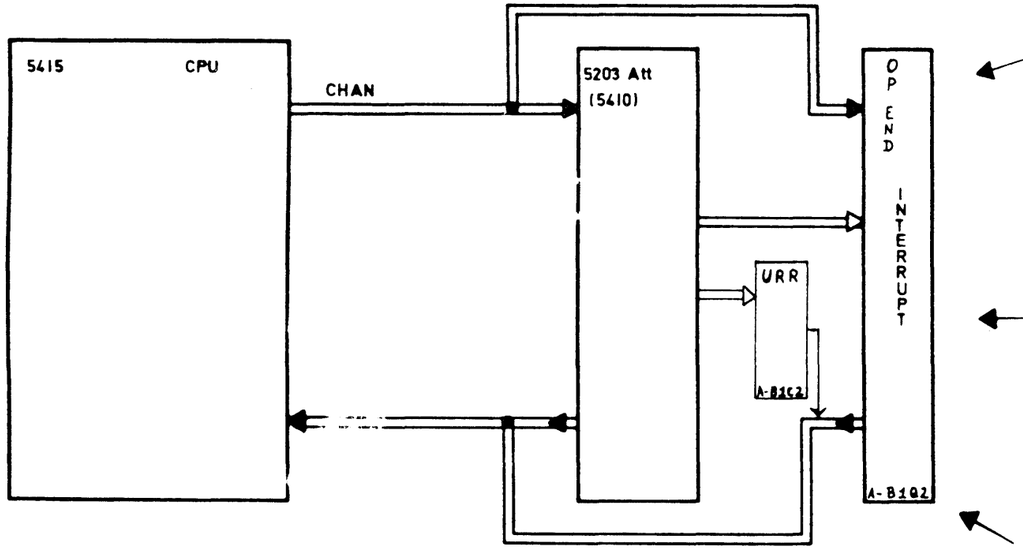
The decoded SIO N3 signal is used to inhibit setting of NO OP latch in attachment and as a set-reset signal of interrupt control latches.

INTERRUPT REQUEST - CIRCUIT OBJECTIVES

All logic is assembled on one MST card placed on printer attachment board 01A-B1 in position Q2. The data flow is shown below.

Be aware that the interrupt logic is added to the logic of the 5203 attachment. If you unplug the card Q2, the attachment works in the same mode as on the System/3 Model 10 except for the cycle steal priority and cycle steal assignment.

The decoder register is set every I/O cycle at 'sample DPO cl 5' time. The outputs of the register are decoded to determine the channel condition A or B for SIO and TIO with N = 3 code.



The Interrupt-card presents Operation End request on level 5.
This request occurs as a result of the following conditions:

1.) Printing is accomplished - PRINT FL is turning off.
2.) Carriage movement is finished.- Carriage Busy is turning off.
3.) NO-OP condition is set by SIO instruction because of the error check in previous print cycle. Note that Interrupt SIO does not set the NO-OP condition latch.
4.) The SIO-skip or SIO-space issued but carriage movement is inhibited. (Example: Space=0, space>3, skip to the line which is already aligned).

CYCLE STEAL REQUEST

The Cycle Steal Request and Assignment is changed according to the table shown below.

		5203 on M10	5203 on M15
CYCLE STEAL REQUEST	CSR BUS LINE	5	7
	CPU clock-cycle	6	6
CYCLE STEAL ASSIGNM.	DBO BIT	5	7

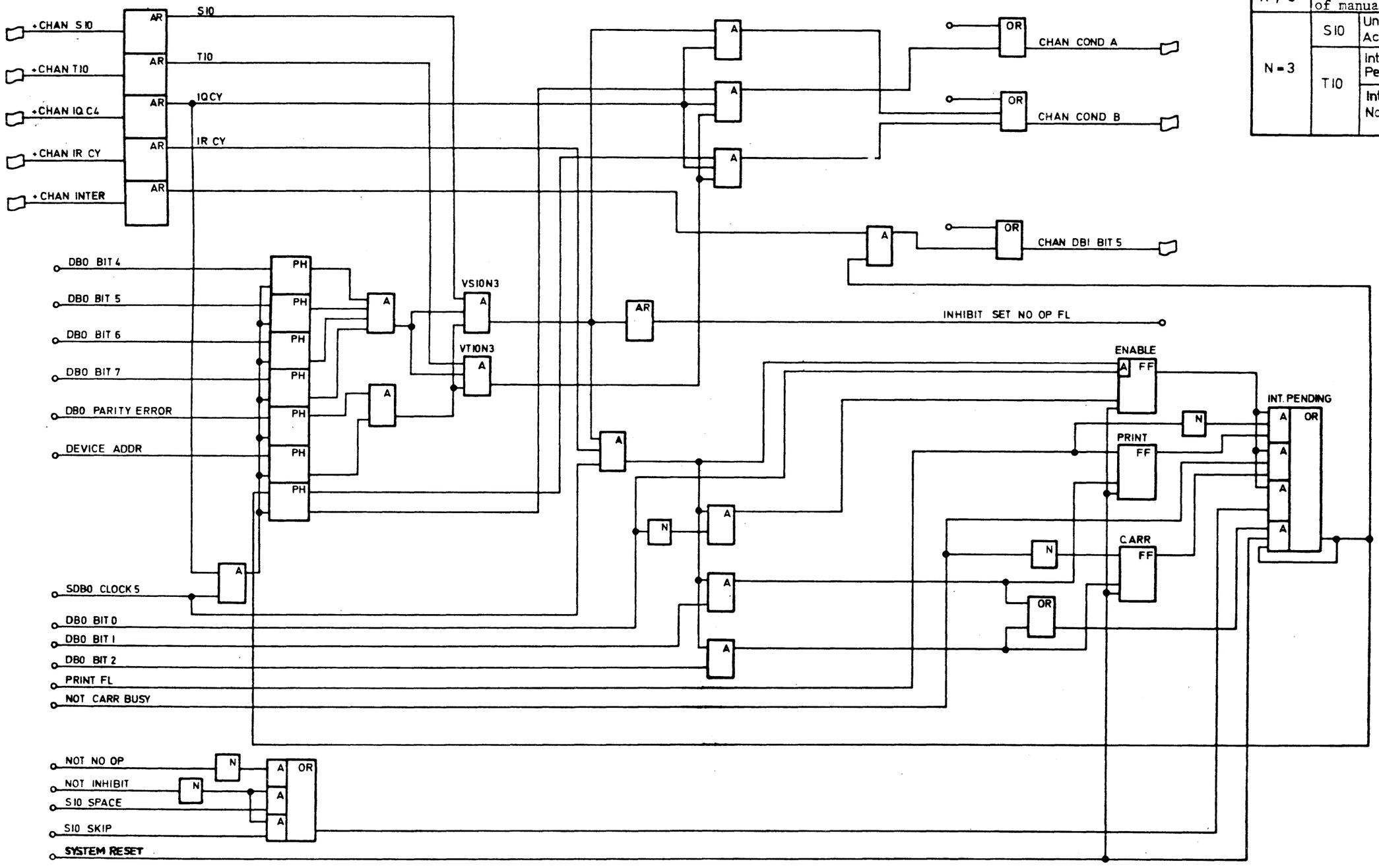
UNIT RECORD RESTART (URR)

Unit record restart feature is added to 5410 printer attachment logic. If enabled the interrupt in level 6 occured when 5203 printer is going from not ready to ready.

5203 Printer attachment on System 3 model 15 (RPQ)

INTERRUPT REQUEST

N Field			COND A	COND B
N ≠ 3	See pages 5-310 to 5-380 of manual SY31-0240			
N = 3	S10	Uncond. Accepted	0	1
	T10	Interrupt Pending	1	0
		Interrupt Not Pending	0	1

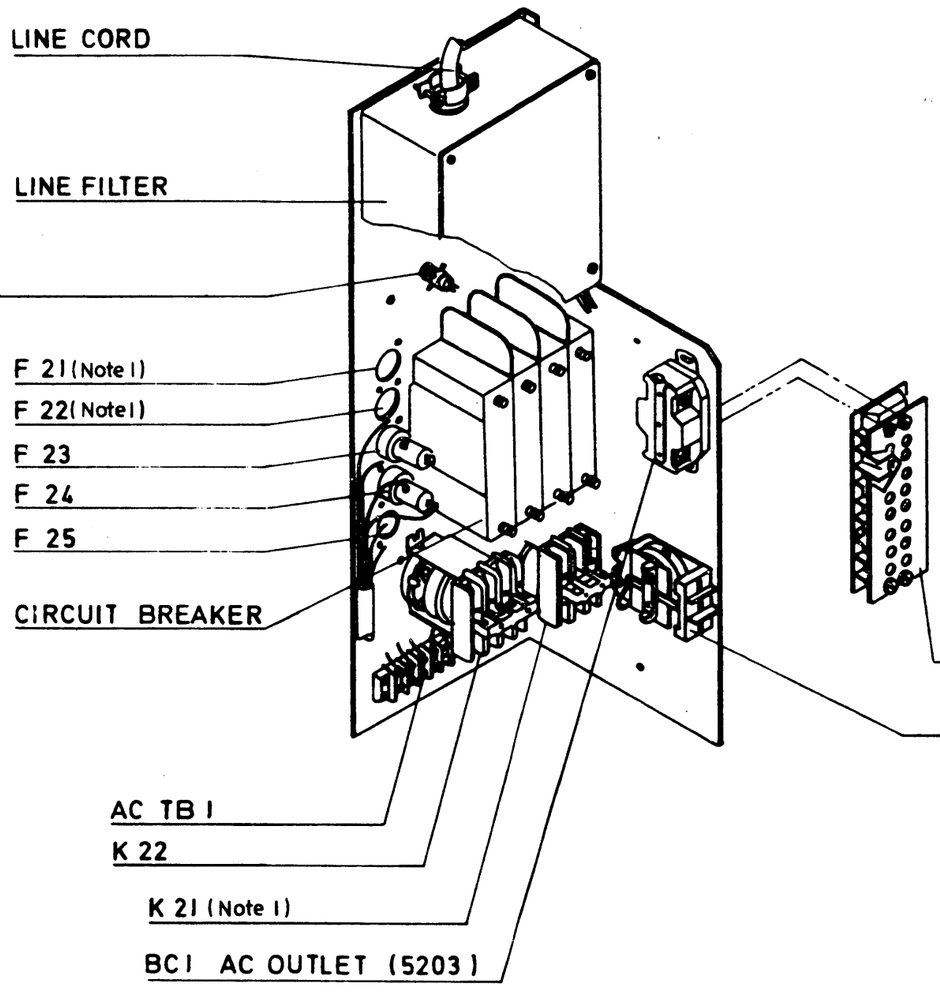


RPQ Y91479

AC Control Box (YB 099)

The ac control box serves as an entry point for the ac line cord. It houses line filters, a master circuit breaker, and two contactors for ac sequencing.

This AC Box is located in 5203 Printer Power Distribution and Supply frame



FAULT INDICATOR
Indicates when PSR is not picked

K 22 5203 AC supply
K 22 distributes ac power to the +60V printer power supply and all 5203 motor contactors.
It is picked by CPU I/O power on signal.

K 21 2560 AC supply
K 21 distributes ac power to the 2560 MFCM for 60Hz machines only. It is picked by CPU I/O power on signal.

