3010/2 POWER SUBSYSTEM

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INTRODUCTION

The Power Subsystem for GE-PAC* 3010/2 process computers controls and distributes AC and DC power throughout the system. The Power Subsystem consists of the control and distribution circuits and at least one System Power Supply module. Several other power supply modules may also be included.

REFERENCES

The following drawings provide information necessary and useful in understanding the Power Subsystem:

- Central System Cabinet Power Distribution Logic; 70C181679.
- System (Logic) Power Supply Schematic; GE drawing no. 71D102026 (INTERDATA dwg. no. 34-012R0xD08).
- 3010/2 Display Panel Schematic; GE drawing no. 71D102024 (INTERDATA dwg. no. 09-051R0xD08).

OPTIONS

Table THEORY. 1 lists the power supplies currently used in the 3010/2 Power Subsystem. The actual number of power supply modules, the types of modules implemented, and their locations are determined by the content and configuration of the system. At least one L1201 System Power Supply will be present in all systems to supply logic power to the basic Central Processor chassis.

Power Failure Detector and Automatic Restart Option

The Power Failure Detector and Automatic Restart features are implemented as a part of the basic 3010/2 Central Processor and actually consist of circuitry on the I/O board in the Processor. The Power Failure Detector monitors the primary AC input to the Central Processor and initiates automatic storage of the contents of the PSW and all General Registers into the core area specified by dedicated core address X'22', the register save pointer, if the line voltage decreases to 95 VAC or less, or drops out for more than one cycle. Central Processors A3503 and A3504 have these options and A3501 and A3502 do not.

The Power Failure Detector initiates the PSW and register storage micro-program sequence early enough that it is completed before the logic power supplied to the Central Processor drops below the operating level.

When AC power returns or is turned back on, a micro-program sequence restores the PSW and General Registers from the core storage area, and the running program may resume as if uninterrupted.

The PSW and register storage and restoration micro-program sequences take place in all Central Processors when the system is initialized by pushing the INT button on the Control Console (Display Panel), whether the Power Failure Detector is implemented, or not. If the Power Failure Detector is not implemented, the system may not be initialized early in the power off sequence, and a restart cannot be made without manual intervention.

If the Power Failure Detector is not implemented, the system should be initialized before turning power off. If it is, the PSW and General Registers will be restored when power is turned back on, and the program can resume where it left off.

Automatic Restart Inhibit Timer

The B1401 Automatic Restart Inhibit Timer is manually adjustable to any time from one minute to 10 minutes, by means of a calibrated dial. This timer prevents automatic restarts after power has been off so long that a safe restart of the computer and its control of the process cannot be made without manual intervention.

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THEORY OF OPERATION

AC DISTRIBUTION

Fig. THEORY. 1 is a simplified schematic of the 3010/2 AC distribution subsystem. A detailed schematic of the AC distribution within the Central System Cabinet (CSC) is provided in the 3010/2 Power Distribution logic on drawing no. 70C181679. The schematics show the distribution for the maximum configuration. As a minimum, a 3010/2 CSC will have a Power Entry panel (PE), an AC Distribution Panel (VAC), a blower assembly, and a System Power Supply (VL1). Other power supplies, an Analog Power Supply Panel (VGA), a Control Power Supply (CP), and termination cabinets are added as required by the system configuration.

CB1 in the PE panel controls the AC supply to the entire CSC and provides protection to the distribution system which brings power to the CSC in the event of a short within the CSC. The PE panel is at the bottom of the left side of the CSC, as viewed from the rear. The Automatic Restart Inhibit Timer, if present, completes the path from CB1 to the VAC panel, unless the timer has run out. If the timer is not present, the connection to VAC is direct. The timer's operation is described under the Automatic Restart Inhibit Timer heading. The VAC panel is in the swing-out page assembly at the rear of the CSC.

CB3 and CB4 control the distribution of power to up to five System Power Supplies, VL1 through VL5. These power supplies are normally controlled by the keyswitch on the CSC's Display Panel. The keyswitch applies a 12 VAC control signal from VL1 to relay K1 in each of the VL supplies, and the relay contacts apply sequenced power to the step-down transformer and DC power supplies. The relay contacts also apply sequenced power to the fans in the card file(s) served by each VL supply. A simplified schematic of the VL input circuit is provided on Fig. THEORY. 2.

If an Analog I/O Subsystem is present, a VGA assembly will be installed in the page assembly at the rear of the CSC. VGA mounts the power supplies used by the Analog I/O Subsystem and K1 on VGA controls the application of AC power to the analog power supplies. K1 is energized when the VL supply powering the basic Analog I/O Controller is on, so the analog subsystem power supplies are on at the same time as that VL supply.

