MODEL
ATE 100-5M
POWER SUPPLY

SERIAL # F30094 REV.7

ORDER NO.	REV. NO
C295024	

AN ISO 9001 COMPANY

KEPCO®

THE POWER SUPPLIER™

SINCE 1946

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INSTRUCTION MANUAL

ATE 100-5M

POWER SUPPLY

AUTOMATIC TEST EQUIPMENT

KEPCO INC.
An ISO 9001 Company.

MODEL
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IMPORTANT NOTES:

1) This manual is valid for the following Model and associated serial numbers:

MODEL	SERIAL NO.	REV. NO.

2) A Change Page may be included at the end of the manual. All applicable changes and revision number changes are documented with reference to the equipment serial numbers. Before using this Instruction Manual, check your equipment serial number to identify your model. If in doubt, contact your nearest Kepco Representative, or the Kepco Documentation Office in New York, (718) 461-7000, requesting the correct revision for your particular model and serial number.

3) The contents of this manual are protected by copyright. Reproduction of any part can be made only with the specific written permission of Kepco, Inc.

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KEPCO® THE POWER SUPPLIER™

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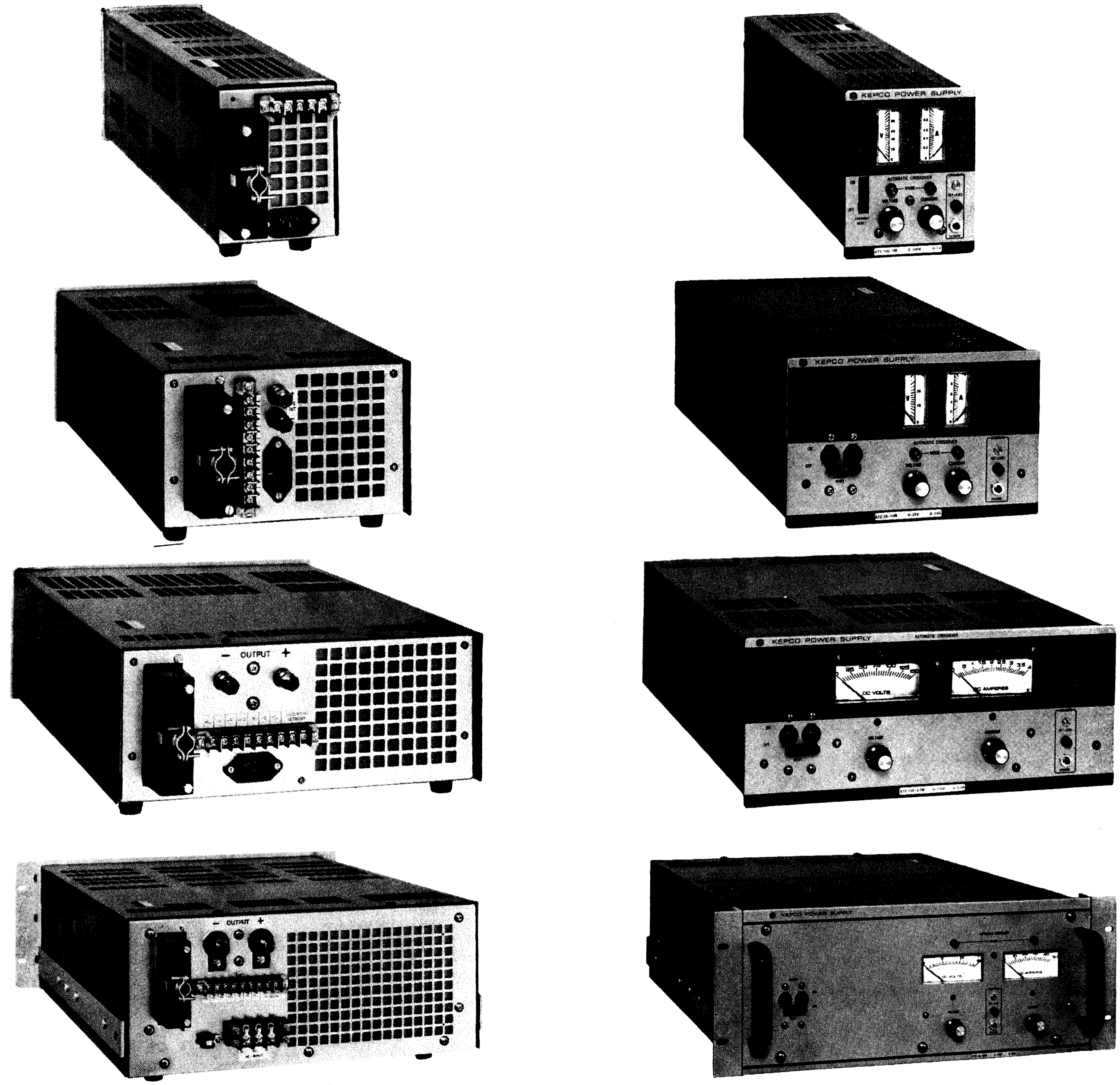


FIG. 1-1 KEPCO ATE POWER SUPPLIES.

(From Top: Size A, B; Size C; Size D; Size E).

1-10 MISCELLANEOUS FEATURES

a) CONTROL/PROGRAMMING

1) VOLTAGE CHANNEL: Output voltage is controlled continuously throughout the range by a panel-mounted, 10-turn rheostat. External control can be exercised by resistance or by a control voltage (See Section III).

2) CURRENT CHANNEL (INTERNAL): Output current is controlled continuously throughout the range by a panel-mounted, 10-turn potentiometer. External control can be exercised by resistance or by a control voltage (See Section III). When controlling the external current channel, the power supply's panel-mounted current control serves as an adjustable maximum current limit.

3) CURRENT CHANNEL (EXTERNAL): Output current may be controlled by means of a separate current channel, applying a 0 to 1V d-c control signal at the REAR PROGRAMMING CONNECTOR, for control over the rated current range. This same channel, properly programmed, may control the output of the power supply responding to control and feedback voltages from temperature or pressure sensors, chemical reactions and the like (See Section III).

4) OVERVOLTAGE PROTECTOR. The crowbar level may be controlled locally by the provided CROWBAR LEVEL control at the front panel. Remote control of the crowbar level can be exercised by connecting a 0—10 volt control source to the REAR PROGRAMMING CONNECTOR. Automatic tracking of the crowbar level with the output voltage level may be achieved by means of the simultaneous connection of the voltage channel programming source to the tracking input.

b) MODE FLAG: A pair of panel LED indicators operate to indicate whether the voltage channel or the internally-sensed current channels have control of the output. In addition, an isolated flag signal is provided through an opto-isolator at the rear programming connector.

c) REMOTE ERROR SENSING: Separate voltage-sensing terminals permit 4-wire connections to a load. Will compensate for static load effects up to 0.5V per lead. An additional 1 volt ouput voltage, beyond the nominal voltage rating of each ATE model, is provided for this purpose.

d) REFERENCE SUPPLIES: Two dual reference sources are available at the REAR PROGRAMMING CONNECTOR: ±6.2V d-c @ 1mA and ±15V d-c @ 10mA.

1-11 MECHANICAL SPECIFICATIONS

a) Refer to the "Mechanical Outline Drawing", FIG. 1-2.

1-12 ACCESSORIES

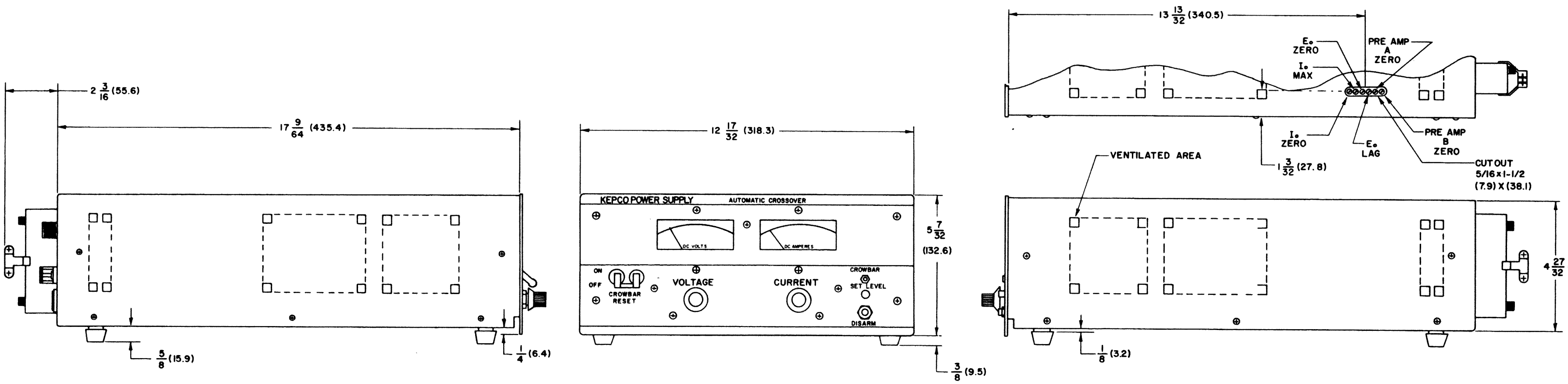
1-13 ATE power supplies are supplied with one Model PC—12 Programming Connector, mounted and wired for front panel output control. Additional connectors are optional and may be ordered as MODEL PC—12 (unwired). ATE models smaller than full-rack size can be rack-mounted using one of several Kepco Rack Adapters:

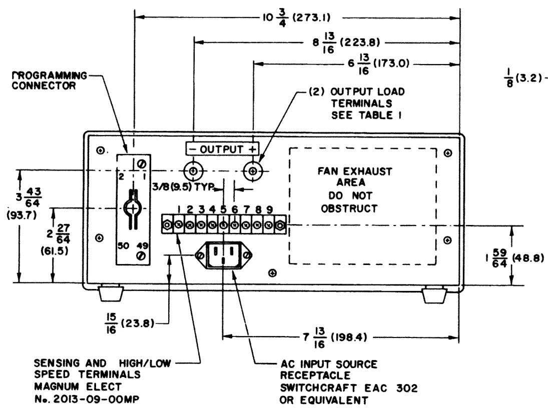
NOTE: ALL KEPCO RACK ADAPTERS FIT STANDARD EIA RACK DIMENSIONS. THEY ARE DRILLED FOR STANDARD CHASSIS SLIDES AND ARE PROVIDED WITH SLIDE SUPPORT BRACKETS.

a) RACK ADAPTER, KEPCO MODEL RA—24. For all Kepco quarter-rack, half-rack and three quarter-rack models, or a mixture of them. Filler panels to cover empty slots, if the adapter is not used to its full capacity, are available.

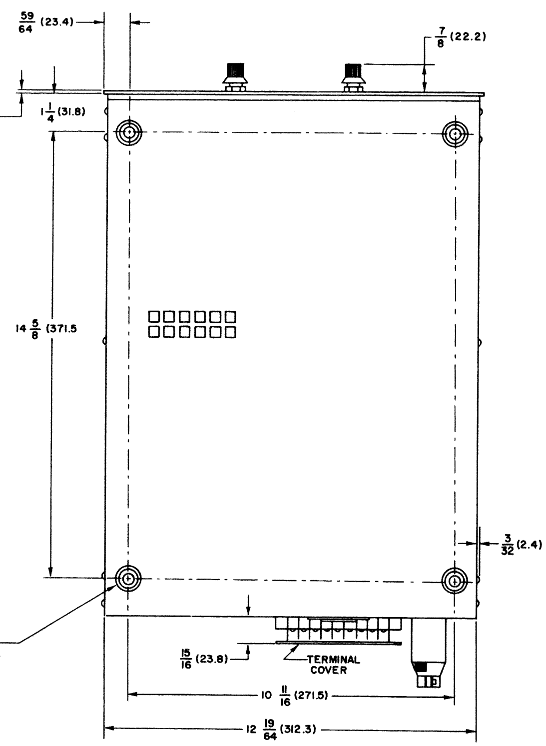
b) RACK ADAPTER, KEPCO MODEL RA—32. For (two) Kepco quarter-rack models or (one) half-rack model. Has additional space for (three) one-sixth rack modular Kepco units. Filler panels to cover empty slots, if the adapter is not used to its full capacity, are available.

c) RACK ADAPTER, KEPCO MODEL RA—37. ***For Kepco ATE models only.*** Accepts quarter-rack, half-rack or three quarter-rack ATE models or a mixture of them. The model RA-37 can be used without filler support brackets when fully loaded.





REAR VIEW



SENSING AND HIGH/LOW SPEED TERMINAL FUNCTIONS

1 (-) CO
2 (-) SENSING
3 (-) OUTPUT MONITOR
4 GROUND
5 (+) OUTPUT MONITOR
6 (+) SENSING
7 (+) CO
8 } GROUNDING
9 } NETWORK

NOTES:

1) THIS DRAWING IS FOR THE FOLLOWING MODELS:
ATE 6–50M, ATE 15–25M, ATE 25–20M, ATE 36–15M
ATE 55–10M, ATE 75–8M, ATE 100–5M, ATE 150–3.5M
2) MATERIAL:
A) CHASSIS AND BACK PLATE: NO. 16 GA (.059) C.R.S.
B) FRONT PANEL: 1/8 THICK ALUMINUM.
C) COVER: NO. 18 GA (.047) C.R.S.
3) FINISH:
A) CHASSIS AND BACK PLATE: CADMIUM PLATE WITH CHROMATE WASH.
B) FRONT PANEL: LIGHT GRAY PER FEDERAL STD 595, COLOR NO. 26440.
C) COVER: CHARCOAL GRAY VINYL TEXTURE.
4) RACK MOUNTING: REMOVE (4) FEET FROM BOTTOM OF CHASSIS.
5) (4) PLASTIC MOUNTING INSERT UNDER FEET, FOR 8-18 x 5/8 SELF-THREADING SCREWS (WITH 1/8 THICK MOUNTING PLATE).
6) DIMENSIONS IN PARENTHESIS ARE IN MILLIMETERS.
7) TOLERANCES:
A) BETWEEN MOUNTING HOLES ±1/64 (±0.4).
B) ALL FRONT PANEL DIMENSIONS TO MIL-STD 189.
C) ALL OTHER DIMENSIONS ±1/32 (±0.8), EXCEPT AS NOTED.

TABLE I

MODELS	OUTPUT TERMINALS
ATE 6-50M ATE 15-25M	BURNDY K2 C17
ATE 25-20M ATE 36-15M ATE 55-10M ATE 75-8M ATE 100-5M ATE 150-3.5M	SUPERIOR ELECT TYPE DF 30

FIG. 1-2 MECHANICAL OUTLINE DRAWING

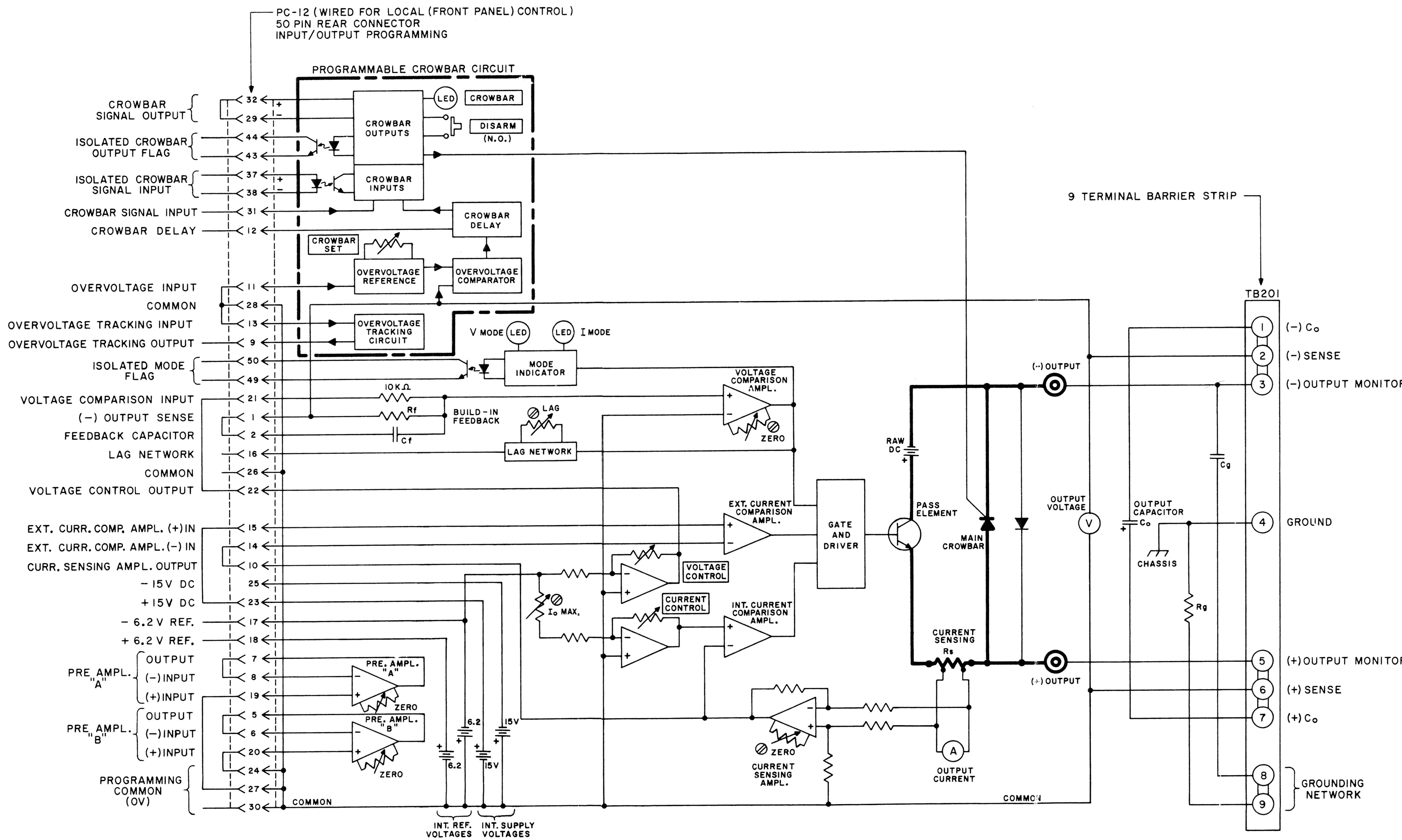


FIG. 4-6 ATE 1/2 RACK, 3/4 RACK AND FULL RACK, SIMPLIFIED SCHEMATIC DIAGRAM

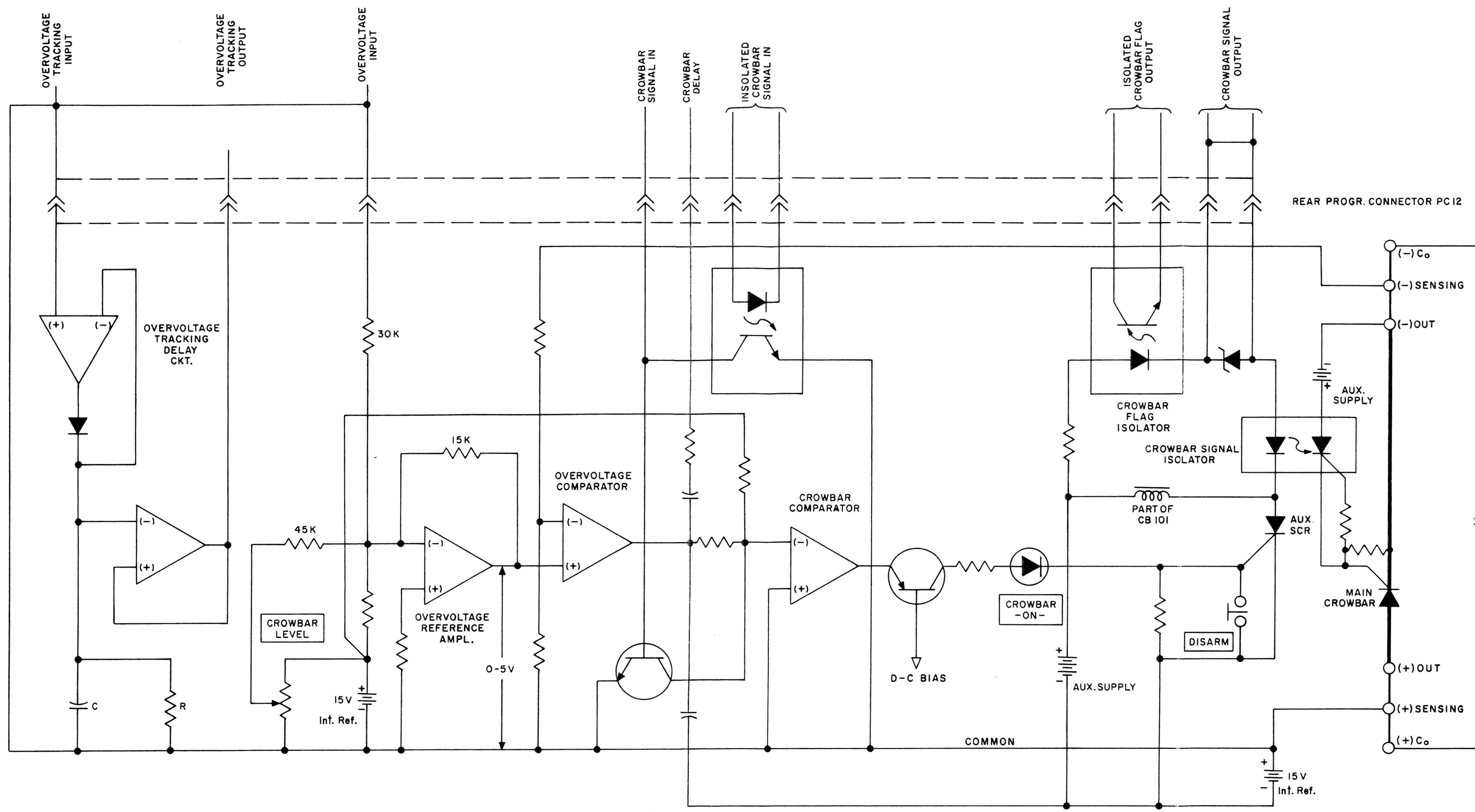
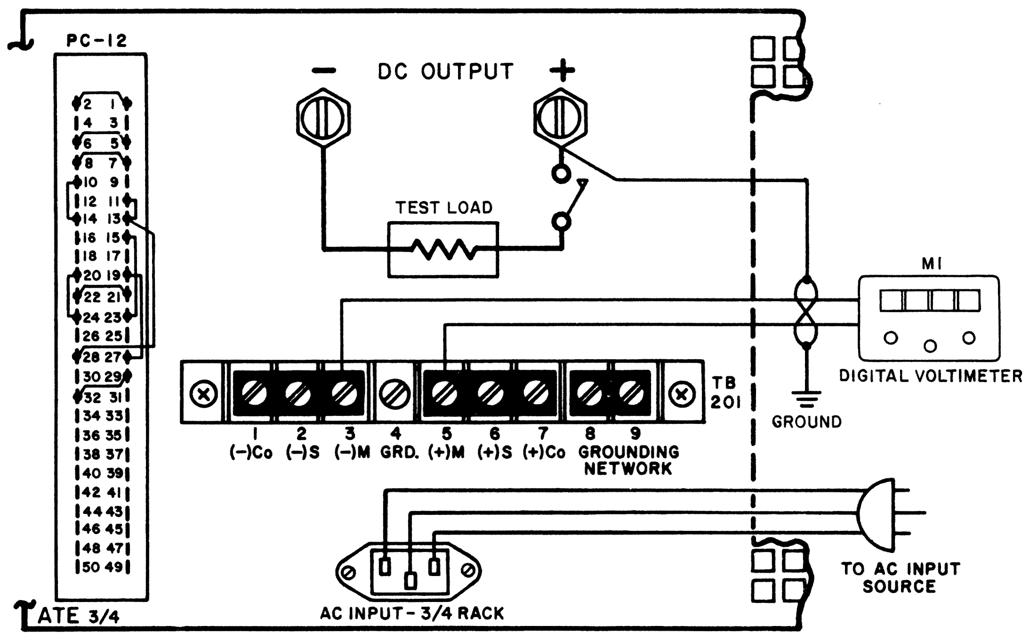
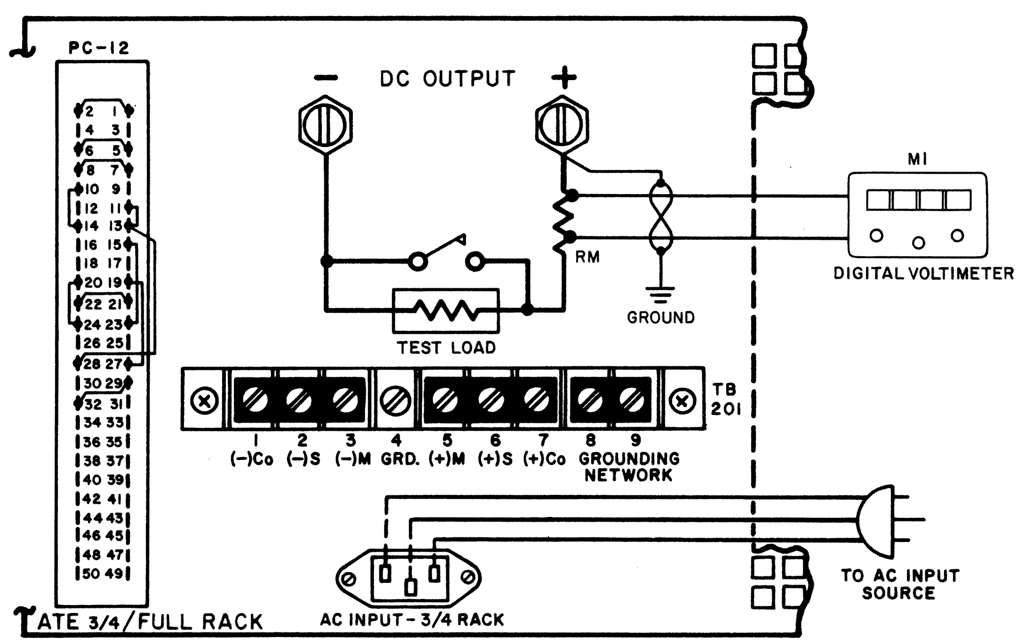


FIG. 4-7 PROGRAMMABLE OVERVOLTAGE PROTECTOR AND CROWBAR CIRCUIT, SIMPLIFIED SCHEMATIC DIAGRAM

NOTES: 1. NOMENCLATURE SAME AS IN MAIN SCHEMATIC DIAGRAM.
2. JUMPER CONNECTIONS ON PC-12 ARE FOR FRONT PANEL (LOCAL) OUTPUT CONTROL.



A) TEST SET-UP FOR "VOLTAGE MODE" MEASUREMENTS.



B) TEST SET-UP FOR "CURRENT MODE" MEASUREMENTS.

FIG. 5-2 TEST SET-UP DIAGRAMS FOR OUTPUT EFFECT MEASUREMENTS.

KEPCO® REPLACEMENT PARTS LIST

ATE 100-5M | **CONTROL ASSEMBLY (A1)** | **Code 08-3084**

REFERENCE DESIGNATION	QTY.	DESCRIPTION	MFRS. NAME & PART NO. SEE BOTTOM NOTE	KEPCO PART NO.	REC. SPARE PART QTY.
C1,2,4	3	Cap., Elect., Ax. Leads 220μF, 20%, 25V	United Chemi-Con Type KMC	117-0713	1
C3	1	Cap., Elect., Ax. Leads 220μF, 20%, 50V	United Chemi-Con Type KMC	117-0651	1
C5,15	2	Cap., Film, Ax. Leads 4700pF, 10%, 200V	Sprague Type 192P	117-0588	1
C6,27,28	3	Cap., Ceramic Disc 100pF, 10%, 500V	Radio Mat. Corp. Type JK	117-0754	1
C7	1	Cap., Film, Ax. Leads 0.22μF, 10%, 200V	Industrial Cond. 2.5LUMZ22	117-0236	1
C8,9	2	Cap., Elect., Ax. Leads 10μF, 20%, 50V	United Chemi-Con Type KMC	117-0136	1
C10,11,12 13,24	5	Cap., Film, Ax. Leads 0.01μF, 20%, 200V	Sprague Type 192P	117-0353	1
C14,20,33,34	4	Cap., Ceramic Disc 500pF, 10%, 500V	Radio Mat. Corp. Type JF	117-0755	1
C16	1	Cap., Film, Ax. Leads 0.015μF, 10%, 200V	Sprague Type 192P	117-0626	1
C17	1	Cap., Elect., Ax. Leads 22μF, 20%, 16V	United Chemi-Con Type KMC	117-0444	1
C18,21	2	Cap., Elect., Tantalum, Ax. Lds. 1μF, 20%, 50V	Sprague Type 162D	117-0815	1
C22	1	Cap., Film, Ax. Leads 1μF, 10%, 200V	Wesco Type 33MM	117-0395	1
C23	1	Cap., Film, Ax. Leads 0.001μF, 10%, 200V	Sprague Type 192P	117-0570	1
C25	1	Cap., Elect., Ax. Leads 220μF, 20%, 16V	United Chemi-Con Type KMC	117-0677	1
C26	1	Cap., Elect., Ax. Leads 220μF, ±75 – 10%, 3V	Mallory Type TT	117-0512	1
C30,31	2	Cap., Ceramic Disc 200pF, 10%, 1KV	Radio Mat. Corp. Type JF	117-0571	1
C32	1	Cap., Ceramic Disc 0.01 μF, +80 – 20%, 50V	Centralab Elect. Type CK-103	117-0860	1
CR1,2,3	3	Rect., Bridge 200V (PIV), 1A	General Instruments Type W-02	124-0346	1
CR4,27	2	Diode, Zener, Ax. Leads 6.8V, 5%, 0.5W	Motorola 1N5235B	121-0080	1
CR5	1	Diode, Zener, Ax. Leads 6.2V, 5%, 0.4W	Motorola 1N827	121-0062	1
CR6	1	Diode, Zener, Ax. Leads 15V, 5%, 1W	Motorola 1N3024B	121-0057	1
CR7	1	Diode, Zener, Ax. Leads 11V, 5%, 0.5W	Motorola 1N5241B	121-0082	1
CR8	1	Diode, Zener, Ax. Leads 12V, 5%, 0.4W	Int. Rect. Corp. 1N963B	121-0058	1

NOTE: REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION.

KEPCO® REPLACEMENT PARTS LIST

MODEL ATE 100-5M **CONTROL ASSEMBLY (A1)** **Code 08-3084**

REFERENCE DESIGNATION	QTY.	DESCRIPTION	MFRS. NAME & PART NO. SEE BOTTOM NOTE	KEPCO PART NO.	REC. SPARE PART QTY.
CR10	1	Diode, Rect., Ax. Leads 400V (PIV), 1A	Semicon Inc. Type SI-4	124-0028	1
CR11 thru 25, 28 thru 42, CR44,45	32	Diode, Switching, Ax. Leads 75V (PIV), 1A, 0.4W	AM Power Devices 1N4148	124-0437	6
CR26	1	Thyristor, SCR, Ax. Leads 100V, (VRXM), 4A	RCA S2062A	124-0496	1
CR43	1	Diode, Zener, Ax. Leads 3.3V, 5%, 0.4W	Motorola 1N746A	121-0060	1
IC1,4,8,9	4	IC, Op. Amp., 741 Type 8 Pin-Dip	Texas Instruments SN72741P	250-0025	1
IC2,5	2	IC, Quad Op. Amp., 324 Type 14 Pin-Dip	National LM324N	250-0050	1
IC3	1	IC, Op. Amp., FET Input 8 Pin-Dip	Texas Instruments TL081CP	250-0100	1
IC6,7	2	IC, Comparator, 311 Type 8 Pin-Dip	Texas Instruments SN72311P	250-0063	1
LC1	1	Opto Coupler (Photo-SCR) 6 Pin-Dip	Kepco Inc. 119-0115	119-0115	1
LC2,3,4	3	Opto Coupler (Photo-TSTR) 6 Pin-Dip	Monsanto MCT2	119-0106	1
Q1,3	2	Transistor, Si., NPN Low Power, TO-5	RCA 2N3053	119-0059	1
Q2	1	Transistor, Si., NPN Medium Power,TO-66	RCA 2N3584	119-0104	1
Q4	1	Transistor, Si., NPN Small Signal, TO-18	Texas Instruments 2N5450	119-0093	1
Q5,6,7	3	Transistor, Si., PNP Small Signal, Plastic	Fairchild 2N5138	119-0096	1
R1,51	2	Res., Fxd., Molded 2.2K ohm, 10%, ¼W	Allen Bradley CB2221	115-2382	1
R2	1	Res., Fxd., Molded 470 ohm, 10%, ¼W	Allen Bradley CB4711	115-2235	1
R3	1	Res., Fxd., Molded 200 ohm, 5%, ½W	Allen Bradley EB2015	115-0538	1
R4	1	Res., Fxd., Molded 510 ohm, 5%, 2W	Allen Bradley HB5115	115-2116	1
R5	1	Res., Fxd., Molded 100 ohm, 10%, ¼W	Allen Bradley CB1011	115-2231	1
R6,57,65	3	Res., Fxd., Molded 10K ohm, 10%, ¼W	Allen Bradley CB1031	115-2211	1
R7,60	2	Res., Fxd., Molded 2K ohm, 5%, ½W	Allen Bradley EB2025	115-0520	1
R8	1	Res., Fxd., Metal Film 8.06K ohm, 1%, ⅛W	Dale Type RN55D	115-2445	1

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MODEL ATE 100-5M **CONTROL ASSEMBLY (A1)** **Code 08-3084**

REFERENCE DESIGNATION	QTY.	DESCRIPTION	MFRS. NAME & PART NO. SEE BOTTOM NOTE	KEPCO PART NO.	REC. SPARE PART QTY.
R9	1	Res., Fxd., Metal Film 5.62K ohm, 1%, 1/8W	Dale Type RN55D	115-2409	1
R10	1	Res., Fxd., Metal Film 1.1K ohm, 1%, 1/4W	Dale Type RN60D	115-1860	1
R11	1	Res., Fxd., W.W., Ax. Leads 7.5K ohm, 5%, 3W	Tepro Type TS3	115-2193	1
R12	1	Res., Fxd., Molded 39 ohm, 10%, 1W	Allen Bradley GB3901	115-1170	1
R13,14,23,33	4	Res., Fxd., Molded 330 ohm, 10%, 1/4W	Allen Bradley CB3311	115-2233	1
R15,17	2	Res., Fxd., Metal Film 10K ohm, 1%, 1/8W	Dale Type RN55D	115-2174	1
R16,25,26,28 31,32,56,70, 71 thru 76, 83	15	Res., Fxd., Molded 1K ohm, 10%, 1/4W	Allen Bradley CB1021	115-2238	4
R18	1	Res., Var., Cermet, Trim 1K ohm, 10%, 3/4W	Bourns Type 3009P	115-2456	1
R19,20	2	Res., Fxd., W.W., Ax. Leads 5.7K ohm, 1%, 1W	Tepro Type TS1	115-1301	1
R22	1	Res., Fxd., Molded 4.7K ohm, 10%, 1/4W	Allen Bradley CB4721	115-2383	1
R24,29	2	Res., Fxd., Molded 10 ohm, 10%, 1/4W	Allen Bradley CB1001	115-2230	1
R27	1	Res., Var., Cermet, Trim. 500 ohm, 10%, 3/4W	Bourns Type 3009P	115-2398	1
R30	1	Res., Var., Cermet, Trim 100K ohm, 10%, 3/4W	Bourns Type 3009P	115-2399	1
R34,37	2	Res., Fxd., Metal Film 2K ohm, 1%, 1/8W	Dale Type RN55D	115-2334	1
R35,67,68	3	Res., Var., Cermet, Trim 10K ohm, 10%, 3/4W	Bourns Type 3009P	115-2481	1
R38,39,52	3	Res., Fxd., Molded 2.7M ohm, 5%, 1/4W	Allen Bradley CB2755	115-2602	1
R40	1	Res., Fxd., Molded 10 ohm, 5%, 1/4w	Allen Bradley CB1005	115-2643	1
R41,46	2	Res., Fxd., Metal Film 1K ohm, 1%, 1/8W	Dale Type RN55D	115-2180	1
R42	1	Res., Fxd., Metal Film 11K ohm, 1%, 1/4W	Dale Type RN60D	115-1804	1
R43	1	Res., Fxd., Metal Film 40.2K ohm, 1%, 1/8W	Dale Type RN55D	115-2391	1
R44	1	Res., Fxd., Molded 3.3M ohm, 5%, 1/4W	Allen Bradley CB3355	115-2644	1
R45	1	Res., Fxd., Metal Film 15K ohm, 1%, 1/8W	Dale Type RN55D	115-2452	1
R47	1	Res., Fxd., Metal Film 4.99K ohm, 1%, 1/8W	Dale Type RN55D	115-2401	1
R48	1	Res., Fxd., Metal Film 95.3K ohm, 1%, 1/4W	Dale Type RN60D	115-2212	1

NOTE: REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION.