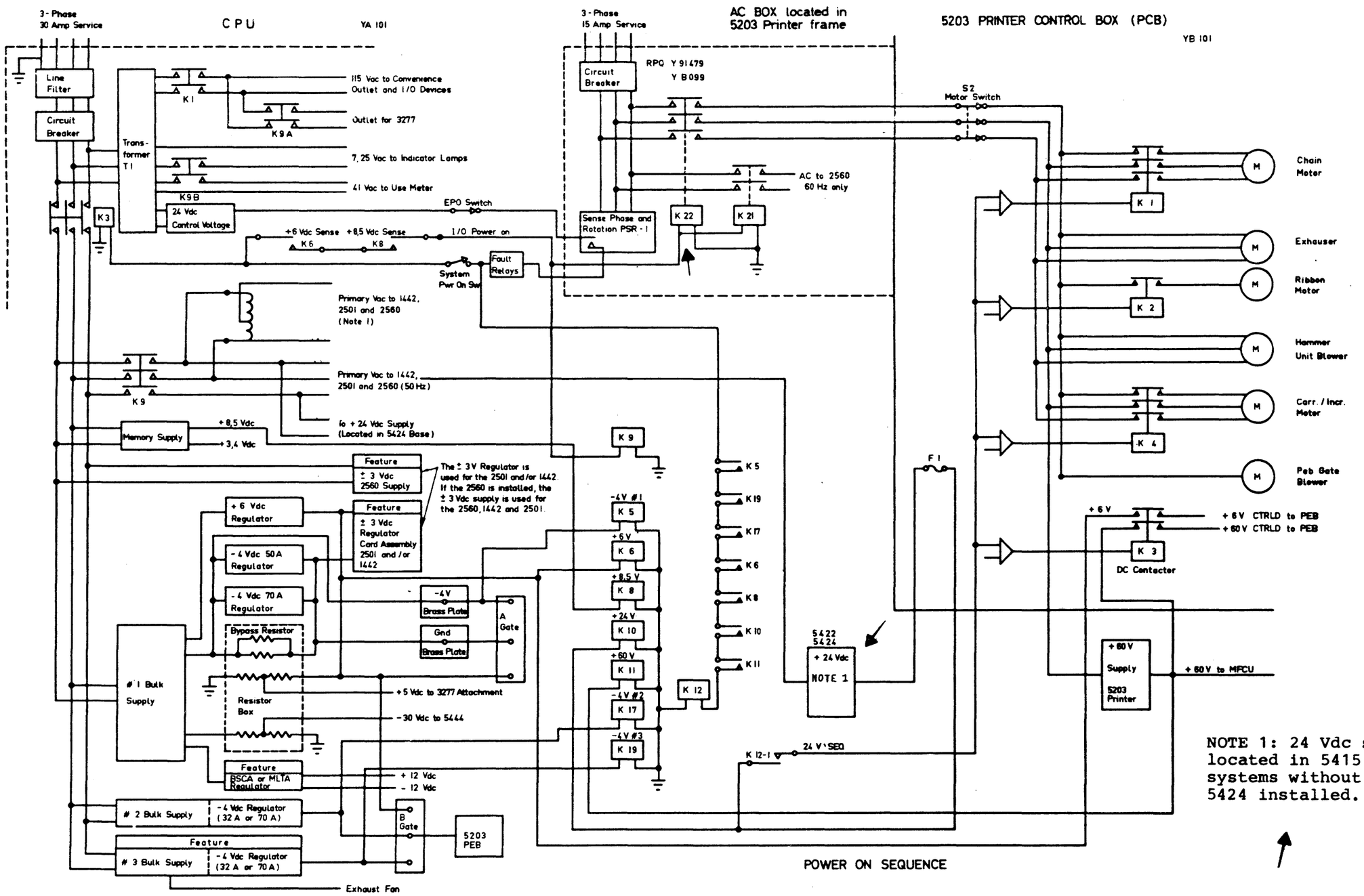
Phase Sense Relay (PSR)

PSR monitors the ac line cord at the output of the master circuit breaker. The PSR has two funcitons: 1) sense that voltage is present on each phase of the customers power source and 2) that they are in the correct phase sequence. The PSR will not pick if the above conditions do not exist. The System/3 emergency power off (EPO) circuit is fed through the PSR points. When this circuit is not completed the system will not power up. The ac power fault indicator is turned on.

NOTE 1

60 Hz installation only

AC CONTROL BOX WIRING DIAGRAM



POWER SUPPLY
(VALID FOR 5203 INSTALLATION)
INTRODUCTION (Part 1 of 2)

AC/DC Voltage

AC POWER

A The 5415 CPU supplies primary ac input power to the following devices:

1442 Card Read/Punch
2501 Card Reader
2560 MFCM (50 Hz – 220 Vac and above)
3277 Display
5415 Power Supplies
5422 Disk Drive Enclosure
5424 MFCU
5444 Disk Drives

B The RPQ Y91479 supplies primary ac power to the 5203. It also supplies primary ac power for the 2560 when the input power is 60 hertz or 50 hertz (200 Vac).

DC POWER

A The following dc voltages are used by the 5415 CPU:

- Voltages (dc) developed within the CPU:

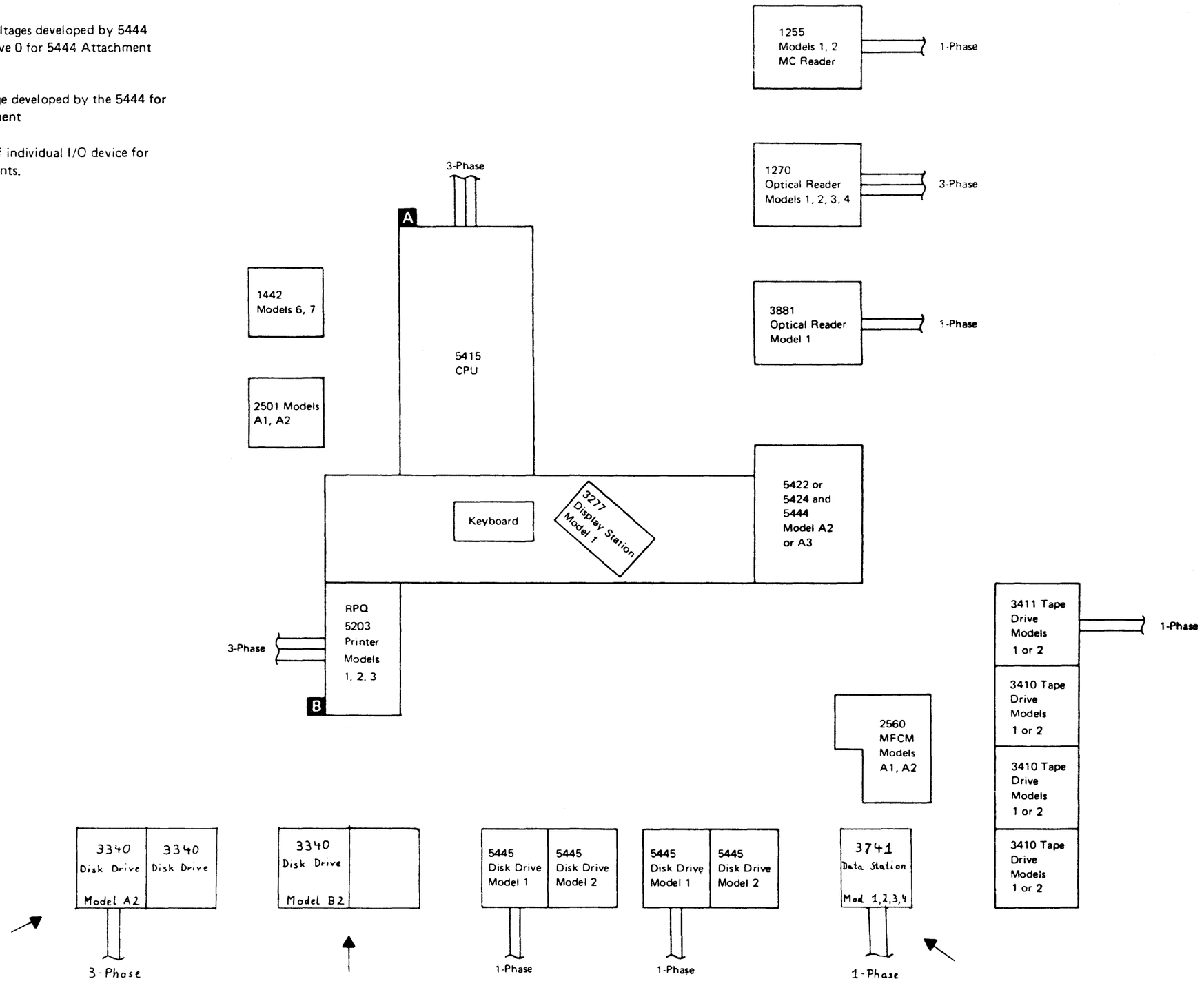
  -4 Vdc (A gate basic)
  -4 Vdc (B gate basic)
  -4 Vdc (B gate feature)
  +6 Vdc (basic)
  +8.5 Vdc and +3.4 Vdc (basic storage)
  +24 Vdc (EPO and sequencing)
  -12 Vdc (BSCA feature)
  ±12 Vdc (MLTA and BSCA features)
  ±3 Vdc (1442, 2501, 2560 features)
  +5 Vdc (3277 Attachment)
  -30 Vdc (5444 Attachment)

- Voltages (dc) supplied by I/O devices for use by the CPU:

  ±3 Vdc
  +6 Vdc
  +12 Vdc
  -36 Vdc
  } Voltages developed by 5444 drive 0 for 5444 Attachment

  +18 Vdc – Voltage developed by the 5444 for the 5444 Attachment

Note: See manual of individual I/O device for dc voltage requirements.



INTRODUCTION (Part 2 of 2)
(FOR 5203 INSTALLATION)
Basic Unit

The primary power input (ac) is distributed to bulk supplies located in the CPU. The bulk supplies supply unregulated filtered dc to the regulator assemblies. The regulators provide the voltage regulation required to operate the system logic. The regulated dc output is distributed to gates A and B and to the appropriate I/O devices.

Input Power Requirements

The input power requirements for System/3 are three-phase power at 30A. Domestic and World Trade input voltage requirements are:

- 60 Hertz: 200 Vac, 208 Vac, and 230 Vac (±10%)
- 50 Hertz: 200 Vac, 220 Vac, 235 Vac, 380 Vac, 408 Vac (±10%)