Where process I/O Termination Cabinets are present, a Control Power Supply (CP) is mounted in the page assembly at the rear of the CSC. 115 VAC is applied to CP when the VL supply powering the basic Digital and/or Analog I/O Controllers is on, and the 24 VDC output from CP energizes an AC control relay in each of the termination cabinets. The AC control relay contacts apply AC power to the power supplies in the Termination Cabinet(s). The Termination Cabinets are normally supplied from the same AC distribution system as the CSC, and each such cabinet has its own power entry panel with a main circuit breaker. The control relay contacts are in the output lines from the circuit breaker.

DC POWER SUPPLIES

Table THEORY. 1 lists the standard DC power supplies used in GE-PAC 3010/2 systems. The power supply output, tolerances, and system functions are listed. Note that designators such as VL1 and VG2 are given with the functions. These designators are marked on the power supply modules. The theory of operation for all of the DC supplies except L1201 and L1101 System Power Supplies (VL), and the two 28V supplies L3201 and L3701, is provided in the vendor manuals supplied with the equipment. The vendor manuals should be found under the Power Supplies tab in the 3010/2 Maintenance Manual shipped with each system. Theory descriptions for L1201, L1101, L3201 and L3701 are provided in this publication. Maintenance instructions for all of the power supplies are provided in the Power Supplies section of the 3010/2 Maintenance Manual. Adjustments should be made only as described in the Power Supplies section of the maintenance manual.

L1201 System Power Supply

The L1201 System Power Supply (VL) provides logic power to the basic Central Processor chassis, and may also be used to supply logic power to any expansion chassis. Some 3010/2 systems use both L1201 and L1101 System Power Supplies. L1101 is used to power 10" vertical air-flow chassis only, and is described under the L1101 System Power Supply heading.

The 115 VAC input to all VL supplies is brought through a control circuit as described under the AC Distribution heading, and as shown on Fig. THEORY. 1 and Fig. THEORY. 2. The regulated outputs from L1201 are connected to DC busses on the chassis served by the supply. The output cable from L1201 supplies is connected to the interior of the supply and fastens to the DC busses by means of clip-on connectors.

The L1201 schematic is on INTERDATA drawing no. 34-012R0xD08 and GE drawing no. 71D101026. The L1201 VL supply has the following characteristics:

- Input - 115 VAC ±10%, 47 to 63 Hz, approximately 6 amperes input current when fully loaded.