PLEASE NOTE: THE MANUFACTURER'S NAME AND PART NUMBER LISTED FOR EACH ITEM ON REPLACEMENT PARTS LISTS REPRESENTS AT LEAST ONE SOURCE FOR THAT ITEM AND IS LISTED SOLELY FOR THE CONVENIENCE OF KEPCO EQUIPMENT OWNERS IN OBTAINING REPLACEMENT PARTS LOCALLY. WE RESERVE THE RIGHT TO USE EQUIVALENT ITEMS FROM ALTERNATE SOURCES. KEPCO, INC.

KEPCO® REPLACEMENT PARTS LIST

ATE 100-5M **CONTROL ASSEMBLY (A1)** **Code 08-3084**

REFERENCE DESIGNATION	QTY.	DESCRIPTION	MFRS. NAME & PART NO. SEE BOTTOM NOTE	KEPCO PART NO.	REC. SPARE PART QTY.
R49,62,84	3	Res., Fxd., Molded 1.5K ohm, 10%, ¼W	Allen Bradley CB1521	115-2229	1
R53,54	2	Res., Fxd., Molded 47K ohm, 10%, ¼W	Allen Bradley CB4731	115-2237	1
R55	1	Res., Fxd., Molded 100K ohm, 10%, ¼W	Allen Bradley CB1041	115-2641	1
R58,59,63	3	Res., Fxd., Molded 12K ohm, 10%, ¼W	Allen Bradley CB1231	115-2276	1
R61,66	2	Res., Fxd., Molded 560 ohm, 10%, ¼W	Allen Bradley CB5611	115-2210	1
R64	1	Res., Fxd., Molded 3.9K ohm, 10%, ¼W	Allen Bradley CB3921	115-2640	1
R77	1	Res., Fxd., Metal Film 30.1K ohm, 1%, ⅛W	Dale Type RN55D	115-2541	1
R78	1	Res., Fxd., Molded 82 ohm, 10%, ¼W	Allen Bradley CB8201	115-2495	1
R79	1	Res., Fxd., Molded 3.3K ohm, 10%, ¼W	Allen Bradley CB3321	115-2257	1
R82	1	Res., Fxd., Molded 39K ohm, 10%, ¼W	Allen Bradley CB3931	115-2469	1
R85	1	Res., Fxd., Molded 220 ohm, 10%, ¼W	Allen Bradley CB2211	115-2227	1
RN1	1	Res., Network 2 units 100K ohm, & 10K ohm, 1%	Kepco Inc. 234-0015	234-0015	1

NOTE: REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION.

KEPCO® REPLACEMENT PARTS LIST

ATE 100-5M **MAIN CHASSIS ASSEMBLY (A2), WITH FRONT PANEL** **Code 08-3084**

REFERENCE DESIGNATION	QTY.	DESCRIPTION	MFRS. NAME & PART NO. SEE BOTTOM NOTE	KEPCO PART NO.	REC. SPARE PART QTY.
CB101	1	Circuit Breaker 2-Pole, 2 CKT	Kepco Inc. 127-0352	127-0352	1
DS101	1	Panel Light, Red 6V d-c -20 mA, LED	Dialco Type 507	152-0092	1
DS102	1	Panel Light, Green 6V d-c -20 mA, LED	Dialco Type 507	152-0097	1
DS103	1	Panel Light, Yellow 6V d-c -20 mA, LED	Dialco Type 507	152-0098	1
M101	1	Meter, 0-5A	Kepco Inc. 135-0520	135-0520	1
M102	1	Meter, 0-100V	Kepco Inc. 135-0519	135-0519	1
R101	1	Res., Var., Multi-turn, W.W. 10K ohm, 5%, 2W	Spectrol Type 534	115-1234	1
R102	1	Res., Var., Multi-turn, W.W. 1K ohm, 5%, 2W	Spectrol Type 534	115-1304	1
R103	1	Res., Var., Cermet, Trim 10K ohm, 10%, 1W	Bourns Type 3059J	115-2621	1
S101	1	Switch, Push-Button N.O., 115V-1/10A	Grayhill 30-1-N.O.	127-0203	1

CHASSIS ASS'Y. CONTAINS:

B201	1	Fan, Motor 50/60 Hz, 115V a-c	Kepco Inc. 148-0026	148-0027	1
C202,203	2	Cap., Ceramic Disc 0.1μF, +80−20%, 500V	Radio Mat. Corp. Type MLC404L	117-0087	1
C204	1	Cap., Elect., Can-Type 3.4KμF, +50 −10%, 200V	Mepco/Electra Type 3186	117-0909	1
C208	1	Cap., Elect., Can-Type 600μF, +75−10%, 150V	Sprague Type 500	117-0736	1
C209	1	Cap., Film, Ax. Leads 0.1μF, 20%, 600V	TRW Type X663F	117-0316	1
CR201,202	2	Diode, Rect., Stud-Mt. 400V (PIV), 15A	Westinghouse R3100415	124-0353	1
CR204	1	Thyristor, SCR, Stud-Mt. 200V (PIV), 40A	Int. Rect. Corp. 40RCS20	124-0359	1
CR205	1	Diode, Rect., Stud-Mt. 200V (PIV), 15A	Westinghouse R3100215	124-0352	1
CR206,207	2	Diode, Rect., Ax. Leads 100V (PIV), if @ 0.5V-5μA max.	Semicon Type HVP	124-0178	1
R201	1	Res., Fxd., W.W. Ax. Leads 5K ohm, 5%, 5W	Tepro Type TS5	115-0232	1

NOTE: REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION.

PLEASE NOTE: THE MANUFACTURER'S NAME AND PART NUMBER LISTED FOR EACH ITEM ON REPLACEMENT PARTS LISTS REPRESENTS AT LEAST ONE SOURCE FOR THAT ITEM AND IS LISTED SOLELY FOR THE CONVENIENCE OF KEPCO EQUIPMENT OWNERS IN OBTAINING REPLACEMENT PARTS LOCALLY. WE RESERVE THE RIGHT TO USE EQUIVALENT ITEMS FROM ALTERNATE SOURCES. KEPCO, INC.

KEPCO® REPLACEMENT PARTS LIST

ATE 100-5M **MAIN CHASSIS ASSEMBLY (A2) cont'd.** **Code 08-3084**

REFERENCE DESIGNATION	QTY.	DESCRIPTION	MFRS. NAME & PART NO. SEE BOTTOM NOTE	KEPCO PART NO.	REC. SPARE PART QTY.
R202	1	Res., Fxd., Power Ribbon 30 ohm, 5%, 700W	Kepco Inc. 115-2502	115-2502	1
R203	1	Res., Fxd., Shunt, W.W. 4-T 0.1 ohm, 1%, 50W	Tepro Type TMK50	115-2356	1
R204	1	Res., Fxd., Molded 100 ohm, 10%, ¼W	Allen Bradley CB1011	115-2231	1
R205	1	Res., Fxd., Molded 10 ohm, 10%, ¼W	Allen Bradley CB1001	115-2230	1
T201	1	Transformer, Power	Kepco Inc. 100-2116	100-2116	1
T202	1	Transformer, Auxiliary	Kepco Inc. 100-2159	100-2159	1

MISCELLANEOUS MECHANICAL PARTS:

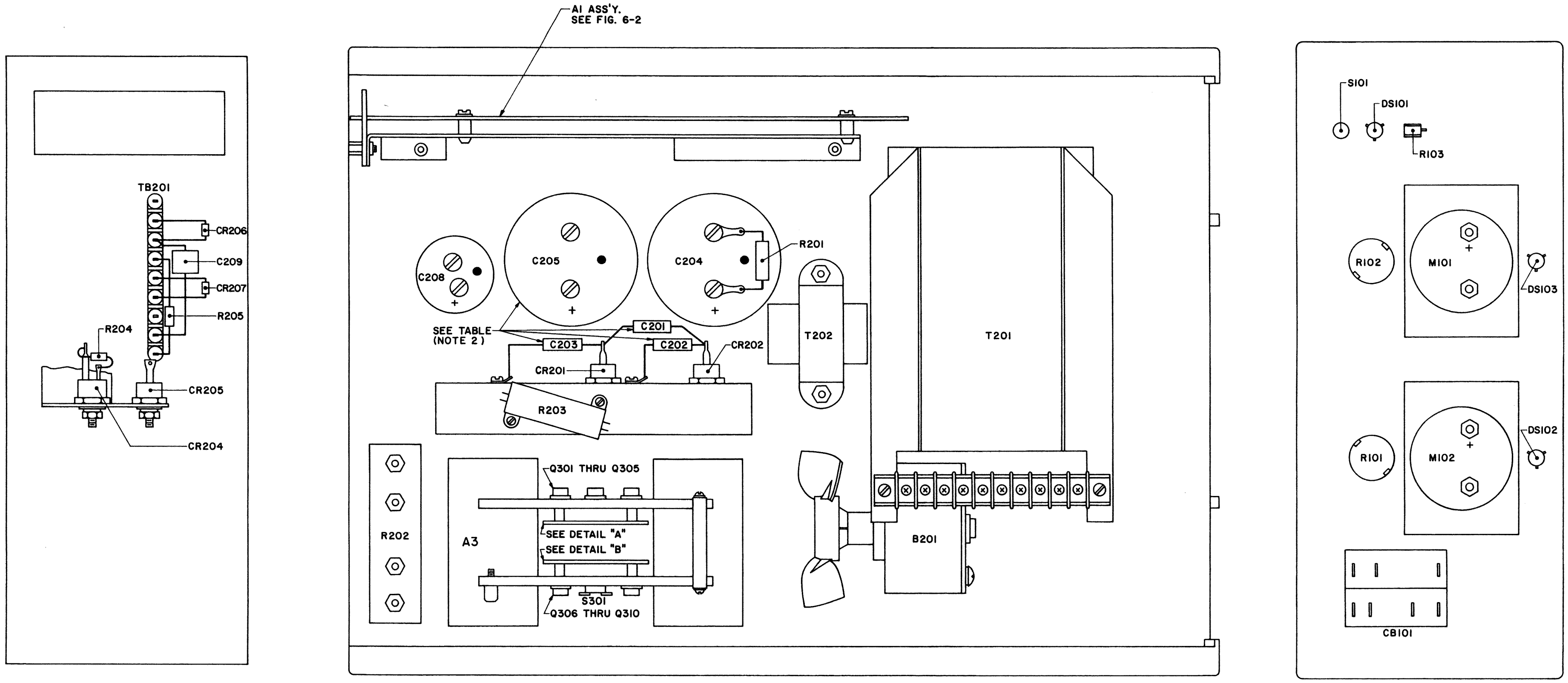
N.A.	3	Holding Clip for Front Panel LED Lamp	Dialco 515-0051	102-0107	1
N.A.	2	Knob, Front Panel Control	Alco PKA-50B-¼	155-0052	1
TB201	1	Barrier Strip, 9-Term, Assembly	Kepco Inc. 167-0884	167-0884	1
N.A.	4	Foot, Bottom	Bruce Plastic Inc. 0965-0014	158-0008	1
N.A.	1	Output Terminal, Black	Superior Electric Type BP30-10B	151-0003	1
N.A.	1	Output Terminal, Red	Superior Electric Type BP30-10R	151-0002	1
N.A.	1	Line Cord, AWG-16 3-Wire with Plug	Kepco Inc. 118-0557	118-0557	1
PC-12	1	Rear Programming Connector, not Wired	Kepco Inc. Model PC-12	Model PC-12	1
N.A.	1	Fan Blade, 4¼" Dia.	Kepco Inc. 149-0023	149-0023	1
P201	1	A-C Power Receptacle	Switchcraft EAC-302	143-0290	1

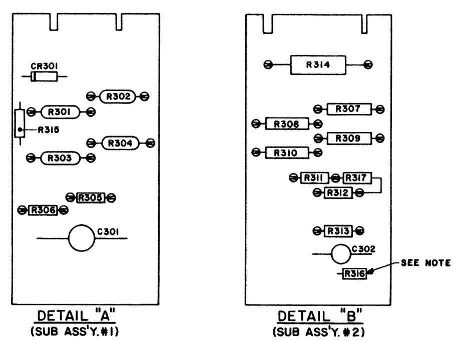
KEPCO® REPLACEMENT PARTS LIST

ATE 100-5M | **HEAT SINK ASSEMBLY (A3)** | **Code 09-0286**

REFERENCE DESIGNATION	QTY.	DESCRIPTION	MFRS. NAME & PART NO. SEE BOTTOM NOTE	KEPCO PART NO.	REC. SPARE PART QTY.
C301	1	Cap., Mica, Rad. Leads 200pF, 5%, 500V	Sangamo Type D15	117-0783	1
C302	1	Cap., Ceramic Disc. 100pF, 10%, 500V	Radio Mat. Corp. Type JK	117-0754	1
CR301	1	Diode, Rect., Ax. Leads 400V (PIV), 1AV	Semicon, Inc. Type SI-4	124-0028	1
Q301 thru 304 306 thru 309	8	Transistor, Si., NPN Power, TO-3	Kepco Inc. 119-0147	119-0147	4
Q305,310	2	Transistor, Si., NPN Med. Power, TO-66	RCA 2N3584	119-0104	1
R301 thru 304 307 thru 310	8	Res., Fxd., Power, Ax. Leads 0.8 ohm, 3%, 3W	Tepro Type TS3	115-2460	1
R305,311	2	Res., Fxd., Molded 100 ohm, 5%, ¼W	Allen Bradley CB1015	115-2231	1
R306,313	2	Res., Fxd., Molded 1K ohm, 10%, ¼W	Allen Bradley CB1021	115-2238	1
R312	1	Res., Fxd., Molded 22 ohm, 10%, ¼W	Allen Bradley CB2201	115-2494	1
R314	1	Res., Fxd., Power, Ax. Leads 5K ohm, 5%, 5W	Tepro Type TS5	115-0232	1
R315	1	Res., Fxd., Molded 330 ohm, 10%, ¼W	Allen Bradley CB3311	115-2233	1
R316	1	Res., Fxd., Molded 82 ohm, 10%, ¼W	Allen Bradley CB8201	115-2495	1
S301	1	Switch, Thermostat N.O., 260 ±10°F, ΔF, 30°F	Texas Instruments Type 1NT	127-0248	1

NOTE: REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION.





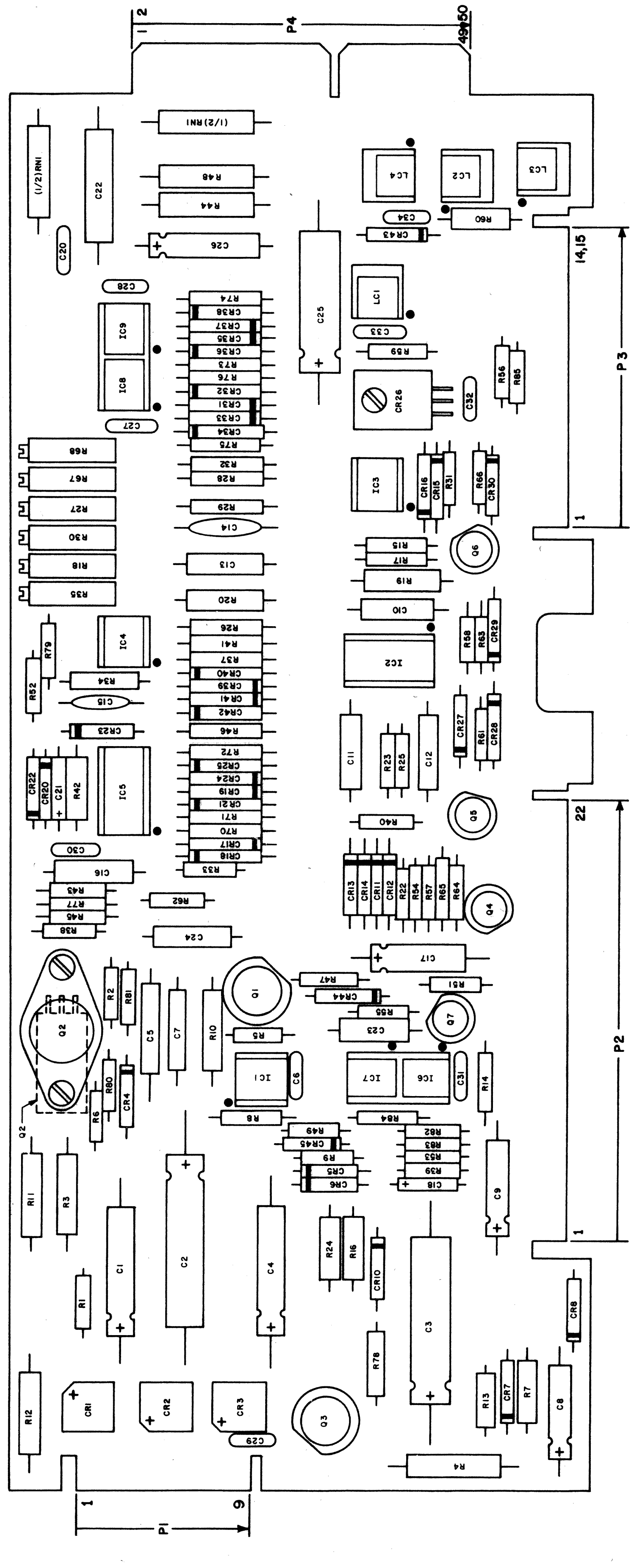
NOTES:
1. THIS DRAWING USED FOR MODELS: ATE25-20M, ATE36-15M, ATE55-10M, ATE75-8M, ATE100-5M & ATE150-3.5M.

2.

MODEL	C201	C202	C203	C205
ATE 25-20M	USED	USED	USED	USED
ATE 36-15M	NOT USED	USED	USED	USED
ATE 55-10M	NOT USED	USED	USED	USED
ATE 75-8M	NOT USED	USED	USED	USED
ATE 100-5M	NOT USED	USED	USED	NOT USED
ATE 150-3.5M	USED	NOT USED	NOT USED	NOT USED

3. WHEN R316 IS NOT USED, A MOLDED JUMPER IS.

FIG. 6-1 COMPONENT LOCATION, MAIN CHASSIS ASSEMBLY WITH FRONT PANEL AND HEATSINK ASSEMBLY.



NOTES:

1. THIS DRAWING, IS USED ON ALL ATE 1/2,3/4 & FULL RACKS.
2. NOT ALL COMPONENTS USED ON ALL MODELS, SEE PARTS LIST.
3. DASHED OUTLINE IS Q2 (FET) USED ON MODEL ATE 325-0.8M.

FIG. 6-2 COMPONENT LOCATION, CONTROL ASSEMBLY.

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SECTION VI – PARTS LIST AND DIAGRAMS

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SECTION I – INTRODUCTION

1-1 SCOPE OF MANUAL

1-2 This manual contains instructions for the installation, operation and maintenance of the "ATE" series of voltage and current stabilized d-c power supplies, manufactured by Kepco, Inc., Flushing, New York, U.S.A.

1-3 GENERAL DESCRIPTION

1-4 The Kepco ATE with programmable overvoltage protector is a precision stabilized power supply which can deliver either stabilized output voltage or current. The prevailing operating mode is indicated by LED mode indicators at the front panel. Operating mode crossover is automatic and may be monitored remotely by means of a flag signal, available at the rear programming connector. The power supply features "full range" output control by means of 10-turn, high resolution front panel potentiometers. A pair of front panel meters constantly monitor the output voltage and output current. This power supply has a linear and fully dissipative NPN pass transistor section driven by high-gain, integrated circuit amplifiers. The output of the power supply is fully programmable. All necessary input terminals are provided on a programming connector at the rear of the chassis. Terminals are also provided for remote error sensing, as well as for the connection of the output capacitor directly at the load.

1-5 The ATE power supply features user-selectable "slow" or "fast" operating modes. Slow mode operation is recommended for applications demanding a constant voltage source. Fast mode operation is best if the output voltage must change rapidly, either in response to an external programming signal or, if the ATE is used as a current stabilizer, as a reaction to changing load resistance.

1-6 The ATE power supply is delivered for "slow mode" operation. See Section II, par. 2-4 for converting the ATE power supply to "fast mode" operation.

1-7 An overvoltage protection circuit, continuously adjustable as well as remotely programmable, is a built-in feature. The trigger point of the overvoltage protector may be set (or checked) under actual operating conditions by the front panel accessible setup controls (refer to Section II of this manual).

1-8 ATE power supplies are built in several mechanical sizes according to their approximate output power ratings:

SIZE	PACKAGE	APPROX. OUTPUT POWER
"A"	QUARTER-RACK MODELS	50 WATT
"B"	QUARTER-RACK MODELS	100 WATT
"C"	HALF-RACK MODELS	250 WATT
"D"	THREE-QUARTER RACK MODELS	500 WATT
"E"	FULL-RACK MODELS	1000 WATT

Power transistors and drivers on all ATE designs are mounted onto highly efficient, patented heat sink assemblies which are cooled by low-noise fans. The ATE main chassis assemblies, as well as the wrap-around covers, are constructed from cold-rolled stell. The front panels are made from aluminum (refer to the "Mechanical Outline Drawing", FIG. 1-2).

1-9 SPECIFICATION, ELECTRICAL

a) AC INPUT SOURCE VOLTAGE:

95 to 113V a-c or
105 to 125V a-c or
190 to 226V a-c or
210 to 250V a-c

} Selectable, See Section II of this Manual

AC INPUT SOURCE CURRENT:

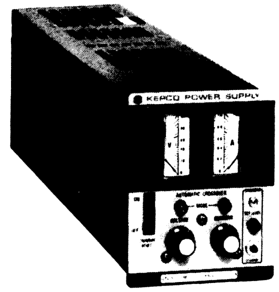
(Worst Case, @ 113V a-c, 95—113V a-c tap, Full Load)

SIZE A	SIZE B	SIZE C	SIZE D	SIZE E
1.4 A	2.4 A	6.0 A	11.0 A	20.0 A

b) DC OUTPUT RATINGS: See Table 1-1.

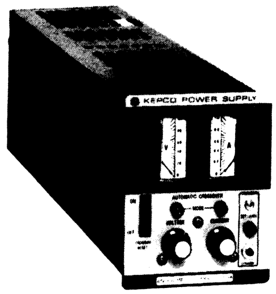
Size "A" Quarter – Rack Models

MODEL	d-c OUTPUT RANGE VOLTS	AMPS	OUTPUT IMPEDANCE VOLTAGE MODE SERIES RESISTANCE	SERIES INDUCTANCE SLOW	FAST	OUTPUT IMPEDANCE CURRENT MODE SHUNT* RESISTANCE	SHUNT CAPACITANCE SLOW	FAST
ATE 6-5M	0-6	0-5	24 μΩ	0.5 μH	5 μH	12 kΩ	1,000 μF	1 μF
ATE 15-3M	0-15	0-3	100 μΩ	0.5 μH	5 μH	30 kΩ	450 μF	0.4 μF
ATE 25-2M	0-25	0-2	250 μΩ	1 μH	10 μH	50 kΩ	250 μF	0.25 μF
ATE 36-1.5M	0-36	0-1.5	480 μΩ	1 μH	10 μH	72 kΩ	200 μF	0.2 μF
ATE 55-1M	0-55	0-1	1.1 mΩ	2 μH	20 μH	110 kΩ	150 μF	0.15 μF
ATE 75-0.7M	0-75	0-0.7	2.15 mΩ	2 μH	20 μH	150 kΩ	110 μF	0.1 μF
ATE 100-0.5M	0-100	0-0.5	4 mΩ	4 μH	40 μH	200 kΩ	50 μF	0.05 μF
ATE 150-0.3M	0-150	0-0.3	10 mΩ	4 μH	40 μH	300 kΩ	55 μF	0.02 μF



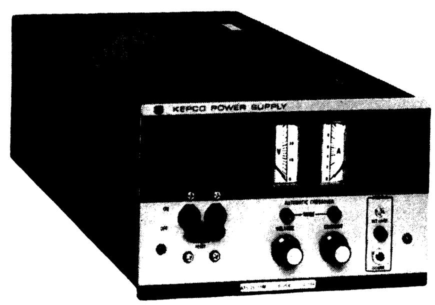
Size "B" Quarter – Rack Models

MODEL	d-c OUTPUT RANGE VOLTS	AMPS	OUTPUT IMPEDANCE VOLTAGE MODE SERIES RESISTANCE	SERIES INDUCTANCE SLOW	FAST	OUTPUT IMPEDANCE CURRENT MODE SHUNT* RESISTANCE	SHUNT CAPACITANCE SLOW	FAST
ATE 6-10M	0-6	0-10	12 μΩ	0.5 μH	5 μH	12 kΩ	1,800 μF	2 μF
ATE 15-6M	0-15	0-6	50 μΩ	0.5 μH	5 μH	30 kΩ	1000 μF	0.8 μF
ATE 25-4M	0-25	0-4	125 μΩ	1 μH	10 μH	50 kΩ	500 μF	0.5 μF
ATE 36-3M	0-36	0-3	240 μΩ	1 μH	10 μH	72 kΩ	350 μF	0.4 μF
ATE 55-2M	0-55	0-2	0.55 mΩ	2 μH	20 μH	110 kΩ	200 μF	0.3 μF
ATE 75-1.5M	0-75	0-1.5	1 mΩ	2 μH	20 μH	150 kΩ	110 μF	0.2 μF
ATE 100-1M	0-100	0-1	2 mΩ	4 μH	40 μH	200 kΩ	80 μF	0.1 μF
ATE 150-0.7M	0-150	0-0.7	4 mΩ	4 μH	40 μH	300 kΩ	55 μF	0.04 μF



Size "C" Half – Rack Models

MODEL	d-c OUTPUT RANGE VOLTS	AMPS	OUTPUT IMPEDANCE VOLTAGE MODE SERIES RESISTANCE	SERIES INDUCTANCE SLOW	FAST	OUTPUT IMPEDANCE CURRENT MODE SHUNT* RESISTANCE	SHUNT CAPACITANCE SLOW	FAST
ATE 6-25M	0-6	0-25	4.8 μΩ	0.5 μH	5 μH	12 kΩ	11,000 μF	5 μF
ATE 15-15M	0-15	0-15	20 μΩ	0.5 μH	5 μH	30 kΩ	5,800 μF	2 μF
ATE 25-10M	0-25	0-10	50 μΩ	1 μH	10 μH	50 kΩ	2,900 μF	1.25 μF
ATE 36-8M	0-36	0-8	90 μΩ	1 μH	10 μH	72 kΩ	2,400 μF	1 μF
ATE 55-5M	0-55	0-5	0.22 mΩ	2 μH	20 μH	110 kΩ	1,400 μF	0.75 μF
ATE 75-3M	0-75	0-3	0.5 mΩ	2 μH	20 μH	150 kΩ	850 μF	0.5 μF
ATE 100-2.5M	0-100	0-2.5	0.8 mΩ	4 μH	40 μH	200 kΩ	375 μF	0.25 μF
ATE 150-1.5M	0-150	0-1.5	2 mΩ	4 μH	40 μH	300 kΩ	275 μF	0.1 μF

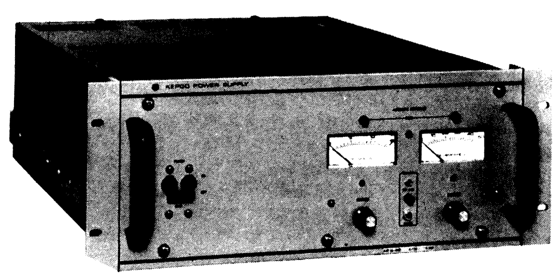


Size "D" Three – Quarter – Rack Models

MODEL	d-c OUTPUT RANGE VOLTS	AMPS	OUTPUT IMPEDANCE VOLTAGE MODE SERIES RESISTANCE	SERIES INDUCTANCE SLOW	FAST	OUTPUT IMPEDANCE CURRENT MODE SHUNT* RESISTANCE	SHUNT CAPACITANCE SLOW	FAST
ATE 6-50M	0-6	0-50	2.4 μΩ	0.5 μH	5 μH	12 kΩ	12,000 μF	10 μF
ATE 15-25M	0-15	0-25	12 μΩ	0.5 μH	5 μH	30 kΩ	8,000 μF	4 μF
ATE 25-20M	0-25	0-20	25 μΩ	1 μH	10 μH	50 kΩ	5,800 μF	2.5 μF
ATE 36-15M	0-36	0-15	48 μΩ	1 μH	10 μH	72 kΩ	4,900 μF	2 μF
ATE 55-10M	0-55	0-10	0.11 mΩ	2 μH	20 μH	110 kΩ	2,900 μF	1.5 μF
ATE 75-8M	0-75	0-8	0.19 mΩ	2 μH	20 μH	150 kΩ	1,200 μF	1 μF
ATE 100-5M	0-100	0-5	0.4 mΩ	4 μH	40 μH	200 kΩ	600 μF	0.5 μF
ATE 150-3.5M	0-150	0-3.5	0.86 mΩ	4 μH	40 μH	300 kΩ	440 μF	0.2 μF

Size "E" Full – Rack Models

MODEL	d-c OUTPUT RANGE VOLTS	AMPS	OUTPUT IMPEDANCE VOLTAGE MODE SERIES RESISTANCE	SERIES INDUCTANCE SLOW	FAST	OUTPUT IMPEDANCE CURRENT MODE SHUNT* RESISTANCE	SHUNT CAPACITANCE SLOW	FAST
ATE 6-100M	0-6	0-100	1.2 μΩ	0.5 μH	5 μH	12 kΩ	22,000 μF	15 μF
ATE 15-50M	0-15	0-50	6 μΩ	0.5 μH	5 μH	30 kΩ	12,000 μF	6 μF
ATE 25-40M	0-25	0-40	12.5 μΩ	1 μH	10 μH	50 kΩ	11,000 μF	4 μF
ATE 36-30M	0-36	0-30	24 μΩ	1 μH	10 μH	72 kΩ	9,500 μF	3 μF
ATE 55-20M	0-55	0-20	55 μΩ	2 μH	20 μH	110 kΩ	5,200 μF	2.25 μF
ATE 75-15M	0-75	0-15	0.1 mΩ	2 μH	20 μH	150 kΩ	3,400 μF	1.5 μF
ATE 100-10M	0-100	0-10	0.2 mΩ	4 μH	40 μH	200 kΩ	1,200 μF	0.75 μF
ATE 150-7M	0-150	0-7	0.42 mΩ	4 μH	40 μH	300 kΩ	1,050 μF	0.3 μF



*Based on 0.5 mA load effect in FAST mode.

TABLE 1-1 DC OUTPUT RATINGS, ATE POWER SUPPLIES.

c) OUTPUT EFFECTS, OFFSETS AND RIPPLE SPECIFICATIONS: See Table 1-2.

INFLUENCE QUANTITY	OUTPUT EFFECTS VOLTAGE MODE Typ.	Max	OUTPUT EFFECTS CURRENT MODE Typ.	Max.	OFFSETS[4] ΔE_{io}	ΔI_{io}
SOURCE VOLTAGE (min.–max.):	<0.0005% E_0 max.	0.001% E_0 max.	<0.002% I_0 max.	0.005% I_0 max.	<1 µV	<1 nA
LOAD (no load–full load):	<0.001% E_0 max.	0.002% E_0 max.	<0.5 mA [1]	1 mA [1]	<1 µV	<1 nA
TIME (8-hour drift):	<0.005% E_0 max.	0.01% E_0 max.	<0.01% I_0 max.	0.02% I_0 max.	<20 µV	<1 nA
TEMPERATURE, per °C:	<0.005% E_0 max.	0.01% E_0 max.	<0.01% I_0 max.	0.02% I_0 max.	<20 µV	<2 nA
RIPPLE and NOISE[2] rms:	<0.1 mV	0.3 mV	<0.01% I_0 max.	0.03% I_0 max.	—	—
(Slow Mode) p-p:[3]	<1 mV	3 mV	<0.1% I_0 max.	0.3% I_0 max.	—	—
RIPPLE and NOISE[2] rms:	<1 mV	3 mV	<0.01% I_0 max.	0.03% I_0 max.	—	—
(Fast Mode) p-p:[3]	<10 mV	30 mV	<0.1% I_0 max.	0.3% I_0 max.	—	—

[1] In slow mode, the leakage current through the output capacitor adds approximately 0-6 mA to the current mode load effect.

[2] One terminal must be grounded for this measurement, or connected so that commun mode current does not flow through the load or, in current mode, through the current sensing resistor.

[3] Peak-to-peak ripple is measured over a 20 Hz to 10 MHz bandwidth.

[4] Preamplifier offsets. The preamplifier offsets are given for the calculation of the output effects of the preamplifiers (A, B) if either of these amplifiers is used for operational programming. In this case, the value of the external feedback and input resistors, the amplifer offsets and the reference voltage variations are combined in the "Error Equation", which represents the "worst case" output effects for the application at hand:

$$\Delta E_{o\,(preamp)} = \Delta E_{ref}\,(R_f/R_i) + \Delta E_{io}\,(1 + R_f/R_i) + \Delta I_{io}\,R_f.$$

where:
- $\Delta E_{o\,(preamp)}$ = Total Preamp Output Voltage Change.
- ΔE_{ref} = Change in the Voltage Reference.
- ΔE_{io} = Change in Offset Voltage.
- ΔI_{io} = Change in Offset Current.
- R_f = External Feedback Resistor.
- R_i = External Input Resistor.

NOTE 1: Variations in the value of the feedback and input resistors are considered secondary effects in the error equation.

NOTE 2: In the Voltage Mode of operation, the calculated preamp output effect, $\Delta E_{o\,(preamp)}$, must be multiplied by the (fixed) gain of the ATE voltage channel to find the total output effect on the output voltage of the ATE power supply. The (fixed) gain of the ATE voltage channel is given by: GAIN = E_O max/10, where "E_O max" is the maximum rated output voltage of each ATE model.

In the Current Mode of operation, the effect of the preamplifier offsets on the total output current may be expressed as a percentage of I_O max by the equation:

$$\Delta I_O\,(\%) = \frac{\Delta E_{o\,(preamp)}}{1\ \text{Volt}} \times 100\%$$

TABLE 1-2 OUTPUT EFFECTS, OFFSET VARIATIONS AND RIPPLE SPECIFICATIONS.

d) OUTPUT RANGES: (See Table 1-1 for specific ratings of each model)

1) VOLTAGE MODE: 0—100% of rated voltage.

2) CURRENT MODE: 0—100% of rated current. Useable range limited to approximately 1% to 100%. The maximum current is factory set to 105% of the rated output current.

e) OPERATING TEMPERATURE RANGE: 0°C to 65°C. No derating to 55°C, derate 10% of listed maximum output current values in Table 1-1 for operation to 65°C ambient temperature.

f) STORAGE TEMPERATURE RANGE: (-)40°C to 85°C.

g) COOLING: High efficiency, single bearing fans, permanently lubricated, with special low-noise nonmetalic blades.

h) ISOLATION: A maximum of 500 volts (d-c or p-p) can be connected between chassis and either output terminal. The common-mode current from either output terminal to ground is less than 5μA (rms) or less than 50μA (p-p) at 115V a-c, 60Hz.

i) DYNAMIC SPECIFICATIONS

1) VOLTAGE RECOVERY FOR A STEP-LOAD CURRENT:
The time reqired for the stabilized output voltage to recover to within 10mV of the output voltage setting, for a 10 to 100% step in rated load current is typically less than 50μsec., 100μsec. maximum.

2) CURRENT RECOVERY FOR A STEP-LOAD VOLTAGE:
The stabilized output current recovers from a step in load (compliance) voltage with an exponential response, the time constant of which is determined by the load resistance and the tabulated output capacitance (See Table 1-1).

3) PROGRAMMING SPEED:
The speed with which the power supply output responds to external programming signals is determined by:

1) The PROGRAMMING TIME CONSTANT, given in the "slow" mode by the load resistance (R_L) and the value of the output capacitor (C_o, see Table 1-1): $\tau = R_L C_o$. In the "fast" mode, the PROGRAMMING TIME CONSTANT is given for the Voltage Control Channel by the internal feedback capacitor (C_F = 500pF) and the internal, fixed feedback resistor (R_F = 1000 ohms per each volt of output rating): $\tau = R_F C_F$. For the Current Control Channel, the PROGRAMMING TIME CONSTANT is 15μsec. typical, 30μsec. maximum.

2) The MAXIMUM RATE OF CHANGE that the power supply output can respond to is given by the setting of the power supply's current control setting (I_{LIM}), divided by the ATE output capacitor (C_o, see Table 1-1):

$$\text{MAXIMUM RATE OF CHANGE} = I_{LIM}/C_o.$$

k) OVERVOLTAGE CROWBAR SPECIFICATIONS:

1) TRIGGERING TIME: $<$50μsec. slow mode, $<$500μsec. fast mode.

2) SETTING RANGE: 3V minimum to 110% maximum rated output voltage.

3) THRESHOLD: Minimum 0.5 volts, or 2% E_o max., whichever is greater.

4) TEMPERATURE COEFFICIENT: $<$0.02% of E_o max. per °C.

SECTION II – INSTALLATION

2-1 UNPACKING AND INSPECTION

2-2 This instrument has been thoroughly inspected and tested prior to packing and is ready for operation. After careful unpacking, inspect for shipping damage before attempting to operate. Perform the preliminary operational check as outlined in paragraph 2-8 below. If any indication of damage is found, file an immediate claim with the responsible transport service.