Parts Replacement

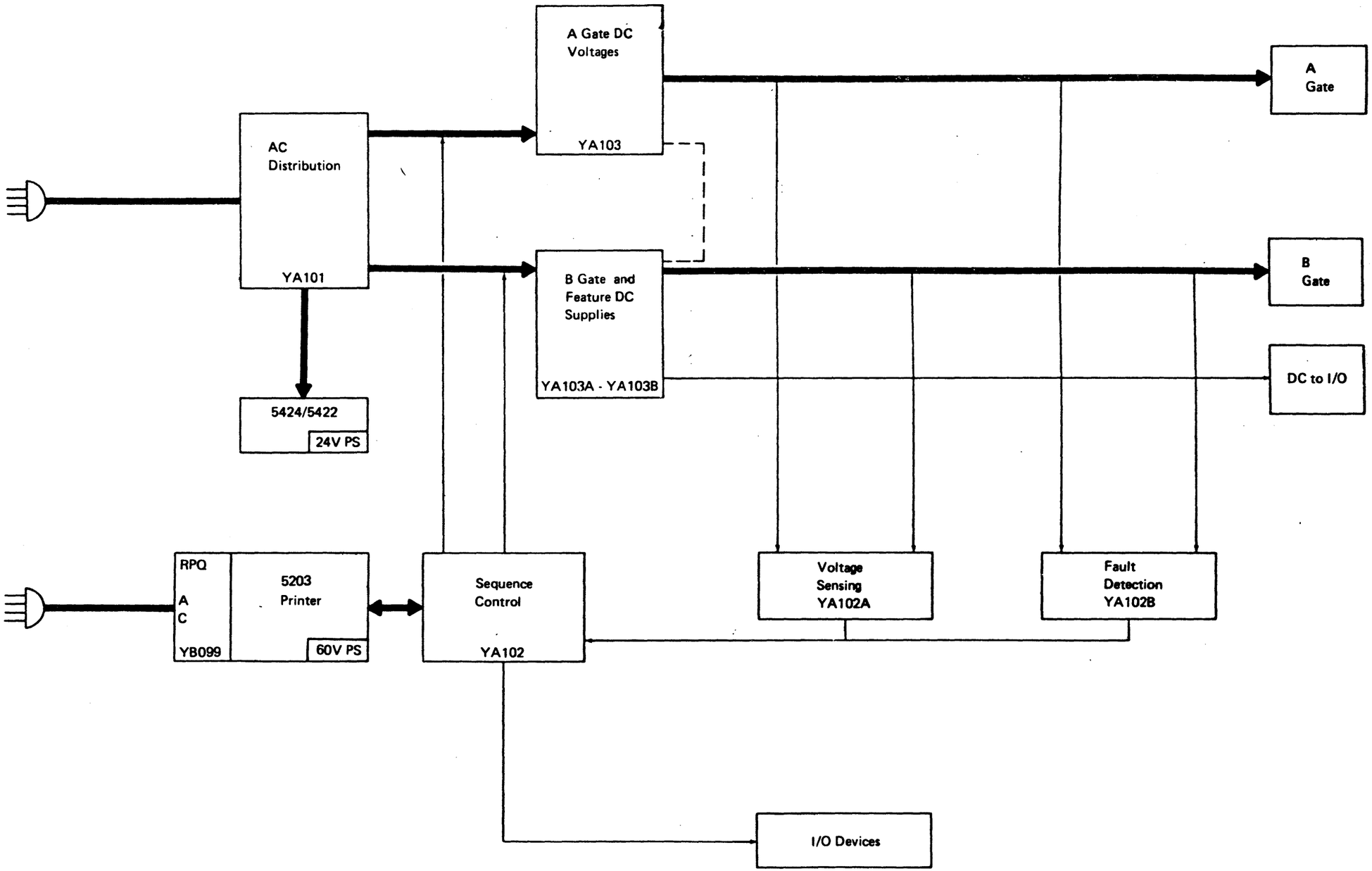
The power system is designed for replacement of power supply subassemblies rather than discrete components. The exceptions include fuses, voltage regulator cards, and relays. However, in large assemblies like the primary control box or bulk supply No. 1, it will be necessary to replace components (filter capacitors, etc.).

Checks and Adjustments

DANGER: After the emergency power switch is opened, power is available at K1, K3, and K9B input terminals and at transformer (T1) terminals.

All voltage measurements should be made in a normal environment (temperature between 68 degrees and 86 degrees F) with a *recently calibrated* Weston* 901 meter or its equivalent.

*Trademark of Weston, Inc.



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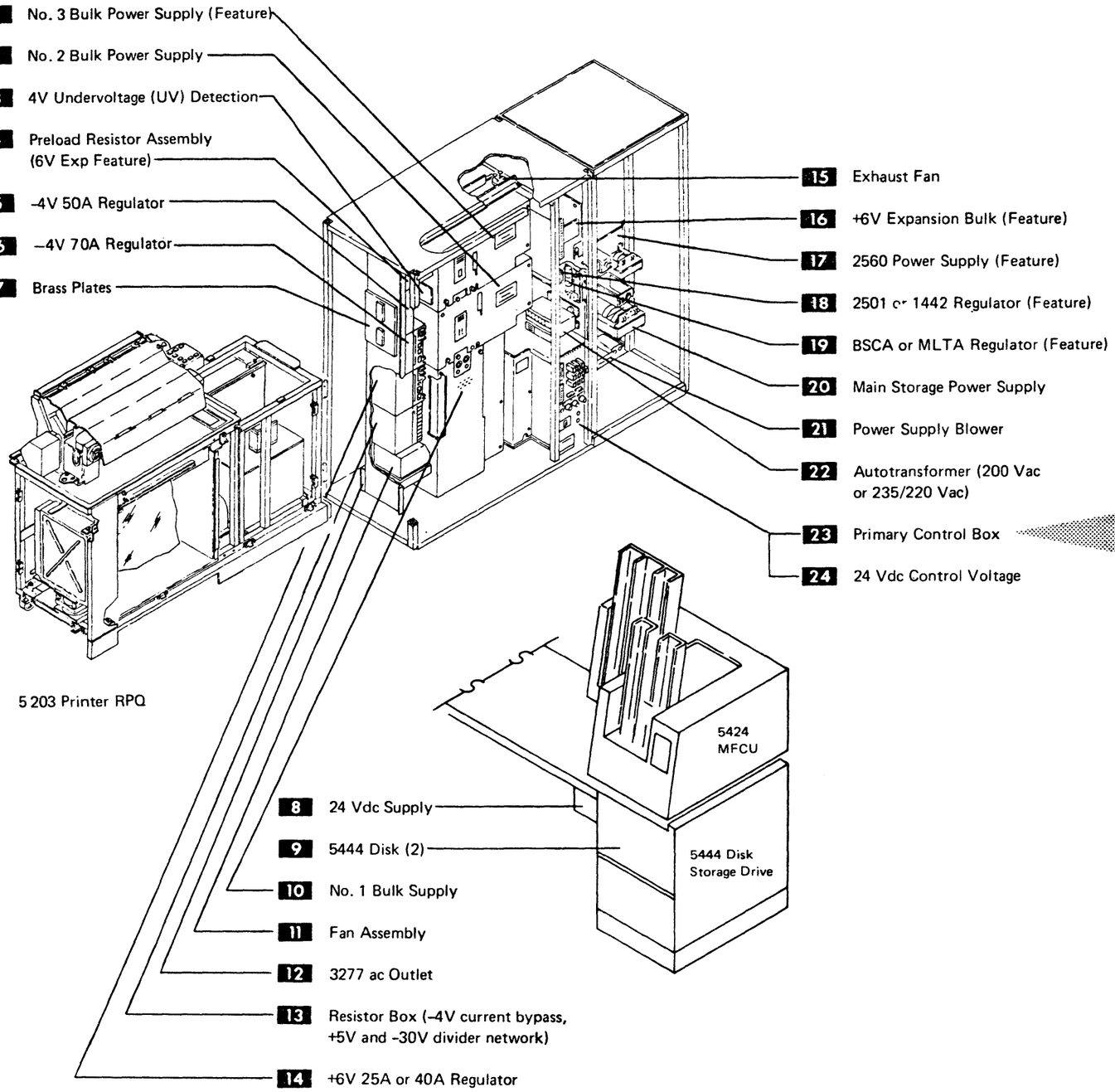
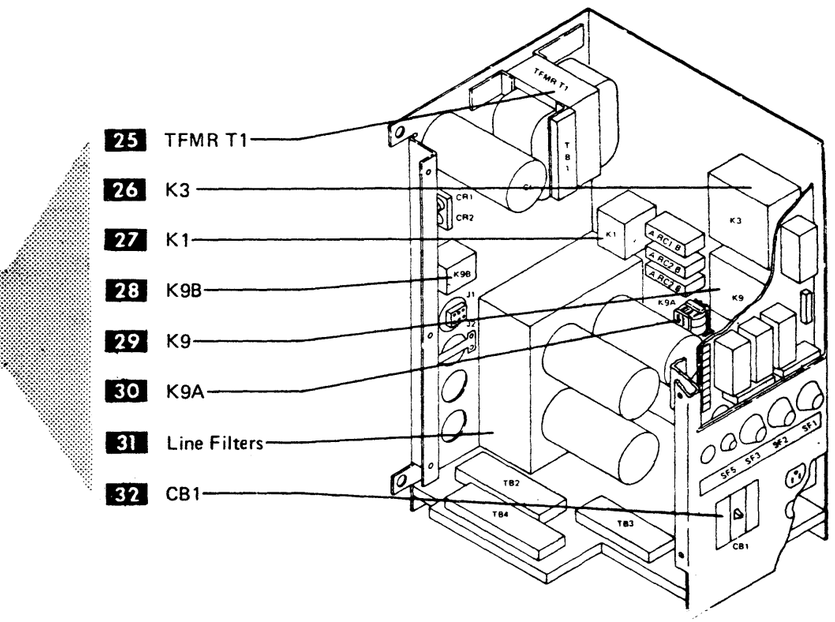
POWER SUPPLIES AND COOLING
(Part 1 of 2)
(FOR 5203 INSTALLATION)



Primary Control Box



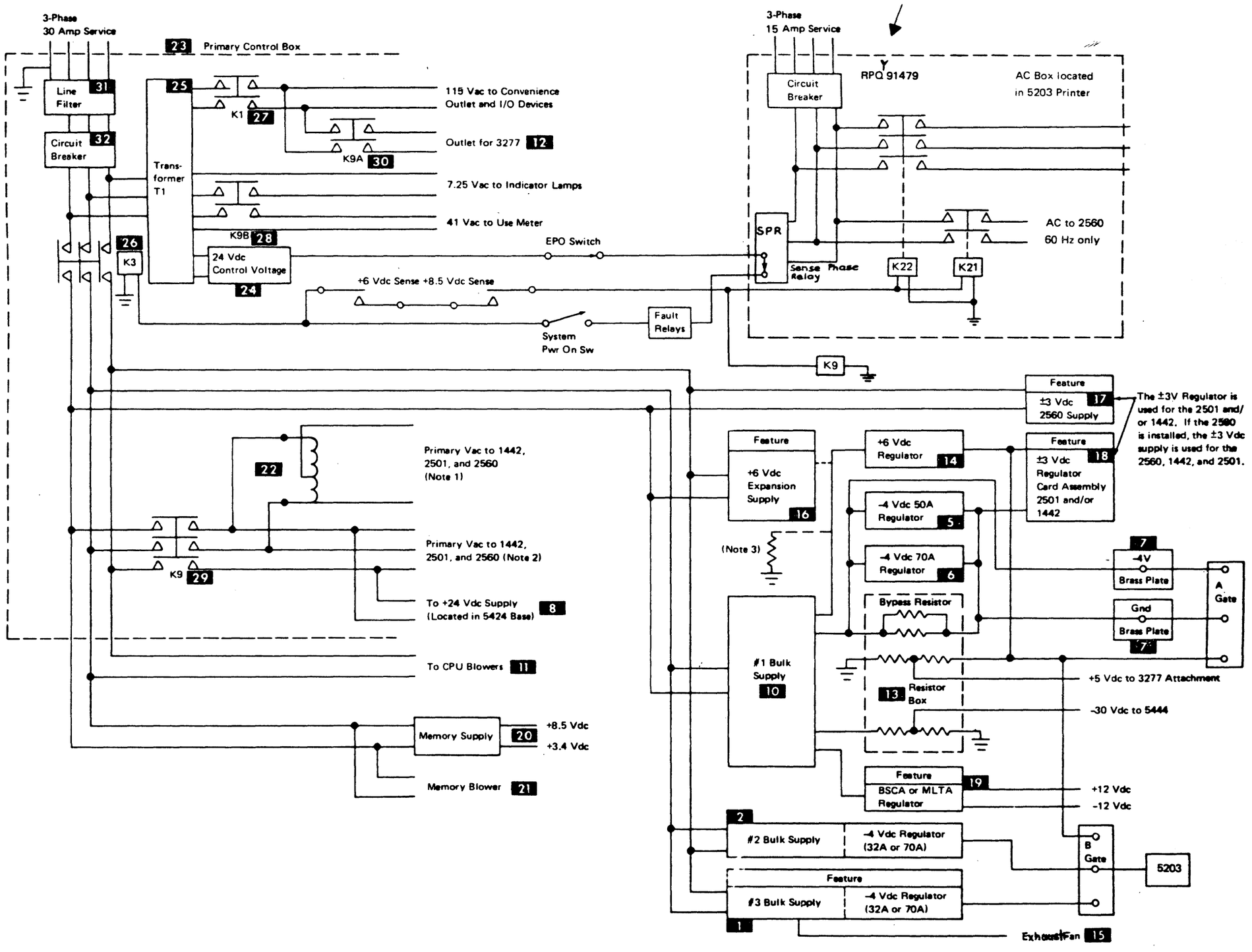
POWER SUPPLIES AND COOLING (Part 2 of 2) (FOR 5203 INSTALLATION)

Notes:

1. If the primary power input is 235 Vac or 408 Vac an autotransformer is required to supply power to the 2560, 2501, or 1442 (if these features are installed).