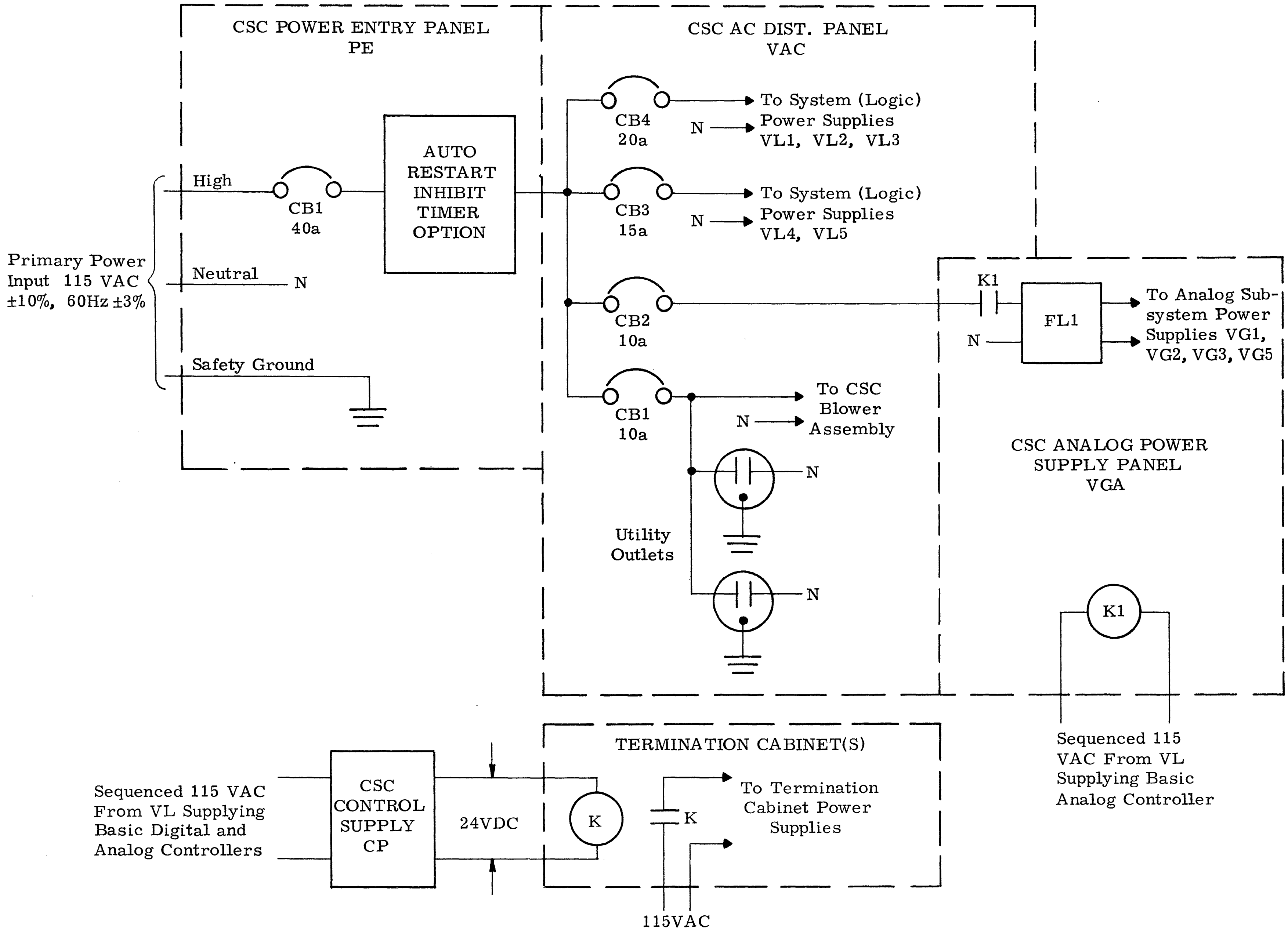
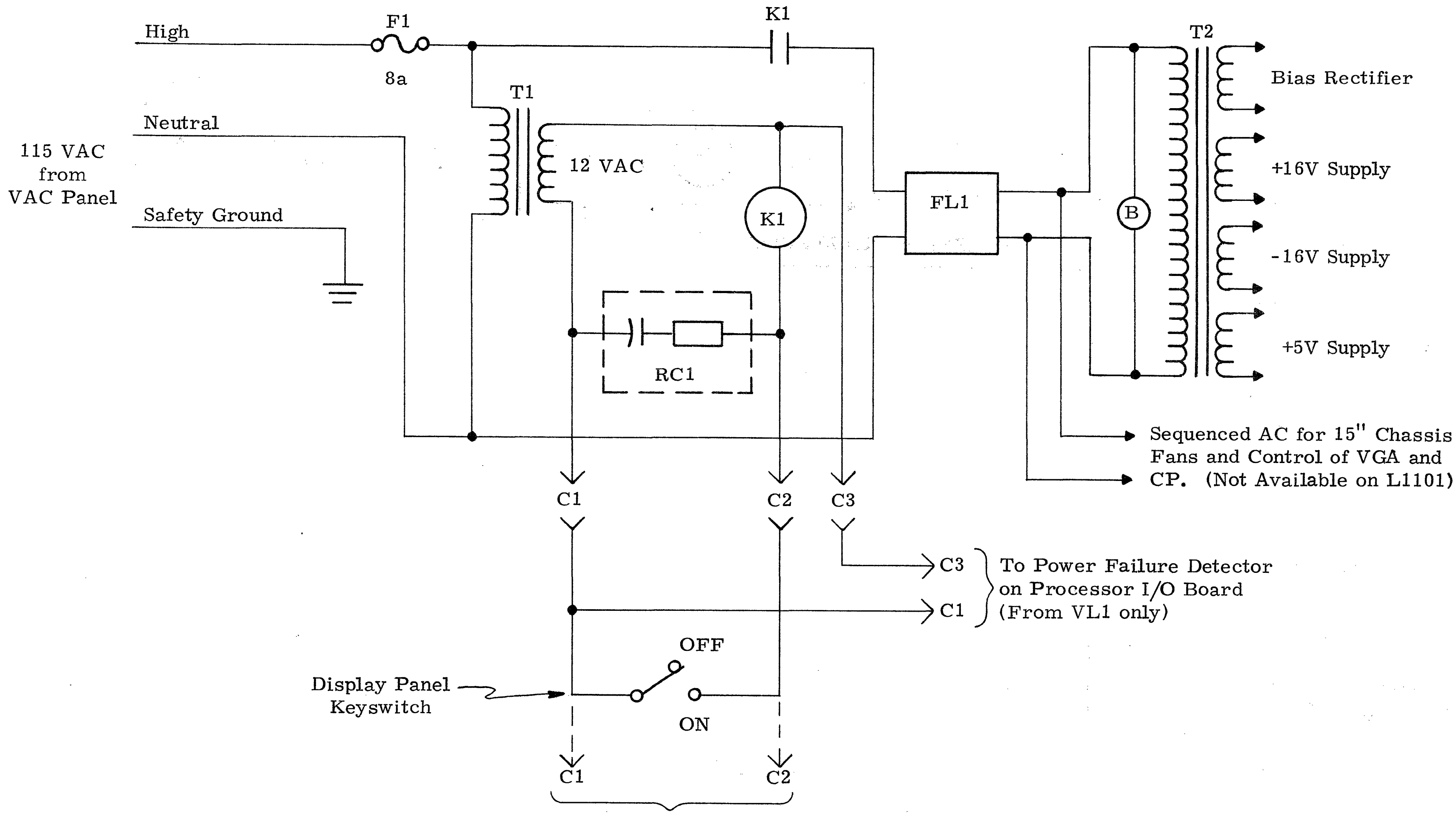