2-3 TERMINATIONS

a) FRONT PANEL: Refer to FIG. 2-2 and Table 2-2.
b) REAR: Refer to FIG. 2-3 and Table 2-3.
c) INTERNAL CONTROLS: Refer to FIG. 2-1 and Table 2-1.

REFERENCE DESIGNATION	CONTROL	PURPOSE
R18	I_O MAX	Maximum Output Current
R27	E_O LAG	Voltage Channel Stability Control
R30	E_O ZERO	Voltage Channel Zero Control
R35	I_O ZERO	Current Channel Zero Control
R67	PREAMP "A" - ZERO	Offset Zero Control for PREAMP "A"
R68	PREAMP "B" - ZERO	Offset Zero Control for PREAMP "B"

TABLE 2-1 INTERNAL CONTROLS AND THEIR FUNCTIONS.

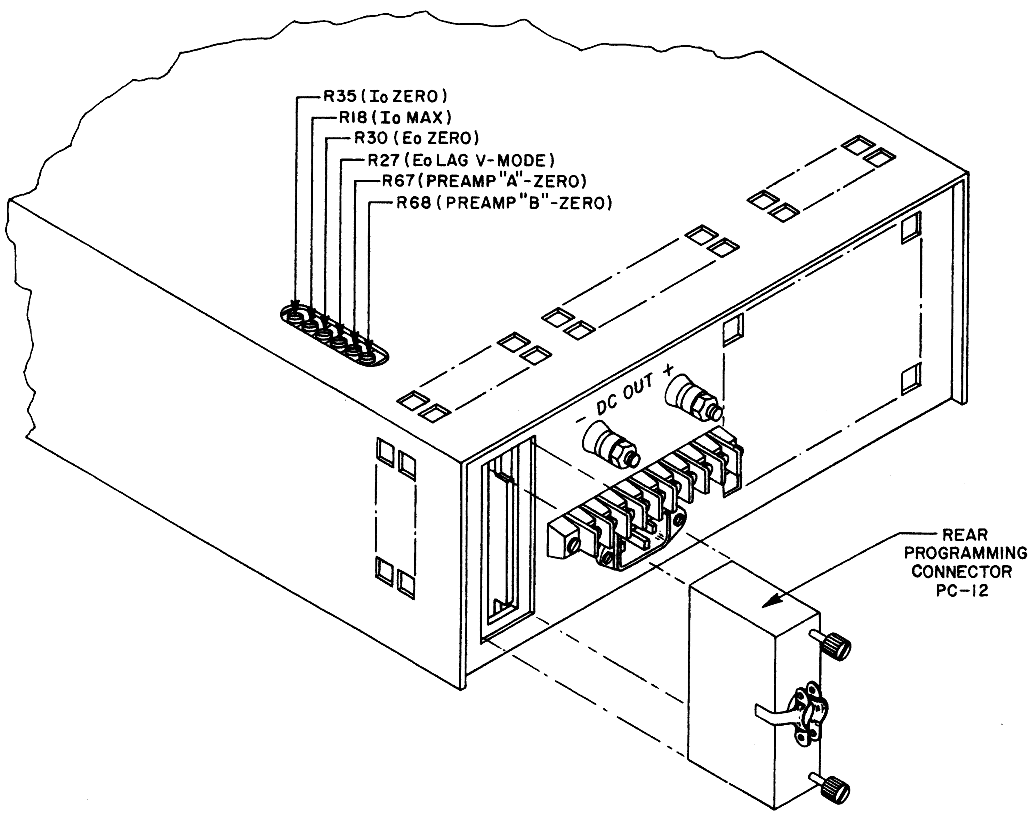


FIG. 2-1 LOCATION OF INTERNAL CONTROLS, ATE 3/4 RACK GROUP.

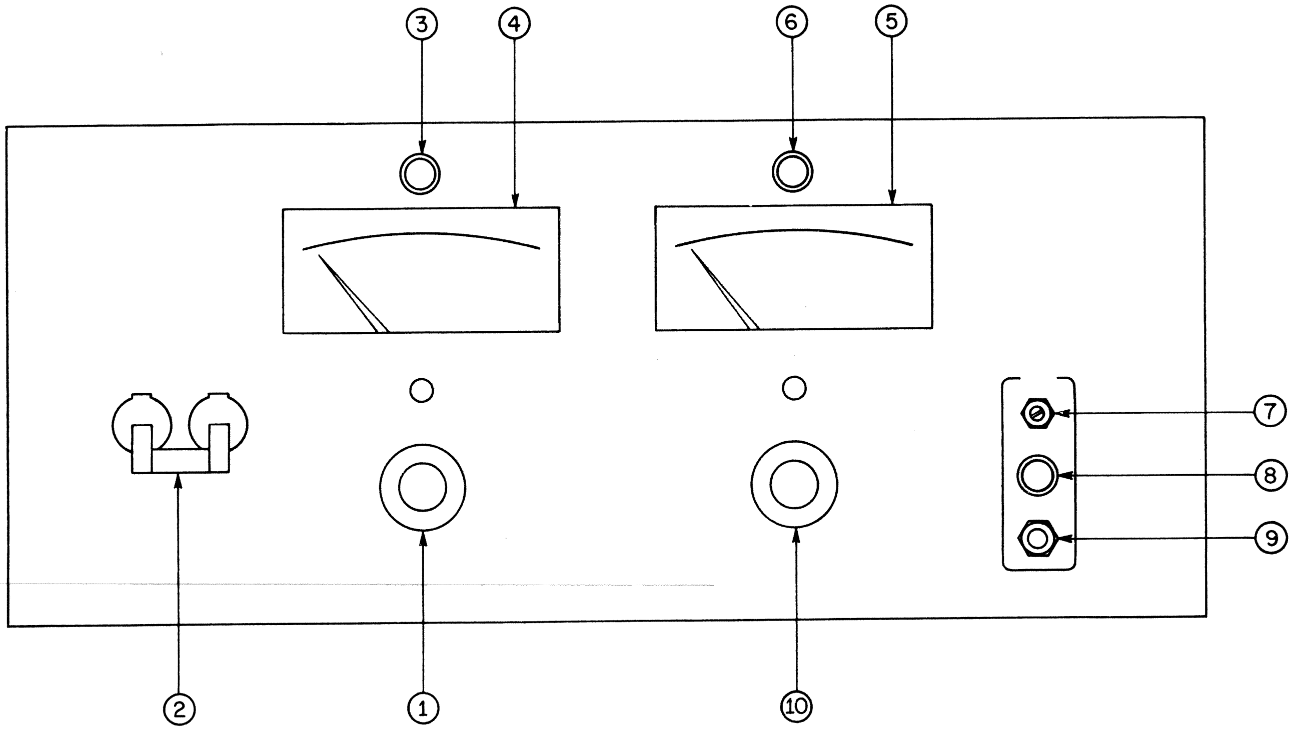


FIG. 2-2 CONTROL AND TERMINATIONS, ATE 3/4 RACK GROUP, FRONT.

NO.	CONTROL OR TERMINATION	FUNCTION
1.	VOLTAGE CONTROL	ADJUSTS OUTPUT VOLTAGE FROM ZERO TO E_O max.
2.	A-C POWER SWITCH/ CIRCUIT BREAKER	SERVES AS A-C POWER SWITCH AND TURNS A-C POWER LINE "OFF" ON OVERLOAD
3.	"V" MODE INDICATOR	ENERGIZES IN VOLTAGE MODE
4.	VOLTMETER	MONITORS OUTPUT VOLTAGE 0-E_O max.
5.	AMMETER	MONITORS OUTPUT CURRENT 0-I_O max.
6.	"I" MODE INDICATOR	ENERGIZES IN CURRENT MODE
7.	"LEVEL" CONTROL	ADJUSTS TRIGGER LEVEL OF CROWBAR CIRCUIT
8.	CROWBAR INDICATOR	LIGHTS WHEN CROWBAR IS TRIGGERED "ON"
9.	"DISARM" PUSH-BUTTON	PUSH TO SET CROWBAR TRIGGER LEVEL
10.	CURRENT CONTROL	ADJUSTS CURRENT FROM 0-100% I_O max.

TABLE 2-2 CONTROLS AND TERMINATIONS, ATE 3/4 RACK GROUP, FRONT.

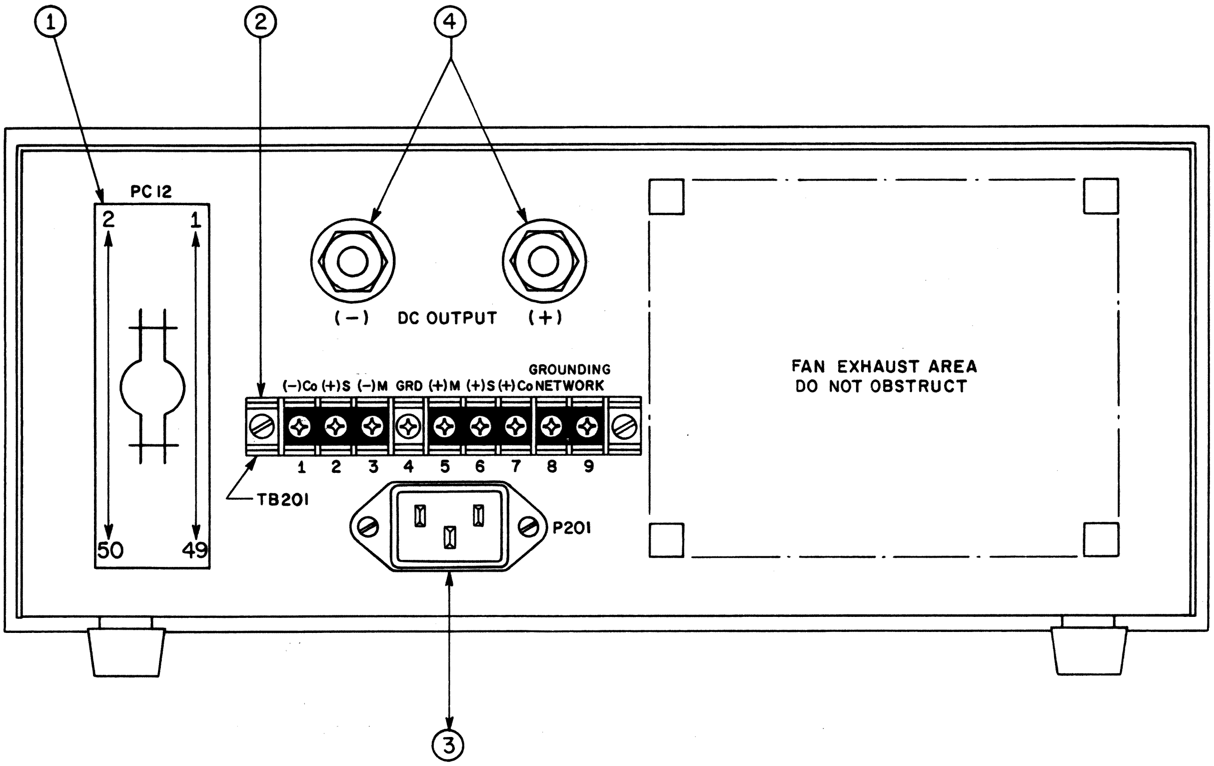


FIG. 2-3 TERMINATIONS, ATE 3/4 RACK GROUP, REAR.

NO.	TERMINATION	FUNCTION	
1.	REAR MATING CONNECTOR (PC-12)	FOR EXTERNAL PROGRAMMING SOURCE INPUT AND ALL OTHER PROGRAMMING FUNCTIONS	
2.	REAR BARRIER STRIP (TB-201)	1) (-) C_O 2) (-) SENSING 3) (-) OUTPUT MONITOR 4) GROUND (CHASSIS)	5) (+) OUTPUT MONITOR 6) (+) SENSING 7) (+) C_O 8) 9) GROUNDING NETWORK
3.	A-C POWER INPUT	ACCEPTS 3-WIRE A-C INPUT CORD (SUPPLIED)	
4.	DC OUTPUT TERMINALS	LOAD CONNECTIONS	

TABLE 2-3 REAR TERMINATIONS, ATE 3/4 RACK GROUP.

2-4 A-C INPUT REQUIREMENTS

2-5 This power supply is normally supplied for operation on a single phase, nominal 115V a-c line. For conversion to other a-c source voltages, refer to FIG. 2-4. Select your nominal source voltage and change the links on the barrier strip of T201 according to the table provided in FIG. 2-4. The circuit breaker (CB101) remains equally effective at all input voltages.

AC SOURCE	CONNECT LINKS
104 V	(3)-(4),(7)-(8)
115 V	(4)-(5),(6)-(7)
208 V	(2)-(3),(8)-(9)
230 V	(5)-(6)

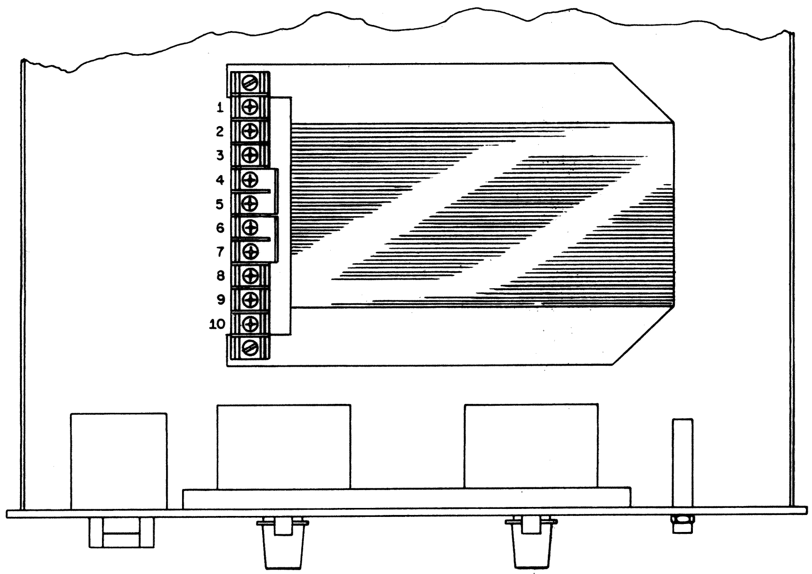


FIG. 2-4 A-C INPUT SOURCE VOLTAGE SELECTION, ATE 3/4 RACK GROUP.

2-6 COOLING

2-7 The power transistors and rectifiers in the ATE power supplies are maintained within their operating temperature range by means of special heat sink assemblies, cooled by internal fans. SIDE PANEL OPENINGS AND THE TOP OF THE CASE MUST BE KEPT CLEAR FROM OBSTRUCTIONS TO INSURE PROPER AIR CIRCULATION. Periodic cleaning of the interior of the power supply is recommended. If the power supply is rack mounted, or installed into confined spaces, care must be taken that the ambient temperature (the temperature immediately surrounding the power supply) does not rise above the limit specified (refer to Section I).

2-8 PRELIMINARY CHECK-OUT

2-9 A simple operating check after unpacking and before permanent installation is advisable to ascertain whether the power supply has suffered damage resulting from shipment. Refer to FIG. 2-2 and to FIG. 2-3 for the location of the operating controls and output terminals.

a) Connect power supply to 115V a-c source or refer to par. 2-4 for other input voltages, if required.

b) Turn CURRENT CONTROL fully clockwise. Turn VOLTAGE CONTROL fully counterclockwise.

c) Turn A-C POWER SWITCH/CIRCUIT BREAKER "on". The VOLTAGE VIX indicator should be energized. Slowly turn VOLTAGE CONTROL clockwise and observe the gradual increase of the output voltage. The VOLTMETER should now read full scale.

d) Check the overvoltage "crowbar" circuit as follows:

   1) Turn the VOLTAGE CONTROL to about one-half of its range.

   2) Depress the DISARM push button and turn the (recessed) LEVEL control ***slowly*** counterclockwise until the CROWBAR INDICATOR lamp lights up.

   3) Turn VOLTAGE CONTROL slightly counterclockwise and release DISARM button.

   4) To reset the adjusted crowbar point, press DISARM button again and advance VOLTAGE CONTROL clockwise. Note voltage at which the CROWBAR INDICATOR lights up. Readjust LEVEL control if necessary, by repeating step (2) and check again by repeating steps (3) and (4).

   5) Turn A-C POWER SWITCH/CIRCUIT BREAKER "off".

e) Place a short circuit across the ATE output terminals. Turn CURRENT CONTROL counterclockwise. Turn the ATE "on". THE CURRENT MODE indicator should now be energized. Slowly turn CURRENT CONTROL clockwise and observe the gradual increase in output current. The AMMETER should now read full scale.

2-10 INSTALLATION (Refer to FIG. 1-3 "Mechanical Outline Drawing")

2-11 The Power Supply may be rack-mounted or operated as a "bench-type" instrument. If the ATE is to be rack-mounted, the (4) bottom feet must be removed.

2-12 For all installations into confined spaces, care must be taken that the temperature immediately surrounding the unit does not exceed the maximum specified ambient temperature (65°C).

2-13 GROUNDING

a) A-C (SAFETY) GROUND. The power supply is equipped with a 3-wire safety line cord and polarized plug. The third (green) wire in the line cord is connected to the chassis and the case of the unit. If a 2-terminal receptacle in combination with an adapter is used, it is imperative that the chassis of the power supply be returned to a-c ground with a separate lead. A grounding terminal is provided (at the rear barrier strip) for this purpose.

b) ISOLATION FROM GROUND. The d-c output is isolated from the a-c source and from any ***direct*** connection to chassis or ground. The maximum output voltage that can be supported between either output terminals and ground or chassis is 500V d-c plus the maximum output voltage of the power supply. Either side of the output may be grounded.

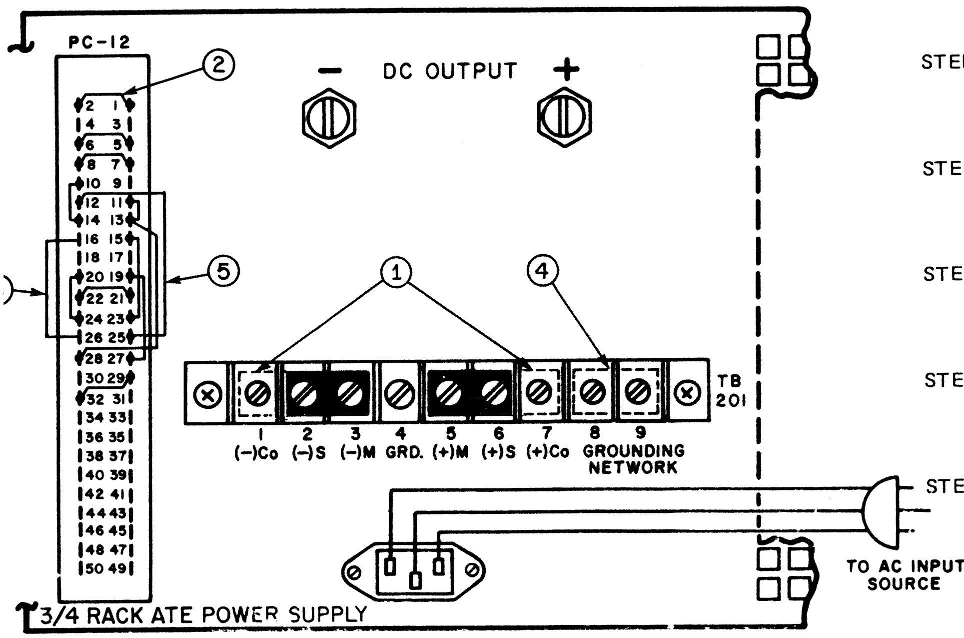
A resistor/capacitor network is connected from the negative monitor terminal to the metal chassis of the power supply. If this internal network is *not* desired, the connection to the chassis can be opened by removing the link (8)-(9) on TB201 (See FIG. 2-3).

2-14 FAST MODE CONVERSION OF THE ATE POWER SUPPLY

2-15 Power supplies designed to operate in a voltage, as well as in a current stabilizing mode, often represent a compromise between the conflicting requirements of a good voltage and a good current source. A good voltage source must have ***low*** output impedance, good output voltage stability and good dynamic stability in the presence of loads with capacitive and/or inductive content. If achieves these design goals by relying to a great extent upon a large output capacitor having a very low terminal impedance, large energy storing ability and great resistance to rapid voltage changes. Unfortunately, the requirements for a good current source are quite opposite to that of the voltage source described above. A current source should have ***high*** output impedance and its terminal voltage must be able to assume rapidly any value as may be needed to keep the output current at the predetermined level, while the load is changing.

2-16 To satisfy these conflicting requirements, the ATE power supply was designed for quick manual change-over from the "slow" mode to the "fast" mode of operation. In the "slow" mode, the ATE power supply approaches an ideal voltage source. Heavy output and feedback capacitors provide for low output noise, excellent voltage stability and good transient response. In the "fast" mode, the output and main feedback capacitors are completely removed, thereby providing the characteristics of a wide-band amplifier, ideal for applications requiring a current stabilizer or for high speed voltage or current programming.

2-17 MANUAL CHANGE-OVER, SLOW/FAST MODE. The ATE power supply is normally delivered for operation in the "slow" mode. By changing jumper connections at the rear of the power supply, the user can quickly convert from the "slow" mode to the "fast" mode or vice versa (See FIG. 2-5).



STEP 1: Remove Links (1)-(2) and (6)-(7) on TB201. This removes the output capacitor (C_O).

STEP 2: Remove jumper (1)-(2) on PC-12. This removes the main feedback capacitor (C_f).

STEP 3: Connect wire jumper on PC-12 from (16) to (26). This connects a lag network.

STEP 4: Remove Links (8)-(9) from TB201. This removes the internal grounding network.

STEP 5: Connect wire jumper from (12) to (25) on PC-12. This introduces a required delay in the crowbar circuit.

FIG. 2-5 REQUIRED STEPS FOR ATE "FAST MODE" CONVERSION.

2-18 PRECAUTIONS. The output capacitor, and to a lesser extent, the feedback capacitor of a power supply, control the programming speed and the current mode recovery time. The removal of these capacitors in the fast mode results in greatly improved power supply performance in these areas. The power supply's dynamic stability, however, is reduced, making the output sensitive to the load phase angle. For this reason, the load presented to the power supply in the fast mode must not contain excessive capacitance (limit: 1000pF). Also, with the output and main feedback capacitors removed, there will be an increase in output noise, mainly high frequency noise and pick-up, so that external shielding of programming leads and good grounding practices assume added importance in the fast mode of operation.

2-19 LAG NETWORK ADJUSTMENT. The ATE power supply operating in the "fast" mode, is dynamically stabilized by means of an internal lag network (E_O LAG, R27, see FIG. 2-1 for location). This control should be adjusted, for each application, by monitoring the load with an oscilloscope and turning the LAG control for best output response and maximum dynamic stability under all operating conditions.

2-20 CROWBAR OPERATION, FAST MODE. The crowbar circuit in the ATE power supply is not completely removed in the "fast" operating mode, but continues to offer protection against dc voltage surges which may harm the load.

> ***NOTE:*** *For fast mode operation into a load interrupted by contactors or relays ("Arcing Load"), a small, high-frequency-type capacitor may be required across the contacts of the interrupting device, or the power supply output terminals, or directly across the load terminals. A ceramic disc capacitor (0.01μF) has been found to be adequate to prevent spurious triggering of the overvoltage circuit.*

SECTION III – OPERATION

3-1 GENERAL

3-2 Interconnections between an a-c power source and a stabilized power supply, and between the power supply and its load are as critical as the interface between other types of electronic equipment. If optimum performance is expected, certain rules for the interconnection of source, power supply and load must be observed by the user. These rules are described in detail in the following paragraphs.

3-3 SAFETY GROUNDING

3-4 National and international safety rules dictate the grounding of the metal cover and case of any instrument connected to the a-c power source.

> **WARNING**
>
> KEEP INSTRUMENT GROUNDED WHILE IT IS CONNECTED TO THE A-C POWER SOURCE.

3-5 Kepco power supplies with flexible a-c power cord are equipped with a 3-prong safety plug, which must be connected to a ***grounded*** a-c power outlet.

3-6 D-C (OUTPUT) GROUNDING

3-7 Connections between the power supply and the load (load and sensing connections), as well as connections to the power supply amplifiers (programming connections) may, despite all precautions such as shielding, twisting of wire-pairs, etc., "pick-up" radiated noise of a wide frequency spectrum. To minimize these undesired effects, one side of the power supply output/load circuit should be grounded.

3-8 Successful d-c grounding depends on careful analysis of the individual situation and only general guide lines can be provided here. One of the major points, however, is to avoid GROUND LOOPS. Ground loops are created when two (or more) points are grounded along the output circuit. Due to the wire impedance between the separated grounded points, a noise voltage is developed which subsequently is superimposed on the load. The only way to avoid ground loops is to investigate the output circuit (including the connected load) carefully by means of an ohmmeter for any resistance to ground. A single d-c ground point can be selected only if the output circuit is completely isolated, a single point is selected along the power supply output/load circuit and this point is returned to ground with a single wire. The exact location of this "best" d-c ground-point is entirely dependent on the application at hand. For single, isolated loads, the d-c ground-point may be located directly at one of the output terminals of the power supply which may be connected to ground. If error sensing is employed, d-c ground can be established at the remote load. In case of an internally grounded load, the d-c ground is automatically established directly at the load.

3-9 ATE Power Supplies have ***one*** side of the output returned to the case over a resistor/capacitor combination (refer to Section II, Par. 2-13). In those cases, therefore, where the ***load*** is internally grounded, or where the signal ground must be established elsewhere, the resistor/capacitor combination must be removed from the power supply case in order to avoid ground loop problems. If there is a choice in selecting either the positive or the negative output of the power supply for the d-c ground point, both sides should be tried, and preference given to the ground point producing the least noise. Output ripple specifications (as measured at the output) are, howver, equally valid for either output side grounded. Care should be taken in measuring the ripple and noise at the power supply output or at the load. Measuring devices which are a-c line operated often introduce ripple and noise into the circuit.

3-10 In the case where the load must be kept completely off ground (d-c isolated) or it must be operated above ground potential, grounding can be accomplished by means of a suitable capacitor connected from either side of the power supply output to the signal ground. The size of the capacitor should be carefully selected. A value between 0.1 and 1 microfarad has been found to be successful in many cases.

3-11 Even simple remote control tasks, such as error sensing or resistance programming, require ***careful shielding*** with 2-wire shielding cable, with the shield (single-ended) returned to the single d-c ground point. In cases where external programming sources are used, additional precautions are required. If all other grounding problems have been solved and a single ground point has been assigned to the system, the programming source must be evaluated for system compatibility. Some of the older signal generators, for example, cannot be successfully used for programming, since their cases are connected permanently to one of the output leads. Aside from these initial problems, the power supply/load system must have the correct "polarity" for voltage programing; e.g., the programming source "common" must be connected to the previously grounded output side. If this is not possible, because of polarity considerations, three choices are open: either the programming source must be "floated;" i.e., it must operate above ground by an amount given by the output voltage of the power supply, or the selected d-c ground point must be changed to the polarity coinciding with that of the programming source, or the polarity of the programming source must be reversed by using the uncommitted preamplifiers of the ATE, as descirbed in this section.

3-12 POWER SUPPLY/LOAD INTERFACE

3-13 The general function of a voltage or current stabilized power supply is to deliver the rated output quantities to the connected load. The load may have any conceivable characteristic: It may be fixed or variable; it may have predominantly resistive, capacitive, or inductive parameters; it may be located very close to the power supply or it may be a considerable distance away. The power supply designer cannot anticipate every conceivable application, location or nature of the load. He must design his product for the widest possible application range and specify the performance at the output terminals of the power supply. The aim of the following paragraphs is to aid the user in the final use of the product: The interface of the power supply and the load.

3-14 The perfect interface between a power source and its load would mean that the specified performance at the output terminals would be transferred without impairment to any load, regardless of its characteristics, distance from the power supply or environment. To approach this ideal, the power supply must satisfy certain requirements, interconnecting rules must be closely followed and Ohm's Law, as well as basic a-c theory must be considered in selecting the interface wiring.

3-15 LOAD WIRE SELECTION. The stabilized d-c power supply is definitely not an ideal voltage or current source with zero output impedance (VOLTAGE MODE) or infinite output impedance (CURRENT MODE) at all frequencies: All ***voltage*** sources have some amount of impedance which ***increases*** with frequency and all ***current*** sources have an output impedance which ***decreases*** with frequency (refer to FIG. 3-1).

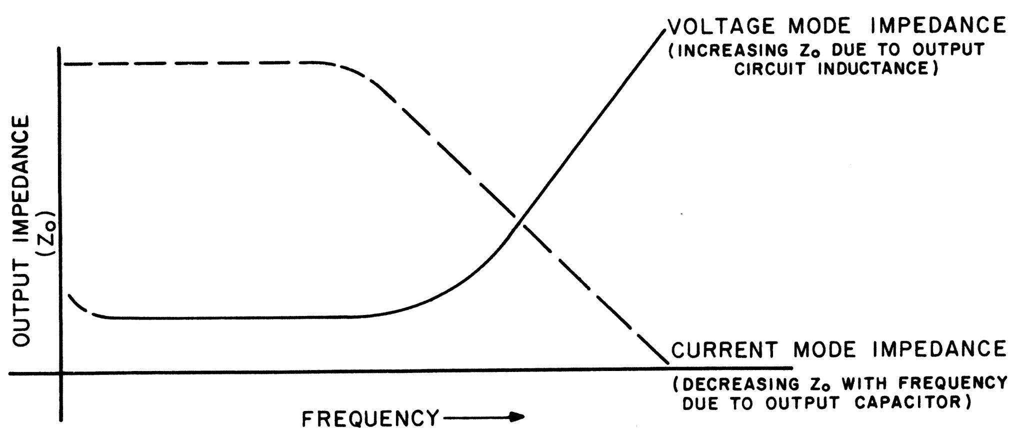


FIG. 3-1 TYPICAL OUTPUT IMPEDANCE VS. FREQUENCY PLOT FOR STABILIZED D-C SOURCES.

NOTE: Load connections for application requiring solely stabilized ***output current*** are not as critical as those requiring stabilized ***output voltage:***

a) D-C wire drops do not influence the current stabilizing action, but must be subtracted from the available compliance voltage.

b) Wire inductance is "swamped-out" by the action of the output capacity.

Emphasis in the following paragraphs is therefore placed on the power supply as a ***voltage source,*** rather than a current source.

A more realistic model for a voltage stabilized power supply must, for example, include a series resistance, representing the small d-c and low frequency source impedance, in series with an inductance, representing the source impedance at higher frequencies. Load wire selection should therefore proceed with those facts in mind. The load-wire size should not only be selected for minimum voltage drop (Error Sensing, as discusses below, will take care of that), but also the series inductance of the load wire must be kept as small as possible compared to the source inductance of the power supply (Error Sensing ***cannot*** compensate for this). These dynamic considerations are especially important if:

1) The load is constantly changing in value.
2) The load is switched "on" and "off."
3) The output of the power supply is step programmed.
4) The load has a primarily reactive characteristic.
5) All other cases where the dynamic output response of the power supply is considered important.

3-16 LOAD CONNECTION, GENERAL

3-17 Kepco has provided a group of terminals on the programming connector PC-12 and on the barrier strip (TB210) at the rear of the power supply, which permit maximum flexibility in power supply/load interface techniques. Although all applications tend to exhibit their own problems, the basic interconnections described may be used as a general guide in the interconnection between power supply and load.

3-18 (Refer to FIG. 3-2). The Kepco power supply is shipped from the factory with several jumper links, connected to the programming connector (PC-12) and to the barrier strip (TB201). These links may be removed and replaced at will, depending on the operating mode and application of the power supply. Positioned as shown in FIG. 3-2, the links are connected for front panel (local) control of the output voltage, output current and VP crowbar level with the power supply operating in the "slow" mode. ***Links remaining on the mating jack must be soldered, links on the barrier strip must be tightened.*** LOOSE WIRES OR LINKS AT THE BARRIER STRIP OR THE MATING JACK WILL CAUSE MALFUNCTION OF THE POWER SUPPLY.

Note: Connection diagrams in Section III are applicable for 3/4 rack and for full-rack ATE power supplies. These diagrams represent partial views of the ATE rear panel. The AC source input (socket and line-cord for 3/4 rack ATE models, barrier strip with wired line-cord and cover for full-rack ATE models, as shown in FIG. 3-2) will be deleted on all further diagrams to simplify the presentation.

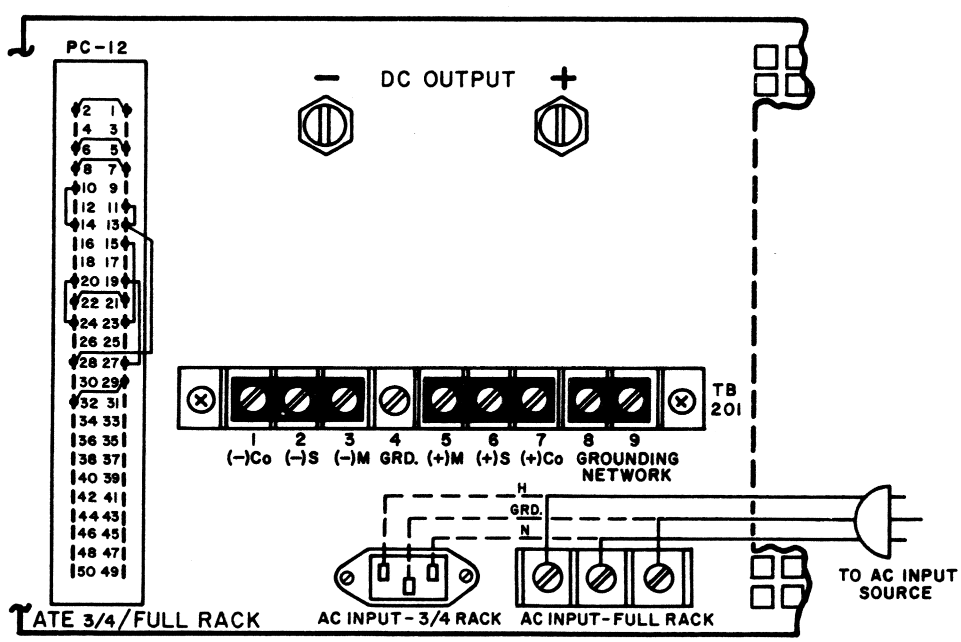


FIG. 3-2 STANDARD JUMPER LINK CONNECTIONS FOR LOCAL (FRONT PANEL) CONTROL OF THE OUTPUT VOLTAGE, OUTPUT CURRENT AND VP CROWBAR LEVEL (SLOW MODE).

3-19 LOAD CONNECTION, METHOD I (LOCAL ERROR SENSING)

3-20 (Refer to FIG. 3-3). The most basic power supply interconnection, to primarily resistive, relatively constant loads, located close to the power supply, or for loads requiring stabilized current exclusively, consists of 2-wire connection from the rear output terminals. Load wire is selected as described previously (refer to par. 3-15). The load leads should be tightly twisted to reduce "pick-up" from stray magnetic fields. After the grounding rules have been applied (refer to par. 3-3 to 3-11), the power supply can be connected to the a-c source and operation may commence.

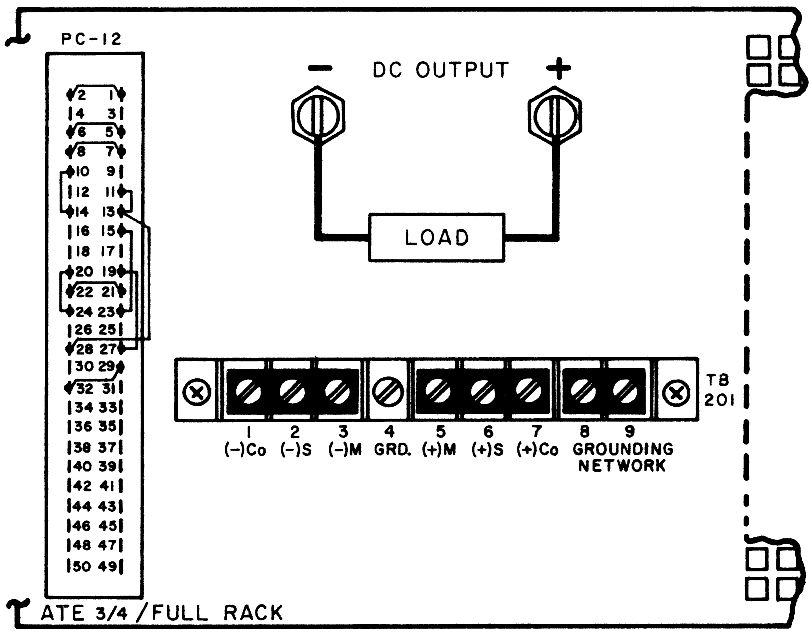


FIG. 3-3 LOAD CONNECTION METHOD I, LOCAL ERROR SENSING.

3-21 LOAD CONNECTION, METHOD II (REMOTE ERROR SENSING)

3-22 To avoid excessive output effects at remote loads, error sensing must be used. A twisted, shielded pair of wire from the sensing terminals directly to the load will compensate for load wire voltage drops up to 0.5 volt per wire (refer to FIG. 3-4). Observe polarities: The ***negative sensing wire*** must go to the ***negative load wire,*** and the ***positive sensing wire*** goes to the ***positive load wire.***

NOTE: For long wire runs, twisting each sensing wire with its associated load wire may give improved results in some cases.