2. Primary power for the 2560 is supplied by the RPQ 5203 Printer on 60 Hz and 200 V ac 50 Hz Systems.

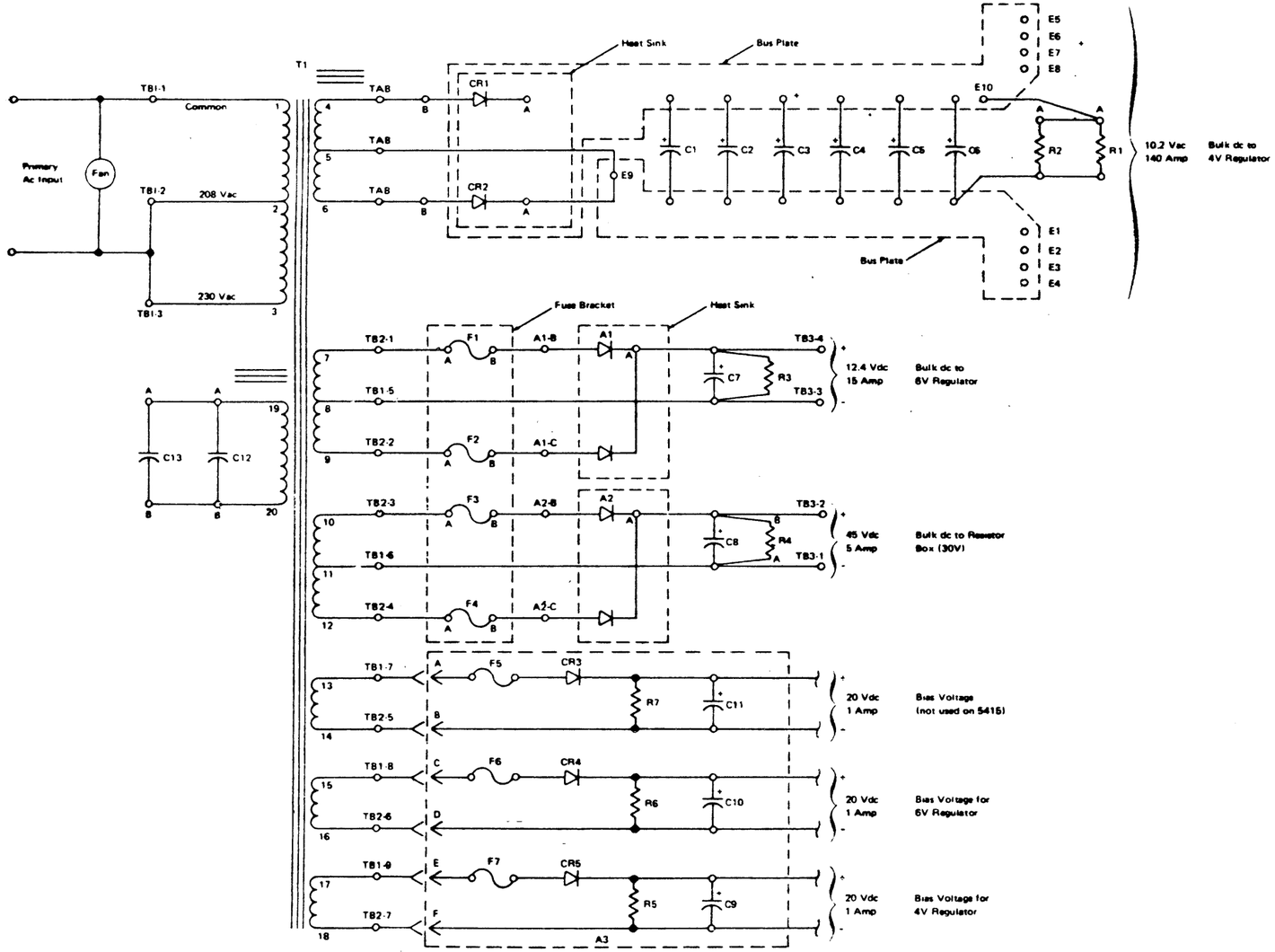
3. Resistor assembly is used to load the No. 1 bulk supply when the 6 Vdc expansion feature is installed. Power to the 6V regulator is supplied by the 6 Vdc expansion supply.

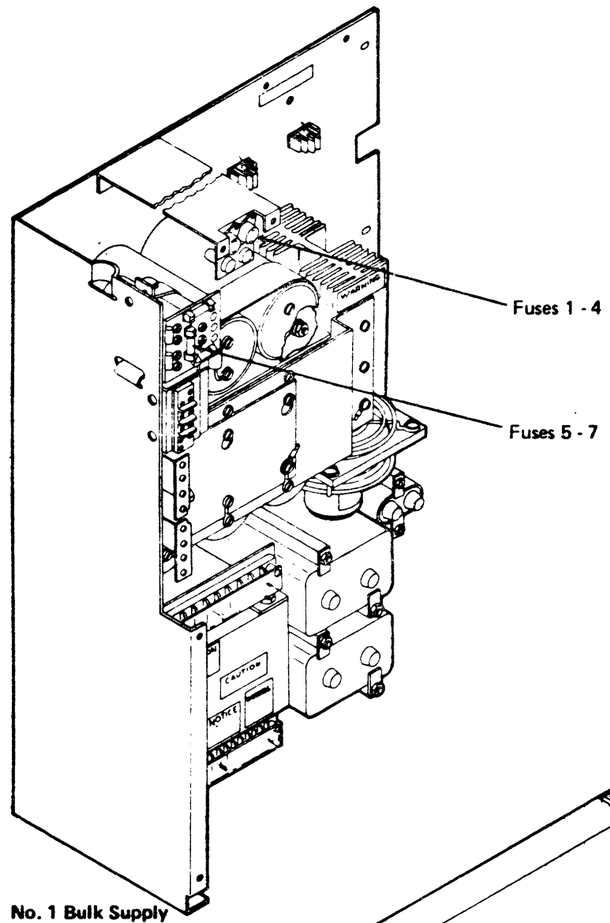


DC Bulk Supplies

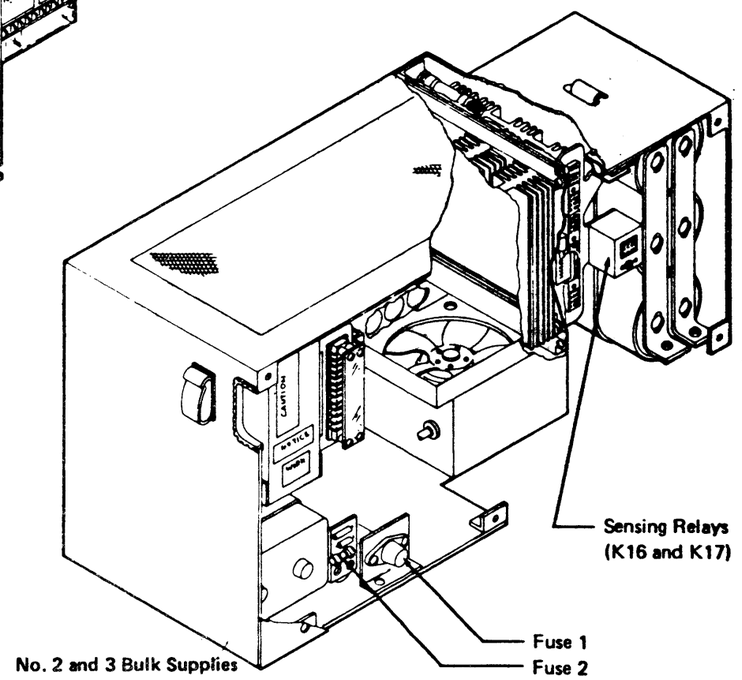
Each bulk power supply contains a ferro-resonant transformer with multiple secondary windings. The transformer outputs are rectified, filtered, and made available to dc regulators for additional regulation. The No. 1 bulk supply is shown in the example. The No. 2 and No. 3 bulks are similar but contain dc bulk and bias voltages for the 4V regulators only.

Note: All outputs (dc bulk and bias voltages) are floating. The outputs are referenced to ground via external wiring.





No. 1 Bulk Supply



No. 2 and 3 Bulk Supplies

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POWER SEQUENCE (Part 1 of 3)

These pages describe the sequential action of the system power supplies and their functional units. The purpose of the relays and coils are described on page 8-24. Reference logic pages YA102 through YA103.

Power Up Sequence

Normal conditions with system POWER switch set OFF, main CB on, line source on, and no power faults:

1. K13 and K14 are not energized (EPO must not be pulled and no point to ground fault).
   a. K13-1 is *not* picked (allows +24V to be passed to K14-2).
   b. K14-2 is *not* picked (allows +24V to be passed through power switch section A in the off position to the thermal switches to energize K2).
2. +24 Vdc control voltage is available (TP2 = 24 Vdc).
3. K1 is energized (convenience outlet on).
4. K2 is energized if:
   a. No thermal switch is open.
   b. +24 Vdc control is available (main CB on).

   Note: Abnormal power down conditions are described on page 8-21.
5. Lamp test switch is active (only TH CHK and PWR CHK lights will light with lamp test).

(1)

(1)

Move the system POWER switch to ON.

Sections A, B, and C of the power switch transfer.

1. Section C turns on PWR CHK light (turns off when K12-2 picks). Section C is also used to inhibit a point-to-ground fault reset while the POWER switch is set ON.
2. Section B provides +24V control to the 5445 (if installed), +24V control to the main storage supply, and +24V to the n/o K6-2 contacts.
3. Section A energizes K3 coil through K2-4 n/o points. (The thermal relay [K2] is now held through K2-3 n/o points.)

K3 relay picks:

1. Power (ac) is applied to all fans.
2. Power (ac) is applied to No. 1, 2, and 3 bulk power supplies and to the +6V expansion power supply.
3. Power (ac) is applied to the main storage supply.
4. Power (ac) is applied to ±3V supply for 2560 (when installed).

(2)

(2)

Bulk logic supply voltage energizes regulators:

1. Bias voltage (20 Vdc ± 10%) is applied to -4V (No. 1, 2, and 3) and +6V regulators (terminals E9 and E10 of each).
2. Bulk voltages are applied to each regulator (terminals E1 and E2 of each).
   a. 9.37V to 11.3 Vdc to -4V regulator
   b. 10.77V to 13.5 Vdc to +6 Vdc regulator
3. 46 Vdc (±10%) is applied to the resistor box assembly (30V section).
4. Approximately 25 Vac is applied to the 12V supply (BSCA/MLTA feature).
5. K30 is energized (senses BSCA -12V supply) or K2 is energized (senses ±12V supply).
6. K30-1 or K2-1 picks (TP9 = 0 Vdc).