Fig. THEORY. 1 Simplified Schematic, AC Distribution



Where other VL's are to be sequenced by the same keyswitch, C1 and C2 are connected in parallel so that the switch will pick-up K1 in each supply. VL's serving Multiplexer Bus common to more than one Processor are normally not sequenced and C1 is jumpered to C2 on such supplies.

Fig. THEORY. 2 Simplified Schematic, VL Input Control Circuit

- Outputs - +5 VDC @ 24 amps. max. +16VDC nominal @ 3 amps. max. - 16V nominal @ 3 amps. max. When the supply serves Core Memory modules, the 16V outputs are temperature programmed as indicated on Fig. THEORY. 3.

- Regulation - ±1% of the output voltage; line, load, ripple, and transient effects combined. Ripple does not exceed 30 millivolts peak to peak.

- Short Circuit Protection - The components are not damaged by a shorted output. Each output is protected by a fuse which blows when the output is shorted or when the overvoltage crowbar fires.

- Overvoltage Protection - SCR crowbars across each of the outputs conduct when the output voltage is excessive. Firing points are 6.0V for the +5V output and 19.5V for the 16V outputs.

+5V Supply

This supply uses eight series pass transistors to regulate and smooth the raw DC from a full-wave rectifier. CR5 and CR6 form the full-wave rectifier. Q9 through Q16 are the series pass transistors. R4 through R11, 0.15 ohm resistors, aid in equalizing the current flowing through each of the series pass transistors. F5, a 30 amp. fuse, is in series with the output.

The +5V regulator's amplifier is a differential amplifier consisting of two stages, Q112 and Q113. This amplifier compares the +5V output with a stable +9V reference voltage developed across zener diode VR102. The output from Q113 is applied to the series pass transistors through emitter followers Q111 and Q8. The output signal contains both DC and AC components which hold the DC output within tolerance and aid in cancelling out ripple and noise.

The accuracy and stability of a differential amplifier is improved if the collector current supplied to it is essentially constant over a wide range of operating conditions. Q110 is a constant current source for the amplifier. The current flowing through Q110 is held fairly constant because a stable voltage (approx. +21V) is applied to its base from the bias supply which appears at the top of the schematic. The emitter follower action of Q110 holds the voltage at its emitter fairly constant so the current flowing through R139, Q110, and the differential amplifier is fairly constant.

+16V Supply

The operation of the +16V supply is quite similar to that of the +5V supply. This supply uses only two series pass transistors, Q2 and Q3. CR1 and CR2 form the full-wave rectifier, and F2, a 5 amp. fuse is in series with the output.

Q103 and Q104 operate as a differential amplifier whose output is applied to the series pass transistors through emitter followers Q102 and Q1. Q101 is a constant current source for the amplifier.

Inputs TA and TB to the supply are connected to the temperature sensor terminals on the chassis served by the supply. If the chassis contain Core Memory modules these terminals are connected to a thermistor on the memory PWB. If the supply does not serve core, a 1000 ohm resistor is connected across the terminals. If the thermistor is connected, the 16V outputs are temperature programmed as indicated by Fig. THEORY. 3. If the 1K resistor is connected, the supplies are adjusted to and remain at 16V ±1%. The thermistor changes the output voltage by changing the operating point of the differential amplifier. The -16V supply tracks the output of the +16V supply.

-16V Supply

The operation of this supply is similar to the others except that the differential amplifier monitors both the +16V and -16V outputs, so that the -16V output always tracks the +16V output within ±50 millivolts.

CR3 and CR4 form the full-wave rectifier, and the output passes through F3 a 5 amp. fuse. Because a negative output is required, the series pass transistors are in the ground return line from logic ground to the positive side of the full-wave rectifier. Two series pass transistors are used, Q5 and Q6.

Q107 and Q108 are the differential amplifier and the output from Q107 is applied to the series pass transistors through emitter followers Q5 and Q6. The constant current source for the differential amplifier is Q118. In some early units, Q118 was not present and the emitters of Q107 and Q108 were tied to +16V through R135. See Note three on the schematic (revision R02 or above).

Crowbars

The crowbar circuits consist of a voltage divider, a transistor, and a silicon controlled rectifier. All three circuits are virtually identical. The transistors are normally not conducting. Should the output voltage increase to the firing point, the transistor will conduct, and pull the gate of the SCR up to fire it. The SCR turns on very quickly, shorting the output until the fuse blows.