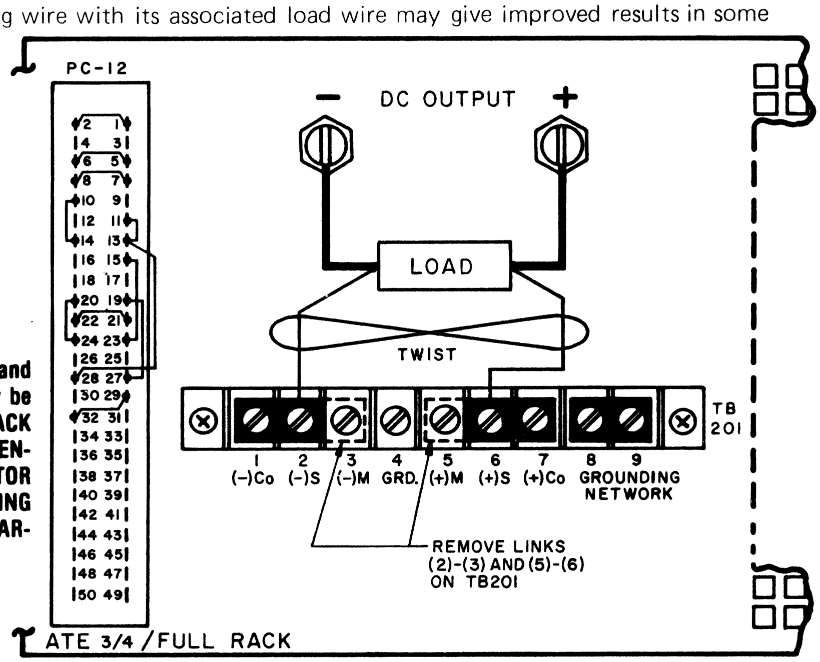


FIG. 3-4 LOAD CONNECTION, METHOD II USING REMOTE ERROR SENSING.

ATTENTION

/hen using remote error sensing with large capacitive loads and ıng load and sensing wires, low frequency oscillations may be bserved at the load. To eliminate the problem the FEEDBACK APACITOR should be disconnected from the (–) OUTPUT SEN-ING terminal and reconnected to the (–) OUTPUT MONITOR ırminal. Remove jumper (1) - (2) on the REAR PROGRAMMING ONNECTOR. Connect a short wire from pin 2 to the REAR BAR-IER-STRIP (TB201-3).

3-23 This method of load interconnection is suitable for loads which do not require rapid changes in voltage or current or for programming with gradually changing waveforms (sine wave, triangular wave shapes, etc.). See par. 3-24 for load connections suitable for rapid (step) changes in the load or in programming.

3-24 LOAD CONNECTION, METHOD III

3-25 This method is suitable if step changes in the load are expected if, for example, the load is rapidly changing in value, or if the power supply is programmed with step functions (square wave, pulse, etc.) and maximum dynamic performance is expected directly at the load terminals. In these cases, the output capacitor is disconnected at the power supply and brought with a heavy, twisted-wire pair directly to the remote load (refer to FIG. 3-4).

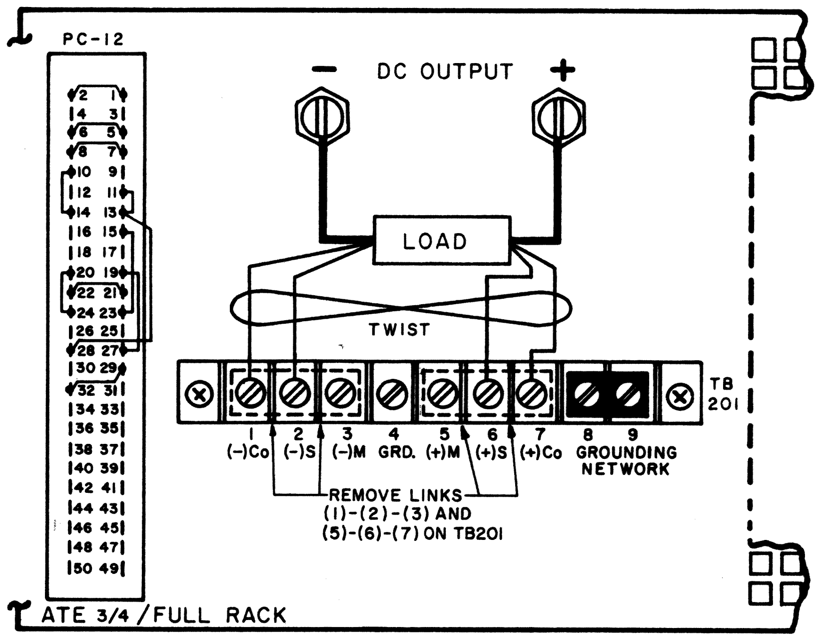


FIG. 3-5 LOAD CONNECTION, METHOD III.

3-26 Since the output capacitor is now removed from the output terminals of the power supply and directly connected to the load, it may be possible in some cases that it can no longer perform its bypass function as far as the ***power supply*** is concerned. If oscillations are observed at the output or at the load, C_O should be left connected in the power supply (by connecting (1)-(3) and (5)-(7) on TB201). The load should be decoupled with another high quality capacitor of a value equal to or greater than C_O. Alternately, good results can sometimes be achieved by disconnecting the internal C_O and operating with an externaly bypass capacitor across the load exclusively. For pulsed loads which drop to zero current during the "off" period, any external output capacitor should be paralled with a "bleeder" resistor. The value of this resistor is determined by the value of the external capacitor, the desired response and the amount of output current which can be sacrificed. As a minimum, the RC time constant of the external output capacitor (C_O ext.) and the bleeded resistor (R_O ext.) should be comparable with the internal output capacitor (C_O) and the bleeder resistor (R_O), so that:

$$R_O \text{ ext. } C_O \text{ ext.} \leqslant R_O C_O$$

NOTE: C_O = C208 and R_O = R11 in 1/2, 3/4 and full-rack ATE Power Supplies, C_O = C6, R_O = R203 in 1/4 rack ATE Power Supplies (SEE "MAIN SCHEMATIC, "SECTION VI, FIG. 6-3 FOR VALUES).

NOTE: There is, unfortunately, no "best" method for interconnecting the load and the power supply. Individual applications, location and nature of the load require careful analysis in each case. Grounding a single point in the output circuit is of great importance. It is hoped that the preceeding paragraphs will be of some assistance in most cases. For help in special applications or difficult problems, consult directly with Kepco's Application Engineering Department.

3-27 VOLTAGE MODE OPERATION (FRONT PANEL CONTROL)

3-28 Once the load is connected to the output terminals of the ATE Power Supply and safety, as well as grounding rules have been applied as described (refer to par's. 3-1 through 3-26), power supply operation can proceed:

1) Turn VOLTAGE CONTROL completely counterclockwise. Turn A-C POWER SWITCH/CIRCUIT BREAKER "on" (The voltage mode VIX indicator should be "on"). Observe front panel VOLTMETER and adjust VOLTAGE CONTROL to the desired output voltage level. Turn a-c power "off".

2) Turn the current control completely counterclockwise.

3) Apply a short circuit across the output terminals of the ATE Power Supply. Turn A-C POWER SWITCH/CIRCUIT BREAKER "on" (the current mode VIX indicator should be "on").

4) Observe front panel CURRENT METER and adjust CURRENT CONTROL to the required load current value, plus 2%. In voltage mode operation, this setting will determine the voltage/current "crossover" point. Turn A-C POWER SWITCH/CIRCUIT BREAKER "off".

5) Remove the short circuit from the output terminals. The power supply is now ready for operation.

3-29 CURRENT MODE OPERATION (FRONT PANEL CONTROL)

Note: Refer to Section I, par. 2-14 for fast mode conversion of the ATE.

3-20 Apply all safety and output grounding rules as described in previous paragraphs (refer to par's. 3-1 through 3-16). Proceed as follows:

1) ***BEFORE*** connecting the load to the power supply output terminals: Turn A-C POWER SWITCH/CIRCUIT BREAKER "on" (the voltage mode VIX indicator should be "on"). Observe the front panel VOLTMETER and adjust the VOLTAGE control to the required compliance (output voltage) level. Turn A-C POWER SWITCH/CIRCUIT BREAKER "off" and connect a short circuit to the output terminals of the ATE.

2) Turn A-C POWER SWITCH/CIRCUIT BREAKER "on". Observe the front panel CURRENT METER and adjust CURRENT control to the desired value. The current mode VIX indicator should go "on" to indicate that the power supply is truly in the current mode of operation. Turn A-C POWER SWITCH/CIRCUIT BREAKER "OFF".

3) Remove the short circuit, connect the load and turn A-C POWER SWITCH/CIRCUIT BREAKER "on". If the ATE does not enter the current mode (as indicated by the front panel "VIX" indicator), the load resistance (R_L) is too high. ***Either*** R_L must be ***decreased, or*** the VOLTAGE CONTROL setting must be ***increased, or*** the CURRENT CONTROL setting must be ***decreased.*** The ATE is now ready for operation.

3-31 OVERVOLTAGE CROWBAR, SETUP AND CHECK

3-32 The overvoltage crowbar circuit protects the load from momentary or long-term overvoltages. The crowbar SCR conducts across the power supply output, and the A-C POWER SWITCH/CIRCUIT BREAKER is tripped if such overvoltages occur. The setting of the front panel LEVEL control determines the "threshold" between the actual operating voltage of the power supply and the level at which the crowbar circuit will be activated. The LEVEL control can be set from 3 volts to 110% of the rated output voltage. The LEVEL control may be adjusted very close the the operating voltage (minimum threshold = 2% of rated output voltage or 0.5 volt, whichever is greater). The operation of the crowbar circuit can be checked ***without*** actually triggering the crowbar. All operating controls are accessible at the front panel (refer to FIG. 2-2, SECTION II).

3-33 SETUP AND CHECK PROCEDURE

1) Without connecting the load to the power supply turn LEVEL control ***fully clockwise.***

2) Turn A-C POWER SWITCH/CIRCUIT BREAKER "on", observe the front panel VOLTMETER, and set VOLTAGE CONTROL to the desired value ***at which the crowbar must trigger*** (NOT to the actual operating voltage).

3) Depress the DISABLE button (and keep it depressed) while turning the LEVEL control ***counterclockwise,*** until the crowbar INDICATOR energizes (simulated crowbar action).

4) Turn VOLTAGE CONTROL slightly ***counterclockwise*** to ***the actual operating voltage.*** Release the DISABLE button.

NOTE: This last adjustment established the "threshold" i.e., the difference voltage between the output voltage and the voltage at which the power supply will "crowbar". For minimum "false triggering" use the largest threshold your load can tolerate.

5) To check the adjusted crowbar trigger level, depress DISARM push button and turn VOLTAGE CONTROL ***clockwise.*** Observe front panel VOLTMETER and note the voltage at which the crowbar INDICATOR lamp energizes. Correct LEVEL adjustment as described above if necessary. Reduce power supply output voltage to its operating value.

NOTE: 1) Readjustment of the LEVEL control may be required after load and power supply have reached thermal equilibrium.

NOTE: 2) If an ***exact*** crowbar point at a ***remote load*** must be established, ***remote error sensing,*** as described in par. 3-21 must be used.

3-34 INTRODUCTION TO REMOTE CONTROL OF THE ATE OUTPUT

3-35 GENERAL (REFER TO THE FOLD-OUT DRAWING AT THE END OF THIS SECTION. For local (front panel) control, the VOLTAGE CONTROL CHANNEL, the CURRENT CONTROL CHANNEL and the OVER-VOLTAGE PROTECTOR of the ATE are locally adjusted by means of their respective front panel controls, with the jumper connections on the REAR PROGRAMMING CONNECTOR as shown. The internal control voltages for the VOLTAGE and CURRENT CONTROL CHANNELS are created by their individual control amplifiers, while the OVERVOLTAGE PROTECTOR "crowbar level" is adjusted by a potentiometer, connected across the (+)15 volt supply.

3-36 By disconnecting the internal control sources at the REAR PROGRAMMING CONNECTOR and substituting remote control circuitry, the ATE VOLTAGE and CURRENT CONTROL CHANNELS, as well as the OVER-VOLTAGE PROTECTOR crowbar level, can be programmed externally. Control can be exercised individually or simultaneously on all three programming channels, although individual programming will be illustrated and discussed in the following paragraphs.

3-37 PROGRAMMING THE VOLTAGE CONTROL CHANNEL

3-38 GENERAL. The ATE output voltage which is controlled by a front panel VOLTAGE CONTROL in the Local control mode, can be remotely controlled by disconnecting the internal VOLTAGE CONTROL AMPL at the REAR PROGRAMMING CONNECTOR (PC—12) and substituting an external control signal at the input of the VOLTAGE COMPARISON AMPL with reference to the PROGRAMMING COMMON. For this "direct drive" method of voltage control, the control signal must be a positive going 0—10 volt d-c voltage source, able to supply at least 1 mA of control current. An application, demonstrating this control method is described in PAR. 3-41, and illustrated in FIG. 3-6.

3-39 Since all terminals of two independent preamplifiers (PREAMP "A", PREAMP "B") are available at the REAR PROGRAMMING CONNECTOR, output voltage control can be exercised in many other ways. Each preamplifier can be used as an uncommitted operational amplifier using the applicable transfer functions. The ***static offsets*** of each preamplifier can be zeroed with the built-in ZERO controls. The ***offset variations*** for each preamplifier, versus the various influence quantities, are specified in Section I of this manual (Refer to Table 1-2).

3-40 Making use of the ATE preamplifiers allows the user to accommodate a variety of programming sources. The basic principle to keep in mind is that a 0 to 10 volts, 1 mA signal, presented at the VOLTAGE COMPARISON AMPL input, will program the ATE output over its rated output voltage range. If the available programming input source does not have the required amplitude, or if the required control current cannot be supplied, the ATE preamplifiers can be used to adapt most input sources and provide the required parameters. The examples presented in the following paragraph should suffice to outline the wide variety of programming circuits which are possible with the ATE power supply.

3-41 OUTPUT VOLTAGE CONTROL WITH AN EXTERNAL 0—10 VOLT D-C CONTROL SIGNAL

3-42 An interesting example of the direct drive method of voltage programming is the control of the ATE output voltage by means of a Kepco Digital Programmer. The IEEE 488 bus compatible Kepco SN—488 system for example, responds to digital input data and can be addressed either by a computer, or manually. The output signal of the SN—488 is a voltage from zero to 10 volts or zero to 1 volt and constitutes the input program for the ATE. Since the SN—488 has two independent outputs (A,B), only one output is needed for voltage control, while the other may be used to control the ATE output current (See par. 3-60).

3-43 PROCEDURE (VOLTAGE CONTROL WITH AN EXTERNAL 0—10 VOLT, 1 mA D-C CONTROL SIGNAL)

1) Connect the EXT. CONTROL VOLTAGE, (SN—488 DIGITAL PROGRAMMER), the LOAD and the PRECISION VOLTMETER (M1) to the ATE as shown in FIG. 3-6.
2) With the SN—488 at zero, turn the ATE "on".
3) Vary the input voltage from the SN—488 from zero to 10 volts. The ATE output voltage, as read-out on M1, should vary from approximately zero volts to its maximum rated output voltage. Return the SN—488 output to zero volts.

3-44 CALIBRATION (Refer to Section II, FIG. 2-1 for the location of all internal controls).

1) Check the PRECISION VOLTMETER (M1) for "zero" reading and correct, if necessary, with the ATE E_O ZERO control.

2) Set the MODEL SN–488 input to 10 volts. Observe M1 and calibrate the ATE output voltage to the exact maximum rated output voltage by means of the SN–488 calibration control.

3) Set the MODEL SN–488 output to "zero" again and check the previously calibrated zero point on M1. Correct with the ATE E_O ZERO control if required.

4) Set the ATE front panel CURRENT CONTROL according to your load requirements, following the procedure given in PAR. 3-28 (2,3,4,5), or use one of the output current programming circuits for remote control of the output current as described in PAR.'s 3-60 or 3-64.

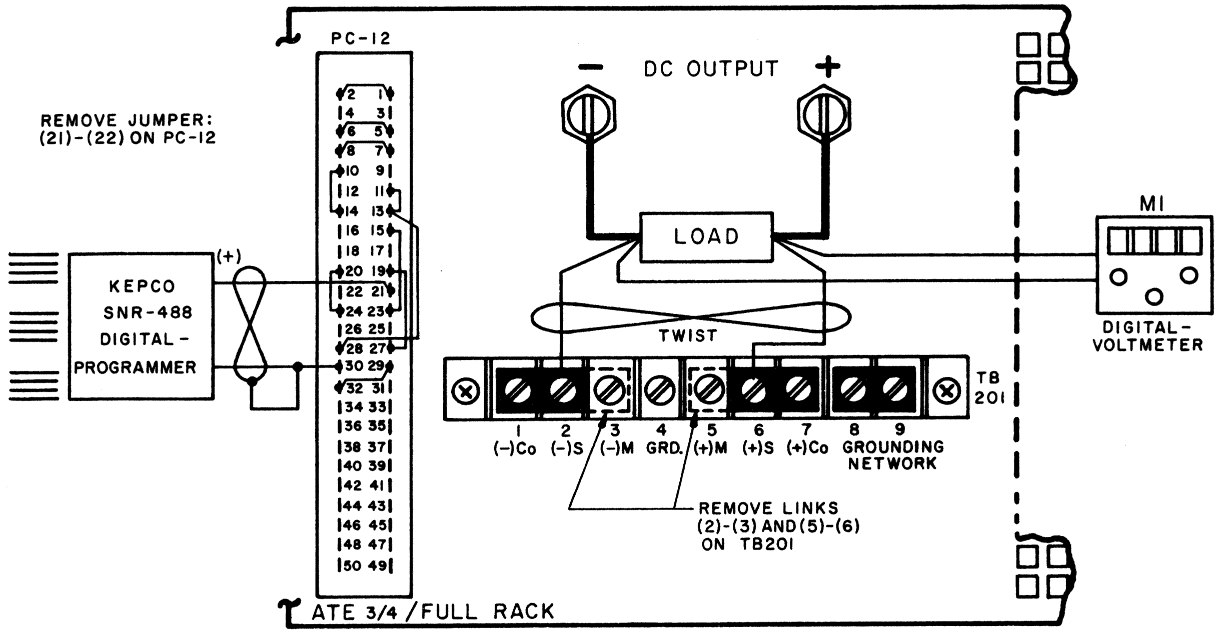


FIG. 3-6 OUTPUT VOLTAGE CONTROL WITH AN EXTERNAL (0–10V, 1 mA) D-C CONTROL SIGNAL.

3-45 VOLTAGE CONTROL WITH A TWO-TERMINAL RESISTANCE

3-46 As mentioned previously (refer to PAR.'s 3-39, 3-40) a wide variety of external programming sources can be used to control the ATE voltage channel. By means of one or both of the ATE's uncommitted preamplifiers, the external control potential can be amplified, inverted and/or summed with an internal d-c signal. Alternately, the preamplifier can be used to perform remote, two-terminal resistance programming of the ATE voltage channel. As seen in FIG. 3-7, the INT. REFERENCE SOURCE (6.2V @ 1 mA) is connected to PREAMP "A" and the external input/feedback components are calculated to produce the required 0 to 10 volts control signal from the preamplifier output.

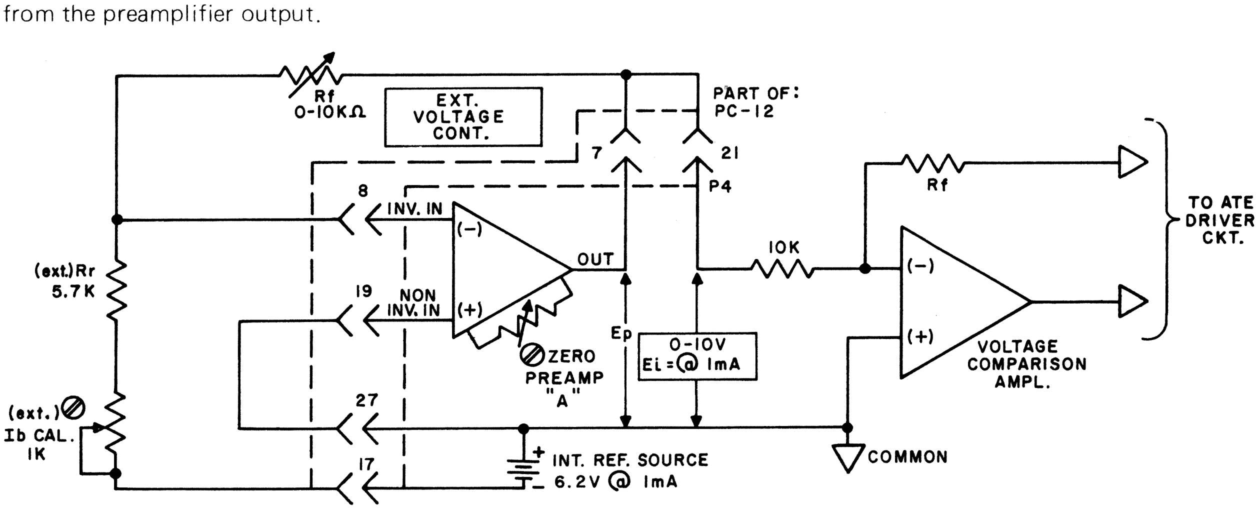


FIG. 3-7 TWO-TERMINAL RESISTANCE PROGRAMMING OF THE VOLTAGE CHANNEL, USING PREAMP "A" AND THE INTERNAL REFERENCE SOURCE.

3-47 (Refer to FIG. 3-7). The preamplifier functions here in the inverting configuration, producing its output voltage (E_p, which is made equal to the required control voltage "E_i") according to the equation:

$$E_p = \frac{E_{ref}}{R_r} \times R_f \quad \text{(Eq. 1)}$$

where:

R_r = Ext. Reference resistor
E_p = Preamplifier output voltage equal to the required control voltage (E_i)
E_{ref} = Internal Reference Voltage 6.2V
R_f = Ext. Feedback Resistor (Voltage Control)

Since the ratio E_{ref}/R_r may be expressed as a control current ($E_{ref}/R_r = I_b$), Eq. 1 can be simplified to read:

$$E_p = E_o \text{ (Preamplifier)} = I_b R_f \quad \text{(Eq. 2)}$$

3-48 If I_b is selected to be 1 mA for example (Control Currents from approximately 0.1 to 1 mA can be selected), a 0 to 10K ohm reostat, decade or other variable resistance will produce the required 0—10 volt control potential and thereby control the ATE output voltage from zero to its maximum rated value. If a 0—10K ohm voltage control resistance is ***not*** available, the control current (I_b) can be changed to accommodate the available resistance value, making use of the preamplifier output equation (Eq. 2). If, for example, a 15K ohm precision potentiometer is available, the control current (I_b) must be: 10V/15KΩ = 0.66 mA. Since the built-in INT. REF. SOURCE is a (nominal) 6.2 volt, the external R_r must be: 6.2V/0.66 mA ≈ 9.4KΩ, which can be made up from a 8KΩ fixed, and a 2KΩ trim resistor (I_b CAL.).

3-49 PROCEDURE, VOLTAGE CONTROL WITH A TWO-TERMINAL RESISTANCE

1) Connect the external components, the LOAD and the PRECISION VOLTMETER (M1) to the ATE as shown in FIG. 3-8.

2) With the EXT. VOLTAGE CONTROL at zero ohms, turn the ATE "on".

3) Vary the EXT. VOLTAGE CONTROL from zero ohms to its maximum resistance. The ATE output voltage, as read out on M1, should vary from approximately zero volts to its rated maximum value. Return the EXT. VOLTAGE CONTROL to its zero ohm position.

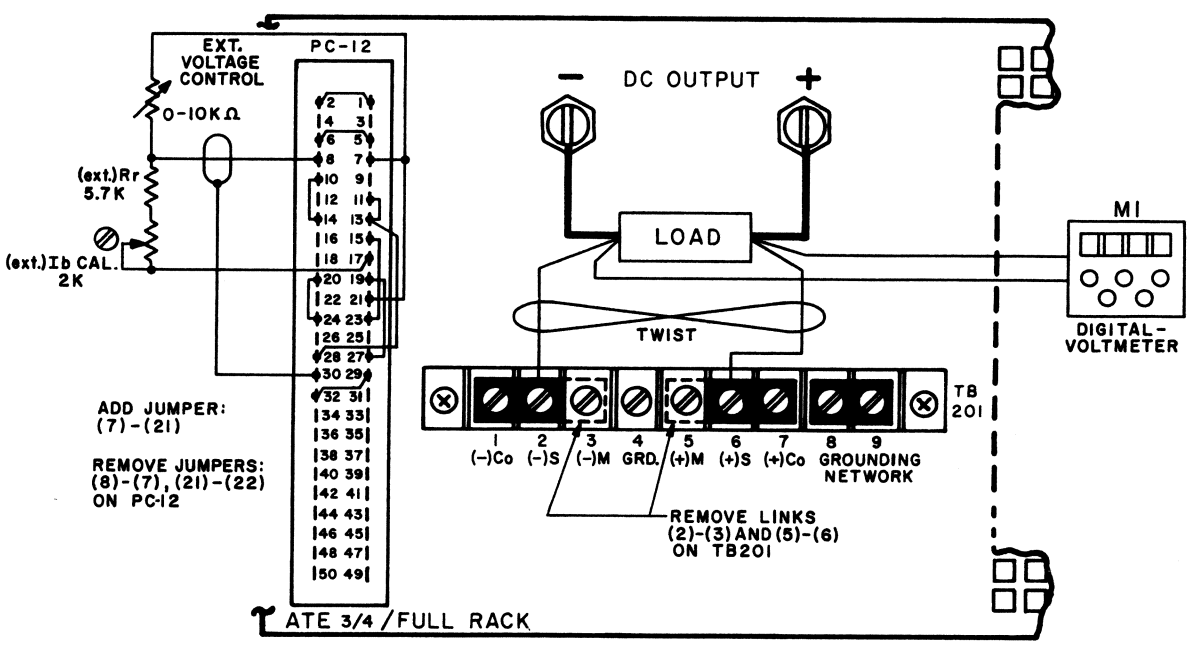


FIG. 3-8 CONNECTIONS FOR VOLTAGE CONTROL WITH A TWO-TERMINAL RESISTANCE.

3-50 CALIBRATION (Refer to Section II, FIG. 2-1 for the location of *all* internal controls).

1) Check the PRECISION VOLTMETER (M1) for "zero" reading and correct, if necessary, with the PREAMP "A" ZERO control.

2) Set EXT. VOLTAGE CONTROL to its maximum resistance. Observe M1 and calibrate the ATE output voltage to the exact maximum rated value by adjusting the EXT. I_b CAL. control.

3) Set EXT. VOLTAGE CONTROL to zero ohms again, re-check the previously calibrated zero point on M1 and correct with the PREAMP "A" ZERO control if required.

4) Set the ATE front panel CURRENT CONTROL according to the LOAD requirements, following the procedure given in PAR. 3-28 (2,3,4,5) or use one of the output current programming circuits for remote control of the output current as described in PAR.'s 3-60 or 3-64. Set the overvoltage protector as described in PAR. 3-31.

5) Operation can now proceed. Check the ATE power supply output, by means of an oscilloscope, for dynamic stability and output ripple amplitude. Refer to PAR. 3-6 if high ripple is present. If the power supply output is dynamically unstable (oscillations), review the paragraphs on power supply/load interface and grounding (PAR.'s. 3-6 through 3-26). Adjust the E_o LAG control if the ATE is configured for fast mode operation.

3-51 VOLTAGE CONTROL WITH A HIGH IMPEDANCE CONTROL SOURCE

3-52 External control sources which cannot supply at least 100μA of control current can be best accommodated by using one of the preamplifiers in the non-inverting configuration. The control source is connected to the ATE as shown in FIG. 3-9.

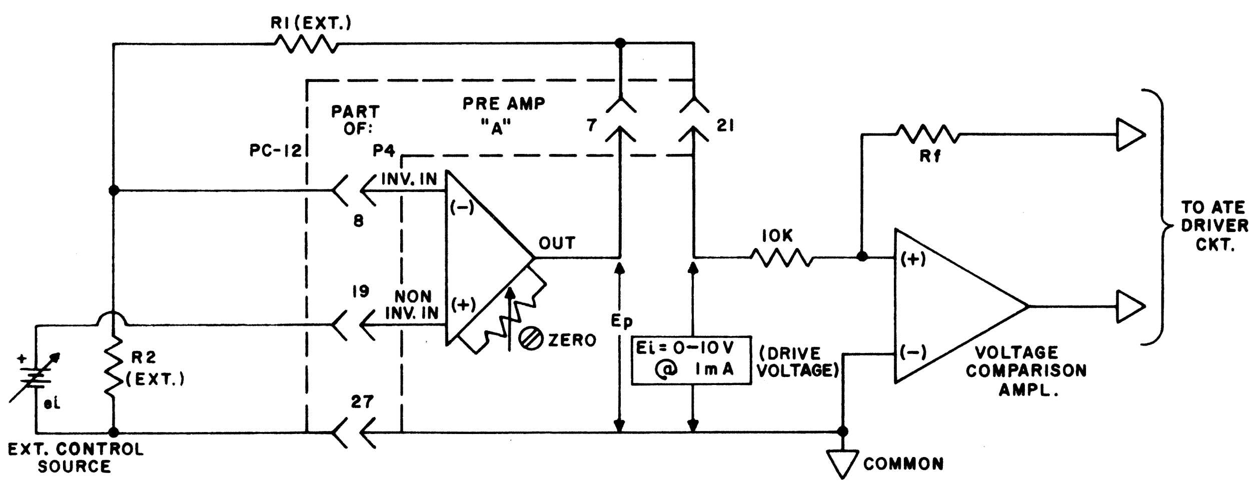


FIG. 3-9 USING PREAMP "A" TO GENERATE THE 0–10V @ 1 mA CONTROL POTENTIAL FROM A HIGH IMPEDANCE SOURCE.

3-53 (Refer to FIG. 3-9). The preamplifier output voltage (E_p) is made equal to the required drive voltage "E_i" by calculating the external resistors (R1, R2) for the required gain, using the equation:

$$E_i = E_p = e_i \times \frac{R1 + R2}{R2} \quad \text{(Eq. 3)},$$

where:

E_p = Preamplifier Output Voltage, equal to the required drive voltage (E_i)

e_i = Available control source.

R1, R2 = External feedback resistors.

3-54 If, for example, a 0 to 0.5 volt control source is available, the preamplifier gain, and therefore the ratio (R1 + R2) over R2 must equal 10/0.5 = 20, so that R1, R2 can be 2KΩ and 38KΩ respectively. If only an impedance match is needed, i.e., if a 0–10 volt source is available, but cannot deliver 1 mA of control current, R1 can be replaced by a short circuit and the preamplifier operates as a voltage-follower.

3-55 PROCEDURE, VOLTAGE CONTROL WITH A HIGH IMPEDANCE CONTROL SOURCE

1) Connect the external components, the LOAD and the PRECISION VOLTMETER (M1) to the ATE as shown in FIG. 3-10.

2) With the EXT. CONTROL SOURCE at zero, turn the ATE "on".

3) Vary the EXT. CONTROL SOURCE from zero to its maximum output level. The ATE output voltage, as read out on M1, should vary from approximately zero volts to its rated maximum value. Return the EXT. CONTROL SOURCE to its zero position.

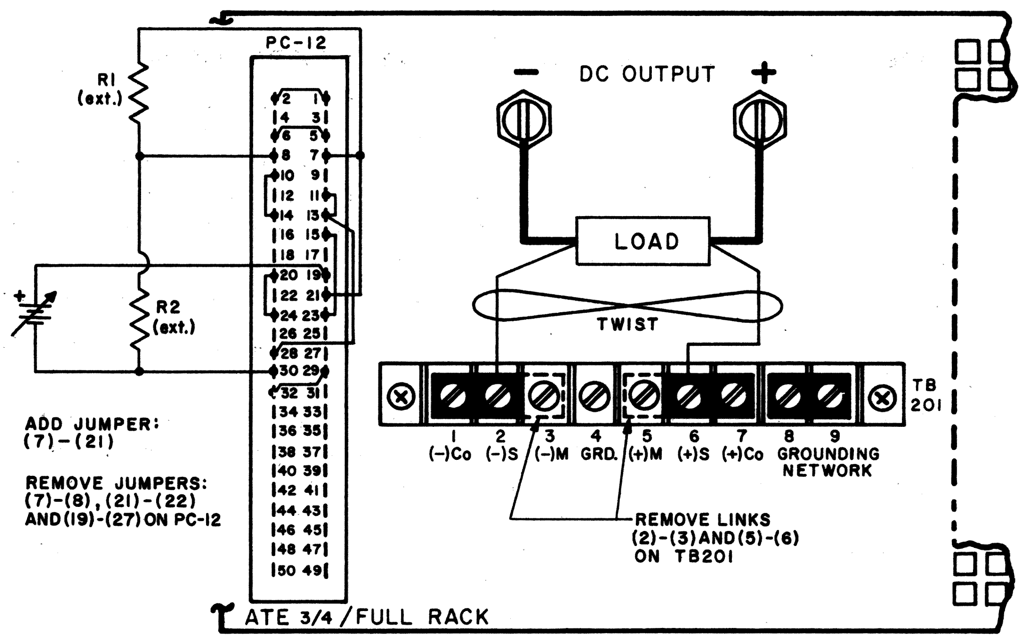


FIG. 3-10 CONNECTIONS FOR VOLTAGE CONTROL WITH A HIGH IMPEDANCE INPUT SOURCE.

3-56 CALIBRATION (Refer to Section II, FIG. 2-1 for the location of ***all*** internal controls).

1) Check the PRECISION VOLTMETER (M1) for "zero" reading and correct, if necessary, with the PREAMP "A" ZERO control.

2) Set EXT. CONTROL SOURCE to maximum output. Observe M1 and calibrate the ATE output voltage to the exact maximum rated value by adjusting the Calibrating Control in the EXT. CONTROL SOURCE.

3) Set EXT. CONTROL SOURCE to zero again, re-check the previously calibrated zero point on M1 and correct with the PREAMP "A" ZERO control if required.

4) Set the ATE front panel CURRENT CONTROL according to the LOAD requirements, following the procedure given in PAR. 3-28 (2,3,4,5), or use one of the output current programming circuits for remote control of the output current as described in PAR.'s 3-60 or 3-64. Set the overvoltage protector as described in PAR. 3-31.

5) Operation can now proceed. Check the ATE power supply output, by means of an oscilloscope, for dynamic stability and output ripple amplitude. Refer to PAR. 3-6 if high ripple is present. If the power supply output is dynamically unstable (oscillations) review the paragraphs on power supply/load interface and grounding (PAR.'s 3-6 through 3-26). Adjust the E_O LAG control, if the ATE is configured for fast mode.

CONSTRUCTION DRAWING LIST

MODEL 100-2359 BY F. AMADOR

DATE 10/10/14 APPROVED BY

DRAWING NO.	DESCRIPTION	REMARKS
MA-900-0936	MAGNETICS BOM and PREPARATION	
MB-100-2359-00	MAGNETIC COMPONENTS ELECTRICAL TEST	
MB-100-2359-10	OUTLINE DRAWING AND INSPECTORS	
MB-100-2359-20	TOROID FINISHING INSTRUCTION SHEET	SHEET 1 OF 3
MB-100-2359-20	TOROID FINISHING INSTRUCTION SHEET	SHEET 2 OF 3
MB-100-2359-20	TOROID FINISHING INSTRUCTION SHEET	SHEET 3 OF 3
MB-100-2359-22	PACKAGING DRAWING	
MB-100-2359-50	TOROID WINDING INSTRUCTION SHEET	

3-57 PROGRAMMING THE CURRENT CONTROL CHANNEL

3-58 GENERAL. The ATE output current, controlled by a front panel CURRENT CONTROL rheostat in the local control mode, can be remotely controlled by disconnecting the (15) bus from the non-inverting input of the EXT. CURRENT COMPARISON AMPL at the REAR PROGRAMMING CONNECTOR, and applying a 0 to 1 volt external control signal with reference to the ATE COMMON terminal. Since the non-inverting input of the EXT. CURRENT COMPARISON AMPL is used, only the small amplifier bias current must be supplied by the external control source. IN ALL CURRENT PROGRAMMING APPLICATIONS, THE FRONT PANEL CURRENT CONTROL SETTING OF THE ATE ACTS AS A "BACK-UP" CURRENT LIMIT AND MUST BE SET SLIGHTLY HIGHER THAN THE REQUIRED MAXIMUM OUTPUT CURRENT. An application, demonstrating this control method is described in PAR. 3-60 and illustrated in FIG. 3-11.

3-59 If the available programming source does not have the required amplitude or polarity, one of the ATE's uncommitted preamplifiers may be used to scale the programming source to the required control potential (0 to 1 volt), or provide the correct polarity. Typical examples of some possible applications are provided in the following paragraphs.