   Note: The ±12V power supply relay K2 should not be confused with K2 in the system (mounted on relay panel).

(3) (To next page)

POWER SEQUENCE (Part 2 of 3)

(3)

-4V regulators power up:

1. Main storage supply powers up (when -4V No. 1 output reaches -3V).
2. K5 is energized (-4V No. 1 regulator output sense).
3. K17 is energized (-4V No. 2 regulator output sense).
4. K19 is energized (-4V No. 3 feature regulator output sense).
5. K5-1 picks (TP2 = 0 Vdc).
6. K17-2 picks (TP3 = 0 Vdc).
7. K19-2 picks (TP4 = 0 Vdc) — -4V No. 3 feature must be installed.
8. K5-2, K17-1, and K19-1 pick (all three picked apply the start-up voltage to terminal E12 of the +6V regulator).

Main storage power supply powers up:

1. K8 is energized (+8.5V sense).
2. K8-1 picks plus K6-2 picked (energizes K9, K9A, and K9B; and passes +24V to the 5203 RPQ K21 and K22)
3. K8-2 picks (TP6 = 0 Vdc).

(4)

(4)

+6V regulator powers up:

1. K6 is energized (+6V regulator output sense).
2. K6-1 picks (passes -30 Vdc to the 5444).
3. K6-2 picks (along with K8-1 picked, energizes K9, K9A, and K9B and also passes +24V to the 5203 RPQ K21 and K22)
4. K6-3 picks (activates -4V UV detection circuit).
5. K6-4 picks (TP5 = 0 Vdc).

K9, K9A, and K9B relays pick:

1. K9B-1 picks (passes 7.25 Vac to lamp distribution TB). Clock 9 is forced on.
2. K9B-2 picks (passes 41 Vac to usage meter control card).
3. K9A-1 and 3 pick (passes ac voltage to 3277).
4. K9-1, 2 and 3 pick (passes ac voltage to I/O devices).

(5)

(5)

+24V supply in 5424/5422 and +60V P/S in 5203 power up:

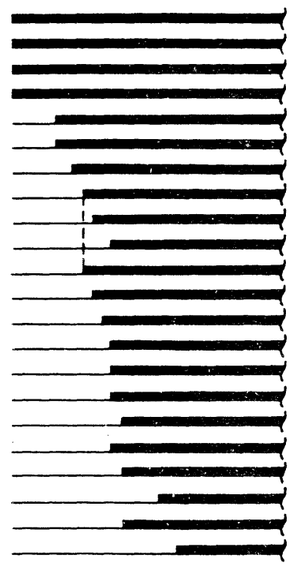
1. K10 and K11 are energized (+24V and +60V sense).
2. K10-2 picks (TP7 = 0 Vdc).
3. K11-2 picks (TP8 = 0 Vdc). K12 is energized.
4. K12-1 picks (passes power sequence complete signal to the 5203 and passes +24V to 2560 feature).
5. K12-2 picks (PWR CHK light goes off).
6. K12-3 picks (inhibits K15 from being energized during a normal power on and off sequence).
7. K12-4 picks ('power on reset' is deactivated and clock 9 goes off).

System is ready for processing.

NOTE 1: 24 Vdc supply is located in 5415 frame for systems without 5424/5422 installed.

Power On Sequence

1. Main CB On (power switch OFF)
2. +24 Vdc control voltage
3. K1 (convenience outlets)
4. K2 (TH CHK light turns off)
5. Turn Power switch ON
6. K3 (ac voltage to logic supplies and fans)
7. K5 (-4V power on)
8. K5-2, K17-1 (+6V power on)
9. K6 (6V sensed)
10. (-30V to 5444 file)
11. (+3.4V power on)
12. (8.5V power on)
13. K8 (8.5V sensed)
14. K9-B (lamp and meter voltage)
15. K9-A (ac voltage to 3277)
16. K9 (ac voltage to I/O devices)
17. (+24V power on in 5424/5422) Note 1
18. K21 and K22 in AC Box (5203)
19. +60V in 5203
20. K10 (+24V sensed)
21. K11 (+60V sensed)
22. K12 (remove POR)



POWER SEQUENCE (Part 3 of 3)

Normal Power Down Sequence

Move the POWER switch to OFF.

Sections A, B, and C of the power switch transfer.

1. Section C deactivates the -4V UV detection circuit. (Applies 'Ax inhibit' to -4V UV detection circuit.)
2. Section A opens. K10-1 and K11-1 hold K3 energized until both the +24V supply and +60V supply are powered down on a normal power off sequence.
3. Section B de-energizes:
   K9, K9A, and K9B (I/O supplies).
   +3.4/8.5V main storage supply.
   5444 supplies.

Main storage supply powers down.

1. K8 is de-energized.
2. K8-1 drops (used in power on sequence).
3. K8-2 drops (TP6 = 24 Vdc)
4. K12 is de-energized.
5. K12-2 drops (PWR CHK light comes on).
6. K12-3 drops (inhibits K15 from being energized).
7. K12-4 drops (activates 'power on reset' to the CPU).

+60V and +24V supplies power down. (I/O supplies de-energize slower than the main storage supply.)

1. K10 and K11 are de-energized.
2. K10-2 and K11-2 drop (TPs).
3. K10-1 and K11-1 (de-energize K3).

(1)

(1)

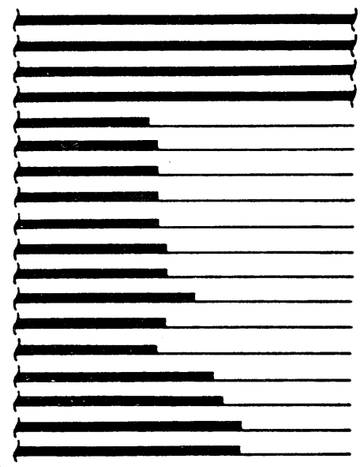
K3 drops (removes bulk and bias voltages to -4V, +6V regulators and voltage divider).

1. -4V regulators (1, 2, and 3) and +6V regulators power down.
2. K5 is de-energized.
3. K5-1, K17-2, and K19-2 drop (TPs).
4. K5-1 drops (TP2 = 24 Vdc and PWR CHK light goes off).
5. K5-2, K17-1, and K19-1 drop (used in power on sequence).
6. K6 is de-energized.
7. K6-1 drops (removes -30V to 5444).
8. K6-4 drops (TP5).

System is in normal power off state.

Power Off Sequence

1. Main CB
2. +24 Vdc control voltage
3. K1 (convenience outlet)
4. K2 (thermal interlock)
5. Turn POWER switch OFF
6. K9 (ac voltage to I/O devices)
7. K9A (ac voltage to 3277)
8. K9B (lamp and meter voltage)
9. K22 in 5203 (+60)
10. K11 (+60 Vdc sensed)
11. K10 (+24 Vdc sensed)
12. K12 (turn on POR)
13. K7 in 5421
14. K8 (+8.5 Vdc)
15. (+3.4 Vdc)
16. K3 (ac voltage to logic supplies and fans)
17. K6 (+6 Vdc sensed)
18. K5 (-4 Vdc sensed)



THERMAL AND POWER CHECKS
(Part 1 of 3)

Abnormal Power Indications

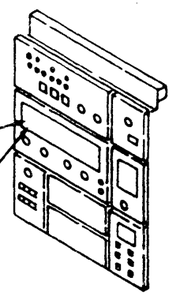
An abnormal power down can be caused by a power check or a thermal check.

A PWR CHK light indicates that one of the following has occurred:

- An abnormal sequence down **A**
- An abnormal sequence up **B**
- An overvoltage, overcurrent, or an undervoltage power failure **C**
- A thermal condition exists (TH CHK light will be on also) **D**

A thermal check indicates that one of the following areas has overheated:

- A or B gate logic
- Bulk supply
- Regulator stack
- Main storage supply
- 5203 and 2560 supplies
- 5203 logic gate



One failure is examined to show how the power supply elements react: With the POWER switch OFF, and if relay K3 fails to drop ac power continues to be supplied to the –4V and +6V regulators. Since K5, K17, and K6 are never de-energized, K5-1, K17-2, and K6-4 never drop. +24 Vdc is measured on TP6. The PWR CHK light is on because +24V is available through K5-1, CR13 and K12-2.

An *abnormal power down sequence* should not be confused with an overvoltage (OV) or overcurrent (OC) fault occurring during a power down. If an OV or OC occurs during a power down sequence, the system powers down as expected and the PWR CHK light does *not* stay on but goes off as soon as all supplies are down. However, a fault relay (K13, K14, K16, or K18) latches so when the POWER switch is moved to ON, an immediate power check occurs with no power supply sequencing. (Normally an OV/OC causes the system to immediately power down at some point in the sequence up state or after all supplies are up.)

A An *abnormal power down sequence* occurs only when the POWER switch is moved to OFF (the operator intends to power down the system). If all system power supplies power down as expected, no power check occurs. If they do not, the PWR CHK light stays on (comes on during normal power down sequence) and +24 Vdc may or may not be available on one of the test points.

Any one of the following faults could cause an abnormal power down sequence.

1. Section A, B, or C of the power switch failed to open.
2. K3 relay did not drop.
3. K9 relay did not drop.
4. K5-1 relay did not drop.

B An *abnormal power up sequence* can occur after the POWER switch is moved to ON. This power failure can occur if any one of the system power supplies fail to power up or if any one of the sense relays fail to sense an associated power supply output. The system does *not* abruptly power down with this fault but inhibits power complete or stops sequencing up at the point of failure for some supplies. +24 Vdc is measured on the TP of the supply that failed to power up. For Example: If the main storage power supply has an internal failure and its output never reaches +8.5V, K8 is not energized and relays K8-1 and K8-2 are not transferred. With K8-1 not picked, K9, K9A, and K9B are not energized (I/O supplies). With K8-2 not picked, +24 Vdc appears at TP6. K12 is not energized and the PWR CHK light stays on.

C A *–4V or +6V overvoltage, overcurrent, or a –4V undervoltage power* failure can be detected during normal power on. With this type of failure, the system powers down *abruptly* as soon as the fault is detected. +24V is measured on the TP of the supply that detected an OV, OC, or UV power failure. The respective regulators sense voltage and current load drain and if preset limits are exceeded, a point-to-ground signal is presented on pin E8 of the respective regulator. This point-to-ground signal (ground potential) is used to energize the appropriate OV/OC sense relay which, in turn, immediately drops all system power. Undervoltage power failures also cause abrupt system power down. Two special UV detection circuits are used to sense the output of the –4V and +6V regulators. If either regulator's output drops below criteria, K6/K15 (+6V UV) or K14 (–4V UV) is energized and powers down the system. However, a +6V UV does *not* power down the system abruptly but causes a power check with all CPU logic supplies up.

Overcurrent (OC) Power Failure Example: System is in a normal power up state.

1. A –4V short-to-ground fault occurs (can be anywhere on the system where –4V from the No. 1 bulk is used).
2. The fault causes excessive current drain on the –4V regulator.
3. A –4V OC fault is sensed by the –4V regulator card.
4. A point-to-ground signal is presented to K13. (The ground side of K13 is normally open to ground.)
5. K13 is energized.
6. K13-2 picks (latches K13 on).
7. K13-1 picks (TP12 = +24 Vdc). When this relay transfers, +24 Vdc control voltage is removed from all relay coils (K2, K3, and K9 in particular).
8. System powers down abruptly.
9. PWR CHK comes on as soon as K12 drops and the POWER switch stays ON.