Each of the voltage dividers on the bases of the transistors includes a firing point adjustment pot. which is set to fire at 6V or 19.5V. These pots. are normally not adjusted in the field.

Bias Supply

CR101 is a full-wave bridge rectifier with a DC output of about 10V. C101 is a filter capacitor which reduces the ripple to an acceptable level. The negative side of the bias supply is tied to +16V so the positive output is at about +26V. VR101 is a shunt regu-

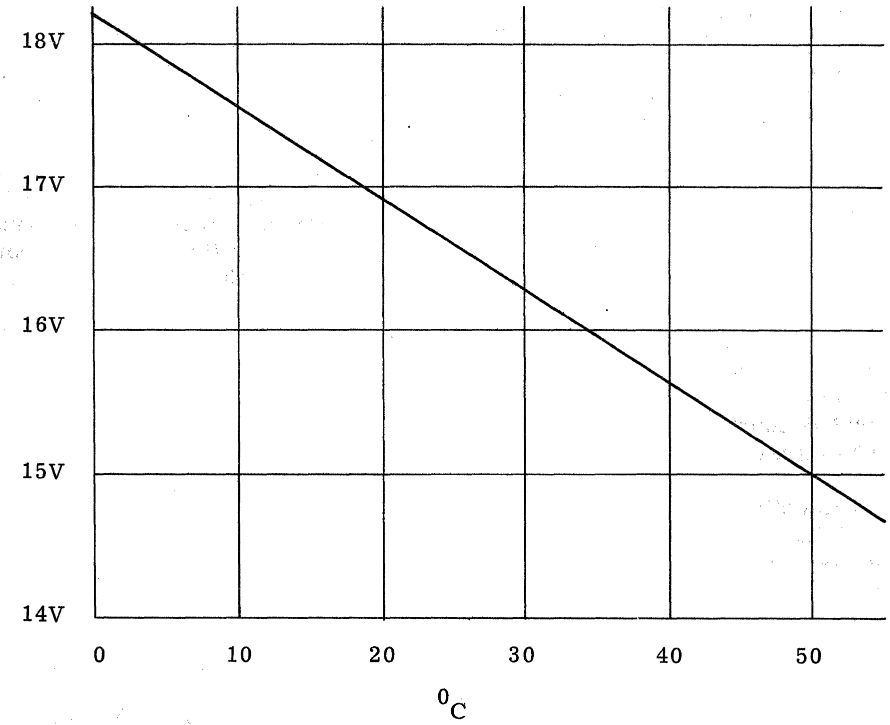


Fig. THEORY.3 16V Supplies, Voltage vs. Temperature

lator which produces a fairly stable DC output at about +21V that is used as the base voltage for each of the constant current source transistors. Q115 is a fourth constant current source that supplies breakdown current to zener diode VR102. The temperature stability of the +9V output at the cathode of VR2 is improved by maintaining fairly constant current through VR102 under all operating conditions. The 9V output is used as a stable reference voltage by the differential amplifiers in the +5V and +16V supplies.

L1101 System Power Supply

The L1101 System Power Supply is used in some 3010/2 systems to provide power to a 10" vertical air-flow expansion chassis.

The input control circuit is similar to that of L1201 and as depicted on Fig. THEORY.1 and Fig. THEORY.2. The regulated outputs are connected to DC busses on the chassis served by the supply. The output cable from L1101 supplies connects to a terminal board on the supply and to TB26 on the expansion chassis.

The L1101 schematic is on INTERDATA drawing no. 34-007M01D08 and on GE drawing no. 71D102018 (formerly 70B113024). The L1101 VL supply has the following characteristics:

- Input - 115 VAC ±10%, 47 to 63 Hz., approximately 6 amperes input current when fully loaded.
- Outputs - +5 VDC @ 20 amps. max. +16 VDC @ 6 amps. max. -16VDC @ 6 amps. max. The 16V supplies are not temperature programmed. In this application, a 1000 ohm resistor is connected across the temperature sensor inputs at TB26-7 and TB26-8.
- Regulation - ±1% of output voltage, line, load, and ripple effects combined.
- Short Circuit Protection - Output current is limited to 130% of rated output when shorted to ground or other outputs. Supply is not damaged by shorted outputs.
- Over Voltage Protection - SCR crowbar across +5V output conducts when output is excessive. Firing point ranges from 5.5 to 7.5V.

+5V Supply

This supply uses an integrated circuit amplifier/sensor to control the conduction of seven series pass transistors which hold the DC output within tolerance. CR4 and CR5 form a full-wave rectifier which supplies raw DC to the series pass transistors, Q1 through Q7. The output of the amplifier is applied to emitter follower Q15, which in turn drives another emitter follower, Q8, and then Q1 through Q7.

CR1 is a full-wave bridge rectifier which provides bias voltage to the amplifier/sensor and to Q15.