3-60 OUTPUT CURRENT CONTROL WITH AN EXTERNAL 0 TO 1V CONTROL SIGNAL

3-61 An interesting example of direct drive method is the control of the ATE output current by means of a Kepco SN—488 Digital Programmer. The SN—488 responds to digital input signals, is IEEE—488 bus compatible and can be addressed either by a computer or manually by means of a keyboard. The commutated output signal of the SN—488 is a voltage from zero to 1 volt and constitutes the input program for the ATE current channel. Since the SN—488 has two independent outputs (A, B) and only one is needed for current control, the other output may be used to control the ATE output voltage (See par. 3-41).

3-62 PROCEDURE (OUTPUT CURRENT CONTROL WITH AN EXTERNAL 0-1 VOLT, D-C CONTROL SIGNAL)

1) Connect the EXT. CONTROL VOLTAGE, (Model SN—488 Digital Programmer), the LOAD and the PRECISION VOLTMETER (M1) to the ATE as shown in FIG. 3-11.

Note: The output current value can be measured directly by means of a suitable ammeter in series with the load or, as indicated in FIG. 3-11, indirectly by means of the precision voltmeter (M1) across a current measuring resistor (R_M). R_M should be selected such that a convenient range on the precision voltmeter can be used, e.g., for a 10 ampere output current, use a 0.1 ohm, resistor to produce a one volt full scale reading. If an electronic voltmeter is used, it should be batter-operated to avoid ground loops.

2) With the SN—488 output at zero, turn the ATE "on".

3) Vary the input voltage from the SN—488 from zero to 1 volt. The ATE output current, as read-out on M1, should vary from approximately zero volts to its maximum rated value. Return the SN—488 output to zero volts.

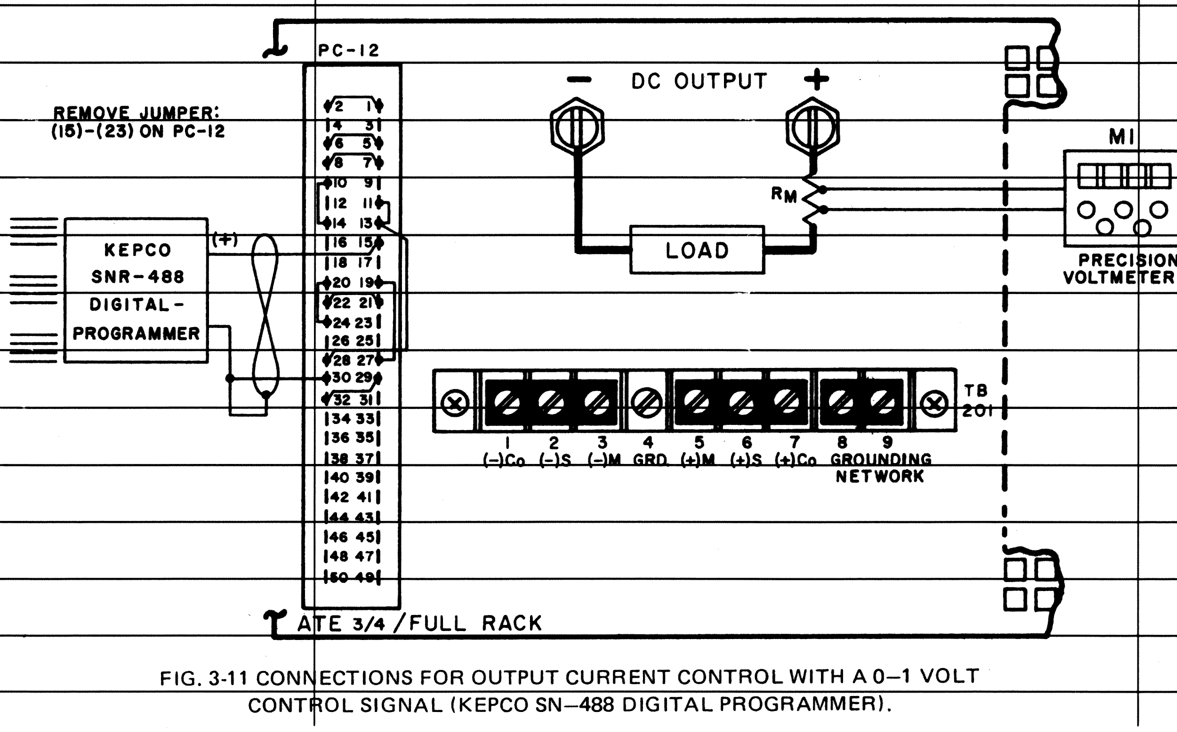


FIG. 3-11 CONNECTIONS FOR OUTPUT CURRENT CONTROL WITH A 0–1 VOLT CONTROL SIGNAL (KEPCO SN—488 DIGITAL PROGRAMMER).

3-63 CALIBRATION (Refer to Section II, FIG. 2-1 for the location of all internal controls).

1) Check the PRECISION VOLTMETER (M1) "zero" reading and correct, if necessary, with the ATE I_o ZERO control.

2) Set the Model SN—488 output to 1 volt. Observe M1 and calibrate the ATE output current to the exact maximum rated output current by means of the SN—488 calibration control.

3) Set the Model SN—488 output to "zero" again and check the previously calibrated zero point on M1. Correct with the ATE I_o ZERO control if required.

4) Set the ATE front panel VOLTAGE CONTROL according to your load requirements, or use one of the output VOLTAGE programming circuits for remote control of the output VOLTAGE as described in PAR's 3-37 through 3-56.

3-64 OUTPUT CURRENT CONTROL WITH A TWO-TERMINAL RESISTANCE

3-65 In this control mode, one of the ATE's preamplifiers is used in conjunction with one of the ATE's reference source, to produce the 0 to 1 volt control signal. The external feedback resistor (R_{cc}) serves as the two-terminal external current control.

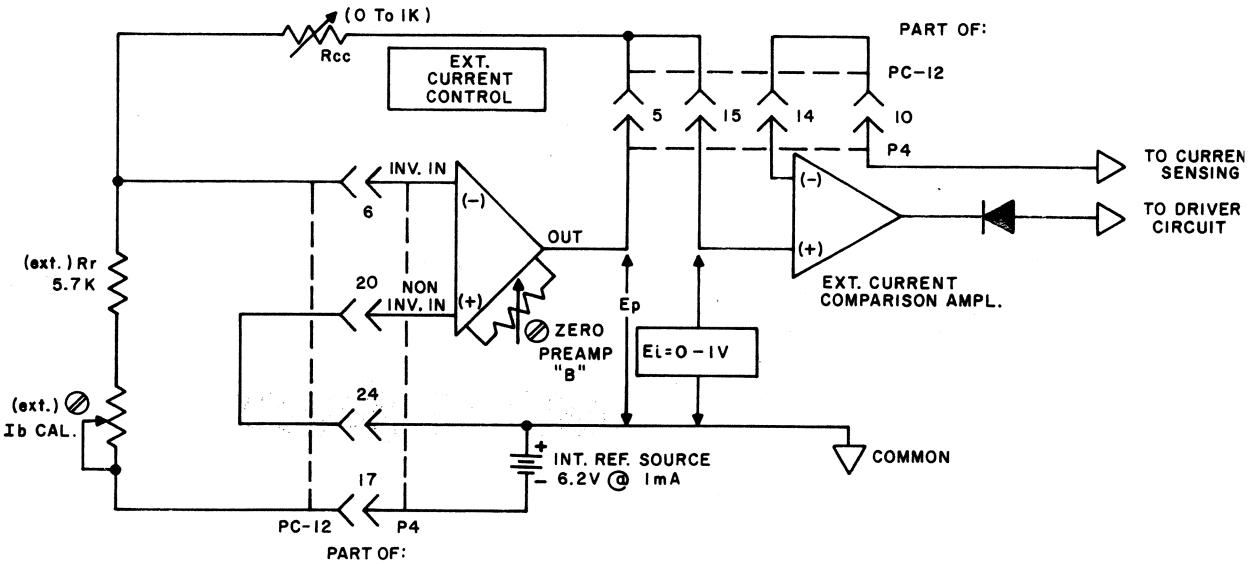


FIG. 3-12 TWO-TERMINAL RESISTANCE PROGRAMMING OF THE CURRENT CHANNEL USING THE PREAMPL AND THE INTERNAL REFERENCE SOURCE.

3-66 (Refer to FIG. 3-12). The preamplifier functions here in the inverting configuration, producing its output voltage (E_p, which is made equal to the required voltage "E_i") according to the equation:

$$E_i = E_p = \frac{E_{ref}}{R_r} x\ R_f \quad \text{(Eq. 1)},$$

where:

R_r = Ext. Reference resistor
E_p = Preamplifier output voltage equal to the required drive voltage (E_i)
E_{ref} = Internal Reference Voltage 6.2V
R_{cc} = Ext. Feedback Resistor (Current Control)

Since the ratio E_{ref}/R_r may be expressed as a control current: ($E_{ref}/R_r = I_b$), Eq. 1 can be simplified to read:

$$E_i = E_p = I_b R_f \quad \text{(Eq. 2)}$$

3-67 If I_b is selected to be 1 mA for example (control current from approximately 0.1 to 1 mA can be selected), a 0 to 1K ohm, rheostat, decade or other variable resistance will produce the required 0—1 volt control potential and thereby control the ATE output current from zero to its maximum rated value. If a 0—1K ohm voltage control resistance is ***not*** available, the control current (I_b) can be changed to accommodate the available resistance value, making use of the preamplifier output equation (Eq. 2). If, for example, a 1.5K ohm precision potentiometer is available, the control current (I_b) must be: $1V/1.5K\Omega = 0.66$ mA. Since the built-in INT. REF. SOURCE is a (nominal) 6.2 volt, the external R_r must be: $6.2V/0.66\ mA \approx 9.4K\Omega$ which can be made up from a $8K\Omega$ fixed, and a $2K\Omega$ trim resistor (I_b CAL.).

3-68 PROCEDURE, ATE OUTPUT CURRENT CONTROL WITH A TWO-TERMINAL RESISTANCE.

1) Connect the external components, the LOAD and the PRECISION VOLTMETER (M1) to the ATE as shown in FIG. 3-13. NOTE: The output current value can be measured directly by means of a suitable ammeter in series with the load or, as indicated in FIG. 3-13, indirectly by means of the precision voltmeter (M1) across a current measuring resistor (R_M). R_M should be selected such that a convenient range on the precision voltmeter can be used, e.g., for a 10 ampere output current, use a 0.1 ohm resistor to produce one volt full scale. If an electronic voltmeter is used, it should be battery operated to avoid ground loops.

2) With the EXT. CURRENT CONTROL at zero ohms, turn the ATE "on".

3) Vary the EXT. CURRENT CONTROL from zero ohms to its maximum resistance. The ATE output current, as read out on M1, should vary from approximately zero to its maximum value. Return the EXT. CURRENT CONTROL to its zero ohm position.

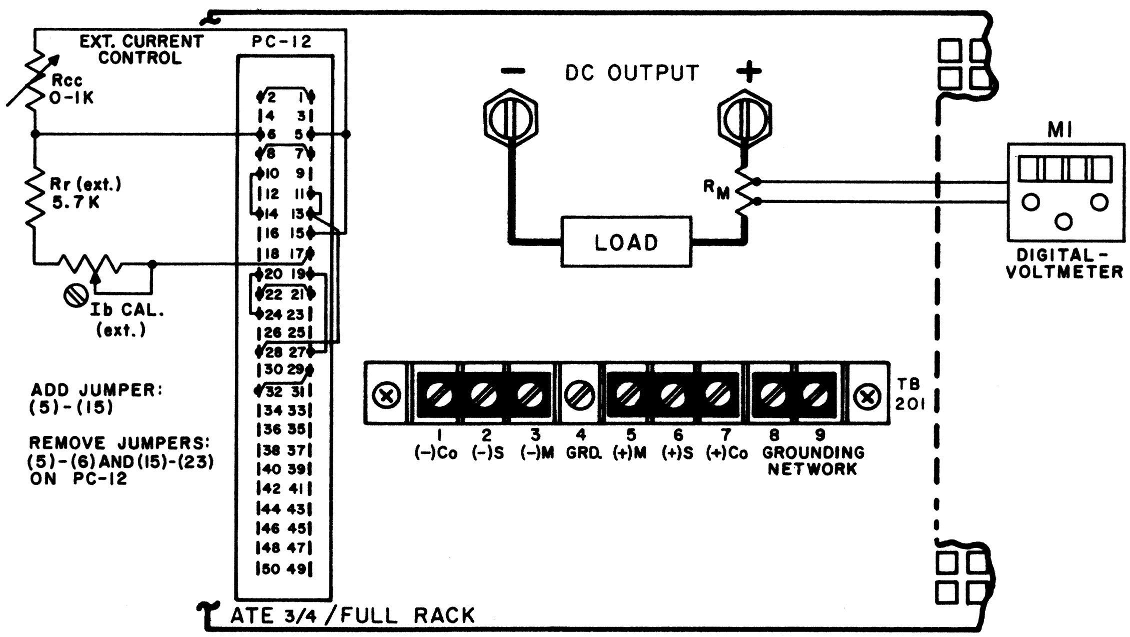


FIG. 3-13 CONNECTIONS FOR ATE OUTPUT CURRENT CONTROL WITH A TWO-TERMINAL RESISTANCE.

3-69 CALIBRATION (Refer to Section II, FIG. 2-1 for the location of ***all*** internal controls).

1) Check the PRECISION VOLTMETER (M1) for "zero" reading and correct, if necessary, with the PREAMP "B" ZERO CONTROL.

2) Set EXT. CURRENT CONTROL to its maximum resistance. Observe M1 and calibrate the ATE output current to the exact maximum rated value by adjusting the EXT. I_b CAL. control.

3) Set EXT. CURRENT CONTROL to zero ohms again, re-check the previously calibrated zero point on M1 and correct with the PREAMP "B" ZERO control if required.

4) Set the ATE front panel VOLTAGE CONTROL according to the LOAD requirements, or use one of the output Voltage programming circuits for remote control as described in PAR's 3-37 through 3-56.

5) Operation can now proceed. Check the output, by means of an oscilloscope across R_M, for dynamic stability and output ripple amplitude. Refer to PAR. 3-6 if high ripple is present. If the power supply output is dynamically unstable (oscillations), review the paragraphs on power supply/load interface and grounding PAR's 3-5 through 3-26).

3-70 PROGRAMMING THE OVERVOLTAGE PROTECTOR

3-71 The ATE overvoltage protector "crowbar level" is normally set by a front panel (screwdriver adjusted) control (SET LEVEL). This local operating mode has been previously described in PAR. 3-31. The crowbar level can be independently remotely controlled by setting the internal crowbar level to zero, turning the front panel SET LEVEL control completely counterclockwise and applying an external control signal (0 to 10V d-c) at the OVERVOLTAGE INPUT. In another programming mode, the crowbar level can be controlled in a "tracking mode", i.e., the 0–10 volt output voltage programming signal can simultaneously be applied to the overvoltage protector, so that the crowbar level automatically "tracks" the output voltage level of the ATE. Typical examples of these programming applications are presented in the following paragraphs.

3-72 REMOTE CROWBAR LEVEL CONTROL WITH AN EXTERNAL (0–10 VOLT D-C, 1 mA) SIGNAL

3-73 The ATE crowbar level can be remotely controlled by an external 0 to 10 volt, 1 mA d-c control source. One example of such a control source is the Kepco SN–488 Digital Programmer, which responds to digital input signals and can be controlled by computer or manually. The output of the SN–488 is from zero to 10 volts or 0 to 1 volt per channel and serves as the input to the ATE overvoltage protector.

3-74 PROCEDURE, CROWBAR LEVEL CONTROL WITH AN EXTERNAL SIGNAL

1) Turn front CROWBAR SET LEVEL completely counterclockwise.
2) Connect a substitute LOAD and the EXT. CONTROL SOURCE to the ATE as shown in FIG. 3-14. Set the EXT. CONTROL SOURCE to its maximum value.
3) Turn the ATE "on" and adjust the front panel VOLTAGE CONTROL to the desired ***crowbar level,*** i.e., the level at which the ATE is to shut down, ***not*** to your load voltage level.
   NOTE: Monitor the power supply voltage either by means of the front panel meter, or if required, connect a precision voltmeter across the load.
4) Slowly reduce the level of the EXT. CONTROL SOURCE and note if the ATE shuts down at the correct crowbar level.
5) Turn the ATE front panel VOLTAGE CONTROL one turn counterclockwise and re-activate the ATE circuit breaker.
6) Test the previously set crowbar level again by turning the front panel VOLTAGE CONTROL slowly counterclockwise and observing the voltmeter. If the ATE does not shut down at the intended crowbar level, correct the setting of the EXT. CONTROL SOURCE, turn front panel VOLTAGE CONTROL one turn counterclockwise, re-activate the ATE circuit breaker and test again.
7) Turn the ATE front panel VOLTAGE CONTROL to the ***exact*** operating voltage which the LOAD requires.

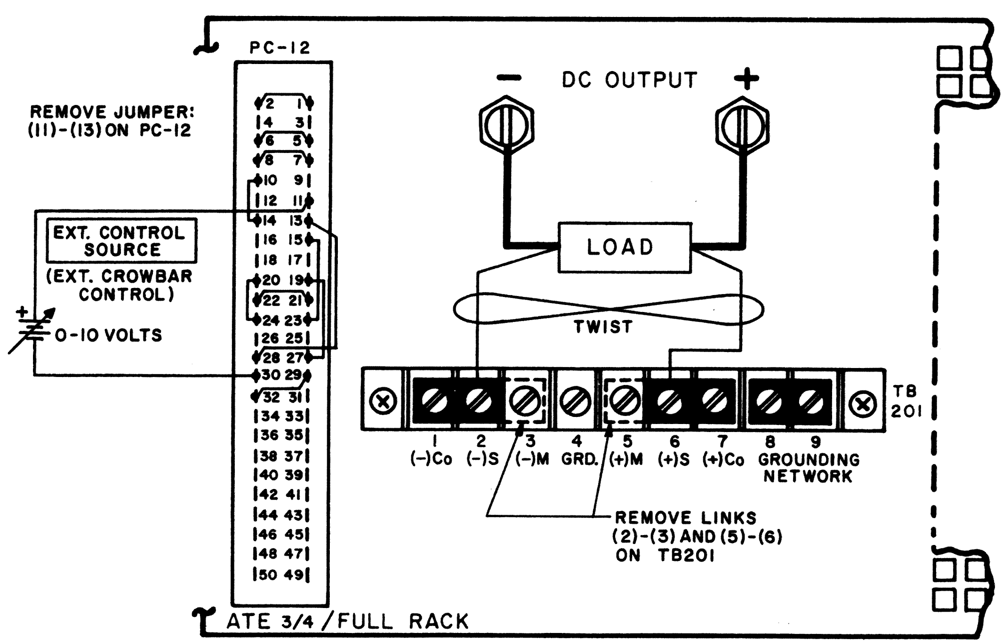


FIG. 3-14 REMOTE CROWBAR LEVEL CONTROL WITH AN EXTERNAL (0–10V D-C @ 1 mA) SIGNAL SOURCE.

3-75 AUTOMATIC (TRACKING) CONTROL OF THE CROWBAR LEVEL

3-76 In this application, an ATE's voltage output is remotely controlled by a 0-10 volt external programming signal which is simultaneously applied as a control signal to the overvoltage protector. As the ATE output voltage is now programmed by the external programming source throughout the specified range of the ATE, the crowbar level is "tracking" the output voltage, i.e., it always remains higher than the instantaneous ATE output voltage, thus providing automatic overvoltage protection throughout the range.

3-77 PROCEDURE, AUTOMATIC (TRACKING) CONTROL OF THE CROWBAR LEVEL, (ATE IN "SLOW" MODE)(1)

1) Connect jumpers on the REAR PROGRAMMING CONNECTOR as indicated in FIG. 3-15 and connect switch (S1) as shown. Turn front panel CROWBAR LEVEL control fully counterclockwise.
2) Connect a substitute LOAD and the EXT. PROGRAMMING SOURCE as shown in FIG. 3-15.
3) To test the overvoltage protector action, turn ATE "on" and set output voltage by means of the EXT. PROGRAMMING SOURCE to a nominal value. Switch S1 from position A to B. The overvoltage protector will crowbar the ATE output. The CROWBAR indicator will be "on" momentarily and the ATE circuit breaker will trip.
4) Remove S1, and connect a jumper between (13)-(21) of PC-12. Connect the actual LOAD, reactivate the ATE circuit breaker and commence operation. Should erratic triggering occur in actual operation, set front panel CROWBAR LEVEL control slightly clockwise. This will increase the "threshold" voltage; that is, the difference voltage between the crowbar level and the operating voltage.

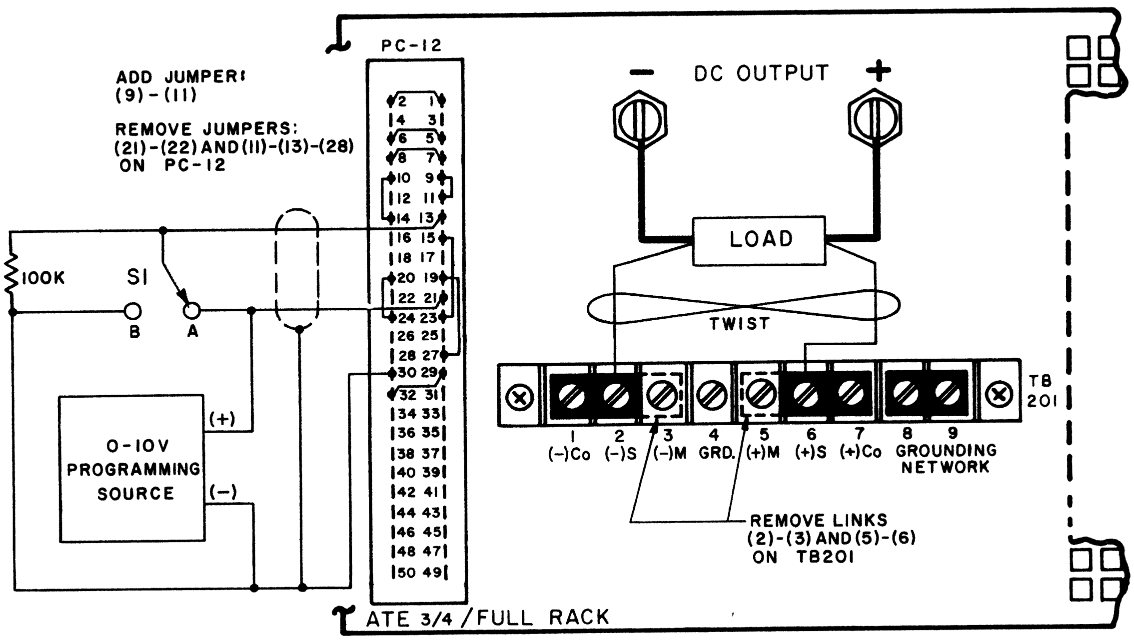


FIG. 3-15 CONNECTIONS FOR SIMULTANEOUSLY PROGRAMMING THE ATE OUTPUT VOLTAGE AND THE CROWBAR LEVEL (AUTOMATIC TRACKING).

(1) For operation with the ATE in "FAST" mode, all connections shown in FIG. 3-15 are valid, for both "SLOW" and "FAST" operating modes, except as follows:

1) Connect S1-Common and 100K ohm resistor to PC-12 pin 11 (**not** pin 13).
2) Do **not** add jumper (9)-(11) on PC-12.
3) Remove only jumpers (21)-(22) and (11)-(13), **not** jumper (13)-(28) on PC-12.
4) In paragraph 3-77, Step 4, connect jumper between pins (11) and (21), **not** between (13) and (21).

3-78 PROGRAMMING THE OUTPUT VOLTAGE AND THE OUTPUT CURRENT SIMULTANEOUSLY BY MEANS OF EXTERNAL, REMOTE CONTROL VOLTAGES

3-79 The output voltage, and the output current of the ATE power supply can be controlled simultaneously by means of remotely located variable voltage sources. The control voltages required to drive the voltage and current channels over the rated output range are 0 to 10 volt at 1 mA for the Voltage Channel and 0 to 1 volt for the Current Channel. An ideal programming source is the Kepco SN—488 Digital Programming System, which provides two independent control voltages of the correct magnitude per programming card.

NOTE: FOR CONTROL SOURCES NOT WITHIN THE GIVEN SPECIFICATIONS, THE TWO PREAMPLIFIERS MAY BE USED, AS DESCRIBED IN PAR.'S 3-45 TO 3-56 AND 3-64 TO 3-69, TO SCALE THE AVAILABLE CONTROL VOLTAGE UP OR DOWN AS REQUIRED.

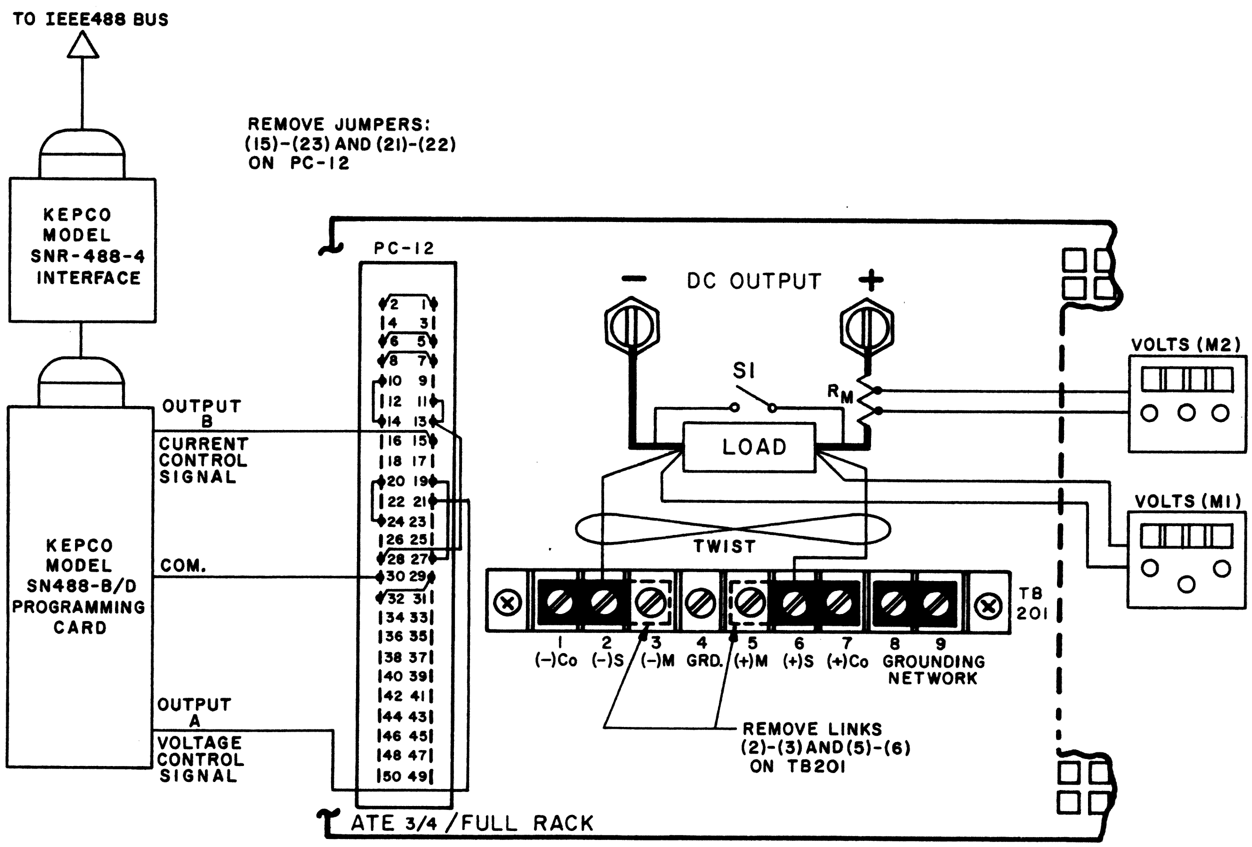


FIG. 3-16 CONNECTIONS FOR CONTROL OF OUTPUT VOLTAGE AND OUTPUT CURRENT BY MEANS OF EXTERNAL, VARIABLE CONTROL VOLTAGES, SUPPLIED BY THE KEPCO SN—488 DIGITAL PROGRAMMING SYSTEM.

3-80 PROCEDURE, OUTPUT CONTROL WITH EXTERNAL CONTROL VOLTAGES, SUPPLIED BY THE KEPCO SN–488

STEP 1: Connect external components, the LOAD, the PRECISION VOLTMETERS and the R_M as shown in FIG. 3-16.

STEP 2: With the VOLTAGE CONTROL SIGNAL (Channel A) at some non-zero value and the CURRENT CONTROL SIGNAL (Channel B) at zero, turn power supply "on".

STEP 3: Close S1. Vary the CURRENT CONTROL SIGNAL from zero to its maximum value. The power supply output current, as read-out on M2, should vary from approximately zero to the rated maximum output current. Leave CURRENT CONTROL SIGNAL at its maximum setting.

STEP 4: Open S1. Vary the VOLTAGE CONTROL SIGNAL from its initial setting to its maximum value. The output voltage, as read-out on M1, should vary from approximately zero to the rated maximum output voltage.

3-81 CALIBRATION, VOLTAGE CHANNEL

(Refer to Section II, FIG. 2-1 for the location of all internal power supply controls).

(Refer to your SN–488 system manual for the location of the system calibration controls).

1) Open S1. Set VOLTAGE CONTROL SIGNAL to zero. Check the PRECISION VOLTMETER (M1) for "zero" reading and correct, if necessary, with the "E_O ZERO" control.

2) Set VOLTAGE CONTROL SIGNAL to its maximum value. Observe M1 and calibrate the power supply output voltage to the exact maximum rated value by adjusting the external control voltage (Channel A, full-scale cal. control).

3) Set VOLTAGE CONTROL SIGNAL to zero again, re-check the previously calibrated zero point on M1 and correct with the power supply "E_O ZERO" control if required.

4) This concludes the calibration of the voltage channel. Leave the VOLTAGE CONTROL SIGNAL at approximately 1/3 its maximum setting.

3-82 CALIBRATION, CURRENT CHANNEL

Note: The output current value can be measured directly by means of a suitable ammeter in series with the load or, as indicated in FIG. 3-16, indirectly by means of the precision voltmeter (M1) across a current measuring resistor (R_M). R_M should be selected such that a convenient range on the precision voltmeter can be used, e.g., for one ampere output current, use a 0.1 ohm resistor to produce 100mV full scale. If an electronic voltmeter is used, it should be battery-operated to avoid ground loops.

1) Close S1. Set CURRENT CONTROL SIGNAL to zero. Check the PRECISION VOLTMETER (M2) for "zero" reading and correct, if necessary, with the power supply "I_O ZERO" control.

2) Set CURRENT CONTROL SIGNAL to its maximum value. Observe M2 and calibrate the power supply output current to the exact maximum rated value by adjusting the external control voltage (Channel B, full-scale cal. control).

3) Set CURRENT CONTROL SIGNAL to zero again, re-check the previously calibrated zero point on M2 and correct with the power supply "I_O ZERO" control if required. Open S1.

3-83 Operation can now proceed. Check the output, by means of an oscilloscope, for dynamic stability and output ripple amplitude. Refer to PAR. 3-6 if high ripple is present. If the power supply output is dynamically unstable (oscillations) review the paragraphs on power supply/load interface and grounding (PAR's 3-6 through 3-26).

3-84 THE USE OF THE "EXT. CURRENT COMPARISON AMPLIFIER" FOR GENERAL FEEDBACK CONTROL

3-85 The output of the ATE power supply is normally controlled either by the VOLTAGE COMPARISON, or by the INT. CURRENT COMPARISON AMPLIFIER, depending on the prevailing operating mode. A glance at the SIMPLIFIED SCHEMATIC DIAGRAM (See end of Section III), however, shows that a third control channel is available, via the EXT. CURRENT COMPARISON AMPLIFIER, which is normally "biased off". The use of this amplifier has previously been shown in an application for external current control (See par.'s 3-57 to 3-63. Since both inputs of the EXT. CURRENT COMPARISON AMPLIFIER are available at the REAR PROGRAMMING CONNECTOR (PC–12), it can be used adavantageously to control the power supply output in response to feedback from such divers physical phenomena as light, temperature, pressure, chemical reactions and the like. Since the (open loop) gain of this third control channel is very high, only minute feedback signals in combination with an appropriate external control are required.

3-86 The design of the required external circuitry is shown by means of the following example: A "target" object requires constant illumination, supplied by a lamp, which is connected at the power supply output. The feedback is supplied by a photo cell, the output of which is 0–100mV, depending on the light input. A "Brightness Control" is required to adjust various illumination levels.

Note: Depending upon the characterisitics of both, lamp and photo-cell, fast mode operation of the ATE might be advisable.

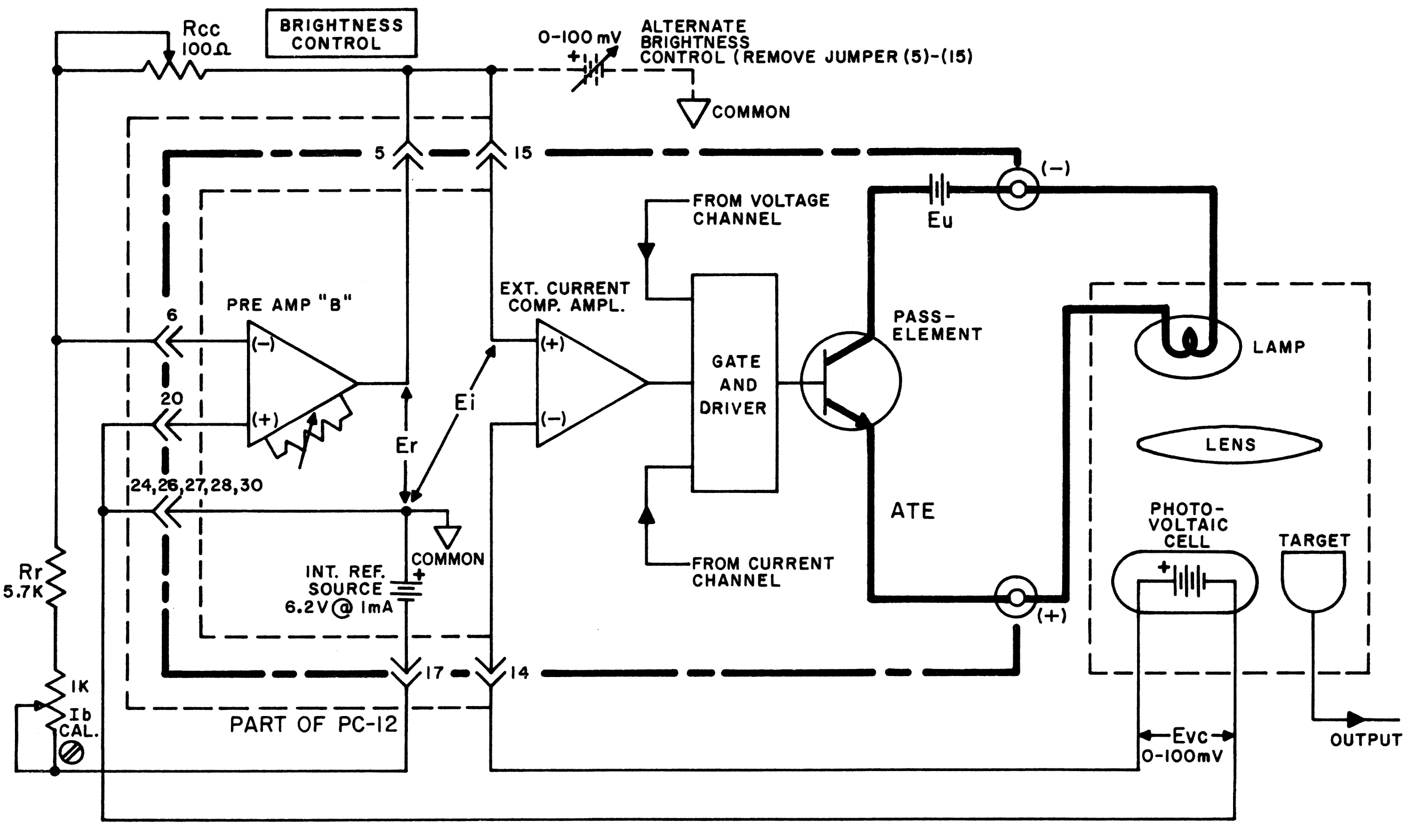


FIG. 3-17 ILLUMINATION CONTROL CIRCUIT WITH THE ATE POWER SUPPLY.

3-87 (Refer to FIG. 3-17). Assuming the ATE power supply is compatible with the requirements of the lamp load, the control circuit may be designed as shown with one of the ATE preamplifiers, or, an external control voltage source can be connected as indicated with the dashed lines in FIG. 3-17. The external source should be adjustable in the range from 0 to 100mV if illumination ***control*** is desired, or it should have a means of ***calibration*** if a fixed external source is used for a constant illumination level.