If the POWER switch is moved to OFF, the PWR CHK light goes off, but comes on again each time the switch is moved to on. The system stays latched in the fault state until the fault relay is reset and the point-to-ground fault is removed.

The fault relay can be reset by setting the POWER switch to OFF and pressing CHECK RESET With the POWER switch set OFF, +24V energizes K13 coil through the closed check reset switch. With check reset open, K13 de-energizes and K13-2 drops (latch) and K13-1 drops. K2 is now energized by the +24V control voltage and the system is ready for a normal power up sequence.

The above description can be used similarly for –4V OV/OC, –4V UV, and +6V OV/OC power failures. Only different supplies and relays are involved.

A +6V UV power failure does *not* cause abrupt system power down. Instead, special solid state circuits sense the +6V regulator output and, if +5.7 Vdc or lower is sensed, coil K6A is energized. Relay K6A-1 picks and causes K15 to energize. Then K15-4 picks and de-energizes K9, K9A, and K9B. This relay drops ac power to the I/O devices, which causes K10 and K11 to drop. The PWR CHK light comes on, but the system does *not* power down since +24V control is not interrupted to K3 or K2.

Undervoltage control circuits are used to ensure that:

a) +6V is always present when –30 and +24 Vdc are present in the 5444 and when +24 and +48 Vdc are present in the 2560.

b) –4V is always present when +6V is present in the 5424, or CPU logic gate.

If the above is not controlled, damage results in I/O device control circuits and electro-magnetic components.

Normally a power supply itself *cannot* cause an OC failure. If an OC condition prevails, an I/O device, logic circuits, or cables have caused the failure. If the supply is abnormally overloaded, an OC condition prevails over an UV condition. Even though the regulated supply voltage may drop, normally the OC sensing by the regulator has powered the system down *before* UV can be detected.

D A *thermal check*, caused by one of the following overheated areas, causes the system to power down in a sequencial manner rather than abruptly.

Thermal check example: System is in a normal power on state.

1. A thermal switch opens from an overheating condition.
2. +24V is interrupted to K2 coil, K2 de-energizes.
3. K2-3 and K2-4 transfer.
4. K2-3 interrupts +24V to K9, K9A, and K9B (I/O supplies power down) and passes +24V to the thermal light.
5. K2-4 transfers, and K3 is held energized through K10-1 and K11-1 until both the +24V power supply and the +60V power supply are down.
6. System powers down as a normal power down sequence, except that the TH CHK light is on.

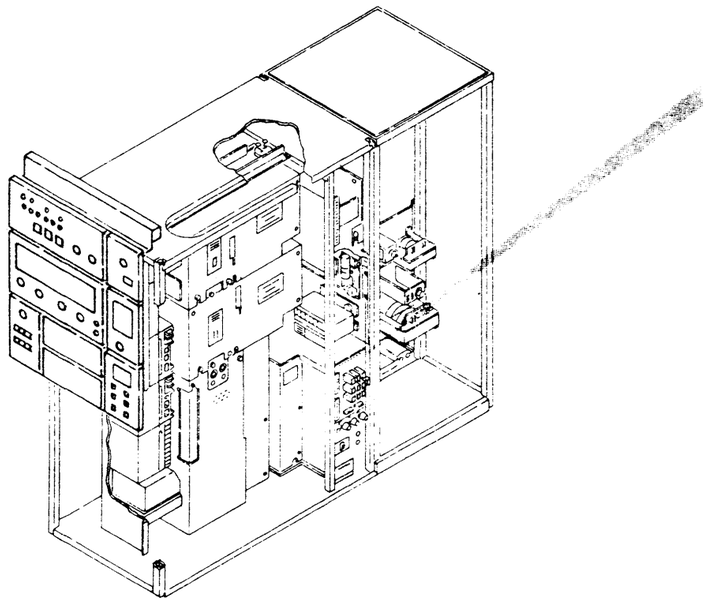
If the POWER switch is set OFF, the TH CHK light stays on if the thermal fault still exists. If the fault is corrected, moving the switch to OFF allows K2 to be energized again and the TH CHK light goes off.

THERMAL AND POWER CHECKS (Part 2 of 3)

Power Check and Thermal Check Indicators

The PWR CHK light comes on during the power on sequence and goes off when the power on sequence is completed. It also lights with the TH CHK light (see chart below) when an overtemperature condition occurs or whenever any power trouble is present.

A 'power on reset' occurs every time the PWR CHK lights. PWR CHK stays off if the 24 Vdc output of the control transformer/rectifier pack (T/R Pac) is missing.



Fault	POWER ON/ OFF Switch	Power Check Ind	Thermal Ind	Action
Internal Power Supply Malfunction	On	On	Off	1. Turn power off. 2. Correct problem. 3. Press check reset. 4. Turn power on.
Thermal Condition	On	On	On	1. Turn power off. 2. Power check indicator goes off. 3. Thermal light stays on until condition is removed.
Customer Power Source Loss	On	On	On	1. Turn power off. 2. All indicators turn off. 3. Turn power on and continue operation.
Emergency Power Off (EPO) Activated	On	Off	Off	1. Turn power off. 2. Correct problem. 3. Restore EPO interlock. 4. Turn power on.

Test Points (TPs)

Test points (TPs) are on the power control box. When a voltage failure occurs, check these test points in numerical sequence to determine the voltage that failed.

If the power on sequence is not completed, the PWR CHK light remains on and the TPs from TP2 to TP9 indicate where the sequence stopped.

For example, a +6V regulator sequencing failure is indicated if TPs 2-4 were zero volts and +24V appeared at TP5.

The machine powers down in any of the conditions detected in TP10-14. Twenty-four volts is readable in TP10-14 until CHECK RESET is pressed. Loss of either the -4V or +6V while the machine is running powers down the system and +24V is present at TP10-14. Loss of +24V while the machine is running does not cause power down but activates 'power on reset' stopping operation of the machine.

For example, an overvoltage/overcurrent failure in the -4V No. 1 regulator occurred if +24V appeared at TP12.

Test Points	Type of Failure If TP = 24 Vdc (26.5 approx)	Supply Checked
TP1	Ground	
TP2	Sequence	-4V Basic logic supply (includes add-on)
TP3	Sequence	-4V #2 Basic logic supply (B gate)
TP4	Sequence	-4V #3 feature supply (5-8 boards in B gate)
TP5	Sequence	+6V Basic
TP6	Sequence	+8.5V main storage supply
TP7	Sequence	5424/5422 (+24V basic) or 5415 Note 1
TP8	Sequence	5203 RPQ (+60V supply SNS circuit)
TP9	Sequence	Feature supply (-12V BSCA supply) (±12V MLTA supply)
TP10	OV/OC	-4V #3 feature supply (5-8 boards in B gate)
TP11	OV/OC	-4V #2 Basic logic supply (B gate)
TP12	OV/OC	-4V #1 Basic logic supply (includes add-on)
TP13	OV/OC	+6V Basic
	UV	-4 Basic
TP14	Sequence	±3V feat. supply (2560)
	UV	+6V Basic

NOTE 1: 24 Vdc supply is located in 5415 frame for systems without 5422/5424 installed.

A
Facing page

THERMAL AND POWER CHECKS (Part 3 of 3)

System Sequencing and Sensing Relays

This is a simplified diagram of the system sequencing and sensing relays. This diagram intends to show more simply how the system is powered up; K1, K2, K3, etc.

Power On Sequence

K1 picks if the 24V control voltage is present through the EPO switch. A quick service check for this 24V supply can be made by pressing LAMP TEST while power is off and observing the TH CHK and PWR CHK lights. If they light, the 24V supply is present.

K2 picks if the CPU, 2560 (if installed), and 5203 thermals are closed, and all fault relays are de-energized.

Note: K1 and K2 pick with the POWER switch on or off.

K3 picks when the POWER switch is turned ON.

K12 picks when the power on sequence is complete.

Abnormal Power Off

The five causes for an abnormal power off sequence are:

1. Overvoltage (OV)
2. Overcurrent (OC)
3. Undervoltage (UV)
4. Thermal (overheating – normal power off sequence)
5. Emergency power off (EPO) switch opened

Overvoltage and Overcurrent Power Off Sequence

Whenever an overvoltage or an overcurrent condition is sensed, one of the OV/OC relays, K13, K14, K16, or K18 is picked. Energizing an OV/OC relay results in de-energizing contactor K3. De-energizing contactor K3 removes power from the logic and main storage supply.

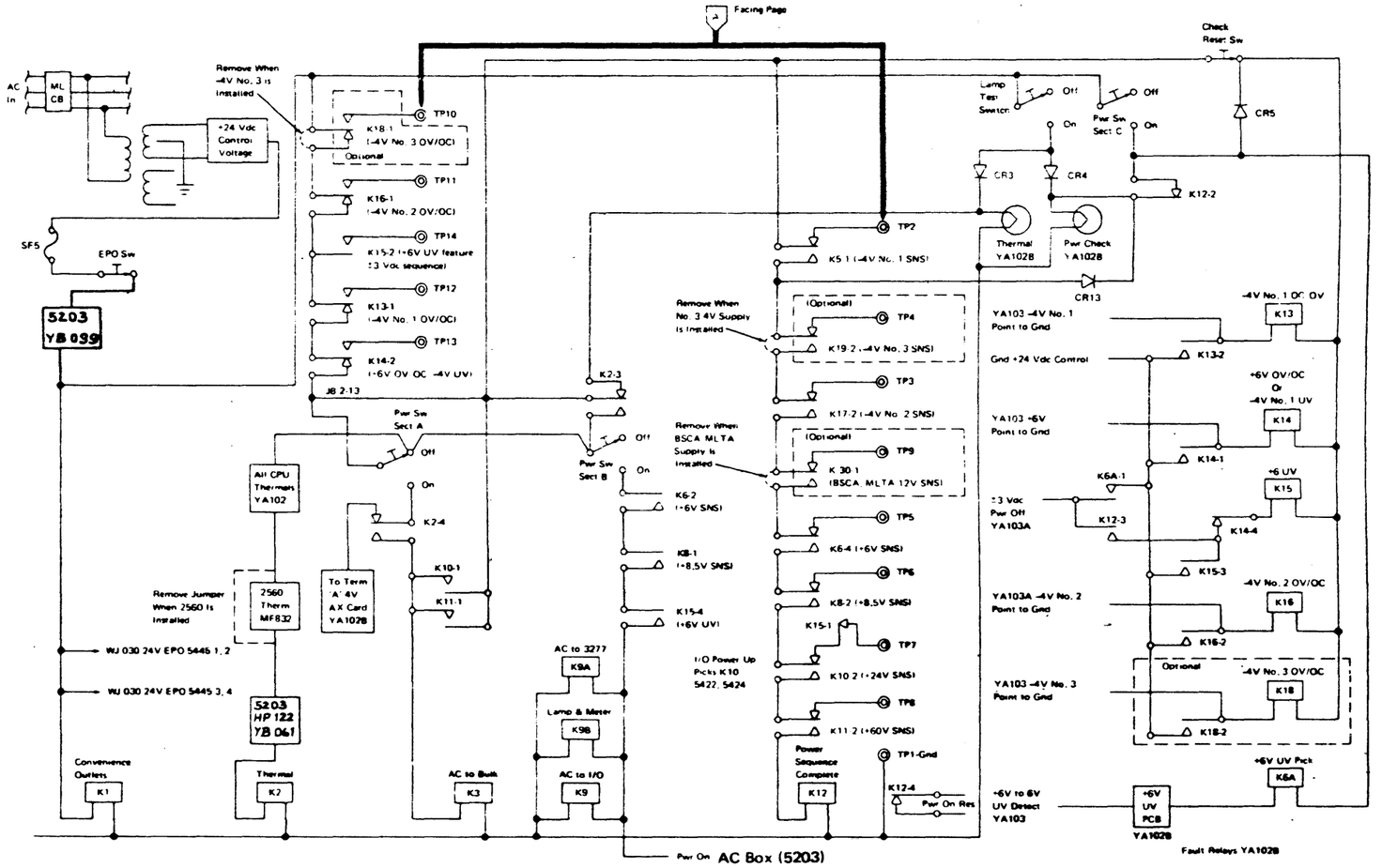
On an abnormal power off, the power check indicator turns on to indicate a failure. Test points indicate the power supply that failed. The energized OV/OC relay contacts hold the relay energized until CHECK RESET is pressed with the POWER switch OFF.