Zener diode VR1 and R1 form a shunt regulator which holds the bias supply at about +5V with respect to the +5V output or +10V with respect to ground.

Overvoltage sensor Q16 is normally not conducting, but should the +5V output rise to the trip point, Q16 will conduct, raising the gate on the crowbar, Q21 to the firing point, and shorting the output. When Q21 is conducting, approximately one volt is across the +5V output terminals.

The output voltage adjustment is R5, which is accessible at the exterior of the power supply. R8 is used to set the current output limit at 130% of the rated output current. R15 is used to set the over voltage crowbar trip point. R8 and R15 are not normally adjusted in the field.

16V Supplies

The +16V supply uses an integrated circuit amplifier/ sensor which drives emitter follower Q1. Q1 in turn drives four series pass transistors Q9 through Q13, which hold the output within tolerance. CR6 and CR7 form a full-wave rectifier which supplies raw DC to the four series pass transistors.

CR3 is a full wave bridge rectifier which provides bias voltage to regulator circuitry in the +16V supply. VR3 and R2 form a shunt regulator which holds the bias voltage to about +5V with respect to the +16V output or +21V with respect to ground.

The -16V supply uses all discrete circuits. Once adjusted, the -16V output tracks the +16V output within about ±0.5%. Q18 is a sensor amplifier which monitors the +16V output and drives emitter follower Q27, which in turn, drives the four series pass transistors Q22 through Q26. Q19 and Q20 are output current sensors, which drive current limiter Q21.

For the +16V supply, R22 is the output voltage adjustment, and R18 is the current limit adjustment. R22 is accessible from the exterior of the supply. R18 is not normally adjusted in the field.

For the -16V supply, R29 is the output voltage adjustment, and R32 is the current limit adjustment. R29 is accessible from the exterior of the supply. R32 is not normally adjusted in the field.

28V POWER SUPPLIES

The L3201 (5 a.) and L3701 (10 a.) power supplies are typically used as digital input contact power supplies, and are usually installed in the rear rack of a Termination Cabinet. Internally, these supplies are identical to Power Supply Models 4290Ax11 (5 a.) and 4290Ax21 (10 a.). The schematics are the same as used for the 4290 versions: 68A998942 (5 a.) and 68A998331 (10 a.). The outputs are adjusted to 28 VDC and in normal operation regulation is ±3% of the output voltage, under all conditions of line, load, ripple and noise.

The circuitry for both of the supplies is similar. The principal difference is the number of series pass transistors used to convert the raw DC to regulated 28V. The 5 ampere supply uses 5 series pass transistors and the 10 amp. supply uses ten.

The step-down transformers use a ferroresonant winding to improve line regulation. The winding is tuned with a capacitor which is selected according to the power line frequency.

In addition to the main full-wave rectifier, each of the supplies uses a 10V bias supply to provide collector current to the single stage regulator amplifier. The amplifier emitters are tied to a stable 5V reference voltage and the bases are connected to an output sensing and adjustment voltage divider. The output from the collector of each amplifier contains both DC and AC components which are applied to the series pass transistors through an emitter follower. The DC component causes the pass transistors to maintain the DC output within tolerance and the AC component aids in cancelling out ripple and noise.

Either the positive or the negative output from the supplies may be grounded. The supplies are protected from shorted outputs by a circuit breaker in the AC input lines which will open if the output is shorted. The overvoltage crowbar and sequencer circuits which appear on the schematic drawings are not used in this application.

AUTOMATIC RESTART INHIBIT TIMER

Any 3010/2 Central Processor which incorporates the Power Failure Detector will restart automatically at the point at which the program was interrupted if the Processor is in the Run mode when power returns.

In situations where the computer's control of a process cannot be safely resumed after some critical time period has passed, an Automatic Restart Inhibit Timer is implemented in the CSC's Power Entry (PE) panel. The timer is adjustable from one minute to 10 minutes by a calibrated dial on its top. When the safe restart period has passed, the timer opens AC line at the output from the PE panel, preventing the application of power to any of the CSC supplies, and any supplies under control of the CSC.

The schematic of the AB1401 Automatic Restart Inhibit Timer is on sheet 2 of the 3010/2 CSC Power Distribution Logic, 70C181679, and in simplified form on Fig. THEORY.4.

If the timer is present and power is to be applied to the CSC for the first time or after the timer period has elapsed, the momentary Reset switch on the top of the timer assembly must be pushed to energize timer relay KT. When KT is not energized but AC power is present, the Reset lamp at the top of the timer is lit, to indicate that power is present and that KT must be reset to allow power to be distributed throughout the CSC.

The sequence of events if the primary power fails and returns before the timer period runs out is as follows:

1. KT is energized and a KT contact set applies power to the VAC Panel and the remainder of the CSC.

2. Power fails - a mechanical timer in KT starts running, and while it is running, the KT contacts retain the same condition as if KT was energized.