3-88 In the example, the ATE internal preamplifier (PREAMPL "B") is used to develop the control signal (E_i = 0–100mV), which is compared with the photo-cell output at the input to the EXT. CURRENT COMPARISON AMPLIFIER. The external reference resistor (R_r) and the control rheostat (R_{CC}) are selected to produce the control signal, similar to the example described in a previous application (See par. 3-64).

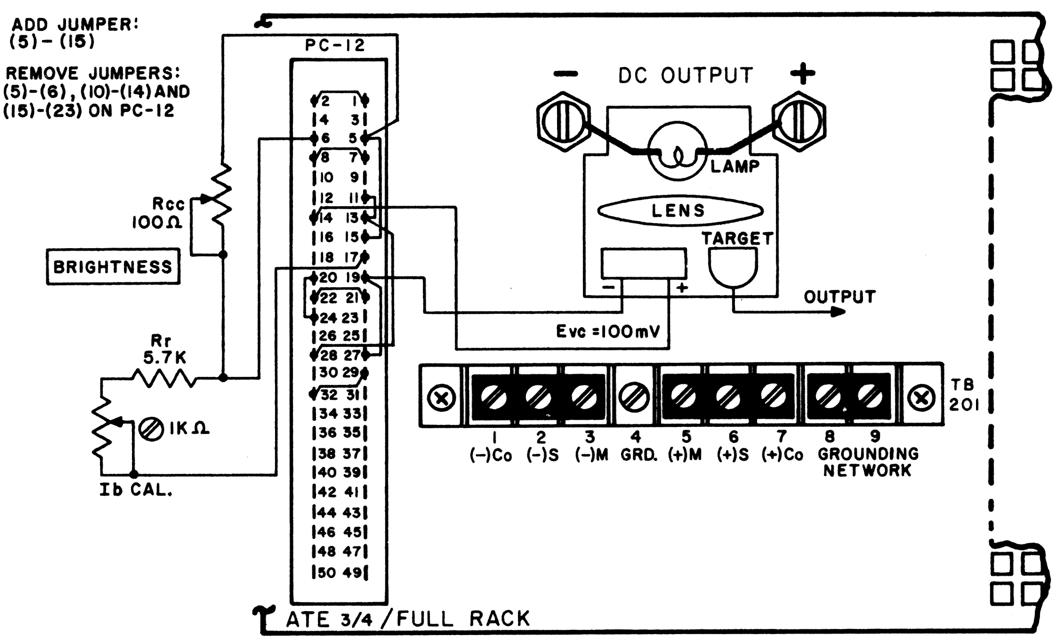


FIG. 3-18 CONNECTIONS FOR ILLUMINATION CONTROL, USING THE EXT. CURRENT COMPARISON AMPL.

3-89 PROCEDURE, ILLUMINATION CONTROL

1) Connect the external components to the ATE power supply as shown in FIG. 3-18.

2) Adjust both, ATE front panel VOLTAGE and CURRENT CONTROLS approximately 10% beyond the values required by the LAMP which represents the power supply load. Although the voltage or current channel are not in control in this application, the setting of the front panel output controls close to the lamp requirements serve as a "back-up" voltage and current limit should feedback control from the photo-cell be lost.

3) Turn the external BRIGHTNESS CONTROL to its mid-range and turn the ATE power supply "on". Vary the BRIGHTNESS CONTROL through its range and observe its effect on the LAMP. The lamp brightness should vary from zero (dark) to the approximate maximum brightness.

3-90 CALIBRATION

Turn the BRIGHTNESS CONTROL (R_{CC}) to its maximum clockwise position and adjust the external I_b CAL. control until the maximum desired brightness is measured.

3-91 MULTIPLE POWER SUPPLY AND SYSTEMS OPERATION

3-92 In applications where several power supplies are used it is often necessary to shut down ***all*** power supplies if a malfunction on a ***single*** supply forces its shut-down. Sometimes, a "PANIC BUTTON" arrangement is desired, where ***all*** system power supplies can be shut-down with a single manual switch or a common signal from a controller. ATE power supplies are ideally suited for multi-unit operation since all necessary crowbar control circuit connections are terminated at the rear PROGRAMMING CONNECTOR (PC—12). The crowbar control connections in a multi-unit application can be externally wired to form a closed loop fault-detection circuit as shown in FIG. 3-19. Although only three ATE power supplies are shown, the control loop may be extended to include as many ATE power supplies as are required.

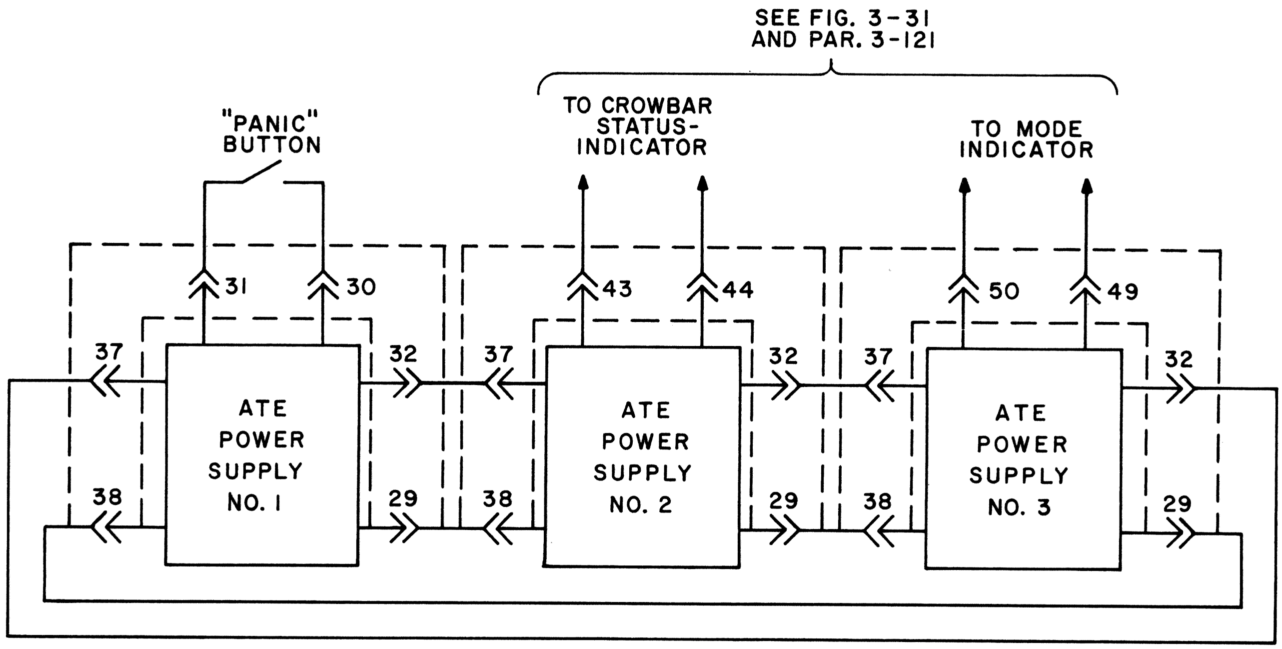


FIG. 3-19 MULTIPLE POWER SUPPLY FAULT DETECTION LOOP.

3-93 In addition to the crowbar input/output terminals, optically isolated flag signals are available at the PROGRAMMING CONNECTOR (PC—12) of each ATE power supply. These signals may be used to indicate the crowbar status and the operating mode of each ATE power supply (See FIG.'s 3-19, 3-31 and PAR. 3-121).

3-94 SERIES CONNECTION OF ATE POWER SUPPLIES

3-95 Kepco ATE power supplies may be connected in series for increased voltage output. Series connection of ***two*** ATE units is described here, but several units, up to an output voltage total of 500 volts may be inter-connected. Two basic methods of series connection are commonly used: The "AUTOMATIC" and the "MASTER/SLAVE" configuration. The choice between these two methods will depend on the application at hand. If individual power supply control is desired, the "Automatic" series connection should be used. If the output of the inter-connected power supplies is to be controlled simultaneously, the "MASTER/SLAVE" method is recommended. For ***either*** method, some general rules should be remembered.

1) Series connect supplies ***only*** up to a total of 500 volts output voltage, this is the isolation voltage limit for the ATE power supply.

2) Series connect supplies if they have the same ***current rating.*** Otherwise, reduce the current limits to a value equal to the lowest output current rated power supply.

3) Use error sensing, as shown in the diagram (See FIG. 3-20), to compensate for load wire drops.

   NOTE: SENSING LEADS ARE NOT REQUIRED IF THE APPLICATION CALLS FOR CURRENT MODE OPERATION EXCLUSIVELY.

4) The load wires should be as short as practicable. Select the load wires as heavy as possible and twist the load wire pair tightly. Approximately equal lengths of load wire between each pair of supplies is recommended.

5) Use the Fault Detection Loop, as described in par. 3-91.

6) All previously described programming circuits may be used on the MASTER power supply, to program the series connected system.

3-96 PROCEDURE, AUTOMATIC SERIES CONNECTION

1) Without connecting the power supplies to the load, turn a-c power "on", and adjust the output voltage on each supply to the required level (the sum of the output voltages will be applied to the load).
2) Adjust the current control on each power supply to its extreme counterclockwise position. Turn a-c power "off". Connect a short circuit, consisting of a short, heavy wire across the output terminals of each power supply. Turn a-c power "on" and adjust each ATE Current Control to the required load current. Turn a-c power "off". Remove shorting wires from output terminals.
3) Make all load connections as shown in the diagram (refer to FIG. 3-20).
4) Turn a-c power "on". Observe output metering and front panel MODE indicators on all series connected ATE powe supplies. The output current should be identical on all series connected supplies and all supplies should operate in the voltage mode (VOLTAGE MODE indicator "on").
5) On those supplies not operating in the voltage mode, turn Current Control slightly clockwise until the VOLTAGE MODE indicator energizes.
6) If current mode operation is desired, turn the front panel Current Control on one of the series connected ATE power supplies slightly counterclockwise, such that the CURRENT MODE INDICATOR is just energizing. The remaining supply (supplies) should remain in the voltage mode of operation. Operation can now proceed.

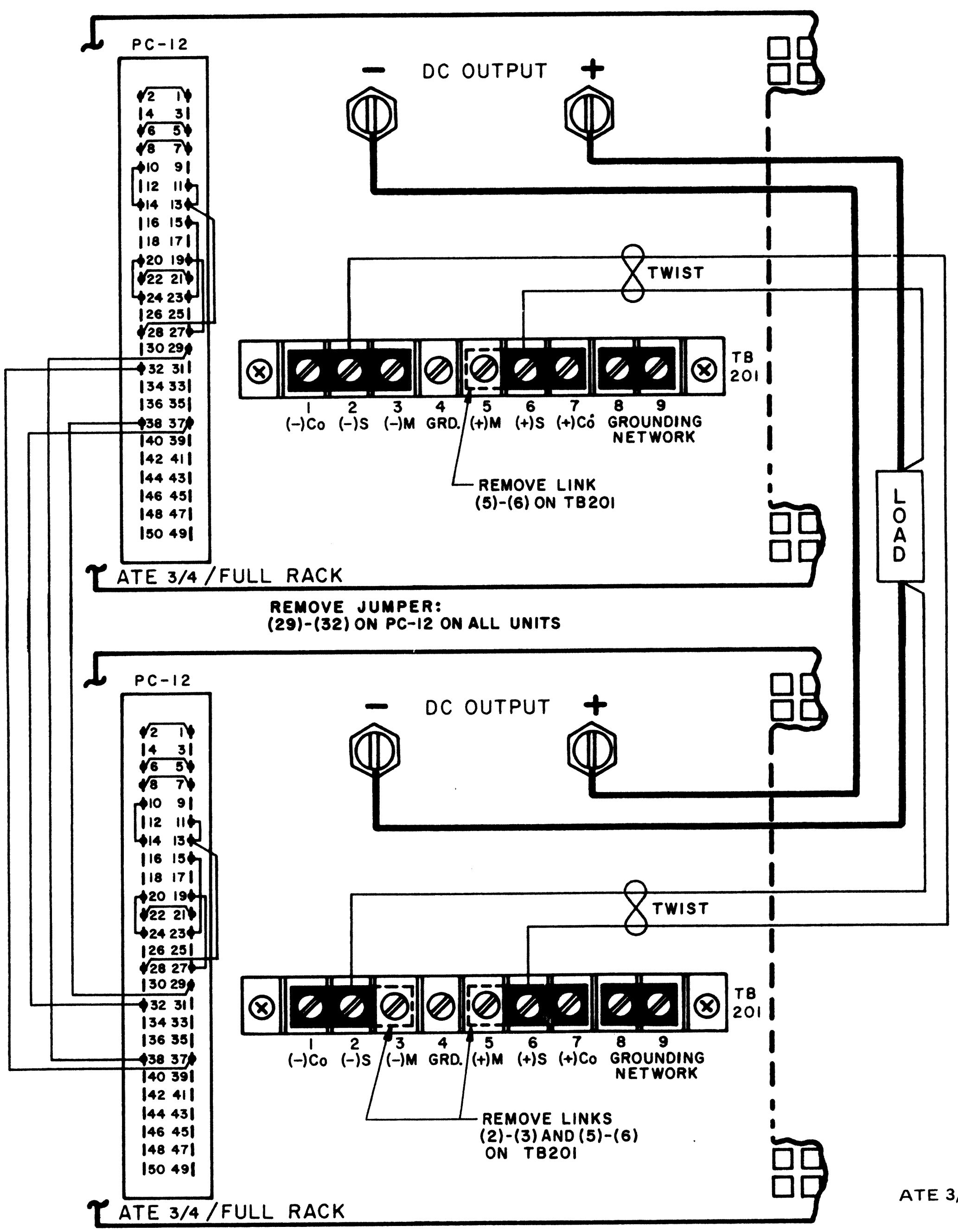


FIG. 3-20 AUTOMATIC SERIES CONNECTION

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3-97 **MASTER/SLAVE SERIES OPERATION.** In this mode of operation the total output voltage of all supplies in the series connection is controlled from a common "Master" supply, while the voltage output of the "Slave" supplies "follow" the output voltage of the "Master".

3-98 As seen from the diagram (FIG. 3-21) in each SLAVE supply, the input to the VOLTAGE COMPARISON AMP is disconnected from the output of the VOLTAGE CONTROL amplifier and an external drive signal is derived from the output voltage of the MASTER supply (E_{om}) and applied via a coupling resistor (R_t), to the SLAVE supply.

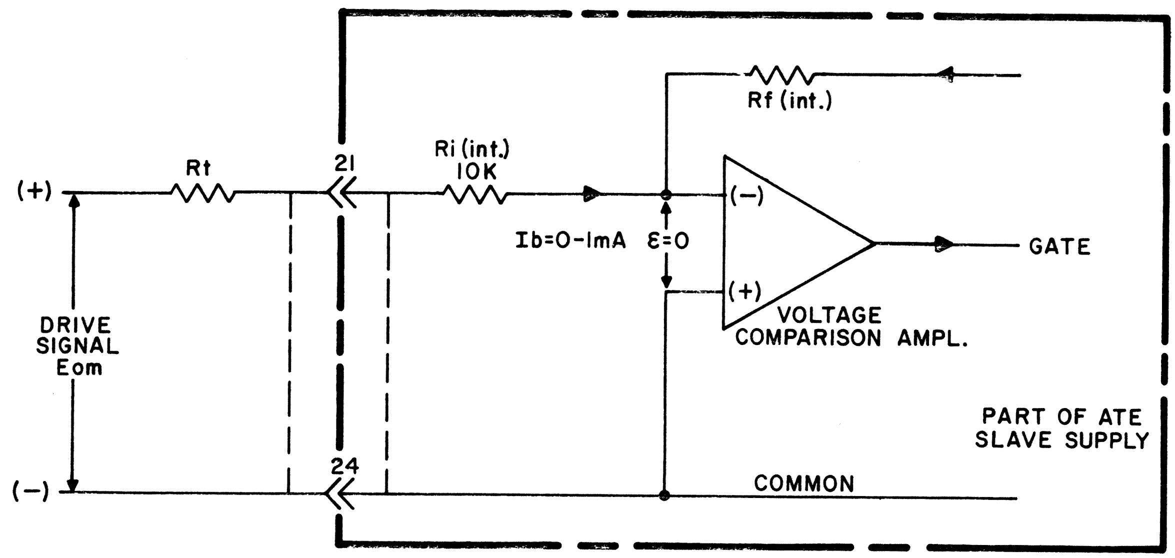


FIG. 3-21 DEVELOPING THE DRIVE FOR THE MASTER/SLAVE SERIES CONNECTION, ATE POWER SUPPLIES WITH RATED OUTPUT VOLTAGE > 6V.

3-99 The output voltage of each SLAVE supply (E_{os}) will be from 0 to its maximum rated output voltage if the input signal to its VOLTAGE COMPARISON AMP (E_i) is proportioned to produce a control current (I_b) of 1mA. Since the null junction voltage (E) equals zero at balance,

$$I_b = \frac{E_{om}}{R_t + R_i\,(int)} \quad \text{or,}\ R_t = \frac{E_{om} - I_b R_i}{I_b} = \frac{E_{om}}{I_b} - R_i$$

Since I_b = 1mA, R_i = 10K ohm in all ATE power supplies, R_t (K ohms)= $\frac{E_{om}}{1mA}$ - 10K

For example, if a series connection of two ATE supplies with maximum output voltage of 36 and 55 volts is planned for an application requiring a voltage supply from 0 to 91 volts into a common load, the coupling resistor is selected as follows:

Let E_{om} = 0-55V (MASTER SUPPLY), then the SLAVE SUPPLY (E_{os}) must vary from zero to 36 volts, as the MASTER supply is varied over its output voltage range. Calculating the coupling resistor.

$R_t = \frac{55V}{1mA} - 10K = 45K$ ohms, and connecting the system as shown in FIG. 3-22 will produce the desired result.

3-100 PROCEDURE, MASTER/SLAVE SERIES OPERATION WITH TWO OR MORE ATE SUPPLIES

1) Connect each individual ATE power supply, to be connected in series, to the a-c power line. Adjust the front panel Current Control on each ATE completely counterclockwise. Connect a short-circuit, consisting of a short wire length across the output terminals of each ATE supply.

2) Turn a-c power "on" and adjust each ATE Current Control to the required load-current plus 5%. Turn a-c power "off", remove short circuit.

3) Interconnect power supplies as shown in FIG. 3-22. Note: Only one SLAVE unit is shown, but more can be added. Turn MASTER supply VOLTAGE CONTROL to its maximum counterclockwise position.

4) Turn a-c power "on". Observe front panel MODE INDICATORS. All "VOLTAGE MODE" indicators should be "on" and all front panel meters should read approximately zero.

5) Slowly, turn MASTER voltage control clockwise, until the desired output voltage level is reached. The load voltage is the sum of the MASTER and all SLAVE output voltage as read out on each front panel output voltage meter. All output current meters should read the identical load current.

6) Set the output current limit point by turning the current control on all series connected supplies counterclockwise, until each supply just transfers into the current mode CURRENT MODE indicator "on", then turn each slightly clockwise again, until each VOLTAGE MODE indicator energizes again.

7) If current mode operation is desired, leave the setting of the "Master" current control such that the CURRENT MODE indicator is energized. While the output current can now be controlled by the "Master" supply, the "Slave" supply will still operate in the voltage mode (VOLTAGE MODE indicator "on" and deliver additional compliance voltage to the load).

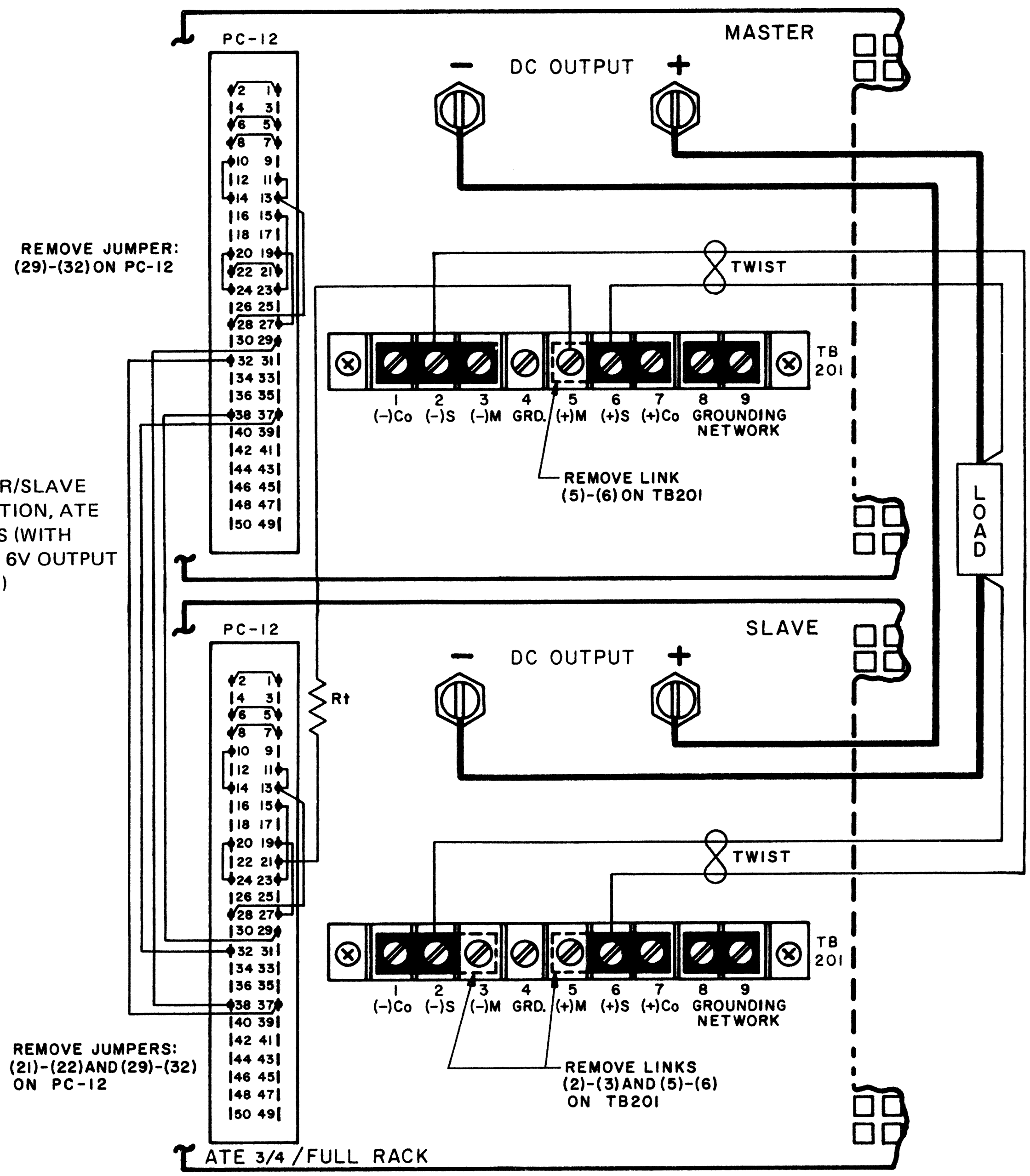


FIG. 3-22 MASTER/SLAVE SERIES CONNECTION, ATE POWER SUPPLIES (WITH GREATER THAN 6V OUTPUT VOLTAGE ONLY)

3-101 MASTER/SLAVE SERIES OPERATION WITH ATE 6V POWER SUPPLIES

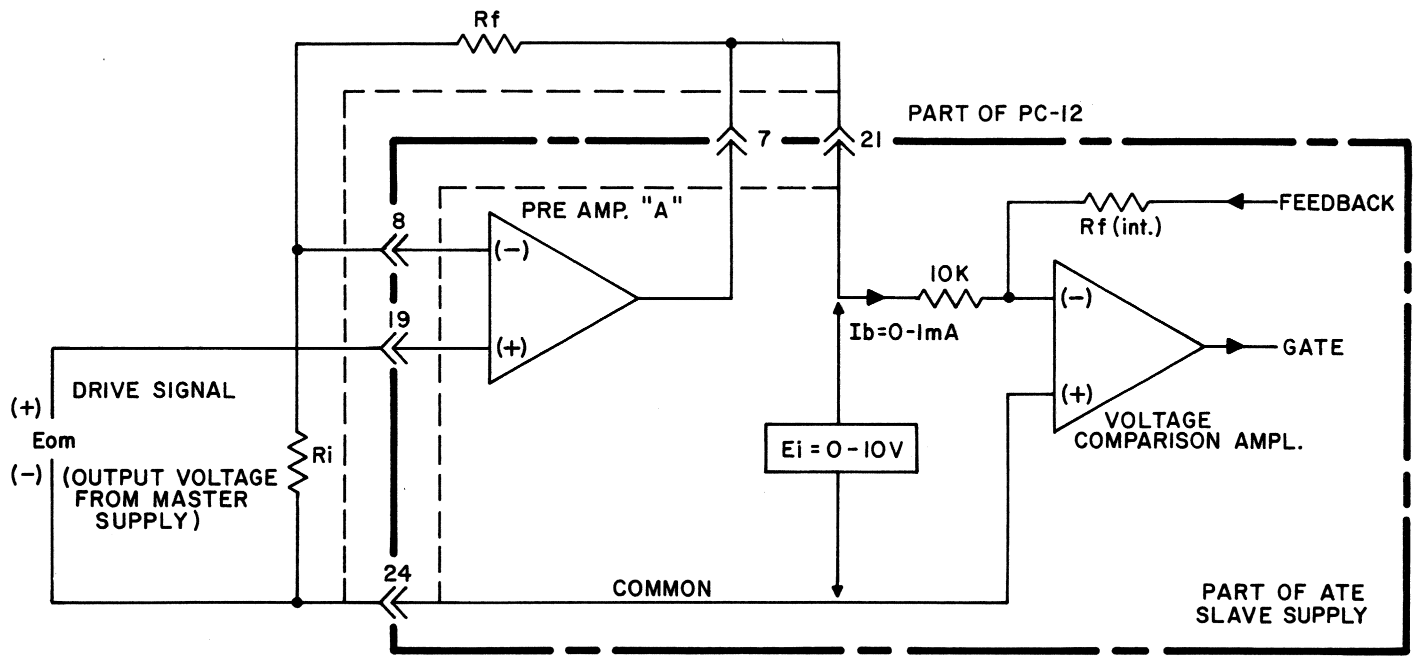


FIG. 3-23 DEVELOPING THE DRIVE FOR THE MASTER/SLAVE SERIES CONNECTION FOR 6V ATE SUPPLIES.

3-102 ATE power supplies with 6 volts maximum output voltage cannot be master/slave connected as described in par. 3-97. Instead, the MASTER output voltage (6V) must first be amplified to 10 volts if the SLAVE supply is to be driven through its full output voltage range. As seen from FIG. 3-23, one of the preamplifiers of the slave unit may be used to proportion the drive signal to the required level. For a 0—1mA control current (I_b) the input voltage (E_i) to the VOLTAGE COMPARISON AMP must be 0—10 volt. Therefore, the MASTER output voltage (E_{om}) is amplified, using PREAMP "A", by selecting the value for the external resistors (R_f, R_i) accordingly. The values for these resistors are calculated on the basis of the equation: E_{out} (preamp) = E_i = E_{om} x $(R_f + R_i)/R_i$. For the example of two 6 volt ATE supplies in series connection: E_{om} = 6V, therefore $(R_f + R_i)/R_i$ (the closed loop gain of PREAMP "A") must be 6 x $(R_f + R_i)/R_i$ = 10 or $(R_f + R_i)/R_i \approx 1.7$. Letting R_f = 3K, R_i must be approximately 5K ohms. R_f may be selected to be a rheostat, so that a convenient gain control is available for calibration.

3-103 PARALLEL OPERATION OF ATE POWER SUPPLIES

3-104 Normally, crowbar equipped power supplies can not be connected in parallel, since a triggered crowbar in one supply, working in a parallel configuration, would present a short circuit to all other supplies and would have to absorb the total output current. In the ATE power supply, crowbar control circuitry is provided, allowing the setup of a fault-detection loop, which shuts off all power supplies in a parallel configuration if one power supply is "crowbared" for any reason.

3-105 As in the previously described "series" connections, an "Automatic" or a "Master/Slave" connection method can be chosen for paralleling ATE power supplies. The choice between the two methods will depend on the application at hand. For constant loads or small load variations (load changes smaller than the maximum output range of a single power supply), the "Automatic" parallel connection can be used. For load changes exceeding the maximum rating of a single power supply, the "Master/Slave" method is suitable. Both methods allow operation in the voltage or current mode. For either method, some general rules should be observed:

1) Parallel only supplies which can be adjusted to the same compliance (output) voltage.

2) Error sensing, as shown in the following diagrams, can be used to compensate for load wire voltage drops.

3) Load wires should be as short as practicable. Select wire gauge as heavy as possible and twist wires tightly. Approximately equal lengths of wire should be used.

4) Use the fault detection loop circuit, as described in par. 3-91.

NOTE: The diagram below (refer to FIG. 3-24) shows how the two power supplies operate in the automatic parallel mode. As seen from FIG. 3-24, load variations should be confined to the stabilization region of SUPPLY #2 since there is an inital adjustment error (ΔE_O) between the two supplies.

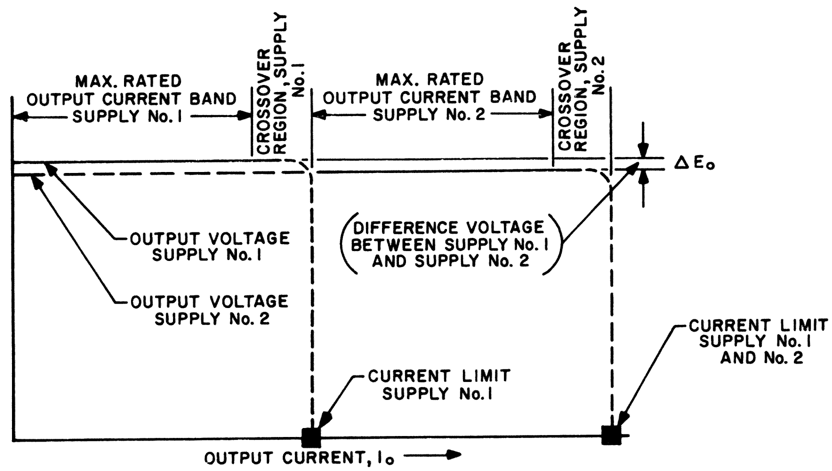


FIG. 3-24 "AUTOMATIC" PARALLEL OPERATION (TWO SUPPLIES).

3-106 If stabilized output current (rather than stabilized output voltage) is desired, all previous comments are valid, except that error sensing is not needed. For stabilized output current, the Current Control of the supply operating initially in the "voltage" mode (SUPPLY #2) is readjusted (counterclockwise) to such a value that SUPPLY #2 just switches to the "current" mode (observe front panel MODE indicators.

3-107 PROCEDURE, AUTOMATIC PARALLEL CONNECTION

Note: The parallel connection of two ATE power supplies is described, although more can be connected.

1) Without connecting the power supplies to the load or to each other, turn a-c power "on", and adjust the output voltage on each supply to the desired value.

2) Adjust both power supply current controls to their maximum (extreme clockwise) position. Turn a-c power "off".

3) Make all load interconnections as shown in the connection diagram (refer to FIG. 3-25).

4) Place the individual a-c power switches of the power supplies in the "on" position. Observe output current meters and mode lights on both units. Since the initial output voltage adjustments were not identical, one of the power supplies (to be designated SUPPLY #1), will be at a slightly higher output voltage than the other (to be designated SUPPLY #2). Consequently, SUPPLY #1) will deliver its maximum load current and will operate in the current mode, CURRENT MODE indicator "on". The rest of the load current is delivered by SUPPLY #2 which is operating in the voltage mode (VOLTAGE MODE indicator "on").

5) The Current Control of SUPPLY #1 can now be adjusted, as to equalize the total load current between SUPPLY #1 and SUPPLY #2, and operation can proceed.

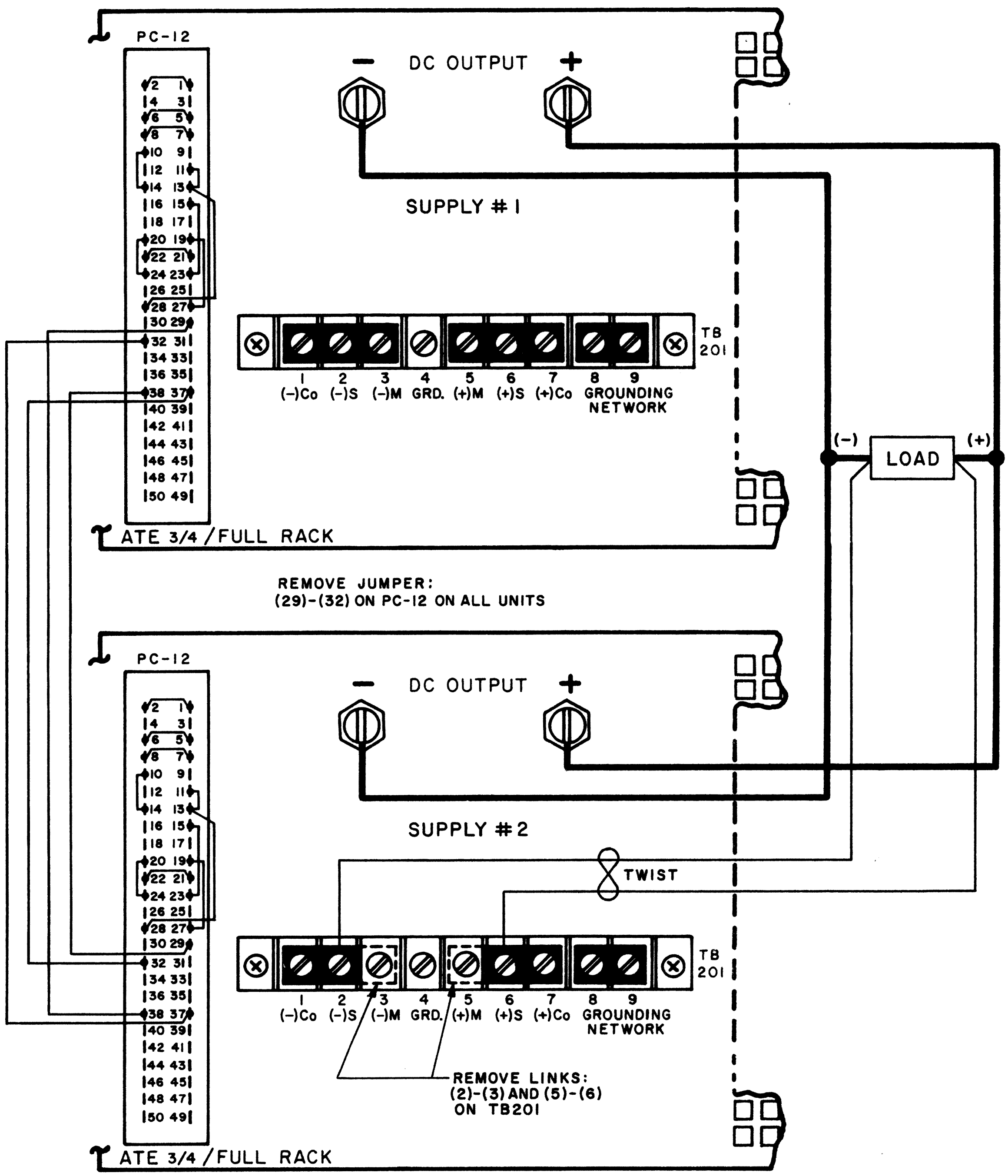


FIG. 3-25 CONNECTIONS FOR AUTOMATIC PARALLEL OPERATION.

3-108 MASTER/SLAVE PARALLEL CONNECTION

3-109 This method is especially convenient with ATE power supplies, since no external current sensing resistors are required and all control connections can be made via the ATE's rear PROGRAMMING CONNECTOR. In the MASTER/SLAVE parallel mode, the EXT. CURRENT COMPARISON AMPL on each SLAVE unit is disconnected from its 15V bias and is driven instead from the common MASTER CURRENT SENSING AMPL. As the MASTER supply delivers load current from zero to its rated maximum value, the signal from its CURRENT SENSING AMPL changes from zero to 1 volt. Applied to each SLAVE unit, this signal programs the output current of the SLAVE units from zero to the maximum value. While all Slave units will operate in the current mode, the MASTER unit can be operated in either the voltage or the current mode.

3-110 PROCEDURE, MASTER/SLAVE PARALLEL CONNECTION

1) All power supplies to be paralleled must be able to deliver the required compliance (load) voltage. Before paralleling, set each power supply voltage control to this voltage.

2) Make all load and sensing connections as shown in FIG. 3-26.

3) Turn all power supplies "on". Observe from panel meters and MODE indicator(s). Adjust the MASTER supply output controls for either voltage or current mode operation. All CURRENT MODE indicator(s) on the SLAVE supplies should be "on".