After an overvoltage, overcurrent, or an undervoltage failure, CHECK RESET must be pressed with the POWER switch set OFF to de-energize the OV/OC/UV relay and to allow a power on sequence.

Undervoltage Power Off Sequence

Only the –4V and the +6V outputs sense for undervoltage conditions. If the –4V No. 1 regulator UV circuit senses an undervoltage condition, the –4V UV circuit (a separate card) immediately signals the +6V regulator to short via the SCR across the +6V regulator output. This is a +6V simulated overcurrent condition and the OV/OC/UV relay K14 energizes. The K14-2 contacts remove +24V from contactor K3. Contactor K3, in turn, removes power to the logic and main storage bulk supply. This results in an immediate system power off.

Because K14 OV/OC/UV relay energizes, +24V is present at TP13 to indicate a +6V power failure. However, a +6V overvoltage, a +6V overcurrent, or a –4V undervoltage could cause the failure condition (see MAPs, Maintenance Analysis Procedures).



Thermal Power Off Sequence

A thermal condition causes relay K2 to be de-energized. The K2-3 contacts turn on the TH CHK light to indicate overheating. Power then sequences off the same as a normal power off sequence by opening the power switch circuit.

The TH CHK light and the PWR CHK light are on when the system power off sequence ends. Turning the POWER switch OFF turns off the PWR CHK light. The TH CHK light remains on until the over-temperature condition has been corrected and the POWER switch has been turned OFF. Power can then be restored to the system by turning the POWER switch ON.

Emergency Power Off

Pulling the emergency power off switch removes +24V to K1, K2, K3, etc. causing system power to drop immediately.

Note: In a normal system power off state, TP2 will read +24 Vdc. Because of a system power failure (power check), +24 Vdc measured on TP2 indicates the –4 Vdc failed to sequence on.

COIL/RELAY FUNCTIONAL DESCRIPTIONS (Part 1 of 3)

The coils/relays described below are classified into two groups: sequence relays or fault relays. Sequence relays allow the system to sequentially power up or power down. Fault relays identify a failing power supply and in some cases, cause the system to abruptly power down to avoid circuit/component damage.

Sequence Relays	Fault Relays
K1 (I/O P/S)	K2 (thermal)
*K2** (±12V sense) MLTA/BSCA	
K3 (bulk power)	
*K5 (–4V No. 1 sense)	K6A (+6V UV)
*K6 (+6V sense)	K12 (power check)
*K8 (main storage supply sense)	ΔK13 (–4V OV/OC)
K9 (I/O supply)	ΔK14 (–4V UV or +6V OV/OC)
K9A (115 Vac distribution)	
K9B (41 Vac and 7.25 Vac distribution)	
*K10 (+24V sense — 5424/5422) Note	K15 (+6V UV or +3V sense)
*K11 (+60V sense — 5203)	ΔK16 (–4V No. 2 OV/OC)
K12 (power supply up sense)	ΔK18 (–4V No. 3 OV/OC)
*K17 (–4V No. 2 sense)	
*K19 (–4V No. 3 sense)	
*K30 (–12V sense) with medium speed BSCA and not MLTA	

*These relays are also fault relays because they identify the failing power supply.

**This K2 is located in ±12V supply, and not in the sequence control box.

ΔThese relays cause an abrupt system power off; all others do not.

Note: K4 and K7 are not used.

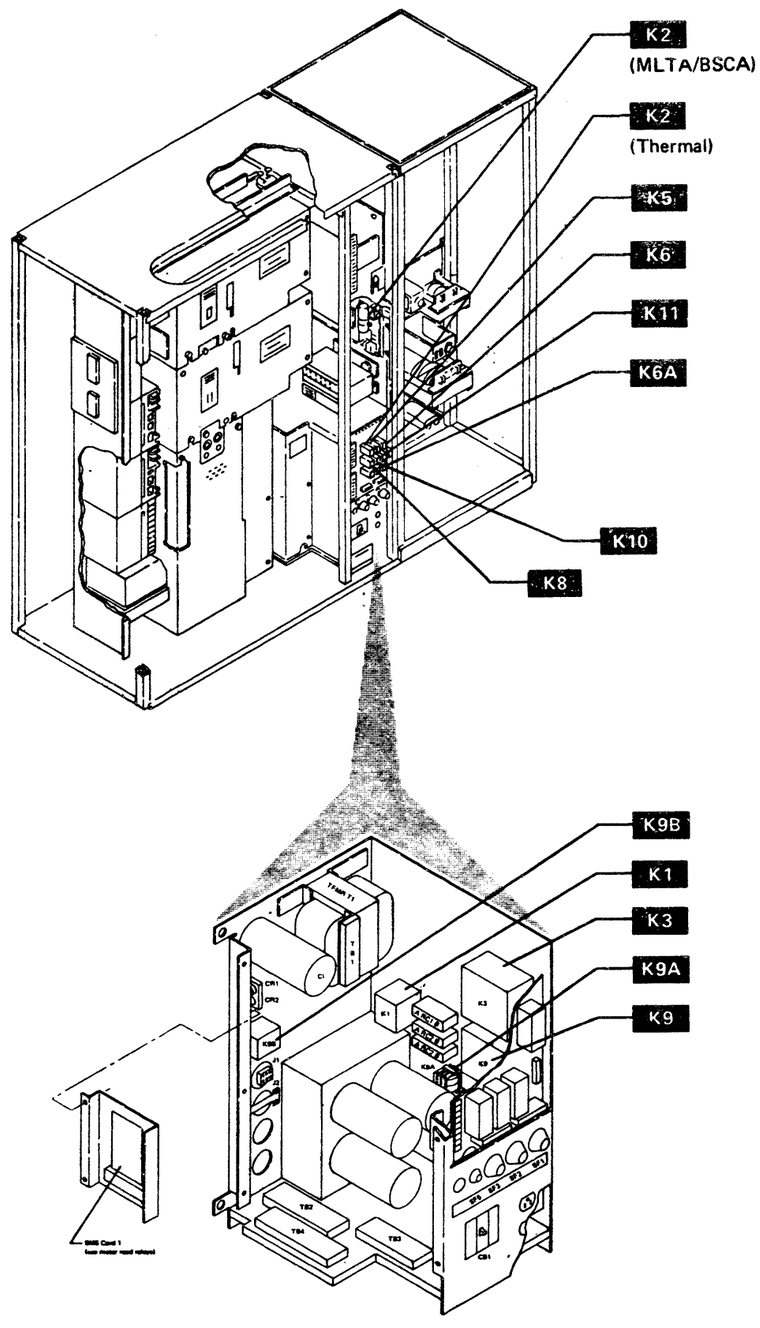
24 Vdc supply is located in 5415 frame for systems without 5422/5424 installed.

K1 Convenience Outlet (YA102)

- Pick
  - 24V sequence power up
  - EPO switch closed (pushed in)
- Drop
  - EPO switch opened (pulled out)
  - Loss of 24V sequence power
- Function
  K1-1, 2 provides control of 115 Vac to system convenience outlets.

K2 Thermal Relay, Relay Panel (YA102)

- Pick
  - System in normal power off state
  - All thermal switches closed
- Drop
  - Any system thermal open
- Function
  - K2-1 not used
  - K2-2 not used
  - K2-3
    a. Provides hold voltage for K2 coil when POWER is ON.
    b. Interrupts hold current to K9, K9A, K9B coils and drops power-on signals to 5203 and 5445 devices on a thermal fault.
    c. Provides power to the TH CHK indicator light when a thermal fault is detected.
    d. Provides input voltage to main storage supply sequence card.
  - K2-4
    a. On normal sequence on, provides a path to allow K3 to pick if no thermal fault is present.
    b. Provides for sequential shutdown of K3 on a power fault condition.
    c. Inhibits –4V UV sense after a thermal fault.
    d. Drops power-up signal to main storage supply.



Primary Control Box

K2 ±12V Supply Sense, Located on Power Supply (MLTA/BSCA-YA140)

- Pick
  - When the MLTA ±12V supply output is approximately ±12 Vdc.
- Drop
  - Loss of either +12V or -12V output.
- Function
  - K2-2
    a. Provides a path for +24V to TP9 when ±12V supply is not up.
    b. Provides the ±12V link in the power complete sequence chain.

Note: The ±12 Vdc supply is required when the MLTA feature is installed. This supply is also used with BSCA and not MLTA if the BSCA feature contains the 1200 bps integrated modem. This supply is not required if BSCA without 1200 bps modem is installed (BSCA without this modem uses -12 Vdc only).

K3 AC Voltage to Bulk Power Supply (YA102)

- Pick
  - Transferring the power switch (section A) after being in a normal power off state.
- Drop
  - A –4V OV/OC power fault
  - A –4V UV or +6V OV/OC power fault
  - Loss of +24V. +60V levels after a thermal fault.
  - Loss of +24V. +60V levels after transferring the power switch to the "OFF" position.
- Function
  - K3-1, 2, 3 controls ac distribution to all CPU bulk supplies:
    a. No. 1 logic –4V/+6V/-30V and 25 Vac to -/±12V supply
    b. No. 2 logic –4V
    c. No. 3 logic –4V
    d. Main storage +8.5V/+3.4V
    e. –6V expansion +6V
    f. ±3V 2560 ±3V

Note: The outputs of the +6V regulator, +8.5V regulator, and +3.4V regulator have additional controlling functions.

  - Provides ac voltage to all CPU cooling fans.

COIL/RELAY FUNCTIONAL DESCRIPTIONS (Part 2 of 3)

K5 –4V No. 1 (A gate) Sense (YA102A)

- Pick
  - –4V No. 1 (A gate) output at approximately 4 Vdc
- Drop
  - Loss of –4V No. 1 (A gate) output
- Function
  - K5-1
    a. Provides path for +24V to TP2 when –4V No. 1 (A gate) level is not up.
    b. Provides control of the PWR CHK light during power down sequence.
    c. Provides the –4V No. 1 (A gate) link in the power complete (K12) sequence chain.
  - K5-2
    a. Provides the –4V No. 1 (A gate) link in the start up control for the +6V regulator.

K6 +6V Sense (YA102A)

- Pick
  - +6V output at approximately +6 Vdc
- Drop
  - Loss of +6V output
- Function
  - K6-1 controls distribution from -30V divider network to 5444 file.
  - K6-2 provides the +6V up-link of the chain required to energize K9, K9A, and K9B relays that provide ac voltage to I/O devices attached to the system.
  - K6-3 provides voltage to –4V UV sense circuit. This line ensures that a –4V UV fault will not be sensed before the +6V supply is up.
  - K6-4
    a. Provides a path for +24V to TP5 when +6V level is not up. For +24V to appear on TP5, all –4V supplies, –12V or ±12V supply, and ±3V 2560 supply (if installed) must be up.
    b. Provides the +6V link in the power complete sequence chain.