3. Before the timer runs out, power returns, the KT timer stops, resets, and the contacts remain in the energized condition. AC is again applied to the VAC panel, the Power Failure Detector in the Central Processor senses the return of power, and after sufficient time for logic power to return releases the system initialize line (SCLR0).

4. The micro-program restores the PSW and General Registers from where it stored them on power failure, and resumes instruction sequencing.

The sequence of events if the primary power fails and does not return until the timer runs out is as follows:

1. Steps 1 and 2 in the preceding sequence occur.

2. The timer runs out before power returns, and the KT contacts return to their normally open and normally closed positions.

3. Power returns. The Reset lamp lights, but KT cannot energize until the Reset switch is pushed. The operator does whatever is necessary to prepare the computer and the process for a restart, pushes the Reset switch, and, if necessary, manually restarts the computer.

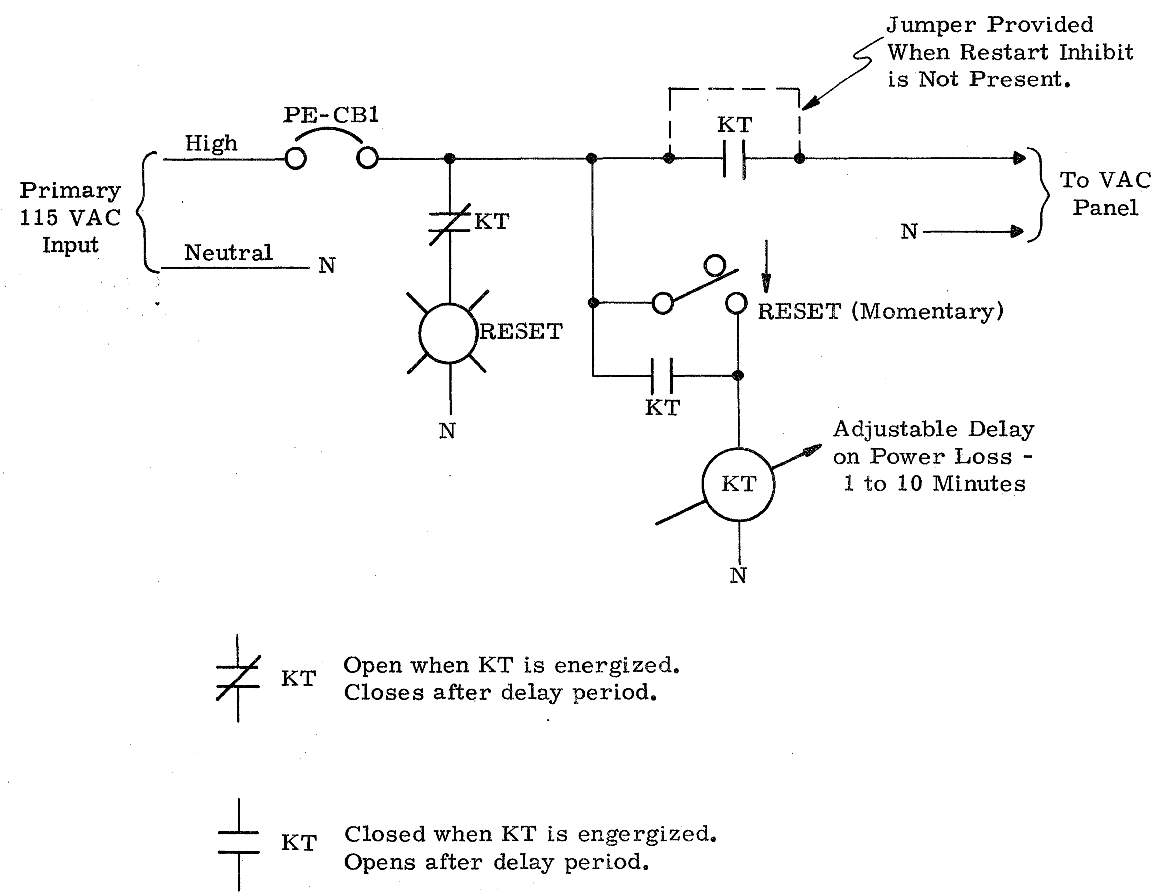


Fig. THEORY. 4 Simplified Schematic, Auto. Restart Inhibit Timer

Model Number	Outputs	Output Tolerance	Purchase Spec.	Vendor Part #	Typical Use
AL1101	+5V 24a +16V 6a* -16V 6a*	±1%		34-007 (INTERDATA) PEC 3388B (North Electric)	Logic supply for 10" vertical air-flow expansion chassis; VL2 through VL5.
AL1201	+5V 20a +16V 3a -16V 3a	±1%		M49-002 (34-012) (INTERDATA) PEC 3560 (North Electric)	System Logic Supply, up to 5 per CSC; VL1 through VL5.
AL1301	5V 30a	±.1% + 5mv	68A8480P00811	ACDC OEM5N35	General purpose 5V helper supply; VH1.
AL2101 AL2103	28V 4a		70A112360P1 70A112360P3		Digital Input Termination Supply. 2101 = 60 Hz; 2103 = 50 Hz.
AL2102 AL2104	48V 4a		70A112360P2 70A112360P4		Digital Input Termination Supply. 2102 = 60 Hz; 2104 = 50 Hz.
AL3101	48V 2.5a	±.5%	68A8479P101	ACDC BC48N2.5-1	Digital Input Termination Supply; 256 points.
AL3102	48V 5a	±.5%	68A8479P102	ACDC BC48N5.0-1	Digital Input Termination Supply; 512 points.
AL3201	28V 5a	±3%	68A8457P112		Digital Input Termination Supply; VX1.
CL3201	28V 2.5a	±.1% + 5mv	68A8480P01111	ACDC OEM28N2.9	28V Termination Cabinet Supply.
CL3301 CL3302	125V 10a	±10%	68A8456P111 68A8456P121		125V Digital Input Termination Supply. 3301 = 60 Hz; 3302 = 50 Hz.
AL3401	24V 1.5a	±.1% + 5mv	68A8480P00610	ACDC OEM24N1.8	Control Power supply in CSC, controls turn-on of supplies in Termination Cabinets; CP.