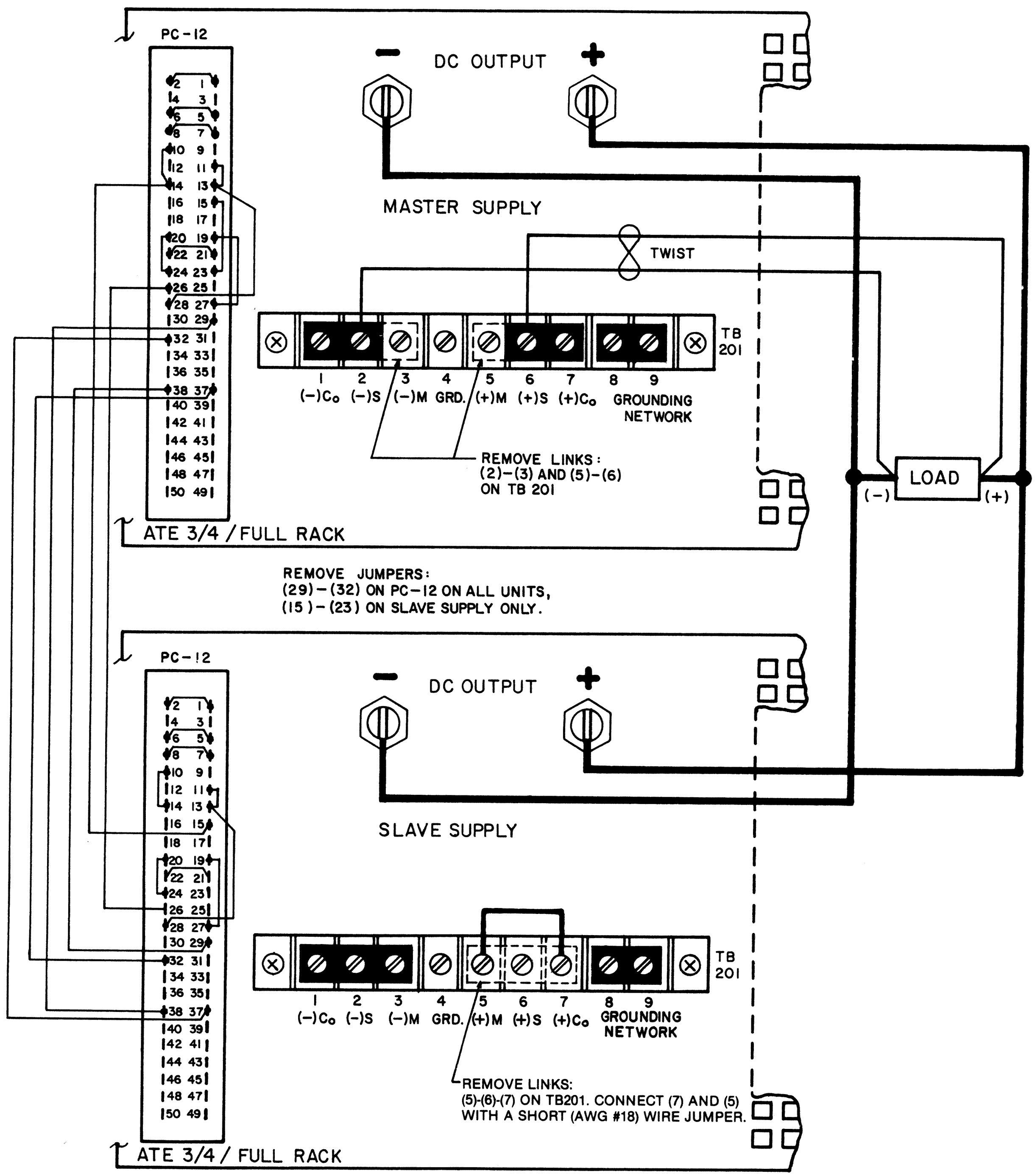


FIG. 3-26 MASTER/SLAVE PARALLEL CONNECTIONS.

3-111 REDUNDANT PARALLEL OPERATION

3-112 Two ATE Power Supplies can be connected in parallel to a load in such a way that if one of the power supplies fails or is interrupted in any other manner, the other will continue to supply uninterrupted load current. The two power supplies are isolated from each other by means of external diodes (D1, D2 in FIG. 3-28) which must be rated for the maximum load voltage and current of the ATE units used.

3-113 The problem encountered in operating power supplies with overvoltage detection circuits in a redundant parallel configuration is that the overvoltage sensing leads are ususally permanently wired to the error sensing leads. If now an overvoltage occurs on ***either*** power supply, ***both*** supplies will shut down, defeating the purpose of the redundant circuit. In the ATE power supplies, provisions are made on the control circuit P.C. card (A1), to disconnect the overvoltage sensing from the error sensing terminal, reconnect it to the output terminal and remove C26, thus successfully solving the problem described. (See FIG. 3-27).

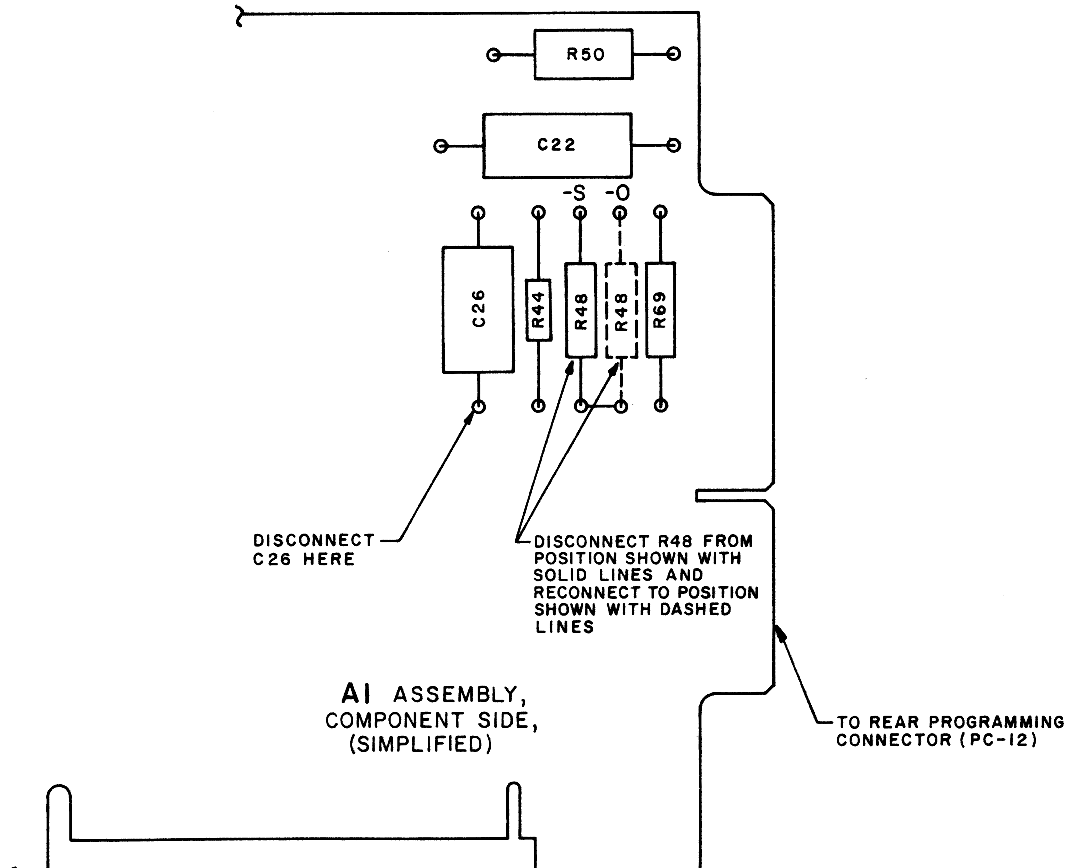


FIG. 3-27 LOCATION OF OVERVOLTAGE SENSING LEAD DISCONNECT.

3-114 PROCEDURE, REDUNDANT PARALLEL OPERATION

1) Remove covers from both ATE power supplies, locate A-1 P.C. card and rewire overvoltage sensing as described in par. 3-113 and as illustrated in FIG. 3-27. Remove capacitor C26 as described in par. 3-113 and as illustrated in FIG. 3-27.

2) Make all load and sensing connections as shown in FIG. 3-28.

3) Turn a-c power "on" and set both ATE supplies to the desired load voltage. One of the ATE supplies (Supply #1) will invariable be at a slightly higher output voltage than the other (Supply #2). Supply #1 will consequently be in control of the load, while Supply #2 will be cut-off. If Supply #2 is desired as the controller, increase its output voltage slightly, until it takes control of the load as evidenced by the read-out on its front panel meters. It is recommended the loading be at least 10% of the rated maximum ATE output current.

4) Test the redundant parallel system by manually shutting off the a-c power on the controlling power supply. The other supply should now deliver the power to the load.

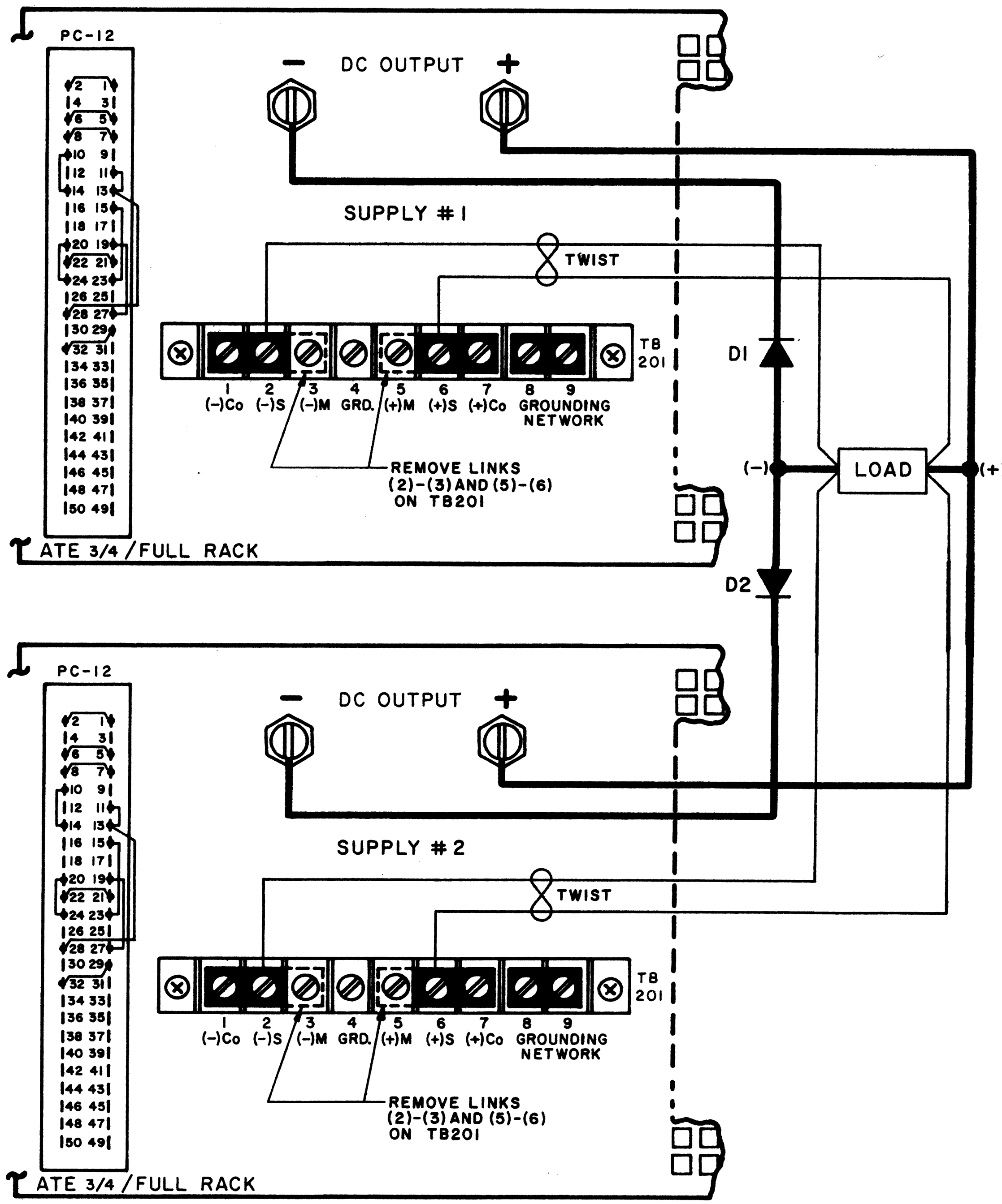


FIG. 3-28 REDUNDANT PARALLEL CONNECTION WITH ATE POWER SUPPLIES.

3-115 PROGRAMMING WITH REFERENCE TO THE NEGATIVE POWER SUPPLY OUTPUT

3-116 ATE power supplies may be used in many unique applications. The two uncommitted ATE preamplifiers make it possible to solve application problems which would require special circuitry or additional equipment with standard power supplies. One example of such an application problem is the case in which the programming common must be the ***negative*** output side of the power supply, rather than the positive side. With standard power supplies, either the programming source would have to be completely isolated, or an isolating interface would be required.

3-117 This problem is readily solved by the ATE power supply (See FIG. 3-29). PREAMP "A" is used to perform as a differential attenuator, permitting a level shift of the programming source, while PREAMP "B" brings the programming signal back to the requied level (0—10V).

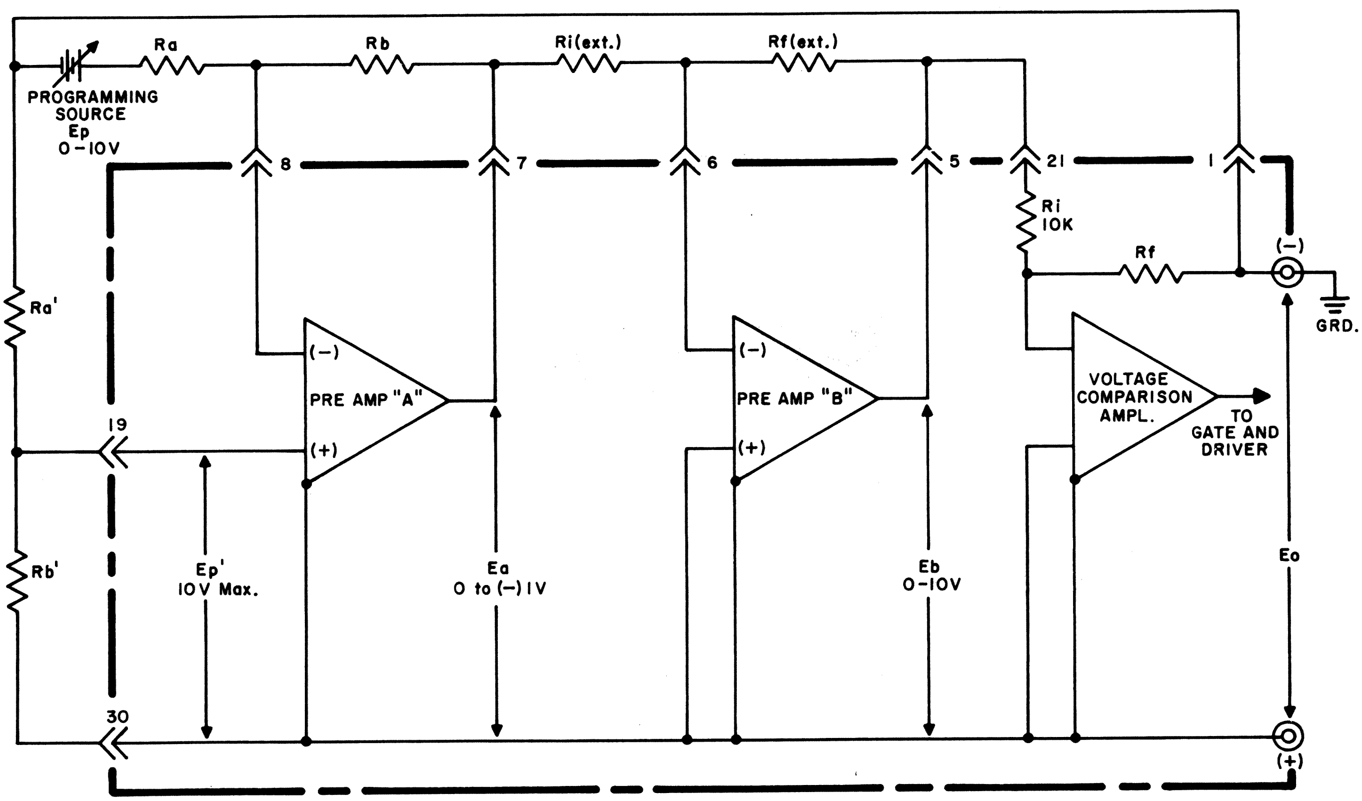


FIG. 3-29 PROGRAMMING WITH REFERENCE TO THE NEGATIVE OUTPUT SIDE OF THE ATE.

Definition of Symbols in FIG. 3-29:

E_o = Power Supply Output Voltage

E_a = PREAMP "A" Output Voltage

E_b = PREAMP "B" Output Voltage

E_p' = Common Mode Voltage Limit (10 Volts max.)

E_p = Programming Voltage

$R_a = R_a'$, $R_b = R_b'$ — Voltage Divider Network

3-118 Component selection will depend on the parameters of the programming source and the ATE power supply output voltage. AN EXAMPLE: An ATE model with an output voltage of 0–100 Volt is programmed through its full output voltage range by a programming source (E_p) of 0–10 volt which can supply 0.1mA. The negative output side of the ATE is grounded. Selecting the voltage divider (R_a', R_b'), such that the common mode voltage, $E_p' < 10V$, we let $R_a = R_a' = 1M$ ohm, $R_b = R_b' = 100K$ ohm. In this case the output voltage for PREAMP "A" can be expressed by:

$$(-)\ E_a = E_p\ R_b/R_a = 0 \text{ to } (-)\ 1 \text{ volt}$$

Note: The equation for the standard differential amplifier is derived in Burr-Brown's "Operational Amplifiers".

3-119 The next step is to select the input resistor (R_i ext.)) and the feedback resistor (R_f ext.) for PREAMP "B". Since an input voltage (E_b) of 0 to 10 volts is required to drive the VOLTAGE COMPARISON AMPL (and thereby the power supply output voltage) over its rated range, the previously derived signal from PREAMP "A" must be reversed and amplified with a gain of 10. PREAMP "B" is used in the inverting configuration, for which the output equation is:

$$E_b = (-)\ E_a\ R_f\ (\text{ext.})/R_i\ (\text{ext.})$$

Selecting a 1K ohm resistor for R_i (ext.), R_f (ext.) must be 10K ohm to achieve the desired result.

Note: The selected resistors should be high quality components with a tolerance of 1%. They should be wired as close to the PROGRAMMING CONNECTOR terminals as possible.

3-120 PROCEDURE, PROGRAMMING WITH REFERENCE TO THE NEGATIVE POWER SUPPLY OUTPUT

1) Connect the external components, the LOAD and the PRECISION VOLTMETER (M1) to the ATE as shown in FIG. 3-30.
2) With the EXT. CONTROL SOURCE at zero, turn ATE "on".
3) Vary the EXT. CONTROL SOURCE from zero to 10 volts. The ATE output voltage, as read out on M1, should vary approximately from zero voltage to the rated value. Return the EXT. CONTROL SOURCE to zero.

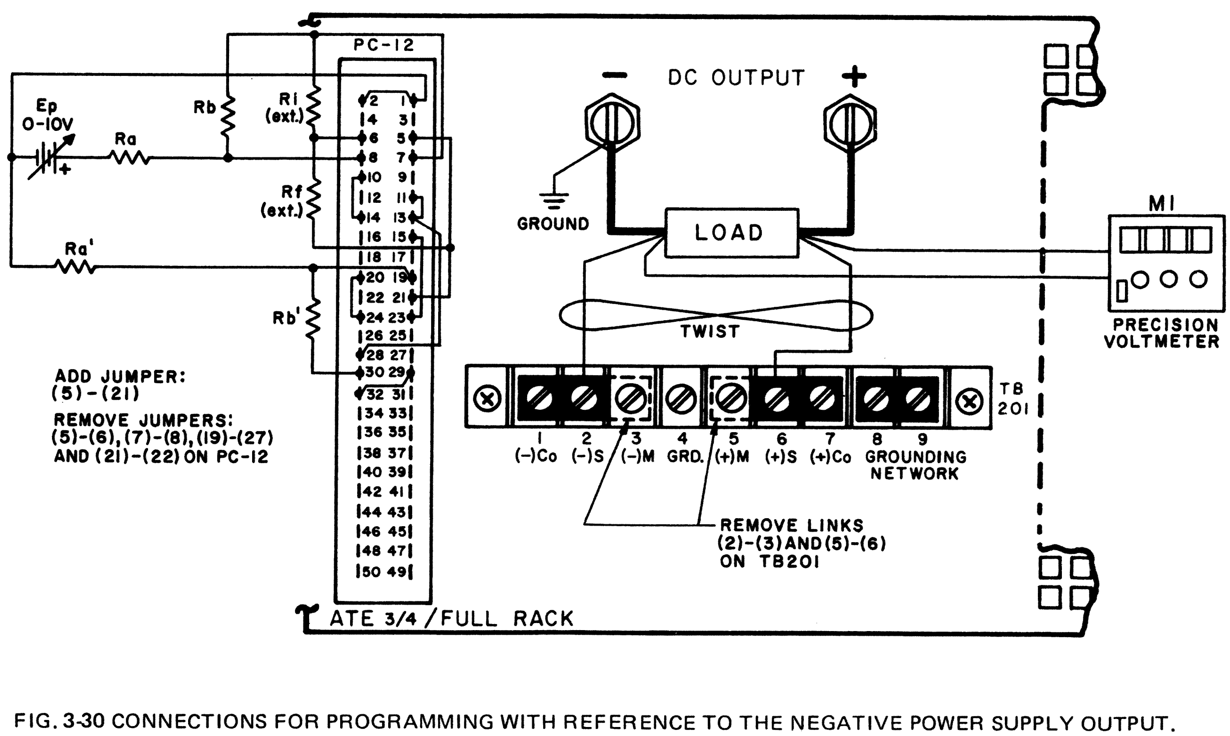


FIG. 3-30 CONNECTIONS FOR PROGRAMMING WITH REFERENCE TO THE NEGATIVE POWER SUPPLY OUTPUT.

3-121 APPLICATION OF THE ISOLATED FLAG SIGNALS

3-122 Two opto-isolated flag signals are provided at the rear programming connector (PC—12). One of them signals the ATE operating mode (Voltage or Current Mode), the other one provides a signal to indicate that the ATE crowbar has been tripped. Both flag signals consist of the Collector/Emmitter terminals of a Photo-Transistor Optical Isolator and change their impedance from high to low if activated. The ATE flag signals may be converted to TTL logic signals as indicated in FIG. 3-31. The photo transistors are capable of sinking at least one (1) standard TTL load (1.6mA). Since the crowbar flag signal is followed by the shut-down of the ATE power supply, the flag signal is the form of a pulse, rather than a permanent level shift.

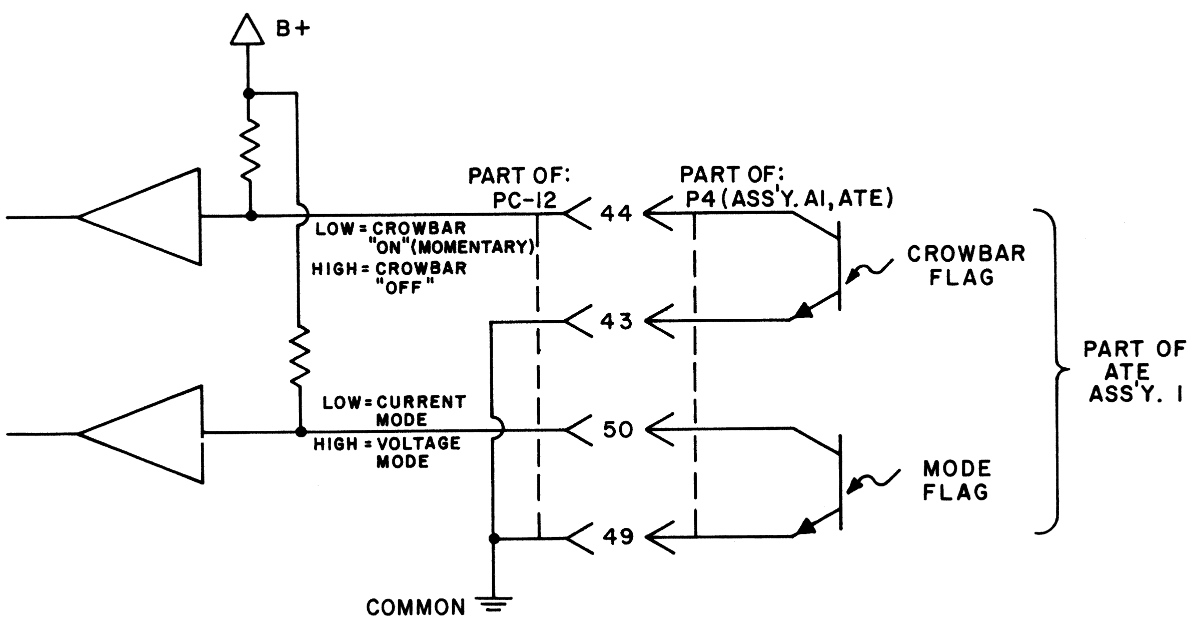


FIG. 3-31 ISOLATED FLAG SIGNAL OUTPUTS.

SECTION IV – THEORY OF OPERATION

NOTE: References in CAPITAL LETTERS refer to the nomenclature used in FIG.'s 4-1 through 4-7.

4-1 SIMPLIFIED DIAGRAM DISCUSSION. REFER TO THE "FOLD-OUT" DRAWING (FIG. 4-6) AT THE END OF THIS SECTION.

4-2 The ATE power supply is basically a voltage and current stabilized d-c source with a sharp crossover between the voltage and the current mode of operation. A linear series PASS ELEMENT is controlled by either the current control channel or the voltage control channel and provides excellent stabilization and fast response in either operating mode. The operating mode of the ATE is determined by the value of the front panel adjusted (or externally controlled) ATE output voltage (E_O) and output current (I_O) and by the magnitude of the load resistance (R_L). The "crossover" resistance (R_{LX}) is given by Ohm's Law:

$$R_{LX} = E_O/I_O \text{ (See FIG. 4-1).}$$

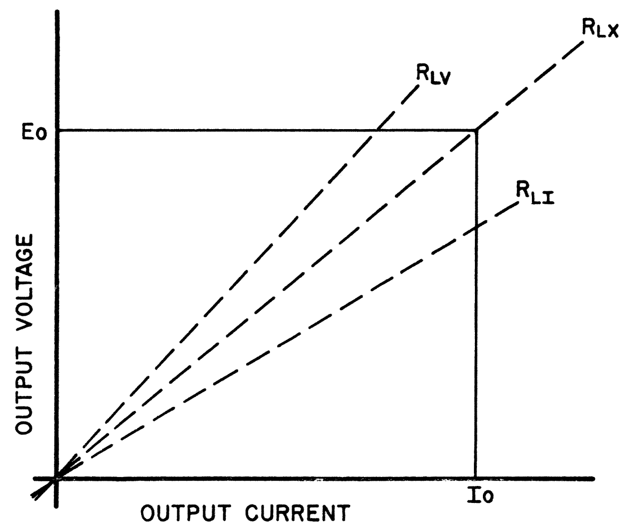


FIG. 4-1 CROSSOVER CHARACTERISITICS, ATE POWER SUPPLY.

4-3 Any load resistance, ***smaller*** than R_{LX} (as for example R_{LI} in FIG. 4-1) will transfer the ATE into the "Current Mode." With a load resistance ***larger*** than R_{LX} (as for example R_{LV} in FIG. 4-1), the ATE will operate in the "Voltage Mode."

4-4 In the voltage mode of operation, the VOLTAGE-COMPARISON AMPL. senses any change in the output voltage by comparing it to a reference potential, developed by the VOLTAGE CONTROL AMPL. (See FIG. 4-2).

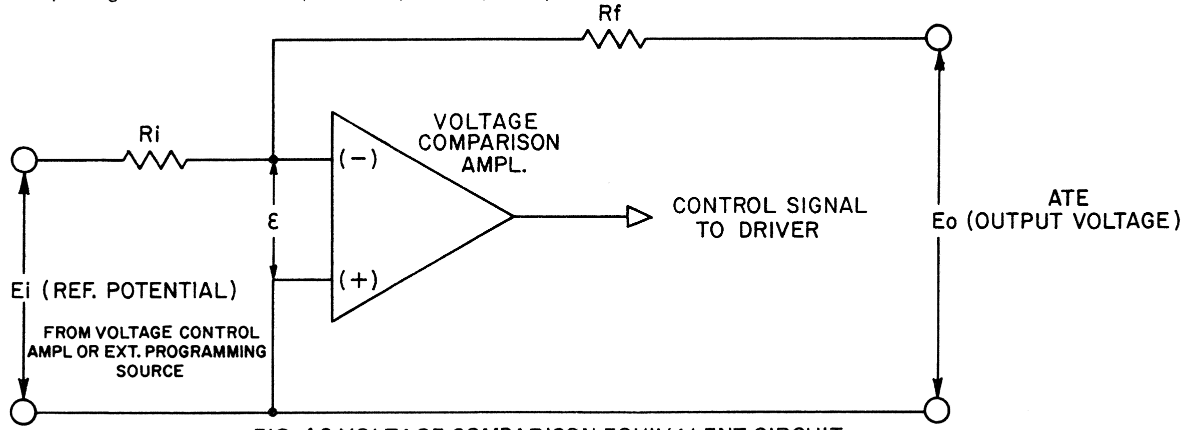


FIG. 4-2 VOLTAGE COMPARISON EQUIVALENT CIRCUIT.

4-5 A condition of balance exists if: $E_O/R_f = E_i/R_i$, and $\epsilon \to 0$. A change in either "E_i" or "E_O" in the balance equation produces an error signal which, amplified by the VOLTAGE COMPARISON AMPL. becomes a control signal for the DRIVER STAGE. The control signal is applied, via the DRIVER stage, to the PASS ELEMENT which increases or decreases its conductance in response to the DRIVER signal as required to maintain the output voltage at the desired value.

4-6 In the current mode of operation, the CURRENT-COMPARISON AMPL. senses any change in the output current by comparing an amplified sensing voltage to a reference potential, developed by the CURRENT-CONTROL AMPL. (See FIG. 4-3).

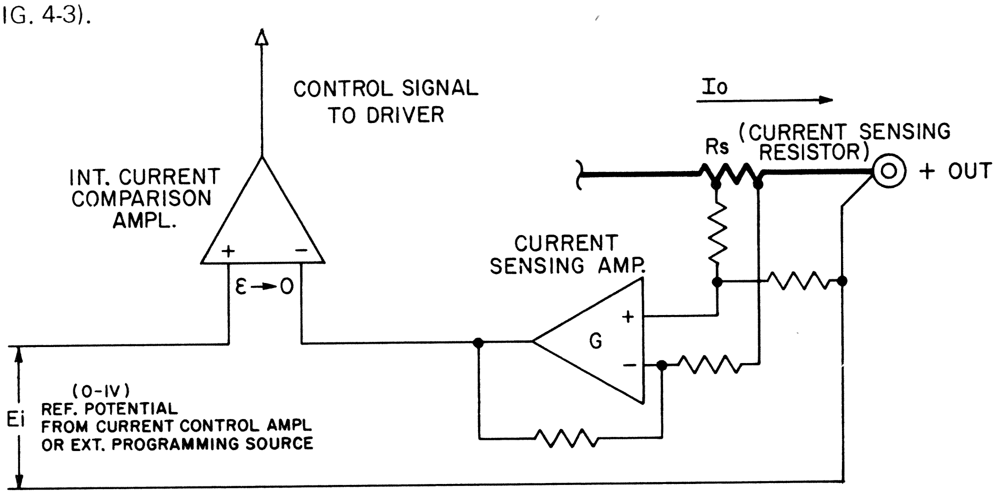


FIG. 4-3 CURRENT COMPARISON EQUIVALENT CIRCUIT.

4-7 The current sensing voltage is derived across the CURRENT SENSING RESISTOR (R_S), in series with the (+) output lead, and is proportional to the flow of output current. The sensing voltage sample across R_S is amplified differentially by the CURRENT SENSING AMPL. and applied, together with the reference potential from the CURRENT CONTROL AMPL. at the differential input of the INT. CURRENT COMPARISON AMPL. A condition of balance extists, if:

$$(G)I_O\, R_S = E_i \text{ and } \epsilon \to 0.$$

A change in either "E_i" or "I_O" in the balance equation produces an error signal which, amplified by the CURRENT COMPARISON AMPL., becomes a control signal for the DRIVER STAGE. The control signal is applied via the DRIVER STAGE to the PASS ELEMENT, which increases or decreases its conductance in response to the driver signal as required to maintain the output current constant and vary the output (compliance) voltage proportionally.

4-8 The internal feedback components in the voltage, as well as in the current control channel of the ATE are selected for each ATE model such that a 0 to 10 volt d-c signal, applied to the VOLTAGE COMPARISON AMPL. or 0–1 volt to the CURRENT COMPARISON AMPL. control the full output range for each ATE model. For local (front panel) control of the ATE output quantities a CONTROL AMPLIFIER is used in a similar manner for the voltage as well as for the current channel. (See FIG. 4-4) to produce the required 0–10V or 0–1V control signal.

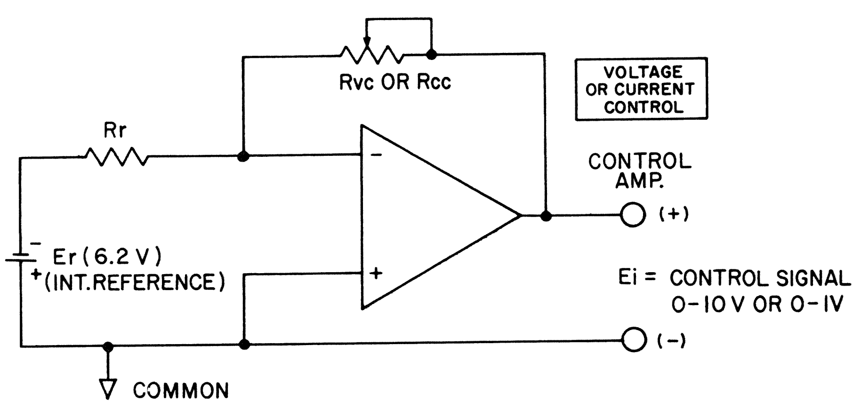


FIG. 4-4 GENERATION OF THE INTERNAL CONTROL SIGNAL FOR THE ATE VOLTAGE AND CURRENT CHANNELS.

4-9 To produce the internal 0–10V or 0–1V control signals (E_i), an operational amplifier is used in the inverting configuration as shown in FIG. 4-4. The output equation for the circuit is $E_i = E_r (R_{vc}/R_r)$.

4-10 External control over the voltage and/or current channel of the ATE can be exercised by disconnecting the internal control channel at the REAR PROGRAMMING CONNECTOR (PC–12) and substituting an external control signal (0–10V or 0–1V for Voltage or Current control over the specified output ranges). Programming examples are given in Section III of this manual.

4-11 Two independent preamplifiers (PREAMP "A", PREAMP "B") are provided in the ATE with all their input/output terminations accessible at the REAR PROGRAMMING CONNECTOR (PC–12). These preamplifiers may be used for a variety of tasks, for example, to boost and/or invert an external programming signal to the required 0 to 10 volt level (Voltage Channel) or 0–1 volt (Current Channel).

4-12 PROGRAMMABLE OVERVOLTAGE PROTECTOR, SIMPLIFIED DIAGRAM DISCUSSION (REFER TO THE "FOLD-OUT" DRAWING FIG. 4-7 AT THE END OF THIS SECTION).

4-13 The ATE overvoltage protector monitors the output voltage at the (±) SENSE terminals. A portion of the output voltage is continuously compared at the differential input of the OVERVOLTAGE COMPARATOR to a reference voltage, produced by the OVERVOLTAGE REFERENCE AMPL. The circuit is inactive as long as the output voltage sample stays below the reference voltage level at the input of the OVERVOLTAGE COMPARATOR. If an overvoltage occurs, this amplifier produces an output signal which turns the CROWBAR COMPARATOR "on" and this fires the AUXILIARY SCR. As a result, the diodes in the CROWBAR FLAG and the CROWBAR SIGNAL ISOLATORS conduct and produce an optical signal to their associated circuit elements. The CROWBAR SIGNAL ISOLATOR fires its SCR, which in turn produces the turn-on pulse for the MAIN SCR. The CROWBAR FLAG ISOLATOR simultaneously produces a flag signal via its associated photo transistor. In addition, the CIRCUIT BREAKER, the coil of which is also in series with the AUXILIARY SCR, removes the a-c power from the ATE input.

4-14 The crowbar level may be adjusted locally by the provided CROWBAR LEVEL front panel control, or it may be externally controlled by means of a 0–10 volt d-c signal. For internal control, the crowbar level is produced by the OVERVOLTAGE REFERENCE AMPL. and the internal REFERENCE SOURCE (SEE FIG. 4-5).