K6A +6V UV Detect (YA102B)

- Pick
  - Loss of +6V output while system is in a normal power on state.
- Drop
  - +6V power restored
- Function
  - K6A-1 provides path for picking the +6 UV fault relay (K15) when system is in a normal power on state, and a +6V undervoltage is detected.

    Note: K6A is energized with +24V only when the ground side of this coil is connected to ground. Transistors Q1 and Q2 sample the +6V regulator output and if +6V is available, Q1 and Q2 do *not* conduct and Q2 presents an open circuit to the ground side of K6A and inhibits this coil from being energized. If +6V is not available, transistors Q1 and Q2 conduct and the ground side of K6A is at ground potential and allows K6A to be energized. This causes K15 fault relay to pick which, in turn, causes a power check (K9 drops, K10 drops, K12 drops, PWR CHK light on).

K8 Main Storage Supply Sense (YA102A)

- Pick
  - +8.5V output at approximately 8.5 Vdc
- Drop
  - Loss of +8.5V output
- Function
  - K8-1 provides the +8.5V required to energize K9, K9A, and K9B relays that provide ac voltage to the I/O devices attached to the system.
  - K8-2
    a. Provides a path for +24V to TP6 when +8.5V level is not up. For +24V to appear on TP6, all –4V supplies, –12V or ±12V supply, ±3V 2560 supply (if installed) and +6V supply must be up.
    b. Provides the +8.5V link in the power complete sequence chain.

Note: The +8.5V supply depends on the +3.4V supply being up. The +3.4V supply is *not* associated with any relay coil. However, the availability of this voltage provides a start-up to the +8.5V supply. Hence, both must be up before K8 can pick.

K9 I/O AC Power 208/230V AC (YA102)

- Pick
  - +6V power up and +8.5V power up
- Drop
  - Any OV/UV/OC fault on –4V or +6V
  - Thermal fault
  - POWER switch being set OFF
  - Loss of the +8.5V level when in a normal power up state
- Function
  - K9-1, 2, 3 controls ac voltage distribution to the following I/O devices:
    a. 2560
    b. 5424
    c. 2501
    d. 1442
    e. 5422

Note: Primary power for the 2560 is supplied by the 5203 RPQ on 60 Hz and 200 Vac 50 Hz systems.

K9A I/O AC Power (YA102)

- Pick
  - +6V power up and +8.5V power up
- Drop
  - Any OV/UV/OC fault on –4V or +6V
  - Thermal fault
  - POWER switch being set OFF
  - Loss of the +8.5V level when in a normal power up state
- Function
  - K9A-1, 3 controls ac power distribution to the 3277.

K9B 7.25 Vac and 41 Vac Distribution (Lamp and Meter – YA102)

- Pick
  - +6V power up and +8.5V power up
- Drop
  - Any OV/UV/OC fault on –4V or +6V
  - Thermal fault
  - POWER switch being set OFF
  - Loss of the +8.5V level when in a normal power up state
- Function
  - K9B-1 controls distribution of the 7.25 Vac power to the indicator lamp bus.
  - K9B-2 controls distribution of the 41 Vac power to the meter control card.

K10 I/O Power Sense (YA102A)

- Pick
  - 5424/5422 +24V power supplies are up.
- Drop
  - Loss of 5424/5422 +24V power supply.
- Function
  - K10-1
    a. Provides path to hold K3 energized after a thermal fault or setting the POWER switch OFF.
    b. Provides path to supply +24V to regulator for main storage supply sequence/ sense circuits.
  - K10-2
    a. Provides a path for +24V to TP7 when +24V in 5424/5422 is not up. For +24V to appear on TP7, all –4V supplies, –12V or ±12V supply, ±3V 2560 supply (if installed), +6V supply, and +8.5V supply must be up.
    b. Provides the +24V supplies link in the power complete sequence chain.

NOTE : 24 Vdc supply is located in 5415 frame for systems without 5422/5424 installed.

K11 +60V Sense (YA102A)

- Pick
  - +60V supply in 5203 RPQ up to approximately +60V
- Drop
  - Loss of +60V output
- Function
  - K11-1
    a. Provides a path to hold K3 energized after a thermal fault or setting the POWER switch OFF.
    b. Provides a path to supply +24V to regulator for main storage supply sequence/ sense circuits.
  - K11-2
    a. Provides a path for +24V to TP8 when +60V in 5203 is not up. For +24V to appear on TP8, all –4V supplies, –12V/ ±12V supply, ±3V 2560 supply (if installed), +6V supply, +8.5V supply, +24V in 5424/5422
    b. Provides the +60V link in the power complete sequence chain.

Note: While it appears that K10 and K11 have duplicate functions, the holding on of K3 until +60V to the MFCU is down (K11-1 n/o) is sufficient justification for K11 being present.

COIL/RELAY FUNCTIONAL DESCRIPTIONS (Part 3 of 3)

K12 Power Sequence Complete

- Pick
  - All -4V power supplies sensed up (K5, K17, K19), -12V or ±12V power supply sensed up (K30, K2 in MLTA supply), ±3V power supply sensed up (K12), +6V power supply sensed up (K6), +8.5V power supply sensed up (K8), +24V in 5424/5422 and +60V power supply in 5203 sensed up (K11).

- Drop
  - Loss of any of the above supply outputs
  - OV/OC fault on -4V or +6V levels
  - UV fault on -4V level

- Function
  - K12-1
    a. Provides power sequence complete to 5203 and 5424
    b. Provides +24V to 2560 switch lines (2).
    c. Provides control line to 3411.
  - K12-2
    a. Provides +24V to PWR CHK light with POWER switch ON and K12 not picked, or with POWER switch OFF though K12 not picked and -4V No. 1 supply (K5) still up.
  - K12-3
    a. Enables picking of +6V UV fault relay (K15) but only after power sequence is complete (inhibits a +6V UV fault during a normal power up and power down sequence).
  - K12-4
    a. Disables 'power on reset' signal to CPU (clock 9 no longer on).

K13 -4V No. 1 (A gate) OV/OC Fault

- Pick
  - An overvoltage or overcurrent condition detected by -4V No. 1 (A gate) regulator.

- Drop
  - Pressing CHECK RESET with the POWER switch OFF.

- Function
  - K13-1
    a. Provides a path for +24V to TP12.
    b. Provides control of distribution of +24V to all sequence control circuits.
  - K13-2
    a. Provides a hold path for K13 requiring a manual reset to clear the fault indicator.

K14 -4V No. 1 (A gate) UV or +6V OV/OC Fault

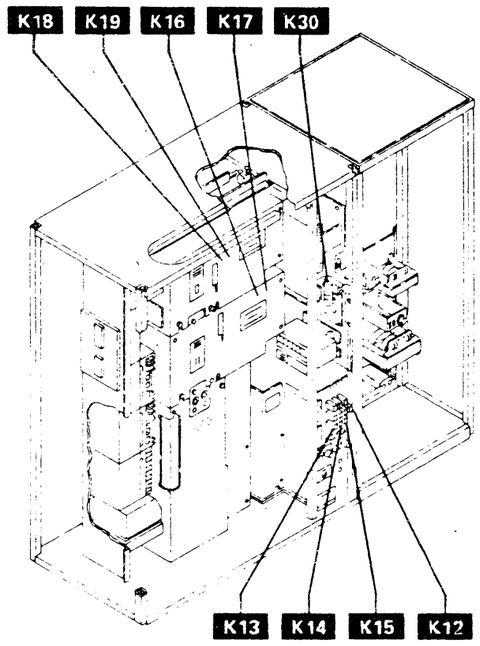
- Pick
  - An overvoltage or overcurrent condition detected by the +6V regulator.
  - An undervoltage condition detected by the -4V No. 1 (A-gate) UV sense circuit.

- Drop
  - Pressing CHECK RESET with the POWER switch OFF.

- Drop
  - Pressing CHECK RESET with the POWER switch OFF.

- Function
  - K14-1
    a. Provides a hold path for K14 requiring a manual reset to clear the fault indicator.
  - K14-2
    a. Provides a path for +24V to TP13.
    b. Provides control of distribution of +24V to all sequence control circuits.
  - K14-3 not used.
  - K14-4
    a. Inhibits picking of K15 when K14 is picked.

Note: K14-4 and K15-1 are used to prevent picking two fault relays when a power fault (OV/OC) occurs. When the system abruptly powers down and K3 is dropped, a race condition (to power down) exists for the -4V and +6V supplies. K14-4 and K15-1 eliminate erroneous test point indications.



K15 +6V UV Fault

K15 is used as a +6V UV detection sense relay and as a ±3V sequence sense (2560 feature) relay.

- Pick
  - A UV condition causing K6A-1 n/o points to close with power complete (K12-3 n/o points closed) and no -4V UV fault or +6V OV/OC fault (K14-4 n/c points closed).

- Drop
  - Pressing CHECK RESET with the POWER switch OFF.

- Function
  - K15-1
    a. Inhibit +24V to TP7 on +6V UV condition.
  - K15-2
    a. Provides a path for +24V to TP14.
  - K15-3
    a. Provides a hold path for K15 requiring a manual reset to clear the fault indicator.
  - K15-4
    a. Provides control of +24V to K9, K9A, and K9B coils and power up signal to 5203 RPQ

K16 -4V No. 2 OV/OC Fault

- Pick
  - An overvoltage or overcurrent condition detected by -4V No. 2 regulator.

- Drop
  - Pressing CHECK RESET with POWER switch OFF.

- Function
  - K16-1
    a. Provides a path for +24V to TP11.
    b. Provides control of distribution of +24V to all sequence control circuits.
  - K16-2
    a. Provides a hold path for K16 requiring a manual reset to clear the fault indicator.

K17 -4V No. 2 Sense

- Pick
  - -4V No. 2 output at approximately -4 Vdc

- Drop
  - Loss of -4V No. 2 output

- Function
  - K17-1
    a. Provides the -4V No. 2 link in the start-up control for the +6V regulator.
  - K17-2
    a. Provides a path for +24V to TP3 when -4V No. 2 level is not up. For +24V to appear on TP3, -4V No. 1 (A gate) and -4V No. 3 supplies must be up.
    b. Provides the -4V No. 2 link in the power complete sequence chain.

K18 -4V No. 3 OV/OC Fault

- Pick
  - An overvoltage or overcurrent condition detected by -4V No. 3 regulator.

- Drop
  - Pressing CHECK RESET switch with POWER switch OFF.

- Function
  - K18-1
    a. Provides a path for +24V to TP10.
    b. Provides control of distribution of +24V to all sequence control circuits.
  - K18-2
    a. Provides a hold path for K18 requiring a manual reset to clear the fault indicator.

K19 -4V No. 3 Sense

- Pick
  - -4V No. 3 output at approximately -4 Vdc

- Drop
  - Loss of -4V No. 3 output

- Function
  - K19-1
    a. Provides the -4V No. 3 link in the start-up control for the +6V regulator.
  - K19-2
    a. Provides a path for +24V to TP4 when -4V No. 3 level is not up. For +24V to appear on TP4, -4V No. 1 (A gate) supply must be up.
    b. Provides the -4V No. 3 link in the power complete sequence chain.

K30 -12V Supply Sense (BSCA)

- Pick
  - The BSCA -12V supply output is at approximately -12 Vdc.

- Drop
  - Loss of -12V supply output

- Function
  - K30-1
    a. Provides a path for +24V to TP9 when the -12V supply is not up.
    b. Provides the -12V link in the power complete sequence chain.

Note: If MLTA and BSCA features are installed, a ±12V supply is installed instead of the -12V supply. In that case, K2 is used to sense its output.