AL3501	12V 1a	Line ±.05% + 4mv; Load ±.03% + 3mv	68A8468P211	Lambda LMB-12; North Elec. N1102A	Input and Output Buffer Relay Supply, CSC and Termination Cabinets; VX2.
AL3601	10V 2.25a	±.05%	68A8455P80011		RTD Supply, Termination Cabinet, VW1.
BL3601 BL3602	10V 2.6a 10V 5.2a	Line ±.05% + 4mv; Load ±.03% + 3mv	68A8468P020	North Elec. N11010A	RTD Supply, Termination Cabinet. BL3602 is two supply modules.
AL3701	28V 10a	±3%	68A8451P112		Digital Input Termination Supply; VX1.
BL3701	28V 10a	±3%	68A8451P112		Digital Input Termination Supply.
CL3701	28V 6a	±.5%	68A8480P00911	ACDC OEM28N6.7	Digital Input Termination Supply.
AL3801	12V 5a	Line ±.05% + 4mv; Load ±.03% + 3mv	68A8468P281	Lambda LXS-C-12	Input and Output Buffer Relay Supply, CSC and Termination Cabinets; VX2.
BL3801	12V 5a	Line ±.05% + 4mv; Load ±.03% + 3mv	68A8468P281	Lambda LXS-C-12	Input and Output Buffer Relay Supply, CSC and Termination Cabinets.
CL3801	12V 5a	±.1% + 5mv	68A8480P00311	ACDC OEM12N5.8	Input and Output Buffer Relay Supply, CSC and Termination Cabinets.
BL4001	15V 1.4a	Line ±.05% + 4mv; Load ±.03% + 3mv	68A8468P161	Lambda LM-227	Analog I/O Supply (CSC); VG1.
BL4002	28V 1.2a	Line ±.05% + 4mv; Load ±.03% + 3mv	68A8468P171	Lambda LM-228	Analog I/O Supply (CSC); VG2.
BL4003	+22V .24a -22V .24a	Line ±.05% + 4mv; Load ±.03% + 3mv	68A8468P231	Lambda LCD-4-33	Analog I/O Supply (CSC); VG3.
BL4004	+22V 1.2a -22V 1.2a	±.01%	68A969566P101	ACDC BX22D1.2-3	Analog I/O Supply; VG3
BL4101	+15V .34a -15V .34a	Line ±.05% + 4mv; Load ±.03% + 3mv	68A8468P301	Lambda LXD-3-152	Absolute Analog Output Supply; VG5.
BL4201	+15V 1.2a -15V 1.2a	Line ±.05% + 4mv; Load ±.03% + 3mv	68A8468P311	Lambda LXD-C-152	Absolute Analog Output Supply; VG5.

NOTES:

1. Model numbers are the last 6 digits of the complete number. Example; AL1201 is 4DP3010AL1201.
2. Power supply vendors are as of the date of publication. New vendors may qualify. Detailed information on supplies with vendor part numbers is provided in the vendor manuals shipped with each system incorporating the supplies, except for AL1101, AL1201, AL3201, and AL3701, which are covered in this publication.
3. Function designators such as VG1, VL1, etc., are marked on or by the supplies, and are typical only. Other designators may be used in some configurations. The actual power supply complement of a system is determined by the system configuration.

* Temperature programmed, see text.

Table THEORY.1 DC Power Supplies