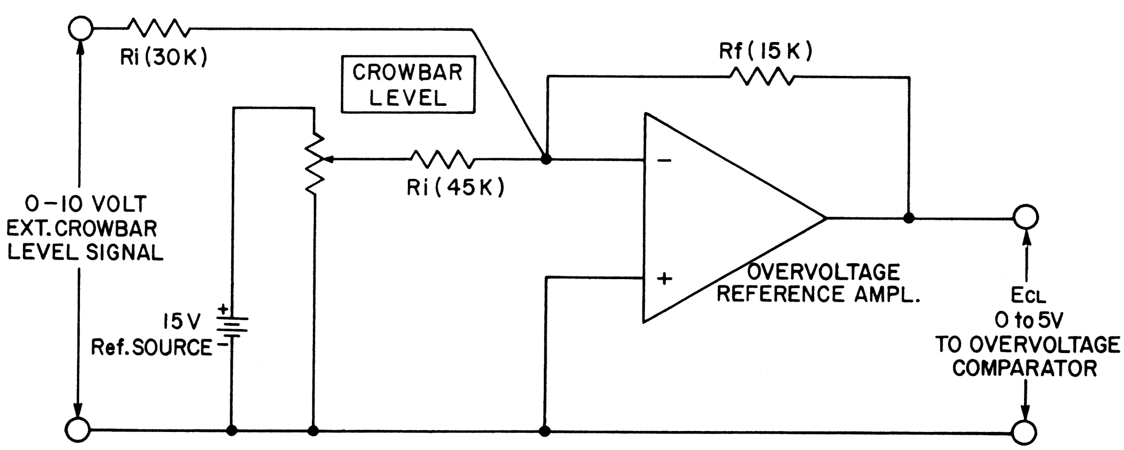


FIG. 4-5 GENERATION OF THE INTERNAL CROWBAR LEVEL SIGNAL.

4-15 An operational amplifier (OVERVOLTAGE REFERENCE AMPL.) is used in an inverting configuration, as shown in FIG. 4-5. The output equation for this circuit is: $E_{CL} = E_r (R_f/R_i)$. Inserting circuit values from FIG. 4-5:

$$E_{CL} = (0\text{–}15V)\ 15K\ ohm/45K\ ohm = 0\ to\ 5\ volt$$

4-16 For external control by means of a 0 to 10 volt signal, the result is:

$$E_{CL} = (0\text{–}10V)\ 15K/30K = 0\ to\ 5\ volt$$

Since the external and internal crowbar levels are summed at the inverting input of the OVERVOLTAGE REFERENCE AMPL., the front panel CROWBAR LEVEL control must be turned to zero if its influence is not desired. The external 0 to 10 volt signal is applied to the OVERVOLTAGE REFERENCE AMPL. via the OVERVOLTAGE TRACKING DELAY CIRCUIT, consisting of two voltage followers (GAIN = 1) and RC network. This delay circuit has the function of preventing false triggering when the overvoltage protector is used in the "tracking mode" (programmed simultaneously with the voltage channel). Without the delay, the overvoltage protector would interpret a fast falling output voltage step as an overvoltage.

4-17 A variety of inputs and outputs to and from the overvoltage protector circuit are provided via the rear PROGRAMMING CONNECTOR (PC—12). Their use has been described in the operating section (Section III) of this manual.

4-18 A front panel CROWBAR light, triggered by the AUXILIARY SCR, indicates when the ATE is in the crowbar condition. A front panel DISARM push-button is provided to facilitate setting of the crowbar level. The depressed DISARM button prevents the MAIN SCR from firing if the CROWBAR LEVEL is inadvertently misadjusted.

4-19 CIRCUIT DESCRIPTION (Refer to MAIN SCHEMATIC DIAGRAM, SECTION VI)

NOTE: MAIN SCHEMATIC NOMENCLATURE IS CAPITALIZED IN THESE PARAGRAPHS.

4-20 For the purpose of analysis, the circuitry of the ATE Power Supply may be divided into several sections which are individually described below.

a) A-C INPUT CIRCUIT. A-C line power is introduced through the (detachable) 3-wire line cord with safety plug. The use of a grounded a-c power outlet will automatically ground the power supply, since the third wire of the line cord is directly connected to the metal chassis and case. Once the a-c power switch/circuit breaker (CB101) is closed, the primary of the main transformer (T201) and the fan (B201)(1) will be energized. The two primary windings of the main transformer are tapped and either connected in parallel (for 104 or 115V a-c nominal line voltage) or in series (for 208 or 230V a-c nominal line voltage) and can be connected for the prevailing a-c input source voltage by means of removable links on the transformer barrier strip. The circuit breaker/power switch (CB101) protects the power supply from overcurrents reflected into the primary winding of T201 and shuts off automatically if the overvoltage crowbar circuit is activated. The current sensing coil of CB101 is connected in such a way that equal protection is provided on any a-c input source voltage.

b) MAIN D-C SUPPLY. The main d-c power is derived from a center-tapped secondary winding on T201. A full-wave rectifier circuit with silicon diodes CR201, CR202 (located on their own heat sink assembly) works into a capacitor input filter (C204. . .C20. . ., number of filter capacitors depending on ATE model, see Main Schematic in Section VI), paralleled by a bleeder resistor (R201). The main d-c supply delivers the output current through the series regulator or pass elements.

c) SERIES REGULATOR (PASS ELEMENTS). The series regulator transistors (Q301, 302. . .number of pass elements depends on ATE model number) are NPN silicon devices, located on a specially constructed heat sink (A3) and cooled by a fan (B201)(1). Electrically, these pass transistors are connected in series with the (unregulated) main d-c supply and the output. The effective series resistance of the pass transistors (and thereby the voltage drop across them) is changed in such a way as to keep either the output voltage (VOLTAGE MODE) or the output current (CURRENT MODE) constant, regardless of variations in the unregu-ated main supply or changes in load conditions. The base drive needed to affect this change in the pass transistors is supplied by the main DRIVER, also located on the heat sink assembly (See Main Schematic, Section VI).

d) VOLTAGE CONTROL CHANNEL. The VOLTAGE COMPARISON AMPL. (IC3) senses the ATE output voltage at the (±) OUTPUT SENSING terminals. A portion of the output voltage is applied via the feedback resistor (R50) to the (+) input of IC3 and compared with either the internal control potential (via R69, PC—12 pin 21, 22 connected) or an external reference (control signal (PC—12 pins 21, 22 open, signal + to pin 21 with reference to pin 26). Internally, the control potential (0—10 volts) is produced by the VOLTAGE CONTROL AMPL. (1/4 IC2) in combination with the negative reference and the required input and feedback resistors (R19 and R101 VOLTAGE CONTROL). By varying the front panel VOLTAGE CONTROL (R101), the internal control potential changes from 0 to 10 volts, while the output voltage is controlled from 0 to its maximum rated value for the individual ATE model. An external 0 to 10 volt potential, applied to PC—12 pin 21 (JUMPER BETWEEN PINS 21, 22 removed) and PIN 26 will exercise similar control over the output voltage.

(1) ATE full-rack group has two fans, B201, B202 and two heat sink assemblys, A3 and A4, with transistors Q301, 302. . ., Q401, 402. . .number of transistors depending on the ATE model.

e) CURRENT CONTROL CHANNEL. The current sensing resistor (R203) in series with the (+) output lead, monitors the output current at all times. The voltage drop across R203, proportional to the output current, is amplified by the CURRENT SENSING AMPL. (IC4), applied to the (-) input of the INTERNAL CURRENT COMPARISON AMPL. (1/4 IC2) and compared to the reference (control) signal from the CURRENT CONTROL AMPL. (1/4 IC2). The current control signal (0 to 1 volt) is produced by the CURRENT CONTROL AMPL. (1/4 IC2) in combination with the NEGATIVE REFERENCE and the input and feedback resistors (R18, R20, R102 CURRENT CONTROL). By varying the front panel CURRENT CONTROL (R102), the internal control signal changes from 0 to 1 volt, while the output current is controlled from zero the maximum rated value for the individual ATE supply. An external (0–1 volt) control signal applied to the REAR PROGRAMMING CONNECTOR (PC–12 pin 15 to pin 26 (common) JUMPER 15, 23 REMOVED) will similarly exercise full range control over the output current. The external signal is applied to the input of a separate amplifier (EXTERNAL CURRENT COMPARISON AMPL., 1/4 IC5) which is connected together with the INTERNAL CURRENT COMPARISON AMPL., (1/4 IC2) to the exclusive OR gate consisting of diodes CR11 through CR14.

f) Two separate preamplifiers (IC8 - PREAMP "A", IC9 - PREAMP "B") are provided in the ATE with their input/output connections terminated at the REAR PROGRAMMING CONNECTOR (PC–12) pins 7, 8, 19 - PREAMP "A", pins 5, 6, 20 - PREAMP "B"). The preamplifier inputs are protected by fast acting signal diodes (CR31 through CR38) and are equipped with their own offset zeroing controls accessible through the ATE top cover (R67 - PREAMP "A", R68 - PREAMP "B"): The preamplifiers are frequency compensated by means of a feedback capacitor (C27 PREAMP "A", C28 - PREAMP "B") and may be used for signal processing etc.

g) OVERVOLTAGE PROTECTOR CIRCUIT. The OVERVOLTAGE COMPARATOR (IC7) compares a sample of the ATE output voltage (via R47, R48) to the reference voltage from the OVERVOLTAGE REFERENCE AMPL. (1/4 IC5). The circuit is inactive, as long as the output voltage sample stays below the reference level at the (+) input of IC7. If an overvoltage occurs (either from internal power supply failure or from an operator's error) the OVERVOLTAGE COMPARATOR (IC7) produces an output signal resulting in the following simultaneous events:

1) The crowbar comparator (IC6) is turned "on", fires the auxiliary SCR (CR26) via Q7 and energizes the front panel CROWBAR indicator (DS101).

2) The light emitting diode in the crowbar flag isolator (LC2) and the crowbar signal zener (CR43) are energized and produce a signal, available at the REAR PROGRAMMING CONNECTOR (PC–12). The crowbar signal isolator (LC1) fires its SCR, which in turn produces a turn-on pulse for the main SCR (CR204).

3) The voltage sensing coil of the main circuit breaker (CB101) is energized by the current through the conducting auxiliary SCR (CR26). As a result CB101 removes the a-c power from the ATE.

h) The reference level to which the output voltage sample is continuously compared, is adjustable through the ATE output voltage range by means of a front panel screwdriver control (CROWBAR LEVEL, R103). The crowbar level reference voltage is derived from a potentiometer (R103) across the (+)15V reference voltage. The 0 to 5 volt crowbar level is established by the OVERVOLTAGE REFERENCE AMPL. (1/4 IC5) and resistors R42, R43 and R45.

i) External control of the crowbar level by means of a 0 to 10 volt signal is performed via the REAR PROGRAMMING CONNECTOR (PC–12). The control signal is applied to the OVERVOLTAGE REFERENCE AMPL. (1/4 IC5) and summed with the internal crowbar level reference at the (-) input. In the tracking mode, the OVERVOLTAGE TRACKING DELAY CIRCUIT (1/2 IC5) is used. It consists of two voltage follower stages which impart a delay to the tracked programming voltage to avoid false triggering of the overvoltage protector circuit.

k) MODE INDICATORS and MODE FLAG. A pair of LED mode indicators on the front panel indicate either voltage mode or current mode of operation. The voltage mode indicator (DS102) and current mode indicator (DS103) are driven from transistors (Q5) and (Q6) respectively. Signals for the VOLTAGE INDICATOR DRIVER (Q5) are derived from the output of the VOLTAGE COMPARISON AMPL. (IC3) via R58 and CR27. When the ATE is operating in voltage mode, the voltage indicator driver will be placed into saturation causing the voltage MODE INDICATOR (DS102) to display and causing the current mode driver (Q6) to cut off. Operation in current mode (either internal or remote control) will cause the voltage indicator driver to cut off, allowing the current indicator driver to turn on and hence, the current mode indicator will energize. The MODE FLAG opto-isolator (LC3) derives its signal from the output of the current indicator driver (Q6) via R66. The MODE FLAG opto-isolator (LC3) transfers the input information from the current indicator driver and presents an isolated flag signal at the MODE FLAG terminals on the REAR PROGRAMMING CONNECTOR (PC—12). In the voltage mode of operation, the phototransistor is off and in the current mode of operation, the phototransistor is in saturation.

i) AUXILIARY SUPPLIES

1) AMPLIFIER POWER SUPPLY. This d-c source is derived from one of the secondary windings on the auxiliary transformer (T202). A bridge rectifier (CR3) and a capacitor filter (C3) provide the unregulated d-c voltage. A voltage regulator stage, consisting of the REFERENCE REGULATOR (IC1) and the pass transistor (Q1) with their associated components (R4, R5, R7, R8, R9, C6) generates the regulated positive 15 volt potential, while the negative 15V potential is established by the zener diode (CR6). The ±15 volt supply is filtered by C8, C9. From this dual (±) 15 volt supply, which provides the operating potential for IC's 2 through IC9, another (±) 12 volt source is derived via zener diodes CR7, CR8 and dropping resistors R13, R14. The dual 12 volt supply is used to terminate the protective input diodes of the two PRE-AMPLIFIERS (CR31 through CR38) and those of the EXT. CURRENT COMPARATOR (CR17, 18, 19, 21). This method of amplifier input protection allows common mode programming signals of 0—10 volts to be used. Finally, the (+) 6.2 volt reference source (CR5) is similarly derived from the (+) 15 volt source, via dropping resistor R10. The negative reference potential is developed by the NEGATIVE REFERENCE amplifier (1/4 IC2) with input resistor R15 and feedback resistor R17. This reference source constitutes the internal reference potential for the VOLTAGE and CURRENT CONTROL AMPLIFIERS. The (±) 6.2 volt reference sources are terminated at the REAR PROGRAMMING CONNECTOR (PINS 17, 18) while the (±) 15 volt source is available at pins 23, and 25.

2) PRE-DRIVER COLLECTOR SUPPLY. A bridge rectifier (CR2) and capacitor filtered (C4) d-c source is derived from a secondary winding on T202, to supply the collector voltage for pre-driver stage (Q3).

3) RETURN AND AUXILIARY SCR SUPPLY. This bridge rectifier (CR1) and capacitor filtered (C1, C2) dual auxiliary supply is derived from the center-tapped secondary winding on T202. The negative auxiliary source serves, via the constant current stage (Q2) as a sink for the I_{cbo} currents of the DRIVER and the pass elements in assembly A3. The positive auxiliary source supplies the operating current (via R12) for the photo SCR (LC1).

m) METERING CIRCUIT. Both output voltage and output current are monitored by front panel meters M101, M102). While the output voltage is measured directly across the error sensing terminals, the output current is measured indirectly as a voltage drop across the current sensing resistor (R203).

SECTION V – MAINTENANCE

5-1 GENERAL

5-2 This section covers maintenance procedures, installation of optional components, calibration and test measurements of the Kepco ATE Power Supplies. Conservative rating of components and the noncongested layout should keep maintenance problems to a minimum. If trouble does develop, however, the easily removed wrap-around cover and the plug-in feature of the circuit boards provide exceptional accessibility to all components of the supply.

5-3 DISASSEMBLY (Refer to FIG. 5-1)

a) COVER REMOVAL. The wrap-around cover may be taken off by loosening and removing its (14) holding screws, (6) on each side and (2) on the top at the rear.

b) CIRCUIT BOARD REMOVAL. The printed circuit board is mounted with (4) screws. After removal of the screws and the (3) printed circuit board connectors, the board may be lifted from the chassis assembly.

c) HEAT SINK REMOVAL. The heat sink assembly is mounted with (4) screws to the chassis bottom. After the screws are taken out, the wiring may be removed by means of the printed circuit board connectors.

d) RE-ASSEMBLY. Re-assembly of all components takes place in reverse order of the above described procedures.

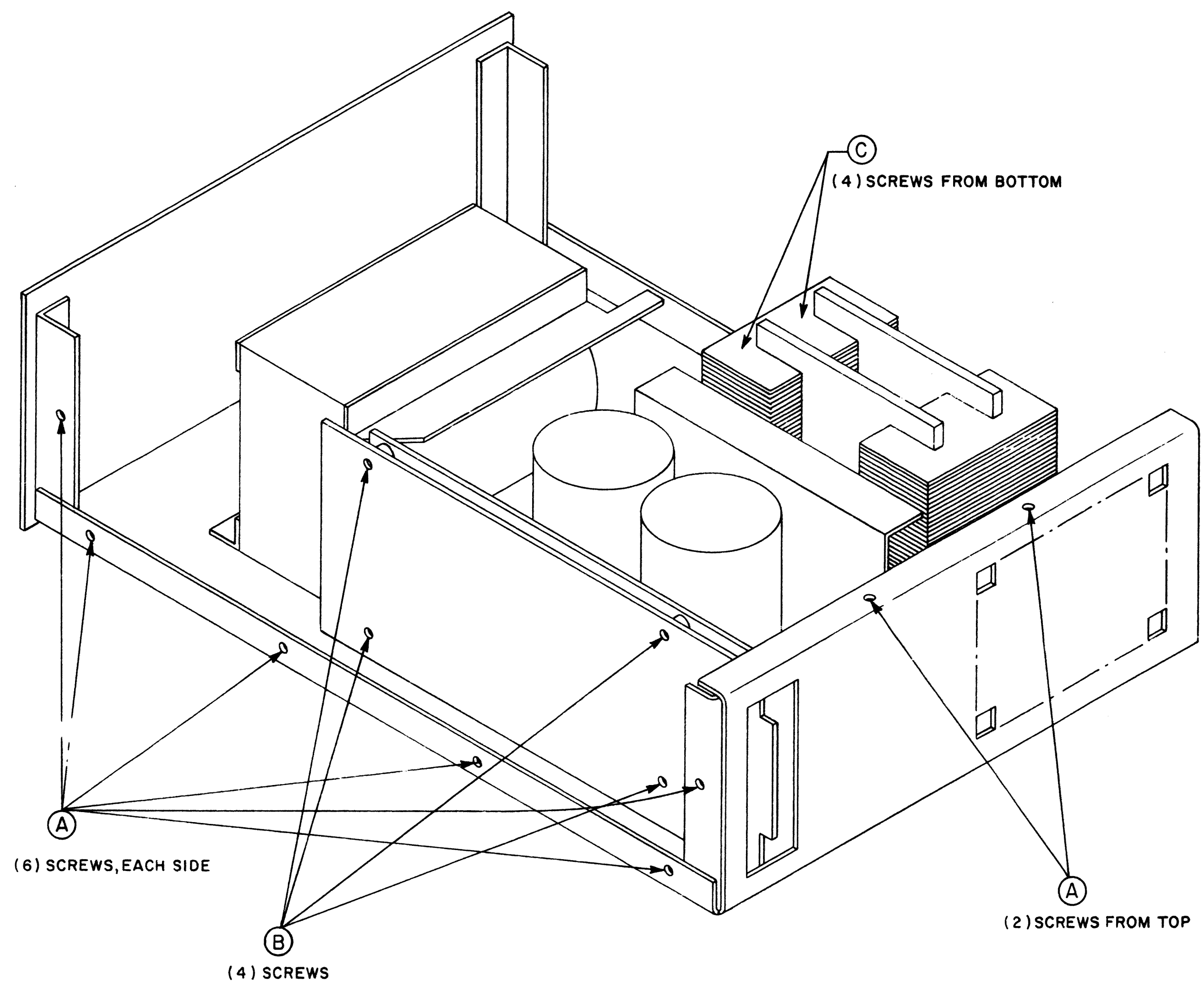


FIG. 5-1 DISASSEMBLY, ATE 3/4 RACK GROUP.

5-4 INTERNAL ADJUSTMENT PROCEDURES

5-5 All available internal controls are located on the MAIN AMPLIFIER ASSEMBLY (A1) and are accessible through the top cover of the ATE (See Section II, FIG. 2-1). The practical use of the individual controls has been described for several applications, in the "CALIBRATION" paragraph of each application. (See Section III of this manual). The following paragraphs summarize the function of ***all*** internal controls.

5-6 PREAMP ZERO CONTROLS (R67, 68). These controls are factory-set to zero output from each preamplifier, with zero input signal. When using one or both of the preamplifiers of the ATE, the zero controls can be used to establish zero output from an external programming source, if the latter does not have a zeroing control.

5-7 I_O and E_O ZERO CONTROLS (R30, 35). These controls are factory-set to zero output from the ATE, with the front panel CURRENT and VOLTAGE controls set to their maximum counterclockwise position. In programming applications, when the ATE is controlled by external means, these controls can be used to establish zero output, with the external programming source at zero.

5-8 LAG NETWORK ADJUSTMENTS. A dynamic stability control in the form of a lag network (connected for fast mode operation only) has been provided in the voltage channel of this power supply (R27, "E_O LAG" see FIG. 2-1 for location). This network has been factory-adjusted for maximum amplifier stability when operating in the fast mode and into a resistive load. Re-adjustment is indicated if components affecting the dynamic characteristics of the amplifier must be replaced, or if the load connected to the power supply contains excessive capacity or inductance, causing instability. Dynamic instability is usually indicated by high frequency oscillation observed with an oscilloscope across the power supply load. In such cases, the lag network should be adjusted so that stable operation is resumed. If, in extreme cases, adjustment of the lag network should not prove sufficient, twisted load and error-sensing wire pairs, or decoupling capacity directly across the load, may provide a solution to the problem. The current channel does not require an adjustable lag control.

5-9 TROUBLE SHOOTING

5-10 Modern, high performance power supplies have reached a state of sophistication which requires thorough understanding of the problems involved in repairing complex, solid-state circuitry. Servicing beyond simple parts replacements should consequently be attempted only by personnel thoroughly familiar with solid state component techniques and with experience in closed-loop circuitry.

5-11 Trouble shooting charts, showing resistance and voltage readings, are of very limited usefulness with feedback amplifiers and are not included here. Instead, a detailed circuit description (Section IV), parts location diagrams, simplified functional schematics and a main schematic with all significant voltage readings are presented.

5-12 The following basic steps in case of power supply malfunctioning may be found helpful:

a) NO OUTPUT:

1) If power supply does not function at all, check obvious points first. Check a-c input source connections, a-c input source voltage and frequency. (Normally the power supply is delivered for 115V a-c service).

2) Connect rear links on barrier strip TB201 for local sensing, see Section III, FIG. 3-2.

3) Check if current control has been inadvertently misadjusted. Turn current control to its maximum ***clockwise*** position.

4) Check the mating of the programming connector (PC—12) with the PC board at the rear of the ATE. Check for correct jumper positions on PC—12 for the application at hand.

5) Check the mating of all printed circuit connectors with their printed circuit card.

6) Check indicated voltage readings on the main schematic, check transistors and start circuit analysis with the help of Section IV.

b) HIGH OUTPUT: Checks number (4), (5), and (6) are also applicable for this condition. In addition, check the following:

1) Test main DRIVER transistor and pass transistors. Refer to the Main Schematic Diagram in Section VI. Turn ATE off. Remove pre-driver transistor (Q3) from the Control Assembly (A1, see Section VI, FIG. 6-2 for location). Turn ATE on. If the ATE output is now zero, the pass element section is functioning. Concentrate trouble shooting on the Control Assembly (A1). Look for burned components, check small signal transistors and IC's either by successive replacement or by using an appropriate test instrument. Replace defective components.
2) If the ATE output voltage is not zero after Q3 has been removed, the possible cause is a shorted pass or driver transistor in the pass element assembly (A3). Note: Full Rack ATE models have two pass element assemblies, A3 and A4. The power transistors may be checked by means of an ohmmeter if a transistor tester is not available. Polarity reversal of the ohmmeter leads should procude an approximate 1:4 resistance ratio on functioning power transistors. Replace transistors with listed types only (See Parts List, Section VI).

c) POOR PERFORMANCE:

1) Excessive output variations are often due to incorrectly connected loads or faulty measurement techniques. Perform measurements only as direct in PAR. 5-13 and follow the connection diagrams.
2) High frequency oscillations at the output are often due to improperrly adjusted lag networks (see Par. 5-8) ***or*** to loads with large inductive or capacitive components and/or long load wires. Tightly twisted load wires of sufficient diameter and kept as short as possible are often the solution to the problem. In extreme cases, decoupling DIRECTLY AT THE LOAD with appropriate capacitance should be applied.
3) High ripple at the output or at the load may be caused by ground loops or long load wires passing through magnetic fields. Grounding of one side of the output and careful lead dressing are often helpful, refer to Section III, par. 3-6 for more grounding information.

d) KEPCO Field Engineering Offices or the KEPCO Applications Engineering Department are always available for consultation or direct help in difficult service or applications problems.

5-13 POWER SUPPLY MEASUREMENTS

5-14 Output effect measurements (regulation measurements) in the voltage or current mode of operation and output ripple measurements are an excellent indication of the power supply's d-c performance and may be performed with a minimum of instrumentation. Since these measurements require special techniques to insure correct results, suggestions for their performance are given below.

a) Required instrumentation.

1) Constant a-c input source voltage with provisions for "stepping" the voltage over the specified region (105—125V). A variable autotransformer is generally adequate if it is rated to deliver the input current of the unit under test.
2) Resistive load, variable, and capable of dissipating the full output power of the unit under test, equipped with on/off and shorting switch.
3) D-C voltage monitor, differential voltmeter or power supply analyzer.
4) A-C ripple monitor, true rms meter, sensitivity better than 1 mV.
5) Optional: Oscilloscope, vertical sensitivity better than 0.1 mV/cm, bandwidth > 10MH.

b) The proper location of the instrument leads when measuring output effects in response to a-c input source changes or load variations is of the utmost importance. Improperly placed leads may measure voltage drops due to contact resistance and load current flow and thus lead to incorrect results. FIG's. 5-2A and 5-2B show clearly how to employ "4-terminal network techniques" when measuring output effets. The principle is very simple but important: ***Do not measure voltage drops due to load current.***

c) Output effects due to source or load variations in the voltage mode of operation are defined as the amount of output voltage change resulting from a specified change in a-c input source voltage or from a change in load resistance. These output effects can be expressed as an absolute change (ΔE_O) or as a percentage in reference to the total output voltage E_O:

$$\%\ \text{Output Effect} = \frac{\Delta E_O}{E_O}\ (100\%) \quad \text{(Eq 1).}$$

USE THE TEST SET-UP SHOWN IN FIG. 5-2. Vary the a-c input ***or*** the load over the specified limits and note the deviation (ΔE_O) on the instrument (M1). Calculate output effects by means of the equation (Eq. 1) above.

d) Output effects due to source or load variations in the current mode of operation are defined as the amount of output current change resulting from a specified change in a-c input source voltage or from a change in load resistance. The output effects can be expressed as an absolute change (ΔI_O) or as a percentage in reference to the total output current I_O:

$$\%\ \text{Output Effect} = \frac{\Delta I_O}{I_O}\ (100\%) \quad \text{(Eq. 2)}.$$

USE THE TEST SET-UP SHOWN IN FIG. 5-2B. Vary the a-c input ***or*** the load over the specified limits and note the deviation (ΔV_{RM}) on the instrument connected across the measuring resistor (M1 across R_M in FIG. 5-2B). The change in output current is equal to: $\Delta I_O = V_{RM}/R_M$. Insert value of ΔI_O into the equation (Eq. 2) above and calculate the output effects.

e) RIPPLE: Rms ripple may be monitored on a true rms reading instrument connected parallel to the instrument measuring the output effects. Careful wire dressing and shielding, as well as good a-c grounding, are of the utmost importance if valid measurements are expected. An oscilloscope may be used for p-p readings of noise and ripple. An approximate rms reading can be calculated from the p-p reading of the ripple displayed on the oscilloscope, if the reading is divided by three.

SECTION VI—ELECTRICAL PARTS LIST AND DIAGRAMS

6-1 GENERAL

6-2 This section contains the main schematic, the parts location diagrams, and a list of all replaceable electrical parts. All components are listed in alpha-numerical order of their reference designations. Consult your Kepco Representative for replacement of parts not listed here.

6-3 ORDERING INFORMATION

6-4 To order a replacement part or to inquire about parts not listed in the parts list, address order or inquiry either to your authorized Kepco Sales Representative or to:

KEPCO, INC.
131-38 Sanford Avenue
Flushing, N.Y. 11352

6-5 Specify the following information for each part:

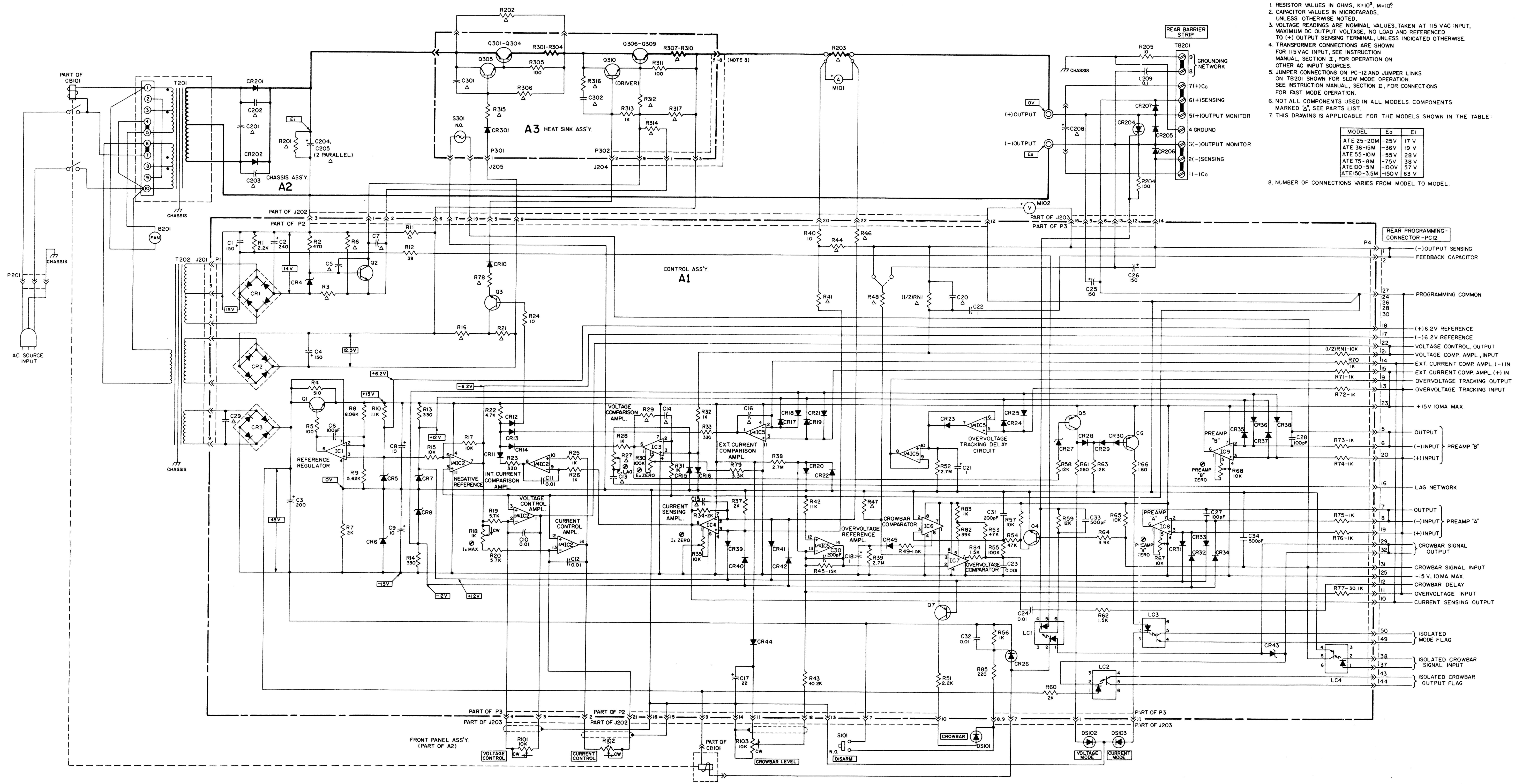
a) Model and complete serial number of instrument.
b) Kepco part number.
c) Circuit reference designator.
d) Description.

6-6 To order a part not listed in the parts list, give a complete description and include its function and location.

NOTE: KEPCO DOES NOT STOCK OR SELL COMPLETE POWER SUPPLY SUBASSEMBLIES AS DESCRIBED HERE AND ELSEWHERE IN THIS INSTRUCTION MANUAL. SOME OF THE REASONS ARE LISTED BELOW:

1) Replacement of a complete subassembly is a comparatively rare necessity.
2) Kepco's subassemblies are readily serviceable, since most of them are of the "plug-in" type.
3) All active componets are socket mounted, making replacement extremely easy.
4) The nature of a closed-loop power supply system requires that subassembly replacement is followed by careful measurement of the total power supply performance. In addition, depending on the function of the subassembly, extensive alignment may be required to restore power supply performance to specified values.

IF REPAIRS INVOLVING SUBASSEMBLY REPLACEMENTS ARE REQUIRED, PLEASE CONSULT YOUR LOCAL KEPCO REPRESENTATIVE OR THE KEPCO SALES ENGINEERING DEPARTMENT IN FLUSHING, NEW YORK, N.Y.



NOTES:

1. RESISTOR VALUES IN OHMS, $K=10^3$, $M=10^6$.
2. CAPACITOR VALUES IN MICROFARADS, UNLESS OTHERWISE NOTED.
3. VOLTAGE READINGS ARE NOMINAL VALUES, TAKEN AT 115 VAC INPUT, MAXIMUM DC OUTPUT VOLTAGE, NO LOAD AND REFERENCED TO (+) OUTPUT SENSING TERMINAL, UNLESS INDICATED OTHERWISE.
4. TRANSFORMER CONNECTIONS ARE SHOWN FOR 115VAC INPUT, SEE INSTRUCTION MANUAL, SECTION II, FOR OPERATION ON OTHER AC INPUT SOURCES.
5. JUMPER CONNECTIONS ON PC-12 AND JUMPER LINKS ON TB201 SHOWN FOR SLOW MODE OPERATION. SEE INSTRUCTION MANUAL, SECTION II, FOR CONNECTIONS FOR FAST MODE OPERATION.
6. NOT ALL COMPONENTS USED IN ALL MODELS. COMPONENTS MARKED "Δ", SEE PARTS LIST.
7. THIS DRAWING IS APPLICABLE FOR THE MODELS SHOWN IN THE TABLE:

MODEL	Eo	Ei
ATE 25-20M	-25V	17 V
ATE 36-15M	-36V	19 V
ATE 55-10M	-55V	28 V
ATE 75-8M	-75V	38 V
ATE 100-5M	-100V	57 V
ATE 150-3.5M	-150V	63 V

8. NUMBER OF CONNECTIONS VARIES FROM MODEL TO MODEL.

FIG. 6-3 MAIN SCHEMATIC DIAGRAM, MODELS: ATE 25-20M, ATE 36-15M, ATE 55-10M, ATE 75-8M, ATE 100-5M AND ATE 150-3.5M

ABBREVIATIONS USED IN KEPCO PARTS LISTS

A) Reference Designators:

C14 1 CAP, Ceramic, Disc 0.005 uF, 20%, 50V SPRAGUE TYPE 5GA-Z5U 117-0061 1 —

A	= Assembly	L	= Inductor
B	= Blower (Fan)	LC	= Light-Coupled Device
C	= Capacitor	M	= Meter
CB	= Circuit Breaker	P	= Plug
CR	= Diode	Q	= Transistor
DS	= Device, Signaling (Lamp)	R	= Resistor
F	= Fuse	S	= Switch
FX	= Fuse Holder	T	= Transformer
IC	= Integrated Circuit	TB	= Terminal Block
J	= Jack	V	= Vacuum Tube
K	= Relay	X	= Socket

B) Descriptive Abbreviations

A	= Ampere	MET	= Metal
a-c	= Alternating Current	n	= Nano (10^{-9})
AMP	= Amplifier	NC	= Normally Closed
AX	= Axial	NO	= Normally Open
CAP	= Capacitor	p	= Pico (10^{-12})
CER	= Ceramic	PC	= Printed Circuit
CT	= Center-Tap	POT	= Potentiometer
°C	= Degree Centigrade	PIV	= Peak Inverse Voltage
d-c	= Direct Current	p-p	= Peak to Peak
DPDT	= Double Pole, Double Throw	ppm	= Parts Per Million
DPST	= Double Pole, Single Throw	PWR	= Power
ELECT	= Electrolytic	RAD	= Radial
F	= Farad	RECT	= Rectifier
FILM	= Polyester Film	RECY	= Recovery
FLAM	= Flammable	REG	= Regulated
FP	= Flame-Proof	RES	= Resistor
°F	= Degree Fahrenheit	RMS	= Root Mean Square
FXD	= Fixed	Si	= Silicon
Ge	= Germanium	S-End	= Single Ended
H	= Henry	SPDT	= Single Pole, Double Throw
Hz	= Hertz	SPST	= Single Pole, Single Throw
IC	= Integrated Circuit	Stud Mt	= Stud Mounted
K	= Kilo (10^3)	TAN	= Tantalum
m	= Milli (10^{-3})	TSTR	= Transistor
M	= Mega (10^6)	μ	= Micro (μ) (10^{-6})
MFR	= Manufacturer	V	= Volt
		W	= Watt
		WW	= Wire Wound

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